Supporting Information

Synthesis of 3-Arylsulfonyl-3-Pyrrolines from Allenyl Sulfonamides by Silver Ion Catalysis

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I. General Information

Isovaleraldehyde, cyclohexyl carbaldehyde, benzaldehyde, p-Methyl, p-Cl, p-OMe, p-NO_2 benzaldehydes, cinnamaldehyde, benzenesulfonamide, 5A^o molecular sieves, amberlyst 15 ion-exchange resin, nBuLi (2.5 M in Hexanes), LiHMDS (1.0 M in THF) and AgF were purchased from sigma aldrich. All reactions were carried out in oven-dried glassware under an argon atmosphere. Tetrahydrofuran and toluene were ordered from Sigma Aldrich and were distilled under a nitrogen atmosphere over sodium metal with benzophenone ketyl as an indicator. Acetonitrile was ordered from Fisher and was distilled under a nitrogen atmosphere over calcium hydride. Analytical thin layer chromatography was performed on silica gel plates with UV indicator. Flash chromatography was carried out using 230-400 mesh silica gel with HPLC grade solvents. ^{1}H NMR spectra were recorded on either a Bruker DRX-500 (500 MHz) or a DRX-600 (600 MHz) spectrometer with chemical shifts reported in δ ppm with tetramethylsilane as an internal reference (s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet of doublets, etc). ^{13}C NMR spectra were obtained on the same instruments at 125 and 150 MHz, respectively, in $CDCl_3$ solution with $CDCl_3$ (77.0 ppm) as an internal reference. Melting points were determined with a Fisher-Johns melting point apparatus and are uncorrected. Infrared spectra were recorded on a Perkin Elmer 1600 series FT-IR spectrometer. High-resolution mass spectra were performed by College of Science Major Instrumentation Center, Old Dominion University, on a Bruker 12 Tesla APEX -Qe FTICR-MS with an Apollo II ion source.

Single crystal X-ray diffraction (SCXRD) data were collected on a Bruker D8 Venture X-ray diffractometer (Bruker AXS, Inc., Madison, WI) equipped with a Photon 100 CMOS area detector using Mo-Kα (λ = 0.71073 Å) from a microfocus source (50 kV, 1.0 mA). The crystals were cooled to 100 K during collection under a cold stream of N_2 using a Cryostream 800 cryostat (Oxford Cryosystems, Oxford, UK). A hemisphere of unique data was collected for each crystal using strategies of scans about the omega and phi axes. Unit cell determination, data collection, data reduction, scaling, and absorption correction were done using the Bruker Apex3 software suite.[1]

The crystal structures were solved by direct methods and refined by full matrix least squares refinement against F^2 using SHELXL v.2014[2] as implemented on Olex2 v.1.2.10.[3] Non-hydrogen atoms were located from the difference map and refined anisotropically. The structure of **6d** showed difference map peaks corresponding to disorder of the tosyl phenyl ring over two positions for one of the symmetry inequivalent molecules; both conformers were refined with their occupancies fixed at 50% each. Hydrogen atoms bonded to carbon were placed in calculated positions, while the N-H hydrogen atom in **7l** was located from the difference map. Hydrogen atoms in **6d** were constrained to have idealized bond distances and angles with their coordinates and thermal parameters riding on the carrier atoms. Hydrogen atoms bonded to methyl groups were refined using a riding rotating model. The coordinates of hydrogen atoms in **7l** were freely refined, while the thermal parameters were constrained to ride on the carrier atom.

II. General procedure for the synthesis of N-Sulfonylimines.

The starting materials allenic sulfones (**5a**, **5b**, **5c**, **5d**, **5e**, **5f**)[4] and N-sulfonylimines were synthesized according to literatures procedures.

***Method A for Aromatic Substituted N-Sulfonylimines (6a, 6d, 6e, 6f, 6g, 6h and 6i)*:**[5] To a stirred solution of benzaldehyde (1.0 g, 9.42 mmol, 1.0 eq) in toluene (11 mL) was added benzenesulfonamide (1.48 g, 9.42 mmol, 1.0 eq) under argon atmosphere at room temperature. Then 5A^{o} molecular sieves (1.0 g) and 13 mg of amberlyst 15 ion-exchange resin were added at rt. The reaction mixture was refluxed under dean-stark conditions for 16h. The reaction progress was monitored by TLC. After completion of the reaction, the reaction mixture was cooled to rt. Then the reaction mixture was filtered through sintered-glass funnel to remove the powdered molecular sieves and ion-exchange resin. The filtrate was evaporated by rotary evaporator. The obtained oily residue was triturated with 20 mL of pentane and the solid crashed out immediately. The solid was filtered through sintered-glass funnel and wash the solid with 20 mL of pentane to remove the unreacted traces of aldehyde. The product N-sulfonylimine **6a** was obtained as a white solid in (2.013 g) 87% yield. (Note- 5A^{o} molecular sieves were activated in the oven (100 ^{o}C) for 7 days, aldehydes were distilled or recrystallized, toluene was distilled).

***Method B for Aliphatic Substituted N-Sulfonylimines (6b and 6c)*:**[5] To a mixture of 15 mL of formic acid: H_2O (1:1) was added cyclohexanecarboxaldehyde (0.5g, 4.45 mmol) at room temperature. Then benzenesulfonamide (0.71g, 4.45 mmol) and sodium p-toluenesulfinate (.794g, 4.45 mmol) were added at room temperature. The white precipitate was slowly formed during the reaction. The reaction mixture was stirred at rt for 12h. The resulting white precipitate was filtered through sintered-glass funnel and washed with H_2O (2 x 5 mL) and 20 mL of pentane. The obtained white solid was dissolved in CH_2Cl_2 (50 mL) and then add sat. $NaHCO_3$ (35 mL). The mixture was stirred vigorously at rt for 2h. The organic phase was separated and the aqueous phase was extracted with CH_2Cl_2 (3 x 20 mL). The combined organic layers were dried over Na_2SO_4, filtered, and evaporated by rotary evaporator. The product N-sulfonylimine **6b** was obtained as a white solid in (0.7g) 62% yield.

References:

1. *Apex3, AXScale and SAINT, version*
2. Sheldrick, G. M. *Acta Crys. Sec. C. Struc. Chem.* **2015**, *71*, 3-8.
3. Dolomanov, O. V.; Bourhis, L. J.; Gildea, R. J.; Howard, J. A. K.; Puschmann, H. *J. Appl. Cryst.* **2009**, *42*, 339-341.
4. (a) Tata, R. R.; Hampton, C. S.; Harmata, M. *Adv. Synth. Catal.* **2017**, *359*, 1232-124. (b) Hampton, C. S.; Harmata, M. *Tetrahedron Lett.* **2015**, *56*, 3243-3245. (c) Tata, R. R.; Hampton, C. S.; Altenhofer, E. F.; Topinka, M.; Ying, W.; Gao, X.; Harmata, M. *Chem. Eur. J.* **2014**, *20*, 13547-13550. (d) Tata, R. R.; Harmata, M. *J. Org. Chem.* **2015**, *80*, 6839-6845.
5. (a) Chemla, F.; Hebbe, V.; Normant, J-F.; *Synthesis*, **2000**, 75-77. (b) Cui, Z.; Yu, H-J.; Yang, R-F.; Gao, W-Y.; Feng, W-Y.; Lin, G-Q. *J. Am. Chem. Soc*. **2011**, *133*, 12394-12397. (c) Vishwakarma, L. C.; Stringer, O. D.; Davis, F. A. *Org. Synth,* **1993**, *Coll. Vol*

8, 546, **1988**, *Vol 66*, 203. (d) Tokimizu, Y.; Wieteck, M.; Rudolph, M.; Oishi, S.; Fujii, N.; Hashmi, S. K.; Ohno, H. *Org. Lett.* **2015**, *17*, 604-607.

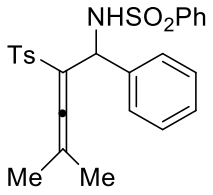
III. General procedure for the synthesis of Allenyl Sulfonamides.

General Procedure A: An oven dried round bottom flask was charged with an allenic sulfone **5a** (0.5 g, 2.25 mmol) in dry THF (22.5 mL) under an argon atmosphere at room temperature. Then the reaction flask was cooled to -78 °C. A solution of lithium bis(trimethylsilyl) amide (LiHMDS) (1.0 M in THF, 2.5 mL, 2.5 mmol) was added dropwise at -78 °C and was stirred for 10 min. Then a solution of N-sulonylimine **6b** (0.61 g, 2.47 mmol) in dry THF (1.5 mL) was added slowly to the reaction mixture at -78 °C and stirred for 1h. The reaction was monitored by TLC. After completion of the reaction, the reaction mixture was quenched with saturated ammonium chloride (15 mL) and extracted with dichloromethane (3 x 15 mL). The combined organic layers were dried over anhydrous Na_2SO_4, filtered, concentrated by rotary evaporation, and purified by flash column chromatography over silica gel. The compound eluted with 35-40% EtOAc in Hexane. The product allenyl sulfonamide **7b** was isolated as a white solid (1.02 g) in 97% yield.

General Procedure B: An oven dried round bottom flask was charged with an allenic sulfone **5a** (0.4 g, 1.8 mmol) in dry THF (18 mL) under an argon atmosphere at room temperature. Then the reaction flask was cooled to -78 °C. A solution of *n*BuLi (2.21 M in THF, 0.98 mL, 2.1 mmol) was added dropwise at -78 °C and was stirred for 10 min. Then a solution of N-sulfonylimine **6f** (0.55 g, 1.98 mmol) in dry THF (1.0 mL) was added slowly to the reaction mixture at -78 °C and stirred for 1h. The reaction was monitored by TLC. After completion of the reaction, the reaction mixture was quenched with saturated ammonium chloride (10 mL) and extracted with dichloromethane (3 x 10 mL). The combined organic layers were dried over anhydrous Na_2SO_4, filtered, concentrated by rotary evaporation, and purified by flash column chromatography over silica gel. The compound eluted with 35-40% EtOAc in Hexane. The product allenyl sulfonamide **7f** was isolated as a white solid (0.87 g) in 97% yield.

IV. Characterization Data of Allenyl Sulfonamides.

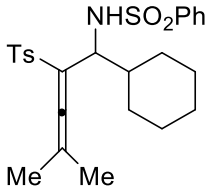
N-(4-methyl-1-phenyl-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide (7a).



Product was isolated as a white solid (mp = 153-155 °C) in 86% (0.09 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79-7-77 (m, 2H), 7.55-7.53 (m, 1H), 7.47-7.44 (m, 2H), 7.34 (d, *J* = 8.5 Hz, 2H), 7.16-7.10 (m, 5H), 7.05-7.03 (m, 2H), 7.56 (d, *J* = 8.0 Hz, 1H), 5.34 (d, *J* = 8.0 Hz, 1H), 2.37 (s, 3H), 1.65 (s, 3H), 1.60 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.3, 143.9, 140.3,

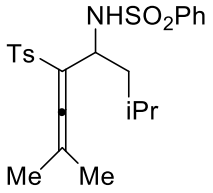
138.0, 137.5, 132.5, 129.3, 129.1, 128.9, 128.3, 127.7, 127.5, 127.1, 126.8, 126.4, 111.8, 109.4, 56.4, 21.5, 19.2, 19.1; IR (cm^{-1}) 3352, 3275, 3056, 2987, 2303, 1597, 1493, 1447, 1421, 1384, 1330, 1266, 1164, 1151, 1088, 896, 813, 787, 704, 672; HRMS m/z calcd for $(C_{25}H_{25}NO_4S_2)Na^+$ 490.1117, found 490.1121.

N-(1-cyclohexyl-4-methyl-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide (7b).



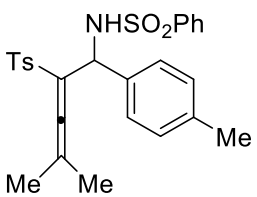
Product was isolated as a white solid (mp = 183-185 °C) in 93% (0.296 g) yield. ^1H NMR (500 MHz, $CDCl_3$) δ 7.81-7-79 (m, 2H), 7.59-7.58 (m, 3H), 7.56-7.52 (m, 1H), 7.48-7.44 (m, 2H), 7.26 (d, *J* = 8.0 Hz, 2H), 5.30 (d, *J* = 10.0 Hz, 1H), 4.01(dd, *J* = 10.5 Hz, *J* = 7.0 Hz, 1H), 2.43 (s, 3H), 1.86-1.70 (m, 3H), 1.64-1.61 (m, 2H), 1.53-1.50 (m, 1H), 1.428 (s, 3H), 1.422 (s, 3H), 1.16-1.04 (m, 3H), 0.99-0.92 (m, 1H), 0.89-0.77 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 202.4, 144.2, 141.0, 138.0, 132.3, 129.4, 128.9, 127.8, 127.1, 110.3, 108.0, 59.0, 41.0, 30.3, 27.8, 26.0, 25.75, 25.74, 21.6, 19.1, 19.0; IR (cm^{-1}) 3346, 3284, 3056, 2982, 2925, 2851, 2300, 1593, 1446, 1425, 1331, 1262, 1164, 1139, 1078, 739, 698, 579; HRMS m/z calcd for $(C_{25}H_{31}NO_4S_2)Na^+$ 496.1586, found 496.1589.

N-(2,7-dimethyl-5-tosylocta-5,6-dien-4-yl)benzenesulfonamide (7c) .



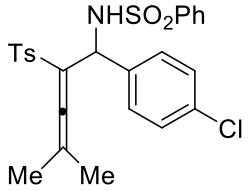
Product was isolated as a white solid (mp = 110-112 °C) in 82% (0.247 g) yield. ^1H NMR (500 MHz, $CDCl_3$) δ 7.81-7-79 (m, 2H), 7.60-7.54 (m, 3H), 7.49-7.46 (m, 2H), 7.27 (d, *J* = 8.0 Hz, 2H), 5.23 (d, *J* = 8.0 Hz, 1H), 4.19-4.14 (m, 1H), 2.43 (s, 3H), 1.69 (septet, *J* = 7.0 Hz, 1H), 1.52 (s, 3H), 1.49 (s, 3H), 1.54-1.44 (m, 2H), 0.78 (d, *J* = 6.5 Hz, 3H), 0.75 (d, *J* = 6.5 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 201.7, 144.2, 140.7, 137.9, 132.4, 129.4, 128.9, 127.8, 127.1, 111.8, 108.6, 52.4, 45.2, 24.7, 22.0, 21.7, 21.5, 19.13, 19.11; IR (cm^{-1}) 3366, 3051, 2958, 2886, 2300, 1597, 1442, 1413, 1258, 1160, 1143, 1090, 898; HRMS m/z calcd for $(C_{23}H_{29}NO_4S_2)Na^+$ 470.1430, found 470.1434.

N-(4-methyl-1-(p-tolyl)-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide (7d).



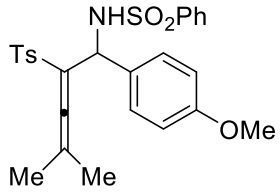
Product was isolated as a white solid (mp = 145-147 °C) in 97% (0.146 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78-7-76 (m, 2H), 7.56-7.52 (m, 1H), 7.46-7.43 (m, 2H), 7.35 (d, *J* = 8.5 Hz, 2H), 7.11(d, *J* = 8.5 Hz, 2H), 6.91 (s, 4H), 5.52 (d, *J* = 8.0 Hz, 1H), 5.29 (d, *J* = 8.0 Hz, 1H), 2.37 (s, 3H), 2.25 (s, 3H), 1.65 (s, 3H), 1.61 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.0, 143.8, 140.3, 138.1, 137.7, 134.6, 132.5, 129.2, 129.0, 128.9, 127.6, 127.2, 126.8, 112.0, 109.4, 56.1, 21.5, 21.0, 19.3, 19.2; IR (cm^{-1}) 3358, 3272, 3047, 2986, 2917, 2251, 1601, 1446, 1413, 1327, 1270, 1164, 1143, 1086, 910, 722; HRMS m/z calcd for $(C_{26}H_{27}NO_4S_2)Na^+$ 504.1273, found 504.1276.

***N*-(1-(4-chlorophenyl)-4-methyl-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide (7e).**



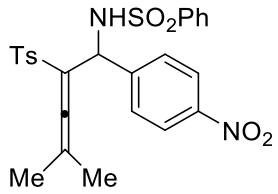
Product was isolated as a white solid (mp = 134-136 ˚C) in 53% (0.238 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.77 (dd, *J* = 8.3 Hz, *J* = 1.1 Hz, 2H), 7.56 (tt, *J* = 7.5 Hz, *J* = 1.2 Hz, 1H), 7.45 (t, *J* = 8.1 Hz, 2H), 7.33 (d, *J* = 8.3 Hz, 2H), 7.13 (d, *J* = 8.0 Hz, 2H), 7.06 (d, *J* = 8.6 Hz, 2H), 6.97 (d, *J* = 8.3 Hz, 2H), 5.79 (d, *J* = 8.0 Hz, 1H), 5.32 (d, *J* = 8.0 Hz, 1H), 2.39 (s, 3H), 1.65 (s, 3H), 1.58 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.2, 144.4, 140.4, 136.4, 134.0, 132.9, 129.6, 129.2, 128.6, 128.5, 127.7, 127.3, 126.5, 111.6, 110.0, 56.0, 21.7, 19.5, 19.4; IR (cm^{-1}) 3364, 2974, 2929, 1917, 1687, 1601, 1511, 1303, 1262, 1176, 1151, 1082; HRMS m/z calcd for $(C_{25}H_{24}ClNO_4S_2)Na^+$: 524.0727, found: 524.0721.

***N*-(1-(4-methoxyphenyl)-4-methyl-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide (7f).**



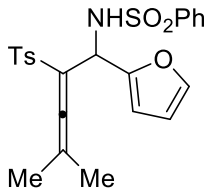
Product was isolated as a white solid (mp = 124-127 ˚C) in 97% (0.719 g) yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.76 (dt, *J* = 7.8 Hz, *J* = 0.6 Hz, 2H), 7.54 (tt, *J* = 7.2 Hz, *J* = 1.2 Hz, 1H), 7.44 (t, *J* = 7.8 Hz, 2H), 7.35 (d, *J* = 8.4 Hz, 2H), 7.12 (d, *J* = 8.4 Hz, 2H), 6.94 (dddd, *J* = 9.6 Hz, *J* = 4.8 Hz, *J* = 3.0 Hz, 2H), 6.62 (dddd, *J* = 10.2 Hz, *J* = 5.4 Hz, *J* = 3.0 Hz, 2H), 5.59 (d, *J* = 8.4 Hz, 1H), 5.30 (d, *J* = 7.8 Hz, 1H), 3.74 (s, 3H), 2.37 (s, 3H), 1.63 (s, 3H), 1.62 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 202.9, 159.3, 143.8, 140.4, 138.1, 132.5, 129.7, 129.3, 128.9, 128.2, 127.6, 127.2, 113.7, 112.2, 109.6, 55.8, 55.2, 21.5, 19.4, 19.2; IR (cm^{-1}) 3271, 3062, 2977, 2950, 2908, 2838, 1958, 1611, 1511, 1445, 1383, 1326, 1248, 1163, 1144, 1082, 1032, 808; HRMS m/z calcd for $(C_{26}H_{27}NO_5S_2)Na^+$: 520.1228, found: 520.1227.

***N-(4-methyl-1-(4-nitrophenyl)-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide* (7g).**



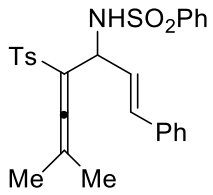
Product was isolated as a yellow solid (mp = 134-135 ˚C) in 72% (0.47 g) yield. ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.98 (dddd, *J* = 11.4 Hz, *J* = 4.2 Hz, *J* = 2.4 Hz, 2H), 7.80 (dddd, *J* = 8.4 Hz, *J* = 3.4 Hz, 1.1 Hz, 2H), 7.59 (tt, *J* = 7.5 Hz, *J* = 1.1Hz, 1H), 7.34 (dddd, *J* = 8.5 Hz, *J* = 3.6 Hz, 1.9 Hz, 2H), 7.28 (dddd, *J* = 10.8 Hz, J = 4.2 Hz, *J* = 2.4 Hz, 2H), 7.14 (d, *J* = 8.0 Hz, 2H), 5.93 (d, *J* = 7.6 Hz, 1H), 5.41 (d, *J* = 7.6 Hz, 1H), 2.38 (s, 3H), 1.67 (s, 3H), 1.53 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 203.3, 147.4, 145.1, 144.8, 139.9, 137.4, 133.0, 129.6, 129.2, 127.9, 127.6, 127.2, 123.5, 110.8, 110.3, 56.1, 21.6, 19.3, 19.2; IR (cm^{-1}) 3352, 3061, 2985, 1520, 1415, 1351, 1252, 1164, 1141, 896; HRMS m/z calcd for $(C_{25}H_{24}N_2O_6S_2)Na^+$: 535.0968, found: 535.0966.

***N-(1-(furan-2-yl)-4-methyl-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide* (7h).**



Product was isolated as a white solid (mp = 114-117 ˚C) in 61% (0.253 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (dd, *J* = 8.6 Hz, *J* = 1.3 Hz, 2H), 7.53 (dddd, *J* = 21.4 Hz, *J* = 13.9 Hz, *J* = 6.5 Hz, 1H), 7.46 (dddd, *J* = 21.0 Hz, *J* = 13.0 Hz, *J* = 4.6 Hz, 4H), 7.19 (d, *J* = 8.1 Hz, 2H), 7.01 (dd, *J* = 1.4 Hz, *J* = 0.9 Hz, 1H), 6.13 (dddd, J = 6.8, 5.1, 3.2 Hz, 2H), 5.75 (d, J = 9.3 Hz, 1H), 5.45 (d, J = 9.3 Hz, 1H), 2.38 (s, 3H), 1.64 (s, 3H), 1.61 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.3, 149.8, 143.9, 142.5, 140.3, 138.0, 132.6, 129.4, 128.9, 127.5, 127.0, 110.4, 110.0, 109.9, 108.6, 50.7, 21.5, 19.3, 19.0; IR (cm^{-1}) νmax = 3269, 3060, 2983, 2909, 1958, 1593, 1450, 1328, 1164, 1144, 1086; HRMS m/z calcd for $(C_{23}H_{23}NO_5S_2)Na^+$: 480.0910, found: 480.0911.

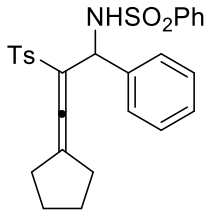
***(E)-N-(6-methyl-1-phenyl-4-tosylhepta-1,4,5-trien-3-yl)benzenesulfonamide* (7i).**



Product was isolated as a yellow solid (mp = 109-122 ˚C) in 64% (0.283 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.85 (d, *J* = 7.4 Hz, 2H), 7.60 (d, *J* = 8.3 Hz, 2H), 7.52 (t, *J* = 7.3 Hz, 1H), 7.45 (d, *J* = 7.9 Hz, 2H), 7.24 (d, *J* = 7.3 Hz, 2H), 7.18 (d, *J* = 8.1 Hz, 2H), 7.09 (dd, *J* = 7.9 Hz, *J* =

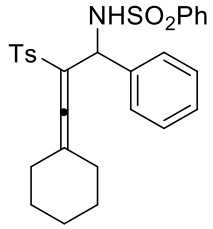
1.5 Hz, 2H), 6.40 (d, J = 15.8 Hz, 1H), 5.83 (dd, J = 15.8 Hz, J = 6.3 Hz, 2H), 5.58 (d, J = 8.6 Hz, 1H), 4.97 (t, J = 6.9 Hz, 1H), 2.35 (s, 3H), 1.64 (s, 3H), 1.61 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 202.5, 144.3, 140.8, 138.2, 135.7, 132.6, 132.4, 129.6, 129.0, 128.4, 128.0, 127.9, 127.2, 126.6, 126.1, 111.0, 109.5, 55.0, 21.5, 19.4, 19.3; IR (cm^{-1}) 3358, 3271, 3052, 2987, 1958, 1319, 1266, 1164, 1143, 1086; HRMS m/z calcd for $(C_{27}H_{27}NO_4S_2)Na^+$: 516.1279, found: 516.1275.

N-(3-cyclopentylidene-1-phenyl-2-tosylallyl)benzenesulfonamide (7j).



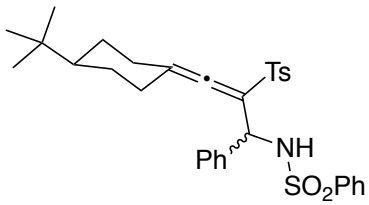
Product was isolated as a white solid (mp = 160-162 °C) in 86% (0.12 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, J = 8.5 Hz, 2H), 7.56-7.53 (m, 1H), 7.45 (dd, J = 8.0 Hz, J = 8.0, 2H), 7.34 (d, J = 8.0 Hz, 2H), 7.15-7.10 (m, 5H), 7.05 (d, J = 7.0 Hz, 2H), 5.65 (d, J = 8.0 Hz, 1H), 5.36 (d, J = 8.5 Hz, 1H), 2.37 (s, 3H), 2.33-2.18 (m, 4H), 1.65-1.63 (m, 4H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 199.0, 143.9, 140.2, 138.1, 137.6, 132.5, 129.3, 128.9, 128.3, 127.8, 127.6, 127.2, 126.9, 117.4, 113.8, 56.1, 31.46, 31.42, 26.9, 26.8, 21.5; IR (cm^{-1}) 3628, 3538, 3162, 3007, 2937, 2251, 1450, 1372, 1172, 1143, 1037, 914, 730; HRMS m/z calcd for $(C_{27}H_{27}NO_4S_2)Na^+$ 516.1273, found 516.1275.

