UNIVERSITY OF CALIFORNIA

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# Progress Towards the Stereoselective Synthesis of Korupensamine A

A thesis submitted in partial satisfaction

of the requirements for the degree of

Masters of Science in Chemistry

by

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November 2005

Progress Towards the Stereoselective Synthesis of Korupensamine A

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Regarding synthesis-

“The two groups had no way of knowing a hell of problems awaited them once they joined forces for the attempt to combine their components. They hung, so to speak, for years in the rocks, roped together, over an abyss of roughly fifty chemical steps, trying to reach the cobyric acid peak.”

- Albert Eschenmoser, remarking on the state of his collaboration with R.B. Woodward to synthesize Vitamin $B_{12}$, circa 1967.

“Then for four miles downhill running, carefree and as happy as the winds that flew with us. Not even the beasts of the forests trespassed upon this ground we were skimming. Forgotten were all the petty, sordid things that surround one in this greedy rush to exist among the smokestacks of the city. For here, in the covert of the towering, unchanging mountains, we *lived*.”

-“In The Northwest,” *American Ski Annual*, 1934.

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Secondly, the support of my family has been invaluable, many thanks to Mom, Bob, Dad, Jackie, Cindy, Greg and Gram for their encouragement throughout.

This thesis is dedicated to the scientific achievements and memory of both Jason Altom, and Dr. Wolfgang Oppolzer.

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Last and most importantly, I would like to thank Bruce Lipshutz for supporting me, monetarily and intellectually, and for providing a stimulating, dynamic scientific environment.

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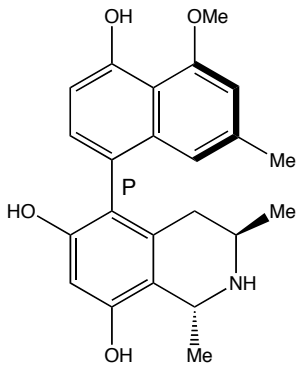
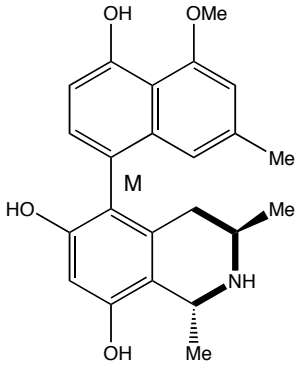



korupensamine A




korupensamine B

Introduction

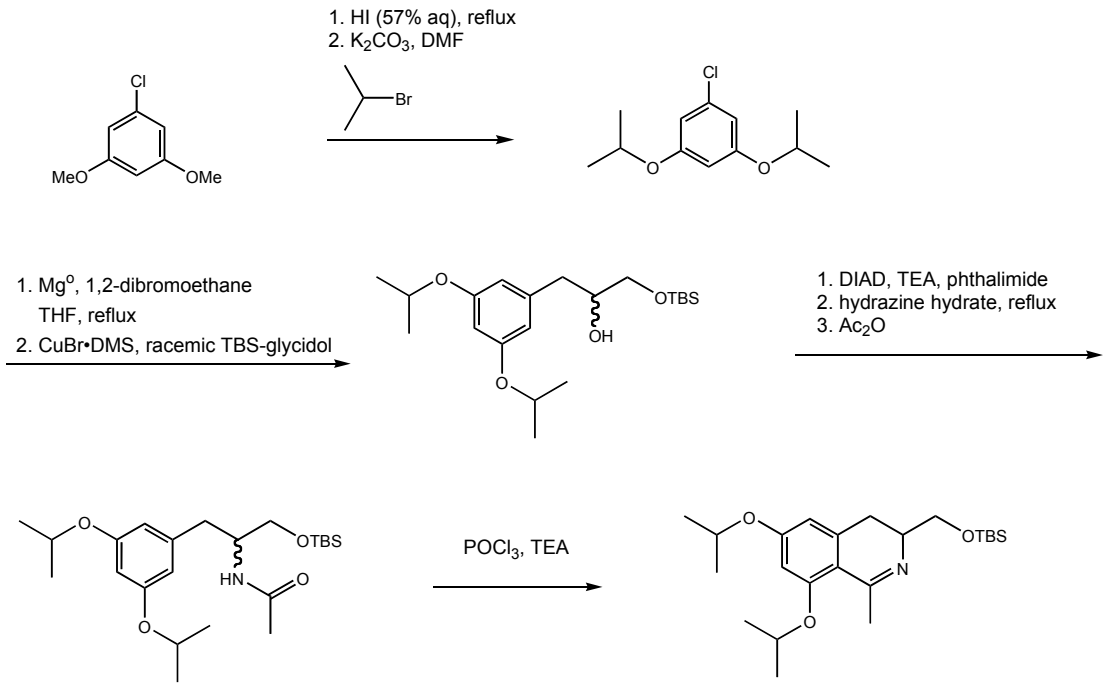
The korupensamines are biaryl containing natural products isolated from *Ancistrocladus korupensis*. These fascinating alkaloids show significant activity against the malaria parasite, *Plasmodium falciparum*. The main synthetic challenges to their total syntheses are (i), the highly polar nature of this system, (ii) two stereogenic $sp^3$ centers, and (iii) control of biaryl stereochemistry. It is the last of these challenges that has made the korupensamines and their dimerized forms, (the michellamines), formidable synthetic targets. Essentially, no simple, robust methodologies exist to control biaryl stereochemistry, and this gap in the literature was the genesis of this project.

In 1999 our group disclosed a remarkable diastereoselective biaryl coupling, using a strategy of internal *chiral* chelation via a phosphino-ester.[1] This methodology had many highly attractive facets- ease of introduction and

the ability to incorporate it at a late stage in the synthesis, avoiding many synthetic pitfalls. However, the subunits pursued by John Keith did not allow full differentiation between aryl methyl ethers, so selective deprotection to afford natural korupensamine A was not possible.

Early in the summer of 2001 I endeavored to begin a new synthesis that would allow construction of the natural product via differentiated protecting groups; namely replacing the aryl methyl ethers with aryl isopropyl ethers. Greene and Wutz[2] indicated that selective removal should be possible.

The first steps involved elaboration of commercially available material to the bis-isopropxy substrate. (Scheme 1). Unfortunately, very few substituted resorcinols are available at any price. Therefore, the same material with which John Keith began, 1-chloro-3-5-dimethoxybenzene, was parlayed into the necessary substrate via demethylation, and subsequent realkylation. The optimized conditions for this transformation were either refluxing concentratred aqueous HI or (more economically) aqueous HBr / HOAc.[3] Yields were generally excellent and no chromatography is necessary.

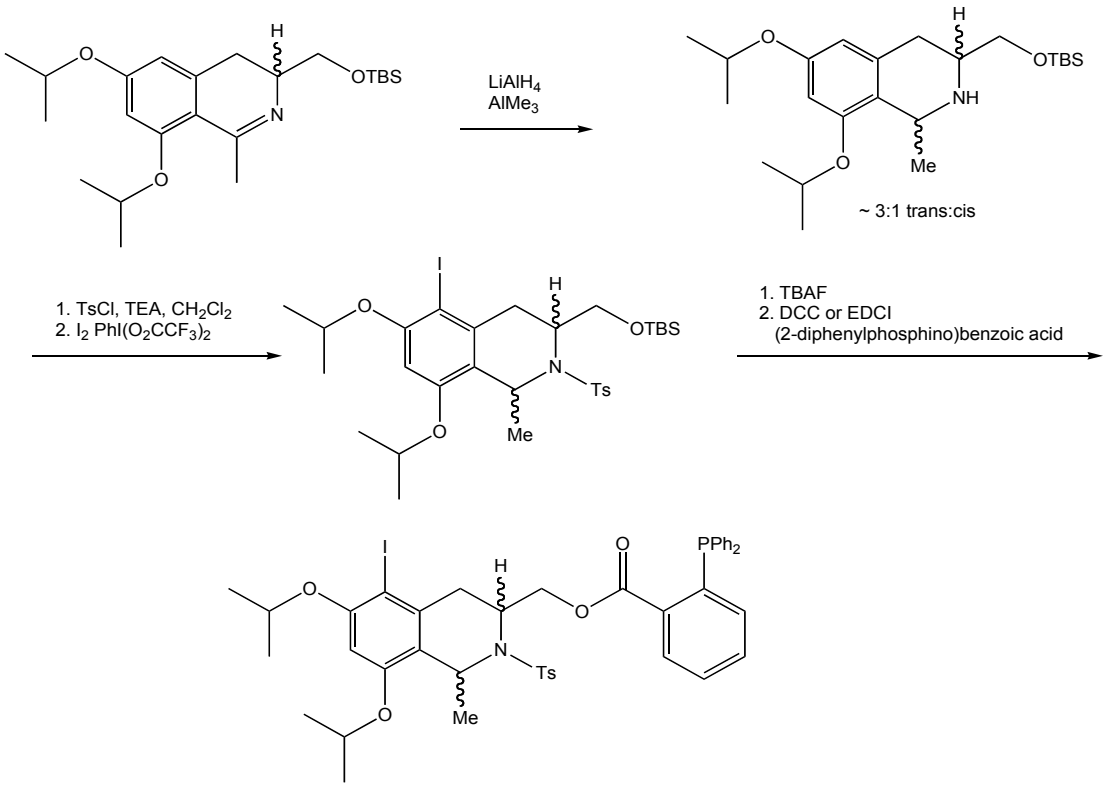



Scheme 1

The second stage of the synthesis involved the Cu-catalyzed epoxide opening with a Grignard nucleophile (Scheme 1). This reaction had highly variable yields, and it was found that recrystallization of the CuBr•DMS complex (*anhydrous* DMS / hexane) was crucial. Even with these precautions the yield was never above 85%. This material was then subjected to the Mitsunobu reaction (either with DEAD or DIAD with no change in yields), deprotection with hydrazine, and then acylation of the primary amine with $Ac_2O$ / DMAP / Hünig's base to produce the acetamide in excellent yields (85-93%). The next step in the sequence was the Bischler-Napieralski reaction; there has been vigorous discussion at various points about the scalability of

the reaction (e.g., see Lori LaRiviere's report). However, in my hands this has not been a problem. Other conditions for this transformation ($Tf_2O$ and TEA) were used on a single occasion without success.[4]

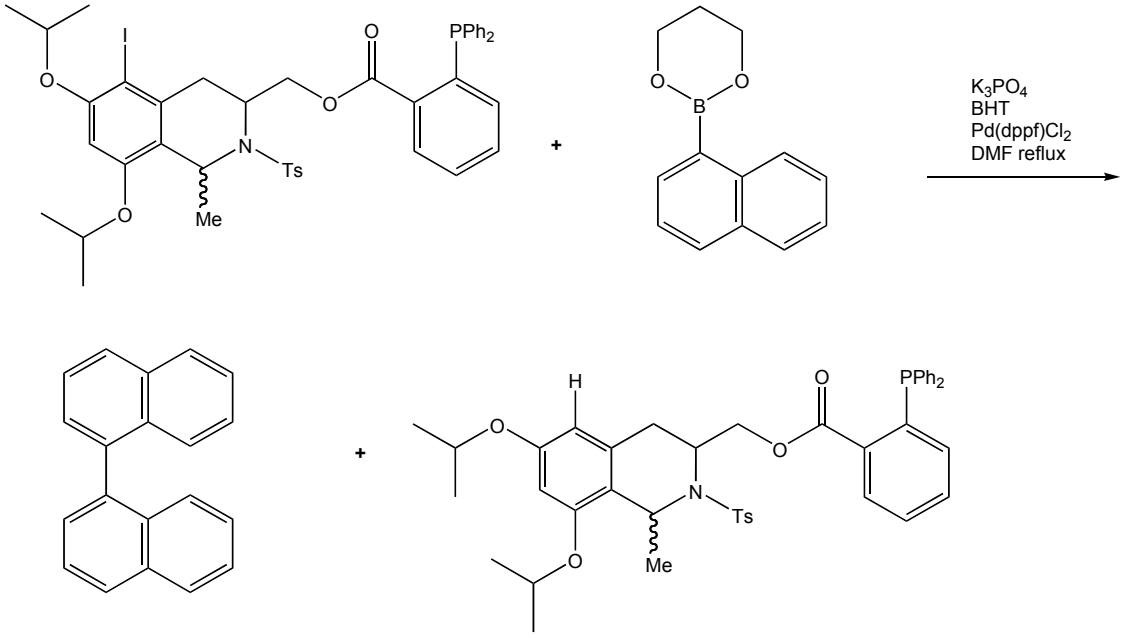
The next transform is imine reduction using $AlMe_3$ and $LiAlH_4$. With a *t*-butyldimethylsilyl protecting group on the primary alcohol, complete deprotection was observed; with the triisopropylsilyl protection mixtures were produced. In both cases, the most expedient process was to subject the crude material to re-silylation followed by normal purification. This last transformation ($LiAlH_4$ reduction) was not performed on the bis-isopropoxy substrate (only on dimethoxy test reactions).




Scheme 2

The material utilized in the remainder of the sequence was kindly moved through this bottleneck by a visiting Japanese researcher, Dr. Yuki Chounan. This material was then iodinated, desilylated, and finally the free alcohol was esterified using the appropriate benzoic acid derivative.

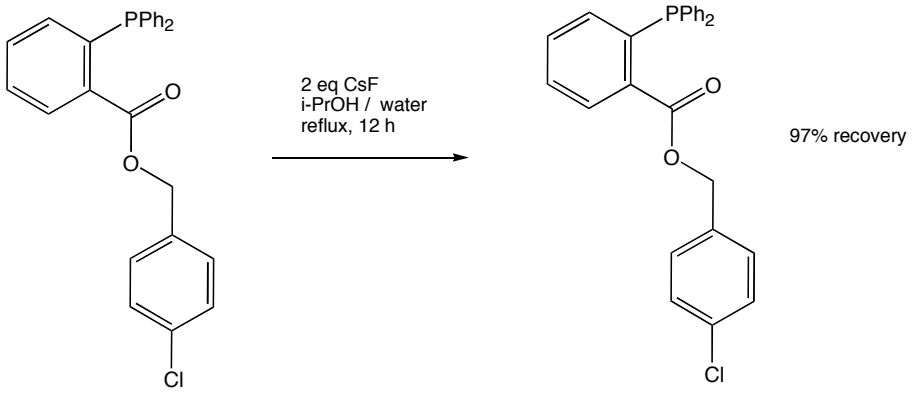
At this point, >300 mg of synthetic material was now ready for couplings to a model naphthalene, namely, 1-naphthalene boronic acid (commercially available from a variety of sources). Initially, John Keith's conditions were reproduced exactly (concentration, number of equivalents, Pd source, time, temperature, boronic ester). After several attempts, the only product isolated was reduced (de-halogenated) THIQ and dimerized boronic ester (Scheme 3).




Scheme 3

At this juncture, the THIQ was again fully characterized ($^{1}H$ and $^{13}C$ NMR, HRMS), the DMF was redistilled / degassed twice, and both the Pd source and ligands were re-ordered from Strem (historically the source of the highest quality). After these laborious precautions, the results remained the same: no coupling. In further experiments, the free boronic acid was used, and the BHT was omitted. This too, led to only reduction of the aryl iodide. Several other solvents were used (NMP, DMPU) without success.

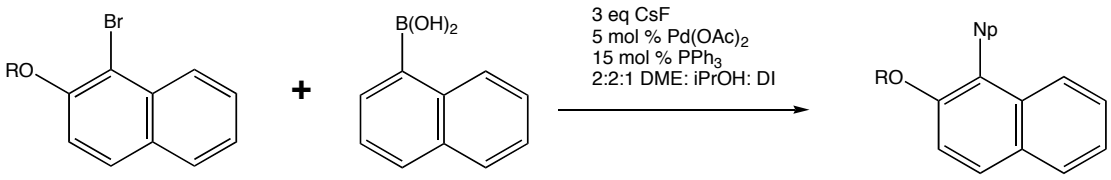
At this juncture, an in-depth survey of the literature was undertaken. A most useful paper was unearthed- the use of $F^-$ as a Lewis base to promote Suzuki reactions. These conditions form a fluoroborate, as opposed to a more standard borate species. In theory, this would allow the use of aqueous conditions, without concomitant hydrolysis of the sensitive ester functionality.




Scheme 4

Gratifyingly, a simple model system showed no detectable saponification even after extended reflux (Scheme 4).

A more comprehensive study was undertaken to determine the limits of this methodology (Figure 1). These experiments showed that even very large *ortho* substituents could be tolerated, and isolated yields were excellent on the less than extreme cases.



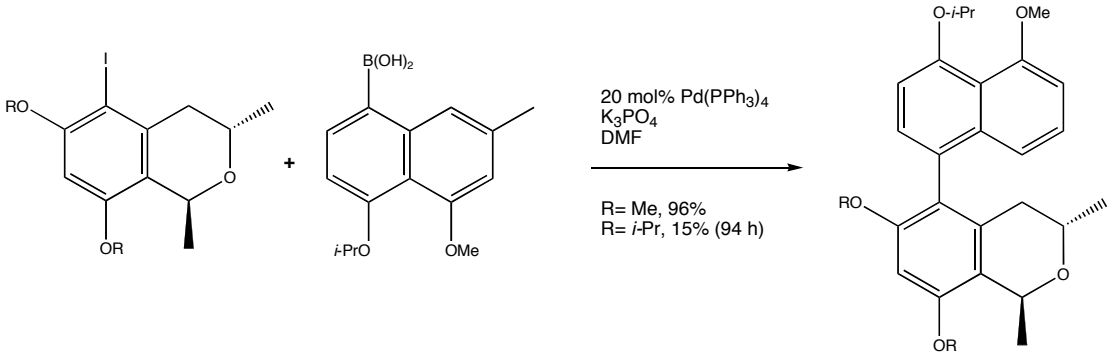

| R | Isolated Yield |
|---|---|
| -H | 61% |
| -Me | 87% |
| -iPr | 68% |
| -Ts | 7% (GC conversion) |

Figure 1

This methodology was then applied to authentic THIQ material, which finally provided coupling. However, the yield was quite poor- 17%. Clearly, this would not allow the throughput necessary. (No diastereoselectivity could be determined due to the small amount of coupled material obtained).

Subsequently, this method has been reported by another group as highly successful for sterically challenged biaryl couplings.[6]

A paper from 2000 proved to be highly informative: a South African group attempted the coupling of isochromane analogues of korupensamine[7] (Scheme 5). The fully optimized yield of the dimethoxy compound was 96%, whereas the diisopropoxy material was a paltry 15% after 94 (!) hours. Clearly, this was our problem; more involved studies with the bis-isopropoxy substrate were unlikely to yield couplings.




Scheme 5

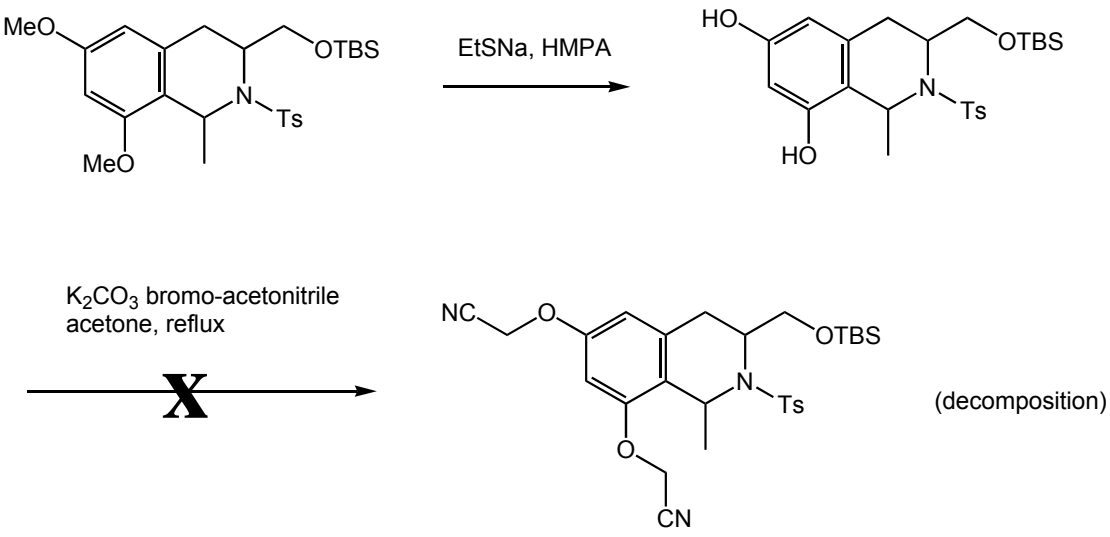
Low-level modeling with energy minimization (MMP, ChemDraw Ultra 7.0) showed the existence of a deep pocket enveloping the iodide. More extensive searching in the literature revealed semi-quantitative parameters of steric bulk, Taft steric parameters ($E_s$). These appear to indicate that the isopropyl group is sterically the equivalent of an iodide.

At this juncture a new path had to be blazed. After extensive study of all the options available in Greene and Wutz[2], several new protecting groups were considered. The likely options were aryl- cyanomethyl-, propargyl-, and

vinyl ethers. The first of these to be considered, the cyanomethyl system, would greatly decrease the electron density of the THIQ system and might, therefore, allow less drastic conditions for the crucial coupling. Unfortunately, this group has only been utilized *once* in the literature (as of 2002).[9] It is introduced with bromoacetonitrile, and can be cleanly removed using Pt/C and $H_2$. It also suffers from total incompatibility with both the Grignard reagent and the $LiAlH/AlMe_3$ reduction. However, the positive aspects appeared to outweigh the liabilities.

The initial plan was to carry through either the dimethoxy or di-isopropoxy compound, and then deprotect / reprotect before the crucial coupling. A secondary consideration was the possibility of using the free phenol in the coupling, although the effects of the possible hydrogen bonds on the diastereoselectivity were wholly unknown. This clearly was not the most ideal synthetic sequence, but few other options presented themselves. A simple fluoride mediated coupling of 2-cyanomethoxy-1-bromonaphthalene with 1-naphthalene boronic acid led to an isolated yield of 94.5%, so the general strategy had significant merit.

The reagents available for cleaving aryl alkyl ethers are all rather harsh. Reagents utilized were $BBr_3$, $BCl_3$, KI/DMSO, and NaCN in DMSO.




Scheme 6

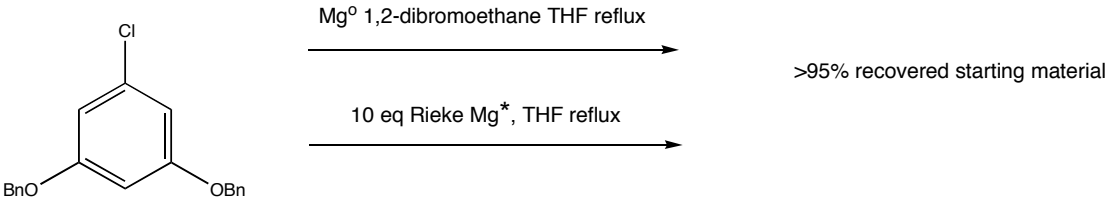
All reagents led to decomposition, mono-deprotection, or no reaction on the dimethoxy THIQ substrate. Desilylation was also an issue with many sets of conditions.

The next series to be investigated was thiolates in HMPA. These were rather “interesting” to work with, yet cleanly cleaved the ethers according to TLC. However, upon isolation and attempted reprotection as the cyanomethyl ethers, dark colored compounds formed under a wide variety of conditions. No products were identifiable by $^{1}$H NMR analysis. It is possible that quinone-type intermediates were formed, followed by expulsion of the N-tosyl fragment.

After several weeks of negative results, another trip to Davidson Library was in order. The answer obtained was straightforward and definitive: michellamine A as a natural product, has a half life of <5 minutes at pH 12.[10]

Any of the standard conditions to reprotect the phenols would likely be pointless. Therefore, this avenue of inquiry was terminated.

The next possibility was perhaps a mysterious choice- the bis-benzyl ether. Simple modeling and literature searching indicated that the planarity and constrained rotation of the system might work to our benefit. The synthesis of the required material proceeded exactly as it had for the bis-isopropoxy system. However, when the formation of the Grignard reagent was attempted, only starting material was obtained after extended reflux. This same observation had been noted earlier by a visiting Swiss student in the group, (Natalie Maulin) in 1999. The next tack was to use highly active Rieke Mg*.[11] A large excess was used, but the result was the same- no insertion.

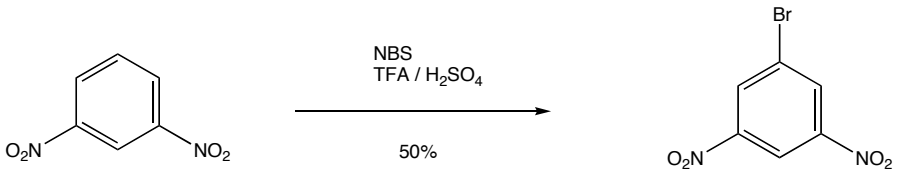



Scheme 7

At this point, the bromide suggested itself as the better substrate. However, SciFinder indicated only a few avenues to this system, and all appeared to be tedious and low-yielding. These included Sandmeyer, Hunsdiecker, and $S_NAr$ displacement manifolds.

