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Frisky Dienes and Hot Electrophiles

Development of synthetic methods to access key structural features of tetrapetalone A

A dissertation submitted in partial satisfaction of the

requirements for the degree

Doctor of Philosophy in Chemistry

by

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December 2015

The dissertation of Marisa Gail Weaver is approved.

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Frisky Dienes & Hot Electrophiles

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1. Barloy, L.; Issenhuth, J-T.; Weaver, M. G.; Pannetier, N.; Sirlin, C.; Pfeffer, M. "Reaction of Chiral Secondary Amines with $[(\eta^5 - C_5Me_5)MCl_2]_2$ (M=Rh(III), Ir(III)): Cyclometalation with or without dehydrogenation." *Organometallics*, **2011**, *30*, 1168-1174.
2. Weaver, M. G.; Pettus, T. R. R. *Synthesis of para- and ortho-Quinones.* In *Comprehensive Organic Synthesis*; Molander, G.; Knochel, P.; Elsevier: Oxford, Vol. 7, Chapter 17, 2014, 373-410.

3. Weaver, M. G.; Bai, W.-J.; Jackson, S. K.; Pettus, T. R. R. "Diels-Alder Construction of *meta*-Amino Phenols." *Org. Lett.* **2014**, *16*, 1294-1297.

4. David, J. G.; Bai, W.-J.; Weaver, M. G.; Pettus, T. R. R. "A General Diastereoselective Catalytic Vinylogous Aldol Reaction Among Tetramic Acid Derivatives." *Org. Lett.* **2014**, *16*, 4384-4387.

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6. Weaver, M. G.; Gainer, M. J. *Multi-Step Synthesis of Nylon-6,6 from Cyclohexene.* In *Comprehensive Organic Chemistry Experiments for the Laboratory Classroom Book. accepted, in press*

7. Weaver, M. G.; Samoshin, A. V.; Lewis, R.; Gainer, M. J. *Organic Synthesis of a Pharmaceutical Target. J. Chem. Educ. submitted*

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1. "Frisky Dienes and Hot Electrophiles." Weaver, M. G. Final Thesis Defense. UCSB Department of Chemistry & Biochemistry. Santa Barbara, CA. *talk*, September 11, 2015.

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3. "Diels-Alder Construction of Isomeric *meta*-Amino Phenols: a tool for synthesis." Weaver, M. G. UCSB Department of Chemistry & Biochemistry Seminar Colloquium Series. Santa Barbara, CA. *invited speaker,* November 2012.

4. "Diels-Alder Construction of Privileged *meta*-Amino Phenols: a tool for total synthesis." Weaver, M. G. UCSB All Gaucho Reunion Alumni Weekend. Santa Barbara, CA. *invited speaker*, April 2012.
5. "Regioselective Synthesis of *meta*-Aminohydroxy Benzenes and Pyridines." Weaver, M. G.; Jackson, S. K.; Pettus, T. R. R. 2012 National ACS Conference. San Diego, CA. *talk*, March 2012.
6. "Regioselective Synthesis of *meta*-Aminohydroxy Benzenes and Pyridines." Weaver, M. G.; Jackson, S. K.; Pettus, T. R. R. 2011 ACS Western Regional Meeting. Pasadena, CA. *talk*, November 2011
7. "Preparation of Iridium & Ruthenium Cyclometallated Complexes for use as Catalysts." Weaver, M. G.; Barloy, L.; Pfeffer, M. SCCUR at CSU Dominguez Hills. Carson, CA. *talk*, November 2009.
8. "Cyclization of Acetals Using Gold Catalysis." Weaver, M. G.; Aponick, A.; Palmes, J. UF & Morehouse College/HHMI Celebration of Undergraduate Creativity in the Arts & Science. Gainesville, FL. *poster*, January 2009.
9. "Preparation of Iridium and Ruthenium Cyclometallated Complexes for use as Catalysts." Weaver, M. G.; Barloy, L.; Pfeffer, M. UF & Morehouse College/HHMI Celebration of Undergraduate Creativity in the Arts & Science. Gainesville, FL. *poster*, January 2010.
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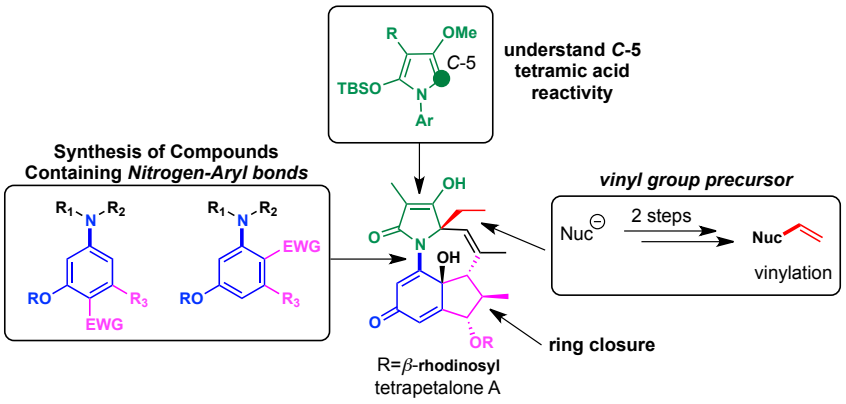
Abstract

Frisky Dienes and Hot Electrophiles

Development of synthetic methods to access key structural features of tetrapetalone A

by

Marisa Gail Weaver



The tetracyclic natural product, tetrapetalone A has eluded chemists since its isolation in 2002. The complex structural features of this natural product provide a platform from which new synthetic methods can be developed. One approach to build tetrapetalone includes formation of a Nitrogen-Aryl bond. Despite the prevalence of this bond connection in natural and pharmaceutical compounds, previous methods to form Nitrogen-Aryl bonds were not applicable in our approach to the tetrapetalone A scaffold. To overcome this limitation and provide a different route to access compounds containing Nitrogen-Aryl

bonds, we approached the problem with a different strategy. This divergent strategy relies upon distinct deprotonation conditions of a cyclic vinylogous amide to afford regioisomeric dienes. Each diene can then undergo a tandem Diels-Alder and *retro*-Diels-Alder sequence with a variety of acetylenic dienophiles to afford a range of *multi*-substituted aromatic products containing Nitrogen-Aryl bonds. The scope of this method and its application toward tetrapetalone A will be discussed. While investigating different synthetic approaches, our group also probed the reactivity of the tetramic acid *C*-5 position. When our group encountered limitations among the current methods to install vinyl groups at the *C*-5 position we turned to develop a more general vinylation strategy. Our progress toward a "vinylation reagent" is reported and future directions will be discussed.

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List of Abbreviations

α = alpha

β = beta

AcOH = acetic acid

AIBN = azoisobutyrylnitrile

aq = aqueous

Bn = benzyl

Bu_3SnH = tributyltin hydride

^{13}C = carbon 13

CA = conjugate addition

CBz = benzoyl chloroformate

$CDCl_3$ = deuterated chloroform

$CH_3C(O)OD$ = deuterated acetic acid

CH_3CN = acetonitrile

C_6D_6 = deuterated benzene

$CHCl_3$ = chloroform

CH_2Cl_2 = dichloromethane

CH_2N_2

CVA = cyclic vinylogous amide

d = doublet

DA = Diels-Alder

DIPEA = diisopropylethylamine

DMAD = dimethylacetylenedicarboxylate

dr = diastereomeric ratio

Et = ethyl

Et_3N = triethylamine

EtOAc = ethyl acetate

equiv = equivalents

g = gram(s)

h = hours

hν = light

^1H = proton

HCl = hydrochloric acid

H_2 = hydrogen gas

H_2O = water

H_2SO_4 = sulfuric acid

Hex = hexanes

HMPA = hexamethylphosphoramide

I_2 = iodine

IR = infra-red

KHMDS = potassium hexamethyl disilazide

KOH = potassium hydroxide

KO*t*-Bu = potassium *tert*-butoxide

(l) = liquid

m = multiplet

M = molarity

(M + Na) = molecular weight + sodium

m/z = mass/charge

MeI = methyl iodide

Me = methyl

$MgSO_4$ = magnesium sulfate

mL = milliliter

mmol = millimole

MS = molecular sieves

n-BuLi = *n*-butyllithium

Na = sodium

$NaHCO_3$ = sodium carbonate

$NaHSO_3$ = sodium bisulfite

Na_2SO_4 = sodium sulfate

NH_4Cl = ammonium chloride

NMR = nuclear magnetic resonance

o = ortho

p = para

Ph = phenyl

Ph_3SnH = triphenyltin hydride

ppm = parts per million

psi = pounds per square inch

q = quartet

R_f = retention factor

RBF = round bottom flask

r-DA = *retro*-Diels-Alder

rt = room temperature

s = singlet

sat'd = saturated

sec = secondary

Sm = samarium

SiO_2 = silicon dioxide

$SOCl_2$ = thionyl chloride

t = triplet

tet = tetrahedral

TBSCl = *tert*-butyldimethylsilyl chloride

THF = tetrahydrofuran

TLC = thin layer chromatography

TMSOTf = trimethylsilyl trifluoromethanesulfonate

wt = weight

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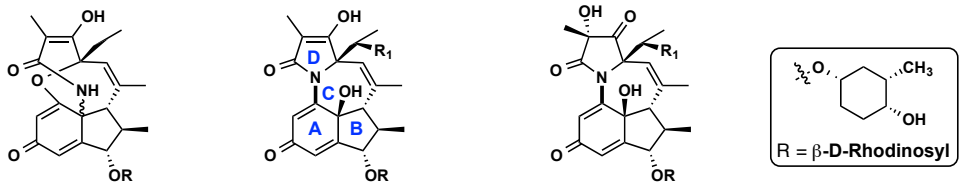
Chapter 1: The Tetrapetalones

1.1 Tetrapetalone A

Tetrapetalone A is a soybean lipoxygenase (SBL) inhibitor isolated from the culture filtrate of the *Streptomyces* sp. USF-4727 strain in 2002.[1] The natural product was initially assigned incorrectly. However, further NMR analysis using ^{1}H-^{15}N HMBC, NOE analysis and chemical derivatization techniques prompted structural reassignment to **1** in 2003 (see Figure 1).[2]

Figure 1: Structures of the Tetrapetalones

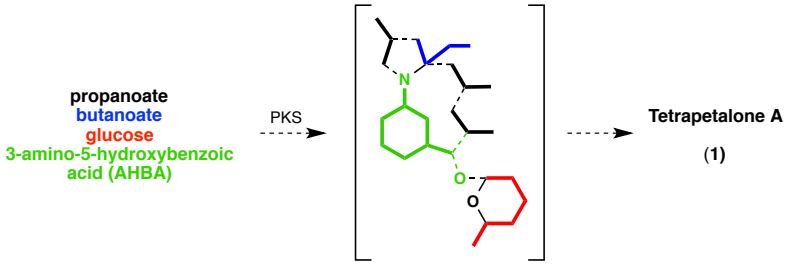


Tetrapetalone A (**1**) is in family of compounds that also includes tetrapetalones B (**2**), C (**3**), and D (**4**).[3] Tetrapetalone A is a biologically interesting synthetic target because it has shown inhibition against soybean lipoxygenase (IC_{50}=190-360 μM). Lipoxygenase inhibitors have been found to inhibit leukotrienes that are important for human allergy, asthma and arthritis treatments.[4] Lipoxygenase inhibitors may also play a role in the process by which human prostate cancer cells suffer apoptosis.[5] As a lipoxygenase inhibitor, tetrapetalone A has potential therapeutic applications in a variety of diseases.

The biosynthetic pathway of the tetrapetalones was studied using feeding experiments by Komoda *et al*.[6] The feeding experiments were conducted using isotope labeled [1-^{13}C] sodium propanoate, [1-^{13}C] sodium butanoate, [carbonyl-^{13}C] 3-amino-5-hydroxybenzoic acid hydrochloride, and [1-^{13}C] glucose. To identify where these fragments were incorporated, the ^{13}C isotope enrichment sites of the product were analyzed. Tetrapetalone A

(**1**) required three molecules of propanoate, one of butanoate, and one molecule of 3-amino-5-hydroxybenzoic acid to be constructed by polyketide synthase (PKS) (see Figure 2).

Figure 2: Biosynthetic Feeding Experiments



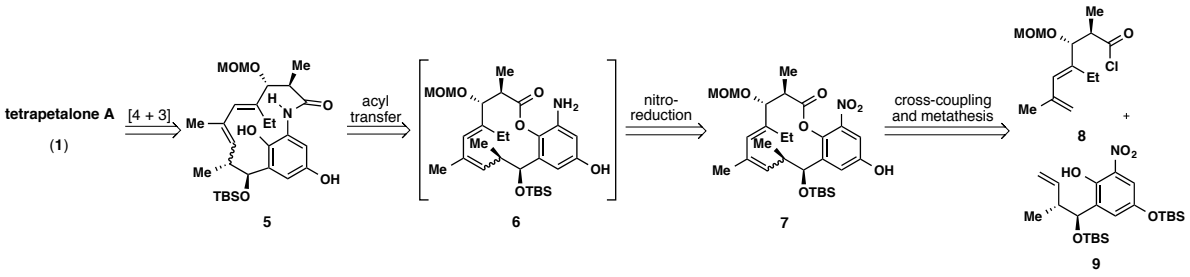
These feeding experiments also revealed the biosynthetic relationship of the tetrapetalone family. Tetrapetalone A (**1**) can be oxidized to form tetrapetalones B (**2**) or C (**3**), and tetrapetalone B (**2**) can be oxidized to form tetrapetalone D (**4**). Separate from the interesting biological activity of the tetrapetalones, their tetracyclic skeleton provides many opportunities to develop new synthetic methods. The unique architecture of the tetrapetalones has attracted the attention of many synthetic chemists since it was isolated.

1.2 Synthetic Attempts to Build Tetrapetalone A

Porco's Strategy

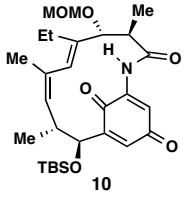
Shortly after tetrapetalone A was isolated, Porco attempted to synthesize the natural product using an approach that was inspired by the similarities that the tetrapetalones share with the ansamycin antibiotics.[7] Porco's synthetic approach aimed to build tetrapetalone A through a transannular [4 + 3] cyclization of **5** to form the B, C and D rings (see Scheme 1).

Scheme 1: Porco's Key Retrosynthetic Step



Porco's group aimed to intercept the macrocylce **5** for their key [4+3] transannular cyclization step. They envisioned that this intermediate could be reached by an acyl transfer in the *meta*-hydroxyaniline **6** which would be obtained by reduction of the aryl nitro group in compound **7**. Porco's group envisioned starting their synthesis to obtain compound **7** by the macrolactonization and metathesis of **8** and **9**. Their first characterization of the reaction product led them to believe that their desired cyclized product was formed. However, further investigation showed that the oxidative their group isolated was just the *para*-quinone **10** (see Figure 3).[8]

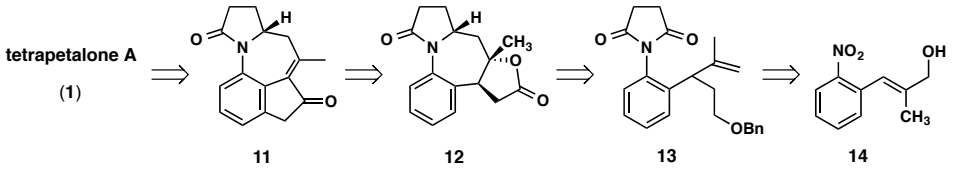
Figure 3: Porco's Corrected Product



Li's Strategy to Build Benzazepines

A method for preparation of the carbon skeleton of the tetrapetalones was developed in 2009.[9] Li et al. prepared the core benzazepine **11** starting from the nitro-styrene **15** (see Scheme 2).

Scheme 2: Synthesis of the Benzazepines

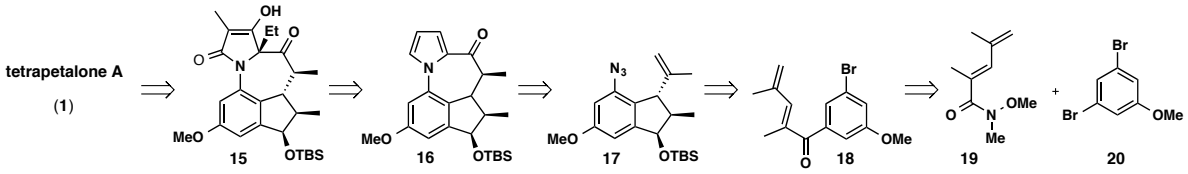


The B-ring of the tetracyclic core in compound **11** was obtained by addition of polyphosphoric acid to break the tethered γ-lactone in compound **12** and promote the electrophilic aromatic substitution of the acid tether with the aromatic ring. The tetracycle **12** was obtained from compound **13**. Compound **13** was obtained by addition of ethyl orthoacetate to compound **14** followed by a Claisen rearrangement and further elaboration of the nitro-group. Although this method provided the core tetracyclic carbon skeleton (**11**) of the tetrapetalones, it is missing some key components. This includes the fully elaborated electron-withdrawing tetramic acid D-ring and functional handles to elaborate into the quinol and to glycosylate the five-membered ring.

Sarpong's Strategy

Sarpong's synthetic route was focused around using a reductive pyrrole alkylation (see Scheme 3).[10]

Scheme 3: Sarpong's Retrosynthetic Strategy



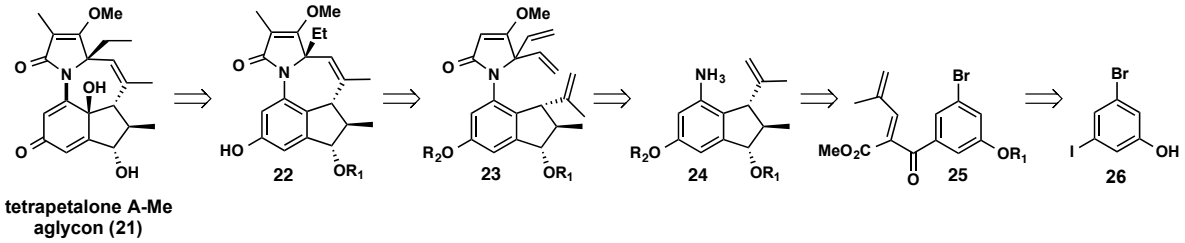
Sarpong envisioned the preparation of **15** by using a reductive alkylation to install the angular ethyl group from the acylated pyrrole **16**. Reduction and further derivatization of **17** would yield the pyrrole. Compound **17** would be prepared by Nazarov cyclization of **18**

followed by lithium-halogen exchange installed the corresponding azide. To begin, the *bis*-bromoanisole **20** and Weinreb amide **19** would be coupled using *n*-butyllithium to afford the dienone **18**. Although Sarpong obtained intermediate **15**, the group abandoned this synthetic route when they determined that their tetracycle **15** could not be further functionalized into the final natural product.

Frontier's Strategy

The tetrapetalones still have yet to be synthesized, but Frontier's strategy has been the closest published attempt and has provided good evidence to confirm the structure of the natural product.[11] Frontier's strategy affords the tetrapetalone A-Me aglycon (**21**) in less than 30 steps from 3-bromo-5-iodo-phenol (see Scheme 4).

Scheme 4: Frontier's Retrosynthetic Strategy



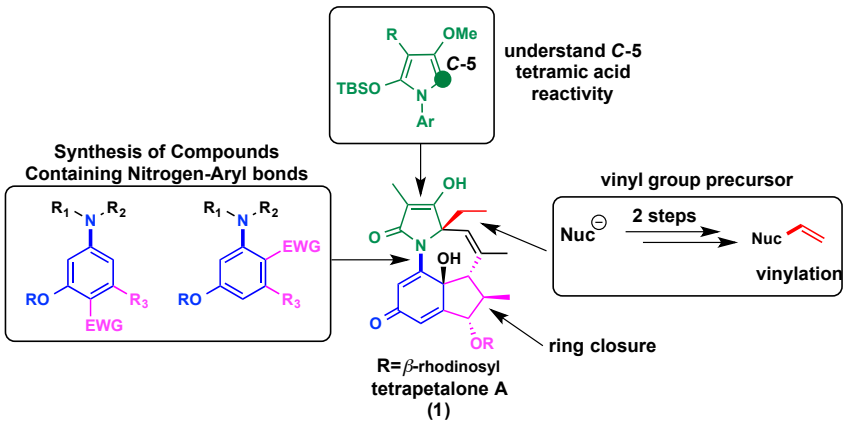
Frontier's strategy incorporates an oxidative dearomatization of intermediate **22**, which was obtained by a diastereoselective ring-closing metathesis of **23**. The tricycle **23** was obtained by elaboration of the aniline nitrogen in compound **24** into the *C*-3 tetramic acid. The nitrogen was incorporated into the core structure through a palladium-cross-coupling reaction of **25** with ammonia. Compound **24** was formed by a Nazarov cyclization, similar to the strategy used by Sarpong.[10] A Negishi cross-coupling reaction with the known phenol **26**, followed by a subsequent [3+2] reaction with an unsaturated nitrone afforded compound **25**. Despite the multitude of efforts and the thirteen years dedicated to synthesize the

tetrapetalones, none of the isolated members in the natural product family have been synthesized.

1.3 Difficulties Associated with Construction of Tetrapetalone A

With many incomplete syntheses over the past twelve years, our group knew that the synthesis of tetrapetalone A would be a challenge. Nevertheless, we decided to approach the target by breaking it into separate pieces. We envisioned developing the chemistry surrounding each of these pieces to understand the reactivity and gain insight to form the most effective strategy to build tetrapetalone A while developing new methods (see Figure 4).

Figure 4: Key Structural Features of Tetrapetalone A



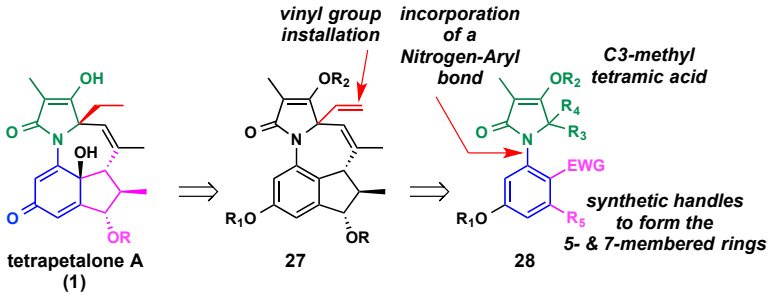
The first challenge would be to synthesize a compound containing the Nitrogen-Aryl bond. Our aim was to do this in such a fashion that would incorporate functional handles that could be used later to build the five- and seven-membered rings in the tetracycle. Due to the rare occurrence of the *C*-3 methyl tetramic acids, the second challenge was to construct a model tetramic acid moiety and then work towards understanding the chemistry surrounding this group. Lastly, previous attempts in our group to install an ethyl group at the *C*-5

position proved difficult with current methods. We envisioned developing a general and mild reagent to incorporate vinyl groups in a facile manner, that could be applied to install the ethyl group in the synthesis of tetrapetalone A.

1.4 Pettus' Retrosynthetic Analysis

In our approach to Tetrapetalone A, we envisioned synthesizing the natural product from the aromatized intermediate **27** (see Scheme 5).

Scheme 5: Pettus' Retrosynthetic Strategy



Intermediate **27** would contain the fully functionalized tetramic acid and be appended to an aromatic core containing the key nitrogen-aryl bond. To form this intermediate, we thought that functional handles could be incorporated onto the aromatic ring and the tetramic acid moiety in compound **28** that would allow for the elaboration into the five- and seven-membered rings of the natural product. In the final steps, we aimed to install a vinyl group using a mild method that could be reduced into the corresponding angular ethyl group on the route to the elusive tetrapetalone A (**1**).

Chapter 2: Nitrogen-Aryl Bond Construction

2.1 Nitrogen-Aryl Bonds in Natural and Synthetic Compounds

Compounds containing nitrogen-aryl bonds are prevalent in a variety of natural and synthetic products that have implications in helping treat disease or are currently being used as FDA-approved pharmaceuticals. Cardiovascular disease is responsible for 1 in 4 deaths that occur in the United States, so much of the spending on health care is directed toward treatment of this disease.[12] In 1996, health costs related to this disease totaled $157 billion dollars.[13] This amount had already doubled by 2008 to $301 billion dollars and is expected to continue to rise. A recent analysis by the Njardson group shows that 40% of the FDA-approved cardiovascular treatments contain nitrogen-aryl bonds.[14] A more commonly used drug containing a nitrogen-aryl bond is acetominophen, the active ingredient in Tylenol. Despite the prevalence of this bond connection in natural and synthetic pharmaceutical compounds, the current methods that exist do have weaknesses. The applications of known methods to the tetrapetalone A scaffold in our strategy are limited.

2.2 Weaknesses of the Nitrogen-aryl Bond Disconnection

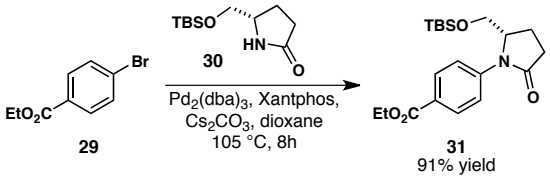
A common theme in the previous synthetic approaches to tetrepetalone A is that the nitrogen heteroatom has not been incorporated as the fully elaborated tetramic acid core moiety. Instead, the tetramic acid has been installed by incorporating a nitro-group that was further reduced, using an azide, or cross-coupling of an aryl halide with ammonia. The aniline cores were then elaborated to the *C*-3 methyl tetramic acid that is characteristic of the tetrapetalones. This post-functionalization approach adds steps and can make it difficult to elaborate intermediates to the final core concisely.

Even with the advances of the palladium-mediated cross-coupling reactions, specifically the Büchwald-Hartwig amination reaction, this approach is not general. When applied in

previous attempts to synthesize tetrapetalone by Frontier's group, many palladium-mediated cross-coupling approaches were tried, but resulted in dead-ends or failure.[15] In the literature, it is difficult to find examples of cross-coupling reactions between partners containing functional group tethers that could be elaborated to build tetrapetalone A. Results that were reported strongly suggested that a cross-coupling approach to form the nitrogen-aryl bond connection would be very limited.

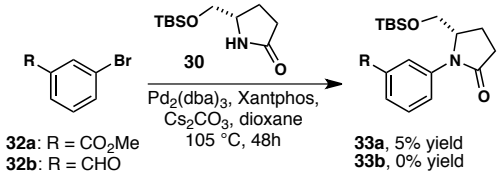
In the cross-coupling reaction between ethyl 4-bromobenzoate **29** and the pyrrolidinone **30**, the reaction affords the product was afforded in 91% yield in only 8 hours (see Scheme 6).[16]

Scheme 6: Büchwald-Hartwig Amination of 29



However, when the electron-withdrawing group on the aryl bromide is shifted to the *meta*-position, the cross-coupling reaction essentially does not proceed (see Scheme 7).

Scheme 7: Cross-Coupling Reaction with Aryl Bromide 32

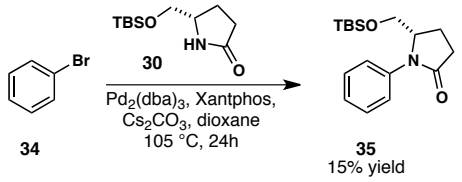


The reaction with the *meta*-substituted methyl ester **32a** proceeds to give the product **33a** in only 5% yield, and the *meta*-substituted aldehyde **32a** does not yield any of the expected product **33b**. These cross-coupling reactions were carried out under similar conditions and with the same lactam nucleophile (**30**) previously reported to work with the *para*-substituted

aryl halide (see Scheme 6). However, changing the substitution pattern of the electron-withdrawing group and moving it closer to the C-*X* bond severely thwarted the desired reaction.

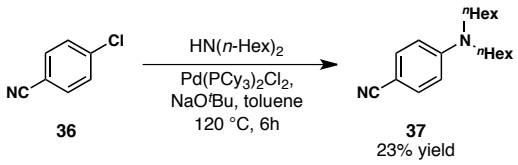
There are limited examples of the Büchwald-Hartwig cross-coupling reaction with an aromatic coupling partner containing any substitutents in the *ortho*- or *meta*- position relative to the C-*X* bond are severely limited. Many of these representative examples of this cross-coupling reaction type are extremely ineffective. With the same electron-deficient lactam nucleophile **30**, the cross-coupling reaction with bromobenzene **34** also failed to proceed satisfactorily and furnished the coupled product in only a 15% yield (see Scheme 8).

Scheme 8: Cross-Coupling of Bromobenzene with 30



If a more nucleophilic nitrogen coupling partner, like a secondary alkyl amine, is coupled with *para*-chlorobenzonitrile **36**, the reaction also fails to proceed efficiently and the product **35** is only formed in a 23% yield (see Scheme 9).[17]

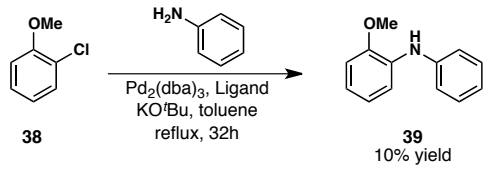
Scheme 9: Cross-Coupling of 36 with *di*-Hexyl Amine



The same poor conversion and inefficiency of this method is observed in cases where an electron-donating group is *ortho*- to the C-*X* bond. When coupling *ortho*-

methoxychlorobenzene **38** with aniline, the reaction only proceeds in 10% yield after 32 hours (see Scheme 10).[18]

Scheme 10: Cross-coupling of 38 with Aniline



Presumably, the inefficiency of this example is related to the C-Cl bond strength due to the resonant donation effect of the methoxy group.

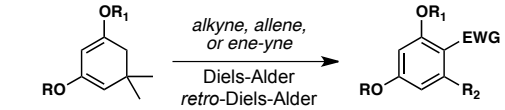
These examples demonstrate that current methods to couple aryl halides possessing electron-donating or electron-withdrawing substituents in the *ortho*- or *meta*- position with a nitrogen coupling partner are inefficient. Furthermore, the use of nitrogen coupling partners that are electron-deficient is ineffective. These examples show that attempting to construct the nitrogen-aryl bond in tetrapetalone A through a palladium-mediated cross-coupling approach with an elaborated tetramic acid nucleophile would likely be unsuccessful. Since our synthetic strategy required an intermediate containing a tetramic acid moiety appended to an elaborated aromatic ring, we were challenged to develop a different method. To overcome the limitation of the cross-coupling strategy, the work of Danishefsky and Reusch provided good inspiration.

2.3 Previous Work

Danishefsky had previously used dienes derived from 1,3-cyclohexadiones to study their reactivity and for their application in total syntheses.[19] These synthesized dienes were often substituted at R and R_1 with the same group to complete the *pseudo*-symmetric design

(diene **40** and **41**), but some have been used with differing R and R_1 groups (diene **42** and **43**) (see Scheme 11).

Scheme 11: Danishefsky's Application of 1,3-Cyclohexadione Derived Dienes



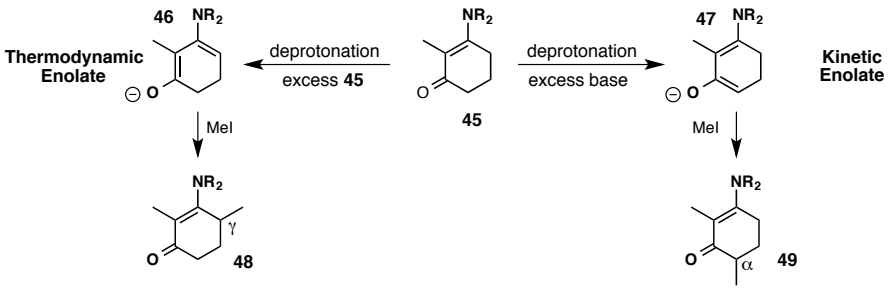
40: R = R_1 = OTMS
41: R = R_1 = OMe
42: R = OMe, R_1 = OAc
43: R = Me, R_1 = OTMS

44

Danishefsky showed that dienes of this nature were shown to undergo a tandem Diels-Alder and *retro*-Diels-Alder reaction to afford tetra-substituted aromatic materials represented by compound **44**. The substitutents of the dienophiles (-EWG and -R_2) could be outfitted in a variety of different ways to provide synthetic handles and allowed for elaboration of the aromatic intermediates into synthetic targets. The ability to form these dienes was rooted in deprotonation studies published decades ago.

In 1976, d'Angelo published a compilation of methods where ketone enolates with a variety of different substituents could be prepared regioselectively by differing deprotonation methods.[20] He highlighted the work by Reusch that demonstrated that the cyclic vinylogous amide (CVA) **45** could be selectively deprotonated to form either the thermodynamic enolate **46** or the kinetic enolate **47** (see Scheme 12).[21]

Scheme 12: Regioselective Deprotonation of CVA 45



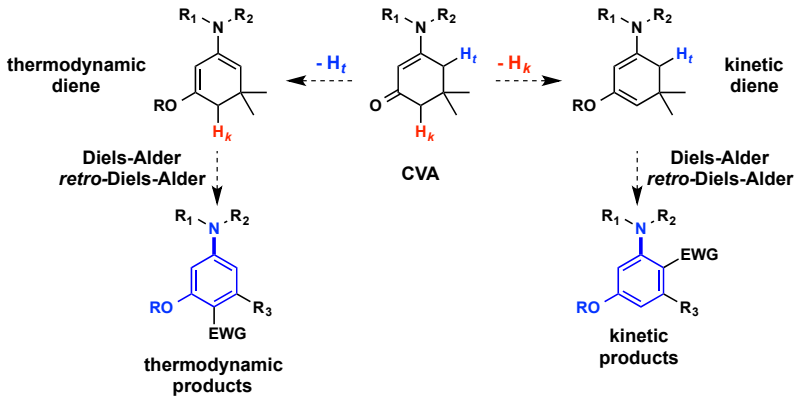
This work showed that in the presence of an excess of the CVA **45**, the thermodynamic enolate **46** (fully conjugated with oxygen) was formed and alkylated at the gamma-position to form **48** upon quenching with methyl iodide. In the presence of excess base, the kinetic enolate **47** (cross-conjugated with oxygen) formed and upon quenching with methyl iodide, the material was preferentially methylated at the alpha-site to yield compound **49**.

The work done by both Danishefsky and Reusch inspired us to develop a Diels-Alder method to form compounds containing a nitrogen-aryl bond from simple 1,3-cyclohexadione derived vinylogous amide starting materials. We envisioned that regioselective deprotonation events with the CVA would allow access to two classes of regiodifferentiated *tetra*-substituted aromatic products. This idea remained unexplored and had only been briefly been investigated by Carter.[22]

2.4 Nitrogen-Aryl Bond Construction Through a Diels-Alder Strategy

Our approach aimed to develop a divergent strategy that would rely upon distinct deprotonation conditions of a cyclic vinylogous amide and afford regioisomeric thermodynamic and kinetic dienes. We envisioned that each diene would then undergo a tandem Diels-Alder (DA) and *retro*-Diels-Alder (*r*-DA) sequence with a variety of acetylenic dienophiles to afford a range of *multi*-substituted regioisomeric aromatic products containing nitrogen-aryl bonds (see Figure 5).[23]

Figure 5: Diels-Alder Strategy to Construct Nitrogen-Aryl Bonds

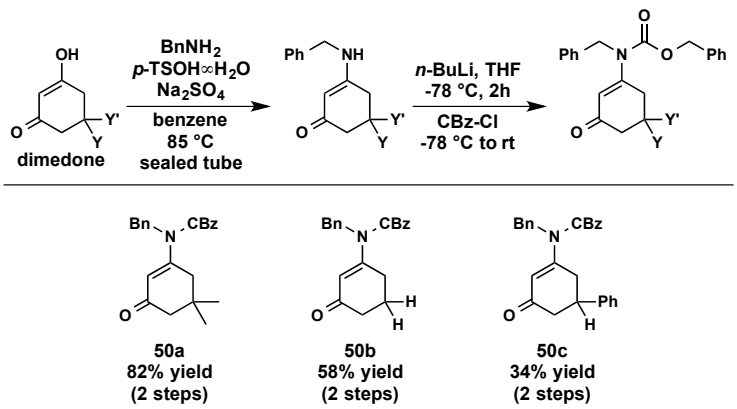


We envisioned that this method would not only allow us access to highly substituted compounds containing nitrogen-aryl bonds which are not generally accessible by current Büchwald-Hartwig amination reaction conditions, but would also allow access to the *meta*-amino phenol scaffold (highlighted in blue) present in a variety of natural and synthetic products. This includes products like the iron-binding siderophore pyoverdine,[24] the therapeutic treatment murrazoline[25] and anti-tumor agents such as geldanamycin.[26]

2.5 Synthesis of a Model CVA System

To develop and probe the scope of our method, the model core systems **50a-c** were synthesized starting from simple commercially available materials (see Scheme 13).

Scheme 13: Synthesis of Model CVA Systems 50a-c

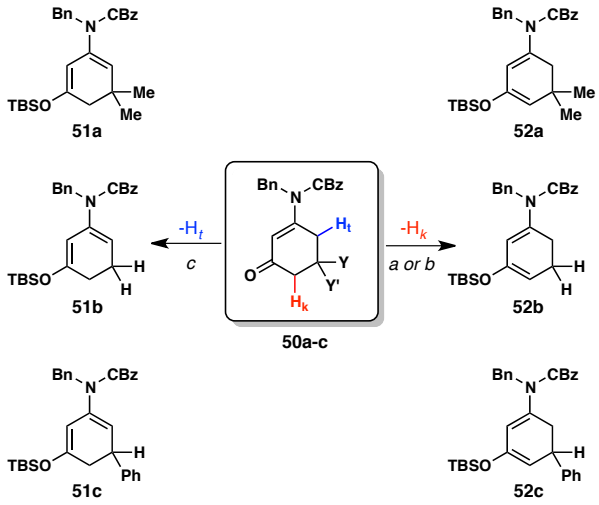


The commercially available and inexpensive 1,3-cyclohexadiones were used to prepare **50a-c** in a short two-step procedure. The acid-catalyzed condensation reaction with benzyl amine afforded an enamine that was deprotonated with *n*-butyllithium and added to benzyl chloroformate to furnish the model systems in good yields.

2.6 Regioselective Deprotonation of CVA Systems

The three model core systems were submitted to our two separate regioselective deprotonation events to yield the corresponding thermodynamic and kinetic dienes (see Table 1).

Table 1: Regioselective Deprotonation Event



Entry	CVA	Thermodynamic Diene (*k*)	Kinetic Diene (*t*)	Ratio *t*:*k*
1[a]	50a	51a	52a	>20:1
2[b]	50a	51a	52a	1:>10
3[a]	50b	51b	52b	>20:1
4[b]	50b	51b	52b	1:~4
5[a]	50c	51c	52c	>20:1
6[c]	50c	51c	52c	1:>10

[a] **50a** (1.3 equiv.) KHMDS (1.0 equiv.), THF (0.02M), 0 °C, 5h; TBSCl (1.1 equiv.). [b] KO^{t}Bu (1.5 equiv.), *n*BuLi (1.5 equiv.), - 78 °C, THF (0.02M), 20 min; **50a** (1.0 equiv.), 10 min; TBSCl (2.0 equiv.), - 78 °C to rt. [c] KHMDS (1.2 equiv.), THF (0.02M), - 78 °C, **50a** (1.0 equiv.), 10 min; TBSCl (1.4 equiv.), - 78 °C to rt.

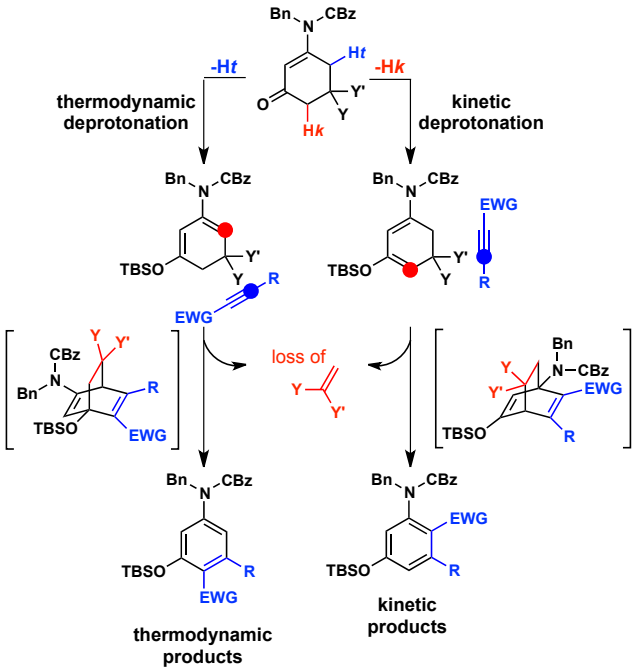
Each of the thermodynamic dienes was formed selectively by using an excess of the corresponding CVAs **50a-c** which allowed for equilibration and formation of the more stable thermodynamic enolate. Addition of *tert*-butydimethylsilylchloride (TBSCl) afforded each of the dienes **50a-c** in good yield as the only product.

Use of excess base to effect the deprotonation of **50a** and **50b** yielded both the kinetic dienes **52a** and **52b** almost exclusively after addition of TBSCl. In the case of **50c**, deprotonation with excess base yielded **52c**, but enriched by only 80%. After purification, each kinetic diene **52a-c**, contained a small amount of its corresponding thermodynamic diene **51a-c**, and was visible by NMR analysis. With these dienes in hand we proceeded to investigate their reactivity in our Diels-Alder and *retro*-Diels-Alder strategy.

2.7 Mechanism of the Diels-Alder and *retro*-Diels-Alder Reaction

The six dienes (**51a-c**) and (**52a-c**) were then subjected to our Diels-Alder and *retro*-Diels-Alder reaction conditions in the presence of an acetylenic dienophile. The general reaction pathway for both the thermodynamic and kinetic dienes is shown below (see Scheme 14).

Scheme 14: General Diels-Alder and *retro*-Diels-Alder Reaction Mechanism

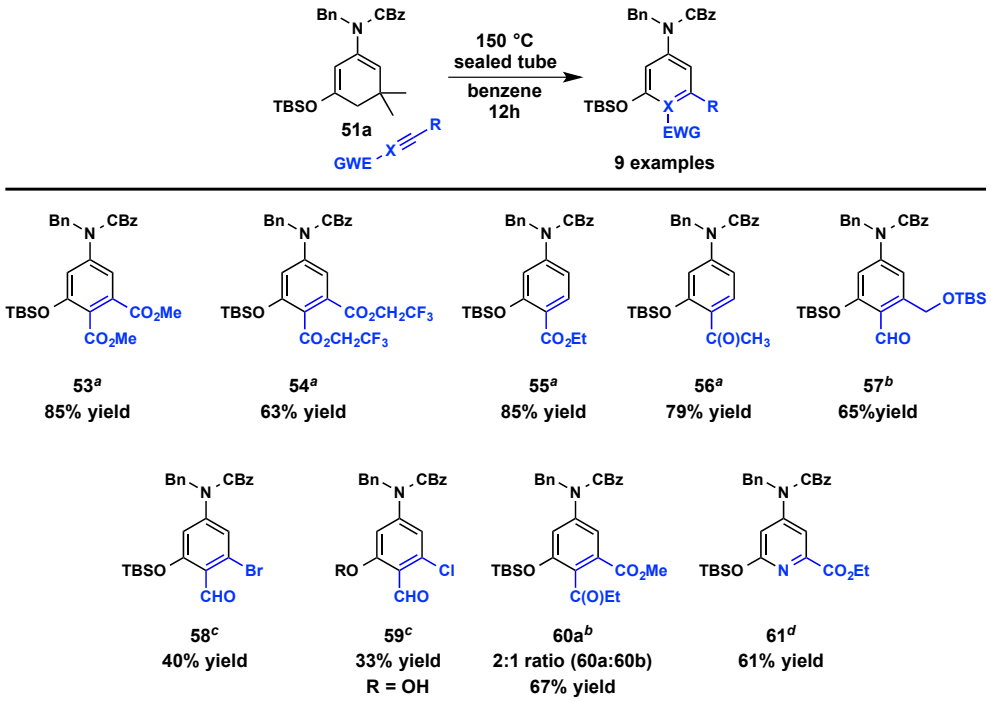


First, the acetylene and diene undergo the initial Diels-Alder cycloaddition reaction to form the bicyclo[2.2.2]octane intermediate. This bicyclic intermediate then proceeds through a *retro*-Diels-Alder reaction to expel isobutylene, ethylene or styrene (depending on Y and Y') to afford the regioisomeric *multi*-substituted aromatic products containing the nitrogen-aryl bond we sought to make. With these initial studies, we determined that core **50a** was the most convenient to use. The simple dimedone starting material was the most inexpensive and provided the best product yields. It should be noted that dienes derived from core **50c** allowed the Diels-Alder reaction temperature to be lowered from 150 °C to 100 °C, but this lowered temperature was not beneficial for our goals. With our model system chosen, we set out to determine the reaction scopes for our dienes.

2.7 Thermodynamic Diene Reaction Scope

Diene **51a** formed a variety of aromatic products **53-61** when subjected to the reaction conditions with a variety of differing acetylenes (see Scheme 15).

Scheme 15: Reaction Scope for Thermodynamic Diene 51a



53[a] 85% yield

54[a] 63% yield

55[a] 85% yield

56[a] 79% yield

57[b] 65%yield

58[c] 40% yield

59[c] 33% yield R = OH

60a[b] 2:1 ratio (60a:60b) 67% yield

61[d] 61% yield

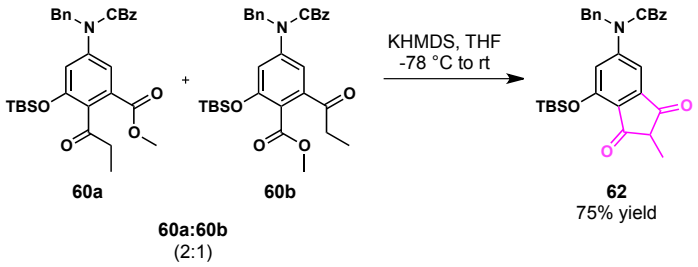
Dienophile Equivalents: [a] 2 equivalents. [b]4 equivalents. [c]Dienophile used crude without purification. [d]10 equivalents.

The reaction sequence with the thermodynamic diene occurred in good yield with acetylenic diesters (**53, 54**), terminal esters (**55**), a terminal ketone (**56**), and with an aldehyde (**57**). The yields were lower when more reactive acetylenes were used. This was the case when the halogenated propionaldehydes (**58, 59**), the acetylenic keto-ester (**60a**, major isomer) and ethyl cyanoformate (**61**) were used. Analysis of the crude spectra suggested that the lower reaction yields were a result of acetylene degradation.

The reaction of diene **51a** with the acetylenic keto-ester gave rise to a mixture of regioisomeric products **60a** (pictured) and **60b** (see Scheme 15). This mixture resulted because of the competing directing effects between the ketone and the ester on either side of the acetylenic dienophile. We envisioned that the ketone and ester groups added to the aromatic ring by the acetylene would serve as good tethers for further functionalization of the tetrapetalone target. We then submitted the product mixture (**60a** & **60b**) to basic

conditions in anticipation of closing the 5-membered ring in a convergent fashion (see Scheme 16).

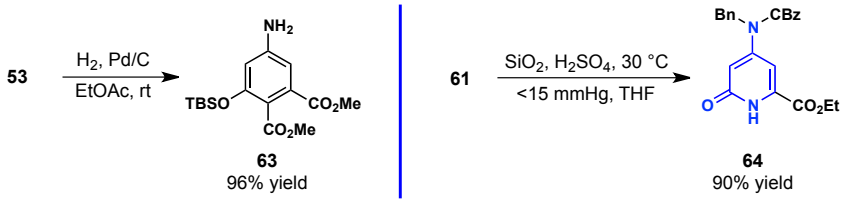
Scheme 16: Convergent Ring-Closure to Form 62



The ring-closed product **62** formed upon slow addition of the substrate mixture (**60a:60b**, 2:1) to KHMDS in THF at -78 °C. With the success of this convergent ring-closure, we anticipated that we could employ a similar strategy to access the fused 5-membered ring in the core of tetrapetalone A while installing ketone functional handles for further elaboration.

The products from the thermodynamic diene were further manipulated into other useful derivatives (see Scheme 17).

Scheme 17: Formation of Anilines and Pyridones



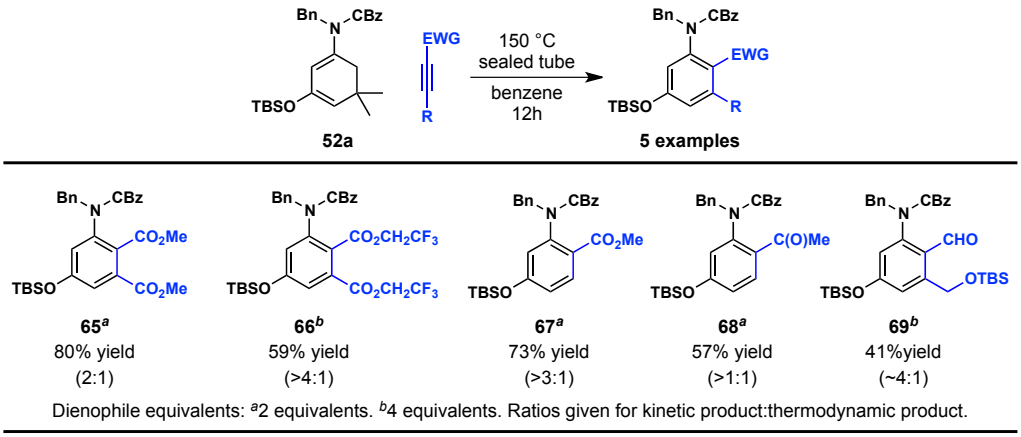
Hydrogenolysis of **53** led to *tetra*-substituted aniline **63** in excellent yield. Product **61** could also be tautomerized under acidic conditions to form pyridone **64**, which contains the carbon skeleton (highlighted in blue) of a patented migraine treatment.[27] These manipulations show that our synthetic strategy can be used to form pyridones and anilines in

good yield over 5 simple steps. This strategy offers an alternative to current preparative methods of elaborate nitrogen-aryl cores, such as Friedel-Crafts reactions that tend to have lower selectivity and the Büchwald-Hartwig amination that does not always work with congested aromatic halides.