N-(3-cyclohexylidene-1-phenyl-2-tosylallyl)benzenesulfonamide (7k).



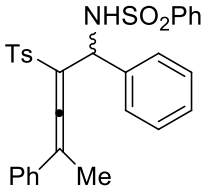
Product was isolated as a white solid (mp = 158-160 °C) in 92% (0.125 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79-7.77 (m, 2H), 7.56-7.53 (m, 1H), 7.46-7.43 (m, 2H), 7.38-7.37 (m, 2H), 7.14-7.12 (m, 5H), 7.07-7.06 (m, 2H), 5.58 (d, J = 7.5 Hz, 1H), 5.34 (d, J = 7.5 Hz, 1H), 2.38 (s, 3H), 2.04-1.86 (m, 4H), 1.46-1.45 (m, 5H), 1.39-1.38 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 200.1, 143.9, 140.2, 138.0, 137.7, 132.5, 129.3, 128.9, 128.3, 127.8, 127.7, 127.2, 126.9, 115.7, 111.6, 56.4, 29.88, 29.82, 26.5, 25.2, 21.5; IR (cm^{-1}) 3366, 3056, 2986, 2263, 1458, 1425, 1266, 1168, 1143, 1086, 910, 739; HRMS m/z calcd for $(C_{28}H_{29}NO_4S_2)Na^+$ 530.1430, found 530.1435.

***N-(3-(4-(tert-butyl)cyclohexylidene)-1-phenyl-2-tosylallyl)benzenesulfonamide* (7l).**



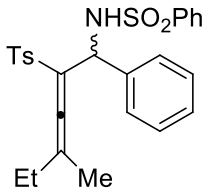
Product was isolated as a white solid (mp = 155-158 ˚C) in 82% yield (0.146 g). ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 8.5 Hz, *J* = 1.3 Hz, 2H), 7.57 (tt, *J* = 7.4 Hz, *J* = 1.2 Hz, 1H), 7.47 (tt, *J* = 8.0 Hz, *J* = 1.7 Hz, 2H), 7.44 (d, *J* = 8.3 Hz, 2H), 7.19-7.14 (m, 7H), 5.60 (d, *J* = 8.1 Hz, 1H), 5.45 (d, *J* = 8.1 Hz, 1H), 5.45 (d, *J* = 8.1 Hz, 1H), 2.38 (s, 3H), 2.12-2.04 (m, 2H), 1.90-1.76 (m, 4H), 0.98 (tt, *J* = 12.0 Hz, *J* = 2.7 Hz, 1H), 0.81 (s, 9H), 0.78-0.72 (m, 2H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 199.0, 144.2, 140.5, 138.1, 138.0, 132.7, 129.4, 129.1, 128.6, 128.2, 128.1, 127.5, 127.2, 115.8, 112.2, 56.4, 47.2, 32.6, 30.3, 30.2, 27.6, 27.4, 21.7; IR (cm^{-1}) 3364, 3049, 2985, 1427, 1269, 896, 762, 698; HRMS m/z calcd for $(C_{32}H_{37}NO_4S_2)Na^+$: 586.2056, found: 586.2053.

N-(4-methyl-1-phenyl-2-tosylhexa-2,3-dien-1-yl)benzenesulfonamide (7m).



Product was isolated as a white solid (mp = 140-142 °C) in 87% (0.113 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.77-7.74 (m, 4H), 7.53-7.50 (m, 3H), 7.45-7.38 (m, 9H), 7.31-7.28 (m, 6H), 7.19-7.08 (m, 19H), 5.69 (d, *J* = 8.0 Hz, 1H), 5.50 (d, *J* = 8.0 Hz, 1H), 5.46 (d, *J* = 5.5 Hz, 2H), 2.37 (s, 3H), 2.35 (s, 3H), 2.00 (s, 3H), 1.91 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 206.3, 206.0, 144.2, 140.19, 140.11, 137.8, 137.5, 133.1, 132.7, 132.6, 132.5, 129.4, 129.1, 128.9, 128.8, 128.7, 128.6, 128.5, 128.4, 128.1, 127.9, 127.7, 127.1, 127.08, 127.04, 126.8, 126.3, 126.2, 116.1, 115.8, 114.1, 113.6, 56.8, 56.6, 22.5, 21.52, 21.51, 16.0; IR (cm^{-1}) 3360, 3158, 3051, 2990, 2251, 1446, 1421, 1462, 1160, 1080, 918, 726, 702, 647; HRMS m/z calcd for $(C_{30}H_{27}NO_4S_2)Na^+$ 552.1273, found 5552.1274.

N-(1,4-diphenyl-2-tosylpenta-2,3-dien-1-yl)benzenesulfonamide (7n).



Product was isolated as a white solid (mp = 128-130 °C) in 96% (0.136 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78-7.75 (m, 3H), 7.55-7.52 (m, 3H), 7.45-7.35 (m, 8H), 7.16-7.09 (m, 10H), 7.05-7.02 (m, 4H), 5.61 (d, *J* = 7.5 Hz, 1H), 5.53 (d, *J* = 7.5 Hz, 1H), 5.34 (d, *J* = 7.5 Hz, 1H),

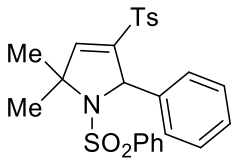
5.33 (d, J = 7.0 Hz, 1H), 2.39 (s, 3H), 2.31 (s, 3H), 1.99 (q, J = 7.5 Hz, 2H), 1.94-1.83 (m, 2H), 1.64 (s, 3H), 1.54 (s, 3H), 0.90 (t, J = 7.5 Hz, 3H), 0.73 (t, J = 7.5 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 203.0, 202.9, 144.06, 144.0, 140.3, 140.1, 137.9, 137.8, 137.6, 132.7, 129.37, 129.31, 129.1, 128.9, 128.8, 18.28, 128.25, 127.85, 127.8, 127.7, 127.6, 127.2, 127.1, 126.9, 126.8, 126.4, 115.9, 115.6, 113.9, 113.7, 56.5, 56.3, 26.97, 26.91, 21.54, 21.52, 17.6, 17.5, 11.7, 11.4; IR (cm^{-1}) 3366, 3051, 2990, 2255, 1601, 1446, 1417, 1327, 1262, 1168, 1147, 1078, 902, 739; HRMS m/z calcd for $(C_{26}H_{27}NO_4S_2)Na^+$ 504.1273, found 504.1274.

V. General procedure for the synthesis of 3-Sulfonyl-3-Pyrrolines.

General Procedure: To a stirred solution of an allenyl sulfonamide **7b** (0.720 g, 1.52 mmol) in acetonitrile (15.2 mL, 0.1 M) under an argon atmosphere was added silver fluoride (3.8 mg, 2 mol%) at room temperature. Then the reaction mixture was stirred at 85 ^{o}C for 40 min. The reaction progress was monitored by TLC. After completion of the reaction, the reaction mixture was cooled down to room temperature. Then the solvent was evaporated by rotary evaporation, and the obtained crude product was purified by flash column chromatography over silica gel. The compound was eluted with 12-15% EtOAc in Hexane. The compound 3-sulfonyl-3-pyrroline **8b** was obtained as a white solid (0.690 g) in 96% yield.

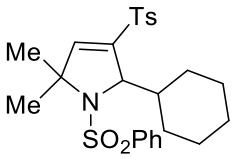
VI. Characterization Data of 3-Sulonyl-3-Pyrrolines.

2,2-dimethyl-5-phenyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole (8a).



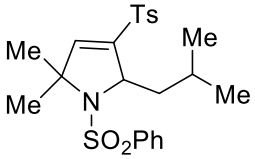
Product was isolated as a white solid (mp = 157-159 °C) in 97% (0.097 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31-7.27 (m, 3H), 7.14-7.10 (m, 4H), 7.01-6.98 (m, 1H), 6.94 (d, J = 8.0 Hz, 2H), 6.85-6.79 (m, 4H), 6.70 (d, J = 1.5 Hz, 1H), 5.71 (d, J = 1.5 Hz, 1H), 2.30 (s, 3H), 1.806 (s, 3H), 1.802 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 146.2, 144.0, 141.0, 140.3, 135.0, 131.8, 129.3, 128.9, 128.2, 128.0, 127.9, 127.6, 127.1, 71.9, 69.4, 28.2, 27.6, 21.4; IR (cm^{-1}) 3049, 2981, 2910, 1621, 1637, 1560, 1510, 1440, 1310, 1268, 1142, 1078, 1042, 803, 729, 660; HRMS m/z calcd for $(C_{25}H_{25}NO_4S_2)Na^+$ 490.1117, found 490.1121.

5-cyclohexyl-2,2-dimethyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole (8b).



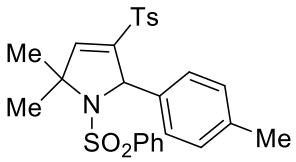
Product was isolated as a white solid (mp = 142-144 °C) in 96% (0.690 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.69-7.66 (m, 4H), 7.54-7.50 (m, 1H), 7.41-7.37 (m, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 6.30 (d, *J* = 1.0 Hz, 1H), 4.54 (s, 1H), 2.47 (s, 3H), 1.98-1.93 (m, 1H), 1.74-1.63 (m, 3H), 1.62 (s, 3H), 1.55-1.48 (m, 4H), 1.41 (s, 3H), 1.39-1.30 (m, 1H), 1.11-0.95 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 147.8, 144.9, 142.1, 139.7, 136.3, 132.2, 129.9, 128.8, 128.1, 127.0, 72.6, 70.7, 42.7, 28.9, 28.5, 27.9, 26.8, 26.6, 26.4, 25.8, 21.6; IR (cm^{-1}) 3068, 2925, 2855, 1629, 1597, 1450, 1343, 1168, 1147, 1086, 1037, 836, 722, 698, 661; HRMS m/z calcd for $(C_{25}H_{31}NO_4S_2)Na^+$ 496.1586, found 496.1587.

5-isobutyl-2,2-dimethyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole (8c).



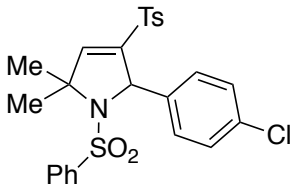
Product was isolated as a white solid (mp = 117-119 °C) in 95% (0.095 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.72-7.70 (m, 2H), 7.63-7.61 (m, 2H), 7.52-7.49 (m, 1H), 7.38-7.34 (m, 4H), 6.38 (d, *J* = 1.0 Hz, 1H), 4.70 (ddd, *J* = 5.0 Hz, *J* = 4.5 Hz, *J* = 1.0 Hz, 1H), 2.48 (s, 3H), 1.95-1.91 (m, 2H), 1.84 (septet, *J* = 3.5 Hz, 1H), 1.61 (s, 3H), 1.36 (s, 3H), 0.89 (d, *J* = 6.0 Hz, 3H), 0.83 (d, *J* = 6.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 146.4, 145.1, 142.1, 141.4, 136.2, 132.2, 130.0, 128.8, 128.0, 126.8, 70.6, 66.0, 44.3, 29.4, 25.4, 24.0, 23.4, 22.9, 21.7; IR (cm^{-1}) 3068, 2953, 2868, 1642, 1601, 1470, 1450, 1343, 1168, 1147, 1094, 1041, 914, 726, 661; HRMS m/z calcd for $(C_{23}H_{29}NO_4S_2)Na^+$ 470.1430, found 470.1437.

2,2-dimethyl-1-(phenylsulfonyl)-5-(p-tolyl)-4-tosyl-2,5-dihydro-1H-pyrrole (8d).



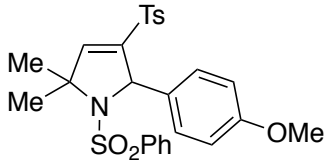
Product was isolated as a white solid (mp = 153-155 °C) in 98% (0.062 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33-7.29 (m, 3H), 7.15-7.12 (m, 4H), 6.95 (d, *J* = 8.0 Hz, 2H), 6.68 (d, *J* = 1.5 Hz, 1H), 6.67 (d, *J* = 8.5 Hz, 2H), 6.61 (d, *J* = 7.5 Hz, 2H), 5.65 (d, *J* = 2.0 Hz, 1H), 2.32 (s, 3H), 2.18 (s, 3H), 1.76 (s, 3H), 1.77 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 145.9, 143.9, 141.1, 140.4, 137.9, 136.1, 132.2, 131.6, 129.1, 128.7, 128.5, 128.1, 127.7, 127.2, 71.7, 69.0, 28.2, 27.5, 21.4, 20.9; IR (cm^{-1}) 3051, 2982, 2917, 1634, 1597, 1515, 1446, 1327, 1270, 1147, 1082, 1045, 812, 735, 698, 661; HRMS m/z calcd for $(C_{26}H_{27}NO_4S_2)Na^+$ 504.1273, found 504.1274.

5-(4-chlorophenyl)-2,2-dimethyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole **(8e).**



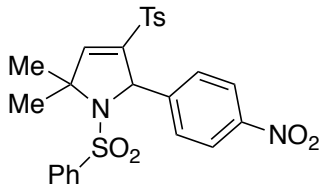
Product was isolated as a white solid (mp = 149-152 ˚C) in 78% (0.062g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 (d, *J* = 7.1 Hz, 2H), 7.18 (t, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 8.2 Hz, 2H), 6.99 (d, *J* = 8.2 Hz, 2H), 6.74 (d, *J* = 8.3 Hz, 3H), 6.69 (d, *J* = 8.4 Hz, 3H), 5.67 (t, *J* = 1.4 Hz, 1H), 2.34 (s, 3H), 1.82 (s, 3H), 1.79 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 146.4, 144.5, 140.9, 140.0, 135.9, 134.2, 133.8, 132.0, 130.0, 129.4, 128.3, 128.0, 127.6, 127.2, 72.0, 68.4, 28.3, 27.4, 21.5; IR (cm^{-1}) 3072, 2978, 2921, 1650, 1491, 1324, 1148, 1086; HRMS m/z calcd for $(C_{25}H_{24}ClNO_4S_2)Na^+$: 524.0727, found: 524.0728.

5-(4-methoxyphenyl)-2,2-dimethyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole **(8f).**



Product was isolated as a white solid (mp = 151-154 ˚C) in 99% yield (0.100 g) . ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33-7.29 (m, 3H), 7.16-7.13 (m, 4H), 6.97 (d, *J* = 8.1 Hz, 2H), 6.68 (d, *J* = 8.7 Hz, 3H), 6.33 (d, *J* = 8.6 Hz, 2H), 5.67 (d, *J* = 1.3 Hz, 1H), 3.70 (s, 3H), 2.32 (s, 3H), 1.79 (s, 3H), 1.79 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 159.6, 145.9, 144.0, 141.3, 140.5, 136.3, 131.7, 130.0, 129.2, 128.2, 127.8, 127.2, 127.1, 113.3, 71.6, 68.8, 55.2, 28.2, 27.6, 21.4; IR (cm^{-1}) 3066, 2929, 1610, 1507, 1446, 1315, 1160, 1086, 1042, 805; HRMS m/z calcd for $(C_{26}H_{27}NO_5S_2)Na^+$: 520.1228, found: 520.1224.

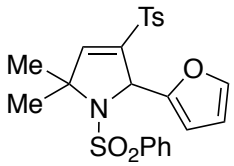
2,2-dimethyl-5-(4-nitrophenyl)-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole **(8g).**



Product was isolated as a white solid (mp = 163-164 ˚C) in 99% (0.095 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.6 Hz, 2H), 7.44 (d, *J* = 7.8 Hz, 2H), 7.38 (t, *J* = 7.4 Hz, 1H), 7.22 (t, *J* = 7.7 Hz, 2H), 7.15 (d, *J* = 8.2 Hz, 2H), 7.01 (d, *J* = 8.5 Hz, 2H), 6.97 (d, *J* = 8.3 Hz, 2H), 6.78 (d, *J* = 1.4 Hz, 1H), 5.75 (d, *J* = 1.4 Hz, 1H), 2.31 (s, 3H), 1.88 (s, 3H), 1.78 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 147.5, 147.1, 145.1, 142.9, 140.4, 139.5, 135.8, 132.6, 129.5, 129.5,

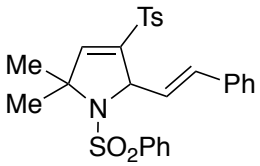
128.6, 127.6, 127.3, 122.9, 72.6, 68.3, 28.6, 27.0, 21.4; IR (cm^{-1}) 3077, 2983, 2929, 1597, 1524, 1340, 1144, 1086, 813; HRMS m/z calcd for $(C_{25}H_{24}N_2O6S_2)Na^+$: 535.0968, found: 535.0968.

5-(furan-2-yl)-2,2-dimethyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole **(8h).**



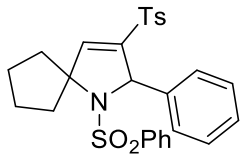
Product was isolated as a white solid (mp = 145-146 ˚C) in 83% (0.083 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46 (d, *J* = 7.4 Hz, 2H), 7.40-7.37 (m, 3H), 7.27 (t, *J* = 8.0 Hz, 2H), 7.14 (t, *J* = 8.1 Hz, 2H), 6.71 (d, *J* = 1.4 Hz, 1H), 6.67 (s, 1H), 6.21 (d, *J* = 3.2 Hz, 1H), 6.00 (dd, *J* = 3.2, 1.9 Hz, 1H), 5.81 (d, *J* = 1.2 Hz, 1H), 2.36 (s, 3H), 1.75 (s, 3H), 1.66 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 147.4, 147.4, 144.3, 142.9, 141.0, 137.7, 135.6, 132.0, 129.5, 128.4, 127.8, 127.0, 111.6, 110.2, , 71.4, 61.9, 27.4, 27.3, 21.5; IR (cm^{-1}) 3068, 2983, 2929, 1597, 1446, 1324, 1152, 1091; HRMS m/z calcd for $(C_{23}H_{23}NO_5S_2)Na^+$: 480.0910, found: 480.0912.

(E)-2,2-dimethyl-1-(phenylsulfonyl)-5-styryl-4-tosyl-2,5-dihydro-1H-pyrrole **(8i).**



Product was isolated as a white solid, (mp = 120-123 ˚C) in 78% (0.66 g) yield; ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (dd, *J* = 8.2, 0.9 Hz, 2H), 7.54 (dd, *J* = 8.3 Hz, 2H), 7.36 (tt, *J* = 8.4, 1.0 Hz, 2H), 7.26 (t, *J* = 7.6 Hz, 2H), 7.22-7.21 (m, 2H), 7.03 (d, *J* = 8.0 Hz, 2H), 6.92-6.90 (m, 2H), 6.69 (d, *J* = 1.5 Hz, 1H), 6.37 (d, *J* = 15.6 Hz, 1H), 5.24 (dd, *J* = 9.4, 0.9 Hz, 1H), 5.07 (dd, *J* = 15.6, 9.4 Hz, 1H), 2.25 (s, 3H), 1.72 (s, 3H), 1.72 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 146.6, 144.8, 141.7, 139.2, 136.1, 135.4, 134.7, 132.3, 129.7, 128.6, 128.4, 128.2, 128.2, 127.7, 126.7, 125.9, 71.6, 68.0, 28.6, 26.9, 21.4; IR (cm^{-1}) 3084, 3060, 2978, 2929, 1654, 1319, 1148, 1086; HRMS m/z calcd for $(C_{27}H_{27}NO_4S_2)Na^+$: 516.1274, found: 516.1272.

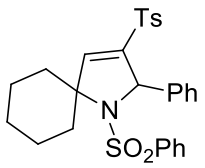
2-phenyl-1-(phenylsulfonyl)-3-tosyl-1-azaspiro[4.4]non-3-ene (8j).



Product was isolated as a white solid (mp = 152-154 °C) in 99% (0.049 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37-7.33 (m, 3H), 7.01-6.98 (m, 1H), 7.19-7.16 (m, 2H), 7.14 (d, *J* = 8.5 Hz, 2H), 7.02-6.98 (m, 1H), 6.95 (d, *J* = 8.0 Hz, 2H), 6.85-6.81 (m, 5H), 5.69 (d, *J* = 1.5 Hz, 1H),

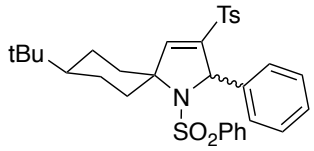
2.91-2.85 (m, 1H), 2.58-2.55 (m, 1H), 2.30 (s, 3H), 2.06-1.97 (m, 3H), 1.85-1.71 (m, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 144.9, 143.9, 141.0, 139.2, 136.2, 135.9, 131.9, 129.3, 128.6, 128.3, 128.0, 127.9, 127.6, 127.1, 69.3, 80.5, 39.0, 36.5, 24.7, 24.2, 21.4; IR (cm^{-1}) 3047, 2986, 1597, 1446, 1421, 1319, 1262, 1155, 1094, 898, 747; HRMS m/z calcd for $(C_{27}H_{27}NO_4S_2)Na^+$ 516.1273, found 516.1275.

2-phenyl-1-(phenylsulfonyl)-3-tosyl-1-azaspiro[4.5]dec-3-ene (8k)



Product was isolated as a white solid (mp = 168-170 °C) in 98% (0.039 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36-7.34 (m, 2H), 7.31-7.28 (m, 2H), 7.16-7.10 (m, 4H), 6.99-6.96 (m, 1H), 6.94 (d, *J* = 8.5 Hz, *J* = 1.0 Hz, 2H), 6.82-6.81(m, 4H), 5.70 (d, *J* = 2.0 Hz, 1H), 2.93-2.87 (m, 1H), 2.66-2.60 (m, 1H), 2.30 (s, 3H), 2.05-2.02 (m, 1H), 1.90-1.80 (m, 4H), 1.58-1.38 (m,3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 143.9, 142.7, 141.4, 141.1, 136.1, 135.3, 131.7, 129.2, 128.9, 128., 127.9, 127.8, 127.6, 127.1, 69.2, 37.9, 36.6, 24.9, 24.7, 24.5, 21.4; IR (cm^{-1}) 3051, 2986, 232, 1450, 1421, 1315, 1274, 1151, 1090, 1045, 898, 743, 702; HRMS m/z calcd for $(C_{28}H_{29}NO_4S_2)Na^+$ 530.1430, found 530.1432.

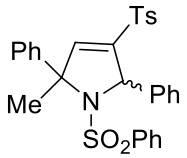
(5s,8s)-8-(tert-butyl)-2-phenyl-1-(phenylsulfonyl)-3-tosyl-1-azaspiro[4.5]dec-3-ene **(8l).**



8l

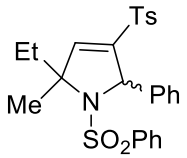
Product was isolated as a white solid (mp = 237-240 ˚C) in 99% (0.038 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (dd, *J* = 8.4, 1.1 Hz, 2H), 7.30 (tt, *J* = 7.5, 1.1 Hz, 1H), 7.26 (d, *J* = 1.9 Hz, 1H), 7.15 (dddd, *J* = 9.9, 9.1, 1.6 Hz, 2H), 7.12 (dt, *J* = 8.3, 1.7 Hz, 2H), 6.97 (d, *J* = 7.9 Hz, 1H), 6.94 (d, *J* = 7.9 Hz, 2H), 6.84-6.80 (m, 4H), 5.70 (d, *J* = 1.7 Hz, 1H), 2.94 (ddd, *J* = 25.4, 12.7, 3.9 Hz, 1H), 2.67 (ddd, *J* = 25.5, 12.8, 4.0 Hz, 1H), 2.30 (s, 3H), 2.08 (dd, *J* = 12.6, 2.5 Hz, 1H), 1.94-1.88 (m, 3H), 1.36-1.23 (m, 3H), 0.93 (s, 9H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 144.1, 142.9, 141.6, 141.3, 136.3, 135.5, 131.9, 129.5, 129.1, 128.4, 128.1, 128.0, 127.8, 127.3, 77.1, 69.4, 47.0, 38.2, 36.7, 32.5, 27.7, 25.8, 25.6, 21.6; IR (cm^{-1}) 3055, 2985, 1450, 1427, 1269, 1147, 1083, 896; HRMS m/z calcd for $(C_{32}H_{37}NO_4S_2)H^+$: 564.2237, found: 564.2239.

2-methyl-2,5-diphenyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole (8m).



Product was isolated as a white solid (mp = 199-201 °C) in 98% (0.062 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58-7.56 (m, 2H), 7.44-7.42 (m, 3H), 7.32-7.27 (m, 6H), 7.17-7.16 (m, 4H), 7.11-7.03 (m, 6H), 7.00-6.96 (m, 9H), 6.83-6.79 (m, 7H), 6.66 (d, *J* = 1.5 Hz, 1H), 6.46 (d, *J* = 2.0 Hz, 1H), 6.44 (d, *J* = 1.5 Hz, 1H), 5.84 (d, *J* = 1.5 Hz, 2H), 2.34 (s, 3H), 2.33 (s, 3H), 2.29 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 139.9, 139.3, 136.15, 136.13, 136.1, 133.9, 131.6, 131.3, 129.5, 129.47, 129.4, 128.64, 128.6, 128.5, 128.4, 128.3, 128.28, 128.2, 128.1, 127.8, 127.78, 127.74, 127.73, 127.5, 127.0, 126.8, 126.6, 74.7, 74.6, 70.8, 68.5, 31.5, 25.8, 24.8, 22.6, 21.5; IR (cm^{-1}) 3060, 3031, 2978, 2917, 1638, 1597, 1507, 1442, 1372, 1160, 1086, 1041, 874, 808, 764, 739, 669; HRMS m/z calcd for $(C_{30}H_{27}NO_4S_2)Na^+$ 552.1273, found 552.1272.

