Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Stereoselective Cyclopropanation of Enamides *via* C—C Bond Cleavage of Cyclopropenes

Jie Chen,[a,b] Jiabin Han,[b] Tao Wu,[b] Jian Zhang,[a] Meng Li,[b] Ying Xu,[a] Jinli Zhang,[b] Yongjuan Jiao,[b] Yanhui Yang,[b] Yaojia Jiang*[a,b]

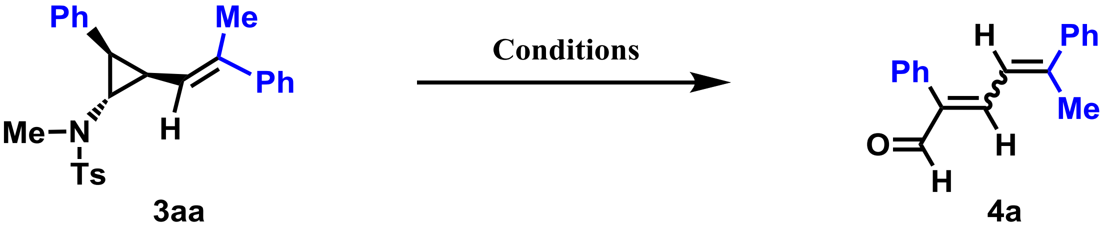
[a] Laboratory Breeding Base of Green Pesticide and Agricultural Bioengineering, Key Laboratory of Green Pesticide and Agricultural Bioengineering Ministry of Education, Guizhou University, Huaxi District, Guiyang 550025, China.
[b] Institute of Advanced Synthesis, School of Chemistry and Molecular Engineering, Nanjing Tech University, Nanjing 211816, China.

Table of Contents

General methods:

All reactions were carried out in flame or oven-dried glassware under nitrogen atmosphere with freshly distilled dry solvents under anhydrous conditions unless otherwise indicated. Flash column chromatography was performed with silica gel 60 (230 – 400 mesh). Chromatograms were visualized by fluorescence quenching with UV light at 254 nm or by staining with base solution of potassium permanganate and molybdate. NMR spectra were recorded at RT on 300 or 400 MHz Bruker spectrometers. The residual solvent signals were taken as the reference (0.00 ppm for ^{1}H NMR spectra and 77.0 ppm for ^{13}C NMR spectra in $CDCl_3$). Chemical shift (δ) is reported in ppm, coupling constants (*J*) are given in Hz. The following abbreviations classify the multiplicity: s = singlet, d = doublet, t = triplet, m = multiplet, dd = doublet of doublet, q = quartet and br = broad signal. HRMS (ESI) spectra were recorded on a Waters Q-Tof premier TM mass spectrometer.

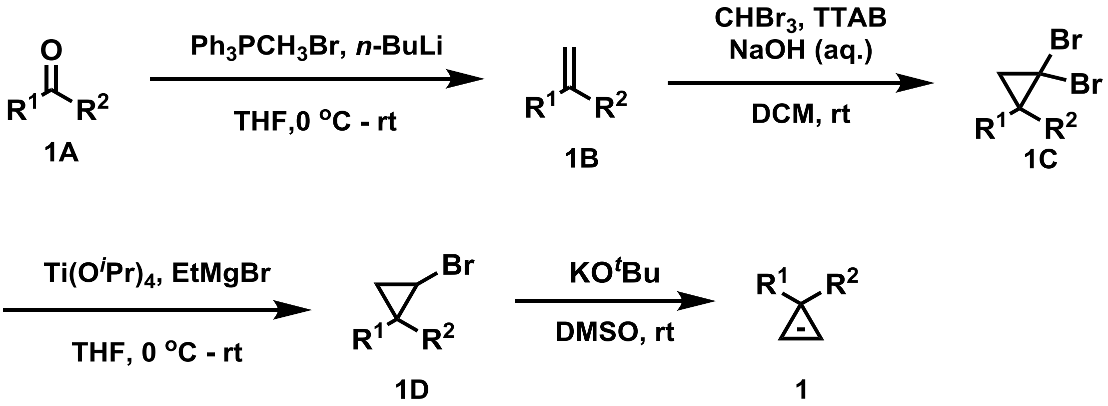
Table-S1 Optimization of Ring-Opening Reaction Conditions:



Entry	Catalyst	Additive (equiv.)	Solvent	Temp.	Yield[a,b]	*E/Z*[c]
1	-	-	DCM (0.1 **M**)	80 °C	-	-
2	-	TsOH (1.0)	DCM (0.1 **M**)	80 °C	-	-
3	AgTFA	1,4-Naphthoquinone (1.0)	DCM (0.1 **M**)	80 °C	21	2.4:1
4	AgTFA	$PhB(OH)_2$ (1.0)	DCM (0.1 **M**)	80 °C	22	2.1:1
5	AgTFA	DDQ (1.0)	DCM (0.1 **M**)	80 °C	31	2.3:1
6	AgTFA	$Cu(OAc)_2$ (1.0)	DCM (0.1 **M**)	80 °C	-	-
7	AgTFA	$Cu(TFA)_2$ (1.0)	DCM (0.1 **M**)	80 °C	25	1.9:1
8	AgTFA	$CuCl_2$ (1.0)	DCM (0.1 **M**)	80 °C	51	1.5:1
9	AgTFA	CuO (1.0)	DCM (0.1 **M**)	80 °C	45	1.3:1
10	AgTFA	$CuCl_2$ (2.0)	DCM (0.1 **M**)	80 °C	68	3.5:1
11	AgTFA	$CuCl_2$ (3.0)	DCM (0.1 **M**)	80 °C	59	3.2:1
12	AgTFA	$CuCl_2$ (2.0)	DCM (0.1 **M**)	60 °C	43	3.3:1
13	AgTFA	$CuCl_2$ (2.0)	DCM (0.1 **M**)	70 °C	55	2.9:1
14	AgTFA	$CuCl_2$ (2.0)	DCM (0.1 **M**)	90 °C	72	3.6:1
15	AgTFA	$CuCl_2$ (2.0)	DCE (0.1 **M**)	90 °C	61	3.1:1
16	AgTFA	$CuCl_2$ (2.0)	Tol. (0.1 **M**)	90 °C	77	3.9:1
17	AgTFA	$CuCl_2$ (2.0)	$PhCF_3$ (0.1 **M**)	90 °C	55	2.8:1
18	AgTFA	$CuCl_2$ (2.0)	Xylene (0.1 **M**)	90 °C	81	3.9:1
19	AgTFA	$CuCl_2$ (2.0)	Xylene (0.05 **M**)	90 °C	85	4.2:1

[a]Conditions: **3** (0.20 mmol, 1.0 equiv.), additive and AgTFA (5 mol %) were stirred in solvent. [b]Isolated yields. [c]The ratio was determined by ^1H NMR.

General procedure for the synthesis of cyclopropenes[1]:



To a stirred solution of Ph_3PCH_3Br (35.7 g, 100 mmol, 2.0 equiv.) in THF (150 mL) at 0 ℃ was added 1.6 M *n*-butyllitium (62.5 ml, 100 mmol, 2.0 equiv.) dropwise over 60 minutes. The reaction mixture was stirred for 2.0 hours at room temperature. Ketone **1A** (50 mmol, 1.0 equiv.) in THF (15 mL) was added dropwise to the cooled reaction mixture at 0 ℃ via cannular. The reaction was then stirred at room temperature for 24 -48 hours, quenched with saturated NH_4Cl (40 mL), diluted with water (30 mL) and extracted with EtOAc (3 x 30 mL). The combined organic extracts were washed with brine (2 x 30 mL), dried over $MgSO_4$ and concentrated under reduced pressure. The crude product was dissolved in hexane and triphenylphosphine oxide was filtered off. The filtrate solution was then concentrated under reduced pressure. The product **1B** was isolated by flash column chromatography (eluent: PE).

---

[1] A. Parra, L. Amenós, M. Guisán-Ceinos, A. López, J. L. G. Ruano and M. Tortosa, Copper-Catalyzed Diastereo- and Enantioselective Desymmetrization of Cyclopropenes: Synthesis of Cyclopropylboronates. *J. Am. Chem. Soc.,* 2014, **136**, 15833-15836.

A solution of 10 M aqueous sodium hydroxide (80 g, 200 mmol, 4.0 equiv.) was added to alkyltrimethylammonium bromide (1.7 g, 5.0 mmol, 0.1 equiv.). To the stirring reaction mixture was added a solution of alkene **1B** (50 mmol, 1.0 equiv.) in DCM (2 mL). Bromoform (100 mmol) in DCM (10 mL) was added dropwise over 1 hour. The reaction was allowed to stir vigorously at 25 ℃ for 24 hours, after which the mixture was extracted with DCM (3 x 100 mL). The combined organic layers were washed with brine (2 x 100 mL), dried over $MgSO_4$ and concentrated under reduced pressure. The product **1C** was purified by flash column chromatography (eluent: PE).

A solution of ethylmagnesium bromide (75 mmol, 1.5 equiv.) was added dropwise over an hour to a stirring solution of 2, 2-dibromocyclopropane **1C** (50 mmol, 1.0 equiv.), $Ti(O^iPr)_4$ (1.4 g, 5.0 mmol, 0.1 equiv.) and Et_2O (50 mL) and the resulting mixture was stirred for 3 hours at 25 ℃. The reaction was quenched by slow addition of water (20 mL) and 1 M HCl (30 mL), stirred for a further few minutes followed by the addition of Et_2O (30 mL). The aqueous layer was washed with Et_2O (3 x 20 mL), combined organic layers washed with saturated sodium bicarbonate (10 mL), brine (10 mL), dried over $MgSO_4$ and concentrated under reduced pressure. The crude oil was purified by flash column chromatography to afford **1D** (eluent: PE).

Potassium *tert*-butoxide (0.84 g, 7.5 mmol, 1.5 equiv.) and dimethyl sulfoxide (10 mL) were heated to 55 ℃ and allowed to stir for 30 minutes at this temperature until the mixture was homogenous. The solution was then cooled to 25 ℃. 2-Bromocyclopropane **1D** (5.0 mmol, 1.0 equiv.) in DMSO (5.0 mL) was added to the reaction mixture over 3 hours and allowed to stir at 25 ℃ for 20 hours. The reaction was quenched with brine (50 mL) and PE (50 mL) and layers partitioned. The aqueous layer was washed with PE (3 x 50 mL) and combined organic layers washed with brine (2 x 50 mL), dried over $MgSO_4$ and concentrated under reduced pressure. The product was purified by flash column chromatography (eluent: PE) to afford cyclopropenes **1a-1t**.

The spectroscopic properties of these compounds were consistent with literature data: 1a – 1h, 1j;[2] 1i, 1k, 1m - 1t;[3] 1l.[4]

---

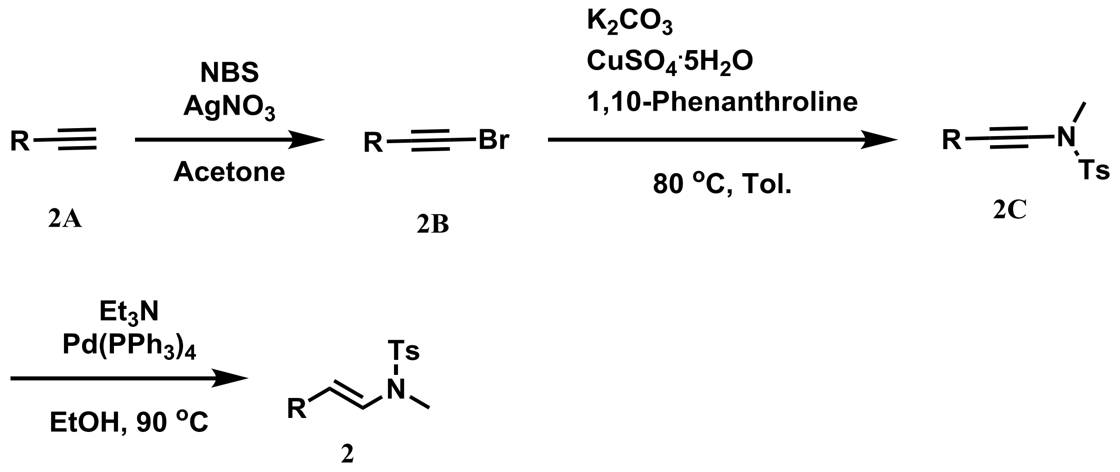
[2] P. Guo, W. Sun, Y. Liu, Y.-X. Li, T.-P. Loh and Y. Jiang, Stereoselective Synthesis of Vinylcyclopropa[*b*]indolines via a Rh-Migration Strategy. *Org. Lett.*, 2020, **22**, 5978−5983.

[3] J. Chen, P. Guo, J. Zhang, J. Rong, W. Sun, Y. Jiang and T.-P. Loh, Synthesis of Functionalized α-Vinyl Aldehydes from Enaminones. *Angew. Chem., Int. Ed.,* 2019, **58**, 12674–12679.

[4] C. Jiang, J. Wu, J. Han, K. Chen, Y. Qian, Z. Zhang and Y. Jiang, An expedient synthesis of highly functionalized 1,3-dienes by employing cyclopropenes as C4 units. *Chem. Commun.,* 2021, **57**, 5710–5713.

[5] A. S. Reddy and K. C. K. Swamy, Ethanol as a Hydrogenating Agent: Palladium-Catalyzed Stereoselective Hydrogenation of Ynamides To Give Enamides. *Angew. Chem., Int. Ed.,* 2017, **56**, 6984–6988.

General procedure for the synthesis of enamides[5]

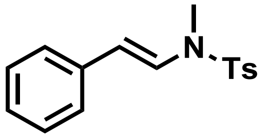


To a solution of the alkyne **2A** (5.0 mmol, 1.0 equiv.) in anhydrous acetone (conc. = 0.30 M) were added *N*-bromosuccinimide (1.07 g, 6.0 mmol, 1.2 equiv.) and $AgNO_3$ (0.085g, 0.5 mmol, 10 mol %). The mixture was stirred at room temperature for 1.0 h. The resulting mixture was then filtrated, and the filtrate was extracted with CH_2Cl_2 (3 x 30 mL). The combined organic layers were washed with 1 M HCl (2 x 40 mL), brine (30 mL), dried (Na_2SO_4) and concentrated under vacuum (25 ℃, 15 mbar) to afford the title compounds **2B**.

Copper(II) sulfate pentahydrate (100 mg, 0.40 mmol, 10 mol %), 1,10-phenanthroline (144 mg, 0.8 mmol, 20 mmol %), potassium carbonate (898 mg, 8.0 mmol, 2.0 equiv.), and *N*-methyl-4-methylbenzenesulfonamide (963 mg, 5.2 mmol, 1.3 equiv.) were placed in a 50 mL reaction flask. The flask was filled with argon by using a standard Schlenk technique. To the flask, a toluene solution (conc = 0.20 M) of bromoethyne (4 mmol, 1.0 equiv) was added. The resulting mixture was stirred for 12 h at 80 ˚C. The reaction was quenched with water (20 mL), and the product was extracted with ethyl acetate (3 x 10 mL). The combined organic layer was dried over sodium sulfate and concentrated in vacuo. The product **2C** was isolated by flash column chromatography (eluent: hexane/ ethyl acetate = 5:1).

To an oven dried Schlenk tube was added *N*-ethynyl-*N*-4-dimethylbenzenesulfonamide **2C** (3.0 mmol, 1.0 equiv.), $Pd(PPh_3)_4$ (173 mg, 0.15 mmol, 5 mol %), ethanol (conc. = 0.20 M) and Et_3N (911 mg, 9.0 mmol, 3.0 equiv.). The tube was sealed under nitrogen atmosphere and heated at 90 ^{o}C (oil bath temperature) overnight. After completion of the reaction as monitored by TLC, the crude mixture was cooled to room temperature. The mixture was then passed through celite, washed with ethyl acetate (20 mL) and concentrated in vacuum. The residue was then purified by using silica gel column chromatography using PE/EtOAc (9:1) as the eluent to afford (*E*)-*N*-4-dimethyl-*N*-styrylbenzenesulfonamide **2a**. Compounds **2a-o** were prepared following the same procedure and the same molar quantities.

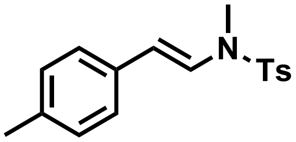
(*E*)-*N*-4-Dimethyl-*N*-styrylbenzenesulfonamide (2a):



The title compound was prepared according to the general procedure. The product was obtained as white solid in 61% yield (0.878 g, 3.05 mmol); Mp. 92 – 93 ^{o}C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.0 Hz, 1H), 7.52 (d, *J* = 16.0 Hz, 1H), 7.31 – 7.29 (m, 6H), 7.26 (s, 1H), 7.21 – 7.16 (m, 1H), 5.67 (d, *J* = 16.0 Hz, 1H), 3.00 (s, 3H), 2.41

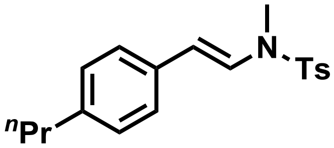
(s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.9, 136.2, 134.4, 129.8, 128.6, 128.1, 126.9, 126.4, 125.4, 110.8, 32.1, 21.4; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{16}H_{18}NO_2S$: 288.1058. Found: 288.1067.

(*E*)-*N*-4-Dimethyl-*N*-(4-methylstyryl)benzenesulfonamide (2b):



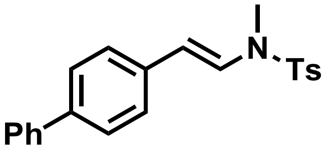
The title compound was prepared according to the general procedure. The product was obtained as white solid in 60% yield (0.906 g, 3.00 mmol); Mp. 112 – 113 °C; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.64 (d, *J* = 8.3 Hz, 2H), 7.45 (d, *J* = 14.5 Hz, 1H), 7.29 – 7.25 (m, 2H), 7.18 (d, *J* = 8.1 Hz, 2H), 7.09 (d, *J* = 8.0 Hz, 2H), 5.64 (d, *J* = 14.4 Hz, 1H), 2.97 (s, 3H), 2.39 (s, 3H), 2.31 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.9, 136.3, 134.5, 133.4, 129.8, 129.4, 127.4, 127.0, 125.4, 111.0, 32.2, 21.5, 21.1; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{17}H_{20}NO_2S$: 302.1215. Found: 302.1224.

(*E*)-*N*-4-Dimethyl-*N*-(4-propylstyryl)benzenesulfonamide (2c):



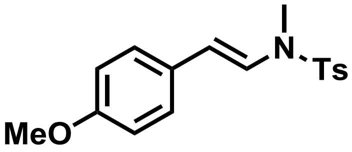
The title compound was prepared according to the general procedure. The product was obtained as yellow solid in 62% yield (1.023 g, 3.10 mmol); Mp. 42 – 43 °C; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.64 (d, *J* = 8.3 Hz, 2H), 7.46 (d, *J* = 14.5 Hz, 1H), 7.29 – 7.25 (m, 2H), 7.20 (d, *J* = 8.2 Hz, 2H), 7.10 (d, *J* = 8.1 Hz, 2H), 5.64 (d, *J* = 14.4 Hz, 1H), 2.97 (s, 3H), 2.56 – 2.53 (m, 2H), 2.39 (s, 3H), 1.64 – 1.59 (q, *J* = 7.4 Hz, 2H), 0.93 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.9, 141.2, 134.5, 133.7, 129.8, 128.8, 127.5, 127.0, 125.4, 111.0, 37.7, 32.2, 24.5, 21.5, 13.8; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{24}NO_2S$: 330.1528. Found: 330.1518.

(*E*)-*N*-(2-([1,1'-Biphenyl]-4-yl)vinyl)-*N*-4-dimethylbenzenesulfonamide (2d):



The title compound was prepared according to the general procedure. The product was obtained as white solid in 60% yield (1.092 g, 3.00 mmol); Mp. 158 – 159 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.2 Hz, 2H), 7.58 (dd, J_1 = 6.4 Hz, J_2 =2.4 Hz, 2H), 7.53 (d, *J* = 8.7 Hz, 2H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.37 – 7.28 (m, 5H), 5.70 (d, *J* = 14.5 Hz, 1H), 3.01 (s, 1H), 2.40 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.0, 140.6, 139.2, 135.4, 134.5, 129.9, 128.8, 128.2, 127.3, 127.2, 127.0, 126.8, 125.8, 110.3, 32.2, 21.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{22}H_{22}NO_2S$: 364.1371. Found: 364.1376.

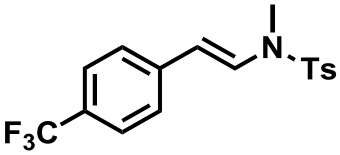
(*E*)-*N*-(4-Methoxystyryl)-*N*-4-dimethylbenzenesulfonamide (2e):



The title compound was prepared according to the general procedure. The product was obtained as yellow oil in 58% yield (0.922 g, 2.90 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.3 Hz, 2H), 7.36 (d, *J* = 14.5 Hz, 1H), 7.28 (d, *J* = 8.1 Hz, 2H), 7.22 –

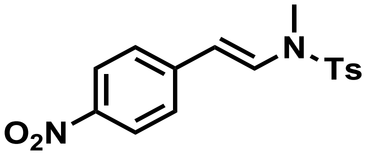
7.20 (m, 2H), 6.83 (d, *J* = 8.7 Hz, 2H), 5.62 (d, *J* = 14.5 Hz, 1H), 3.79 (s, 3H), 2.96 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 158.4, 143.8, 134.4, 129.8, 128.8, 127.9, 126.9, 126.5, 114.1, 110.8, 55.2, 32.2, 21.4; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{17}H_{20}NO_3S$: 318.1164. Found: 318.1157.

(*E*)-*N*-4-Dimethyl-*N*-(4-(trifluoromethyl)styryl)benzenesulfonamide (2f):



The title compound was prepared according to the general procedure. The product was obtained as white solid in 56% yield (0.997 g, 2.80 mmol); Mp. 114 – 115°C; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.65 (d, *J* = 12.0 Hz, 2H), 7.60 (d, *J* = 14.5 Hz, 1H), 7.52 (d, *J* = 8.2 Hz, 2H), 7.36 (d, *J* = 8.2 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 5.65 (d, *J* = 14.4 Hz, 1H), 3.01 (s, 3H), 2.41 (s, 3H); ^{19}F NMR (376 MHz, CDCl$_3$) δ -62.3; ^{13}C NMR (100 MHz, CDCl$_3$) δ 144.3, 140.1, 134.5, 130.2, 130.0, 127.0, 125.6 (q, *J* = 3.8 Hz), 125.4, 108.9, 32.1, 21.6; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{17}H_{17}F_3NO_2S$: 356.0932. Found: 356.0929.

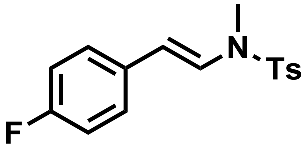
(*E*)-*N*-4-Dimethyl-*N*-(4-nitrostyryl)benzenesulfonamide (2g):



The title compound was prepared according to the general procedure. The product was obtained as yellow solid in 61% yield (1.016 g, 3.05 mmol); Mp. 137 – 138 °C; ^{1}H

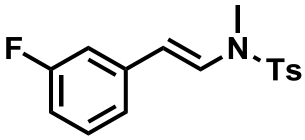
NMR (400 MHz, $CDCl_3$) δ 8.13 (d, *J* = 8.8 Hz, 2H), 7.71 (d, *J* = 14.4 Hz, 1H), 7.67 (d, *J* = 8. 4 Hz, 2H), 7.38 (d, *J* = 8.9 Hz, 2H), 7.33 – 7.31 (m, 2H), 5.67 (d, *J* = 14.4 Hz, 1H), 3.03 (s, 3H), 2.41(s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 145.8, 144.5, 143.5, 134.5, 131.9, 130.1, 127.0, 125.5, 124.3, 107.9, 32.1, 21.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{16}H_{17}N_2O_4S$: 333.0909. Found: 333.0902.

(*E*)-*N*-(4-Fluorostyryl)-*N*-4-dimethylbenzenesulfonamide (2h):



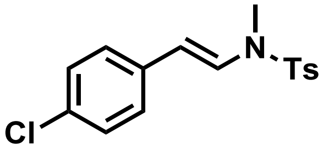
The title compound was prepared according to the general procedure. The product was obtained as black oil in 60% yield (0.918 g, 3.00 mmol); ^1H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 8.2 Hz, 2H), 7.52 (d, *J* = 14.4 Hz, 1H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.23 – 7.20 (m, 1H), 7.04 (d, *J* = 1.4 Hz, 1H), 6.98 – 6.95 (m, 1H), 6.84 (td, *J* = 8.4, 2.5 Hz, 1H), 5.62 (d, *J* = 14.4 Hz, 1H), 2.98 (s, 3H), 2.40 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.20; ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.0 (d, *J* = 245.0 Hz), 144.1, 138.7 (d, *J* = 8.1 Hz), 134.3, 130.0 (d, *J* = 8.7 Hz), 129.9, 129.1, 126.9, 121.1 (d, *J* = 2.9 Hz), 113.0 (d, *J* = 21.3 Hz), 111.8 (d, *J* = 22.3 Hz), 109.4 (d, *J* = 3.0 Hz), 32.0, 21.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{16}H_{17}FNO_2S$: 306.0964. Found: 306.0960.

(*E*)-*N*-(3-Fluorostyryl)-*N*-4-dimethylbenzenesulfonamide (2i):



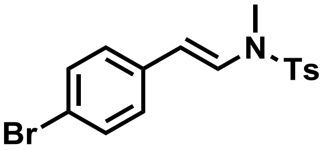
The title compound was prepared according to the general procedure. The product was obtained as yellow solid in 61% yield (0.933 g, 3.05 mmol); Mp. 55 – 56 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 8.4 Hz, 2H), 7.48 (d, J = 14.4 Hz, 1H), 7.29 (d, J = 8.3 Hz, 2H), 7.23 – 7.18 (m, 4H), 5.60 (d, J = 14.4 Hz, 1H), 2.98 (s, 3H), 2.40 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.2; ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.1, 134.9, 134.5, 131.9, 129.9, 128.8, 128.6, 127.0, 126.6, 109.4, 32.1, 21.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{16}H_{17}FNO_2S$: 306.0964. Found: 306.0958.

(*E*)-*N*-(4-Chlorostyryl)-*N*-4-dimethylbenzenesulfonamide (2j):



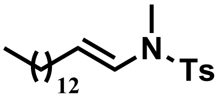
The title compound was prepared according to the general procedure. The product was obtained as yellow solid in 62% yield (0.998 g, 3.10 mmol); Mp. 113 – 114 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 8.2 Hz, 2H), 7.52 (d, J = 14.4 Hz, 1H), 7.30 (d, J = 8.0 Hz, 2H), 7.27 – 7.18 (m, 1H), 7.04 (d, J = 8.0 Hz, 1H), 6.97 (d, J = 8.0 Hz, 1H), 6.84 (td, J_1 = 2.5 Hz, J_2 = 8.3 Hz, 1H), 5.62 (d, J = 14.4 Hz, 1H), 2.99 (s, 3H), 2.40 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.1, 134.8, 134.5, 131.9, 129.9, 128.8, 128.6, 127.0, 126.6, 109.4, 32.1, 21.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{16}H_{17}ClNO_2S$: 322.0669. Found: 322.0674.

(*E*)-*N*-(4-Bromostyryl)-*N*-4-dimethylbenzenesulfonamide (2k):



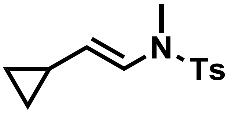
The title compound was prepared according to the general procedure. The product was obtained as white solid in 63% yield (1.163 g, 3.15 mmol); Mp. 77 – 78 ºC; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.64 (d, J = 8.3 Hz, 2H), 7.49 (d, J = 14.4 Hz, 1H), 7.38 (d, J = 8.4 Hz, 2H), 7.29 (d, J = 8.1 Hz, 2H), 7.13 (d, J = 8.4 Hz, 2H), 5.58 (d, J = 14.4 Hz, 1H), 2.97 (s, 3H), 2.39 (s, 3H). ^{13}C NMR (100 MHz, CDCl$_3$) δ 144.1, 135.3, 134.3, 131.6, 129.9, 128.6, 126.9, 119.8, 109.4, 32.1, 21.5; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{16}H_{17}BrNO_2S$: 366.0163. Found: 366.0156.

(*E*)-*N*-4-Dimethyl-*N*-(pentadec-1-en-1-yl)benzenesulfonamide (2l):



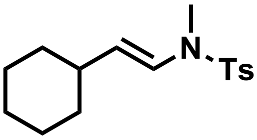
The title compound was prepared according to the general procedure. The product was obtained as white solid in 51% yield (1.005 g, 2.55 mmol); Mp. 41 – 42 ºC; ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.60 (d, J = 8.3 Hz, 2H), 7.27 (d, J = 8.1 Hz, 2H), 6.67 (d, J = 14.0, 1H), 4.67 (dt, J_1 = 14.0 Hz, J_2 = 7.2 Hz, 1H), 2.79 (s, 3H), 2.40 (s, 3H), 1.99 (q, J = 7.4 Hz, 2H), 1.31 – 1.22 (m, 22H), 0.86 (t, J = 6.3 Hz, 3H). ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.5, 134.3, 129.6, 127.5, 127.0, 112.1, 32.2, 31.9, 30.1, 30.0, 29.7, 29.6, 29.6, 29.4, 29.3, 28.9, 22.7, 21.5, 14.1; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{23}H_{40}NO_2S$: 394.2780. Found: 394.2788.

(*E*)-*N*-(2-Cyclopropylvinyl)-*N*-4-dimethylbenzenesulfonamide (2m):



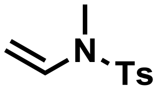
The title compound was prepared according to the general procedure. The product was obtained as yellow oil in 41% yield (0.517 g, 2.05 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 (d, J = 8.3 Hz, 2H), 7.30 – 7.28 (m, 2H), 6.76 (dd, J_1 = 14.0 Hz, J_2 = 0.7 Hz, 1H), 4.36 (dd, J_1 = 14.0 Hz, J_2 = 8.0 Hz, 1H), 2.77 (s, 3H), 2.41 (s, 3H), 1.38 – 1.30 (m, 1H), 0.69 – 0.64 (m, 2H), 0.28 – 0.24 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.5, 134.3, 129.6, 127.0, 126.2, 115.4, 32.2, 21.4, 11.5, 6.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{13}H_{18}NO_2S$: 252.1058. Found: 252.1052.

(*E*)-*N*-(2-Cyclohexylvinyl)-*N*-4-dimethylbenzenesulfonamide (2n):



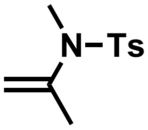
The title compound was prepared according to the general procedure. The product was obtained as yellow oil in 45% yield (0.661 g, 2.25 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, J = 8.3 Hz, 2H), 7.23 (d, J = 7.7 Hz, 2H), 6.63 (dd, J_1 = 14.2 Hz, J_2 = 1.1 Hz, 1H), 4.61 (dd, J_1 = 14.2 Hz, J_2 = 7.3 Hz, 1H), 2.72 (s, 3H), 2.33 (s, 3H), 1.94 – 1.85 (m, 1H), 1.66 – 1.54 (m, 5H), 1.25 – 1.14 (m, 2H), 1.11 – 0.92 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.3, 134.1, 129.4, 126.7, 125.9, 117.9, 38.5, 33.6, 32.9, 25.8, 25.7, 21.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{16}H_{24}NO_2S$: 294.1528. Found: 294.1534.

***N*-4-Dimethyl-*N*-vinylbenzenesulfonamide (2o):**



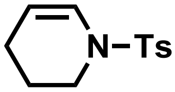
The product was obtained as colorless oil in 70% yield (0.742 g, 3.50 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (d, J = 6.5 Hz, 2H), 7.23 (d, J = 7.2 Hz, 2H), 6.95 – 6.88 (m, 1H), 4.25 (dd, J_1 = 9.0 Hz, J_2 = 1.6 Hz, 1H), 4.12 (dd, J_1 = 15.6 Hz, J_2 = 1.6 Hz, 1H), 2.78 (s, 3H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 134.4, 133.4, 129.5, 126.6, 93.0, 31.0, 21.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{10}H_{13}NO_2S$: 212.0745. Found: 212.0750.

_N_-4-Dimethyl-_N_-(prop-1-en-2-yl)benzenesulfonamide (2p):



The product was obtained as yellow oil in 71% yield (0.802 g, 3.55 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, J = 8.3 Hz, 2H), 7.26 (d, J = 7.9 Hz, 2H), 4.75 (d, J = 1.3 Hz, 1H), 4.48 (s, 1H), 2.91 (s, 3H), 2.38 (s, 3H), 1.91 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.9, 143.4, 134.2, 129.3, 127.5, 109.5, 37.1, 22.1, 21.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{11}H_{15}NO_2S$: 226.0902. Found: 226.0906.

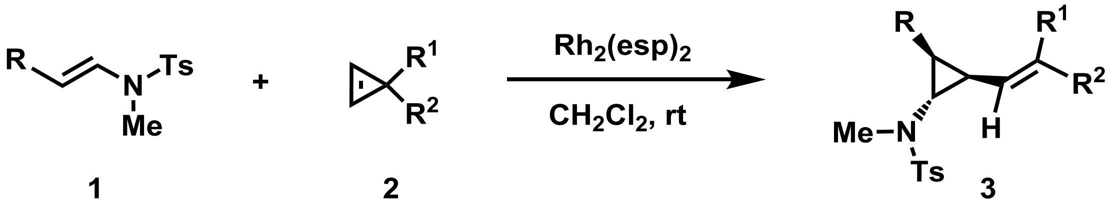
1-Tosyl-1,2,3,4-tetrahydropyridine (2q):



The product was obtained as colorless oil in 70% yield (0.833 g, 3.50 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, J = 8.3 Hz, 2H), 7.18 (d, J = 8.1 Hz, 2H), 6.50 (dt, J_1 =

8.4 Hz, J_2 = 2.0 Hz, J_3 = 2.0 Hz 1H), 4.85 – 4.81 (m, 1H), 3.24 – 3.21 (m, 2H), 2.26 (s, 3H), 1.76 – 1.72 (m, 2H), 1.52 – 1.46 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.1, 134.4, 129.2, 126.5, 124.4, 108.0, 43.3, 20.9, 20.4, 20.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{21}H_{15}NO_2S$: 238.0902. Found: 238.0910.

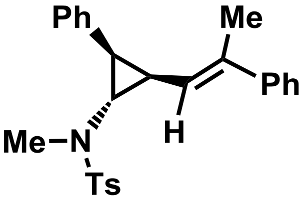
General procedure for the synthesis of the vinyl cyclopropylamides:



A mixture of enamide **1** (0.2 mmol, 1.0 equiv.), cyclopropane **2** (0.6 mmol, 3.0 equiv.) and $Rh_2(esp)_2$ (1.5 mg, 0.002 mmol, 1.0 mol %) was dissolved in CH_2Cl_2 (2.0 mL) in a Schlenk tube under N_2 protection. The mixture was stirred until the enamide **1** was consumed completely about 12 hours at room temperature. Then the mixture was concentrated directly under reduced pressure and purified by column chromatography (petroleum ether:ether acetate =19 : 1) to give the vinyl cyclopropylamide **3**.

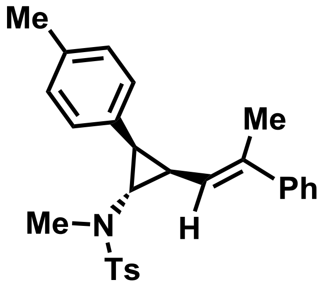
When the reaction was scaled up to 3.0 mmol, the Schlenk tube was replaced by Schlenk flask. An oven dried Schlenk tube was charged with **2a** (864 mg, 3.0 mmol, 1.0 equiv.), **1a** (1170 mg, 9.0 mmol, 3.0 equiv.) and $Rh_2(esp)_2$ (22.8 mg, 0.03 mmol, 1.0 mol %) in dichloromethane (0.10 M, 30 mL). The tube was then sealed without inert gas protection and reacted at room temperature until **1a** was consumed completely. Then resulting reaction mixture was diluted with dichloromethane, washed with water and brine. The organic layer was dried over anhydrous Na_2SO_4, filtered, and concentrated to give the crude product, which was purified through a flash column chromatography (eluent: 5% ethyl acetate in petroleum solution) to afford **3aa** (1.20 g, 2.881 mmol, 96% yield).

N-4-Dimethyl-*N*-((1*S*,2*R*,3*R*)-2-phenyl-3-((*E*)-2-phenylprop-1-en-1-yl)cyclopropyl) benzenesulfonamide (3aa):



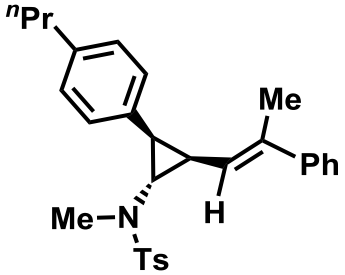
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3aa** as yellow oil in 93% yield (77.6 mg, 0.186 mmol, *E/Z* = 98:2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (d, *J* = 8.3 Hz, 2H), 7.33 – 7.28 (m, 4H), 7.25 – 7.16 (m, 8H), 5.09 & 4.82 (dd, J_1 = 9.5 Hz, J_2 = 1.4 Hz & dd, J_1 = 9.8 Hz, J_2 = 1.5 Hz, 1H), 2.89 (s, 3H), 2.86 (dd, J_1 = 10.1 Hz, J_2 = 4.3 Hz, 1H), 2.76 – 2.68 (m, 1H), 2.44 (s, 3H), 2.27 (t, *J* = 4.0 Hz, 1H), 2.22 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 143.1, 137.7, 136.1, 132.3, 129.6, 128.7, 128.2, 128.1, 128.0, 126.7, 126.5, 125.4, 123.2, 45.7, 37.3, 32.3, 28.7, 21.5, 16.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{28}NO_2S$: 418.1841. Found: 418.1848.

N-4-Dimethyl-*N*-((1*S*,2*R*,3*R*)-2-((*E*)-2-phenylprop-1-en-1-yl)-3-(*p*-tolyl)cyclopropyl) benzenesulfonamide (3ba):



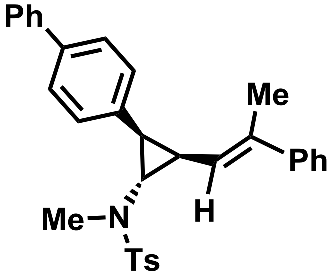
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ba** as yellow oil in 89% yield (76.7mg, 0.178 mmol, *E/Z* = 96:4); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, J = 8.1 Hz, 2H), 7.29 (d, J = 7.9 Hz, 2H), 7.25 – 7.21 (m, 2H), 7.19 – 7.16 (m, 3H) 7.10 – 7.02 (m, 4H), 5.09 & 4.80 (dd, J_1 = 9.6 Hz, J_2 = 1.6 Hz & dd, J_1 = 9.5 Hz, J_2 =1.7 Hz, 1H), 2.86 (s, 3H), 2.79 (dd, J_1 = 10.1 Hz, J_2 = 4.2 Hz, 1H), 2.68 – 2.62 (m, 1H), 2.41 (s, 3H), 2.29 (s, 3H), 2.22 (t, J = 3.9 Hz, 1H), 2.19 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 143.2, 137.5, 136.0, 133.0, 132.5, 129. 6, 128.9, 128.6, 128.0, 128.0, 126.6, 125.4, 123.4, 45.8, 37.3, 32.0, 28.7, 21.5, 21.0, 16.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{27}H_{30}NO_2S$: 432.1997. Found: 432.1992.

_N_-4-Dimethyl-_N_-((1_S_,2_R_,3_R_)-2-((_E_)-2-phenylprop-1-en-1-yl)-3-(4-propylphenyl) cyclopropyl) benzenesulfonamide (3ca):



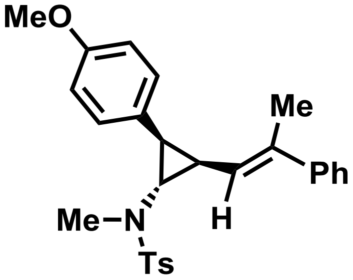
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ca** as yellow oil in 95% yield (87.2 mg, 0.190 mmol, *E/Z* = 94:6); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 8.2 Hz, 2H), 7.23 (d, *J* = 8.0 Hz, 2H), 7.16-7.14 (m, 2H), 7.12 – 7.08 (m, 3H), 6.98 (s, 4H), 4.98 & 4.73 (dd, J_1 = 9.6 Hz, J_2 = 1.4 Hz & dd, J_1 = 9.7 Hz, J_2 = 1.6 Hz, 1H), 2.79 (s, 3H), 2.72 (dd, J_1 = 10.1 Hz, J_2 = 4.2 Hz, 1H), 2.62 – 2.56 (m, 1H), 2.48 – 2.44 (m, 2H), 2.35 (s, 3H), 2.15 (t, *J* = 4.0 Hz, 1H), 2.13 (s, 3H), 1.54 – 1.52 (m, 2H), 0.84 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 143.3, 140.9, 137.5, 133.4, 132.5, 129.6, 128.6, 128.3, 128.1, 126.7, 125.5, 123.6, 45.9, 37.6, 37.3, 32.0, 28.7, 24.5, 21.5, 16.5, 13.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{29}H_{34}NO_2S$: 460.2310. Found: 460.2319.

_N_-((1_S_,2_R_,3_R_)-2-([1,1'-Biphenyl]-4-yl)-3-((_E_)-2-phenylprop-1-en-1-yl)cyclopropyl)-_N_-4-dimethylbenzenesulfonamide (3da):



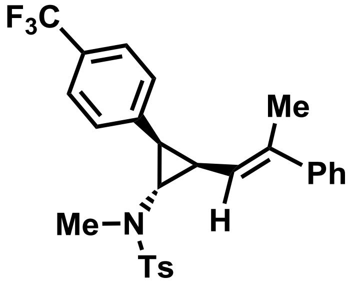
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3da** as yellow oil in 93% yield (91.7 mg, 0.186mmol, *E/Z* = 98:2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 8.1 Hz, 2H), 7.52 (d, *J* = 7.7 Hz, 2H), 7.45 (d, *J* = 8.1 Hz, 2H), 7.37 (t, *J* = 7.5 Hz, 2H), 7.28 – 7.25 (m, 2H), 7.20 – 7.13 (m, 8H), 5.08 & 4.81 (dd, J_1 = 9.4 Hz, J_2 = 1.3 Hz & d, J = 9.8 Hz, 1H), 2.84 (s, 3H), 2.81 (d, J = 8.0 Hz, 1H), 2.70 – 2.63 (m, 1H), 2.38 (s, 3H), 2.24 (t, J = 4.0 Hz, 1H), 2.16 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 143.2, 140.7, 139.3, 137.9, 135.4, 132.4, 129.6, 129.2, 128.7, 128.1, 128.1, 127.2, 126.9, 126.9, 126.8, 125.5, 123.1, 46.0, 37.4, 32.2, 28.9, 21.6, 16.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{32}H_{32}NO_2S$: 494.2154. Found: 494.2160.

***N*-((1*S*,2*R*,3*R*)-2-(4-Methoxyphenyl)-3-((*E*)-2-phenylprop-1-en-1-yl)cyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3ea):**



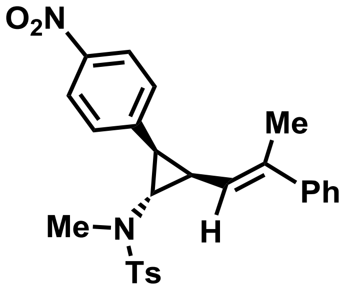
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ea** as yellow oil in 92% yield (82.2 mg, 0.184 mmol, *E/Z* = 97:3); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.60 (m, 2H), 7.24 – 7.22 (m, 2H), 7.19 – 7.15 (m, 2H), 7.12 – 7.09 (m, 3H), 7.01 – 6.99 (m, 2H), 6.74 – 6.71 (m, 2H), 4.98 & 4.69 (d, J = 9.6 Hz & d, J =9.9 Hz, 1H), 3.70 (s, 3H), 2.79 (s, 3H), 2.71 – 2.68 (m, 1H), 2.57 – 2.52 (m, 1H), 2.35 (s, 3H), 2.13 – 2.11 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.2, 143.7, 143.2, 137.4, 132.5, 129.9, 129.6, 128.2, 128.1, 128.1, 126.7, 125.4, 123.5, 113.6, 55.2, 46.0, 37.3, 31.7, 28.5, 21.5, 16.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{27}H_{30}NO_3S$: 448.1946. Found: 448.1943.

N-4-Dimethyl-N-((1S,2R,3R)-2-((E)-2-phenylprop-1-en-1-yl)-3-(4-(trifluoromethyl) phenyl)cyclopropyl) benzenesulfonamide (3fa):



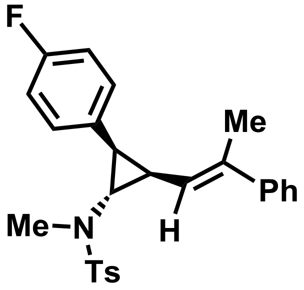
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3fa** as yellow oil in 92% yield (89.2 mg, 0.184 mmol, *E/Z* = 95:5); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.1 Hz, 2H), 7.52 (d, *J* = 8.1 Hz, 2H), 7.32 (d, *J* = 8.2 Hz, 2H), 7.26 – 7.19 (m, 5H), 7.16 – 7.14 (m, 2H), 5.05 & 4.78 (d, *J* = 9.2 Hz & d, *J* = 9.3 Hz, 1H), 2.92 - 2.89 (m, 1H), 2.87 (s, 3H), 2.74 – 2.67 (m, 1H), 2.44 (s, 3H), 2.30 (t, *J* = 4.1 Hz, 1H), 2.17 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.2; ^{13}C NMR (100 MHz, $CDCl_3$) δ 144.0, 142.9, 140.6, 138.9, 132.4, 129.7, 128.9, 128.2, 128.0, 127.0, 125.4, 125.1 (q, *J* = 4.1 Hz), 122.2, 45.9, 37.3, 32.6, 28.9, 21.5, 16.6; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.3; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{27}H_{27}NF_3O_2S$: 486.1715. Found: 486.1723.

N-4-Dimethyl-N-((1S,2R,3R)-2-(4-nitrophenyl)-3-((E)-2-phenylprop-1-en-1-yl)cyclopropyl)benzenesulfonamide (3ga):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:4) as the eluent the desired product **3ga** as yellow oil in 93% yield (85.9 mg, 0.186 mmol, *E/Z* = 98:2); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (d, J = 8.8 Hz, 2H), 7.65 (d, J = 8.2 Hz, 2H), 7.33 – 7.28 (m, 4H), 7.25 – 7.19 (m, 3H), 7.14 – 7.12 (m, 2H), 5.05 & 4.79 (dd, J_1 = 8.9 Hz, J_2 = 1.4 Hz & d, J = 8.9 Hz, 1H), 2.95 (dd, J_1 = 10.1 Hz, J_2 = 4.2 Hz, 1H), 2.86 (s, 3H), 2.75 – 2.70 (m, 1H), 2.44 (s, 3H), 2.35 (t, J = 4.1 Hz, 1H), 2.13 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.5, 144.5, 144.1, 142.6, 139.8, 132.3, 129.8, 129.2, 128.3, 128.0, 127.2, 125.4, 123.5, 121.4, 46.2, 37.2, 33.0, 29.5, 21.6, 16.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{27}N_2O_4S$: 463.1692. Found: 463.1700.

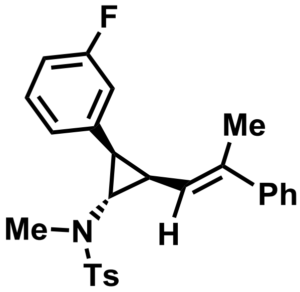
***N*-((1*S*,2*R*,3*R*)-2-(4-Fluorophenyl)-3-((*E*)-2-phenylprop-1-en-1-yl)cyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3ha):**



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the

eluent the desired product **3ha** as yellow oil in 88% yield (75.6 mg, 0.176 mmol, *E/Z* = 95:5); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, J = 8.1 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 7.25 – 7.22 (m, 2H), 7.20 – 7.11 (m, 5H), 6.95 (t, J = 8.6 Hz, 2H), 5.01 & 4.74 (dd, J_1 = 12.0 Hz, J_2 = 4.0 Hz & d, J = 9.5 Hz, 1H), 2.87 (s, 1H), 2.81 (dd, J_1 = 12.0 Hz, J_2 = 4.0 Hz, 1H), 2.68 – 2.60 (m, 1H), 2.43 (s, 1H), 2.21 (t, J = 3.9 Hz, 1H), 2.19 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -115.9; ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 143.0, 138.0, 132.5, 131.9 (d, J = 10.0 Hz), 130.3 (d, J = 8.1 Hz), 129.6, 128.2, 128.0, 126.8, 125.4, 123.0, 115.2, 115.0, 46.0, 37.3, 31.8, 28.4, 21.5, 16.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{27}NFO_2S$: 436.1747. Found: 436.1750.

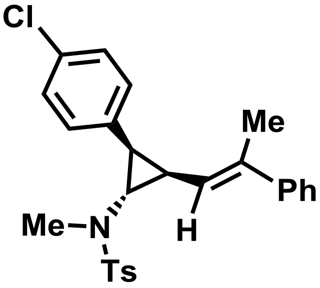
_N_-((1_S_,2_R_,3_R_)-2-(3-Fluorophenyl)-3-((_E_)-2-phenylprop-1-en-1-yl)cyclopropyl)-_N_-4-dimethylbenzenesulfonamide (3ia):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ia** as yellow oil in 85% yield (73.9 mg, 0.170 mmol, *E/Z* > 99:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, J = 8.1 Hz, 2H), 7.32 (d, J = 8.0 Hz, 2H), 7.26 – 7.15 (m, 6H), 6.95 – 6.82 (m, 3H), 5.03 (dd, J_1 = 9.4 Hz, J_2 = 1.6 Hz, 1H), 2.86 (s, 3H), 2.85 – 2.82 (m, 1H), 2.67 (td, J_1 = 9.8 Hz, J_2 = 3.7 Hz, 1H), 2.43 (s, 3H), 2.24

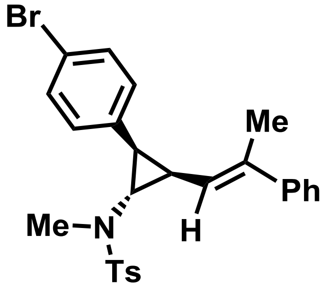
(t, *J* = 4.0 Hz, 1H), 2.18 (s, 3H); ^{19}F NMR (376 MHz, CDCl$_3$) *δ* -113.2; ^{13}C NMR (100 MHz, CDCl$_3$) *δ* 162.6 (d, *J* = 244.6 Hz), 143.5 (d, *J* = 87.4 Hz), 138.9 (d, *J* = 7.7 Hz), 138.4, 132.4, 129.7 (d, *J* = 7.1 Hz), 129.7, 128.2, 128.0, 126.9, 125.4, 124.5 (d, *J* = 3.1 Hz), 122.6, 115.5 (d, *J* = 21.6 Hz), 113.5 (d, *J* = 20.9 Hz), 45.8, 37.3, 32.3, 32.3, 28.9, 21.5, 16.6; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{26}H_{27}NFO_2S$: 436.1747. Found: 436.1743.

***N*-((1*S*,2*R*,3*R*)-2-(4-Chlorophenyl)-3-((*E*)-2-phenylprop-1-en-1-yl)cyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3ja):**



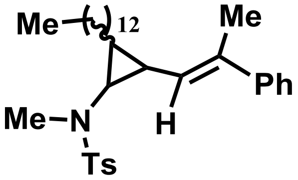
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R$_f$ = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ja** as yellow oil in 93% yield (83.3 mg, 0.186 mmol, *E/Z* = 94:6); ^{1}H NMR (400 MHz, CDCl$_3$) *δ* 7.67 (d, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 8.1 Hz, 2H), 7.25 – 7.22 (m, 4H), 7.19 – 7.15 (m, 3H), 7.09 (d, *J* = 8.5 Hz, 2H), 5.03 & 4.75 (dd, J_1 = 9.3 Hz, J_2 =1.7 Hz & d, *J* = 9.2 Hz, 1H), 2.86 (s, 3H), 2.81 (dd, J_1 = 12.0 Hz, J_2 = 4.0 Hz, 1H), 2.67 – 2.61 (m, 1H), 2.43 (s, 3H), 2.22 (t, *J* = 4.0 Hz, 1H), 2.17 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) *δ* 143.9, 143.0, 138.4, 134.8, 132.4, 132.3, 130.1, 129.7, 128.4, 128.2, 128.0, 126.9, 125.4, 122.6, 45.9, 37.3, 32.0, 28.6, 21.5, 16.6.; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{26}H_{27}NClO_2S$: 452.1451. Found: 452.1454.

N-((1*S*,2*R*,3*R*)-2-(4-Bromophenyl)-3-((*E*)-2-phenylprop-1-en-1-yl)cyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3ka):



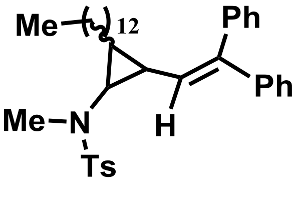
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ka** as yellow oil in 92% yield (91.1 mg, 0.184 mmol, *E/Z* = 99:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.2 Hz, 2H), 7.39 – 7.37 (m, 2H), 7.32 – 7.30 (m, 2H), 7.26 – 7.23 (m, 2H), 7.21 – 7.16 (m, 3H), 7.04 – 7.02 (m, 2H), 5.03 & 4.75 (d, *J* = 9.3 Hz & d, *J* = 9.6 Hz, 1H), 2.86 (s,3H), 2.80 (dd, J_1 = 10.1 Hz, J_2 = 4,2 Hz, 1H), 2.67 – 2.61 (m, 1H), 2.43 (s, 3H), 2.23 – 2.21 (m, 1H), 2.17 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.9, 142.9, 138.4, 135.4, 132.4, 131.3, 130.4, 129.7, 128.2, 128.0, 126.9, 125.4, 122.6, 120.4, 45.9, 37.3, 32.1, 28.6, 21.5, 16.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{27}NBrO_2S$: 496.0946. Found: 496.0954.

(*E*)-*N*-4-Dimethyl-*N*-(2-(2-phenylprop-1-en-1-yl)-3-tridecylcyclopropyl) benzenesulfonamide (3la):



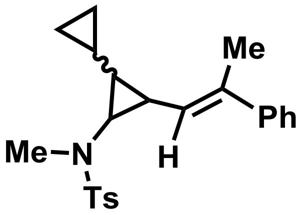
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.3$) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3la** as yellow oil in 91% yield (95.2 mg, 0.182 mmol, *d.r.* = 79:21); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 – 7.58 (m, 2H), 7.31 – 7.27 (m, 2H), 7.25 – 7.22 (m, 4H), 7.19 – 7.13 (m, 2H), 5.54 & 5.23 (dd, J_1 = 9.6 Hz, J_2 =1.4 Hz & dd, J_1 = 12.0 Hz, J_2 =4.0 Hz, 1H), 2.70 & 2.64 & 2.56 & 2.51(m, 1H), 2.68 & 2.60 (s, 3H), 2.37 & 2.36 (s, 3H), 2.19 – 2.14 & 1.99 – 1.97 (m, 1H), 2.11 & 2.04 (s, 3H), 1.50 – 1.47 (m, 1H), 1.20 – 1.15 (m, 24H), 0.80 (t, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.5, 137.4, 132.7, 129.5, 128.2, 128.0, 126.7, 125.4, 125.3, 124.0, 46.8, 44.8, 37.2, 31.9, 29.7, 29.6, 29.6, 29.6, 29.5, 29.4, 29.3, 29.0, 28.5, 27.7, 26.0, 22.7, 21.5, 16.3, 14.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{33}H_{50}NO_2S$: 524.3562. Found: 524.3566.

N-(2-(2,2-Diphenylvinyl)-3-ethylcyclopropyl)-N-4-dimethylbenzenesulfonamide (3la'):



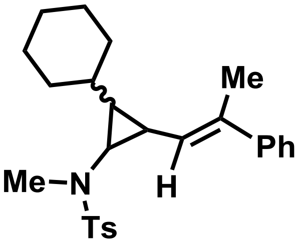
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.2$) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3la'** as yellow oil in 93% yield (111.5 mg, 0.186 mmol, *d.r.* = 75:45); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 – 7.68 (m, 2H), 7.40 – 7.15 (m, 12H), 5.90 & 5.57 (d, J = 10.3 Hz & d, J = 10.3 Hz, 1H), 2.76 & 2.63 (s, 3H), 2.44 & 2.43 (s, 3H), 1.99 – 1.93 & 1.73 –1.25 (m, 27H), 0.98 – 0.86 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 143.5, 143.4, 142.5, 142.1, 141.6, 140.2, 139.7, 132.9, 132.6, 130.1, 130.0, 129.5, 129.5, 128.3, 128.2, 128.1, 128.1, 128.0, 128.0, 127.3, 127.2, 127.1, 127.0, 126.9, 126.9, 125.7, 47.3, 45.4, 37.7, 37.0, 31.9, 31.7, 30.9, 29.7, 29.6, 29.6, 29.5, 29.3, 29.0, 28.4, 27.9, 26.6, 26.0, 22.7, 21.5, 21.5, 14.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{38}H_{52}NO_2S$: 586.3719. Found: 586.3724.

