UNIVERSITY OF CALIFORNIA

Santa Barbara

Total Synthesis of Bioactive Marine Natural Products Inspired by Enolate Chemsitry

&

Developments of New Haloalkylations via Soft Enolizations

A Dissertation submitted in partial satisfaction of the requirements for

the degree Doctor of Philosophy in Chemistry

by

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March 2015

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March 2015

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Curriculum Vitae

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2. Gu, Z.; Herrmann, A. T.; Stivala, C. E.; Zakarian, A. "Stereoselective Construction of Adjacent Quaternary Chiral Centers by the Ireland–Claisen Rearrangement: Stereoselection with Esters of Cyclic Alcohols" *Synlett* **2010**, *11*, 1717-1722
3. Gu, Z.; Herrmann, A. T.; Zakarian, A. "Dual Ti-Ru Catalysis in the Direct Radical Haloalkylation of *N*-Acyloxazolidinones" *Angew Chem Int. Ed*. **2011**, *50*, 7136-7139

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5. Herrmann, A. T.; Smith, L. L.; Zakarian, A. "A Simple Method for Asymmetric Trifluoromethylation of *N*-Acyl Oxazolidinones via Ru-Catalyzed Radical Addition to Zirconium Enolates" *J. Am. Chem. Soc.* **2012**, *134*, 6976-6979
6. Herrmann, A. T.; Alvarado, J.; Zakarian, A. "Stereoselective α–Fluorination of *N*-Acyloxazolidinones Room Temperature within 1 h." *J. Org. Chem.* **2014**, 79, 6206-6220.

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ABSTRACT

Total Synthesis of Bioactive Marine Natural Products

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Marine natural products have long served as promising compounds and scaffolds for new therapeutic agents; however, their utilization is often extremely limited due to poor availability from natural sources and their molecular complexity. Hence, synthetic investigation of utilizing innovative techniques offers shortcuts in the production of such agents and modification. Studies directed toward the synthesis of marine natural products and their scaffolds inspire the development of new, efficient, and economical methods that are useful for medicinal research and for the synthesis of new pharmaceuticals and organic compounds.

The first part of this dissertation focuses on the synthetic studies directed toward the synthesis of nuphar thiaspirane alkaloids. The main drive of this effort is to allow access to each of the four classes of nuphar thiaspirane alkaloids. During these studies, a new procedure for the generation of tetrasubstituted tetrahydrothiophenes

was developed. This method has been further applied for a late-stage Stevens rearrangement to generate each class of nuphar thiaspirane alkaloids from common intermediates.

The second part describes the total synthesis of the marine natural product (+)-brevisamide. The art and science of natural product total synthesis has become increasingly more associated with the various principles of the "economies" of synthesis. Evaluation of protecting group use serves as one metric of synthetic efficiency and can provide a framework for developing a synthesis plan. A new protecting-group-free synthesis of, the marine cyclic ether alkaloid, brevisamide was completed.

The third part describes the development of new and exciting chemical transformations revolving around haloalkylations of *N*-acyl oxazolidinones via Group IVa metal enolates by both radical and electrophilic methods. These studies include: mechanistic eludication of trichloromethylations, perfluoroalkylation and trifluoromethylation methodology development, and a generic α-fluorination method.

The final part describes a new procedure for the generation of *syn*-1,3-diols, which addresses both stereo- and regiocontrol in the rhenium catalyzed transposition of allylic alcohols.

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Chapter 3: Haloalkylation of *N*-Acyl Oxazolidinones via Group IVa Metal Enolates

List of Abbreviations

Abbreviation, symbol, or chemical formula	Term
9-BBN	9-borabicyclo[3.3.1]nonane
[α]	specific rotation
α	alpha
AcOH	acetic acid
aq.	Aqueous
$AgBF_4$	silver tetrafluoroborate
$AgClO_4$	silver perchlorate
AgOTf	silver triflate
$AuCl_3$	gold(III) chloride
β	beta
$BF_3 Et_2O$	boron trifluoride diethyl etherate
Bn	benzyl
BnBr	benzyl bromide
Boc	*tert*-butyl carbonate
Boc_2O	di-*tert*-butyl dicarbonate
br	broad
brsm	based on recovery of starting material
$BrCCl_3$	bromotrichloromethane
BSA	bis(trimethylsilyl)acetamide
Bu	butyl

Bu_4NI	tetrabutylammonium iodide
Bz	benzoate
BzCl	benzoyl chloride
°C	degrees Celsius
c	concentration
^{13}C	carbon 13
calcd	calculated
CBz	benzyloxycarbonyl
CCl_4	carbon tetrachloride
$CDCl_3$	deuterochloroform
C_6D_6	deuterobenzene
CD_3OD	deuteromethanol
$CF_3CO_2CH_2CF_3$	2,2,2-trifluoroethyl trifluoroacetate
$(CF_3CO)_2O$	Trifluoroacetic anhydride
CH_2Cl_2	dichloromethane
CH_2O	formaldehyde
CH_3CN	acetonitirile
$C_2H_4Cl_2$	1,2-dichloroethane
$(COCl)_2$	oxalyl chloride
CrO_3	chromium(III) oxide
CSA	camphorsulfonic acid
Cs_2CO_3	cesium carbonate

CuBr	copper(I) bromide
$CuBr \cdot Me_2Br$	copper(I) bromide dimethyl sulfide complex
CuCl	copper(I) chloride
$Cu(OAc)_2$	copper(II) acetate
δ	chemical shift(s)
d (NMR)	doublet
d (time)	days
DBU	1,8-diazabicyclo[5.4.0]undec-7-ene
DCE	dichloroethane
DDQ	2,3-dichloro-5,6-dicyano-*p*-benzoquinone
DHP	dihydropyran
DIPEA	di-*iso*-propylethylamine
DIBAL	diisobutylaluminum hydride
DMAP	*N*,*N*-4-dimethylaminopyridine
DMF	dimethylformamide
DMP	Dess-Martin periodinane
DMPU	1,3-dimethyl-3,4,5,6-tetrahydro-2(1H)-pyrimidinone
DMSO	Dimethyl sulfoxide
DPPA	diphenyl phosphoryl azide
DPEphos	(Oxydi-2,1-phenylene)bis(diphenylphosphine)
dr	diastereoseomeric ratio
DTMP	2,6-di-*tert*-butyl-4-methylpyridine

E	entgegen
EDCI	1-ethyl-3-(3-dimethylaminopropyl)-carbodiimidehydrochloride
ee	enantiomeric excess
EI	electron impact
equiv.	equivalent
ESI	electrospray ionization
Et	ethyl
Et_3N	triethylamine
Et_2O	diethyl ether
EtOAc	ethyl acetate
EtOH	ethanol
Et_3SiH	triethylsilane
Et_3SiOTf	trimethylsilyl trifluoromethanesulfonate
Et_2Zn	diethyl zinc
$FeCl_3 \cdot 6H_2O$	iron(III) chloride hexahydrate
g	gram(s)
GII	Grubbs Catalyst 2^{nd} generation
h	hour(s)
^1H	proton
HCl	hydrochloric acid
HF	hydrofluoric acid
$HfCl_4$	hafnium tetrachloride

HFIP	1,1,1,3,3,3-hexafluoroisopropanol
HGII	Hoveydα–Grubbs Catalyst 2nd generation
HMPA	hexamethylphosphoramide
H_2O	water
HOBt	*N*-hydroxybenzotriazole
HPLC	high performance liquid chromatography
HRMS	high resolution mass spectroscopy
H_2SO_4	sulfuric acid
Hünig's base	*N*,*N*-diisopropylethylamine
hν	light
Hz	hertz
ImH	imidazole
i	iso
I_2	iodine
i-Bu_2AlH	diisobutylaluminum hydride
$^{i}Pr_2NH$	di-*iso*-propylamine
$^{i}Pr_2NEt$	di-*iso*-propylethylamine (Hünig's Base)
$^{i}PrOH$	isopropanol or (2-propanol)
IR	Infrared Spectroscopy
$[Ir(COD)Cl]_2$	chloro(1,5-cyclooctadiene)iridium(I) dimer
KCN	potassium cyanide
KHMDS	potassium hexamethyldisilazane

K_2CO_3	potassium carbonate
KOH	potassium hydroxide
J	coupling constant
L	liter(s)
LDA	lithium diisopropylamide
$LiAlH_4$	lithium aluminum hydride
LiBr	lithium bromide
$LiBF_4$	lithium tetrafluoroborate
LiCl	lithium chloride
LiDBB	lithium di-tert-butyl biphenyl
LiOH	lithium hydroxide
LiOOH	lithium peroxide
m	multiplet
M	molarity
m/z	mass/charge
(M + Na)	molecular weight + sodium
MBz	*para*–methoxybenzoyl
mCPBA	*meta*–chloroperoxybenzoic acid
Me	methyl
MeCN	acetonitrile
MeI	iodomethane
MeLi	methyl lithium

MeMgBr	methylmagnesium bromide
$MeNO_2$	nitromethane
MeO	methoxy
MeOH	methanol
$MeReO_3$	methyltrioxorhenium
Me_2CuLi	Gilman's reagent
Me_2S	dimethyl sulfide
$Me_3S^+I^-$	trimethylsulfonium iodide
Me_3SiCl	trimethylsilyl chloride
Me_3SiOK	potassium trimethylsilanolate
$(MeSO_2)_2O$	methanesulfonic anhydride
mg	milligram(s)
Mg	magnesium
MHz	megahertz
μL	microliter(s)
min	minute(s)
mL	milliliter(s)
mmol	millimole
mmHg	millimeters of mercury
MOM	methoxymethyl
MOMCl	chloromethyl methyl ether
MS	mass spectrometry

MsCl	methanesulfonyl chloride
MTO	methyltrioxorhenium
$Na(AcO)_3BH$	sodium triacetoxyborohydride
$NaBH_4$	sodium borohydride
$NaClO_2$	sodium chlorite
n-BuOLi	lithium *n*-butoxide
Na	sodium
NaH	sodium hydride
$NaHCO_3$	sodium bicarbonate
NaHMDS	sodium 1,1,1,3,3,3-hexamethylsilazane
NaH_2PO_4	sodium dihydrogen phosphate
$NaHSO_3$	sodium bisulfite
$NaIO_4$	sodium periodate
NaN_3	sodium azide
NaOAc	sodium acetate
NaOH	sodium hydroxide
NaO-*t*Bu	sodium tert-butoxide
$Na_2S_4 \cdot H_2O$	sodium sulfide hydrate
$Na_2S_8 \cdot 9H_2O$	sodium sulfide nonahydrate
Na_2SO_4	sodium sulfate
NBS	*N*-bromosuccinimide
NFSI	*N*-fluorobenzenesulfonimide

$NH_2OH{\cdot}HCl$	hydroxylamine hydrochloride
n-BuLi	*n*-butyllithium
NIS	*N*-iodosuccinimide
NMO	*N*-methylmorpholine-*N*-oxide
NMP	*N*-methyl-2-pyrrolidone
NMR	nuclear magnetic resonance
NOE	nuclear Overhauser effect
O_3	ozone
OsO_4	osmium(VIII) oxide
Pd/C	palladium(0) on charcoal
$Pd/CaCO_3$	palladium (0) on calcium carbonate Lindlar Catalyst
$PdCl_2$(dppf)	[1,1'-bis(diphenylphosphino)ferrocene]palladium(II) dichloride
$Pd(PPh_3)_4$	tetrakis(triphenylphosphine)palladium (0)
$Pd_2(dba)_3$	tris(dibenzylideneacetone)dipalladium (0)
$[Pd(allyl)Cl]_2$	allylpalladium(II) chloride dimer
Ph	phenyl
Ph_2SiH_2	diphenylsilane
Ph_3As	triphenylarsine
$PhI(OAc)_2$	(diacetoxyiodo)benzene
PhMe	toluene
$[Ph_3P]_3RuCl_2$	dichlorotris(triphenylphosphine)ruthenium(II)
$Ph_3SiOReO_3$	triphenylsilyl perrhenate

PivCl	Pivaloyl chloride
PMe_3	trimethylphosphine
$POCl_3$	phosphorus(V) oxychloride
PPh_3	triphenylphosphine
PPh_3AuCl	chloro(triphenylphosphine)gold(I)
PMB	*para*–methoxybenzyl
PMP	*para*–methoxyphenyl
ppm	parts per million
PPTS	pyridinium *p*-toluenesulfonate
PTSA	*para*-toluenesulfonic acid
p-ABSA	4-acetamidobenzenesulfonyl azide
p-Tol	*para*–tolyl
p-TsOH	*para*–toluenesulfonic acid
$PtCl_2$	platinum(II) chloride
PvCl	pivaloyl chloride
Py	pyridine
$[Rh(COD)Cl]_2$	chloro(1,5-cyclooctadiene)rhodium(I) dimer
RCM	ring-closing metathesis
Re_2O_7	rhenium(VII) oxide
$Rh_2(OAc)_4$	rhodium acetate
rt	room temperature

(*R*)-(*p*-tolyl)$_2$BINAP	(*R*)-(−)-*para*-toluenesulfinamide
s	singlet
SO_3	sulfur trioxide
TBAF	tetrabutylammonium fluoride
TBAI	tetrabutylammonium iodide
t-BuLi	*tert*-butyl lithium
t-BuOH	*tert*-butanol
TBD	1,5,7-triazabicyclo[4.4.0]dec-5-ene
TBDPS	*tert*-butyldiphenylsilyl
TBDPSCl	*tert*-butyl(chloro)diphenylsilane
TBS	*tert*-butyldimethylsilyl
TBSCl	*tert*-butyldimethylsilyl chloride
TEMPO	2,2,6,6-tetramethyl-1-piperidinyloxy, free radical
TES	triethylsilyl
TESCl	triethylsilyl chloride
TFA	trifluoroacetic acid
THF	tetrahydrofuran
$TiCl_4$	titanium(IV) chloride
TIPS	triisopropylsilyl
TIPSCl	chlorotriisopropylsilane
TMS	trimethylsilyl
TMSCl	trimethylsilyl chloride

$TMSCHN_2$	trimethylsilyldiazomethane
Ts	4-toluenesulfonyl
TsCl	4-toluenesulfonyl chloride
Z	zusammen
Zn	Zinc
$ZrCl_4$	zirconium tetrachloride
$ZrHCp_2Cl$	zirconocene chloride hydride (Schwartz's reagent)

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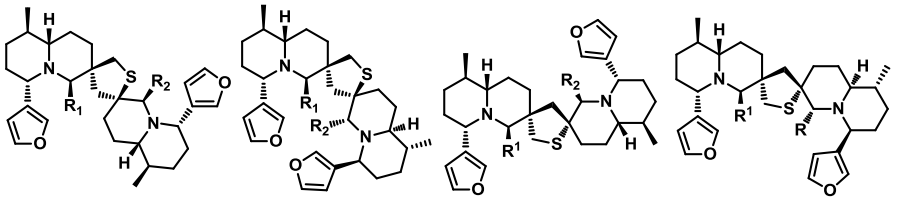
Chapter 1

Studies Towards the Total Synthesis of Nuphar Thiaspirane Alkaloids

1.1 Nuphar Thiaspirane Alkaloids Background

Nupharis Rhizoma was used as a tonic, diuretic, and treatment of blood stasis syndrome in Chinese and Japanese traditional medicine. Various alkaloids have been isolated from rhizome of *Nuphar japonicum* and *Nuphar pumilum* (T_{IMM}.) DC, including three types of dimeric sesquiterpene alkaloids in the thiobinupharidine, thionuphlutine, and neothiobinupharidine series (Figure 1.1.1). In 1965, Birnbaum corrected the structure of thiohemiaminal-type dimeric sesquiterpene neothiobinupharidine **1.3b**,[1] which had first been isolated by Achmatowicz a year earlier,[2] via X-ray crystallographic diffraction. In the 1970s, LaLonde extensively studied the structural elucidation of these dimeric sesquiterpene alkaloids, especially thiohemiaminal-type alkaloids, and also insightfully proposed their biogenesis from monomeric sesquiterpene congeners.[3]

Figure 1.1.1 Nuphar Thiaspirane Alkaloids



thiobinupharidine series
1.1a: R_1 = H, R_2 = OH
1.1b: R_1 = R_2 = OH
1.1c: R_1 = OH, R_2 = H
1.1d: R_1 = R_2 = H

thionuphlutine series
1.2a: R_1 = H, R_2 = OH
1.2b: R_1 = R_2 = OH
1.2c: R_1 = OH, R_2 = H
1.2d: R_1 = R_2 = H

neothiobinupharidine series
1.3a: R_1 = H, R_2 = OH
1.3b: R_1 = R_2 = OH
1.3c: R_1 = OH, R_2 = H
1.3d: R_1 = R_2 = H

neothionuphlutine series
1.4a: R_1 = H, R_2 = OH
1.4b: R_1 = R_2 = OH
1.4c: R_1 = OH, R_2 = H
1.4d: R_1 = R_2 = H

1.2 Biological Activities of Nuphar Thiaspirane Alkaloids

In general, alkaloids of botanical origin display a wide variety of unique and potent activities against disease targets; furthermore, they possess special promise as anticancer agents.[4] A recent study found that 57% of the 155 antineoplastic agents marketed in Western countries since the 1940s have been either unmodified natural products (25 compounds, 16%) or semi-synthetic derivatives of natural products (48 compounds, 41%).[5]

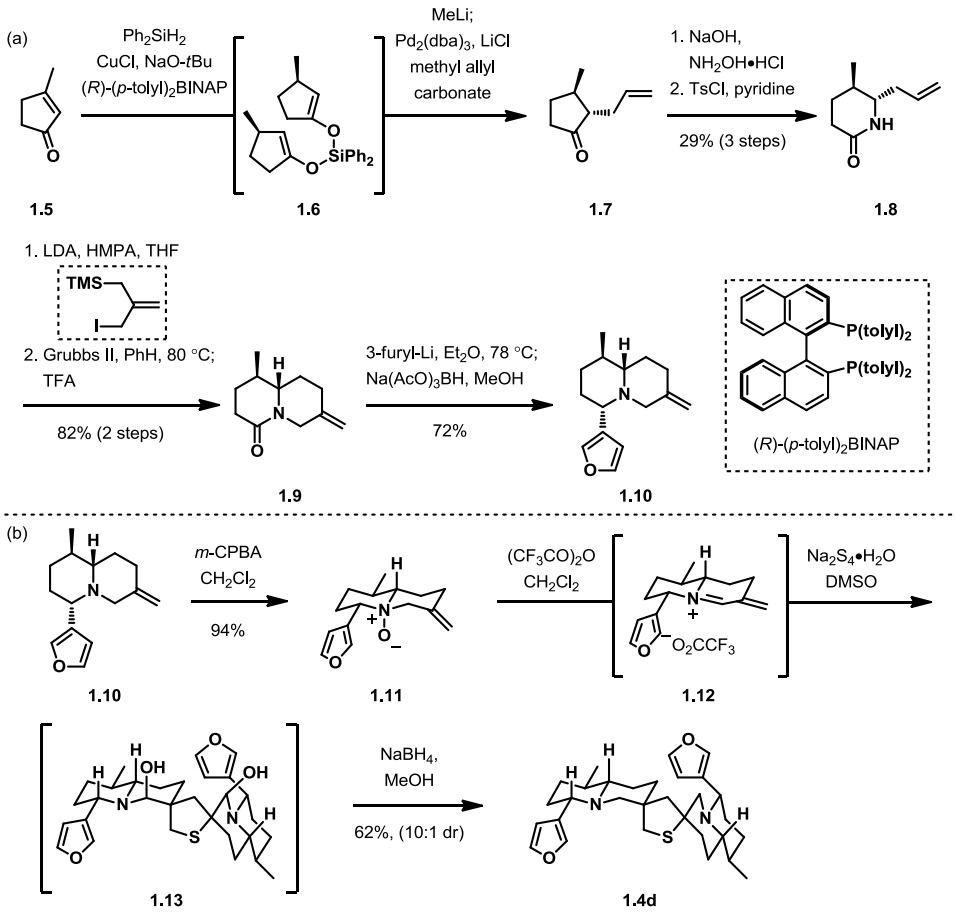
Despite the long history of these nuphar thiaspirane alkaloids, the remarkable biological activities of these dimeric nuphar thiaspirane alkaloids were not detected until the 2000s. These include antibacterial, antifungal, immunosuppressive, and potent *in vitro* cytotoxicity against U937 human leukemia, B16F10 mouse melanoma, and HT1080 human fibroblast cell lines.[6] Distinctive nuphar dimers 6-hydroxythiobinupharidine (**1.1a**), 6,6′-dihydroxythiobiunpharidine (**1.1b**), and 6-hydroxythionuphlutine B (**1.2a**) have been shown to inhibit invasion of B16 murine melanoma cells across collagen-coated filters *in vitro* with IC_{50} values of 29 nM, 87 nM, and 360 nM, respectively.[7] Recently, Gopas and co-workers reported that methanolic extracts from *Nuphar lutea* inhibit nuclear factor κB (NFκB) and exhibit synergistic effects with conventional chemotherapy.[8] NFκB signaling has been implicated in oncogenesis and tumor progression, inhibition of which has enabled the search for its specific target and applications against cancer and inflammation.

1.3 Previous Syntheses of Nuphar Thiaspirane Alkaloids

To date, only one synthesis of one member from this family of natural products has been reported. In 2013, Shenvi and co-workers reported an eight-step synthesis of (-)-neothiobinupharidine (**1.4d**), an isomer that has never been isolated from natural sources (Scheme 1.3.1).[9] Quinolizidine monomer **1.10** was elegantly prepared from 3-

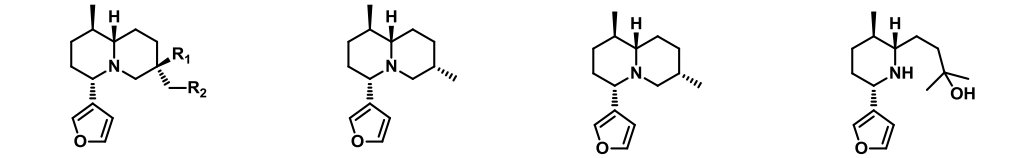
methylcyclopentenone **1.5** through a conjugate reduction-allylation sequence to form cyclopentane **1.7**. Formation of the quinolizidine core **1.9** was completed by ring closing metathesis (RCM) followed by protodesilylation. Dimerization of the quinolizidine monomers **1.10** in the presence of sodium tetrasulfide produced **1.4d** in 62% yield stereoselectively. Unfortunately, the authors did not report any biological activity of their synthetic isomer.

Scheme 1.3.1 Shenvi's Total Synthesis of (-)-Neothiobinupharidine



There have been various syntheses of monomeric sesquiterpene alkaloids by various groups shown in Figure 1.3.1 (*vide infra*).[10]

Figure 1.3.1 Monomeric Sesquiterpene Alkaloid Syntheses



R_1= R_2= H; (-)-Deoxynupharidine
R_1= H; R_2= OH; (-)-Castoramine
R_1= OH; R_2= H; (-)-Nupharolutine
Harrity and co-workers

(-)-Deoxynupharidine
Harrity and co-workers

(-)-Nupharamine
Shimizu and Yamazaki
Davis and Santhanaraman

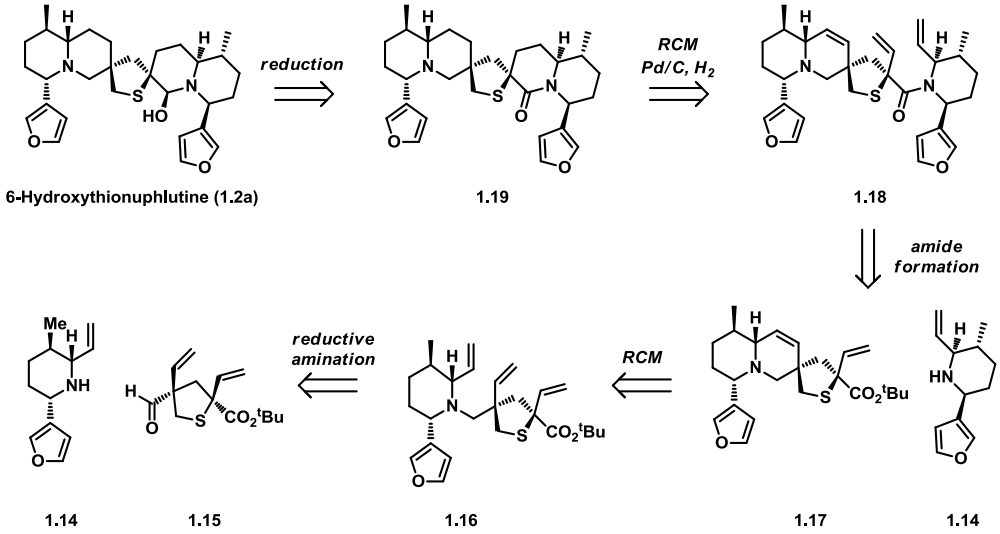
(-)-Nupharamine
Barluenga and co-workers

A new strategy is necessary to access other members of the family to provide the significant quantities of the natural isomers, which would be necessary for studies towards the elucidation of their biological targets and mechanism of action, both of which are absent from current literature.

1.4 Initial Synthetic Plan

In devising an overall approach to synthesize the four classes of nuphar thiaspirane alkaloids, we became interested in developing a general strategy of coupling a piperidine to one of four tetrahyrdothiophene isomers, shown in Scheme 1.4.1. Initial coupling of our tetrahydrothiophene **1.15** with piperidine **1.14** through reductive amination would deliver **1.16**, followed by RCM to form the first quinolizidine core **1.17**. To gain access to **1.18**, amide bond formation between **1.17** and piperidine **1.14** would be implemented. To form the second quinolizidine core, a RCM followed by hydrogenation would yield **1.19**. Finally, reduction of **1.19** would deliver our desired nuphar thiaspirane alkaloid, 6-hydroxythionuphlutine **1.2a**.

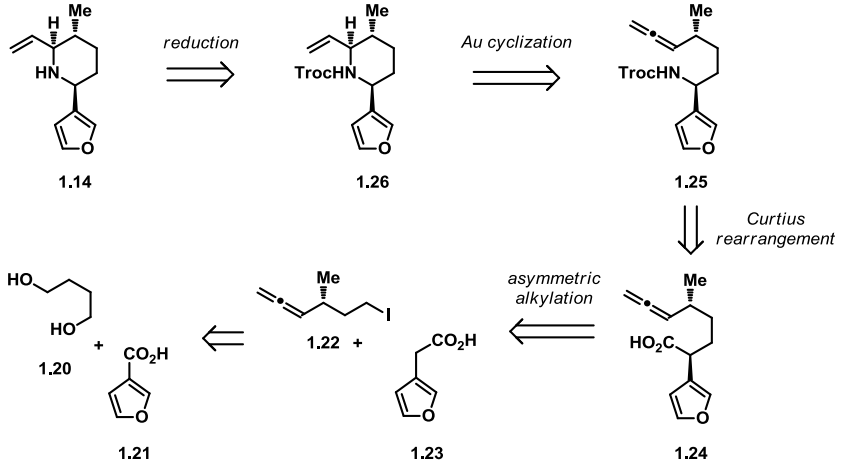
Scheme 1.4.1 Synthetic Plan of Nuphar Thiaspirane Alkaloids



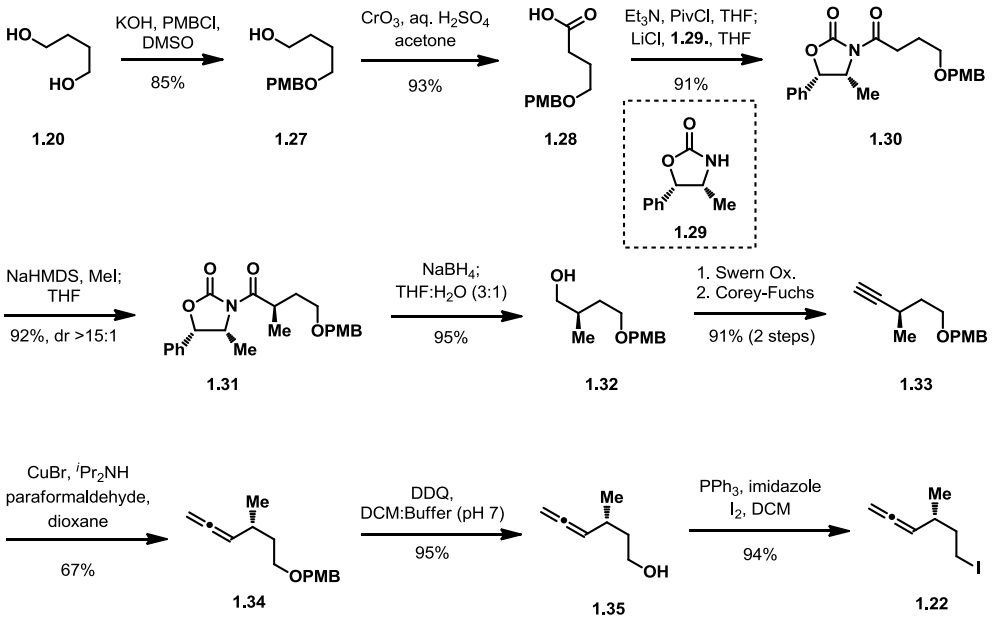
1.5 1st Generation Synthesis of Piperidine 1.14

In order to implement the final stages of our synthetic strategy, we conceived a strategy to synthesize piperidine **1.14.** We planned to use an asymmetric alkylation methodology, devised in the Zakarian group, coupling allene iodide **1.22** with 3-furylacetic acid **1.23** forming carboxylic acid **1.24**.[11] Curtius rearrangement would deliver carbamate **1.25**. A key gold cyclization followed by protecting group removal would deliver **1.14**.

Scheme 1.5.1 Synthetic Plan of Piperidine **1.14**

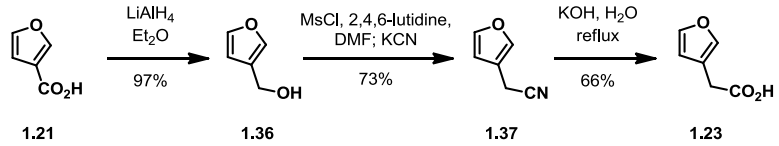


Scheme 1.5.2 Synthesis of Allene Iodide **1.22**



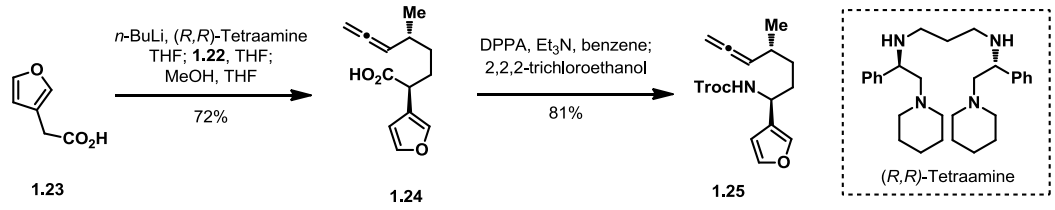
The synthesis of the allene iodide **1.22**, shown in Scheme 1.5.2, began from commercially available 1,4-butanediol **1.20**, which was mono-PMB protected to afford the corresponding primary alcohol **1.27**, in 85% yield.[12] After protection, the resultant alcohol was oxidized by means of a Jones oxidation yielding carboxylic acid **1.28**, and then coupled with oxazolidinones **1.29**, in 85% yield over two steps.[13] Methylation of *N*-acyl oxazolidione **1.30** formed **1.31** in high yield and diastereoselectivity. Reduction of **1.31** with $NaBH_4$ delivered primary alcohol **1.32** in 95% and the oxazolidinone **1.29** was quantitatively recovered. Swern oxidation followed by a Corey-Fuchs reaction provided alkyne **1.33** in 91% yield over two steps.[14] Allene **1.34** was formed using paraformaldehyde in a one carbon homologation reaction.[15] Deprotection of PMB followed by an Appel reaction produced allene iodide **1.22**.[13,16]

Scheme 1.5.3 Synthesis of 3-Furylacetic Acid **1.23**



Formation of 3-furylacetic acid **1.23** was initiated via reduction of commercially available 3-furanoic acid **1.21** with $LiAlH_4$, which delivered primary alcohol **1.36** (Scheme 1.5.3). Alcohol **1.36** was first mesylated, followed by cyanide addition to form nitrile **1.37**. Treatment of nitrile **1.37** with potassium hydroxide under refluxing conditions produced 3-furylacetic acid **1.23**, in 47% yield over three steps.[17]

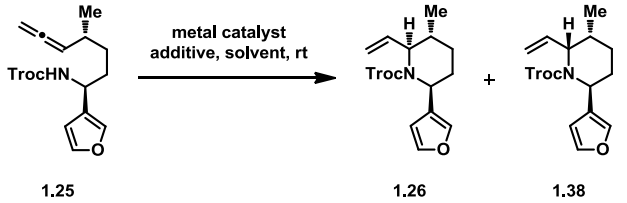
Scheme 1.5.4 Asymmetric Alkylation & Curtius Rearrangement



Utilizing chemistry developed in the Zakarian group, 3-furylacetic acid **1.23** was coupled with allene iodide **1.22** through an asymmetric alkylation with (*R*,*R*)-tetraamine, delivering carboxylic acid **1.24** in good yield and excellent selectivity.[11] Curtius rearrangement formed carbamate **1.25** in 81% yield.[18]

An initial screen of metals was performed to assess the ability to cyclize carbamate **1.25** to piperidine **1.26** (Table 1.5.1). Cyclization was not observed when using rhodium, iridium, iron, silver, platinum, or palladium[19] (entries 1-9) as our metal catalyst. When carbamate **1.25** was subjected to PPh_3AuCl, with silver triflate as an additive, cyclization was observed in good yield but with no stereoselectivity (entries 12-13).[20]

Table 1.5.1 Metal Screen: Piperidine **1.26** Cyclization



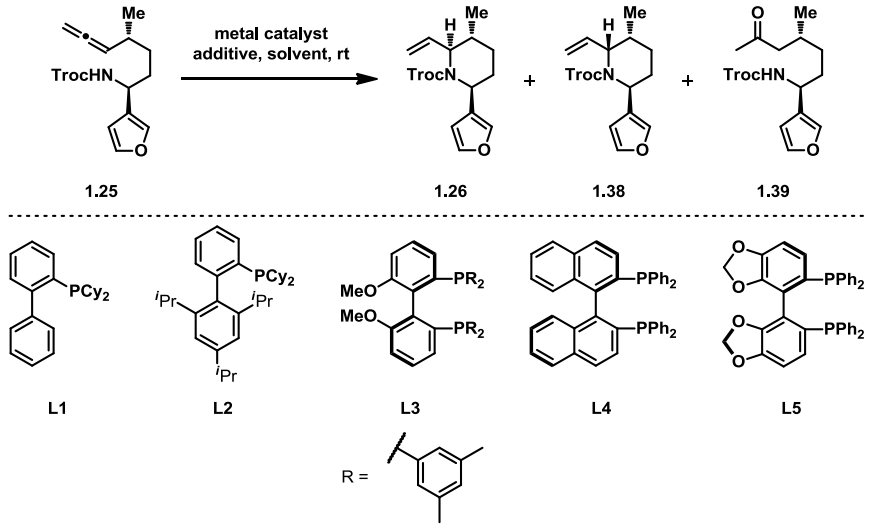
1.25 **1.26** **1.38**

Entry	Metal (mol %)	Additive (mol %)	Solvent	Yield
1	$[Rh(COD)Cl]_2$ (1.0)	DPEphos (3.0)	EtOH:DCE	0%[a]
2	$[Ir(COD)Cl]_2$ (1.0)	DPEphos (3.0)	THF	0%
3	$FeCl_3 \cdot 6H_2O$ (10.0)		CH_2Cl_2	0%
4	AgOTf (50.0)		toluene	0%
5	$AgBF_4$ (50.0)		toluene	0%
6	$AgClO_4$ (50.0)		toluene	0%
7	$PtCl_2$ (10.0)		CH_2Cl_2	0%
8	$[Pd(allyl)Cl]_2$ (10.0)	dppf (20.0)	THF	0%[a]
9	$PdCl_2$(dppf) (10.0)		THF	0%
10	$AuCl_3$ (5.0)	$AgClO_4$ (10.0)	xylenes	0%
11	$AuCl_3$ (5.0)	$AgClO_4$ (10.0)	CH_2Cl_2	0%
12	PPh_3AuCl (20.0)	AgOTf (40.0)	toluene	68%, dr 1:1
13	PPh_3AuCl (30.0)	AgOTf (60.0)	CH_2Cl_2	50%, dr 1:1

(a) **1.1** was consumed, formation of an unknown product.

We sought to improve our conversion and diastereoselectivity by using ligands to assist in our gold cyclization reaction. Phosphine ligands JohnPhos (**L1**), XPhos (**L2**), and (*R*)-SegPhos (**L5**) were tested but no conversion to the cyclized piperidine was observed (Table 1.5.2, entries 1-2, 5). Chiral ligand MeOBIPHEP (**L3**) was used and led to full conversion but only formed the non-cyclized methyl ketone **1.39** (entry 3). Among the phosphine ligands, usage of (*R*)-BINAP led to full conversion, forming piperidine **1.26** and **1.38** as the major products, along with a minor amount of methyl ketone **1.39** (entry 4). Unfortunately there was no improvement of diastereoselectivity with the conditions used.

Table 1.5.2 Au-Ligand Screen[a]



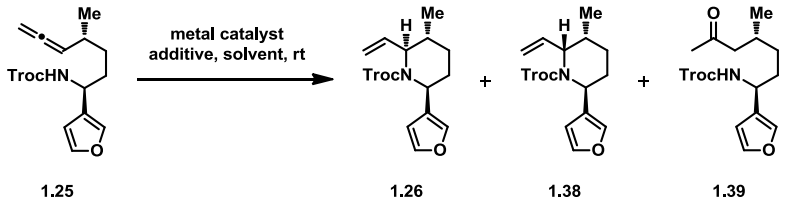
Entry	Au source (mol %)	Additive (mol %)	Solvent	Conversion	1.14:1.38:1.39
1	$AuNTf_2 \cdot L_1$ (10.0)[b]	AgOTf (10.0)	dioxane	0%	
2	$AuNTf_2 \cdot L_2$ (10.0)[c]	AgOTf (10.0)	dioxane	0%	
3	$AuCl \cdot L_3$ (5.0)[d]	AgOTf (10.0)	toluene	100%	0:0:1
4	$AuCl \cdot L_4$ (25.0)[e]	AgOTf (50.0)	CH_2Cl_2	100%	2:2:1
5	$AuCl \cdot L_5$ (25.0)[f]	AgOTf (50.0)	toluene	0%	

(a) Standard conditions: solvent (0.5 M) at room temp. (b) L1: Cyclohexyl JohnPhos (c) L2: XPhos (d) L3: (*R*)-3,5-Xyl-MeOBIPHEP (e) L4: (*R*)-BINAP (f) L5: (*R*)-SegPhos

Further reaction optimization of the gold cyclization was completed in order to improve the diastereoselectivity and minimize the methyl ketone **1.39** by-product. Under optimized conditions, 20 mol % of AuCl[(*R*)-BINAP], 80 mol % of silver tetrafluoroborate ($AgBF_4$) and 4Å molecular sieves, in a solvent mixture of toluene and dichloromethane are required for affording the piperidine **1.26** albeit in modest yield and selectivity (Table 1.5.3, entry 9). Variation of solvents, toluene:acetonitrile and dioxane, led to no product formation (entries 1, 4). Reduction of gold and silver loading led to reduced yields (entries 2-3). Using dichloromethane as the only solvent led to good yield, but poor diastereoselectivity and large amount of methyl ketone **1.39** formation (entry 5). In attempts to ensure dry reaction

conditions, 4Å MS were added, which led to a reduction in the amount of methyl ketone **1.39?** but low diastereoselectivity remained a problem (entries 6-7).

Table 1.5.3 Reaction Optimization

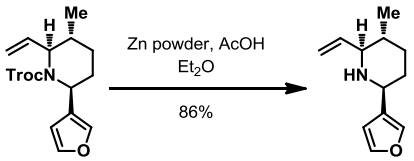


1.25 1.26 1.38 1.39

Entry	AuCl[(*R*)-BINAP]	$AgBF_4$	Additive	Solvent	Yield	1.14:1.38:1.39
1[a]	20 mol %	40 mol %		toluene:CH_3CN	0%	
2	15 mol %	30 mol %		CH_2Cl_2	35%	1.7:1:1
3	15 mol %	30 mol %		toluene:CH_2Cl_2	49%	2.8:1:1
4	15 mol %	30 mol %		dioxane	0%	
5	20 mol %	40 mol %		CH_2Cl_2	85%	1:1:0.7
6	20 mol %	40 mol %	4Å MS	CH_2Cl_2	64%	1:1:0.4
7	20 mol %	40 mol %	4Å MS	toluene:CH_2Cl_2	89%	1:1:0.6
8	20 mol %	40 mol %	4Å MS, LiCl	toluene:CH_2Cl_2	0%	
9	20 mol %	80 mol %	4Å MS	toluene:CH_2Cl_2	71%	2.1:1:1.3

(a) Standard conditions: **1.25** is added to a mixture of AuCl[(*R*)-BINAP] and $AgBF_4$ in solvent at room temperature. (b) reaction was heated to 45 °C.

Scheme 1.5.5 Formation of Piperidine **1.14**



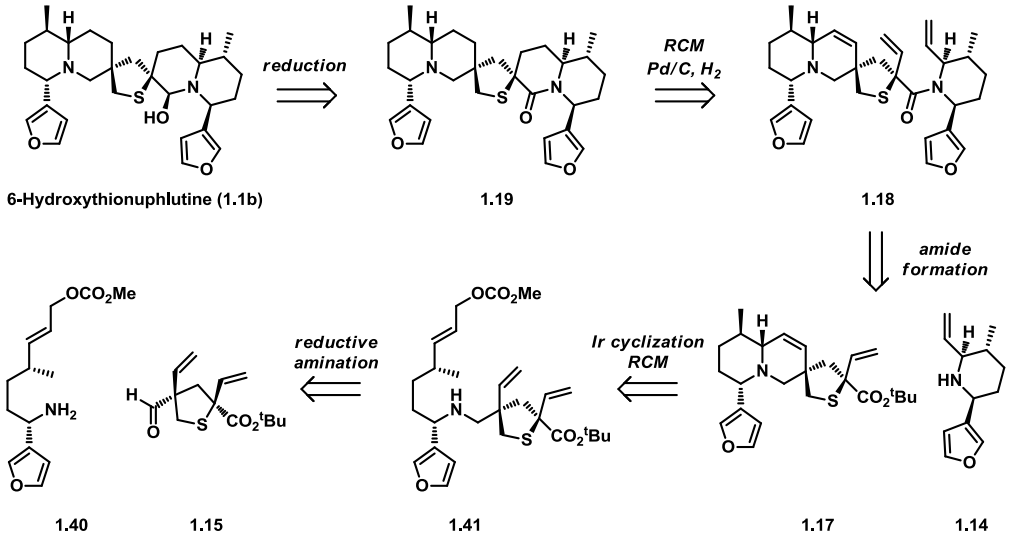
1.26 1.14

Deprotection of carbamate **1.26** with zinc in acetic acid and diethyl ether provided piperidine **1.14** in high yield (Scheme 1.5.5). Due to the high number of steps and lack of selectivity in the key gold cyclization, this plan to synthesize piperidine **1.14** was revised.

1.6 Revised Synthetic Plan

In revising our overall approach to synthesize the four classes of nuphar thiaspirane alkaloids, we planned to use an iridium-catalyzed allylic cyclization as our key step to form the quinolizidine cores, shown in Scheme 1.6.1. Initial coupling of our tetrahydrothiophene **1.15** with amine **1.40** through reductive amination would deliver **1.41**. A key iridium-catalyzed allylic cyclization followed by ring closing metathesis would form the first quinolizidine core **1.17**. To gain access to **1.18**, amide bond formation between **1.17** and piperidine **1.14** would be implemented. To form the second quinolizidine core, a RCM followed by hydrogenation would yield **1.19**. Finally, reduction of **1.19** would deliver the desired thiaspirane, 6-hydroxythionuphlutine **1.1b**.

Scheme 1.6.1 Synthetic Plan of Nuphar Thiaspirane Alkaloids

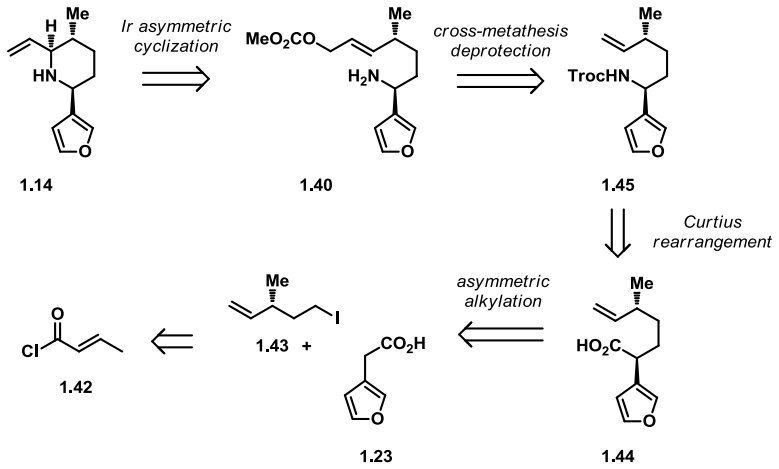


1.7 2nd Generation Synthesis of Piperidine 1.14

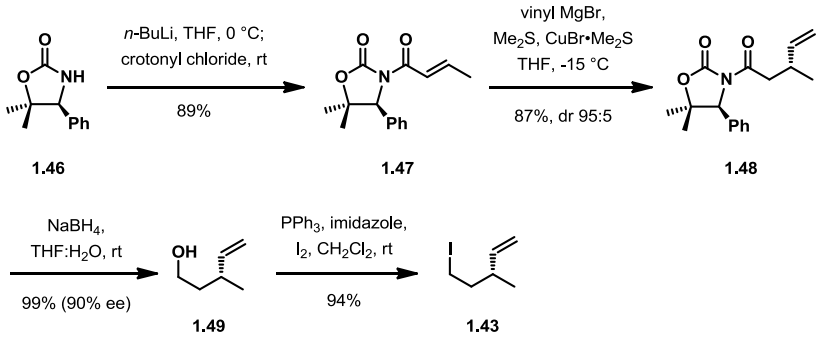
Due to the high step count and low overall yield for our initial synthesis of piperidine **1.14,** a revision was proposed. In devising a new approach, we planned to form piperidine **1.14** in a similar manner to the first generation synthesis. We varied our plan by using an

iridium-catalyzed allylic cyclization of amine **1.40** to produce piperidine **1.14** (Scheme 1.7.1).[21]

Scheme 1.7.1 Revised Synthetic Plan of Piperidine **1.14**

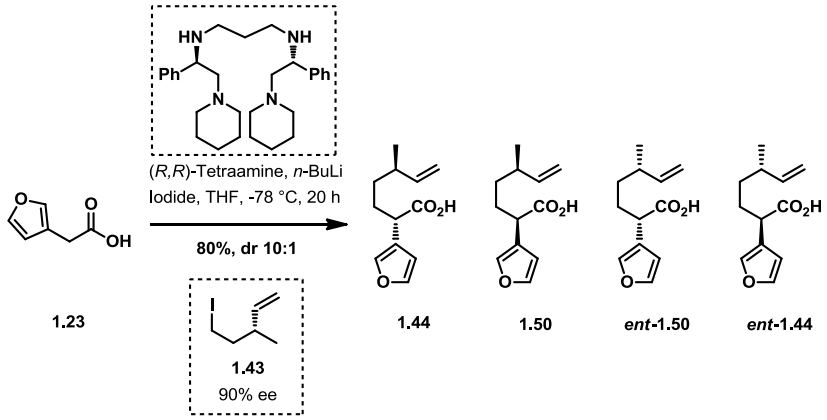


Scheme 1.7.2 Synthesis of Alkyl Iodide **1.43**



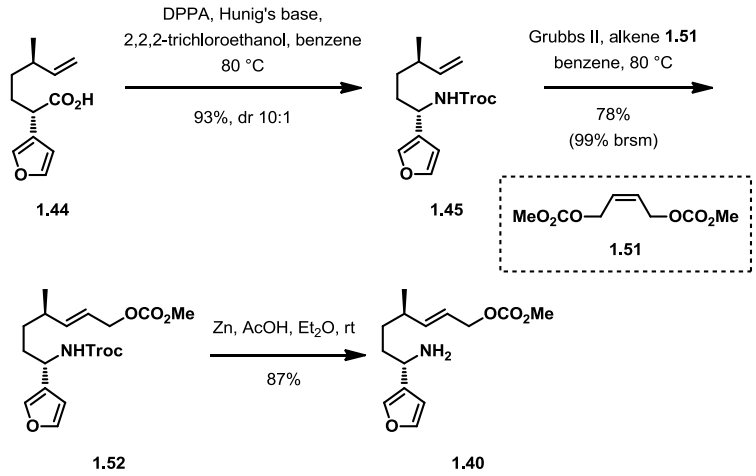
Acylation of oxazolidione **1.46** with crotonyl chloride delivered *N*-acyl oxazolidione **1.47** in high yield. A 1,4-addition of vinyl cuprate produced terminal alkene **1.48** in 87% yield and high diastereoselectivity.[22] Reduction with $NaBH_4$ followed by an Appel reaction produced the alkene iodide **1.43**. Thus, the synthesis of the iodide was completed in 5 steps, an overall 81% yield in 90% enantiomeric excess.

Scheme 1.7.3 Asymmetric Alkylation



An asymmetric alkylation of iodide **1.43** with 3-furylacetic acid **1.23** using (*R,R*)-tetraamine produced our desired addition producing **1.44** in high yield with great stereoselectivity in addition with the remaining three inseparable isomers. The reaction increased the enantiomeric excess of our desired product **1.44** over its enantiomer ***ent*-1.44**.

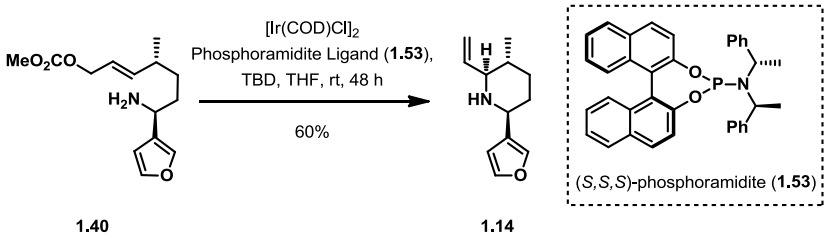
Scheme 1.7.4 Synthesis of Primary Amine **1.40**



The sterically bulky Hünig's base proved to be the key in the Curtius rearrangement of acid **1.44** by completely eliminating epimerization during the formation of carbamate **1.45**. The sterically smaller triethylamine leads to a partion epimerization, reducing dr from 10:1 to 3:1. Cross-metathesis proved uneventful, providing carbonate **1.52** in good yield, with the

starting material making up the remaining mass balance.[23] Removal of the Troc protecting group with zinc powder led to key primary amine **1.40**.

Scheme 1.7.5 Iridium-Catalyzed Allylic Cyclization

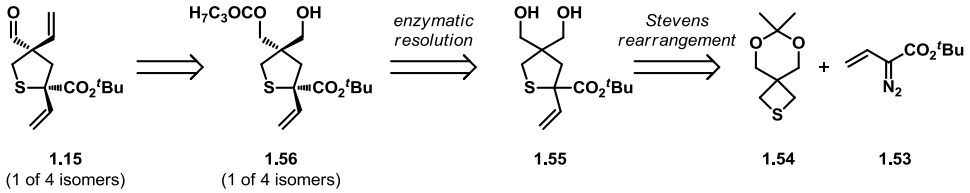


Cyclization of primary amine **1.40** via iridium catalysis under Helmchen conditions with phosphoramidite ligand[24] **1.53** provided piperidine **1.14** in good yield and excellent selectivity.[25]

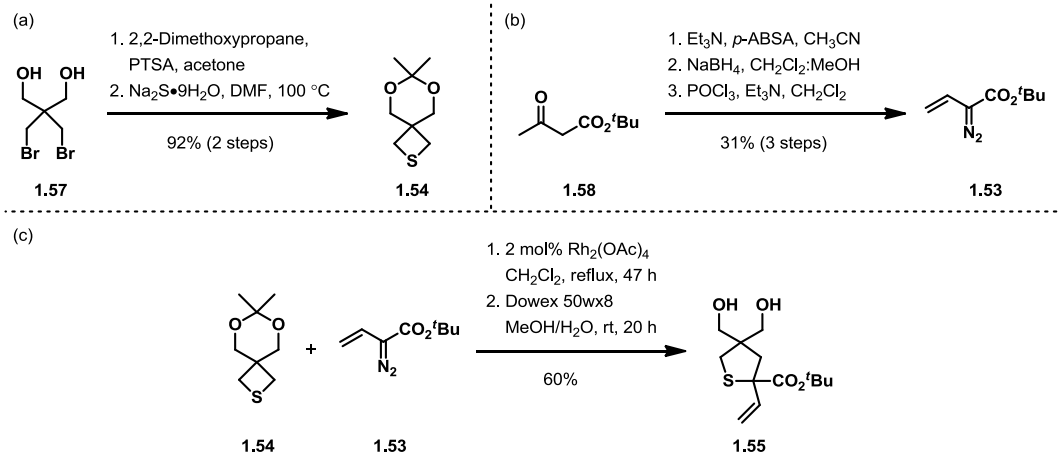
1.8 Synthesis of Tetrahydrothiophene 1.15

Our synthetic strategy was guided by the decision to pursue all four types of dimeric sesquiterpene alkaloids, assembled from one of four tetrasubstituted tetrahydrothiophene isomers. Preparation of tetrahydrothiophene **1.15** will commence with a Stevens rearrangement between thietane **1.54** and diazo **1.53** forming the initial tetrahydrothiophene core **1.55**.[26] To access all four isomers, we plan to use enzymatic resolution followed by multiple steps to achieve the desired coupling partner **1.15.**

Scheme 1.8.1 Synthetic Plan of Tetrahydrothiophene **1.15**

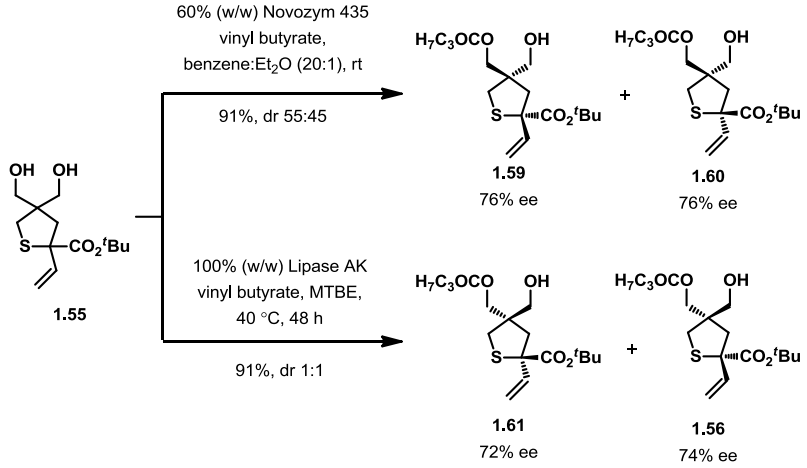


Scheme 1.8.2 Synthesis of Tetrahydrothiophene **1.55**



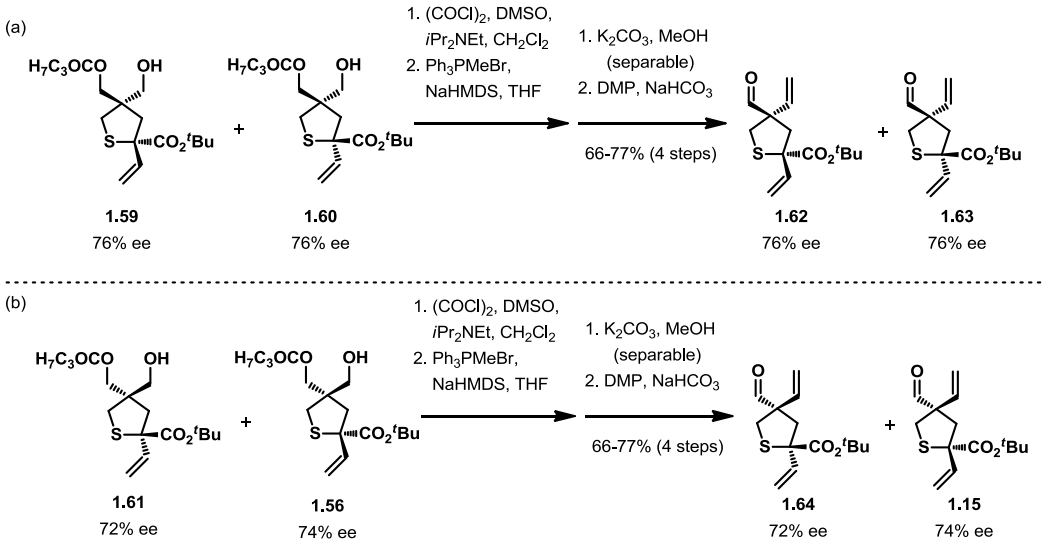
Thietane **1.54** was prepared from diol **1.57** by diol protection followed by thio-substitution with sodium sulfide, depicted in Scheme 1.8.2a.[27] Commercially available *tert*-butyl acetoacetate **1.58** was subjected to diazo formation with *p*-ABSA, followed by reduction with $NaBH_4$, and elimination to deliver diazo **1.53** in three steps (Scheme 1.8.2b).[28] Diol **1.55** was prepared in two steps via Stevens rearrangement of **1.54** with **1.53** and subsequent removal of acetonide (Scheme 1.8.2c)

Scheme 1.8.3 Enzymatic Resolution of Tetrahydrothiophene **1.55**



Desymmetrization is a powerful tool for the preparation of enatiomerically pure substrates. Desymmetrization of one prochiral carbon center in a racemic substrate would give two diastereomers with *de facto* enantiomeric purity. Although the copper-catalyzed desymmetrization reaction gave no better than 40% ee,[29] enzyme-mediated reaction afforded the desired diastereomers **1.59** and **1.60** after optimization. In presence of Novozym 435, diastereomers **1.59** and **1.60** could be isolated in 91% combined yield with a nearly 1:1 diastereomeric ratio and 76% ee (Scheme 1.8.3). In addition, **1.61** and **1.56** could also be efficiently prepared using enzyme lipase AK. Thus, four isomers of tetrahydrothiophenes could be feasibly accessed by choice of enzyme (Scheme 1.8.3).

Scheme 1.8.4 Synthesis of Tetrahydrothiophenes – 4 Isomers



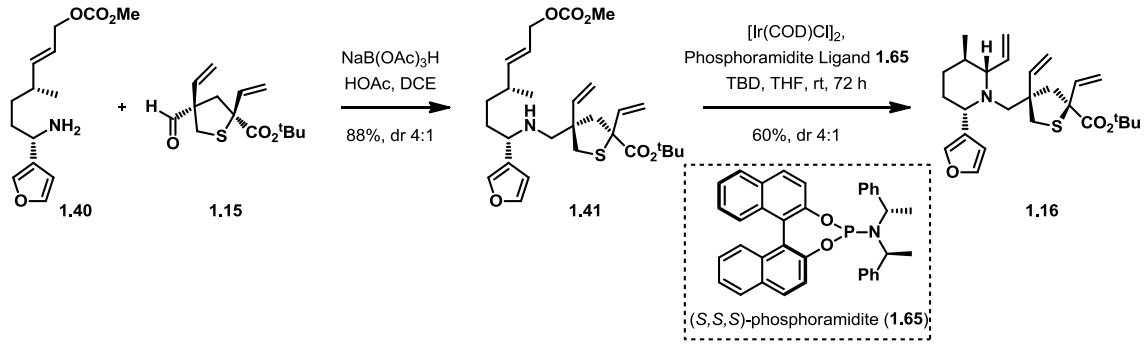
To prepare the final four tetrahydrothiophene isomers, the enzymatically resolved tetrahydrothiophenes **1.56** and **1.59-1.61** were subjected to Swern oxidation followed by Wittig olefination (Scheme 1.8.4–b). The tetrahydrothiophenes were subjected to deprotection and at this point isomers were separated by column chromatography. Dess-

Martin oxidation produced the desired tetrahydrothiophene isomers: **1.62**, **1.63**, **1.64**, and **1.15** in a total of four steps, in good yield and enantiomeric excess.

1.9 Synthesis of Nuphar Thiaspirane Alkaloids

Obtaining key fragments, amine **1.5** and all tetrahydrothiophene isomers (**1.15**, **1.62-1.64**), permitted the total synthesis of nuphar thiaspirane alkaloids to proceed via coupling of fragments.

Scheme 1.9.1 Formation of Quinolizidone Core

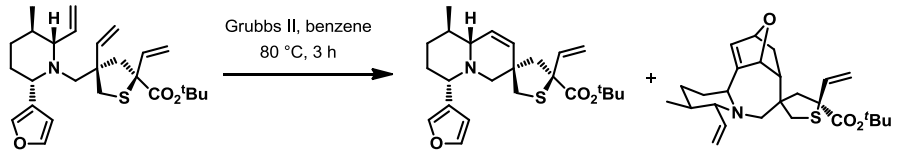


Reductive amination of primary amine **1.40** with aldehyde **1.15** provided the coupled fragment **1.41** in high yield and good diastereoselectivity (Scheme 1.9.1). Our first key iridium allylic cyclization proved to be uneventful, delivering piperidine **1.16** in good yield and complete stereoselectivity. At this point diastereomers could be separated and isomer **1.16** was subjected to RCM conditions.

A fast screen of metal catalysts revealed that Grubbs 2nd generation catalyst led to full conversion (Table 1.9.1, entry 1). Hoveyda-Grubbs 2nd generation (HGII) and Schrock catalysts were also screened but led to incomplete conversion (entries 2-3). Extended reaction times led to a greater amount of Diels-Alder by-product **1.66** (entry 4). Lowering reaction time to 6 hours led to full conversion with a 52% of desired quinolizidine **1.17**

(entry 5). Due to the high catalyst loading, it was proposed that the GII catalyst was forming a tightly bound intermediate with the substrate after one turnover of the catalyst. In an attempt to achieve full conversion to the desired quinolizidine **1.17** and lower the catalyst loading, ethylene was used to replace argon as the reaction atmosphere but this proved to be unfruitful (entry 7).

Table 1.9.1 Ring-Closing Metathesis[a]

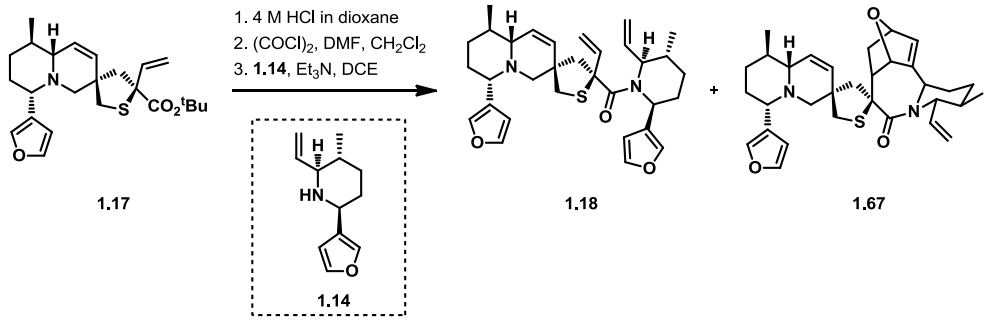


1.16 1.17 1.66

Entry	Catalyst (mol %)	Solvent	Time (h)	Conversion	Yield	1.17:1.66
1	GII[b] (37.5)	benzene	24	100%	-	1:1
2	HGII[c] (37.5)	benzene	24	84%	-	1.3:1
3	Schrock (37.5)	benzene	12	50%	-	0:1
4	GII (30.0)	benzene	14	100%	74%	1.6:1
5	GII (50.0)	benzene	6	100%	58%	10:1
6	GII (50.0)	benzene	3	100%	56%	10:1
7[d]	GII (25.0)	benzene	8	55%	30%	5:1

(a) Standard conditions: **1.16** in degassed benzene (0.01 M) in a sealed flask at 80 °C. (b) GII: Grubbs 2nd generation catalyst. (c) HGII: Hoveyda Grubbs 2nd generation catalyst. (d) reaction run under ethylene atmosphere.

Scheme 1.9.2 Amide Bond Formation



1.17 1.14 1.18 1.67

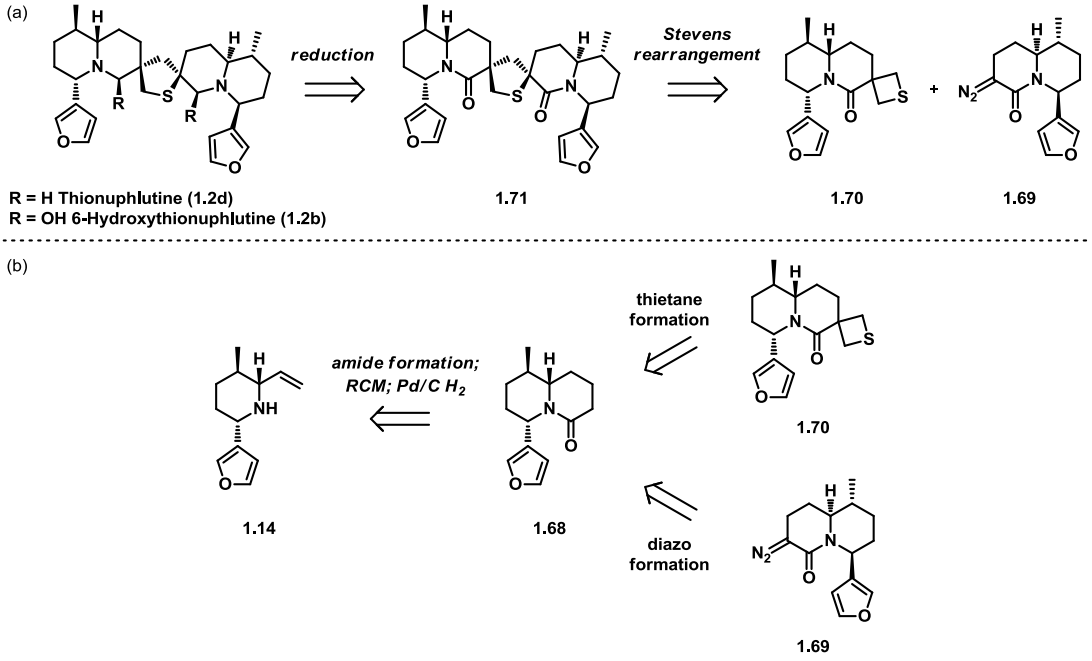
Advancing the synthesis, quinolizidine **1.17** was subjected to saponification in quantitative yield (Scheme 1.9.2). A screen of peptide bond forming reactions was conducted, including EDC/HOBt, DCC, EDC/DMAP, HATU, and HBTU, but no product formation was observed. Treatment of the acid with oxalyl chloride proved successful in preparing the acid chloride. Amide bond formation was examined with treatment of the acid chloride, piperidine **1.17**, and triethylamine inhigh concentration. The reaction was screened at various temperatures and times, but led exclusively to the undesired Diels-Alder byproduct **1.67** due to the Thorpe-Ingold effect. Unable to circumvent this unwanted side-product, the synthetic route was abandoned.

1.10 Revised Synthetic Plan of Nuphar Thiaspirane Alkaloids

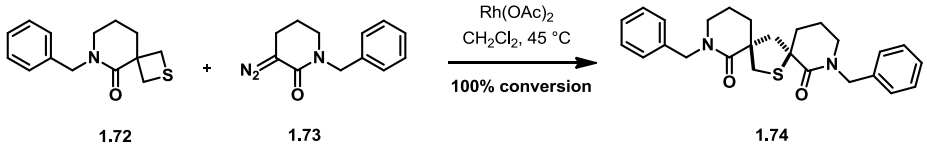
Revising our synthetic plan, formation of thietane **1.70** and diazo **1.69** could be formed from a common quinolizondine **1.68** intermediate (Scheme 1.10.1b). These two quinolizidines **1.69** and **1.70** could then be subjected to a Stevens rearrangement to deliver the bis-amide thioalkaloid **1.711** (Scheme 1.10.1a). Simple reduction could afford the bis-hemiaminal **1.2b** or the fully reduced **1.2d**.

To test the key Stevens rearrangement, a model reaction of thietane **1.72** and diazo lactam **1.73** was attempted. In the presence of catalytic $Rh_2(OAc)_4$, the reaction of thietane **1.72** with diazo **1.73** smoothly afforded the desired thiaspirane **1.74** in full conversion (Scheme 1.10.2) as a single isomer.

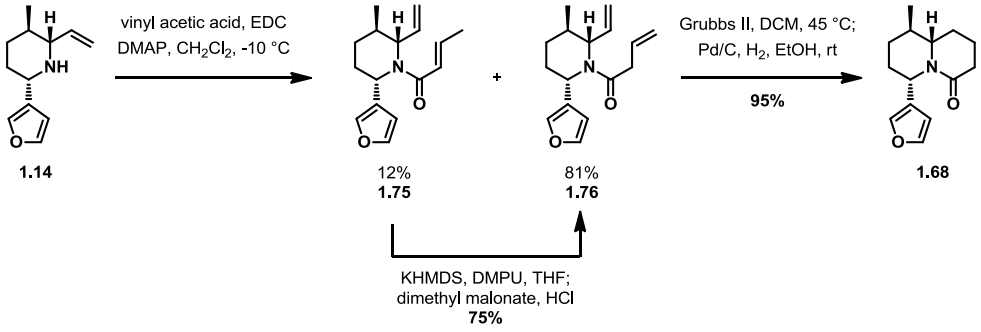
Scheme 1.10.1 Revised Synthetic Plan



Scheme 1.10.2 Stevens Rearrangement Model Reaction



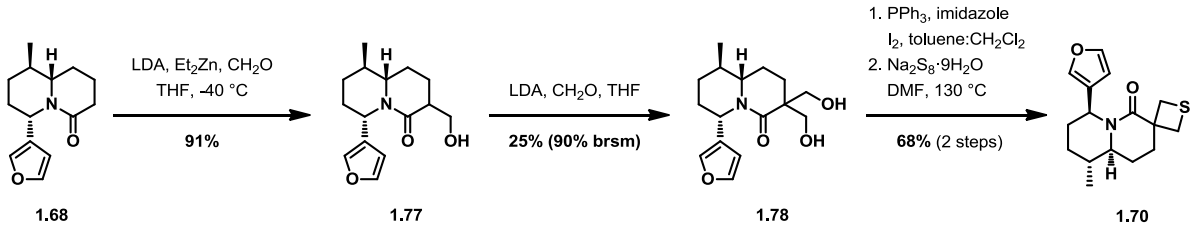
Scheme 1.10.3 Synthesis of Quinolizidine Core **1.68**



Synthesis of quinolizidine **1.68** was completed in two steps from piperidine **1.14** (Scheme 1.10.3). Amide bond formation took place upon treatment of piperidine **1.14** with vinyl acetic acid, EDC, and DMAP in good yield. A small amount of isomerization to the

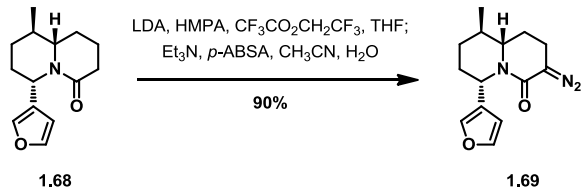
α,β-unsaturated amide **1.75** was observed, but was easily transformed back to the desired unconjugated product **1.76** upon treatment with KHMDS and quenching with dimethyl malonate in 75% yield.[30] RCM followed by hydrogenation proved uneventful, forming the quinolizidine core **1.68** in 95% yield.

Scheme 1.10.4 Synthesis of Thietane **1.70**



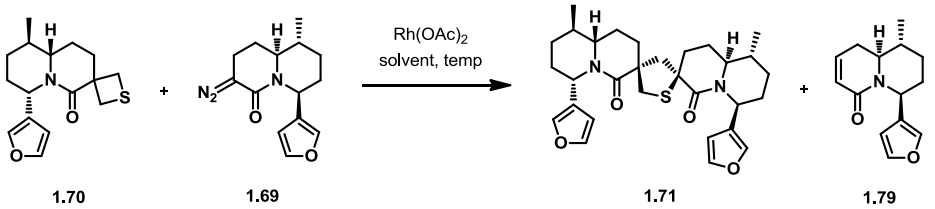
The initial aldol reaction began with the treatment of quinolizidine **1.68** with LDA and diethyl zinc, forming the zinc enolate. A solution of formaldehyde in THF was added, providing alcohol **1.77** in high yield (Scheme 1.10.4). An additional aldol was performed, but led to incomplete conversion, forming diol **1.78** in modest yield while retaining the remaining mixture as starting material **1.77**. Thietane formation proved to be successful with treatment of diol **1.78** by iodination followed by thio-substitution supplying thietane **1.70** in good yield over two steps.

Scheme 1.10.5 Synthesis of Diazo **1.69**



Next the α-diazo amide **1.69** was prepared via diazo transfer with use of *para*–acetamidobenzenesulfonyl azide (*p*-ABSA) from quinolizidine **1.68** (Scheme 1.10.5).[31]

Table 1.10.1 Stevens Rearrangement[a]



1.70 1.69 1.71 1.79

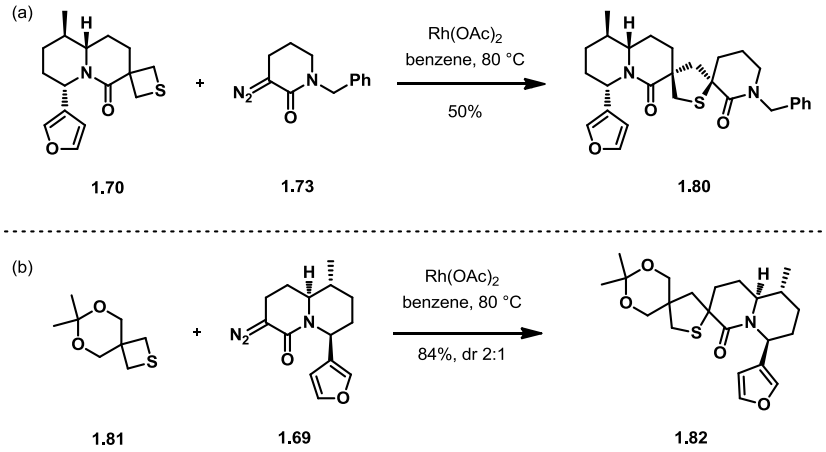
Entry	$Rh(OAc)_2$	Solvent	Temp	Yield	34:1.8:1.7
1[b]	25 mol %	CH_2Cl_2	45 °C	0%	1.5:0:1
2[c]	25 mol %	CH_2Cl_2	45 °C	0%	1.5:0:0
3[d]	25 mol%	DCE	90 °C	$0\%_2$	1.5:0:0

(a) Standard conditions: **1.70** (1.5 equiv), **1.69** (1.0 equiv), in DCM (0.05 M). (b) addition of diazo **1.69** over 1.5 h. (c) addition of diazo **1.69** over 3.5 h. (d) addition of diazo **1.69** over 16 h.

The key Stevens rearrangement was tested next with thietane **1.70** and diazo **1.69**. No product formation was observed when diazo **1.69** was added over 1.5 h to a solution of thietane **1.70** and $Rh_2(OAc)_4$ in dichloromethane at reflux (Table 1.10.1, entry 1). Formation of α,β-conjugated lactam **1.79** was exclusively observed along with unreacted thietane **1.70**. Extending addition time from 1.5 h to 3.5 h of diazo **1.69** reduced β-hydride elimination but no product formation was observed (entry 2). Increasing temperature to 90 °C and addition time to 16 h did not produce product **1.71** (entry 3).

Due to lack of product formation from the Stevens rearrangement, a new late-stage model was performed (Scheme 1.10.6). The model systems were to test reactivity of both thietane **1.70** and diazo **1.69**. Thietane **1.70** was reacted with model diazo **1.73** with $Rh_2(OAc)_4$ in refluxing benzene (Scheme 1.10.6a). Formation of product **1.80** was observed in 50% yield with 1 diastereomer observed. Next diazo **1.69** was reacted with model thietane **1.81** with $Rh_2(OAc)_4$ in refluxing benzene (Scheme 1.10.6b). Again, formation of product **1.82** was observed in high yield with a dr 2:1.

Scheme 1.10.6 Stevens Rearrangement: Late Stage Model

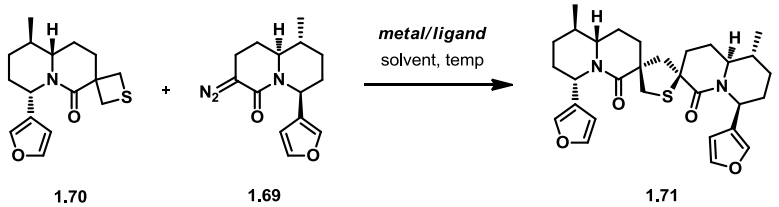


With these results (*vide supra*), we hypothesized that both the thietane **1.70** and diazo **1.69** are reactive and can undergo the Stevens rearrangement; however, the steric bulk in both compounds may lead to slow reactivity when coupling both together. We have observed that different metal/ligand combinations during Stevens rearrangement lead to different results be it higher and some times lower yields in the formation of thietanes. With the absence of desired thietane formation currently with $Rh_2(OAc)_4$, new studies will need to be performed.

1-11 Future Studies

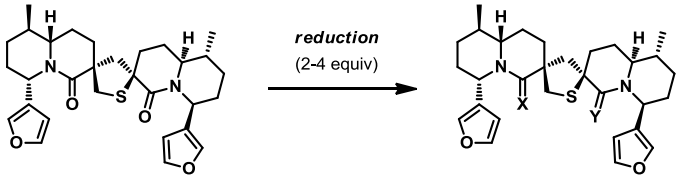
Future studies will concentrate on screening metal/ligand combinations to deliver the desired Stevens rearrangement (Scheme 1.11.1). Metals such as rhodium, ruthenium, copper, and iridium have been used in Stevens rearrangements successfully.

Scheme 1.11.1 Future Stevens Rearrangement Studies



Additional studies will include selective reduction to obtain multiple nuphar alkaloids (Scheme 1.11.2).

Scheme 1.11.2 Future Stevens Rearrangement Studies



1.71

1.2b X = H,OH; Y = H,OH
1.2d X = H,H; Y = H,H

Chapter 2

A Concise Asymmetric Total Synthesis of (+)-Brevisamide

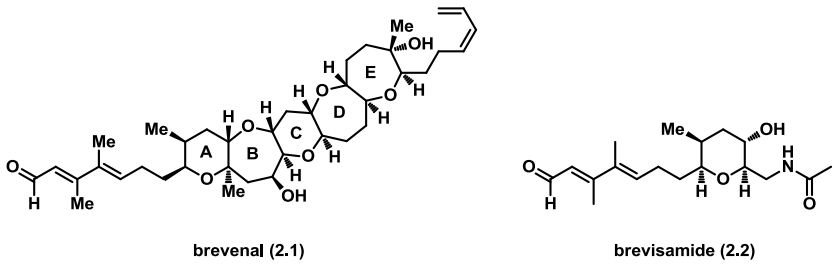
2-1 Introduction

The art and science of natural product total synthesis has become increasingly more associated with the various principles of the "economies" of synthesis.[32,33] Evaluation of protecting group use serves as one metric of synthetic efficiency and can provide a framework for developing a synthesis plan. Among various classes of natural products prepared by total synthesis without the use of protecting groups, examples featuring polyketides or cyclic ethers are scarce.[5,34] Herein, we report a concise, enantioselective, protecting-group-free total synthesis of the diversely functionalized cyclic ether natural product brevisamide.

2-2 Brevisamide Background

The "Red Tide" off of the Florida coast and in the Gulf of Mexico has led to the death of a wide range of marine life and human food poisoning.[35] Dinoflagellates blooms have been the root cause of this due to the secretion of brevetoxins by *Ptychodiscu brevis*.[36] Another species of dinoflagellates, *Karenia brevis* produces the metabolite, brevenal (**2.1**) (Figure 2.2.1), which has been shown to have antagonistic activity against the brevetoxins.[37] In 2008, Wright and co-workers isolated another metabolite, brevisamide (**2.2**), from *K. brevis*. This monocyclic ether contains very similar structural features to the A–ring and dienal fragment of brevenal.[38]

Figure 2.2.1. Brevenal **2.1** and Brevisamide **2.2**



Brevisamide appears to be an important biosynthetic precursor to brevenal and possibly other polycyclic ethers. Brevisamide is comprised of a complex functionalized tetrahydropyran core containing a conjugated 3,4-dimethylhepta–2,4-dienal and acetylated terminal amine subunits. The tetrahydropyran ring also contains methyl and hydroxyl substituents. Since brevisamide has been reported as a biosynthetic precursor to brevenal, a great deal of interest has been generated towards its total synthesis. Multiple groups have synthesized brevisamide since its isolation in 2008, with the first four total syntheses being reported in 2009.

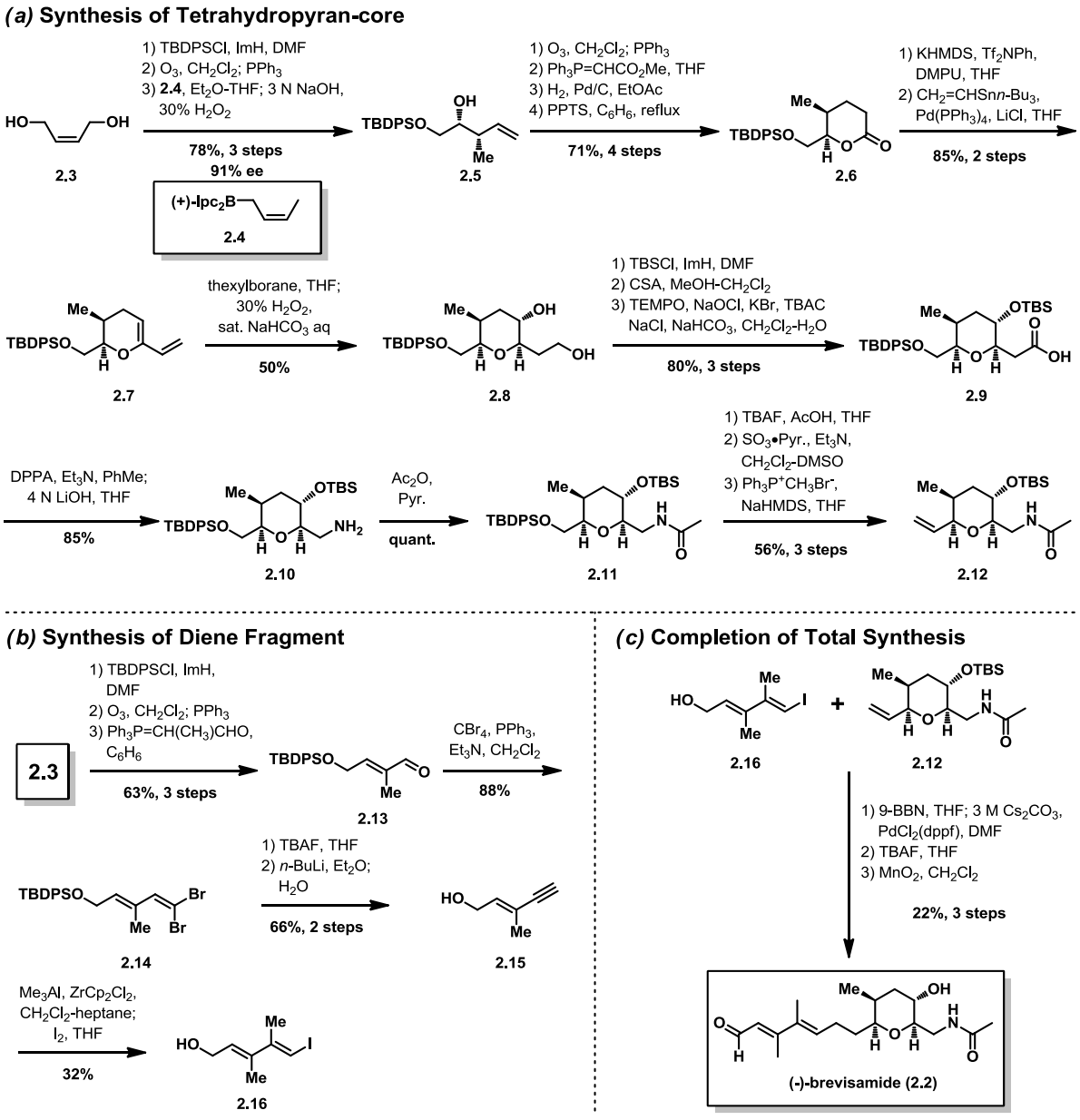
2-3 Previous Syntheses

2-3-1 Satake's Synthesis of Brevisamide

The Satake group completed the first total synthesis, outlined in Scheme 2.3.1.[39] The tetrahydropyran-core (Scheme 2.3.1, part a) was synthesized by three key reactions: Brown crotylation to generate **2.5**, which led to lactone formation yielding **2.6**, and finally hydroboration was utilized to install the secondary alcohol **2.8**.[40,41,42] Curtius rearrangement generated primary amine **2.10**, a precursor to amide **2.11**.[43] Suzuki-Miyaura cross coupling (part c) of **2.12** and **2.16** installed the diene fragment, which was then followed by MnO_2 oxidation, which completed the first total synthesis of brevisamide (**2.2**) in 21 steps and a

2.0% overall yield. This synthesis also confirmed the absolute stereochemical structure of brevisamide (**2.2**).

Scheme 2.3.1. Satake's Synthesis of Brevisamide **2.2**



2-3-2 Lindsley's Synthesis of Brevisamide

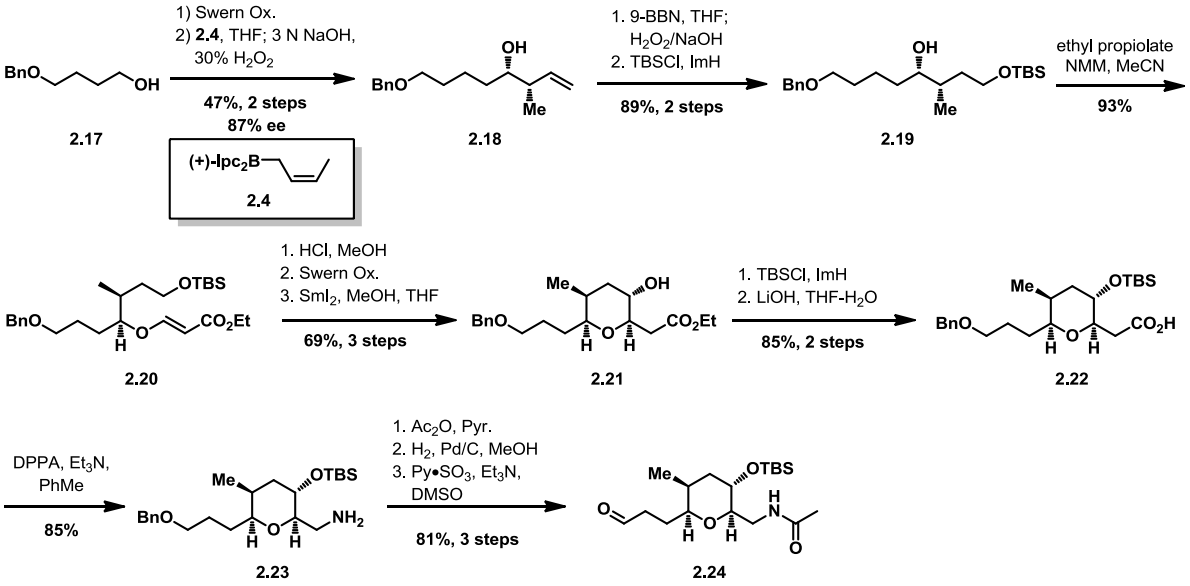
Shortly after the achievement of the first total synthesis, Lindsley and Fadeyi completed another total synthesis.[44] While their approach was similar to Satake's synthesis in the stepwise construction of the tetrahydropyran-core, they differed in the dienal construction. The tetrahydropyran-core (Scheme 2.3.2, part a) was synthesized by two key reactions: Brown crotylation to generate **2.18** and a samarium(II) iodide reductive cyclization reaction to create the key core **2.21**.[45] Curtius rearrangement was used to generate the primary amine **2.23** that led to amide **2.24**.[46] A Horner-Wadsworth-Emmons reaction (part c) of aldehyde **2.24** and phosphonate **2.27** installed the diene fragment, which was then followed by MnO_2 oxidation, which completed the shortest total synthesis of brevisamide (**2.2**) in 18 steps and 6.3% overall yield.

2-3-3 Ghosh's Synthesis of Brevisamide

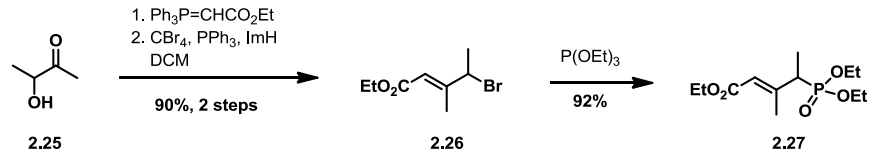
Ghosh and Li completed the third total synthesis.[47] Their synthesis had an alternative synthetic plan in construction of the tetrahydropyran-core from previous groups. They used Jacobsen's asymmetric Hetero-Diels-Alder reaction of diene **2.31** and aldehyde **2.32** using Jacobsen's chromium catalyst **2.33** to produce **2.34** (Scheme 2.3.3, part a) in high diastereo- and enantioselectivity.[48] A Rubottom oxidation was used to install the secondary alcohol **2.35**. [49] Amide **2.38** was produced from a Mitsunobu reaction followed by azide reduction and amine acylation.[50] A Suzuki-Miyaura cross coupling (part c) of **2.39** and **2.44** installed the diene fragment, which was then followed by TEMPO oxidation that delivered brevisamide (**2.2**) in 19 steps and 1.5% overall yield.[51]

Scheme 2.3.2 Lindsley's Synthesis of Brevisamide **2.2**

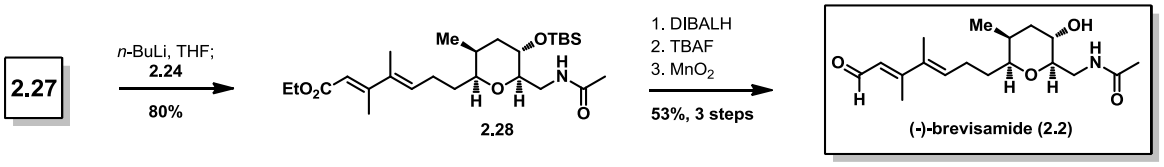
***(a)* Synthesis of Tetrahydropyran-core**



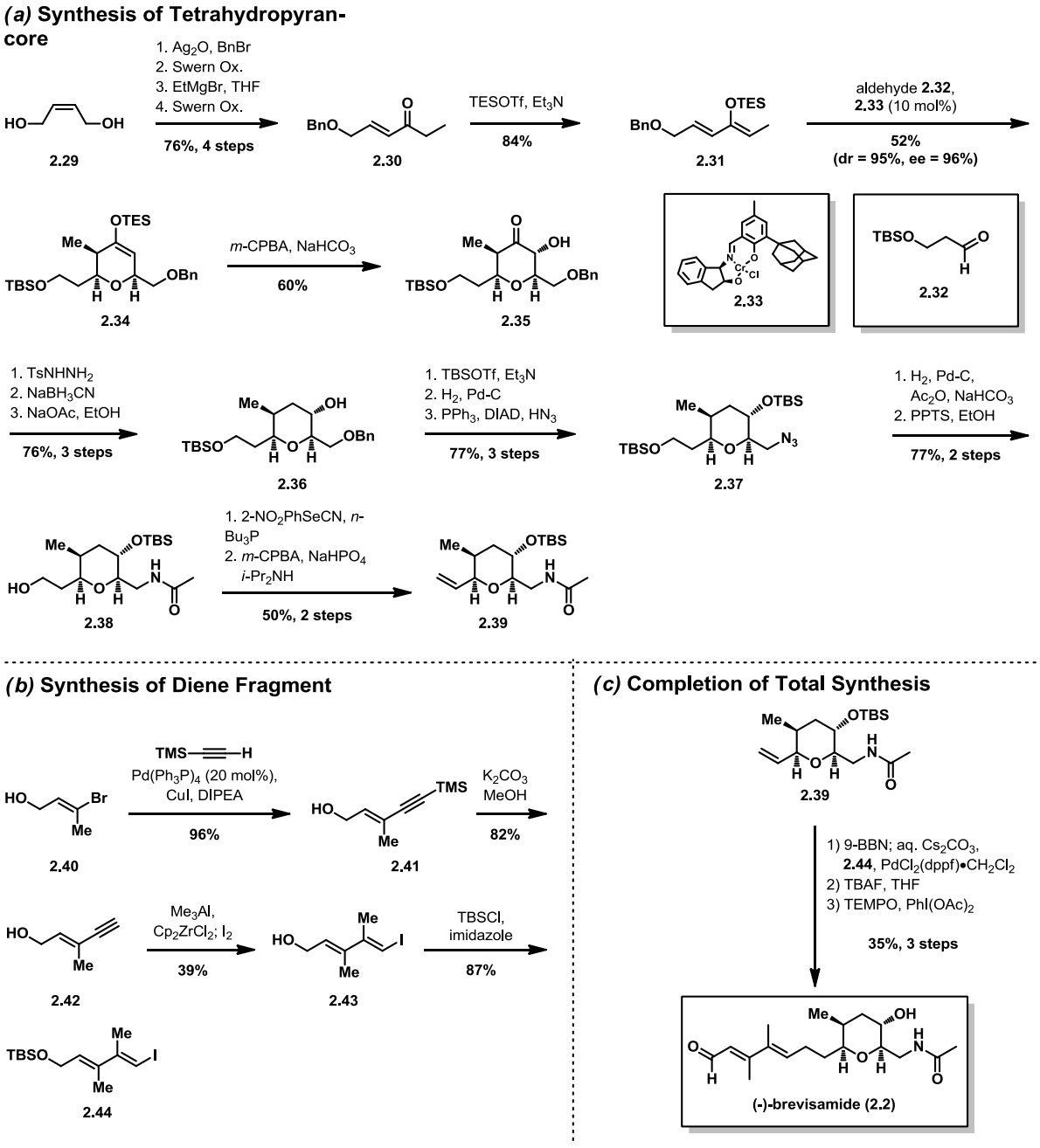
***(b)* Synthesis of Phosphonate Fragment**



***(c)* Completion of Total Synthesis**



Scheme 2.3.3 Ghosh's Synthesis of Brevisamide **2.2**

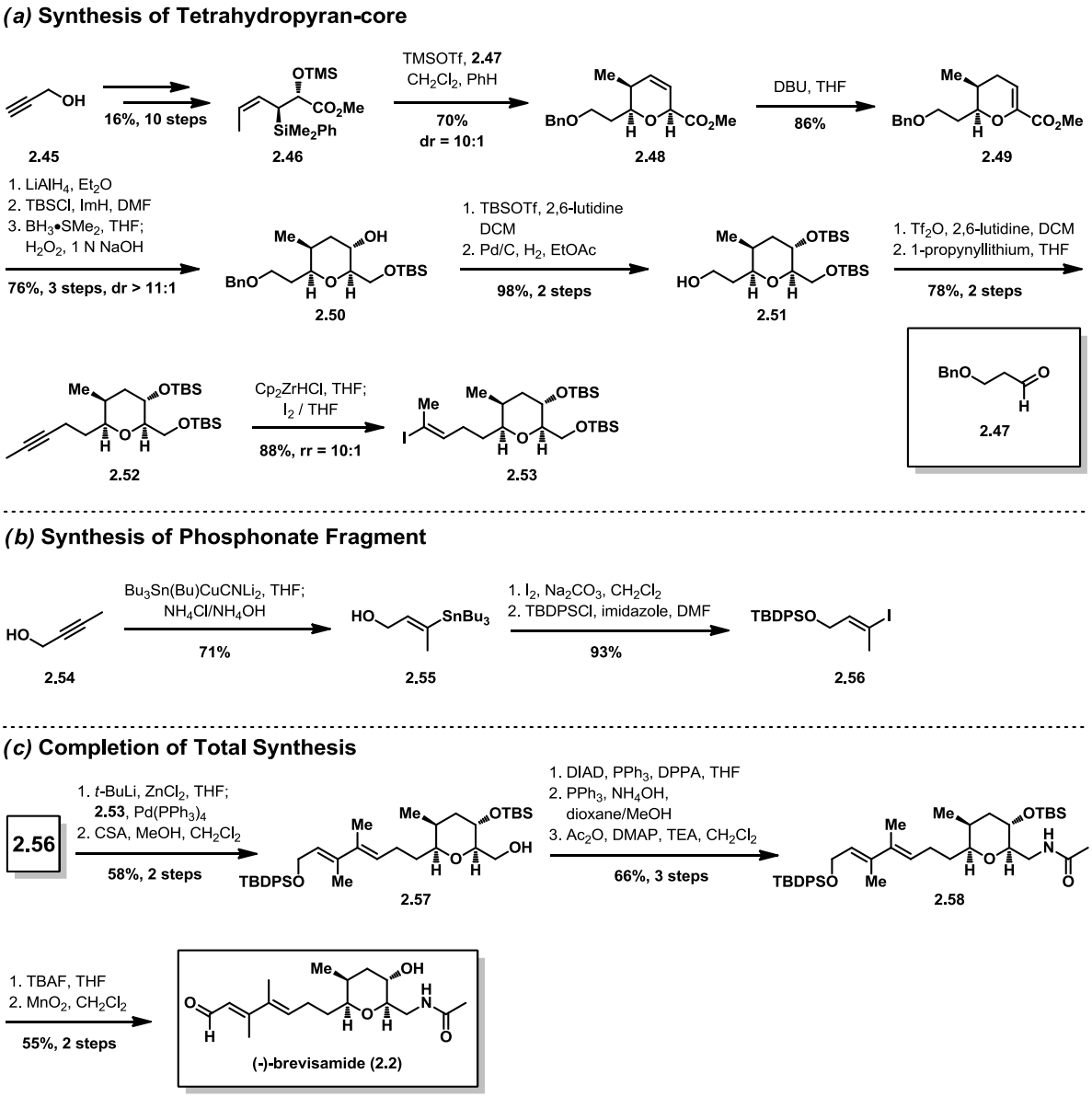


2-3-4 Panek's Synthesis of Brevisamide

Panek and Lee completed the fourth total synthesis of brevisamide (**2.2**).[52] Their synthesis centered on Panek's silicon directed [4+2]-annulation utilizing a *Z*-crotylsilane to construct the tetrahydropyran-core **2.48** (Scheme 2.3.4, part a).[53] Hydroboration was used to

synthesize the equatorial secondary alcohol **2.50**. A Negishi cross-coupling (part c) of **2.53** and **2.56** installed the diene fragment.[54] The amide **2.58** was produced from a Mitsunobu reaction followed by azide reduction and amine acylation, which was then followed by MnO_2 oxidation, which constructed brevisamide (**2.2**) in 27 steps and 0.8% overall yield.[55,56]

Scheme 2.3.4 Panek's Synthesis of Brevisamide **2.2**



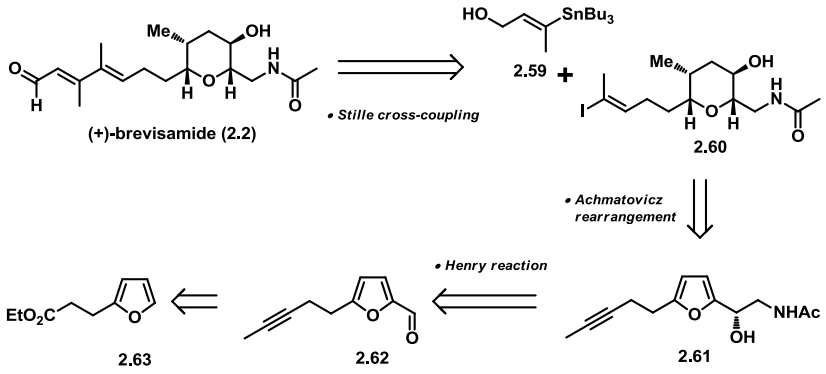
2-3-5 Formal syntheses

Since this latest completed total synthesis, two formal syntheses have been accomplished by the groups of Smith and Sabitha.[57]

2-4 Synthetic Plan of Brevisamide

In devising our own approach, we became intrigued by the challenge of developing a concise, enantioselective, and protecting-group-free construction of the diversely functionalized tetrahydropyran ring in brevisamide. A synthesis plan based on the combination of a catalytic asymmetric Henry reaction and an Achmatowicz rearrangement,[58] outlined in Scheme 1, proved to be successful in meeting this challenge. The final operation in the synthesis was envisioned to employ a Stille-cross-coupling reaction to install the conjugated (*E,E*)-dieneal.

Scheme 2.4.1 Synthetic Plan of Brevisamide **2.2**

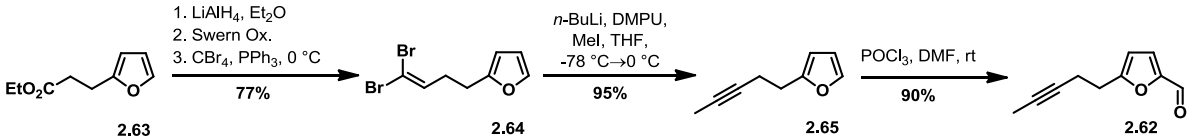


2-5 Total Synthesis of Brevisamide

The synthesis of the aldehyde **2.62**, shown in Scheme 2.5.1, began from commercially available ethyl 3-(furan-2-yl)propionate **2.63**, which was treated with $LiAlH_4$ to afford the corresponding primary alcohol. After oxidation, the resultant aldehyde was immediately submitted to the Corey–Fuchs reaction yielding dibromoalkene **2.64**,[59] which was treated

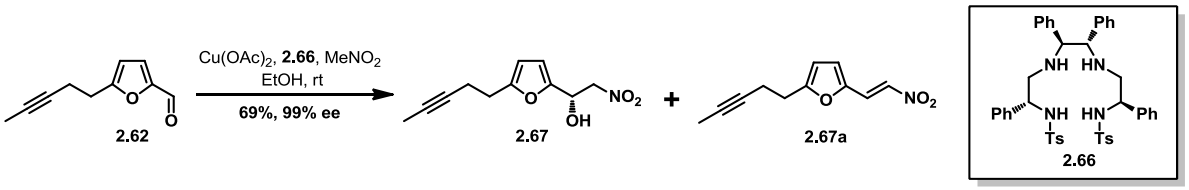
with *n*-butyllithium and iodomethane to form the desired alkyne **2.65**, along with a furan methylation byproduct. Addition of DMPU prior to the addition of iodomethane resulted in the isolation of only the desired methylated alkyne **2.65** in high yield. Aldehyde **2.62** was prepared directly from **2.65** by a Vilsmeier–Haack reaction in 90% yield.[60]

Scheme 2.5.1 Synthesis of Aldehyde **2.62**



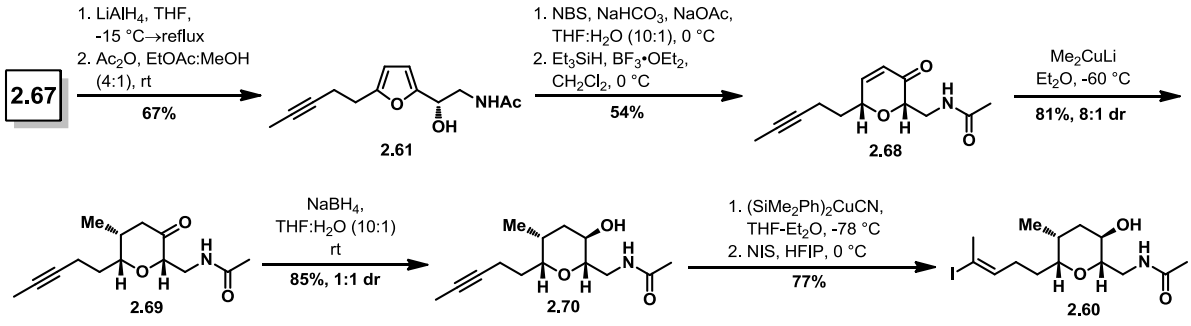
With aldehyde **2.62** in hand, the key enantioselective Henry reaction was investigated. Although a variety of methods are available for this transformation, we focused on a procedure developed by Wan and co-workers.[61] This method has been reported to provide products in high enantioselectivity, under practical reaction conditions at room temperature and within reasonable reaction times. The method employs a catalytic system derived from readily available $Cu(OAc)_2 \cdot H_2O$ and ligand **2.66** in ethanol as the solvent. Much to our delight, when **2.62** was exposed to these conditions, the product **2.67** was isolated with a 99% ee. Extended reaction times resulted in accumulation of the nitroalkene **2.67a** as a byproduct resulting from dehydration of the initially formed nitro-alcohol **2.67** (Scheme 2.5.2). To minimize this problem, the reaction was terminated after 40 h at room temperature and the products were separated to provide the requisite Henry addition product **2.67** (57% yield, 99% ee), the starting material (33% yield), and the nitroalkene **2.67a** (10% yield). The starting material was then resubmitted to the reaction conditions to afford **2.67** in a 69% combined yield and 99% ee after one recycle.

Scheme 2.5.2 Asymmetric Henry Reaction



After the development of the enantioselective Henry reaction, the synthesis was advanced as illustrated in Scheme 2.5.3. The nitro group in **2.67** was reduced to the corresponding amine with $LiAlH_4$ under carefully controlled reaction conditions. Lithium aluminum hydride was preferred to other commonly used reagents for reduction of nitro compounds such as H_2 and Pd/C, Raney-Nickel, and SmI_2, due to incompatibility of these reagents with the alkyne group present in the substrate.[33,62] After assessment of a variety of reaction conditions, it was determined that a dropwise addition of a solution of the nitro compound **4** into a precooled solution of $LiAlH_4$ in THF (−15 °C) limited the retro-Henry process leading to the formation of an undesired primary alcohol. The reaction was then heated to reflux, which delivered the primary amine in optimized yields. The primary amine was then chemoselectively acetylated with acetic anhydride in ethyl acetate–methanol (4:1), giving amide **2.61** in 67% yield over the two steps.

Scheme 2.5.3 Synthesis of the Tetrahydropyran Core



According to our synthesis plan, acetamide **2.61** was now properly functionalized for the ensuing key Achmatowicz rearrangement. Furan **2.61** underwent oxidative ring expansion in the presence of NBS to form the cyclic hemiketal, which was then treated with $BF_3 \cdot OEt_2$ and Et_3SiH to produce intermediate **2.68** in a satisfactory 54% yield.[63] Installation of the methyl group was achieved by conjugate addition of lithium dimethylcuprate directly to enone **2.68** (81% yield, 8:1 dr).[64]

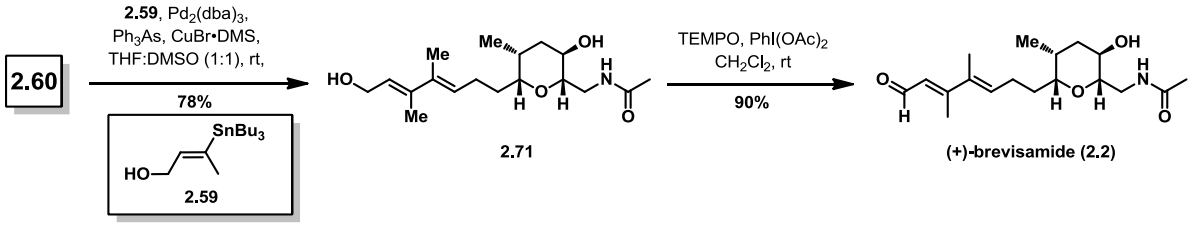
Our next goal was reduction of **2.69** under thermodynamic conditions to generate the more stable diastereomer **2.70** that has the desired configuration at the newly generated stereocenter. Our initial attempts centered on various versions of the Meerwein–Pondorf–Verley (MPV) reaction using $Al(OPr\text{-}i)_3$ and $Sm(OPr\text{-}i)_3$ reagents. With the aluminum-based reagent, the desired diastereomer **2.70** was formed exclusively at high temperatures (100 °C), however, at low yields. An unidentified byproduct was formed in significant quantities apparently resulting from reactivity of the acetamide. At lower temperatures (75 °C), an equimolar mixture of diastereomeric alcohols was produced. A ligand-based reduction was used in our next approach, employing (*R*)-CBS catalyst. This method led to a mixture of diastereomeric alcohols, with poor selection. Similar outcomes were observed with the samarium-based reagent. Reduction with sodium borohydride under standard conditions in methanol produced the undesired axial alcohol exclusively. On the other hand, reduction with $NaBH_4$ in aqueous THF substantially increased the fraction of the desired equatorial alcohol, giving a 1:1 mixture of separable products in 85% isolated yield.[65] The undersired isomer could be separated and recycled through an additional oxidation–reduction sequence.

Installation of vinyl iodide proceeded in high regioselectivity and yield employing the silylcupration-iododesylilation protocol.[66,67] Silylcupration took place with complete stereoselectivity and high regioselectivity (~13:1). Subsequent iododesilyation with *N*-

iodosuccinimide (NIS) in hexafluoroisopropanol (HFIP) successfully delivered the (*E*)-iodoalkene **2.60** in high yield and with complete retention of the double bond geometry.[38,68]

Known vinyltin reagent **2.59** (prepared by hydrostannylation of 2-butyn-1-ol)[69] was used in a Stille cross-coupling reaction with **2.60** to forge the conjugated diene (Scheme 2.5.4). Sasaki and co-workers previously reported a similar Stille coupling in the total synthesis of brevenal.[39] In our work, copper(I) thiophene-2-carboxylate was replaced with the copper(I) bromide dimethylsulfide complex (CuBr•DMS) without any detrimental effect on the $Pd_2(dba)_3/Ph_3As$-catalyzed cross-coupling process, furnishing **2.71** in 78% yield. Completion of the synthesis was achieved with a chemoselective oxidation of the allylic alcohol using TEMPO in the presence of $PhI(OAc)_2$ in CH_2Cl_2 at room temperature, yielding (+)-brevisamide (**2.2**) in 90% yield.[19]

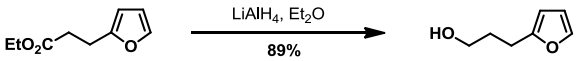
Scheme 2.5.4 Completetion of Brevisamide (**2.2**) Synthesis



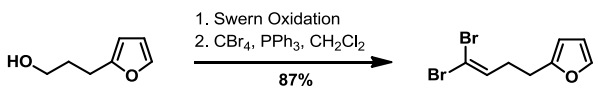
2-6 Conclusion

In summary, the total synthesis of (+)-brevisamide (**2.2**) has been completed in 16 steps (longest linear sequence) and an overall yield of 2.5% starting from the commercially available ethyl 3-(furan-2-yl)propionate **2.63**. The strategy was developed based on a notion of concise enantioselective assembly of the properly functionalized tetrahydropyran ring without the use of protecting groups. A catalytic asymmetric Henry reaction and then an Achmatowicz rearrangement were enlisted to successfully achieve this goal.

2-7: Brevisamide Supporting Information



3-(Furan-2-yl)propan-1-ol (2.72). Lithium aluminum hydride (4.29 g, 113 mmol, 3.0 equiv.) in diethyl ether (160 mL) was cooled to -78 °C. Ethyl 3-(furan-2-yl)propionate (**2.63**) (6.00 mL, 37.6 mmol) in diethyl ether (28 mL total with rinses) was added to the reaction vessel. After 10 min of stirring at -78 °C, the reaction vessel was allowed to warm to 0 °C and was stirred for 1 h. The reaction vessel was then warmed to rt and stirred for an additional 1 h before cooling back to 0 °C and slowly quenching with diH_2O (4.29 mL). The reaction mixture was stirred for 5 min at 0 °C at which time a 15 wt% NaOH (4.29 mL) solution and diH_2O (12.9 mL) were added sequentially and stirred for 5 min. The reaction vessel was then warmed to rt and stirred until a white precipitate and a clear organic solution were formed. The precipitate was filtered off and washed with diethyl ether, and the organic solution was collected and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 30% ethyl acetate – hexanes) delivering product **2.72** (4.21 g, 33.4 mmol, 89%). ^{1}H NMR (400 MHz, $CDCl_3$); δ(ppm): 7.31-7.30 (m, 1H); 6.28 (dd, *J1*=3.2 Hz, *J2*=2.0 Hz, 1H); 6.01 (dd, *J1*=3.2 Hz, *J2*=1.2 Hz, 1H); 3.69 (dd, *J1*=*J2*=6.0 Hz, 2H); 2.74 (dd, *J1*=*J2*=7.2 Hz, 2H); 1.95-1.86 (m, 2H); 1.42 (br s, 1H).[70]

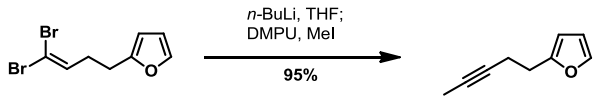


2-(4,4-Dibromobut-3-en-1-yl)furan (2.64). Dimethylsulfoxide (1.70 mL, 24.1 mmol, 3.0 equiv.) was added to oxalyl chloride (1.05 mL, 12.0 mmol, 1.5 equiv.) in dichloromethane (30 mL) at -78 ˚C and was stirred for 15 min. Substrate **2.72** (1.00 g, 7.93 mmol) in

dichloromethane (22.8 mL total with rinses) was transferred to the reaction vessel and stirred at -78 °C for 25 min. Triethylamine (5.00 mL, 35.9 mmol, 4.5 equiv.) was added to the reaction vessel and stirred for 10 min at -78 °C. The solution was then warmed to rt and stirred for an additional 10 min before 1.0 M HCl (30 mL); diH_2O (30 mL); diethyl ether (75 mL) were added. The phases were separated, and the aqueous phase was extracted with diethyl ether (3x50 mL). The combined organic phases were washed with a 1:1 v/v mixture of brine and saturated aqueous sodium bicarbonate and dried over sodium sulfate. The volatile crude aldehyde was concentrated by simple distillation at 60 °C to a volume of 5-10 mL remained at which point pentane (20 mL) was added and the distillation was continued until 5-10 mL remained. The crude organic mixture was then purified rapidly by column chromatography (silica, 30% diethyl ether – pentane) to avoid the decomposition of the aldehyde. Fractions containing the aldehyde were collected and concentrated by simple distillation at 60 °C until 5-10 mL remained, which was submitted to the Corey-Fuchs reaction.

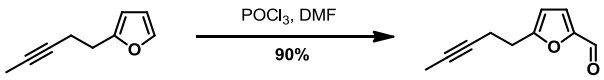
Triphenylphosphine (8.32 g, 31.7 mmol, 4.0 equiv.) was added to a solution of carbon tetrabromide (5.27 g, 15.9 mmol, 2.0 equiv.) in dichloromethane (15.4 mL) at 0 °C and stirred for 30 min. Then the diluted pure aldehyde (*ca.* 7.93 mmol) in dichloromethane (10.0 mL total with rinses) was added to the reaction vessel and stirred for 15 min at 0 °C. The reaction mixture was quenched with the addition of diH_2O (20 mL) and diethyl ether (40 mL). The phases were separated, and the aqueous layer was extracted with diethyl ether (3x20 mL). The combined organic phases were washed with brine, dried over sodium sulfate, and concentrated *in vacuo*. Removal of the triphenylphospine oxide was accomplished by addition of a small amount of diethyl ether (5 mL) to the crude product

followed by addition of pentane (60 mL) with agitation, which caused formation of a white solid (triphenylphosphine oxide). Solids were filtered through a plug column and washed with pentane. The collected organic phase was concentrated *in vacuo*. The residue was purified by column chromatography (silica, 100% pentane) delivering product **2.64** (1.93 g, 6.90 mmol, 87% over 2 steps). ^{1}H NMR (400 MHz, $CDCl_3$); δ(ppm): 7.33-7.31 (m, 1H); 6.42 (dd, *J1*=3.2, *J2*=2.0 Hz, 1H); 6.29 (dd, *J1*=3.2 Hz, *J2*=2.0 Hz, 1H); 6.03 (dd, *J1*=3.2 Hz, *J2*=0.8 Hz, 1H); 2.76 (dd, *J1*=*J2*=7.2 Hz, 2H); 2.44 (ddd, *J1*=*J2*=*J3*=7.2 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 154.3, 141.5, 137.4, 110.4, 105.8, 90.0, 31.8, 26.4. LRMS (ESI) calcd for $C_8H_9Br_2O$ [M+H] 278.90, found 279.89.



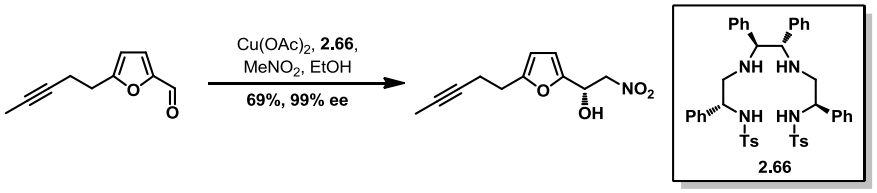
2-(Pent-3-yn-1-yl)furan (2.65). Substrate **2.64** (0.240 g, 0.857 mmol) in THF (1.10 mL) was cooled to -78 °C. *n*-Butyllithium (2.47 M, 1.05 mL, 2.59 mmol, 3.0 equiv.) was added to the reaction mixture and stirred for 1.25 h at -78 °C. DMPU (0.310 mL, 2.56 mmol, 3.0 equiv.) was added to the mixture at -78 °C and stirred for 5 min; followed by addition of methyl iodide (1.00 mL, 16.1 mmol, 18.8 equiv.). The reaction mixture was stirred for 1 h at -78°C and was then warmed to rt and stirred for an additional 1 h before adding saturated aqueous ammonium chloride. The resulting phases were separated, and the aqueous phase was extracted with diethyl ether (3x5 mL). The combined organic phases were washed with diH_2O (3x10 mL); brine (2x10 mL); dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 100% pentane) delivering product **2.65** (0.1094 g, 0.815 mmol, 95%). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.31-7.30

(m, 1H); 6.29-6.28 (m, 1H); 6.07-6.05 (m, 1H); 2.82 (dd, *J1=J2*=7.0 Hz, 2H); 2.48–2.43 (m, 2H); 1.77 (dd, *J1=J2*=2.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 154.8, 141.2, 110.3, 105.5, 78.2, 76.4, 28.2, 18.2, 3.8. LRMS (ESI) calcd for $C_9H_{10}O$ [M] 134.07, found 134.07.



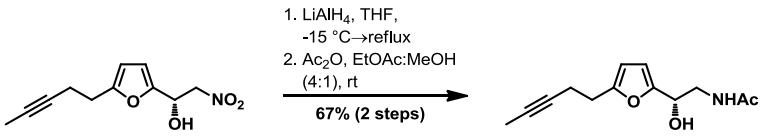
5-(Pent-3-yn-1-yl)furan-2-carbaldehyde (2.62). Dimethylformamide (1.35 mL, 17.4 mmol, 1.3 equiv.) was added to pre-cooled (0 °C) phosphonyl trichloride (1.35 mL, 14.7 mmol, 1.1 equiv.). The reaction vessel was capped and heated to 85 °C for 1.5 h. The reaction vessel was then cooled to 0 °C and substrate **8** (1.77 g, 13.2 mmol) in dimethylformamide (6.60 mL total with rinses) was added and stirred for 5 min. The reaction vessel was then capped, warmed to rt, and stirred for 24 h. The reaction mixture was added slowly to saturated aqueous sodium bicarbonate (50 mL) to quench the reaction. Additional saturated aqueous sodium bicarbonate was added until the reaction mixture had a pH 8-9. The phases were separated and the aqueous phase was extracted with dichloromethane (3x20 mL). The combined organic phases were then washed with a 1:1 mixture of brine and saturated aqueous sodium bicarbonate, dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 20% ethyl acetate - hexane) delivering product **2.62** (1.93 g, 11.9 mmol, 90%). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 9.54 (s, 1H); 7.18 (d, *J*=4.0 Hz, 1H); 6.34 (d, *J*=4.0 Hz, 1H); 2.91 (dd, *J1=J2*=7.5 Hz, 2H); 2.55–2.50 (m, 2H); 1.75 (dd, *J1=J2*=2.5 Hz, 3H). ^{13}C NMR (125

MHz, C_6D_6); δ(ppm): 176.8, 161.4, 153.0, 121.8, 109.3, 77.8, 77.3, 28.6, 18.0, 3.7. LRMS (ESI) calcd for $C_{10}H_{10}O_2$ [M] 162.07, found 162.07.



(*S*)-2-Nitro-1-(5-(pent-3-yn-1-yl)furan-2-yl)ethanol (2.67). Copper(II) acetate monohydrate (30.9 mg, 0.155 mmol, 0.025 equiv.) and ligand **2.66**[71] (0.235 g, 0.310 mmol, 0.050 equiv.) were dissolved in freshly distilled ethanol (6.20 mL) and stirred at rt for 1 h. Substrate **2.62** (1.00 g, 6.17 mmol) in freshly distilled ethanol (6.20 mL total with rinses) was added to the reaction vessel, followed by addition of freshly distilled nitromethane (6.60 mL, 123 mmol, 20 equiv.) and stirred at rt for 40 h. The reaction mixture was concentrated *in vacuo* and the residue was purified rapidly by column chromatography (silica, 10% diethyl ether – pentane, 30 % diethyl ether – pentane). The recovered starting material was then resubmitted to similar reaction conditions. Copper(II) acetate monohydrate (9.4 mg, 47 μmol, 0.025 equiv.) and ligand **2.66** (71.3 mg, 94 μmol, 0.050 equiv.) were dissolved in freshly distilled ethanol (1.90 mL) and stirred at rt for 1 h. Recovered substrate **2.62** (0.304 g, 1.87 mmol) in freshly distilled ethanol (1.90 mL total with rinses) was added to the reaction vessel, followed by addition of freshly distilled nitromethane (2.00 mL, 37.4 mmol, 20 equiv.) and stirred at rt for 72 h. The reaction mixture was concentrated *in vacuo* and the residue was purified rapidly by column chromatography (silica, 10% diethyl ether – pentane, 30 % diethyl ether – pentane) delivering the combined product **2.67** (0.955 g, 4.28 mmol, 69%); ee >99% by chiral HPLC analysis (Daicel Chiralcel OJ-H, 10% *i*-PrOH/hexanes,

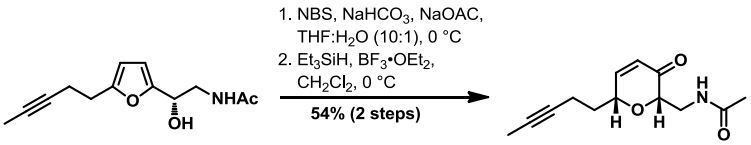
λ=215 nm, r=1.0 ml/min, R_t=30.6 min). $[\alpha]_D^{23}$ -38.6 (*c* 10.0, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 6.29 (d, *J1*=4.0 Hz, 1H); 6.06 (d, *J1*=4.0 Hz, 1H); 5.45-5.40 (m, 1H); 4.78 (dd, *J1*=14.0 Hz, *J2*=9.5 Hz, 1H); 4.66 (dd, *J1*=14.0 Hz, *J2*=3.5 Hz, 1H); 2.79 (dd, *J1*=*J2*=7.0 Hz, 2H); 2.66 (d, *J1*=5.5 Hz, 2H); 2.47–2.41 (m, 2H); 1.77 (dd, *J1*=*J2*=2.5 Hz, 3H). ^{13}C NMR (125 MHz, CD_3OD); δ(ppm): 156.6, 152.3, 109.3, 107.5, 80.2, 78.7, 77.1, 65.9, 29.1, 18.7, 3.2. LRMS (ESI) calcd for $C_{11}H_{13}NO_4Na$ [M+Na] 246.07, found 246.09.



(*S*)-*N*-(2-Hydroxy-2-(5-(pent-3-yn-1-yl)furan-2-yl)ethyl)acetamide (2.61). Lithium aluminum hydride (0.681 g, 17.9 mmol, 3.0 equiv.) in THF (18.0 mL) was cooled to -15 °C. Substrate **2.67** (0.802 g, 3.59 mmol) in THF (54 mL total with rinses) was slowly added to the reaction vessel and stirred for 30 min at -15 °C. The reaction mixture was warmed to rt and stirred for 30 min; then heated to reflux for 1.5 h before cooling back to 0 °C and slowly quenching with diH_2O (0.68 mL). The reaction mixture was stirred for 5 min at the same temperature at which time 15 wt% NaOH (0.68 mL) and diH_2O (2.05 mL) were added sequentially and stirred for 5 min. The reaction mixture was warmed to rt and stirred for 4 hours (until an off-white precipitate formed). The precipitate was filtered off and washed with diethyl ether. The collected organic phase was concentrated *in vacuo* and submitted to the next reaction without further purification.

The crude substrate was suspended in ethyl acetate (11.5 mL) and methanol (2.90 mL). Acetic anhydride (0.370 mL, 3.91 mmol, 1.1 equiv.) was added to the reaction vessel and

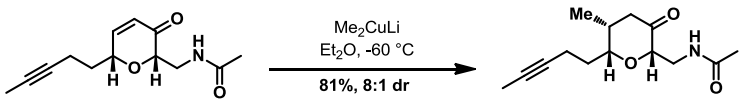
stirred at rt for 12 h. An aqueous solution of 10 wt% K_2CO_3 (15 mL) was added to the reaction vessel and stirred at rt for 10 min. The resulting phases were separated and the aqueous phase was extracted with ethyl acetate (3x10 mL). The combined organic phases were washed with brine, dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 80% ethyl acetate – hexanes, 90% ethyl acetate – hexanes, 100% ethyl acetate – hexanes, 95% ethyl acetate – methanol) delivering product **2.61** (0.567 g, 2.41 mmol, 67% over 2 steps). $[\alpha]_D^{23}$ -35.4 (*c* 10.0, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 6.19 (d, *J1*=3.0 Hz, 1H); 6.01 (d, *J1*=3.0 Hz, 1H); 5.96 (br s, 1H); 4.79-4.75 (m, 1H); 3.75 (ddd, *J1*=14.0 Hz, *J2*=6.5 Hz, *J3*=3.5Hz, 1H); 3.51 (ddd, *J1*=13.5 Hz, *J2*=7.5 Hz, *J3*=5.5 Hz, 1H); 3.12-3.10 (m, 1H); 2.78 (dd, *J1*=*J2*=7.0 Hz, 2H); 2.46–2.41 (m, 2H); 2.01 (s, 3H); 1.77 (dd, *J1*=*J2*=2.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 171.6, 154.8, 152.8, 107.7, 106.4, 78.1, 76.6, 67.7, 44.6, 28.1, 23.4, 18.1, 3.7. LRMS (ESI) calcd for $C_{13}H_{17}NO_3Na$ [M+Na] 258.11, found 258.12.



***N*-(((2R,6S)-3-Oxo-6-(pent-3-yn-1-yl)-3,6-dihydro-2H-pyran-2-yl)methyl)acetamide (2.68).** *N*-bromo-succinimide (0.223 g, 1.25 mmol, 1.0 equiv.) was added to a mixture of substrate **2.61** (0.293 g, 1.25 mmol), sodium bicarbonate (0.210 g, 2.50 mmol, 2.0 equiv.), and sodium acetate (0.103 g, 1.25 mmol, 1.0 equiv.) in THF (7.90 mL) and diH_2O (2.6 mL) at 0 °C (the reaction vessel was open to air). The reaction vessel was stirred at 0 °C for 1.5 h before addition of saturated aqueous ammonium chloride (10 mL). The phases were

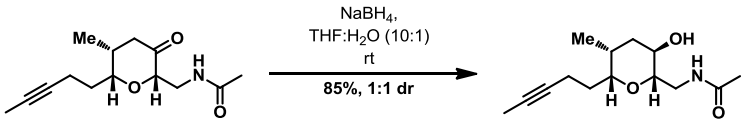
separated and the aqueous phase was extracted with ethyl acetate (3x10 mL). The combined organic phases were washed with brine, dried over sodium sulfate, and concentrated *in vacuo*. The crude product was submitted to the next reaction without further purification.

The crude substrate in dichloromethane (12.5 mL) was cooled to 0 °C. Triethylsilane (1.00 mL, 6.26 mmol, 5.0 equiv.) was added to the reaction vessel followed by addition of BF_3•Et_2O (0.310 mL, 2.51 mmol, 2.0 equiv.) at 0 °C and stirring for 30 min. The reaction was quenched by addition of saturated aqueous sodium bicarbonate (15 mL). The phases were separated and the aqueous phase was extracted with ethyl acetate (3x10 mL). The combined organic phases were washed with brine, dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 80% ethyl acetate – hexanes) delivering product **2.68** (0.159 g, 0.676 mmol, 54% over 2 steps). $[\alpha]_D^{23}$ 22.5 (*c* 10.0, $CHCl_3$). ^{1}H NMR (400 MHz, $CDCl_3$); δ(ppm): 6.95 (dd, *J1*=10.4 Hz, *J2*=1.6 Hz, 1H); 6.09 (dd, *J1*=10.4 Hz, *J2*=2.4 Hz, 1H); 6.02 (br s, 1H); 4.55-4.49 (m, 1H); 4.04 (ddd, *J1*=*J2*=5.60 Hz, *J3*=1.6 Hz, 1H); 3.70–3.55 (m, 2H); 2.38–2.22 (m, 2H); 1.97 (s, 3H); 1.86–1.79 (m, 2H); 1.76 (dd, *J1*=*J2*=2.4 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$); δ(ppm): 195.9, 170.2, 151.8, 127.0, 78.1, 77.8, 77.0, 73.1, 39.4, 34.0, 23.5, 14.7, 3.7. LRMS (ESI) calcd for $C_{13}H_{17}NO_3Na$ [M+Na] 258.11, found 258.11.

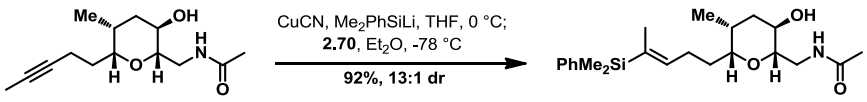


***N*-(((2R,5S,6S)-5-Methyl-3-oxo-6-(pent-3-yn-1-yl)tetrahydro-2H-pyran-2-yl)methyl)acetamide (2.69).** Methyl-lithium (1.64 M in diethyl ether, 1.19 mL, 1.95 mmol,

3.3 equiv.) was added to a solution of copper(I) bromide-dimethyl sulfide complex (0.200 g, 0.973 mmol, 1.65 equiv.) in diethyl ether (1.35 mL) at -60 °C. The reaction vessel was warmed to -30 °C and stirred for 20 min then cooled to -78 °C and substrate **2.68** (0.138 g, 0.587 mmol) in diethyl ether (4.50 mL total with rinses) was added dropwise. The reaction vessel was stirred at -78 °C for 1 h and then warmed to 0 °C over 30 min before being quenched with a 9:1 v/v solution of saturated aqueous ammonium chloride and ammonium hydroxide (15 mL). The biphasic mixture was stirred for 3 h at rt (until a dark blue solution formed). The phases were separated and the aqueous phase was extracted with diethyl ether (3x10 mL). The combined organic phases were washed with brine, dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 80% ethyl acetate – hexanes) delivering product **2.69** (0.120 g, 0.477 mmol, 81%, 8:1 dr). A sample of the diastereomers was separated using preparative HPLC. The separation was conducted on a YMC-Pack Sil HPLC column (250x30mmID, S-10 μm, 12 nm) with 2.0 mL injection (10% *i*-PrOH/hexanes as eluent at a rate of 20 mL/min, λ=210 nm, R_t=48.0 min) afforded pure product **12** (80.4 mg, 0.320 mmol). $[\alpha]_D^{23}$ 52.3 (c 10.0, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 5.86 (br s, 1H); 4.01 (ddd, *J1*=9.0 Hz, *J2*=4.5 Hz, *J3*=2.0 Hz, 1H); 3.92 (dd, *J1*=*J2*=6.0 Hz, 1H); 3.58 (ddd, *J1*=14.0 Hz, *J2*=*J3*=6.0 Hz, 1H); 3.49 (ddd, *J1*=14.0 Hz, *J2*=*J3*=6.0 Hz, 1H); 2.71 (dd, *J1*=15.0 Hz, *J2*=6.0 Hz, 1H); 2.34 (dd, *J1*=15.0 Hz, *J2*=2.0 Hz, 1H); 2.32–2.25 (m, 3H); 1.97 (s, 3H); 1.80–1.73 (m, 3H); 1.79 (dd, *J1*=*J2*=2.5 Hz, 3H); 1.60–1.54 (m, 1H); 0.94 (d, *J1*=6.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 208.1, 170.1, 80.5, 78.4, 78.0, 76.4, 47.4, 39.1, 36.0, 31.9, 23.6, 15.9, 13.5, 3.8. LRMS (ESI) calcd for $C_{14}H_{21}NO_3Na$ [M+Na] 274.14, found 274.15.

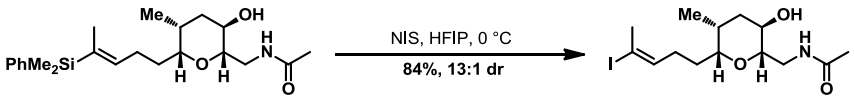


***N*-(((2R,3S,5S,6S)-3-Hydroxy-5-methyl-6-(pent-3-yn-1-yl)tetrahydro-2H-pyran-2-yl)methyl)acetamide (2.70)**. Sodium borohydride (21.8 mg, 0.576 mmol, 4.0 equiv.) in diH_2O (0.26 mL) was added dropwise to substrate **2.69** (36.3 mg, 0.144 mmol) in THF (2.60 mL) at rt and stirred for 5 min before it was quenched with saturated aqueous ammonium chloride (5 mL). The phases were separated and the aqueous phase was extracted with ethyl acetate (3x5 mL). The combined organic phases were washed with brine, dried over sodium sulfate, concentrated *in vacuo*. The residue was purified by column chromatography (silica, 70% ethyl acetate – hexanes to 100% ethyl acetate - hexanes) delivering product **2.70** (15.5 mg, 61.2 µmol, 42.5%) as a single diastereomer. $[\alpha]_D^{23}$ 124.5 (c 10.0, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 5.96 (br s, 1H); 3.99–3.93 (m, 2H); 3.54–3.50 (m, 1H); 3.46-3.40 (m, 1H); 3.14–3.07 (m, 2H); 2.27–2.12 (m, 2H); 2.05 (s, 3H); 1.94 (ddd, *J1*=12.5 Hz, *J2*=4.5 Hz, *J3*=2.5 Hz, 1H); 1.90–1.83 (m, 1H); 1.78 (dd, *J1*=*J2*=2.5 Hz, 3H); 1.70–1.59 (m, 2H); 1.50–1.44 (m, 1H); 0.91 (d, *J1*=7.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 172.3, 82.6, 79.1, 78.8, 76.0, 62.3, 41.2, 38.6, 32.8, 32.4, 23.2, 15.9, 13.1, 3.8. LRMS (ESI) calcd for $C_{14}H_{23}NO_3Na$ [M+Na] 276.33, found 276.19.

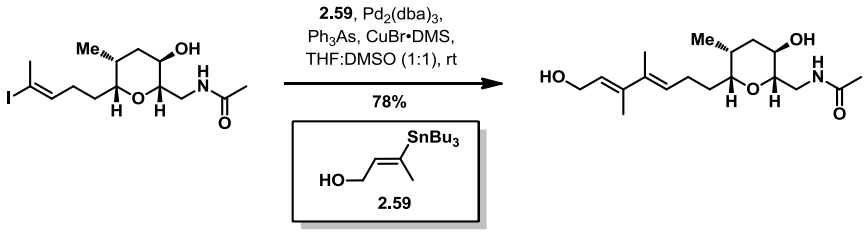


***N*-(((2R,5S,6S)-6-((E)-4-(Dimethyl(phenyl)silyl)pent-3-en-1-yl)-5-methyl-3-oxotetrahydro-2H-pyran-2-yl)methyl)acetamide (2.73).** $PhMe_2SiLi$ (0.9 M solution in

THF, 4.20 mL, 3.78 mmol, 20 equiv.) was added to a solution of copper cyanide (0.170 g, 1.90 mmol, 10 equiv.) in THF (4.80 mL) at 0 °C and stirred for 20 minutes. The reaction vessel was cooled to -78 °C followed by addition of substrate **2.70** (47.9 mg, 0.189 mmol) in ether (6.30 mL total with rinses) and then THF (0.30 mL). The reaction vessel was stirred at -78 °C for 1 h and was warmed to 0 °C and stirred for 1 h before being quenched with a 9:1 v/v solution of saturated aqueous ammonium chloride and ammonium hydroxide (15 mL). The biphasic mixture was stirred for 3 h at rt (until a dark blue aqueous solution formed). The phases were separated and the aqueous layer was extracted with ethyl acetate (3x10 mL). The combined organic phases were washed with saturated aqueous sodium bicarbonate, brine, dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 60% ethyl acetate – hexanes to 80% ethyl acetate - hexanes) delivering product **2.73** (68.2 mg, 0.175 mmol, 93%,) as a 13:1 inseparable mixture of regioisomers. $[\alpha]_D^{23}$ 62.1 (*c* 5.0, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.52-7.46 (m, 2H); 7.36-7.32 (m, 3H); 5.97 (br s, 1H); 5.78 (ddd, *J1*=*J2*=7.0 Hz, *J3*=1.5 Hz, 1H); 4.03–3.89 (m, 2H); 3.47–3.34 (m, 2H); 3.12–3.02 (m, 2H); 2.22-2.10 (m, 2H); 2.04 (s, 3H); 1.94 (ddd, *J1*=13.0 Hz, *J2*=4.5 Hz, *J3*=2.5 Hz, 1H); 1.90–1.82 (m, 1H); 1.66 (s, 3H); 1.65–1.51 (m, 2H); 1.41–1.32 (m, 1H); 0.92 (d, *J1*=6.5 Hz, 3H); 0.32 (s, 6H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 172.3, 141.0, 138.9, 135.0, 134.1, 129.0, 127.9, 82.7, 80.0, 62.2, 41.2, 38.7, 32.8, 32.3, 25.3, 23.2, 14.9, 12.9, -3.2. LRMS (ESI) calcd for $C_{32}H_{35}NO_2SiNa$ [M+Na] 412.23, found 412.23.

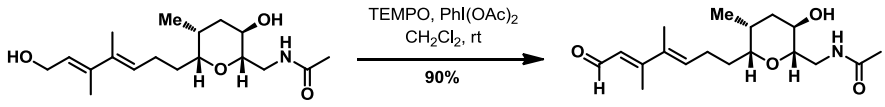


***N*-(((2R,5S,6S)-6-((E)-4-Iodopent-3-en-1-yl)-5-methyl-3-oxotetrahydro-2H-pyran-2-yl)methyl)acetamide (2.60)**. *N*-Iodosuccinimide (74.7 mg, 0.332 mmol, 2.0 equiv.) was added to a solution of substrate **2.73** (64.8 mg, 0.166 mmol) and 2,6-lutidine (15.5 µL, 0.133 mmol, 0.8 equiv.) in hexafluoroisopropanol (1.70 mL) at 0 °C and stirred for 5 min. Ethyl acetate (3 mL) and diH_2O (3 mL) were added to the reaction mixture. The phases were separated and the aqueous phase was extracted with ethyl acetate (3x5 mL). The combined organic phases were washed with saturated aqueous sodium thiosulfate (10 mL); 1 M HCl (10 mL); diH_2O (10 mL); brine, dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 60% ethyl acetate – hexanes to 80% ethyl acetate - hexanes) delivering product **2.60** (53.0 mg, 0.139 mmol, 84%) as a 13:1 inseparable mixture of regioisomers. $[\alpha]_D^{23}$ 104.1 (*c* 5.0, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 6.15 (ddd, *J1*=*J2*=7.5 Hz, *J3*=1.5 Hz, 1H); 5.98 (br s, 1H); 4.05–3.96 (m, 2H); 3.46–3.35 (m, 2H); 3.11–3.04 (m, 2H); 2.37 (s, 3H); 2.12–2.04 (m, 2H); 2.06 (s, 3H); 1.94 (ddd, *J1*=12.5 Hz, *J2*=4.5 Hz, *J3*=2.5 Hz, 1H); 1.88–1.80 (m, 1H); 1.70–1.61 (m, 1H); 1.59-1.49 (m, 1H) 1.38–1.30 (m, 1H); 0.91 (d, *J1*=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 172.4, 140.9, 94.1, 82.7, 79.6, 62.1, 41.1, 38.6, 33.0, 32.0, 27.64, 27.60, 23.2, 13.0. LRMS (ESI) calcd for $C_{14}H_{24}NO_2INa$ [M+Na] 404.07, found 404.09.



***N*-(((2R,3S,5S,6S)-3-Hydroxy-6-((3E,5E)-7-hydroxy-4,5-dimethylheptα–3,5-dien-1-yl)-5-methyltetrahydro-2H-pyran-2-yl)methyl)acetamide (2.71).** Vinyl stannane **2.59**[72] (56.0 mg, 0.155 mmol, 5.0 equiv.) in a 1:1 v/v solution of THF and dimethylsulfoxide (3.40 mL) was added to a solution of substrate 14 (14.1 mg, 37.0 µmol) in a 1:1 v/v solution of THF and dimethylsulfoxide (1:1, 0.60 mL) at rt. Copper(I) bromide-dimethylsulfide complex (81.0 mg, 0.394 mmol, 12.7 equiv.); triphenylarsenic (7.7 mg, 25.1 µmol, 0.8 equiv.); and $Pd_2(dba)_3$ (2.8 mg, 3.1 µmol, 0.8 equiv.) were added sequentially to the reaction vessel at rt and stirred for 1 h. diH_2O (4 mL) was added to the reaction vessel at rt and stirred for 20 min. The reaction vessel was filtered through Celite and washed with ethyl acetate (30 mL total with rinses). The collected organic phases were washed with diH_2O (20 mL); brine (20 mL); dried over sodium sulfate, and concentrated *in vacuo*. The residue was purified by column chromatography (silica, 60% ethyl acetate – hexanes to 80% ethyl acetate – hexanes to 100% ethyl acetate to 5% methanol - ethyl acetate) and fractions containing product **2.71** were collected and concentrated *in vacuo*. The residue was purified again to remove traces of the vinyl stannane **2** by column chromatography (silica, 60% ethyl acetate – hexanes to 80% ethyl acetate – hexanes to 100% ethyl acetate to 5% methanol - ethyl acetate) delivering product **14** (9.4 mg, 28.9 µmol, 78%).$[\alpha]_D^{23}$ 92.4 (c 2.0, $CHCl_3$). ^{1}H NMR (500 MHz, CD_3OD); δ(ppm): 8.01 (br s, 1H); 5.65 (dd, *J1*=*J2*=6.5 Hz, 1H); 5.60 (dd, *J1*=*J2*=6.5 Hz, 1H); 4.22 (d, *J1*=6.5 Hz, 2H); 3.58–3.53 (m, 1H); 3.45–3.38 (m, 2H); 3.36–3.32 (m, 1H);

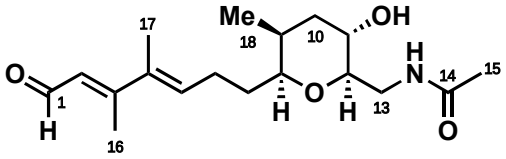
3.08 (ddd, *J1*=9.50 Hz, *J2*=6.50 Hz, *J3*=2.5 Hz, 1H); 2.34–2.16 (m, 2H); 1.97 (s, 3H); 1.92 (ddd, *J1*=12.5 Hz, *J2*=4.5 Hz, *J3*=2.5 Hz, 1H); 1.87–1.82 (m, 1H); 1.81 (s, 3H); 1.80 (s, 3H); 1.66–1.57 (m, 2H); 1.43–1.33 (m, 1H); 0.97 (d, *J1*=7 Hz, 3H). ^{13}C NMR (125 MHz, CD_3OD); δ(ppm): 173.9, 139.5, 137.7, 128.0, 125.8, 83.2, 80.5, 65.1, 60.2, 42.7, 41.0, 34.3, 33.9, 26.2, 22.6, 14.4, 14.3, 13.2. LRMS (ESI) calcd for $C_{18}H_{31}NO_4Na$ [M+Na] 348.22, found 348.30.



(+)-brevisamide (2.2)

(+)-Brevisamide (2.2). (Diacetoxyiodo)benzene (7.4 mg, 23.0 µmol, 1.5 equiv.) in dichloromethane (0.600 mL) was added dropwise to a solution of substrate **2.71** (4.8 mg, 14.7 µmol) and TEMPO (1.2 mg, 7.7 µmol, 0.5 equiv.) in CH_2Cl_2 (0.600 mL) at rt and was stirred for 2 h. The reaction mixture was concentrated *in vacuo*. The residue was purified by column chromatography (silica, 2.5% methanol - chloroform) delivering (+)-brevisamide **2.2** (4.3 mg, 13.3 µmol, 90%). $[\alpha]_D^{23}$ 15.5 (c 1.0, MeOH) *^{1}H* NMR (500 MHz, CD_3OD); δ(ppm): 10.10 (d, *J1*=8.5 Hz, 1H); 6.24 (dd, *J1*=*J2*=7.5 Hz, 1H); 6.05 (d, *J1*=8.5 Hz, 1H); 3.55 (dd, *J1*=14.5 Hz, *J2*=3.0 Hz, 1H); 3.46–3.38 (m, 2H); 3.37-3.33 (m, 1H); 3.09 (ddd, *J1*=9.5 Hz, *J2*=7.0 Hz, *J3*=3.0 Hz, 1H); 2.40 – 2.32 (m, 1H); 2.34 (s, 3H); 1.97 (s, 3H); 1.92 (ddd, *J1*=12.5 Hz, *J2*=5.0 Hz, *J3*=2.5 Hz, 1H); 1.88 (s, 3H); 1.87–1.82 (m, 1H); 1.71–1.58 (m, 2H); 1.50–1.42 (m, 1H); 0.98 (d, *J1*=7.0 Hz, 3H). ^{13}C NMR (125 MHz, CD_3OD); δ(ppm): 194.5, 173.9, 161.1, 137.4, 137.0, 126.4, 83.2, 80.5, 65.1, 42.7, 41.0, 34.4, 33.3, 27.0, 22.6, 14.7, 14.1, 13.2. LRMS (ESI) calcd for $C_{18}H_{29}NO_4Na$ [M+Na] 346.20, found 346.23.

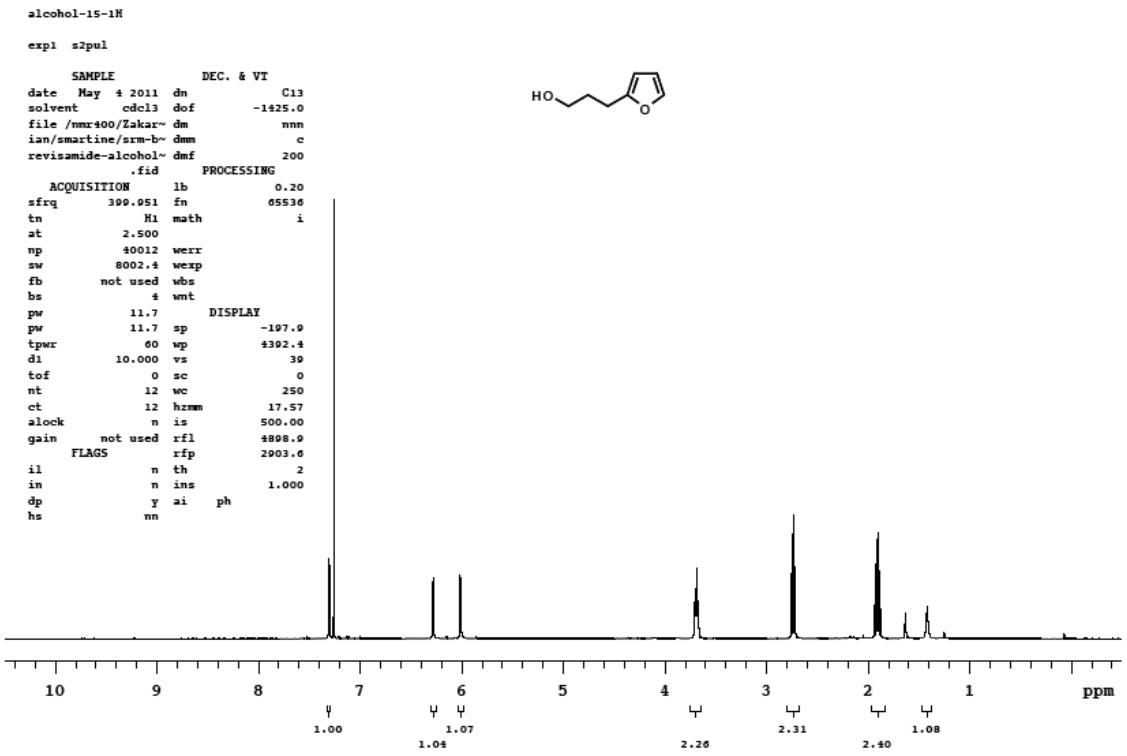
Table 1. Synthetic Brevisamide Spectral Data Compared to Natural Brevisamide Data



brevisamide (**1**)

Position	^{1}H NMR (mult, *J* in Hz)		^{13}C NMR	
	Synthetic	Natural	Synthetic	Natural
1	10.10 (d, 8.5)	10.10 (d, 7.9)	194.5	194.4
2	6.05 (d, 8.5)	6.04 (d, 7.9)	126.4	126.3
3			161.1	160.9
4			137.4	137.2
5	6.24 (dd, 7.5)	6.23 (t, 7.1)	137.0	136.8
6	2.36 m	2.34 m	27.0	26.9
7a	1.65 m	1.65 m	33.3	33.2
7b	1.46 m	1.44 m		
8ax	3.42 m	3.39 m	80.5	80.3
9eq	1.85 m	1.85 m	34.4	34.3
10eq	1.92 (ddd, 2.5, 5.0, 12.5)	1.90 m	41.0	40.9
10ax	1.65 m	1.65 m		
11ax	3.42 m	3.42 m	65.1	65.0
12a	3.09 (ddd, 3.0, 7.0, 9.5)	3.08 (ddd, 2.6, 7.0, 9.3)	83.2	83.1
13a	3.55 (dd, 3.0, 14.5)	3.53 (dd, 2.6, 14.0)	42.7	42.5
13b	3.35 m	3.32 (dd, 7.1, 14.0)		
14			173.9	173.7
15	1.97 s	1.95 s	22.6	22.5
16	2.34 s	2.33 s	14.7	14.6
17	1.88 s	1.86 s	14.1	14.0
18	0.98 (d, 7.0)	0.95 (d, 6.9 Hz)	13.2	13.1

^{1}H NMR: Synthetic at 500 MHz; Natural at 500 MHz in CD_3OD
^{13}C NMR: Synthetic at 125 MHz; Natural at 125 MHz in CD_3OD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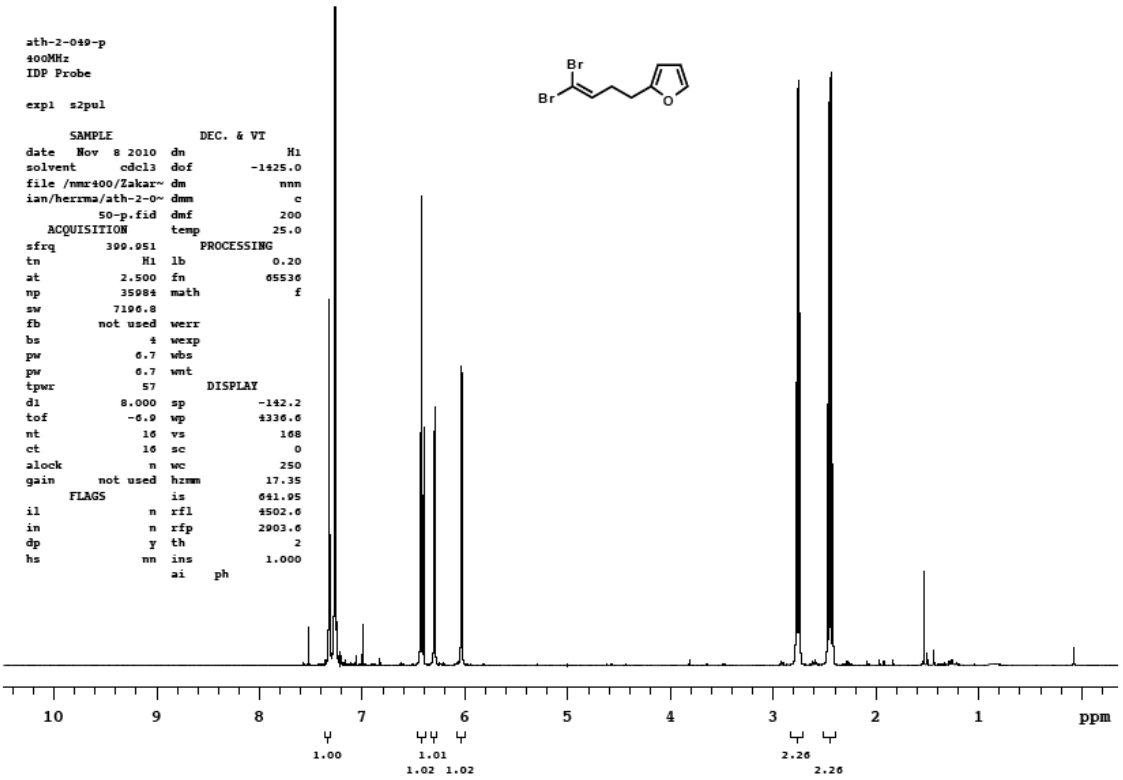
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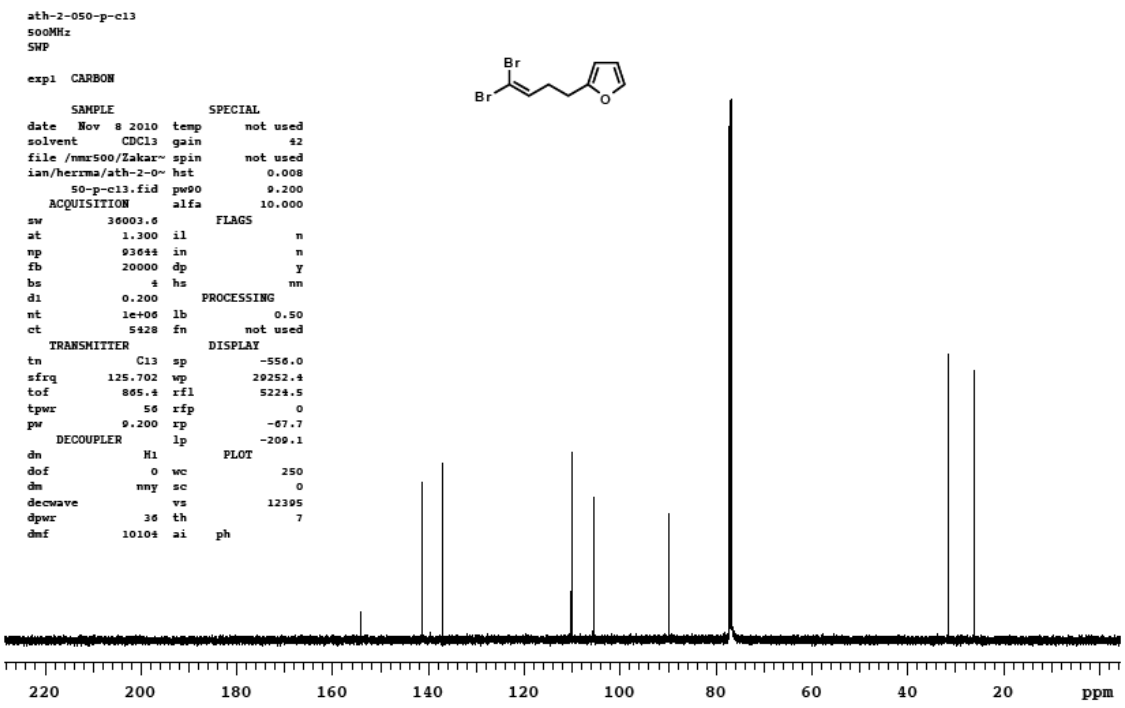
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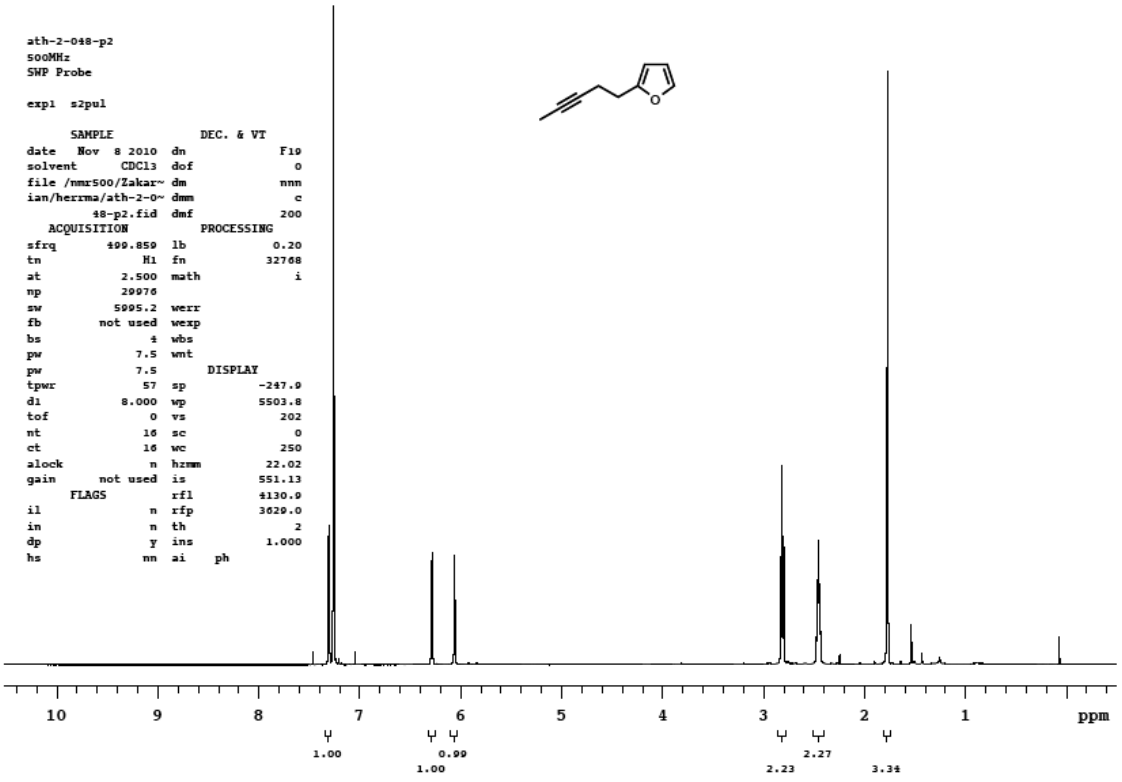
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wbs
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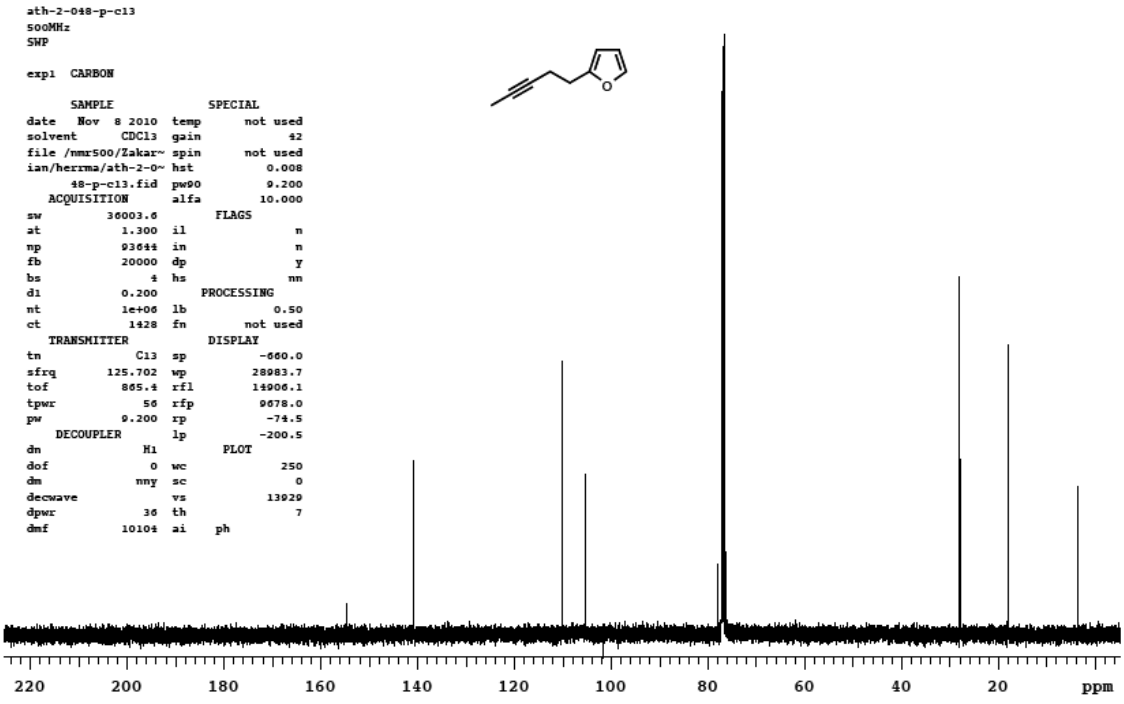
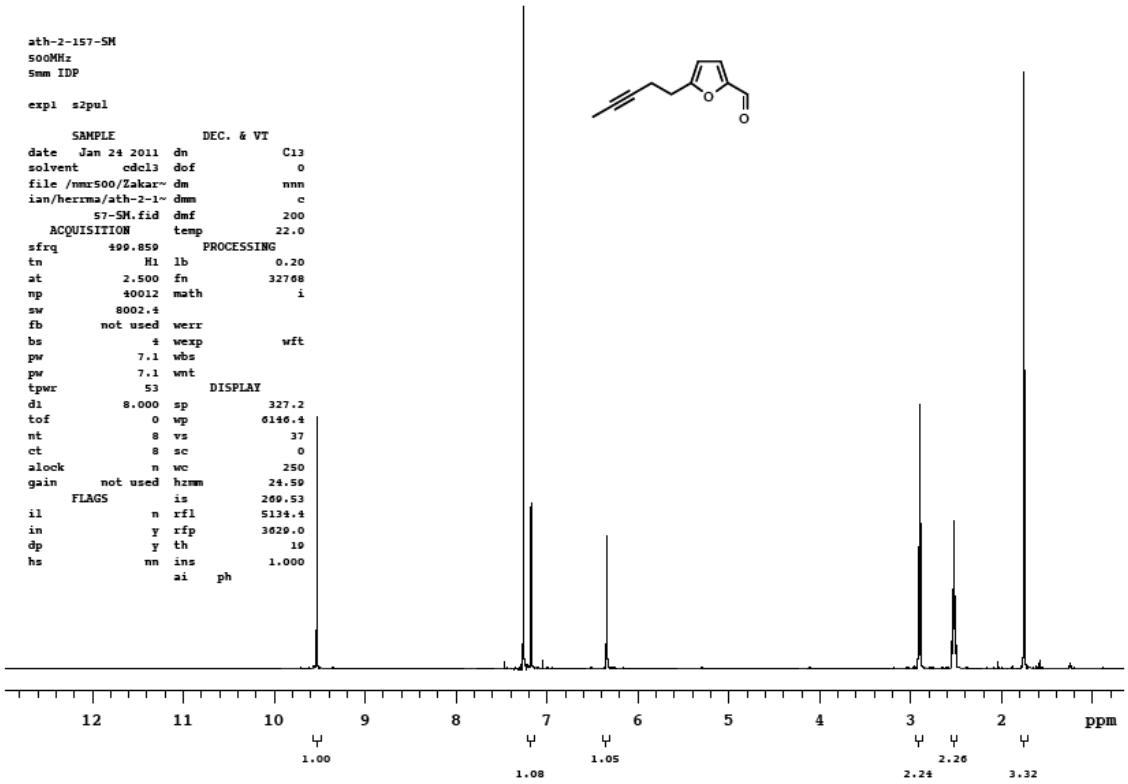
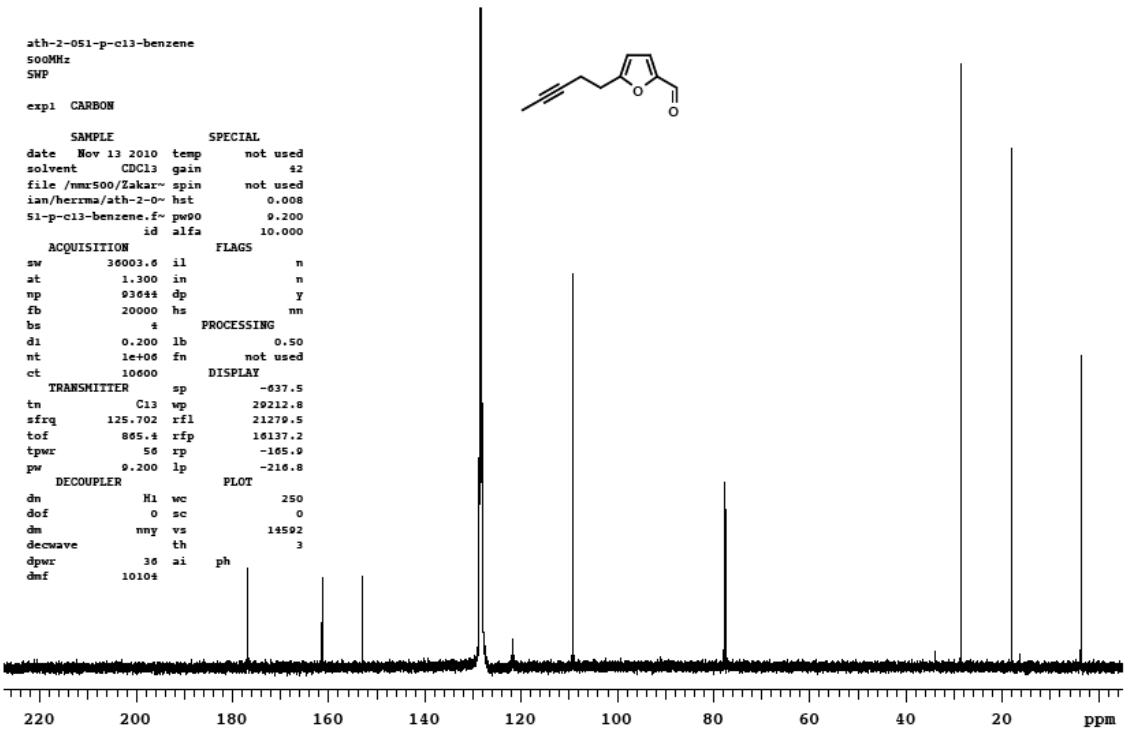
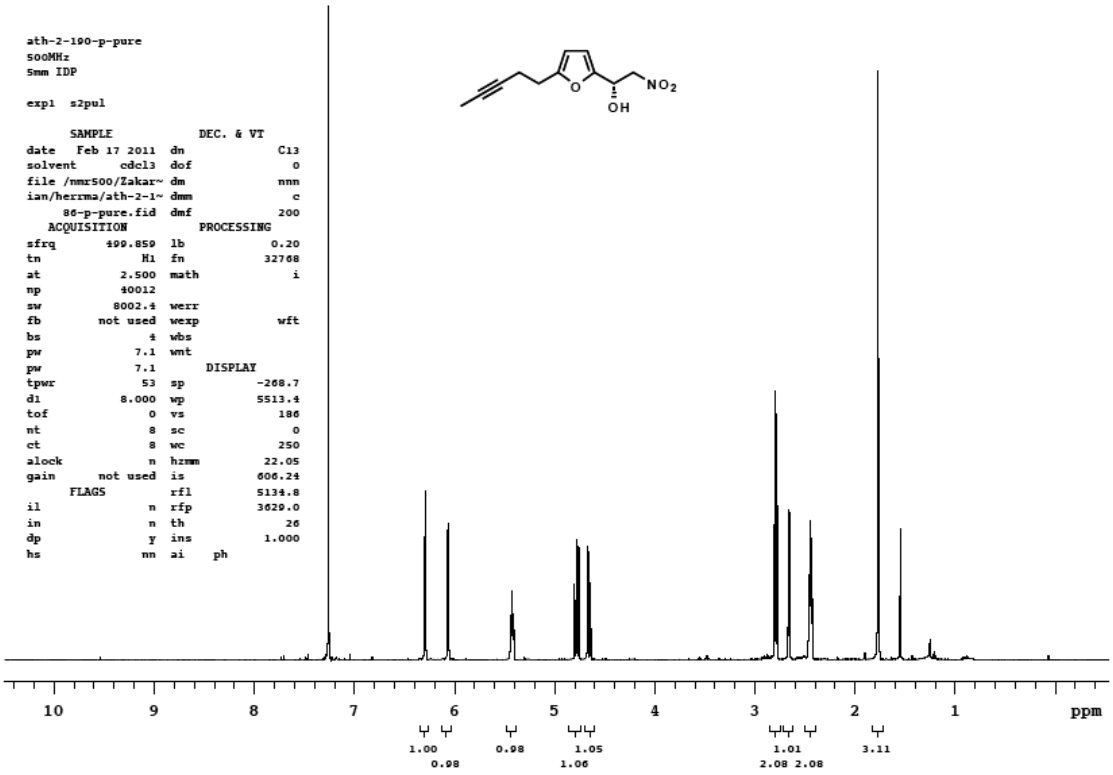
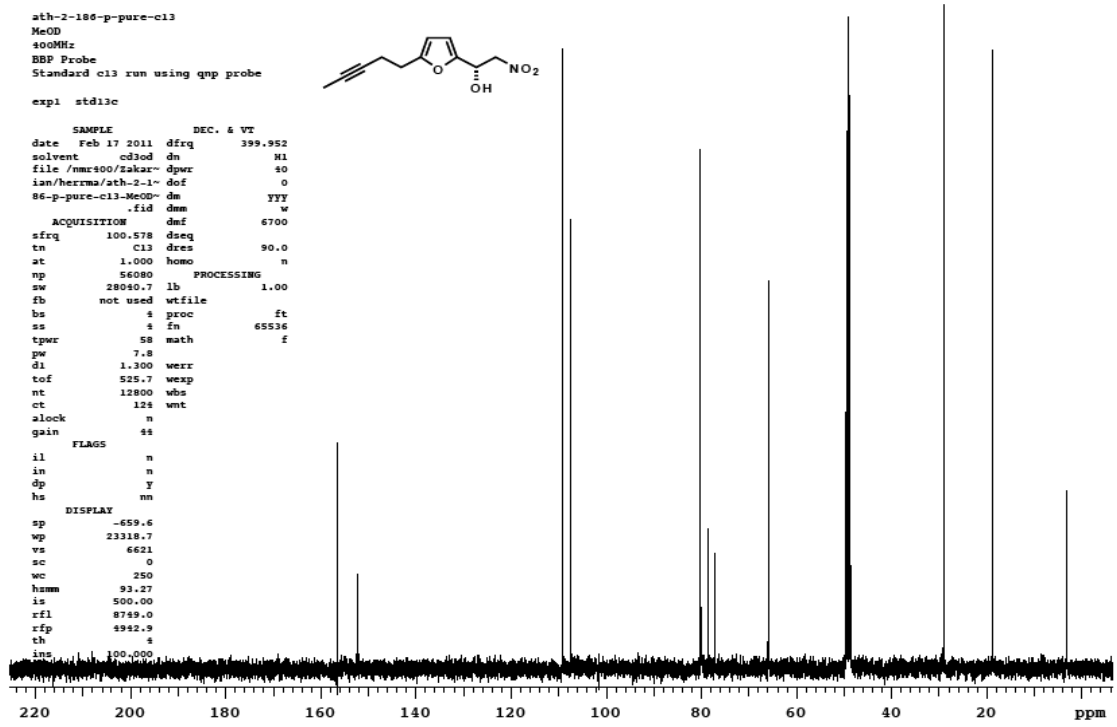
rfl 4130.9
rfp 3629.0
th 2
ins 1.000
ai ph
10
9
8
7
6
5
4
3
2
1
ppm
1.00
0.99
1.00
2.23
2.27
3.34


ath-2-048-p-c13
500MHz
SWP
exp1 CARBON
SAMPLE
date Nov 8 2010
solvent CDCl3
file /nmr500/Zakar~
ian/herrma/ath-2-0~
48-p-c13.fid
ACQUISITION
sw 36003.6
at 1.300
np 93644
fb 20000
bs 4
d1 0.200
nt 1e+06
ct 1428
TRANSMITTER
tn C13
sfrq 125.702
tof 865.4
tpwr 56
pw 9.200
DECOUPLER
dn H1
dof 0
dm nny
decwave
dpwr 36
dmf 10104
SPECIAL
temp not used
gain 42
spin not used
hst 0.008
pw90 9.200
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -660.0
wp 28983.7
rfl 14906.1
rfp 9678.0
rp -74.5
lp -200.5
PLOT
wc 250
sc 0
vs 13929
th 7
ai ph
220
200
180
160
140
120
100
80
60
40
20
ppm


ath-2-157-SM
500MHz
5mm IDP
exp1 s2pul
SAMPLE
date Jan 24 2011
solvent cdcl3
file /nmr500/Zakar~
ian/herrma/ath-2-1~
57-SM.fid
ACQUISITION
sfrq 499.859
tn H1
at 2.500
np 40012
sw 8002.4
fb not used
bs 4
pw 7.1
pw 7.1
tpwr 53
d1 8.000
tof 0
nt 8
ct 8
alock n
gain not used
FLAGS
il n
in y
dp y
hs nn
DEC. & VT
dn C13
dof 0
dm nnn
dmm c
dmf 200
temp 22.0
PROCESSING
lb 0.20
fn 32768
math i
werr
wexp wft
wbs
wnt
DISPLAY
sp 327.2
wp 6146.4
vs 37
sc 0
wc 250
hzmm 24.59
is 269.53
rfl 5134.4
rfp 3629.0
th 19
ins 1.000
ai ph
O
O
12
11
10
9
8
7
6
5
4
3
2
ppm
1.00
1.08
1.05
2.24
2.26
3.32

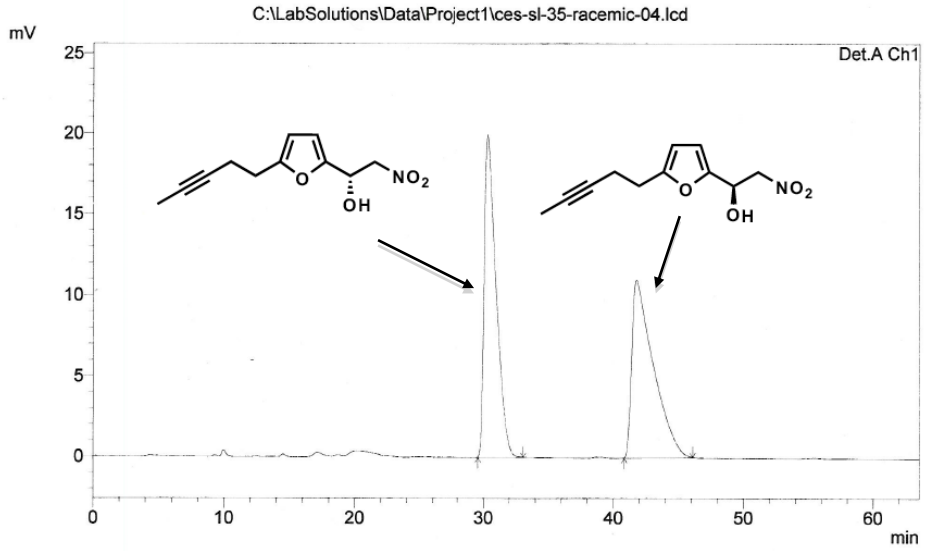

ath-2-051-p-c13-benzene
500MHz
SWP
exp1 CARBON
SAMPLE
date Nov 13 2010
solvent CDCl3
file /nmr500/Zakar~
ian/herrma/ath-2-0~
51-p-c13-benzene.f~
id
ACQUISITION
sw 36003.6
at 1.300
np 93644
fb 20000
bs 4
d1 0.200
nt 1e+06
ct 10600
TRANSMITTER
tn C13
sfrq 125.702
tof 865.4
tpwr 56
pw 9.200
DECOUPLER
dn H1
dof 0
dm nny
decwave
dpwr 36
dmf 10104
SPECIAL
temp not used
gain 42
spin not used
hst 0.008
pw90 9.200
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -637.5
wp 29212.8
rfl 21279.5
rfp 16137.2
rp -165.9
lp -216.8
PLOT
wc 250
sc 0
vs 14592
th 3
ai ph
O
O
220
200
180
160
140
120
100
80
60
40
20
ppm


ath-2-190-p-pure
500MHz
5mm IDP
exp1 s2pul
SAMPLE
date Feb 17 2011
solvent cdcl3
file /nmr500/Zakar~
ian/herrma/ath-2-1~
86-p-pure.fid
ACQUISITION
sfrq 499.859
tn H1
at 2.500
np 40012
sw 8002.4
fb not used
bs 4
pw 7.1
pw 7.1
tpwr 53
d1 8.000
tof 0
nt 8
ct 8
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn C13
dof 0
dm nnn
dmm c
dmf 200
PROCESSING
lb 0.20
fn 32768
math i
werr
wexp wft
wbs
wnt
DISPLAY
sp -268.7
wp 5513.4
vs 186
sc 0
wc 250
hzmm 22.05
is 606.24
rfl 5134.8
rfp 3629.0
th 26
ins 1.000
ai ph
NO2
OH
10
9
8
7
6
5
4
3
2
1
ppm
1.00
0.98
0.98
1.05
1.06
1.01
2.08
2.08
3.11


ath-2-186-p-pure-c13
MeOD
400MHz
BBP Probe
Standard c13 run using qnp probe
exp1 std13c
SAMPLE
date Feb 17 2011
solvent cd3od
file /nmr400/Zakar~
ian/herrma/ath-2-1~
86-p-pure-c13-MeOD~
.fid
ACQUISITION
sfrq 100.578
tn C13
at 1.000
np 56080
sw 28040.7
fb not used
bs 4
ss 4
tpwr 58
pw 7.8
d1 1.300
tof 525.7
nt 12800
ct 124
alock n
gain 44
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -659.6
wp 23318.7
vs 6621
sc 0
wc 250
hzmm 93.27
is 500.00
rfl 8749.0
rfp 4942.9
th 4
ins 100.000
DEC. & VT
dfrq 399.952
dn H1
dpwr 40
dof 0
dm YYY
dmm w
dmf 6700
dseq
dres 90.0
homo n
PROCESSING
lb 1.00
wtfile
proc ft
fn 65536
math f
werr
wexp
wbs
wnt
NO2
OH
220
200
180
160
140
120
100
80
60
40
20
ppm

==== Shimadzu LCsolution LC Data Image ====

<Chromatogram>



Sample Information

Acquired by	: Admin
Sample Name	: ces-sl-35-racemic
Sample ID	: ces-sl-35-racemic
Vail#	:
Injection Volume	: 30 uL
Data Filename	: ces-sl-35-racemic-04.lcd
Method Filename	: ces-OJ-H-analytical.lcm
Batch Filename	:
Report Filename	: Default.lcr
Date Acquired	: 8/18/2010 6:20:28 PM
Data Processed	: 8/18/2010 7:24:02 PM

PeakTable

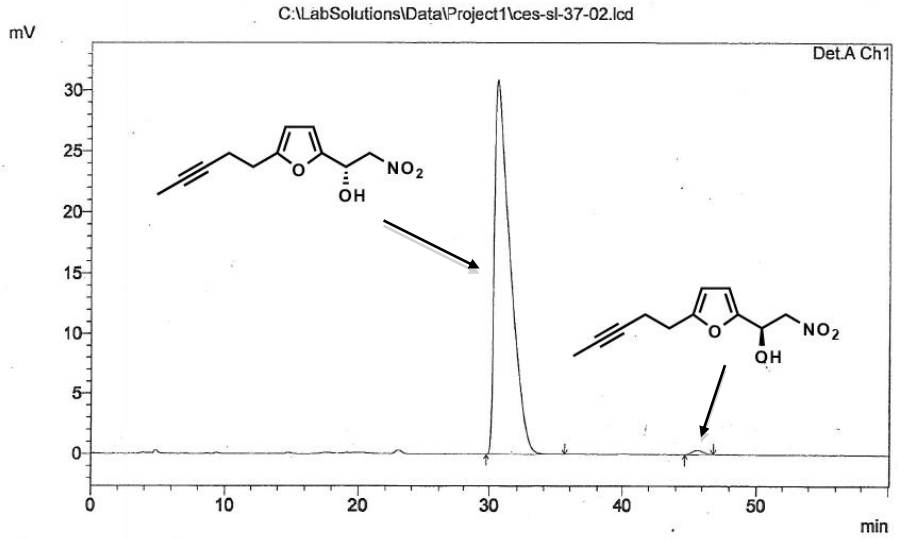
Detector A Ch1 215nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	30.310	1271586	19959	50.121	64.482
2	41.773	1265471	10994	49.879	35.518
Total		2537057	30954	100.000	100.000

==== Shimadzu LCsolution LC Data Image ====

natc

<Chromatogram>



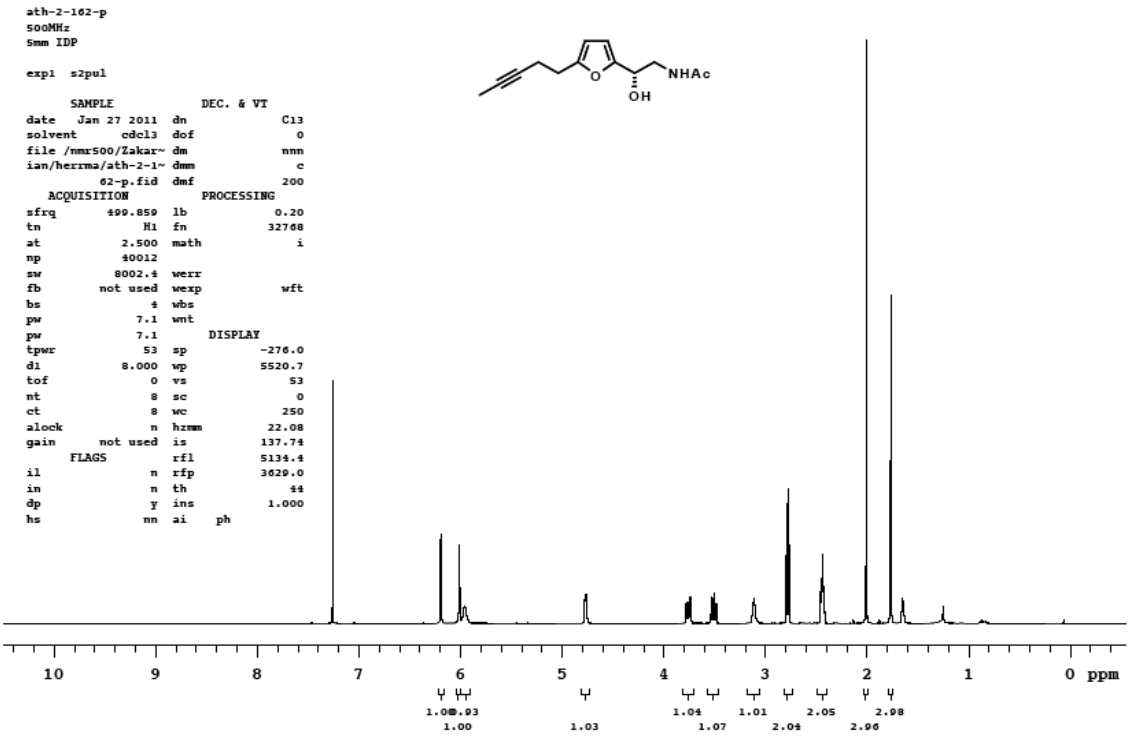
Sample Information

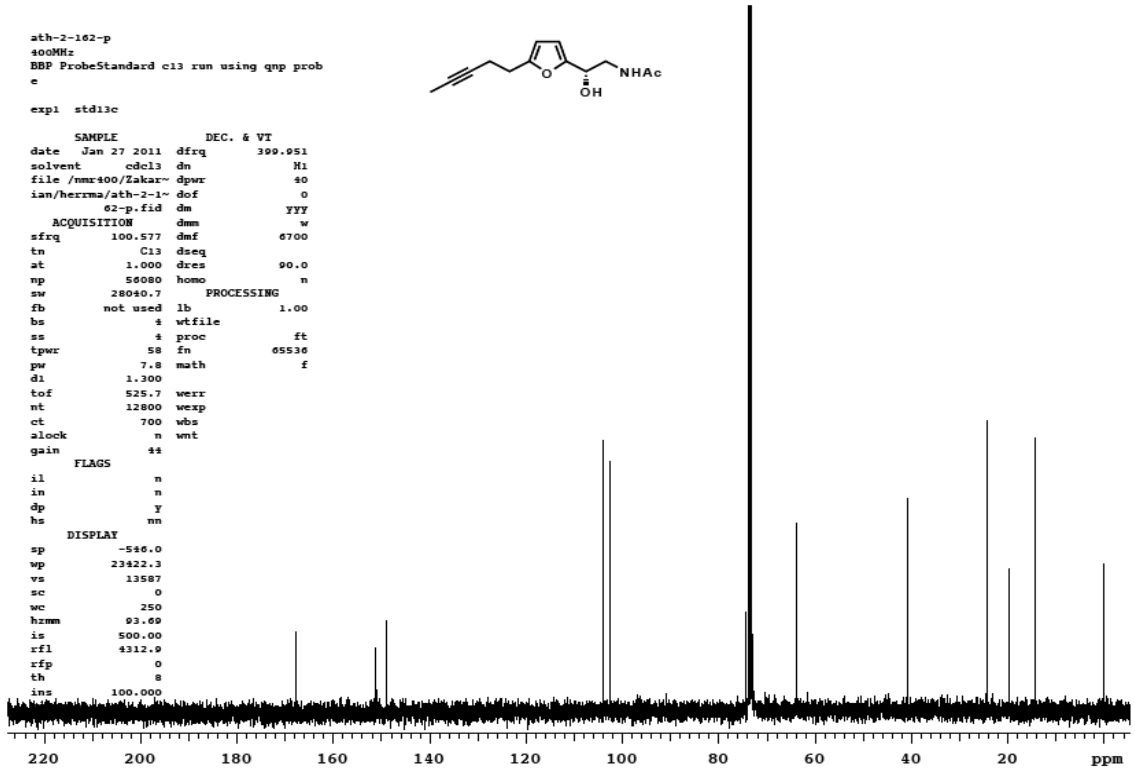
Acquired by	: Admin
Sample Name	: ces-sl-37
Sample ID	: ces-sl-37
Vail#	:
Injection Volume	: 50 uL
Data Filename	: ces-sl-37-02.lcd
Method Filename	: ces-OJ-H-analytical.lcm
Batch Filename	:
Report Filename	: Default.lcr
Date Acquired	: 8/21/2010 12:49:10 PM
Data Processed	: 8/21/2010 2:49:12 PM

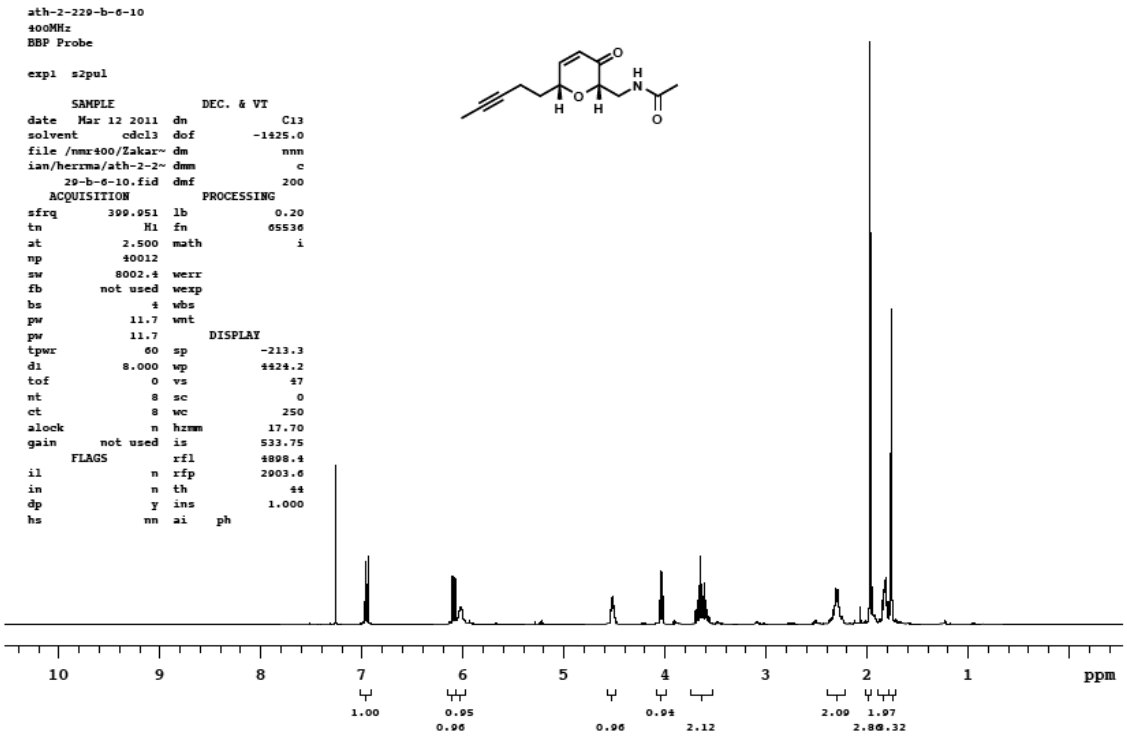
PeakTable

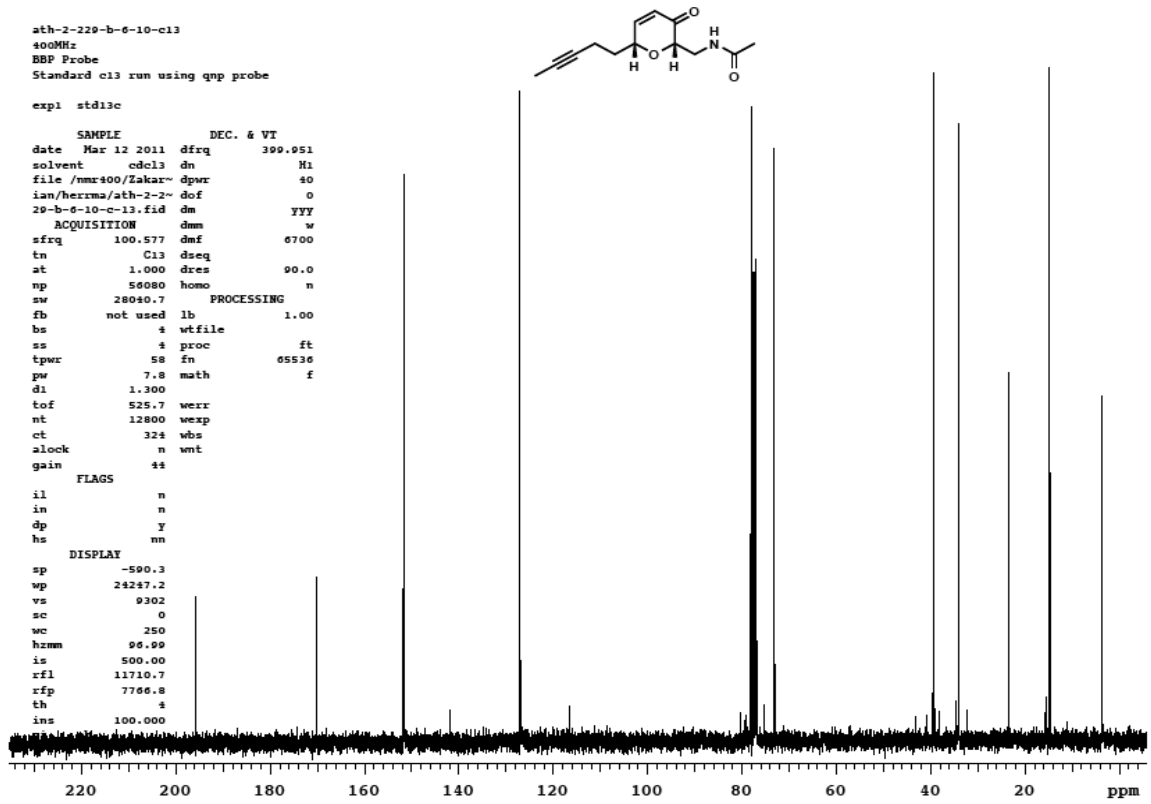
Detector A Ch1 215nm

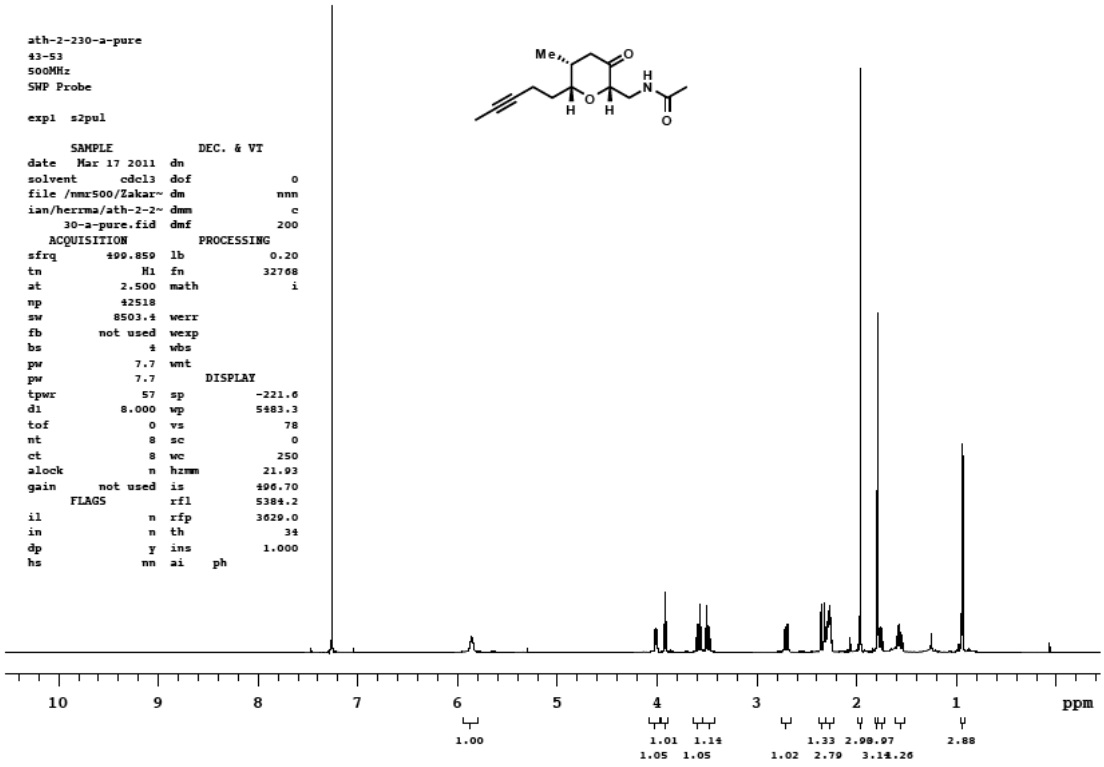
Peak#	Ret. Time	Area	Height	Area %	Height %
1	30.590	2437456	30916	99.154	98.914
2	45.631	20796	340	0.846	1.086
Total		2458252	31256	100.000	100.000

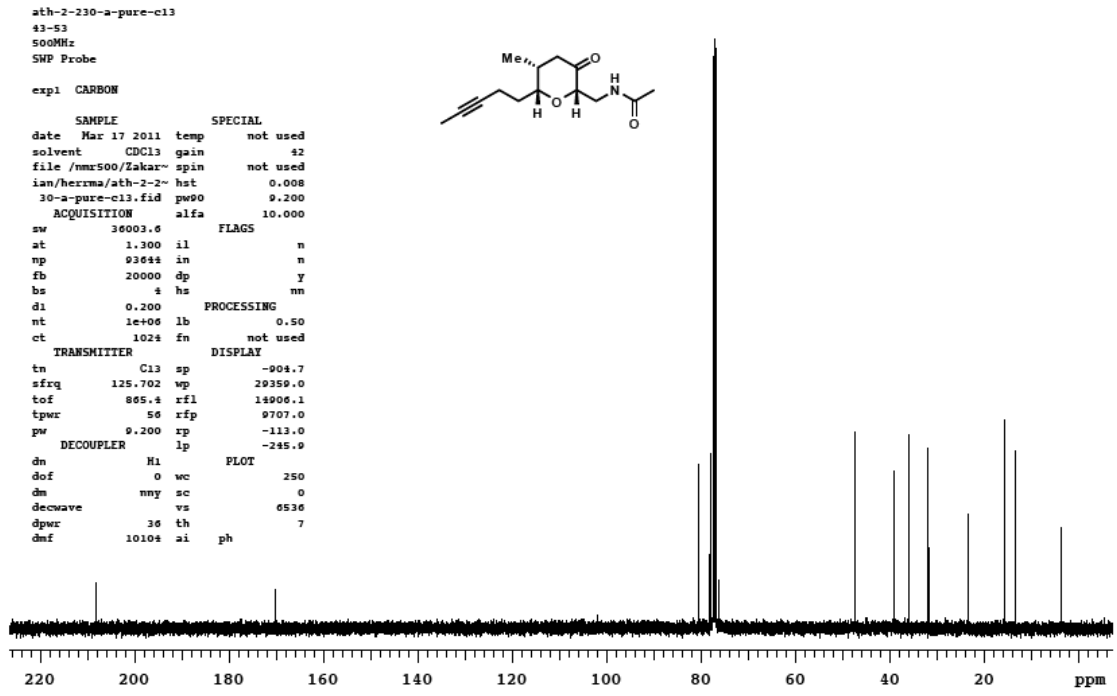

ath-2-162-p
500MHz
5mm IDP
exp1 s2pul
SAMPLE
date Jan 27 2011
solvent cdcl3
file /nmr500/Zakar~
ian/herrma/ath-2-1~
62-p.fid
ACQUISITION
sfrq 499.859
tn H1
at 2.500
np 40012
sw 8002.4
fb not used
bs 4
pw 7.1
pw 7.1
tpwr 53
d1 8.000
tof 0
nt 8
ct 8
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn C13
dof 0
dmm c
dmf 200
PROCESSING
lb 0.20
fn 32768
math i
werr
wexp wft
wbs
wnt
DISPLAY
sp -276.0
wp 5520.7
vs 53
sc 0
wc 250
hzmm 22.08
is 137.74
rfl 5134.4
rfp 3629.0
th 44
ins 1.000
ai ph
NHAc
OH
10
9
8
7
6
5
4
3
2
1
0 ppm
1.00
0.93
1.03
1.04
1.07
1.01
2.04
2.05
2.96
2.98

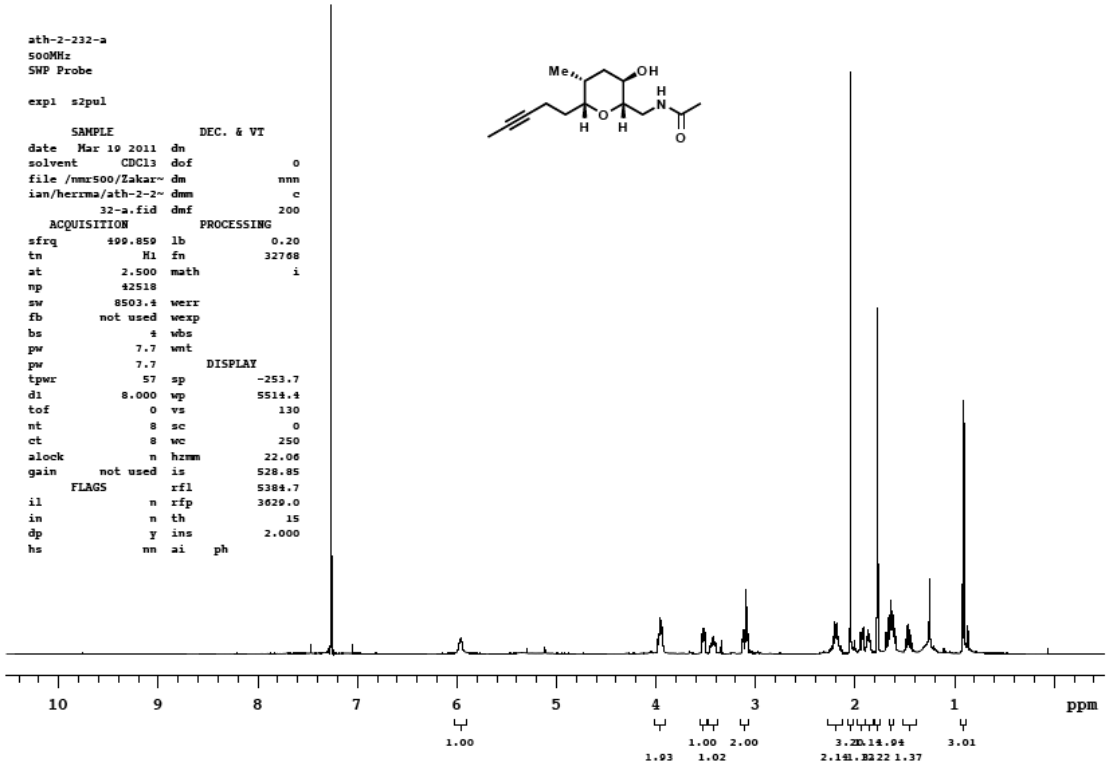

ath-2-162-p
400MHz
BBP ProbeStandard c13 run using qnp prob
e
exp1 std13c
SAMPLE
date Jan 27 2011
solvent cdcl3
file /nmr400/Zakar~
ian/herrma/ath-2-1~
62-p.fid
ACQUISITION
sfrq 100.577
tn C13
at 1.000
np 56080
sw 28040.7
fb not used
bs 4
ss 4
tpwr 58
pw 7.8
d1 1.300
tof 525.7
nt 12800
ct 700
alock n
gain 44
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -546.0
wp 23422.3
vs 13587
sc 0
wc 250
hzmm 93.69
is 500.00
rfl 4312.9
rfp 0
th 8
ins 100.000
DEC. & VT
dfrq 399.951
dn H1
dpwr 40
dof 0
dm yyy
dmm w
dmf 6700
dseq
dres 90.0
homo n
PROCESSING
lb 1.00
wtfile
proc ft
fn 65536
math f
werr
wexp
wbs
wnt
NHAc
OH
220
200
180
160
140
120
100
80
60
40
20
ppm

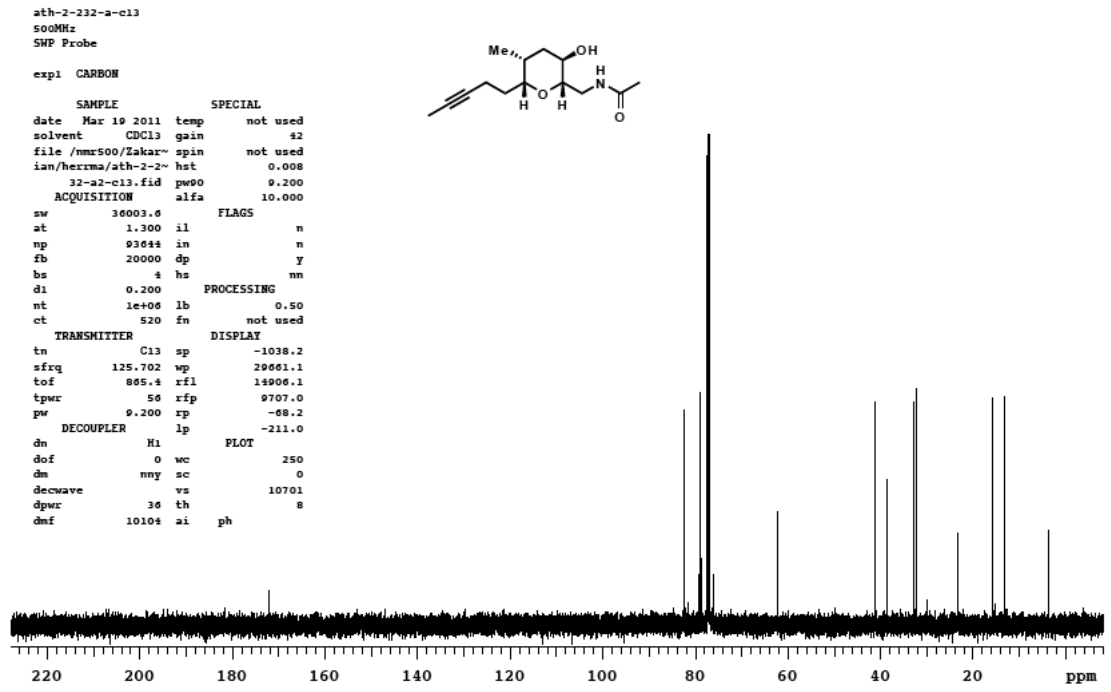

ath-2-229-b-6-10
400MHz
BBP Probe
exp1 s2pul
SAMPLE
date Mar 12 2011
solvent cdcl3
file /nmr400/Zakar~
ian/herrma/ath-2-2~
29-b-6-10.fid
ACQUISITION
sfrq 399.951
tn H1
at 2.500
np 40012
sw 8002.4
fb not used
bs 4
pw 11.7
pw 11.7
tpwr 60
d1 8.000
tof 0
nt 8
ct 8
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn C13
dof -1425.0
dm nnn
dmm c
dmf 200
PROCESSING
lb 0.20
fn 65536
math i
werr
wexp
wbs
wnt
DISPLAY
sp -213.3
wp 4424.2
vs 47
sc 0
wc 250
hzmm 17.70
is 533.75
rfl 4898.4
rfp 2903.6
th 44
ins 1.000
ai ph
10
9
8
7
6
5
4
3
2
1
ppm
1.00
0.95
0.96
0.96
0.94
2.12
2.09
1.97
2.80
4.32


ath-2-229-b-6-10-c13
400MHz
BBP Probe
Standard c13 run using qnp probe
exp1 std13c
SAMPLE
date Mar 12 2011
solvent cdcl3
file /nmr400/Zakar~
ian/herrma/ath-2-2~
29-b-6-10-c-13.fid
ACQUISITION
sfrq 100.577
tn C13
at 1.000
np 56080
sw 28040.7
fb not used
bs 4
ss 4
tpwr 58
pw 7.8
d1 1.300
tof 525.7
nt 12800
ct 324
alock n
gain 44
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -590.3
wp 24247.2
vs 9302
sc 0
wc 250
hzmm 96.99
is 500.00
rfl 11710.7
rfp 7766.8
th 4
ins 100.000
DEC. & VT
dfrq 399.951
dn H1
dpwr 40
dof 0
dm YYY
dmm w
dmf 6700
dseq
dres 90.0
homo n
PROCESSING
lb 1.00
wtfile
proc ft
fn 65536
math f
werr
wexp
wbs
wnt
220
200
180
160
140
120
100
80
60
40
20
ppm


ath-2-230-a-pure
43-53
500MHz
SWP Probe
exp1 s2pul
SAMPLE
date Mar 17 2011
solvent cdcl3
file /nmr500/Zakar~
ian/herrma/ath-2-2~
30-a-pure.fid
ACQUISITION
sfrq 499.859
tn H1
at 2.500
np 42518
sw 8503.4
fb not used
bs 4
pw 7.7
pw 7.7
tpwr 57
d1 8.000
tof 0
nt 8
ct 8
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn
dof 0
dm nnn
dmm c
dmf 200
PROCESSING
lb 0.20
fn 32768
math i
werr
wexp
wbs
wnt
DISPLAY
sp -221.6
wp 5483.3
vs 78
sc 0
wc 250
hzmm 21.93
is 496.70
rfl 5384.2
rfp 3629.0
th 34
ins 1.000
ai ph
Me
O
H
N
O
H
O
H
10
9
8
7
6
5
4
3
2
1
ppm
1.00
1.01
1.05
1.14
1.05
1.02
1.33
2.79
2.98
3.14
0.97
1.26
2.88


ath-2-230-a-pure-c13
43-53
500MHz
SWP Probe
exp1 CARBON
SAMPLE
date Mar 17 2011
solvent CDCl3
file /nmr500/Zakar~
ian/herrma/ath-2-2~
30-a-pure-c13.fid
ACQUISITION
sw 36003.6
at 1.300
np 93644
fb 20000
bs 4
d1 0.200
nt 1e+06
ct 1024
TRANSMITTER
tn C13
sfrq 125.702
tof 865.4
tpwr 56
pw 9.200
DECOUPLER
dn H1
dof 0
dm nny
decwave
dpwr 36
dmf 10104
SPECIAL
temp not used
gain 42
spin not used
hst 0.008
pw90 9.200
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -904.7
wp 29359.0
rfl 14906.1
rfp 9707.0
rp -113.0
lp -245.9
PLOT
wc 250
sc 0
vs 6536
th 7
ai ph
Me
O
H
N
O
H
O
H
220
200
180
160
140
120
100
80
60
40
20
ppm


ath-2-232-a
500MHz
SWP Probe
exp1 s2pul
SAMPLE
date Mar 19 2011
solvent CDCl3
file /nmr500/Zakar~
ian/herrma/ath-2-2~
32-a.fid
ACQUISITION
sfrq 499.859
tn H1
at 2.500
np 42518
sw 8503.4
fb not used
bs 4
pw 7.7
pw 7.7
tpwr 57
d1 8.000
tof 0
nt 8
ct 8
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn
dof 0
dm nnn
dmm c
dmf 200
PROCESSING
lb 0.20
fn 32768
math i
werr
wexp
wbs
wnt
DISPLAY
sp -253.7
wp 5514.4
vs 130
sc 0
wc 250
hzmm 22.06
is 528.85
rfl 5384.7
rfp 3629.0
th 15
ins 2.000
ai ph
Me
OH
H
N
O
H
O
H
10
9
8
7
6
5
4
3
2
1
ppm
1.00
1.93
1.02
1.00
2.00
3.01
2.14
1.37


ath-2-232-a-c13
500MHz
SWP Probe
exp1 CARBON
SAMPLE
date Mar 19 2011
solvent CDCl3
file /nmr500/Zakar~
ian/herrma/ath-2-2~
32-a2-c13.fid
ACQUISITION
sw 36003.6
at 1.300
np 93644
fb 20000
bs 4
d1 0.200
nt 1e+06
ct 520
TRANSMITTER
tn C13
sfrq 125.702
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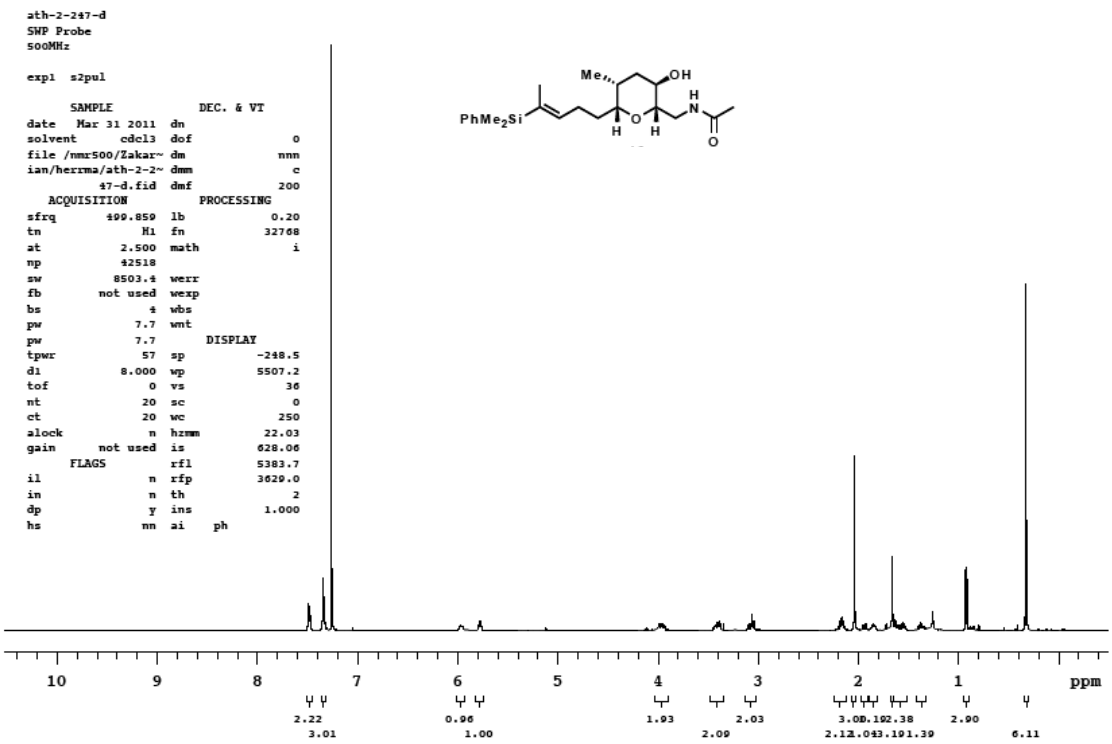
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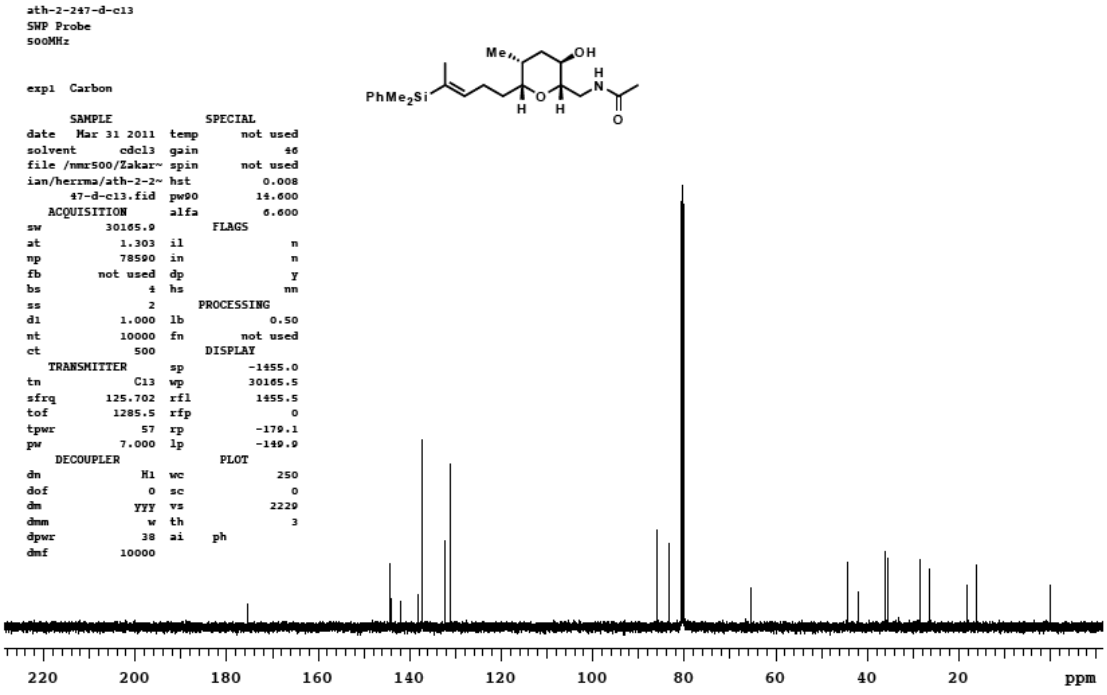
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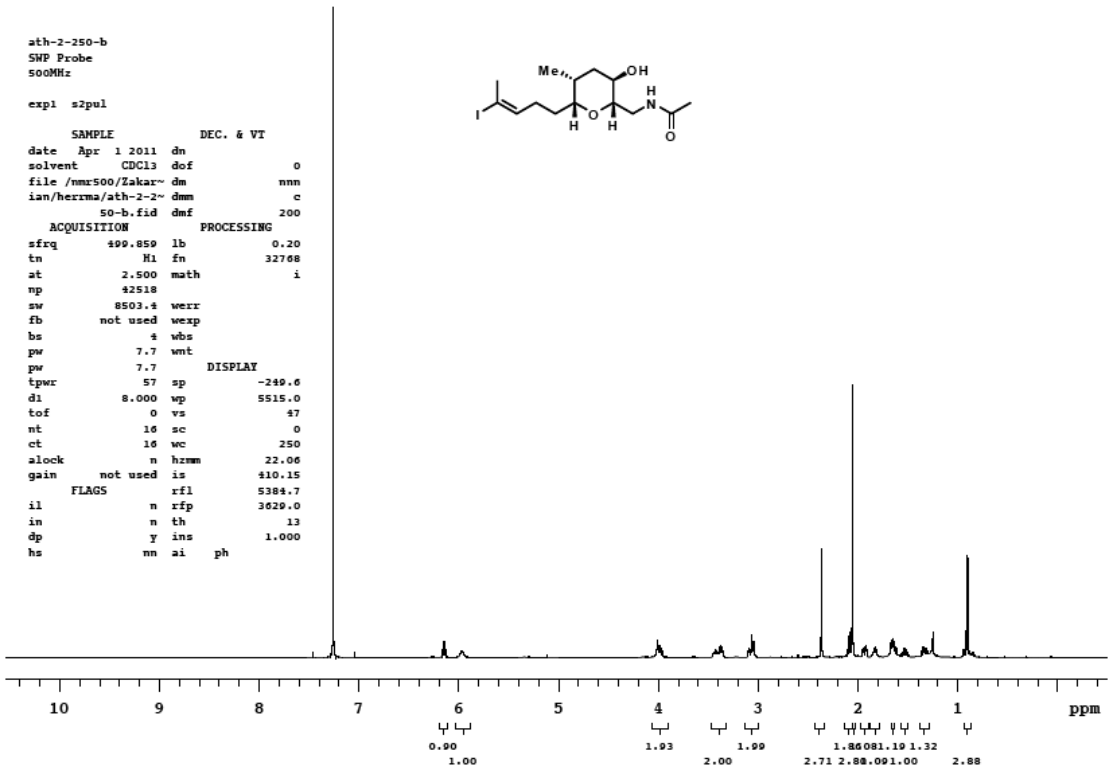
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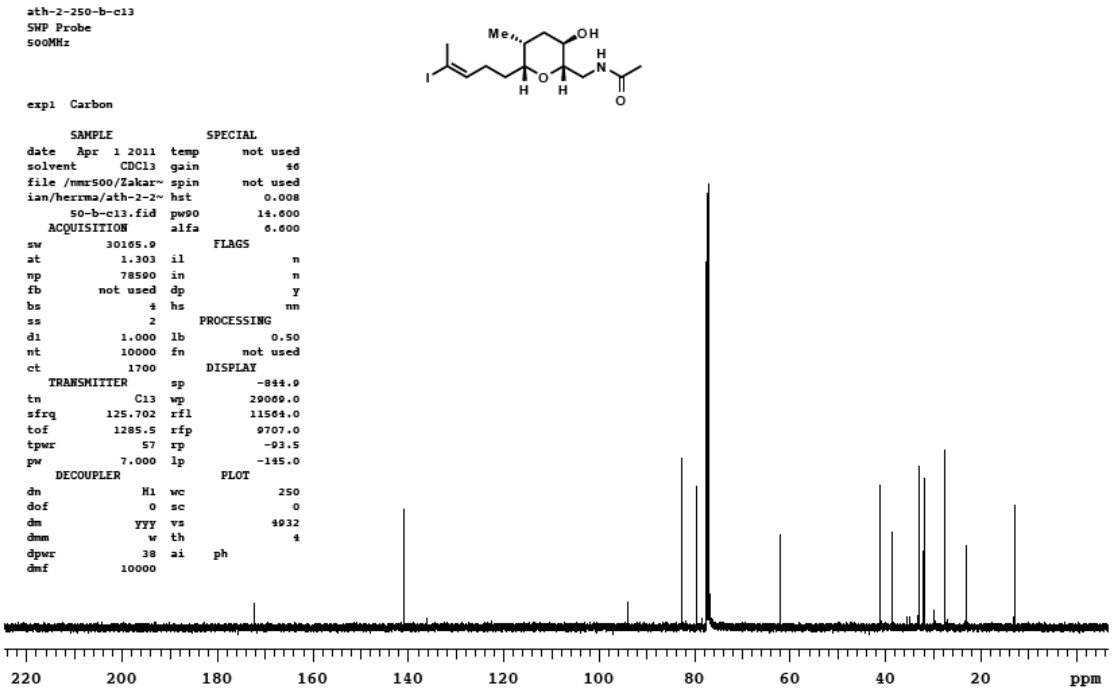
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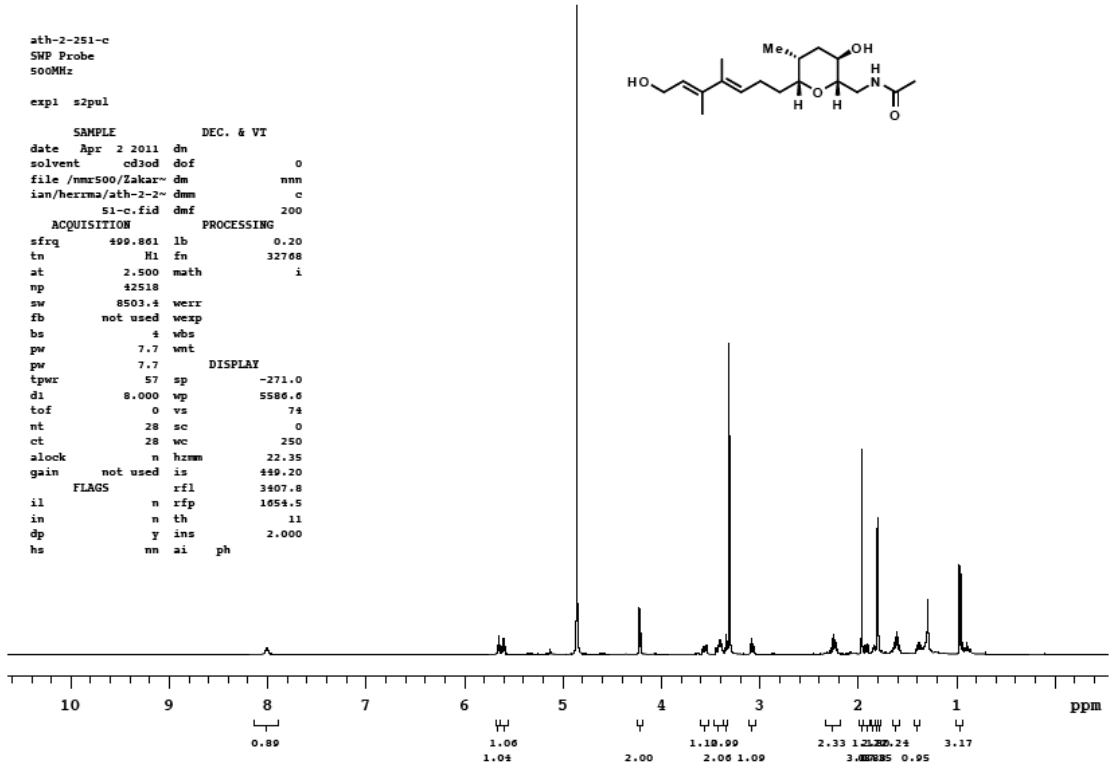
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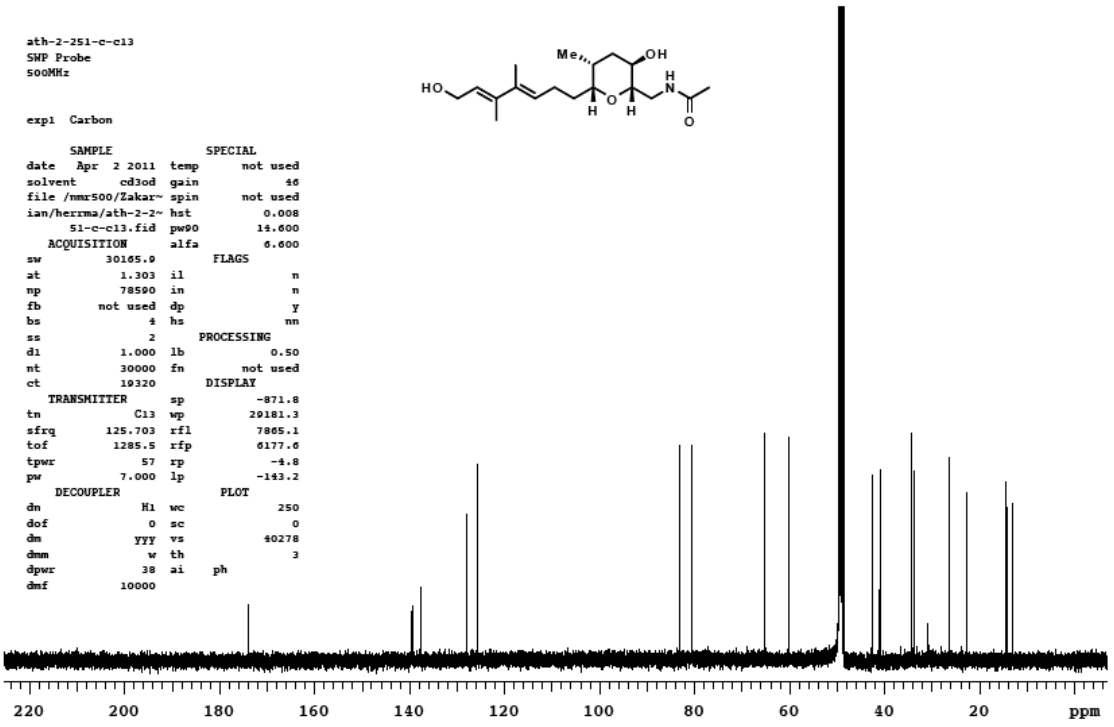
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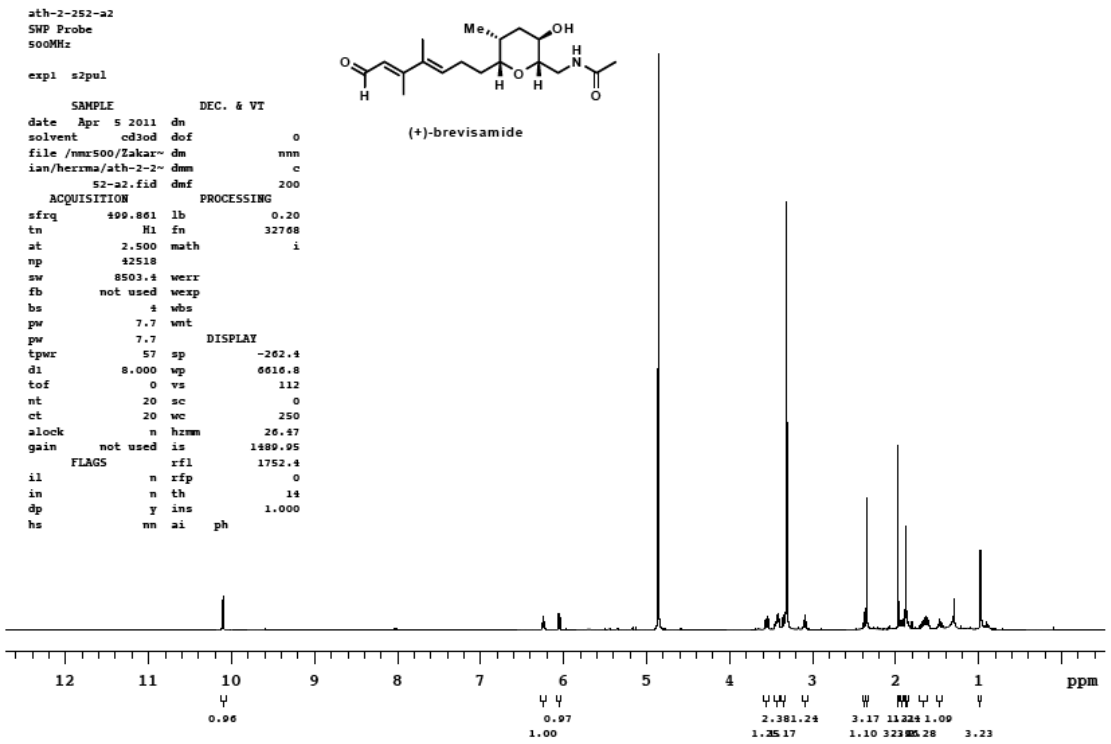
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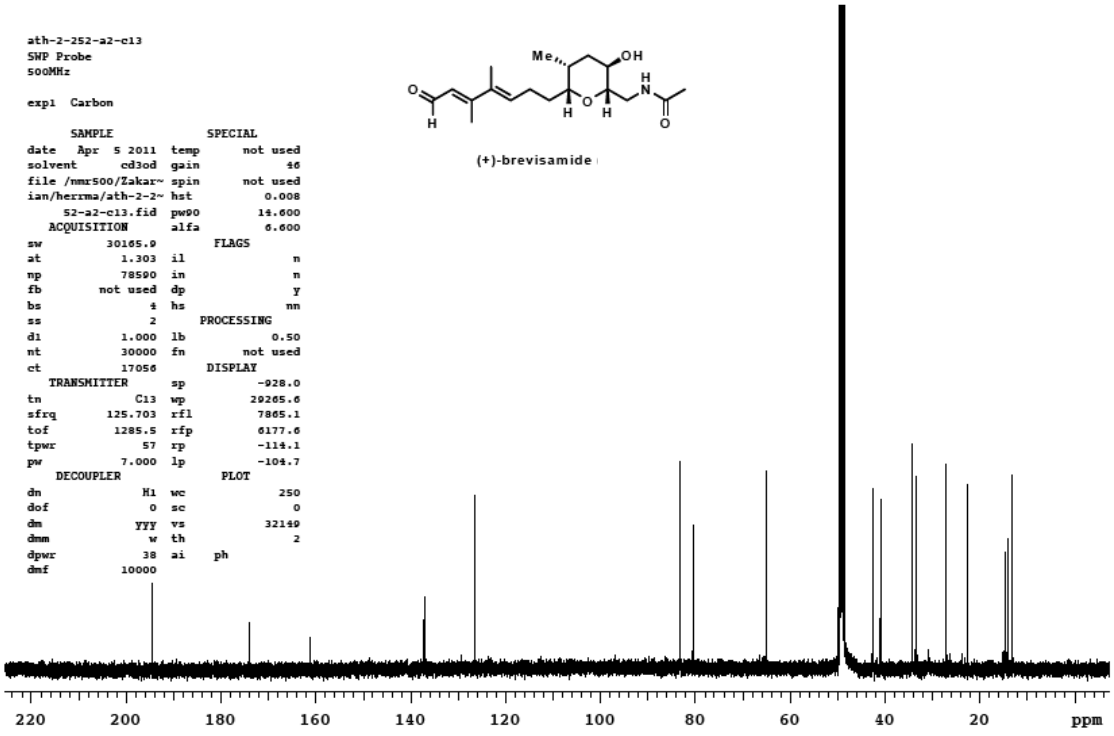
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Chapter 3

Haloalkylations of *N*-Acyl Oxazolidinones via Group IVa Metal Enolates

3-1 Halogenated Natural Products

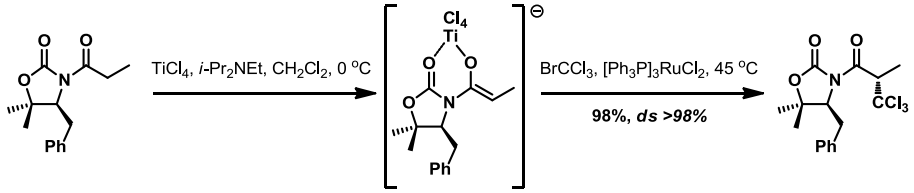
Recently there has been a mounting realization of the advantage in both the unique physical and chemical properties of a wide variety of halogenated organic compounds. An increasingly broad application of these compounds can in turn be used in many areas of research: natural product synthesis, medicinal, materials sciences, and agrochemicals are a few among the many. Due to this reason, new synthetic methods have been and must be developed in order to introduce halogens into a variety of organic compounds. Our group focused on the development of synthetic methods for stereoselective haloalkylations in order to provide an overall practical, efficient, and operationally simple technique.