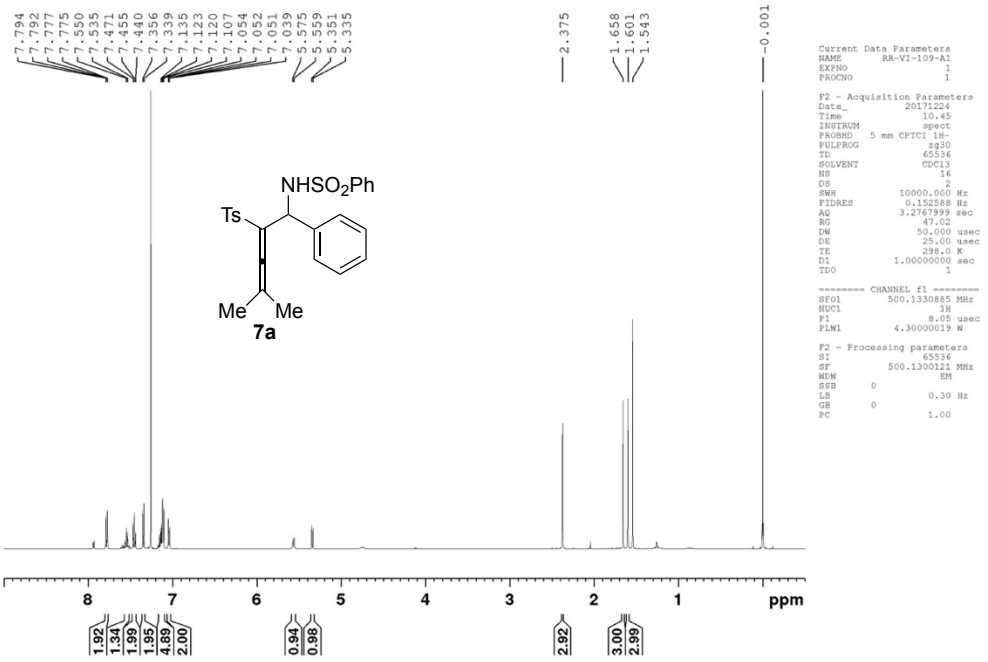
2-ethyl-2-methyl-5-phenyl-1-(phenylsulfonyl)-4-tosyl-2,5-dihydro-1H-pyrrole (8n)



Product was isolated as a white solid (mp = 158-160 °C) in 99% (0.075 g) yield. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.29-7.27 (m, 1H), 7.25-7.20 (m, 3H), 7.19-7.17 (m, 2H), 7.13-7.08 (m, 6H), 7.02-6.97 (m, 6H), 6.95-6.93 (m, 2H), 6.83-6.76 (m, 9H), 6.62 (d, *J* = 2.0 Hz, 1H), 5.71 (d, *J* = 2.0 Hz, 2H), 2.64-2.56 (m, 1H), 2.31 (s, 3H), 2.30 (s, 3H), 2.29-2.27 (m, 1H), 2.21-2.13 (m, 1H), 1.84-1.80 (m, 1H), 1.79 (s, 3H), 1.77 (s, 3H), 1.05-1.00 (m, 6H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 141.8, 141.6, 140.93, 140.9, 136.2, 136.1, 134.8, 131.8, 129.4, 129.3, 129.28, 129.24, 128.16, 128.15, 128.10, 127.9, 127.8, 127.7, 127.5, 127.1, 126.8, 70.7, 68.9, 33.9, 33.1, 27.0, 25.8, 21.48, 21.46, 10.4, 8.7; IR (cm^{-1}) 3064, 2970, 2933, 2872, 1634, 1597, 1458, 1450, 1339, 1323, 1160, 1080, 1041, 812, 771, 726, 690; HRMS m/z calcd for $(C_{26}H_{27}NO_4S_2)Na^+$ 504.1273, found 504.1272.

VII. Spectral data of ^{1}H NMR Spectra and ^{13}C NMR

RR-VI-109-A1

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PROCNO                 1

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PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ            3.2767999 sec
RG                 47.02
DW                50.000 usec
DE                25.00 usec
TE                298.0 K
D1            1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1         500.1330885 MHz
NUC1                   1H
P1                  8.05 usec
PLW1          4.30000019 W

F2 - Processing parameters
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WDW                   EM
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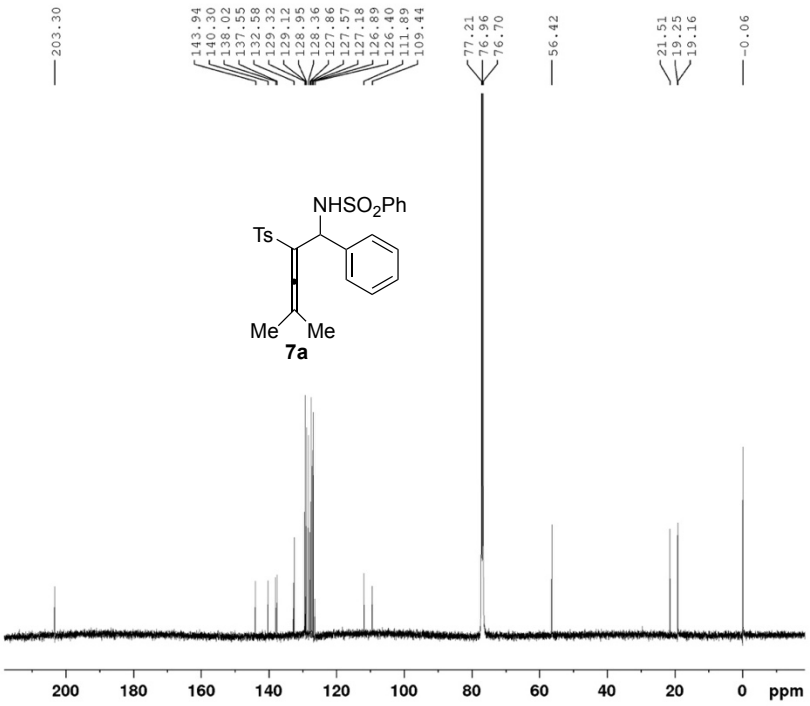
RR-VI-109-A1

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Current Data Parameters
NAME        RR-VI-109-A1
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20171224
Time              11.58
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 2677
DS                    4
SWH           29761.904 Hz
FIDRES        0.454131 Hz
AQ            1.1010048 sec
RG               184.57
DW               16.800 usec
DE               35.00 usec
TE               298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         125.7703637 MHz
NUC1               13C
P1               10.65 usec
PLW1         69.00000000 W

======== CHANNEL f2 ========
SFO2         500.1320005 MHz
NUC2               1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          4.30000019 W
PLW12         0.04628500 W
PLW13         0.02328100 W

F2 - Processing parameters
SI                32768
SF           125.7577960 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
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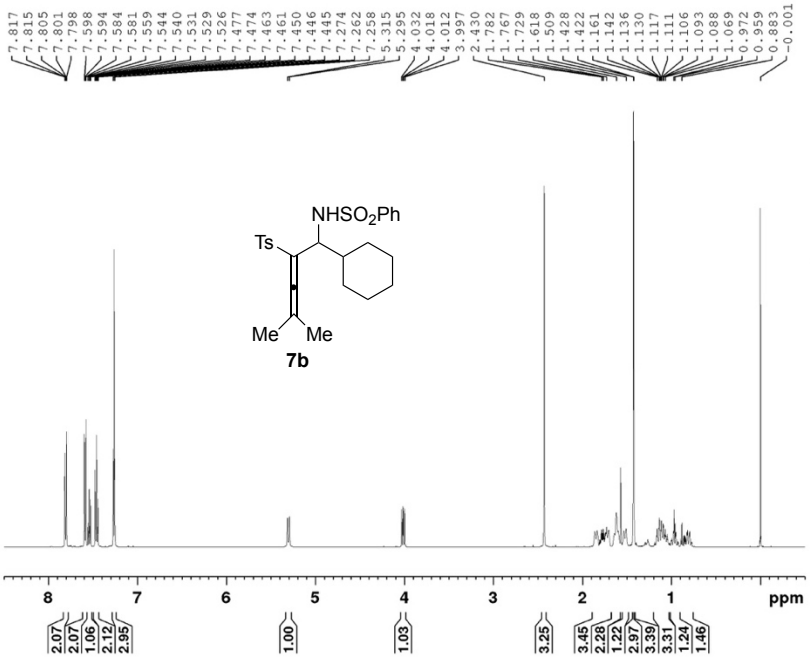
TR-IV-126-A1

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Current Data Parameters
NAME        TR-IV-126-A1
EXPNO                  2
PROCNO                 1

F2 - Acquisition Parameters
Date_           20180121
Time              15.48
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG            zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH           10000.000 Hz
FIDRES        0.152588 Hz
AQ            3.2767999 sec
RG               30.26
DW               50.000 usec
DE               25.00 usec
TE               298.0 K
D1            1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         500.1330885 MHz
NUC1               1H
P1                8.05 usec
PLW1          4.30000019 W

F2 - Processing parameters
SI                65536
SF           500.1300109 MHz
WDW                EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
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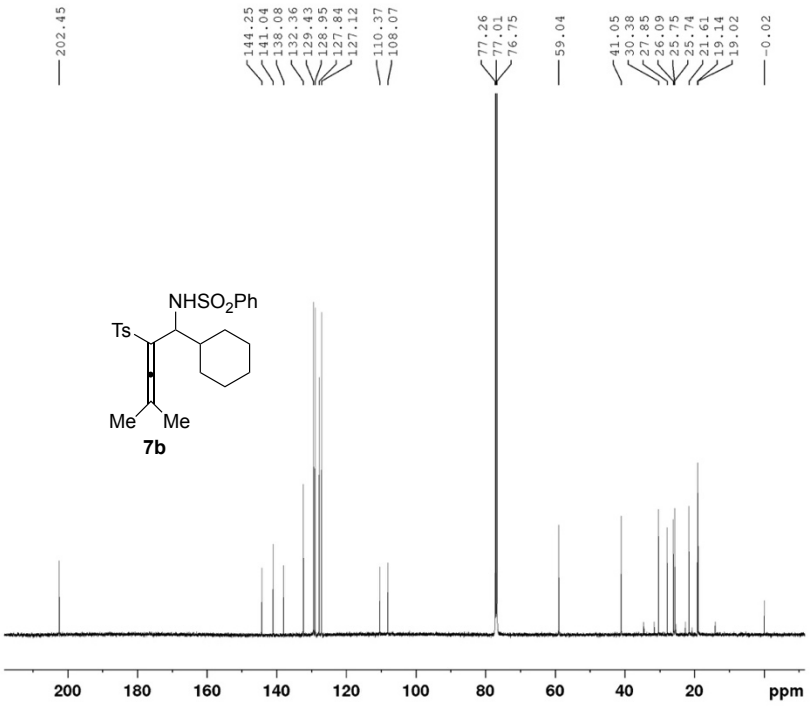
TR-IV-126-A1

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Current Data Parameters
NAME        TR-IV-126-A1
EXPNO                  3
PROCNO                 1

F2 - Acquisition Parameters
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Time              16.36
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                  754
DS                    4
SWH           29761.904 Hz
FIDRES         0.454131 Hz
AQ             1.1010048 sec
RG                184.57
DW                16.800 usec
DE                35.00 usec
TE                298.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         125.7703637 MHz
NUC1                 13C
P1                10.65 usec
PLW1         69.00000000 W

======== CHANNEL f2 ========
SFO2         500.1320005 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          4.30000019 W
PLW12         0.04628500 W
PLW13         0.02328100 W

F2 - Processing parameters
SI                  32768
SF           125.7577911 MHz
WDW                    EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
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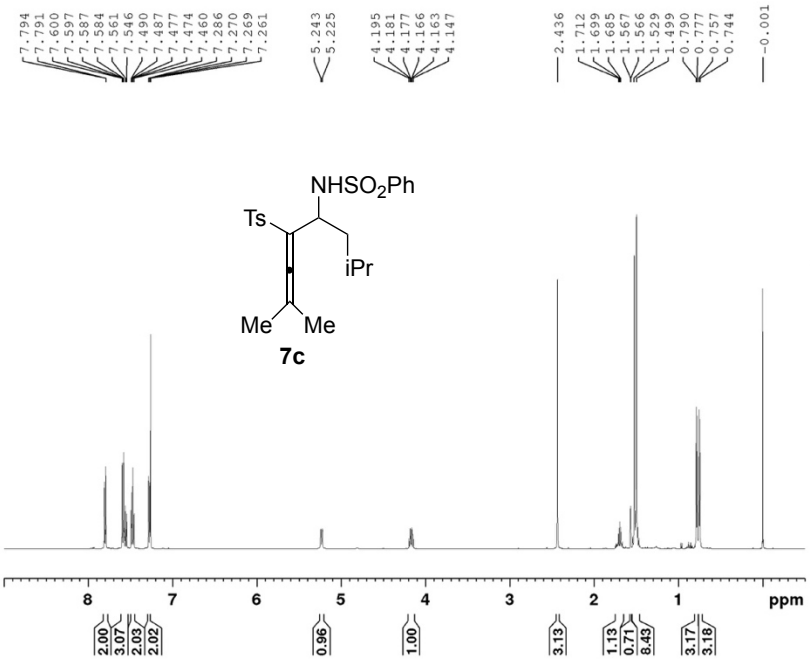
TR-IV-127-A1

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Current Data Parameters
NAME         TR-IV-127-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_           20180121
Time              15.04
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG           zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ            3.2767999 sec
RG                30.26
DW                50.000 usec
DE                25.00 usec
TE                298.0 K
D1            1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          500.1330885 MHz
NUC1                  1H
P1                 8.05 usec
PLW1          4.30000019 W

F2 - Processing parameters
SI                65536
SF            500.1300114 MHz
WDW                  EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
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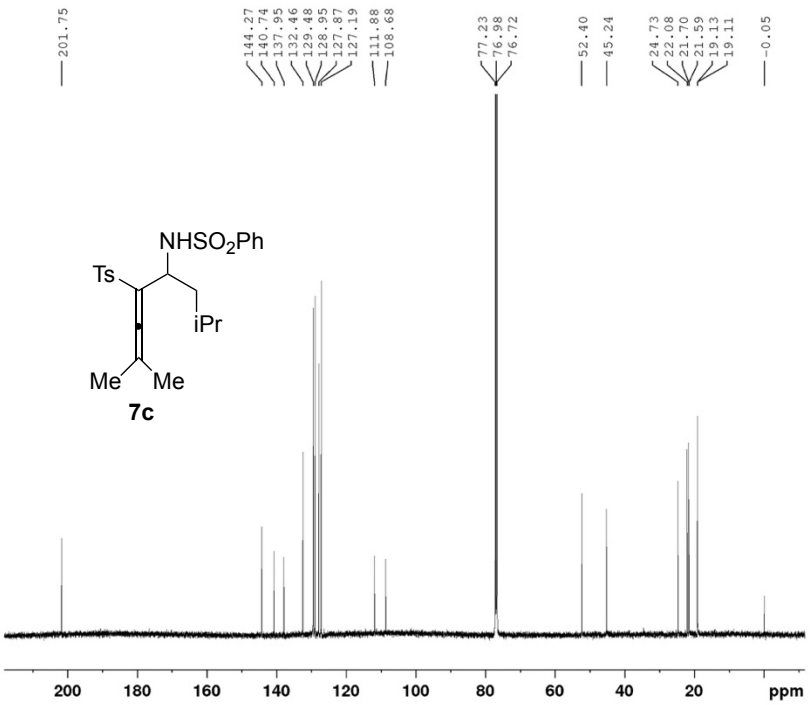
TR-IV-127-A1

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Current Data Parameters
NAME         TR-IV-127-A1
EXPNO                   2
PROCNO                  1

F2 - Acquisition Parameters
Date_           20180121
Time              15.19
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                  409
DS                    4
SWH           29761.904 Hz
FIDRES            0.454131 Hz
AQ            1.1010048 sec
RG                184.57
DW                16.800 usec
DE                35.00 usec
TE                298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          125.7703637 MHz
NUC1                  13C
P1                10.65 usec
PLW1          69.00000000 W

======== CHANNEL f2 ========
SFO2          500.1320005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          4.30000019 W
PLW12         0.04628500 W
PLW13         0.02328100 W

F2 - Processing parameters
SI                32768
SF            125.7577947 MHz
WDW                  EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
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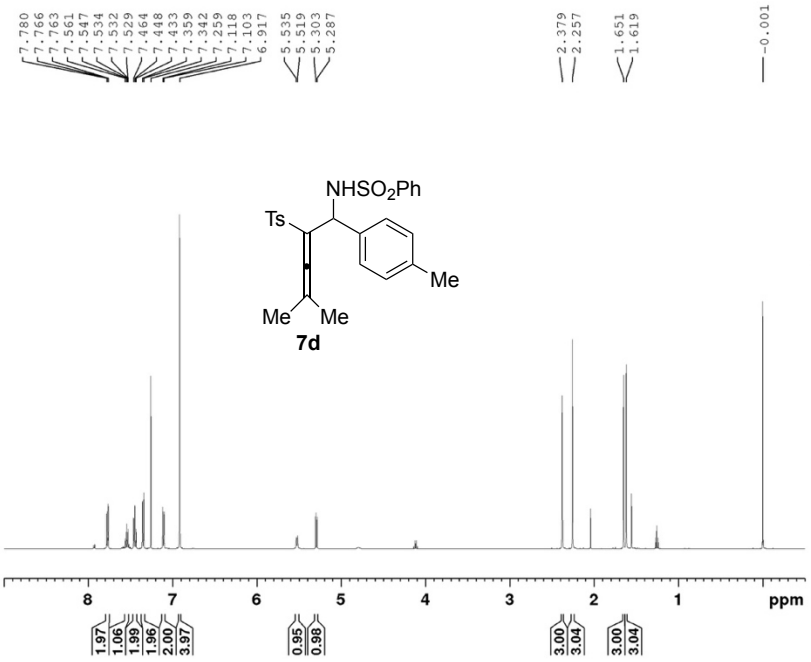
RR-IV-110-A1

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Current Data Parameters
NAME          RR-IV-110-A1
EXPNO                    1
PROCNO                   1

F2 - Acquisition Parameters
Date_          20171225
Time             12.11
INSTRUM          spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zg30
TD              65536
SOLVENT          CDCl3
NS                  16
DS                   2
SWH          10000.000 Hz
FIDRES           0.152588 Hz
AQ           3.2767999 sec
RG                30.26
DW               50.000 usec
DE               25.00 usec
TE               298.0 K
D1           1.00000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1        500.1330885 MHz
NUC1               1H
P1                 8.05 usec
PLW1         4.30000019 W

F2 - Processing parameters
SI              65536
SF          500.1300124 MHz
WDW                EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
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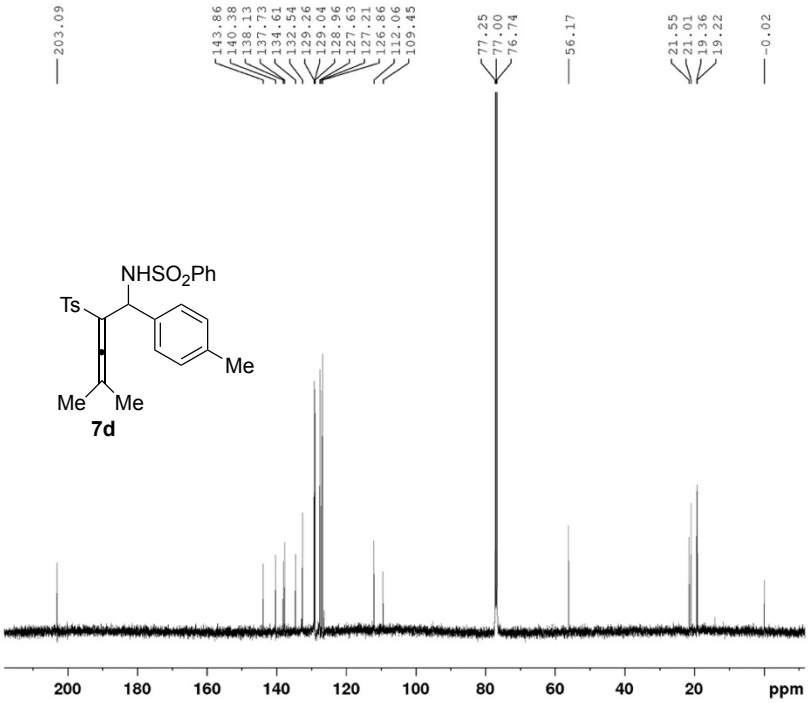
RR-IV-110-A1

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Current Data Parameters
NAME          RR-IV-110-A1
EXPNO                    2
PROCNO                   1

F2 - Acquisition Parameters
Date_          20171225
Time             12.21
INSTRUM          spect
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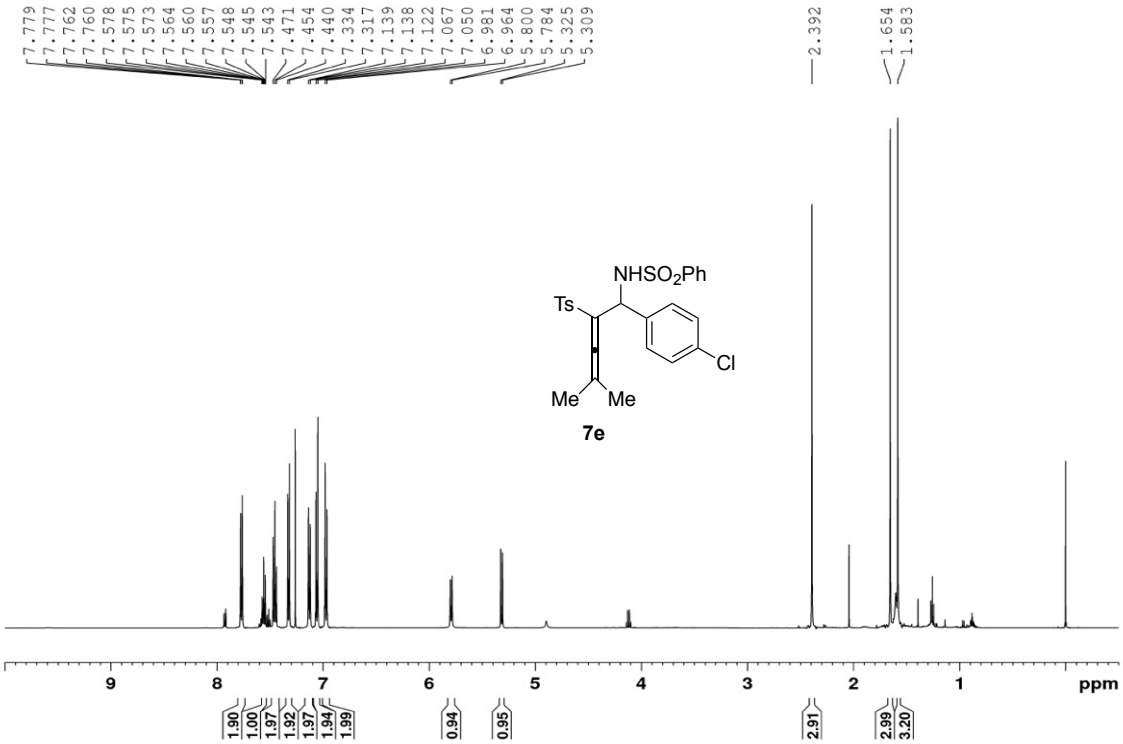
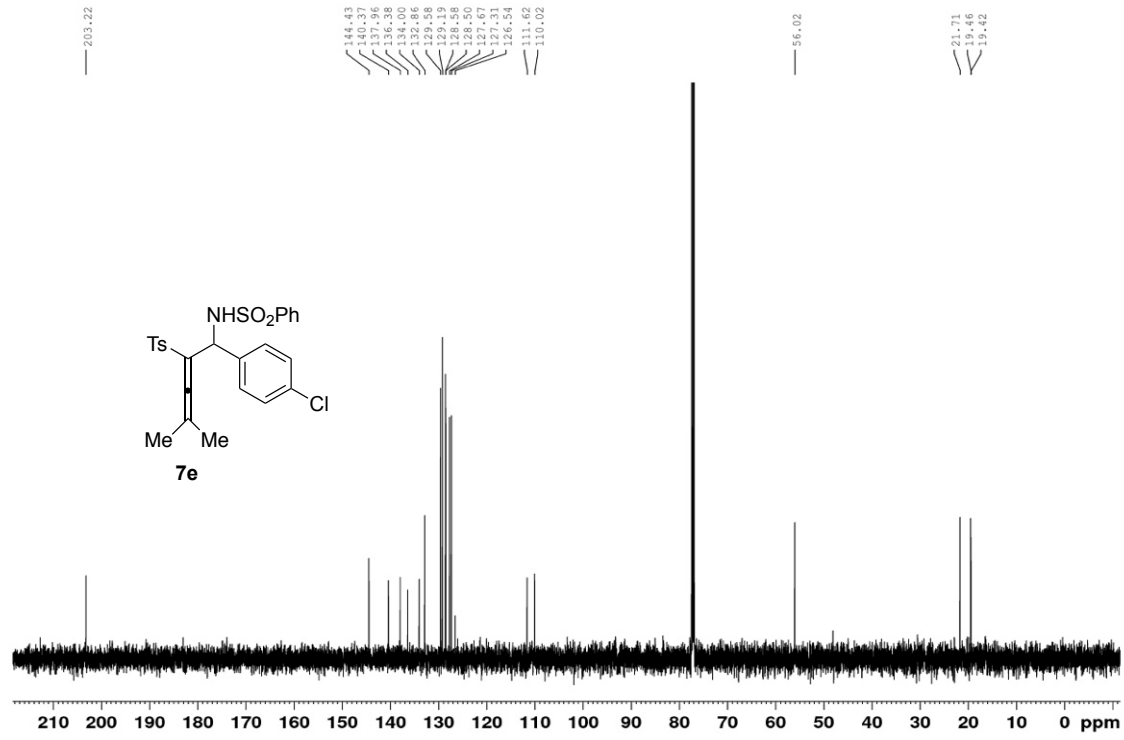
PULPROG          zgpg30
TD              65536
SOLVENT          CDCl3
NS                 157
DS                   4
SWH          29761.904 Hz
FIDRES           0.454131 Hz
AQ           1.1010048 sec
RG                184.57
DW               16.800 usec
DE               35.00 usec
TE               298.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                  1