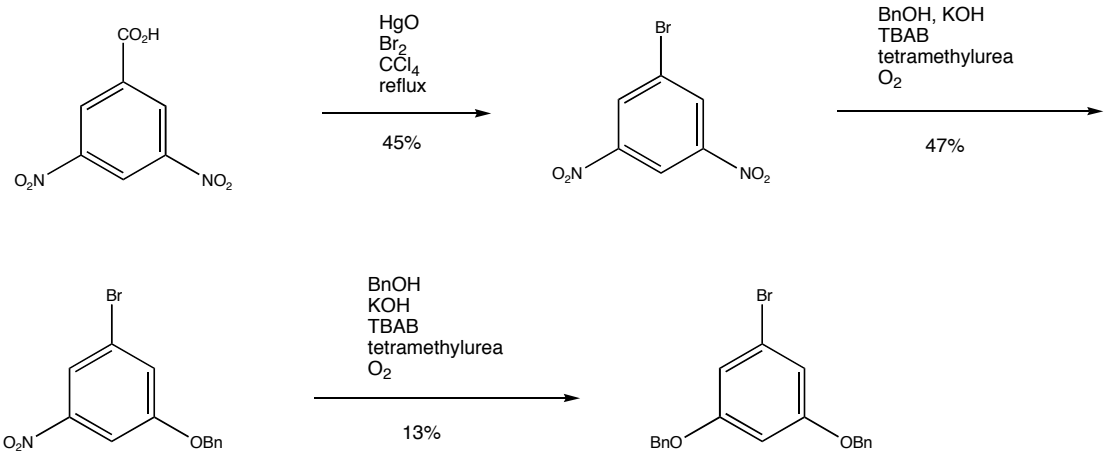
The first avenue that was pursued was *ipso* displacement of aryl nitro compounds. There was precedent for this chemistry, namely a 1991 *Chem.*

*Berichte* paper.[12] An initial problem here was that 1-bromo-3,5-dinitrobenzene is not commercially available, and needed to be synthesized by one of two tedious routes: bromination of 1,3-dinitrobenzene, or via a Hunsdiecker reaction of the corresponding benzoic acid. Conditions for the bromination of such highly deactivated substrates had been reported, using a mixture of TFA and $H_2SO_4$.[13] The problems here were two-fold: the reaction only proceeded in ~50% yield, and the *m*-dinitrobenzene is very volatile and toxic, making for an extremely difficult workup. After several attempts at moving material forward, this route was abandoned.




Scheme 8

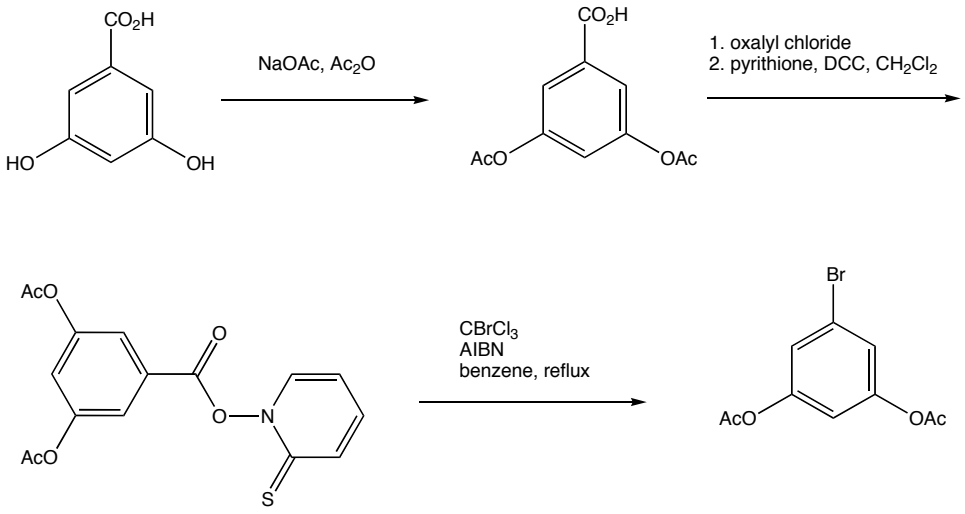
The exact Hunsdiecker required had been reported in the literature from Al Meyers' lab.[14] This reaction involves treating the benzoic acid derivative and HgO with elemental bromine *at reflux* in $CCl_4$. Due to the scarcity of $CCl_4$ (at least in California) the reaction was also attempted in both benzene and chloroform with no success.




Scheme 9

This reaction sequence proceeded as per Scheme 9. After many repetitions, and using the majority of $CCl_4$ available at UCSB, the best results that were ever obtained from this three step sequence was ~ 4% overall. Throughput of a significant quantity of material is a key component of any synthetic scheme; therefore, this avenue was not pursued further.

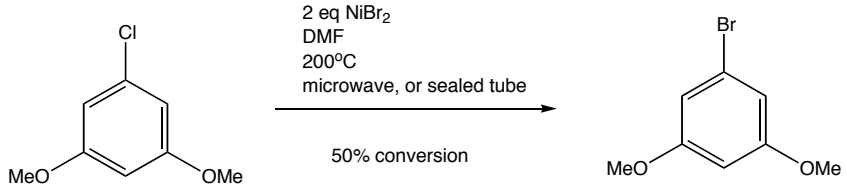
In the early 1980's Derek Barton's laboratory, noting the difficulties with classical Hunsdiecker chemistry, published a series of papers on a free radical, heavy-metal free, Hunsdiecker-type reaction sequence. This involves formation of a mixed anhydride, (so called "pyrithione" ester) followed by AIBN mediated bromination (Scheme 10).




Scheme 10

The most significant barrier to implementation of this chemistry was the use of unfamiliar radical reactions. This manifold has been used extensively in the literature for alkyl substitution, but only a few examples involving benzoic acids from labs other than Barton's have appeared.[16] After a long series of experiments, wherein the mixed anhydride was made and isolated, or made *in situ*, with a variety of radical generation conditions, the best yields obtained were ~10%. A confounding problem was the instability of the benzyl ethers to the radical conditions; the substrate had to be switched to the di-acetoxy derivative as soon as this was noticed. This improved the yield only marginally. However, a small amount of the desired bromide was obtained. This was then deprotected, and alkylated as the bisbenzyl compound which gratifyingly formed the Grignard reagent, allowing access to the desired glycidol addition product for the first time.

At this juncture, a very interesting paper by Leadbeater appeared, showing a microwave promoted Finkelstein reaction of aryl substrates.[17] (Scheme 11).



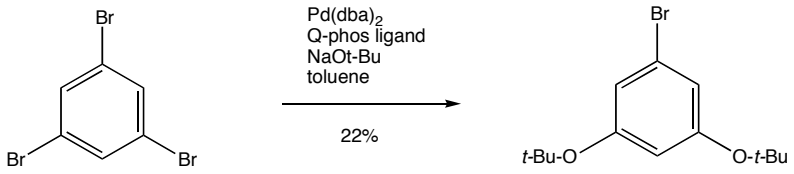

Scheme 11

This reaction was quickly run on the 1-chloro-3,5-dimethoxybenzene with excess $NiBr_2$. As reported, the reaction only proceeds to a 50% conversion. If the mixture is then resubjected to the reaction conditions, a 3:1 mixture favoring the ArBr is produced. The reaction also scales well in a sealed tube reactor, and a large amount of material was produced in this fashion. However, two factors doomed this approach: the first was financial, the cost of 1-chloro-3,5-dimethoxybenzene skyrocketed from ~$1.50/g to over $4/g, and secondly, all attempts to separate the product from the starting material (chromatography, distillation, and crystallization) were unsuccessful. However, the possibility of using the mixture in the formation of a Grignard cannot be ruled out.

A few attempts were also made to transfer this chemistry to aryl triflates, as phloroglucinol can be easily transformed into the dibenzyloxyphenyl triflate or nonflate. Reasonable yields were obtained using an excess of $ZnBr_2$ and $Ni^o$ in DMF, under microwave conditions. Dominika

Pcion then undertook some preliminary experiments in this area. It is important to note that no conditions for this transformation have ever been reported in the literature.

Another attempt at this moiety involved Buchwald-Hartwig etherification chemistry[18] (Scheme 13).

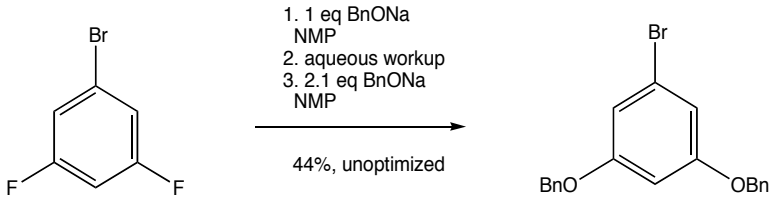



Scheme 13

This chemistry is well developed for aminations, but ether formation has received far less attention. Beginning with *s*-tribromobenzene, a variety of Pd sources, ligands and benzyl alcohol salts were screened. In almost all cases, the only products obtained were those of reduction, and unreacted starting material. However, use of NaO-*t*-Bu from the glovebox led to a modest yield under microwave conditions (22%). Two avenues remain to be explored; namely, the use of *s*-triiodobenzene, or the formation of the tris-triflate from phloroglucinol. It is not unreasonable that these compounds, or newer ligand families, could lead to success.

Lastly, 1-iodo-3,5-dimethoxybenzene was produced in good yield from the Grignard of the chloride after quenching with elemental iodine. However, the cost again remains a high hurdle.

Finally, a single attempt was also made to produce the required substrate via *ipso*-displacement of 1-bromo-3,5-difluorobenzene (Scheme 14). Gratifyingly, two successive displacements with BnONa led to the intended substrate in 44% yield from commercially available materials. It is hoped that this methodology can be optimized and will allow high throughput of material for THIQ substrates. However, this will be another investigator's path, and not mine to tell.




Scheme 14

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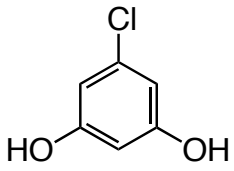
**Experimental Section**

**General**: All flash chromatographic separations were performed using ICN 60 A silica. All solvents were distilled prior to use, using standard methods, or from laboratory stills. TLC analysis utilized Merck plates with 254 nm fluorescence. "Seebach's" stain for TLC refers to 2.5 g phosphomolybdic acid, 1 g $Ce(SO_4)_2$, and 6 mL concentrated $H_2SO_4$ dissolved in 94 mL water. All glassware for sensitive reactions was either oven dried (130$^o$ C, overnight) or flame dried under vacuum, and backflushed (x3) with Argon prior to use. "Purified via column chromatography" indicates "Flash" chromatography as described in Still's seminal paper (*J. Org. Chem.* **1978**, *43*, 2923).
All NMR work was performed on the department's 200, 400 or 500 MHz Varian instruments. High resolution mass spectral analysis was performed by Dr. James Pavlovich at the UCSB MS Center. Compound numbers refer to notebook volume and page number.

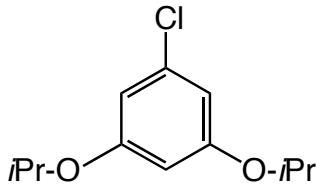



**Compound 1.** (AAL-I-3). 1-Chloro-3,5-dihydroxybenzene. Into a 250 mL rb flask with a condenser was added 5.5 g (31.9 mmol) of 1-chloro-3,5-dimethoxybenzene. This was suspended in 40 mL HI (aq, 57%), and gently

refluxed for 90 min. The solution was cooled to rt, quenched with aqueous $Na_2SO_3$, diluted with 50 mL water, and extracted with ether (2 x 50 mL). The organic layers were combined, washed with $Na_2CO_3$ (sat aq), and brine and then dried over anhydrous $MgSO_4$. This solution was filtered and evaporated in vacuo to provide 4.4 g of off-white crystals. This material was purified via flash chromatography (hexanes/ethyl acetate, 80:20) to provide 4.2 g of white crystals that slowly yellowed on exposure to light, 91% yield. $R_f$ = 0.5 in 1:1 hexanes/ethyl acetate.

Alternative method- use of HBr/AcOH led to identical yields.

**$^{13}$C NMR** (100 MHz, $d_6$-acetone) $\delta$ 106.2, 114.6, 138.5, 165.0.



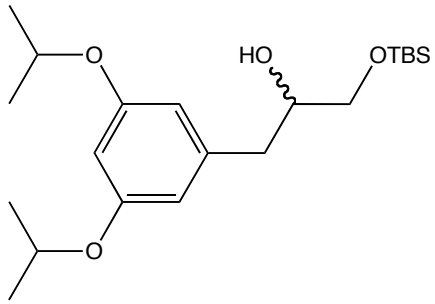

**Compound 2** (AAL-I-9). 1-Chloro-3,5-diisopropoxybenzene. In a 250 mL dry rb flask was added compound **1** (2.9 g, 20 mmol), dry DMF (80 mL), $Cs_2CO_3$ (13.0 g, 40 mmol, 2.0 eq) and isopropylbromide (6.6 mL, 70 mmol, 3.5 eq). The resulting slurry was stirred with rapid agitation, at rt for 24h. Water (20 mL) was then added, the reaction was neutralized with glacial acetic acid, and then extracted with ether (6 x 20 mL). The organic layers were then combined, and washed with brine (3 x 20 mL), dried over anhydrous $MgSO_4$ and concentrated via rotary evaporator, to yield a pale yellow oil. This

material purified via flash chromatography (hexanes/ethyl acetate, 90:10) to provide 3.7 g of clear oil, 82% yield.

**$^{1}$H NMR** (200 MHz, $CDCl_3$) $\delta$ 1.33 (d, 12 H, J = 5.8 Hz), 4.49 (hept, J = 5.8 Hz, 2H), 6.31 (d, J = 2.2 Hz, 1H), 6.47 (d, J = 2.2 Hz, 2H)

**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 22.1, 70.3, 102.5, 108.5, 135.2, 159.6.

**HREIMS** Calculated for $C_{12}H_{17}O_2Cl$: (m/z) 228.0917. Found: 228.0911. ($\Delta$= 2.8 ppm).

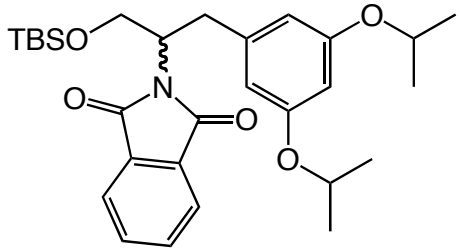



**Compound 3** (AAL-I-108) 1-(*tert*-Butyldimethylsilanyloxy)-3-(3,5-diisopropoxyphenyl)-propan-2-ol

Into 250 mL rb flask was added compound **2**, (7.85 g, 34.3 mmol, 1.5 eq), Mg turnings, (2.46 g, 101.1 mmol, 4.25 eq) and THF (25 mL), with 4 drops of 1,2-dibromoethane. This mixture was then refluxed under Ar for 16 h; a dark grey-black suspension was obtained. In a second round bottom was added CuBr•DMS complex (783 mg, 3.8 mmol, 0.15 eq), in THF (8 mL). This suspension was cooled to $0^{o}$ C, and the Grignard reagent was transferred to it via a large bore cannula. This was stirred for 20 min, cooled to $-30^{0}$ C, and racemic TBS-protected glycidol (4.5 g, 23.8 mmol, 1.0 eq) was added

dropwise. The reaction was then stirred at this temperature for 8h, and then quenched with sat. aq. $NH_4Cl$. Extraction into ether, washing with $NH_4Cl$ and brine, drying and concentration via rotary evaporator yielded a dark brown oil. This material was purified via flash chromatography (hexanes/ethyl acetate, 90:10) to yield 7.5 g of clear oil, 58% yield. Yields could be improved to ~70% by recrystallization of the CuBr•DMS complex (anhydrous DMS / hexanes).

**$^1$H NMR** (200 MHz, $CDCl_3$) $\delta$ 0.07, (s, 3 H), 0.09 (s, 3H), 0.91 (s, 9H), 1.34 (d, J = 5.8 Hz, 12H), 2.41 (s, 1 H), 2.69 (d, J = 6.6 Hz, 2H), 3.52 (dd, $J^1$ = 6.6 Hz, $J^2$= 10 Hz, 1H), 3.63 (dd, $J^1$ = 4 Hz, $J^2$ = 10 Hz, 1H), 3.78 (m, 1H), 4.51 (sept, J = 5.8 Hz, 2H), 6.31 (d, J = 2.2 Hz, 1H), 6.35 (d, J = 2.2 Hz, 2H).



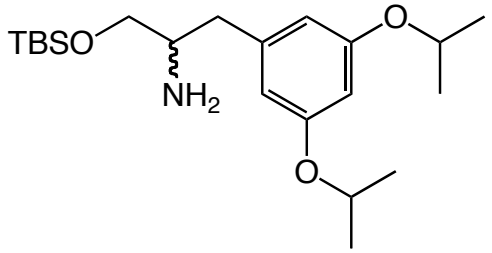

**Compound 4** (AAL-I-109) 2-[1-(t-butyldimethylsilylanyloxymethyl)-2-(3,5-diisopropoxyphenyl)ethylisoindol-1,3-dione.

To a 250 mL rb flask was added compound **3**, (7.5 g,19.6 mmol, 1.0 eq), $PPh_3$ (7.7 g, 29.4 mmol, 1.5 eq), phthalimide (3.6 g, 25.5 mmol, 1.25 eq). THF (125 mL) was then added and stirred at rt until dissolution was observed. The solution was then cooled to 0$^o$ C, and DEAD (4.8 mL, 30.4 mmol, 1.55

eq) was added dropwise over 10 minutes. The reaction then allowed to warm to rt overnight with stirring. The reaction was then evaporated to dryness, and the residue purified via flash chromatography (hexanes/ethyl acetate, 94:6) to provide 6.6 g of pale yellow oil, 66% yield.

**$^1$H NMR** (200 MHz, $CDCl_3$) $\delta$ -0.07 (s, 3H), 0.02 (s, 3H), 0.76 (s, 9H), 1.22 (d, J = 6Hz, 6H), 3.09 (dd, $J^1$ = 5.5 Hz, $J^2$ = 13 Hz, 1H), 3.17 (dd, $J^1$ = 10 Hz, $J^2$ = 13 Hz, 1H), 3.90 (dd, $J^1$ = 5.5 Hz, $J^2$ = 10 Hz, 1H), 4.10 (dd, $J^1$ = 10 Hz, $J^2$ = 10 Hz, 1H), 4.41 (sept, J = 6 Hz, 2H), 4.67 (m, 1H), 6.22 (d, J = 2.2 Hz, 1H), 6.31 (d, J = 2.2 Hz, 2H), 7.67 (m, 2H), 7.77 (m, 2H)

**HRCIMS** Calculated for $C_{29}H_{42}NO_5Si$ $(M+H)^+$: 512.2832. Found: 512.2831. ($\Delta$ = 0.3 ppm).



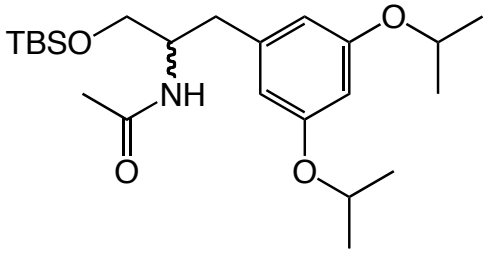

**Compound 5** (AAL-I-118) 1-(*tert*-Butyldimethylsilanyloxymethyl)-2-(3,5-diisopropoxyphenyl)-ethylamine

7.0 g of compound **4** was dissolved in anhydrous EtOH (400 mL), and hydrazine (45 mL) was added. The reaction was then refluxed for 12h, and then cooled to rt. While cooling, a large amount of white byproduct

precipitated. This material was filtered off, and the filtrates were evaporated to dryness, and partitioned between $CH_2Cl_2$ and brine. After drying the organics, evaporation yielded 4.55 g of pale yellow oil. No further purification was nessesary, 88% yield.

**$^1$H NMR** (200 MHz, $CDCl_3$) $\delta$ -0.05 (s, 3H), 0.01 (s, 3H), 0.79 (s, 9H), 1.22 (d, J = 6H, 6H), 3.12 (dd, $J^1$ = 5.5 Hz, $J^2$ = 13 Hz, 1H), 3.18 (dd, $J^1$ = 10 Hz, $J^2$ = 13 Hz, 1H), 3.90 (dd, $J^1$ = 5.5 Hz, $J^2$ = 10 Hz, 1H), 4.14 (dd, $J^1$ = 10 Hz, $J^2$=10 Hz, 1H), 4.40 (sept, J = 6 Hz, 2H), 4.67 (m, 1H), 6.22 (d, J = 2.2 Hz, 1H), 6.31 (d, J = 2.2 Hz, 2H).

**HRCIMS** Calculated for $C_{21}H_{40}NO_3Si$ $(M+H)^+$: 382.2777. Found: 382.2761 ($\Delta$ = 4.3 ppm).




**Compound 6** (AAL-I-130) *N*-[1-(*tert*-Butyldimethylsilanyloxymethyl)-2-(3,5-diisopropoxyphenyl)ethyl]-acetamide

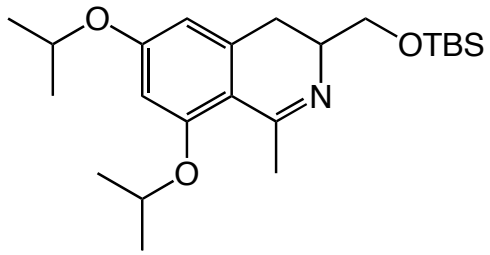
Compound **5** (4.55 g,1.0 eq, 11.92 mmol) was dissolved in $CH_2Cl_2$ (70 mL). To this was added triethylamine (11mL, 78.26 mmol, 6.5 eq), $Ac_2O$ (13.2 mL, 139.65 mmol, 11.7 eq) and DMAP (75 mg). The reaction was stirred at rt for

14h, and then quenched with water, and finally diluted with $Et_2O$ (150 mL). After extraction and washing, the solution was dried, concentrated, and then purified via column chromatography (hexanes/ethyl acetate, 95:5) to give 4.17 g of pale yellow oil, 83% yield.

**$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 0.047 (s, 1H), 0.057 (s, 1 H), 0.92 (s, 9H), 1.31 (d, J = 6 Hz, 12H), 1.96 (s, 3H), 2.77 (app q, J = 6, 2H), 3.54 (m, $J_{app}$= 2.8 Hz, 2H), 4.18 (m, 1H), 4.50 (sept, J = 6 Hz, 2H), 6.29 (s, 1H), 6.34 (s, 2H).

**LREIMS** Calculated for $C_{23}H_{41}NO_4Si$ : 423.28**.** Found: 423, 408, 366 (100%), 307, 216, 149, 116, 75.

**HRCIMS** Calculated for $C_{23}H_{41}NO_4Si$ $(M+H)^+$: 423.2805. Found: 423.2800 ($\Delta$ = 1.2 ppm).



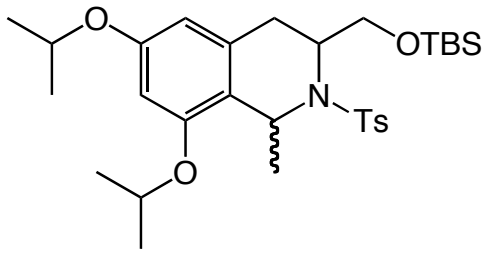

**Compound 7** (AAL-I-250) 3-(*tert*-Butyldimethylsilanyloxymethyl)-6,8-diisopropoxy-1-methyl-3,4-dihydroisoquinoline

Compound **6** (1.17 g, 2.7 mmol) was dissolved in anhydrous $CH_3CN$ (28 mL), and 2,6-lutidine (800 µL, 7.1 mmol, 2.6 eq) was added, with five 4Å molecular sieves. The reaction was argon flushed again, and $POCl_3$ (450 µL, 4.8 mmol,

1.8 eq) was added, and then the reaction was heated to 70° C for 3.5h, when TLC analysis indicated complete consumption of starting material. The reaction was cooled to rt and quenched by pouring it into a mixture of $Et_2O$, water, and TEA (15:3:1 v/v). After extraction into ether, washing, drying, concentrating, the dark oily residue was purified via column chromatography (hexanes/methylene chloride, 85:15) to give 755 mg of yellow oil, 69% yield.