(*E*)-*N*-4-Dimethyl-*N*-(3-(2-phenylprop-1-en-1-yl)-[1,1'-bi(cyclopropan)]-2-yl)benzenesulfonamide (3ma):



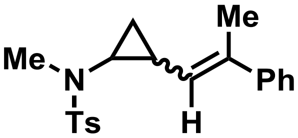
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ma** as yellow oil in 91% yield (69.3 mg, 0.182 mmol, *d.r.* = 80:20); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 & 7.71 (d, J = 8.1 Hz & d, J = 8.0 Hz, 2H), 7.36 – 7.30 (m, 6H), 7.24 – 7.19 (m, 1H), 5.56 & 5.45 (dd, J_1 = 9.6 Hz, J_2 = 1.5 Hz & J_1 = 9.4 Hz, J_2 = 1.5 Hz, 1H), 2.71 & 2.64 (s, 3H), 2.44 & 2.43 (m, 3H), 2.24 – 2.20 & 1.85 – 1.82 (m, 1H), 2.19 & 2.10 (s, 3H), 1.62 – 1.58 (m, 1H), 1.43 – 1.38 (m, 1H), 1.24 (s, 1H), 0.58 – 0.48 (m, 3H), 0.35 – 0.34 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.6, 143.4, 137.3, 132.4, 129.6, 128.2, 128.0, 126.7, 125.4, 124.2, 45.7, 37.3, 31.9, 26.4, 21.6, 16.4, 8.4, 4.8, 4.7; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{23}H_{28}NO_2S$: 382.1841. Found: 382.1838.

(*E*)-*N*-(2-Cyclohexyl-3-(2-phenylprop-1-en-1-yl)cyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3na):



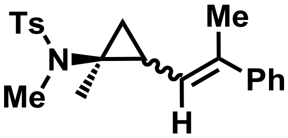
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3na** as yellow oil in 91% yield (76.5 mg, 0.182 mmol, *d.r.* = 82:18); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 & 7.69 (d, J = 8.3 Hz & d, J = 8.3 Hz, 2H), 7.38 – 7.28 & 7.26 – 7.19 (m, 7H), 5.61 & 5.32 (dd, J_1 = 9.6 Hz, J_2 = 1.3 Hz & dd, J_1 = 9.9 Hz, J_2 = 1.3 Hz, 1H), 2.75 & 2.70 (s, 3H), 2.43 & 2.42 (s, 3H), 2.37 (td, J = 9.9 Hz & td, J = 3.3 Hz, 1H), 2.21 & 2.13 (s, 3H), 2.07 – 2.04 & 1.78 – 1.59 & 1.23 – 1.00 & 0.92 – 0.82 (m, 13H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 143.5, 137.3, 132.7, 129.5, 128.2, 128.0, 126.6, 125.5, 124.1, 45.8, 37.3, 36.7, 34.1, 33.0, 32.1, 26.6, 26.2, 26.0, 25.9, 21.5, 16.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{34}NO_2S$: 424.2310. Found: 424.2302.

N-4-Dimethyl-*N*-(2-(2-phenylprop-1-en-1-yl)cyclopropyl)benzenesulfonamide (3oa):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3oa** as yellow oil in 92% yield (62.7 mg, 0.184 mmol, *d.r.* > 99:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.71 (d, *J* = 8.2 Hz, 2H), 7.37 – 7.28 (m, 6H), 7.23 - 7.20 (m, 1H), 5.57 (dd, J_1 = 9.7 Hz, J_2 = 1.5 Hz, 1H), 2.68 (s, 3H), 2.43 (s, 3H), 2.10 (s, 3H), 2.00 – 1.96 (m, 1H), 1.82 – 1.74 (m, 1H), 1.45 – 1.41 (m, 1H), 1.36 – 1.32 (m, 1H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.6, 143.1, 135.9, 132.6, 129.6, 128.2, 128.0, 126.7, 125.5, 125.4, 38.4, 37.7, 21.6, 17.7, 16.8, 16.2; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{26}H_{34}NO_2S$: 342.1528. Found: 342.1525.

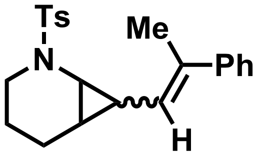
(*S*)-*N*-4-Dimethyl-*N*-(1-methyl-2-(2-phenylprop-1-en-1-yl)cyclopropyl)benzenesulfonamide (3pa):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3pa** as yellow oil in 83% yield (59.0 mg, 0.166 mmol, *d.r.* = 79:21); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.72 (d, *J* = 8.3 Hz, 2H), 7.44 – 7.42 (m, 1H), 7.36 – 7.31 (m, 5H), 7.25 – 7.20 (m, 1H), 5.83 & 5.32 (dd, J_1 = 8.2 Hz, J_2 = 1.4 Hz, 1H & dd, J_1 = 8.9 Hz, J_2 = 1.4 Hz, 1H), 2.87 & 2.83 (s, 3H), 2.43 & 2.41 (s, 3H), 2.21 &

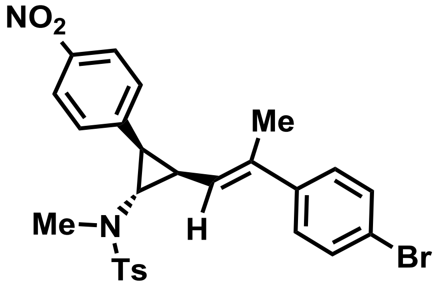
2.18 (s, 3H), 2.15 – 2.06 (m, 1H), 1.62 &1.29 (s, 3H), 1.16 – 1.11 & 1.58 – 1.55 (m, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 148.9, 143.6, 143.2, 138.0, 137.5, 129.5, 128.4, 128.2, 128.2, 127.4, 127.3, 126.7, 126.6, 125.9, 125.5, 125.2, 123.2, 41.4, 34.4, 34.0, 30.8, 29.6, 27.3, 22.8, 22.7, 21.5, 17.8, 16.6, 16.1; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{26}H_{34}NO_2S$: 356.1684. Found: 356.1680.

7-(2-Phenylprop-1-en-1-yl)-2-tosyl-2-azabicyclo[4.1.0]heptane (3qa):



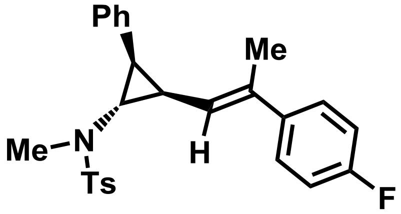
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.4$) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3qa** as yellow oil in 67% yield (51.1 mg, 0.134 mmol, *E/Z.* > 99:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.73 (d, J = 8.3 Hz, 2H), 7.30 – 7.27 (m, 4H), 7.25 – 7.19 (m, 3H), 5.52 (dd, J_1 = 6.9 Hz, J_2 = 1.3 Hz, 1H), 3.48 – 3.44 (m, 1H), 3.03 – 3.00 (m, 1H), 2.70 – 2.64 (m, 1H), 2.34 (s, 3H), 2.09 (s, 3H), 1.79 – 1.70 (m, 2H), 1.63 – 1.51 (m, 2H), 1.49 – 1.40 (m, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.2, 142.8, 137.9, 135.9, 129.5, 128.0, 127.2, 126.5, 125.3, 121.5, 43.3, 33.4, 23.6, 21.4, 20.4, 16.7, 16.5, 15.2; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{26}H_{34}NO_2S$: 368.1684. Found: 368.1680.

***N*-((1*S*,2*R*,3*R*)-2-((*E*)-2-(4-Bromophenyl)prop-1-en-1-yl)-3-(4-nitrophenyl)cyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3ra):**



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.3$) on silica gel using EtOAc/PE (1:4) as the eluent the desired product **3ra** as yellow solid in 95% yield (102.6 mg, 0.190 mmol, *E/Z* = 98:2); Mp. 52 – 53 °C; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (d, *J* = 8.7 Hz, 2H), 7.64 (d, *J* = 8.3 Hz, 2H), 7.34 – 7.25 (m, 6H), 6.99 (d, *J* = 8.5 Hz, 2H), 5.04 & 4.81 (dd, J_1 = 9.0 Hz, J_2 = 1.4 Hz & d, *J* = 9.9 Hz, 1H), 2.96 (dd, J_1 = 10.2 Hz, J_2 = 4.3 Hz, 1H), 2.86 (s, 3H), 2.74 – 2.68 (m, 1H), 2.43 (s, 3H), 2.36 (t, *J* = 4.2 Hz, 1H), 2.10 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 146.6, 144.4, 144.2, 141.4, 138.7, 132.4, 131.3, 129.8, 129.2, 128.0, 127.0, 123.5, 122.1, 121.1, 46.2, 37.2, 33.0, 29.5, 21.6, 16.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{26}N_2BrO_4S$: 541.0797. Found: 541.0791.

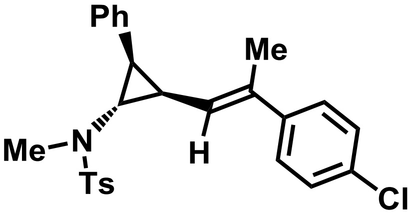
_N_-((1_S_,2_R_,3_R_)-2-((_E_)-2-(4-Fluorophenyl)prop-1-en-1-yl)-3-phenylcyclopropyl)-_N_-4-dimethylbenzenesulfonamide (3ab):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.2$) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ab** as yellow oil in 88% yield (76.7 mg, 0.176 mmol, *E/Z* =

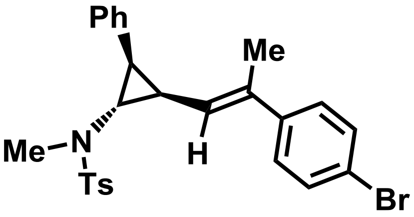
99:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.68 (d, *J* = 7.9 Hz, 2H), 7.32 – 7.25 (m, 4H), 7.22 – 7.19 (m, 1H), 7.15 – 7.09 (m, 4H), 6.93 – 6.89 (m, 2H), 4.99 & 4.09 (dd, J_1 = 9.4 Hz, J_2 = 1.6 Hz & d, *J* = 6.5 Hz, 1H), 2.87 (s, 3H), 2.83 (dd, J_1 = 10.1 Hz, J_2 = 4.3 Hz, 1H), 2.66 (td, J_1 = 9.8 Hz, J_2 = 3.6 Hz, 1H), 2.43 (s, 1H), 2.26 (t, *J* = 4.0 Hz, 1H), 2.17 (s, 3H); ^{19}F NMR (376 MHz, CDCl$_3$) δ -116.0; ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.8, 139.3 (d, *J* = 3.4 Hz), 136.8, 136.2, 132.5, 129.6, 128.8, 128.2, 128.1, 127.0, 126.9, 126.2, 123.2 (d, *J* = 1.9 Hz), 114.9 (d, *J* = 21.2 Hz), 45.7, 37.3, 32.4, 28.7, 21.5, 16.7; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{26}H_{27}NFO_2S$: 436.1747. Found: 436.1742.

N-((1S,2R,3R)-2-((E)-2-(4-Chlorophenyl)prop-1-en-1-yl)-3-phenylcyclopropyl)-N-4-dimethylbenzenesulfonamide (3ac):



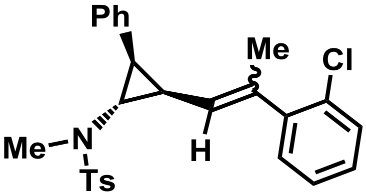
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R$_f$ = 0.2) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ac** as yellow oil in 93% yield (84.1 mg, 0.186 mmol, *E/Z* = 95:5); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.68 (d, *J* = 8.2 Hz, 2H), 7.34 – 7.28 (m, 3H), 7.25 – 7.21 (m, 2H), 7.20 – 7.13 (m, 4H), 7.08 – 7.06 (m, 2H), 5.04 & 4.82 (dd, J_1 = 9.5 Hz, J_2 = 1.5 Hz & dd, J_1 = 9.9 Hz, J_2 = 1.7 Hz, 1H), 2.87 (s, 3H), 2.86 – 2.82 (m, 1H), 2.72 – 2.64 (m, 1H), 2.43 (s, 1H), 2.27 (t, *J* = 4.0 Hz, 1H), 2.16 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 144.0, 141.7, 136.8, 136.2, 132.6, 129.8, 128.9, 128.4, 128.3, 128.2, 126.8, 126.7, 124.0, 45.9, 37.5, 32.6, 28.9, 21.7, 16.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{27}NClO_2S$: 452.1451. Found: 452.1446.

N-((1S,2R,3R)-2-((E)-2-(4-Bromophenyl)prop-1-en-1-yl)-3-phenylcyclopropyl)-N-4-dimethylbenzenesulfonamide (3ad):



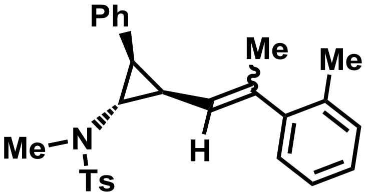
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.3$) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ad** as yellow oil in 95% yield (94.2 mg, 0.190 mmol, *E/Z* = 94:6); ^1H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 8.2 Hz, 2H), 7.34 – 7.24 (m, 6H), 7.21 – 7.12 (m, 3H), 7.01 (d, *J* = 8.0 Hz, 2H), 5.04 & 4.82 (d, *J* = 9.5 Hz & d, *J* = 9.9 Hz, 1H), 2.87 (s, 3H), 2.86 – 2.82 (m, 1H), 2.71 – 2.64 (m, 1H), 2.43 (s, 3H), 2.27 (t, *J* = 4.0 Hz, 1H), 2.16 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 142.0, 136.7, 136.1, 132.4, 131.1, 129.6, 128.7, 128.3, 128.0, 127.0, 126.6, 124.0, 120.5, 45.7, 37.3, 32.4 28.8, 21.5, 16.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{27}NBrO_2S$: 496.0946. Found: 496.0938.

N-((1S,2R,3R)-2-(2-(2-Chlorophenyl)prop-1-en-1-yl)-3-phenylcyclopropyl)-N-4-dimethylbenzenesulfonamide (3ae):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ae** as yellow oil in 93% yield (84.1 mg, 0.186 mmol, *E/Z* = 82:18); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 & 7.65 (d, *J* = 8.1 Hz & d, *J* = 8.0 Hz, 2H), 7.41 (d, *J* = 7.6 Hz, 1H), 7.33 – 7.27 (m, 5H), 7.25 – 7.15 (m, 4H), 7.13 – 7.10 & 6.95 – 6.92 (m, 1H), 4.82 & 4.70 (d, *J* = 10.0 Hz & dd, J_1 = 8.9 Hz, J_2 = 1.6 Hz, 1H), 2.89 & 2.63 (s, 3H), 2.81 – 2.71 (m, 1H), 2.44 & 2.43 (s, 3H), 2.26 & 2.19 (t, *J* = 4.0 Hz & t, *J* = 4.0 Hz, 1H), 2.16 & 1.87 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 143.7, 143.6, 140.5, 137.9, 136.4, 136.1, 132.8, 132.4, 132.1, 130.2, 129.9, 129.7, 129.6, 129.4, 128.9, 128.4, 128.2, 128.2, 128.2, 128.0, 127.9, 127.0, 126.5, 126.4, 126.2, 45.5, 44.8, 37.4, 36.8, 31.8, 28.3, 21.5, 18.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{26}H_{27}NClO_2S$: 452.1451. Found: 452.1454.

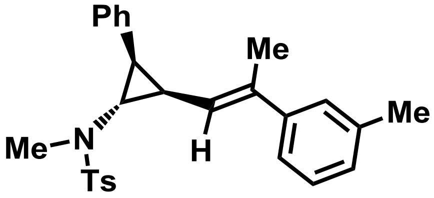
N-4-Dimethyl-N-((1S,2R,3R)-2-phenyl-3-(2-(o-tolyl)prop-1-en-1-yl)cyclopropyl) benzenesulfonamide (3af):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the

eluent the desired product **3af** as yellow oil in 93% yield (80.5 mg, 0.186 mmol, *E/Z* = 78:22); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.72 & 7.64 (d, *J* = 8.2 Hz & d, *J* = 8.1 Hz, 2H), 7.34 – 7.29 (m, 4H), 7.26 – 7.16 (m, 5H), 7.12 – 7.05 & 6.92 – 6.90 (m, 2H), 4.80 & 4.62 (dd, J_1 = 10.0 Hz, J_2 = 1.7 Hz & dd, J_1 = 8.9 Hz, J_2 = 1.6 Hz, 1H), 2.87 & 2.59 (s, 3H), 2.80 – 2. 68 (m, 1H), 2.44 & 2.43 (s, 3H), 2.27 (t, *J* = 4.0 Hz, 1H), 2.23 & 2.06 (s, 3H), 2.22 – 2.20 (m, 1H), 1.82 (s, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 144.9, 143.8, 143.6, 139.6, 136.6, 136.3, 134.7, 132.9, 132.5, 130.1, 129.9, 129.5, 128.7, 128.2, 128.2, 128.1, 128.1, 128.0, 128.0, 126.9, 126.5, 126.4, 126.3, 125.9, 125.4, 124.5, 122.5, 45.3, 37.4, 36.6, 32.6, 31.9, 29.7, 28.6, 27.8, 21.5, 19.6, 19.1, 18.8; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{27}H_{30}NO_2S$: 432.1997. Found: 432.2004.

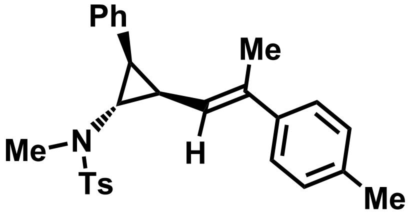
_N_-4-Dimethyl-_N_-((1_S_,2_R_,3_R_)-2-phenyl-3-((_E_)-2-(_m_-tolyl)prop-1-en-1-yl)cyclopropyl) benzenesulfonamide (3ag):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ag** as colorless oil in 91% yield (80.4 mg, 0.182 mmol, *E/Z* = 99:1); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.69 (d, *J* = 8.3 Hz, 2H) 7.31 – 7.24 (m, 4H), 7.21 – 7.10 (m, 4H), 7.00 – 6.94 (m, 3H), 5.05 (dd, J_1 = 9.4 Hz, J_2 = 1.5 Hz, 1H), 2.88 (s, 3H), 2.83 (dd, J_1 = 10.1 Hz, J_2 = 4.4 Hz, 1H), 2.67 (td, J_1 = 9.8 Hz, J_2 = 3.8 Hz, 1H), 2.43 (s, 3H), 2.28 (s, 3H), 2.26 (t, *J* = 4.0 Hz, 1H), 2.17 (s, 3H); ^{13}C NMR (100 MHz,

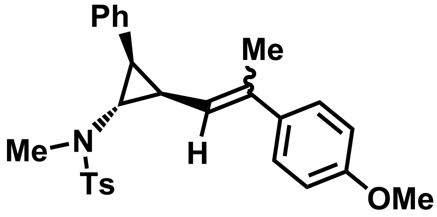
$CDCl_3$) δ 143.7, 143.3, 137.9, 137.6, 136.3, 132.6, 129.6, 128.8, 128.2, 128.1, 128.0, 127.5, 126.5, 126.3, 123.1, 122.6, 45.9, 37.3, 32.4, 28.7, 21.5, 21.4, 16.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{27}H_{30}NO_2S$: 432.1997. Found: 432.1993.

_N_-4-Dimethyl-_N_-((1_S_,2_R_,3_R_)-2-phenyl-3-((_E_)2-(_p_-tolyl)prop-1-en-1-yl)cyclopropyl) benzenesulfonamide (3ah):



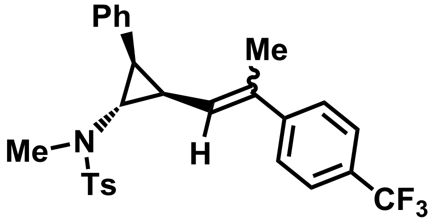
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ah** as yellow oil in 89% yield (77.1 mg, 0.178 mmol, *E/Z* = 98:2); ^1H NMR (400 MHz, $CDCl_3$) δ 7.70 – 7.67 (m, 2H), 7.31 – 7.28 (m, 2H), 7.27 – 7.23 (m, 2H), 7.20 – 7.13 (m, 4H), 7.08 – 7.02 (m, 3H), 5.04 & 4.77 (d, *J* = 9.4 Hz & *J* = 9.7 Hz, 1H), 2.87 (s, 3H), 2.82 (dd, J_1 = 10.2 Hz, J_2 = 4.2 Hz, 1H), 2.73 – 2.64 (m, 1H), 2.42 (s, 3H), 2.29 (s, 3H), 2.24 (t, *J* = 3.9 Hz, 1H), 2.17 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.7, 140.3, 137.6, 136.4, 136.3, 132.4, 129.6, 128.8, 128.8, 128.2, 128.1, 126.4, 125.3, 122.3, 45.8, 37.3, 32.4, 28.7, 21.5, 20.9, 16.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{27}H_{30}NO_2S$: 432.1997. Found: 432.1993.

_N_-((1_S_,2_R_,3_R_)-2-(2-(4-Methoxyphenyl)prop-1-en-1-yl)-3-phenylcyclopropyl)-_N_-4-dimethylbenzenesulfonamide (3ai):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ai** as yellow oil in 93% yield (76.0 mg, 0.186 mmol, *E/Z* = 93:7); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 8.3 Hz, 2H), 7.23 – 7.19 (m, 2H), 7.18 – 7.16 (m, 2H), 7.13 – 7.00 (m, 5H), 6.83 – 6.81 & 6.71 – 6.67 (m, 2H), 4.91 & 4.68 (dd, J_1 = 9.4 Hz, J_2 = 1.4 Hz & dd, J_1 = 9.5 Hz, J_2 = 1.6 Hz, 1H), 3.68 (s, 3H), 2.79 (s, 3H), 2.74 (dd, J_1 = 10.1 Hz, J_2 = 4.2 Hz, 1H), 2.63 – 2.56 (m, 1H), 2.35 (s, 3H), 2.16 (t, *J* = 4.0 Hz, 1H), 2.08 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.5, 143.7, 137.0, 136.3, 135.7, 132.4, 129.6, 128.8, 128.2, 128.1, 126.4, 121.5, 113.4, 55.2, 45.8, 37.3, 32.3, 28.7, 21.5, 16.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{27}H_{30}NO_3S$: 448.1946. Found: 448.1943.

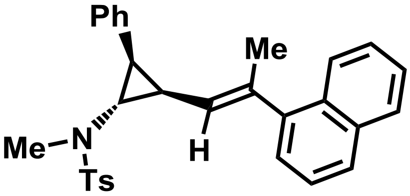
N-4-Dimethyl-*N*-((1*S*,2*R*,3*R*)-2-phenyl-3-(2-(4-(trifluoromethyl)phenyl)prop-1-en-1-yl)cyclopropyl) benzenesulfonamide (3aj):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the

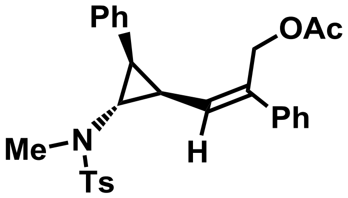
eluent the desired product **3aj** as yellow oil in 91% yield (83.4 mg, 0.182 mmol, *E/Z* = 91:9); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.68 & 7.61 (d, *J* = 8.0 Hz & d, *J* = 7.9 Hz, 2H), 7.47 & 7.41 (d, *J* = 8.2 Hz & d, *J* = 8.0 Hz, 2H), 7.32 – 7.30 (m, 3H), 7.25 – 7.19 (m, 4H), 7.15 – 7.14 (m, 2H), 5.12 & 4.89 (d, *J* = 9.5 Hz & d, *J* = 10.0 Hz, 1H), 2.88 (s, 3H), 2.86 – 2. 85 (m, 1H), 2.73 – 2.68 (m, 1H), 2.43 (s, 3H), 2.31 (t, *J* = 4.0 Hz, 1H), 2.21 (s, 3H); ^{19}F NMR (376 MHz, CDCl$_3$) δ -62.2, -62.3; ^{13}C NMR (100 MHz, CDCl$_3$) δ 146.6, 143.9, 136.6, 135.9, 132.4, 129.7, 128.7, 128.5, 128.3, 128.0, 126.7, 125.6, 125.6, 125.1 (q, *J* = 4.0 Hz), 45.7, 37.3, 32.5, 28.8, 21.5, 16.3; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{27}H_{27}NF_3O_2S$: 486.1715. Found: 486.1712.

***N*-4-Dimethyl-*N*-((1*S*,2*R*,3*R*)-2-(2-(naphthalen-1-yl)prop-1-en-1-yl)-3-phenylcyclopropyl) benzenesulfonamide (3ak):**



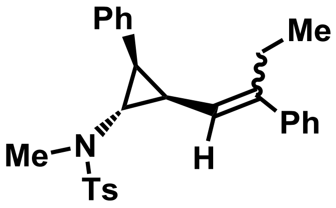
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ak** as yellow oil in 45% yield (41.9 mg, 0.090 mmol, *E/Z* = 98:2); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.75 – 7.66 (m, 5H), 7.61 (s, 1H), 7.45 – 7.37 (m, 2H), 7.31 – 7.27 (m, 4H), 7.26 – 7.25 (m, 1H), 7.22 – 7.17 (m, 3H), 5.22 & 4.89 (dd, J_1 = 9.5 Hz, J_2 = 1.4 Hz & d, *J* = 9.9 Hz, 1H), 2.89 (s, 3H), 2.88 – 2.86 (m, 1H), 2.77 – 2.69 (m, 1H), 2.42 (s, 3H), 2.31 – 2.29 (m, 4H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.8, 140.3, 137.5, 136.3, 133.3, 132.5, 132.4, 129.6, 128.8, 128.3, 128.1, 128.0, 127.6, 127.4, 126.6, 126.1, 125.5, 124.0, 124.0, 123.9, 45.9, 37.4, 32.6, 28.9, 21.5, 16.5; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{30}H_{30}NO_2S$: 468.1997. Found: 468.1992.

(*Z*)-3-((1*R*,2*S*,3*R*)-2-((*N*-4-Dimethylphenyl)sulfonamido)-3-phenylcyclopropyl)-2-phenylallyl acetate (3al):



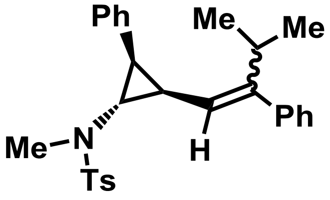
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.2$) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3al** as yellow oil in 83% yield (48.9 mg, 0.166 mmol, *E/Z* > 99:1); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 8.0 Hz, 2H), 7.25 – 7.13 (m, 8H), 7.11 – 7.07 (m, 4H), 5.17 (d, *J* = 10.0 Hz, 1H) 5.15 – 5.03 (m, 2H), 2.85 – 2.82 (m, 1H), 2.81 (s, 3H), 2.75 – 2.69 (td, J_1 = 10.1 Hz, J_2 = 3.6 Hz, 1H) 2.36 (s, 3H), 2.28 (t, *J* = 4.0 Hz, 1H), 1.95 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 171.2, 144.0, 140.2, 136.6, 135.8, 132.7, 130.2, 129.8, 129.0, 128.5, 128.5, 128.2, 127.4, 127.0, 126.0, 61.6, 45.9, 37.3, 33.0, 28.3, 21.7, 21.1; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{28}H_{30}NO_4S$: 476.1896. Found: 476.1893.

***N*-4-Dimethyl-*N*-((1*S*,2*R*,3*R*)-2-phenyl-3-(2-phenylbut-1-en-1-yl)cyclopropyl) benzenesulfonamide (3am):**



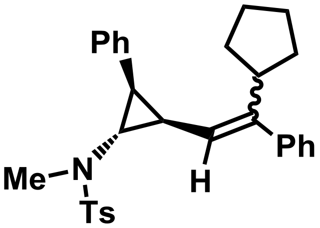
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3am** as yellow oil in 96% yield (82.8 mg, 0.192 mmol, *E/Z* = 88:12); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.69 (d, *J* = 8.0 Hz, 2H), 7.31 – 7.29 (m, 3H), 7.25 – 7.18 (m, 5H), 7.16 – 7.12 (m, 4H), 4.92 & 4.73 (d, *J* = 9.6 Hz & d, *J* = 9.8 Hz, 1H), 2.87 (s, 3H), 2.82 (dd, J_1 = 10.1 Hz, J_2 = 4.3 Hz, 1H), 2.74 – 2.59 (m, 4H), 2.42 (s, 3H), 2.26 – 2.24 (t, *J* = 4.0 Hz, 1H), 1.02 & 0.81 (t, *J* = 7.6 Hz & t, *J* = 7.4 Hz, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 144.4, 143.7, 142.1, 136.2, 132.3, 129.6, 128.7, 128.1, 128.1, 128.0, 126.6, 126.5, 126.0, 122.9, 45.8, 37.3, 32.4, 28.3, 23.4, 21.5, 13.5; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{27}H_{30}NO_2S$: 432.1997. Found: 432.1992.

***N*-4-Dimethyl-*N*-((1*S*,2*R*,3*R*)-2-(3-methyl-2-phenylbut-1-en-1-yl)-3-phenylcyclopropyl) benzenesulfonamide (3an):**



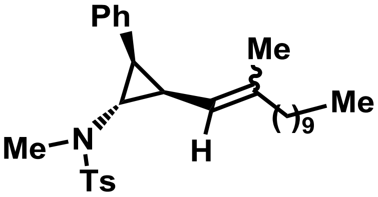
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3an** as yellow oil in 81% yield (72.1 mg, 0.162 mmol, *E/Z* = 55:45); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.70 & 7.66 (d, *J* = 8.3 Hz & d, *J* = 8.2 Hz, 2H), 7.36 – 7.27 (m, 4H), 7.25 – 7.10 (m, 7H), 6.97 – 6.95 (m, 1H), 4.68 & 4.61 (dd, J_1 = 9.8 Hz, J_2 = 1.1 Hz & d, J = 8.8 Hz, 1H), 3.21 – 3.14 & 2.74 – 2.68 (m, 1H), 2.86 & 2.66 (s, 3H), 2.80 – 2.76 & 2.63 – 2.60 (m, 1H), 2.47 – 2.45 & 2.42 – 2.38 & 2.07 – 2.01 (m, 1H), 2.44 & 2.43 (s, 3H), 2.25 & 2.19 (t, J = 4.0 Hz, 1H), 1.14 & 0.81 (d, J = 7.0 Hz & d, J = 6.8 Hz, 3H), 0.89 & 0.87 (d, J = 5.3 Hz & d, J = 5.2Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.3, 150.3, 143.7, 143.6, 142.5, 140.7, 136.6, 136.3, 132.9, 132.4, 129.6, 129.5, 128.8, 128.8, 128.7, 128.4, 128.1, 128.1, 128.0, 127.4, 126.6, 126.4, 126.3, 126.3, 123.6, 120.1, 46.0, 45.7, 37.3, 36.9, 35.8, 32.7, 32.4, 30.0, 27.8, 27.6, 21.8, 21.7, 21.5, 21.4; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{28}H_{32}NO_2S$: 446.2154. Found: 446.2157.

_N_-((1_S_,2_R_,3_R_)-2-(2-Cyclopentyl-2-phenylvinyl)-3-phenylcyclopropyl)-_N_-4-dimethylbenzenesulfonamide (3ao):



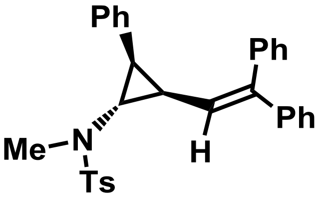
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ao** as yellow oil in 55% yield (51.8 mg, 0.110 mmol, *E/Z* = 85:15); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 & 7.64 (d, J = 8.2 Hz & d, J = 8.0 Hz, 2H), 7.35 – 7.27 (m, 6H), 7.23 – 7.11 & 6.95 – 6.93 (m, 6H), 4.71 & 4.65 (dd, J_1 = 9.8 Hz, J_2 = 1.3 Hz & d, J = 8.7 Hz, 1H), 3.21 – 3.12 & 2.58 – 2.50 (m, 1H), 2.85 & 2.64 (s, 3H), 2.78 – 2.68 & 2.62 – 2.60 (m, 1H), 2.43 & 2.42 (s, 3H), 2.25 & 2.18 (t, *J* = 4.0 Hz & t, *J* = 4.0 Hz, 1H), 2.05 – 1.99 & 1.92 – 1.90 (m, 1H), 1.57 – 1.40 & 1.27 – 1.08 (m, 8H), 1.56 – 1.40 (m, 6H), 1.27 – 1.08 (m, 2H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 147.4, 143.6, 141.1, 136.7, 132.9, 129.5, 128.8, 128.7, 128.1, 128.1, 128.0, 126.6, 126.3, 120.5, 48.1, 45.7, 36.8, 32.8, 31.5, 31.2, 27.7, 24.3, 24.2, 21.6. HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{30}H_{34}NO_2S$: 472.2310. Found: 472.2313.

_N_-4-Dimethyl-_N_-((1_S_,2_R_,3_R_)-2-(2-methylundec-1-en-1-yl)-3-phenylcyclopropyl) benzenesulfonamide (3ap):



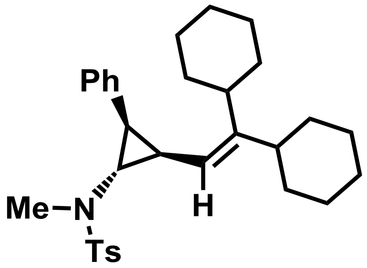
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R$_f$ = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ap** as yellow oil in 56% yield (52.3 mg, 0.112 mmol, *E/Z* = 54:46); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.66 (d, *J* = 7.9 Hz, 2H), 7.30 (d, *J* = 7.8 Hz, 2H), 7.25 – 7.15 (m, 3H), 7.10 – 7.08 (m, 2H), 4.46 (d, *J* = 9.2 Hz, 1H), 2.83 & 2.81 (s, 3H), 2.71 – 2.65 (m, 1H), 2.51 – 2.45 (m, 1H), 2.43 (s, 3H), 2.13 – 2.08 (m, 2H), 1.88 – 1.84 (t, *J* = 7.4 Hz, 1H), 1.72 & 1.57 (s, 3H), 1.30 – 1.19 (m, 16H), 0.90 – 0.86 (m, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.7, 134.7 139.7, 139.6, 136.8, 136.8, 132.8, 132.7, 129.7, 128.9, 128.8, 128.2, 128.2, 128.1, 126.3, 126.3, 119.7, 119.3, 45.6, 45.6, 39.6, 37.4, 37.3, 32.6, 32.3, 32.0, 32.0, 31.9, 29.8, 29.8, 29.7, 29.7, 29.6, 29.5, 29.2, 28.1, 27.9, 27.8, 23.5, 22.8, 22.8, 21.7, 16.8, 14.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{30}H_{44}NO_2S$: 482.3093. Found: 482.3101.

***N*-((1*S*,2*R*,3*R*)-2-(2,2-Diphenylvinyl)-3-phenylcyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3aq):**



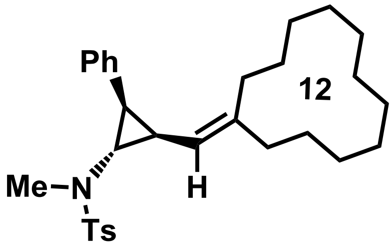
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_f = 0.3$) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3aq** as yellow oil in 85% yield (81.5 mg, 0.170 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, J = 8.2 Hz, 2H), 7.42 – 7.39 (m, 2H), 7.36 – 7.27 (m, 7H), 7.24 – 7.22 (m, 3H), 7.17 – 7.15 (m, 3H), 6.98 – 6.95 (m, 2H), 5.31 (d, J = 10.2 Hz, 1H), 2.78 – 2.75 (m, 1H), 2.74 (s, 3H), 2.46 – 2.44 (t, J = 4.0 Hz, 1H), 2.44 (s, 3H), 2.41 – 2.35 (td, J_1 = 10.2 Hz, J_2 = 3.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 143.8, 142.1, 139.6, 136.2, 132.7, 130.0, 129.6, 128.9, 128.4, 128.3, 128.0, 128.0, 127.3, 127.1, 127.0, 126.6, 125.1, 46.1, 37.0, 33.4, 29.1, 21.6; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{31}H_{30}NO_2S$: 480.1997. Found: 480.2000.

***N*-((1*S*,2*R*,3*R*)-2-(2,2-Dicyclohexylvinyl)-3-phenylcyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3ar):**



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3ar** as yellow oil in 71% yield (69.7 mg, 0.142 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (dd, J_1 = 8.2 Hz, J_2 = 1.7 Hz, 2H), 7.30 – 7.14 (m, 5H), 7.07 – 7.05 (m, 2H), 4.42 (dd, J_1 = 8.5 Hz, J_2 = 1.5 Hz, 1H), 2.84 (s, 3H), 2.67 (dd, J_1 = 10.1 Hz, J_2 = 4.0 Hz, 1H), 2.57 – 2.51 (m, 1H), 2.44 (s, 3H), 2.02 (t, J = 4.0, 1H), 1.78 – 1.56 (m, 10H), 1.37 – 1.14 (m, 10H), 1.05 – 0.92 (m, 1H), 0.80 – 0.71 (m, 1H).; ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.3, 143.6, 136.7, 132.5, 129.5, 128.8, 128.2, 127.8, 126.1, 117.2, 46.4, 41.4, 40.1, 37.3, 35.0, 34.6, 32.2, 30.8, 30.5, 27.1, 27.1, 27.0, 26.6, 26.5, 26.1, 26.1, 21.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{31}H_{42}NO_2S$: 492.2936. Found: 492.2940.

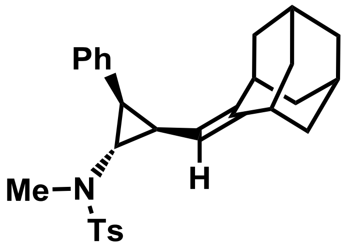
***N*-((1*S*,2*R*,3*R*)-2-(Cyclododecylidenemethyl)-3-phenylcyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3as):**



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:19) as the

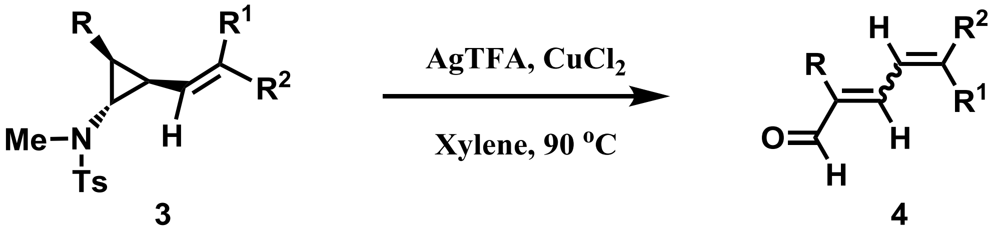
eluent the desired product **3as** as yellow oil in 62% yield (59.4 mg, 0.124 mmol); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.66 (d, *J* = 8.2 Hz, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 7.23 – 7.19 (m, 2H), 7.16 – 7.12 (m, 1H), 7.08 – 7.06 (m, 2H), 4.52 (d, *J* = 9.6 Hz, 1H), 2.81 (s, 3H), 2.70 (dd, J_1 = 10.2 Hz, J_2 = 4.2 Hz, 1H), 2.51 (td, J_1 = 10.0 Hz, J_2 = 3.8 Hz, 1H), 2.43 (s, 3H), 2.30 (dt, J_1 = 14.2 Hz, J_2 = 6.9 Hz, 1H), 2.17 (t, *J* = 4.0 Hz, 1H), 2.06 – 1.87 (m, 3H), 1.42 – 1.15 (m, 15H), 1.03 – 0.91 (m, 3H); ^{13}C NMR (100 MHz, CDCl$_3$) δ 143.6, 141.1, 132.6, 129.5, 128.6, 128.2, 128.0, 126.1, 120.2, 45.6, 37.2, 32.4, 31.4, 29.6, 28.1, 25.3, 24.9, 24.0, 24.0, 24.0, 23.2, 23.1, 23.0, 22.2, 21.6; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{30}H_{42}NO_2S$: 480.2936. Found: 480.2945.

N-((1*S*,2*R*,3*R*)-2-((*E*)-((1*R*,3*S*,5*S*)-Adamantan-2-ylidene)methyl)-3-phenylcyclopropyl)-*N*-4-dimethylbenzenesulfonamide (3at):



The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R$_f$ = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **3at** as yellow oil in 64% yield (57.2 mg, 0.128 mmol); ^{1}H NMR (400 MHz, CDCl$_3$) δ 7.69 – 7.67 (m, 2H), 7.30 (d, *J* = 8.0 Hz, 2H), 7.25 – 7.21 (m, 2H), 7.18 – 7.14 (m, 1H), 7.09 – 7.06 (m, 2H), 4.41 (d, *J* = 8.5 Hz, 1H), 2.98 – 2.93 (s, 1H), 2.80 (s, 3H), 2.61 (dd, J_1 = 10.2 Hz, J_2 = 4.2 Hz, 1H), 2.52 – 2.47 (m, 1H), 2.43 (s, 3H), 2.18 (s, 1H), 2.04 (t, *J* = 4.0 Hz, 1H), 1.92 – 1.87 (m, 2H), 1.83 – 1.70 (m, 8H), 1.53 (d, *J* = 12.1 Hz, 1H), 1.35 (d, *J* = 12.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 151.8, 143.6, 136.8, 132.5, 129.5, 128.7, 128.1, 127.9, 126.1, 110.7, 45.6, 40.2, 39.9, 39.5, 38.8, 38.5, 37.2, 37.1, 32.8, 31.9, 28.4, 28.3, 27.0, 21.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{28}H_{34}NO_2S$: 448.2310. Found: 448.2304.

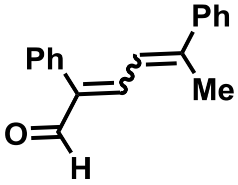
General procedure for the synthesis of the 1,3-dienyl aldehydes:



To an Schlenk tube was added the vinyl cyclopropylamide **3** (0.20 mmol, 1.0 equiv.), AgTFA (2.2 mg, 0.01 mmol, 5 mol%), $CuCl_2$ (53,8 mg, 0.40 mmol, 2.0 equiv.) and Xylene (4.0 mL, 0.05 **M**). The tube was sealed under air and heated to 90 °C overnight. After completion of the reaction as monitored by TLC, the crude mixture was cooled to room temperature. The mixture was then passed through celite, washed with ethyl acetate and concentrated in vacuum. The residue was then purified by using silica gel column chromatography using PE/EtOAc (19:1) as the eluent to afford the 1,3-dienyl aldehyde **4**.

When the reaction was scaled up to 1.2 mmol, the Schlenk tube was replaced by Schlenk flask. An oven dried Schlenk tube was charged with **3aa** (502 mg, 1.20 mmol, 1.0 equiv.), $CuCl_2$ (322.7 mg, 2.40 mmol, 2.0 equiv.) and AgTFA (13.3 mg, 0.06 mmol, 5 mol%) in xylene (0.05 M, 24 mL). The reaction mixture was then reacted at 90 °C without inert gas protection until the cyclopropane **3aa** was consumed completely. Then the resulting reaction mixture was diluted with ethyl acetate, washed with water and brine. The organic layer was dried over anhydrous Na_2SO_4, filtered, and concentrated to give the crude product, which was purified through a flash column chromatography (eluent: 5 % ethyl acetate in petroleum solution) to afford **4a** (208.3 mg, 0.839 mmol, *E/Z* = 79:21, 70% yield).

2,5-Diphenylhexa-2,4-dienal (4a):

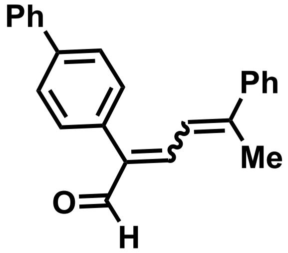


The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_{f(E)}$ = 0.3, $R_{f(Z)}$ = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4a** as yellow oil in 85% yield (42.1 mg, 0.170 mmol, *E*/*Z* = 81:19);

(2*E*,4*E*)-2,5-Diphenylhexa-2,4-dienal (*major* of 4a): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.74 (s, 1H), 7.52 (d, *J* = 11.8 Hz, 1H), 7.45 – 7.38 (m, 4H), 7.38 – 7.30 (m, 4H), 7.29 – 7.26 (m, 2H), 6.83 (dd, J_1 = 11.9 Hz, J_2 = 1.3 Hz, 1H), 2.42 (d, *J* = 1.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.4, 148.0, 145.2, 141.8, 141.2, 132.7, 130.0, 128.7, 128.5, 128.3, 128.1, 126.2, 122.9, 29.7, 16.9. HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{17}O$: 249.1279. Found: 249.1269.

(2*E*,4*Z*)-2,5-Diphenylhexa-2,4-dienal (*minor* of 4a): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.47 (s, 1H), 7.46 – 7.35 (m, 6H), 7.32 – 7.26 (m, 4H), 7.11 (d, *J* = 11.7 Hz, 1H), 6.50 (dd, J_1 = 11.7 Hz, J_2 = 1.5 Hz, 1H), 2.21 (s, 3H);^{13}C NMR (100 MHz, $CDCl_3$) δ 193.6, 151.8, 147.6, 140.4, 140.1, 132.8, 129.9, 128.5, 128.4, 128.2, 128.2, 128.0, 123.5, 26.4. HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{17}O$: 249.1279. Found: 249.1275.

2-([1,1'-Biphenyl]-4-yl)-5-phenylhexa-2,4-dienal (4b):

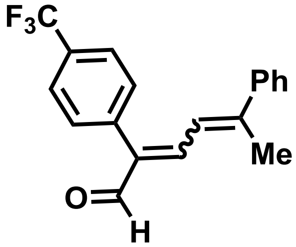


The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_{f(E)}$ = 0.2, $R_{f(Z)}$ = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4b** as yellow oil in 81% yield (52.4 mg, 0.162 mmol, *E*/*Z* = 76:24);

(2*E*,4*E*)-2-([1,1'-Biphenyl]-4-yl)-5-phenylhexa-2,4-dienal (*major* of 4b): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.78 (s,1H), 7.66 – 7.62 (m, 4H), 7.55 (d, *J* = 11.9 Hz, 1H), 7.47 – 7.43 (m, 4H), 7.38 – 7.32 (m, 6H), 6.92 (dd, J_1 = 11.8 Hz, J_2 = 1.3 Hz, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.5, 148.3, 145.7, 141.9, 141.0, 140.9, 140.8, 131.7, 130.6, 128.9, 128.7, 127.6, 127.3, 127.2, 126.3, 123.0, 17.1; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{24}H_{21}O$: 325.1592. Found: 325.1586.

(2*E*,4*Z*)-2-([1,1'-Biphenyl]-4-yl)-5-phenylhexa-2,4-dienal (*minor* of 4b): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.78 (s, 1H), 7.68 – 7.60 (m, 4H), 7.55 (d, *J* = 11.9 Hz, 1H), 7.47 – 7.42 (m, 4H), 7.39 – 7.32 (m, 5H), 6.92 (dd, J_1 = 11.9 Hz, J_2 = 1.3 Hz, 1H), 2.44 (d, *J* = 1.3 Hz, 3H);^{13}C NMR (100 MHz, $CDCl_3$) δ 193.5, 148.2, 145.5, 141.8, 140.9, 140.7, 140.7, 131.6, 130.4, 128.8, 128.5, 127.4, 127.1, 127.0, 126.2, 122.9, 16.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{24}H_{21}O$: 325.1592. Found: 325.1584.

5-Phenyl-2-(4-(trifluoromethyl)phenyl)hexa-2,4-dienal (4c):

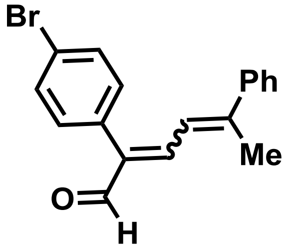


The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_{f(E)}$ = 0.2, $R_{f(Z)}$ = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4c** as yellow oil in 67 % yield (42.3 mg, 0.134 mmol, *E*/*Z* = 80:20);

(2*E*,4*E*)-5-Phenyl-2-(4-(trifluoromethyl)phenyl)hexa-2,4-dienal (*major* of 4c): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.74 (s, 1H), 7.69 (d, *J* = 8.0 Hz, 2H), 7.60 (d, *J* = 11.9 Hz, 1H), 7.44 – 7.34 (m, 7H), 6.77 (dd, J_1 = 12.0 Hz, J_2 = 1.3 Hz, 1H), 2.44 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.52; ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.7, 149.6, 146.2, 141.6, 139.8, 136.5, 130.4, 130.0, 129.1, 128.6, 127.0, 126.2, 125.3 (d, *J* = 3.8 Hz), 122.1, 17.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{16}OF_3$: 317.1153. Found: 317.1143.

(2*E*,4*Z*)-5-Phenyl-2-(4-(trifluoromethyl)phenyl)hexa-2,4-dienal (*minor* of 4c): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.47 (s, 1H), 7.70 (d, *J* = 8.9 Hz, 2H), 7.47 – 7.39 (m, 5H), 7.32 – 7.30 (m, 2H), 7.17 (d, *J* = 11.8 Hz, 1H), 6.44 (dd, J_1 =11.7 Hz, J_2 =1.4 Hz, 1H), 2.23 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.5; ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.9, 153.4, 148.4, 139.9, 139.0, 136.6, 130.3, 128.7, 128.6, 128.2, 125.2, 125.2, 125.1, 122.9, 26.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{16}OF_3$: 317.1153. Found: 317.1143.

2-(4-Bromophenyl)-5-phenylhexa-2,4-dienal (4d):

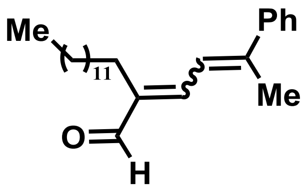


The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_{f(E)}$ = 0.2, $R_{f(Z)}$ = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4d** as yellow oil in 76% yield (49.1 mg, 0.152 mmol, *E*/*Z* = 78:22);

(2*E*,4*E*)-2-(4-Bromophenyl)-5-phenylhexa-2,4-dienal (*major* of 4d): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.71 (s, 1H), 7.66 – 7.51 (m, 3H), 7.43 – 7.40 (m, 2H), 7.35 – 7.33 (m, 3H), 7.15 (d, *J* = 8.4 Hz, 2H), 6.78 (dd, J_1 = 11.9 Hz, J_2 = 1.4 Hz, 1H), 2.42 (s, 3H).;^{13}C NMR (100 MHz, $CDCl_3$) δ 192.9, 148.8, 145.7, 141.6, 140.0, 131.7, 131.6, 131.5, 129.0, 128.6, 126.1, 122.4, 122.4, 16.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{16}OBr$: 327.0385. Found: 327.0379.

(2*E*,4*Z*)-2-(4-Bromophenyl)-5-phenylhexa-2,4-dienal (*minor* of 4d): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.44 (s, 1H), 7.57 – 7.55 (m, 2H), 7.46 – 7.39 (m, 3H), 7.31 – 7.28 (m, 2H), 7.16 – 7.14 (m, 2H), 7.11 (d, *J* = 11.7 Hz, 1H), 6.45 (dd, J_1 = 11.7 Hz, J_2 = 1.4 Hz, 1H), 2.22 (s, 3H);^{13}C NMR (100 MHz, $CDCl_3$) δ 193.1, 152.6, 147.8, 140.0, 139.2, 131.7, 131.6, 131.5, 128.6, 128.6, 128.2, 123.2, 122.3, 26.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{18}H_{16}OBr$: 327.0385. Found: 327.0378.

2-(3-Phenylbut-2-en-1-ylidene)pentadecanal (4e):

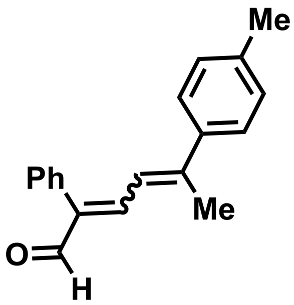


The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_{f(E)}$ = 0.3, $R_{f(Z)}$ = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4e** as yellow oil in 69% yield (48.8 mg, 0.138 mmol, *E*/*Z* = 78:22);

(2*E*,4*E*)-2-(3-phenylbut-2-en-1-ylidene)pentadecanal (*major* of 4e): ^{1}H NMR (400 MHz, CDCl$_3$) δ 9.50 (s, 1H), 7.52 (d, *J* = 7.5 Hz, 2H), 7.42 – 7.33 (m, 3H), 7.24 (d, *J* = 10.4 Hz, 1H), 6.88 (d, *J* = 11.8 Hz, 1H), 2.41 (t, *J* = 7.7 Hz, 2H), 2.35 (s, 3H), 1.42 – 1.19 (m, 24H), 0.86 (t, *J* = 6.7 Hz, 3H);^{13}C NMR (100 MHz, CDCl$_3$) δ 195.0, 146.4, 144.7, 142.6, 142.3, 128.6, 128.6, 126.1, 121.9, 31.9, 29.7, 29.7, 29.6, 29.6, 29.4, 29.4, 29.2, 24.1, 22.7, 16.7, 14.1; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{25}H_{39}O$: 355.3001. Found: 355.2994.

(2*E*,4*Z*)-2-(3-Phenylbut-2-en-1-ylidene)pentadecanal (*minor* of 4e): ^{1}H NMR (400 MHz, CDCl$_3$) δ 9.50 (s, 1H), 7.43 – 7.35 (m, 3H), 7.26 – 7.24 (s, 1H), 6.84 (d, *J* = 11.8 Hz, 1H), 6.59 (d, *J* = 11.7 Hz, 1H) 2.37 – 2.33 (m, 2H), 2.29 (s, 3H), 1.32 – 1.25 (m, 26H), 0.88 – 0.85 (m, 3H);^{13}C NMR (100 MHz, CDCl$_3$) δ 195.2, 149.7, 146.4, 141.5, 140.2, 128.4, 128.2, 128.1, 122.5, 31.9, 29.7, 29.6, 29.6, 29.5, 29.4, 29.2, 26.6, 24.1, 22.7, 14.1; HRMS (ESI) m/z [M+H]$^+$: Calcd for $C_{25}H_{39}O$: 355.3001. Found: 355.2998.

2-Phenyl-5-(*p*-tolyl)hexa-2,4-dienal (4f):

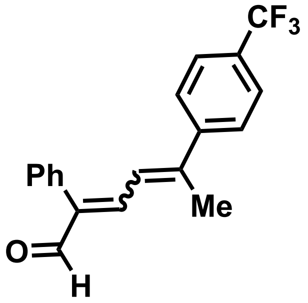


The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_{f(E)}$ = 0.3, $R_{f(Z)}$ = 0.4) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4f** as yellow oil in 75% yield (39.2 mg, 0.150 mmol, *E*/*Z* = 77:23);

(2*E*,4*E*)-2-Phenyl-5-(*p*-tolyl)hexa-2,4-dienal (*major* of 4f): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.73 (s, 1H), 7.51 (d, J = 11.9 Hz, 1H), 7.43 – 7.26 (m, 7H), 7.13 (d, J = 8.0 Hz, 2H), 6.82 (dd, J_1 = 11.9 Hz, J_2 = 1.3 Hz, 1H), 2.40 (s, 3H), 2.33 (s, 1H);^{13}C NMR (100 MHz, $CDCl_3$) δ 193.6, 148.2, 145.7, 140.9, 139.1, 139.0, 132.9, 130.1, 129.4, 128.4, 128.2, 126.2, 122.2, 21.3, 16.9; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{19}O$: 263.1436. Found: 263.1433.

(2*E*,4*Z*)-2-Phenyl-5-(*p*-tolyl)hexa-2,4-dienal (*minor* of 4f): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.48 (s, 1H), 7.45 – 7.41 (m, 2H), 7.38 – 7.36 (m, 1H), 7.29 – 7.26 (m, 2H), 7.24 – 7.20 (m, 4H), 7.14 (d, J = 11.8 Hz, 1H), 6.47 (dd, J_1 = 11.7 Hz, J_2 = 1.4 Hz, 1H), 2.41 (s, 3H), 2.19 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.4, 148.0, 145.5, 140.9, 139.0, 132.9, 130.0, 129.2, 128.3, 128.1, 126.1, 122.1, 21.2, 16.8; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{19}O$: 263.1436. Found: 263.1429.

2-Phenyl-5-(4-(trifluoromethyl)phenyl)hexa-2,4-dienal (4g):

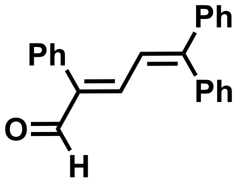


The title compound was prepared according to the general procedure. Purification by column chromatography (TLC $R_{f(E)}$ = 0.2, $R_{f(Z)}$ = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4g** as yellow oil in 80% yield (49.9 mg, 0.160 mmol, *E*/*Z* = 80:20);

(2*E*,4*E*)-2-Phenyl-5-(4-(trifluoromethyl)phenyl)hexa-2,4-dienal (*major* of 4g): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.77 (s, 1H), 7.58 – 7.56 (m, 2H), 7.52 – 7.48 (m, 3H), 7.45 – 7.38 (m, 3H), 7.28 – 7.25 (m, 2H), 6.84 (d, *J* = 11.6 Hz, 1H), 2.43 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.5; ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.5, 146.2, 145.4, 144.3, 142.3, 132.5, 130.1, 128.5, 128.5, 126.5, 125.6 (q, *J* = 4.2 Hz), 125.6, 125.4, 124.6, 17.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{16}OF_3$: 317.1153. Found: 317.1148.