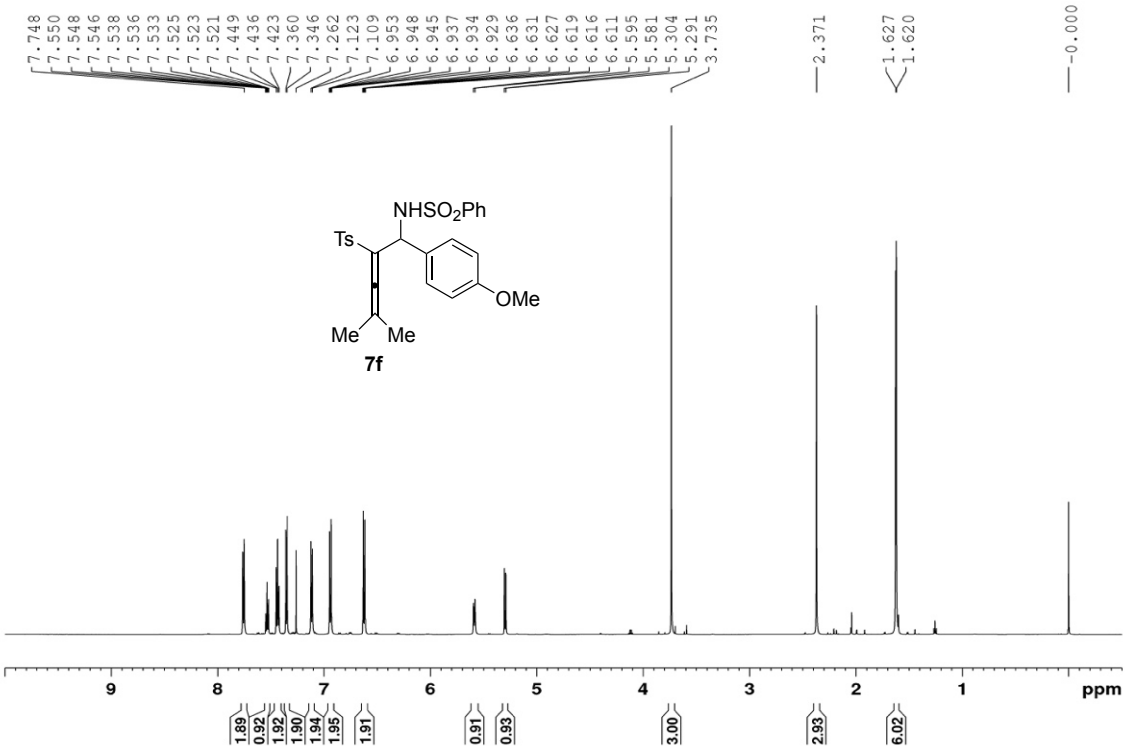
======== CHANNEL f1 ========
SFO1        125.7703637 MHz
NUC1               13C
P1                10.65 usec
PLW1        69.00000000 W

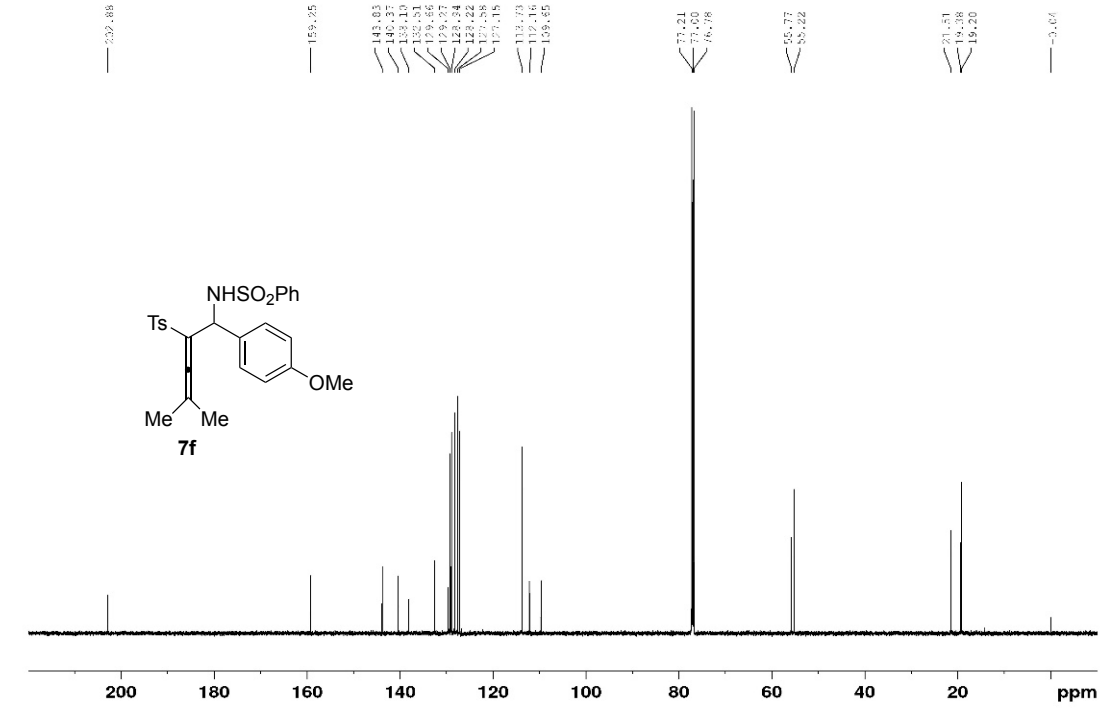
======== CHANNEL f2 ========
SFO2        500.1320005 MHz
NUC2               1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         4.30000019 W
PLW12        0.04628500 W
PLW13        0.02328100 W

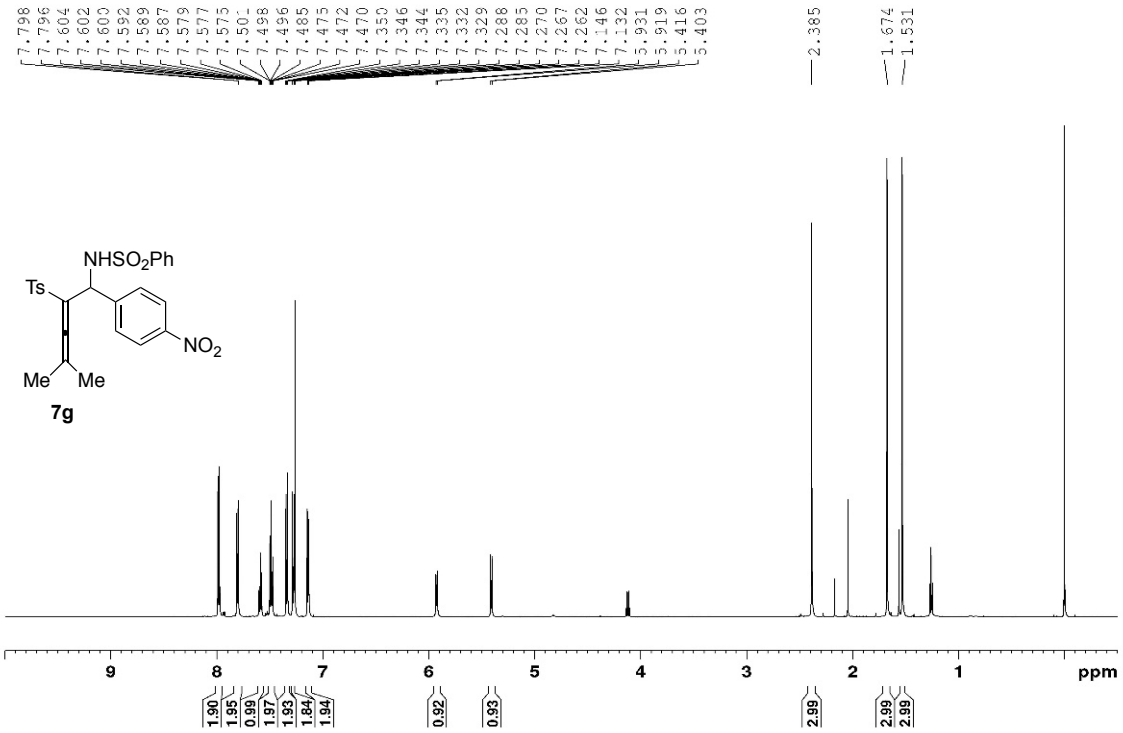
F2 - Processing parameters
SI              32768
SF          125.7577919 MHz
WDW                EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```

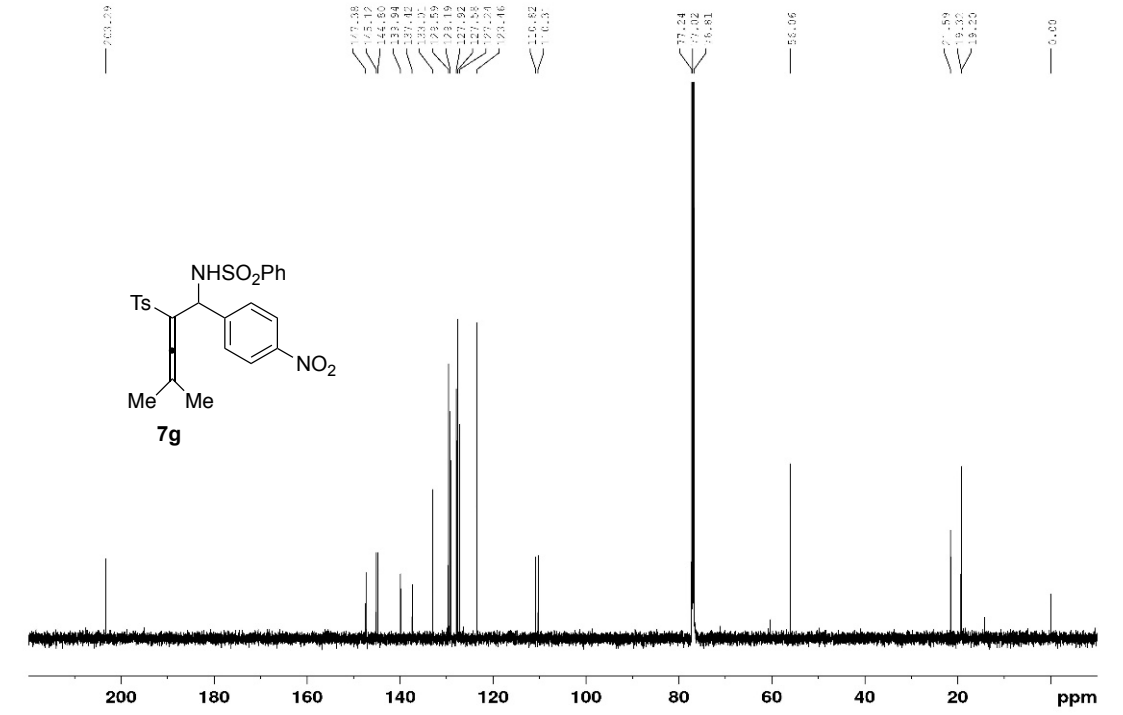

7.779
7.777
7.762
7.760
7.578
7.575
7.573
7.564
7.560
7.557
7.548
7.545
7.543
7.471
7.454
7.440
7.334
7.317
7.139
7.138
7.122
7.067
7.050
6.981
6.964
5.800
5.784
5.325
5.309
2.392
1.654
1.583
NHSO2Ph
Ts
Cl
Me
Me
7e
9
8
7
6
5
4
3
2
1
ppm
1.90
1.00
1.97
1.92
1.97
1.94
1.99
0.94
0.95
2.91
2.99
3.20

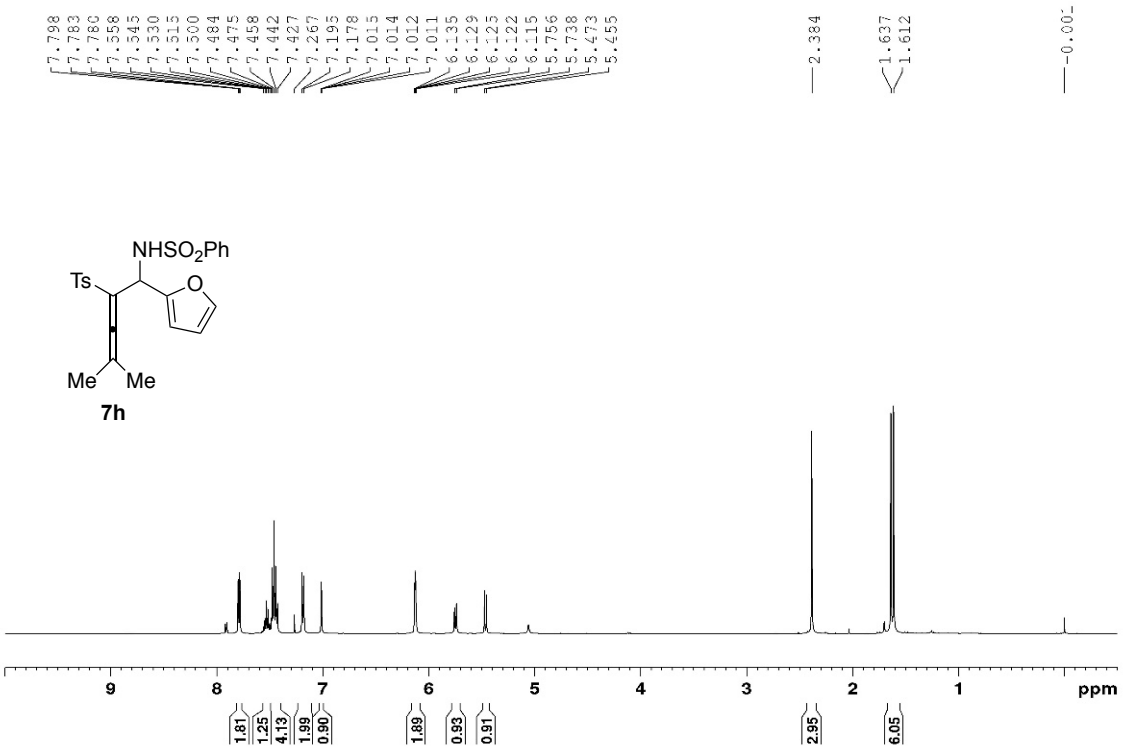

203.22
144.43
140.37
137.96
136.38
134.00
132.86
129.58
129.19
128.58
128.50
127.67
127.31
126.54
111.62
110.02
56.02
21.71
19.46
19.42
NHSO2Ph
Ts
Cl
Me
Me
7e
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0 ppm

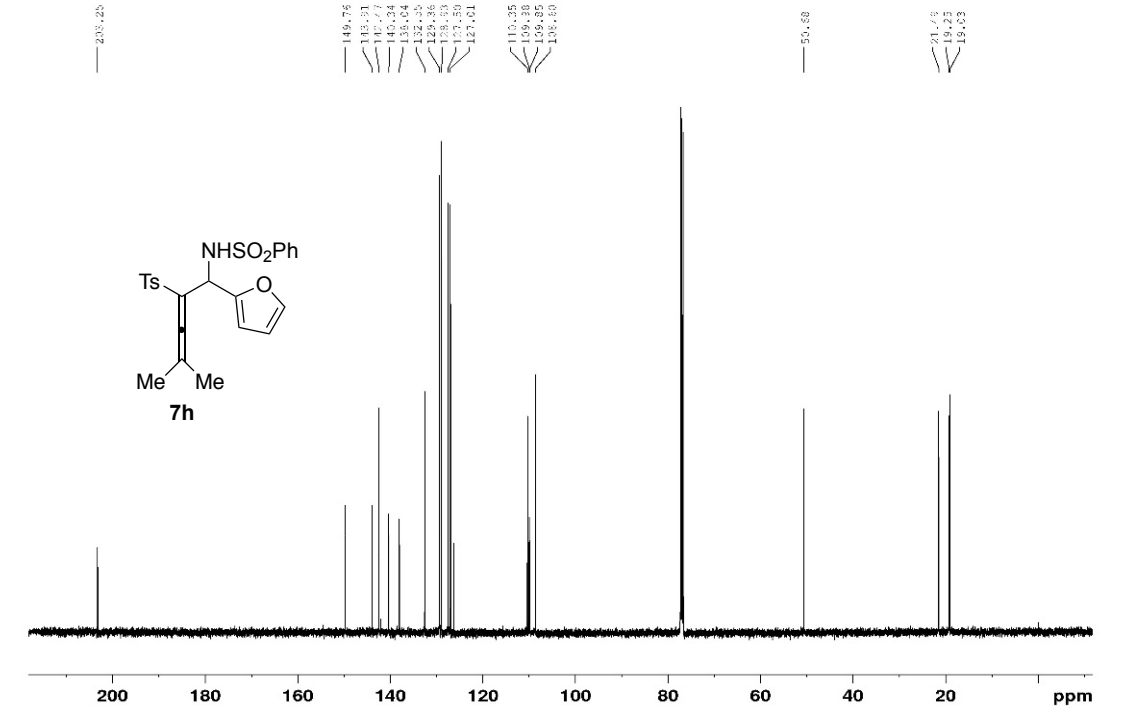

7.748
7.550
7.548
7.546
7.538
7.536
7.533
7.525
7.523
7.521
7.449
7.436
7.423
7.360
7.346
7.262
7.123
7.109
6.953
6.948
6.945
6.937
6.934
6.929
6.636
6.631
6.627
6.619
6.616
6.611
5.595
5.581
5.304
5.291
3.735
2.371
1.627
1.620
0.000
NHSO2Ph
Ts
OMe
Me
Me
7f
9
8
7
6
5
4
3
2
1
ppm
1.89
0.92
1.92
1.90
1.94
1.95
1.91
0.91
0.93
3.00
2.93
6.02

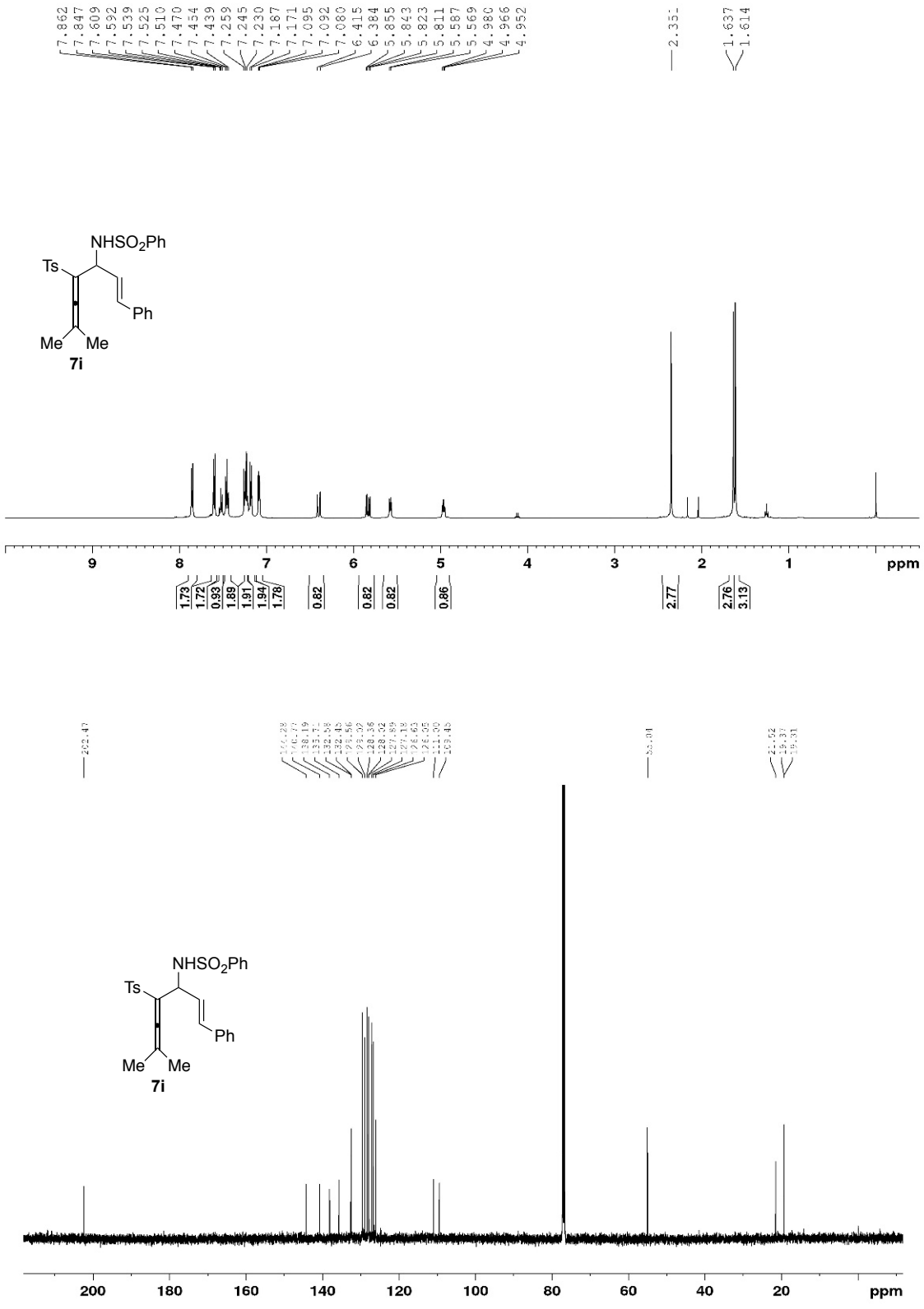

159.25
143.83
142.37
138.10
135.51
129.66
129.27
128.34
128.22
127.58
127.15
113.73
112.16
109.65
77.24
77.00
76.78
55.77
55.22
21.51
19.38
19.20
NHSO2Ph
Ts
OMe
Me
Me
7f
200
180
160
140
120
100
80
60
40
20
ppm


NHSO2Ph
Ts
NO2
Me
Me
7g
ppm

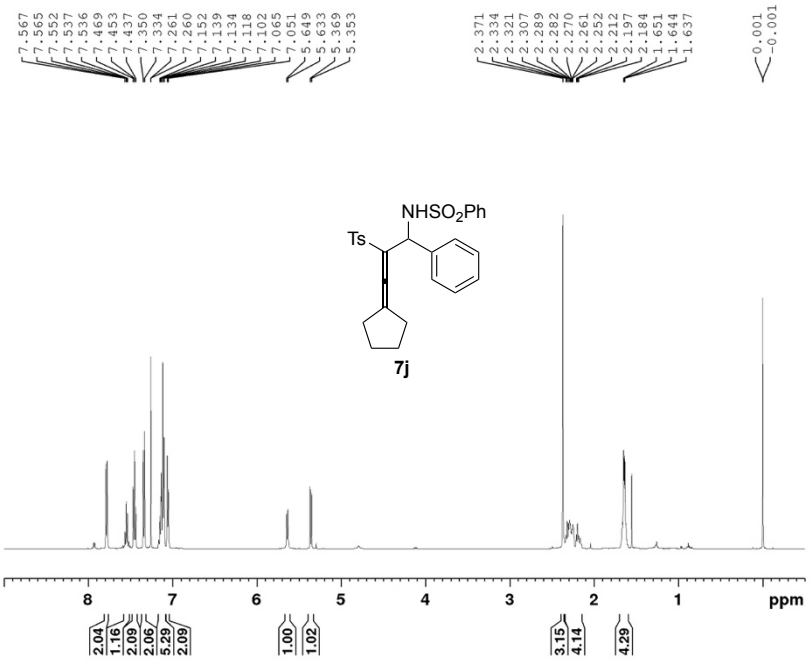

NHSO2Ph
Ts
NO2
Me
Me
7g
ppm


7.798
7.783
7.780
7.558
7.345
7.330
7.515
7.500
7.484
7.475
7.458
7.442
7.427
7.267
7.195
7.178
7.015
7.014
7.012
7.011
6.135
6.129
6.123
6.122
6.115
5.756
5.738
5.473
5.455
2.384
1.637
1.612
0.000
NHSO2Ph
Ts
O
Me
Me
7h
9
8
7
6
5
4
3
2
1
ppm
1.81
1.25
4.13
1.99
0.90
1.89
0.93
0.91
2.95
6.05


238.25
149.76
143.91
140.34
135.64
132.35
129.38
127.50
127.61
110.35
109.98
109.85
108.60
50.68
21.48
19.23
18.03
NHSO2Ph
Ts
O
Me
Me
7h
200
180
160
140
120
100
80
60
40
20
ppm


7.862
7.847
7.609
7.592
7.539
7.525
7.510
7.470
7.454
7.439
7.259
7.245
7.230
7.187
7.171
7.095
7.092
7.080
6.415
6.384
6.855
5.843
5.823
5.811
5.587
5.569
4.980
4.966
4.952
2.335
1.637
1.614
NHSO2Ph
Ts
Ph
Me
Me
7i
9
8
7
6
5
4
3
2
1
ppm
1.73
1.72
0.93
1.89
1.91
1.94
1.78
0.82
0.82
0.82
0.86
2.77
2.76
3.13
202.47
55.04
21.52
20.37
19.31
200
180
160
140
120
100
80
60
40
20
ppm