**$^1$H NMR** (200 MHz, $CDCl_3$) $\delta$ 0.08 (s, 6H), 0.91 (s, 9H), 1.22 (d, J = 6.2 Hz, 12H), 2.34 (m, 1H), 2.41 (s, 3H), 2.85 (dd, $J^1$ = 5 Hz, $J^2$ = 16 Hz, 1H), 3.35 (br m, 1H), 3.64 (app t, 1H), 4.06 (dd, $J^1$ = 10 Hz, $J^2$ = 5 Hz, 1H), 4.41 (sept, J = 6.2 Hz, 2H) 6.37 (s, 2H)

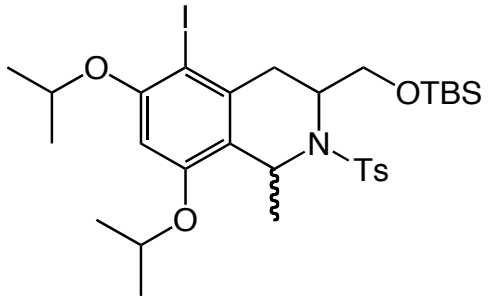
**LREIMS** *m/z* calc. for $C_{23}H_{39}NO_3Si$: 405.26. Found: 405, 390, 348, 334, 306, 260, 218, 176 (100%), 147, 91, 73, 57.




**Compound 9** (Yuki Chounon) 3-(*tert*-Butyldimethylsilanyloxymethyl)-6,8-diisopropoxy-1-methyl-2-(toluene-4-sulfonyl)-1,2,3,4-tetrahydroisoquinoline

**$^{13}$C NMR** (100 MHz, $CDCl_3$) δ -5.2, 18.2, 21.4, 22.0, 22.1, 22.2, 22.3, 23.0, 25.9, 30.1, 47.9, 48.5, 55.2, 62.9, 68.3, 69.6, 70.0, 99.4, 100.2, 106.1, 107.2, 120.1, 126.9, 127.1, 129.0, 129.5, 134.5, 136.3, 140.1, 142.5, 142.8, 153.8, 157.5.

**LREIMS** *m/z* Calculated for $C_{30}H_{47}N0_5SSi$: 561.29. Found: 561, 530, 504, 416 (100%), 270, 250, 176, 161, 91, 73, 57.

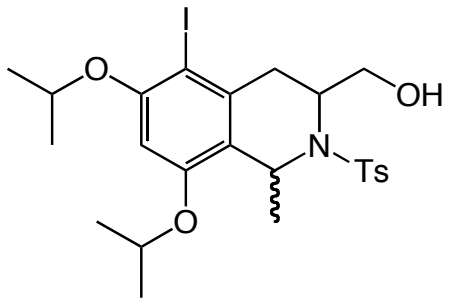



**Compound 10** (AAL-I-123) 3-(*tert*-Butyldimethylsilanyloxymethyl)-5-iodo-6,8-diisopropoxy-1-methyl-2-(toluene-4-sulfonyl)-1,2,3,4-tetrahydroisoquinoline. Into a 0.1 M solution of compound **9** (850 mg, 1.51 mmol) in $CH_2Cl_2$ was added freshly sublimed $I_2$ (268 mg, 0.7 eq, 1.37 mmol) and $PhI(OCOCF_3)_2$ (522 mg, 0.8 eq, 1.57 mmol). This was then stirred at rt for 1.5h and then quenched by the slow addition of $Na_2SO_3$ (sat. aq.). The reaction was diluted with $CH_2Cl_2$, and washed with brine. The solution was then dried, concentrated to a yellow-orange oil, and purified via column chromatography (hexanes/ethyl acetate, 90:10) to give 739 mg of clear semi-crystalline oil,

71% yield. This material was prone to dehalogenation (even in foil at 0$^{o}$ C), and should not be stored for extended periods.

**$^{1}$H NMR** (500 MHz, $d_6$-acetone) $\delta$ 0.16 (s, 3H), 0.17 (s, 3H), 0.97 (s, 9H), 1.27 (d, J = 6.8Hz, 3H), 1.32, (d, J = 6Hz, 6H) 1.34 (d, J = 6Hz, 6H), 1.44 (d, J = 6.6 Hz, 3H), 2.26 (s, 3H), 2.83, (m, 1H), 3.26 (m, 1H), 3.78 (m, 1H), 3.86 (d, J = 6.2 Hz, 2H), 4.09 (d, J = 6.2 Hz, 1H), 4.61 (sept, J = 6 Hz, 1H), 4.67 (sept, J = 6Hz, 1H), 5.34 (q, J = 7.5 Hz, 1H), 6.45 (s, 1H), 7.13 (d, J = 8.7 Hz, 2H), 7.51 (d, J = 8.7 Hz, 2H).

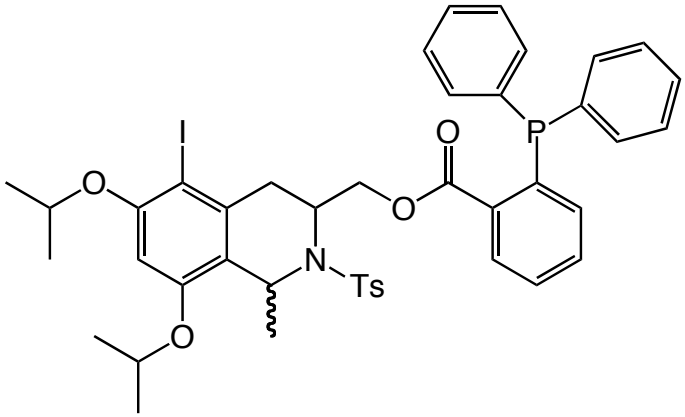
**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ -5.1, 12.9, 18.6, 21.6, 22.3, 22.5, 23.1, 26.0, 26.2, 29.9, 48.0, 55.3, 67.4, 68.4, 70.0, 70.1, 97.3, 99.5, 106.1, 106.2, 127.2, 127.3, 127.1, 129.6, 134.8, 142.6, 154.0, 157.5, 161.2.




**Compound 11** (AAL-I-115) [5-Iodo-6,8-diisopropoxy-1-methyl-2-(toluene-4-sulfonyl)-1,2,3,4-tetrahydroisoquinolin-3-yl]-methanol Compound **10** (48 mg, 0.07 mmol, 1.0 eq) was dissolved in THF (1 mL), and TBAF (105 $\mu$L, 1.0 M in THF) was added. The reaction was stirred at rt for 2h, diluted with EtOAc, and then washed with water (x2), $NaHCO_3$ (x2) and brine (x2). It was then dried,

concentrated and purified via column chromatography (ethyl acetate/hexanes, 70:30) to give 37 mg of white foam, 92% yield.

**$^1$H NMR** (300 MHz, $CDCl_3$) 1.31 (d, J = 6Hz, 6H) 1.35 (d, J = 6Hz, 6H), 1.42, (d, J = 6.8Hz, 3H), 2.26 (s, 3H), 2.81, (m, 1H), 3.26 (m, 1H), 3.78 (m, 1H), 3.86 (d, J = 6.2 Hz, 2H), 4.09 (d, J = 6.2 Hz, 1H), 4.61 (sept, J = 6 Hz, 1H), 4.67 (sept, J = 6Hz, 1H), 5.34 (q, J = 7.5 Hz, 1H), 6.45 (s, 1H), 7.13 (d, J = 8.7 Hz, 2H), 7.51 (d, J = 8.7 Hz, 2H).




**Compound 12** (AAL-I-156) (2-diphenylphosphinobenzoic acid)-5-iodo-6,8-diisopropoxy-1-methyl-2-(toluene-4-sulfonyl)-1,2,3,4 -tetrahydroisoquinolin-3-ylmethyl ester.

Into a 5 mL conical vial was added primary alcohol **11** (25 mg, 0.044 mmol), 2-diphenylphosphinobenzoic acid (15 mg, 0.048 mmol, 1.1 eq), DCC (10 mg, 0.048 mmol, 1.1 eq) and DMAP (3 mg, 0.022 mmol, 0.5 eq) and anhydrous $CH_2Cl_2$ (1.0 mL). The reaction was then stirred at rt for 22h, evaporated, and purified via column chromatography (hexanes/ethyl acetate, 65:35) to yield 31

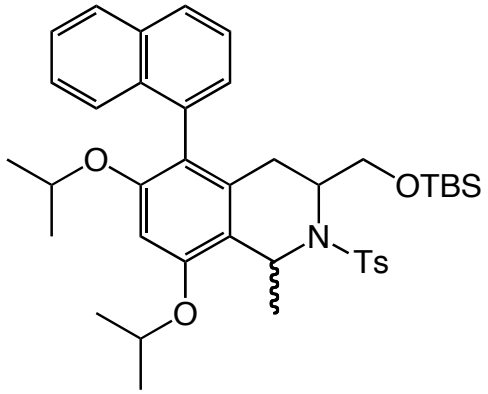
mg off-white foam, 82% yield. (This compound was a mixture of trans/cis, ~7:1 determined by $^1$H NMR analysis).

**$^1$H NMR** (500 MHz, $d_6$-acetone) $\delta$ 1.31 (d, J = 6Hz, 6H), 1.33 (d, J = 6 Hz, 6H) 1.43 (d, J = 6.6 Hz, 3H), 2.27 (s, 3H), 2.32 (s, 1H), 2.79 (d of d, $J^1$ = 16.5 Hz, $J^2$ = 4.2 Hz, 1H), 3.25 (d of d, $J^1$ = 16.5 Hz, $J^2$ = 4.2 Hz, 1H), 4.15 (m, 1H), 4.45 (d of d, $J^1$ = 11 Hz, $J^2$= 5.5 Hz, 1H), 4.49 (d of d, $J^1$ = 11, $J^2$ = 5.5 Hz, 1H), 4.62, (sept, J = 6Hz, 1H) 4.68 (sept, J = 6 Hz, 1H), 5.34 (q, J = 7 Hz, 1H), 6.47 (s, 1H), 6.96 (d of d, $J^1$ = 7.6 Hz, $J^2$ = 4.2 Hz, 1H), 7.15 (d, J = 8.5 Hz, 2H), 7.22-7.7.40 (broad m, 9H), 7.47 (m, 3H), 7.67, (d, J = 8.5 Hz, 2H), 8.18 (m, 1H).

**$^{13}$C NMR** (100 MHz, $d_6$-acetone) $\delta$ 21.4, 22.3, 22.5, 35.3, 48.7, 53.3, 69.3, 70.8, 72.9, 83.8, 99.5, 122.5, 127.8, 128.0, 129.45, 129.51, 129.56, 129.57, 129.66, 129.70, 130.10, 130.33, 131.64, 133.0, 134.6, 134.7, 134.8, 134.8, 135.0, 135.6, 135.7, 137.0, 137.7, 139.0, 139.1, 139.1, 139.2, 141.1, 141.3, 144.0, 154.9, 157.2, 167.1.

**$^{31}$P NMR** ($H_3PO_4$ = 0.0 ppm) $\delta$ -0.4 (phosphine), 32 ppm (phosphine oxide). Integration indicates 94.5% phosphine.

**HR-FAB / NBA / PEG** Calculated for $C_{43}H_{46}NO_6PSI$ $(M+H)^+$: 862.1828. Found: 862.1815 ($\Delta$ = 1.5 ppm).



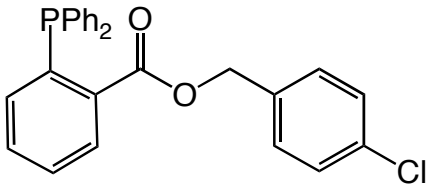

**Compound 13** (AAL-I-249) 3-(*tert*-Butyldimethylsilanyloxymethyl)-6,8-diisopropoxy-1-methyl-5-naphthalen-1-yl-2-(toluene-4-sulfonyl)-1,2,3,4-tetrahydroisoquinoline

A 4 dram pyrex vial with a "flea" stirbar was flame dried, capped with a 14/20 septum and Ar flushed until cool. It was then transferred to the glovebox, and compound **12** (60 mg, 0.087 mmol, 1 eq), naphthalene-1-boronic acid (23 mg, 0.131 mmol, 1.5 eq), $Pd(OAc)_2$ (2.0 mg, 0.008 mmol, 0.1 eq), $PPh_3$ (7 mg, 0.026 mmol, 0.3 mmol) and anhydrous CsF (40 mg, 0.261 mmol, 3.0 eq) were added. The reaction was removed, and degassed dimethoxyethane:water (80:20, 1 mL) was added via syringe. The septum was then removed, and a vial cap with a teflon insert was added. Reaction was sealed and heated in a 130$^{o}$ C sandbath for 10h. It was then cooled and partitioned between brine and ether. The aqueous layers were extracted three times; the organic layers were combined and washed with brine (x3), dried and concentrated to give a light brown oil. This material was then

purified via column chromatography (hexanes/ethyl acetate, 85:15), then all fractions showing possible product (via $^1$H NMR) were purified via semi-preparatory HPLC (Zorbax silica column, gradient elution with hexanes/IPA, 99.5:0.5 to 90:10). 3 mg of coupled material, along with 6 mg of de-silylated biaryl were obtained, 17% combined yield.

**$^1$H NMR** (500 MHz, $d_8$-THF) $\delta$ -0.14 (s, 3H), -0.07 (s, 3H), 0.63 (s, 9H), 1.41 (d, J = 6 Hz, 6H), 1.45 (d, J = 6.9Hz, 3H), 1.49 (d, J = 6Hz, 6H), 2.30 (s, 3H), 2.47 (m, 2H), 3.42 (m, 1H), 3.61 (m, 2H), 3.87 (m, 1H), 4.17 (sept, J = 6 Hz, 1H), 4.59 (sept, J = 6Hz, 1H), 6.37 (s, 1H), 6.87 (d, J = 5.5 H, 1H), 7.12 (d, J = 8Hz, 1H), 7.25-7.43 (m, 4H), 7.50 (d, J = 8Hz, 1H), 7.77 (d, J = 8.5 Hz, 2H), 7.82 (d, J = 8.5 Hz, 2H).

**HREIMS** Calculated for $C_{40}H_{53}NO_5SiS$ $(M+H)^+$: 687.3414. Found: 687.3393 ($\Delta$ = 3.0 ppm).




**Compound 14** (AAL-I-234) 2-(Diphenylphosphino)-benzoic acid 4-chloro-benzyl ester

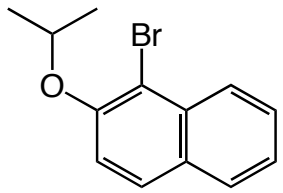
Into a 25 mL rb flask was added *p*-(hydroxymethyl)chlorobenzene (100 mg, 0.71 mmol), 2-diphenylphosphinobenzoic acid (239 mg, 0.78 mmol, 1.1 eq),

DMAP (17 mg, 0.14 mmol, 0.2 eq) and EDCI (150 mg, 0.78 mmol, 1.1 eq). The contents were dissolved in $CH_2Cl_2$ (2.5 mL) at $0^o$ C, and stirred at this temperature for 2 h. The reaction was then allowed to warm to rt overnight, when it was concentrated and partitioned between EtOAc and brine. The aqueous layers were extracted with EtOAc (x3), the organics were then combined and washed with water, $NaHCO_3$, and brine (all x 2). This was then dried, concentrated and purified via column chromatography (hexanes/ethyl acetate, 85:15) to give 287 mg of clear oil, 94% yield. $R_f$ of 0.55 (hexanes/ethyl acetate, 70:30).

**$^1$H NMR** (300 MHz, $CDCl_3$) $\delta$ 5.15 (s, 2H), 6.9-8.12 (m, 18H).

**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 67.6, 128.1, 128.3, 129.0, 130.1, 130.2, 132.5, 133.3, 135.2, 135.5, 136.0, 138.2, 138.8, 140.1, 142.3, 167.2.

**LREIMS** *m/z* Calculated for $C_{26}H_{20}ClO_2P$: 430.86. Found: 429, 341, 325, 142, 125, 107, 79 (100%) 63, 51.




**Compound 15** (AAL-I-201). 1-Bromo-2-isopropoxynaphthalene

Into a 250 mL rb flask was placed 1-bromo-2-naphthol, (3.1 g,13.9 mmol), $K_2CO_3$ (2.4 g,17.4 mmol, 1.25 eq). This was dissolved in DMF: acetone (1:1,

75 mL). Isopropylbromide (2.0 mL, 22.2 mmol, 1.6 eq) was then added via syringe. The reaction was stirred at rt for 12 h, when TLC analysis indicated significant starting material remaining. The reaction was then heated at 100$^{o}$ C for 4h, and cooled to rt. The mixture was then neutralized with $CH_3CO_2H$, and partitioned between brine and ether. The organics were separated, washed, dried and concentrated. The dark oil was then purified via column chromatography (hexanes/ethyl acetate, 90:10) to provide 2.8 g of clear oil, 76% yield.

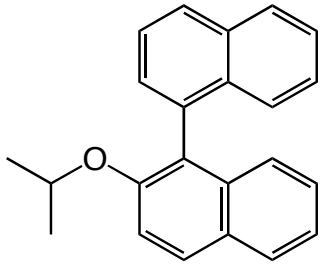
**$^1$H NMR** (500 MHz, $CDCl_3$) $\delta$ 1.45 (d, 6H, J = 6.2 Hz), 4.69 (hept, J = 6.2 Hz, 2H), 7.25 (d, J = 10.5 Hz, 1H), 7.42 (t, J = 8.5 Hz, 1H), 7.57 (t, J = 8.5 Hz, 1H), 7.78 (m, 2H), 8.25 (d, J = 10.5, 1H)

**LREIMS** *m/z* Calculated for $C_{13}H_{13}BrO$ 265.14. Found: 266, 264, 224, 222, 205, 203, 195, 193, 183, 143, 115 (100%), 89, 75, 63, 51.

General Optimized Procedure for Fluoride-mediated Suzuki Couplings

1 eq of the aryl bromide, 1.1-1.5 eq of the aryl boronic acid, 5 mol % $Pd(OAc)_2$, 15 mol % $PPh_3$, and 3.5 eq CsF were transferred to a 4 dram vial or 5 mL microwave synthesis vial. The reagents was then dissolved in 2:2:1 DME:IPA:$H_2O$ and stirred at room temp for about 5 minutes. For sealed tube reactions, the vial capped with a Teflon septum and tightly sealed, and heated on a sand bath; indicated temperature is the measured sand bath temperature. Microwave reactions were performed using the Personal

Chemistry “Emrys Optimizer” microwave system. When the reaction was cooled to rt, it was diluted with brine. It was then extracted with EtOAc (x4), and the organics were filtered through a small silica plug to remove Pd salts, concentrated, and finally purified via column chromatography in the solvent system indicated.




**Compound 16** (AAL-I-242) 2-Isopropoxy-[1,1']binaphthyl

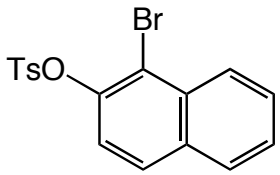
Prepared according to the general procedure, starting with 1-bromo-2-*iso*-propoxynapthalene (72 mg, 0.27 mmol, 1.0 eq) of and 1.1 eq of 1-napthalene boronic acid to give, after chromatography (hexanes:$Et_2O$, 95:5), 57 mg of off-white foam, 68% yield.

This compound exists as an about 5:1 mixture of rotamers at room temperature.

**$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 0.94 (d, J = 6Hz, major rotamer, 6H), 1.30 (d, J = 6Hz, minor, 6H), 4.28 (hept, J = 6Hz, major, 1H), 4.61 (hept, J = 6Hz, minor, 1H), 7.06-7-87 (m, 13H)

**$^{13}$C NMR** (100 MHz, $CDCl_3$) δ 22.2, 22.5, 72.6, 118.4, 124.0, 125.6, 125.8, 125.9, 126.0, 126.6, 126.4, 126.7, 127.7, 128.0, 128.3, 128.8, 129.4, 129.6, 133.2, 133.8, 135.0, 153.5.

**LREIMS** Calculated for $C_{23}H_{20}O$: 312.40. Found: m/z+: 312, 270 (100%), 252, 239, 207, 183, 152, 127, 77, 51.




**Compound 17** (AAL-I-227) Toluene-4-sulfonic acid 1-bromo-naphthalen-2-yl ester

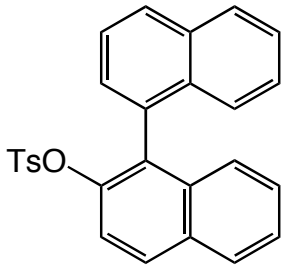
1-bromo-2-naphthol (3.1 g, 13.9 mmol), tosyl chloride (4.0 g, 20.8 mmol, 1.5 eq) and $K_2CO_3$ (2.5 g, 18.1 mmol, 1.3 eq) were dissolved in acetone (65 mL) and refluxed overnight. After cooling, the reaction was partitioned between EtOAc and half-saturated brine. After extraction (x3) and washing (aq. $NH_4Cl$, then brine) the solution was dried and concentrated. The semi-crystalline slurry was then recrystallized from $Et_2O$ to give 4.3 of tan crystalline material, 83% yield.

mp = 124-126$^{o}$ C

**$^{1}$H NMR** (500 MHz, $d_6$-acetone) δ 2.43 (s, 3H), 7.47-8.28 (m, 10H).

**$^{13}$C NMR** (100 MHz, $d_6$-acetone) $\delta$ 21.7, 116.3, 122.4, 127.8, 128.1, 129.4, 129.6, 130.3, 131.0, 133.3, 133.7, 133.7, 146.1, 147.2.

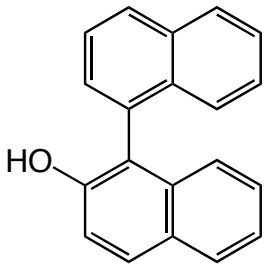
**HRCIMS** Calculated for $C_{17}H_{13}O_3SBr$ $(M+H)^+$: 375.9769. Found: 375.9776 ($\Delta$ = 1.8 ppm).




**Compound 18** (AAL-1-238) Toluene-4-sulfonic acid [1,1']binaphthyl-2-yl ester Coupling under standard conditions lead to only ~7% coupling as estimated by GC, the remainder being reduction of the aryl bromide and bis-napthalene. An analytical sample was purified by preparatory TLC (hexanes/$Et_2O$, 75:25).

**$^1$H NMR** (300 MHz, $CDCl_3$) 2.55 (s, 3H), 7.32-8.15 (m, 17H).

**LREIMS** *m/z* Calculated for $C_{27}H_{20}O_3S$: 424.51. Found: 424, 269 (100%), 239, 207, 91, 65.

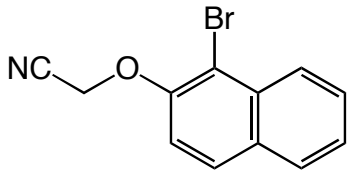


**Compound 19** (AAL-II-58) As per standard conditions starting with 1-bromo-2-naphthol (78 mg, 0.35 mmol) irradiating at 190$^{o}$ C for 360 seconds, and then chromatography (hexanes:$Et_2O$, 85:15) to give 58 mg of light brown semicrystalline material, 61% yield.

**$^{1}$H NMR** (400 MHz, $CDCl_3$) $\delta$ 4.96 (br s, 1H), 7.11-8.06 (m, 13H)

**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 117.6, 118.9, 123.6, 123.8, 125.2, 126.0, 126.2, 126.8, 127.1, 128.2, 128.7, 129.1, 129.5, 129.9, 130.1, 131.6, 133.0, 134.1, 134.4, 151.1.

**LREIMS** Calculated for $C_{20}H_{14}O$: 270.33. Found: (no mass ion observed) 204 (100%), 189, 176, 163, 150, 126, 101, 88, 75, 63, 51.



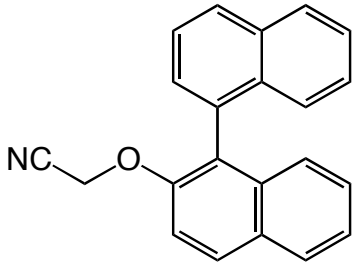

**Compound 20** (AAL-I-258) (1-Bromonaphthalen-2-yloxy)-acetonitrile

1-bromo-2-naphthol (3.05 g, 13.7 mmol), bromoacetonitrile (1.4 mL, 20.5 mmol, 1.5 eq) and $K_2CO_3$ (2.8 g, 20.5 mmol,1.5 eq) were dissolved in acetone (45 mL) and refluxed under $N_2$ overnight. After cooling, the reaction was diluted with $Et_2O$ and brine, then extracted ($Et_2O$, x3) and washed with brine (x2). After drying and concentrating, the material was purified via column

chromatography (hexanes:$Et_2O$, 90:10) to give 3.3 g of white crystalline material, 92% yield.

**$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 4.95 (s, 2H), 7.38 (d, J = 5.5 Hz, 1H), 7.53, (t, J = 4.5 Hz, 1H), 7.62 (t, J = 4.5 Hz, 1H), 7.85-7.90 (m, 2H), 8.28 (d, J = 5.5 Hz, 1H).