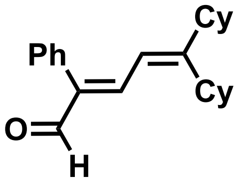
(2*E*,4*Z*)-2-Phenyl-5-(4-(trifluoromethyl)phenyl)hexa-2,4-dienal (*minor* of 4g): ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.50 (s, 1H), 7.72 – 7.69 (m, 2H), 7.47 – 7.38 (m, 5H), 7.28 – 7.25 (m, 2H), 6.99 (d, *J* = 11.7 Hz, 1H), 6.55 (dd, J_1 = 11.7 Hz, J_2 = 1.3 Hz, 1H), 2.21 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.5; ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.7, 149.6, 146.3, 141.5, 130.4, 129.1, 128.6, 126.2, 125.3 (q, *J* = 4.0 Hz), 122.1, 17.0; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{19}H_{16}OF_3$: 317.1153. Found: 317.1157.

(*E*)-2,5,5-Triphenylpenta-2,4-dienal (4h):



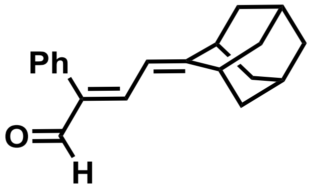
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.2) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4h** as yellow oil in 74% yield (56.1 mg, 0.148 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.52 (s, 1H), 7.51 – 7.28 (m, 13H), 7.24 – 7.20 (m, 2H), 7.15 (d, *J* = 11.7 Hz, 1H), 7.02 (d, *J* = 11.7 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.6, 153.4, 147.6, 141.9, 141.2, 138.6, 132.8, 130.7, 130.1, 129.2, 128.9, 128.6, 128.6, 128.5, 128.5, 128.4, 123.5; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{23}H_{19}O$: 311.1436. Found: 311.1432.

(*E*)-5,5-Dicyclohexyl-2-phenylpenta-2,4-dienal (4i):



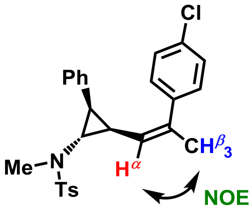
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4i** as yellow oil in 76% yield (48.8 mg, 0.152 mmol); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.66 (s, 1H), 7.51 (d, *J* = 11.9 Hz, 1H), 7.44 – 7.40 (m, 2H), 7.36 – 7.34 (m, 1H), 7.25 – 7.22 (m, 2H), 6.24 (d, *J* = 11.9 Hz, 1H), 2.87 (t, *J* = 12.9 Hz, 1H), 2.09 (t, *J* = 11.8 Hz, 1H), 1.84 – 1.56 (m, 10H), 1.46 – 1.36 (m, 4H), 1.24 – 0.96 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.6, 167.9, 145.5, 139.1, 132.9, 130.0, 128.1, 127.8, 119.1, 42.1, 41.8, 33.8, 30.8, 26.6, 26.3, 25.9, 25.8; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{23}H_{31}O$: 323.2375. Found: 323.2378.

***(E)*-2,5,5-Triphenylpenta-2,4-dienal (4j):**



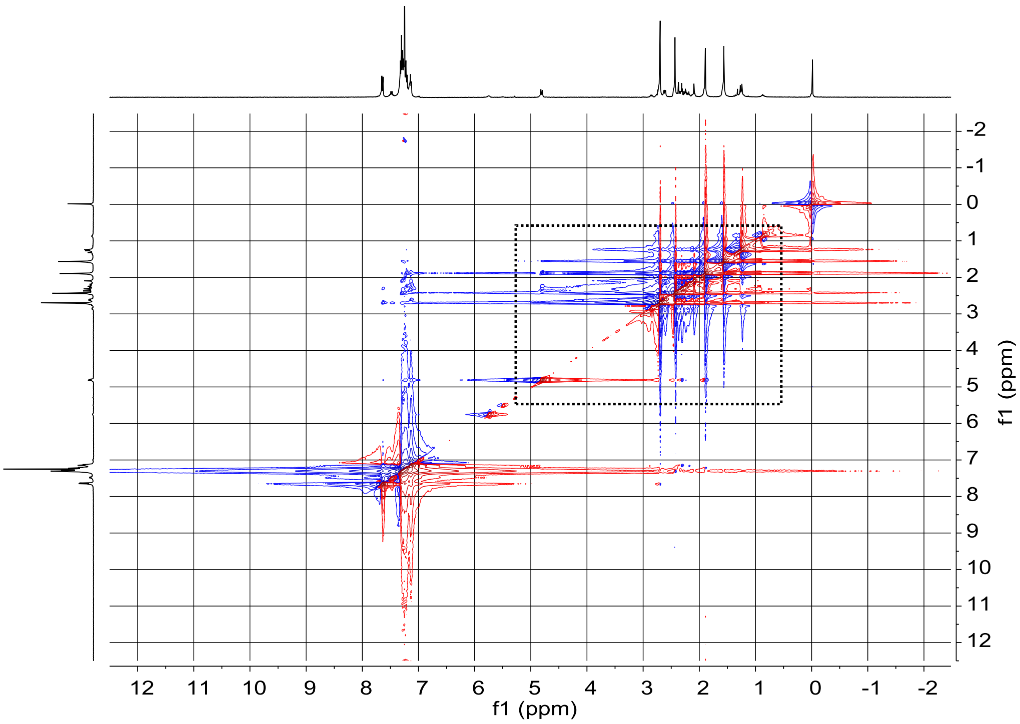
The title compound was prepared according to the general procedure. Purification by column chromatography (TLC R_f = 0.3) on silica gel using EtOAc/PE (1:19) as the eluent the desired product **4j** as yellow oil in 55% yield (30.5 mg, 0.110 mmol); ^1H NMR (400 MHz, $CDCl_3$) δ 9.63 (s, 1H), 7.44 – 7.31 (m, 4H), 7.26 – 7.25 (m, 1H), 7.24 – 7.23 (d, *J* = 1.3 Hz, 1H), 6.19 (d, *J* = 12.1 Hz, 1H), 3.31, (s, 1H), 2.44 (s, 1H), 2.05 – 1.79 (m, 13H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.7, 167.2, 145.2, 139.0, 133.0, 129.9, 128.2, 127.7, 114.4, 41.9, 40.0, 39.4, 36.8, 33.8, 28.2; HRMS (ESI) m/z $[M+H]^+$: Calcd for $C_{20}H_{23}O$: 279.1749. Found: 279.1745.

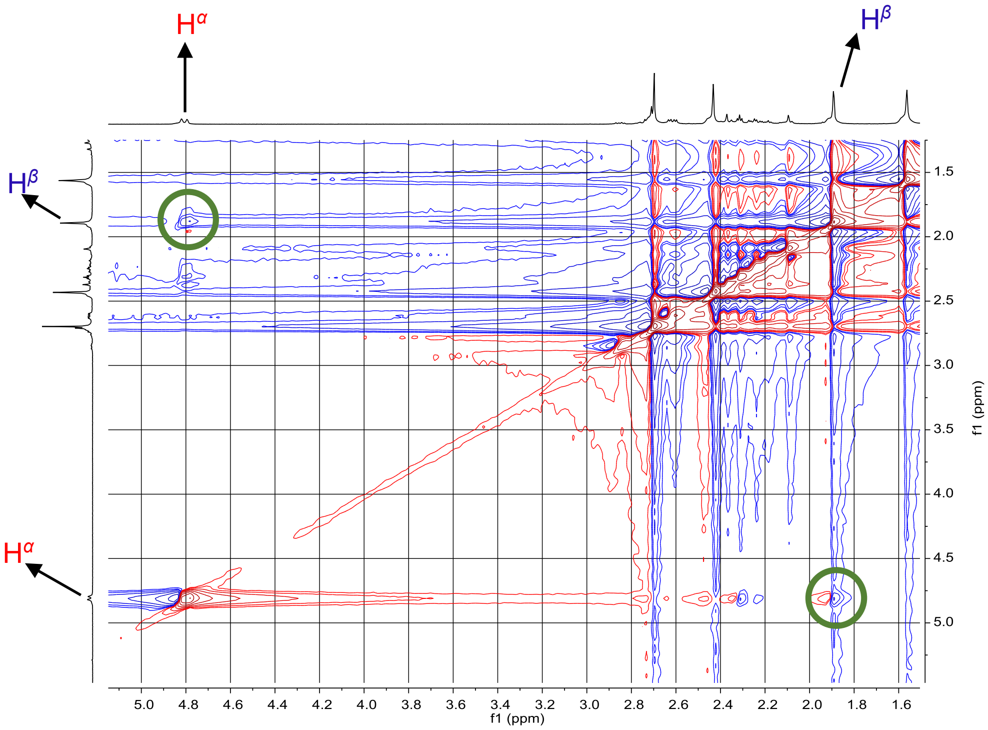
NOESY NMR spectra of product:

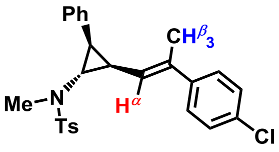


Minor of 3ac

NOE was observed between H^{α} and H^{β}

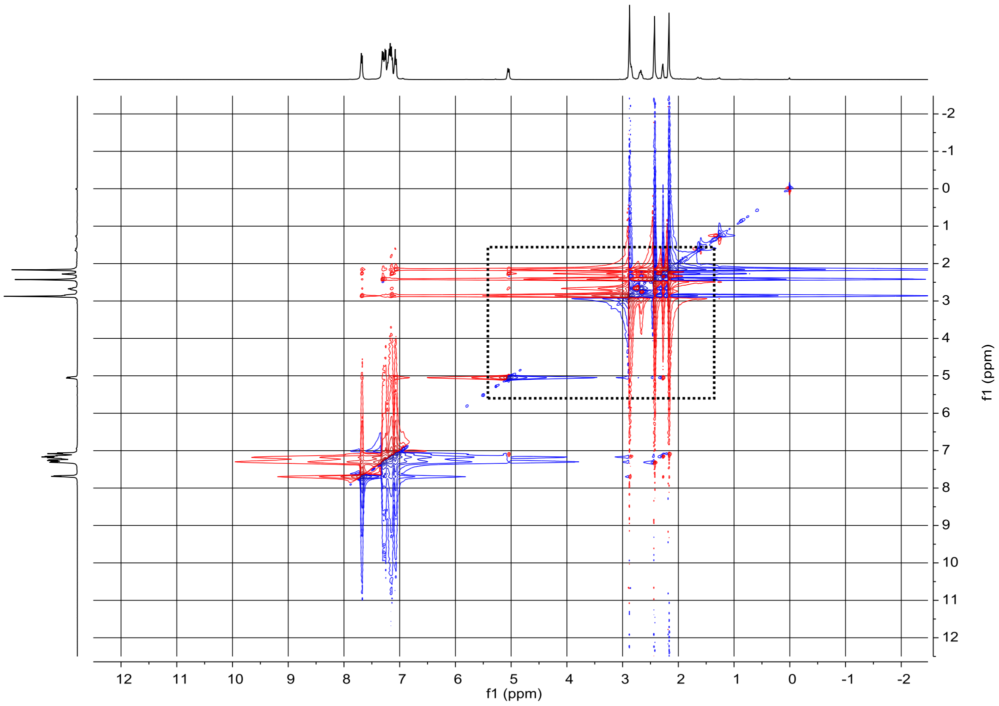


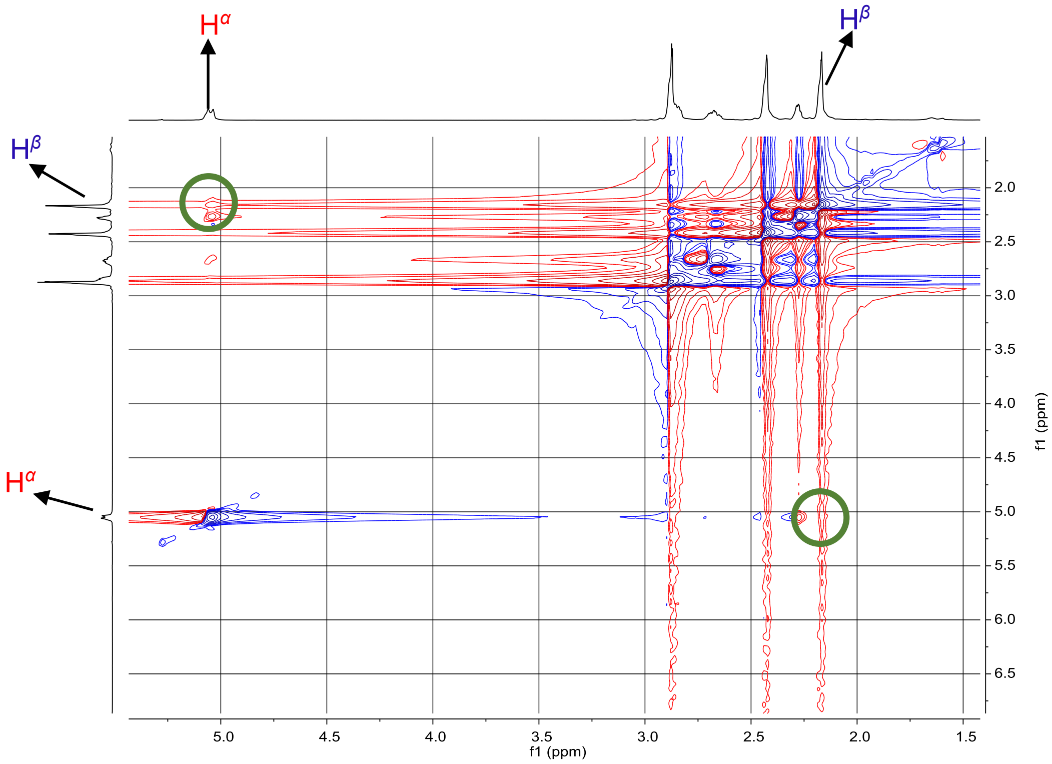


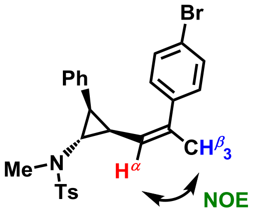


Major of 3ac

No NOE was observed between H$^{\alpha}$ and H$^{\beta}$

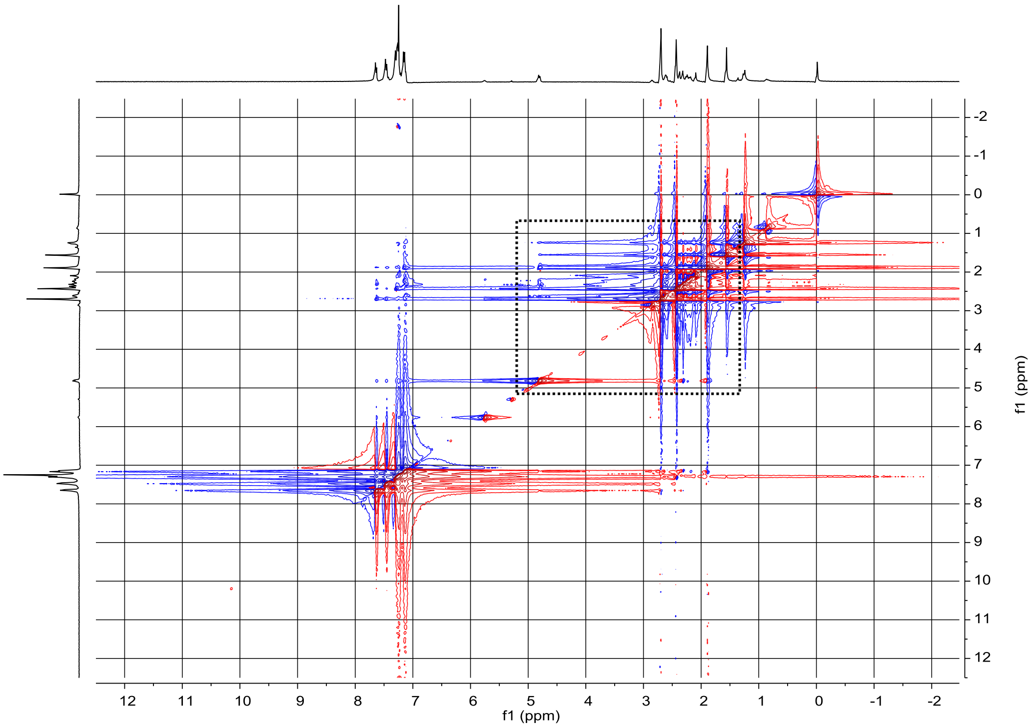


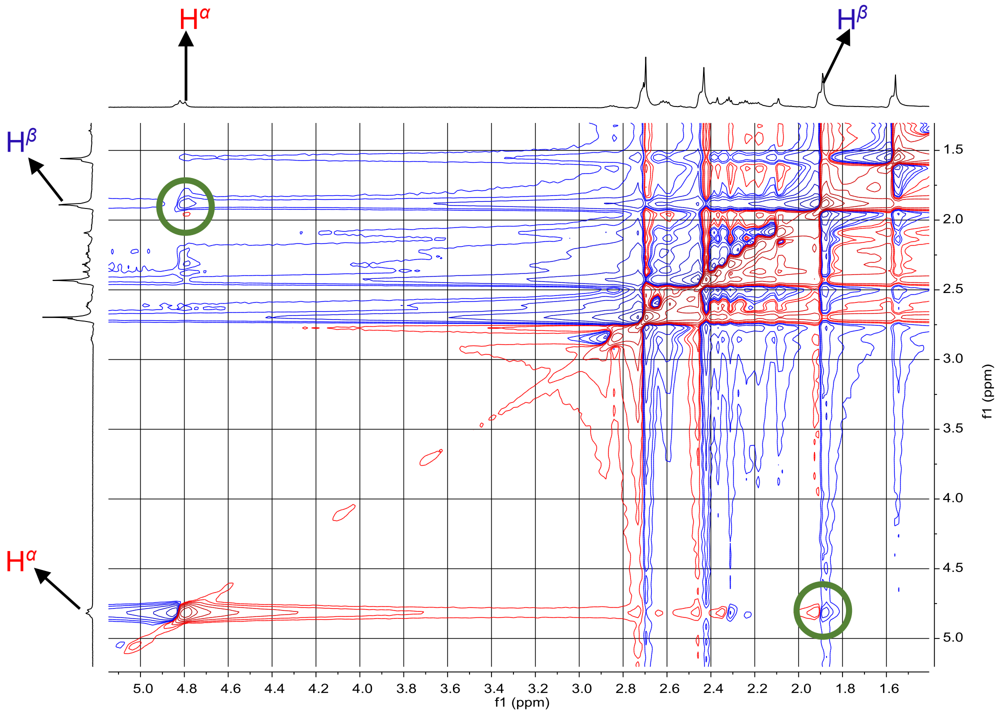


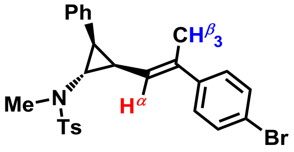


Minor of 3ad

NOE was observed between H^{α} and H^{β}

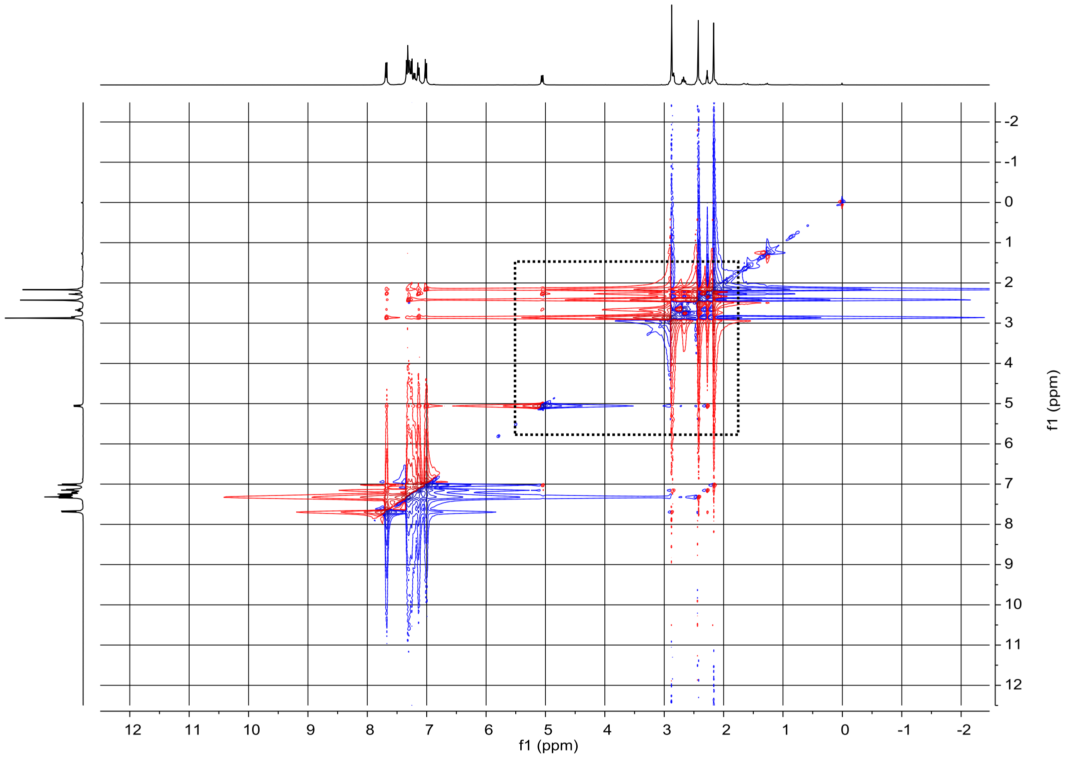


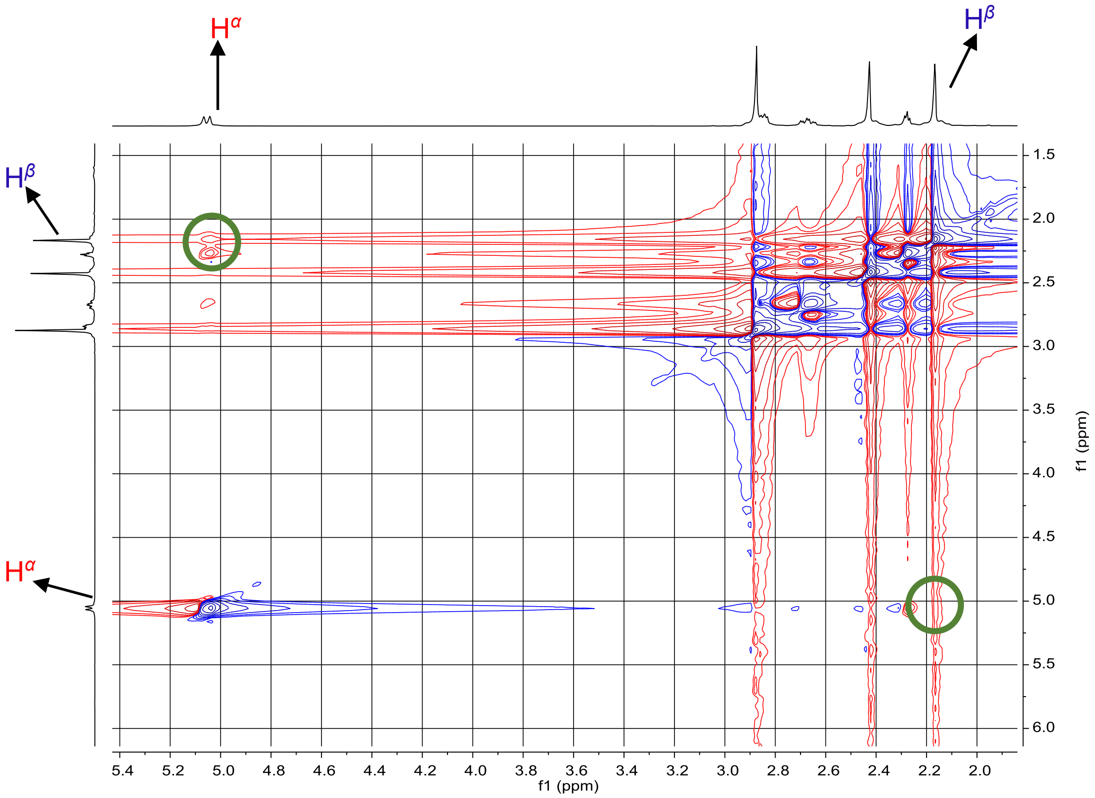


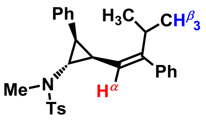


Major of 3ad

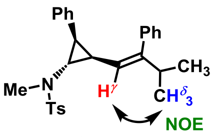
No NOE was observed between H^{α} and H^{β}







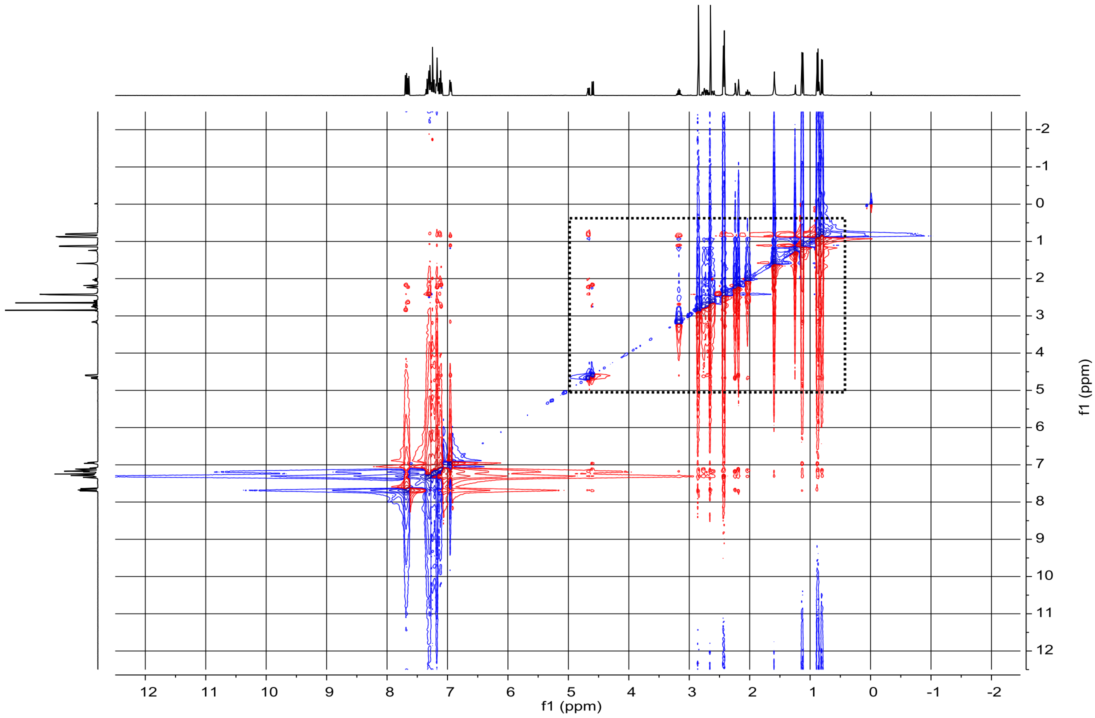
Major of 3an

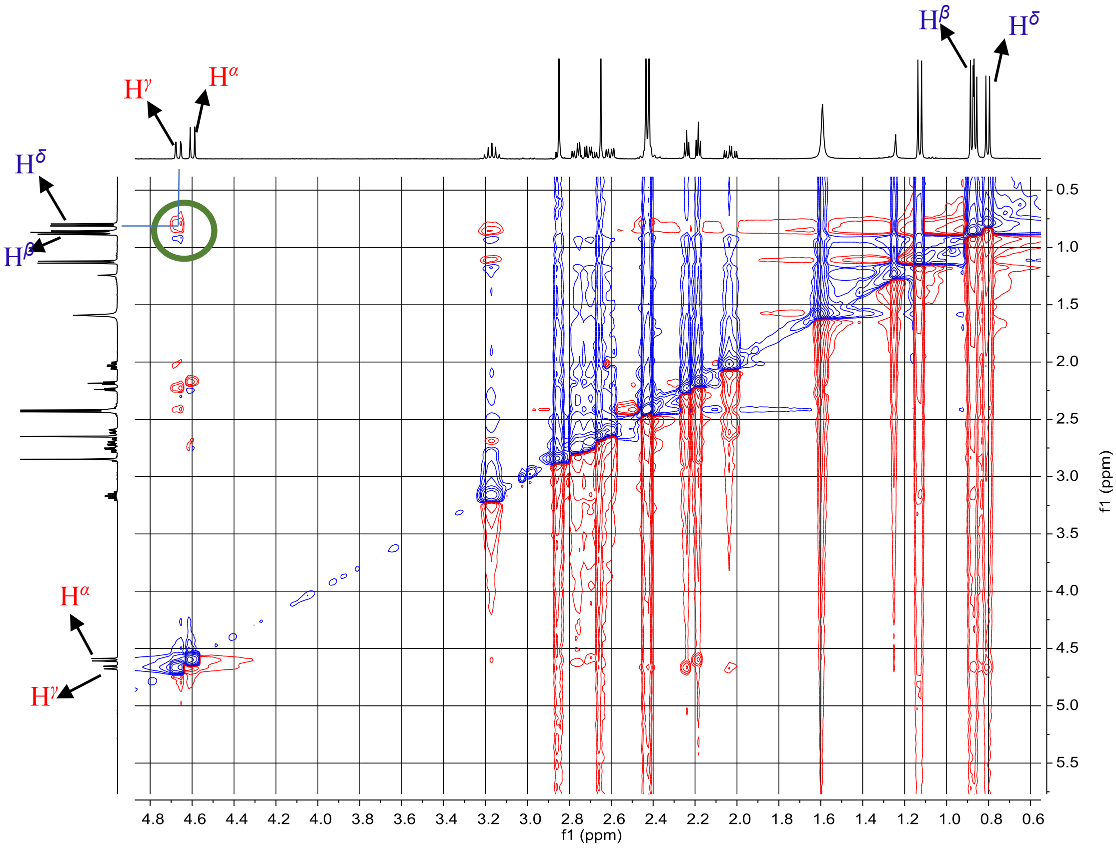


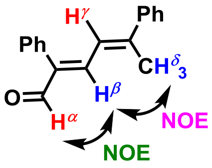
Minor of 3an

No NOE was observed

between H^{α} and H^{β};







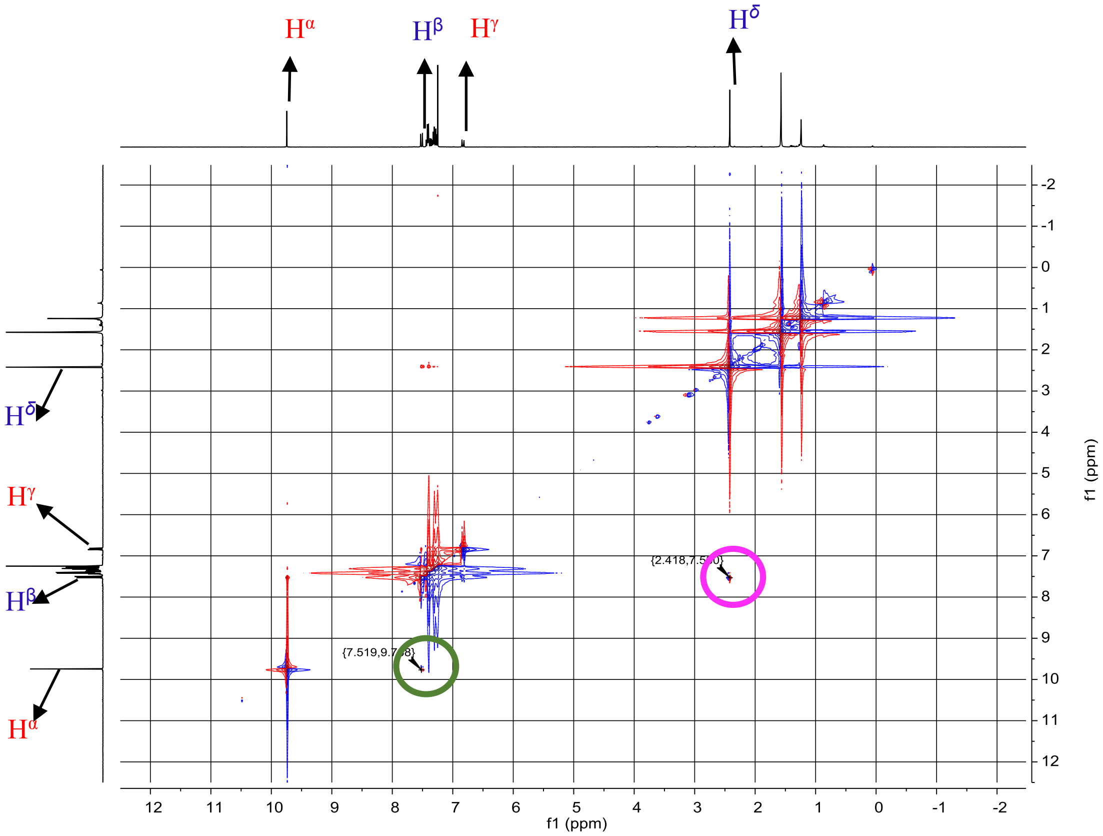
Major of 4a

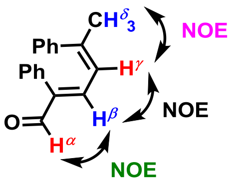
NOE was observed between H^{α} and H^{β}

NOE was observed between H^{β} and H^{δ}

No NOE was observed between H^{γ} and H^{δ}

No NOE was observed between H^{β} and H^{γ}





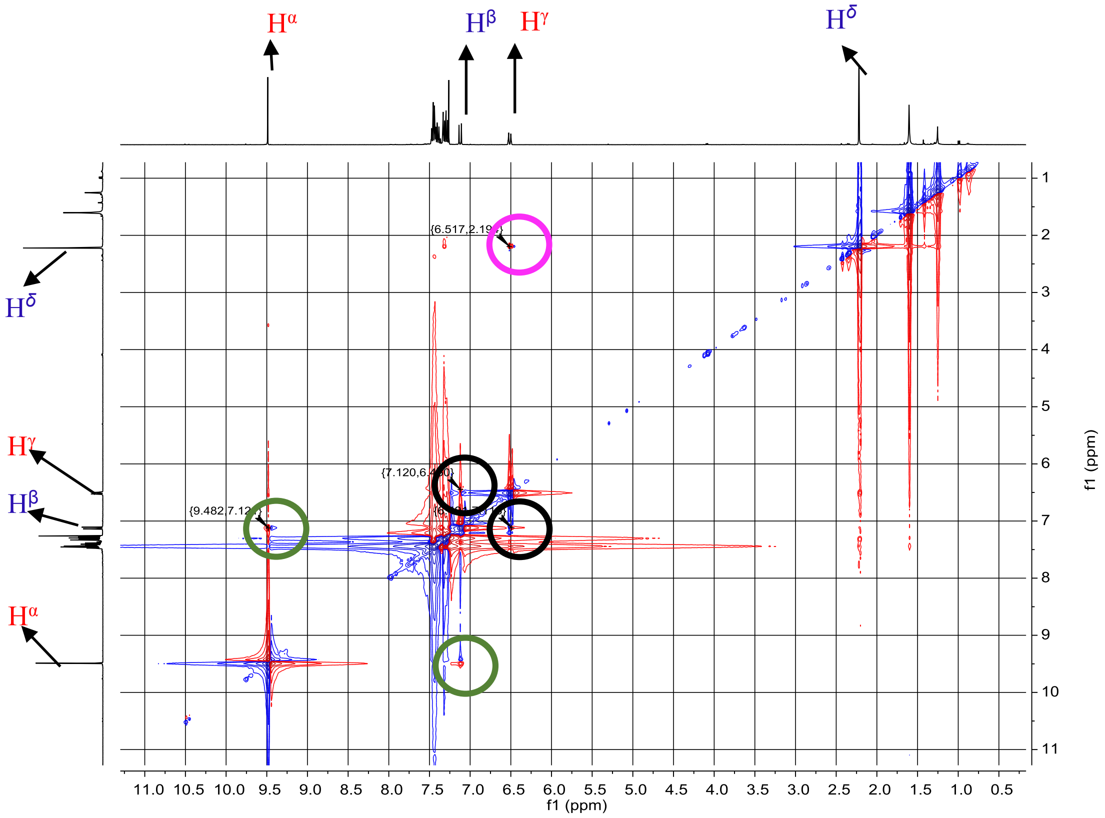
Minor of 4a

NOE was observed between H^{α} and H^{β}

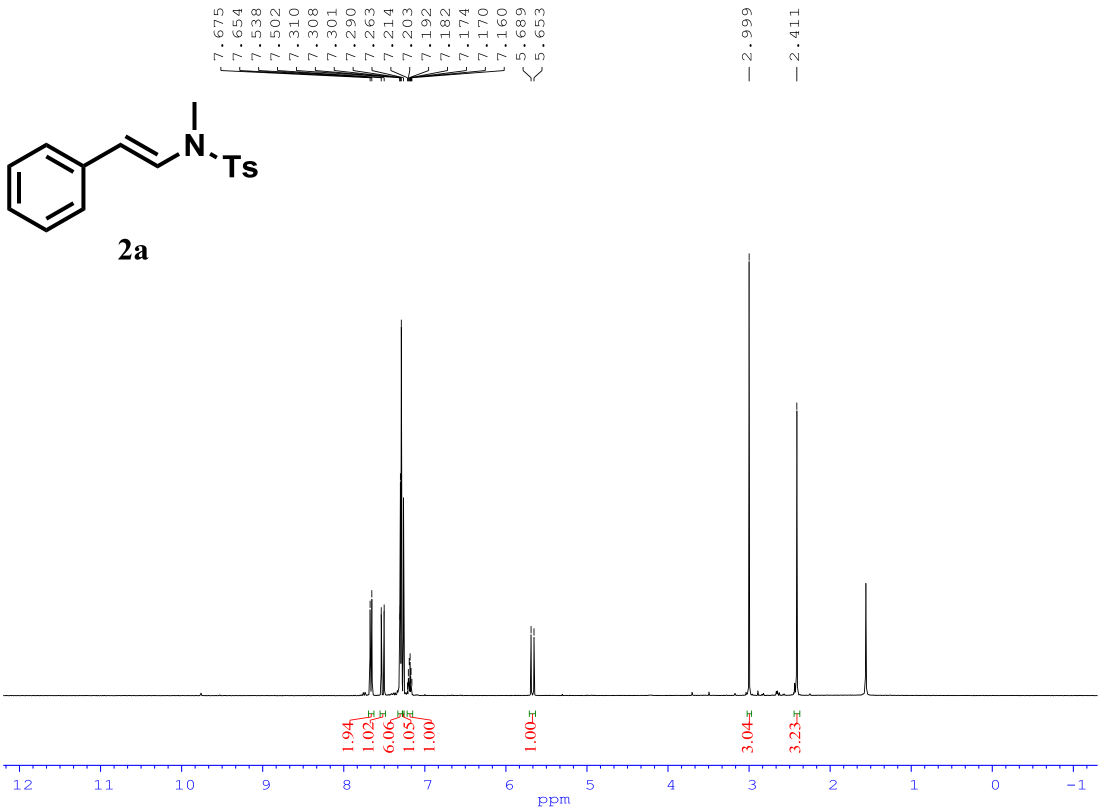
NOE was observed between H^{β} and H^{γ}

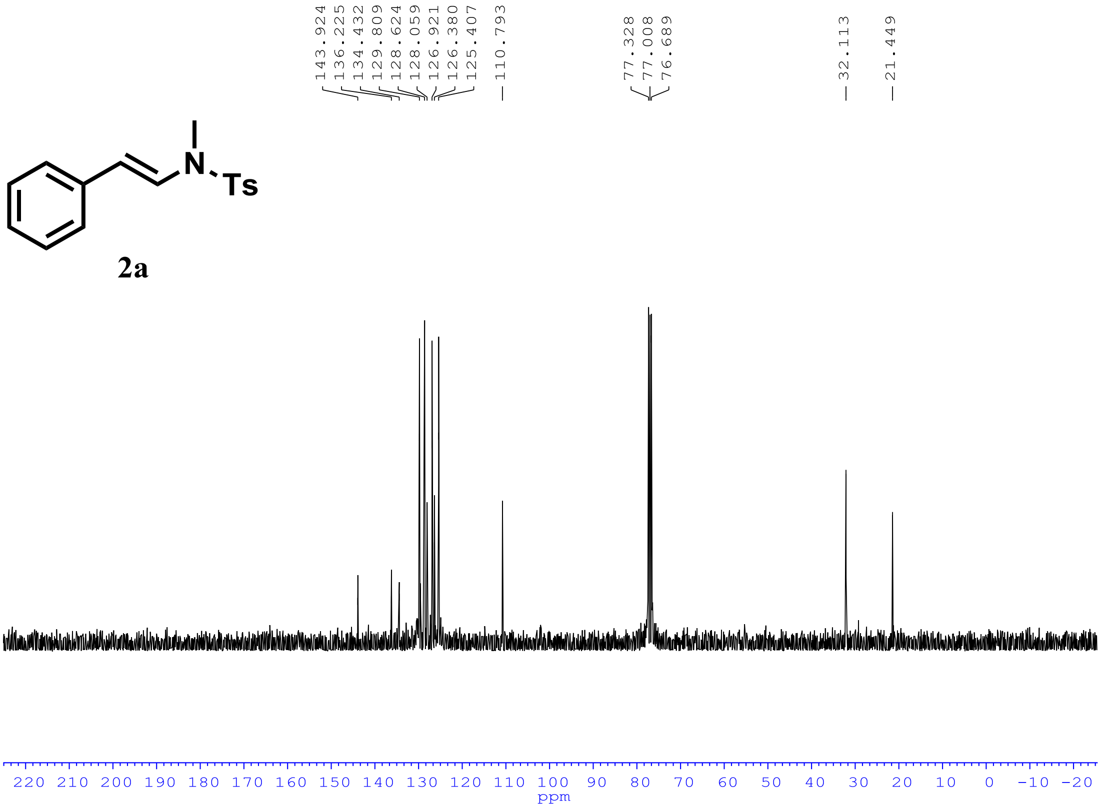
NOE was observed between H^{γ} and H^{δ}

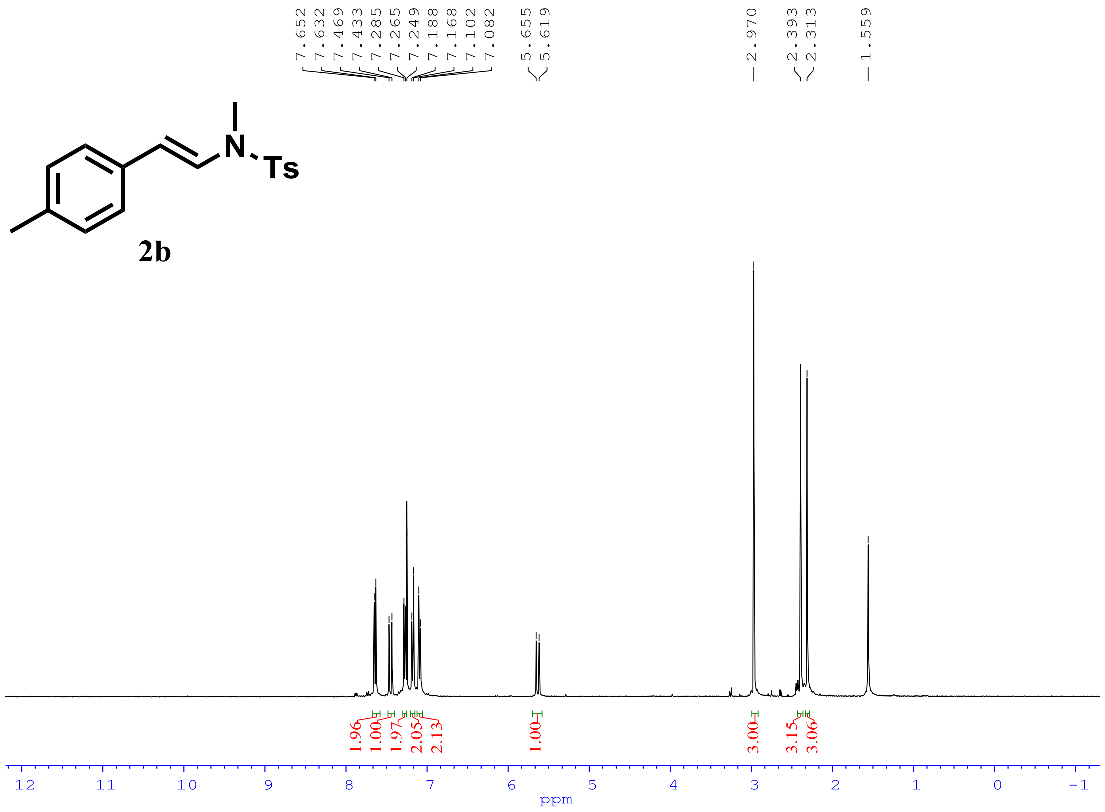
No NOE was observed between H^{β} and H^{δ}

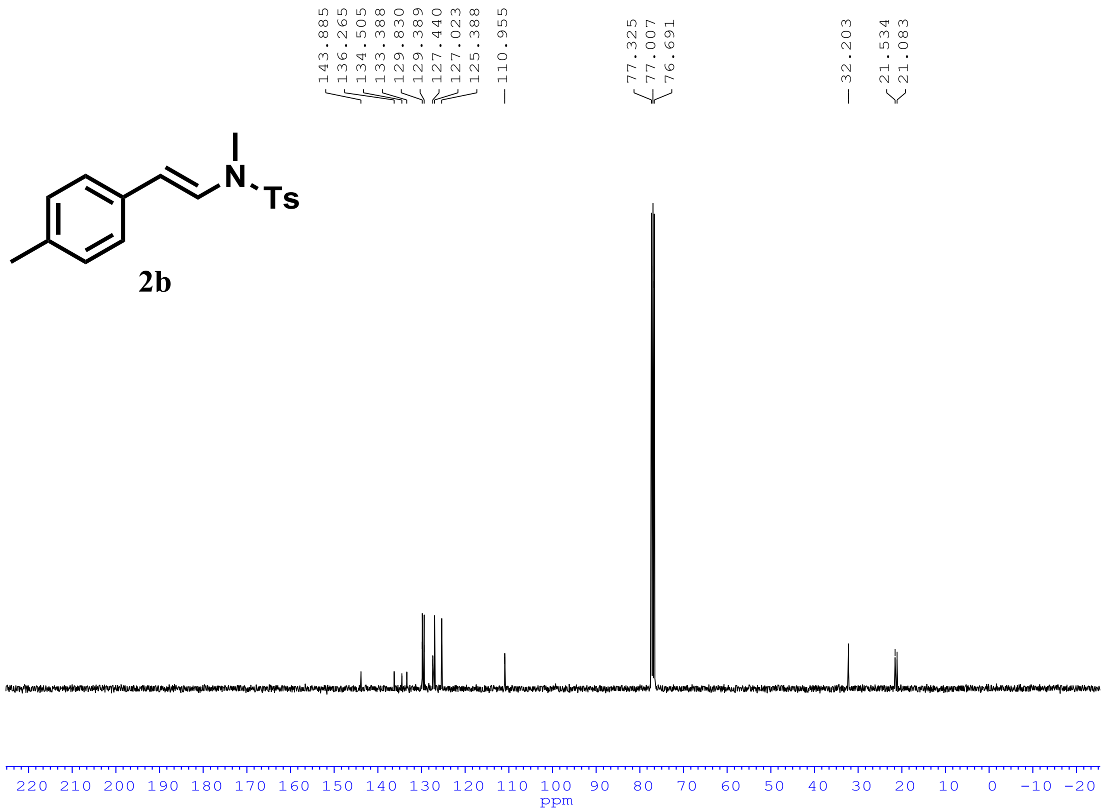


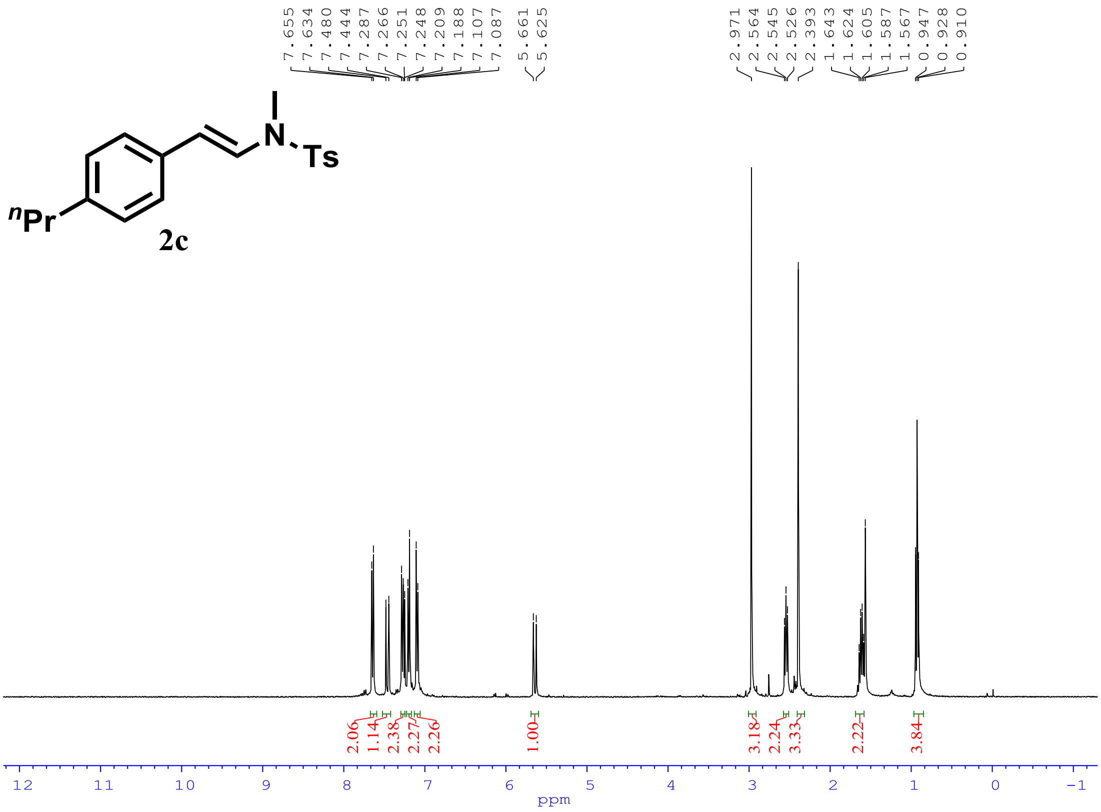
NMR spectra for enamides:

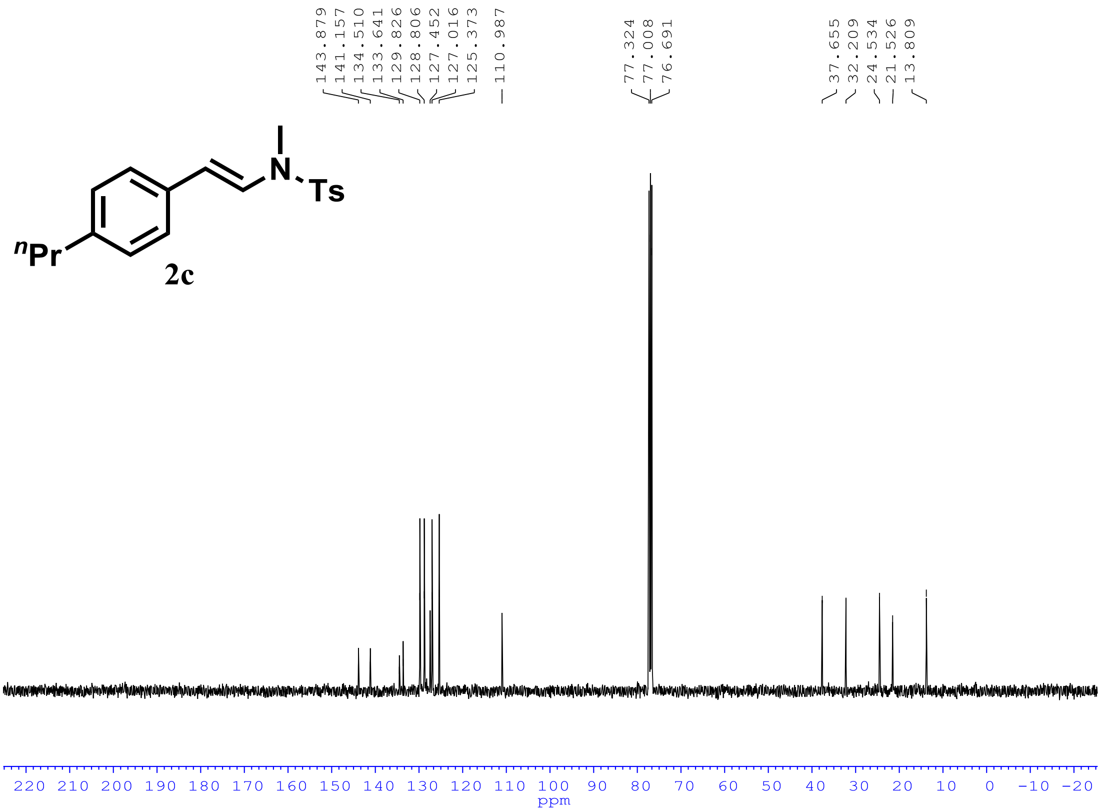


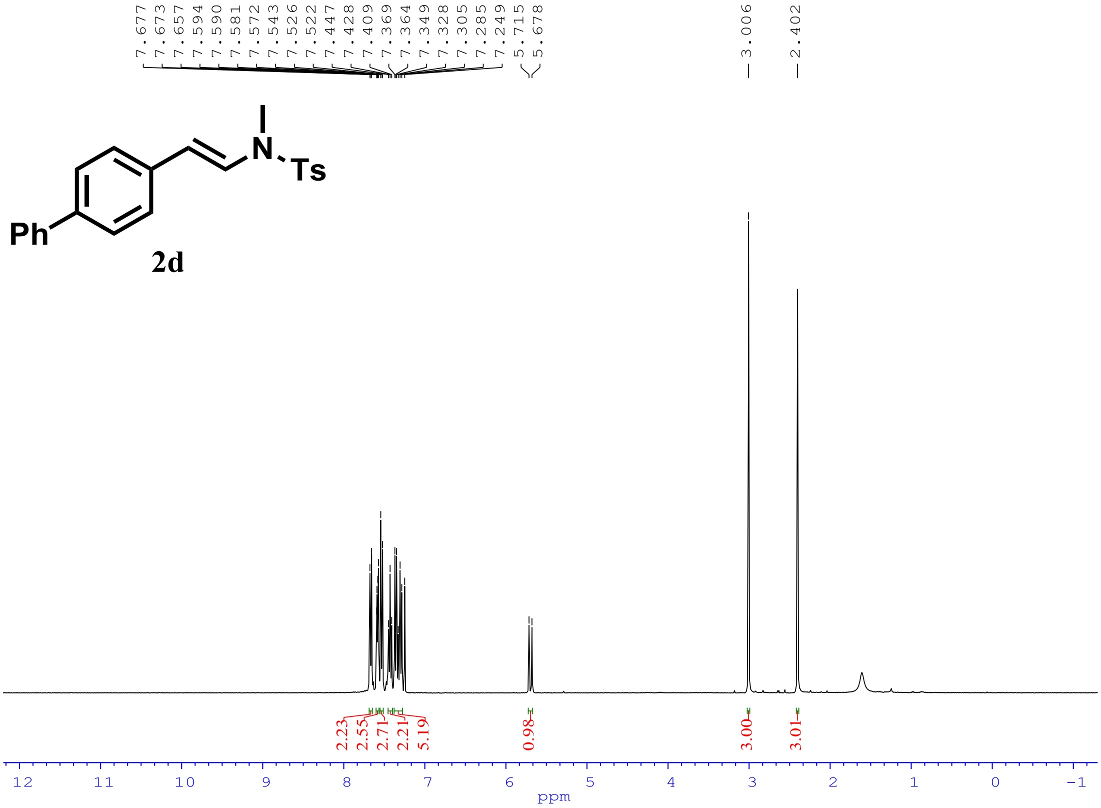


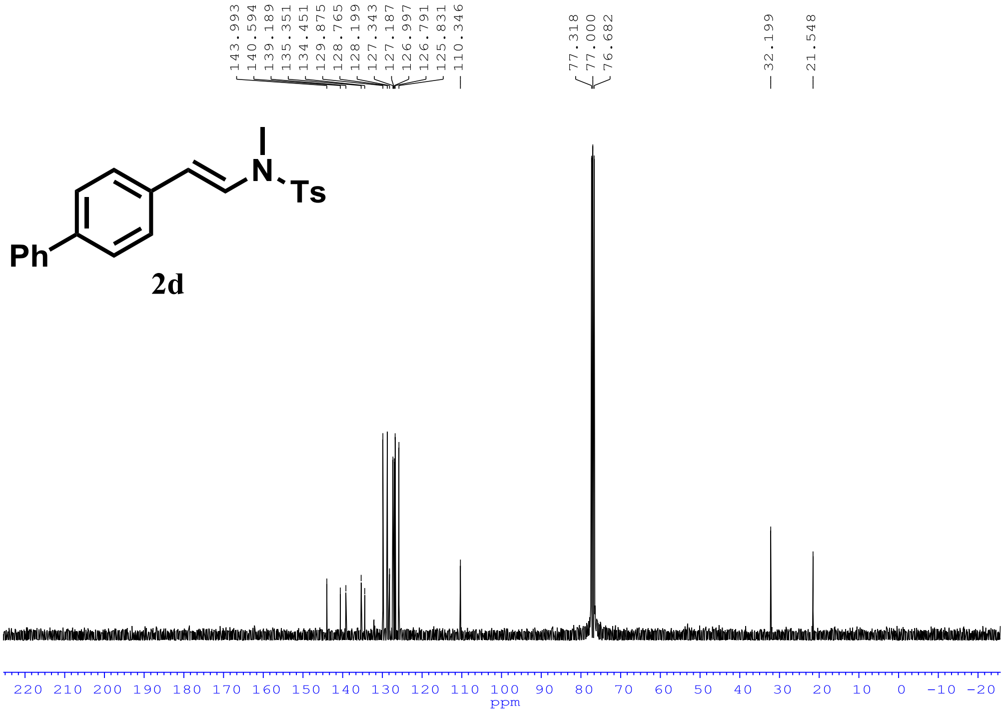

7.652
7.632
7.469
7.433
7.285
7.265
7.249
7.188
7.168
7.102
7.082
5.655
5.619
2.970
2.393
2.313
1.559
N
Ts
2b
1.96
1.00
1.97
2.05
2.13
1.00
3.00
3.15
3.06
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