3-2 Trichloroalkylations via $TiCl_4$ Enolates

Titanium enolates have found widespread use in organic synthesis as a result of their unique reactivity and ease of preparation from inexpensive and nontoxic titanium reagents under mild conditions that are compatible with a range of functional groups.[73] The most prevalent application of titanium enolates is in stereoselective aldol reactions.[74] Several examples of the alkylation of titanium enolates with strongly electrophilic reagents have also been reported.[75] Valence tautomerism in titanium enolates provided the initial conceptual foundation for the development of direct radical chloroalkylation. Using studies completed by Moreira and co-workers allowed for the postulation that the unconventional biradical character of titanium enolates could allow them to act as efficient radical acceptors.[76]

Titanium enolates can be formed from inexpensive and nontoxic titanium reagents, under mild conditions that are compatible with a range of functional groups. This strategy of soft-enolate formation was coupled with the Kharasch-type reaction involving Ru(II)-catalyzed redox of trichloromethyl bromide. Upon initial studies this proved true, when *N*-acyl oxazolidinone **3.1** was treated with $TiCl_4$ and Hünig's base (*i*-Pr_2NEt); Ti enolate **3.1A** was formed as evidenced by ^1H NMR (Scheme **3.2.1**). Upon addition of $BrCCl_3$ in the presence of $[(Ph_3P)_3RuCl_2]$, product **3.2** was obtained in nearly quantitative yield and excellent stereocontrol.[77]

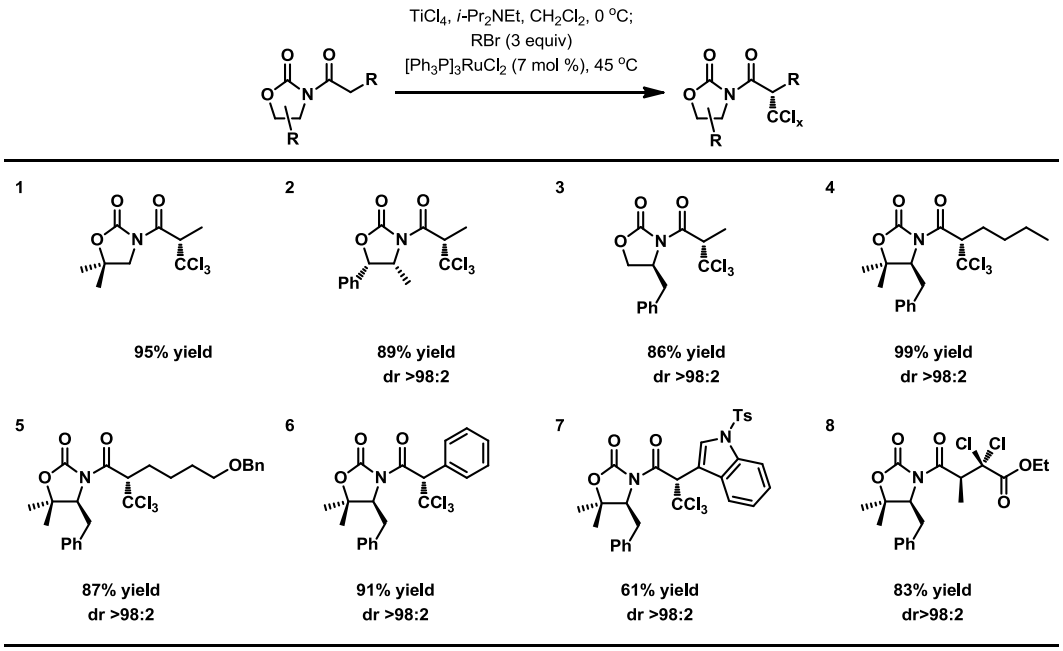
Scheme 3.2.1 Trichloromethylation of *N*-Acyl Oxazolidinones



The scope of direct chloroalkylation using the new titanium enolate derived synthetic method was carried out in which Table **3.2.1** demonstrates different Evans-type chiral auxillaries and a wide variety of substituents on the *N*-acyl oxazolidinones. Aromatic, heterocyclic, along with alkyl substituents proved to be very compatible with the reaction conditions proceeding in high yields and high stereocontrol.

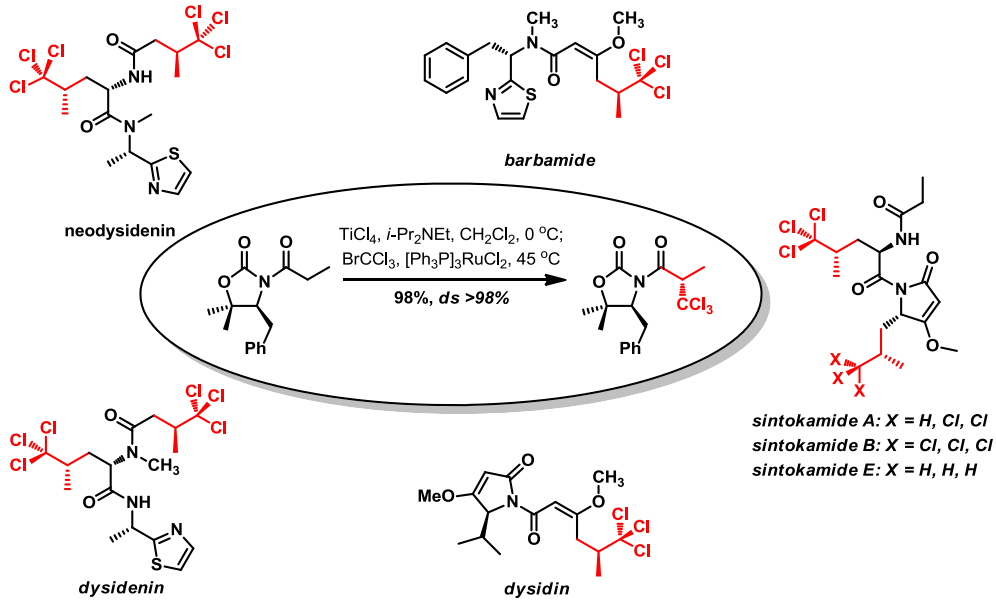
Application of trichloromethylation via titanium enolates was demonstrated by the Zakarian group in multiple total syntheses: neodysidenin, barbamide, dysidenin, dysidin, and sintokamides A, B, & E (Scheme 3.2.2).[77,78] The high yield and excellent stereocontrol allowed for efficient use in each total synthesis.

Table 3.2.1 Radical Trichloromethylation: *N*-Acyl Oxazolidinone Scope



(a) All yields are of isolated products; dr determined by 500 MHz ^{1}H NMR of the crude mixture of products.

Scheme 3.2.2 Total Syntheses Applying Trichloromethylation Methodology

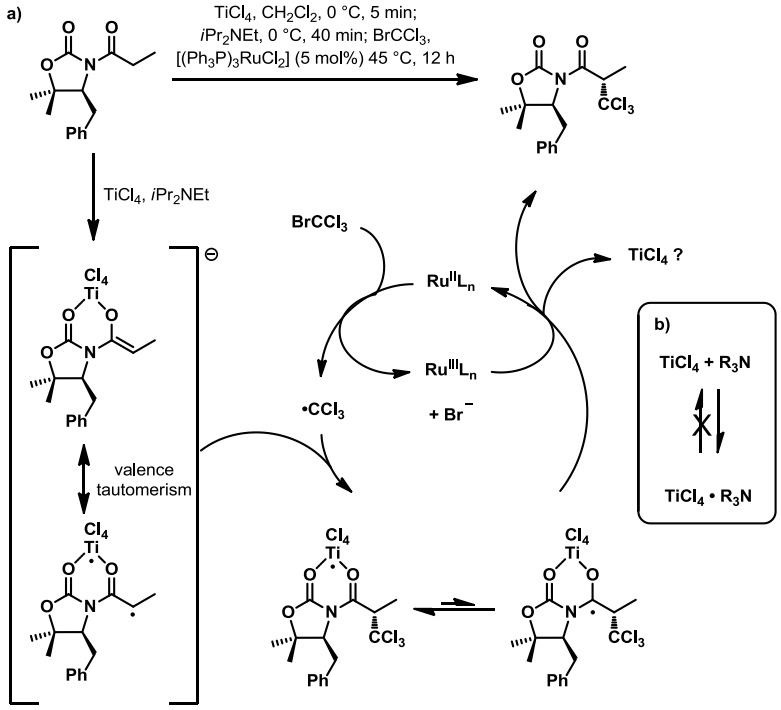


3-3 Dual Ti-Ru Catalysis in the Direct Radical Haloalkylation of *N*-Acyl Oxazolidinones

We described a different mode of alkylation of titanium enolates in which they serve as efficient radical acceptors for haloalkyl radicals generated by a ruthenium-catalyzed redox process (*vide supra*). It has been postulated that the enolate serves as an electroactive ligand for the titanium center,[79] whereby it facilitates the radical addition process and participates in the ruthenium catalytic cycle. The utility of this method in the synthesis of a range of chloroleucine-derived natural products has been illustrated.[77,80] One intriguing aspect of the reaction that emerged during our investigations is the possibility of the catalytic generation and alkylation of the titanium enolate species. Herein, we describe the development of a haloalkylation process that is catalytic in both ruthenium and titanium and thus constitutes the first example of a catalytic enolate alkylation involving titanium enolates.

During an examination of the putative mechanism of the trichloromethylation process outlined in Scheme 3.3.1,[77,79] we directed our attention toward the function of titanium tetrachloride. This mechanism suggests that $TiCl_4$ should be regenerated at the completion of the reaction, which creates potential for the development of a catalytic process. According to the seminal studies by Evans *et. al.*, initial complexation of the substrate and titanium tetrachloride is prerequisite to the addition of the amine base and the ensuing enolization.[81] If the order of the reagent addition is reversed, enolization is precluded by the apparently irreversible formation of an unreactive $TiCl_4$–amine adduct. Thus, the potential interception of the regenerated $TiCl_4$ by the amine base would be a major challenge in the catalytic recovery of the reagent.

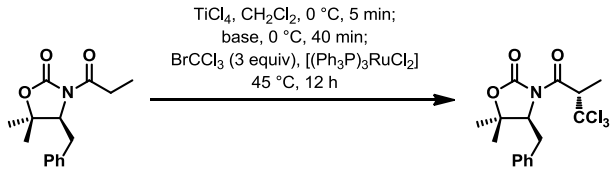
Scheme 3.3.1 Radical Trichloromethylation Mechanism



Radical Trichloromethylation Based on Valence Tautomerism in Titanium Enolates: a) an initial overview of the mechanism; b) potential sequestering of $TiCl_4$ by the amine.

Preliminary experimentation revealed that indeed the haloalkylation reaction could reach completion withsubstoichiometric titanium tetrachloride under the original reaction conditions with diisopropylethylamine (Hünig's base). On the other hand, the conversion decreased precipitously when less than 0.3 equivalents of $TiCl_4$ were used (Table 3.3.1, entries 1–4). We hypothesized that the decline in conversion at around 0.3–0.4 equivalents of $TiCl_4$ could be attributed to one of the following factors: 1) the possible formation of higher-order titanium enolates with a 2:1 or 3:1 ligand-to-metal ratio, in which case no catalytic turnover of $TiCl_4$ would occur, or 2) inefficient catalytic recovery of the titanium reagent and, possibly, a strong inhibitory effect by the amine.

Table 3.3.1 Amine Influence on the Course of the Catalytic Trichloromethylation Reaction



3.1 3.2

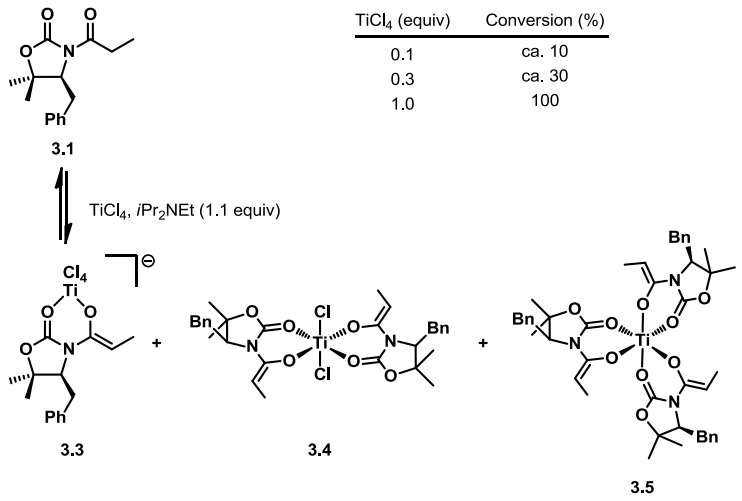
Entry	$TiCl_4$ (mol %)	Amine (equiv)	Conversion (%)
1	40	*i*Pr_2Net (1.1)	> 95
2	30	*i*Pr_2Net (1.1)	75
3	20	*i*Pr_2Net (1.1)	50
4	10	*i*Pr_2Net (1.1)	14
5	30	*i*Pr_2Net (3.0)	47
6	30	*i*Pr_2Net (4.5)	28
7	30	Et_3N (1.1)	76
8	30	Et_3N (3.0)	100
9	10	Et_3N (3.0)	75
10	10	Et_3N (3.0)	74
11	10	Et_3N (4.5)	76
12	30	PMP (1.1)	100
13	10	PMP (1:1)	100

(a) Conversion was determined by ^{1}H NMR spectroscopy of the crude mixture of products. (b) The reaction time was 48 h. PMP = 1,2,2,6,6-pentamethylpiperidine.

Although it is well-known that titanium forms hexa– or octa-coordinated complexes,[82] higher-order titanium enolates such as those depicted in Scheme 3.3.2 have not been documented. We monitored the enolization reaction with the Hünig's base (1.1 equiv) and varying amounts of titanium tetrachloride by NMR spectroscopy and found no conclusive support for the existence of higher-order titanium enolates; however, it was evident that the

degree of enolization diminished proportionally with decreasing substoichiometric amounts of $TiCl_4$. Thus, whereas complete enolization was observed with 1.0 equivalent of $TiCl_4$, the conversion was approximately 10% with 0.1 equivalents of $TiCl_4$ and about 30% with 0.3 equivalents of $TiCl_4$. Notably, it could be clearly observed that more than one distinct enolate species was generated, and the relative ratios changed substantially as the amount of the titanium reagent was varied. Although the nature of the additional species is presently unclear,[83] we concluded that full conversion in the trichloromethylation reaction with a substoichiometric amount of $TiCl_4$ could not be rationalized through the implication of higher-order titanium enolates.

Scheme 3.3.2 Hypothetical Formation of Higher-Order $TiCl_4$ Enolates

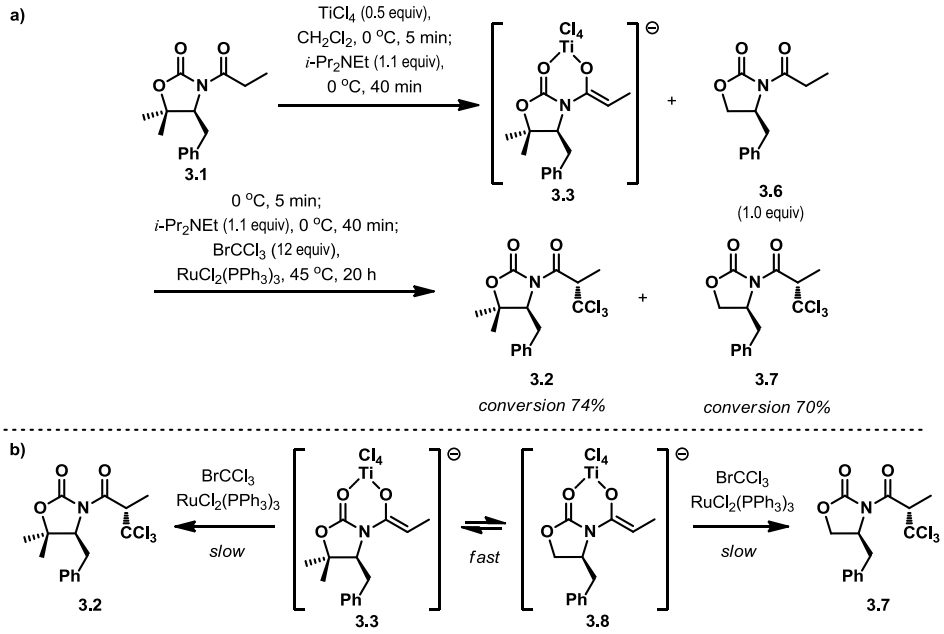


Higher-order enolates during the enolization of **3.1** with substoichiometric $TiCl_4$. Bn=benzyl.

The next series of experiments was designed to probe the catalytic recovery of titanium tetrachloride. Specifically, we aimed to establish whether titanium tetrachloride could be efficiently transferred between different *N*-acyloxazolidinone species once enolization was completed. The cross-over experiment in Scheme 3.3.3 was particularly illuminating and revealed a number of notable factors. When the enolization of **3.1** was complete ($TiCl_4$ (0.5

equiv), Hünig's base (1.1 equiv), 0 °C, 45 min), the *N*-acyloxazolidinone **3.6** (1.0 equiv) was added along with additional Hünig's base (1.1 equiv), and, after 40 min at 0 °C, the ruthenium-catalyzed radical trichloromethylation was initiated under the standard conditions. With the ultimate loading of titanium tetrachloride at 0.25 equivalents, products **3.2** and **3.7** resulting from the trichloromethylation of both substrates were produced in nearly equimolar amounts, which provided conclusive support for a rapid transfer of $TiCl_4$ between different *N*-acyloxazolidinone species in the presence of diisopropylethylamine. This experiment corroborates the feasibility of the catalytic turnover of $TiCl_4$ and suggests inhibition by the amine as a reason for its poor efficiency. It can be hypothesized that a fast equilibrium is established between titanium enolates **3.3** and **3.8** (Scheme 3.3.3b). This process is accompanied by a slow radical addition, and the distribution of products **3.2** and **3.7** is determined by the Curtin–Hammett principle.

Scheme 3.3.3 Cross-over Experiment



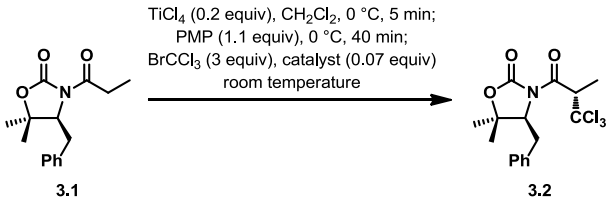
a) Cross-over experiment; b) product distribution is in accord with the Curtin–Hammett principle.

To ascertain the influence of the amine on the efficiency of the catalytic turnover of titanium tetrachloride and to probe further the equilibrium in Scheme 3.3.1b, we carried out the trichloromethylation reaction with various amounts of the Hünig's base as well as less-hindered triethylamine and more-hindered 1,2,2,6,6-pentamethylpiperidine (PMP; Table 3.3.1). An increase in the concentration of the Hünig's base consistently resulted in lower conversion (Table 3.3.1, entries 5 and 6), which supports the proposed inhibitory effect of the amine.

Remarkably, both less-hindered triethylamine and more-hindered PMP proved to be superior to the Hünig base for the catalytic turnover of $TiCl_4$. Complete conversion was observed with 30 mol % of $TiCl_4$ with 3 equivalents of Et_3N, whereas conversion was 76 % with 1.1 equivalents of the amine (Table 3.3.1, entries 7 and 8). The same conversion (ca. 75 %) was observed with 10 mol % of $TiCl_4$ and Et_3N (3 equiv). Interestingly, no inhibitory effect was observed for triethylamine. With PMP (1.1 equiv), full conversion was observed with either 10 or 30 mol % of $TiCl_4$ (Table3.3.1, entries 12 and 13). As with Et_3N, no inhibition of the trichloromethylation reaction was observed in the presence of excess PMP. Thus, the inhibitory effect appears to be confined to the Hünig's base.

We compared the original catalyst, $[RuCl_2(PPh_3)_3]$, with a more active catalyst, $[Cp^*RuCl(PPh_3)_2]$,[84] to ascertain whether the rate of trichloromethylation was limited by low catalytic turnover frequency of $TiCl_4$ or other factors associated with the radical process (Scheme 3.3.4). When the reaction was carried out at room temperature in the presence of $TiCl_4$ (20 mol %) and PMP (1.1 equiv), a substantial acceleration of the process was observed with $[Cp^*RuCl(PPh_3)_2]$ as the redox catalyst. This observation indicates that radical generation is the rate-limiting step, and both the turnover frequency of $TiCl_4$ and the addition of $\cdot CCl_3$ to the titanium enolate are relatively fast (Scheme 3.3.3b).

Scheme 3.3.4 Catalysis Comparison



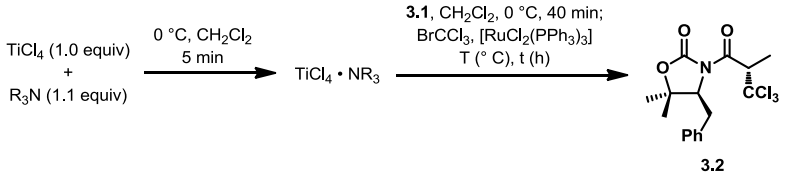
3.1 3.2

Catalyst	***t* (h)**	**Conversion** (%)
$[RuCl_2(PPh_3)_3$	48	76
$[Cp^*RuCl(PPh_3)_2]$	3	93

Comparison between $[RuCl_2(PPh_3)_3]$ and $[Cp^*RuCl(PPh_3)_2]$ as the redox catalyst for radical generation. Cp*=1,2,3,4,5-pentamethylcyclopentadienyl anion.

In the next series of experiments, the order of reagent addition during the formation of the titanium enolate was changed to examine the irreversibility of the formation of $TiCl_4$–amine complexes under the trichloromethylation reaction conditions. The seminal studies by Evans et al. emphasized the importance of the initial $TiCl_4$–substrate complexation; no enolate formation was observed if diisopropylethylamine or triethylamine were allowed to react with uncomplexed titanium tetrachloride first.[45] Therefore, we were surprised to discover substantial conversion in experiments in which $TiCl_4$ and the amine were mixed prior to the addition of the substrate (Table 3.3.2). Although the conversion was lower than that observed under the original enolization conditions, these results indicate notable, albeit rather inefficient, reversibility in the formation of $TiCl_4$–amine adducts.

Table 3.3.2 Influence of the Inverse Addition of the Amines on Conversion.



3.2

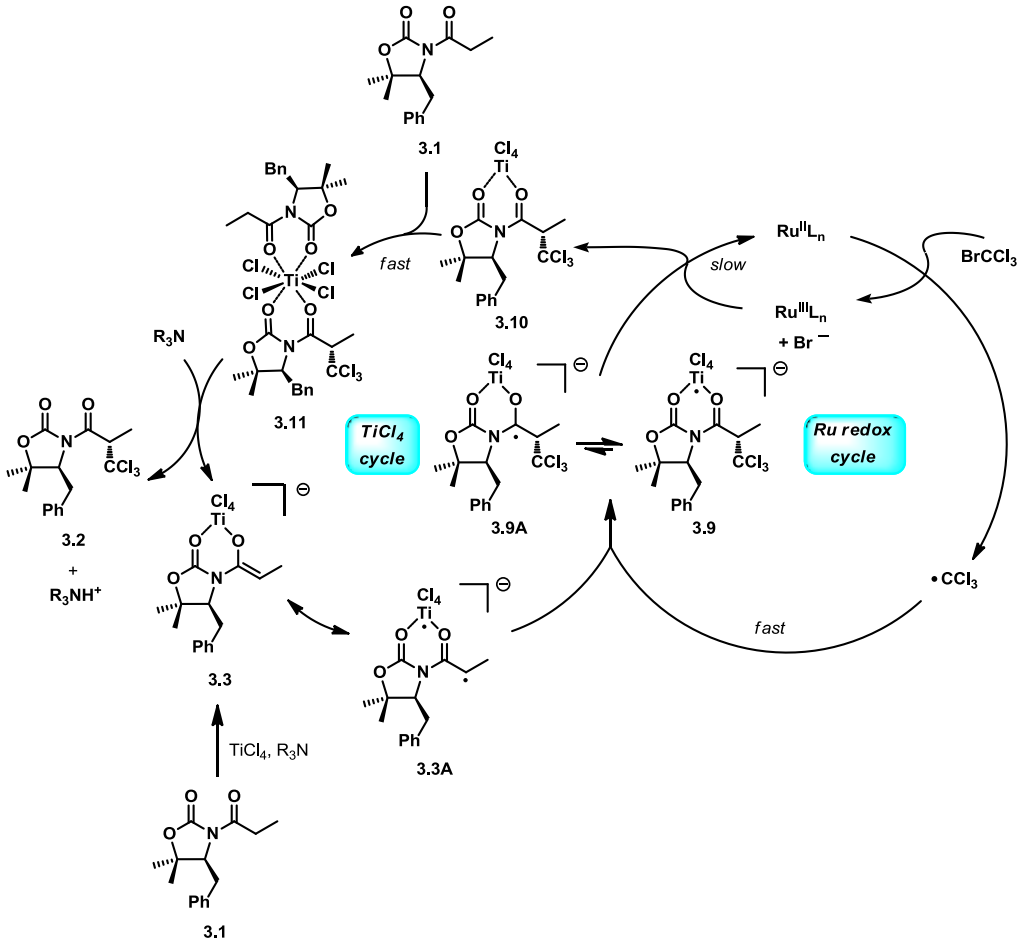
Entry	Amine (equiv)	T (° C)	t (h)	Conversion (%)
1	*i*Pr$_2$NEt	20	12	41
2	*i*Pr$_2$NEt	45	12	45
3	*i*Pr$_2$NEt	50	24	57
4	PMP	20	12	57
5	PMP	45	12	63
6	Et$_3$N	45	12	35

(a) Conversion was determined by ^{1}H NMR spectroscopy of the crude mixture of products. (b) The reaction time was 48 h. PMP = 1,2,2,6,6-pentamethylpiperidine.

On the basis of the experimental results of this study, we propose the catalytic cycle depicted in Scheme 3.3.5 for the dual Ru–Ti catalysis in the direct trichloroalkylation of *N*-acyl oxazolidinones. An initial complexation of $TiCl_4$ and substrate **1**, followed by addition of the amine, produces enolate **3.3** along with its biradical valence tautomer **3.3A**.[79,85] An electron transfer from the Ru^{II} catalyst to $BrCCl_3$ generates $\cdot CCl_3$, which adds to the electron-rich titanium enolate to directly afford **3.9**, rather than the carbon-centered radical **3.9A**, along with the Ru^{III}counterpart.[86] Intermediate **3.9**, which is essentially the final product **3.2** complexed to a Ti^{III} center, regenerates the Ru^{II} catalyst, by a slow, rate-limiting single-electron-transfer event, to give the Ti^{IV} chelate **3.10**. At this stage, $TiCl_4$ is transferred directly and at a relatively high rate to another molecule of the substrate, potentially via an octacoordinated species, such as **3.11**. Alternatively, $TiCl_4$ can be intercepted by excess

amine, which accounts for the inhibitory effect of the amine. It is highly unlikely that uncoordinated $TiCl_4$ is present at any time during the course of the reaction.[87]

Scheme 3.3.5 Proposed Mechanism for Ti-Ru Catalysis in the Radical Haloalkylation of Titanium Enolates.



In summary, a direct radical trichloromethylation reaction that is catalytic in both the titanium and ruthenium reagents has been developed as a result of a deeper mechanistic investigation of the process. This reaction constitutes the first alkylation of titanium enolates that is catalytic in titanium and provides a foundation for expanding the scope of catalytic radical alkylation reactions of titanium enolates. Important findings include: 1) the discovery that the complexation of trialkyl amines to $TiCl_4$ appears to be reversible, especially at

elevated temperatures, although the decomplexation is of limited efficiency; and 2) the observation that the turnover frequency for the catalytic transfer of $TiCl_4$ is relatively high in comparison with the rate of radical generation, even with the more reactive ruthenium catalyst [$Cp^*RuCl(PPh_3)_2$].

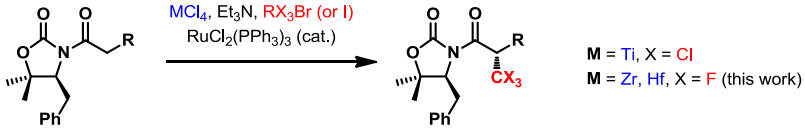
3-4 Asymmetric Trifluoromethylation of *N*-Acyl Oxazolidinones via Ru-Catalyzed Radical Addition to Zirconium Enolates

3-4-1 Initial Trifluoroalkylation Studies

The growing appreciation of unique physical and chemical properties of fluorinated organic compounds has resulted in their increasingly broad application in medicine, materials sciences, agrochemicals, and many other areas of research.[88] In order to enable future advances in the discovery and application of fluorinated materials, practical methods for efficient and selective fluorination are needed. Within this general context,[88a,89] stereoselective introduction of the trifluoromethyl and other perfluoroalkyl groups at the α-position of carbonyl compounds has remained an ongoing challenge, with several notable developments reported in the past few years. Following early studies in diastereoselective radical trifluoromethylation of lithium enolates employing the iodotrifluoromethane–Et_3B/O_2 system for CF_3 radical generation,[90] a number of elegant alternatives based on electrophilic,[91] radical,[92] or photoredox organocatalytic strategies[93] have been developed.[94] These methods collectively constitute important advances toward highly selective α-fluoroalkylation of a diverse range of carbonyl compounds and highlight novel patterns of reactivity. On the other hand, issues of practicality related to experimental simplicity, cost of reagents, and energy efficiency (use of cryogenic conditions or high temperatures) remain persistent, stimulating continued progress in this area.

After, we demonstrated that an experimentally simple, high-yielding diastereoselective α-trichloromethylation of titanium enolates can be achieved.[95] The process is based on a Ru-catalyzed redox formation of the trichloromethyl radical from $BrCCl_3$ followed by its

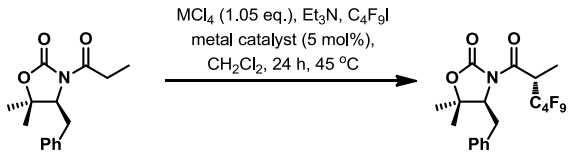
addition to catalytically generated titanium enolates derived from chiral *N*-acyl oxazolidinones. This type of radical addition may be facilitated by the putative biradical character of titanium enolates.[96] Overall, the process allows for a direct, one-step chloroalkylation of *N*-acyl oxazolidinones, and its utility in the synthesis of natural products with CCl_3-substituted stereogenic centers has been highlighted.[95c,97] Although direct extension of this type of reactivity to fluoroalkylation reactions has proven to be highly challenging, we have succeeded in reaching this goal by enlisting in situ generated zirconium enolates (eq 1). The development of this protocol highlighting operational simplicity in the direct α-fluoroalkylation of *N*-acyl oxazolidinones is described herein.[98]



(1)

Early attempts to extend the chloroalkylation reaction of titanium enolates to fluoroalkylations concentrated on screening a range of transition metal catalysts, including those that have been previously used in Kharasch-type additions of iodoperfluoroalkanes to olefins. Typical examples include $[Ph_3P]_3RuCl_2$,[99] $Ru_3(CO)_{12}$,[100] $Fe_3(CO)_{12}$,[13] and $Co_2(CO)_8$;[13] however, in no instance any amount of fluoroalkylation product was detected. After exhausting our options with titanium enolates, we explored other metal halides potentially capable of effecting soft enolizations ($SmBr_3$, $BiCl_3$, $InCl_3$, $Yb(OTf)_3$, $VOCl_3$, VCl_3, VCl_4, $ZrCl_4$, $HfCl_4$).[101] In contrast to our expectations, it was the group IVa metal halides, $ZrCl_4$ and $HfCl_4$,[102] that proved to be uniquely competent in the fluoroalkylation reactions.

Table 3.4.1 Identification of Transition Metal Catalysts Suitable for Fluoroalkylation of Zirconium and Hafnium Enolates[a].



3.12 3.13

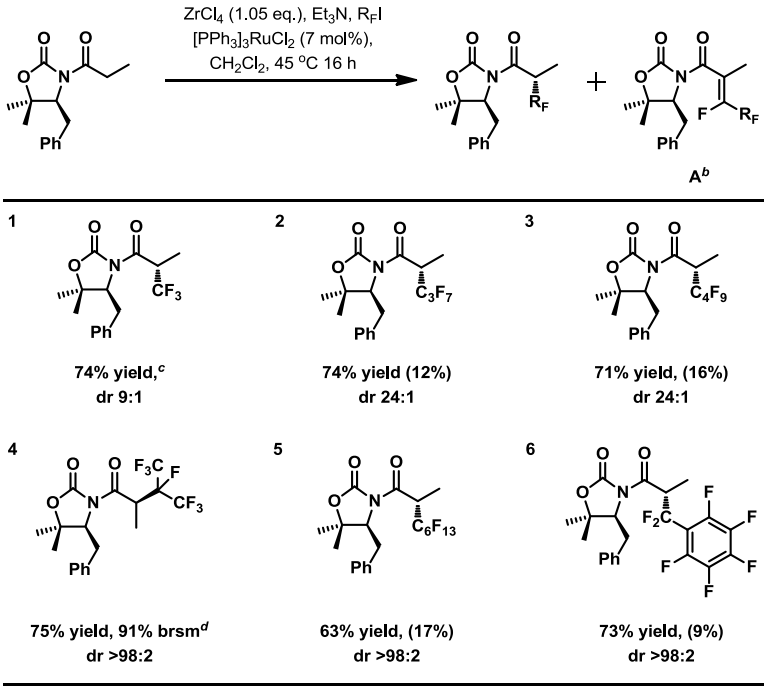
Entry	MCl_4	metal catalyst (5-7 mol %)	Conversion[b] (%)	3.13 (%)[b]
1	$ZrCl_4$	$Fe_3(CO)_{12}$	17	0
2		$Co_2(CO)_8$	26	0
3		$Ru_3(CO)_{12}$	37	0
4		$FeBr_2$	31	0
5		Cu(OEP)[f]	33	0
6		$[Rh(cod)Cl]_2$	30	0
7		$[(p\text{-cymene})RuCl_2]_2$	46	22
8		$[(C_6H_6)RuCl_2]_2$	61	28
9		$IndRu[PPh_3]_2Cl{\cdot}CH_2Cl_2$	49	19
10		$Cp^*Ru[PPh_3]_2Cl$	87	59[c]
11[e]		$Ru[PPh_3]_3Cl_2$[g]	97	74[d]
12[e]	$HfCl_4$	$Ru[PPh_3]_3Cl_2$[g]	>98	57

(a) Standard conditions: 1 (0.50 mmol), $ZrCl_4$ (1.05 equiv), Et_3N (2.0 equiv), *n*-C_4F_9I (5.0 equiv), CH_2Cl_2 (~0.1 M), mixed and stirred at 45 °C for 24 h. (b) Determined by the 500 MHz NMR analysis of the crude mixture of products. (c) In addition, 18% of α,β-unsaturated byproduct resulting from HF elimination has also been observed. (d) In addition, 12% of α,β-unsaturated byproduct resulting from HF elimination has also been observed. (e) *n*-C_3F_7I (5.0 equiv) was used. (f) OEP = 2,3,7,8,12,13,17,18-octaethyl-21*H*,23*H*-porphirine. (g) 7 mol % of the metal catalyst was used.

Once these metal halides had been identified, a number of transition metal redox catalysts for the generation of perfluoroalkyl radicals were examined (Table 3.4.1). Among these, ruthenium catalysts emerged as the most promising (entries 7–11), with $Ru[Ph_3P]_3Cl_2$, the catalyst used in the original chloroalkylation of titanium enolates, being the most effective. The ruthenium-catalyzed perfluoropropylation of *N*-acyl oxazolidinones **3.12**, which served as a benchmark reaction, was characterized by a clean transformation to **3.13** using only a moderate excess (5 equiv) of *n*-C_3F_7I (entry 11). The side products were comprised of only the α,β-unsaturated imide as a result of HF elimination from **3.13** (12%) and the cleaved oxazolidinone auxiliary (11%),[103] which together accounted for the majority of the remaining mass balance. Similar outcomes were observed with hafnium enolates derived in situ from hafnium tetrachloride and Et_3N (entry 12).

The scope of perfluoroalkylating agent was investigated next (Table 3.4.2).[104] No byproduct resulting from α,β-elimination of hydrogen fluoride was observed in any trifluoromethylation reactions (entry 1; also see Table 3.4.3). We did observe partial (9–17%) formation of an α,β-unsaturated byproduct (**A**) with primary perfluoroalkyl- and perfluorobenzyl-substituted products (entries 2, 3, 5, and 6). As in the trifluoromethylation reaction, no HF elimination was detected when the 2-perfluoropropyl group was introduced (entry 4).

Table 3.4.2 Scope of Perfluoroalkylating Agent[a]



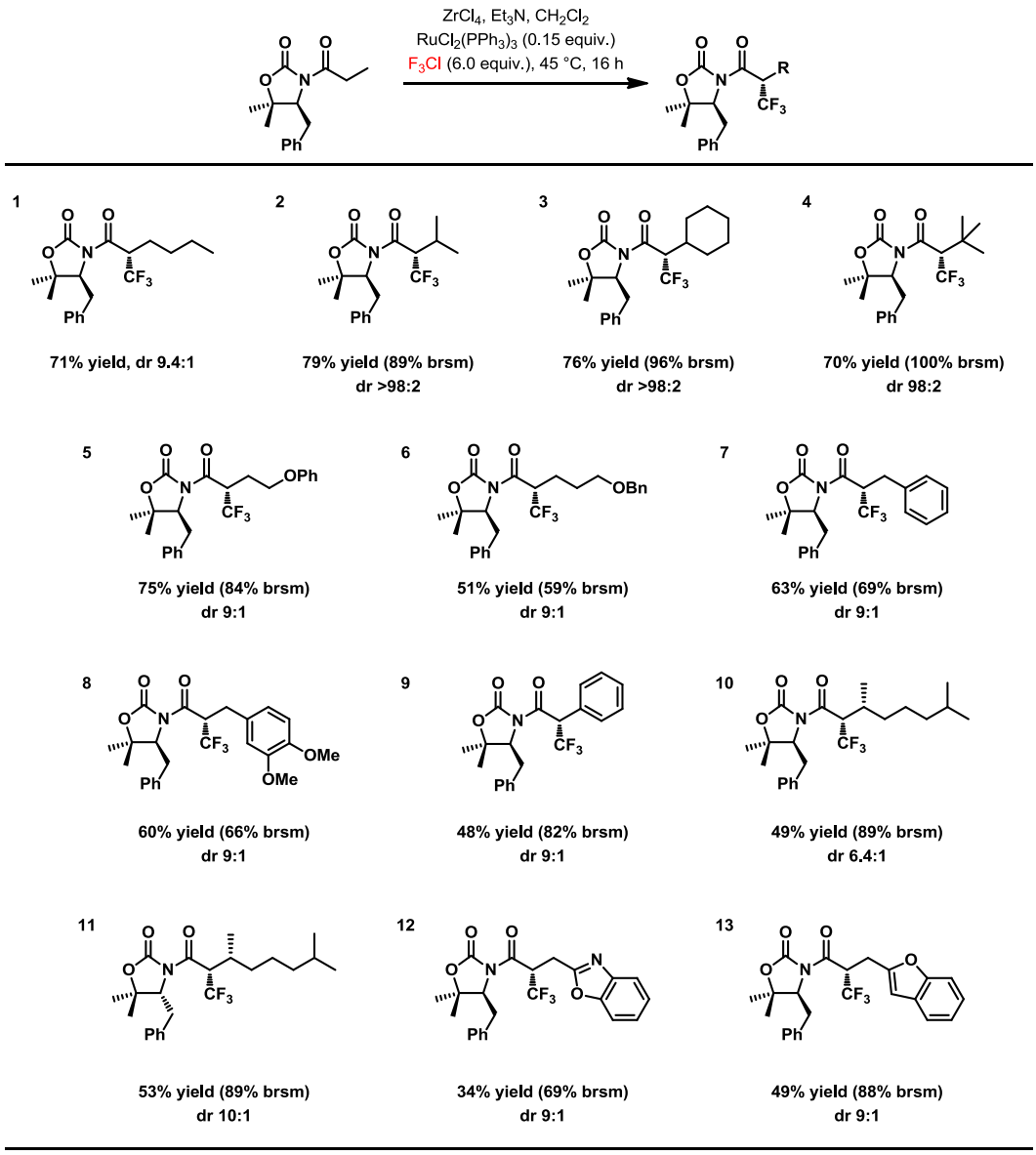
(a) Yields of isolated products are reported. The numbers in parentheses are yields of the corresponding α,β-unsaturated byproduct **A**, when observed. Diastereomer ratios were determined by 500 MHz ^{1}H NMR analysis. (b) observed for primary perfluoroalkyl groups only. (c) 15 mol % of $[Ph_3P]_3RuCl_2$ were used. (d) brsm = based on recovered starting material.

A variety of *N*-acyl oxazolidinones can be successfully trifluoromethylated using the simple protocol developed in the course of this investigation (Table 3.4.3). We found that reagents can be mixed all at once in any order at room temperature with no influence on the isolated yield of the desired product. Therefore, the reaction setup can be guided solely by experimental convenience rather than by other factors intrinsic to the reaction. *N*-Acyl oxazolidinones obtained from unfunctionalized alkanoic acids undergo efficient and diastereoselective trifluoromethylations, with yields increasing for β-branched substrates (entries 1–4). These are clean transformations, where unreacted starting material is the major byproduct as indicated by yields based on recovered starting materials (entries 2–4), while

auxiliary cleavage (25%) was observed for the reaction in entry 1. The presence of aryl and benzyl ethers is well-tolerated (entries 5, 6), as is the presence of functionalized β-aryl substitution, although the extent of chiral auxiliary detachment was higher (31–34% for entries 7, 8). Substitution with a phenyl group at the α-position resulted in a clean reaction (82% yield brsm, entry 9), albeit at a reduced conversion under the standard conditions (59%). Diastereoselective alkylations controlled by the oxazolidinone stereochemistry can be performed with substrates that have a stereogenic center at the β-position in the *N*-acyl substituent (entries 10, 11). More functionalized heterocyclic substituents such as benzofurans and benzoxazoles are also compatible with the reaction conditions (entries 12, 13).

The proposed mechanism of the reaction based on the related Ru-catalyzed trichloromethylation is depicted in Scheme 3.4.1.[95a,97] NMR spectroscopic studies of the enolate formation using *N*-propionyl oxazolidinones **3.12**, zirconium tetrachloride, triethylamine, and $CDCl_3$revealed that a rapid, clean, and essentially complete enolization producing enolate **3.15** occurs at room temperature. We succeeded in obtaining a single-crystal X-ray structure of a complex between the substrate and $ZrCl_4$ revealing a nearly perfectly planar arrangement of atoms in the six-membered cyclic chelate **3.17** which is in all respects similar to the corresponding titanium complex (not shown). Therefore, we surmise that the geometric structures of the zirconium (**3.15**) and titanium enolates are similar, and it is the dissimilarities in their electronic structure that are responsible for differences in their reactivity in the ruthenium-catalyzed fluoroalkylation reaction. Once **3.15** is formed, it undergoes an addition reaction with the trifluoromethyl radical generated by a

Table 3.4.3 Scope of *N*-Acyl Oxazolidinones in the Trifluoromethylation Reaction[a]

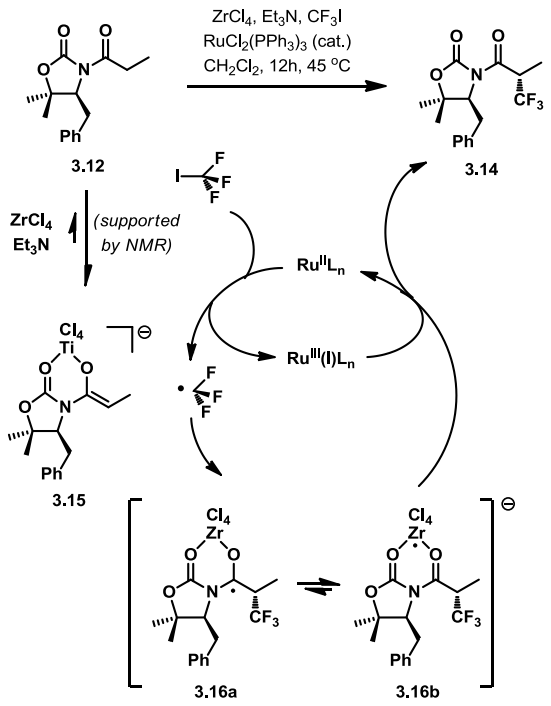


(a) Yields of isolated products are reported. At least two experiments were carried out to confirm reproducibility. The numbers in parentheses are yields based on recovered starting material (brsm). Diastereomer ratios were determined by 500 MHz ^{1}H NMR analysis of the crude mixture of products.

redox process from iodotrifluoromethane and the ruthenium(II) catalyst. The addition product is probably better represented by resonance form **3.16b** rather than carbon-centered form **3.16a**, and a potential biradical character of **3.15** may facilitate the addition of the CF_3

radical. The ruthenium catalyst is recovered by a single electron transfer from intermediate **3.16b** to Ru(III) species.

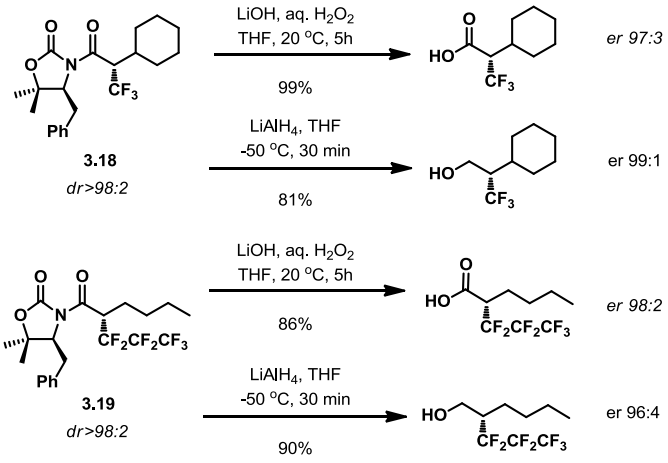
Scheme 3.4.1 Proposed Mechanism of the Ru-Catalyzed Trifluoromethylation Reaction



Additional insight into the course of the perfluoroalkylation was acquired from the following experiments. First, when the catalyst loading in the perfluoropropylation of **3.12** was increased from 7 to 30 mol %, the rate of the process was notably enhanced. The reaction was complete in 4 rather than 16 h, showing a substantially reduced level of side reactions and giving the expected product in 86% isolated yield. Similar, albeit somewhat lower efficiency was observed when the amount of *n*-C_3F_7I was increased from 5 to 15 equiv. Taken together, these observations suggest that the generation of the perfluoroalkyl radical is the rate-limiting step of the process. Second, monitoring the course of the reaction performed in CD_2Cl_2 by ^1H and ^{19}F NMR spectroscopy revealed that another major pathway of reactivity for *n*-C_3F_7–I is reduction to *n*-C_3F_7–H, which presumably occurs by oxidation of

triethylamine. Overall, these key observations are expected to aid in developing more efficient perfluoroalkylation processes based on radical additions to transition metal enolates.

Scheme 3.4.2 Preparation of Versatile Enantioenriched Fluorinated Building Blocks by Hydrolytic and Reductive Removal of the Chiral Auxiliary[a]



(a) The chiral auxiliary is recovered in nearly quantitative yield in all reactions.

Conversion of the reaction products to broadly useful fluorinated building blocks for organic synthesis is illustrated by examples in Scheme 3.4.2 that include hydrolytic and reductive removal of the chiral auxiliary. Trifluoromethyl-substituted derivative **3.18** and perfluoropropyl derivative **3.19**[105] could be readily hydrolyzed with a LiOH–H_2O_2 reagent system to the corresponding carboxylic acids with a high level of retention of stereochemical integrity. While reductions of these compounds with sodium borohydride in aqueous THF were sluggish, removal of the oxazolidinone could be readily achieved by treatment with lithium aluminum hydride. For substrate **3.19**, virtually complete preservation of stereochemistry was observed, while only a minor erosion of stereochemistry was noted for

the perfluoropropyl-substituted substrate. Notably, these transformations are characterized by very good yields and nearly quantitative recovery of the chiral auxiliary.

In closing, we report an experimentally simple asymmetric fluoroalkylation reaction of *N*-acyl oxazolidinones based on the unique radical reactivity of group IVa metal enolates. For titanium enolates, the biradical character has been supported by computational and spectroscopic studies that provide an intriguing conceptual basis for reaction development. From a practical perspective, the reaction requires inexpensive reagents, which can be mixed in any order, and mild heating over the course of a few hours delivers fluoroalkylation products directly in good yields and high diastereoselectivities. Ongoing studies are directed at the development of a more active catalytic system, catalytic generation of the metal enolate, and defining a more detailed picture for the mechanism of the reaction.

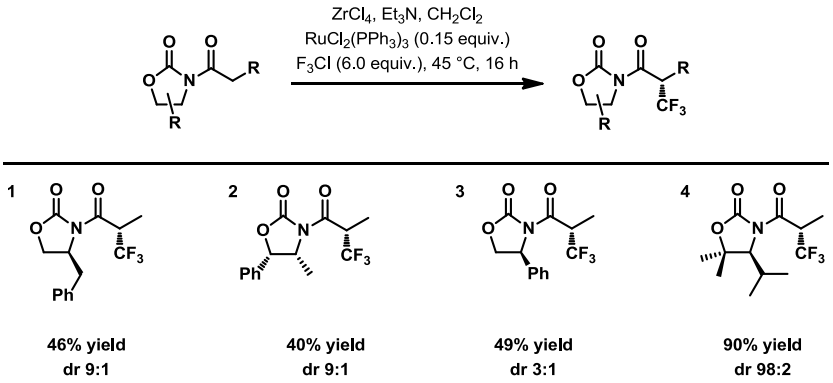
3-4-2: Continuing Trifluoroalkylation Studies

After the preliminary trifluoroalkylation studies, further investigates were conducted to increase either yield or diastereoselectivity. An initial screen of oxazolidinones was conducted to see the effect on diastereoselectivity as seen in Table 3.4.3. We found that if there was a lack of quaternary substitution at the 5-position on the auxiliary; it led to low yield and decomposition of the starting material (entries 1-3). Further screening indicated that an isopropyl auxilixary led to improvement for yield and diastereoselectivity (entry 4).

After selecting 4-isopropyl-5,5-dimethyloxazolidin-2-one as the auxiliary, a small screen of *N*-acyl oxazolidinones was conducted as shown in Table 3.4.4. For all substrates both catalyst loading and reaction time was decreased by 50% or more. Drastic improvement in both yield +19% and diastereoselectivity >98:2 was observed for the *N*-Acyl oxazolidinones obtained from hexanoic acid (Table 3.4.4, entry 1). An astonishing increase in yield (+30%)

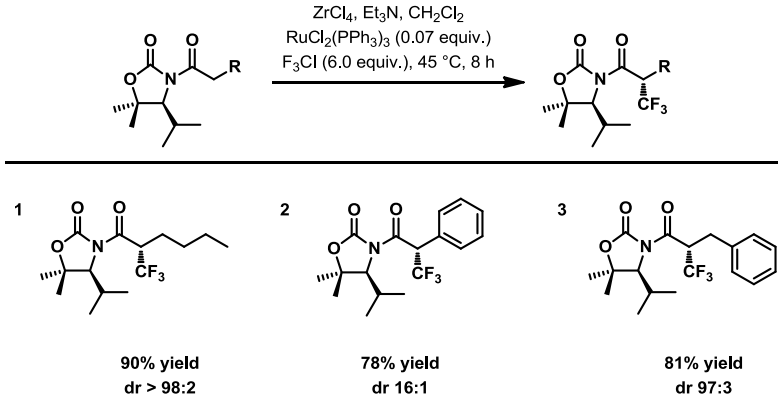
and slight improvement in diastereoselectivity was observed for phenyl acetic acid derivative (entry 2).

Table 3.4.3 Scope of *N*-Acyl Oxazolidinones in the Trifluoromethylation Reaction[a]



(a) Yields of isolated products are reported. Diastereomer ratios were determined by 500 MHz ^{1}H NMR analysis.

Table 3.4.4 Scope of Trifluoromethylation of Isopropyl *N*-Acyl Oxazolidinone[a]



(a) Yields of isolated products are reported. Diastereomer ratios were determined by 500 MHz ^{1}H NMR analysis.

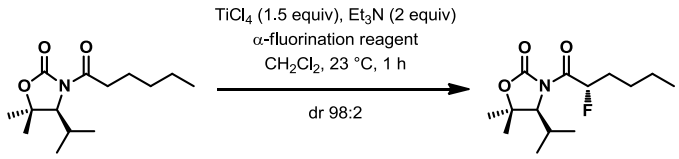
3.5 Stereoselective α-Fluorination of *N*-Acyl Oxazolidinones at Room Temperature

The importance of organofluorine compounds has been amply validated by broad application in medicinal sciences, materials, and agrochemicals.[106] Fluorine incorporation is typically performed to acquire the unique physical and chemical properties that fluorine substitution imparts on organic compounds. Although many methods for fluorination have already been reported in the literature,[106a,106b,106m,107] future advancements in the discovery and application of fluorinated materials require the availability of new methods for economical and selective fluorination. Despite the broad utility of fluorine-containing organic compounds, stereoselective incorporation of the fluorine atom at the α-position of the carbonyl group has remained an ongoing challenge; several notable recent developments exploit reagent, catalyst, or substrate control in α-fluorination reactions.[108] Following early work on diastereoselective electrophilic α-fluorination of lithium enolates with *N*-fluoro-*o*-benzenedisulfonimide (NFOBS) as the fluorinating reagent,[109] a number of elegant alternatives describing the use of *N*-fluoropyridinium 2,8-diazobicyclo[2,2,2]octane and sulfonamide reagents as the electrophilic source of fluorine were developed.[110] In all, these methods expanded the repertoire of selective α-monofluorination for a diverse range of carbonyl compounds, at the same time highlighting their unique patterns of reactivity. On the other hand, issues of practicality, limitations in substrate scope, high cost of reagents, extended reaction time, and energy efficiency (use of cryogenic conditions or high temperatures) remain persistent, stimulating continued progress in this area.

Demonstration of the efficacy of group IVa metal enolates generated by soft enolization[111] in ruthenium-catalyzed radical trichloromethylation, trifluoromethylation, and perfluoroalkylation reactions.[112] We applied this experimentally simple protocol, good to

high yields of various α-haloalkylation products can be achieved with high diastereoselectivity. Herein, we describe the utility of group IVa metal enolates derived from *N*-acyl oxazolidinones in rapid economical and operationally simple electrophilic α-fluorination reactions that take place at room temperature and display high diastereoselectivity.

Table 3.5.1 Identification of Optimal Fluorinating Reagent[a]



3.20 **3.21**

Entry	Reagent	Conversion[b] (%)	$/mmol
1	NFSI	99	$0.35[c]
2	Selectfluor	70[d]	$0.82[e]
3	1-fluoro-2,4,6-trimethylpyridinium triflate	<1	$3.67[f]
4	1-fluoro-2,4,6-trimethylpyridinium tetrafluoroborate	<1	$4.09[f]

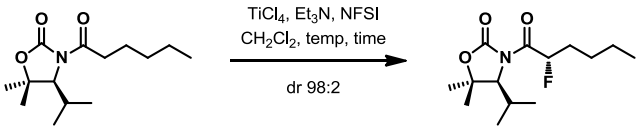
(a) Standard conditions: **3.20** (0.50 mmol), $TiCl_4$ (1.5 equiv), Et_3N (2.0 equiv), CH_2Cl_2 (0.5 M), reagent (2.0 equiv), mixed and stirred at room temperature for 1 h. (b) Determined by the 600 MHz NMR analysis of the crude mixture of products. (c) Oakwood Products. (d) Reaction solvent was a 1:1 mixture of acetonitrile/CH_2Cl_2, dr 5:1. (e) Apollo Scientific. (f) TCI America.

The aim of initial experiments was to identify the optimal electrophilic source of fluorine, with the chemical efficiency of the α-fluorination reaction and reagent cost being the most important factors (Table 3.5.1). Examination of the most common commercial sources of electrophilic fluorine, summarized in Table 3.5.1, revealed that *N*-fluorobenzenesulfonimide (NFSI), the most inexpensive reagent tested, displayed superior

performance by a substantial margin. Under standard conditions, complete conversion in the α-fluorination of **3.20** was achieved with NFSI within 1 h at room temperature. The reaction occurred with a diastereoselectivty of 98:2. Selectfluor, the second best reagent, provided 70% conversion with a decrease of diastereoselectivity to 5:1, whereas both 1-fluoro-2,4,6-trimethylpyridinium triflate and 1-fluoro-2,4,6-trimethylpyridinium tetrafluoroborate were not efficient sources of electrophilic fluorine due to lack of solubility in dichloromethane.

Early experimentation also revealed a rather high reactivity of titanium enolates in the α-fluorination reaction. In contrast to other reported stereoselective α-fluorinations of carbonyl compounds, the reaction reaches 90% conversion within 30 min at room temperature while maintaining high diastereoselectivity (Table 3.5.2, entry 1). Full conversion requires 60 min at 23 °C (Table 3.5.2, entry 2). Under optimized conditions, 1.5 equiv of $TiCl_4$ and 2 equiv each of Et_3N and NFSI are required for full conversion (Table 3.5.2, entry 5), and reduction in the stoichiometry of any of these reagents erodes conversion (Table 3.5.2, entries 4 and 6–9) with the strongest effect observed for NFSI (Table 3.5.2, entry 4).[113] Similar results, including high diastereoselectivity of 98:2, were noted when $ZrCl_4$ and $HfCl_4$ (Table 3.5.2, entries 10 and 11) were used for enolate generation under identical conditions, although conversions were lower by about 10%.[114] All three common oxazolidinones surveyed 3-propionyl-5,5-dimethyl-4-benzyl- (Table 3.5.2, entry 12), 3-propionyl-5,5-dimethyl-4-isopropyl-, and 3-propionyl-4-benzyloxazolidin-2-ones (Table 3.5.2, entry 13) showed high diastereoselectivity (>10:1), with the 5,5-dimethyl-4-isopropyl derivative related to **3.20** giving the highest stereoselectivity (dr 98:2). Therefore, further studies were carried out with NFSI as the fluorinating reagent and the 5,5-dimethyl-4-isopropyl-substituted oxazolidinone as the stereodirecting group.

Table 3.5.2 Optimization of α–Fluorination Reaction[a]



3.20 3.21

Entry	$TiCl_4$ (equiv)	Et_3N (equiv)	NFSI (equiv)	Time (h)	Conversion[b] (%)
1	2.0	3.0	2.0	0.5	90
2	2.0	3.0	2.0	1	99
3	2.0	2.0	2.0	1	99
4	2.0	3.0	1.25	1	50
5	1.5	2.0	2.0	1	99
6	1.25	2.0	2.0	1	93
7	1.5	1.5	1.5	1	77
8	0.5	3.0	2.0	12	40[c]
9	1.0	3.0	2.0	12	80[c]
10	1.5 ($ZrCl_4$)[d]	2.0	2.0	1	87
11	1.5 ($HfCl_4$)[e]	2.0	2.0	1	78
12	1.5	2.0	2.0	1	99[f]

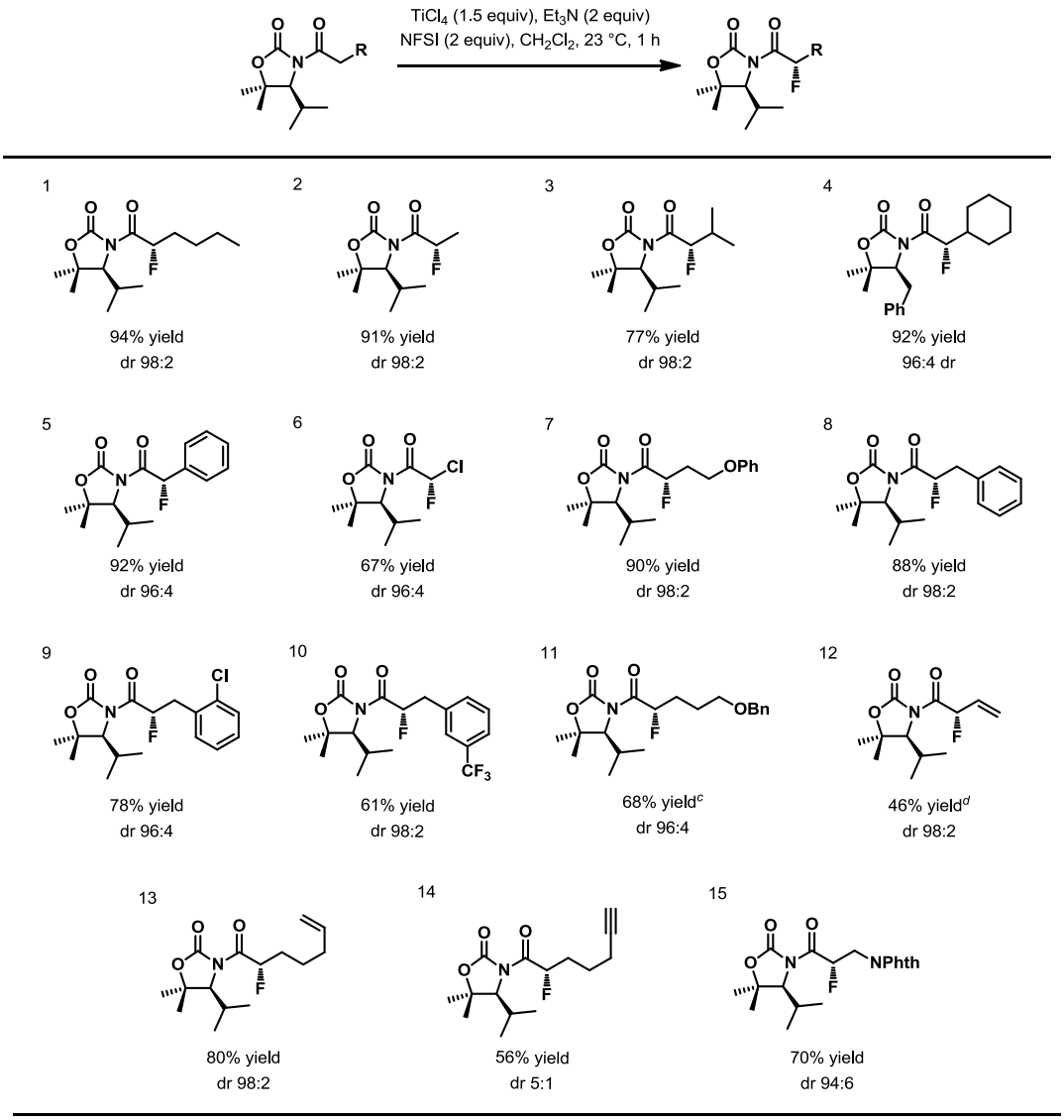
(a) Standard conditions: **3.20** (0.50 mmol), CH_2Cl_2 (0.5 M), mixed and stirred at room temperature. (b) Determined by the 600 MHz ^1H NMR analysis of the crude mixture of products. (c) Reactions were performed at 45 °C. (d) $ZrCl_4$ was used in place of $TiCl_4$. (e) $HfCl_4$ was used in place of $TiCl_4$. (f) 3-propionyl-5,5-dimethyl-4-benzyloxazolidin-2-one was used (dr 96:4).

Substrates derived from simple unfunctionalized alkanoic acids generally afford high yields of α-fluorination products with high diastereoselectivity under standard conditions at room temperature within 1 h (Table 3.5.3, entries 1-4). The derivative of isovaleric acid (Table 3.5.3, entry 3) afforded a somewhat depressed yield of 77% due to competitive formation of α-chlorination product (10% yield, >99:1 dr). 3-Phenylacetyl-5,5-dimethyl-4-

isopropyloxazolidinone afforded the α-fluorination product in high yield and diastereoselectivity (Table 3.5.3, entry 5). A unique derivative of α-chloro-α-fluoroacetic acid has been prepared by this procedure with high stereoselectivity (Table 3.5.3, entry 6). An example, entry 4, illustrates that analogues in which the stereodirecting 4-isopropyl substituent is replaced with a benzyl group provide comparable yields and diastereomeric ratios of α-fluorination products. Aryl ether groups are well tolerated (Table 3.5.3, entry 7). A number of compounds produced from hydrocinnamic acids are also good substrates for the α-fluorination reaction (Table 3.5.3, entries 8-10), while benzyl ethers undergo partial debenzylation, which can be mitigated by replacing $TiCl_4$ with $ZrCl_4$ (Table 3.5.3, entry 11).

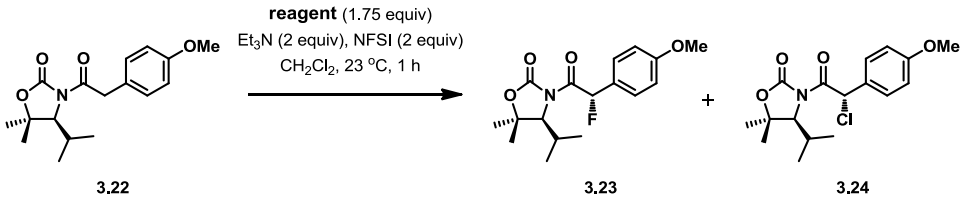
α-Fluorination via titanium enolates of substrates containing unsaturation can be accomplished efficiently in the presence of double bonds (Table 3.5.3, entries 12-13), yet terminal alkynes can display notably lower yields (Table 3.5.3, entry 14). Although no specific byproducts have presently been isolated, the lower efficiency can hypothetically be ascribed to the competitive formation of alkynyltitanium species under the reaction conditions. The protected form of α-fluoro-β-alanine can be prepared in 70% yield and 94:6 diastereomeric ratio (Table 3.5.3, entry 15). In most cases, the product can be isolated as the isomerically pure diastereomer either by recrystallization or flash column chromatography.

Table 3.5.3 Scope of *N*-Acyl Oxazolidinones in the α–Fluorination Reaction[a,b]



(a) Standard conditions: substrate (0.50 mmol), $TiCl_4$ (1.5 equiv), Et_3N (2.0 equiv), NFSI (2.0 equiv), CH_2Cl_2 (0.5 M), mixed and stirred at room temperature for 1 h. (b) Yields of isolated products are reported. Diastereomer ratios were determined by 600 MHz ^{1}H NMR analysis of the crude mixture of products. (c) 1.5 equiv of $ZrCl_4$ was used in place of $TiCl_4$. (d) (*S*)-3-(2-Butenoyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one was used as the starting material.

Table 3.5.4 Optimization of α-Fluorination of 3-(4-Methoxyphenylacetyl)-5,5-dimethyl-4-isopropyloxazolidin-2-one **3.22**[a,b]



3.22 3.23 3.24

Entry	Reagent	% 3.23 (dr)[b,c]	% 3.24 (dr)[b,c]
1	$TiCl_4$	0	82 (1:1)
2	$Ti(OPr\text{-}i)_2Cl_2$	52 (93:7)	41 (1:1)
3	$Ti(OPr\text{-}i)_2Cl_2{\cdot}2E_3NHCl$	77 (93:7)	17 (1:1)
4	$Ti(OPr\text{-}i)_3Cl_2{\cdot}3E_3NHCl$	17 (93:7)	0
5	$Ti(OPr\text{-}i)\ Cl_2{\cdot}E_3NHCl$	0	100 (1:1)
6	$ZrCl_4$	0	100 (1:1)

(a) Standard conditions: **3.22** (0.50 mmol), Ti reagent (1.75 equiv), Et_3N (2.0 equiv), NFSI (2.0 equiv), CH_2Cl_2 (0.5 M), mixed and stirred at room temperature for 1 h. (b) Percent composition of the compound in the crude mixture of products as determined by 600 ^{1}H NMR analysis. (c) Diastereomeric ratio (dr) was determined by the 600 MHz ^{1}H NMR analysis of the crude mixture of products.

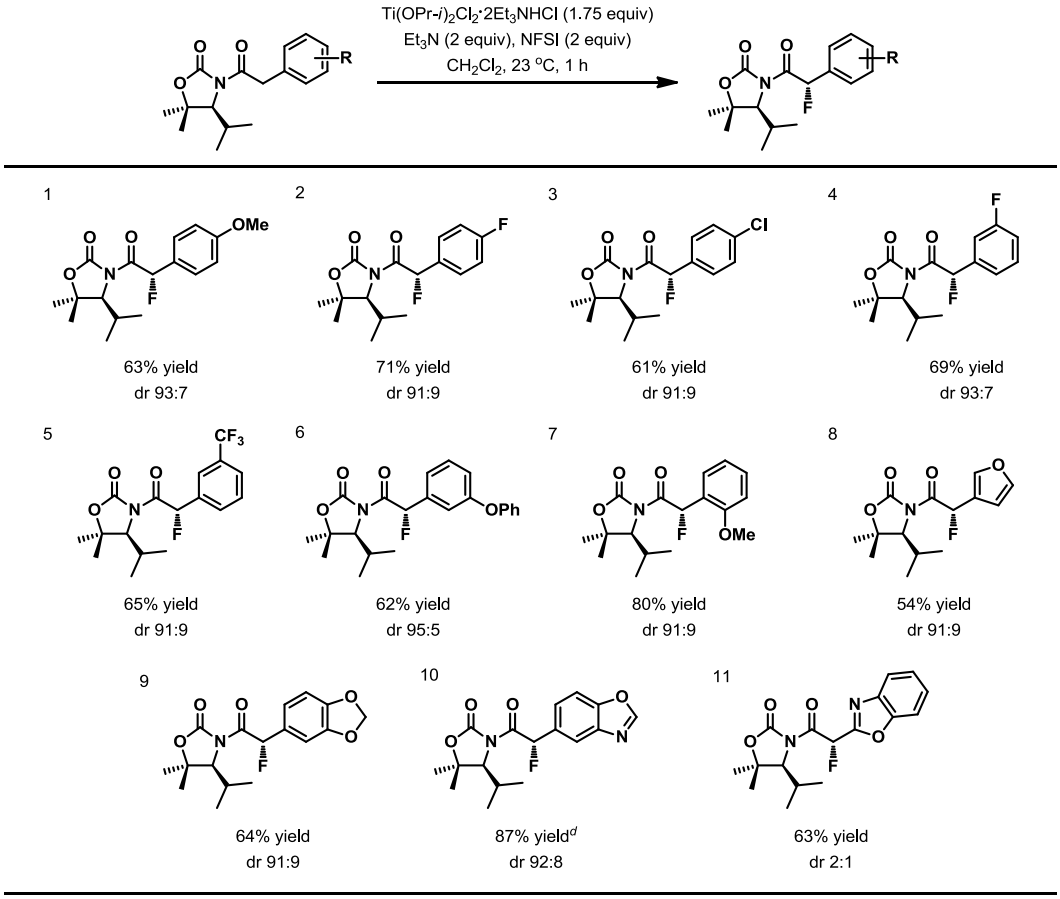
In contrast to the unfunctionalized phenylacetic acid derivative (cf. Table 3.5.4, **3.22**), substitution in the phenyl ring resulted in substantially different reactivity under the standard conditions. In fact, the attempted α-fluorination of 4-methoxyphenyl analogue **3.22** resulted in the exclusive formation of α-chlorination product **3.24** as a 1:1 mixture of diastereomers (Table 3.5.4, entry 1). The hypothesis that replacing $TiCl_4$ with an alternative titanium(IV) Lewis acid would minimize the competitive chlorination was put to the test next. Delightfully, a significant improvement in α-fluorination was achieved when $Ti(OPr\text{-}i)_2Cl_2$, prepared by a reaction of equimolar amounts of $TiCl_4$ and $Ti(OPr\text{-}i)_4$,[115] was used for enolate

generation (Table 3.5.4, entry 2). When diisopropoxytitanium dichloride was prepared by an alternative procedure from $TiCl_4$, 2 equiv of 2-propanol, and 2 equiv of triethylamine, a further improvement was achieved (Table 3.5.4, entry 3).[116] The use of triisopropoxytitanium chloride, isopropoxytitanium trichloride, or zirconium tetrachloride led to either low reactivity or exclusive formation of the α-chlorination product (Table 3.5.4, entries 4–6).

With the protocol utilizing the $Ti(OPr\text{-}i)_2Cl_2 \cdot 2Et_3NHCl$ reagent, a range of substituted phenylacetic acid derivatives can be effectively α-fluorinated with very good diastereocontrol (Table 3.5.5). Modification of the phenyl group with electron-donating or mildly electron-withdrawing substituents in the ortho-, metα–, and paraα–positions is tolerated (Table 3.5.5, entries 1-7, 11). Diastereoselectivities are lower than with substrates represented in Table 3.5.4 but still in the practically useful range of greater than 10:1, and in most cases, the diastereomers are separable by column chromatography.

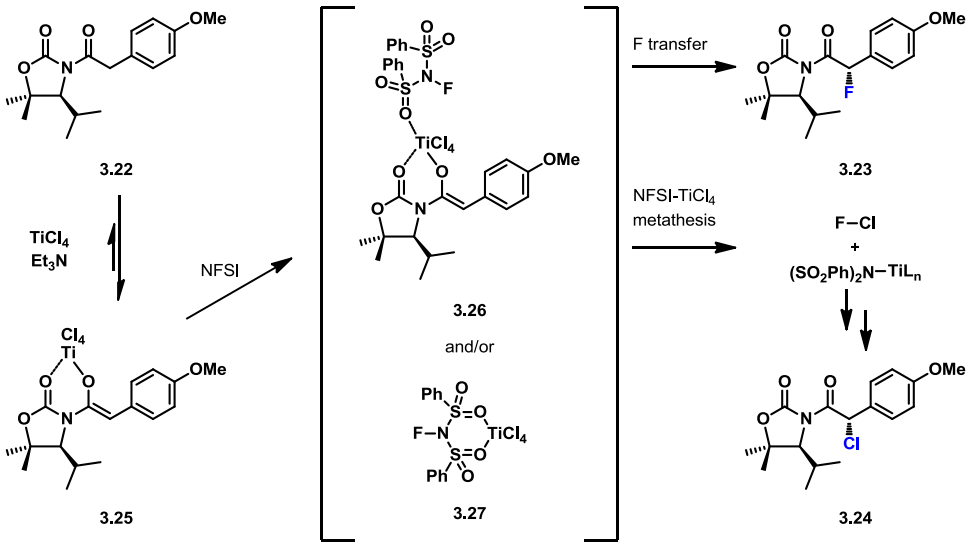
In addition, heteroaromatic substituents can effectively afford α-fluorination products with high diastereoselectivity, as demonstrated with the derivatives of 3-furanacetic acid (Table 3.5.5, entry 8) and 2-(benzo[*d*]oxazol-5-yl)acetic acid (Table 3.5.5, entry 10). On the other hand, fluorination of oxazolidinone derived from 2-(benzo[*d*]oxazol-2-yl)acetic acid (Table 3.5.5, entry 11) afforded a 2:1 mixture of diastereomers. The reduction in diastereoselectivity may be attributed to increased C–H acidity of this compound resulting in the enolization of products. Isolation of difluorination products observed for these examples supports this hypothesis.

Table 3.5.5 Scope of α-Fluorination of α-Aryl Acetic Acid *N*-Acyl Oxazolidinone Derivatives[a,b,c]



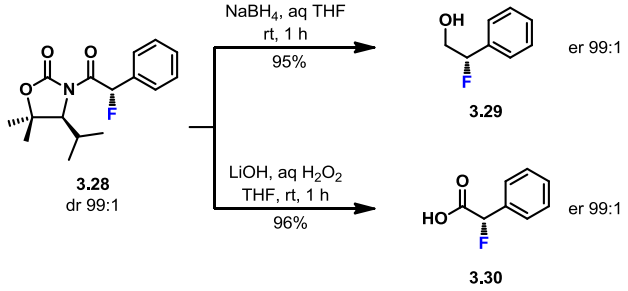
(a) Yields are of isolated pure major diastereomers unless indicated otherwise. Diastereomer ratios were determined by 600 MHz ^{1}H NMR analysis of the crude mixture of products. (b) Standard conditions: substrate (0.50 mmol), $TiCl_2(O^iPr)_2 \cdot 2Et_3NHCl$ (1.75 equiv), Et_3N (2.0 equiv), NFSI (2.0 equiv), CH_2Cl_2 (0.5 M), mixed and stirred at room temperature for 1 h. (c) Less than 10% of chlorinated products were observed along with products entries 2-11. (d) $Ti(OPr\text{-}i)_2Cl_2$ (1.75 equiv) was used; product isolated as a mixture of diastereomers.

Scheme 3.5.1 Mechanistic Hypothesis for the α-Fluorination Reaction



A plausible mechanism outlined in Scheme 3.4.1 accounts for the experimental observations, including higher than expected reactivity of titanium enolates in the electrophilic fluorination as well as the appearance of α-chlorination byproduct **3.24**. Soft enolization of 4-methoxyphenyl derivative **3.22** with $TiCl_4$ and Et_3N affords affords the expected Ti enolate. This newly formed Lewis acid could activate NFSI directly to form **3.26**, or NFSI could be activated by excess $TiCl_4$ to form **3.27**. The latter mode of activation may explain the need for 1.5–1.75 equiv of the reagent required for complete conversion. Activation of the NSFI by Lewis acid was documented to be essential for electrophilic fluorination of enolates by others.[108e,117] Subsequent electrophilic fluorination typically affords **3.23** as the major product. Concurrently, a group exchange between Cl–TiL_n reagent (**3.26**, **3.27**, or other) and NFSI may take place giving rise to chlorine(I) fluoride, which is an electrophilic source of chloronium. When ClF reacts with the titanium enolate, α-chlorination product **3.24** is formed.[118] The kinetics of these processes is likely affected by the identity of the Ti reagent among other reaction parameters.

Scheme 3.5.2 Preparation of Enantioenriched Fluorinated Building Blocks via Hydrolytic and Reductive Removal of the Chiral Auxiliary

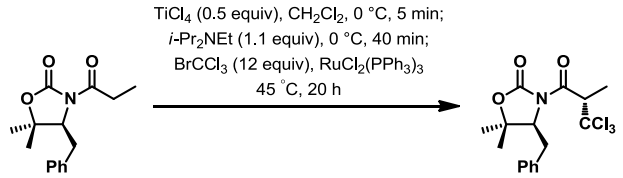


Conversion of the reaction products to broadly useful fluorinated building blocks for organic synthesis is illustrated by examples in Scheme 3.4.2. These include hydrolytic and reductive removal of the chiral auxiliary. The monofluorinated derivative **3.28** could be readily reduced using sodium borohydride in aqueous THF, delivering the corresponding fluoroalcohol **3.29** in high yields and with a high level of retention of stereochemical integrity. Compound **3.28** could also be hydrolyzed with a LiOH–H_2O_2 reagent system to yield the corresponding acid **3.30** in high yields and virtually complete preservation of stereochemistry. Notably, these transformations are characterized by excellent yields and nearly quantitative recovery of the chiral auxiliary.

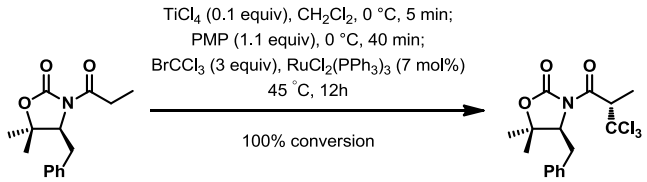
We have reported an operationally simple asymmetric α-fluorination reaction of *N*-acyl oxazolidinones based on the unique reactivity of group IVa metal enolates. From a practical perspective, the reaction requires inexpensive reagents, mild conditions, short reaction times at ambient temperatures, and delivers α-fluorination products directly in good yields and high diastereoselectivities.[119,120] Ongoing studies are directed at defining a more detailed picture of the mechanism for the fluorination of α-arylacetic acid derivatives and determination of the structure and function of the $TiCl_2(OPr\text{-}i)_2 \cdot 2Et_3NHCl$ complex.

Chapter 3: Supporting Information

3-6: Dual Ti-Ru Catalysis Supporting Information



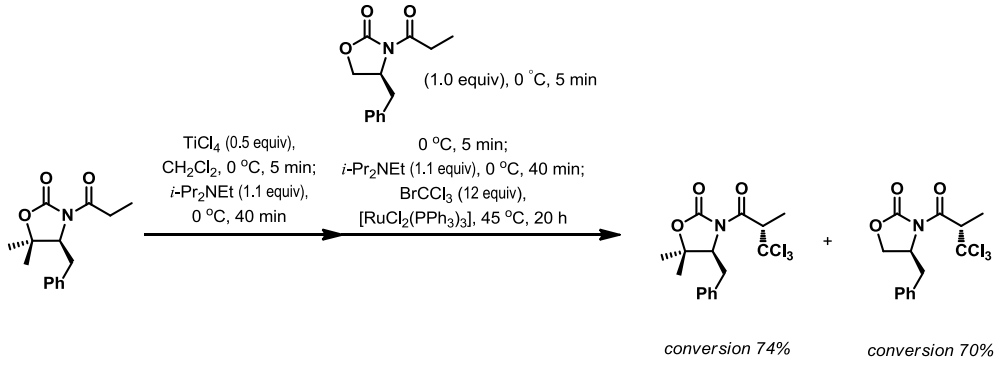
Titanium tetrachloride (1.0 M in CH_2Cl_2, 0.25 ml, 0.25 mmol, 0.50 eq) was added to a solution of the substrate **3.1** (0.131 g, 0.50 mmol) in CH_2Cl_2 (0.75 ml) in a vial at 0 °C and the mixture was stirred for 5 min at the same temperature. Diisopropylethylamine (96 μl, 0.55 mmol, 1.1 eq) was added and the resulting deep red mixture was stirred at 0 °C for 40 min. Bromotrichloromethane (0.60 ml, 6.0 mmol, 12 eq) was added, followed by $RuCl_2(PPh_3)_3$ (34 mg, 0.035 mmol, 7 mol%) and the mixture was sealed and heated at 45 °C for 20 h. After cooling to room temperature, the reaction was quenched by adding water and extracted with CH_2Cl_2. The organic layer was washed with brine and dried over Na_2SO_4. After filtration and concentration, the crude product was analyzed by ^{1}H NMR spectroscopy indicating >97% conversion.



Titanium tetrachloride (1.0 M in CH_2Cl_2, 0.10 ml, 0.10 mmol, 0.1 eq) was added to a solution of 4-benzyl-5,5-dimethyl-*N*-propionyloxazolidin-2-one (0.261 g, 1.0 mmol) in CH_2Cl_2 (1.2 ml) in a vial at 0 °C and the mixture was stirred for 5 min at the same temperature. 1,2,2,6,6-Pentamethylpiperidine (0.20 ml, 1.10 mmol, 1.1 eq) was added and

the resulting deep red mixture was stirred at 0 °C for 40 min. Bromotrichloromathane (0.30 ml, 3.0 mmol, 3 eq) was added, followed by $RuCl_2(PPh_3)_3$ (68 mg, 0.070 mmol, 7 mol%) and the mixture was sealed and heated at 45 °C for 12 h. After cooling down, the reaction was quenched by adding water and extracted with CH_2Cl_2. The organic layer was washed with brine and dried over Na_2SO_4. After filtration and concentration, the residue was analyzed by ^1H NMR spectroscopy, which indicated a 100% conversion. Purification by column chromatography on silica gel afforded the product (0.368 g, 0.97 mmol, 97%). 1H NMR (400 MHz, CDCl3); δ(ppm): 7.38-7.20 (m, 5H); 5.31 (q, J=6.4 Hz, 1H); 4.53(dd, J1=2.8 Hz, J2=10.4 Hz, 1H); 3.27 (dd, J1=2.8 Hz, J2=14.4 Hz, 1H); 2.81(dd, J1=10.4 Hz, J2=14.4 Hz, 1H); 1.60 (J=6.4 Hz, 3H); 1.34 (s, 3H); 1.30 (s, 3H).

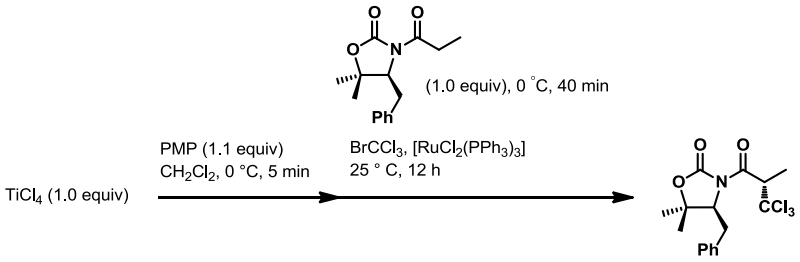
The crossover experiment:



Titanium tetrachloride (1.0 M in CH_2Cl_2, 0.25 ml, 0.25 mmol) was added to a solution of the substrate **3.1** (0.131 g, 0.50 mmol, 1.0 eq) in CH_2Cl_2 (0.75 mL) in a vial at 0 °C and the mixture was stirred for 5 min at the same temperature. Diisopropylethylamine (96 μl, 0.55 mmol, 1.1 eq) was added and the resulting deep red mixture was stirred at 0 °C for 40 min. Oxazolidinone **3.6** (0.117 g, 0.50 mmol, 1.0 eq) in CH_2Cl_2 (0.4 ml) was added to the above reaction mixture and 5 min later *i*-Pr_2NEt (96 μl, 0.55 mmol, 1.1 eq) was added. After

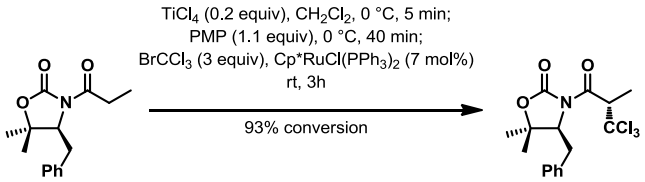
stirring for additional 40 min at 0 °C, $BrCCl_3$ (0.60 ml, 6.0 mmol, 12 eq) and $RuCl_2(PPh_3)_3$ (34 mg, 0.035 mmol, 7 mol%) were added, and the mixture was sealed and heated at 45 °C for 20 h. After cooling down, the reaction was quenched by adding water and extracted with CH_2Cl_2. The organic layer was washed with brine and dried over Na_2SO_4. After filtration and concentration, the residue was analyzed by ^1H NMR, which indicated a clean transformation with a 74% conversion of **3.1** and 70% conversion of **3.6**.

The effects of the order of addition of reagents:



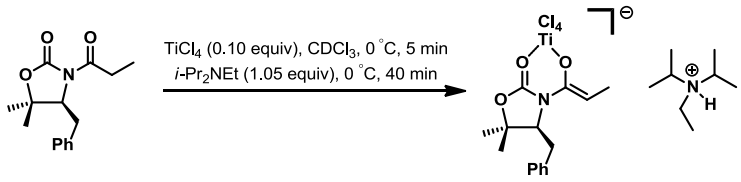
1,2,2,6,6-Pentamethylpiperidine (0.10 ml, 0.55 mmol) was added to a solution of $TiCl_4$ (1.0 M in CH_2Cl_2, 0.50 ml, 0.50 mmol, 1.0 eq) at 0 °C and stirred for 5 min. A solution of **3.1** (0.131 g, 0.50 mmol, 1.0 eq) in CH_2Cl_2 (1.2 ml) was added. After stirring at the same temperature for 40 min, $BrCCl_3$ (0.15 ml, 1.50 mmol, 3 eq) and $RuCl_2(PPh_3)_3$ (34 mg, 0.035 mmol, 7 mol%) were added, and the mixture was allowed to stir at room temperature for 12 h. After cooling down, the reaction was quenched by adding water and extracted with CH_2Cl_2. The organic layer was washed with brine and dried over Na_2SO_4. After filtration and concentration, the residue was monitored by ^1H NMR with a conversion of 57%.

The effect of Ru-catalyst:



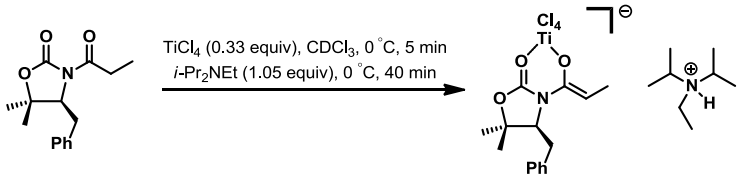
Titanium tetrachloride (1.0 M in CH_2Cl_2, 0.10 ml, 0.10 mmol, 0.2 eq) was added to a solution of the substrate **3.1** (0.131 g, 0.50 mmol, 1.0 eq) in CH_2Cl_2 (1.2 ml) in a vial at 0 °C and the mixture was stirred for 5 min at the same temperature. PMP (0.10 ml, 0.55 mmol, 1.1 eq) was added and the resulting deep red mixture was stirred at 0 °C for 40 min. Bromotrichloromathane (0.15 ml, 1.5 mmol, 3 eq) was added, followed by $Cp^*RuCl(PPh_3)_2$ (28 mg, 0.035 mmol, 7 mol%) and the mixture was stirred at room temperature. The reaction was monitored by TLC indicating around 90% conversion after 1.5 h, and the reaction was quenched at 3 h by adding water. The mixture extracted with CH_2Cl_2 and the organic layer was washed with brine and dried over Na_2SO_4. The conversion was 93% measured by ^1H NMR of the crude material.

^1H NMR Studies of enolization in $CDCl_3$:

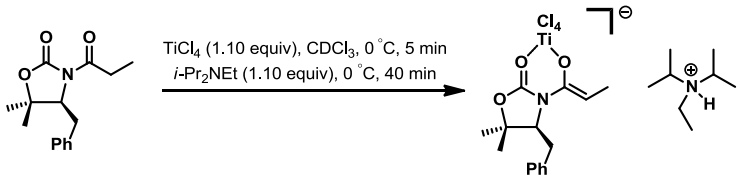


Titanium tetrachloride (1.0 M in $CDCl_3$, 0.15 ml, 0.15 mmol, 0.1 eq) was added to a solution of the substrate **3.1** (0.392 g, 1.50 mmol, 1.0 eq) in $CDCl_3$ (5.2 ml) in a vial at 0 °C and the mixture was stirred for 5 min at the same temperature. Diisopropylethylamine (0.274 ml, 1.58 mmol, 1.05 eq) was added and the resulting deep red mixture was stirred at 0 °C for 40

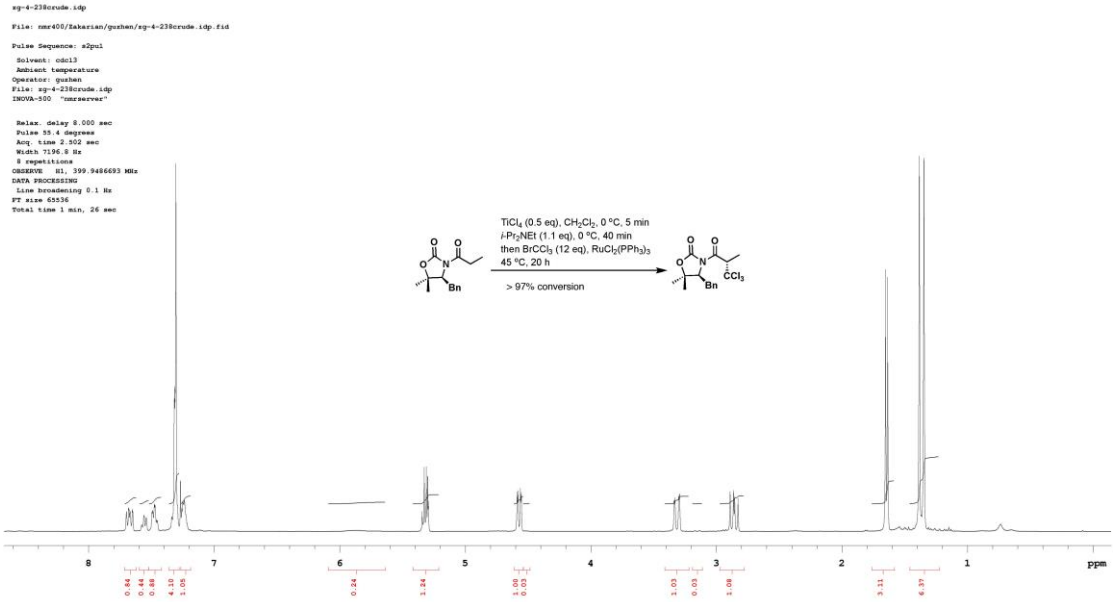
min. The reaction mixture was transferred via cannula to a NMR tube which was pre-filled with Ar.



Titanium tetrachloride (1.0 M in $CDCl_3$, 0.17 ml, 0.17 mmol, 0.33 eq) was added to a solution of the substrate **3.1** (0.136 g, 0.52 mmol, 1.0 eq) in $CDCl_3$ (1.8 ml) in a vial at 0 °C and the mixture was stirred for 5 min at the same temperature. Diisopropylethylamine (95 µl, 0.55 mmol, 1.05 eq) was added and the resulting deep red mixture was stirred at 0 °C for 40 min. The reaction mixture was transferred via cannula to a NMR tube which was pre-filled with Ar.



Titanium tetrachloride (1.0 M in $CDCl_3$, 0.58 ml, 0.58 mmol, 1.1 eq) was added to a solution of the substrate **3.1** (0.138 g, 0.53 mmol, 1.0 eq) in $CDCl_3$ (1.8 ml) in a vial at 0 °C and the mixture was stirred for 5 min at the same temperature. Diisopropylethylamine (0.l0 ml, 0.58 mmol, 1.1 eq) was added and the resulting deep red mixture was stirred at 0 °C for 40 min. The reaction mixture was transferred via cannula to a NMR tube which was pre-filled with Ar.


sg-4-238crude.idp
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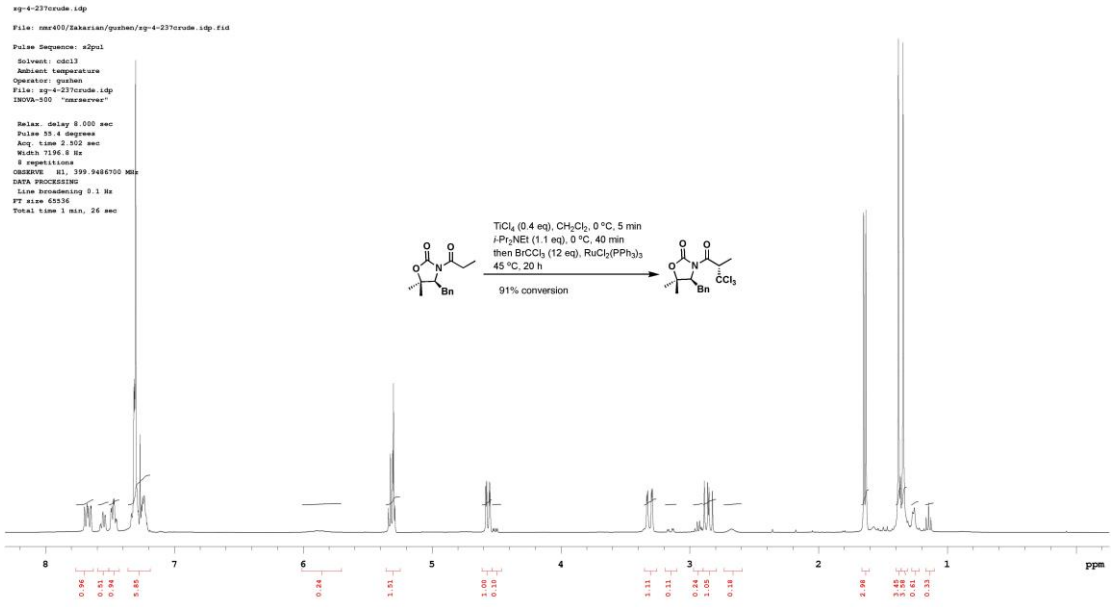
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-238crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486693 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.5 eq), CH2Cl2, 0 °C, 5 min
i-Pr2NEt (1.1 eq), 0 °C, 40 min
then BrCCl3 (12 eq), RuCl2(PPh3)3
45 °C, 20 h
> 97% conversion
Bn
CCl3
ppm


sg-4-237crude.idp
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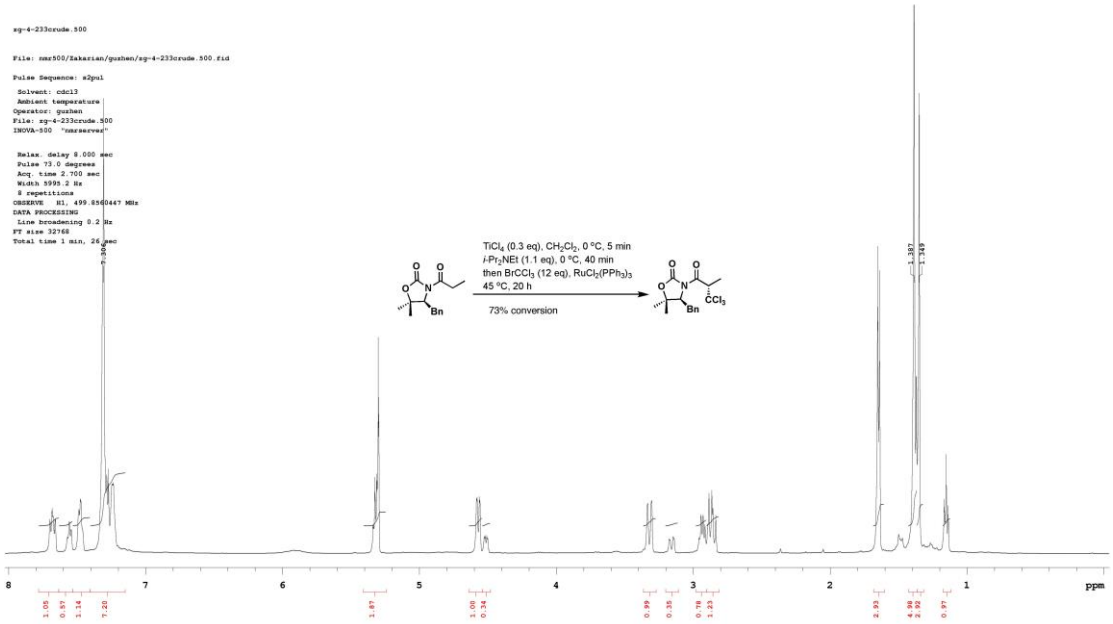
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-237crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486700 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.4 eq), CH2Cl2, 0 °C, 5 min
i-Pr2NEt (1.1 eq), 0 °C, 40 min
then BrCCl3 (12 eq), RuCl2(PPh3)3
45 °C, 20 h
91% conversion
Bn
CCl3
ppm


sg-4-233crude.500
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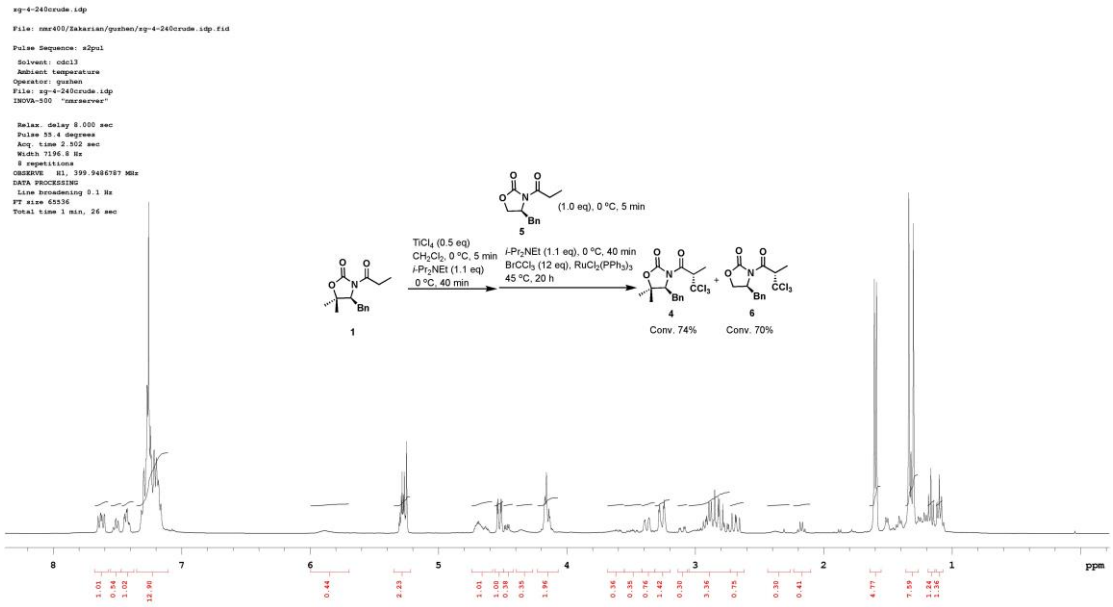
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-233crude.500
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560447 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
TiCl4 (0.3 eq), CH2Cl2, 0 °C, 5 min
i-Pr2NEt (1.1 eq), 0 °C, 40 min
then BrCCl3 (12 eq), RuCl2(PPh3)3
45 °C, 20 h
73% conversion
Bn
CCl3
ppm


sg-4-240crude.idp
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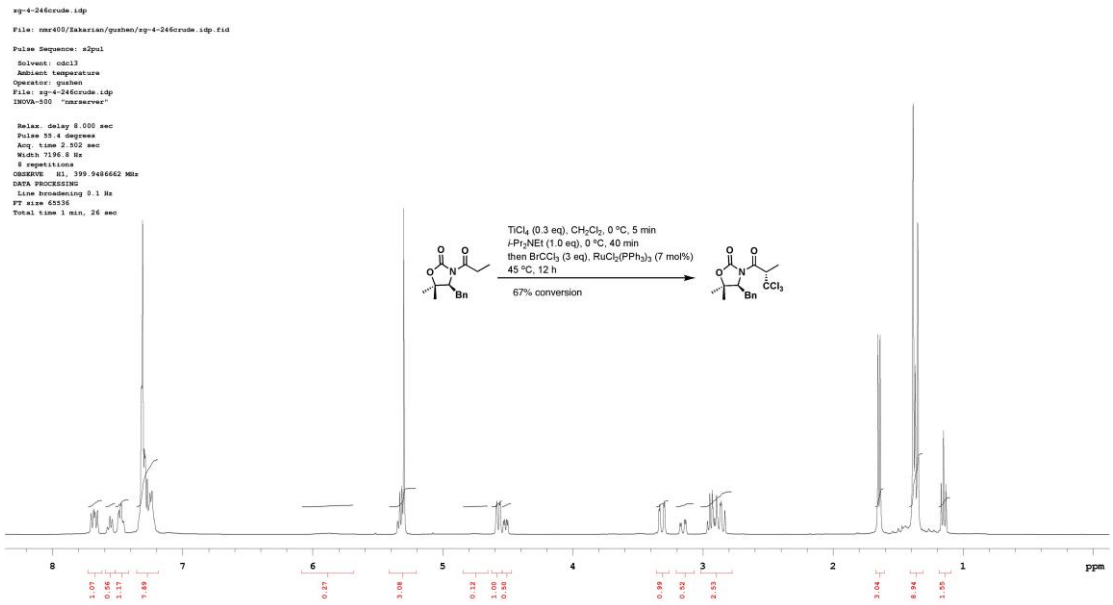
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-240crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 35.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486787 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
(1.0 eq), 0 °C, 5 min
5
TiCl4 (0.5 eq)
CH2Cl2, 0 °C, 5 min
i-Pr2NEt (1.1 eq)
0 °C, 40 min
i-Pr2NEt (1.1 eq), 0 °C, 40 min
BrCCl3 (12 eq), RuCl2(PPh3)3
45 °C, 20 h
1
4
Conv. 74%
6
Conv. 70%
Bn
CCl3
ppm


sg-4-246crude.idp
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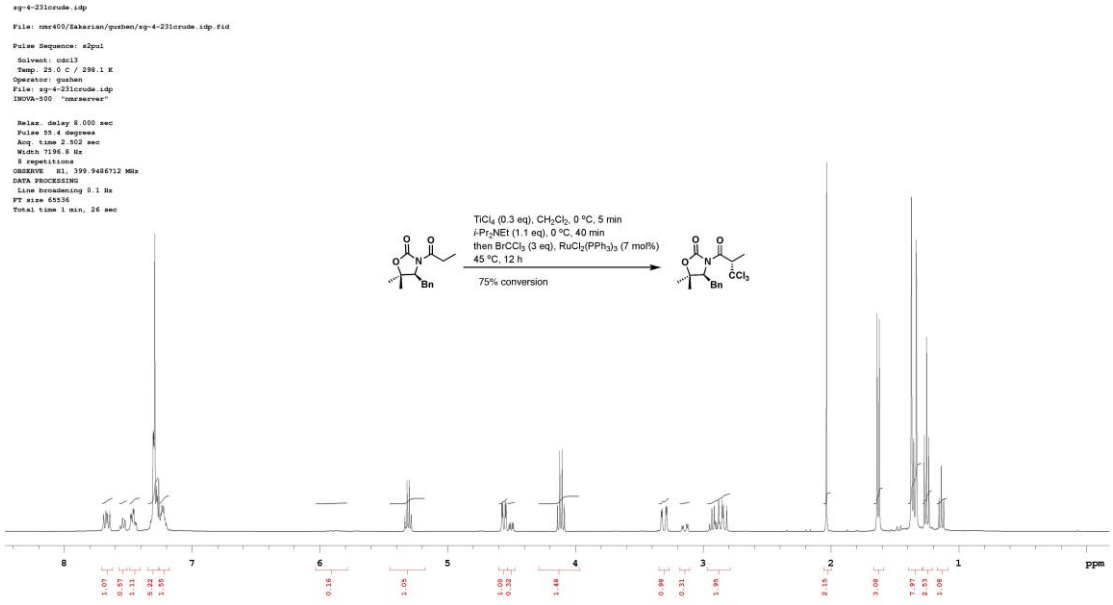
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-246crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486662 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.3 eq), CH2Cl2, 0 °C, 5 min
i-Pr2NEt (1.0 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
67% conversion
Bn
CCl3
8
7
6
5
4
3
2
1
ppm
1.07
0.56
2.17
7.89
0.37
3.08
0.12
1.00
0.50
0.99
0.52
2.53
3.04
8.94
1.55


sg-4-231crude.idp
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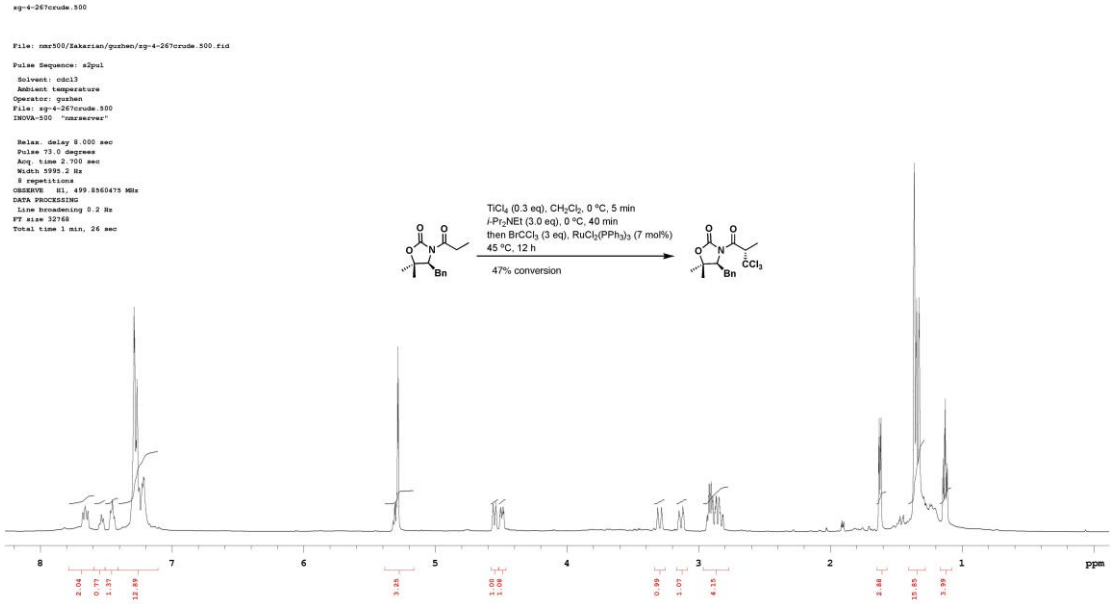
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: gushen
File: sg-4-231crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486712 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.3 eq), CH2Cl2, 0 °C, 5 min
i-Pr2NEt (1.1 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
75% conversion
Bn
CCl3
8
7
6
5
4
3
2
1
ppm
1.07
0.57
2.11
5.22
1.50
0.16
1.05
1.00
0.32
1.40
0.94
0.31
1.95
2.19
3.00
7.97
2.53
1.00


sg-4-267crude.500
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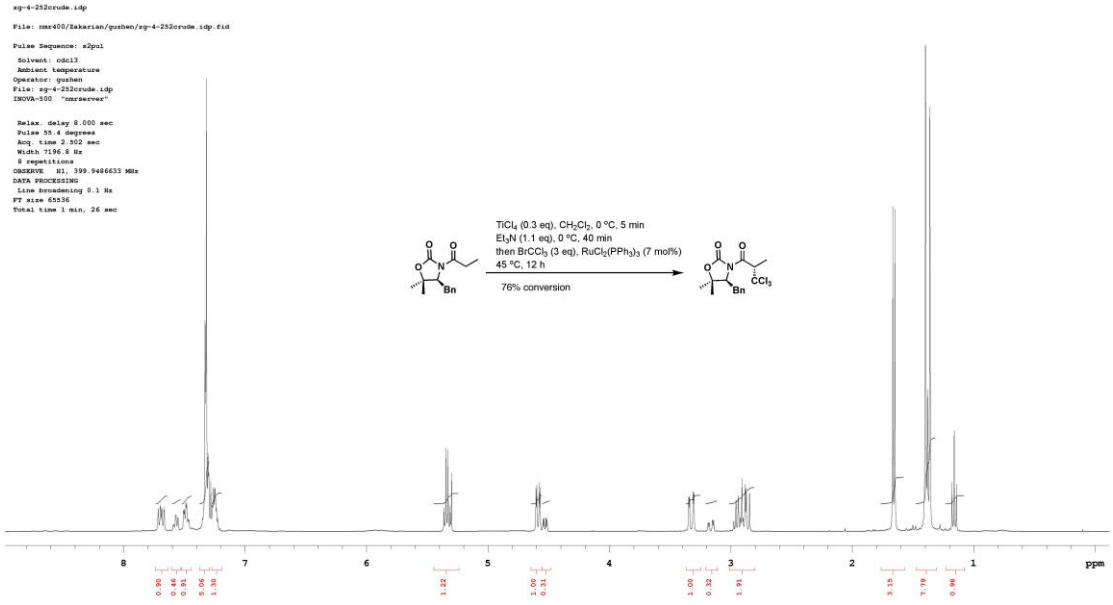
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-267crude.500
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560475 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
TiCl4 (0.3 eq), CH2Cl2, 0 °C, 5 min
i-Pr2NEt (3.0 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
47% conversion
Bn
CCl3
ppm


sg-4-252crude.idp
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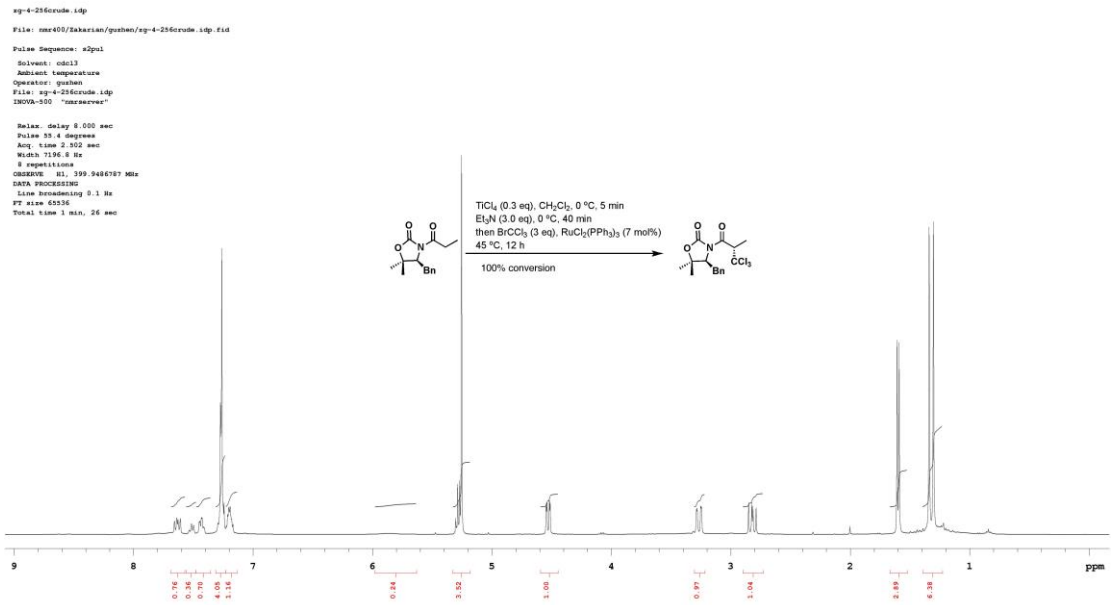
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-252crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486633 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.3 eq), CH2Cl2, 0 °C, 5 min
Et3N (1.1 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
76% conversion
Bn
CCl3
ppm


sg-4-256crude.idp
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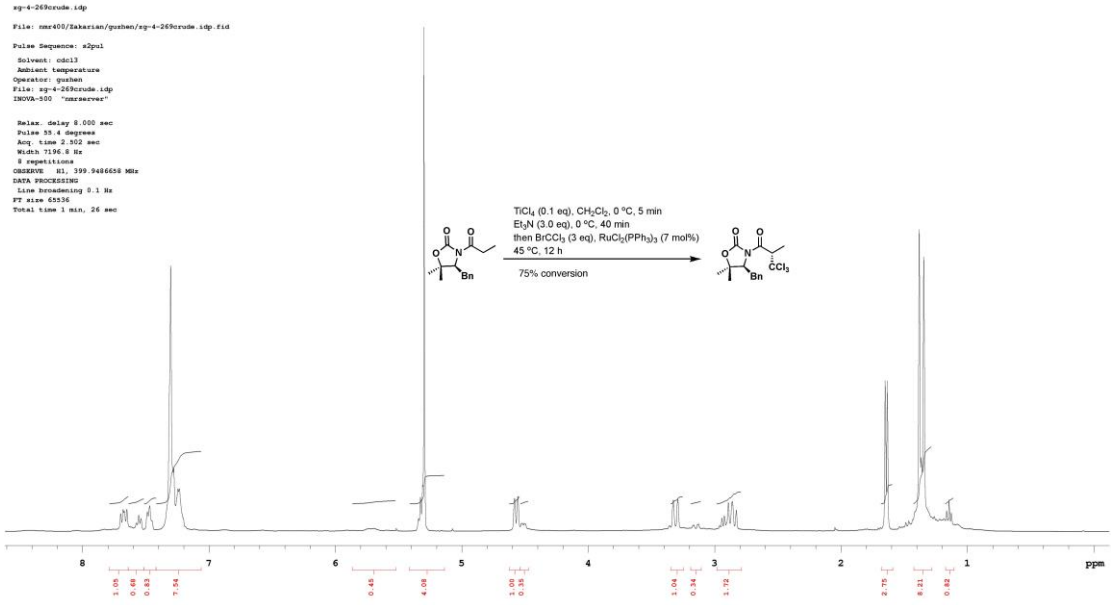
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-256crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486787 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.3 eq), CH2Cl2, 0 °C, 5 min
Et3N (3.0 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
100% conversion
Bn
CCl3
ppm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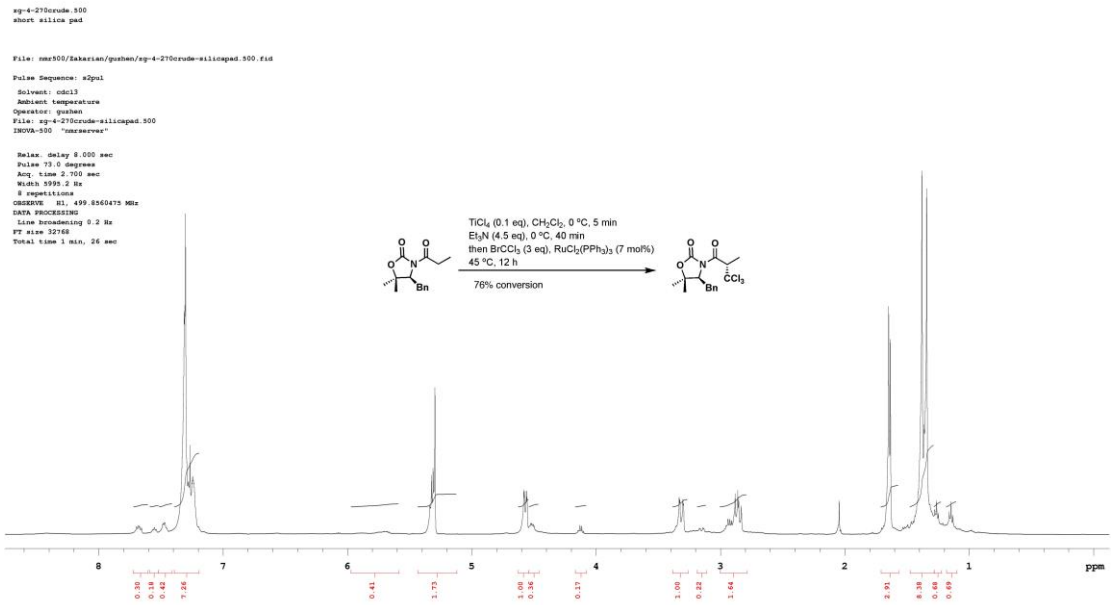
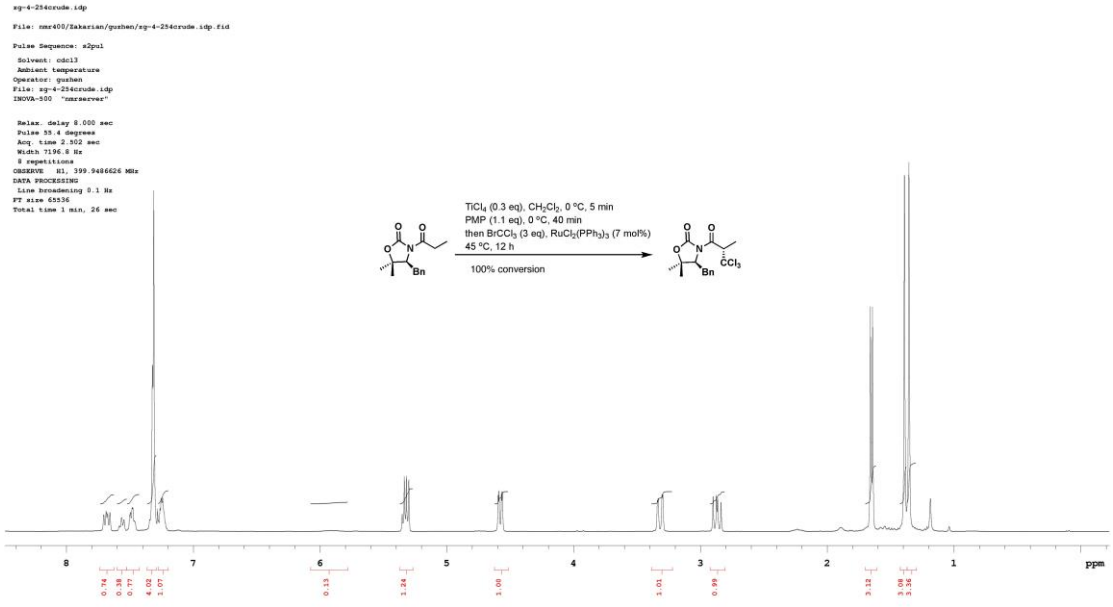
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-269crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486658 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.1 eq), CH2Cl2, 0 °C, 5 min
Et3N (3.0 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
75% conversion
Bn
CCl3
ppm


sg-4-270crude.500
short silica pad
File: nmr500/Zakarian/gushen/sg-4-270crude-silicapad.500.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-270crude-silicapad.500
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560475 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
TiCl4 (0.1 eq), CH2Cl2, 0 °C, 5 min
Et3N (4.5 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
76% conversion
Bn
CCl3
ppm


sg-4-254crude.idp
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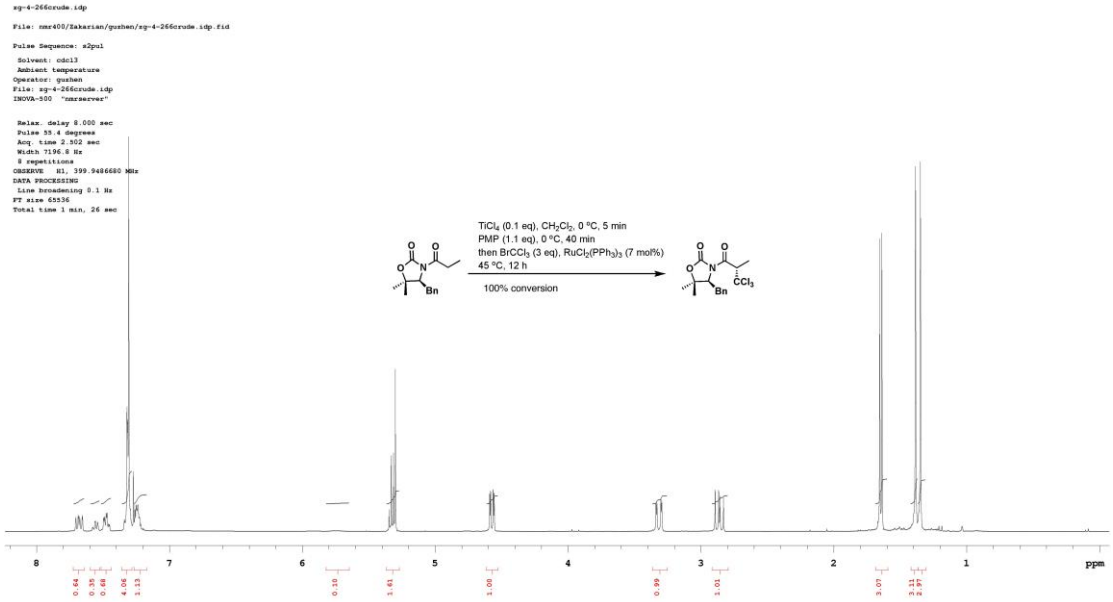
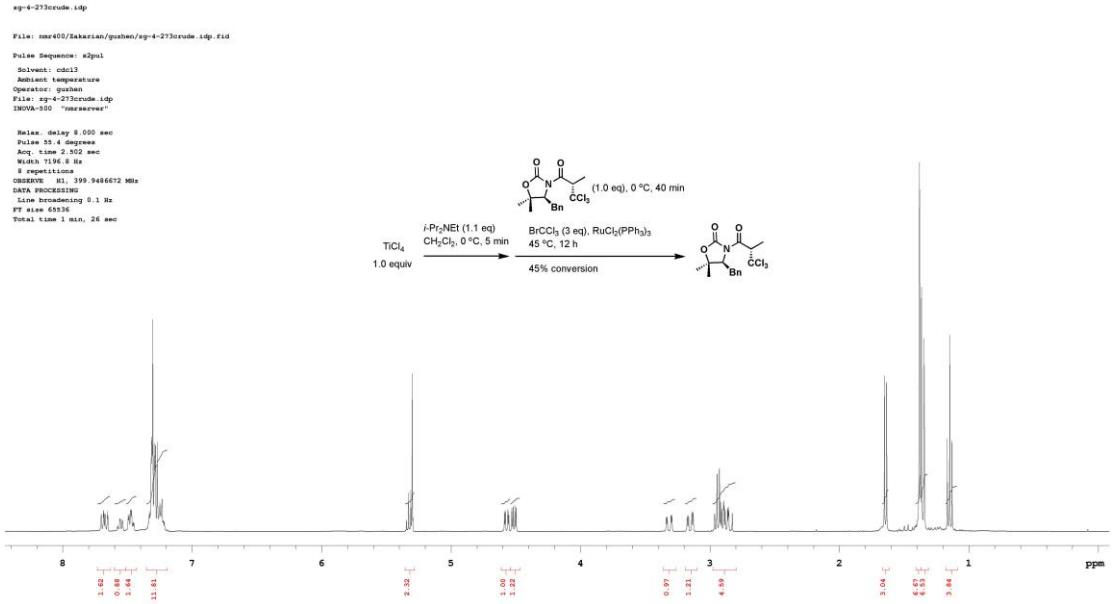
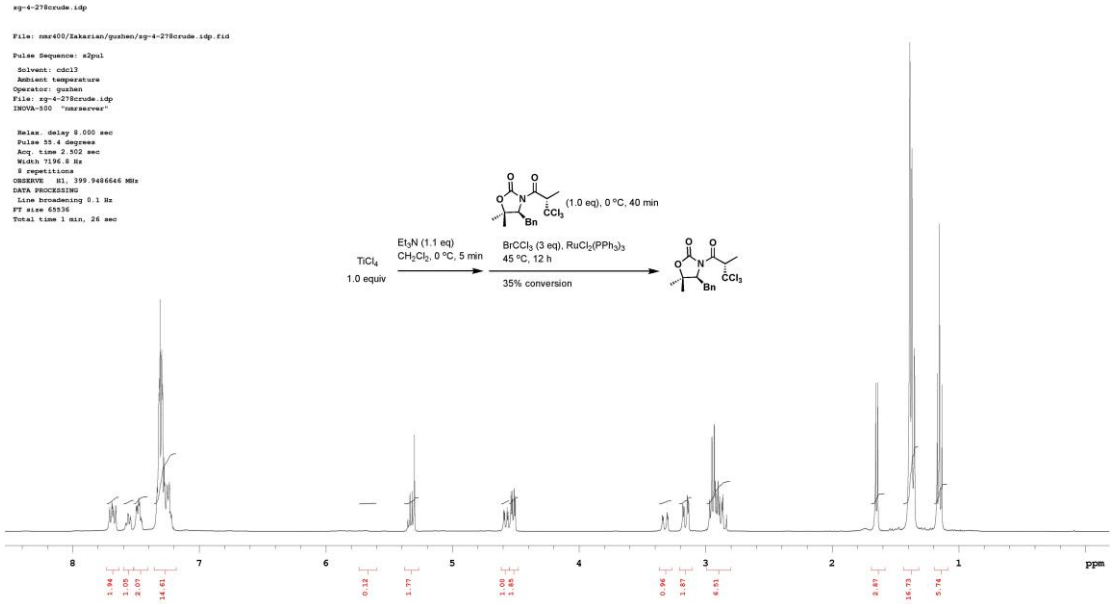
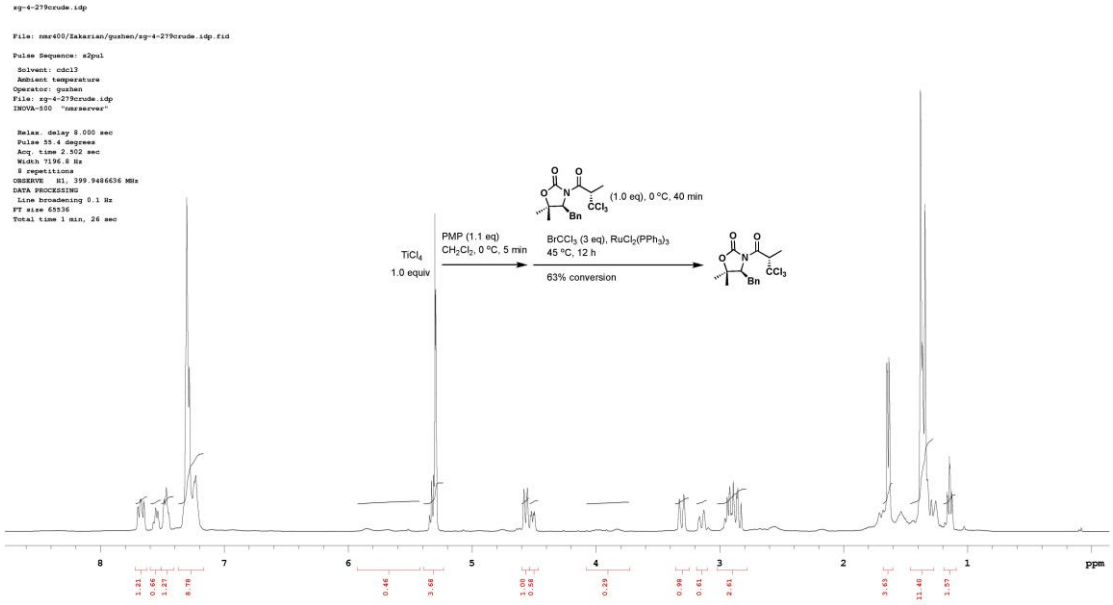
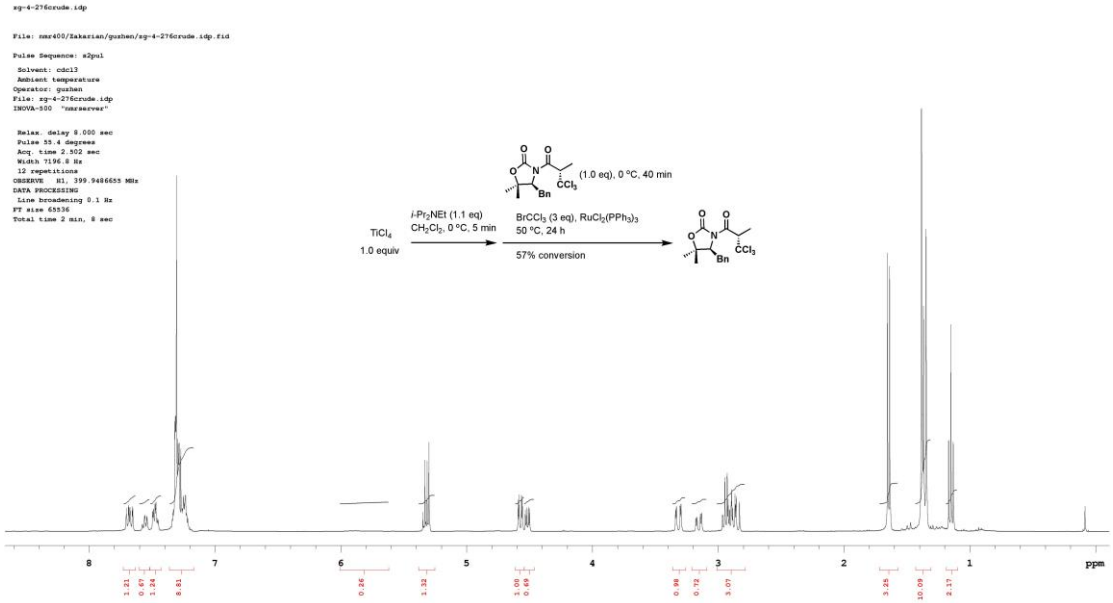
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-254crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486626 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.3 eq), CH2Cl2, 0 °C, 5 min
PMP (1.1 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
100% conversion
Bn
CCl3
ppm


sg-4-266crude.idp
File: nmr400/Zakarian/gushen/sg-4-266crude.idp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-266crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486680 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.1 eq), CH2Cl2, 0 °C, 5 min
PMP (1.1 eq), 0 °C, 40 min
then BrCCl3 (3 eq), RuCl2(PPh3)3 (7 mol%)
45 °C, 12 h
100% conversion
Bn
CCl3
ppm


sg-4-273crude.idp
File: nmr400/Zakarian/gushen/sg-4-273crude.idp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-273crude.idp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486672 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
(1.0 eq), 0 °C, 40 min
TiCl4
1.0 equiv
i-Pr2NEt (1.1 eq)
CH2Cl2, 0 °C, 5 min
BrCCl3 (3 eq), RuCl2(PPh3)3
45 °C, 12 h
45% conversion
Bn
CCl3
ppm


sg-4-278crude.idp
File: nmr400/Zakarian/gushen/sg-4-278crude.idp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-278crude.idp
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486646 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
(1.0 eq), 0 °C, 40 min
Et3N (1.1 eq)
CH2Cl2, 0 °C, 5 min
TiCl4
1.0 equiv
BrCCl3 (3 eq), RuCl2(PPh3)3
45 °C, 12 h
35% conversion
Bn
CCl3
ppm


sg-4-279crude.idp
File: nmr400/Zakarian/gushen/sg-4-279crude.idp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-279crude.idp
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486636 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
(1.0 eq), 0 °C, 40 min
PMP (1.1 eq)
CH2Cl2, 0 °C, 5 min
TiCl4
1.0 equiv
BrCCl3 (3 eq), RuCl2(PPh3)3
45 °C, 12 h
63% conversion
Bn
CCl3
ppm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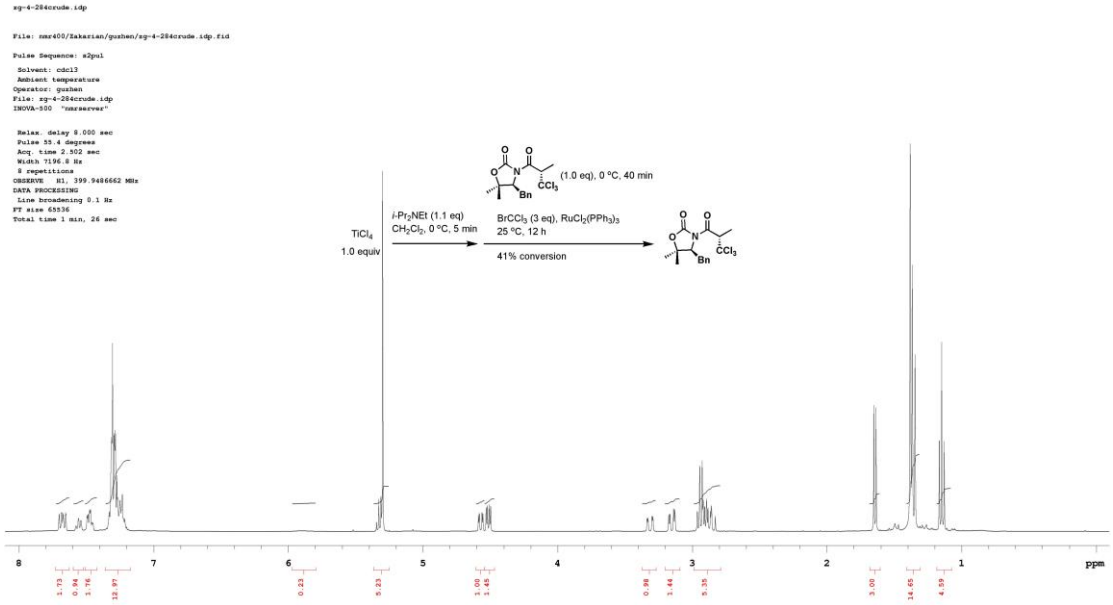
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-276crude.idp
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
12 repetitions
OBSERVE H1, 399.9486655 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 2 min, 8 sec
(1.0 eq), 0 °C, 40 min
i-Pr2NEt (1.1 eq)
CH2Cl2, 0 °C, 5 min
TiCl4
1.0 equiv
BrCCl3 (3 eq), RuCl2(PPh3)3
50 °C, 24 h
57% conversion
ppm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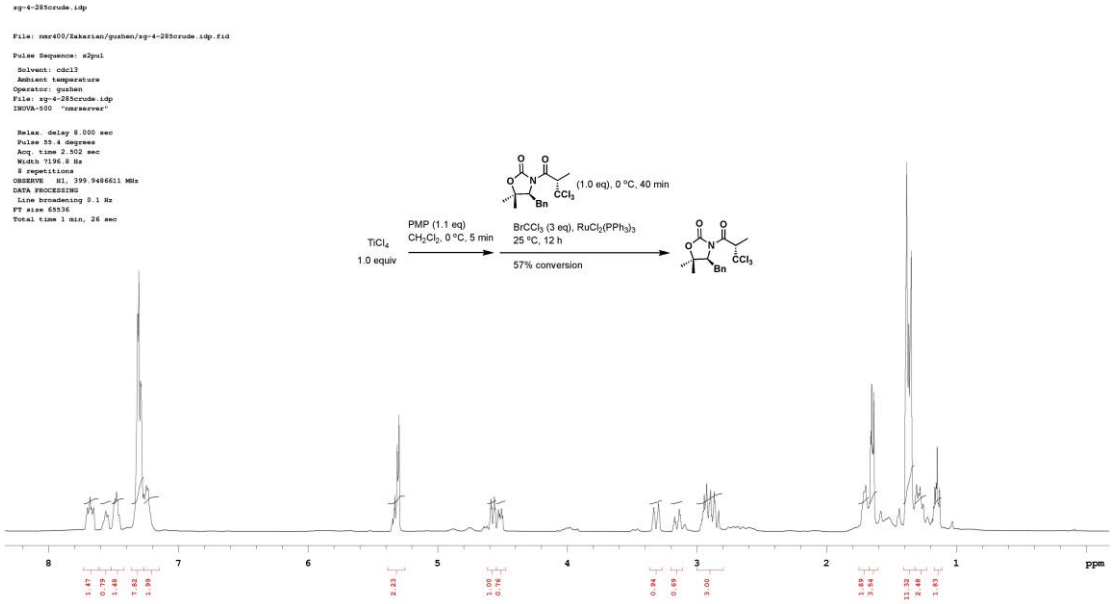
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-284crude.idp
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486662 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
(1.0 eq), 0 °C, 40 min
i-Pr2NEt (1.1 eq)
CH2Cl2, 0 °C, 5 min
TiCl4
1.0 equiv
BrCCl3 (3 eq), RuCl2(PPh3)3
25 °C, 12 h
41% conversion
ppm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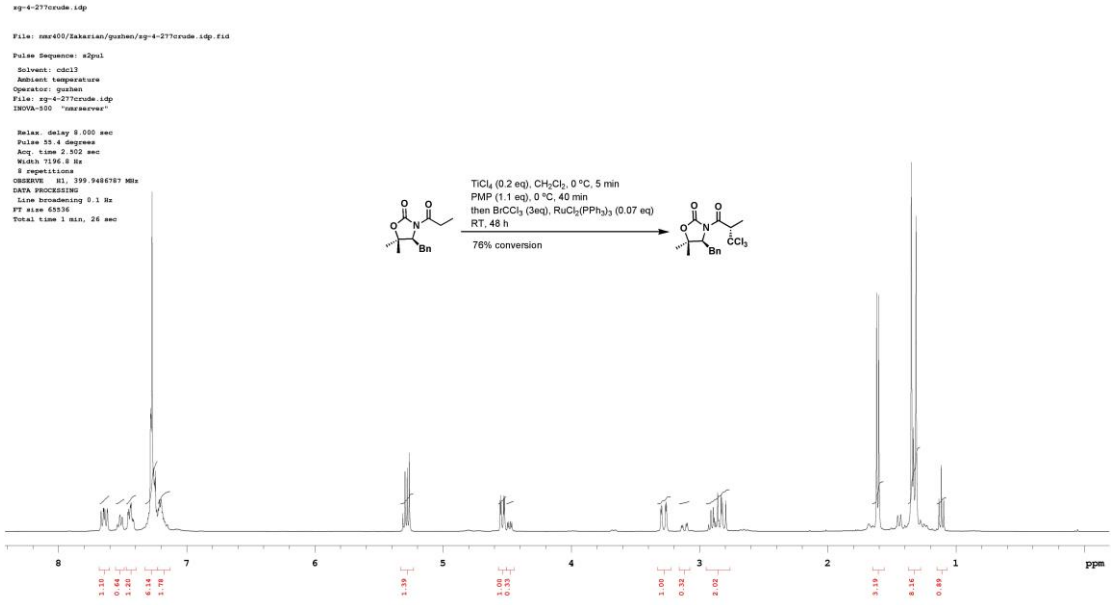
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-285crude.idp
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486611 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
(1.0 eq), 0 °C, 40 min
PMP (1.1 eq)
CH2Cl2, 0 °C, 5 min
TiCl4
1.0 equiv
BrCCl3 (3 eq), RuCl2(PPh3)3
25 °C, 12 h
57% conversion
ppm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Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
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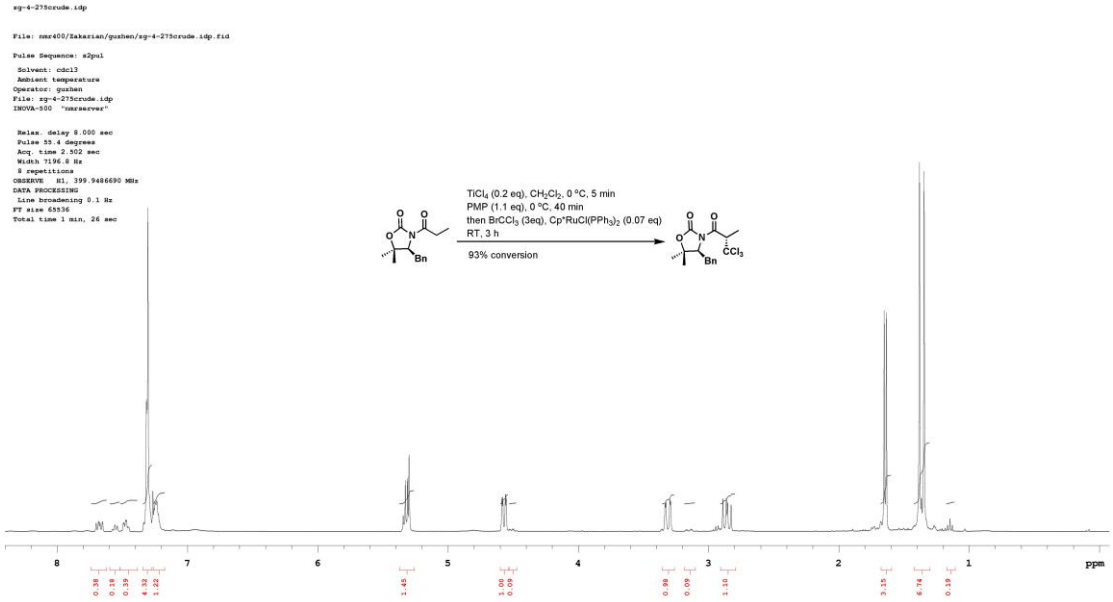
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486787 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.2 eq), CH2Cl2, 0 °C, 5 min
PMP (1.1 eq), 0 °C, 40 min
then BrCCl3 (3eq), RuCl2(PPh3)3 (0.07 eq)
RT, 48 h
76% conversion
ppm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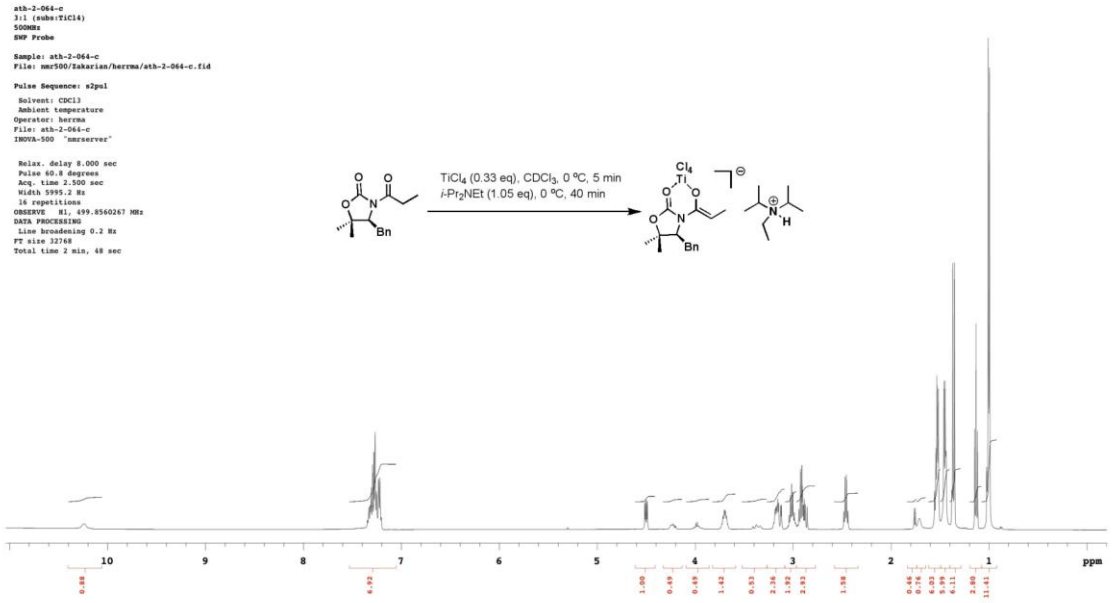
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-275crude.idp
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 55.4 degrees
Acq. time 2.502 sec
Width 7196.8 Hz
8 repetitions
OBSERVE H1, 399.9486690 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 1 min, 26 sec
TiCl4 (0.2 eq), CH2Cl2, 0 °C, 5 min
PMP (1.1 eq), 0 °C, 40 min
then BrCCl3 (3eq), Cp*RuCl(PPh3)2 (0.07 eq)
RT, 3 h
93% conversion
Bn
CCl3
ppm


ath-2-064-c
3:1 (subs:TiCl4)
500MHz
SWP Probe
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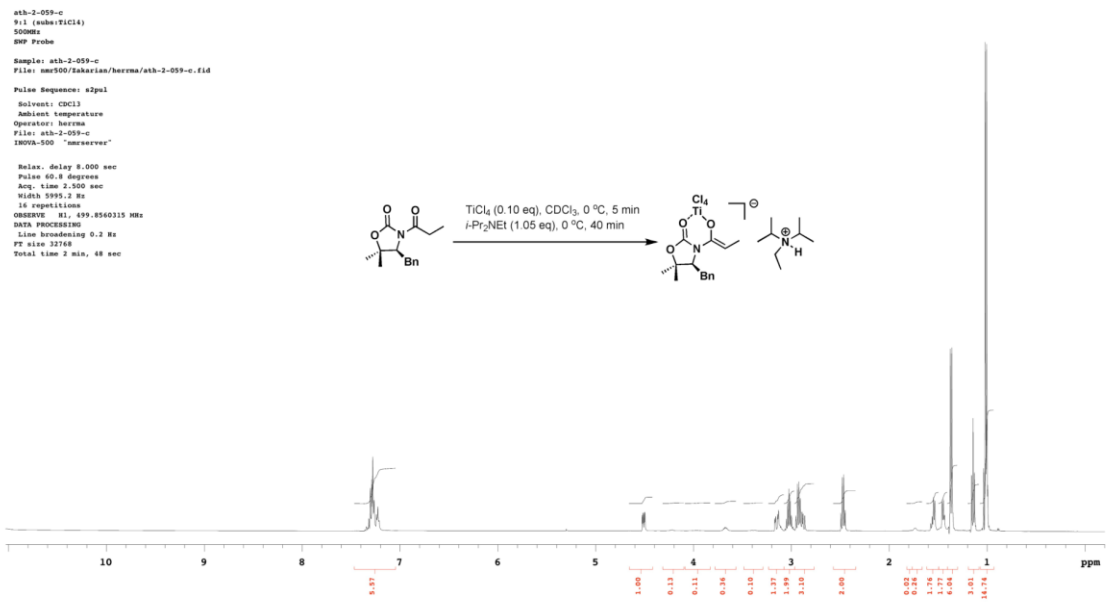
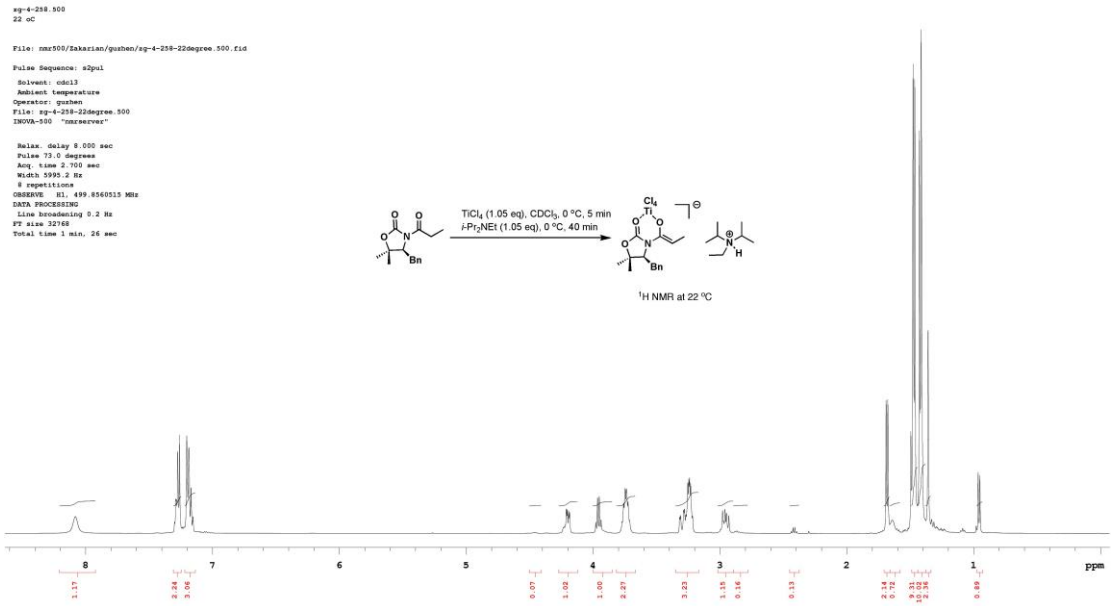
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: herrma
File: ath-2-064-c
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 60.8 degrees
Acq. time 2.500 sec
Width 5995.2 Hz
16 repetitions
OBSERVE H1, 499.8560267 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 2 min, 48 sec
TiCl4 (0.33 eq), CDCl3, 0 ºC, 5 min
i-Pr2NEt (1.05 eq), 0 ºC, 40 min
Bn
ppm


ath-2-059-c
9:1 (subs:TiCl4)
500MHz
BWP Probe
Sample: ath-2-059-c
File: nmr500/Zakarian/herrma/ath-2-059-c.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: herrma
File: ath-2-059-c
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 60.8 degrees
Acq. time 2.500 sec
Width 5995.2 Hz
16 repetitions
OBSERVE H1, 499.8560315 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 2 min, 48 sec
TiCl4 (0.10 eq), CDCl3, 0 °C, 5 min
i-Pr2NEt (1.05 eq), 0 °C, 40 min
Bn
ppm


sg-4-258.500
22 oC
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Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-258-22degree.500
INOVA-500 "nmrserver"
Relax. delay 9.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560515 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
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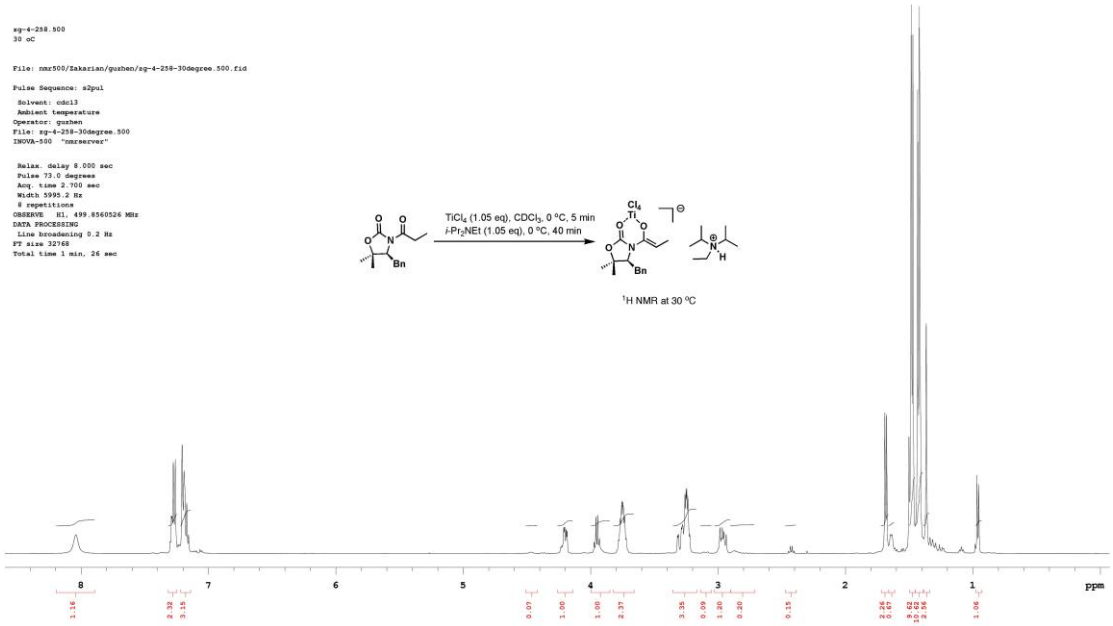
i-Pr2NEt (1.05 eq), 0 °C, 40 min
Bn
1H NMR at 22 °C
ppm


sg-4-258.500
30 oC
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Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: gushen
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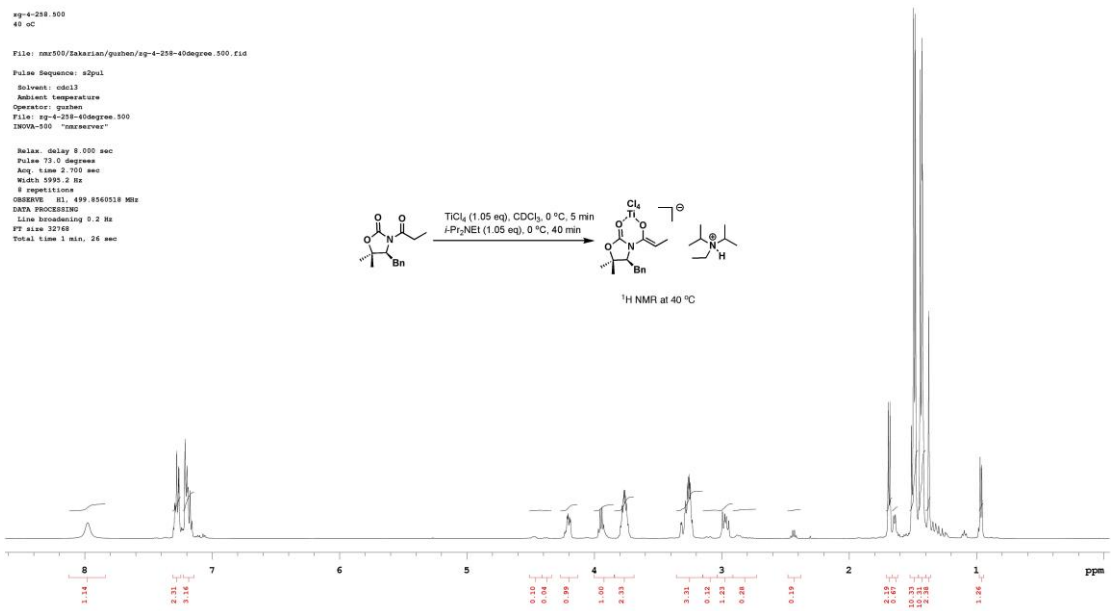
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560526 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
TiCl4 (1.05 eq), CDCl3, 0 °C, 5 min
i-Pr2NEt (1.05 eq), 0 °C, 40 min
Bn
Bn
1H NMR at 30 °C
8
7
6
5
4
3
2
1
ppm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40 oC
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Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: guzhen
File: sg-4-258-40degree.500
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560518 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
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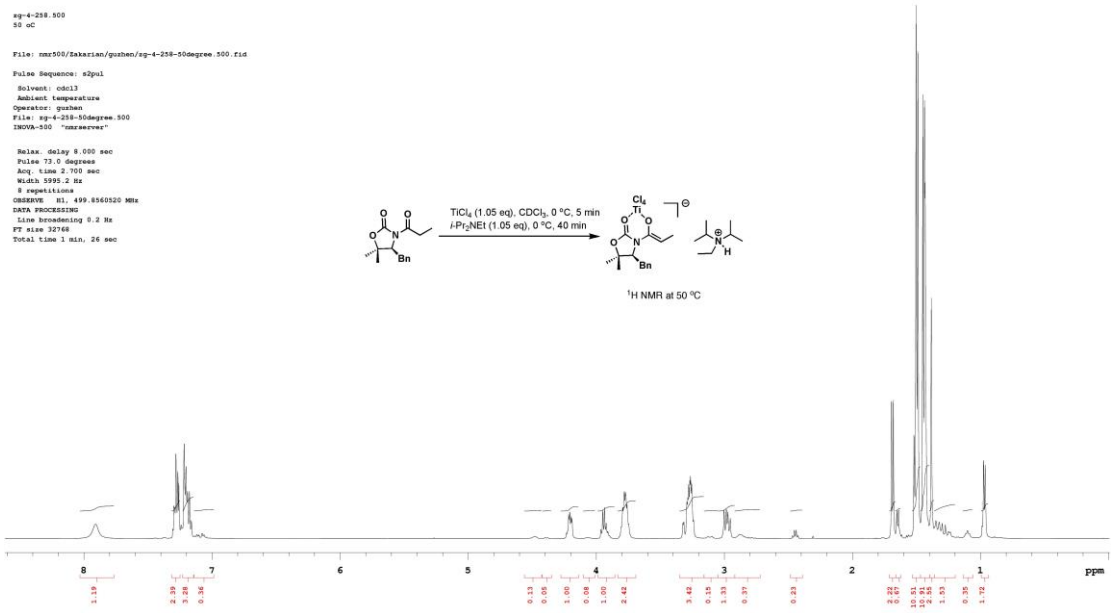
i-Pr2NEt (1.05 eq), 0 °C, 40 min
Bn
1H NMR at 40 °C
ppm


sg-4-258.500
50 oC
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Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: guzhen
File: sg-4-258-50degree.500
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560520 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
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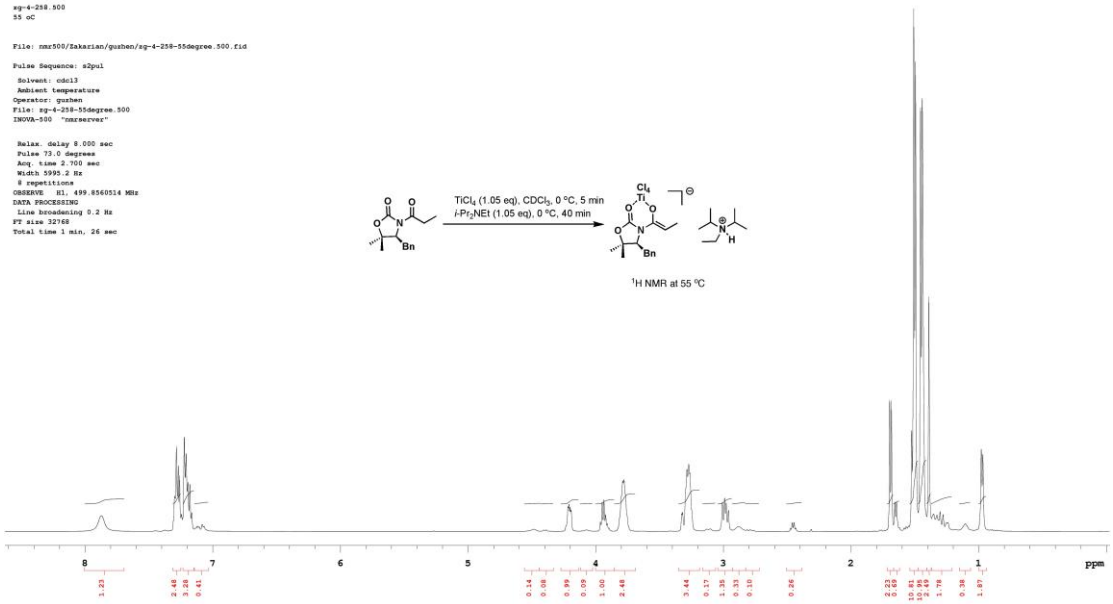
i-Pr2NEt (1.05 eq), 0 °C, 40 min
Bn
1H NMR at 50 °C
ppm


sg-4-258.500
55 oC
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Solvent: cdcl3
Ambient temperature
Operator: gushen
File: sg-4-258-55degree.500
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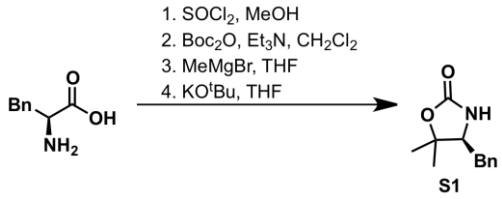
Relax. delay 8.000 sec
Pulse 73.0 degrees
Acq. time 2.700 sec
Width 5995.2 Hz
8 repetitions
OBSERVE H1, 499.8560514 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
TiCl4 (1.05 eq), CDCl3, 0 °C, 5 min
i-Pr2NEt (1.05 eq), 0 °C, 40 min
Bn
Cl4
Ti
H
1H NMR at 55 °C
8
7
6
5
4
3
2
1
ppm

3-7: Perfluoroalkylations of *N*-Acyl Oxazolidinones Supporting Information

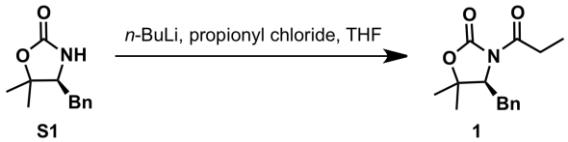


(*S*)-4-Benzyl-5,5-dimethyloxazolidin-2-one. Thionyl chloride (5.50 mL, 74.8 mmol) was added dropwise to a solution of *L*-phenylalanine (6.17 g, 37.4 mmol) in methanol (104 mL) at 0 °C. The reaction was stirred for 30 min at 0 °C, and then heated to reflux for 4 h. The solution was cooled to rt and methanol was removed *in vacuo*. The crude residue was submitted to the next step without purification.

Di-*tert*-butyl dicarbonate (8.08 g, 37.0 mmol) was added to a mixture of the crude substrate (37.4 mmol), triethylamine (5.70 mL, 41.4 mmol), and dichloromethane (83.0 mL) at rt. The reaction was stirred at rt for 2 h and then quenched with HCl (1M). The layers were separated. The aqueous layer was extracted with dichloromethane (3x30 mL). The combined organic layers were dried with sodium sulfate and concentrated *in vacuo* to afford a white solid. The crude residue was submitted to the next step without further purification.

Methylmagnesium bromide (3 M in Et_2O, 49.9 mL, 150 mmol) was added dropwise to a solution of the crude substrate (37.4 mmol) in THF (125 mL) at 0 °C. The reaction was stirred at 0 °C for 10 min, then warmed to rt and stirred for 36 h. The solution was cooled to 0 °C and quenched with methanol. The solvent was removed *in vacuo*, and the solids were re-dissolved in ethyl acetate and water. The layers were separated. The aqueous layer was extracted with ethyl acetate (3x75 mL). The combined organic layers were dried with sodium sulfate and concentrated *in vacuo* delivering a light yellow oil. The crude residue was submitted to the next step without further purification.

Potassium *tert*-butoxide (4.74 g, 42.2 mmol) was added to a solution of the crude substrate (37.4 mmol) in THF (101 mL) at 0 °C. The reaction was warmed to rt and stirred for 2.5 h. The reaction was then quenched with saturated aqueous ammonium chloride. The layers were separated. The aqueous layer was extracted with ethyl acetate (3x40 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated *in vacuo*. The crude product was purified by column chromatography (silica, 40% ethyl acetate – hexanes, 60% ethyl acetate - hexanes) to afford the white/yellow solid oxazolidinone **S1** (6.31 g, 30.7 mmol, 82% over 4 steps)[121]. ^{1}H NMR (400 MHz, $CDCl_3$); δ(ppm): 7.37-7.32 (m, 1H); 7.30-7.23 (m, 1H); 7.19-7.16 (m, 2H); 4.69 (brs, 1H); 3.68 (dd, J1=10.8 Hz, J2=3.6 Hz, 1H); 2.84 (dd, J1=13.6 Hz, 3.6 Hz, 1H); 2.67 (dd, J1=13.6 Hz, J2=10.8 Hz, 1H); 1.50 (s, 3H); 1.47 (s, 3H).

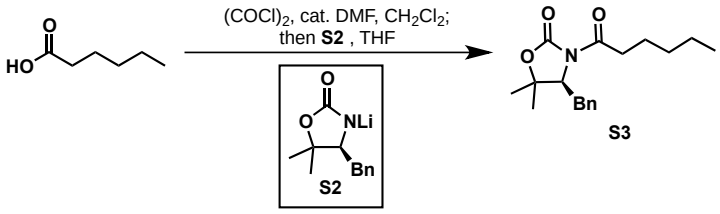


(*S*)-4-Benzyl-5,5-dimethyl-3-propionyloxazolidin-2-one (3.12). *n*-Butyllithium (10.4 mL, mmol, 2.45 M in hexanes) was added to a solution of the oxazolidinones **S1** (5.00 g, 24.4 mmol) in THF (81.3 mL) at -78 °C. After 30 min, propionyl chloride (2.16 mL, 24.9 mmol) was added and the reaction was stirred for an additional 30 min. The reaction was warmed to 0 °C and stirred for 1.5 h. The reaction was quenched with saturated aqueous ammonium chloride and the layers were separated. The aqueous layer was extracted with ethyl acetate (3x100 mL). The combined organic layers were washed with brine, dried with sodium sulfate, concentrated, and purified by column chromatography (silica, 30% ethyl acetate - hexanes) to afford the desired product (5.93 g, 24.5 mmol, 93%). α_D^{22} -29.3° (c 1.0,

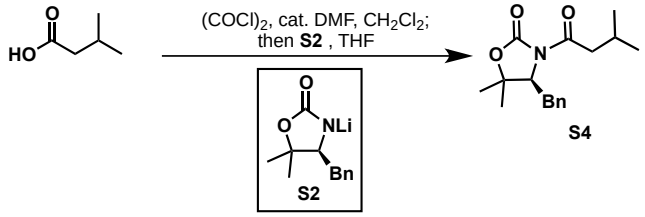
dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.25 (m, 4H); 7.25-7.20 (m, 1H); 4.50 (dd, J1=10.2 Hz, J2=4.2 Hz, 1H); 3.15 (dd, J1=15.0 Hz, J2=4.2 Hz, 1H); 2.98-2.88 (m, 2H); 2.88 (dd, J1=4.2 Hz, J2=15.0 Hz, 1H); 1.37 (s, 3H); 1.36 (s, 3H); 1.14 (dd, J1=J2=7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 174.5, 152.9, 137.2, 129.3 (2C), 128.9 (2C), 127.0, 82.4, 63.7, 35.6, 29.6, 28.8, 22.5, 8.6. LRMS (ESI) calcd for $C_{15}H_{19}NO_3Na$ [M+Na] 284.1263, found 284.14.

Standard procedure for the synthesis of *N*-acyl oxazolidinones:

Oxalyl chloride (0.96 mL, 11.0 mmol) was added to a solution of carboxylic acid (1.26 mL, 10.0 mmol), dimethylformamide (10 μl), and dichloromethane (3.30 mL) at 0 °C. After 10 min, the solution was warmed to rt and stirred for 1 h (until bubbling stops). The solution was concentrated on a rotary evaporator. In a separate flask, *n*-butyllithium (2.48 M in hexanes, 2.82 mL, 7.0 mmol), was added to a solution of oxazolidinone **S1** (1.37 g, 6.67 mmol) in THF (18.2 mL) at -78 °C under argon. The solution was stirred for 30 min at -78 °C. A solution of the crude acyl chloride in THF (16.7 mL total with rinses) was added dropwise at -78 °C. After stirring at -78 °C for 2 h, the reaction mixture was quenched with saturated aqueous ammonium chloride. The aqueous layer was extracted with ethyl acetate (3x20 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated on a rotary evaporator. The resultant oil or solid was purified by column chromatography to give the corresponding *N*-acyl oxazolidinone.

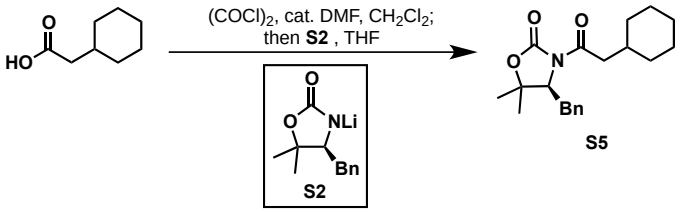


(*S*)-4-Benzyl-3-hexanoyl-5,5-dimethyloxazolidin-2-one (3.31). The title compound was prepared from commercially available hexanoic acid (0.630 mL, 5.00 mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a colorless oil (1.17 g, 3.86 mmol, 77%) after purification by column chromatography (silica, 30% ethyl acetate - hexanes). α_D^{23} -28.8° (c 1.0, dichloromethane). ^{1}H NMR (400 MHz, $CDCl_3$); δ(ppm): 7.34-7.20 (m, 5H); 4.51 (dd, J1=9.6 Hz, J2=4.0 Hz, 1H); 3.13 (dd, J1=14.4 Hz, J2=4.0 Hz, 1H); 2.98-2.82 (m, 3H); 1.68-1.60 (m, 2H); 1.37 (s, 3H); 1.35 (s, 3H); 1.40-1.30 (m, 4H); 0.90 (dd, J=7.2 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 173.9, 152.9, 137.2, 129.3 (2C), 128.9 (2C), 127.0, 82.3, 63.7, 35.9, 35.6, 31.5, 28.8, 24.3, 22.7, 22.5, 14.2. LRMS (ESI) calcd for $C_{18}H_{25}NO_3Na$ [M+Na] 326.1732, found 326.18.

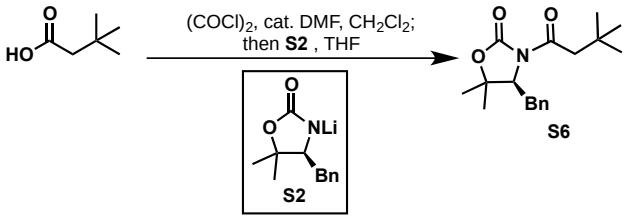


(*S*)-4-Benzyl-5,5-dimethyl-3-(3-methylbutanoyl)oxazolidin-2-one (3.32). The title compound was prepared from commercially available isovaleric acid (1.09 mL, 10.0 mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a colorless oil (1.29 g, 4.46 mmol, 45%) after purification by column chromatography (silica, 10% ethyl acetate - hexanes). α_D^{24} -31.8° (c 1.0, dichloromethane).

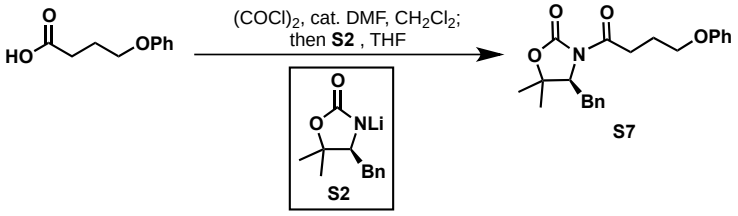
^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.26 (m, 4H); 7.24-7.20 (m, 1H); 4.52 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.14 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.88 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 2.85-2.78 (m, 2H); 2.19-2.12 (m, 1H); 1.36 (s, 3H); 1.35 (s, 3H); 0.97 (d, J=7.2 Hz, 3H); 0.96 (d, J=7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.1, 152.8, 137.2, 129.3 (2C), 128.9 (2C), 127.0, 82.2, 63.7, 44.3, 35.6, 28.7, 25.4, 22.7, 22.6, 22.5. LRMS (ESI) calcd for $C_{17}H_{23}NO_3Na$ [M+Na] 312.1576, found 312.17.



(*S*)-4-Benzyl-3-(2-cyclohexylacetyl)-5,5-dimethyloxazolidin-2-one (3.33). The title compound was prepared from commercially available cyclohexaneacetic acid (0.710 g, 5.00 mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a white solid (1.00 g, 3.04 mmol, 61%) after purification by column chromatography (silica, 10% ethyl acetate - hexanes). α_D^{24} -31.5° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.25 (m, 4H); 7.24-7.20 (m, 1H); 4.51 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.13 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.88 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 2.81 (ddd, J1=22.8 Hz, J2=15.6 Hz, J3=7.2 Hz, 2H); 1.88-1.79 (m, 1H); 1.73-1.62 (m, 5H); 1.36 (s, 3H); 1.35 (s, 3H); 1.32-1.22 (m, 2H); 1.19-1.10 (m, 1H); 1.05-0.95 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.1, 152.9, 137.2, 129.3 (2C), 128.9 (2C), 127.0, 105.2, 82.2, 63.7, 42.9, 35.7, 34.7, 33.3, 33.2, 28.8, 26.4, 26.3, 22.5. LRMS (ESI) calcd for $C_{20}H_{27}NO_3Na$ [M+Na] 352.1889, found 352.20.

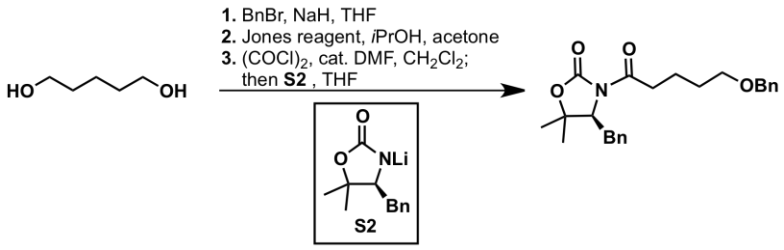


(*S*)-4-Benzyl-3-(3,3-dimethylbutanoyl)-5,5-dimethyloxazolidin-2-one (3.34). The title compound was prepared from commercially available 3,3-dimethylbutyric acid (1.27 mL, 10.0 mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a colorless oil (1.74 g, 5.74 mmol, 57%) after purification by column chromatography (silica, 10% ethyl acetate - hexanes). α_D^{23} -28.8° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.27 (m, 4H); 7.24-7.21 (m, 1H); 4.55 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.17 (dd, J1=13.8 Hz, J2=3.6 Hz, 1H); 2.96-2.83 (m, 3H); 1.35 (s, 6H); 1.05 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 172.4, 152.9, 137.3, 129.2 (2C), 128.9 (2C), 127.0, 81.8, 63.8, 46.5, 35.6, 31.8, 29.9 (3C), 28.8, 22.6. LRMS (ESI) calcd for $C_{18}H_{25}NO_3Na$ [M+Na] 326.1732, found 326.18.



(*S*)-4-Benzyl-5,5-dimethyl-3-(4-phenoxybutanoyl)oxazolidin-2-one (3.35). The title compound was prepared from commercially available 4-phenoxybutanoic acid (1.80 g, 10.0 mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a yellowish oil (1.55 g, 4.22 mmol, 42%) after purification by column chromatography (silica, 30% ethyl acetate - hexanes). α_D^{22} -27.0° (c 1.0, dichloromethane).

^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.30-7.24 (m, 6H); 7.22-7.20 (m, 1H); 6.95-6.92 (m, 1H); 6.90-6.88 (m, 2H); 4.52 (dd, J1=9.6 Hz, J2=4.8, 1H); 4.04-3.95 (m, 2H); 3.16-3.10 (m, 3H); 2.88 (dd, J1=13.8 Hz, J2=9.0 Hz, 1H); 2.16-2.07 (m, 2H); 1.38 (s, 3H); 1.36 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.1, 159.0, 152.9, 137.1, 129.6 (2C), 129.3 (2C), 128.9 (2C), 127.0, 120.9, 114.7 (2C), 82.5, 66.7, 63.7, 35.7, 32.6, 28.7, 24.2, 22.5. LRMS (ESI) calcd for $C_{22}H_{25}NO_4Na$ [M+Na] 390.1681, found 390.17.



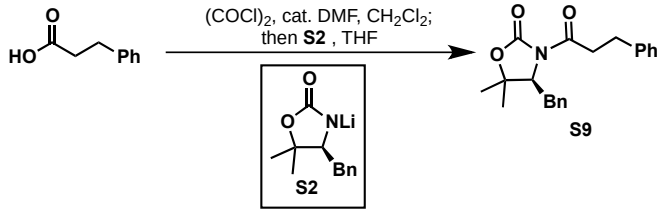
(*S*)-4-Benzyl-3-(5-(benzyloxy)pentanoyl)-5,5-dimethyloxazolidin-2-one (3.36). A solution of 1,5-pentanediol (1.60 mL, 15.2 mmol) in THF (3.20 mL) was added to a slurry of sodium hydride (60wt% in mineral oil, 0.104 g, 2.62 mmol) in THF (6.39 mL) over 30 min at 0 ˚C. After stirring for an additional 30 min, a solution of benzyl bromide (0.260 mL, 2.18 mmol) in THF (3.21 mL) was added to the reaction mixture over 30 min. The reaction mixture was then warmed to rt and stirred an additional 20 h. The reaction was quenched with water, and THF was removed *in vacuo*. The aqueous layer was extracted with ethyl acetate (3x20 mL). The combined organic layers were washed with water (6x20 mL), dried with sodium sulfate, and concentrated *in vacuo*. The resulting oil was submitted to the next reaction without further purification.

The crude mono-protected alcohol (0.517 g, 2.66 mmol) was dissolved in acetone (14.8 mL) and cooled to 0 ˚C. Jones reagent (3.35 M in water, 1.98 mL, 6.65 mmol) was added

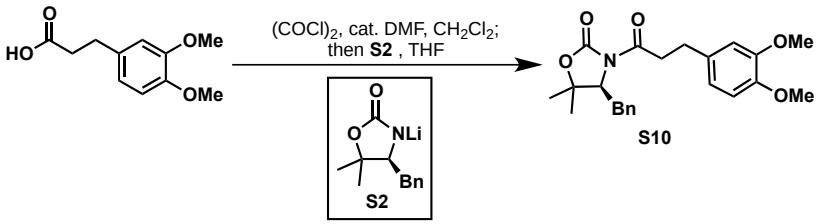
dropwise over 20 min. After 1 h at 0 ˚C, isopropanol (3.8 mL) was added to the reaction mixture. After 30 min at 0 ˚C, solid sodium bicarbonate was added until the reaction mixture was neutral (pH ~ 7). The reaction mixture was filtered through Celite and the solids were washed with acetone and diethyl ether. The solution was concentrated *in vacuo*. Solid sodium hydroxide was added to the resulting aqueous solution until basic (pH ~ 12). The aqueous layer was extracted with diethyl ether (3x20 mL). Concentrated HCl (12 M) was then added to the aqueous layer until acidic (pH ~ 1). The aqueous layer was extracted with diethyl ether (3x20 mL). The combined organic layers were dried with sodium sulfate and concentrated *in vacuo*. The resulting white solid was submitted to the next reaction without further purification.

Oxalyl chloride (0.660 mL, 0.770 mmol) was added to a solution of the crude carboxylic acid (0.146 g, 0.700 mmol), dimethylformamide (about 10 μl), and dichloromethane (0.470 mL) at 0 °C. After 10 min, the solution was warmed to rt and stirred an additional 15 min (until all bubbling had stopped). The solution was concentrated *in vacuo*. In a separate flask, *n*-butyllithium (2.43 M in hexanes, 0.200 mL, 0.490 mmol), was added to a solution of oxazolidinone **S1** (94.0 mg, 0.460 mmol) in THF (1.20 mL) at -78 °C under argon. The solution was stirred for 30 min at -78 °C then the crude acid chloride in THF (1.30 mL total with rinses) was added dropwise at -78 °C. After 2 h, the reaction mixture was warmed to 0 °C over 30 min and was quenched with saturated aqueous ammonium chloride. The aqueous layer was extracted with ethyl acetate (3x10 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated *in vacuo*. The desired compound **S8** was obtained as a yellowish oil (0.123 g, 0.311 mmol, 44% over 3 steps) after purification

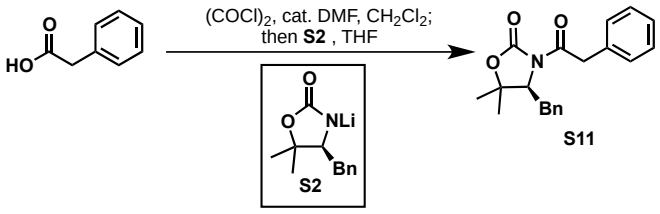
by column chromatography (silica, 30% ethyl acetate – hexanes). α_D^{24} -20.8° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.34-7.22 (m, 10H); 4.52-4.47 (m, 3H); 3.50 (dd, J1=J2=6.0 Hz, 2H); 3.13 (dd, J1=11.4 Hz, J2=3.6 Hz, 1H); 3.00-2.89 (m, 2H); 2.85 (dd, J1=13.8 Hz, J2=9.0 Hz, 1H); 1.77-1.71 (m, 2H); 1.70-1.64 (m, 2H); 1.36 (s, 3H); 1.34 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.5, 152.9, 138.8, 137.2, 129.3 (2C), 128.7 (2C), 128.6 (2C), 127.9 (2C), 127.7, 127.0, 82.4, 73.1, 70.2, 63.7, 35.60, 35.59, 29.3, 28.8, 22.5, 21.3. LRMS (ESI) calcd for $C_{24}H_{29}NO_4Na$ [M+Na] 418.1994, found 418.21.



(*S*)-4-Benzyl-5,5-dimethyl-3-(3-phenylpropanoyl)oxazolidin-2-one (3.37). The title compound was prepared from commercially available hydrocinnamic acid (1.50 g, 10.0 mmol) following the standard procedure for the synthesis of *N*-acyl oxazolidinones and was obtained as a white solid (1.74 g, 5.16 mmol, 52%) after purification by column chromatography (silica, 20% ethyl acetate - hexanes). α_D^{24} -21.7° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.18 (m, 10H); 4.50 (dd, J1=9.6 Hz, J2=4.2 Hz, 1H); 3.31-3.21 (m, 2H); 3.13 (dd, J1=14.4 Hz, J2=4.2 Hz, 1H); 3.01-2.92 (m, 2H); 2.86 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 1.36 (s, 3H); 1.32 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 172.8, 152.8, 140.6, 137.1, 129.3 (2C), 128.9 (2C), 128.70 (2C), 128.66 (2C), 127.0, 126.4, 82.4, 63.7, 37.4, 35.5, 30.7, 28.7, 22.5. LRMS (ESI) calcd for $C_{21}H_{23}NO_3Na$ [M+Na] 360.1576, found 360.16.

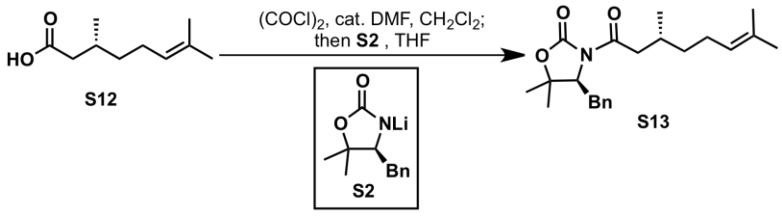


(*S*)-4-Benzyl-3-(3-(3,4-dimethoxyphenyl)propanoyl)-5,5-dimethyloxazolidin-2-one (3.38). The title compound was prepared from commercially available 3-(3,4-dimethoxyphenyl)propanoic acid (2.10 g, 10.0 mol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a yellowish solid (2.37 g, 5.96 mmol, 60%) after purification by column chromatography (silica, 40% ethyl acetate - hexanes). α_D^{22} -17.3° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.31-7.20 (m, 5H); 6.80-6.76 (m, 3H); 4.49 (dd, J1=10.2 Hz, J2=4.2 Hz, 1H); 3.87 (s, 3H); 3.85 (s, 3H); 3.29-3.19 (m, 2H); 3.11 (dd, J1=14.4 Hz, J2=4.2 Hz, 1H); 2.94-2.87 (m, 2H); 2.85 (dd, J1=14.4 Hz, J2=10.2 Hz, 1H); 1.36 (s, 3H); 1.31 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 172.9, 152.8, 149.1, 147.7, 137.1, 133.2, 129.3 (2C), 128.9 (2C), 127.0, 120.6, 112.0, 114.5, 82.5, 63.7, 56.2, 56.0, 37.6, 35.5, 30.4, 28.7, 22.5. LRMS (ESI) calcd for $C_{23}H_{27}NO_5Na$ [M+Na] 420.1787, found 420.18.



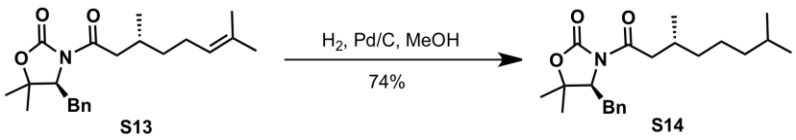
(*S*)-4-Benzyl-5,5-dimethyl-3-(2-phenylacetyl)oxazolidin-2-one (3.39). The title compound was prepared from commercially available phenylacetic acid (0.681 g, 5.00

mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a white solid (0.788 g, 2.44 mmol, 49%) after purification by column chromatography (silica, 20% ethyl acetate - hexanes). α_D^{24} -21.5° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.35-7.31 (m, 2H); 7.31-7.19 (m, 8H); 4.50 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 4.28 (AB, JA=18.6 Hz, JB=15.6 Hz, 2H); 3.14 (dd, J1=13.8 Hz, J2=3.6 Hz, 1H); 2.86 (dd, J1=13.8 Hz, J2=9.6 Hz, 1H); 1.36 (s, 3H); 1.32 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 171.7, 152.8, 137.0, 133.9, 129.9 (2C), 129.3 (2C), 128.9 (2C), 128.8 (2C), 127.4, 127.0, 85.6, 64.0, 42.0, 35.4, 28.8, 22.5. LRMS (ESI) calcd for $C_{20}H_{21}NO_3Na$ [M+Na] 346.1419, found 346.15.



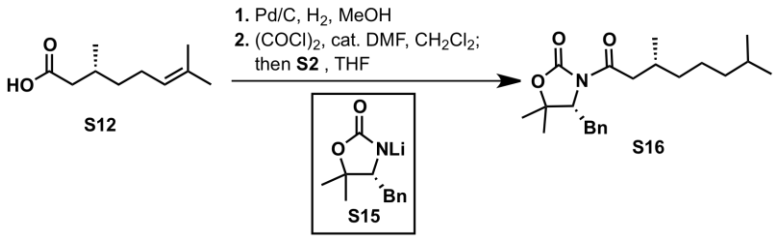
(*S*)-4-Benzyl-3-((*R*)-3,7-dimethyloct-6-enoyl)-5,5-dimethyloxazolidin-2-one (3.40). The title compound was prepared from (R)-(+)-citronellic acid **S14** (5.88 g, 16.5 mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as a colorless oil (4.82 g, 13.5 mmol, 82%) after purification by column chromatography (silica, 20% ethyl acetate - hexanes). α_D^{22} -21.4° (c 10.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.26 (m, 4H); 7.25-7.20 (m, 1H); 5.11-5.06 (m, 1H); 4.52 (dd, J1=9.0 Hz, J2=3.6 Hz, 1H); 3.15 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.93-2.84 (m, 2H); 2.79 (dd, J1=16.8 Hz, J2=7.8 Hz, 1H); 2.08-1.92 (m, 3H); 1.67 (s, 3H), 1.59 (s, 3H); 1.42-1.35 (m, 1H); 1.36 (s, 3H); 1.35 (s, 3H); 1.28-1.20 (m, 1H); 0.93 (d, J=6.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.2, 152.7, 137.2, 131.7, 129.3 (2C), 128.9

(2C), 127.0, 124.6, 82.2, 63.7, 42.7, 37.0, 35.6, 29.7, 28.8, 25.9, 25.7, 22.5, 19.8, 17.9. LRMS (ESI) calcd for $C_{22}H_{31}NO_3Na$ [M+Na] 380.2202, found 380.24.



S13 S14

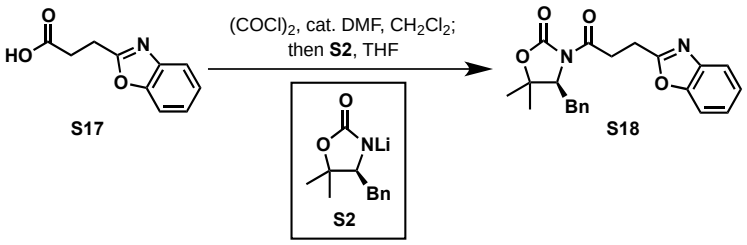
(*S*)-4-Benzyl-3-((*R*)-3,7-dimethyloctanoyl)-5,5-dimethyloxazolidin-2-one (3.41). The substrate **3.40** (0.441 g, 1.23 mmol) and palladium on carbon (30.4 mg) were dissolved in methanol (6.83 mL). Hydrogen gas was bubbled through the reaction mixture for 2 min at room temp. The reaction mixture flask was pressurized with hydrogen and the reaction was stirred for 1 h at rt. The reaction mixture was filtered through Celite and the solvent was removed *in vacuo* to afford the desired product (0.476 g, 1.33 mmol, 74%). α_D^{23} -21.5° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.25 (m, 4H); 7.25-7.20 (m, 1H); 4.52 (dd, J1=9.6 Hz, J2=4.2 Hz, 1H); 3.15 (dd, J1=14.4 Hz, J2=4.2 Hz, 1H); 2.94-2.84 (m, 2H); 2.75 (dd, J1=15.6 Hz, J2=7.8 Hz, 1H); 2.06-1.98 (m, 1H); 1.57-1.50 (m, 1H); 1.36 (s, 3H); 1.35 (s, 3H); 1.35-1.12 (m, 6H); 0.92 (d, J=6.6 Hz, 3H); 0.862 (d, J=6.6 Hz, 3H); 0.859 (d, J=6.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.3, 152.9, 137.2, 129.3 (2C), 128.9 (2C), 127.0, 82.2, 63.7, 42.8, 39.3, 37.2, 35.6, 30.0, 28.8, 28.2, 24.9, 22.9, 22.8, 22.5, 19.9. LRMS (ESI) calcd for $C_{22}H_{33}NO_3Na$ [M+Na] 382.2358, found 382.23.



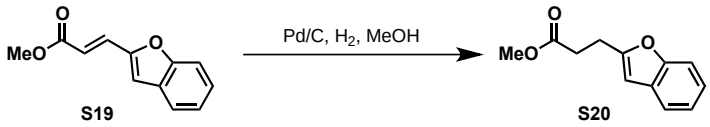
(*R*)-4-Benzyl-3-((*R*)-3,7-dimethyloct-6-enoyl)-5,5-dimethyloxazolidin-2-one (3.42). Oxalyl chloride (0.200 mL, 2.20 mmol) was added to a solution of (R)-(+)-citronellic acid (0.341 g, 2.00 mmol), dimethylformamide (10 μl), and dichloromethane (1.00 mL) at 0 °C. After 10 min, the solution was warmed to rt and stirred an additional 15 min (until all bubbling had stopped). The solution was concentrated *in vacuo*. In a separate flask, *n*-butyllithium (2.39 M in hexanes, 0.880 mL, 2.10 mmol) was added to a solution of oxazolidinone (0.411 g, 2.00 mmol) in THF (4.00 mL) at -78 °C under argon. The solution was stirred for 30 min at -78 °C then the crude acyl chloride in THF (4.00 mL total with rinses) was added dropwise at -78 °C. After 2 h, the reaction mixture was warmed to 0 °C over 30 min and was quenched with saturated aqueous ammonium chloride. The aqueous layer was extracted with ethyl acetate (3x20 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated *in vacuo*. The resultant oil was submitted to the next reaction without further purification.

The crude substrate and palladium on carbon (48.0 mg) were dissolved in methanol (10.0 mL). Hydrogen gas was bubbled through the reaction mixture for 2 min at room temp. The reaction mixture flask was pressurized with hydrogen and the reaction was stirred for 3h at rt. The reaction mixture was filtered through Celite and the solvent was removed *in vacuo*. The desired compound **3.42** was obtained as an oil (0.406 g, 1.12 mmol, 56%) after purification by column chromatography (silica, 20% ethyl acetate - hexanes). α_D^{23} 22.1° (c

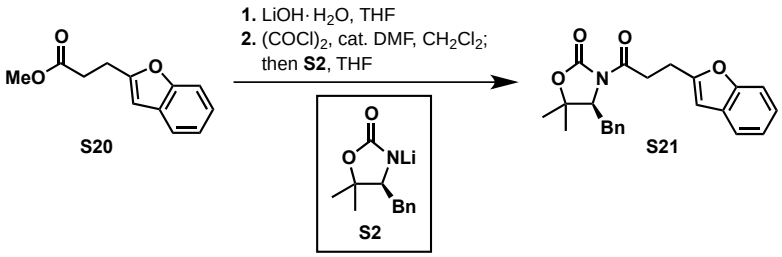
1.0, $CHCl_3$). ^1H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32-7.26 (m, 4H); 7.25-7.20 (m, 1H); 4.52 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.15 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.93-2.84 (m, 2H); 2.75 (dd, J1=15.6 Hz, J2=7.8 Hz, 1H); 2.07-1.97 (m, 1H); 1.56-1.48 (m, 1H); 1.36 (s, 3H); 1.35 (s, 3H); 1.35-1.11 (m, 6H); 0.93 (d, J=6.6 Hz, 3H); 0.87 (d, J=6.6 Hz, 3H); 0.86 (d, J=6.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.4, 152.9, 137.2, 129.3 (2C), 128.9 (2C), 127.0, 82.2, 63.7, 42.9, 39.3, 37.3, 35.6, 30.0, 28.7, 28.2, 24.9, 22.9, 22.8, 22.5, 19.9. LRMS (ESI) calcd for $C_{22}H_{33}NO_3Na$ [M+Na] 382.2358, found 382.22.



(*S*)-3-(3-(Benzo[*d*]oxazol-2-yl)propanoyl)-4-benzyl-5,5-dimethyloxazolidin-2-one (3.44). The title compound was prepared from carboxylic acid **3.43** (0.471 g, 2.46 mmol)[122] following the standard procedure for the synthesis of N-acyl oxazolidinones and was obtained as white solid (0.391 g, 1.03 mmol, 44%) after purification by column chromatography (silica, 25% ethyl acetate – hexanes, 40% ethyl acetate – hexanes). α_D^{23} -11.9° (c 1.0, dichloromethane). ^1H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.65-7.58 (m, 1H); 7.48-7.42 (m, 1H); 7.31-7.15 (m, 7H); 4.50 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.66-3.55 (m, 1H); 3.54-3.42 (m, 1H); 3.33-3.18 (m, 2H); 3.14 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.90 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 1.39 (s, 3H); 1.37 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 171.7, 165.8, 152.8, 151.0, 141.5, 137.0, 129.2 (2C), 128.8 (2C), 127.0, 124.7, 124.3, 119.8, 110.5, 82.8, 63.7, 35.5, 32.6, 28.7, 23.4, 22.5. LRMS (ESI) calcd for $C_{22}H_{22}N_2O_4Na$ [M+Na] 401.1477, found 401.14.