2.8 Kinetic Diene Reaction Scope

Diene **52a** was submitted to the same reaction conditions with a variety of dienophiles and afforded the corresponding aromatic products (see Scheme 18).

Scheme 18: Reaction Scope for Diene 52a



Dienophile equivalents: [a]2 equivalents. [b]4 equivalents. Ratios given for kinetic product:thermodynamic product.

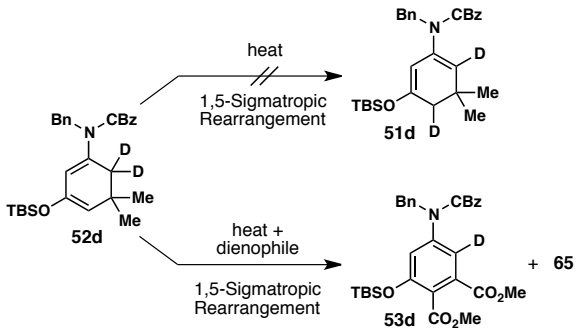
The reactions worked in moderate to good yields, however two products were identified. Further investigation revealed that the expected products **65-69** were formed in addition to the corresponding regioisomeric product resulting from reaction of diene **51a** with the respective acetylene. It became apparent that during the course of the Diels-Alder reaction a 1,5-sigmatropic rearrangement was occurring. The starting ratio of the dienes **52a**:**51a** was >10:1, but the product ratios were at best about 4:1.

Danishefsky never mentioned this rearrangement in his work likely because most of his 1,3-cyclohexadione derived dienes were *pseudo*-symmetric and do not undergo the rearrangement. The idea had largely been overlooked, and only once briefly mentioned by Burnell, using a diene derived from dimedone outfitted with an –OTMS and –OMe group.[28] He mentions that with heat they see conversion from their desired diene to its isomer, but he does not perform any further studies to investigate his speculations.

2.9 Unexpected 1,5-Sigmatropic Rearrangement

Due to the limited precedent, we decided to further investigate this phenomenon. Core **52a** was enriched with deuterium to 80% and deprotonated to form diene **52d** in a >10:1 ratio of **52d**:**51d**. When the kinetic diene **52d** was heated, an increase in the amount of the thermodynamic diene **51d** was not seen. However heating diene **52a** does give some rearranged diene over 3d. This was nowhere near the magnitude observed in our Diels-Alder reactions, so we have speculated that the dienophile facilitates the rearrangement, but have not investigated this idea further. When diene **52d** was heated in the presence of dimethyl acetylenedicarboxylate (DMAD), both products **53d** and **65** were observed in about a 2:1 ratio. This was consistent with what we observed under the same reaction conditions with diene **51a** (see Scheme 19).

Scheme 19: Deuteration Experiments

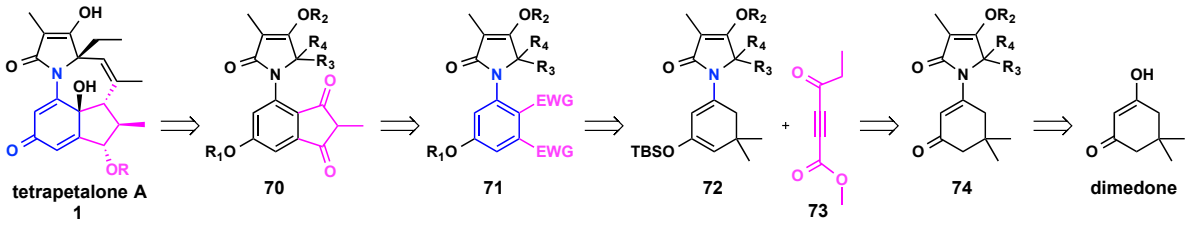


Our observations support the possibility that addition of the acetylene forms a charge transfer complex between the acetylene and the diene that facilitates the 1,5-sigmatropic rearrangement.[29] We anticipate that this 1,5-sigmatropic rearrangement occurs because the thermodynamic diene **51a** that is fully conjugated with oxygen is more stable than the kinetic diene counterpart **52a** that is cross-conjugated with oxygen. It should be noted that this same rearrangement was seen when dienes **52b** and **52c** were used for the Diels-Alder reaction, but no ratio improvements were observed.

2.10 Method Application Strategy for Tetrapetalone A

Our approach to tetrapetalone A began with the idea that the A ring probably could come from an aromatic intermediate like **70** (see Scheme 20).

Scheme 20: Pettus' Retrosynthesis of Tetrapetalone A



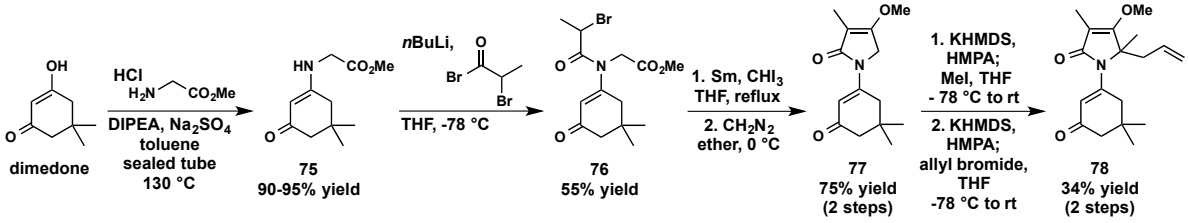
We envisioned the seven- and five-membered rings could be elaborated using the appended functional handles on **71**. We envisioned that these functional group tethers could be installed through our Diels-Alder and *retro*-Diels-Alder method by reaction of the

elaborate diene **72** with acetylene **73**. Using a similar strategy that was employed in our model system, we envisioned forming our tetramic acid CVA **74** from the commercially available dimedone.

2.11 Synthetic Application of our method to Tetrapetalone A

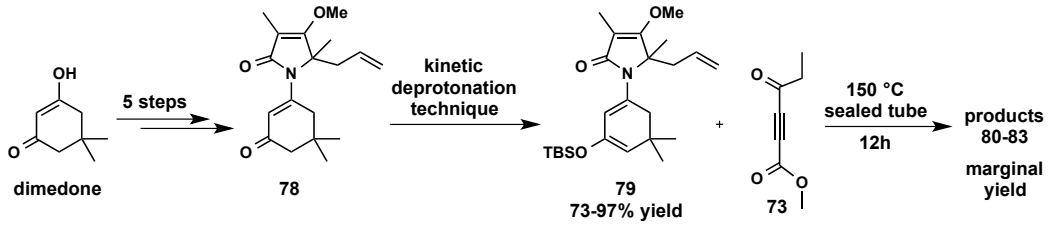
To begin the synthesis, glycine methyl ester hydrochloride was condensed with dimedone to form **75** in excellent yield. This intermediate compound was then subjected to deprotonation using *n*-butyllithium followed by addition of 3-bromopropionylbromide to afford **76** in moderate yield (see Scheme 21).

Scheme 21: Preparation of Synthetic Intermediate 78



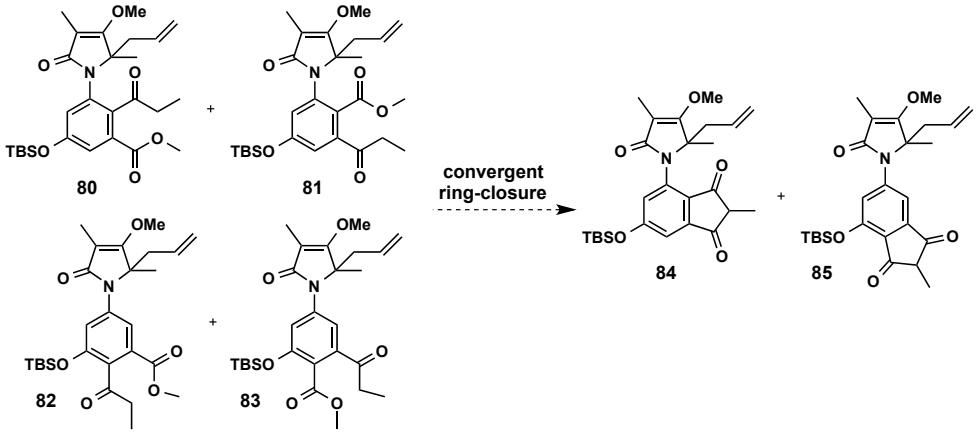
The acylated intermediate **76** was then subjected to a mild SmI_2-cyclization using a method recently developed in our laboratory to afford the *C*-3 methylated tetramic acid **77** in good yield after addition of diazomethane.[30] Deprotonation of **77** with KHMDS and addition of methyl iodide formed the *C*-5 methylated tetramic acid compound. This intermediate was again subjected to the same deprotonation conditions followed by addition of allyl bromide and afforded compound **78** in 13% yield over the 5 steps. With compound **78** in hand, we subjected it our recently developed deprotonation technique and obtained diene **79** in good to excellent yields (see Scheme 22).

Scheme 22: Kinetic Deprotonation and Diels-Alder Reaction of 78



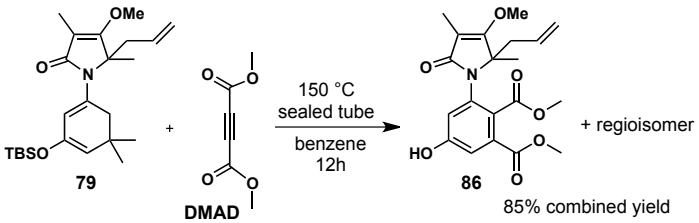
Unfortunately, the same 1,5-sigmatropic rearrangement that occurred in our model system occurred with our tetramic acid diene **79** and afforded a range of products (**80-83**) upon reaction with dienophile **73** (see Scheme 23).

Scheme 23: Attempted Convergent Ring-Closure of 80-83



However, we had envisioned that the mixture of isomers (**80-83**) could be submitted to basic conditions in a similar fashion to that we used successfully in our model system (see Scheme 16). Unfortunately, attempts to affect the same ring closure that we performed on our model system with this elaborate mixture of compounds proved unsuccessful. We turned to implement a simpler dienophile in hopes that with only two possible products, the products would be separable and isolated for use in further reactions (see Scheme 24).

Scheme 24: Reaction of Diene 79 with DMAD



We were pleased to find that submitting our elaborate diene **79** to our Diels-Alder reaction conditions with dimethylacetylenedicarboxylate (DMAD) furnished compound **86** and its regioisomer in a good combined yield. Upon separation of phenol **86**, we added a triisopropylsilyl protecting group to increase the molecular weight of the compound and attempted to further elaborate the methyl esters into the five-membered ring seen in tetrapetalone A.[31] Unfortunately, despite many attempts, the product was not formed.

2.12 Conclusion

Using a simple and inexpensive starting material, we demonstrated that our strategy to form compounds containing nitrogen-aryl bonds works well to form *meta*-amino phenols decorated with a variety of differing functional groups on an aromatic core. We encountered an unprecedented 1,5-sigmatropic rearrangement that hindered the use of this method for application to tetrapetalone A. However, we were able to demonstrate the tolerance of this method and synthesize an elaborate diene which allowed construction of two of the ring skeletons in the tetrapetalone A target.

Chapter 3: Progress Toward a Vinylation Reagent

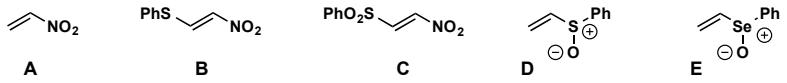
3.1 Another Piece of the Tetrapetalone A Puzzle

While investigating different synthetic approaches to tetrapetalone A, our group probed the reactivity of the tetramic acid *C*-5 position.[32] In our group's most recent synthetic approach, we aimed to install a vinyl group at the *C*-5 position so that it could used to install the ethyl group. However, when we encountered limitations among the current methods to install vinyl groups, we turned to develop a more general vinylation strategy. Our progress toward a "vinylation reagent" is reported and future directions will be discussed.

3.2 Common Vinyl Group Surrogates

One of the known methods to install a vinyl group is to add a nucleophile to one of the common electrophiles shown below and further manipulate the intermediate to obtain a vinylated product (see Figure 6).

Figure 6: Common Electrophiles Used to Incorporate Vinyl Groups

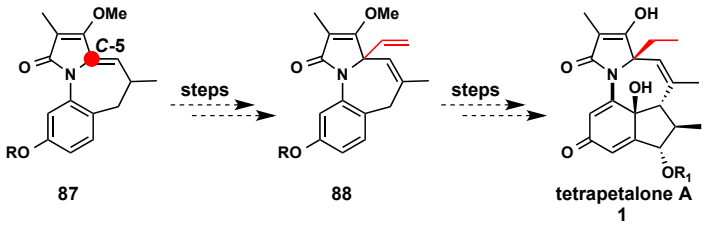


Nitroethylene (**A**) is one of these electrophiles, however it readily polymerizes and can only be stored as a 10% solution in dry benzene for about six months.[33] Conjugate addition of nucleophiles to both the sulfide (**B**) and sulfone (**C**) afford products that can undergo elimination in a similar fashion to afford alkenes.[34] The vinyl sulfoxide (**D**) is also a good electrophile and the conjugate addition product can undergo elimination in a similar fashion to the selenoxide elimination (**E**).[35] The selenoxide elimination is well known and used fairly often in synthesis.[36] However selenium is toxic and there is a high motivation to decrease the use of toxic materials as organic synthesis makes steps towards green chemistry.[37]

3.3 Pettus' Approach to Tetrapetalone A

In a different strategy to tetrapetalone A, the Pettus group synthesized the tricycle **87** and made many attempts to install a vinyl group to obtain intermediate **88** to be further elaborated into the ethyl group at the highlighted *C*-5 carbon (see Scheme 25).[38]

Scheme 25: Pettus Group Attempts to Install the Ethyl Group

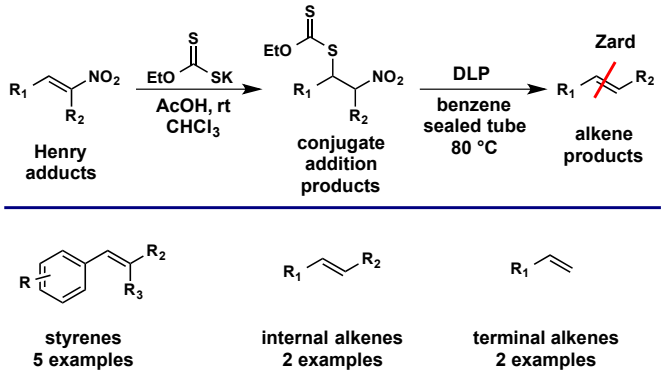


However, most of the traditional vinyl group surrogates failed to afford synthetically useful intermediates (see Figure 6). With our unproductive attempts using common methods, work by Zard provided a prospect for this approach for the natural product.

3.4 β-Nitro Xanthates to Form Alkenes

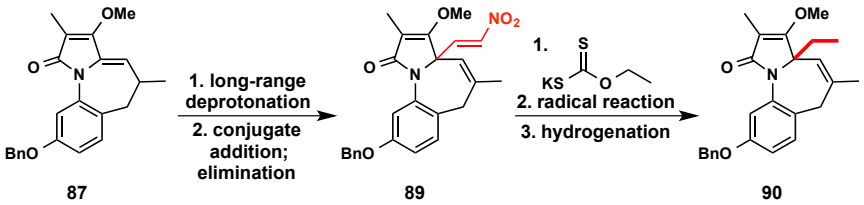
In 2003, the Zard group published their work using β-nitro xanthates as olefin precursors.[39] Zard showed that nitroolefin Henry adducts could undergo conjugate addition of potassium ethyl xanthogenate in acetic acid and chloroform (see Scheme 26).

Scheme 26: Zard's Approach to Construct Olefins



Submission of the conjugate addition products to heat with the radical initiator dilauroyl peroxide afforded the desired alkene products. Zard shows that his bond disconnection is useful to afford styrenes, internal alkenes and a few terminal alkenes. To test the viability of this strategy, our group installed a vinyl nitro substituent to the tetramic acid *C*-5 carbon of compound **87** (see Scheme 27).[38]

Scheme 27: Installation of the Tetrapetalone A Ethyl Group



Long-range deprotonation of **87** and addition of the triene to the sulfone (see Figure 6, **C**) furnished the vinyl nitro product **89** in 80% yield. With this adduct in hand, our group tested Zard's chemistry and found that the addition of potassium ethyl xanthogenate followed by the radical reaction with AIBN and Bu_3SnH furnished the vinylated product. Hydrogenation of the vinylated material using Wilkinson's catalyst afforded the desired compound **90** in good yield.

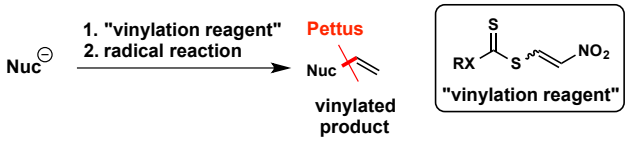
With the success of this mild reaction, we wanted to broaden the possible ways to implement this type of vinylation procedure to further its utility in synthesis.

3.5 Strategy to Develop a Vinylation Reagent

The aim of our strategy was to develop a "vinylation reagent." We envisioned a reagent in which a broad range of nucleophiles could be added to form a β-nitro xanthate conjugate addition product. Coupling our experience with Zard's precedent, we envisioned that these

addition products could then undergo radical reaction using dilauroyl peroxide or with the standard tin conditions to afford the corresponding vinylated products (see Scheme 28).

Scheme 28: Vinylation Reagent Goals

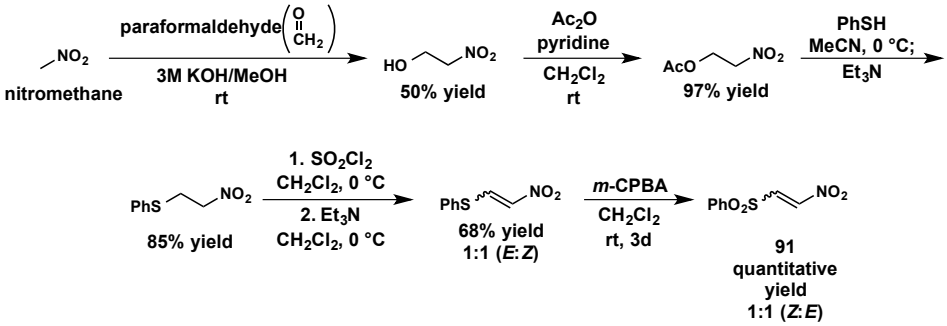


Our group had already demonstrated that we could make a bond disconnection distinct from Zard's in our application to tetrapetalone A (see Scheme 27), but our aim was to shorten the synthetic sequence and make it more general. We intended to do this by synthesizing a "vinylation reagent" that would allow a different synthetic bond disconnection (highlighted in red) to be made and afford vinylated products in only 2 steps using mild reaction conditions.

3.6 Sulfone Synthesis

We began the synthesis of our vinylation reagent by starting from the known phenylvinylnitrosulfone **91** (see Scheme 29).

Scheme 29: Sulfone Synthesis



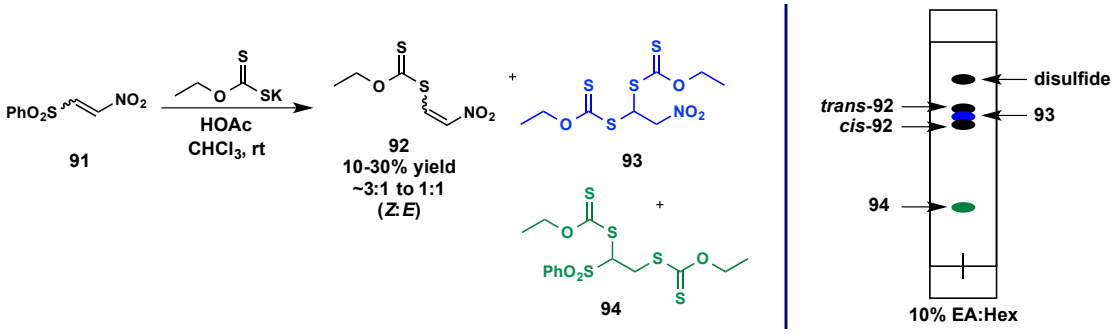
The known sulfone **91** could be readily synthesized from nitromethane in 5 steps and 25% overall yield.[40] With the sulfone in hand, we set out to try our planned conjugate

addition with potassium ethyl xanthogenate to invoke the elimination of phenyl sulfinic acid and obtain the first generation of our vinylation reagent.

3.7 Vinylation Reagent Synthesis

Potassium ethyl xanthogenate was added to the synthesized sulfone **91** to give a mixture of the *cis*- and *trans*-xanthate reagent **92** (see Scheme 30).

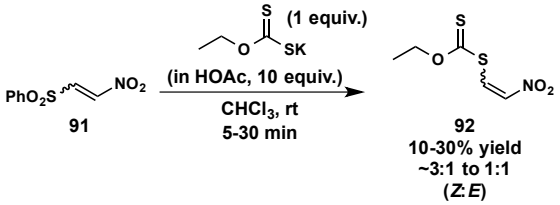
Scheme 30: Synthesis of the Xanthate Vinylation Reagent



Upon purification of the reaction mixture, we found that our desired reagent could be synthesized, but in only 10-30% yield and as a mixture of isomers. The alkene isomer products were inconsequential, but the yield was not acceptable for general use of this reagent. Characterization of the side-products revealed that the thioacetal **93** and the product **94** resulting from both the conjugate addition and nitro group substitution were also formed under the reaction conditions. After many attempts at purifying the side-products from the desired vinylation reagent isomers, the thioacetal product **93** could not be removed effectively. The thioacetal product was sandwiched between the *trans*- and *cis*-isomers of our desired reagent **92** which did not lend to simple purification. Despite efforts to use the thioacetal product **93** as a precursor to the desired product, all attempts were unsuccessful.[41] Fortunately, we were able to improve the results of the reaction and evade the formation of

93 and **94** by changing the order of addition, the equivalents of the reagents and the reaction time (see Scheme 31).

Scheme 31: Modified Reaction Conditions

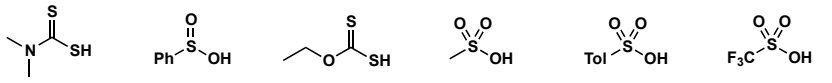


However, the low yields were persistent. To reason through these results, we turned to look at the pKa values of the conjugate acids in our addition and elimination reactions.

3.8 pKa Analysis

The pKa of the conjugate acid of the phenyl sulfinate leaving group is 2.5. The pKa of the conjugate acid of our xanthate nucleophile is lower than this and has been reported to be between 1.7 and 2.0 (see Figure 7).[42]

Figure 7: *pKa* values of Relevant Acids



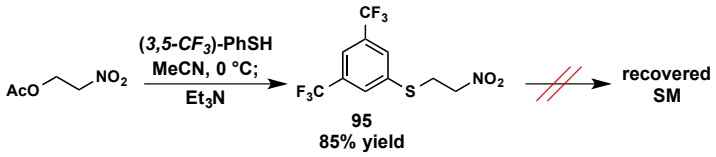
pKa (in H_2O)	**5.4**	**2.5**	**1.7-2.0**	**-2.6**	**-2.8**	**-14**

We attributed the low yield of our vinylation reagent to the unfavored reaction conditions that result from the higher pKa value of the conjugate acid of our leaving group compared to that of our xanthic acid nucleophile. With this notion in mind, we turned to determine another nucleophile or leaving group that would favor our desired reaction.

3.9 Synthetic Route Variation

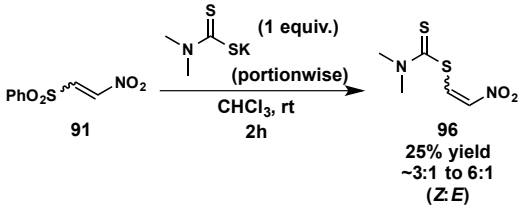
We attempted to decrease the pKa value of the sulfone leaving group by using *bis*-trifluoromethylthiophenol in our synthesis of the beta-nitrovinylsulfone. The synthesis began with the addition of *bis*-trifluoromethylthiophenol to the previously synthesized acetate which afforded the β-nitro substitution product **95** (see Scheme 32).

Scheme 32: Attempt to Decrease the *pKa* of Sulfone Leaving Group



Although the overall substitution reaction worked quite well, the chlorination and elimination reaction failed to afford the desired unsaturated product and returned starting material. We thought that we could continue to use the original sulfone **91** if the xanthate nucleophile had a higher pKa value compared to the conjugate acid of the sulfinate leaving group. We turned to use the dimethyldithiocarbamate salt as our nucleophile because the conjugate acid has a pKa value of 5.4 compared to the sulfinate leaving group at 2.5 (see Scheme 33).

Scheme 33: Synthesis of the Vinylation Reagent with Dimethyldithiocarbamate



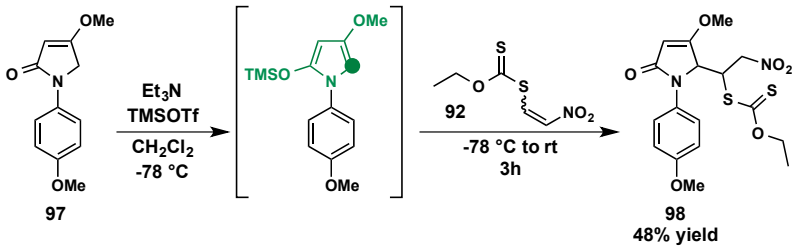
The synthesis of the dimethyldithiocarbamate vinylation reagent worked to afford the product in only 25% yield, but was a more reliable reaction than that with the ethyl

xanthogenate derivative (see Scheme 30). The main advantages were that the corresponding thioacetal and nitro-substitution product were more polar and could therefore be separated quite easily if they formed. However, the two undesired by-products formed when the equivalents of the xanthate salt were high or the reaction was allowed to run longer than two hours. Acetic acid was not used because it did not have consequences on the reaction as it did in the reaction with the ethyl xanthogenate. With two different vinylation reagents in hand, the conjugate addition reactions were attempted with different nucleophiles.

3.10 Conjugate Addition to the Vinylation Reagent

The effectiveness of the reagent was first tested with a model system we had used to probe the reactivity of the tetramic acid *C*-5 carbon.[43] Upon deprotonation of the tetramic acid and addition of the electrophile, the reaction proceeded to afford compound **98** (see Scheme 34).

Scheme 34: Conjugate Addition of Tetramic Acid to the Vinylation Reagent

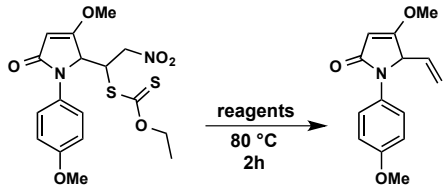


Although the reaction proceeded to give our desired product **98**, the yield remained quite low at only 48%. Despite the marginal yield, we proceeded to test the radical reaction on our isolated intermediate.

3.11 Radical Reaction to Install a Vinyl Group

The radical reaction of the conjugate addition product **98** proceeds much smoother and afforded the vinylated product **99** (see Scheme 35).

Scheme 35: Radical Reaction to Affect the Vinylation



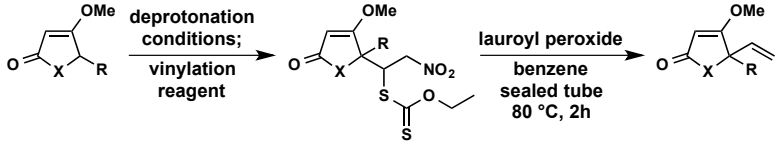
98 **99**

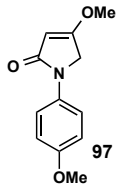
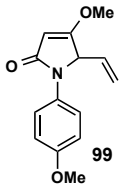
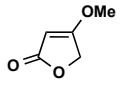
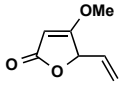
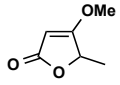
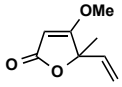
The radical reaction was attempted with dilauroyl peroxide and the conventional AIBN/Bu_3SnH and AIBN/Ph_3SnH. All of the reactions furnished the vinylated product in similar high yields, so we chose to proceed with the most benign dilauroyl peroxide reagent.

3.12 Substrate Scope

The conjugate addition reaction and radical reaction worked not only with the tetramic acid core **97**, but also with the tetronic acids **100** and **102** (see Table 2).

Table 2: Vinylation Reagent Reaction Scope

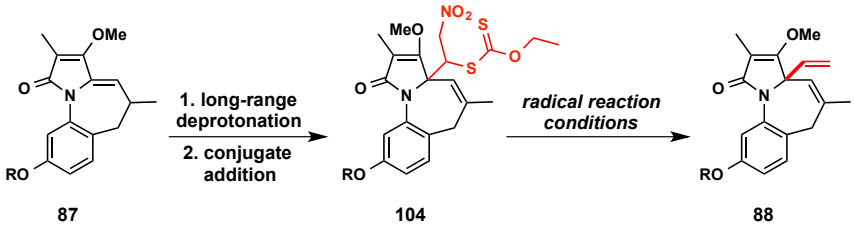


Entry	Nucelophile	Deprotonation Conditions	Product	Yield (2 steps)
1	 97	Et_3N, TMSOTf, CH_2Cl_2, -78 °C to rt 3h	 99	27% yield
2	 100	*n*BuLi, THF, -78 °C to rt, 3h	 101	43% yield
3	 102	*n*BuLi, THF, -78 °C to rt, 3h	 103	38% yield

All of the conjugate addition reactions yielded products in marginal yields of about 50%, however, the yields of the radical reactions were nearly quantitative. The tetramic acid **97** was subjected to the conjugate addition and radical reaction conditions and afforded the vinylated product **99** in nearly 30% over the 2 steps (Entry 1). The conjugate addition reaction with the tetronate **100** followed by the radical reaction furnished the vinylated product **101** in 43% yield over the 2 steps (Entry 2). Finally, in the reaction with the *C*-3 methyl tetronic acid **102**, the vinylated product **103** was obtained in a lower yield of 38% over the 2 steps (Entry 3), presumably due to the *tetra*-substituted center. Although our conjugate additions had low yields, Zard observed similar low yields with his conjugate additions of the ethyl xanthogenate salt.[39] With this reagent in hand, we set out to demonstrate that the reagent could be used in a more complex system to decrease the

number of synthetic steps required for our synthetic approach to tetrapetalone A (see Scheme 36).

Scheme 36: Demonstration of Vinylation Reagent Feasibility for Tetrapetalone A

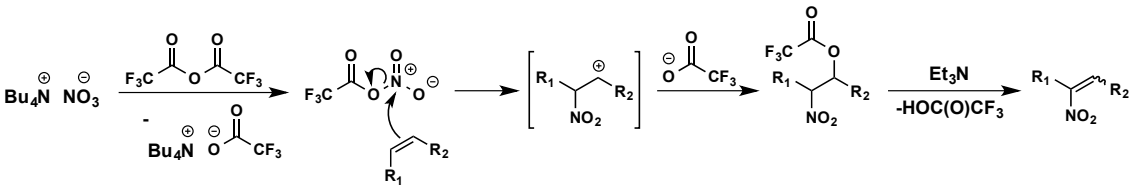


Although we were able to synthesize a "vinylation reagent," the synthesis was tedious so we began investigations into another reasonable route to prepare the vinylation reagent.

3.13 Alkene Nitration Methods

Upon searching the literature, many methods for nitration of alkenes were found. These methods usually furnished the product by either a cationic mechanism[44] or a radical mechanism.[45] The nitration processes that occurred by a cationic mechanism were most promising since we hoped our reagent would react under radical conditions (see Scheme 37).[44]

Scheme 37: Proposed Cationic Mechanism of Nitroolefin Formation

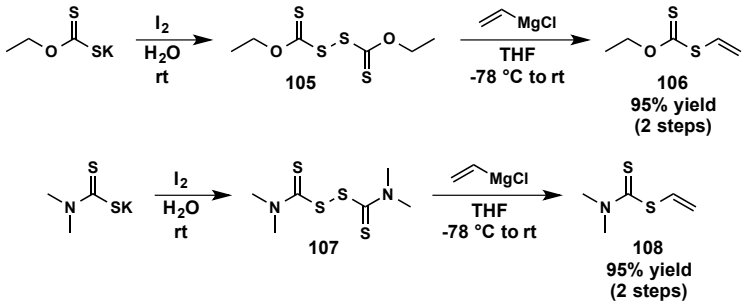


With this promising approach, we began investigation into another synthetic route to prepare the promising vinylation reagent.

3.14 Vinyl Xanthate Synthesis and Nitration Attempts

In order to use the reported nitration methods, we began with the synthesis of the known disulfides **105** and **107** by oxidation with iodine.[46] Subsequent addition of vinyl grignard to each intermediate afforded the corresponding vinyl xanthates **106** and **108** in excellent yields over the 2 steps (see Scheme 38).[47]

Scheme 38: Synthesis of vinyl xanthates 106 and 108



However, attempts to add the nitro group to the vinyl functional group using both the previously reported cationic and radical protocols were unsuccessful.

3.15 Conclusions and Future Work

Despite having some successes that proved our concept of a vinylation reagent, the synthesis was tedious and we were unable to find a route that furnished the reagent in scalable quantities. Moreover, although we found that our vinylation protocol could be used with both tetramic acid and tetronic acid nucleophiles, other nucleophiles proved difficult and proper conditions to vinylate other substrates were not established. If a more general route can be established to synthesize the xanthate vinylation reagent, then more conditions can be screened and the nucleophile scope may be broadened. However, it is also worth investigating other reagents that would be able to function in a similar fashion. These would

include any compounds that could be removed through a gentle radical process and may include compounds containing stannanes or Barton esters.

Experimental Section

General Techniques

In reactions, where water was *not* present as solvent, reagent, or as a by-product, vessels were flame-dried under a slow nitrogen flow. A slight positive pressure of dry nitrogen was maintained via rubber septa seal during the course of the reaction. The nitrogen stream originated from a regulated high pressure 55 L $N_{2(l)}$ tank and was further dried by passage through a tube filled with Drierite®. Reagents were purified according to the procedures describe in the *Perrin & Perrin* laboratory manual.

Reactions were monitored by analytical thin-layer chromatography on EM-Science hard layer silica gel-60F-250 plates cut into 1 x 2.5 cm pieces. Visualization was effected by ultraviolet light (254 nm), followed by staining [Seebach or permanganate] the plate and drying with a heat gun. The Seebach stain was made with 2.5 g of phosphomolybdic acid, 1.0 g of cerium sulfate, 6 mL H_2SO_4, and 94 mL of H_2O. The potassium permanganate stain was made with 198 mL H_2O, 1.5 g $KMnO_4$, 10.0 g of K_2CO_3, and 2 mL of 10% NaOH.

All reactions were stirred with Teflon®-coated magnetic stir bars by *Thomas*® Magne- Matic magnetic stirrers. Removal of solvents was typically accomplished using a *Buchi*® rotary evaporator (model #R-114) connected to a Fisher KNF®-vacuum pump (model #UN820-3). The condenser was cooled to -2 °C by a Fisher® chiller circulator bath (model #1013S). If the product was non-volatile, trace solvents were removed using a *Labconco*® freeze dryer system at a pressure of approximately 0.01 mmHg. Ethyl acetate (anhydrous) and hexanes were utilized directly from the bottle. Deuterated chloroform was filtered through basic alumina prior to use. Solvents were distilled

before use, under a slight positive pressure of nitrogen. Diethyl ether, tetrahydrofuran, benzene, and toluene were distilled from sodium and benzophenone. Dichloromethane was distilled from CaH_2. Chloroform was filtered through alumina before being fractionally distilled. For distillation, a specific low pressure (760 – 1 mm Hg) was obtained and monitored with a *Buchi*®-vacuum controller (model #B-721) in combination with a *Welch*® direct drive pump (model #8915A). Lower pressures were achieved using a vacuum manifold connected to an oil- diffusion pump and backed by a *Welch*® direct drive vacuum pump, (model #8910A).

^{1}H-NMR spectra were recorded at 400 MHz, 500 MHz or AS600 600 MHz on a *Varian*® Unity Inova spectrometer. Select spectra were recorded at 800 MHz on a Bruker Avance III Ultrashield Plus spectrometer. Chemical shifts are reported in ppm after referencing the solvent resonance of $CDCl_3$ (7.26 ppm) or benzene (7.16 ppm). ^{13}C NMR spectra were recorded at 600 MHz with a solvent resonance of $CDCl_3$ (77.16 ppm) or benzene (128.06 ppm). NMR spectra were evaluated using iNMR, MaestraNova or VNMR-J.

Infrared spectra were recorded on a *Shimadzu*® FTIR-8300 Fourier transform infrared spectrometer neat. Infrared frequencies are reported in reciprocal centimeters (cm^{-1}). UV-Vis spectra were recorded using a Beckman DU- 640 UV-Vis spectrophotometer.

Accurate mass measurement data (i.e. HRMS) were obtained on an electrospray ionization/time-of-flight mass spectrometer.

Diels-Alder reactions were set-up in one of two ways. ACE sealed tubes were used with a nitrogen blanket over the reaction vessel and sealed using a teflon threaded cap with

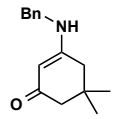
an O-ring. Alternatively, reaction vials lined with teflon tape on the threads and sealed with a cap lined with a teflon liner insert were used for smaller volumes. The reaction vessel was chosen so that the reaction volume was a minimum of half the total vessel volume.

Commercial acetylenes were used out of the bottle if they were purchased recently. If they were used after being stored for a prolonged period of time, they were purified by Kügelröhr distillation, then used. Prepared acetylenes were purified or used crude as noted within their methods of preparation.

Experimental Procedures

Preparation of CVAs (modification and expansion of known methods)[48]

Procedure 1: Compound **50a precursor**

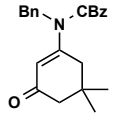


50a precursor

Dimedone (5.0 g, 35.7 mmol, 1.00 equiv.), $BnNH_2$ (3.9 mL, 35.7 mmol, 1.0 equiv.), *p*-$TsOH•H_2O$ (679 mg, 3.57 mmol, 10%), Na_2SO_4 (10.14 g, 71.4 mmol, 2 equiv.) and benzene (30 mL, 1.2 M dimedone) were added to a sealed tube. The mixture was heated at 85 °C overnight. The solution was then concentrated and diluted with CH_2Cl_2, washed 3x with sat'd $NaHCO_3$ and 1x with brine. The organic layer was dried over Na_2SO_4, filtered and concentrated in vacuo to yield **50a precursor** (quant.). The solid product was recrystallized in benzene to afford known compound **50a precursor** as bright yellow crystals (86% yield). This procedure also works by refluxing the reaction instead of using the sealed tube set-up.

^1H NMR (400 MHz, $CDCl_3$): δ 7.38-7.25 (m, 5H), 5.24 (br s, 1H), 4.83 (br s, 1H), 4.27 (d, J = 5.20 Hz, 2H), 2.32 (s, 2H) 2.21 (s, 2H), 1.08 (s, 6H).

Procedure 2: Compound **50a**

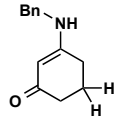


50a

Ene-amine **50a precursor** (796 mg, 3.47 mmol, 1.0 equiv.) was azeotroped 3x in toluene, then diluted in THF (22 mL, 0.16 M **50a precursor**) and put over 4Å MS. This solution was cannulated into a 100 mL flame-dried RBF. The solution was cooled to -78 °C and *n*-BuLi (1.08 mL, 3.17 M, 3.42 mmol, 1.0 equiv.) was added slowly to form a deep-red solution. This solution was stirred for 2h at -78 °C, then benzyl chloroformate (694 μL, 1.4 equiv.) was added neat. The reaction vessel was allowed to warm to rt overnight. The reaction was quenched with sat'd $NaHCO_3$ and extracted using EtOAc. The organic layer was washed with brine, dried using Na_2SO_4, filtered and concentrated in vacuo. The crude yellow oil was purified using column chromatography (SiO_2, eluent: hexanes to 20% ethyl acetate, 80% hexanes) to yield **50a** (1.082 g, 86%) as a light yellow oil. Recrystallization from benzene gives a very light yellow or white crystalline solid.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.33-7.13 (m, 10H), 5.75 (s, 1H), 5.20 (s, 2H), 4.87 (s, 2H), 2.58 (s, 2H), 2.17 (s, 2H), 0.94 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 199.65, 160.49, 154.18, 136.78, 135.38, 128.88, 128.74, 128.65, 128.50, 127.64, 126.69, 116.86, 68.68, 52.89, 50.66, 44.25, 34.11, 28.08.; HRMS (ESI/TOF) *m/z* calculated for $C_{23}H_{25}NO_3Na$: $[M + Na]^+$ 386.1722; found 386.1732.; IR (neat) cm^{-1}: 2956, 1721, 1712, 1660, 1652, 1455, 1393, 1367, 1359, 1300, 1209, 1126, 1025, 873, 734, 698.; R_f=0.20 (20% ethyl acetate, 80% hexanes).

Procedure 3: Compound **50b precursor**

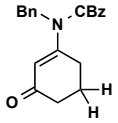


50b precursor

1,3-Cyclohexanedione (200 mg, 1.78 mmol, 1.00 equiv.), $BnNH_2$ (195 µL, 1.78 mmol, 1.0 equiv.), *p*-TsOH•H_2O (34 mg, 0.178 mmol, 10%), Na_2SO_4 (506 mg, 3.56 mmol, 2 equiv.) and benzene (1.5 mL, 1.2 M dione) were added to a sealed tube. The mixture was heated at 85 °C overnight. The solution was then concentrated and diluted with EtOAc, washed 3x with sat'd $NaHCO_3$ and 1x with brine. The organic layer was dried over Na_2SO_4, filtered and concentrated in vacuo to yield known compound **50b precursor** (165 mg, 46%) as a brown oil which was used crude. This procedure also works by refluxing the reaction as opposed to using the sealed tube set-up.

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.38-7.26 (m, 5H), 5.21 (s, 1H), 4.65 (br s, 1H), 4.23 (d, *J* = 5.25 Hz, 2H), 2.34-2.32 (m, 4H), 1.99 (t, *J* = 6.3, 2H).

Procedure 4: Compound **50b**



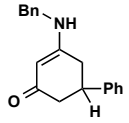
50b

Ene-amine **50b precursor** (160 mg, .795 mmol, 1.0 equiv.) was azeotroped 3x in toluene, then diluted in THF (10 mL, 0.16 M **50b precursor**) and put over 4Å MS. This solution was cannulated into a 50 mL flame-dried RBF. The solution was cooled to -78 °C and *n*-BuLi (0.374 mL, 2.55 M, .954 mmol, 1.2 equiv.) was added slowly to form a deep-red solution. This solution was stirred for 1h at -78 °C, then benzyl chloroformate (694 µL, 1.4

equiv.) was added neat. The reaction vessel was allowed to warm to rt overnight. The reaction was quenched with sat'd $NaHCO_3$ and extracted using EtOAc. The organic layer was washed with brine, dried using Na_2SO_4, filtered and concentrated in vacuo. The crude yellow oil was purified using column chromatography (SiO_2, eluent: hexanes to 25% ethyl acetate, 75% hexanes) to yield **50b** (195 mg, 73%) as a brown oil.

^{1}H NMR (600 MHz, solvent): δ 7.32-7.12 (m, 10H), 5.74 (s, 1H), 5.19 (s, 2H), 4.87 (s, 2H), 2.74 (t, *J* = 5.4 Hz, 2H), 2.34 (t, *J* = 6.6 Hz, 2H), 1.94 (q, *J* = 6.00 Hz, 2H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 199.60, 162.82, 154.08, 136.78, 135.43, 128.93, 128.75, 128.61, 128.36, 127.60, 126.42, 117.26, 68.64, 52.94, 37.00, 30.35, 23.16.; HRMS (ESI/TOF) *m/z* calculated for $C_{21}H_{21}NO_3$: $[M + Na]^+$ 358.1419; found 358.1414.; IR (neat) cm^{-1}: 3064, 3032, 2952, 2925, 2359, 2340, 1715, 1667, 1593, 1496, 1455, 1393, 1231, 1213, 1185, 1125, 1011, 911, 732.; R_f=0.13 (20% ethyl acetate, 80% hexanes).

Procedure 5: Compound **50c precursor**



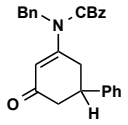
50c precursor

5-phenyl-1,3-Cyclohexanedione (500 mg, 2.66 mmol, 1.00 equiv.), $BnNH_2$ (290 µL, 2.66 mmol, 1.0 equiv.), *p*-TsOH•H_2O (51 mg, 0.27 mmol, 10%), Na_2SO_4 (756 mg, 5.32 mmol, 2 equiv.) and benzene (2.2 mL, 1.2 M dione) were added to a sealed tube. The mixture was heated at 85 °C overnight. The solution was then concentrated and diluted with EtOAc, washed 3x with sat'd $NaHCO_3$ and 1x with brine. The organic layer was dried over Na_2SO_4, filtered and concentrated in vacuo to yield known compound **50c precursor** (590

mg, 80%) as a bright yellow powder that was used crude. This procedure also works by refluxing the reaction as opposed to using the sealed tube set-up.

^{1}H NMR (400 MHz, $CDCl_3$): δ 7.37-7.22 (m, 10H), 5.28 (s, 1H), 4.66 (br s, 1H), 4.26 (d, *J* = 4.80 Hz, 2H), 3.39 (m, 1H), 2.75-2.42 (m, 4H).

Procedure 6: Compound **50c**



50c

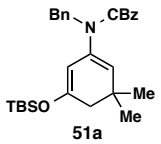
Ene-amine **50c precursor** (550 mg, 1.98 mmol, 1.0 equiv.) was azeotroped 3x in Ph-Me, then diluted in THF (20 mL, 0.16 M, **50c precursor**) and put over 4Å MS. This solution was cannulated into a 50 mL flame-dried RBF and cooled to -78 °C. *n*-BuLi (0.8 mL, 2.97 M, 2.38 mmol, 1.2 equiv.) was added slowly to form a deep-red solution. This solution was stirred for 2h at -78 °C, then benzyl chloroformate (396 µL, 1.4 equiv.) was added neat. The reaction vessel was allowed to warm to rt overnight. The reaction was then quenched with sat'd $NaHCO_3$ and extracted using EtOAc. The organic layer was washed with brine, dried using Na_2SO_4, filtered and concentrated in vacuo. The crude yellow oil was purified using column chromatography (SiO_2, eluent: hexanes to 20% ethyl acetate, 80% hexanes) to yield **50c** (594 mg, 73%) as an off-white powder.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.27-7.07 (m, 15H), 5.75 (s, 1H), 5.11 (q, *J* = 12 Hz, *J* = 7.8 Hz, 2H), 4.95 (*d*, *J* = 16.8 Hz, 1H), 4.73 (*d*, *J* = 16.8 Hz, 1H), 3.18-3.14 (m, 1H), 2.96-2.86 (m, 2H), 2.58-2.47 (m, 2H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 198.77, 161.68, 154.02, 142.83, 136.62, 135.21, 128.97, 128.88, 128.75, 128.66, 128.49, 127.66, 127.19, 126.87, 126.42, 116.72, 68.81, 53.06, 43.87, 41.33, 38.26.; HRMS (ESI/TOF) *m/z* calculated for

$C_{27}H_{25}NO_3$: $[M + Na]^+$ 434.1732; found 434.1711.; IR (neat) cm^{-1}: 3063, 3030, 2952, 2894, 1715, 1596, 1496, 1454, 1393, 1356, 1204, 1131, 1040, 1029, 1013, 910, 759, 734.; R_f=0.23 (20% ethyl acetate, 80% hexanes).

Preparation of Thermodynamic Dienes Using Method C Equilibration Conditions

Procedure 7: Compound **51a**



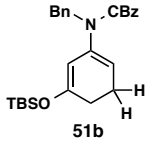
51a

CVA **50a** (1.5 g, 4.13 mmol, 1.3 equiv.) was azeotroped 3x in toluene and diluted in THF (180 mL, 0.023 M **50a**), then put over 4Å MS. This solution was cannulated into a 250 mL RBF and cooled to 0 °C. Upon addition of KHMDS (3.5 mL, 3.18 mmol, 0.917 M in THF, 1.0 equiv.) a darker yellow solution formed and was kept stirring at 0 °C for 5h. At this time, *tert*-butyldimethylsilyl chloride (528 mg, 3.5 mmol, 1.1 equiv.) was added in three portions using THF (20 mL). This solution was allowed to warm to rt over 2h. This solution was concentrated and filtered over a frit with a 1" silica gel pad treated with 3% Et_3N, 97% hexanes using 5% ethyl acetate, 3% Et_3N, 92% hexanes as the eluent. This afforded **51a** (1.111 g, 73%) as a light yellow oil. This was then stored in a freezer in benzene and stable for weeks.

^1H NMR (400 MHz, $CDCl_3$): δ 7.27-7.18 (m, 10H), 5.12 (s, 2H), 4.84 (br s, 1H), 4.82 (br s, 1H), 4.56 (s, 2H), 1.99 (s, 2H), 0.89 (s, 6H), 0.84 (s, 9H), 0.02 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 153.95, 138.21, 135.94, 135.28, 128.43, 128.40, 128.34, 127.77, 127.50, 127.28, 125.07, 103.25, 69.79, 67.11, 53.20, 43.46, 33.18, 28.08, 25.70, 18.07, -4.34.; No

HRMS, IR or R_f data taken due to the diene sensitivity. The acid sensitive compound was used crude.