RR-IV-115-A1



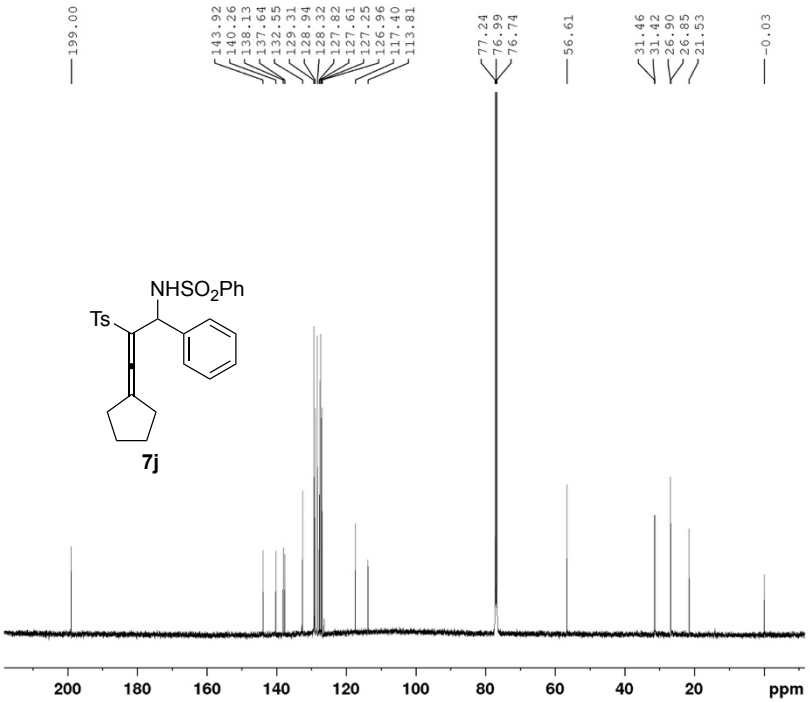

```
Current Data Parameters
NAME          RR-IV-115-A1
EXPNO                    1
PROCNO                   1

F2 - Acquisition Parameters
Date_          20180101
Time             15.34
INSTRUM          spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zg30
TD              65536
SOLVENT          CDCl3
NS                 16
DS                  2
SWH          10000.000 Hz
FIDRES           0.152588 Hz
AQ             3.2767999 sec
RG                30.26
DW               50.000 usec
DE               25.00 usec
TE               298.0 K
D1            1.00000000 sec
TD0                 1

======== CHANNEL f1 ========
SFO1         500.1330885 MHz
NUC1               1H
P1                8.05 usec
PLW1          4.30000019 W

F2 - Processing parameters
SI                65536
SF           500.1300118 MHz
WDW                EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```

RR-IV-115-A1




```
Current Data Parameters
NAME          RR-IV-115-A1
EXPNO                    2
PROCNO                   1

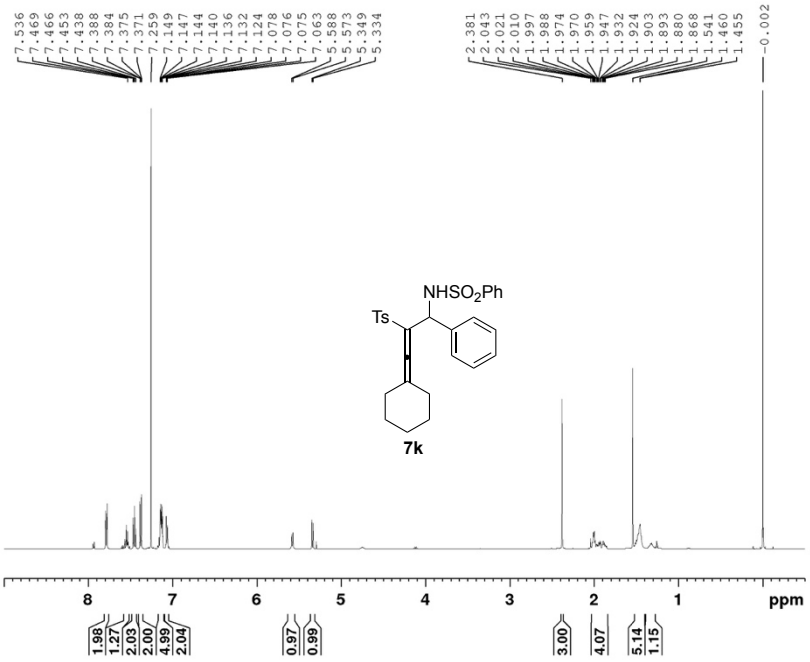
F2 - Acquisition Parameters
Date_          20180101
Time             15.42
INSTRUM          spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD              65536
SOLVENT          CDCl3
NS                608
DS                  4
SWH          29761.904 Hz
FIDRES           0.454131 Hz
AQ             1.1010048 sec
RG               184.57
DW               16.800 usec
DE               35.00 usec
TE               298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                 1

======== CHANNEL f1 ========
SFO1         125.7703637 MHz
NUC1               13C
P1               10.65 usec
PLW1         69.00000000 W

======== CHANNEL f2 ========
SFO2         500.1320005 MHz
NUC2               1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          4.30000019 W
PLW12         0.04628500 W
PLW13         0.02328100 W

F2 - Processing parameters
SI                32768
SF           125.7577931 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

RR-IV-111-A1



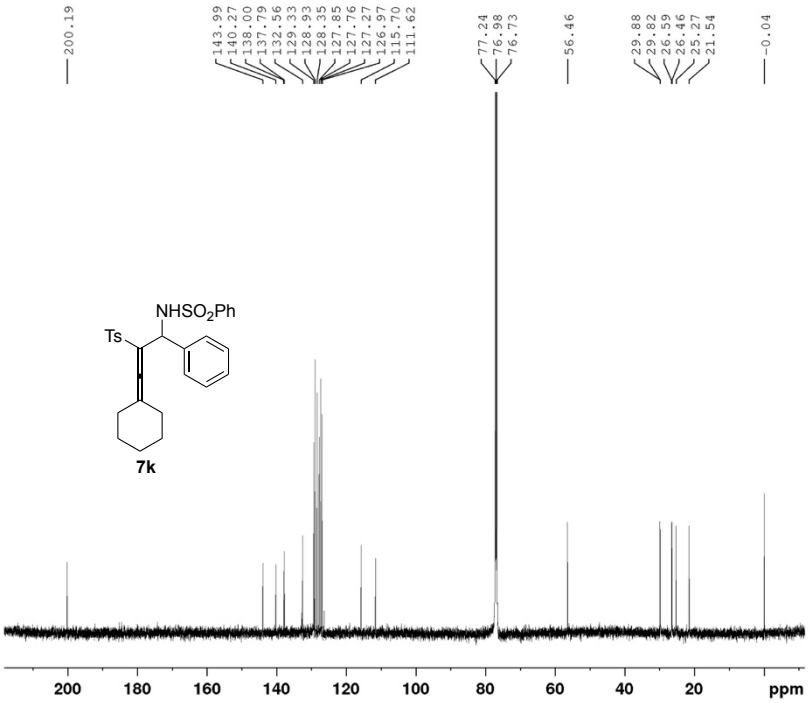

```
Current Data Parameters
NAME         RR-IV-111-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_           20171225
Time              12.40
INSTRUM            spect
PROBHD   5 mm CPTCI 1H-
PULPROG           zg30
TD                65536
SOLVENT           CDC13
NS                   16
DS                    2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ             3.2767999 sec
RG                52.18
DW                50.000 usec
DE                25.00 usec
TE                298.0 K
D1             1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          500.1330885 MHz
NUC1                  1H
P1                  8.05 usec
PLW1           4.30000019 W

F2 - Processing parameters
SI                 65536
SF            500.1300127 MHz
WDW                   EM
SSB       0
LB                  0.30 Hz
GB        0
PC                  1.00
```

RR-IV-111-A1



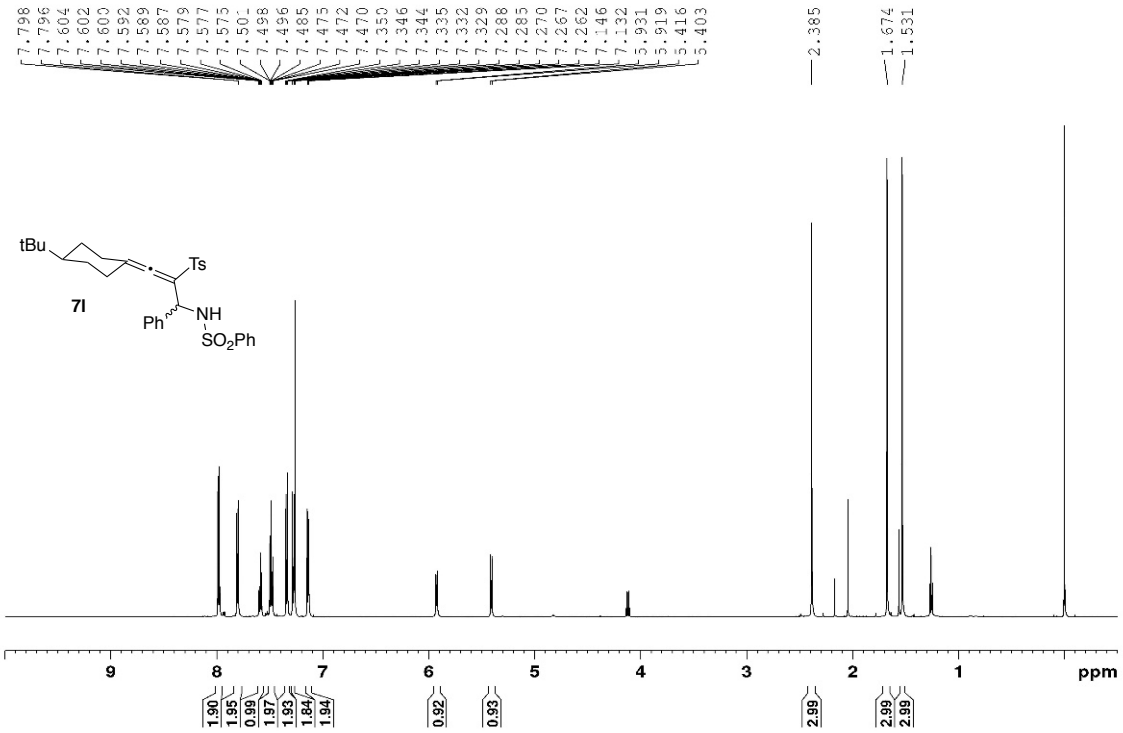

```
Current Data Parameters
NAME         RR-IV-111-A1
EXPNO                   2
PROCNO                  1

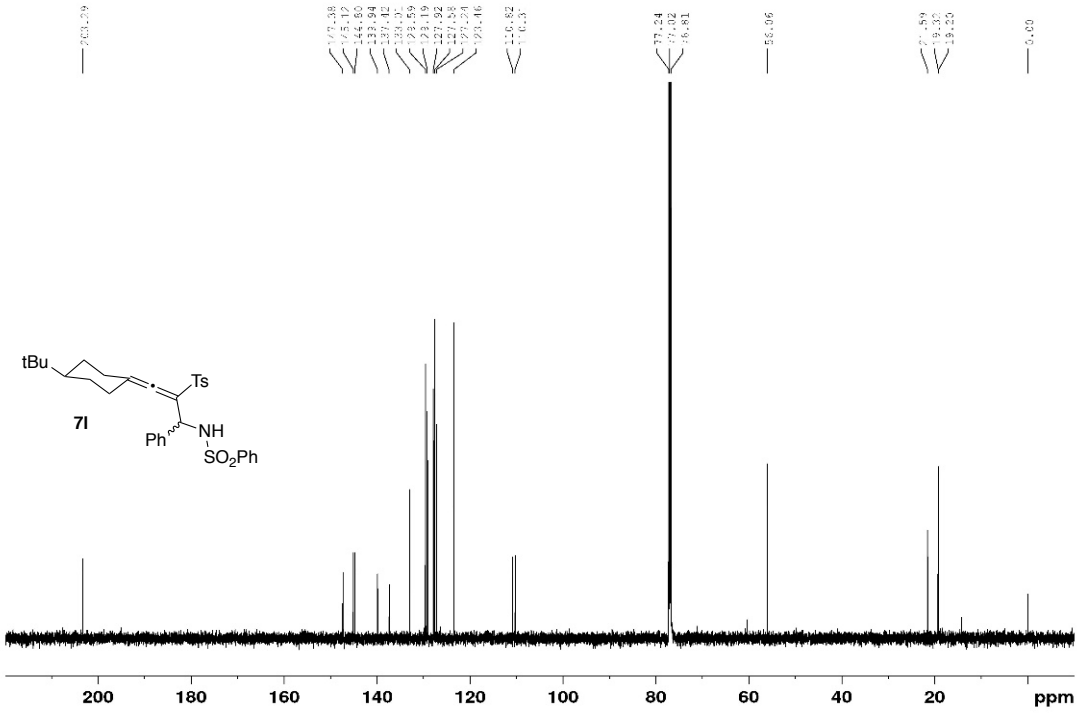
F2 - Acquisition Parameters
Date_           20171225
Time              12.50
INSTRUM            spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                65536
SOLVENT           CDC13
NS                  987
DS                    4
SWH           29761.904 Hz
FIDRES            0.454131 Hz
AQ             1.1010048 sec
RG                184.57
DW                16.800 usec
DE                35.00 usec
TE                298.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          125.7703637 MHz
NUC1                  13C
P1                 10.65 usec
PLW1          69.00000000 W

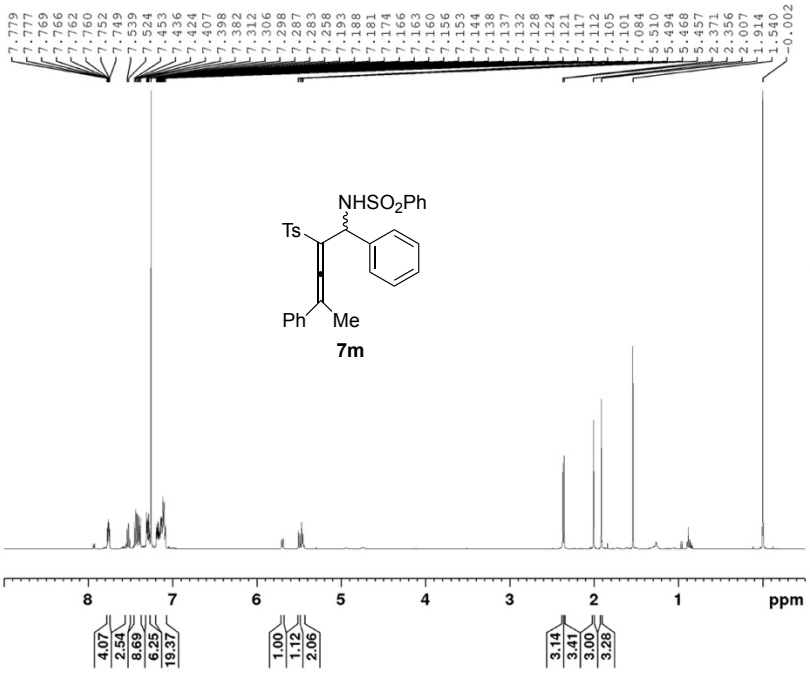
======== CHANNEL f2 ========
SFO2          500.1320005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              80.00 usec
PLW2           4.30000019 W
PLW12          0.04628500 W
PLW13          0.02328100 W

F2 - Processing parameters
SI                 32768
SF            125.7577930 MHz
WDW                   EM
SSB       0
LB                  1.00 Hz
GB        0
PC                  1.40
```


7.798
7.796
7.604
7.602
7.600
7.592
7.589
7.587
7.579
7.577
7.575
7.488
7.496
7.485
7.475
7.472
7.470
7.350
7.346
7.344
7.335
7.332
7.329
7.288
7.285
7.270
7.267
7.262
7.146
7.132
5.931
5.919
5.416
5.403
2.385
1.674
1.531
tBu
Ts
7l
Ph
NH
SO2Ph
9
8
7
6
5
4
3
2
1
ppm
1.90
1.95
0.99
1.97
1.93
1.84
1.94
0.92
0.93
2.99
2.99
2.99


77.24
77.02
76.81
56.06
0.00
tBu
Ts
7l
Ph
NH
SO2Ph
200
180
160
140
120
100
80
60
40
20
ppm

RR-IV-113-A1



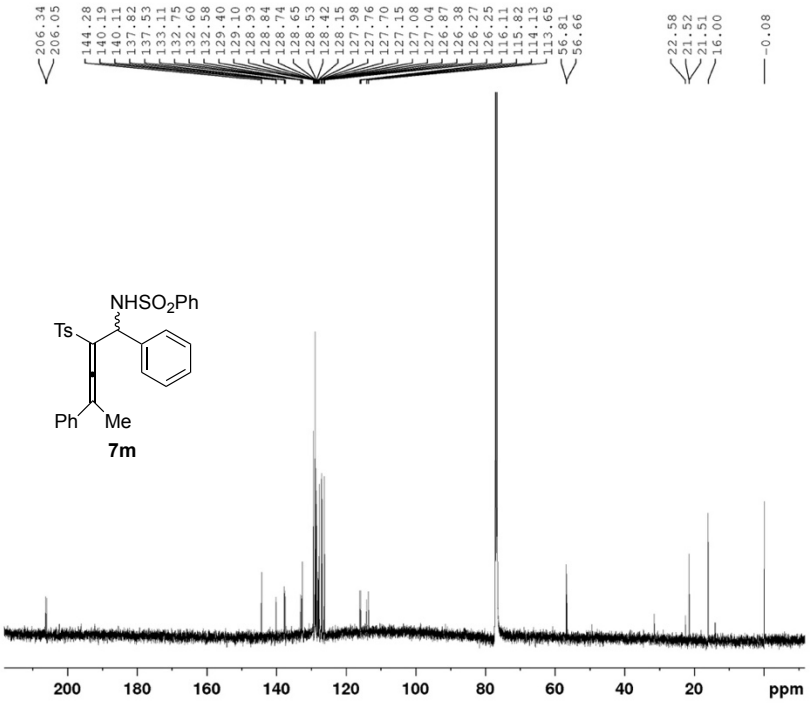

```
Current Data Parameters
NAME          RR-IV-113-A1
EXPNO                    1
PROCNO                   1

F2 - Acquisition Parameters
Date_           20171231
Time              14.49
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zg30
TD              65536
SOLVENT          CDCl3
NS                  16
DS                   2
SWH          10000.000 Hz
FIDRES           0.152588 Hz
AQ             3.2767999 sec
RG                47.02
DW                50.000 usec
DE                25.00 usec
TE                298.0 K
D1             1.00000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1         500.1330885 MHz
NUC1               1H
P1                 8.05 usec
PLW1          4.30000019 W

F2 - Processing parameters
SI                65536
SF           500.1300132 MHz
WDW                EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
```

RR-IV-113-A1




```
Current Data Parameters
NAME          RR-IV-113-A1
EXPNO                    2
PROCNO                   1

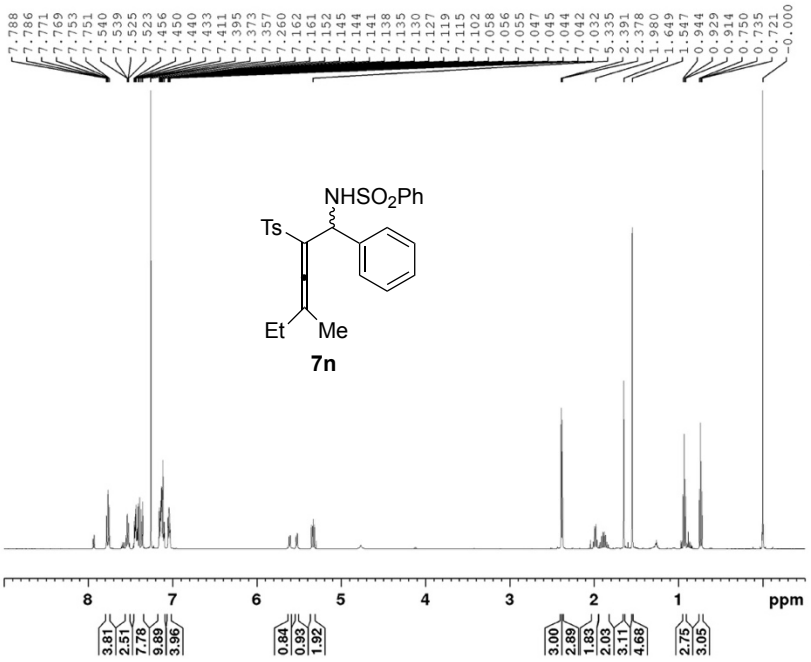
F2 - Acquisition Parameters
Date_           20171231
Time              14.59
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD              65536
SOLVENT          CDCl3
NS                1205
DS                   4
SWH          29761.904 Hz
FIDRES           0.454131 Hz
AQ             1.1010048 sec
RG                184.57
DW                16.800 usec
DE                35.00 usec
TE                298.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                  1

======== CHANNEL f1 ========
SFO1         125.7703637 MHz
NUC1               13C
P1                10.65 usec
PLW1         69.00000000 W

======== CHANNEL f2 ========
SFO2         500.1320005 MHz
NUC2               1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          4.30000019 W
PLW12         0.04628500 W
PLW13         0.02328100 W

F2 - Processing parameters
SI                32768
SF           125.7577984 MHz
WDW                EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```

RR-IV-114-A1



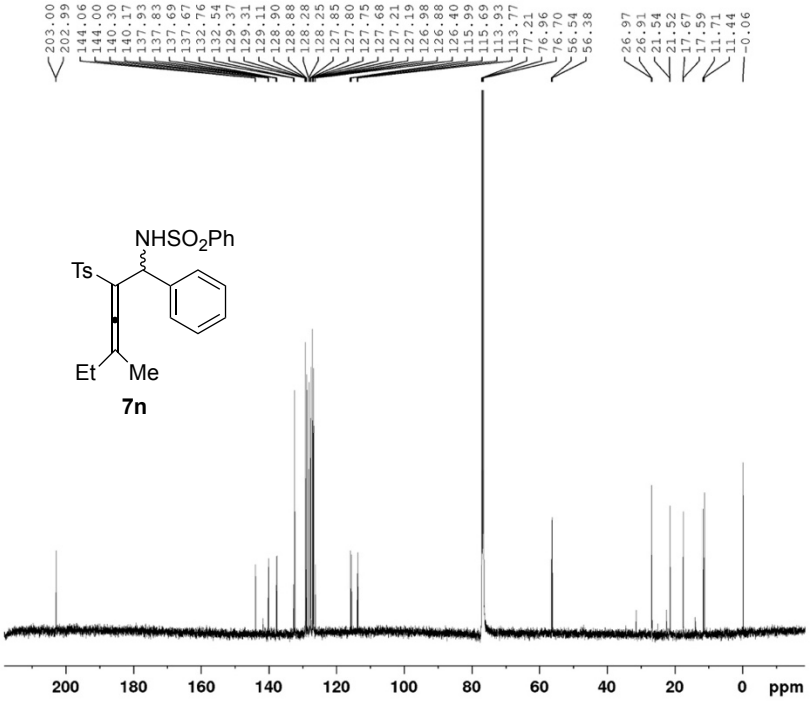

```
Current Data Parameters
NAME         RR-IV-114-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_          20171231
Time             16.10
INSTRUM          spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zg30
TD              65536
SOLVENT          CDCl3
NS                 16
DS                  2
SWH         10000.000 Hz
FIDRES          0.152588 Hz
AQ            3.2767999 sec
RG               52.18
DW               50.000 usec
DE               25.00 usec
TE              298.0 K
D1           1.00000000 sec
TD0                 1

======== CHANNEL f1 ========
SFO1        500.1330885 MHz
NUC1               1H
P1                8.05 usec
PLW1         4.30000019 W

F2 - Processing parameters
SI                65536
SF          500.1300120 MHz
WDW                EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```