**LREIMS** Calculated for $C_{12}H_8BrNO$: 260.98. Found: 263, 261, 223, 221, 195 (100%), 193, 152, 114, 87, 63.

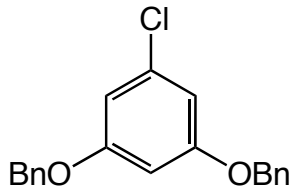



**Compound 21** (AAL-II-12) ([1,1']Binaphthalenyl-2-yloxy)-acetonitrile

Prepared according to the general procedure, beginning with (1-Bromo-naphthalen-2-yloxy)-acetonitrile (50mg, 0.19mmol), irradiating for 360 seconds at 190$^o$ C. After workup, the reaction was purified via column chromatography (hexanes:$Et_2O$ 95:5) to give 60.0 mg of white foam. (94.5% yield).

**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 55.6, 115.5, 116.0, 125.3, 125.7, 126.0, 126.15, 126.22, 126.3, 126.4, 126.5, 127.1, 128.2, 128.6, 128.7, 130.3, 130.7, 132.8, 133.1, 133.8, 134.3, 151.7.

**HREIMS** Calculated for $C_{22}H_{15}NO$ (m/z): 309.1154. Found 309.1142 ($\Delta$ = 3.9 ppm).



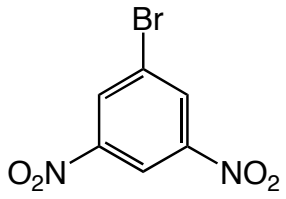

**Compound 22** (AAL-II-64) 1-chloro-3,5-dibenzyloxybenzene

Into a 1L three neck round bottom, fitted with an overhead stirrer, was added 1-chloro-3,5-dihydroxybenzene (21 g, 144.8 mmol, 1.0 eq), and $K_2CO_3$ (44g, 319 mmol, 2.2 eq). To this was added a mixture of acetone / acetonitrile (1:1, 300 mL), and benzyl bromide (39 mL, 326 mmol, 2.25 eq). The reaction was refluxed under an argon blanket for 16h, then diluted with $Et_2O$ and brine. After washing, drying and concentrating, the oil was distilled to remove excess benzyl bromide, to give 36.5 g of white crystalline material, 78% yield.

**$^1$H NMR** (300 MHz, $CDCl_3$) $\delta$ 5.01 (4 H, s), 6.53 (app t, J = 1.3 Hz, 1H), 6.64 (app d, J = 1.3 Hz, 2H), 7.35-7.44 (m, 10H).

**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 70.5, 101.0, 108.3, 127.7, 128.4, 128.9, 135.4, 136.5, 160.4

**HREIMS** Calculated for $C_{20}H_{17}O_2Cl$ $(M+H)^+$: 324.0917. Found: 324.0912. ($\Delta$ = 1.7 ppm).




**Compound 23**- (Method I) (AAL-II-70) 1-Bromo-3,5-dinitrobenzene

Method I. Into a 250 mL rb flask was placed 3,5-dinitrobenzoic acid (3.2 g, 15 mmol) and yellow HgO (4.9 g, 22.5 mmol, 1.5 eq). Anhydrous $CCl_4$ (75 mL) was added, and a large, efficient condenser was attached. The reaction brought to reflux in an oil bath, and a 100 W bulb was placed against the round bottom. Elemental $Br_2$ (1.1 mL, 22.5 mmol, 1.5 eq) was then added carefully dropwise down the condenser. The reaction was then refluxed with irradiation for 2 hrs, cooled to room temp, and quenched by the addition of sat. aq $NaHCO_3$ (45 mL). The slurry was then filtered through Celite to remove Hg salts, extracted with EtOAc, washed, dried and purified via column chromatography (hexanes:$CH_2Cl_2$, 70:30) to give 1.7 g of pale yellow crystals, 45% yield.

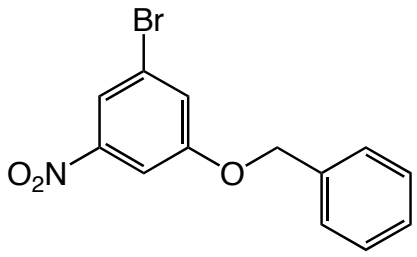
Method II. *m*-dinitrobenzene (8.4 g, 50 mmol) was dissolved in TFA (25 mL) and $H_2SO_4$ (10 mL) and heated to 45$^oC$ (oil bath). *N*-bromosuccinimide (NBS) (13.3 g, 75 mmol, 1.5 eq), was added portionwise over 8 hrs, and heated at 45$^oC$ for 48 hrs. Rx was then cooled to room temp, and poured into ice water. The mixture was then extracted with $CH_2Cl_2$, which was then washed and

dried, and purified via chromatography (hexanes:$CH_2Cl_2$, 70:30) to give 5.05 g of tan crystals, 41% yield.

**$^1$H NMR** (200 MHz, $CDCl_3$) $\delta$ 8.72 (s, 2H), 8.95 (s, 2H).

**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 117.9, 124.0, 132.3, 148.9.

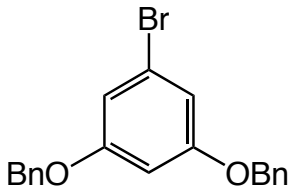
**HREIMS** Calculated for $C_6H_3N_2O_4Br$ (M): 245.9276. Found: 245.9281 ($\Delta$ = 2.1 ppm).




**Compound 24** 1-Bromo-3-benzyloxy-5-nitro-benzene (AAL-II-72). A 100 mL rb flask was fitted with an addition funnel, stir bar and flushed with $O_2$. 1-bromo-3,5-dinitrobenzene (1.7 g, 6.9 mmol) was added along with powdered anhydrous KOH (700 mg, 12.4 mmol, 1.8 eq), and anhydrous tetrabutylammonium bromide (2.2 g, 6.9 mmol, 1.0 eq). A solution of benzyl alcohol (815 $\mu$L, 7.9 mmol,1.15 eq) dissolved in anhydrous tetramethylurea (8mL) was added drop wise via the addition funnel over a period of one hour, all under an $O_2$ atmosphere. Reaction was a dark ruby red color after the addition. The entire reaction was then poured onto ice (~50 g), with the formation of a dark purple emulsion. This was extracted with $Et_2O$ (20 mL

x5). The organics were then washed $NH_4Cl$ (x3) and brine (x3), then dried and‘concentrated. This dark brown oil was then purified via column chromatography (hexanes:$CH_2Cl_2$, 80:20) to yield 998 mg of pale yellow oil, 47% yield.

Spectral data matches that in reference *12* .




**Compound 25** 1-bromo-3,5-dibenzyloxybenzene

Method I (AAL-II-73). A 100 mL rb flask was fitted with an addition funnel, stir bar and flushed with $O_2$. 1.0 g of 1-Bromo-3-isoproxy-5-nitrobenzene (6.9 mmol) was added along with 325 mg powdered anhydrous KOH (5.8 mmol, 1.8 eq), and 1.03 g anhydrous tetrabutylammonium bromide (1.0 eq). The solids were then dissolved in 4 mL anhydrous tetramethylurea. 463 uL of benzyl alcohol (4.5 mmol,1.4 eq) was added dropwise via the addition funnel over a period of one hour, all under an $O_2$ atmosphere. The reaction was then heated to an oil bath temperature of 50$^o$ C for 24 hrs. Reaction was a dark reddish-black color after heating. The reaction acidified with 10% aq HCl and was then poured onto ice (~20 g), with the formation of a dark purple emulsion. This was extracted with $Et_2O$ (10 mL x 5). The organics were then

washed with brine (x3), dried and concentrated. This dark brown oil was then purified via column chromatography (hexanes:$Et_2O$, 90:10) to yield 150 mg white needles, 13 % yield.

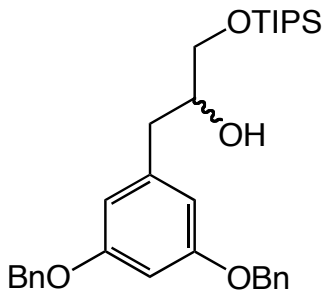
Method II. To a dry 25 mL rb flask was added NaH (95%) (141 mg, 5.25 mmol, 1.05 eq). This was suspended in 8 mL anhydrous NMP, cooled to 0$^o$ C, and benzyl alcohol (541 μL, 5.25 mmol, 1.05 eq) was added dropwise. This was allowed to warm to room temperature, and then cooled back to 0$^o$C. 1-bromo-3,5-difluorobenzene were then added (965 mg, 1.05eq, density unavailable). This was then heated at 45$^o$ C over a weekend; TLC analysis indicated complete consumption of starting material. The reaction was then diluted with brine (50 mL) and $Et_2O$ (50 mL). The layers were separated, and the aqueous layers were extracted with $Et_2O$ (x3); the organics were combined, washed 10% aq KOH (x2) and brine (x3), and dried and concentrated to give a light yellow oil. $^1$H NMR analysis of the crude product showed two benzyl protons relative to eight aromatic signals. This material was then used without further purification in the next reaction.

Using 2.10 eq of both NaH and benzyl alcohol, the above reaction was repeated, heating at 115$^o$ C for 12 hrs. An identical workup was performed and the resulting brown oil was purified via column chromatography (hexanes:$Et_2O$, 90:10) to give 827 mg of white crystalline material, 44% yield over two steps.

**$^1$H NMR** (500 MHz, $CDCl_3$) $\delta$ 5.02 (s, 4 H), 6.57 (t, J = 2 Hz, 1H), 6.80 (d, J = 2 Hz, 2H), 7.39-7.43 (m, 5H).

**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 70.5, 101.5, 111.1, 123.1, 127.7, 128.4, 128.9, 136.5, 160.5.

**HREIMS** Calculated for $C_{20}H_{17}O_2Br$ (M): 368.0412. Found: 368.0409 ($\Delta$ = 0.7 ppm).



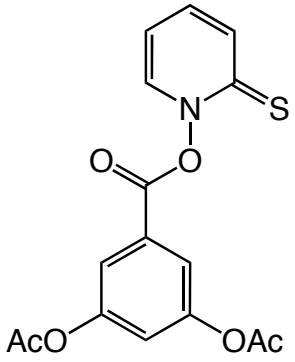

**Compound 26** (AAL-II-85)

1-(3,5-dibenzyloxyphenyl)-3-(triisproylsilanyloxy)-propan-2-ol

A procedure identical to compound (**3**) was followed, starting with 1-bromo-3,5-dibenzyloxybenzene (70 mg, 0.19 mmol, 1.25 eq). The material was then purified via column chromatography (hexanes:EtOAc, 85:15) to give 47 mg of clear oil, 60% yield.

**$^1$H NMR** (300 MHz, $CDCl_3$) $\delta$ 1.09 (m, 21H), 2.65 (d, J= 6Hz, 2H), 3.48 (dd, J = 6Hz, 1H), 3.78 (dd, 2H), 5.08 (s, 4H), 6.42 (d, J = 2Hz, 1H), 6.55 (d, J = 2Hz, 2H), 7.35-7.41 (m, 10H).

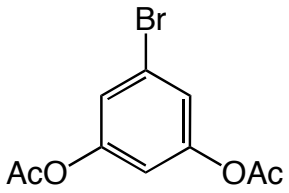
**$^{13}$C NMR** (100 MHz, $CDCl_3$) δ 12.0, 18.1, 34.7, 64.5, 71.4, 71.8, 100.1, 108.3, 127.2, 128.5, 129.0, 135.9, 155.8.




**Compound 27** 3,5-Diacetoxybenzoic acid 2-thioxo-2*H*-pyridin-1-yl ester (AAL-II-115) 3,5-diacetoxybenzoic acid (2.47 g, 9.5 mmol) was dissolved in anhydrous dimethoxyethane (12 mL). This was cooled to 0° C, and oxalyl chloride (1.2 mL, 14.3 mmol, 1.5 eq) was added. The reaction was allowed to warm to rt overnight, and then the volatiles removed in vacuo. The oil was redissolved in $CH_2Cl_2$ (10 mL) , and this solution was cannulated into a solution of pyrithone *N*-oxide (1.33 g, 10.5 mmol, 1.1 eq) in $CH_2Cl_2$ (7 mL), at 0° C. Reaction warmed to rt and stirred for 4 hrs, and then the solution was used in photochemistry experiments. A sample for analytical analysis was extracted (EtOAc), washed (brine) and purified via column chromatography (hexanes/ethyl acetate, 75:25) to give yellow crystals that darkened on exposure to light.

**$^1$H NMR** (400 MHz, $CDCl_3$) $\delta$ 2.29 (s, 6H), 6.65 (d of t, $J^1$ = 6.8 Hz, $J^2$ = 1.6 Hz, 1H), 7.21 (m, 1H), 7.31 (t, J = 2.4 Hz, 1H), 7.65 (m, 1H), 7.83 (d, J = 2.4 Hz, 2H).

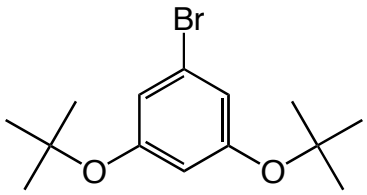
**HRCIMS** Calculated for $C_{16}H_{14}NO_5S$ $(M+H)^+$: 332.0593. Found: 332.0603. ($\Delta$ = 3.1 ppm).




**Compound 28** (AAL-II-119) 1-bromo-3,5-diacetoxybenzene Into a 1-L rb fitted with a reflux condenser was placed anhydrous toluene (300mL) and anhydrous $CBrCl_3$ (100 mL). A single scoop of 4Å sieves was added, and the entire reaction was sparged with Ar for 25 minutes. 3,5-diacetoxybenzoyl chloride (10.1 g, 39.4 mmol, 1.0 eq) was then added, with 5.5 g pyrithone *N*-oxide (5.5 g, 43 mmol, 1.1 eq) and DMAP (490 mg, 4 mmol, 0.1 eq). The entire rb was then wrapped in foil, and heated to 130$^o$ C in an oil bath. AIBN (1.3 g, 8 mmol, 0.20 eq) was then dissolved in $CBrCl_3$ (6 mL) and toluene (4mL), and added via syringe pump (5 mL/hr) to the refluxing reaction. This AIBN addition was then repeated a second time. The reaction was then refluxed for another 35 minutes after this final addition, then cooled and concentrated. The dark residue was partitioned between EtOAc and brine,

washed and concentrated. The oil was then purified via column chromatography (ethyl acetate:hexanes, 75:25) to give 220 mg of white-crystalline material, 2.04 % yield.

**LREIMS** Calculated for $C_{10}H_9BrO_4$ m/z: 271.97. Found 274, 272, 232, 230, 190, 188 (100%), 161, 109, 91, 81, 69, 62, 51.

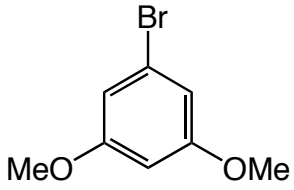



**Compound 29** (AAL-II-147) Into a 10 mL microwave synthesis vial in the glove box was transferred *s*-tribromobenzene (77 mg, 0.24 mmol, 1 eq), sodium *t*-butoxide (51 mg, 0.53 mmol, 2.15 eq), $Pd(dba)_2$ (7 mg, 0.012 mmol, 0.05 eq) and Q-Phos (Strem) (8.5 mg, 0.012 mmol, 0.05 eq). The vial was capped, and anhydrous THF (2.5 mL) was transferred via syringe. The sample was then irradiated at 175$^{o}$ C for 5 minutes, cooled to room temp, and concentrated to a dark gum. This was then purified via column chromatography (hexanes:$Et_2O$, 95:5) to provide 16 mg of a clear oil, 22% yield.

**$^{1}$H NMR** (300 MHz, $CDCl_3$) $\delta$ 1.35 (s, 18H), 6.91 (d, J = 5 Hz, 2H), 6.60, (t, J = 5Hz, 1H).

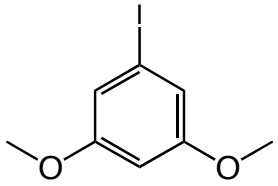
**$^{13}$C NMR** (100 MHz, $CDCl_3$) $\delta$ 29.0, 79.7, 119.2, 121.2, 122.7, 156.7.

**LREIMS** Calculated for $C_{14}H_{21}BrO$ m/z: 300.07. Found: 302, 300, 281, 207, 188 (100%), 186 (98%), 150, 57.




**Compound 30** (AAL-II-139) Into a 300 mL sealed tube reactor (Ace Glass, Teflon screw-top closure) was charged of 1-chloro-3,5-dimethoxybenzene (6 g, 34.8 mmol), anhydrous $NiBr_2$ (15.1g, 75 mmol, 2.0 eq) and anhydrous DMF (18 mL). The reactor was then Ar flushed, and sealed and heated in a 180$^{o}$ C oil bath for 4h, and then cooled to rt. GC analysis indicated a 50% conversion, with the balance being unreacted starting material. The reaction was extracted into ether, washed with brine, dried, and concentrated. It was then resubjected to the reaction conditions, with provided a 77% conversion by GC. All attempts to separate the starting material from the product (chromatography, distillation, recrystallization) were unsuccessful.

**HRCIMS** Calculated for $C_8H_9O_2Br$ (m/z): 215.9786. Found 215.9793 ($\Delta$ = 3.3 ppm).



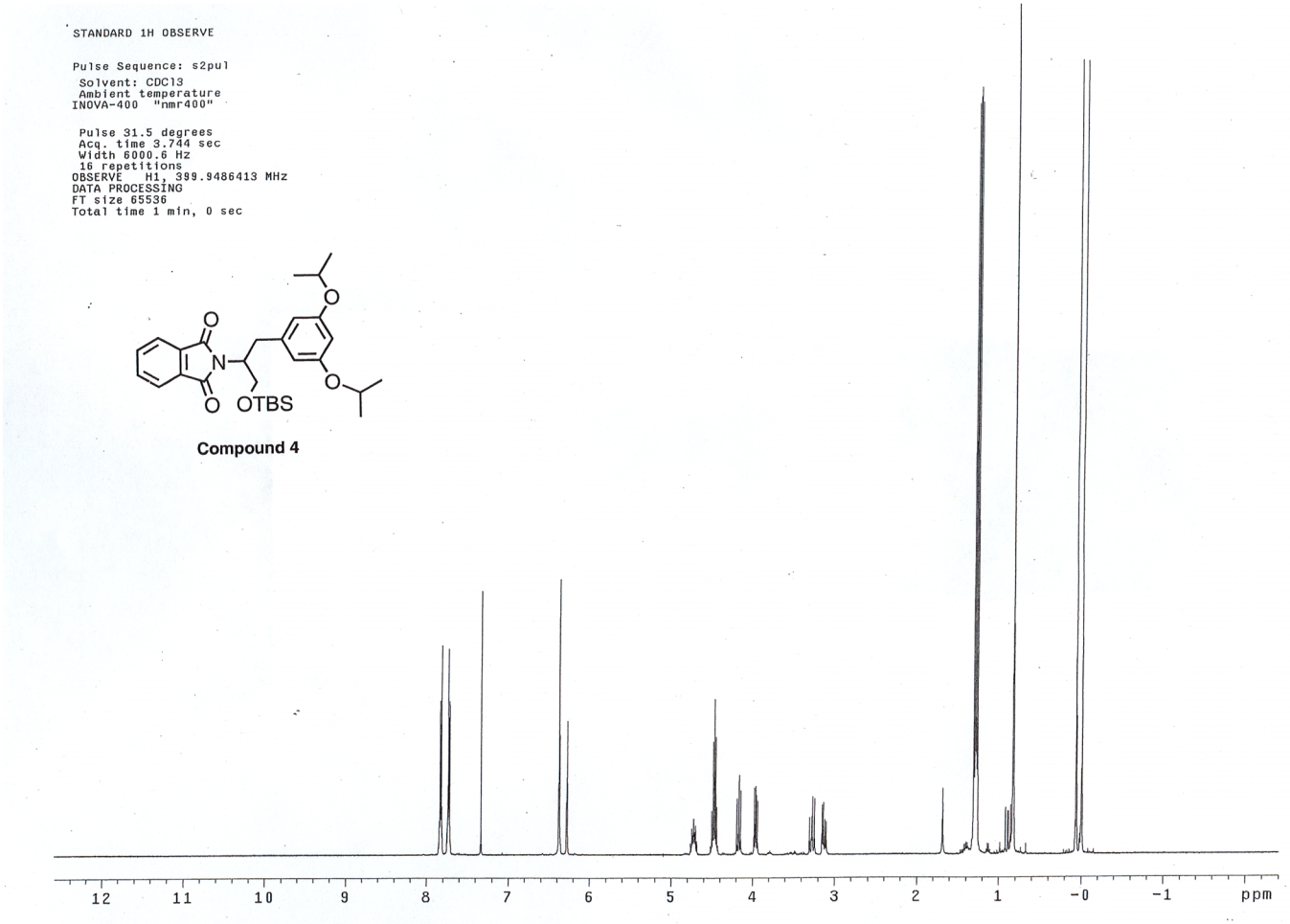
**Compound 31** (AAL-II-152) 1-iodo-3,5-dimethoxybenzene

1-chloro-3,5-dimethoxybenzene (5.0 g, 29 mmol) was refluxed with Mg (2.7g, 110 mmol, 3.8 eq), and 0.5 mL 1,2-dibromoethane in THF (25 mL) overnight. This was cooled to rt, and then to $0^{o}$ C. Elemental $I_2$ (24.0 g, 94.55 mmol, 3.3 eq) was dissolved in THF (25 mL), and then added via syringe. Upon addition, a dark black-grey paste formed. This was stirred with rapid agitation at rt for 2h, and then quenched with $NH_4Cl$ (sat. aq). The residue was diluted with ether, washed with $Na_2SO_3$, and brine. This was dried, concentrated, and purified via column chromatography (petroleum ether: ethyl acetate, 90:10) to give 5.9g of white crystals, 77% yield.

Analytical data matches in reference (*21*).