Procedure 8: Compound **51b**

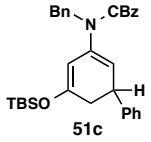


51b

CVA **50b** (108 mg, 0.322 mmol, 1.2 equiv.) was azeotroped 3x in toluene and diluted in THF (13 mL, 0.025 M **50b**), then put over 4Å MS. This solution was cannulated into a 50 mL RBF and cooled to 0 °C. KHMDS (0.292 mL, 0.268 mmol, 0.917 M in THF, 1.0 equiv.) was added and stirred at 0 °C for 5.5h. At this time, *tert*-butyldimethylsilyl chloride (56 mg, 0.375 mmol, 1.4 equiv.) was added in three portions using THF (3 mL). This solution was allowed to warm to rt over 2h. This solution was concentrated and filtered over a frit with a 1" silica gel pad treated with 3% Et_3N, 97% hexanes using 5% ethyl acetate, 3% Et_3N, 92% hexanes as the eluent. This afforded **51b** (49 mg, 36%) as a yellow oil. This was then used immediately, but should be stable to storage.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.33-7.17 (m, 10H), 5.13 (s, 2H), 5.10 (br s, 1H), 4.86 (br s, 1H), 4.56 (s, 2H), 2.23-2.19 (m, 2H), 2.11-2.08 (m, 2H), 0.84 (s, 9H), 0.03 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 155.05, 138.39, 136.98, 128.71, 128.47, 128.45, 128.42, 128.11, 127.84, 127.61, 127.24, 113.25, 104.26, 67.20, 53.27, 28.31, 25.71, 22.89, 18.15, -4.43.; No HRMS, IR or R_f data taken due to the diene sensitivity. The acid sensitive compound was used crude.

Procedure 9: Compound **51c**



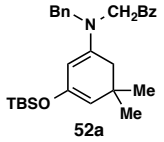
51c

CVA **50c** (100 mg, 0.243 mmol, 1.2 equiv.) was azeotroped 3x in toluene and diluted in THF (10 mL), then put over 4Å MS. This solution was cannulated into a 50 mL RBF and cooled to 0 °C. KHMDS (0.221 mL, 0.203 mmol, 0.917 M in THF, 1.0 equiv.) was added and kept stirring at 0 °C for 5.5h. At this time, *tert*-butyldimethylsilyl chloride (43 mg, 0.284 mmol, 1.4 equiv.) was added using THF (3 mL). This solution was allowed to warm to rt over 2h. It was purified by filtration over a frit with a 1" silica gel pad treated with 3% Et_3N, 97% hexanes using 5% ethyl acetate, 3% Et_3N, 92% hexanes as the eluent. This afforded **51c** (23 mg, 22%) as a light yellow oil. This was then used immediately, although it probably would be stable to storage by freezing in benzene.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.38-7.12 (m, 15H), 5.22-5.17 (m, 3H), 4.99 (br s, 1H), 4.67 (q, J = 14.7 Hz, 12.6 Hz, 2H), 3.68 (m, 1H), 2.55-2.51 (m, 1H), 2.29-2.24 (m, 1H), 0.84 (s, 9H), 0.00 (d, J = 34.8 Hz, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 153.68, 144.42, 138.16, 136.84, 128.73, 128.56, 128.54, 128.32, 127.97, 127.84, 127.67, 127.37, 126.57, 104.13, 69.87, 67.45, 53.10, 40.51, 37.59, 25.72, 18.09, -4.37 + -4.57 (same carbon).; No HRMS, IR or R_f data taken due to the diene sensitivity. The acid sensitive compound was used crude.

Preparation of Kinetic Dienes Using Method A and B

Procedure 10: Compound **52a**



52a

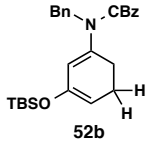
Method A: Recently sublimed KO*t*-Bu (278 mg, 2.48 mmol, 1.5 equiv.) was added to a flame-dried 100 mL RBF and lightly flame-dried. The solid was diluted in THF (5 mL) and cooled to -78 °C. *n*-BuLi (0.84 mL, 2.48 mmol, 2.97 M, 1.5 equiv.) was then added to the mixture and stirred for 20 minutes. CVA **50a** (600 mg, 1.65 mmol, 1.0 equiv.) was azeotroped 3x in toluene and diluted in THF (35 mL, 0.023 M **50a**), then put over 4Å MS. This solution was cannulated slowly into the reaction mixture at -78 °C and stirred for 10 - 15 minutes forming a yellow-brown solution. *tert*-Butyldimethylsilyl chloride (497 mg, 3.3 mmol, 2 equiv.) was then added via cannula using THF (3 mL). This solution was allowed to warm to rt slowly over 7h. The reaction vessel was concentrated in vacuo. The product was then filtered over a frit with a 1" silica pad treated with 3% Et_3N, 97% hexanes using 5% ethyl acetate, 3% Et_3N, 92% hexanes as the eluent. This afforded **52a** (487 mg, 62%) as a dark yellow oil in a >10:1 ratio of **52a**:**51a**. This was then used immediately. Storage in the freezer in benzene led to erosion of the diene ratio **52a**:**51a**.

Method B: KHMDS (1.2 equiv., 1.0 M in THF) was cooled to -78 °C in a RBF. CVA **50a** (1.0 equiv.) was azeotroped 3x in toluene, then diluted in THF to make an approximately 0.015 M solution and put over 4Å MS. This solution was cannulated slowly to the vessel at -78 °C and stirred for 20 min. *tert*-Butyldimethylsilyl chloride (31.4 mg, 0.209 mmol, 1.4 equiv.) in THF (2 mL) was cannulated to the reaction mixture at -78 °C. This solution was allowed to warm slowly to rt over 7h. The reaction vessel was

concentrated in vacuo and filtered over a frit with a 1" silica pad treated with 3% Et_3N, 97% hexanes using 5% ethyl acetate, 3% Et_3N, 92% hexanes as the eluent. This afforded **52a** as a very light yellow oil in a 7:1 or 5:1 ratio of **52a**:**51a**. The diene mixture was then used crude. This diene was stable to storage in benzene for a few days, but the diene ratio erodes slowly when stored. This compound is acid sensitive.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32-7.00 (m, 10H), 5.61 (d, *J* =1.5 Hz, 1H), 5.12 (s, 2H), 4.66 (d, *J* = 1.5 Hz, 1H), 4.60 (s, 2H), 2.22 (s, 2H), 0.98 (s, 6H), 0.94 (s, 9H), 0.06 (s, 6H).; No ^{13}C data, HRMS, or IR data taken due to the diene ratio and acid sensitivity. The compound was used crude.; R_f=0.80 (Et_3N SiO_2 TLC plate, 5% ethyl acetate, 95% hexanes), acid sensitive.

Procedure 11: Compound **52b**



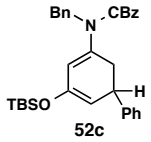
52b

KHMDS (0.18 mL, 0.179 mmol, 0.98 M in THF, 1.2 equiv.) was cooled to -78 °C in a 50 mL RBF. CVA **50b** (50 mg, 0.149 mmol, 1.0 equiv.) was azeotroped 3x in toluene, then diluted in THF (8 mL) and put over 4Å MS. This solution was cannulated slowly to the vessel at -78 °C and stirred for 20 min. *tert*-Butyldimethylsilyl chloride (31.4 mg, 0.209 mmol, 1.4 equiv.) in THF (2 mL) was cannulated to the reaction mixture at -78 °C. This solution was allowed to warm slowly to rt over 7h. The reaction vessel was concentrated in vacuo and filtered over a frit with a 1" silica pad treated with 3% Et_3N, 97% hexanes using 5% ethyl acetate, 3% Et_3N, 92% hexanes as the eluent. This afforded **52b** (487 mg, 61%) as

a very light yellow oil in a 4:1 ratio of **52b**:**51b**. This was then used immediately. Storage may result in isomerization to a degraded diene ratio, but was not tested.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33-7.23 (m, 10H), 5.47 (s, 1H), 5.18 (s, 2H), 4.76 (t, *J* = 2.8 Hz, 1.6 Hz, 1H), 4.72 (s, 2H), 2.25-2.10 (m, 4H), 0.87 (s, 9H), 0.06 (s, 6H).; No ^{13}C data, HRMS, IR or R_f data were obtained due to the diene ratio and acid sensitivity. The diene was used crude.

Procedure 12: Compound **52c**



52c

KHMDS (0.19 mL, 0.175 mmol, 0.98 M in THF, 1.2 equiv.) was cooled to -78 °C in a 50 mL RBF. CVA **50c** (60 mg, 0.146 mmol, 1.0 equiv.) was azeotroped 3x in toluene, then diluted in THF (8 mL) and put over 4Å MS. This solution was cannulated slowly to the vessel at -78 °C and stirred for 10 min. *tert*-Butyldimethylsilyl chloride (31 mg, 0.204 mmol, 1.4 equiv.) in THF (2 mL) was then cannulated to the reaction mixture at -78 °C. This solution was allowed to warm slowly to rt over 7h. The reaction vessel was concentrated in vacuo and diluted in ether. This solution was then filtered over dry celite, then concentrated. This afforded **52c** (50 mg, 64%) as a light yellow oil in a >10:1 ratio of **52c**:**51c**. The diene was then used immediately. Storage may result in isomerization to a degraded diene ratio, but was not tested.

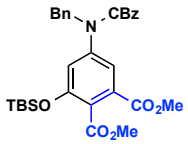
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38-7.11 (m, 15H), 5.49 (s, 1H), 5.11-5.00 (m, 2H), 4.80-4.79 (m, 1H), 4.69-4.52 (m, 2H), 3.59-3.52 (m, 1H), 2.57-2.28 (m, 2H), 0.85 (s, 9H), 0.04 (s, 6H).; No ^{13}C data, HRMS, or IR data taken due to the diene ratio. The acid sensitive

compound was used crude.; R_f=0.76 (Et_3N SiO_2 TLC plate, 5% ethyl acetate, 95% hexanes), acid sensitive.

Thermodynamic Diene Aromatic Diels-Alder & retro-Diels-Alder Products

General Procedure: Diene **51a** was prepared and stored in benzene frozen until needed for use. For the following reactions, **51a** (0.14 M in benzene) and the corresponding acetylene (≥2 equiv., neat) were added to a sealed tube using the outlined general conditions for sealed tube reactions. Each vial was then heated at 150 °C for 12-16h (although reactions were probably complete after 5-8h). The contents were diluted in EtOAc, transferred to a RBF and concentrated in vacuo. The crude contents were then purified by gradient column chromatography (SiO_2, eluent: varying solvent conditions) to afford products **53-61**.

Procedure 13: Compound **53**



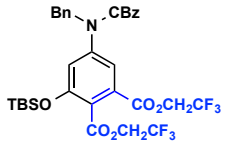
53

Diene **51a** (238 mg, 0.5 mmol, 1.0 equiv., in benzene) and dimethylacetylenedicarboxylate (123 µL, 1.0 mmol, 2.0 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 12% ethyl acetate, 88% hexanes) yielded **53** (240 mg, 85%) as a light yellow viscous oil.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.49 (br s, 1H), 7.32-7.17 (m, 10H), 6.71 (br s, 1H), 5.19 (s, 2H), 4.87 (s, 2H), 3.88 (s, 3H), 3.84 (s, 3H), 0.89 (s, 9H), 0.01 (s, 6H).; ^{13}C NMR (151

MHz, $CDCl_3$): δ 167.56, 165.20, 155.12, 152.92, 143.22, 137.24, 136.08, 129.16, 128.72, 128.54, 128.37, 128.14, 127.99, 127.62, 125.97, 121.82, 120.69, 67.84, 54.00, 52.57, 52.44, 25.40, 17.94, -4.64.; HRMS (ESI/TOF) *m/z* calculated for $C_{31}H_{37}NO_7SiNa$: $[M + Na]^+$ 586.2237; found 586.2216.; IR (neat) cm^{-1}: 2951, 2929, 1738, 1733, 1716, 1429, 1322, 1238, 1100, 1036, 834, 786.; R_f=0.22 (10% ethyl acetate, 90% hexanes).

Procedure 14: Compound **54**



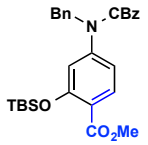
54

Diene **51a** (238 mg, 0.5 mmol, 1.0 equiv., in benzene) and bis(2,2,2-trifluoroethyl) acetylenedicarboxylate (90%, 1.11 mL, 1.0 mmol, 2.0 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 20% ethyl acetate, 80% hexanes) yielded **54** (221 mg, 63%) as a light yellow viscous oil.

^1H NMR (600 MHz, $CDCl_3$): δ 7.46 (br s, 1H), 7.27-7.13 (m, 10H), 6.78 (br s, 1H), 5.16 (s, 2H), 4.84 (s, 2H), 4.56-4.51 (m, 4H), 0.82 (s, 9H), -0.03 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 165.28, 163.15, 155.15, 158.61, 144.33, 137.16, 136.02, 128.79, 128.51, 128.25, 128.07, 127.71, 127.47, 127.40, 123.98, 122.35, 120.57, *quartet* (125.67, 125.46, 123.84, 123.62, 122.00, 121.78, 120.17, 119.95), 68.22, *two quartets overlapped* (62.23, 61.99, 61.75, 61.51, 61.27, 61.02), 54.06, 25.54, 18.10, -4.53.; HRMS (ESI/TOF) *m/z* calculated for $C_{33}H_{35}F_6NO_7SiNa$: $[M + Na]^+$ 722.1985; found 722.1959.; IR (neat) cm^{-1}: 2958, 2932,

2860, 1751, 1714, 1600, 1400, 1325, 1285, 1251, 1162, 1099,1065, 985, 830, 785, 699.; R_f=0.30 (20% ethyl acetate, 80% hexanes).

Procedure 15: Compound **55**

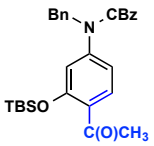


55

Diene **51a** (238 mg, 0.5 mmol, 1.0 equiv.) and methyl propiolate (89 µL, 1.0 mmol, 2.0 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 15% ethyl acetate, 85% hexanes) yielded **55** (85%) as a light yellow viscous oil.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.67 (d, J = 8.4 Hz, 1H), 7.27-7.14 (m, 10H), 6.81 (d, J = 7.8 Hz, 1H), 6.60 (br s, 1H), 5.16 (s, 2H), 4.85 (s, 2H), 3.80 (s, 3H), 0.90 (s, 9H), 0.01 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 166.79, 155.68, 155.25, 146.33, 137.58, 136.29, 132.17, 128.75, 128.60, 128.19, 127.99, 127.58, 127.52, 119.02, 118.76, 67.85, 54.05, 51.94, 25.69, 18.30, -4.47.; HRMS (ESI/TOF) *m/z* calculated for $C_{29}H_{35}NO_5SiNa$: $[M + Na]^+$: 528.2182; found 528.2162.; IR (neat) cm^{-1}: 3032, 2951, 2931, 2893, 2858, 1708, 1604, 1496, 1435, 1392, 1361, 1284, 1253, 1234, 1134, 1087, 972, 956, 837.; R_f=0.60 (20% ethyl acetate, 80% hexanes).

Procedure 16: Compound **56**

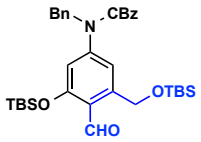


56

Diene **51a** (238 mg, 0.5 mmol, 1.0 equiv.) and 3-butyn-2-one (78 µL, 1.0 mmol, 2.0 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 10% ethyl acetate, 90% hexanes) yielded **56** (194 mg, 80%) as a light yellow viscous oil.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.53 (d, J = 8.4 Hz, 1H), 7.28-7.13 (m, 10H), 6.83 (d, J = 7.8 Hz, 1H), 6.61 (s, 1H), 5.16 (s, 2H), 4.84 (s, 2H), 2.52 (s, 3H), 0.87 (s, 9H), 0.04 (s, H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 199.81, 155.34, 155.26, 146.35, 137.60, 136.30, 130.69, 128.81, 128.62, 128.24, 128.05, 127.60, 127.38, 118.84, 117.92, 67.91, 54.06, 31.46, 25.92, 18.51, -4.05.; HRMS (ESI/TOF) *m/z* calculated for $C_{29}H_{35}NO_4SiNa$: $[M + Na]^+$: 522.2233; found 512.2222.; IR (neat) cm^{-1}: 3032, 2954, 2930, 2857, 1712, 1600, 1359, 1315, 1263, 1231, 1208, 1134, 1068, 965, 835, 784, 699, 668.; R_f=0.60 (20% ethyl acetate, 80% hexanes).

Procedure 17: Compound **57**

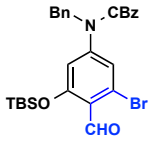


57

Diene **51a** (238 mg, 0.5 mmol, 1.0 equiv.) and 4-(*tert*-butyldimethylsilyloxy) but-2-ynal (417.5 mg, 2.0 mmol, 4.0 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 10% ethyl acetate, 90% hexanes) yielded **57** (200 mg, 64%) as a yellow solid. Recovered some of CVA **50a** (35 mg).

^{1}H NMR (600 MHz, $CDCl_3$): δ 10.44 (s, 1H), 7.33 (s, 1H) 7.27-7.15 (m, 10H), 6.65 (br s, 1H), 5.18 (s, 2H), 4.99 (s, 2H), 4.92 (s, 2H), 0.92 (s, 9H), 0.85 (s, 9H), 0.08 (s, 6H), 0.03 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 191.45, 160.44, 155.12, 148.12, 147.60, 137.57, 136.20, 128.80, 128.58, 128.21, 128.01, 127.50, 127.07, 121.01, 115.40, 115.26, 67.97, 63.39, 53.77, 26.08, 25.77, 18.44, 18.41, -4.37, -5.28.; HRMS (ESI/TOF) *m/z* calculated for $C_{35}H_{49}NO_5Si_2Na$: $[M + Na]^+$: 642.3047; found 642.3068.; IR (neat) cm^{-1}: 3032, 2954, 2929, 2856, 1715, 1676, 1597, 1443, 1400, 1390, 1316, 1254,1227, 1177, 1121, 1060, 1027, 833, 781, 696, 668.; R_f=0.47 (10% ethyl acetate, 90% hexanes).

Procedure 18: Compound **58**



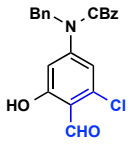
58

Diene **51a** (260 mg, 0.54 mmol, 1.0 equiv.) and 3-bromopropionaldehyde (used crude, in excess, contained ethyl acetate) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 10% ethyl acetate, 90% hexanes) yielded **58** (121 mg, 40%) as a light brown oil. Much of the remaining balance was isolated as **50a** (84 mg, 42%).

^{1}H NMR (600 MHz, $CDCl_3$): δ 10.29 (s, 1H), 7.37-7.16 (m, 11H), 6.62 (s, 1H), 5.22 (s, 2H), 4.91 (s, 2H), 0.92 (s, 9H), 0.06 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 189.37, 159.29, 154.81, 147.39, 137.06, 135.83, 128.97, 128.71, 128.45, 128.21, 127.79, 127.07, 124.37, 123.99, 123.18, 116.51, 68.33, 53.71, 25.68, 18.38, -4.43.; HRMS (ESI/TOF) *m/z* calculated for $C_{28}H_{32}BrNO_4SiNa$: $[M + Na]^+$: 576.1182; found 576.1158.; IR (neat) cm^{-1}:

3032, 2951, 2931, 1697, 1589, 1543, 1496, 1454, 1388, 1357, 1303, 1222, 1057, 1130, 979, 837.; R_f=0.68 (10% ethyl acetate, 90% hexanes).

Procedure 19: Compound **59**

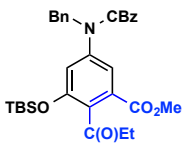


59

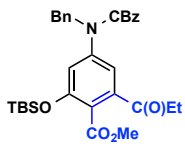
Diene **51a** (24 mg, 0.05 mmol, 1.0 equiv.) and 3-chloropropionaldehyde (used crude, in excess, in ethanol) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 20% ethyl acetate, 80% hexanes) yielded **59** (6 mg, 33%) as a bright yellow oil. The remaining mass balance was collected as **51a** (18 mg, 67%).

^{1}H NMR (600 MHz, $CDCl_3$): δ 11.98 (s, 1H), 10.27 (s, 1H), 7.32-7.16 (m, 10H), 7.02 (s, 1H), 6.74 (s, 1H), 5.22 (s, 2H), 4.95 (s, 2H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 194.34, 164.41, 154.59, 150.29, 138.32, 136.86, 135.64, 128.97, 128.73, 128.51, 128.26, 127.78, 126.87, 118.24, 114.51, 112.04, 68.51, 53.41.; HRMS (ESI/TOF) *m/z* calculated for $C_{22}H_{18}ClNO_4Na$: $[M + Na]^+$: 418.0822; found 418.0807.; IR (neat) cm^{-1}: 3032, 2951, 2931, 2858, 1728, 1712, 1431, 1396, 1369, 1323, 1257, 1242, 1211, 1165, 1111, 1060, 1010, 960, 887, 840.; R_f=0.35 (20% ethyl acetate, 80% hexanes).

Procedure 20: Compound **60a** and **60b**



60a



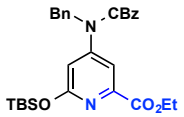
60b

Diene **51a** (621 mg, 1.30 mmol, 1.0 equiv.) and 4-oxo-hex-2-ynoic acid methyl ester (366 mg, 2.6 mmol, 2.0 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 20% ethyl acetate, 80% hexanes) yielded **60a** & **60b** (2:1, 487 mg, 67% combined yield) as light yellow viscous oils.

60a: ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.47 (br s, 1H), 7.32-7.16 (m, 10H), 6.67 (br s, 1H), 5.19 (s, 2H), 4.86 (s, 2H), 3.80 (s, 3H), 2.76 (q, J = 7.2 Hz, 2H), 1.16 (t, J = 7.2 Hz, 3H), 0.85 (s, 9H), -0.03 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 205.93, 165.70, 155.33, 152.19, 142.68, 137.40, 136.24, 134.61, 128.81, 128.76, 128.59, 128.24, 128.06, 127.70, 127.67, 121.95, 121.05, 67.91, 54.17, 52.57, 37.36, 25.56, 18.07, 7.44, -4.54.; HRMS (ESI/TOF) *m/z* calculated for $C_{32}H_{39}NO_6SiNa$: $[M + Na]^+$: 584.2444; found 584.2417.; IR (neat) cm^{-1}: 3032, 2951, 2935, 2858, 1712, 1600, 1438, 1396, 1369, 1319, 1253, 1165, 1130, 1064, 1030, 964, 833, 786, 732, 698.; No R_f obtained, less polar than **60b**.

60b: ^{1}H NMR (600 MHz, $CDCl_3$): δ 7.34-7.19 (m, 11H), 6.70 (br s, 1H), 5.20 (s, 2H), 4.86 (s, 2H), 3.87 (s, 3H), 2.69 (q, J = 6.6 Hz, 2H), 1.09 (t, J = 7.2 Hz, 3H), 0.89 (s, 9H), 0.02 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 200.07, 168.23, 155.29, 153.60, 143.49, 137.41, 136.92, 136.13, 128.91, 128.69, 128.40, 128.28, 127.84, 127.76, 123.91, 121.28, 119.83, 68.04, 54.24, 52.52, 32.65, 25.51, 18.09, 8.08, -4.49.; HRMS (ESI/TOF) *m/z* calculated for $C_{32}H_{39}NO_6SiNa$: $[M + Na]^+$: 584.2444; found 584.2421.; IR (neat) cm^{-1}: 3032, 2951, 2935, 2893, 2858, 1712, 1600, 1438, 1396, 1369, 1319, 1253, 1165, 1130, 1064, 1030, 964, 833, 786, 698.; No R_f obtained, more polar than **60a**.

Procedure 21: Compound **61**

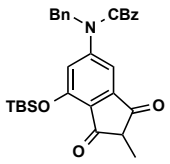


61

Diene **51a** (238 mg, 0.5 mmol, 1.0 equiv.) and ethyl cyanoformate (494 µL, 5.0 mmol, 10.0 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 10% ethyl acetate, 90% hexanes) yielded **61** (158 mg, 61%) as a light pink viscous oil. This product tautomerizes to pyridone **64** easily.

^{1}H NMR (600 MHz, $CDCl_3$): δ 7.67 (s, 1H), 7.38-7.19 (m, 10H), 6.81 (s, 1H), 5.23 (s, 2H), 4.98 (s, 2H), 4.34 (q, J = 6.6, 7.2, 2H), 1.36 (t, J = 7.2, 3H), 0.97 (s, 9H), 0.33 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 165.07, 163.35, 154.62, 152.74, 146.48, 137.07, 135.71, 128.85, 128.64, 128.37, 128.15, 127.62, 126.93, 114.60, 111.28, 68.33, 61.50, 52.92, 26.06, 18.18, 14.27, -4.18.; HRMS (ESI/TOF) *m/z* calculated for $C_{29}H_{36}N_2O_5SiNa$: $[M + Na]^+$: 543.2291; found 543.2274.; IR (neat) cm^{-1}: 2956, 2930, 2899, 2857, 1718, 1598, 1558, 1436, 1387, 1332, 1249, 1153, 1032, 698, 668.; R_f=0.65 (20% ethyl acetate, 80% hexanes).

Procedure 22: Compound **62**



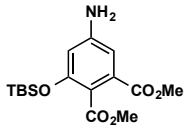
62

KHMDS (0.05 mmol, 0.917 M in THF) was added to a flame-dried round bottom flask under a nitrogen atmosphere and cooled to -78 °C. A mixture of **60a** and **60b** were

azeotroped twice in toluene and diluted in THF and 4Å molecular sieves were added. This solution was cannulated slowly to the base and rinsed twice with THF (20 mL total THF). The solution was allowed to warm to room temperature and quenched with 1M HCl. The reaction mixture was extracted twice with ethyl acetate, washed twice with water, once with brine and dried over Na_2SO_4. The combined organics were then filtered and concentrated to yield 15 mg of the product **62** in a 76% yield.

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.60 (s, 1H), 7.35-7.13 (m, 12H), 5.22 (s, 2H), 4.99 (s, 2H), 3.04 (q, *J* = 8 Hz, 1H), 1.38 (d, *J* = 8 Hz, 3H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 203.41, 199.67, 156.81, 154.67, 151.59, 142.07, 136.60, 135.55, 128.81, 128.57, 128.35, 128.12, 127.69, 126.94, 123.44, 119.15, 111.96, 68.35, 53.64, 49.07, 10.52.; HRMS (ESI/TOF) *m/z* calculated for $C_{25}H_{21}NO_5Na$: $[M + Na]^+$: 438.1317; found 438.1304.; IR (neat) cm^{-1}: 3371, 2924, 2854, 1739, 1693, 1620, 1477, 1454, 1396, 1307, 1226, 1130, 759, 740, 698.

Procedure 23: Compound **63**

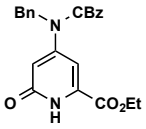


63

tert-Butyldimethylsilyl-protected *m*-APhOH **53** (65 mg, 0.115 mmol) and Pd/C (4 mg, 6 wt%) were transferred using EtOAc (5 mL) into a flask fitted with a T-valve. It was purged of air and attached to an H_2 balloon and allowed to stir at rt for 19h. The crude product was filtered over a celite plug to yield **63** (37 mg, 96%) as a bright yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$): δ 6.83 (d, *J* = 2 Hz, 1H), 6.27 (d, *J* = 2 Hz, 1H), 3.83 (s, 3H), 3.82 (s, 3H), 0.96 (s, 9H), 0.21 (s, 6H), [*NH_2 not found*]; ^{13}C NMR (151 MHz, $CDCl_3$): δ 168.22, 166.34, 154.02, 148.09, 130.47, 117.80, 109.15, 109.94, 52.38, 52.18, 25.48, 18.02, -4.48.; HRMS (ESI/TOF) *m/z* calculated for $C_{16}H_{25}NO_5SiNa$: $[M + Na]^+$: 362.1400; found 362.1385.; IR (neat) cm^{-1}: 3474, 3380, 2951, 2930, 2898, 2858, 1726, 1604, 1455, 1434, 1365, 1271, 1261, 1219, 1193, 1168, 1096, 1041, 1005, 919, 837, 784.; No R_f value determined.

Procedure 24: Compound **64**



64

tert-butyldimethylsilyl-protected *m*-APyOH **61** (75 mg, 0.144 mmol, 1 equiv.), SiO_2 (4 g), H_2SO_4 (0.5 mL), and THF (30 mL) were concentrate on a rotary evaporator in vacuo (<15 mmHg) at 40 °C for 15 minutes. The solid was washed through a filter frit plugged with SiO_2 using EtOAc. The resultant organic layer was washed with brine, dried over Na_2SO_4 and filtered. Removal of the solvent yielded **64** (53 mg, 90%) without any further purification.

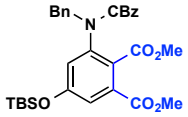
^{1}H NMR (600 MHz, $CDCl_3$): δ 9.84 (br s, 1H), 7.31-7.08 (m, 11H), 6.39 (s, 1H), 5.18 (s, 2H), 4.89 (s, 2H), 4.32 (q, *J* = 7.2 Hz, 2H), 1.30 (t, *J* = 7.2 Hz, 3H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 163.01, 160.81, 154.28, 153.14, 136.38, 135.35, 133.02, 129.02, 128.72, 128.60, 128.37, 127.79, 126.58, 116.08, 108.57, 68.75, 63.04, 52.90, 14.24.; HRMS (ESI/TOF) *m/z* calculated for $C_{23}H_{22}N_2O_5Na$: $[M + Na]^+$: 429.1426; found 429.1406.; IR (neat) cm^{-1}: 3032,

2982, 2938, 1721, 1716, 1651, 1645, 1496, 1455, 1422, 1389, 1355, 1264, 1212, 1136, 1058, 1028, 913, 861, 770, 733, 698.; No R_f value determined.

Kinetic Diene Aromatic Diels-Alder & retro-Diels-Alder Products

General Procedure: Diene **52a** was prepared and stored in benzene frozen until needed for use. For the following reactions, **52a** (0.14 M in benzene) and the corresponding acetylene (≥2 equiv., neat) were added to a sealed tube using the outlined general conditions for sealed tube reactions. Each vial was then heated at 150 °C for 12-16h (although reactions were probably complete after 5-8h). The contents were diluted in EtOAc, transferred to a RBF and concentrated in vacuo. The crude contents were then purified by gradient column chromatography (SiO_2, eluent: varying solvent conditions) to afford products **65-69**.

Procedure 25: Compound **65**



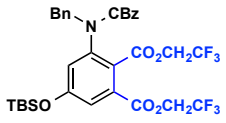
65

Diene **52a** (111 mg, 0.234 mmol, 1 equiv.) and dimethylacetylenedicarboxylate (57 µL, 0.468 mmol, 2 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by column chromatography (SiO_2, eluent: dichloromethane) yielded **65** and **53** (106 mg, 80%, combined yield) as a 2:1 mixture of products. The mixture was difficult to separate, so treatment with TBAF facilitated separation of the corresponding phenols by gradient column chromotography (SiO_2: hexanes to 30% ethyl acetate, 70% hexanes). The corresponding phenol, **65**-OH (24 mg, 0.053 mmol, 1.0 equiv.) was then submitted to reaction with DBU (8.8 µL, 0.058 mmol, 1.2 equiv.) in dichloromethane (5 mL, 0.01 M) and

stirred for 5 min. The intermediate phenoxide was protected with *tert*- butyldimethylsilyl chloride (10.4 mg, 0.069 mmol, 1.3 equiv.) and stirred for 1hour. The product was extracted 3x CH_2Cl_2, dried over Na_2SO_4, filtered and concentrated. The product was then purified using gradient column chromotography (SiO_2, eluent: hexanes to 12% ethyl acetate, 82% hexanes) and isolated to give **65** (24 mg, 80%) and characterized as such.

^{1}H NMR (500 MHz, C_6D_6, T=70 °C) δ 7.48 (s, 1H), 7.23-6.98 (m, 10H), 6.52 (br s, 1H), 5.71 (br, 1H), 5.14 (q, 2H), 4.36 (br, 1H), 3.59 (3H), 3.34 (s, 3H), 0.81 (s, 9H), -0.14 (s, 6H). Data here for unresolved peaks, VT spectrum of **65** included in spectra section.; ^{13}C NMR (151 MHz, solvent) δ 167.69, 165.96, 165.02, 156.61, 155.71, 140.14, 137.42, 136.59, 131.18, 129.16, 128.70, 128.42, 127.86, 127.76, 127.57, 125.62, 121.27, 67.68, 54.18, 52.85, 52.78, 25.60, 18.20, -4.54.; HRMS (ESI/TOF) *m/z* calculated for $C_{31}H_{37}NO_7SiNa$: $[M + Na]^+$: 586.2237; found 586.2209.; IR (neat) cm^{-1}: 3032, 2955, 2850, 1716, 1643, 1620, 1562, 1492, 1454, 1423, 1388, 1307, 1215, 1130, 1049, 976, 868, 848.; R_f=0.54 (30% ethyl acetate, 70% hexanes).

Procedure 26: Compound **66**

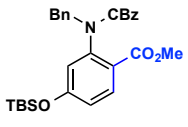


66

Diene **52a** (125 mg, 0.261 mmol, 1.0 equiv.) and bis(2,2,2-trifluoroethyl) acetylenedicarboxylate (145 mg, 0.522 mmol, 2 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 15% ethyl acetate, 85% hexanes) yielded **66** and **54** (108 mg, 59%, combined yield) as a >4:1 mixture of products.

^{1}H NMR (500 MHz, T=70 °C, C_6D_6) δ 7.36 (d, *J* = 2 Hz, 1H), 7.19-7.00 (m, 10H), 6.52 (s, 1H), [br, 2H, *too broad to see in VT*,], 4.36 (q, *J* = 8.5 Hz, 2H), 4.10 (q, *J* = 8.5 Hz, 2H), 0.79 (s, 9H), -0.10 (s, 6H). Spectra from before and after VT included.; ^{13}C NMR (200 MHz, T=70 °C, C_6D_6) δ 165.43, 163.95, 158.01, 155.88, 142.57, 138.31, 137.35, 130.85, 129.72, 129.21, 128.93, 128.74, 128.69, 128.63, 127.20, 127.08, *2xC split by F* (126.13, 125.82, 124.75, 124.44, 123.37, 123.06), 121.78, 68.53, *2xC quartets* (62.43, 62.25, 62.07, 61.97, 61.88, 61.78, 61.60, 61.42), 55.02, 25.94, 18.59, -4.27.; [peaks near C_6D_6 solvent may not be assigned correctly due to solvent interference].; HRMS (ESI/TOF) *m/z* calculated for $C_{33}H_{35}F_6NO_7SiNa$: $[M + Na]^+$: 722.1985; found 722.1957.; IR (neat) cm^{-1}: 3032, 2955, 2931, 2885, 2858, 1712, 1681, 1597, 1469, 1396, 1361, 1311, 1253, 1168, 1111, 1060, 1006, 837, 779, 732, 698.; R_f=0.50 (20% ethyl acetate, 80% hexanes).

Procedure 27: Compound **67**



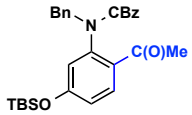
67

Diene **52a** (163 mg, 0.34 mmol, 1.0 equiv.) and methyl propiolate (69 µL, 0.68 mmol, 2 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 15% ethyl acetate, 85% hexanes) yielded **67** and **55** (94 mg, 62%, combined yield) as a >4:1 mixture of products.

^{1}H NMR (600 MHz, C_6D_6) δ 7.98 (d, *J* = 9 Hz, 1H), 7.27-6.97 (m, 10H), 6.58-6.57 (m, 1H), 6.51 (d, *J* = 2.4 Hz, 1H), 5.58 (d, *J* = 15.6 Hz, 1H), 5.20 (d, *J* = 12.6 Hz, 1H), 5.02 (d, *J* = 13.2 Hz, 1H), 4.24 (d, *J* = 15 Hz, 1H), 3.38 (s, 3H), 0.84 (s, 9H), -0.11 (d, *J* = 6 Hz, 6H).; ^{13}C NMR (125 MHz, d_7-DMF) δ 166.53, 160.51, 156.50, 139.30, 138.37, 134.04, 129.74,

129.46, 129.37, 128.82, 128.59, 128.47, 122.93, 122.76, 120.02, 68.08, 55.51, 26.69, 26.36, 26.35, 19.07, -3.92.; HRMS (ESI/TOF) *m/z* calculated for $C_{29}H_{35}NO_5SiNa$: $[M + Na]^+$: 528.2182; found 528.2164.; IR (neat) cm^{-1}: 3032, 2951, 2931, 2858, 1712, 1600, 1566, 1496, 1435, 1396, 1357, 1303, 1278, 1257, 1192, 1126, 1095, 956, 840, 810.; R_f=0.48 (20% ethyl acetate, 80% hexanes).

Procedure 28: Compound **68**

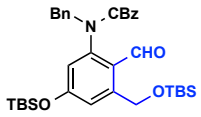


68

Diene **52a** (120 mg, 0.251 mmol, 1.0 equiv.) and but-3-yne-2-one (40 µL, 0.502 mmol, 2 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 20% ethyl acetate, 80% hexanes) yielded **68** and **56** (70 mg, 57%) as a >4:1 mixture of products. Compound **68** was characterized as the corresponding phenol.

^1H NMR (600 MHz, $CDCl_3$) δ 12.31 (s, 1H), 7.62 (d, *J* = 9Hz, 1H), 7.32-7.18 (m, 10H), 6.83 (s, 1H), 6.82 (s, 1H), 5.21 (s, 2H), 4.94 (s, 2H), 2.57 (s, 3H).; ^{13}C NMR (151 MHz, $CDCl_3$) δ 203.43, 163.05, 154.86, 149.24, 137.26, 135.92, 131.01, 128.63, 128.48, 128.14, 127.94, 127.42, 127.05, 117.29, 116.65, 114.25, 67.93, 53.55, 26.53.; HRMS (ESI/TOF) *m/z* calculated for $C_{23}H_{21}NO_4Na$: $[M + Na]^+$: 398.1368; found 398.1349.; IR (neat) cm^{-1}: 3063, 3032, 2924, 2850, 1708, 1639, 1573, 1496, 1454, 1392, 1365, 1323, 1273, 1226, 1130, 1076, 1033, 968, 806, 732, 698.; R_f=0.19 (20% ethyl acetate, 80% hexanes).

Procedure 29: Compound **69**



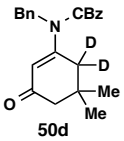
69

Diene **52a** (163 mg, 0.34 mmol, 1.0 equiv.) and 4-(*tert*-butyldimethylsilyloxy) but-2-ynal (105.4 mg, 0.53 mmol, 1.56 equiv.) were heated at 150 °C in a sealed vial overnight. Purification by gradient column chromatography (SiO_2, eluent: hexanes to 10% ethyl acetate, 90% hexanes) yielded **69** and **57** (87 mg, 41%, combined yield) as a >4:1 mixture of products.

^{1}H NMR (500 MHz, C_6D_6, T=70 °C) δ 10.13 (s, 1H), 7.54 (s, 1H), 7.16-7.07 (m, 10H), 6.47 (s, 1H), 5.26 (s, 2H), 5.04 (s, 2H), 4.62 (br, 2H), 0.98 (s, 9H), 0.92 (s, 9H), 0.08 (s, 6H), 0.06 (s, 6H).; ^{13}C NMR (200 MHz, T=70 °C, C_6D_6) δ 189.70, 160.97, 155.69, 148.67, 137.41, 137.00, 129.37, 128.76, 128.58, 128.30, 128.24, 128.07, 127.95, 127.64, 124.12, 119.20, 117.78, 67.97, 63.64, 55.71, 26.17, 25.71, 18.53, 18.34, -4.35, -5.34.; [peaks near C_6D_6 solvent may not be assigned correctly due to solvent interference]. HRMS (ESI/TOF) *m/z* calculated for $C_{35}H_{49}NO_5Si_2Na$: $[M + Na]^+$: 642.3047; found 642.3024.; IR (neat) cm^{-1}: 2955, 2931, 2858, 2831, 1751, 1716, 1600, 1400, 1369, 1327, 1288, 1249, 1168, 1107, 1072, 1033, 968, 837, 810, 786, 702.; R_f=0.29 (10% ethyl acetate, 90% hexanes).

Preparation of Deuterated Materials

Procedure 30: Compound **50d**

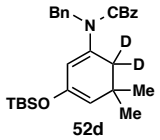


50d

Deuterated (80%) CVA **50d** was formed by deprotonation of **50a** using KHMDS under equilibrating conditions. CVA **50a** (1.3 equiv.) was azeoptroped 3x in toluene and diluted in THF with 4Å molecular sieves. This solution was cannulated to a flame-dried RBF and cooled to 0 °C. KHMDS (1.0 equiv.) was added slowly and the resultant solution was stirred at 0 °C for 5h. *tert*-Butyldimethylsilyl chloride (1.4 equiv.) was added by cannula in THF and the solution was allowed to warm to rt to give the corresponding *t*-D- **51a**. The reaction mixture was concentrated and the diene was purified in the usual manner, through a solution of 3% Et_3N, 5% ethyl acetate, 93% hexanes. The diene was stirred with *d*4-acetic acid to give the deuterated CVA **50d**. This was repeated a total of four times to incorporate deuterium at the desired position in 80%. The product was purified using gradient column chromatography (SiO_2: hexanes to 30% ethyl acetate, 70% hexanes).

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33-7.13 (m, 10H), 5.75 (s, 1H), 5.2 (s, 2H), 4.87 (s, 2H), 2.56 (br d, *deuterium incorporated*, 0.30, 2*D*/H), 2.17 (s, 2H), 0.93 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$) δ 199.49, 160.27, 154.02, 136.61, 135.22, 128.72, 128.54, 128.50, 128.34, 127.48, 126.51, 120.49, 116.63, 68.52, 52.72, 50.46, 33.80, 27.87.; No HRMS obtained.; IR (neat) cm^{-1}: 3032, 2958, 2870, 1716, 1658, 1597, 1496, 1454, 1396, 1354, 1307, 1273, 1207, 1126, 999, 960.; R_f=0.47 (30% ethyl acetate, 70% hexanes).

Procedure 31: Compound **52d**



52d

Deuterated diene **52d** was formed by using the modified Schlosser's conditions to form kinetic diene **52d**. Deuterated **50d** was azeotroped 3x in toluene and diluted in THF, then

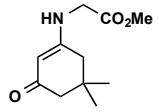
put over 4Å molecular sieves. To a RBF with KO^{t}Bu (92 mg, 0.823 mmol, 1.5 equiv.) was added THF. This solution was cooled to -78 °C and *n*-BuLi (0.316 mL, 0.823 mmol, 1.5 equiv.) was added. The solution of **50d** was cannulated into the cooled base solution when TBS-Cl (165 mg, 1.098 mmol, 2.0 equiv.) was cannulated into the enolate solution after 10 minutes. The solution was allowed to warm to rt and then concentrated. The solution was diluted in 50 mL of 3% Et_3N, 5% ethyl acetate, 93% hexanes and filtered through a pad of silica to form **52d** in good yield.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.21-7.01 (m, 10H), 5.6 (d, J = 1.5 Hz, 1H), 5.11 (s, 2H), 4.65 (d, J = 1.5 Hz, 1H), 4.60 (s, 2H), 0.93 (s, 9H), 0.67 (s, 6H).; No ^{13}C data, HRMS, IR or R_f data obtained due to the compound sensitivity; used crude.

The general procedure for the tandem Diels-Alder and *retro*-Diels-Alder reactions was used to afford a mixture of compounds **65** and **53d**. A spectrum of the mixture of **65:53d** is included with the spectra.

Method Application Towards Tetrapetalone A

Procedure 32: Compound **75**



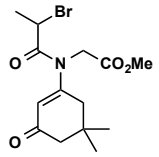
75

A pressure tube was charged with dimedone (5.6 g, 40.1 mmol, 1 equiv.), glycine methyl ester hydrochloride (5.5 g, 40.1 mmol, 1 equiv.) and Na_2SO_4 (11.4 g, 80.2 mmol, 2 equiv.) in toluene (67 mL) and DIPEA (7.3 mL, 42.1 mmol, 1.05 equiv.) was added. The tube was purged with N_2 and sealed, then placed in an oil bath at 130 ºC, and stirred for 3h.

The reaction mixture was washed with 5% HCl, saturated aqueous $NaHCO_3$ and brine. The organic fraction was dried with Na_2SO_4, filtered and concentrated to yield the crude product. Trituration with 5% ethyl acetate, 95% hexanes afforded the pure product **75** (8.1 g, 90%) which matched known characterization data.

^{1}H NMR (500 MHz, $CDCl_3$): δ 5.01 (s, 1H), 4.98 (br s, 1H), 3.84 (d, J = 4.5 Hz, 2H), 3.81 (s, 3H), 2.25 (s, 2H), 2.19 (s, 2H), 1.07 (s, 6H).; Spectrum not included.

Procedure 33: Compound **76**



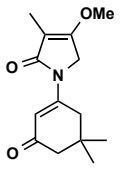
76

To a solution of the compound **75** in THF (47.0 mL, 0.2 M, 1.0 equiv.) was added *n*-BuLi (4.07 mL, 2.56 M, 1.1 equiv.) at -78 ºC. After stirring at this temperature for 20 min, 2-bromopropionyl bromide (1.5 mL, 14.22 mmol, 1.5 equiv.) was added dropwise. The reaction mixture was stirred and warmed slowly to room temperature over 12 h before it was quenched with saturated aqueous $NaHCO_3$. The solution was extracted with EtOAc, and the combined organic solutions were washed with brine, dried with $MgSO_4$, and concentrated *in vacuo*. The residue was purified by column chromatography (SiO_2, eluent: hexanes-ethyl acetate = 7/1 to 2/1) to afford product **76** (1.68 g, 4.86 mmol, 51%) as a yellow oil.

^{1}H NMR (500 MHz, $CDCl_3$): δ 5.97 (s, 1H), 4.63 (q, J = 6.6 Hz, 1H), 4.23 (d, J = 17.5 Hz, 1H), 4.12 (d, J = 17.6 Hz, 1H), 3.70 (s, 3H), 2.52 (d, J = 18.2 Hz, 1H), 2.41 (d, J = 18.3 Hz, 1H), 2.25 (s, 2H), 1.75 (d, J = 6.6 Hz, 3H), 1.07 (s, 3H), 1.05 (s, 3H).; ^{13}C NMR (126

MHz, $CDCl_3$): δ 198.8, 169.2, 168.4, 158.4, 124.9, 52.6, 50.7, 48.8, 42.4, 38.1, 33.3, 28.1, 27.9, 21.6.; HRMS (FI) *m/z* calculated for $C_{14}H_{20}BrNO_4Na$: $[M + Na]^+$ 368.0473; found 368.0484. IR (neat) cm^{-1}: 2959, 2870, 1751, 1670, 1628, 1385, 1207, 1015.; R_f=0.08 (20% ethyl acetate, 80% hexanes).

Procedure 34: Compound **77**

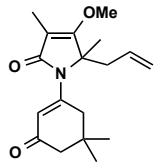


77

A flask charged with acyl bromide **76** (1.0 g, 2.89 mmol, 1 equiv.), CHI_3 (2.32 g, 5.89 mmol, 2.0 equiv.) and Sm (1.46g, 9.73 mmol, 3.3 equiv.), was fitted with a reflux condenser and thoroughly purged with N_2. THF (60 mL) was sparged with N_2 and added into the flask. The reaction mixture was brought to reflux until TLC analysis revealed complete consumption of starting material before it was quenched with 0.5 M HCl. The solution was extracted with EtOAc, and the combined organic solutions were washed with brine, dried with $MgSO_4$, and concentrated *in vacuo*. To a solution of this residue in Et_2O (29 mL, 0.1 M, 1 equiv.) was added CH_2N_2 (58 mL, 0.4 M, 8 equiv.) at 0 ºC. The mixture was stirred at this temperature for 3 h, and quenched with 0.5 M AcOH. Then the solution was extracted with EtOAc, and the combined organic solutions were washed with brine, dried with $MgSO_4$, and concentrated *in vacuo*. The residue was purified by column chromatography (SiO_2, eluent: 33% ethyl acetate, 66% hexanes) to afford product **77** (0.58 g, 2.34 mmol, 81%) as a yellow solid.

mp=149-152 °C.; ^{1}H NMR (600 MHz, $CDCl_3$): δ 5.45 (s, 1H), 4.02 (s, 2H), 3.94 (s, 3H), 3.02 (s, 2H), 2.16 (s, 2H), 1.74 (s, 3H), 1.02 (s, 6H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 199.1, 172.2, 166.1, 156.9, 106.0, 105.6, 57.6, 50.3, 47.8, 40.3, 33.0, 28.4, 6.8.; HRMS (FI) *m/z* calculated for $C_{14}H_{19}NO_3Na$: $[M + Na]^+$ 272.1263; found 272.1250.; IR (neat) cm^{-1}: 2924, 2851, 1740, 1667, 1458, 1373, 1242, 1045.; R_f=0.15 (50% ethyl acetate, 50% hexanes).

Procedure 35: Compound **78**



78

To a solution of the compound **77** (180 mg, 0.72 mmol, 1 equiv.) and HMPA (0.63 mL, 3.61 mmol, 5 equiv.) in THF (13.6 mL, 0.05 M) was added KHMDS (0.87 mL, 1.0 M, 1.2 equiv.) at -78 ºC. After stirring at this temperature for 1 h, MeI (0.36 mL, 5.76 mmol, 8 equiv.) was added dropwise. The reaction mixture was kept at this temperature for 6 h and then warmed slowly to room temperature over 12 h before it was quenched with saturated aqueous NH_4Cl. The solution was extracted with EtOAc, and the combined organic solutions were washed with brine, dried with $MgSO_4$, and concentrated *in vacuo*. The residue was purified by column chromatography (SiO_2, eluent: 16% ethyl acetate, 84% hexanes to 50% ethyl acetate, 50% hexanes) to afford product **77'** (167 mg, 0.63 mmol, 88%) as a yellow oil.