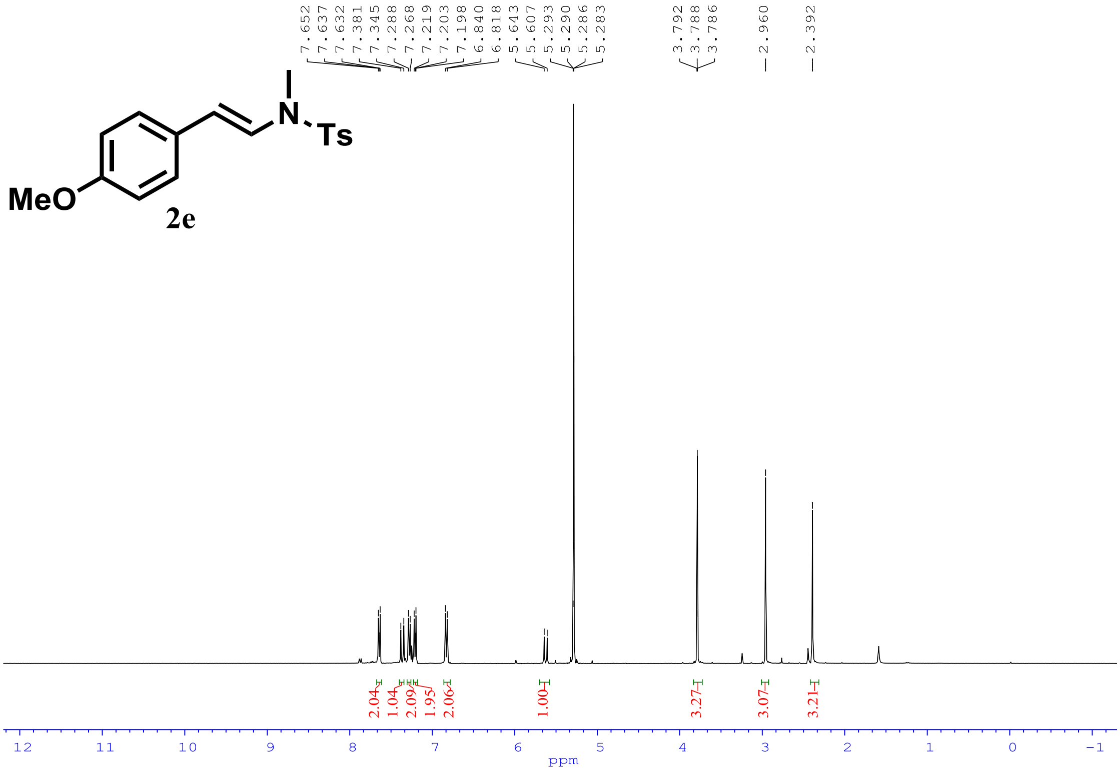

143.885
136.265
134.505
133.388
129.830
129.389
127.440
127.023
125.388
110.955
77.325
77.007
76.691
32.203
21.534
21.083
N
Ts
2b
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

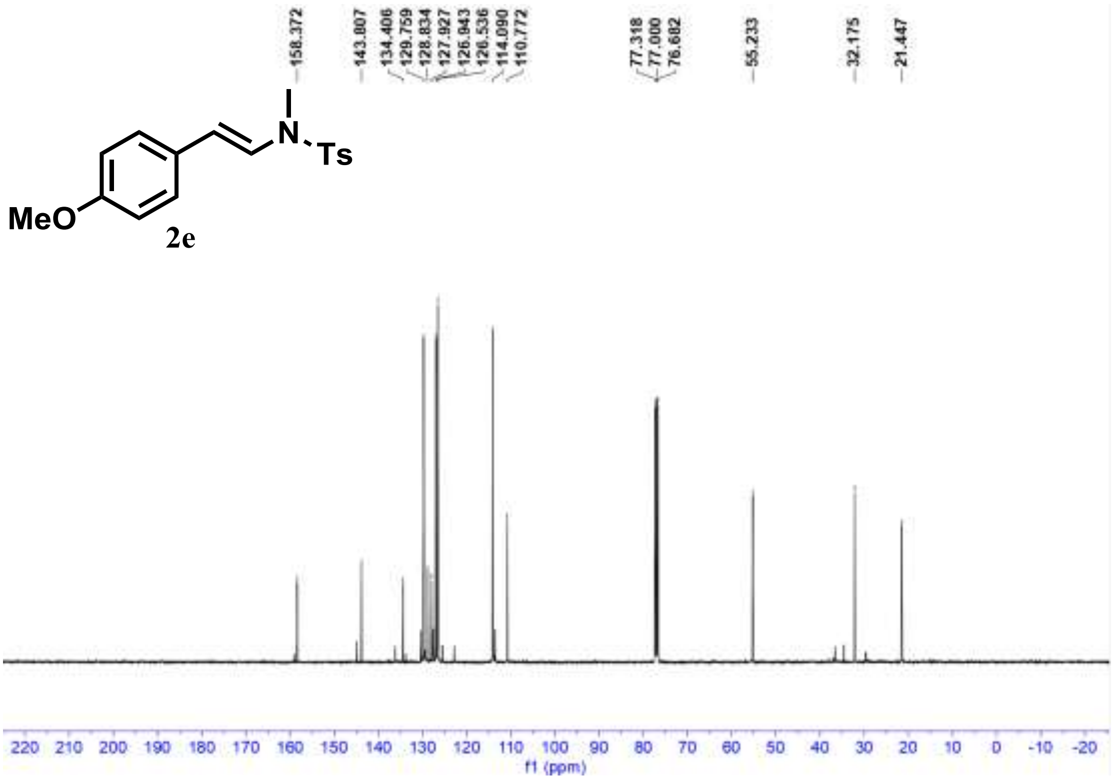

7.655
7.634
7.480
7.444
7.287
7.266
7.251
7.248
7.209
7.188
7.107
7.087
5.661
5.625
2.971
2.564
2.545
2.526
2.393
1.643
1.624
1.605
1.587
1.567
0.947
0.928
0.910
N
Ts
^{n}Pr
2c
2.06
1.14
2.38
2.27
2.26
1.00
3.18
2.24
3.33
2.22
3.84
12 11 10 9 8 7 6 5 4 3 2 1 0 -1
ppm

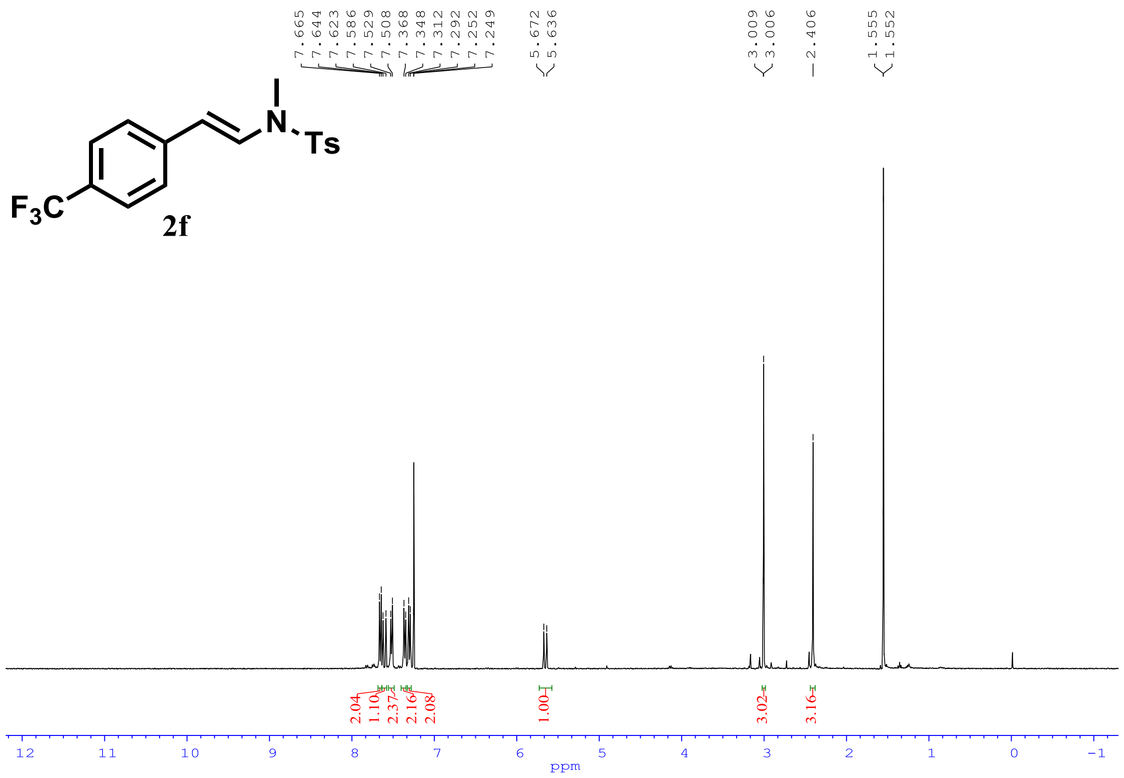

143.879
141.157
134.510
133.641
129.826
128.806
127.452
127.016
125.373
110.987
77.324
77.008
76.691
37.655
32.209
24.534
21.526
13.809
N
Ts
^{n}Pr
2c
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
ppm

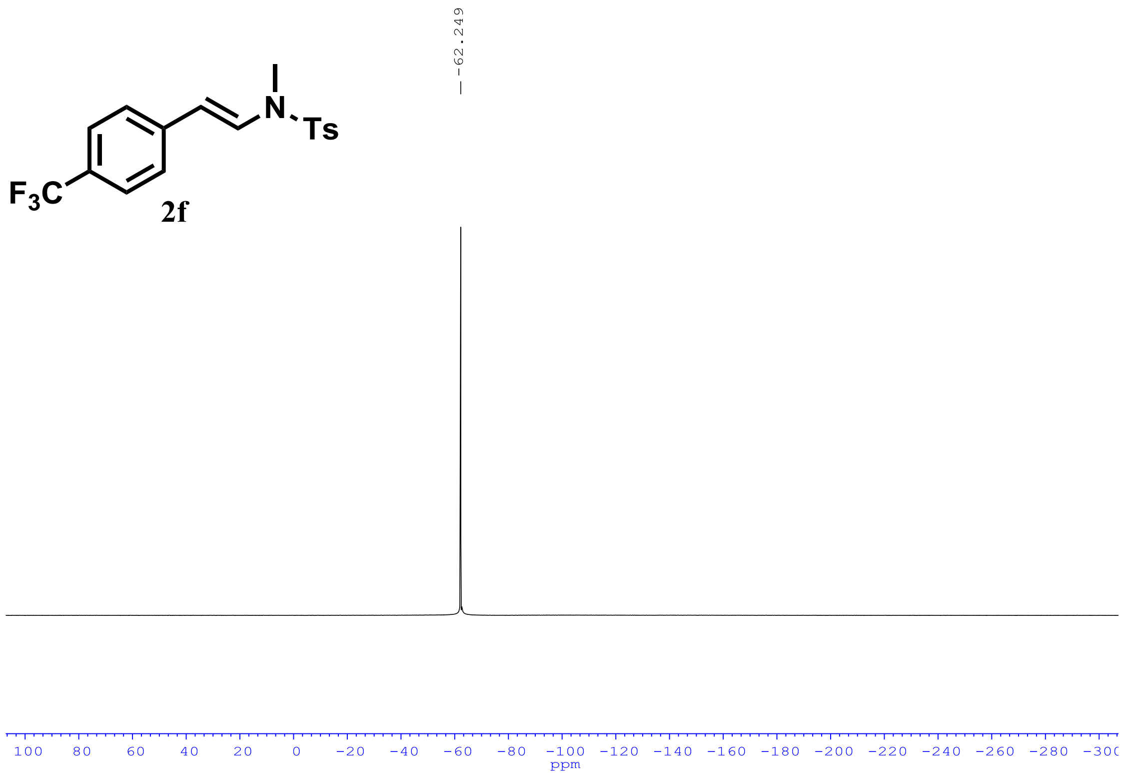

7.677
7.673
7.657
7.594
7.590
7.581
7.572
7.543
7.526
7.522
7.447
7.428
7.409
7.369
7.364
7.349
7.328
7.305
7.285
7.249
5.715
5.678
3.006
2.402
N
Ts
Ph
2d
2.23
2.55
2.71
2.21
5.19
0.98
3.00
3.01
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

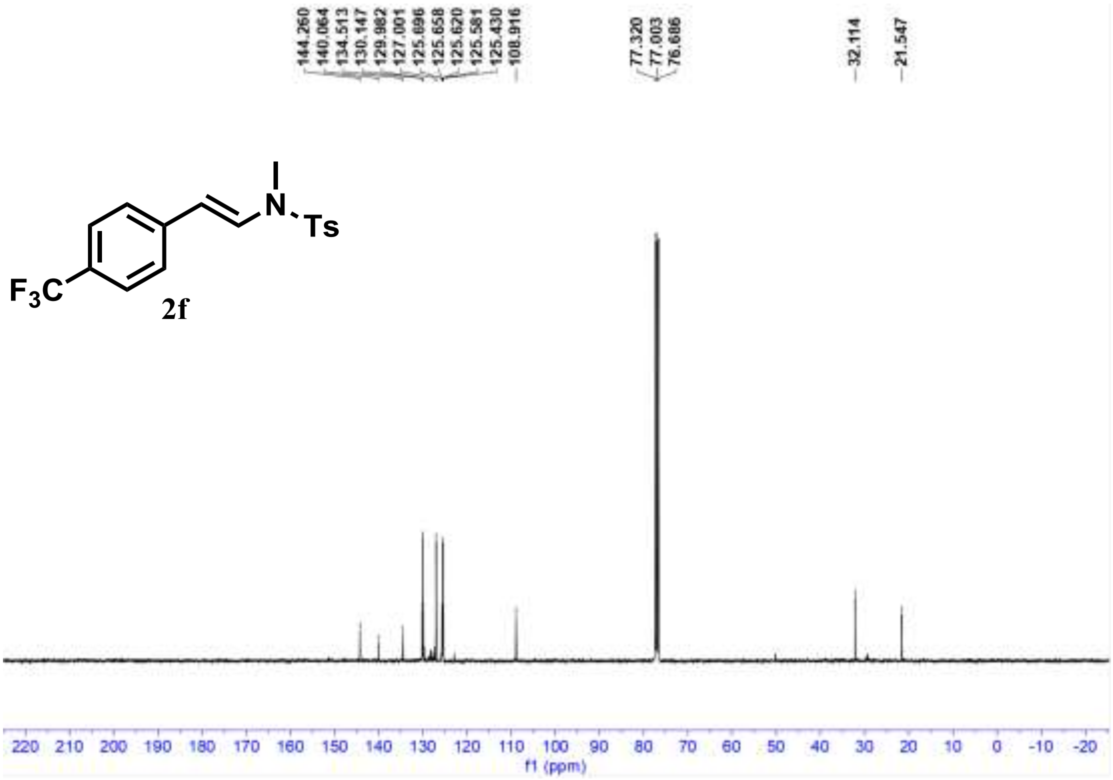

143.993
140.594
139.189
135.351
134.451
129.875
128.765
128.199
127.343
127.187
126.997
126.791
125.831
110.346
77.318
77.000
76.682
32.199
21.548
N
Ts
Ph
2d
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


MeO
N
Ts
2e
7.652
7.637
7.632
7.381
7.345
7.288
7.268
7.219
7.203
7.198
6.840
6.818
5.643
5.607
5.293
5.290
5.286
5.283
3.792
3.788
3.786
2.960
2.392
2.04
1.04
2.09
1.95
2.06
1.00
3.27
3.07
3.21
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
ppm

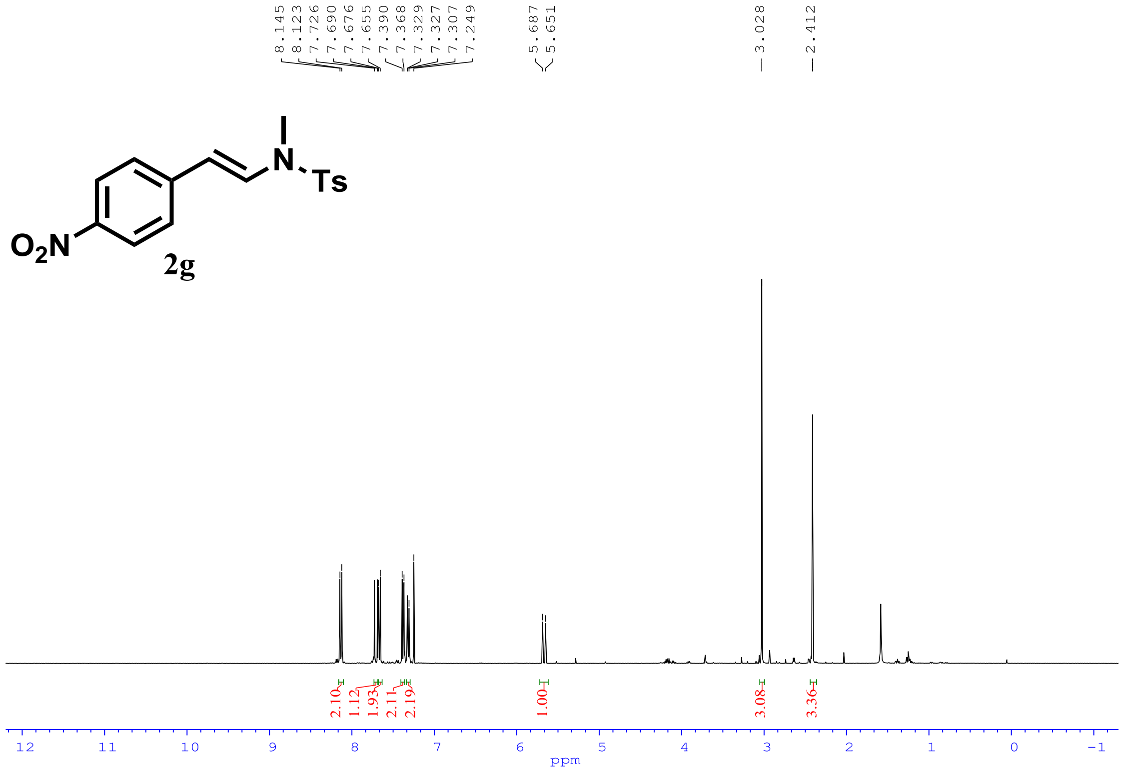

MeO
N
Ts
2e
158.372
143.807
134.406
129.759
128.834
127.927
126.943
126.536
114.090
110.772
77.318
77.000
76.682
55.233
32.175
21.447
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

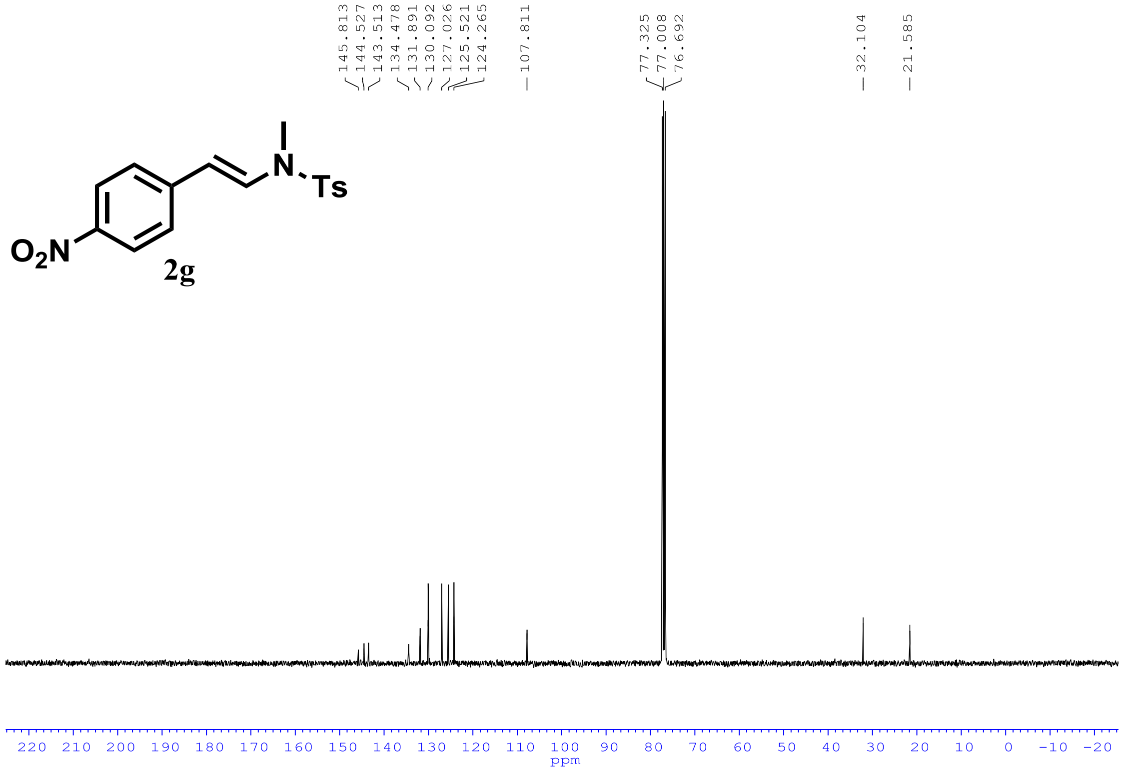

7.665
7.644
7.623
7.586
7.529
7.508
7.368
7.348
7.312
7.292
7.252
7.249
5.672
5.636
3.009
3.006
2.406
1.555
1.552
N
Ts
F3C
2f
2.04
1.10
2.37
2.16
2.08
1.00
3.02
3.16
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

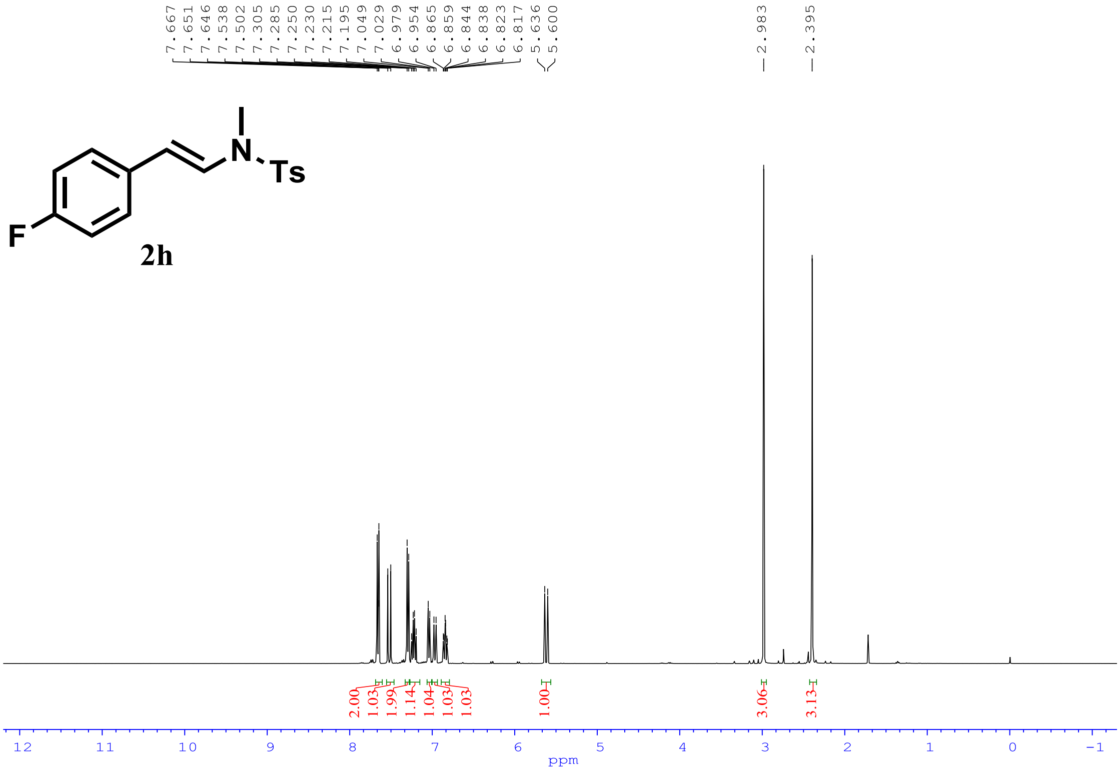

-62.249
N
Ts
F3C
2f
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
ppm

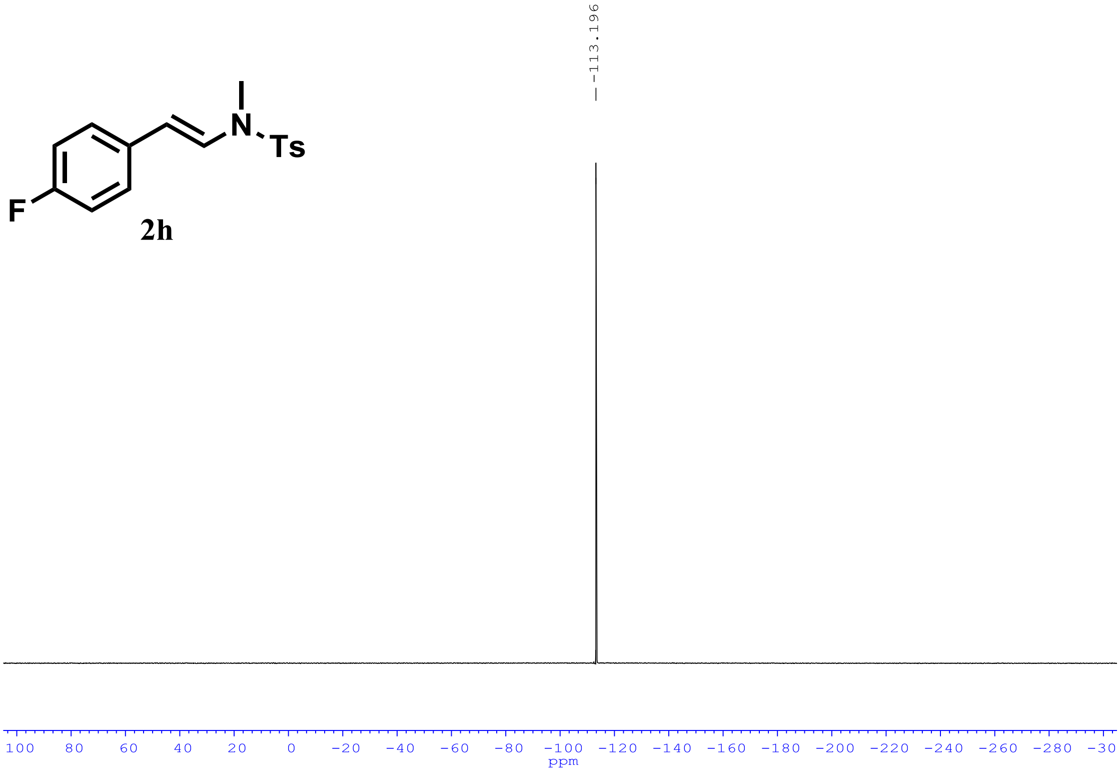

144.260
140.064
134.513
130.147
129.982
127.001
125.896
125.658
125.620
125.581
125.430
108.916
77.320
77.003
76.686
32.114
21.547
N
Ts
F3C
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

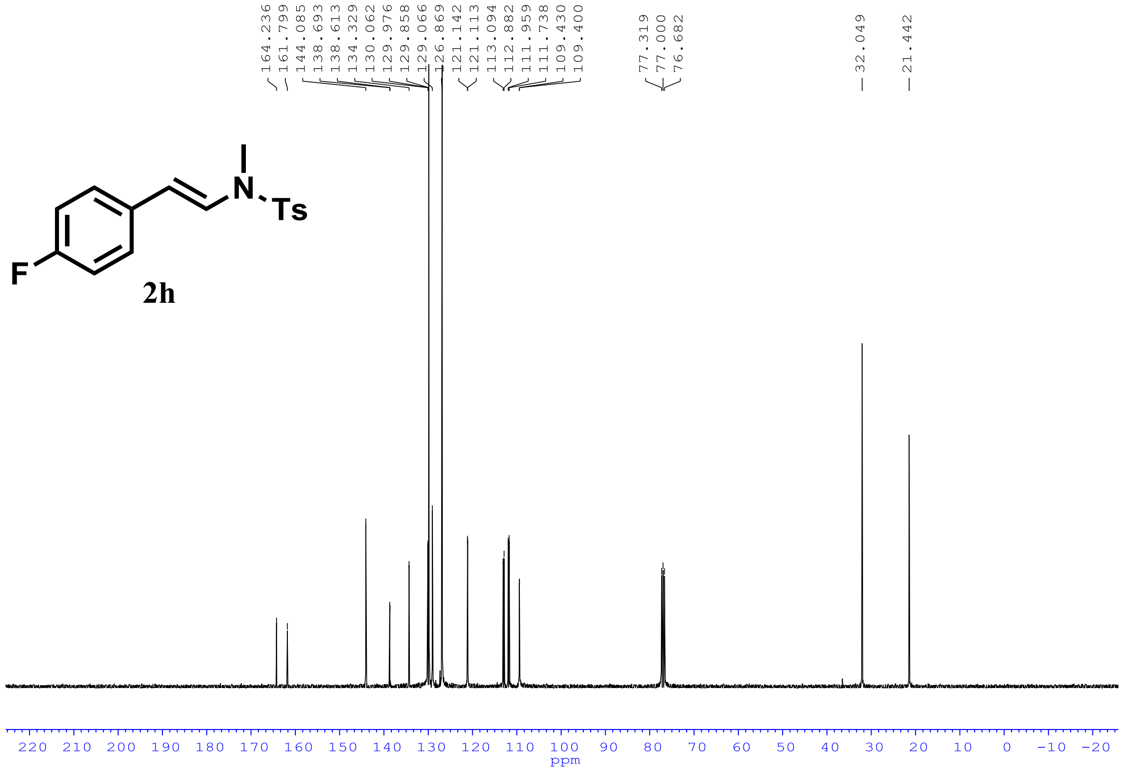
2f

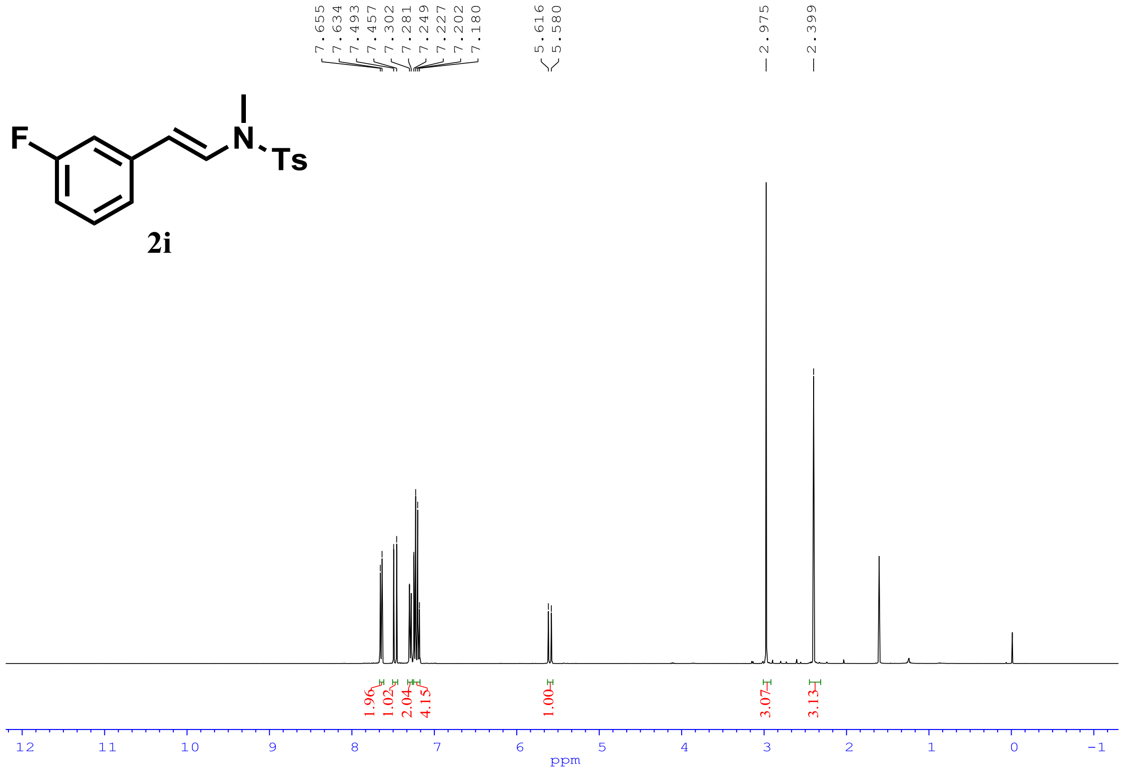

8.145
8.123
7.726
7.690
7.676
7.655
7.390
7.368
7.329
7.327
7.307
7.249
5.687
5.651
3.028
2.412
O_2N
N
Ts
2g
2.10
1.12
1.93
2.11
2.19
1.00
3.08
3.36
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

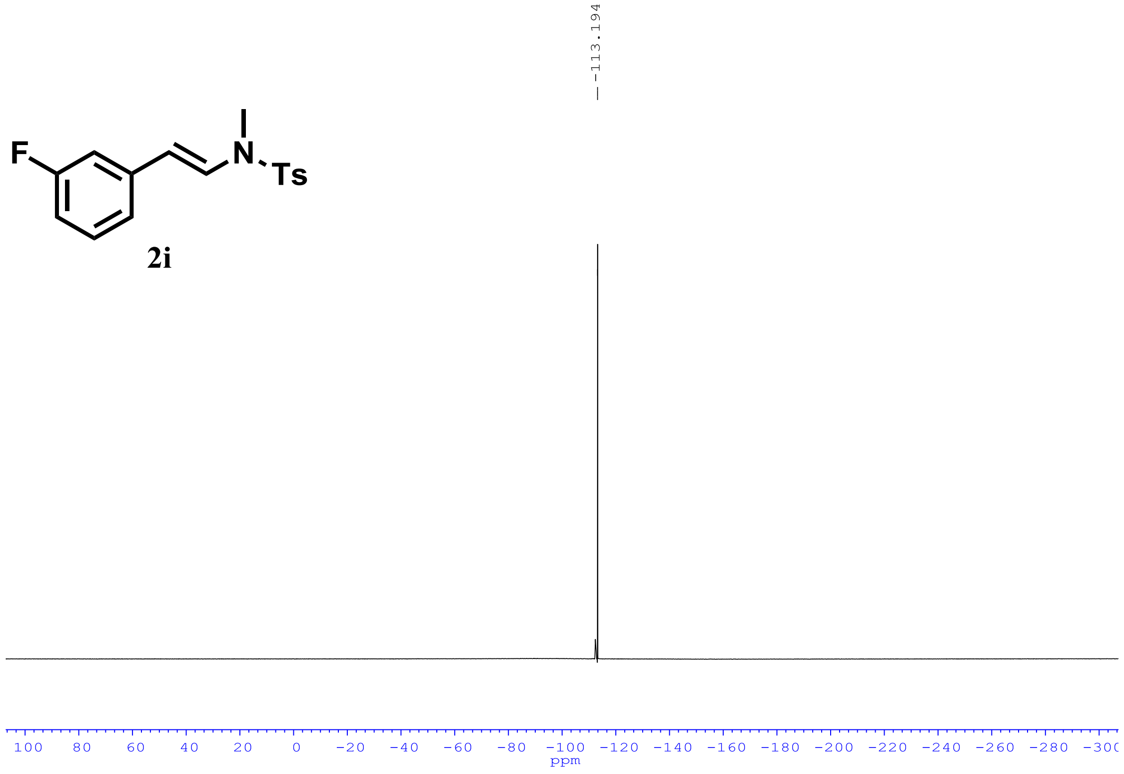

145.813
144.527
143.513
134.478
131.891
130.092
127.026
125.521
124.265
107.811
77.325
77.008
76.692
32.104
21.585
O_2N
N
Ts
2g
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

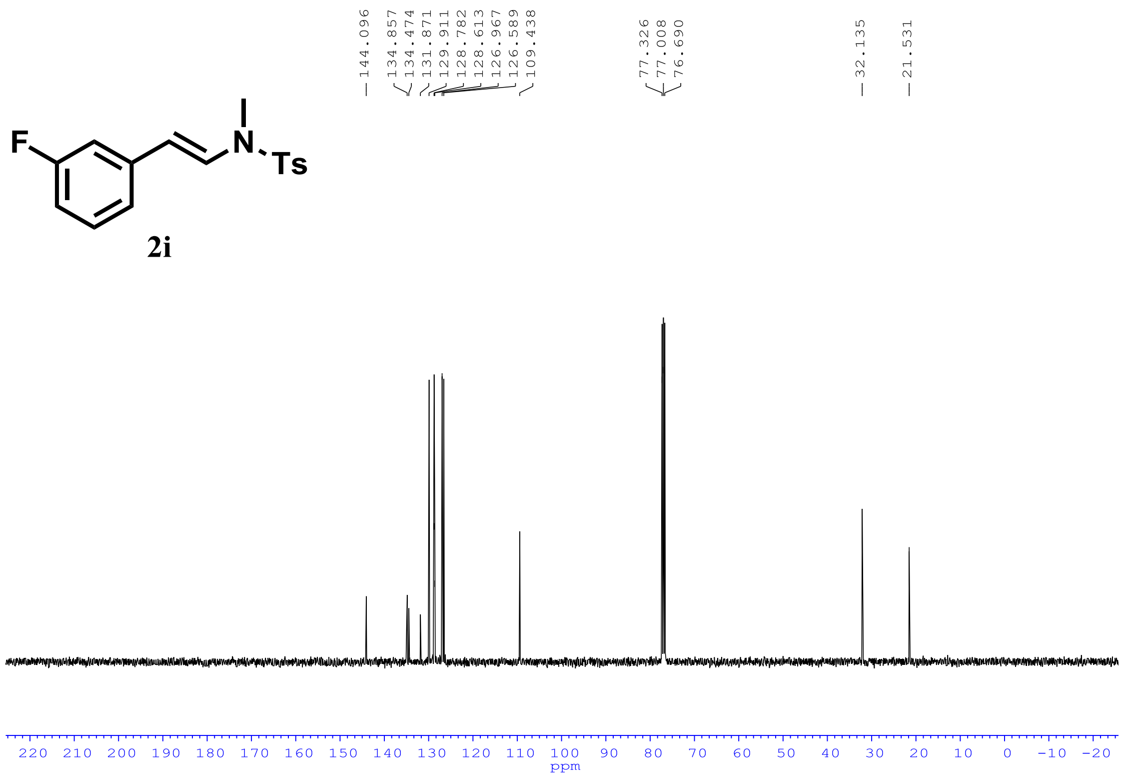

7.667
7.651
7.646
7.538
7.502
7.305
7.285
7.250
7.230
7.215
7.195
7.049
7.029
6.979
6.954
6.865
6.859
6.844
6.838
6.823
6.817
5.636
5.600
2.983
2.395
N
Ts
F
2h
2.00
1.03
1.99
1.14
1.04
1.03
1.03
1.00
3.06
3.13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm


-113.196
N
Ts
F
2h
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-30
ppm

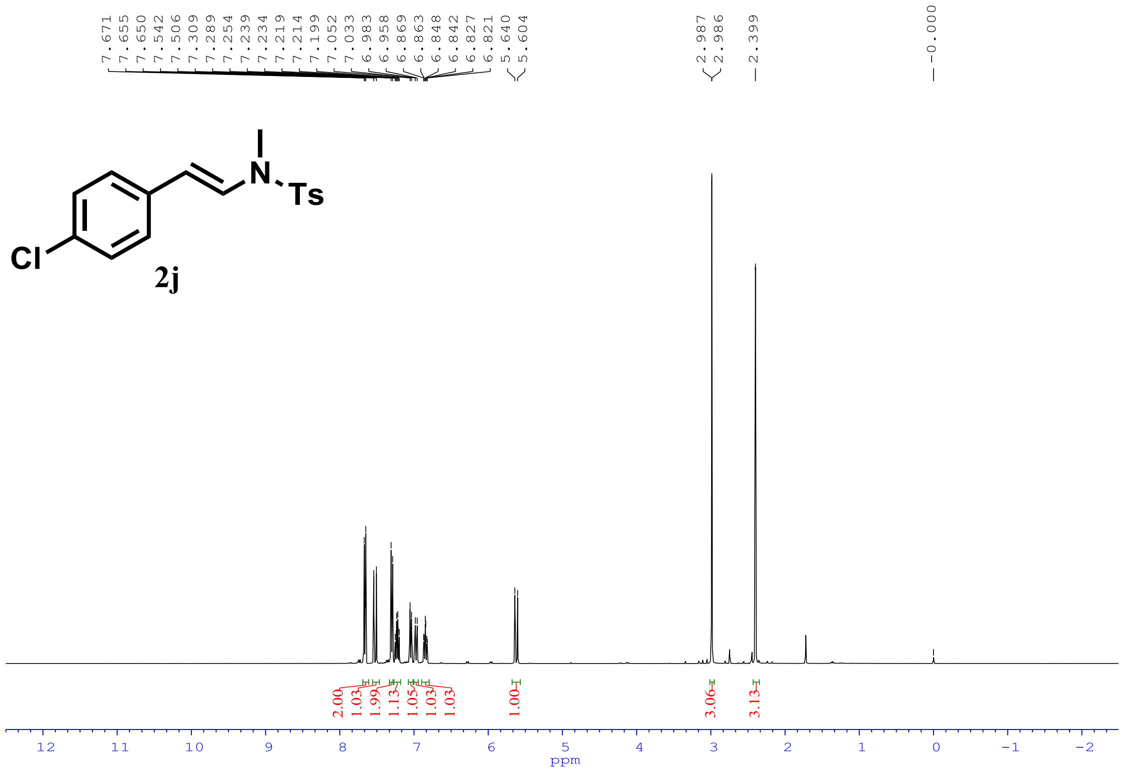

164.236
161.799
144.085
138.693
138.613
134.329
130.062
129.976
129.858
129.066
126.869
121.142
121.113
113.094
112.882
111.959
111.738
109.430
109.400
77.319
77.000
76.682
32.049
21.442
F
N
Ts
2h
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
ppm

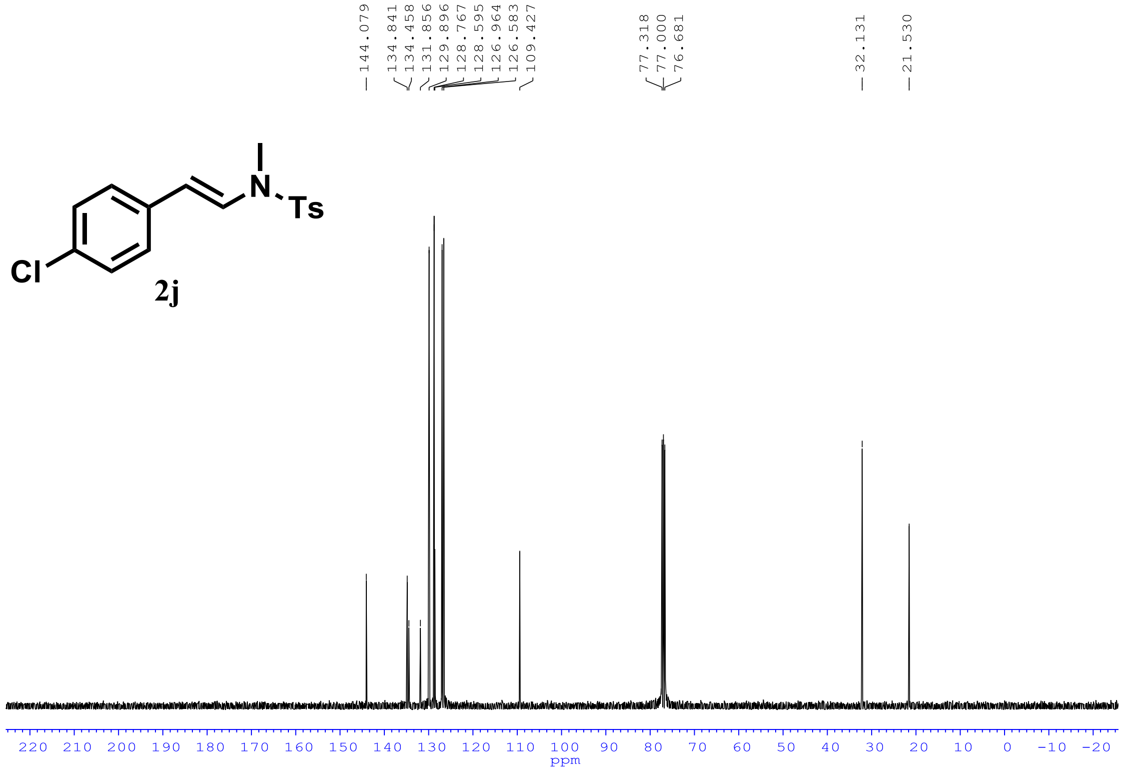

7.655
7.634
7.493
7.457
7.302
7.281
7.249
7.227
7.202
7.180
5.616
5.580
2.975
2.399
F
N
Ts
2i
1.96
1.02
2.04
4.15
1.00
3.07
3.13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

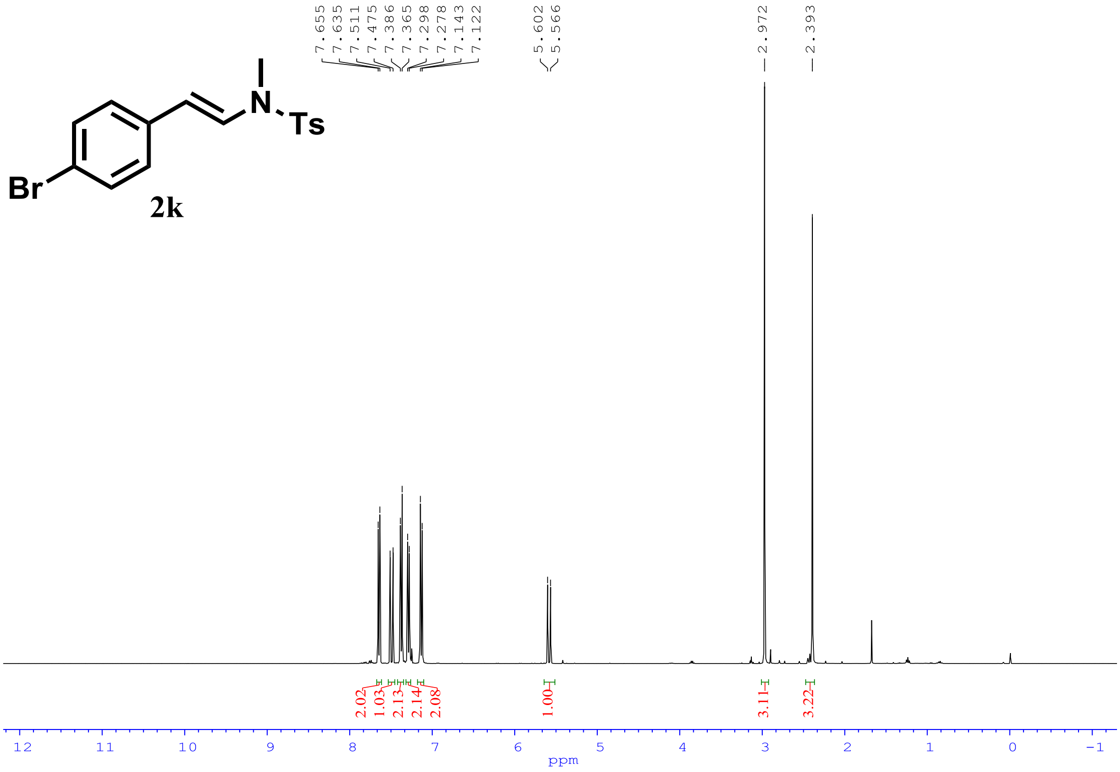

-113.194
F
N
Ts
2i
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
ppm

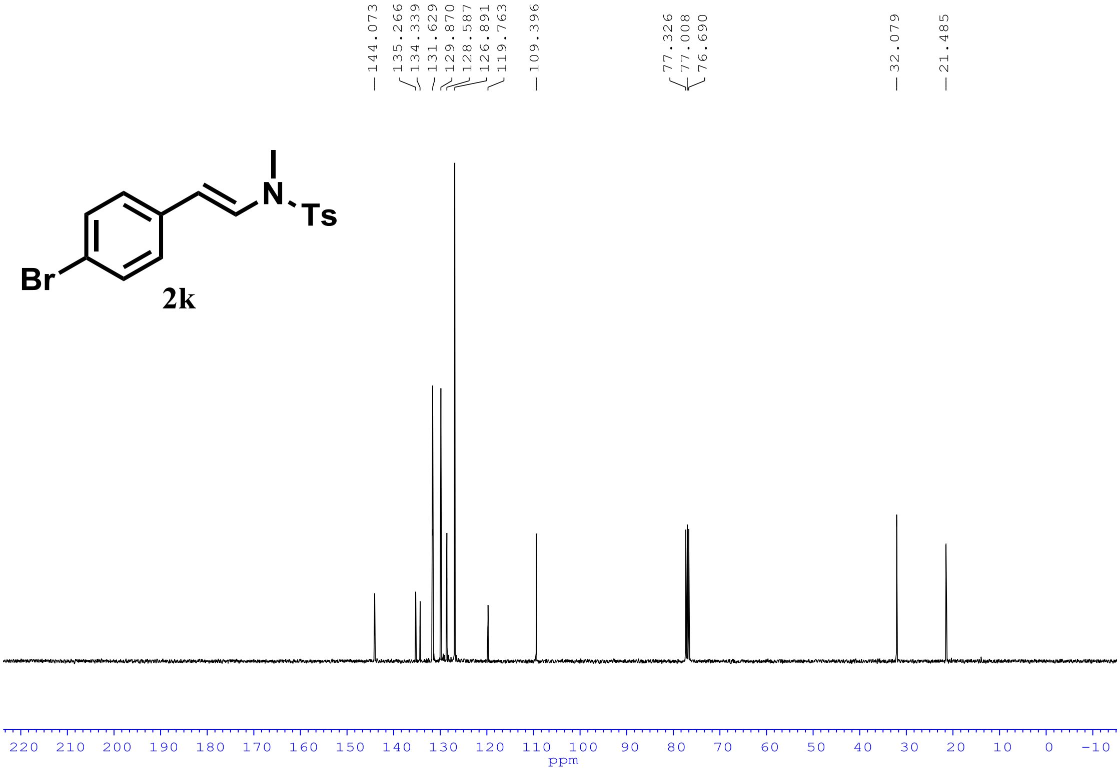

F
N
Ts
144.096
134.857
134.474
131.871
129.911
128.782
128.613
126.967
126.589
109.438
77.326
77.008
76.690
32.135
21.531
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
ppm

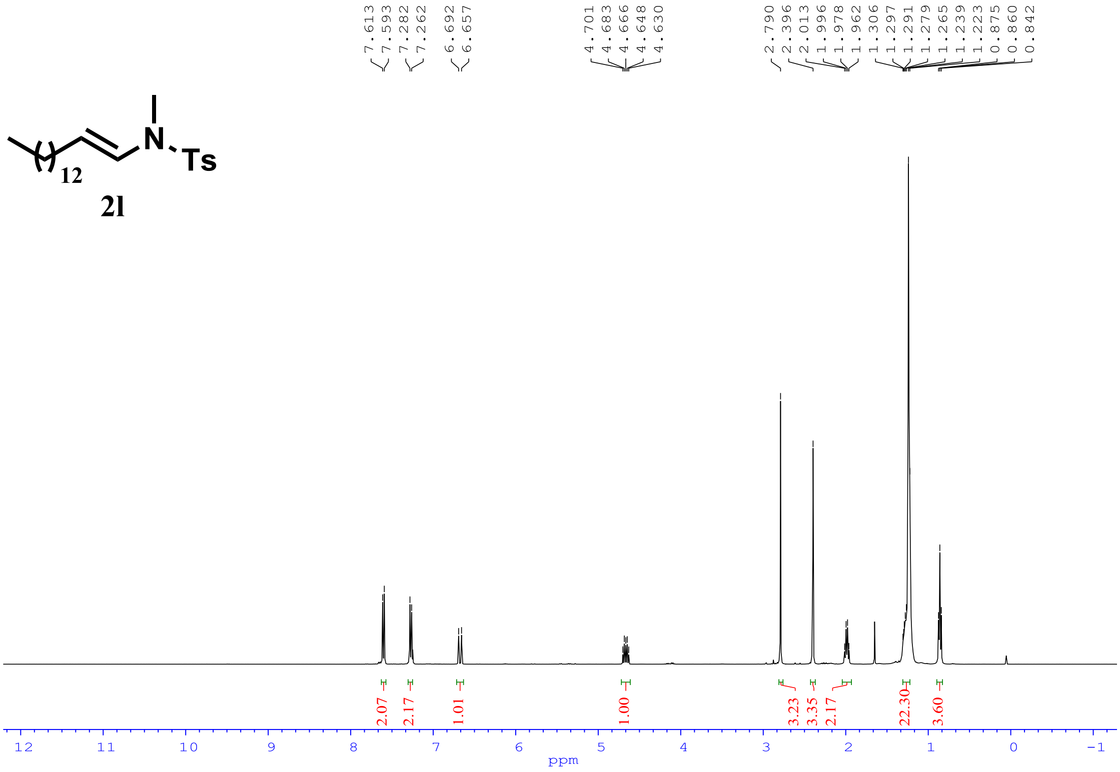
2i


7.671
7.655
7.650
7.542
7.506
7.309
7.289
7.254
7.239
7.234
7.219
7.214
7.199
7.052
7.033
6.983
6.958
6.869
6.863
6.848
6.842
6.827
6.821
5.640
5.604
2.987
2.986
2.399
-0.000
Cl
N
Ts
2j
2.00
1.03
1.99
1.13
1.05
1.03
1.03
1.00
3.06
3.13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

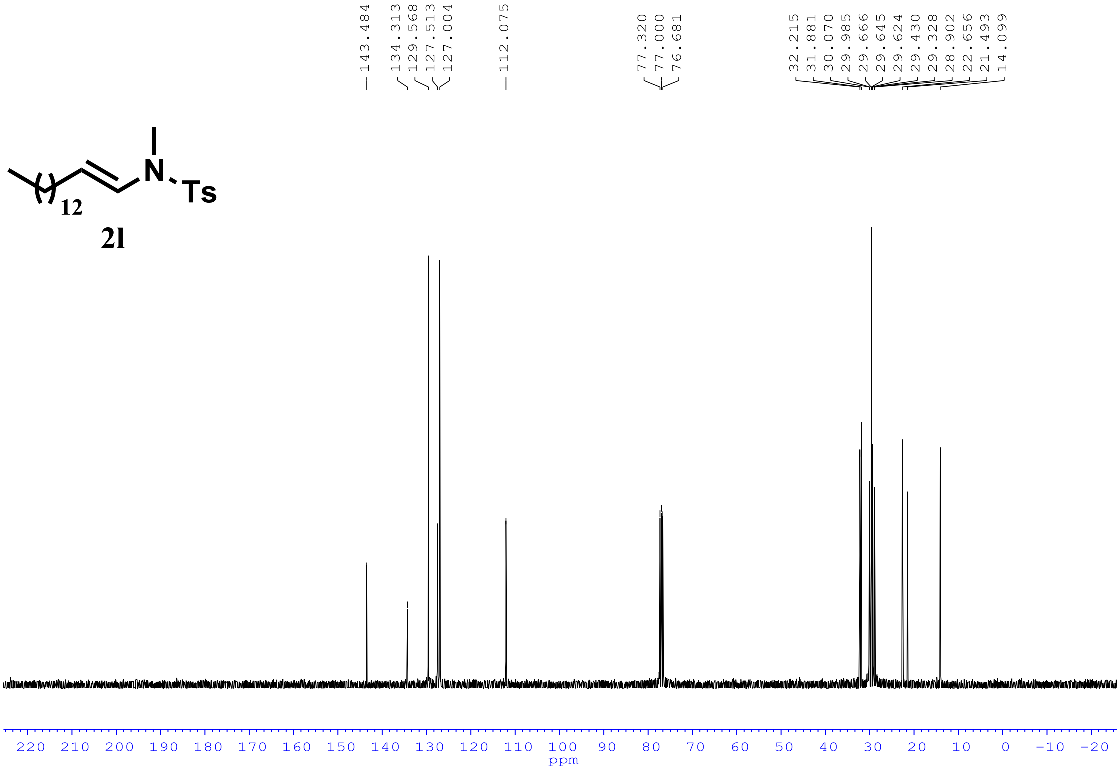

144.079
134.841
134.458
131.856
129.896
128.767
128.595
126.964
126.583
109.427
77.318
77.000
76.681
32.131
21.530
Cl
N
Ts
2j
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