RR-IV-114-A1




```
Current Data Parameters
NAME         RR-IV-114-A1
EXPNO                   2
PROCNO                  1

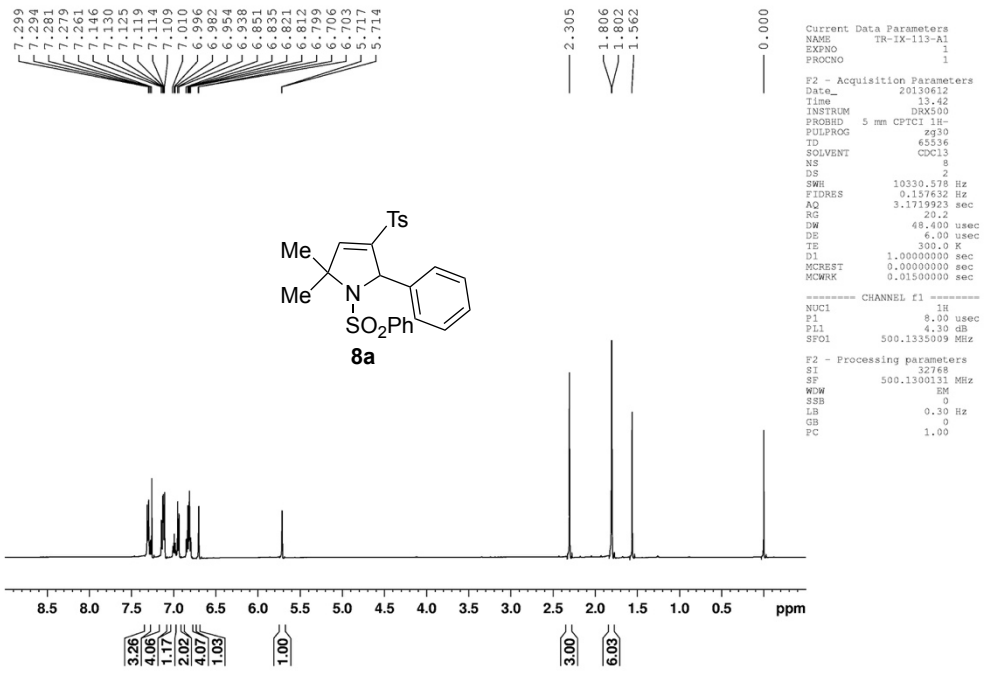
F2 - Acquisition Parameters
Date_          20171231
Time             16.25
INSTRUM          spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD              65536
SOLVENT          CDCl3
NS                1985
DS                   4
SWH         29761.904 Hz
FIDRES          0.454131 Hz
AQ            1.1010048 sec
RG              184.57
DW               16.800 usec
DE               35.00 usec
TE              298.0 K
D1           2.00000000 sec
D11          0.03000000 sec
TD0                 1

======== CHANNEL f1 ========
SFO1        125.7703637 MHz
NUC1               13C
P1               10.65 usec
PLW1        69.00000000 W

======== CHANNEL f2 ========
SFO2        500.1320005 MHz
NUC2               1H
CPDPRG[2         waltz16
PCPD2             80.00 usec
PLW2         4.30000019 W
PLW12        0.04628500 W
PLW13        0.02328100 W

F2 - Processing parameters
SI                32768
SF          125.7577965 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

TR-IX-113-A1



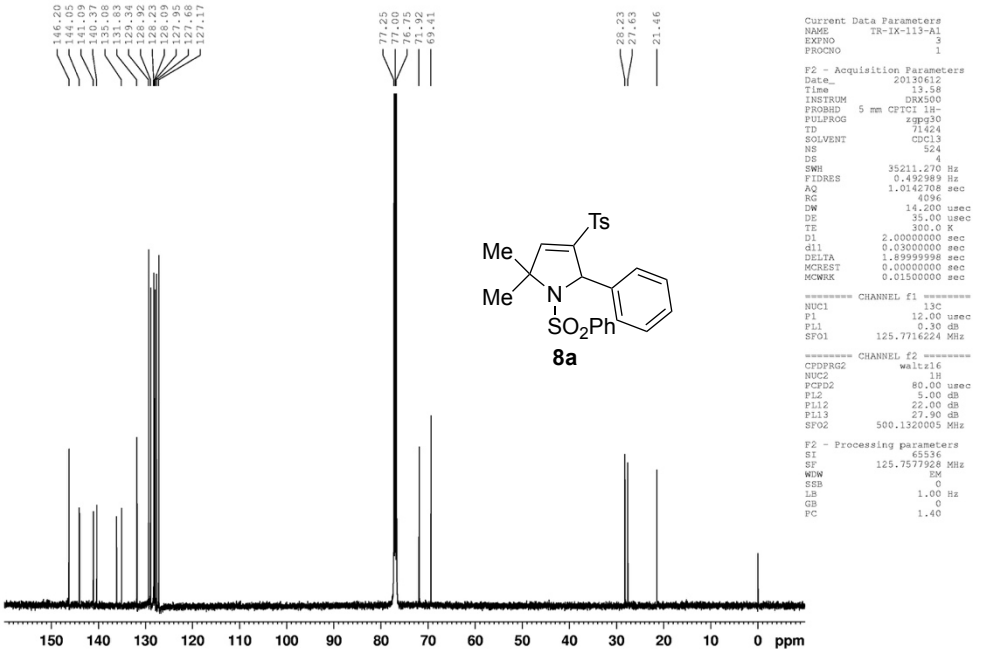
Current Data Parameters
NAME TR-IX-113-A1
EXPNO 1
PROCNO 1

F2 - Acquisition Parameters
Date_ 20130612
Time 13.42
INSTRUM DRX500
PROBHD 5 mm CPTCI 1H-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 8
DS 2
SWH 10330.578 Hz
FIDRES 0.157632 Hz
AQ 3.1719923 sec
RG 20.2
DW 48.400 usec
DE 6.00 usec
TE 300.0 K
D1 1.00000000 sec
MCREST 0.00000000 sec
MCWRK 0.01500000 sec

======== CHANNEL f1 ========
NUC1 1H
P1 8.00 usec
PL1 4.30 dB
SFO1 500.1335009 MHz

F2 - Processing parameters
SI 32768
SF 500.1300131 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

TR-IX-113-A1



Current Data Parameters
NAME TR-IX-113-A1
EXPNO 3
PROCNO 1

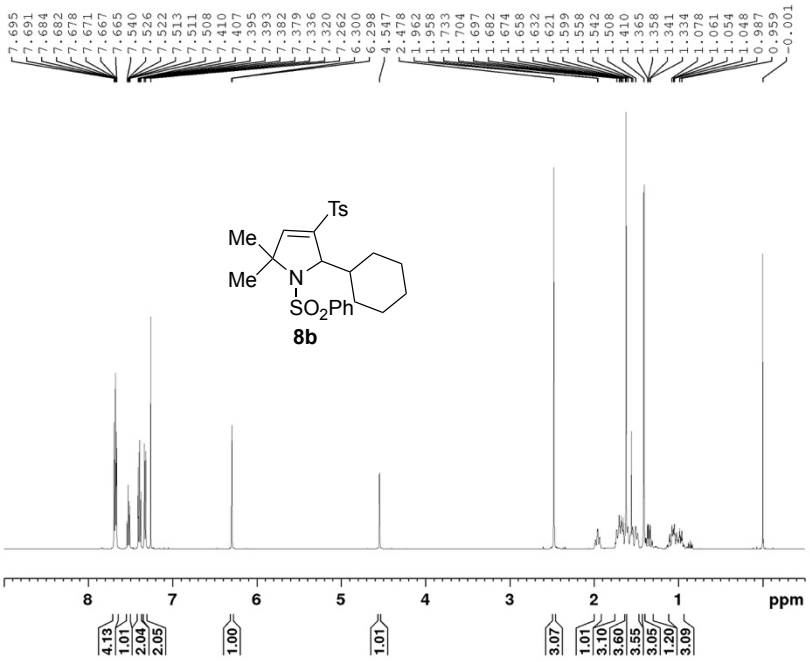
F2 - Acquisition Parameters
Date_ 20130612
Time 13.58
INSTRUM DRX500
PROBHD 5 mm CPTCI 1H-
PULPROG zgpg30
TD 71424
SOLVENT CDCl3
NS 524
DS 4
SWH 35211.270 Hz
FIDRES 0.492989 Hz
AQ 1.0142708 sec
RG 4096
DW 14.200 usec
DE 35.00 usec
TE 300.0 K
D1 2.00000000 sec
d11 0.03000000 sec
DELTA 1.89999998 sec
MCREST 0.00000000 sec
MCWRK 0.01500000 sec

======== CHANNEL f1 ========
NUC1 13C
P1 12.00 usec
PL1 0.30 dB
SFO1 125.7716224 MHz

======== CHANNEL f2 ========
CPDPRG2 waltz16
NUC2 1H
PCPD2 80.00 usec
PL2 5.00 dB
PL12 22.00 dB
PL13 27.90 dB
SFO2 500.1320005 MHz

F2 - Processing parameters
SI 65536
SF 125.7577928 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40

TR-IV-129-A1



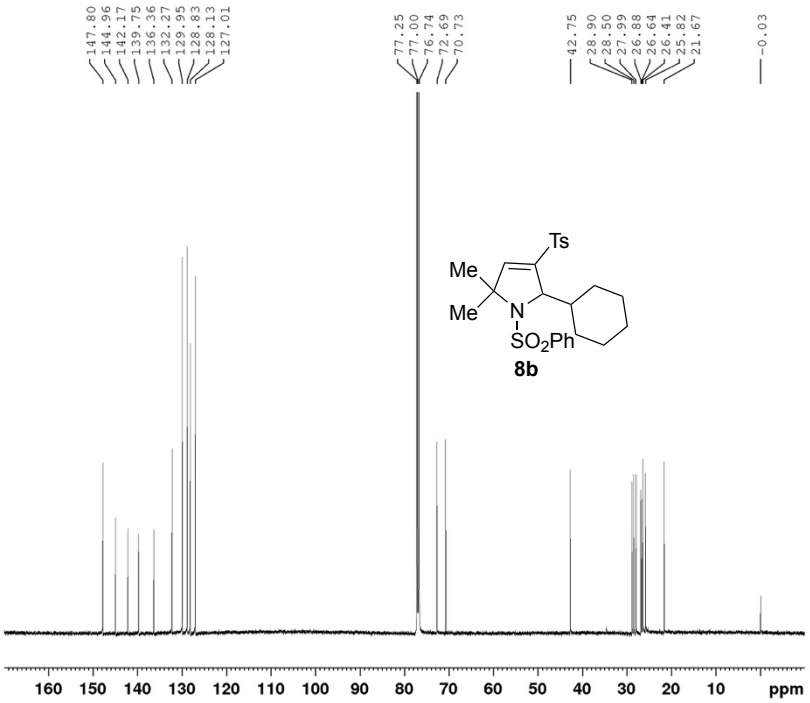

```
Current Data Parameters
NAME         TR-IV-129-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_           20180128
Time              15.55
INSTRUM             spect
PROBHD   5 mm CPTCI 1H-
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ                3.2767999 sec
RG                   30.26
DW                 50.000 usec
DE                  25.00 usec
TE                 298.0 K
D1              1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          500.1330885 MHz
NUC1                  1H
P1                  8.05 usec
PLW1           4.30000019 W

F2 - Processing parameters
SI                 65536
SF            500.1300111 MHz
WDW                   EM
SSB       0
LB                  0.30 Hz
GB        0
PC                  1.00
```

TR-IV-129-A1




```
Current Data Parameters
NAME         TR-IV-129-A1
EXPNO                   2
PROCNO                  1

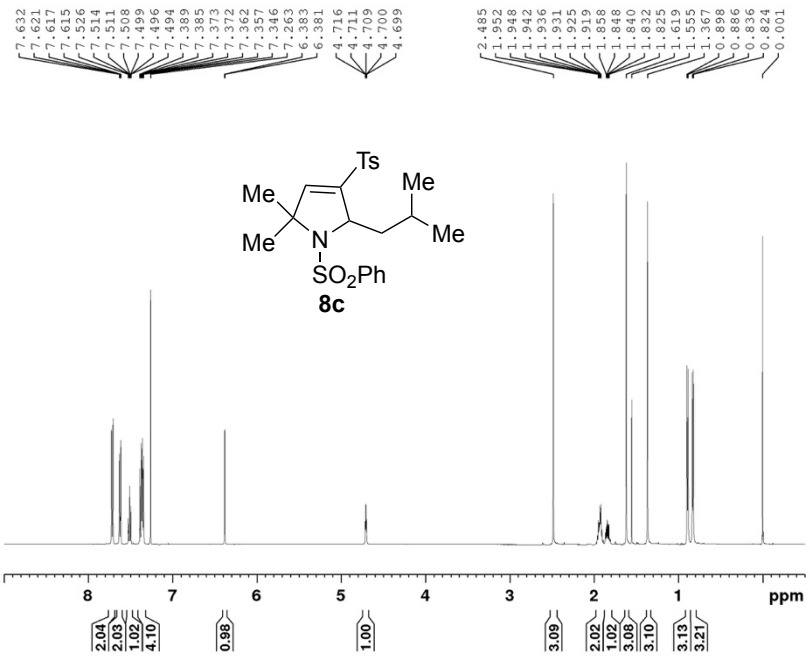
F2 - Acquisition Parameters
Date_           20180128
Time              16.04
INSTRUM             spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                   812
DS                     4
SWH           29761.904 Hz
FIDRES            0.454131 Hz
AQ                1.1010048 sec
RG                  184.57
DW                 16.800 usec
DE                  35.00 usec
TE                 298.0 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          125.7703637 MHz
NUC1                  13C
P1                 10.65 usec
PLW1          69.00000000 W

======== CHANNEL f2 ========
SFO2          500.1320005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              80.00 usec
PLW2           4.30000019 W
PLW12          0.04628500 W
PLW13          0.02328100 W

F2 - Processing parameters
SI                 32768
SF            125.7577924 MHz
WDW                   EM
SSB       0
LB                  1.00 Hz
GB        0
PC                  1.40
```

TR-IV-128-A1



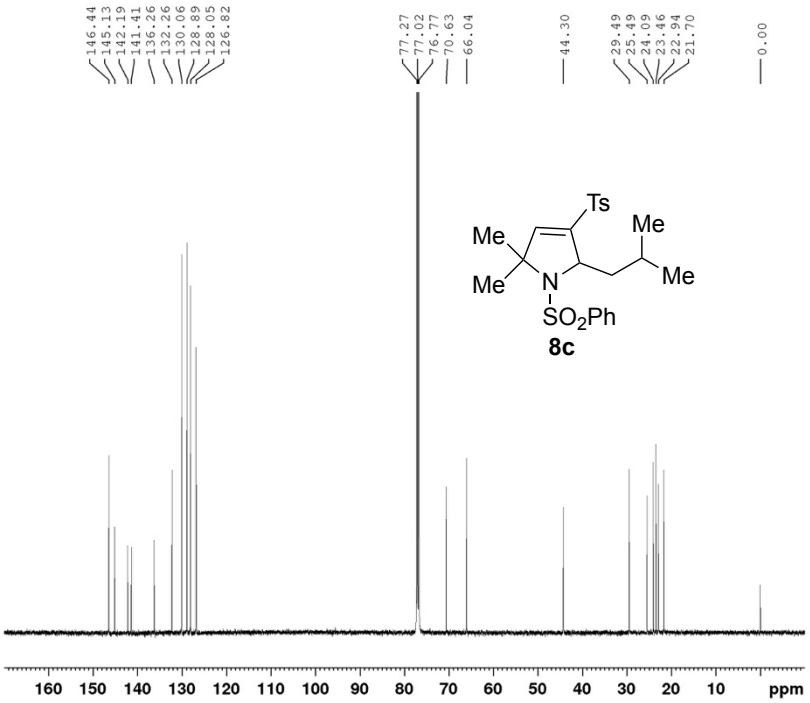

```
Current Data Parameters
NAME         TR-IV-128-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_           20180128
Time              16.52
INSTRUM             spect
PROBHD   5 mm CPTCI 1H-
PULPROG             zg30
TD                 65536
SOLVENT             CDCl3
NS                     16
DS                      2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ             3.2767999 sec
RG                  30.26
DW                 50.000 usec
DE                 25.00 usec
TE                298.0 K
D1             1.00000000 sec
TD0                     1

======== CHANNEL f1 ========
SFO1          500.1330885 MHz
NUC1                   1H
P1                  8.05 usec
PLW1           4.30000019 W

F2 - Processing parameters
SI                 65536
SF            500.1300106 MHz
WDW                   EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
```

TR-IV-128-A1




```
Current Data Parameters
NAME         TR-IV-128-A1
EXPNO                   2
PROCNO                  1

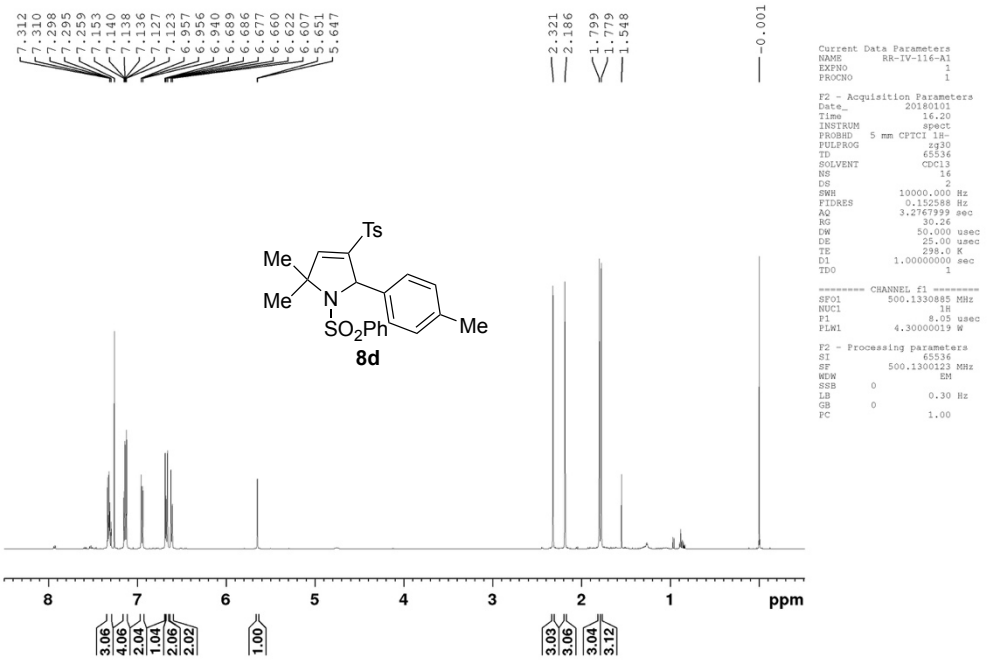
F2 - Acquisition Parameters
Date_           20180128
Time              17.28
INSTRUM             spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                 65536
SOLVENT             CDCl3
NS                    604
DS                      4
SWH           29761.904 Hz
FIDRES            0.454131 Hz
AQ             1.1010048 sec
RG                 184.57
DW                 16.800 usec
DE                 35.00 usec
TE                298.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                     1

======== CHANNEL f1 ========
SFO1          125.7703637 MHz
NUC1                   13C
P1                 10.65 usec
PLW1          69.00000000 W

======== CHANNEL f2 ========
SFO2          500.1320005 MHz
NUC2                   1H
CPDPRG[2           waltz16
PCPD2              80.00 usec
PLW2           4.30000019 W
PLW12          0.04628500 W
PLW13          0.02328100 W

F2 - Processing parameters
SI                 32768
SF            125.7577892 MHz
WDW                   EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```

RR-IV-116-A1



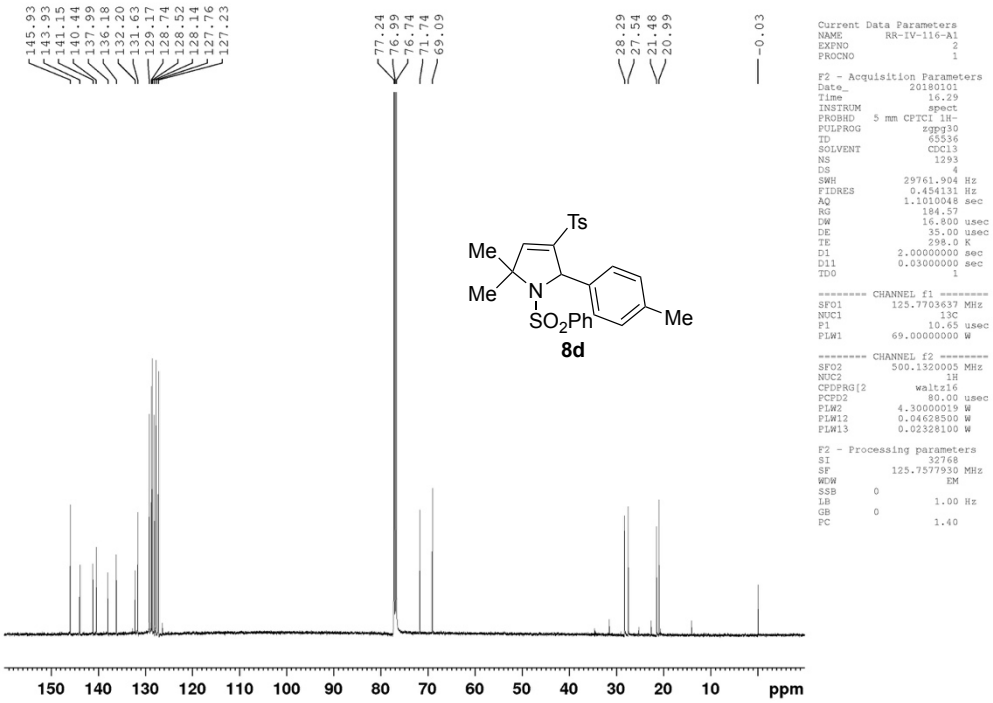

```
Current Data Parameters
NAME         RR-IV-116-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_          20180101
Time             16.20
INSTRUM          spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zg30
TD              65536
SOLVENT          CDCl3
NS                 16
DS                  2
SWH          10000.000 Hz
FIDRES           0.152588 Hz
AQ             3.2767999 sec
RG                30.26
DW               50.000 usec
DE               25.00 usec
TE               298.0 K
D1            1.00000000 sec
TD0                 1

======== CHANNEL f1 ========
SFO1         500.1330885 MHz
NUC1               1H
P1                8.05 usec
PLW1          4.30000019 W

F2 - Processing parameters
SI                65536
SF           500.1300123 MHz
WDW                EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```

RR-IV-116-A1



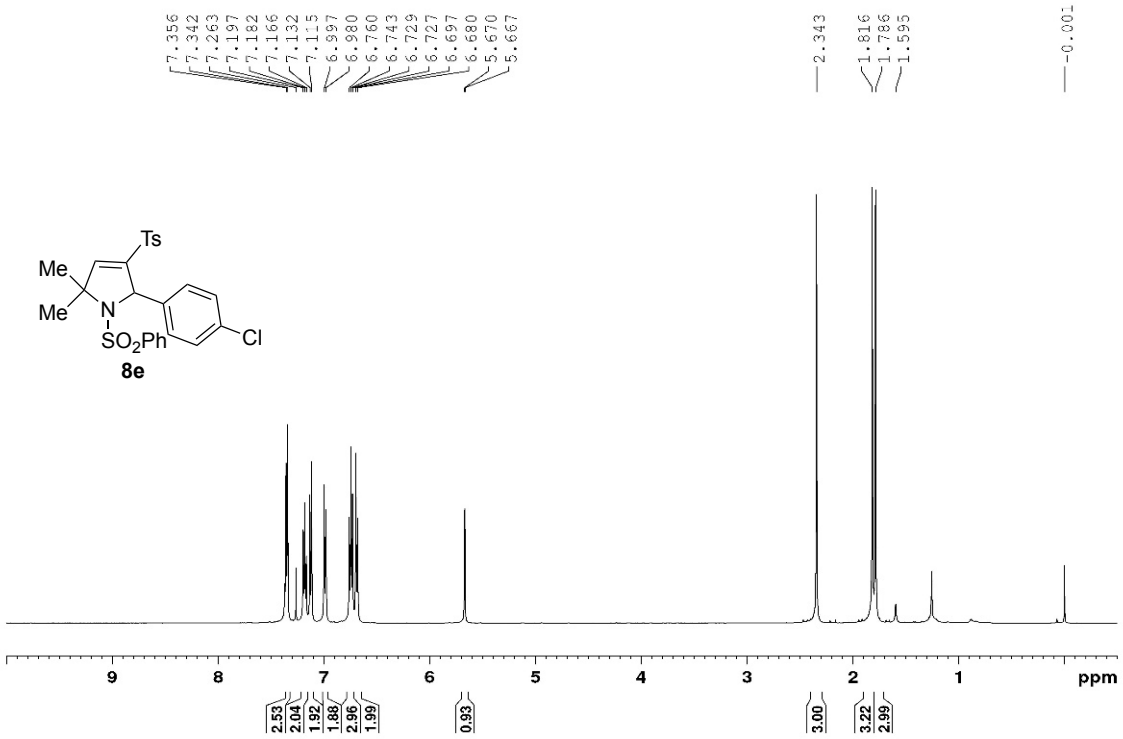

```
Current Data Parameters
NAME         RR-IV-116-A1
EXPNO                   2
PROCNO                  1

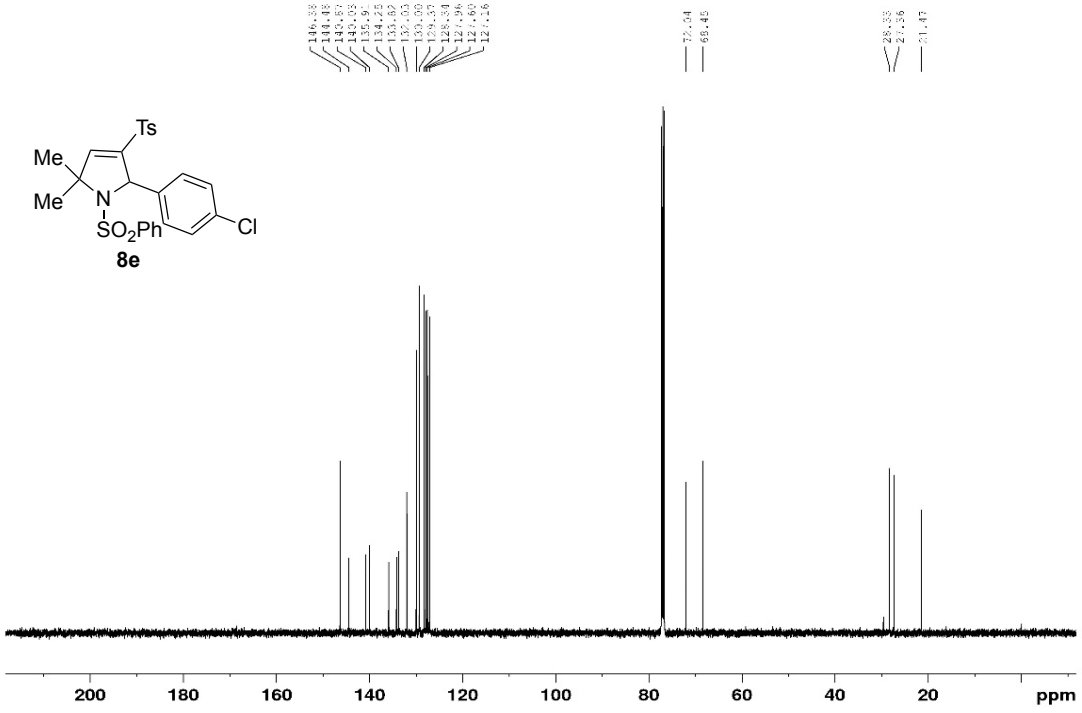
F2 - Acquisition Parameters
Date_          20180101
Time             16.29
INSTRUM          spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD              65536
SOLVENT          CDCl3
NS                1293
DS                   4
SWH          29761.904 Hz
FIDRES           0.454131 Hz
AQ             1.1010048 sec
RG                184.57
DW               16.800 usec
DE                35.00 usec
TE               298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                 1