**HREIMS** Calculated for $C_{16}H_{14}NO_5S$ (m/z): 263.9647. Found 263.9654 ($\Delta$ = 2.6 ppm).

**Selected Spectra**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Width 6000.6 Hz
16 repetitions
OBSERVE H1, 399.9486413 MHz
DATA PROCESSING
FT size 65536
Total time 1 min, 0 sec
O
N
O
O
O
OTBS
O
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11
10
9
8
7
6
5
4
3
2
1
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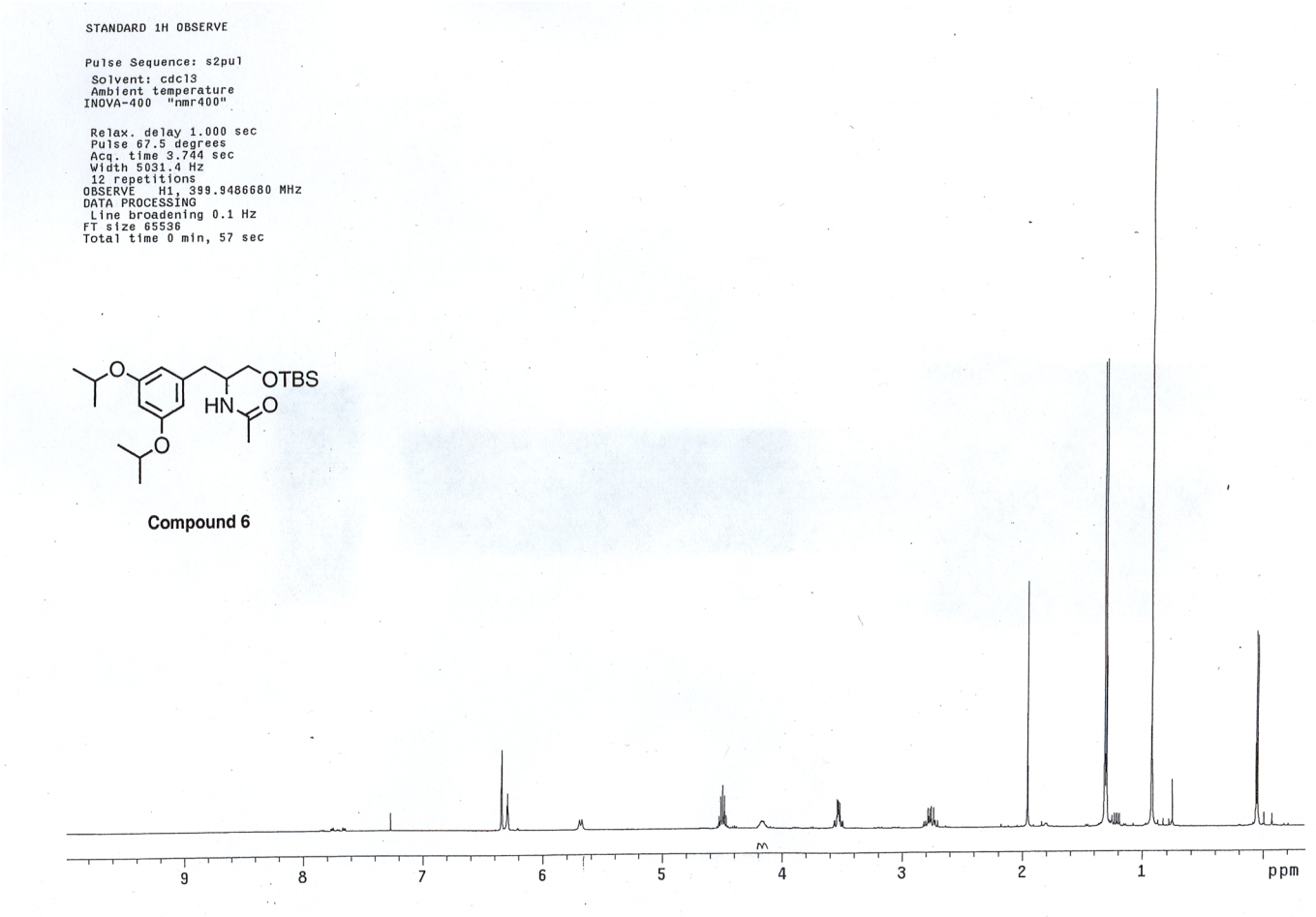
-1
ppm

**Compound 4**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Solvent: cdcl3
Ambient temperature
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Pulse 67.5 degrees
Acq. time 3.744 sec
Width 5031.4 Hz
12 repetitions
OBSERVE H1, 399.9486680 MHz
DATA PROCESSING
Line broadening 0.1 Hz
FT size 65536
Total time 0 min, 57 sec
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OTBS
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O
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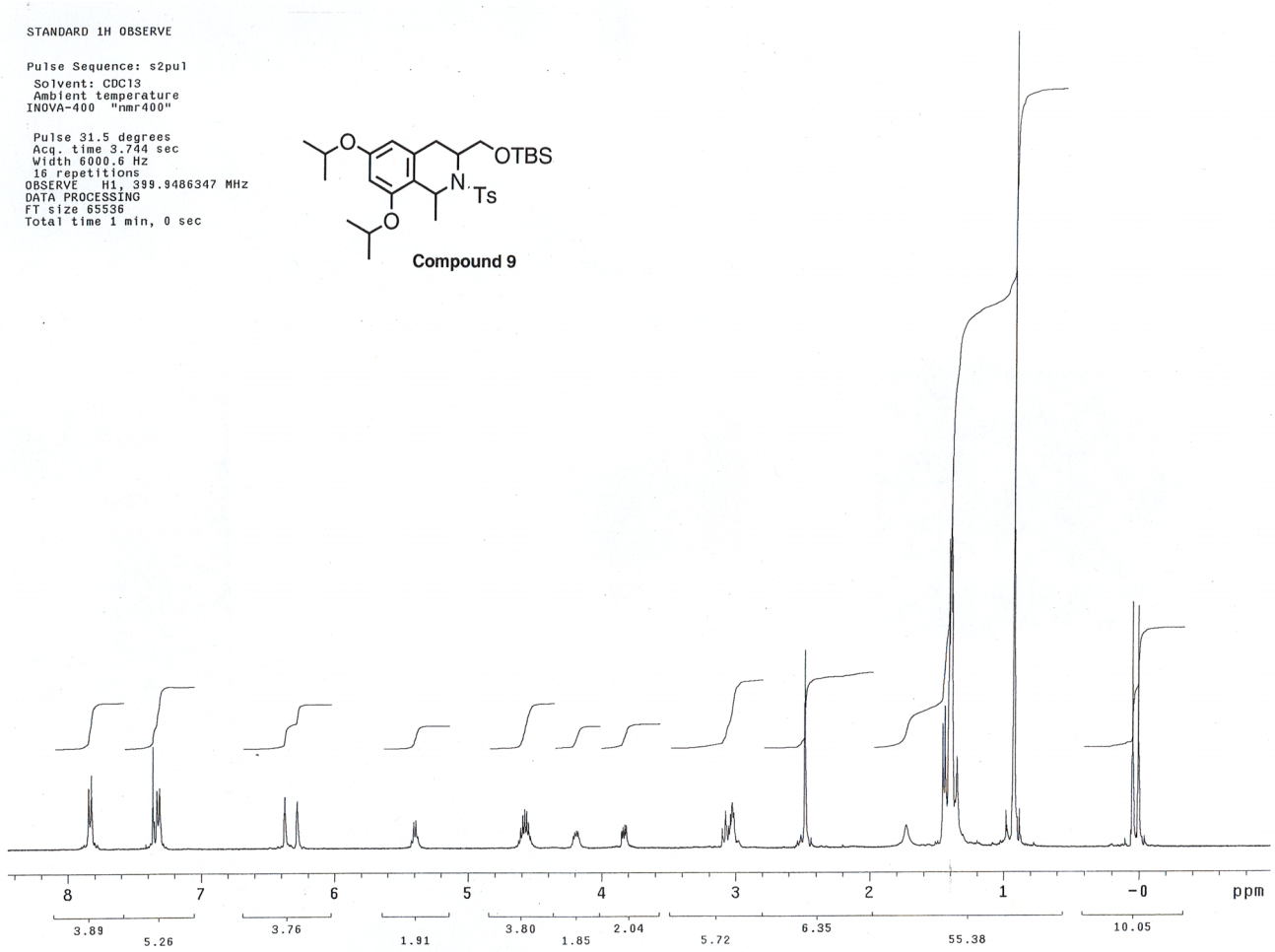
8
7
6
5
4
3
2
1
ppm

**Compound 6**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Solvent: CDCl3
Ambient temperature
INOVA-400 "nmr400"
Pulse 31.5 degrees
Acq. time 3.744 sec
Width 6000.6 Hz
16 repetitions
OBSERVE H1, 399.9486347 MHz
DATA PROCESSING
FT size 65536
Total time 1 min, 0 sec
OTBS
N
Ts
Compound 9
8
7
6
5
4
3
2
1
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2.04
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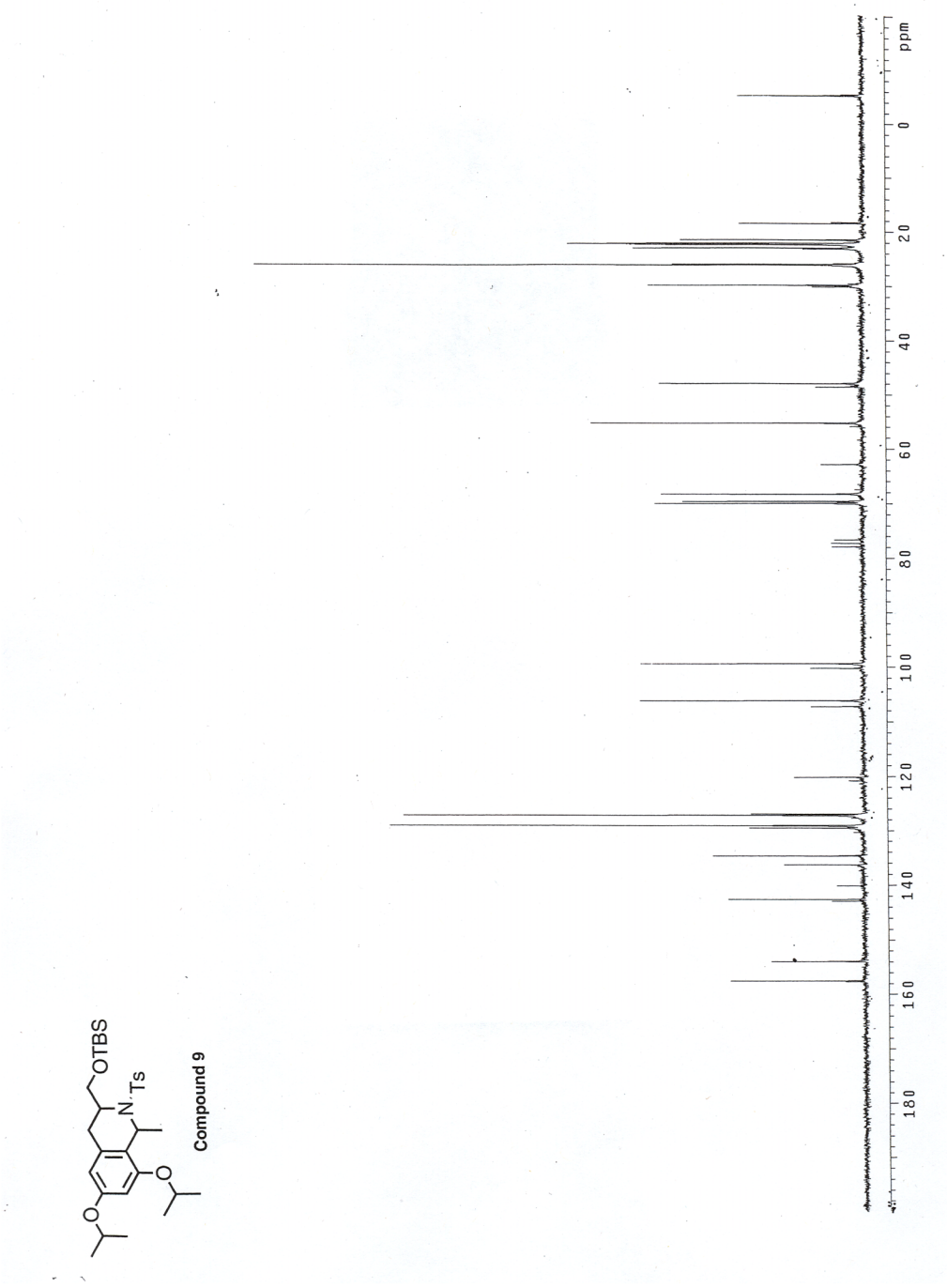
10.05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Ts
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O
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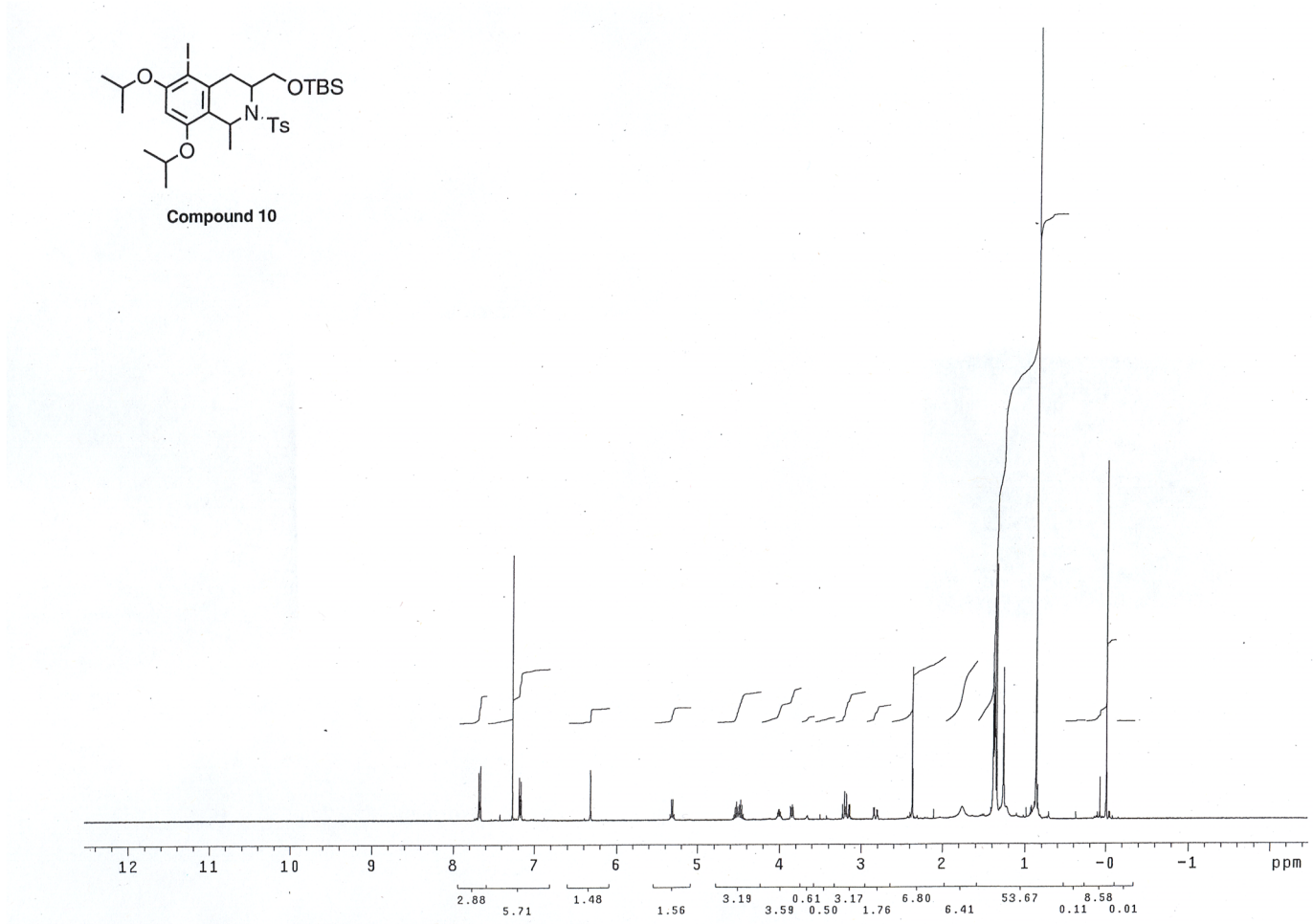
140
120
100
80
60
40
20
0


I
O
OTBS
N
Ts
O
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12
11
10
9
8
7
6
5
4
3
2
1
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-1
ppm
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5.71
1.48
1.56
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0.50
3.17
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6.80
6.41
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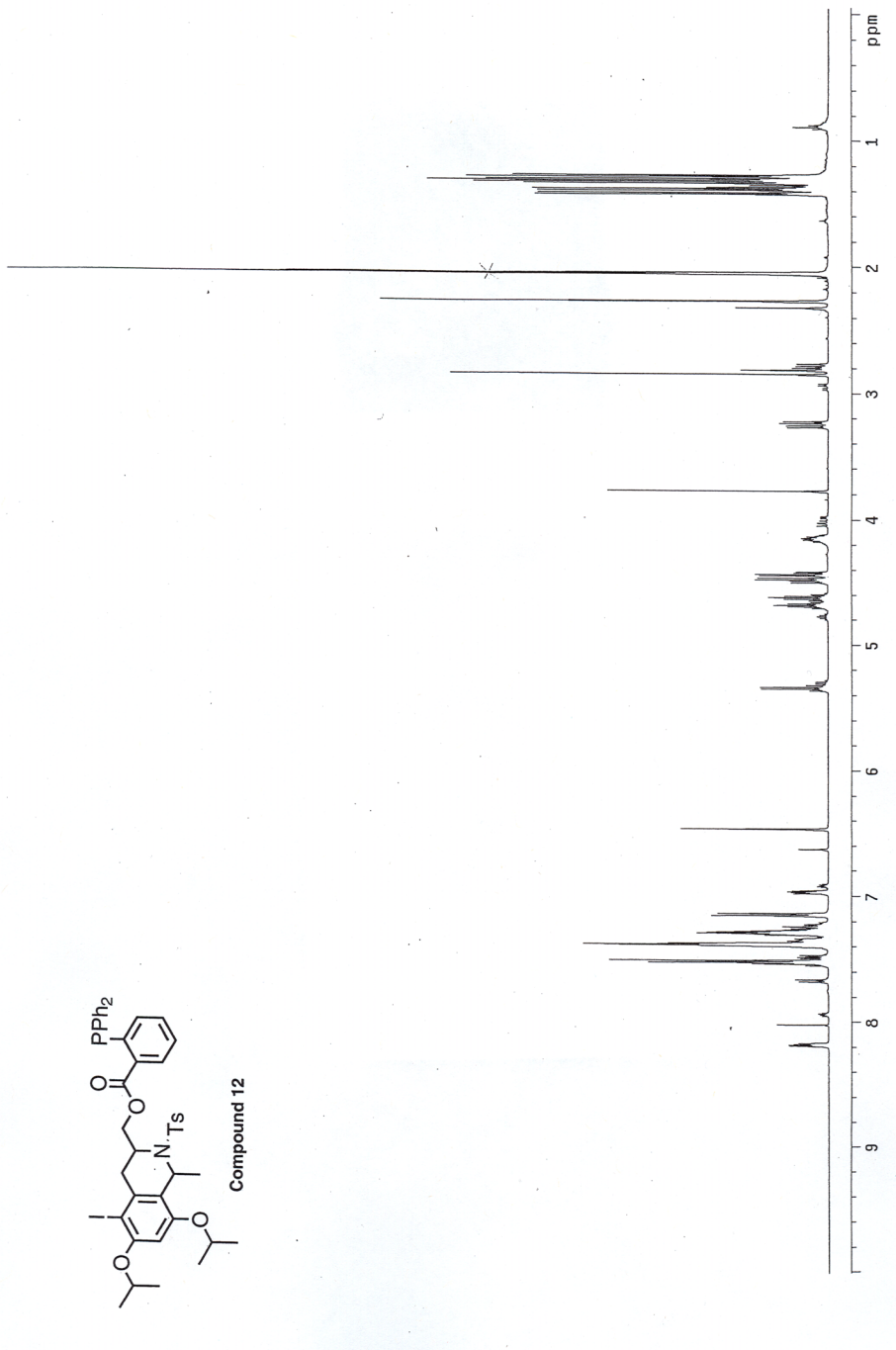
0.11
0.01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N
Ts
I
O
O
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ppm
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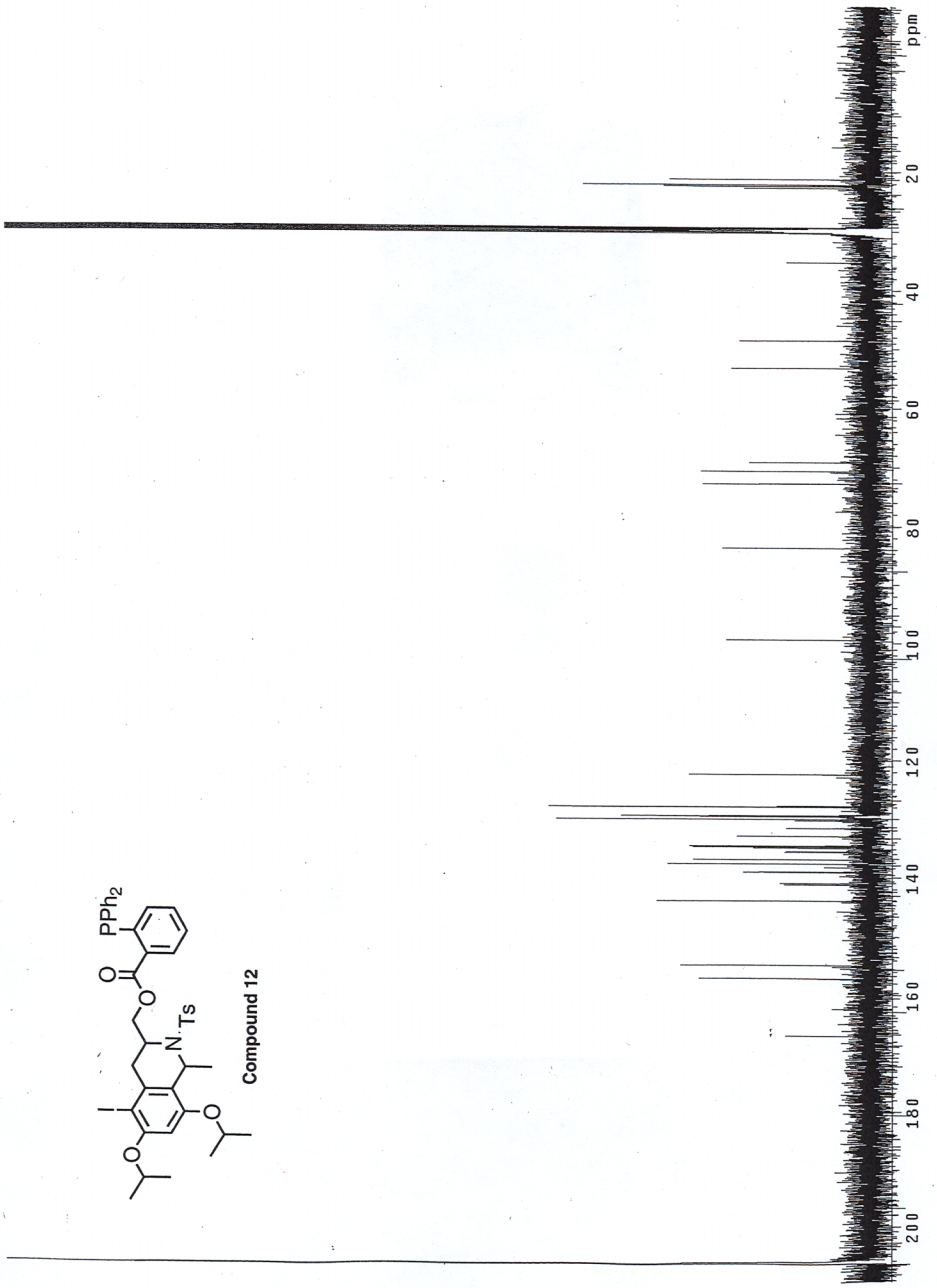
2
3
4
5
6
7
8
9


PPh2
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60
80
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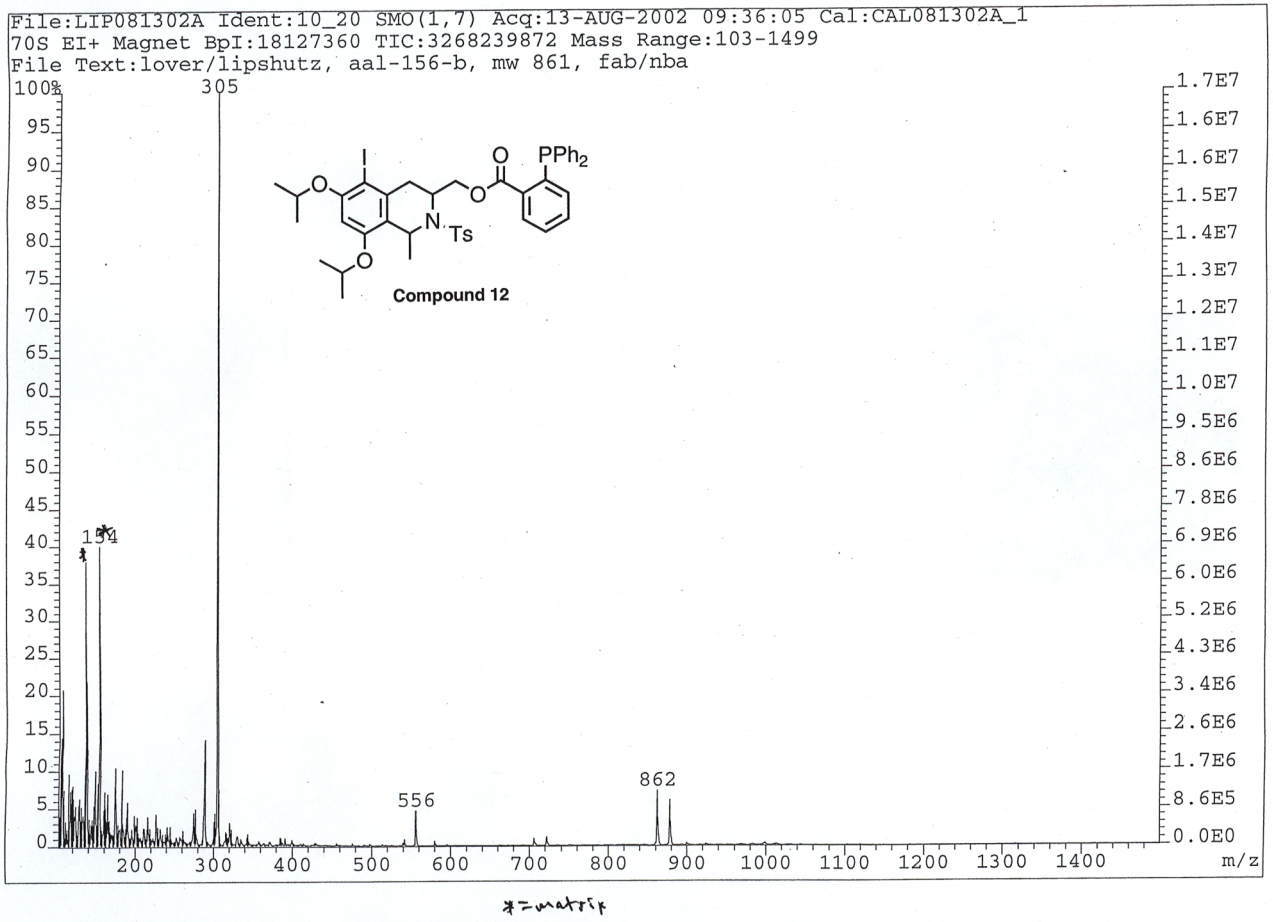
120
140
160
180
200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305
154
556
862
m/z
Compound 12
*=matrix