7.655
7.635
7.511
7.475
7.386
7.365
7.298
7.278
7.143
7.122
5.602
5.566
2.972
2.393
Br
N
Ts
2k
2.02
1.03
2.13
2.14
2.08
1.00
3.11
3.22
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

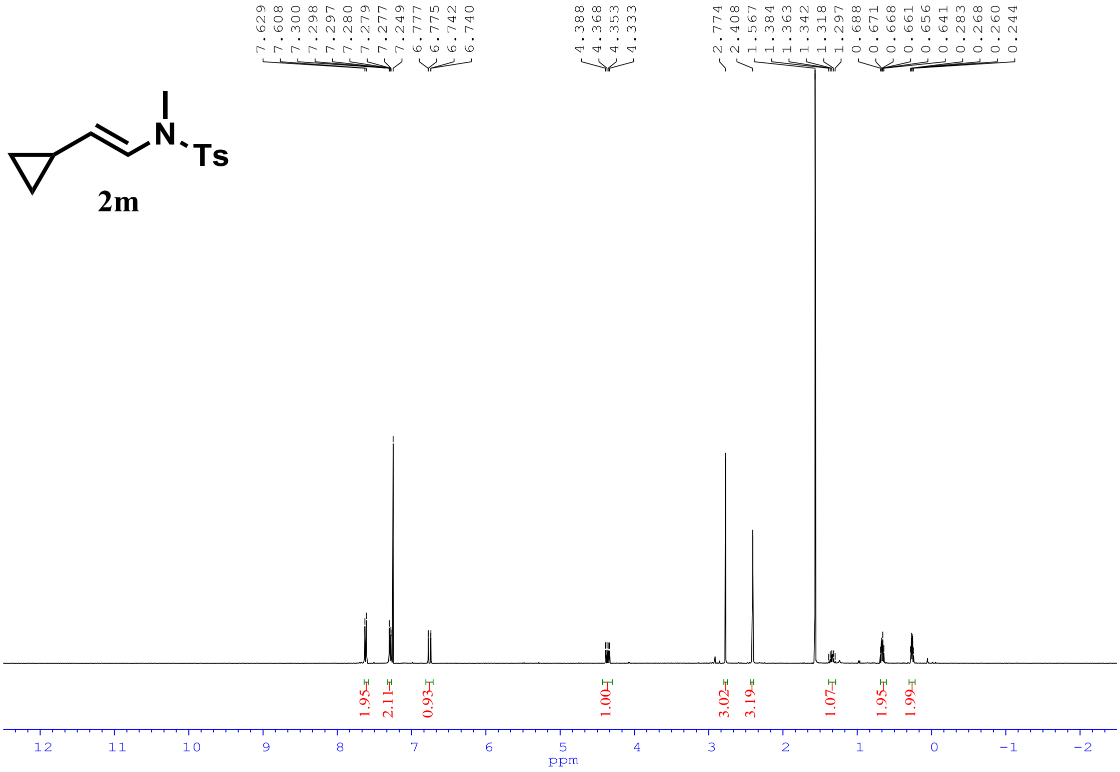

144.073
135.266
134.339
131.629
129.870
128.587
126.891
119.763
109.396
77.326
77.008
76.690
32.079
21.485
Br
N
Ts
2k
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

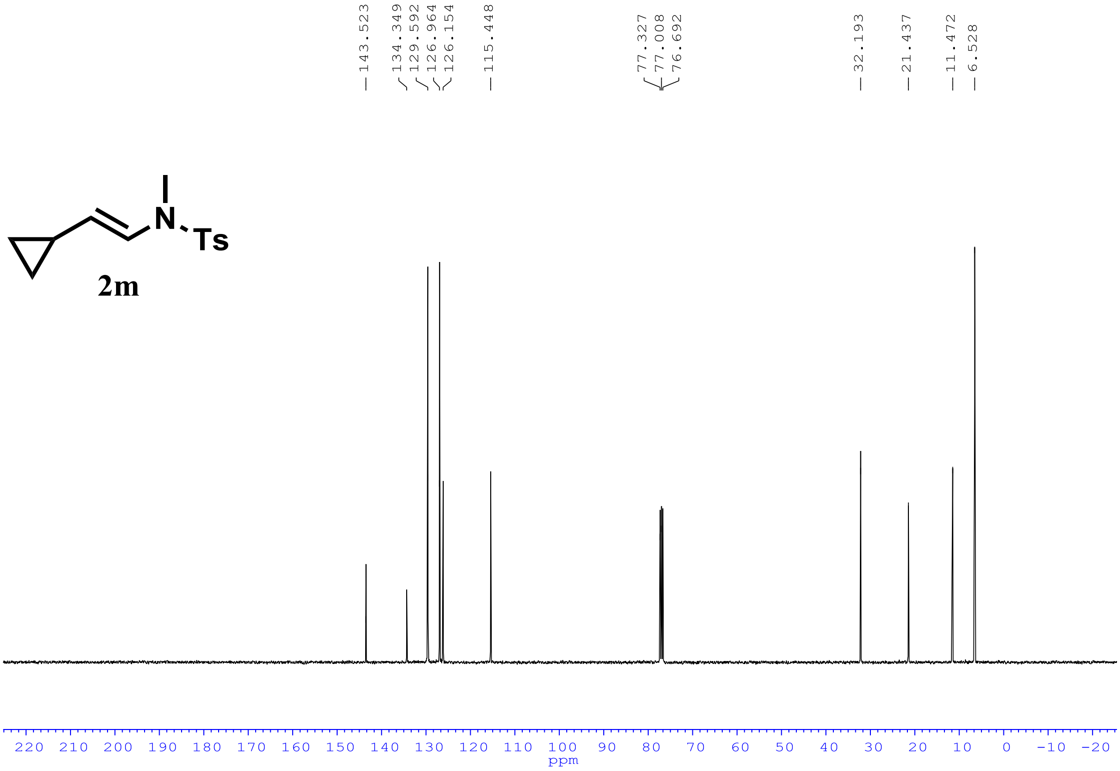

7.613
7.593
7.282
7.262
6.692
6.657
4.701
4.683
4.666
4.648
4.630
2.790
2.396
2.013
1.996
1.978
1.962
1.306
1.297
1.291
1.279
1.265
1.239
1.223
0.875
0.860
0.842
N
Ts
12
2.07
2.17
1.01
1.00
3.23
3.35
2.17
22.30
3.60
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

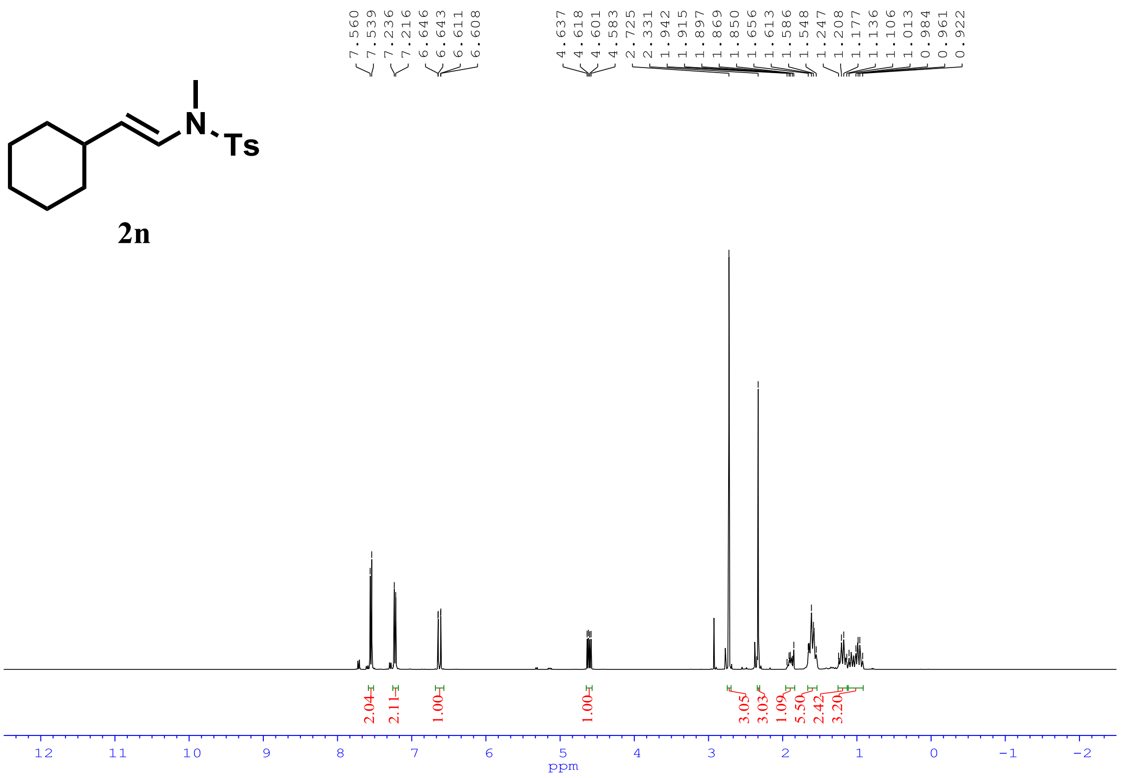
2l


143.484
134.313
129.568
127.513
127.004
112.075
77.320
77.000
76.681
32.215
31.881
30.070
29.985
29.666
29.645
29.624
29.430
29.328
28.902
22.656
21.493
14.099
N
Ts
12
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

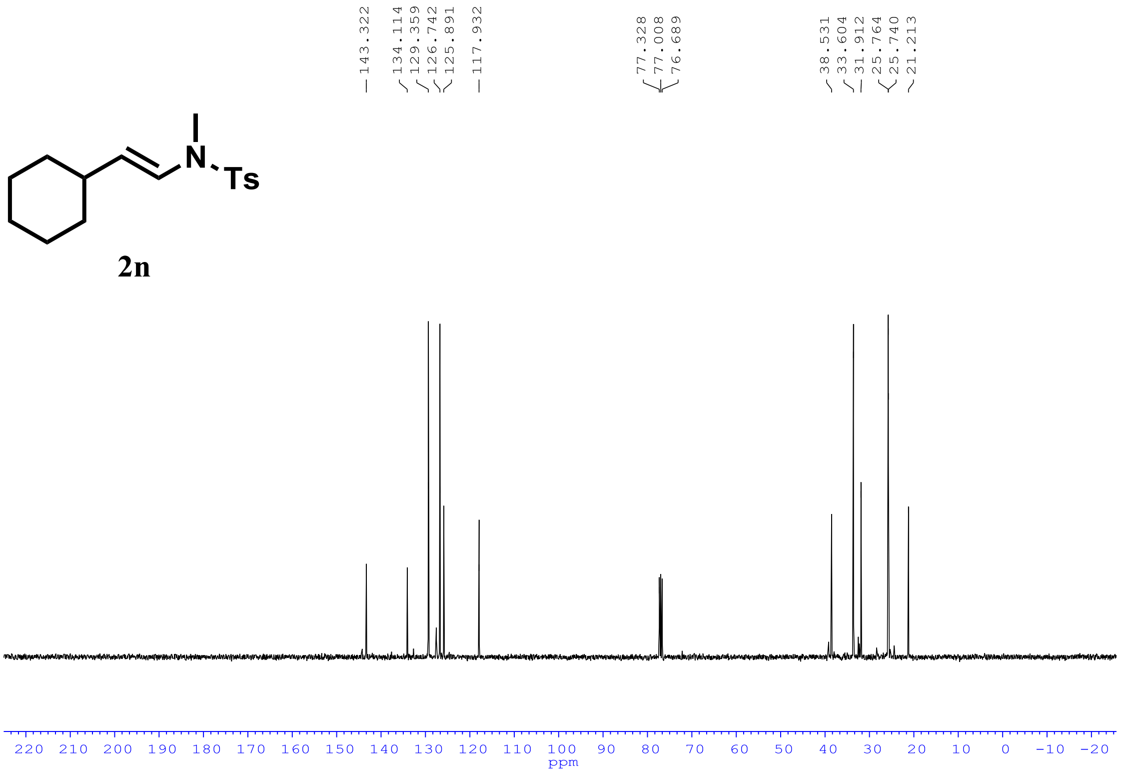
2l


7.629
7.608
7.300
7.298
7.297
7.280
7.279
7.277
7.249
6.777
6.775
6.742
6.740
4.388
4.368
4.353
4.333
2.774
2.408
1.567
1.384
1.363
1.342
1.318
1.297
0.688
0.671
0.668
0.661
0.656
0.641
0.283
0.268
0.260
0.244
N
Ts
2m
1.95
2.11
0.93
1.00
3.02
3.19
1.07
1.95
1.99
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

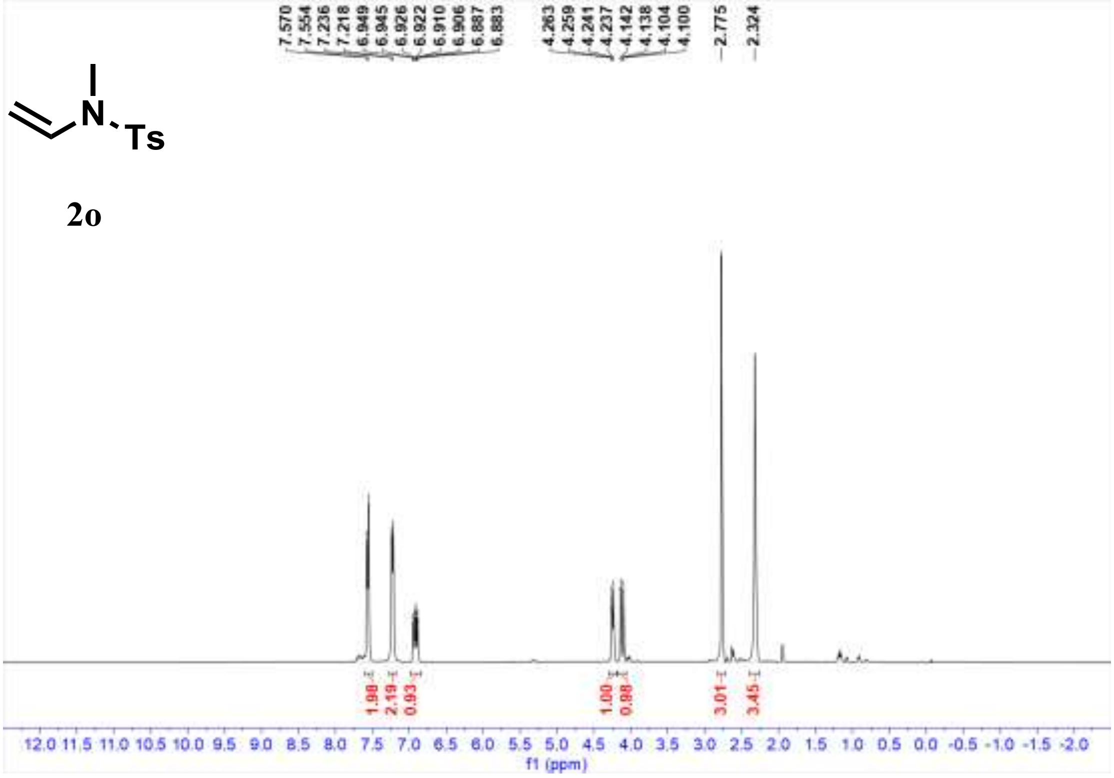

143.523
134.349
129.592
126.964
126.154
115.448
77.327
77.008
76.692
32.193
21.437
11.472
6.528
N
Ts
2m
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


7.560
7.539
7.236
7.216
6.646
6.643
6.611
6.608
4.637
4.618
4.601
4.583
2.725
2.331
1.942
1.915
1.897
1.869
1.850
1.656
1.613
1.586
1.548
1.247
1.208
1.177
1.136
1.106
1.013
0.984
0.961
0.922
N
Ts
2.04
2.11
1.00
1.00
3.05
3.03
1.09
5.50
2.42
3.20
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

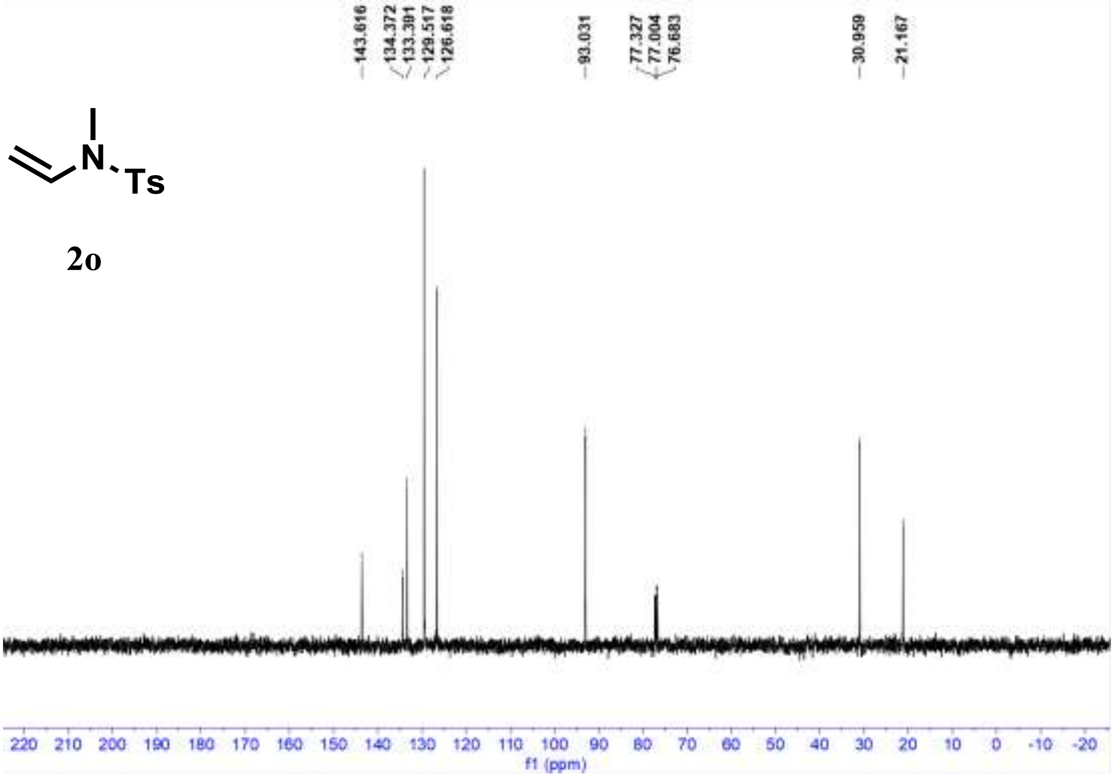
2n


143.322
134.114
129.359
126.742
125.891
117.932
77.328
77.008
76.689
38.531
33.604
31.912
25.764
25.740
21.213
N
Ts
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

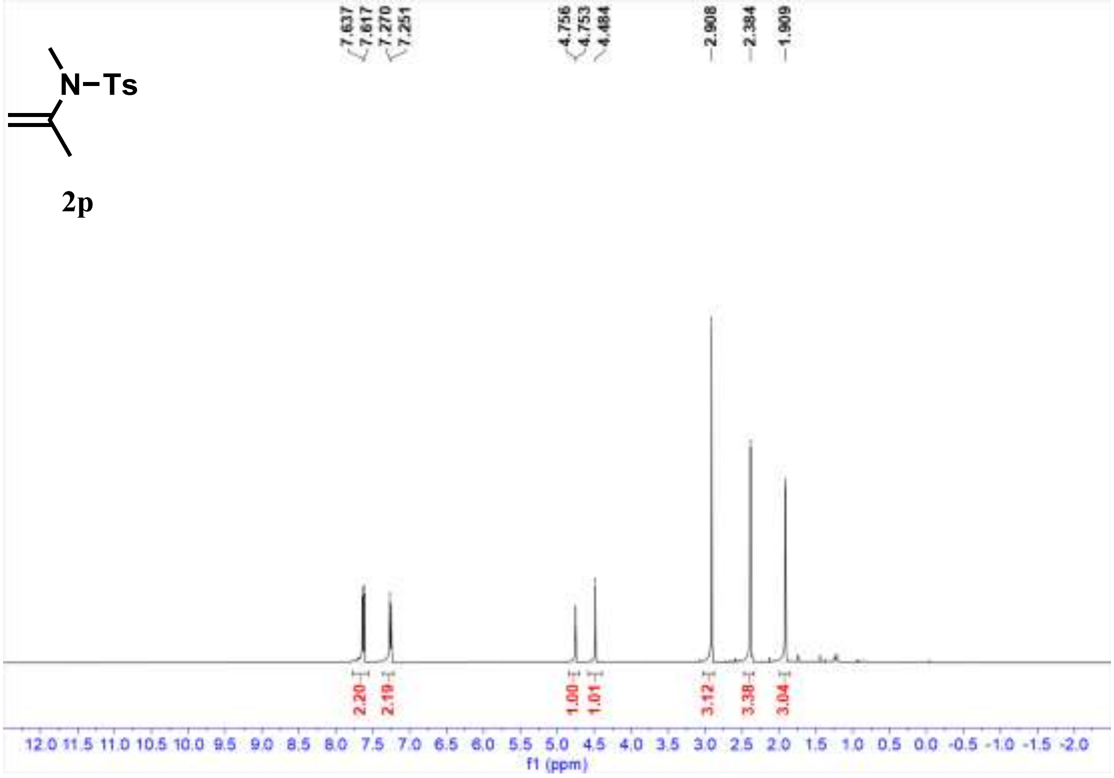
2n


7.570
7.554
7.236
7.218
6.949
6.945
6.926
6.922
6.910
6.906
6.887
6.883
4.263
4.259
4.241
4.237
4.142
4.138
4.104
4.100
2.775
2.324
N
Ts
1.98
2.19
0.93
1.00
0.98
3.01
3.45
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0
f1 (ppm)

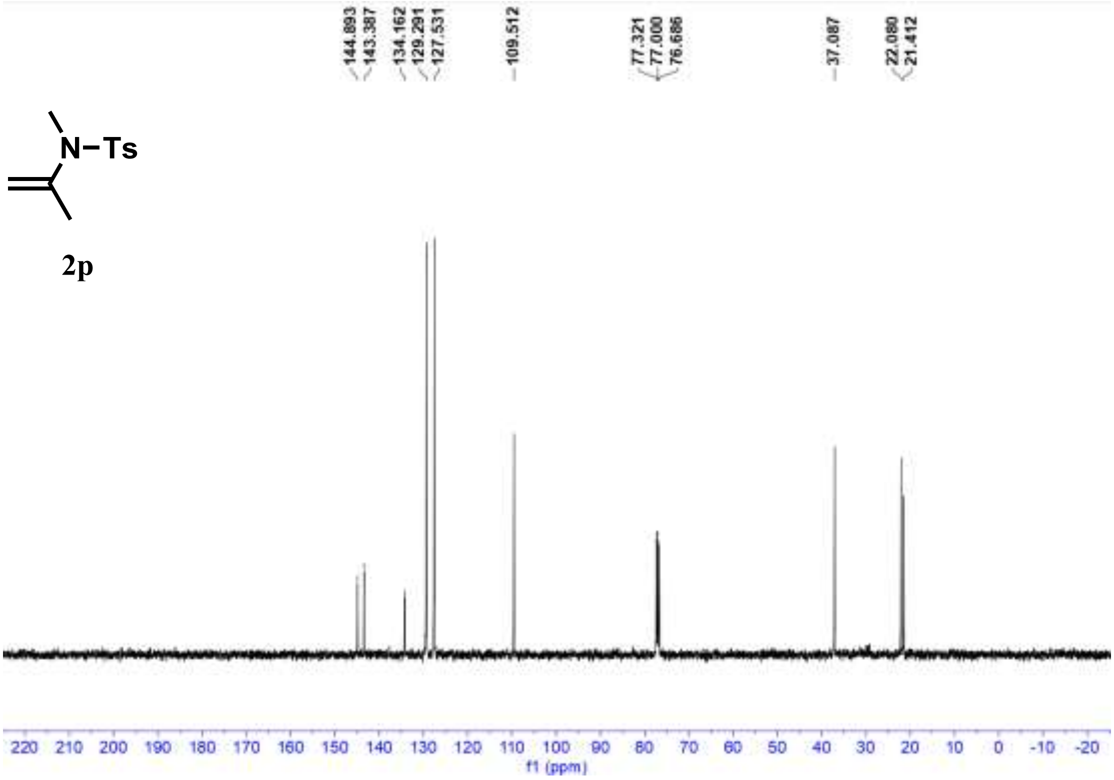
2o


143.616
134.372
133.391
129.517
126.618
93.031
77.327
77.004
76.683
30.959
21.167
N
Ts
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

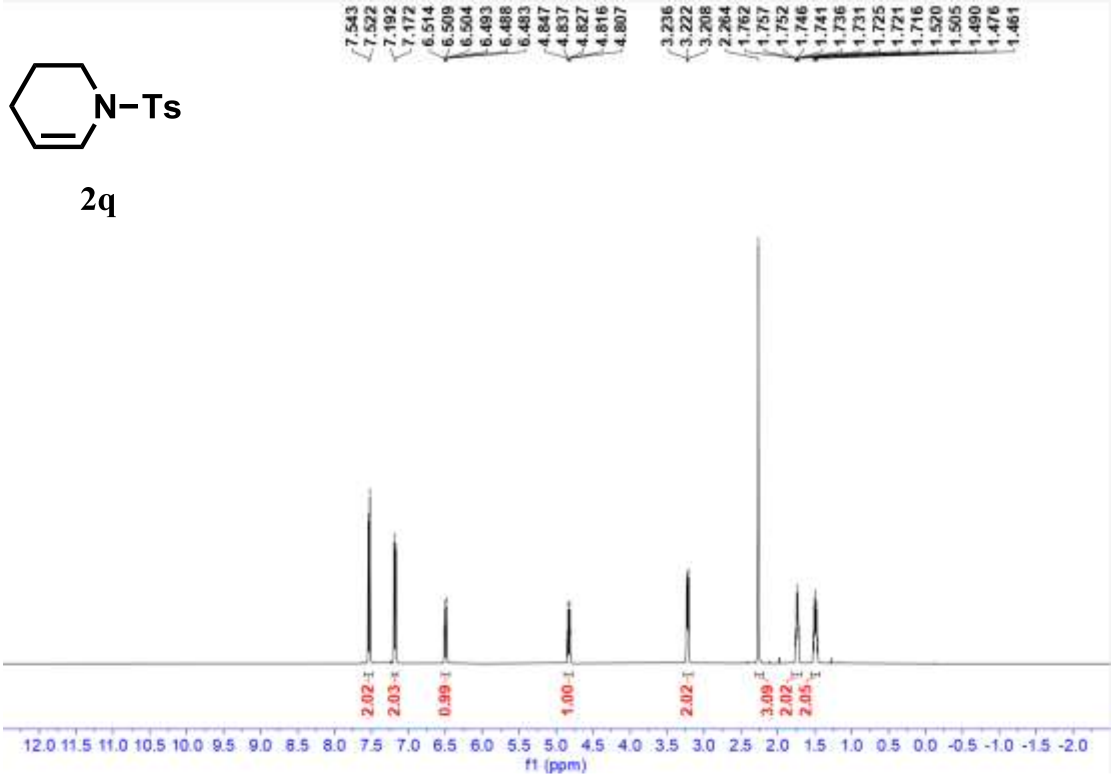
2o

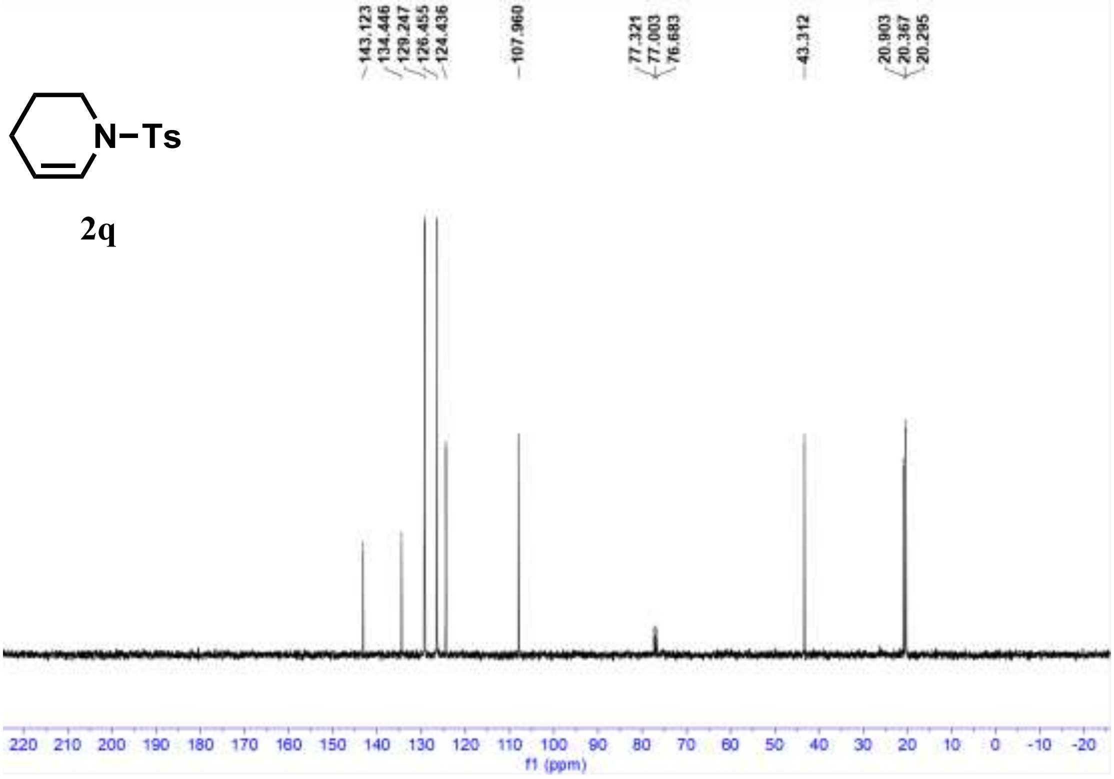

7.637
7.617
7.270
7.251
4.756
4.753
4.484
2.908
2.384
1.909
N−Ts
2.20
2.19
1.00
1.01
3.12
3.38
3.04
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0
f1 (ppm)

2p

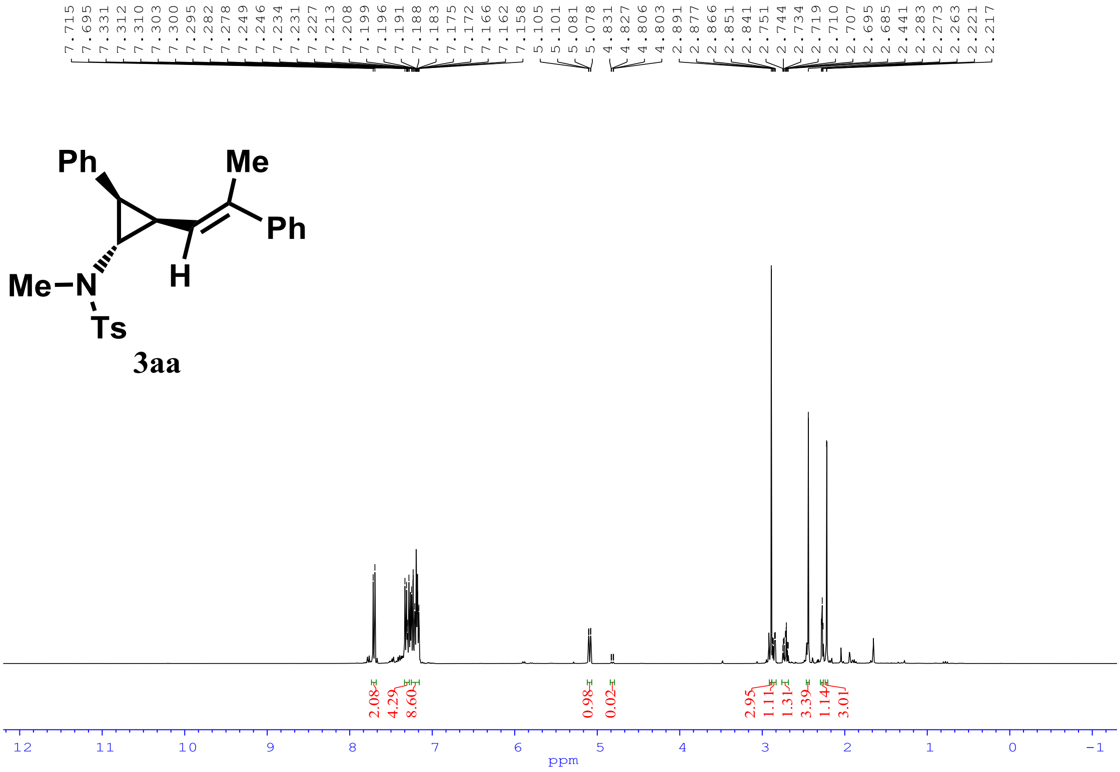

144.893
143.387
134.162
129.291
127.531
109.512
77.321
77.000
76.686
37.087
22.080
21.412
N−Ts
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

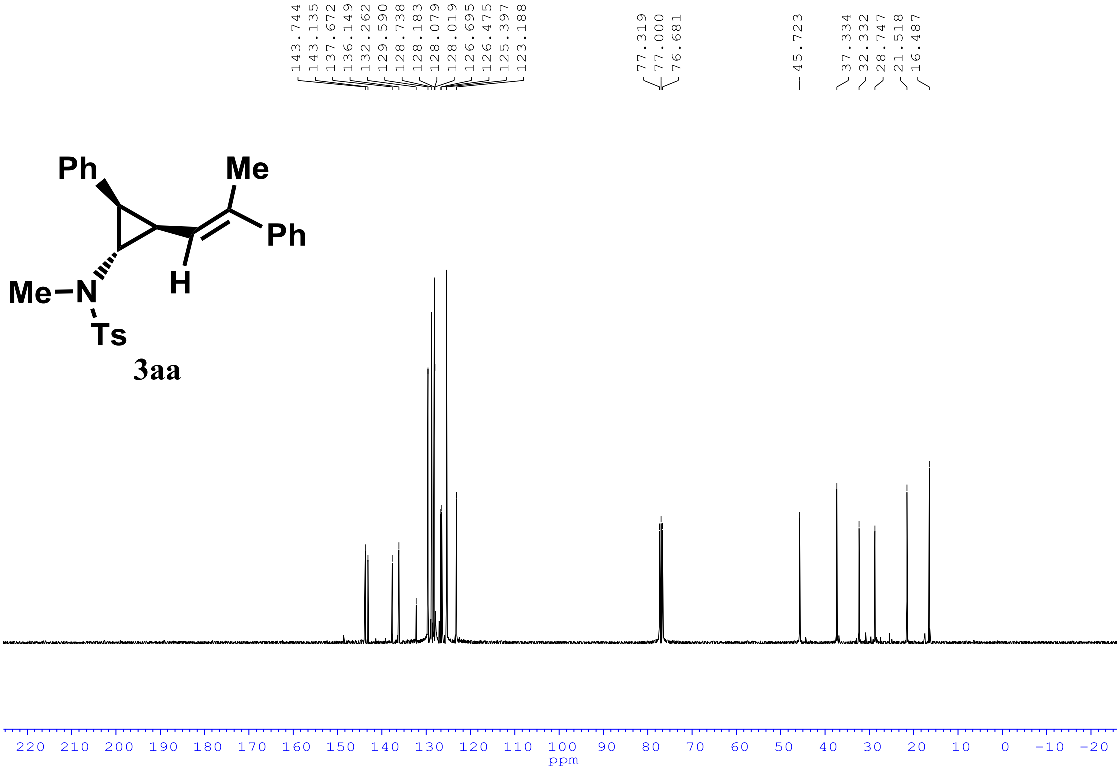
2p

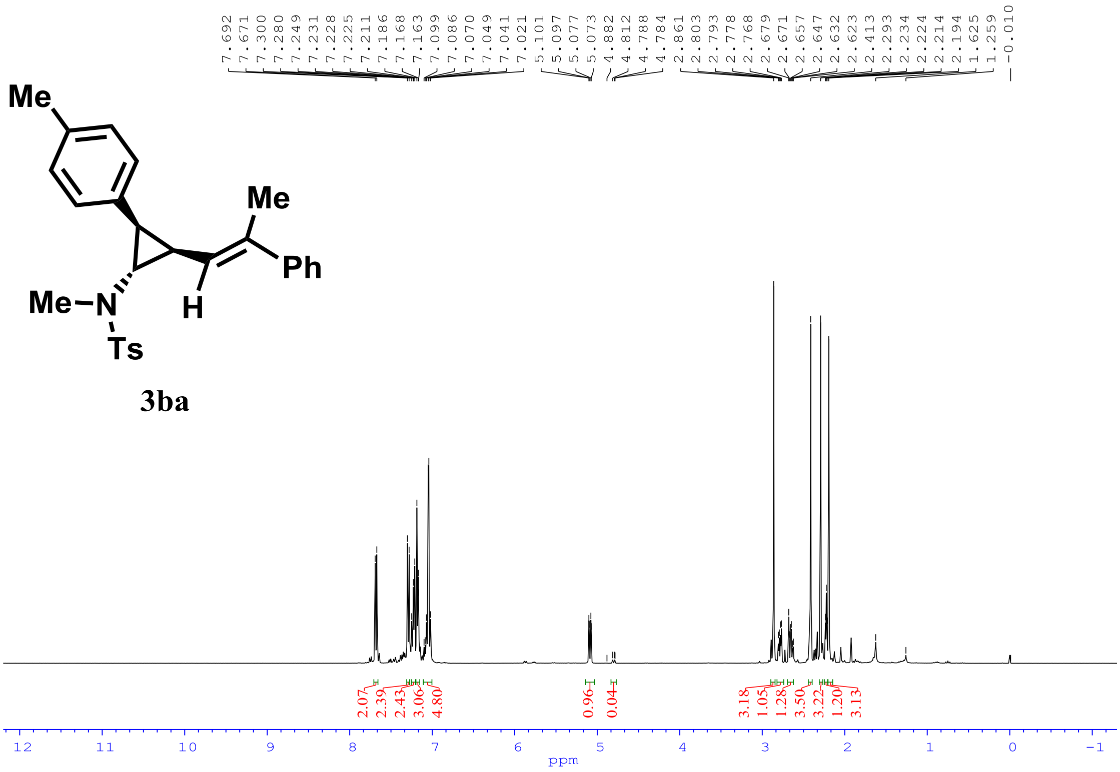

7.543
7.522
7.192
7.172
6.514
6.509
6.504
6.493
6.488
6.483
4.847
4.837
4.827
4.816
4.807
3.236
3.222
3.208
2.264
1.762
1.757
1.752
1.746
1.741
1.736
1.731
1.725
1.721
1.716
1.520
1.505
1.490
1.476
1.461
N−Ts
2q
2.02
2.03
0.99
1.00
2.02
3.09
2.02
2.05
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0
f1 (ppm)

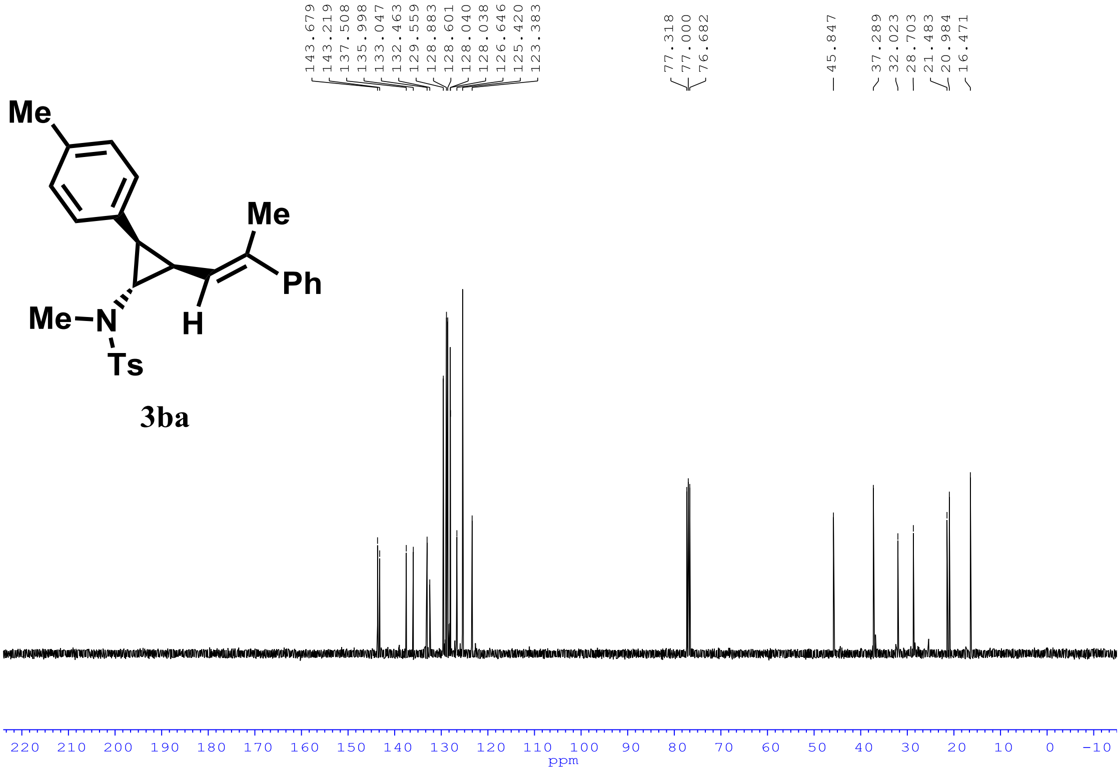

143.123
134.446
129.247
126.455
124.436
107.960
77.321
77.003
76.683
43.312
20.903
20.367
20.295
N−Ts
2q
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

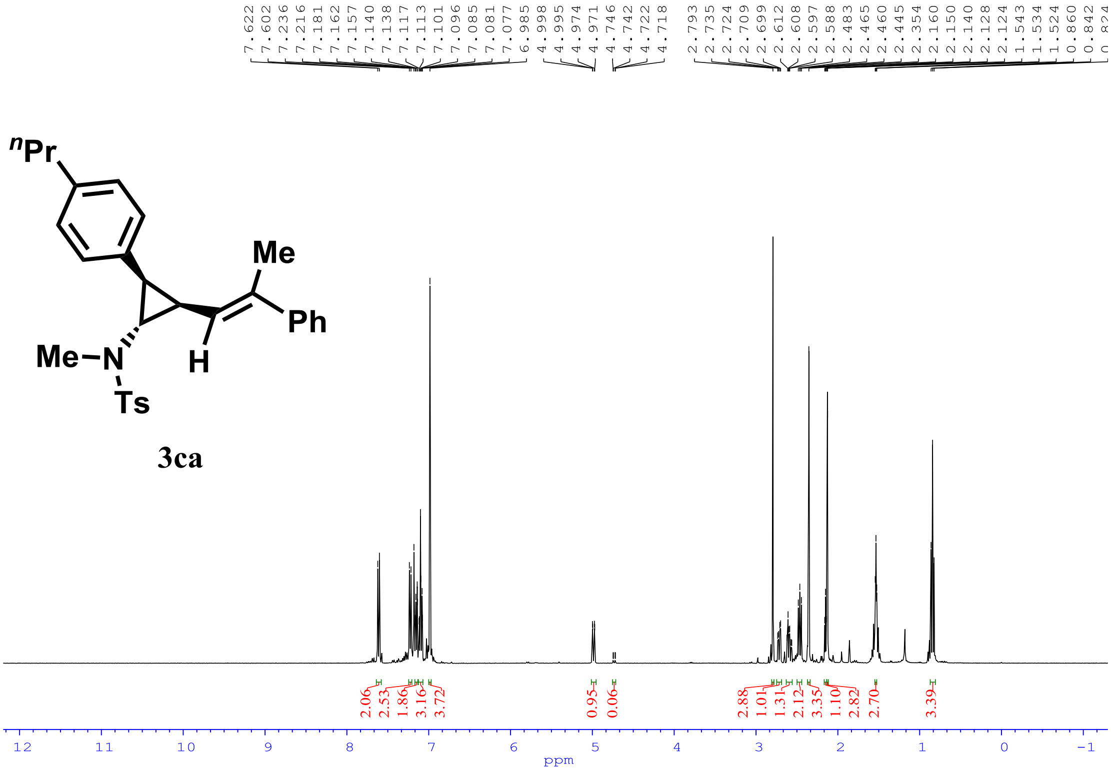
NMR Spectra for vinyl cyclopropylamides:

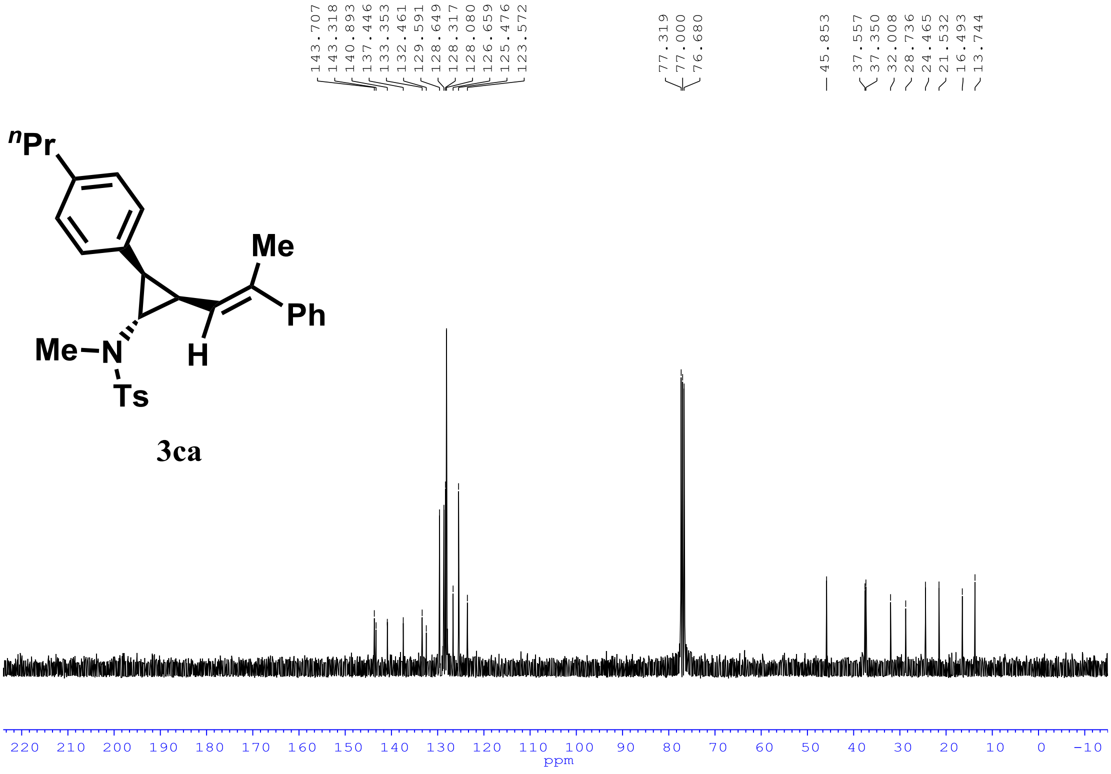


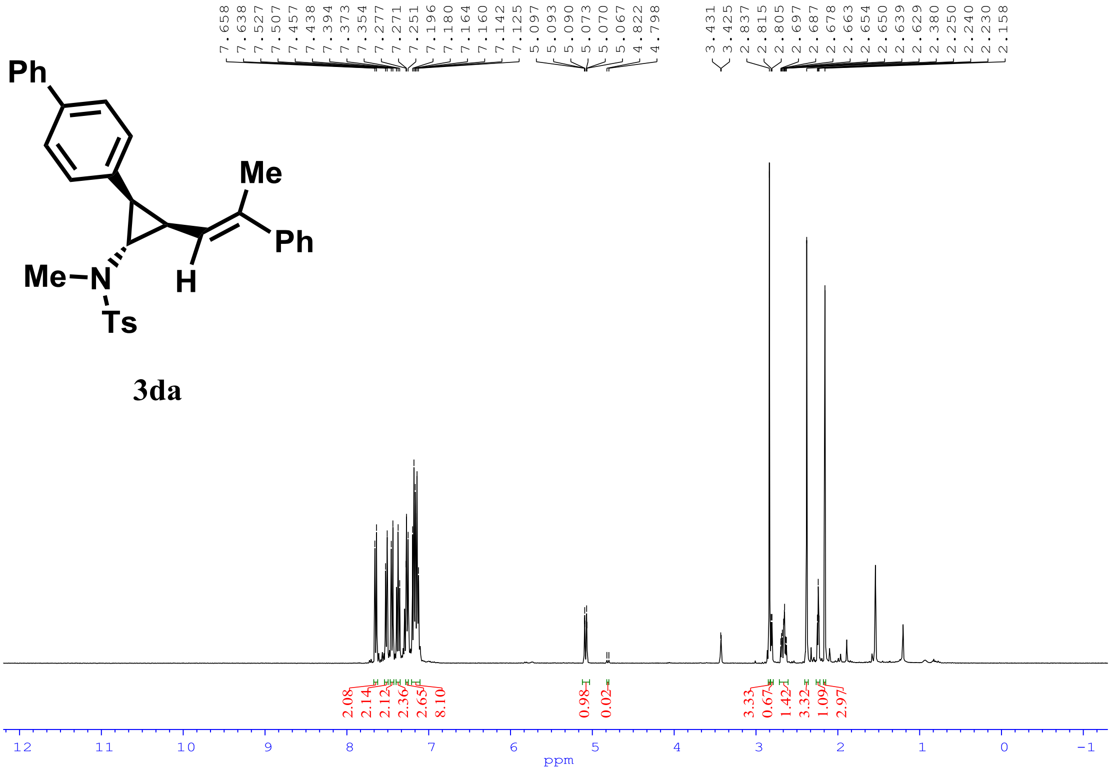


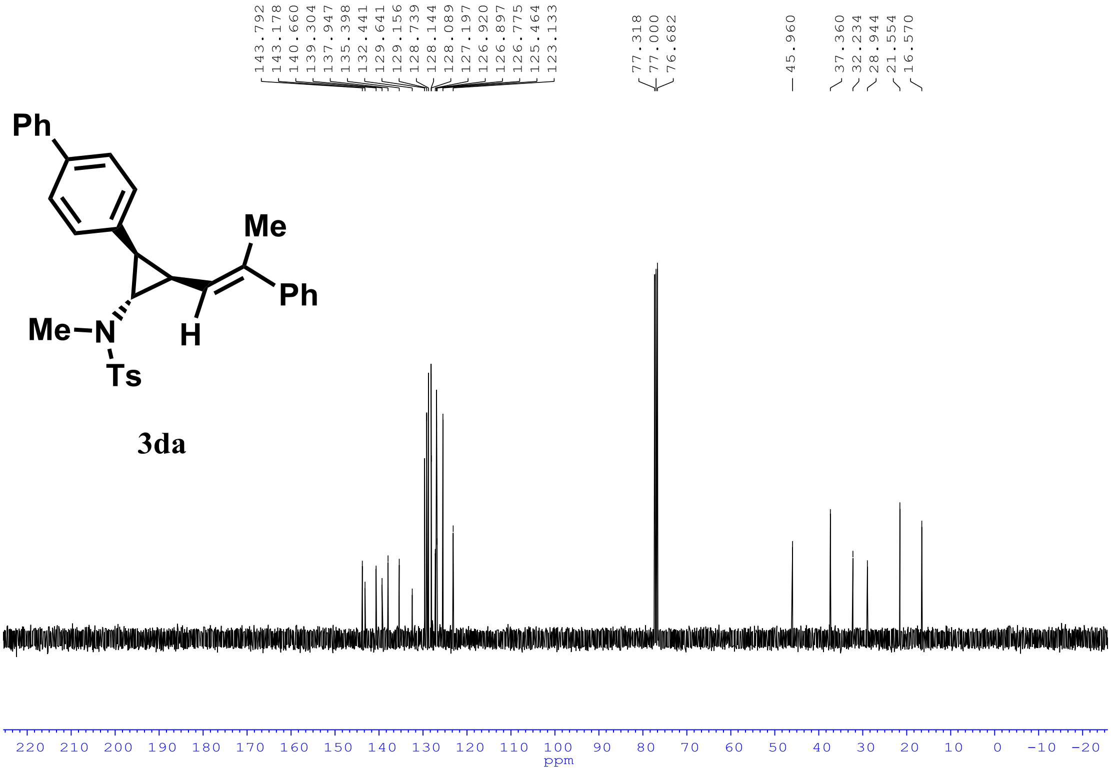

3ba
Me
Me
Ph
Me−N
H
Ts
7.692
7.671
7.300
7.280
7.249
7.231
7.228
7.225
7.211
7.186
7.168
7.163
7.099
7.086
7.070
7.049
7.041
7.021
5.101
5.097
5.077
5.073
4.882
4.812
4.788
4.784
2.861
2.803
2.793
2.778
2.768
2.679
2.671
2.657
2.647
2.632
2.623
2.413
2.293
2.234
2.224
2.214
2.194
1.625
1.259
−0.010
2.07
2.39
2.43
3.06
4.80
0.96
0.04
3.18
1.05
1.28
3.50
3.22
1.20
3.13
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
ppm

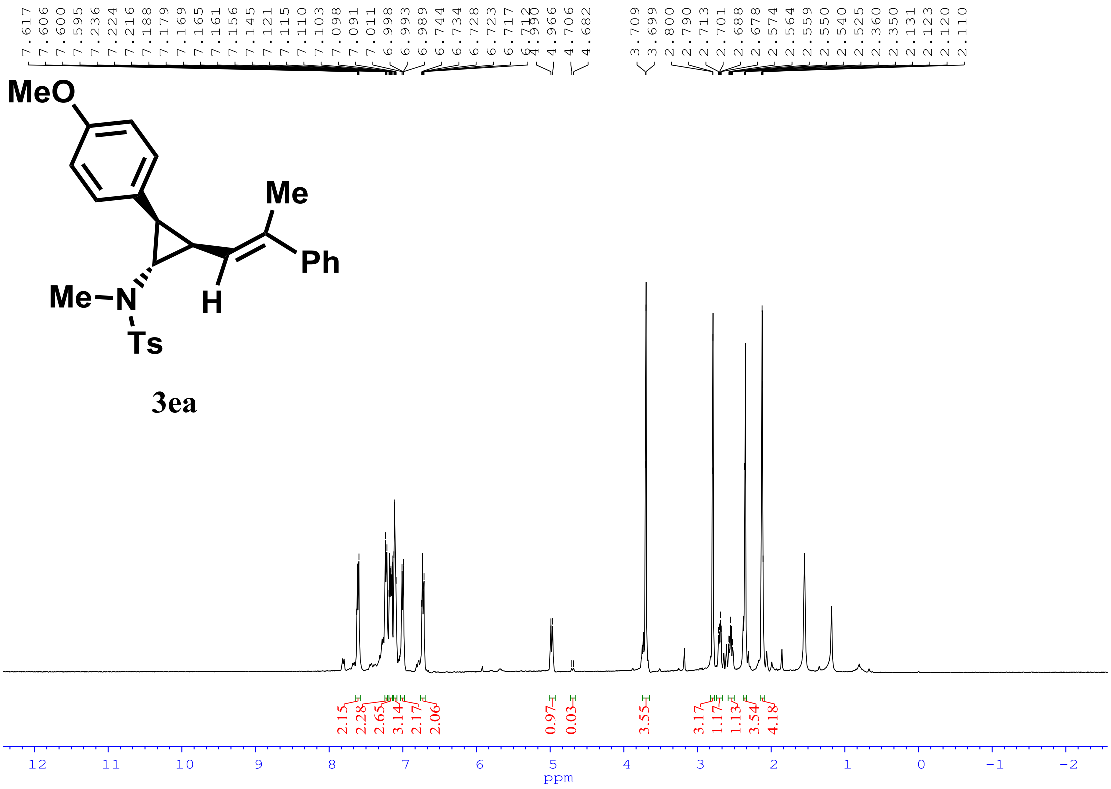

3ba
Me
Me
Ph
Me−N
H
Ts
143.679
143.219
137.508
135.998
133.047
132.463
129.559
128.883
128.601
128.040
128.038
126.646
125.420
123.383
77.318
77.000
76.682
45.847
37.289
32.023
28.703
21.483
20.984
16.471
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
ppm


7.622
7.602
7.236
7.216
7.181
7.162
7.157
7.140
7.138
7.117
7.113
7.101
7.096
7.085
7.081
7.077
6.985
4.998
4.995
4.974
4.971
4.746
4.742
4.722
4.718
2.793
2.735
2.724
2.709
2.699
2.612
2.608
2.597
2.588
2.483
2.465
2.460
2.445
2.354
2.160
2.150
2.140
2.128
2.124
1.543
1.534
1.524
0.860
0.842
0.824
^{n}Pr
Me
Ph
Me–N
H
Ts
3ca
2.06
2.53
1.86
3.16
3.72
0.95
0.06
2.88
1.01
1.31
2.12
3.35
1.10
2.82
2.70
3.39
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