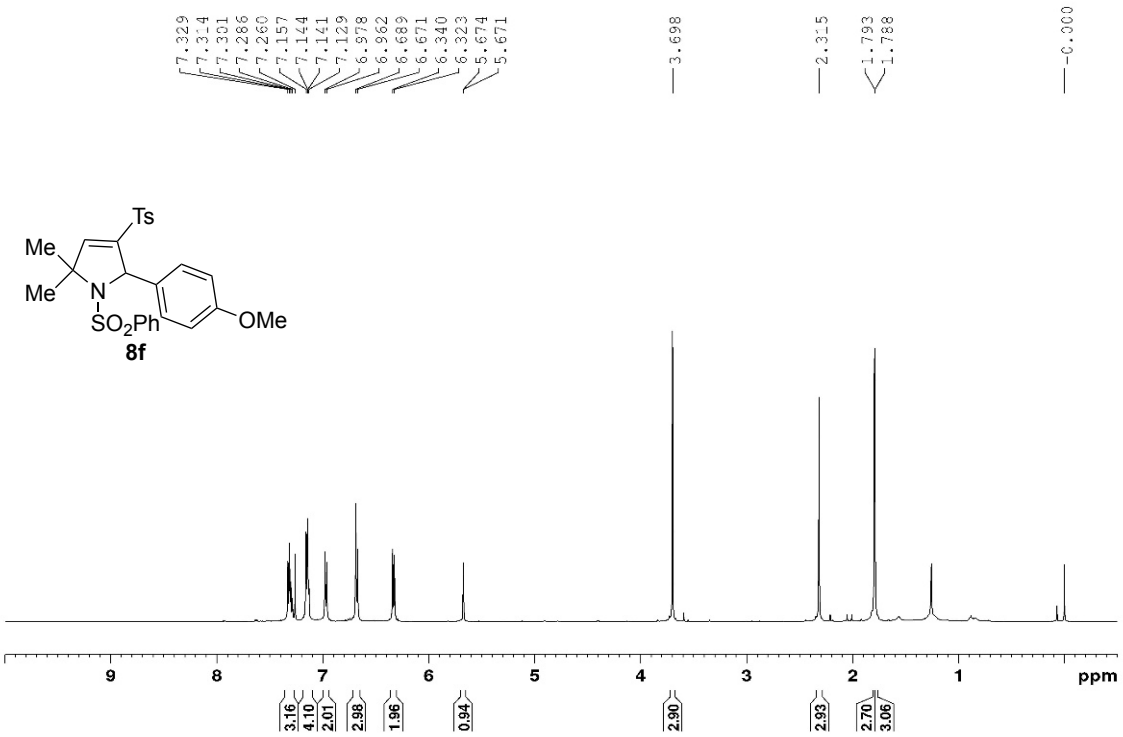
======== CHANNEL f1 ========
SFO1         125.7703637 MHz
NUC1               13C
P1                10.65 usec
PLW1         69.00000000 W

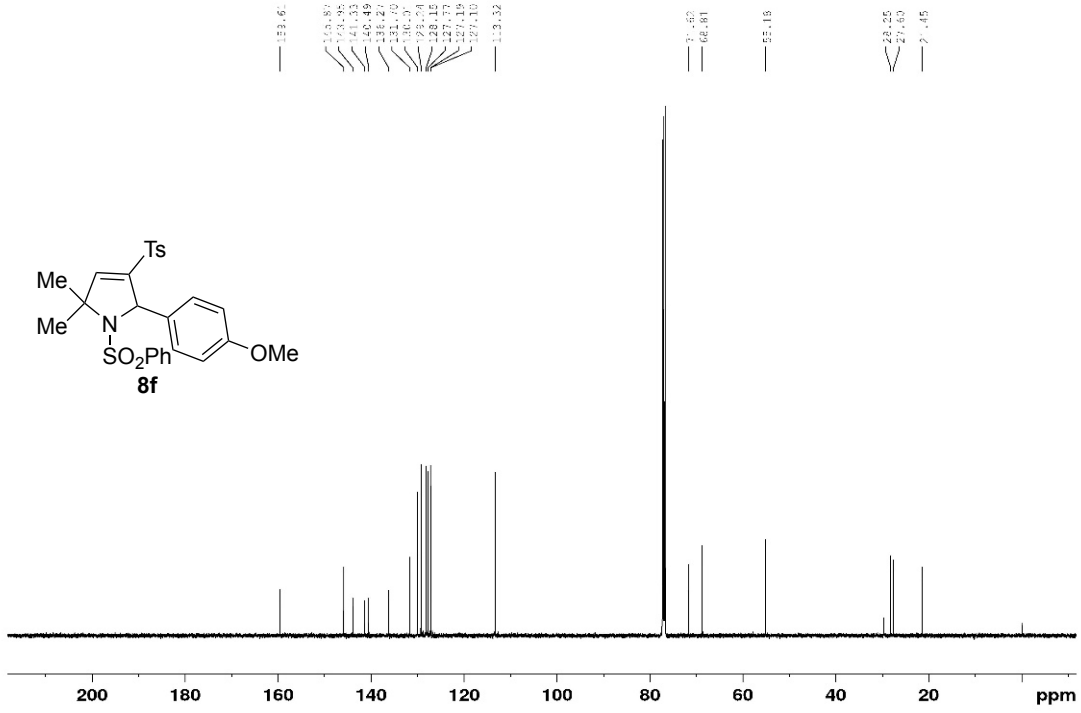
======== CHANNEL f2 ========
SFO2         500.1320005 MHz
NUC2               1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          4.30000019 W
PLW12         0.04628500 W
PLW13         0.02328100 W

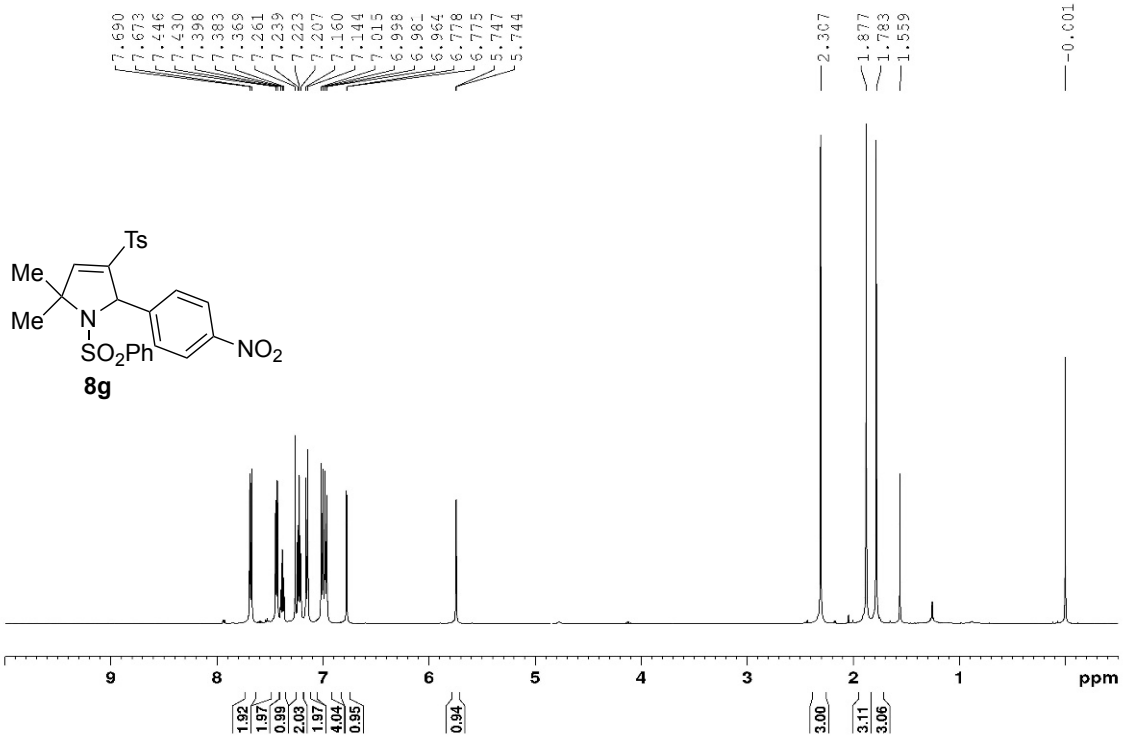
F2 - Processing parameters
SI                32768
SF           125.7577930 MHz
WDW                EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```

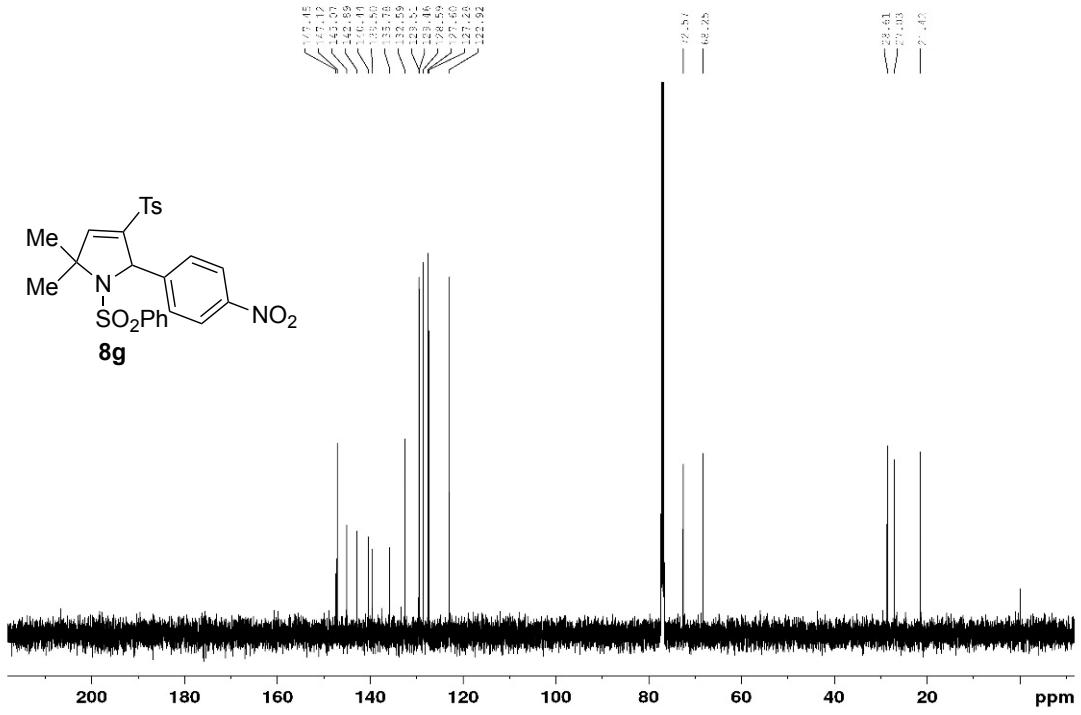

7.356
7.342
7.263
7.197
7.182
7.166
7.132
7.115
6.997
6.980
6.760
6.743
6.729
6.727
6.697
6.680
5.670
5.667
2.343
1.816
1.786
1.595
-0.001
Ts
Me
Me
N
SO2Ph
Cl
8e
9
8
7
6
5
4
3
2
1
ppm
2.53
2.04
1.92
1.88
2.96
1.99
0.93
3.00
3.22
2.99

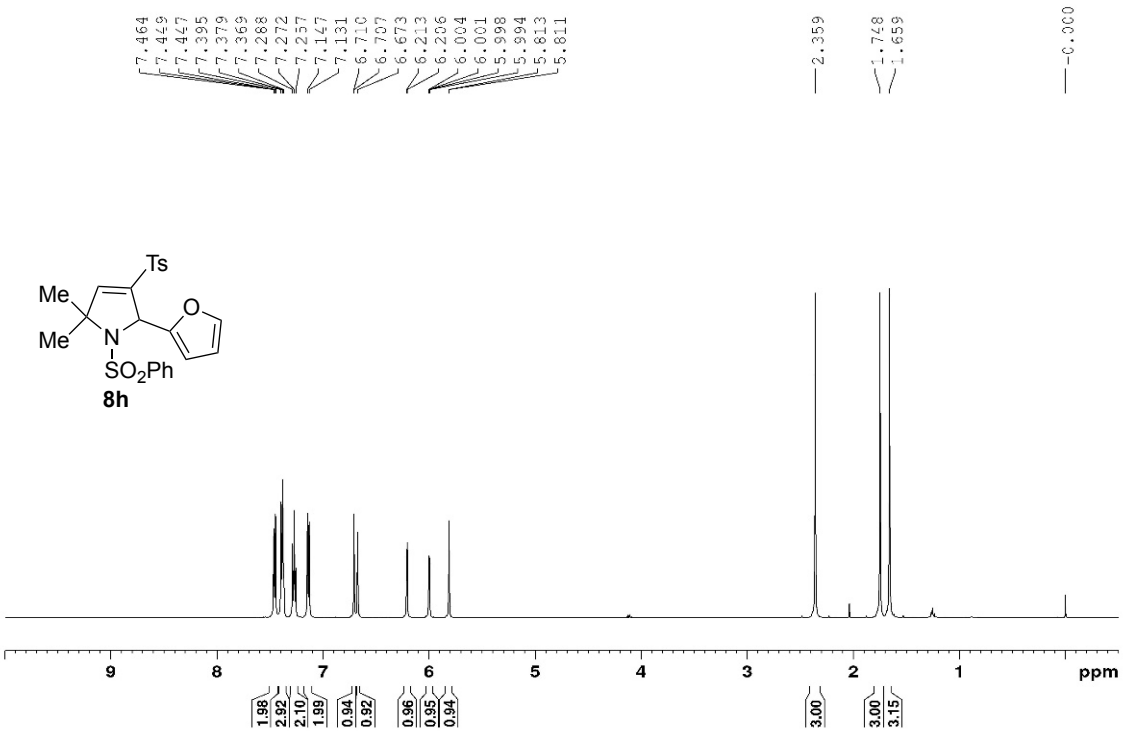

146.38
144.48
143.63
143.03
135.99
134.25
133.62
132.03
133.00
129.37
128.34
127.96
127.60
127.16
78.04
69.45
28.33
27.56
21.47
Ts
Me
Me
N
SO2Ph
Cl
8e
200
180
160
140
120
100
80
60
40
20
ppm

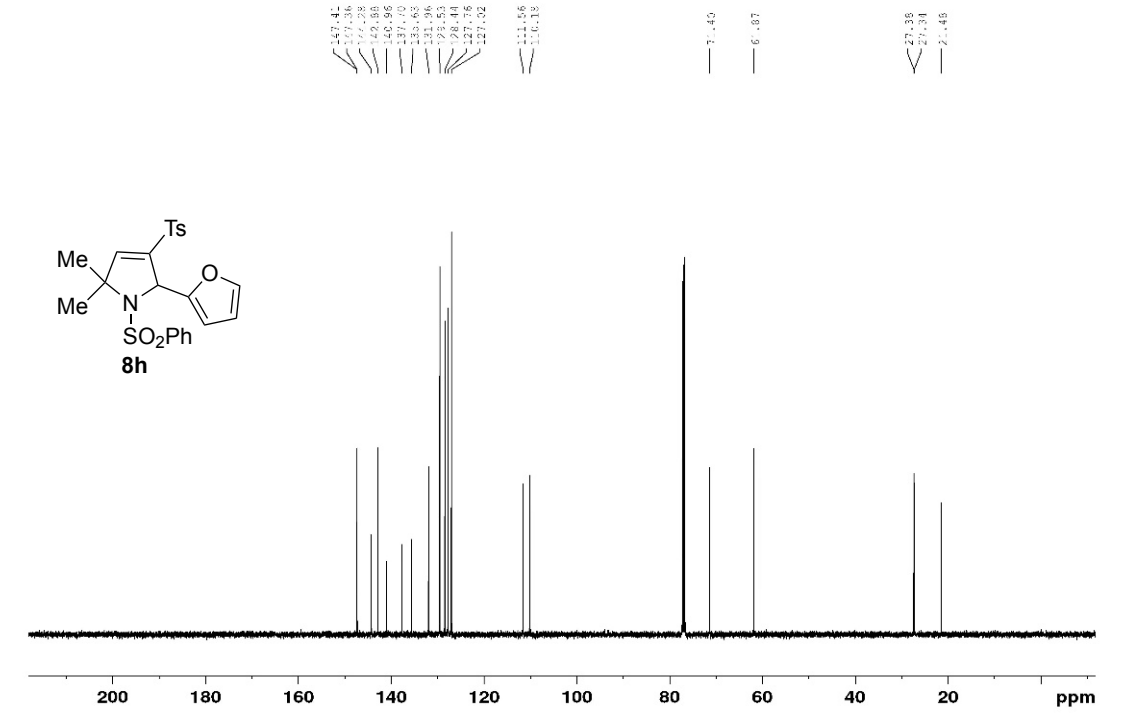

7.329
7.314
7.301
7.286
7.260
7.157
7.144
7.141
7.129
6.978
6.962
6.689
6.671
6.340
6.323
5.674
5.671
3.698
2.315
1.793
1.788
0.000
Ts
Me
Me
N
SO2Ph
OMe
8f
9
8
7
6
5
4
3
2
1
ppm
3.16
4.10
2.01
2.98
1.96
0.94
2.90
2.93
2.70
3.06

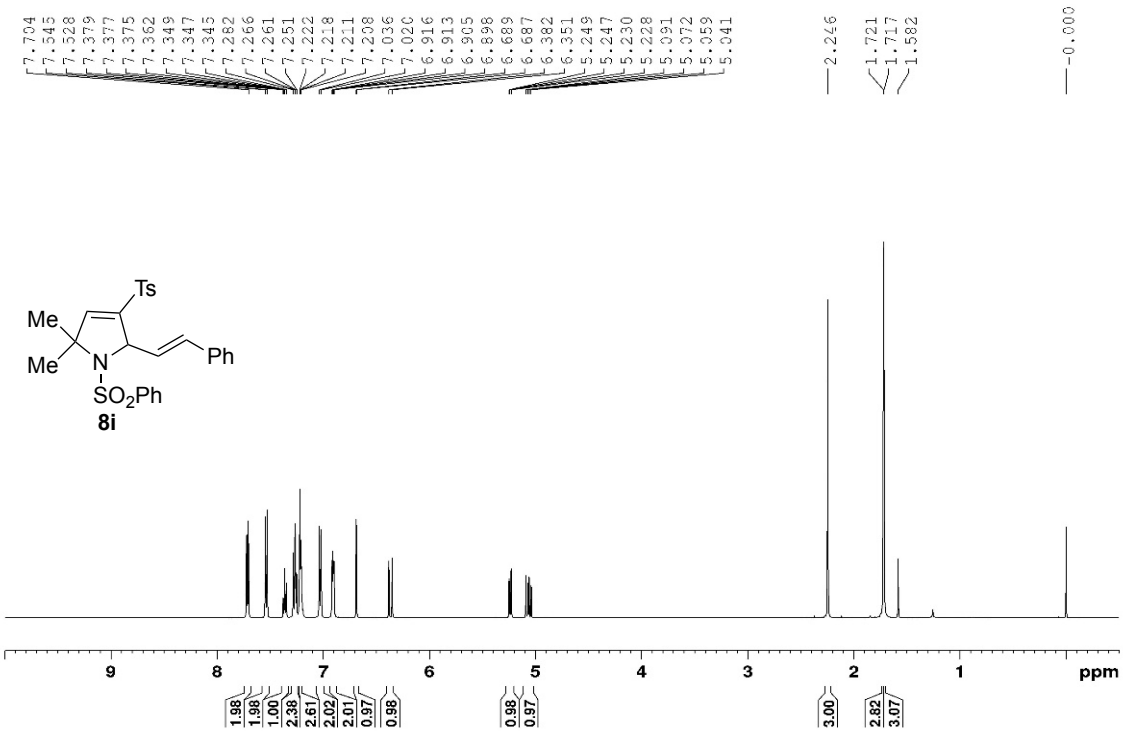

68.61
55.18
28.25
27.60
Ts
Me
Me
N
SO2Ph
OMe
8f
200
180
160
140
120
100
80
60
40
20
ppm

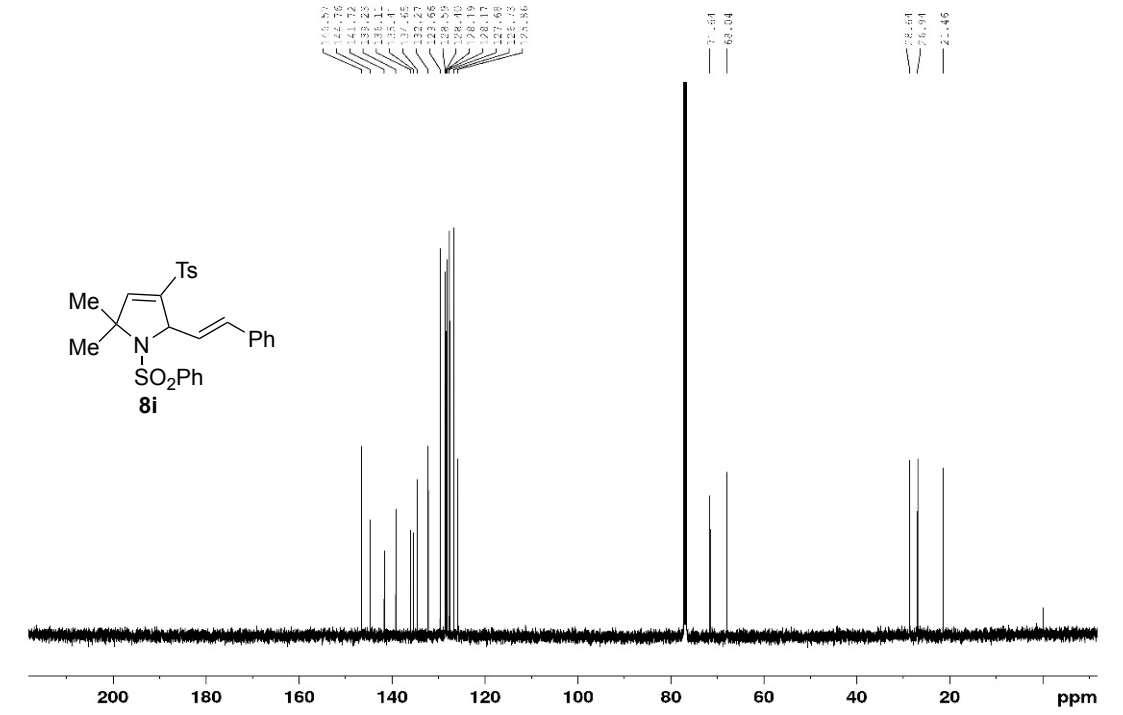

7.690
7.673
7.446
7.430
7.398
7.383
7.363
7.261
7.239
7.223
7.207
7.160
7.144
7.015
6.998
6.981
6.964
6.778
6.775
5.747
5.744
2.367
1.877
1.783
1.559
0.001
Ts
Me
Me
N
SO2Ph
NO2
8g
9
8
7
6
5
4
3
2
1
ppm
1.92
1.97
0.99
2.03
1.97
4.04
0.95
0.94
3.00
3.11
3.06


Ts
Me
Me
N
SO2Ph
NO2
8g
200
180
160
140
120
100
80
60
40
20
ppm

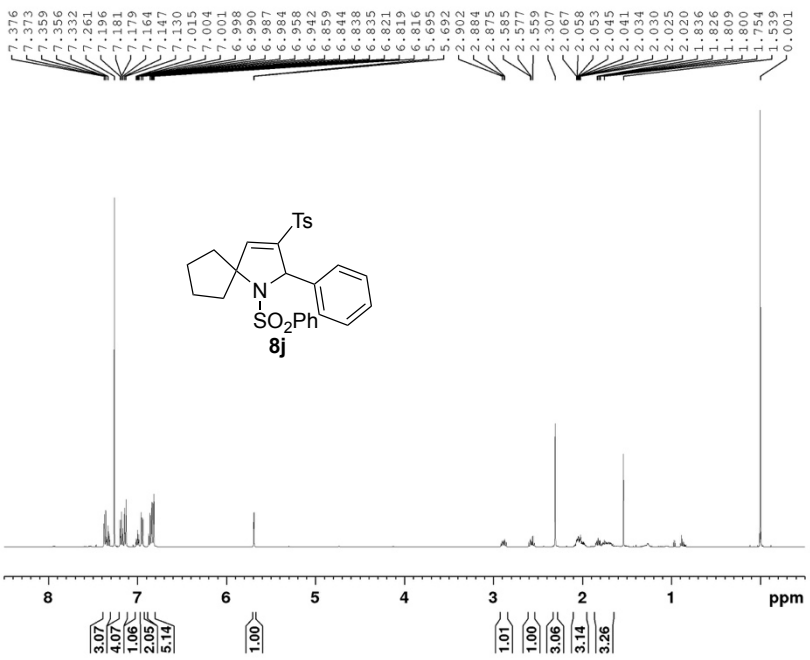

7.464
7.449
7.447
7.395
7.379
7.369
7.288
7.272
7.257
7.147
7.131
6.710
6.707
6.673
6.213
6.206
6.004
6.001
5.998
5.994
5.813
5.811
2.359
1.748
1.659
0.000
Ts
Me
Me
N
O
SO2Ph
8h
9
8
7
6
5
4
3
2
1
ppm
1.98
2.92
2.10
1.99
0.94
0.92
0.96
0.95
0.94
3.00
3.00
3.15