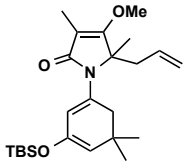
^{1}H NMR (600 MHz, $CDCl_3$): δ 5.33 (s, 1H), 4.12 (q, J = 6.3 Hz, 1H), 4.02 (s, 3H), 3.19 (d, J = 18.2 Hz, 1H), 2.72 (d, J = 18.1 Hz, 1H), 2.16 (q, J = 12.8 Hz, 2H), 1.88 (s, 3H), 1.30 (d, J = 6.5 Hz, 3H), 1.04 (s, 3H), 0.98 (s, 3H).; ^{13}C NMR (151 MHz, $CDCl_3$): δ 199.1,

172.0, 170.6, 155.8, 108.6, 102.5, 58.8, 54.6, 50.3, 41.2, 33.4, 29.3, 27.2, 16.4, 7.9.; HRMS (FI) *m/z* calculated for $C_{15}H_{21}NO_3Na$: $[M + Na]^+$ 286.1419; found 286.1415.; IR (neat) cm^{-1}: 2955, 1655, 1586, 1458, 1377, 1250, 1076, 1030.; R_f=0.20 (50% ethyl acetate, 50% hexanes).

The procedure to prepare compound **78** is similar to the one to yield compound **77'**, during which the allyl bromide (13.5 equiv.) was used instead of MeI. The crude product was purified by gradient column chromatography (SiO_2, eluent: 16% ethyl acetate, 84% hexanes to 50% ethyl acetate, 50% hexanes) to afford **78** as a yellow oil in 38% yield (52% based on recovery of starting material).

^1H NMR (500 MHz, $CDCl_3$): δ 5.73 (s, 1H), 5.33-5.28 (m, 1H), 5.01-4.97 (m, 2H), 4.08 (s, 3H), 2.90 (q, *J* = 13.8 Hz, 2H), 2.76 (dd, *J* = 14.8, 6.8 Hz, 1H), 2.47 (dd, *J* = 14.7, 7.1 Hz, 1H), 2.21 (s, 2H), 1.96 (s, 3H), 1.48 (s, 3H), 1.05 (s, 3H), 1.03 (s, 3H).; ^{13}C NMR (126 MHz, $CDCl_3$): δ 199.6, 172.3, 171.6, 156.3, 130.9, 119.1, 111.1, 101.9, 66.8, 59.1, 50.2, 42.4, 38.5, 33.6, 28.4, 28.1, 23.2, 8.1.; HRMS (FI) *m/z* calculated for $C_{18}H_{25}NO_3Na$: $[M + Na]^+$ 326.1732; found 326.1727. IR (neat) cm^{-1}: 2955, 1709, 1670, 1589, 1362, 1281, 1238, 1099.; R_f=0.21 (25% ethyl acetate, 75% hexanes).

Procedure 36: Compound **79**



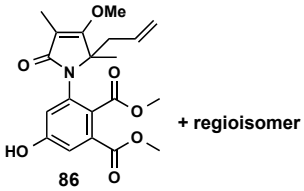
79

CVA **78** was azeotroped 3x in toluene, diluted in THF and put over 4Å molecular sieves. KHMDS (0.94 M, 0.114 mL, 0.107 mmol, 1.3 equiv.) in THF was cooled to -78 °C.

The THF solution of **78** was cannulated into the base and stirred for 5 min. The enolate was protected with TBS-Cl (24.83 mg, 0.1648 mmol, 2.0 equiv.) by cannulation in THF. The resultant reaction mixture was allowed to warm to rt over 5h. The solution was concentrated, diluted in ether and filtered over celite. The solution was concentrated to afford the diene **79** (73%-97%), which was used crude.

^{1}H NMR (500 MHz, $CDCl_3$) δ 5.56 (s, 1H), 5.51-5.43 (m, 1H), 5.04-4.98 (m, 2H), 4.63 (d, *J* = 1.5 Hz, 1H), 4.02 (s, 3H), 2.51-2.38 (m, 3H), 2.23-2.24 (dd, *J* = 1.5, 15.5 Hz, 1H), 1.96 (s, 3H), 1.32 (s, 3H), 1.06 (s, 3H), 1.04 (s, 3H), 0.85 (s, 9H), -0.01 (s, 6H).; No ^{13}C, HRMS, IR or R_f data taken due to the diene sensitivity. The acid sensitive compound was used crude.

Procedure 37: Compound **86**



86

Diene **79** was subjected to Diels-Alder reaction conditions with DMAD (15 μL, 0.1197 mmol, 2 equiv.) and benzene (2 mL). The mixture was heated at 150 °C for 12h to yield a regioisomeric mixture of phenolic products in a 2:1 ratio. The major product was the desired isomer and the corresponding thermodynamic aromatic product was the minor product. The products were purified by column chromatography (SiO_2, eluent: hexanes to 60% ethyl acetate, 40% hexanes) to yield **86** and the thermodynamic isomer **86b** (20 mg, 85%, combined yield).

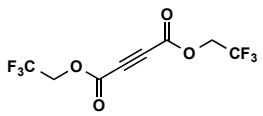
86: ^{1}H NMR (500 MHz, C_6D_6, T=70 °C) δ 7.44 (S, 1H), 6.50 (S, 1H), 5.76-5.68 (m, 1H), 5.05-3.94 (m, 2H), 3.61 (s, 3H), 3.51 (s, 3H), 3.42 (s, 3H), 2.42-2.24 (m, 2H), 1.86 (s, 3H), 1.25 (s, 3H).; ^{13}C NMR (151 MHz, $CDCl_3$) δ 173.74, 171.02, 167.14, 166.73, 158.95, 134.14, 133.14, 131.87, 125.14, 121.81, 118.87, 117.56, 100.70, 67.17, 58.86, 52.49, 52.36, 40.33, 20.69, 8.16.; HRMS (ESI/TOF) *m/z* calculated for $C_{20}H_{23}O_7N$: $[M + Na]^+$ 412.1372; found 412.1366.; IR (neat) cm^{-1}: 3132, 3078, 3001, 2951, 2252, 1732, 1651, 1608, 1435, 1392, 1334, 1265, 1234, 1145, 991, 918.; R_f=0.14 (60% ethyl acetate, 40% hexanes).

86 as phenol methyl ester (86-ME): ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.28 (s, 1H), 6.92 (s, 1H), 5.68-5.61 (m, 1H), 5.16-5.08 (m, 2H), 4.08 (s, 3H), 3.86 (s, 3H), 3.83 (s, 3H), 3.74 (s, 3H), 2.54-2.53 (m, 2H), 2.02 (s, 3H), 1.29 (s, 3H).

86b: ^{1}H NMR (600 MHz, $CDCl_3$) δ 10.68 (s, 1H), 7.21 (s, 1H), 7.06 (s, 1H), 5.46-5.39 (m, 1H), 5.017-4.96 (m, 2H), 4.10 (s, 3H), 3.90 (s, 3H), 3.86 (s, 3H), 2.56-2.48 (m, 2H), 2.03 (s, 3H), 1.44 (s, 3H).; ^{13}C NMR (151 MHz, $CDCl_3$) δ 172.28, 170.35, 169.98, 161.83, 143.18, 138.21, 135.99, 131.27, 119.05, 116.45, 114.29, 106.84, 101.61, 66.32, 58.98, 52.77, 52.61, 39.67, 23.87, 8.19.; HRMS (ESI/TOF) *m/z* calculated for $C_{20}H_{23}O_7N$: $[M + Na]^+$ 412.1372; found 412.1362. No IR data obtained.; R_f=0.23 (60% ethyl acetate, 40% hexanes).

Preparation of Acetylenic Dienophiles

Procedure 38: Acetylene *bis*(2,2,2-trifluoroethyl) but-2-ynedioate

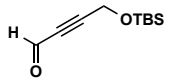


A

Acetylene **A** was prepared by modification of a previous procedure and the product was confirmed with the known ^{1}H and ^{13}C data.[49] Butynedioic acid (1.5 g, 13.15 mmol, 1 equiv.), $BF_3 \bullet OEt_2$ (3.5 mL, 27.62 mmol, 2.1 equiv.) and 2,2,2-trifluoroethanol were added to a RBF fitted with a reflux condenser. The solution was refluxed at 80 °C for 3.5h and then stirred overnight at rt. The reaction mixture was diluted in Et_2O and washed with water multiple times, then with brine. The acetylene **A** was used in crude form with >90% purity and stored frozen as a solution in benzene.

R_f=0.45 (10% ether, 90% hexanes).

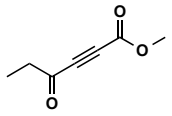
Procedure 39: Acetylene 4-((*tert*-butyldimethylsilyl)oxy)but-2-ynal



B

B was prepared from 4-(*tert*-butyldimethylsilyloxy) but-2-yn-1-ol (**B-1**). The mono-protected diol was prepared by a known procedure and compared with known ^{1}H and ^{13}C values.[50] Oxidation to the aldehyde **B** was done by modifying a known procedure that uses Dess-Martin Periodinane.[51] As an alternative to DMP, we use IBX, prepared using oxone.[52] Mono-protected diol **B-1** (273 mg, 1.37 mmol, 1.0 equiv.), IBX (422 mg, 1.507 mmol, 1.1 equiv.) and EtOAc (10 mL) were added to a 50 mL RBF fitted with a reflux condenser and refluxed at 80 °C for 7h. The reaction was then filtered over a frit and concentrated in vacuo. The crude reaction mixture was purified by column chromatography (SiO_2, eluent: hexanes to 5% ethyl acetate, 95% hexanes) to afford the product **B** (232 mg, 85%) as a pure oil which was stored frozen as a solution in benzene.

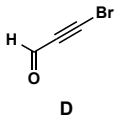
Procedure 40: Acetylene methyl-4-oxohex-2-ynoate



C

C was prepared from methyl 4-hydroxyhex-2-ynoate (**C-1**) which was prepared from a known literature procedure.[53] Propargyllic alcohol **C-1** using an adaptation from a known procedure which uses DMP.[54] Alcohol **C-1** (1.015 g, 7.14 mmol, 1.0 equiv.), IBX (3.0 g, 10.71 mmol, 1.5 equiv.) and EtOAc (60 mL) were added to a 100 mL RBF fitted with a reflux condenser and refluxed at 80 °C for 24h. The reaction mixture was then filtered over a frit, concentrated and purified using gradient column chromatography (SiO_2, eluent: hexanes to 10% ethyl acetate, 90% hexanes) to yield **C** (407 mg, 41%) as a colorless oil which matched previously reported ^1H data.

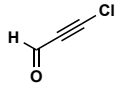
Procedure 41: Acetylene 3-propionaldehyde



D

Acetylene **D** was prepared by bromination of propargyl alcohol as outlined in previous work.[55] 1- bromo-propargyl alcohol (1 equiv.) was then oxidized using IBX (1.2 equiv.) by refluxing in ethyl acetate to afford 3-bromopropionaldehyde upon filtration through celite to match published information.[56] This was used crude as a solution in ethyl acetate for the Diels-Alder reaction.

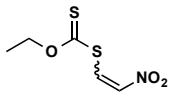
Procedure 42: Acetylene 3-chloropropionaldehyde



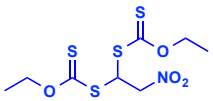
E

Acetylene **E** was prepared by chlorination of propargyl alcohol diethyl acetal as outlined by name.[57] 1-chloro-propargyl aldehyde diethyl acetal (3.96 g) and 4M H_2SO_4 (20 mL) were added to a RBF attached to a short-path vigreaux distillation apparatus. The solution was refluxed and 3-chloropropionaldehyde was collected in the receiving flask at -78 °C as a solution in ethanol. This was used crude in ethanol for the Diels-Alder reaction.

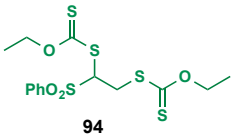
Procedure 43: Compound **92**



92



93



94

Sulfone **91** (50 mg, 0.25 mmol, 1 equiv.) and the potassium ethyl xanthogenate salt (48 mg, 0.27 mmol, 1.1 equiv.) were added to a round bottom flask fitted with a stir bar open to air. The solids were then diluted in $CHCl_3$ (5 mL, 0.05 M) and stirring of the suspension was started. Acetic acid (0.14 mL, 2.5 mmol, 10 equiv.) was then added dropwise and the reaction was stirred until reaction completion. This usually takes about 5-20 minutes. The reaction mixture was diluted with water and the organic products were extracted with $CHCl_3$ (3 x 5 mL). The combined organic layers were then dried over Na_2SO_4 and filtered and concentrated. The products were then purified by column chromatography (SiO_2, eluent: hexanes to 6% ethyl acetate, 94% hexanes) to yield **92** as a mixture of *cis*- and *trans*-isomers of the xanthate reagent *cis*-**92** and *trans*-**92** (2:1 ratio in crude mixture, 16 mg, 33% yield). Note: When acetic acid was added first, the xanthate acetal **93** was formed. When >2

equivalents of the potassium ethyl xanthogenate salt were added, the double substitution product **94** was formed as the predominant product, especially after prolonged stirring.

cis-**92:** ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.49 (d, 1H, *J* = 7.6 Hz), 7.25 (d, 1H, *J* = 7.6 Hz), 4.78 (q, 2H, *J* = 7.1 Hz), 1.50 (t, 3H, *J* = 7.1 Hz.; R_f=0.75 (10% ethyl acetate, 90% hexanes).

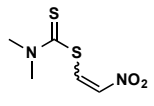
trans-**92:** ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.84 (d, 1H, *J* = 13.8 Hz), 7.27 (d, 1H, *J* = 13.8 Hz), 4.78 (q, 2H, *J* = 7.1 Hz), 1.50 (t, 3H, *J* = 7.1 Hz).; R_f=0.5 (10% ethyl acetate, 90% hexanes).

cis- and *trans*-**92:** ^{13}C NMR (151 MHz, $CDCl_3$) δ 207.93, 203.34, 139.50, 138.99, 134.66, 133.21, 72.15, 72.09, 13.67, 13.65.

acetal **93:** ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.10 (t, 1H, *J* = 6.0 Hz), 5.05 (d, 2H, *J* = 6.0 Hz), 4.68 (q, 4H, *J* = 7.1 Hz), 1.45 (t, 6H, *J* = 7.1 Hz).; ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.56, 71.16, 52.32, 13.68.; R_f=0.625 (10% ethyl acetate, 90% hexanes).

double substation product **94:** ^{1}H NMR (500 MHz, $CDCl_3$) δ 8.02-7.97 (m, 2H), 7.68 (ddt, 1H, *J* = 8.0, 7.0, 1.2 Hz), 7.56 (m, 2H), 7.62-7.47 (m, 2H), 5.66 (dd, 1H, *J* = 11.4, 3.7 Hz), 4.67-4.55 (m, 2H), 4.58-4.41 (m, 3H), 4.18 (dd, 1H, *J* = 14.6, 3.8 Hz), 3.33 (dd, 1H, *J* = 14.6, 11.4 Hz), 1.40 (t, 3H, *J* = 7.1 Hz), 1.33 (t, 3H, *J* = 7.1 Hz).; ^{13}C NMR (151 MHz, $CDCl_3$) δ 212.21, 209.06, 136.50, 134.41, 129.84, 129.10, 71.62, 71.00, 70.61, 33.86, 13.70, 13.58.; R_f=0.25 (10% ethyl acetate, 90% hexanes).

Procedure 44: Compound **96**

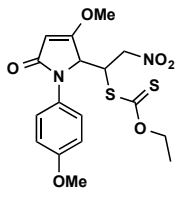


96

Sulfone **91** (9.1 g, 45 mmol, 1 equiv.) was added to a round bottom flask with a stir bar and diluted in $CHCl_3$ (350 mL, 0.05 M). Stirring was started and sodium dimethyldithiocarbamate hydrate (7.12 g, 50 mmol, 1.1 equiv.) was added to the solution portionwise. The reaction was stirred open to air at room temperature until completion by TLC. This usually took about 2-6 hours and was not changed when stirred for longer periods of time. The reaction mixture was then diluted with water and the organic product was extracted with $CHCl_3$ (3 x 5 mL). The combined organic layers were then dried over Na_2SO_4 and filtered and concentrated. The products were then purified by column chromatography (SiO_2, eluent: hexanes to 30% ethyl acetate, 70% hexanes) to yield **92** as a mixture of *cis*- and *trans*-isomers of the xanthate reagent *cis*-**92** and *trans*-**92** (~4:1 to ~10:1, 1.99 g, 23% yield).

cis-**96:** ^{1}H NMR (500 MHz, $CDCl_3$) δ 9.09 (d, 1H, J = 7.8 Hz), 7.33 (d, 1H, J = 7.8 Hz), 3.63 (s, 3H), 3.55 (s, 3H.; ^{13}C NMR (151 MHz, $CDCl_3$) δ 190.57, 141.14, 133.23, 129.92, 46.99, 41.76.; R_f=0.45 (33% ethyl acetate, 67% hexanes).

Procedure 45: Compound **98**



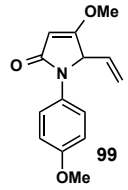
98

A 10 mL RBF was flame-dried under a nitrogen balloon and the solid tetramic acid **97** (20 mg, 0.091 mmol, 1 equiv.) was added to the flask. Dry dichloromethane was then added to the flask and was cooled to -78 °C. Upon cooling, Et_3N (25 μL, 0.182 mmol, 2 equiv.) was added dropwise to the flask and stirred for 10 minutes. TMSOTf (35 μL, 0.182 mmol, 2

equiv.) was then added to the reaction mixture and allowed to stir for 15 minutes. The vinyl nitro xanthate reagent **92** (mixture of isomers in dry CH_2Cl_2) was then added dropwise to the reaction and the resultant mixture was allowed to warm to rt over 4h upon completion by TLC. The reaction mixture was quenched with saturated NH_4Cl and the products (mixture of diastereomers) were extracted using dichloromethane (3 x 5 mL). The combined organics were then dried over Na_2SO_4, filtered then concentrated. The crude mixture was purified by column chromatography (SiO_2, eluent: hexanes to 70% ethyl acetate, 30% hexanes) to yield **98** as a mixture of diastereomers (18 mg, 48% yield).

98: ^{1}H NMR: not reporting data.; ^{13}C NMR: no data collected.; R_f=0.33 (60% ethyl acetate, 40% hexanes).

Procedure 46: Compound **99**

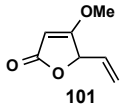


99

The conjugate addition product **98** (18 mg, 0.044 mmol, 1 equiv., mixture of diastereomers) was added to a sealed tube and diluted in benzene (3 mL, 0.015 M). The flask was charged with a stir bar and lauroyl peroxide (51 mg, 0.13 mmol, 3 equiv.) and sealed with a Teflon lined cap. The reaction vessel was then heated for 2h at 80 °C. After the reaction was complete, the solution was concentrated and purified by by column chromatography (SiO_2, eluent: hexanes to 75% ethyl acetate, 25% hexanes) to yield **99** (6 mg, 56% yield).

99: ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36-7.32 (m, 2H), 6.90-6.86 (m, 2H), 5.58 (ddd, 1H, *J* = 17.1, 10.1, 7.8 Hz), 5.41-5.30 (m, 2H), 5.17 (d, 1H, *J* = 0.8 Hz), 4.90 (dd, 1H, *J* = 7.8, 0.8 Hz), 3.84 (s, 3H), 3.78 (s, 3H).; ^{13}C NMR: no data collected.; R_f=0.17 (50% ethyl acetate, 50% hexanes).

Procedure 47: Compound **101**



101

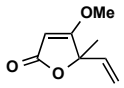
A 10 mL RBF was flame dried and a nitrogen balloon was attached. The solid tetronic acid **101** (11.7 mg, 0.103 mmol, 1 equiv.) was added to the flask and diluted in dry THF (5 mL, 0.02 M). The mixture was then cooled to -78 °C and *n*-BuLi (0.067 mL, 0.114 mmol, 1.1 equiv.) was then added dropwise. The resultant solution was stirred for 10 minutes. At this time, the xanthate reagent **92** (40 mg, 0.207 mmol, 2 equiv., mixture of isomers in dry THF) was added dropwise and the solution turned a dark orange color. The reaction mixture was quenched upon completion by TLC (50 minutes) with saturated NH_4Cl and extracted with EtOAc (3 x 5 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated. The reaction mixture was purified by column chromatography (SiO_2, eluent: hexanes to 35% ethyl acetate, 65% hexanes) to yield the conjugate addition product, **101 CA product** (14 mg, 45% yield).

101 CA product: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum included, no values reported.; ^{13}C NMR: no data collected.; R_f=0.17 (33% ethyl acetate, 67% hexanes).

The purified product **101 CA product** (14 mg, 0.045 mmol, 1 equiv.) was then dissolved in benzene (2.5 mL, 0.02 M) and added to a vial fitted with a stir bar. Lauroyl peroxide (54 mg, 0.14 mmol, 3 equiv.) was then added to the reaction vial and it was sealed with a Teflon lined cap and heated at 80 °C for 2h. The reaction mixture was concentrated and purified by column chromatography (SiO_2, eluent: hexanes to 40% ethyl acetate, 60% hexanes) to yield **101** (6 mg, 95% yield).

101: ^{1}H NMR (500 MHz, $CDCl_3$) δ 5.75 (m, 1H), 5.57 (d, 1H), 5.17 (d, 1H), 5.38 (d, 1H), 5.05 (s, 1H), 3.87 (s, 3H.; ^{13}C NMR (151 MHz, $CDCl_3$) δ 181.04, 172.15, 130.90, 120.48, 88.16, 79.38, 59.57, 29.68.; R_f=0.3 (33% ethyl acetate, 67% hexanes).

Procedure 48: Compound **103**



103

A 10 mL RBF was flame dried and a nitrogen balloon was attached. The *C*-3 methyl tetronic acid **102** (6.6 mg, 0.517 mmol, 1 equiv.) was added to the flask and diluted in dry THF (5 mL, 0.01 M). The mixture was then cooled to -78 °C and *n*-BuLi (0.032 mL, 0.054 mmol, 1.05 equiv.) was then added dropwise. The resultant solution was stirred for 10 minutes. At this time, the xanthate reagent **92** (20 mg, 0.103 mmol, 2 equiv., mixture of isomers in dry THF) was added dropwise and the solution turned a dark orange color. The reaction mixture was quenched upon completion by TLC (50 minutes) with saturated NH_4Cl and extracted with EtOAc (3 x 5 mL). The combined organic layers were dried over Na_2SO_4, filtered and concentrated. The reaction mixture was purified by column

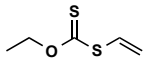
chromatography (SiO_2, eluent: hexanes to 35% ethyl acetate, 65% hexanes) to yield **102 CA product** (7 mg, 42% yield).

102 CA product: ^{1}H NMR (500 MHz, $CDCl_3$): spectrum included, values not reported.; ^{13}C NMR: no data collected.; R_f=0.40 (50% ethyl acetate, 50% hexanes).

The purified conjugate addition product, **103 CA product** (7 mg, 0.022 mmol, 1 equiv.) was then dissolved in benzene (2 mL, 0.01 M) and added to a vial fitted with a stir bar. Lauroyl peroxide (26 mg, 0.065 mmol, 3 equiv.) was then added to the reaction vial and it was sealed with a Teflon lined cap and heated at 80 °C for 2h. The reaction mixture was concentrated and purified by column chromatography (SiO_2, eluent: hexanes to 45% ethyl acetate, 55% hexanes) to yield **103** (3 mg, 89% yield).

103: ^{1}H NMR (600 MHz, $CDCl_3$) δ 5.90 (dd, 1H), 5.43 (dd, 1H), 5.22 (dd, 1H), 4.98 (s, 1H), 3.92 (s, 3H), 1.56 (s, 3H).; ^{13}C NMR: no data collected.; R_f=0.45 (50% ethyl acetate, 50% hexanes).

Procedure 49: Compound **106**



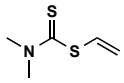
106

A 50 mL round bottom flask was flame dried with 4Å MS and put under a nitrogen balloon. The known disulfide **105** (360 mg, 1.485 mmol, 1 equiv.) was then added as a solution in THF (15 mL, 0.1 M) and the mixture was cooled to -78 °C. After cooling for 10 minutes, vinyl magnesium chloride (0.78 mL, 1.485 mmol, 1 equiv., 1.9M in THF) was then added dropwise to the solution and it was allowed to warm to rt over 5h. After stirring at rt

for 15 minutes, the reaction mixture was quenched with 1M HCl to yield the vinylated ethyl xanthate **106** in quantitative yield without purification.

106: ^{1}H NMR (500 MHz, $CDCl_3$) δ 6.99 (dd, 1H, *J* = 17.3, 10.0 Hz), 5.52 (d, 1H, *J* = 10.0 Hz), 5.50 (d, 1H, *J* = 17.3 Hz), 4.67 (q, 2H, *J* = 7.3 Hz), 1.43 (t, 3H, *J* = 7.3 Hz).

Procedure 50: Compound **108**

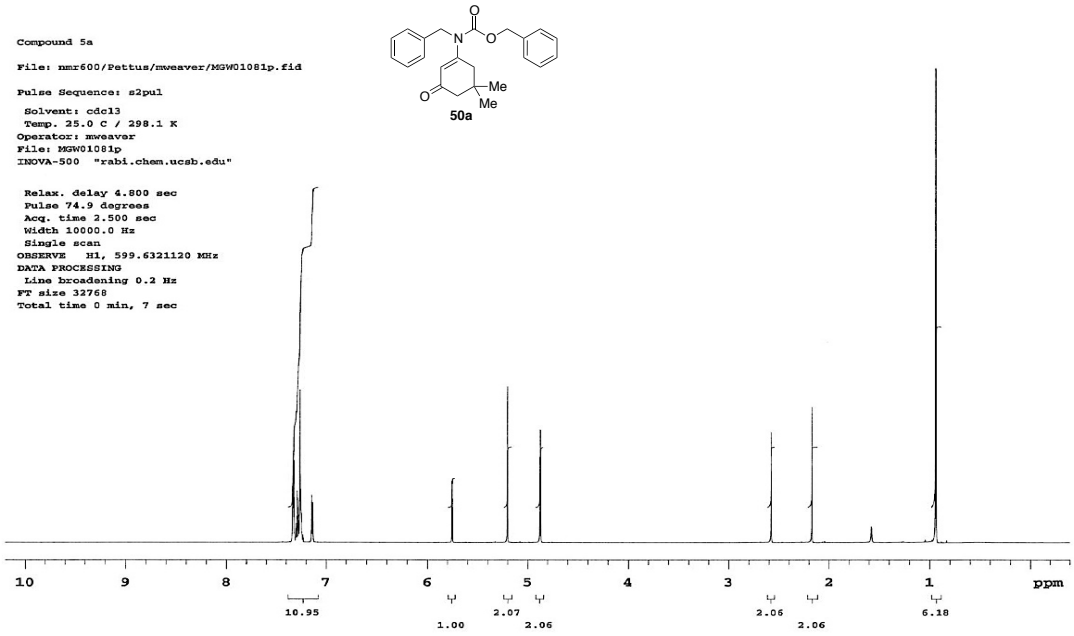


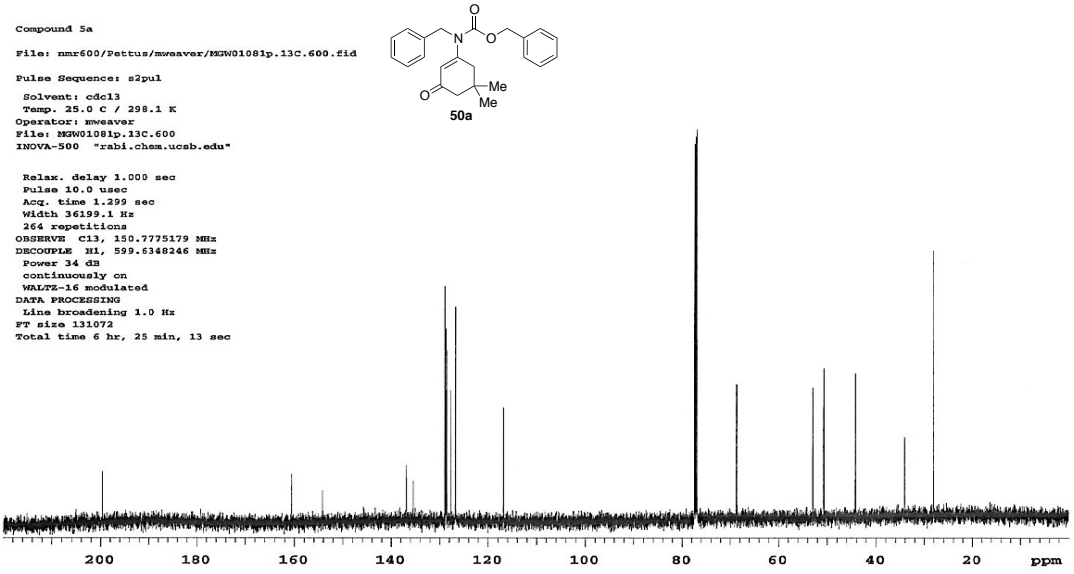
108

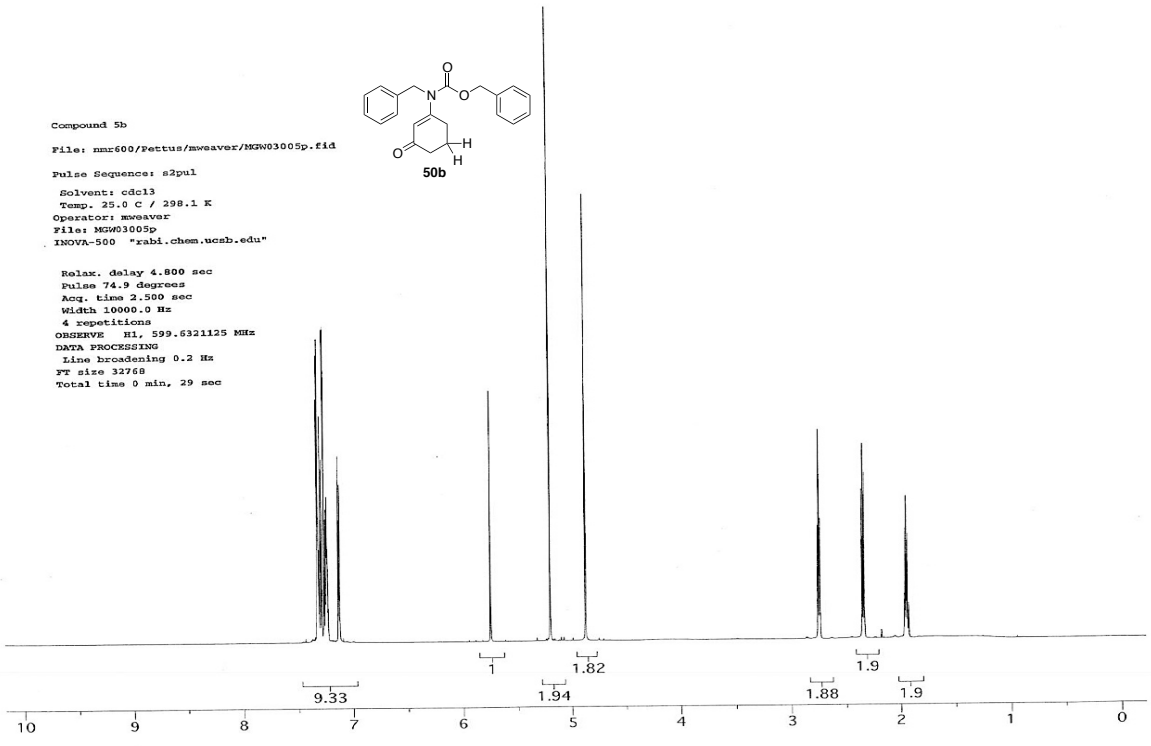
A 50 mL round bottom flask was flame dried with 4Å MS and put under a nitrogen balloon. The known disulfide **107** (70 mg, 0.29 mmol, 1 equiv.) was then added as a solution in THF (5 mL, 0.06 M) and the mixture was cooled to -78 °C. After cooling for 10 minutes, vinyl magnesium chloride (0.84 mL, 1.45 mmol, 5 equiv., 1.9M in THF) was then added dropwise to the solution and it was allowed to warm to rt over 1h. After stirring at rt for 15 minutes, the reaction mixture was quenched with 1M HCl to yield the vinylated dimethyldithiocarbamate **108** in quantitative yield without purification.

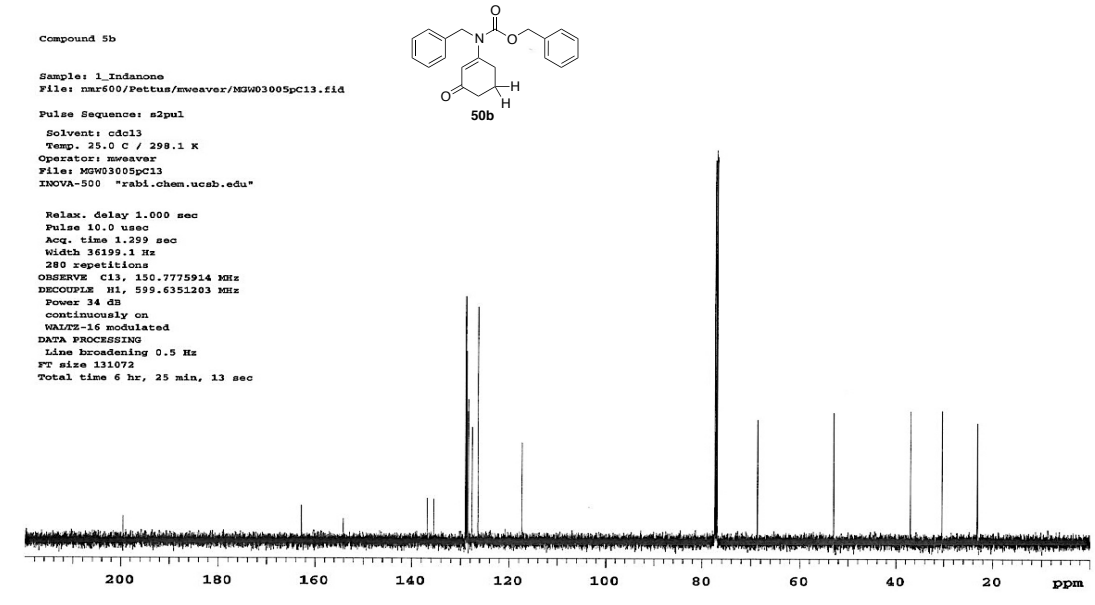
108: ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.16 (dd, 1H), 5.57 (dd, 1H), 3.56 (s, 3H), 3.38 (s, 3H).

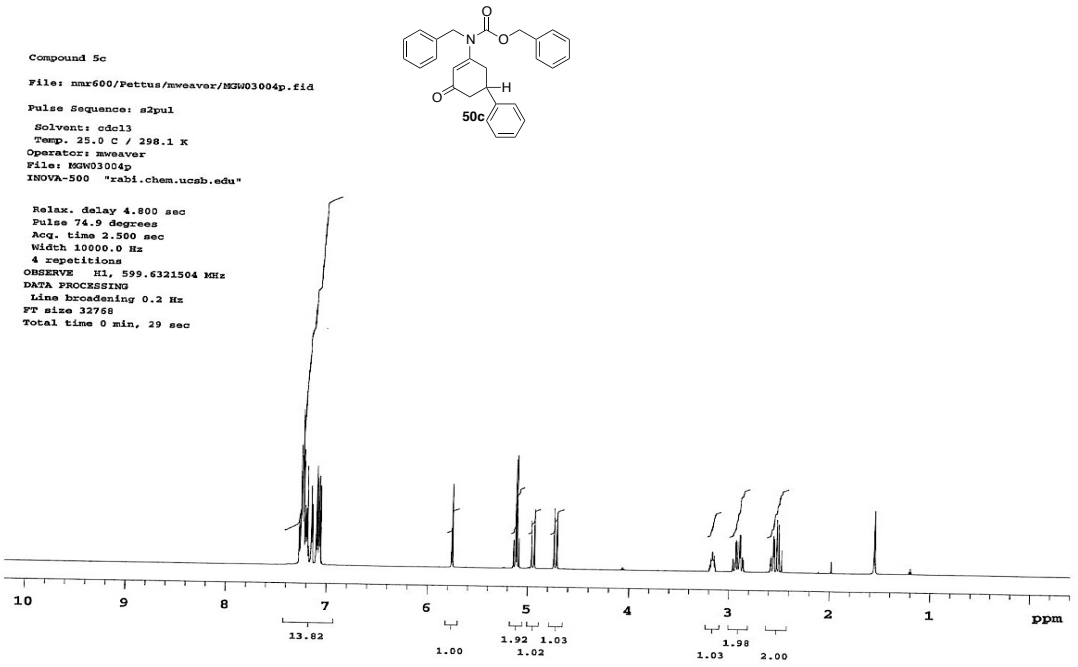
NMR Spectra

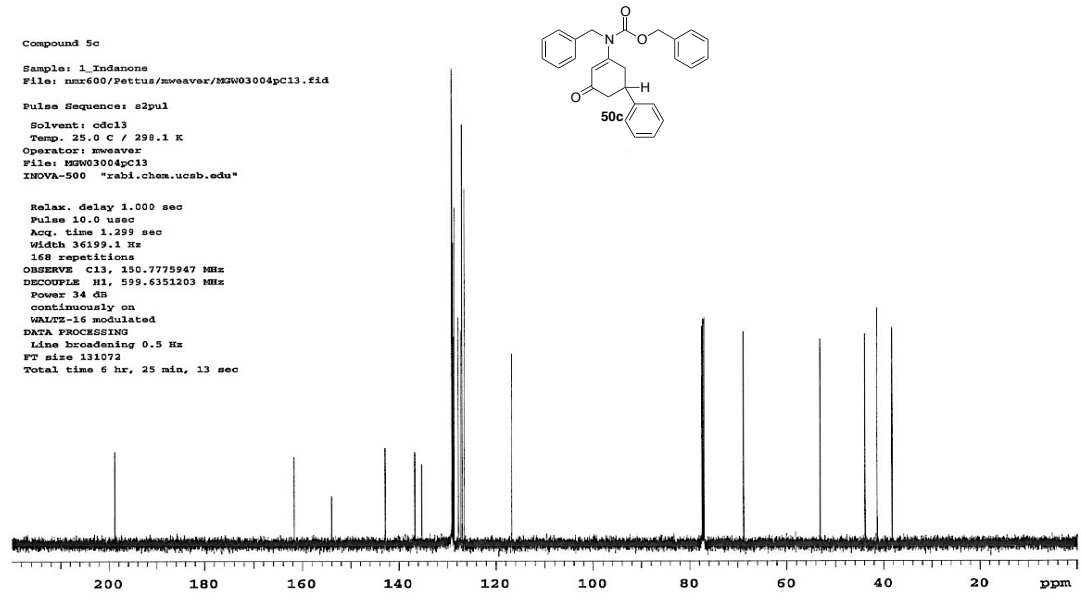

Compound 5a
File: nmr600/Pettus/mweaver/MGW01081p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW01081p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
Single scan
OBSERVE H1, 599.6321120 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 7 sec
Me
Me
50a
10
9
8
7
6
5
4
3
2
1
ppm
10.95
1.00
2.07
2.06
2.06
2.06
6.18

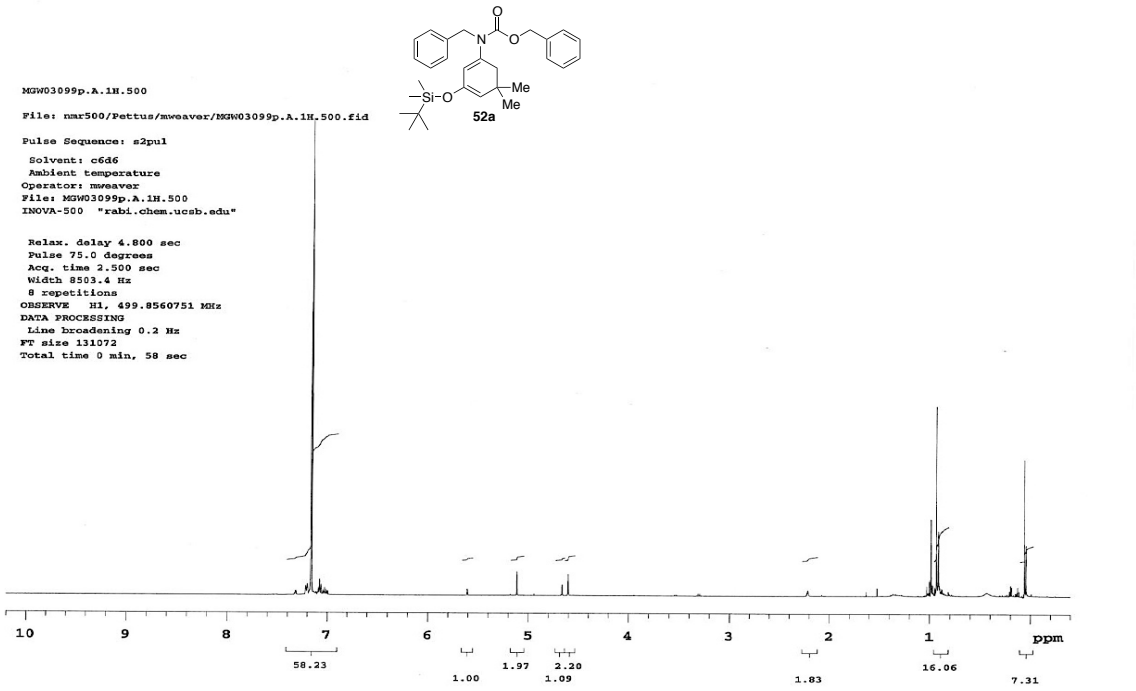

Compound 5a
File: nmr600/Pettus/mweaver/MGW01081p.13C.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW01081p.13C.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
264 repetitions
OBSERVE C13, 150.7775179 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
Me
Me
50a
200
180
160
140
120
100
80
60
40
20
ppm

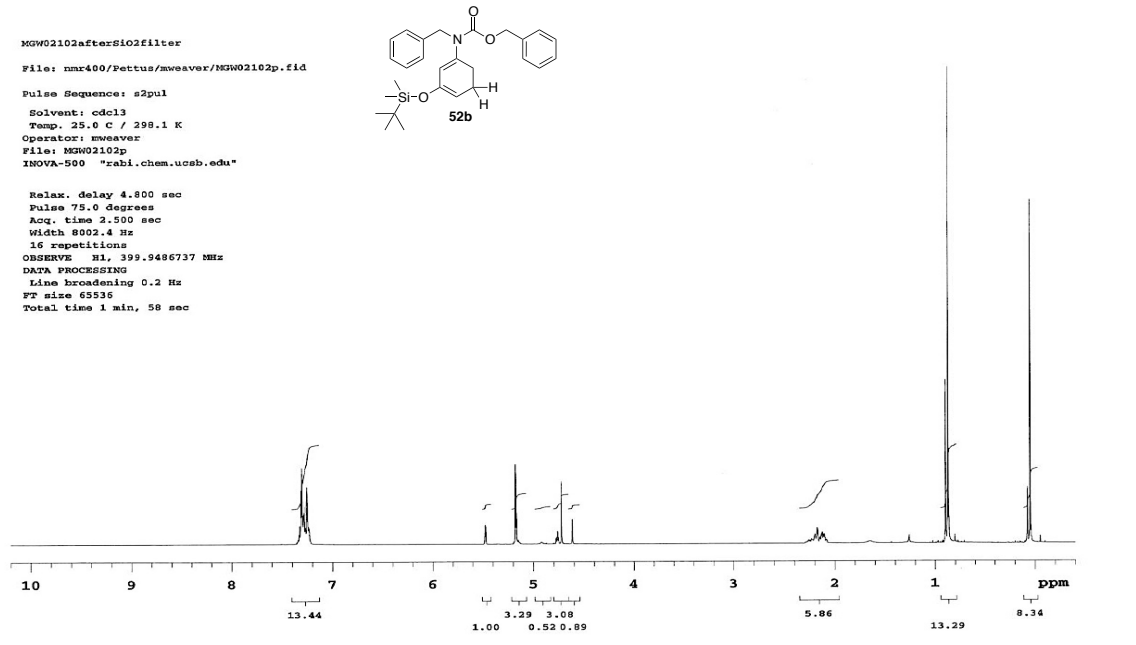

Compound 5b
File: nmr600/Pettus/mweaver/MGW03005p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03005p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
4 repetitions
OBSERVE H1, 599.6321125 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 29 sec
50b
9.33
1
1.94
1.82
1.88
1.9
1.9
10
9
8
7
6
5
4
3
2
1
0

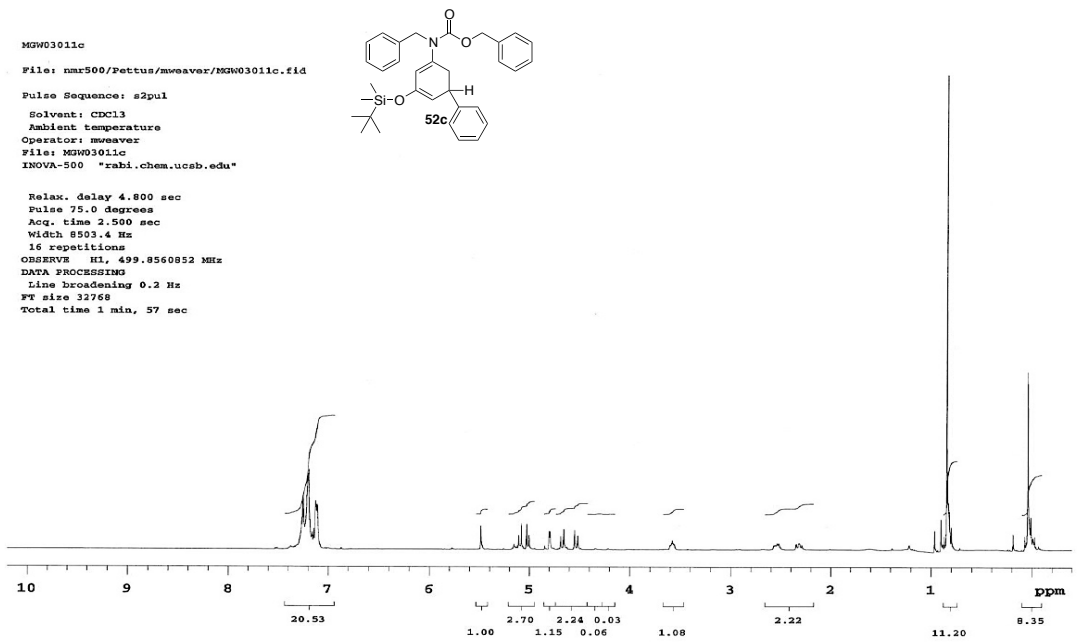

Compound 5b
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW03005pC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03005pC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
280 repetitions
OBSERVE C13, 150.7775914 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
50b
200
180
160
140
120
100
80
60
40
20
ppm

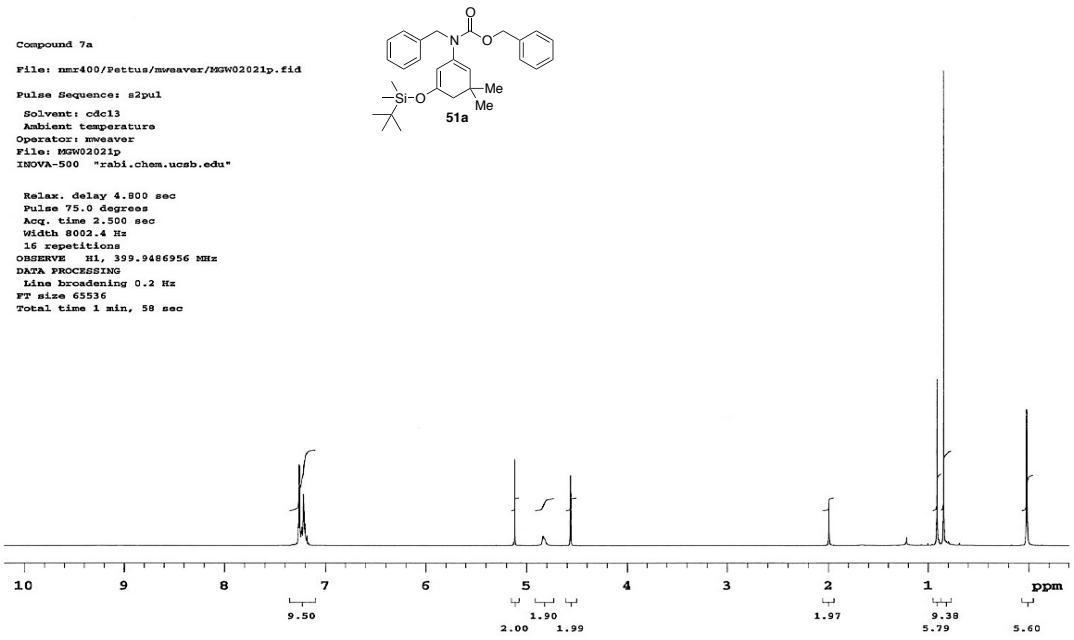

Compound 5c
File: nmr600/Pettus/mweaver/MGW03004p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03004p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
4 repetitions
OBSERVE H1, 599.6321504 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 29 sec
50c
10
9
8
7
6
5
4
3
2
1
ppm
13.82
1.00
1.92
1.03
1.02
1.03
1.98
2.00