Methyl 3-(benzofuran-2-yl)propanoate (3.46). Crude α,β-unsaturated ester **3.45** (0.753 g, 3.42 mmol)[123] and palladium on carbon (75.3 mg) were dissolved in methanol (23.0 mL). Hydrogen was bubbled through the reaction mixture for 2 min at rt. The reaction mixture flask was pressurized with Hydrogen gas and the reaction was stirred for 1.5 h at rt. The reaction mixture was filtered through Celite and the solvent was removed *in vacuo*. The desired compound **3.46** was obtained as an oil (0.379 g, 1.86 mmol, 54%) after purification by column chromatography (silica, 5% ethyl acetate – hexanes, 10% ethyl acetate – hexanes, 15% ethyl acetate – hexanes). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.50-7.46 (m, 1H); 7.43-7.39 (m, 1H); 7.24-7.16 (m, 2H); 6.43 (s, 1H); 3.71 (s, 3H); 3.12 (dd, J1=J2=7.8 Hz, 2H); 2.78 (dd, J1=J2=8.4 Hz, 2H); ^{13}C NMR (150 MHz, $CDCl_3$); □(ppm): 172.9, 157.4, 154.9, 128.9, 123.7, 122.8, 120.6, 111.0, 102.7, 52.0, 32.3, 24.1. LRMS (ESI) calcd for $C_{12}H_{12}O_3Na$ [M+Na] 227.0786, found 227.08**.**



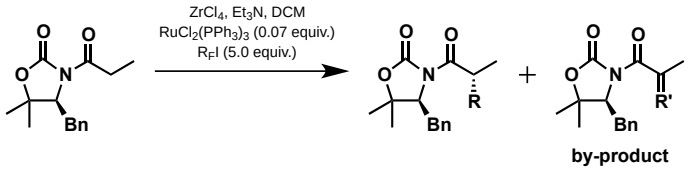
(*S*)-3-(3-(Benzofuran-2-yl)propanoyl)-4-benzyl-5,5-dimethyloxazolidin-2-one (3.48). LiOH•H_2O (3.00 mL, 7.2 mmol, 2.42 M in water) was added to methyl ester **3.47** (0.367 g, 1.80 mmol) in THF (9.00 mL) at 0 °C. After 10 min the reaction mixture was warmed to rt

and stirred for 12 h. HCl (1 M) was then added until the reaction mixture was acidic (pH ~ 4), and the layers were separated. The aqueous layer was extracted with ethyl acetate (3x20 mL). The combined organic layers were dried with sodium sulfate and concentrated. The resultant solid was submitted to the next reaction without further purification.

Oxalyl chloride (0.172 mL, 1.97 mmol) was added to a solution of the crude carboxylic acid (0.340 g, 1.79 mmol), dimethylformamide (10 µl), and dichloromethane (1.80 mL) at 0 °C. After 10 min, the solution was warmed to rt and stirred an additional 15 min (until all bubbling had stopped). The solution was concentrated *in vacuo*. In a separate flask, *n*-butyllithium (2.10 M in hexanes, 0.895 mL, 1.88 mmol), was added to a solution of oxazolidinone (0.376 g, 1.83 mmol) in THF (3.60 mL) at -78 °C under argon. The solution was stirred for 30 min at -78 °C then the crude acid chloride in THF (3.60 mL total with rinses) was added dropwise at -78 °C. After 2 h, the reaction mixture was warmed to 0 °C over 30 min and was quenched with saturated aqueous ammonium chloride. The layers were separated. The aqueous layer was extracted with ethyl acetate (3x20 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated. The desired compound **3.48** was obtained as a white solid (0.538 g, 1.43 mmol, 79%) after purification by column chromatography (silica, 15% ethyl acetate – hexanes, 30% ethyl acetate – hexanes). α_D^{23} -25.7° (c 1.63, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.50-7.46 (m, 1H); 7.43-7.38 (m, 1H); 7.32-7.24 (m, 4H); 7.24-7.15 (m, 3H); 6.45 (s, 1H); 4.53 (dd, J1=9.6 Hz, J2=4.2 Hz, 1H); 3.45-3.34 (m, 2H); 3.19-3.09 (m, 3H); 2.88 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 1.38 (s, 3H), 1.36 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 172.0, 157.5, 154.8, 152.8, 137.0, 129.2 (2C), 129.0, 128.8 (2C), 127.0, 123.5, 122.7, 120.6, 111.0, 102.8, 82.6, 63.7, 35.5, 34.0, 28.7, 23.3, 22.5. LRMS (ESI) calcd for $C_{23}H_{23}NO_4Na$ [M+Na]

400.1525, found 400.11.

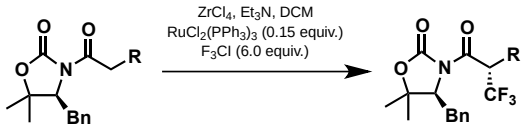
Standard procedure for perfluoralkylation of *N*-acyl oxazolidinones:



An *N*-acyl oxazolidinone (63.5 mg, 0.250 mmol), zirconium(IV) chloride (61.3 mg, 0.263 mmol, 1.05 equiv), and $RuCl_2(PPh_3)_3$ (16.8 mg, 0.0175 mmol, 0.07 equiv) were weighed out and added to a oven-dried vial equipped with a magnetic stir bar. Each reaction was capped with a black phenolic open-top screw cap lined with a white Silicone/TFE septum. The reaction vial was then backfilled with argon followed by addition of dry dichloromethane (2.50 mL) at rt. Triethylamine (0.122 mL, 0.875 mmol, 3.50 equiv) was added to the reaction mixture and stirred for 5 min, followed by addition of perfluoroalkyl iodide (1.25 mmol, 5.00 equiv). The vial cap was then replaced with a Teflon-lined cap. The reaction mixture was stirred for 1 h at rt, then heated to 45 ˚C and stirred for an additional 16 h. The sealed reaction vial was slowly opened (reaction is under pressure), and then added to HCl (1 M, 20 mL) in a separatory funnel. The layers were separated. The aqueous layer was extracted with dichloromethane (3x10 mL). The combined organic layers were dried with sodium sulfate, and concentrated on a rotary evaporator. The resulting compound was purified by column chromatography to give the corresponding α-perfluoralkylated oxazolidinone.

*Alternative procedure for workup***:** The final reaction mixture can simply be filtered through a 1.5 cm plug of silica gel with ~ 1.0 cm of Celite on top washing with ethyl acetate. The filtrate is concentrated under reduced pressure to deliver the crude product.

Standard procedure for trifluoromethylation of *N*-acyl oxazolidinones:



For solid substrates**:** The *N*-acyl oxazolidinone (0.500 mmol), zirconium(IV) chloride (0.122 g, 0.525 mmol, 1.05 equiv), and $RuCl_2(PPh_3)_3$ (71.9 mg, 0.075 mmol, 0.15 equiv) were weighed out and added to a oven-dried vial equipped with a magnetic stir bar. Each reaction was capped with a black phenolic open-top screw cap lined with a white Silicone/TFE septum. The reaction vial was then backfilled with argon followed by addition of dry dichloromethane (1.00 mL) at rt. The reaction was cooled to -78 ˚C, then triethylamine (0.280 mL, 2.00 mmol, 4.00 equiv) was added and the reaction was stirred for 5 min. Trifluoroiodomethane (~0.230 mL, ~3.00 mmol, ~6.00 equiv) was then bubbled in via needle at -78 ˚C. The vial cap was then replaced with a solid Teflon-lined cap. The reaction was warmed to rt and stirred for 1 h, then heated to 45 ˚C and stirred for an additional 16 h. The sealed reaction vial was slowly opened (reaction is under pressure) until bubbling stopped, and then added to HCl (1 M, 20 mL) in a separatory funnel. The aqueous layer was extracted with dichloromethane (3x10 mL). The combined organic layers were dried with sodium sulfate, and concentrated on a rotary evaporator. The resulting compound was purified by column chromatography to give the corresponding α-trifluoromethylated *N*-acyl oxazolidinone.

*Alternative procedure for workup***:** The final reaction mixture can simply be filtered through a 1.5 cm plug of silica gel with ~ 1.0 cm of Celite on top washing with ethyl acetate. The filtrate is concentrated under reduced pressure to deliver the crude product.

For liquid or amorphous substrates: Zirconium(IV) chloride (0.122 g, 0.525 mmol, 1.05 equiv) and $RuCl_2(PPh_3)_3$ (71.9 mg, 0.075 mmol, 0.15 equiv) were weighed out and added to a oven-dried vial equipped with a magnetic stir bar. Each reaction was capped with a black phenolic open-top screw cap lined with a white Silicone/TFE septum. The reaction vial was then backfilled with argon followed by addition of a solution of the *N*-acyl oxazolidinone (0.500 mmol) in dichloromethane (3 rinses, total of 1.00 mL) at rt. The reaction mixture was cooled to -78 ˚C, then triethylamine (0.280 mL, 2.00 mmol, 4.00 equiv) was added and the reaction was stirred for 5 min. Trifluoroiodomethane (~0.230 mL, ~3.00 mmol, ~6.00 eq.) was then bubbled in via needle at -78 ˚C. The vial cap was then replaced with a solid Teflon-lined cap. The reaction was warmed to rt and stirred for 1 h, then heated to 45 ˚C and stirred for an additional 16 h. The sealed reaction vial was slowly opened (reaction is under pressure) until bubbling stopped, and then added to HCl (1 M, 20 mL) in a separatory funnel. The aqueous layer was extracted with dichloromethane (3x10 mL). The combined organic layers were dried with sodium sulfate, and concentrated on a rotary evaporator. The resulting compound was purified by column chromatography to give the corresponding α-trifluoromethylated *N*-acyl oxazolidinone.

*Alternative procedure for workup***:** The final reaction mixture can simply be filtered through a 1.5 cm plug of silica gel with ~ 1.0 cm of Celite on top washing with ethyl acetate. The filtrate is concentrated under reduced pressure to deliver the crude product.

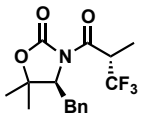


Table 3.4.2, entry 1. The title compound was prepared from oxazolidinone **3.12** (0.131 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.122 g, 0.370 mmol, 74%, dr 9:1) after purification by column chromatography (silica, 45% dichloromethane – hexanes, 15% ethyl acetate – hexanes, 20% ethyl acetate – hexanes). α_D^{25} 14.5° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.29 (m, 2H); 7.28-7.22 (m, 3H); 4.83 (app heptet, J=7.8 Hz, 1H); 4.53 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.19 (dd, J1=14.4 Hz, J2=3.0 Hz, 1H); 2.88 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 1.44 (d, J=7.2 Hz, 3H); 1.40 (s, 3H); 1.34 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.6 (q, J=2.9 Hz), 152.3, 136.6, 129.2 (2C), 129.0 (2C), 127.2, 125.2 (q, J=278.4 Hz), 82.9, 64.2, 42.5 (q, J=27.3 Hz), 35.1, 28.8, 22.6, 11.4 (q, J=2.9 Hz). ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -69.15 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{16}H_{18}F_3NO_3Na$ [M+Na] 352.1136, found 352.13.

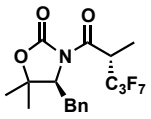


Table 3.4.2, entry 2. The title compound was prepared from oxazolidinone **3.12** (65.3 mg, 0.250 mmol) following the standard perfluoroalkylation procedure and was obtained as a colorless oil (79.0 mg, 0.185 mmol, 74%, dr 24:1) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 50% dichloromethane – hexanes). Analytically pure sample (white solid) was obtained using HPLC by dissolving the mixture in 0.5% *i*-ProH/hexanes with the concentration of 10

mg/ml. The separation was conducted on a YMC-Pack Sil HPLC column (250x30mmID, S-10 μm, 12 nm) with 4.5 mL injection (0.25% *i*-PrOH/hexanes as eluent at a rate of 20 mL/min, λ=215 nm, R_t=14.55 min) afforded pure product**.** α_D^{25} -32.7° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.26 (m, 4H); 7.26-7.22 (m, 1H); 5.09 (app octet, J=7.2 Hz, 1H); 4.54 (dd, J1=10.8 Hz, J2=3.0 Hz, 1H); 3.25 (dd, J1=14.4 Hz, J2=3.0 Hz, 1H); 2.82 (dd, J1=14.4 Hz, J2=10.8 Hz, 1H); 1.48 (d, J=7.2 Hz, 3H); 1.38 (s, 3H); 1.32 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 168.7 (t, J=3.3 Hz), 152.3, 136.8, 129.1 (2C), 129.0 (2C), 127.2, 121.8-105.0 (m, 3C), 82.8, 64.4, 39.3 (t, J=21.0 Hz), 34.7, 29.9, 28.9, 22.7, 11.4-11.2 (m, 1C). ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -80.59 (dd, J1=J2=10.2 Hz, 3F), -115.4 (m, 2F), -124.68 (m, 2F). LRMS (ESI) calcd for $C_{18}H_{18}F_7NO_3Na$ [M+Na] 452.1073, found 452.13.

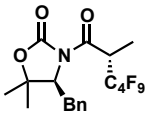


Table 3.4.2, entry 3. The title compound was prepared from oxazolidinone **3.12** (65.3 mg, 0.250 mmol) following the standard perfluoroalkylation procedure and was obtained as a colorless oil (85.4 mg, 0.178 mmol, 71%, dr 24:1) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 50% dichloromethane – hexanes). Analytically pure sample (white solid) was obtained using HPLC by dissolving the mixture in 0.5% *i*-ProH/hexanes with the concentration of 10 mg/ml. The separation was conducted on a YMC-Pack Sil HPLC column (250x30mmID, S-10 μm, 12 nm) with 4.5 mL injection (0.25% *i*-PrOH/hexanes as eluent at a rate of 20 mL/min, λ=215 nm, R_t=12.49 min) afforded pure product . α_D^{25} -24.3° (c 1.0,

dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.34-7.26 (m, 4H), 7.26-7.22 (m, 1H), 5.11 (app octet, J=7.2 Hz, 1H), 4.54 (dd, J1=10.2 Hz, J2=3.0 Hz, 1H), 3.24 (dd, J1=15.0 Hz, J2=3.0 Hz, 1H); 2.83 (dd, J1=15.0 Hz, J2=10.2 Hz, 1H); 1.48 (d, J=7.2 Hz, 3H); 1.38 (s, 3H); 1.33 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.8-168.6 (m, 1C), 152.3, 136.8, 129.2 (2C), 129.0 (2C), 127.2, 121.0-106.4 (m, 4C), 82.6, 64.4, 39.4 (t, J=21.5 Hz), 34.7, 28.8, 22.6, 11.5-11.3 (m, 1C). ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -80.91 (dd, J=9.6 Hz, 3F), -114.77 (m, 2F), -121.4 (m, 2F), -126.06 (m, 2F). LRMS (ESI) calcd for $C_{19}H_{18}F_9NO_3Na$ [M+Na] 502.1041, found 502.13.

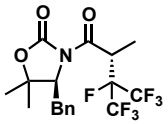


Table 3.4.2, entry 4. The title compound was prepared from oxazolidinone **3.12** (0.131 mg, 0.500 mmol) following the standard perfluoroalkylation procedure and was obtained as a colorless oil (0.161 g, 0.374 mmol, 75%, dr >98:2) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 50% dichloromethane – hexanes). α_D^{23} -17.2° (c 1.0, dichloromethane). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.34-7.27 (m, 4H); 7.26-7.20 (m, 1H); 5.18 (dq, J_d=14.5 Hz, J_q=7.5 Hz, 1H); 4.53 (dd, J1=11.0 Hz, J2=2.5 Hz, 1H); 3.29 (dd, J1=14.5 Hz, J2=2.5 Hz, 1H); 2.76 (dd, J1=14.5 Hz, J2=11.0 Hz, 1H); 1.50 (d, J=7.0 Hz, 3H); 1.36 (s, 3H); 1.30 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 169.2 (d, J=3.3 Hz), 152.3, 136.8, 129.1 (2C), 129.0 (2C), 127.1, 120.98 (dq, J=28.1 Hz, J=286.4 Hz), 120.96 (dq, J=28.1 Hz, 286.4 Hz), 92.4 (dh, J=31.4 Hz, J=210.0 Hz), 82.6, 64.5, 37.5 (d, J=19.4 Hz), 34.1, 28.7, 22.3, 12.4. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -72.94 (dddd, J=9.6 Hz, 3F), -73.38 (dddd, J=9.6 Hz, 3F), -

182.04 (m, 1F). LRMS (ESI) calcd for $C_{18}H_{18}F_7NO_3Na$ [M+Na] 452.1073, found 452.09.

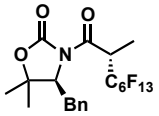


Table 3.4.2, entry 5. The title compound was prepared from oxazolidinone **3.12** (65.3 mg, 0.250 mmol) following the standard perfluoroalkylation procedure and was obtained as a white solid (93.0 mg, 0.159 mmol, 64%, dr >98:2) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 50% dichloromethane – hexanes). Analytically pure sample (white solid) was obtained using HPLC by dissolving the mixture in 0.5% *i*-ProH/hexanes with the concentration of 10 mg/ml. The separation was conducted on a YMC-Pack Sil HPLC column (250x30mmID, S-10 μm, 12 nm) with 4.5 mL injection (0.25% *i*-PrOH/hexanes as eluent at a rate of 20 mL/min, λ=215 nm, R_t=14.65 min) afforded pure product**.** α_D^{25} -19.1° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.27 (m, 4H); 7.26-722 (m, 1H); 5.11 (app octet, J=7.2 Hz, 1H); 4.54 (dd, J1=10.2 Hz, J2=3.0 Hz, 1H); 3.25 (dd, J1=14.4 Hz, J2=3.0 Hz, 1H); 2.82 (dd, J1=14.4 Hz, J2=10.2 Hz, 1H); 1.48 (d, J=7.2 Hz, 3H); 1.38 (s, 3H); 1.33 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.8-168.6 (m, 1C), 152.3, 136.8, 129.2 (2C), 129.0 (2C), 127.2, 120.5-106.4 (m, 6C), 82.7, 64.4, 39.4 (t, J=21.5 Hz), 34.7, 28.8, 22.6, 11.4. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -80.78 (dd, J1=J2=9.6 Hz, 3F), -114.52 (m, 2F), -120.36 (m, 2F), -121.91 (m, 2F), -122.72 (m, 2F), -126.09 (m, 2F). LRMS (ESI) calcd for $C_{21}H_{18}F_{13}NO_3Na$ [M+Na] 602.0977, found 602.08.

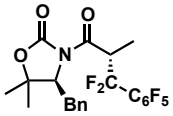


Table 3.4.2, entry 6. The title compound was prepared from oxazolidinone **3.12** (65.3 mg, 0.250 mmol) following the standard perfluoroalkylation procedure and was obtained as a white solid (87.4 mg, 0.183 mmol, 73%, dr >98:2) after purification by column chromatography (silica, 12.5% ethyl acetate – hexanes, 15% ethyl acetate – hexanes, 20% ethyl acetate – hexanes). Analytically pure sample (white solid) was obtained using HPLC by dissolving the mixture in 0.5% *i*-ProH/hexanes with the concentration of 10 mg/ml. The separation was conducted on a YMC-Pack Sil HPLC column (250x30mmID, S-10 μm, 12 nm) with 4.5 mL injection (0.25% *i*-PrOH/hexanes as eluent at a rate of 20 mL/min, λ=215 nm, R_t=13.44 min) afforded pure product**.** α_D^{23} -28.7° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.30-7.26 (m, 2H); 7.25-7.20 (m, 3H); 5.00 (app octet, J=6.6 Hz, 1H); 4.49 (dd, J1=10.2 Hz, J2=3.6 Hz, 1H); 3.14 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.81 (dd, J1=14.4 Hz, J2=10.2 Hz, 1H); 1.45 (d, J=6.6 Hz, 3H); 1.37 (s, 3H); 1.33 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 169.9 (dd, J1=1.8 Hz, J2=6.2 Hz), 152.3, 146.0-144.0 (m, 2C), 143.6-141.6 (m, 1C), 139.0-137.0 (m, 2C), 136.7, 129.2 (2C), 128.9 (2C), 127.1, 119.5 (t, J=251.7 Hz), 110.3 (m, 1C), 82.9, 64.2, 45.8 (t, J=25.2 Hz), 34.8, 28.8, 22.5, 11.5 (t, J=4.5 Hz). ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -77.97 (dtd, J_{d1}=10.6 Hz, J_t=22.1 Hz, J_{d2}=232 Hz, 1F), -80.68 (dtd, J_{d1}=12.1 Hz, J_t=25.8 Hz, J_{d2}=232 Hz, 1F), -117.90 (m, 2F), -127.67 (t, J=17.5 Hz, 1F), 136.77 (m, 2F). LRMS (ESI) calcd for $C_{22}H_{18}F_7NO_3Na$ [M+Na] 500.1073, found 500.09.

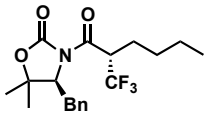


Table 3.4.3, entry 1. The title compound was prepared from oxazolidinone **3.31** (0.152 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.131 g, 0.353 mmol, 71%, dr ~9.4:1) after purification by column chromatography (silica, 40% dichloromethane – hexanes, 15% ethyl acetate – hexanes). α_D^{23} 6.8° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.25 (m, 4H); 7.25-7.21 (m, 1H); 4.99-4.89 (m, 1H); 4.56 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.15 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.90 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 2.04-1.95 (m, 1H); 1.87-1.79 (m, 1H); 1.39 (s, 3H); 1.42-1.25 (m, 4H); 1.35 (s, 3H); 0.90 (dd, J1=J2=6.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.1 (q, J=3.5 Hz), 152.3, 136.7, 129.2 (2C), 128.9 (2C), 127.1, 125.0 (q, J=279 Hz), 82.7, 64.3, 47.0 (q, J=26.3 Hz), 35.2, 29.0, 28.7, 26.4 (q, J=1.7 Hz), 22.6, 22.4, 13.9. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -67.11 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{19}H_{24}F_3NO_3Na$ [M+Na] 394.1606, found 394.17.

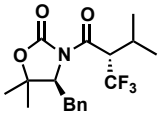


Table 3.4.3, entry 2. The title compound was prepared from oxazolidinone **3.32** (0.145 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.141 g, 0.395 mmol, 79%, dr >24:1) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 20% ethyl acetate – hexanes). α_D^{24} 5.4° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.27 (m, 4H); 7.25-7.21 (m, 1H), 4.82 (dq, J_d=J_q=8.4 Hz, 1H), 4.56

(dd, J1=10.2 Hz, J2=3.6 Hz, 1H), 3.16 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H), 2.90 (dd, J1=14.4 Hz, J2=10.2 Hz, 1H), 2.47-2.37 (m, 1H), 1.37 (s, 3H), 1.36 (s, 3H), 1.14 (d, J=6.6 Hz, 3H), 1.03 (d, J=6.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.1 (q, J=3.9 Hz), 152.4, 136.8, 129.2 (2C), 128.9 (2C), 127.1, 125.1 (q, J=280.1 Hz), 82.5, 64.3, 52.9 (q, J=25.7 Hz), 35.1, 28.8, 28.1, 22.4, 20.8, 20.4. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -63.03 (d, J=9.0 Hz, 3F). LRMS (ESI) calcd for $C_{18}H_{22}F_3NO_3Na$ [M+Na] 380.1449, found 380.15.

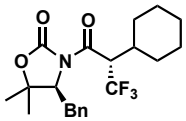


Table 3.4.3, entry 3. The title compound was prepared from oxazolidinone **3.33** (0.165 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.150 g, 0.378 mmol, 76%, dr >24:1) after purification by column chromatography (silica, 25% dichloromethane – hexanes, 35% dichloromethane – hexanes, 20% ethyl acetate – hexanes). α_D^{23} 19.3° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.34-7.27 (m, 4H); 7.25-7.21 (m, 1H); 4.88 (dq, J_d=J_q=9.0 Hz, 1H); 4.55 (dd, J1=10.2 Hz, J2=3.6 Hz, 1H); 3.16 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.90 (dd, J1=14.4 Hz, J2=10.2 Hz, 1H); 2.18-2.09 (m, 1H); 2.01-1.95 (m, 1H); 1.81-1.69 (m, 2H); 1.69-1.60 (m, 2H); 1.37 (s, 3H); 1.36 (s, 3H); 1.33-1.24 (m, 2H); 1.22-1.15 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.2 (q, J=3.9 Hz), 152.4, 136.9, 129.2 (2C), 128.9 (2C), 127.1, 125.1 (q, J=280.7 Hz), 82.5, 64.3, 52.3 (q, J=25.2 Hz), 37.2, 35.2, 30.7, 30.4, 28.8, 26.1, 25.9 (2C), 22.4. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -62.32 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{21}H_{26}F_3NO_3Na$ [M+Na] 420.1762, found 420.18.

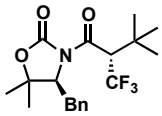


Table 3.4.3, entry 4. The title compound was prepared from oxazolidinone **3.34** (0.153 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.129 g, 0.348 mmol, 70%, dr >98:2) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes). α_D^{25} 90.9° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.29 (m, 4H); 7.26-7.21 (m, 1H); 5.10 (q, J=9.0 Hz, 1H); 4.57 (dd, J1=10.2 Hz, J2=3.0 Hz, 1H); 3.15 (dd, J1=14.4 Hz, J2=3.0 Hz, 1H); 2.90 (dd, J1=14.4 Hz, J2=10.2 Hz, 1H); 1.36 (s, 3H); 1.36 (s, 3H); 1.18 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 167.3 (q, J=3.3 Hz), 152.6, 136.9, 129.2 (2C), 128.9 (2C), 127.1, 125.4 (q, J=281.3 Hz), 82.3, 64.3, 53.8 (q, J=24.6 Hz), 35.2, 34.2, 28.9, 28.7 (3C), 22.4. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -59.86 (d, J=9.0 Hz, 3F). LRMS (ESI) calcd for $C_{19}H_{24}F_3NO_3Na$ [M+Na] 394.1606, found 394.17.

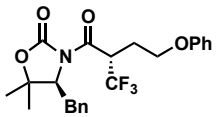


Table 3.4.3, entry 5. The title compound was prepared from oxazolidinone **3.35** (0.184 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.146 g, 0.336 mmol, 75%, dr 9:1) after purification by column chromatography (silica, 10% ethyl acetate – hexanes, 15% ethyl acetate – hexanes). α_D^{23} 42.8° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.34-7.29 (m, 2H); 7.29-7.21 (m, 5H); 6.94 (t, J=7.2 Hz, 1H); 6.86 (m, J=8.4 Hz, 2H); 5.41-5.31 (m, 1H); 4.51 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 4.19-4.13 (m, 1H); 3.98-3.81 (m, 1H); 3.16 (dd, J1=14.4

Hz, J2=3.6 Hz, 1H); 2.88 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 2.56-2.48 (m, 1H); 2.35-2.28 (m, 1H); 1.33 (s, 3H); 1.05 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 167.2 (q, J=3.3 Hz), 158.5, 152.2, 136.8, 129.7 (2C), 129.2 (2C), 128.9 (2C), 127.1, 125.1 (q, J=279.0 Hz), 121.6, 115.0 (2C), 82.6, 65.0, 64.3, 44.4 (q, J=27.3 Hz) 35.2, 28.3, 26.5-26.3 (m, 1C), 22.5. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -67.44 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{23}H_{24}F_3NO_4Na$ [M+Na] 458.1555, found 458.18.

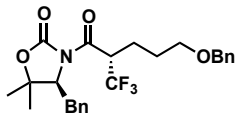


Table 3.4.3, entry 6. The title compound was prepared from oxazolidinone **3.36** (0.198 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.119 g, 0.256 mmol, 51%, dr 9:1) after purification by column chromatography (silica, 15% ethyl acetate – hexanes, 20% ethyl acetate – hexanes, 30% ethyl acetate – hexanes). α_D^{23} 10.3° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.38-7.22 (m, 10H); 5.08-4.98 (m, 1H); 4.58-4.53 (m, 1H); 4.53-4.46 (m, 2H); 3.54-3.43 (m, 2H); 3.17 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.90 (dd, J1=14.4 Hz, J2=10.2 Hz, 1H); 2.17-2.08 (m, 1H); 2.01-1.92 (m, 1H); 1.72-1.62 (m, 2H); 1.39 (s, 3H); 1.33 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 167.8 (q, J=2.9 Hz), 152.2, 138.4, 136.7, 129.2 (2C), 128.9 (2C), 128.6 (2C), 127.9 (2C), 127.8, 127.1, 125.0 (q, J=280.7 Hz), 82.7, 73.2, 69.4, 64.2, 46.8, (q, J=26.9 Hz), 35.1, 28.6, 26.9, 23.7, 22.4. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -66.99 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{25}H_{28}F_3NO_4Na$ [M+Na] 486.1868, found 486.17.

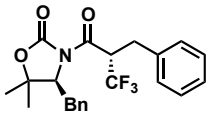


Table 3.4.3, entry 7. The title compound was prepared from oxazolidinone **3.37** (0.175 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.128 g, 0.315 mmol, 63%, dr 9.2:1) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 20% ethyl acetate – hexanes). α_D^{25} 96.0° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.31-7.25 (m, 4H); 7.25-7.18 (m, 6H); 5.45-5.36 (m, 1H); 4.25 (dd, J1=9.6 Hz, J2=4.8 Hz, 1H); 3.26-3.15 (m, 2H); 3.01 (dd, J1=15.0 Hz, J2=4.8 Hz, 1H); 2.85 (dd, J1=15.0 Hz, J2=9.6 Hz, 1H); 1.26 (s, 3H); 0.74 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 166.8 (q, J=3.1 Hz), 152.1, 136.6, 136.0, 129.4 (2C), 129.2 (2C), 129.0 (2C), 128.9 (2C), 127.5, 127.1, 124.6 (q, J=279.6 Hz), 82.7, 64.0, 48.1 (q, J=26.3 Hz), 35.5, 32.9 (q, J=2.2 Hz), 27.6, 22.2. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -67.38 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{22}H_{22}F_3NO_3Na$ [M+Na] 428.1449, found 428.16.

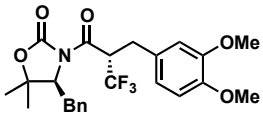


Table 3.4.3, entry 8. The title compound was prepared from oxazolidinone **3.38** (0.199 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.140 g, 0.300 mmol, 60%, dr 9:1) after purification by column chromatography (silica, 15% ethyl acetate – hexanes, 25% ethyl acetate – hexanes). α_D^{25} 90.9° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.31-7.26 (m, 2H); 7.26-7.21 (m, 3H); 6.78-6.73 (m, 3H); 5.44 (app sextet, J=7.2 Hz, 1H); 4.26 (dd, J1=9.0 Hz,

J2=4.2 Hz, 1H); 3.87 (s, 3H); 3.81 (s, 3H); 3.15 (d, J=7.8 Hz, 2H); 3.02 (dd, J1=14.4 Hz, J2=4.2 Hz, 1H); 2.87 (dd, J1=14.4 Hz, J2=9.0 Hz, 1H); 1.29 (s, 3H); 0.80 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 166.8 (q, J=2.9 Hz), 152.2, 149.3, 148.4, 136.5, 129.2 (2C), 128.9 (2C), 128.2, 127.1, 124.6 (q, J=279.0 Hz), 121.4, 112.2, 111.6, 82.6, 64.0, 56.1 (2C), 47.9 (q, J=26.3 Hz), 35.5, 32.5 (q, J=2.3 Hz), 27.4, 22.1. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -67.31 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{24}H_{26}F_3NO_5Na$ [M+Na] 488.1661, found 488.19.

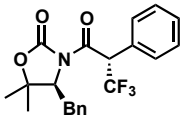


Table 3.4.3, entry 9. The title compound was prepared from oxazolidinone **3.39** (0.162 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (93.1 mg, 0.238 mmol, 48%, dr 8.4:1) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 20% ethyl acetate – hexanes). α_D^{24} 24.3° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.50-7.46 (m, 2H); 7.40-7.36 (m, 3H); 7.34-7.27 (m, 4H); 7.27-7.23 (m, 1H); 5.90 (q, J=7.8 Hz, 1H); 4.44 (dd, J1=9.6 Hz, J2=3.6 Hz, 1H); 3.22 (dd, J1=14.4 Hz, J2=3.6 Hz, 1H); 2.96 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H); 1.34 (s, 3H); 1.04 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 166.0 (q, J=2.3 Hz), 152.0, 136.6 (2C), 130.4 (2C), 129.6, 129.3 (2C), 129.1 (2C), 129.0 (2C), 127.2, 124.0 (q, J=278.4 Hz), 83.1, 64.3, 53.1 (q, J=28.5 Hz), 35.5, 28.4, 22.2. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -66.71 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{21}H_{20}F_3NO_3Na$ [M+Na] 414.1293, found 414.15.

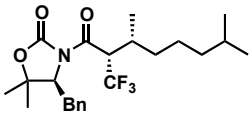


Table 3.4.3, entry 10. The title compound was prepared from oxazolidinone **3.41** (0.133 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.105 g, 0.245 mmol, 49%, dr 6.4:1) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 20% ethyl acetate – hexanes). α_D^{22} 11.7° (c 0.46, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.27 (m, 4H); 7.25-7.21 (m, 1H); 4.86 (dq, J_d=J_q=8.4 Hz, 1H); 4.56 (dd, J1=9.6 Hz, J2=3.0 Hz, 1H); 3.16 (dd, J1=15.0 Hz, J2=3.0 Hz, 1H); 2.90 (dd, J1=15.0 Hz, J2=10.2 Hz, 1H); 2.33-2.23 (m, 1H); 1.55-1.46 (m, 1H); 1.37 (s, 3H); 1.36 (s, 3H); 1.43-1.20 (m, 6H); 1.11 (d, J=6.0 Hz, 3H); 0.86 (d, J=2.4 Hz, 3H); 0.85 (d, J=2.4 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.30-168.25 (m, 1C), 152.4, 136.8, 129.2 (2C), 129.0 (2C), 127.1, 125.1 (q, J=280.8 Hz), 82.6, 64.3, 52.3 (q, J=26.3 Hz), 39.1, 35.2, 34.8, 32.8, 28.8, 28.1, 24.5, 22.9, 22.7, 22.4, 16.6. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -62.35 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{23}H_{32}F_3NO_3Na$ [M+Na] 450.2232, found 450.20.

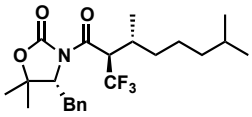


Table 3.4.3, entry 11. The title compound was prepared from oxazolidinone **3.42** (0.183 g, 0.500 mmol) following the standard trifluoromethylation procedure and was obtained as a colorless oil (0.113 g, 0.265 mmol, 53%, dr 10:1) after purification by column chromatography (silica, 35% dichloromethane – hexanes, 45% dichloromethane – hexanes, 20% ethyl acetate – hexanes). α_D^{22} -7.2° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz,

$CDCl_3$); δ(ppm): 7.33-7.27 (m, 4H); 7.26-7.21 (m, 1H); 4.95 (dq, J_d=J_q=8.4 Hz, 1H); 4.55 (dd, J1=9.6 Hz, J2=3.0 Hz, 1H); 3.16 (dd, J1=15.0 Hz, J2=3.0 Hz, 1H); 2.91 (dd, J1=15.0 Hz, J2=9.6 Hz, 1H); 2.32-2.24 (m, 1H); 1.62-1.48 (m, 2H); 1.38 (s, 3H); 1.36 (s, 3H); 1.34-1.20 (m, 3H); 1.20-1.12 (m, 2H); 1.02 (d, J=6.6 Hz, 3H); 0.87 (d, J=3.0 Hz, 3H); 0.86 (d, J=3.0 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.0 (q, J=3.5 Hz), 152.4, 136.8, 129.2 (2C), 129.0 (2C), 127.1, 125.1 (q, J=280.5 Hz), 82.3, 64.1, 51.4 (q, J=25.5 Hz), 39.1, 35.2, 33.8, 32.7, 28.8, 28.1, 24.2, 22.9, 22.7, 22.4, 17.1. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -62.73 (d, J=8.5 Hz, 3F). LRMS (ESI) calcd for $C_{23}H_{32}F_3NO_3Na$ [M+Na] 450.2232, found 450.24.

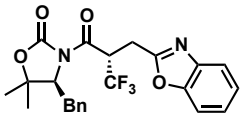


Table 3.4.3, entry 12. The title compound was prepared from oxazolidinone **3.44** (97.5 mg, 0.250 mmol) following the standard trifluoromethylation procedure (shorter reaction time: 4 h at 45 ˚C) with 0.20 equiv of $RuCl_2(PPh_3)_3$ (47.9 mg, 0.05 mmol) and was obtained as a colorless oil (37.5 mg, 0.084 mmol, 34%, dr 8.3:1) after purification by column chromatography (silica, 20% ethyl acetate – hexanes, 30% ethyl acetate – hexanes). Isomerically pure sample was obtained using HPLC by dissolving the mixture in 0.5% *i*-PrOH/hexanes with the concentration of 10 mg/ml. The separation was conducted on a YMC-Pack Sil HPLC column (250x30mmID, S-10 μm, 12 nm) with 4.5 mL injection (0.25% *i*-PrOH/hexanes as eluent at a rate of 20 mL/min, λ=215 nm, R_t=13.37 min) affording pure product**.** α_D^{23} 36.1° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.50-7.45 (m, 2H); 7.32-7.20 (m, 7H); 5.74-5.66 (m, 1H); 4.57 (dd, J1=9.0 Hz,

J2=5.4 Hz, 1H); 3.76 (dd, J1=17.4 Hz, J2=12.0 Hz, 1H); 3.31 (dd, J1=17.4 Hz, J2=3.0 Hz, 1H); 3.07 (dd, J1=14.4 Hz, J2=5.4 Hz, 1H); 2.99 (dd, J1=14.4 Hz, J2=9.0 Hz, 1H); 1.56 (s, 3H); 1.44 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 166.3 (m, 1C), 162.9, 152.6, 151.3, 141.0, 136.6, 129.3 (2C), 128.9 (2C), 127.1, 125.3, 124.6, 124.2 (q, J=279.8 Hz), 119.7, 110.8, 83.3, 64.2, 43.8 (q, J=28.1 Hz), 36.0, 28.6, 25.6 (q, J=2.9 Hz), 22.3. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -67.58 (d, J=7.9 Hz, 3F). LRMS (ESI) calcd for $C_{23}H_{21}F_3N_2O_4Na$ [M+Na] 469.1351, found 469.14.

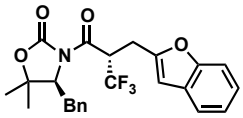
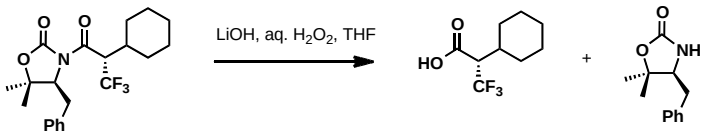


Table 3.4.3, entry 13. The title compound was prepared from oxazolidinone **3.45** (83.0 mg, 0.220 mmol), zirconium(IV) chloride (61.3 mg, 0.263 mmol), and $RuCl_2(PPh_3)_3$ (47.9 mg, 0.05 mmol) following the standard trifluoromethylation procedure (shorter reaction time: 4 h at 45 ˚C). The product was obtained as a colorless oil (48.0 mg, 0.108 mmol, 49%, dr 9.1:1) after purification by column chromatography (silica, 15% ethyl acetate – hexanes, 20% ethyl acetate – hexanes). α_D^{23} 104.9° (c 1.0, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.48-7.44 (m, 1H); 7.40-7.35 (m, 1H); 7.32-7.27 (m, 2H); 7.26-7.14 (m, 5H), 6.51 (s, 1H); 5.60-5.50 (m, 1H); 4.43 (dd, J1=9.6 Hz, J2=4.2 Hz, 1H); 3.55 (dd, J1=15.0 Hz, J2=11.4 Hz, 1H); 3.28 (dd, J1=15.0 Hz, J2=3.6 Hz, 1H); 3.09 (dd, J1=14.4 Hz, J2=4.2 Hz, 1H); 2.89 (dd, J1=14.4 Hz, J2=9.6 Hz, 1H), 1.31 (s, 3H); 0.97 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 166.4 (q, J=2.7 Hz), 155.0, 153.2, 152.1, 136.5, 129.2 (2C), 128.9 (2C), 128.4, 127.1, 124.4 (q, J=279.6 Hz), 124.3, 123.1, 120.9, 111.2, 104.7, 82.9, 64.2, 45.7 (q, J=26.9 Hz), 35.4, 27.9, 25.9-25.8 (m, 1C), 22.3. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -

67.57 (d, J=8.5 Hz, 3F). LRMS (ESI) calcd for $C_{24}H_{22}F_3NO_4Na$ [M+Na] 468.1399, found 468.10.

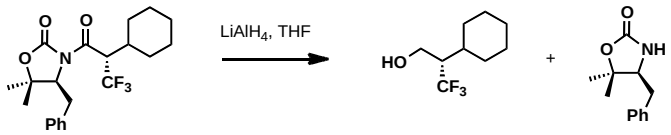


(*S*)-2-Cyclohexyl-3,3,3-trifluoropropanoic acid. Lithium hydroxide monohydrate (32 mg, 0.763 mmol) was added to a solution of the substrate (99.4 mg, 0.25 mmol), hydrogen peroxide (30%, 0.24 mL), and water (0.24 mL) in THF (1.00 mL) at 0 °C. The reaction was warmed to rt and stirred for 3 h, after which time H_2O (0.15 mL), H_2O_2 (0.15 mL), and $LiOH{\cdot}H_2O$ (30.0 mg) were added at rt and stirred for 3 h. The reaction was quenched with aqueous sodium sulfite (1.5 M) and HCl (1 M) and allowed to stir until two transparent layers were visible (pH ~4). The layers were separated and the aqueous layer was extracted with ethyl acetate (3x10 mL). The organic layer was then washed with brine, dried with sodium sulfate, and concentrated *in vacuo*. The crude material was then dissolved in ethyl acetate (5 mL) and extracted with aqueous sodium hydroxide (3 M, 3x5 mL) and water (2x5 mL). The aqueous extractions were combined and set aside. The organic layer was washed with HCl (1 M), brine, dried with sodium sulfate, and concentrated *in vacuo* to afford the oxazolidinone auxiliary (50.3 mg, 0.245 mmol, 98%). The previously saved aqueous layers were acidified with HCl (1 M). The aqueous layer was extracted with ethyl acetate (3x30 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated to afford the desired pure carboxylic acid (51.9 mg, 0.247 mmol, 99%). α_D^{21} 5.3° (c 1.0, dichloromethane). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 10.22-8.63 (bs, 1H); 2.98 (apparent pentet, J=8.5 Hz, 1H); 2.06-1.97 (m, 1H); 1.93-1.86 (m, 1H); 1.82-1.73 (m,

3H); 1.71-1.65 (m, 1H); 1.35-1.10 (m, 5H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 173.5 (m, 1C), 124.7 (q, J=279.8 Hz), 56.4 (q, J=25.8 Hz), 36.3, 31.0, 30.5, 26.1, 26.0, 25.9. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -64.28 (d, J=8.5 Hz, 3F). LRMS (-ESI) calcd for $C_9H_{12}F_3O_2$ [M-H] 209.09, found 209.08.

Determination of er for the acid: A solution of the (*S*)-2-cyclohexyl-3,3,3-trifluoropropanoic acid in diethyl ether (0.2 M) was added to a solution of lithium aluminum hydride (4.0 equiv.) in diethyl ether (0.5 M) at -78 °C and stirred for 15 min. The reaction mixture was warmed to rt over 1 h and then quenched using Feiser workup and allowed to stir for 2 h. The reaction mixture was filtered and concentrated *in vacuo*. No further purification was done.

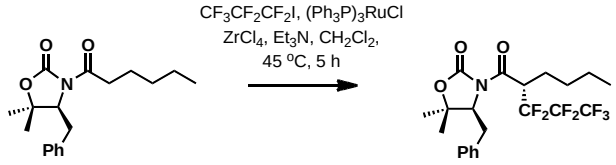
2-Naphthoyl chloride (2.0 equiv.) was added to a solution of the crude alcohol, triethylamine (2.0 equiv.), and 4-dimethylaminopyridine (0.1 equiv.) in dichloromethane (0.2 M) at 0 °C. After 10 min, the reaction was warmed to rt and stirred for 30 min. The mixture was quenched with aqueous ammonium chloride and the layers were separated. The aqueous layer was extracted with ethyl acetate (3x10 mL). The combined organic layers were washed with brine, dried with sodium sulfate, concentrated *in vacuo*, and purified by column chromatography (silica, 100% hexanes, 5% ethyl acetate – hexanes) to afford the desired naphthoyl ester derivative. HPLC analysis of the 2-naphthoyl ester derivative (OD-H, 2% Pr^iOH - hexanes, 1.0 mL/min, 254 nm) indicated er 97.2:2.8: R_T (major) = 6.8 minutes, R_T (minor) = 9.1 minutes.



(*S*)-2-Cyclohexyl-3,3,3-trifluoropropan-1-ol. A solution of the substrate (0.128 g, 0.322 mmol) in THF (1.10 mL total with rinses) was added to a solution of lithium aluminum hydride (22.1 mg, 0.582 mmol) in THF (0.58 mL) at -78 °C. After stirring 30 min, the reaction mixture was warmed to -50 °C and stirred an additional 30 min. The reaction mixture was quenched with water (23 μL) at -78 °C and stirred for 5 min. Then aqueous sodium hydroxide (3 M, 23 μL) was added at -78 °C and stirred for 5 min and warmed to rt. Then additional water (69 μL) was added and the reaction was stirred 2 h. The reaction mixture was filtered, concentrated *in vacuo*, and purified by column chromatography (silica, 15% EtOAc – Hexanes, 20% EtOAc – Hexanes, 40% EtOAc – Hexanes) to afford the desired alcohol (50.9 mg, 0.260 mmol, 81%) and the purified oxazolidinone (65.7 mg, 0.320 mmol, 99%). α_D^{21} -4.0° (c 1.0, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 3.89 (dd, J1=11.4 Hz, J2=5.4 Hz, 1H); 3.82 (dd, J1=11.4 Hz, J2=4.2 Hz, 1H); 2.17-2.09 (m, 1H); 1.82-1.71 (m, 5H); 1.69-1.65 (m, 1H); 1.59 (bs, 1H); 1.30-1.20 (m, 3H); 1.19-1.10 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 128.5 (q, J=280.8 Hz), 59.0 (q, J=3.9 Hz), 51.2 (q, J=21.6 Hz), 35.7, 31.2, 29.9, 26.9, 26.8, 26.3. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -65.04 (d, J=10.2 Hz, 3F). FI calcd for $C_9H_{15}F_3O$ [M] 196.11, found 196.11.

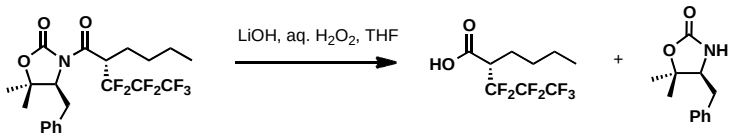
Determination of er for the alcohol: 2-Naphthoyl chloride (2.0 equiv.) was added to a solution of the crude alcohol substrate, triethylamine (2.0 equiv.), and 4-dimethylaminopyridine (0.1 equiv.) in dichloromethane (0.2 M) at 0 °C. After 10 min, the reaction was warmed to rt and stirred for 30 min. The reaction was quenched with aqueous

ammonium chloride and the layers were separated. The aqueous layer was extracted with ethyl acetate (3x10 mL). The combined organic layers were washed with brine, dried with sodium sulfate, concentrated *in vacuo*, and purified by column chromatography chromatography (silica, 100% hexanes, 5% ethyl acetate – hexanes) to afford the desired naphthoyl ester derivative. HPLC analysis of the 2-naphthoyl ester derivative (OD-H, 2% Pr^iOH - hexanes, 1.0 mL/min, 254 nm) indicated er 99.2:0.8: R_T (major) = 6.5 minutes, R_T (minor) = 8.7 minutes.



Perfluoropropylation product 3.19: The title compound was prepared from oxazolidinone **3.31** (0.740 g, 2.44 mmol), zirconium(IV) chloride (0.597 g, 2.56 mmol), and $RuCl_2(PPh_3)_3$ (0.468 g, 0.488 mmol) following the standard perfluoroalkylation procedure (shorter reaction time: 5 h at 45 ˚C). The product was obtained as a an oil (0.750 g, 1.59 mmol, 65%, dr >98:2) along with recovered starting material (0.154 g, 0.510 mmol, 21%) after purification by column chromatography (silica, 15% ethyl acetate – hexanes, 20% ethyl acetate – hexanes). α_D^{23} 9.2° (c 1.0, CH_2Cl_2). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33-7.29 (m, 4H); 7.25-7.21 (m, 1H), 5.24-5.15 (m, 1H); 4.58 (dd, J1=10.8 Hz, J2=3.0 Hz, 1H); 3.22 (dd, J1=14.4 Hz, J2=3.0 Hz, 1H); 2.84 (dd, J1=14.4 Hz, J2=10.8 Hz, 1H), 2.12-2.05 (m, 1H); 1.93-1.84 (m, 1H); 1.42-1.24 (m, 4H); 1.36 (s, 3H); 1.34 (s, 3H); 0.91 (dd, J=7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 168.2 (d, J=5.7 Hz), 152.3, 136.9, 129.1 (2C), 129.0 (2C), 127.1, 119.1-107.3 (m, 3C), 82.5, 64.5, 43.9 (m, 1C), 34.8, 28.9, 28.8, 26.0 (m, 1C), 22.6, 22.5, 13.9. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -80.55 (d, J=10.2

Hz, 3F); -113.99 (m, 2F); -127.70 (m, 2F). LRMS (ESI) calcd for $C_{24}H_{22}F_3NO_4Na$ [M+Na] 494.06, found 494.06.

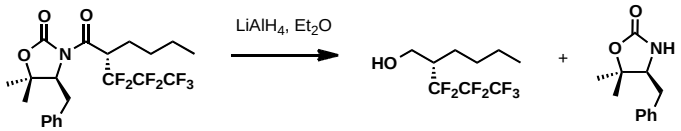


(*S*)-2-(Perfluoropropyl)hexanoic acid. Lithium hydroxide monohydrate (33.9 mg, 0.804 mmol) was added to a solution of the substrate (0.127 g, 0.269 mmol), hydrogen peroxide (30% in water, 0.40 mL), and water (0.40 mL) in THF (1.60 mL) at 0 °C and stirred for 10 min. The reaction was then warmed to rt and stirred for 3 h, after which additional H_2O (0.20 mL), H_2O_2 (0.20 mL), and $LiOH{\cdot}H_2O$ (30.0 mg) were added at rt and stirred for 2 h. The reaction was quenched with aqueous sodium sulfite (1.5 M) and HCl (1 M) and allowed to stir until two transparent layers were visible (pH ~4). The layers were separated and the aqueous layer was extracted with ethyl acetate (3x10 mL). The organic layer was then washed with brine, dried with sodium sulfate, and concentrated *in vacuo*. The crude material was then dissolved in ethyl acetate (5 mL) and extracted with aqueous sodium hydroxide (3 M, 3x5 mL) and water (2x5 mL). The aqueous extractions were combined and set aside. The organic layer was washed with HCl (1 M), brine, dried with sodium sulfate, and concentrated *in vacuo* to afford the oxazolidinone auxiliary (54.1 mg, 0.263 mmol, 98%). The previously saved aqueous layers were acidified with HCl (1 M). The aqueous layer was extracted with ethyl acetate (3x30 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated *in vacuo* to afford the desired carboxylic acid (65.4 mg, 0.230 mmol, 86%). α_D^{21} 9.5° (c 1.0, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 10.48 (bs, 1H); 3.22-2.13 (m, 1H); 2.01-1.93 (m, 1H); 1.92-1.84 (m, 1H);

1.45-1.32 (m, 4H); 0.93 (dd, J1=J2=6.6 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 174.0 (d, J=8.0 Hz), 121.0-107.2 (m, 3C), 48.1 (t, J=20.7 Hz), 29.1, 25.0, 22.4, 13.8. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -80.59 (dd, J=11.3 Hz, 3F), -115.52 (m, 2F), -125.45 (m, 2F). FI calcd for $C_9H_{11}F_7O_2$ [M] 284.06, found 284.06.

Determination of er for the acid: A solution of the substrate in diethyl ether (0.2 M) was added to a solution of lithium aluminum hydride (4.0 equiv.) in diethyl ether (0.5 M) at -78 °C and stirred for 15 min. The reaction was warmed to rt over 1 h then the reaction was quenched using Feiser workup and allowed to stir for 2 h. The reaction mixture was filtered and concentrated *in vacuo*. No further purification was done.

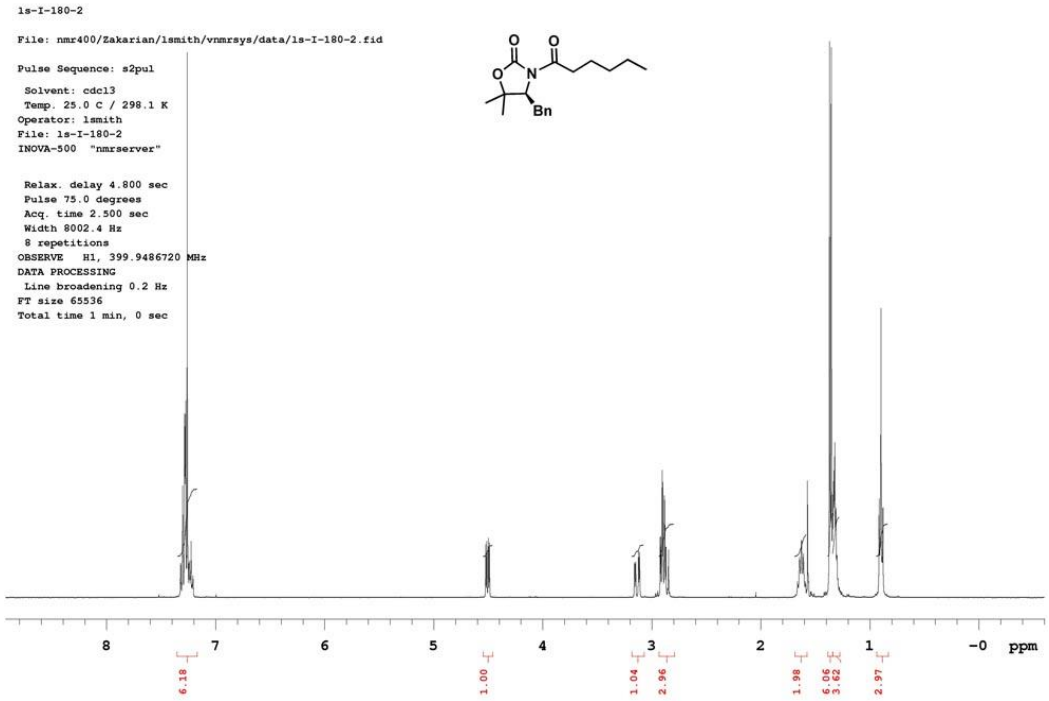
2-Naphthoyl chloride (2.0 equiv.) was added to a solution of the crude alcohol substrate, triethylamine (2.0 equiv.), and 4-dimethylaminopyridine (0.1 equiv.) in dichloromethane (0.2 M) at 0 °C. After 10 min, the reaction was warmed to rt and stirred for 30 min. The reaction was quenched with aqueous ammonium chloride and the layers were separated. The aqueous layer was extracted with ethyl acetate (3x10 mL). The combined organic layers were washed with brine, dried with sodium sulfate, concentrated *in vacuo*, and purified by column chromatography (silica, 100% hexanes, 5% ethyl acetate – hexanes) to afford the desired naphthoyl ester derivative. HPLC analysis of the 2-naphthoyl ester derivative (OD-H, 0.5% Pr^iOH - hexanes, 1.0 mL/min, 254 nm) indicated er 98.1:1.9: R_T (major) = 7.6 minutes, R_T (minor) = 11.2 minutes.



(*S*)-2-(Perfluoropropyl)hexan-1-ol. A solution of the substrate (0.150 g, 0.318 mmol) in diethyl ether (1.60 mL total with rinses) was added to a solution of lithium aluminum hydride (24.3 mg, 0.640 mmol) in Et_2O (1.28 mL) at -78 °C and stirred for 30 min. Feiser workup: The reaction was quenched with water (24 μL) at -78 °C and stirred for 5 min. Then aqueous sodium hydroxide (3 M, 24 μL) was added at -78 °C and stirred for 5 min and warmed to rt. Then additional water (72 μL) was added and the reaction was stirred 2h. The reaction mixture was filtered, concentrated *in vacuo*, and purified by column chromatography (silica, 15% Et_2O – Pentane, 25% Et_2O – Pentane, 50% Et_2O – Pentane) to afford a mixture of the alcohol and allylic alcohol (76.9 mg, 0.286 mmol, 90%, containing 6% allylic alcohol) and the purified auxiliary (65.0 mg, 0.317 mmol, 99%). α_D^{21} 3.8° (c 1.0, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 3.93-3.84 (m, 2H); 2.34-2.24 (m, 1H); 1.74-1.67 (m, 1H); 1.67-1.57 (m, 2H); 1.52-1.45 (m, 1H); 1.40-1.31 (m, 3H); 0.93 (dd, J=7.2 Hz, 3H); ^{13}C NMR (150 MHz, $CDCl_3$); δ(ppm): 121.2-107.7 (m, 3C), 59.2 (dd, J=5.9 Hz), 43.9 (dd, J=18.5 Hz), 29.4, 23.8-23.7 (m), 22.8, 14.0. ^{19}F NMR (564.3 MHz, $CDCl_3$); δ(ppm): -80.76 (m, 3F), -114.74 (m, 2F), -125.36 (m, 2F). FI calcd for $C_9H_{14}F_7O$ [M+H] 271.09, found 271.10.

Determination of er for the alcohol: 2-Naphthoyl chloride (2.0 equiv.) was added to a solution of the crude alcohol substrate, triethylamine (2.0 equiv.), and 4-dimethylaminopyridine 0.1 equiv.) in dichloromethane (0.2 M) at 0 °C. After 10 min, the reaction was warmed to rt and stirred for 30 min. The reaction was quenched with aqueous

ammonium chloride and the layers were separated. The aqueous layer was extracted with ethyl acetate (3x10 mL). The combined organic layers were washed with brine, dried with sodium sulfate, concentrated *in vacuo*, and purified by column chromatography chromatography (silica, 100% hexanes, 5% ethyl acetate – hexanes) to afford the desired naphthoyl ester derivative. HPLC analysis of the 2-naphthoyl ester derivative (OD-H, 0.5% $Pr^{i}OH$ - hexanes, 1.0 mL/min, 254 nm) indicated er 96.6:3.4: R_T (major) = 7.5 minutes, R_T (minor) = 11.0 minutes.


ls-I-180-2
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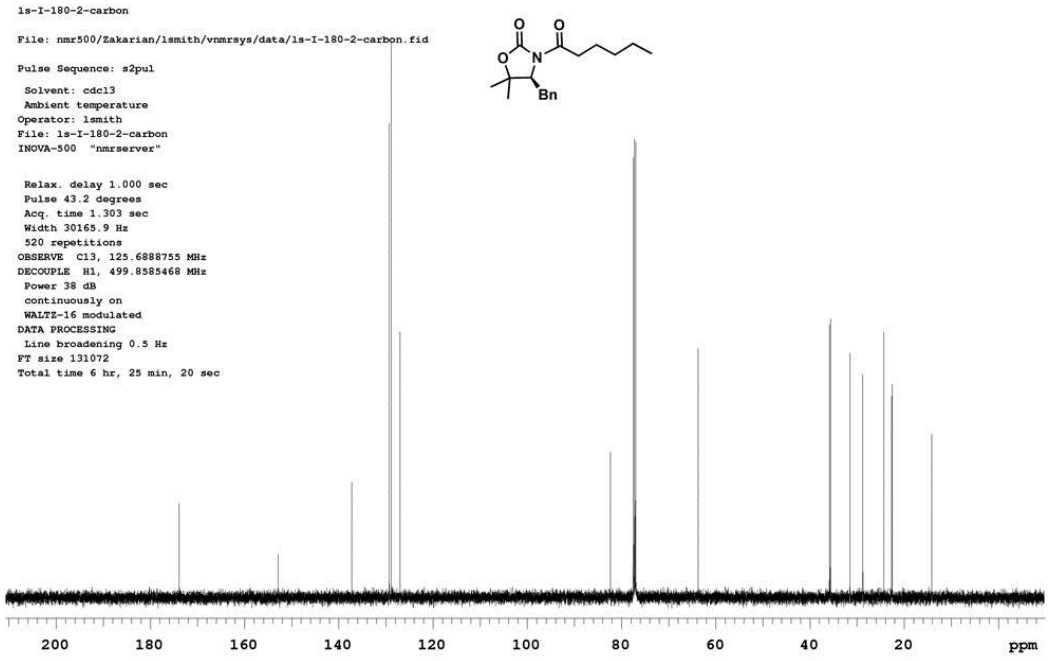
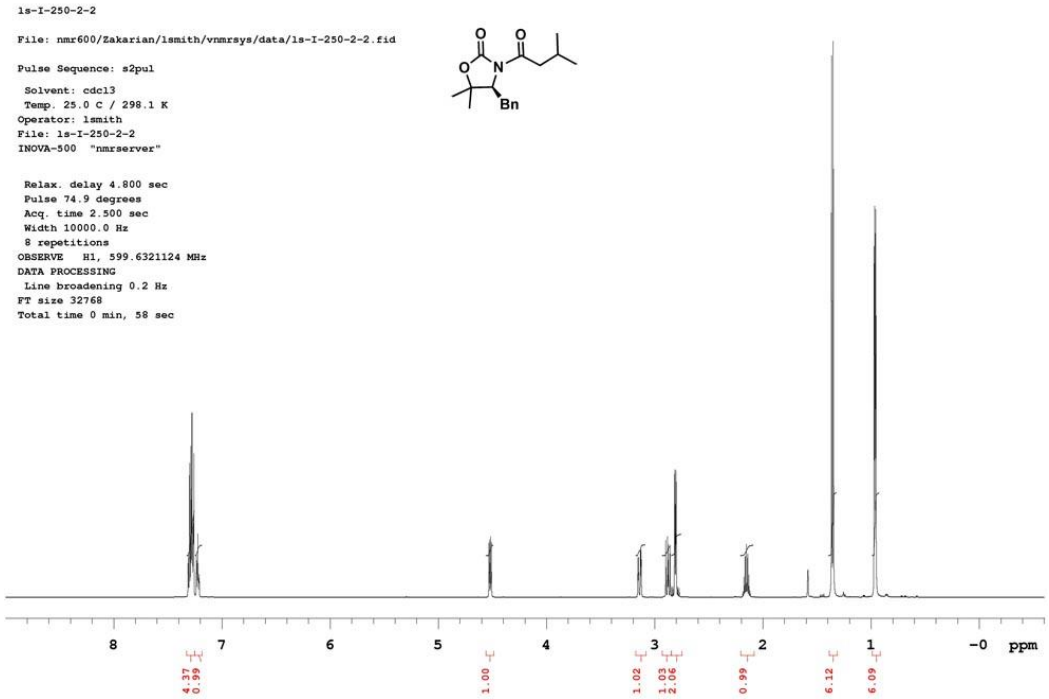
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-180-2
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8002.4 Hz
8 repetitions
OBSERVE H1, 399.9486720 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 65536
Total time 1 min, 0 sec
Bn
8
7
6
5
4
3
2
1
-0
ppm
6.18
1.00
1.04
2.96
1.98
6.06
3.62
2.97


ls-I-180-2-carbon
File: nmr500/Zakarian/lsmith/vnmrsys/data/ls-I-180-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: lsmith
File: ls-I-180-2-carbon
INOVA-500 "nmrserver"
Relax. delay 1.000 sec
Pulse 43.2 degrees
Acq. time 1.303 sec
Width 30165.9 Hz
520 repetitions
OBSERVE C13, 125.6888755 MHz
DECOUPLE H1, 499.8585468 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 20 sec
Bn
200
180
160
140
120
100
80
60
40
20
ppm


ls-I-250-2-2
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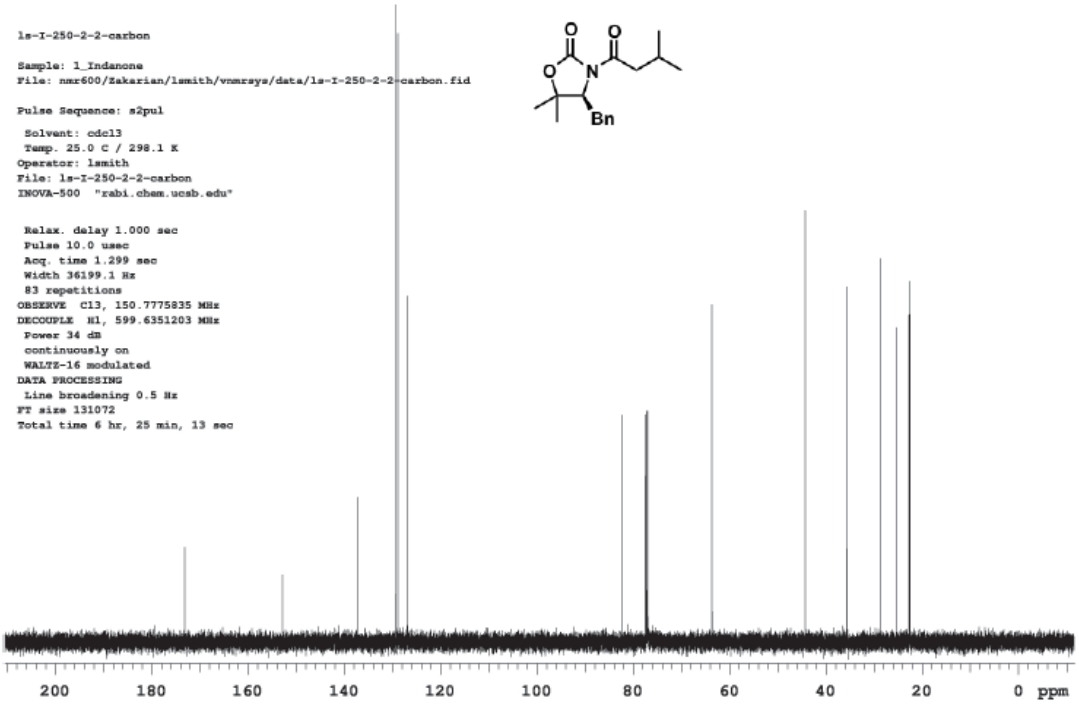
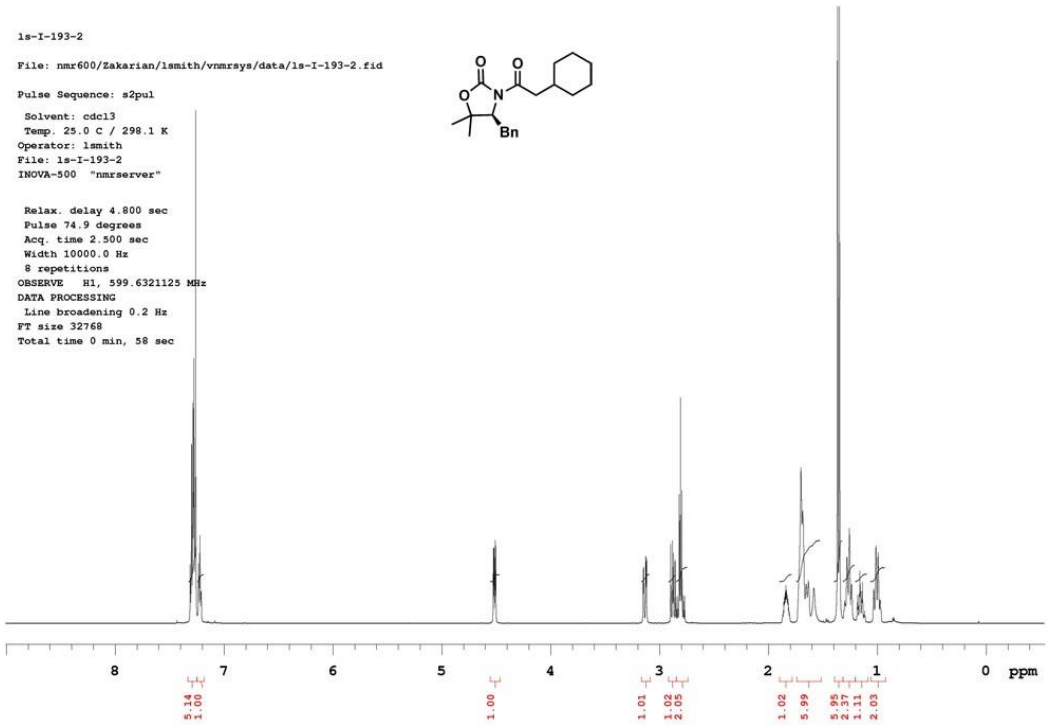
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-250-2-2
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321124 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
Bn
8
7
6
5
4
3
2
1
-0
ppm
4.37
0.99
1.00
1.02
1.03
2.06
0.99
6.12
6.09


ls-I-250-2-2-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-250-2-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-250-2-2-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
83 repetitions
OBSERVE C13, 150.7775835 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Bn
200
180
160
140
120
100
80
60
40
20
0
ppm


ls-I-193-2
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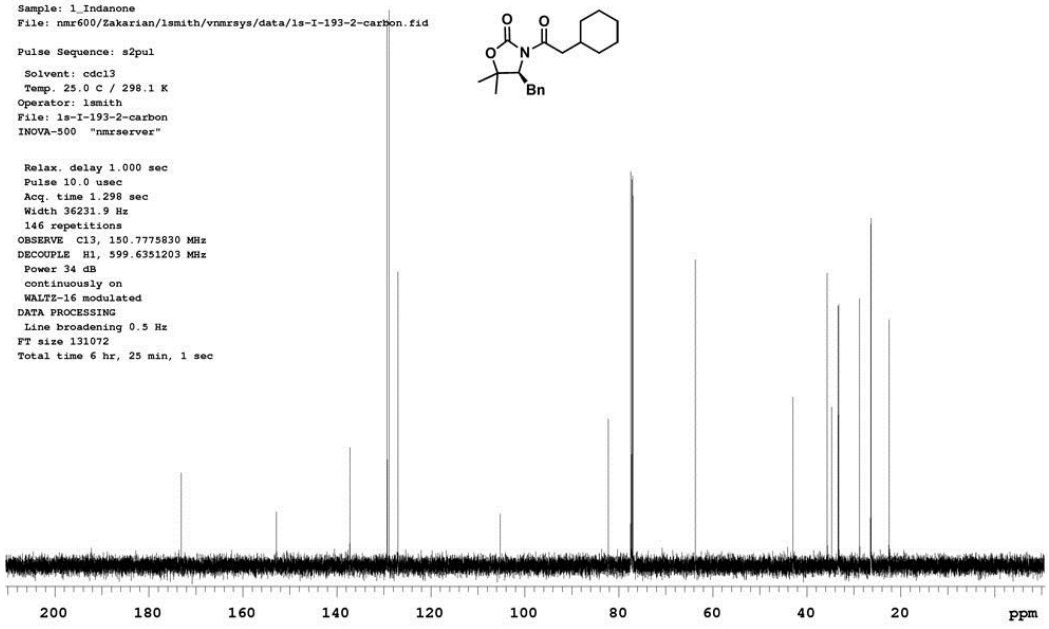
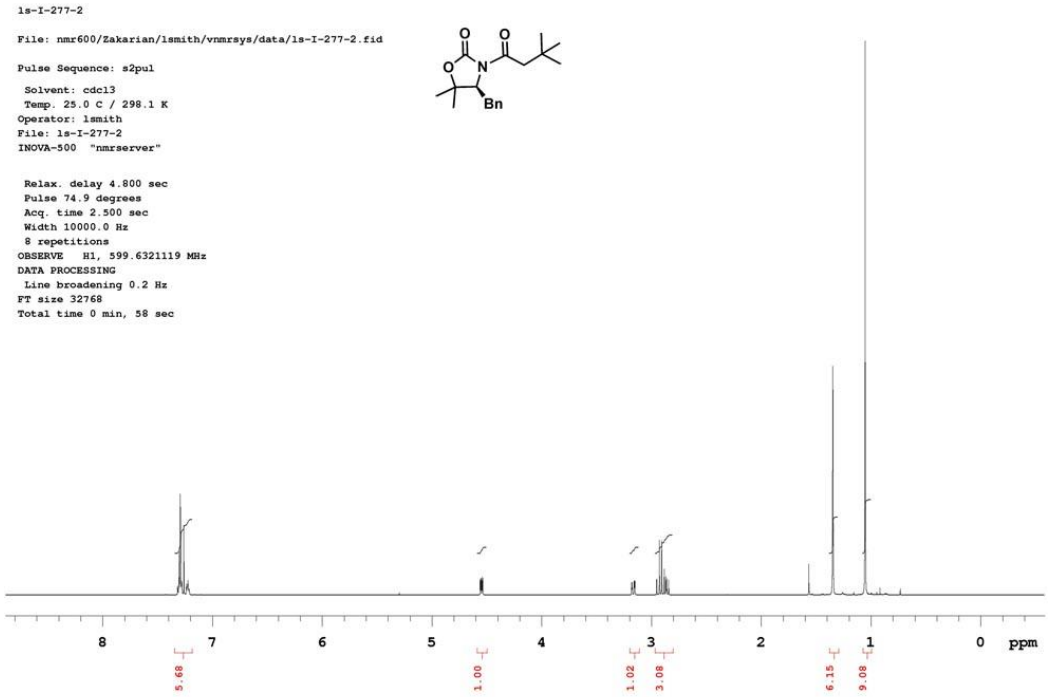
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-193-2
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321125 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
Bn
8
7
6
5
4
3
2
1
0
ppm
5.14
1.00
1.00
1.01
1.02
2.05
1.02
5.99
5.95
2.37
1.11
2.03


ls-I-193-2-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-193-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-193-2-carbon
INOVA-500 "nmrserver"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.298 sec
Width 36231.9 Hz
146 repetitions
OBSERVE C13, 150.7775830 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 1 sec
Bn
200
180
160
140
120
100
80
60
40
20
ppm


ls-I-277-2
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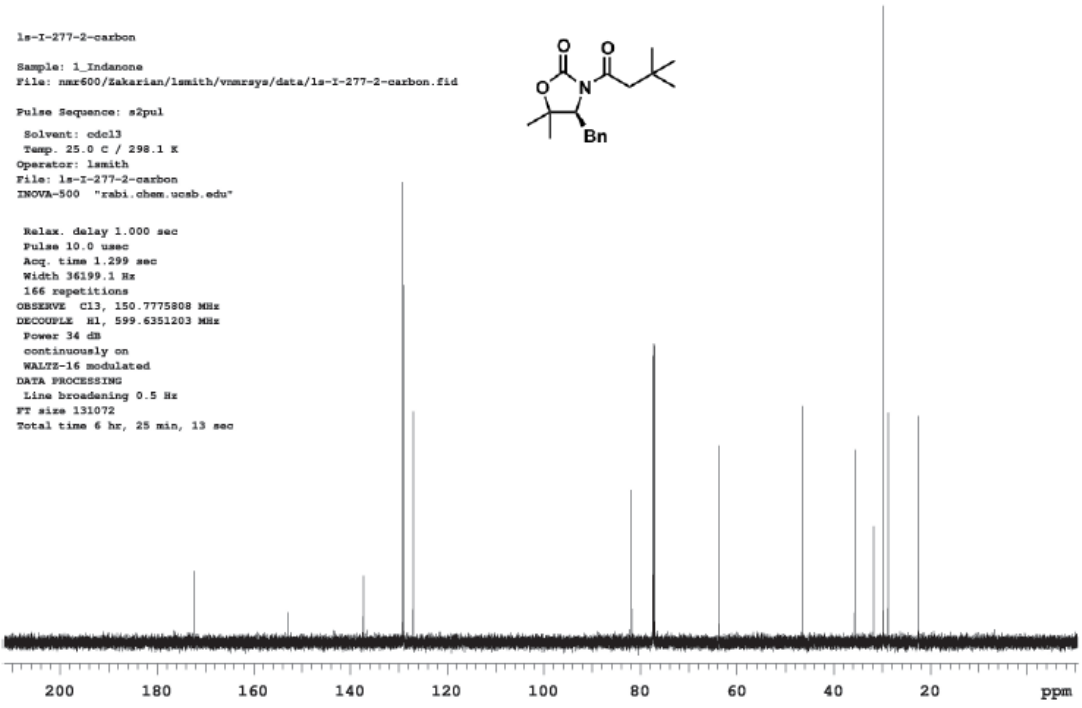
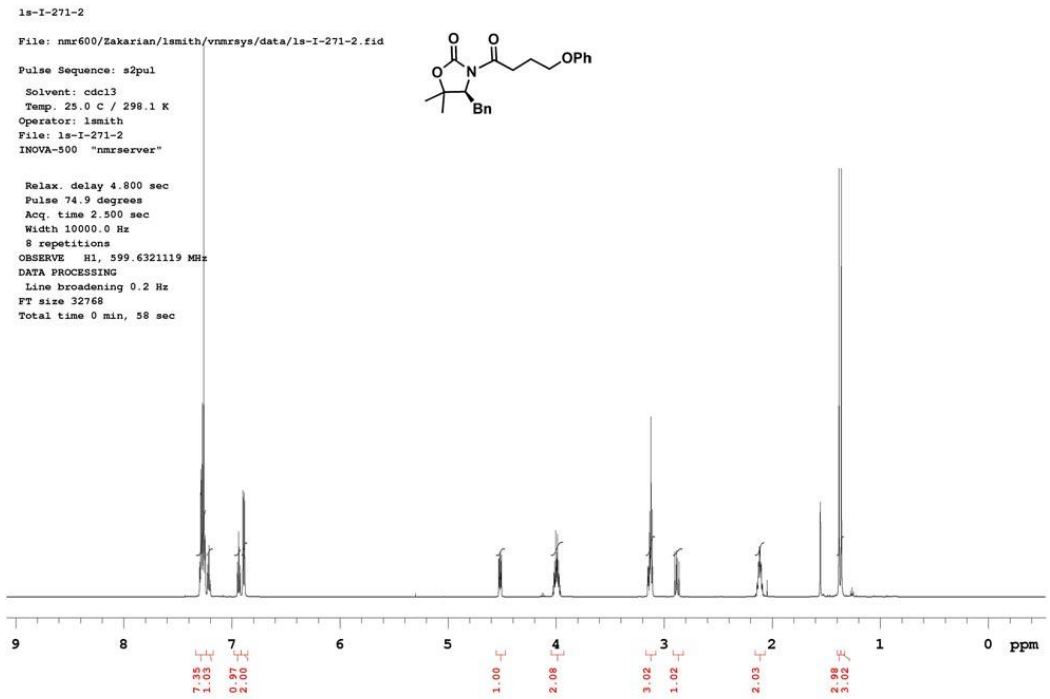
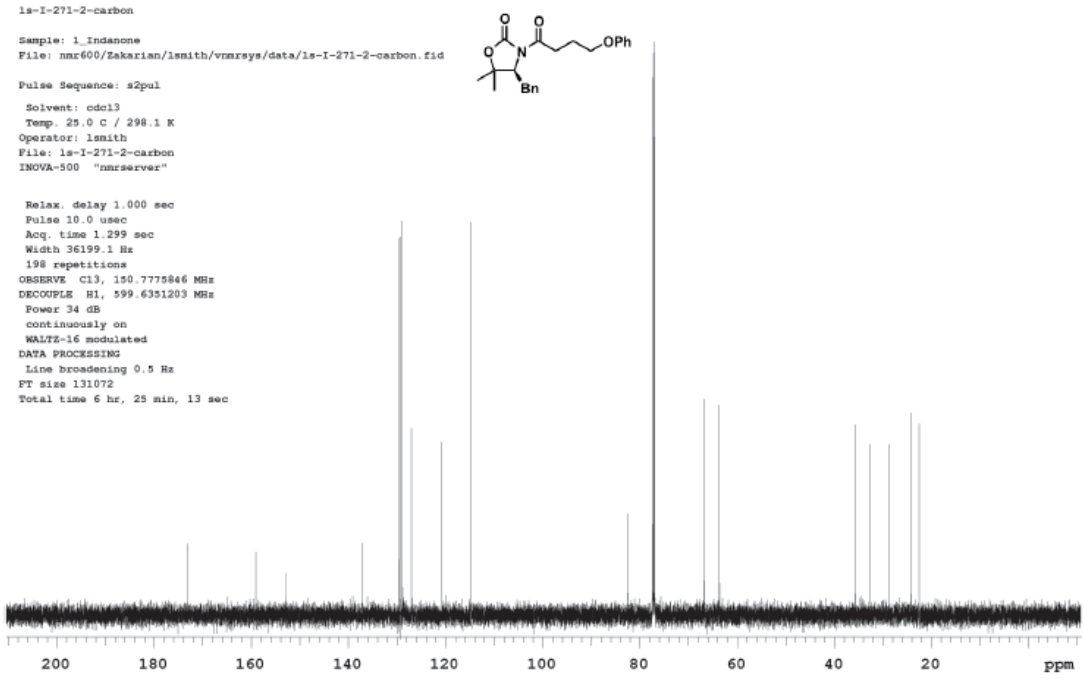
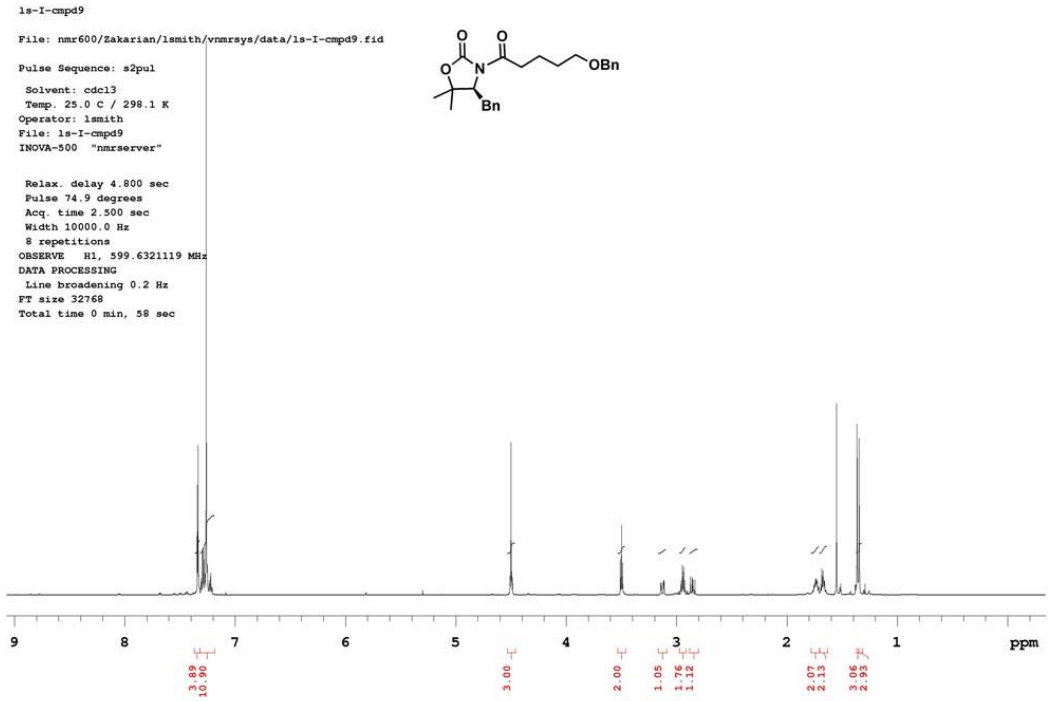
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-277-2
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321119 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
Bn
8
7
6
5
4
3
2
1
0
ppm
5.68
1.00
1.02
3.08
6.15
9.08


ls-I-277-2-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-277-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-277-2-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
166 repetitions
OBSERVE C13, 150.7775808 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Bn
200
180
160
140
120
100
80
60
40
20
ppm


ls-I-271-2
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-271-2.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-271-2
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321119 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
OPh
Bn
9
8
7
6
5
4
3
2
1
0
ppm
7.35
1.03
0.97
2.00
1.00
2.08
3.02
1.02
2.03
2.98
3.02


ls-I-271-2-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-271-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-271-2-carbon
INOVA-500 "nmrserver"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
198 repetitions
OBSERVE C13, 150.7775846 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
OPh
Bn
200
180
160
140
120
100
80
60
40
20
ppm


ls-I-cmpd9
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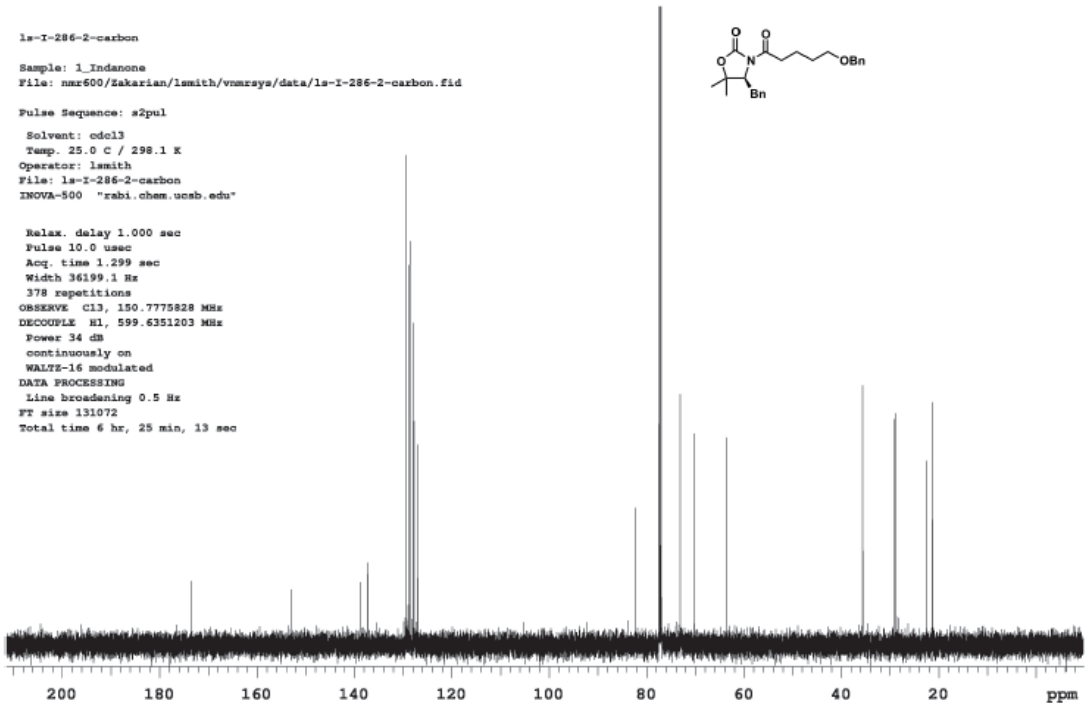
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-cmpd9
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321119 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
OBn
Bn
9
8
7
6
5
4
3
2
1
ppm
3.89
10.90
3.00
2.00
1.05
1.78
1.12
2.07
2.13
3.06
2.93


ls-I-286-2-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-286-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-286-2-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
378 repetitions
OBSERVE C13, 150.7775828 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
OBn
Bn
200
180
160
140
120
100
80
60
40
20
ppm

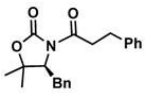
ls-I-295-2

File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-265-2.fid

Pulse Sequence: s2pul

Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-265-2
INOVA-500 "nmrserver"

Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321234 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec



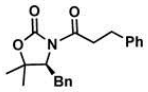
ls-I-265-2-carbon

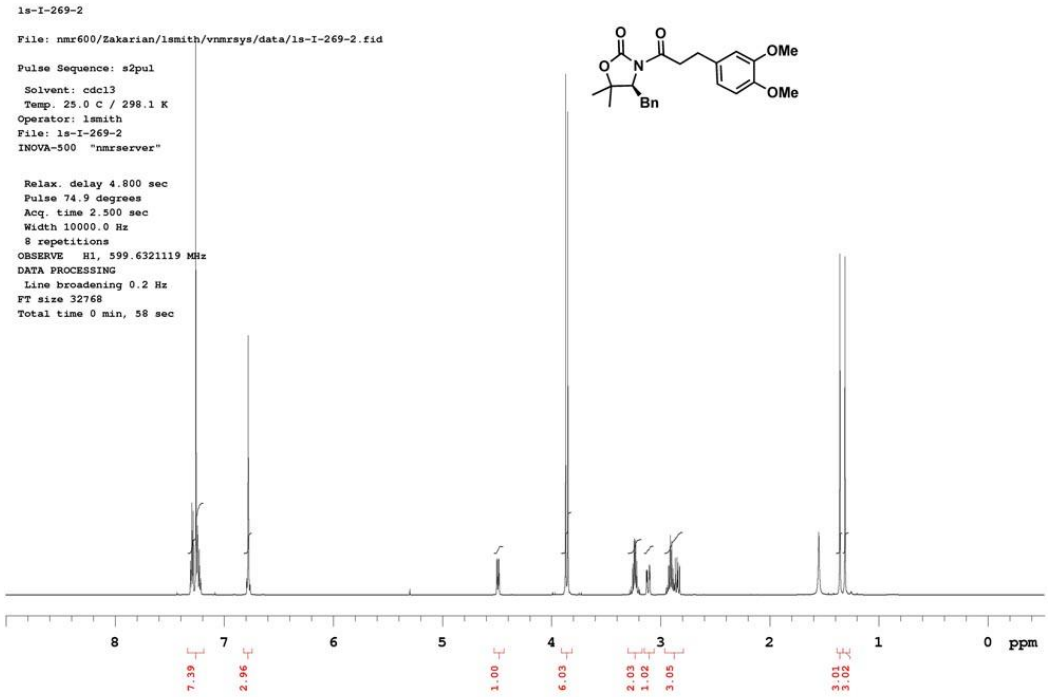
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-265-2-carbon.fid

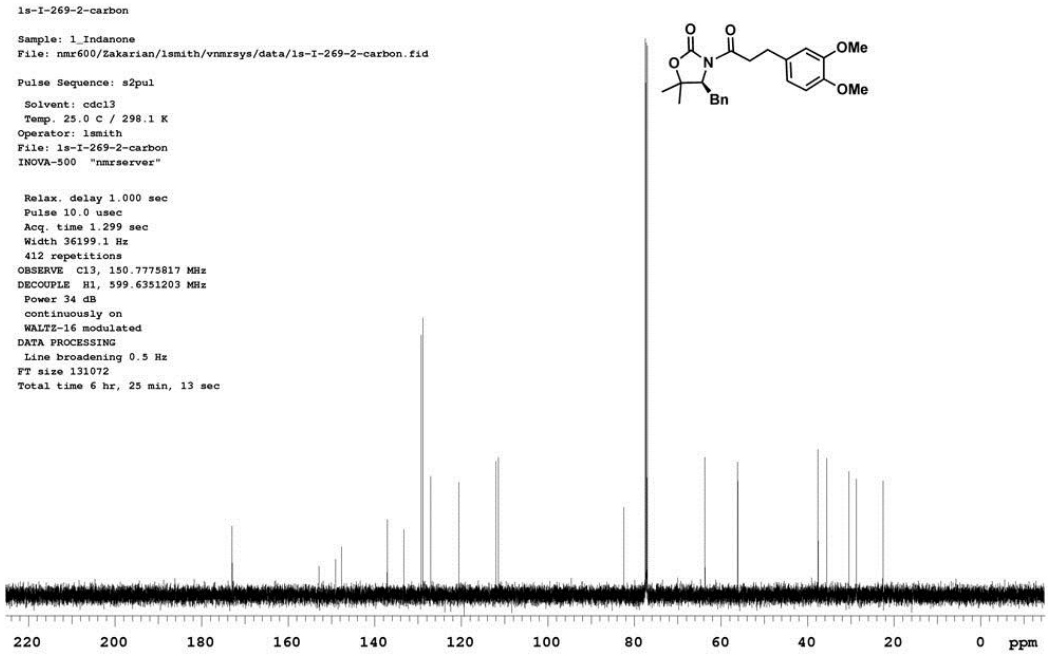
Pulse Sequence: s2pul

Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-265-2-carbon
INOVA-500 "nmrserver"

Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
47 repetitions
OBSERVE C13, 150.7775901 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec




ls-I-269-2
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-269-2.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-269-2
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321119 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
OMe
OMe
Bn
8
7
6
5
4
3
2
1
0
ppm
7.39
2.96
1.00
6.03
2.03
1.02
3.05
3.01
3.02


ls-I-269-2-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-269-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-269-2-carbon
INOVA-500 "nmrserver"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
412 repetitions
OBSERVE C13, 150.7775817 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
OMe
OMe
Bn
220
200
180
160
140
120
100
80
60
40
20
0
ppm

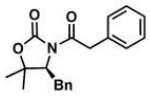
ls-I-188-2-2

File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-188-2-2.fid

Pulse Sequence: s2pul

Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-188-2-2
INOVA-500 "nmrserver"

Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321460 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec



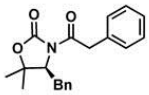
ls-I-188-2-carbon

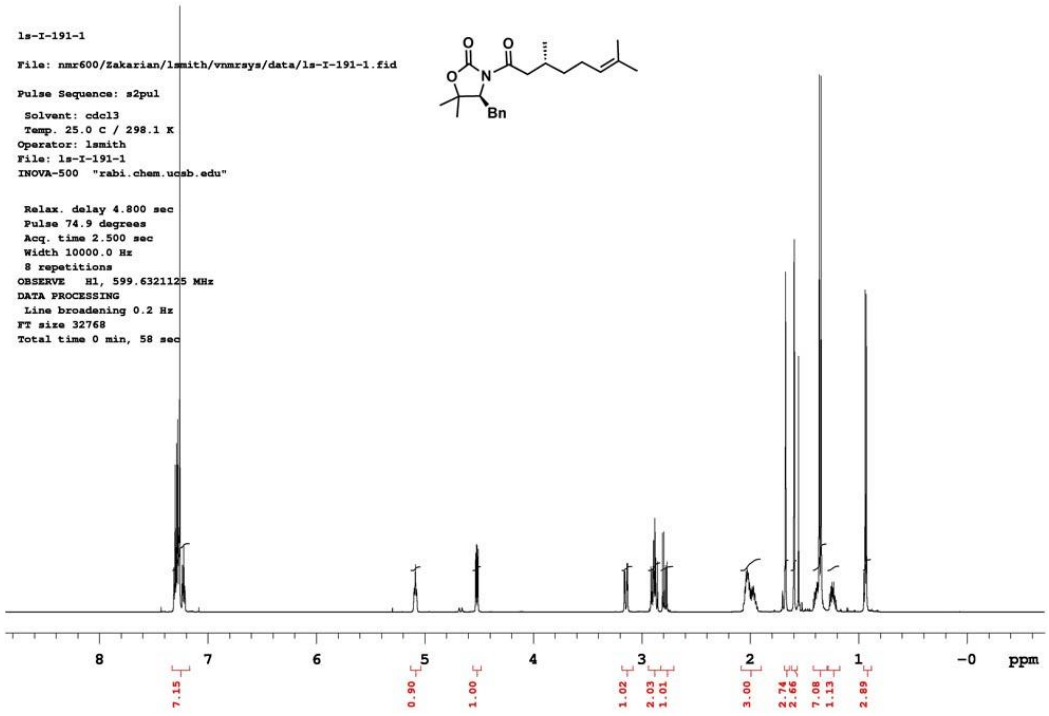
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-188-2-carbon.fid

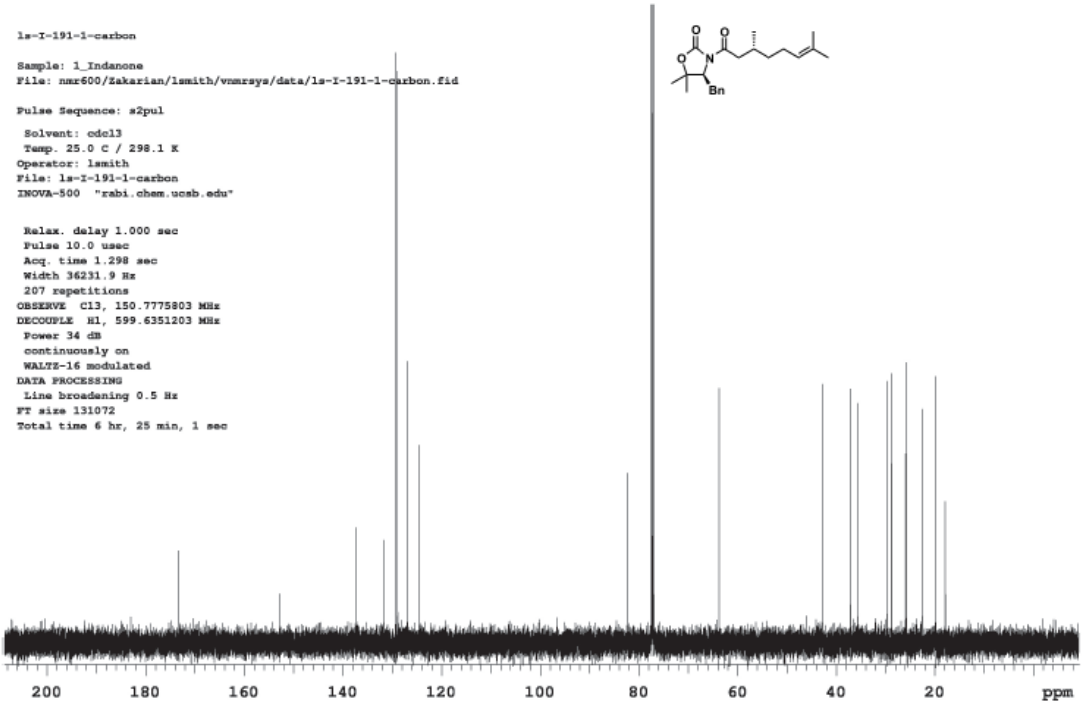
Pulse Sequence: s2pul

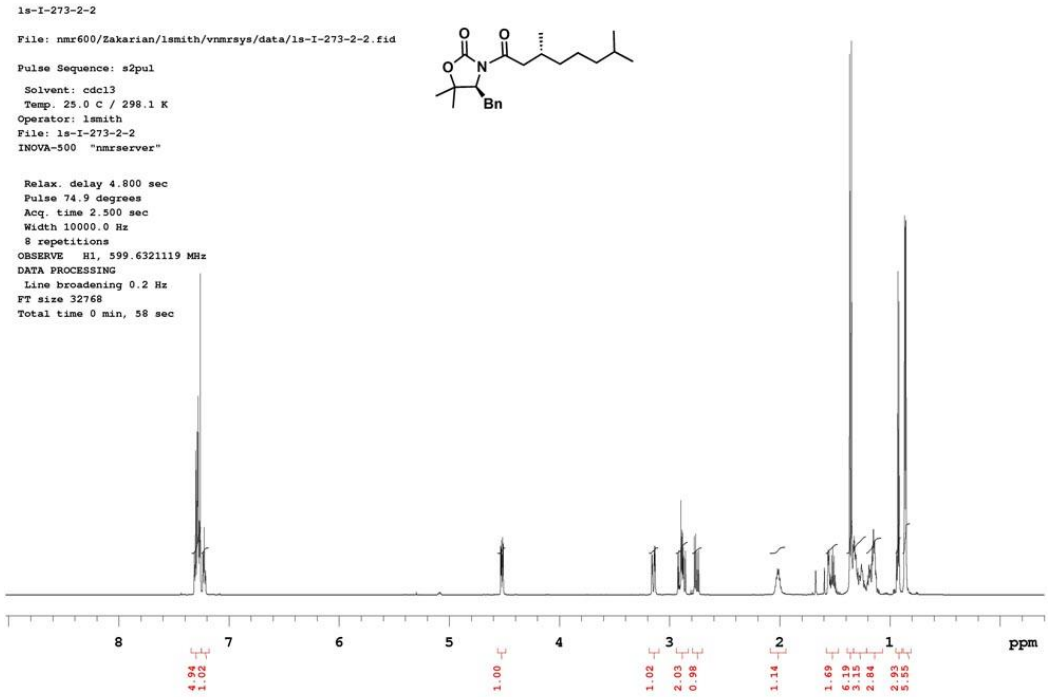
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-188-2-carbon
INOVA-500 "nmrserver"

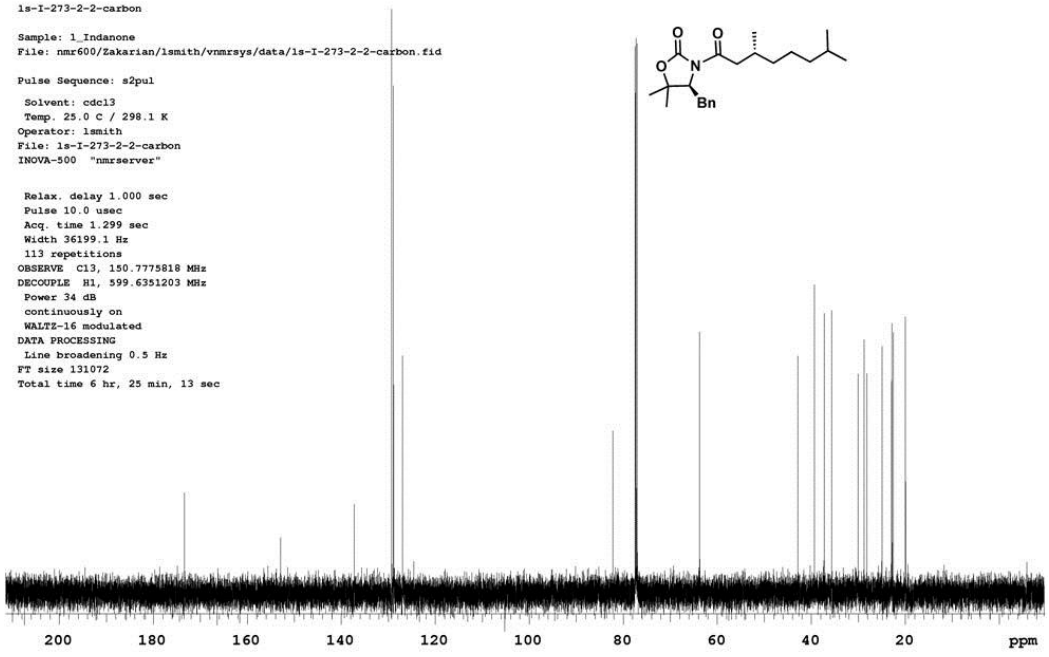
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.298 sec
Width 36231.9 Hz
762 repetitions
OBSERVE C13, 150.7775824 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 1 sec

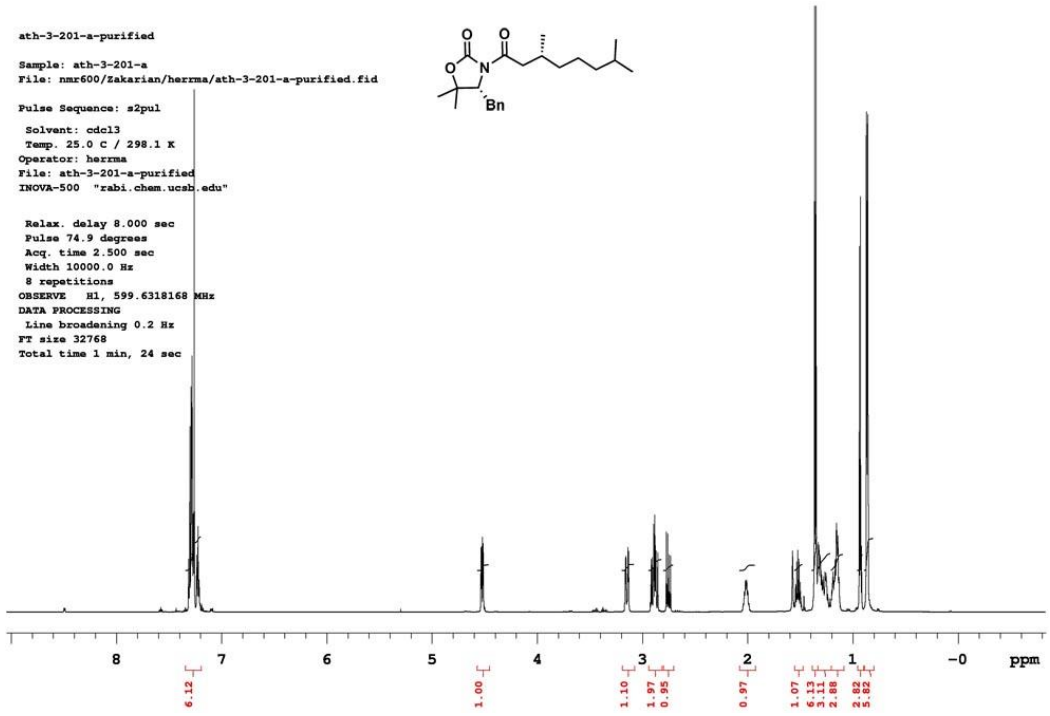


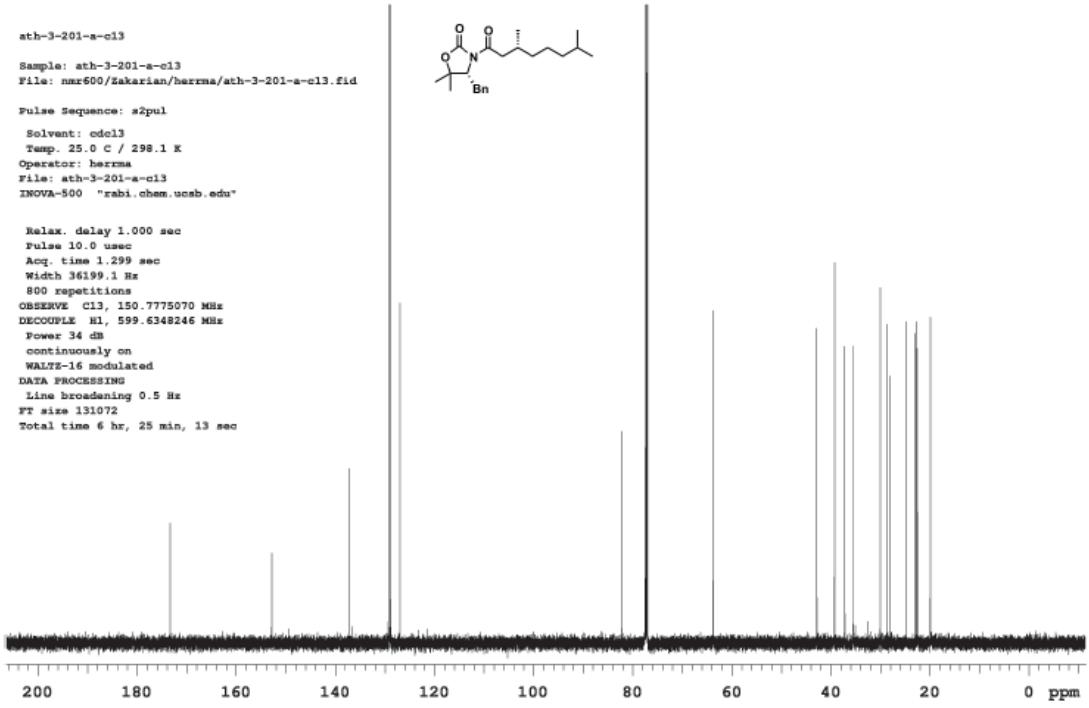

ls-I-191-1
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-191-1.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-191-1
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321125 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
Bn
8
7
6
5
4
3
2
1
−0
ppm
7.15
0.90
1.00
1.02
2.03
1.01
3.00
2.74
2.66
7.08
1.13
2.89

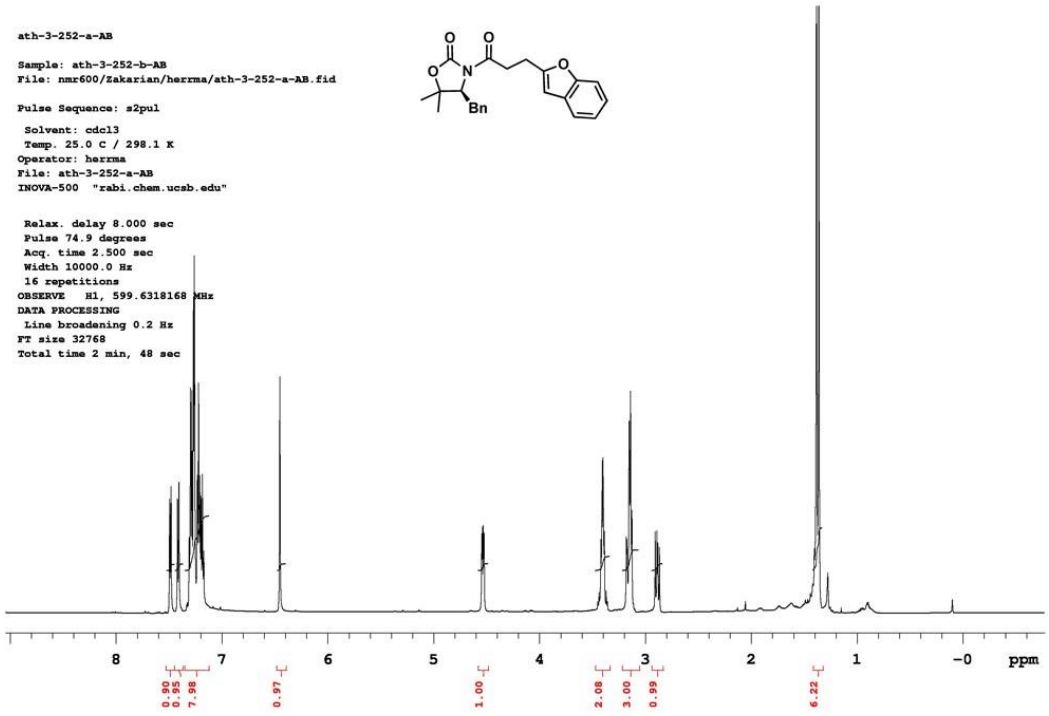

ls-I-191-1-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-191-1-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-191-1-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.298 sec
Width 36231.9 Hz
207 repetitions
OBSERVE C13, 150.7775803 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 1 sec
Bn
200
180
160
140
120
100
80
60
40
20
ppm

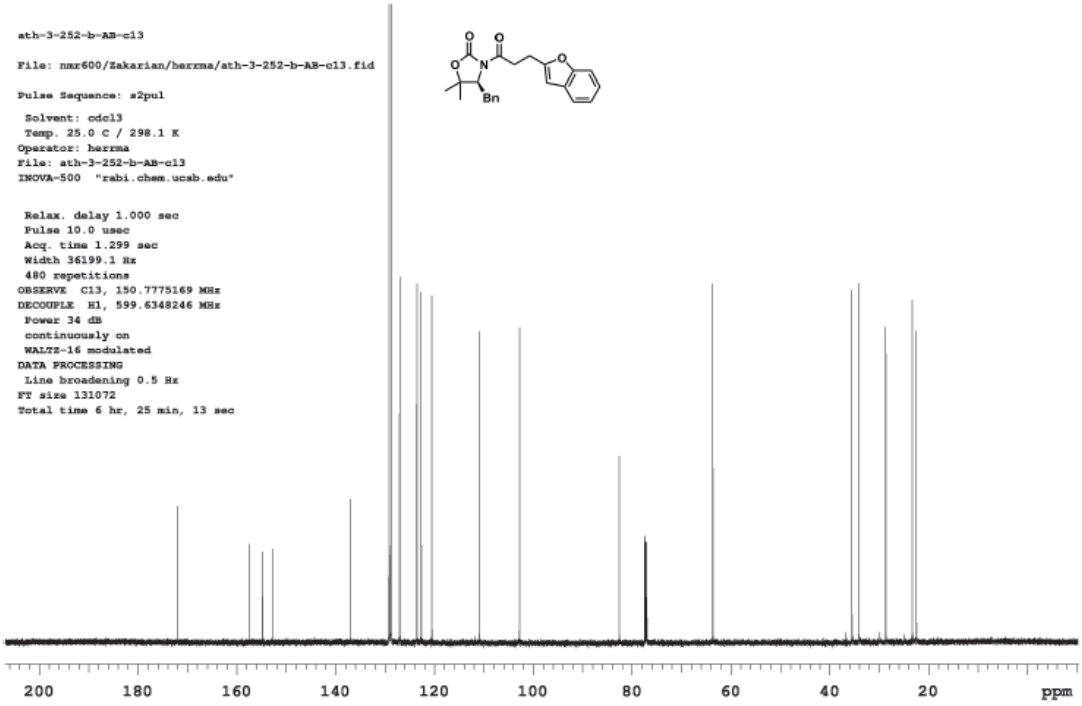

ls-I-273-2-2
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-273-2-2.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-273-2-2
INOVA-500 "nmrserver"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321119 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
Bn
8
7
6
5
4
3
2
1
ppm
4.94
1.02
1.00
1.02
2.03
0.98
1.14
1.69
6.19
3.13
2.84
2.93
5.55

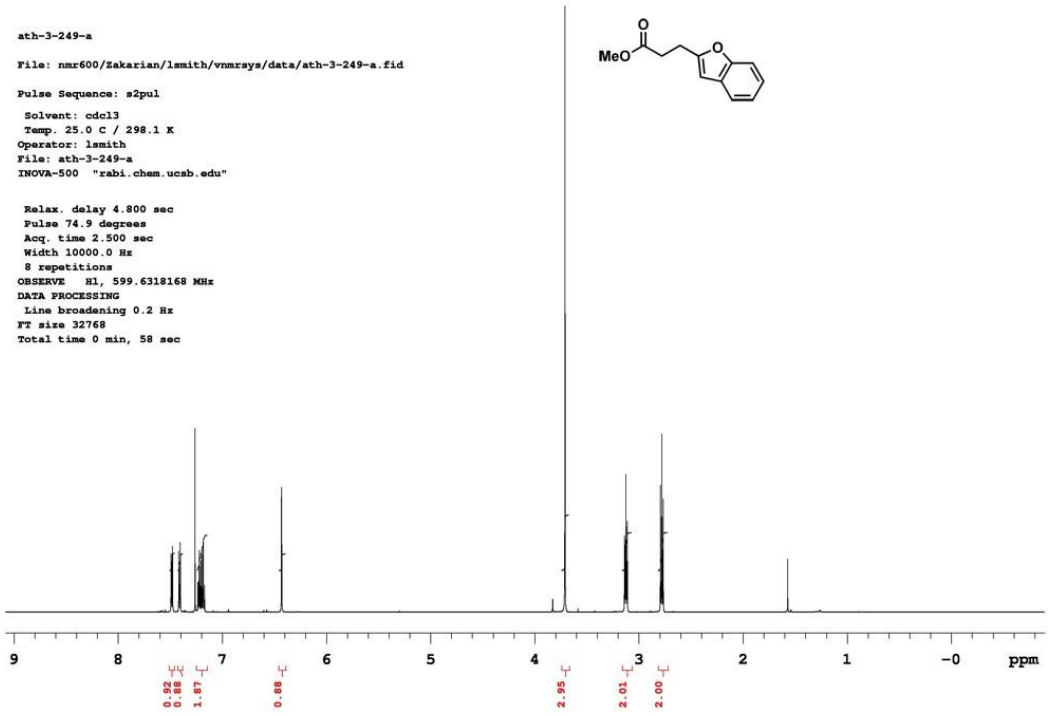

ls-I-273-2-2-carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-I-273-2-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-I-273-2-2-carbon
INOVA-500 "nmrserver"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
113 repetitions
OBSERVE C13, 150.7775818 MHz
DECOUPLE H1, 599.6351203 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Bn
200
180
160
140
120
100
80
60
40
20
ppm

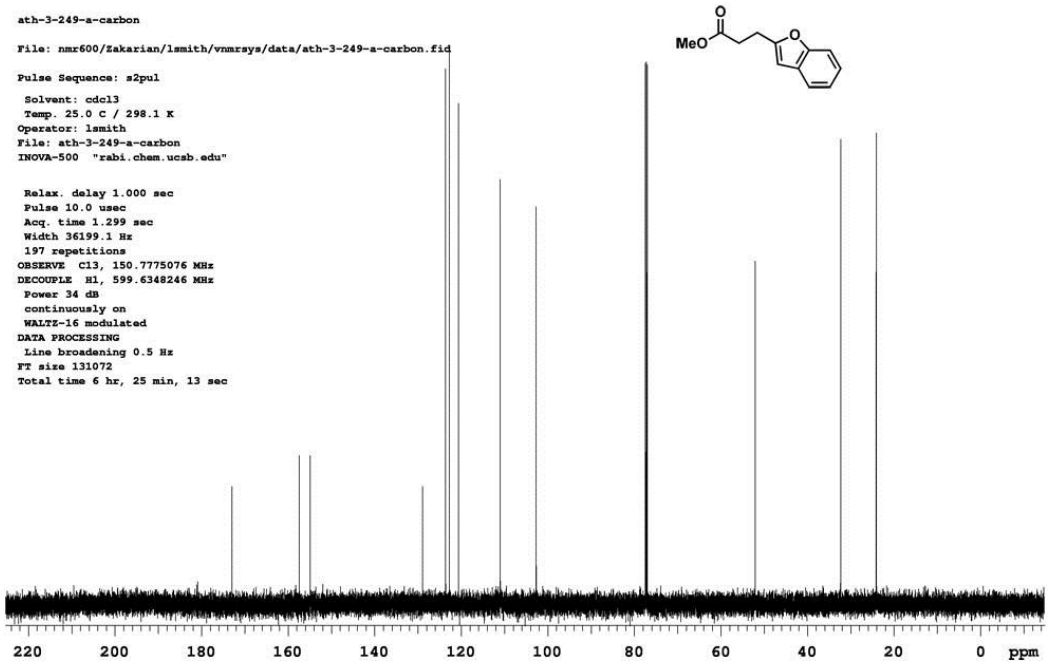

ath-3-201-a-purified
Sample: ath-3-201-a
File: nmr600/Zakarian/herrma/ath-3-201-a-purified.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
File: ath-3-201-a-purified
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 8.000 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 24 sec
Bn
8
7
6
5
4
3
2
1
−0
ppm
6.12
1.00
1.10
1.97
0.95
0.97
1.07
6.13
3.11
2.88
2.82
5.82

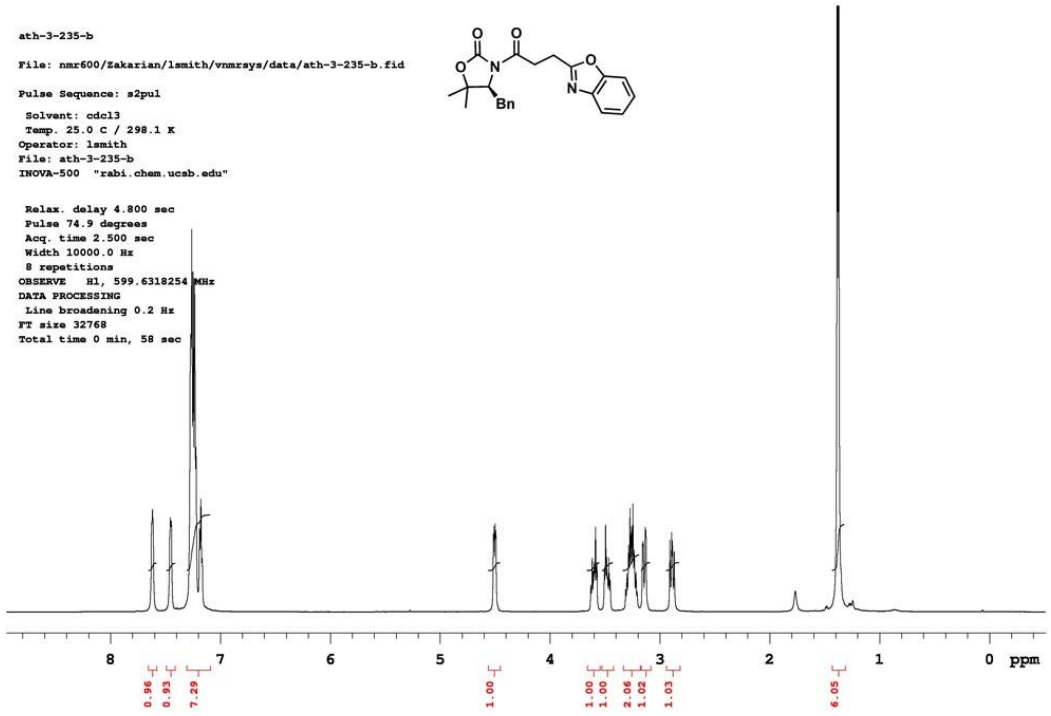

ath-3-201-a-c13
Sample: ath-3-201-a-c13
File: nmr600/Zakarian/herrma/ath-3-201-a-c13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
File: ath-3-201-a-c13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
800 repetitions
OBSERVE C13, 150.7775070 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Bn
200
180
160
140
120
100
80
60
40
20
0 ppm

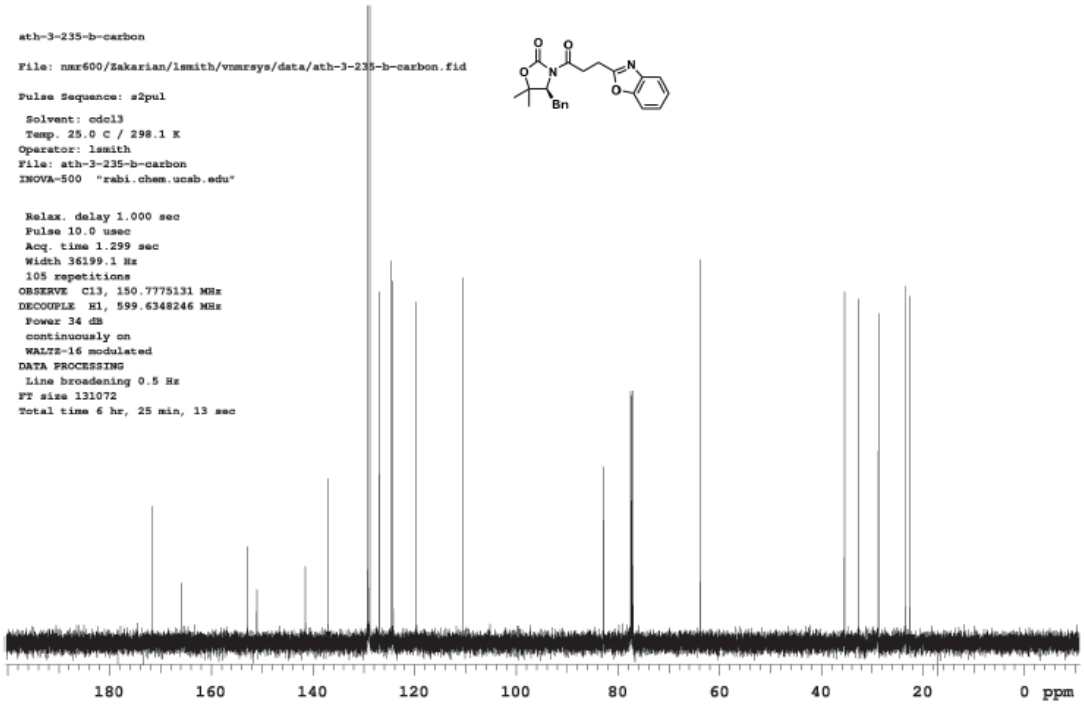

ath-3-252-a-AB
Sample: ath-3-252-b-AB
File: nmr600/Zakarian/herrma/ath-3-252-a-AB.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
File: ath-3-252-a-AB
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 8.000 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
16 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 2 min, 48 sec
Bn
8
7
6
5
4
3
2
1
−0
ppm
0.90
0.95
7.98
0.97
1.00
2.08
3.00
0.99
6.22

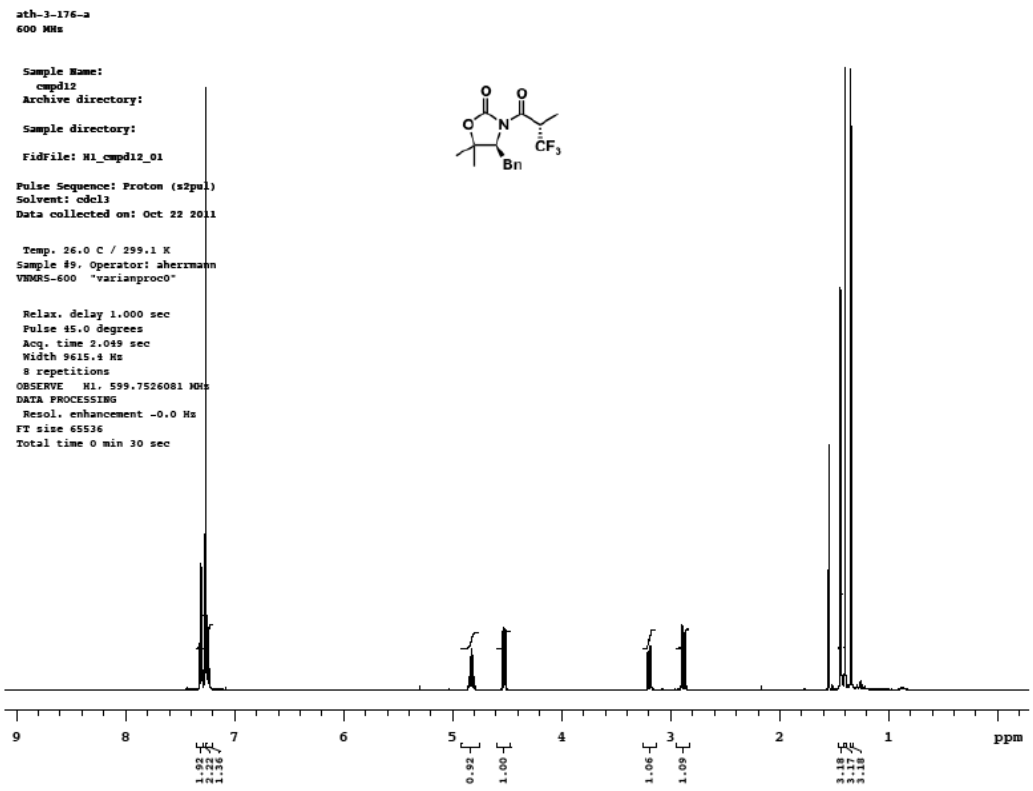

ath-3-252-b-AB-c13
File: nmr600/Zakarian/herrma/ath-3-252-b-AB-c13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
File: ath-3-252-b-AB-c13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
480 repetitions
OBSERVE C13, 150.7775169 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Bn
200
180
160
140
120
100
80
60
40
20
ppm

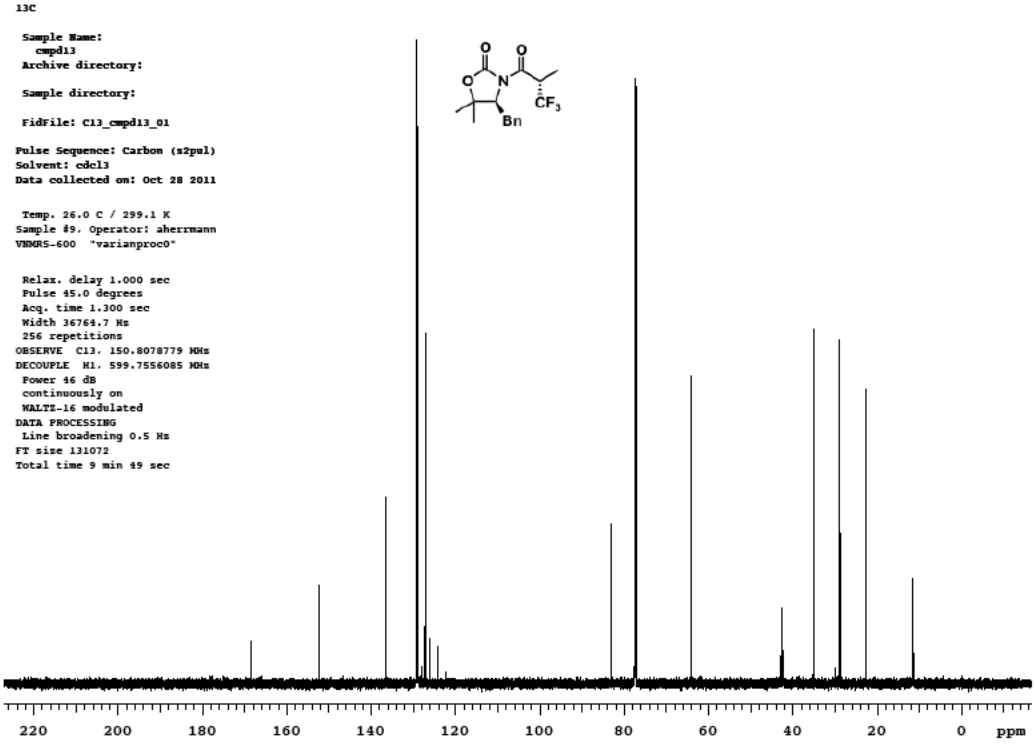

ath-3-249-a
File: nmr600/Zakarian/lsmith/vnmrsys/data/ath-3-249-a.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ath-3-249-a
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
MeO
O
O
9
8
7
6
5
4
3
2
1
−0
ppm
0.92
0.88
1.87
0.88
2.95
2.01
2.00

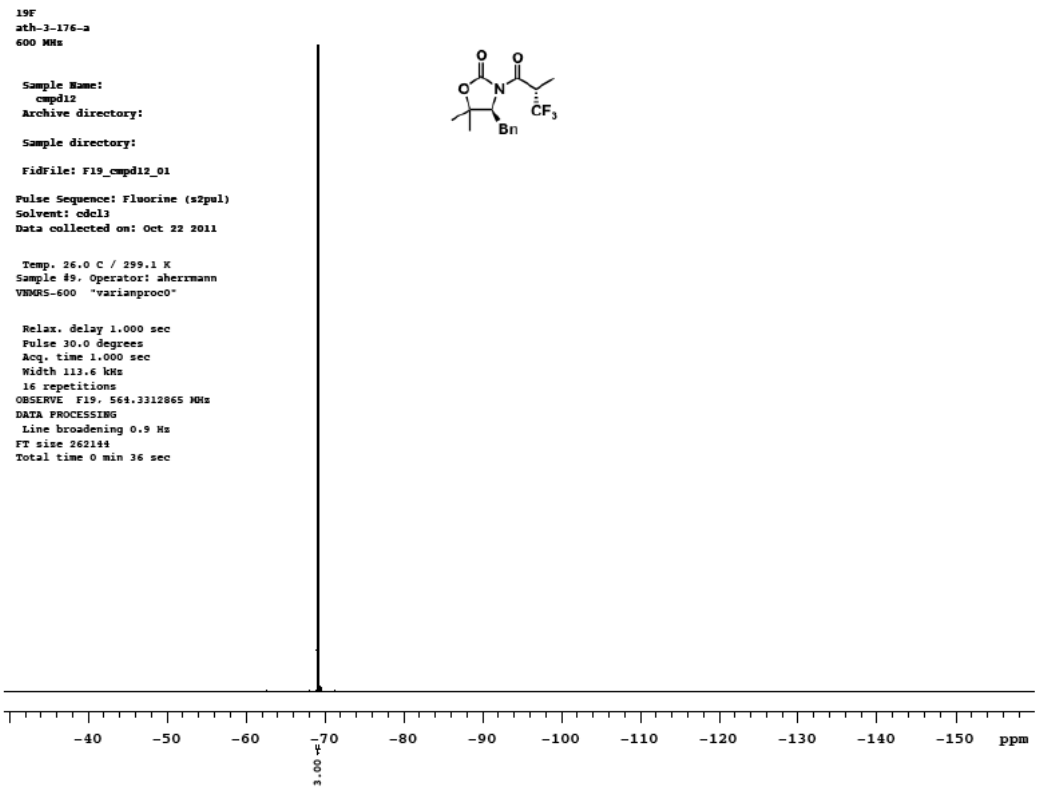

ath-3-249-a-carbon
File: nmr600/Zakarian/lsmith/vnmrsys/data/ath-3-249-a-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ath-3-249-a-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
197 repetitions
OBSERVE C13, 150.7775076 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
MeO
O
O
220
200
180
160
140
120
100
80
60
40
20
0
ppm

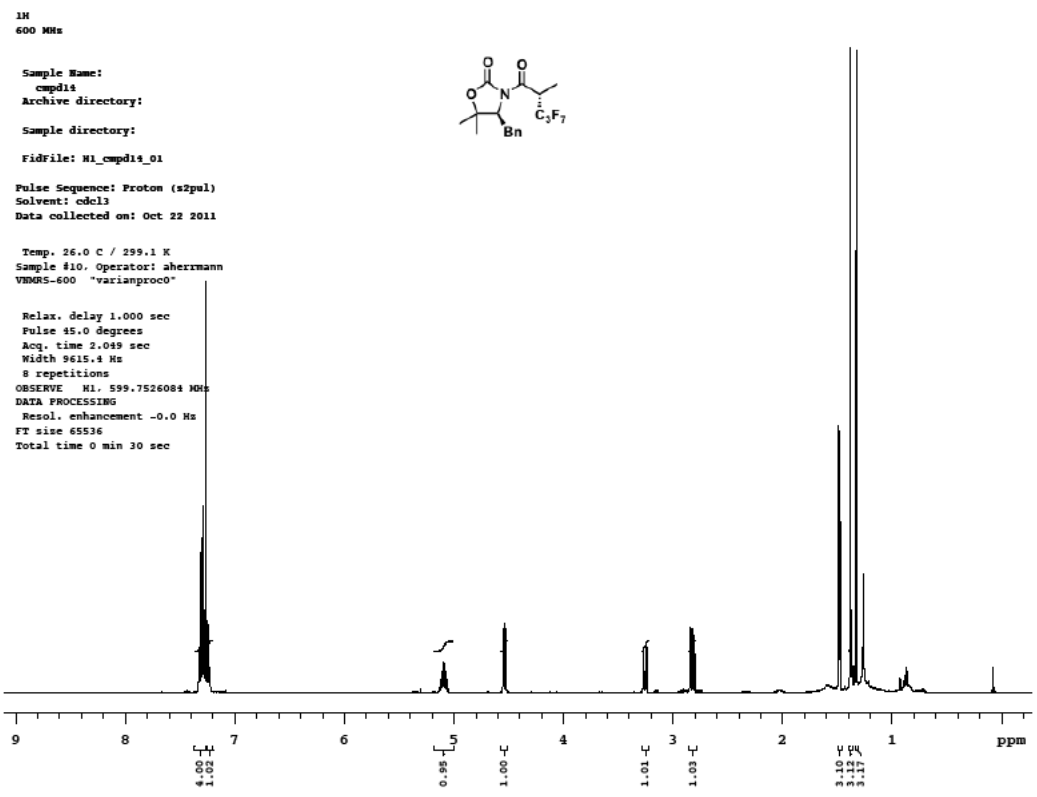

ath-3-235-b
File: nmr600/Zakarian/lsmith/vnmrsys/data/ath-3-235-b.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ath-3-235-b
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318254 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
Bn
8
7
6
5
4
3
2
1
0 ppm
0.96
0.93
7.29
1.00
1.00
1.00
2.06
1.02
1.03
6.05

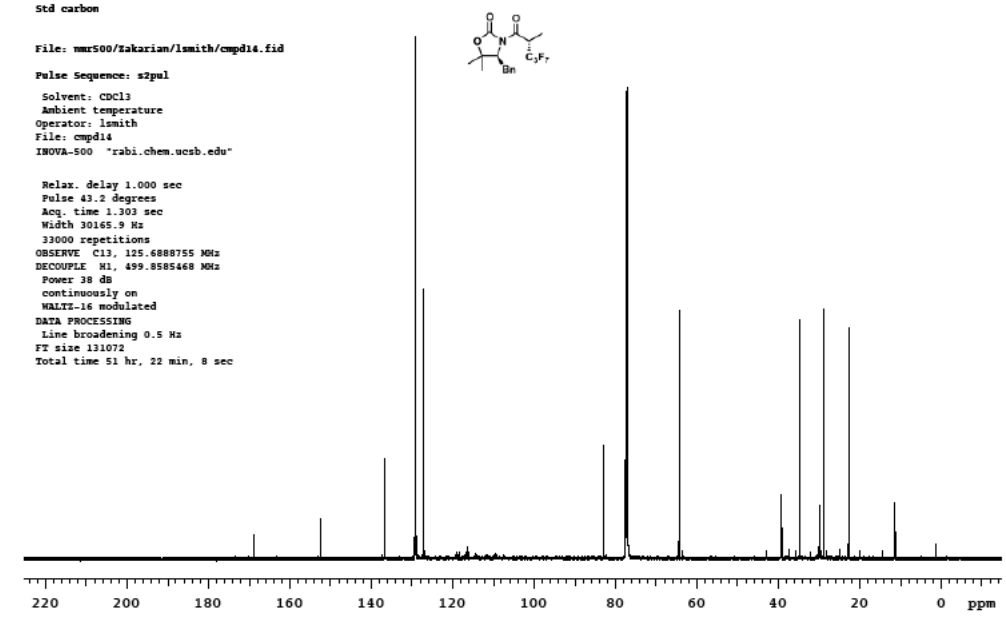

ath-3-235-b-carbon
File: nmr600/Zakarian/lsmith/vnmrsys/data/ath-3-235-b-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ath-3-235-b-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
105 repetitions
OBSERVE C13, 150.7775131 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Bn
180
160
140
120
100
80
60
40
20
0 ppm

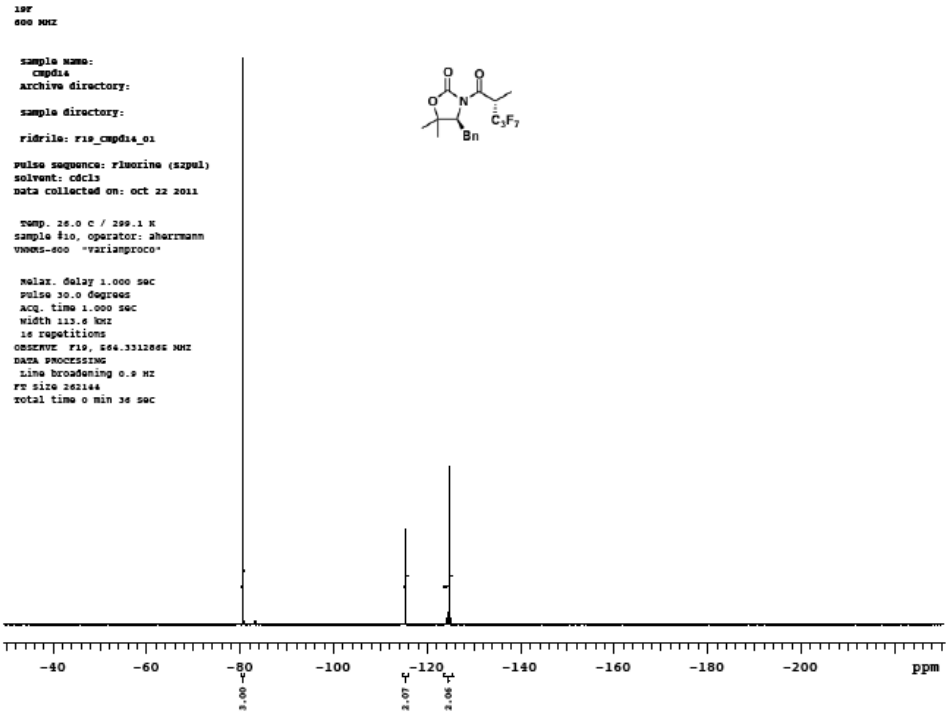

ath-3-176-a
600 MHz
Sample Name:
cmpd12
Archive directory:
Sample directory:
FidFile: H1_cmpd12_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #9, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526081 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
Bn
CF3
9
8
7
6
5
4
3
2
1
ppm
1.92
2.22
1.36
0.92
1.00
1.06
1.09
3.18
3.17
3.18

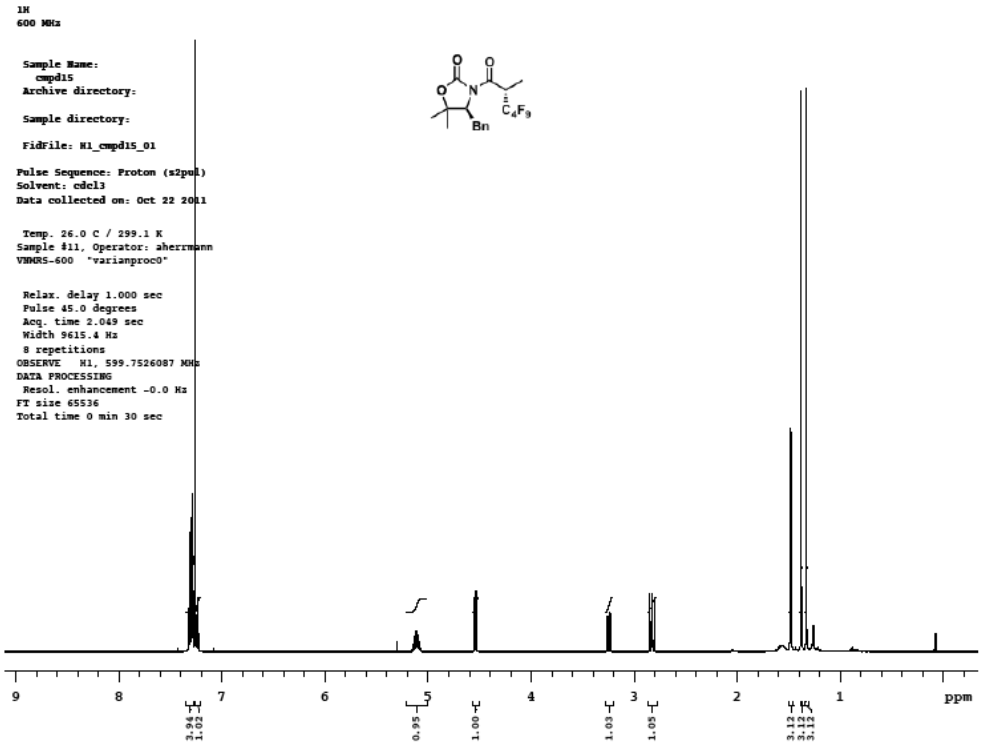

13C
Sample Name:
cmpd13
Archive directory:
Sample directory:
FidFile: C13_cmpd13_01
Pulse Sequence: Carbon (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample #9, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.300 sec
Width 36764.7 Hz
256 repetitions
OBSERVE C13, 150.8078779 MHz
DECOUPLE H1, 599.7556085 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 9 min 49 sec
Bn
CF3
220
200
180
160
140
120
100
80
60
40
20
0
ppm

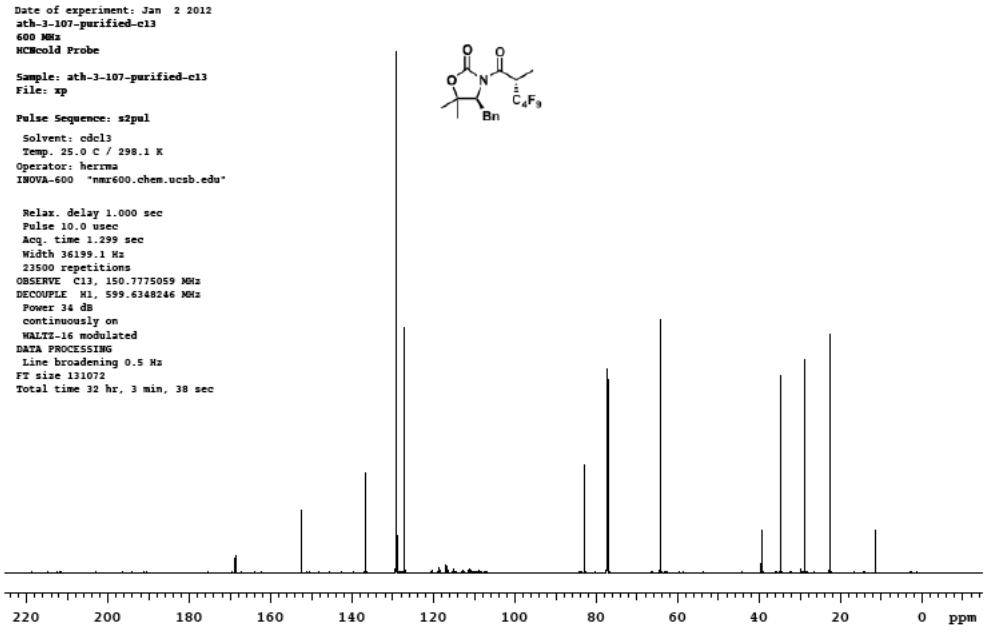

19F
ath-3-176-a
600 MHz
Sample Name:
cmpd12
Archive directory:
Sample directory:
FidFile: F19_cmpd12_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #9, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
O
N
CF3
Bn
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

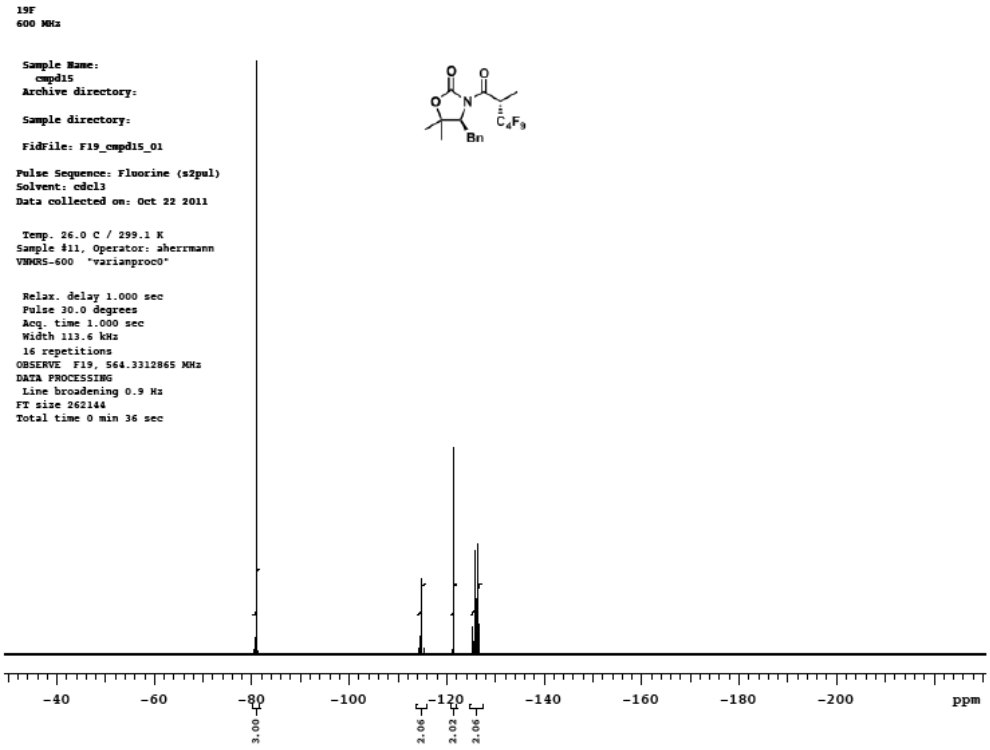

1H
600 MHz
Sample Name:
cmpd14
Archive directory:
Sample directory:
FidFile: H1_cmpd14_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #10, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526084 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
Bn
C3F7
9
8
7
6
5
4
3
2
1
ppm
4.00
1.02
0.98
1.00
1.01
1.03
3.10
3.12
3.17

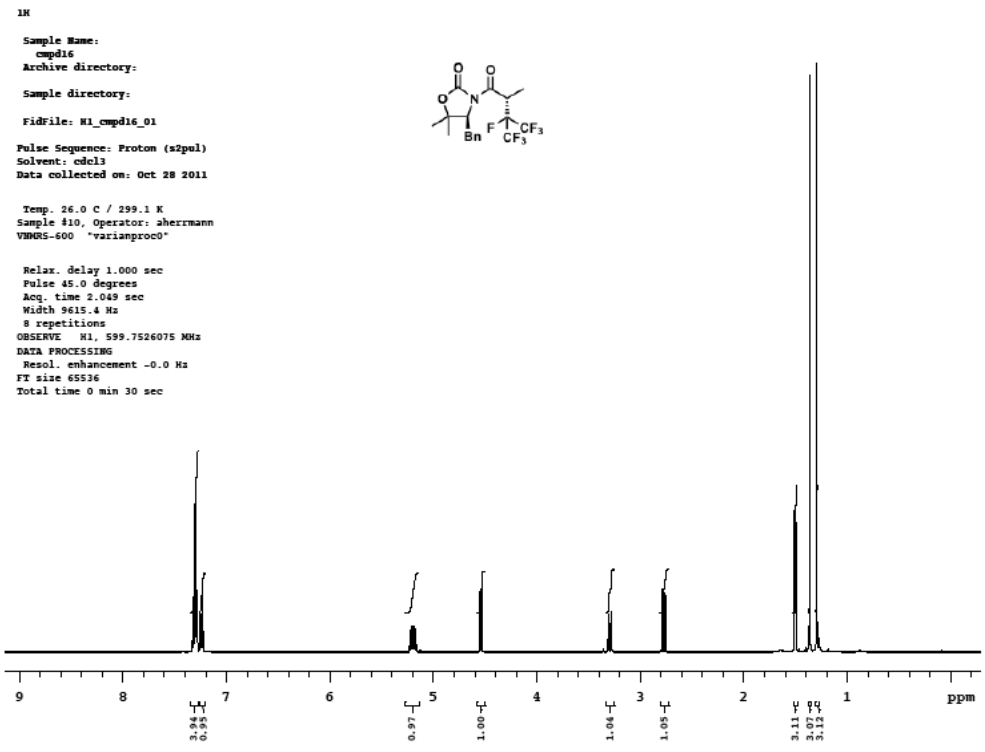

Std carbon
File: nmr500/Zakarian/lsmith/cmpd14.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: lsmith
File: cmpd14
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 43.2 degrees
Acq. time 1.303 sec
Width 30165.9 Hz
33000 repetitions
OBSERVE C13, 125.6888755 MHz
DECOUPLE H1, 499.8585468 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 51 hr, 22 min, 8 sec
Bn
C3F7
220
200
180
160
140
120
100
80
60
40
20
0
ppm

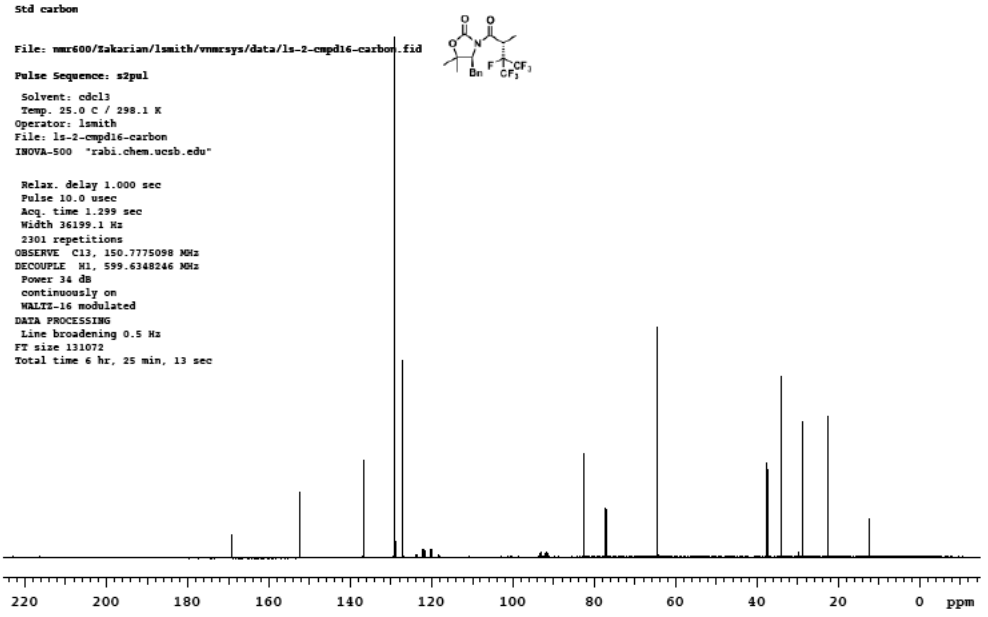

19F
600 MHZ
sample name:
cmpd14
archive directory:
sample directory:
fidfile: f19_cmpd14_01
pulse sequence: fluorine (szpul)
solvent: cdcl3
data collected on: oct 22 2011
temp. 26.0 C / 299.1 K
sample #10, operator: aherrmann
VNMRS-600 "varianproco"
relax. delay 1.000 sec
pulse 30.0 degrees
acq. time 1.000 sec
width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312866 MHZ
DATA PROCESSING
line broadening 0.9 HZ
FT size 262144
total time 0 min 36 sec
O
O
O
N
C_3F_7
Bn
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm
3.00
2.07
2.06

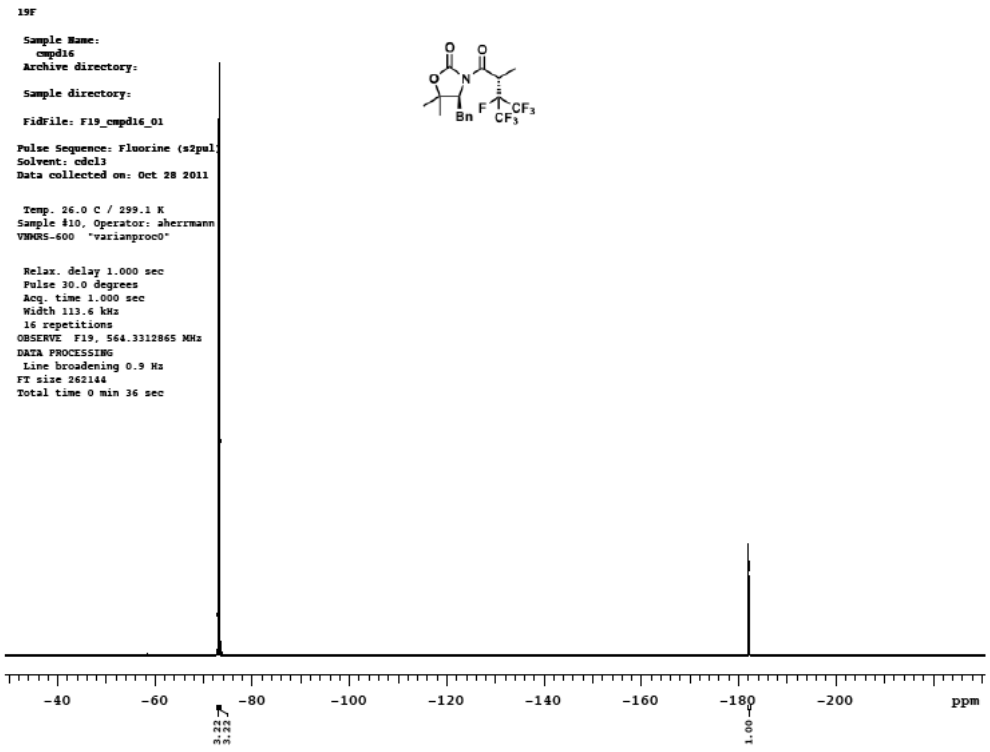

1H
600 MHz
Sample Name:
cmpd15
Archive directory:
Sample directory:
FidFile: H1_cmpd15_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #11, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526087 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
Bn
C4F9
9
8
7
6
5
4
3
2
1
ppm
3.04
1.02
0.95
1.00
1.03
1.05
3.12
3.12
3.12

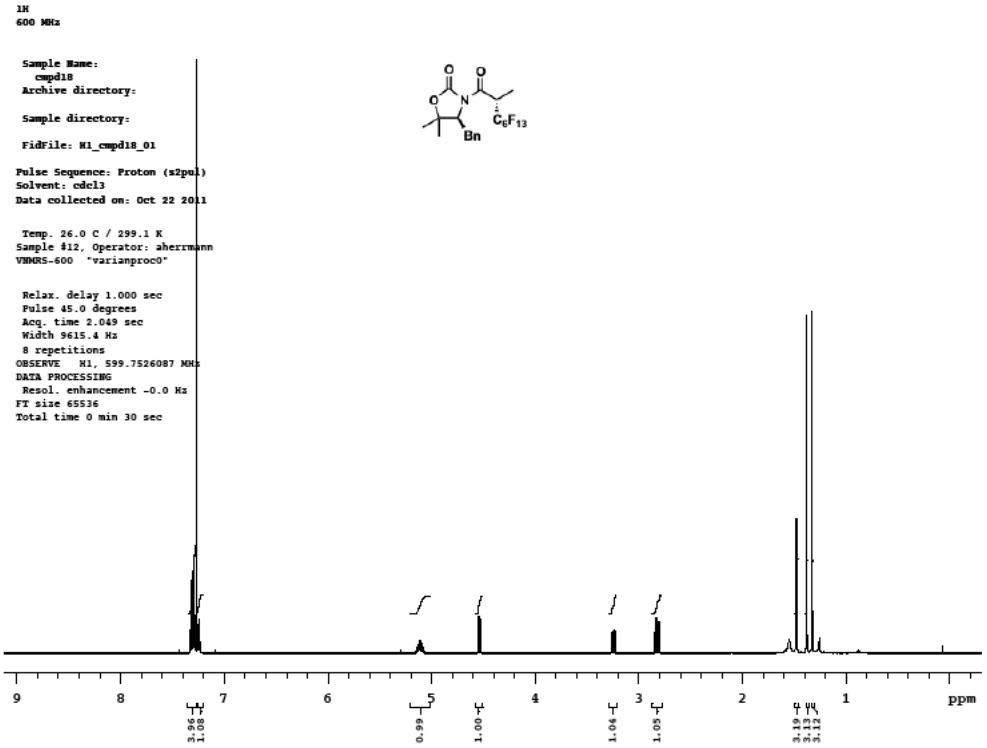

Date of experiment: Jan 2 2012
ath-3-107-purified-c13
600 MHz
HCNcold Probe
Sample: ath-3-107-purified-c13
File: xp
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
INOVA-600 "nmr600.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
23500 repetitions
OBSERVE C13, 150.7775059 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 32 hr, 3 min, 38 sec
Bn
C4F9
220
200
180
160
140
120
100
80
60
40
20
0
ppm

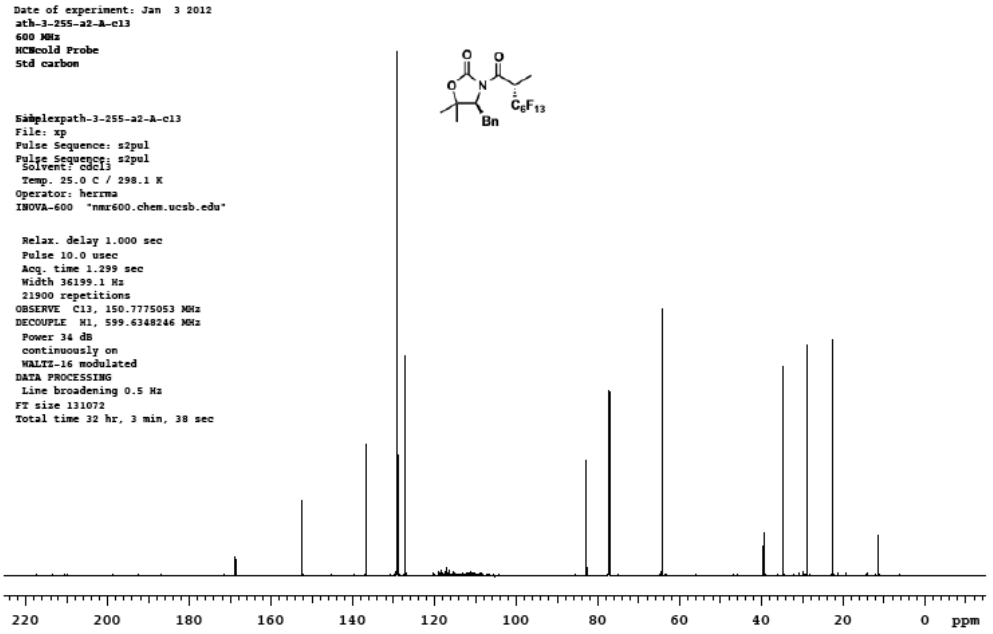

19F
600 MHz
Sample Name:
cmpd15
Archive directory:
Sample directory:
FidFile: F19_cmpd15_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #11, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
O
N
C4F9
Bn
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm
3.00
2.06
2.02
2.06

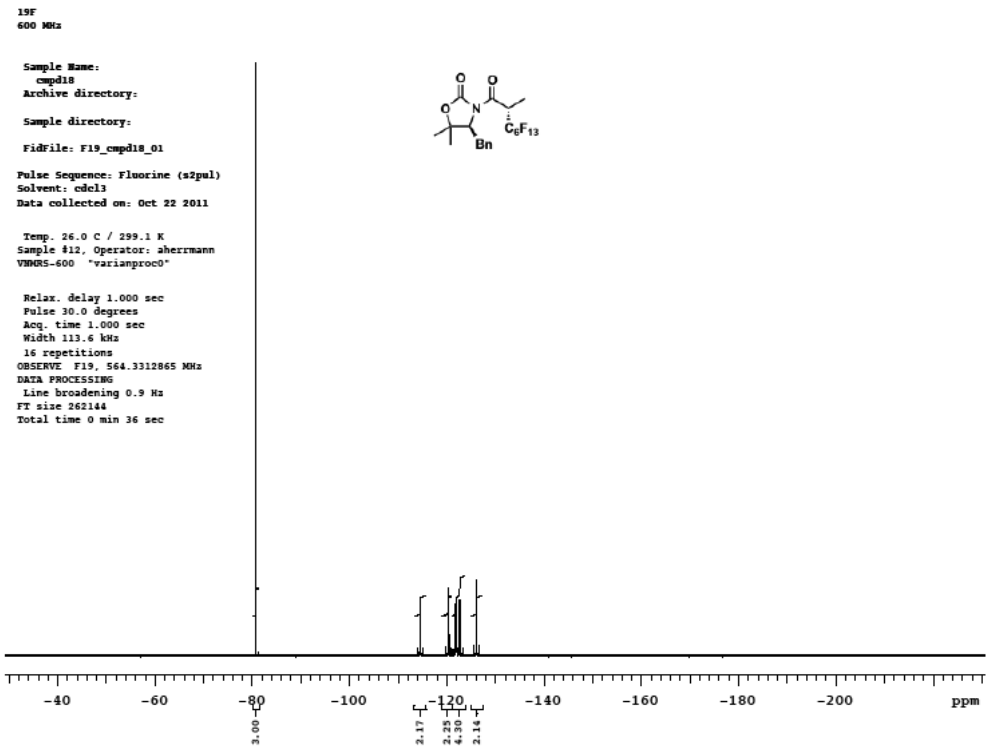

1H
Sample Name:
cmpd16
Archive directory:
Sample directory:
FidFile: H1_cmpd16_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample #10, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526075 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
Bn
F
CF3
CF3
9
8
7
6
5
4
3
2
1
ppm
3.94
0.99
0.97
1.00
1.04
1.05
3.11
3.07
3.12

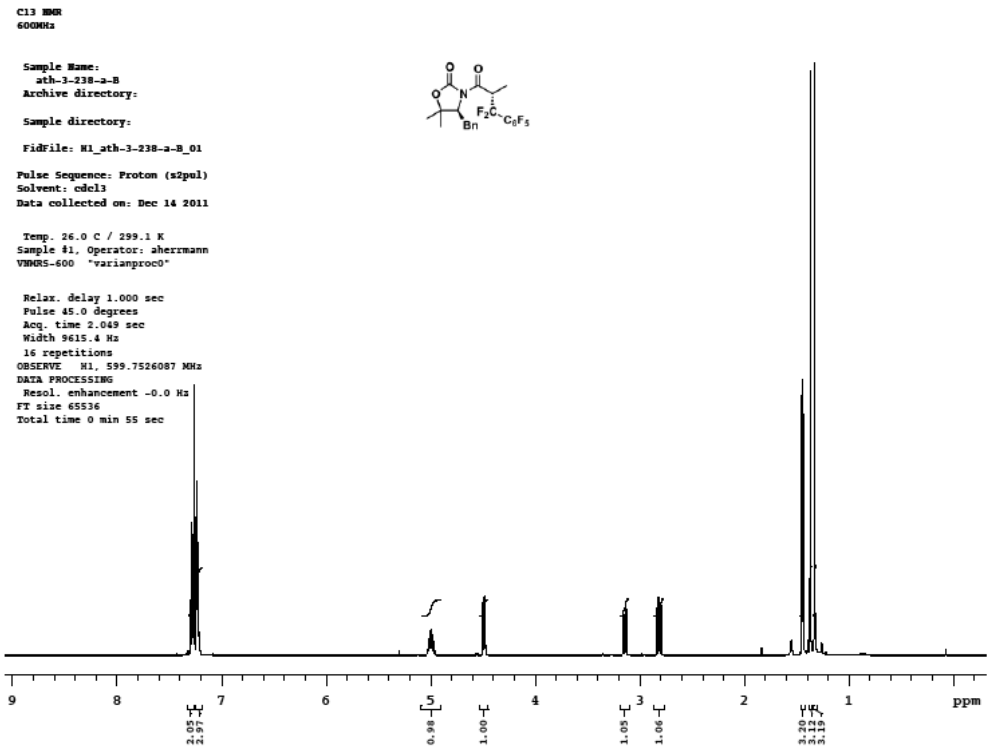

Std carbon
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-2-cmpd16-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-2-cmpd16-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
2301 repetitions
OBSERVE C13, 150.7775098 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Bn
F
CF3
CF3
220
200
180
160
140
120
100
80
60
40
20
0
ppm

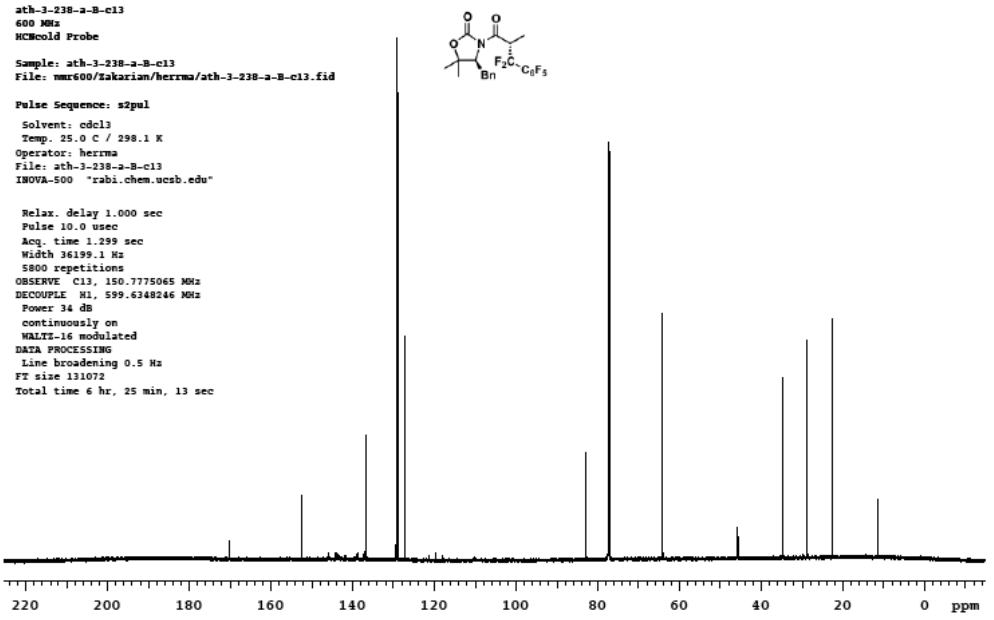

19F
Sample Name:
cmpd16
Archive directory:
Sample directory:
FidFile: F19_cmpd16_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample #10, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
Bn
F
CF3
CF3
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm
3.22
3.22
1.00

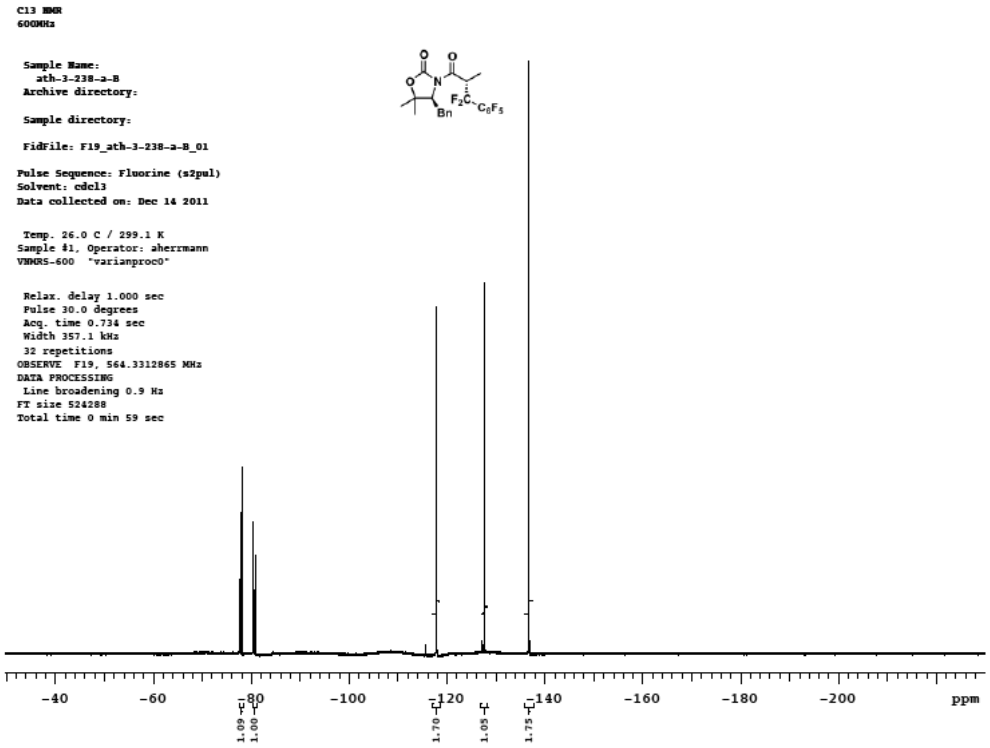

1H
600 MHz
Sample Name:
cmpd18
Archive directory:
Sample directory:
FidFile: H1_cmpd18_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #12, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526087 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
O
O
O
N
Bn
C6F13
9
8
7
6
5
4
3
2
1
ppm
3.06
1.08
0.99
1.00
1.04
1.05
3.19
3.13
3.12

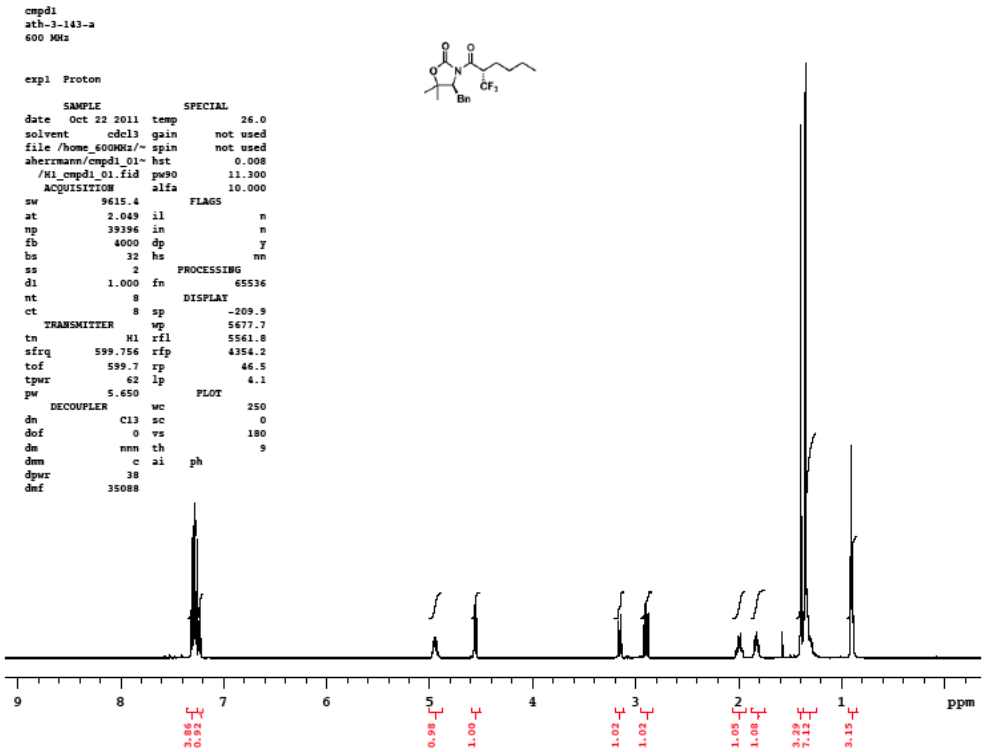

Date of experiment: Jan 3 2012
ath-3-255-a2-A-c13
600 MHz
HCNcold Probe
Std carbon
Samplexpath-3-255-a2-A-c13
File: xp
Pulse Sequence: s2pul
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
INOVA-600 "nmr600.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
21900 repetitions
OBSERVE C13, 150.7775053 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 32 hr, 3 min, 38 sec
O
O
O
N
Bn
C6F13
220
200
180
160
140
120
100
80
60
40
20
0
ppm

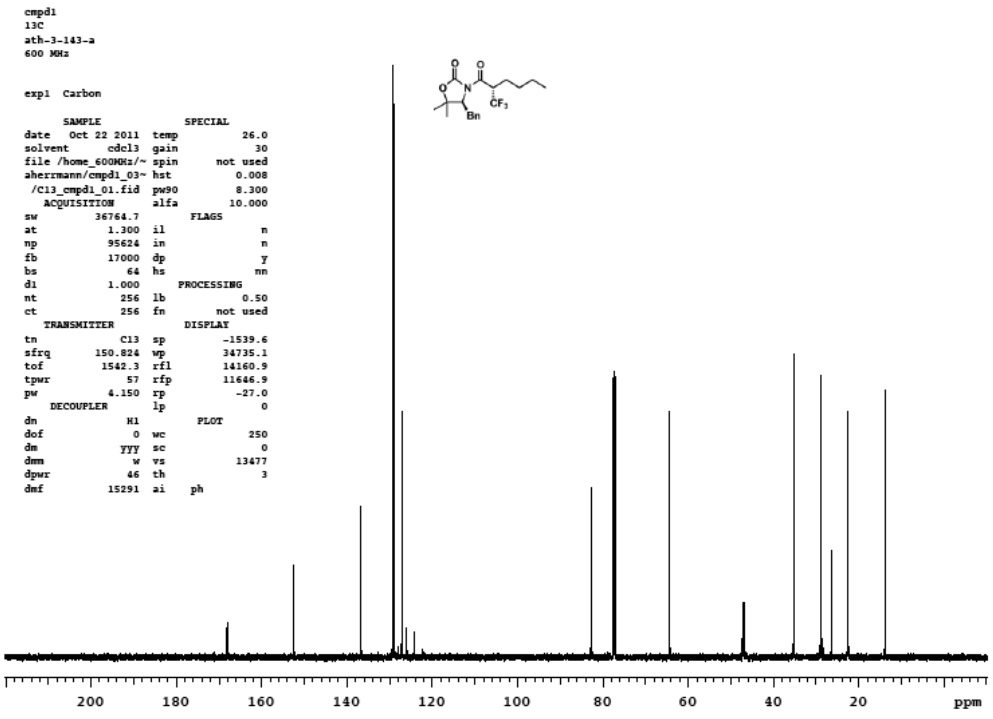

19F
600 MHz
Sample Name:
cmpd18
Archive directory:
Sample directory:
FidFile: F19_cmpd18_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #12, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
O
N
Bn
C6F13
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm
3.00
2.17
2.25
4.30
2.14

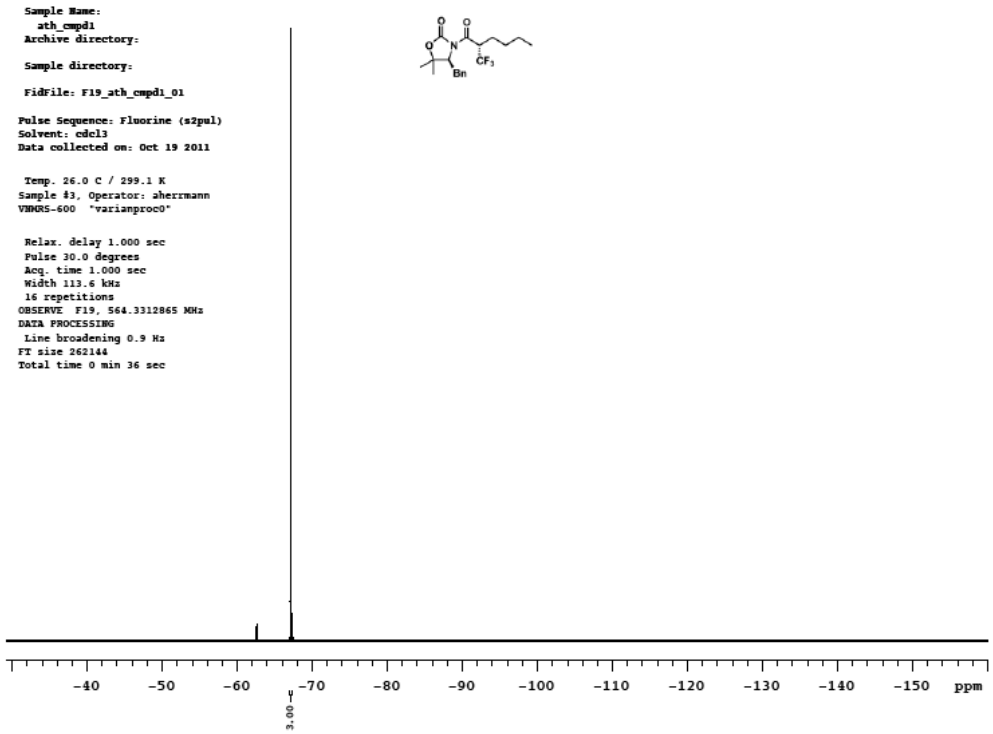

C13 NMR
600MHz
Sample Name:
ath-3-238-a-B
Archive directory:
Sample directory:
FidFile: H1_ath-3-238-a-B_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Dec 14 2011
Temp. 26.0 C / 299.1 K
Sample #1, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
16 repetitions
OBSERVE H1, 599.7526087 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 55 sec
ppm
2.05
2.97
0.98
1.00
1.05
1.06
3.20
3.13
3.18

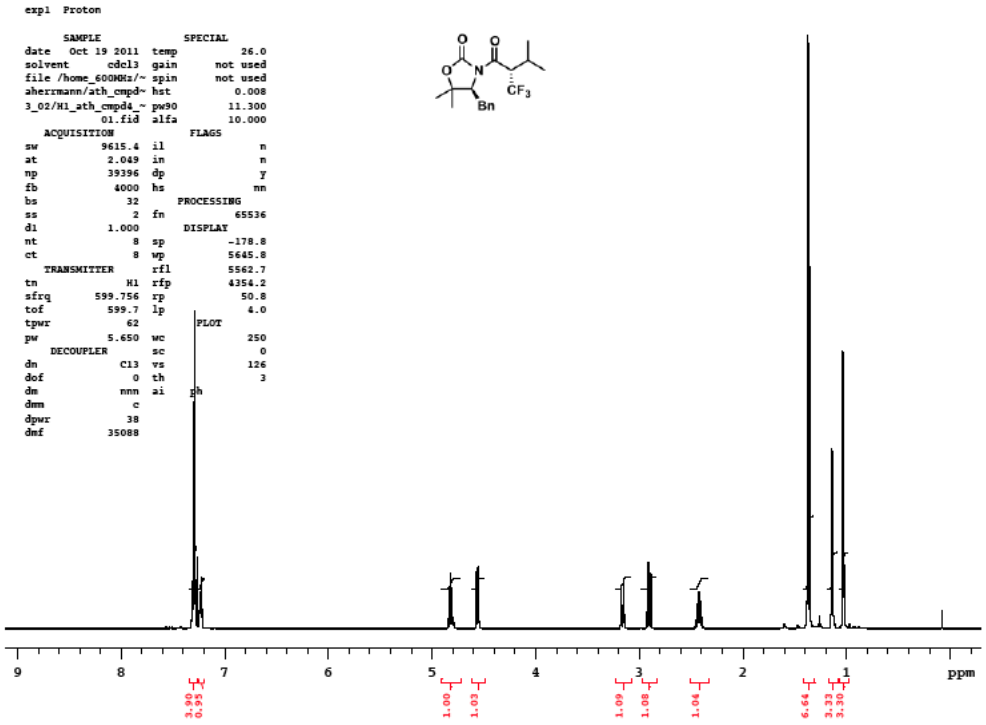

ath-3-238-a-B-c13
600 MHz
HCNcold Probe
Sample: ath-3-238-a-B-c13
File: nmr600/Zakarian/herrma/ath-3-238-a-B-c13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
File: ath-3-238-a-B-c13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
5800 repetitions
OBSERVE C13, 150.7775065 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
ppm

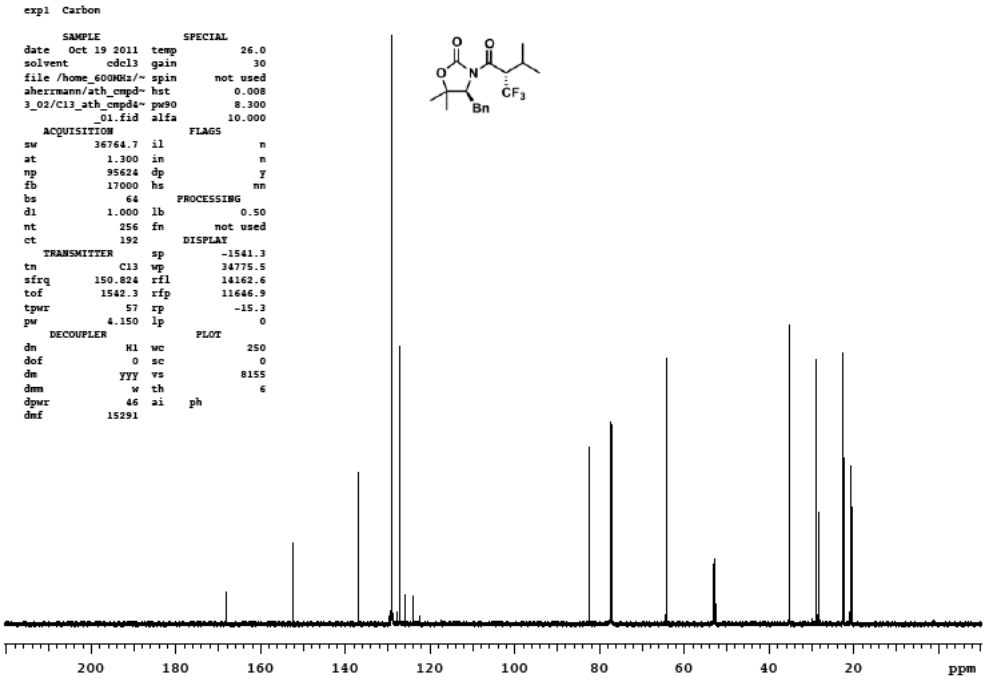

C13 NMR
600MHz
Sample Name:
ath-3-238-a-B
Archive directory:
Sample directory:
FidFile: F19_ath-3-238-a-B_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Dec 14 2011
Temp. 26.0 C / 299.1 K
Sample #1, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 0.734 sec
Width 357.1 kHz
32 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 524288
Total time 0 min 59 sec
Bn
F2C
C6F5
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm
1.09
1.00
1.70
1.05
1.75

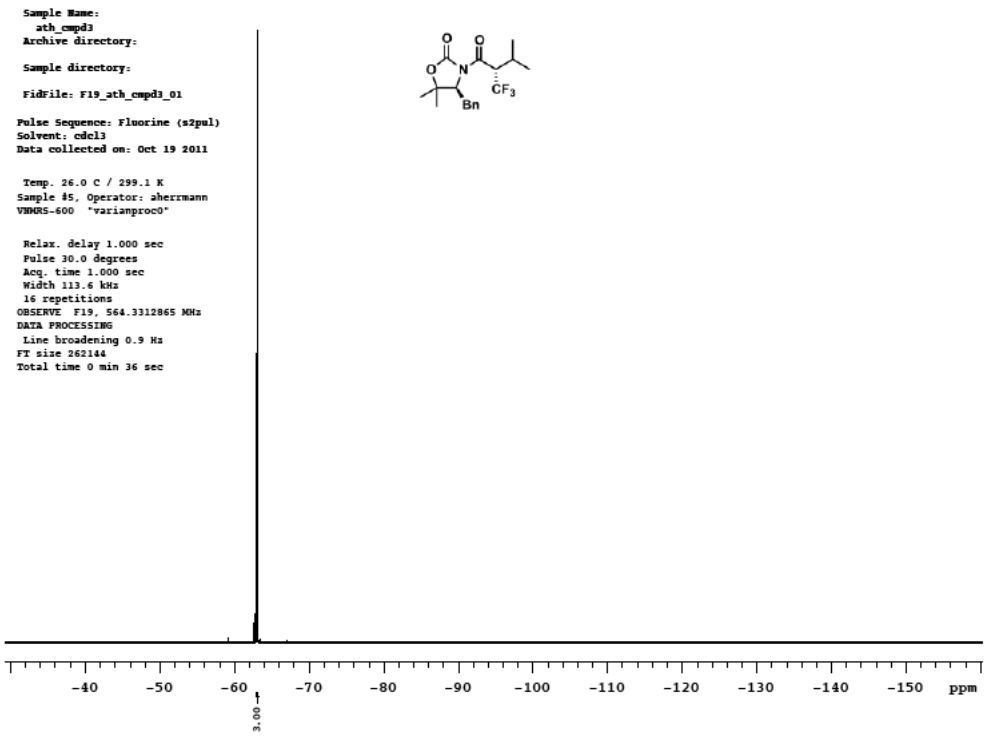

cmpd1
ath-3-143-a
600 MHz
exp1 Proton
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
ahermann/cmpd1_01~
/H1_cmpd1_01.fid
ACQUISITION
sw 9615.4
at 2.049
np 39396
fb 4000
bs 32
ss 2
d1 1.000
nt 8
ct 8
TRANSMITTER
tn H1
sfrq 599.756
tof 599.7
tpwr 62
pw 5.650
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 35088
SPECIAL
temp 26.0
gain not used
spin not used
hst 0.008
pw90 11.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn 65536
DISPLAY
sp -209.9
wp 5677.7
rfl 5561.8
rfp 4354.2
rp 46.5
lp 4.1
PLOT
wc 250
sc 0
vs 180
th 9
ai ph
Bn
CF3
9
8
7
6
5
4
3
2
1
ppm
3.86
0.92
0.98
1.00
1.02
1.03
1.05
1.08
3.39
7.12
3.15

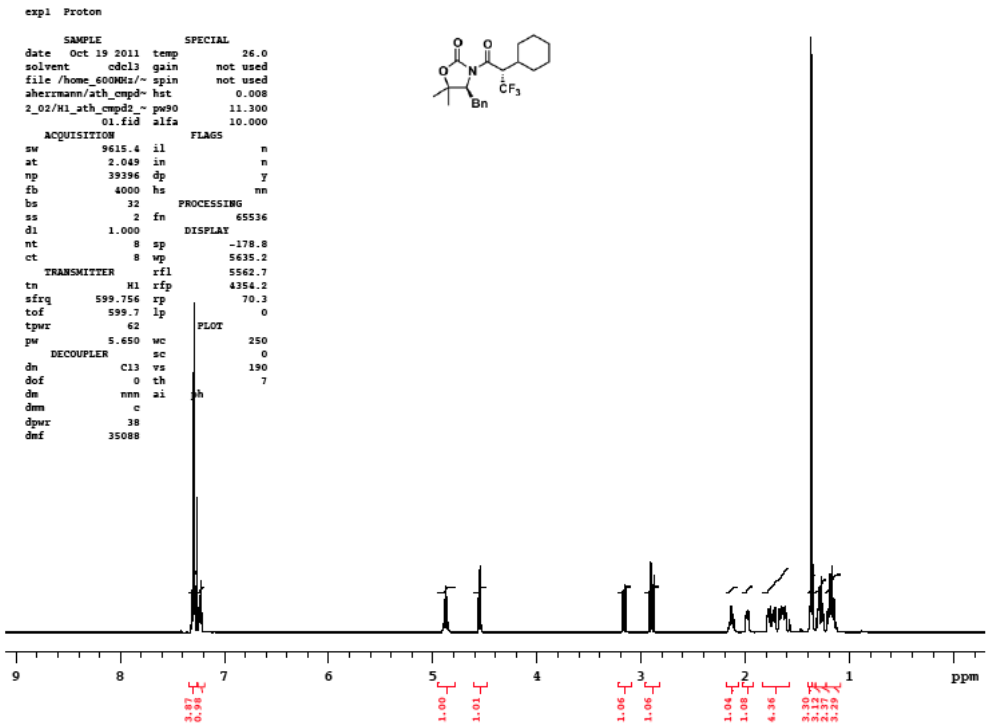

cmpd1
13C
ath-3-143-a
600 MHz
exp1 Carbon
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
ahermann/cmpd1_03~
/C13_cmpd1_01.fid
ACQUISITION
sw 36764.7
at 1.300
np 95624
fb 17000
bs 64
d1 1.000
nt 256
ct 256
TRANSMITTER
tn C13
sfrq 150.824
tof 1542.3
tpwr 57
pw 4.150
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 46
dmf 15291
SPECIAL
temp 26.0
gain 30
spin not used
hst 0.008
pw90 8.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -1539.6
wp 34735.1
rfl 14160.9
rfp 11646.9
rp -27.0
lp 0
PLOT
wc 250
sc 0
vs 13477
th 3
ai ph
Bn
CF3
200
180
160
140
120
100
80
60
40
20
ppm

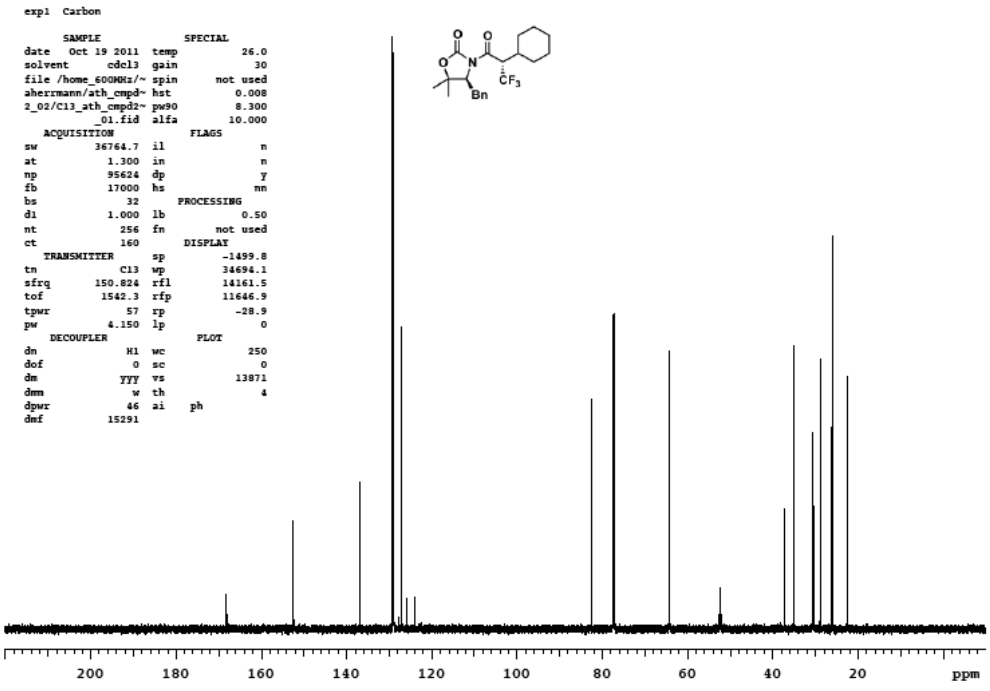

Sample Name:
ath_cmpd1
Archive directory:
Sample directory:
FidFile: F19_ath_cmpd1_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 19 2011
Temp. 26.0 C / 299.1 K
Sample #3, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

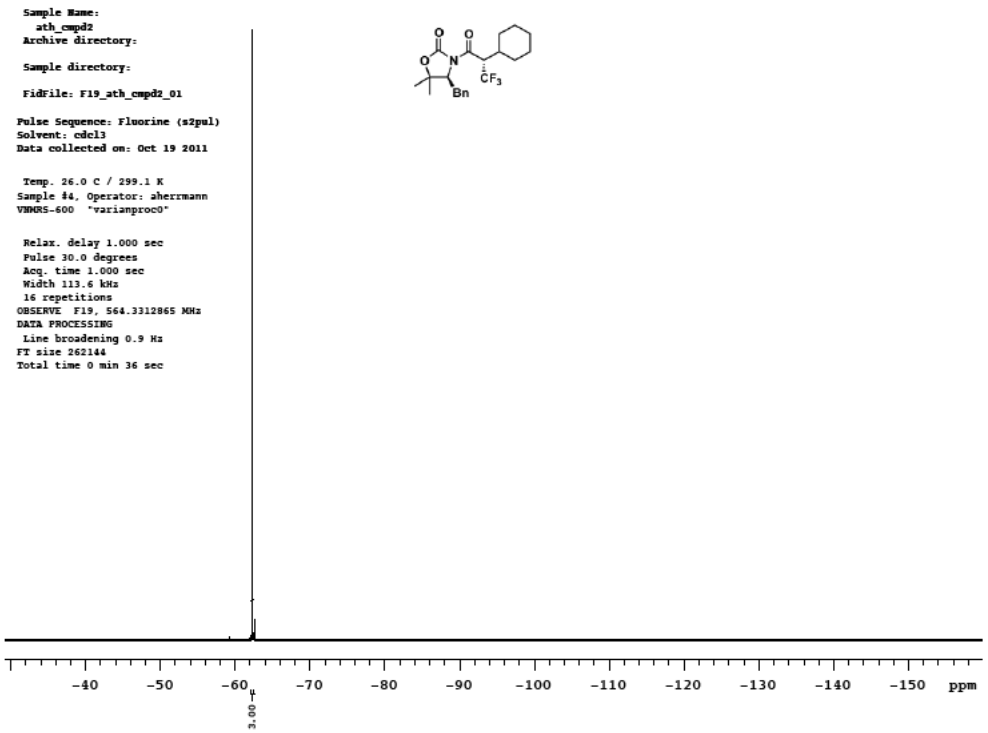

exp1 Proton
SAMPLE
date Oct 19 2011
solvent cdcl3
file /home_600MHz/~
aherrmann/ath_cmpd~
3_02/H1_ath_cmpd4_~
01.fid
ACQUISITION
sw 9615.4
at 2.049
np 39396
fb 4000
bs 32
ss 2
d1 1.000
nt 8
ct 8
TRANSMITTER
tn H1
sfrq 599.756
tof 599.7
tpwr 62
pw 5.650
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 35088
SPECIAL
temp 26.0
gain not used
spin not used
hst 0.008
pw90 11.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn 65536
DISPLAY
sp -178.8
wp 5645.8
rfl 5562.7
rfp 4354.2
rp 50.8
lp 4.0
PLOT
wc 250
sc 0
vs 126
th 3
ai ph
Bn
CF3
9
8
7
6
5
4
3
2
1
ppm
3.90
0.95
1.00
1.03
1.09
1.08
1.04
6.64
3.33
3.30

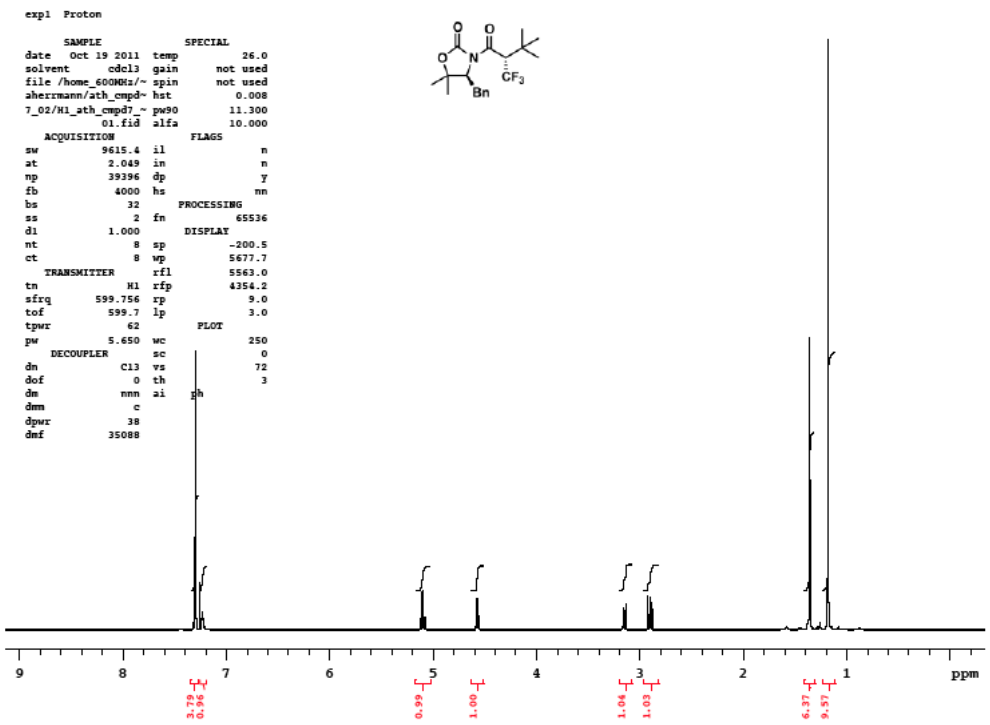

exp1 Carbon
SAMPLE
date Oct 19 2011
solvent cdcl3
file /home_600MHz/~
aherrmann/ath_cmpd~
3_02/C13_ath_cmpd4~
01.fid
ACQUISITION
sw 36764.7
at 1.300
np 95624
fb 17000
bs 64
d1 1.000
nt 256
ct 192
TRANSMITTER
tn C13
sfrq 150.824
tof 1542.3
tpwr 57
pw 4.150
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 46
dmf 15291
SPECIAL
temp 26.0
gain 30
spin not used
hst 0.008
pw90 8.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -1541.3
wp 34775.5
rfl 14162.6
rfp 11646.9
rp -15.3
lp 0
PLOT
wc 250
sc 0
vs 8155
th 6
ai ph
Bn
CF3
200
180
160
140
120
100
80
60
40
20
ppm

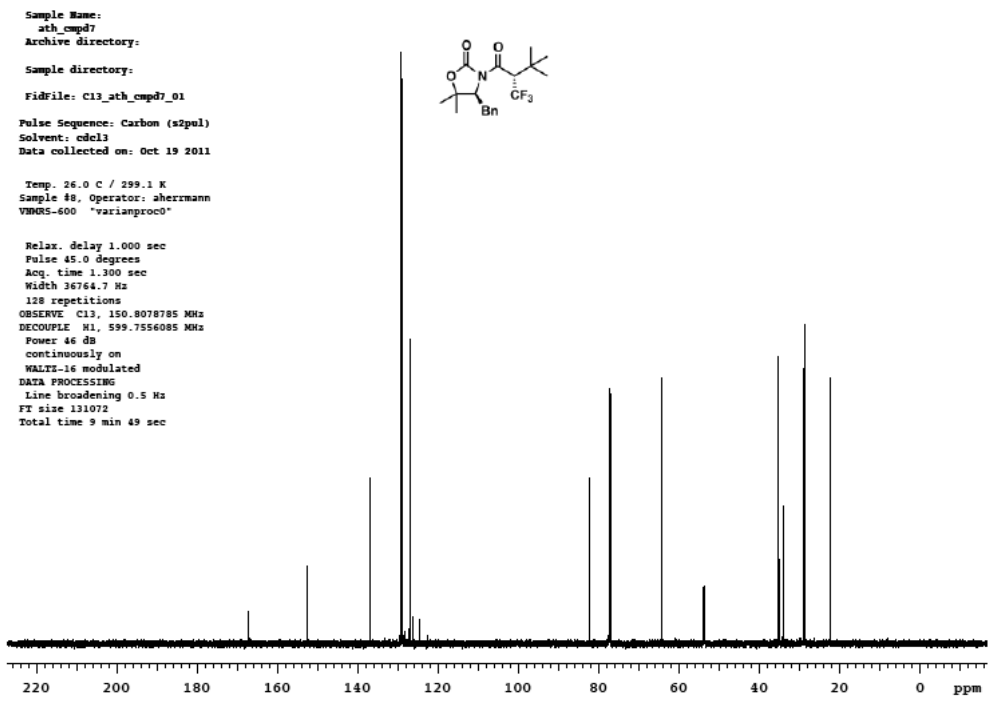

Sample Name:
ath_cmpd3
Archive directory:
Sample directory:
FidFile: F19_ath_cmpd3_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 19 2011
Temp. 26.0 C / 299.1 K
Sample #5, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
O
N
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

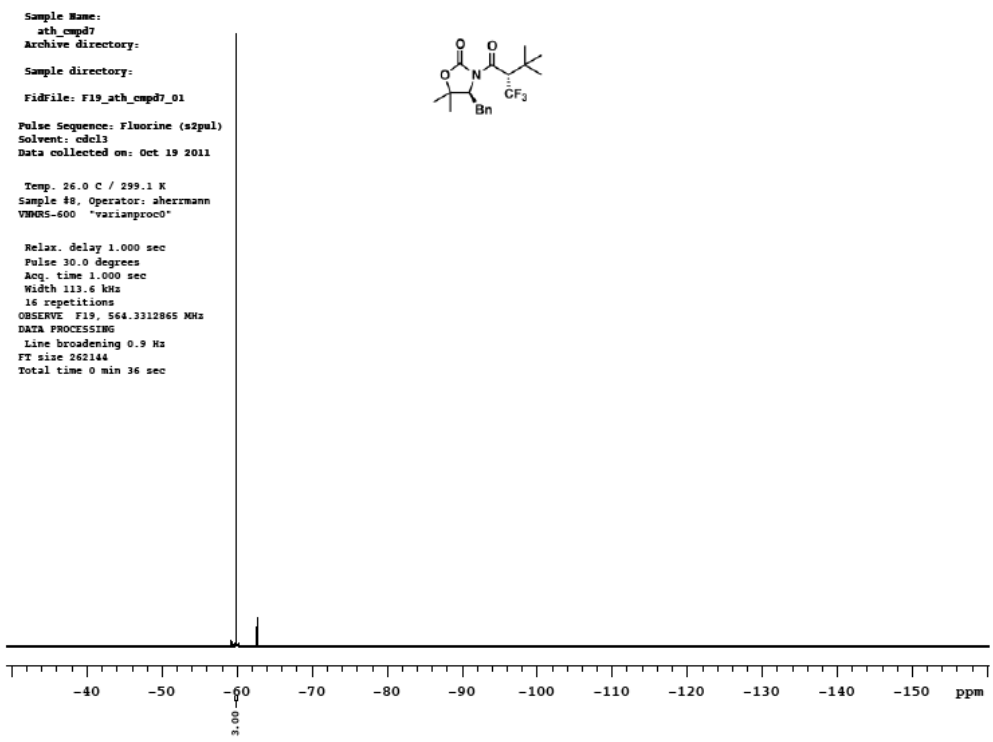

exp1 Proton
SAMPLE
date Oct 19 2011
solvent cdcl3
file /home_600MHz/~
aherrmann/ath_cmpd~
2_02/H1_ath_cmpd2_~
01.fid
ACQUISITION
sw 9615.4
at 2.049
np 39396
fb 4000
bs 32
ss 2
d1 1.000
nt 8
ct 8
TRANSMITTER
tn H1
sfrq 599.756
tof 599.7
tpwr 62
pw 5.650
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 35088
SPECIAL
temp 26.0
gain not used
spin not used
hst 0.008
pw90 11.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn 65536
DISPLAY
sp -178.8
wp 5635.2
rfl 5562.7
rfp 4354.2
rp 70.3
lp 0
PLOT
wc 250
sc 0
vs 190
th 7
ai ph
Bn
CF3
9
8
7
6
5
4
3
2
1
ppm
3.87
0.98
1.00
1.01
1.06
1.06
1.04
1.08
4.36
3.30
3.12
3.17
3.29

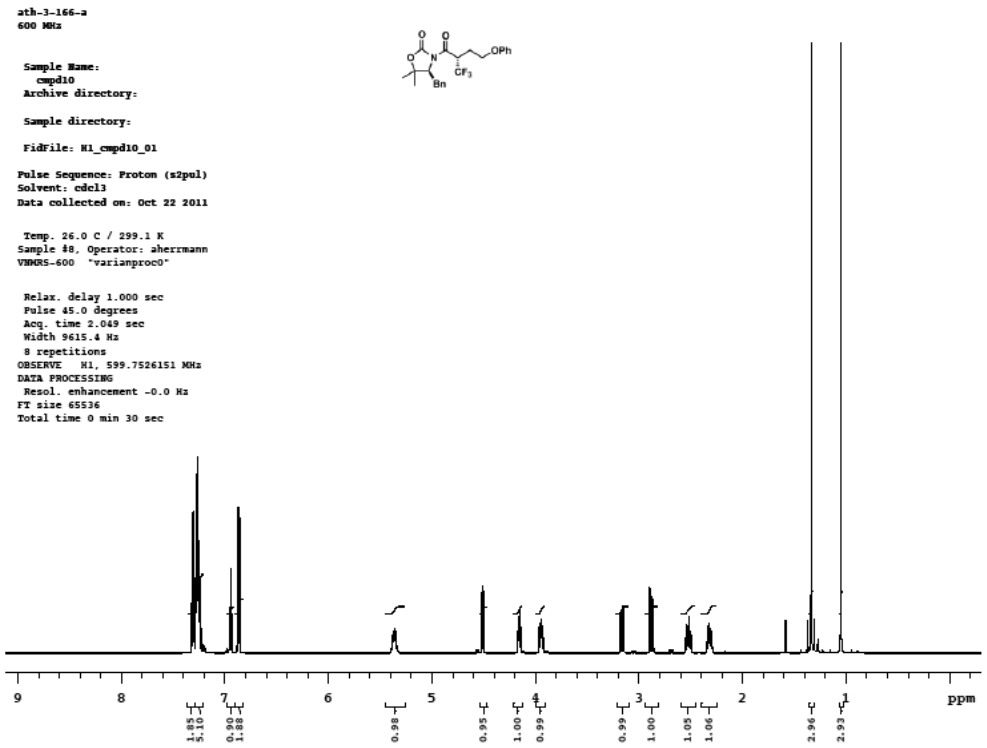

exp1 Carbon
SAMPLE
date Oct 19 2011
solvent cdcl3
file /home_600MHz/~
aherrmann/ath_cmpd~
2_02/C13_ath_cmpd2~
01.fid
ACQUISITION
sw 36764.7
at 1.300
np 95624
fb 17000
bs 32
d1 1.000
nt 256
ct 160
TRANSMITTER
tn C13
sfrq 150.824
tof 1542.3
tpwr 57
pw 4.150
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 46
dmf 15291
SPECIAL
temp 26.0
gain 30
spin not used
hst 0.008
pw90 8.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -1499.8
wp 34694.1
rfl 14161.5
rfp 11646.9
rp -28.9
lp 0
PLOT
wc 250
sc 0
vs 13871
th 4
ai ph
Bn
CF3
200
180
160
140
120
100
80
60
40
20
ppm

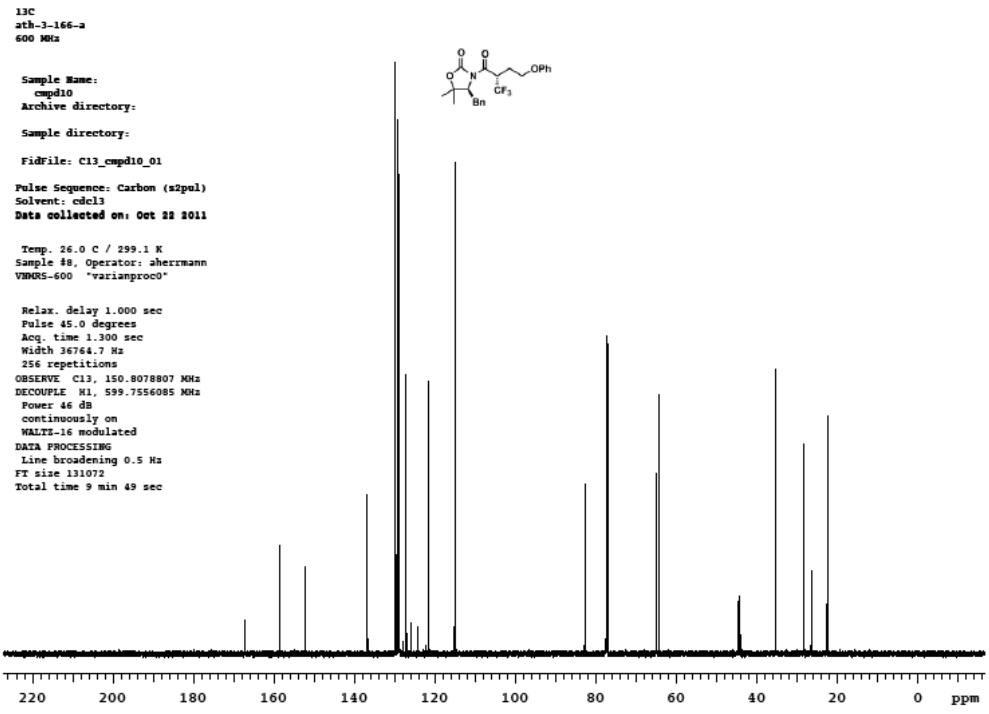

Sample Name:
ath_cmpd2
Archive directory:
Sample directory:
FidFile: F19_ath_cmpd2_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 19 2011
Temp. 26.0 C / 299.1 K
Sample #4, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
O
N
CF3
Bn
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

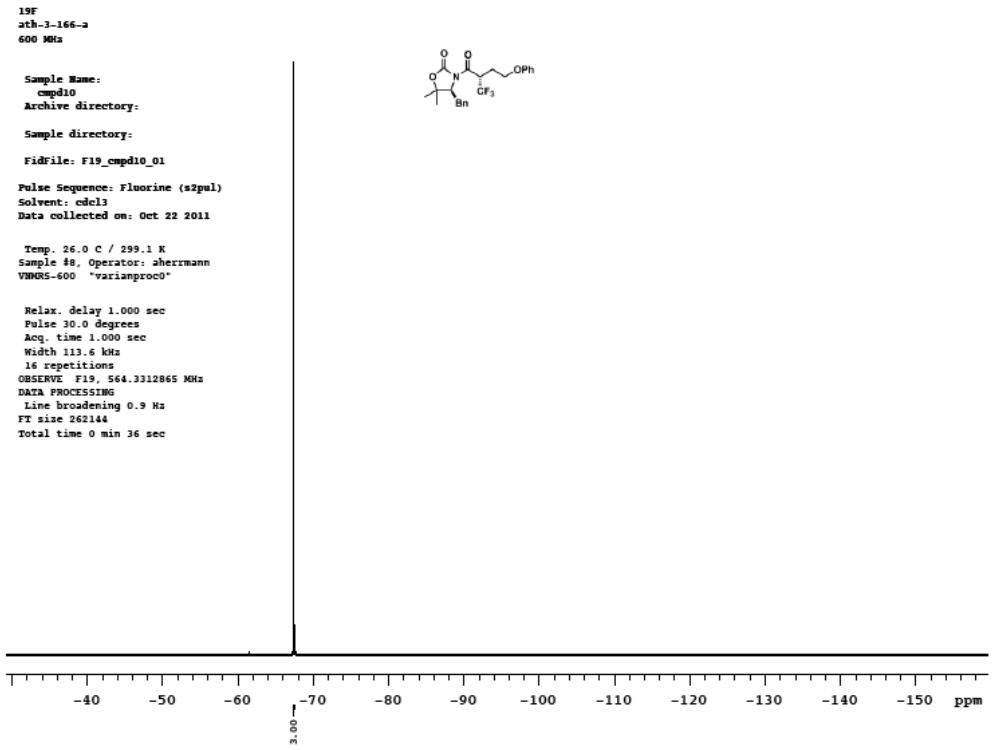

exp1 Proton
SAMPLE
date Oct 19 2011
solvent cdcl3
file /home_600MHz/~
aherrmann/ath_cmpd~
7_02/H1_ath_cmpd7_~
01.fid
ACQUISITION
sw 9615.4
at 2.049
np 39396
fb 4000
bs 32
ss 2
d1 1.000
nt 8
ct 8
TRANSMITTER
tn H1
sfrq 599.756
tof 599.7
tpwr 62
pw 5.650
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 35088
SPECIAL
temp 26.0
gain not used
spin not used
hst 0.008
pw90 11.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn 65536
DISPLAY
sp -200.5
wp 5677.7
rfl 5563.0
rfp 4354.2
rp 9.0
lp 3.0
PLOT
wc 250
sc 0
vs 72
th 3
ai ph
CF3
Bn
9
8
7
6
5
4
3
2
1
ppm
3.79
0.96
0.99
1.00
1.04
1.03
6.37
9.57