**Elemental Composition** Date : 14-AUG-2002

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70S EI+ Voltage BpI:2461324 TIC:451320064 Flags:NORM Mass Range:840-920
File Text:lover/lipshutz, aal-156-b, m/z 862, fab/nba/peg
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

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| **Mass** | **mDa** | **PPM** | **Calc. Mass** | **DBE** | **C** | **H** | **N** | **O** | **P** | **S** | **I** |
| 862.181508 | 0.4 | 0.4 | 862.181863 | 17.0 | 39 | 47 | 2 | 8 | | 2 | 1 |
| | -0.9 | -1.0 | 862.180637 | 21.0 | 43 | 49 | 2 | 1 | 2 | 2 | 1 |
| | 1.0 | 1.2 | 862.182513 | 26.0 | 47 | 43 | | 6 | | 1 | 1 |
| | -1.0 | -1.2 | 862.180458 | 12.5 | 36 | 51 | 1 | 9 | 2 | 1 | 1 |
| | -1.2 | -1.4 | 862.180324 | 25.5 | 47 | 46 | 1 | 1 | 1 | 2 | 1 |
| | 1.2 | 1.4 | 862.182713 | 27.5 | 46 | 42 | 1 | 8 | 2 | 2 | |
| | 1.3 | 1.5 | 862.182826 | 21.5 | 43 | 46 | 1 | 6 | 1 | 1 | 1 |
| | -1.4 | -1.6 | 862.180146 | 17.0 | 40 | 48 | | 9 | 1 | 1 | 1 |
| | -1.5 | -1.7 | 862.180012 | 30.0 | 51 | 43 | | 1 | | 2 | 1 |
| | 1.6 | 1.9 | 862.183138 | 17.0 | 39 | 49 | 2 | 6 | 2 | 1 | 1 |
| | -1.7 | -2.0 | 862.179766 | 22.0 | 42 | 45 | 2 | 6 | 2 | | 1 |
| | 2.0 | 2.3 | 862.183518 | 12.0 | 37 | 52 | | 9 | 1 | 2 | 1 |
| | -2.1 | -2.4 | 862.179454 | 26.5 | 46 | 42 | 1 | 6 | 1 | | 1 |
| | 2.3 | 2.6 | 862.183789 | 26.0 | 47 | 45 | | 4 | 2 | | 1 |
| | 2.3 | 2.7 | 862.183830 | 7.5 | 33 | 55 | 1 | 9 | 2 | 2 | 1 |
| | -3.0 | -3.5 | 862.178491 | 22.0 | 42 | 43 | 2 | 8 | | 1 | 1 |
| | -3.1 | -3.6 | 862.178378 | 28.0 | 45 | 39 | 2 | 10 | 1 | 2 | |
| | -3.6 | -4.1 | 862.177957 | 16.5 | 40 | 51 | 1 | 4 | 2 | 2 | 1 |
| | -3.9 | -4.5 | 862.177644 | 21.0 | 44 | 48 | | 4 | 1 | 2 | 1 |
| | 4.0 | 4.6 | 862.185506 | 26.0 | 46 | 44 | 2 | 3 | 1 | 1 | 1 |
| | -4.2 | -4.9 | 862.177265 | 26.0 | 46 | 45 | 2 | 1 | 2 | 1 | 1 |
| | 4.4 | 5.1 | 862.185885 | 21.0 | 44 | 47 | | 6 | | 2 | 1 |
| | -4.4 | -5.1 | 862.177086 | 17.5 | 39 | 47 | 1 | 9 | 2 | | 1 |
| | 4.7 | 5.4 | 862.186198 | 16.5 | 40 | 50 | 1 | 6 | 1 | 2 | 1 |
| | -4.7 | -5.5 | 862.176774 | 22.0 | 43 | 44 | | 9 | 1 | | 1 |
| | 5.0 | 5.8 | 862.186510 | 12.0 | 36 | 53 | 2 | 6 | 2 | 2 | 1 |
| | -5.5 | -6.4 | 862.175989 | 26.0 | 46 | 43 | 2 | 3 | | 2 | 1 |
| | 5.7 | 6.6 | 862.187161 | 21.0 | 44 | 49 | | 4 | 2 | 1 | 1 |
| | 6.2 | 7.2 | 862.187695 | 26.5 | 46 | 41 | 1 | 8 | | | 1 |
| | -6.2 | -7.2 | 862.175277 | 12.0 | 37 | 53 | | 7 | 2 | 2 | 1 |
| | 6.4 | 7.4 | 862.187895 | 28.0 | 45 | 40 | 2 | 10 | 2 | 1 | |
| | -6.4 | -7.4 | 862.175119 | 27.0 | 45 | 39 | 2 | 8 | | | 1 |
| | 6.5 | 7.5 | 862.188007 | 22.0 | 42 | 44 | 2 | 8 | 1 | | 1 |
| | -6.9 | -8.0 | 862.174585 | 21.5 | 43 | 47 | 1 | 4 | 2 | 1 | 1 |
| | 7.1 | 8.2 | 862.188565 | 25.5 | 47 | 45 | 1 | 3 | | 2 | 1 |
| | -7.2 | -8.4 | 862.174273 | 26.0 | 47 | 44 | | 4 | 1 | 1 | 1 |
| | 7.4 | 8.5 | 862.188878 | 21.0 | 43 | 48 | 2 | 3 | 1 | 2 | 1 |
| | -7.9 | -9.1 | 862.173622 | 17.0 | 39 | 48 | 2 | 6 | 1 | 2 | 1 |
| | 8.0 | 9.3 | 862.189529 | 30.0 | 51 | 44 | | 1 | 1 | 1 | 1 |
| | 8.2 | 9.5 | 862.189663 | 17.0 | 40 | 49 | | 9 | 2 | | 1 |
| | -8.2 | -9.5 | 862.173309 | 21.5 | 43 | 45 | 1 | 6 | | 2 | 1 |
| | 8.3 | 9.7 | 862.189841 | 25.5 | 47 | 47 | 1 | 1 | 2 | 1 | 1 |
| | 9.0 | 10.5 | 862.190533 | 16.0 | 41 | 53 | | 4 | 2 | 2 | 1 |
| | 9.4 | 11.0 | 862.190954 | 27.5 | 46 | 41 | 1 | 10 | 1 | 2 | |
| | 9.6 | 11.1 | 862.191067 | 21.5 | 43 | 45 | 1 | 8 | | 1 | 1 |
| | -9.6 | -11.1 | 862.171905 | 17.0 | 40 | 49 | | 7 | 2 | 1 | 1 |
| | 9.7 | 11.3 | 862.191245 | 30.0 | 50 | 43 | 2 | | | 2 | 1 |
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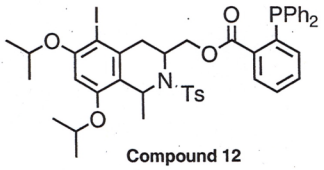
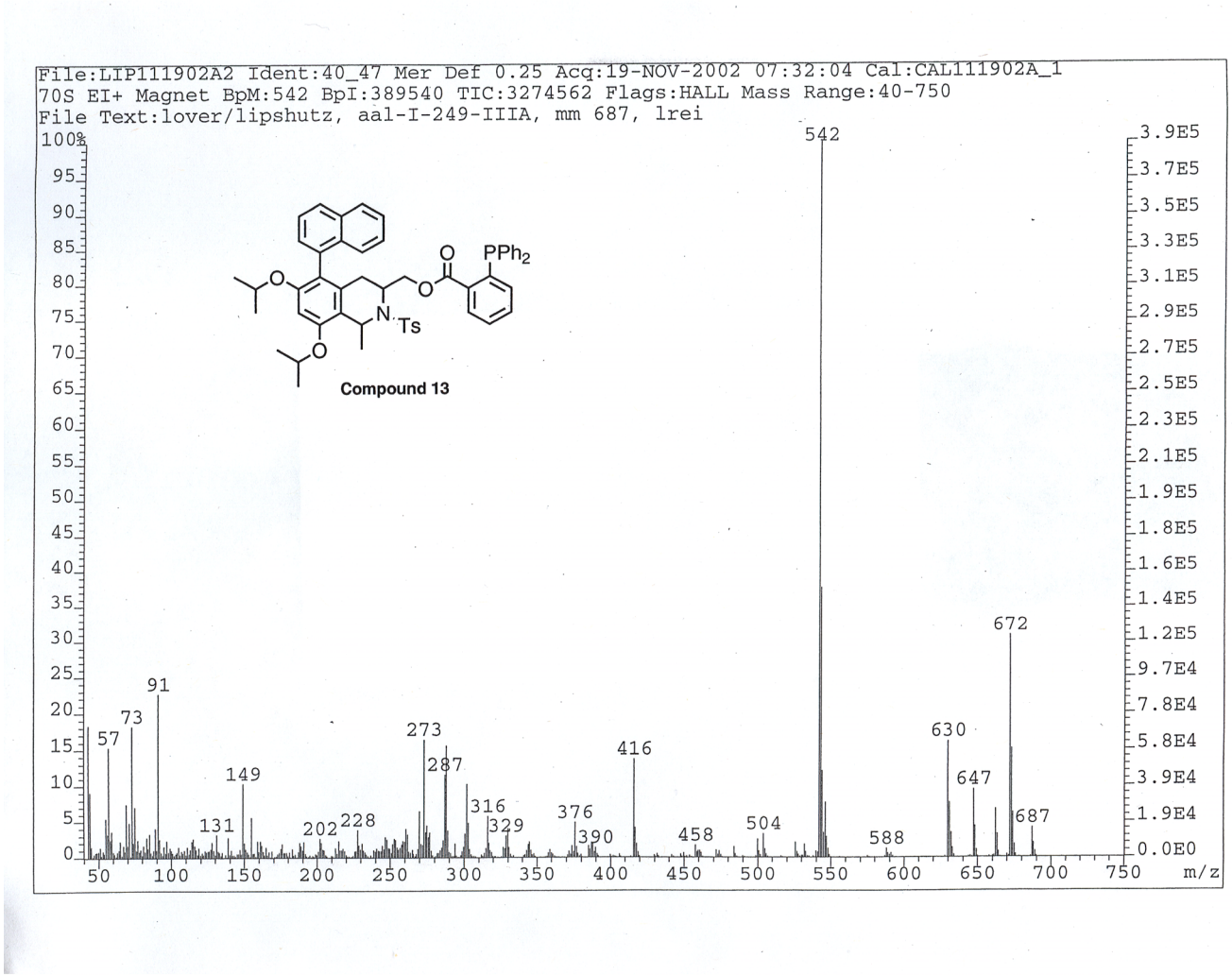
$(M+H)^+$






**Compound 12**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672
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287
149
416
630
647
687
131
202
228
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390
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504
588
m/z

**Elemental Composition** Date : 19-NOV-2002

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70S EI+ Voltage BpI:1186104 TIC:280718944 Flags:NORM Mass Range:600-700
File Text:lover/lipshutz, aal-I-249-IIIA, m/z 630, hrei
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

| | | | | -0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
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| **Mass** | **mDa** | **PPM** | **Calc. Mass** | **DBE** | **C** | **H** | **N** | **O** | **Si** | **S** |
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| | 0.1 | 0.2 | 687.339390 | 17.5 | 38 | 47 | 4 | 8 | | |
| | -0.4 | -0.5 | 687.338923 | 11.5 | 38 | 55 | | 7 | | 2 |
| | -0.4 | -0.6 | 687.338873 | 20.0 | 44 | 53 | 1 | | 1 | 2 |
| | 0.5 | 0.8 | 687.339803 | 16.5 | 37 | 51 | 4 | 5 | 2 | |
| | -0.6 | -0.9 | 687.338695 | 11.5 | 37 | 55 | | 8 | 1 | 1 |
| | -0.6 | -0.9 | 687.338644 | 20.0 | 43 | 53 | 1 | 1 | 2 | 1 |
| | 0.7 | 1.1 | 687.340032 | 16.5 | 38 | 51 | 4 | 4 | 1 | 1 |
| | -0.8 | -1.2 | 687.338466 | 11.5 | 36 | 55 | | 9 | 2 | |
| | 1.0 | 1.4 | 687.340261 | 16.5 | 39 | 51 | 4 | 3 | | 2 |
| | -1.1 | -1.5 | 687.338231 | 21.0 | 44 | 49 | 1 | 4 | | 1 |
| | 1.2 | 1.8 | 687.340495 | 7.0 | 31 | 57 | 3 | 8 | 2 | 1 |
| | -1.2 | -1.8 | 687.338044 | 2.5 | 29 | 59 | 2 | 10 | 1 | 2 |
| | -1.3 | -1.9 | 687.338003 | 21.0 | 43 | 49 | 1 | 5 | 1 | |
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| | 1.4 | 2.0 | 687.340683 | 25.5 | 46 | 47 | 2 | 2 | 1 | |
| | 1.4 | 2.1 | 687.340724 | 7.0 | 32 | 57 | 3 | 7 | 1 | 2 |
| | 1.5 | 2.1 | 687.340733 | 17.0 | 40 | 49 | 1 | 9 | | |
| | 1.6 | 2.4 | 687.340911 | 25.5 | 47 | 47 | 2 | 1 | | 1 |
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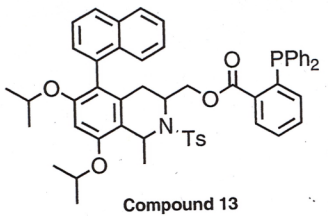
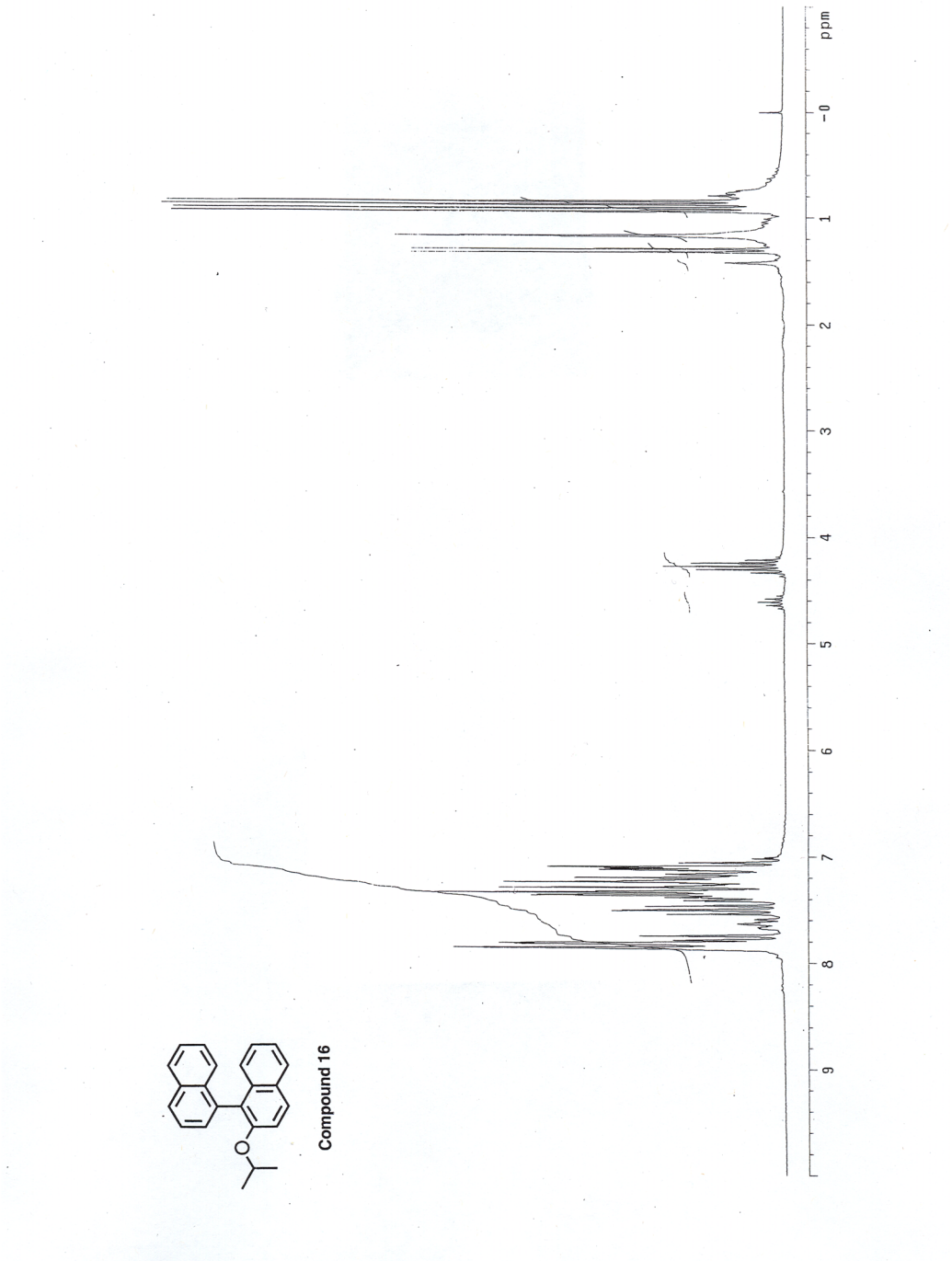
| | 1.9 | 2.7 | 687.341146 | 16.0 | 39 | 53 | 1 | 6 | 2 | |
| | -1.9 | -2.8 | 687.337352 | 12.0 | 35 | 53 | 3 | 7 | 1 | 1 |
| | -2.0 | -2.9 | 687.337302 | 20.5 | 41 | 51 | 4 | | 2 | 1 |
| | 2.1 | 3.0 | 687.341375 | 16.0 | 40 | 53 | 1 | 5 | 1 | 1 |
| | -2.2 | -3.1 | 687.337123 | 12.0 | 34 | 53 | 3 | 8 | 2 | |
| | 2.3 | 3.4 | 687.341603 | 16.0 | 41 | 53 | 1 | 4 | | 2 |
| | -2.4 | -3.5 | 687.336889 | 21.5 | 42 | 47 | 4 | 3 | | 1 |
| | 2.6 | 3.7 | 687.341838 | 6.5 | 33 | 59 | | 9 | 2 | 1 |
| | -2.6 | -3.8 | 687.336660 | 21.5 | 41 | 47 | 4 | 4 | 1 | |
| | 2.7 | 4.0 | 687.342016 | 15.0 | 40 | 57 | 1 | 1 | 2 | 2 |
| | 2.8 | 4.1 | 687.342066 | 6.5 | 34 | 59 | | 8 | 1 | 2 |
| | -3.1 | -4.5 | 687.336193 | 15.5 | 41 | 55 | | 3 | 1 | 2 |
| | 3.3 | 4.7 | 687.342533 | 12.5 | 34 | 51 | 4 | 9 | 1 | |
| | -3.3 | -4.8 | 687.335964 | 15.5 | 40 | 55 | | 4 | 2 | 1 |
| | 3.5 | 5.1 | 687.342762 | 12.5 | 35 | 51 | 4 | 8 | | 1 |
| | -3.7 | -5.4 | 687.335551 | 16.5 | 41 | 51 | | 7 | | 1 |
| | -3.8 | -5.5 | 687.335501 | 25.0 | 47 | 49 | 1 | | 1 | 1 |
| | 3.9 | 5.7 | 687.343175 | 11.5 | 34 | 55 | 4 | 5 | 2 | 1 |
| | -4.0 | -5.8 | 687.335323 | 16.5 | 40 | 51 | | 8 | 1 | |
| | -4.0 | -5.8 | 687.335314 | 6.5 | 32 | 59 | 2 | 6 | 2 | 2 |
| | -4.0 | -5.8 | 687.335272 | 25.0 | 46 | 49 | 1 | 1 | 2 | |
| | 4.1 | 6.0 | 687.343404 | 11.5 | 35 | 55 | 4 | 4 | 1 | 2 |
| | 4.1 | 6.0 | 687.343413 | 21.5 | 43 | 47 | 2 | 6 | | |
| | -4.4 | -6.4 | 687.334901 | 7.5 | 33 | 55 | 2 | 9 | | 2 |
| | -4.4 | -6.4 | 687.334859 | 26.0 | 47 | 45 | 1 | 4 | | |
| | -4.4 | -6.4 | 687.334850 | 16.0 | 39 | 53 | 3 | 2 | 1 | 2 |



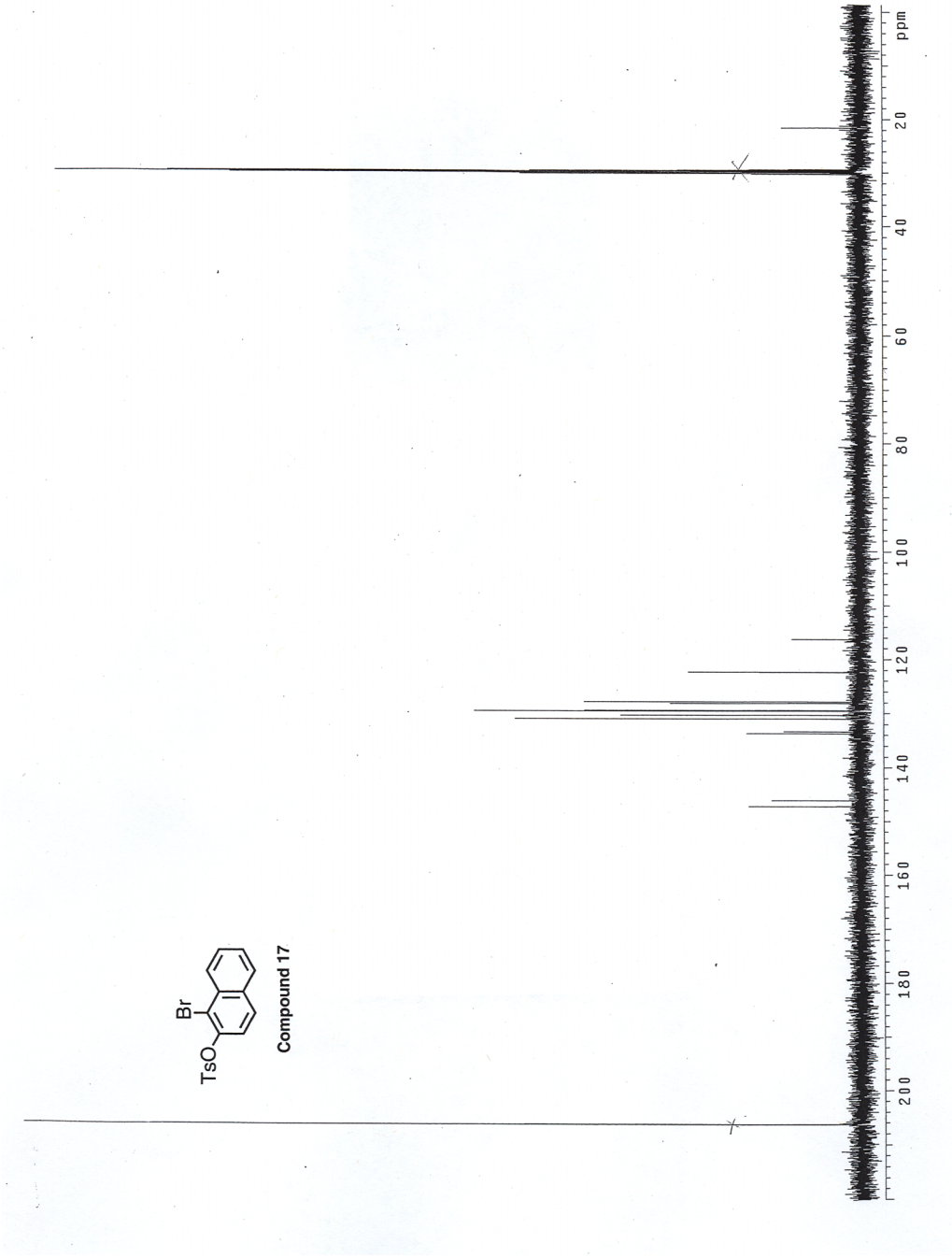



Compound 13

Br
O
Compound 15
ppm
1
2
3
4
5
6
7
8
9
45.92
7.37
46.72


Compound 16
ppm
9
8
7
6
5
4
3
2
1
0

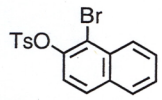
Br
TsO
Compound 17
11
10
9
8
7
6
5
4
3
2
1
ppm