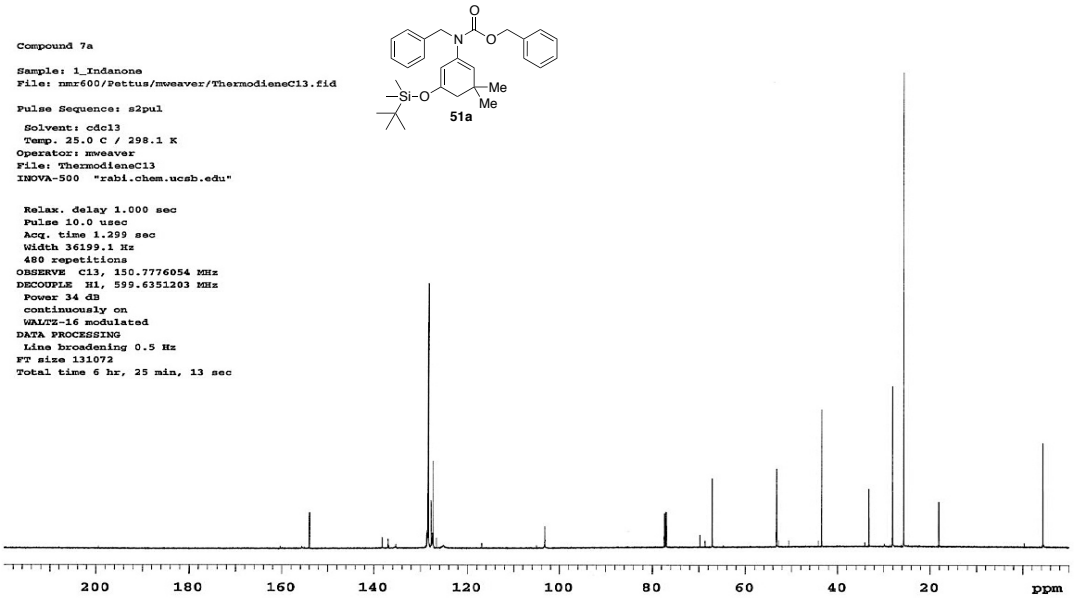

Compound 5c
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW03004pC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03004pC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
168 repetitions
OBSERVE C13, 150.7775947 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
50c
200
180
160
140
120
100
80
60
40
20
ppm

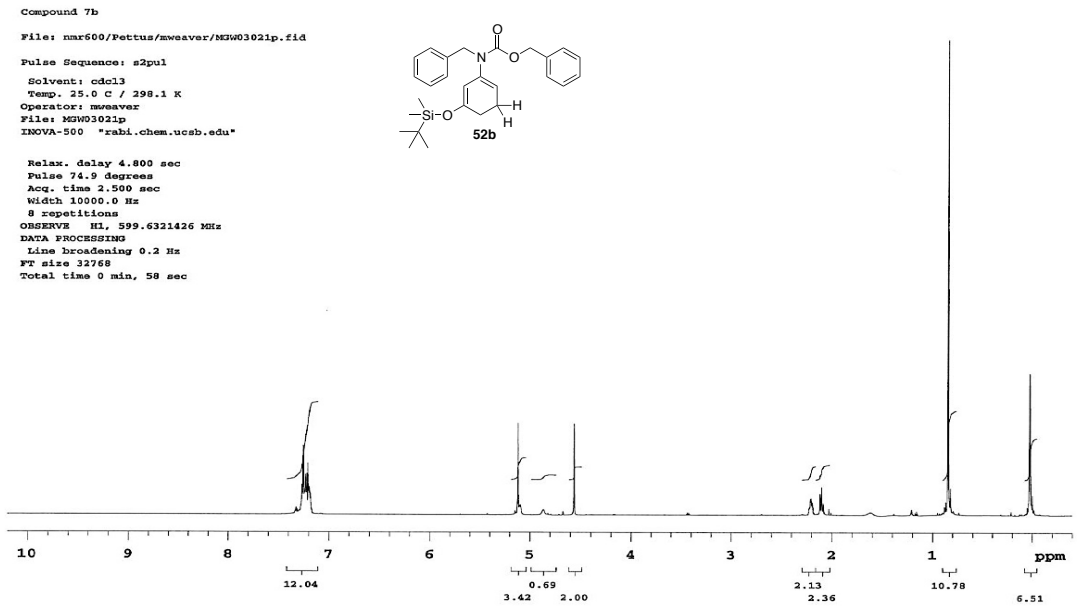

MGW03099p.A.1H.500
File: nmr500/Pettus/mweaver/MGW03099p.A.1H.500.fid
Pulse Sequence: s2pul
Solvent: c6d6
Ambient temperature
Operator: mweaver
File: MGW03099p.A.1H.500
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560751 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
52a
Me
Me
Si
O
N
O
10
9
8
7
6
5
4
3
2
1
ppm
58.23
1.00
1.97
2.20
1.09
1.83
16.06
7.31

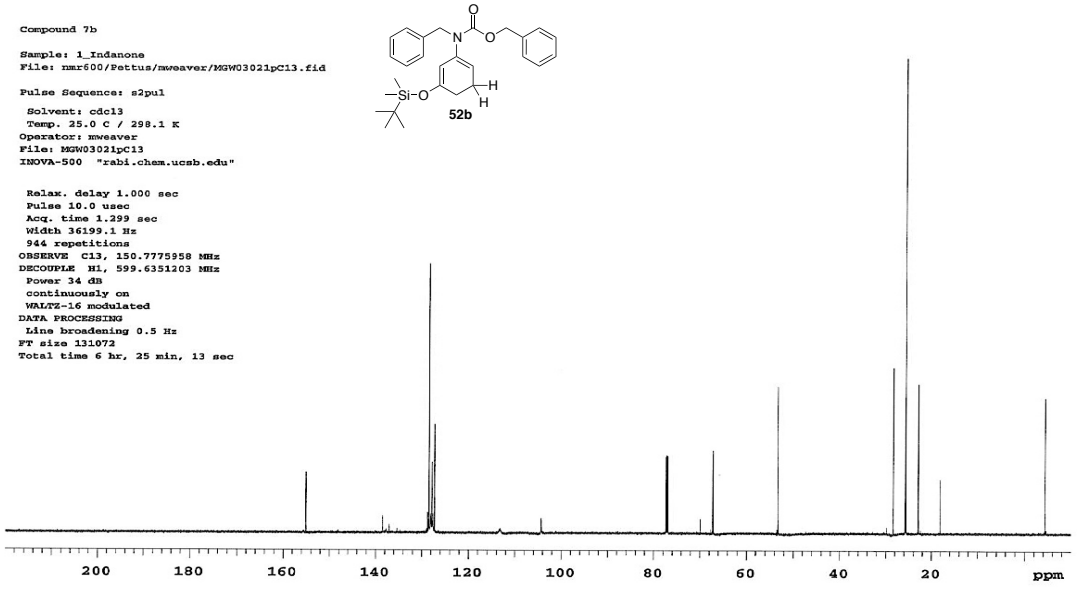

MGW02102afterSiO2filter
File: nmr400/Pettus/mweaver/MGW02102p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02102p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8002.4 Hz
16 repetitions
OBSERVE H1, 399.9486737 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 65536
Total time 1 min, 58 sec
52b
H
H
Si
O
N
O
10
9
8
7
6
5
4
3
2
1
ppm
13.44
1.00
3.29
0.52
3.08
0.89
5.86
13.29
8.34

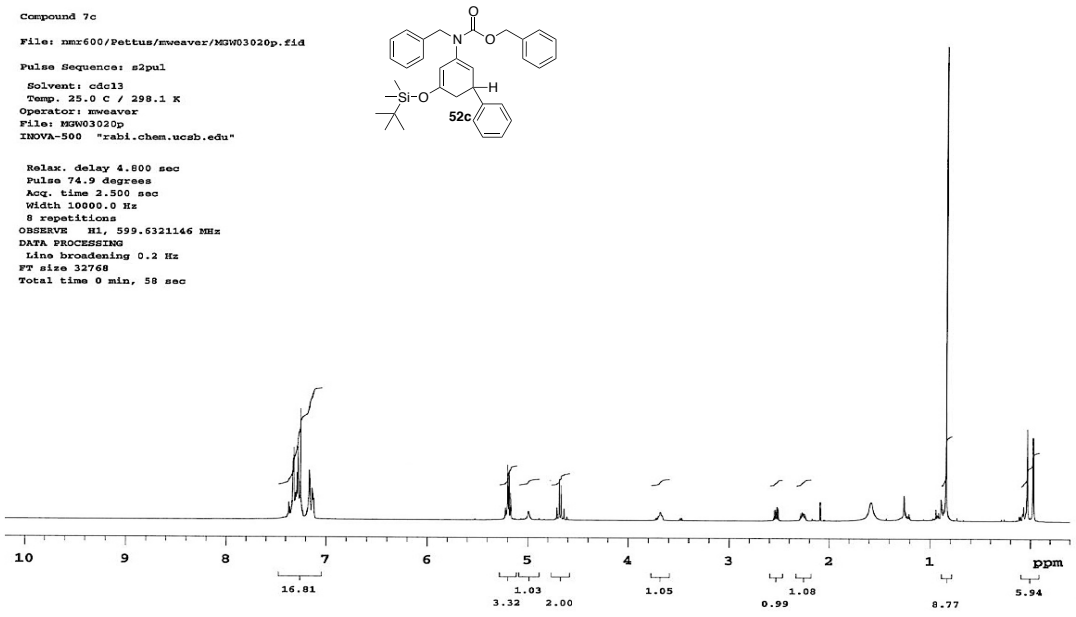

MGW03011c
File: nmr500/Pettus/mweaver/MGW03011c.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mweaver
File: MGW03011c
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
16 repetitions
OBSERVE H1, 499.8560852 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 57 sec
52c
10
9
8
7
6
5
4
3
2
1
ppm
20.53
1.00
2.70
1.15
2.24
0.06
0.03
1.08
2.22
11.20
8.35

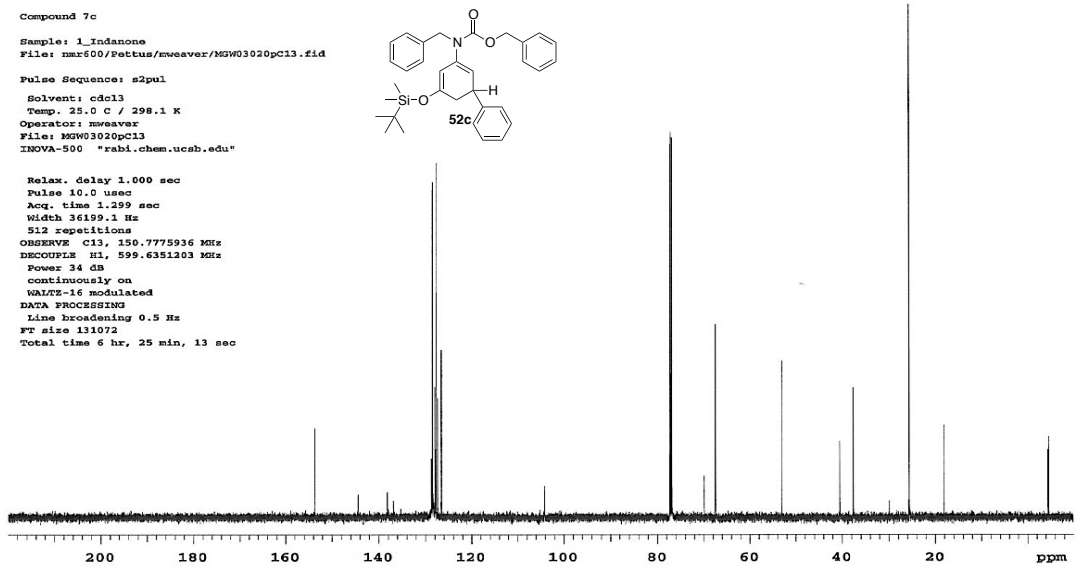

Compound 7a
File: nmr400/Pettus/mweaver/MGW02021p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Ambient temperature
Operator: mweaver
File: MGW02021p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8002.4 Hz
16 repetitions
OBSERVE H1, 399.9486956 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 65536
Total time 1 min, 58 sec
51a
10
9
8
7
6
5
4
3
2
1
ppm
9.50
2.00
1.90
1.99
1.97
9.38
5.79
5.60

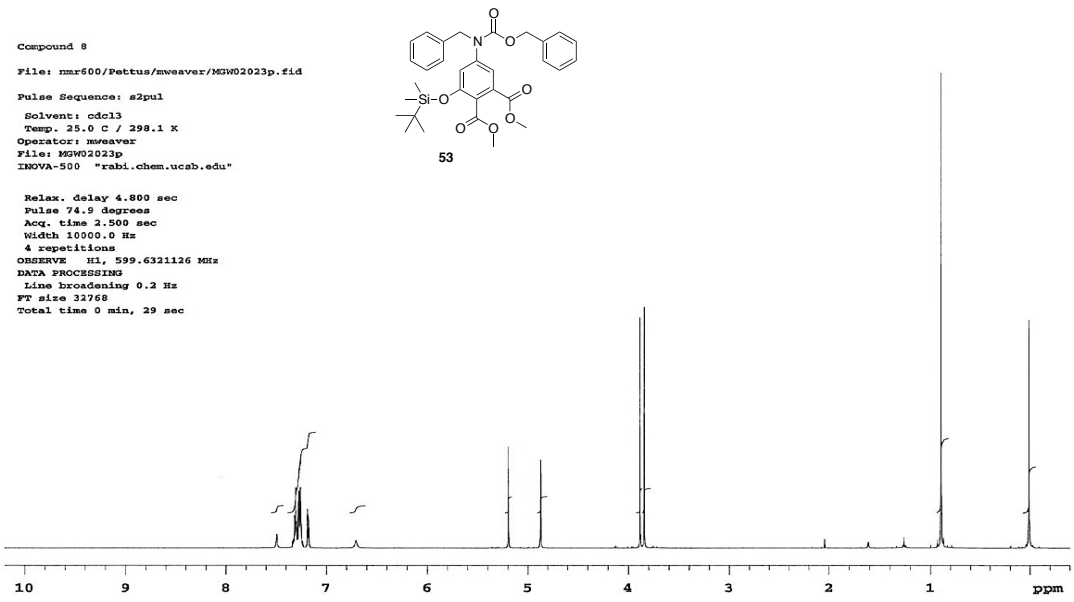

Compound 7a
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/ThermodieneC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: ThermodieneC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
480 repetitions
OBSERVE C13, 150.7776054 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
51a
200
180
160
140
120
100
80
60
40
20
ppm

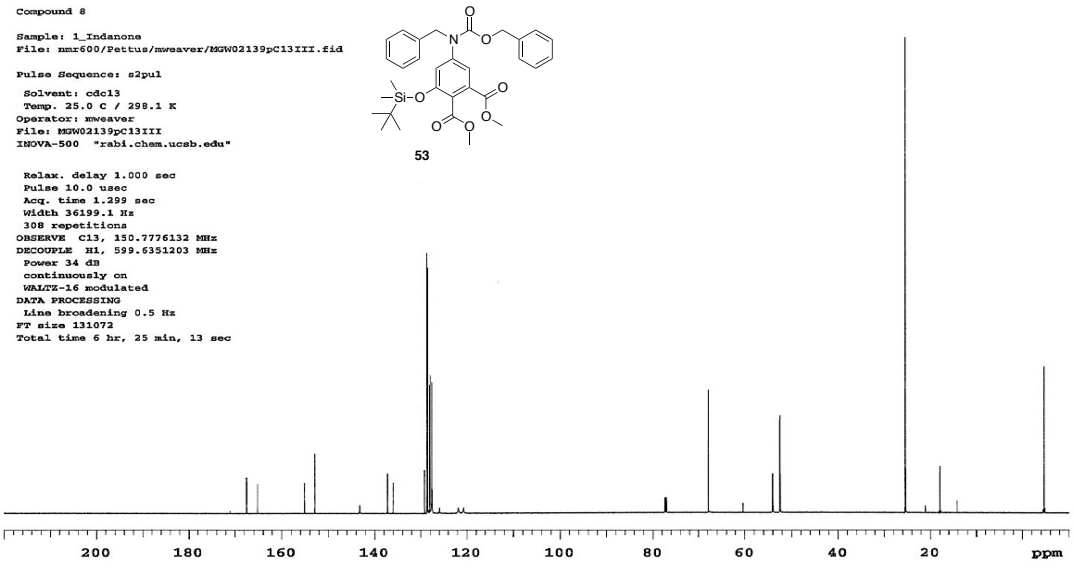

Compound 7b
File: nmr600/Pettus/mweaver/MGW03021p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03021p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321426 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
52b
10
9
8
7
6
5
4
3
2
1
ppm
12.04
0.69
3.42
2.00
2.13
2.36
10.78
6.51

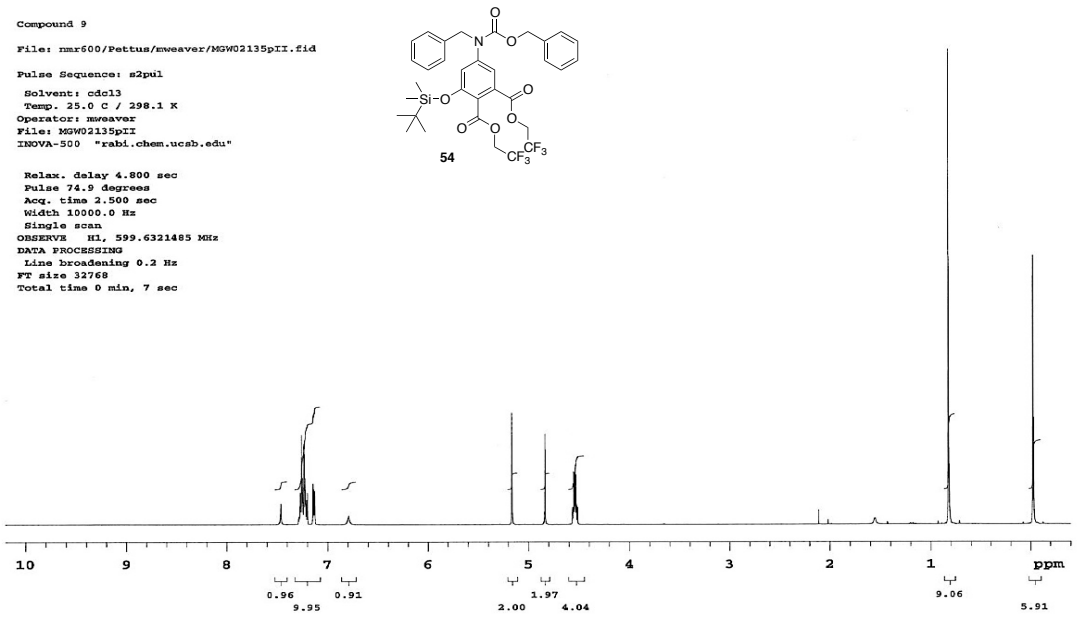

Compound 7b
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW03021pC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03021pC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
944 repetitions
OBSERVE C13, 150.7775958 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
52b
200
180
160
140
120
100
80
60
40
20
ppm

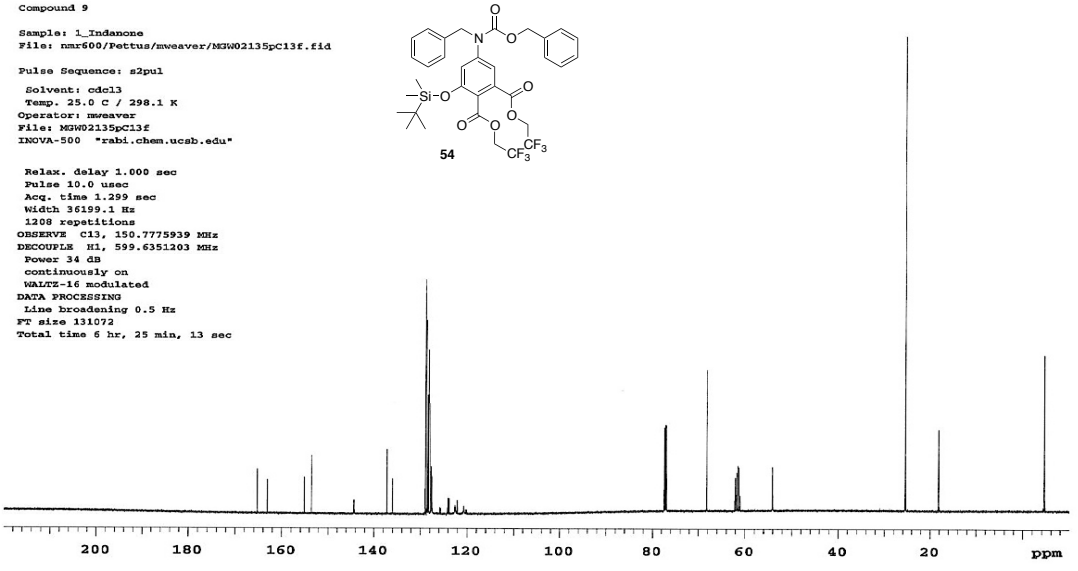

Compound 7c
File: nmr600/Pettus/mweaver/MGW03020p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03020p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.5321146 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
52c
10
9
8
7
6
5
4
3
2
1
ppm
16.81
1.03
3.32
2.00
1.05
1.08
0.99
8.77
5.94

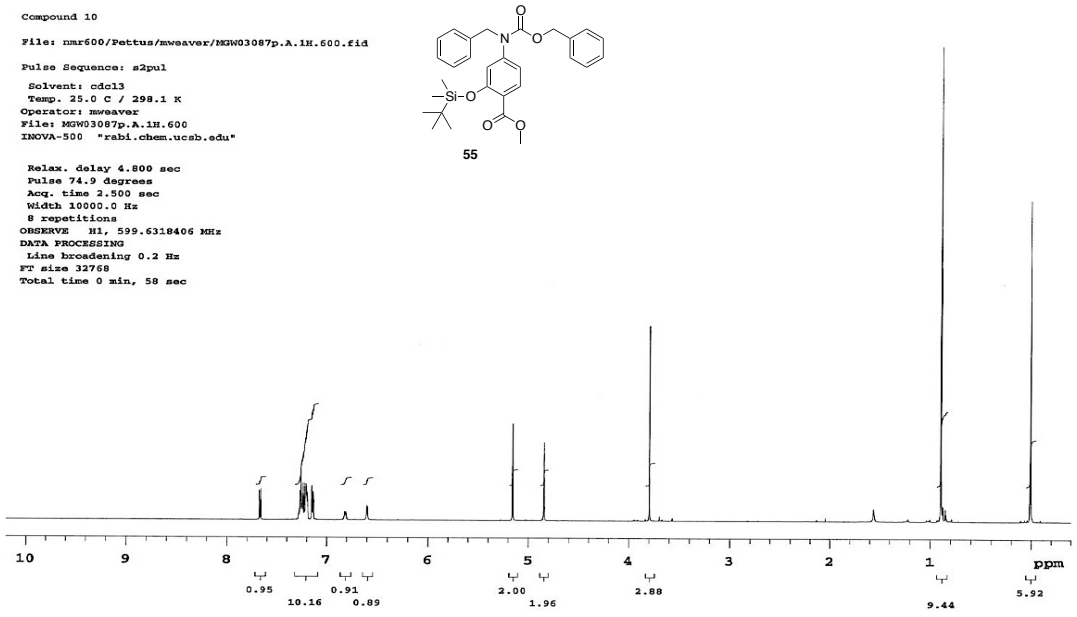

Compound 7c
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW03020pC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03020pC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
512 repetitions
OBSERVE C13, 150.7775936 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
52c
200
180
160
140
120
100
80
60
40
20
ppm

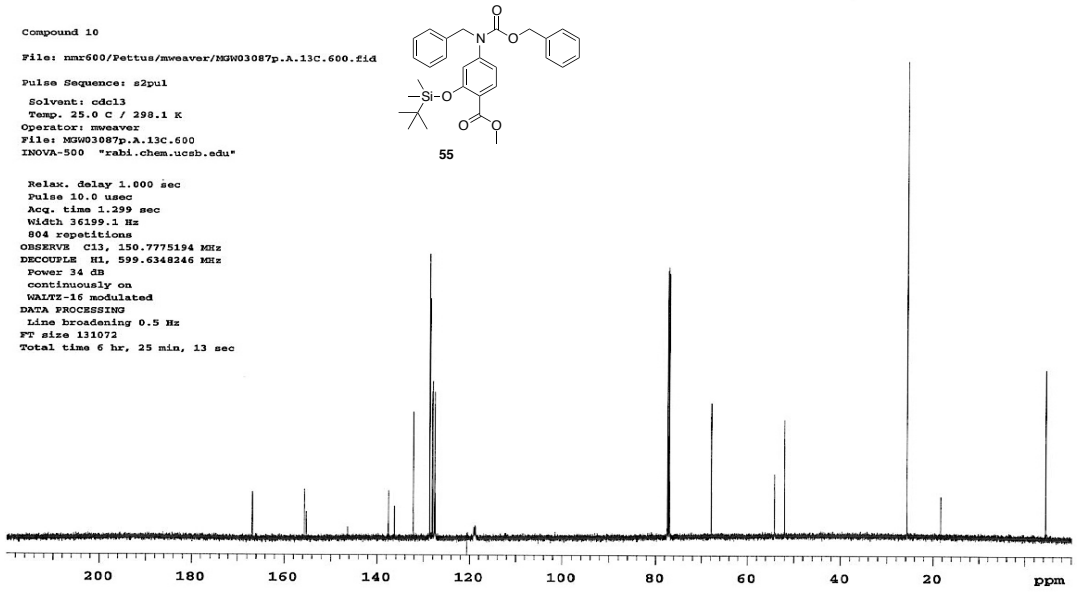

Compound 8
File: nmr600/Pettus/mweaver/MGW02023p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02023p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
4 repetitions
OBSERVE H1, 599.6321126 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 29 sec
53
10
9
8
7
6
5
4
3
2
1
ppm

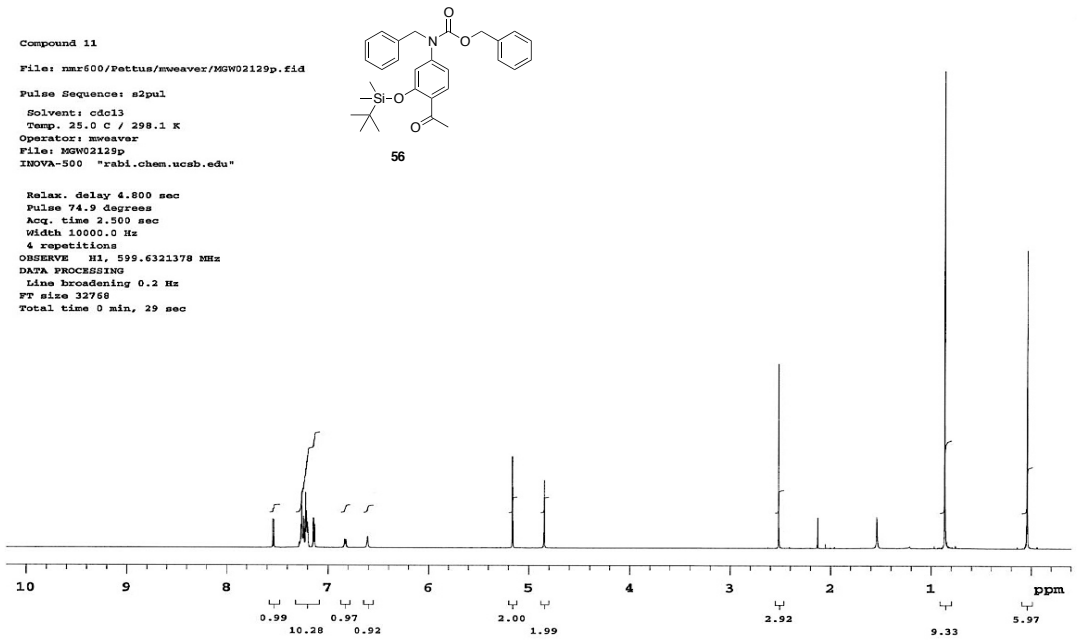

Compound 8
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW02139pC13III.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02139pC13III
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
308 repetitions
OBSERVE C13, 150.7776132 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
53
200
180
160
140
120
100
80
60
40
20
ppm

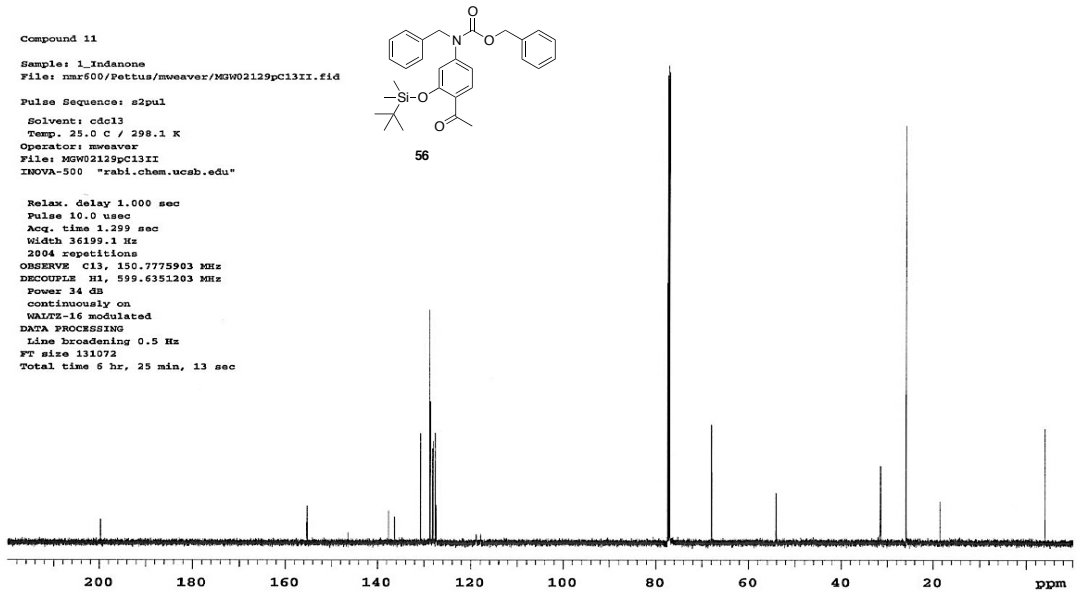

Compound 9
File: nmr600/Pettus/mweaver/MGW02135pII.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02135pII
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
Single scan
OBSERVE H1, 599.6321485 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 7 sec
54
10
9
8
7
6
5
4
3
2
1
ppm
0.96
9.95
0.91
1.97
2.00
4.04
9.06
5.91

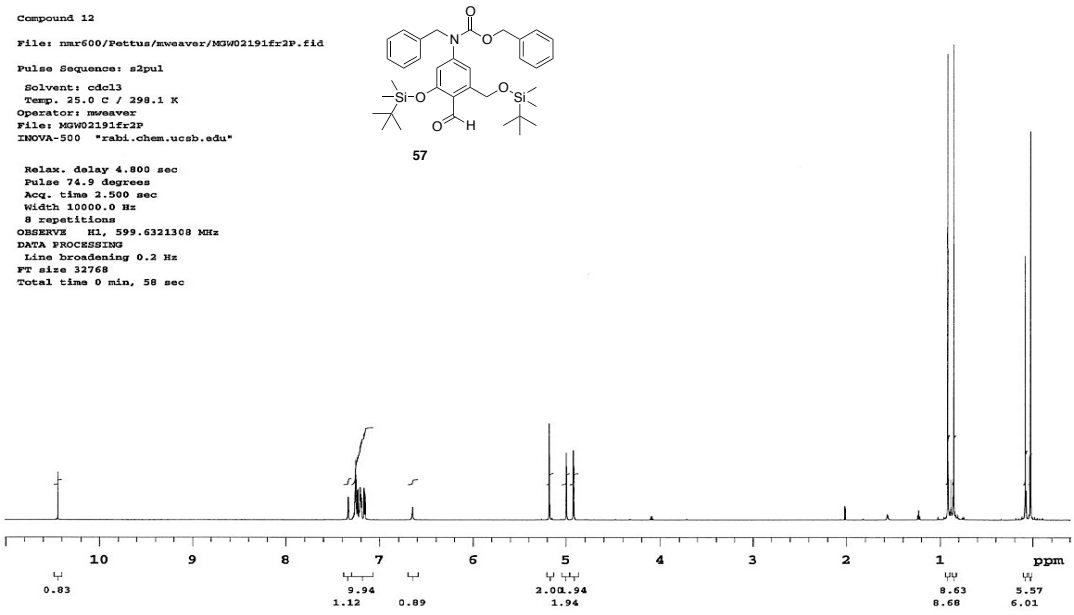

Compound 9
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW02135pC13f.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02135pC13f
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
1208 repetitions
OBSERVE C13, 150.7775939 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
54
200
180
160
140
120
100
80
60
40
20
ppm

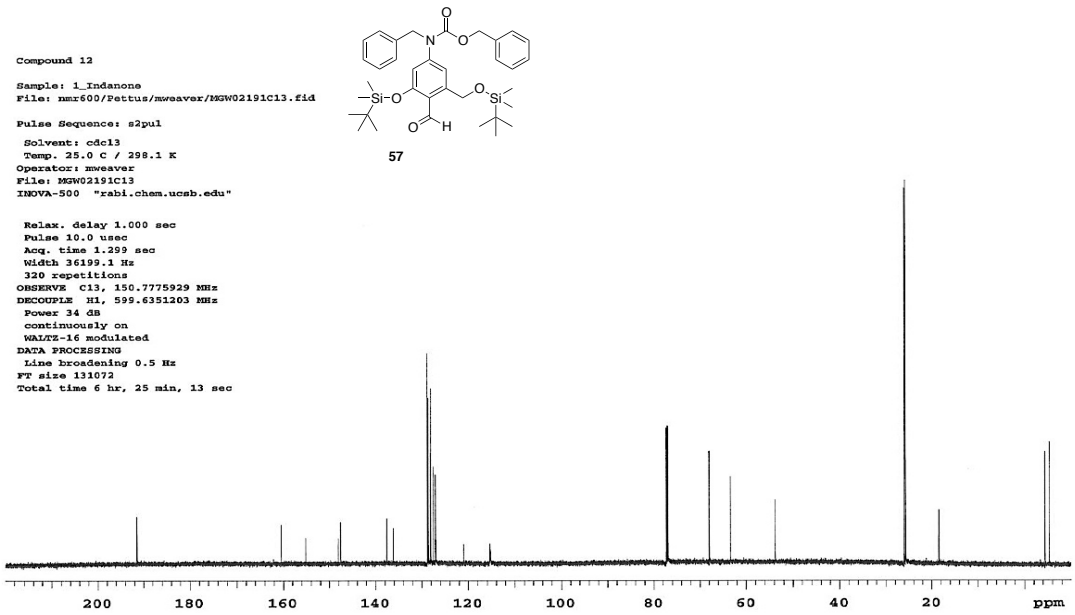

Compound 10
File: nmr600/Pettus/mweaver/MGW03087p.A.1H.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03087p.A.1H.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318406 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
55
10
9
8
7
6
5
4
3
2
1
ppm
0.95
10.16
0.91
0.89
2.00
1.96
2.88
9.44
5.92

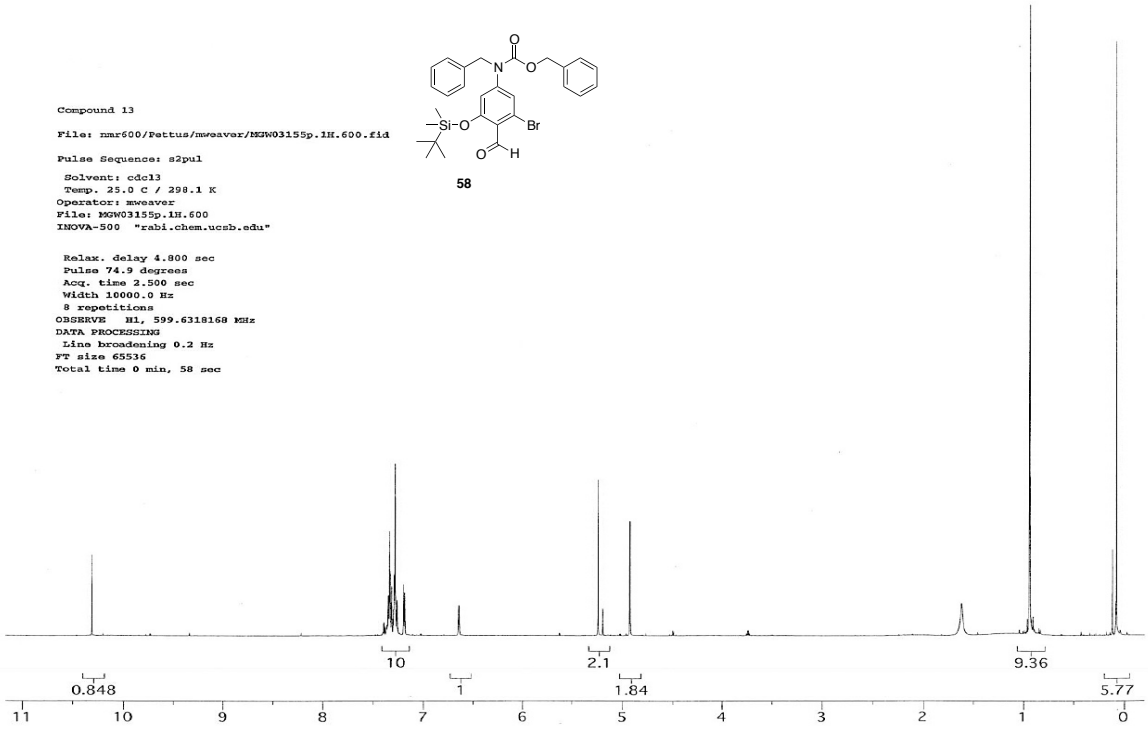

Compound 10
File: nmr600/Pettus/mweaver/MGW03087p.A.13C.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03087p.A.13C.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
804 repetitions
OBSERVE C13, 150.7775194 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
55
200
180
160
140
120
100
80
60
40
20
ppm

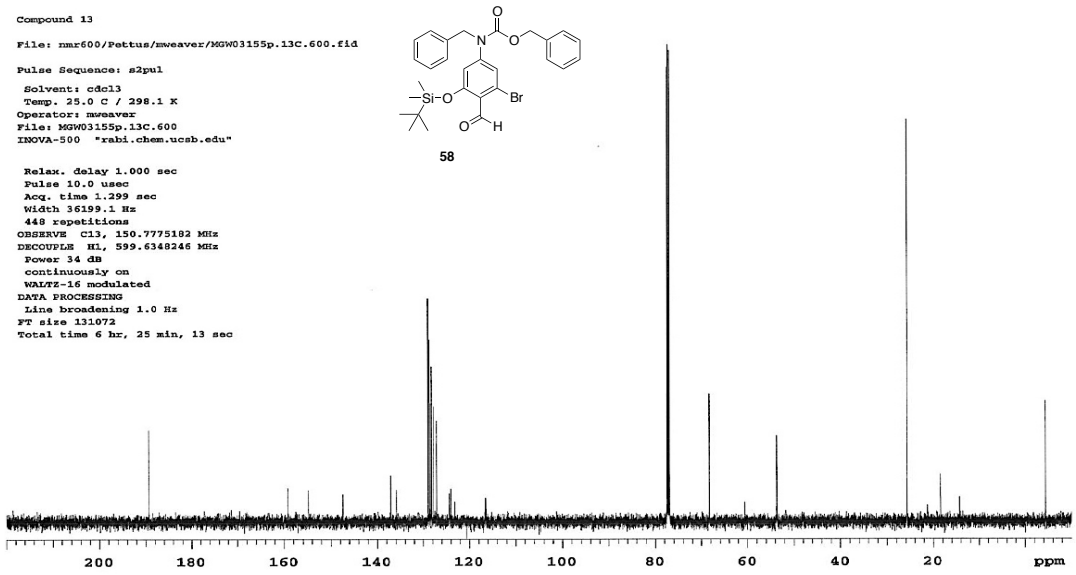

Compound 11
File: nmr600/Pettus/mweaver/MGW02129p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02129p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
4 repetitions
OBSERVE H1, 599.6321378 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 29 sec
56
10
9
8
7
6
5
4
3
2
1
ppm
0.99
10.28
0.97
0.92
2.00
1.99
2.92
9.33
5.97

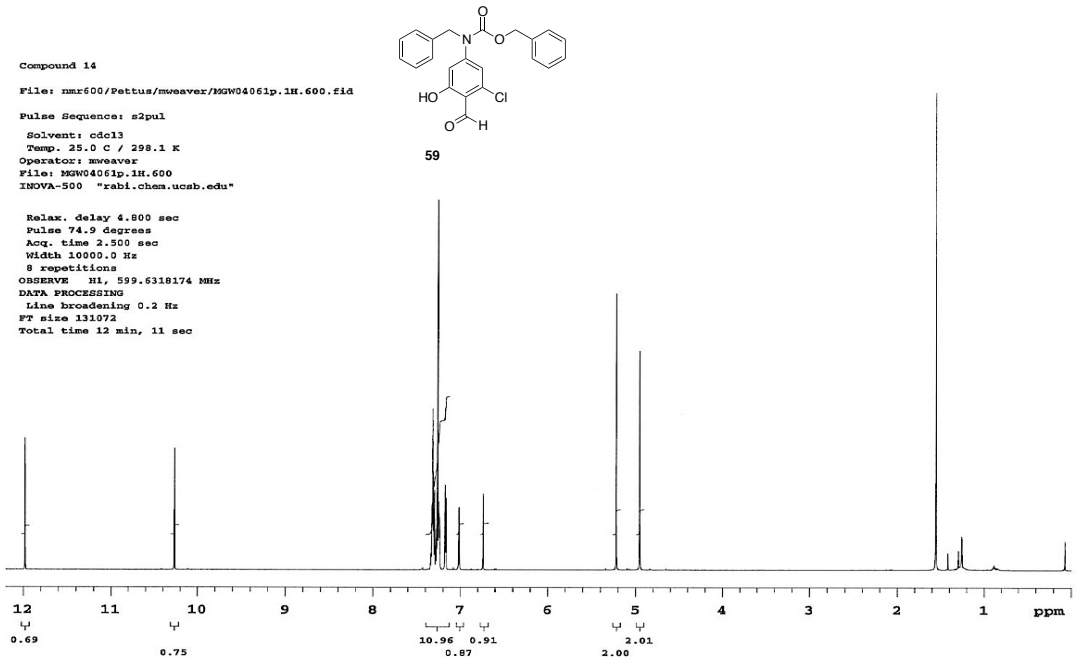

Compound 11
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW02129pC13II.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02129pC13II
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
2004 repetitions
OBSERVE C13, 150.7775903 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
56
200
180
160
140
120
100
80
60
40
20
ppm

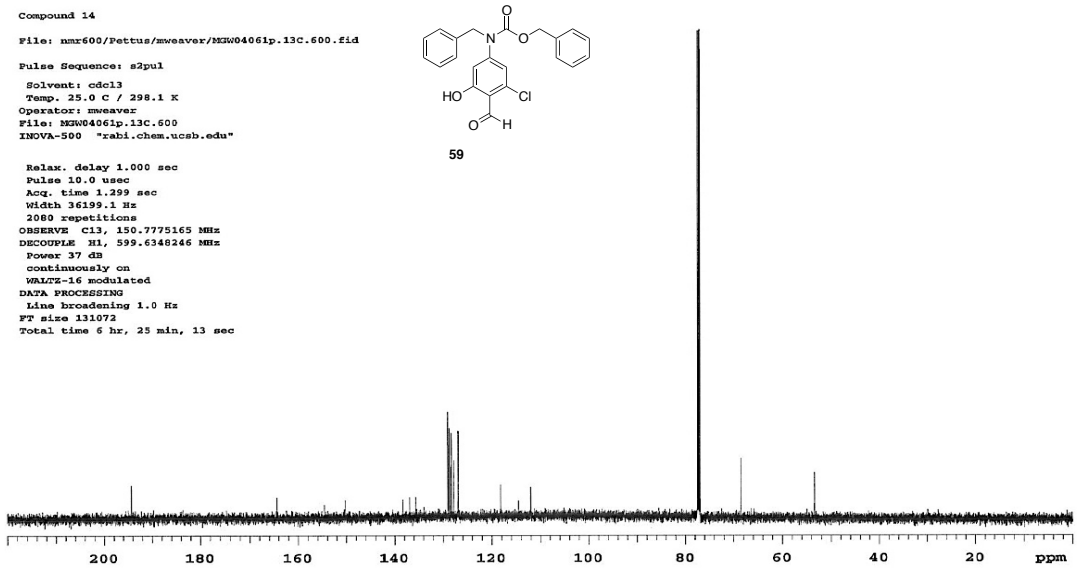

Compound 12
File: nmr600/Pettus/mweaver/MGW02191fr2P.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02191fr2P
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321308 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
57
10
9
8
7
6
5
4
3
2
1
ppm
0.83
9.94
1.12
0.89
2.00
1.94
1.94
8.63
8.68
5.57
6.01

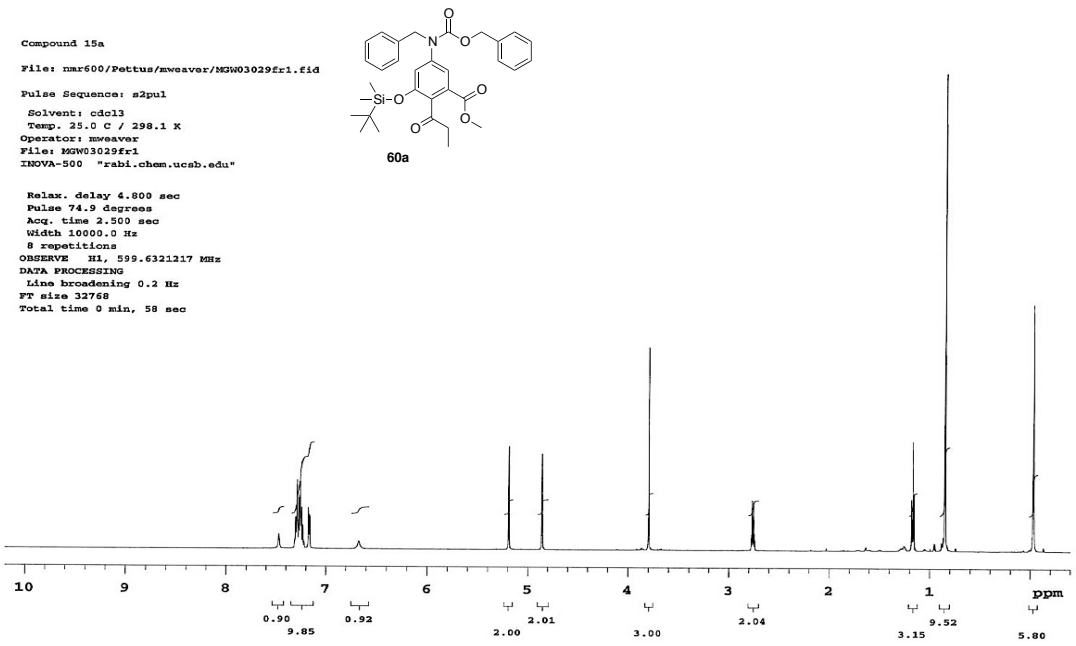

Compound 12
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW02191C13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02191C13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
320 repetitions
OBSERVE C13, 150.7775929 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
57
200
180
160
140
120
100
80
60
40
20
ppm

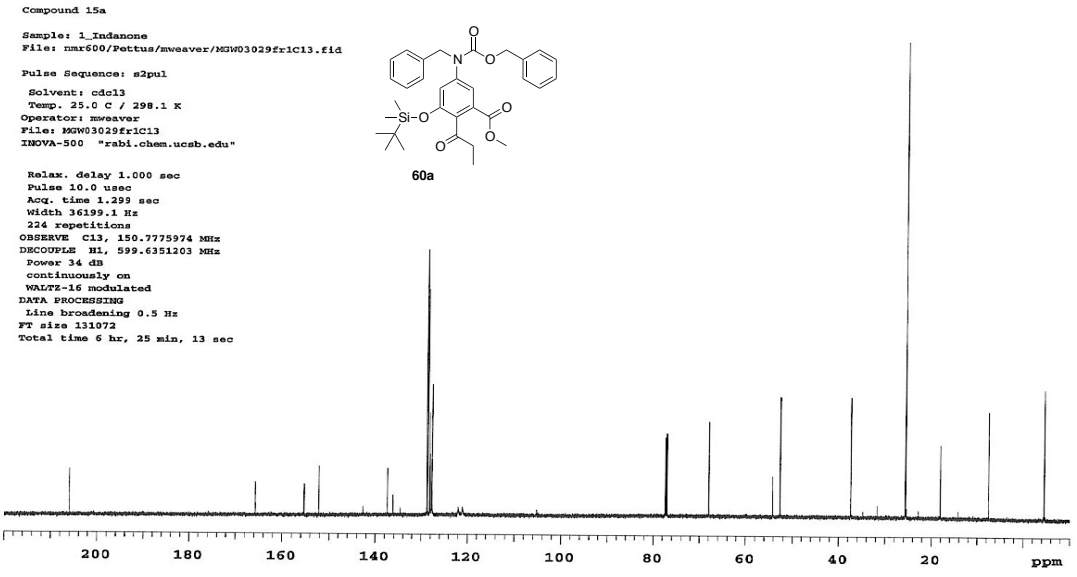

Compound 13
File: nmr600/Pettus/mweaver/MGW03155p.1H.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03155p.1H.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 65536
Total time 0 min, 58 sec
58
0.848
10
1
2.1
1.84
9.36
5.77