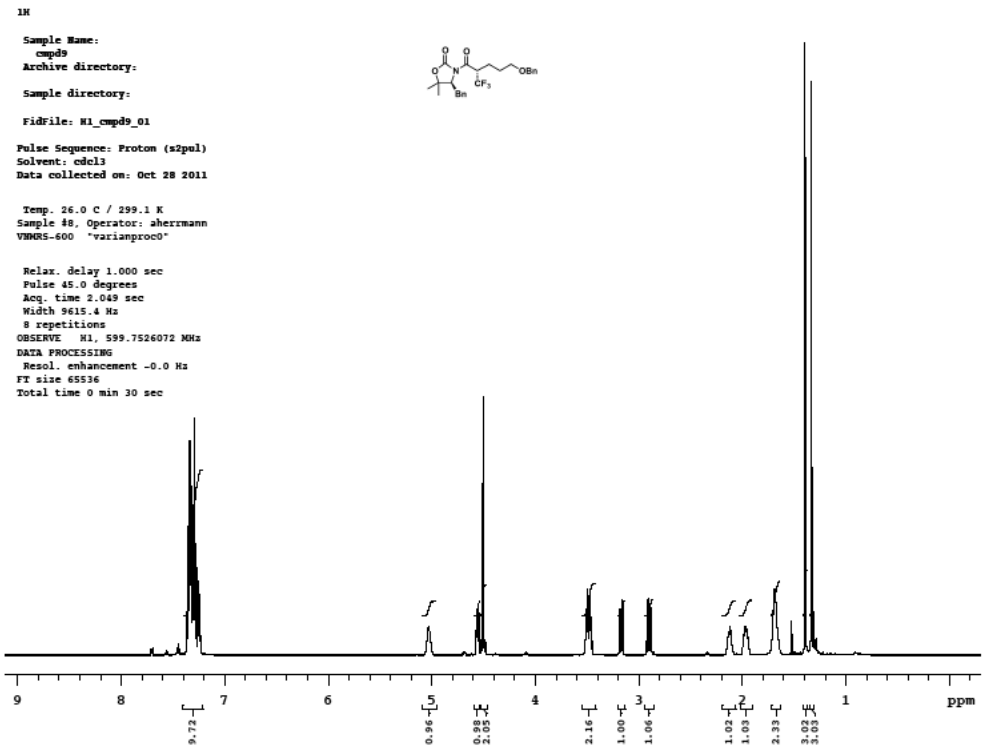

Sample Name:
ath_cmpd7
Archive directory:
Sample directory:
FidFile: C13_ath_cmpd7_01
Pulse Sequence: Carbon (s2pul)
Solvent: cdcl3
Data collected on: Oct 19 2011
Temp. 26.0 C / 299.1 K
Sample #8, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.300 sec
Width 36764.7 Hz
128 repetitions
OBSERVE C13, 150.8078785 MHz
DECOUPLE H1, 599.7556085 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 9 min 49 sec
CF3
Bn
220
200
180
160
140
120
100
80
60
40
20
0
ppm

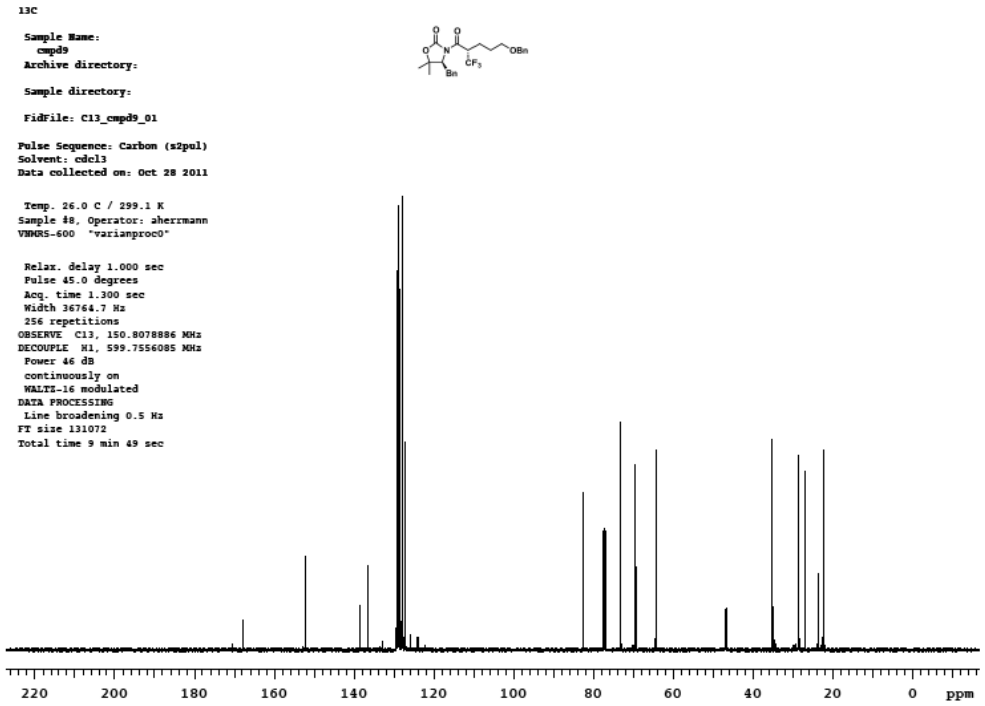

Sample Name:
ath_cmpd7
Archive directory:
Sample directory:
FidFile: F19_ath_cmpd7_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 19 2011
Temp. 26.0 C / 299.1 K
Sample #8, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
N
O
CF3
Bn
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

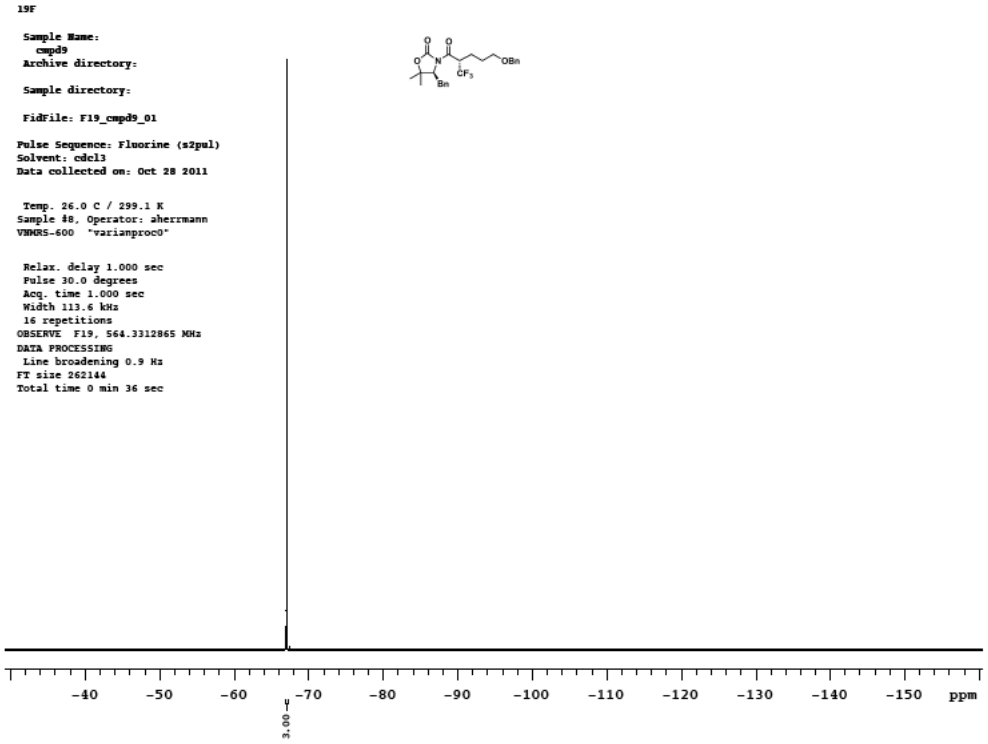

ath-3-166-a
600 MHz
Sample Name:
cmpd10
Archive directory:
Sample directory:
FidFile: H1_cmpd10_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #8, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526151 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
OPh
CF3
Bn
9
8
7
6
5
4
3
2
1
ppm
1.85
5.10
0.90
1.88
0.98
0.95
1.00
0.99
0.99
1.00
1.05
1.06
2.96
2.93

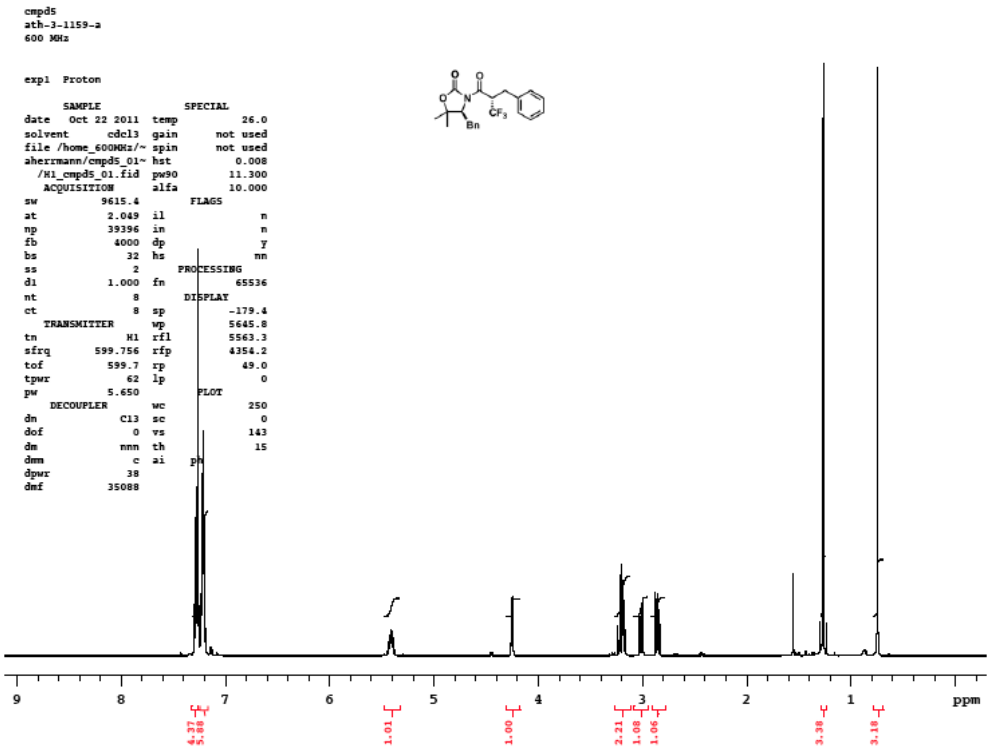

13C
ath-3-166-a
600 MHz
Sample Name:
cmpd10
Archive directory:
Sample directory:
FidFile: C13_cmpd10_01
Pulse Sequence: Carbon (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #8, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.300 sec
Width 36764.7 Hz
256 repetitions
OBSERVE C13, 150.8078807 MHz
DECOUPLE H1, 599.7556085 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 9 min 49 sec
OPh
CF3
Bn
220
200
180
160
140
120
100
80
60
40
20
0
ppm

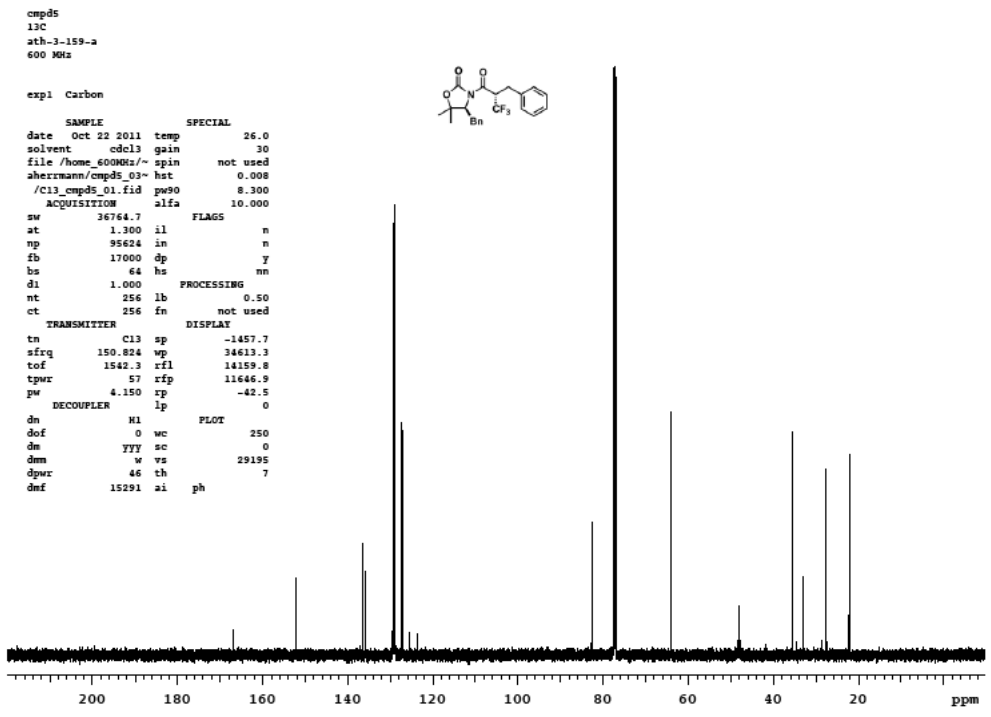

19F
ath-3-166-a
600 MHz
Sample Name:
cmpd10
Archive directory:
Sample directory:
FidFile: F19_cmpd10_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #8, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
OPh
CF3
Bn
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

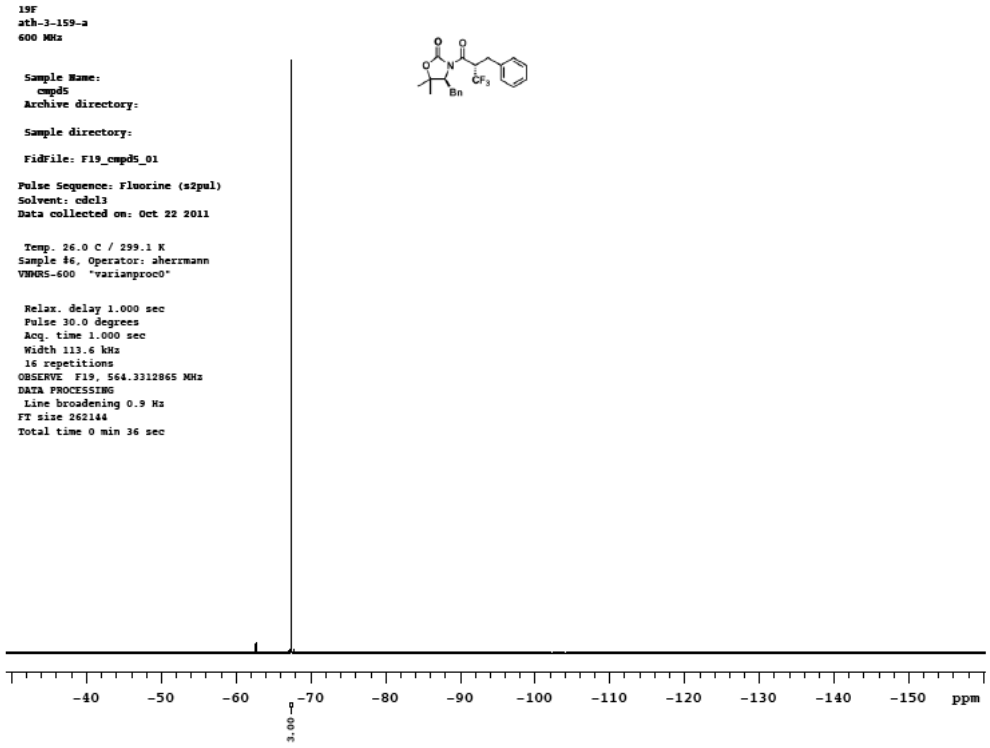

1H
Sample Name:
cmpd9
Archive directory:
Sample directory:
FidFile: H1_cmpd9_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample 48, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526072 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
OBn
Bn
CF3
9
8
7
6
5
4
3
2
1
ppm
9.72
0.96
0.98
2.05
2.16
1.00
1.06
1.02
1.03
2.33
3.02
3.03

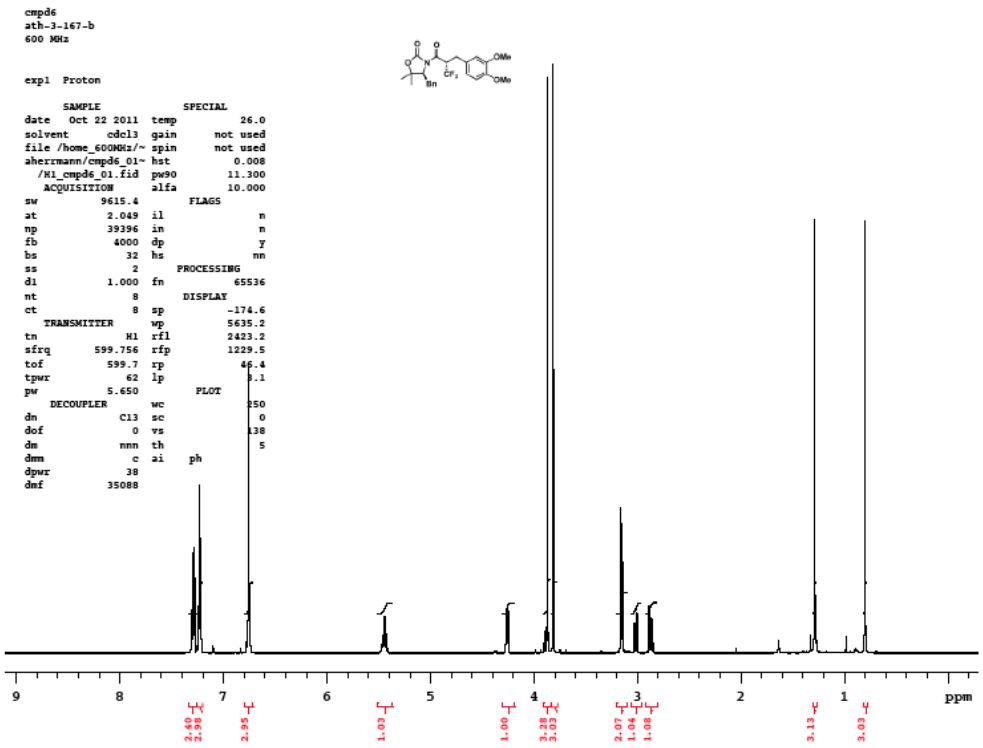

13C
Sample Name:
cmpd9
Archive directory:
Sample directory:
FidFile: C13_cmpd9_01
Pulse Sequence: Carbon (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample 48, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.300 sec
Width 36764.7 Hz
256 repetitions
OBSERVE C13, 150.8078886 MHz
DECOUPLE H1, 599.7556085 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 9 min 49 sec
OBn
Bn
CF3
220
200
180
160
140
120
100
80
60
40
20
0
ppm

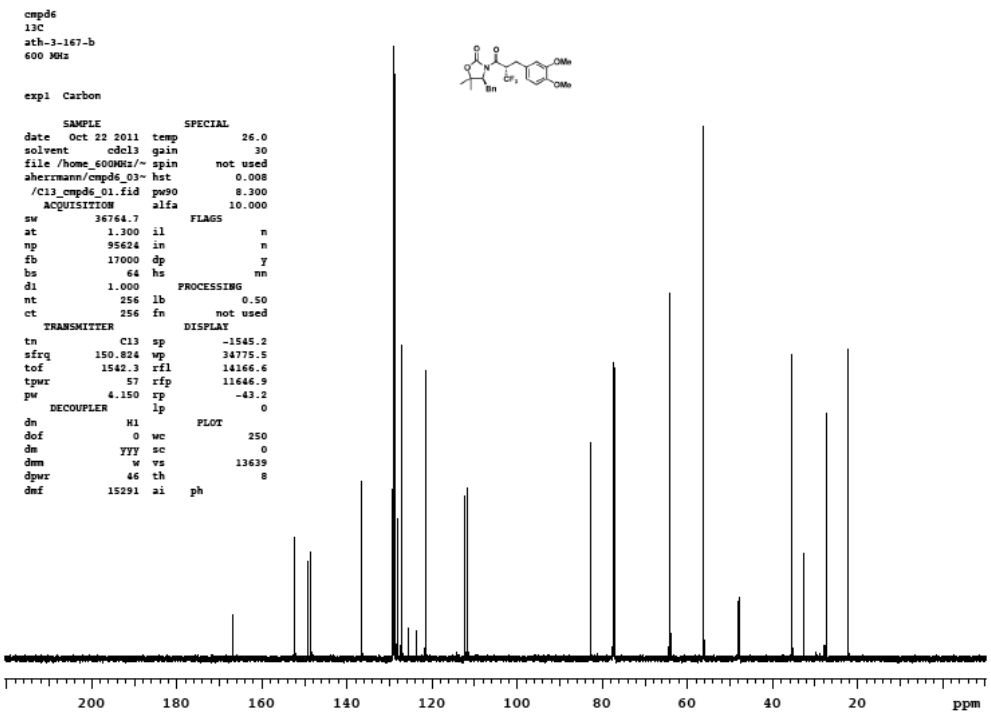

19F
Sample Name:
cmpd9
Archive directory:
Sample directory:
FidFile: F19_cmpd9_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample 48, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
OBn
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

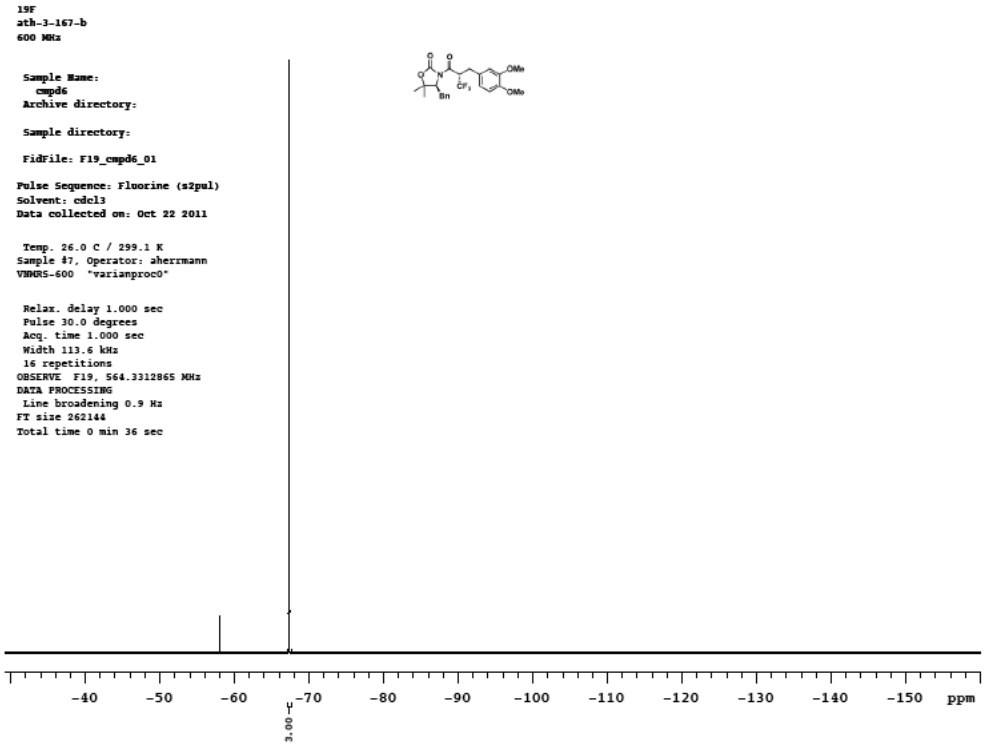

cmpd5
ath-3-1159-a
600 MHz
exp1 Proton
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
ahermann/cmpd5_01~
/H1_cmpd5_01.fid
ACQUISITION
sw 9615.4
at 2.049
np 39396
fb 4000
bs 32
ss 2
d1 1.000
nt 8
ct 8
TRANSMITTER
tn H1
sfrq 599.756
tof 599.7
tpwr 62
pw 5.650
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 35088
SPECIAL
temp 26.0
gain not used
spin not used
hst 0.008
pw90 11.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn 65536
DISPLAY
sp -179.4
wp 5645.8
rfl 5563.3
rfp 4354.2
rp 49.0
lp 0
PLOT
wc 250
sc 0
vs 143
th 15
ai ph
Bn
CF3
9
8
7
6
5
4
3
2
1
ppm
4.37
5.88
1.01
1.00
2.21
1.08
1.06
3.38
3.18

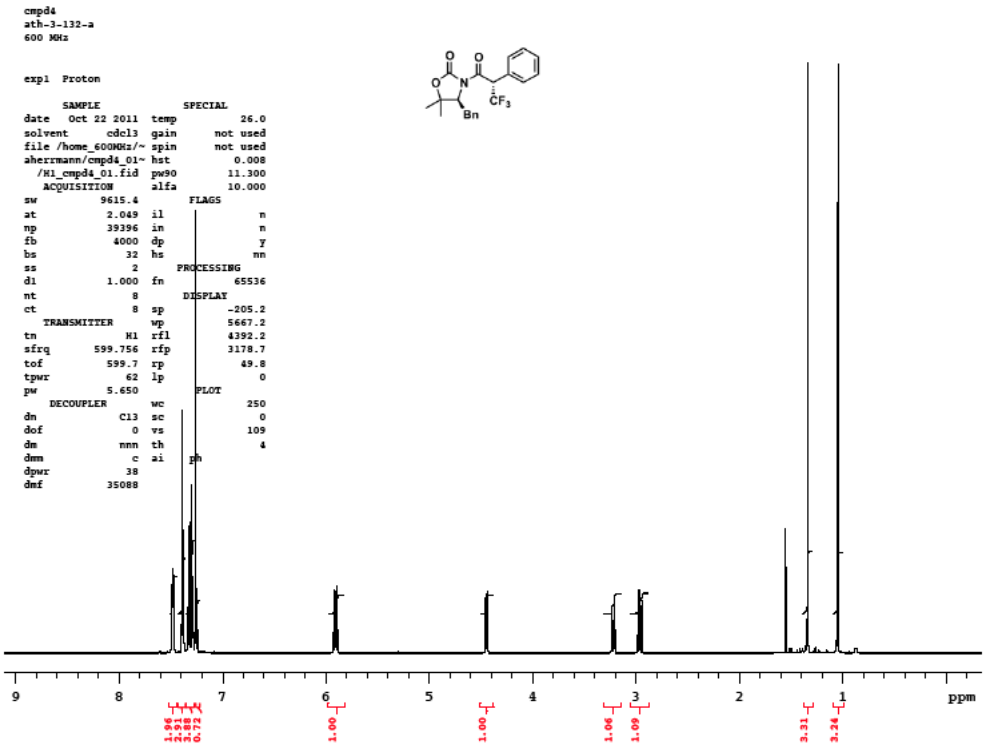

cmpd5
13C
ath-3-159-a
600 MHz
exp1 Carbon
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
ahermann/cmpd5_03~
/C13_cmpd5_01.fid
ACQUISITION
sw 36764.7
at 1.300
np 95624
fb 17000
bs 64
d1 1.000
nt 256
ct 256
TRANSMITTER
tn C13
sfrq 150.824
tof 1542.3
tpwr 57
pw 4.150
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 46
dmf 15291
SPECIAL
temp 26.0
gain 30
spin not used
hst 0.008
pw90 8.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -1457.7
wp 34613.3
rfl 14159.8
rfp 11646.9
rp -42.5
lp 0
PLOT
wc 250
sc 0
vs 29195
th 7
ai ph
Bn
CF3
200
180
160
140
120
100
80
60
40
20
ppm

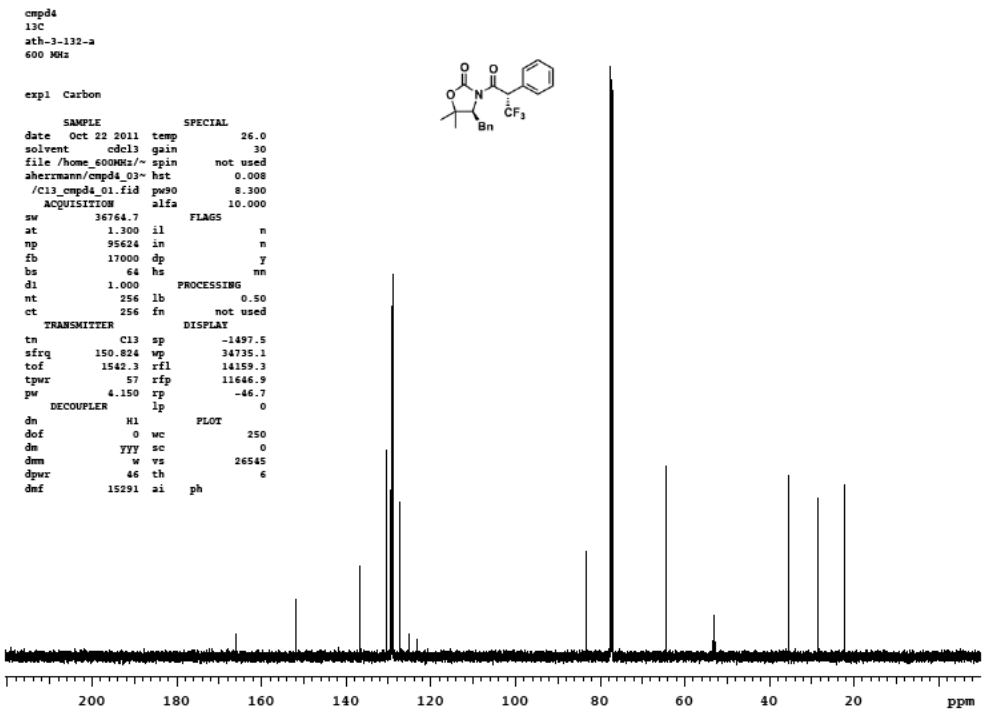

19F
ath-3-159-a
600 MHz
Sample Name:
cmpd5
Archive directory:
Sample directory:
FidFile: F19_cmpd5_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #6, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

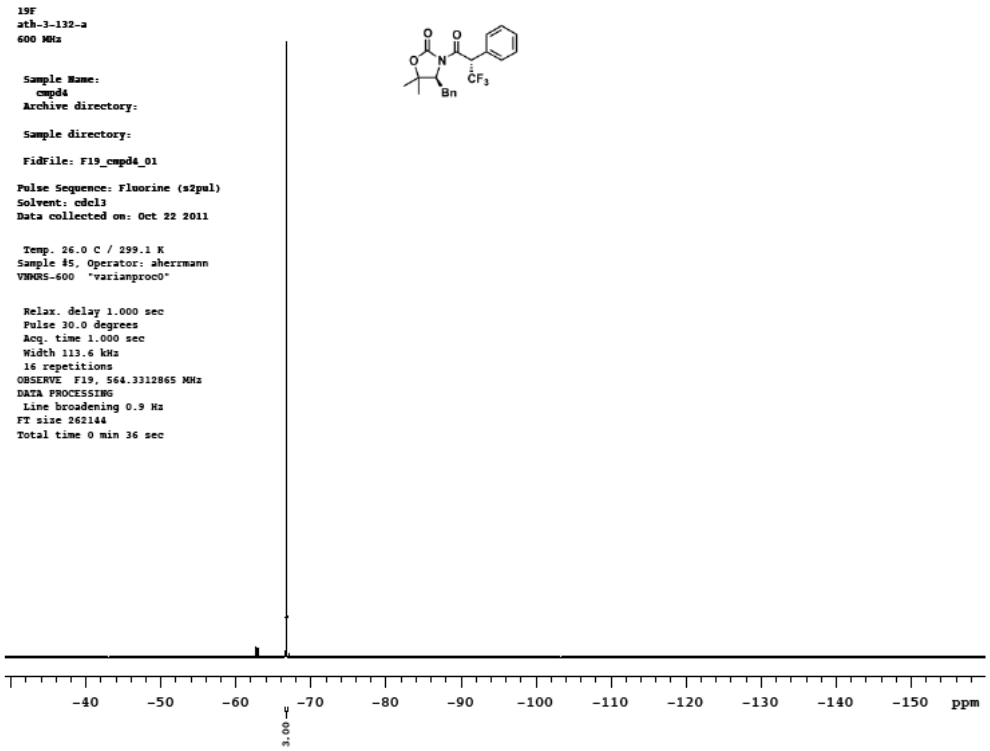

cmpd6
ath-3-167-b
600 MHz
exp1 Proton
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
aherrmann/cmpd6_01~
/H1_cmpd6_01.fid
ACQUISITION
sw 9615.4
at 2.049
np 39396
fb 4000
bs 32
ss 2
d1 1.000
nt 8
ct 8
TRANSMITTER
tn H1
sfrq 599.756
tof 599.7
tpwr 62
pw 5.650
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 35088
SPECIAL
temp 26.0
gain not used
spin not used
hst 0.008
pw90 11.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn 65536
DISPLAY
sp -174.6
wp 5635.2
rfl 2423.2
rfp 1229.5
rp 46.4
lp 9.1
PLOT
wc 250
sc 0
vs 138
th 5
ai ph
9
8
7
6
5
4
3
2
1
ppm
2.40
2.98
2.95
1.03
1.00
3.28
3.03
2.07
1.04
1.08
3.13
3.03

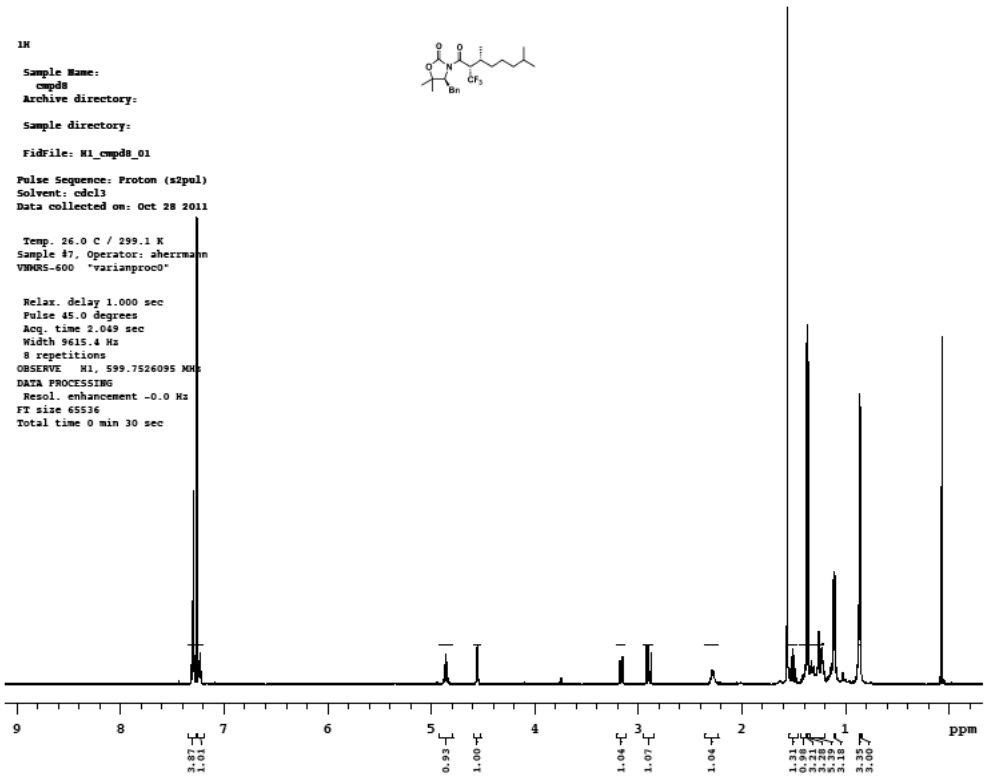

cmpd6
13C
ath-3-167-b
600 MHz
exp1 Carbon
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
aherrmann/cmpd6_03~
/C13_cmpd6_01.fid
ACQUISITION
sw 36764.7
at 1.300
np 95624
fb 17000
bs 64
d1 1.000
nt 256
ct 256
TRANSMITTER
tn C13
sfrq 150.824
tof 1542.3
tpwr 57
pw 4.150
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 46
dmf 15291
SPECIAL
temp 26.0
gain 30
spin not used
hst 0.008
pw90 8.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -1545.2
wp 34775.5
rfl 14166.6
rfp 11646.9
rp -43.2
lp 0
PLOT
wc 250
sc 0
vs 13639
th 8
ai ph
200
180
160
140
120
100
80
60
40
20
ppm

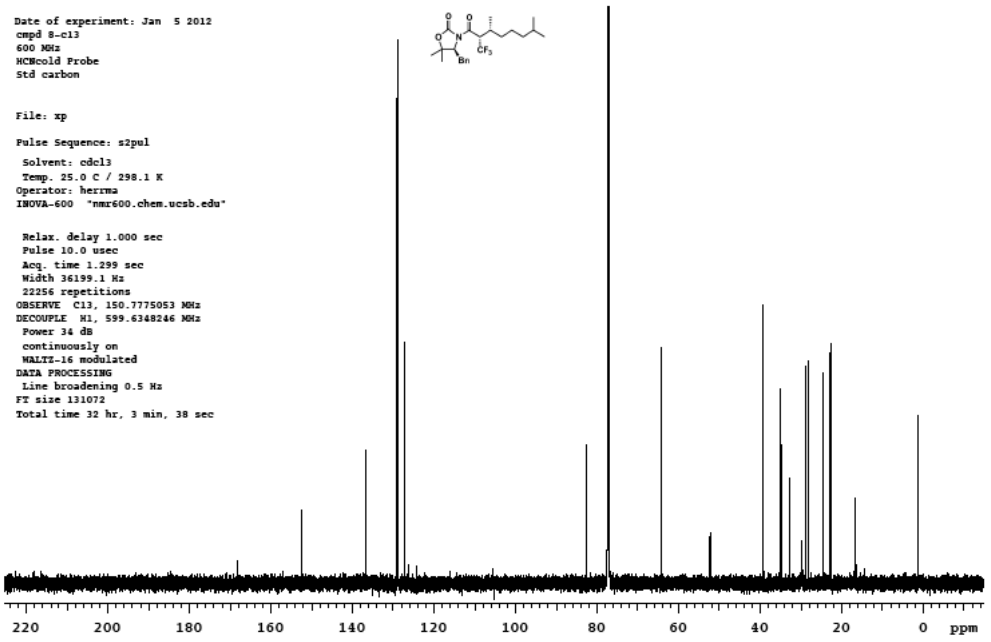

19F
ath-3-167-b
600 MHz
Sample Name:
cmpd6
Archive directory:
Sample directory:
FidFile: F19_cmpd6_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #7, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
OMe
OMe
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

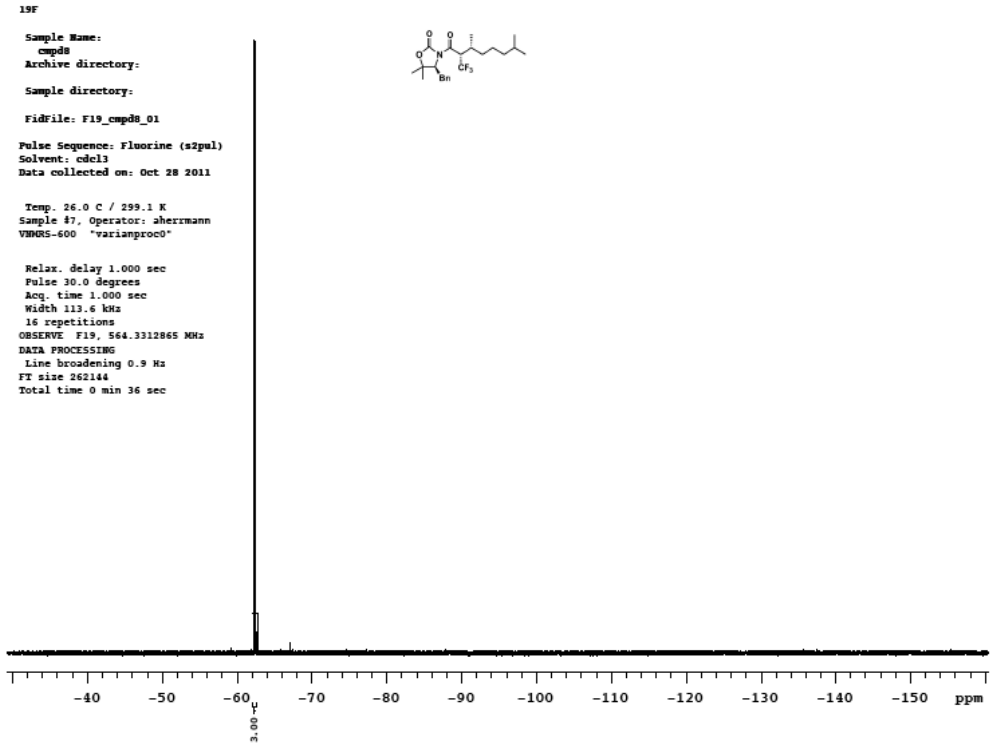

cmpd4
ath-3-132-a
600 MHz
exp1 Proton
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
ahermann/cmpd4_01~
/H1_cmpd4_01.fid
ACQUISITION
sw 9615.4
at 2.049
np 39396
fb 4000
bs 32
ss 2
d1 1.000
nt 8
ct 8
TRANSMITTER
tn H1
sfrq 599.756
tof 599.7
tpwr 62
pw 5.650
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 35088
SPECIAL
temp 26.0
gain not used
spin not used
hst 0.008
pw90 11.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn 65536
DISPLAY
sp -205.2
wp 5667.2
rfl 4392.2
rfp 3178.7
rp 49.8
lp 0
PLOT
wc 250
sc 0
vs 109
th 4
ai ph
Bn
CF3
9
8
7
6
5
4
3
2
1
ppm
1.96
2.01
3.88
0.72
1.00
1.00
1.06
1.09
3.31
3.24

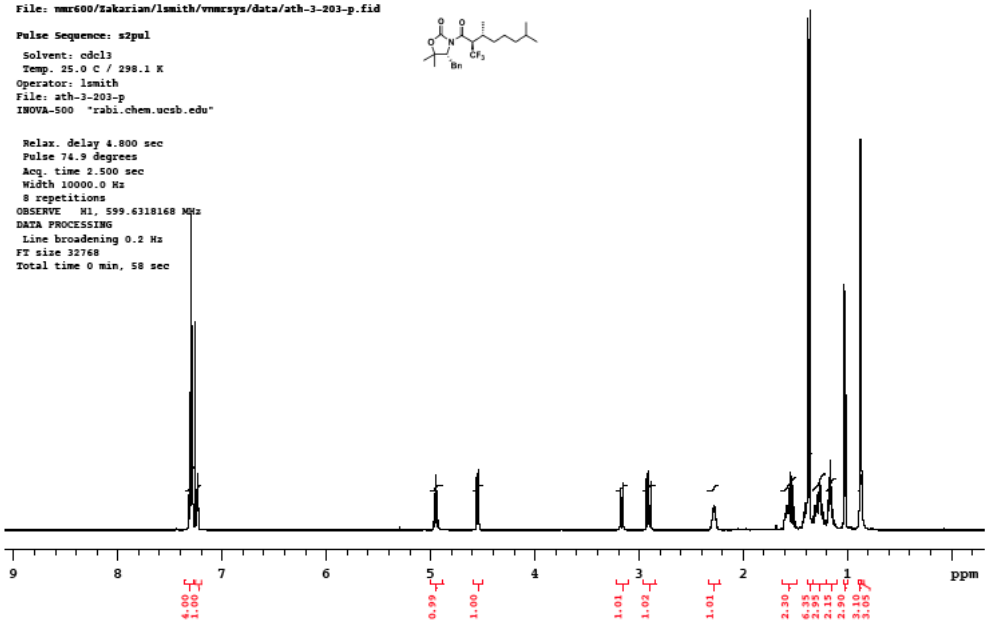

cmpd4
13C
ath-3-132-a
600 MHz
exp1 Carbon
SAMPLE
date Oct 22 2011
solvent cdcl3
file /home_600MHz/~
ahermann/cmpd4_03~
/C13_cmpd4_01.fid
ACQUISITION
sw 36764.7
at 1.300
np 95624
fb 17000
bs 64
d1 1.000
nt 256
ct 256
TRANSMITTER
tn C13
sfrq 150.824
tof 1542.3
tpwr 57
pw 4.150
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 46
dmf 15291
SPECIAL
temp 26.0
gain 30
spin not used
hst 0.008
pw90 8.300
alfa 10.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 0.50
fn not used
DISPLAY
sp -1497.5
wp 34735.1
rfl 14159.3
rfp 11646.9
rp -46.7
lp 0
PLOT
wc 250
sc 0
vs 26545
th 6
ai ph
Bn
CF3
200
180
160
140
120
100
80
60
40
20
ppm

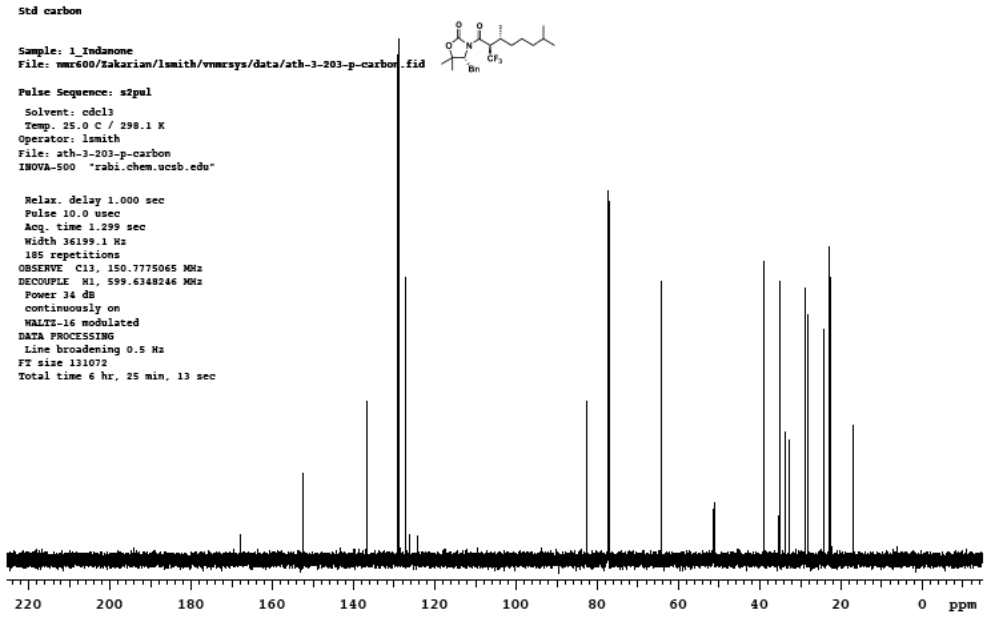

19F
ath-3-132-a
600 MHz
Sample Name:
cmpd4
Archive directory:
Sample directory:
FidFile: F19_cmpd4_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 22 2011
Temp. 26.0 C / 299.1 K
Sample #5, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
O
N
O
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

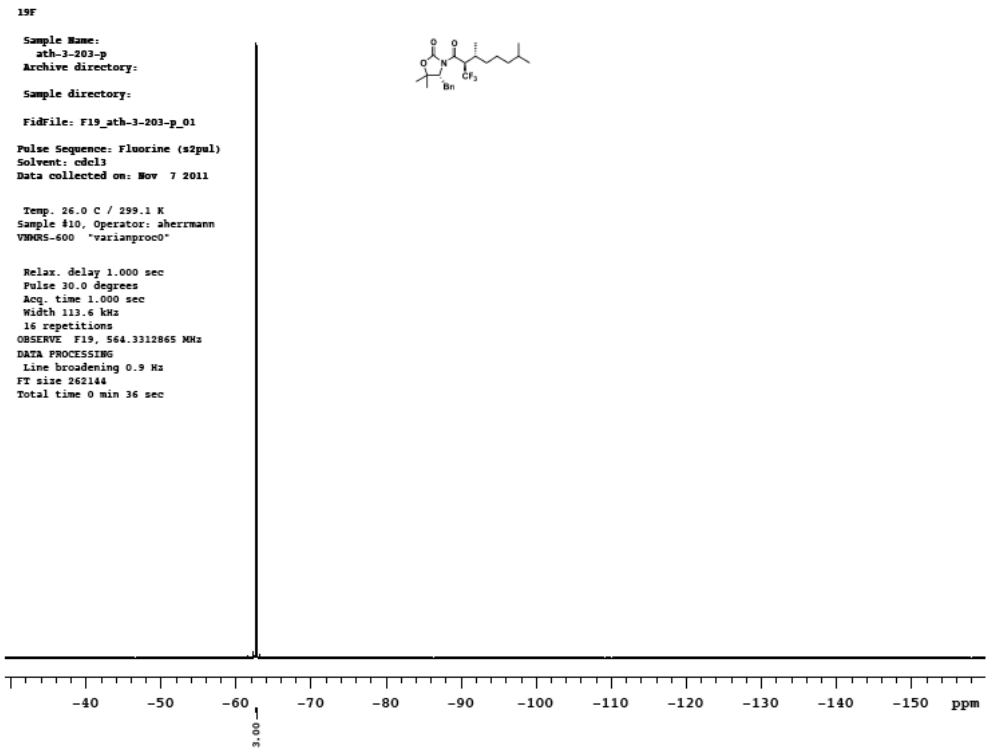

1H
Sample Name:
cmpd8
Archive directory:
Sample directory:
FidFile: H1_cmpd8_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample 47, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526095 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
9
8
7
6
5
4
3
2
1
ppm
3.87
1.01
0.93
1.00
1.04
1.07
1.04
1.31
0.98
3.21
3.20
3.19
3.35
3.00

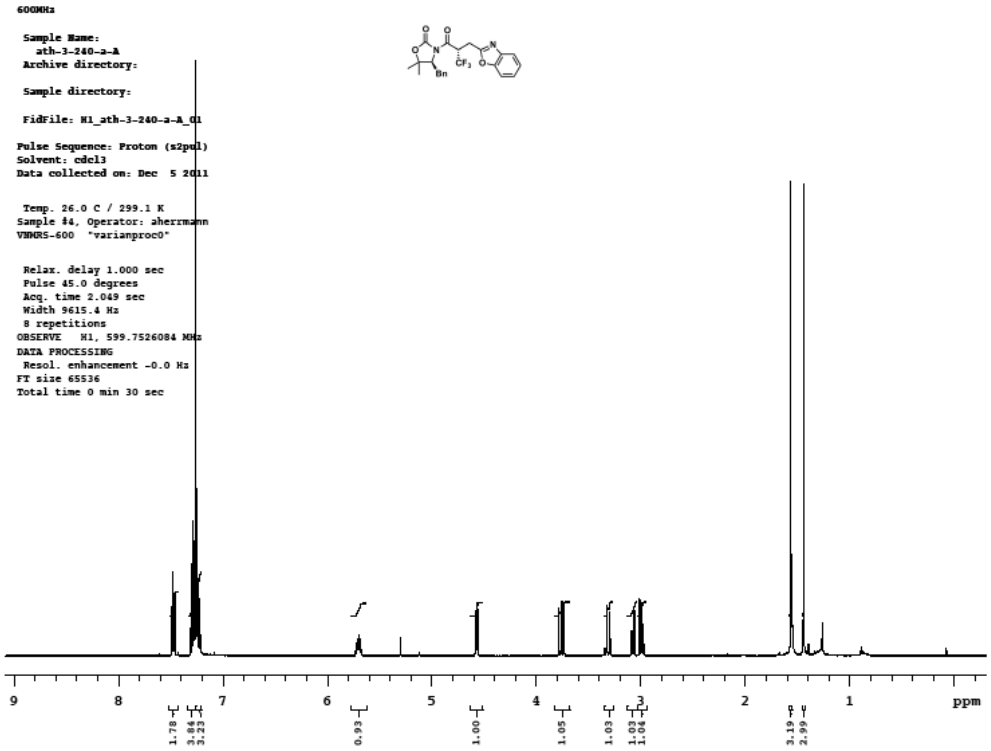

Date of experiment: Jan 5 2012
cmpd 8-c13
600 MHz
HCBcold Probe
Std carbon
File: xp
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
INOVA-600 "nmr600.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
22256 repetitions
OBSERVE C13, 150.7775053 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 32 hr, 3 min, 38 sec
220
200
180
160
140
120
100
80
60
40
20
0
ppm

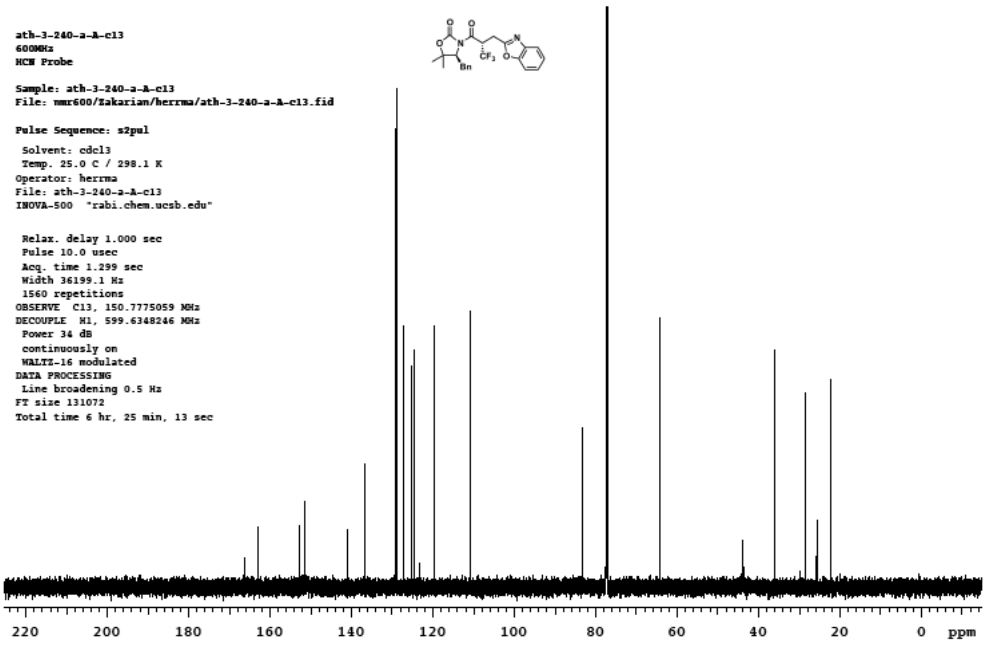

19F
Sample Name:
cmpd8
Archive directory:
Sample directory:
FidFile: F19_cmpd8_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Oct 28 2011
Temp. 26.0 C / 299.1 K
Sample #7, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

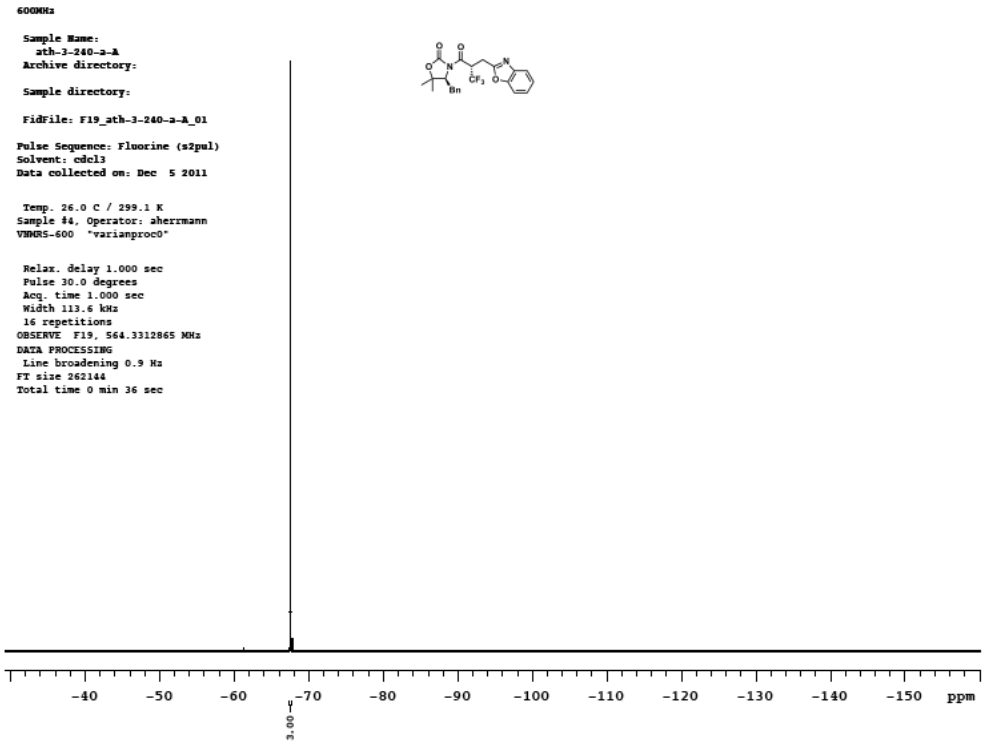

File: nmr600/Zakarian/lsmith/vnmrsys/data/ath-3-203-p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ath-3-203-p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
9
8
7
6
5
4
3
2
1
ppm
1.00
1.00
0.99
1.00
1.01
1.02
1.01
2.30
6.35
2.95
2.15
2.90
3.10
3.05

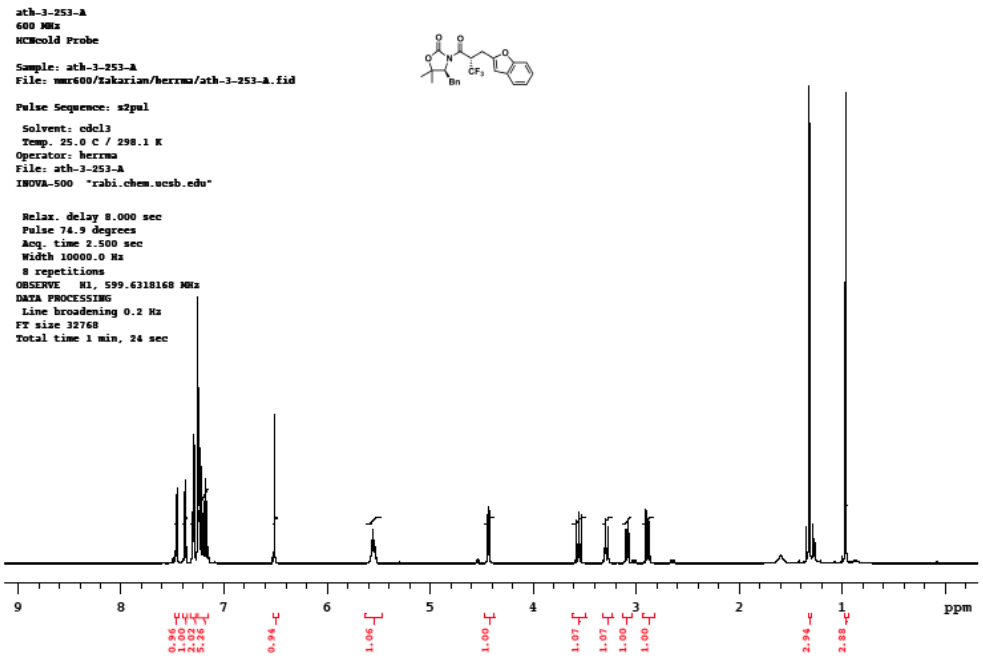

Std carbon
Sample: 1_Indanone
File: nmr600/Zakarian/lsmith/vnmrsys/data/ath-3-203-p-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ath-3-203-p-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
185 repetitions
OBSERVE C13, 150.7775065 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
220
200
180
160
140
120
100
80
60
40
20
0
ppm

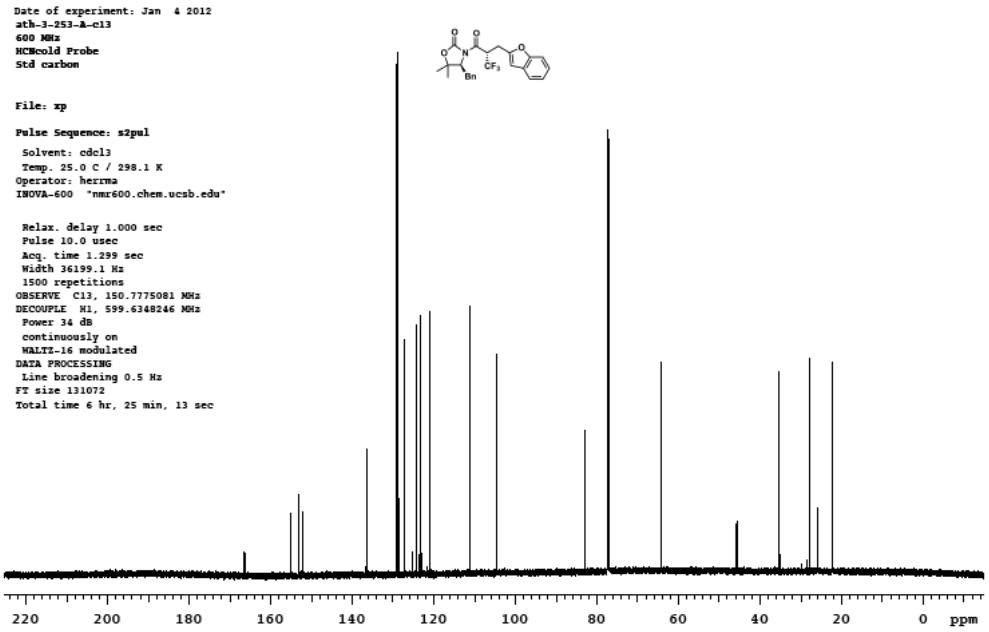

19F
Sample Name:
ath-3-203-p
Archive directory:
Sample directory:
FidFile: F19_ath-3-203-p_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Nov 7 2011
Temp. 26.0 C / 299.1 K
Sample #10, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
Bn
CF3
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

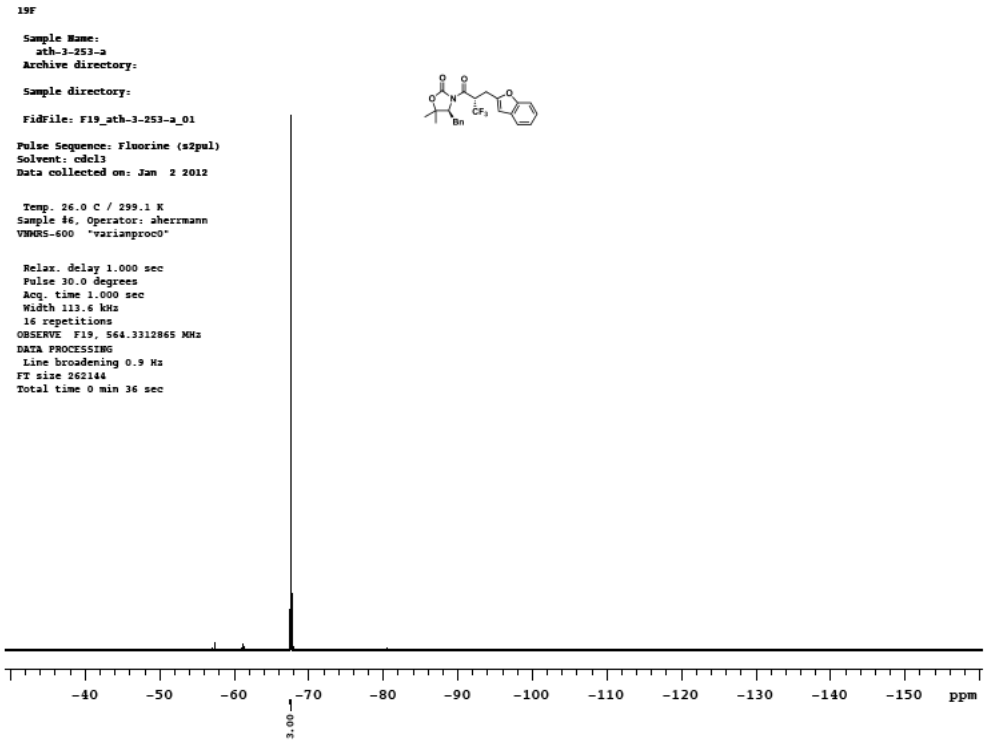

600MHz
Sample Name:
ath-3-240-a-A
Archive directory:
Sample directory:
FidFile: H1_ath-3-240-a-A_01
Pulse Sequence: Proton (s2pul)
Solvent: cdcl3
Data collected on: Dec 5 2011
Temp. 26.0 C / 299.1 K
Sample #4, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 2.049 sec
Width 9615.4 Hz
8 repetitions
OBSERVE H1, 599.7526084 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 65536
Total time 0 min 30 sec
9
8
7
6
5
4
3
2
1
ppm
1.78
3.84
3.23
0.93
1.00
1.05
1.03
1.03
1.04
3.19
2.99

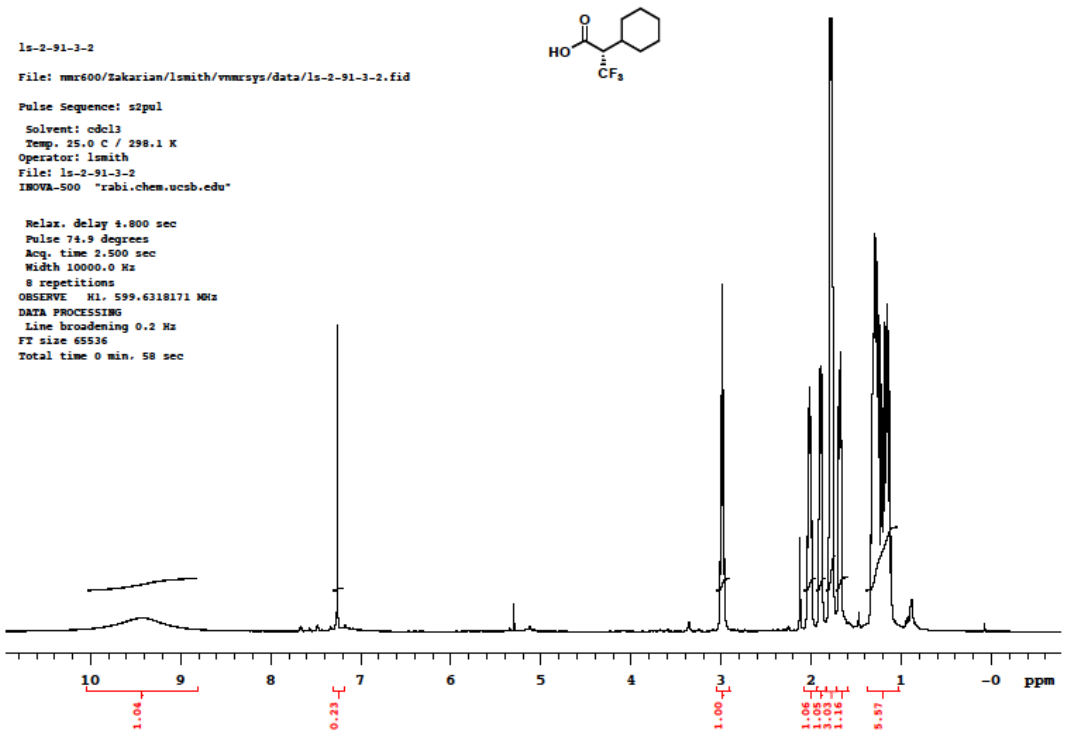

ath-3-240-a-A-c13
600MHz
HCN Probe
Sample: ath-3-240-a-A-c13
File: nmr600/Zakarian/herrma/ath-3-240-a-A-c13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
File: ath-3-240-a-A-c13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
1560 repetitions
OBSERVE C13, 150.7775059 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
220
200
180
160
140
120
100
80
60
40
20
0
ppm

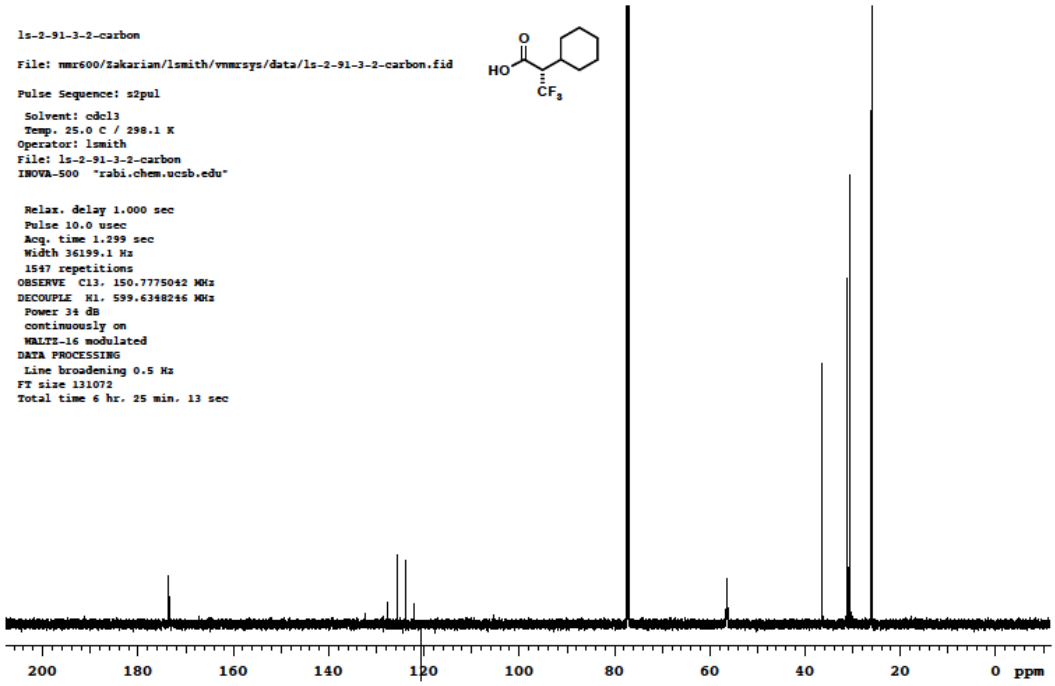

600MHz
Sample Name:
ath-3-240-a-A
Archive directory:
Sample directory:
FidFile: F19_ath-3-240-a-A_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Dec 5 2011
Temp. 26.0 C / 299.1 K
Sample 84, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
N
O
Bn
CF3
N
O
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

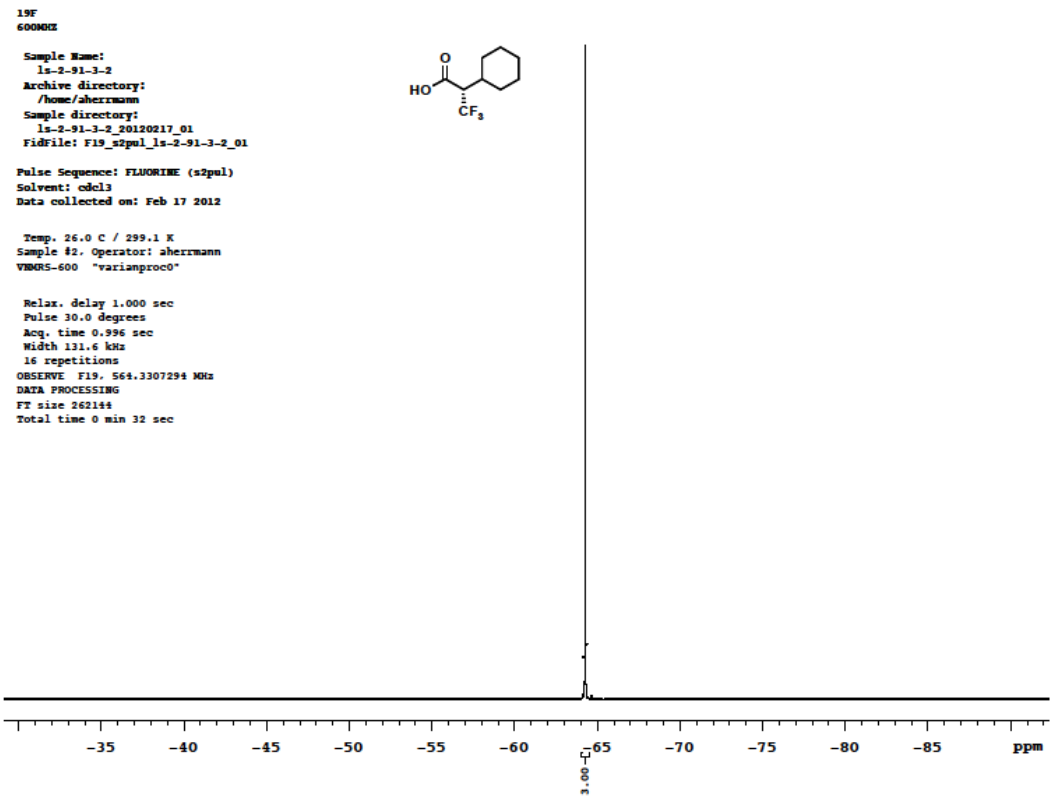

ath-3-253-A
600 MHz
HCNcold Probe
Sample: ath-3-253-A
File: nmr600/Zakarian/herrma/ath-3-253-A.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
File: ath-3-253-A
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 8.000 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 24 sec
9
8
7
6
5
4
3
2
1
ppm
0.96
1.00
1.03
5.26
0.94
1.06
1.00
1.07
1.07
1.00
1.00
2.94
2.88

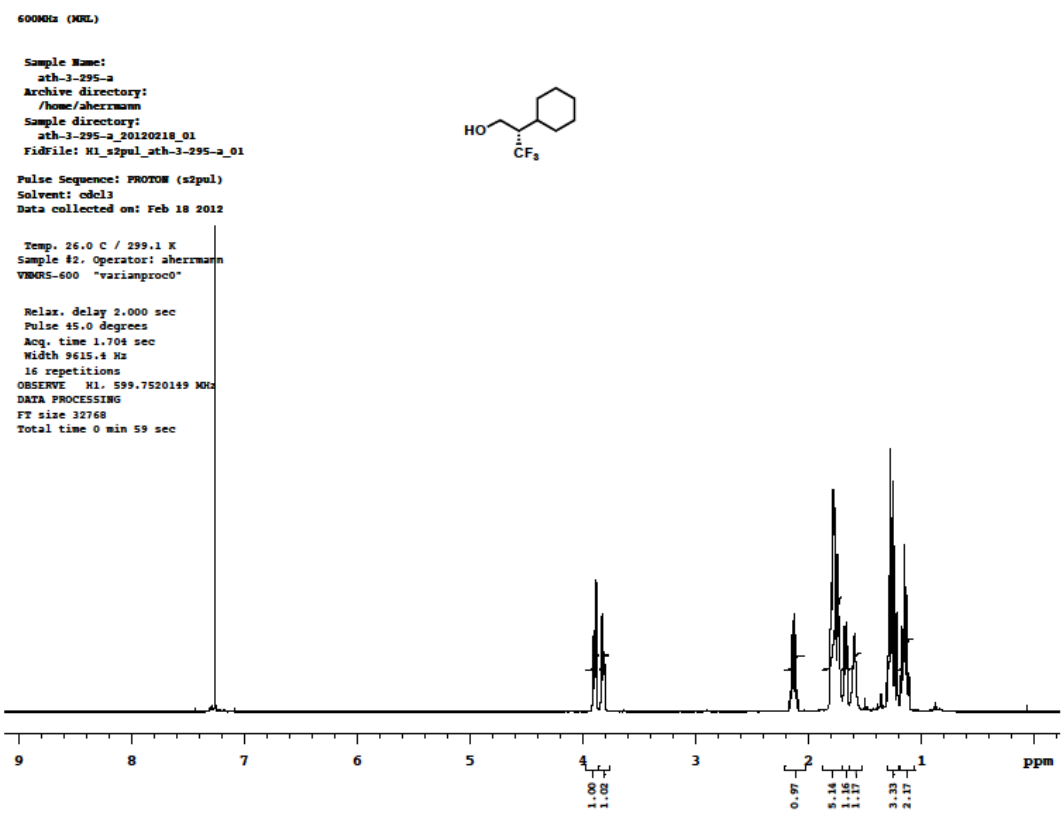

Date of experiment: Jan 4 2012
ath-3-253-A-c13
600 MHz
HCNcold Probe
Std carbon
File: xp
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: herrma
INOVA-600 "nmr600.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
1500 repetitions
OBSERVE C13, 150.7775081 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
220
200
180
160
140
120
100
80
60
40
20
0
ppm

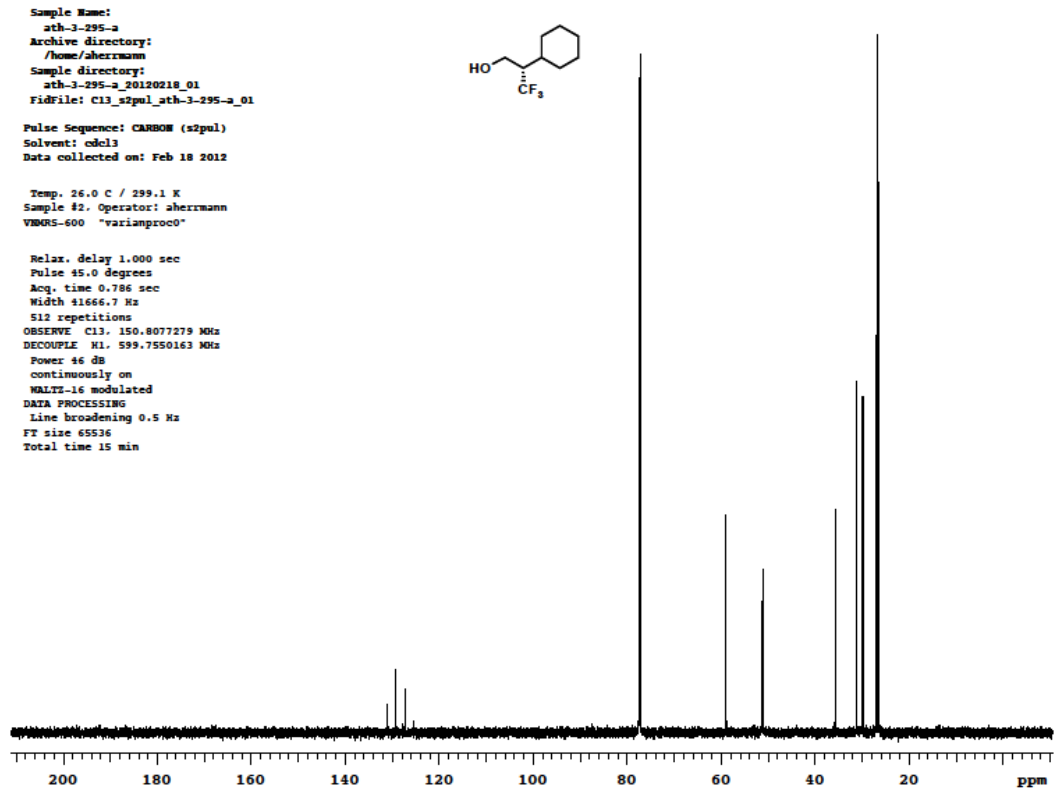

19F
Sample Name:
ath-3-253-a
Archive directory:
Sample directory:
FidFile: F19_ath-3-253-a_01
Pulse Sequence: Fluorine (s2pul)
Solvent: cdcl3
Data collected on: Jan 2 2012
Temp. 26.0 C / 299.1 K
Sample #6, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.000 sec
Width 113.6 kHz
16 repetitions
OBSERVE F19, 564.3312865 MHz
DATA PROCESSING
Line broadening 0.9 Hz
FT size 262144
Total time 0 min 36 sec
O
O
N
O
Bn
CF3
O
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.00

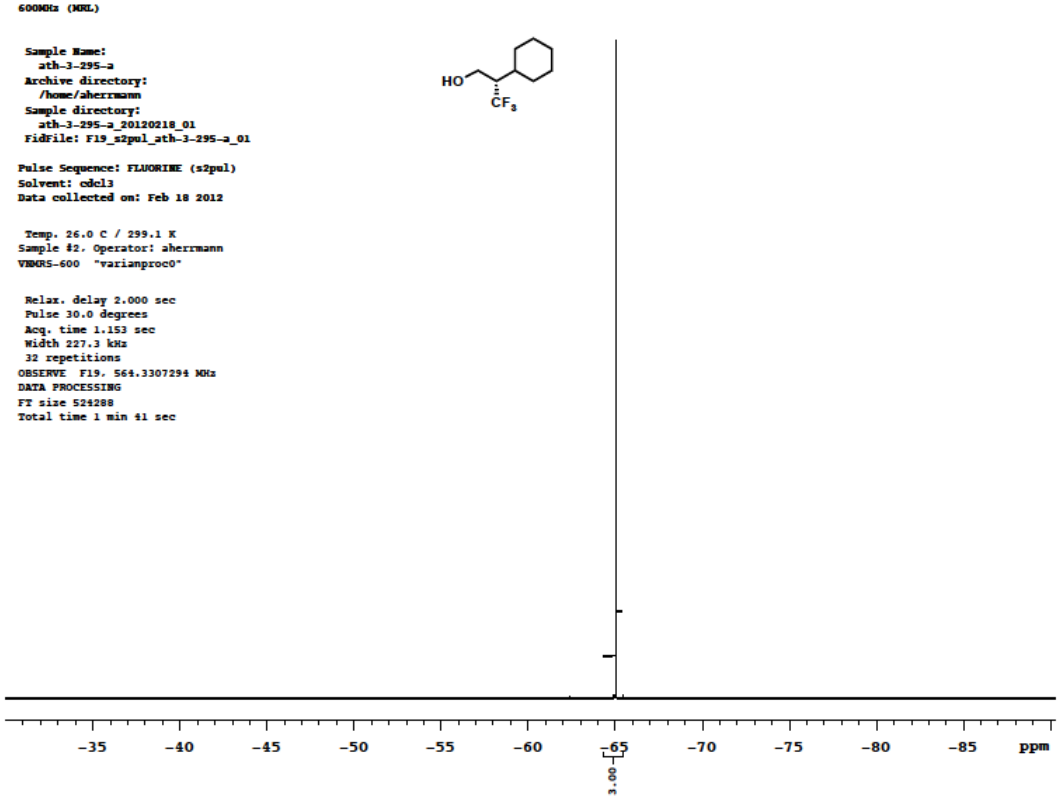

ls-2-91-3-2
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-2-91-3-2.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-2-91-3-2
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318171 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 65536
Total time 0 min, 58 sec
HO
O
CF3
10
9
8
7
6
5
4
3
2
1
−0
ppm
1.04
0.23
1.00
1.06
1.05
1.03
1.16
5.57

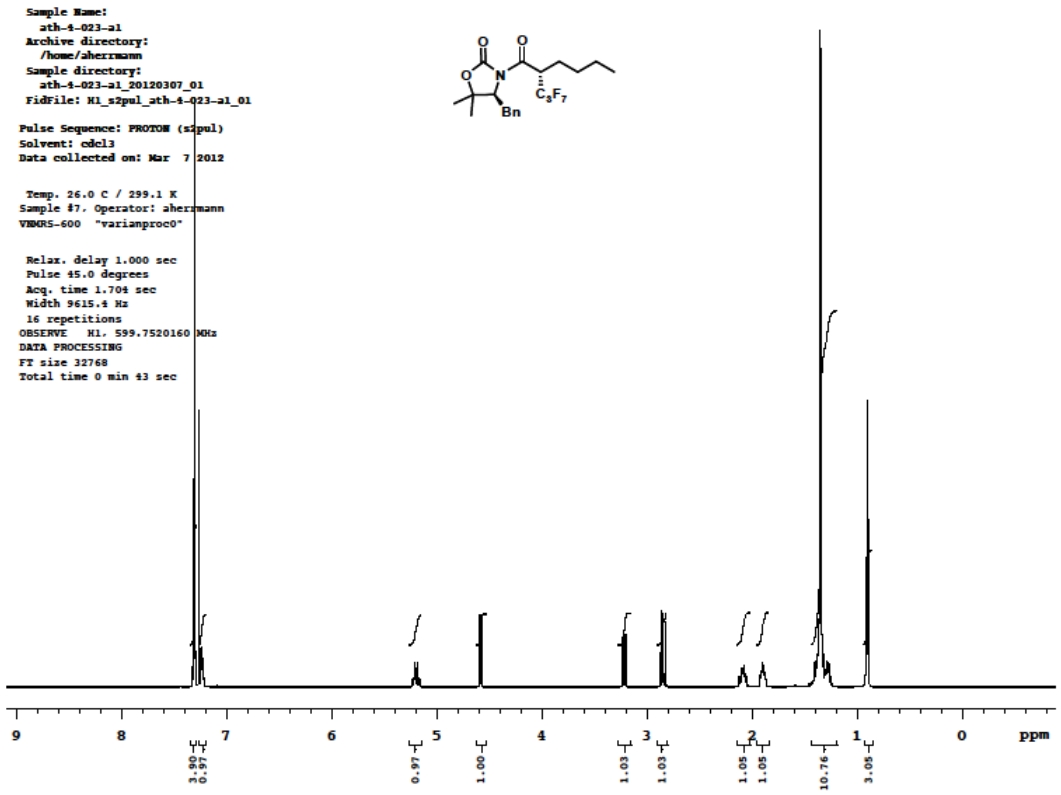

ls-2-91-3-2-carbon
File: nmr600/Zakarian/lsmith/vnmrsys/data/ls-2-91-3-2-carbon.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: lsmith
File: ls-2-91-3-2-carbon
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
1547 repetitions
OBSERVE C13, 150.7775042 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
HO
O
CF3
200
180
160
140
120
100
80
60
40
20
0
ppm

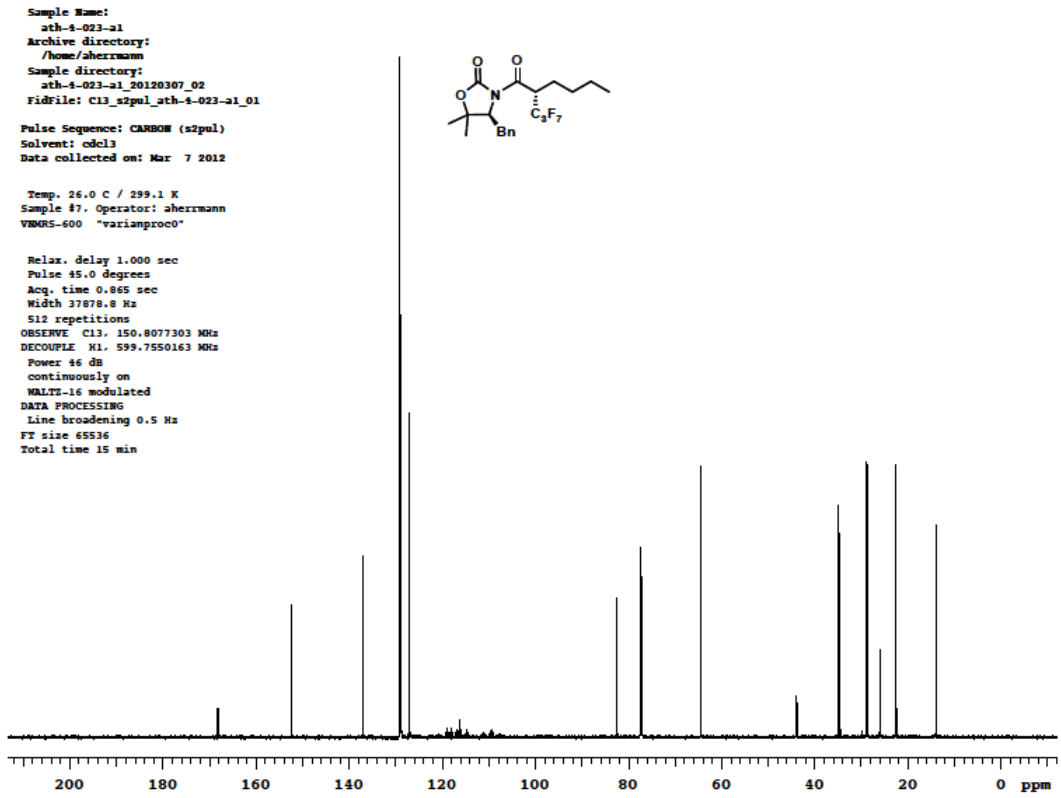

19F
600MHz
Sample Name:
ls-2-91-3-2
Archive directory:
/home/aherrmann
Sample directory:
ls-2-91-3-2_20120217_01
FidFile: F19_s2pul_ls-2-91-3-2_01
Pulse Sequence: FLUORINE (s2pul)
Solvent: cdcl3
Data collected on: Feb 17 2012
Temp. 26.0 C / 299.1 K
Sample #2, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 0.996 sec
Width 131.6 kHz
16 repetitions
OBSERVE F19, 564.3307294 MHz
DATA PROCESSING
FT size 262144
Total time 0 min 32 sec
HO
O
CF3
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
ppm
3.00

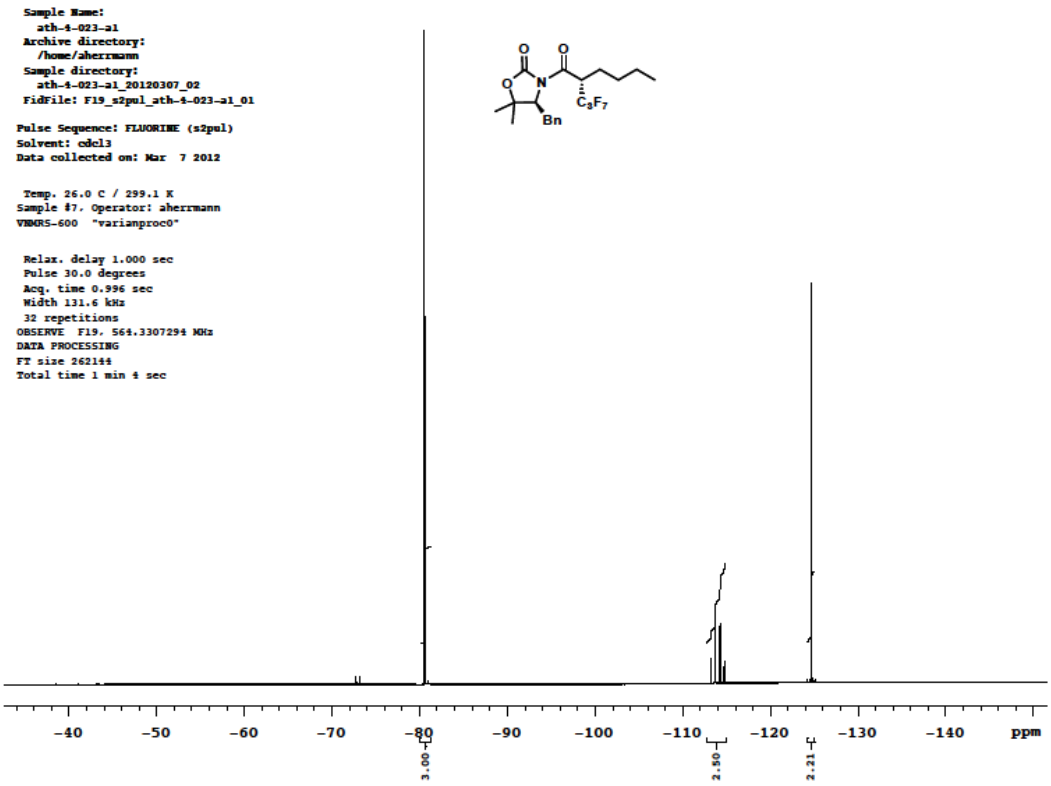

600MHz (MRL)
Sample Name:
ath-3-295-a
Archive directory:
/home/aherrmann
Sample directory:
ath-3-295-a_20120218_01
FidFile: H1_s2pul_ath-3-295-a_01
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Feb 18 2012
Temp. 26.0 C / 299.1 K
Sample #2, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 2.000 sec
Pulse 45.0 degrees
Acq. time 1.704 sec
Width 9615.4 Hz
16 repetitions
OBSERVE H1, 599.7520149 MHz
DATA PROCESSING
FT size 32768
Total time 0 min 59 sec
HO
CF3
9
8
7
6
5
4
3
2
1
ppm
1.00
1.02
0.97
5.14
1.16
1.17
3.33
2.17

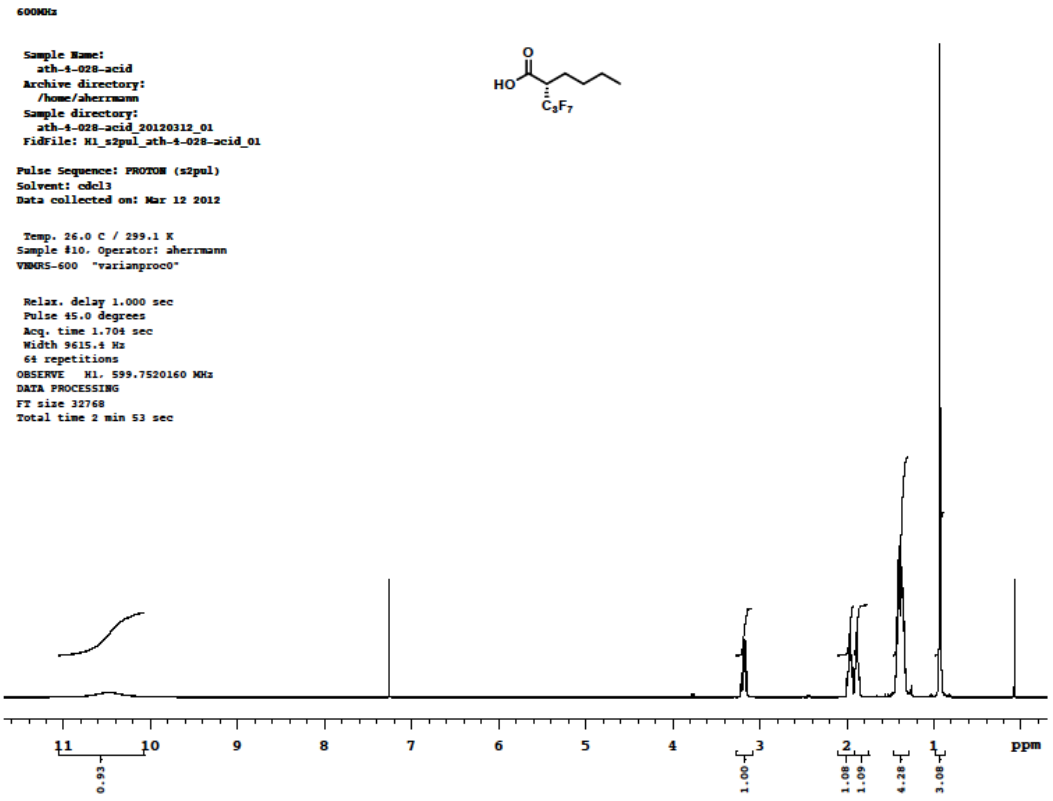

Sample Name:
ath-3-295-a
Archive directory:
/home/aherrmann
Sample directory:
ath-3-295-a_20120218_01
FidFile: C13_s2pul_ath-3-295-a_01
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Feb 18 2012
Temp. 26.0 C / 299.1 K
Sample #2, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 0.786 sec
Width 41666.7 Hz
512 repetitions
OBSERVE C13, 150.8077279 MHz
DECOUPLE H1, 599.7550163 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 65536
Total time 15 min
HO
CF3
200
180
160
140
120
100
80
60
40
20
ppm

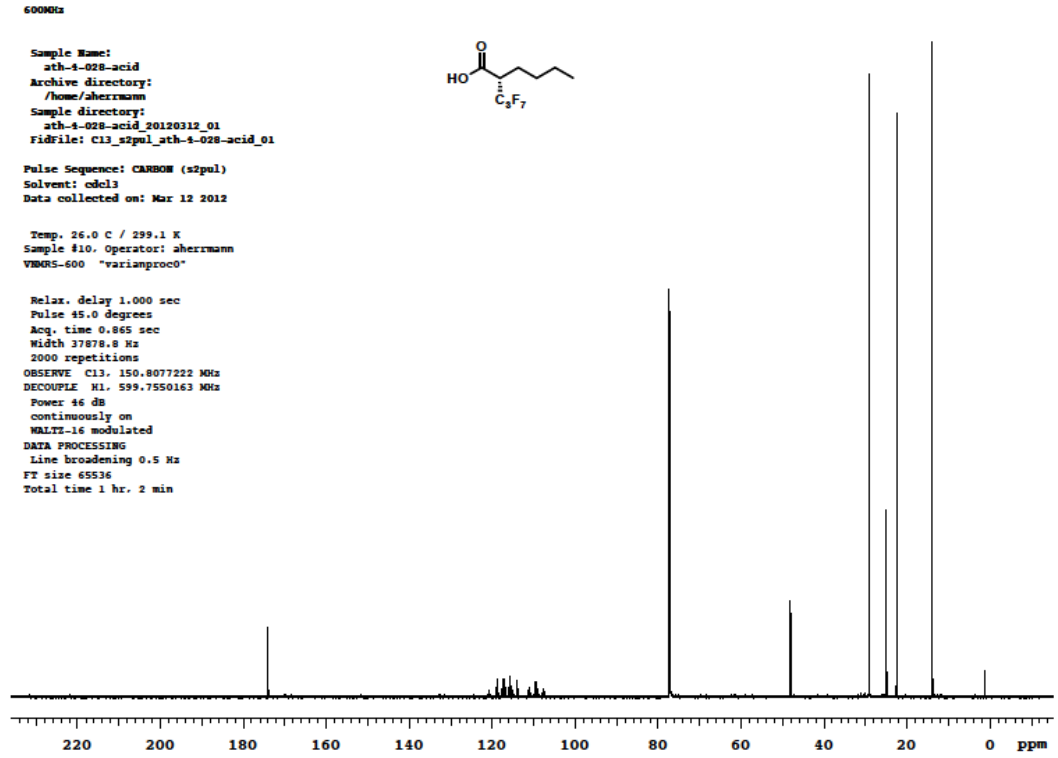

600MHz (MRL)
Sample Name:
ath-3-295-a
Archive directory:
/home/aherrmann
Sample directory:
ath-3-295-a_20120218_01
FidFile: F19_s2pul_ath-3-295-a_01
Pulse Sequence: FLUORINE (s2pul)
Solvent: cdcl3
Data collected on: Feb 18 2012
Temp. 26.0 C / 299.1 K
Sample #2, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 2.000 sec
Pulse 30.0 degrees
Acq. time 1.153 sec
Width 227.3 kHz
32 repetitions
OBSERVE F19, 564.3307294 MHz
DATA PROCESSING
FT size 524288
Total time 1 min 41 sec
HO
CF3
-35
-40
-45
-50
-55
-60
-65
-70
-75
-80
-85
ppm
3.00

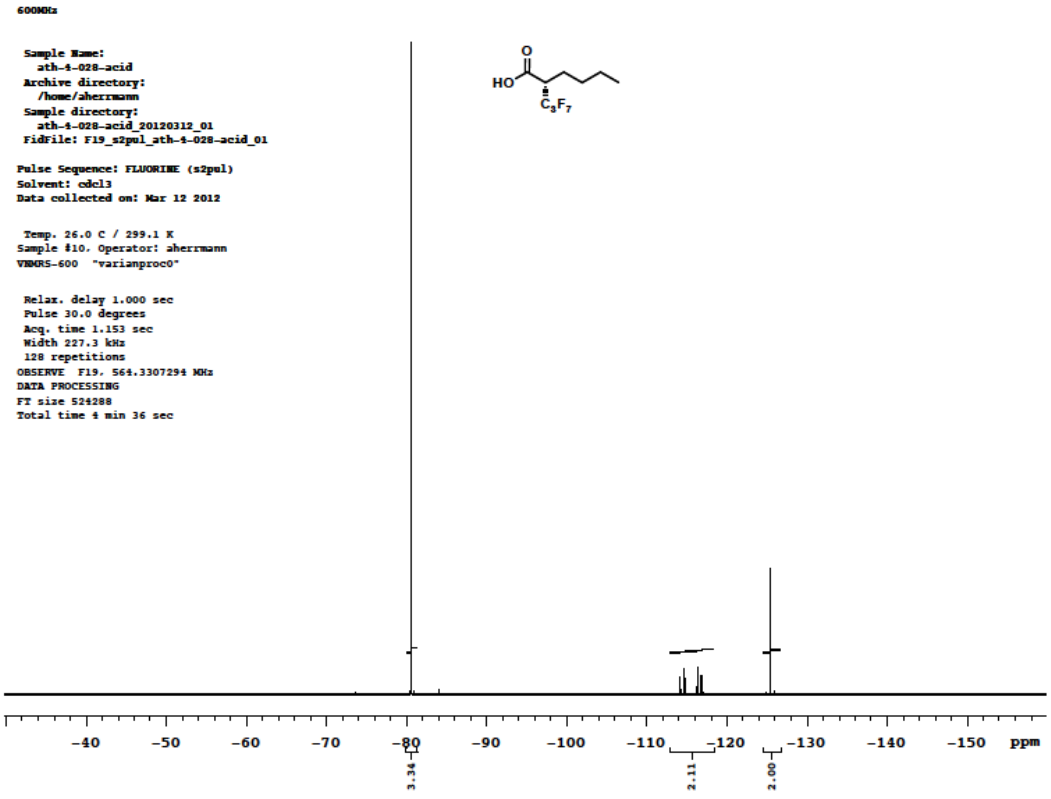

Sample Name:
ath-4-023-a1
Archive directory:
/home/aherrmann
Sample directory:
ath-4-023-a1_20120307_01
FidFile: H1_s2pul_ath-4-023-a1_01
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Mar 7 2012
Temp. 26.0 C / 299.1 K
Sample #7, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.704 sec
Width 9615.4 Hz
16 repetitions
OBSERVE H1, 599.7520160 MHz
DATA PROCESSING
FT size 32768
Total time 0 min 43 sec
O
O
O
N
Bn
C3F7
9
8
7
6
5
4
3
2
1
0
ppm
3.90
0.97
0.97
1.00
1.03
1.03
1.05
1.05
10.76
3.05

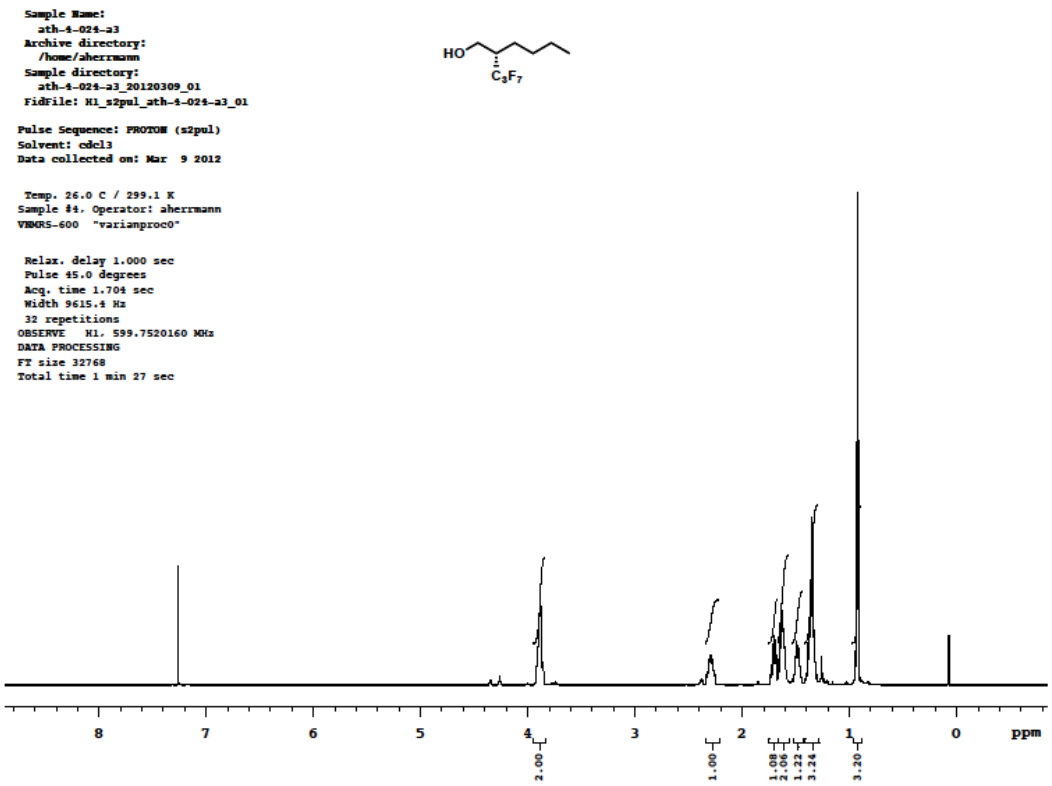

Sample Name:
ath-4-023-a1
Archive directory:
/home/aherrmann
Sample directory:
ath-4-023-a1_20120307_02
FidFile: C13_s2pul_ath-4-023-a1_01
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Mar 7 2012
Temp. 26.0 C / 299.1 K
Sample #7, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 0.865 sec
Width 37878.8 Hz
512 repetitions
OBSERVE C13, 150.8077303 MHz
DECOUPLE H1, 599.7550163 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 65536
Total time 15 min
O
O
O
N
Bn
C3F7
200
180
160
140
120
100
80
60
40
20
0
ppm

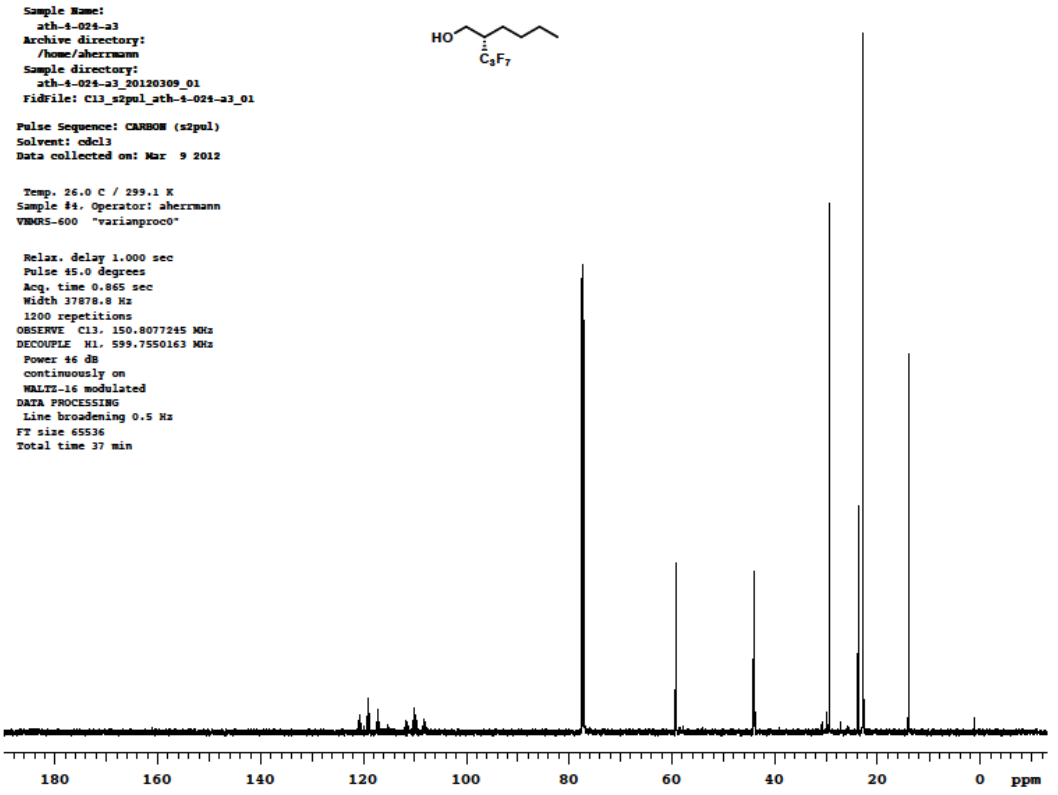

Sample Name:
ath-4-023-a1
Archive directory:
/home/aherrmann
Sample directory:
ath-4-023-a1_20120307_02
FidFile: F19_s2pul_ath-4-023-a1_01
Pulse Sequence: FLUORINE (s2pul)
Solvent: cdcl3
Data collected on: Mar 7 2012
Temp. 26.0 C / 299.1 K
Sample #7. Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 0.996 sec
Width 131.6 kHz
32 repetitions
OBSERVE F19, 564.3307294 MHz
DATA PROCESSING
FT size 262144
Total time 1 min 4 sec
O
O
O
N
Bn
C3F7
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
ppm
3.00
2.50
2.21

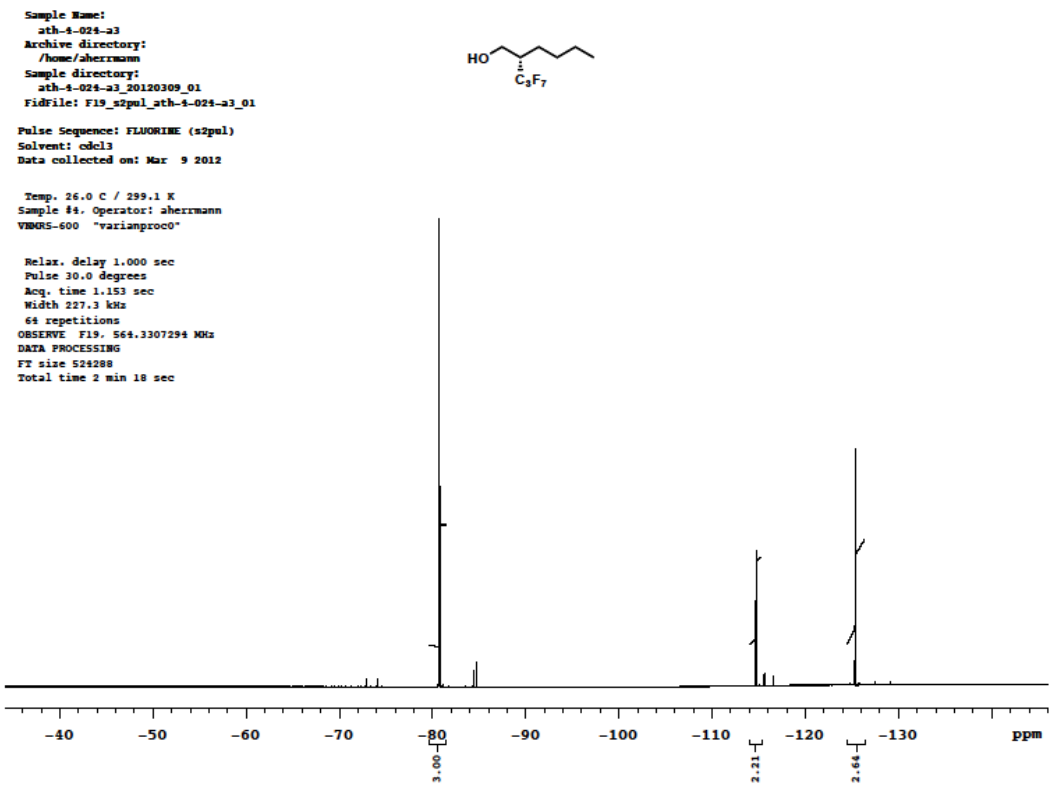

600MHz
Sample Name:
ath-4-028-acid
Archive directory:
/home/aherrmann
Sample directory:
ath-4-028-acid_20120312_01
FidFile: H1_s2pul_ath-4-028-acid_01
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Mar 12 2012
Temp. 26.0 C / 299.1 K
Sample #10, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.704 sec
Width 9615.4 Hz
64 repetitions
OBSERVE H1, 599.7520160 MHz
DATA PROCESSING
FT size 32768
Total time 2 min 53 sec
HO
O
C3F7
11
10
9
8
7
6
5
4
3
2
1
ppm
0.93
1.00
1.08
1.09
4.28
3.08


600MHz
Sample Name:
ath-4-028-acid
Archive directory:
/home/aherrmann
Sample directory:
ath-4-028-acid_20120312_01
FidFile: C13_s2pul_ath-4-028-acid_01
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Mar 12 2012
Temp. 26.0 C / 299.1 K
Sample #10, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 0.865 sec
Width 37878.8 Hz
2000 repetitions
OBSERVE C13, 150.8077222 MHz
DECOUPLE H1, 599.7550163 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 65536
Total time 1 hr, 2 min
HO
O
C3F7
220
200
180
160
140
120
100
80
60
40
20
0
ppm


600MHz
Sample Name:
ath-4-028-acid
Archive directory:
/home/aherrmann
Sample directory:
ath-4-028-acid_20120312_01
FidFile: F19_s2pul_ath-4-028-acid_01
Pulse Sequence: FLUORINE (s2pul)
Solvent: cdcl3
Data collected on: Mar 12 2012
Temp. 26.0 C / 299.1 K
Sample #10, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.153 sec
Width 227.3 kHz
128 repetitions
OBSERVE F19, 564.3307294 MHz
DATA PROCESSING
FT size 524288
Total time 4 min 36 sec
HO
O
C3F7
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
ppm
3.34
2.11
2.00


Sample Name:
ath-4-024-a3
Archive directory:
/home/aherrmann
Sample directory:
ath-4-024-a3_20120309_01
FidFile: H1_s2pul_ath-4-024-a3_01
Pulse Sequence: PROTON (s2pul)
Solvent: cdcl3
Data collected on: Mar 9 2012
Temp. 26.0 C / 299.1 K
Sample #4, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.704 sec
Width 9615.4 Hz
32 repetitions
OBSERVE H1, 599.7520160 MHz
DATA PROCESSING
FT size 32768
Total time 1 min 27 sec
HO
C3F7
8
7
6
5
4
3
2
1
0
ppm
2.00
1.00
1.08
2.06
1.22
3.24
3.20

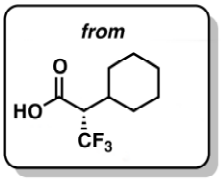

Sample Name:
ath-4-024-a3
Archive directory:
/home/aherrmann
Sample directory:
ath-4-024-a3_20120309_01
FidFile: C13_s2pul_ath-4-024-a3_01
Pulse Sequence: CARBON (s2pul)
Solvent: cdcl3
Data collected on: Mar 9 2012
Temp. 26.0 C / 299.1 K
Sample #4, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 0.865 sec
Width 37878.8 Hz
1200 repetitions
OBSERVE C13, 150.8077245 MHz
DECOUPLE H1, 599.7550163 MHz
Power 46 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 65536
Total time 37 min
HO
C3F7
180
160
140
120
100
80
60
40
20
0
ppm


Sample Name:
ath-4-024-a3
Archive directory:
/home/aherrmann
Sample directory:
ath-4-024-a3_20120309_01
FidFile: F19_s2pul_ath-4-024-a3_01
Pulse Sequence: FLUORINE (s2pul)
Solvent: cdcl3
Data collected on: Mar 9 2012
Temp. 26.0 C / 299.1 K
Sample #4, Operator: aherrmann
VNMRS-600 "varianproc0"
Relax. delay 1.000 sec
Pulse 30.0 degrees
Acq. time 1.153 sec
Width 227.3 kHz
64 repetitions
OBSERVE F19, 564.3307294 MHz
DATA PROCESSING
FT size 524288
Total time 2 min 18 sec
HO
C3F7
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
ppm
3.00
2.21
2.64

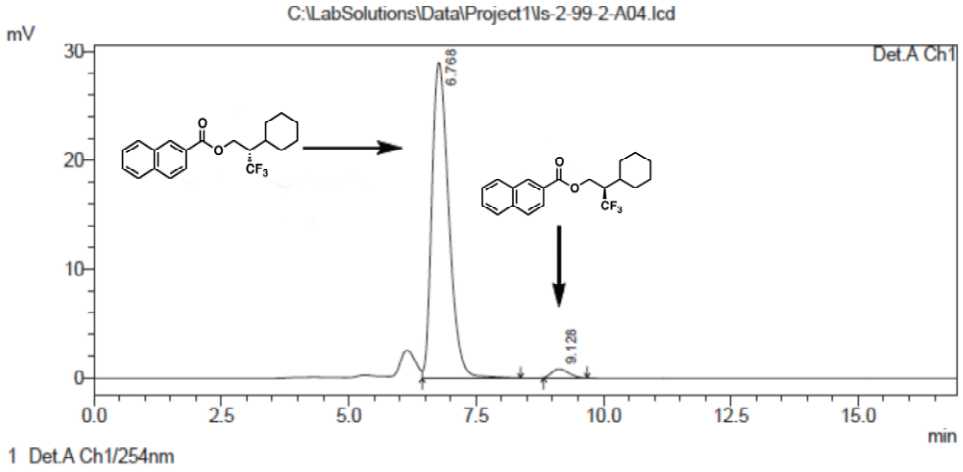
==== Shimadzu LCsolution Analysis Report ====

C:\LabSolutions\Data\Project1\ls-2-99-2-A04.lcd

Acquired by	: Admin
Sample Name	: ls-2-99-2-A
Sample ID	: ls-2-99-2-A
Vail #	:
Injection Volume	: 50 uL
Data File Name	: ls-2-99-2-A04.lcd
Method File Name	: ath-OD-H-analytical 0.46cm x 25cm.lcm
Batch File Name	:
Report File Name	: Default.lcr
Data Acquired	: 3/14/2012 12:33:48 AM
Data Processed	: 3/14/2012 12:50:44 AM



<Chromatogram>



1 Det.A Ch1/254nm

PeakTable

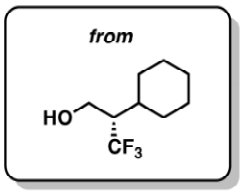
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.768	668339	28968	97.217	97.207
2	9.128	19130	832	2.783	2.793
Total		687468	29800	100.000	100.000

==== Shimadzu LCsolution Analysis Report ====

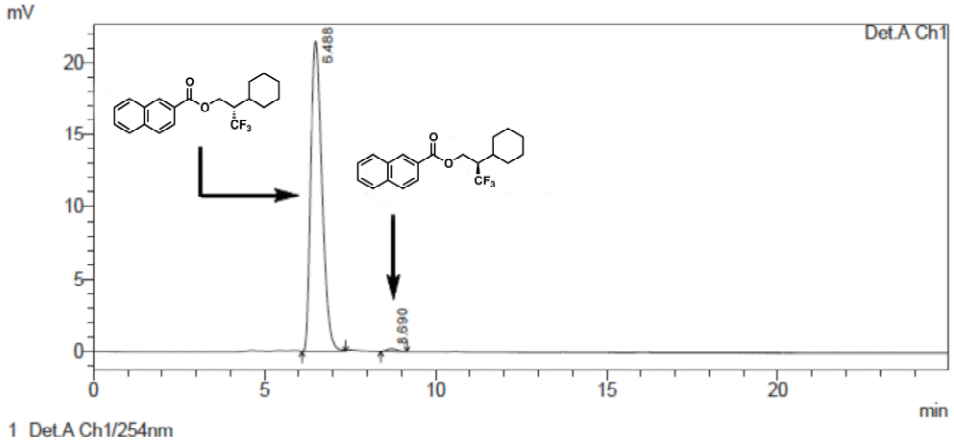
C:\LabSolutions\Data\ATH\ath-3-300-a02.lcd

Acquired by	: Admin
Sample Name	: ath-3-300-a
Sample ID	: ath-3-300-a
Vail #	:
Injection Volume	: 50 uL
Data File Name	: ath-3-300-a02.lcd
Method File Name	: ath-OD-H-analytical 0.46cm x 25cm.lcm
Batch File Name	:
Report File Name	: Default.lcr
Data Acquired	: 2/27/2012 3:59:07 PM
Data Processed	: 2/27/2012 4:24:06 PM



<Chromatogram>

C:\LabSolutions\Data\ATH\ath-3-300-a02.lcd



1 Det.A Ch1/254nm

PeakTable

Detector A Ch1 254nm

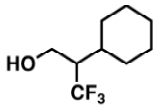
Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.488	491241	21496	99.200	99.165
2	8.690	3960	181	0.800	0.835
Total		495202	21677	100.000	100.000

==== Shimadzu LCsolution Analysis Report ====

C:\LabSolutions\Data\Project1\ls-2-99-04.lcd

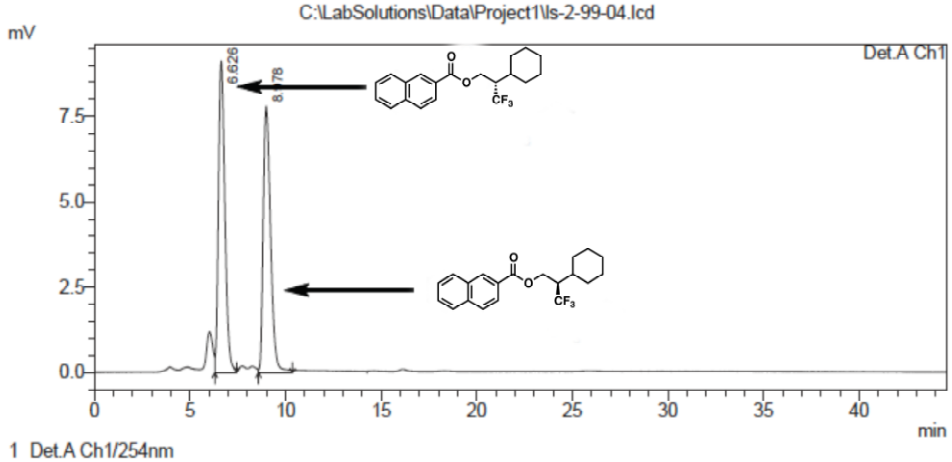
Acquired by	: Admin
Sample Name	: ath-4-011-a1
Sample ID	: ath-4-011-a1
Vail #	:
Injection Volume	: 50 uL
Data File Name	: ls-2-99-04.lcd
Method File Name	: ath-OD-H-analytical 0.46cm x 25cm.lcm
Batch File Name	:
Report File Name	: Default.lcr
Data Acquired	: 2/29/2012 1:59:39 PM
Data Processed	: 2/29/2012 2:44:14 PM

from racemic



<Chromatogram>

C:\LabSolutions\Data\Project1\ls-2-99-04.lcd



1 Det.A Ch1/254nm

PeakTable

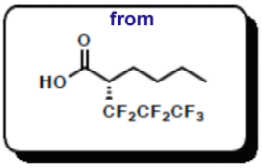
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.626	216113	9135	50.485	53.946
2	8.978	211957	7798	49.515	46.054
Total		428070	16933	100.000	100.000

==== Shimadzu LCsolution Analysis Report ====

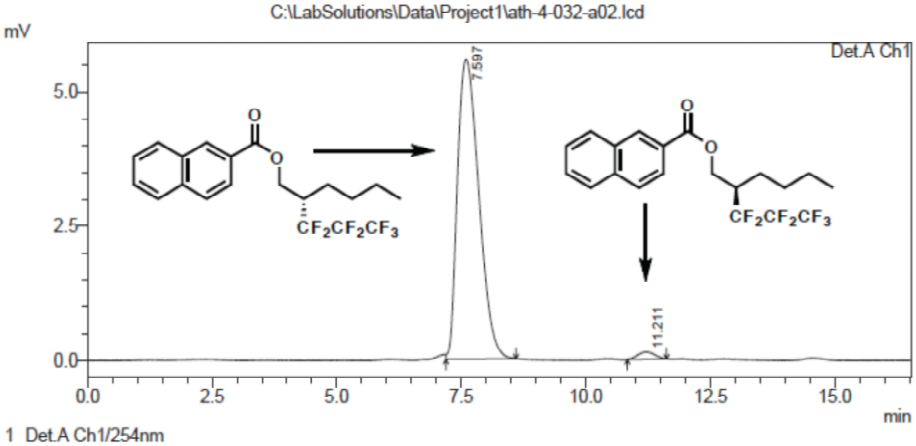
C:\LabSolutions\Data\Project1\ath-4-032-a02.lcd

Acquired by	: Admin
Sample Name	: ath-4-032-a
Sample ID	: ath-4-032-a
Vail #	:
Injection Volume	: 20 uL
Data File Name	: ath-4-032-a02.lcd
Method File Name	: ath-OD-H-analytical 0.46cm x 25cm.lcm
Batch File Name	:
Report File Name	: Default.lcr
Data Acquired	: 3/15/2012 1:45:41 AM
Data Processed	: 3/15/2012 2:02:14 AM



<Chromatogram>

C:\LabSolutions\Data\Project1\ath-4-032-a02.lcd



1 Det.A Ch1/254nm

PeakTable

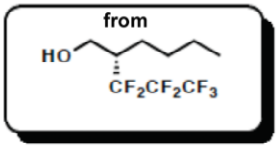
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.597	166730	5591	98.124	97.667
2	11.211	3188	134	1.876	2.333
Total		169918	5724	100.000	100.000

==== Shimadzu LCsolution Analysis Report ====

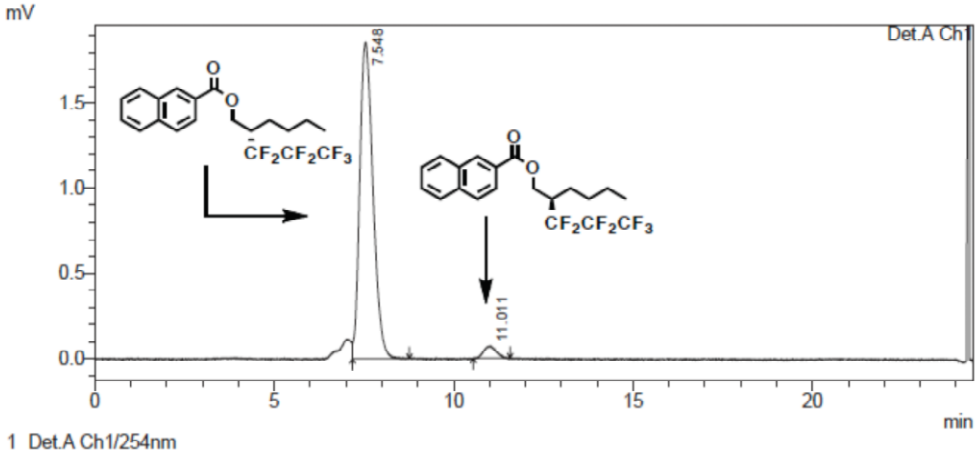
C:\LabSolutions\Data\ATH\ath-4-027-a-A03.lcd

Acquired by	: Admin
Sample Name	: ath-4-027-a-A
Sample ID	: ath-4-027-a-A
Vail #	:
Injection Volume	: 5 uL
Data File Name	: ath-4-027-a-A03.lcd
Method File Name	: ath-OD-H-analytical 0.46cm x 25cm.lcm
Batch File Name	:
Report File Name	: Default.lcr
Data Acquired	: 3/13/2012 2:20:14 PM
Data Processed	: 3/13/2012 2:44:43 PM



<Chromatogram>

C:\LabSolutions\Data\ATH\ath-4-027-a-A03.lcd



1 Det.A Ch1/254nm

PeakTable

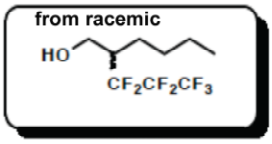
Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.548	47647	1859	96.625	96.392
2	11.011	1664	70	3.375	3.608
Total		49311	1929	100.000	100.000

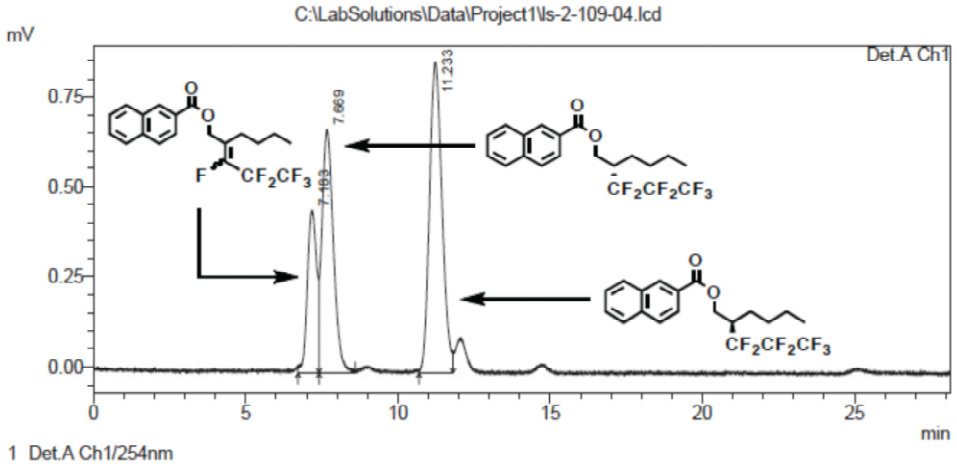
==== Shimadzu LCsolution Analysis Report ====

C:\LabSolutions\Data\Project1\ls-2-109-04.lcd

Acquired by	: Admin
Sample Name	: ls-2-109-3
Sample ID	: ls-2-109-3
Vail #	:
Injection Volume	: 10 uL
Data File Name	: ls-2-109-04.lcd
Method File Name	: ath-OD-H-analytical 0.46cm x 25cm.lcm
Batch File Name	:
Report File Name	: Default.lcr
Data Acquired	: 3/15/2012 12:32:24 AM
Data Processed	: 3/15/2012 1:00:32 AM



<Chromatogram>



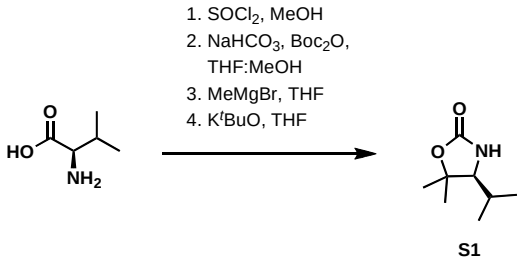
1 Det.A Ch1/254nm

PeakTable

Detector A Ch1 254nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.183	9631	452	18.533	22.731
2	7.669	17653	677	33.972	34.035
3	11.233	24680	860	47.495	43.234
Total		51964	1989	100.000	100.000

3-8: α-Fluorination of *N*-Acyl Oxazolidinones Supporting Information



S1

(S)-4-Isopropyl-5,5-dimethyloxazolidin-2-one (S2). Thionyl chloride (31.1 mL, 427 mmol) was added dropwise to a solution of L-valine (25.0 g, 213 mmol) in methanol (430 mL) at 0 °C. The reaction was stirred for 10 min at 0 °C, and then heated to reflux for 4 h. The solution was cooled to rt and methanol was removed in vacuo. The crude residue was submitted to the next step without purification.

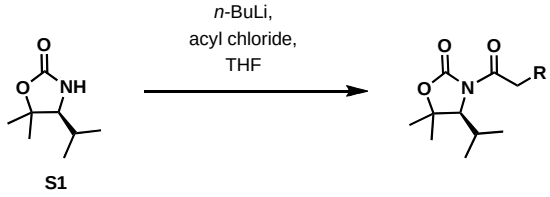
Sodium hydrogen carbonate (53.7 g, 640 mmol) was added to a solution of crude substrate (213 mmol) in a 4:1 mixture of THF:MeOH (560 mL) at 0 °C and stirred for 5 min. Di-tert-butyl dicarbonate (47.0 g, 215 mmol) was added to the mixture at 0 °C. The reaction was warmed to rt and stirred for 2 h and then quenched with water. The layers were separated. The aqueous layer was extracted with diethyl ether (3 x 100 mL). The combined organic layers were washed with saturated sodium bicarbonate, brine, and dried with sodium sulfate and concentrated *in vacuo* to afford a yellow oil. The crude residue was submitted to the next step without further purification.

Methylmagnesium bromide (3.0 M in Et_2O, 250 mL, 750 mmol) was added dropwise to a solution of the crude substrate (213 mmol) in THF (500 mL) at 0 °C. The reaction mixture was stirred at 0 °C for 10 min, then warmed to rt and stirred for 48 h. The solution was cooled to 0 °C and quenched with saturated ammonium chloride. The layers were separated. The aqueous layer was extracted with ethyl acetate (3 x 100 mL). The combined organic

layers were washed with brine and dried with sodium sulfate and concentrated *in vacuo* delivering a light yellow oil. The crude residue was submitted to the next step without further purification.

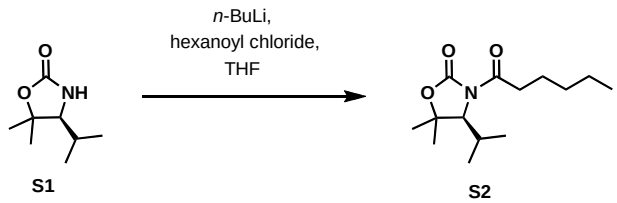
Potassium tert-butoxide (26.8 g, 239 mmol) was added to a solution of the crude substrate (213 mmol) in THF (575 mL) at 0 °C. The reaction was warmed to rt and stirred for 2.5 h. The reaction was then quenched with saturated aqueous ammonium chloride. The layers were separated. The aqueous layer was extracted with ethyl acetate (3 x 100 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated *in vacuo*. The crude product was purified by column chromatography (silica, 40% ethyl acetate in hexanes, 75% ethyl acetate in hexanes) to afford the white/yellow solid oxazolidinone **S2** (28.1 g, 179 mmol, 84%).

Standard procedure 1: Synthesis of *N*-acyl oxazolidinones via acyl chloride

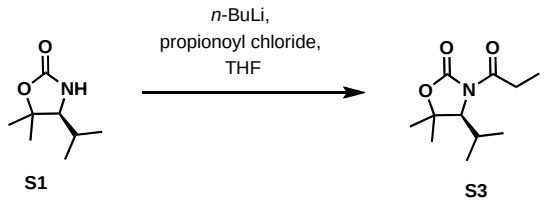


n-Butyllithium (2.48 M in hexanes, 2.88 ml, 7.14 mmol, 1.1 equiv) was added to a solution of **S2** (1.02 g, 6.49 mmol, 1.0 equiv) in tetrahydrofuran (22.0 ml, 0.30 M) at –78 ℃ and stirred at room temperature for 30 minutes. The solution was cooled to –78 ℃ and the corresponding acyl chloride (7.78 mmol, 1.2 equiv) was added to the reaction mixture and stirred for 15 min at -78 °C. The reaction solution was warmed to rt and stirred for 2 h. The reaction was quenced with saturated ammonium chloride and the layers were seperated. The aqeuous layer was extracted with ethyl acetate (3 x 20 ml). The combined organic layers

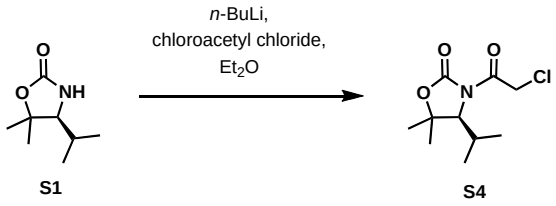
were washed with brine, dried over sodium sulfate, concentrated *in vacuo*, and purified by column chromatography to give the corresponding *N*-acyl oxazolidinone.



(S)-3-Hexanoyl-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.49). The title compound was prepared from commercially available hexanoyl chloride (1.08 ml, 7.78 mmol) following standard procedure 1 for the synthesis of N-acyl oxazolidinones via acyl chloride and was obtained as a yellow oil (1.36 g, 5.32 mmol, 82%) after purification by column chromatography (silica, 6% ethyl acetate in hexanes – 12% ethyl acetate in hexanes). α_D^{27} + 31.21 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 4.11 (d, *J* = 3.3 Hz, 1H), 3.01 – 2.92 (m, 1H), 2.87 – 2.79 (m, 1H), 2.15 – 2.06 (m, 1H), 1.69 – 1.59 (m, 2H), 1.47 (s, 3H), 1.34 (s, 3H), 1.33 – 1.29 (m, 4H), 0.99 (dd, *J* = 7.0, 3.5 Hz, 3H), 0.91 (dd, *J* = 6.8, 3.5 Hz, 3H), 0.88 – 0.84 (m, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 173.84 (s), 153.46 (s), 82.56 (s), 66.12 (s), 35.34 (s), 31.23 (s), 29.46 (s), 28.72 (s), 24.34 (s), 22.31 (s), 21.41 (s), 21.30 (s), 16.97 (s), 13.83 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{14}H_{25}NO_3Na$, 278.1732; found, 278.1728.

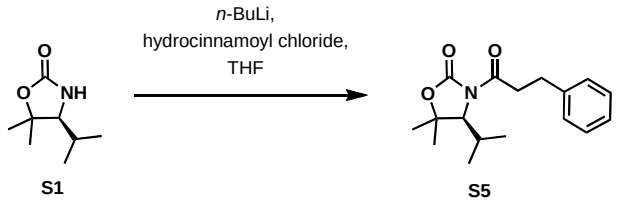


(S)-4-Isopropyl-5,5-dimethyl-3-propionyloxazolidin-2-one (3.50). The title compound was prepared from commercially available propionoyl chloride (0.68 mL, 7.78 mmol) following standard procedure 1 for the synthesis of *N*-acyl oxazolidinones via acyl chloride and was obtained as a white solid (1.22 g, 5.72 mmol, 88%) after purification by column chromatography (silica, 10 ethyl acetate in hexanes - 15% ethyl acetate in hexanes). α_D^{25} + 38.28 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 4.13 (d, *J* = 3.3 Hz, 1H), 2.99 (dddd, *J* = 17.4, 7.4 Hz, 1H), 2.89 (dddd, *J* = 17.4, 7.3 Hz, 1H), 2.13 (ddd, *J* = 13.8, 6.9, 3.4 Hz, 1H), 1.49 (s, 3H), 1.36 (s, 3H), 1.17 (dd, *J* = 9.6, 5.2 Hz, 3H), 1.01 (d, *J* = 7.0 Hz, 3H), 0.93 (d, *J* = 6.8 Hz, 3H).; ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 174.59 (s), 153.56 (s), 82.71 (s), 66.24 (s), 29.51 (s), 29.07 (s), 28.80 (s), 21.43 (s), 21.37 (s), 17.02 (s), 8.72 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{11}H_{19}NO_3Na$, 236.1263; found, 236.1268.



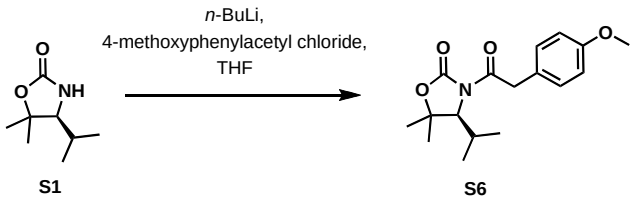
(S)-3-(2-Chloroacetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.51). The title compound was prepared from commercially available chloroacetyl chloride (0.62 ml, 7.78 mmol) following standard procedure 1 for the synthesis of *N*-acyl oxazolidinones via acyl chloride using diethyl ether (22.0 mL, 0.30 M) and was obtained as a yellow oil (1.25 g, 5.38

mmol, 83%) after purification by column chromatography (silica, 10 ethyl acetate in hexanes - 15% ethyl acetate in hexanes). α_D^{27} + 39.55 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); □(ppm): 4.75 (ddd, *J* = 15.3 Hz, 2H), 4.16 (d, *J* = 3.2 Hz, 1H), 2.22 – 2.14 (m, 1H), 1.54 (s, 3H), 1.42 (s, 3H), 1.06 (d, *J* = 7.0 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); □(ppm): 166.44 (s), 152.97 (s), 83.96 (s), 66.77 (s), 43.38 (s), 29.37 (s), 28.63 (s), 21.29 (s), 21.18 (s), 16.67 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{10}H_{16}ClNO_3Na$, 256.0716; found, 256.0700.

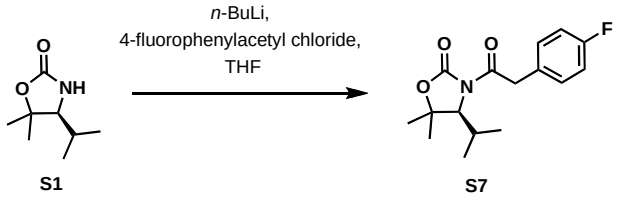


(S)-4-Isopropyl-5,5-dimethyl-3-(3-phenylpropanoyl)oxazolidin-2-one (3.52). The title compound was prepared from commercially available hydrocinnamoyl chloride (1.16 mL, 7.78 mmol) following standard procedure 1 for the synthesis of N-acyl oxazolidinones via acyl chloride and was obtained as a yellow oil (1.41 g, 4.87 mmol, 74%) after purification by column chromatography (silica, 10 ethyl acetate in hexanes - 18% ethyl acetate in hexanes). α_D^{27} + 36.16 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.30 – 7.26 (m, 3H), 7.25 (s, 1H), 7.21 – 7.17 (m, 1H), 4.13 (d, *J* = 3.3 Hz, 1H), 3.34 (ddd, *J* = 16.5, 9.0, 6.3 Hz, 1H), 3.29 – 3.22 (m, 1H), 3.08 – 2.93 (m, 2H), 2.12 (dddd, *J* = 13.8, 6.9, 3.5 Hz, 1H), 1.50 (s, 3H), 1.32 (s, 3H), 0.99 (d, *J* = 7.0 Hz, 3H), 0.91 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 172.89 (s), 153.48 (s), 140.41 (s), 128.46 (s), 128.39 (s),

126.15 (s), 82.77 (s), 66.27 (s), 36.82 (s), 30.68 (s), 29.47 (s), 28.70 (s), 21.35 (s), 16.99 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{23}NO_3Na$, 312.1576; found, 312.1559.

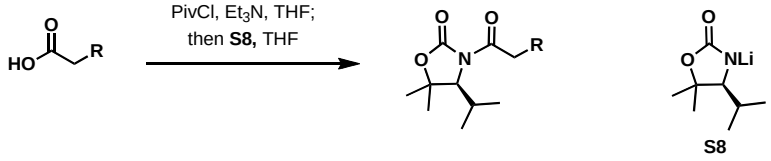


(S)-4-Isopropyl-3-(2-(4-methoxyphenyl)acetyl)-5,5-dimethyloxazolidin-2-one (3.53). The title compound was prepared from commercially available 4-methoxyphenylacetyl chloride (1.19 mL, 7.78 mmol) following standard procedure 1 for the synthesis of N-acyl oxazolidinones via acyl chloride and was obtained as a yellow oil (1.02 g, 3.34 mmol, 52%) after purification by column chromatography (silica, 15 - 22% ethyl acetate in hexanes. α_D^{26} 70.63 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.27 (s, 1H), 7.26 – 7.25 (m, 1H), 6.85 (d, *J* = 8.6 Hz, 2H), 4.30 (d, *J* = 15.0 Hz, 1H), 4.19 (d, *J* = 15.0 Hz, 1H), 4.12 (d, *J* = 3.1 Hz, 1H), 3.79 (s, 3H), 2.10 (ddd, *J* = 10.5, 6.8, 3.4 Hz, 1H), 1.49 (s, 3H), 1.31 (s, 3H), 0.95 (d, *J* = 7.0 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 172.05 (s), 158.62 (s), 153.48 (s), 130.60 (s), 125.97 (s), 113.86 (s), 82.77 (s), 66.39 (s), 55.14 (s), 40.58 (s), 29.53 (s), 28.69 (s), 21.38 (s), 21.29 (s), 16.79 (s); HRMS-EI *(m/z)*: $[M]^+$ calcd for $C_{17}H_{23}NO_4$, 305.1627, found, 305.1637.



(S)-3-(2-(4-Fluorophenyl)acetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.54). The title compound was prepared from commercially available 4-fluorophenylacetyl chloride, (1.07 mL, 7.78 mmol) following standard procedure 1 for the synthesis of N-acyl oxazolidinones via acyl chloride and was obtained as a colorless oil (1.06 g, 3.61 mmol, 56%) after purification by column chromatography (silica, 9 ethyl acetate in hexanes - 13% ethyl acetate in hexanes). α_D^{27} + 45.86 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.32 (dd, *J* = 8.1, 5.7 Hz, 2H), 7.01 (dd, *J* = 8.7 Hz, 2H), 4.35 (d, *J* = 15.1 Hz, 1H), 4.20 (d, *J* = 15.1 Hz, 1H), 4.13 (d, *J* = 3.1 Hz, 1H), 2.14 – 2.06 (m, 1H), 1.50 (s, 3H), 1.32 (s, 3H), 0.95 (d, *J* = 7.0 Hz, 3H), 0.86 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 171.52 (s), 162.90 (s), 160.95 (s), 153.41 (s), 131.15 (d, *J* = 8.0 Hz), 129.63 (d, *J* = 3.2 Hz), 115.25 (d, *J* = 21.4 Hz), 82.87 (s), 66.39 (s), 40.61 (s), 29.50 (s), 28.65 (s), 21.36 (s), 21.23 (s), 16.74 (s); HRMS-ESI *(m/z)*: $[M]^+$ calcd for $C_{16}H_{20}NO_3$, 293.1427; found, 293.1435.

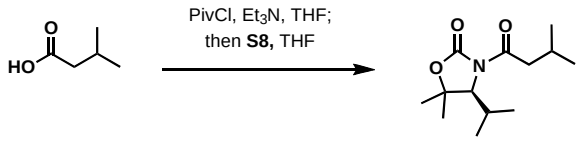
Standard procedure 2: Synthesis of *N*-acyl oxazolidinones via carboxylic acid



Solution A: Trimethylacetic acid chloroanhydride (1.45 equiv) was added to a solution of carboxylic acid (1.20 equiv) and triethylamine (4.80 equiv) in tetrahydrofuran (0.15 M) at –20℃. The solution was allowed to stir at -20 °C for 2 h.

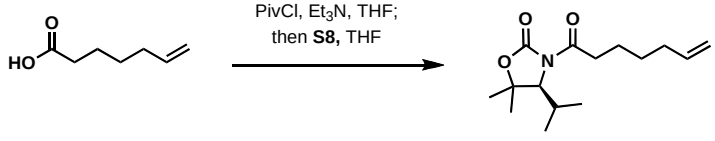
Solution B: In a separate flame-dried flask, *n*-butyllithium (1.10 equiv) was added to a solution of oxazolidione **S2** (1.00 equiv) in tetrahydrofuran (0.30 M) at -78 °C and the mixture was allowed to warm to room temperature and stir for 30 min.

Both flasks were then chilled to –78℃. The flask containg the lithianted oxazolidione **S3 (solution B),** was cannulated to the flask containing the mixed anhydride (**solution A**). After the addition was complete, the reaction mixture was warmed to room temperature and stirred for 3 h. The reaction was quenced with saturated ammonium chloride and the layers were seperated. The aqeuous layer was extracted with ethyl acetate (3 x 25 ml). The combined organic layers were washed with brine, dried over sodium sulfate, concentrated *in vacuo*, and purified by column chromatography to give the corresponding *N*-acyl oxazolidinone.



S9

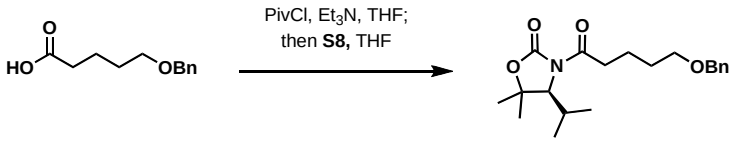
(S)-4-Isopropyl-5,5-dimethyl-3-(3-methylbutanoyl)oxazolidin-2-one (3.55). The title compound was prepared from commercially available 3-methylbutanoic acid (0.84 mL, 7.63 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as a colorless oil (1.34 g, 3.64 mmol, 88%) after purification by column chromatography (silica, 10 ethyl acetate in hexanes - 15% ethyl acetate in hexanes). α_D^{25} + 30.87 (*c* 1.0, CHCl3); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 4.16 (d, *J* = 3.2 Hz, 1H), 2.91 (dd, *J* = 15.6, 6.7 Hz, 1H), 2.76 (dd, *J* = 15.6, 7.1 Hz, 1H), 2.25 – 2.16 (m, 1H), 2.14 (ddd, *J* = 16.9, 8.5, 5.2 Hz, 1H), 1.50 (s, 3H), 1.37 (s, 3H), 1.06 – 0.96 (m, 9H), 0.95 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 173.10 (s), 153.51 (s), 82.53 (s), 66.16 (s), 43.87 (s), 29.50 (s), 28.76 (s), 25.30 (s), 22.50 (s), 22.34 (s), 21.46 (s), 21.34 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{13}H_{23}NO_3Na$, 264.1576; found, 264.1561.



S10

(S)-3-(Hept-6-enoyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.56). The title compound was prepared from commercially available 6-heptenoic acid (0.63 mL, 7.63 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as a colorless oil (1.53 g, 3.38 mmol, 90%) after

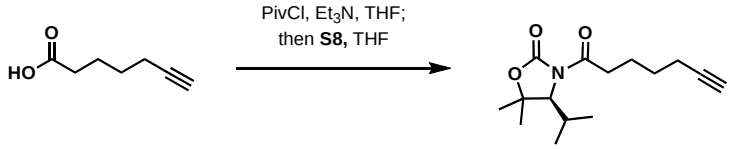
purification by column chromatography (silica, 9% ethyl acetate in hexanes). α_D^{26} + 32.15 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 5.78 (dddd, *J* = 16.9, 10.2, 6.7 Hz, 1H), 5.02 – 4.91 (m, 2H), 4.13 (d, *J* = 3.3 Hz, 1H), 2.99 (ddd, *J* = 16.1, 8.5, 6.4 Hz, 1H), 2.90 – 2.82 (m, 1H), 2.16 – 2.04 (m, 3H), 1.75 – 1.60 (m, 2H), 1.49 (s, 3H), 1.48 – 1.42 (m, 2H), 1.36 (s, 3H), 1.00 (d, *J* = 7.0 Hz, 3H), 0.92 (d, *J* = 6.8 Hz, 3H.); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 173.69 (s), 153.50 (s), 138.39 (s), 114.59 (s), 82.65 (s), 66.19 (s), 35.25 (s), 33.40 (s), 29.49 (s), 28.77 (s), 28.31 (s), 24.12 (s), 21.44 (s), 21.35 (s), 17.02 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{15}H_{25}NO_3Na$, 290.1732; found, 290.1720.



S11

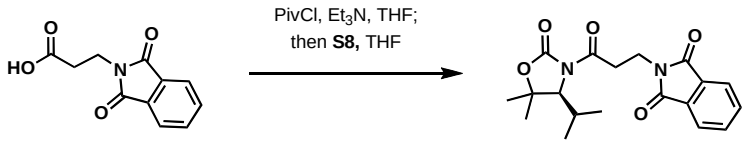
(S)-3-(5-(Benzyloxy)pentanoyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.57). The title compound was prepared from 6-heptenoic acid[124] (2.08 g, 10.0 mmol) following the standard procedure for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as a white solid (2.71 g, 7.81 mmol, 78%) after purification by column chromatography (silica, 15% ethyl acetate – hexanes). α_D^{26} + 24.09 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.33 (d, *J* = 4.4 Hz, 4H), 7.28 (dd, *J* = 8.3, 4.1 Hz, 1H), 7.25 (s, 1H), 4.50 (s, 2H), 4.14 (d, *J* = 3.3 Hz, 1H), 3.51 (t, *J* = 6.2 Hz, 2H), 3.03 (ddd, *J* = 16.8, 8.1, 6.5 Hz, 1H), 2.91 (ddd, *J* = 16.8, 8.2, 6.3 Hz, 1H), 2.13 (dddd, *J* = 13.8, 6.9, 3.4 Hz, 1H), 1.82 – 1.74 (m, 2H), 1.73 – 1.66 (m, 2H), 1.50 (s, 3H), 1.37 (s, 3H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.93 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 173.58 (s), 153.54 (s),

138.55 (s), 128.31 (s), 127.60 (s), 127.45 (s), 82.71 (s), 72.86 (s), 69.91 (s), 66.23 (s), 35.19 (s), 29.52 (s), 29.13 (s), 28.81 (s), 21.48 (s), 21.42 (s), 21.39 (s), 17.07 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{20}H_{29}NO_4Na$, 370.1994; found, 370.2002.



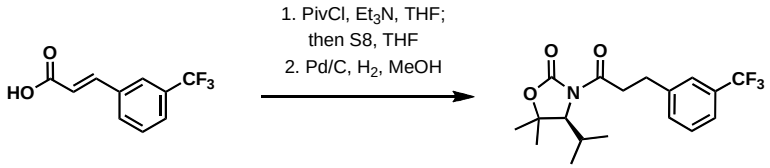
S12

(S)-3-(Hept-6-ynoyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.58). The title compound was prepared from commercially available 6-heptynoic acid (0.69 g, 5.42 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as a clear oil (1.41 g, 2.15 mmol, 75%) after purification by column chromatography (silica, 10 ethyl acetate in hexanes – 18% ethyl acetate in hexanes). α_D^{26} + 33.58 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 4.15 (d, *J* = 3.3 Hz, 1H), 3.03 (ddd, *J* = 16.6, 8.4, 6.5 Hz, 1H), 2.91 (ddd, *J* = 16.7, 8.3, 6.6 Hz, 1H), 2.24 (ddd, *J* = 7.1, 2.6 Hz, 2H), 2.14 (dtd, *J* = 13.8, 6.9, 3.4 Hz, 1H), 1.95 (dd, *J* = 2.6 Hz, 1H), 1.86 – 1.74 (m, 2H), 1.66 – 1.59 (m, 2H), 1.51 (s, 3H), 1.38 (s, 3H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.94 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 173.37 (s), 153.51 (s), 83.96 (s), 82.73 (s), 68.51 (s), 66.22 (s), 34.92 (s), 29.49 (s), 28.80 (s), 27.86 (s), 23.69 (s), 21.45 (s), 21.36 (s), 18.21 (s), 17.04 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{15}H_{23}NO_3Na$, 288.1576; found, 288.1571



S13

(S)-2-(3-(4-Isopropyl-5,5-dimethyl-2-oxooxazolidin-3-yl)-3-oxopropyl)isoindoline-1,3-dione (3.59). The title compound was prepared from commercially available 3-(1,3-Dioxo-1,3-dihydro-2H-isoindol-2-yl)-propanoic acid (8.69 g, 39.7 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as a white solid (6.78 g, 18.9 mmol, 48%) after purification by column chromatography (silica, 20 ethyl acetate in hexanes - 25% ethyl acetate in hexanes); α_D^{26} + 18.79 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.86 – 7.83 (m, 2H), 7.73 – 7.69 (m, 2H), 4.13 (d, *J* = 3.2 Hz, 1H), 4.09 – 4.05 (m, 2H), 3.43 – 3.35 (m, 1H), 3.29 (ddd, *J* = 17.1, 7.5 Hz, 1H), 2.14 (ddd, *J* = 13.9, 6.9, 3.2 Hz, 1H), 1.51 (s, 3H), 1.44 (s, 3H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.96 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 170.79 (s), 167.96 (s), 153.43 (s), 133.91 (s), 132.00 (s), 123.21 (s), 83.15 (s), 66.30 (s), 34.24 (s), 33.44 (s), 29.48 (s), 28.78 (s), 21.41 (s), 21.21 (s), 16.95 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{19}H_{22}N_2O_5Na$, 381.1426; found, 381.1427.

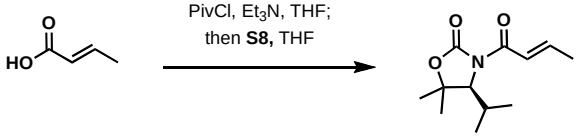


S14

(S)-4-Isopropyl-5,5-dimethyl-3-(3-(3-(trifluoromethyl)phenyl)propanoyl)oxazolidin-2-one (3.60). The title compound was prepared starting from commercially available 3-trifluoromethylcinnamic acid (1.65 g, 7.63 mmol) following standard procedure 2 for the

synthesis of N-acyl oxazolidinones via carboxylic acid without purification. The resultant oil was then submitted to the next reaction.

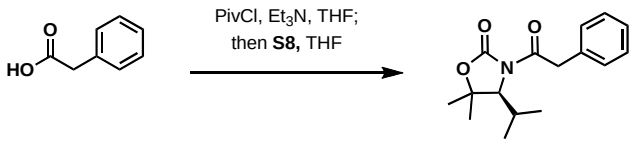
The crude substrate and palladium on carbon (0.20 g) were mixed in ethanol (28.0 mL, 0.2 M). Hydrogen gas was then bubbled through the reaction mixture for 15 min at rt. The reaction mixture flask was pressurized with hydrogen gas and the reaction was stirred for 3h at rt. The reaction mixture was filtered through Celite and the solvent was removed *in vacuo*. The title compound was obtained as a clear oil (1.98 g, 5.54 mmol, 88%) after purification by column chromatography (silica, 15% ethyl acetate in hexanes). α_D^{26} + 25.37 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.50 (s, 1H), 7.45 (d, *J* = 7.7 Hz, 2H), 7.41 – 7.37 (m, 1H), 4.13 (d, *J* = 3.4 Hz, 1H), 3.37 (ddd, *J* = 16.9, 8.6, 6.6 Hz, 1H), 3.24 (ddd, *J* = 16.9, 8.2, 6.7 Hz, 1H), 3.14 – 2.99 (m, 2H), 2.11 (dddd, *J* = 13.8, 6.9, 3.4 Hz, 1H), 1.49 (s, 3H), 1.32 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.88 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 172.39 (s), 153.50 (s), 141.40 (s), 131.99 (d, *J* = 1.3 Hz), 130.69 (q, *J* = 32.0 Hz), 128.84 (s), 125.22 (q, *J* = 3.8 Hz), 123.23 – 122.77 (m), 82.94 (s), 66.34 (s), 36.58 (s), 30.34 (s), 29.46 (s), 28.70 (s), 21.35 (s), 21.33 (s), 16.96 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{18}H_{22}F_3NO_3Na$, 380.1449; found, 380.1450.



S15

(S,*E*)-3-(But-2-enoyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.61). The title compound was prepared from commercially available crotonoic acid (0.517 g, 6.00 mmol**)**

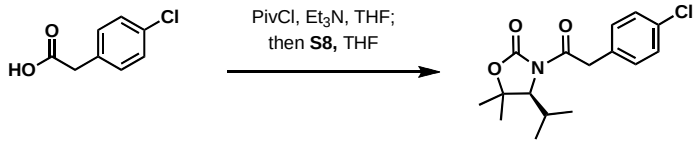
following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as a white soild (0.770 g, 3.42 mmol, 68%) after purification by column chromatography (silica, 10 ethyl acetate in hexanes - 30% ethyl acetate in hexanes). α_D^{26} + 52.90 (*c* 1.0, $CHCl_3$). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.29 (ddd, *J* = 15.2, 3.2, 1.5 Hz, 1H), 7.12 (dddd, *J* = 15.1, 6.9 Hz, 1H), 4.19 (d, *J* = 3.4 Hz, 1H), 2.13 (dddd, *J* = 13.8, 6.9, 3.5 Hz, 1H), 1.93 (dd, *J* = 6.9, 1.6 Hz, 3H), 1.49 (s, 3H), 1.36 (s, 3H), 1.01 (d, *J* = 7.0 Hz, 3H), 0.93 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 165.54 (s), 153.48 (s), 146.44 (s), 121.88 (s), 82.63 (s), 66.23 (s), 29.60 (s), 28.73 (s), 21.37 (s), 21.33 (s), 18.40 (s), 17.03 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{12}H_{19}NO_3Na$, 248.1263; found, 248.1255.



S16

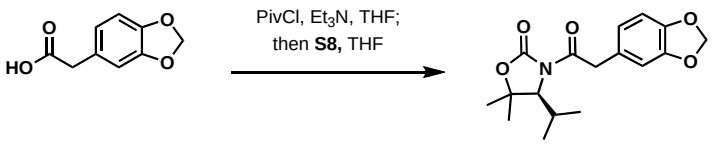
(S)-4-Isopropyl-5,5-dimethyl-3-(2-phenylacetyl)oxazolidin-2-one (3.62). The title compound was prepared from commercially available phenyl acetic acid (1.51 g, 11.1 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as yellow oil (2.24 g, 8.1 mmol, 81%) after purification by column chromatography (silica, 15% ethyl acetate – hexanes. α_D^{26} + 36.65 (*c* 0.7, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.36 – 7.30 (m, 4H), 7.27 (dd, *J* = 1.9 Hz, 1H), 7.26 – 7.24 (m, 1H), 4.37 (d, *J* = 15.0 Hz, 1H), 4.26 (d, *J* = 15.0 Hz, 1H), 4.13 (d, *J* = 3.3 Hz, 1H), 2.11 (dddd, *J* = 13.8, 6.9, 3.3 Hz, 1H), 1.49 (s, 3H), 1.31 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); □(ppm): 171.77 (s), 153.53 (s), 133.99

(s), 129.64 (s), 128.50 (s), 127.12 (s), 82.86 (s), 66.51 (s), 41.56 (s), 29.60 (s), 28.76 (s), 21.43 (s), 21.37 (s), 16.86 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{16}H_{21}NO_3Na$ 298.1419; found, 298.1414.



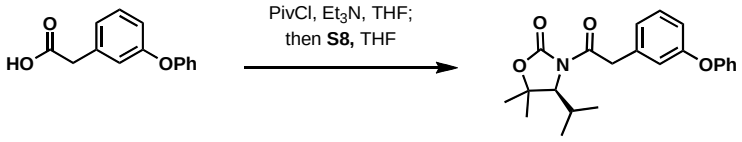
S17

(S)-3-(2-(4-Chlorophenyl)acetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.63). The title compound was prepared from commercially available 2-(4-chlorophenyl)acetic acid (1.30 g, 7.63 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as green solid (0.54 g, 1.7 mmol, 28%) after purification by column chromatography (silica, 20 - 25% ethyl acetate in hexanes). α_D^{27} + 37.17 (*c* 1.0, CHCl3); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.29 (d, *J* = 2.0 Hz, 4H), 4.35 (d, *J* = 15.1 Hz, 1H), 4.20 (d, *J* = 15.1 Hz, 1H), 4.13 (d, *J* = 3.2 Hz, 1H), 2.14 – 2.06 (m, 1H), 1.50 (s, 3H), 1.33 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 171.05 (s), 153.28 (s), 132.83 (s), 132.34 (s), 130.87 (s), 128.44 (s), 82.81 (s), 66.30 (s), 40.70 (s), 29.41 (s), 28.57 (s), 21.31 (s), 21.14 (s), 16.69 (s); HRMS-EI *(m/z)*: $[M]^+$ calcd for $C_{16}H_{20}ClNO_3$, 309.1132; found, 309.1132.



S18

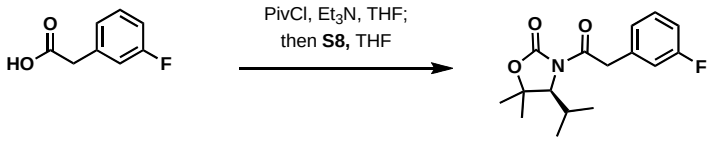
(S)-3-(2-(Benzo[d][1,3]dioxol-5-yl)acetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.64). The title compound was prepared from commercially available 2-(benzo[1,3]dioxol-5-yl)acetic acid (1.65 g, 7.63 mmol) following standard procedure 2 for the synthesis of *N*-acyl oxazolidinones via carboxylic acid and was obtained as white solid (1.43 g, 4.45 mmol, 71%) after purification by column chromatography (silica, 11% ethyl acetate in hexanes). α_D^{23} + 39.58 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 6.84 (d, *J* = 1.3 Hz, 1H), 6.81 – 6.78 (m, 1H), 6.75 (d, *J* = 7.9 Hz, 1H), 5.93 (s, 2H), 4.27 (d, *J* = 15.1 Hz, 1H), 4.17 (s, 1H), 4.13 (d, *J* = 3.2 Hz, 1H), 2.15 – 2.07 (m, 1H), 1.50 (s, 3H), 1.33 (s, 3H), 0.97 (d, *J* = 7.0 Hz, 3H), 0.88 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 171.81 (s), 153.47 (s), 147.62 (s), 146.64 (s), 127.50 (s), 122.75 (s), 110.09 (s), 108.20 (s), 100.91 (s), 82.85 (s), 66.45 (s), 41.06 (s), 29.55 (s), 28.75 (s), 21.42 (s), 21.32 (s), 16.85 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{21}NO_5Na$, 342.1317; found, 342.1306.



S19

(S)-4-Isopropyl-5,5-dimethyl-3-(2-(3-phenoxyphenyl)acetyl)oxazolidin-2-one (3.65). The title compound was prepared from commercially available 2-(3-phenoxyphenyl)acetic acid (0.326 g, 1.43 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as yellow oil (0.36 g, 0.98 mmol, 76%) after purification by column chromatography (silica, 12% ethyl acetate in hexanes). α_D^{22} + 52.08 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.34 – 7.26 (m, 3H), 7.09 (dd, *J* = 7.4 Hz, 2H), 7.02 – 6.97 (m, 3H), 6.91 (dd, *J* = 8.1, 1.9 Hz, 1H), 4.36 (d, *J* = 15.1 Hz, 1H),

4.22 (d, *J* = 15.1 Hz, 1H), 4.14 (d, *J* = 3.2 Hz, 1H), 2.11 (dddd, *J* = 13.8, 6.9, 3.3 Hz, 1H), 1.49 (s, 3H), 1.33 (s, 3H), 0.97 (d, *J* = 7.0 Hz, 3H), 0.88 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 171.28 (s), 157.21 (s), 157.08 (s), 153.40 (s), 129.67 (s), 129.64 (s), 124.55 (s), 123.14 (s), 120.14 (s), 118.79 (s), 117.55 (s), 82.85 (s), 66.42 (s), 41.37 (s), 29.55 (s), 28.74 (s), 21.40 (s), 21.31 (s), 16.85 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{22}H_{25}NO_4Na$, 390.1681; found, 390.1698.

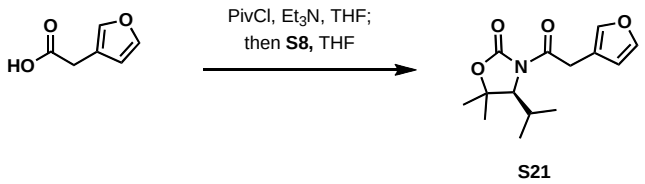


S20

(S)-3-(2-(3-Fluorophenyl)acetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.66)

The title compound was prepared from commercially available 2-(3-fluorophenyl)acetic acid (1.17 g, 7.60 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as yellow oil (1.46 g, 4.97 mmol, 79%) after purification by column chromatography (silica, 12% ethyl acetate in hexanes). α_D^{23} + 48.61 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.30 – 7.26 (m, 1H), 7.25 (s, 1H), 7.11 (dd, *J* = 7.7, 0.4 Hz, 1H), 7.08 – 7.04 (m, 1H), 6.98 – 6.93 (m, 1H), 4.37 (d, *J* = 15.1 Hz, 1H), 4.23 (d, *J* = 15.1 Hz, 1H), 4.13 (d, *J* = 3.3 Hz, 1H), 2.11 (dddd, *J* = 13.8, 6.9, 3.3 Hz, 1H), 1.49 (s, 3H), 1.33 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 171.07 (s), 162.71 (d, *J* = 245.8 Hz), 153.44 (s), 136.24 (d, *J* = 7.9 Hz), 129.86 (d, *J* = 8.4 Hz), 125.33 (d, *J* = 3.1 Hz), 116.62 (d, *J* = 21.8 Hz), 114.08 (d, *J* = 21.0 Hz), 82.97 (s), 66.49 (s), 41.20 (d, *J* = 2.0 Hz), 29.55 (s), 28.74 (s),

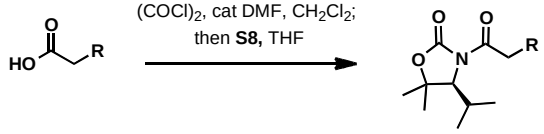
21.41 (s), 21.31 (s), 16.83 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{16}H_{20}FNO_3Na$, 316.1325; found, 316.1324.



S21

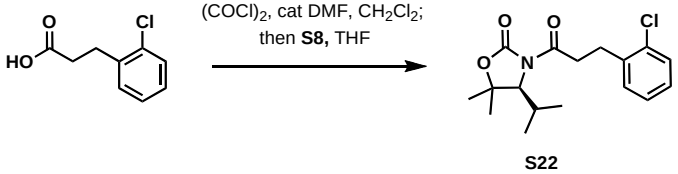
(S)-3-(2-(Furan-3-yl)acetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.67) The title compound was prepared from commercially available 3-furylacetic acid (0.191 g, 1.51 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained after purification by column chromatography (silica, 20% ethyl acetate in hexanes) as a clear oil (0.266 g, 1.00 mmol, 66%). α_D^{21} + 39.04 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.41 (d, *J* = 0.5 Hz, 1H), 7.34 (t, *J* = 1.6 Hz, 1H), 6.37 (d, *J* = 1.1 Hz, 1H), 4.13 (d, *J* = 16.0 Hz, 1H), 4.10 (d, *J* = 3.2 Hz, 1H), 4.04 (d, *J* = 16.0 Hz, 1H), 2.09 (dtd, *J* = 13.8, 6.9, 3.3 Hz, 1H), 1.46 (s, 3H), 1.30 (s, 3H), 0.95 (d, *J* = 7.0 Hz, 3H), 0.86 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 171.04 (s), 153.34 (s), 142.69 (s), 140.89 (s), 117.09 (s), 111.33 (s), 82.82 (s), 66.28 (s), 31.63 (s), 29.45 (s), 28.59 (s), 21.31 (s), 21.19 (s), 16.71 (s). LRMS *(m/z)*: $[M+Na]^+$ calcd for $C_{15}H_{23}NO_3Na$, 288.12; found, 288.15.

Standard procedure 3: Synthesis of *N*-acyl oxazolidinones via acyl chloride from carboxylic acid



Oxalyl chloride (1.65 equiv) was added to a solution of carboxylic acid (1.50 equiv), dimethylformamide (10 µl), and dichloromethane (2.0 M) at 0 °C. After 10 min, the solution was warmed to rt and stirred for 45 min (or until bubbling stops). The solution was concentrated on a rotary evaporator.

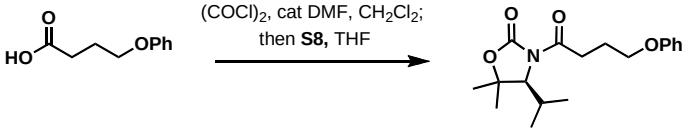
In a separate flask, *n*-butyllithium (1.05 equiv), was added to a solution of oxazolidinone **S2** (1.00 equiv) in THF (0.35 M) at -78 °C under argon. The solution was stirred for 30 min at -78 °C. A solution of the crude acyl chloride in THF (0.6 M total, 3 rinses) was added dropwise at -78 °C. After stirring at -78 °C for 2 h, the reaction mixture was warmed to rt and stirred for 2 h. The reaction mixture was quenched with saturated aqueous ammonium chloride. The layers were separated. The aqueous layer was extracted with ethyl acetate (3 x 20 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated *in vacuo*. The resultant oil or solid was purified by column chromatography to give the corresponding *N*-acyl oxazolidinone.



S22

(S)-3-(3-(2-Chlorophenyl)propanoyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.68). The title compound was prepared from commercially available 3-(2-

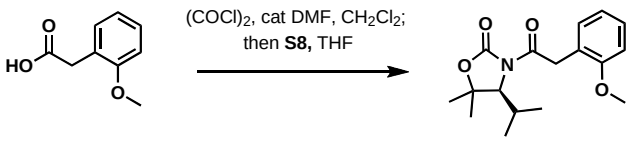
Chlorophenyl)propanoic acid (1.29 g, 7.00 mmol) following the standard procedure for the synthesis of *N*-acyl oxazolidinones via acyl chloride from carboxylic acid and was obtained as a yellow oil (1.77 g, 5.46 mmol, 74%) after purification by column chromatography (silica, 15% ethyl acetate in hexanes). α_D^{26} + 30.14 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ(ppm): 7.36 – 7.27 (m, 2H), 7.16 (ddd, *J* = 13.5, 10.5, 6.2 Hz, 2H), 4.15 (d, *J* = 3.1 Hz, 1H), 3.38 – 3.20 (m, 2H), 3.12 (dt, *J* = 9.0, 6.0 Hz, 2H), 2.14 (ddd, *J* = 10.3, 8.3, 5.1 Hz, 1H), 1.50 (s, 3H), 1.36 (s, 3H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.94 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 172.66 (s), 153.47 (s), 138.05 (s), 134.00 (s), 130.50 (s), 129.48 (s), 127.71 (s), 126.80 (s), 82.85 (s), 66.36 (s), 35.15 (s), 29.49 (s), 28.83 (s), 28.34 (s), 21.40 (s), 17.07 (s). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{22}ClNO_3Na$, 346.1186; found, 346.1189.



S23

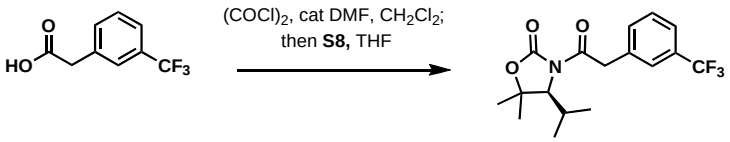
(S)-4-Isopropyl-5,5-dimethyl-3-(4-phenoxybutanoyl)oxazolidin-2-one (3.69). The title compound was prepared from commercially available 4-phenoxybutanoic acid (2.70 g, 15.0 mmol) following the standard procedure for the synthesis of *N*-acyl oxazolidinones via acyl chloride from carboxylic acid and was obtained as a white solid (2.95 g, 0.92 mmol, 92%) after purification by column chromatography (silica, 5 -25% ethyl acetate in hexanes). α_D^{26} + 29.90 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.29 – 7.27 (m, 1H), 7.25 (dd, *J* = 4.7, 2.6 Hz, 1H), 6.95 – 6.88 (m, 3H), 4.15 (d, *J* = 3.4 Hz, 1H), 4.04 (dd, *J* = 6.2 Hz, 2H), 3.16 (ddddd, *J* = 17.5, 7.8, 6.8 Hz, 2H), 2.22 – 2.11 (m, 3H), 1.50 (s, 3H), 1.37 (s, 3H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.94 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$);

δ(ppm): 173.16 (s), 158.80 (s), 153.51 (s), 129.35 (s), 120.61 (s), 114.50 (s), 82.82 (s), 66.58 (s), 66.31 (s), 32.11 (s), 29.51 (s), 28.81 (s), 28.81 (s), 24.22 (s), 21.44 (s), 21.37 (s), 17.05 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{18}H_{25}NO_4Na$, 342.1681; found, 342.1679.



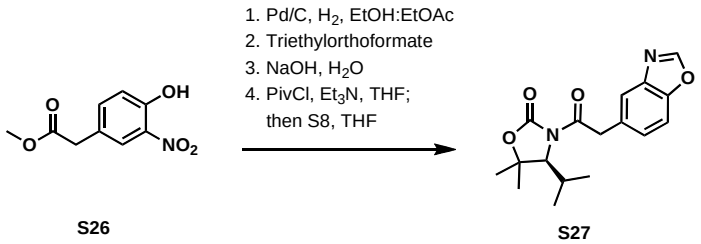
S24

(S)-4-Isopropyl-3-(2-(2-methoxyphenyl)acetyl)-5,5-dimethyloxazolidin-2-one (3.70). The title compound was prepared from commercially available 2-(2-methoxyphenyl)acetic acid (0.73 g, 4.00 mmol) following standard procedure 3 for the synthesis of N-acyl oxazolidinones via acyl chloride from carboxylic acid and was obtained as white solid (0.51 g g, 1.67 mmol, 42%) after purification by column chromatography (silica, 15% ethyl acetate in hexanes). α_D^{26} + 25.03 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.28 (d, *J* = 1.5 Hz, 1H), 7.25 (d, *J* = 1.7 Hz, 1H), 7.17 (d, *J* = 7.3 Hz, 1H), 6.92 (dd, *J* = 7.1 Hz, 1H), 6.87 (d, *J* = 8.2 Hz, 1H), 4.25 (ddd, *J* = 17.3 Hz, 2H), 4.17 (d, *J* = 3.2 Hz, 1H), 3.78 (s, 3H), 2.18 – 2.12 (m, 1H), 1.53 (s, 3H), 1.42 (s, 3H), 1.02 (d, *J* = 7.0 Hz, 3H), 0.99 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 171.74 (s), 157.36 (s), 153.77 (s), 131.16 (s), 128.50 (s), 123.31 (s), 120.46 (s), 110.26 – 109.82 (m), 82.80 (s), 66.50 (s), 55.26 (s), 37.19 (s), 29.57 (s), 28.69 (s), 21.51 (s), 21.31 (d, *J* = 6.5 Hz), 16.89 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{23}NO_4Na$, 328.1525; found, 328.1522.



S25

(S)-4-Isopropyl-5,5-dimethyl-3-(2-(3-(trifluoromethyl)phenyl)acetyl)oxazolidin-2-one (3.71). The title compound was prepared from commercially available 2-(3-trifluoromethyl)acetic acid (1.71 g, 8.40 mmol) following standard procedure 3 for the synthesis of N-acyl oxazolidinones via acyl chloride from carboxylic acid and was obtained as yellow oil (1.01 g, 2.94 mmol, 35%) after purification by column chromatography (silica, 30% ethyl acetate – hexanes). α_D^{23} + 33.10 (*c* 0.1, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.59 (s, 1H), 7.53 (d, *J* = 7.8 Hz, 2H), 7.44 (dd, *J* = 7.7 Hz, 1H), 4.44 (d, *J* = 15.4 Hz, 1H), 4.29 (d, *J* = 15.4 Hz, 1H), 4.15 (d, *J* = 3.2 Hz, 1H), 2.15 – 2.09 (m, 1H), 1.50 (s, 3H), 1.50 (s, 3H), 1.34 (s, 3H), 1.34 (s, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.96 (d, *J* = 7.0 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 170.90 (s), 153.44 (s), 134.90 (s), 133.25 (d, *J* = 1.2 Hz), 131.31 – 130.18 (m), 128.88 (d, *J* = 7.3 Hz), 126.29 (q, *J* = 3.8 Hz), 124.00 (q, *J* = 3.8 Hz), 124.00 (d, *J* =272.2 Hz), 83.07, (s), 66.52 (s), 41.34 (s), 29.57 (s), 28.75 (s), 21.38 (s), 21.31 (s), 16.81 (s); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{20}F_3NO_3Na$, 366.1293; found, 366.1292.



(S)-3-(2-(benzo[d]oxazol-5-yl)acetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.73) The title compound was prepared starting from known methyl ester **3.72**[125] using the following procedure.

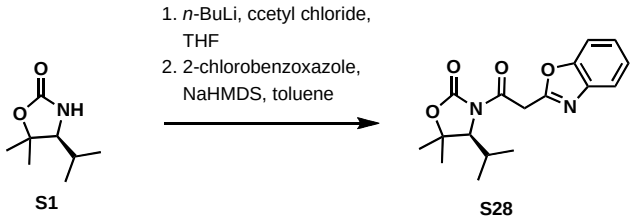
Pd/C (20 mol %) was added to a solution of **3.72** (1.37 g, 6.48 mmol) in a 1:1 mixture of EtOH/EtOAc (0.16 M). The reaction mixture was placed under an atmosphere of H_2 and stirred for 14 h. The reaction mixture was then filtered through a pad of celite and the remaining residue was washed using a solvent system of 1:1 EtOH and EtOAc. The filtrate was concentrated in *vacuo* providing a dark brown solid (1.08 g, 99%). The crude product was used without further purification

Triethylorthoformate (13.3 mL, 0.8 M) was added to the crude substrate (10.6 mmol) and the mixture was heated at reflux for 18 h. The reaction mixture was then transferred to a separatory funnel containing water (90 mL) and extracted with ethyl acetate (3 x 15 ml). The organic layer was dried over Na_2SO_4 and concentrated in *vacuo* providing a light brown oil (1.75 g, 10.5 mmol, 99%). The crude product was used without further purification.

An aqueous solution of NaOH was added (0.4 M, 11.36 mmol, 1.2 equiv) to a solution of crude substrate (1.81 g, 9.47 mmol) in methanol (0.37 M) and the mixture was stirred for 12 h. The reaction mixture was diluted with H_2O to a concentration of 0.035 M. Concentrated aqueous HCl was added until a pH of ~4 was achieved. The solution was

allowed to stir for 1 h and the solids were collected by filtration and washed with cold water providing the product as a crude tan solid (0.673 g, 3.52 mmol, 41%).

The title compound was prepared from the solid collected (0.375 g, 2.11 mmol) following standard procedure 2 for the synthesis of N-acyl oxazolidinones via carboxylic acid and was obtained as white solid (0.433 g, 1.37 mmol, 65%) after purification by column chromatography (silica, 24% ethyl acetate to 30% ethyl acetate in hexanes). α_D^{21} + 29.80 (*c* 1.0, $CHCl_3$). ^1H NMR (600 MHz, $CDCl_3$) δ(ppm): 8.05 (s, 1H), 7.73 (s, 1H), 7.49 (d, *J* = 8.4 Hz, 1H), 7.34 (d, *J* = 8.4 Hz, 1H), 4.47 (d, *J* = 15.4 Hz, 1H), 4.33 (d, *J* = 15.4 Hz, 1H), 4.11 (d, *J* = 3.1 Hz, 1H), 2.11 – 2.03 (m, 1H), 1.45 (s, 3H), 1.29 (s, 3H), 0.92 (d, *J* = 7.0 Hz, 3H), 0.83 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 171.51 (s), 153.38 (s), 152.77 (s), 149.04 (s), 140.20 (s), 130.55 (s), 127.25 (s), 121.47 (s), 110.62 (s), 82.86 (s), 66.37 (s), 41.27 (s), 29.44 (s), 28.67 (s), 21.35 (s), 21.21 (s), 16.77 (s). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{20}N2O_4Na$, 339.1321; found, 339.1314.



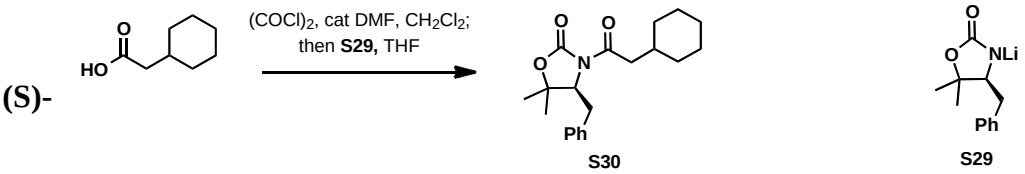
(S)-3-(2-(benzo[d]oxazol-2-yl)acetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.74) The title compound was prepared starting from oxazolidone **S2** using the following procedure.

To a solution of **S2** (1.5 g, 9.54 mmol) in THF (0.3 M) at –78 °C, *n*-BuLi (4.5 mL, 2.33 M in hexanes, 10.5 mmol, 1.1 equiv) was added dropwise. After the addition was complete,

the reaction mixture was warmed to room temperature and stirred for 30 min. The reaction mixture was chilled to -78 °C and acetyl chloride (0.82 mL, 11.45 mmol, 1.2 equiv) was added. After the addition was complete, the reaction mixture was warmed to room temperature and stirred for 12 h. The reaction was quenced with saturated ammonium chloride and the layers were seperated. The aqeuous layer was extracted with ethyl acetate (3 x 25 ml). The combined organic layers were washed with brine, dried over sodium sulfate, concentrated *in vacuo.* (S)-3-acetyl-4-isopropyl-5,5-dimethyloxazolidin-2-one was obtained after purification by column chromatography (silica, 12% ethyl acetate to 14% ethyl acetate in hexanes) as a colorless oil (1.4 g, 7.03 mmol, 74%).

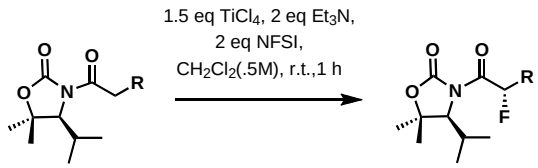
To a solution of (S)-3-acetyl-4-isopropyl-5,5-dimethyloxazolidin-2-one (0.500 g, 2.50 mmol) and 2-chlorobenzoxazole (0.385 g, 2.50 mmol) in toluene (11 mL) at 0 °C, NaHMDS (0.6 M in toluene, 8.3 mL, 5 mmol, 2 equiv) was added dropwise. After the addition was complete, the reaction mixture was allowed to stir at 0 °C for 2 h and then warmed to room temperature and stirred 12 h. The reaction was quenched with 1N NH_4Cl solution (38 mL, 15.3 equiv). The organic layer was separated and collected. The aqueous layer was extracted with EtOAc (3 x 15 mL), the combined organic layers were dried over Na_2SO_4 and concentrated in *vacuo*. The title compound was obtained after purification by column chromatography (silica, 21% ethyl acetate to 25% ethyl acetate in hexanes as a green solid (0.510 g, 1.61 mmol, 65%). α_D^{20} + 49.79 (*c* 1.0, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ(ppm): 7.68 – 7.64 (m, 1H), 7.48 (d, *J* = 5.0 Hz, 1H), 7.32 – 7.27 (m, 2H), 4.73 (d, *J* = 17.1 Hz, 1H), 4.55 (d, *J* = 17.1 Hz, 1H), 4.20 (d, *J* = 2.5 Hz, 1H), 2.21 – 2.15 (m, 1H), 1.52 (d, *J* = 6.3 Hz, 3H), 1.47 (s, 3H), 1.06 (d, *J* = 7.0 Hz, 3H), 0.99 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 166.63 (s), 159.96 (d, *J* = 0.9 Hz), 153.40 (s), 151.02 (s),

141.07 (s), 124.88 (s), 124.21 (s), 119.85 (s), 110.48 (s), 83.63 (s), 66.76 (s), 36.75 (s), 29.56 (s), 28.74 (s), 21.42 (s), 21.30 (s), 16.85 (s). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{20}N2O_4Na$, 339.1321; found, 339.1331.



3-(2-Cyclohexylacetyl)-4-isopropyl-5,5-dimethyloxazolidin-2-one (3.75). The title compound was prepared from commerically available 2-cyclohexylacetic acid following known literature protocols by Herrmann *et al*. ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.32 – 7.26 (m, 4H), 7.26 – 7.25 (m, 1H), 7.22 (ddd, *J* = 8.5, 3.8, 1.8 Hz, 1H), 4.51 (dd, *J* = 9.6, 3.9 Hz, 1H), 3.13 (dd, *J* = 14.4, 3.8 Hz, 1H), 2.91 – 2.75 (m, 3H), 1.88 – 1.78 (m, 1H), 1.74 – 1.60 (m, 5H), 1.36 (s, 3H), 1.34 (s, 3H), 1.31 – 1.21 (m, 2H), 1.18 – 1.10 (m, 1H), 1.04 – 0.95 (m, 2H). ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 172.78 (s), 152.58 (s), 136.96 (s), 129.02 (s), 128.59 (s), 126.71 (s), 81.92 (s), 77.25 (s), 77.00 (s), 76.75 (s), 63.46 (s), 42.68 (s), 35.39 (s), 34.44 (s), 33.01 (d, *J* = 10.0 Hz), 28.50 (s), 26.11 (d, *J* = 10.4 Hz), 22.24 (s).

Standard procedure for a–monofluorination of *N*-acyl oxazolidinones:



The substrate (0.50 mmol, 1.00 equiv) was charged to a flame dried 10 ml round bottom flask or 1 dram vial. The reaction vessel was then backfilled with argon 3 times. Next,

dichloromethane (0.50 M) was added and the solution was then cooled to 0 °C. A solution of $TiCl_4$ (1.00 M in CH_2Cl_2, 0.75 mL, 0.75 mmol, 1.50 equiv) was added dropwise to the reaction mixture at 0 °C and the mixture was stirred for 5 min. Triethylamine (0.14 mL, 1.00 mmol, 2.00 equiv) was added and the reaction mixture was stirred at 0 °C for 30 min. *N*-Fluorobenzenesulfonimide (NFSI, 0.315 g, 2.00 mmol, 2.00 equiv) was then added to the reaction mixture in one portion at 0 °C (CAUTION: reaction may bubble vigourously upon addition). The reaction was then warmed to rt and stirred for 1 h. The reaction mixture was filtered through a 1.5 cm silica gel plug, and the silica plug was washed with dichloromethane (5 mL) and ethyl acetate (40 mL). The combined filtrate was concentrated *in vacuo* and the residue purified by flash column chromatography to give the corresponding α–monofluorinated *N*-acyl oxazolidinone.

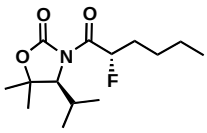


Table 3.5.3, entry 1. The title compound was prepared from oxazolidinone **3.49** (0.128 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 15% ethyl acetate in hexanes) to afford product as a colorless oil (0.128 g, 0.47 mmol, 94%, single diastereomer). α_D^{24} + 13.60 (*c* 1.0, $CHCl_3$); **^{1}**H NMR (600 MHz, $CDCl_3$); δ(ppm): 5.99 (d, *J* = 51.4 Hz, 1H), 4.10 (d, *J* = 3.0 Hz, 1H), 2.20 (dddd, *J* = 13.8, 6.9, 3.1 Hz, 1H), 1.87 – 1.76 (m, 2H), 1.53 (s, 3H), 1.52 – 1.45 (m, 1H), 1.41 (dd, *J* = 13.2, 7.8 Hz, 1H), 1.39 (s, 3H), 1.38 – 1.30 (m, 1H), 1.07 (d, *J* = 7.0 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H), 0.91 (dd, *J* = 7.3 Hz, 3H); **^{13}**C NMR (151 MHz,

$CDCl_3$); δ(ppm): 170.50 (d, *J* = 22.7 Hz), 153.08 (s), 89.14 (d, *J* = 178.5 Hz), 84.01 (s), 66.87 (s), 32.04 (d, *J* = 22.1 Hz), 29.47 (s), 28.95 (s), 26.90 (d, *J* = 1.9 Hz), 22.13 (s), 21.40 (s), 21.31 (s), 16.98 (s), 13.82 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -192.24 – -192.48 (m, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{14}H_{24}FNO_3Na$, 296.1638; found, 296.1633.

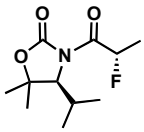


Table 3.5.3, entry 2. The title compound was prepared form oxazolidinone **3.50** (0.107 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 11% ethyl acetate in hexanes) to afford product as a white solid (0.105 g, 0.46 mmol, 91%, single diastereomer. α_D^{26} + 14.78 (*c* 0.42, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 6.08 (dddd, *J* = 49.2, 6.5 Hz, 1H), 4.11 (d, *J* = 3.2 Hz, 1H), 2.19 (dddd, *J* = 13.9, 7.0, 3.2 Hz, 1H), 1.57 (dd, *J* = 23.8, 6.5 Hz, 3H), 1.53 (s, 3H), 1.39 (s, 3H), 1.06 (d, *J* = 7.0 Hz, 3H), 0.97 (d, *J* = 6.9 Hz, 3H); ^{13}C NMR (201 MHz, $CDCl_3$); δ(ppm): 172.79 (d, *J* = 22.4 Hz), 154.80 (s), 87.58 (d, *J* = 176.6 Hz), 85.87 (s), 68.62 (s), 31.27 (s), 30.74 (s), 23.16 (s), 23.11 (s), 19.90 (d, *J* = 23.6 Hz), 18.73 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -183.56 - -183.80 (m, 1F). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{11}H_{18}FNO_3Na$, 254.1168; found, 254.1164.

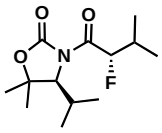


Table 3.5.3, entry 3. The title compound was prepared form oxazolidinone **3.55** (0.121 g, 0.50 mmol) following the standard α–monofluorination procedure. The diastereoselectivity (dr >98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 6% ethyl acetate in hexanes) to afford product as a colorless oil (0.100 g, 0.39 mmol, 77%, single diastereomer). α_D^{26} + 42.22 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 5.89 (dd, *J* = 49.6, 3.2 Hz, 1H), 4.11 (d, *J* = 3.0 Hz, 1H), 2.23 – 2.11 (m, 2H), 1.53 (s, 3H), 1.38 (s, 3H), 1.11 (d, *J* = 6.9 Hz, 3H), 1.08 (d, *J* = 7.0 Hz, 3H), 0.97 (dd, *J* = 6.6 Hz, 6H); ^{13}C NMR (151 MHz, $CDCl_3$); δ(ppm): 169.73 (d, *J* = 23.0 Hz), 153.12 (s), 92.31 (dd, *J* = 181.2, 19.7 Hz), 83.86 (s), 67.03 (d, *J* = 19.1 Hz), 30.63 (t, *J* = 20.2 Hz), 29.49 (d, *J* = 19.9 Hz), 28.86 (d, *J* = 11.6 Hz), 21.40 (d, *J* = 6.6 Hz), 21.24 (s), 18.85 (d, *J* = 18.9 Hz), 16.98 (d, *J* = 17.4 Hz), 15.26 (d, *J* = 16.3 Hz); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -204.40 (dd, *J* = 50.2, 28.3 Hz, 1F). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{13}H_{22}FNO_3Na$, 282.1481; found, 282.1489.

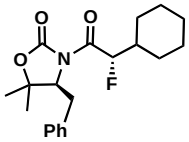


Table 3.5.3, entry 4. The title compound was prepared from oxazolidinone **3.75** (0.165 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 96:4) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 20% ethyl acetate in hexanes - 25%

ethyl acetate in hexanes) to afford product as a white soild (0.160 g, 0.46 mmol, 92%, single diastereomer). α_D^{26} + 19.05 (*c* 0.42, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.33 – 7.27 (m, 4H), 7.24 (dd, *J* = 7.1 Hz, 1H), 5.83 (dd, *J* = 49.6, 3.6 Hz, 1H), 4.46 (dd, *J* = 9.9, 3.0 Hz, 1H), 3.25 (dd, *J* = 14.5, 2.8 Hz, 1H), 2.93 (dd, *J* = 14.5, 9.9 Hz, 1H), 1.84 (dddd, *J* = 58.1, 34.1, 16.5, 8.1 Hz, 4H), 1.65 (dd, *J* = 21.0, 12.8 Hz, 2H), 1.44 – 1.35 (m, 7H), 1.35 – 1.27 (m, 2H), 1.23 – 1.11 (m, 2H); ^{13}C NMR (201 MHz, $CDCl_3$); δ(ppm): 169.54 (d, *J* = 23.5 Hz), 152.13 (s), 136.63 (s), 129.04 (s), 128.75 (s), 126.93 (s), 92.10 (d, *J* = 180.8 Hz), 83.50 (s), 64.05 (s), 40.34 (d, *J* = 20.8 Hz), 35.02 (s), 28.63 (d, *J* = 3.3 Hz), 28.53 (s), 26.07 (d, *J* = 4.3 Hz), 26.01 (s), 25.81 (s), 25.76 (s), 22.15 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -201.83 (dd, *J* = 50.1, 26.9 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{20}H_{26}FNO_3Na$, 370.1794; found, 370.1800.

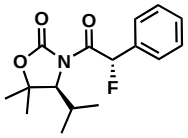


Table 3.5.3, entry 5. The title compound was prepared from oxazolidinone **3.62** (0.138 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 96:4) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 3% diethyl ether in toluene - 5% diethyl ether in toluene) to afford product as a yellow solid (0.135 g, 0.46 mmol, 92%, single diastereomer). α_D^{26} + 132.53 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.52 (d, *J* = 4.9 Hz, 2H), 7.38 (d, *J* = 5.4 Hz, 3H), 6.98 (d, *J* = 48.8 Hz, 1H), 3.99 (d, *J* = 3.1 Hz, 1H), 2.18 (dddd, *J* = 13.8, 6.9, 3.2 Hz, 1H), 1.44 (s, 3H), 1.12 (d, *J* = 7.0 Hz, 3H), 1.00 (d, *J* = 6.8

Hz, 3H), 0.94 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 168.89 (d, *J* = 26.9 Hz), 152.96 (s), 133.44 (d, *J* = 20.2 Hz), 130.10 (d, *J* = 3.1 Hz), 128.77 (s), 128.76 (s), 128.49 (s), 128.46 (s), 88.87 (d, *J* = 180.2 Hz), 84.20 (s), 67.54 (s), 29.47 (s), 28.35 (s), 21.43 (s), 21.25 (s), 16.98 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -172.63 (d, *J* = 48.8 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{16}H_{20}FNO_3Na$, 316.1325; found, 316.1324.

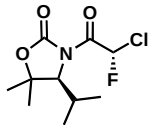


Table 3.5.3, entry 6. The title compound was prepared from oxazolidinone **3.51** (0.117 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 15% ethyl acetate in hexanes - 25% ethyl acetate in hexanes) to afford product as a white solid (84 mg, 0.34 mmol, 67%, single diastereomer). α_D^{26} + 38.40 (*c* 0.7, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.45 (d, *J* = 51.6 Hz, 1H), 4.08 (d, *J* = 3.0 Hz, 1H), 2.24 – 2.18 (m, 1H), 1.56 (s, 3H), 1.45 (s, 3H), 1.09 (d, *J* = 7.0 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 163.97 (d, *J* = 26.3 Hz), 152.59 (s), 90.25 (d, *J* = 248.8 Hz), 85.16 (s), 67.67 (s), 29.47 (s), 28.91 (s), 21.46 (s), 21.31 (s), 16.87 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -149.72 (dd, *J* = 51.6, 3.6 Hz, 1F);. HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{10}H_{15}FClNO_3Na$, 274.0622; found, 274.0610.

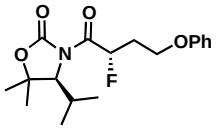


Table 3.5.3, entry 7. The title compound was prepared from oxazolidinone **3.69** (0.160 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 1.5% diethyl ether in toluene) to afford product as a white soild (0.155 g, 0.46 mmol, 92%, single diastereomer). α_D^{26} + 31.81 (*c* 1.0, $CHCl_3$); **1**H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.27 (d, *J* = 7.6 Hz, 1H), 7.25 (s, 1H), 6.95 (dd, *J* = 7.3 Hz, 1H), 6.89 (d, *J* = 8.3 Hz, 2H), 6.21 (ddd, *J* = 49.0, 5.3 Hz, 1H), 4.22 – 4.14 (m, 2H), 4.13 (d, *J* = 3.0 Hz, 1H), 2.41 (ddd, *J* = 5.9 Hz, 1H), 2.37 (ddd, *J* = 5.9 Hz, 1H), 2.21 (ddd, *J* = 13.8, 8.4, 5.0 Hz, 1H), 1.53 (s, 3H), 1.41 (s, 3H), 1.08 (d, *J* = 7.0 Hz, 3H), 0.99 (d, *J* = 6.8 Hz, 3H); **13**C NMR (126 MHz, $CDCl_3$); δ(ppm): 169.52 (d, *J* = 22.6 Hz), 158.44 (s), 153.03 (s), 129.39 (s), 121.07 (s), 114.81 (d, *J* = 0.7 Hz), 86.32 (d, *J* = 178.7 Hz), 84.16 (s), 66.92 (s), 62.85 (d, *J* = 3.3 Hz), 32.01 (d, *J* = 21.8 Hz), 29.44 (s), 28.94 (s), 21.39 (s), 21.25 (s), 16.95 (s); **19**F NMR (564 MHz, $CDCl_3$); δ(ppm): -192.47 – -192.69 (m, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{18}H_{24}FNO_4Na$, 360.1587; found, 360.1594.

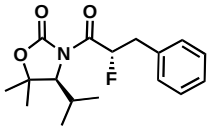


Table 3.5.3, entry 8. The title compound was prepared from oxazolidinone **3.52** (0.145 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The

residue was purified by column chromatography (silica, 12% ethyl acetate in hexanes - 15% ethyl acetate in hexanes) to afford product as a colorless oil after purification (0.136 g, 0.44 mmol, 88%, single diastereomer). α_D^{26} + 37.73 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.34 – 7.29 (m, 4H), 7.25 (dd, *J* = 8.4, 2.4 Hz, 1H), 6.22 (ddd, *J* = 49.5, 8.6, 3.3 Hz, 1H), 4.10 (d, *J* = 3.0 Hz, 1H), 3.14 (dddd, *J* = 22.9, 19.4, 14.3, 6.0 Hz, 2H), 2.19 (dddd, *J* = 13.7, 6.9, 3.2 Hz, 1H), 1.51 (s, 3H), 1.30 (s, 3H), 1.07 (d, *J* = 7.0 Hz, 3H), 0.97 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 169.50 (d, *J* = 22.5 Hz), 152.95 (s), 135.05 (d, *J* = 1.9 Hz), 129.43 (s), 128.45 (s), 127.07 (s), 89.17 (d, *J* = 181.1 Hz), 84.00 (s), 66.73 (s), 38.47 (d, *J* = 22.5 Hz), 29.37 (s), 28.72 (s), 21.29 (s), 21.20 (s), 16.87 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -188.75 (ddd, *J* = 49.6, 33.6, 19.4 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{22}FNO_3Na$, 330.1481; found, 330.1485.

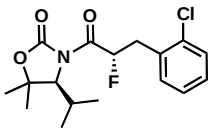


Table 3.5.3, entry 9. The title compound was prepared from oxazolidinone **3.68** (0.162 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 96:4) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 12% diethyl ether in toluene - 15% diethyl ether in toluene) to afford product as a colorless oil (0.133 g, 0.39 mmol, 78%, single diastereomer). α_D^{25} + 26.92 (*c* 0.1, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.43 (d, *J* = 7.3 Hz, 1H), 7.36 (d, *J* = 7.6 Hz, 1H), 7.32 (d, *J* = 5.8 Hz, 1H), 7.25 – 7.18 (m, 2H), 6.32 (ddd, *J* = 48.7, 8.2, 4.2 Hz, 1H), 4.13 (d, *J* = 3.1 Hz, 1H), 3.46 (ddd, *J* = 18.6, 14.7, 8.1 Hz, 1H), 3.30 (ddd, *J* = 30.1, 14.6, 4.1 Hz, 1H), 2.21 (dddd, *J* = 13.8, 5.1 Hz, 1H), 1.53 (s, 3H),

1.35 (s, 3H), 1.07 (d, *J* = 7.0 Hz, 3H), 0.99 (d, *J* = 6.8 Hz, 3H); **13**C NMR (126 MHz, $CDCl_3$); δ(ppm): 169.34 (d, *J* = 22.6 Hz), 152.78 (s), 134.54 (s), 132.75 (d, *J* = 2.9 Hz), 131.58 (d, *J* = 1.3 Hz), 129.55 (s), 128.61 (s), 126.93 (s), 87.69 (d, *J* = 181.0 Hz), 83.95 (s), 66.88 (s), 35.20 (d, *J* = 22.7 Hz), 29.52 (s), 28.90 (s), 21.49 (s), 21.33 (s), 16.96 (s). **19**F NMR (564 MHz, $CDCl_3$); δ(ppm): -187.68, -187.87 (m, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{21}FClNO_3Na$, 364.109; found, 364.1102.

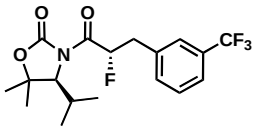


Table 3.5.3, entry 10. The title compound was prepared from oxazolidinone **3.60** (0.179 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 1.5% diethyl ether in toluene) to afford product as a white solid (0.115 g, 0.31 mmol, 61%, 98:2 dr. α_D^{26} + 25.27 (*c* 1.0, $CHCl_3$); **1**H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.57 (s, 1H), 7.56 – 7.51 (m, 2H), 7.45 (dd, *J* = 7.7 Hz, 1H), 6.18 (ddd, *J* = 49.4, 8.7, 2.5 Hz, 1H), 4.12 (d, *J* = 2.9 Hz, 1H), 3.19 (dddd, *J* = 34.6, 23.1, 14.5, 5.7 Hz, 2H), 2.21 (dddd, *J* = 13.7, 6.9, 3.2 Hz, 1H), 1.54 (s, 3H), 1.35 (s, 3H), 1.07 (d, *J* = 7.0 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H); **13**C NMR (126 MHz, $CDCl_3$); δ(ppm): 169.15 (d, *J* = 22.5 Hz), 153.11 (s), 136.24 (d, *J* = 1.0 Hz), 133.00 (s), 130.88 (q, *J* = 32.2 Hz), 129.03 (s), 126.26 (q, *J* = 3.7 Hz), 124.12 (q, *J* = 3.8 Hz), 124.01 (d, *J* = 273.42 Hz), 89.08 (d, *J* = 181.9 Hz), 84.29 (s), 66.87 (s), 38.23 (d, *J* = 22.5 Hz), 29.48 (s), 28.91 (s), 21.38 (s), 21.27 (s), 16.95 (s); **19**F NMR (564 MHz, $CDCl_3$); δ(ppm): -62.65 (s, 3F), -189.13

(ddd, J = 49.5, 34.0, 20.1 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{18}H_{21}F_4NO_3Na$, 398.1355; found, 398.1356.

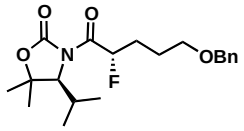


Table 3.5.3, entry 11. The title compound was prepared from oxazolidinone **3.57** (0.174 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 15% ethyl acetate in hexanes hexanes – 25% ethyl acetate in hexanes) to afford product as a colorless oil (0.124 g, 0.34 mmol, 68%, single diastereomer). α_D^{25} + 30.86 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.35 – 7.30 (m, 4H), 7.29 – 7.26 (m, 1H), 6.10 – 5.99 (m, 1H), 4.49 (d, J = 2.8 Hz, 2H), 4.10 (d, J = 3.0 Hz, 1H), 3.57 – 3.49 (m, 2H), 2.20 (dddd, J = 13.9, 7.0, 3.2 Hz, 1H), 2.02 – 1.91 (m, 2H), 1.90 – 1.79 (m, 2H), 1.53 (s, 3H), 1.36 (s, 3H), 1.07 (d, J = 7.0 Hz, 3H), 0.98 (d, J = 6.8 Hz, 3H); ^{13}C NMR (201 MHz, $CDCl_3$); δ(ppm): 171.99 (d, J = 22.7 Hz), 154.85 (s), 140.20 (s), 130.11 (s), 129.43 (s), 129.29 (s), 90.71 (d, J = 178.8 Hz), 85.87 (s), 74.58 (s), 70.99 (s), 68.68 (s), 31.26 (s), 31.01 (d, J = 22.1 Hz), 30.71 (s), 26.80 (d, J = 2.0 Hz), 23.18 (s), 23.10 (s), 18.76 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -192.32 (ddd, J = 50.1, 30.1, 24.4 Hz, 1F). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{20}H_{28}FNO_4Na$, 388.1900; found, 388.1901.

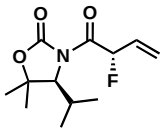


Table 3.5.3, entry 12. The title compound was prepared from oxazolidinone **3.61** (0.113 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr >98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 15% ethyl acetate in hexanes - 25% ethyl acetate in hexanes) to afford product as a clear oil (56 mg, 0.23 mmol, 46%, single diastereomer). α_D^{25} + 36.44 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); dppm): 6.46 (dd, *J* = 48.7, 6.2 Hz, 1H), 6.07 – 5.97 (m, 1H), 5.65 (dd, *J* = 17.3, 3.2 Hz, 1H), 5.46 (d, *J* = 10.7 Hz, 1H), 4.07 (d, *J* = 2.9 Hz, 1H), 2.19 (dddd, *J* = 13.7, 6.9, 3.1 Hz, 1H), 2.19 (dddd, *J* = 13.7, 6.9, 3.1 Hz, 1H), 1.52 (s, 3H), 1.34 (s, 3H), 1.08 (d, *J* = 7.0 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); dppm): 168.36 (d, *J* = 24.7 Hz), 153.03 (s), 129.94 (d, *J* = 19.8 Hz), 121.75 (d, *J* = 10.9 Hz), 87.69 (d, *J* = 179.0 Hz), 84.32 (s), 67.19 (s), 29.46 (s), 28.96 (s), 21.33 (s), 16.94 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -186.01 (ddd, *J* = 49.0, 14.3, 3.6 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{12}H_{18}FNO_3Na$, 266.1168; Found, 266.1158.

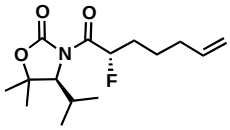


Table 3.5.3, entry 13. The title compound was prepared from oxazolidinone **3.56** (0.134 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 98:2) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 9% ethyl acetate in hexanes - 11%

ethyl acetate in hexanes) to afford product as a colorless oil (0.114 g, 0.40 mmol, 80%, single diastereomer). α_D^{26} + 31.46 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 6.05 – 5.94 (m, 1H), 5.78 (dddd, *J* = 16.9, 10.2, 6.6 Hz, 1H), 4.99 (dd, *J* = 32.4, 13.7 Hz, 2H), 4.10 (d, *J* = 2.9 Hz, 1H), 2.19 (dddd, *J* = 10.3, 7.2, 3.3 Hz, 1H), 2.16 – 2.05 (m, 2H), 1.88 – 1.77 (m, 2H), 1.70 – 1.60 (m, 2H), 1.53 (s, 3H), 1.38 (s, 3H), 1.07 (d, *J* = 7.0 Hz, 3H), 0.97 (d, *J* = 6.9 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 170.32 (d, *J* = 22.6 Hz), 153.05 (s), 137.78 (s), 115.14 (s), 89.00 (d, *J* = 178.7 Hz), 84.04 (s), 66.86 (s), 32.95 (s), 31.72 (d, *J* = 22.1 Hz), 29.45 (s), 28.94 (s), 24.01 (d, *J* = 1.9 Hz), 21.37 (s), 21.29 (s), 16.95 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -192.17 – -192.40 (m, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{15}H_{24}FNO_3Na$, 308.1638; found, 308.1642.

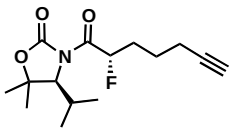


Table 3.5.3, entry 3.58. The title compound was prepared from oxazolidinone **S12** (0.132 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 5:1) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 12% ethyl acetate in hexanes) to afford product as a colorless oil (79 mg, 0.28 mmol, 56%, single diastereomer). α_D^{26} + 30.73 (*c* 0.316, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$) δ(ppm): 6.02 (ddd, *J* = 50.1, 7.4, 3.6 Hz, 1H), 4.11 (d, *J* = 2.8 Hz, 1H), 2.28 (dt, *J* = 16.7, 8.0 Hz, 2H), 2.24 – 2.18 (m, 1H), 2.06 – 1.89 (m, 3H), 1.78 (ddd, *J* = 22.5, 14.4, 7.0 Hz, 2H), 1.54 (s, 3H), 1.40 (s, 3H), 1.08 (d, *J* = 7.0 Hz, 3H), 0.98 (d, *J* = 6.8 Hz, 2H); ^{13}C NMR (201 MHz, $CDCl_3$) δ(ppm): 170.04 (d, *J* = 22.6 Hz), 153.06 (s), 88.76 (d, *J* = 179.1 Hz), 84.12 (s), 83.36 (s), 69.02 (s), 66.91 (s), 31.27

(d, J = 22.1 Hz), 29.48 (s), 29.02 (s), 23.77 (d, J = 2.0 Hz), 21.41 (s), 21.31 (s), 17.99 (s), 16.98 (s). ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -192.21 (ddd, J = 50.0, 31.2, 23.3 Hz). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{15}H_{22}FNO_3Na$, 306.1481; found, 306.1476.

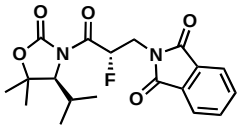
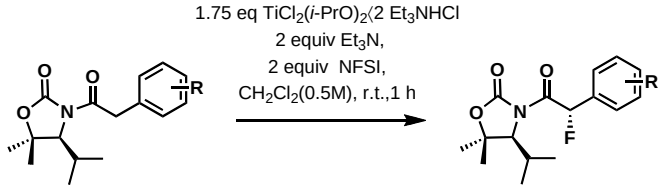


Table 3.5.3, entry 15. The title compound was prepared from oxazolidinone **3.59** (0.179 g, 0.50 mmol) following the standard a–monofluorination procedure. The diastereoselectivity (dr 94:6) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 5% diethyl ether in toluene - 10% diethyl ether in toluene) to afford product as a white solid (0.132 g, 0.35 mmol, 70%, single diastereomer). α_D^{22} + 13.20 (*c* 1.0, $CHCl_3$); **1**H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.75 (ddd, J = 72.2, 5.3, 3.1 Hz, 4H), 6.22 (ddd, J = 46.7, 4.4, 1.9 Hz, 1H), 4.38 (ddd, J = 15.3, 10.7, 4.7 Hz, 1H), 4.26 (ddd, J = 31.6, 15.2, 1.6 Hz, 1H), 4.16 (d, J = 2.8 Hz, 1H), 2.19 (dddd, J = 6.8, 3.9 Hz, 1H), 1.69 (s, 3H), 1.55 (s, 3H), 1.01 (d, J = 7.0 Hz, 3H), 0.95 (d, J = 6.8 Hz, 3H); **13**C NMR (126 MHz, $CDCl_3$); δ(ppm): 167.74 (s), 167.51 (d, J = 23.2 Hz), 153.48 (s), 134.07 (s), 131.73 (s), 123.47 (s), 85.87 (d, J = 183.8 Hz), 84.73 (s), 66.68 (s), 38.08 (d, J = 21.7 Hz), 29.43 (s), 28.83 (s), 21.84 (s), 21.16 (s), 17.01 (s); **19**F NMR (564 MHz, $CDCl_3$); δ(ppm): -194.15 (ddd, J = 44.1, 32.2, 11.3 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{19}H_{21}FN_2O_5Na$, 399.1332; found, 399.1339.

Standard procedure for α–monofluorination of *N*-(arylacetyl)oxazolidinones:



Preparation of $TiCl_2(iPrO)_2 \cdot 2\ Et_3NHCl$: In a flame dried flask, *i*-PrOH (2 equiv) was added to $TiCl_4$ (1 equiv, 1.0 M in CH_2Cl_2) dropwise over 5 min at rt under an argon. The mixture was stirred for an additional 10 min (HCl gas evolution was observed). Et_3N (2 equiv) was then added dropwise over 10 min at rt. The mixture was stirred for an additional 30 min (most of the initially formed white precipitate eventually redissolves).

α-Monofluorination reaction: In a separate flame-dried flask, $TiCl_2(iPrO)_2 \bullet 2Et_3NHCl$ (1.75 equiv) was added dropwise to the solution of *N*-acyl oxazolidinone (0.50 mmol, 1.00 equiv) in CH_2Cl_2 (0.5 M) at 0 °C under argon, and the resultant mixture was stirred for 5 min (solution becomes a deep red upon complete addition). Et_3N (2.0 equiv) was added dropwise at 0 °C and the reaction mixture was stirred for 30 min. NFSI (2.0 equiv) was added in one portion to the reaction at 0 °C (CAUTION: reaction mixture may bubble vigorously upon addition of NFSI). The reaction mixture was warmed to rt and stirred for 1 h. The reaction was filtered through a 1.5 cm silica gel plug and washed with dichloromethane (10 mL) and ethyl acetate (50 mL). The filtrate was then concentrated and the residue was purified by flash column chromatography to give the product.