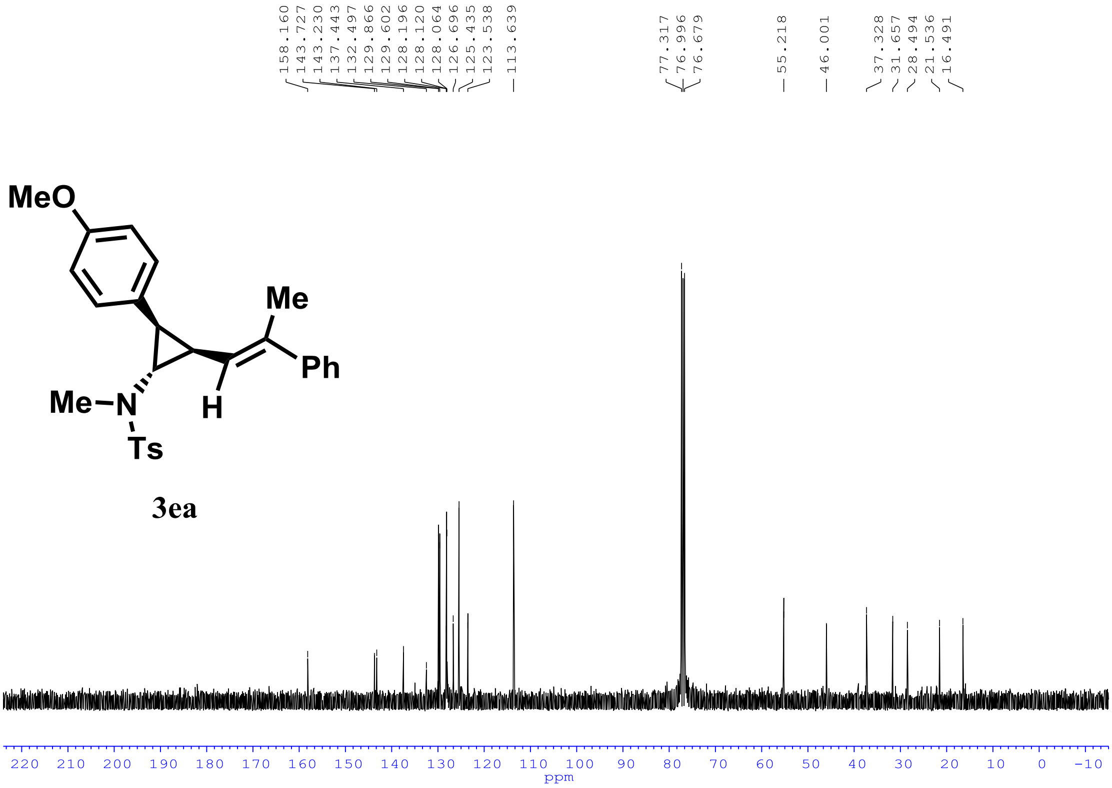

143.707
143.318
140.893
137.446
133.353
132.461
129.591
128.649
128.317
128.080
126.659
125.476
123.572
77.319
77.000
76.680
45.853
37.557
37.350
32.008
28.736
24.465
21.532
16.493
13.744
^{n}Pr
Me
Ph
Me–N
H
Ts
3ca
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm


7.658
7.638
7.527
7.507
7.457
7.438
7.394
7.373
7.354
7.277
7.271
7.251
7.196
7.180
7.164
7.160
7.142
7.125
5.097
5.093
5.090
5.073
5.070
5.067
4.822
4.798
3.431
3.425
2.837
2.815
2.805
2.697
2.687
2.678
2.663
2.654
2.650
2.639
2.629
2.380
2.250
2.240
2.230
2.158
Ph
Me
Ph
Me–N
H
Ts
3da
2.08
2.14
2.12
2.36
2.65
8.10
0.98
0.02
3.33
0.67
1.42
3.32
1.09
2.97
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

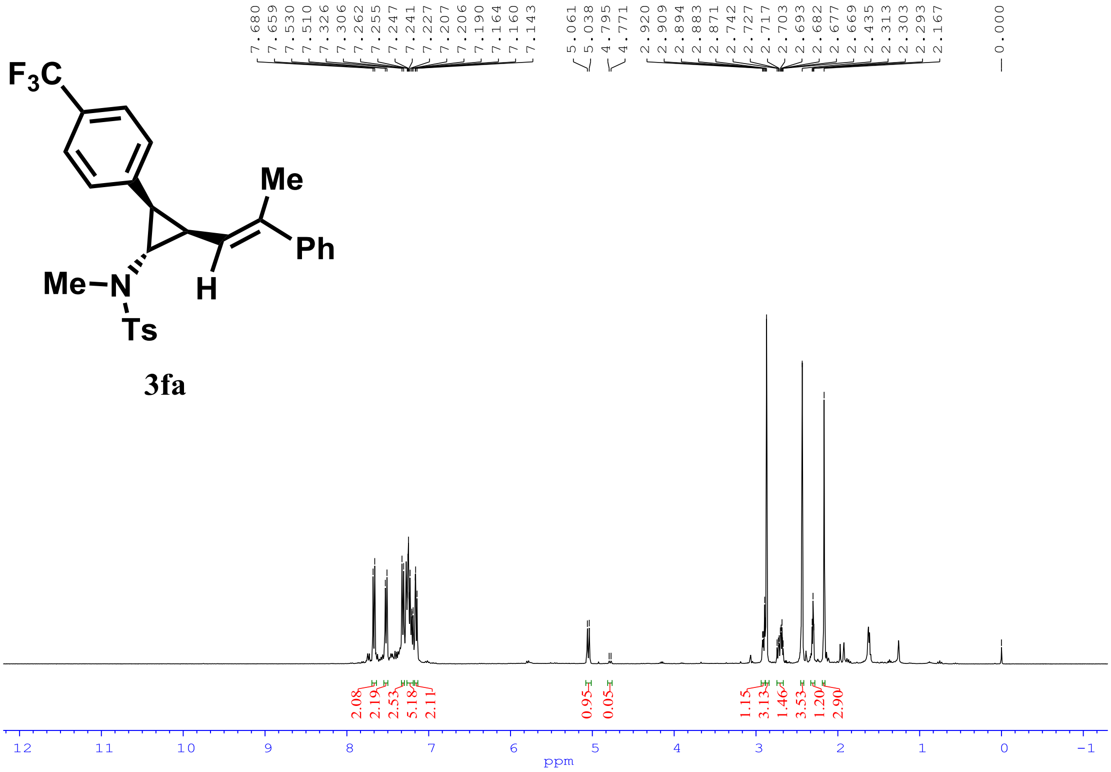

143.792
143.178
140.660
139.304
137.947
135.398
132.441
129.641
129.156
128.739
128.144
128.089
127.197
126.920
126.897
126.775
125.464
123.133
77.318
77.000
76.682
45.960
37.360
32.234
28.944
21.554
16.570
Ph
Me
Ph
Me–N
H
Ts
3da
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


7.617
7.606
7.600
7.595
7.236
7.224
7.216
7.188
7.179
7.169
7.165
7.161
7.156
7.145
7.121
7.115
7.110
7.103
7.098
7.091
7.011
6.998
6.993
6.989
6.744
6.734
6.728
6.723
6.717
6.712
4.990
4.966
4.706
4.682
3.709
3.699
2.800
2.790
2.713
2.701
2.688
2.678
2.574
2.564
2.559
2.550
2.540
2.525
2.360
2.350
2.131
2.123
2.120
2.110
MeO
Me
Ph
Me
N
H
Ts
2.15
2.28
2.65
3.14
2.17
2.06
0.97
0.03
3.55
3.17
1.17
1.13
3.54
4.18
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

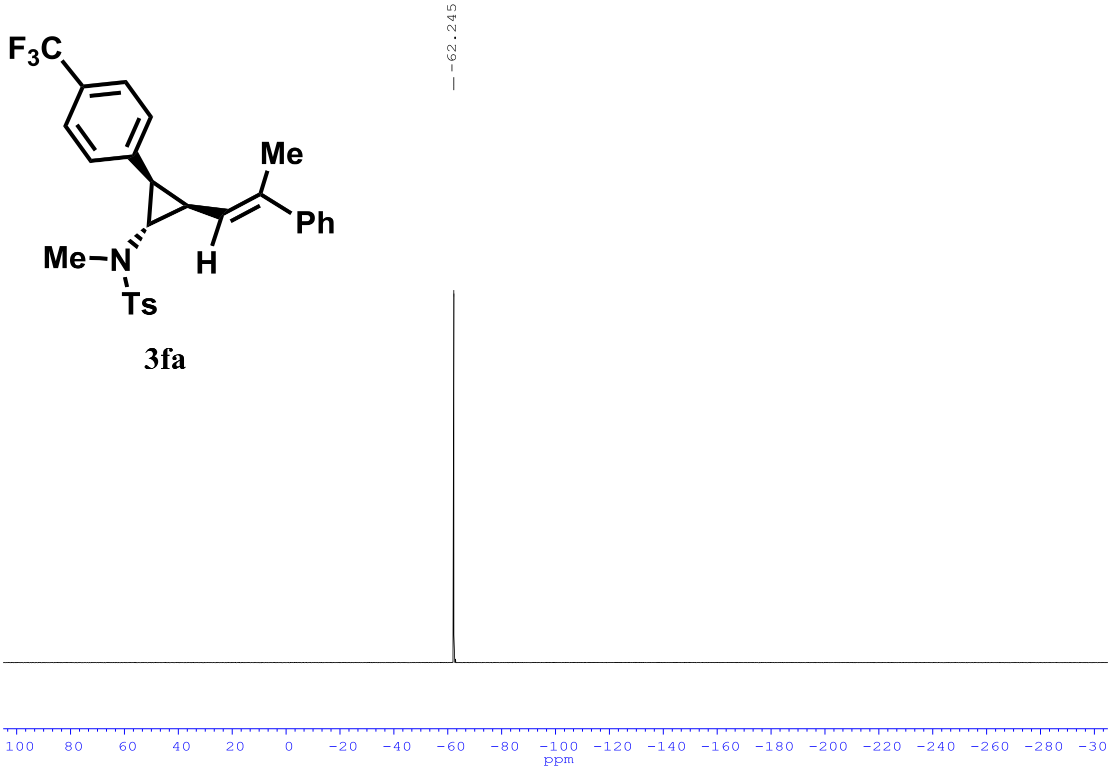
3ea


158.160
143.727
143.230
137.443
132.497
129.866
129.602
128.196
128.120
128.064
126.696
125.435
123.538
113.639
77.317
76.996
76.679
55.218
46.001
37.328
31.657
28.494
21.536
16.491
MeO
Me
Ph
Me
N
H
Ts
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

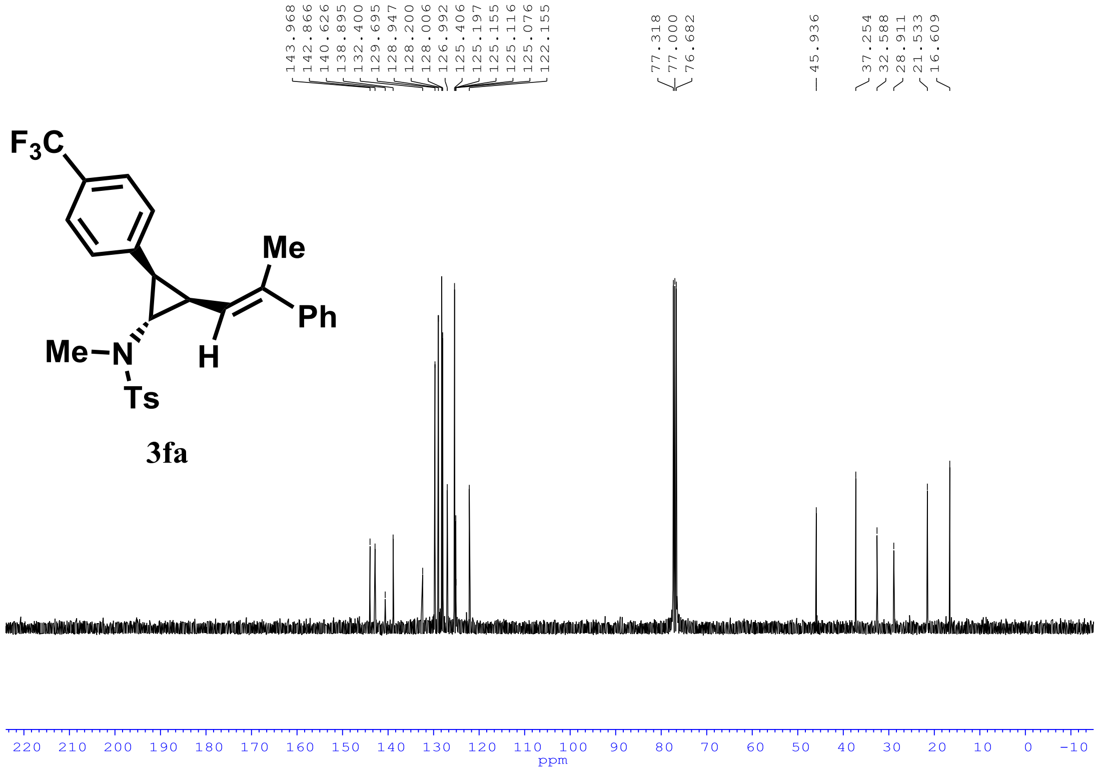
3ea


F3C
Me
Ph
Me–N
H
Ts
7.680
7.659
7.530
7.510
7.326
7.306
7.262
7.255
7.247
7.241
7.227
7.207
7.206
7.190
7.164
7.160
7.143
5.061
5.038
4.795
4.771
2.920
2.909
2.894
2.883
2.871
2.742
2.727
2.717
2.703
2.693
2.682
2.677
2.669
2.435
2.313
2.303
2.293
2.167
0.000
2.08
2.19
2.53
5.18
2.11
0.95
0.05
1.15
3.13
1.46
3.53
1.20
2.90
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

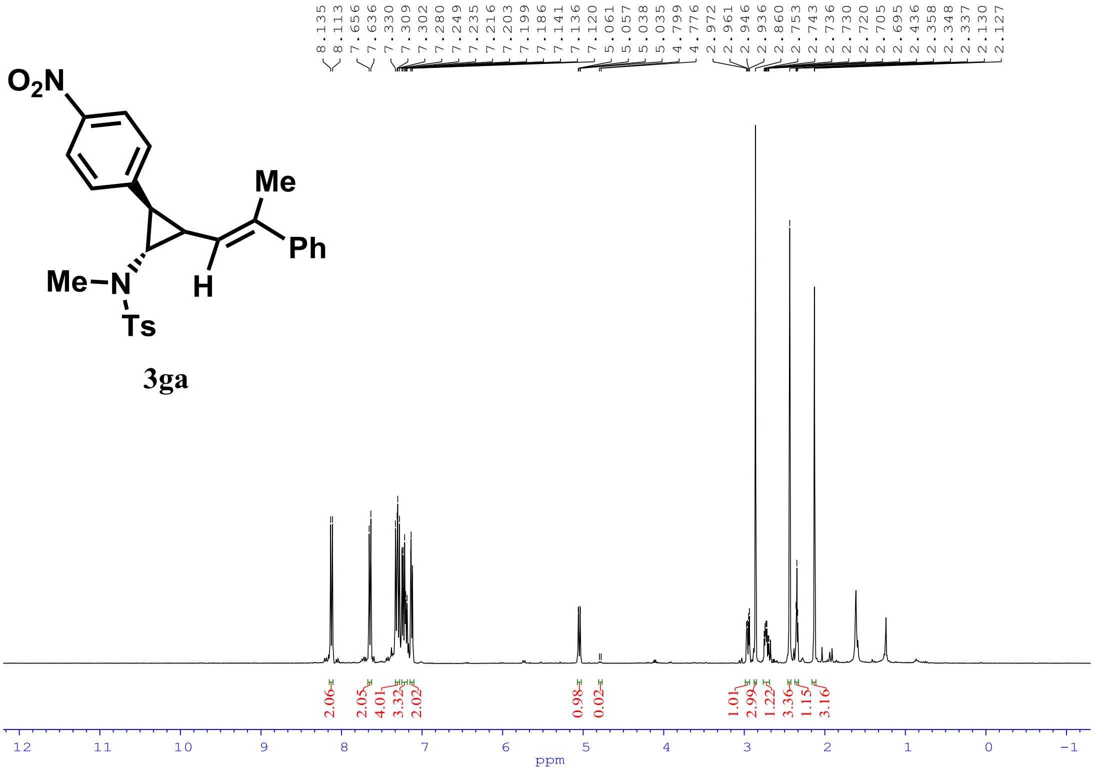
3fa


F3C
Me
Ph
Me–N
H
Ts
-62.245
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-30
ppm

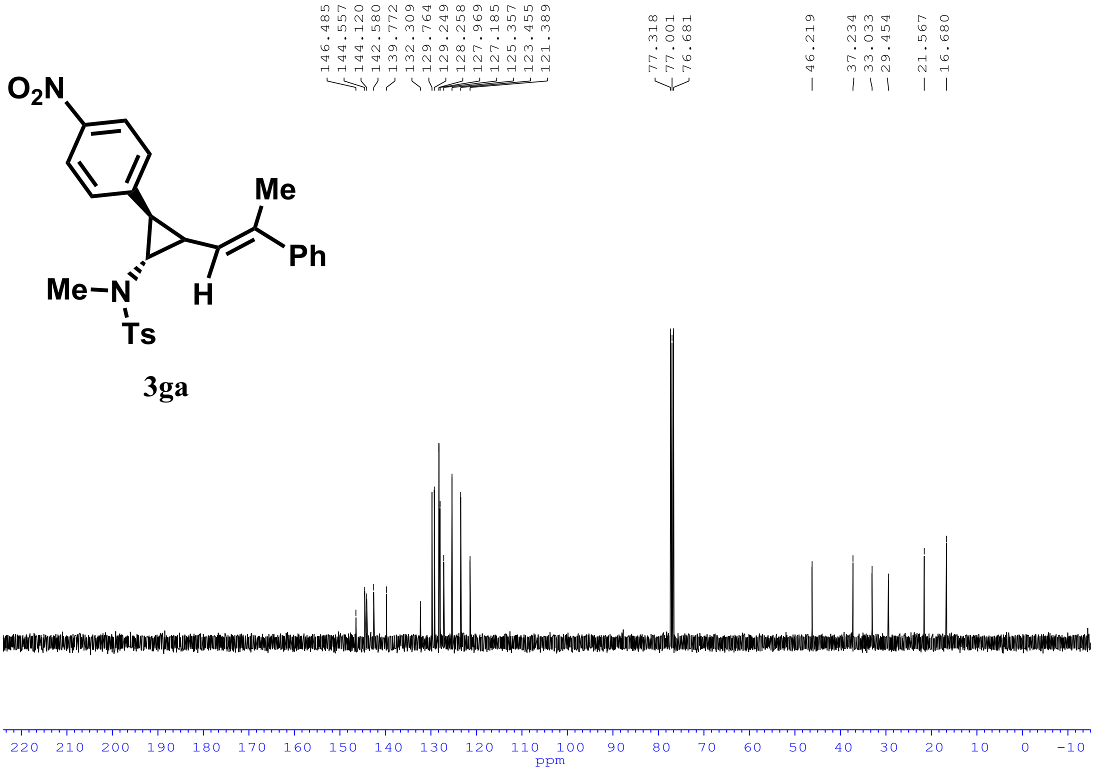
3fa


143.968
142.866
140.626
138.895
132.400
129.695
128.947
128.200
128.006
126.992
125.406
125.197
125.155
125.116
125.076
122.155
77.318
77.000
76.682
45.936
37.254
32.588
28.911
21.533
16.609
F3C
Me
Ph
Me
N
Ts
H
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
ppm

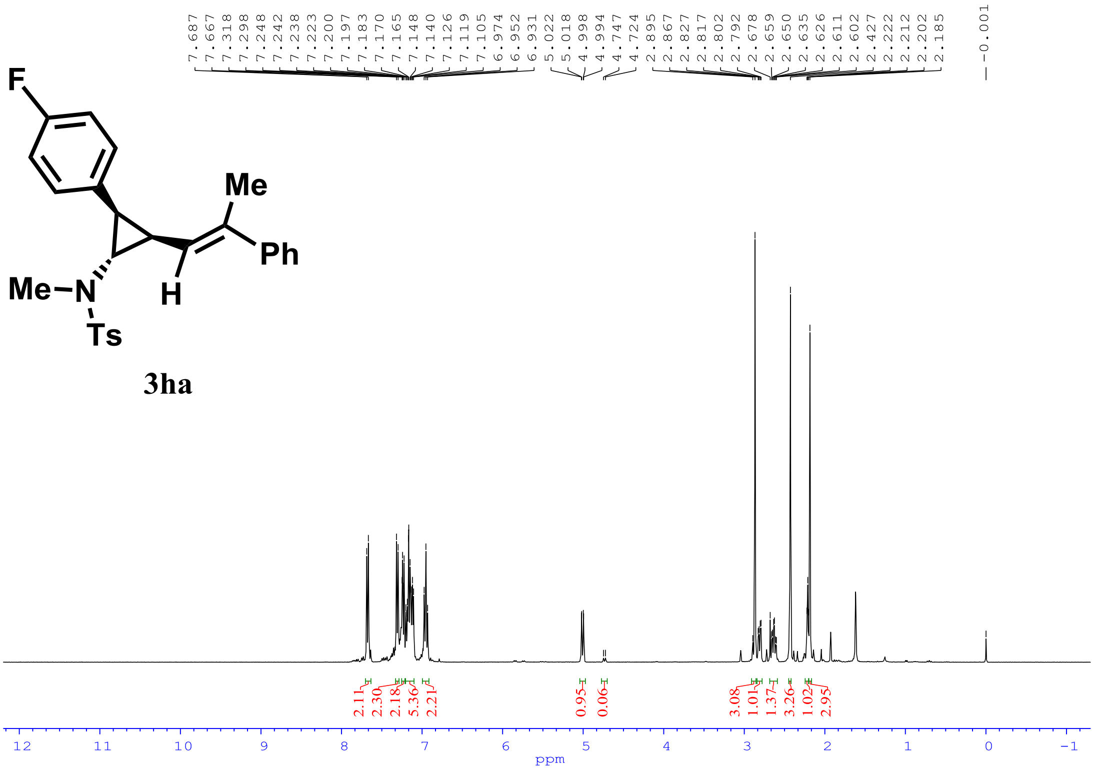
3fa


O$_2$N
Me
Ph
Me–N
H
Ts
8.135
8.113
7.656
7.636
7.330
7.309
7.302
7.280
7.249
7.235
7.216
7.203
7.199
7.186
7.141
7.136
7.120
5.061
5.057
5.038
5.035
4.799
4.776
2.972
2.961
2.946
2.936
2.860
2.753
2.743
2.736
2.730
2.720
2.705
2.695
2.436
2.358
2.348
2.337
2.130
2.127
2.06
2.05
4.01
3.32
2.02
0.98
0.02
1.01
2.99
1.22
3.36
1.15
3.16
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

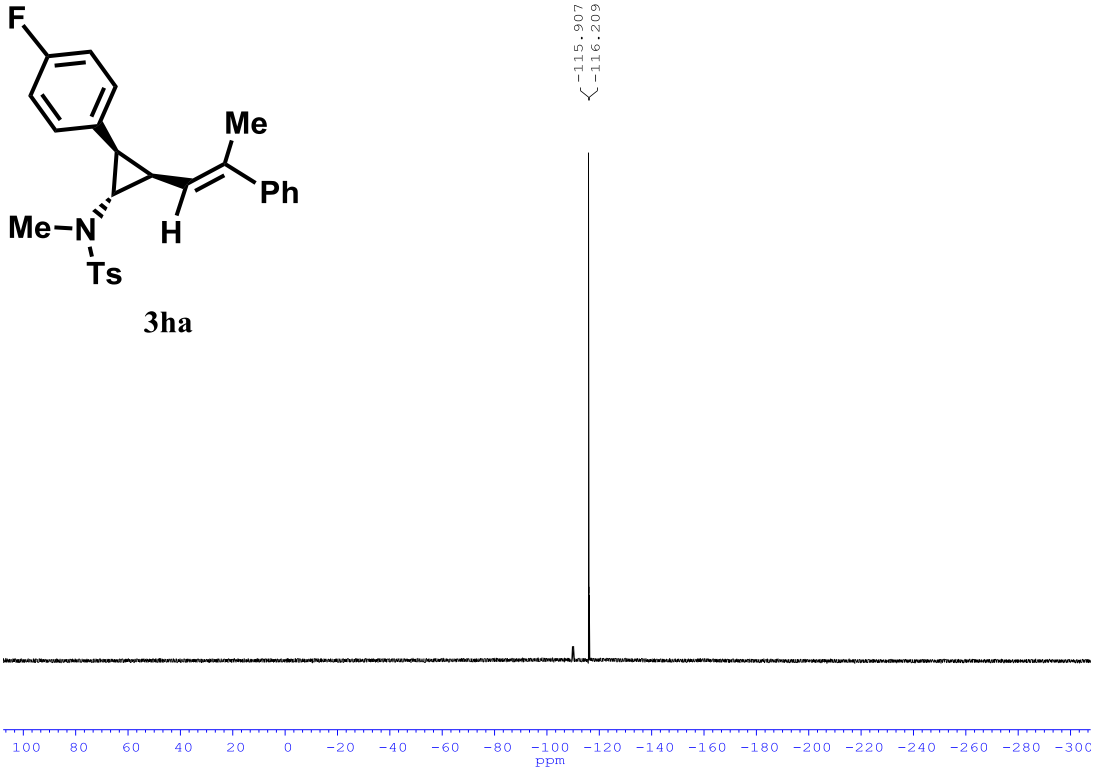
3ga


O$_2$N
Me
Ph
Me–N
H
Ts
146.485
144.557
144.120
142.580
139.772
132.309
129.764
129.249
128.258
127.969
127.185
125.357
123.455
121.389
77.318
77.001
76.681
46.219
37.234
33.033
29.454
21.567
16.680
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

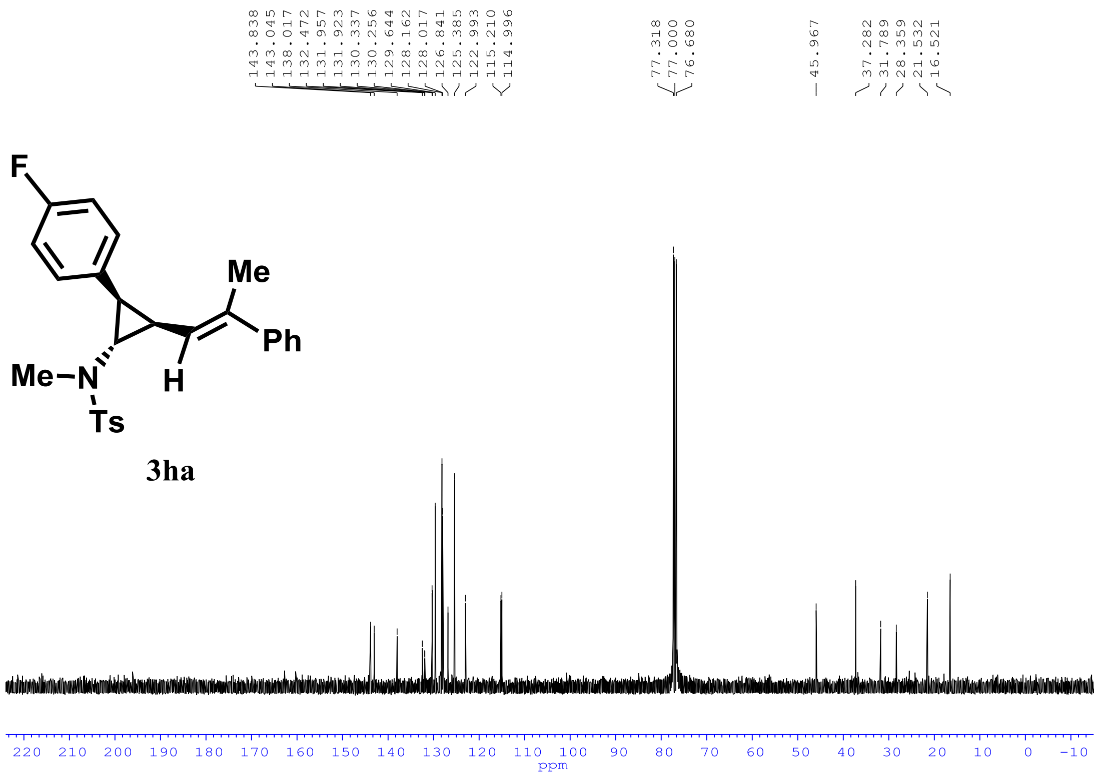
3ga


7.687
7.667
7.318
7.298
7.248
7.242
7.238
7.223
7.200
7.197
7.183
7.170
7.165
7.148
7.140
7.126
7.119
7.105
6.974
6.952
6.931
5.022
5.018
4.998
4.994
4.747
4.724
2.895
2.867
2.827
2.817
2.802
2.792
2.678
2.659
2.650
2.635
2.626
2.611
2.602
2.427
2.222
2.212
2.202
2.185
-0.001
F
Me
Ph
Me–N
H
Ts
2.11
2.30
2.18
5.36
2.21
0.95
0.06
3.08
1.01
1.37
3.26
1.02
2.95
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

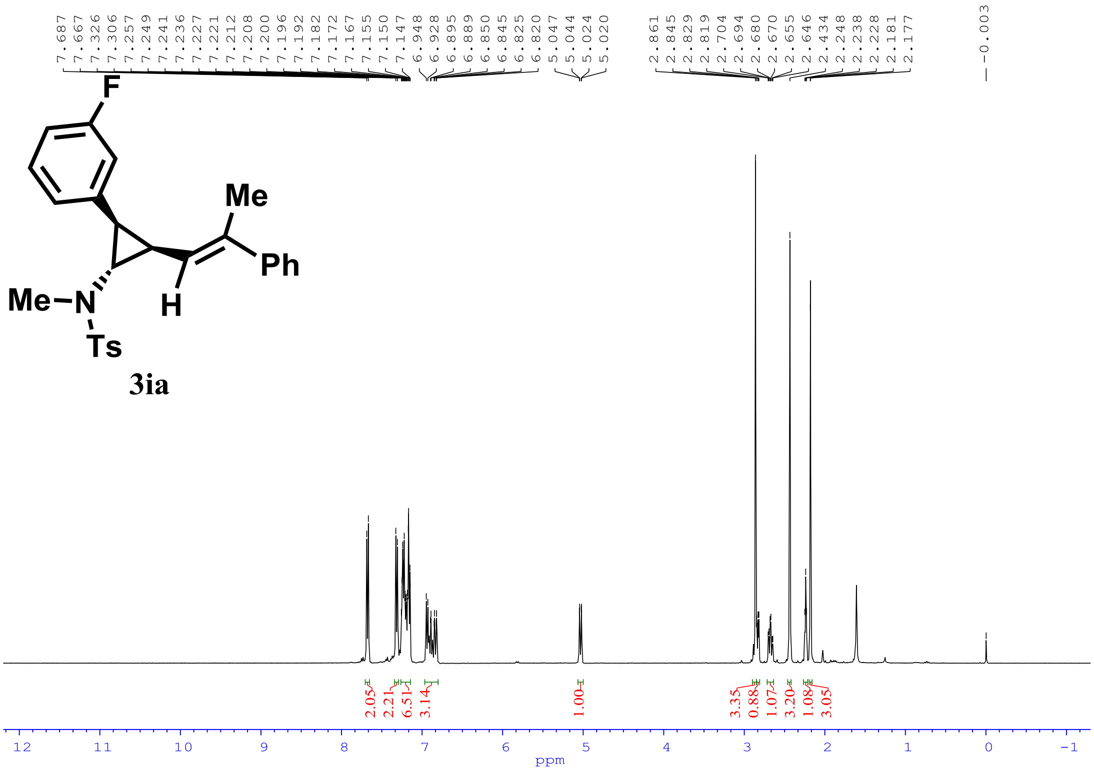
3ha


-115.907
-116.209
F
Me
Ph
Me–N
H
Ts
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
ppm

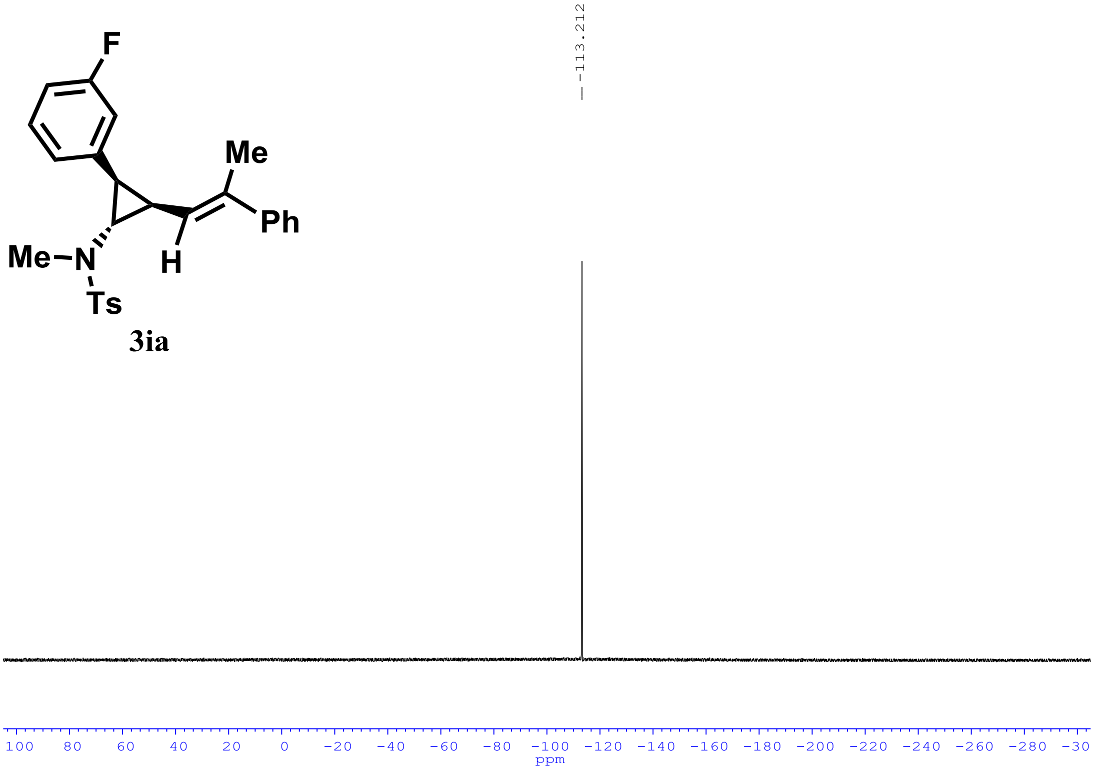
3ha


143.838
143.045
138.017
132.472
131.957
131.923
130.337
130.256
129.644
128.162
128.017
126.841
125.385
122.993
115.210
114.996
77.318
77.000
76.680
45.967
37.282
31.789
28.359
21.532
16.521
F
Me
Ph
Me
N
Ts
H
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
ppm

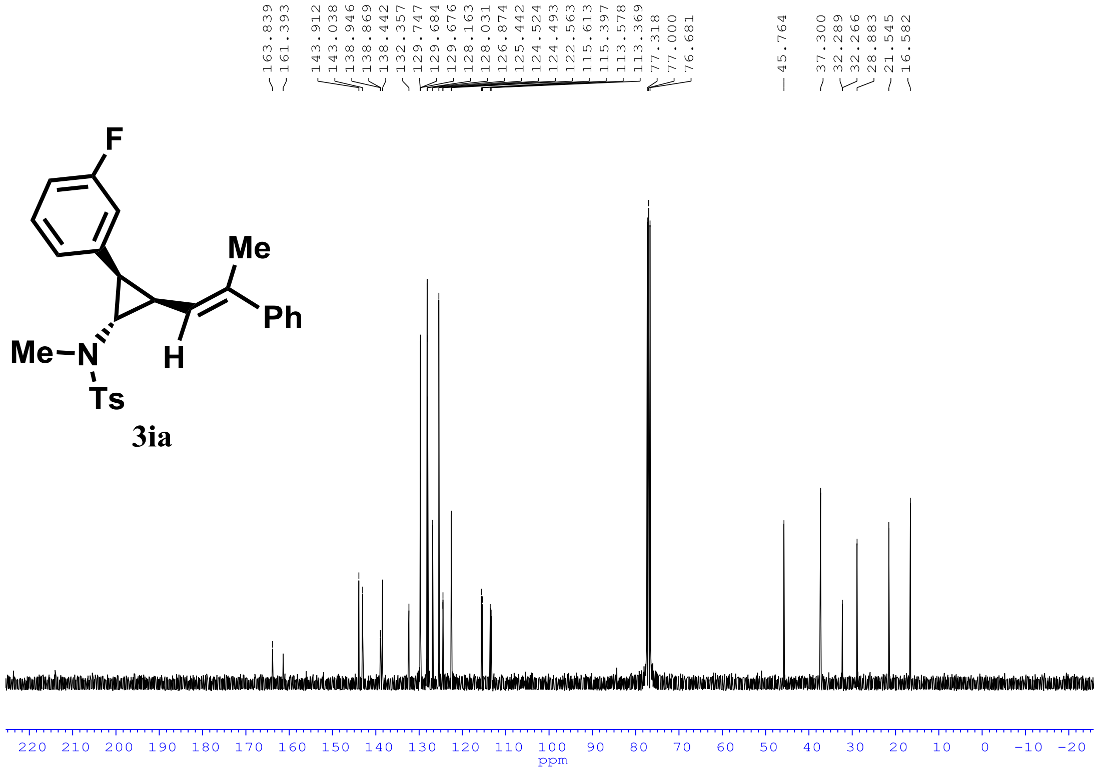
3ha

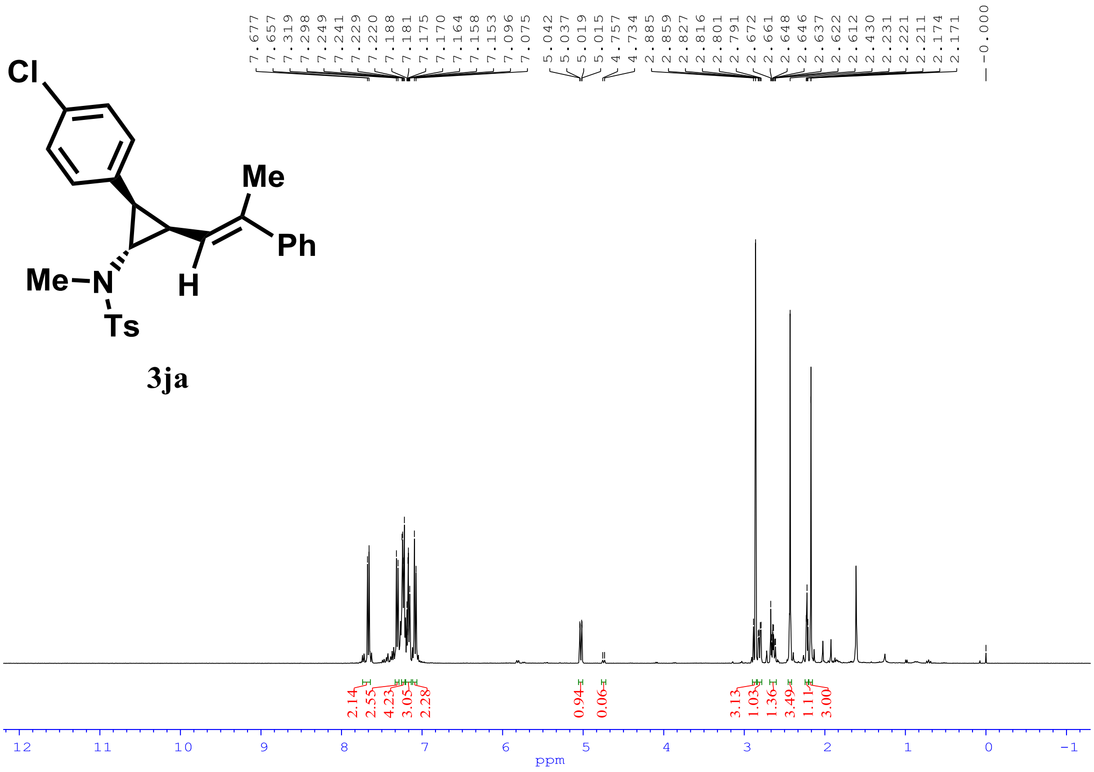

7.687
7.667
7.326
7.306
7.257
7.249
7.241
7.236
7.227
7.221
7.212
7.208
7.200
7.196
7.192
7.182
7.172
7.167
7.155
7.150
7.147
6.948
6.928
6.895
6.889
6.850
6.845
6.825
6.820
5.047
5.044
5.024
5.020
2.861
2.845
2.829
2.819
2.704
2.694
2.680
2.670
2.655
2.646
2.434
2.248
2.238
2.228
2.181
2.177
-0.003
F
Me
Ph
Me–N
H
Ts
2.05
2.21
6.51
3.14
1.00
3.35
0.88
1.07
3.20
1.08
3.05
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

3ia

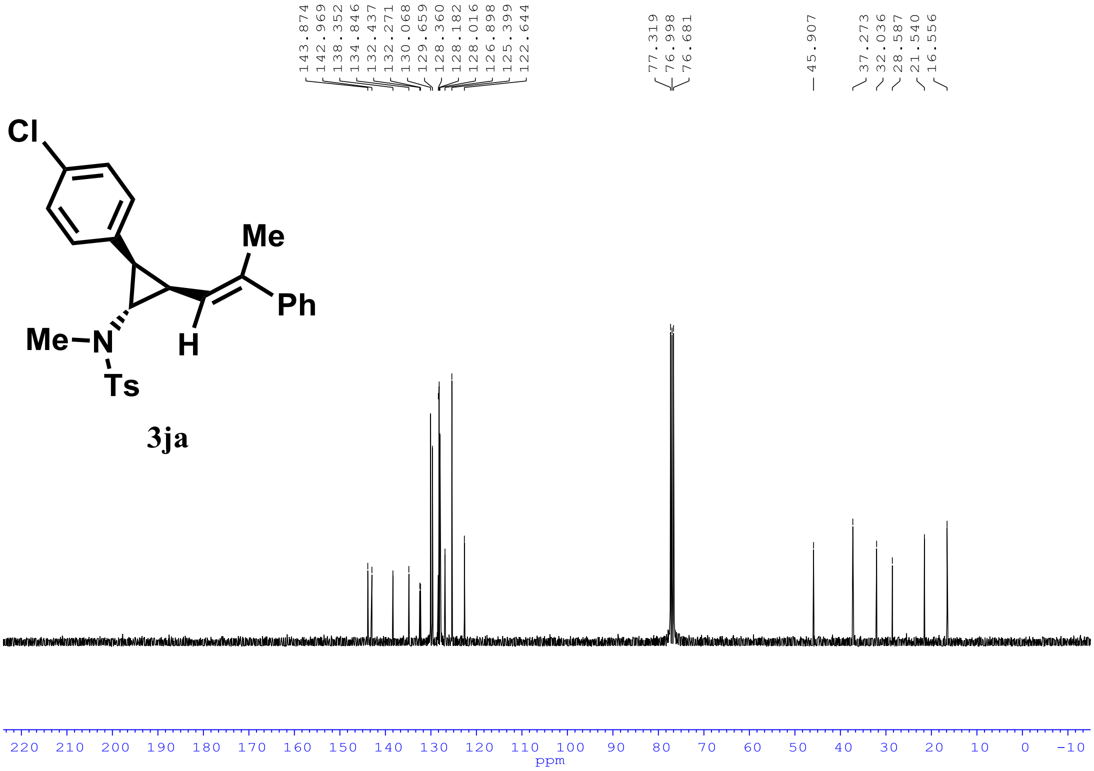

-113.212
F
Me
Ph
Me–N
H
Ts
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-30
ppm

3ia

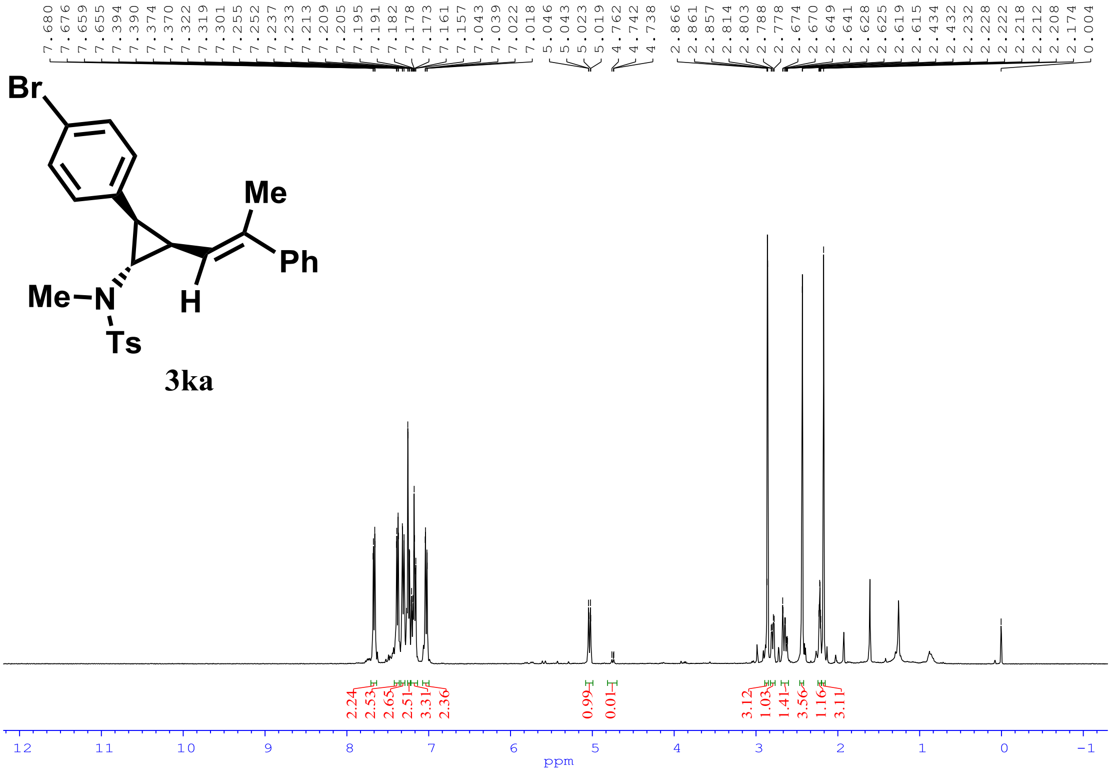

163.839
161.393
143.912
143.038
138.946
138.869
138.442
132.357
129.747
129.684
129.676
128.163
128.031
126.874
125.442
124.524
124.493
122.563
115.613
115.397
113.578
113.369
77.318
77.000
76.681
45.764
37.300
32.289
32.266
28.883
21.545
16.582
F
Me
Ph
Me
N
H
Ts
3ia
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


Cl
Me
Ph
Me–N
H
Ts
7.677
7.657
7.319
7.298
7.249
7.241
7.229
7.220
7.188
7.181
7.175
7.170
7.164
7.158
7.153
7.096
7.075
5.042
5.037
5.019
5.015
4.757
4.734
2.885
2.859
2.827
2.816
2.801
2.791
2.672
2.661
2.648
2.646
2.637
2.622
2.612
2.430
2.231
2.221
2.211
2.174
2.171
-0.000
2.14
2.55
4.23
3.05
2.28
0.94
0.06
3.13
1.03
1.36
3.49
1.11
3.00
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

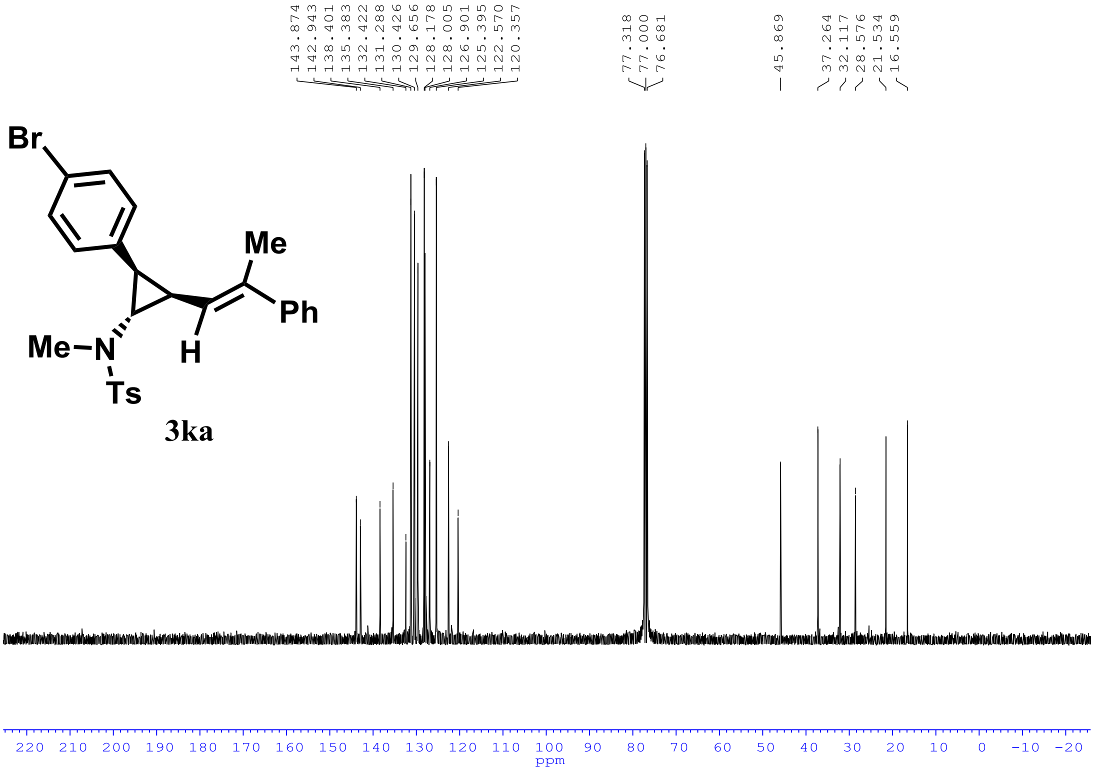
3ja


Cl
Me
Ph
Me–N
H
Ts
143.874
142.969
138.352
134.846
132.437
132.271
130.068
129.659
128.360
128.182
128.016
126.898
125.399
122.644
77.319
76.998
76.681
45.907
37.273
32.036
28.587
21.540
16.556
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

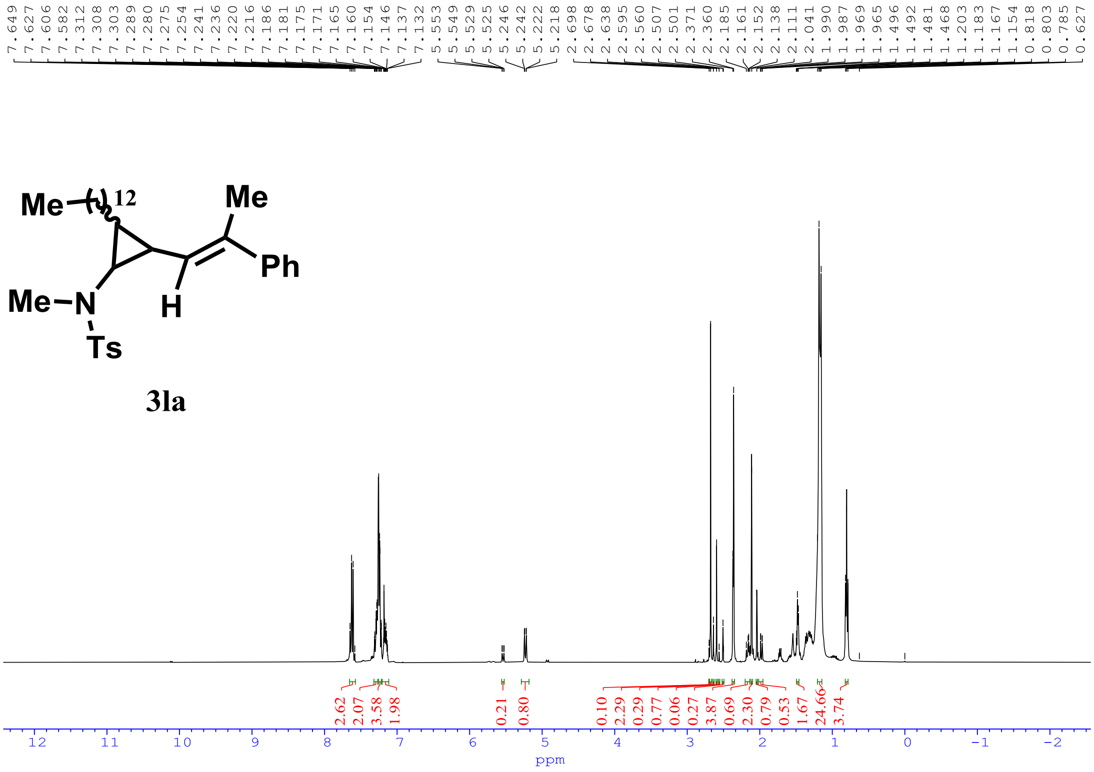
3ja

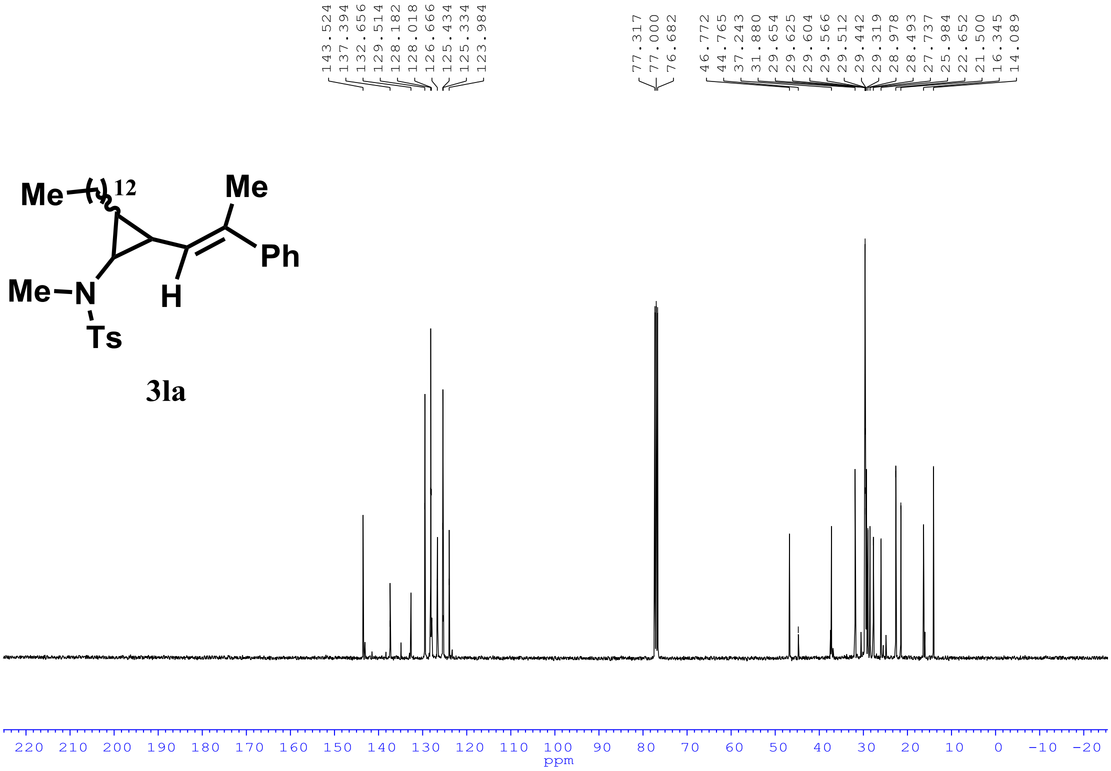

7.680
7.676
7.659
7.655
7.394
7.390
7.374
7.370
7.322
7.319
7.301
7.255
7.252
7.237
7.233
7.213
7.209
7.205
7.195
7.191
7.182
7.178
7.173
7.161
7.157
7.043
7.039
7.022
7.018
5.046
5.043
5.023
5.019
4.762
4.742
4.738
2.866
2.861
2.857
2.814
2.803
2.788
2.778
2.674
2.670
2.649
2.641
2.628
2.625
2.619
2.615
2.434
2.432
2.232
2.228
2.222
2.218
2.212
2.208
2.174
0.004
Br
Me
Ph
Me
N
H
Ts
2.24
2.53
2.65
2.51
3.31
2.36
0.99
0.01
3.12
1.03
1.41
3.56
1.16
3.11
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