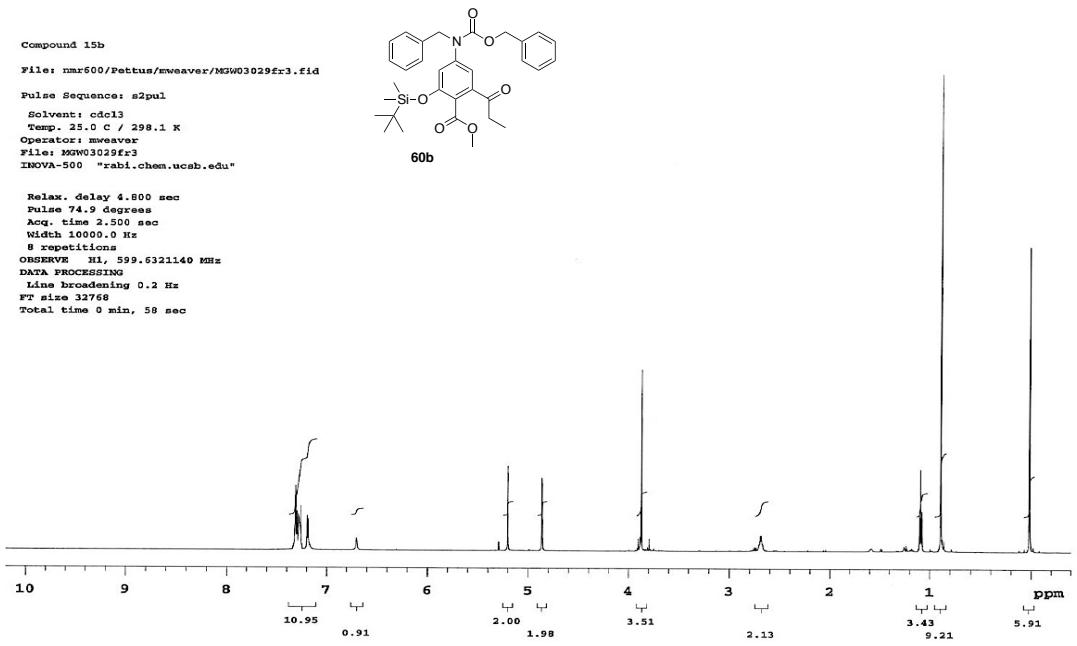

Compound 13
File: nmr600/Pettus/mweaver/MGW03155p.13C.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03155p.13C.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
448 repetitions
OBSERVE C13, 150.7775182 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
58
ppm

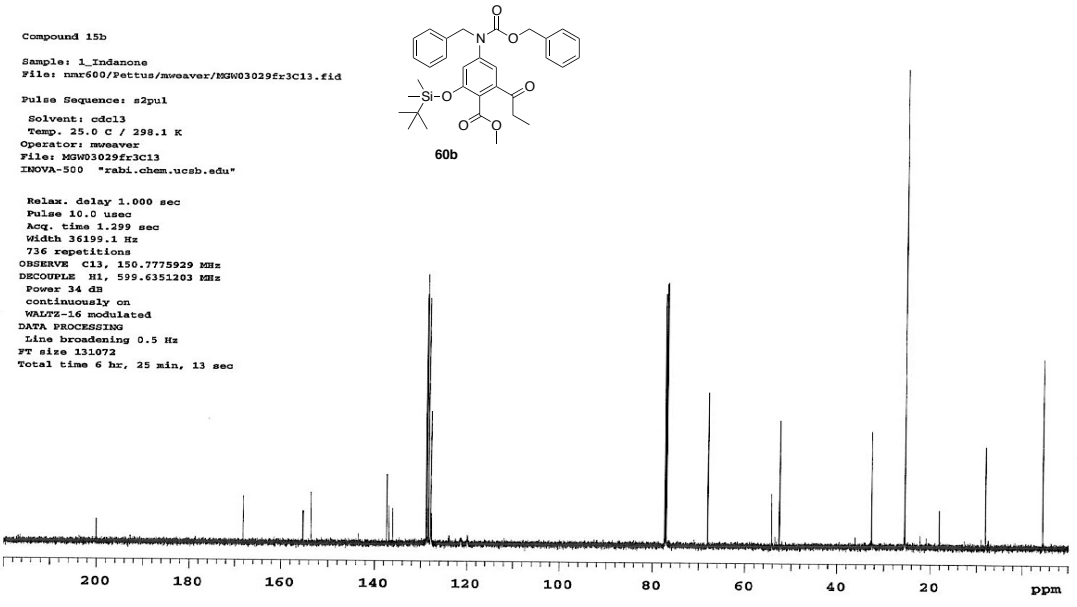

Compound 14
File: nmr600/Pettus/mweaver/MGW04061p.1H.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW04061p.1H.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318174 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 12 min, 11 sec
HO
Cl
O
H
59
12
11
10
9
8
7
6
5
4
3
2
1
ppm
0.69
0.75
10.96
0.91
0.87
2.01
2.00

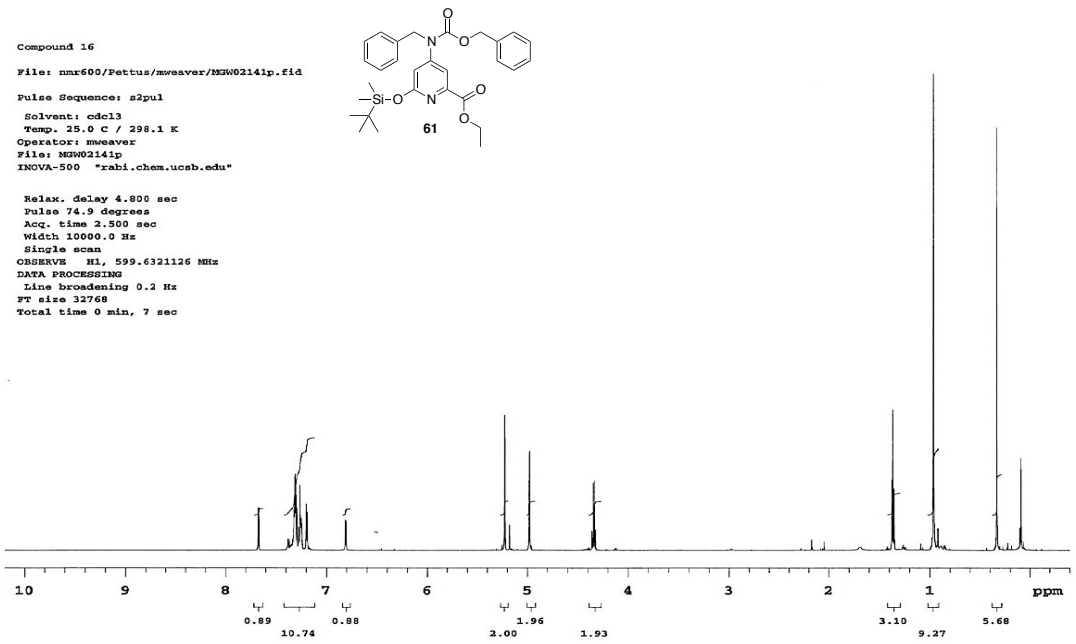

Compound 14
File: nmr600/Pettus/mweaver/MGW04061p.13C.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW04061p.13C.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
2080 repetitions
OBSERVE C13, 150.7775165 MHz
DECOUPLE H1, 599.6348246 MHz
Power 37 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
HO
Cl
O
H
59
200
180
160
140
120
100
80
60
40
20
ppm

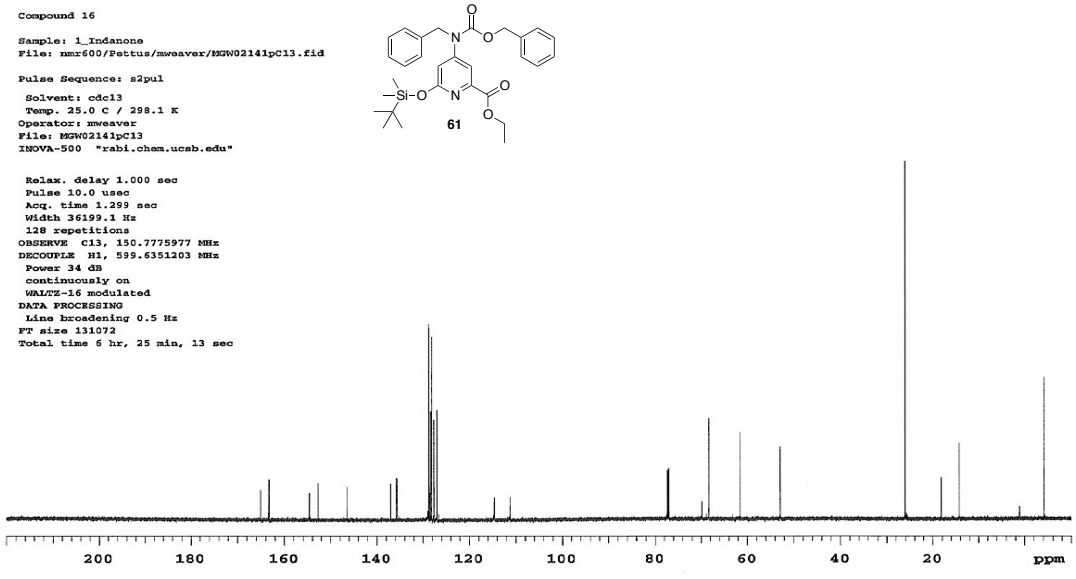

Compound 15a
File: nmr600/Pettus/mweaver/MGW03029fr1.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03029fr1
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321217 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
60a
10
9
8
7
6
5
4
3
2
1
ppm
0.90
9.85
0.92
2.00
2.01
3.00
2.04
3.15
9.52
5.80

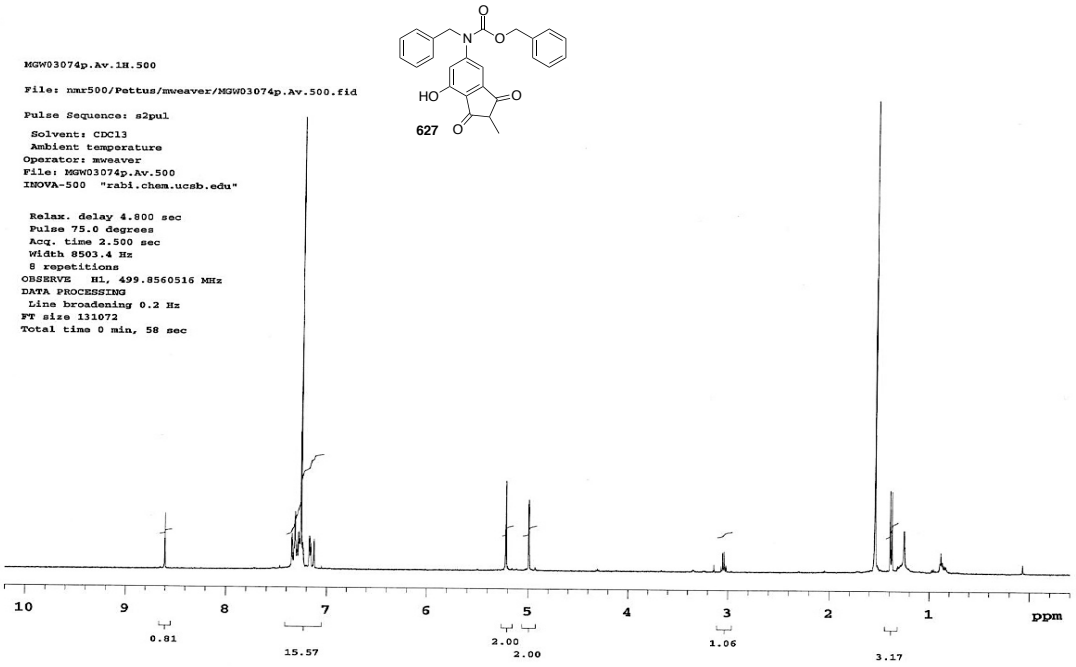

Compound 15a
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW03029fr1C13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03029fr1C13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
224 repetitions
OBSERVE C13, 150.7775974 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
60a
200
180
160
140
120
100
80
60
40
20
ppm

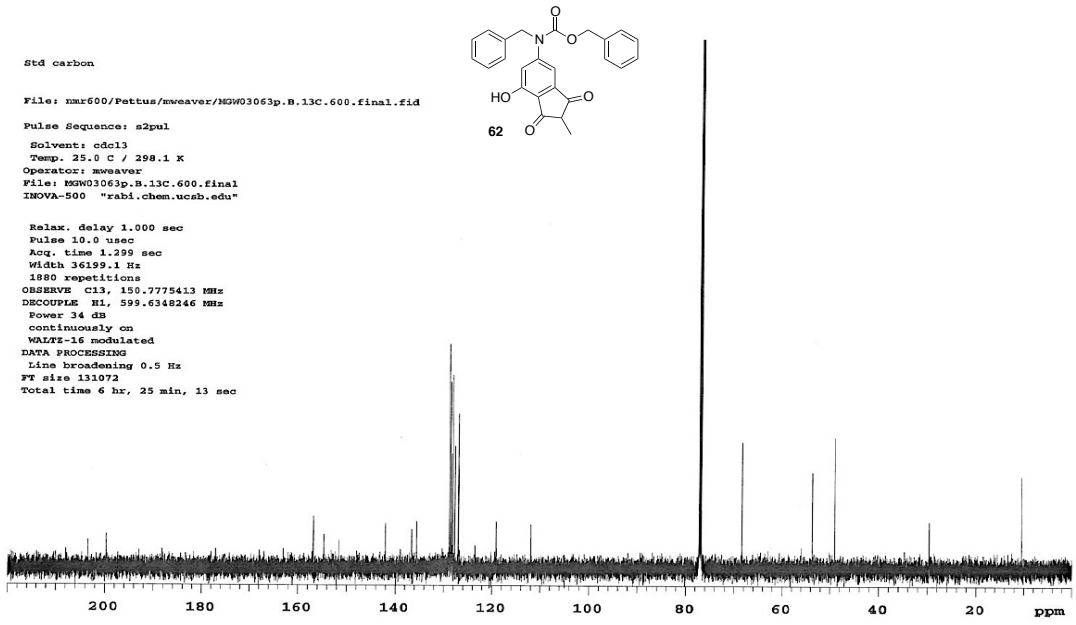

Compound 15b
File: nmr600/Pettus/mweaver/MGW03029fr3.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03029fr3
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6321140 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
60b
10
9
8
7
6
5
4
3
2
1
ppm
10.95
0.91
2.00
1.98
3.51
2.13
3.43
9.21
5.91

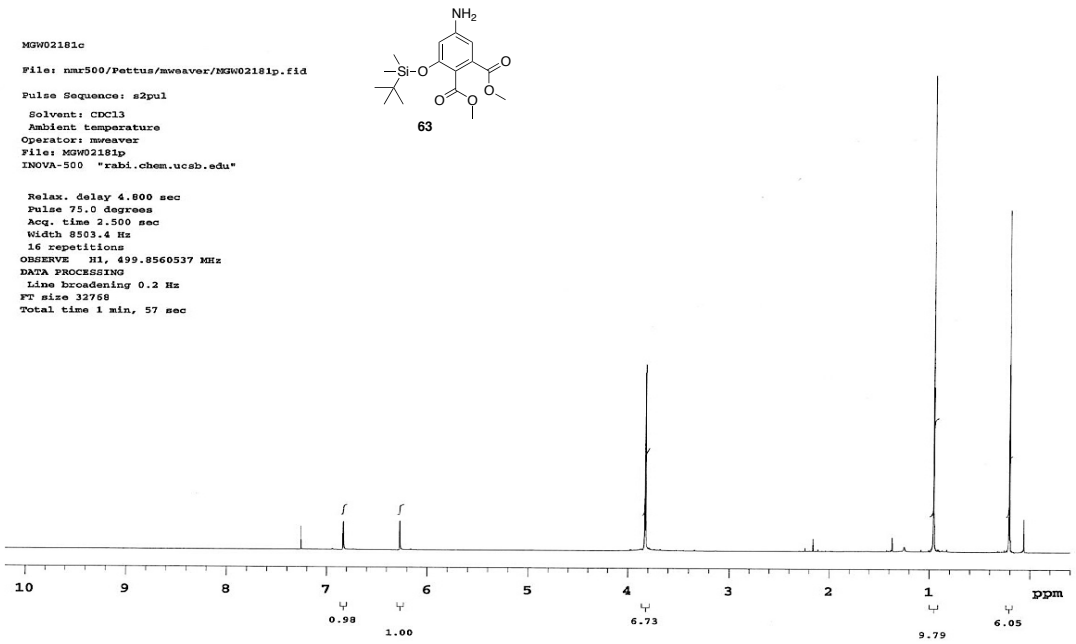

Compound 15b
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW03029fr3C13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03029fr3C13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
736 repetitions
OBSERVE C13, 150.7775929 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
60b
200
180
160
140
120
100
80
60
40
20
ppm

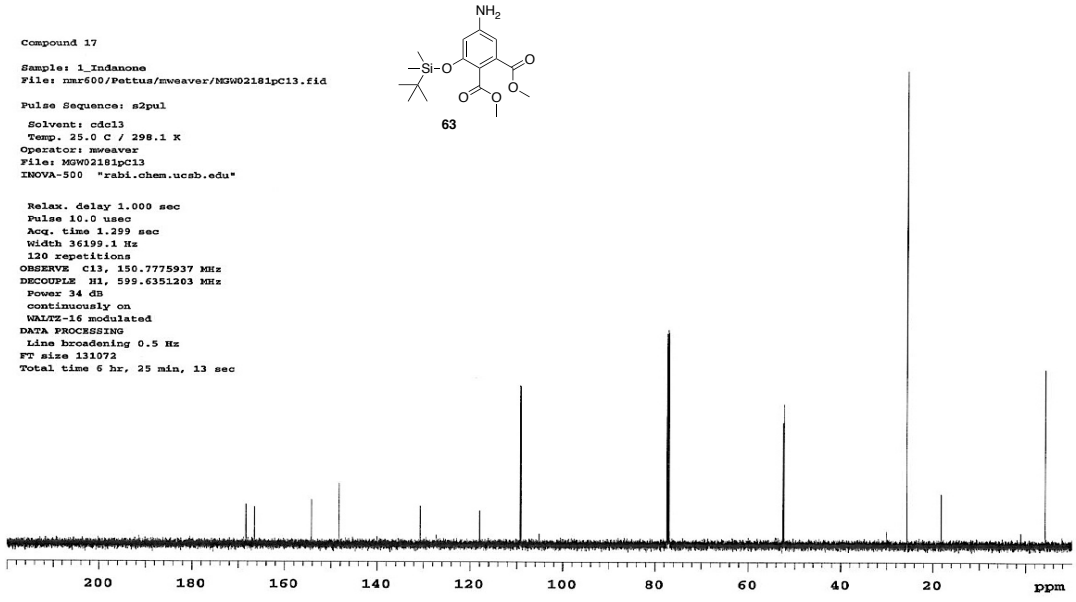

Compound 16
File: nmr600/Pettus/mweaver/MGW02141p.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02141p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
Single scan
OBSERVE H1, 599.6321126 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 7 sec
61
10
9
8
7
6
5
4
3
2
1
ppm
0.89
10.74
0.88
1.96
2.00
1.93
3.10
9.27
5.68

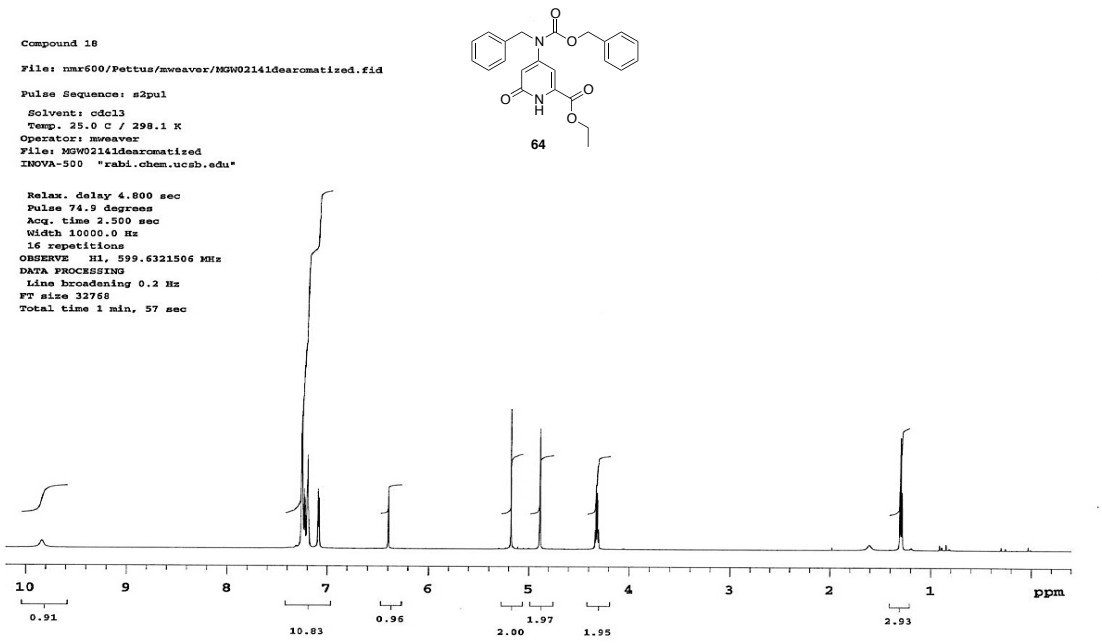

Compound 16
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW02141pC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02141pC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
128 repetitions
OBSERVE C13, 150.7775977 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
61
200
180
160
140
120
100
80
60
40
20
ppm

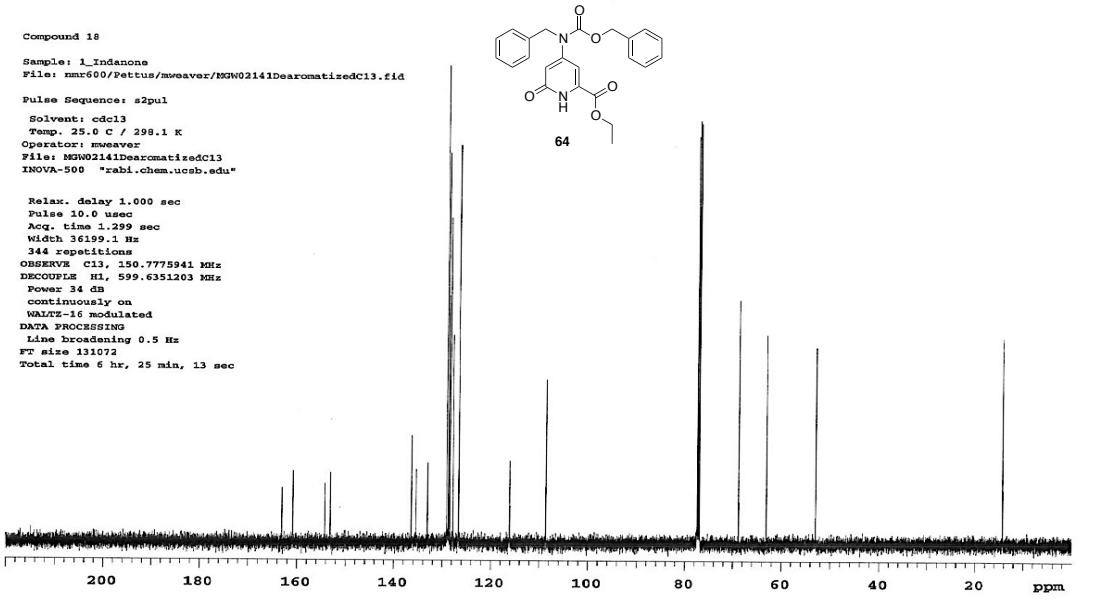

627
MGW03074p.Av.1H.500
File: nmr500/Pattus/mweaver/MGW03074p.Av.500.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mweaver
File: MGW03074p.Av.500
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560516 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
10
9
8
7
6
5
4
3
2
1
ppm
0.81
15.57
2.00
2.00
1.06
3.17

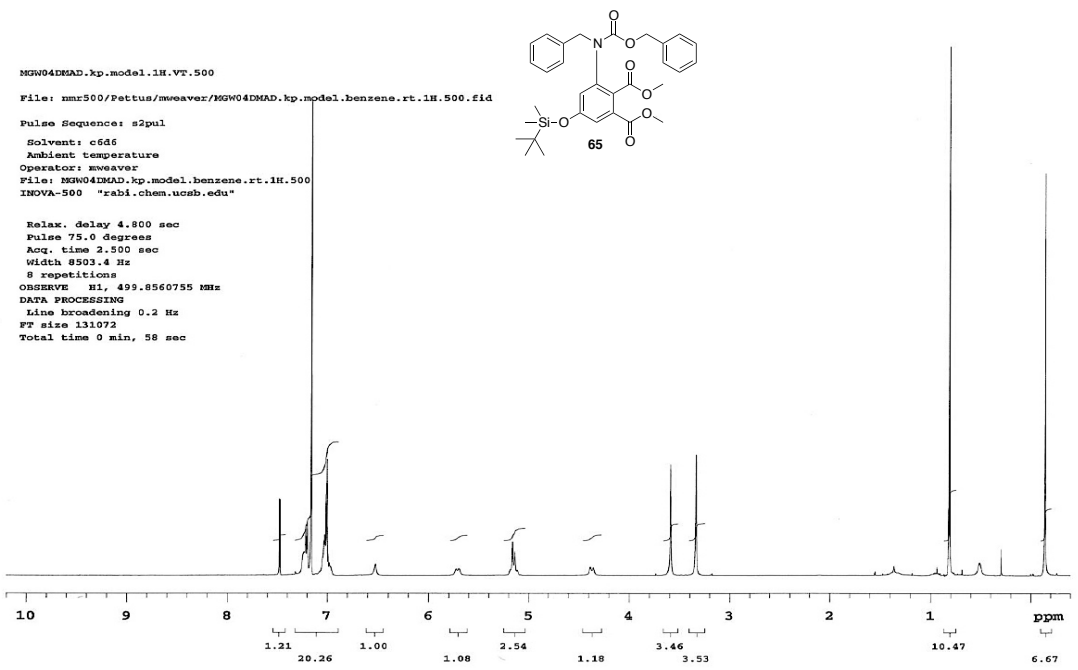

62
Std carbon
File: nmr600/Pattus/mweaver/MGW03063p.B.13C.600.final.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03063p.B.13C.600.final
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
1880 repetitions
OBSERVE C13, 150.7775413 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
200
180
160
140
120
100
80
60
40
20
ppm


MGW02181c
File: nmr500/Pettus/mweaver/MGW02181p.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mweaver
File: MGW02181p
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
16 repetitions
OBSERVE H1, 499.8560537 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 57 sec
NH2
Si
O
63
10
9
8
7
6
5
4
3
2
1
ppm
0.98
1.00
6.73
9.79
6.05

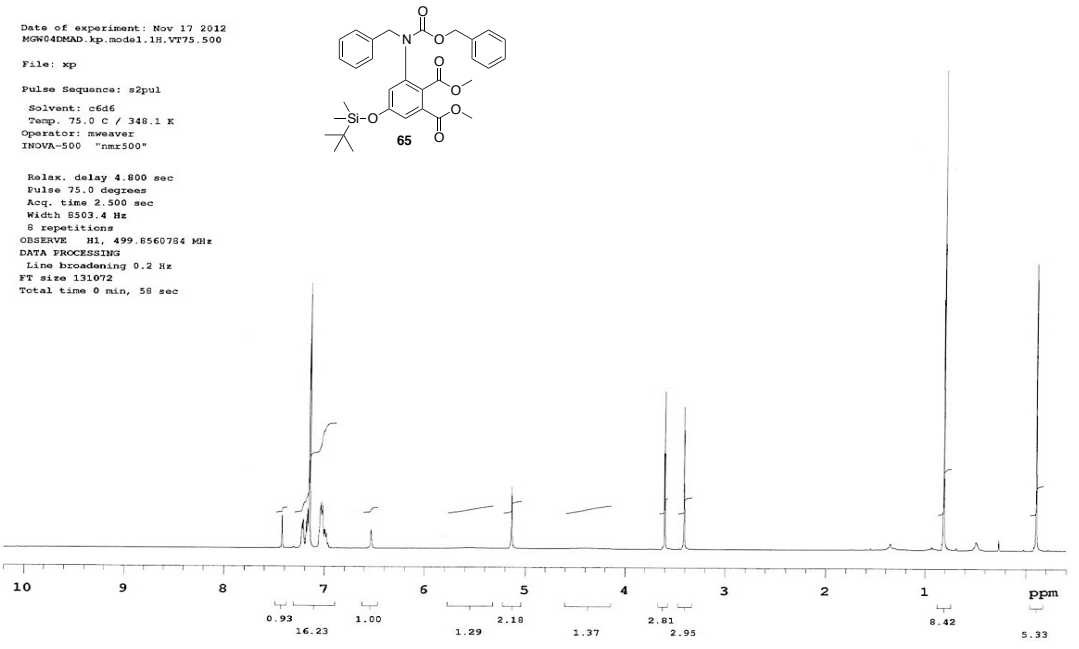

Compound 17
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW02181pC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02181pC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
120 repetitions
OBSERVE C13, 150.7775937 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
NH2
Si
O
63
200
180
160
140
120
100
80
60
40
20
ppm


Compound 18
File: nmr600/Pettus/mweaver/MGW02141dearomatized.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02141dearomatized
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
16 repetitions
OBSERVE H1, 599.6321506 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 1 min, 57 sec
64
10
9
8
7
6
5
4
3
2
1
ppm
0.91
10.83
0.96
2.00
1.97
1.95
2.93

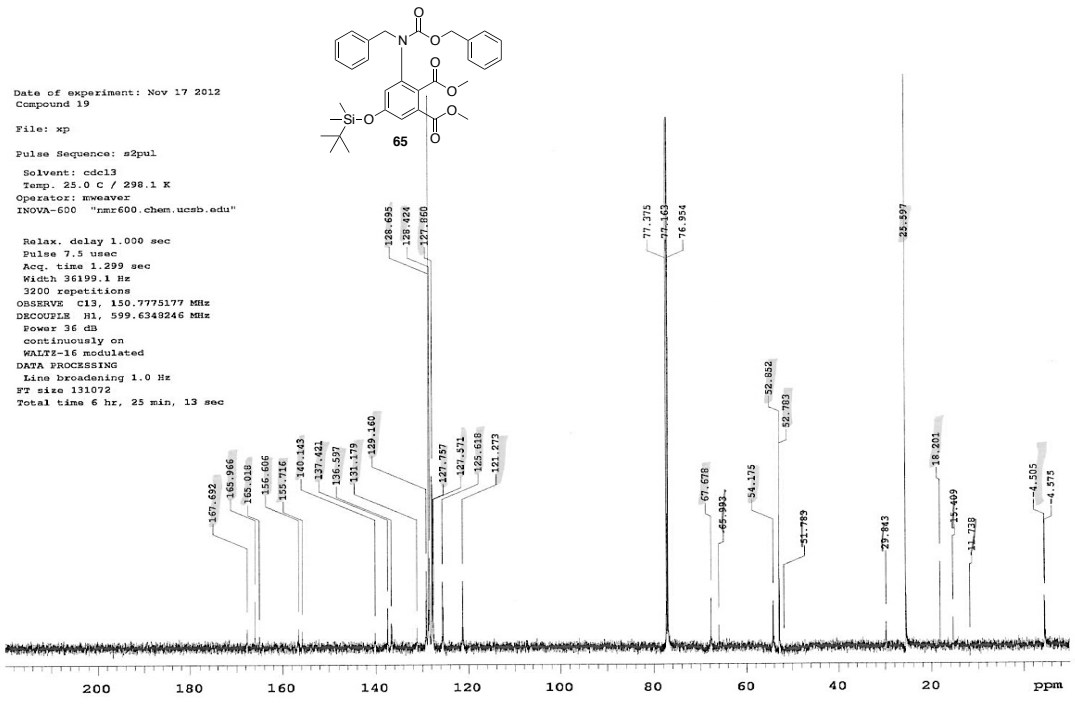

Compound 18
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW02141DearomatizedC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW02141DearomatizedC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
344 repetitions
OBSERVE C13, 150.7775941 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
64
200
180
160
140
120
100
80
60
40
20
ppm

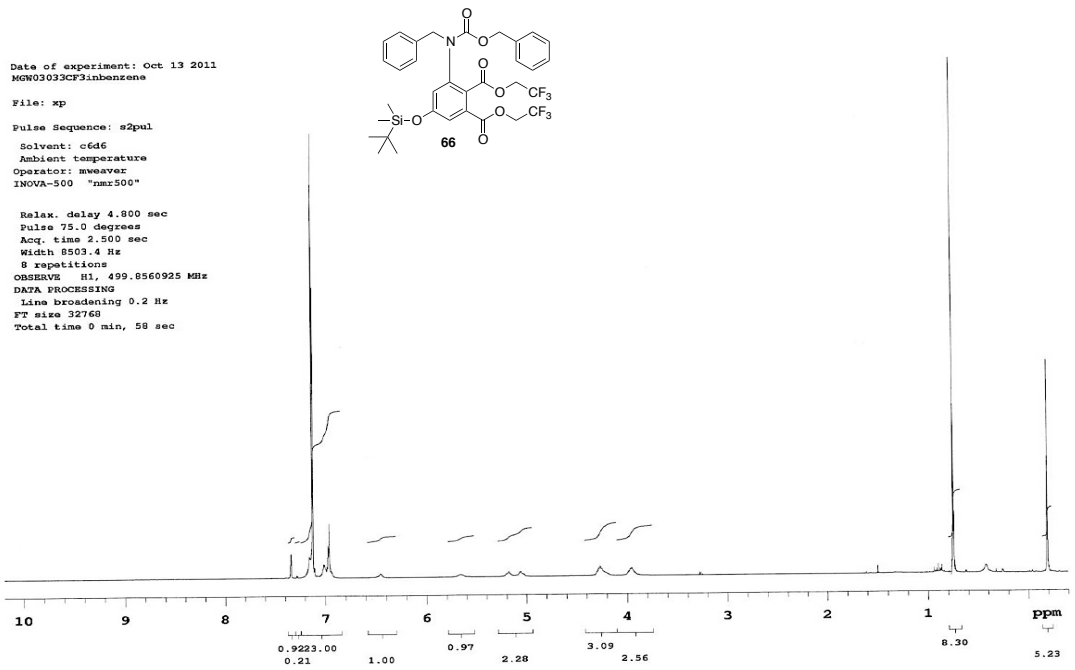


Ambient temperature, C_6D_6

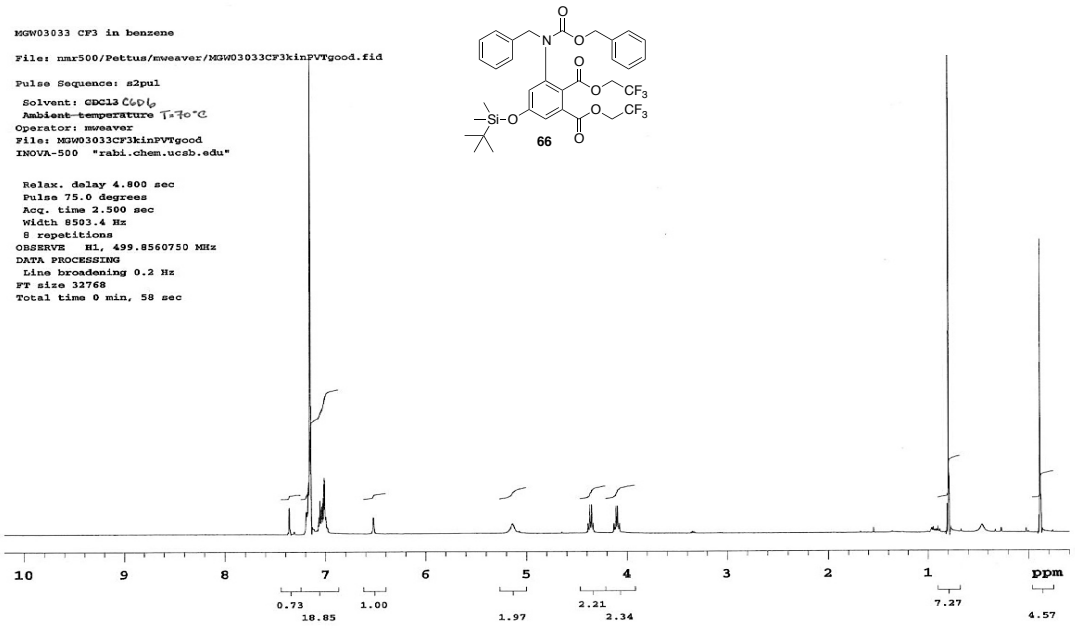


75.0 °C, C_6D_6

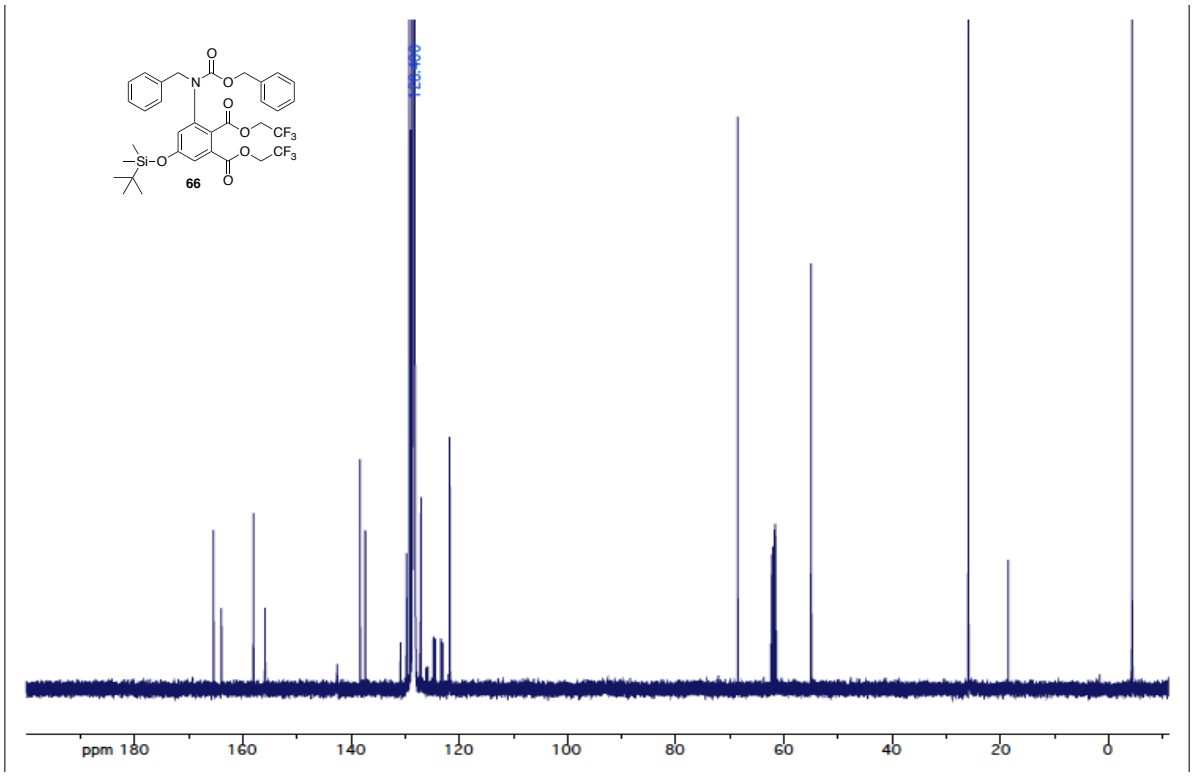

Date of experiment: Nov 17 2012
Compound 19
File: xp
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
INOVA-600 "nmr600.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 7.5 usec
Acq. time 1.299 sec
Width 36199.1 Hz
3200 repetitions
OBSERVE C13, 150.7775177 MHz
DECOUPLE H1, 599.6348246 MHz
Power 36 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
65
167.692
165.966
165.018
156.606
155.716
140.143
137.421
136.597
131.179
129.160
128.695
128.424
127.860
127.757
127.571
125.618
121.273
77.375
77.163
76.954
67.678
65.993
54.175
52.852
52.703
51.789
29.843
25.597
18.201
15.409
11.138
4.505
4.575
200
180
160
140
120
100
80
60
40
20
ppm



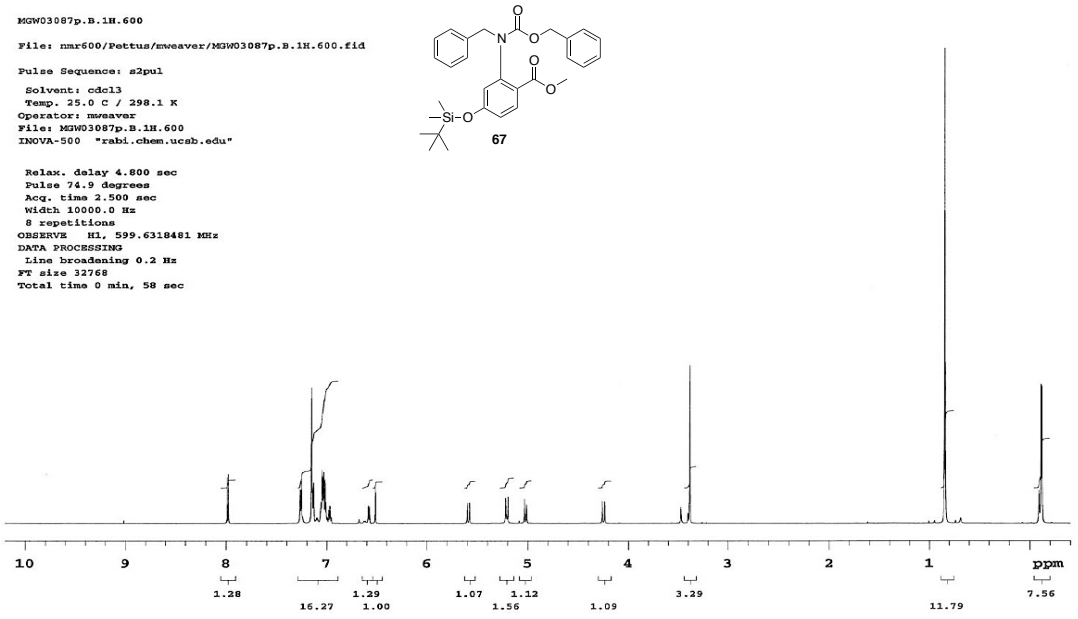
Ambient temperature, C_6D_6



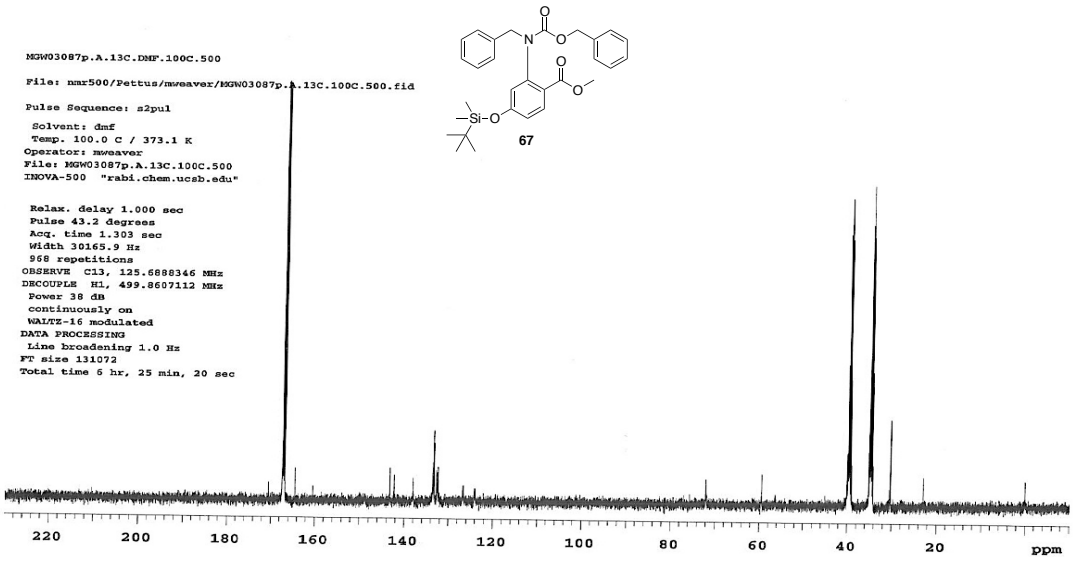
70 °C, C_6D_6



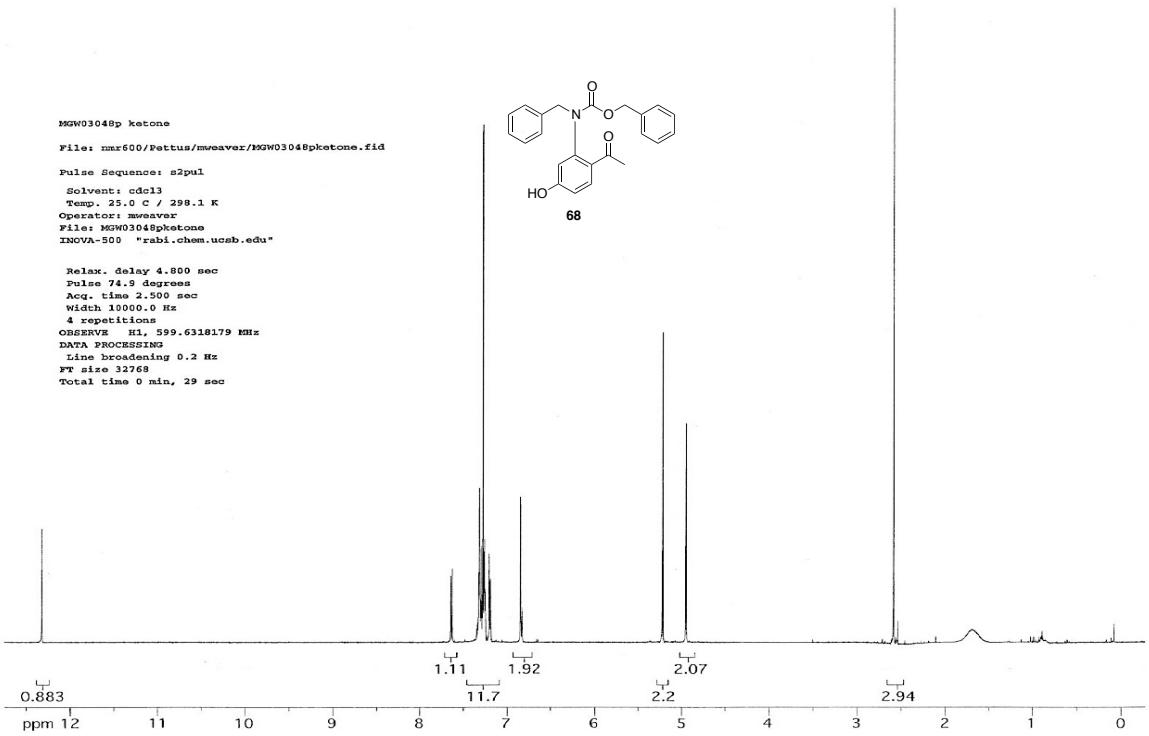
T=70 °C, C_6D_6

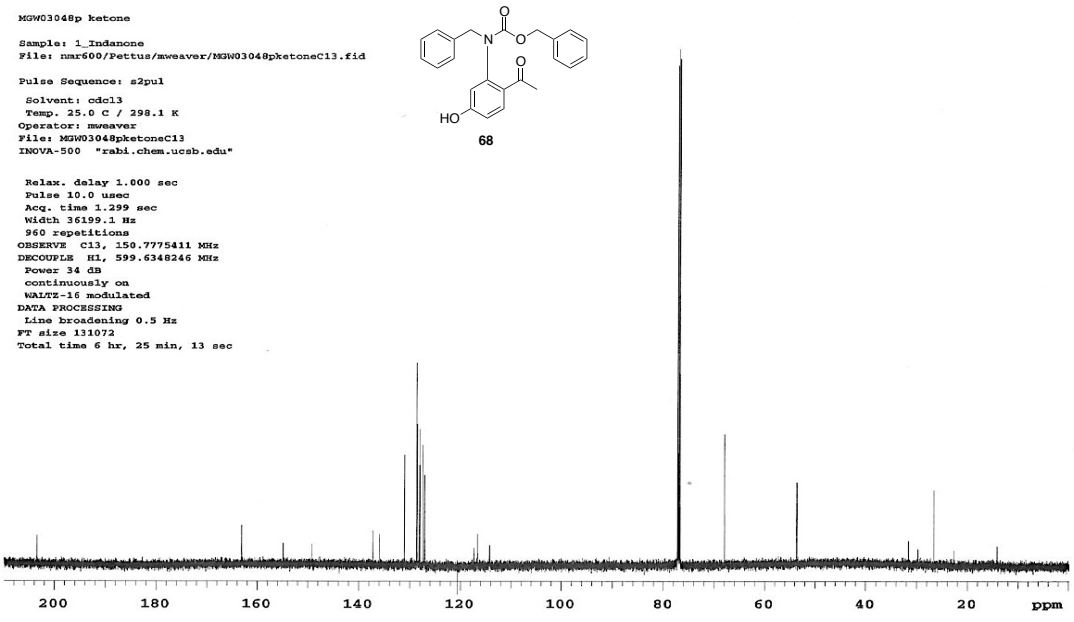


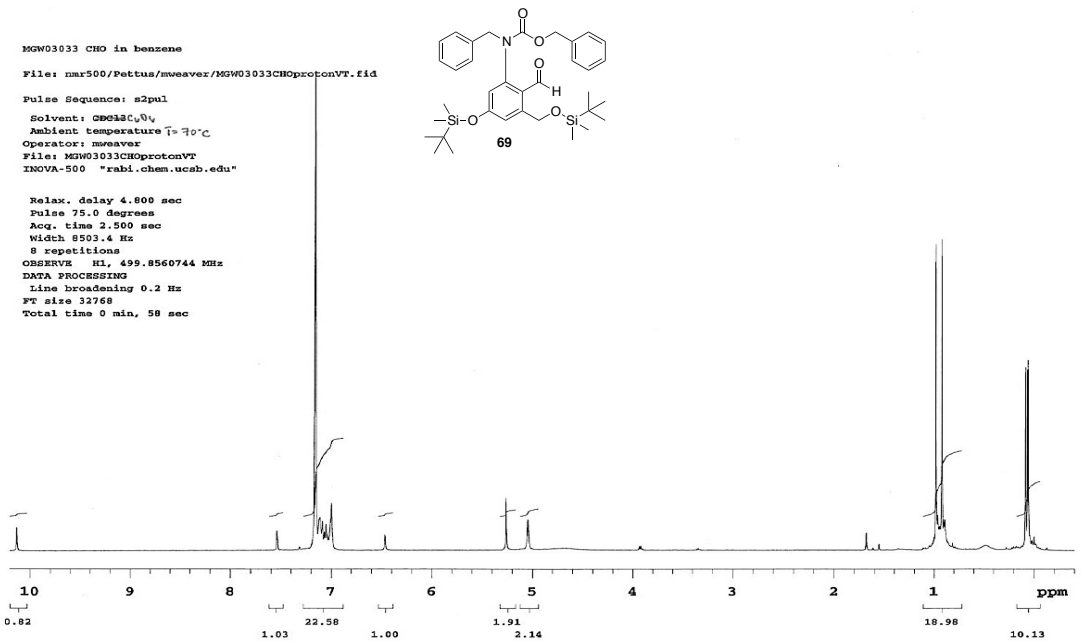
Ambient temperature, C_6D_6

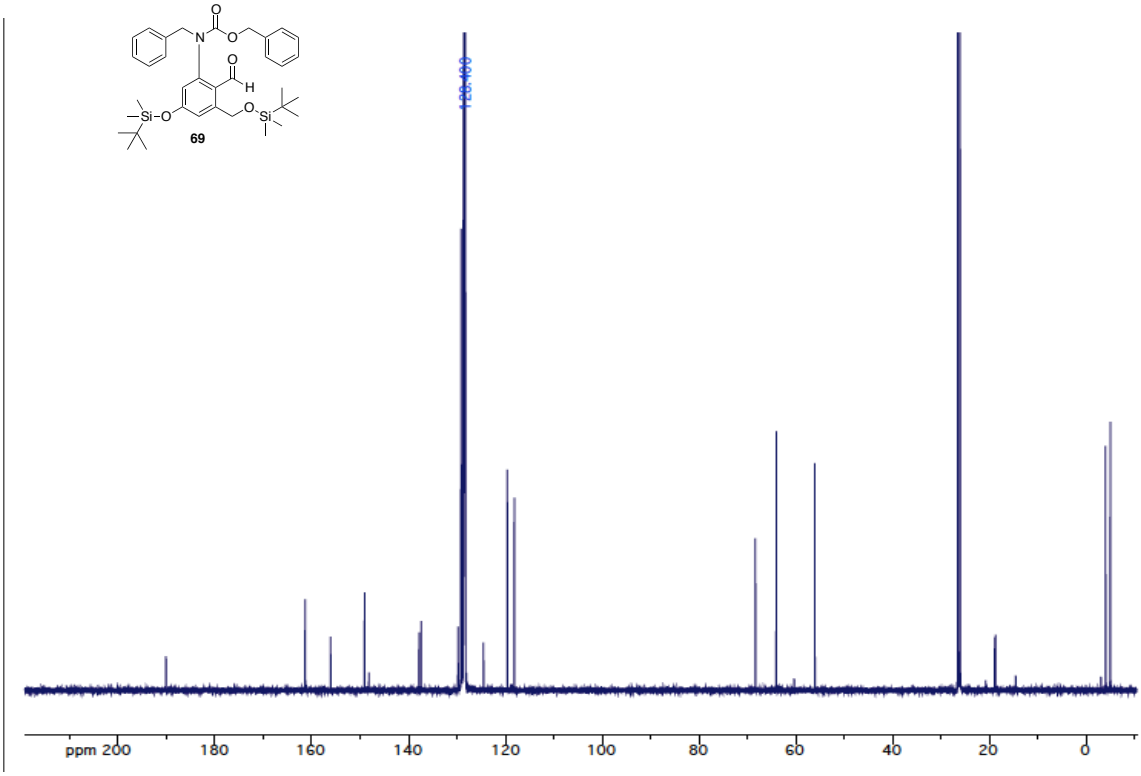


100 °C, d_7-DMF

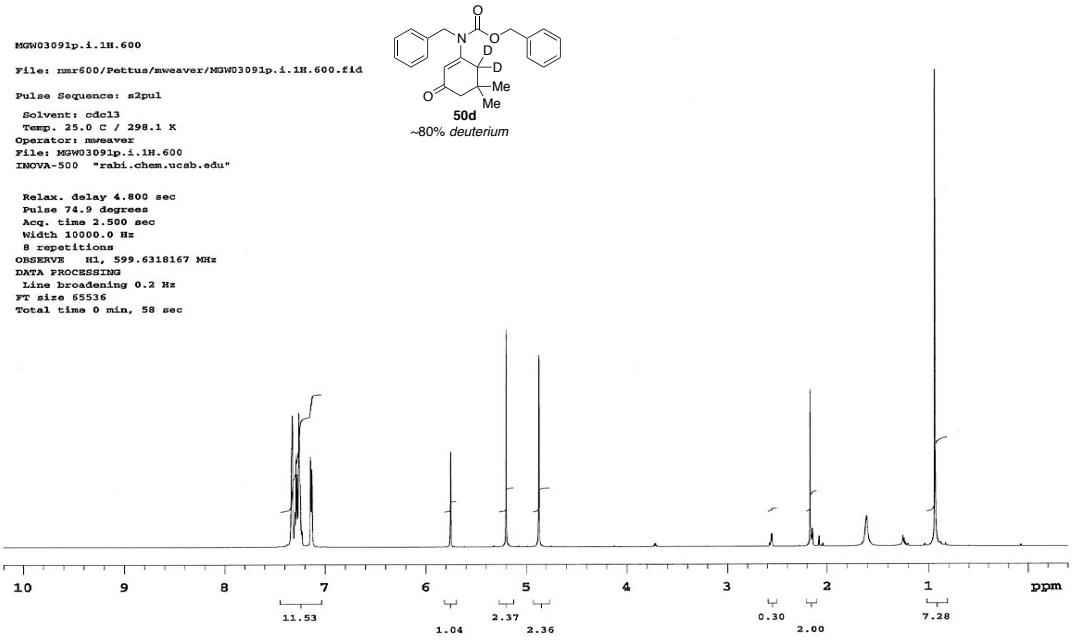

MGW03048p ketone
File: nmr600/Pettus/mweaver/MGW03048pketone.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03048pketone
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
4 repetitions
OBSERVE H1, 599.6318179 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 29 sec
68
1.11
1.92
2.07
0.883
11.7
2.2
2.94
ppm 12
11
10
9
8
7
6
5
4
3
2
1
0