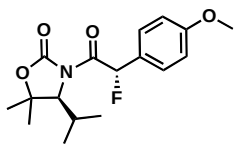


Table 3.5.5, entry 1. The title compound was prepared from oxazolidinone **3.53** (0.153 g, 0.50 mmol) following the standard a–monofluorination of *N*-(arylacetyl)oxazolidinones. The diastereoselectivity (dr 93:7) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 4% diethyl ether in toluene) to afford product as a colorless oil (0.102 g, 0.31 mmol, 63%, single diastereomer). α_D^{26} + 141.92 (*c* 0.3, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.45 (d, *J* = 8.3 Hz, 2H), 6.91 (d, *J* = 48 Hz, 1 H), 6.89 (d, *J* = 8.5 Hz, 2H), 4.01 (d, *J* = 3.0 Hz, 1H), 3.81 (s, 3H), 2.18 (dddd, *J* = 13.8, 6.9, 3.2 Hz, 1H), 1.57 (s, 3H), 1.45 (s, 3H), 1.12 (d, *J* = 7.1 Hz, 3H), 1.00 (d, *J* = 6.8 Hz, 3H), 0.98 (s, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 169.14 (d, *J* = 27.8 Hz), 160.89 (d, *J* = 2.9 Hz), 152.94 (s), 130.25 (s), 130.22 (s), 125.55 (d, *J* = 21.0 Hz), 114.15 (s), 114.14 (s), 88.60 (d, *J* = 179.9 Hz), 84.14 (s), 67.45 (s), 55.29 (s), 29.50 (s), 28.49 (s), 21.45 (s), 21.28 (s), 17.01 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -169.50 (d, *J* = 49.4 Hz, 1F). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{22}FNO_4Na$, 346.1431; found, 346.1439.

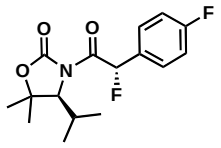


Table 3.5.5, entry 2. The title compound was prepared from oxazolidinone **3.54** (0.146 g, 0.50 mmol) following the standard procedure for a–monofluorination of *N*-(arylacetyl)oxazolidinones. The diastereoselectivity (dr 10:1) was determined by ^{1}H NMR of

the crude reaction mixture. The residue was purified by column chromatography (silica, 1% diethyl ether in toluene) to afford product as a white soild (0.110 g, 0.36 mmol, 71%, single diastereomer). α_D^{25} + 141.77 (*c* 1.0, $CHCl_3$); **1**H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.53 – 7.49 (m, 1H), 7.06 (dd, *J* = 8.4 Hz, 1H), 6.94 (d, *J* = 48.6 Hz, 1H), 3.99 (d, *J* = 2.9 Hz, 1H), 2.17 (ddd, *J* = 10.5, 6.8, 3.3 Hz, 1H), 1.44 (s, 2H), 1.10 (d, *J* = 7.0 Hz, 2H), 0.98 (d, *J* = 6.8 Hz, 1H), 0.97 (s, 1H); **13**C NMR (126 MHz, $CDCl_3$); δ(ppm): 168.66 (d, *J* = 27.2 Hz), 163.58 (dd, *J* = 250.0, 3.2 Hz), 152.90 (s), 130.65 (d, *J* = 4.3 Hz), 130.59 (d, *J* = 4.3 Hz), 129.45 (dd, *J* = 20.9, 3.3 Hz), 115.91 (d, *J* = 1.7 Hz), 115.73 (d, *J* = 1.7 Hz), 88.00 (d, *J* = 180.5 Hz), 84.26 (s), 67.44 (s), 29.43 (s), 28.40 (s), 21.39 (s), 21.16 (s), 16.90 (s); **19**F NMR (564 MHz, $CDCl_3$); δ(ppm): -110.25 – -110.31 (m, 1F), -171.32 (dd, *J* = 48.6, 5.4 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{16}H_{19}F_2NO_3Na$, 334.1234; found, 334.1240.

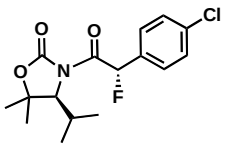


Table 3.5.5, entry 3. The title compound was prepared from oxazolidinone **3.63** (0.155 g, 0.50 mmol) following the standard procedure for a–monofluorination of *N*-(arylacetyl)oxazolidinones. The diastereoselectivity (dr 10:1) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 3% diethyl ether in toluene – 5% diethyl ether in toluene) to afford product as green crystals (0.100 g, 0.31 mmol, 61%, 10:1 dr, single diastereomer). α_D^{26} + 125.38 (*c* 1.0, $CHCl_3$); **1**H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.47 (d, *J* = 7.6 Hz, 2H), 7.36 (d, *J* = 8.2 Hz, 2H), 6.95 (d, *J* = 48.5 Hz, 1H), 4.00 (d, *J* = 2.7 Hz, 1H), 2.21 – 2.15 (m, 1H), 1.45 (s, 3H), 1.11 (d, *J* =

7.0 Hz, 3H), 1.00 (s, 4H), 0.99 (s, 1H); ^{13}C NMR (151 MHz, $CDCl_3$); δ(ppm): 168.46 (d, *J* = 26.9 Hz), 152.91 (s), 136.21 (d, *J* = 3.5 Hz), 131.95 (d, *J* = 20.6 Hz), 129.89 (s), 129.86 (s), 129.05 (s), 129.04 (s), 88.02 (d, *J* = 180.6 Hz), 84.33 (s), 67.45 (s), 29.46 (s), 28.54 (s), 21.42 (s), 21.22 (s), 16.94 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -172.51 (d, *J* = 48.5 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{16}H_{19}FNO_3Na$, 350.0935; found, 350.0928.

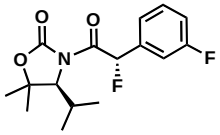


Table 3.5.5, entry 4. The title compound was prepared from oxazolidinone **3.66** (0.147 g, 0.50 mmol) following the standard procedure for a–monofluorination of *N*-(arylacetyl)oxazolidinones. The diastereoselectivity (dr 93:7) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 1% diethyl ether in toluene) to afford product as a white soild (0.107 g, 0.35 mmol, 69%, single diastereomer). α_D^{26} + 126.11 (*c* 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.38 – 7.29 (m, 2H), 7.26 – 7.22 (m, 1H), 7.08 (ddddd, *J* = 9.6, 5.6, 1.4 Hz, 1H), 6.98 (d, *J* = 48.5 Hz, 1H), 3.99 (d, *J* = 3.2 Hz, 1H), 2.18 (dddd, *J* = 13.9, 6.9, 3.2 Hz, 1H), 1.45 (s, 3H), 1.10 (d, *J* = 7.0 Hz, 3H), 1.02 – 0.97 (m, 6H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 168.34 (d, *J* = 26.6 Hz), 162.64 (dd, *J* = 247.8, 1.5 Hz), 152.97 (s), 135.72 (dd, *J* = 20.6, 7.4 Hz), 130.44 (dd, *J* = 8.1, 1.4 Hz), 124.13 (dd, *J* = 4.8, 3.2 Hz), 117.17 (dd, *J* = 21.1, 2.8 Hz), 115.34 (dd, *J* = 22.7, 4.8 Hz), 87.95 (dd, *J* = 181.1, 1.8 Hz), 84.37 (s), 67.54 (s), 29.48 (s), 28.46 (s), 21.43 (s), 21.24 (s), 16.95 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -111.55 (td, *J* = 9.6, 6.0

Hz, 1F), -173.59 (d, *J* = 48.9 Hz); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{16}H_{19}F_2NO_3Na$; 334.1231; found, 334.1241.

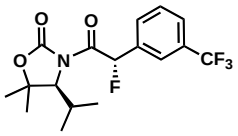


Table 3.5.5, entry 5. The title compound was prepared from oxazolidinone **3.71** (0.172 g, 0.50 mmol) following the standard procedure for a–monofluorination of *N*-(arylacetyl)oxazolidinones. The diastereoselectivity (dr 10:1) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 1% diethyl ether in toluene) to afford product as a white solid (0.117 g, 0.33 mmol, 65%, 10:1 dr, single diastereomer). α_D^{26} + 140.82 (*c* 0.8, $CHCl_3$); **1**H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.79 – 7.72 (m, 2H), 7.67 (d, *J* = 7.4 Hz, 1H), 7.54 (dd, *J* = 7.8 Hz, 1H), 7.04 (d, *J* = 48.5 Hz, 1H), 4.03 (d, *J* = 3.2 Hz, 1H), 2.20 (dddd, *J* = 13.9, 6.9, 3.2 Hz, 1H), 1.46 (s, 3H), 1.12 (d, *J* = 7.0 Hz, 3H), 1.01 (d, *J* = 7.7 Hz, 6H); **13**C NMR (126 MHz, $CDCl_3$); δ(ppm): 168.17 (d, *J* = 26.4 Hz), 152.93 (s), 134.56 (d, *J* = 20.6 Hz), 132.21 (dd, *J* = 4.5, 1.1 Hz), 131.80 – 130.88 (m), 129.40 (d, *J* = 1.2 Hz), 126.96 – 126.64 (m), 125.02 – 124.76 (m), 123.60 (d, *J* = 272.5 Hz), 88.06 (d, *J* = 181.2 Hz), 84.45 (s), 67.50 (s), 29.50 (s), 28.43 (s), 21.43 (s), 21.25 (s), 16.97 (s); **19**F NMR (564 MHz, $CDCl_3$); δ(ppm): -62.85 (s, 3F), -173.31 (d, *J* = 48.5 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{19}F_4NO_3Na$, 384.1199; found, 384.1196.

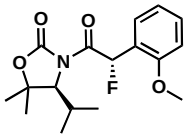


Table 3.5.5, entry 6. The title compound was prepared from oxazolidinone **3.70** (0.153 g, 0.50 mmol) following the standard procedure for a–monofluorination of *N*-(arylacetyl)oxazolidinones. The diastereoselectivity (dr 10:1) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 1.5% diethyl ether in toluene – 3% diethyl ether in toluene) to afford product as a colorless oil (0.129 g, 0.40 mmol, 80%, single diastereomer. α_D^{26} + 158.73 (*c* 1.0, $CHCl_3$); **^{1}**H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.35 (dd, *J* = 7.8 Hz, 1H), 7.28 (d, *J* = 7.5 Hz, 1H), 7.22 (d, *J* = 48.5 Hz, 1H), 6.94 (dd, *J* = 14.7, 7.7 Hz, 2H), 4.11 (d, *J* = 3.0 Hz, 1H), 3.86 (s, 3H), 2.20 (dddd, *J* = 13.7, 6.9, 2.9 Hz, 1H), 1.46 (s, 3H), 1.21 (s, 3H), 1.11 (d, *J* = 7.0 Hz, 3H), 0.99 (d, *J* = 6.8 Hz, 3H); **^{13}**C NMR (126 MHz, $CDCl_3$); δ(ppm): 168.90 (d, *J* = 25.6 Hz), 157.66 (d, *J* = 3.7 Hz), 152.55 (s), 131.39 (d, *J* = 3.4 Hz), 128.11 (d, *J* = 5.0 Hz), 122.39 (d, *J* = 19.1 Hz), 120.54 (d, *J* = 1.2 Hz), 111.38 (s), 84.82 (d, *J* = 177.7 Hz), 83.84 (s), 67.14 (s), 55.80 (s), 29.51 (s), 28.57 (s), 21.40 (s), 21.32 (s), 16.88 (s); **^{19}**F NMR (564 MHz, $CDCl_3$); δ(ppm): -177.76 (d, *J* = 48.4 Hz, 1F); HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{22}FNO_4Na$, 346.1431; found, 346.1436.

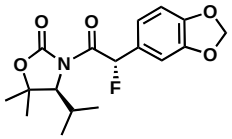


Table 3.5.5, entry 7. The title compound was prepared from oxazolidinone **3.64** (0.160 g, 0.50 mmol) following the standard procedure for a–monofluorination of *N*-

(arylacetyl)oxazolidinones. The diastereoselectivity (dr 10:1) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 1.5% diethyl ether in toluene – 2% diethyl ether in toluene) to afford product as a white solid (0.107 g, 0.32 mmol, 64%, single diastereomer). α_D^{26} + 138.76 (*c* 0.83, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$); δ(ppm): 7.01 (d, *J* = 9.2 Hz, 2H), 6.88 (d, *J* = 48.7 Hz, 1H), 6.80 (d, *J* = 7.8 Hz, 1H), 5.98 (s, 2H), 4.01 (d, *J* = 3.1 Hz, 1H), 2.21 – 2.15 (m, 1H), 1.47 (s, 3H), 1.12 (d, *J* = 7.0 Hz, 3H), 1.05 (s, 3H), 1.00 (d, *J* = 6.8 Hz, 3H); **^{13}**C NMR (201 MHz, $CDCl_3$); δ(ppm): 206.97 (s), 168.90 (d, *J* = 27.8 Hz), 152.94 (s), 148.52 (dd, *J* = 224.9, 2.4 Hz), 127.10 (d, *J* = 20.9 Hz), 123.07 (d, *J* = 5.2 Hz), 108.63 (dd, *J* = 89.3, 2.9 Hz), 101.46 (s), 88.54 (d, *J* = 180.6 Hz), 84.21 (s), 67.47 (s), 30.92 (s), 29.50 (s), 28.59 (s), 21.45 (s), 21.29 (s), 17.00 (s); **^{19}**F NMR (564 MHz, $CDCl_3$); δ(ppm): -169.32 – -169.84 (m, 1F). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{20}FNO_5Na$ 360.1223; found, 360.1226

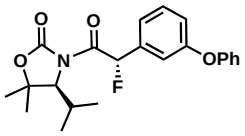


Table 3.5.5, entry 8. The title compound was prepared from oxazolidinone **3.65** (0.184 g, 0.50 mmol) following the standard procedure for a–monofluorination of *N*-(arylacetyl)oxazolidinones. The diastereoselectivity (dr 95:5) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 1% diethyl ether in toluene) to afford product as a white solid (0.119 g, 0.31 mmol, 62%, single diastereomer). α_D^{26} + 148.96 (*c* 1.0, $CHCl_3$); **^{1}**H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.31 – 7.26 (m, 3H), 7.19 (d, *J* = 7.9 Hz, 1H), 7.13 (s, 1H), 7.05 (dd, *J* = 7.4 Hz, 1H), 6.97 (d, *J* =

8.1 Hz, 1H), 6.93 (s, 1H), 6.91 (d, *J* = 7.9 Hz, 2H), 6.83 (s, 1H), 3.94 (d, *J* = 3.0 Hz, 1H), 2.13 (dddd, *J* = 13.8, 6.9, 3.1 Hz, 1H), 1.40 (s, 3H), 1.05 (d, *J* = 7.0 Hz, 3H), 0.97 (s, 3H), 0.94 (d, *J* = 6.8 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$); δ(ppm): 168.53 (d, *J* = 26.7 Hz), 157.57 (d, *J* = 1.6 Hz), 156.66 (s), 152.91 (s), 135.24 (d, *J* = 20.3 Hz), 130.17 (d, *J* = 1.6 Hz), 129.83 (s), 123.65 (s), 123.16 (d, *J* = 4.6 Hz), 120.38 (d, *J* = 3.0 Hz), 118.96 (s), 118.79 (d, *J* = 4.6 Hz), 88.50 (d, *J* = 180.8 Hz), 84.28 (s), 67.51 (s), 29.50 (s), 28.54 (s), 21.43 (s), 21.28 (s), 16.99 (s); ^{19}F NMR (564 MHz, $CDCl_3$); δ(ppm): -172.83 (d, *J* = 48.8 Hz, 1F). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{22}H_{24}FNO_4Na$, 408.1587; found, 408.1600

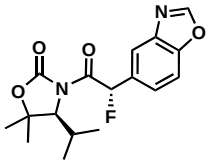


Table 3.5.5, entry 9

Preparation of $TiCl_2$(*i*PrO)$_2$·2 Et_3NHCl: In a flame dried flask under argon, *i*PrOH (2 equiv) was added dropwise to $TiCl_4$ (1 equiv, 1.0 M in CH_2Cl_2) over 5 min at rt . The mixture was stirred for an additional 10 min (HCl gas evolution was observed). Et_3N (2 equiv) was then added dropwise over 10 min at rt. The mixture was stirred for an additional 30 min (white precipitate initially forms but majority eventually redissolves into solution).

α-Monofluorination reaction: In a separate flame dried flask under argon $TiCl_2$(*i*PrO)$_2$•2Et_3NHCl (0.33 mL, ca. 1.0 M solution in CH_2Cl_2, 1.75 equiv) was added dropwise to the solution of *N*-acyl oxazolidinone **3.73** (0.10 g, 0.31 mmol, 1.00 equiv) in CH_2Cl_2 (0.38 mL) at 0 °C and stirred for 3 min (solution should become a deep red upon complete addition). Et_3N (86 μL, 0.62 mmol, 2.0 equiv) was added dropwise to the reaction

mixture at 0 °C and stirred for 3 min. NFSI (0.195 g, 062 mmol, 2.0 equiv) was added in one portion to the reaction at 0 °C. The reaction mixture was warmed to room temperature and stirred for 1 h. The reaction was filtered through a 1.5 cm silica gel plug and washed with dichloromethane (10 mL) and ethyl acetate (60 mL). The filtrate was then concentrated *in vacuo.* The diastereoselectivity (dr 92:8) was determined by ^{1}H NMR of the crude reaction mixture. The residue was purified by column chromatography (silica, 4% diethyl ether in toluene) to afford product as a white solid (0.119 g, 0.31 mmol, 87%, mixture of diastereomers). α_D^{21} + 115.77 (*c* 1.0, $CHCl_3$);^{1}H NMR (600 MHz, $CDCl_3$) δ(ppm): 8.13 (s, 1H), 7.98 (s, 1H), 7.61 (s, 2H), 7.10 (d, *J* = 48.6 Hz, 1H), 4.03 (d, *J* = 2.9 Hz, 1H), 2.25 – 2.15 (m, 1H), 1.44 (s, 3H), 1.13 (d, *J* = 7.0 Hz, 3H), 1.01 (d, *J* = 6.8 Hz, 3H), 0.95 (s, 3H) ^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 168.69 (d, *J* = 27.1 Hz), 153.42 (s), 152.87 (s), 150.88 – 150.72 (m), 140.35 (s), 130.35 (d, *J* = 20.8 Hz), 126.45 (d, *J* = 4.2 Hz), 121.22 (d, *J* = 4.6 Hz), 111.40 (d, *J* = 1.5 Hz), 88.62 (d, *J* = 180.9 Hz), 84.25 (s), 67.42 (s), 29.50 (s), 28.59 (s), 21.44 (s), 21.24 (s), 16.98 (s).^{19}F NMR (564 MHz, $CDCl_3$) δ(ppm): -169.22 (s), -169.31 (s). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{19}FN_2O_4Na$, 357.1227; found, 357.1224.

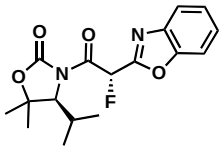


Table 3.5.5, entry 10.

Preparation of $TiCl_2(OPr\text{-}i)_2$: In a flame-dried flask, $Ti(OPr\text{-}i)_4$ (1.0 equiv) was added dropwise to $TiCl_4$ (1.0 equiv, 1.0 M in CH_2Cl_2) over 5 min at rt under argon. The mixture was stirred for an additional 10 min.

α-Monofluorination reaction: In a separate flame-dried flask, $TiCl_2(OPr\text{-}i)_2$ (0.44 mL, ca. 2.0 M solution in CH_2Cl_2, 1.75 equiv) was added dropwise to the solution of *N*-acyl oxazolidinone **3.74** (0.158 g, 0.50 mmol, 1.00 equiv) in CH_2Cl_2 (0.38 mL) at 0 °C and stirred for 2 min under argon. Et_3N (0.14 mL, 1.0 mmol, 2.0 equiv) was added dropwise at 0 °C and the reaction mixture was stirred for 2 min. NFSI (0.315 g, 1.0 mmol, 2.0 equiv) was added in one portion to the reaction at 0 °C. The reaction mixture was warmed to rt and stirred for 30 min. The reaction was filtered through a 1.5 cm silica gel plug and washed with dichloromethane (10 mL) and ethyl acetate (60 mL). The filtrate was then concentrated *in vacuo*. The diastereoselectivity (dr 2:1) was determined by ^{1}H NMR analysis of the crude product. The residue was purified by column chromatography (silica, 4% diethyl ether in toluene) to afford product as a white solid (0.105 g, 0.32 mmol, 63%, single diastereomer. α_D^{21} + 77.97 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$) δ(ppm): 7.68 (d, *J* = 7.9 Hz, 1H), 7.60 (d, *J* = 8.2 Hz, 1H), 7.42 (t, *J* = 7.8 Hz, 1H), 7.36 (t, *J* = 7.7 Hz, 1H), 7.06 (d, *J* = 50.4 Hz, 1H), 4.30 (d, *J* = 3.0 Hz, 1H), 2.24 (dq, *J* = 6.8, 3.8 Hz, 1H), 1.59 (s, 3H), 1.53 (s, 3H), 1.15 (d, *J* = 7.0 Hz, 3H), 1.02 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 164.15 (d, *J* = 23.3 Hz), 158.11 (d, *J* = 21.8 Hz), 153.66 (s), 151.09 (s), 126.53 (d, *J* = 1.2 Hz), 124.96 (s), 120.82 (d, *J* = 0.9 Hz), 111.34 (d, *J* = 0.9 Hz), 85.65 (s), 82.90 (d, *J* = 183.5 Hz), 67.34 (s), 29.56 (s), 28.81 (s), 21.59 (s), 21.43 (s), 16.99 (s). ^{19}F NMR (564 MHz, $CDCl_3$) δ(ppm): -185.48 (s), -185.57 (s). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{17}H_{19}FN_2O_4Na$, 357.1227; found, 357.1216.

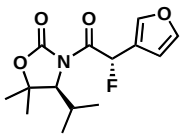
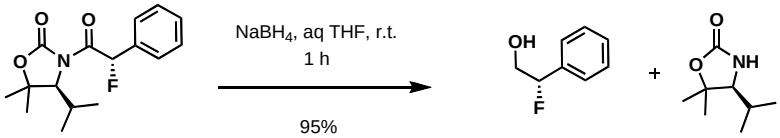


Table 3.5.5, entry 8.

Preparation of $TiCl_2(OPr\text{-}i)_2 \cdot 2\ Et_3NHCl$: In a flame dried-flask, *i*-PrOH (2 equiv) was added dropwise to $TiCl_4$ (1 equiv, 1.0 M in CH_2Cl_2) over 5 min at rt under argon. The mixture was stirred for an additional 10 min (HCl gas evolution was observed). Et_3N (2 equiv) was then added dropwise over 10 min at rt. The mixture was stirred for an additional 30 min (white precipitate initially forms but eventually redissolves).

α-Monofluorination reaction: In a separate flame-dried flask, $TiCl_2(OPr\text{-}i)_2 \bullet 2Et_3NHCl$ (0.33 mL, ca. 1.0 M solution in CH_2Cl_2, 1.75 equiv) was added dropwise to the solution of *N*-acyl oxazolidinone **3.67** (50 mg, 0.19 mmol, 1.00 equiv) in CH_2Cl_2 (0.38 mL) at 0 °C under argon, and the resulting mixture was stirred for 2 min (solution should become a deep red upon complete addition). Et_3N (53 μL, 0.38 mmol, 2.0 equiv) was added dropwise at 0 °C and the reaction mixture was stirred for 2 min. NFSI (0.12 g, 0.38 mmol, 2.0 equiv) was added in one portion to the reaction at 0 °C. The reaction mixture was warmed to rt and stirred for 30 min. The reaction was filtered through a 1.5 cm silica gel plug and washed with dichloromethane (10 mL) and ethyl acetate (60 mL). The filtrate was then concentrated *in vacuo.* The diastereoselectivity (10:1) was determined by ^{1}H NMR analysis of the crude mixture of products. The residue was purified by column chromatography (silica, 4% diethyl ether in toluene) to afford product as a white solid (29 mg, 0.103 mmol, 54%, single diastereomer). α_D^{20} + 61.94 (*c* 1.0, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$) δ(ppm): 7.65 (d, *J* = 4.0 Hz, 1H), 7.41 (d, *J* = 1.1 Hz, 1H), 6.99 (d, *J* = 48.6 Hz, 1H), 6.52 (s, 1H), 4.02 (d, *J* =

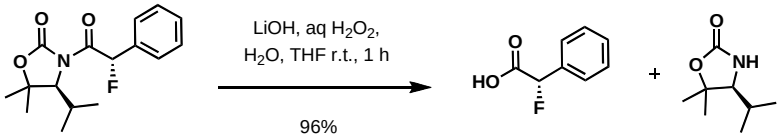
2.5 Hz, 1H), 2.22 – 2.13 (m, 1H), 1.48 (s, 3H), 1.10 (d, *J* = 5.8 Hz, 6H), 1.00 (d, *J* = 6.6 Hz, 3H). ^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 168.55 (d, *J* = 27.2 Hz), 153.03 (s), 143.80 (d, *J* = 7.4 Hz), 143.29 (d, *J* = 8.7 Hz), 118.94 (d, *J* = 24.2 Hz), 108.79 (s), 84.31 (s), 82.04 (dd, *J* = 177.6, 10.1 Hz), 67.30 (d, *J* = 12.0 Hz), 29.50 (s), 28.58 (s), 21.44 (s), 21.26 (d, *J* = 2.7 Hz), 16.96 (d, *J* = 4.1 Hz).^{19}F NMR (564 MHz, $CDCl_3$) δ(ppm): -176.65 (d, *J* = 4.8 Hz), -176.73 (d, *J* = 4.8 Hz). HRMS-ESI *(m/z)*: $[M+Na]^+$ calcd for $C_{14}H_{48}FNO_4Na$, 306.1118; found, 306.1122.



(*S*)-2-Fluoro-2-phenylethanol. Sodium borohydride (63.7 mg, 1.68 mmol) was added to a solution of the substrate (0.175 g, 0.561 mmol) in a 3:1 mixture of THF:H_2O (8.50 mL) at 0 °C and the reaction mixture was stirred for 10 min. The reaction mixture was warmed to rt and stirred an additional 1 h. The reaction mixture was quenched with aqueous 1 M HCl (5 mL). The layers were separated. The aqueous layer was extracted with diethyl ether (3 x 5 mL). The organic layers were combined and washed with brine, dried with sodium sulfate, concentrated *in vacuo*, and the residue purified by column chromatography (silica, 50% diethyl ether in pentane - 80% diethyl ether in pentane) to afford the desired alcohol (72.2 mg, 0.52 mmol, 93%) and the purified oxazolidinone (83 mg, 0.53 mmol, 95%). α_D^{23} + 51.03 (c 1.0, $CHCl_3$). ^{1}H NMR (600 MHz, $CDCl_3$) δ(ppm): 7.38 (dt, *J* = 17.5, 7.3 Hz, 5H), 5.57 (ddd, *J* = 48.7, 7.8, 2.8 Hz, 1H), 3.98 – 3.89 (m, 1H), 3.83 (dd, *J* = 30.1, 12.5 Hz, 1H), 2.38 (s, 1H^{13}C NMR (126 MHz, $CDCl_3$) δ(ppm): 136.34 (d, *J* = 19.6 Hz), 128.74 (d, *J* = 1.7

Hz), 128.54 (s), 125.68 (d, J = 7.0 Hz), 94.80 (d, J = 171.9 Hz), 66.48 (d, J = 24.7 Hz). ^{19}F NMR (564 MHz, $CDCl_3$) δ(ppm): -186.89 (ddd, J = 49.5, 30.6, 19.1 Hz). HRMS-EI *(m/z)*: $[M]^+$ calcd for C_8H_9FO, 140.0637; found, 140.0634.

Determination of er for the product: 2-Naphthoyl chloride (3.0 equiv.) was added to a solution of the purified alcohol, triethylamine (3.0 equiv.), and 4-dimethylaminopyridine (0.5 equiv.) in dichloromethane (0.1 M) at 0 °C. After 10 min, the reaction was warmed to rt and stirred for 30 min. The reaction was quenched with aqueous ammonium chloride and the layers were separated. The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined organic layers were washed with brine, dried with sodium sulfate, concentrated *in vacuo*, and purified by column chromatography chromatography (silica, 15% ethyl acetate in hexanes) to afford the desired naphthoyl ester derivative. HPLC analysis of the 2-naphthoyl ester derivative (OJ-H, 2.5% ^{i}PrOH - hexanes, 1.0 mL/min, 254 nm) indicated er of 0.8:99.2: R_T (minor) = 37.5 minutes, R_T (major) = 45.5 minutes.



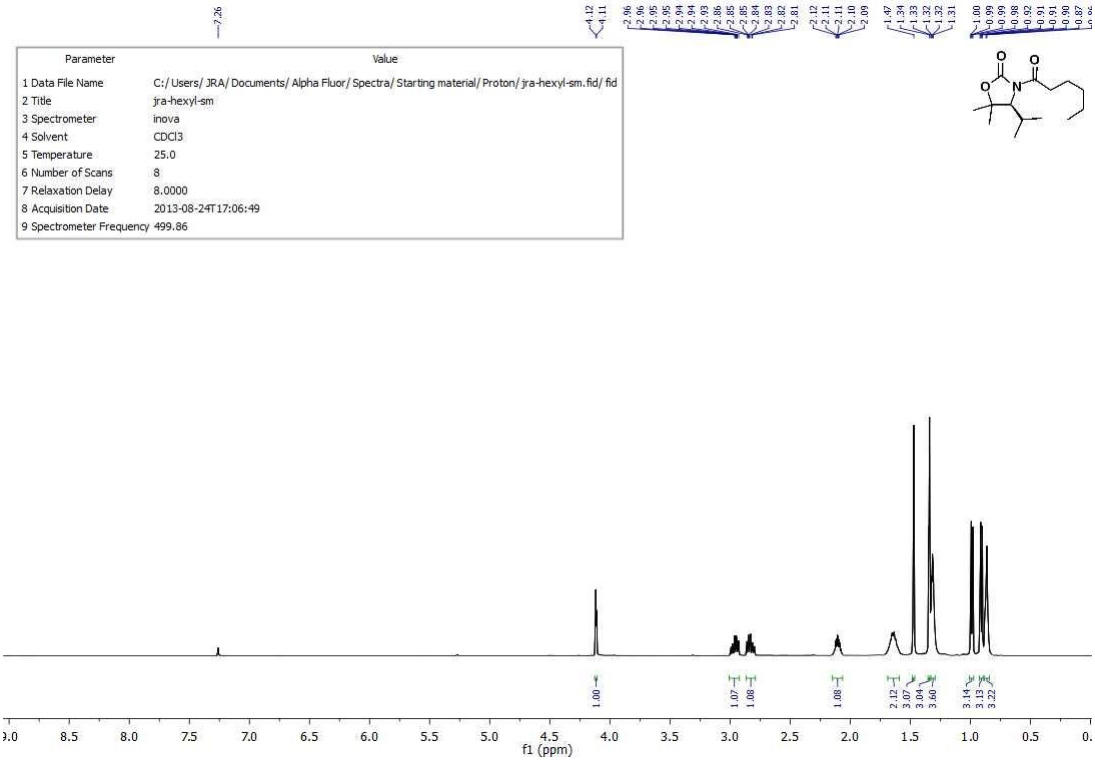
(*S*)-2-Fluoro-2-phenyacetic acid. Lithium hydroxide monohydrate (32.1 mg, 0.765 mmol) was added to a solution of the substrate (0.117 g, 0.373 mmol), hydrogen peroxide (30%, 0.40 mL), and water (0.40 mL) in THF (1.50 mL) at 0 °C, and the mixture was stirred for 5 min. The reaction was warmed to room temperature and stirred for 1 h. The reaction was quenched with aqueous sodium sulfite (1.5 M, 3.0 mL) and HCl (1 M, 3.0 mL) and allowed to stir for 5 min until two transparent layers were visible. The layers were separated

and the aqueous layer was extracted with diethyl ether (3 x 10 mL). The organic layer was extracted with aqueous sodium hydroxide (3 M, 3 x 3 mL) and water (3 x 5 mL). The aqueous extractions were combined and set aside. The organic layer was washed with HCl (1 M), brine, dried with sodium sulfate, and concentrated *in vacuo* to recover the oxazolidinone auxiliary (56.6 mg, 0.36 mmol, 97%). The previously saved aqueous layers were acidified with aqueous HCl (1 M). The aqueous layer was extracted with diethyl ether (3 x 30 mL). The combined organic layers were washed with brine, dried with sodium sulfate, and concentrated *in vacuo* to afford the desired pure carboxylic acid (55.2 mg, 0.358 mmol, 96%). α_D^{21} + 116.06 (c 0.843, $CHCl_3$); ^{1}H NMR (600 MHz, $CDCl_3$) δ(ppm): 9.23 (s, 1H), 7.46 (d, *J* = 34.7 Hz, 5H), 5.83 (d, *J* = 47.4 Hz, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ(ppm): 174.06 (d, *J* = 28.0 Hz), 133.42 (d, *J* = 20.5 Hz), 129.90 (d, *J* = 30.1 Hz), 128.87 (d, *J* = 31.6 Hz), 126.65 (d, *J* = 33.8 Hz), 88.78 (dd, *J* = 186.7, 15.5 Hz). ^{19}F NMR (564 MHz, $CDCl_3$) δ(ppm): -180.78 (d, *J* = 47.8 Hz). HRMS-EI *(m/z)*: $[M]^+$ calcd for $C_8H_7FO_2$, 154.0430; found, 154.0434.

Determination of er for the acid: A solution of the (*S*)-2-fluoro-2-phenyacetic acid (1.0 equiv) in diethyl ether (0.2 M) was added to a solution of lithium aluminum hydride (4.0 equiv) in diethyl ether (0.5 M) at 0 °C and the mixture was stirred for 10 min. The reaction mixture was warmed to room temperature and stirred for 10 min and quenched using the Feiser workup: the reaction was cooled to 0 ˚C; H_2O (1:1 volume/weight to $LiAlH_4$) was added dropwise to the reaction (CAUTION: highly exothermic) and stirred for 5 min. A solution (1:1 by volume/weight to $LiAlH_4$) of aqueous NaOH (15 wt% NaOH in H_2O) was added dropwise and stirred for 5 min. Finally H_2O (3:1 by volume/weight to $LiAlH_4$) was

added dropwise. The solution was warmed to room temperature and allowed to stir for 1 h, until a white precipitate forms. The reaction mixture was filtered and concentrated *in vacuo*. No further purification was done.

2-Naphthoyl chloride (5.0 equiv.) was added to a solution of the crude alcohol, triethylamine (5.0 equiv.), and 4-dimethylaminopyridine (1.0 equiv.) in dichloromethane (0.1 M) at 0 °C. After 10 min, the reaction was warmed to room temperature and stirred for 30 min. The mixture was quenched with aqueous ammonium chloride and the layers were separated. The aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined organic layers were washed with brine, dried with sodium sulfate, concentrated *in vacuo*, and purified by column chromatography (silica, 12.5% ethyl acetate in hexanes) to afford the desired naphthoyl ester derivative. HPLC analysis of the 2-naphthoyl ester derivative (OJ-H, 2.5% ^{i}PrOH - hexanes, 1.0 mL/min, 254 nm) indicated er 1.1:98.9: R_T (minor) = 35.9 minutes, R_T (major) = 46.4 minutes.



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3 Spectrometer	inova
4 Solvent	CDCl3
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7 Relaxation Delay	8.0000
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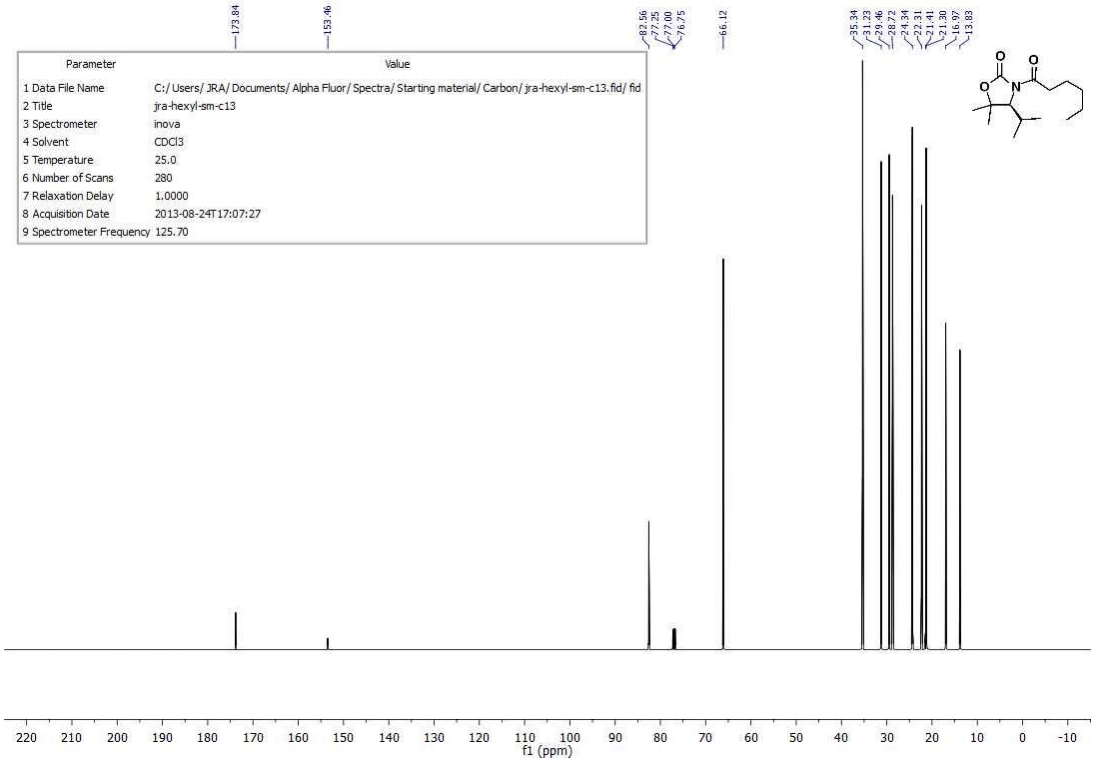
9 Spectrometer Frequency	499.86



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4 Solvent	CDCl3
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7 Relaxation Delay	1.0000
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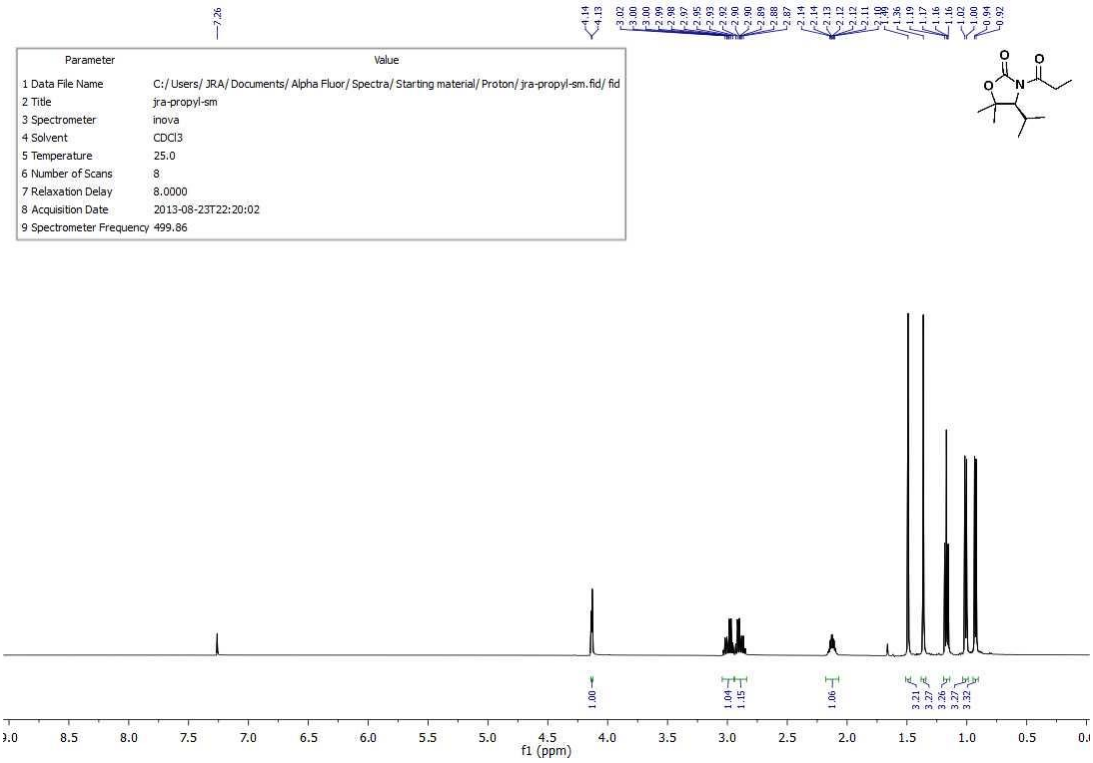
9 Spectrometer Frequency	125.70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2.12
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inova
4 Solvent
CDCl3
5 Temperature
25.0
6 Number of Scans
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7 Relaxation Delay
8.0000
8 Acquisition Date
2013-08-23T22:20:02
9 Spectrometer Frequency
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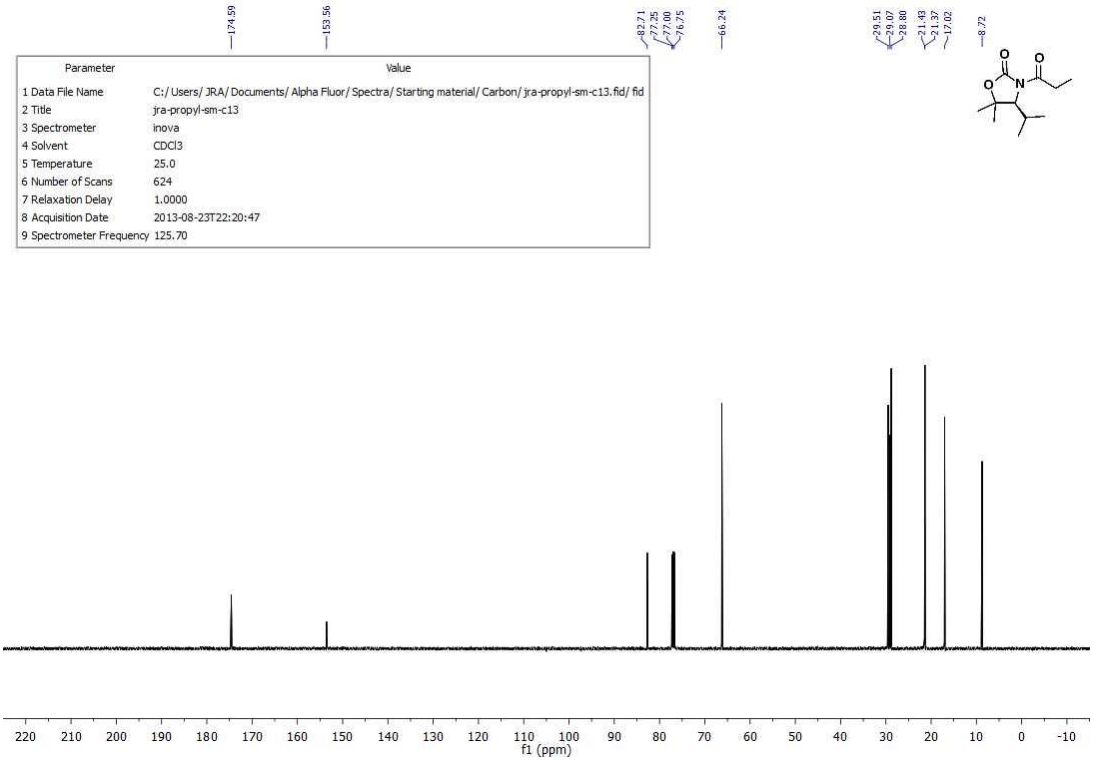
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inova
4 Solvent
CDCl3
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25.0
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8 Acquisition Date
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9 Spectrometer Frequency
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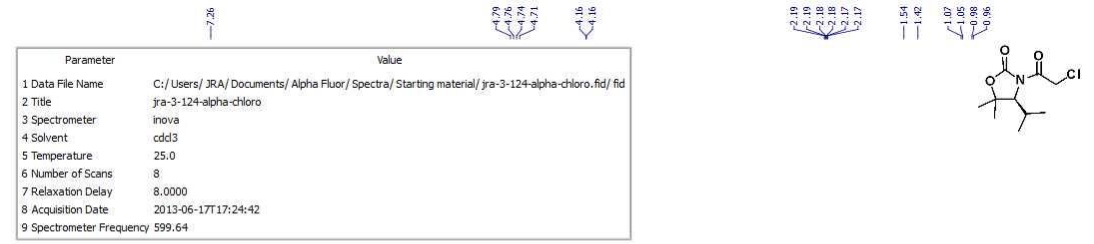
f1 (ppm)



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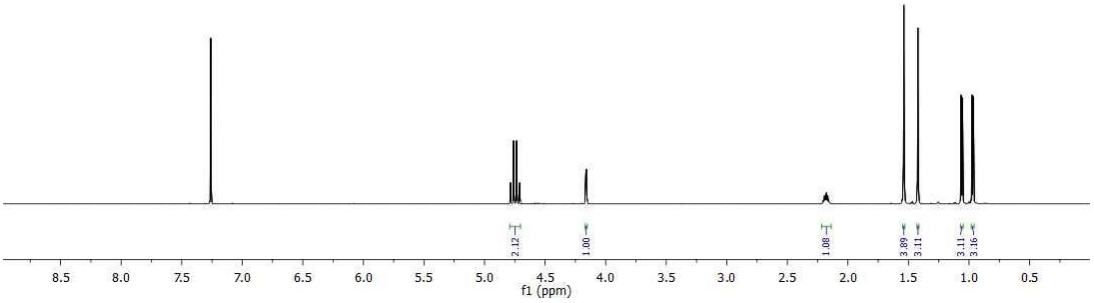
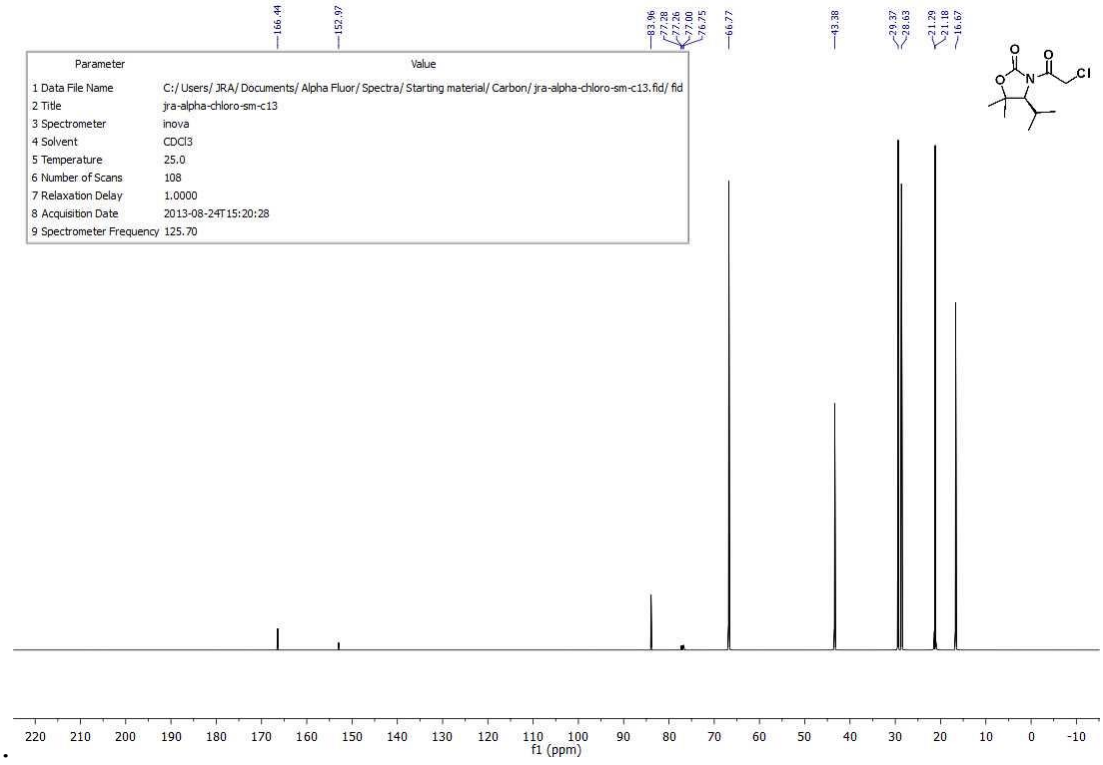
3 Spectrometer	inova
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-06-17T17:24:42
9 Spectrometer Frequency	599.64





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2 Title	jra-alpha-chloro-sm-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
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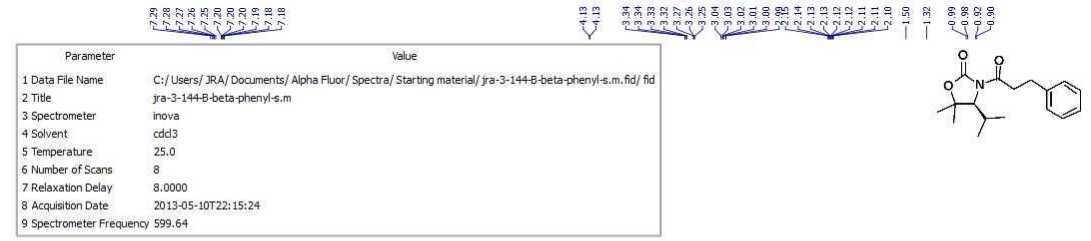
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-24T15:20:28
9 Spectrometer Frequency	125.70



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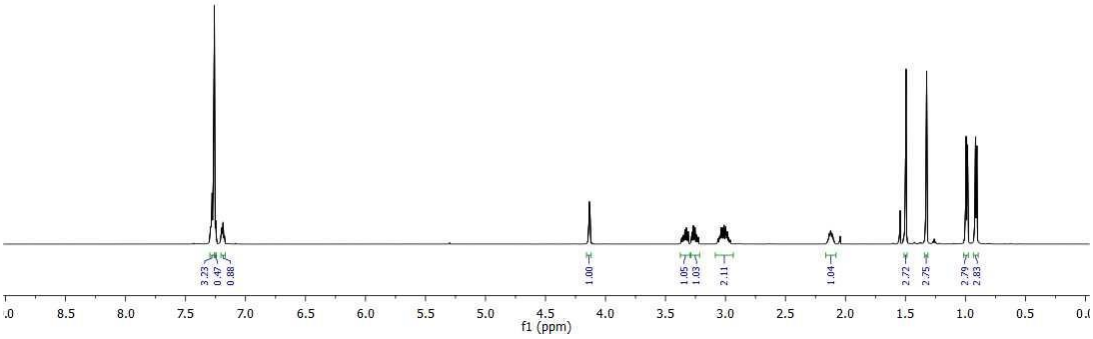
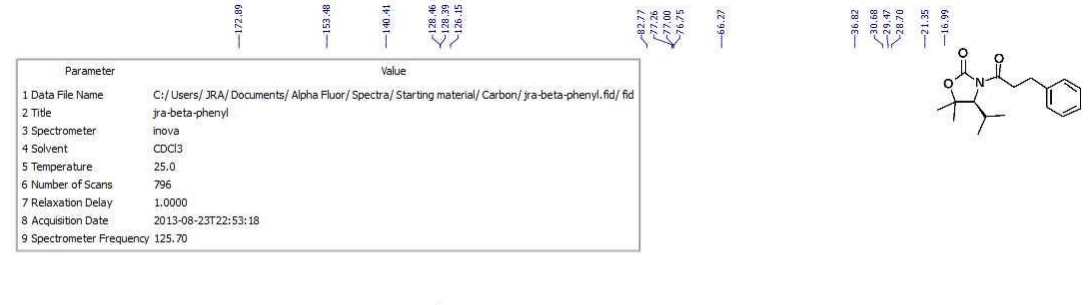
2 Title	jra-3-144-B-beta-phenyl-s.m
3 Spectrometer	inova
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-05-10T22:15:24
9 Spectrometer Frequency	599.64





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4 Solvent	CDCl3
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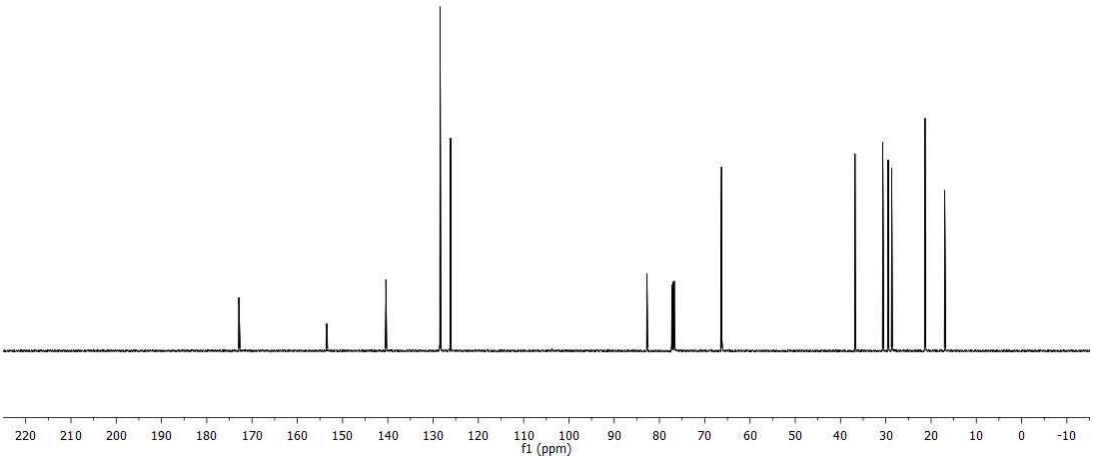
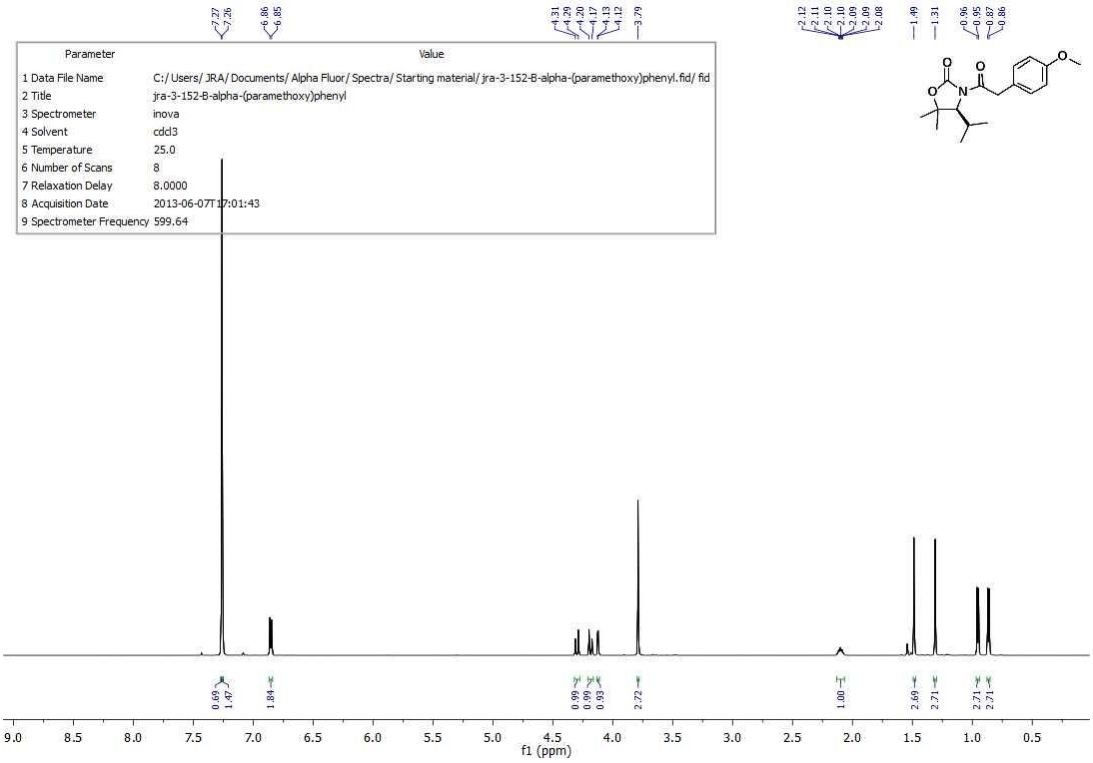
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-23T22:53:18
9 Spectrometer Frequency	125.70

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4.17
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4.12
3.79
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2.11
2.10
2.10
2.09
2.09
2.08
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1.31
0.96
0.95
0.87
0.86
Parameter
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jra-3-152-B-alpha-(paramethoxy)phenyl
3 Spectrometer
inova
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
8
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-06-07T17:01:43
9 Spectrometer Frequency
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0.99
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2.69
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2.71
2.71
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8.0
7.5
7.0
6.5
6.0
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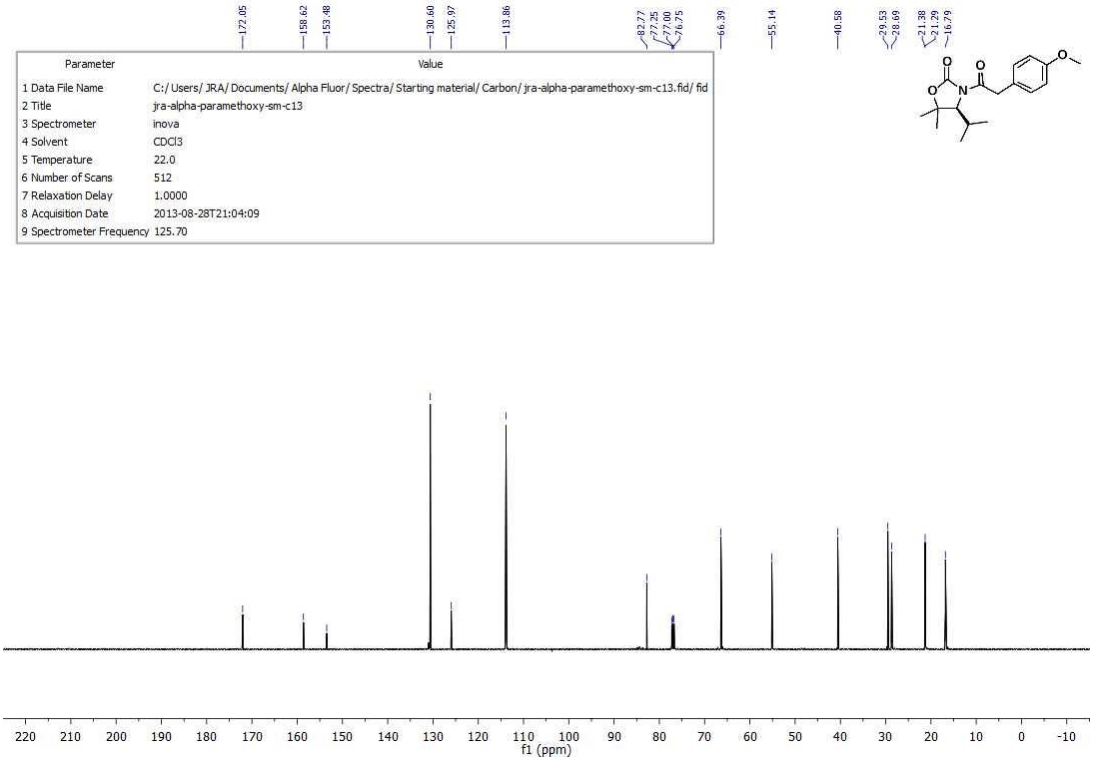
2.0
1.5
1.0
0.5
f1 (ppm)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jra-alpha-paramethoxy-sm-c13
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4 Solvent
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5 Temperature
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6 Number of Scans
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7 Relaxation Delay
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8 Acquisition Date
2013-08-28T21:04:09
9 Spectrometer Frequency
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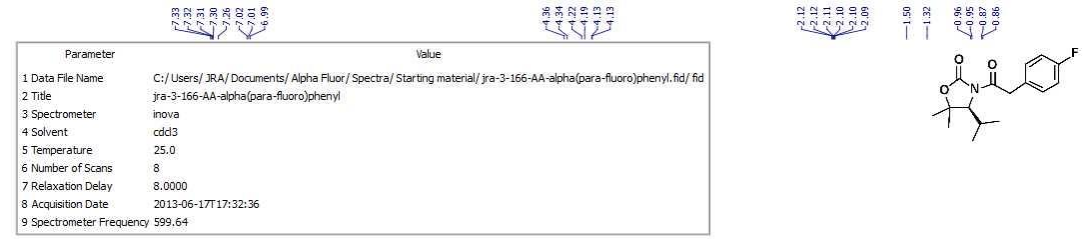
f1 (ppm)



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3 Spectrometer	inova
4 Solvent	cdcl3
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6 Number of Scans	8
7 Relaxation Delay	8.0000
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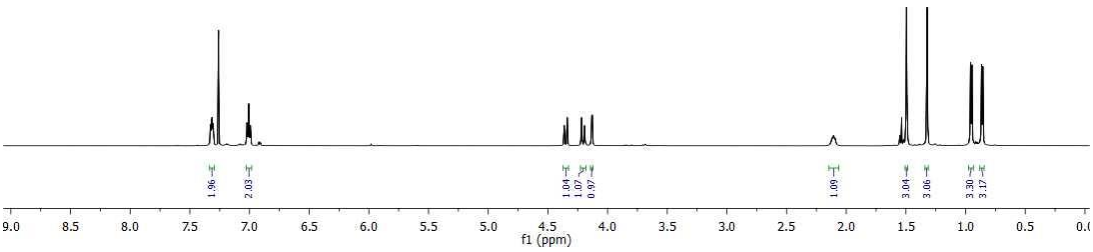
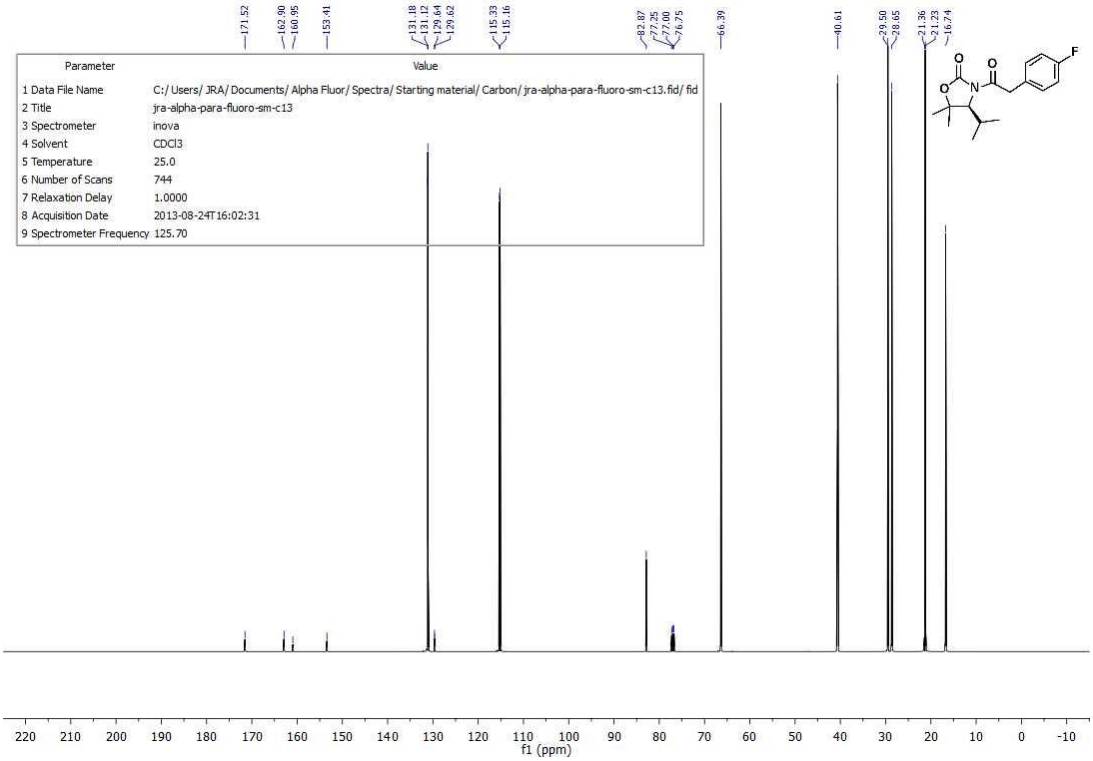
9 Spectrometer Frequency	599.64





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3 Spectrometer	inova
4 Solvent	CDCl3
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7 Relaxation Delay	1.0000
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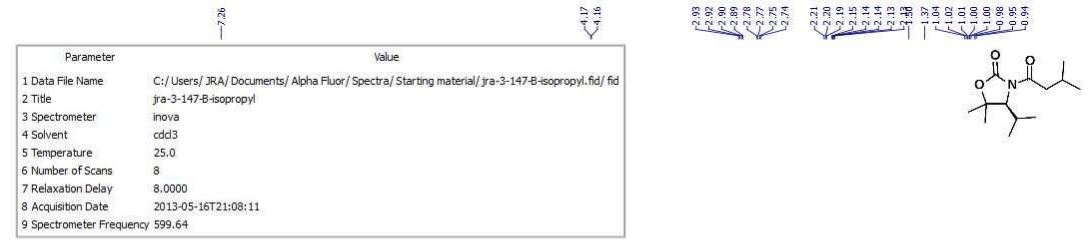
9 Spectrometer Frequency	125.70



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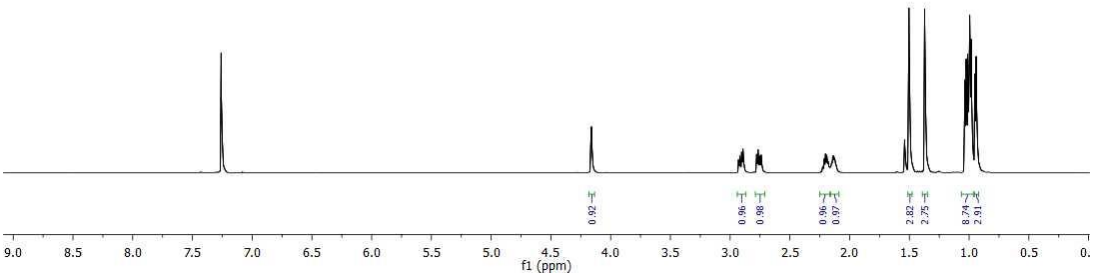
9 Spectrometer Frequency	599.64



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7 Relaxation Delay	1.0000
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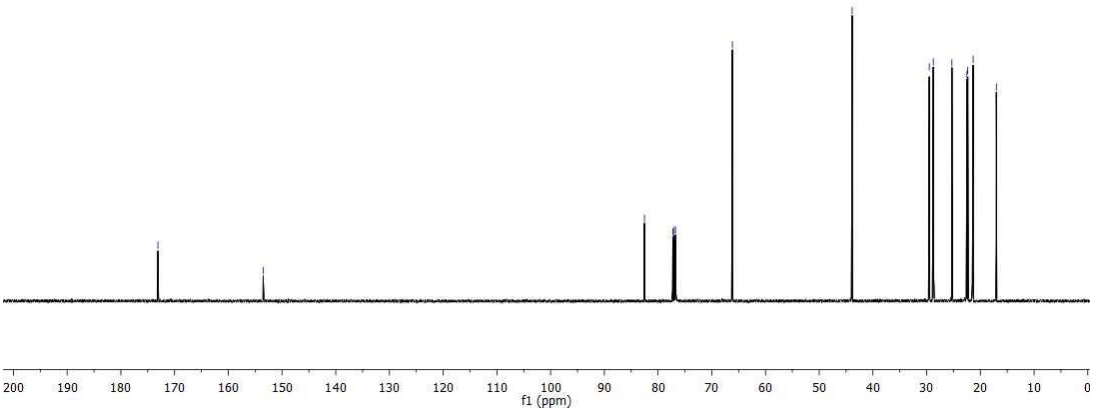
9 Spectrometer Frequency	125.70



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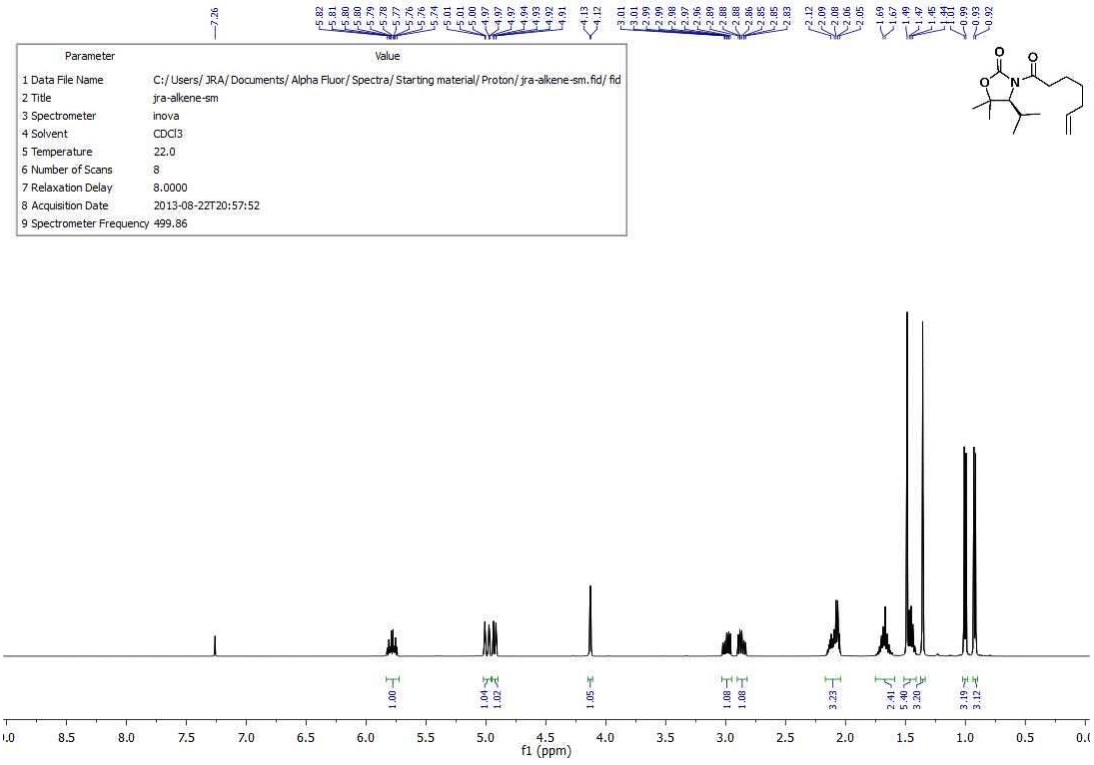
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3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
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6 Number of Scans
8
7 Relaxation Delay
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8 Acquisition Date
2013-08-22T20:57:52
9 Spectrometer Frequency
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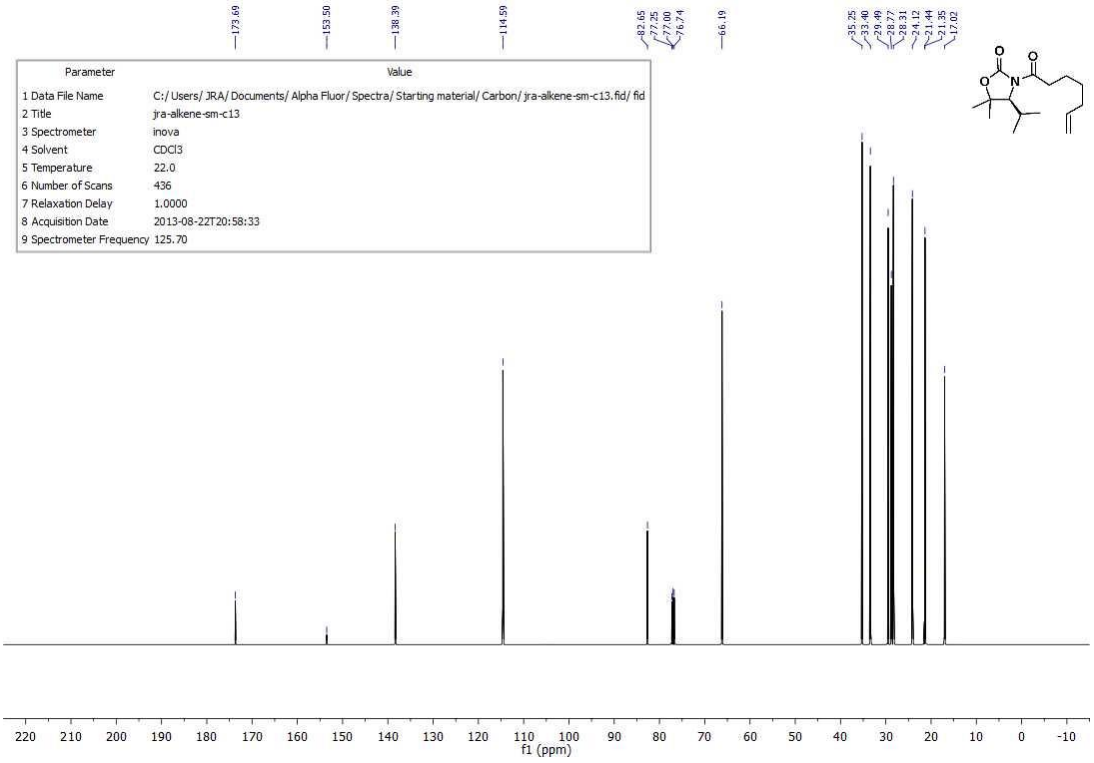
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21.35
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Parameter
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3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
22.0
6 Number of Scans
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9 Spectrometer Frequency
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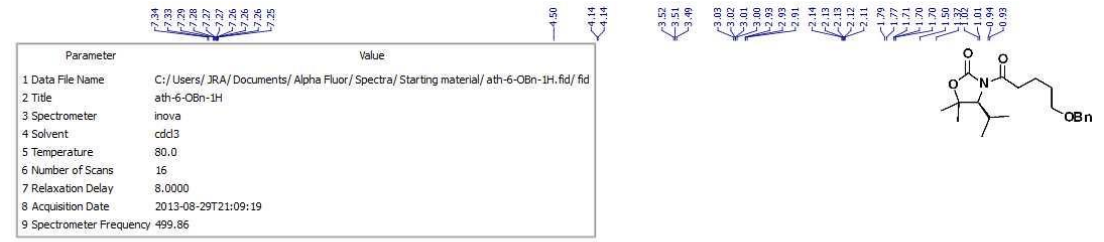
f1 (ppm)



Parameter	Value
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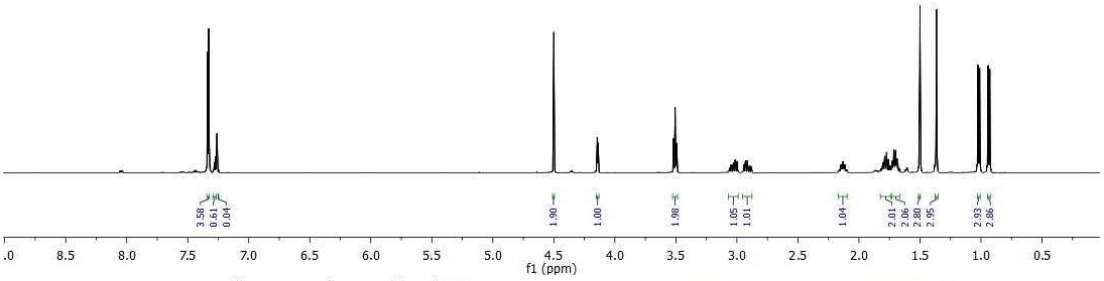
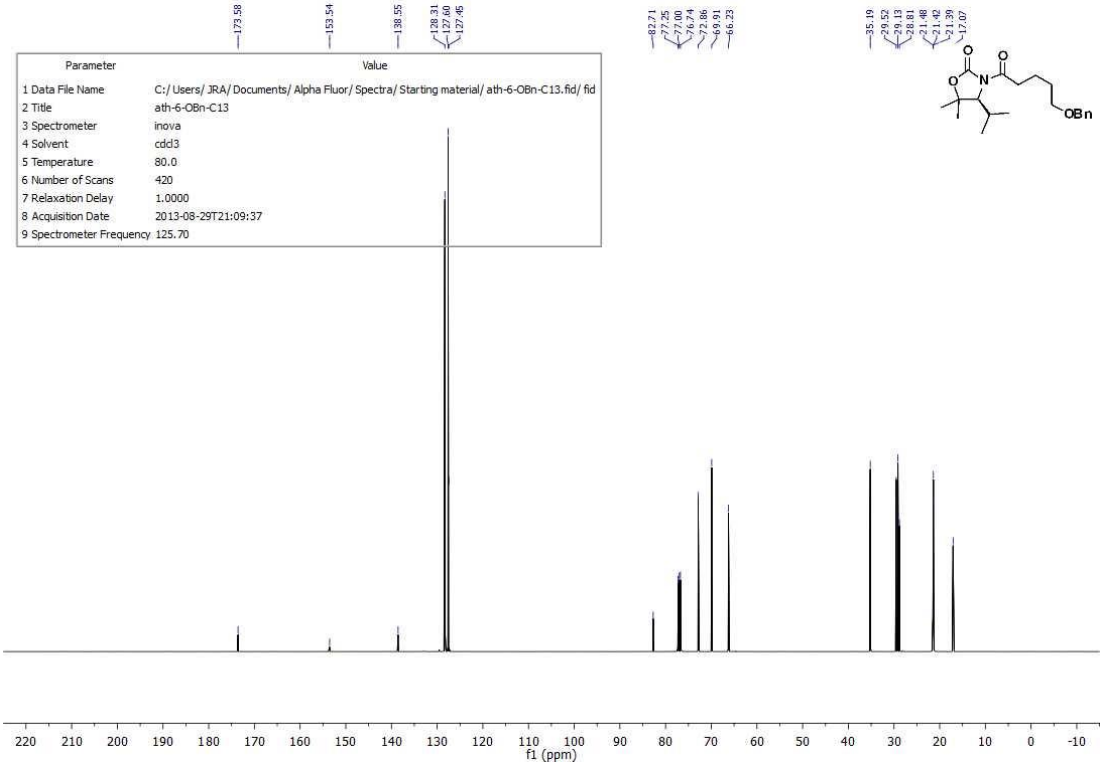
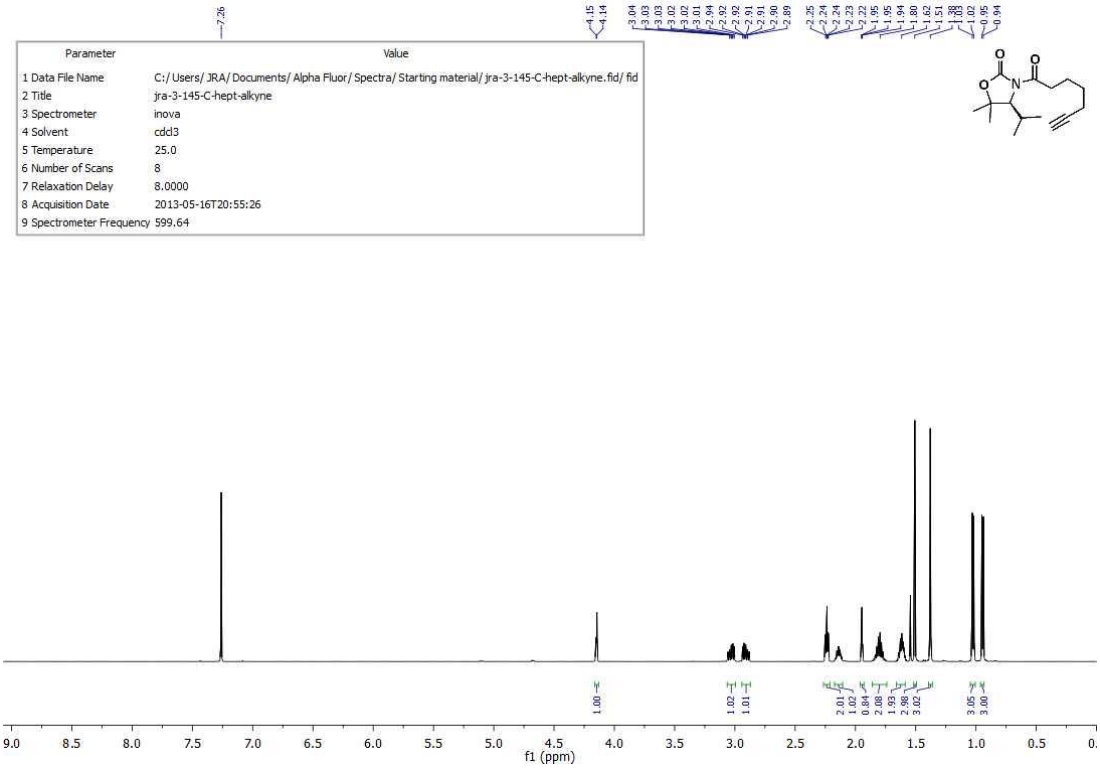
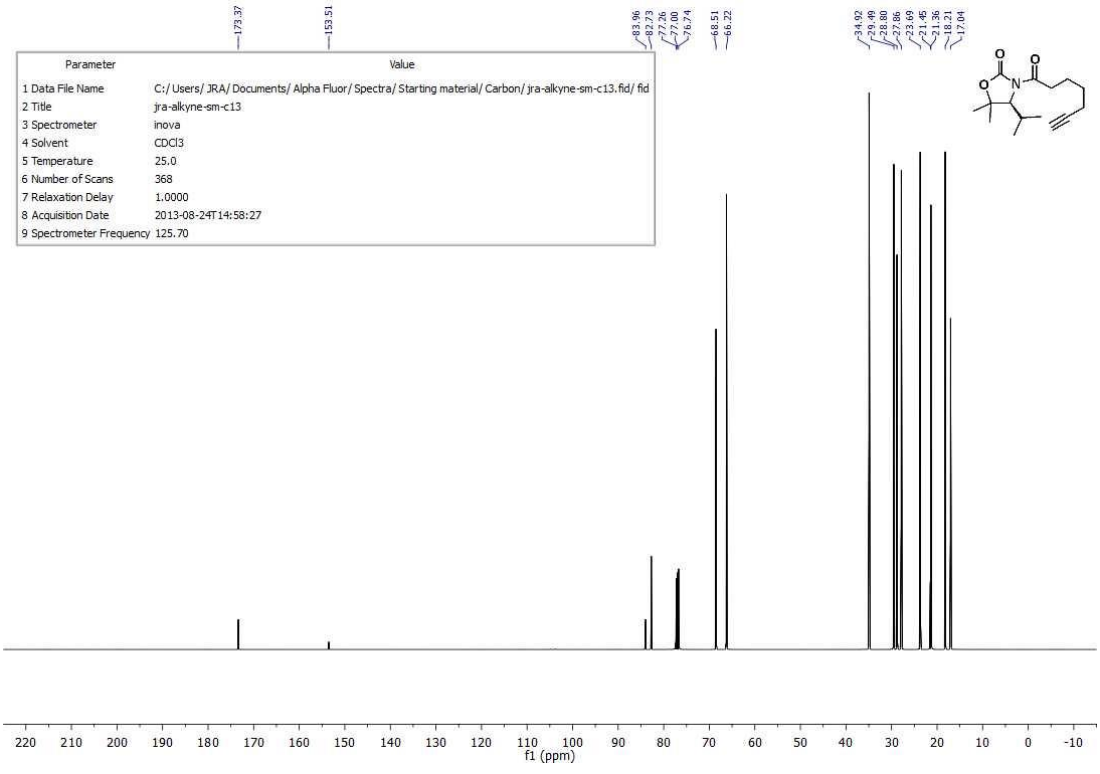
4 Solvent	cdcl3
5 Temperature	80.0
6 Number of Scans	16
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-08-29T21:09:19
9 Spectrometer Frequency	499.86

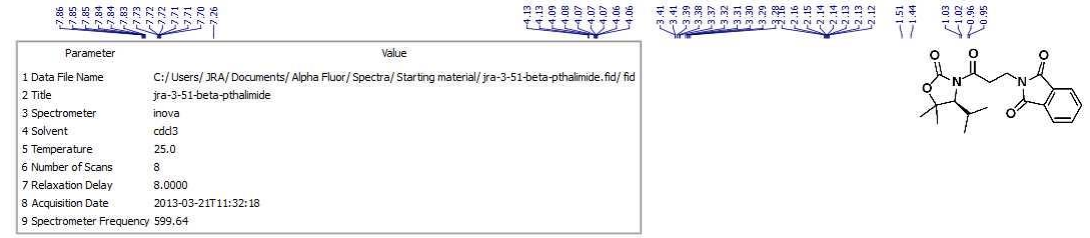




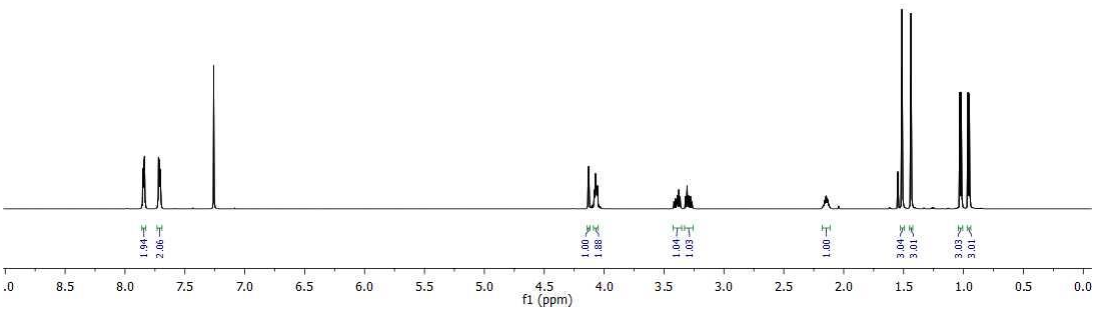
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ ath-6-OBn-C13.fid/ fid
2 Title	ath-6-OBn-C13
3 Spectrometer	inova
4 Solvent	cdcl3
5 Temperature	80.0
6 Number of Scans	420
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-29T21:09:37
9 Spectrometer Frequency	125.70

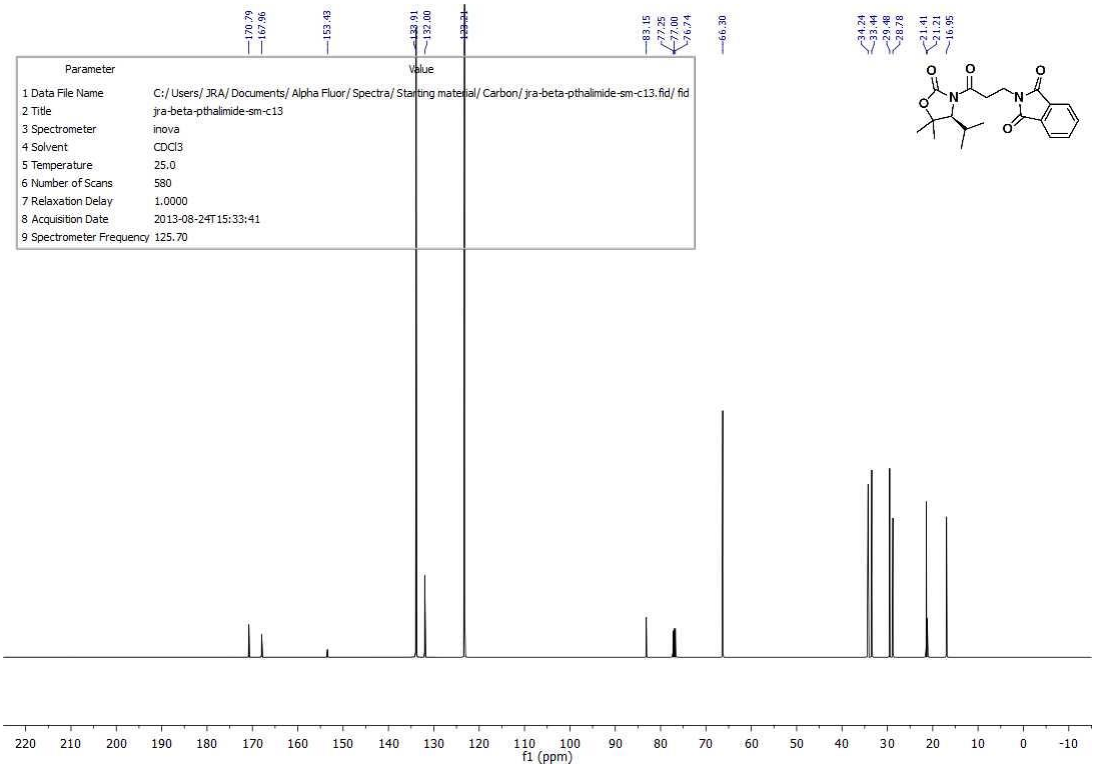

7.26
4.15
4.14
3.04
3.03
3.03
3.02
3.02
3.01
2.94
2.92
2.92
2.91
2.91
2.90
2.89
2.25
2.24
2.24
2.23
2.22
1.95
1.95
1.94
1.80
1.62
1.51
1.38
1.38
1.02
0.95
0.94
Parameter Value
1 Data File Name C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/jra-3-145-C-hept-alkyne.fid/fid
2 Title jra-3-145-C-hept-alkyne
3 Spectrometer inova
4 Solvent cdcl3
5 Temperature 25.0
6 Number of Scans 8
7 Relaxation Delay 8.0000
8 Acquisition Date 2013-05-16T20:55:26
9 Spectrometer Frequency 599.64
1.00
1.02
1.01
2.01
1.02
0.84
2.08
1.93
2.98
3.02
3.05
3.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)


173.37
153.51
83.96
82.73
77.26
77.00
76.74
68.51
66.22
34.92
29.49
28.80
27.86
23.69
21.45
21.36
18.21
17.04
Parameter Value
1 Data File Name C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/Carbon/jra-alkyne-sm-c13.fid/fid
2 Title jra-alkyne-sm-c13
3 Spectrometer inova
4 Solvent CDCl3
5 Temperature 25.0
6 Number of Scans 368
7 Relaxation Delay 1.0000
8 Acquisition Date 2013-08-24T14:58:27
9 Spectrometer Frequency 125.70
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

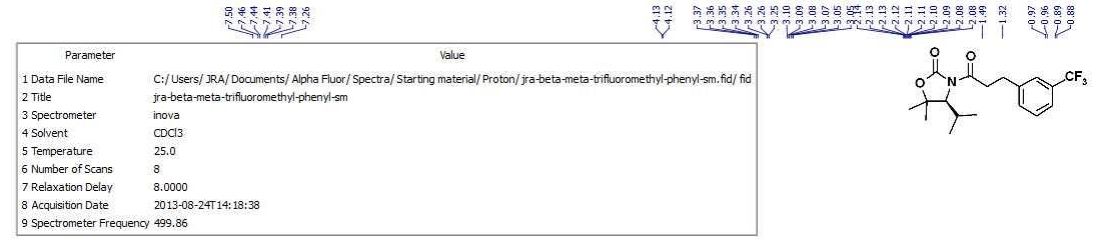


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ jra-3-51-beta-pthalimide.fid/ fid
2 Title	jra-3-51-beta-pthalimide
3 Spectrometer	inova
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-03-21T11:32:18
9 Spectrometer Frequency	599.64

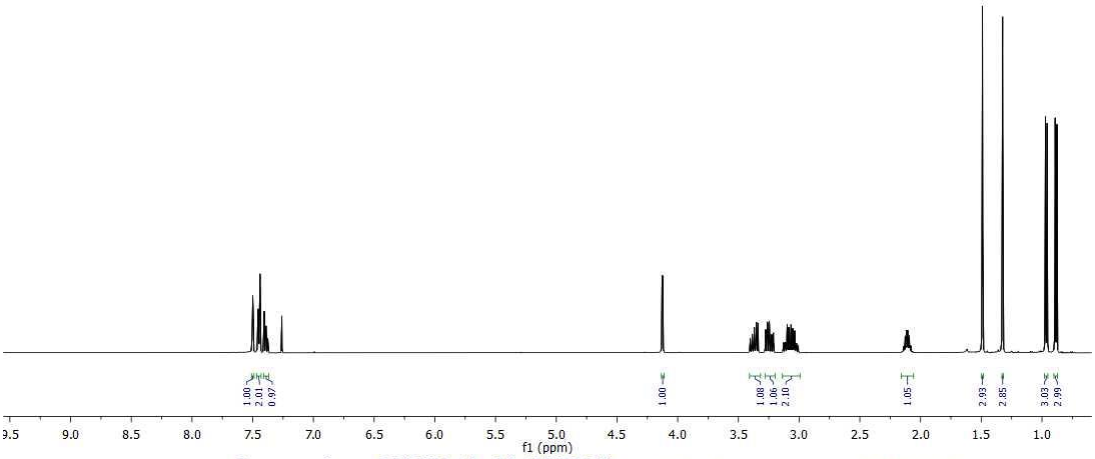


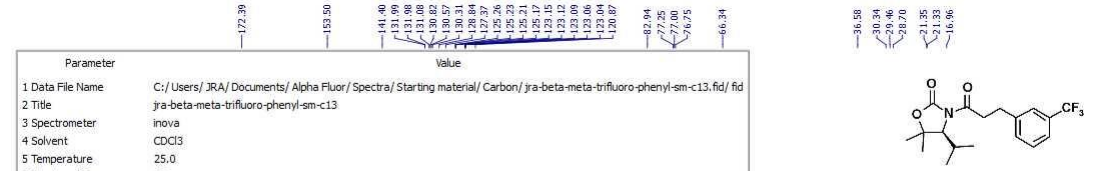


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-beta-pthalimide-sm-c13.fid/ fid
2 Title	jra-beta-pthalimide-sm-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	580
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-24T15:33:41
9 Spectrometer Frequency	125.70

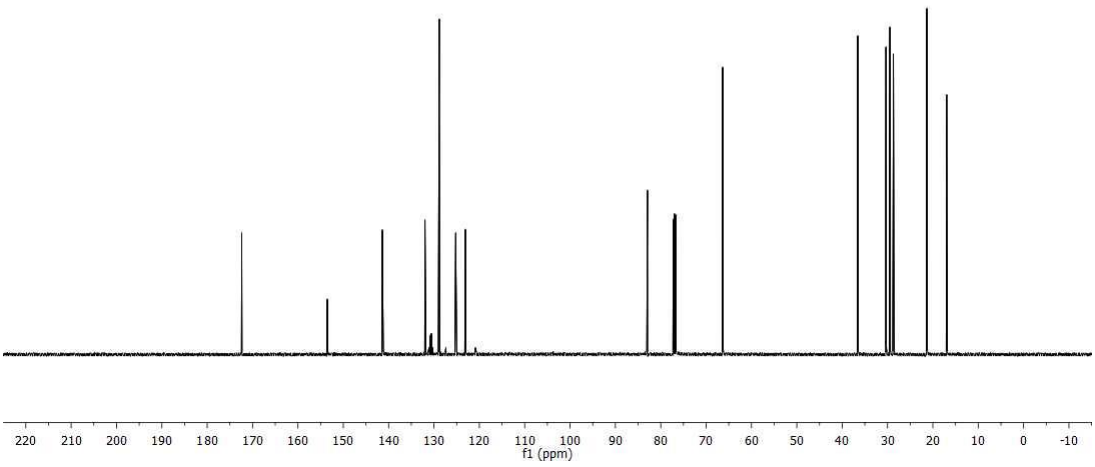


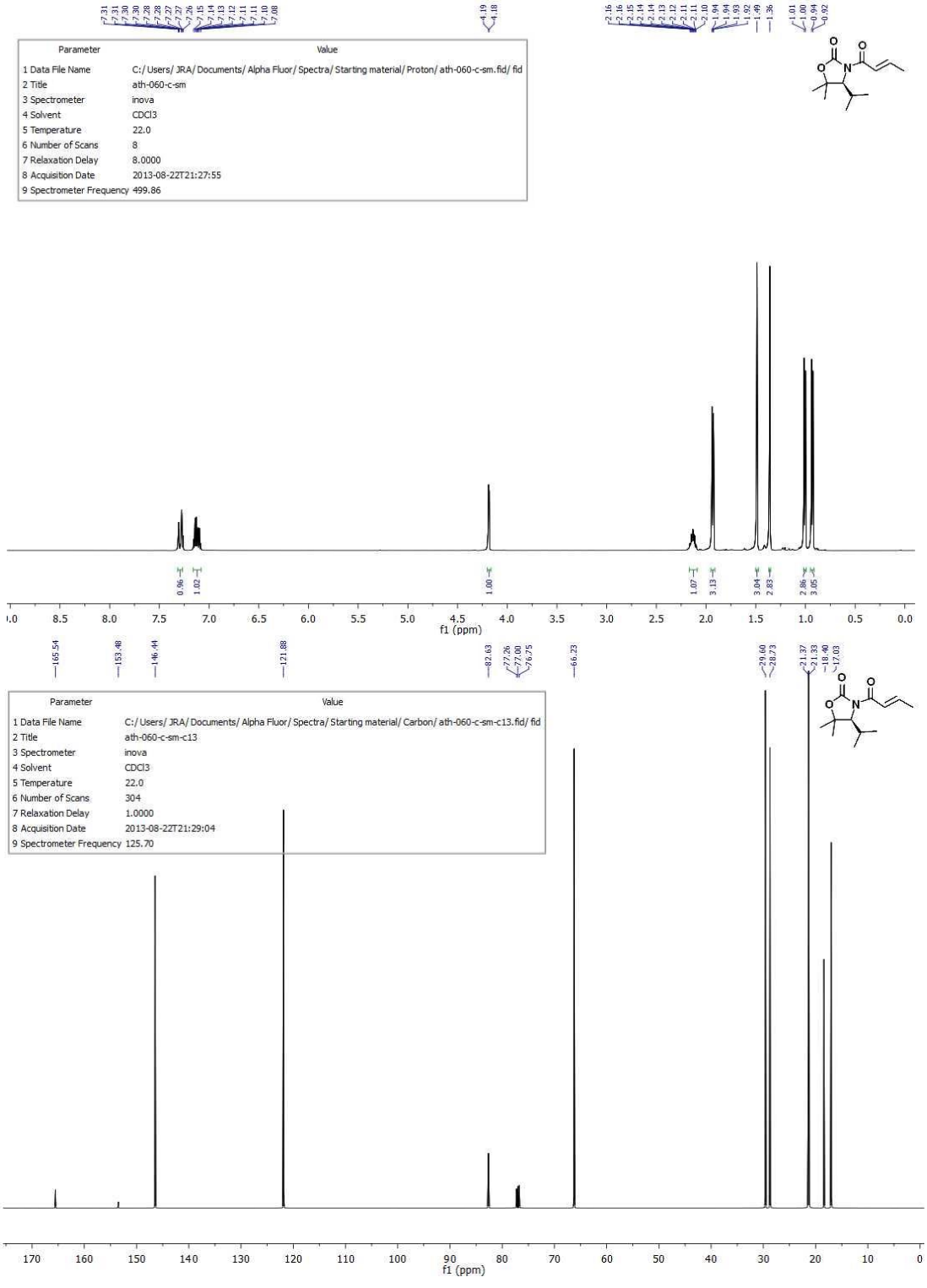
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Proton/ jra-beta-meta-trifluoromethyl-phenyl-sm.fid/ fid
2 Title	jra-beta-meta-trifluoromethyl-phenyl-sm
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-08-24T14:18:38
9 Spectrometer Frequency	499.86

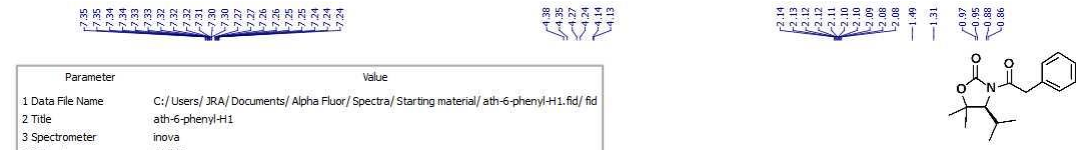




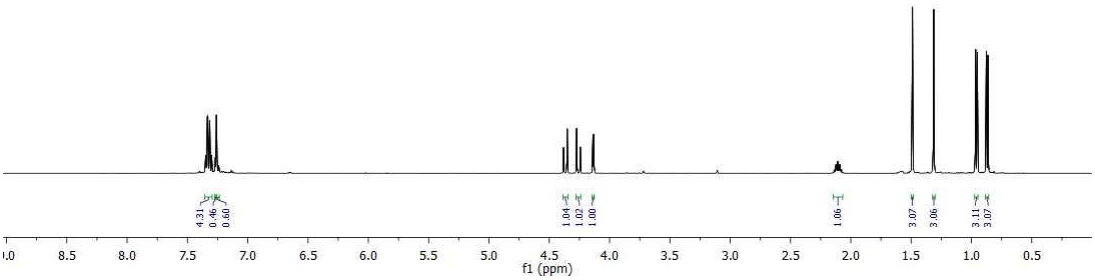
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-beta-meta-trifluoro-phenyl-sm-c13.fid/ fid
2 Title	jra-beta-meta-trifluoro-phenyl-sm-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	828
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-24T14:19:41
9 Spectrometer Frequency	125.70

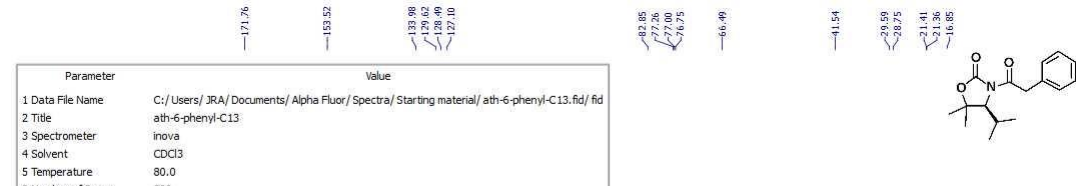



Parameter Value
1 Data File Name C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/Proton/ath-060-c-sm.fid/fid
2 Title ath-060-c-sm
3 Spectrometer inova
4 Solvent CDCl3
5 Temperature 22.0
6 Number of Scans 8
7 Relaxation Delay 8.0000
8 Acquisition Date 2013-08-22T21:27:55
9 Spectrometer Frequency 499.86
f1 (ppm)
Parameter Value
1 Data File Name C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/Carbon/ath-060-c-sm-c13.fid/fid
2 Title ath-060-c-sm-c13
3 Spectrometer inova
4 Solvent CDCl3
5 Temperature 22.0
6 Number of Scans 304
7 Relaxation Delay 1.0000
8 Acquisition Date 2013-08-22T21:29:04
9 Spectrometer Frequency 125.70
f1 (ppm)

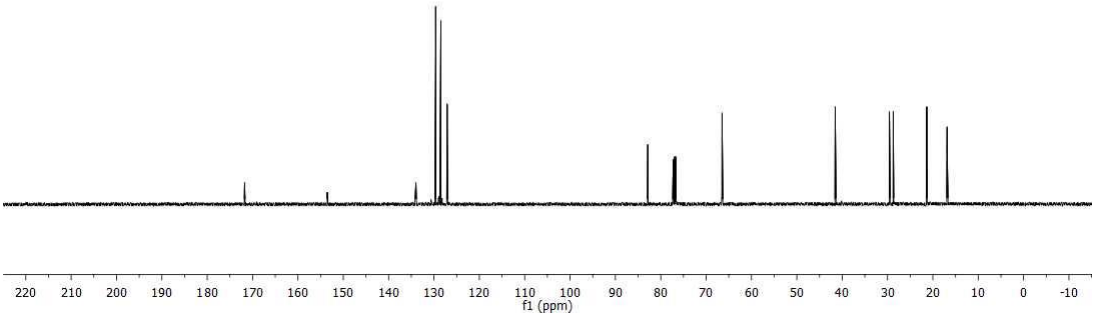


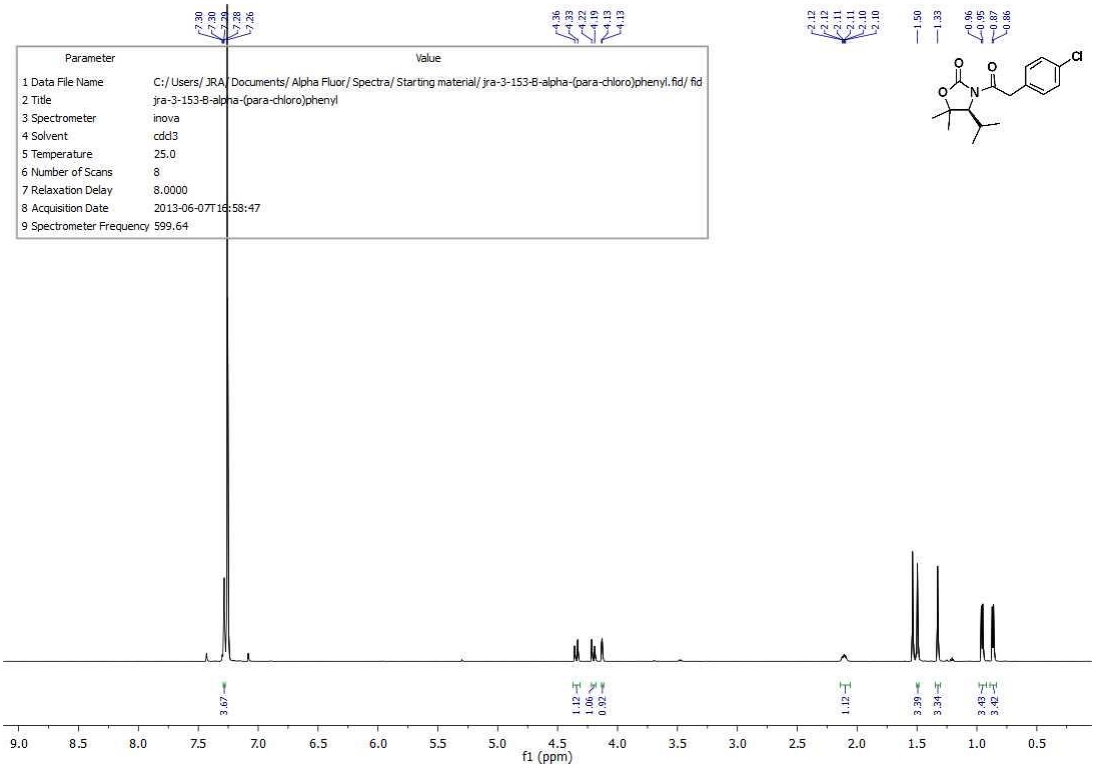
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ ath-6-phenyl-H1.fid/ fid
2 Title	ath-6-phenyl-H1
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	80.0
6 Number of Scans	16
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-08-29T22:59:35
9 Spectrometer Frequency	499.86

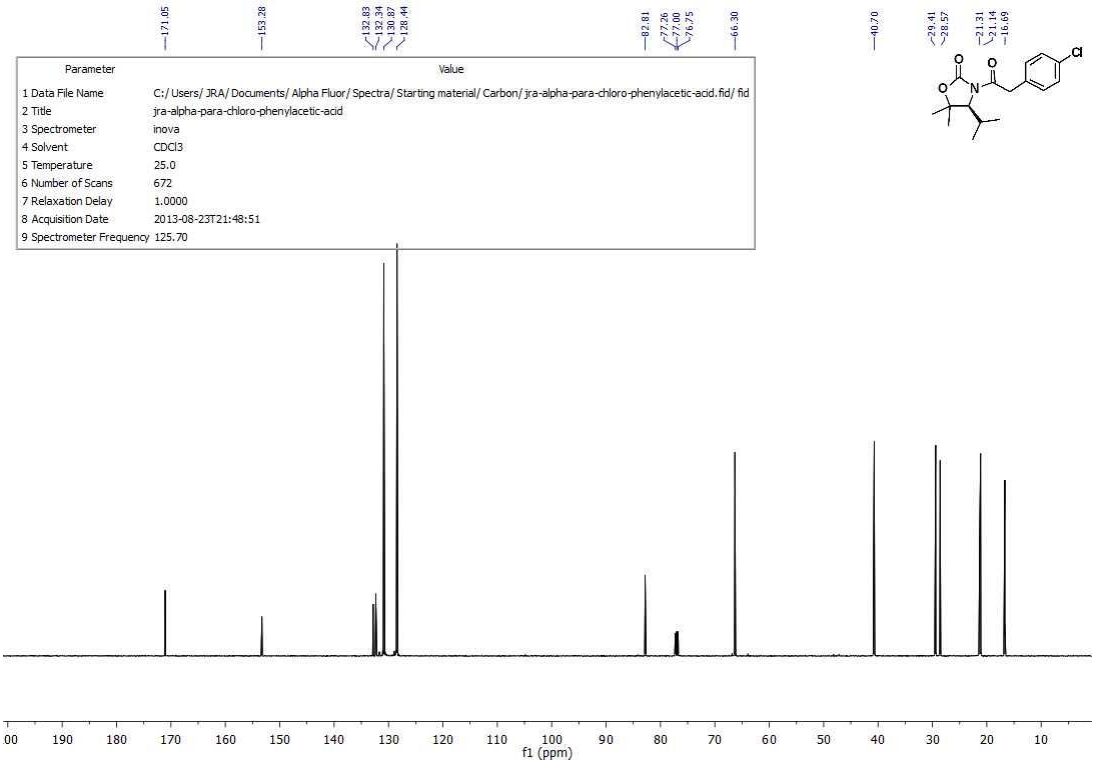


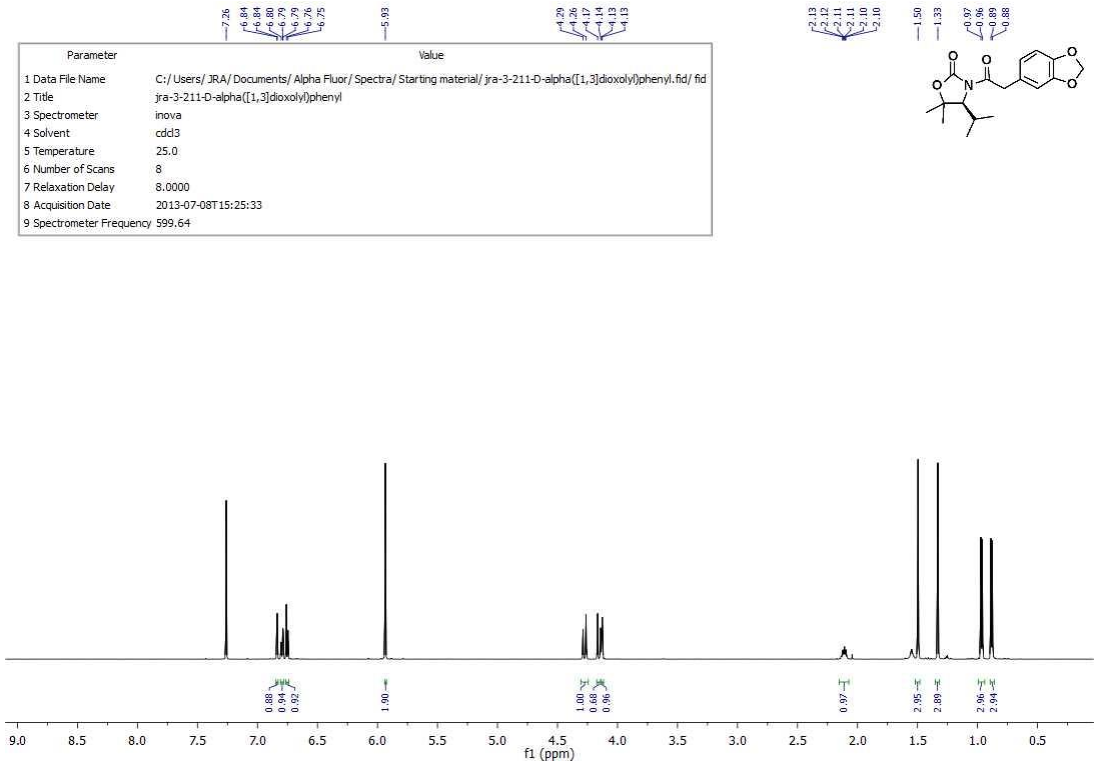


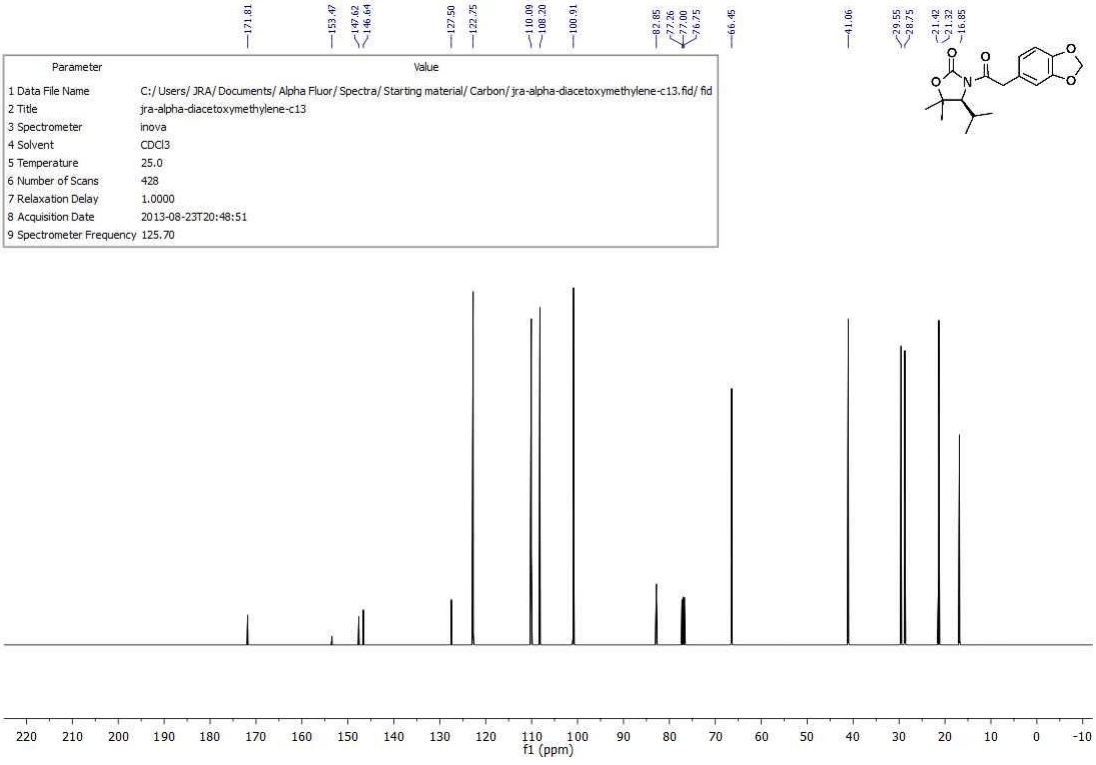
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ ath-6-phenyl-C13.fid/ fid
2 Title	ath-6-phenyl-C13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	80.0
6 Number of Scans	280
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-29T22:59:57
9 Spectrometer Frequency	125.70

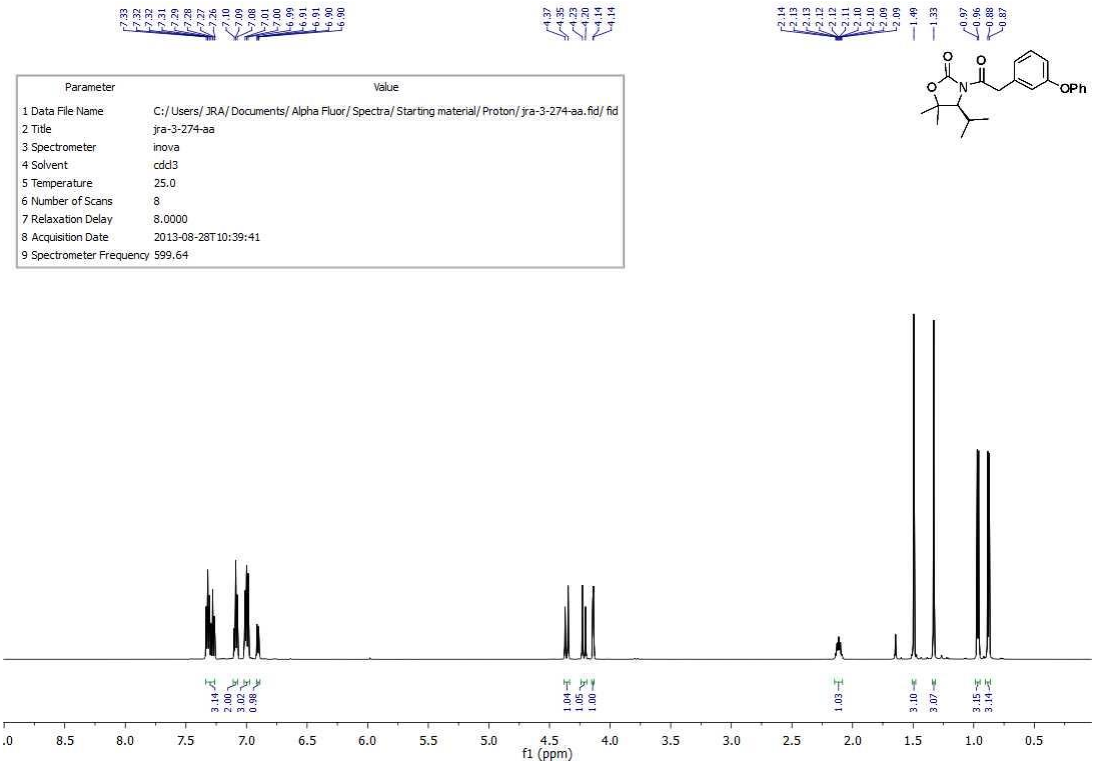


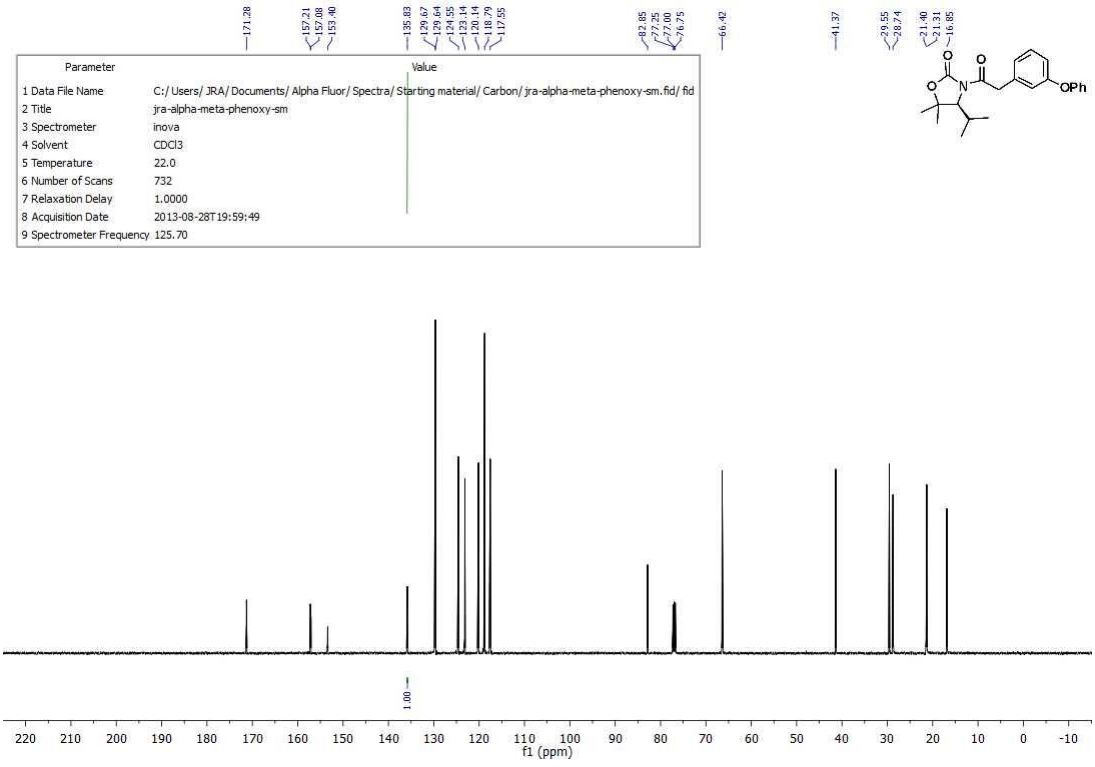

7.30
7.30
7.29
7.28
7.26
4.36
4.33
4.22
4.19
4.13
4.13
2.12
2.12
2.11
2.11
2.10
2.10
1.50
1.33
0.96
0.95
0.87
0.86
Cl
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/jra-3-153-B-alpha-(para-chloro)phenyl.fid/fid
2 Title
jra-3-153-B-alpha-(para-chloro)phenyl
3 Spectrometer
inova
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
8
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-06-07T16:58:47
9 Spectrometer Frequency
599.64
3.67
1.12
1.06
0.92
1.12
3.39
3.34
3.43
3.42
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


171.05
153.28
132.83
132.34
130.87
128.44
82.81
77.26
77.00
76.75
66.30
40.70
29.41
28.57
21.31
21.14
16.69
Cl
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/Carbon/jra-alpha-para-chloro-phenylacetic-acid.fid/fid
2 Title
jra-alpha-para-chloro-phenylacetic-acid
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
25.0
6 Number of Scans
672
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-08-23T21:48:51
9 Spectrometer Frequency
125.70
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

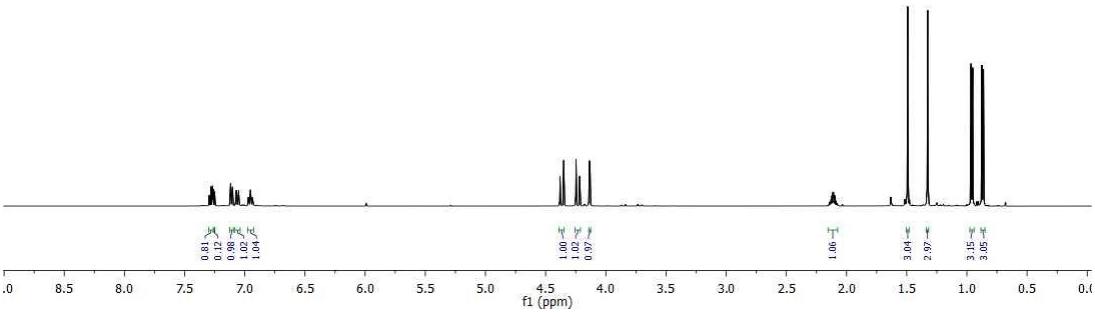

7.26
6.84
6.84
6.80
6.79
6.76
6.75
5.93
4.29
4.26
4.17
4.14
4.13
4.13
2.13
2.12
2.11
2.11
2.10
2.10
1.50
1.33
0.97
0.96
0.89
0.88
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ jra-3-211-D-alpha([1,3]dioxolyl)phenyl.fid/ fid
2 Title
jra-3-211-D-alpha([1,3]dioxolyl)phenyl
3 Spectrometer
inova
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
8
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-07-08T15:25:33
9 Spectrometer Frequency
599.64
0.88
0.94
0.92
1.90
1.00
0.68
0.96
0.97
2.95
2.89
2.96
2.94
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

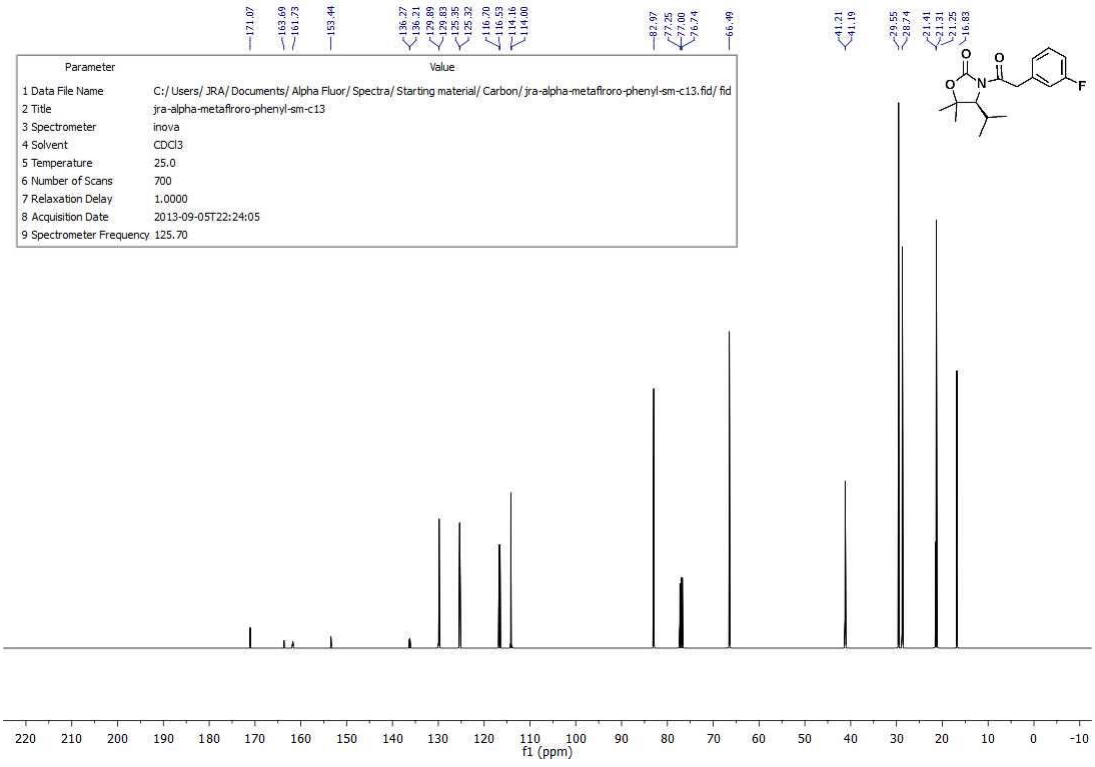

171.81
153.47
147.62
146.64
127.50
122.75
110.09
108.20
100.91
82.85
77.26
77.00
76.75
66.48
41.06
29.55
28.75
21.42
21.32
16.85
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-alpha-diacetoxymethylene-c13.fid/ fid
2 Title
jra-alpha-diacetoxymethylene-c13
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
25.0
6 Number of Scans
428
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-08-23T20:48:51
9 Spectrometer Frequency
125.70
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.33
7.32
7.32
7.31
7.29
7.28
7.27
7.26
7.10
7.09
7.08
7.01
7.00
6.99
6.91
6.90
6.90
4.37
4.35
4.23
4.20
4.14
4.14
2.14
2.13
2.13
2.12
2.12
2.11
2.10
2.10
2.09
2.09
1.49
1.33
0.97
0.96
0.88
0.87
OPh
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Proton/ jra-3-274-aa.fid/ fid
2 Title
jra-3-274-aa
3 Spectrometer
inova
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
8
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-08-28T10:39:41
9 Spectrometer Frequency
599.64
3.14
2.00
3.02
0.98
1.04
1.05
1.00
1.03
3.10
3.07
3.15
3.14
f1 (ppm)

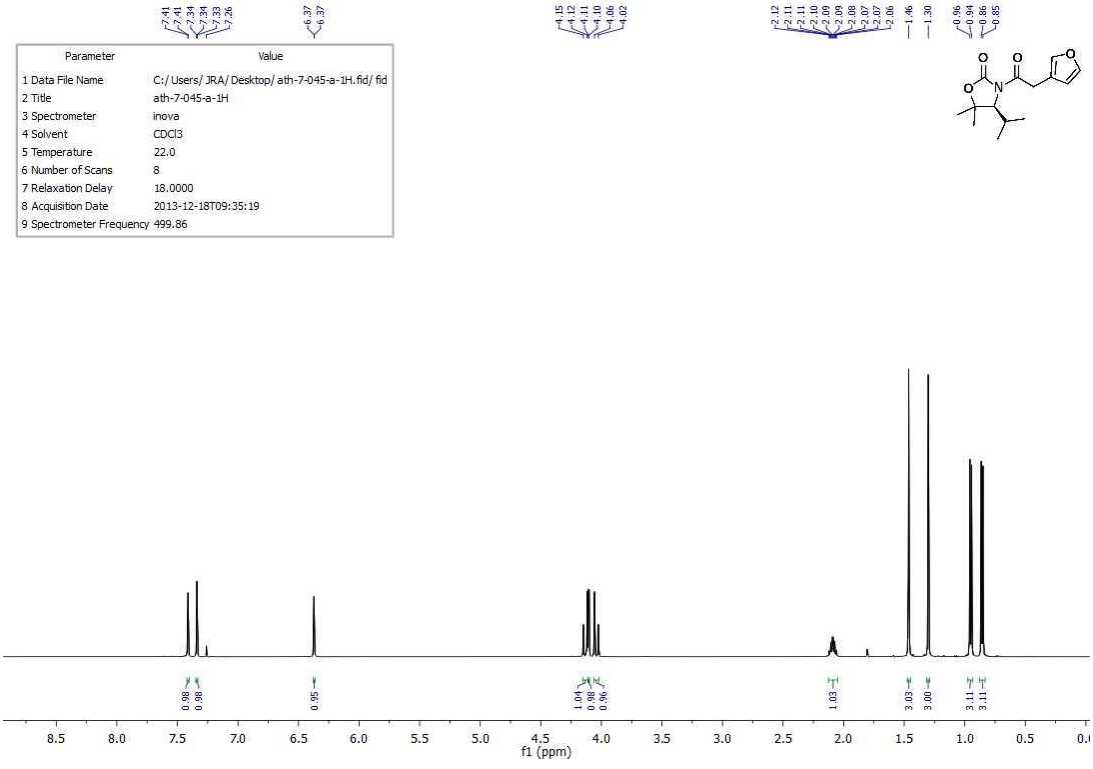

171.28
157.21
157.08
153.40
135.83
129.67
129.64
124.55
123.14
120.14
118.79
117.55
82.85
77.25
77.00
76.75
66.42
41.37
29.55
28.74
21.40
21.31
16.85
OPh
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-alpha-meta-phenoxy-sm.fid/ fid
2 Title
jra-alpha-meta-phenoxy-sm
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
22.0
6 Number of Scans
732
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-08-28T19:59:49
9 Spectrometer Frequency
125.70
1.00
f1 (ppm)

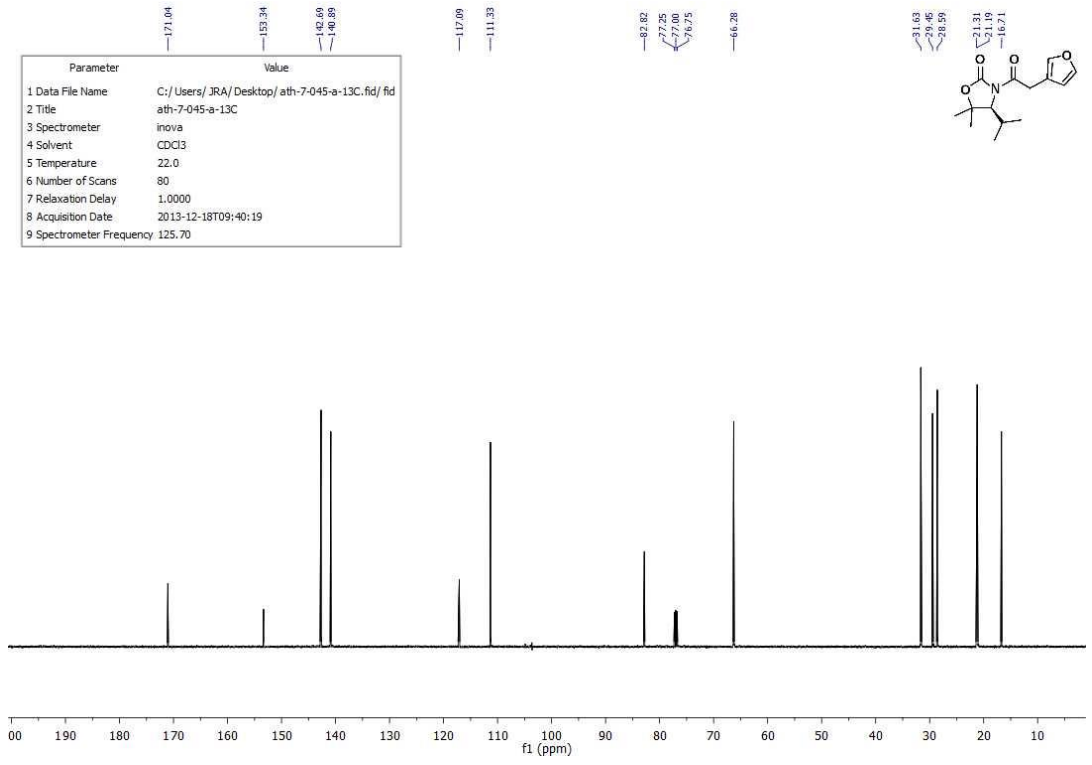
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Proton/ jra-alpha-metafluoro-phenyl-sm.fid/ fid
2 Title	jra-alpha-metafluoro-phenyl-sm
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-09-05T22:22:27
9 Spectrometer Frequency	499.86



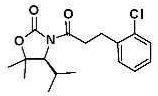


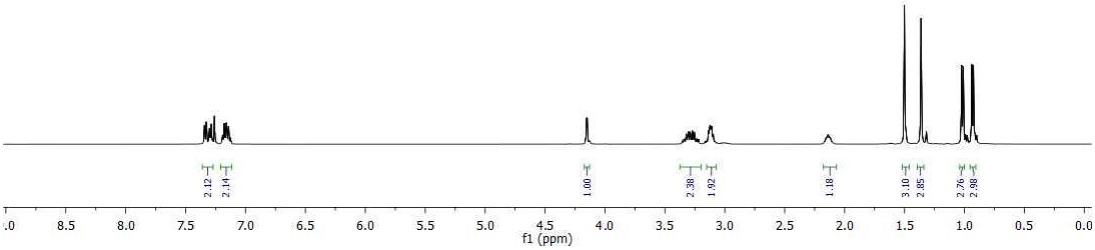
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-alpha-metafroro-phenyl-sm-c13.fid/ fid
2 Title	jra-alpha-metafroro-phenyl-sm-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	700
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-09-05T22:24:05
9 Spectrometer Frequency	125.70


7.41
7.41
7.34
7.34
7.33
7.26
6.37
6.37
4.15
4.12
4.11
4.10
4.06
4.02
2.12
2.11
2.11
2.10
2.09
2.09
2.08
2.07
2.07
2.06
1.46
1.30
0.96
0.94
0.86
0.85
Parameter Value
1 Data File Name C:/Users/JRA/Desktop/ath-7-045-a-1H.fid/fid
2 Title ath-7-045-a-1H
3 Spectrometer inova
4 Solvent CDCl3
5 Temperature 22.0
6 Number of Scans 8
7 Relaxation Delay 18.0000
8 Acquisition Date 2013-12-18T09:35:19
9 Spectrometer Frequency 499.86
0.98
0.98
0.95
1.04
0.98
0.96
1.03
3.03
3.00
3.11
3.11
f1 (ppm)

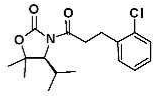

171.04
153.34
142.69
140.89
117.09
111.33
82.82
77.25
77.00
76.75
66.28
31.63
29.45
28.59
21.31
21.19
16.71
Parameter Value
1 Data File Name C:/Users/JRA/Desktop/ath-7-045-a-13C.fid/fid
2 Title ath-7-045-a-13C
3 Spectrometer inova
4 Solvent CDCl3
5 Temperature 22.0
6 Number of Scans 80
7 Relaxation Delay 1.0000
8 Acquisition Date 2013-12-18T09:40:19
9 Spectrometer Frequency 125.70
f1 (ppm)

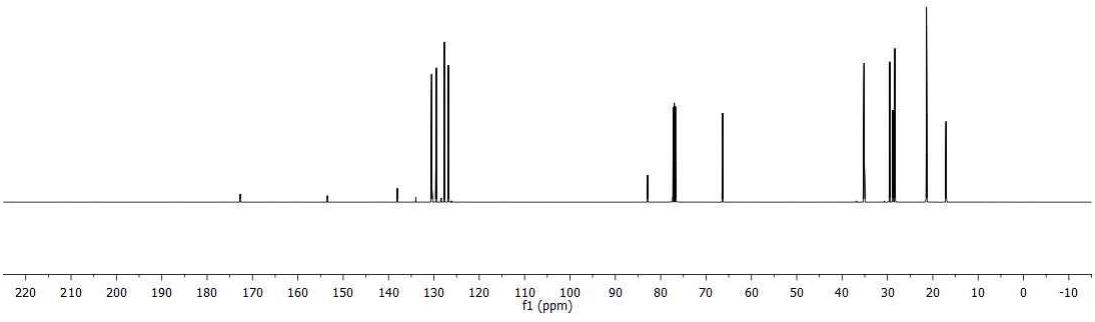
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ jra-orthocl-sm.fid/ fid
2 Title	jra-orthocl-sm
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-09-25T20:28:48
9 Spectrometer Frequency	499.86

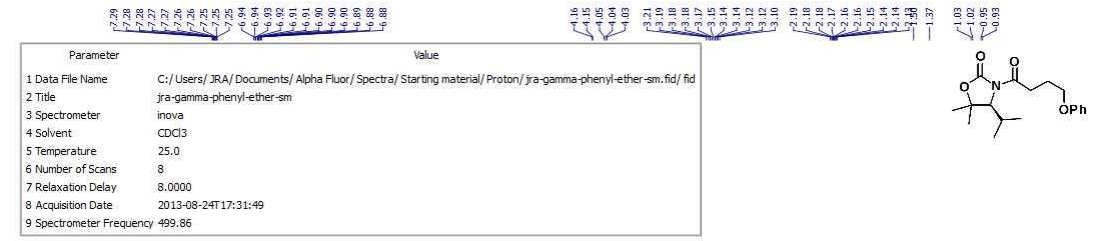




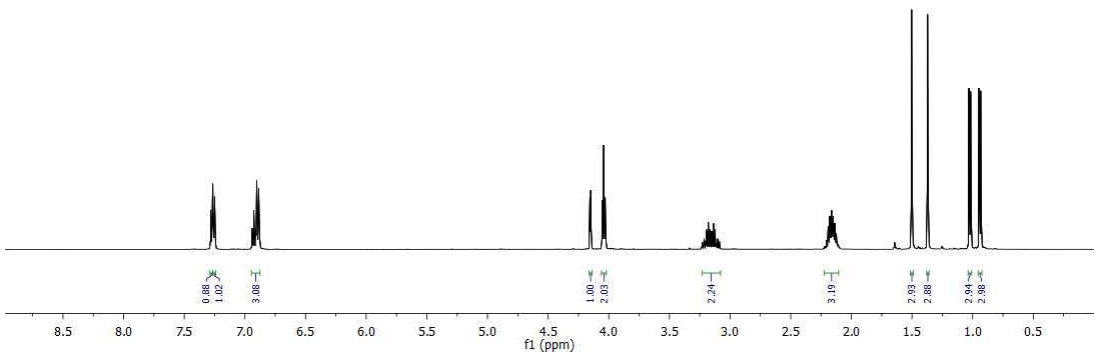
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ jra-orthoCl-sm-c13.fid/ fid
2 Title	jra-orthoCl-sm-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	348
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-09-25T20:29:51
9 Spectrometer Frequency	125.70

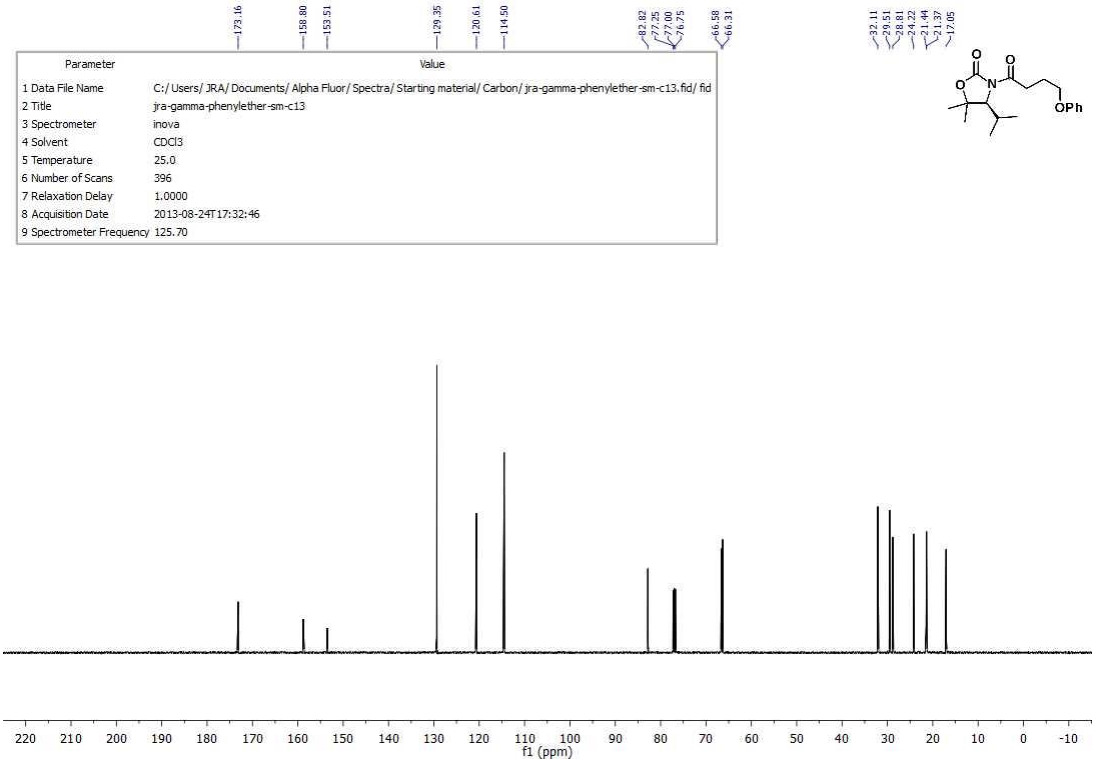




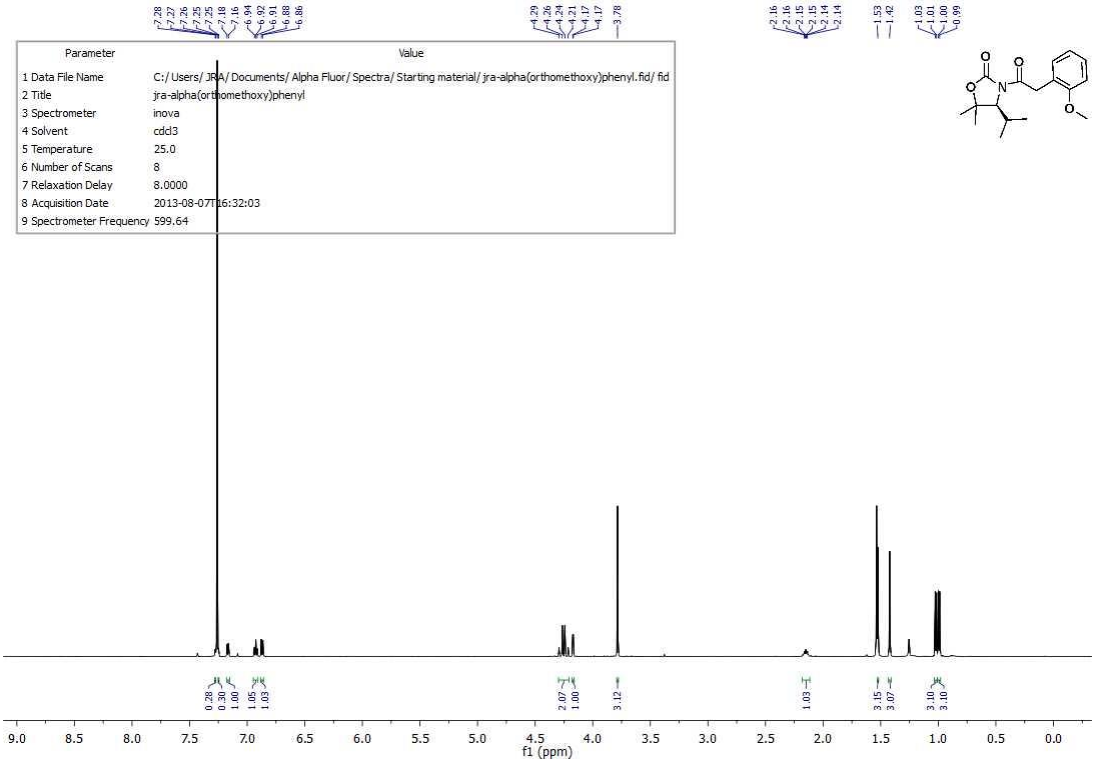


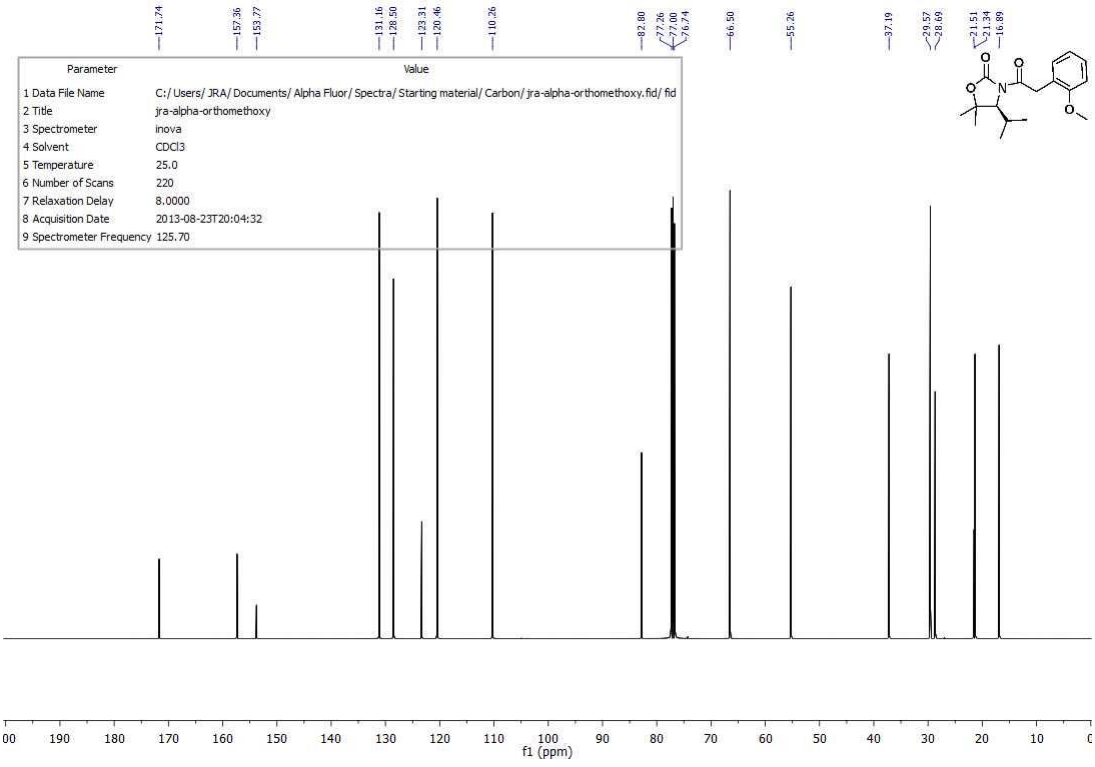
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Proton/ jra-gamma-phenyl-ether-sm.fid/ fid
2 Title	jra-gamma-phenyl-ether-sm
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-08-24T17:31:49
9 Spectrometer Frequency	499.86

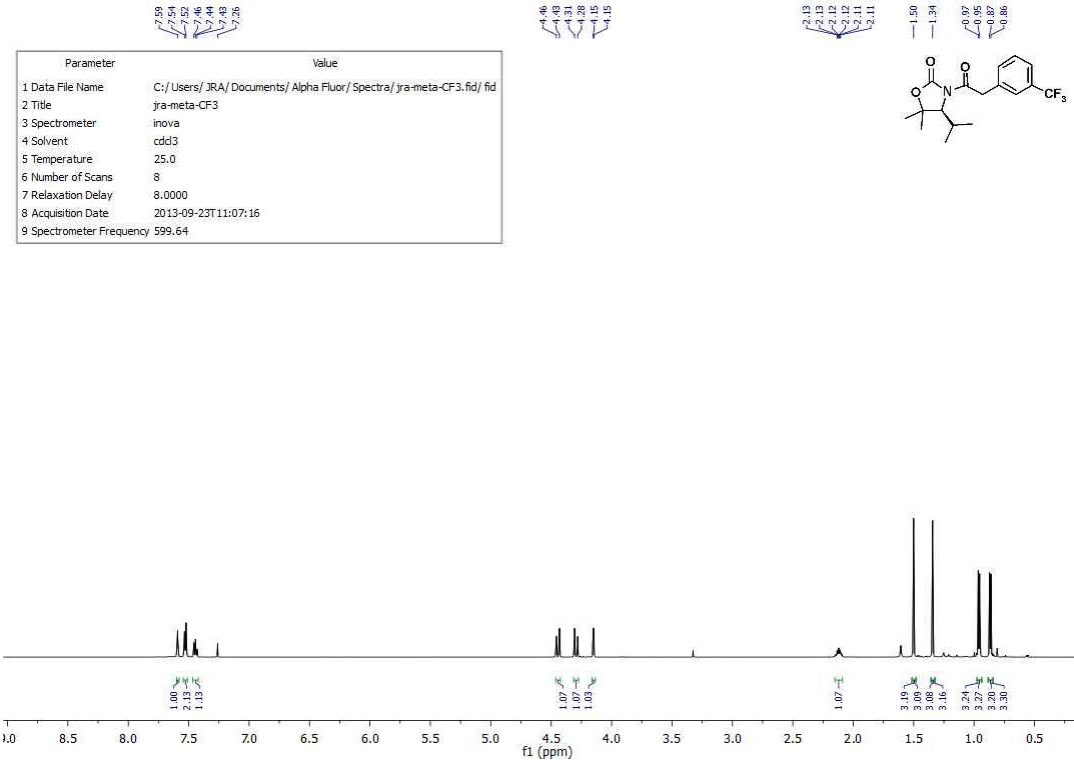


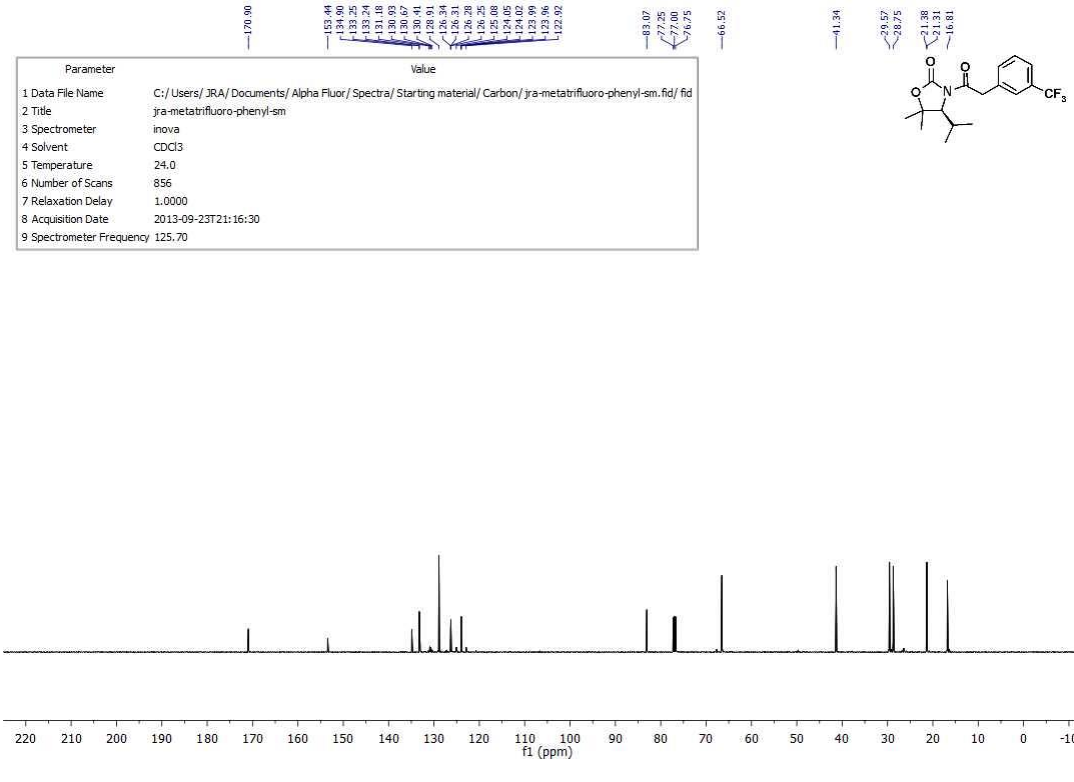


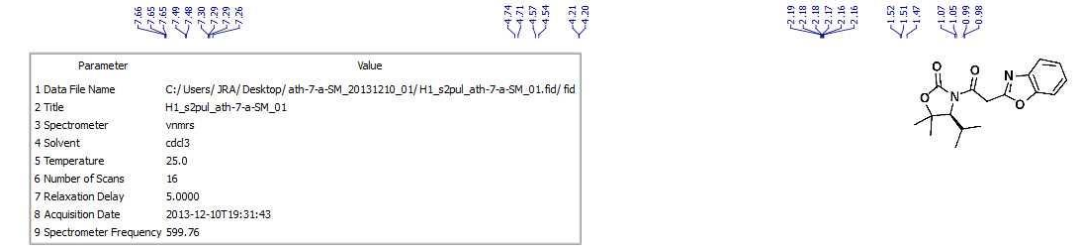
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-gamma-phenylether-sm-c13.fid/ fid
2 Title	jra-gamma-phenylether-sm-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	396
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-24T17:32:46
9 Spectrometer Frequency	125.70


7.28
7.27
7.26
7.25
7.25
7.18
7.16
6.94
6.92
6.91
6.88
6.86
4.29
4.26
4.24
4.21
4.17
4.17
3.78
2.16
2.16
2.15
2.15
2.14
2.14
1.53
1.42
1.03
1.01
1.00
0.99
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ jra-alpha(orthomethoxy)phenyl.fid/ fid
2 Title
jra-alpha(orthomethoxy)phenyl
3 Spectrometer
inova
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
8
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-08-07T16:32:03
9 Spectrometer Frequency
599.64
0.28
0.30
1.00
1.05
1.03
2.07
1.00
3.12
1.03
3.15
3.07
3.10
3.10
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

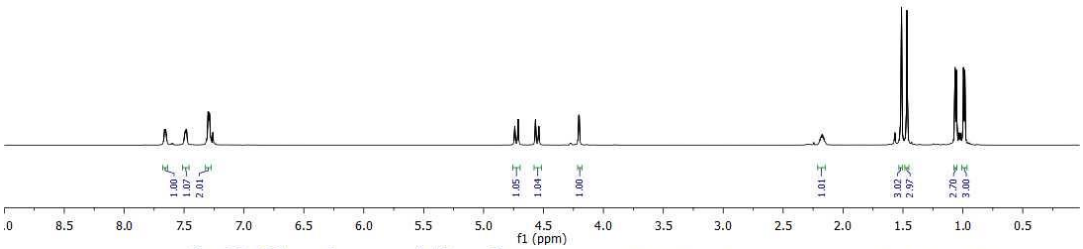

171.74
157.36
153.77
131.16
128.50
123.31
120.46
110.26
82.80
77.26
77.00
76.74
66.50
55.26
37.19
29.57
28.69
21.51
21.34
16.89
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-alpha-orthomethoxy.fid/ fid
2 Title
jra-alpha-orthomethoxy
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
25.0
6 Number of Scans
220
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-08-23T20:04:32
9 Spectrometer Frequency
125.70
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

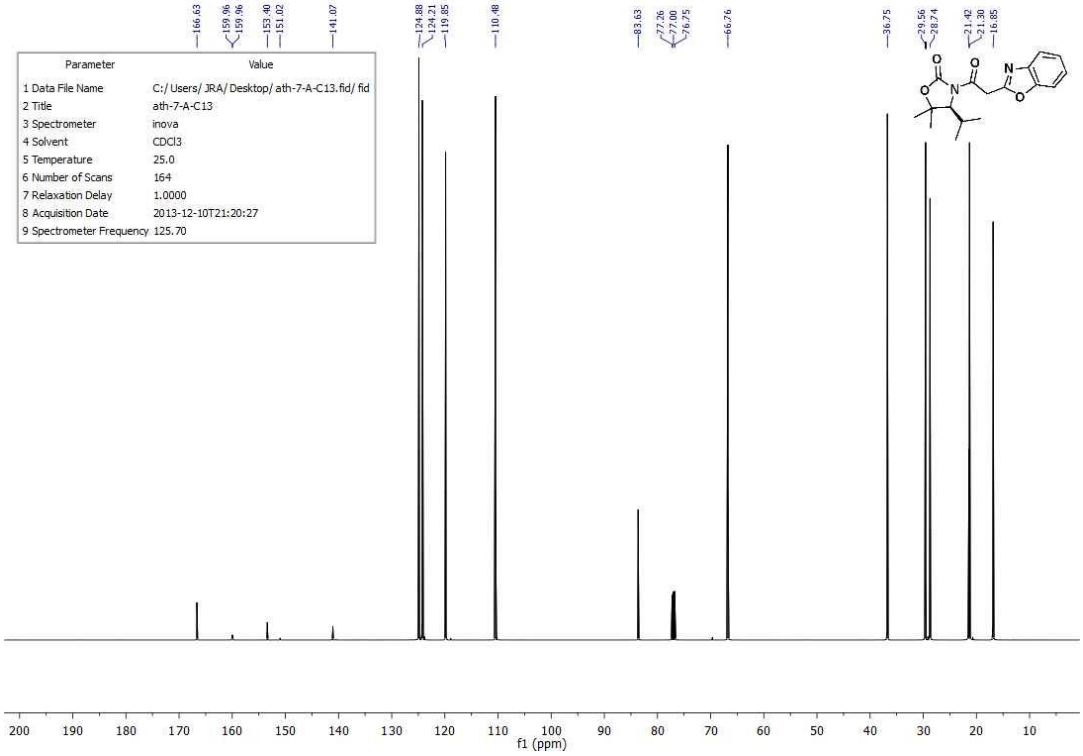

7.59
7.54
7.52
7.46
7.44
7.43
7.26
4.46
4.43
4.31
4.28
4.15
4.15
2.13
2.13
2.12
2.12
2.11
1.50
1.34
0.97
0.95
0.87
0.86
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/jra-meta-CF3.fid/fid
2 Title
jra-meta-CF3
3 Spectrometer
inova
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
8
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-09-23T11:07:16
9 Spectrometer Frequency
599.64
CF3
1.00
2.13
1.13
1.07
1.07
1.03
1.07
3.19
3.09
3.08
3.16
3.24
3.27
3.20
3.30
f1 (ppm)


170.90
153.44
134.90
133.25
133.24
131.18
130.93
130.67
130.41
129.91
126.34
126.31
126.28
126.25
125.08
124.05
124.02
123.99
123.96
122.92
83.07
77.25
77.00
76.75
66.52
41.34
29.57
28.75
21.38
21.31
16.81
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/Carbon/jra-metatrifluoro-phenyl-sm.fid/fid
2 Title
jra-metatrifluoro-phenyl-sm
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
24.0
6 Number of Scans
856
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-09-23T21:16:30
9 Spectrometer Frequency
125.70
CF3
f1 (ppm)

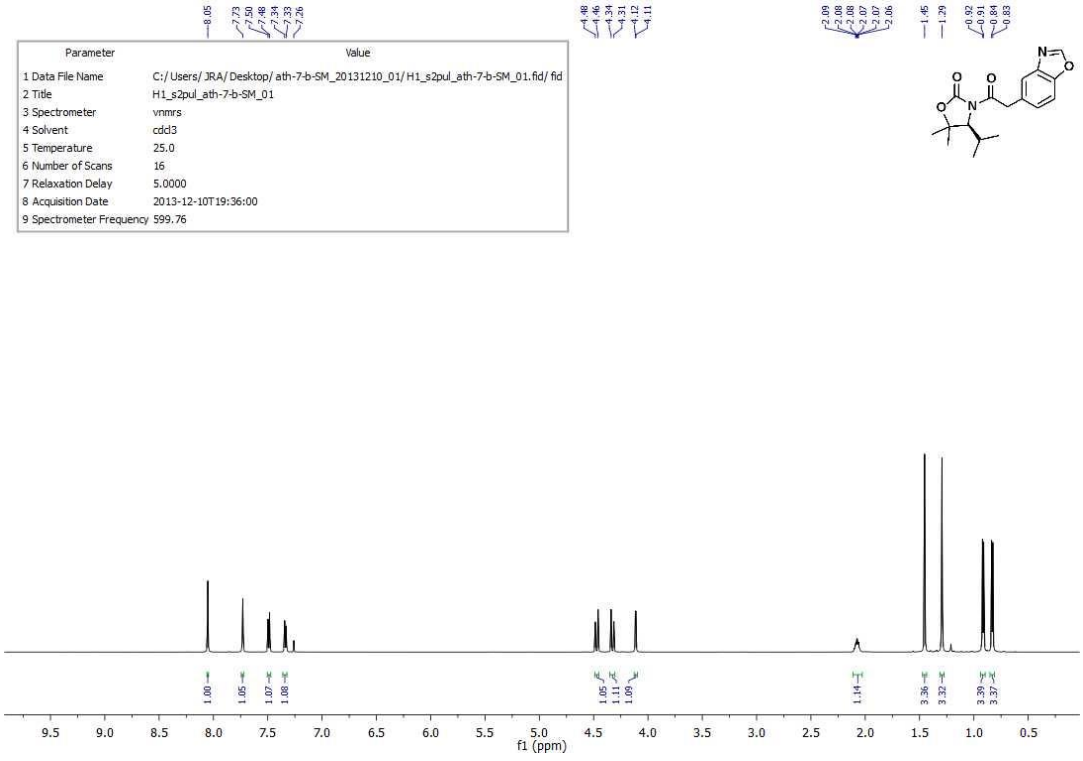


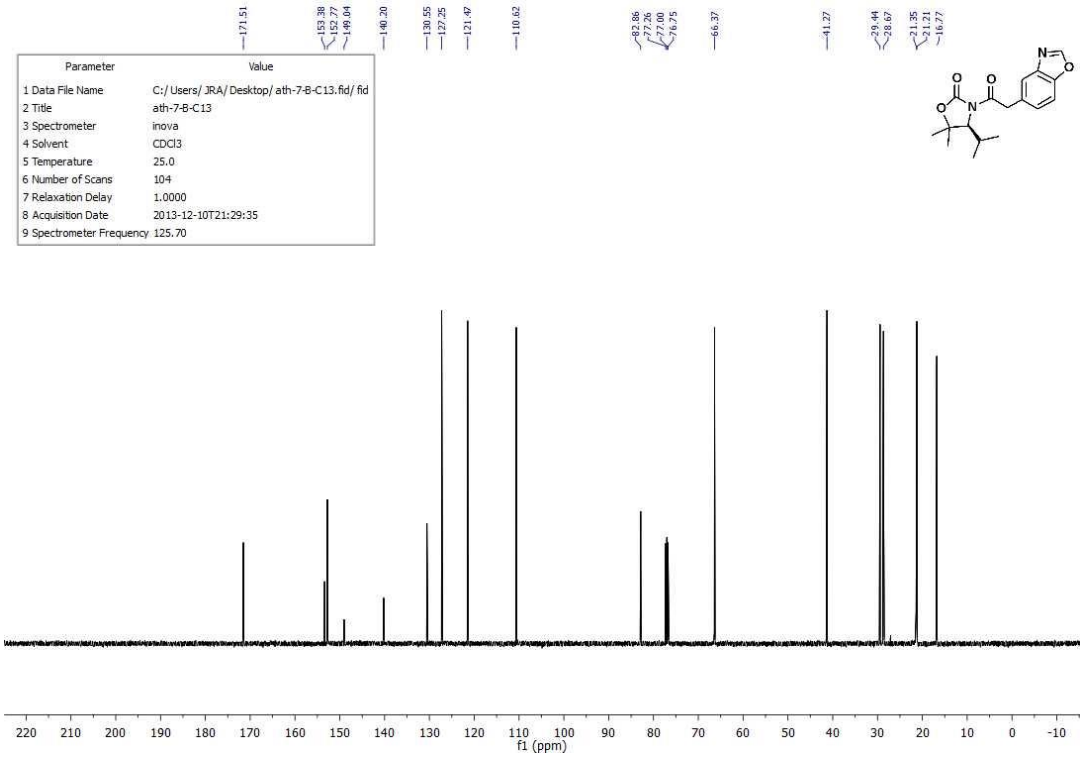
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Desktop/ ath-7-a-SM_20131210_01/ H1_s2pul_ath-7-a-SM_01.fid/ fid
2 Title	H1_s2pul_ath-7-a-SM_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-12-10T19:31:43
9 Spectrometer Frequency	599.76

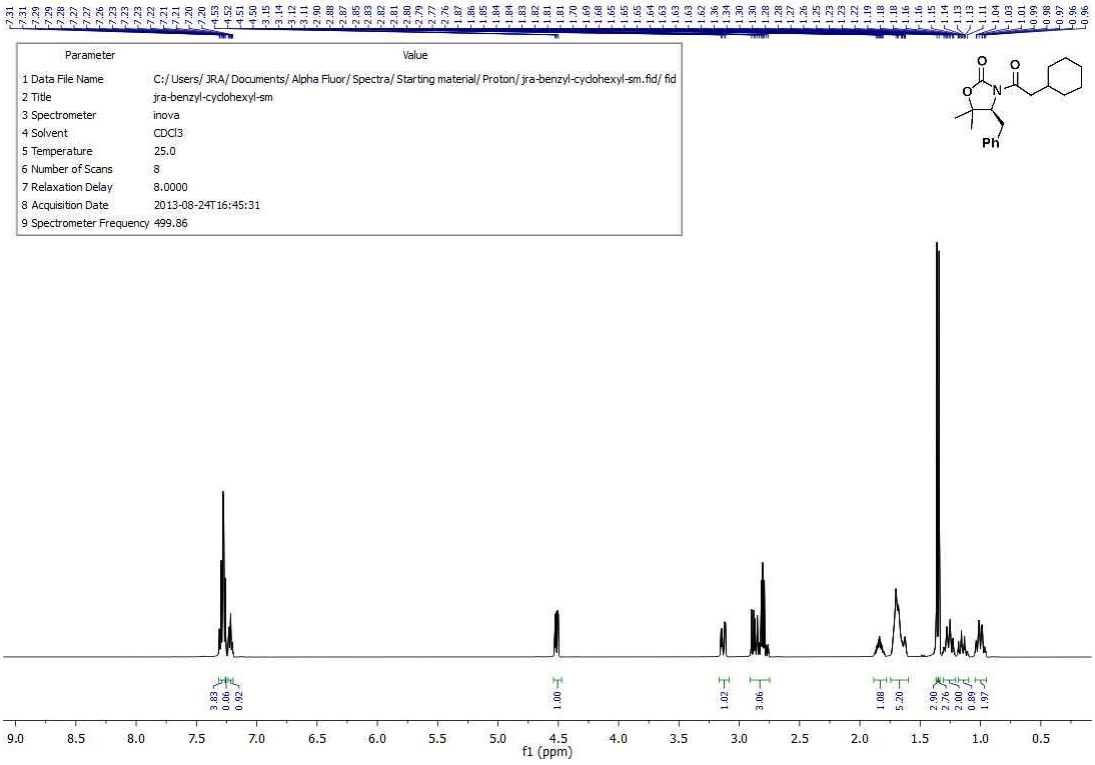


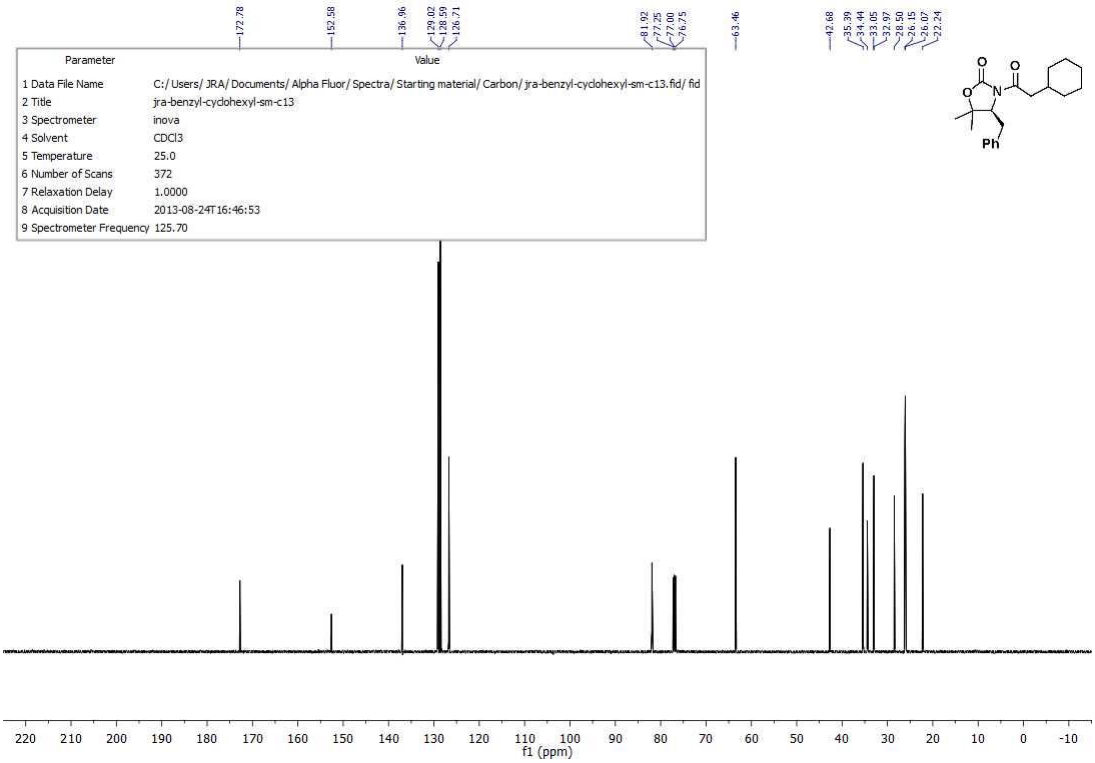


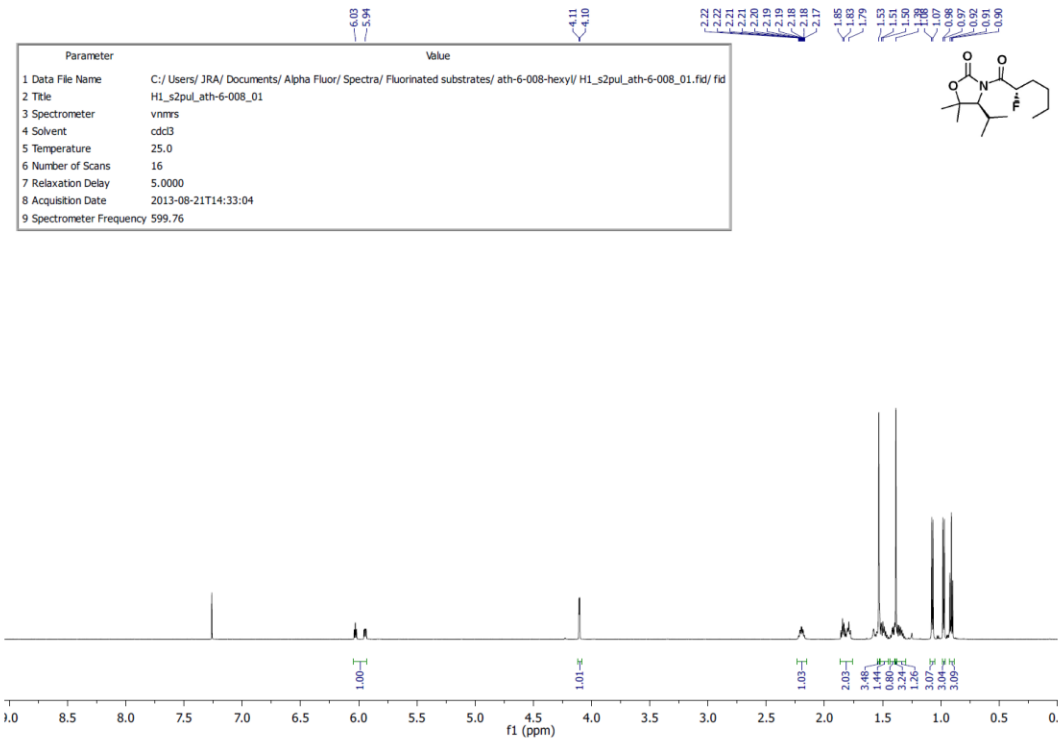
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Desktop/ ath-7-A-C13.fid/ fid
2 Title	ath-7-A-C13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	164
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-12-10T21:20:27
9 Spectrometer Frequency	125.70

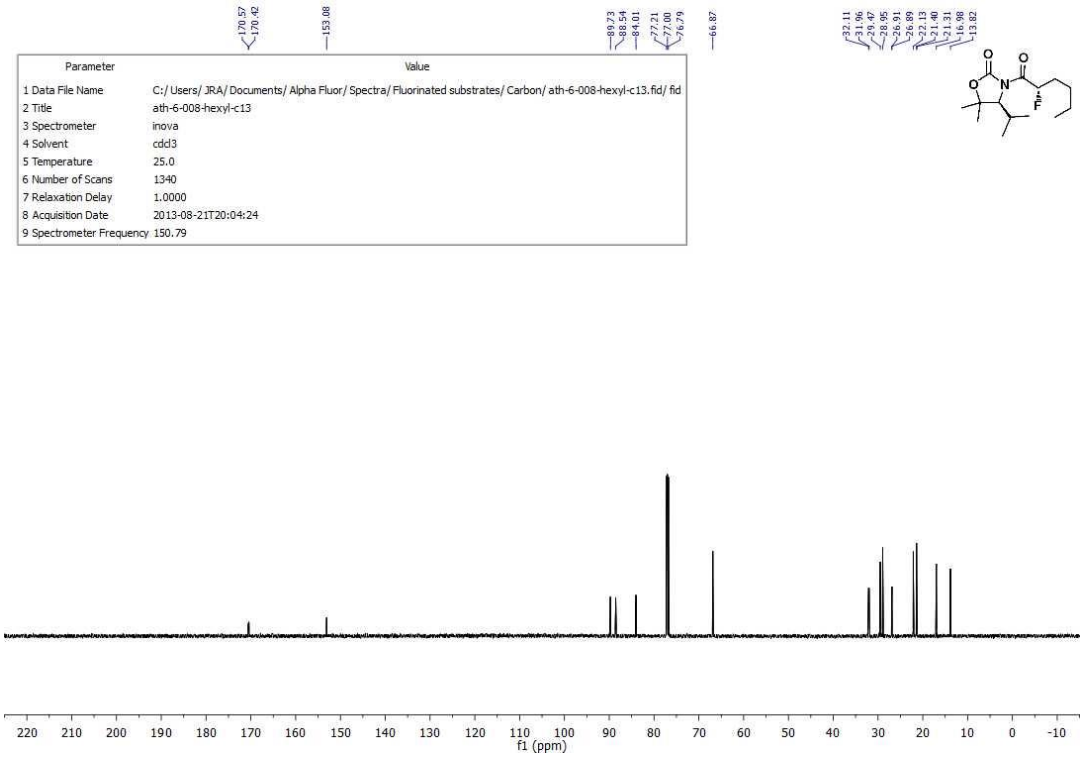

8.05
7.73
7.50
7.48
7.34
7.33
7.26
4.48
4.46
4.34
4.31
4.12
4.11
2.09
2.08
2.08
2.07
2.07
2.06
1.45
1.29
0.92
0.91
0.84
0.83
Parameter
Value
1 Data File Name
C:/Users/JRA/Desktop/ath-7-b-SM_20131210_01/H1_s2pul_ath-7-b-SM_01.fid/fid
2 Title
H1_s2pul_ath-7-b-SM_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-12-10T19:36:00
9 Spectrometer Frequency
599.76
1.00
1.05
1.07
1.08
1.05
1.11
1.09
1.14
3.36
3.32
3.39
3.37
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

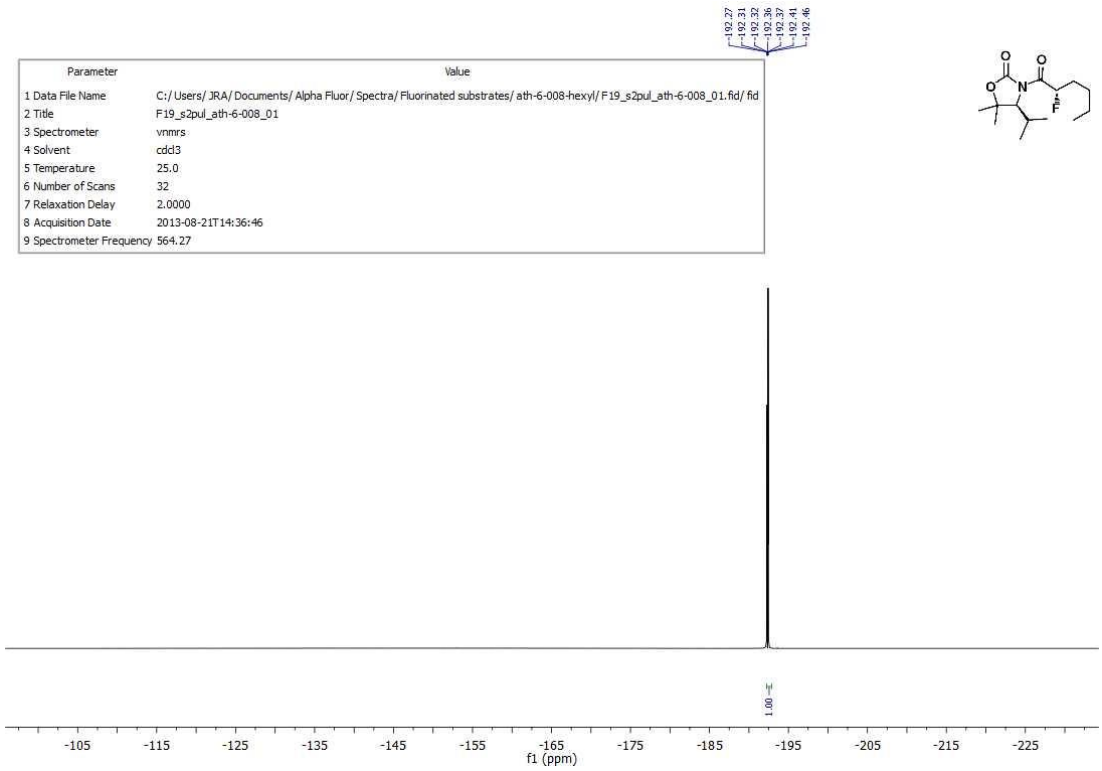

171.51
153.38
152.77
149.04
140.20
130.55
127.25
121.47
110.62
82.86
77.26
77.00
76.75
66.37
41.27
29.44
28.67
21.35
21.21
16.77
Parameter
Value
1 Data File Name
C:/Users/JRA/Desktop/ath-7-B-C13.fid/fid
2 Title
ath-7-B-C13
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
25.0
6 Number of Scans
104
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-12-10T21:29:35
9 Spectrometer Frequency
125.70
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

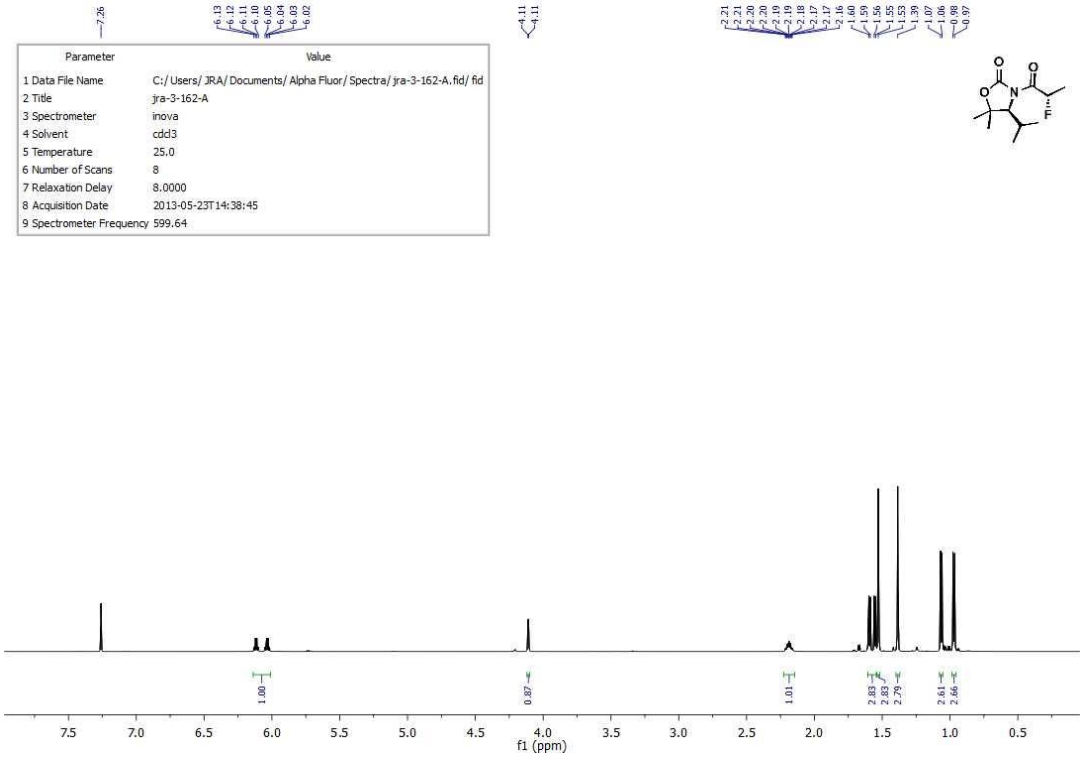

Parameter Value
1 Data File Name C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Proton/ jra-benzyl-cyclohexyl-sm.fid/ fid
2 Title jra-benzyl-cyclohexyl-sm
3 Spectrometer inova
4 Solvent CDCl3
5 Temperature 25.0
6 Number of Scans 8
7 Relaxation Delay 8.0000
8 Acquisition Date 2013-08-24T16:45:31
9 Spectrometer Frequency 499.86
Ph
f1 (ppm)


Parameter Value
1 Data File Name C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Starting material/ Carbon/ jra-benzyl-cyclohexyl-sm-c13.fid/ fid
2 Title jra-benzyl-cyclohexyl-sm-c13
3 Spectrometer inova
4 Solvent CDCl3
5 Temperature 25.0
6 Number of Scans 372
7 Relaxation Delay 1.0000
8 Acquisition Date 2013-08-24T16:46:53
9 Spectrometer Frequency 125.70
Ph
f1 (ppm)


6.03
5.94
4.11
4.10
2.22
2.22
2.21
2.21
2.20
2.19
2.19
2.18
2.18
2.17
1.85
1.83
1.79
1.53
1.51
1.50
1.08
1.07
0.98
0.97
0.92
0.91
0.90
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ ath-6-008-hexyl/ H1_s2pul_ath-6-008_01.fid/ fid
2 Title
H1_s2pul_ath-6-008_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-08-21T14:33:04
9 Spectrometer Frequency
599.76
1.00
1.01
1.03
2.03
3.48
1.44
1.00
3.24
1.26
3.07
3.04
3.09
f1 (ppm)


170.57
170.42
153.08
89.73
88.54
84.01
77.21
77.00
76.79
66.87
32.11
31.96
29.47
28.95
26.91
26.89
22.13
21.40
21.31
16.98
13.82
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ ath-6-008-hexyl-c13.fid/ fid
2 Title
ath-6-008-hexyl-c13
3 Spectrometer
inova
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
1340
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-08-21T20:04:24
9 Spectrometer Frequency
150.79
f1 (ppm)


-192.27
-192.31
-192.32
-192.36
-192.37
-192.41
-192.46
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ ath-6-008-hexyl/ F19_s2pul_ath-6-008_01.fid/ fid
2 Title
F19_s2pul_ath-6-008_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-08-21T14:36:46
9 Spectrometer Frequency
564.27
1.00
-105
-115
-125
-135
-145
-155
-165
-175
-185
-195
-205
-215
-225
f1 (ppm)


7.26
6.13
6.12
6.11
6.10
6.05
6.04
6.03
6.02
4.11
4.11
2.21
2.21
2.20
2.20
2.19
2.19
2.18
2.17
2.17
2.16
1.60
1.59
1.56
1.55
1.53
1.39
1.07
1.06
0.98
0.97
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ jra-3-162-A.fid/ fid
2 Title
jra-3-162-A
3 Spectrometer
inova
4 Solvent
cdd3
5 Temperature
25.0
6 Number of Scans
8
7 Relaxation Delay
8.0000
8 Acquisition Date
2013-05-23T14:38:45
9 Spectrometer Frequency
599.64
1.00
0.87
1.01
2.83
2.83
2.79
2.61
2.66
7.5
7.0
6.5
6.0
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4.0
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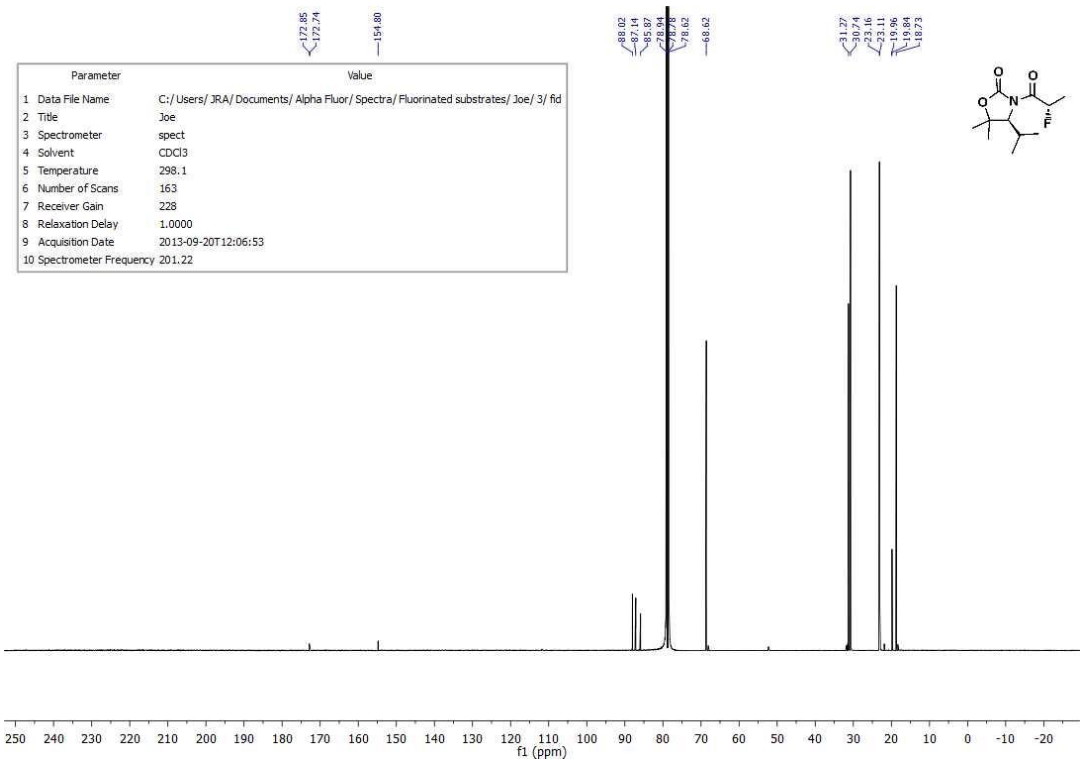
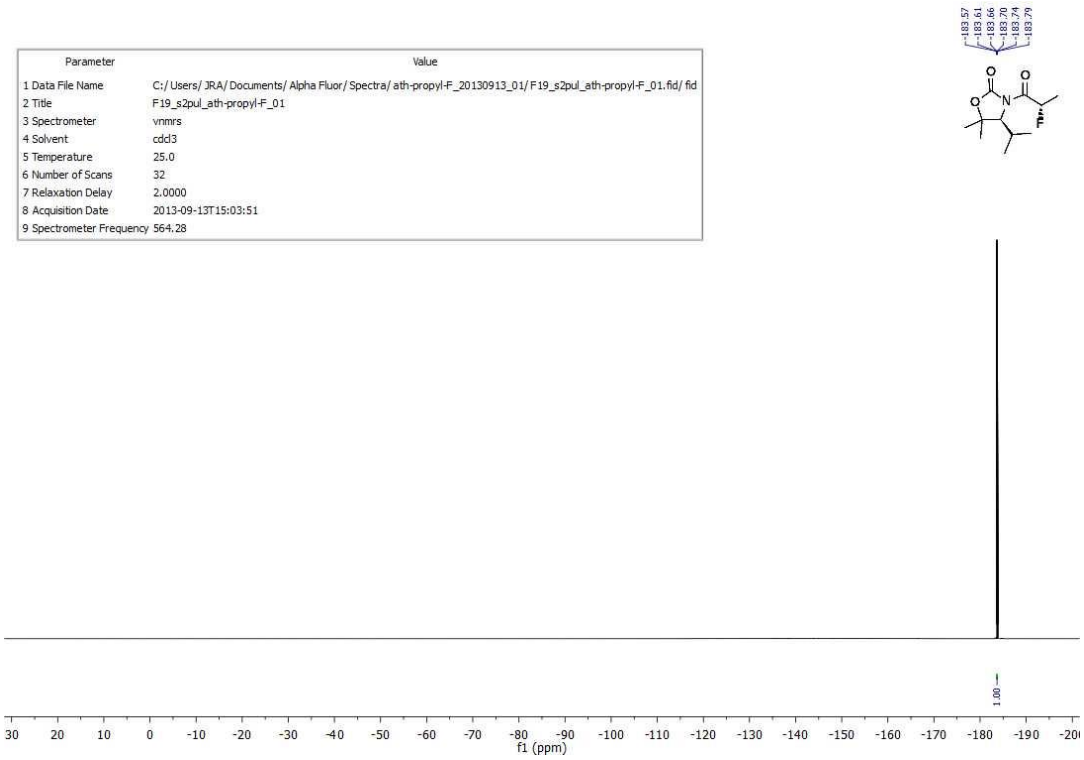
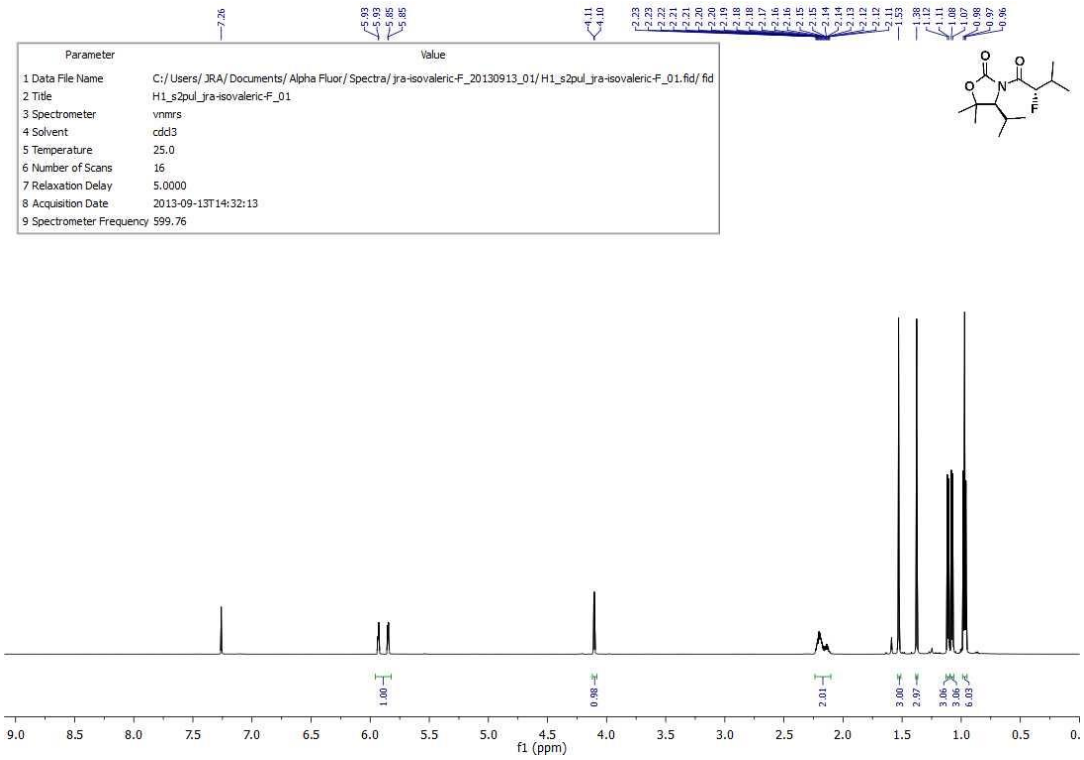
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


172.85
172.74
154.80
88.02
87.14
85.87
78.94
78.78
78.62
68.62
31.27
30.74
23.16
23.11
19.96
19.84
18.73
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Joe/ 3/ fid
2 Title
Joe
3 Spectrometer
spect
4 Solvent
CDCl3
5 Temperature
298.1
6 Number of Scans
163
7 Receiver Gain
228
8 Relaxation Delay
1.0000
9 Acquisition Date
2013-09-20T12:06:53
10 Spectrometer Frequency
201.22
250
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/ath-propyl-F_20130913_01/F19_s2pul_ath-propyl-F_01.fid/fid
2 Title	F19_s2pul_ath-propyl-F_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-09-13T15:03:51
9 Spectrometer Frequency	564.28




7.26
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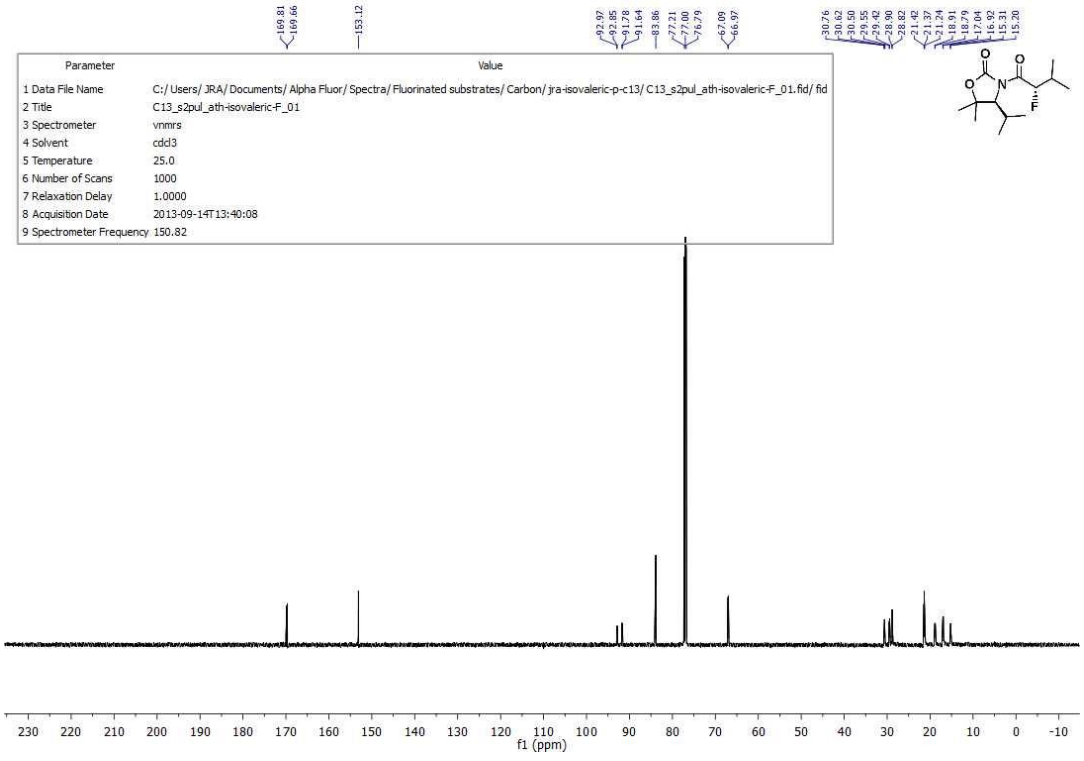
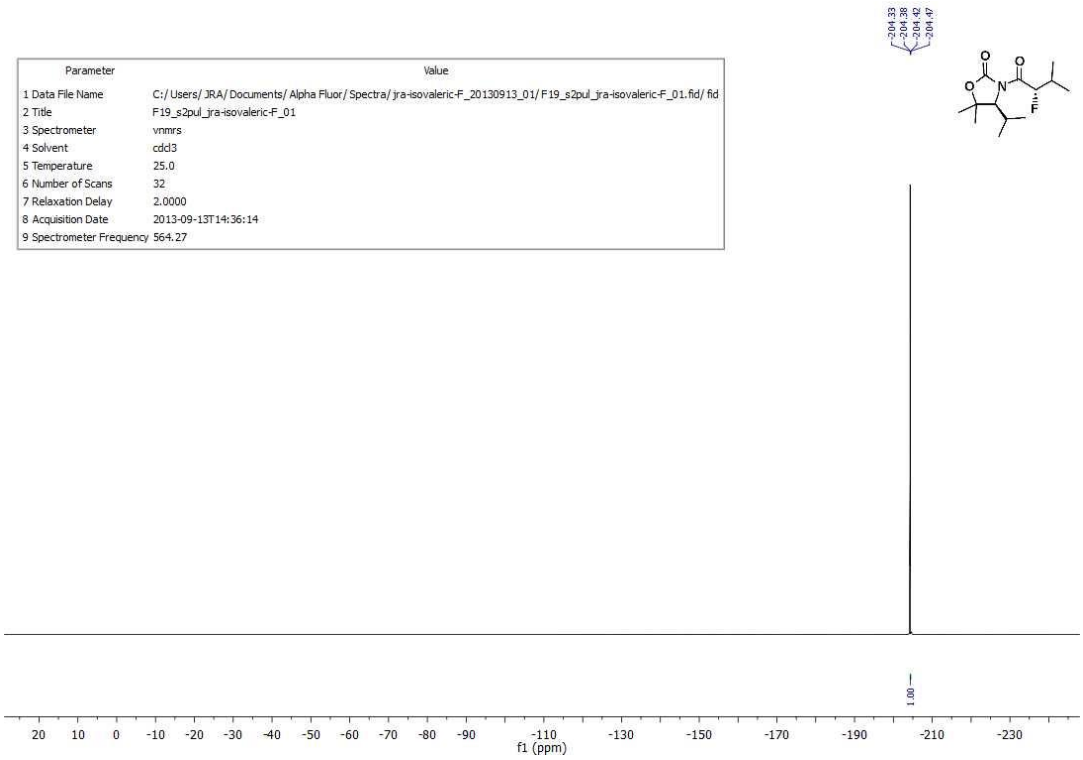
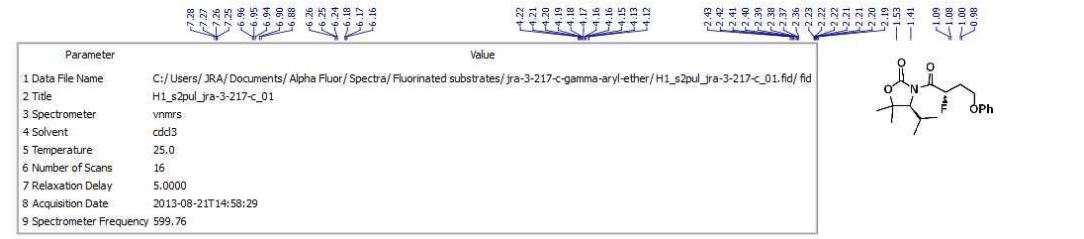
5.85
5.85
4.11
4.10
2.23
2.23
2.22
2.22
2.21
2.21
2.20
2.20
2.19
2.18
2.18
2.17
2.16
2.16
2.15
2.15
2.14
2.14
2.13
2.12
2.12
2.11
1.55
1.38
1.12
1.11
1.08
1.07
0.98
0.97
0.96
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/jra-isovaleric-F_20130913_01/H1_s2pul_jra-isovaleric-F_01.fid/fid
2 Title
H1_s2pul_jra-isovaleric-F_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-09-13T14:32:13
9 Spectrometer Frequency
599.76
1.00
0.98
2.01
3.00
2.97
3.06
3.08
6.03
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

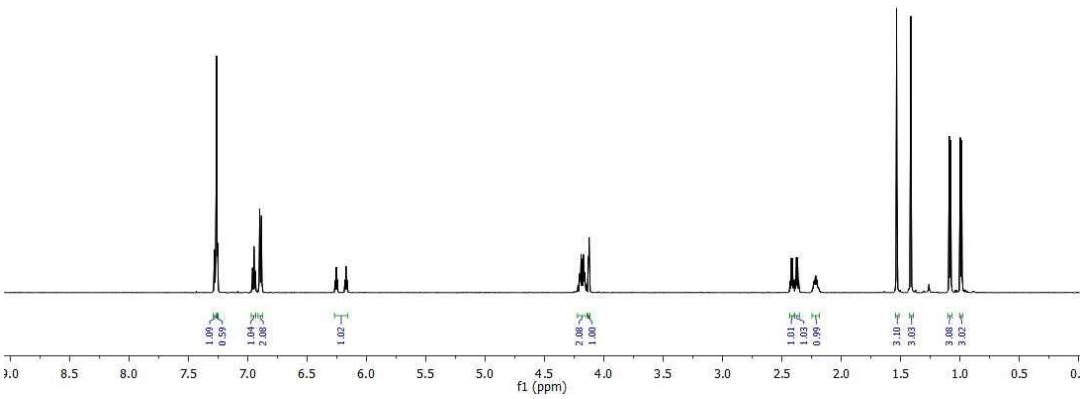

169.81
169.66
153.12
92.97
92.85
91.78
91.64
83.86
77.21
77.00
76.79
67.09
66.97
30.76
30.62
30.50
29.55
29.42
28.90
28.82
21.45
21.37
21.24
18.91
18.79
17.04
16.92
15.31
15.20
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/Carbon/jra-isovaleric-p-c13/C13_s2pul_ath-isovaleric-F_01.fid/fid
2 Title
C13_s2pul_ath-isovaleric-F_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
1000
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-09-14T13:40:08
9 Spectrometer Frequency
150.82
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

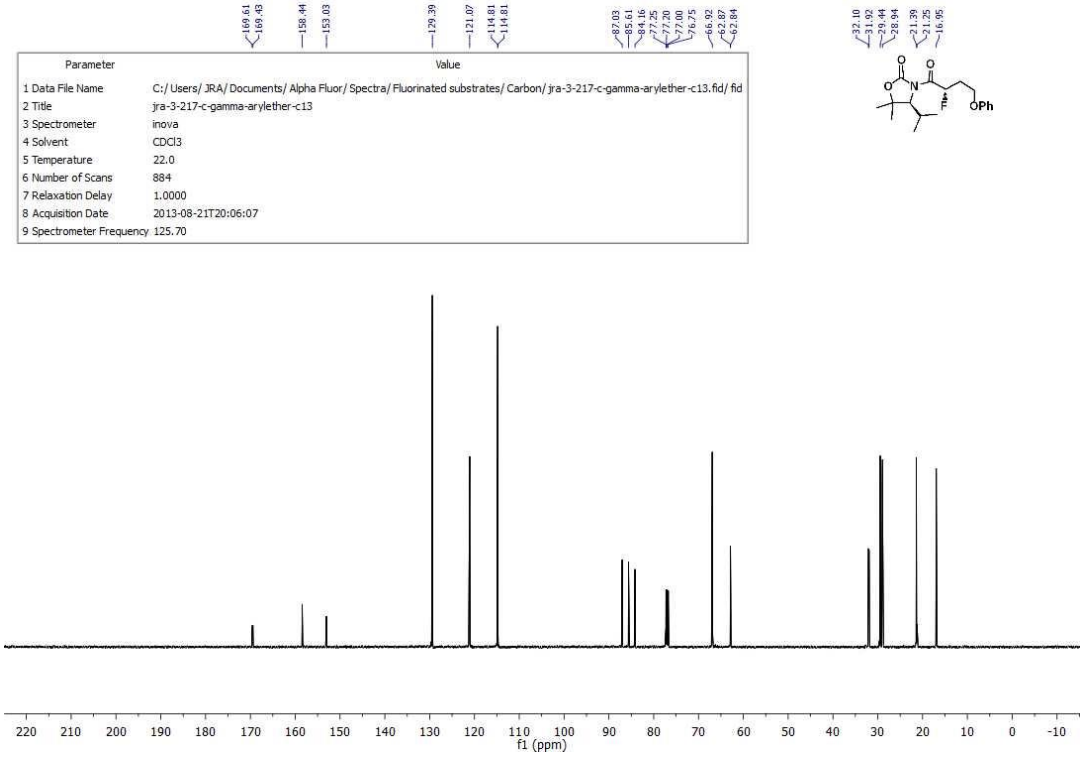
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/jra-isovaleric-F_20130913_01/F19_s2pul_jra-isovaleric-F_01.fid/fid
2 Title	F19_s2pul_jra-isovaleric-F_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-09-13T14:36:14
9 Spectrometer Frequency	564.27





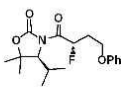
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ jra-3-217-c-gamma-aryl-ether/ H1_s2pul_jra-3-217-c_01.fid/ fid
2 Title	H1_s2pul_jra-3-217-c_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-21T14:58:29
9 Spectrometer Frequency	599.76

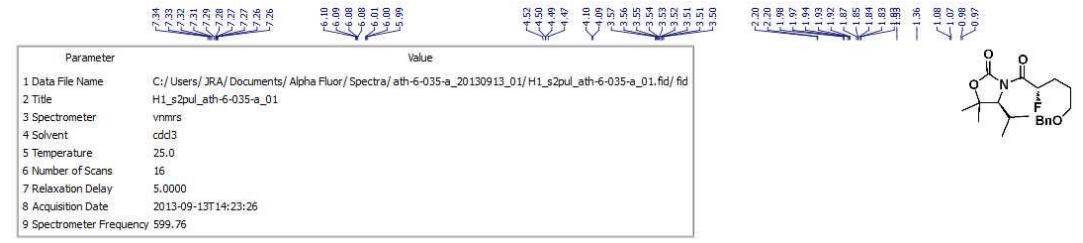




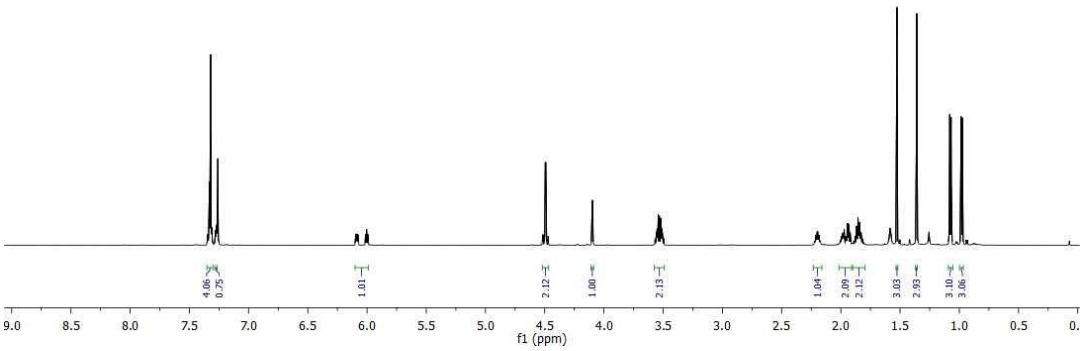
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ jra-3-217-c-gamma-arylether-c13.fid/ fid
2 Title	jra-3-217-c-gamma-arylether-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	22.0
6 Number of Scans	884
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-21T20:06:07
9 Spectrometer Frequency	125.70

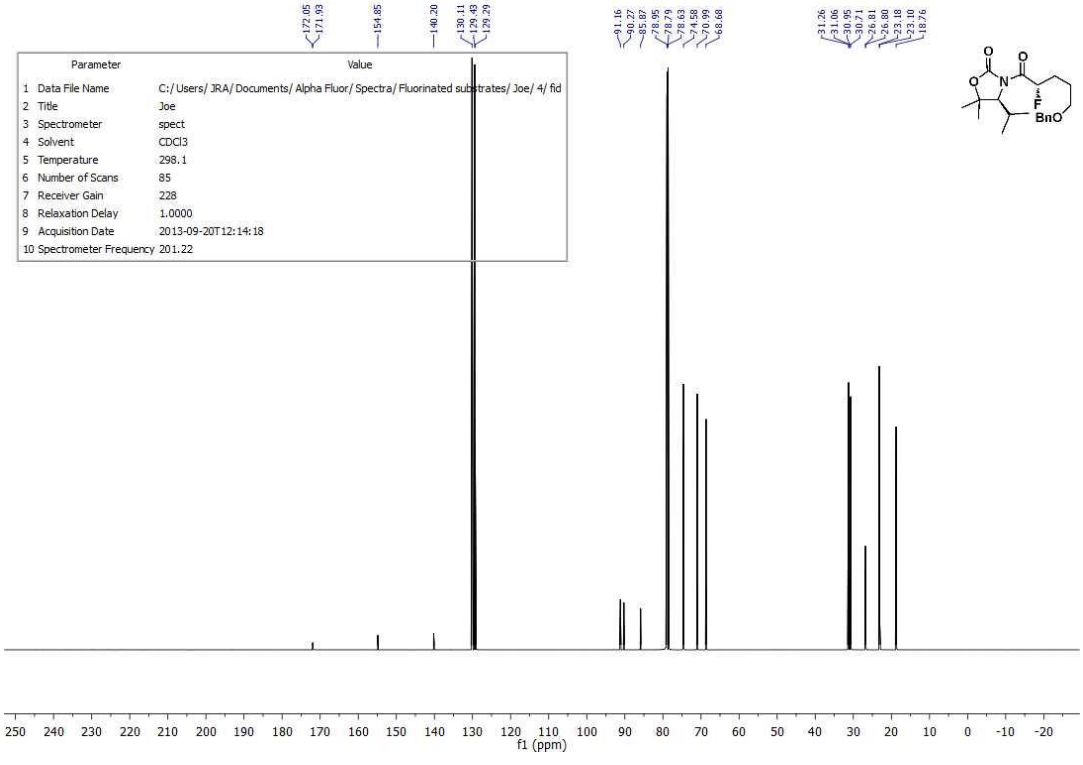
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ jra-3-217-c-gamma-aryl-ether/ F19_s2pul_jra-3-217-c_01.fid/ fid
2 Title	F19_s2pul_jra-3-217-c_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-21T15:02:11
9 Spectrometer Frequency	564.28





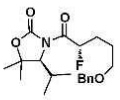
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ ath-6-035-a_20130913_01/ H1_s2pul_ath-6-035-a_01.fid/ fid
2 Title	H1_s2pul_ath-6-035-a_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-09-13T14:23:26
9 Spectrometer Frequency	599.76

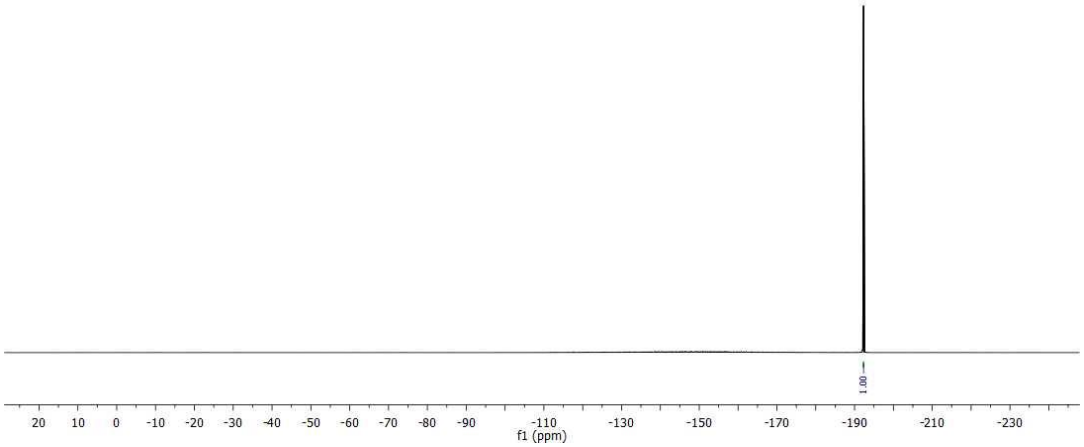


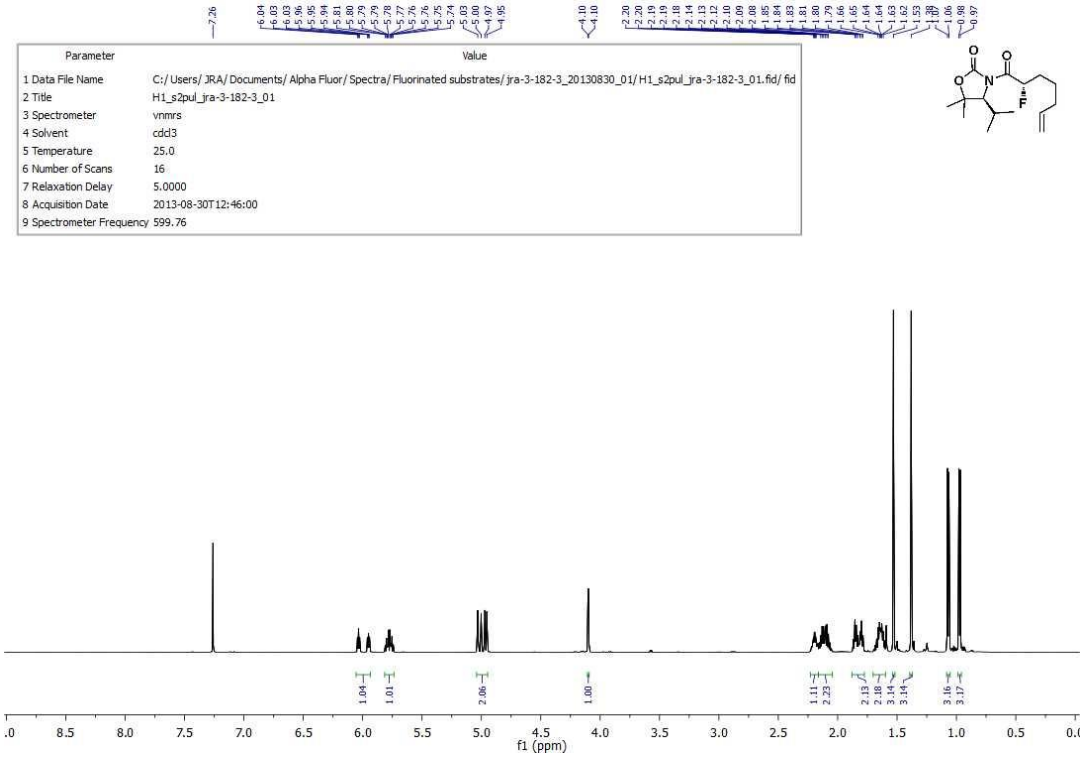


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Joe/ 4/ fid
2 Title	Joe
3 Spectrometer	spect
4 Solvent	CDCl3
5 Temperature	298.1
6 Number of Scans	85
7 Receiver Gain	228
8 Relaxation Delay	1.0000
9 Acquisition Date	2013-09-20T12:14:18
10 Spectrometer Frequency	201.22

Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/ath-6-035-a_20130913_01/F19_s2pul_ath-6-035-a_01.fid/fid
2 Title	F19_s2pul_ath-6-035-a_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-09-13T14:27:20
9 Spectrometer Frequency	564.27

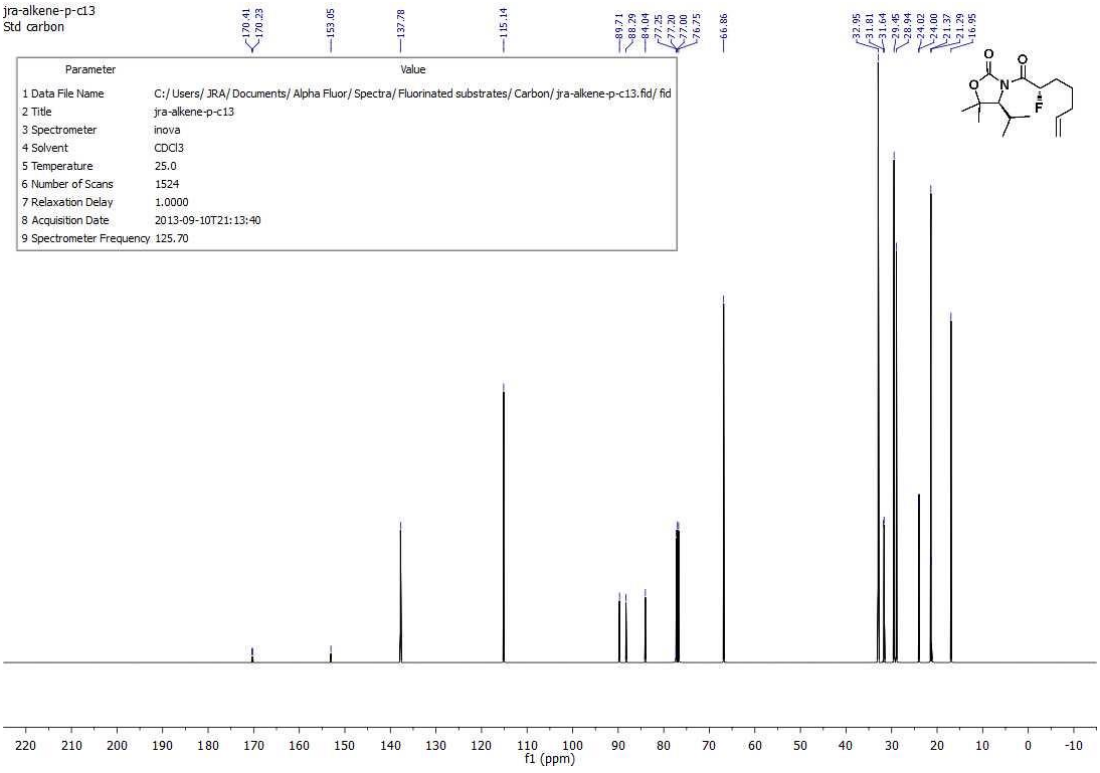






Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ jra-3-182-3_20130830_01/ H1_s2pul_jra-3-182-3_01.fid/ fid
2 Title	H1_s2pul_jra-3-182-3_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-30T12:46:00
9 Spectrometer Frequency	599.76

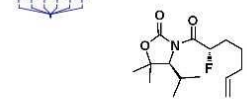
jra-alkene-p-c13
Std carbon

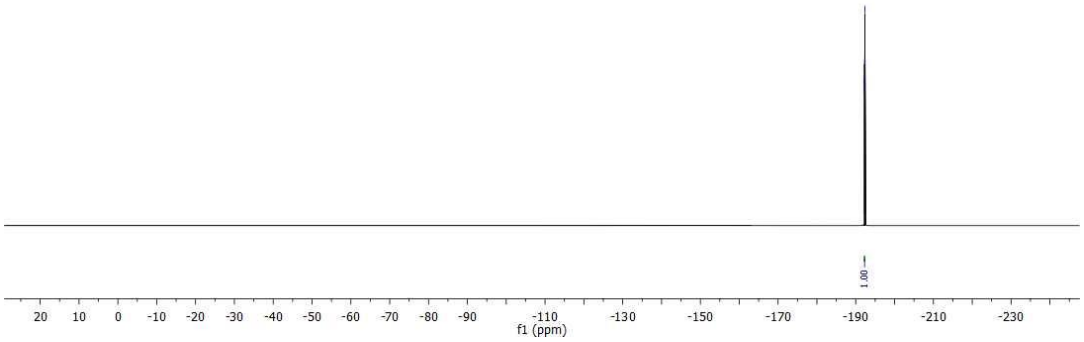


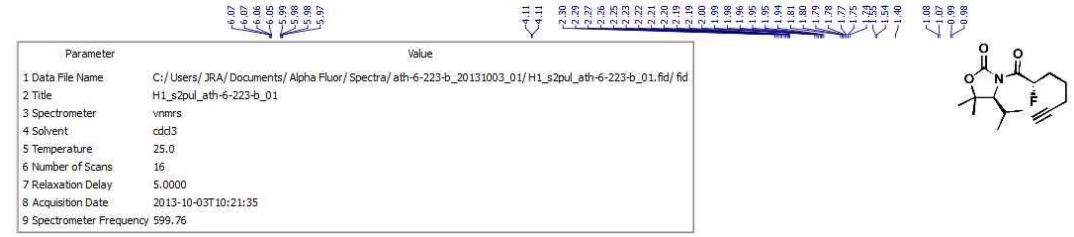
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ jra-alkene-p-c13.fid/ fid
2 Title	jra-alkene-p-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	1524
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-09-10T21:13:40
9 Spectrometer Frequency	125.70

F19_s2pul_jra-3-182-3_01
jra-3-182-3
600MHz

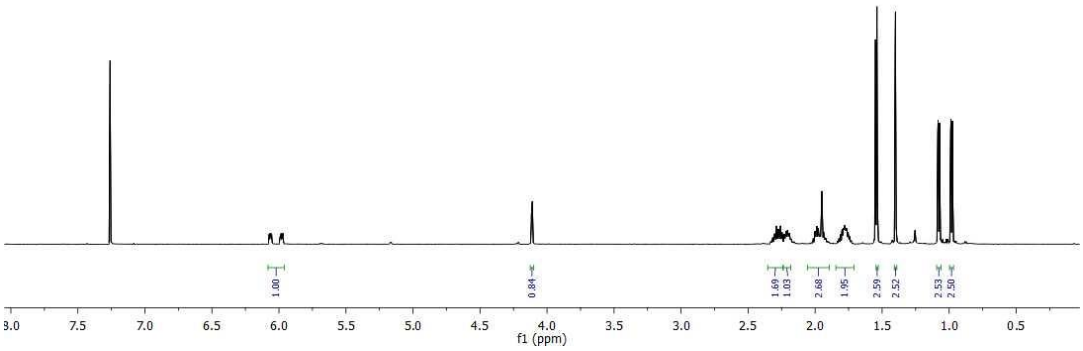
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ jra-3-182-3_20130830_01/ F19_s2pul_jra-3-182-3_01.fid/ fid
2 Title	F19_s2pul_jra-3-182-3_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-30T12:49:19
9 Spectrometer Frequency	564.27

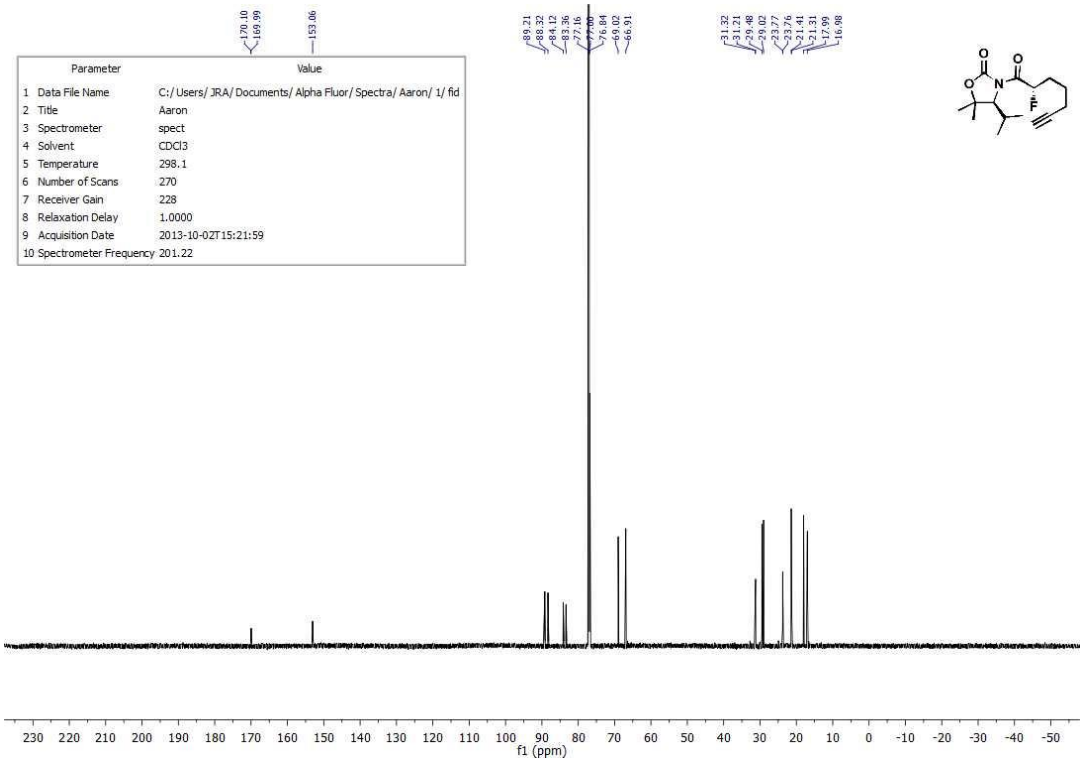




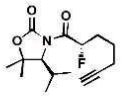


Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/ath-6-223-b_20131003_01/H1_s2pul_ath-6-223-b_01.fid/fid
2 Title	H1_s2pul_ath-6-223-b_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-10-03T10:21:35
9 Spectrometer Frequency	599.76

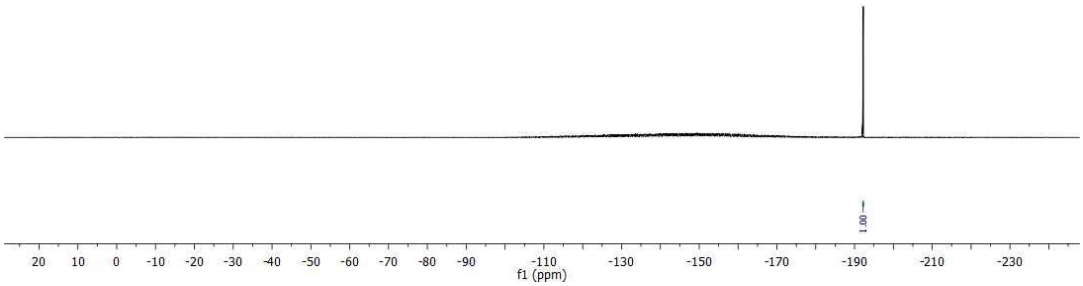


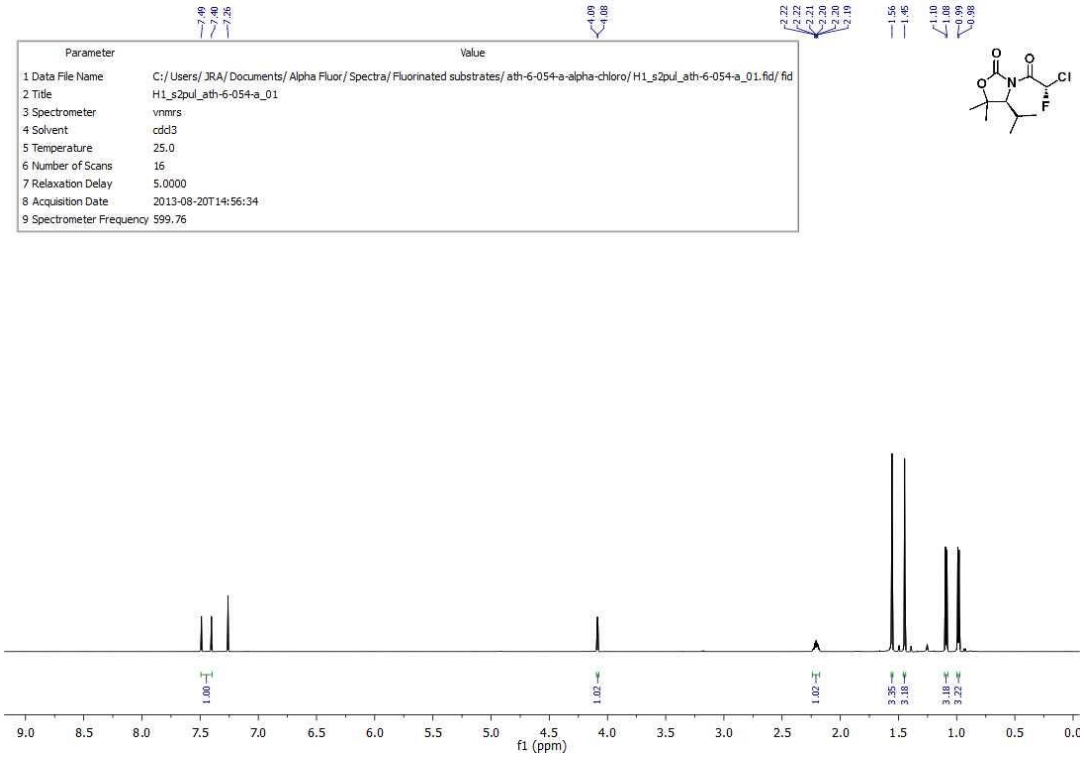


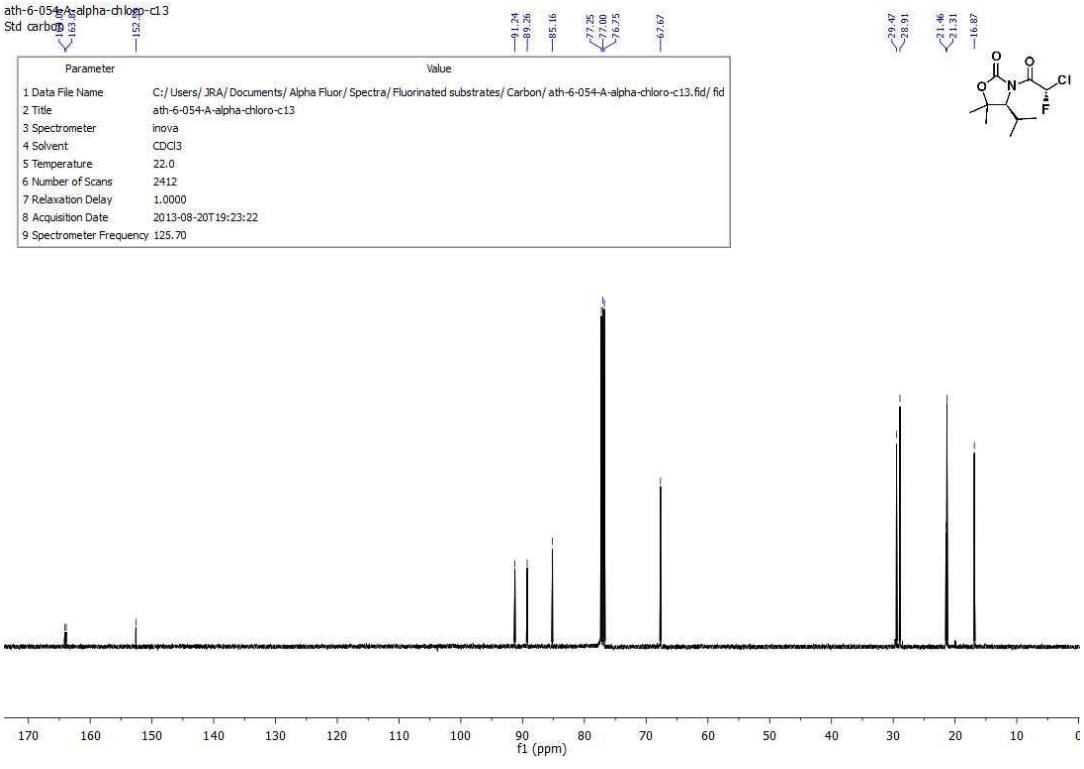
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Aaron/1/fid
2 Title	Aaron
3 Spectrometer	spect
4 Solvent	CDCl3
5 Temperature	298.1
6 Number of Scans	270
7 Receiver Gain	228
8 Relaxation Delay	1.0000
9 Acquisition Date	2013-10-0ZT15:21:59
10 Spectrometer Frequency	201.22



Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ ath-6-223-b_20131003_01/ F19_s2pul_ath-6-223-b_01.fid/ fid
2 Title	F19_s2pul_ath-6-223-b_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-10-03T10:25:03
9 Spectrometer Frequency	564.27




7.49
7.49
7.26
4.09
4.08
2.22
2.22
2.21
2.20
2.20
2.19
1.56
1.45
1.10
1.08
0.99
0.98
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ ath-6-054-a-alpha-chloro/ H1_s2pul_ath-6-054-a_01.fid/ fid
2 Title
H1_s2pul_ath-6-054-a_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-08-20T14:56:34
9 Spectrometer Frequency
599.76
Cl
F
1.00
1.02
1.02
3.35
3.18
3.18
3.22
f1 (ppm)


ath-6-054-A-alpha-chloro-c13
Std carbon
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152.22
91.24
89.26
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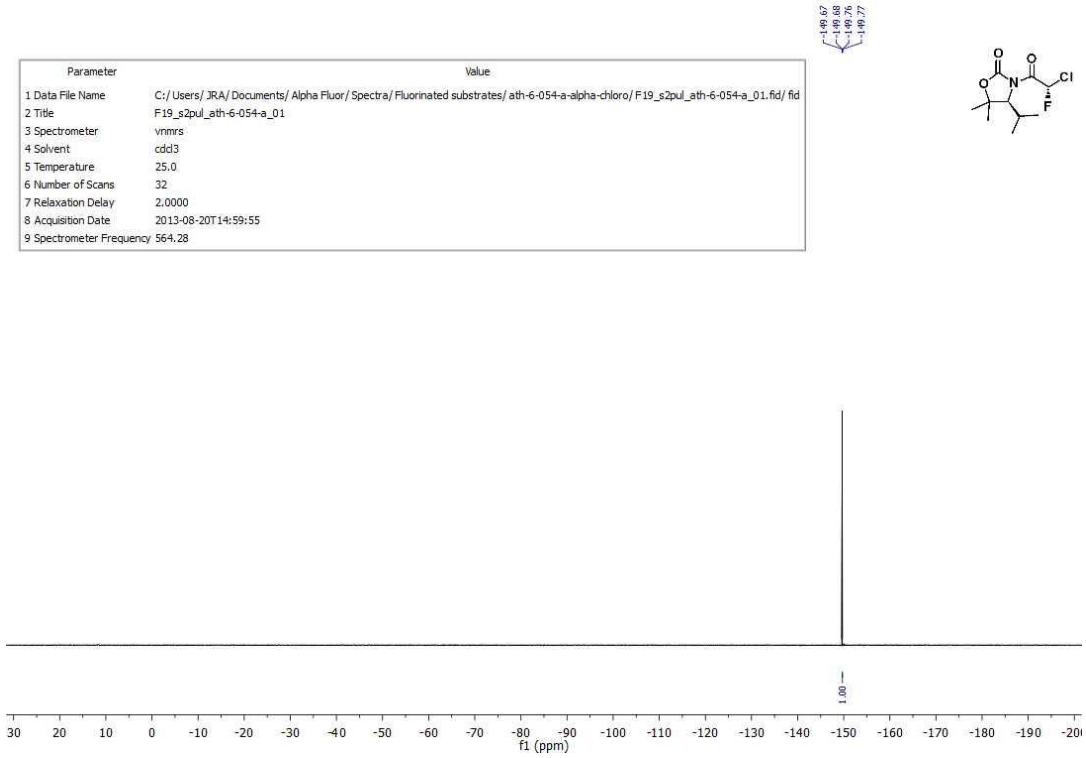
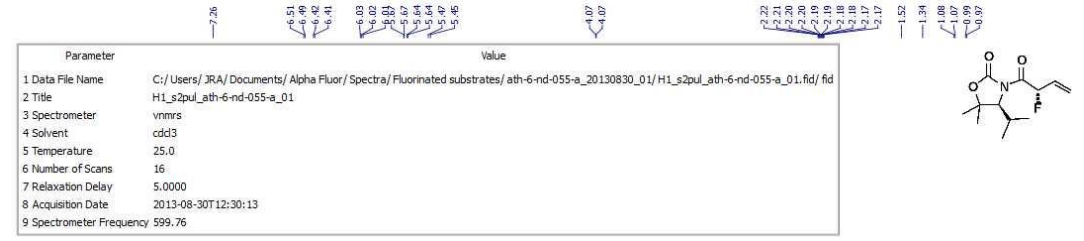
77.00
76.75
67.67
29.47
28.91
21.46
21.31
16.87
Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ ath-6-054-A-alpha-chloro-c13.fid/ fid
2 Title
ath-6-054-A-alpha-chloro-c13
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
22.0
6 Number of Scans
2412
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-08-20T19:23:22
9 Spectrometer Frequency
125.70
Cl
F
f1 (ppm)

Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ ath-6-054-a-alpha-chloro/ F19_s2pul_ath-6-054-a_01.fid/ fid
2 Title	F19_s2pul_ath-6-054-a_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-20T14:59:55
9 Spectrometer Frequency	564.28





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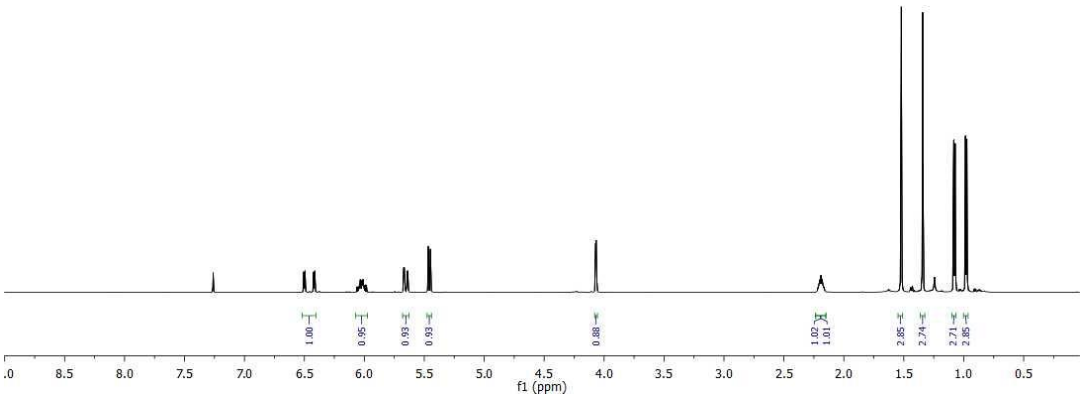
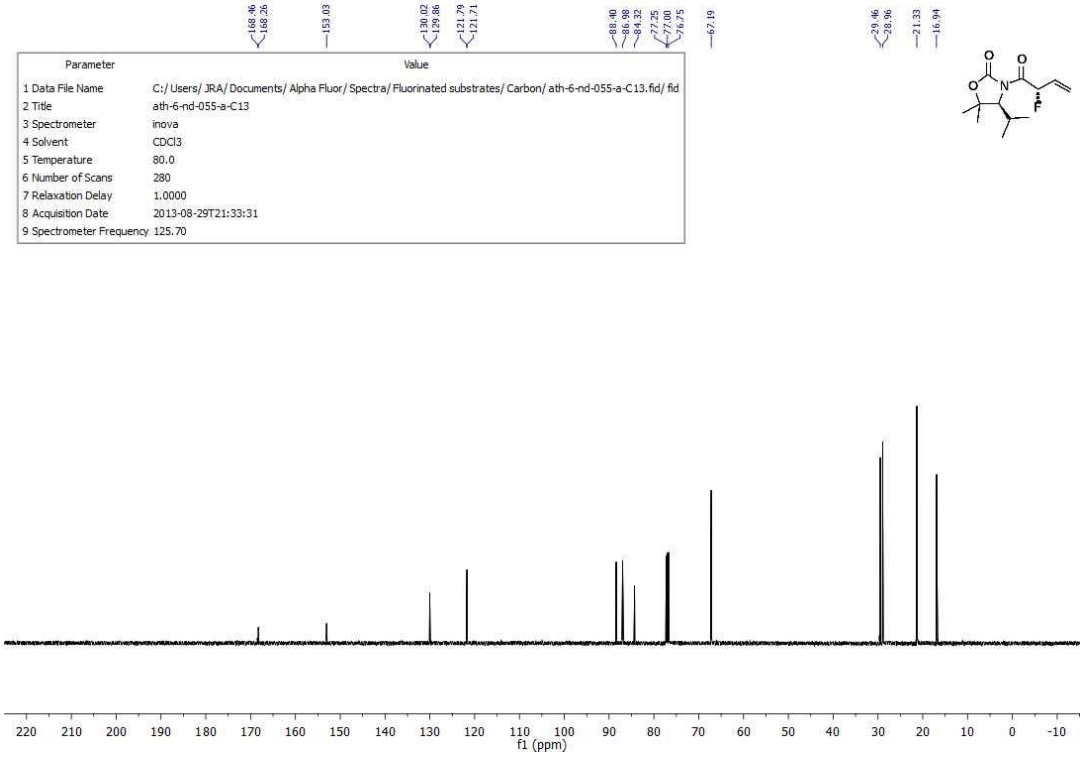
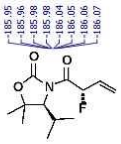
2 Title	H1_s2pul_ath-6-nd-055-a_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-30T12:30:13
9 Spectrometer Frequency	599.76

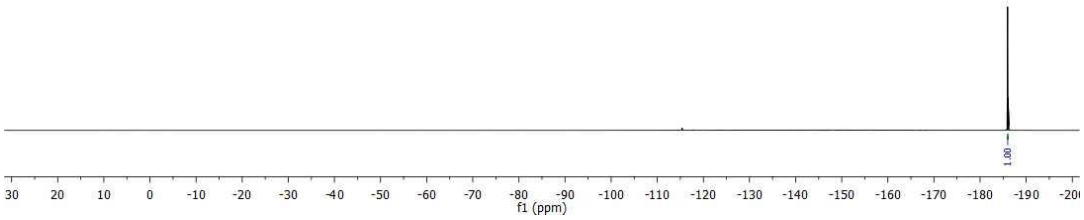


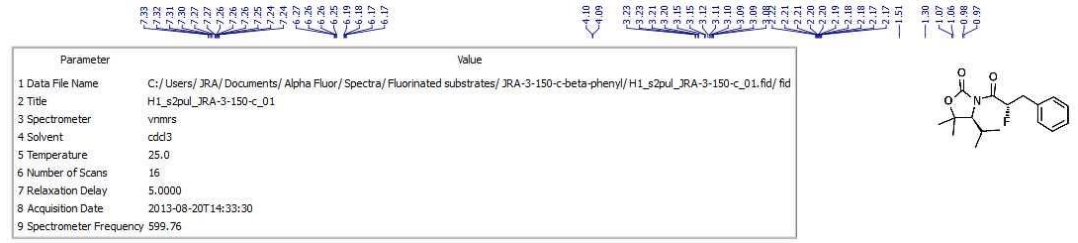


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ ath-6-nd-055-a-C13.fid/ fid
2 Title	ath-6-nd-055-a-C13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	80.0
6 Number of Scans	280
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-29T21:33:31
9 Spectrometer Frequency	125.70

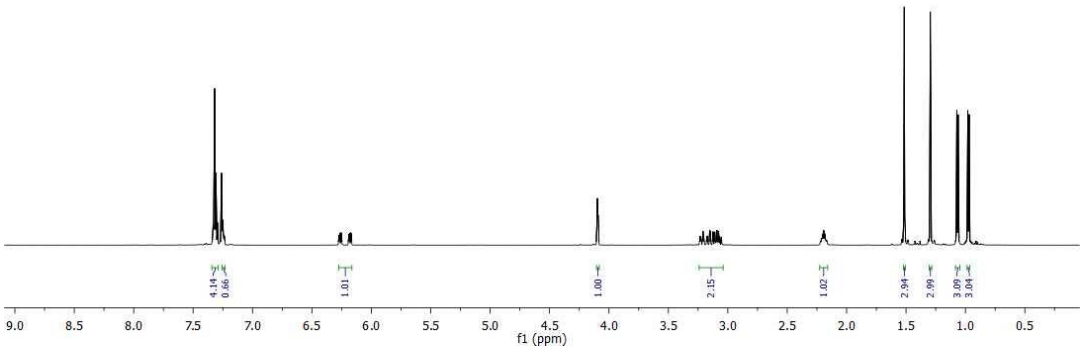
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/ath-6-064-a-crotonoic/F19_s2pul_ath-6-064-a_01.fid/fid
2 Title	F19_s2pul_ath-6-064-a_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-21T15:19:03
9 Spectrometer Frequency	564.28

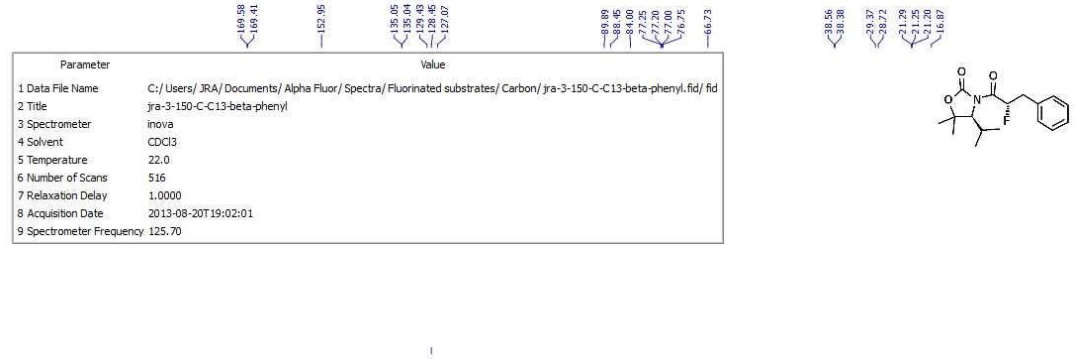




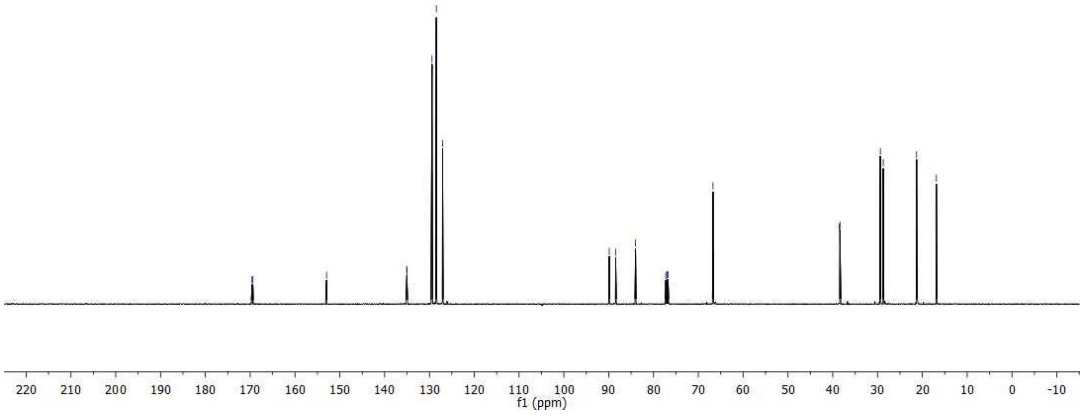


Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/JRA-3-150-c-beta-phenyl/H1_s2pul_JRA-3-150-c_01.fid/fid
2 Title	H1_s2pul_JRA-3-150-c_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-20T14:33:30
9 Spectrometer Frequency	599.76

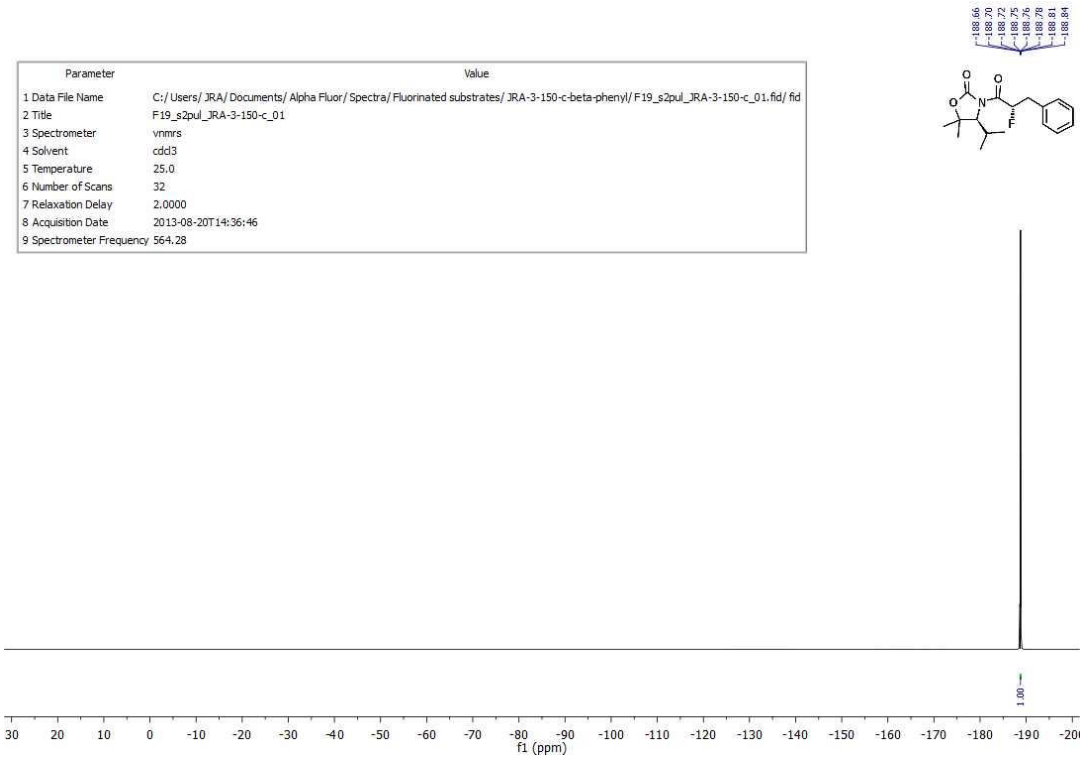


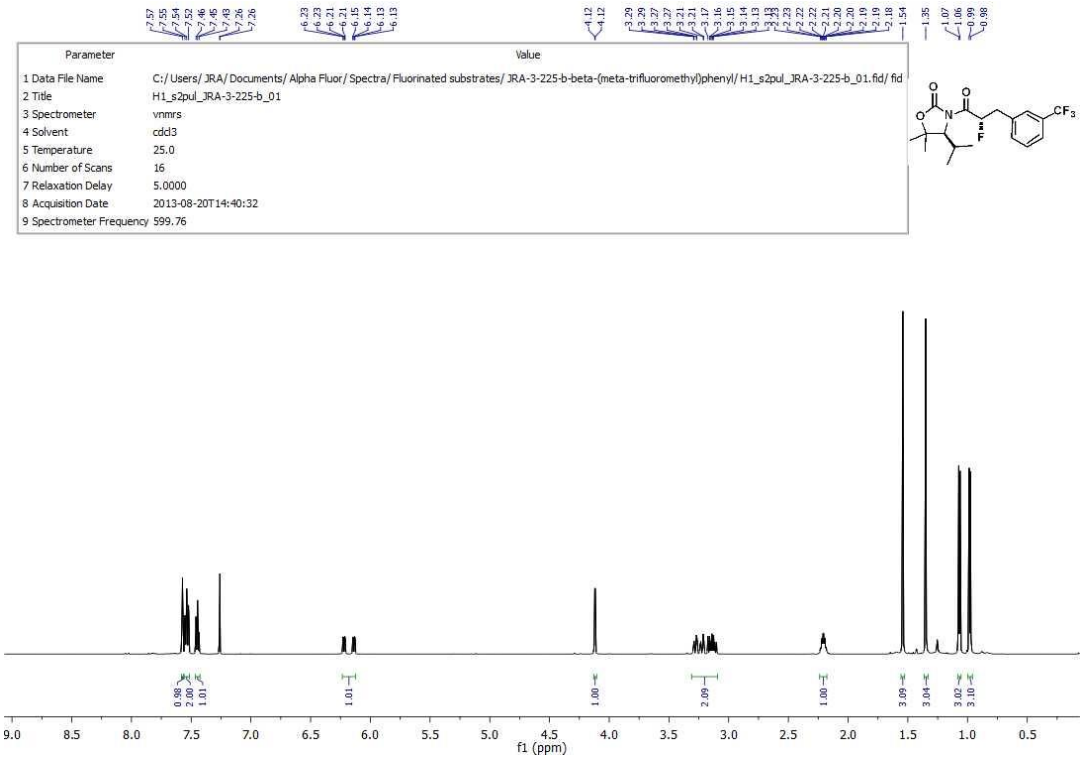


Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/Carbon/jra-3-150-C-C13-beta-phenyl.fid/fid
2 Title	jra-3-150-C-C13-beta-phenyl
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	22.0
6 Number of Scans	516
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-20T19:02:01
9 Spectrometer Frequency	125.70



Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ JRA-3-150-c-beta-phenyl/ F19_s2pul_JRA-3-150-c_01.fid/ fid
2 Title	F19_s2pul_JRA-3-150-c_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-20T14:36:46
9 Spectrometer Frequency	564.28

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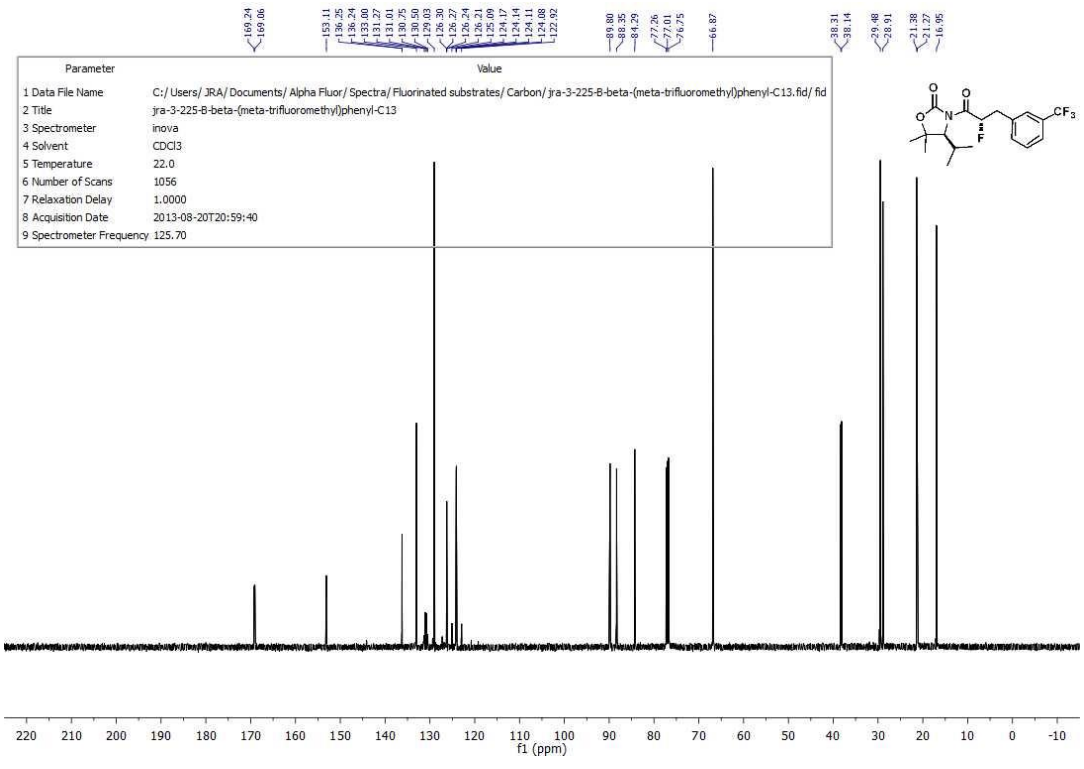
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ JRA-3-225-b-beta-(meta-trifluoromethyl)phenyl/ H1_s2pul_JRA-3-225-b_01.fid/ fid
2 Title
H1_s2pul_JRA-3-225-b_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-08-20T14:40:32
9 Spectrometer Frequency
599.76
f1 (ppm)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Value
1 Data File Name
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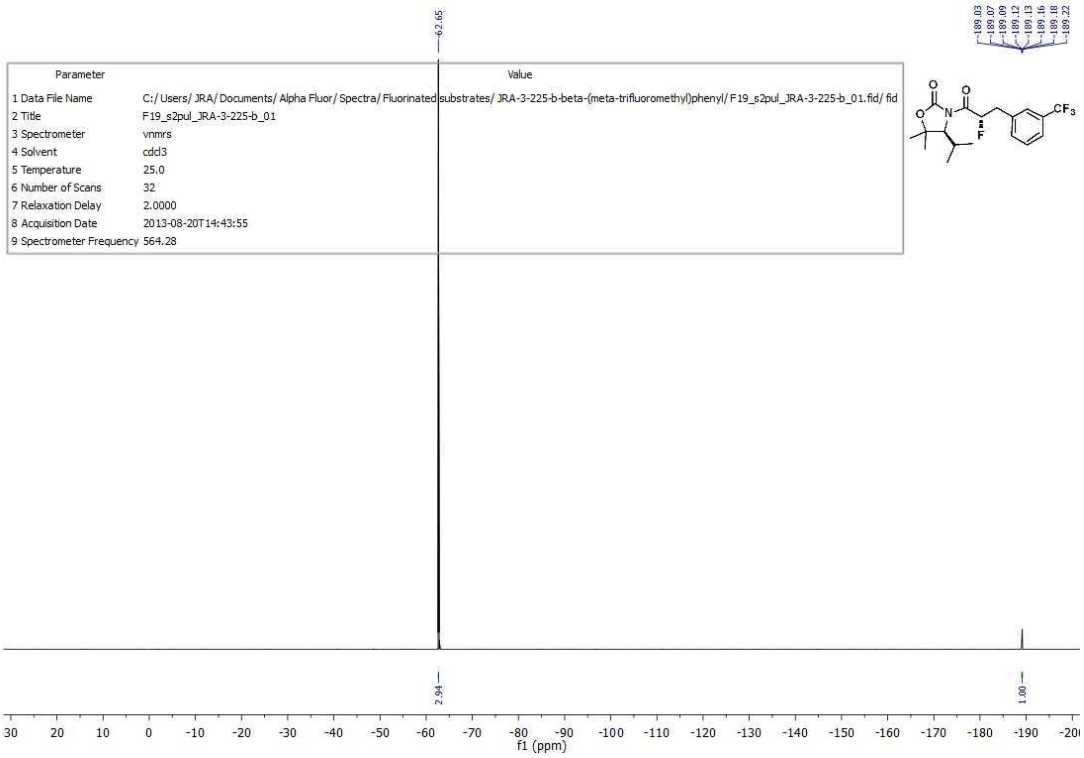
2 Title
jra-3-225-B-beta-(meta-trifluoromethyl)phenyl-C13
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
22.0
6 Number of Scans
1056
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-08-20T20:59:40
9 Spectrometer Frequency
125.70
f1 (ppm)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-189.07
-189.09
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-189.16
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Parameter
Value
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ JRA-3-225-b-beta-(meta-trifluoromethyl)phenyl/ F19_s2pul_JRA-3-225-b_01.fid/ fid
2 Title
F19_s2pul_JRA-3-225-b_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-08-20T14:43:55
9 Spectrometer Frequency
564.28
O
O
O
N
F
CF3
2.94
1.00
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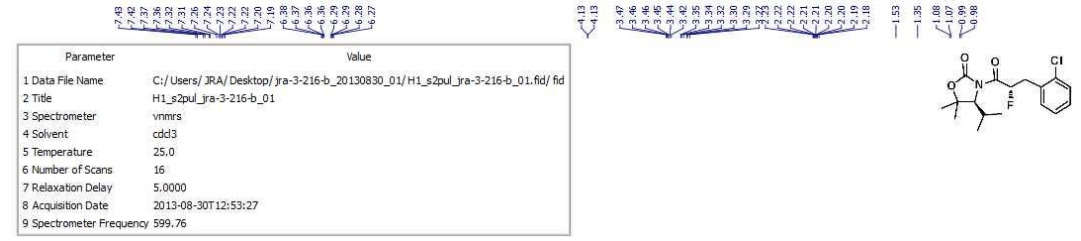
f1 (ppm)



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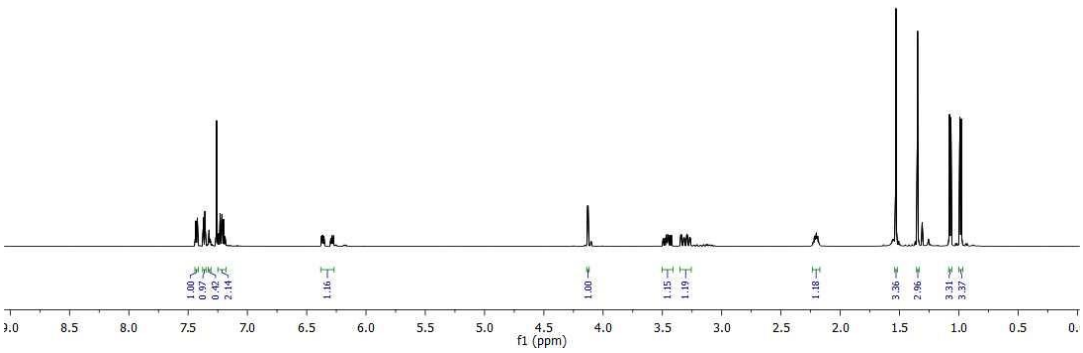
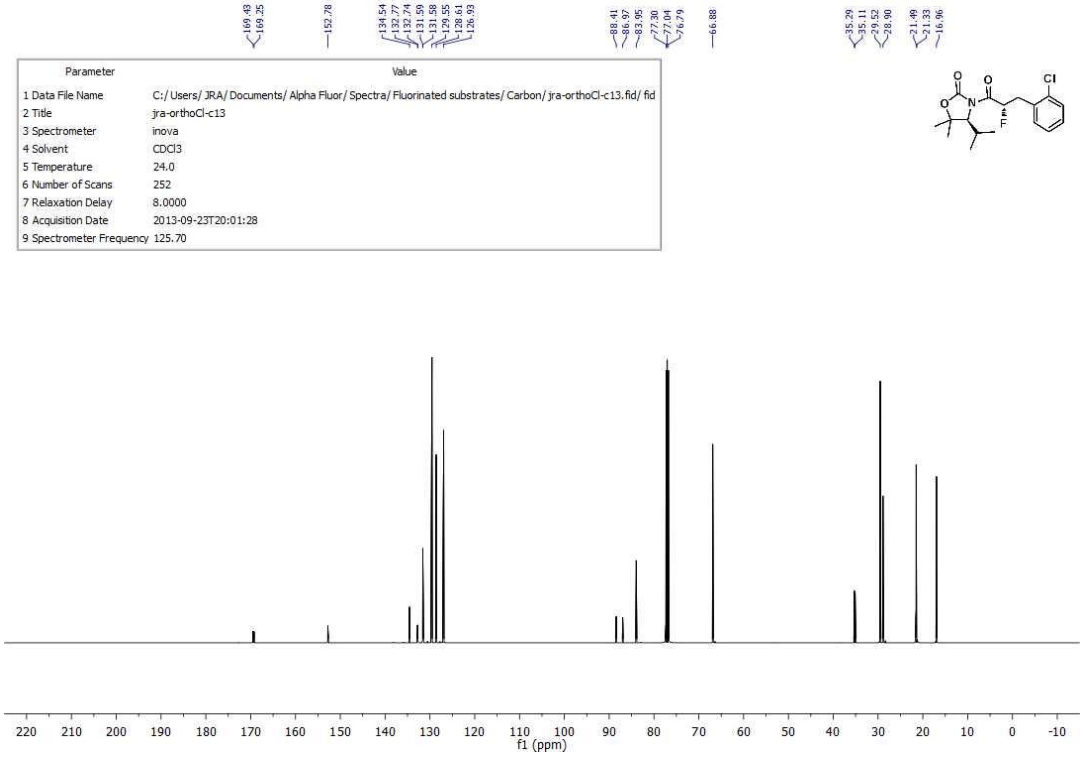
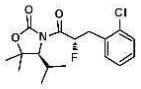
2 Title	H1_s2pul_jra-3-216-b_01
3 Spectrometer	vnmrs
4 Solvent	cdd3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-30T12:53:27
9 Spectrometer Frequency	599.76

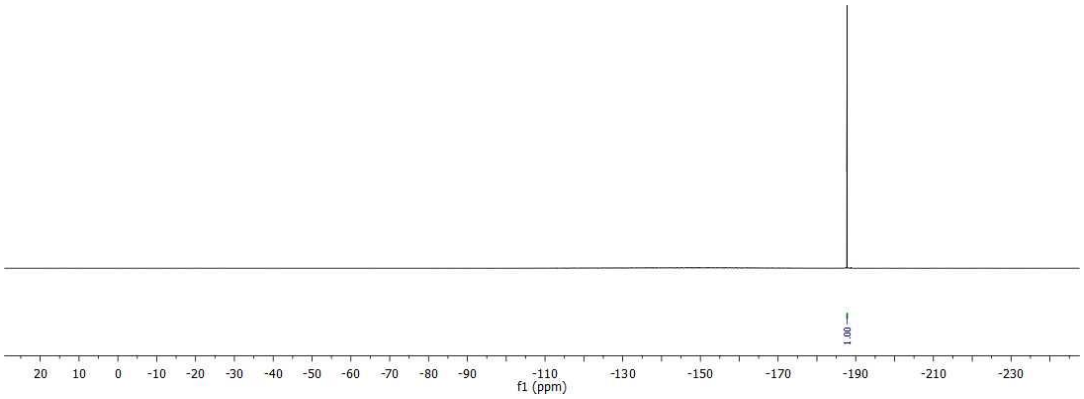


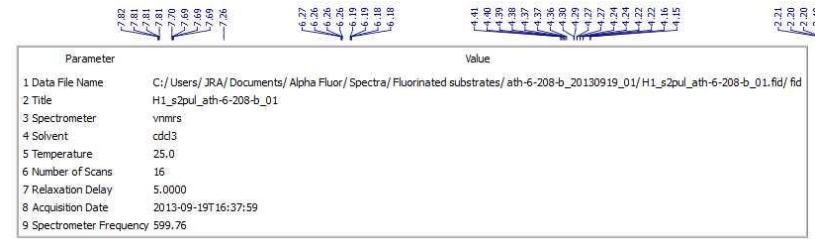


Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/Carbon/jra-orthoCl-c13.fid/fid
2 Title	jra-orthoCl-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	24.0
6 Number of Scans	252
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-09-23T20:01:28
9 Spectrometer Frequency	125.70

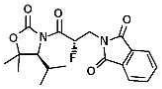
Parameter	Value
1 Data File Name	C:/Users/JRA/Desktop/jra-3-216-b_20130830_01/F19_s2pul_jra-3-216-b_01.fid/fid
2 Title	F19_s2pul_jra-3-216-b_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-30T12:56:55
9 Spectrometer Frequency	564.27

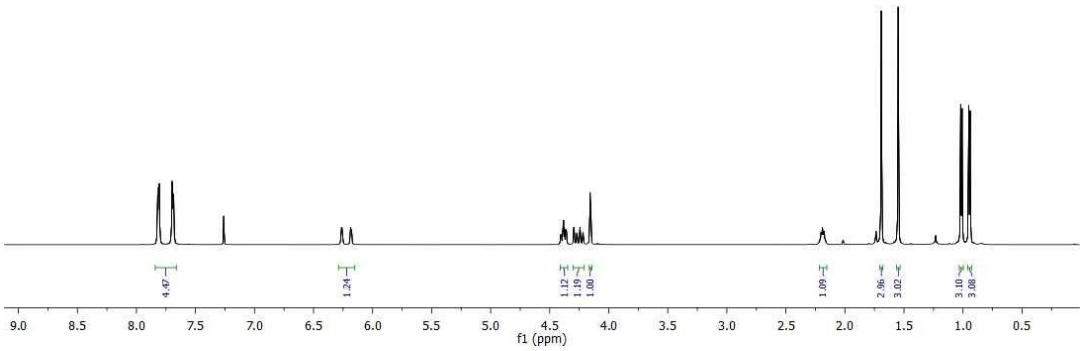


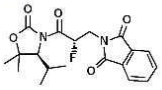


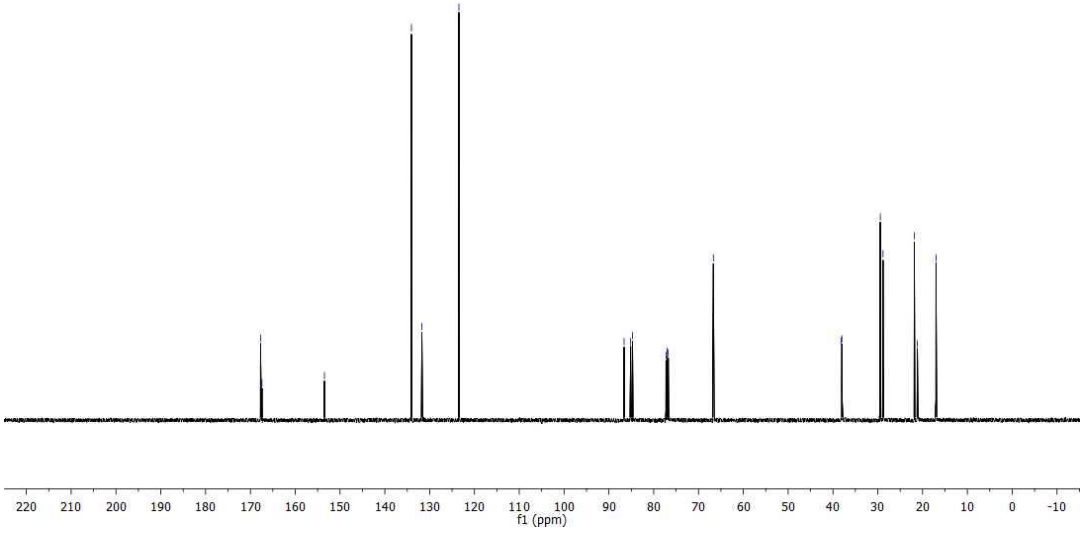


Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/ath-6-208-b_20130919_01/H1_s2pul_ath-6-208-b_01.fid/fid
2 Title	H1_s2pul_ath-6-208-b_01
3 Spectrometer	vnmrs
4 Solvent	cdd3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-09-19T16:37:59
9 Spectrometer Frequency	599.76

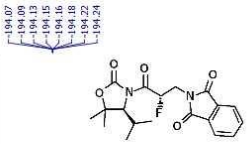


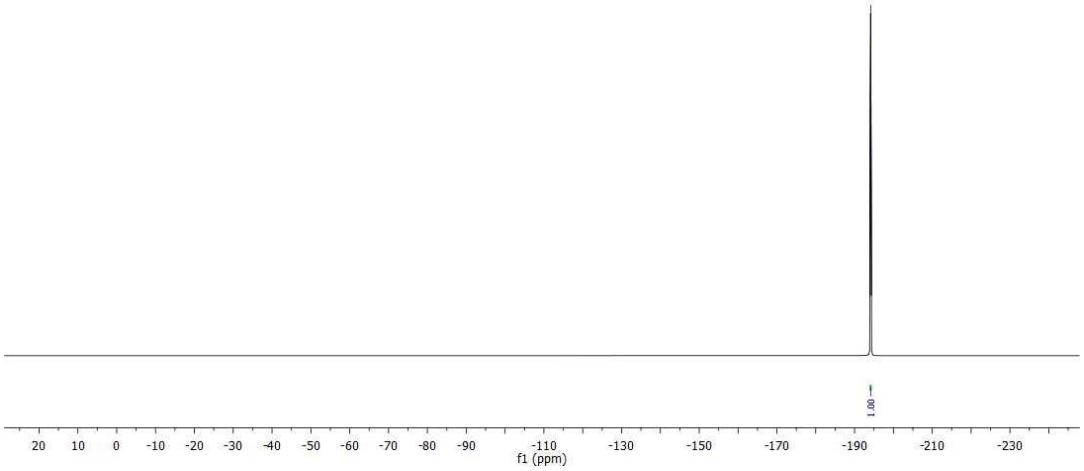


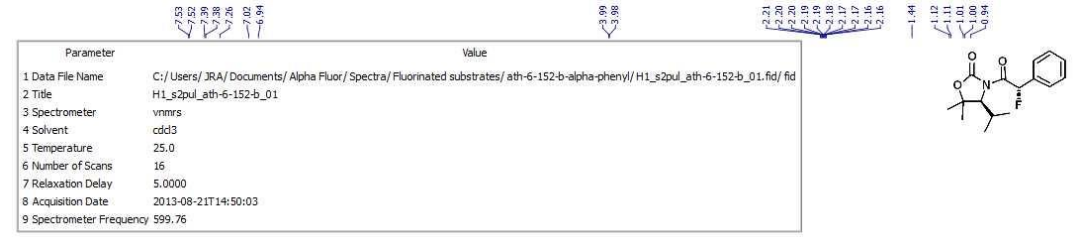




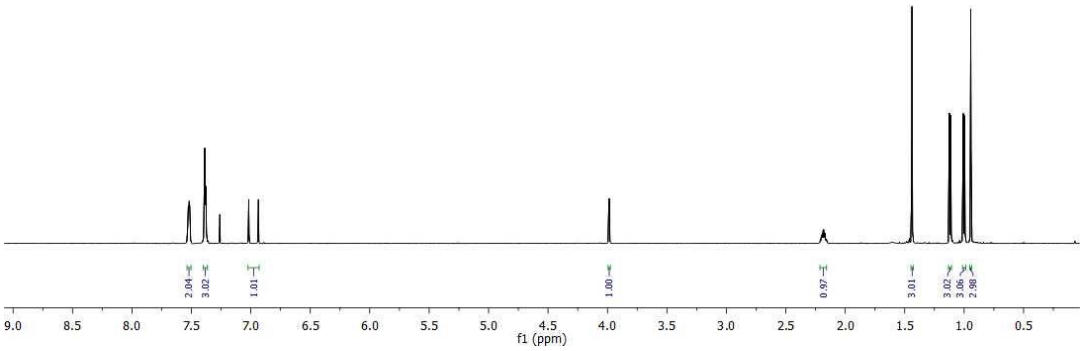
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/ath-6-208-b_20130919_01/F19_s2pul_ath-6-208-b_01.fid/fid
2 Title	F19_s2pul_ath-6-208-b_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-09-19T16:42:21
9 Spectrometer Frequency	564.27

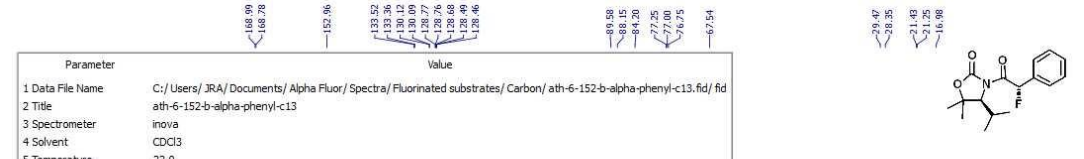




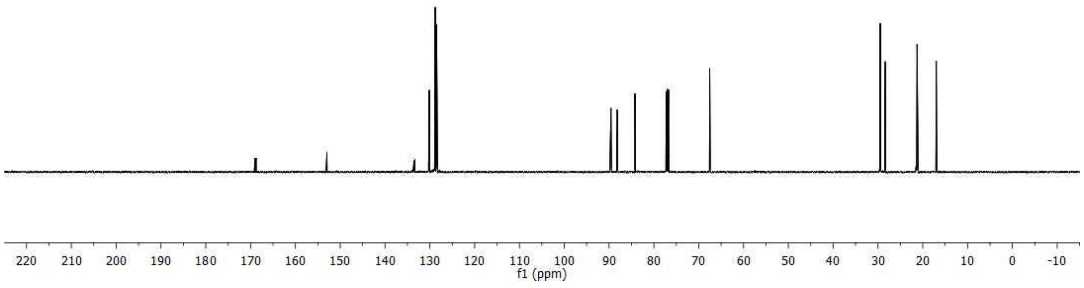


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ ath-6-152-b-alpha-phenyl/ H1_s2pul_ath-6-152-b_01.fid/ fid
2 Title	H1_s2pul_ath-6-152-b_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-21T14:50:03
9 Spectrometer Frequency	599.76

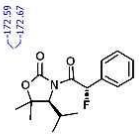


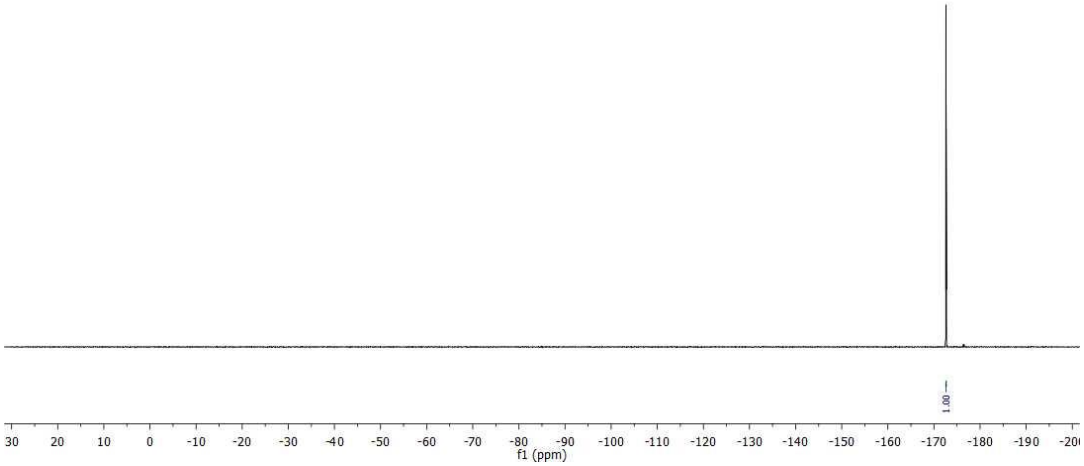


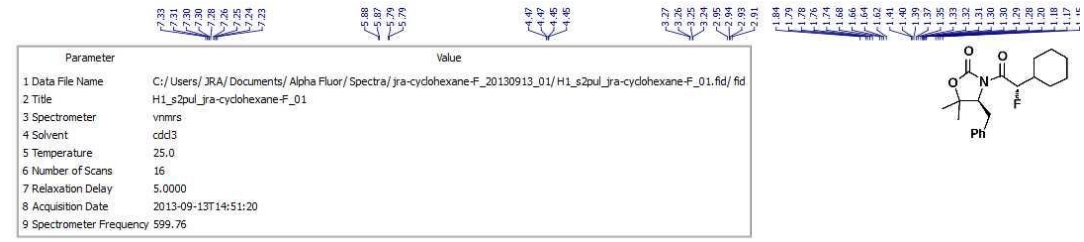
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ ath-6-152-b-alpha-phenyl-c13.fid/ fid
2 Title	ath-6-152-b-alpha-phenyl-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	22.0
6 Number of Scans	1016
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-21T21:16:14
9 Spectrometer Frequency	125.70



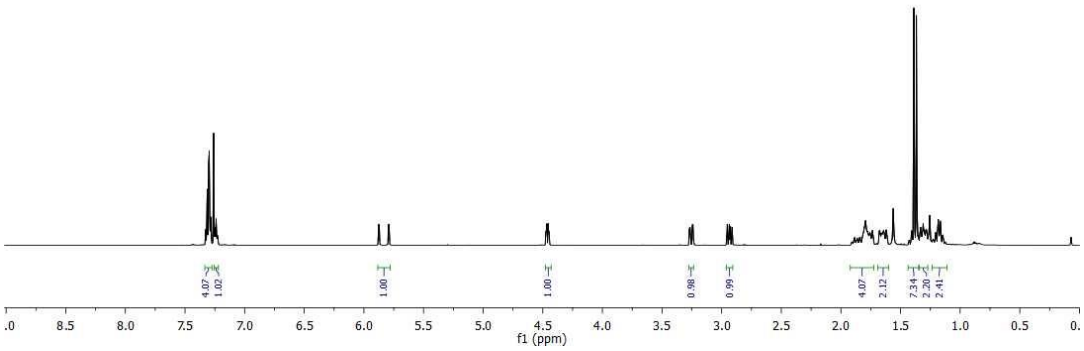
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/ath-6-152-b-alpha-phenyl/F19_s2pul_ath-6-152-b_01.fid/fid
2 Title	F19_s2pul_ath-6-152-b_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-21T14:53:39
9 Spectrometer Frequency	564.28

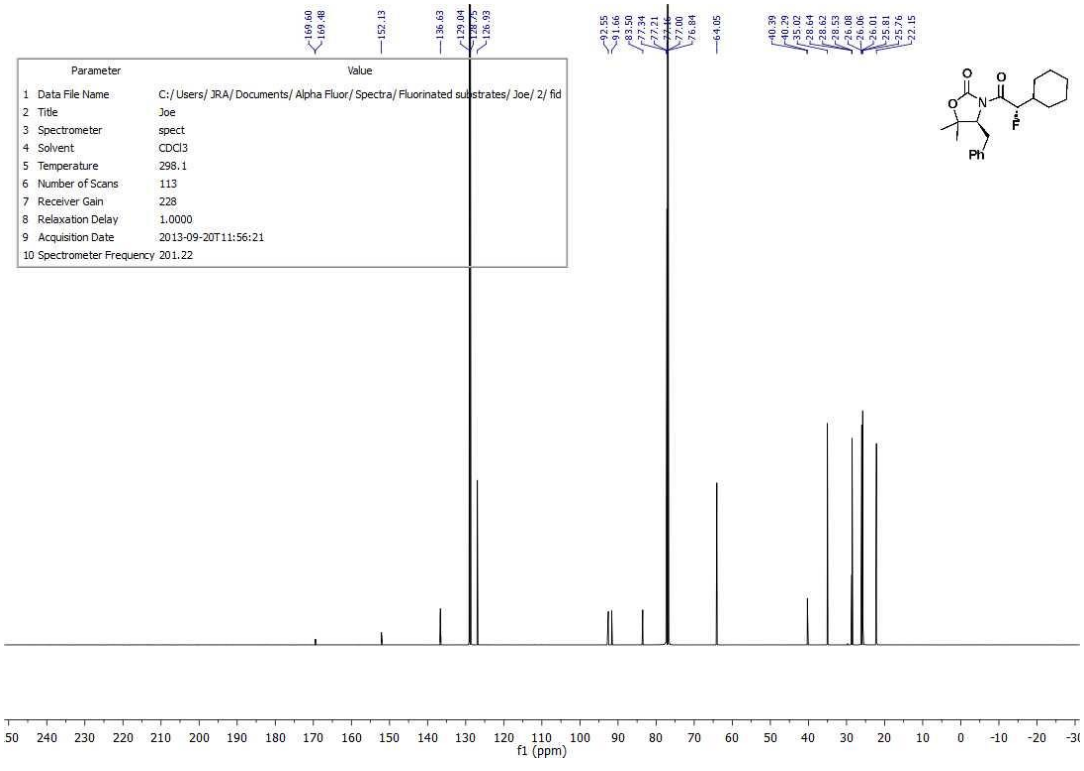




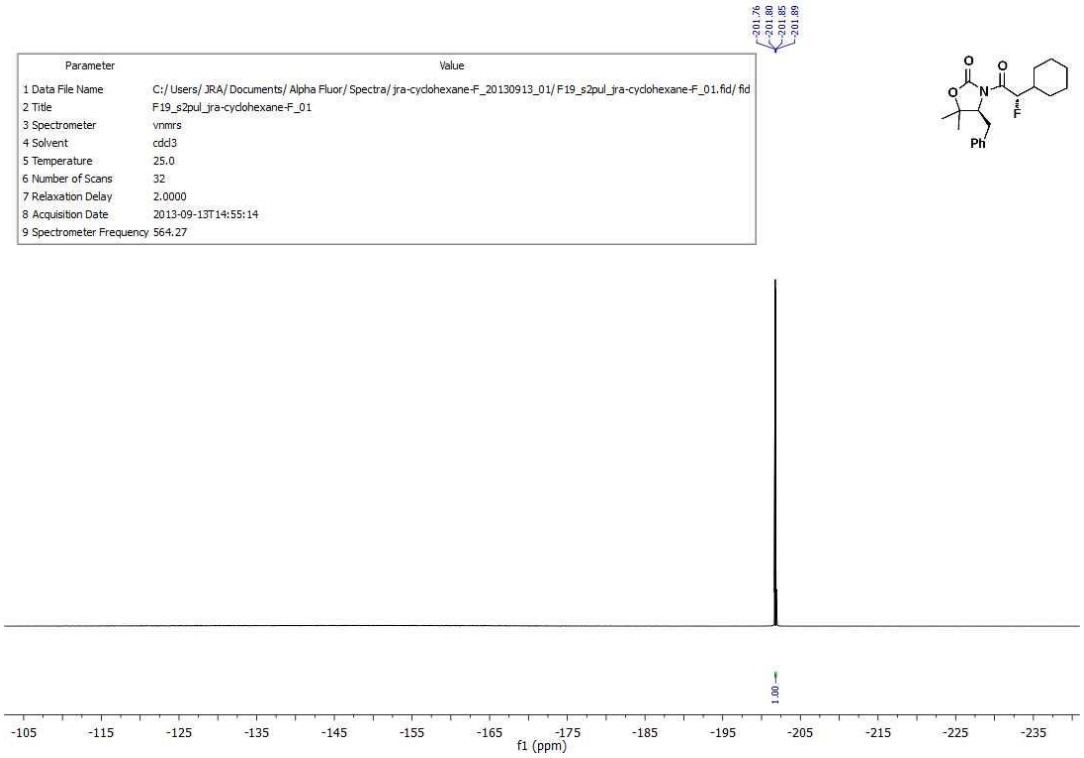


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ jra-cyclohexane-F_20130913_01/ H1_s2pul_jra-cyclohexane-F_01.fid/ fid
2 Title	H1_s2pul_jra-cyclohexane-F_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-09-13T14:51:20
9 Spectrometer Frequency	599.76





Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Joe/ 2/ fid
2 Title	Joe
3 Spectrometer	spect
4 Solvent	CDCl3
5 Temperature	298.1
6 Number of Scans	113
7 Receiver Gain	228
8 Relaxation Delay	1.0000
9 Acquisition Date	2013-09-20T11:56:21
10 Spectrometer Frequency	201.22


-201.76
-201.80
-201.85
-201.89
Parameter
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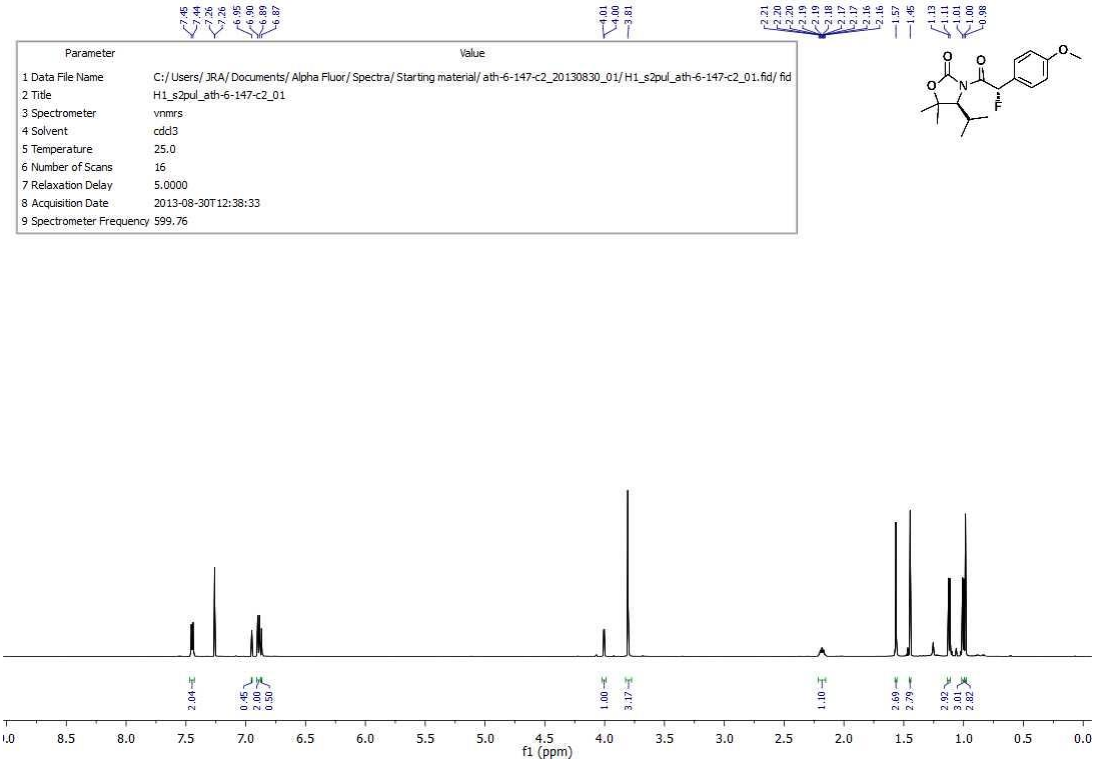
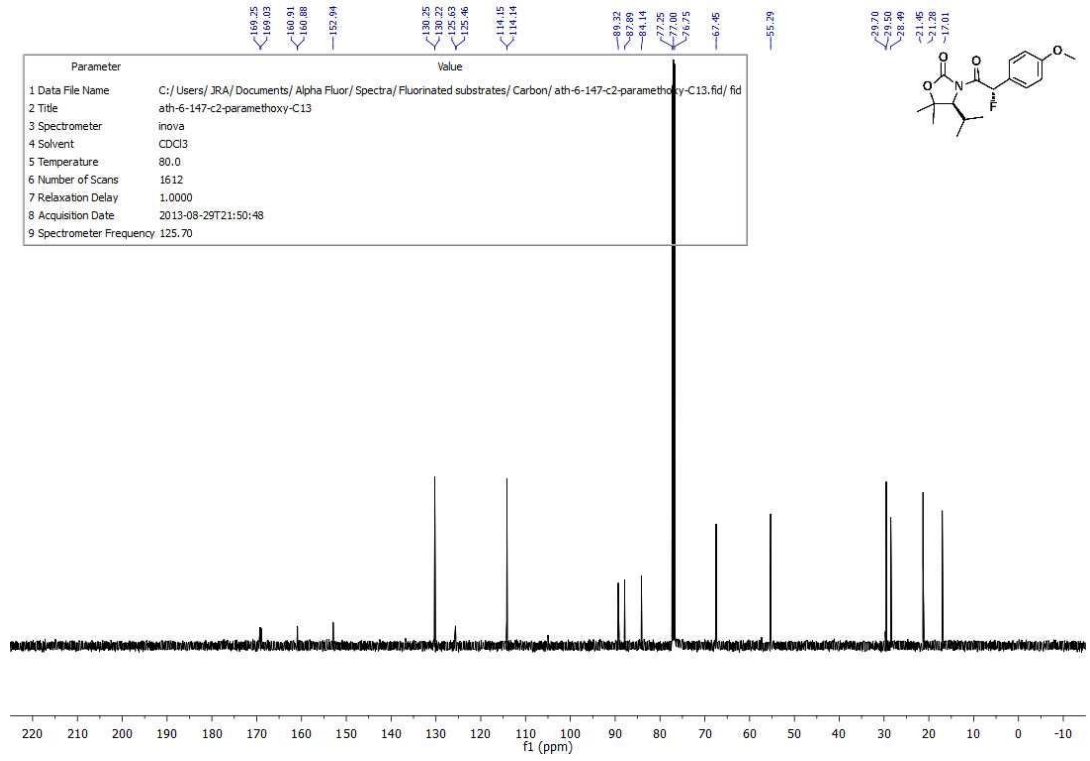
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ jra-cyclohexane-F_20130913_01/ F19_s2pul_jra-cyclohexane-F_01.fid/ fid
2 Title
F19_s2pul_jra-cyclohexane-F_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-09-13T14:55:14
9 Spectrometer Frequency
564.27
O
O
O
N
F
Ph
1.00
-105
-115
-125
-135
-145
-155
-165
-175
-185
-195
-205
-215
-225
-235
f1 (ppm)


7.45
7.44
7.26
7.26
6.95
6.90
6.89
6.87
4.01
4.00
3.81
2.21
2.20
2.20
2.19
2.19
2.18
2.17
2.17
2.16
2.16
1.57
1.45
1.13
1.11
1.01
1.00
0.98
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Starting material/ath-6-147-c2_20130830_01/H1_s2pul_ath-6-147-c2_01.fid/fid
2 Title
H1_s2pul_ath-6-147-c2_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-08-30T12:38:33
9 Spectrometer Frequency
599.76
2.04
0.45
2.00
0.50
1.00
3.17
1.10
2.69
2.79
2.92
3.01
2.82
f1 (ppm)


169.25
169.03
160.91
160.88
152.94
130.25
130.22
125.63
125.46
114.15
114.14
89.32
87.89
84.14
77.25
77.00
76.75
67.45
55.29
29.70
29.50
28.49
21.45
21.28
17.01
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/Carbon/ath-6-147-c2-paramethoxy-C13.fid/fid
2 Title
ath-6-147-c2-paramethoxy-C13
3 Spectrometer
inova
4 Solvent
CDCl3
5 Temperature
80.0
6 Number of Scans
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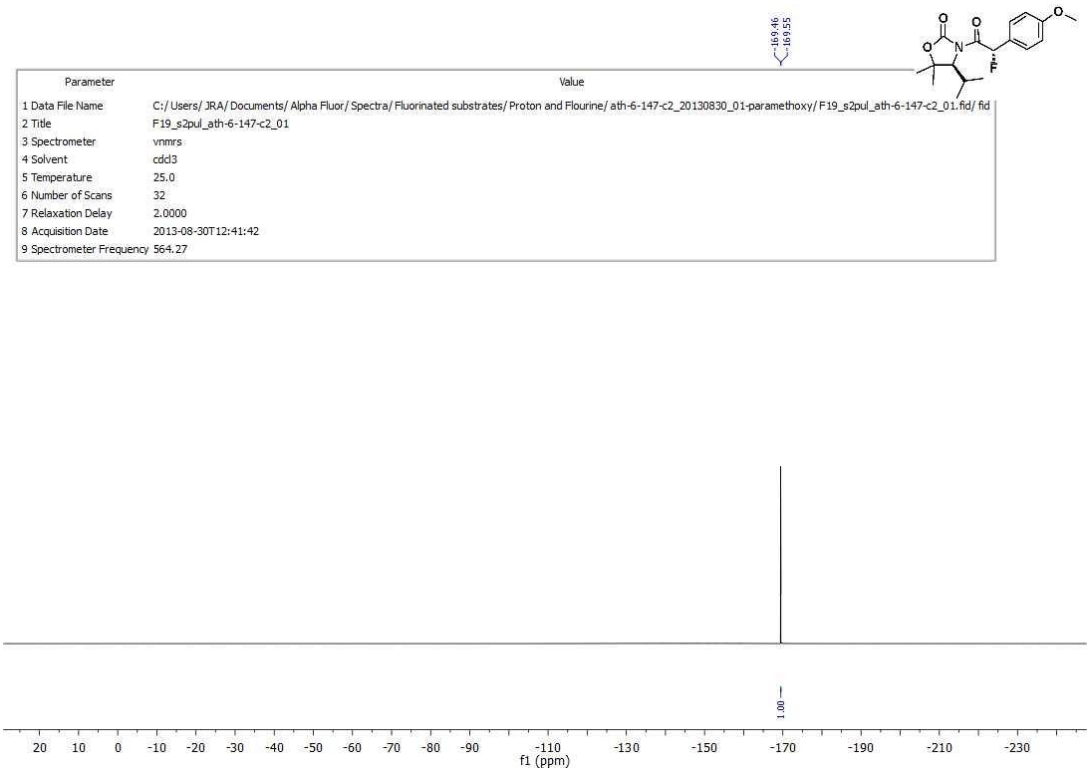
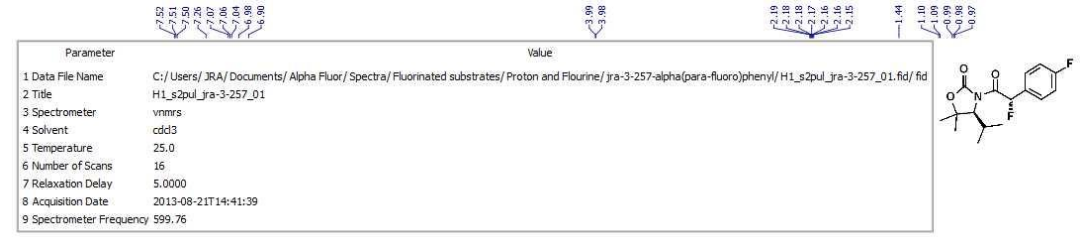
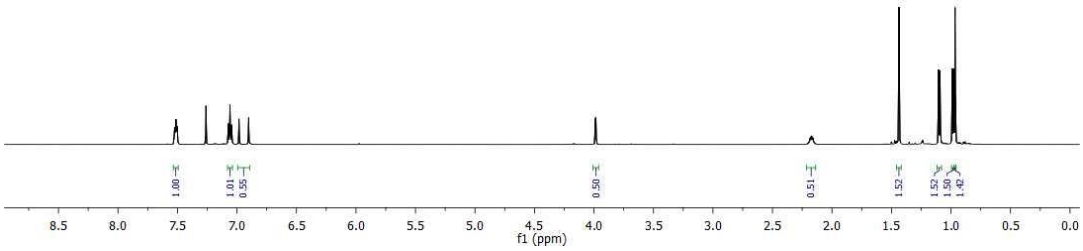
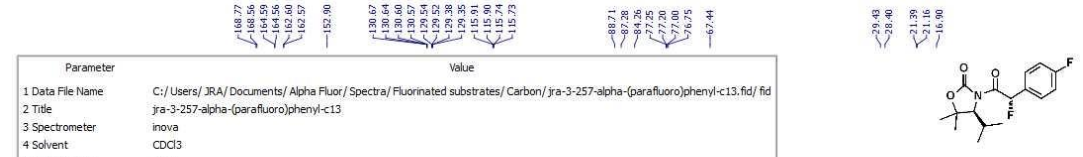
7 Relaxation Delay
1.0000
8 Acquisition Date
2013-08-29T21:50:48
9 Spectrometer Frequency
125.70
f1 (ppm)


-169.46
-169.55
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/Proton and Flourine/ath-6-147-c2_20130830_01-paramethoxy/F19_s2pul_ath-6-147-c2_01.fid/fid
2 Title
F19_s2pul_ath-6-147-c2_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-08-30T12:41:42
9 Spectrometer Frequency
564.27
1.00
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

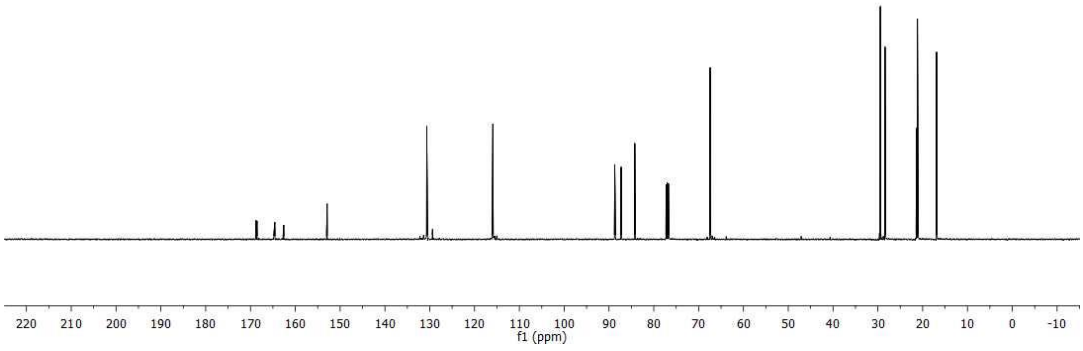


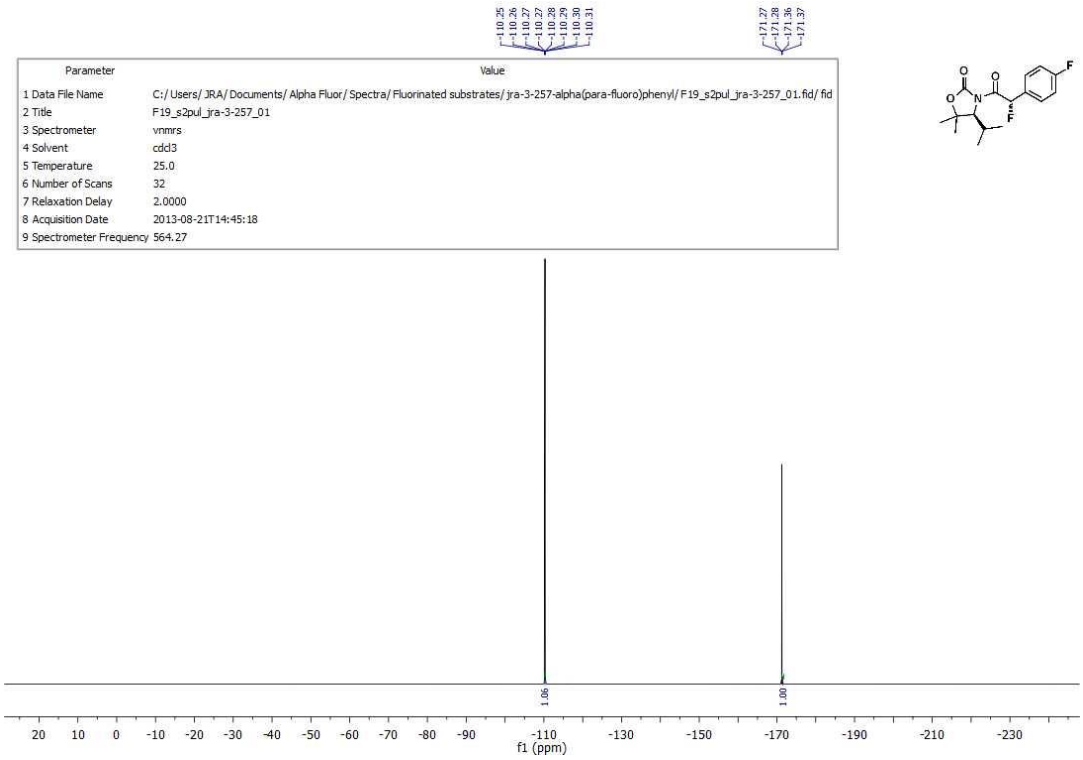
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Proton and Flourine/ jra-3-257-alpha(para-fluoro)phenyl/ H1_s2pul_jra-3-257_01.fid/ fid
2 Title	H1_s2pul_jra-3-257_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-21T14:41:39
9 Spectrometer Frequency	599.76

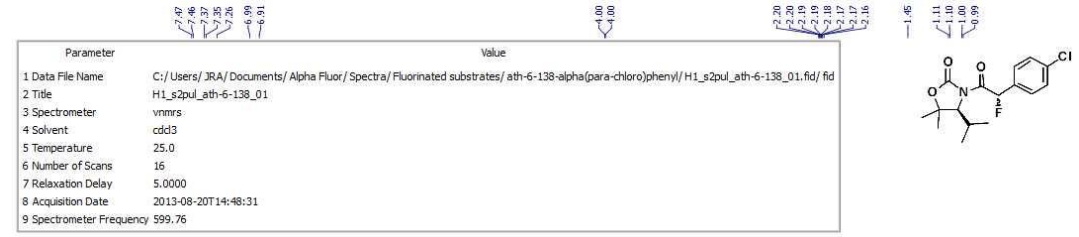




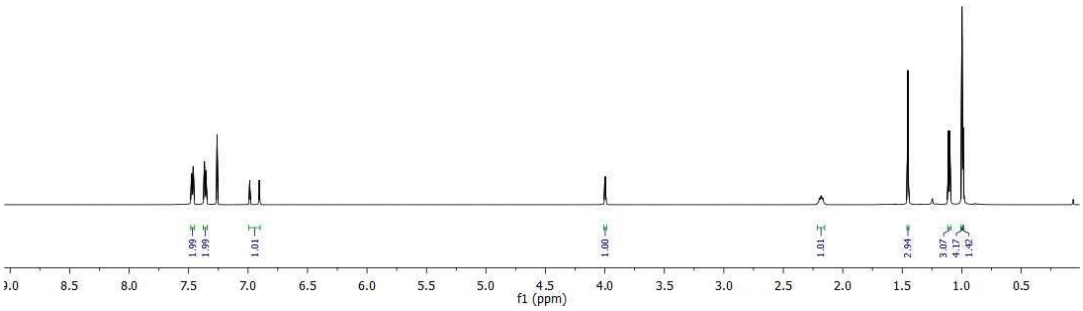
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ jra-3-257-alpha-(parafluoro)phenyl-c13.fid/ fid
2 Title	jra-3-257-alpha-(parafluoro)phenyl-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	22.0
6 Number of Scans	832
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-21T20:42:53
9 Spectrometer Frequency	125.70

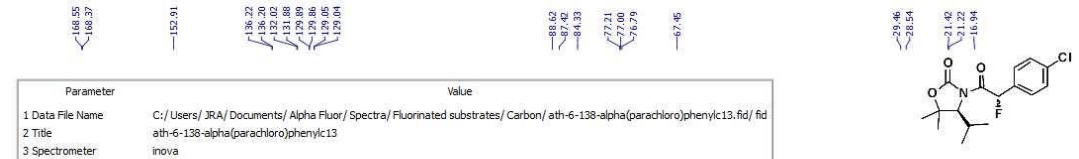



-110.25
-110.26
-110.27
-110.27
-110.28
-110.29
-110.30
-110.31
-171.27
-171.28
-171.36
-171.37
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/jra-3-257-alpha(para-fluoro)phenyl/F19_s2pul_jra-3-257_01.fid/fid
2 Title
F19_s2pul_jra-3-257_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-08-21T14:45:18
9 Spectrometer Frequency
564.27
O
O
O
N
F
F
1.06
1.00
20
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
-210
-230
f1 (ppm)

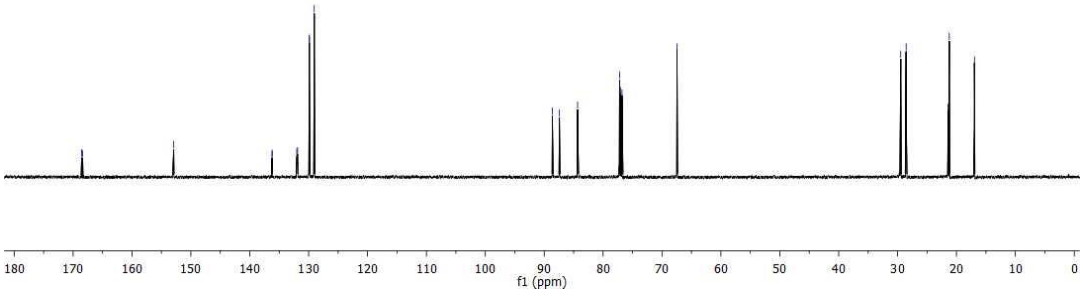


Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/ath-6-138-alpha(para-chloro)phenyl/H1_s2pul_ath-6-138_01.fid/fid
2 Title	H1_s2pul_ath-6-138_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-20T14:48:31
9 Spectrometer Frequency	599.76

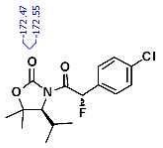


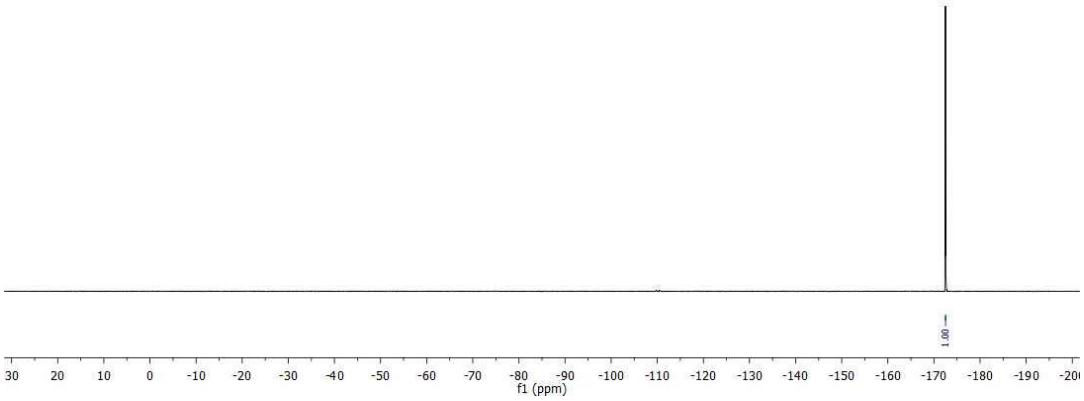


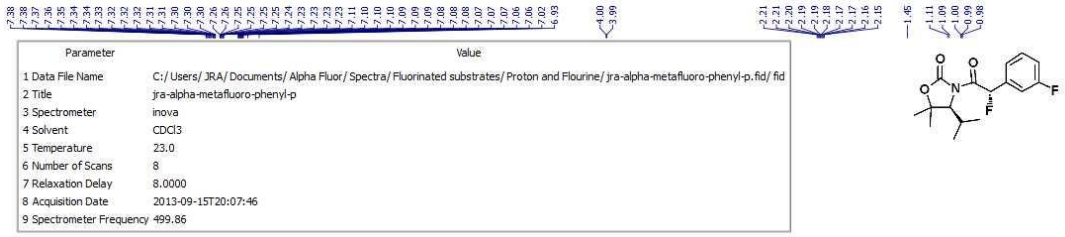
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/Carbon/ath-6-138-alpha(parachloro)phenylc13.fid/fid
2 Title	ath-6-138-alpha(parachloro)phenylc13
3 Spectrometer	inova
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	876
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-20T21:01:02
9 Spectrometer Frequency	150.79



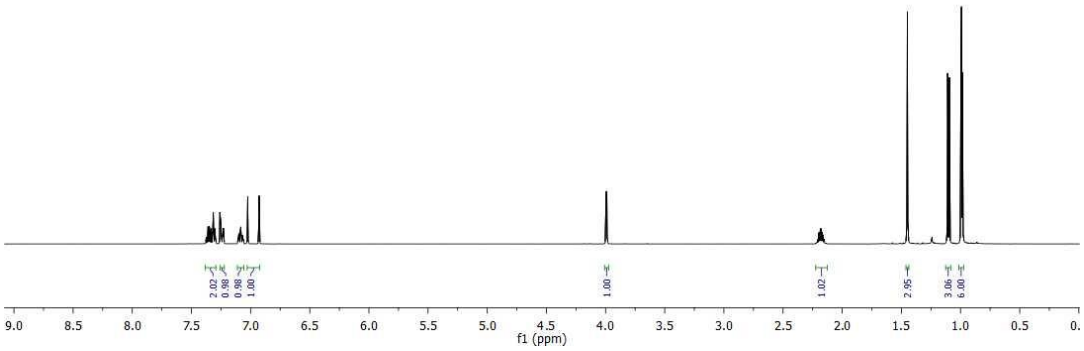
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/ath-6-138-alpha(para-chloro)phenyl/F19_s2pul_ath-6-138_01.fid/fid
2 Title	F19_s2pul_ath-6-138_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-20T14:51:50
9 Spectrometer Frequency	564.28

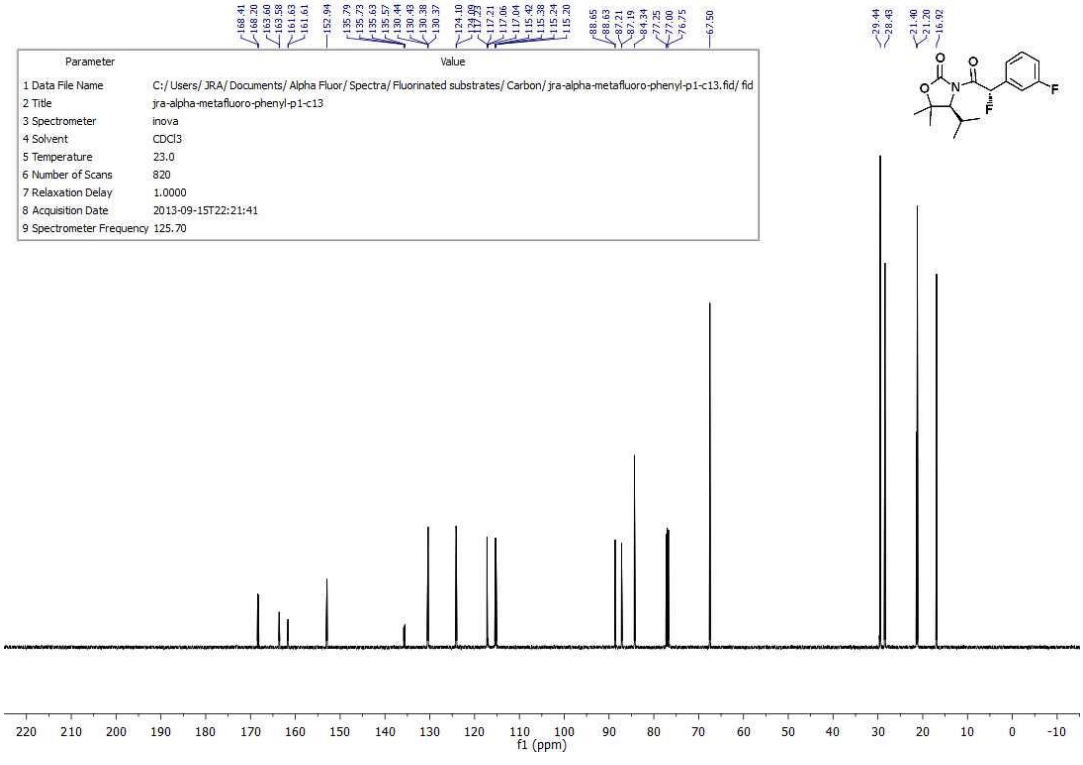




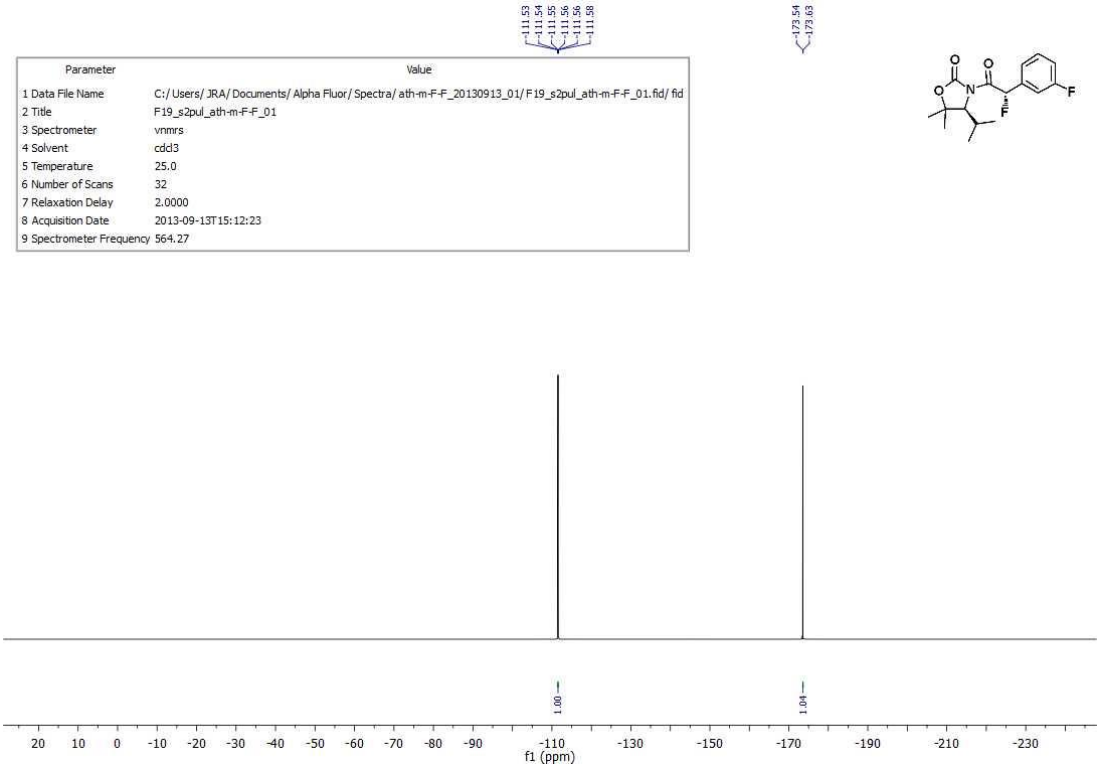


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Proton and Flourine/ jra-alpha-metafluoro-phenyl-p.fid/ fid
2 Title	jra-alpha-metafluoro-phenyl-p
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	23.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-09-15T20:07:46
9 Spectrometer Frequency	499.86





Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ jra-alpha-metafluoro-phenyl-p1-c13.fid/ fid
2 Title	jra-alpha-metafluoro-phenyl-p1-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	23.0
6 Number of Scans	820
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-09-15T22:21:41
9 Spectrometer Frequency	125.70


-111.53
-111.54
-111.55
-111.56
-111.56
-111.58
-173.54
-173.63
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/ath-m-F-F_20130913_01/F19_s2pul_ath-m-F-F_01.fid/fid
2 Title
F19_s2pul_ath-m-F-F_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-09-13T15:12:23
9 Spectrometer Frequency
564.27
O
O
O
N
F
F
1.00
1.04
20
10
0
-10
-20
-30
-40
-50
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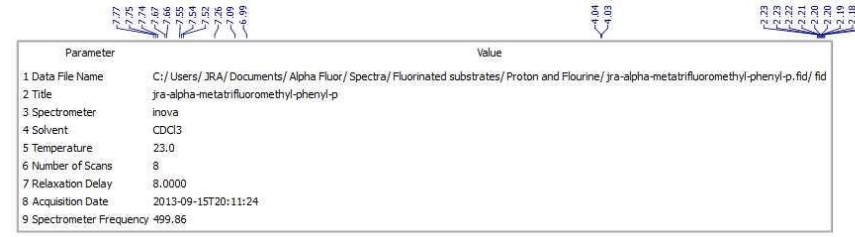
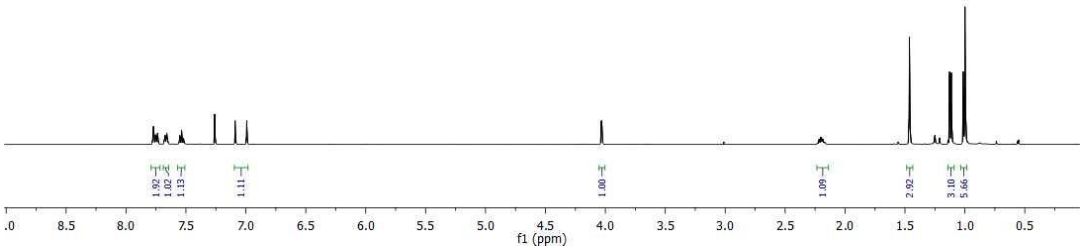
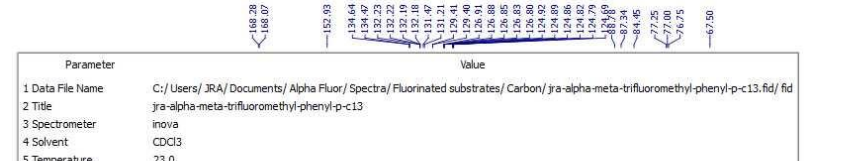
-70
-80
-90
-110
-130
-150
-170
-190
-210
-230
f1 (ppm)

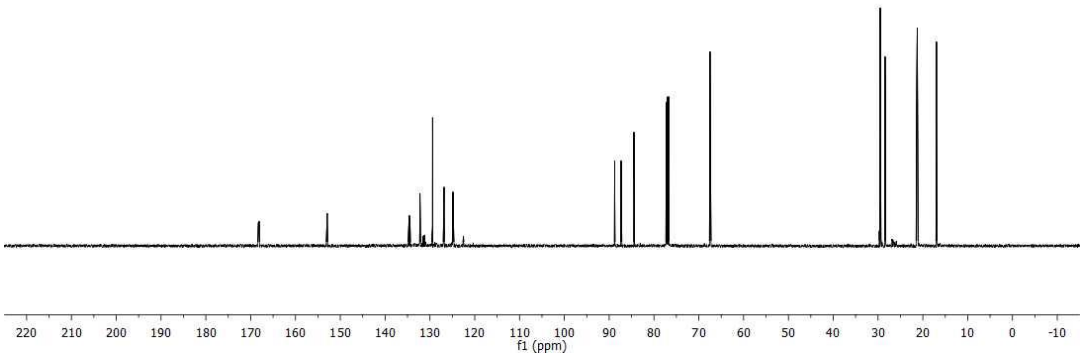


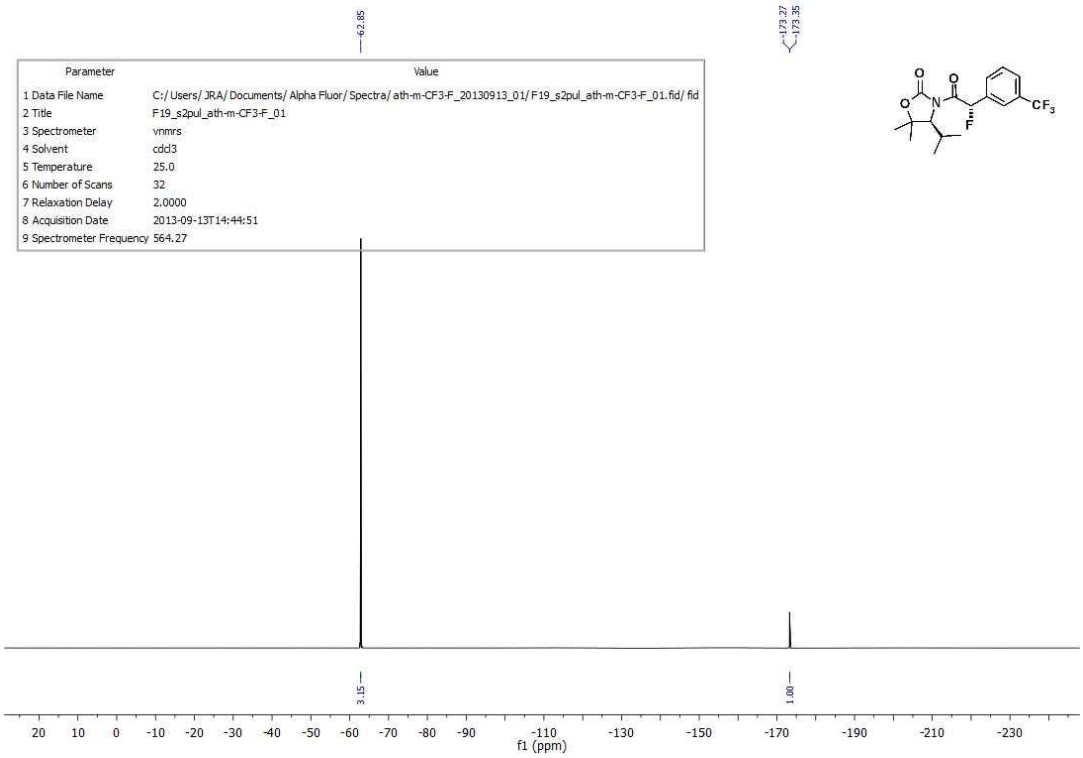
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Proton and Flourine/ jra-alpha-metatrifluoromethyl-phenyl-p.fid/ fid
2 Title	jra-alpha-metatrifluoromethyl-phenyl-p
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	23.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-09-15T20:11:24
9 Spectrometer Frequency	499.86





Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ jra-alpha-meta-trifluoromethyl-phenyl-p-c13.fid/ fid
2 Title	jra-alpha-meta-trifluoromethyl-phenyl-p-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	23.0
6 Number of Scans	2424
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-09-15T20:18:21
9 Spectrometer Frequency	125.70

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-173.27
-173.35
Parameter
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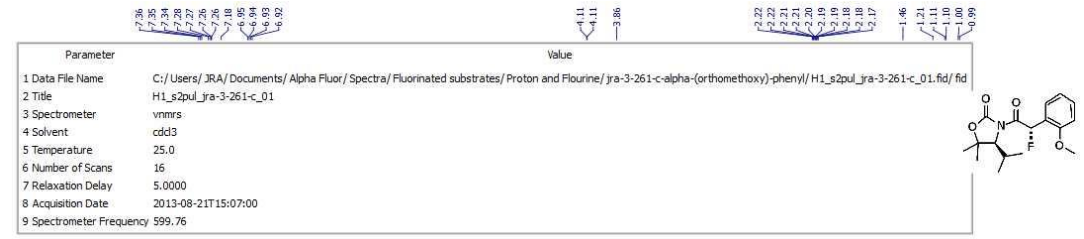
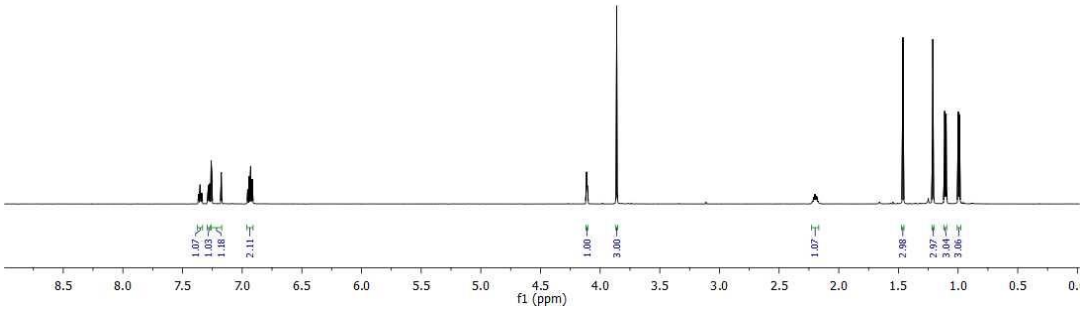
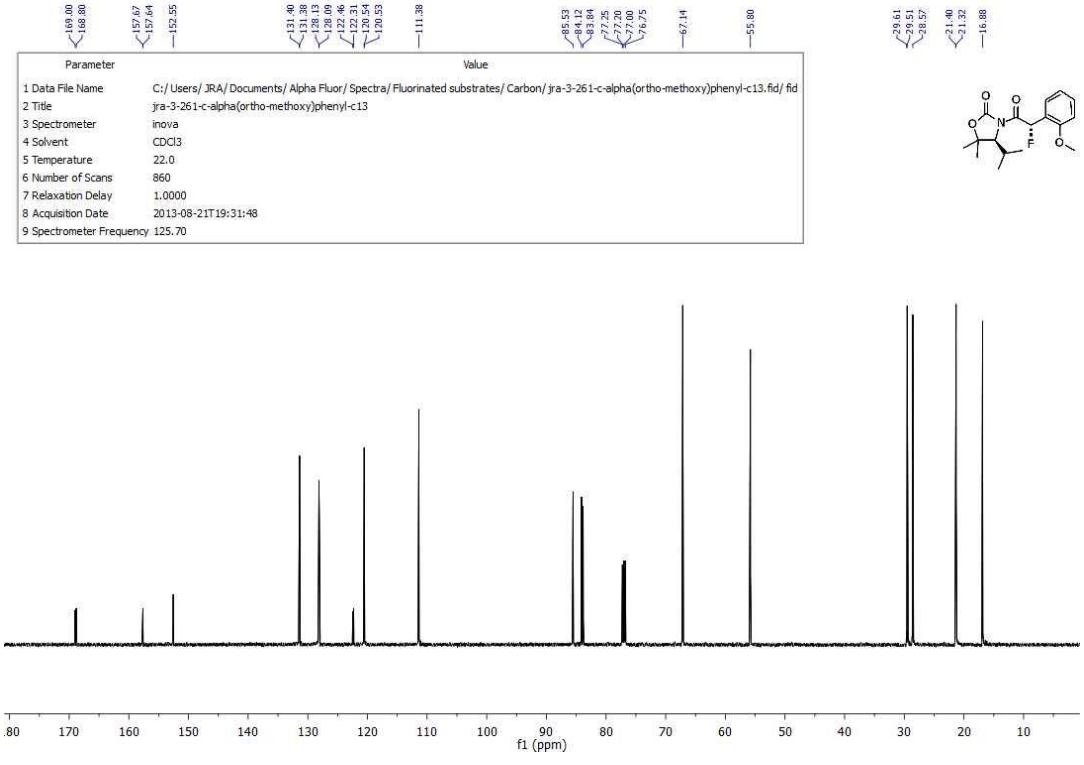
1 Data File Name
C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ ath-m-CF3-F_20130913_01/ F19_s2pul_ath-m-CF3-F_01.fid/ fid
2 Title
F19_s2pul_ath-m-CF3-F_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-09-13T14:44:51
9 Spectrometer Frequency
564.27
O
O
O
N
F
CF3
3.15
1.00
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)

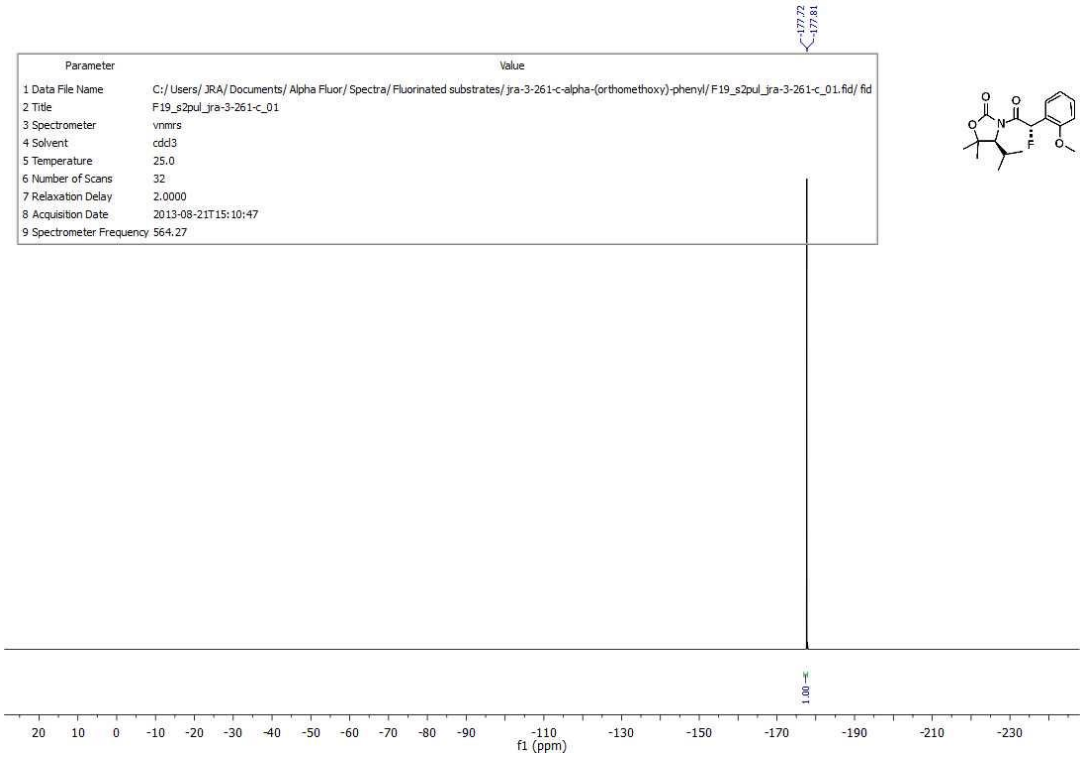


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Proton and Flourine/ jra-3-261-c-alpha-(orthomethoxy)-phenyl/ H1_s2pul_jra-3-261-c_01.fid/ fid
2 Title	H1_s2pul_jra-3-261-c_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-08-21T15:07:00
9 Spectrometer Frequency	599.76





Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ jra-3-261-c-alpha(ortho-methoxy)phenyl-c13.fid/ fid
2 Title	jra-3-261-c-alpha(ortho-methoxy)phenyl-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	22.0
6 Number of Scans	860
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-08-21T19:31:48
9 Spectrometer Frequency	125.70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-177.81
Parameter
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1 Data File Name
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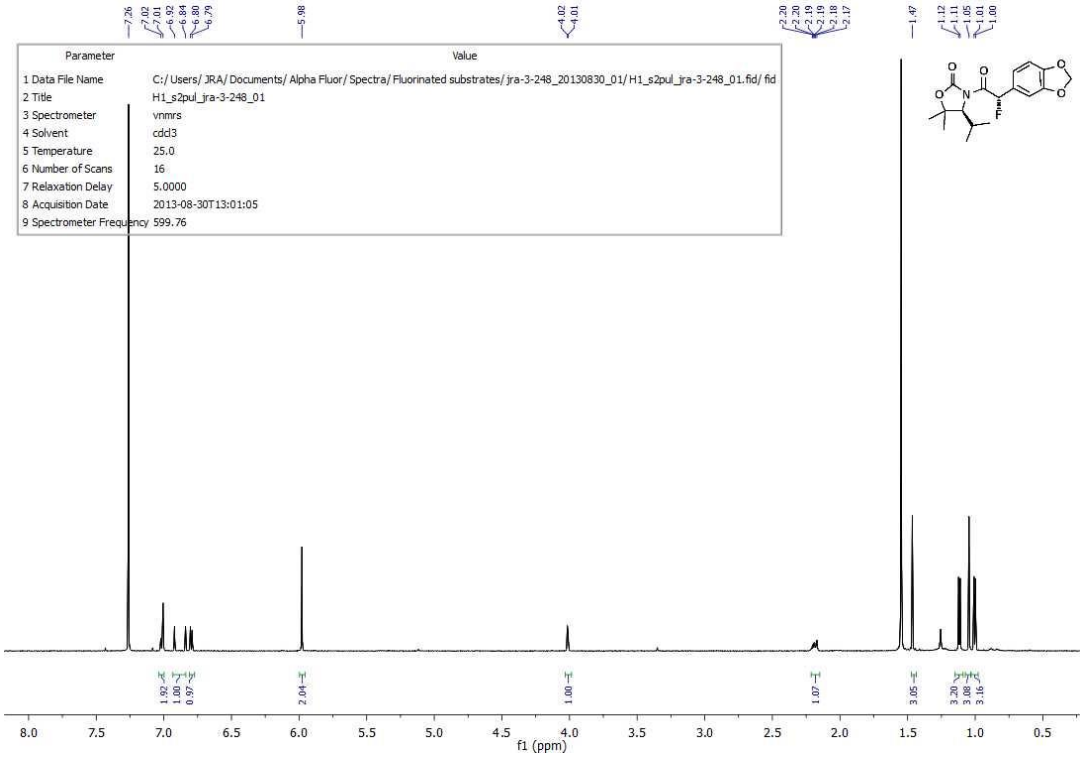
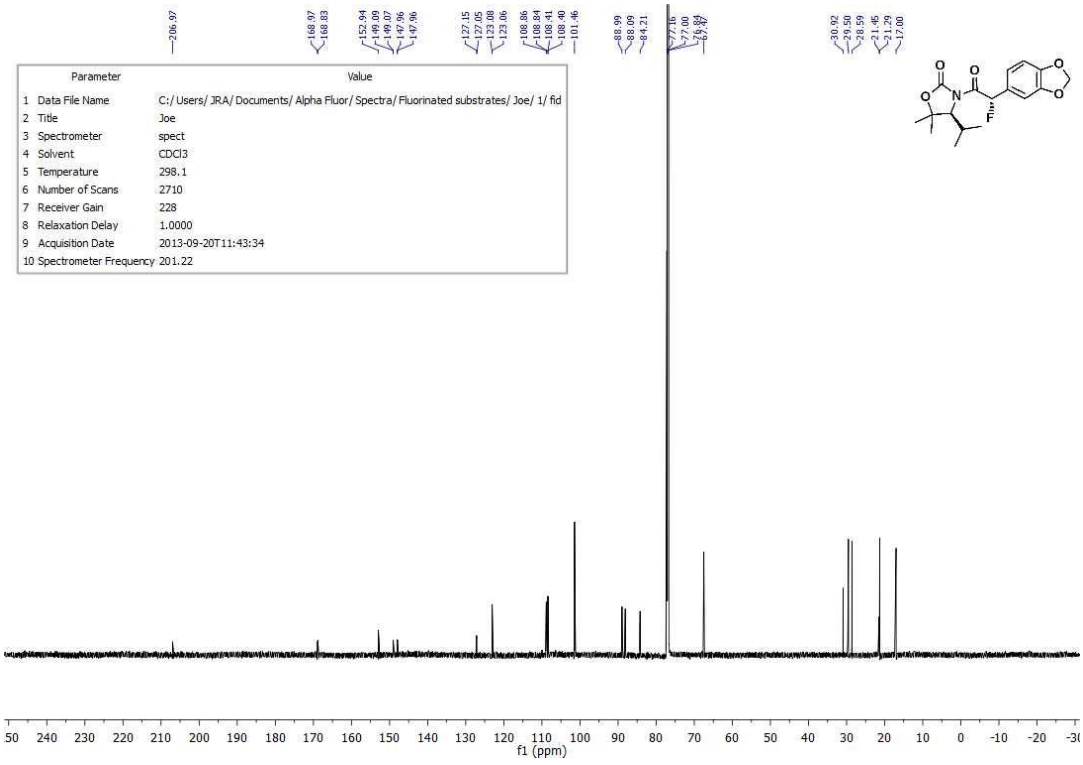
2 Title
F19_s2pul_jra-3-261-c_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-08-21T15:10:47
9 Spectrometer Frequency
564.27
1.00
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)


7.26
7.02
7.01
6.92
6.84
6.80
6.79
5.98
4.02
4.01
2.20
2.20
2.19
2.19
2.18
2.17
1.47
1.12
1.11
1.05
1.01
1.00
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/jra-3-248_20130830_01/H1_s2pul_jra-3-248_01.fid/fid
2 Title
H1_s2pul_jra-3-248_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-08-30T13:01:05
9 Spectrometer Frequency
599.76
1.92
1.00
0.97
2.04
1.00
1.07
3.05
3.20
3.08
3.16
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


206.97
168.97
168.83
152.94
149.09
149.07
147.96
147.96
127.15
127.05
123.08
123.06
108.86
108.84
108.41
108.40
101.46
88.99
88.09
84.21
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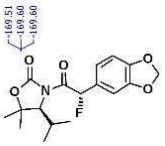
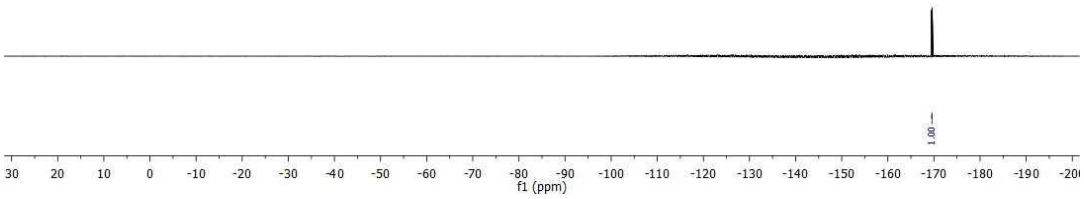
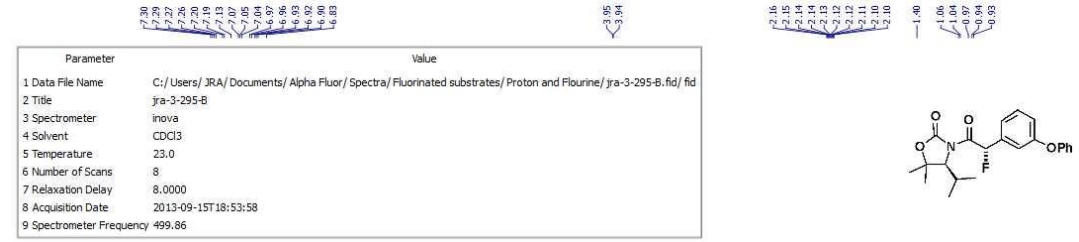
77.00
76.84
76.47
30.92
29.50
28.59
21.45
21.39
17.00
Parameter
Value
1 Data File Name
C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/Joe/1/fid
2 Title
Joe
3 Spectrometer
spect
4 Solvent
CDCl3
5 Temperature
298.1
6 Number of Scans
2710
7 Receiver Gain
228
8 Relaxation Delay
1.0000
9 Acquisition Date
2013-09-20T11:43:34
10 Spectrometer Frequency
201.22
50
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
-3(
f1 (ppm)

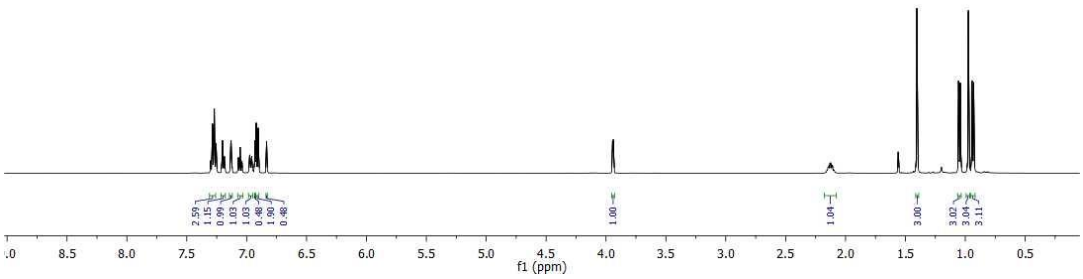
Parameter	Value
1 Data File Name	C:/Users/JRA/Documents/Alpha Fluor/Spectra/Fluorinated substrates/jra-3-248_20130830_01/F19_s2pul_jra-3-248_01.fid/fid
2 Title	F19_s2pul_jra-3-248_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-08-30T13:04:33
9 Spectrometer Frequency	564.28

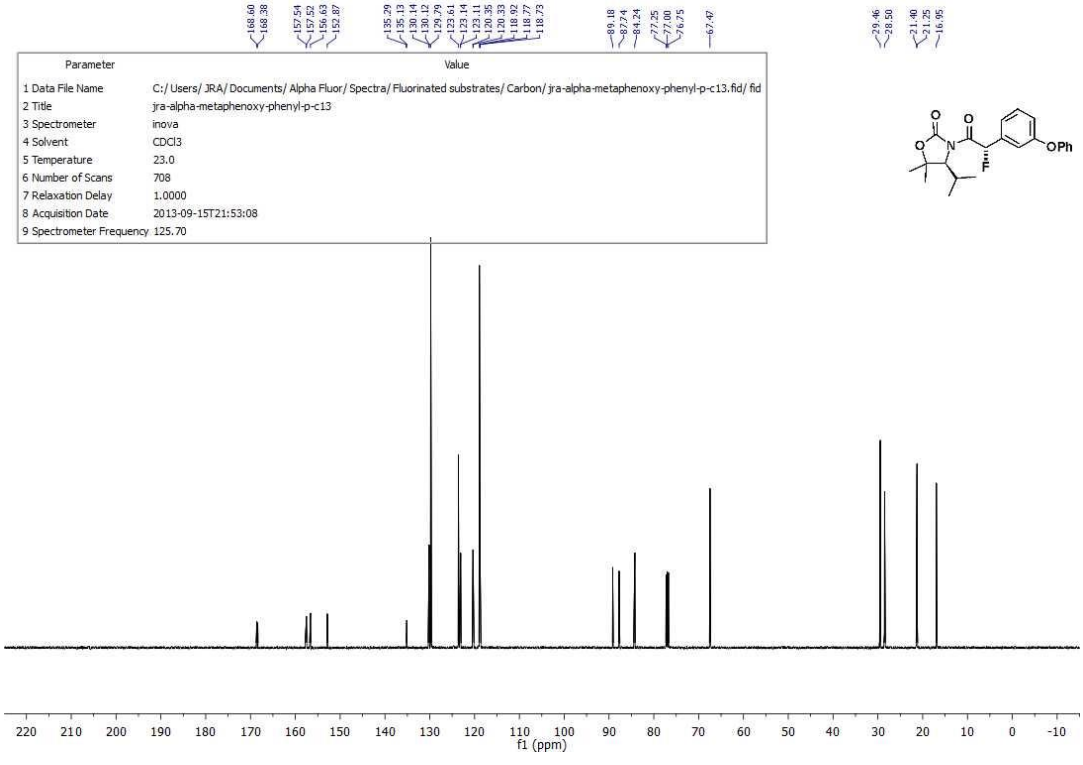




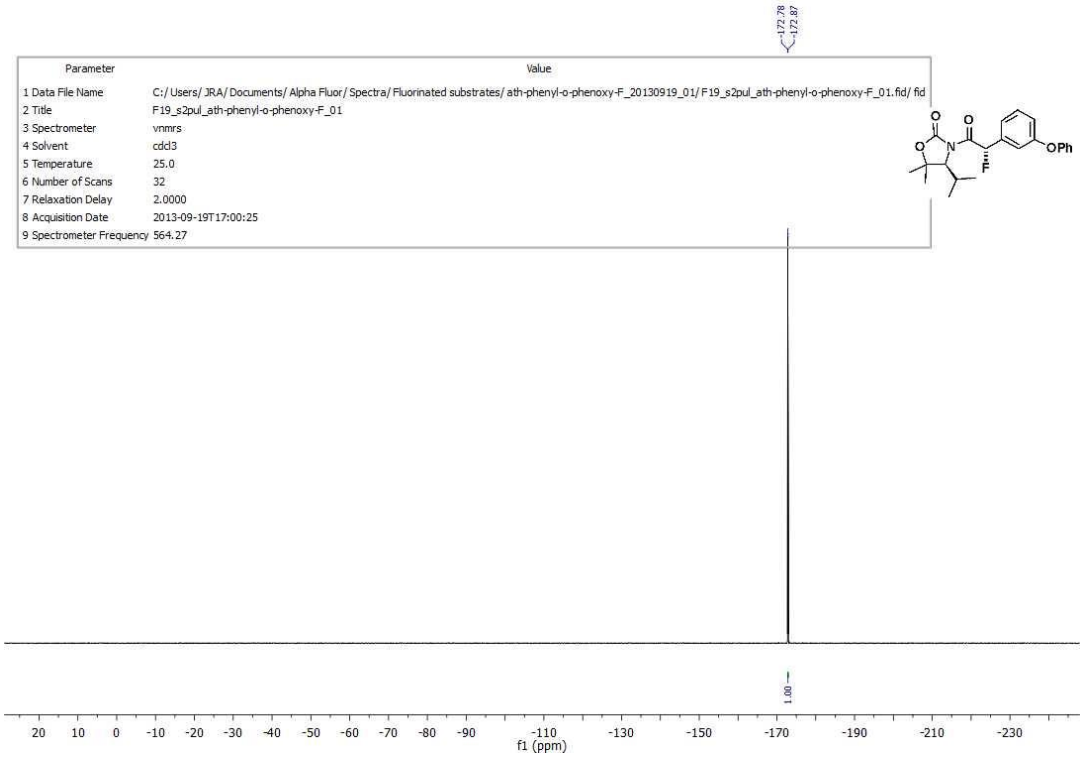


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Proton and Flourine/ jra-3-295-B.fid/ fid
2 Title	jra-3-295-B
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	23.0
6 Number of Scans	8
7 Relaxation Delay	8.0000
8 Acquisition Date	2013-09-15T18:53:58
9 Spectrometer Frequency	499.86





Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Documents/ Alpha Fluor/ Spectra/ Fluorinated substrates/ Carbon/ jra-alpha-metaphenoxy-phenyl-p-c13.fid/ fid
2 Title	jra-alpha-metaphenoxy-phenyl-p-c13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	23.0
6 Number of Scans	708
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-09-15T21:53:08
9 Spectrometer Frequency	125.70


-172.78
-172.87
Parameter
Value
1 Data File Name
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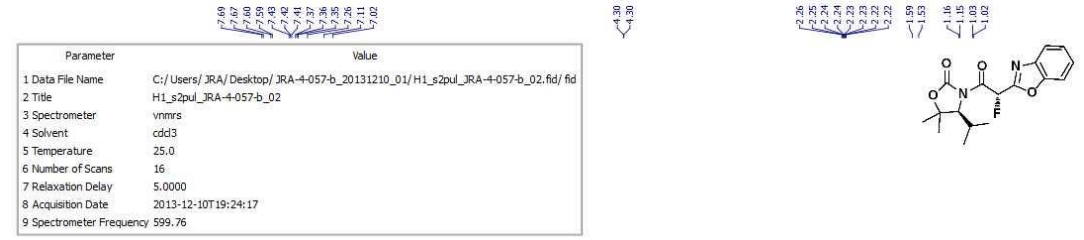
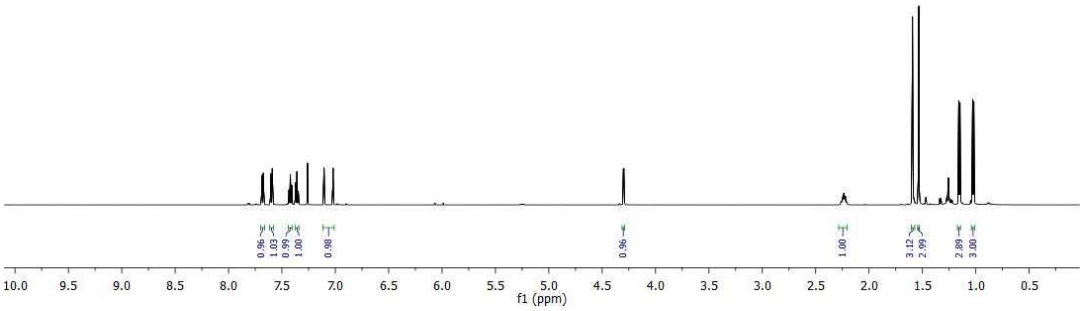
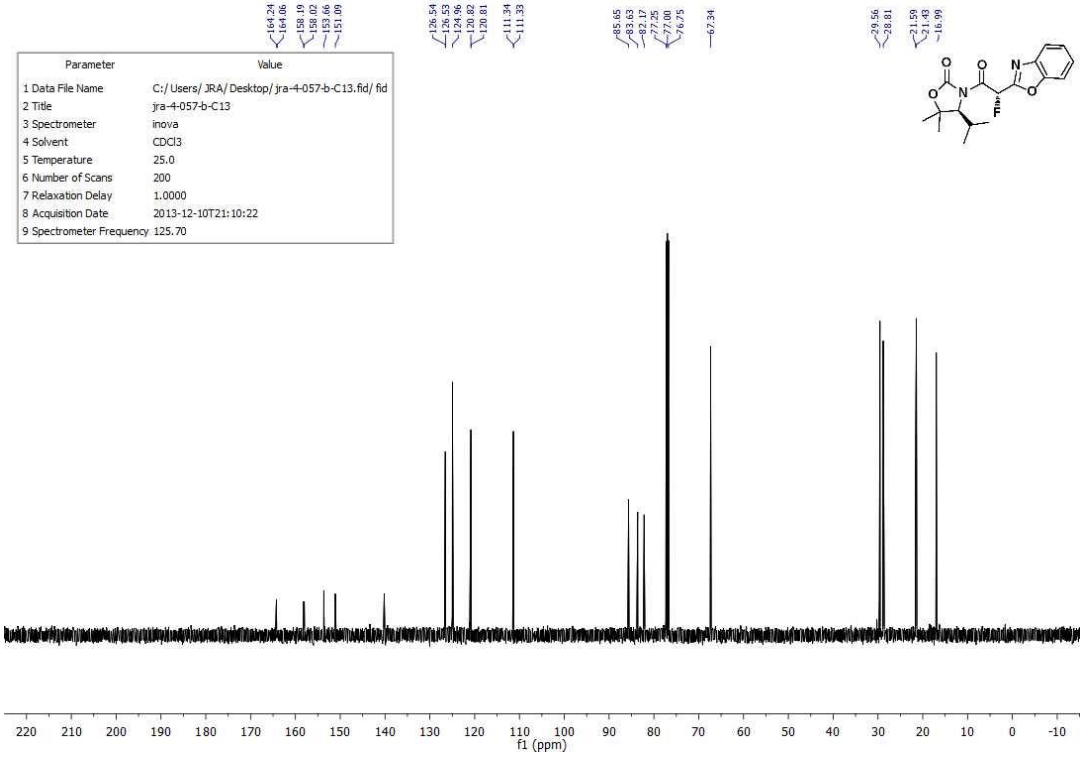
2 Title
F19_s2pul_ath-phenyl-o-phenoxy-F_01
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
32
7 Relaxation Delay
2.0000
8 Acquisition Date
2013-09-19T17:00:25
9 Spectrometer Frequency
564.27
OPh
1.00
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190 -210 -230
f1 (ppm)



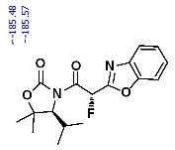
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Desktop/ JRA-4-057-b_20131210_01/ H1_s2pul_JRA-4-057-b_02.fid/ fid
2 Title	H1_s2pul_JRA-4-057-b_02
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-12-10T19:24:17
9 Spectrometer Frequency	599.76

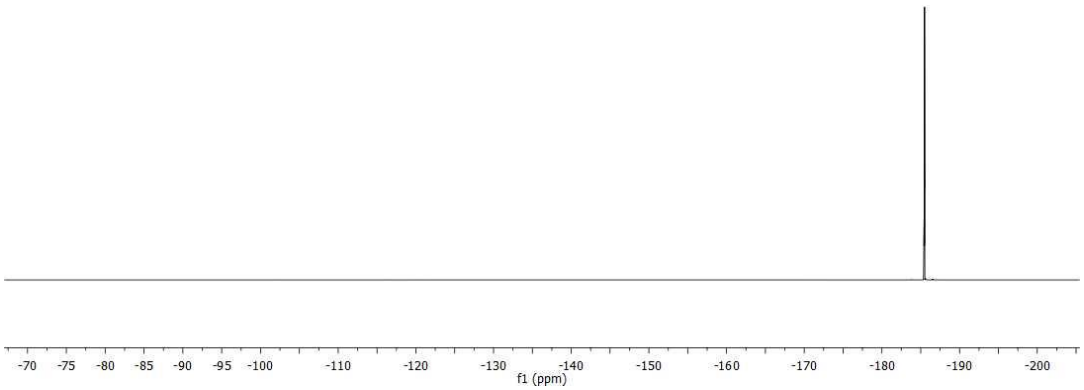


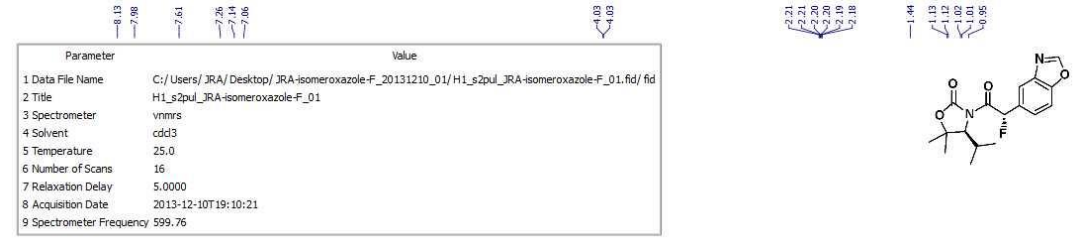


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Desktop/ jra-4-057-b-C13.fid/ fid
2 Title	jra-4-057-b-C13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	200
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-12-10T21:10:22
9 Spectrometer Frequency	125.70

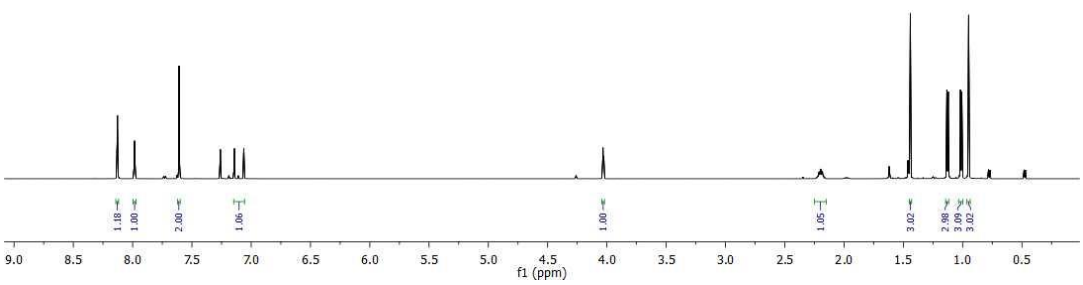
Parameter	Value
1 Data File Name	C:/Users/JRA/Desktop/JRA-4-057-b_20131210_01/F19_s2pul_JRA-4-057-b_02.fid/fid
2 Title	F19_s2pul_JRA-4-057-b_02
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-12-10T19:27:30
9 Spectrometer Frequency	564.27



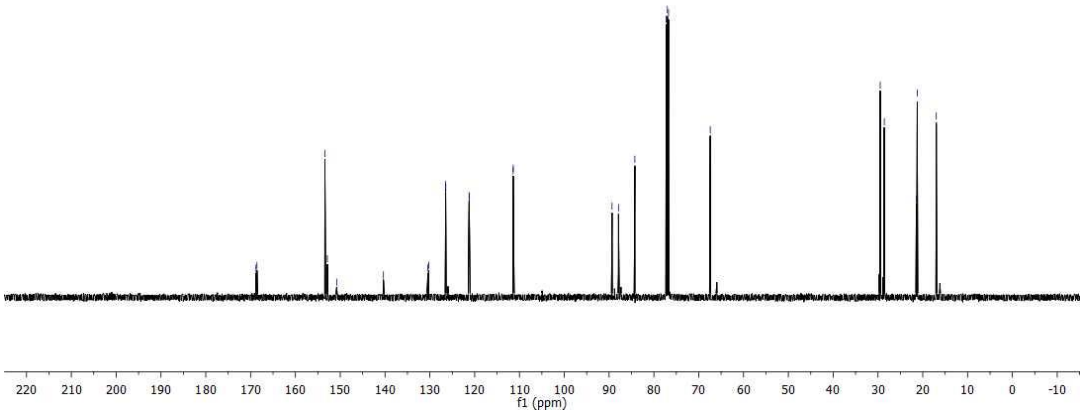




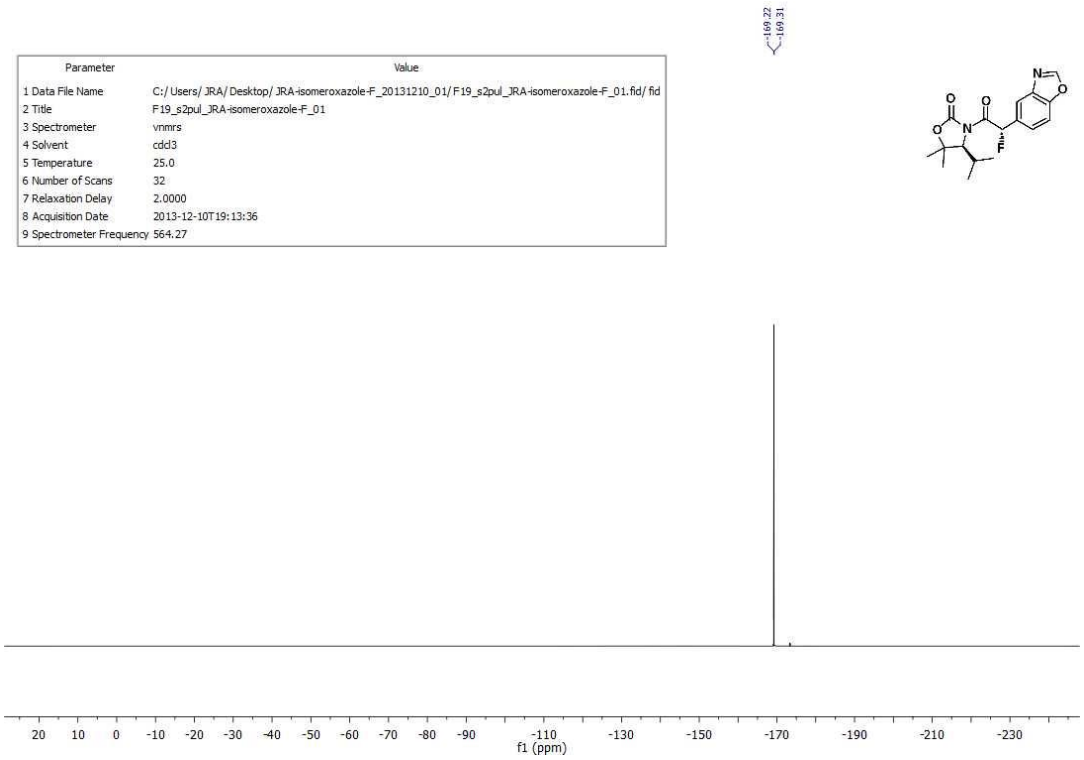
Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Desktop/ JRA-isomeroxazole-F_20131210_01/ H1_s2pul_JRA-isomeroxazole-F_01.fid/ fid
2 Title	H1_s2pul_JRA-isomeroxazole-F_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	16
7 Relaxation Delay	5.0000
8 Acquisition Date	2013-12-10T19:10:21
9 Spectrometer Frequency	599.76

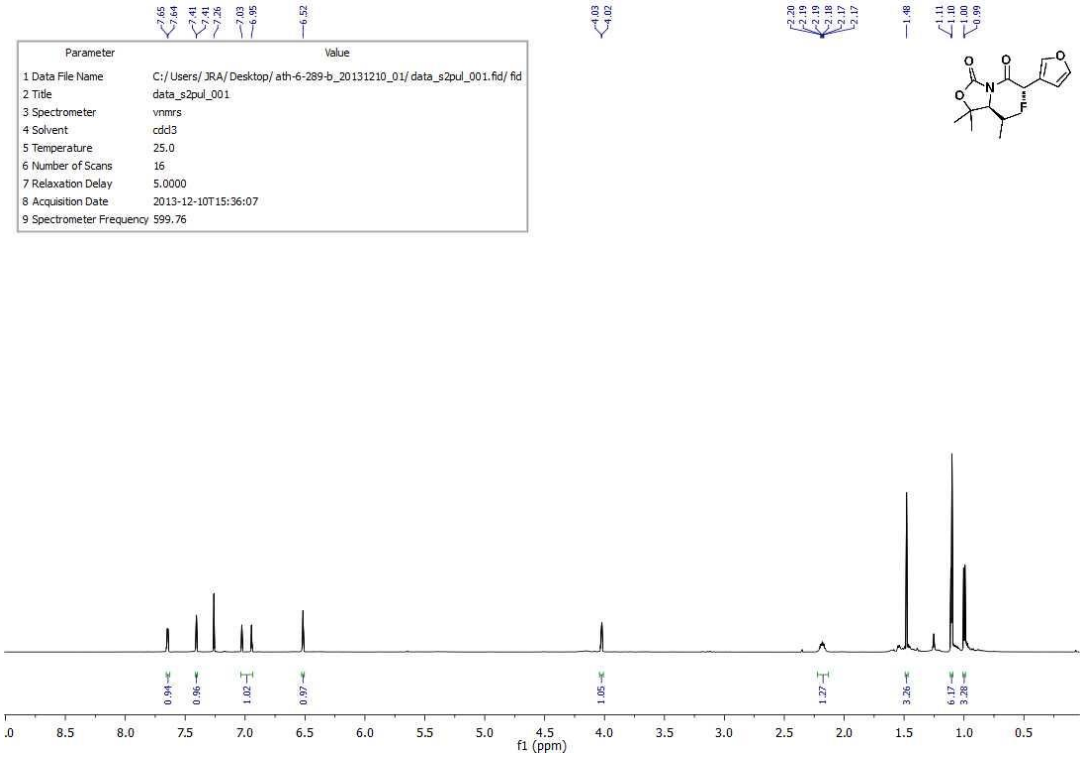


Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Desktop/ jra-4-isomeroxazole-f-C13.fid/ fid
2 Title	jra-4-isomeroxazole-f-C13
3 Spectrometer	inova
4 Solvent	CDCl3
5 Temperature	25.0
6 Number of Scans	520
7 Relaxation Delay	1.0000
8 Acquisition Date	2013-12-10T21:35:58
9 Spectrometer Frequency	125.70



Parameter	Value
1 Data File Name	C:/ Users/ JRA/ Desktop/ JRA-isomeroxazole-F_20131210_01/ F19_s2pul_JRA-isomeroxazole-F_01.fid/ fid
2 Title	F19_s2pul_JRA-isomeroxazole-F_01
3 Spectrometer	vnmrs
4 Solvent	cdcl3
5 Temperature	25.0
6 Number of Scans	32
7 Relaxation Delay	2.0000
8 Acquisition Date	2013-12-10T19:13:36
9 Spectrometer Frequency	564.27




7.65
7.64
7.41
7.41
7.26
7.03
6.95
6.52
4.03
4.02
2.20
2.19
2.19
2.18
2.17
2.17
1.48
1.11
1.10
1.00
0.99
Parameter
Value
1 Data File Name
C:/Users/JRA/Desktop/ath-6-289-b_20131210_01/data_s2pul_001.fid/fid
2 Title
data_s2pul_001
3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
25.0
6 Number of Scans
16
7 Relaxation Delay
5.0000
8 Acquisition Date
2013-12-10T15:36:07
9 Spectrometer Frequency
599.76
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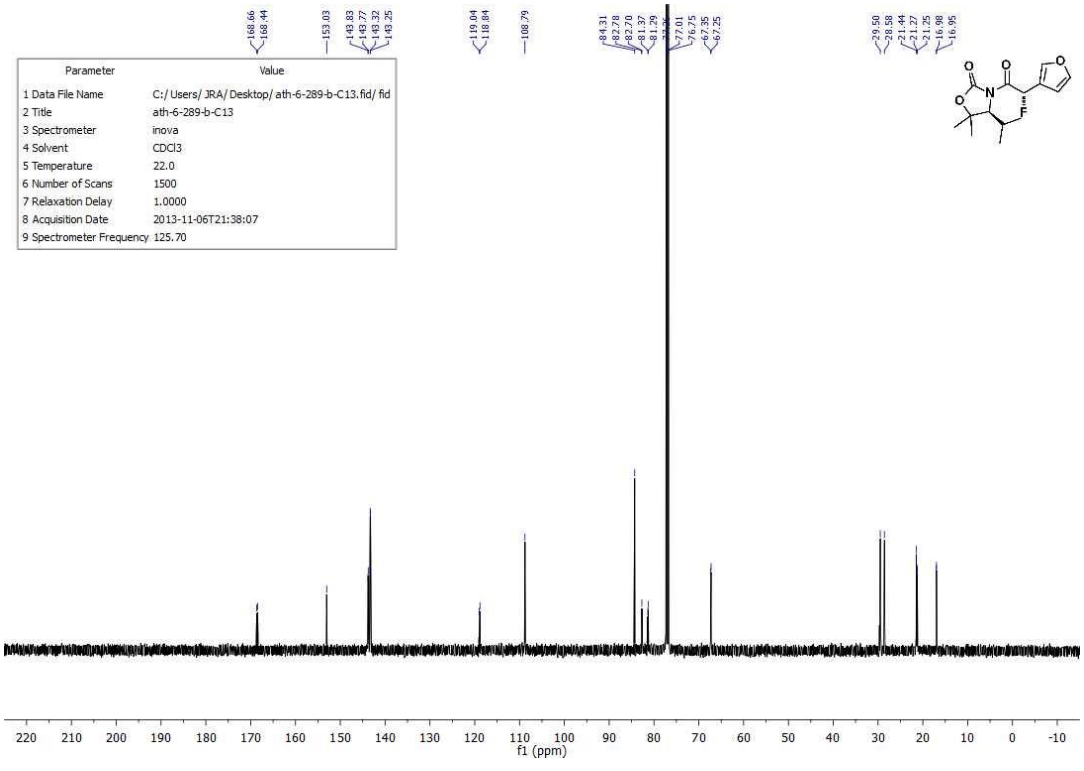
0.96
1.02
0.97
1.05
1.27
3.26
6.17
3.28
f1 (ppm)


168.66
168.44
153.03
143.83
143.77
143.32
143.25
119.04
118.84
108.79
84.31
82.78
82.70
81.37
81.29
77.01
76.75
76.75
67.25
29.50
28.58
21.44
21.27
21.25
16.98
16.95
Parameter
Value
1 Data File Name
C:/Users/JRA/Desktop/ath-6-289-b-C13.fid/fid
2 Title
ath-6-289-b-C13
3 Spectrometer
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4 Solvent
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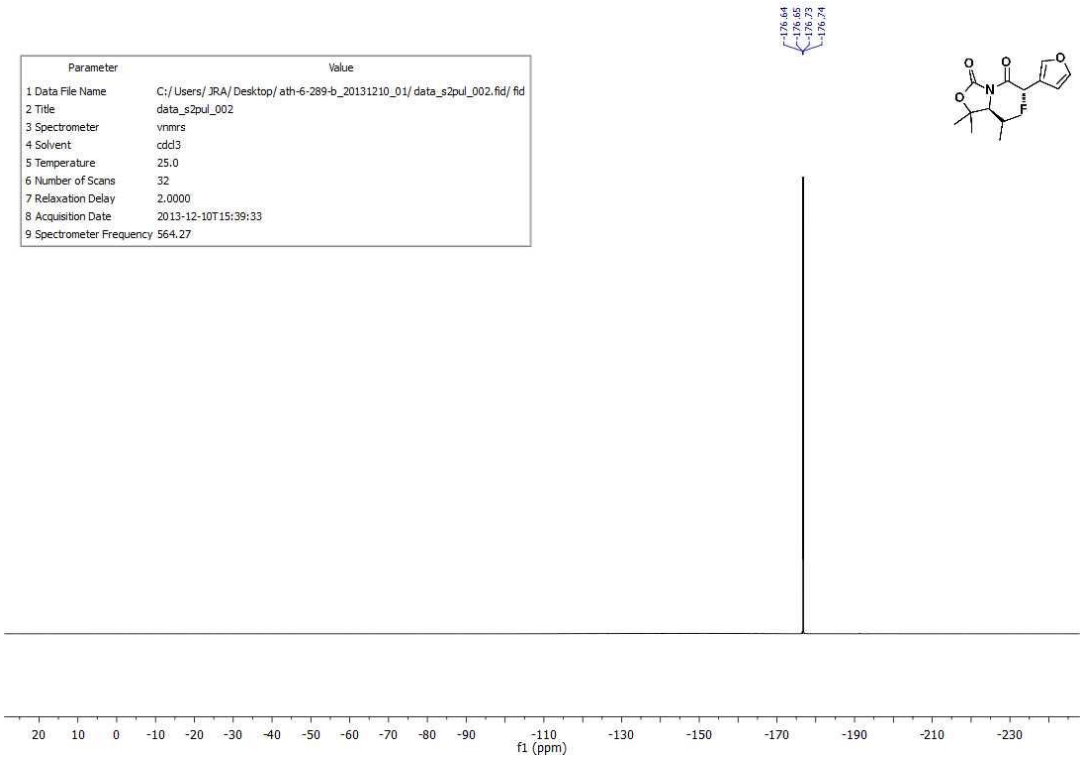

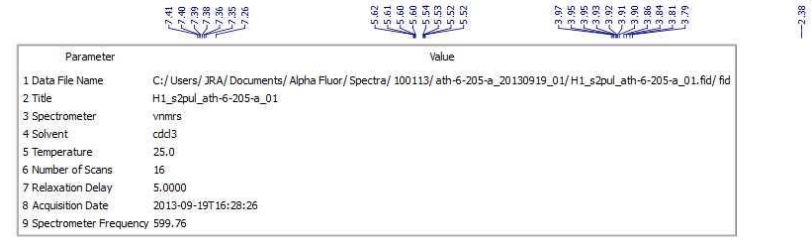

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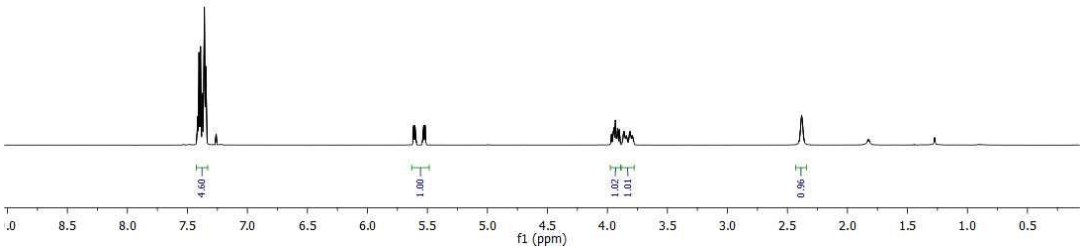

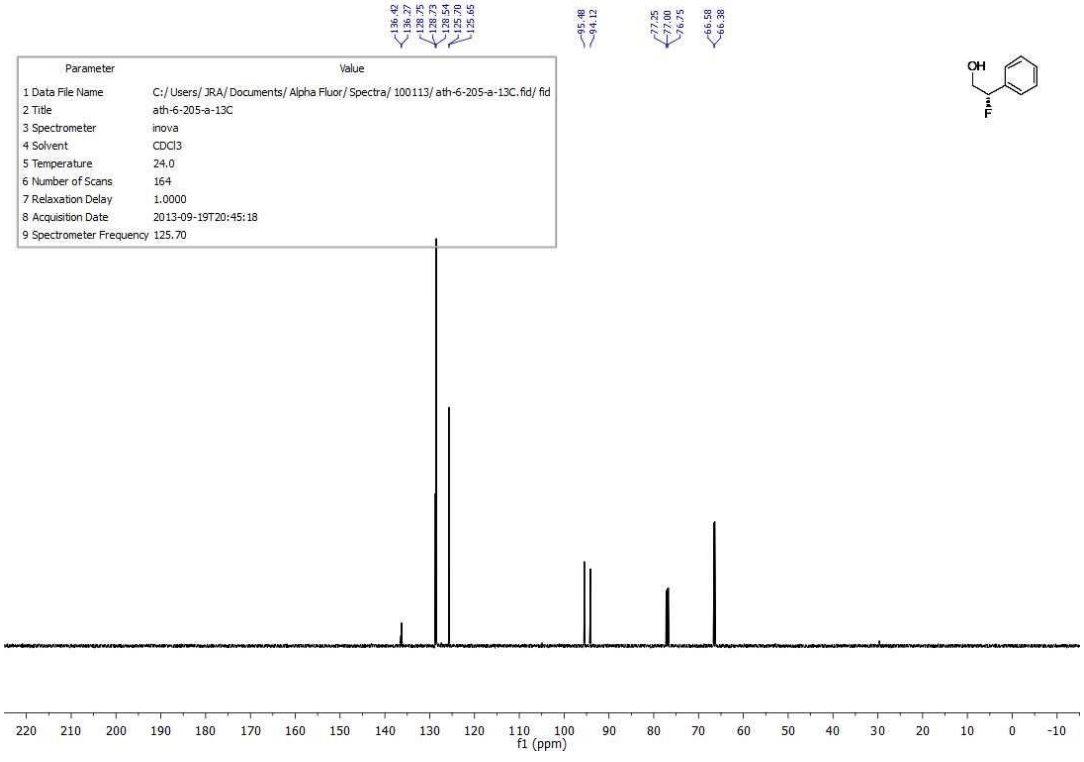

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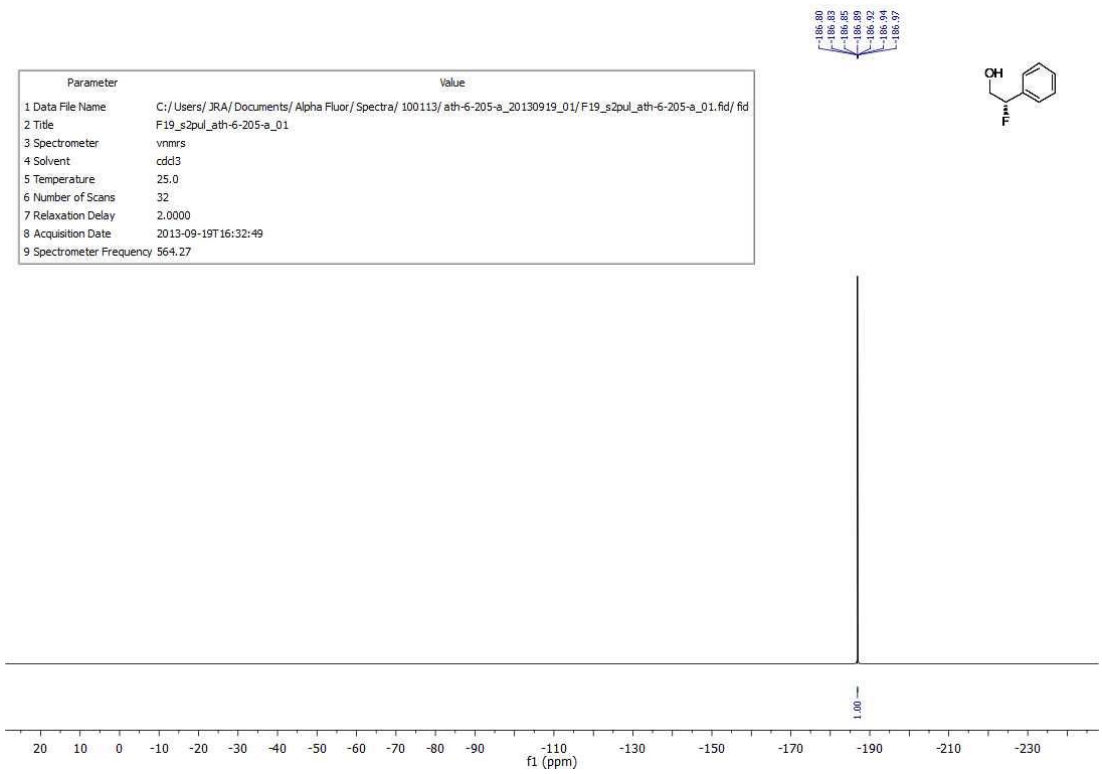

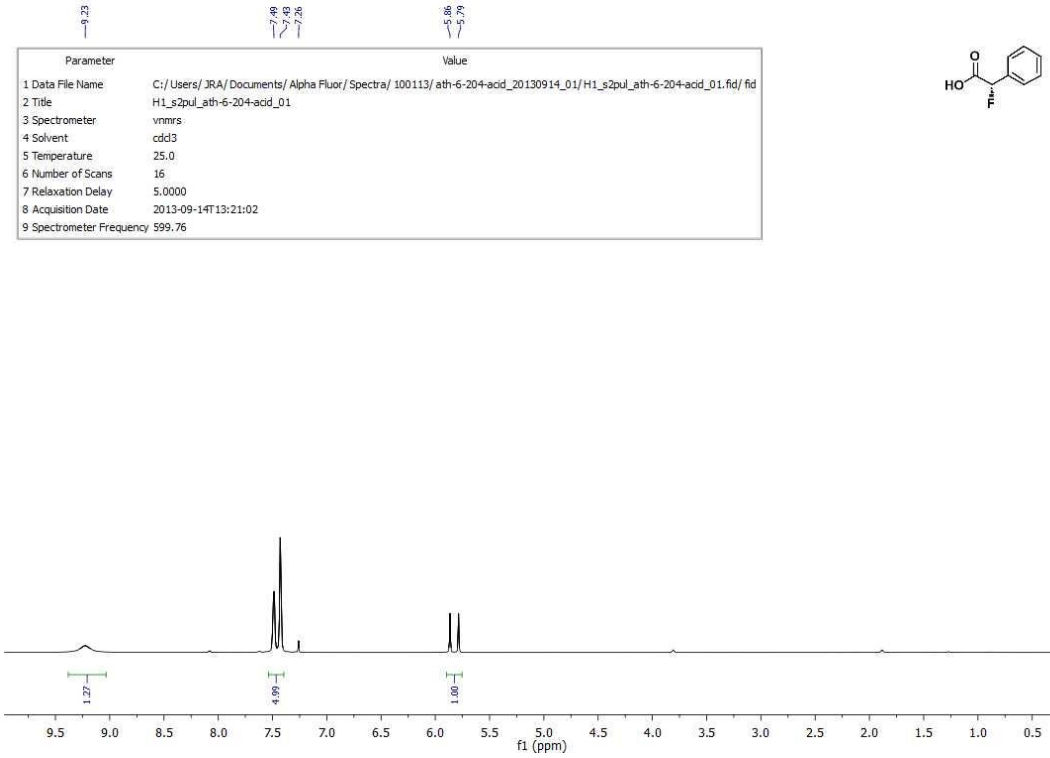
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3 Spectrometer
vnmrs
4 Solvent
cdcl3
5 Temperature
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6 Number of Scans
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7 Relaxation Delay
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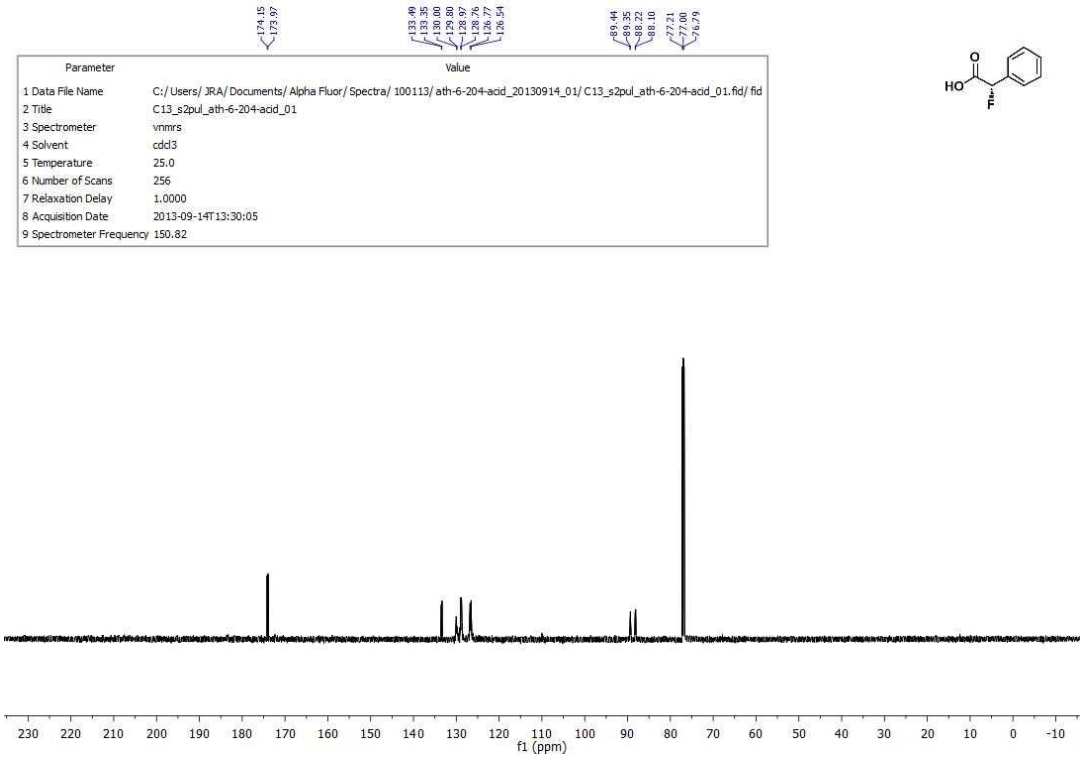
f1 (ppm)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88.10
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77.00
76.79
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3 Spectrometer
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9 Spectrometer Frequency
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f1 (ppm)

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2 Title	F19_s2pul_ath-6-204-acid_01
3 Spectrometer	vnmrs
4 Solvent	cdd3
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7 Relaxation Delay	2.0000
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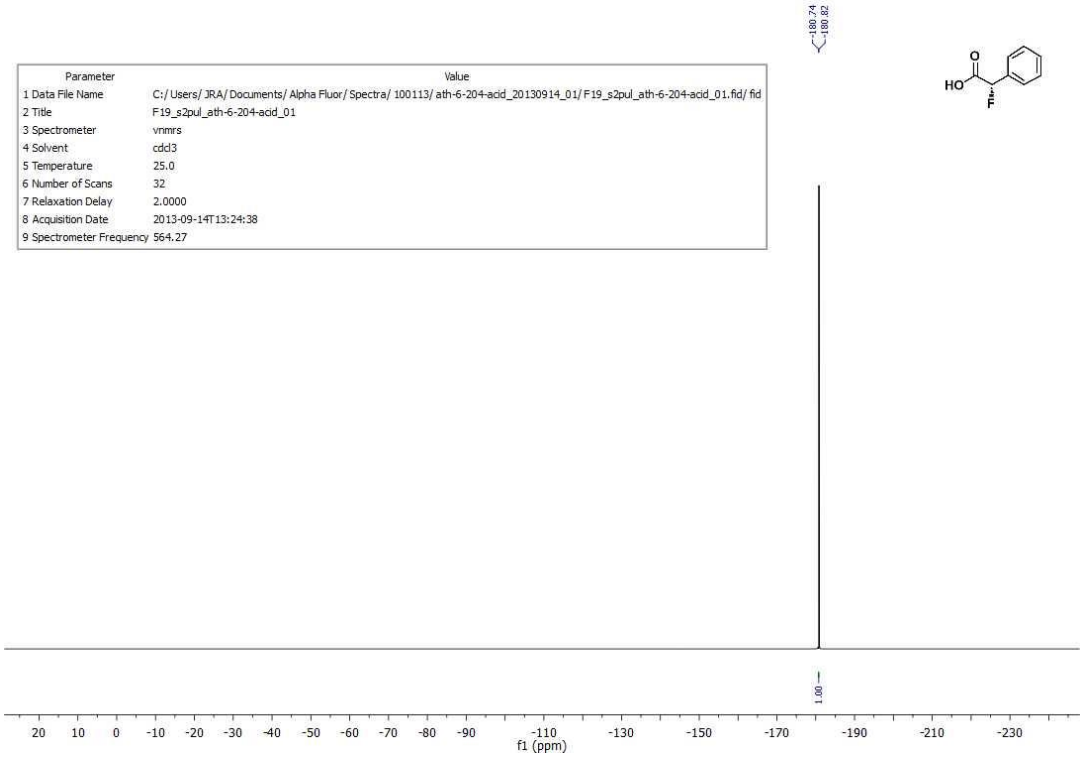

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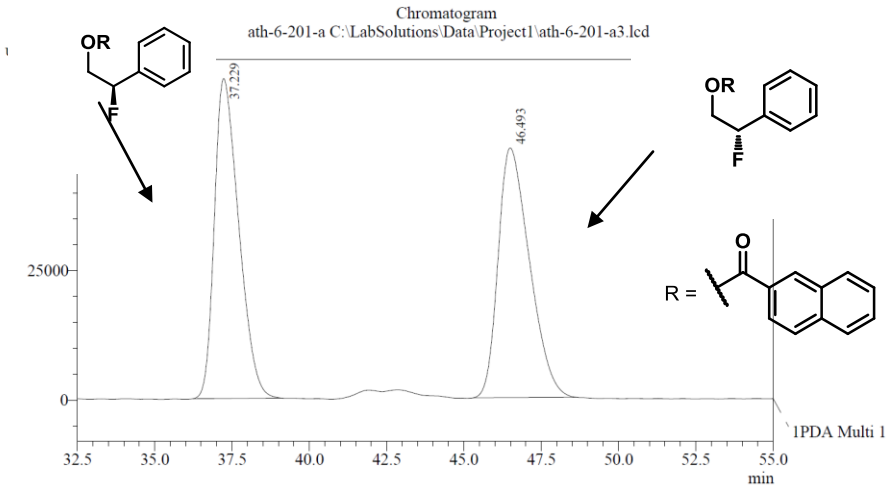

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PeakTable

PDA Ch1 254nm 4nm

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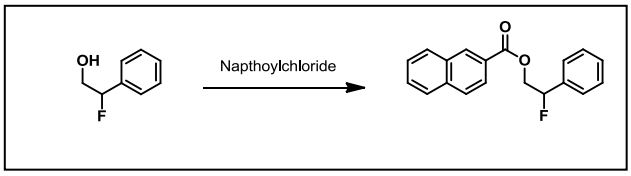

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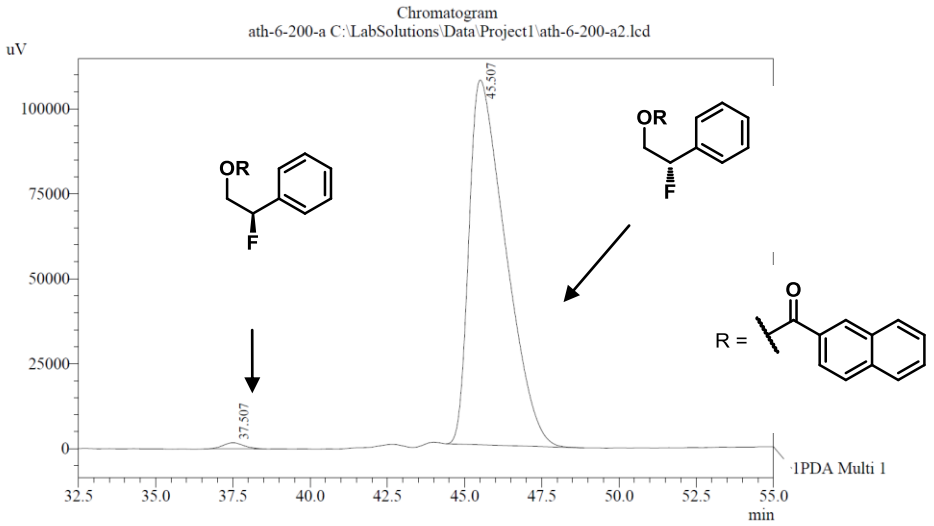

1 PDA Multi 1 / 254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

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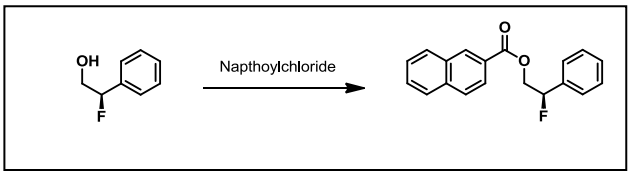
Total		8931224	109130	100.000	100.000



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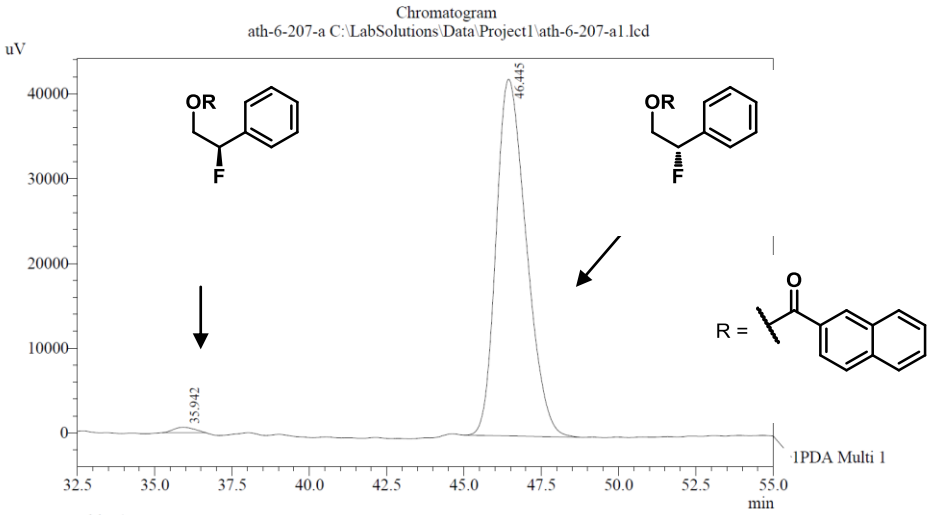

1 PDA Multi 1 / 254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

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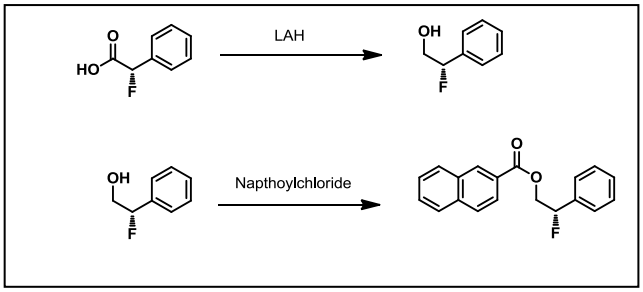
Total		2892870	42747	100.000	100.000



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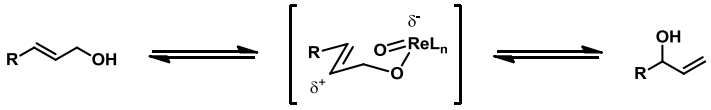
Chapter 4

Regio- and Stereocontrol in Rhenium-Catalyzed Transposition of Allylic Alcohols

4-1: Introduction

Direct catalytic transposition of allylic alcohols is a powerful approach to the synthesis of complex hydroxylated organic compounds.[126] Several transition metal catalysts have been developed for this purpose, including vanadium,[127] molybdenum,[127] and rhenium reagents.[128] Among these, rhenium(VII) oxide and triphenylsilyl perrhenate have been found to be superior in terms of reactivity and chemoselectivity, displaying high activity at low temperatures with no competitive oxidation observed with some of the other catalysts. One drawback of the reversible process (eq 1) is a general lack of regioselectivity;[129] stereoselectivity in the transposition of primary allylic alcohols is also low.



(1)

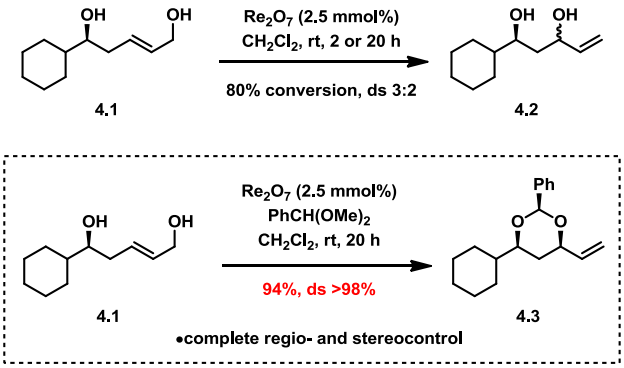
We describe a practical method that allows for control of the regio- and stereoselectivity in the rhenium-catalyzed transposition of allylic alcohols, expanding the scope of the reaction for the stereoselective synthesis of complex molecules.[130]

4-2: Initial Screen and Reaction Optimization

In our initial experiments, rearrangement of substrate **4.1** in the presence of Re_2O_7 (2.5 mol %) occurred with low regio- and stereoselectivity as expected, delivering **4.2** with 60% conversion as a 3:2 mixture of diastereomers (Scheme 4.2.1). We hypothesized that the

reaction medium must be slightly acidic due to formation of a catalytic amount of perrhenic acid (pK_a= 1.25)[131] upon interaction of rhenium(VII) oxide with the substrate and/or adventitious water.[132] In the presence of a catalytic acid the rearranged product can in principle be trapped as an acetal or ketal, and then the 1,3-*syn* diastereomer should be favored on thermodynamic grounds. Remarkably, upon exposure of **4.1** to benzaldehyde dimethyl acetal and Re_2O_7 (2.5 mol %), essentially a single product was formed in 94% yield after 20 h at room temperature. Thus, the rhenium catalyst performs a dual catalytic function as a transition metal catalyst for the hydroxyl group transposition and as an acid catalyst for acetal formation.

Scheme 4.2.1 Re-Catalyzed Transposition of **4.1**

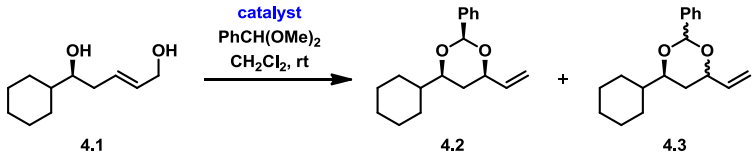


Screening of the reaction parameters demonstrated that although a number of solvents can be used (toluene, Et_2O, THF, CH_2Cl_2),[133] dichloromethane provides the best results in terms of reaction rate. Typically, reactions are characterized by a rapid formation of a diastereomeric mixture of rearranged diol acetals (within ~20 min at room temperature) followed by slow equilibration of the acetals to the 1,3-*syn* product (**4.3**).

The influence of reaction time with alternative rhenium catalysts is summarized in Table 4.2.1. With all three catalysts studied, methyltrioxorhenium (MTO), $Ph_3SiOReO_3$, and

Re_2O_7, the rearrangement/acetalization was complete within 3 h at room temperature. As expected, MTO is the least reactive catalyst.[127c,134] Notably, with *all* of the three rhenium catalysts the initial acetal formation was followed by equilibration to **4.3**. The highest rate of equilibration was observed with Re_2O_7, generating **4.3** with >98% selectivity after 20 h. With $Ph_3SiOReO_3$, a high level of selectivity (96:4) was also reached after 20 h at room temperature.

Table 4.2.1 Influence of the Catalyst and Reaction Time



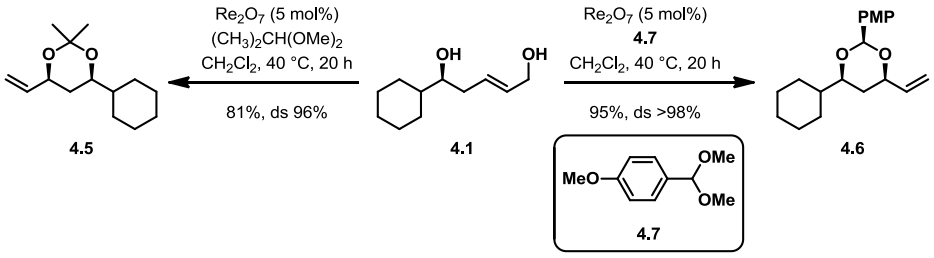
4.1 4.2 4.3

Entry	Catalyst (mol %)	Time	Conversion[a] (%)	4.2:4.3[a]
1	$MeReO_3$ (5)	40 min	45	36:64
2	$MeReO_3$ (5)	3 h	100	40:60
3	$MeReO_3$ (5)	20 h	100	63:37
4	$Ph_3SiOReO_3$ (5)	40 min	100	65:35
5	$Ph_3SiOReO_3$ (5)	3 h	100	87:13
6	$Ph_3SiOReO_3$ (5)	20 h	100	**96:4**
7	Re_2O_7 (2.5)	40 min	100	80:20
8	Re_2O_7 (2.5)	3 h	100	91:9
9	**Re_2O_7 (2.5)**	**20 h**	**100**	**>98:2**

(a) Measured by 500 MHz NMR spectroscopy using a crude mixture of products.

As illustrated in Scheme 4.1.2, the highly stereo- and regioselective transposition can be achieved with other commonly employed diol masking groups. Acetonide formation occurred in an 81% yield (96% ds), and the *p*-methoxyphenyl (PMP) acetal **4.6** was isolated in a 95% yield with greater than 98% diastereoselectivity.

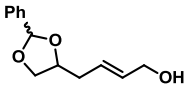
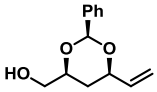
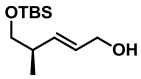
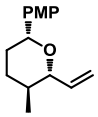
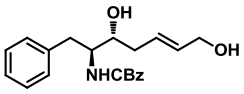
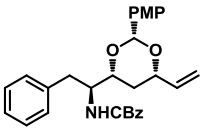
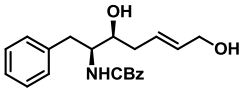
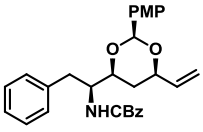
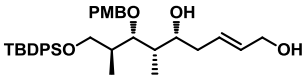
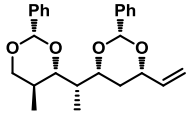
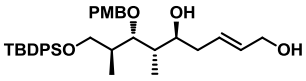
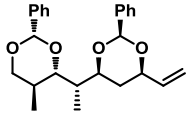
Scheme 4.2.2 Formation of the Acetonide and PMP-Acetals



4-3: Substrate Scope

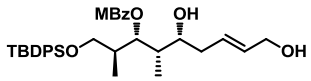
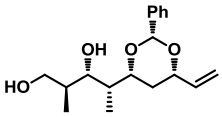
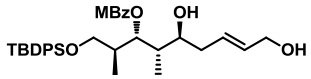
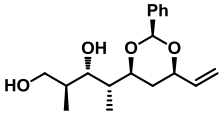
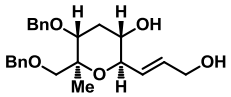
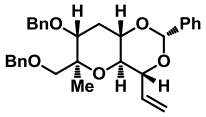
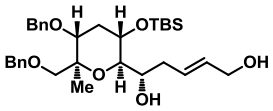
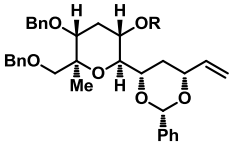
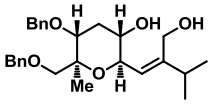
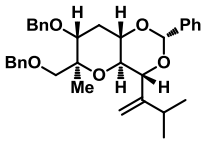
The reaction scope with a range of substrates of higher complexity was explored next (Table 4.3.1). Migration of the resident benzylidene group accompanying the transposition was possible as illustrated in entry 1 (Table 4.3.1). Desilylation can be accomplished simultaneously without a need for an additional step (Table 4.3.1, entry 2). A Cbz-protected primary amine is compatible with the reaction conditions, and the relative stereochemistry of the amino alcohol has no influence on the stereoselectivity of the reaction (Table 4.3.1, entries 3, 4). Upon prolonged exposure (20 h), a complete removal of acid sensitive PMB and TBDPS groups was observed, which were replaced with the benzylidene acetal (Table 4.3.1, entries 5, 6). A more oxidized *p*-methoxybenzoyl (MBz) group and shorter reaction times (4 h) resulted in a much improved conservation of the original protecting groups (Table 4.3.2, entries 1, 2). Functionalized tetrahydropyran substrates underwent the transposition reaction with the generally observed high regiocontrol and high stereoselectivity (Table 4.3.2, entries 3, 4). Thermodynamically disfavored 1,1-disubstituted alkenes can be readily prepared in high yield (Table 4.3.2, entry 5).

Table 4.3.1 Scope of the Re-Catalyzed Transposition/Acetalization with Complex Substrates[a]

Entry	Substrates	Product	yield, dr
1			80%, 96:4
2			84%, 85:15
3			65%, >98:2
4			71%, >98:2
5			79%, >98:2
6			84%, >98:2

(a) Reactions were performed in CH_2Cl_2 (~0.2 M) with 2.5 mol % of Re_2O_7 and 2.0 equiv of $PhCH(OMe)_2$ or 4-MeOPhCH$(OMe)_2$; dr is determined by 500 MHz ^{1}H NMR.

Table 4.3.2 Scope of the Re-Catalyzed Transposition/Acetalization with Complex Substrates[a]

Entry	Substrates	Product	yield, dr
1			76%,[b] >98:2
2			84%,[b] >98:2
3			81%, 96:4
4			82%,[c] >98:2
5			97%, >98:2

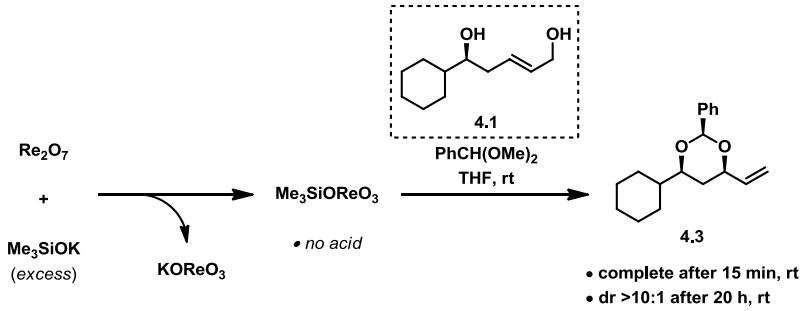
(a) Reactions were performed in CH_2Cl_2 (~0.2 M) with 2.5 mol % of Re_2O_7 and 2.0 equiv of $PhCH(OMe)_2$ or 4-MeOPhCH$(OMe)_2$; dr is determined by 500 MHz ^{1}H NMR. (b) Overall yield after treatment with TBAF. (c) R═H/R═TBS 5.3:1.

An intriguing aspect of the reaction is that the transposition and acetalization are typically complete in an initially nonstereoselective manner within minutes (less than 30 min), followed by relatively slow isomerization to the preferred stereoisomer. In a control experiment, when a 6:3:1 diastereomeric mixture of benzylidene acetals **4.4** was subjected to the standard reaction conditions (dry CH_2Cl_2, argon atmosphere, 2.5 mol % Re_2O_7, rt, 20 h), a single stereoisomer (**4.3**) was isolated in 90% yield. In contrast, treatment of the same

mixture with *p*-TsOH (5 mol %, dry CH_2Cl_2, argon atmosphere, rt, 21 h) resulted in no change.

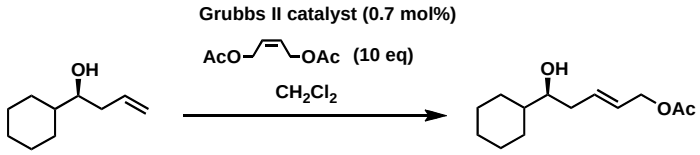
As was also noted by Grubbs and Rychnovsky,[128b,131] addition of 0.2 equiv of 2,6-di-*tert*-butyl-4-methylpyridine (DTMP) completely suppressed the transposition and acetalization with either Re_2O_7 or $Ph_3SiOReO_3$. Addition of Bu_4NOAc or a proton sponge also suppressed the reaction. These results may be explained either by increasing the pH of the medium or by a modification of the catalyst through irreversible complexation.[128b,131] To conclusively establish reactivity in the absence of acid or alternative ligands, we prepared the catalyst in situ using an excess of strongly basic Me_3SiOK (0.35 equiv) and Re_2O_7 (0.20 equiv) in THF.[135] As shown in Scheme 4.3.1, the system maintained full catalytic activity, indicating a possibility where the acetal formation is likely due to the Lewis acidic character of trimethylsilyl perrhenate.

Scheme 4.3.1 Reactivity in the Absence of a Brønsted Acid



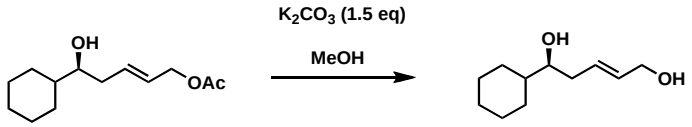
In summary, we developed a method that allows the control of regio- and stereoselectivity by a neighboring hydroxyl group in the Re-catalyzed transposition of allylic alcohols with accompanying formation of acetals.

4-4: Rhenium-Catalyzed Transposition of Allylic Alcohols Supporting Information

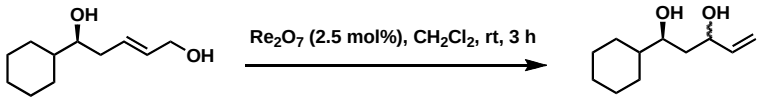


Typical procedure for cross metathesis: (*E*)-5-Cyclohexyl-5-hydroxypent-2-enyl acetate.

Grubbs II catalyst (0.116 g, 0.136 mmol) was added to a solution of the substrate[136] (3.00 g, 19.4 mmol) and *cis*-1,4-diacetoxy-2-butene (33.5 g, 0.19 mol) in degassed dichloromethane (280 ml). The reaction vessel was sealed and heated at 40 °C. After 4 h, the reaction vessel was removed from the oil bath and continued to stir at room temperature for 12 h. The reaction was concentrated on a rotary evaporator, and cis-1,4-diacetoxy-2-butene was distilled off. The 500 MHZ ^{1}H NMR of the crude mixture indicated a 5:1 selectivity favoring the *E*-isomer. The residue was purified by column chromatography (silica, 15% (500 ml) to 20% (500 ml) to 30% EtOAc – hexanes) delivering the product (3.51 g, 15.5 mmol, 80%). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 5.81 (ddd, J1=15.0 Hz, J2=J3=6.5 Hz, 1H); 5.67 (ddd, J1=15.0 Hz, J2=J3=6.0 Hz, 1H); 4.54 (d, J=6.0 Hz, 2H); 3.40 (bs, 1H); 2.34-2.28 (m, 1H); 2.19-2.11 (m, 1H); 2.06 (m, 3H); 1.84 (d, J=12.0 Hz, 1H); 1.80-1.72 (m, 2H); 1.68-1.61 (m, 2H); 1.51 (bs, 1H); 1.38-1.31 (m, 1H); 1.28-0.97 (m, 5H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 171.1, 132.9, 127.3, 75.2, 65.2, 43.4, 37.4, 29.3, 28.2, 26.7, 26.5, 26.3, 21.2. HRMS (ESI) calcd for $C_{13}H_{22}O_3Na$ [M+Na] 249.1467, found 249.1474.

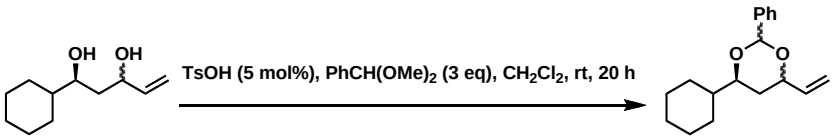


Typical procedure for deacetylation: **(*E*)-5-Cyclohexylpent-2-ene-1,5-diol.** Potassium carbonate (3.22 g, 23.3 mmol) was added to a solution of the substrate (3.51 g, 15.5 mmol) in methanol (78 ml) at 0 °C. After 10 min, the reaction was warmed to rt and continued to stir for 1 h 20 min. Dilute with water and ethyl acetate. The mixture was extracted with ethyl acetate (4x30 ml), and the organic layers were washed with brine, dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 60% to 80% to 100% EtOAc – hexanes) delivering the product (2.52 g, 13.7 mmol, 88%). IR (cm^{-1}) 3306.4, 2925.5, 1668.1, 1095.4; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 5.79-5.70 (m, 2H); 4.16-4.10 (m, 2H); 3.42-3.37 (m, 1H); 2.34-2.29 (m, 1H); 2.17-2.11 (m, 1H); 1.87-1.82 (m, 1H); 1.79-1.74 (m, 2H); 1.70-1.64 (m, 2H); 1.53 (bs, 1H); 1.45-1.40 (m, 1H); 1.39-1.32 (m, 1H); 1.29-0.97 (m, 5H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 132.3, 129.6, 75.4, 63.4, 43.4, 37.2, 29.2, 28.4, 26.7, 26.4, 26.3. HRMS (ESI) calcd for $C_{11}H_{20}O_2Na$ [M+Na] 207.1361, found 207.1356.

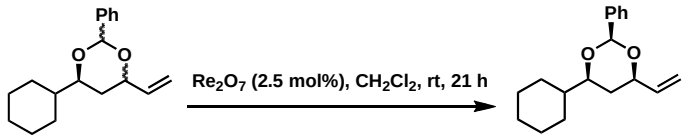


1-Cyclohexylpent-4-ene-1,3-diol, mixture of diastereomers. Rhenium(VII) oxide (6 mg, 0.013 mmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). Dichloromethane (2 ml) was added to the flask. The substrate (92 mg, 0.50 mmol) in dichloromethane (3 ml total with rinses) was added to the reaction vessel. After 3 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture was stirred vigorously for 10 min. The aqueous layer was extracted with

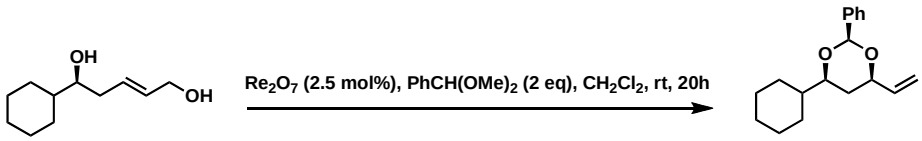
dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 40% EtOAc – hexanes) delivering the product (55.3 mg, 0.300 mmol, 60%). The remaining starting material was not collected. ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 5.94 (ddd, J1=17.0 Hz, J2=10.5 Hz, J3=5.5 Hz, 0.4H); 5.89 (ddd, J1=17.5 Hz, J2=10.5 Hz, J3=6.5 Hz, 0.6H); 5.30 (ddd, J=17.0 Hz, J2=J3=1.5 Hz, 0.4H); 5.26 (ddd, J1=17.5 Hz, J2=J3=1.5 Hz, 0.6H); 5.14 (ddd, J1=11.0 Hz, J2=J3=1.5 Hz, 0.4H); 5.10 (ddd, J1=10.5 Hz, J2=1.5 Hz, 0.6H); 4.47 (bs, 0.4H); 4.36 (bs, 0.6H); 3.72-3.64 (m, 1H); 2.95 (s, 0.6H); 2.63 (s, 0.6H); 2.50 (d, J=4.5 Hz, 0.4H); 2.11 (d, J=3.5 Hz, 0.4H); 1.86-1.53 (m, 7H); 1.39-1.31 (m, 1H); 1.28-0.95 (m, 5H). LRMS (ESI) calcd for $C_{11}H_{20}O_2Na$ [M+Na] 207, found 207.



4-Cyclohexyl-2-phenyl-6-vinyl-1,3-dioxane, mixture of diastereomers. *p*-Toluenesulfonic acid (3 mg, 0.015 mmol) was added to a solution of the substrate (55 mg, 0.300 mmol), and benzaldehyde dimethyl acetal (0.14 ml, 0.90 mmol) in dichloromethane (3.0 ml). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x20 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 5% EtOAc – hexanes) delivering the product (65.5 mg, 0.240 mmol, 80%) as a 6:3:1 mixture of three diastereomers as determined by 500 MHz ^{1}H NMR.

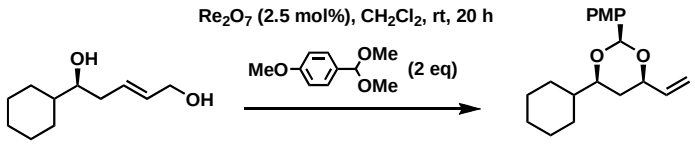


***cis,cis*-4-Cyclohexyl-2-phenyl-6-vinyl-1,3-dioxane.** Rhenium(VII) oxide (6.7 mg, 13.7 mol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). Dichloromethane (2.5 ml) was added to the flask. The substrate (0.150 g, 0.551 mmol) in dichloromethane (3 ml total with rinses) was added to the reaction vessel. After 21 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 5% EtOAc – hexanes) delivering the product (0.136 mg, 0.498 mmol, 90%). IR (cm^{-1}) 3423.0, 3035.4, 2926.5, 1451.17, 1273.6; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.55-7.53 (m, 2H); 7.38-7.30 (m, 3H); 5.95 (ddd, J1=17.0 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.57 (s, 1H); 5.35 (ddd, J1=17.5 Hz, J2=J3=1.5 Hz, 1H); 5.17 (ddd, J1=11.0 Hz, J2=J3=1.5 Hz, 1H); 4.33 (dddd, J1=10.0 Hz, J2=5.5 Hz, J3=3.0 Hz, J4=1.5 Hz, 1H); 3.59 (ddd, J1= 11.0 Hz, J2=7.0 Hz, J3=2.5 Hz, 1H); 2.04-2.02 (m, 1H); 1.78-1.75 (m, 3H); 1.70-1.67 (m, 2H); 1.57-1.50 (m, 2H); 1.30-1.13 (m, 3H); 1.11-1.01 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 139.2, 138.4, 128.7, 128.3, 126.4, 115.5, 100.7, 81.2, 77.7, 42.8, 34.2, 29.1, 28.4, 26.8, 26.3, 26.2. HRMS (ESI) calcd for $C_{18}H_{24}O_2Na$ [M+Na] 295.1674, found 295.1674.



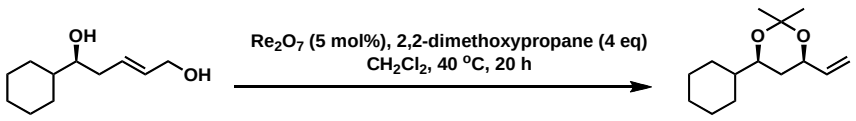
<u>Typical procedure for the stereoselective Re-catalyzed transposition/ acetalization</u>: *cis,cis*-4-Cyclohexyl-2-phenyl-6-vinyl-1,3-dioxane. Rheni-um(VII) oxide (12 mg, 0.025 mmol)

was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3), and dichloromethane (5 ml) was added. The substrate (0.184 g, 1.00 mmol) in dichloromethane (5 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (0.30 ml, 2.00 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x20 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 5% EtOAc – hexanes) delivering the product (0.255 g, 0.936 mmol, 94%). IR (cm^{-1}) 3423.0, 3035.4, 2926.5, 1451.17, 1273.6; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.55-7.53 (m, 2H); 7.38-7.30 (m, 3H); 5.95 (ddd, J1=17.0 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.57 (s, 1H); 5.35 (ddd, J1=17.5 Hz, J2=J3=1.5 Hz, 1H); 5.17 (ddd, J1=11.0 Hz, J2=J3=1.5 Hz, 1H); 4.33 (dddd, J1=10.0 Hz, J2=5.5 Hz, J3=3.0 Hz, J4=1.5 Hz, 1H); 3.59 (ddd, J1= 11.0 Hz, J2=7.0 Hz, J3=2.5 Hz, 1H); 2.04-2.02 (m, 1H); 1.78-1.75 (m, 3H); 1.70-1.67 (m, 2H); 1.57-1.50 (m, 2H); 1.30-1.13 (m, 3H); 1.11-1.01 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 139.2, 138.4, 128.7, 128.3, 126.4, 115.5, 100.7, 81.2, 77.7, 42.8, 34.2, 29.1, 28.4, 26.8, 26.3, 26.2. HRMS (ESI) calcd for $C_{18}H_{24}O_2Na$ [M+Na] 295.1674, found 295.1674.



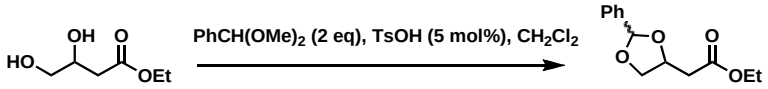
***cis,cis*-4-Cyclohexyl-2-(4-methoxyphenyl)-6-vinyl-1,3-dioxane.** Rhenium(VII) oxide (12 mg, 0.025 mmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (5 ml). The substrate (0.184 g, 1.00 mmol) in dichloromethane (5 ml total with rinses) was added to the reaction vessel

followed by addition of anisaldehyde dimethyl acetal (0.34 ml, 2.00 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x20 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 5% EtOAc – hexanes) delivering the product (0.285 g, 0.942 mmol, 94%). IR (cm^{-1}) 2926.5, 1615.1, 1517.7, 1248.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.47-7.43 (m, 2H); 6.89-6.87 (m, 2H); 5.94 (ddd, J1=17.5 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.52 (s, 1H); 5.33 (ddd, J1=17.5 Hz, J2=J3=1.5 Hz, 1H) 5.15 (ddd, J1=10.5 Hz, J2=J3=1.5 Hz, 1H); 4.30 (dddd, J1=9.5 Hz, J2=5.5 Hz, J3=2.5 Hz, J4=1.0 Hz, 1H); 3.80 (s, 3H); 3.57 (ddd, J1=11.5 Hz, J2=7.0 Hz, J3=2.5 Hz, 1H); 2.0 (bd, J=13.0 Hz, 1H); 1.77-1.71 (m, 3H); 1.70-1.64 (m, 2H); 1.55-1.48 (m, 2H); 1.30-1.12 (m, 3H); 1.10-0.98 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 159.9, 138.4, 131.8, 127.6, 115.5, 113.7, 100.6, 81.1, 77.6, 55.5, 42.8, 34.1, 29.0, 28.4, 26.8, 26.3, 26.2. HRMS (ESI) calcd for $C_{19}H_{26}O_3Na$ [M+Na] 325.1780, found 325.1791.



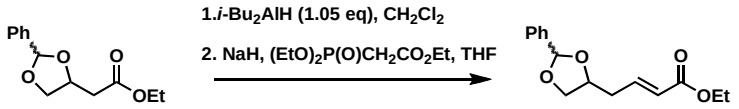
***cis*-4-Cyclohexyl-2,2-dimethyl-6-vinyl-1,3-dioxane.** Rhenium(VII) oxide (24 mg, 0.050 mmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). Dichloromethane (5 ml) was added to the flask. The substrate (0.184 g, 1.00 mmol) in dichloromethane (5 ml total with rinses) was added to the reaction vessel followed by addition of 2,2-dimethoxypropane (0.60 ml, 4.00 mmol). The reaction vessel was sealed and heated at 40 °C. After 20 h, the reaction vessel was allowed to cool to room temperature, and saturated aqueous sodium bicarbonate was added. The biphasic mixture stirred vigorously for 10

min. The aqueous layer was extracted with dichloromethane (3x20 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 5% EtOAc – hexanes) delivering the product (0.182 g, 0.811 mmol, 81%). IR (cm^{-1}) 2924.5, 1645.0, 1026.9; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 5.83 (ddd, J1=16.5 Hz, J2=10.0 Hz, J3=5.5 Hz, 1H); 5.25 (ddd, J1=17.0 Hz, J2=J3=1.0 Hz, 1H); 5.11 (ddd, J1=10.5 Hz, J2=J3=1.0 Hz, 1H); 4.31 (dddd, J1=10.0 Hz, J2=6.0 Hz, J3=2.5 Hz, J4=1.5 Hz, 1H); 3.57 (ddd, J1=11.5 Hz, J2=7.0 Hz, J3=2.5 Hz, 1H); 1.94-1.88 (m, 1H); 1.75-1.64 (m, 4H); 1.53 (ddd, J1=13.0 Hz, J2=J3=3.0 Hz, 1H); 1.45 (s, 3H); 1.41 (s, 3H); 1.37-1.09 (m, 5H); 0.99-0.88 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 139.3, 115.4, 98.7, 73.2, 70.7, 43.0, 34.1, 30.5, 29.1, 28.2, 26.9, 26.3, 26.2, 20.0. LRMS (CI) calcd for $C_{14}H_{24}O_2Na$ [M+H] 225, found 225.



Ethyl 2-(2-phenyl-1,3-dioxolan-4-yl)acetate. *p*-Toluenesulfonic acid (0.118 g, 12.4 mmol) was added to a solution of the substrate[137] (1.84 g, 12.4 mmol) and benzaldehyde dimethyl acetal (5.60 ml, 37.2 mmol) in dichloromethane (41 ml) at rt. After 30 min, saturated aqueous sodium bicarbonate was added. The aqueous layer was extracted with dichloromethane (2x30 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% → 20% EtOAc – hexanes) delivering the product (1.80 g, 7.62 mmol, 61%). IR (cm^{-1}) 3064.3, 2935.1, 1717.3, 1654.6, 1602.6, 1273.8; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.49-7.45 (m, 2H); 7.41-7.35 (m, 3H); 5.95 (s, 0.5H); 5.81 (s, 0.5H); 4.66-4.60 (m, 1H); 4.37 (dd, J1=8.0 Hz, J2=5.5 Hz, 0.5H); 4.222 (dd, J1=8.5 Hz, J2=6.5 Hz, 0.5H); 4.20-4.13 (m, 2H); 3.87 (dd, J1=8.0 Hz, J2=5.5 Hz, 0.5H); 3.75 (dd, J1=8.5 Hz, J2=6.5 Hz, 0.5H); 2.85 (dd, J1=16.0 Hz, J2=6.0 Hz, 1H); 2.63 (ddd, J1=16.0 Hz, J2=J3=8.0 Hz,

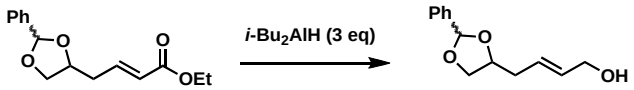
1H); 1.28 (dd, J1=J2=6.5 Hz, 1.5H); 1.27 (dd, J1=J2=7.0 Hz, 1.5H). LRMS (ESI) calcd for $C_{13}H_{16}O_4Na$ [M+Na] 259.1, found 259.1.



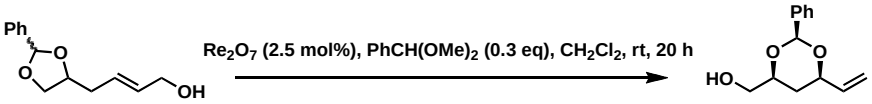
(*E*)-Ethyl 4-(2-phenyl-1,3-dioxolan-4-yl)but-2-enoate. Diisobutylaluminum hydride (1 M in toluene, 6.45 ml, 6.44 mmol) was added to a solution of the substrate (1.45 g, 6.13 mmol) in dichloromethane (30.6 ml) at -78 °C over 30 min. The reaction was allowed to stir at -78 °C for an additional 30 min before being quenched with a solution of Rochelle's salt at -78 °C. The mixture was stirred vigorously at rt for 2 h, the layers were separated, and the aqueous layer was extracted with dichloromethane (2x30 ml). The organic layers were dried with sodium sulfate and concentrated, and the residue was submitted to the next reaction without further purification.

To a suspension of sodium hydride (60% suspension in oil, 0.295 g, 7.36 mmol) and dry THF (20.6 ml) was added triethyl phosphonoacetate (1.85 ml, 9.19 mmol) at -10 °C, and the mixture was stirred for 30 min. A solution of the residue in THF (10 ml total with rinses) was added to the solution at -10 °C. The mixture was allowed to stir for 30 min before being quenched with saturated aqueous ammonium chloride. The mixture was extracted with ethyl acetate (3x30 ml), and the combined organic layers were washed with water and brine, dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 20% EtOAc – hexanes) delivering the product (1.28 g, 4.88 mmol, 80% over 2 steps). IR (cm^{-1}) 3064.3, 2935.1, 1717.3, 1654.6, 1602.6, 1273.8; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.50-7.45 (m, 2H); 7.40-7.36 (m, 3H); 7.01-6.94 (m, 1H); 5.97-5.92 (m, 1H); 5.96 (s, 0.4H); 5.81 (s, 0.6H); 4.42-4.34 (m, 1H); 4.27 (dd, J1=8.0 Hz, J2=6.0 Hz, 0.4 H); 4.22-4.17 (m, 2H); 4.13 (dd, J1=8.0 Hz, J2=7.0 Hz, 0.6H); 3.79 (dd, J1=8.0 Hz, J2=6.0 Hz, 0.6H); 3.69 (dd, J1=8.0 Hz, J2=7.0 Hz,

0.4H); 2.68-2.61 (m, 1H); 2.58-2.49 (m, 1H); 1.30-1.26 (m, 3H). LRMS (ESI) calcd for $C_{15}H_{18}O_4Na$ [M+Na] 285.1, found 285.1.