147.41
142.68
140.96
111.56
110.13
77.40
76.87
27.38
27.34
21.48
Ts
Me
Me
N
O
SO2Ph
8h
200
180
160
140
120
100
80
60
40
20
ppm


Ts
Me
Me
N
Ph
SO2Ph
8i
ppm


Ts
Me
Me
N
Ph
SO2Ph
8i
ppm

TR-IV-118-A1



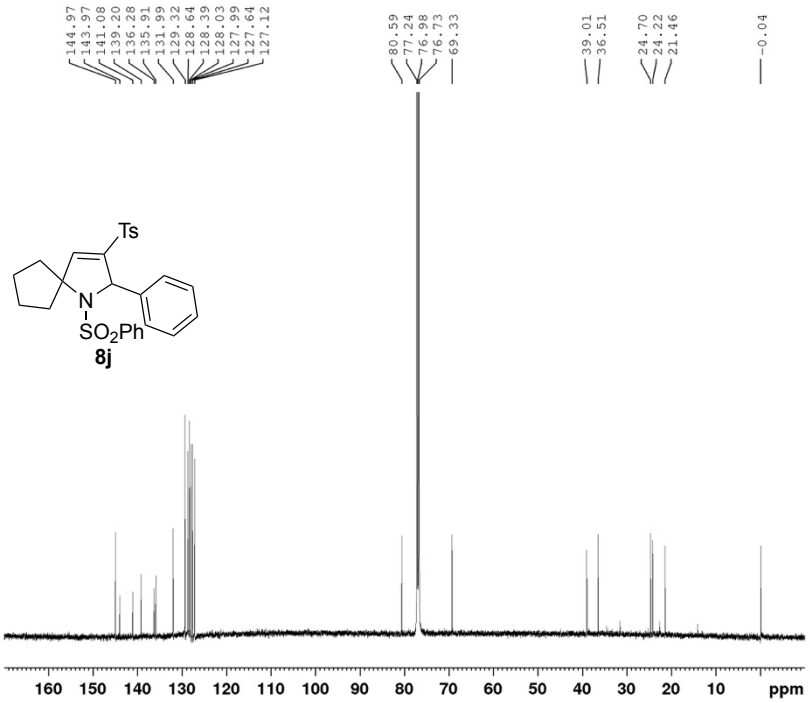

```
Current Data Parameters
NAME        TR-IV-118-A1
EXPNO                  1
PROCNO                 1

F2 - Acquisition Parameters
Date_           20180120
Time              17.05
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG           zg30
TD               65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ             3.2767999 sec
RG                47.02
DW                50.000 usec
DE                25.00 usec
TE                298.0 K
D1             1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          500.1330885 MHz
NUC1                  1H
P1                  8.05 usec
PLW1           4.30000019 W

F2 - Processing parameters
SI                65536
SF          500.1300116 MHz
WDW                  EM
SSB       0
LB                 0.30 Hz
GB        0
PC                 1.00
```

TR-IV-118-A1




```
Current Data Parameters
NAME        TR-IV-118-A1
EXPNO                  2
PROCNO                 1

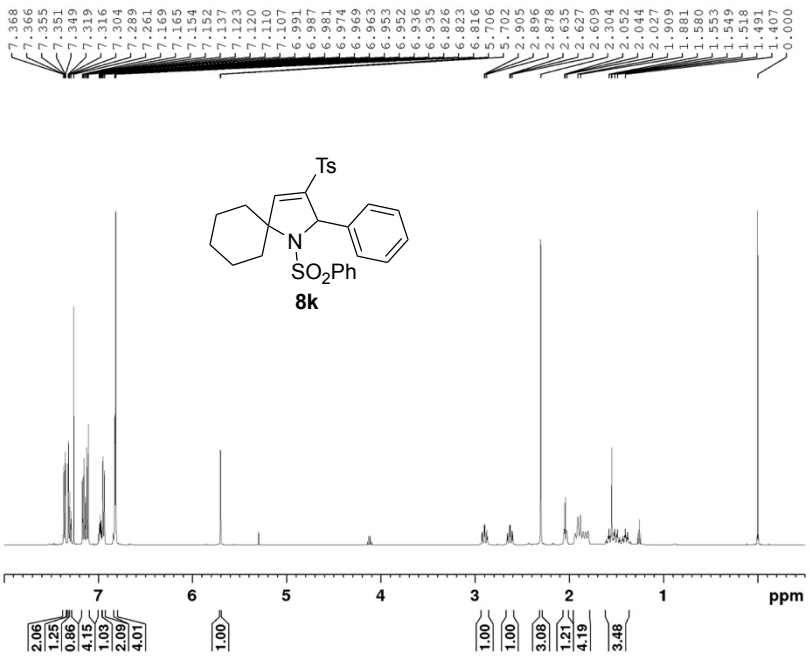
F2 - Acquisition Parameters
Date_           20180120
Time              17.18
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG         zgpg30
TD               65536
SOLVENT           CDCl3
NS                 1587
DS                    4
SWH           29761.904 Hz
FIDRES            0.454131 Hz
AQ             1.1010048 sec
RG                184.57
DW                16.800 usec
DE                35.00 usec
TE                298.0 K
D1             2.00000000 sec
D11            0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1          125.7703637 MHz
NUC1                  13C
P1                 10.65 usec
PLW1          69.00000000 W

======== CHANNEL f2 ========
SFO2          500.1320005 MHz
NUC2                  1H
CPDPRG[2          waltz16
PCPD2              80.00 usec
PLW2           4.30000019 W
PLW12          0.04628500 W
PLW13          0.02328100 W

F2 - Processing parameters
SI                32768
SF          125.7577930 MHz
WDW                  EM
SSB       0
LB                 1.00 Hz
GB        0
PC                 1.40
```

RR-IV-119-A1



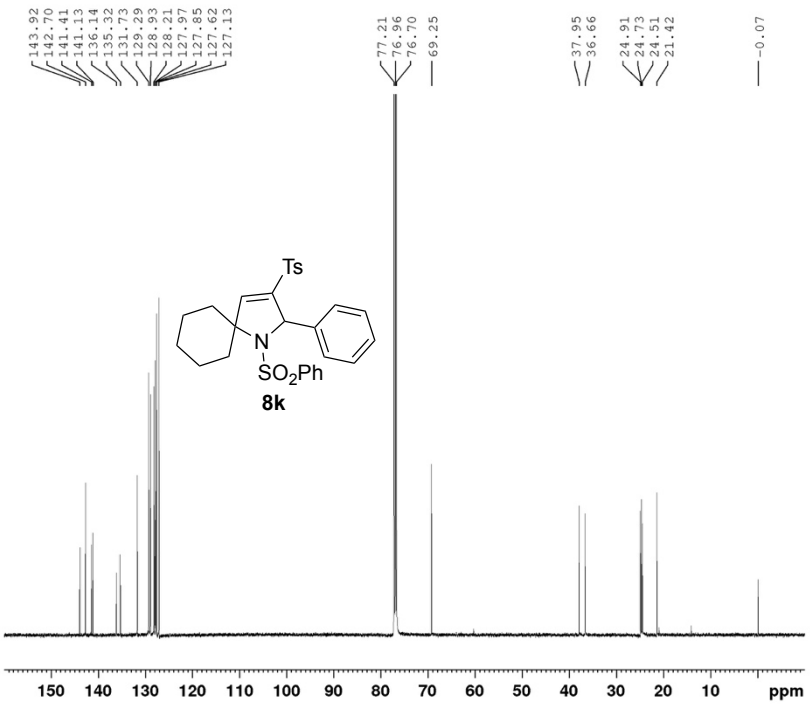

```
Current Data Parameters
NAME         RR-IV-119-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_           20180101
Time              17.42
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG           zg30
TD                65536
SOLVENT           CDCl3
NS                   16
DS                    2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ            3.2767999 sec
RG                30.26
DW                50.000 usec
DE                25.00 usec
TE                298.0 K
D1            1.00000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         500.1330885 MHz
NUC1                 1H
P1                8.05 usec
PLW1         4.30000019 W

F2 - Processing parameters
SI                65536
SF           500.1300115 MHz
WDW                  EM
SSB       0
LB                0.30 Hz
GB        0
PC                1.00
```

RR-IV-119-A1



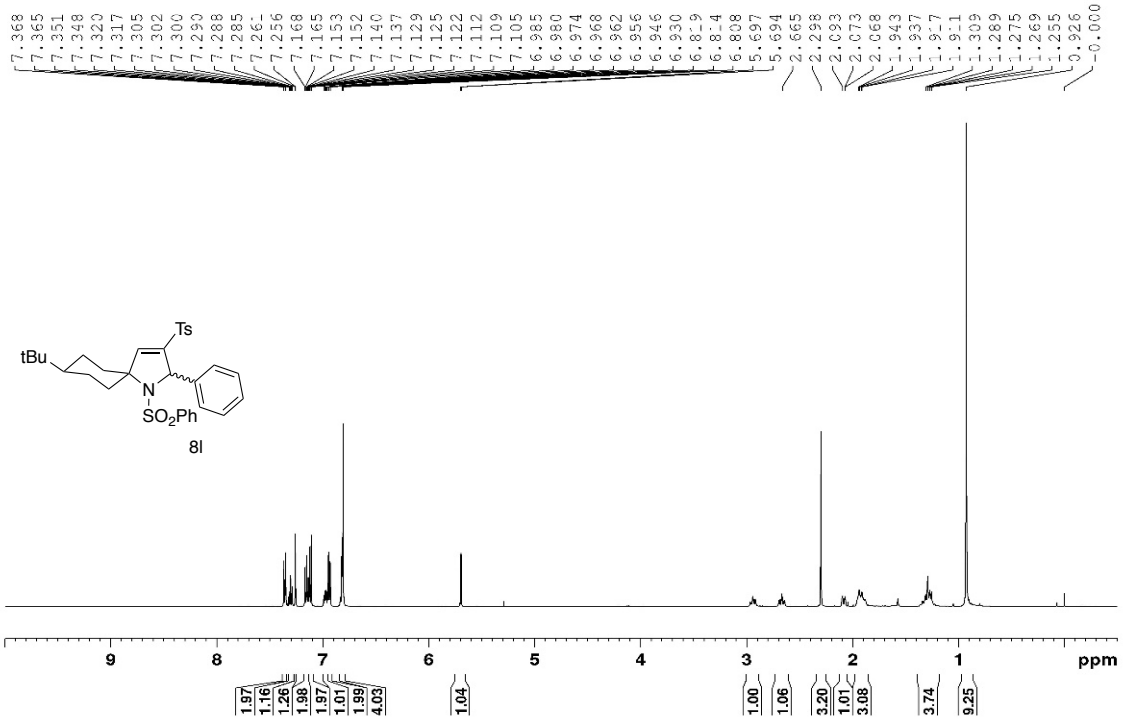

```
Current Data Parameters
NAME         RR-IV-119-A1
EXPNO                   2
PROCNO                  1

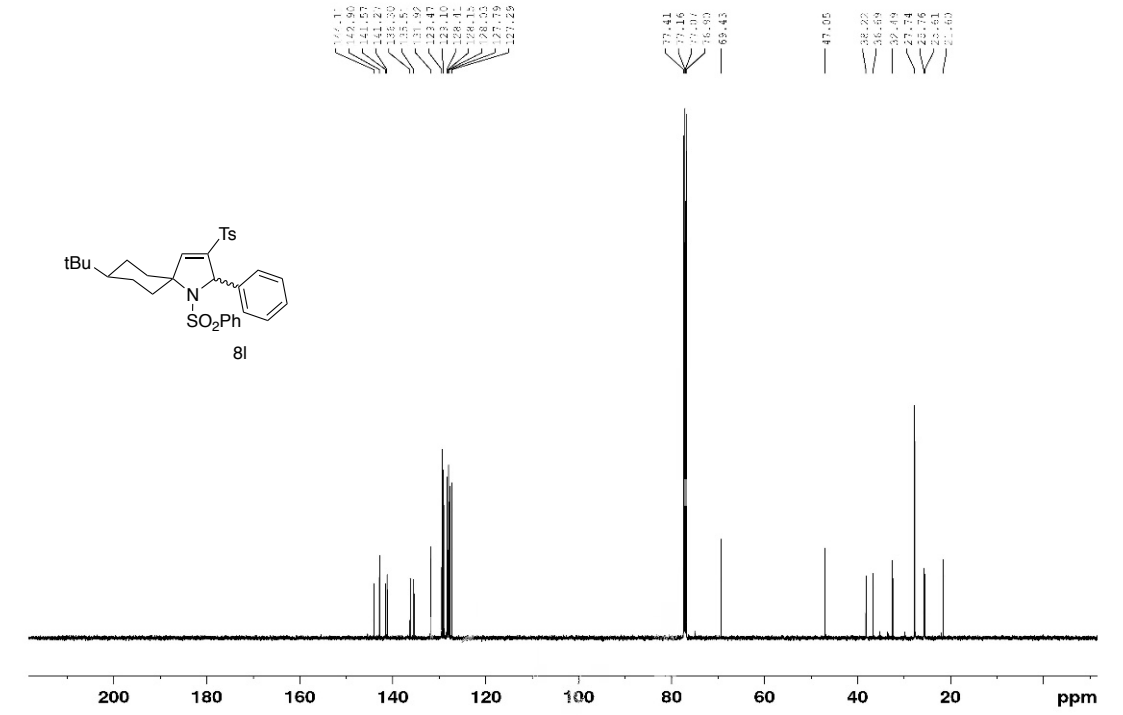
F2 - Acquisition Parameters
Date_           20180101
Time              17.53
INSTRUM           spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                65536
SOLVENT           CDCl3
NS                 1020
DS                    4
SWH           29761.904 Hz
FIDRES            0.454131 Hz
AQ            1.1010048 sec
RG                184.57
DW                16.800 usec
DE                35.00 usec
TE                298.0 K
D1            2.00000000 sec
D11           0.03000000 sec
TD0                   1

======== CHANNEL f1 ========
SFO1         125.7703637 MHz
NUC1                 13C
P1               10.65 usec
PLW1         69.00000000 W

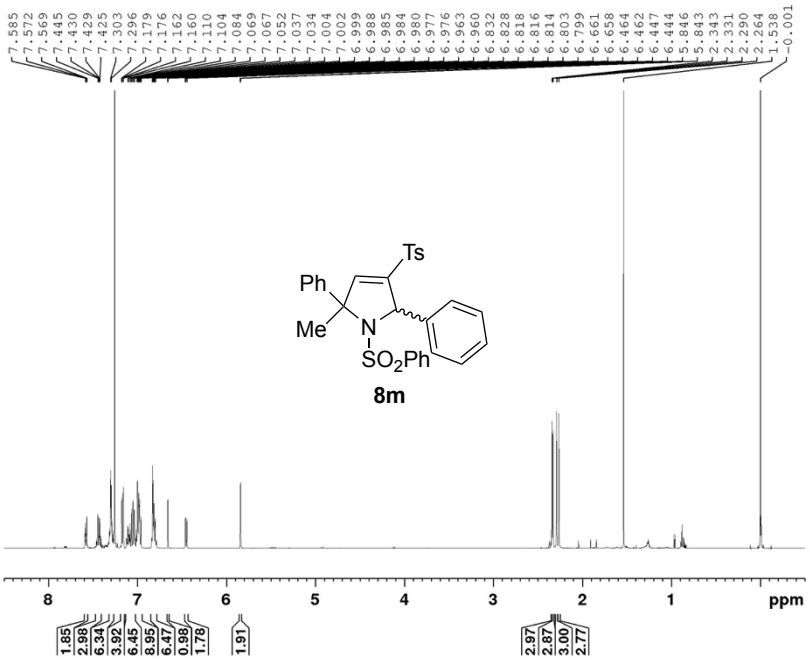
======== CHANNEL f2 ========
SFO2         500.1320005 MHz
NUC2                 1H
CPDPRG[2          waltz16
PCPD2             80.00 usec
PLW2          4.30000019 W
PLW12         0.04628500 W
PLW13         0.02328100 W

F2 - Processing parameters
SI                32768
SF           125.7577976 MHz
WDW                  EM
SSB       0
LB                1.00 Hz
GB        0
PC                1.40
```


tBu
Ts
N
SO2Ph
8l
ppm


tBu
Ts
N
SO2Ph
8l
ppm

TR-IV-120-A1



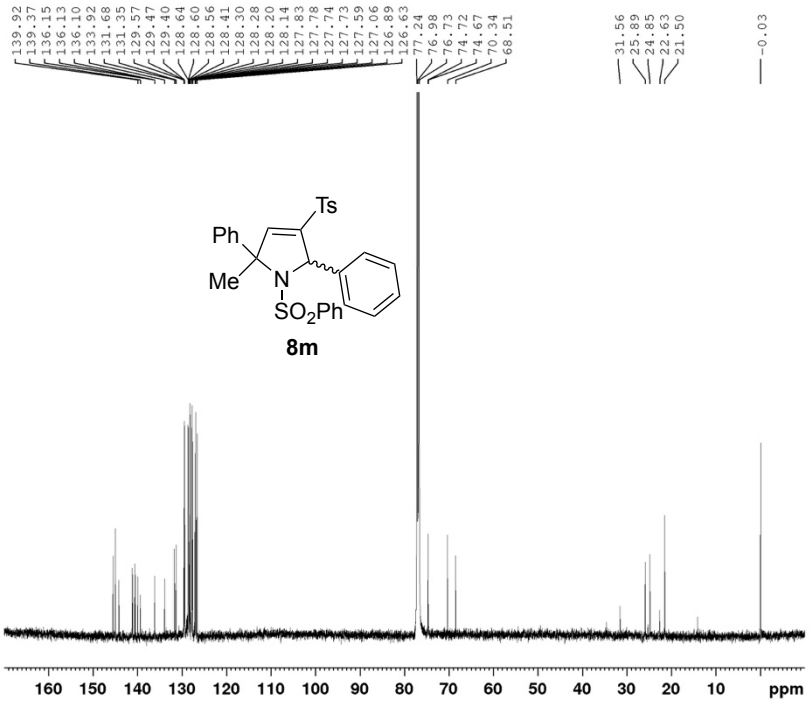

```
Current Data Parameters
NAME         TR-IV-120-A1
EXPNO                   1
PROCNO                  1

F2 - Acquisition Parameters
Date_           20180120
Time              18.50
INSTRUM             spect
PROBHD   5 mm CPTCI 1H-
PULPROG             zg30
TD                 65536
SOLVENT            CDCl3
NS                    16
DS                     2
SWH           10000.000 Hz
FIDRES            0.152588 Hz
AQ                3.2767999 sec
RG                   52.18
DW                  50.000 usec
DE                  25.00 usec
TE                  298.0 K
D1              1.00000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          500.1330885 MHz
NUC1                   1H
P1                   8.05 usec
PLW1           4.30000019 W

F2 - Processing parameters
SI                 65536
SF            500.1300128 MHz
WDW                   EM
SSB       0
LB                  0.30 Hz
GB        0
PC                  1.00
```

TR-IV-120-A1




```
Current Data Parameters
NAME         TR-IV-120-A1
EXPNO                   2
PROCNO                  1

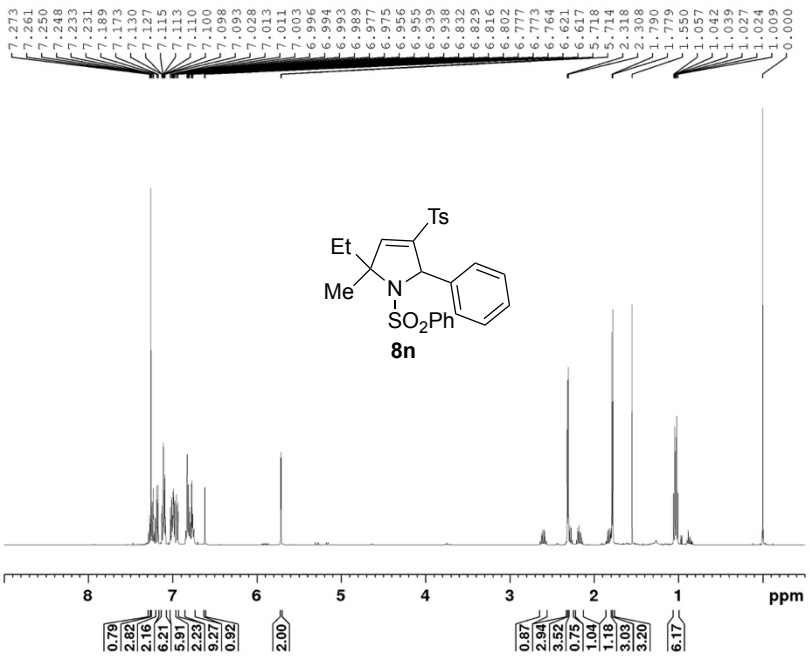
F2 - Acquisition Parameters
Date_           20180120
Time              19.01
INSTRUM             spect
PROBHD   5 mm CPTCI 1H-
PULPROG          zgpg30
TD                 65536
SOLVENT            CDCl3
NS                  3853
DS                     4
SWH           29761.904 Hz
FIDRES            0.454131 Hz
AQ                1.1010048 sec
RG                  184.57
DW                  16.800 usec
DE                  35.00 usec
TE                  298.0 K
D1              2.00000000 sec
D11             0.03000000 sec
TD0                    1

======== CHANNEL f1 ========
SFO1          125.7703637 MHz
NUC1                   13C
P1                  10.65 usec
PLW1          69.00000000 W

======== CHANNEL f2 ========
SFO2          500.1320005 MHz
NUC2                   1H
CPDPRG[2          waltz16
PCPD2               80.00 usec
PLW2           4.30000019 W
PLW12          0.04628500 W
PLW13          0.02328100 W

F2 - Processing parameters
SI                 32768
SF            125.7577930 MHz
WDW                   EM
SSB       0
LB                  1.00 Hz
GB        0
PC                  1.40
```

TR-IV-121-A1



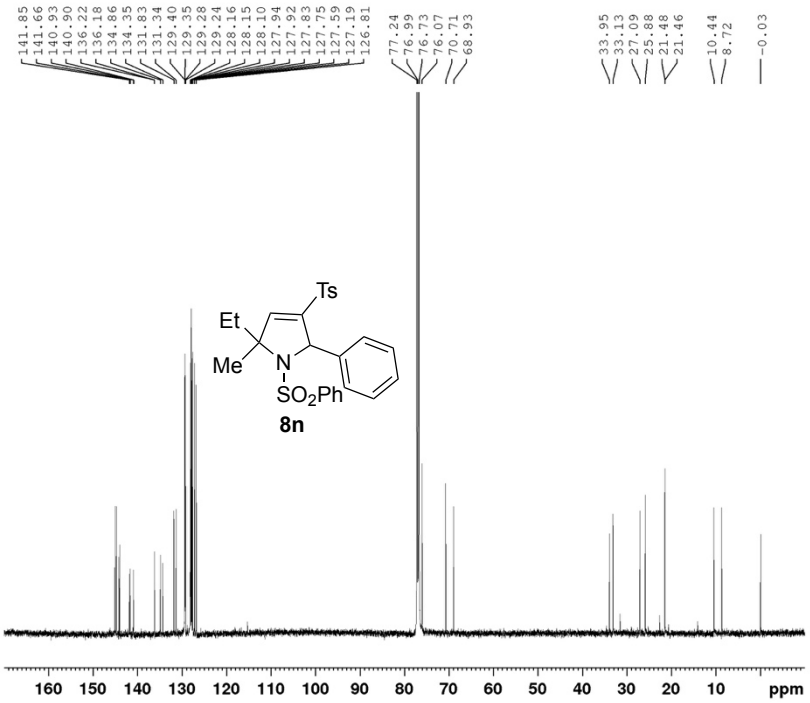
Current Data Parameters
NAME TR-IV-121-A1
EXPNO 1
PROCNO 1

F2 - Acquisition Parameters
Date_ 20180121
Time 16.43
INSTRUM spect
PROBHD 5 mm CPTCI 1H-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 10000.000 Hz
FIDRES 0.152588 Hz
AQ 3.2767999 sec
RG 47.02
DW 50.000 usec
DE 25.00 usec
TE 298.0 K
D1 1.00000000 sec
TD0 1

======== CHANNEL f1 ========
SFO1 500.1330885 MHz
NUC1 1H
P1 8.05 usec
PLW1 4.30000019 W

F2 - Processing parameters
SI 65536
SF 500.1300114 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00

TR-IV-121-A1



Current Data Parameters
NAME TR-IV-121-A1
EXPNO 2
PROCNO 1

F2 - Acquisition Parameters
Date_ 20180121
Time 17.23
INSTRUM spect
PROBHD 5 mm CPTCI 1H-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 1797
DS 4
SWH 29761.904 Hz
FIDRES 0.454131 Hz
AQ 1.1010048 sec
RG 184.57
DW 16.800 usec
DE 35.00 usec
TE 298.0 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1

======== CHANNEL f1 ========
SFO1 125.7703637 MHz
NUC1 13C
P1 10.65 usec
PLW1 69.00000000 W

======== CHANNEL f2 ========
SFO2 500.1320005 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 80.00 usec
PLW2 4.30000019 W
PLW12 0.04628500 W
PLW13 0.02328100 W

F2 - Processing parameters
SI 32768
SF 125.7577930 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40