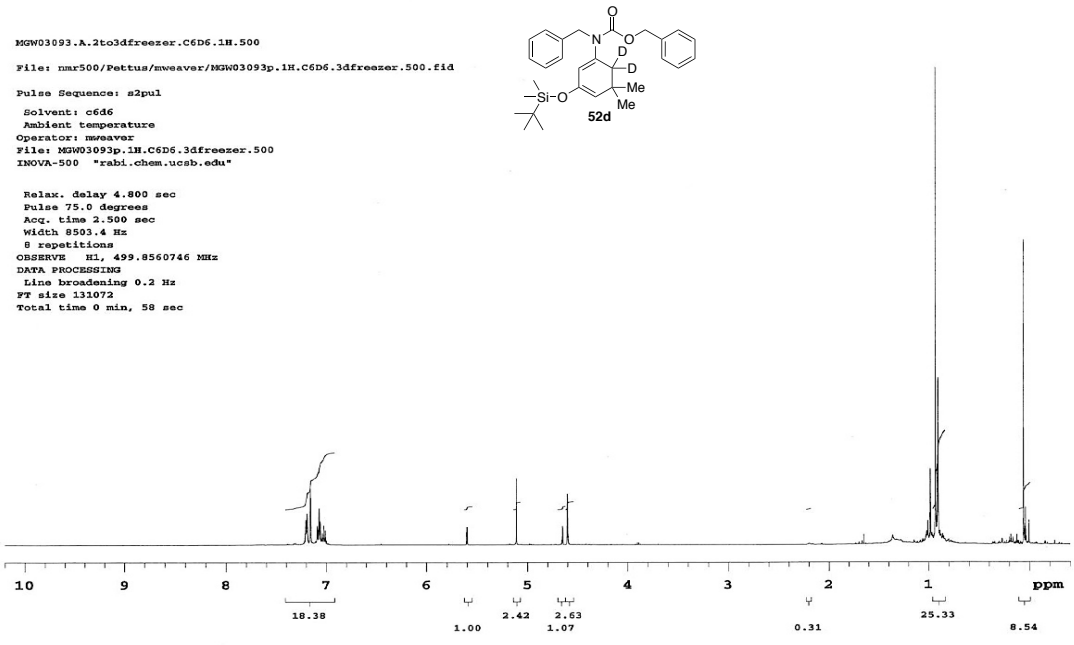

MGW03048p ketone
Sample: 1_Indanone
File: nmr600/Pettus/mweaver/MGW03048pketoneC13.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03048pketoneC13
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
960 repetitions
OBSERVE C13, 150.7775411 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
68
200
180
160
140
120
100
80
60
40
20
ppm

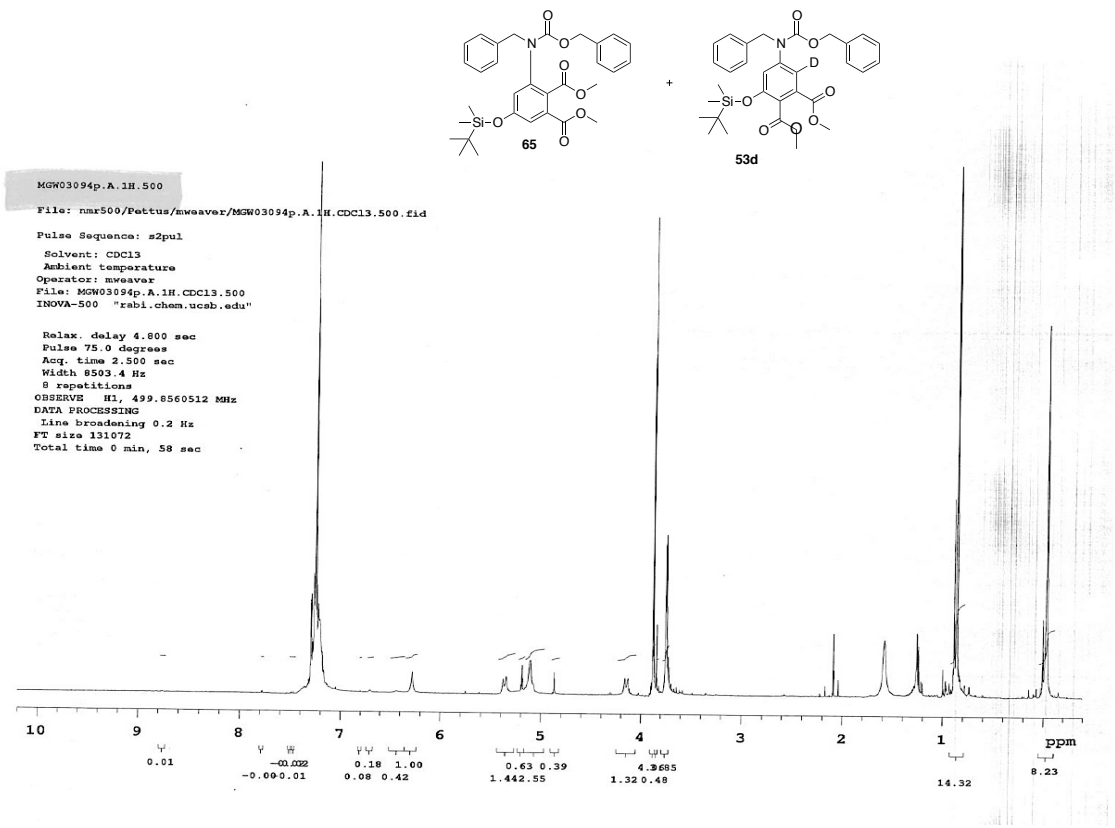

MGW03033 CHO in benzene
File: nmr500/Pettus/mweaver/MGW03033CHOprotonVT.fid
Pulse Sequence: s2pul
Solvent: C6D6
Ambient temperature T= 70°C
Operator: mweaver
File: MGW03033CHOprotonVT
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560744 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 32768
Total time 0 min, 58 sec
69
10
9
8
7
6
5
4
3
2
1
ppm
0.82
1.03
22.58
1.00
1.91
2.14
18.98
10.13


69
ppm 200
180
160
140
120
100
80
60
40
20
0

T=70 °C, C_6D_6

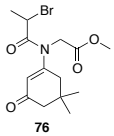

MGW03091p.i.1H.600
File: nmr600/Pettus/mweaver/MGW03091p.i.1H.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW03091p.i.1H.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
8 repetitions
OBSERVE H1, 599.6318167 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 65536
Total time 0 min, 58 sec
50d
~80% deuterium
10 9 8 7 6 5 4 3 2 1 ppm
11.53 1.04 2.37 2.36 0.30 2.00 7.28


MGW03093.A.2to3dfreezer.C6D6.1H.500
File: nmr500/Pettus/mweaver/MGW03093p.1H.C6D6.3dfreezer.500.fid
Pulse Sequence: s2pul
Solvent: c6d6
Ambient temperature
Operator: mweaver
File: MGW03093p.1H.C6D6.3dfreezer.500
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560746 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
52d
10 9 8 7 6 5 4 3 2 1 ppm
18.38 1.00 2.42 2.63 1.07 0.31 25.33 8.54

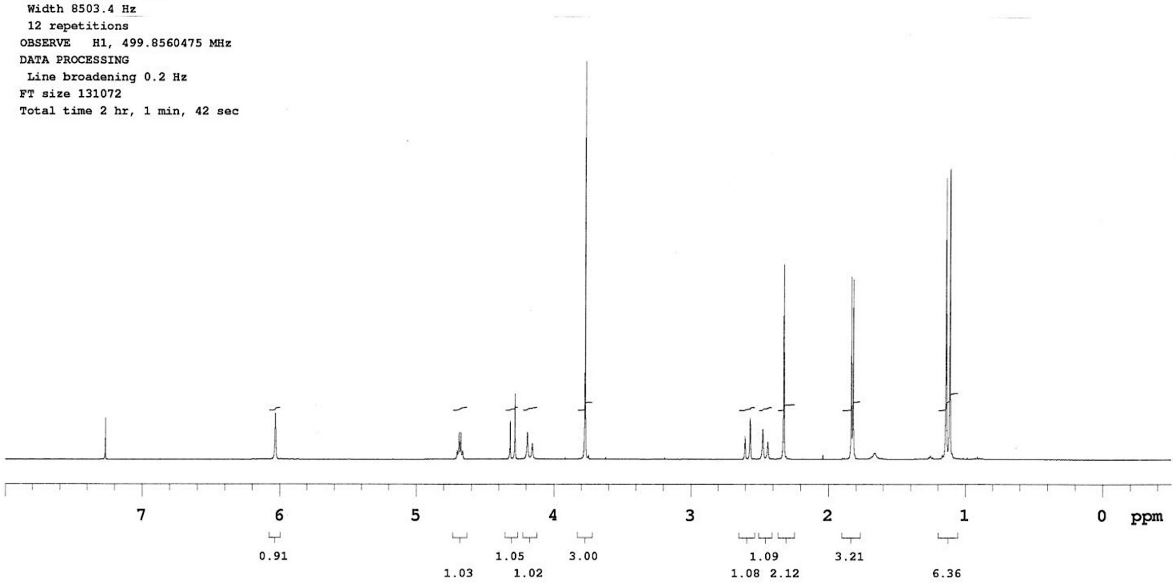

65
53d
MGW03094p.A.1H.500
File: nmr500/Pettus/mweaver/MGW03094p.A.1H.CDCl3.500.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mweaver
File: MGW03094p.A.1H.CDCl3.500
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560512 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
10
9
8
7
6
5
4
3
2
1
ppm
0.01
0.18
1.00
0.63
0.39
1.44
2.55
1.32
0.48
14.32
8.23

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: wbai
INOVA-500 "nmr500"

Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
12 repetitions
OBSERVE H1, 499.8560475 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 2 hr, 1 min, 42 sec

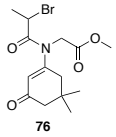


76

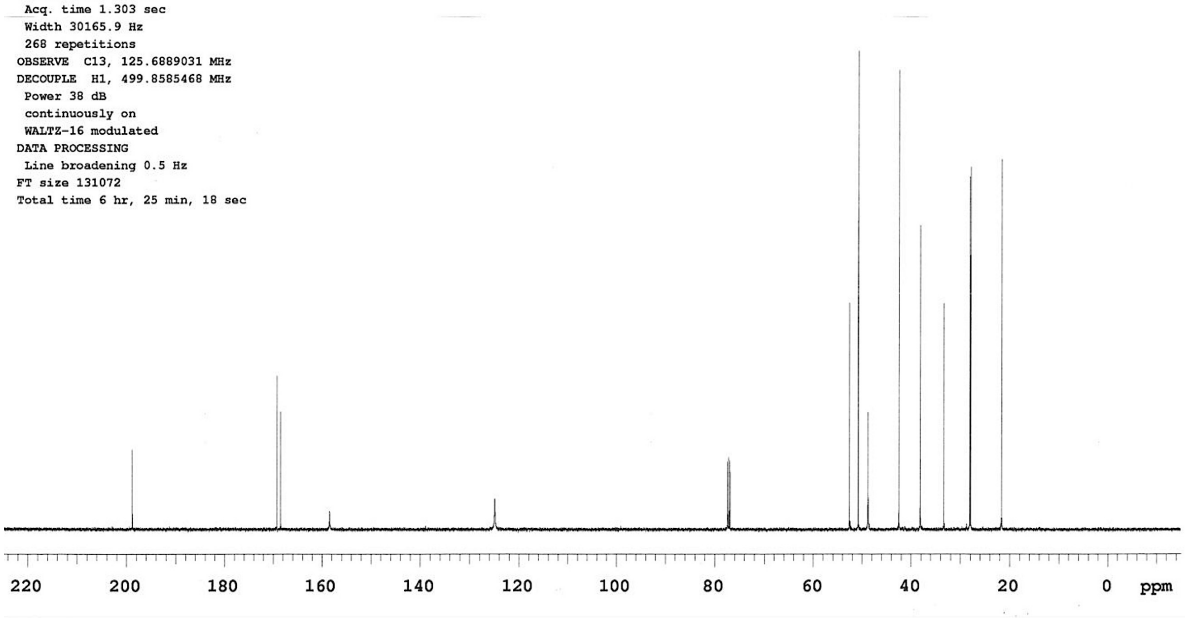


Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: wbai
INOVA-500 "nmr500"

Relax. delay 1.000 sec
Pulse 43.2 degrees
Acq. time 1.303 sec
Width 30165.9 Hz
268 repetitions
OBSERVE C13, 125.6889031 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, 18 sec



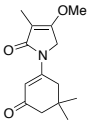
76



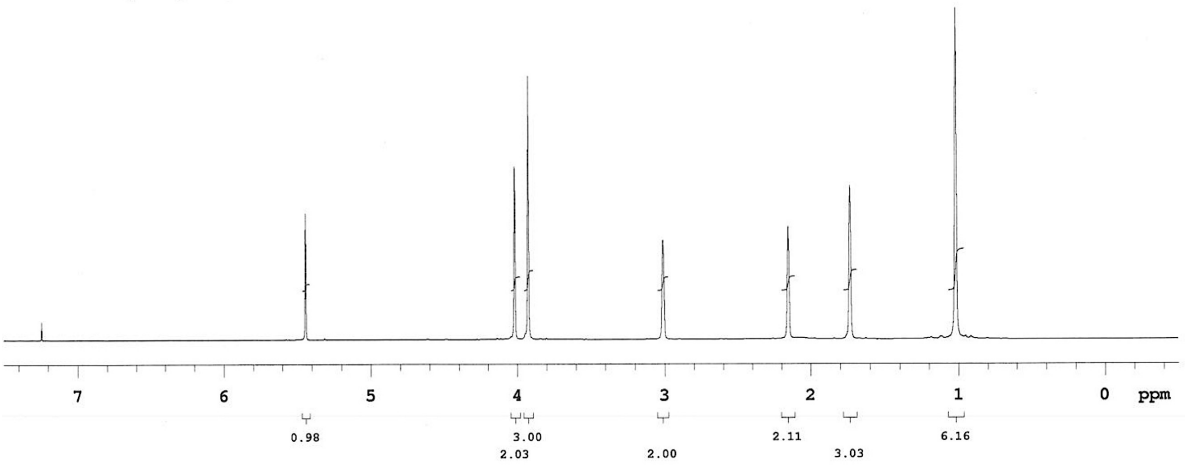
Pulse Sequence: s2pul

Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: wbai
INOVA-600 "nmr600.chem.ucsb.edu"

Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10000.0 Hz
20 repetitions
OBSERVE H1, 599.6318264 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 65536
Total time 2 hr, 1 min, 42 sec



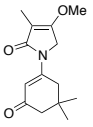
77



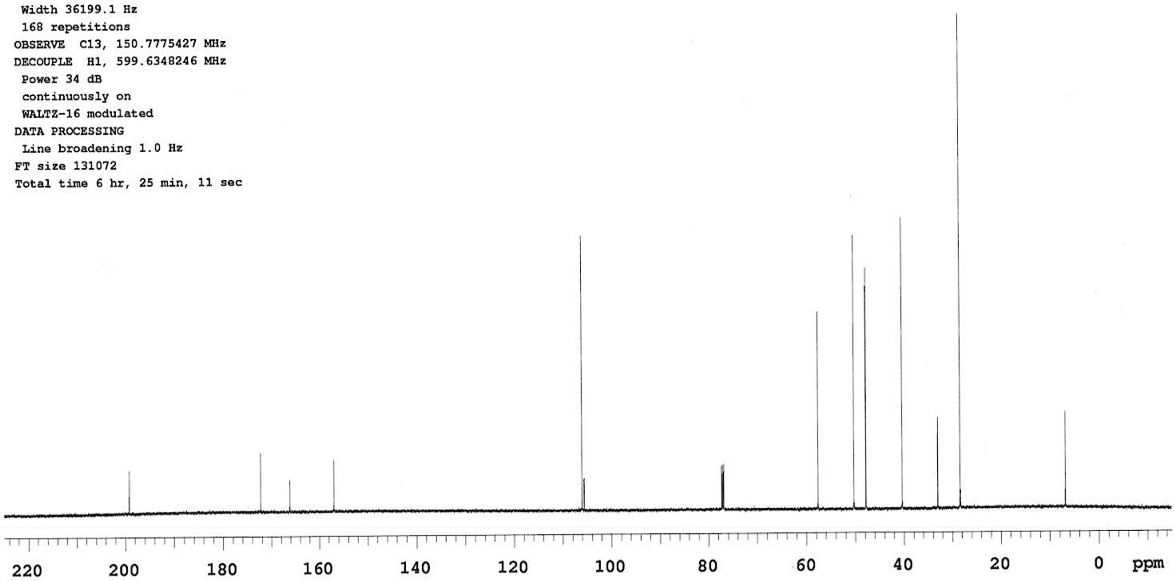
Pulse Sequence: s2pul

Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: wbai
INOVA-600 "nmr600.chem.ucsb.edu"

Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
168 repetitions
OBSERVE C13, 150.7775427 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 6 hr, 25 min, 11 sec



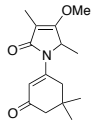
77



File: xp

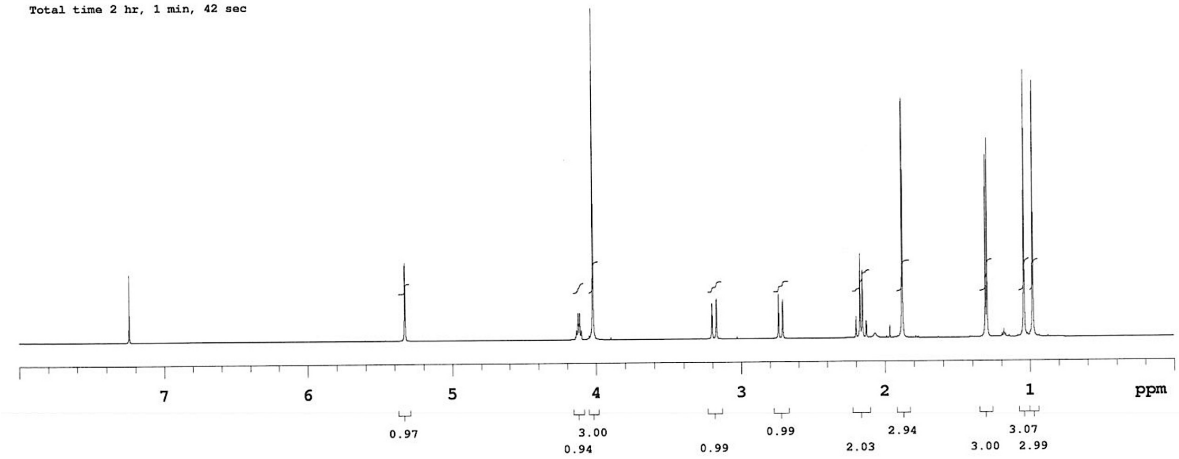
Pulse Sequence: s2pul

Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: wbai
INOVA-600 "nmr600.chem.ucsb.edu"



78 precursor

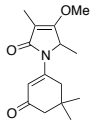
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 10787.5 Hz
16 repetitions
OBSERVE H1, 599.6318264 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 2 hr, 1 min, 42 sec



File: xp

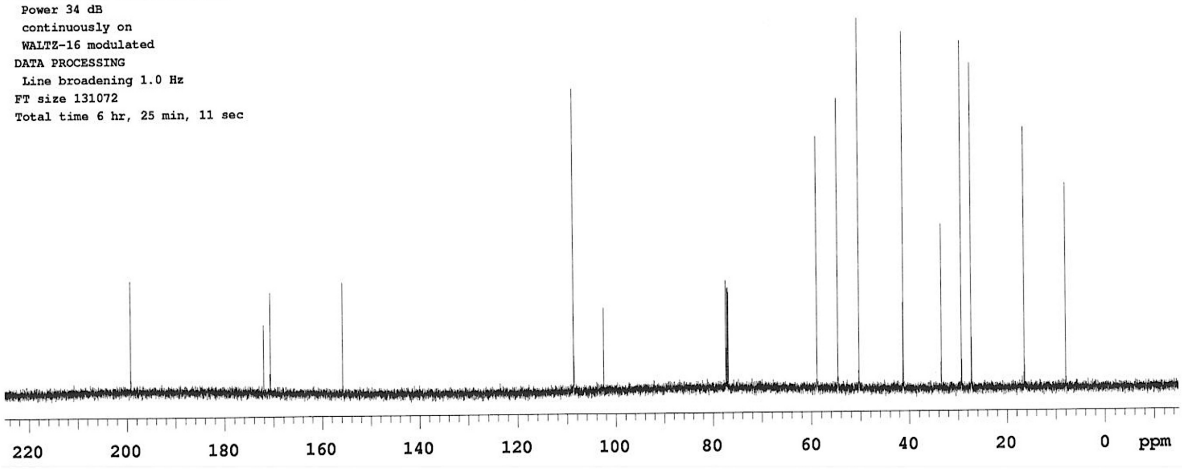
Pulse Sequence: s2pul

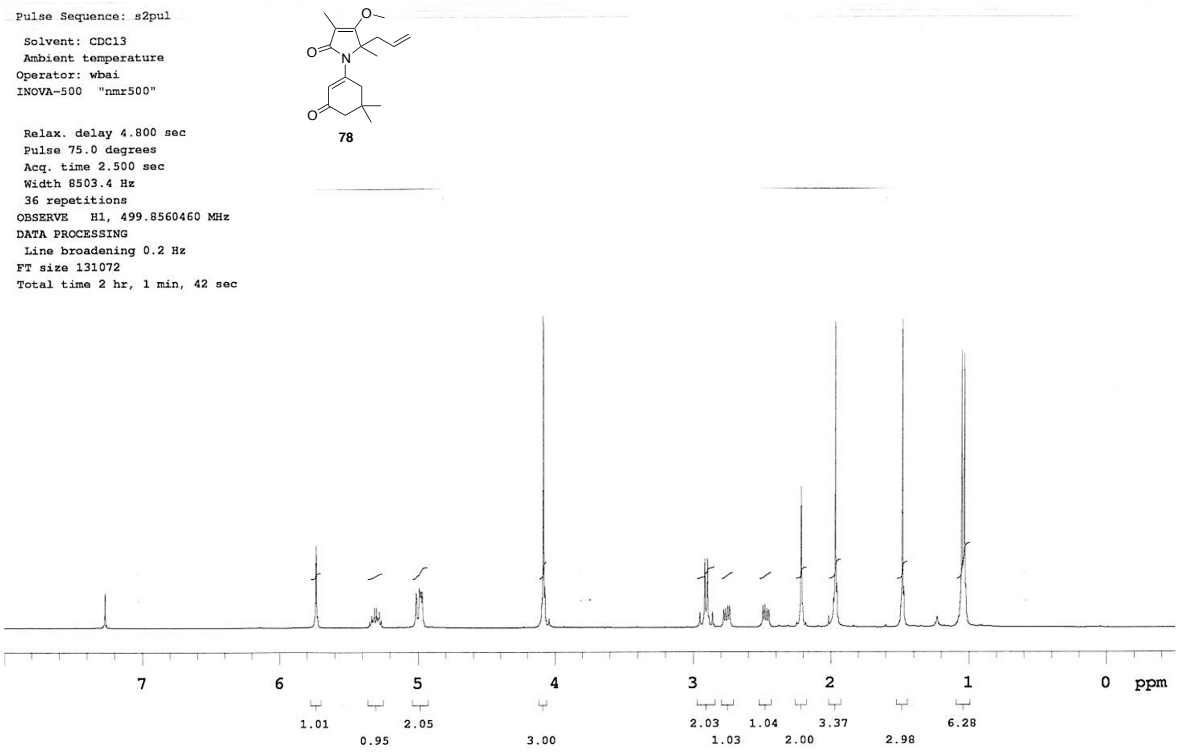
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: wbai
INOVA-600 "nmr600.chem.ucsb.edu"

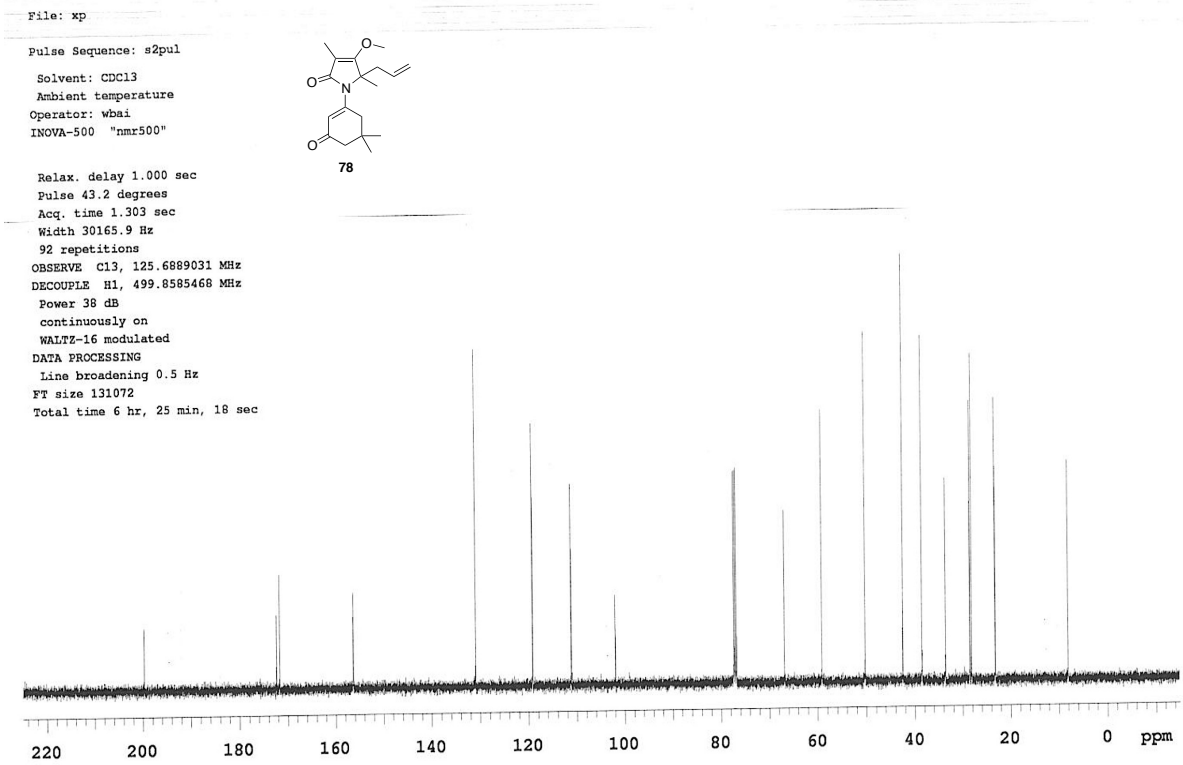


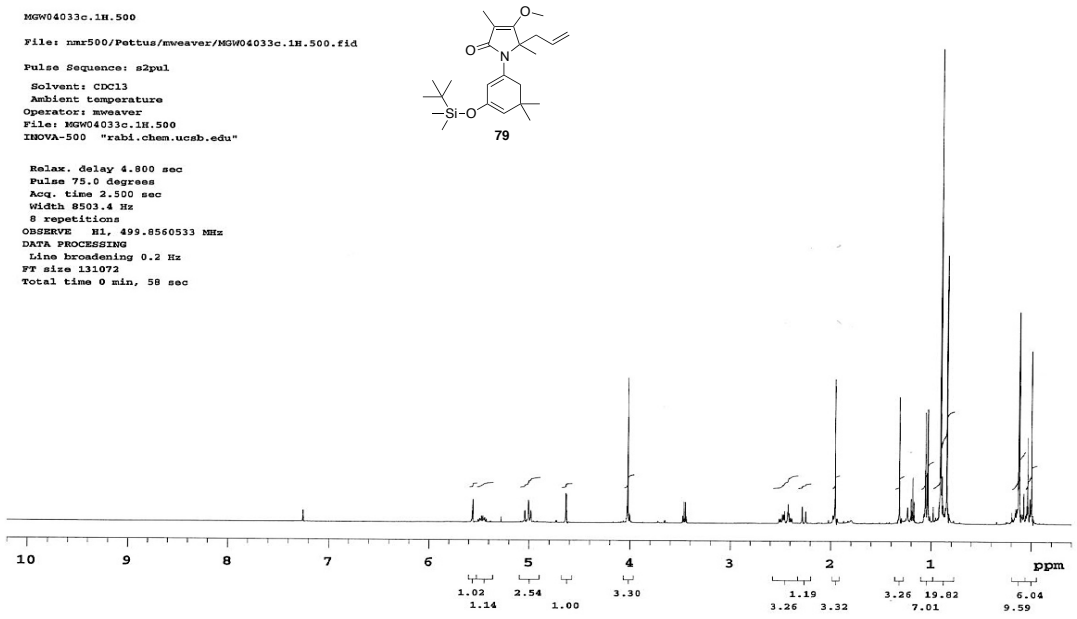
78 precursor

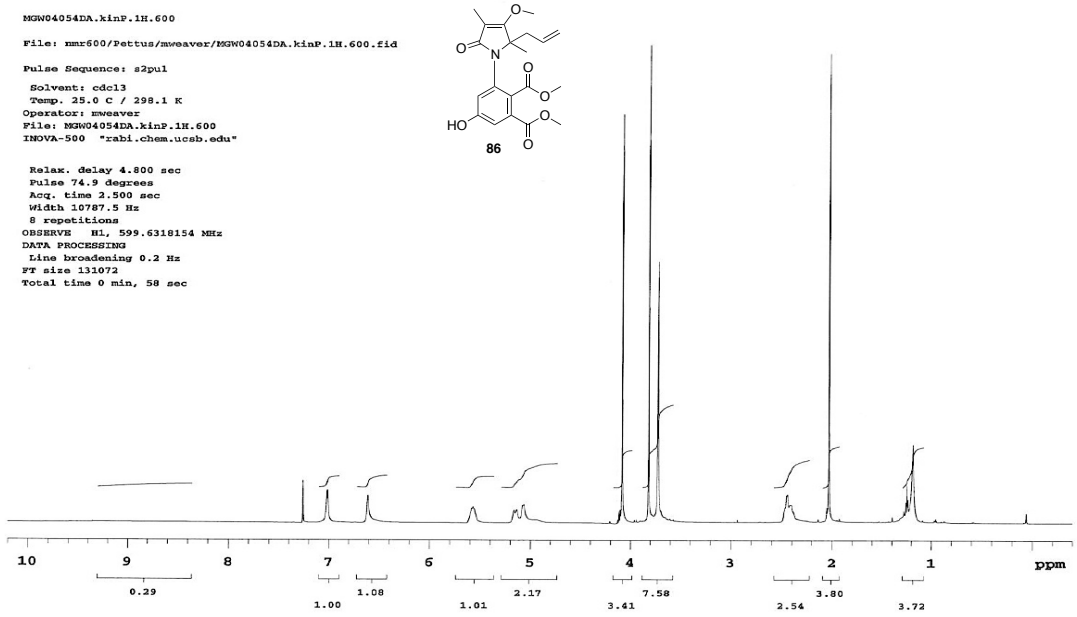
Relax. delay 1.000 sec
Pulse 10.0 usec
Acq. time 1.299 sec
Width 36199.1 Hz
44 repetitions
OBSERVE C13, 150.7775427 MHz
DECOUPLE H1, 599.6348246 MHz
Power 34 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 6 hr, 25 min, 11 sec



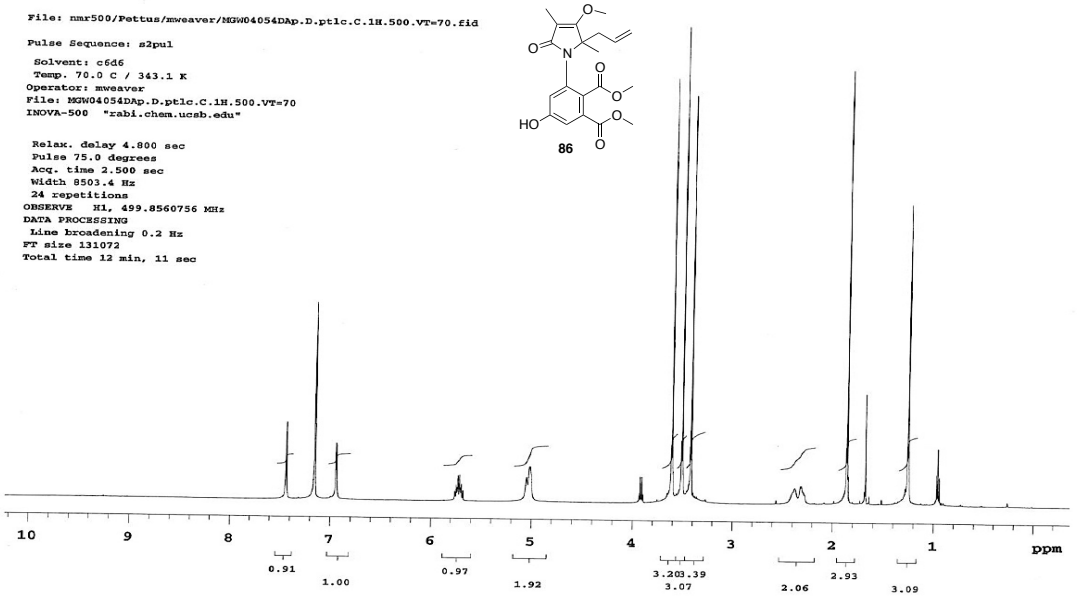

Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: wbai
INOVA-500 "nmr500"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
36 repetitions
OBSERVE H1, 499.8560460 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 2 hr, 1 min, 42 sec
78
7
6
5
4
3
2
1
0
ppm
1.01
0.95
2.05
3.00
2.03
1.03
1.04
2.00
3.37
2.98
6.28


File: xp
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: wbai
INOVA-500 "nmr500"
Relax. delay 1.000 sec
Pulse 43.2 degrees
Acq. time 1.303 sec
Width 30165.9 Hz
92 repetitions
OBSERVE C13, 125.6889031 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, 18 sec
78
220
200
180
160
140
120
100
80
60
40
20
0
ppm

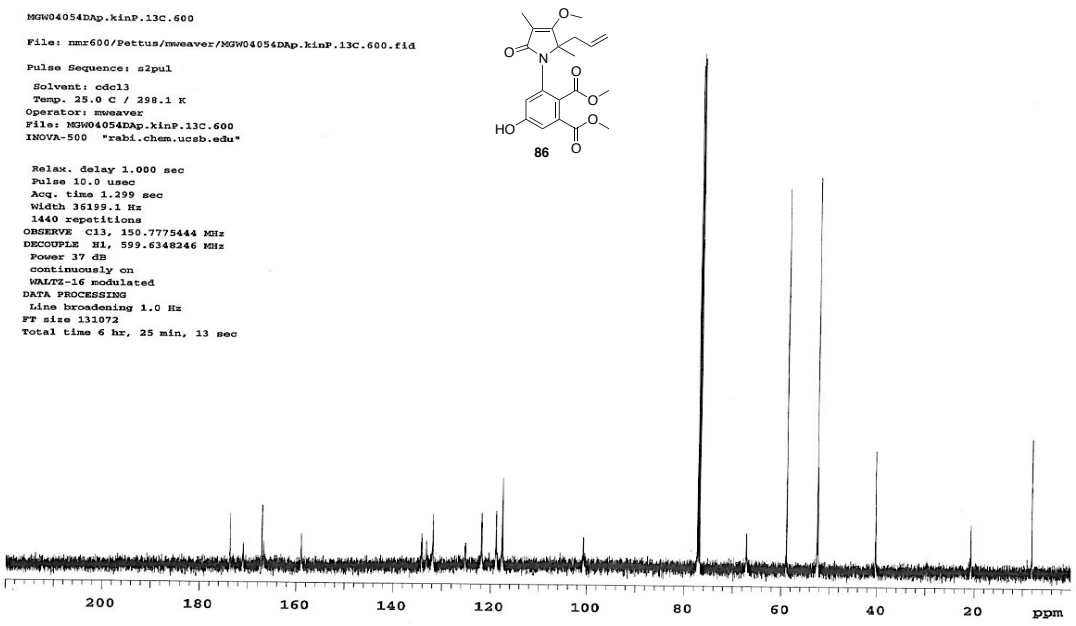

MGW04033c.1H.500
File: nmr500/Pettus/mweaver/MGW04033c.1H.500.fid
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mweaver
File: MGW04033c.1H.500
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 75.0 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560533 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
79
10
9
8
7
6
5
4
3
2
1
ppm
1.02
1.14
2.54
1.00
3.30
1.19
3.26
3.32
3.26
19.82
7.01
6.04
9.59