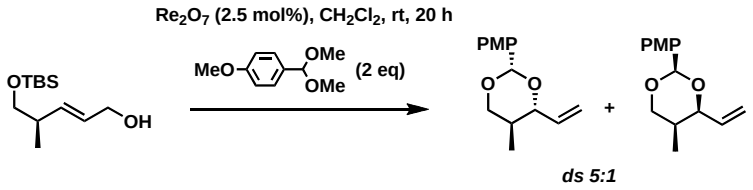


(*E*)-4-(2-phenyl-1,3-dioxolan-4-yl)but-2-en-1-ol. Diisobutylaluminum hydride (1 M in toluene, 14.5 ml, 14.5 mmol) was added to a solution of the substrate (1.27 g, 4.84 mmol) in dichloromethane (24.2 ml) at -78 °C. The reaction was allowed to warm from -78 °C to -20 °C over 1 h before being quenched with a solution of Rochelle's salt at 0 °C. The mixture was stirred vigorously for 2 h, the layers were separated, and the aqueous layer was extracted with dichloromethane (2x30 ml). The combined organic layers were dried with sodium sulfate and concentrated, and the residue was purified by column chromatography (silica, 60% → 80% ethyl acetate – hexanes) to give the desired product (0.571 g, 2.59 mmol, 54%). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.52-7.45 (m, 2H); 7.40-7.33 (m, 3H); 5.95 (s, 1H); 5.82-5.71 (m, 2H); 4.30 (dd, J1=8.0 Hz, J2=6.5 Hz, 1H); 4.25-4.22 (m, 1H); 4.14-4.11 (m, 2H); 3.68 (dd, J1=8.0 Hz, J2=7.0 Hz, 1H); 2.52 (ddd, J1=13.5 Hz, J2=J3=6.5 Hz, 1H); 2.38 (ddd, J1=13.5 Hz, J2=J3=7.0 Hz, 1H); 1.36-1.30 (m, 1H). LRMS (ESI) calcd for $C_{13}H_{16}O_3Na$ [M+Na] 243.1, found 243.1.



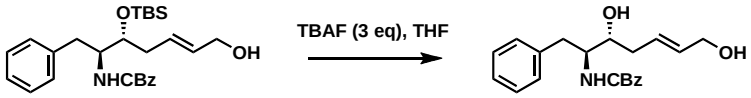
***cis,cis*-2-Phenyl-6-vinyl-1,3-dioxan-4-yl)methanol.** The typical procedure was followed: rhenium(VII) oxide (12 mg, 0.025 mmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). Dichloromethane (2.5 ml) was added. The substrate (0.220 g, 1.00 mmol) in dichloromethane (2.5 ml total with rinses) was added to the

reaction vessel followed by addition of benzaldehyde dimethyl acetal (45 □l, 0.30 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x20 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 35% EtOAc – hexanes) delivering the product (0.175 g, 0.795 mmol, 80%). IR (cm^{-1}) 3420.1, 3067.2, 2921.6, 1647.9, 1601.59, 1275.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.54-7.52 (m, 2H); 7.40-7.34 (m, 3H); 5.95 (ddd, J1=17.5 Hz, J2=11.0 Hz, J3=5.5 Hz, 1H); 5.63 (s, 1H); 5.36 (ddd, J1=17.0 Hz, J2=J3=1.5 Hz, 1H); 5.20 (ddd, J1=11.0 Hz, J2=J3=1.5 Hz, 1H); 4.40-4.36 (s, 1H); 4.05-4.00 (m, 1H); 3.74-3.68 (m, 1H); 3.65 (dd, J1=11.5 Hz, J2=6.5 Hz, 1H); 2.23 (bs, 1H); 1.69-1.59 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 138.4, 137.7, 129.5, 128.5, 126.5, 116.1, 100.9, 77.3, 77.1, 65.8, 32.4. HRMS (ESI) calcd for $C_{13}H_{16}O_3Na$ [M+Na] 243.0997, found 243.0993.



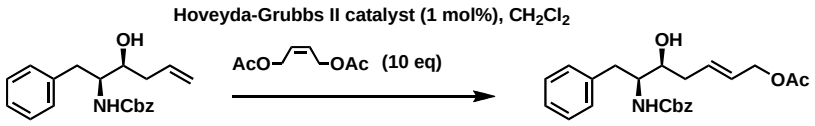
(2*S*,4*R*,5*S*)-2-(4-Methoxyphenyl)-5-methyl-4-vinyl-1,3-dioxane. Following the typical procedure, rhenium(VII) oxide (7.9 mg, 0.016 mmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (1.25 ml). The substrate[138] (0.150 g, 0.651 mmol) in dichloromethane (2.5 ml total with rinses) was added to the reaction vessel followed by addition of anisaldehyde dimethyl acetal (0.220 ml, 1.30 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was

extracted with dichloromethane (3x20 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 5% EtOAc – hexanes) delivering the product (0.128 g, 0.546 mmol, 84%) as a 5:1 inseparable mixture diastereomers. IR (cm^{-1}) 2958.3, 1615.1, 1518.7, 1249.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): (major diastereomer) 7.46-7.43 (m, 2H); 6.90-6.87 (m, 2H); 5.89 (ddd, J1=17.5 Hz, J2=10.5 Hz, J3=7.4 Hz, 1H); 5.50 (s, 1H); 5.35 (ddd, J1=17.5 Hz, J2=J3=2.0 Hz, 1H); 5.25 (ddd, J1=10.5 Hz, J2=1.5 Hz, J3=0.5 Hz, 1H); 4.15 (dd, J1=11.5 Hz, J2=5.0 Hz, 1H); 3.87 (dd, J1=10.0 Hz, J2=7.0 Hz, 1H); 3.80 (s, 3H); 3.54 (dd, J1=J2=11.0 Hz, 1H); 1.94-1.86 (m, 1H); 0.79 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 160.1, 136.2, 131.2, 127.7, 118.1, 113.8, 101.1, 84.9, 73.1, 55.5, 34.0, 12.5. HRMS (ESI) calcd for $C_{14}H_{18}O_3Na$ [M+Na] 257.1154, found 257.1147.

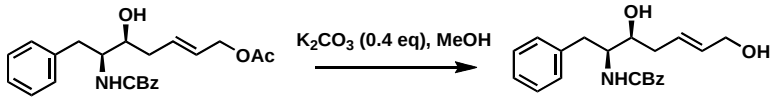


***anti*-Benzyl 3,7-dihydroxy-1-phenylhept-5-en-2-ylcarbamate.** Tetrα–*n*-butyl-ammonium fluoride (1M in THF, 0.385 ml, 0.385 mmol) was added to a solution of the substrate[139] (60 mg, 0.128 mmol) in THF (0.25 ml) at room temperature. The solution was stirred at room temperature for 2 h and was quenched with a saturated solution of ammonium chloride. The aqueous layer was extracted with ethyl acetate (3x10 ml), dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 5% methanol - dichloromethane) to give the desired diol (43.1 mg, 0.121 mmol, 95%). IR (cm^{-1}) 3394.1, 3029.6, 2930.2, 1696.1, 1516.7, 1254.5; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.37-7.16 (m, 10H); 5.69 (ddd, J1=16.0 Hz, J2=J3=5.5 Hz, 1H); 5.60 (ddd, J1=15.0 Hz, J2=J3=6.5 Hz, 1H); 5.17 (bd, J=8.5 Hz, 1H); 5.08 (AB, JA=16.0 Hz, JB=12.5 Hz, 2H); 4.07 (d, J=5.0 Hz, 2H); 3.85 (dd, J1=15.0 Hz, J2=7.0 Hz, 1H); 3.63 (dd, J1=J2=6.5 Hz, 1H); 2.95-2.82 (m, 2H); 2.23 (dd,

J1=J2=7.5 Hz, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 156.8, 138.3, 136.7, 133.0, 129.5(2C), 128.7(2C), 128.3, 128.1, 126.7, 70.4, 66.9, 63.4, 56.0, 39.0, 37.9. HRMS (ESI) calcd for $C_{21}H_{25}NO_4Na$ [M+Na] 378.1681, found 378.1667.

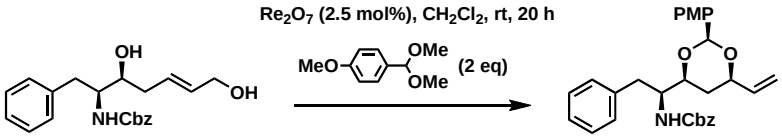


***syn*-6-(Benzyloxycarbonylamino)-5-hydroxy-7-phenylhept-2-enyl acetate**. The typical procedure for cross-metathesis was followed using Hoveydα–Grubbs II catalyst (17 mg, 27.9 μmol), *cis*-1,4-diacetoxy-2-butene (0.480 g, 2.79 mmol) in degassed dichloromethane (4.2 ml). The crude product (*E*-selectivity 10:1) was purified by column chromatography (silica, 30% (350 ml) to 45% (250 ml) to 50% EtOAc – hexanes) delivering the product (57.5 mg, 0.145 mmol, 52%). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm):7.36-7.18 (m, 10H); 5.86-5.77 (ddd, J1=13.5 Hz, J2=J3=6.5 Hz, 1H); 5.73-5.67 (ddd, J1=12.5 Hz, J2=J3=6.0 Hz, 1H); 5.03 (s, 2H); 4.92-4.86 (m, 1H); 4.55-4.54 (d, J=6.0 Hz, 2H); 3.96-3.86 (m, 1H); 3.81-3.72 (m, 1H); 2.96 (dd, J1=14.0 Hz, J2=4.5 Hz, 1H); 2.84-2.78 (m, 1H); 2.64-2.58 (m, 1H); 2.39-2.33 (m, 1H); 2.32-2.24 (m, 1H); 2.07 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 171.1, 156.6, 137.9, 136.5, 131.6, 129.5, 128.8, 128.7, 128.3, 128.1, 127.9, 126.8, 72.8, 67.0, 65.0, 56.7, 37.0, 35.5, 21.2. HRMS (ESI) calcd for $C_{23}H_{27}NO_5Na$ [M+Na] 378.1681, found 378.1667.



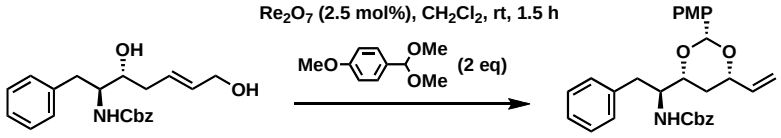
***syn*-Benzyl 3,7-dihydroxy-1-phenylhept-5-en-2-ylcarbamate.** The typical procedure for deacetylation was followed with potassium carbonate (15.1 mg, 0.109 mmol), the substrate (57.5

mg, 0.145 mmol) in methanol (2.9 ml) at rt. The crude product was crystallized in a mixture of EtOAc and hexanes, delivering the product (43.1 mg, 0.121 mmol, 84%). IR (cm^{-1}) 3031.6, 2940.0, 1694.2, 1603.5, 1548.6; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.36-7.17 (m, 10H); 5.79-5.70 (m, 2H); 5.02 (s, 2H); 4.83 (bd, J=8.0 Hz, 1H); 4.13 (bs, 2H); 3.95-3.86 (m, 1H); 3.78-3.71 (m, 1H); 2.96 (dd, J1=14.0 Hz, J2=4.5 Hz, 1H); 2.81 (dd, J1=13.5 Hz, J2=9.5 Hz, 1H); 2.48 (bs, 1H); 2.35 (ddd, J1=13.5 Hz, J2=J3=4.5 Hz, 1H); 2.29-2.23 (m, 1H); 1.60-1.50 (m, 1H). ^{13}C NMR (125 MHz, CD_3OD); δ(ppm): 158.6, 140.5, 138.7, 133.2, 130.6, 129.66, 129.54, 129.36, 128.9, 128.6, 127.4, 74.7, 67.2, 63.8, 58.6, 38.0, 37.3. HRMS (ESI) calcd for $C_{21}H_{25}NO_4Na$ [M+Na] 378.1681, found 378.1692.



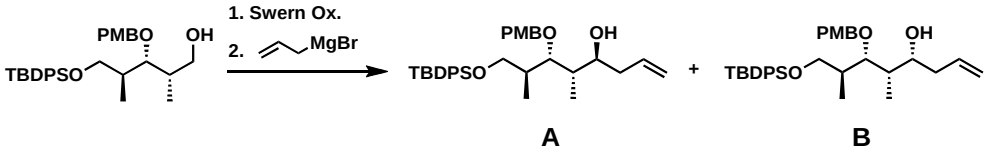
Benzyl 2-(4-methoxyphenyl)-6-vinyl-1,3-dioxan-4-yl)-2-phenylethylcarbamate. The typical procedure was followed: rhenium(VII) oxide (1.2 mg, 2.5 □mol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (0.2 ml). The substrate (35.5 mg, 0.10 mmol) in dichloromethane (0.8 ml total with rinses) was added to the reaction vessel followed by addition of anisaldehyde dimethyl acetal (35 □l, 0.20 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, dichloromethane (to remove anisaldehyde) then 5% ethyl acetate – dichloromethane) delivering the product (33.6 mg, 71 □mol, 71%). IR (cm^{-1}) 3324.7, 3028.7, 2957.3, 1698.0,

1615.1, 1517.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.47 (m, 2H); 7.35-7.18 (m, 10H); 6.92 (m, 2H); 5.92 (ddd, J1=16.5 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.54 (s, 1H); 5.31 (d, J=17.0 Hz, 1H); 5.17 (d, J=10.5 Hz, 1H); 5.03 (s, 2H); 4.83 (d, J=9.5 Hz, 1H); 4.32-4.26 (m, 1H); 4.08-4.01 (m, 1H); 3.90-3.84 (m, 1H); 3.82 (s, 3H); 3.05 (dd, J1=14.0 Hz, J2=3.5 Hz, 1H); 2.93 (dd, J1=14.5 Hz, J2=8.5 Hz, 1H); 1.74-1.64 (m, 2H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 160.2, 156.1, 137.7, 136.7, 131.1, 129.7, 128.7(2C), 128.3, 128.1, 127.8, 126.7, 116.0, 113.8, 100.8, 77.8, 77.4, 66.8, 55.5, 55.3, 35.7, 33.6. HRMS (ESI) calcd for $C_{29}H_{31}NO_5Na$ [M+Na] 496.2100, found 496.2093.



Benzyl 2-(4-methoxyphenyl)-6-vinyl-1,3-dioxan-4-yl)-2-phenylethylcarbamate. The typical procedure was followed: rhenium(VII) oxide (1.2 mg, 2.5 □mol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (0.2 ml). The substrate (35.5 mg, 0.10 mmol) in dichloromethane (0.8 ml total with rinses) was added to the reaction vessel followed by addition of anisaldehyde dimethyl acetal (35 □l, 0.20 mmol). After 1 h 30 min of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, dichloromethane (to remove anisaldehyde) then 5% ethyl acetate – dichloromethane) delivering the product (30.6 mg, 65 □mol, 65%). IR (cm^{-1}) 3430.7, 3331.4, 3028.7, 1717.3, 1648.8, 1516.7, 1248.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.47-7.45 (m,

2H); 7.38-7.23 (m, 10H); 6.93-6.91 (m, 2H); 5.87 (ddd, J1=17.0 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.48 (s, 1H); 5.28 (d, J=17.5 Hz, 1H); 5.21 (d, J=9.5 Hz, 1H); 5.15 (d, J=11.0 Hz, 1H); 5.12 (d, J=13.0 Hz, 1H); 5.06 (d, J=12.5 Hz, 1H); 4.30-4.25 (m, 1H); 3.93 (dd, J1=16.5 Hz, J2=8.0 Hz, 1H); 3.83 (s, 3H); 3.83-3.81 (m, 1H); 3.00-2.92 (m, 2H); 1.76 (dd, J1=24.5 Hz, J2=12.0 Hz, 1H); 1.46 (d, J=13.5 Hz, 1H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 160.2, 156.5, 138.2, 137.6, 136.7, 131.1, 129.6, 128.8, 128.7, 128.3, 128.2, 127.6, 126.7, 115.9, 113.8, 100.6, 77.1, 74.8, 67.0, 55.8, 55.5, 38.5, 33.2. HRMS (ESI) calcd for $C_{29}H_{31}NO_5Na$ [M+Na] 496.2100, found 496.2090.



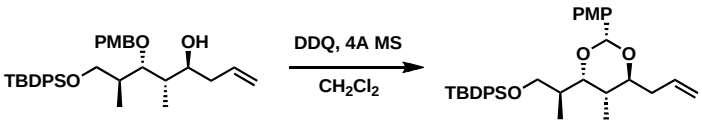
Compounds A and B. Dimethylsulfoxide (0.17 ml, 2.4 mmol) was added to a solution of oxalyl chloride (0.105 ml, 1.18 mmol) in dry dichloromethane (1.9 ml) at -78 °C. After 15 min, a solution of the alcohol[140] (0.300 g, 0.592 mmol) in dichloromethane (4 ml total with rinses) was added. The mixture was stirred for 20 min, and then triethylamine (0.50 ml, 3.55 mmol) was added dropwise. After 15 min the mixture was warmed to 0 °C and stirred for 10 min. The reaction was quenched with 1 M aqueous HCl. The mixture was extracted with ethyl acetate (3x10 ml), and the combined organic layers were washed with water and brine, dried with sodium sulfate, concentrated, and the residue was submitted to the next reaction without further purification.

Allyl magnesium bromide (1M in ether, 0.71 ml, 0.71 mmol), was added to a solution of the crude aldehyde in ether (5.9 ml) at -78 °C. After 30 min of stirring, the reaction was warmed to -15 °C where it continued to stir for an additional 30 min before being quenched with

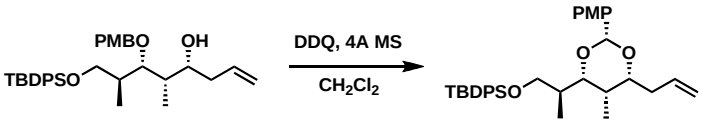
saturated aqueous ammonium chloride. The mixture was extracted with ethyl acetate (3x10 ml). The combined organic layers were washed with water and brine, dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% EtOAc – hexanes) to give product A (88 mg, 0.160 mmol, 27%) and product B (0.175 g, 0.320 mmol, 54% over 2 steps). Data for Product **A**. $[\alpha]_D^{22}$ +11.9 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3466.4, 3048.9, 2930.3, 1613.2, 1513.9, 1247.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.67-7.64 (m, 4H); 7.43-7.40 (m, 2H); 7.38-7.33 (m, 4H); 7.05-7.02 (m, 2H); 6.78-6.75 (m, 2H); 5.89-5.81 (m, 1H); 5.17 (d, J=3.5 Hz, 1H); 5.15 (s, 1H); 4.52 (d, J=10.5 Hz, 1H); 4.39 (d, J=10.5 Hz, 1H); 3.83 (dd, J1=9.0 Hz, J2=1.0 Hz, 1H); 3.80-3.73 (m, 2H); 3.78 (s, 3H); 3.60-3.55 (m, 1H); 2.48-2.42 (m, 1H); 2.23 (d, J=4.0 Hz, 1H); 2.14 (ddd, J1=15.5 Hz, J2=J3=8.0 Hz, 1H); 1.96-1.88 (m, 1H); 1.74-1.68 (m, 1H); 1.09 (s, 9H); 0.96 (d, J=7.0 Hz, 3H); 0.88 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 159.2, 136.00, 135.9, 135.3, 134.1, 134.0, 131.2, 129.8, 129.4, 127.83, 127.78, 118.4, 113.9, 79.7, 73.7, 72.58, 66.2, 55.5, 40.2, 39.8, 38.9, 27.2, 19.5, 14.8, 10.7. HRMS (ESI) calcd for $C_{34}H_{46}O_4SiNa$ [M+Na] 569.3063, found 569.3062. Data for Product **B**. $[\alpha]_D^{22}$ +21.7 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3466.4, 3048.9, 2930.3, 1613.2, 1513.9, 1247.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.67-7.63 (m, 4H); 7.44-7.40 (m, 2H); 7.39-7.33 (m, 4H); 7.03-7.01 (m, 2H); 6.79-6.76 (m, 2H); 5.82 (dddd, J1=18.0 Hz, J2=11.0 Hz, J3=J4=7.5 Hz, 1H); 5.12 (dd, J1=17.5 Hz, J2=1.5 Hz, 1H); 5.09 (dd, J1=12.5 Hz, J2=1.5 Hz, 1H); 4.49 (d, J=10.5 Hz, 1H); 4.43 (d, J=11.0 Hz, 1H); 3.87 (dd, J1=J2=7.0 Hz, 1H); 3.79 (dd, J1=10.0 Hz, J2=5.5 Hz, 1H); 3.78 (s, 3H); 3.73 (dd, J1=9.5 Hz, J2=4.0 Hz, 1H); 3.65 (dd, J1=8.5 Hz, J2=3.0 Hz, 1H); 3.05 (s, 1H); 2.31 (ddd, J1=13.5 Hz, J2=J3=7.0 Hz, 1H); 2.24-2.17 (m, 1H); 2.02-1.97 (m, 1H); 1.81-1.75 (m, 1H); 1.09 (s, 9H); 0.97 (d, J=7.0 Hz, 3H); 0.91 (d, J=7.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 159.4, 136.0, 135.9, 135.7, 133.85, 133.79, 130.3, 129.9, 129.7, 127.9, 127.8,

117.3, 114.0, 85.0, 75.2, 73.8, 65.6, 55.5, 39.9, 38.7, 38.0, 27.2, 19.5, 14.4, 6.7. HRMS (ESI) calcd for $C_{34}H_{46}O_4SiNa$ [M+Na] 569.3063, found 569.3055.

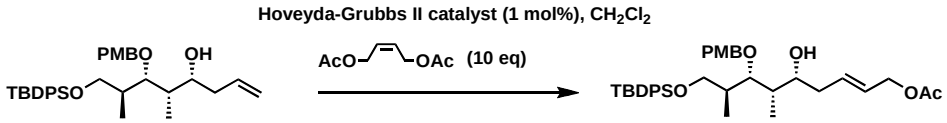
Determination of stereochemistry for Products A and B for the above reaction:



DDQ (9.3 mg, 41.1 μmol) was added to the substrate (15 mg, 27.4 μmol) 4A molecular sieves in dichloromethane (0.5 ml) at 0 °C. After 10 min the reaction flask was warmed to rt where it continued to stir for 20 min before being quenched with saturated aqueous sodium bicarbonate. The mixture was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 7% EtOAc – hexanes) to give desired product (6 mg, 11 μmol, 40%). $[\alpha]_D^{22}$ -14.2 (*c* 0.60, CH_2Cl_2). IR (cm^{-1}) 3071.1, 2931.3, 1615.1, 1516.7, 1248.7; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.67-7.62 (m, 4H); 7.42-7.30 (m, 6H); 7.24-7.20 (m, 2H); 6.88-6.85 (m, 2H); 5.86 (dddd, J1=17.0 Hz, J2=10.0 Hz, J3=J4=7.5 Hz, 1H); 5.68 (s, 1H); 5.14 (dd, J1=17.0 Hz, J2=2.0 Hz, 1H); 5.12 (d, J=9.5 Hz, 1H); 4.15 (dd, J1=10.5 Hz, J2=2.0 Hz, 1H); 3.99-3.94 (m, 2H); 3.81 (s, 3H); 3.65 (dd, J1=9.5 Hz, J2=2.0 Hz, 1H); 2.88-2.82 (m, 1H); 2.57-2.51 (m, 1H); 1.86-1.81 (m, 1H); 1.61 (dddd, J1=J2=J3=7.0 Hz, J4=1.0 Hz, 1H); 1.20 (d, J=7.0 Hz, 3H); 1.07 (s, 9H); 1.02 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 159.9, 135.8, 135.7, 135.0, 134.1, 132.1, 129.72, 129.65, 127.81, 127.77, 127.57, 117.3, 113.7, 94.9, 79.7, 74.4, 64.9, 55.6, 36.9, 35.4, 31.1, 27.1, 19.7, 13.1, 12.7. HRMS (ESI) calcd for $C_{34}H_{44}O_4SiNa$ [M+Na] 567.2907, found 567.2896.

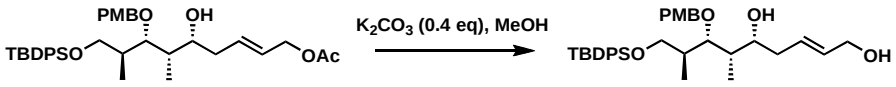


DDQ (8.5 mg, 37.6 μmol) was added to the substrate (13.7 mg, 25.1 μmol) 4A molecular sieves in dichloromethane (0.5 ml) at 0 °C. After 10 min the reaction flask was warmed to rt where it continued to stir for 20 min before being quenched with saturated aqueous sodium bicarbonate. The mixture was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 7% EtOAc – hexanes) to give desired product (7 mg, 12.8 μmol, 51%). $[\alpha]_D^{22}$ +9.8 (*c* 0.70, CH_2Cl_2). IR (cm^{-1}) 3071.1, 2930.3, 1616.1, 1517.7, 1248.7; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.67-7.65 (m, 2H); 7.63-7.61 (m, 2H); 7.42-7.38 (m, 1H); 7.36-7.33 (m, 5H); 7.22-7.19 (m, 2H); 6.88-6.85 (m, 2H); 5.91-5.83 (m, 1H); 5.47 (s, 1H); 5.16 (dd, J1=17.0 Hz, J2=1.5 Hz, 1H); 5.10 (d, J=10.5 Hz, 1H); 3.96 (dd, J1=9.5 Hz, J2=4.0 Hz, 1H); 3.90 (ddd, J1=J2=7.0 Hz, J3=2.0 Hz, 1H); 3.86 (dd, J1=10.5 Hz, J2=1.5 Hz, 1H); 3.82 (s, 3H); 3.64 (dd, J1=9.5 Hz, J2=2.5 Hz, 1H); 2.52-2.46 (m, 1H); 2.29-2.23 (m, 1H); 1.90-1.86 (m, 1H); 1.64-1.60 (m, 1H); 1.05 (s, 9H); 1.04 (d, J=7.0 Hz, 3H); 0.96 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 159.9, 135.81, 135.76, 134.7, 134.1, 134.0, 131.9, 129.7, 129.6, 127.8, 127.75, 127.6, 117.3, 113.7, 101.4, 81.0, 64.9, 55.6, 37.5, 36.9, 32.1, 27.1, 19.7, 12.6, 5.7. HRMS (ESI) calcd for $C_{34}H_{44}O_4SiNa$ [M+Na] 567.2907, found 567.2894.



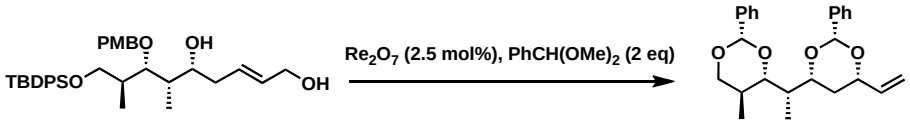
(5*R*,6*S*,7*S*,8*S*,*E*)-9-(*tert*-Butyldiphenylsilyloxy)-5-hydroxy-7-(4-methoxybenzyl-oxy)-6,8-dimethylnon-2-enyl acetate. Prepared following the typical procedure for cross-metathesis with

the Hoveydα–Grubbs II catalyst (1.6 mg, 2.51 μmol) and the substrate (0.137 g, 0.251 mmol). *E*-selectivity >90%. Purified by column chromatography (silica, 20% → 30% EtOAc – hexanes) delivering the product (0.138 g, 0.223 mmol, 89%). $[\alpha]_D^{22}$ +24.8 (c 1.0, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.67-7.63 (m, 4H); 7.45-7.42 (m, 2H); 7.39-7.35 (m, 4H); 7.02-7.00 (m, 2H); 6.79-6.76 (m, 2H); 5.80 (ddd, J1=15.0 Hz, J2=J3=6.5 Hz, 1H); 5.66 (ddd, J1=15.5 Hz, J2=J3=6.0 Hz, 1H); 4.53 (dd, J1=6.5 Hz, J2=1.5 Hz, 2H); 4.68 (d, J=10.5 Hz, 1H); 4.42 (d, J=10.5 Hz, 1H); 3.88 (ddd, J1=7.5 Hz, J2=5.5 Hz, J3=2.0 Hz, 1H); 3.80 (dd, J1=10.0 Hz, J2=5.0 Hz, 1H); 3.78 (s, 3H); 3.73 (dd, J1=10.0 Hz, J2=4.0 Hz, 1H); 3.64 (dd, J1=8.0 Hz, J2=2.5 Hz, 1H); 3.20-3.04 (bs, 1H); 2.33 (ddd, J1=14.0 Hz, J2=J3=7.0 Hz, 1H); 2.21-2.15 (m, 1H); 2.06 (s, 3H); 2.02-1.93 (m, 1H); 1.76-1.72 (m, 1H); 1.09 (s, 9H); 0.97 (d, J=7.0 Hz, 3H); 0.90 (d, J=7.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 171.0, 159.4, 136.0, 135.9, 133.8, 133.7, 133.0, 130.2, 129.9, 129.7, 127.9, 127.8, 126.5, 114.0, 84.9, 75.2, 73.8, 65.6, 65.3, 55.4, 38.6, 38.4, 38.2, 27.2, 21.2, 19.5, 14.4, 6.7. HRMS (ESI) calcd for $C_{37}H_{50}O_6SiNa$ [M+Na] 641.3274, found 641.3255.



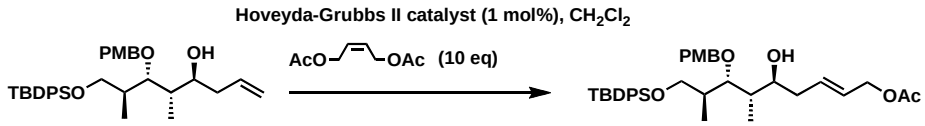
(5*R*,6*S*,7*S*,8*S*,*E*)-9-(*tert*-Butyldiphenylsilyloxy)-7-(4-methoxybenzyloxy)-6,8-dimethylnon-2-ene-1,5-diol. The typical procedure for deacetylation was followed with 0.138 g (0.223 mmol) of the substrate. Purified by column chromatography (silica, 50% to 60% to 80% EtOAc – hexanes) delivering the product (0.115 g, 0.199 mmol, 89%). $[\alpha]_D^{22}$ +24.1 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3398.0, 3071.1, 2931.3, 1514.8, 1248.7; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.70-7.63 (m, 4H); 7.45-7.42 (m, 2H); 7.39-7.35 (m, 4H); 7.02-7.00 (m, 2H); 6.79-6.76

(m, 2H); 5.75 (dd, J1=15.5 Hz, J2=4.5 Hz, 1H); 5.70 (dd, J1=15.0 Hz, J2=5.0 Hz, 1H); 4.50 (d, J=11.0 Hz, 1H); 4.42 (d, J=10.5 Hz, 1H); 4.11 (bs, 1H); 3.86 (dd, J1=J2=6.0 Hz, 1H); 3.80 (dd, J1=10.5 Hz, J2=5.5 Hz, 1H); 3.78 (s, 3H); 3.73 (dd, J1=10.0 Hz, J2=4.5 Hz, 1H); 3.65 (dd, J1=8.5 Hz, J2=3.0 Hz, 1H); 3.14 (bs, 1H); 2.34-2.28 (m, 1H); 2.19-2.15 (m, 1H); 2.02-1.95 (m, 1H); 1.78-1.71 (m, 1H); 1.44-1.35 (bs, 1H); 1.09 (s, 9H); 0.97 (d, J=7.0 Hz, 3H); 0.90 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 159.4, 135.99, 135.95, 133.82, 133.78, 131.8, 130.3, 129.90, 129.72, 127.94, 127.86, 114.1, 85.0, 75.4, 73.8, 65.6, 63.8, 55.5, 38.6, 38.4, 38.3, 27.2, 19.5, 14.4, 6.7. HRMS (ESI) calcd for $C_{35}H_{48}O_5SiNa$ [M+Na] 599.3169, found 599.3158.



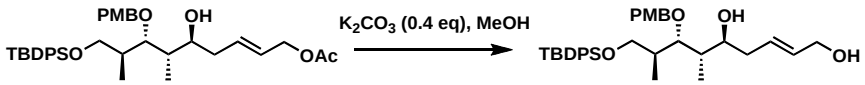
(2*S*,4*S*,5*S*)-5-methyl-2-phenyl-4-((*S*)-1-((2*R*,4*R*,6*S*)-2-phenyl-6-vinyl-1,3-dioxan-4-yl)ethyl)-1,3-dioxane. The typical procedure was followed: rhenium(VII) oxide (1.2 mg, 2.5 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (0.2 ml). The substrate (57.7 mg, 0.10 mmol) in dichloromethane (0.8 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (30 μl, 0.200 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 50% to 80% dichloromethane – hexane) delivering the product (31.1 mg, 79 μmol, 79%). $[\alpha]_D^{22}$ +39.0 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3033.5, 2938.0, 1647.9, 1460.8, 1214.0; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.55-7.53 (m, 2H); 7.49-7.47 (m, 2H);

7.42-7.31 (m, 6H); 5.96 (ddd, J1=17.0 Hz, J2=11.0 Hz, J3=5.5 Hz, 1H); 5.61 (s, 1H); 5.47 (s, 1H); 5.36 (ddd, J1=17.5 Hz, J2=J3=1.5 Hz, 1H); 5.18 (d, J=11.0 Hz, 1H); 4.35-4.33 (m, 1H); 4.14 (dd, J1=11.0 Hz, J2=4.5 Hz, 1H); 3.92 (ddd, J1=11.0 Hz, J2=8.5 Hz, J3=2.5 Hz, 1H); 3.65 (dd, J1=10.5 Hz, J2=2.0 Hz, 1H); 3.54 (dd, J1=J2=11.0 Hz, 1H); 2.18-2.11 (m, 1H); 2.03-1.97 (m, 1H); 1.83 (ddd, J1=12.5 Hz, J2=J3=2.0 Hz, 1H); 1.61-1.55 (m, 1H); 1.19 (d, J=7.0 Hz, 3H); 0.76 (d, J=6.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 139.04, 139.02, 138.2, 128.94, 128.75, 128.44, 128.34, 126.28, 126.25, 115.8, 101.0, 100.6, 81.8, 78.9, 77.4, 73.5, 39.5, 34.6, 30.6, 12.2, 10.1. HRMS (ESI) calcd for $C_{25}H_{30}O_4Na$ [M+Na] 417.2042, found 417.2046.

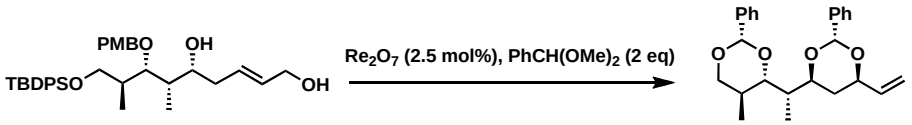


(5*S*,6*S*,7*S*,8*S*,*E*)-9-(*tert*-Butyldiphenylsilyloxy)-5-hydroxy-7-(4-methoxybenzyl-oxy)-6,8-dimethylnon-2-enyl acetate. The typical procedure for cross-metathesis was followed with the Hoveydα–Grubbs II catalyst (1.7 mg, 2.74 μmol) and the substrate (0.150 g, 0.274 mmol). *E*-selectivity >90%. Purified by column chromatography (silica, 20% to 30% EtOAc – hexanes) delivering the product (0.140 g, 0.226 mmol, 83%). $[\alpha]_D^{22}$ +15.5 (*c* 1.0, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.66-7.34 (m, 4H); 7.43-7.40 (m, 2H); 7.38-7.33 (m, 4H); 7.05-7.02 (m, 2H); 6.78-6.76 (m, 2H); 5.81 (ddd, J1=14.0 Hz, J2=J3=6.5 Hz, 1H); 5.69 (ddd, J1=15.5 Hz, J2=J3=6.0 Hz, 1H); 4.55 (d, J=6.0 Hz, 2H); 4.51 (d, J=11.5 Hz, 1H); 4.40 (d, J=11.0 Hz, 1H); 3.81 (dd, J1=9.0 Hz, J2=1.5 Hz, 1H); 3.78 (s, 3H); 3.78-3.74 (m, 2H); 3.60-3.56 (m, 1H); 2.44-2.39 (m, 1H); 2.31 (d, J=4.5 Hz, 1H); 2.19-2.13 (m, 1H); 2.06 (s, 3H); 1.95-1.90 (m, 1H); 1.73-1.68 (m, 1H); 1.09 (s, 9H); 0.96 (d, J=7.0 Hz, 3H); 0.88 (d, J=7.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 171.0, 159.2, 136.0, 135.9, 134.0, 133.9, 132.4, 131.1, 129.8, 129.4, 127.81,

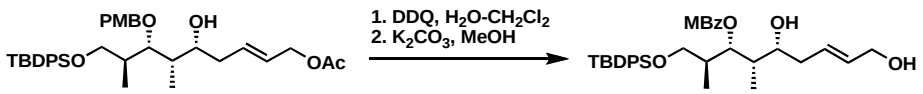
127.76, 127.46, 113.8, 79.8, 73.5, 72.9, 66.1, 65.1, 55.4, 39.8, 38.8, 38.6, 27.2, 21.2, 19.5, 14.8, 11.0. HRMS (ESI) calcd for $C_{37}H_{50}O_6SiNa$ [M+Na] 641.3274, found 641.3262.



(5*S*,6*S*,7*S*,8*S*,*E*)-9-(*tert*-butyldiphenylsilyloxy)-7-(4-methoxybenzyloxy)-6,8-dimethylnon-2-ene-1,5-diol. The typical procedure for deacetylation was followed with 0.140 g (0.226 mmol) of the substrate. Purified by column chromatography (silica, 50% to 60% to 80% EtOAc – hexanes) delivering the product (0.110 g, 0.191 mmol, 84%). $[\alpha]_D^{22}$ +18.6 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3366.1, 3070.1, 2930.3, 1513.9, 1247.7; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.68-7.63 (m, 4H); 7.44-7.40 (m, 2H); 7.40-7.33 (m, 4H); 7.04-7.02 (m, 2H); 6.78-6.76 (m, 2H); 5.772 (dd, J1=15.5 Hz, J2=5.0 Hz, 1H); 5.72 (dd, J1=15.0 Hz, J2=5.5 Hz, 1H); 4.50 (d, J=10.5 Hz, 1H); 4.40 (d, J=11.0 Hz, 1H); 4.15-4.11 (m, 2H); 3.82 (d, J=9.5 Hz, 1H); 3.78 (s, 3H); 3.78-3.74 (m, 1H); 3.59-3.53 (m, 1H); 2.45-2.39 (m, 1H); 2.39-2.28 (m, 1H); 2.17 (s, 1H); 2.17-2.11 (m, 1H); 1.97-1.88 (m, 1H); 1.75-1.67 (m, 1H); 1.09 (s, 9H); 0.966 (d, J=7.0 Hz, 3H); 0.886 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 159.9, 135.98, 135.94, 134.03, 133.98, 132.7, 131.1, 129.76, 129.44, 129.10, 127.83, 127.78, 113.9, 79.8, 73.6, 73.0, 66.1, 63.6, 55.4, 39.9, 38.8, 38.5, 27.2, 19.5, 14.8, 11.0. HRMS (ESI) calcd for $C_{35}H_{48}O_5SiNa$ [M+Na] 599.3169, found 599.3147.

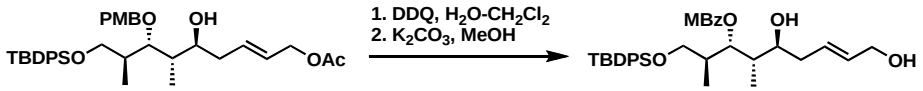


(2*S*,4*S*,5*S*)-5-Methyl-2-phenyl-4-((*S*)-1-((2*R*,4*S*,6*R*)-2-phenyl-6-vinyl-1,3-dioxan-4-yl)ethyl)-1,3-dioxane. The typical procedure was followed: rhenium(VII) oxide (1.2 mg, 2.5 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (0.2 ml). The substrate (57.7 mg, 0.10 mmol) in dichloromethane (0.8 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (30 μl, 0.200 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 50% to 80% dichloromethane – hexane) delivering the product (33.1 mg, 84 □mol, 84%). $[\alpha]_D^{22}$ +76.8 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3034.4, 2928.4, 1647.9, 1585.2, 1274.7; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.54-7.50 (m, 2H); 7.50-7.47 (m, 2H); 7.43-7.33 (m, 6H); 5.96 (ddd, J1=17.0 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.60 (s, 1H); 5.52 (s, 1H); 5.35 (ddd, J1=17.5 Hz, J2=J3=1.5 Hz, 1H); 5.17 (ddd, J1=10.5 Hz, J2=J3=1.5 Hz, 1H); 4.38-4.35 (m, 1H); 4.14 (dd, J1=11.0 Hz, J2=4.5 Hz, 1H); 4.00-3.96 (m, 2H); 3.56 (dd, J1=J2=11.0 Hz, 1H); 2.13-2.06 (m, 1H); 2.01-1.95 (m, 1H); 1.84 (ddd, J1=13.0 Hz, J2=J3=2.0 Hz, 1H); 1.53-1.46 (m, 1H); 1.00 (d, J=7.5 Hz, 3H); 0.75 (d, J=6.5 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 139.3, 139.0, 138.2, 128.83, 128.75, 128.38, 128.35, 126.28, 126.25, 115.7, 101.2, 100.4, 81.0, 77.6, 76.9, 73.5, 39.2, 35.4, 30.4, 12.2, 8.7. HRMS (ESI) calcd for $C_{25}H_{30}O_4Na$ [M+Na] 417.2042, found 417.2050.



(2*S*,3*S*,4*S*,5*R*,*E*)-1-(*tert*-Butyldiphenylsilyloxy)-5,9-dihydroxy-2,4-dimethylnon-7-en-3-yl benzoate. DDQ (0.180 g, 0.795 mmol) was added to a solution of the substrate (0.164 g, 0.265 mmol) in dichloromethane (5.3 ml) and water (4.8 μl) at rt. After stirring for 4 h the reaction mixture was quenched with saturated aqueous sodium bicarbonate. The mixture was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was submitted to the next reaction without further purification.

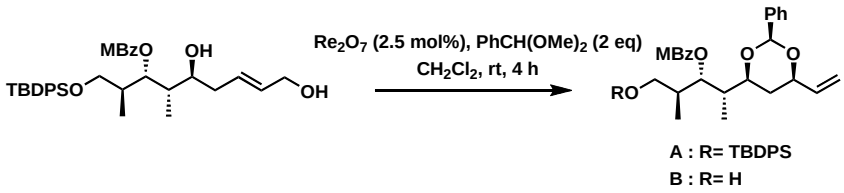
Potassium carbonate (14.7 mg, 0.106 mmol) was added to a solution of the crude substrate in methanol (2.7 ml) at 0 C. After 10 min the reaction was warmed to rt and continued to stir for 1 h. Dilute with water and ethyl acetate. The mixture was extracted with ethyl acetate (4x30 ml), and the organic layers were washed with brine, dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 20% → 40% → 60% EtOAc – hexanes) delivering the product (83.4 mg, 0.141 mmol, 53% over 2 steps). $[\alpha]_D^{22}$ -4.9 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3388.3, 3048.9, 2931.3, 1709.6, 1605.5, 1510.0, 1257.4; ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.91-7.89 (m, 2H); 7.64-7.62 (m, 2H); 7.57-7.55 (m, 2H); 7.41-7.31 (m, 4H); 7.26-7.23 (m, 2H); 6.09-6.87 (m, 2H); 5.73 (ddd, J1=15.0 Hz, J2=J3=10.0 Hz, 1H); 5.68 (ddd, J1=16.0 Hz, J2=J3=9.5 Hz, 1H); 5.23 (dd, J1=8.0 Hz, J2=4.0 Hz, 1H); 4.08 (d, J=4.5 Hz, 2H); 3.87 (s, 3H); 3.73-3.68 (s, 1H); 3.64 (dd, J1=10.0 Hz, J2=4.5 Hz, 1H); 3.57 (dd, J1=10.0 Hz, J2=6.0 Hz, 1H); 2.33 (ddd, J1=14.5 Hz, J2=J3=5.5 Hz, 1H); 2.27-2.21 (m, 2H); 2.19-2.12 (m, 1H); 2.01-1.95 (m, 1H); 1.46-1.32 (m, 1H); 1.04 (d, J=7.0 Hz, 3H); 1.02 (s, 9H); 0.98 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 166.6, 163.6, 135.80, 135.76, 133.8, 133.6, 132.5, 131.9, 129.76, 129.69, 129.3, 127.8, 127.7, 122.8, 113.8, 76.9, 73.2, 65.3, 63.7, 55.7, 39.6, 38.5, 38.0, 27.0, 19.4, 14.6, 8.6. HRMS (ESI) calcd for $C_{35}H_{46}O_6SiNa$ [M+Na] 613.2961, found 613.2939.



(2*S*,3*S*,4*S*,5*S*,*E*)-1-(*tert*-Butyldiphenylsilyloxy)-5,9-dihydroxy-2,4-dimethylnon-7-en-3-yl benzoate. DDQ (86.5 mg, 0.381 mmol) was added to a solution of the substrate (78.5 mg, 0.127 mmol) in dichloromethane (2.5 ml) and water (4.8 μl) at rt. After stirring for 5 h the reaction mixture was quenched with saturated aqueous sodium bicarbonate. The mixture was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was submitted to the next reaction without further purification.

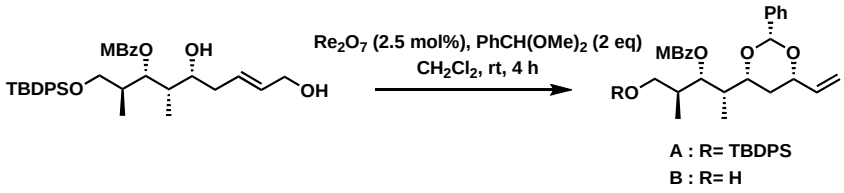
Potassium carbonate (7.1 mg, 51 μmol) was added to a solution of the crude substrate in methanol (1.3 ml) at 0 C. After 10 min the reaction was warmed to rt and continued to stir for 1 h 20 min. Dilute with water and ethyl acetate. The mixture was extracted with ethyl acetate (4x30 ml), and the organic layers were washed with brine, dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 20% → 40% → 60% EtOAc – hexanes) delivering the product (44.7 mg, 75.7 μmol, 60% over 2 steps). $[\alpha]_D^{22}$ -11.1 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3428.8, 3048.9, 2930.3, 1687.4, 1605.5, 1511.0, 1258.3; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.92-7.89 (m, 2H); 7.61-7.59 (m, 2H); 7.47-7.46 (m, 2H); 7.39-7.36 (m, 1H); 7.32-7.22 (m, 3H); 7.13-7.10 (m, 2H); 6.91-6.88 (m, 2H); 5.85 (ddd, J1=15.5 Hz, J2=J3=7.0 Hz, 1H); 5.71 (ddd, J1=15.0 Hz, J2=J3=5.5 Hz, 1H); 5.66 (d, J=10.0 Hz, 1H); 4.33 (d, J=3.5 Hz, 1H); 4.13-4.08 (m, 2H); 3.89 (s, 3H); 3.61 (dd, J1=9.5 Hz, J2=5.0 Hz, 1H); 3.55 (dd, J1=10.0 Hz, J2=2.5 Hz, 1H); 3.22-3.14 (m, 1H); 2.45-2.38 (m, 1H); 2.20-2.06 (m, 2H); 1.84-1.77 (m, 1H); 1.83 (d, J=7.0 Hz, 3H); 1.0 (s, 9H); 0.89 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 167.6, 163.8, 135.8, 135.7, 133.7, 133.5, 132.1, 131.4, 130.0, 129.7, 129.6,

127.7, 127.6, 122.2, 113.9, 74.7, 71.6, 65.5, 63.9, 55.7, 40.5, 37.5, 37.1, 27.0, 19.4, 14.4, 9.7. HRMS (ESI) calcd for $C_{35}H_{46}O_6SiNa$ [M+Na] 613.2961, found 613.2964.



(2*S*,3*S*,4*S*)-1-Hydroxy-2-methyl-4-((2*S*,4*S*,6*R*)-2-phenyl-6-vinyl-1,3-dioxan-4-yl)pentan-3-yl 4-methoxybenzoate. According to the typical procedure, rhenium(VII) oxide (0.8 mg, 1.7 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (0.1 ml). The substrate (39 mg, 66 μmol) in dichloromethane (0.6 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (20 μl, 0.13 mmol). After 4 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% to 20% to 30% EtOAc – hexane) delivering compound **A** (11.0 mg, 16.2 μmol, 25%) and compound **B** (16.3 mg, 38.4 μmol, 58%). Data for <u>compound **A**</u>: $[\alpha]_D^{22}$ +48.3 (*c* 0.82, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.94-7.91 (m, 2H); 7.73-7.71 (m, 1H); 7.65-7.61 (m, 4H); 7.57-7.55 (m, 2H); 7.42-7.27 (m, 6H); 7.22-7.15 (m, 2H); 6.92-6.89 (m, 2H); 5.93 (ddd, J1=17.5 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.67 (dd, J1=9.5 Hz, J2=2.0 Hz, 1H); 5.53 (s, 1H); 5.33 (ddd, J1=17.5 Hz, J2=J3=1.0 Hz, 1H); 5.16 (ddd, J1=11.0 Hz, J2=J3=1.5 Hz, 1H); 4.29-4.26 (m, 1H); 3.88 (s, 3H); 3.67 (ddd, J1=11.0 Hz, J2=9.0 Hz, J3=2.0 Hz, 1H); 3.63-3.60 (m, 2H); 2.14-2.02 (m, 2H); 1.68 (ddd, J1=13.0 Hz, J2=J3=2.0 Hz, 1H); 1.51-1.44 (m, 1H);

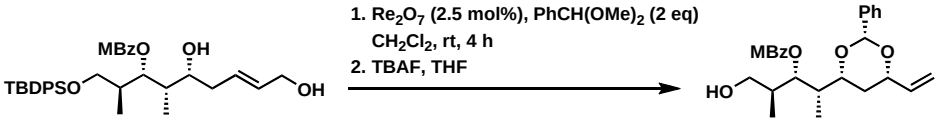
1.07 (d, J=7.0 Hz, 3H); 1.02 (s, 9H); 0.972 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 165.6, 163.4, 138.9, 138.2, 135.9, 135.8, 133.9, 133.8, 131.8, 129.64, 129.58, 128.5, 128.2, 127.73, 127.67, 126.4, 123.2, 115.5, 113.8, 100.2, 77.6, 73.6, 65.6, 55.7, 39.9, 38.2, 34.9, 29.9, 27.0, 19.4, 14.6, 8.9. HRMS (ESI) calcd for $C_{42}H_{50}O_6SiNa$ [M+Na] 701.3274, found 701.3261. Data for <u>compound **B**</u>: $[\alpha]_D^{22}$ +112.2 (*c* 1.00, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$); δ(ppm): 8.03-7.98 (m, 2H); 7.52-7.51 (m, 2H); 7.37-7.28 (m, 3H); 6.95-6.91 (m, 2H); 5.93 (ddd, J1=17.0 Hz, J2=10.5 Hz, J3=5.5 Hz, 1H); 5.58 (dd, J1=10.0 Hz, J2=1.5 Hz, 1H); 5.35 (s, 1H); 5.33 (ddd, J1=17.0 Hz, J2=J3=1.5 Hz, 1H) 5.17 (ddd, J1=10.5 Hz, J2=J3=1.5 Hz, 1H); 4.28-4.25 (m, 1H); 3.87 (s, 3H); 3.67 (ddd, J1=11.0 Hz, J2=9.0, J3=2.0 Hz, 1H); 3.60-3.56 (m, 1H); 3.49-3.44 (m, 1H); 2.90-2.82 (bs, 1H); 2.10-2.04 (m, 1H); 1.98-1.91 (m, 1H); 1.79 (ddd, J1=13.0 Hz, J2=J3=2.5 Hz, 1H); 1.53-1.46 (m, 1H); 1.09 (d, J=7.0 Hz, 3H); 1.06 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 167.3, 163.9, 138.5, 138.0, 132.0, 128.7, 128.3, 126.2, 122.4, 115.7, 114.0, 100.2, 77.9, 77.3, 73.3, 64.2, 55.7, 39.4, 37.3, 35.3, 14.0, 9.0. HRMS (ESI) calcd for $C_{26}H_{32}O_6SiNa$ [M+Na] 463.2097, found 463.2090.



(2*S*,3*S*,4*S*)-1-Hydroxy-2-methyl-4-((2*R*,4*R*,6*S*)-2-phenyl-6-vinyl-1,3-dioxan-4-yl)pentan-3-yl 4-methoxybenzoate. In accord with the typical procedure, rhenium(VII) oxide (0.9 mg, 1.9 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (0.1 ml). The substrate (44 mg, 75 μmol) in dichloromethane (0.7 ml total with rinses) was added to the reaction vessel followed by

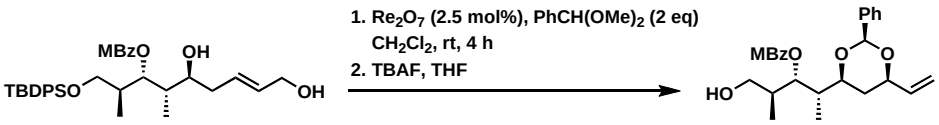
addition of benzaldehyde dimethyl acetal (22 μl, 0.15 mmol). After 4 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% → 30% EtOAc – hexane) delivering product **A** (24.2 mg, 35.6 μmol, 48%) and product **B** (12.5 mg, 28.4 μmol, 38%). Data for <u>compound **A**</u>: $[\alpha]_D^{22}$ +0.2 (*c* 1.00, CH_2Cl_2). IR (cm^{-1}) 3048.9, 2930.3, 1709.6, 1605.5, 1510.0, 1257.4; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.87-7.84 (m, 2H); 7.26-7.61 (m, 2H); 7.56-7.55 (m, 2H); 7.42-7.21 (m, 11H); 6.87-6.84 (m, 2H); 5.94 (ddd, J1=17.5 Hz, J2=10.5, J3=5.5 Hz, 1H); 5.47 (s, 1H); 5.35 (d, J=17.5 Hz, 1H); 5.31 (dd, J1=9.0 Hz, J2=3.0 Hz, 1H); 5.16 (d, J=10.5 Hz, 1H); 4.32-4.29 (m, 1H); 3.87 (s, 3H); 3.78 (ddd, J1=11.0 Hz, J2=7.0 Hz, J3=2.0 Hz, 1H); 3.62 (dd, J1=10.5 Hz, J2-4.0 Hz, 1H); 3.56 (dd, J1=10.5 Hz, J2=6.5 Hz, 1H); 2.17 (m, 1H); 2.05-1.99 (m, 2H); 1.57-1.50 (m, 1H); 1.13 (d, J=6.5 Hz, 3H); 1.06, (d, J=6.5 Hz, 3H); 1.02 (s, 9H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 166.0, 163.4, 138.9, 138.1, 135.8, 133.9, 133.7, 131.9, 129.71, 129.66, 128.5, 128.1, 127.8, 127.7, 126.3, 123.0, 115.5, 113.7, 100.5, 78.6, 77.2, 74.9, 65.4, 55.7, 40.3, 38.0, 35.1, 27.0, 19.4, 14.7, 9.3. HRMS (ESI) calcd for $C_{42}H_{50}O_6SiNa$ [M+Na] 701.3274, found 701.3267. Data for <u>compound **B**</u>: $[\alpha]_D^{22}$ +11.1 (*c* 1.00, CH_2Cl_2). IR (cm^{-1}) 3493.4, 3035.4, 2925.5, 1708.6, 1605.5, 1511.0, 1258.3; ^1H NMR (500 MHz, $CDCl_3$); δ(ppm): 7.99-7.96 (m, 2H); 7.44-7.42 (m, 2H); 7.31-7.27 (m, 3H); 6.92-6.89 (m, 2H); 5.91 (ddd, J1=17.0 Hz, J2=10.5 Hz, J3=5.0 Hz, 1H); 5.49 (s, 1H); 5.32 (dd, J1=17.5 Hz, J2=J3=1.5 Hz, 1H); 5.22 (dd, J1=10.5 Hz, J2=2.5 Hz, 1H); 5.16 (ddd, J1=10.5 Hz, J2=J3=1.5 Hz, 1H); 4.26-4.22 (m, 1H); 3.87 (s, 3H); 3.72 (ddd, J1=11.0 Hz, J2=7.5 Hz, J3=2.0 Hz, 1H); 3.56 (dd, J1=11.5 Hz, J2=2.5 Hz, 1H); 3.48 (bd, J=11.5 Hz, 1H); 2.58-2.48 (bs, 1H); 2.09-1.96 (m, 2H); 1.82 (ddd, J1=13.0 Hz, J2=J3=2.5 Hz, 1H); 1.58-1.51 (m,

1H); 1.25 (d, J=7.0 Hz, 3H); 1.07 (d, J=7.0 Hz, 3H). ^{13}C NMR (125 MHz, $CDCl_3$); δ(ppm): 167.4, 164.0, 138.8, 137.8, 132.2, 128.7, 128.2, 126.3, 122.1, 115.8, 114.0, 100.7, 79.1, 77.1, 74.5, 64.0, 55.7, 39.9, 37.4, 35.0, 14.2, 9.4. HRMS (ESI) calcd for $C_{26}H_{32}O_6Na$ [M+Na] 463.2097, found 463.2090.



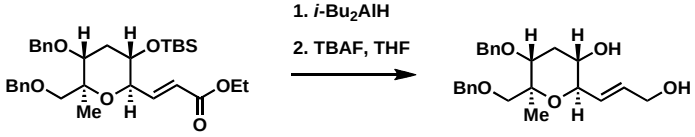
(2*S*,3*S*,4*S*)-1-Hydroxy-2-methyl-4-((2*R*,4*R*,6*S*)-2-phenyl-6-vinyl-1,3-dioxan-4-yl)pentan-3-yl 4-methoxybenzoate (procedure for two steps). According to the typical procedure, rhenium(VII) oxide (0.8 mg, 1.7 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). Dichloromethane (0.1 ml) was added to the flask. The substrate (34 mg, 58 μmol) in dichloromethane (0.7 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (18 μl, 0.12 mmol). After 4 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was submitted to the next reaction without further purification.

Tetrα–*n*-butylammonium fluoride (1M in THF, 0.18 ml, 0.18 mmol) was added to a solution of the crude residue in THF (0.8 ml). After 1 h 30 min the reaction was quenched with saturated aqueous ammonium chloride. The mixture was extracted with dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% to 20% to 30% EtOAc – hexane) delivering the product (19 mg, 44 μmol, 76% over two steps).



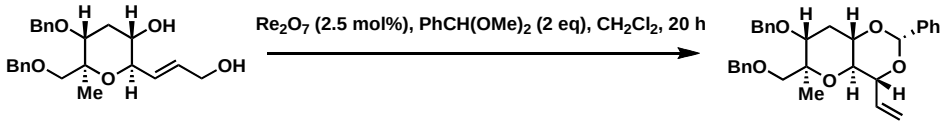
(2*S*,3*S*,4*S*)-1-Hydroxy-2-methyl-4-((2*S*,4*S*,6*R*)-2-phenyl-6-vinyl-1,3-dioxan-4-yl)pentan-3-yl 4-methoxybenzoate (procedure for two steps). According to the typical procedure, rhenium(VII) oxide (0.4 mg, 0.9 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). Dichloromethane (0.1 ml) was added to the flask. The substrate (16 mg, 27 μmol) in dichloromethane (0.4 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (10 μl, 54 μmol). After 4 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was submitted to the next reaction without further purification.

Tetrα–*n*-butylammonium fluoride (1M in THF, 0.10 ml, 0.10 mmol) was added to a solution of the crude residue in THF (0.5 ml). After 1 h the reaction was quenched with saturated aqueous ammonium chloride. The mixture was extracted with dichloromethane (3x10 ml) The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% to 20% to 30% EtOAc – hexane) delivering the product (10 mg, 23 μmol, 84% over two steps).



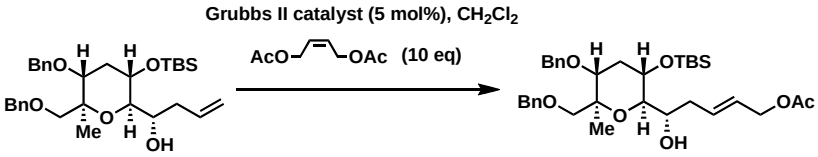
(2*R*,3*S*,5*R*,6*S*)-5-(Benzyloxy)-6-(benzyloxymethyl)-2-((*E*)-3-hydroxyprop-1-enyl)-6-methyltetrahydro-2*H*-pyran-3-ol. Diisobutylaluminum hydride (1 M in toluene, 1.7 ml, 1.7 mmol) was added to a solution of the substrate[141] (0.473 g, 0.788 mmol) in dichloromethane (8 ml) at -78 °C. After stirring at the same temperature for 1 h, *i*-PrOH, H_2O, SiO_2, Celite and dichloromethane were added and the mixture was warmed to rt. The mixture was stirred at rt for 1 h. $MgSO_4$ was added. The mixture was filtered through a pad of Celite and the filtrate was concentrated i*n vacuo*. The residue was passed through a short column (silica, *n*-hexane:EtOAc = 3:1).

Tetrα–*n*-butylammonium fluoride (1M in THF, 1.18 ml, 1.18 mmol) was added to a solution of the crude substrate at room temperature. The solution was stirred at room temperature for 1 h. Water was added and the mixture was extracted with EtOAc. The organic layer was washed with brine, dried over magnesium sulfate, and concentrated *in vacuo*. The residue was purified by flash column chromatography (silica, *n*-hexane:EtOAc = 3:1 to 2:1) to give the diol (0.307 g, 0.770 mmol, 98% over 2 steps). $[\alpha]_D^{22}$ –9.0 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3367.2, 2987.2, 2940.9, 1605.5, 1496.5, 1455, 1370.2, 1207.2, 1089.6, 904.5, 736.7, 698.1; ^1H NMR (500 MHz, $CDCl_3$) δ 7.31–7.22 (m, 10H), 6.00 (ddd, *J* = 16.0, 5.0, 5.0 Hz, 1H), 5.75 (dd, *J* = 16.0, 7.5 Hz, 1H), 4.63 (d, *J* = 12.5 Hz, 1H), 4.57 (d, *J* = 11.5 Hz, 1H), 4.52 (d, *J* = 12.5 Hz, 1H), 4.41 (d, *J* = 11.5 Hz, 1H), 4.19 (d, *J* = 4.5 Hz, 2H), 3.81 (m, 1H), 3.78 (dd, *J* = 12.0, 5.0 Hz, 1H), 3.55 (d, *J* = 10.5 Hz, 1H), 3.45 (d, *J* = 10.5 Hz, 1H), 3.35 (ddd, *J* = 11.5, 9.5, 5.0 Hz, 1H), 2.39 (ddd, *J* = 12.0, 4.5, 4.5 Hz, 1H), 1.85 (bs, 1H), 1.63 (ddd, *J* = 12.0, 12.0, 12.0 Hz, 1H), 1.20 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.7 (2C), 134.0, 129.7, 128.51 (2C), 128.50 (2C), 127.9 (2C), 127.73 (2C), 127.71 (2C), 77.6, 76.1, 74.7, 73.84, 73.79, 71.5, 69.5, 63.0, 32.9, 13.8; HRMS (ESI) calcd for $C_{24}H_{30}O_5Na$ [$(M + Na^+)$] 421.1991, found 421.1982.

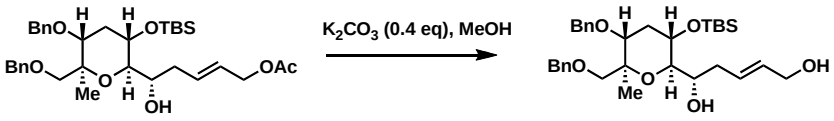


(2*S*,4*R*,4a*S*,6*S*,7*R*,8a*S*)-7-(Benzyloxy)-6-(benzyloxymethyl)-6-methyl-2-phenyl-4-vinylhexahydropyrano[3,2-*d*][1,3]dioxine. Following the typical procedure, rhenium(VII) oxide (4.0 mg, 8.16 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3). To the flask was added dichloromethane (1.25 ml). The substrate (0.130 g, 0.326 mmol) in dichloromethane (2.0 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (0.10 ml, 0.65 mmol). The reaction vessel was sealed and heated at 40 °C. After 20 h the reaction was allowed to cool to rt and saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min. The aqueous layer was extracted with dichloromethane (3x10 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% EtOAc – hexane) delivering the product (0.128 g, 0.263 mmol, 81%). $[\alpha]_D^{22}$ +5.2 (*c* 1.0, CH_2Cl_2). IR (cm^{-1}) 3088, 3063.4, 3030.6, 2987.2, 2944.8, 2859, 1496.5, 1454.1, 1365.4, 1292.1, 1207.2, 1097.3, 1027.9, 926.6; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.54–7.52 (m, 2H), 7.39–7.24 (m, 13H), 6.02 (ddd, *J*= 17.5, 10.5, 5.5 Hz, 1H), 5.66 (s, 1H), 5.47 (ddd, *J* = 17.5, 1.5, 1.5 Hz, 1H), 5.27 (ddd, *J* = 10.5, 1.5, 1.5 Hz, 1H), 4.64–4.56 (m, 3H), 4.44 (d, *J* = 11.5 Hz, 1H), 4.19 (dd, *J* = 9.0, 5.0 Hz, 1H), 3.88 (ddd, *J* = 11.5, 4.5 Hz, 1H), 3.57 (m, 1H), 3.57 (d, *J* = 10.5 Hz, 1H), 3.48 (d, *J* = 10.5 Hz, 1H), 3.31 (dd, *J* = 9.0, 9.0 Hz, 1H), 2.46 (ddd, *J* = 11.5, 4.0, 4.0 Hz, 1H), 1.78 (ddd, *J* = 11.5, 11.5, 11.5 Hz, 1H), 1.20 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.8, 138.5, 137.8, 134.7, 129.1, 128.5 (3C), 128.4 (2C), 127.74 (3C), 127.67 (2C), 127.6 (2C), 126.4 (2C), 117.2, 101.2, 79.7, 79.0, 76.6, 74.4, 74.1,

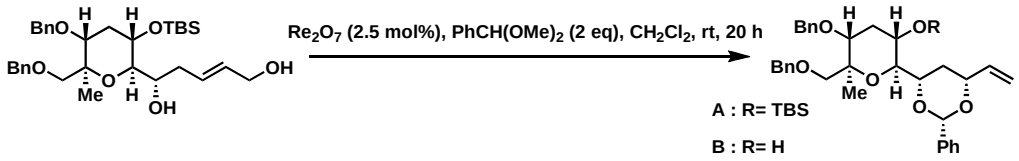
73.7, 71.43, 71.41, 30.6, 14.2; HRMS (ESI) calcd for $C_{31}H_{34}O_5Na$ [M+Na] 509.2304, found 509.2296.



(*S*,*E*)-5-((2*R*,3*S*,5*R*,6*S*)-5-(Benzyloxy)-6-(benzyloxymethyl)-3-(*tert*-butyldimethylsilyloxy)-6-methyltetrahydro-2*H*-pyran-2-yl)-5-hydroxypent-2-enyl acetate. Prepared according to the typical procedure for cross-metathesis using Grubbs II catalyst (6.8 mg, 8.1 μmol) and 85 mg (0.161 mmol) of the substrate. *E*-selectivity >90%. Purified by column chromatography (silica, 25% EtOAc - hexanes) delivering the product (92 mg, 0.154 mmol, 96%). $[\alpha]_D^{22}$ +13 (*c* 1.0, CH_2Cl_2). ^{1}H NMR (500 MHz, $CDCl_3$); □(ppm): 7.35-7.26 (m, 10H); 5.78 (ddd, J1=14.5 Hz, J2=7.5 Hz, J3=6.5 Hz, 1H); 5.64 (ddd, J1=15.0 Hz, J2=J3=6.5 Hz, 1H); 4.54 (d, J=12.0 Hz, 1H); 4.56-4.50 (m, 3H); 4.45 (d, J=11.5 Hz, 1H); 3.78 (bs, 1H); 3.70-3.65 (m, 2H); 3.54 (d, J=10.5 Hz, 1H); 3.42 (d, J=10.0 Hz, 1H); 3.18 (dd, J1=9.5 Hz, J2=1.0 Hz, 1H); 2.41-2.34 (m, 1H); 2.31-2.25 (m, 1H); 2.20-2.16 (m, 2H); 2.05 (s, 3H); 1.82 (bs, 1H); 1.57 (dd, J1=24.0 Hz, J2=11.5 Hz, 1H); 1.13 (s, 3H); 0.87 (s, 9H); 0.08 (s, 3H); 0.06 (s, 3H). ^{13}C NMR (125 MHz, $CDCl_3$) δ 171.0, 138.8, 138.6, 132.7, 128.58, 128.56, 128.14, 127.79, 127.78, 127.77, 126.5, 77.3, 75.2, 74.8, 73.60, 73.55, 71.7, 68.5, 66.3, 65.3, 37.9, 34.6, 26.0 (3C), 21.2, 18.1, 13.8, -4.0, -4.6. HRMS (ESI) calcd for $C_{34}H_{50}O_7SiNa$ [M+Na] 621.3224, found 621.3217.



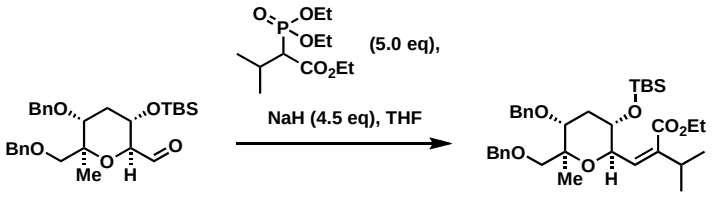
(*S*,*E*)-5-((2*R*,3*S*,5*R*,6*S*)-5-(Benzyloxy)-6-(benzyloxymethyl)-3-(*tert*-butyldimethylsilyloxy)-6-methyltetrahydro-2*H*-pyran-2-yl)pent-2-ene-1,5-diol. Prepared according to the typical procedure for deacetylation from 92 mg (0.154 mmol) of the substrate. Purified by column chromatography (silica, 65% to 80% EtOAc – hexanes) delivering the product (80 mg, 0.144 mmol, 93%). $[\alpha]_D^{22}$ –6.7 (*c* 1.0, CH_2Cl_2); IR (cm^{-1}) 3426.9, 3064.2, 3030.6, 2926.5, 2855.1, 1496.5, 1455, 1362.5, 1252.5, 1208.2, 1088.6, 864, 837; ^1H NMR (500 MHz, $CDCl_3$) δ 7.33–7.24 (m, 10H), 5.70 (m, 2H), 4.56– 4.50 (m, 3H), 4.43 (d, *J* = 11.5 Hz, 1H), 4.08 (d, *J* = 3.0 Hz, 2H), 3.77 (dd, *J* = 7.0, 7.0 Hz, 1H), 3.67 (ddd, *J* = 10.5, 4.5, 4.5 Hz, 1H), 3.62 (dd, *J* = 12.0, 5.0 Hz, 1H), 3.51 (d, *J* = 11.0 Hz, 1H), 3.42 (d, *J* = 11.0 Hz, 1H), 3.19 (d, *J* = 9.0 Hz, 1H), 2.35 (m, 1H), 2.27 (m, 1H), 2.17 (ddd, *J* = 12.0, 5.0, 5.0 Hz, 1H), 1.60 (bs, 1H), 1.56 (ddd, *J* = 11.5, 11.5, 11.5 Hz, 1H), 1.14 (s, 3H) 0.89 (s, 9H), 0.07 (s, 3H), 0.05 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.8 , 138.6, 131.7, 129.4, 128.6 (2C), 128.5 (2C), 127.82 (2C), 127.81 (2C), 127.79 (2C), 77.3, 75.4, 74.9, 73.7, 73.6, 71.7, 68.6, 66.3, 63.9, 38.0, 34.6, 26.0 (3C), 18.2, 13.8, –4.0, –4.6; HRMS (ESI) calcd for $C_{32}H_{48}O_6SiNa$ [M+Na] 579.3118, found 579.3103.



Compounds A and B. The typical procedure was followed: rhenium(VII) oxide (1.7 mg, 3.6 μmol) was quickly weighed out into a flame-dried flask. The flask was evacuated and backfilled with argon (x3), and dichloromethane (0.4 ml) was added. The substrate (80 mg, 0.144 mmol) in dichloromethane (1.0 ml total with rinses) was added to the reaction vessel followed by addition of benzaldehyde dimethyl acetal (45 μl, 0.288 mmol). After 20 h of stirring at rt, saturated aqueous sodium bicarbonate was added and the biphasic mixture stirred vigorously for 10 min.

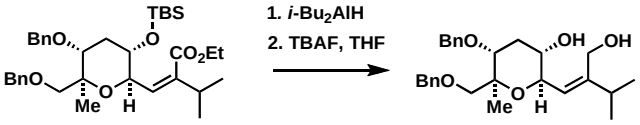
The aqueous layer was extracted with dichloromethane (3x5 ml). The combined organic layers were dried with sodium sulfate, concentrated, and the residue was purified by column chromatography (silica, 10% to 20% to 50% EtOAc – hexanes) delivering the product **A** (11.8 mg, 18.3 μmol, 13%) and product **B** (52.6 mg, 99.1 μmol, 69%). Data for Product **A**: $[\alpha]_D^{22}$ –5.7 (*c* 1.0, CH_2Cl_2); IR (cm^{-1}) 3064.3, 031.6, 2927.4, 2856.1, 1496.5, 1455, 1250.6, 1177.3, 1145.5, 1012.5, 924.7, 862, 837; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 (dd, *J* = 8.0, 2.0 Hz, 2H), 7.36 (d, *J* = 7.0 Hz, 2H), 7.31–7.23 (m, 11H), 5.97 (ddd, *J*= 17.5, 10.5, 5.0 Hz, 1H), 5.52 (s, 1H), 5.35 (d, *J* = 17.5 Hz, 1H), 5.18 (d, *J* = 10.0 Hz, 1H), 4.78 (d, *J* = 12.5 Hz, 1H), 4.67 (d, *J* = 12.5 Hz, 1H), 4.57 (d, *J* = 11.5 Hz, 1H), 4.52 (d, *J* = 11.5 Hz, 1H), 4.39 (dd, *J* = 10.5, 5.0 Hz, 1H), 4.17 (d, *J* = 11.5 Hz, 1H), 3.86 (ddd, *J* = 11.0, 9.5, 5.0 Hz, 1H), 3.77 (dd, *J* = 12.0, 4.5 Hz, 1H), 3.64 (d, *J* = 11.0 Hz, 1H), 3.44 (d, *J* = 11.0 Hz, 1H), 3.24 (dd, *J* = 14.0, 1.0 Hz, 1H), 2.20–2.13 (m, 2H), 1.59 (ddd, *J* = 12.0, 12.0, 12.0 Hz, 1H), 1.41 (ddd, *J* = 13.0, 2.0, 2.0 Hz, 1H), 1.12 (s, 3H) 0.89 (s, 9H), 0.02 (s, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 139.3, 139.1, 139.0, 138.3, 128.8 (2C), 128.46, 128.44, 128.2 (2C), 128.0 (2C), 127.7 (2C), 127.6, 127.3 (2C), 126.8 (2C), 115.8, 101.6, 78.3, 78.0, 76.3, 74.0, 73.65, 73.61, 73.5, 71.9, 65.4, 35.1, 32.5, 26.0 (3C), 18.1, 13.4, –4.0, –4.6; HRMS (ESI) calcd for $C_{39}H_{52}O_6SiNa$ [M+Na] 667.3431, found 667.3409. Data for Product **B**: □□□$_D^{22}$ –35.6 (*c* 1.0, CH_2Cl_2); IR (cm^{-1}) 3443.3, 3031.6, 2925.5, 2868.6, 1496.5, 1454.1, 1342.2, 1309.4, 1211.1, 1143.6, 1090.6, 1027.9, 926.6, 839.8; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48–7.46 (m, 2H), 7.33–7.24 (m, 13H), 5.95 (ddd, *J*= 17.0, 10.5, 5.0 Hz, 1H), 5.59 (s, 1H), 5.35 (ddd, *J* = 17.0, 1.5, 1.5 Hz, 1H), 5.20 (ddd, *J* = 10.5, 1.0, 1.0 Hz, 1H), 4.63 (d, *J* = 12.0 Hz, 1H), 4.59 (d, *J* = 12.0 Hz, 1H), 4.55 (d, *J* = 12.5 Hz, 1H), 4.43 (d, *J* = 12.0 Hz, 1H), 4.40 (m, 1H), 4.32 (ddd, *J* = 11.0, 3.0, 2.5 Hz, 1H), 3.85 (ddd, *J* = 11.0, 11.0, 5.0 Hz, 1H), 3.65 (ddd, *J* = 11.5, 11.5, 4.5 Hz, 1H), 3.55 (d, *J* = 11.0 Hz, 1H), 3.45 (d, *J* = 11.0 Hz, 1H), 3.05 (bs, 1H), 2.37 (ddd,

J = 12.0, 4.5, 4.5 Hz, 1H), 1.86 (ddd, *J* = 11.5, 11.5, 11.5 Hz, 1H), 1.74 (ddd, *J* = 13.5, 2.5, 2.5 Hz, 1H), 1.62 (ddd, *J* = 12.0, 12.0, 12.0 Hz, 1H), 1.20 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 139.0, 138.7, 138.2, 137.7, 129.2, 128.52 (2C), 128.51 (2C), 128.49 (2C), 127.8 (2C), 127.74 (2C), 127.71 (2C), 127.6, 126.3, 116.0, 101.6, 77.9 (2C), 77.6, 74.7, 73.6 (2C), 73.4, 71.4, 65.9, 32.9, 31.1, 13.5; HRMS (ESI) calcd for $C_{33}H_{38}O_6Na$ [M+Na] 553.2566, found 553.2560.



(*Z*)-Ethyl 2-(((2*R*,3*S*,5*R*,6*S*)-5-(benzyloxy)-6-(benzyloxymethyl)-3-(*tert*-butyldimethylsilyloxy)-6-methyltetrahydro-2*H*-pyran-2-yl)methylene)-3-methylbutanoate. To a stirred solution of triethyl 2-phosphono-isopentyrate (0.466 g, 1.75 mmol) in THF (10 mL) was added NaH (63 mg, 1.58 mmol) at 0 °C. After stirring for 10 min, a solution of aldehyde (0.170 g, 0.351 mmol) in THF (25 mL) was added dropwise at 0 °C under argon atmosphere. After stirring at rt for 14 h, saturated aqueous NH_4Cl was added at 0 °C, and the mixture was extracted with EtOAc. The organic layer was washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by flash column chromatography (*n*-hexane:EtOAc = 5:1→3:1) to give ester (0.111 g, 53% yield). $[\alpha]_D^{22}$ +29.3 (*c* 1.0, CH_2Cl_2); IR (cm^{-1}) 3087.5, 3063.4, 3030.6, 2959.2, 1948.7, 1721.2, 1659.5, 1604.5, 1496.5, 1462.7, 1363.4, 1221.7, 1094.4, 939.2, 906.4, 837; ^{1}HNMR (500 MHz, $CDCl_3$) δ 7.35–7.23 (m, 10H), 5.54 (dd, *J*= 8.5, 1.5 Hz, 1H), 4.63 (d, *J* = 12.5 Hz, 1H), 4.53 (d, *J* = 11.5 Hz, 1H), 4.52 (d, *J* = 12.5 Hz, 1H), 4.44 (dd, *J* = 8.5, 8.5 Hz, 1H), 4.42 (d, *J* = 12.0 Hz, 1H), 4.24–4.13 (m, 2H), 3.75 (dd, *J* = 12.0, 5.0 Hz, 1H), 3.53 (d, *J* = 10.0 Hz, 1H), 3.43 (d, *J* = 10.0 Hz, 1H), 3.36 (ddd, *J* = 11.0, 9.5, 5.0 Hz, 1H), 2.70

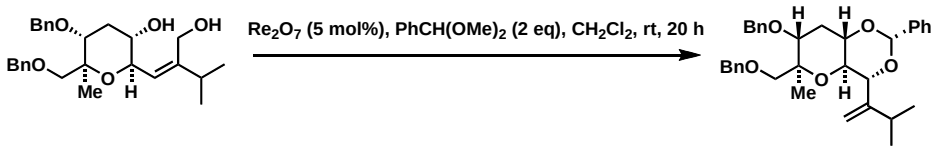
(dquin, *J* = 7.0, 7.0, 7.0, 7.0, 1.5 Hz, 1H), 2.16 (ddd, *J* = 12.0, 4.5, 4.5 Hz, 1H), 1.59 (ddd, *J* = 12.5, 12.5, 12.5 Hz, 1H), 1.28 (dd, *J* = 7.0, 7.0 Hz, 1H), 1.17 (s, 3H), 1.06 (dd, *J* = 7.0, 4.5 Hz, 6H), 0.83 (s, 9H), 0.00 (s, 3H), -0.02 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 168.9, 143.4, 138.9, 138.8, 130.8, 128.7 (2C), 128.1 (2C), 127.8 (2C), 127.71 (2C), 127.67 (2C), 77.4, 74.6, 73.8, 73.6, 72.1, 71.6, 70.7, 60.4, 35.2, 32.0, 25.9 (3C), 21.5, 21.0, 18.1, 14.4, 13.9, -4.1, -4.4; HRMS (ESI) calcd for $C_{35}H_{52}O_6SiNa$ [M+Na] 619.3424, found 619.3425.



(2*R*,3*S*,5*R*,6*S*)-5-(benzyloxy)-6-(benzyloxymethyl)-2-((*Z*)-2-(hydroxymethyl)-3-methylbut-1-enyl)-6-methyltetrahydro-2*H*-pyran-3-ol. To a solution of α,β-unsaturated ester (46.0 mg, 77 μmol) in CH_2Cl_2 (0.8 mL) was added DIBALH (1.0 M in toluene, 0.23 mL, 0.23 mmol) at −78 °C under argon atmosphere. After stirring at the same temperature for 1 h, *i*-PrOH, H_2O, SiO_2, Celite and CH_2Cl_2 were added, and the mixture was warmed to rt. The mixture was stirred at rt for 1 h and magnesium sulfate was added. The mixture was filtered through Celite pad and the filtrate was concentrated i*n vacuo*, and the residue was submitted to the next reaction without further purification.

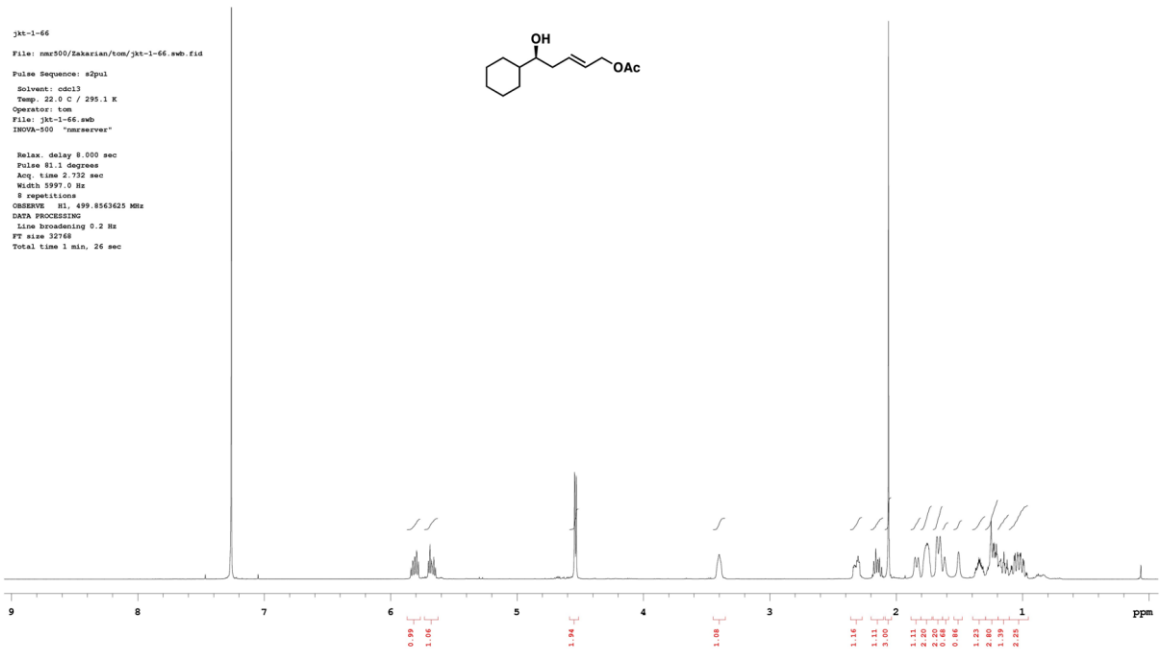
To a solution of the crude was added TBAF (1.0 M in THF, 0.16 mL, 0.16 mmol) at room temperture. After stirring for 1 h, water was added and the mixture was extracted with EtOAc. The organic layer was washed with brine, dried over magnesium sulfate, and concentrated *in vacuo*. The residue was purified by flash column chromatography (silica, hexane:EtOAc = 2:1) to give diol (30.0 mg, 88% yield, 2 steps). $[\alpha]_D^{22}$ +7.6 (*c* 1.0, CH_2Cl_2); IR (cm^{-1}) 3348.8, 3063.4, 3029.6, 3958.3, 2870.5, 1496.5, 1454.1, 1365.4, 1234.2, 1207.2, 1104.1, 1027.9, 903.5; ^{1}HNMR

(500 MHz, $CDCl_3$) δ 7.33–7.22 (m, 10H), 5.38 (d, *J*= 7.5 Hz, 1H), 4.61 (d, *J* = 12.5 Hz, 1H), 4.57 (d, *J* = 12.0 Hz, 1H), 4.52 (d, *J* = 12.5 Hz, 1H), 4.41 (d, *J* = 12.0 Hz, 1H), 4.18 (dd, *J* = 9.5, 8.0 Hz, 1H), 4.02 (d, *J* = 12.0 Hz, 1H), 3.74 (dd, *J* = 11.5, 4.5 Hz, 1H), 3.51 (d, *J* = 10.0 Hz, 1H), 3.45 (d, *J* = 10.0 Hz, 1H), 3.38 (ddd, *J* = 11.0, 9.5, 4.5 Hz, 1H), 2.41 (dquin, *J* = 7.0, 7.0, 7.0, 7.0, 1.0 Hz, 1H), 2.38 (ddd, *J* = 12.0, 4.5, 4.5 Hz, 1H), 1.66 (ddd, *J* = 12.0, 12.0, 12.0 Hz, 1H), 1.24 (s, 3H), 1.08 (dd, *J* = 7.0, 1.5 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 151.2, 138.64, 138.58, 128.5 (2C), 128.0 (2C), 127.8 (2C), 127.7 (2C), 125.3, 77.6, 74.7, 73.9, 73.7, 71.7, 71.5, 69.3, 59.8, 35.0, 33.7, 21.7, 13.7; HRMS (ESI) calcd for $C_{27}H_{36}O_5Na$ [M+Na] 463.2460, found 463.2448.



(2*S*,4*R*,4a*S*,6*S*,7*R*,8a*S*)-7-(benzyloxy)-6-(benzyloxymethyl)-6-methyl-4-(3-methyl-but-1-en-2-yl)-2-phenylhexahydropyrano[3,2-*d*][1,3]dioxine. Following the typical procedure, to a solution of diol (15.0 mg, 0.034 mmol) and benzaldehyde dimethyl acetal (10 μL, 0.068 mmol) in CH_2Cl_2 (0.35 mL) was added rhenium(VII) oxide (0.8 mg, 1.7 μmol) under argon atmosphere. After stirring at the same temperature for 20 h, saturated aqueous $NaHCO_3$ was added at 0 °C, and the mixture was extracted with EtOAc. The organic layer was washed with brine, dried over $MgSO_4$, and concentrated *in vacuo*. The residue was purified by flash column chromatography (silica, hexane:EtOAc = 10:1→5:1) to give the product (17.4 mg, 97% yield). $[\alpha]_D^{22}$ -1.9 (*c* 1.0, CH_2Cl_2); IR (cm^{-1}) 2923.6, 1496.5, 1457.9, 1369.2, 1284.4, 1207.2, 1095.4, 1025.9, 910.2, 806.1; ^1H NMR (500 MHz, $CDCl_3$) δ 7.52–7.50 (m, 2H), 7.36–7.27 (m, 13H), 5.64 (s, 1H), 5.23 (s, 1H), 5.08 (s, 1H), 4.61 (d, *J* = 11.5 Hz, 1H), 4.58 (s, 1H), 4.46 (d, *J* = 11.5 Hz, 1H), 4.14 (d, *J*

= 9.0 Hz, 1H), 3.86 (dd, *J* = 12.0, 5.0 Hz, 1H), 3.58 (ddd, *J* = 12.0, 9.5, 4.5 Hz, 1H), 3.54 (d, *J* = 10.5 Hz, 1H), 3.46 (dd, *J* = 9.0, 9.0 Hz, 1H), 3.45 (d, *J* = 11.0 Hz, 1H), 2.52 (quin, *J* = 7.0 Hz, 1H), 2.45 (ddd, *J* = 11.0, 4.0, 4.0 Hz, 1H), 1.79 (ddd, *J* = 11.5, 11.5, 11.5 Hz, 1H), 1.19 (s, 3H), 1.10 (d, *J* = 7.0 Hz, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 153.2, 139.0, 138.6, 138.0, 129.1, 128.53 (2C), 128.49 (2C), 128.45 (2C), 127.81 (2C), 127.77 (2C), 127.7 (2C), 127.6, 126.5, 111.1, 101.5, 82.2, 79.0, 76.9, 74.6, 74.1, 73.7, 71.5, 71.2, 30.80, 30.78, 23.0, 22.8, 14.0; HRMS (ESI) calcd for $C_{34}H_{40}O_5Na$ [M+Na] 551.2768, found 551.2775.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Operator: tom
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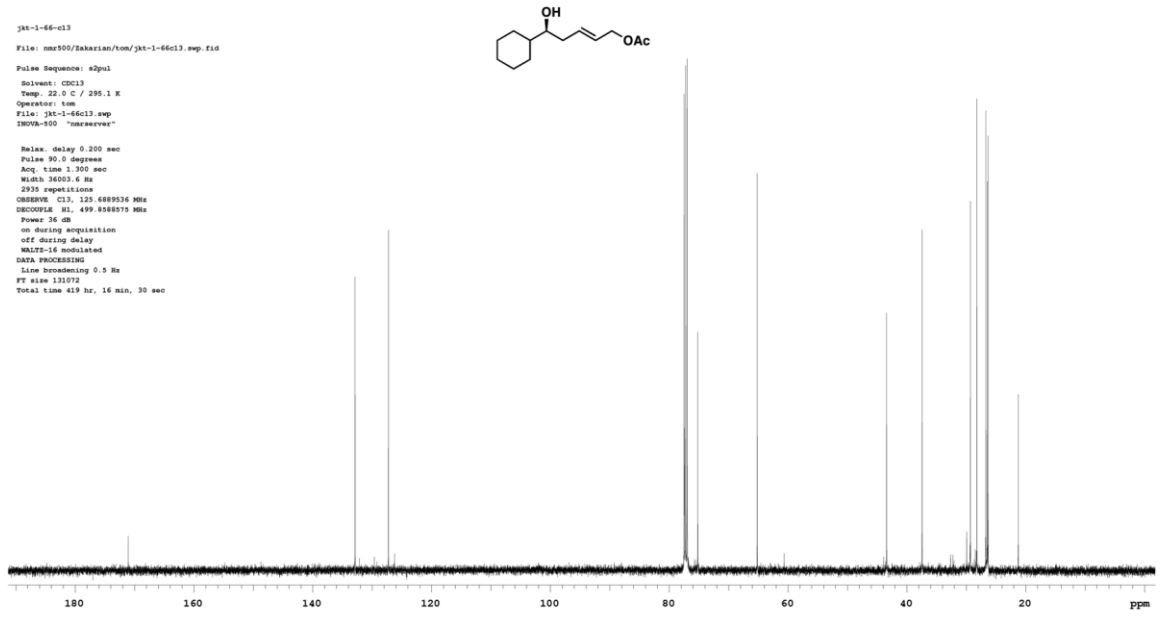
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563625 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OAc
9
8
7
6
5
4
3
2
1
ppm
0.99
1.06
1.94
1.08
1.14
1.11
3.00
1.11
2.20
2.20
0.66
0.86
1.23
2.80
1.39
2.29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Power 36 dB
on during acquisition
off during delay
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140
120
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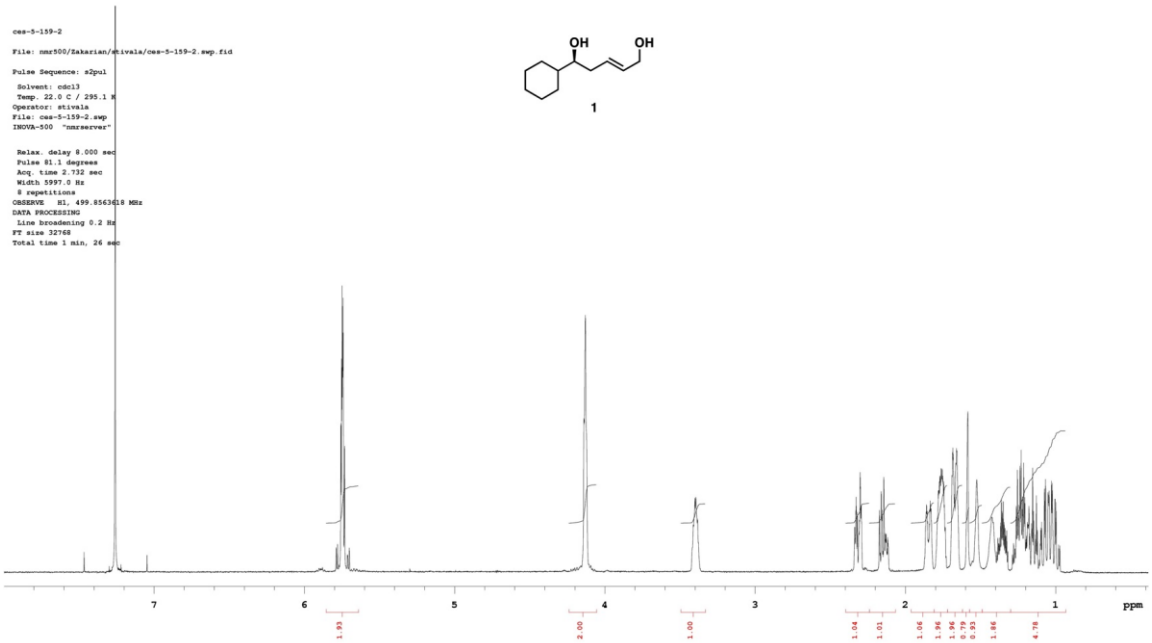
80
60
40
20
ppm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Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
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INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
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OH
1
7
6
5
4
3
2
1
ppm
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1.00
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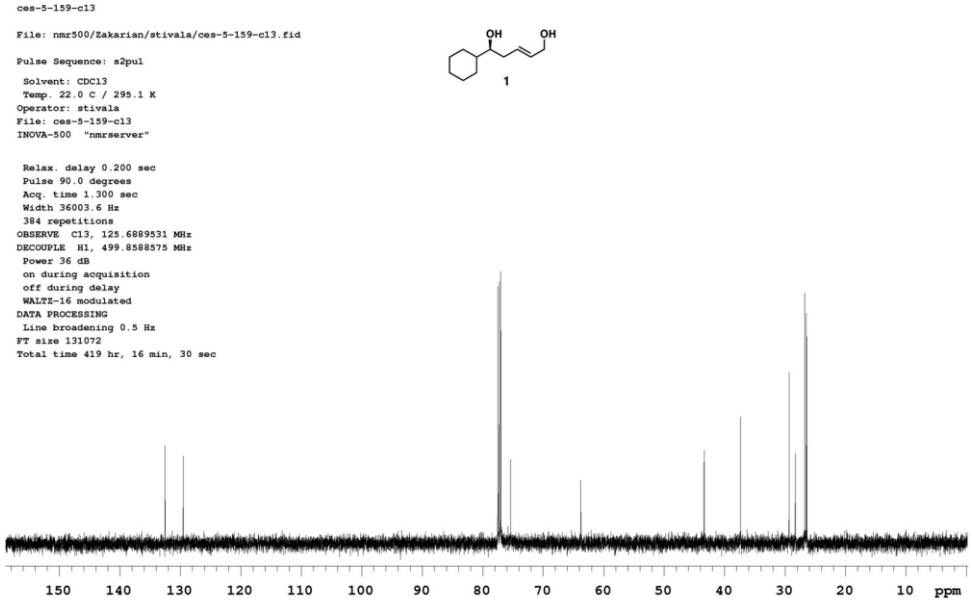
1.01
1.06
1.96
1.96
0.79
0.93
1.86
4.78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DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
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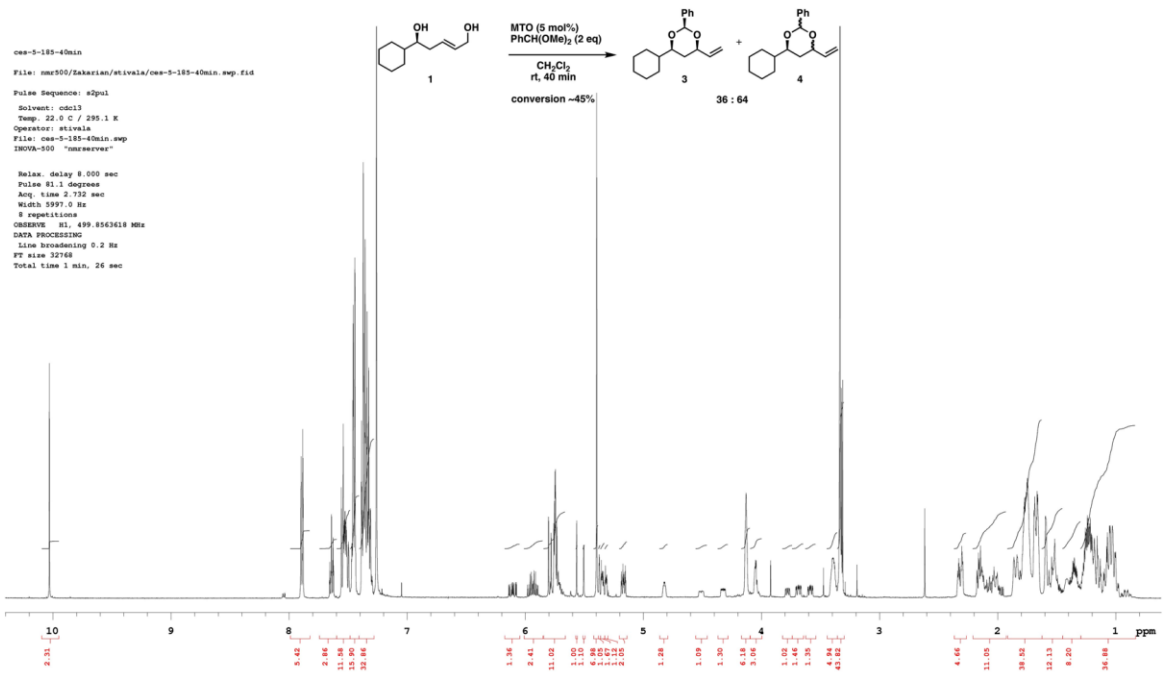
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm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Solvent: cdcl3
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Operator: stivala
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Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
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OH
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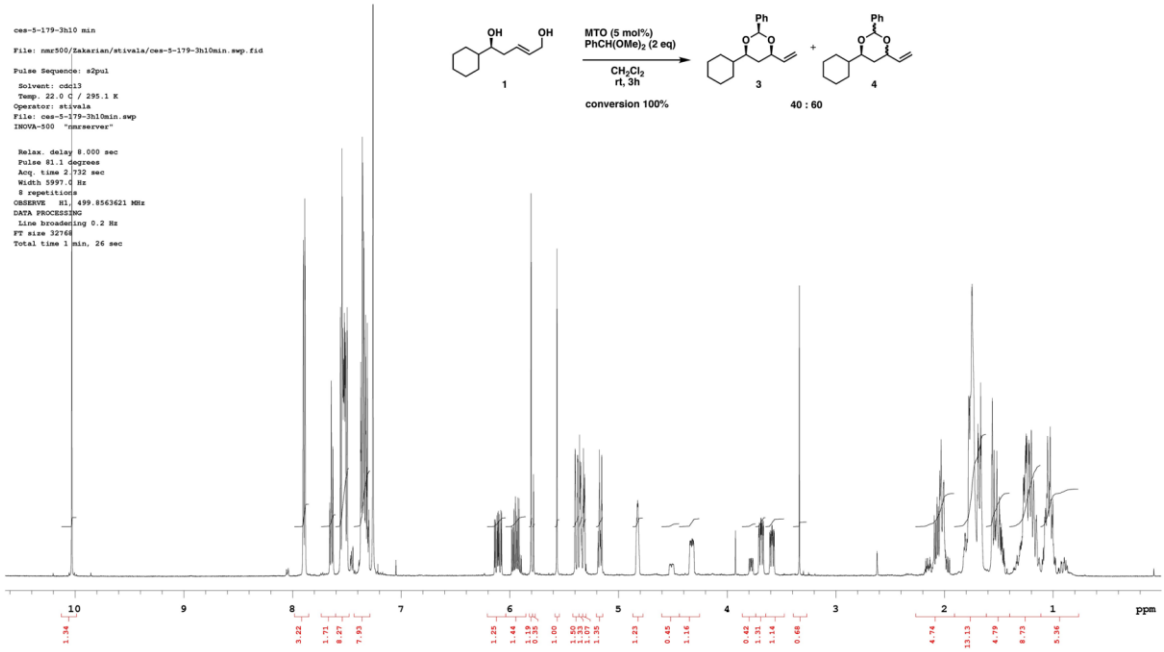
MTO (5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 40 min
conversion ~45%
Ph
3
Ph
4
36 : 64
ppm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Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
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OH
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MTO (5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 3h
conversion 100%
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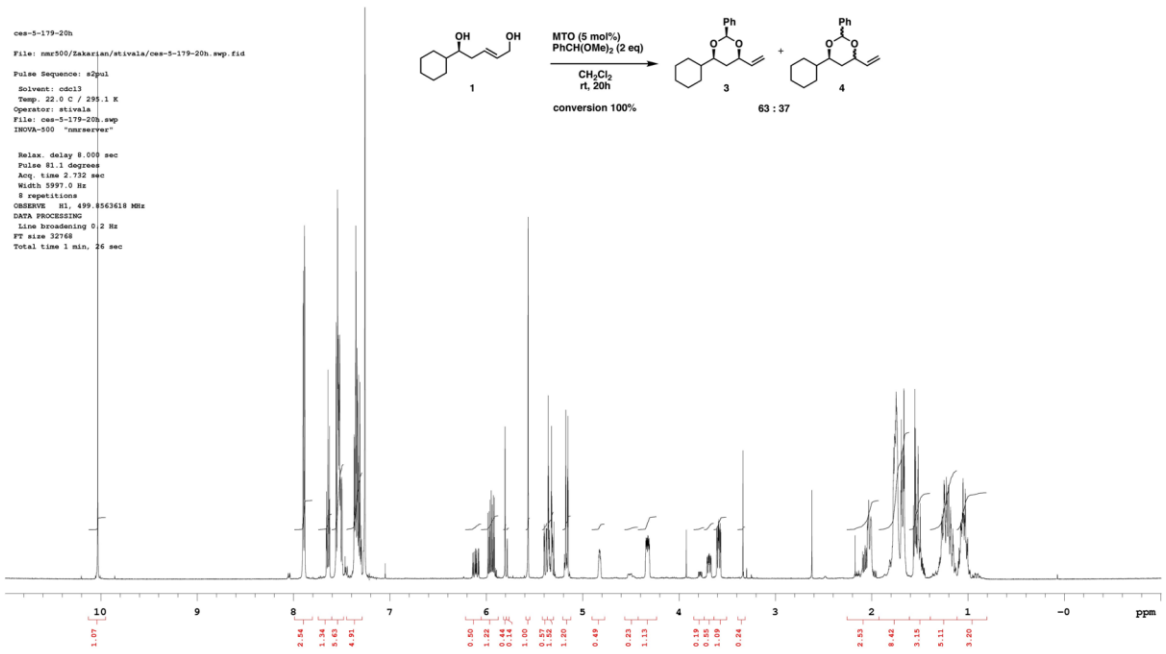
Ph
4
40 : 60
ppm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Operator: stivala
File: ces-5-179-20h.swp
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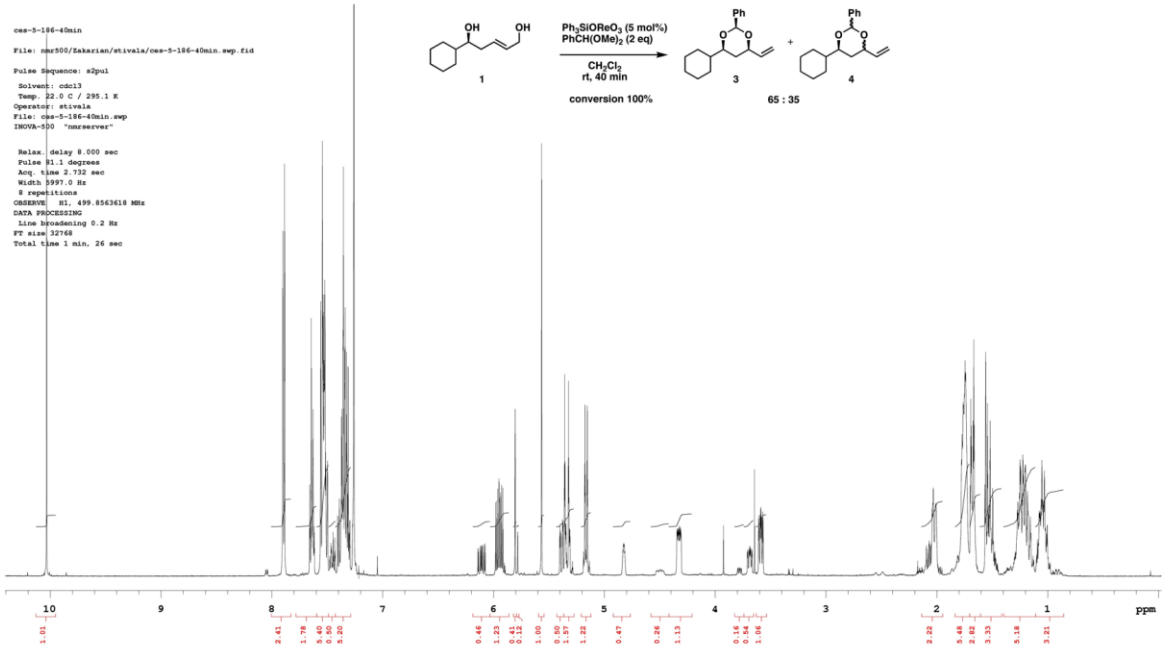
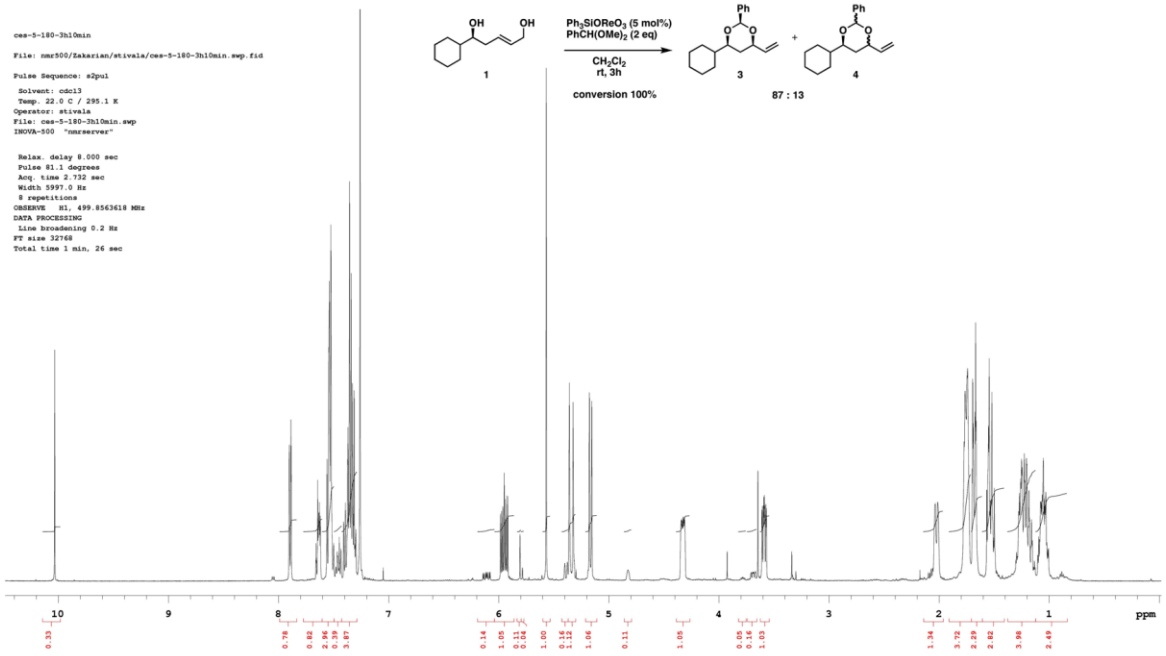
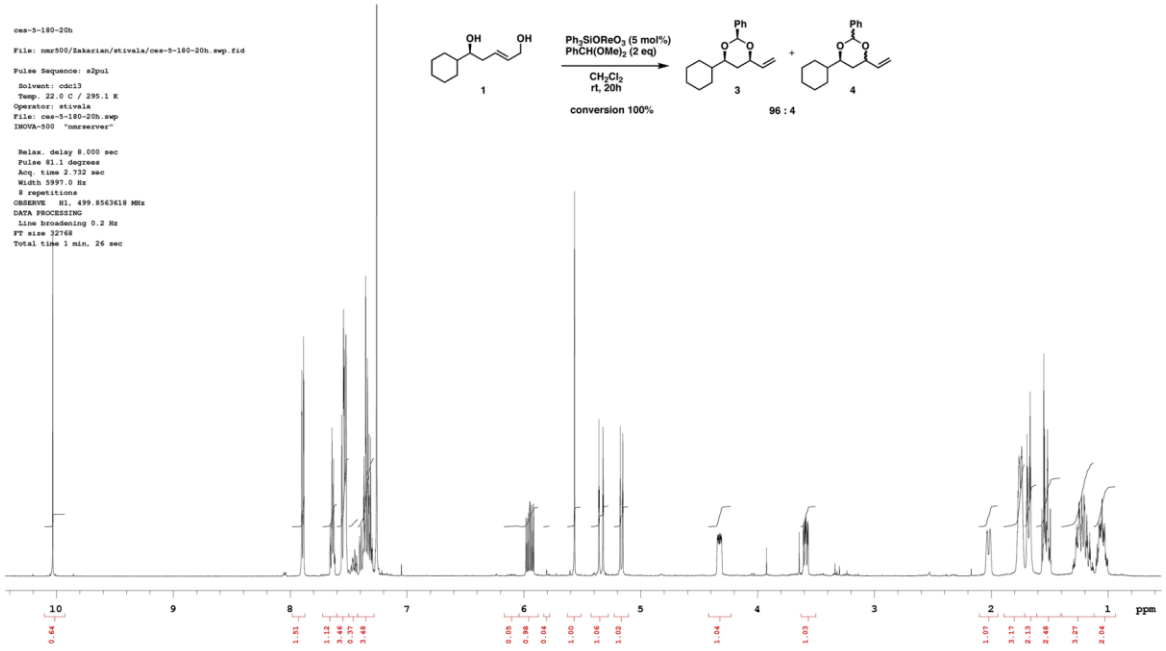
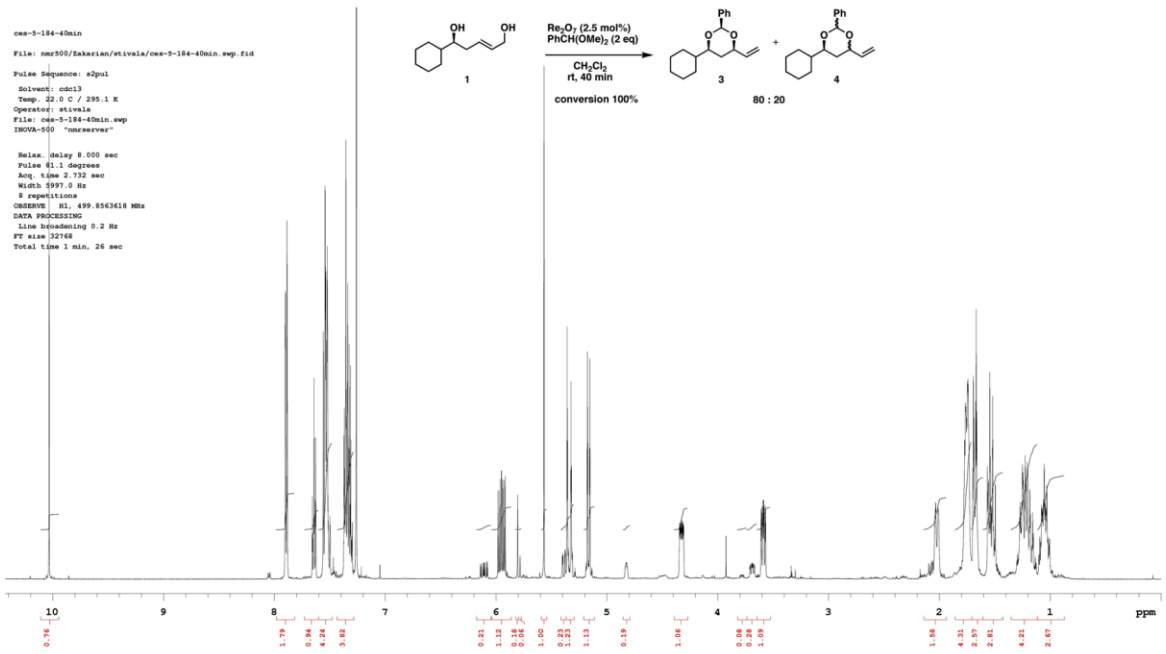
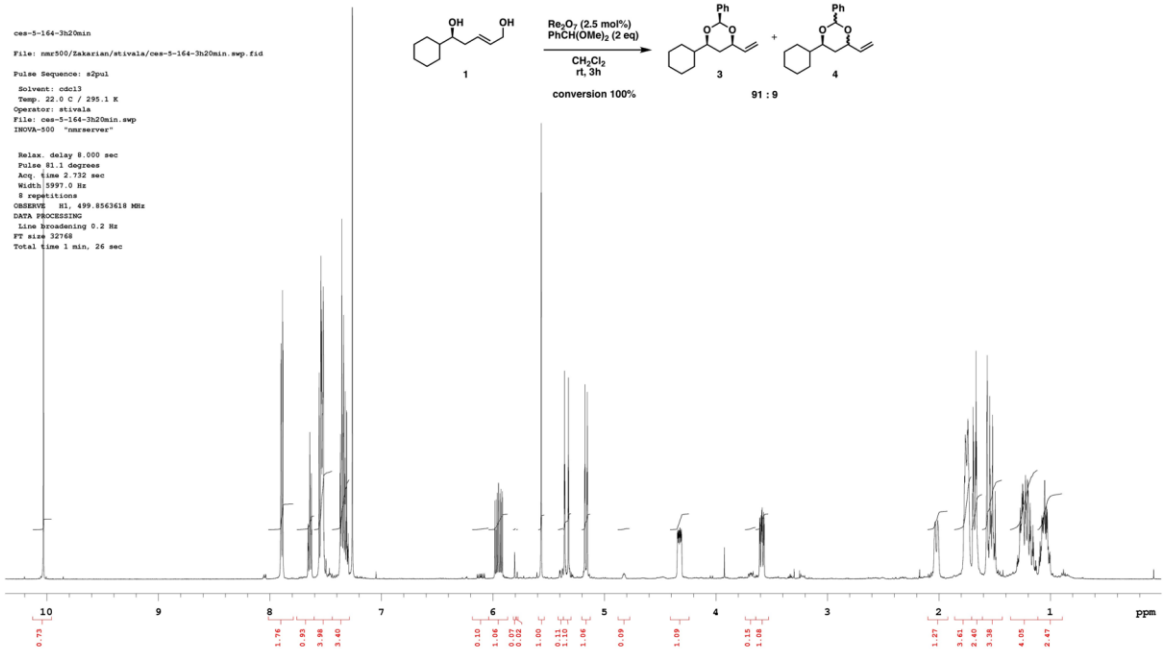
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
MTO (5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 20h
conversion 100%
Ph
3
Ph
4
63 : 37
ppm

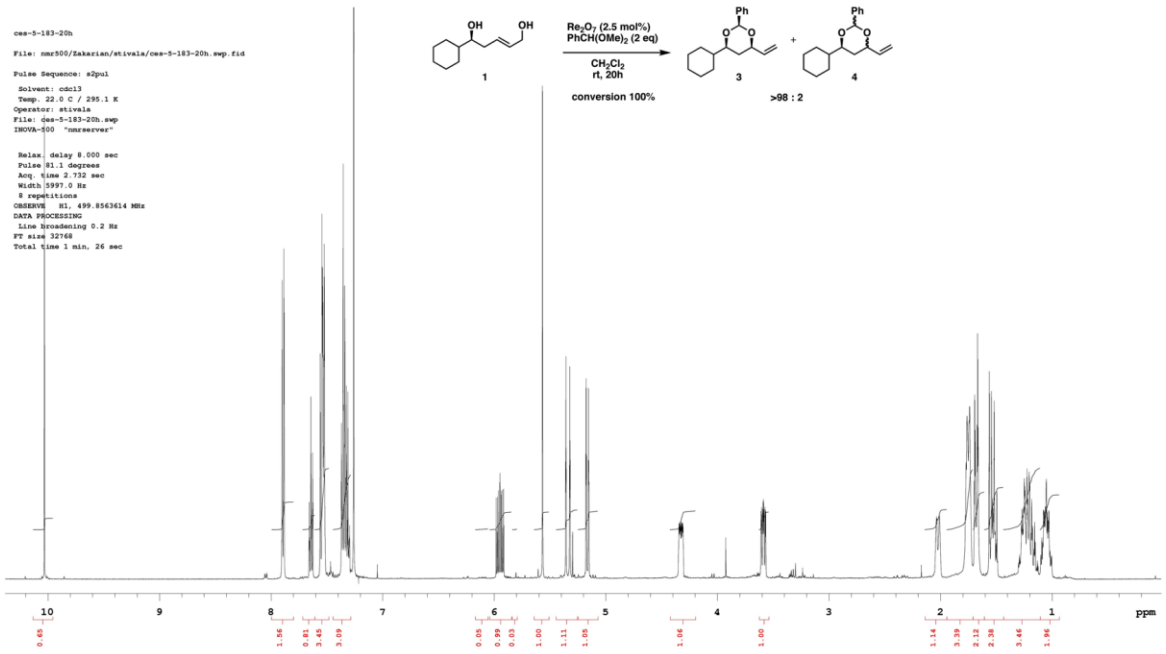

ces-5-186-40min
File: nmr500/Zakarian/stivala/ces-5-186-40min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-186-40min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Ph3SiORe03 (5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 40 min
conversion 100%
Ph
3
Ph
4
65 : 35
ppm

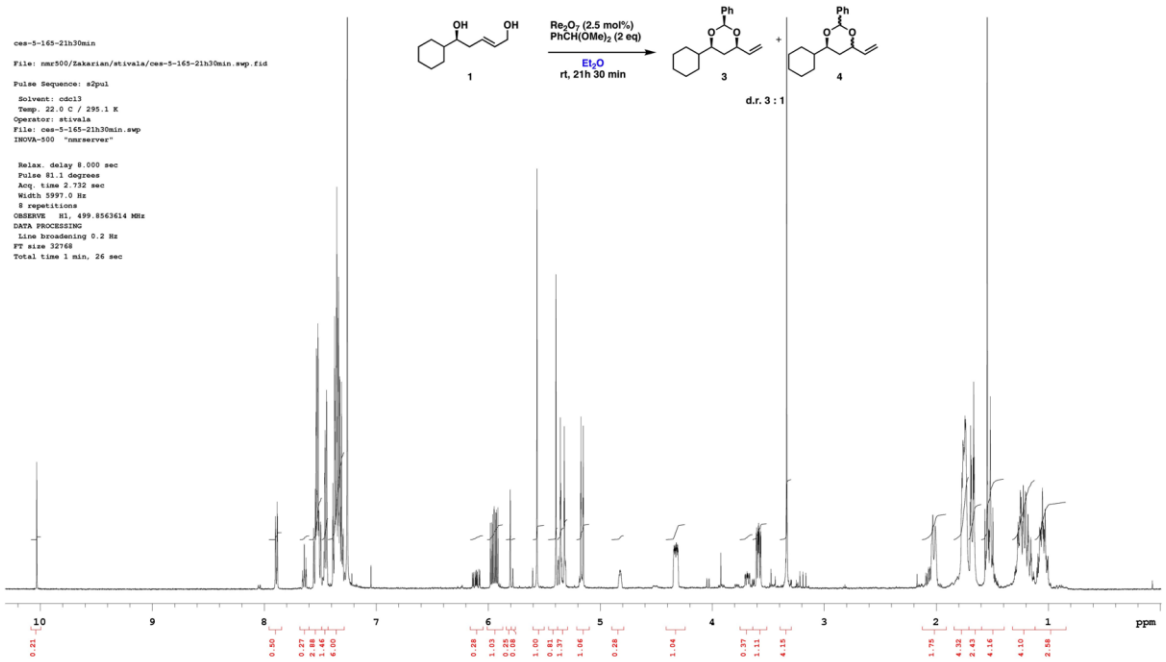

ces-5-180-3h10min
File: nmr500/Zakarian/stivala/ces-5-180-3h10min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-180-3h10min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Ph3SiOReO3 (5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 3h
conversion 100%
Ph
3
Ph
4
87 : 13
ppm

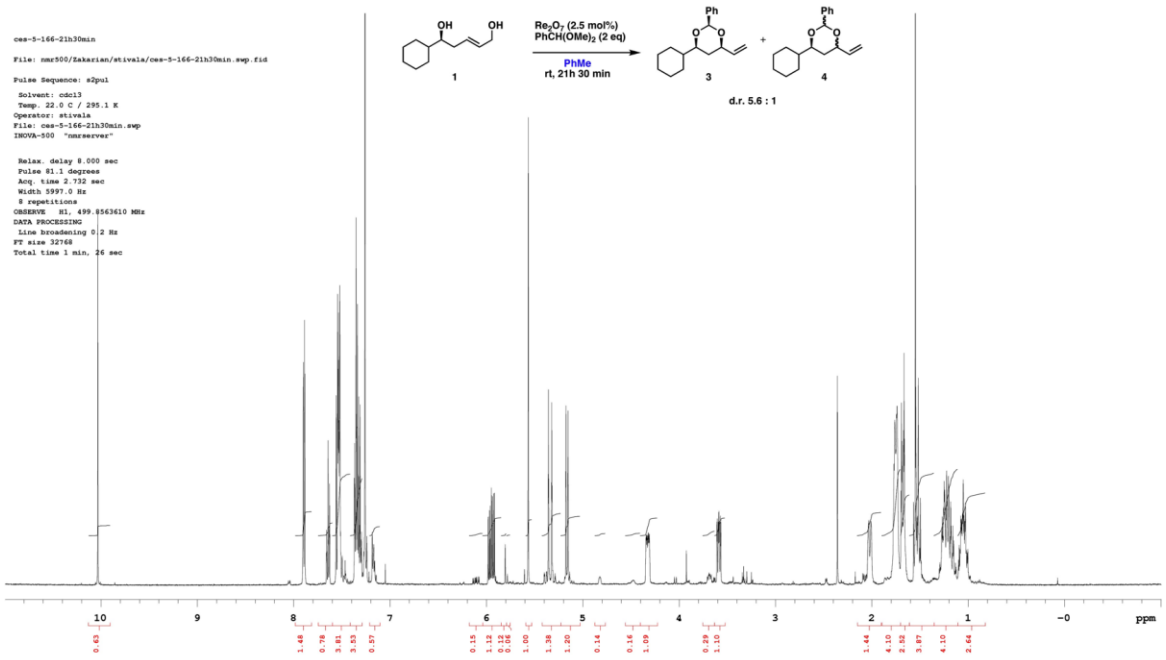

ces-5-180-20h
File: nmr500/Zakarian/stivala/ces-5-180-20h.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-180-20h.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Ph3SiOReO3 (5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 20h
conversion 100%
Ph
3
Ph
4
96 : 4
ppm

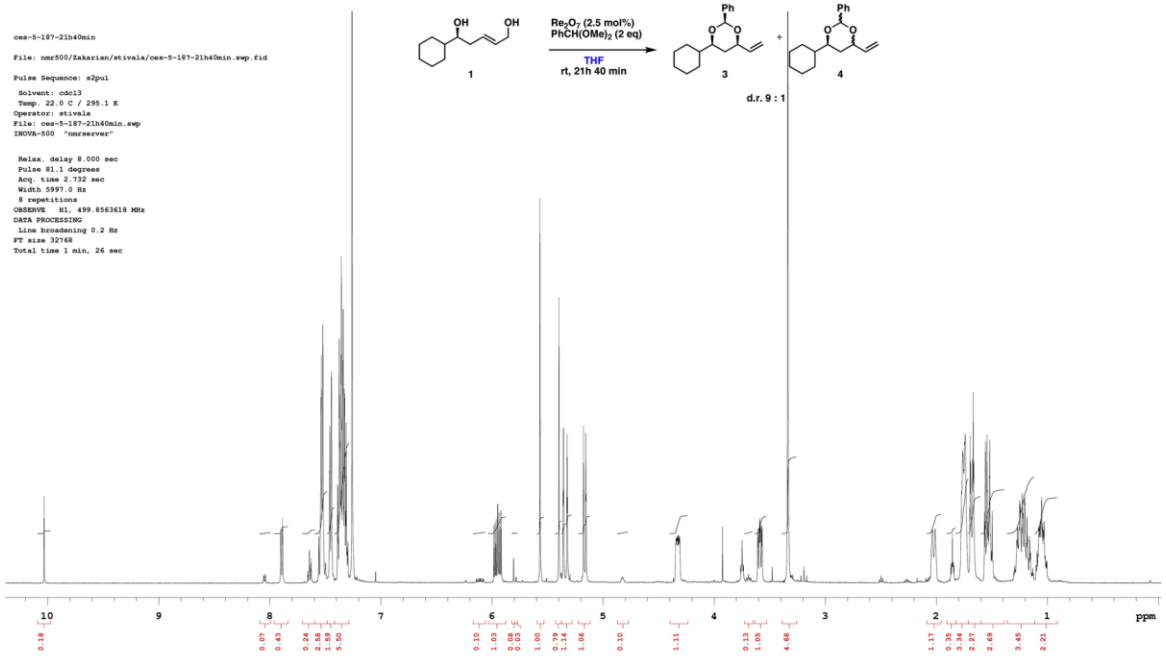

ces-5-184-40min
File: nmr500/Zakarian/stivala/ces-5-184-40min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-184-40min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Re2O7 (2.5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 40 min
conversion 100%
Ph
3
Ph
4
80 : 20
ppm

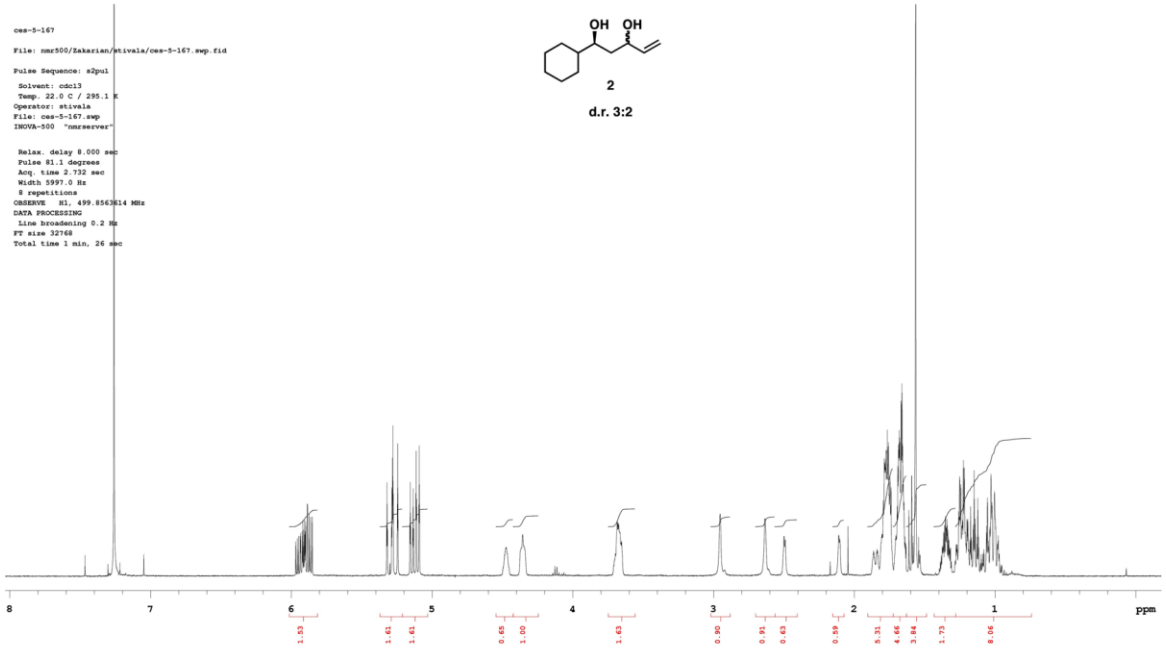

ces-5-164-3h20min
File: nmr500/Zakarian/stivala/ces-5-164-3h20min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-164-3h20min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Re2O7 (2.5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 3h
conversion 100%
Ph
3
Ph
4
91 : 9
ppm

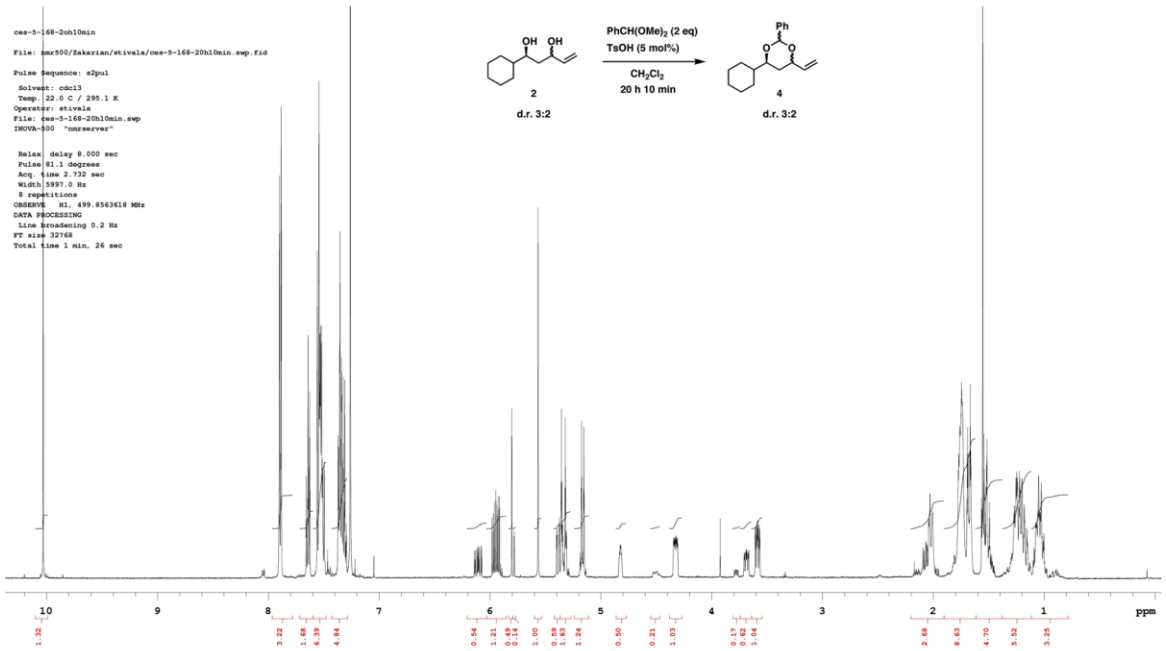

ces-5-183-20h
File: nmr500/Zakarian/stivala/ces-5-183-20h.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-183-20h.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Re2O7 (2.5 mol%)
PhCH(OMe)2 (2 eq)
CH2Cl2
rt, 20h
conversion 100%
Ph
3
4
>98 : 2
ppm

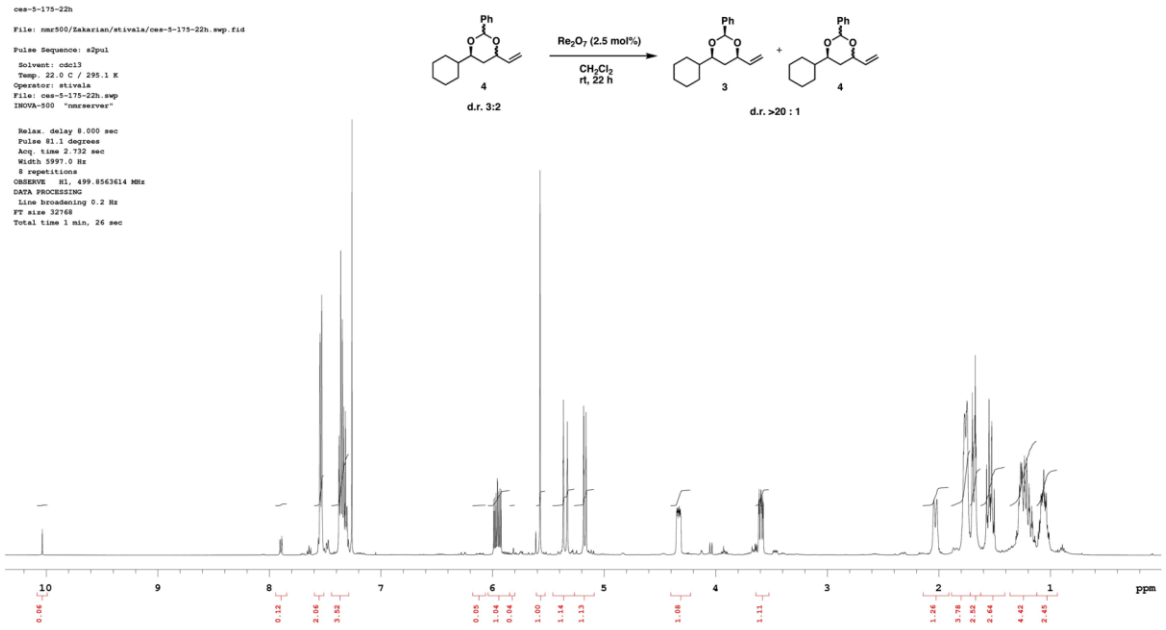

ces-5-165-21h30min
File: nmr500/Zakarian/stivala/ces-5-165-21h30min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-165-21h30min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Re2O7 (2.5 mol%)
PhCH(OMe)2 (2 eq)
Et2O
rt, 21h 30 min
Ph
3
4
d.r. 3 : 1
ppm

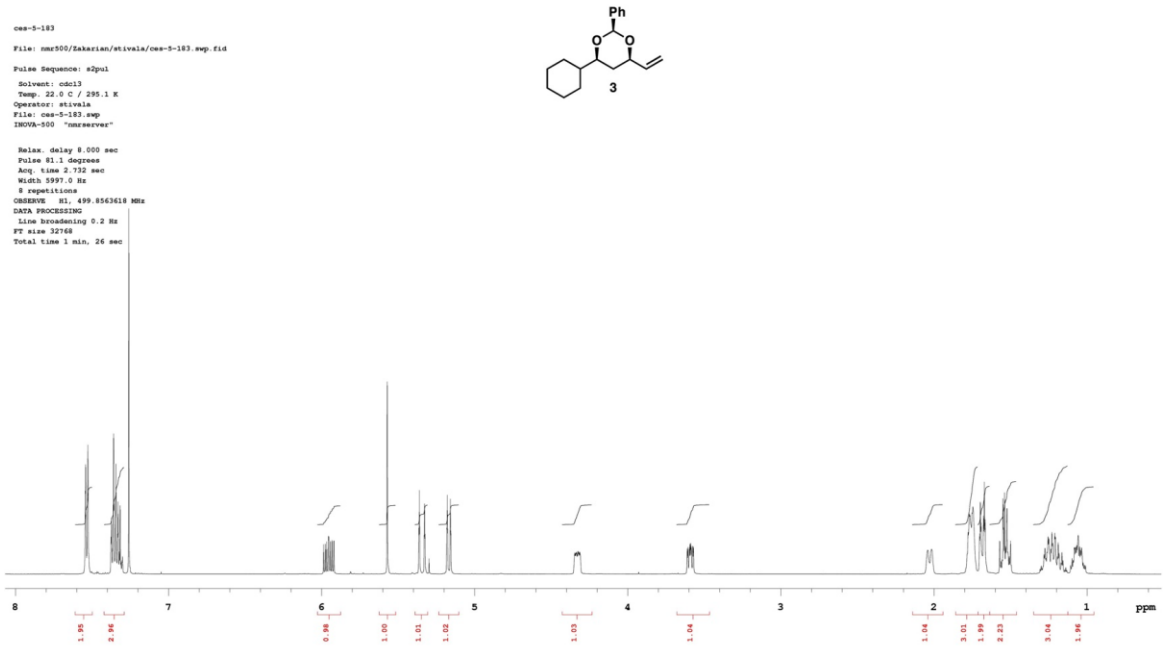

ces-5-166-21h30min
File: nmr500/Zakarian/stivala/ces-5-166-21h30min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-166-21h30min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Re2O7 (2.5 mol%)
PhCH(OMe)2 (2 eq)
PhMe
rt, 21h 30 min
Ph
3
4
d.r. 5.6 : 1
ppm

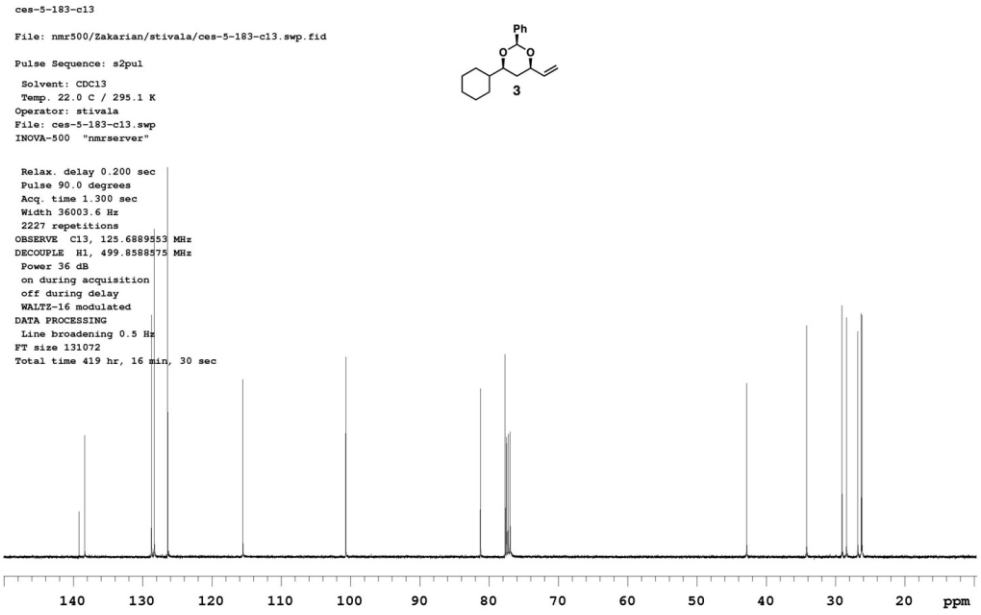

ces-5-187-21h40min
File: nmr500/Zakarian/stivala/ces-5-187-21h40min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-187-21h40min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
1
Re2O7 (2.5 mol%)
PhCH(OMe)2 (2 eq)
THF
rt, 21h 40 min
Ph
3
4
d.r. 9 : 1
ppm

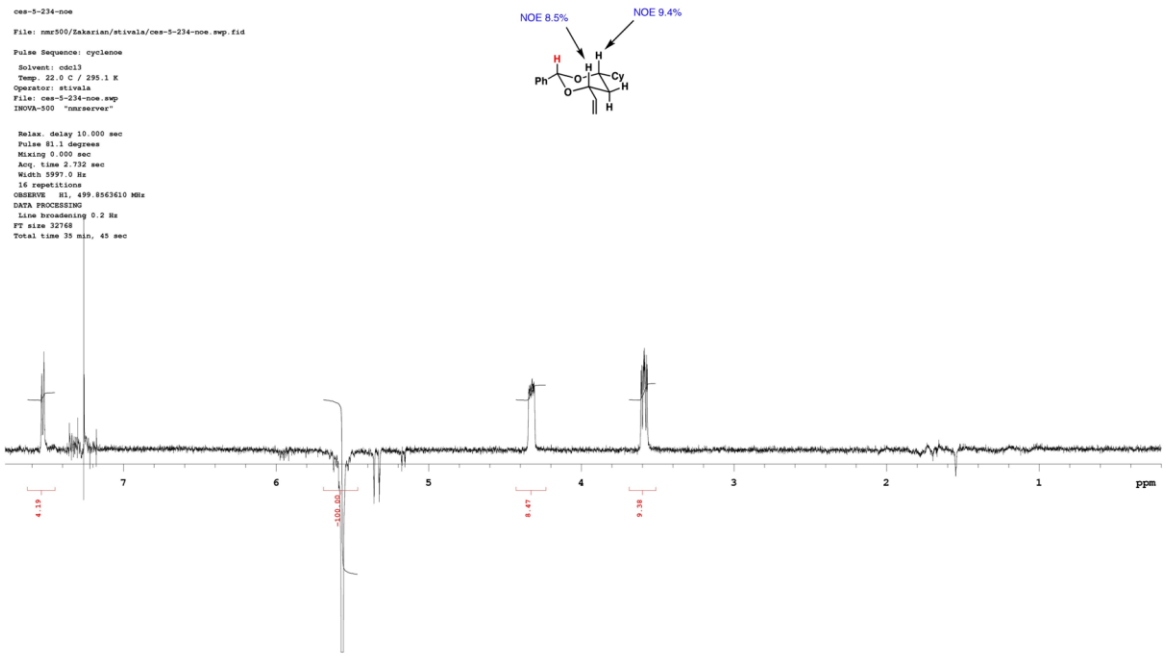

ces-5-167
File: nmr500/Zakarian/stivala/ces-5-167.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-167.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH OH
2
d.r. 3:2
ppm

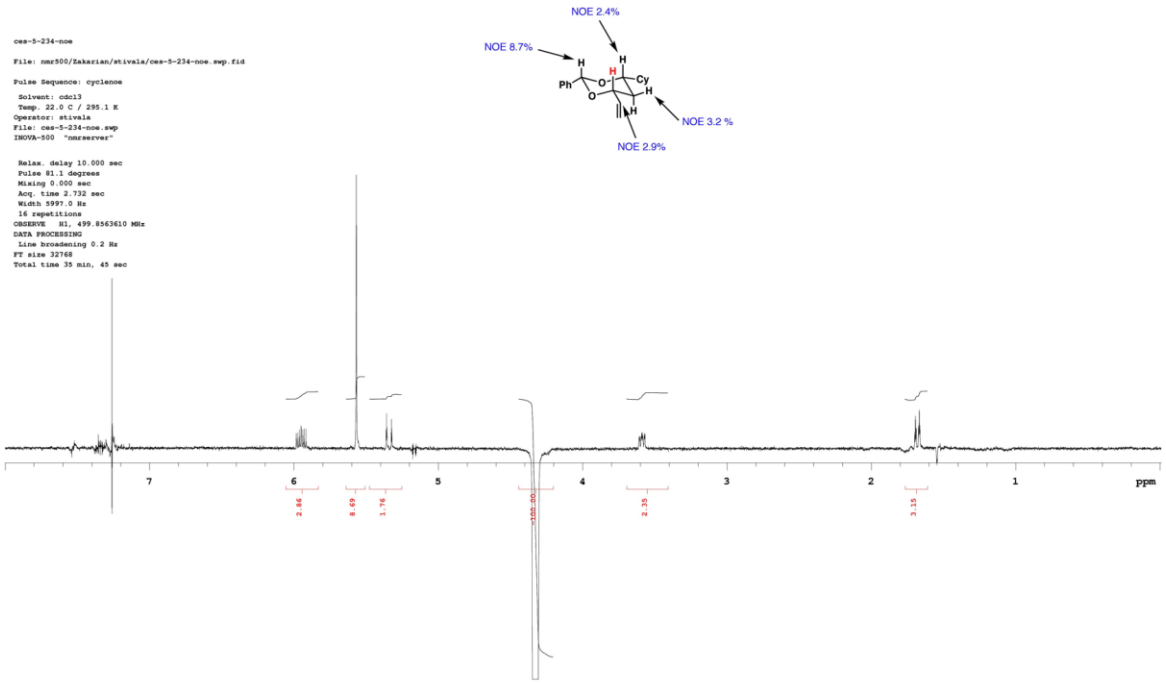

ces-5-168-20h10min
File: nmr500/Zakarian/stivala/ces-5-168-20h10min.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-168-20h10min.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH OH
2
d.r. 3:2
PhCH(OMe)2 (2 eq)
TsOH (5 mol%)
CH2Cl2
20 h 10 min
Ph
O O
4
d.r. 3:2
ppm

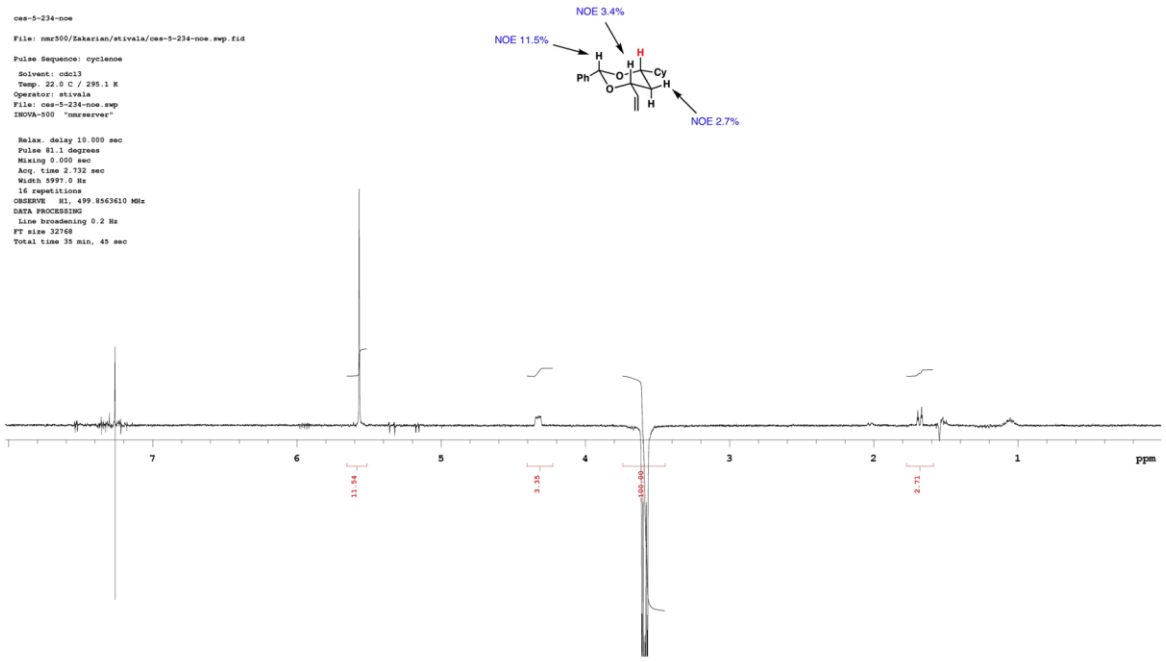

ces-5-175-22h
File: nmr500/Zakarian/stivala/ces-5-175-22h.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-175-22h.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
4
d.r. 3:2
Re2O7 (2.5 mol%)
CH2Cl2
rt, 22 h
3
d.r. >20 : 1
ppm

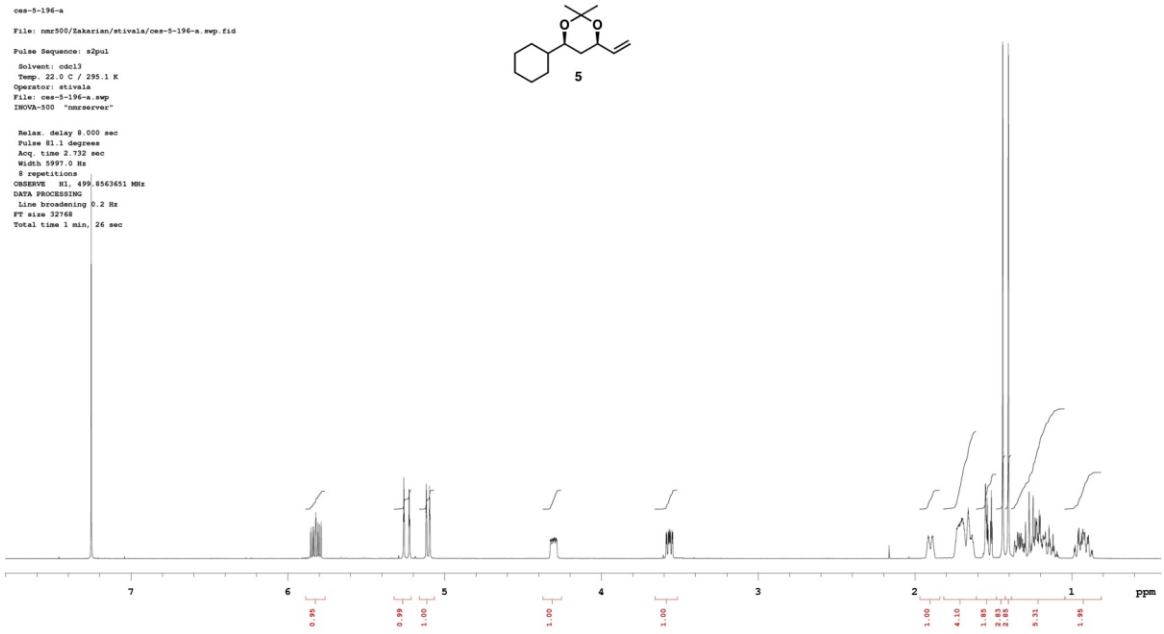

ces-5-183
File: nmr500/Zakarian/stivala/ces-5-183.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-183.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
3
ppm

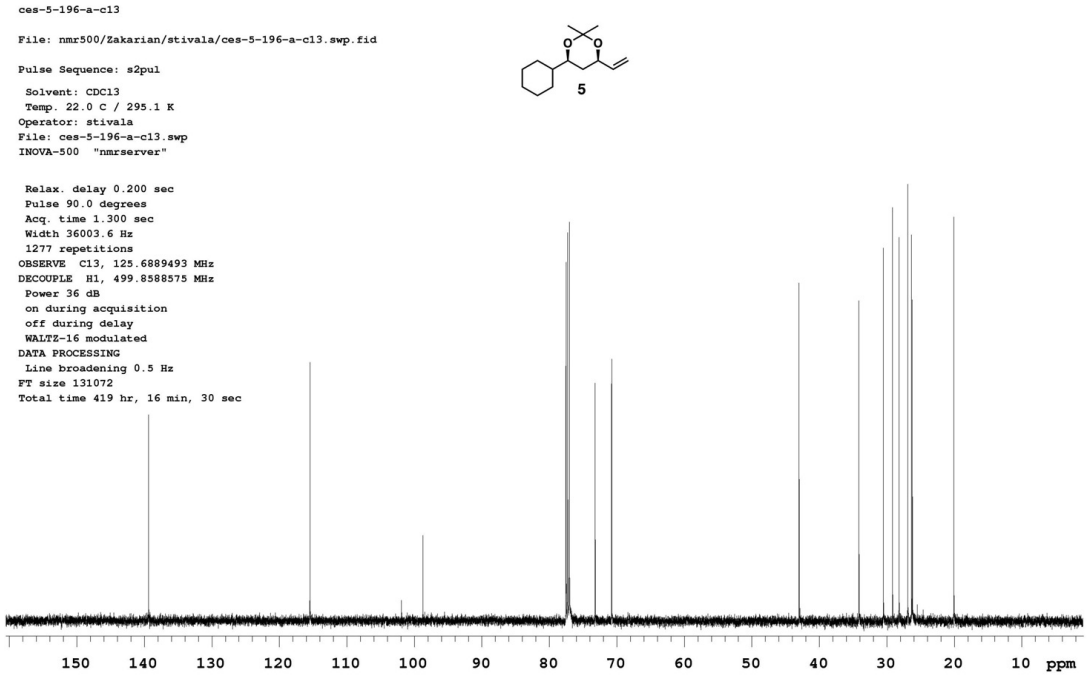

ces-5-183-c13
File: nmr500/Zakarian/stivala/ces-5-183-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-183-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
2227 repetitions
OBSERVE C13, 125.6889553 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
Ph
O
O
3
140
130
120
110
100
90
80
70
60
50
40
30
20
ppm

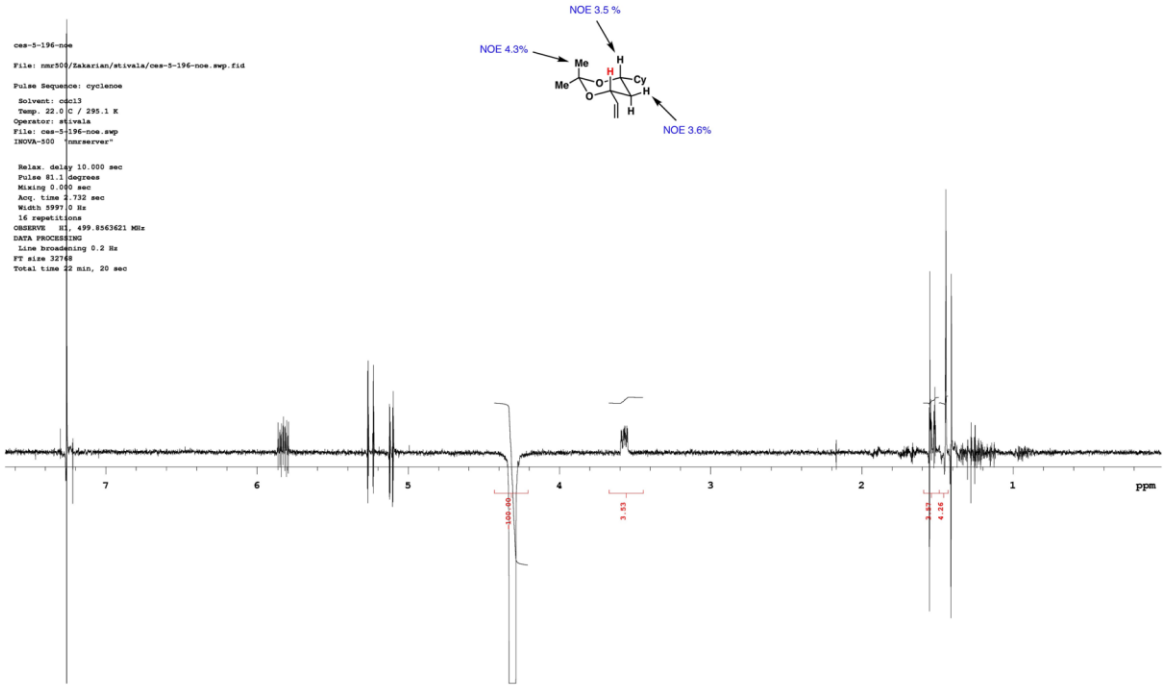

ces-5-234-noe
File: nmr500/Zakarian/stivala/ces-5-234-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-234-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 35 min, 45 sec
NOE 8.5%
NOE 9.4%
H
H
Ph
O
O
Cy
H
H
7
6
5
4
3
2
1
ppm
4.19
-100.00
8.47
9.38

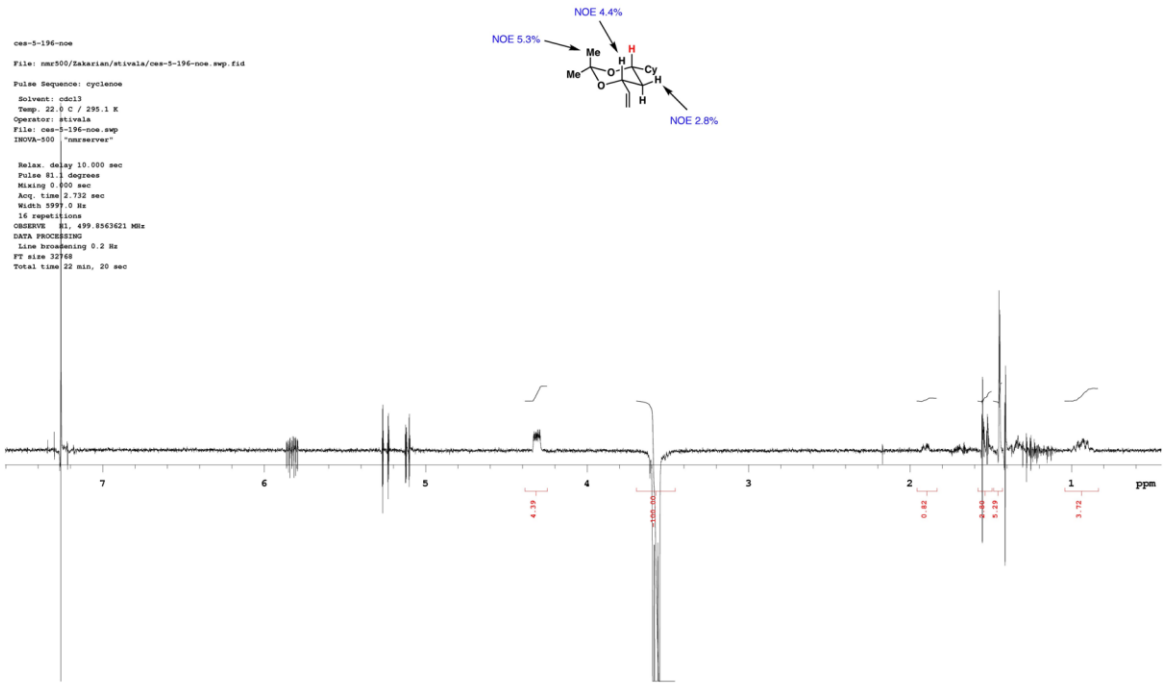

NOE 2.4%
NOE 8.7%
NOE 3.2 %
NOE 2.9%
ppm

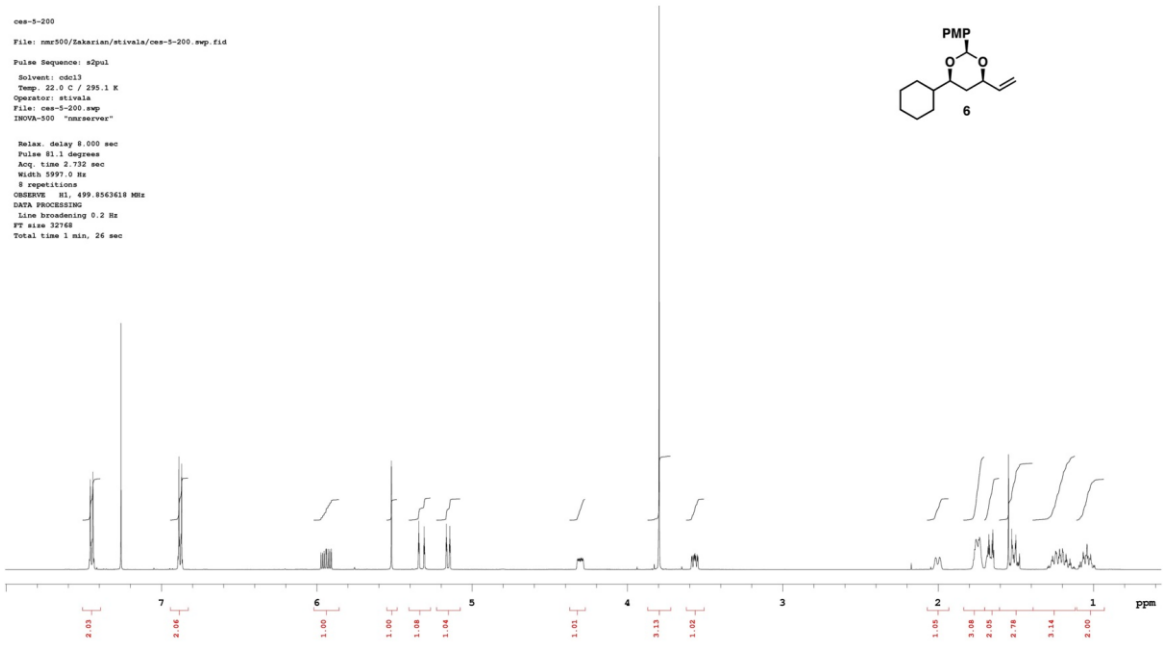

NOE 3.4%
NOE 11.5%
NOE 2.7%
ppm

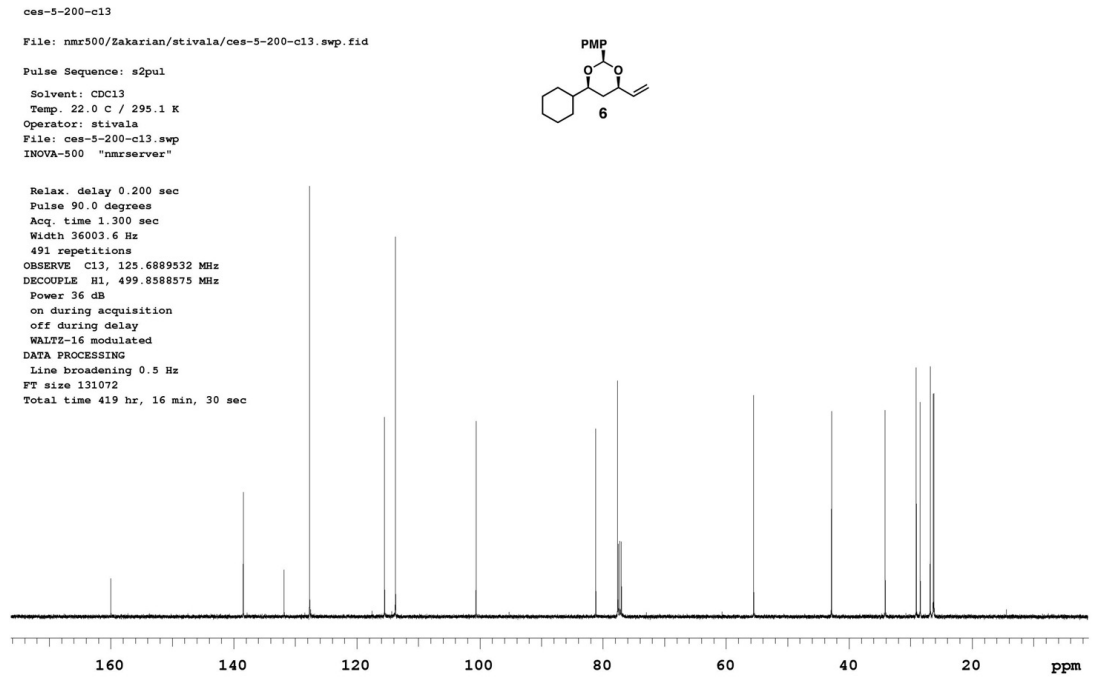

ces-5-196-a
File: nmr500/Zakarian/stivala/ces-5-196-a.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-196-a.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563651 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
5
7
6
5
4
3
2
1
ppm
0.95
0.99
1.00
1.00
1.00
1.00
4.10
1.85
2.83
2.85
5.31
1.95

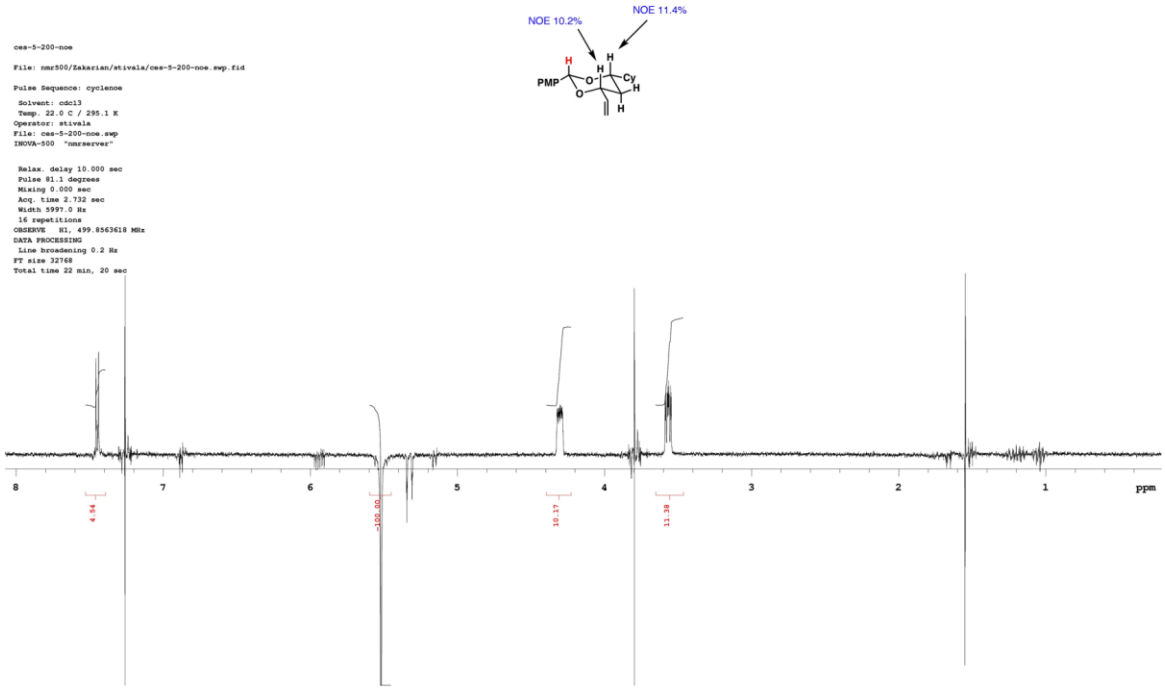

ces-5-196-a-c13
File: nmr500/Zakarian/stivala/ces-5-196-a-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-196-a-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1277 repetitions
OBSERVE C13, 125.6889493 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
5
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

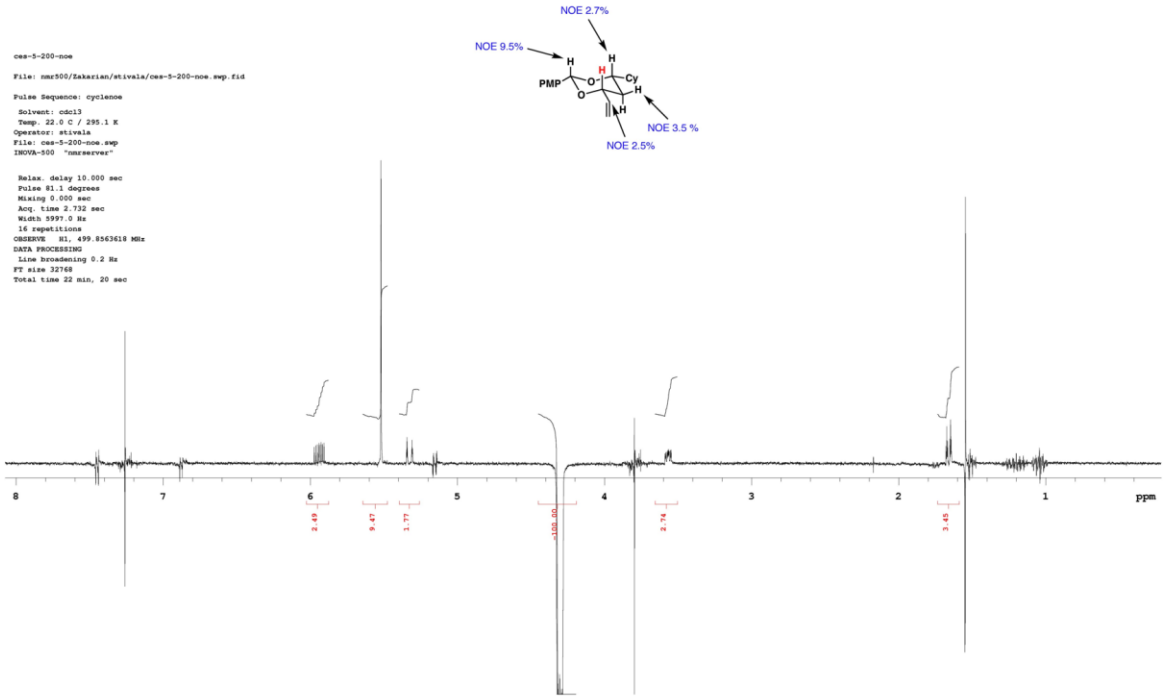

NOE 3.5 %
NOE 4.3%
NOE 3.6%
Me
H
Cy
O
ces-5-196-noe
File: nmr500/Zakarian/stivala/ces-5-196-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-196-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 22 min, 20 sec
7
6
5
4
3
2
1
ppm
-100.00
3.53
3.83
4.26

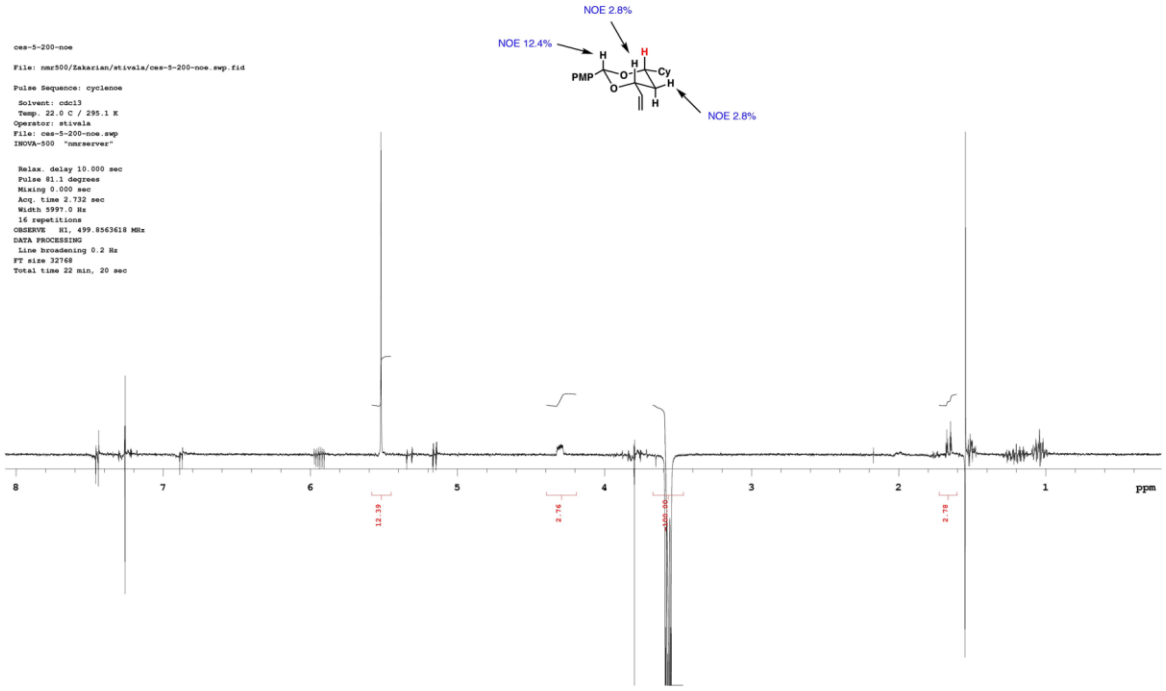

NOE 4.4%
NOE 5.3%
NOE 2.8%
Me
H
Cy
O
ces-5-196-noe
File: nmr500/Zakarian/stivala/ces-5-196-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-196-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 22 min, 20 sec
7
6
5
4
3
2
1
ppm
4.39
-100.00
0.82
5.39
3.72

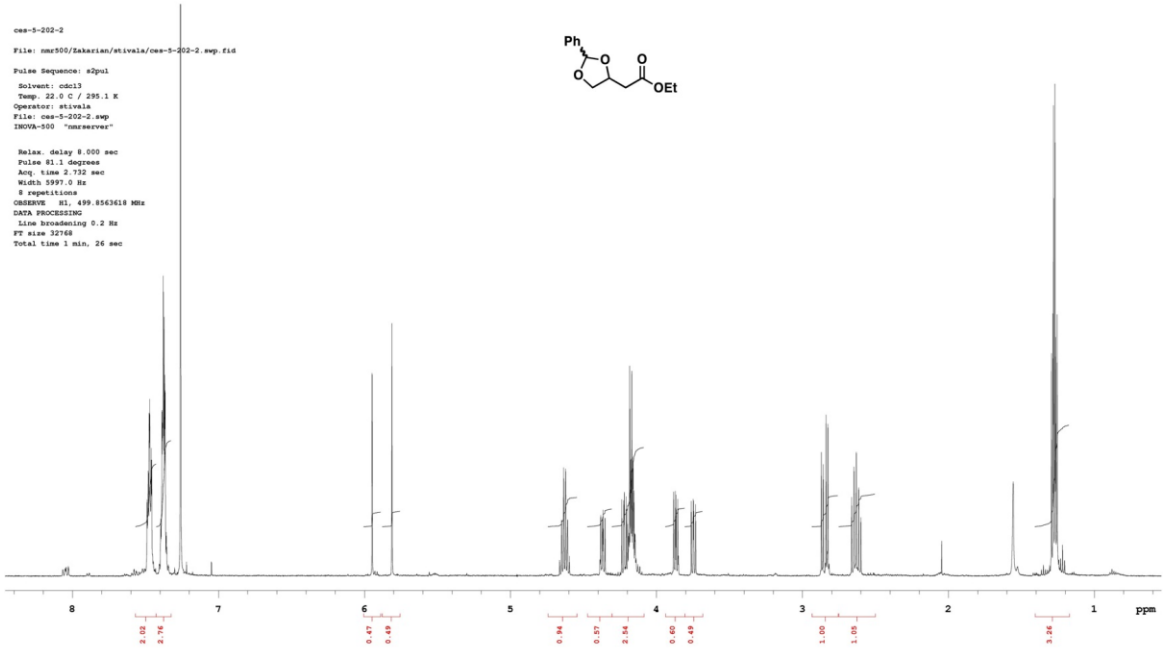

ces-5-200
File: nmr500/Zakarian/stivala/ces-5-200.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-200.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
PMP
6
7
6
5
4
3
2
1
ppm
2.03
2.06
1.00
1.00
1.08
1.04
1.01
3.13
1.02
1.05
3.08
2.05
2.78
3.14
2.00

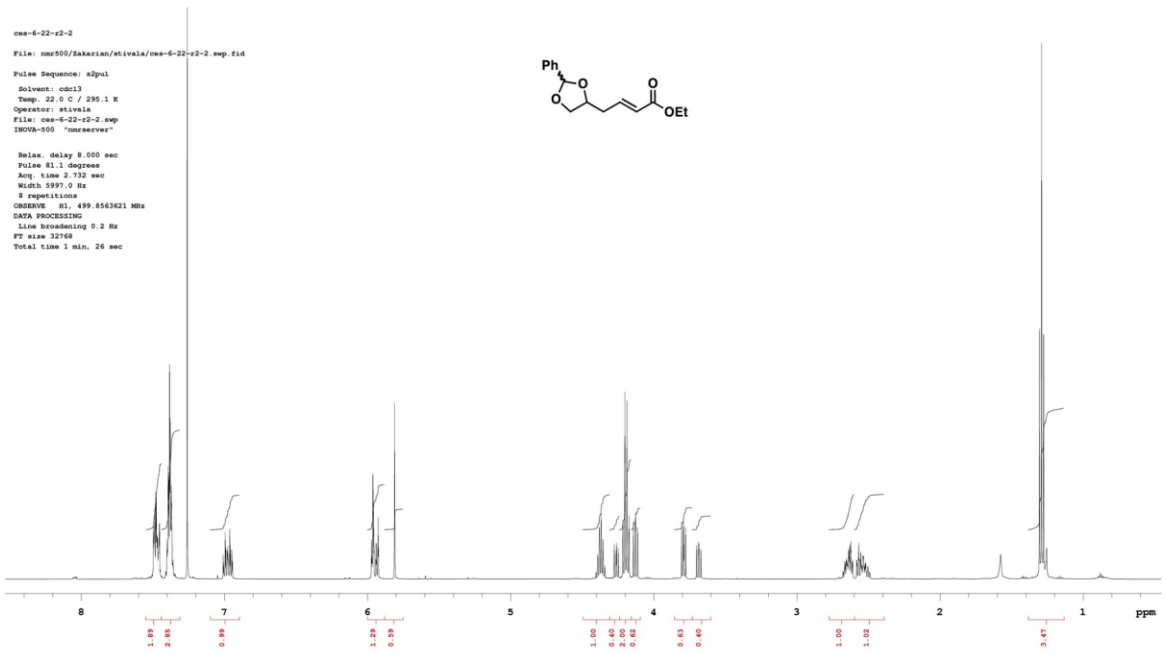

ces-5-200-c13
File: nmr500/Zakarian/stivala/ces-5-200-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-200-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
491 repetitions
OBSERVE C13, 125.6889532 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
PMP
6
160
140
120
100
80
60
40
20
ppm

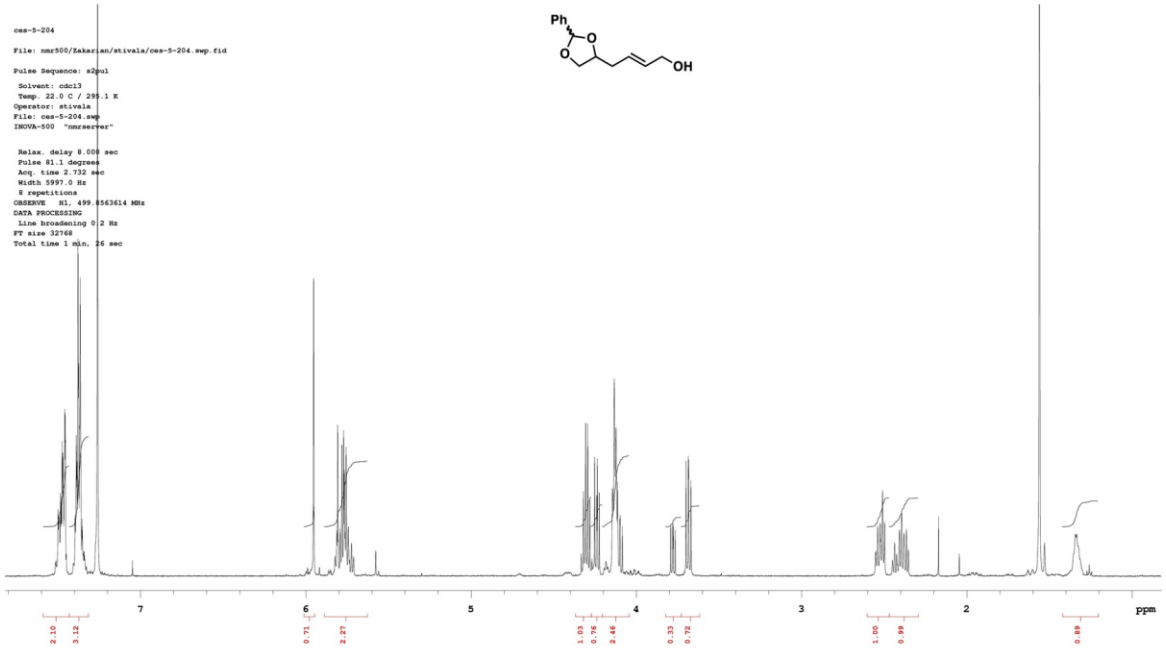

NOE 10.2%
NOE 11.4%
PMP
Cy
ces-5-200-noe
File: nmr500/Zakarian/stivala/ces-5-200-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-200-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 22 min, 20 sec
8
7
6
5
4
3
2
1
ppm
4.54
-100.00
10.17
11.38

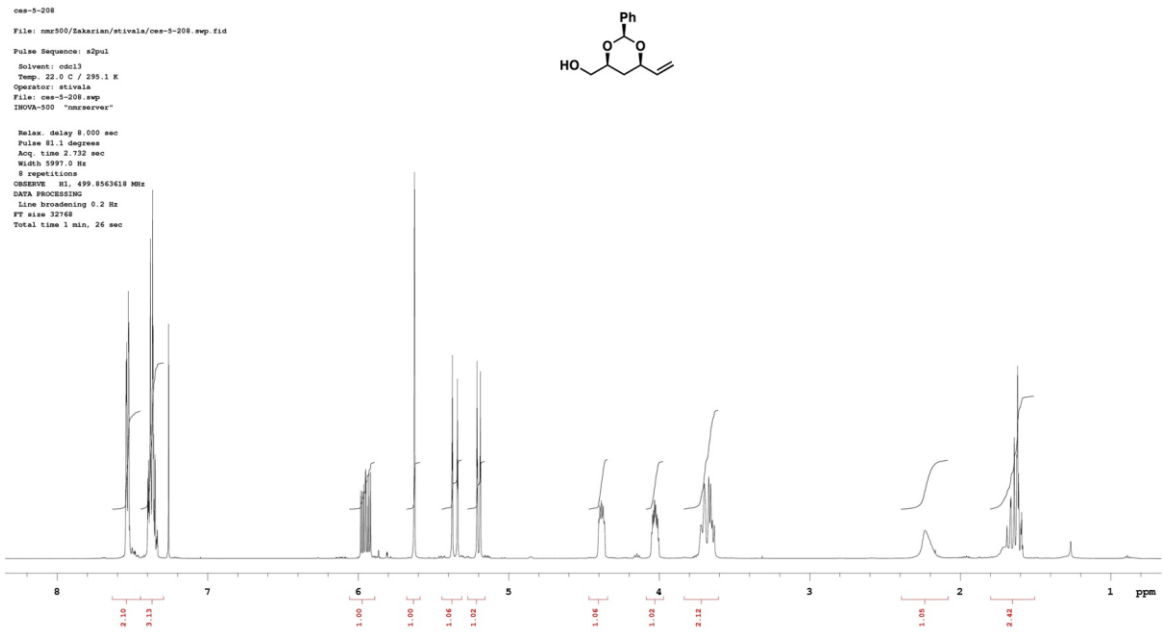

NOE 2.7%
NOE 9.5%
NOE 3.5 %
NOE 2.5%
PMP
Cy
ces-5-200-noe
File: nmr500/Zakarian/stivala/ces-5-200-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-200-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 22 min, 20 sec
8
7
6
5
4
3
2
1
ppm
2.49
9.47
1.77
-100.00
2.74
3.45

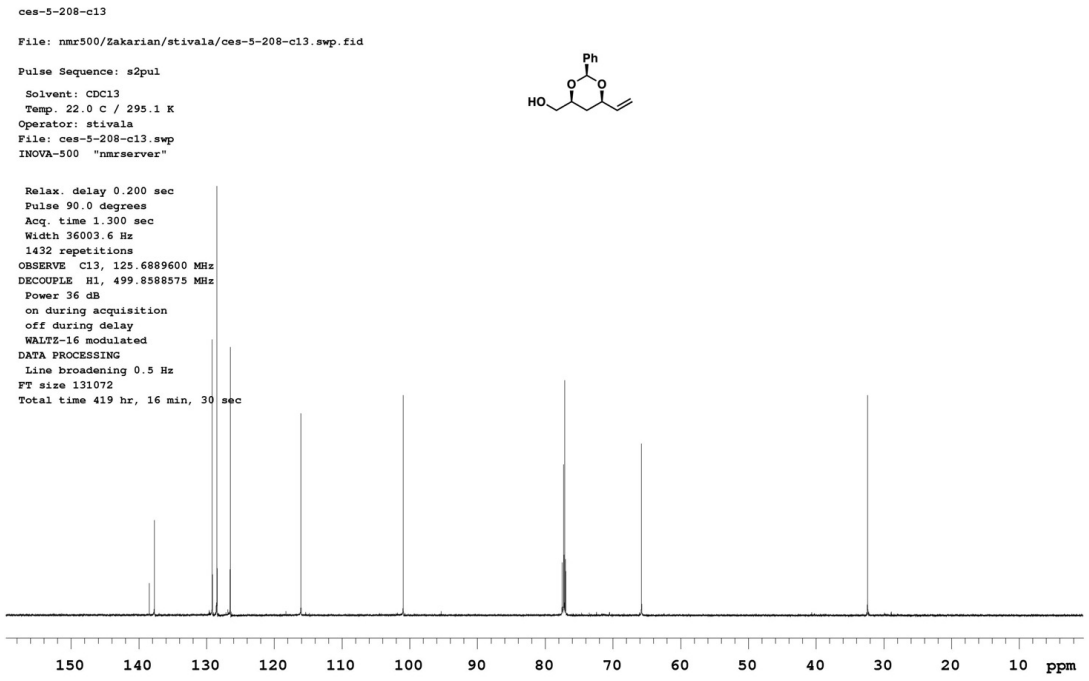

NOE 2.8%
NOE 12.4%
NOE 2.8%
PMP
Cy
ppm

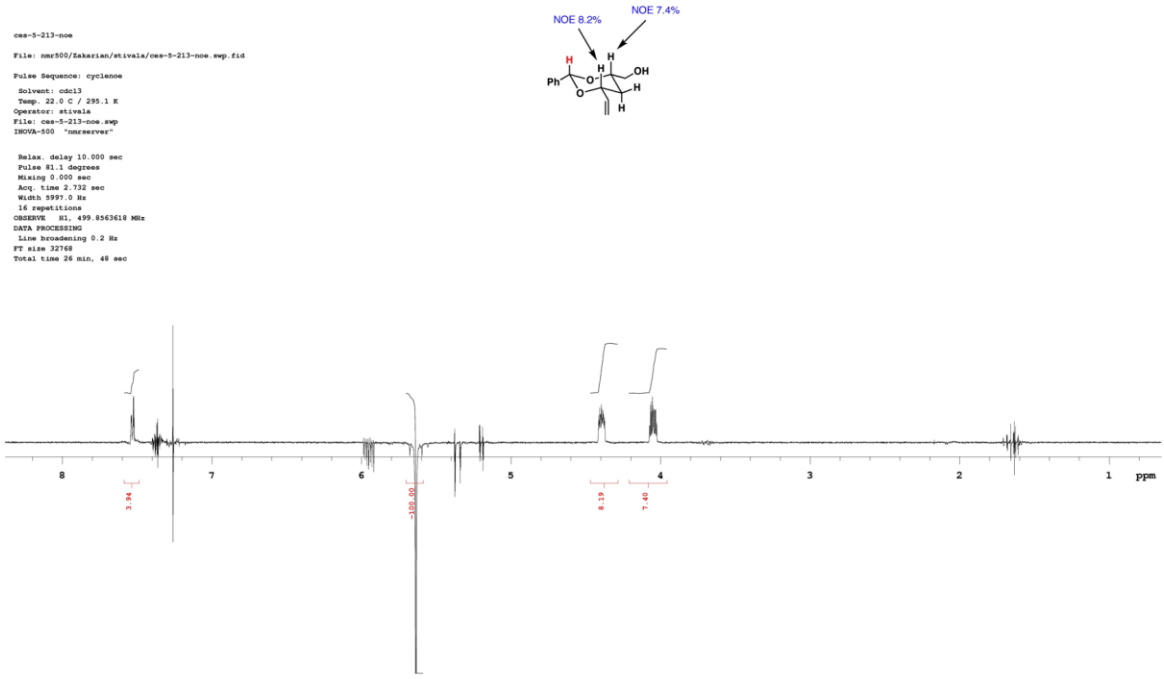

Ph
OEt
ppm

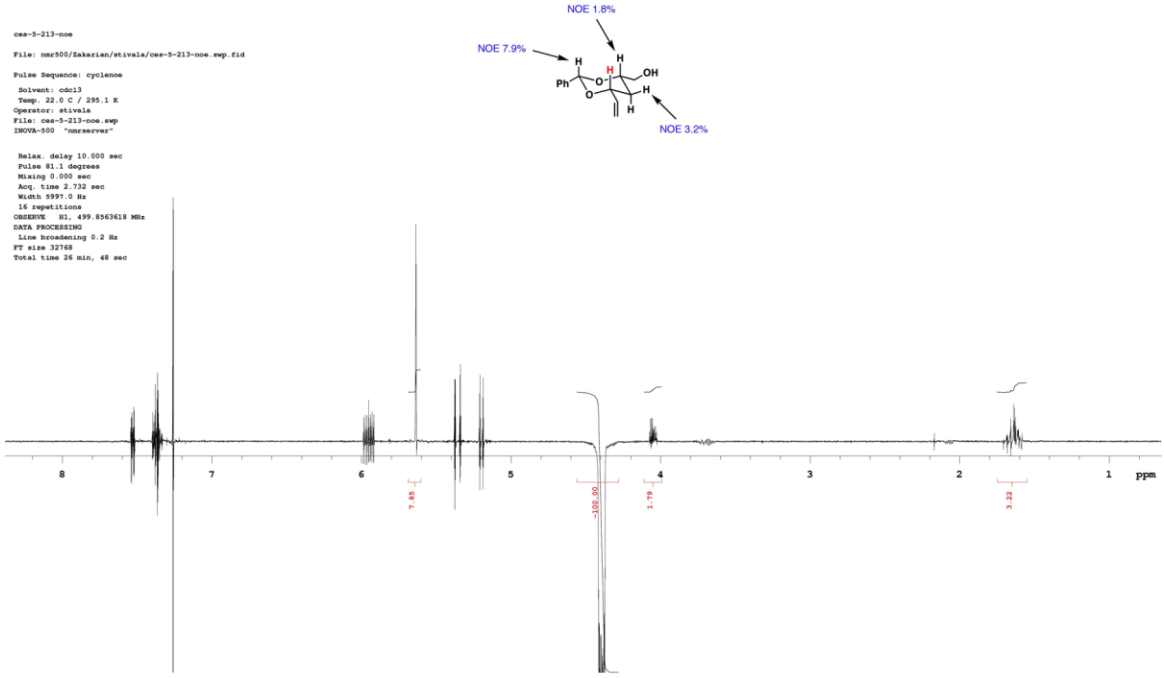

ces-6-22-r2-2
File: nmr500/Zakarian/stivala/ces-6-22-r2-2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-22-r2-2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
O
O
O
OEt
8
7
6
5
4
3
2
1
ppm
1.89
2.85
0.99
1.29
0.59
1.00
0.40
2.00
0.62
0.63
0.40
1.00
1.02
3.47

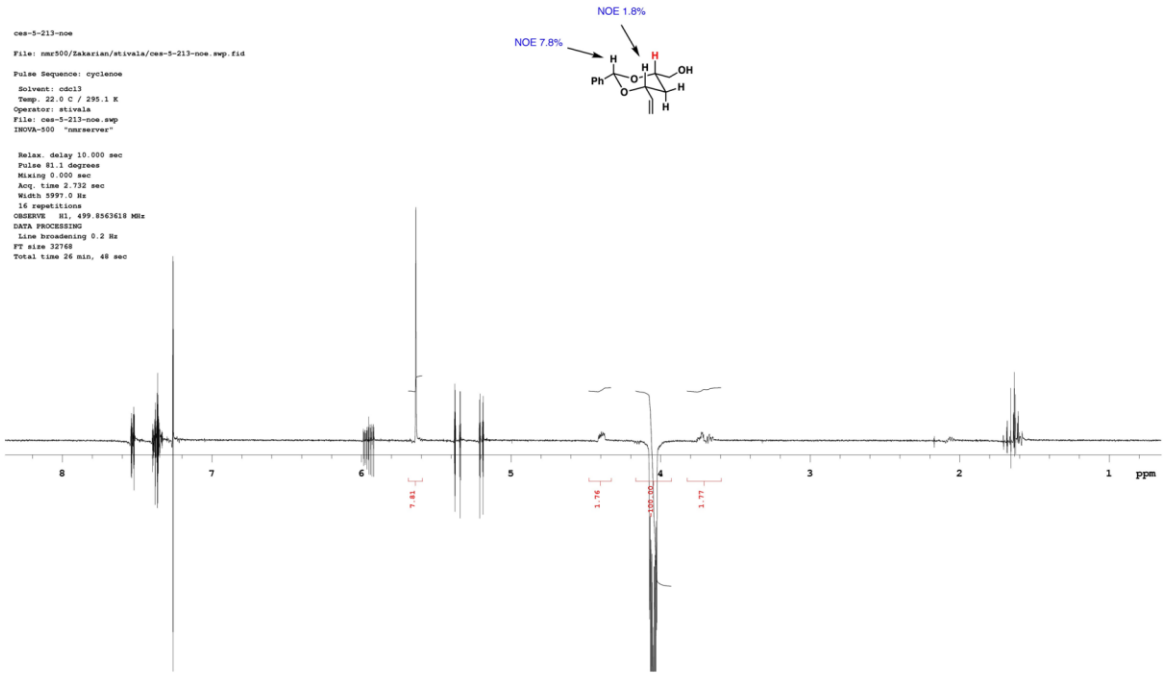

ces-5-204
File: nmr500/Zakarian/stivala/ces-5-204.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-204.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
O
O
OH
7
6
5
4
3
2
ppm
2.10
3.12
0.71
2.27
1.03
0.76
2.46
0.33
0.72
1.00
0.99
0.89

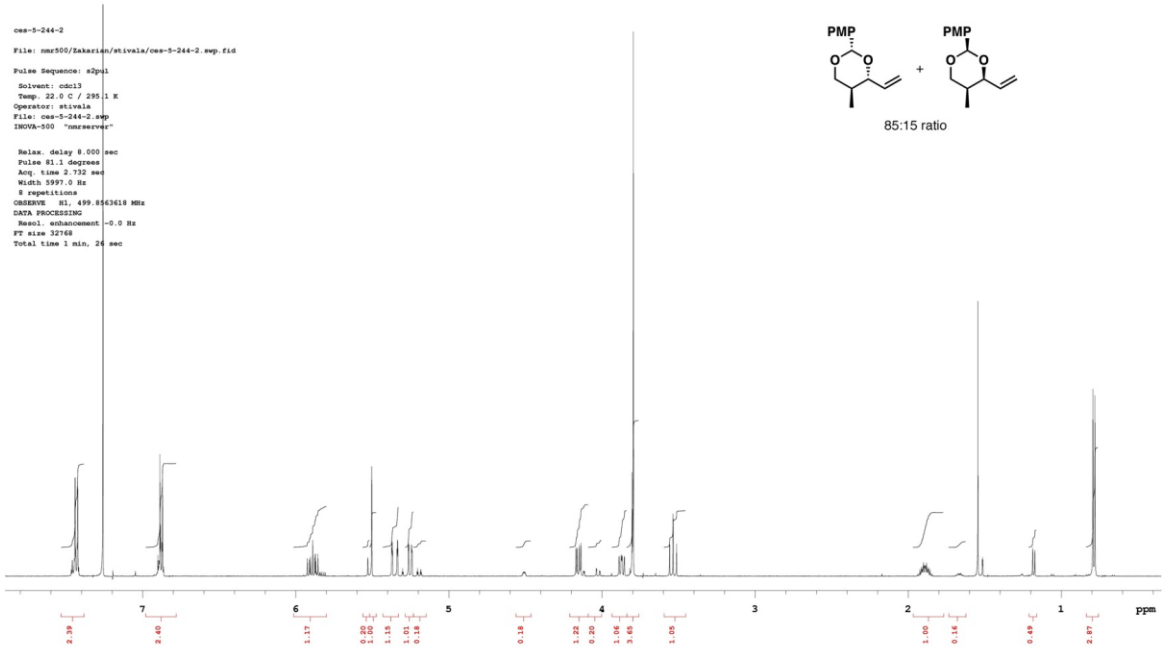

ces-5-208
File: nmr500/Zakarian/stivala/ces-5-208.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-208.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
O
O
HO
8
7
6
5
4
3
2
1
ppm
2.10
3.13
1.00
1.00
1.06
1.02
1.06
1.02
2.12
1.05
2.42

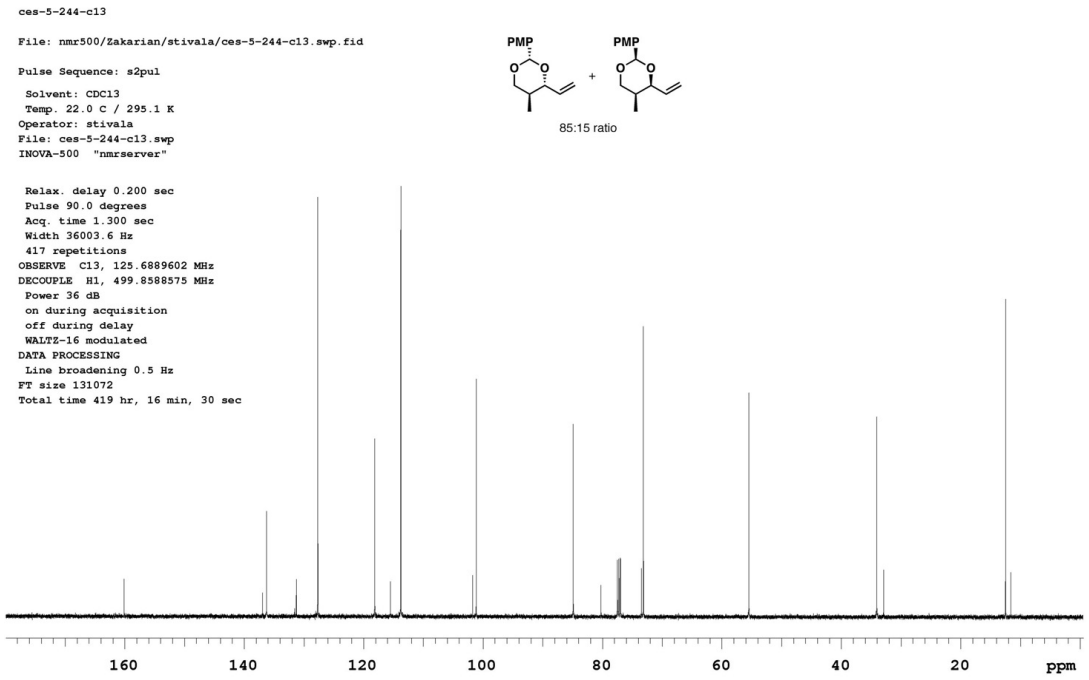

ces-5-208-c13
File: nmr500/Zakarian/stivala/ces-5-208-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-208-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1432 repetitions
OBSERVE C13, 125.6889600 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
Ph
O
O
HO
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

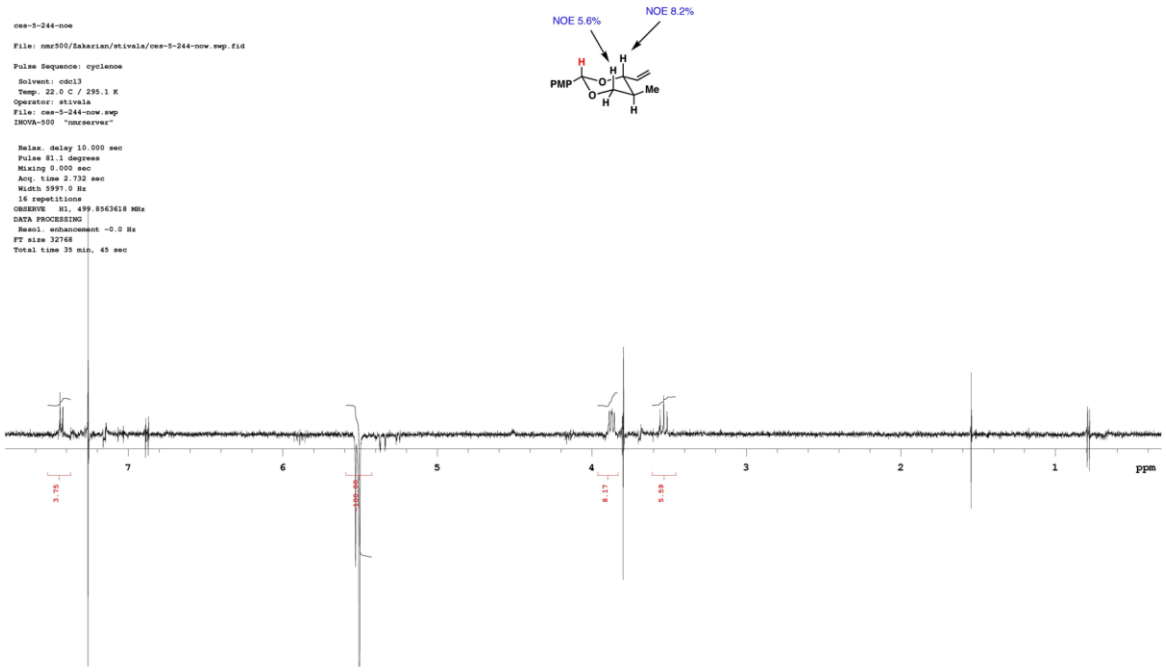

ces-5-213-noe
File: nmr500/Zakarian/stivala/ces-5-213-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-213-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 26 min, 48 sec
NOE 8.2%
NOE 7.4%
Ph
OH
8
7
6
5
4
3
2
1
ppm
3.94
-100.00
8.19
7.40

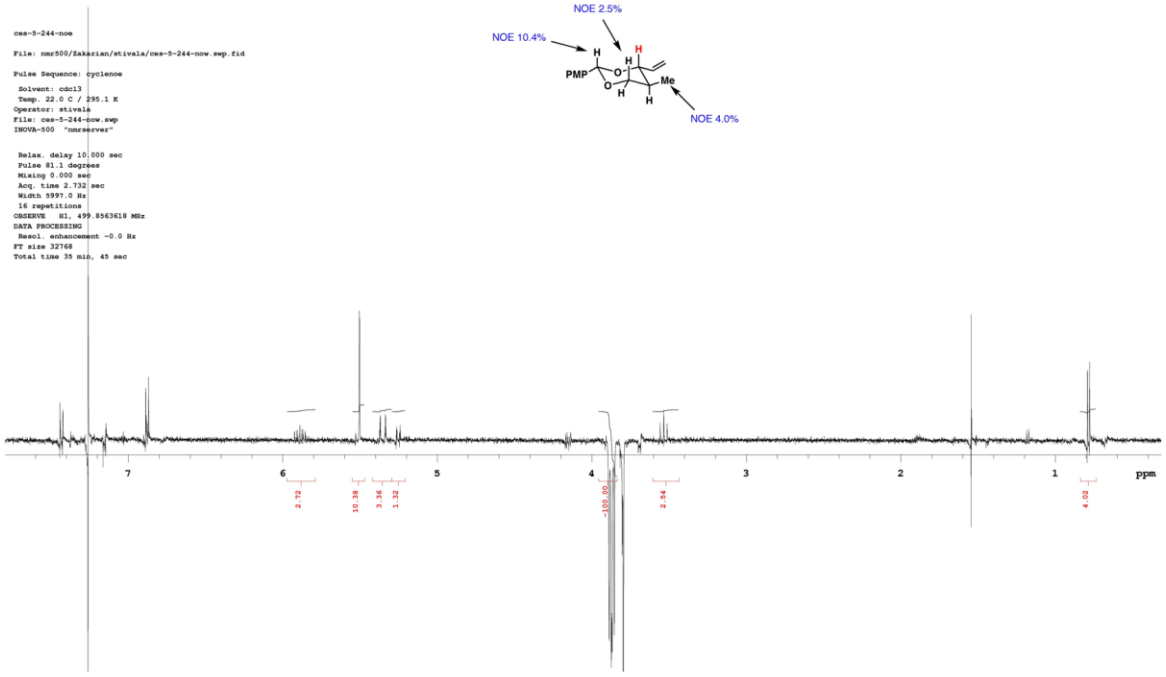

ces-5-213-noe
File: nmr500/Zakarian/stivala/ces-5-213-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-213-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 26 min, 48 sec
NOE 1.8%
NOE 7.9%
NOE 3.2%
Ph
OH
8
7
6
5
4
3
2
1
ppm
7.85
-100.00
1.79
3.22

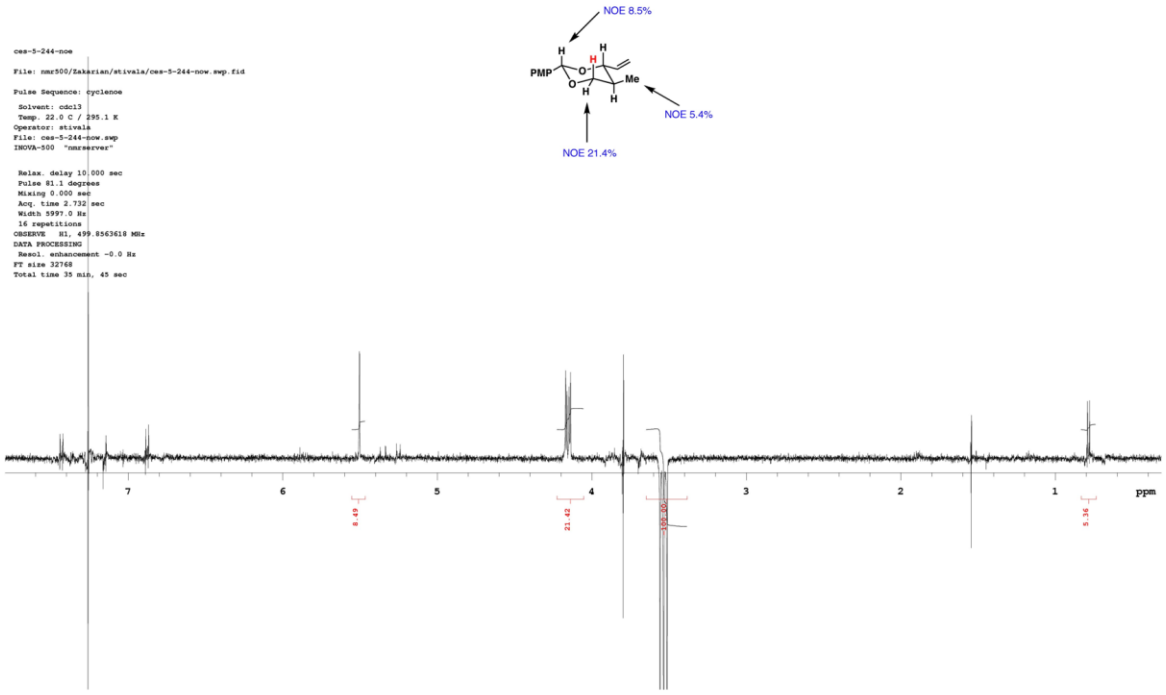

NOE 1.8%
NOE 7.8%
ces-5-213-noe
File: nmr500/Zakarian/stivala/ces-5-213-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-213-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 26 min, 48 sec
ppm

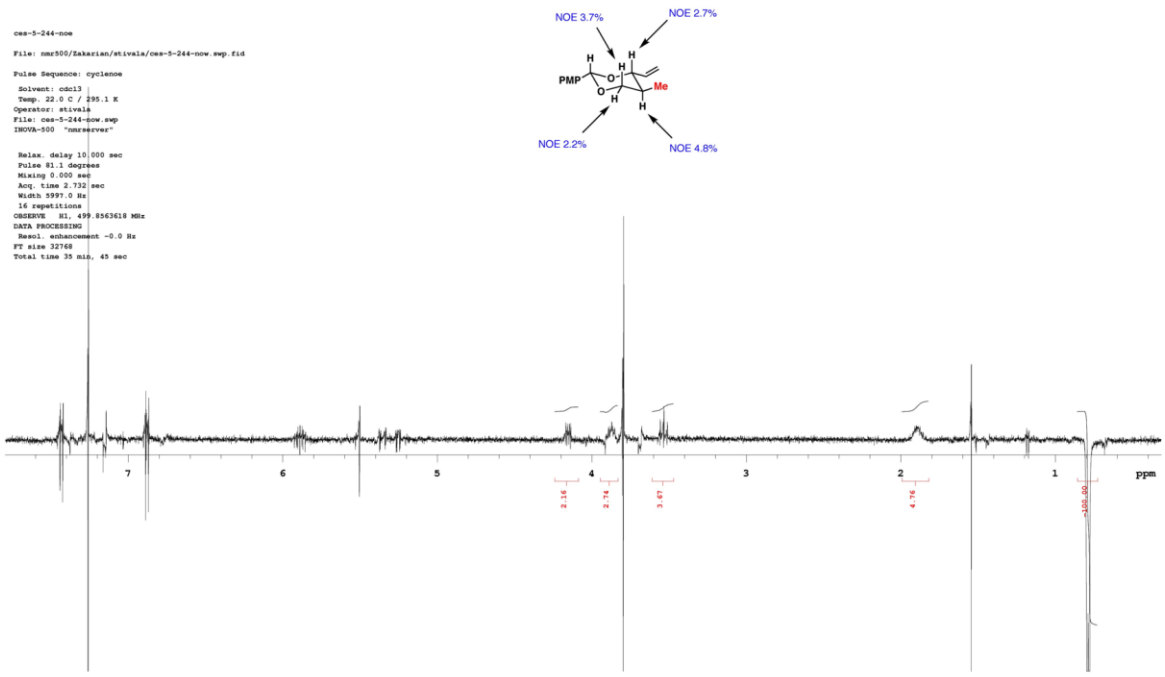

ces-5-244-2
File: nmr500/Zakarian/stivala/ces-5-244-2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-244-2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 1 min, 24 sec
PMP
PMP
85:15 ratio
ppm

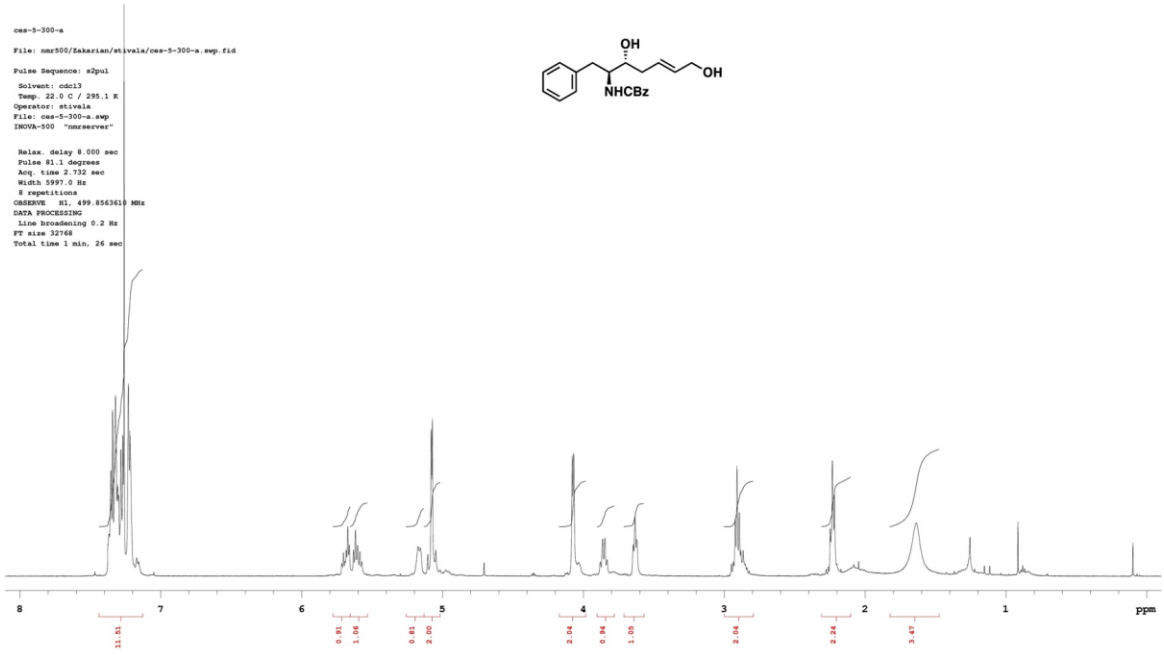

ces-5-244-c13
File: nmr500/Zakarian/stivala/ces-5-244-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-244-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
417 repetitions
OBSERVE C13, 125.6889602 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
PMP
PMP
85:15 ratio
160
140
120
100
80
60
40
20
ppm

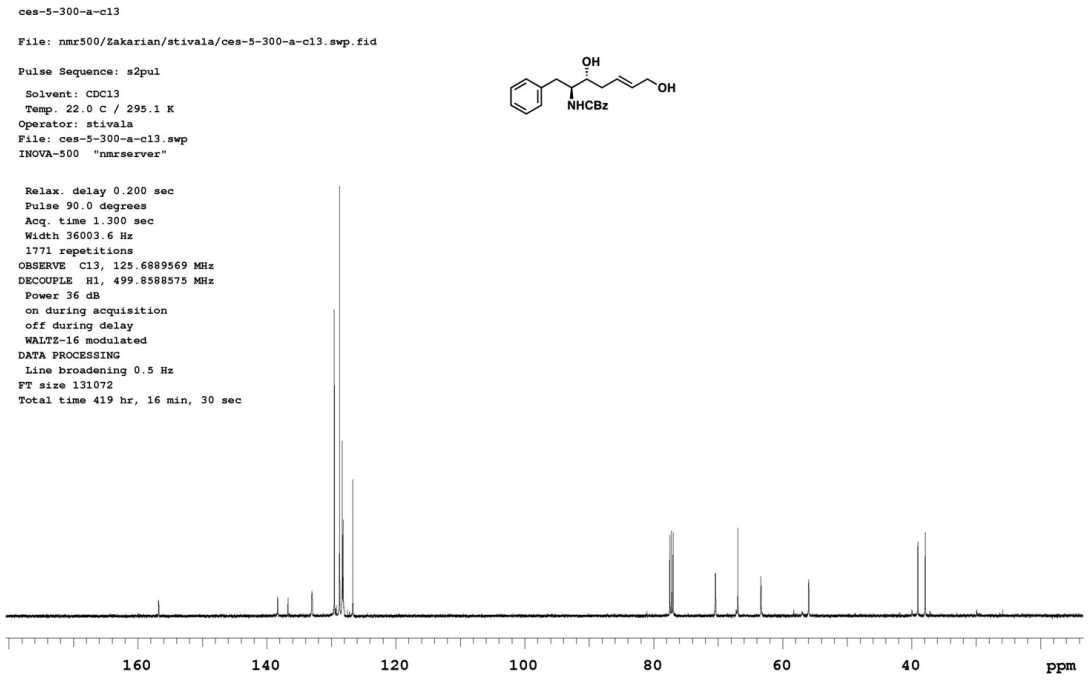

ces-5-244-noe
File: nmr500/Zakarian/stivala/ces-5-244-now.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-244-now.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 35 min, 45 sec
NOE 5.6%
NOE 8.2%
PMP
Me
7
6
5
4
3
2
1
ppm