Br
TsO
Compound 17
ppm
200
180
160
140
120
100
80
60
40
20

**Elemental Composition** Date : 18-FEB-2004

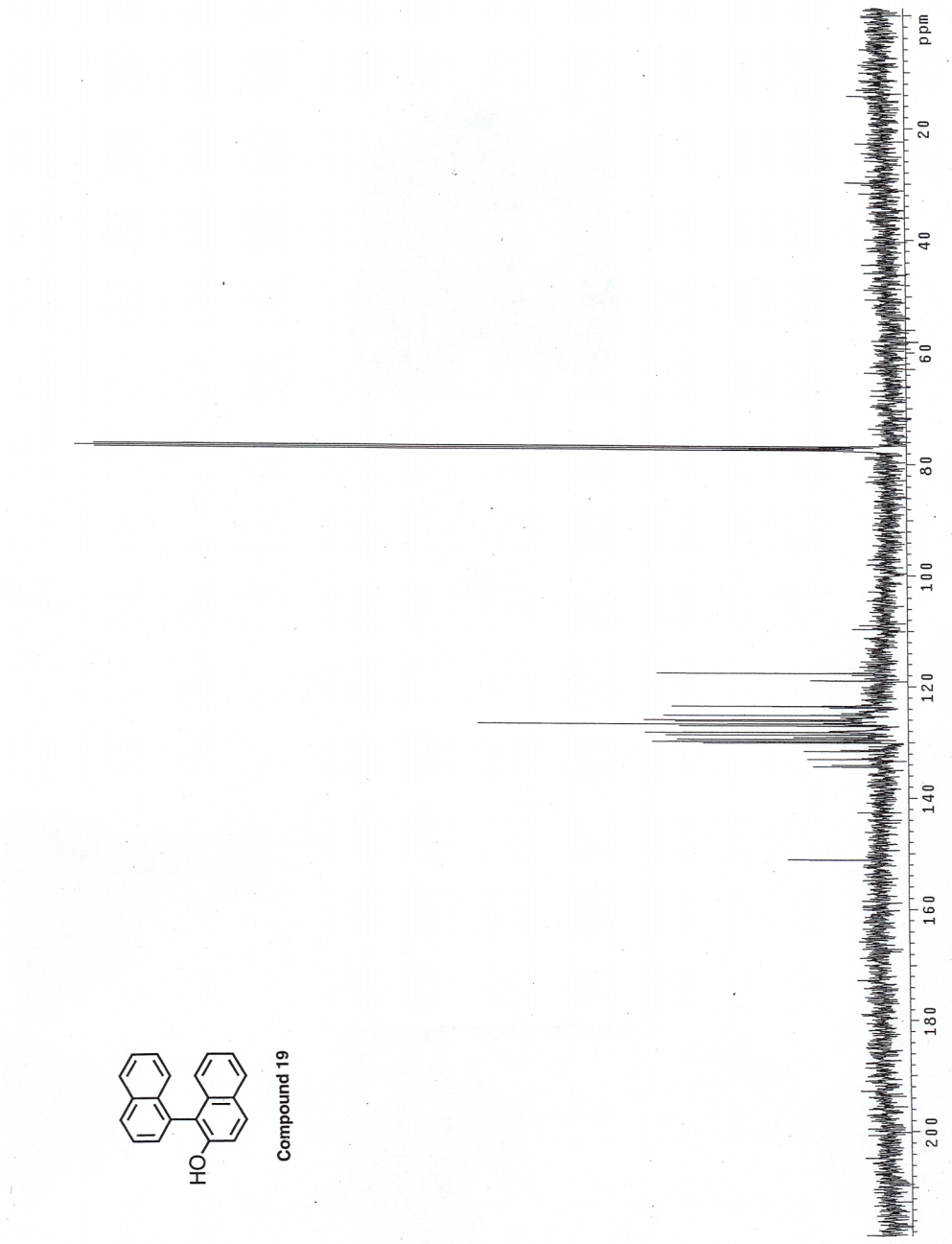
File:LIP021804D Ident:20_30 SMO(1,7) PKD(7,3,7,0.50%,0.0,0.00%,F,F)
70S EI+ Voltage BpI:3982400 TIC:369257088 Flags:NORM
File Text:lover/lipshutz, aal-II-234, m/z 376, Brei
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

| | | | | -0.5 | 0 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|---|
| 375.977563 | 10.0 | | | 20.0 | 200 | 400 | 10 | 10 | 2 | 2 |
| **Mass** | **mDa** | **PPM** | **Calc. Mass** | **DBE** | **C** | **H** | **N** | **O** | **S** | **Br** |
| 375.977563 | 0.0 | 0.0 | 375.977564 | 7.0 | 10 | 13 | 6 | 1 | 2 | 1 |
| | 0.1 | 0.3 | 375.977665 | 18.5 | 16 | 2 | 5 | 5 | 1 | |
| | -0.3 | -0.9 | 375.977243 | 5.5 | 11 | 16 | 5 | | | 2 |
| | 0.5 | 1.2 | 375.978031 | 13.0 | 10 | 5 | 10 | 2 | | 1 |
| | 0.5 | 1.3 | 375.978036 | 7.5 | 11 | 11 | 3 | 7 | | 1 |
| | -0.5 | -1.5 | 375.977014 | 9.5 | 8 | 6 | 7 | 7 | 2 | |
| | -0.7 | -1.8 | 375.976877 | 11.0 | 17 | 13 | | 3 | 1 | 1 |
| | 0.8 | 2.1 | 375.978357 | 9.0 | 10 | 8 | 4 | 8 | 2 | |
| | -0.9 | -2.3 | 375.976693 | 8.0 | 9 | 9 | 6 | 6 | | 1 |
| | 1.0 | 2.7 | 375.978586 | 5.0 | 13 | 18 | 2 | 1 | | 2 |
| | 1.2 | 3.1 | 375.978723 | 3.5 | 4 | 11 | 9 | 5 | 1 | 1 |
| | -1.2 | -3.3 | 375.976328 | 13.5 | 15 | 6 | 1 | 9 | 1 | |
| | -1.2 | -3.3 | 375.976322 | 19.0 | 14 | | 8 | 4 | 1 | |
| | 1.3 | 3.4 | 375.978824 | 15.0 | 10 | | 8 | 9 | | |
| | -1.3 | -3.6 | 375.976227 | 2.0 | 9 | 17 | 2 | 5 | 2 | 1 |
| | -1.3 | -3.6 | 375.976221 | 7.5 | 8 | 11 | 9 | | 2 | 1 |
| | 1.3 | 3.6 | 375.978907 | 6.5 | 12 | 15 | 3 | 2 | 2 | 1 |
| | 1.4 | 3.8 | 375.979008 | 18.0 | 18 | 4 | 2 | 6 | 1 | |
| | -1.7 | -4.4 | 375.975906 | 0.5 | 10 | 20 | 1 | 4 | | 2 |
| | 1.8 | 4.8 | 375.979373 | 12.5 | 12 | 7 | 7 | 3 | | 1 |
| | 1.8 | 4.8 | 375.979379 | 7.0 | 13 | 13 | | 8 | | 1 |
| | -1.9 | -5.0 | 375.975672 | 10.0 | 6 | 4 | 10 | 6 | 2 | |
| | 2.0 | 5.3 | 375.979557 | 15.5 | 20 | 11 | 1 | | 1 | 1 |
| | -2.0 | -5.4 | 375.975535 | 11.5 | 15 | 11 | 3 | 2 | 1 | 1 |
| | 2.1 | 5.7 | 375.979694 | 14.0 | 11 | 4 | 8 | 4 | 2 | |
| | 2.1 | 5.7 | 375.979700 | 8.5 | 12 | 10 | 1 | 9 | 2 | |
| | -2.2 | -5.9 | 375.975356 | 3.0 | 8 | 13 | 2 | 10 | | 1 |
| | -2.2 | -5.9 | 375.975351 | 8.5 | 7 | 7 | 9 | 5 | | 1 |
| | 2.5 | 6.7 | 375.980065 | 3.0 | 6 | 13 | 6 | 6 | 1 | 1 |
| | -2.6 | -6.9 | 375.974985 | 14.0 | 13 | 4 | 4 | 8 | 1 | |
| | 2.6 | 6.9 | 375.980167 | 14.5 | 12 | 2 | 5 | 10 | | |
| | -2.7 | -7.1 | 375.974884 | 2.5 | 7 | 15 | 5 | 4 | 2 | 1 |
| | 2.7 | 7.1 | 375.980249 | 6.0 | 14 | 17 | | 3 | 2 | 1 |
| | -3.0 | -8.0 | 375.974563 | 1.0 | 8 | 18 | 4 | 3 | | 2 |
| | 3.1 | 8.1 | 375.980615 | 0.5 | 8 | 20 | 5 | | 1 | 2 |
| | 3.2 | 8.4 | 375.980716 | 12.0 | 14 | 9 | 4 | 4 | | 1 |
| | -3.2 | -8.6 | 375.974334 | 5.0 | 5 | 8 | 6 | 10 | 2 | |
| | -3.4 | -9.0 | 375.974192 | 12.0 | 13 | 9 | 6 | 1 | 1 | 1 |
| | 3.5 | 9.2 | 375.981037 | 13.5 | 13 | 6 | 5 | 5 | 2 | |
| | -3.5 | -9.4 | 375.974013 | 3.5 | 6 | 11 | 5 | 9 | | 1 |
| | 3.7 | 9.7 | 375.981224 | -0.5 | | 11 | 9 | 10 | | 1 |
| | -3.7 | -9.9 | 375.973826 | 17.5 | 19 | 6 | 1 | 4 | 2 | |
| | 3.8 | 10.2 | 375.981403 | 8.0 | 7 | 9 | 10 | 2 | 1 | 1 |
| | 3.8 | 10.2 | 375.981408 | 2.5 | 8 | 15 | 3 | 7 | 1 | 1 |
| | -3.9 | -10.4 | 375.973642 | 14.5 | 11 | 2 | 7 | 7 | 1 | |
| | -4.0 | -10.7 | 375.973541 | 3.0 | 5 | 13 | 8 | 3 | 2 | 1 |
| | -4.1 | -10.8 | 375.973505 | 16.0 | 20 | 9 | | 3 | | 1 |
| | -4.3 | -11.5 | 375.973220 | 1.5 | 6 | 16 | 7 | 2 | | 2 |

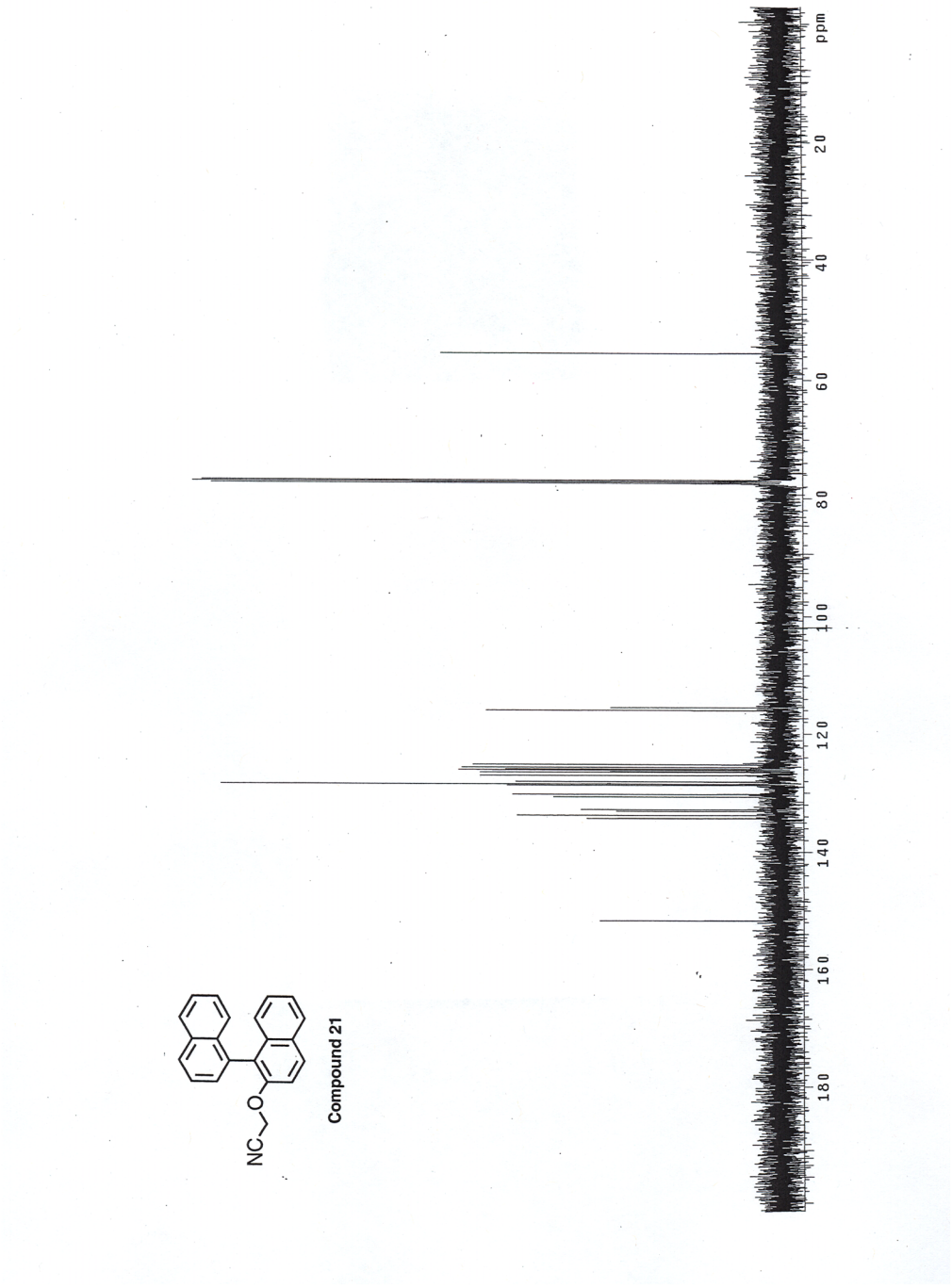



Compound 17

- 1 -


HO
Compound 19
ppm
200
180
160
140
120
100
80
60
40
20

Br
NC
O
Compound 20
ppm
8.18
19.53
32.24
0.00
23.01
8.14
8.90

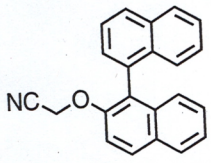

NC
O
Compound 21
ppm
20
40
60
80
100
120
140
160
180

Elemental Composition Date : 23-FEB-2004

File:LIP022304F Ident:30_46 PKD(7,3,7,0.00%,0.0,0.00%,F,F)
70S EI+ Voltage BpI:2213120 TIC:211251648 Flags:NORM
File Text:lover/lipshutz, AAL-II-12, m/z 309, hrei
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

| | | | | -0.5 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| 309.114158 | 10.0 | | | 20.0 | 200 | 400 | 10 | 10 | 2 |

| Mass | mDa | PPM | Calc. Mass | DBE | C | H | N | O | Br |
|---|---|---|---|---|---|---|---|---|---|
| 309.114158 | -0.1 | -0.4 | 309.114022 | 16.5 | 20 | 13 | 4 | | |
| | 0.4 | 1.2 | 309.114530 | 4.0 | 6 | 15 | 9 | 6 | |
| | 0.9 | 3.0 | 309.115079 | 1.5 | 8 | 22 | 8 | | 1 |
| | 1.2 | 3.9 | 309.115364 | 16.0 | 22 | 15 | 1 | 1 | |
| | -1.5 | -4.8 | 309.112684 | 11.5 | 19 | 17 | | 4 | |
| | 1.7 | 5.5 | 309.115872 | 3.5 | 8 | 17 | 6 | 7 | |
| | 2.3 | 7.3 | 309.116422 | 1.0 | 10 | 24 | 5 | 1 | 1 |
| | -2.3 | -7.5 | 309.111850 | -0.5 | 3 | 17 | 8 | 9 | |
| | -2.8 | -9.1 | 309.111342 | 12.0 | 17 | 15 | 3 | 3 | |
| | 3.1 | 9.9 | 309.117210 | 8.5 | 9 | 13 | 10 | 3 | |
| | 3.1 | 9.9 | 309.117215 | 3.0 | 10 | 19 | 3 | 8 | |
| | 3.6 | 11.7 | 309.117764 | 0.5 | 12 | 26 | 2 | 2 | 1 |
| | -4.2 | -13.5 | 309.109999 | 12.5 | 15 | 13 | 6 | 2 | |
| | 4.4 | 14.2 | 309.118552 | 8.0 | 11 | 15 | 7 | 4 | |
| | 4.4 | 14.2 | 309.118558 | 2.5 | 12 | 21 | | 9 | |
| | -4.9 | -16.0 | 309.109211 | 5.0 | 16 | 24 | 1 | | 1 |
| | -5.5 | -17.8 | 309.108662 | 7.5 | 14 | 17 | 2 | 6 | |
| | -5.5 | -17.8 | 309.108656 | 13.0 | 13 | 11 | 9 | 1 | |
| | 5.7 | 18.6 | 309.119895 | 7.5 | 13 | 17 | 4 | 5 | |
| | -6.8 | -22.1 | 309.107319 | 8.0 | 12 | 15 | 5 | 5 | |
| | 7.1 | 22.9 | 309.121232 | 12.5 | 14 | 13 | 8 | 1 | |
| | 7.1 | 22.9 | 309.121238 | 7.0 | 15 | 19 | 1 | 6 | |
| | -7.6 | -24.7 | 309.106531 | 0.5 | 13 | 26 | | 3 | 1 |
| | 7.6 | 24.7 | 309.121787 | 4.5 | 17 | 26 | | | 1 |
| | -8.2 | -26.5 | 309.105982 | 3.0 | 11 | 19 | 1 | 9 | |
| | -8.2 | -26.5 | 309.105976 | 8.5 | 10 | 13 | 8 | 4 | |
| | 8.4 | 27.2 | 309.122575 | 12.0 | 16 | 15 | 5 | 2 | |
| | 8.9 | 28.9 | 309.123083 | -0.5 | 2 | 17 | 10 | 8 | |
| | -9.0 | -29.0 | 309.105188 | 1.0 | 11 | 24 | 3 | 2 | 1 |
| | -9.5 | -30.8 | 309.104639 | 3.5 | 9 | 17 | 4 | 8 | |
| | 9.8 | 31.6 | 309.123918 | 11.5 | 18 | 17 | 2 | 3 | |

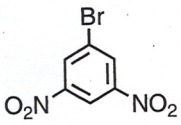



Compound 21

Elemental Composition Date : 23-FEB-2004

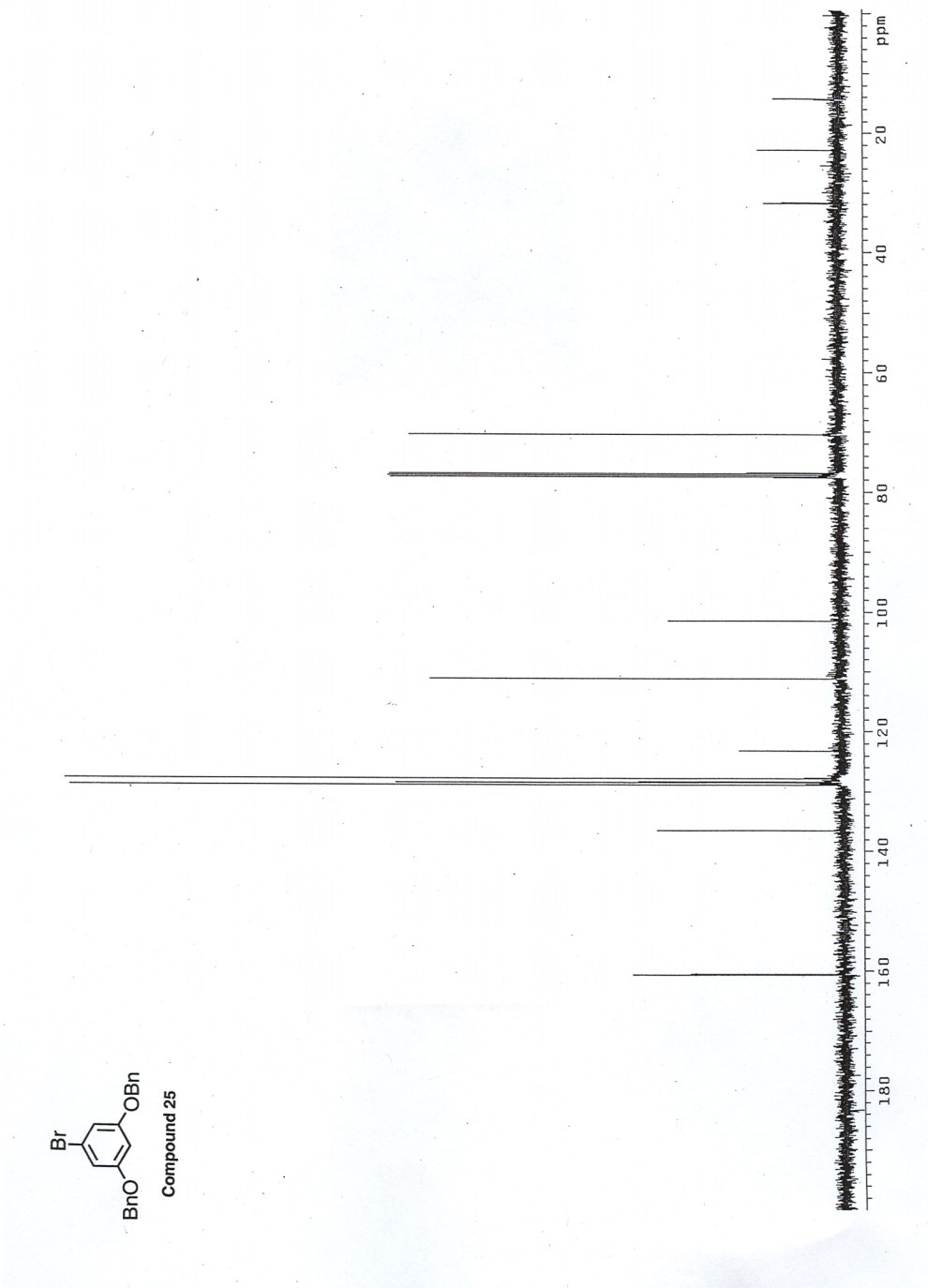
File:LIP022304C Ident:30_43 PKD(7,3,7,0.00%,0.0,0.00%,F,F)
70S EI+ Voltage BpI:2124032 TIC:302824448 Flags:NORM
File Text:lover/lipshutz, AAL-II-82, m/z 246, hrei
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | -0.5 | 0 | 0 | 0 | 0 | 0 |
| 245.928141 | 10.0 | | | 20.0 | 200 | 400 | 10 | 10 | 2 |
| **Mass** | **mDa** | **PPM** | **Calc. Mass** | **DBE** | **C** | **H** | **N** | **O** | **Br** |
| 245.928141 | -0.5 | -2.1 | 245.927618 | 6.0 | 6 | 3 | 2 | 4 | 1 |
| | -1.9 | -7.6 | 245.926275 | 6.5 | 4 | 1 | 5 | 3 | 1 |
| | 2.2 | 8.8 | 245.930298 | 10.5 | 9 | 1 | 3 | 1 | 1 |
| | -3.2 | -13.0 | 245.924938 | 1.5 | 3 | 5 | 1 | 7 | 1 |
| | 3.5 | 14.2 | 245.931641 | 10.0 | 11 | 3 | | 2 | 1 |
| | -4.0 | -16.2 | 245.924145 | -0.5 | 3 | 10 | 3 | | 2 |
| | -4.5 | -18.5 | 245.923595 | 2.0 | 1 | 3 | 4 | 6 | 1 |
| | 6.7 | 27.2 | 245.934828 | 2.0 | | 3 | 6 | 5 | 1 |
| | 8.0 | 32.7 | 245.936171 | 1.5 | 2 | 5 | 3 | 6 | 1 |
| | -9.1 | -36.9 | 245.919064 | 10.5 | 10 | 1 | 1 | 2 | 1 |
| | 9.4 | 38.1 | 245.937508 | 6.5 | 3 | 1 | 7 | 2 | 1 |
| | 9.4 | 38.1 | 245.937514 | 1.0 | 4 | 7 | | 7 | 1 |




**Compound 23**

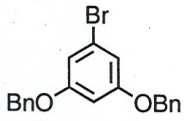
Br
OBn
BnO
Compound 25
9
8
7
6
5
4
3
2
1
-0
ppm