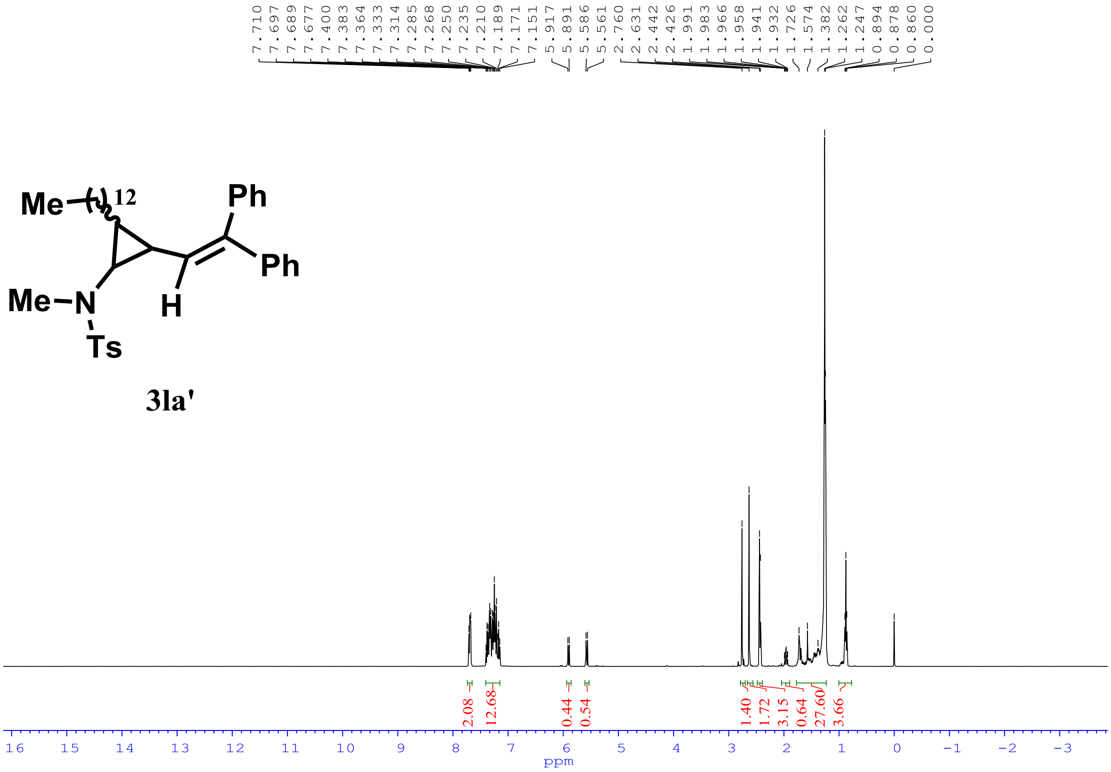
3ka

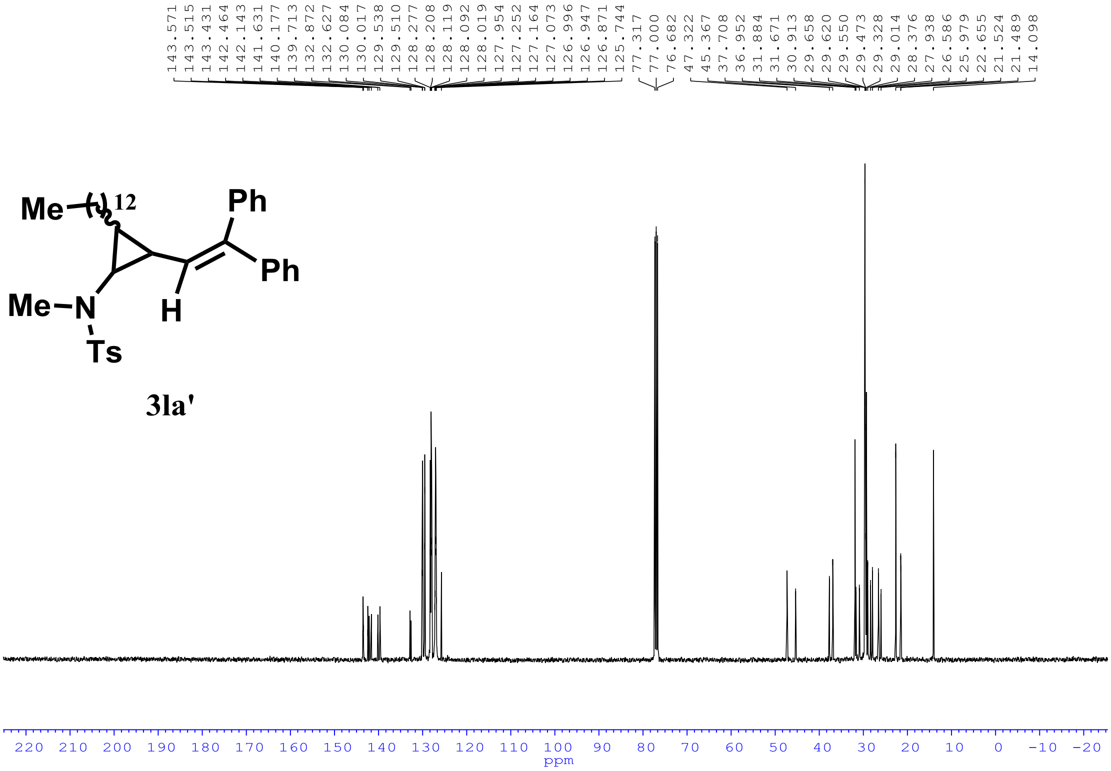

143.874
142.943
138.401
135.383
132.422
131.288
130.426
129.656
128.178
128.005
126.901
125.395
122.570
120.357
77.318
77.000
76.681
45.869
37.264
32.117
28.576
21.534
16.559
Br
Me
Ph
Me
N
H
Ts
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

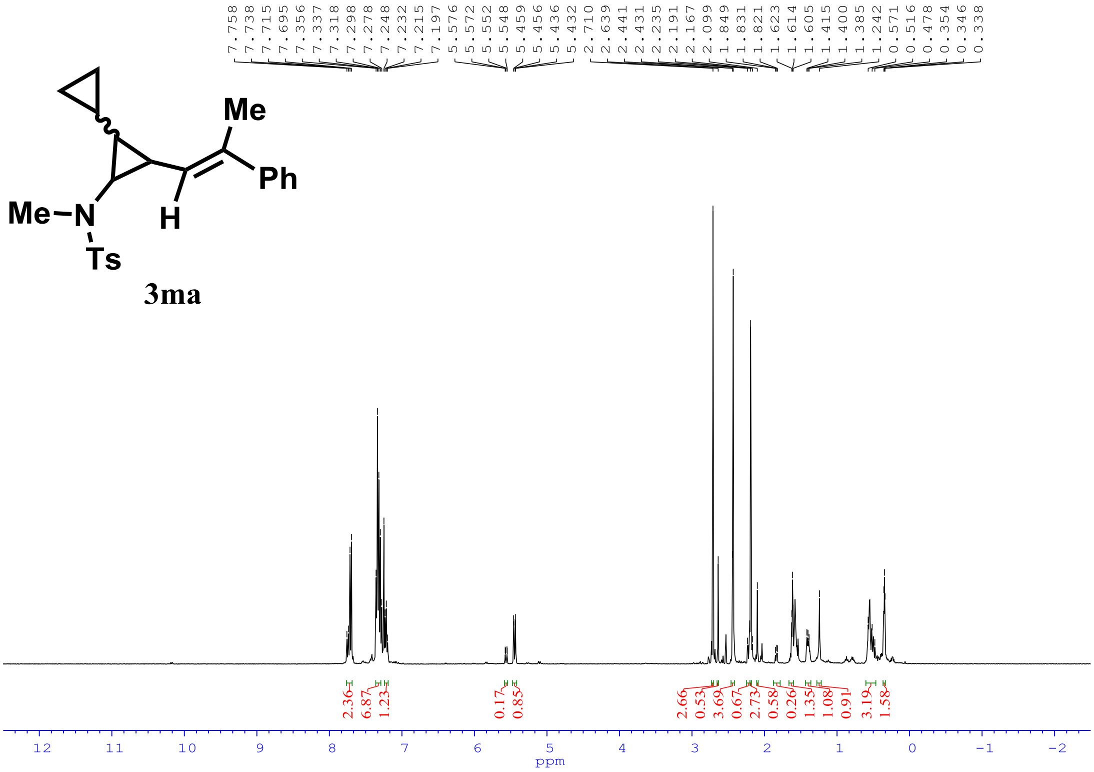
3ka


7.649
7.627
7.606
7.582
7.312
7.308
7.303
7.289
7.280
7.275
7.254
7.241
7.236
7.220
7.216
7.186
7.181
7.175
7.171
7.165
7.160
7.154
7.146
7.137
7.132
5.553
5.549
5.529
5.525
5.246
5.242
5.222
5.218
2.698
2.678
2.638
2.595
2.560
2.507
2.501
2.371
2.360
2.185
2.161
2.152
2.138
2.111
2.041
1.990
1.987
1.969
1.965
1.496
1.492
1.481
1.468
1.203
1.183
1.167
1.154
0.818
0.803
0.785
0.627
Me
12
Me
Ph
Me
N
H
Ts
3la
2.62
2.07
3.58
1.98
0.21
0.80
0.10
2.29
0.29
0.77
0.06
0.27
3.87
0.69
2.30
0.79
0.53
1.67
24.66
3.74
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

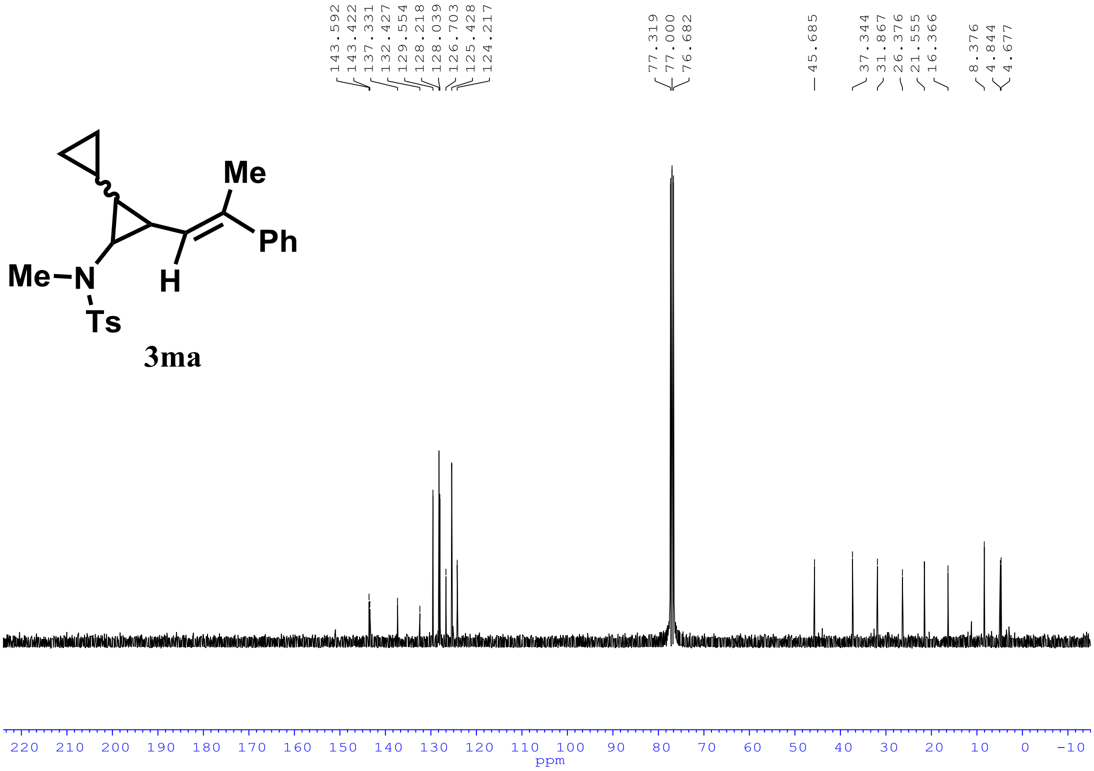

143.524
137.394
132.656
129.514
128.182
128.018
126.666
125.434
125.334
123.984
77.317
77.000
76.682
46.772
44.765
37.243
31.880
29.654
29.625
29.604
29.566
29.512
29.442
29.319
28.978
28.493
27.737
25.984
22.652
21.500
16.345
14.089
Me
12
Me
Ph
Me
N
H
Ts
3la
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


7.710
7.697
7.689
7.677
7.400
7.383
7.364
7.333
7.314
7.285
7.268
7.250
7.235
7.210
7.189
7.171
7.151
5.917
5.891
5.586
5.561
2.760
2.631
2.442
2.426
1.991
1.983
1.966
1.958
1.941
1.932
1.726
1.574
1.382
1.262
1.247
0.894
0.878
0.860
0.000
Me
12
Ph
Ph
Me
N
H
Ts
3la'
2.08
12.68
0.44
0.54
1.40
1.72
3.15
0.64
27.60
3.66
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
ppm

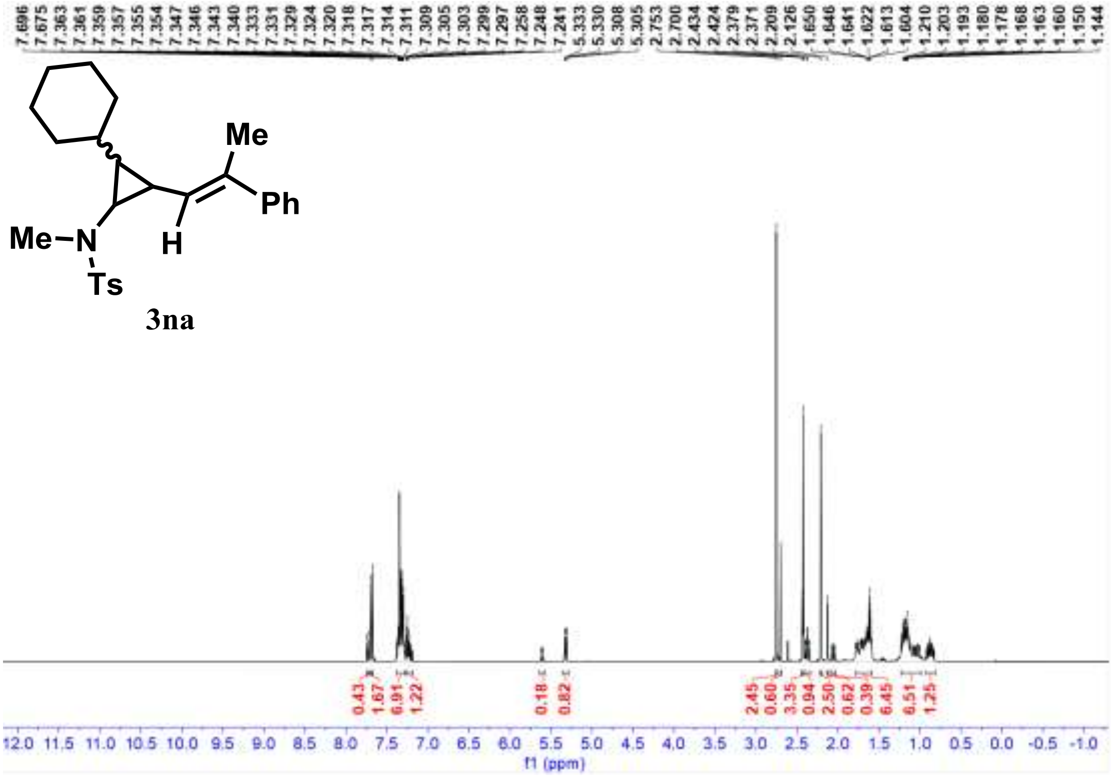

143.571
143.515
143.431
142.464
142.143
141.631
140.177
139.713
132.872
132.627
130.084
130.017
129.538
129.510
128.277
128.208
128.119
128.092
128.019
127.954
127.252
127.164
127.073
126.996
126.947
126.871
125.744
77.317
77.000
76.682
47.322
45.367
37.708
36.952
31.884
31.671
30.913
29.658
29.620
29.550
29.473
29.328
29.014
28.376
27.938
26.586
25.979
22.655
21.524
21.489
14.098
Me
12
Ph
Ph
Me
N
H
Ts
3la'
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
ppm


7.758
7.738
7.715
7.695
7.356
7.337
7.318
7.298
7.278
7.248
7.232
7.215
7.197
5.576
5.572
5.552
5.548
5.459
5.456
5.436
5.432
2.710
2.639
2.441
2.431
2.235
2.191
2.167
2.099
1.849
1.831
1.821
1.623
1.614
1.605
1.415
1.400
1.385
1.242
0.571
0.516
0.478
0.354
0.346
0.338
Me
Ph
Me
N
H
Ts
2.36
6.87
1.23
0.17
0.85
2.66
0.53
3.69
0.67
2.73
0.58
0.26
1.35
1.08
0.91
3.19
1.58
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
−2
ppm

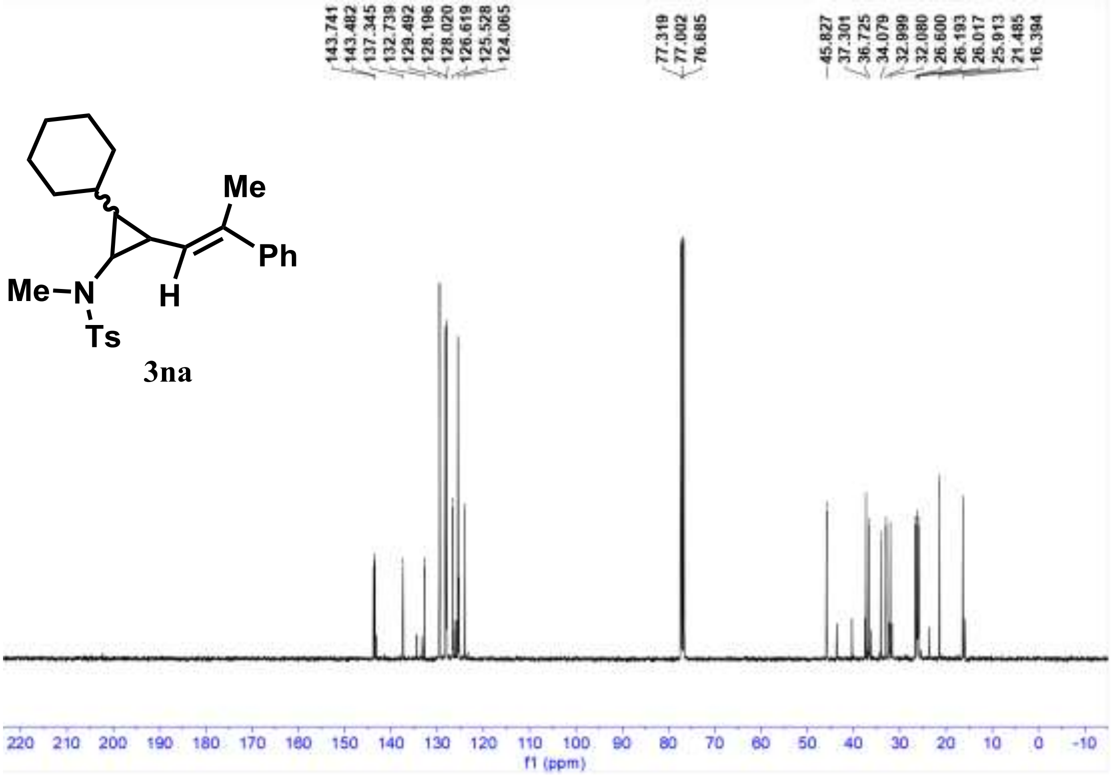
3ma


143.592
143.422
137.331
132.427
129.554
128.218
128.039
126.703
125.428
124.217
77.319
77.000
76.682
45.685
37.344
31.867
26.376
21.555
16.366
8.376
4.844
4.677
Me
Ph
Me
N
H
Ts
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
ppm

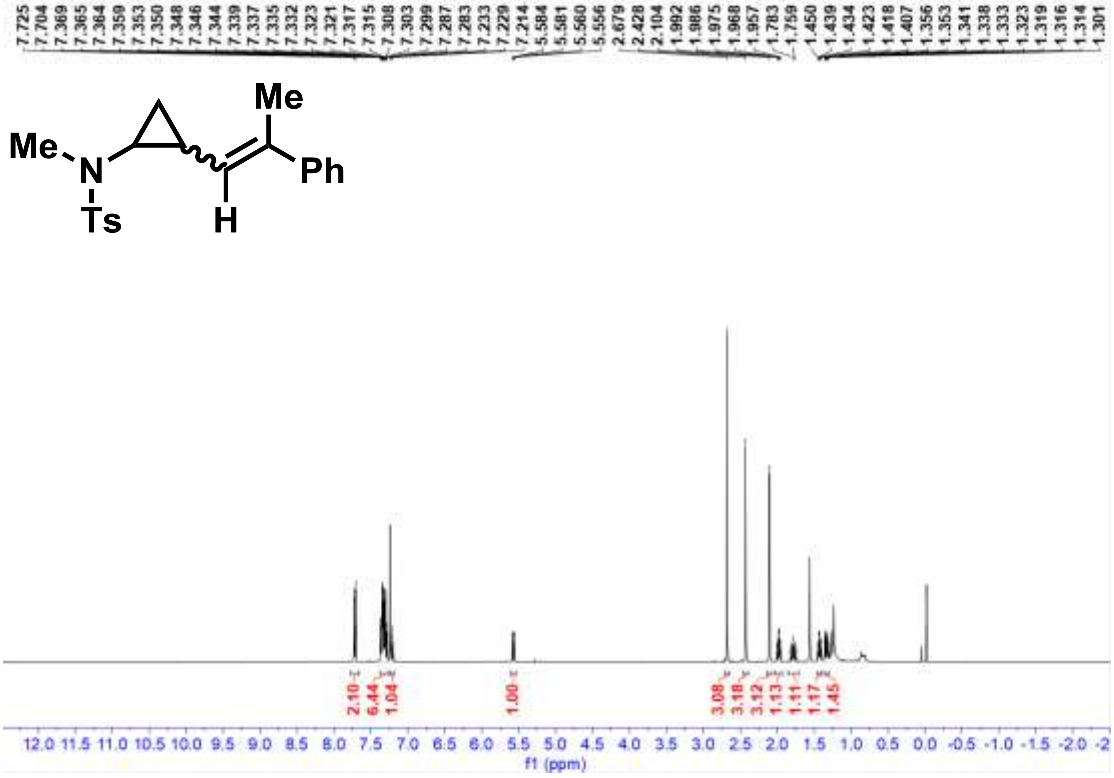
3ma

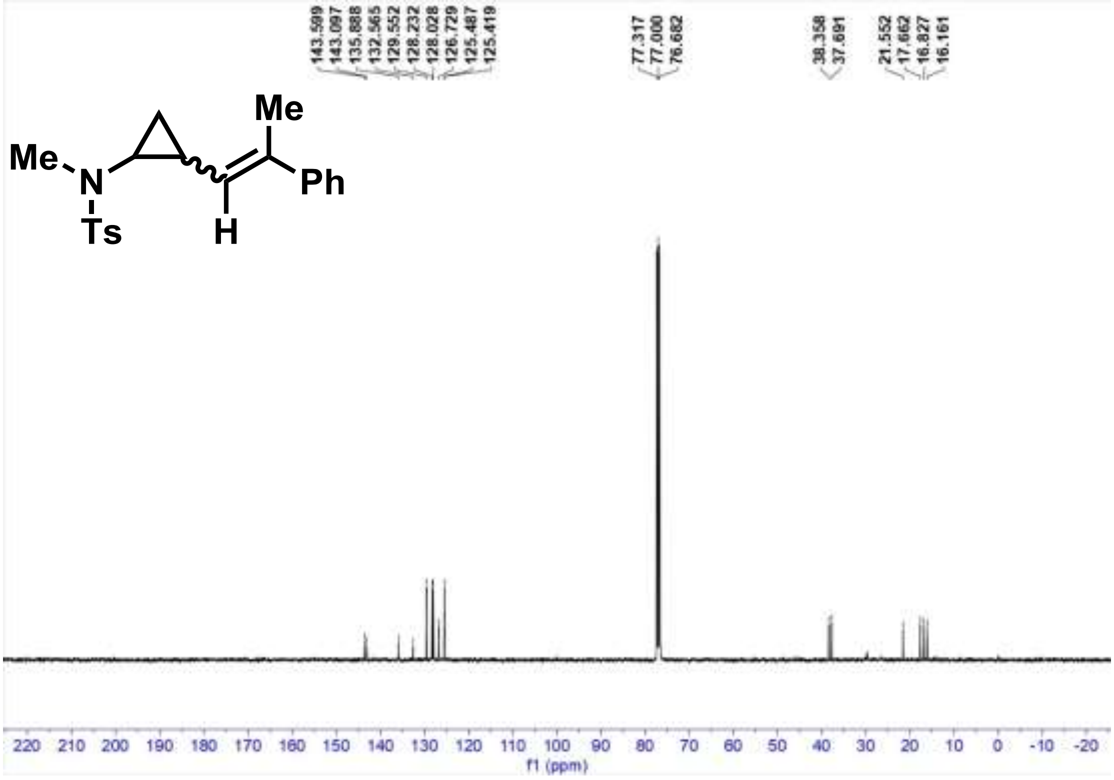

7.696
7.675
7.363
7.361
7.359
7.357
7.355
7.354
7.347
7.346
7.343
7.340
7.333
7.331
7.329
7.324
7.320
7.318
7.317
7.314
7.311
7.309
7.305
7.303
7.299
7.297
7.258
7.248
7.241
5.333
5.330
5.308
5.305
2.753
2.700
2.434
2.424
2.379
2.371
2.209
2.126
1.650
1.646
1.641
1.622
1.613
1.604
1.210
1.203
1.193
1.180
1.178
1.168
1.163
1.160
1.150
1.144
Me
Ph
Me−N
H
Ts
0.43
1.67
6.91
1.22
0.18
0.82
2.45
0.60
3.35
0.94
2.50
0.62
0.39
6.45
6.51
1.25
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

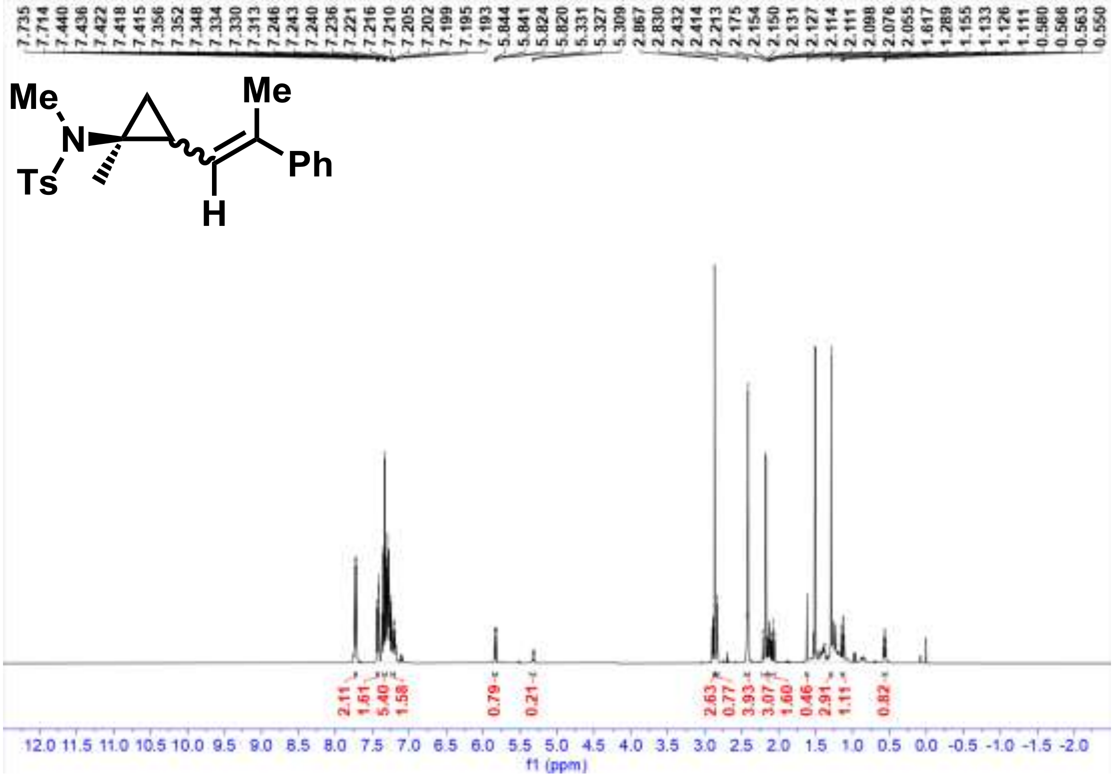
3na

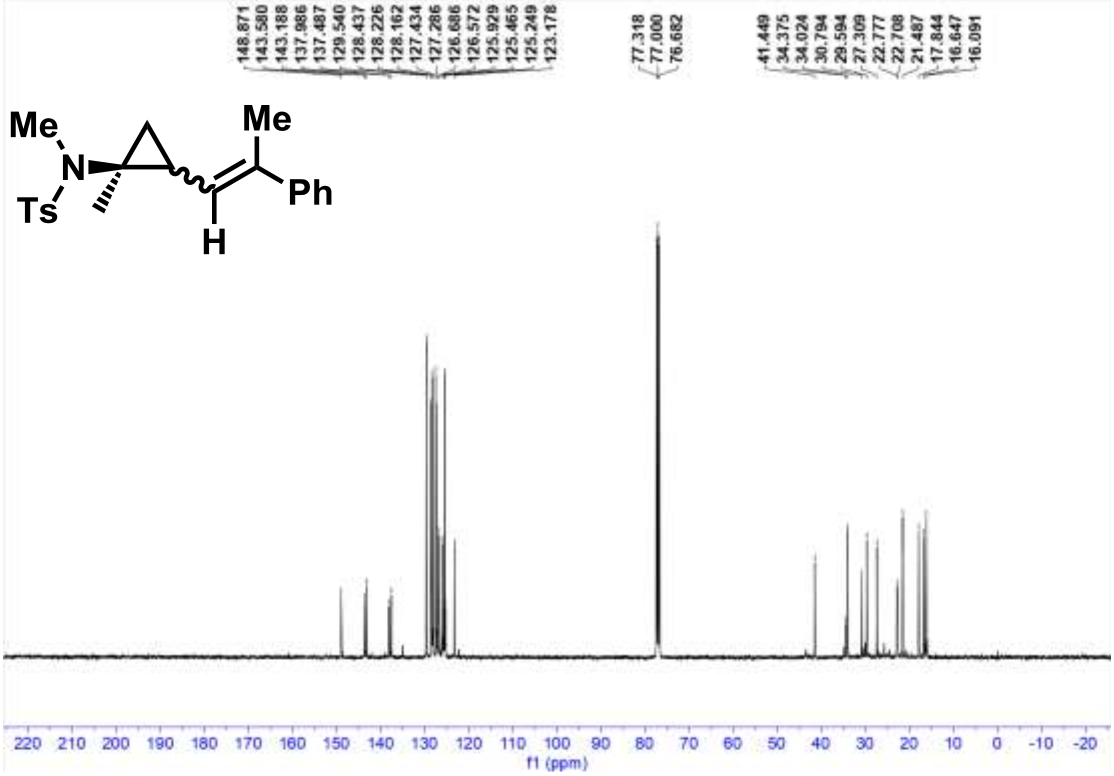

143.741
143.482
137.345
132.739
129.492
128.196
128.020
126.619
125.528
124.065
77.319
77.002
76.685
45.827
37.301
36.725
34.079
32.999
32.080
26.600
26.193
26.017
25.913
21.485
16.394
Me
Ph
Me−N
H
Ts
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

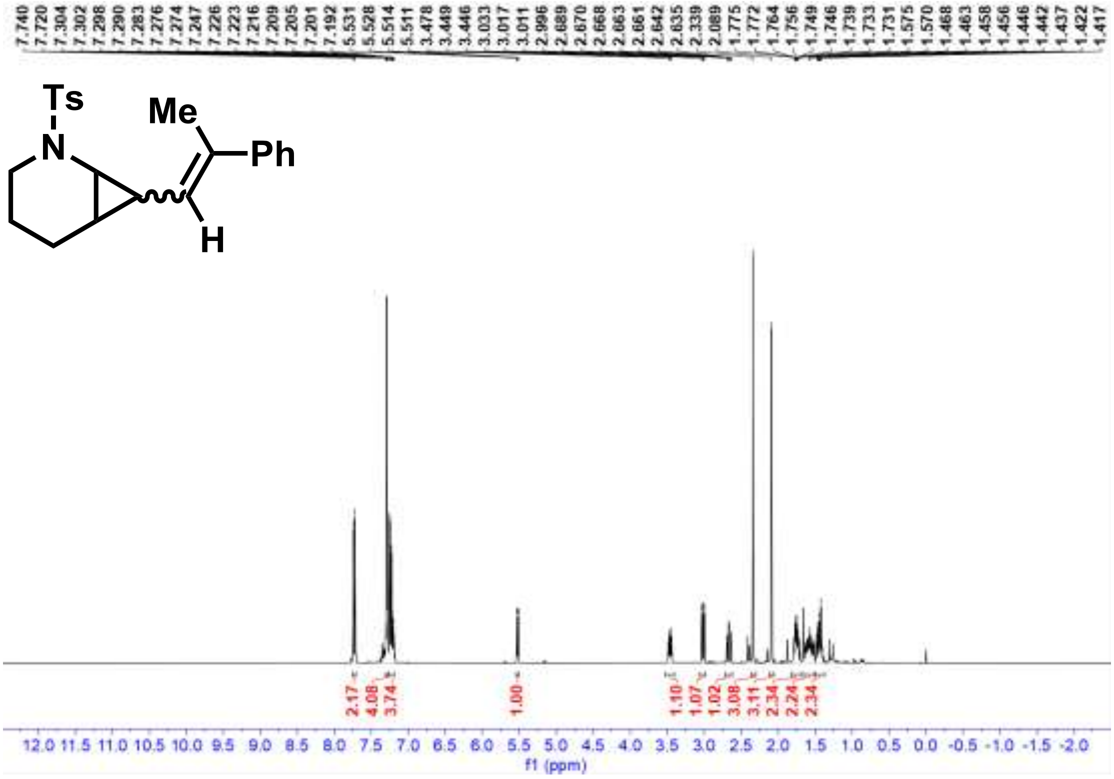
3na

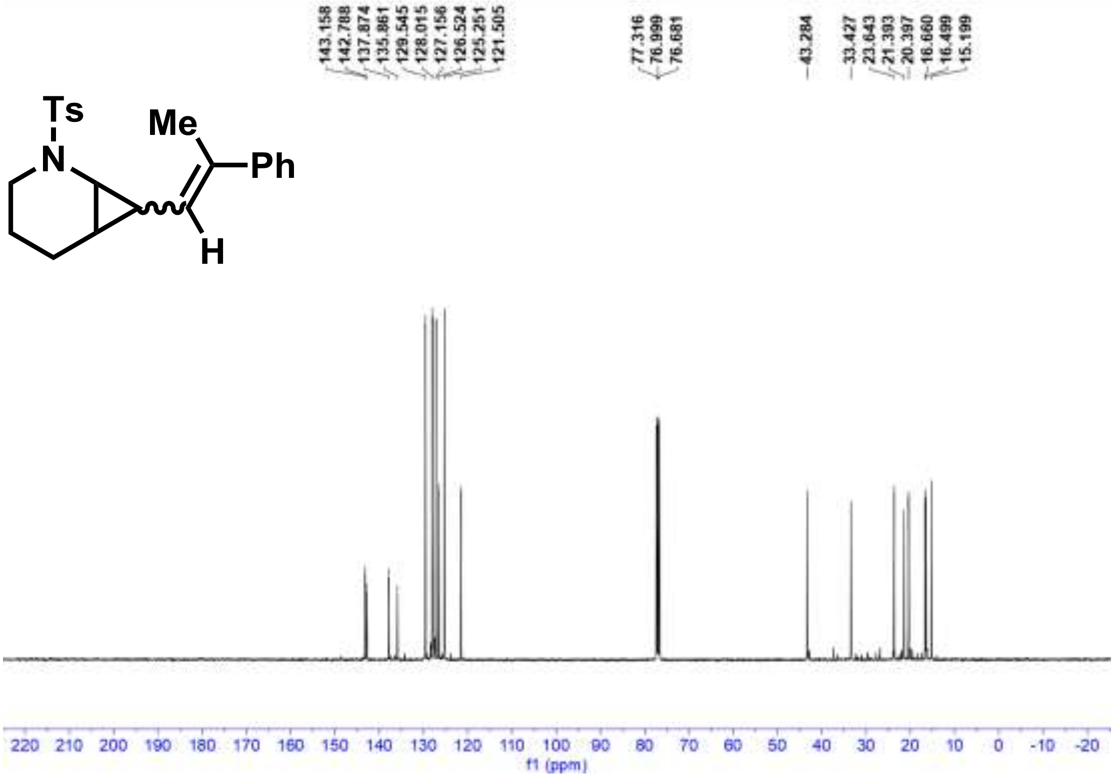

7.725
7.704
7.369
7.365
7.364
7.359
7.353
7.350
7.348
7.346
7.344
7.339
7.337
7.335
7.332
7.323
7.321
7.317
7.315
7.308
7.303
7.299
7.287
7.283
7.233
7.229
7.214
5.584
5.581
5.560
5.556
2.679
2.428
2.104
1.992
1.986
1.975
1.968
1.957
1.783
1.759
1.450
1.439
1.434
1.423
1.418
1.407
1.356
1.353
1.341
1.338
1.333
1.323
1.319
1.316
1.314
1.301
Me
Me
N
Ts
H
Ph
2.10
6.44
1.04
1.00
3.08
3.18
3.12
1.13
1.11
1.17
1.45
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0 -2
f1 (ppm)

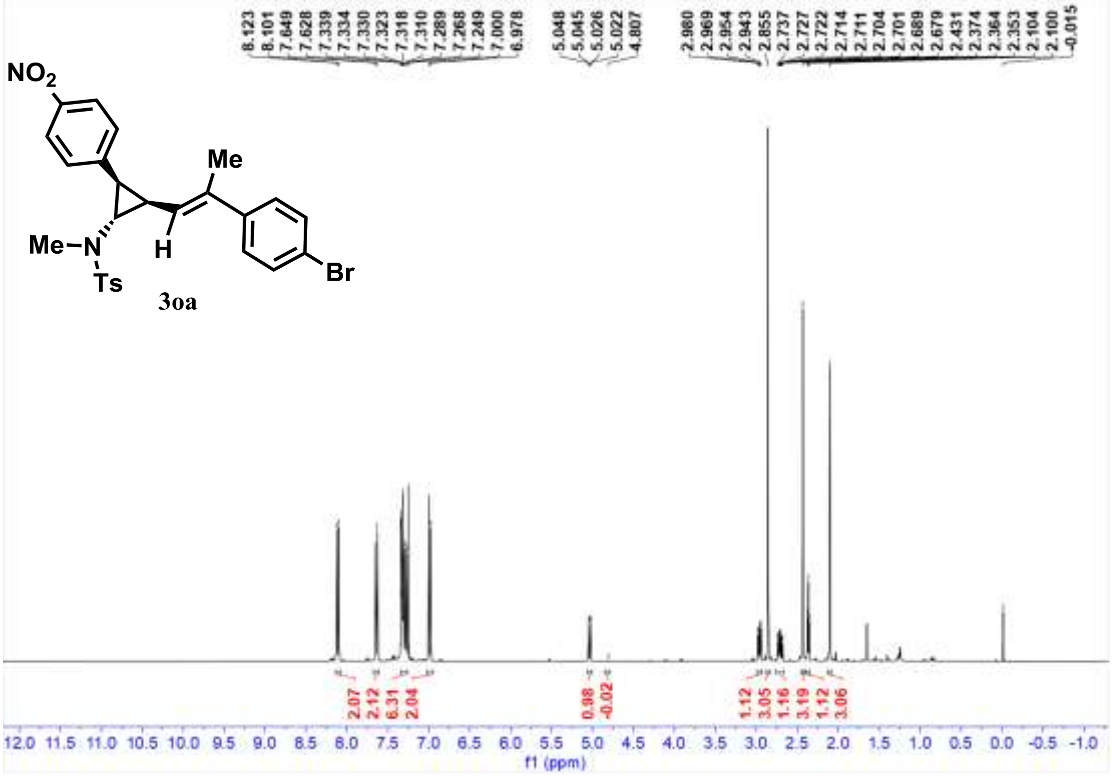

143.599
143.097
135.888
132.565
129.552
128.232
128.028
126.729
125.487
125.419
77.317
77.000
76.682
38.358
37.691
21.552
17.662
16.827
16.161
Me
Me
N
Ts
H
Ph
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

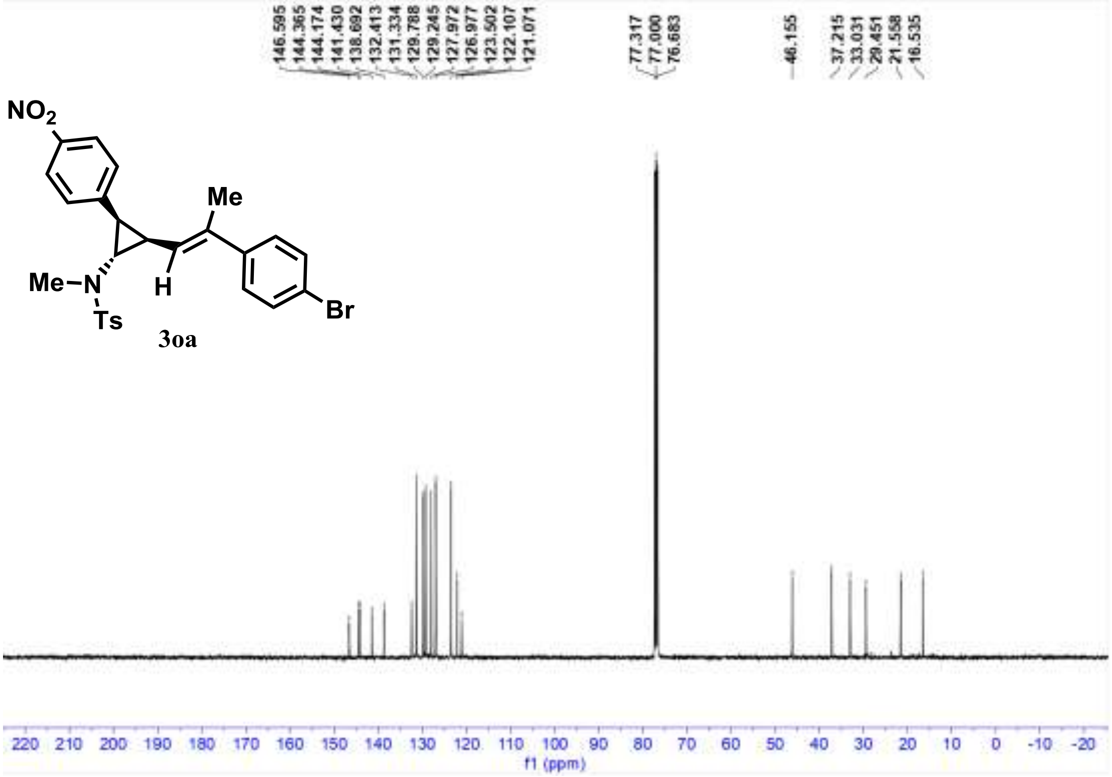

7.735
7.714
7.440
7.436
7.422
7.418
7.415
7.356
7.352
7.348
7.334
7.330
7.313
7.246
7.243
7.240
7.236
7.221
7.216
7.210
7.205
7.202
7.199
7.195
7.193
5.844
5.841
5.824
5.820
5.331
5.327
5.309
2.867
2.830
2.432
2.414
2.213
2.175
2.154
2.150
2.131
2.127
2.114
2.111
2.098
2.076
2.055
1.817
1.289
1.155
1.133
1.126
1.111
0.580
0.566
0.563
0.550
Me
N
Ts
Me
Ph
H
2.11
1.61
5.40
1.58
0.79
0.21
2.63
0.77
3.93
3.07
1.60
0.46
2.91
1.11
0.82
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
f1 (ppm)

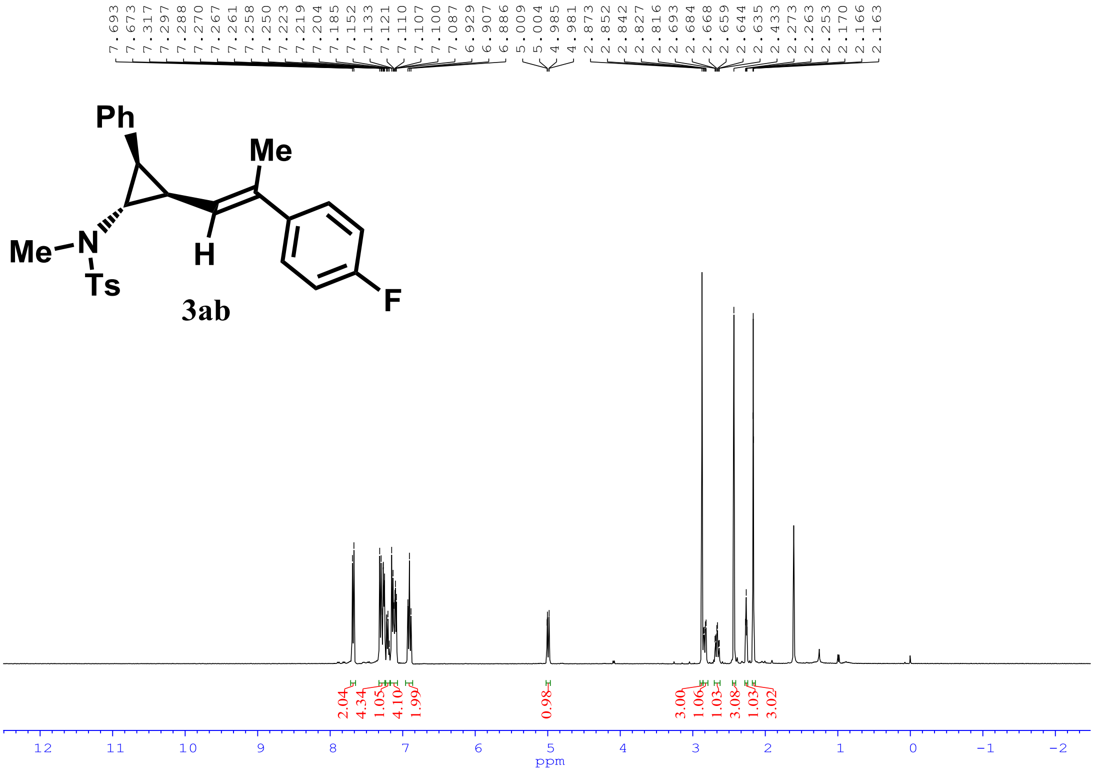

148.871
143.580
143.188
137.986
137.487
129.540
128.437
128.226
128.162
127.434
127.286
126.686
126.572
125.929
125.465
125.249
123.178
77.318
77.000
76.682
41.449
34.375
34.024
30.794
29.594
27.309
22.777
22.708
21.487
17.844
16.647
16.091
Me
N
Ts
Me
Ph
H
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)

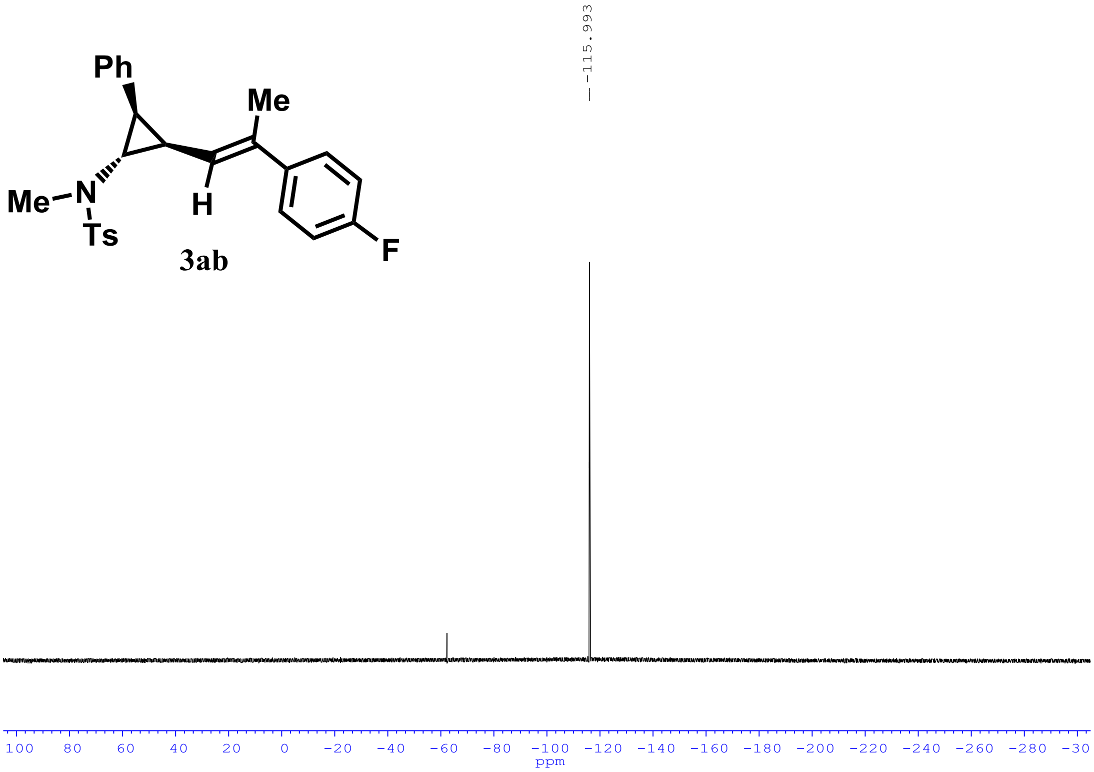

7.740
7.720
7.304
7.302
7.298
7.290
7.283
7.276
7.274
7.247
7.226
7.223
7.216
7.209
7.205
7.201
7.192
5.531
5.528
5.514
5.511
3.478
3.449
3.446
3.033
3.017
3.011
2.996
2.689
2.670
2.668
2.663
2.661
2.642
2.635
2.339
2.089
1.775
1.772
1.764
1.756
1.749
1.746
1.739
1.733
1.731
1.575
1.570
1.468
1.463
1.458
1.456
1.446
1.442
1.437
1.422
1.417
Ts
N
Me
Ph
H
2.17
4.08
3.74
1.00
1.10
1.07
1.02
3.08
3.11
2.34
2.24
2.34
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0
f1 (ppm)

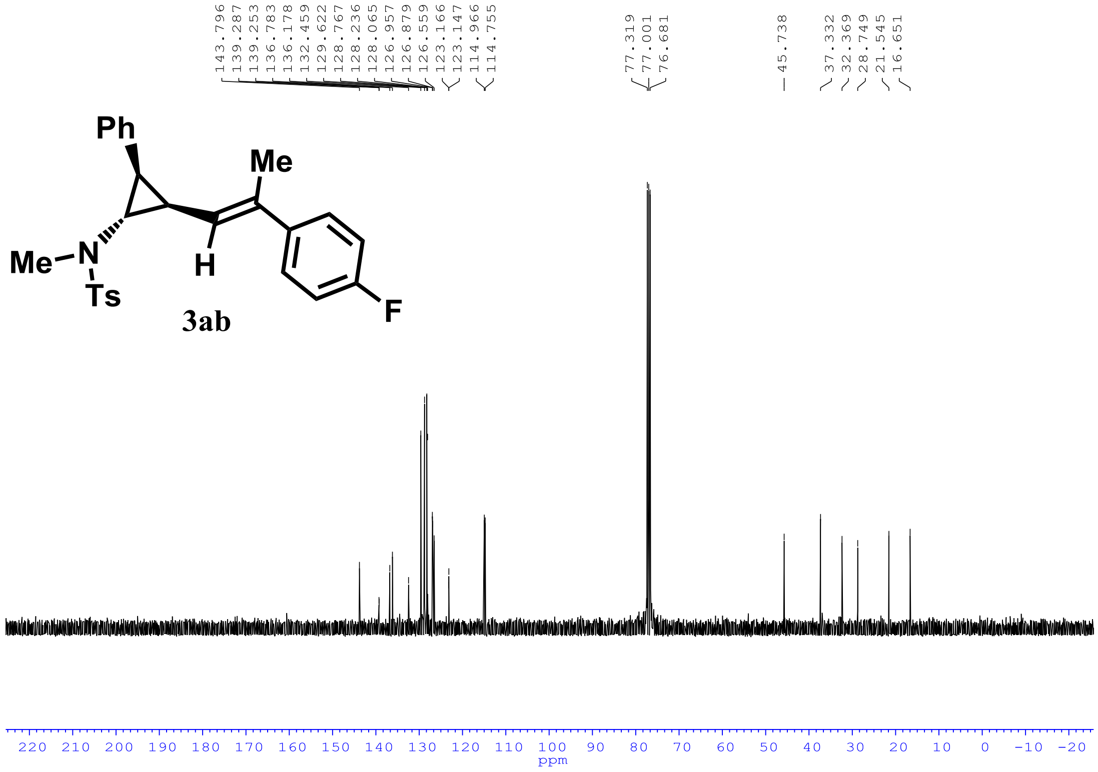

143.158
142.788
137.874
135.861
129.545
128.015
127.156
126.524
125.251
121.505
77.316
76.999
76.681
43.284
33.427
23.643
21.393
20.397
16.660
16.499
15.199
Ts
N
Me
Ph
H
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)


8.123
8.101
7.649
7.628
7.339
7.334
7.330
7.323
7.318
7.310
7.289
7.268
7.249
7.000
6.978
5.048
5.045
5.026
5.022
4.807
2.980
2.969
2.954
2.943
2.855
2.737
2.727
2.722
2.714
2.711
2.704
2.701
2.689
2.679
2.431
2.374
2.364
2.353
2.104
2.100
-0.015
NO2
Me
Me−N
Ts
H
Br
3oa
2.07
2.12
6.31
2.04
0.98
-0.02
1.12
3.05
1.16
3.19
1.12
3.06
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


146.595
144.365
144.174
141.430
138.692
132.413
131.334
129.788
129.245
127.972
126.977
123.502
122.107
121.071
77.317
77.000
76.683
46.155
37.215
33.031
29.451
21.558
16.535
NO2
Me
Me−N
Ts
H
Br
3oa
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)

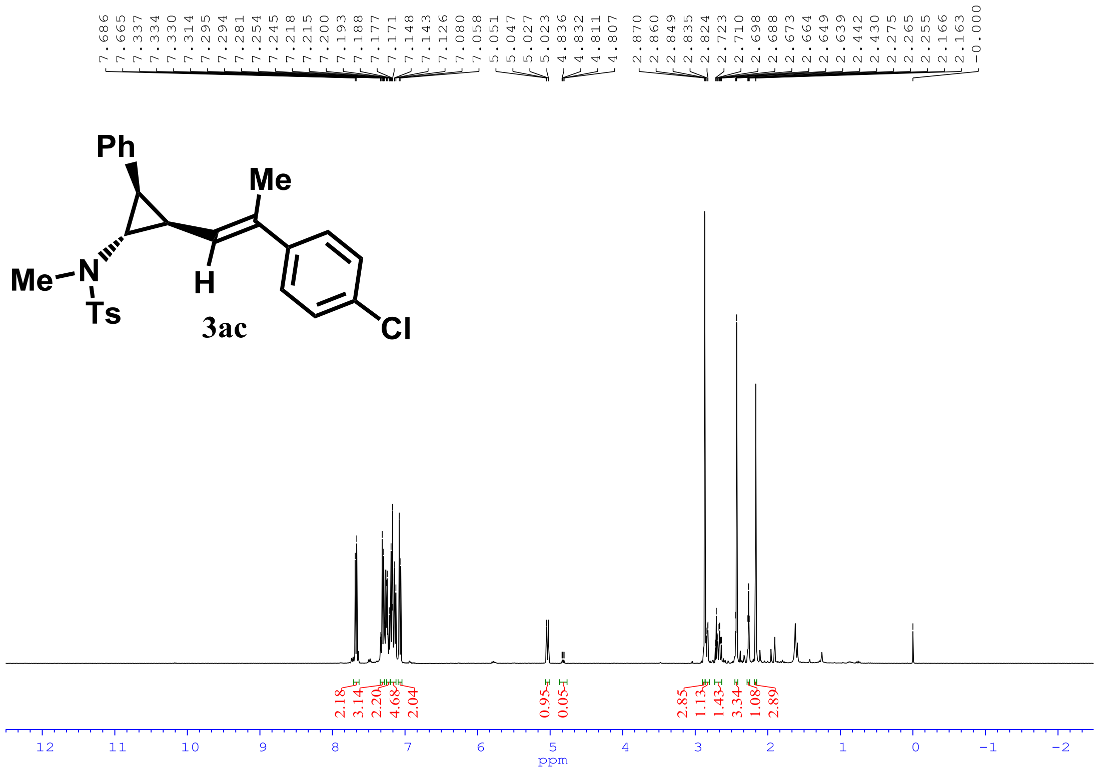

7.693
7.673
7.317
7.297
7.288
7.270
7.267
7.261
7.258
7.250
7.223
7.219
7.204
7.185
7.152
7.133
7.121
7.110
7.107
7.100
7.087
6.929
6.907
6.886
5.009
5.004
4.985
4.981
2.873
2.852
2.842
2.827
2.816
2.693
2.684
2.668
2.659
2.644
2.635
2.433
2.273
2.263
2.253
2.170
2.166
2.163
Ph
Me
Me
N
Ts
H
F
3ab
2.04
4.34
1.05
4.10
1.99
0.98
3.00
1.06
1.03
3.08
1.03
3.02
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