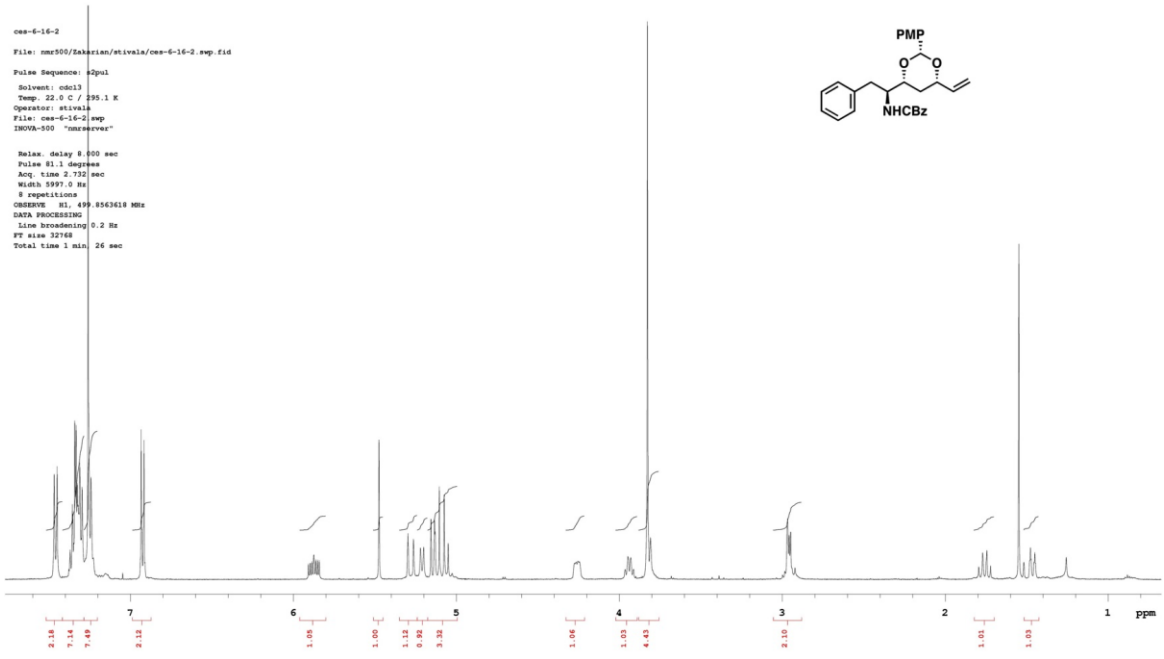

ces-5-244-noe
File: nmr500/Zakarian/stivala/ces-5-244-now.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-244-now.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 35 min, 45 sec
NOE 2.5%
NOE 10.4%
NOE 4.0%
PMP
Me
7
6
5
4
3
2
1
ppm
2.72
10.38
3.36
1.32
-100.00
2.54
4.02

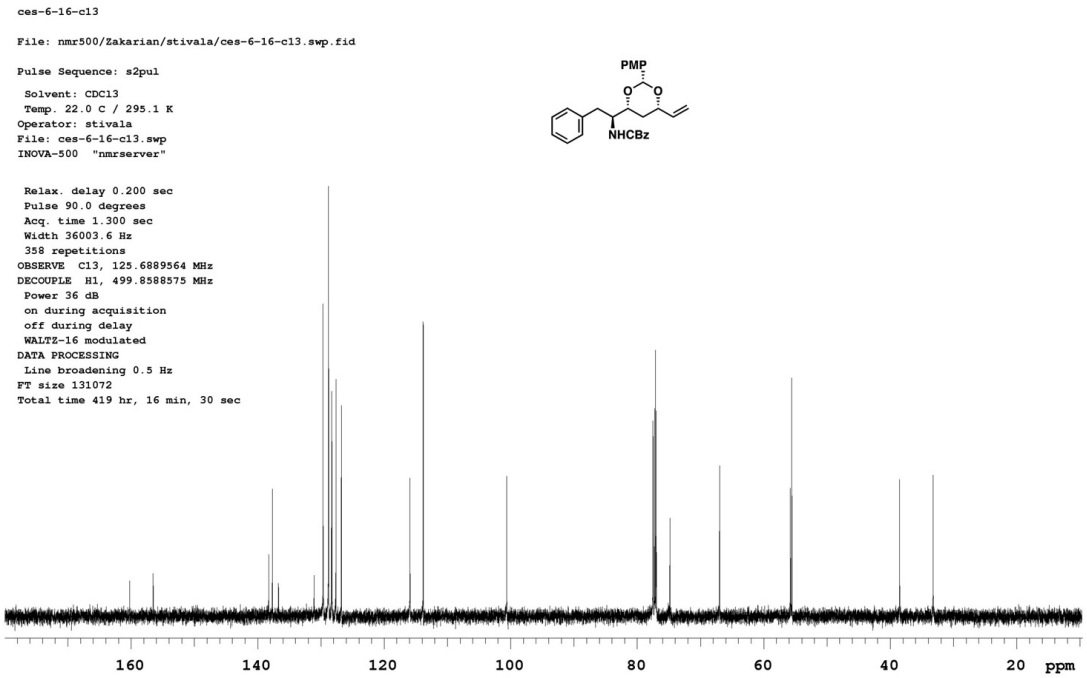

ces-5-244-noe
File: nmr500/Zakarian/stivala/ces-5-244-now.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-244-now.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 35 min, 45 sec
NOE 8.5%
NOE 5.4%
NOE 21.4%
PMP
Me
7
6
5
4
3
2
1
ppm
8.49
21.42
-100.00
5.36

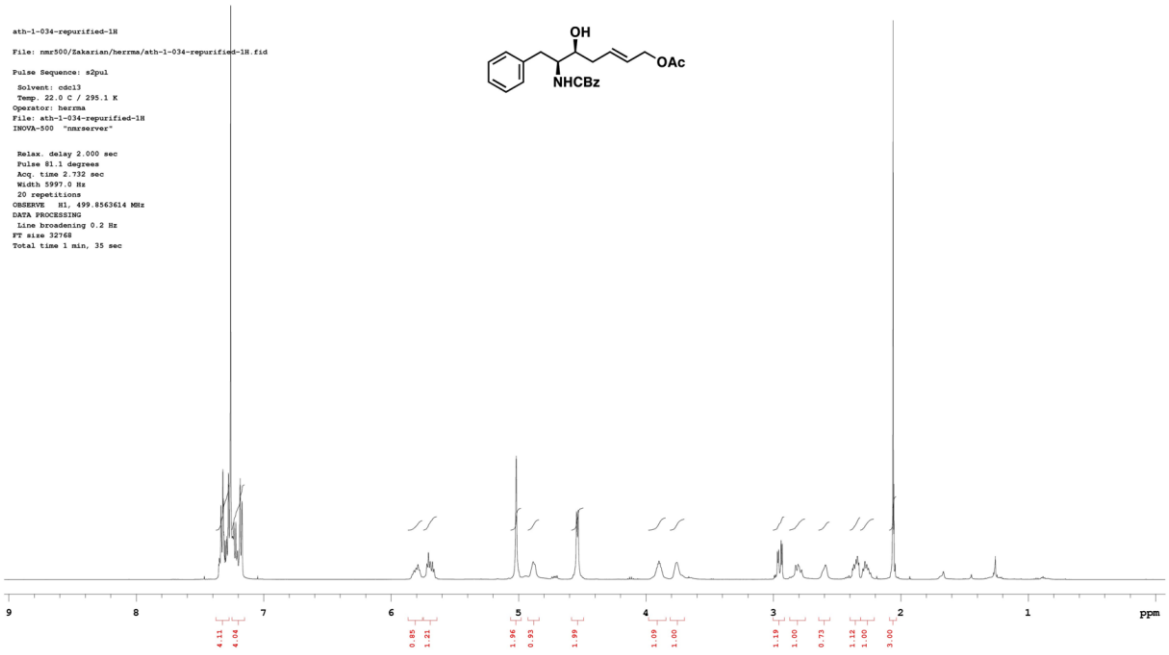

ces-5-244-noe
File: nmr500/Zakarian/stivala/ces-5-244-now.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-244-now.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 35 min, 45 sec
NOE 3.7%
NOE 2.7%
NOE 2.2%
NOE 4.8%
PMP
Me
ppm

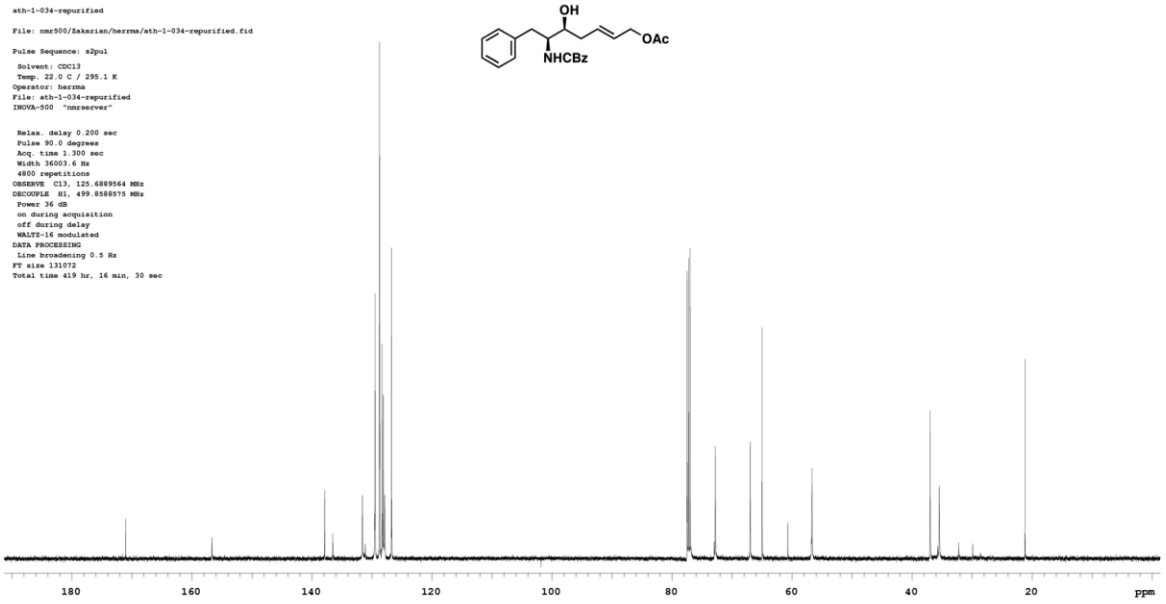

ces-5-300-a
File: nmr500/Zakarian/stivala/ces-5-300-a.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-300-a.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
NHCBz
OH
ppm

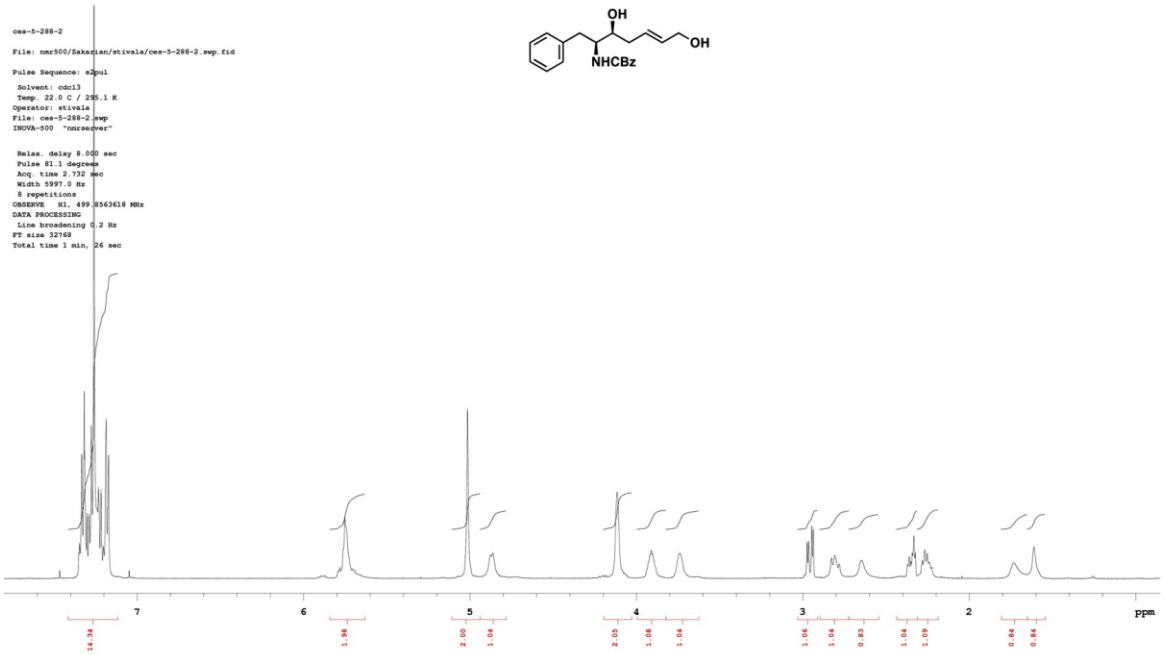

ces-5-300-a-c13
File: nmr500/Zakarian/stivala/ces-5-300-a-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-300-a-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1771 repetitions
OBSERVE C13, 125.6889569 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
OH
OH
NHCBz
160
140
120
100
80
60
40
ppm

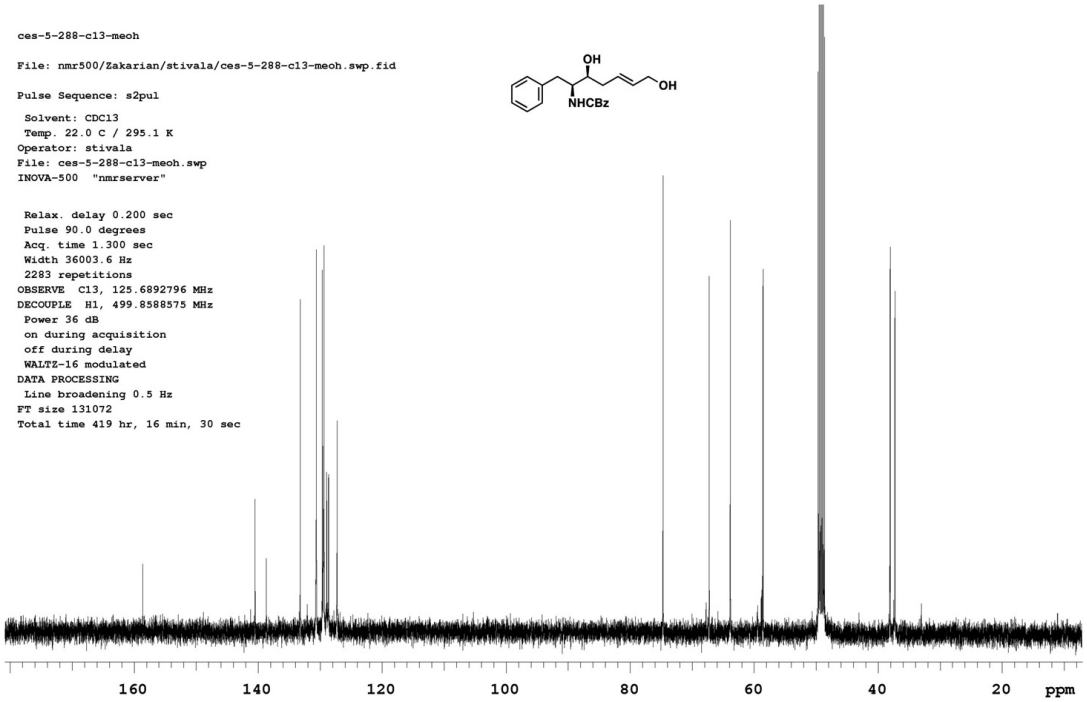

ces-6-16-2
File: nmr500/Zakarian/stivala/ces-6-16-2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-16-2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
PMP
O
O
NHCBz
7
6
5
4
3
2
1
ppm
2.18
7.14
7.49
2.12
1.05
1.00
1.12
0.92
3.32
1.04
1.03
4.43
2.10
1.01
1.03

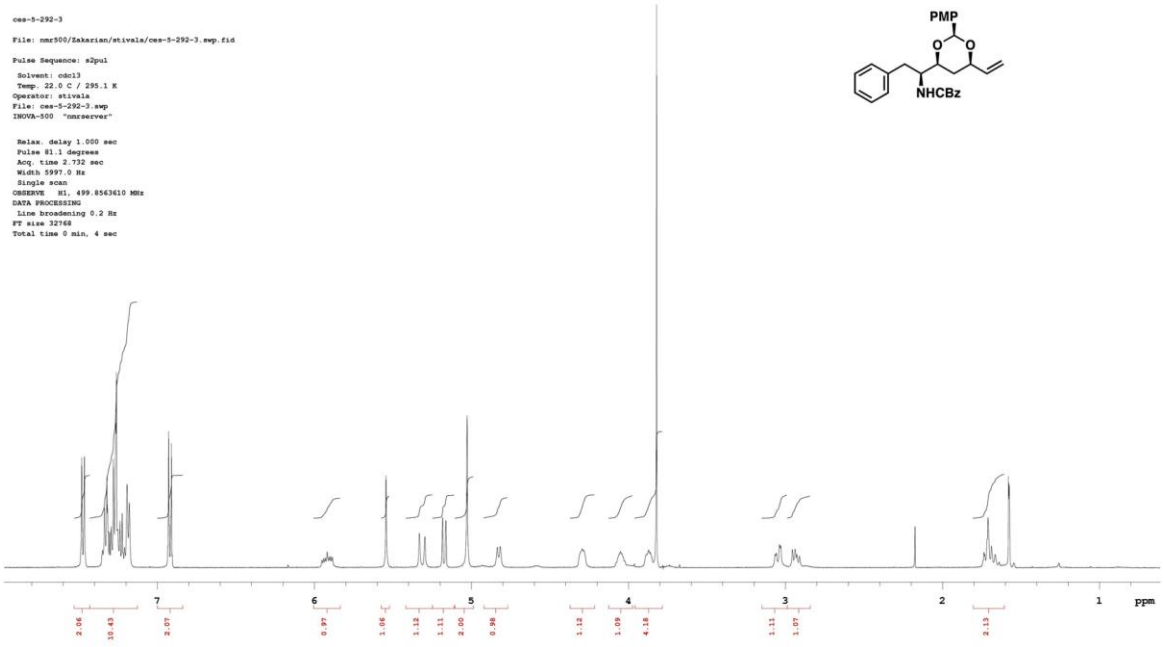

ces-6-16-c13
File: nmr500/Zakarian/stivala/ces-6-16-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-16-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
358 repetitions
OBSERVE C13, 125.6889564 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
PMP
O
O
NHCBz
160
140
120
100
80
60
40
20
ppm


ath-1-034-repurified-1H
File: nmr500/Zakarian/herrma/ath-1-034-repurified-1H.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: herrma
File: ath-1-034-repurified-1H
INOVA-500 "nmrserver"
Relax. delay 2.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
20 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 35 sec
OH
OAc
NHCBz
9
8
7
6
5
4
3
2
1
ppm
4.11
4.04
0.85
1.21
1.96
0.93
1.99
1.09
1.00
1.19
1.00
0.73
1.12
1.00
3.00


ath-1-034-repurified
File: nmr500/Zakarian/herrma/ath-1-034-repurified.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: herrma
File: ath-1-034-repurified
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
4800 repetitions
OBSERVE C13, 125.6889564 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
OH
OAc
NHCBz
180
160
140
120
100
80
60
40
20
ppm


ces-5-288-2
File: nmr500/Zakarian/stivala/ces-5-288-2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-288-2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
OH
OH
NHCBz
7
6
5
4
3
2
ppm
14.34
1.98
2.00
1.04
2.05
1.08
1.04
1.06
1.04
0.83
1.04
1.09
0.84
0.84


ces-5-288-c13-meoh
File: nmr500/Zakarian/stivala/ces-5-288-c13-meoh.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-288-c13-meoh.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
2283 repetitions
OBSERVE C13, 125.6892796 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
OH
OH
NHCBz
160
140
120
100
80
60
40
20
ppm


ces-5-292-3
File: nmr500/Zakarian/stivala/ces-5-292-3.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-292-3.swp
INOVA-500 "nmrserver"
Relax. delay 1.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
Single scan
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 4 sec
PMP
O
O
NHCBz
7
6
5
4
3
2
1
ppm
2.04
10.43
2.07
0.97
1.06
1.12
1.11
2.00
0.98
1.12
1.09
4.18
1.11
1.07
2.13

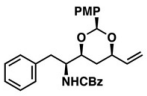
ces-5-292-c13-2

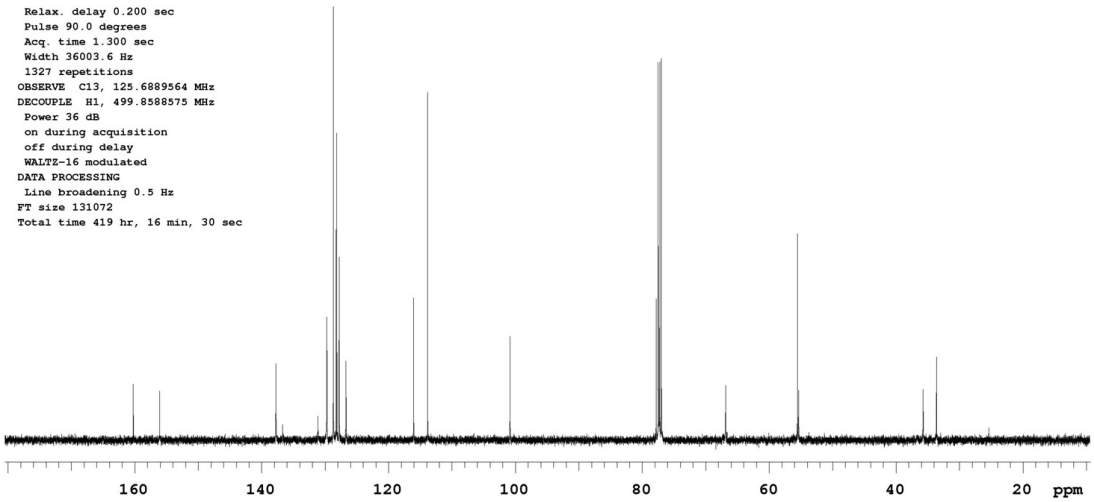
File: nmr500/Zakarian/stivala/ces-5-292-c13-2.swp.fid

Pulse Sequence: s2pul

Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-292-c13-2.swp
INOVA-500 "nmrserver"

Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1327 repetitions
OBSERVE C13, 125.6889564 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec





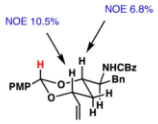
ces-5-292-noe

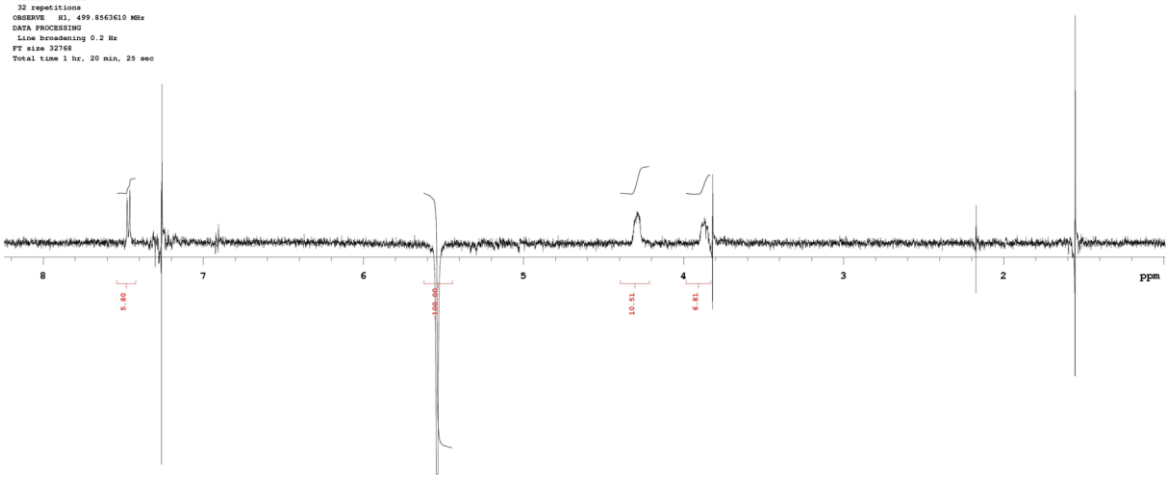
File: nmr500/Zakarian/stivala/ces-5-292-noe.swp.fid

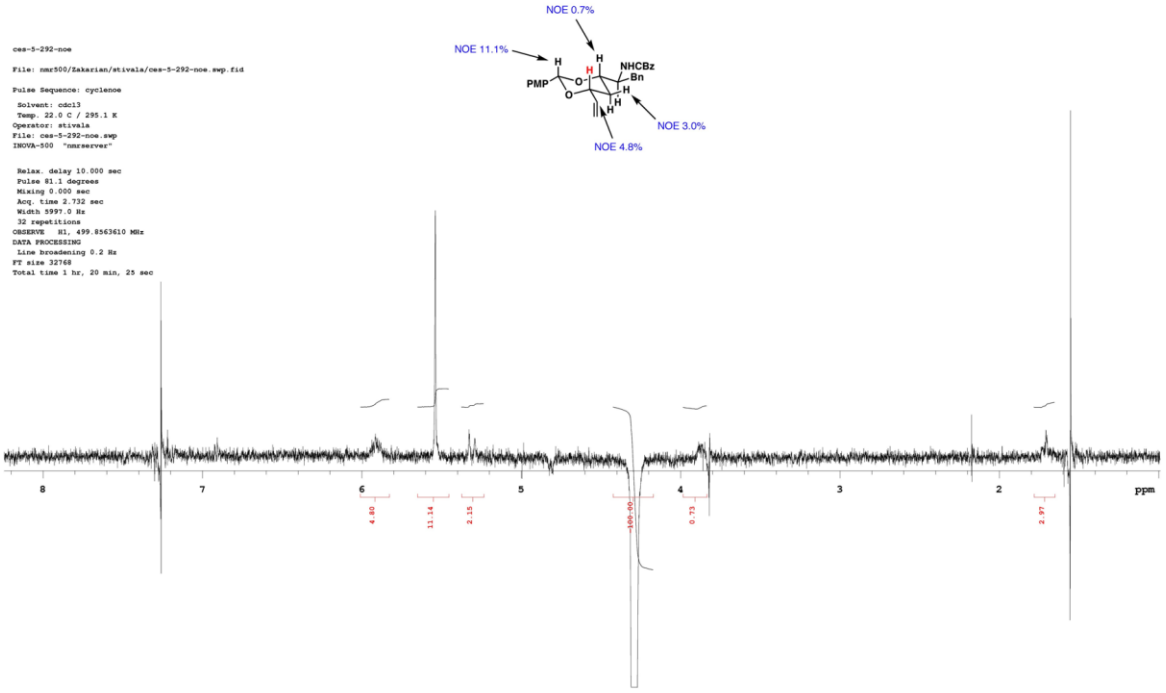
Pulse Sequence: cyclenoe

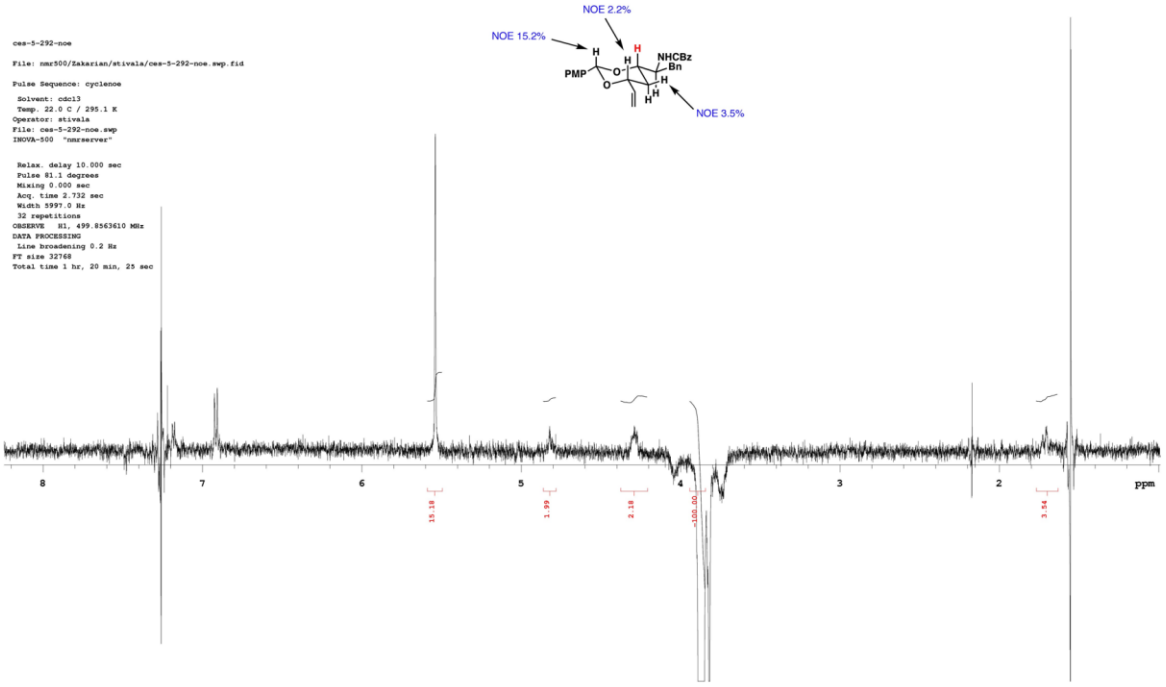
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-292-noe.swp
INOVA-500 "nmrserver"

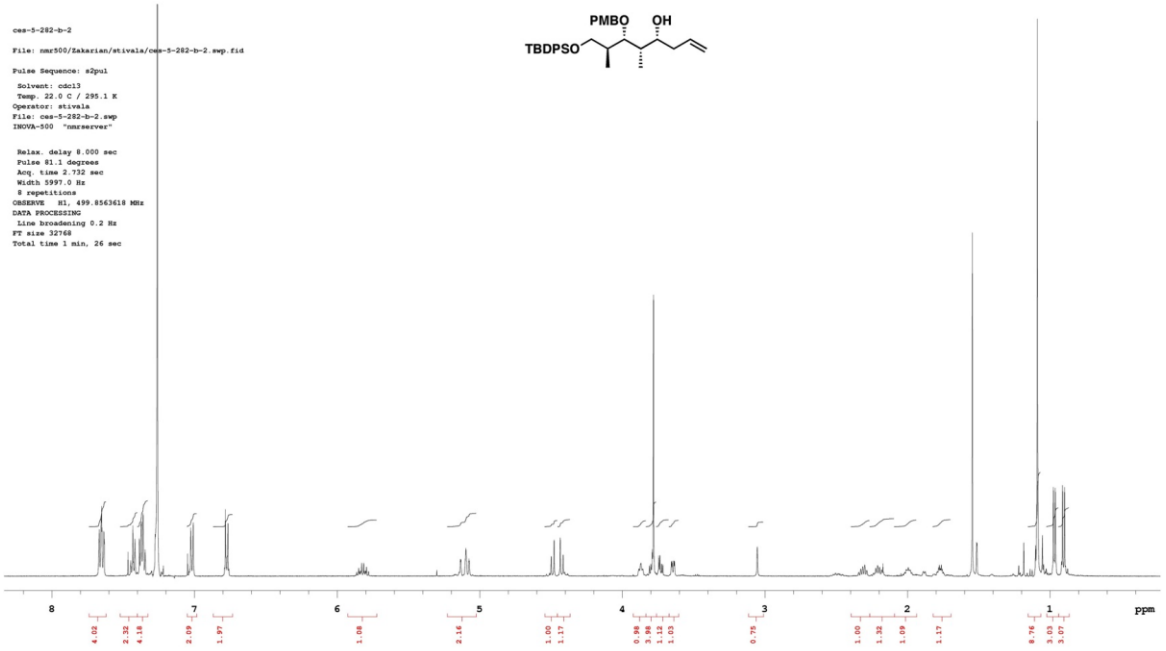
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
32 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 20 min, 25 sec

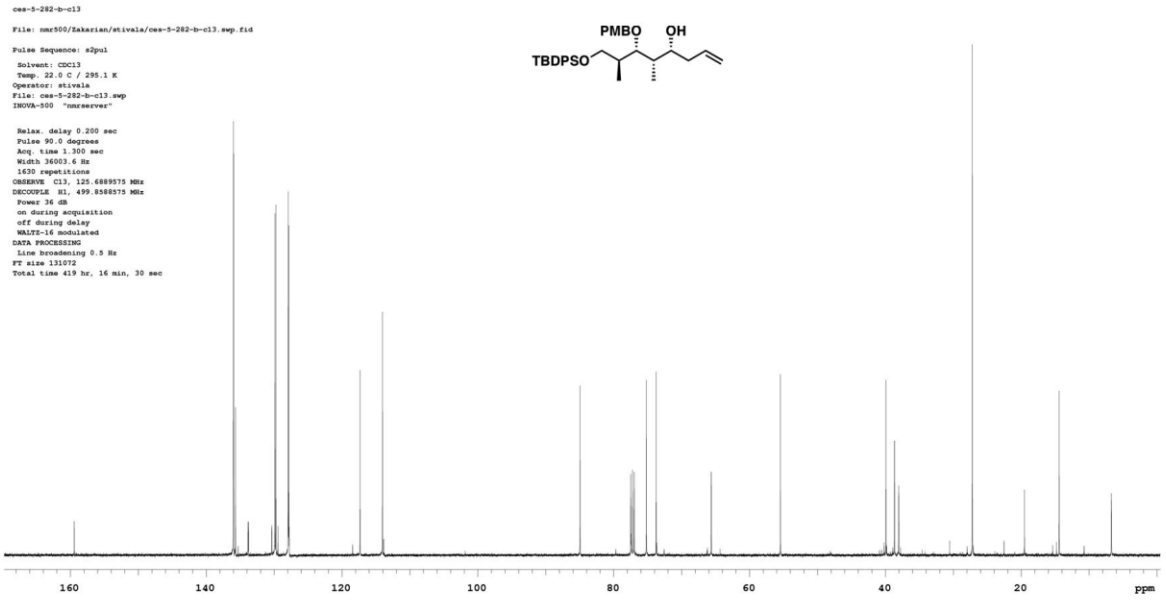


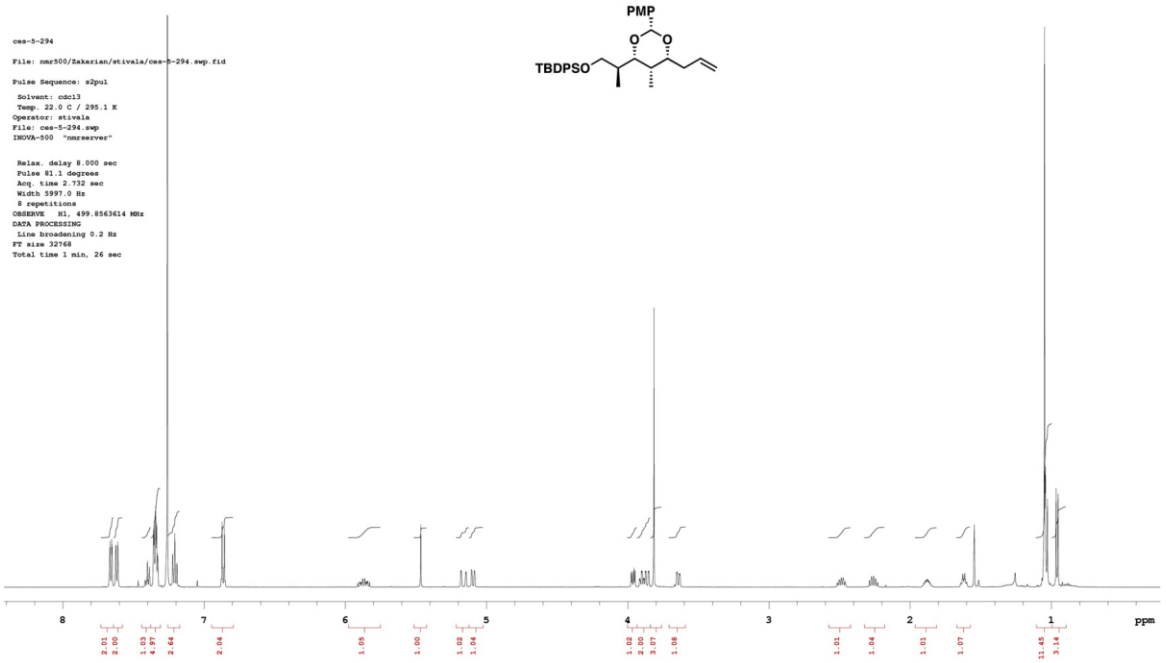


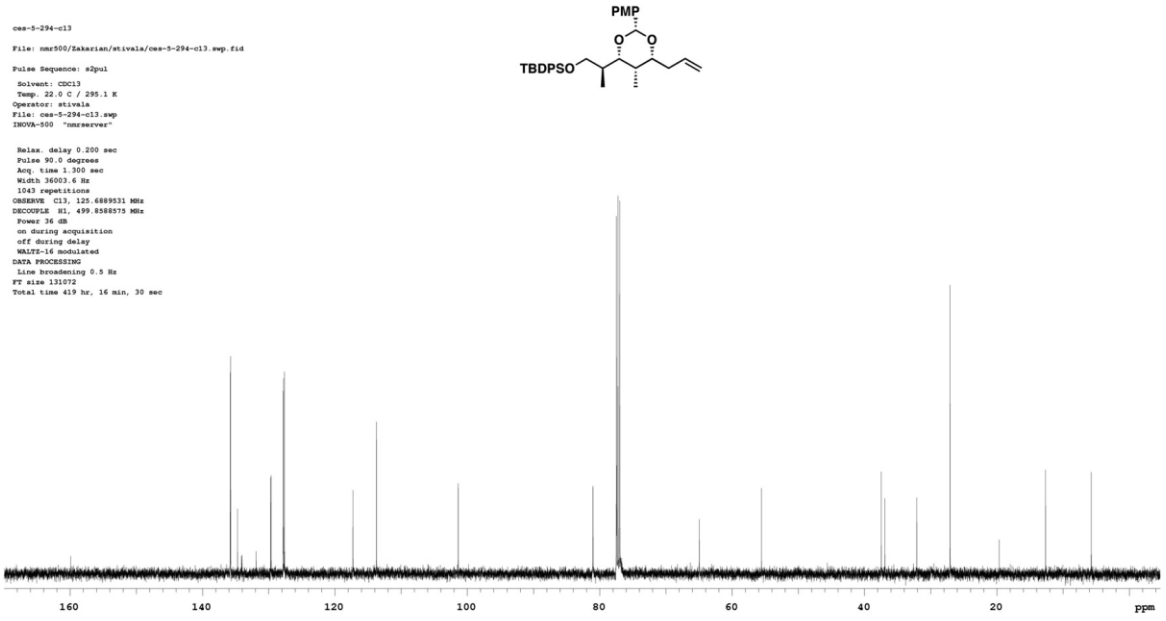

NOE 0.7%
NOE 11.1%
NOE 3.0%
NOE 4.8%
NHCBz
Bn
PMP
ces-5-292-noe
File: nmr500/Zakarian/stivala/ces-5-292-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-292-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
32 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 20 min, 25 sec
8
7
6
5
4
3
2
ppm
4.80
11.14
2.15
-100.00
0.73
2.97

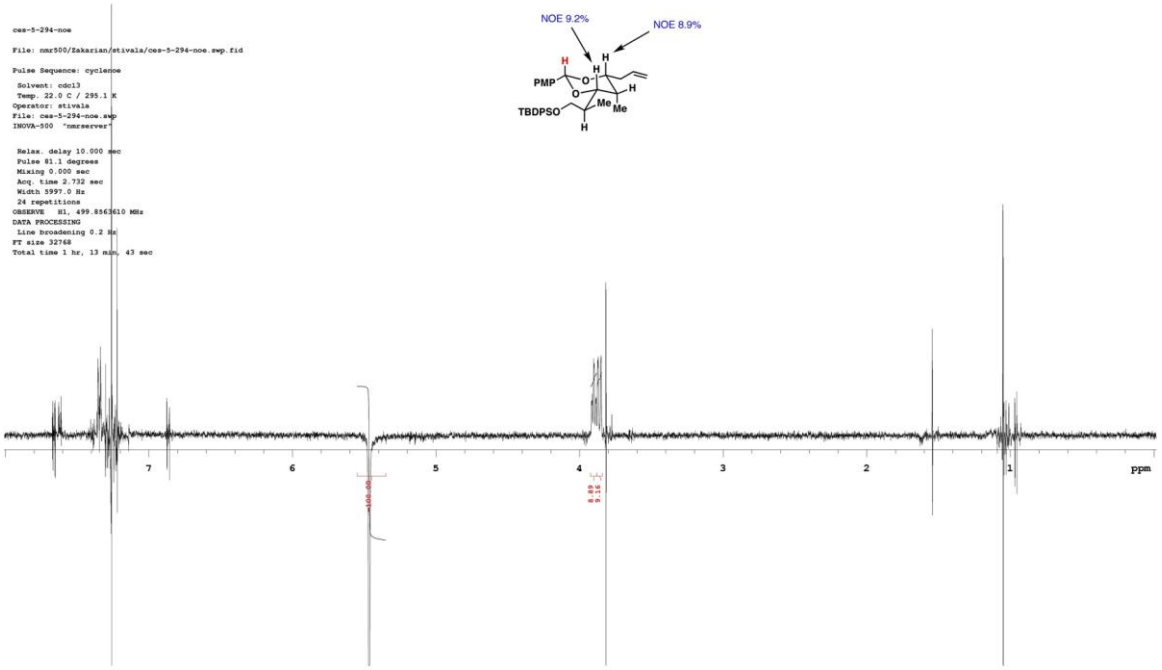

NOE 2.2%
NOE 15.2%
NOE 3.5%
NHCBz
Bn
PMP
ces-5-292-noe
File: nmr500/Zakarian/stivala/ces-5-292-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-292-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
32 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 20 min, 25 sec
8
7
6
5
4
3
2
ppm
15.18
1.99
2.18
-158.30
3.54

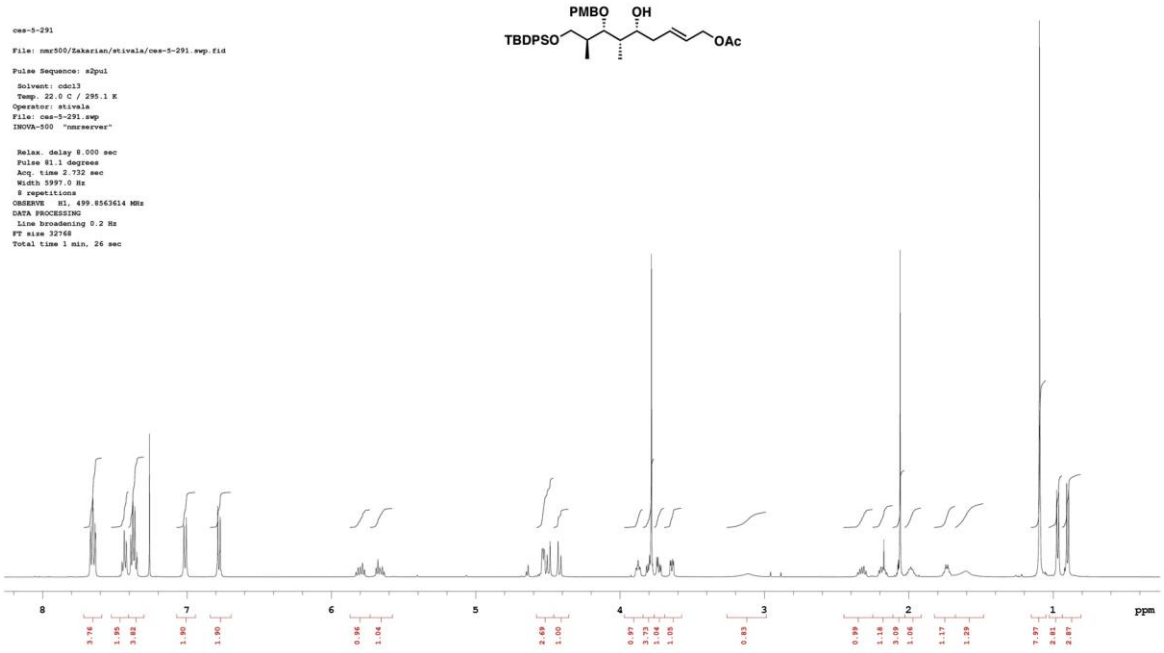

ces-5-282-b-2
File: nmr500/Zakarian/stivala/ces-5-282-b-2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-282-b-2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
PMBO
OH
TBDPSO
8
7
6
5
4
3
2
1
ppm
4.02
2.32
4.18
2.09
1.97
1.08
2.14
1.00
1.17
0.98
3.98
1.12
1.03
0.75
1.00
1.32
1.09
1.17
8.76
3.03
3.07

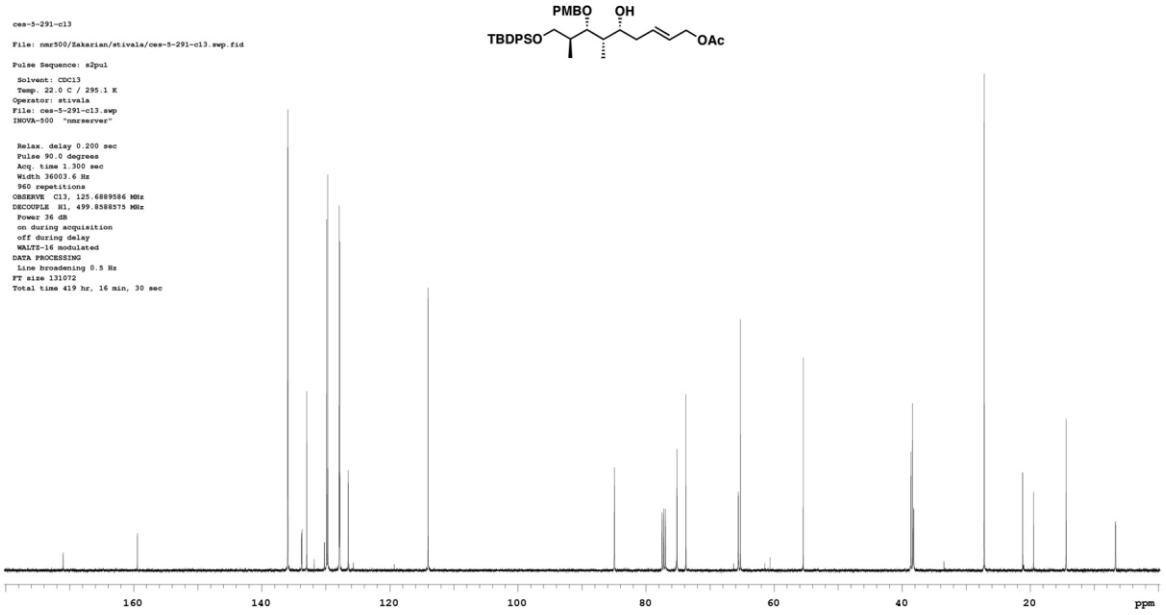

ces-5-282-b-c13
File: nmr500/Zakarian/stivala/ces-5-282-b-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-282-b-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1630 repetitions
OBSERVE C13, 125.6889575 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
PMBO
OH
TBDPSO
160
140
120
100
80
60
40
20
ppm

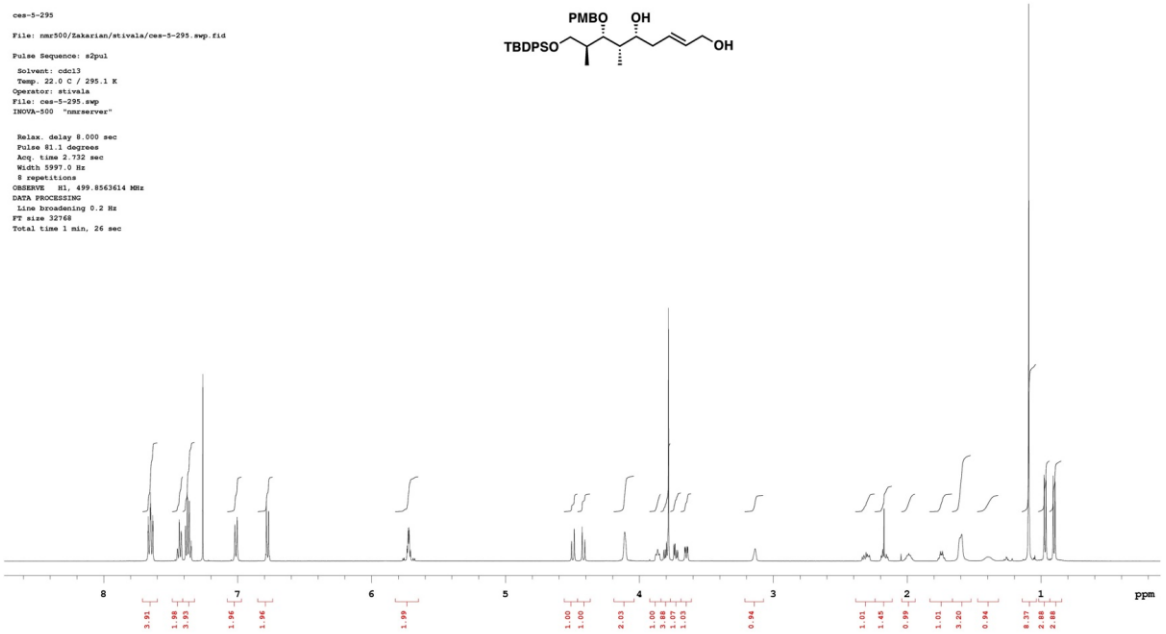

PMP
TBDPSO
ces-5-294
File: nmr500/Zakarian/stivala/ces-5-294.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-294.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
8
7
6
5
4
3
2
1
ppm
2.01
2.00
1.03
4.97
2.64
2.04
1.05
1.00
1.02
1.04
1.02
2.00
3.07
1.08
1.01
1.04
1.01
1.07
11.45
3.14

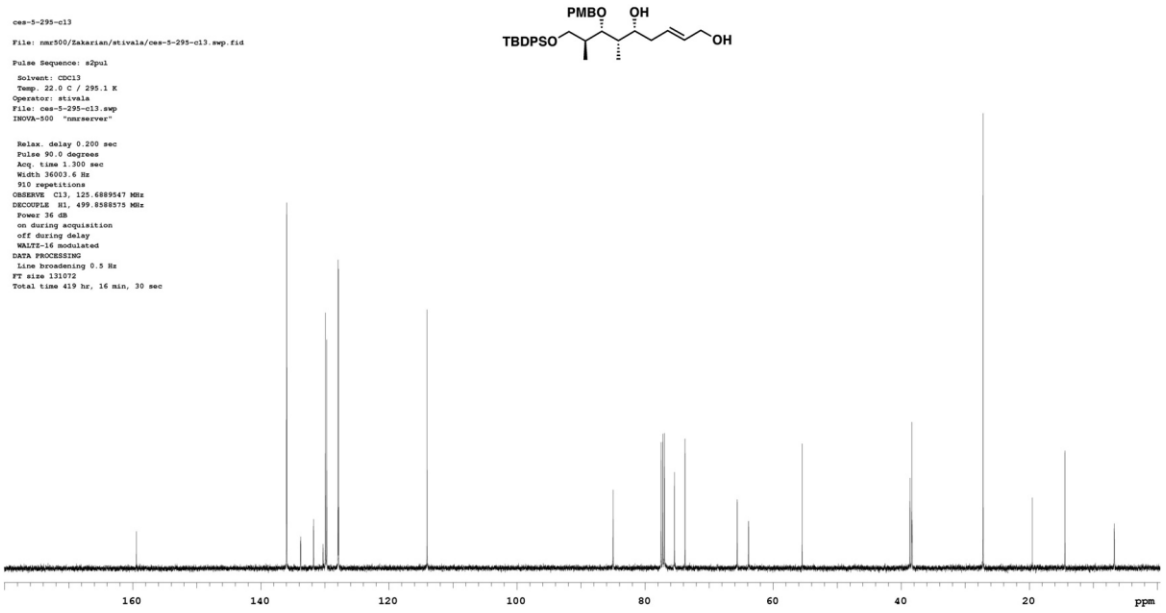

PMP
TBDPSO
ces-5-294-c13
File: nmr500/Zakarian/stivala/ces-5-294-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-294-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1043 repetitions
OBSERVE C13, 125.6889531 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
160
140
120
100
80
60
40
20
ppm

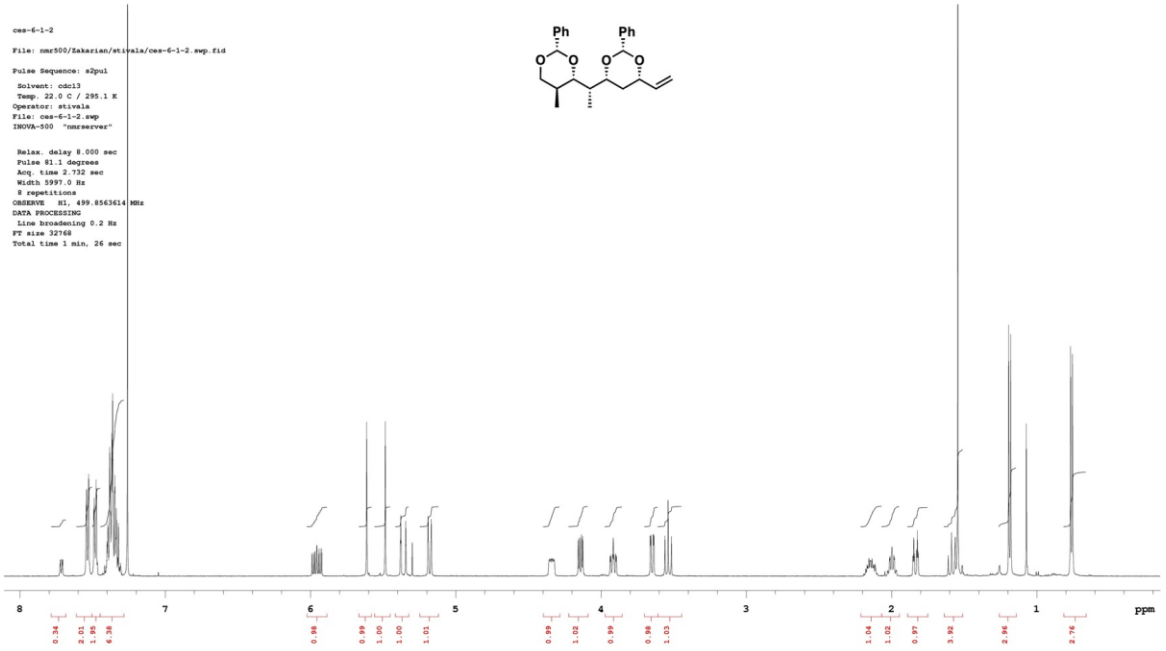

ces-5-294-noe
File: nmr500/Zakarian/stivala/ces-5-294-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-294-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
24 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 13 min, 43 sec
NOE 9.2%
NOE 8.9%
PMP
TBDPSO
Me
Me
ppm

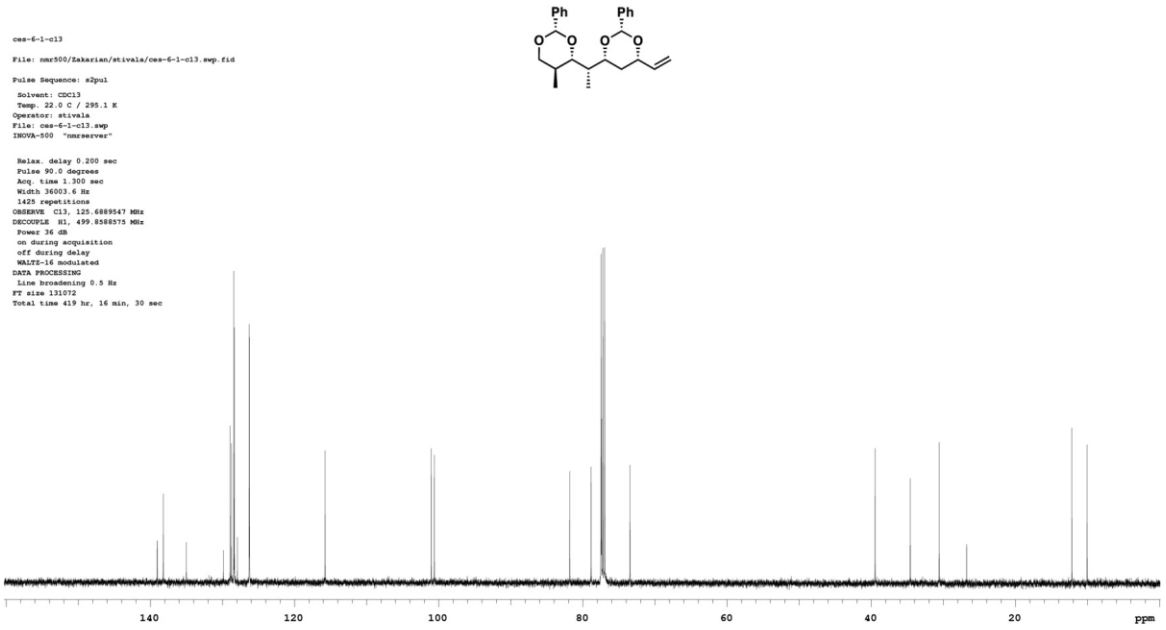

ces-5-291
File: nmr500/Zakarian/stivala/ces-5-291.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-291.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
PMBO
OH
TBDPSO
OAc
ppm

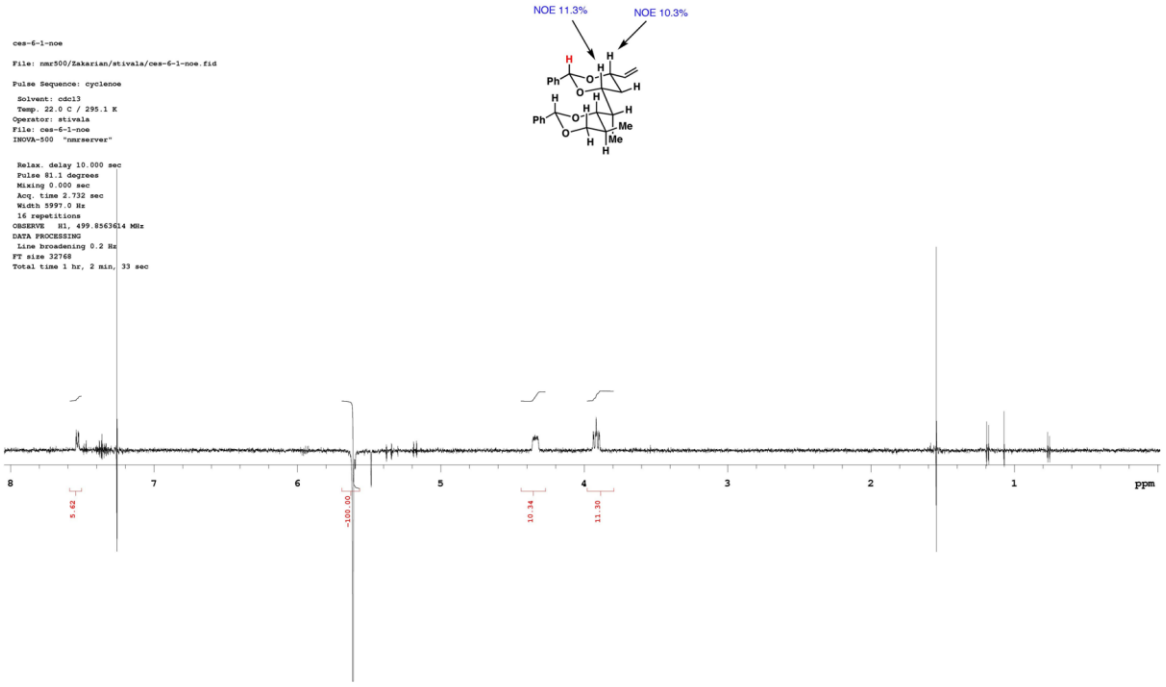

PMBO
OH
TBDPSO
OAc
ces-5-291-c13
File: nmr500/Zakarian/stivala/ces-5-291-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-291-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
960 repetitions
OBSERVE C13, 125.6889586 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
160
140
120
100
80
60
40
20
ppm

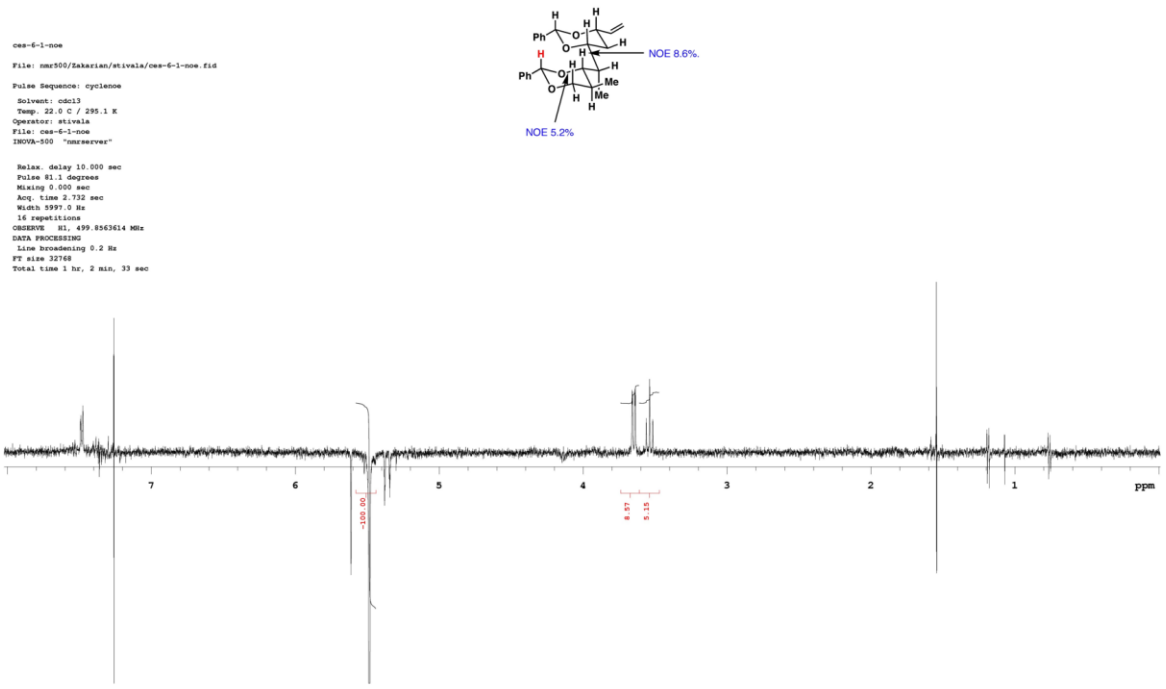

PMBO
OH
TBDPSO
OH
ces-5-295
File: nmr500/Zakarian/stivala/ces-5-295.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-295.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
8
7
6
5
4
3
2
1
ppm
3.91
1.88
3.80
1.96
1.96
1.99
1.00
1.00
2.03
1.00
3.48
1.07
1.03
0.84
1.01
1.45
0.99
1.01
3.20
0.84
8.37
2.88
2.88

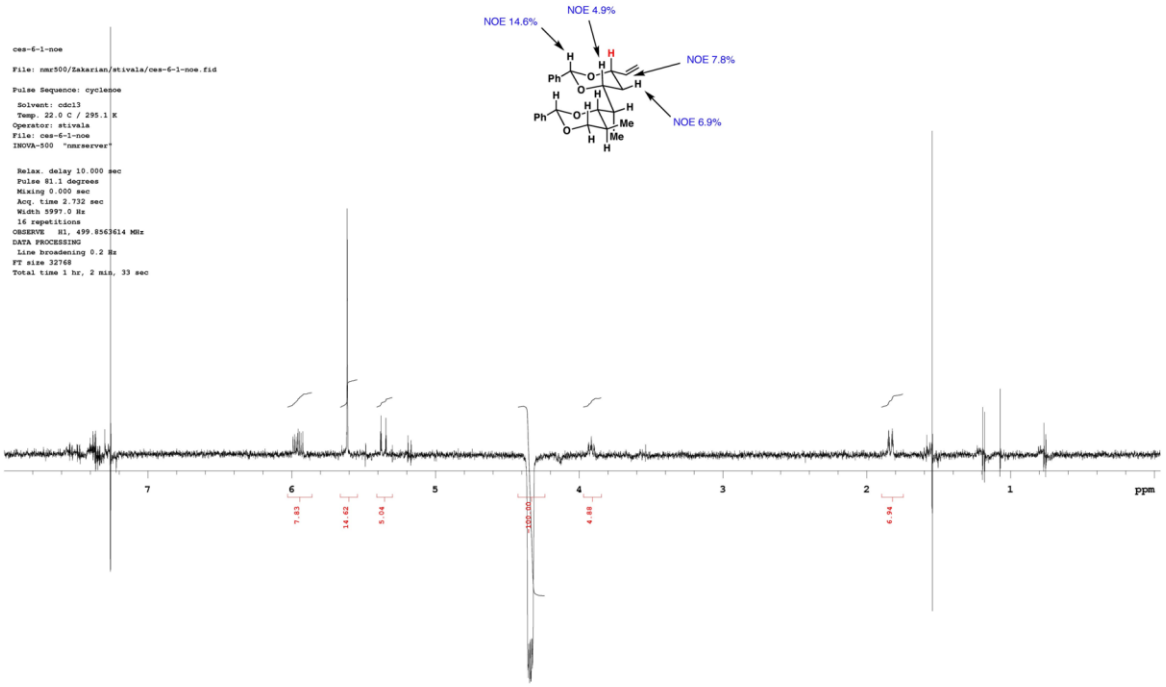

PMBO
OH
TBDPSO
OH
ces-5-295-c13
File: nmr500/Zakarian/stivala/ces-5-295-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-295-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
910 repetitions
OBSERVE C13, 125.6889547 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
160
140
120
100
80
60
40
20
ppm

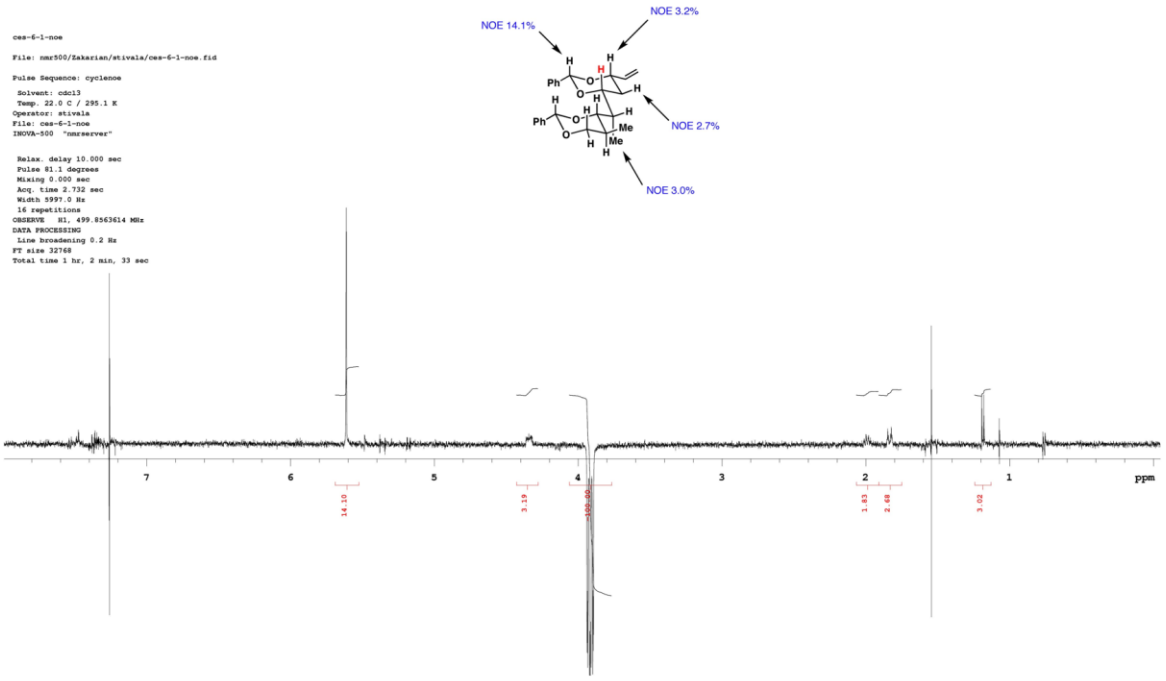

Ph
Ph
O
O
O
O
ces-6-1-2
File: nmr500/Zakarian/stivala/ces-6-1-2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-1-2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
8
7
6
5
4
3
2
1
ppm
0.34
2.01
1.95
6.38
0.88
0.99
1.00
1.00
1.01
0.99
1.02
0.99
0.98
1.03
1.04
1.02
0.97
3.92
2.96
2.76

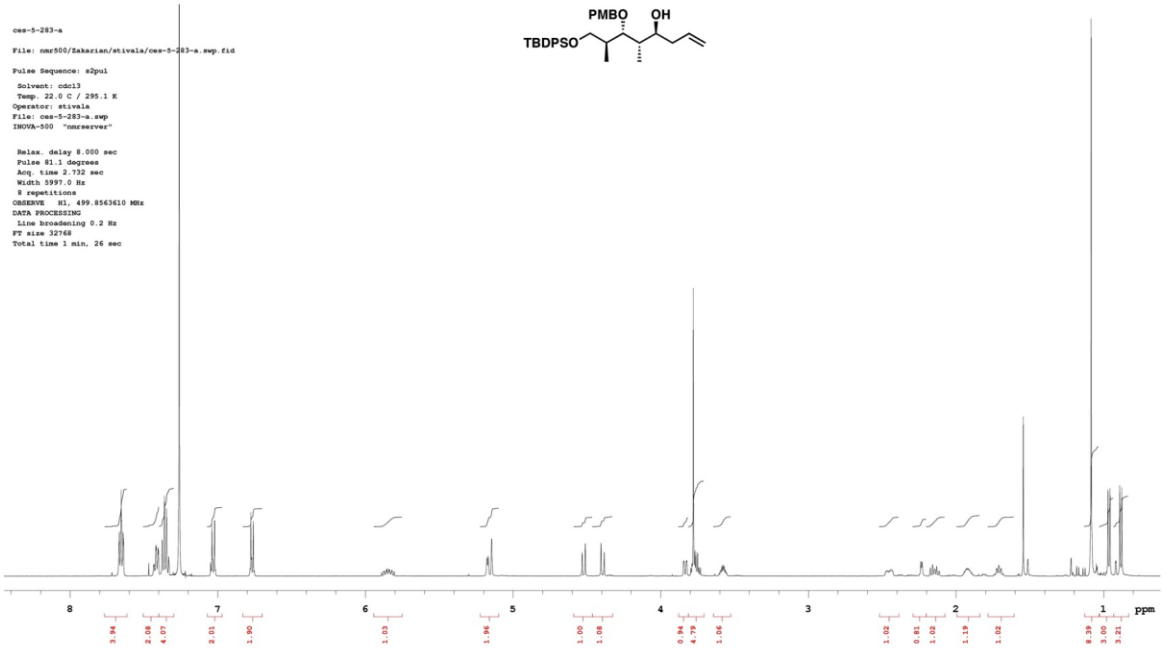

Ph
Ph
ces-6-1-c13
File: nmr500/Zakarian/stivala/ces-6-1-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-1-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1425 repetitions
OBSERVE C13, 125.6889547 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
140
120
100
80
60
40
20
ppm

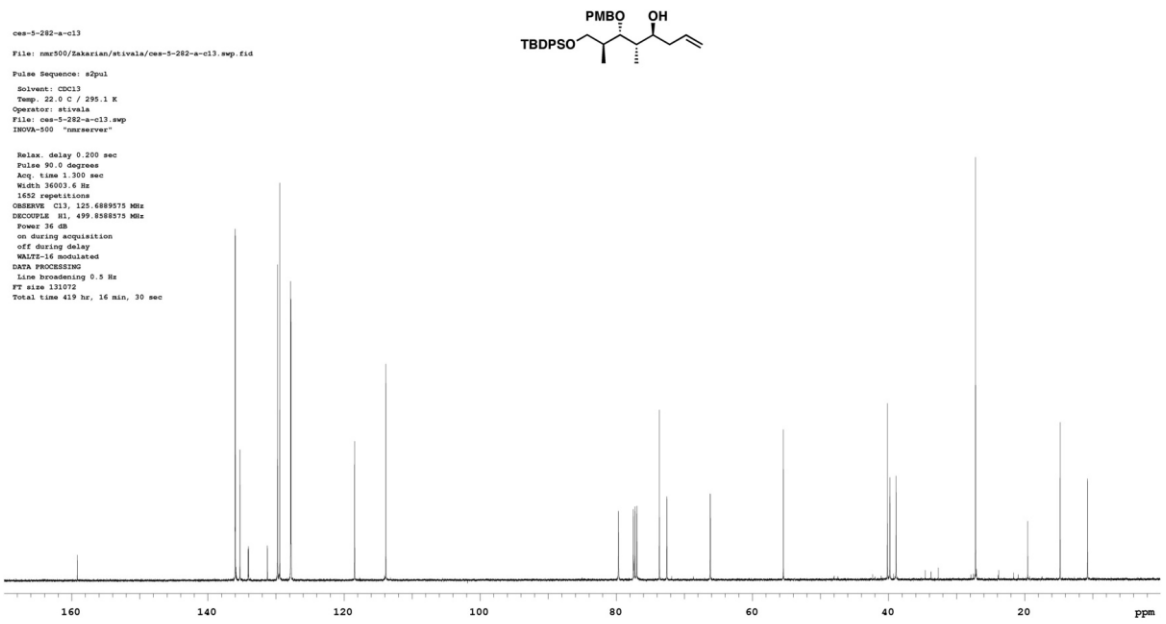

NOE 11.3%
NOE 10.3%
H
Ph
O
H
H
Ph
O
H
H
H
Me
H
H
ces-6-1-noe
File: nmr500/Zakarian/stivala/ces-6-1-noe.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-1-noe
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 2 min, 33 sec
8
7
6
5
4
3
2
1
ppm
5.62
-100.00
10.34
11.30

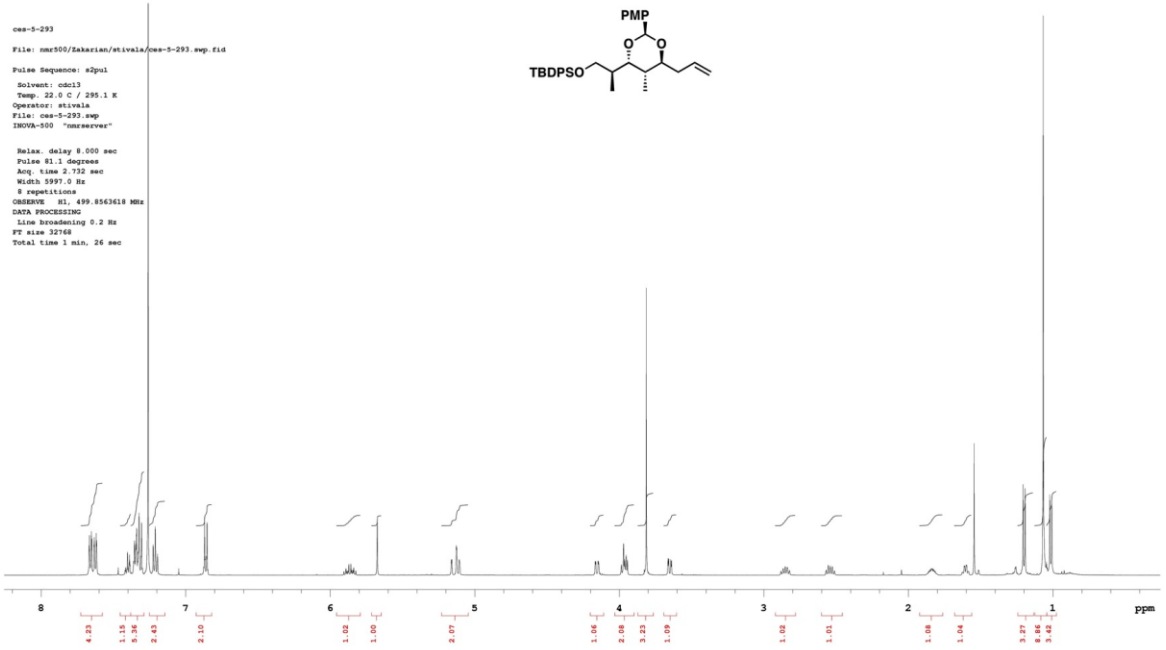

ces-6-1-noe
File: nmr500/Zakarian/stivala/ces-6-1-noe.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-1-noe
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 2 min, 33 sec
NOE 8.6%.
NOE 5.2%
7
6
5
4
3
2
1
ppm
-100.00
8.57
5.15

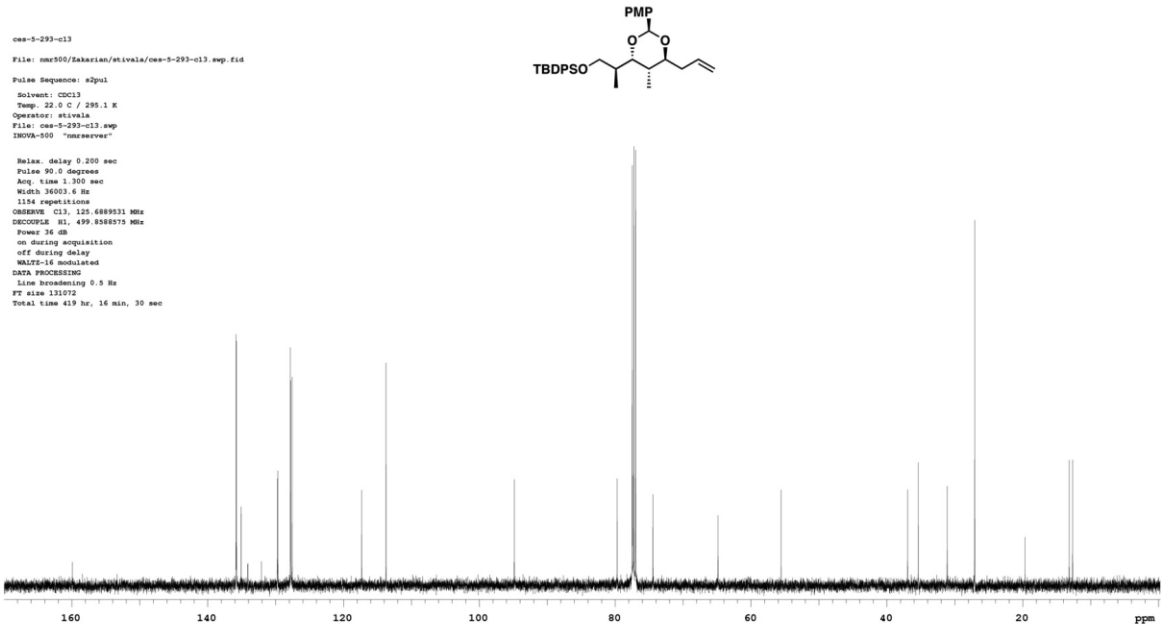

ces-6-1-noe
File: nmr500/Zakarian/stivala/ces-6-1-noe.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-1-noe
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 2 min, 33 sec
NOE 14.6%
NOE 4.9%
NOE 7.8%
NOE 6.9%
7
6
5
4
3
2
1
ppm
7.83
14.62
5.04
-100.00
4.89
6.94

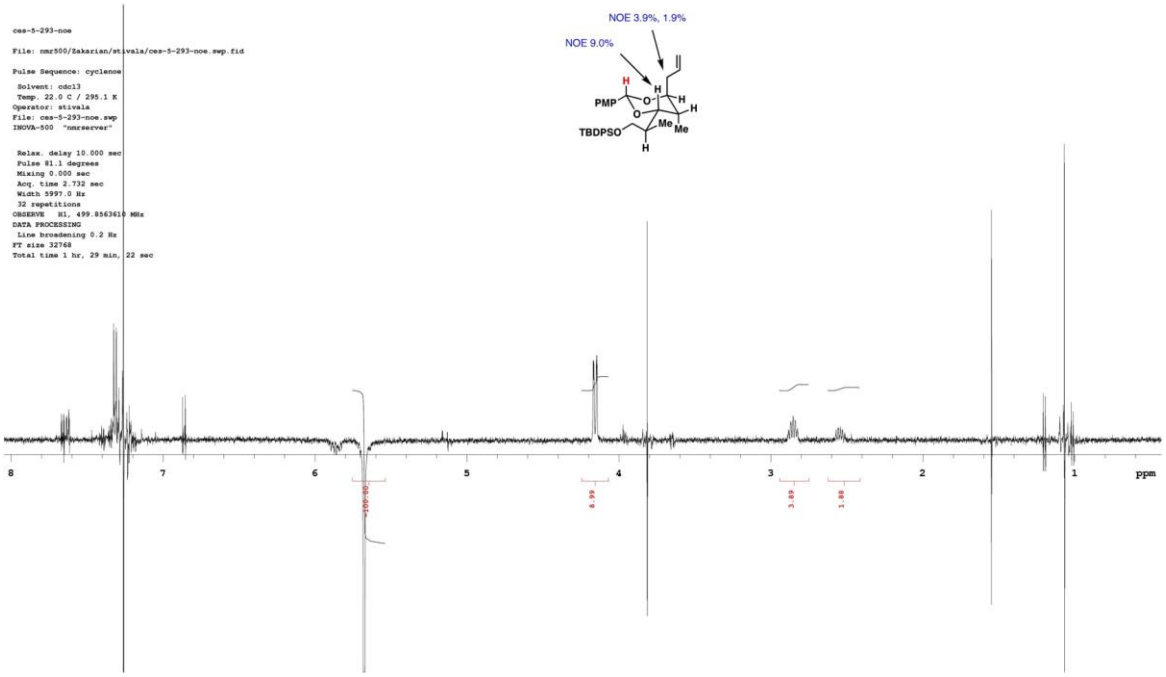

ces-6-1-noe
File: nmr500/Zakarian/stivala/ces-6-1-noe.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-1-noe
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 2 min, 33 sec
NOE 14.1%
NOE 3.2%
NOE 2.7%
NOE 3.0%
Ph
Me
ppm

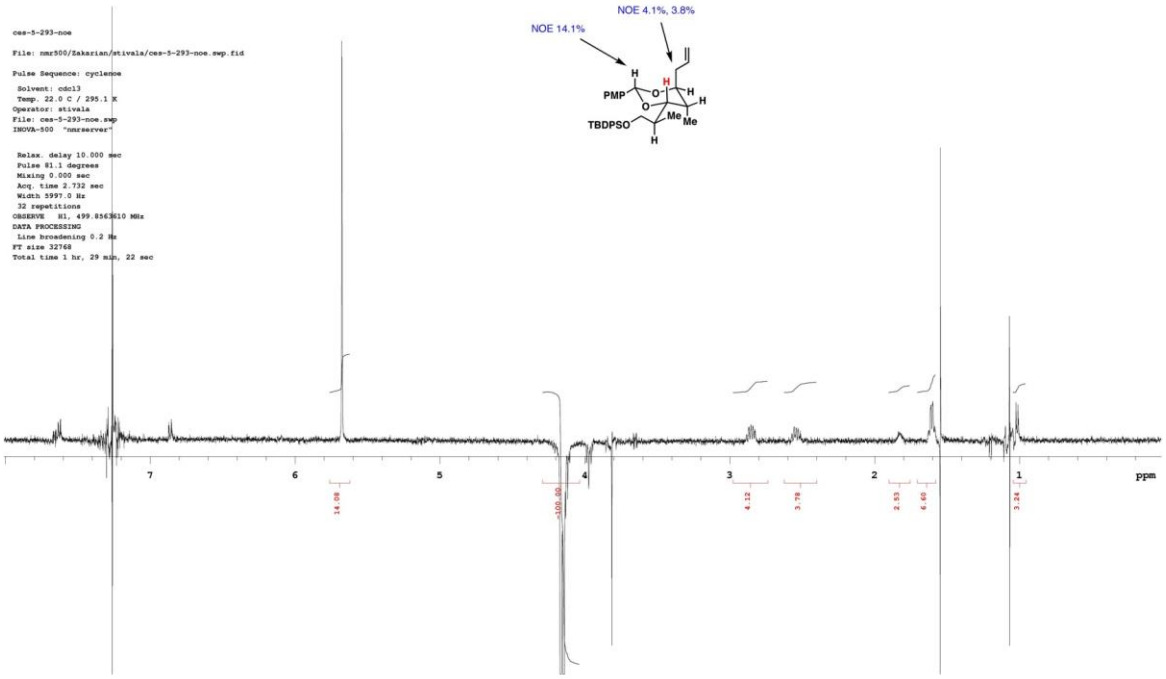

ces-5-283-a
File: nmr500/Zakarian/stivala/ces-5-283-a.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-283-a.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
PMBO
OH
TBDPSO
ppm

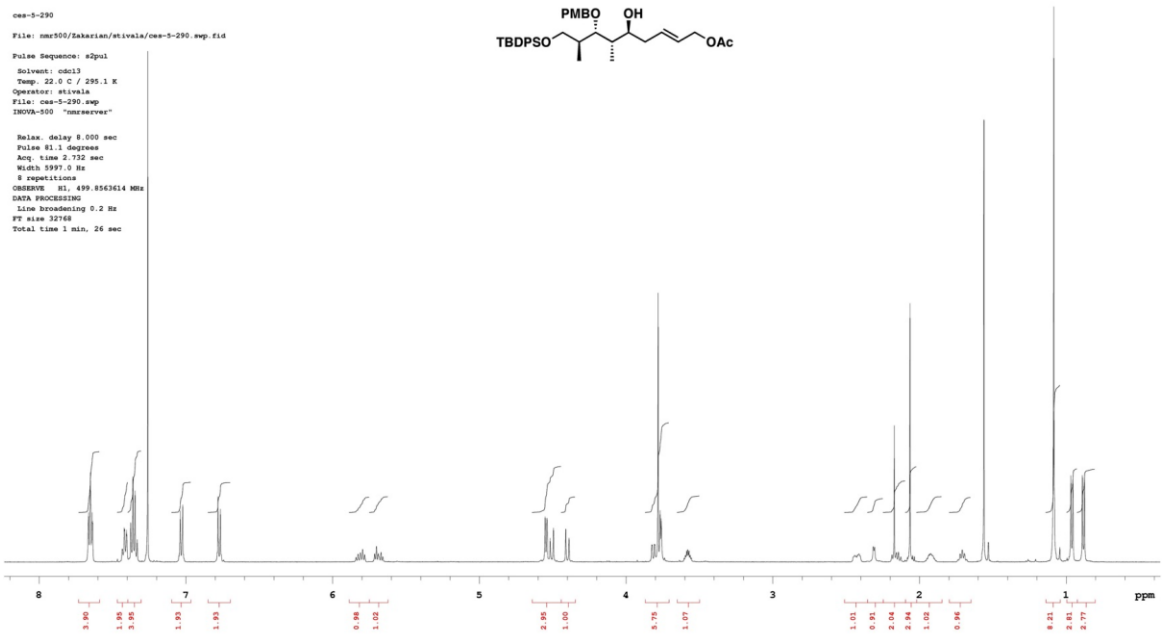

PMBO
OH
TBDPSO
ces-5-282-a-c13
File: nmr500/Zakarian/stivala/ces-5-282-a-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-282-a-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1652 repetitions
OBSERVE C13, 125.6889575 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
160
140
120
100
80
60
40
20
ppm

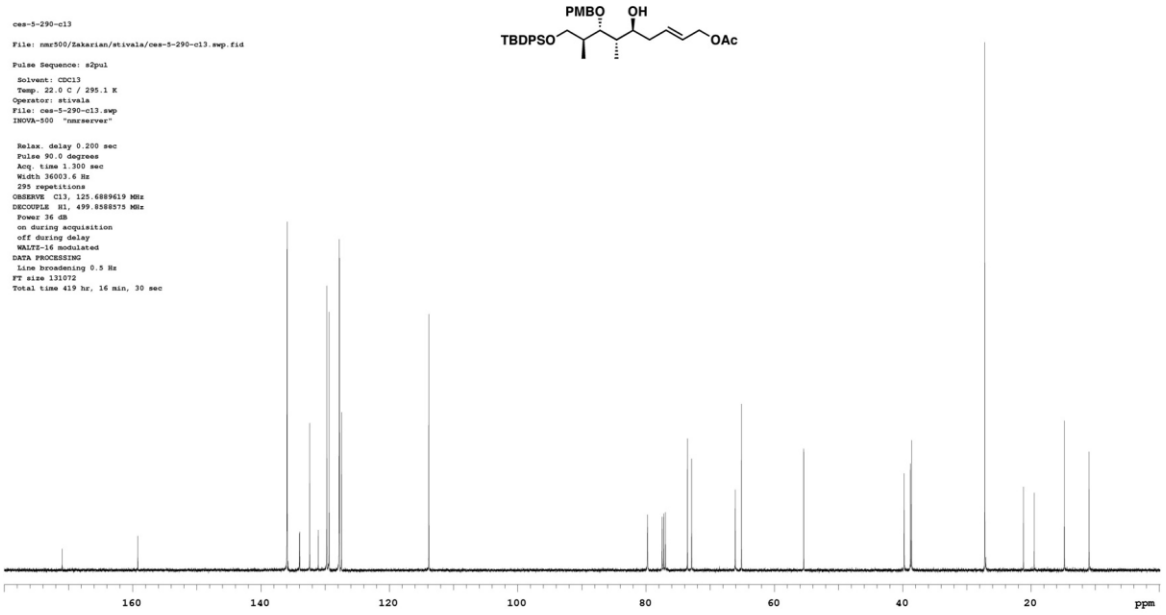

PMP
O
O
TBDPSO
ces-5-293
File: nmr500/Zakarian/stivala/ces-5-293.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-293.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
8
7
6
5
4
3
2
1
ppm
4.23
1.15
5.36
2.43
2.10
1.02
1.00
2.07
1.06
2.08
3.23
1.09
1.02
1.01
1.88
1.04
3.27
8.86
3.42

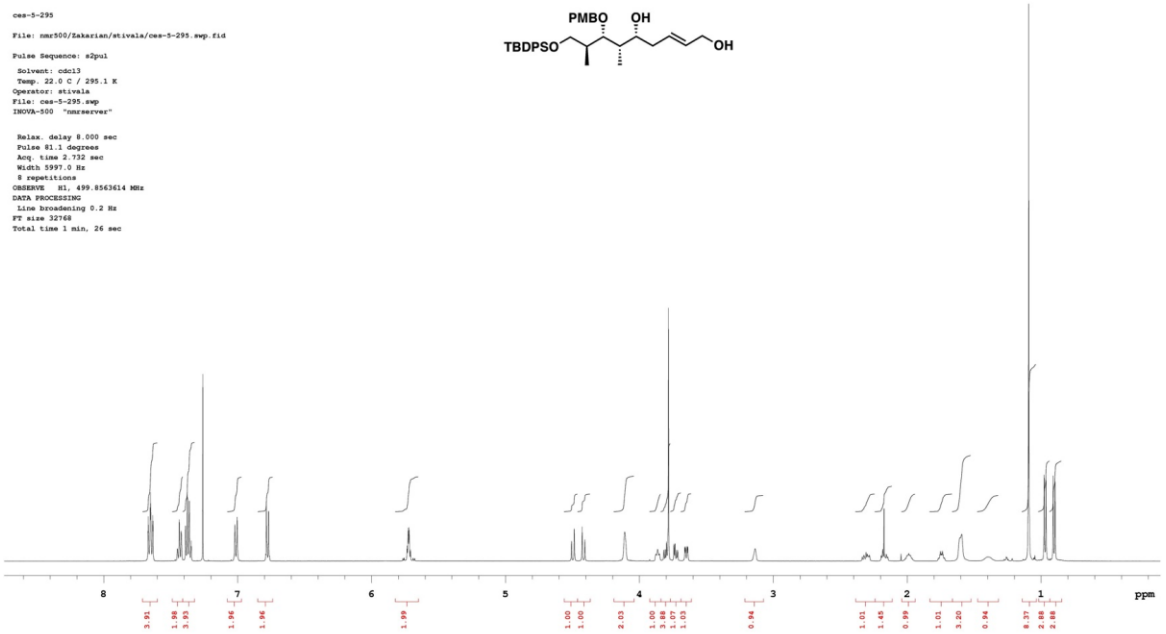

PMP
TBDPSO
ces-5-293-c13
File: nmr500/Zakarian/stivala/ces-5-293-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-293-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1154 repetitions
OBSERVE C13, 125.6889531 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
160
140
120
100
80
60
40
20
ppm

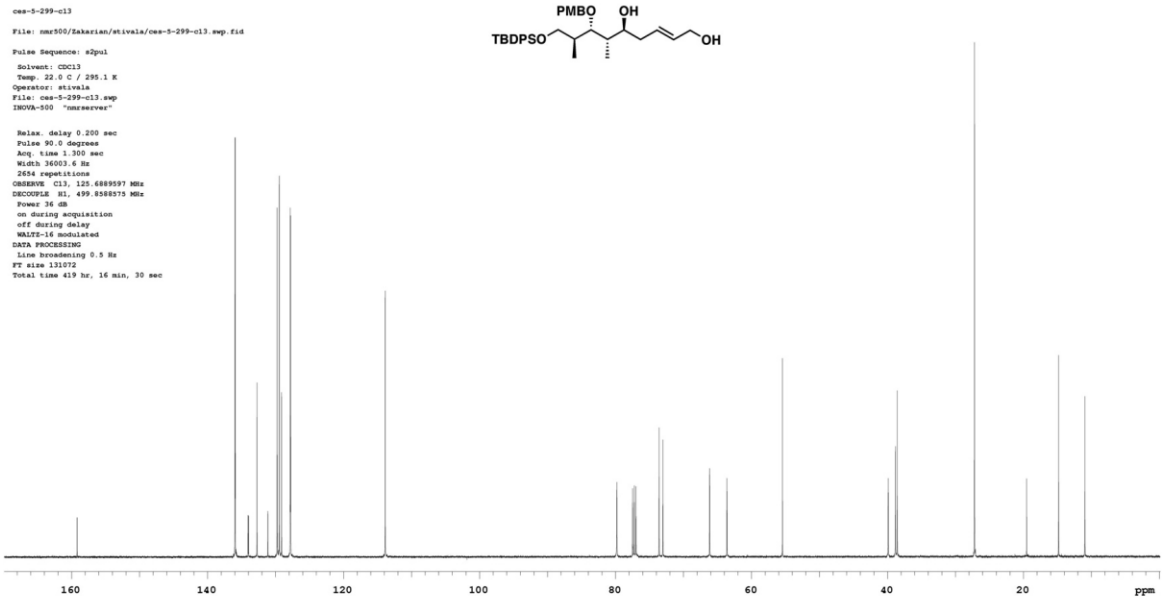

NOE 3.9%, 1.9%
NOE 9.0%
PMP
TBDPSO
Me
Me
ces-5-293-noe
File: nmr500/Zakarian/stivala/ces-5-293-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-293-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
32 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 29 min, 22 sec
8
7
6
5
4
3
2
1
ppm
-100.000
6.99
3.89
1.88

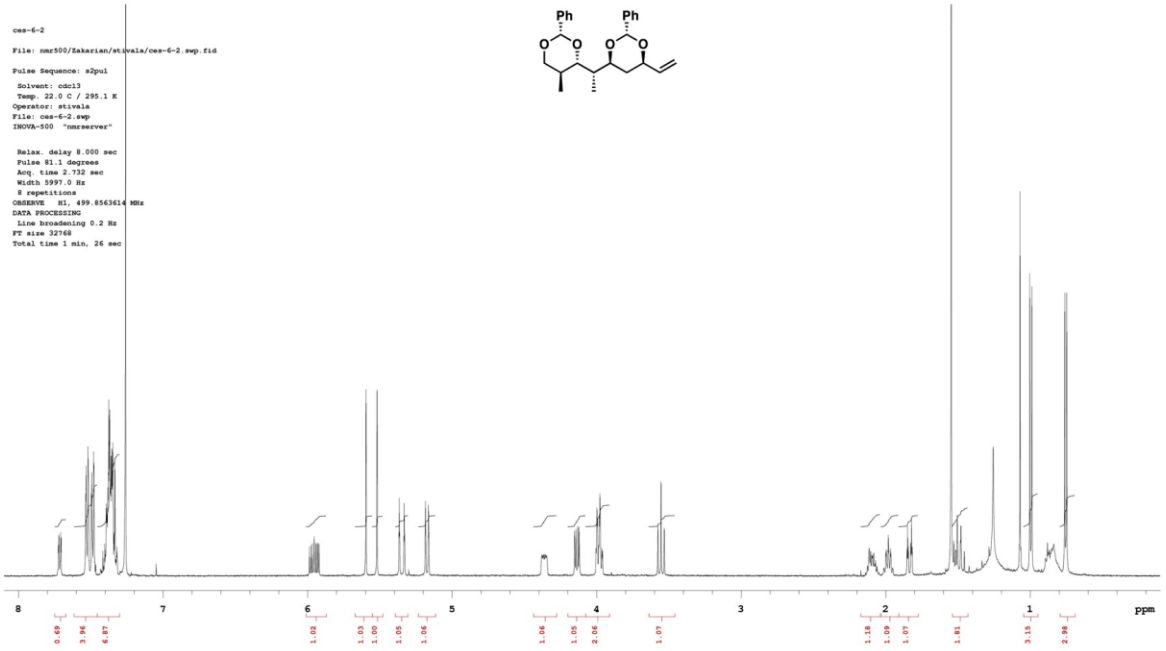

ces-5-293-noe
File: nmr500/Zakarian/stivala/ces-5-293-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-293-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
32 repetitions
OBSERVE H1, 499.8563610 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 hr, 29 min, 22 sec
NOE 14.1%
NOE 4.1%, 3.8%
PMP
TBDPSO
Me
Me
ppm

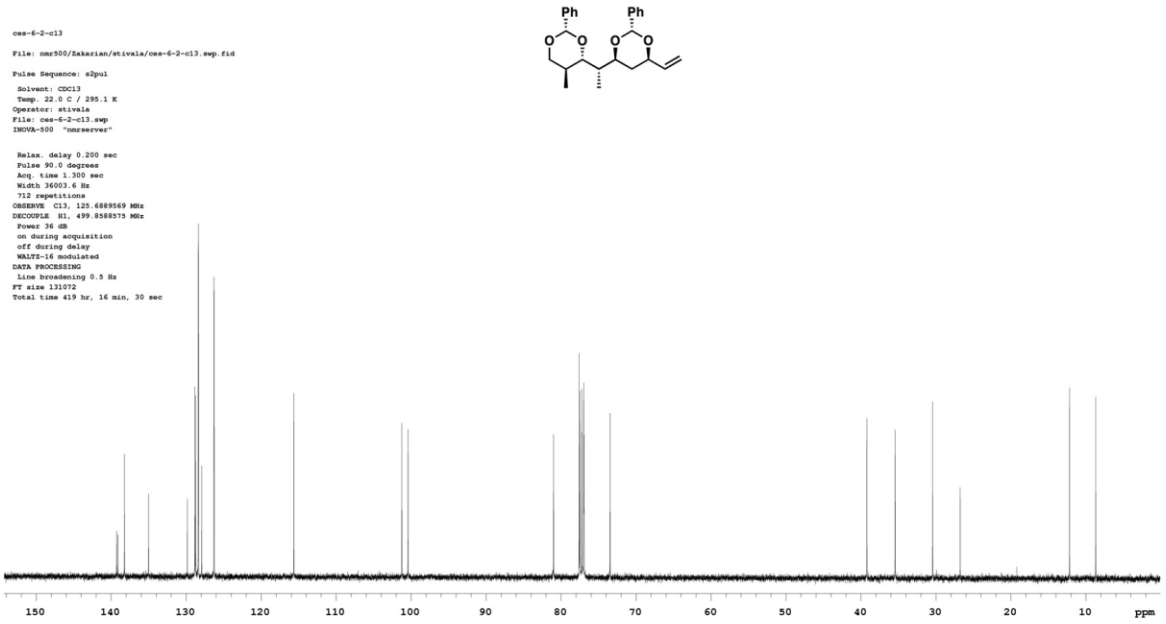

ces-5-290
File: nmr500/Zakarian/stivala/ces-5-290.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-290.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
PMBO
OH
TBDPSO
OAc
ppm

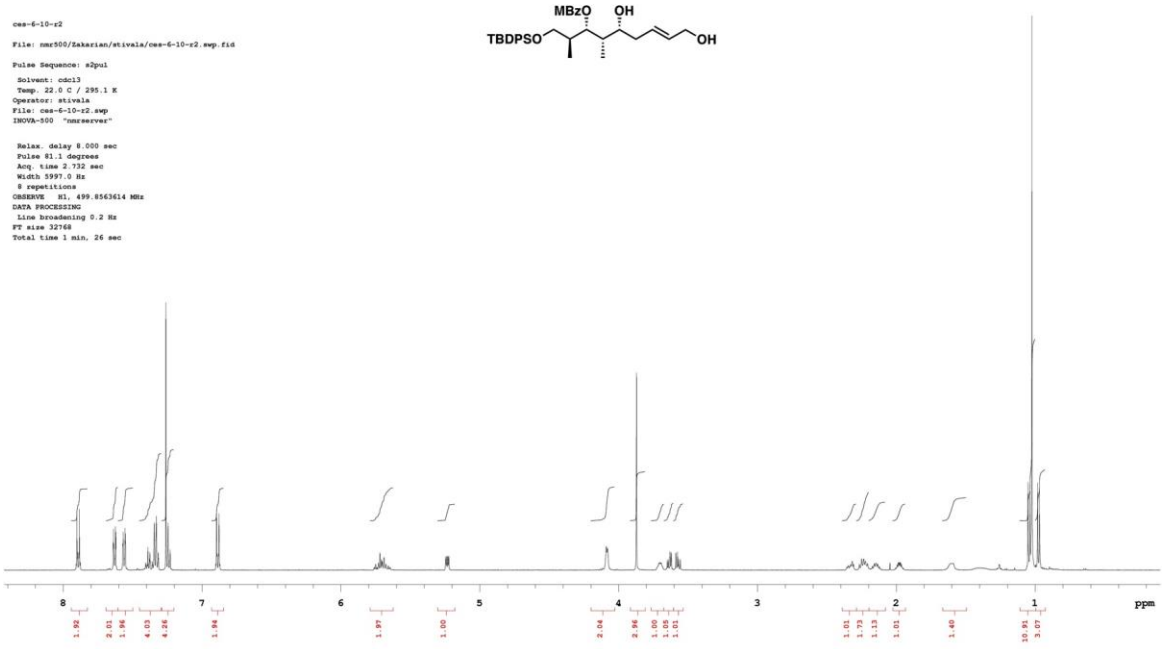

PMBO
OH
TBDPSO
OAc
ces-5-290-c13
File: nmr500/Zakarian/stivala/ces-5-290-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-290-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
295 repetitions
OBSERVE C13, 125.6889619 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
160
140
120
100
80
60
40
20
ppm

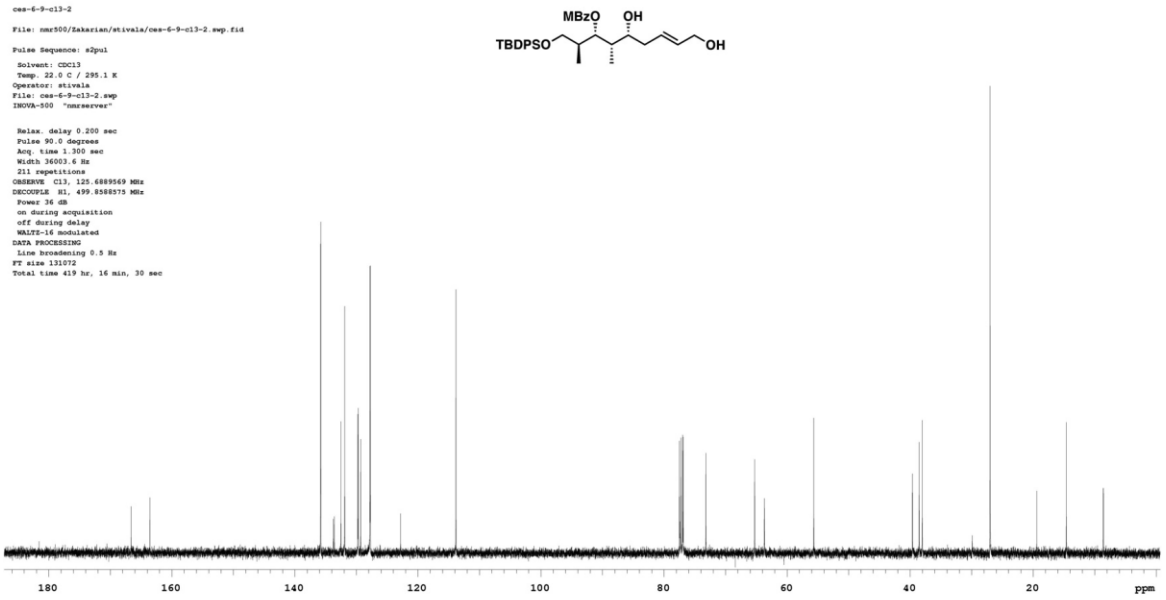

PMBO
OH
TBDPSO
OH
ces-5-295
File: nmr500/Zakarian/stivala/ces-5-295.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-295.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
8
7
6
5
4
3
2
1
ppm
3.91
1.88
3.80
1.96
1.96
1.99
1.00
1.00
2.03
1.00
3.48
1.07
1.03
0.84
1.01
1.45
0.99
1.01
3.20
0.84
8.37
2.88
2.88

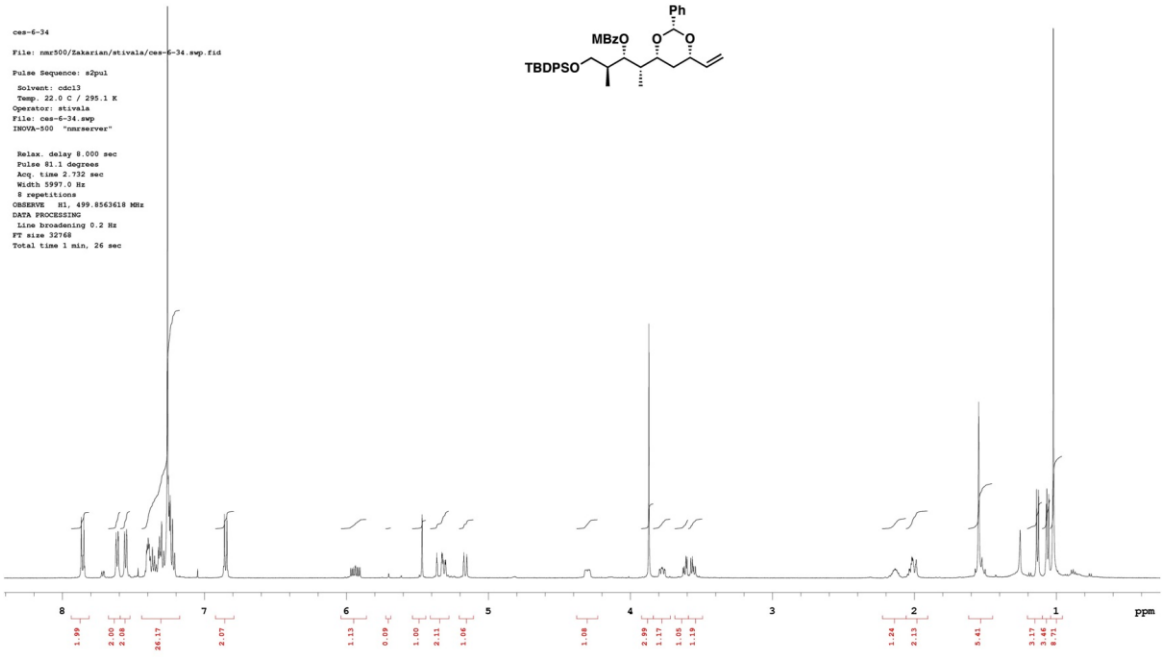

ces-5-299-c13
File: nmr500/Zakarian/stivala/ces-5-299-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-299-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
2654 repetitions
OBSERVE C13, 125.6889597 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
PMBO
OH
TBDPSO
OH
160
140
120
100
80
60
40
20
ppm

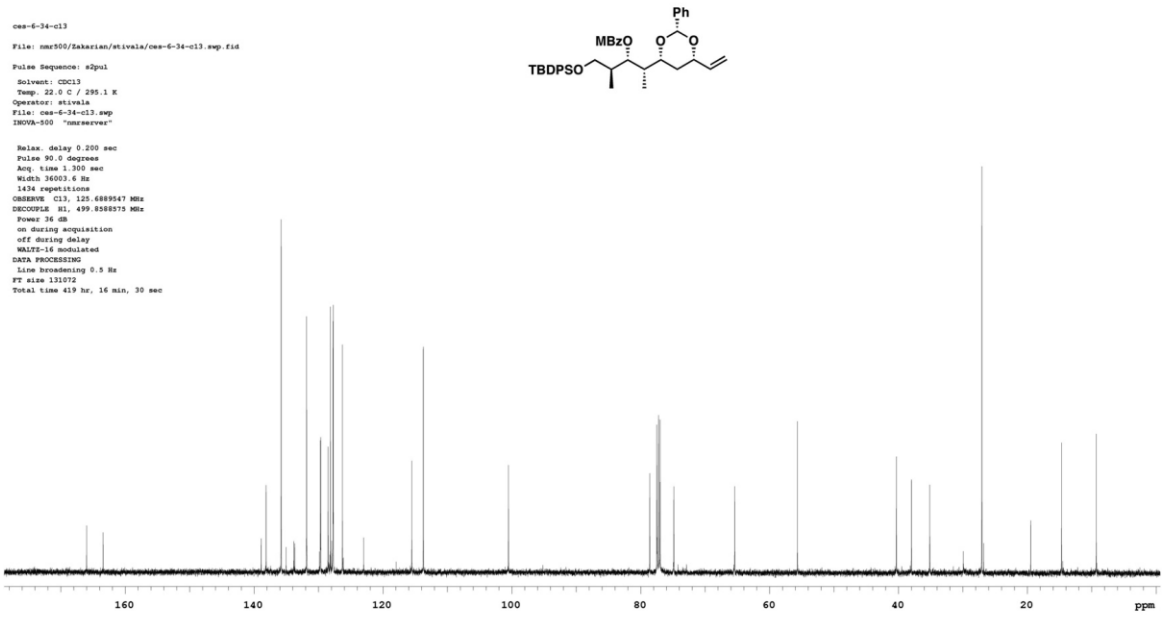

ces-6-2
File: nmr500/Zakarian/stivala/ces-6-2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
Ph
O
O
O
O
8
7
6
5
4
3
2
1
ppm
0.69
3.96
6.87
1.02
1.03
1.00
1.05
1.06
1.06
1.05
2.06
1.07
1.18
1.09
1.07
1.81
3.15
2.98

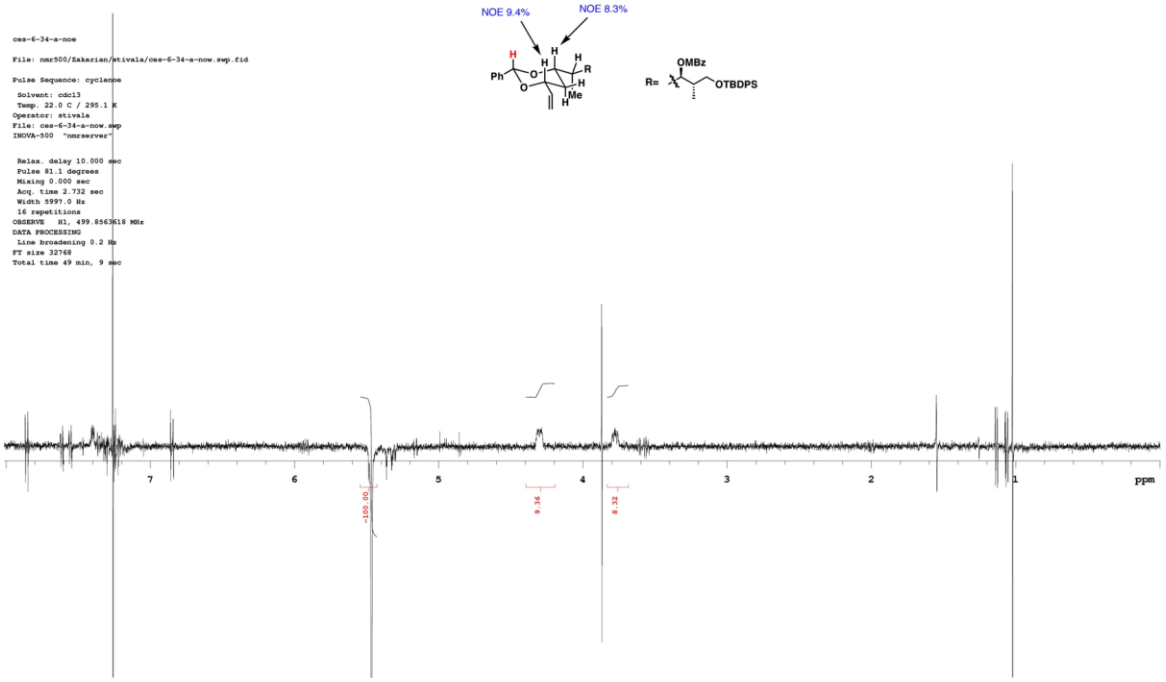

ces-6-2-c13
File: nmr500/Zakarian/stivala/ces-6-2-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-2-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
712 repetitions
OBSERVE C13, 125.6889569 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
Ph
Ph
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

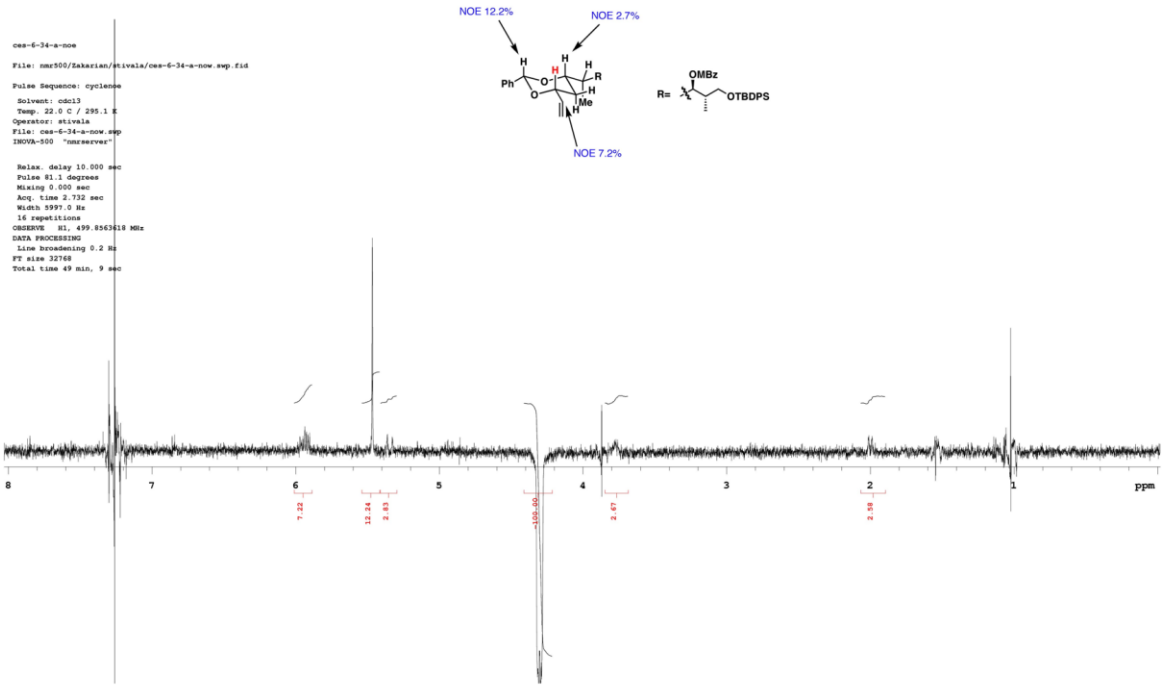

ces-6-10-r2
File: nmr500/Zakarian/stivala/ces-6-10-r2.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-10-r2.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
MBzO
OH
TBDPSO
OH
8
7
6
5
4
3
2
1
ppm
1.92
2.01
1.96
4.03
4.26
1.84
1.97
1.00
2.04
2.86
1.00
1.05
1.01
1.01
1.79
1.13
1.01
1.40
10.91
3.07

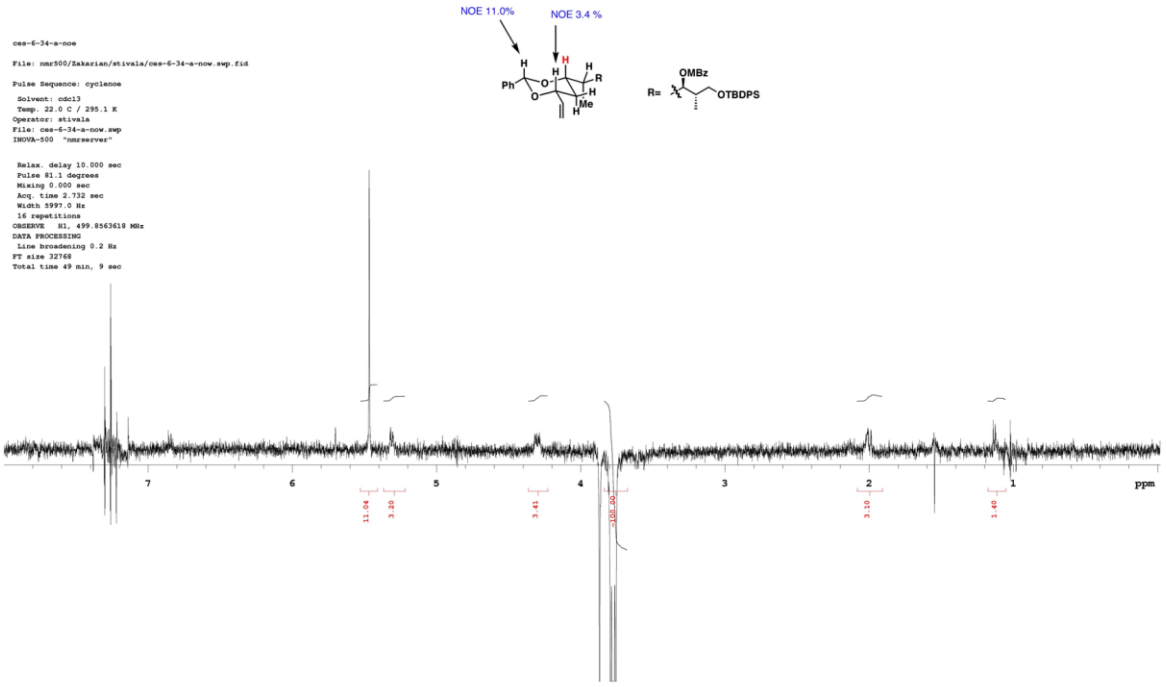

ces-6-9-c13-2
File: nmr500/Zakarian/stivala/ces-6-9-c13-2.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-9-c13-2.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
211 repetitions
OBSERVE C13, 125.6889569 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
MBzO
OH
TBDPSO
OH
180
160
140
120
100
80
60
40
20
ppm

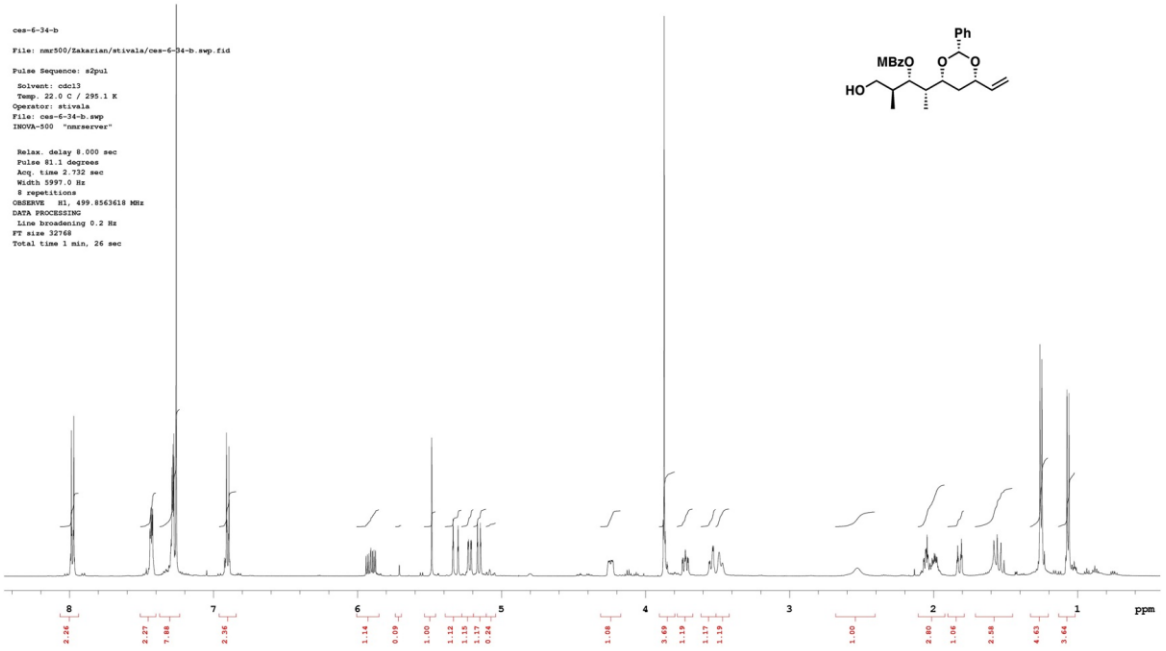

ces-6-34
File: nmr500/Zakarian/stivala/ces-6-34.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-34.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
MBzO
O
O
TBDPSO
8
7
6
5
4
3
2
1
ppm
1.99
2.00
2.08
26.17
2.07
1.13
0.09
1.00
2.11
1.06
1.08
2.99
1.17
1.08
1.19
1.24
2.13
5.41
3.17
3.46
8.71

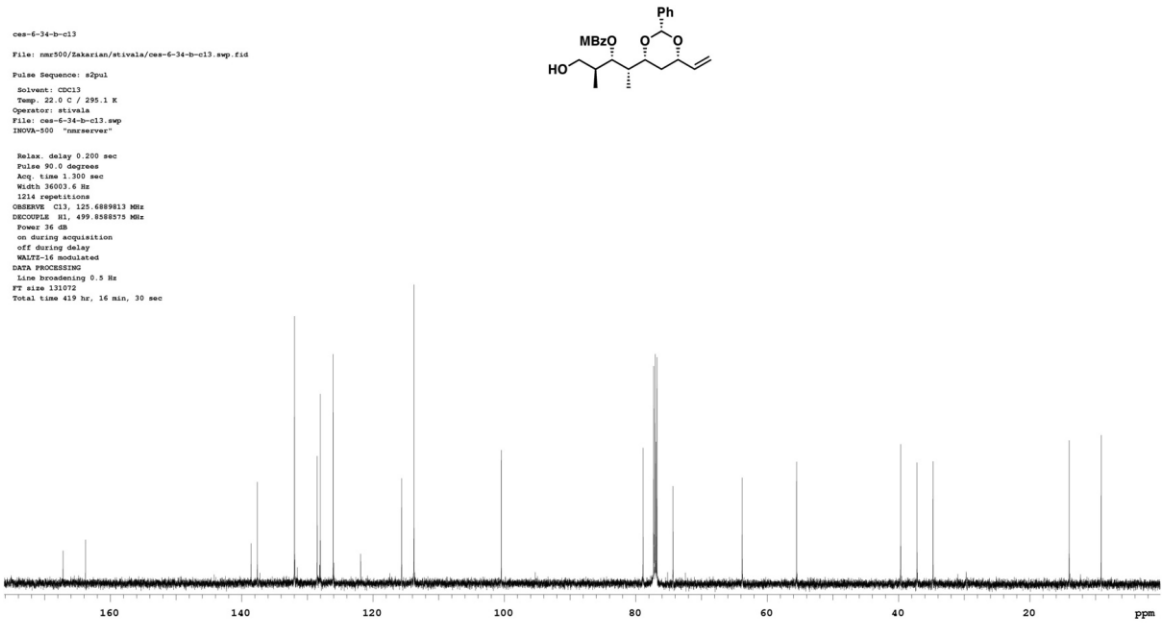

ces-6-34-c13
File: nmr500/Zakarian/stivala/ces-6-34-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-34-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1434 repetitions
OBSERVE C13, 125.6889547 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
Ph
MBzO
TBDPSO
160
140
120
100
80
60
40
20
ppm

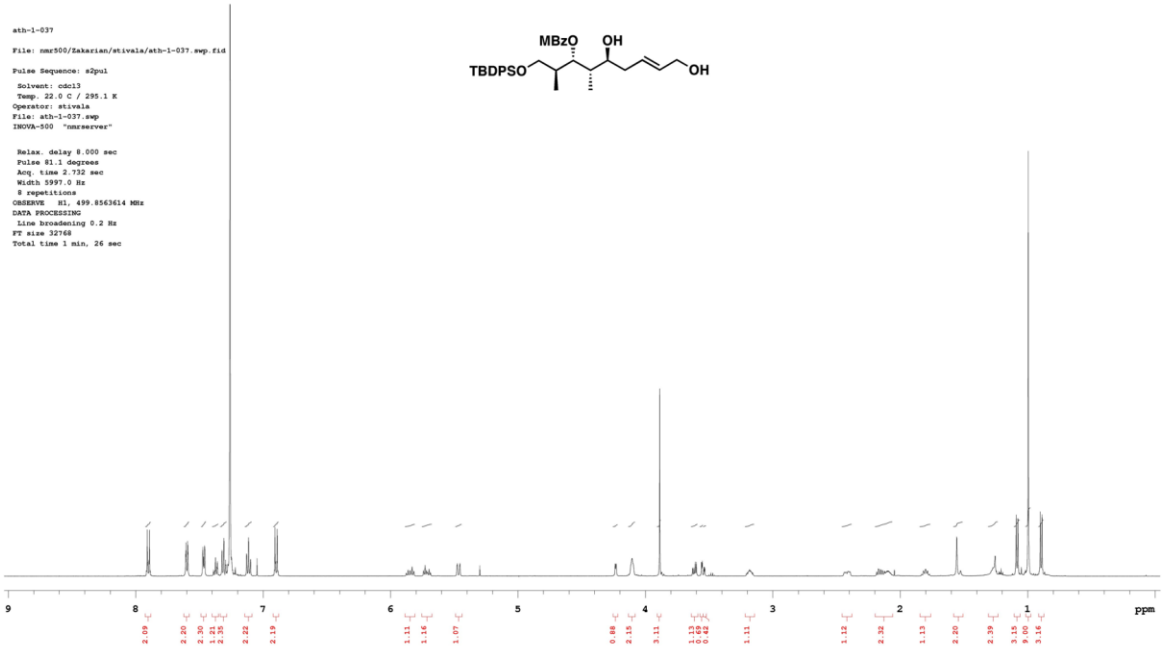

ces-6-34-a-noe
File: nmr500/Zakarian/stivala/ces-6-34-a-now.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-34-a-now.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 49 min, 9 sec
NOE 9.4%
NOE 8.3%
R=
OMBz
OTBDPS
7
6
5
4
3
2
1
ppm
-100.00
9.36
8.32

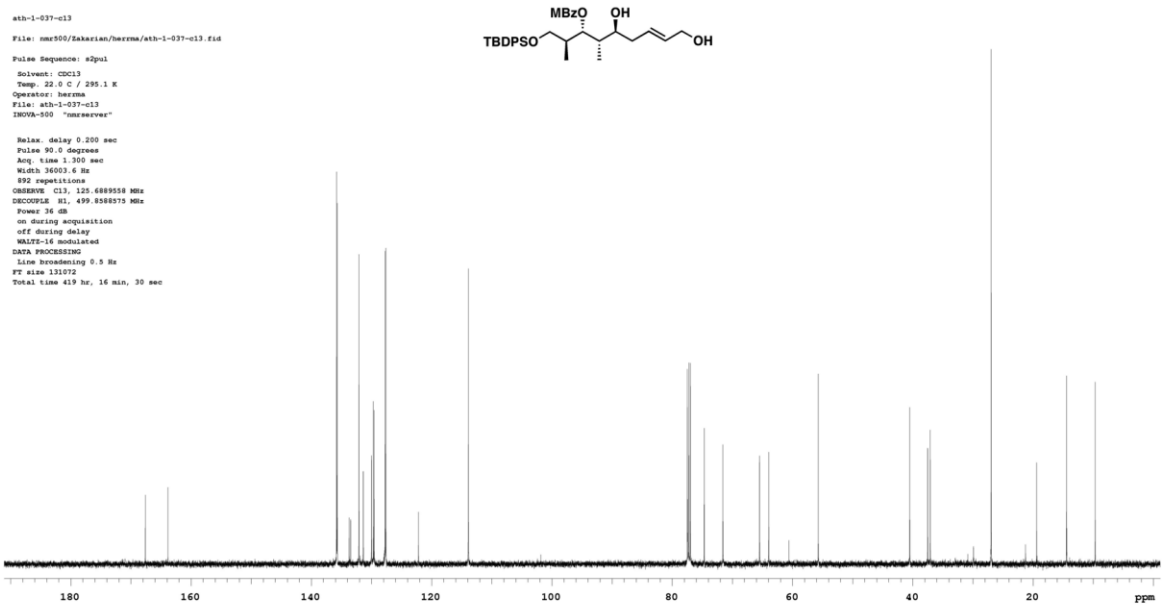

NOE 12.2%
NOE 2.7%
NOE 7.2%
OMBz
OTBDPS
R=
ces-6-34-a-noe
File: nmr500/Zakarian/stivala/ces-6-34-a-now.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-34-a-now.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 49 min, 9 sec
8
7
6
5
4
3
2
1
ppm
7.22
12.24
2.83
-100.00
2.67
2.58

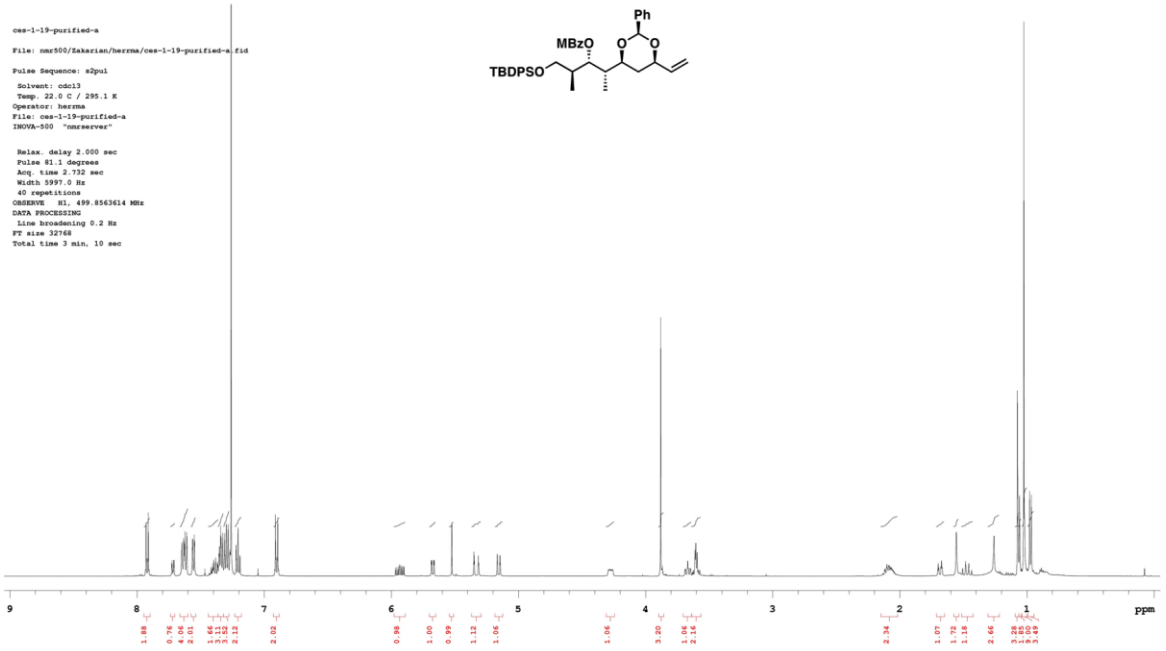

NOE 11.0%
NOE 3.4 %
OMBz
OTBDPS
R=
ces-6-34-a-noe
File: nmr500/Zakarian/stivala/ces-6-34-a-now.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-34-a-now.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 49 min, 9 sec
7
6
5
4
3
2
1
ppm
11.04
3.20
3.41
-100.00
3.10
1.40

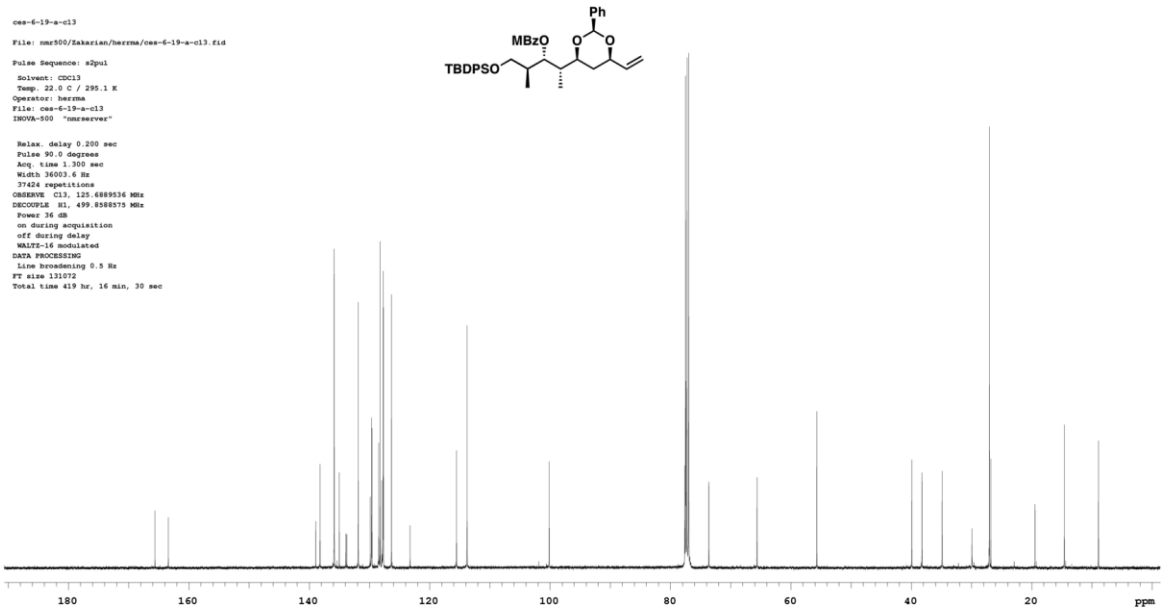

ces-6-34-b
File: nmr500/Zakarian/stivala/ces-6-34-b.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-34-b.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
Ph
MBzO
O
O
HO
8
7
6
5
4
3
2
1
ppm
2.26
2.27
7.88
2.36
1.14
0.09
1.00
1.12
1.15
1.17
0.24
1.08
3.69
1.19
1.17
1.19
1.00
2.80
1.06
2.58
4.63
3.64

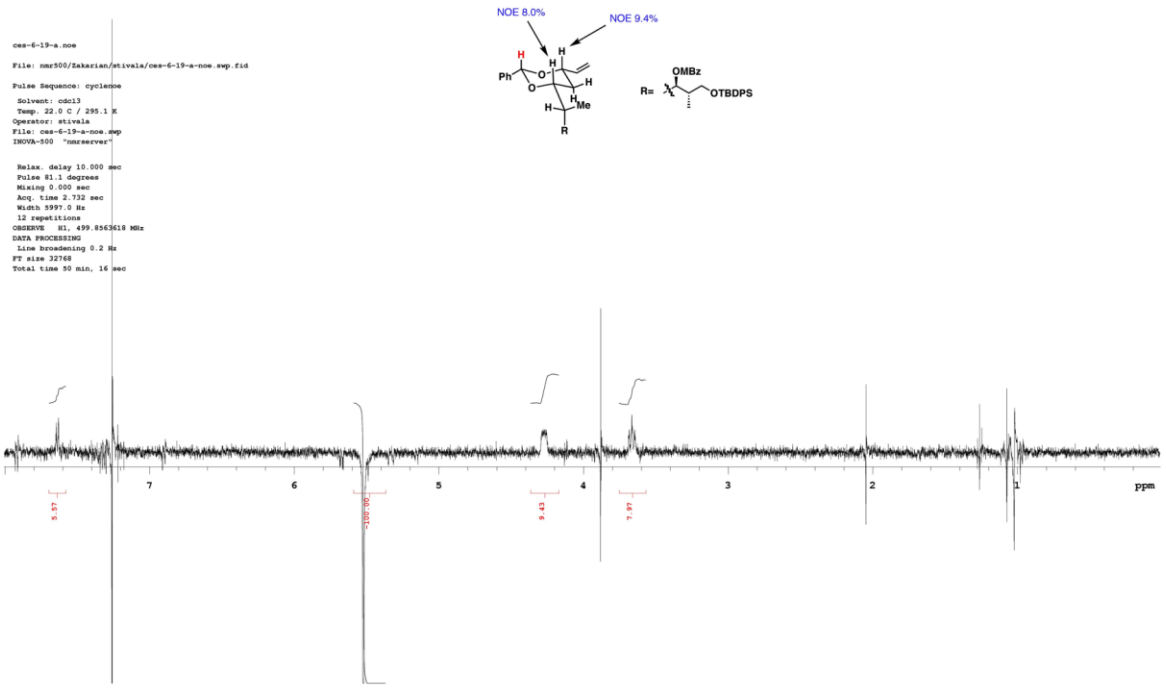

ces-6-34-b-c13
File: nmr500/Zakarian/stivala/ces-6-34-b-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-34-b-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1214 repetitions
OBSERVE C13, 125.6889813 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
Ph
MBzO
O
O
HO
160
140
120
100
80
60
40
20
ppm

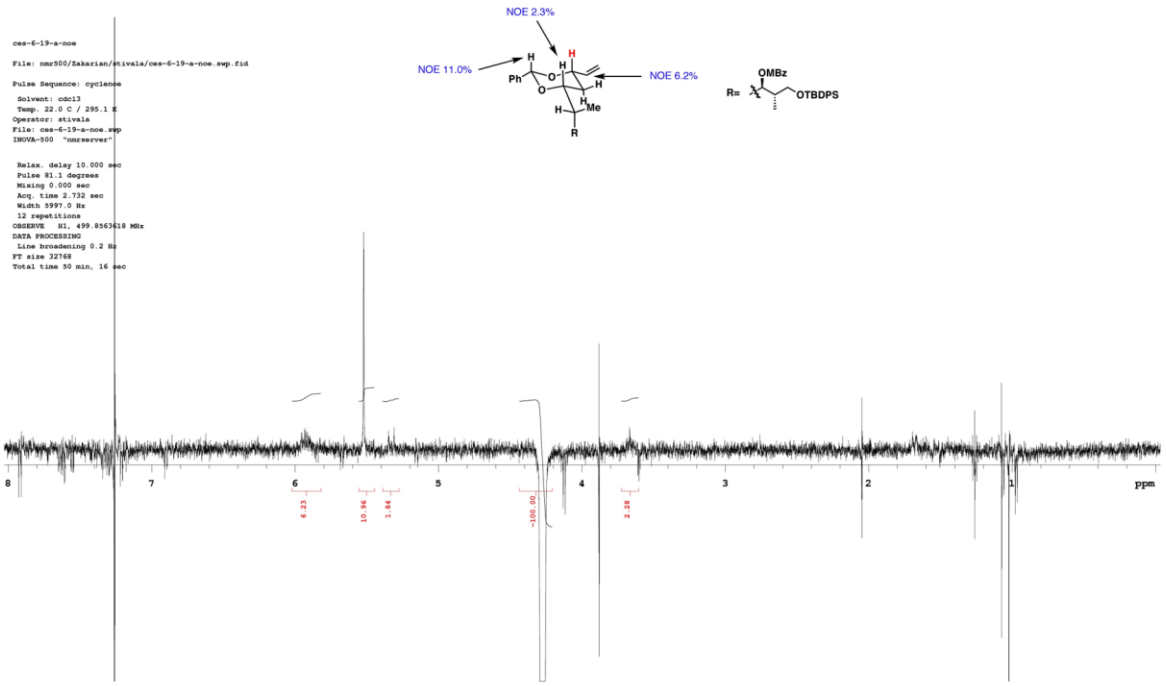

ath-1-037
File: nmr500/Zakarian/stivala/ath-1-037.swp.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ath-1-037.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 26 sec
MBzO
OH
TBDPSO
OH
9
8
7
6
5
4
3
2
1
ppm
2.09
2.20
2.30
1.21
2.35
2.22
2.19
1.11
1.16
1.07
0.68
2.15
3.11
1.13
0.69
0.42
1.11
1.12
2.32
1.13
2.20
2.39
3.15
9.00
3.16

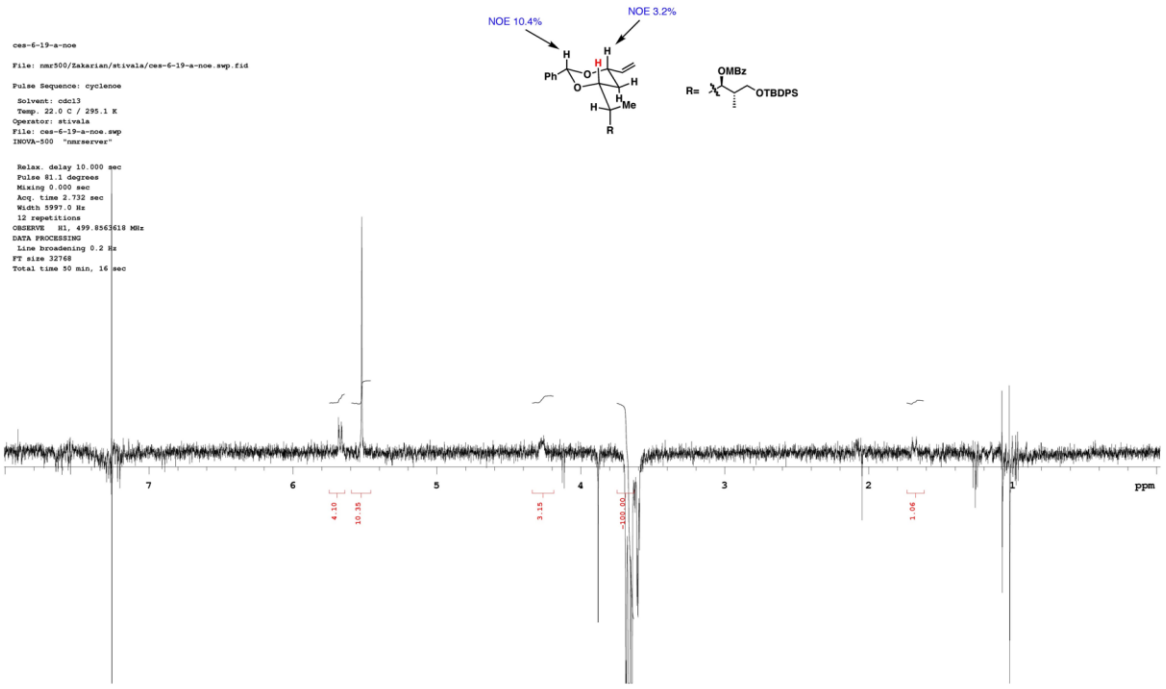

ath-1-037-c13
File: nmr500/Zakarian/herrma/ath-1-037-c13.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: herrma
File: ath-1-037-c13
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
892 repetitions
OBSERVE C13, 125.6889558 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
MBzO
OH
TBDPSO
OH
180
160
140
120
100
80
60
40
20
ppm

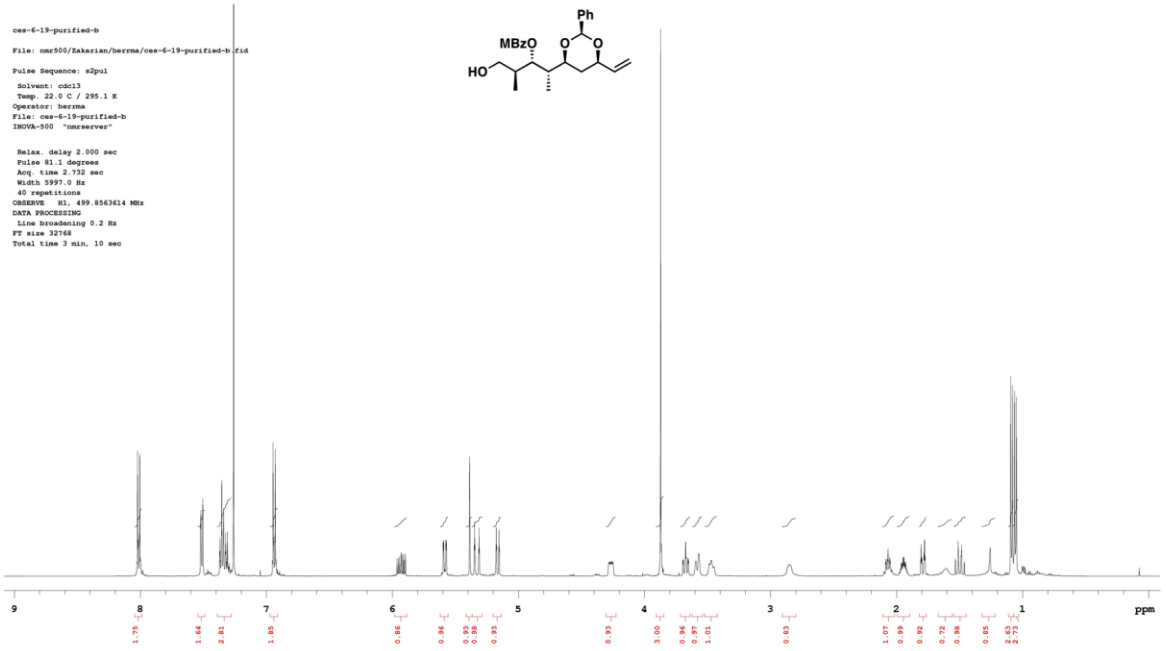

ces-1-19-purified-a
File: nmr500/Zakarian/herrma/ces-1-19-purified-a.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: herrma
File: ces-1-19-purified-a
INOVA-500 "nmrserver"
Relax. delay 2.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
40 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 3 min, 10 sec
Ph
MBzO
O
O
TBDPSO
9
8
7
6
5
4
3
2
1
ppm
1.88
0.76
4.06
2.01
1.64
3.32
2.12
2.02
0.98
1.00
0.99
1.12
1.06
1.06
3.20
1.04
2.16
2.34
1.07
1.72
1.18
2.66
3.28
1.85
1.00
3.49

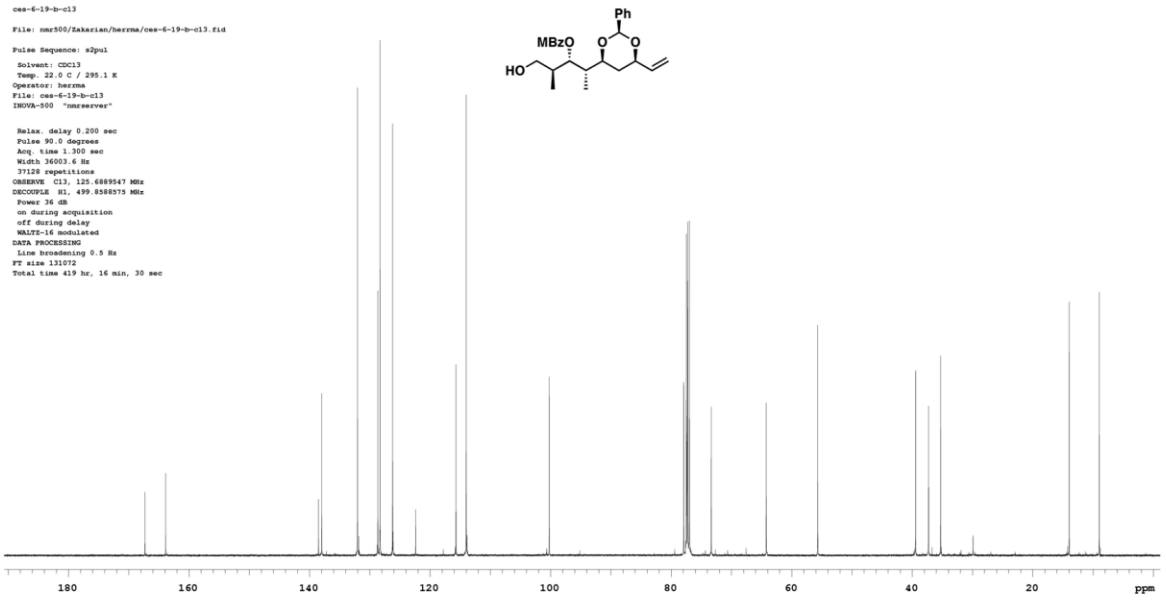

ces-6-19-a-c13
File: nmr500/Zakarian/herrma/ces-6-19-a-c13.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: herrma
File: ces-6-19-a-c13
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
37424 repetitions
OBSERVE C13, 125.6889536 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
Ph
MBzO
O
O
TBDPSO
180
160
140
120
100
80
60
40
20
ppm

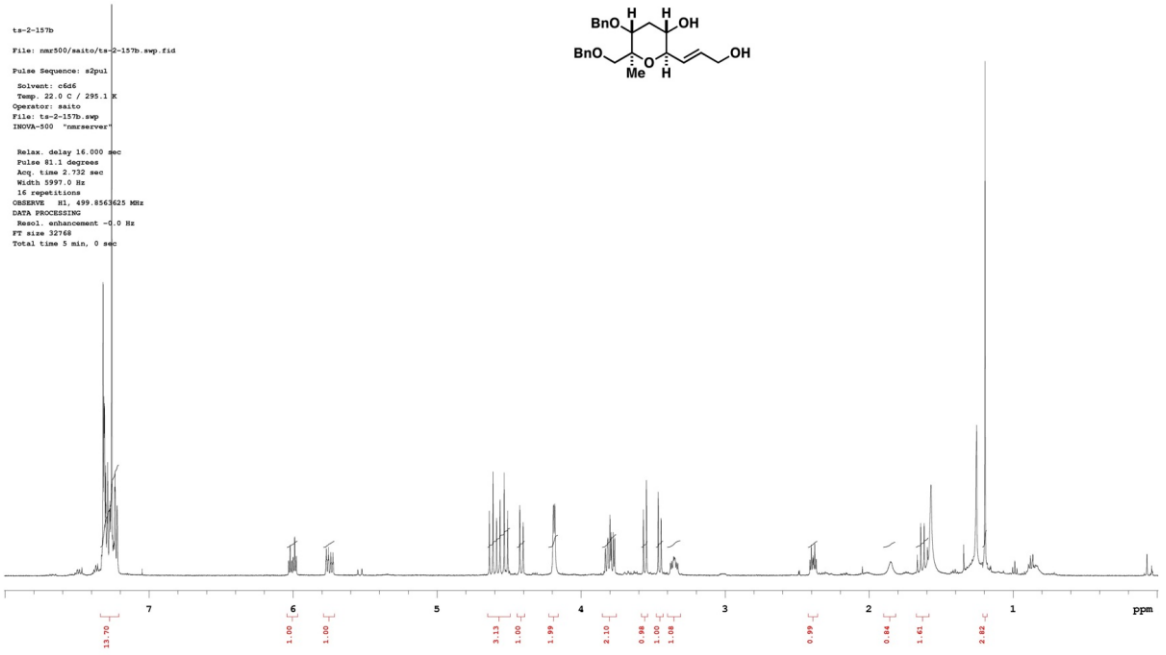

ces-6-19-a.noe
File: nmr500/Zakarian/stivala/ces-6-19-a-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-19-a-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
12 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 50 min, 16 sec
NOE 8.0%
NOE 9.4%
R=
OMBz
OTBDPS
ppm
5.57
-100.00
9.43
7.97

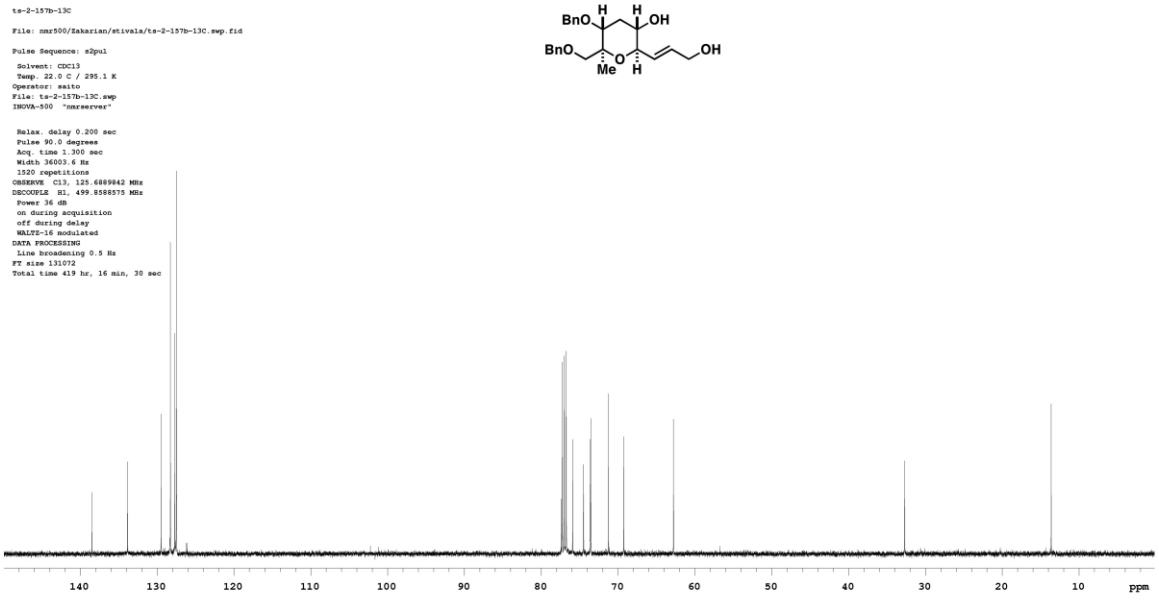

ces-6-19-a-noe
File: nmr500/Zakarian/stivala/ces-6-19-a-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-19-a-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
12 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 50 min, 16 sec
NOE 2.3%
NOE 11.0%
NOE 6.2%
R=
OMBz
OTBDPS
ppm
6.23
10.96
1.84
-100.00
2.28

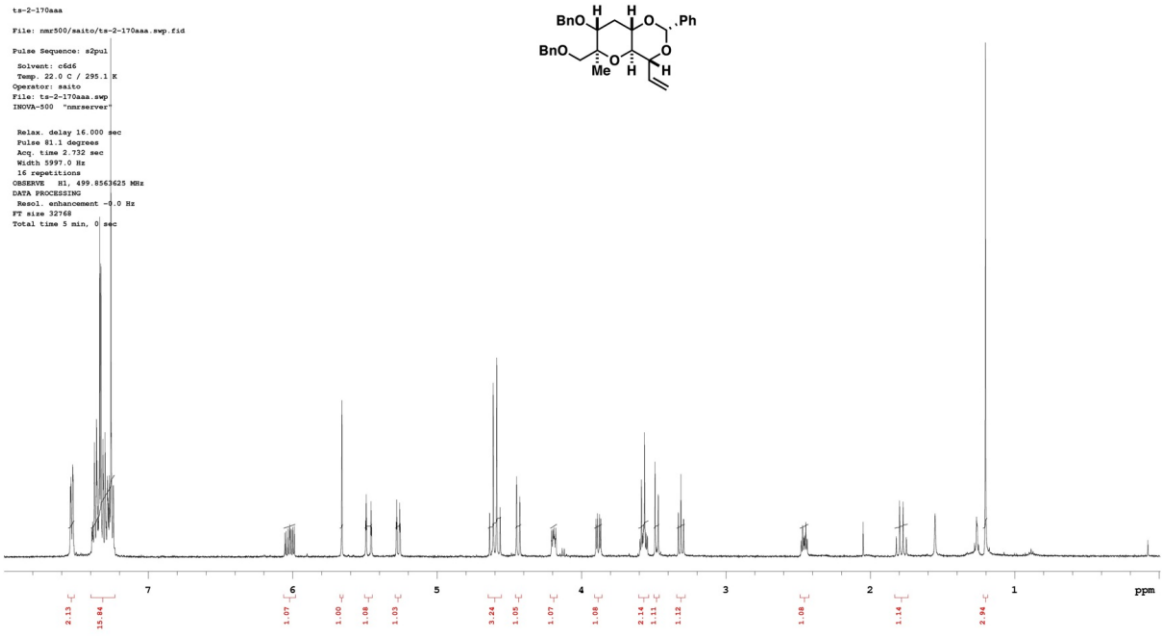

NOE 10.4%
NOE 3.2%
OMBz
R=
OTBDPS
ces-6-19-a-noe
File: nmr500/Zakarian/stivala/ces-6-19-a-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-6-19-a-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
12 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 50 min, 16 sec
ppm

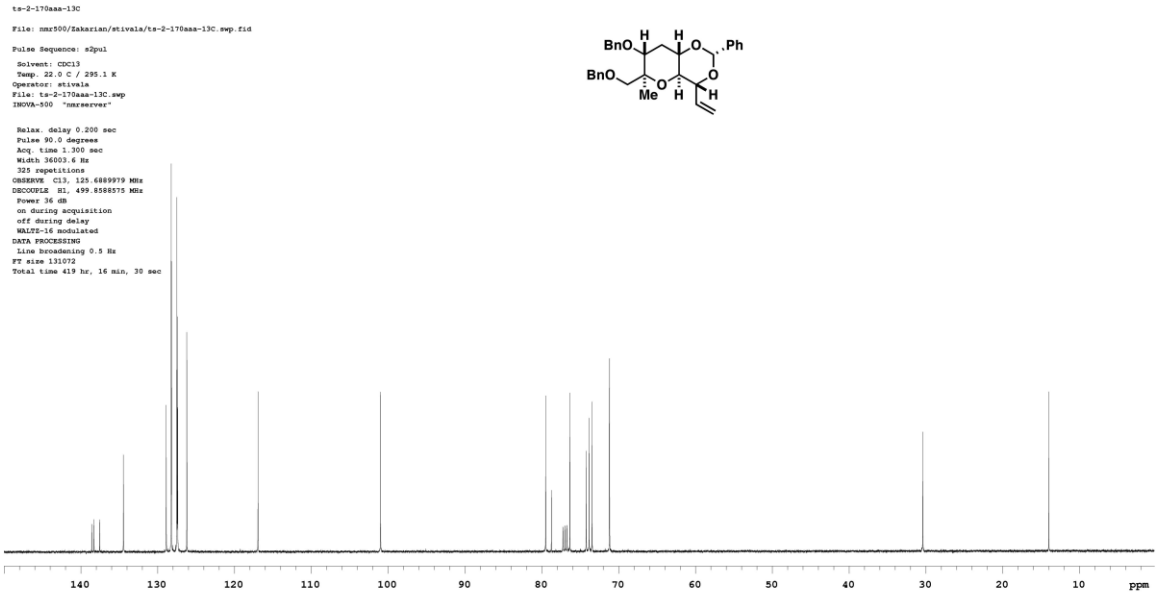

ces-6-19-purified-b
File: nmr500/Zakarian/herma/ces-6-19-purified-b.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: herma
File: ces-6-19-purified-b
INOVA-500 "nmrserver"
Relax. delay 2.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
40 repetitions
OBSERVE H1, 499.8563614 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 3 min, 10 sec
MBzO
HO
Ph
ppm

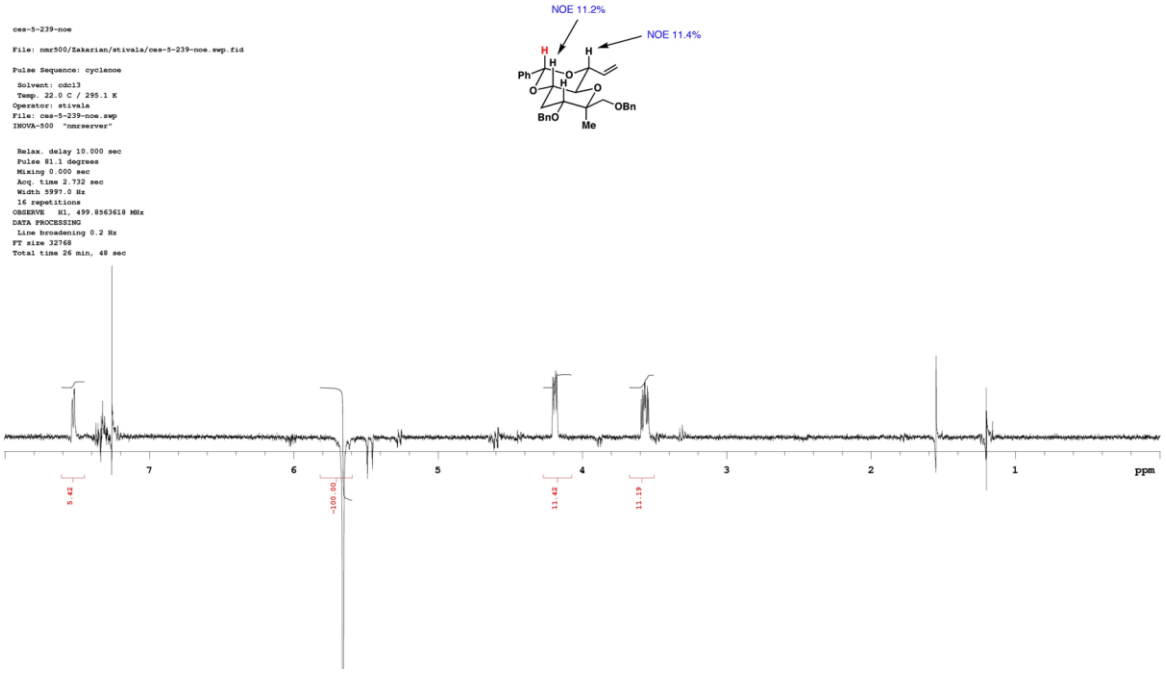

ces-6-19-b-c13
File: nmr500/Zakarian/herrma/ces-6-19-b-c13.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: herrma
File: ces-6-19-b-c13
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
37128 repetitions
OBSERVE C13, 125.6889547 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
Ph
MBzO
O
O
HO
180
160
140
120
100
80
60
40
20
ppm

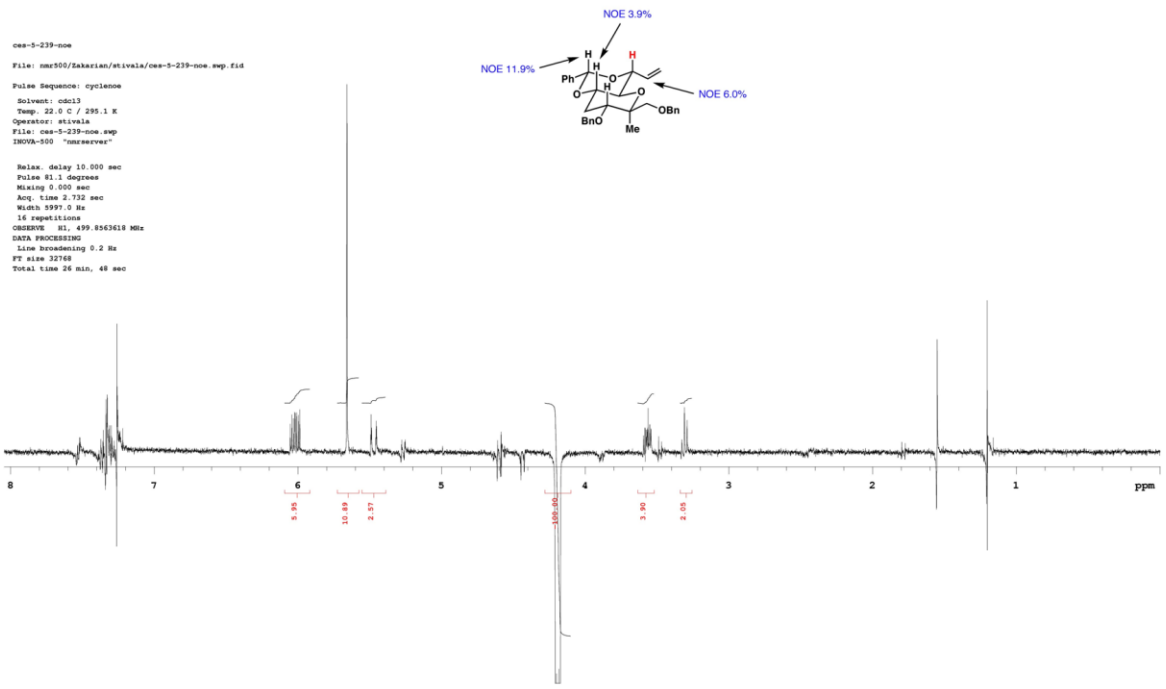

ts-2-157b
File: nmr500/saito/ts-2-157b.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-157b.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563625 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 5 min, 0 sec
BnO
H
H
OH
BnO
O
Me
H
OH
7
6
5
4
3
2
1
ppm
13.70
1.00
1.00
3.13
1.00
1.99
2.10
0.98
1.00
1.08
0.99
0.84
1.63
2.82

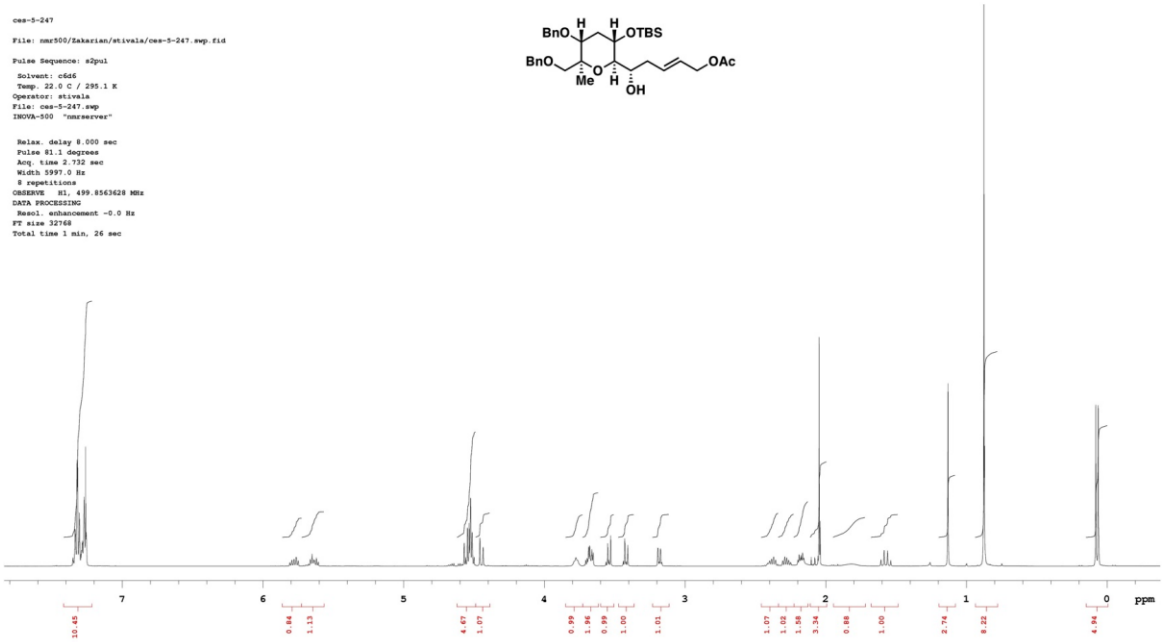

ts-2-157b-13C
File: nmr500/Zakarian/stivala/ts-2-157b-13C.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-157b-13C.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1520 repetitions
OBSERVE C13, 125.6889842 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
BnO
H
H
OH
BnO
O
OH
Me
H
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

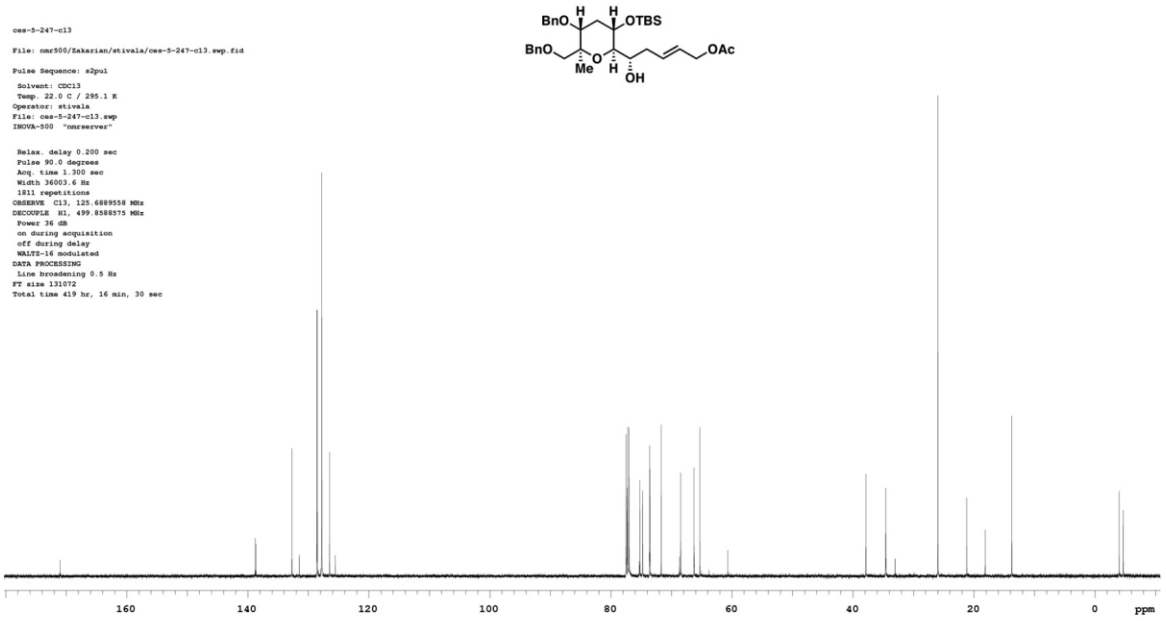

ts-2-170aaa
File: nmr500/saito/ts-2-170aaa.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-170aaa.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563625 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 5 min, 0 sec
BnO
H
H
O
.Ph
BnO
O
O
Me
H
H
7
6
5
4
3
2
1
ppm
2.13
15.84
1.07
1.00
1.08
1.03
3.24
1.05
1.07
1.08
2.14
1.11
1.12
1.08
1.14
2.94

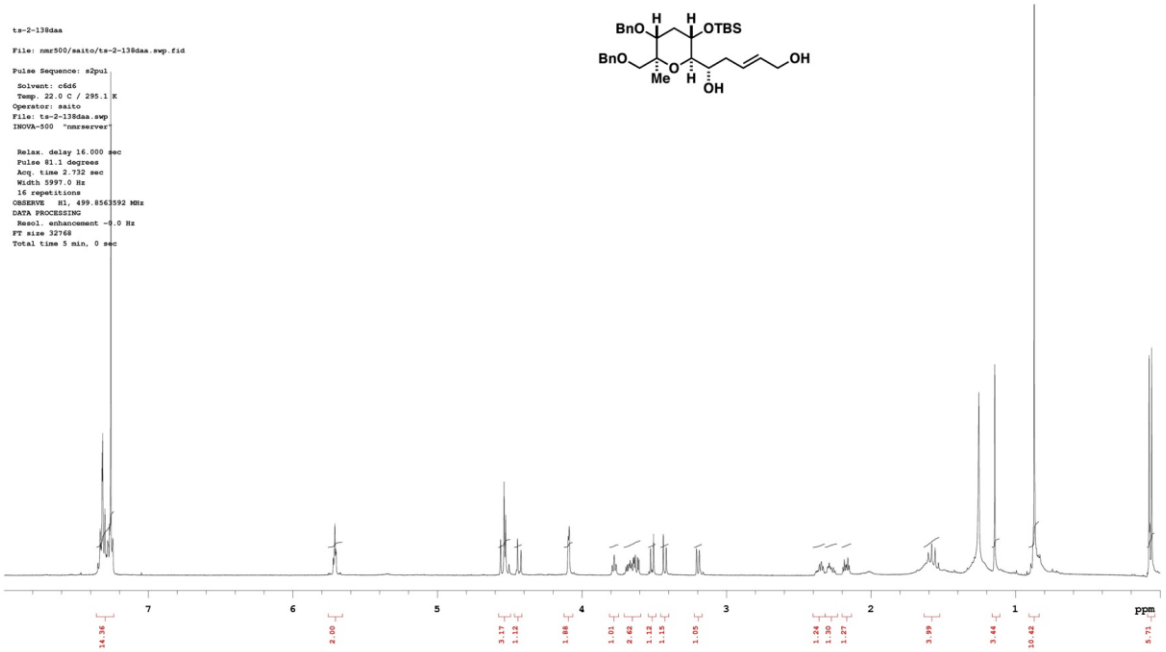

ts-2-170aaa-13C
File: nmr500/Zakarian/stivala/ts-2-170aaa-13C.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ts-2-170aaa-13C.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
325 repetitions
OBSERVE C13, 125.6889979 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
BnO
H
H
O
Ph
BnO
O
O
Me
H
H
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

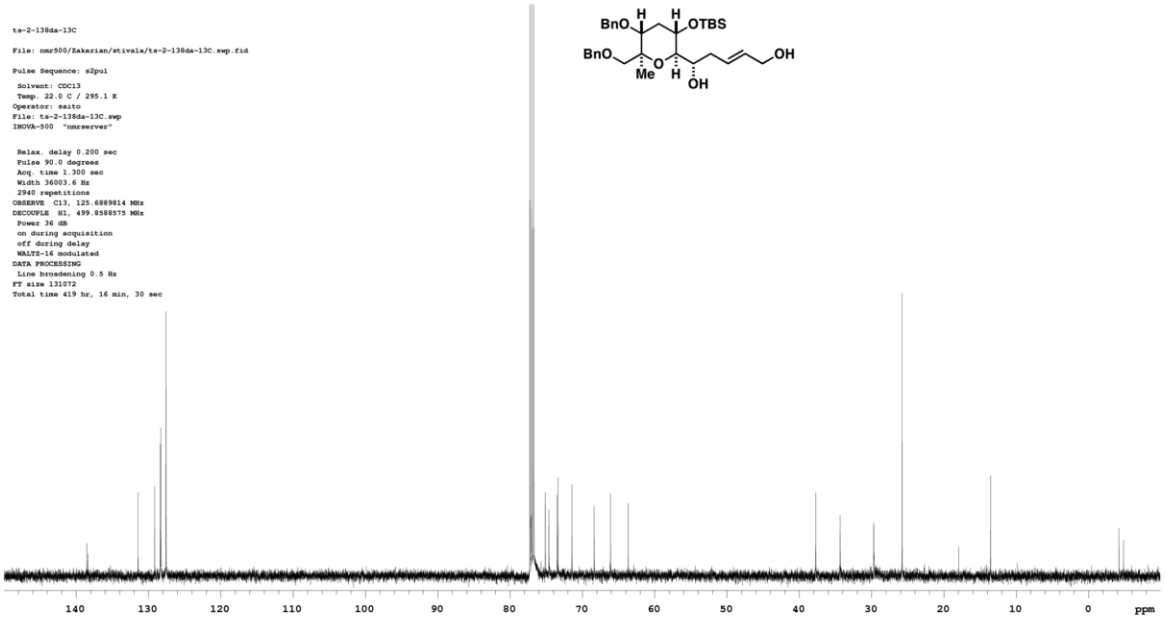

ces-5-239-noe
File: nmr500/Zakarian/stivala/ces-5-239-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-239-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 26 min, 48 sec
NOE 11.2%
NOE 11.4%
H
H
H
Ph
O
H
O
O
BnO
OBn
Me
5.42
-100.00
11.42
11.19
7
6
5
4
3
2
1
ppm

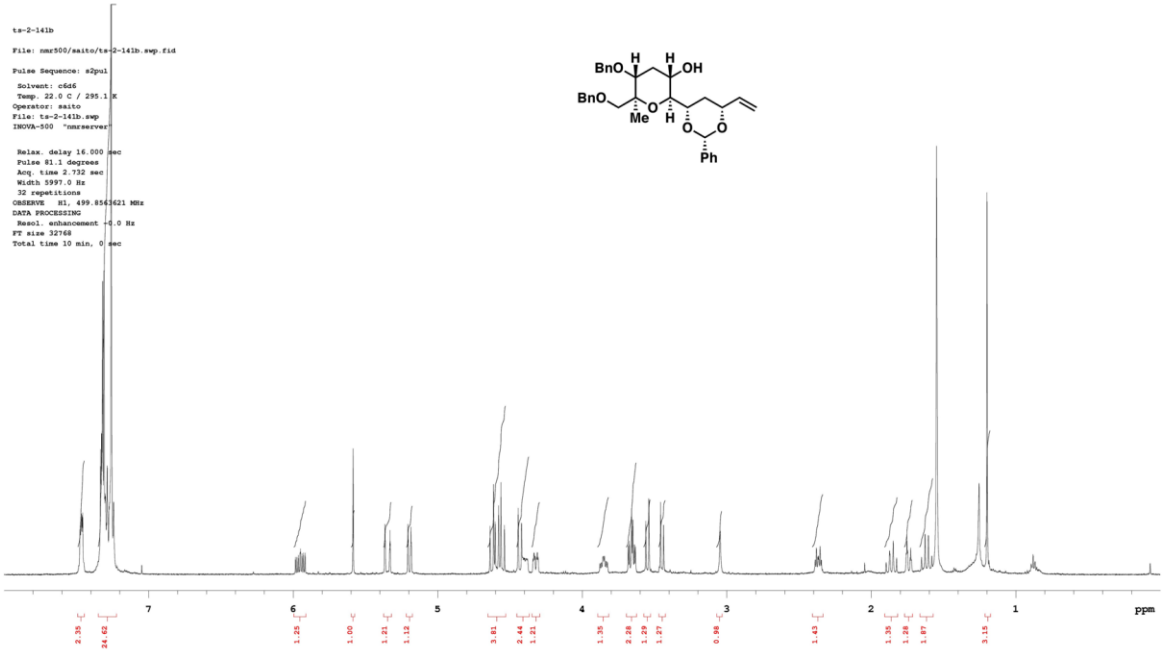

ces-5-239-noe
File: nmr500/Zakarian/stivala/ces-5-239-noe.swp.fid
Pulse Sequence: cyclenoe
Solvent: cdcl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-239-noe.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563618 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 26 min, 48 sec
NOE 3.9%
NOE 11.9%
NOE 6.0%
Ph
BnO
OBn
Me
ppm

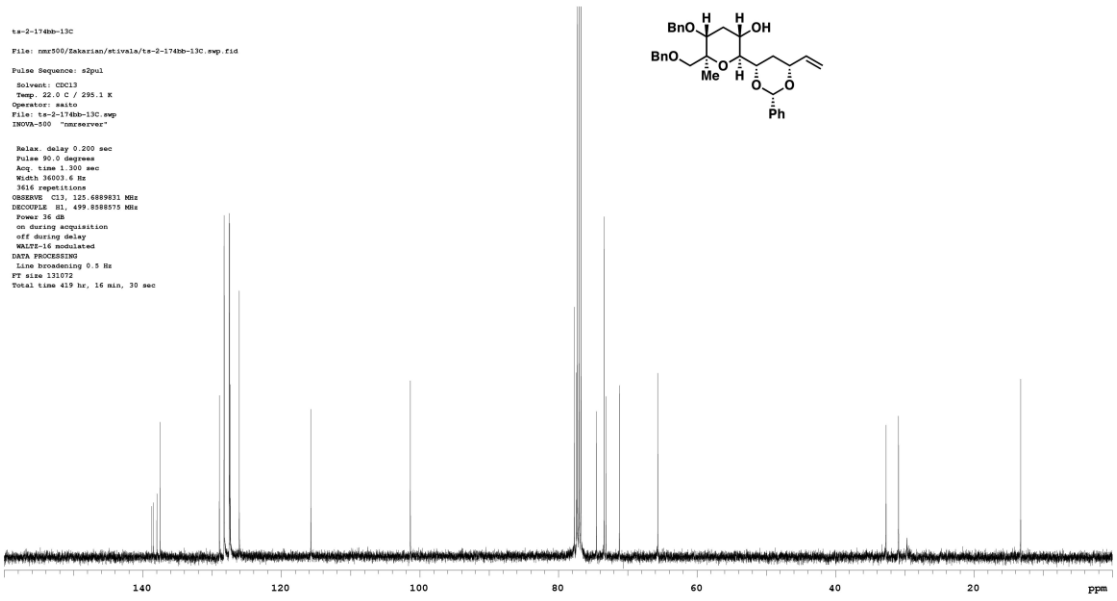

ces-5-247
File: nmr500/Zakarian/stivala/ces-5-247.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-247.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
8 repetitions
OBSERVE H1, 499.8563628 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 1 min, 26 sec
BnO
OTBS
OAc
Me
OH
ppm

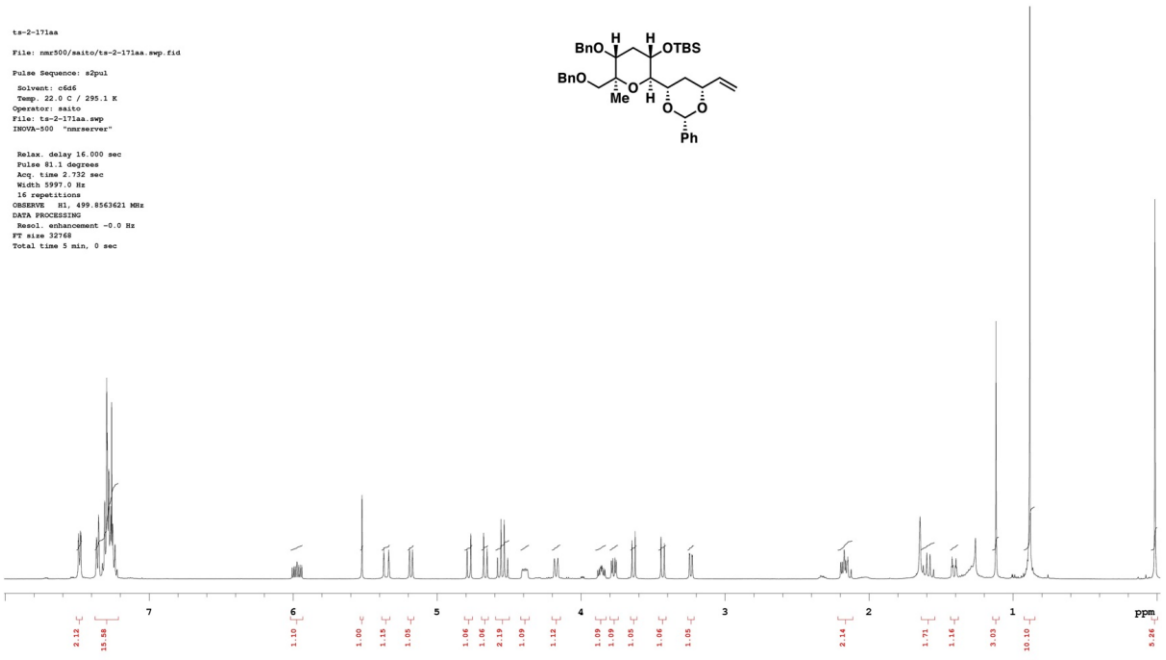

BnO
H
H
OTBS
BnO
Me
O
H
OH
OAc
ces-5-247-c13
File: nmr500/Zakarian/stivala/ces-5-247-c13.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: stivala
File: ces-5-247-c13.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1811 repetitions
OBSERVE C13, 125.6889558 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
160
140
120
100
80
60
40
20
0
ppm

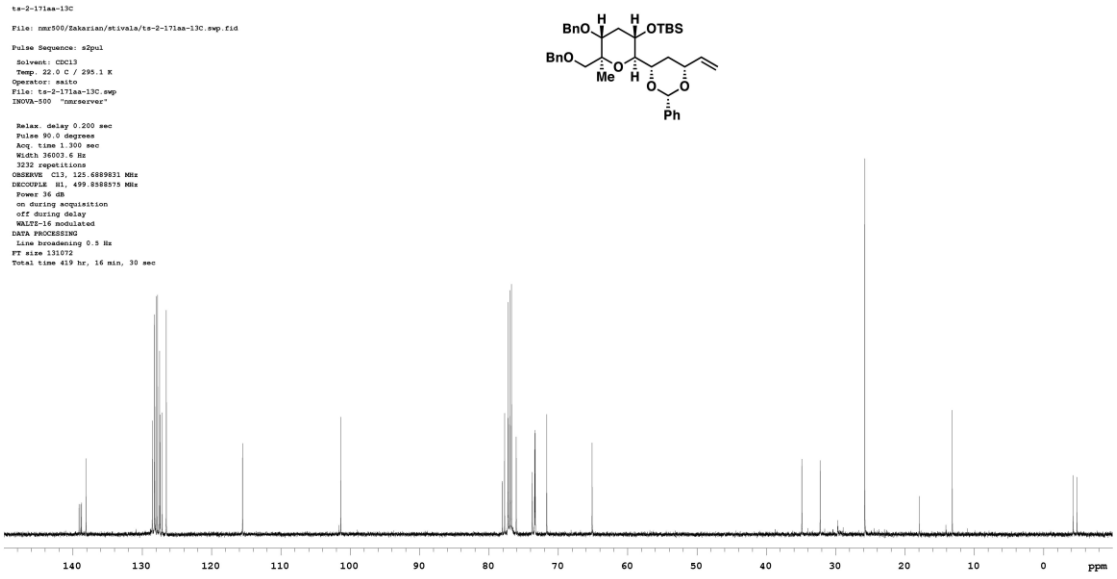

BnO
H
H
OTBS
BnO
Me
O
H
OH
OH
ts-2-138daa
File: nmr500/saito/ts-2-138daa.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-138daa.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563992 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 5 min, 0 sec
7
6
5
4
3
2
1
ppm
14.36
2.00
3.17
1.12
1.88
1.01
2.62
1.12
1.15
1.05
1.24
1.30
1.27
3.99
3.44
10.42
5.71

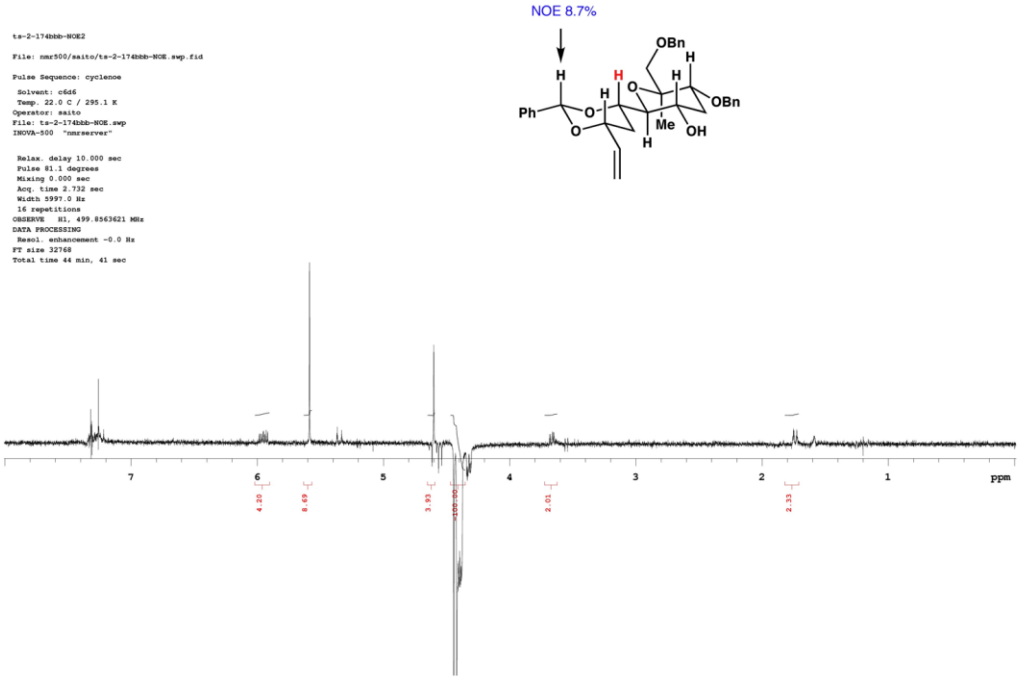

ts-2-138da-13C
File: nmr500/Zakarian/stivala/ts-2-138da-13C.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-138da-13C.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
2940 repetitions
OBSERVE C13, 125.6889814 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
BnO
H
H
OTBS
BnO
Me
O
H
OH
OH
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

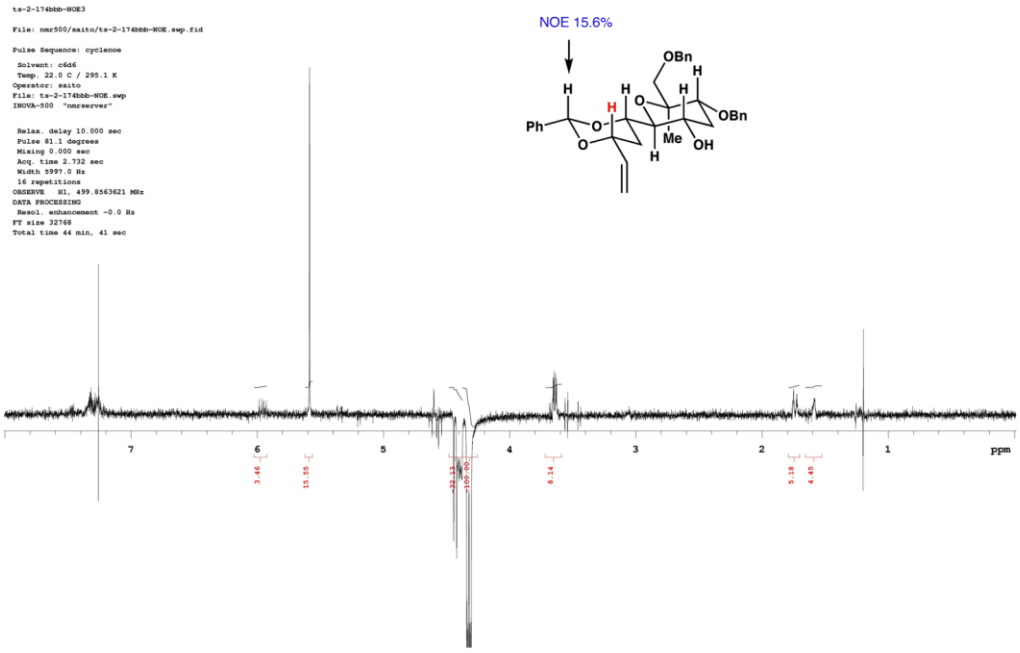

ts-2-141b
File: nmr500/saito/ts-2-141b.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-141b.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
32 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 10 min, 0 sec
BnO
H
H
OH
BnO
Me
O
H
O
O
Ph
7
6
5
4
3
2
1
ppm
2.35
24.62
1.25
1.00
1.21
1.12
3.81
2.44
1.21
1.35
2.28
1.29
1.27
0.98
1.43
1.35
1.28
1.87
3.15

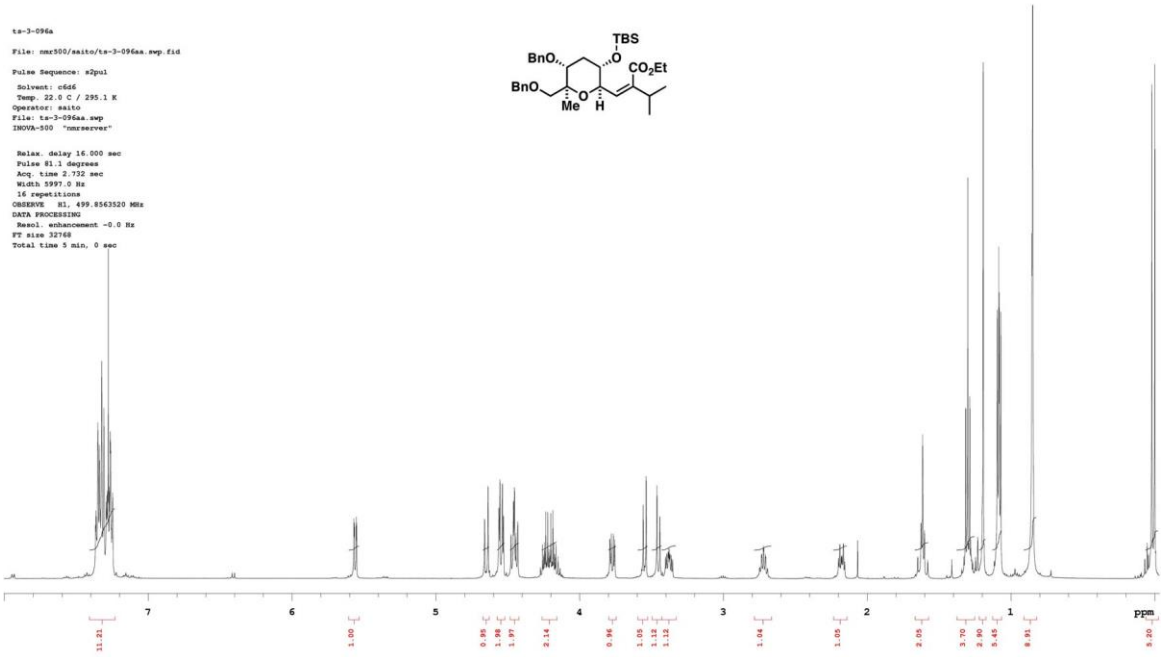

ts-2-174bb-13C
File: nmr500/Zakarian/stivala/ts-2-174bb-13C.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-174bb-13C.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
3616 repetitions
OBSERVE C13, 125.6889631 MHz
DECOUPLE H1, 499.8588578 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
BnO
H
H
OH
BnO
Me
O
H
O
O
Ph
140
120
100
80
60
40
20
ppm

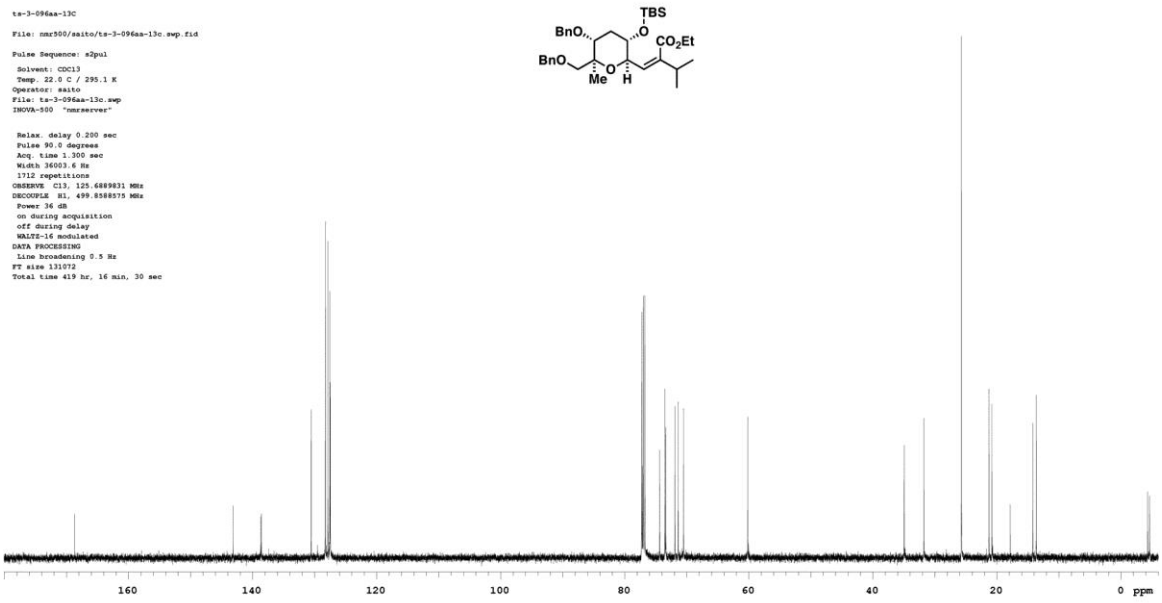

ts-2-171aa
File: nmr500/saito/ts-2-171aa.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-171aa.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 5 min, 0 sec
BnO
H
H
OTBS
BnO
Me
O
H
O
O
Ph
7
6
5
4
3
2
1
ppm
2.12
15.58
1.10
1.00
1.15
1.05
1.06
1.06
2.19
1.09
1.12
1.09
1.09
1.05
1.04
1.05
2.14
1.71
1.16
3.03
10.10
5.26


ts-2-171aa-13C
File: nmr500/Zakarian/stivala/ts-2-171aa-13C.swp.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-171aa-13C.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
3232 repetitions
OBSERVE C13, 125.6889831 MHz
DECOUPLE H1, 499.8388875 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
BnO
H
H
OTBS
BnO
O
Me
H
O
O
Ph
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


NOE 8.7%
ts-2-174bbb-NOE2
File: nmr500/saito/ts-2-174bbb-NOE.swp.fid
Pulse Sequence: cyclenoe
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-174bbb-NOE.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 44 min, 41 sec
OBn
H
H
H
H
O
Ph
O
O
OBn
Me
OH
H
7
6
5
4
3
2
1
ppm
4.20
8.69
3.83
100.00
2.01
2.33


ts-2-174bbb-NOE3
File: nmr500/saito/ts-2-174bbb-NOE.swp.fid
Pulse Sequence: cyclenoe
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-2-174bbb-NOE.swp
INOVA-500 "nmrserver"
Relax. delay 10.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 44 min, 41 sec
NOE 15.6%
OBn
H
H
H
H
O
OBn
Ph
O
O
Me
OH
H
7
6
5
4
3
2
1
ppm
3.46
15.55
32.13
100.00
8.14
5.18
4.45


ts-3-096a
File: nmr500/saito/ts-3-096aa.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-3-096aa.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563520 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 5 min, 0 sec
TBS
BnO
O
CO2Et
BnO
Me
O
H
7
6
5
4
3
2
1
ppm
11.21
1.00
0.86
1.98
1.97
2.14
0.96
1.05
1.13
1.12
1.04
1.05
2.05
3.70
2.90
5.45
8.81
9.20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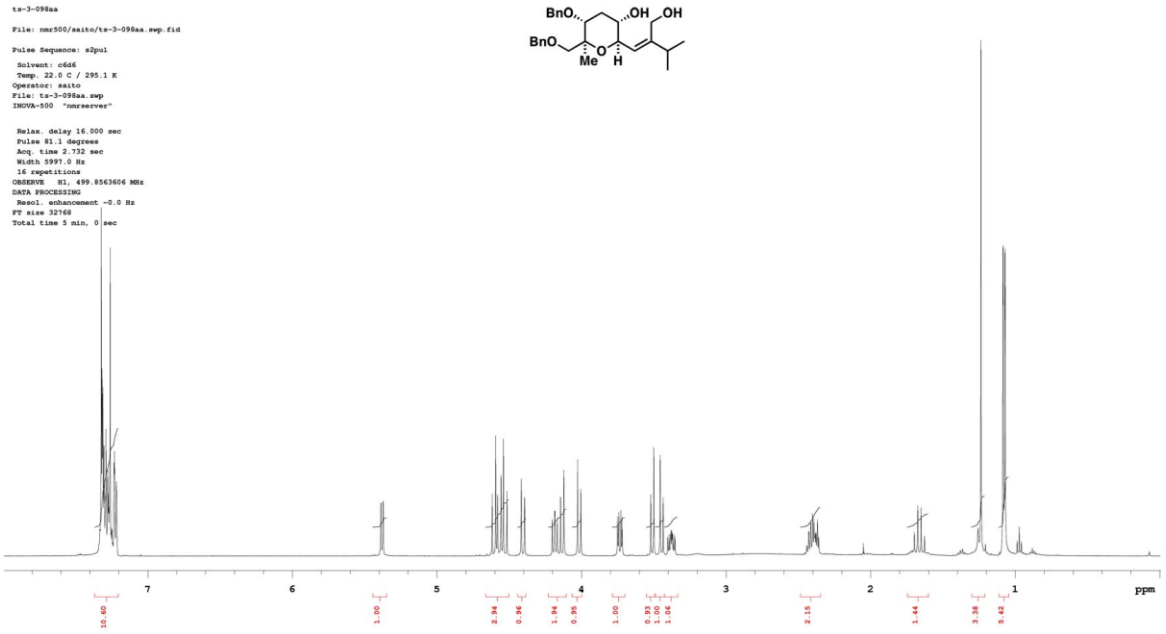
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-3-096aa-13c.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1712 repetitions
OBSERVE C13, 125.6889831 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
TBS
BnO
BnO
CO2Et
Me
H
160
140
120
100
80
60
40
20
0 ppm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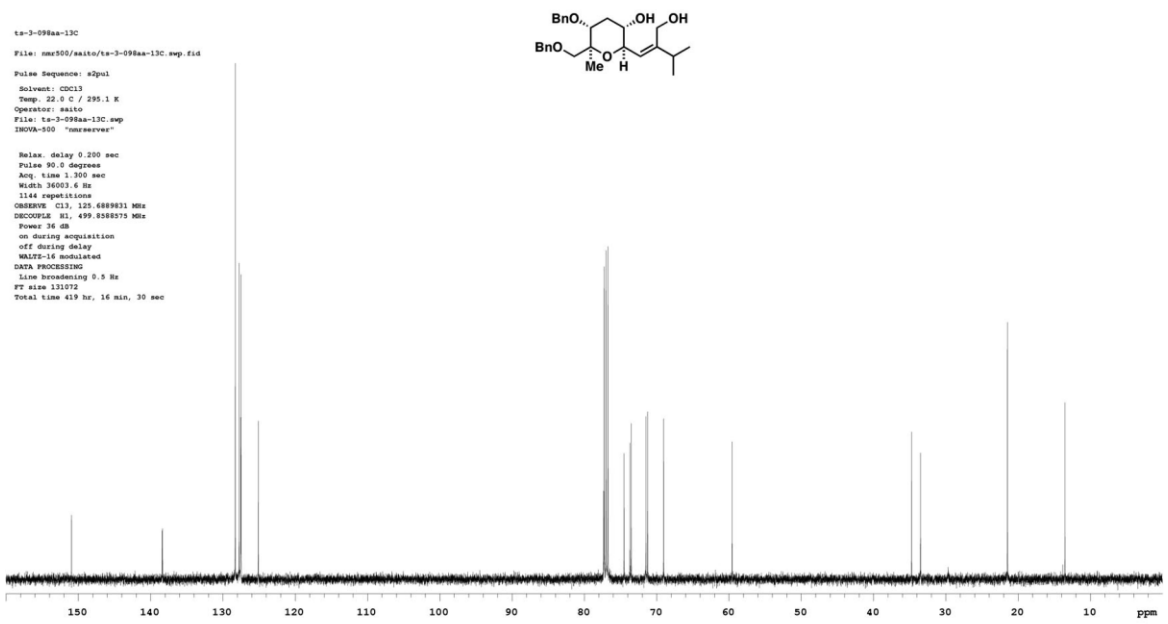
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-3-098aa.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563606 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 5 min, 0 sec
BnO
BnO
OH
OH
Me
H
7
6
5
4
3
2
1
ppm
10.60
1.00
2.94
0.96
1.94
0.95
1.00
0.93
1.00
1.06
2.15
1.44
3.38
5.42


BnO
OH
OH
BnO
Me
H
ts-3-098aa-13C
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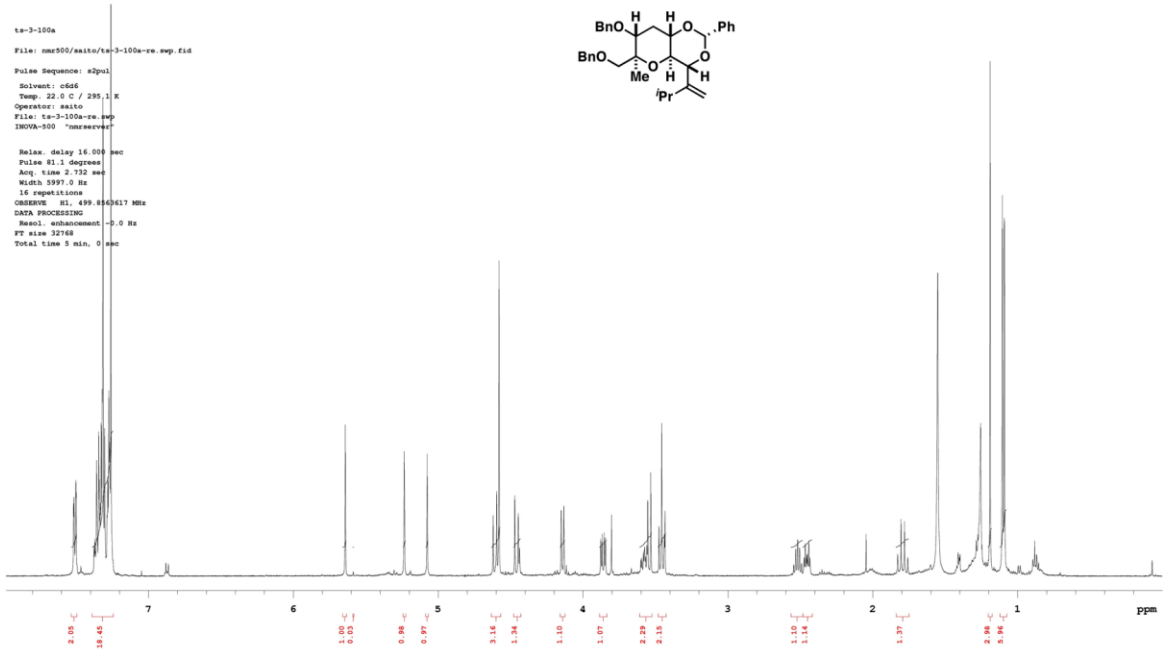
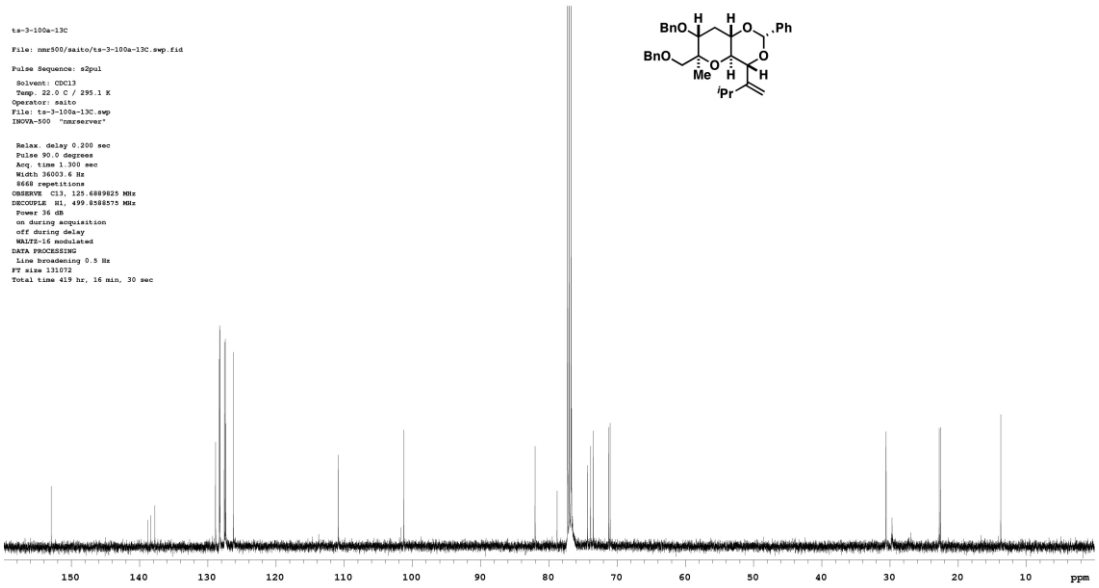
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-3-098aa-13C.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
1144 repetitions
OBSERVE C13, 125.6889831 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


BnO
H
H
O
Ph
BnO
O
O
Me
H
H
iPr
ts-3-100a
File: nmr500/saito/ts-3-100a-re.swp.fid
Pulse Sequence: s2pul
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-3-100a-re.swp
INOVA-500 "nmrserver"
Relax. delay 16.000 sec
Pulse 81.1 degrees
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563617 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 5 min, 0 sec
7
6
5
4
3
2
1
ppm
2.05
18.45
1.00
0.03
0.98
0.97
3.16
1.34
1.10
1.07
2.29
2.15
1.10
1.14
1.37
2.98
5.86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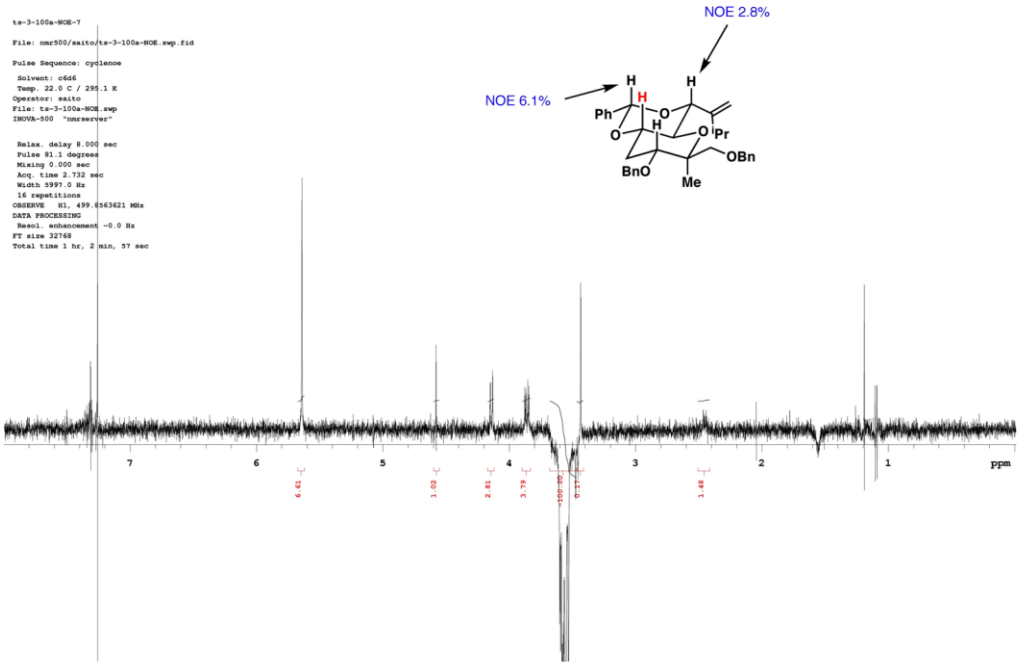
Pulse Sequence: s2pul
Solvent: CDCl3
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-3-100a-13C.swp
INOVA-500 "nmrserver"
Relax. delay 0.200 sec
Pulse 90.0 degrees
Acq. time 1.300 sec
Width 36003.6 Hz
8668 repetitions
OBSERVE C13, 125.6889825 MHz
DECOUPLE H1, 499.8588575 MHz
Power 36 dB
on during acquisition
off during delay
WALTZ-16 modulated
DATA PROCESSING
Line broadening 0.5 Hz
FT size 131072
Total time 419 hr, 16 min, 30 sec
BnO
H
H
O
Ph
BnO
O
O
Me
H
H
iPr
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm


ts-3-100a-NOE-7
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Pulse Sequence: cyclenoe
Solvent: c6d6
Temp. 22.0 C / 295.1 K
Operator: saito
File: ts-3-100a-NOE.swp
INOVA-500 "nmrserver"
Relax. delay 8.000 sec
Pulse 81.1 degrees
Mixing 0.000 sec
Acq. time 2.732 sec
Width 5997.0 Hz
16 repetitions
OBSERVE H1, 499.8563621 MHz
DATA PROCESSING
Resol. enhancement -0.0 Hz
FT size 32768
Total time 1 hr, 2 min, 57 sec
NOE 2.8%
NOE 6.1%
H
H
Ph
H
O
O
H
O
iPr
OBn
BnO
Me
7
6
5
4
3
2
1
ppm
6.61
1.02
2.61
3.79
100.00
0.77
1.48

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