Br
OBn
BnO
Compound 25
ppm
180
160
140
120
100
80
60
40
20

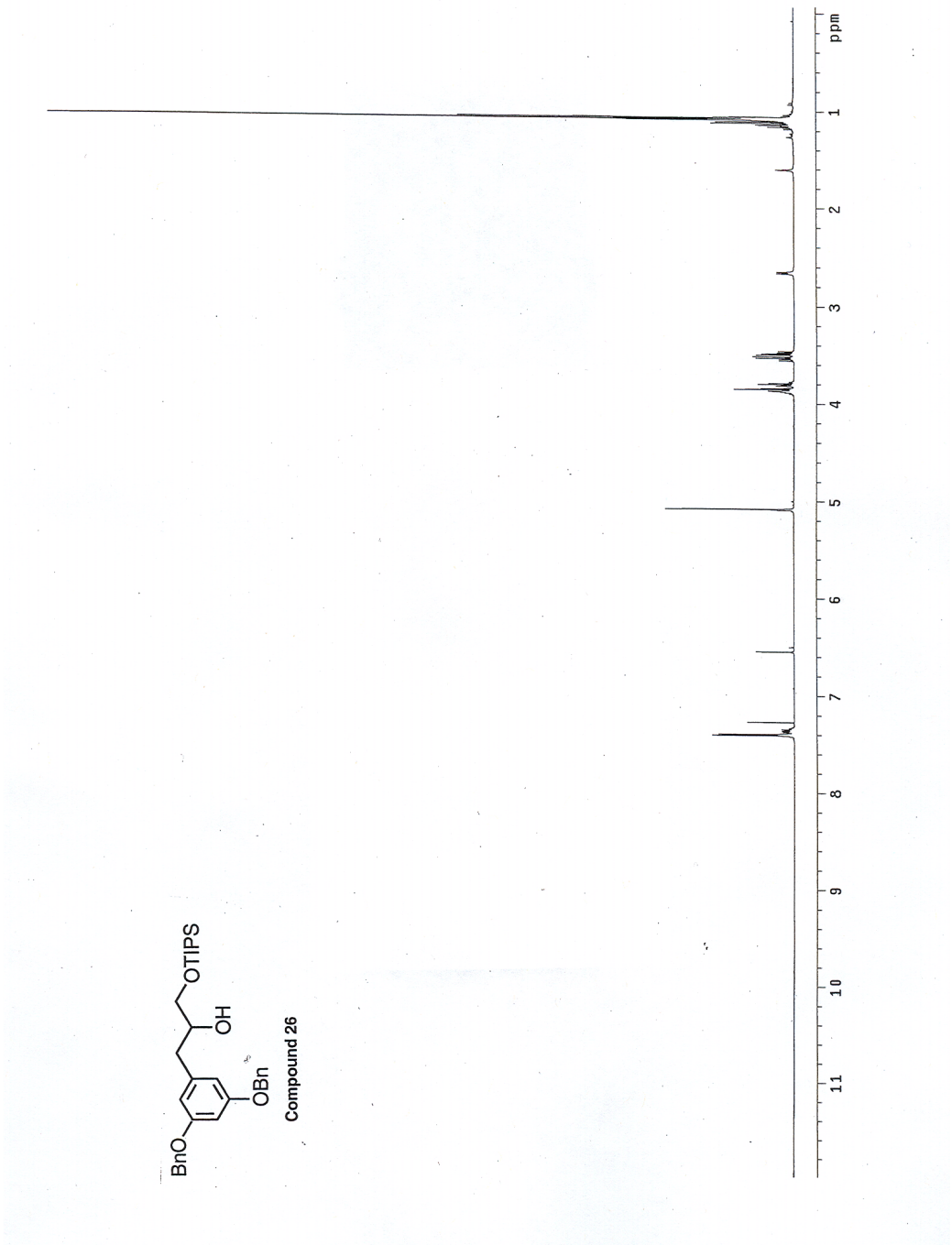
Elemental Composition Date : 14-JUL-2003

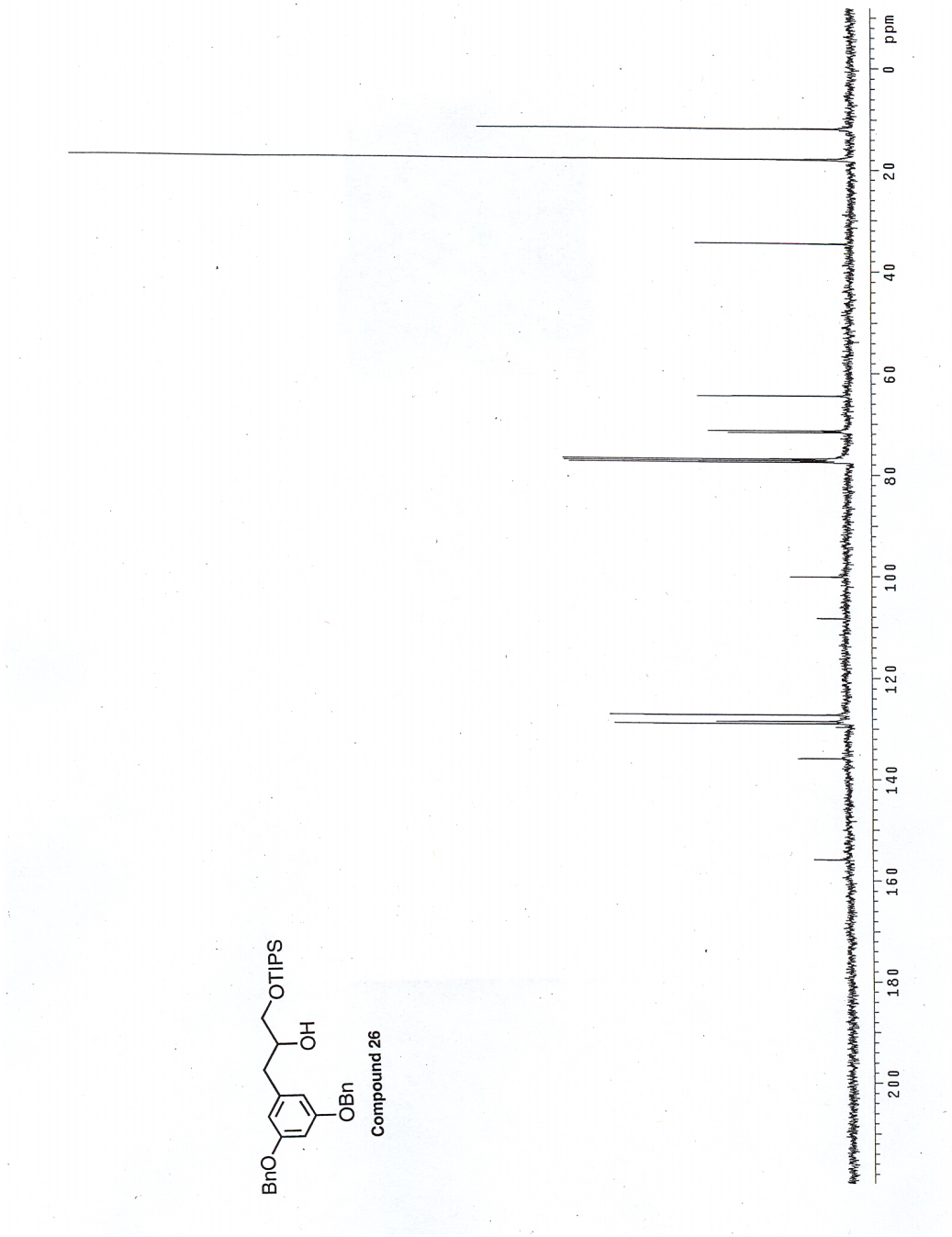
File:LIP071403I Ident:39_44 SMO(1,7) PKD(7,3,7,0.00%,0.0,0.00%,F,F)
70S EI+ Voltage BpI:978248 TIC:115707760 Flags:NORM
File Text:lover/lipshutz, aal-II-73, m/z 368, hrei
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | -0.5 | 0 | 0 | 0 | 0 |
| 368.041532 | 10.0 | | | 20.0 | 200 | 400 | 10 | 2 |
| **Mass** | **mDa** | **PPM** | **Calc. Mass** | **DBE** | **C** | **H** | **O** | **Br** |
| 368.041532 | -0.3 | -0.9 | 368.041191 | 12.0 | 20 | 17 | 2 | 1 |
| | 5.5 | 15.0 | 368.047064 | 3.0 | 13 | 21 | 7 | 1 |
| | -6.5 | -17.6 | 368.035038 | 1.0 | 14 | 26 | 1 | 2 |
| | -9.4 | -25.7 | 368.032088 | 19.0 | 22 | 8 | 6 | |




**Compound 25**


OTIPS
OH
OBn
BnO
Compound 26
ppm
1
2
3
4
5
6
7
8
9
10
11

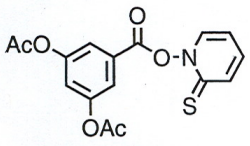

OTIPS
OH
OBn
BnO
Compound 26
200
180
160
140
120
100
80
60
40
20
0
ppm

Elemental Composition Date : 18-FEB-2004

File:LIP021804E1 Ident:34_38 PKD(7,3,7,0.00%,0.0,0.00%,F,F)
70S EI+ Voltage BpI:12287488 TIC:964863936 Flags:NORM
File Text:lover/lipshutz, aal-II-119, m/z 332, hrci/ch4
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

| | | | | -0.5 | 0 | 0 | 0 | 0 | 0 |
|---|---|---|---|---|---|---|---|---|---|
| 332.060293 | 10.0 | | | 20.0 | 200 | 400 | 10 | 10 | 2 |

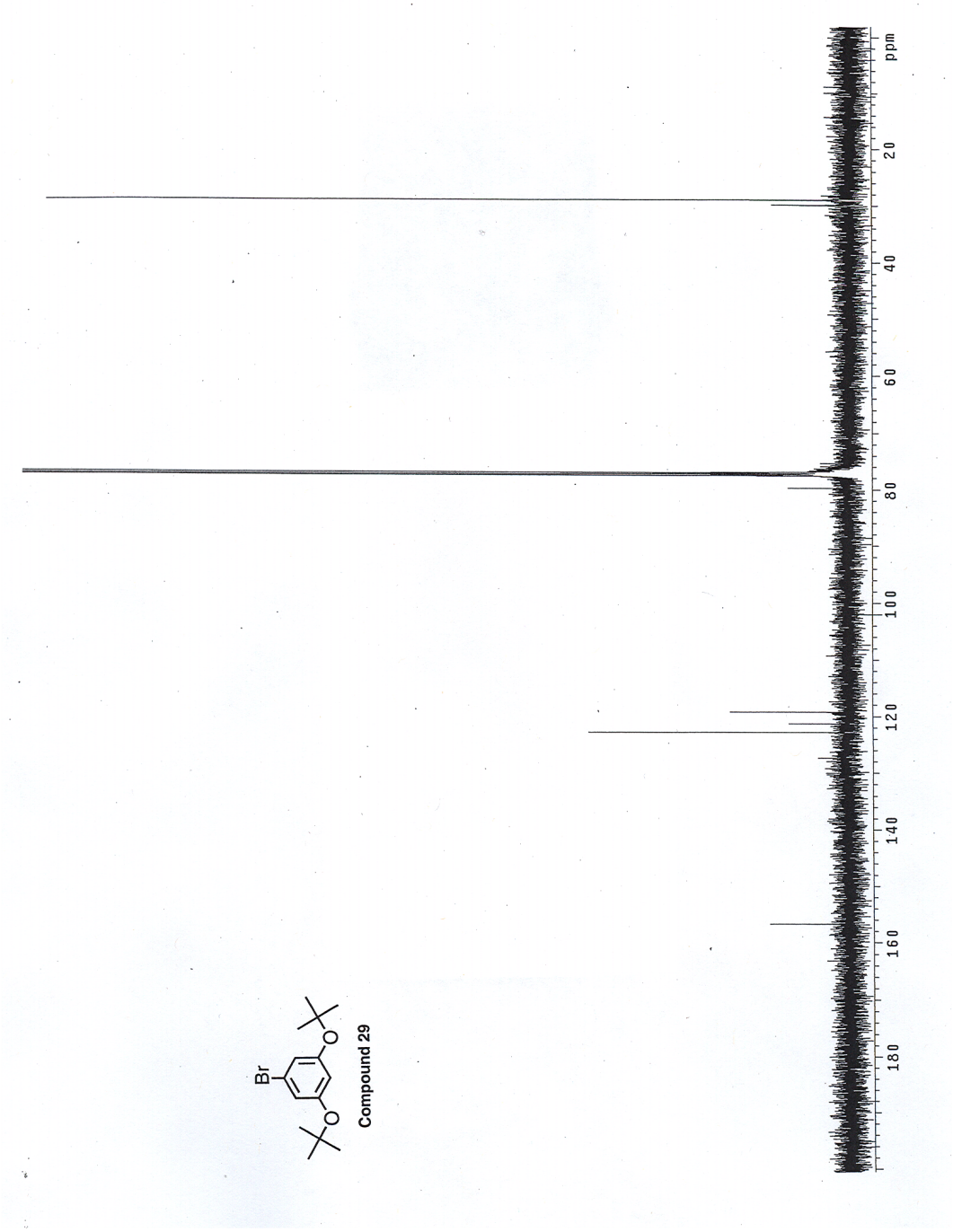
| Mass | mDa | PPM | Calc. Mass | DBE | C | H | N | O | S |
|---|---|---|---|---|---|---|---|---|---|
| 332.060293 | 0.1 | 0.4 | 332.060428 | 7.0 | 10 | 12 | 4 | 9 | |
| | 0.3 | 0.9 | 332.060607 | 15.5 | 17 | 10 | 5 | 1 | 1 |
| | -0.3 | -1. | 332.059962 | 1.0 | 10 | 20 | | 8 | 2 |
| | -0.3 | -1.0 | 332.059956 | 6.5 | 9 | 14 | 7 | 3 | 2 |
| | 0.8 | 2.5 | 332.061115 | 3.0 | 3 | 12 | 10 | 7 | 1 |
| | 1.0 | 3.0 | 332.061299 | 6.0 | 11 | 16 | 4 | 4 | 2 |
| | -1.0 | -3.1 | 332.059270 | 10.5 | 16 | 14 | 1 | 5 | 1 |
| | -1.0 | -3.1 | 332.059264 | 16.0 | 15 | 8 | 8 | | 1 |
| | -1.2 | -3.6 | 332.059086 | 7.5 | 8 | 10 | 7 | 8 | |
| | 1.5 | 4.4 | 332.061766 | 12.0 | 11 | 8 | 8 | 5 | |
| | 1.5 | 4.4 | 332.061771 | 6.5 | 12 | 14 | 1 | 10 | |
| | 1.7 | 5.0 | 332.061950 | 15.0 | 19 | 12 | 2 | 2 | 1 |
| | -1.7 | -5.0 | 332.058619 | 1.5 | 8 | 18 | 3 | 7 | 2 |
| | -1.7 | -5.1 | 332.058613 | 7.0 | 7 | 12 | 10 | 2 | 2 |
| | -1.7 | -5.2 | 332.058578 | 20.0 | 22 | 8 | 2 | 2 | |
| | 2.2 | 6.5 | 332.062458 | 2.5 | 5 | 14 | 7 | 8 | 1 |
| | 2.3 | 7.1 | 332.062636 | 11.0 | 12 | 12 | 8 | | 2 |
| | 2.3 | 7.1 | 332.062642 | 5.5 | 13 | 18 | 1 | 5 | 2 |
| | -2.4 | -7.1 | 332.057927 | 11.0 | 14 | 12 | 4 | 4 | 1 |
| | -2.6 | -7.7 | 332.057743 | 8.0 | 6 | 8 | 10 | 7 | |
| | 2.8 | 8.5 | 332.063108 | 11.5 | 13 | 10 | 5 | 6 | |
| | -3.0 | -9.1 | 332.057276 | 2.0 | 6 | 16 | 6 | 6 | 2 |
| | 3.5 | 10.6 | 332.063800 | 2.0 | 7 | 16 | 4 | 9 | 1 |
| | -3.5 | -10.6 | 332.056768 | 14.5 | 20 | 14 | 1 | | 2 |
| | 3.7 | 11.1 | 332.063979 | 10.5 | 14 | 14 | 5 | 1 | 2 |
| | -3.7 | -11.2 | 332.056590 | 6.0 | 13 | 16 | | 8 | 1 |
| | -3.7 | -11.2 | 332.056584 | 11.5 | 12 | 10 | 7 | 3 | 1 |
| | 4.2 | 12.5 | 332.064446 | 16.5 | 14 | 6 | 9 | 2 | |
| | 4.2 | 12.5 | 332.064451 | 11.0 | 15 | 12 | 2 | 7 | |
| | -4.4 | -13.1 | 332.055933 | 2.5 | 4 | 14 | 9 | 5 | 2 |
| | -4.4 | -13.2 | 332.055898 | 15.5 | 19 | 10 | 1 | 5 | |
| | 4.8 | 14.6 | 332.065138 | 7.0 | 8 | 12 | 8 | 5 | 1 |
| | 4.8 | 14.6 | 332.065143 | 1.5 | 9 | 18 | 1 | 10 | 1 |
| | 5.0 | 15.1 | 332.065322 | 10.0 | 16 | 16 | 2 | 2 | 2 |
| | -5.0 | -15.2 | 332.055247 | 6.5 | 11 | 14 | 3 | 7 | 1 |
| | -5.1 | -15.2 | 332.055241 | 12.0 | 10 | 8 | 10 | 2 | 1 |
| | -5.2 | -15.8 | 332.055063 | 3.5 | 3 | 10 | 9 | 10 | |
| | 5.5 | 16.5 | 332.065788 | 16.0 | 16 | 8 | 6 | 3 | |
| | 5.7 | 17.1 | 332.065972 | 19.0 | 24 | 12 | | | 1 |
| | -5.7 | -17.3 | 332.054555 | 16.0 | 17 | 8 | 4 | 4 | |
| | 6.2 | 18.6 | 332.066480 | 6.5 | 10 | 14 | 5 | 6 | 1 |
| | -6.2 | -18.7 | 332.054088 | 10.0 | 17 | 16 | | 3 | 2 |
| | -6.4 | -19.2 | 332.053904 | 7.0 | 9 | 12 | 6 | 6 | 1 |
| | 6.8 | 20.6 | 332.067131 | 15.5 | 18 | 10 | 3 | 4 | |
| | -6.9 | -20.8 | 332.053396 | 19.5 | 23 | 10 | 1 | | 1 |
| | -7.1 | -21.3 | 332.053218 | 11.0 | 16 | 12 | | 8 | |
| | -7.1 | -21.3 | 332.053212 | 16.5 | 15 | 6 | 7 | 3 | |
| | 7.3 | 22.1 | 332.067639 | 3.0 | 4 | 12 | 8 | 10 | |



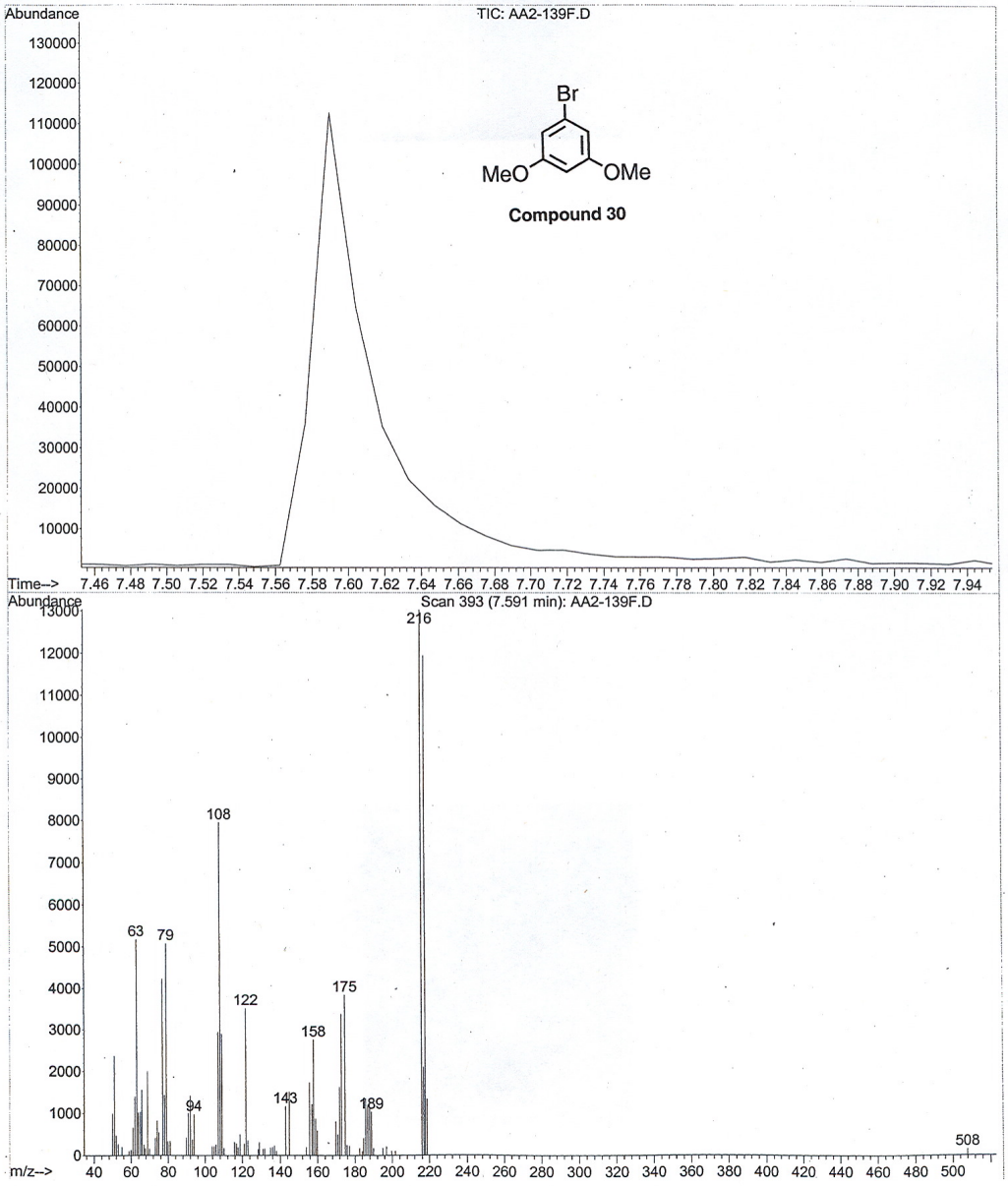
Compound 27

$(M+H)^+$

- 1 -


Br
O
O
Compound 29
ppm
20
40
60
80
100
120
140
160
180

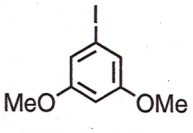
File : E:\HPCHEM\1\DATA\AA2-139F.D
Operator :
Acquired : 19 Feb 2004 10:12 using AcqMethod STAN_2
Instrument : GC/MS
Sample Name:
Misc Info : AAL-II-139, Ar-Br off column
Vial Number: 1



Elemental Composition Date : 5-MAR-2004

File:LIP030504A Ident:150_156 SMO(1,7) PKD(7,3,7,0.00%,0.0,0.00%,F,F)
70S EI+ Voltage BpI:1760272 TIC:227046336 Flags:NORM
File Text:lover/lipshutz, AAL-II-152, m/z 264, hrei
Heteroatom Max: 20 Ion: Both Even and Odd
Limits:

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | -0.5 | 0 | 0 | 0 | 0 | 0 |
| 263.965406 | 10.0 | | | 20.0 | 200 | 400 | 10 | 10 | 1 |
| **Mass** | **mDa** | **PPM** | **Calc. Mass** | **DBE** | **C** | **H** | **N** | **O** | **I** |
| 263.965406 | 0.1 | 0.2 | 263.965465 | 11.0 | 9 | | 2 | 8 | |
| | -0.7 | -2.6 | 263.964732 | 4.0 | 8 | 9 | | 2 | 1 |
| | -2.0 | -7.6 | 263.963389 | 4.5 | 6 | 7 | 3 | 1 | 1 |
| | -3.4 | -12.7 | 263.962046 | 5.0 | 4 | 5 | 6 | | 1 |
| | -4.0 | -15.0 | 263.961442 | 7.0 | 4 | | 4 | 10 | |
| | 4.1 | 15.5 | 263.969488 | 15.0 | 14 | | | 6 | |
| | -4.7 | -17.8 | 263.960709 | 0.0 | 3 | 9 | 2 | 4 | 1 |
| | 5.2 | 19.7 | 263.970600 | 0.5 | | 7 | 7 | 2 | 1 |
| | -6.0 | -22.9 | 263.959366 | 0.5 | 1 | 7 | 5 | 3 | 1 |
| | 6.5 | 24.8 | 263.971942 | 0.0 | 2 | 9 | 4 | 3 | 1 |
| | 7.3 | 27.5 | 263.972676 | 7.0 | 3 | | 6 | 9 | |
| | 7.9 | 29.8 | 263.973285 | -0.5 | 4 | 11 | 1 | 4 | 1 |
| | 8.6 | 32.6 | 263.974019 | 6.5 | 5 | 2 | 3 | 10 | |
| | 9.2 | 34.9 | 263.974622 | 4.5 | 5 | 7 | 5 | | 1 |




Compound 31