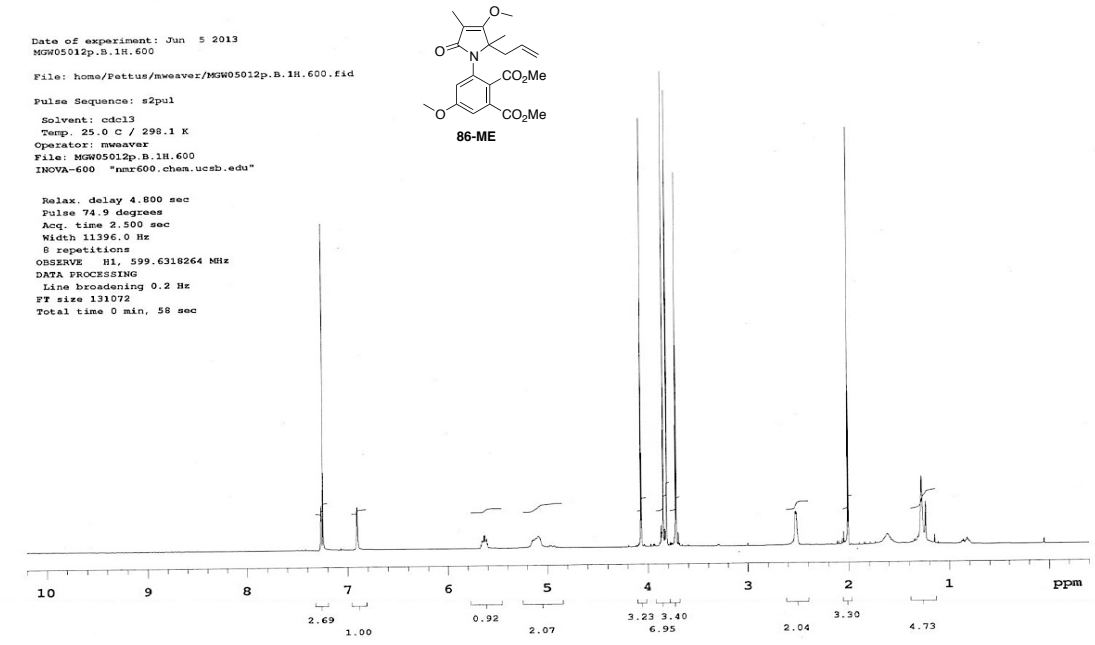
Ambient temperature, $CDCl_3$

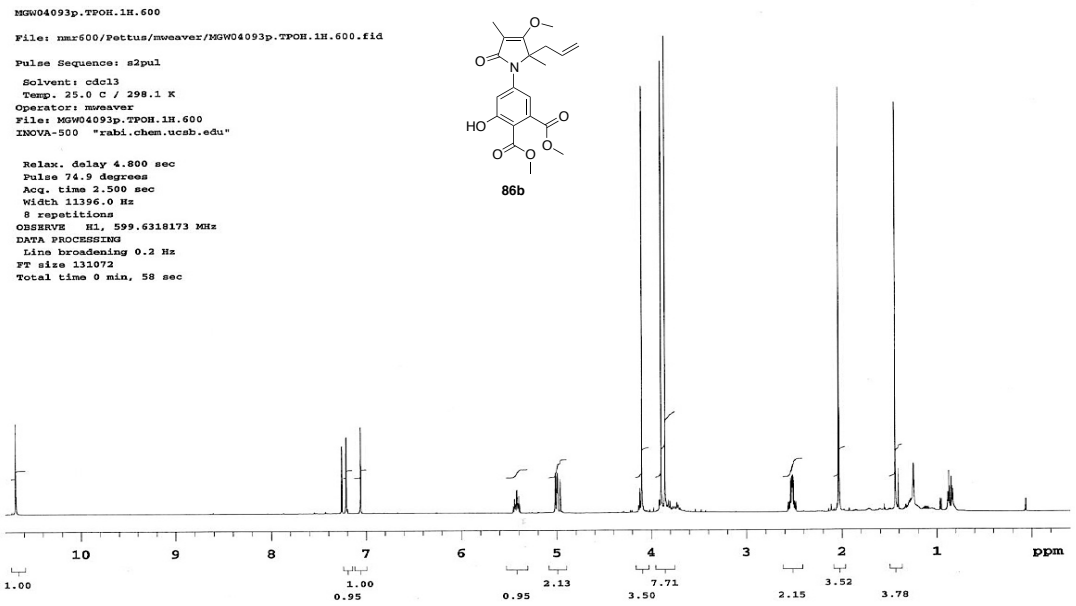


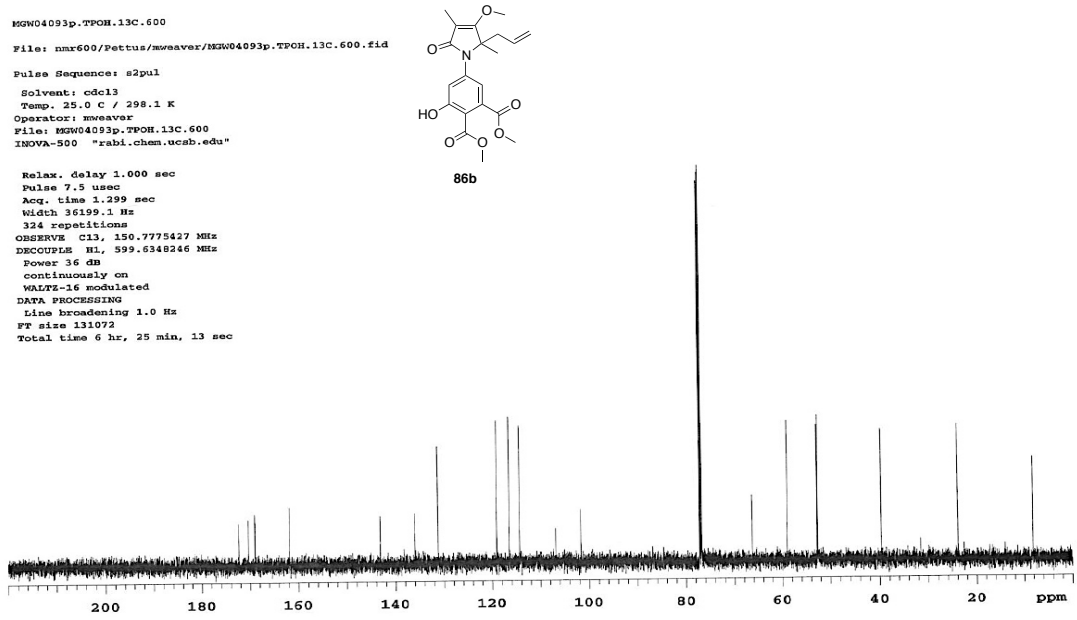
70 °C, C_6D_6

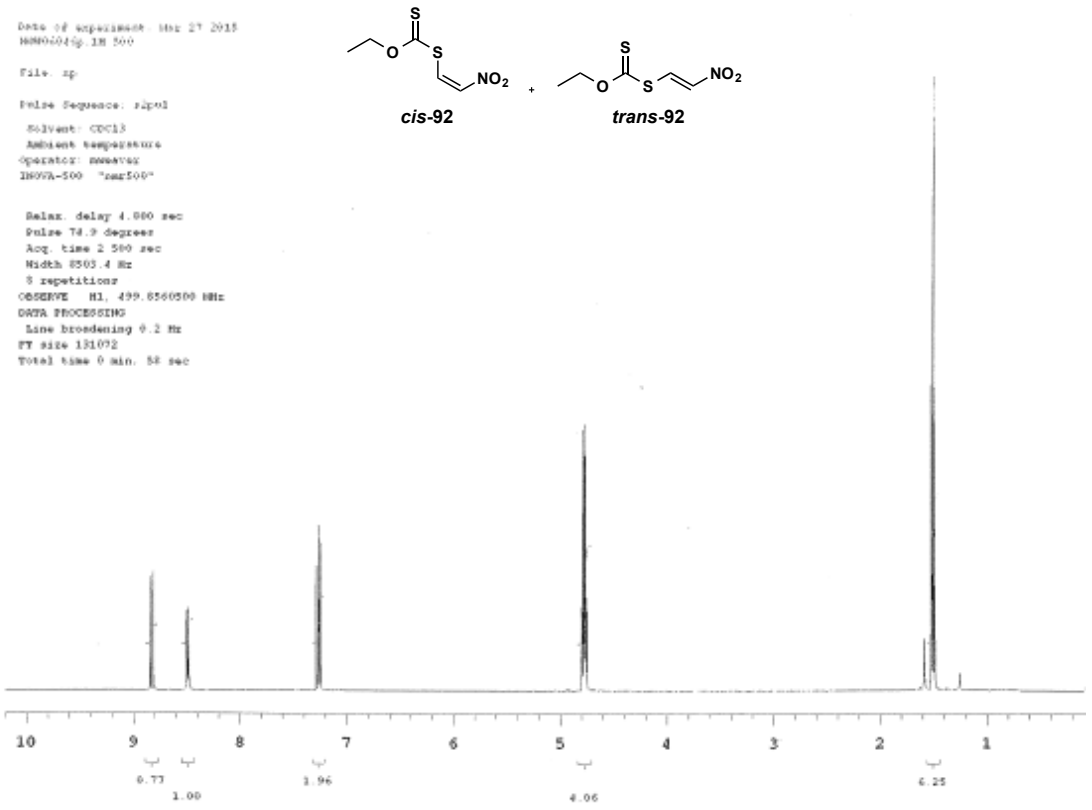


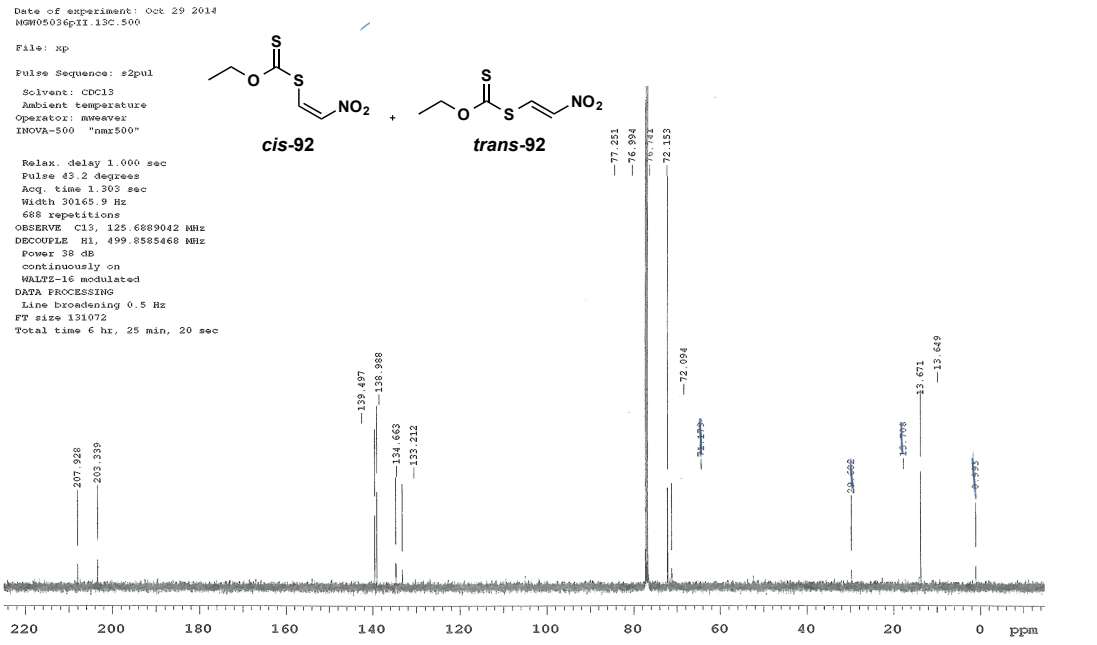
Ambient temperature, $CDCl_3$

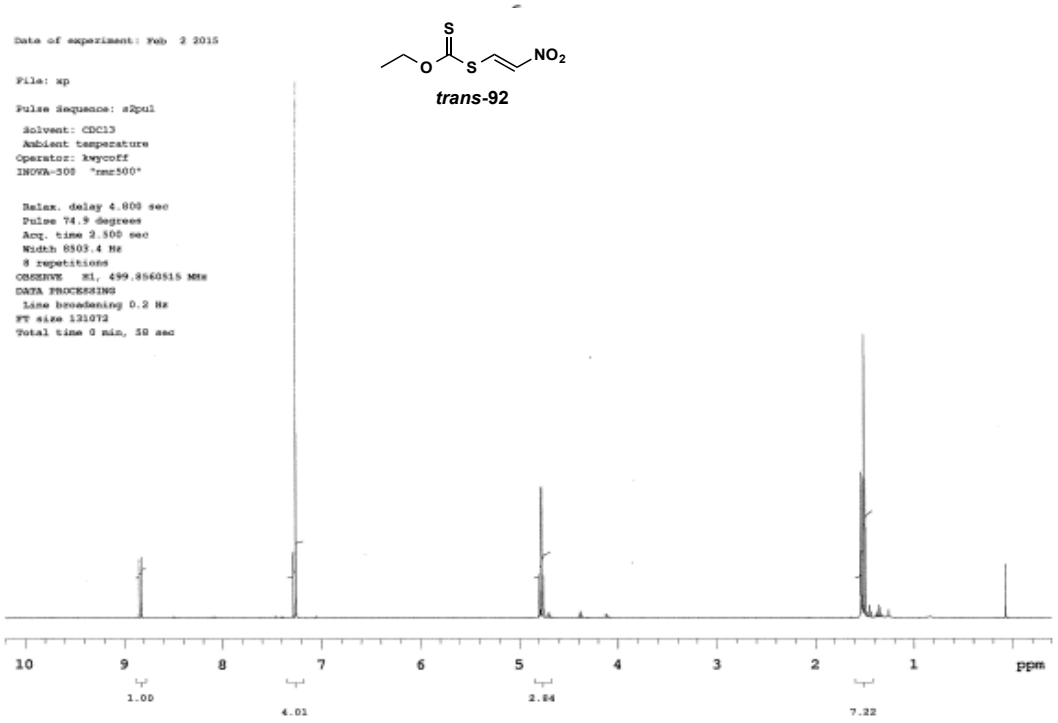


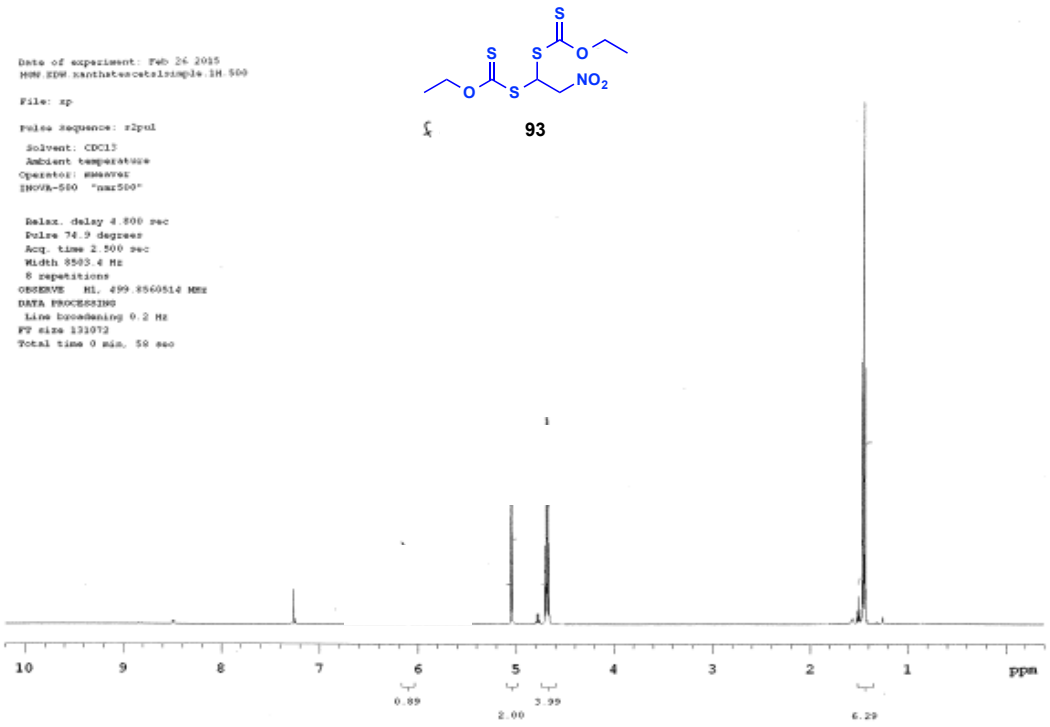

MGW04093p.TPOH.1H.600
File: nmr600/Pettus/mweaver/MGW04093p.TPOH.1H.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW04093p.TPOH.1H.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 11396.0 Hz
8 repetitions
OBSERVE H1, 599.6318173 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
86b
10
9
8
7
6
5
4
3
2
1
ppm
1.00
1.00
0.95
0.95
2.13
7.71
3.50
2.15
3.52
3.78

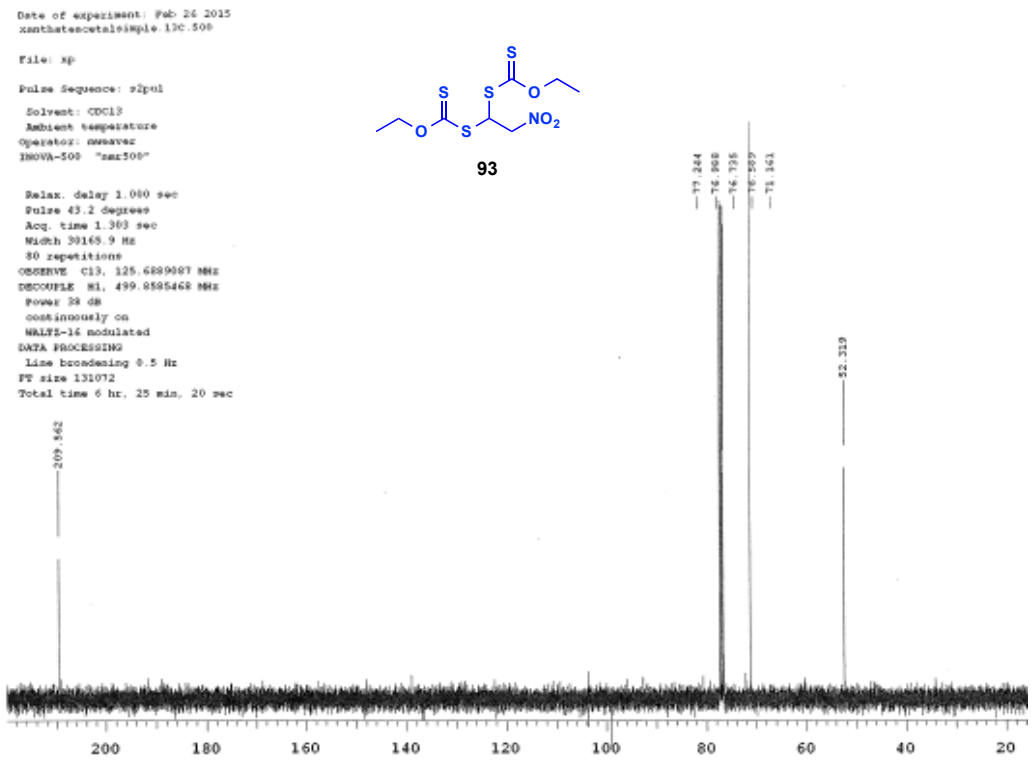

MGW04093p.TPOH.13C.600
File: nmr600/Pettus/mweaver/MGW04093p.TPOH.13C.600.fid
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
File: MGW04093p.TPOH.13C.600
INOVA-500 "rabi.chem.ucsb.edu"
Relax. delay 1.000 sec
Pulse 7.5 usec
Acq. time 1.299 sec
Width 36199.1 Hz
324 repetitions
OBSERVE C13, 150.7775427 MHz
DECOUPLE H1, 599.6348246 MHz
Power 36 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 6 hr, 25 min, 13 sec
86b
200
180
160
140
120
100
80
60
40
20
ppm

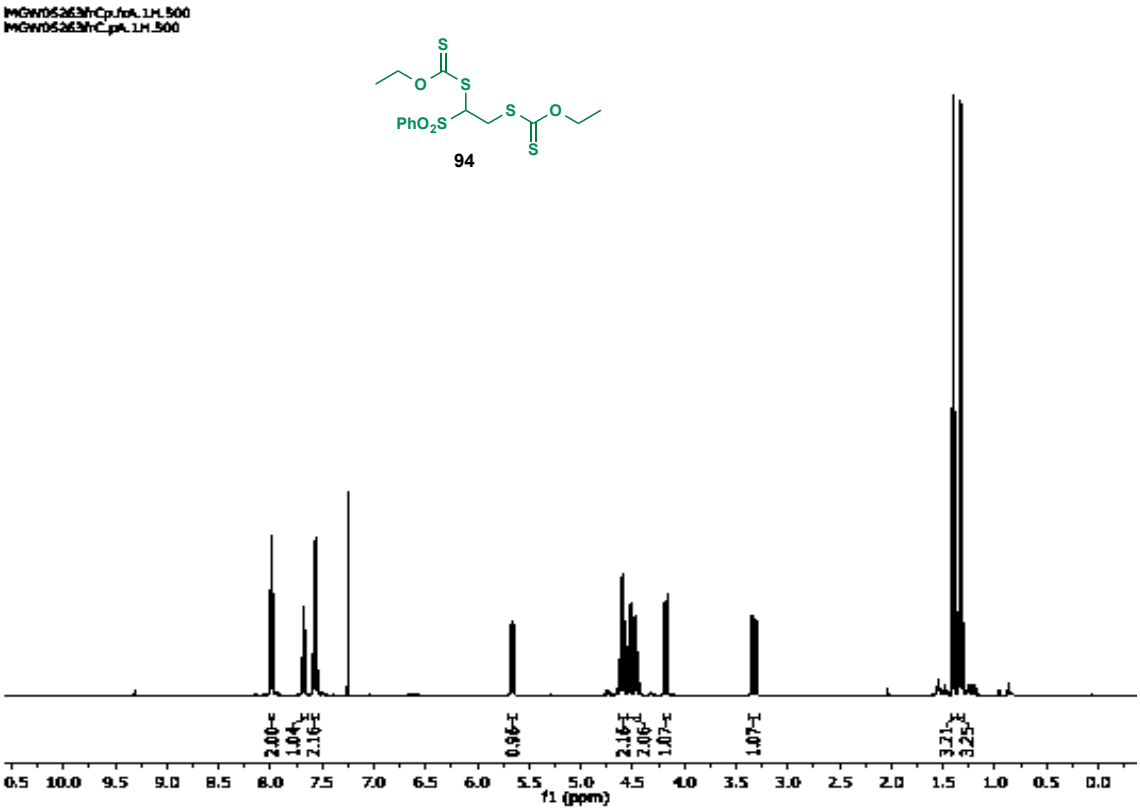

Date of experiment: Mar 27 2015
MGW06046.1H.500
File: xp
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mweaver
INOVA-500 "nmr500"
Relax. delay 4.000 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560500 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
cis-92
trans-92
10
9
8
7
6
5
4
3
2
1
0.77
1.00
1.96
4.06
6.25

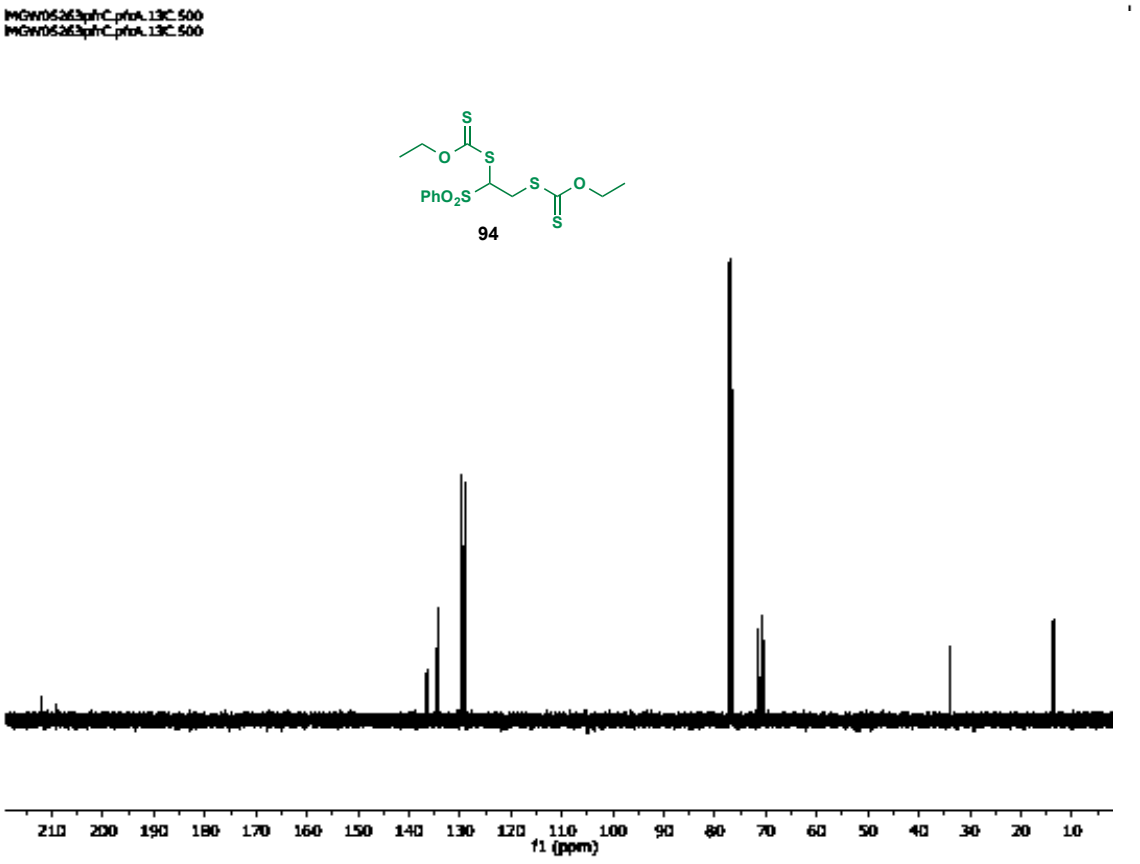

Date of experiment: Oct 29 2014
MGW05036pXI.13C.500
File: xp
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mweaver
INOVA-500 "nmr500"
Relax. delay 1.000 sec
Pulse 43.2 degrees
Acq. time 1.303 sec
Width 30165.9 Hz
688 repetitions
OBSERVE C13, 125.6889042 MHz
DECOUPLE H1, 499.8585468 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
cis-92
trans-92
207.928
203.339
139.497
138.988
134.663
133.212
77.251
76.994
76.741
72.153
72.094
29.202
15.708
13.671
13.649
220
200
180
160
140
120
100
80
60
40
20
0
ppm

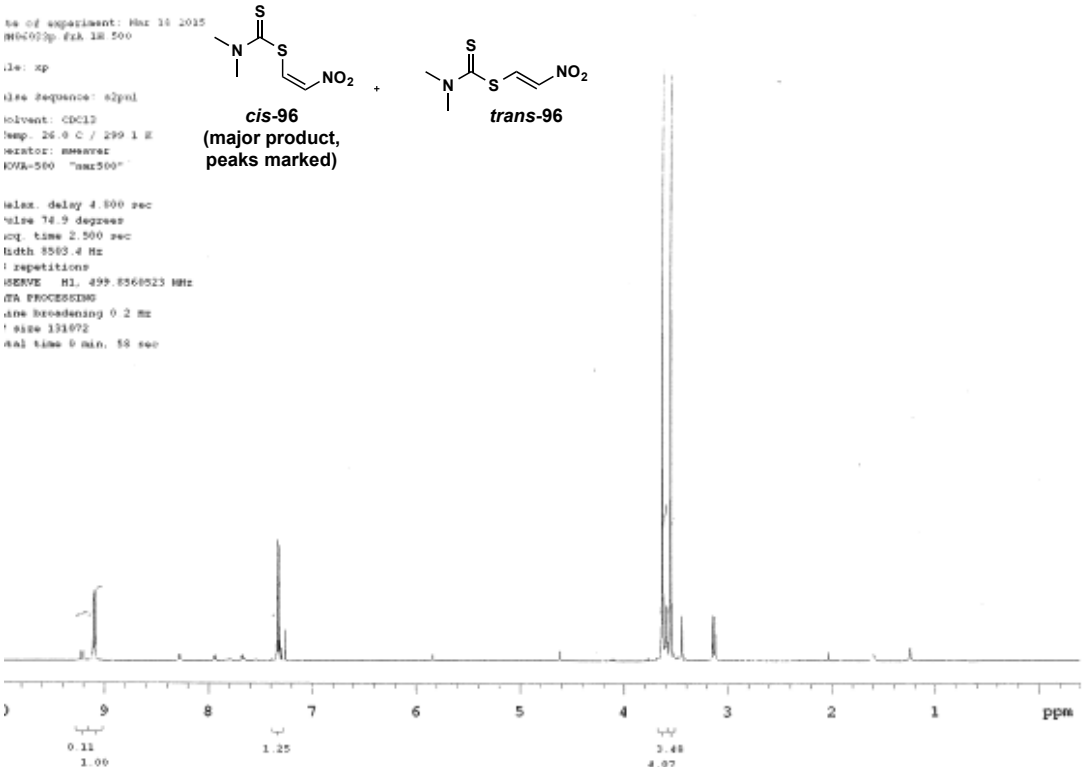

Date of experiment: Feb 2 2015
File: xp
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: kwycoff
INOVA-500 "rmr500"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560515 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 30 sec
S
O
S
NO2
trans-92
10
9
8
7
6
5
4
3
2
1
ppm
1.00
4.01
2.84
7.22


Date of experiment: Feb 26 2015
HSM.EDW.xanthatescetalsimple.1H.500
File: xp
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mmeaver
INOVA-500 "nmr500"
Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
8 repetitions
OBSERVE H1, 499.8560514 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 59 sec
93
10
9
8
7
6
5
4
3
2
1
ppm
0.89
2.00
3.99
6.29


Date of experiment: Feb 26 2015
xanthatescetalsimple.13C.500
File: xp
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Operator: mmeaver
INOVA-500 "nmr500"
Relax. delay 1.000 sec
Pulse 43.2 degrees
Acq. time 1.303 sec
Width 30165.9 Hz
80 repetitions
OBSERVE C13, 125.6889087 MHz
DECOUPLE H1, 499.8595468 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
93
77.244
76.988
76.735
70.559
71.141
52.319
209.562
200
180
160
140
120
100
80
60
40
20

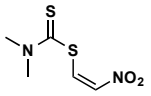

94
2.00
1.04
2.16
0.96
2.16
2.06
1.07
1.07
3.21
3.25
f1 (ppm)


94
f1 (ppm)

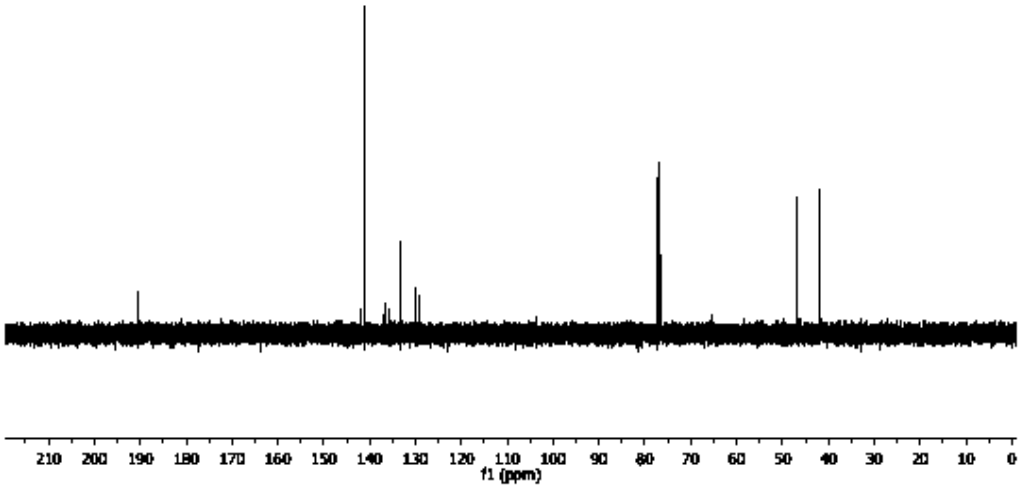


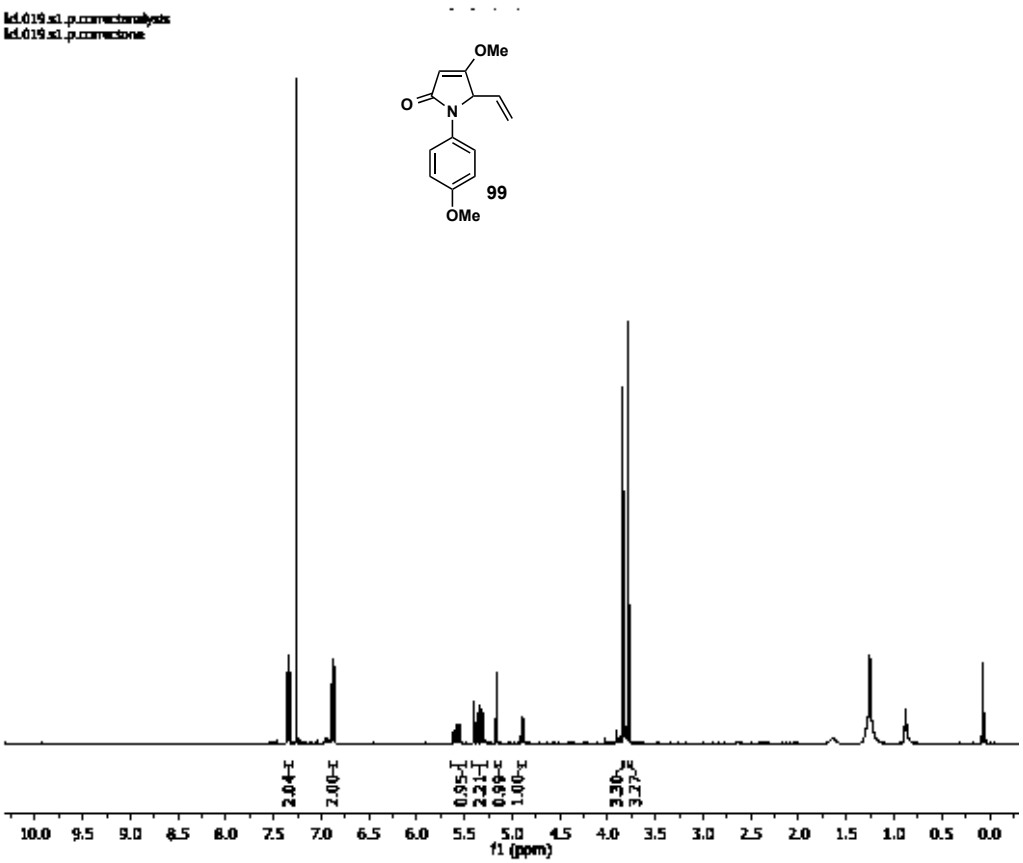
***cis*-96**
(major product, peaks marked)

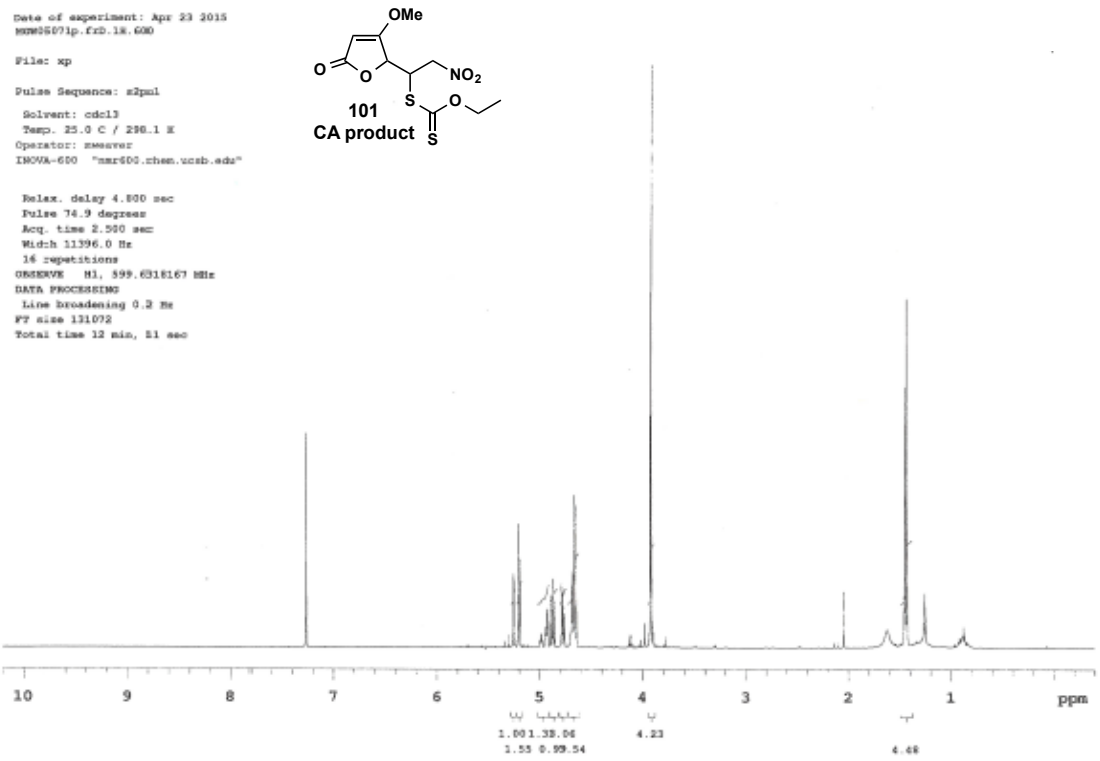
***trans*-96**

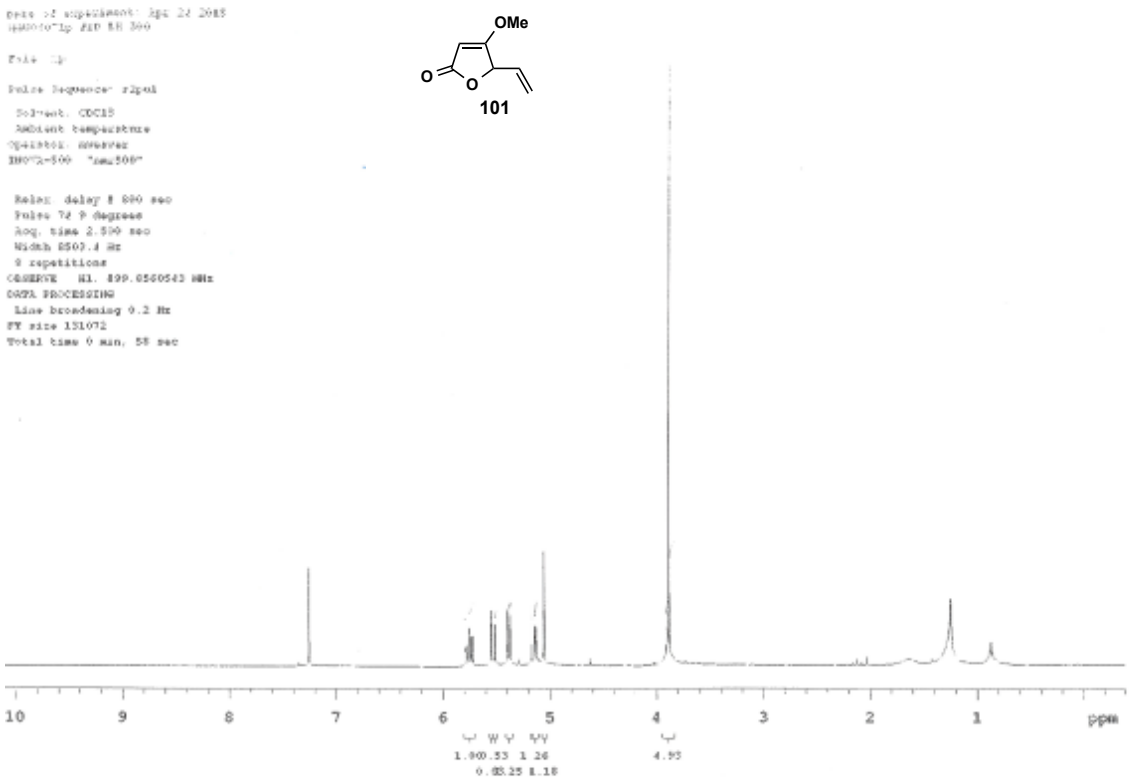


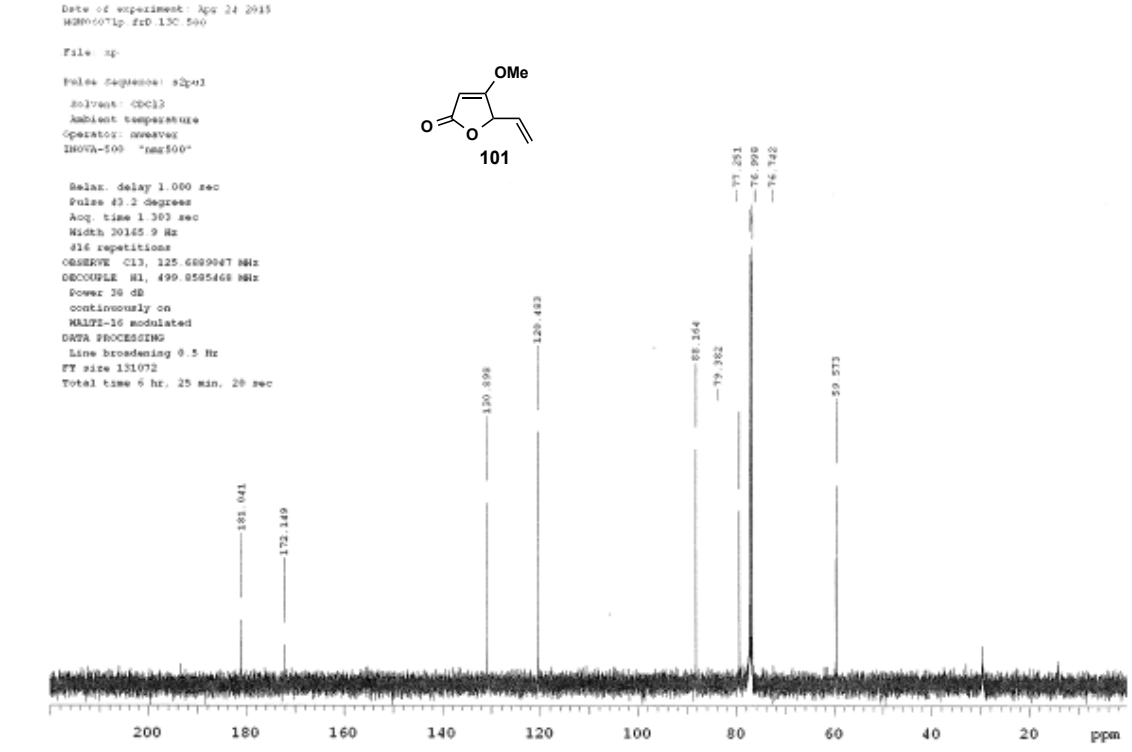
***cis*-96**
(major product, peaks marked)

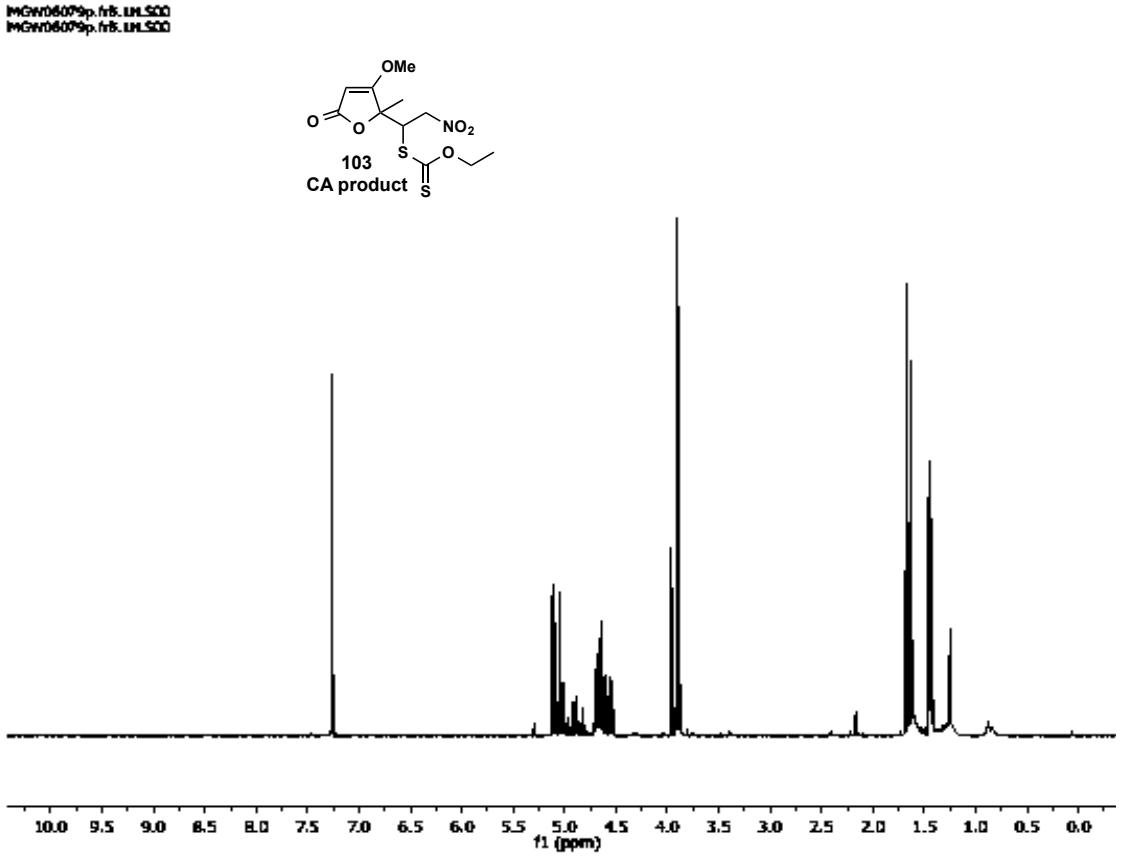


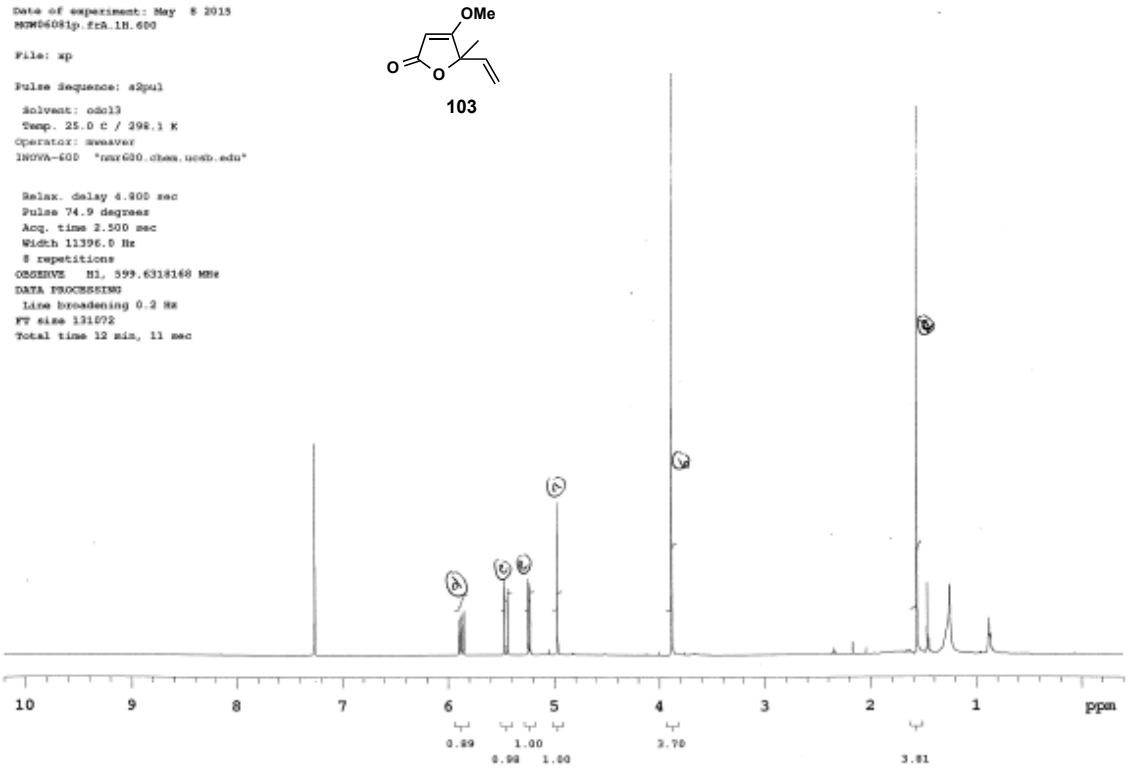

OMe
O
N
99
OMe
2.04
2.00
0.95
2.21
0.99
1.00
3.30
3.27
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


Date of experiment: Apr 23 2015
mmr05071p.fid.1H.600
File: xp
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mmeaver
INOVA-600 "mmr600.chem.ucsb.edu"
Relax. delay 4.000 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 11396.0 Hz
16 repetitions
OBSERVE H1, 599.6318167 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 12 min, 51 sec
OMe
O
O
NO2
S
O
S
101
CA product
10
9
8
7
6
5
4
3
2
1
ppm
1.00 1.38 0.86
1.55 0.99 0.54
4.23
4.48

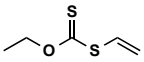

OMe
O
O
101
Solvent: CDCl3
Ambient temperature
Relax. delay 8.000 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 8503.4 Hz
9 repetitions
OBSERVE H1, 899.8560543 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 0 min, 58 sec
10
9
8
7
6
5
4
3
2
1
ppm
1.00
0.53
1.26
0.85
1.18
4.93


Solvent: CDCl3
Ambient temperature
Relax. delay 1.000 sec
Pulse 43.2 degrees
Acq. time 1.303 sec
Width 30165.9 Hz
816 repetitions
OBSERVE C13, 125.6899047 MHz
DECOUPLE H1, 499.8595468 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, 28 sec
OMe
O
O
101
77.251
76.998
76.742
88.164
79.362
120.483
120.698
59.573
181.041
172.149
200
180
160
140
120
100
80
60
40
20
ppm

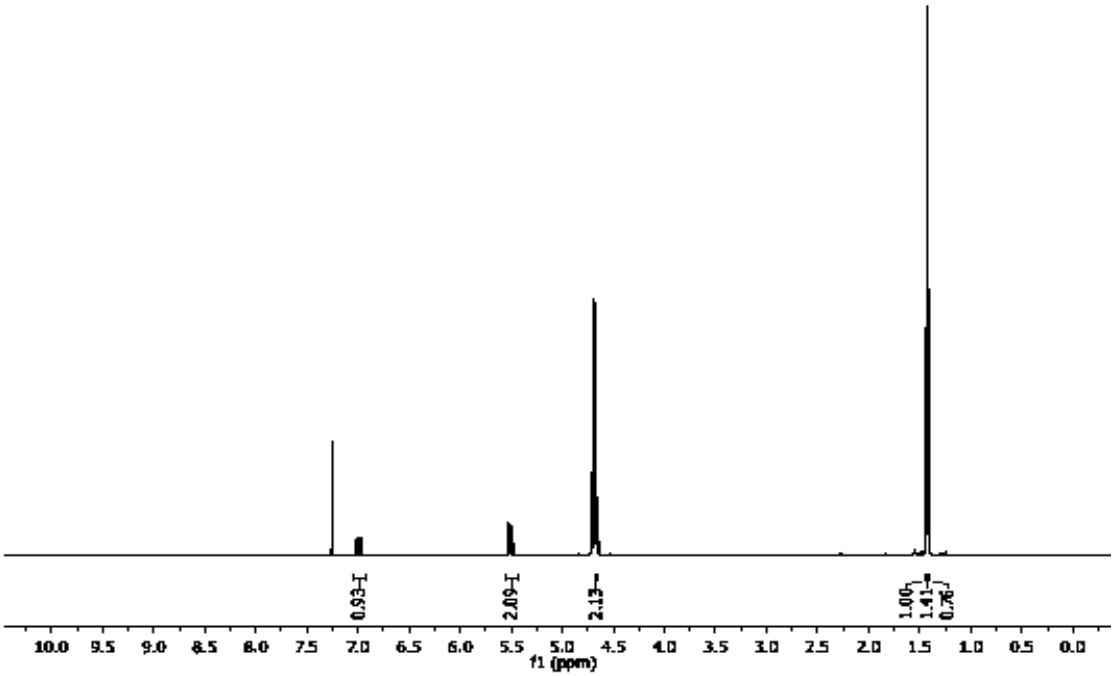

OMe
O
O
NO2
S
O
S
103
CA product
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


Date of experiment: May 8 2015
MGW0608lp.frA.1H.600
File: xp
Pulse Sequence: s2pul
Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
INOVA-600 "nmr600.chem.ucsb.edu"
Relax. delay 4.900 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 11396.0 Hz
8 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 12 min, 11 sec
OMe
O
O
103
10 9 8 7 6 5 4 3 2 1 ppm
0.89 1.00 2.70
0.98 1.00 3.81

MGW06097c.1H.500
MGW06097c.1H.500



106



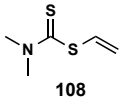
Data of experiment: May 28 2015
MGW06099c.1H.600

File: mp

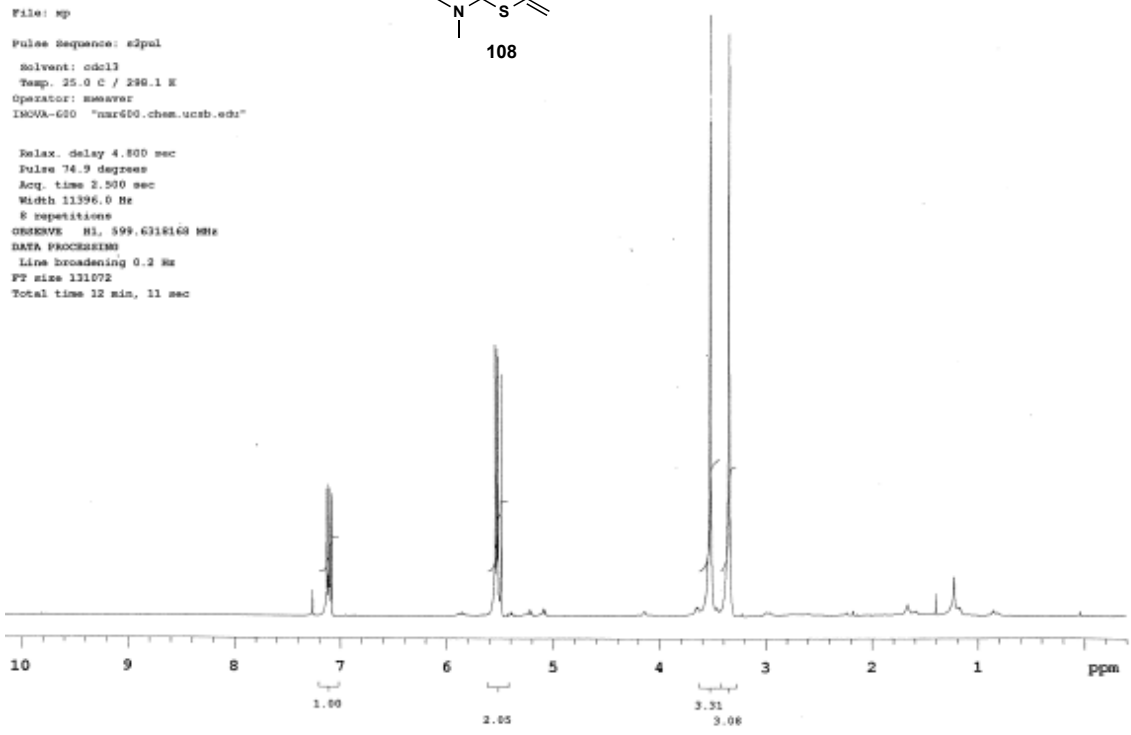
Pulse Sequence: s2pul

Solvent: cdcl3
Temp. 25.0 C / 298.1 K
Operator: mweaver
INOVA-600 "nmr600.chem.ucsb.edu"

Relax. delay 4.800 sec
Pulse 74.9 degrees
Acq. time 2.500 sec
Width 11396.0 Hz
8 repetitions
OBSERVE H1, 599.6318168 MHz
DATA PROCESSING
Line broadening 0.2 Hz
FT size 131072
Total time 12 min, 11 sec



108



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