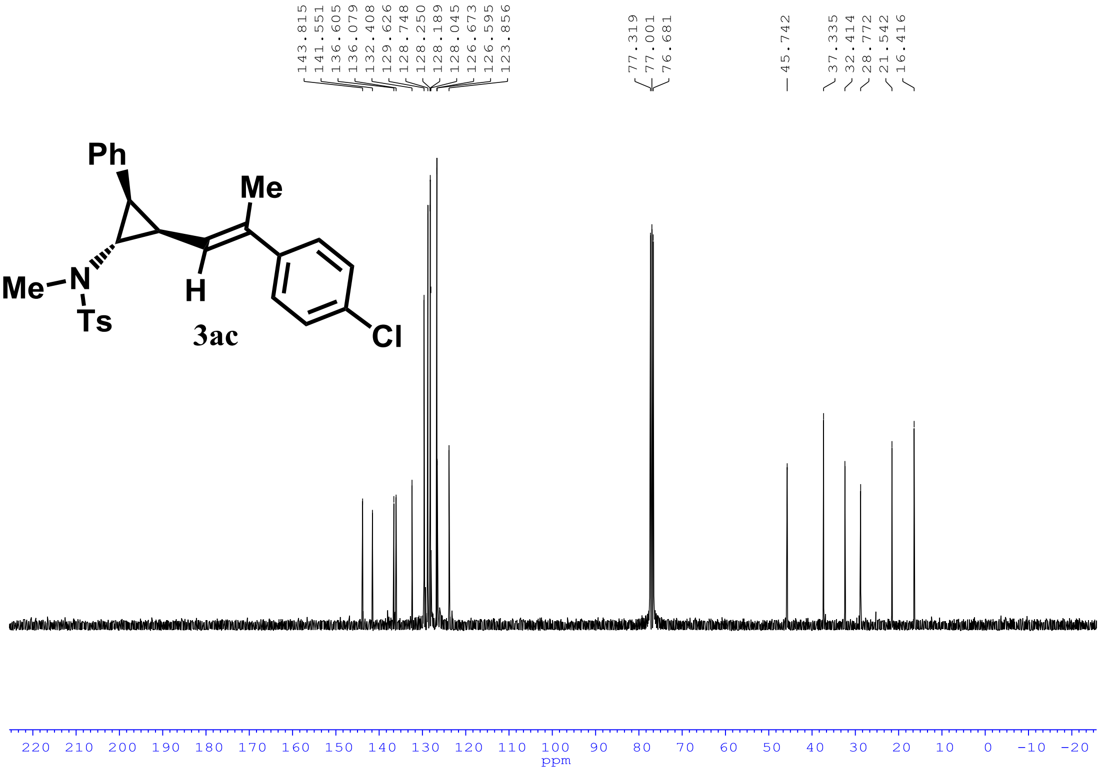

-115.993
Ph
Me
Me
N
Ts
H
F
3ab
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-30
ppm

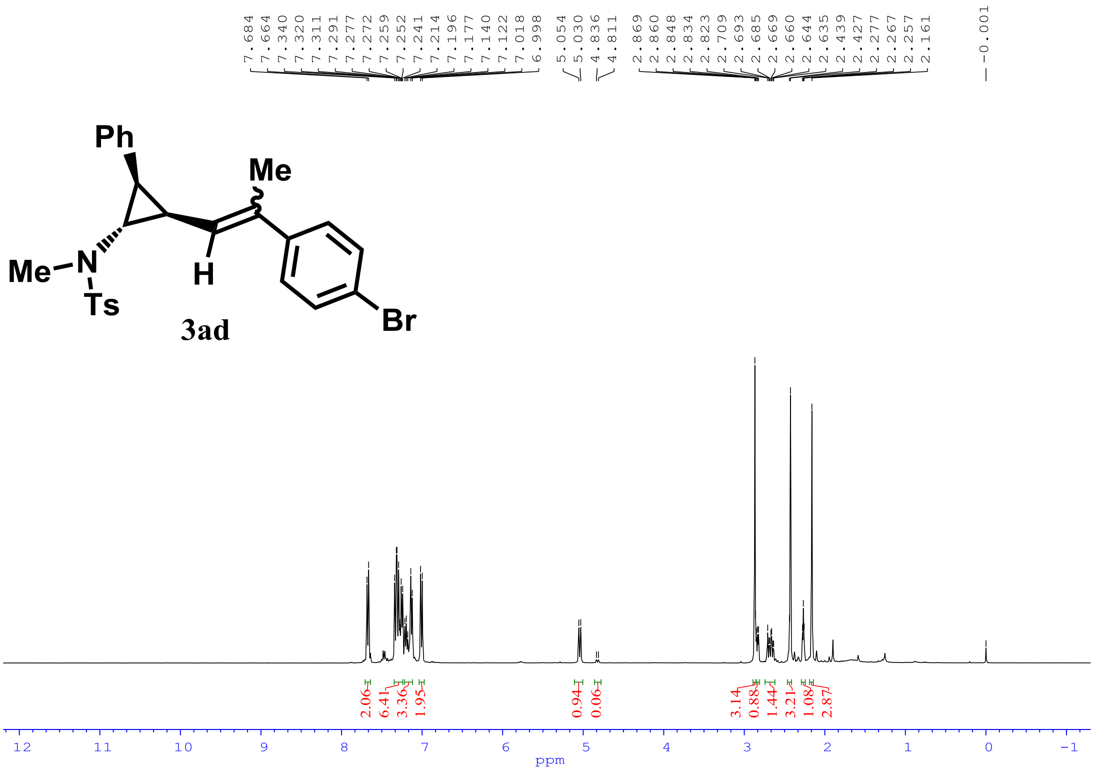


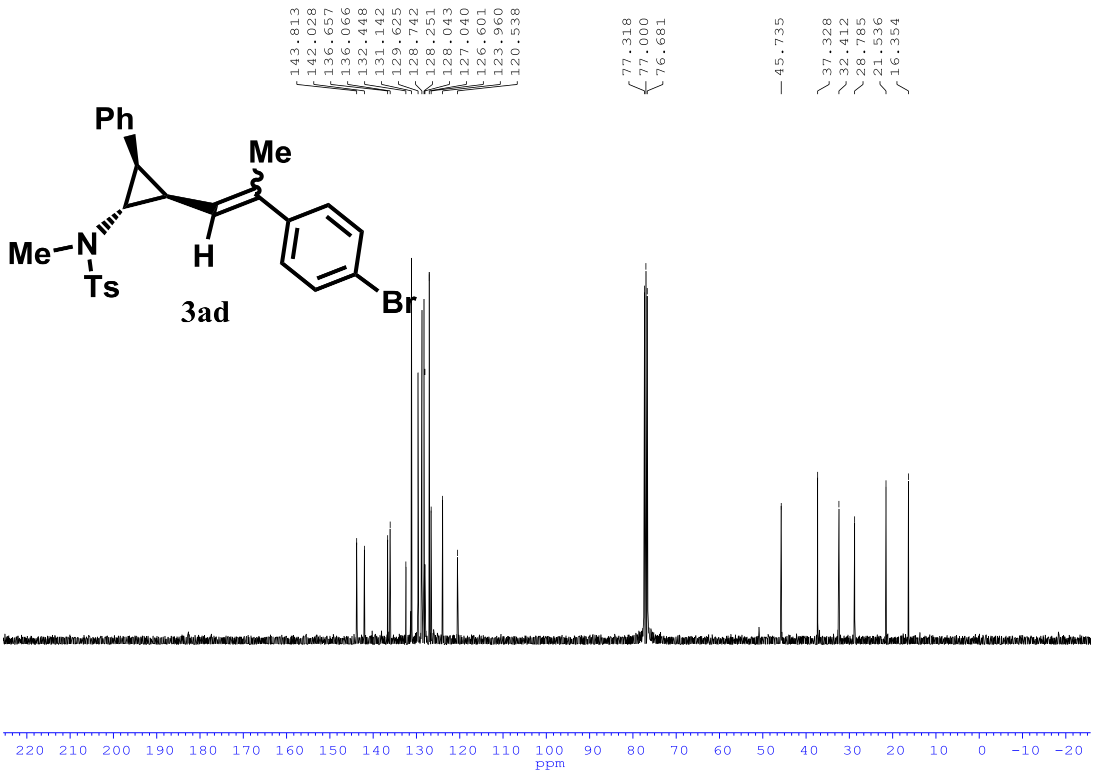
3ab

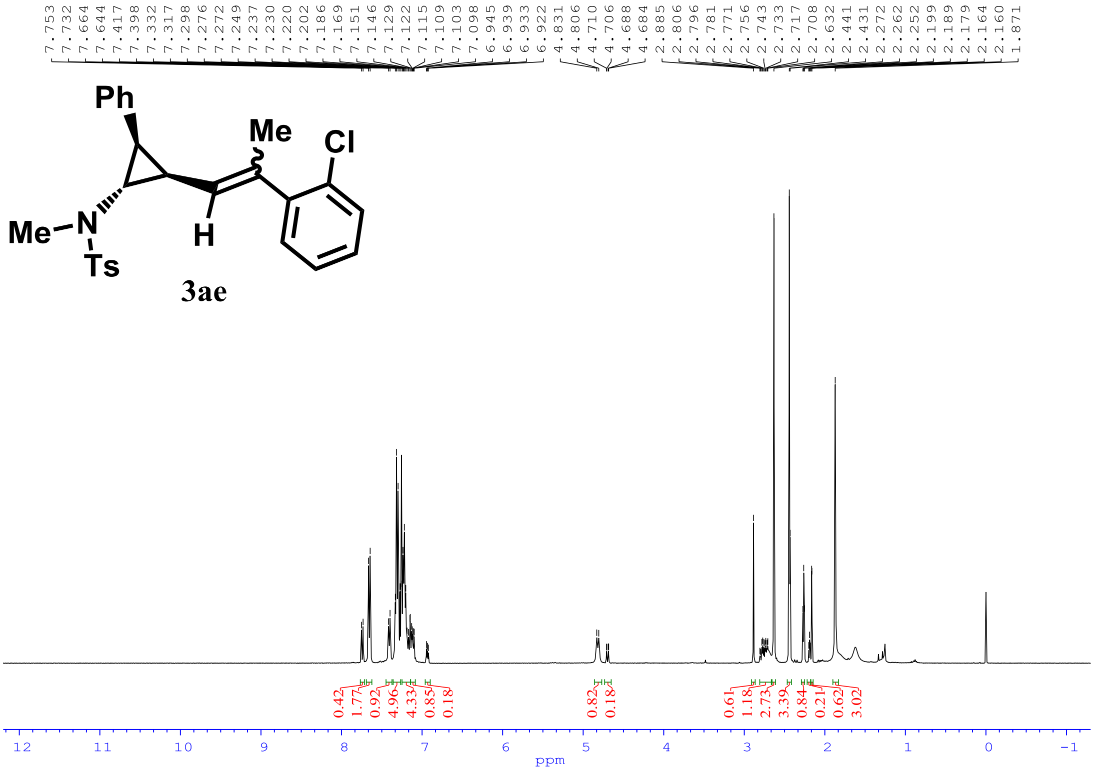
143.796
139.287
139.253
136.783
136.178
132.459
129.622
128.767
128.236
128.065
126.957
126.879
126.559
123.166
123.147
114.966
114.755
77.319
77.001
76.681
45.738
37.332
32.369
28.749
21.545
16.651
Ph
Me
Me
N
Ts
H
F
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
ppm


7.686
7.665
7.337
7.334
7.330
7.314
7.295
7.294
7.281
7.254
7.245
7.218
7.215
7.200
7.193
7.188
7.177
7.171
7.148
7.143
7.126
7.080
7.058
5.051
5.047
5.027
5.023
4.836
4.832
4.811
4.807
2.870
2.860
2.849
2.835
2.824
2.723
2.710
2.698
2.688
2.673
2.664
2.649
2.639
2.442
2.430
2.275
2.265
2.255
2.166
2.163
-0.000
Ph
Me
Me
N
Ts
H
Cl
3ac
2.18
3.14
2.20
4.68
2.04
0.95
0.05
2.85
1.13
1.43
3.34
1.08
2.89
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

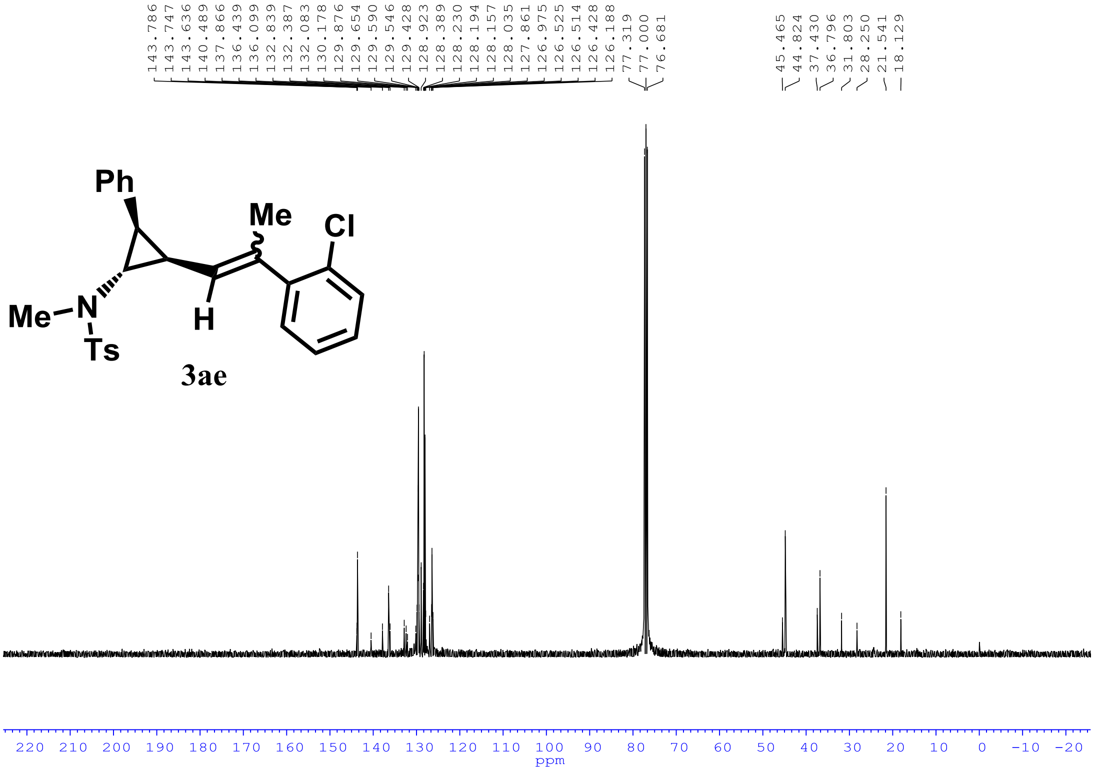

143.815
141.551
136.605
136.079
132.408
129.626
128.748
128.250
128.189
128.045
126.673
126.595
123.856
77.319
77.001
76.681
45.742
37.335
32.414
28.772
21.542
16.416
Ph
Me
Me
N
Ts
H
Cl
3ac
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


7.684
7.664
7.340
7.320
7.311
7.291
7.277
7.272
7.259
7.252
7.241
7.214
7.196
7.177
7.140
7.122
7.018
6.998
5.054
5.030
4.836
4.811
2.869
2.860
2.848
2.834
2.823
2.709
2.693
2.685
2.669
2.660
2.644
2.635
2.439
2.427
2.277
2.267
2.257
2.161
-0.001
Ph
Me
Me
N
Ts
H
Br
3ad
2.06
6.41
3.36
1.95
0.94
0.06
3.14
0.88
1.44
3.21
1.08
2.87
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

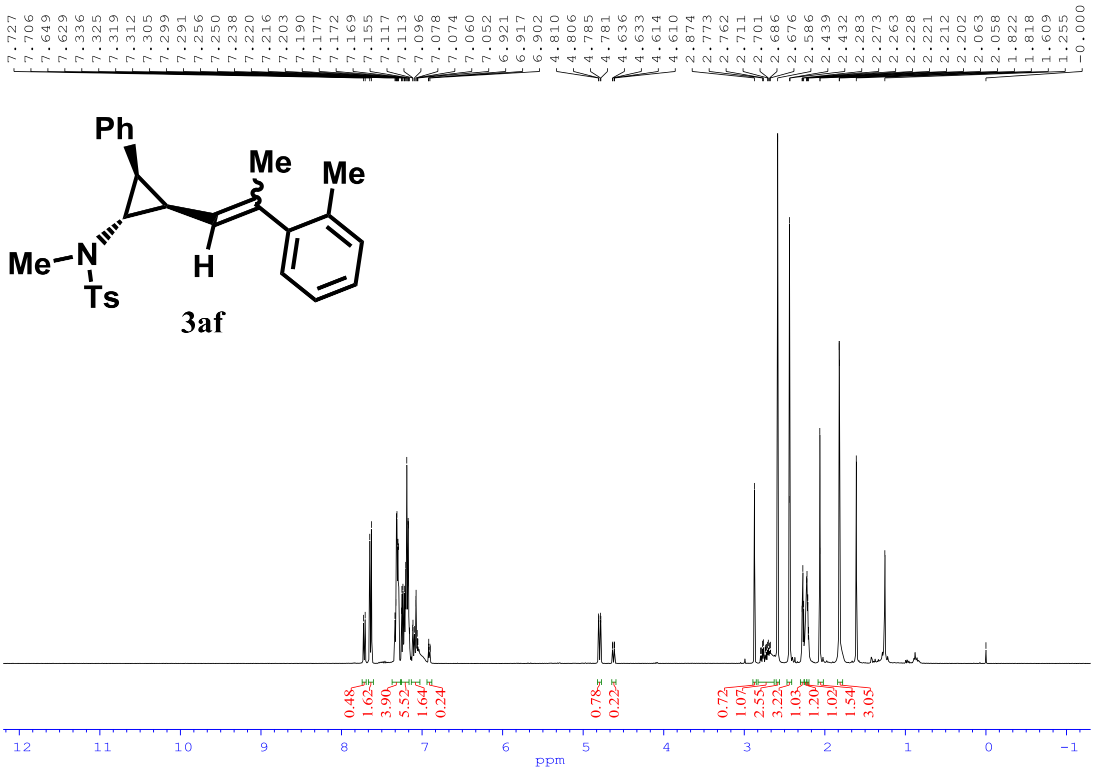

143.813
142.028
136.657
136.066
132.448
131.142
129.625
128.742
128.251
128.043
127.040
126.601
123.960
120.538
77.318
77.000
76.681
45.735
37.328
32.412
28.785
21.536
16.354
Ph
Me
Me
N
Ts
H
Br
3ad
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

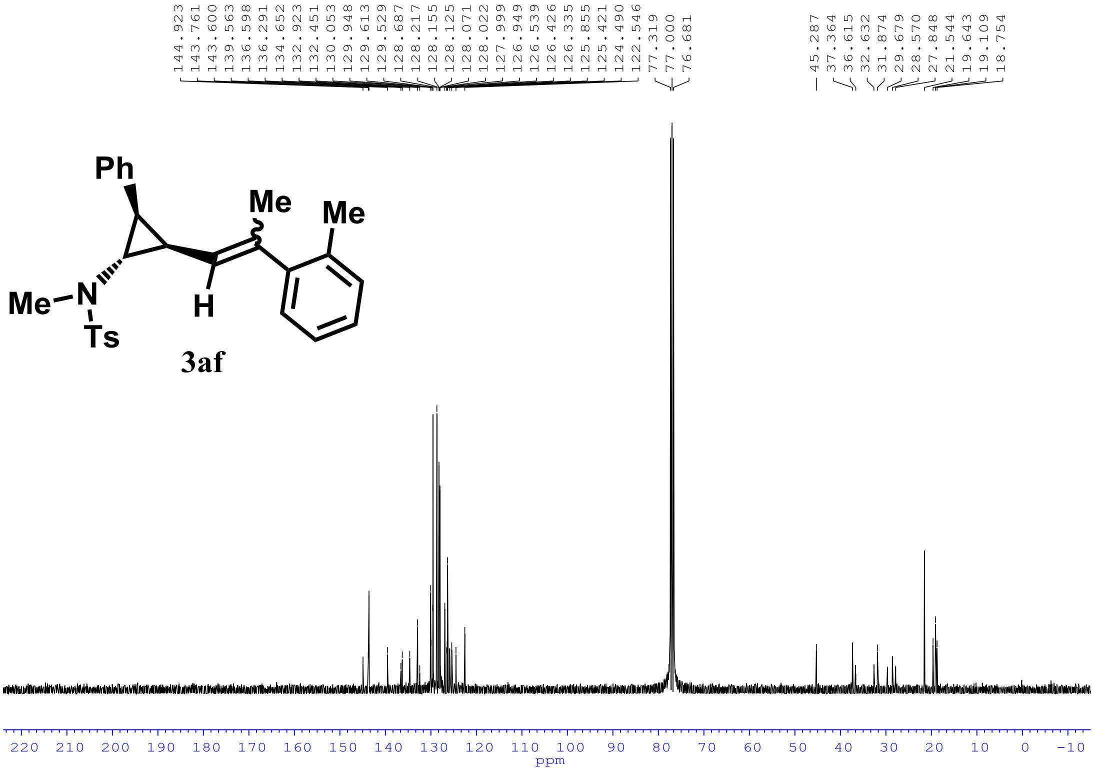

7.753
7.732
7.664
7.644
7.417
7.398
7.332
7.317
7.298
7.276
7.272
7.249
7.237
7.230
7.220
7.202
7.186
7.169
7.151
7.146
7.129
7.122
7.115
7.109
7.103
7.098
6.945
6.939
6.933
6.922
4.831
4.806
4.710
4.706
4.688
4.684
2.885
2.806
2.796
2.781
2.771
2.756
2.743
2.733
2.717
2.708
2.632
2.441
2.431
2.272
2.262
2.252
2.199
2.189
2.179
2.164
2.160
1.871
Ph
Me
Cl
Me
N
Ts
H
0.42
1.77
0.92
4.96
4.33
0.85
0.18
0.82
0.18
0.61
1.18
2.73
3.39
0.84
0.21
0.62
3.02
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

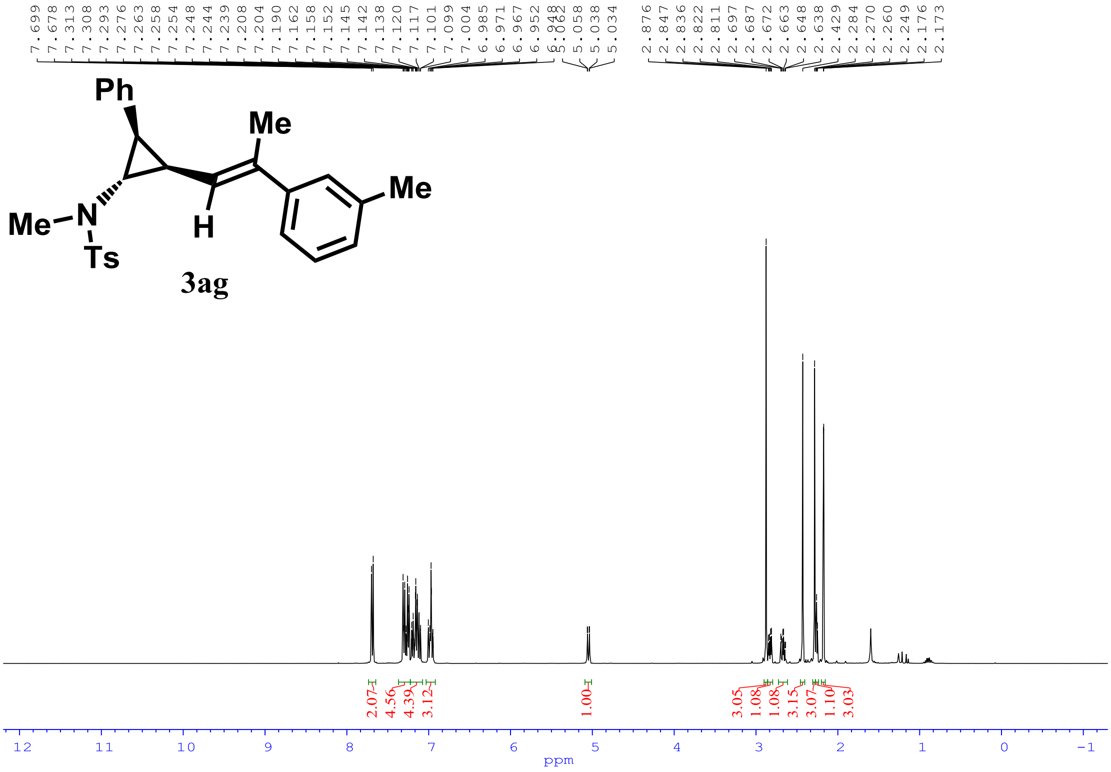
3ae

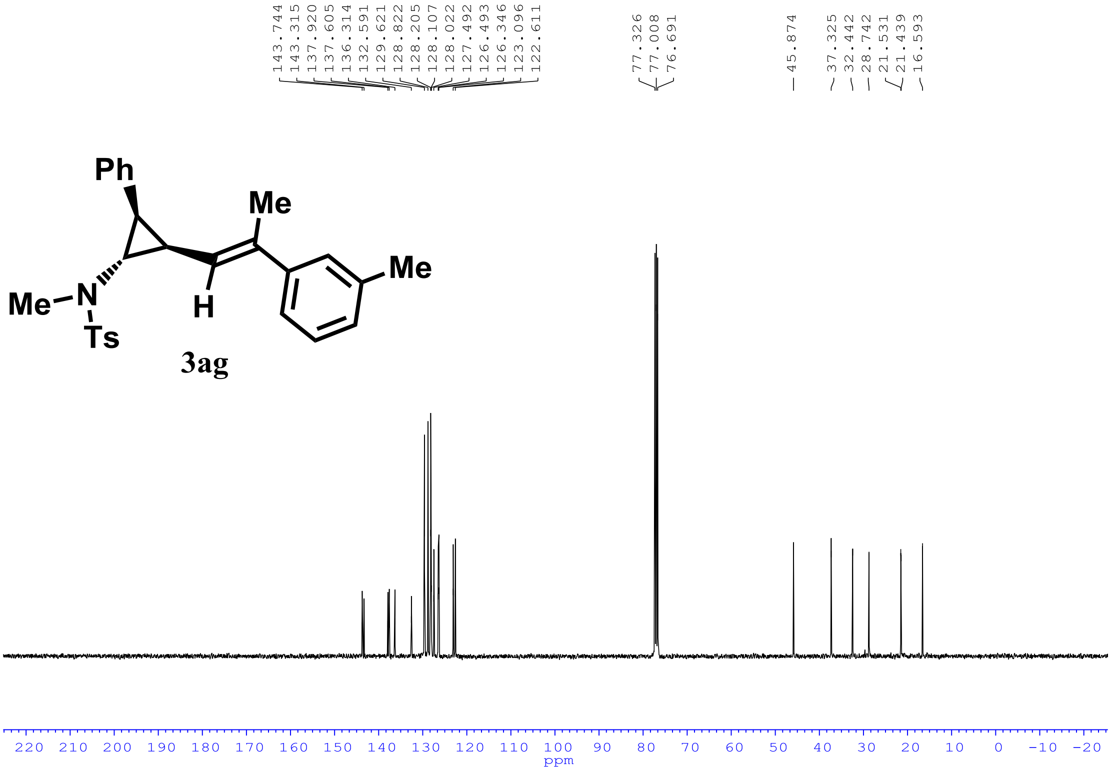

143.786
143.747
143.636
140.489
137.866
136.439
136.099
132.839
132.387
132.083
130.178
129.876
129.654
129.590
129.546
129.428
128.923
128.389
128.230
128.194
128.157
128.035
127.861
126.975
126.525
126.514
126.428
126.188
77.319
77.000
76.681
45.465
44.824
37.430
36.796
31.803
28.250
21.541
18.129
Ph
Me
Cl
Me
N
Ts
H
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

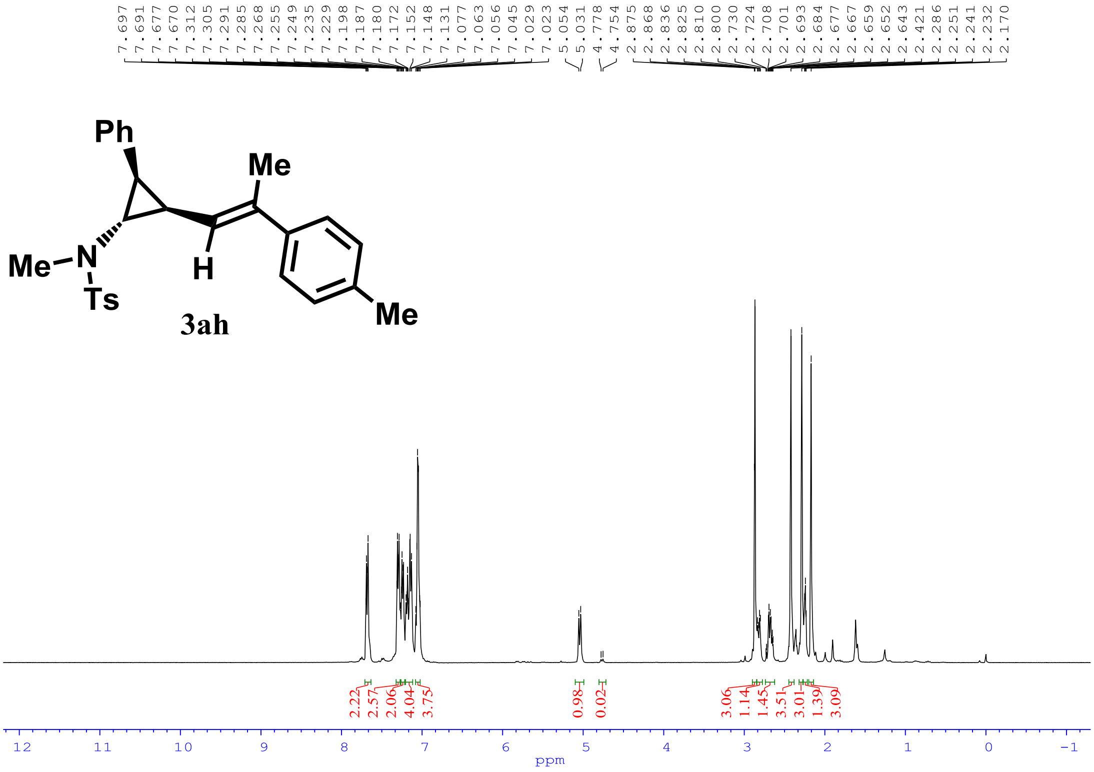
3ae


7.727
7.706
7.649
7.629
7.336
7.325
7.319
7.312
7.305
7.299
7.291
7.256
7.250
7.238
7.220
7.216
7.203
7.190
7.177
7.172
7.169
7.155
7.117
7.113
7.096
7.078
7.074
7.060
7.052
6.921
6.917
6.902
4.810
4.806
4.785
4.781
4.636
4.633
4.614
4.610
2.874
2.773
2.762
2.711
2.701
2.686
2.676
2.586
2.439
2.432
2.283
2.273
2.263
2.228
2.221
2.212
2.202
2.063
2.058
1.822
1.818
1.609
1.255
-0.000
Ph
Me
Me
Me
N
Ts
H
3af
0.48
1.62
3.90
5.52
1.64
0.24
0.78
0.22
0.72
1.07
2.55
3.22
1.03
1.20
1.02
1.54
3.05
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

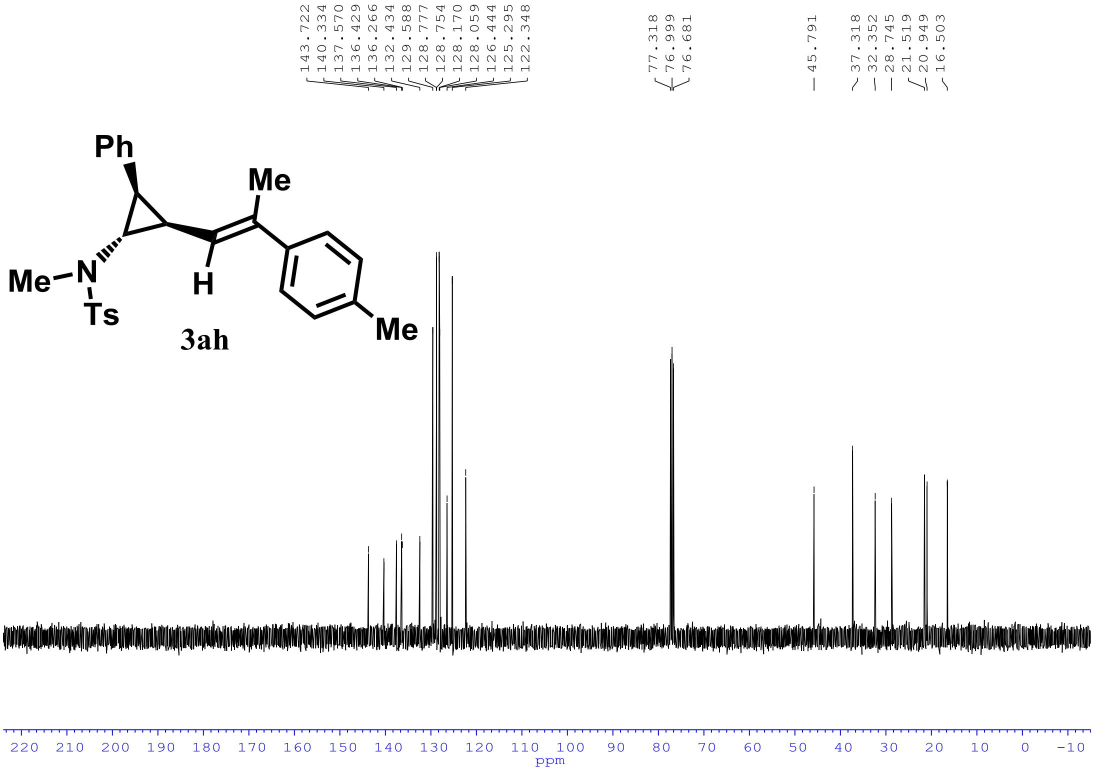

144.923
143.761
143.600
139.563
136.598
136.291
134.652
132.923
132.451
130.053
129.948
129.613
129.529
128.687
128.217
128.155
128.125
128.071
128.022
127.999
126.949
126.539
126.426
126.335
125.855
125.421
124.490
122.546
77.319
77.000
76.681
45.287
37.364
36.615
32.632
31.874
29.679
28.570
27.848
21.544
19.643
19.109
18.754
Ph
Me
Me
Me
N
Ts
H
3af
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm


7.699
7.678
7.313
7.308
7.293
7.276
7.263
7.258
7.254
7.248
7.244
7.239
7.208
7.204
7.190
7.162
7.158
7.152
7.145
7.142
7.138
7.120
7.117
7.101
7.099
7.004
6.985
6.971
6.967
6.952
6.948
5.062
5.058
5.038
5.034
2.876
2.847
2.836
2.822
2.811
2.697
2.687
2.672
2.663
2.648
2.638
2.429
2.284
2.270
2.260
2.249
2.176
2.173
Ph
Me
Me
Me
N
H
Ts
3ag
2.07
4.56
4.39
3.12
1.00
3.05
1.08
1.08
3.15
3.07
1.10
3.03
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

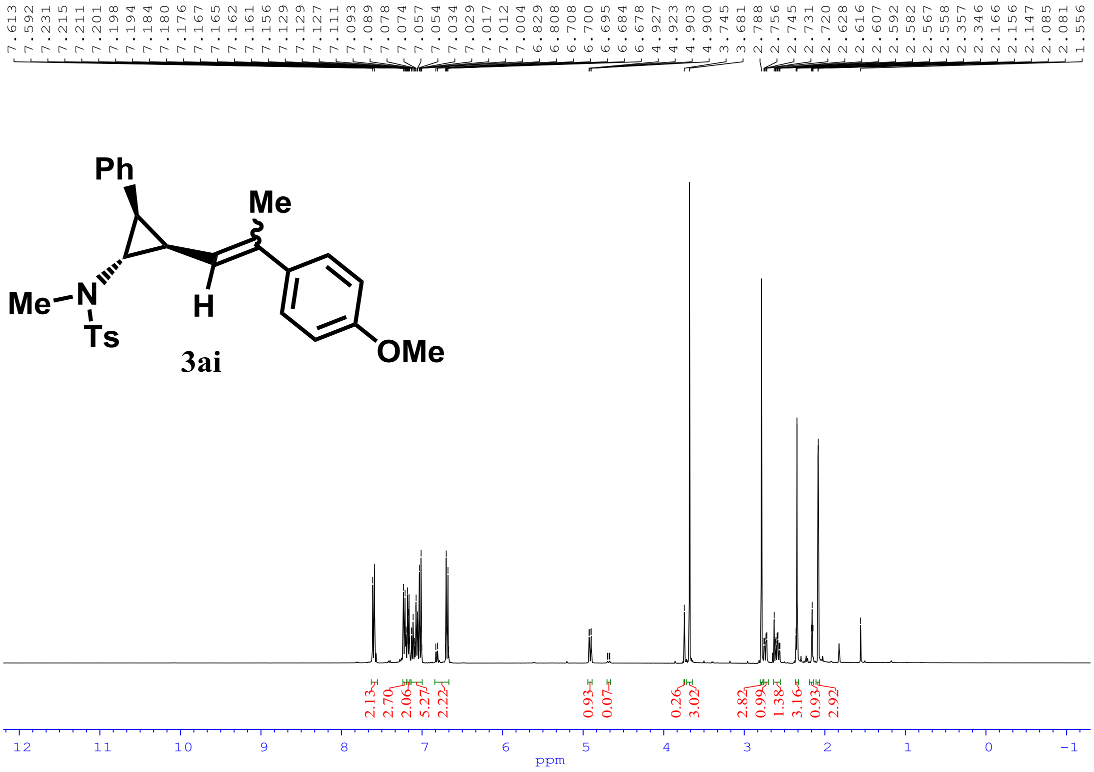

143.744
143.315
137.920
137.605
136.314
132.591
129.621
128.822
128.205
128.107
128.022
127.492
126.493
126.346
123.096
122.611
77.326
77.008
76.691
45.874
37.325
32.442
28.742
21.531
21.439
16.593
Ph
Me
Me
Me
N
H
Ts
3ag
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

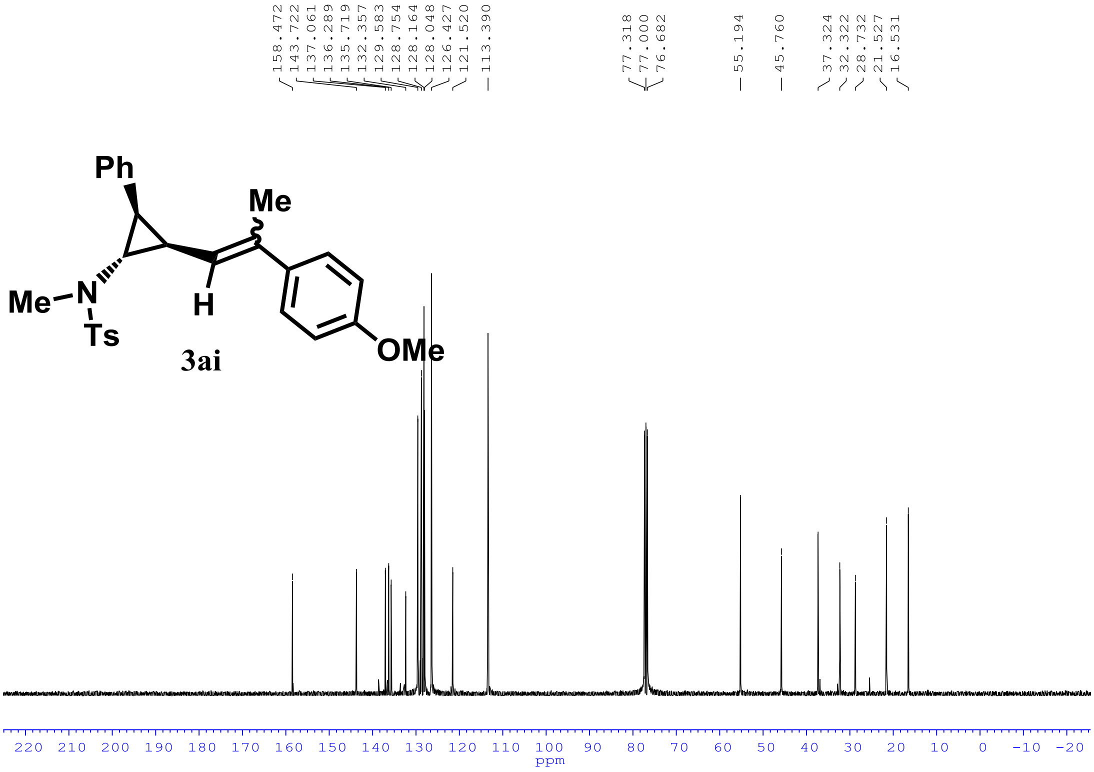

7.697
7.691
7.677
7.670
7.312
7.305
7.291
7.285
7.268
7.255
7.249
7.235
7.229
7.198
7.187
7.180
7.172
7.152
7.148
7.131
7.077
7.063
7.056
7.045
7.029
7.023
5.054
5.031
4.778
4.754
2.875
2.868
2.836
2.825
2.810
2.800
2.730
2.724
2.708
2.701
2.693
2.684
2.677
2.667
2.659
2.652
2.643
2.421
2.286
2.251
2.241
2.232
2.170
Ph
Me
Me
N
Ts
H
Me
2.22
2.57
2.06
4.04
3.75
0.98
0.02
3.06
1.14
1.45
3.51
3.01
1.39
3.09
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

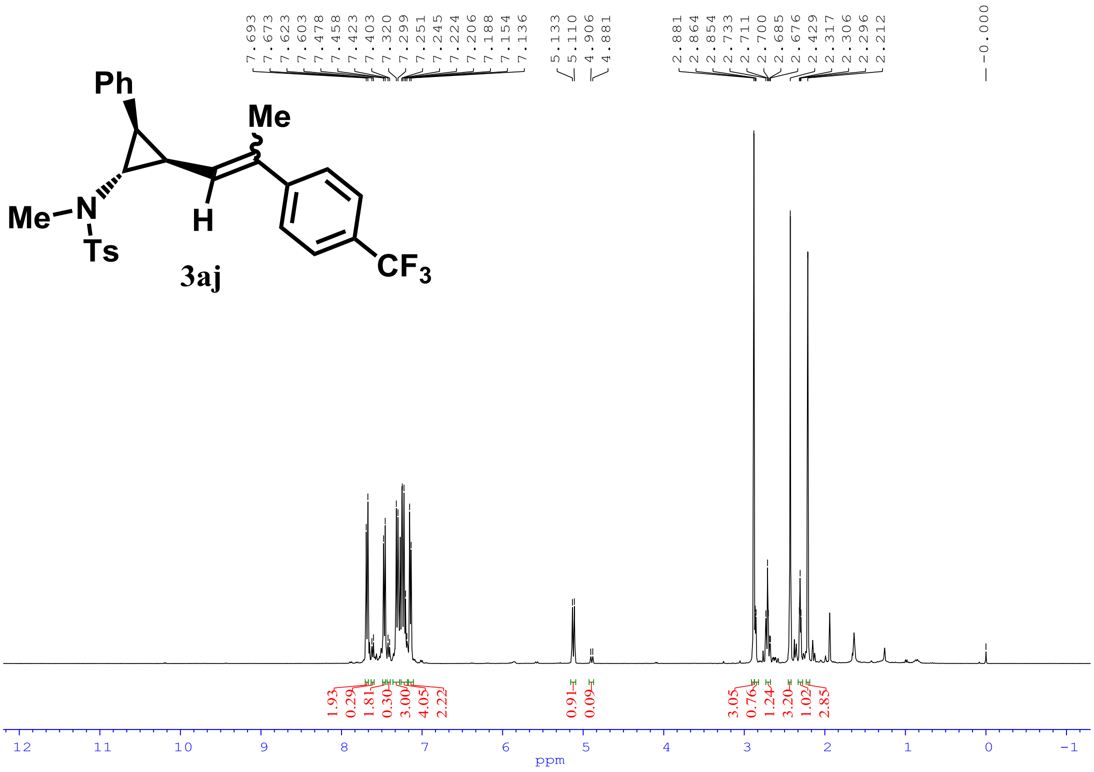
3ah

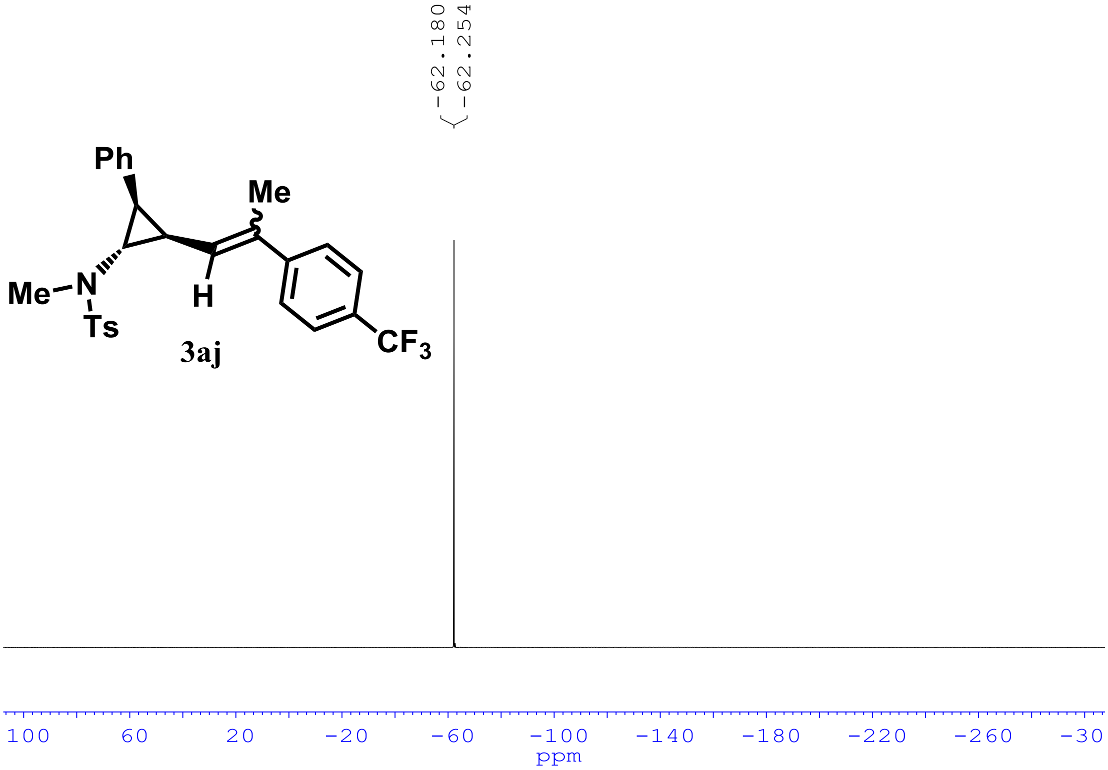

143.722
140.334
137.570
136.429
136.266
132.434
129.588
128.777
128.754
128.170
128.059
126.444
125.295
122.348
77.318
76.999
76.681
45.791
37.318
32.352
28.745
21.519
20.949
16.503
Ph
Me
Me
N
Ts
H
Me
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

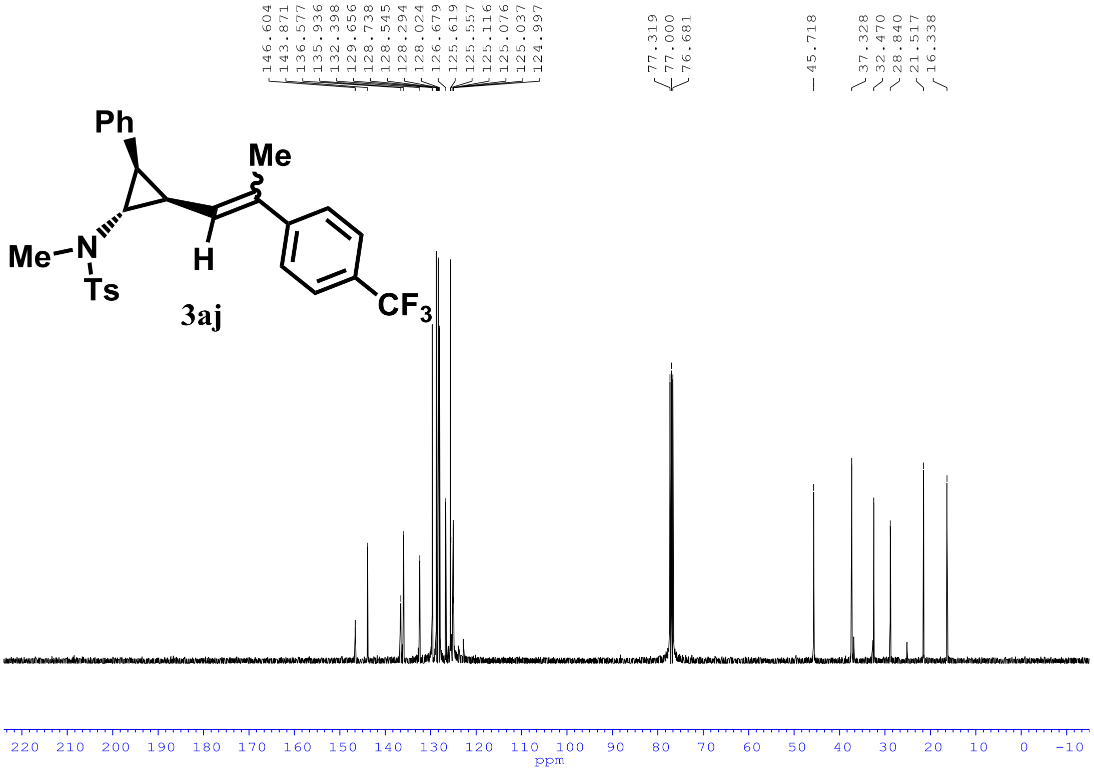
3ah


7.613
7.592
7.231
7.215
7.211
7.201
7.198
7.194
7.184
7.180
7.176
7.167
7.165
7.162
7.161
7.156
7.129
7.129
7.127
7.111
7.093
7.089
7.078
7.074
7.057
7.054
7.034
7.029
7.017
7.012
7.004
6.829
6.808
6.708
6.700
6.695
6.684
6.678
4.927
4.923
4.903
4.900
3.745
3.681
2.788
2.756
2.745
2.731
2.720
2.628
2.616
2.607
2.592
2.582
2.567
2.558
2.357
2.346
2.166
2.156
2.147
2.085
2.081
1.556
Ph
Me
Me
N
Ts
H
OMe
3ai
2.13
2.70
2.06
5.27
2.22
0.93
0.07
0.26
3.02
2.82
0.99
1.38
3.16
0.93
2.92
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

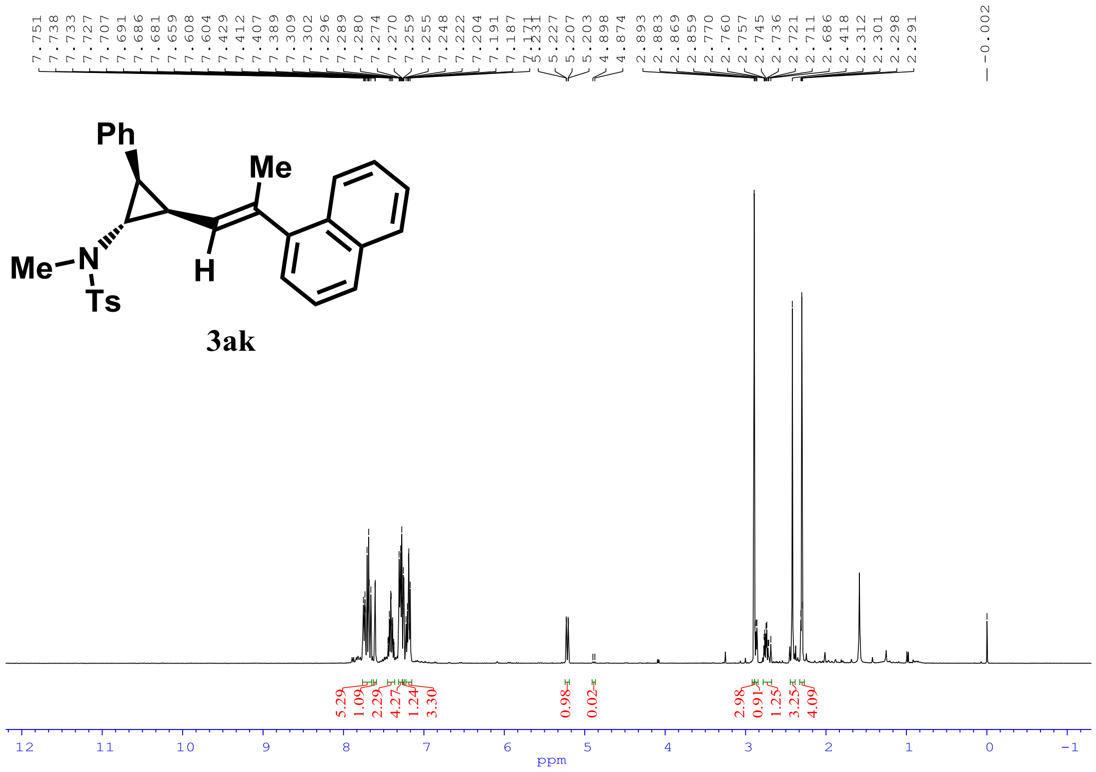

158.472
143.722
137.061
136.289
135.719
132.357
129.583
128.754
128.164
128.048
126.427
121.520
113.390
77.318
77.000
76.682
55.194
45.760
37.324
32.322
28.732
21.527
16.531
Ph
Me
Me
N
Ts
H
OMe
3ai
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

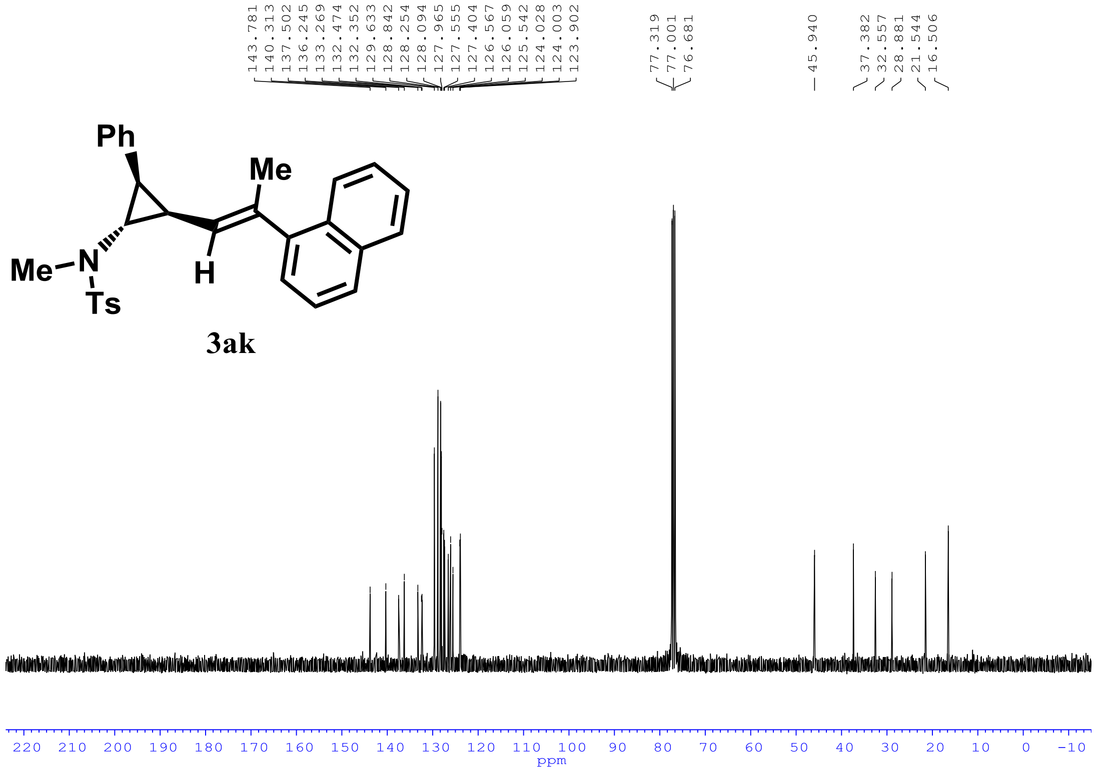

Ph
Me
Me
N
Ts
H
CF3
3aj
7.693
7.673
7.623
7.603
7.478
7.458
7.423
7.403
7.320
7.299
7.251
7.245
7.224
7.206
7.188
7.154
7.136
5.133
5.110
4.906
4.881
2.881
2.864
2.854
2.733
2.711
2.700
2.685
2.676
2.429
2.317
2.306
2.296
2.212
-0.000
1.93
0.29
1.81
0.30
3.00
4.05
2.22
0.91
0.09
3.05
0.76
1.24
3.20
1.02
2.85
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

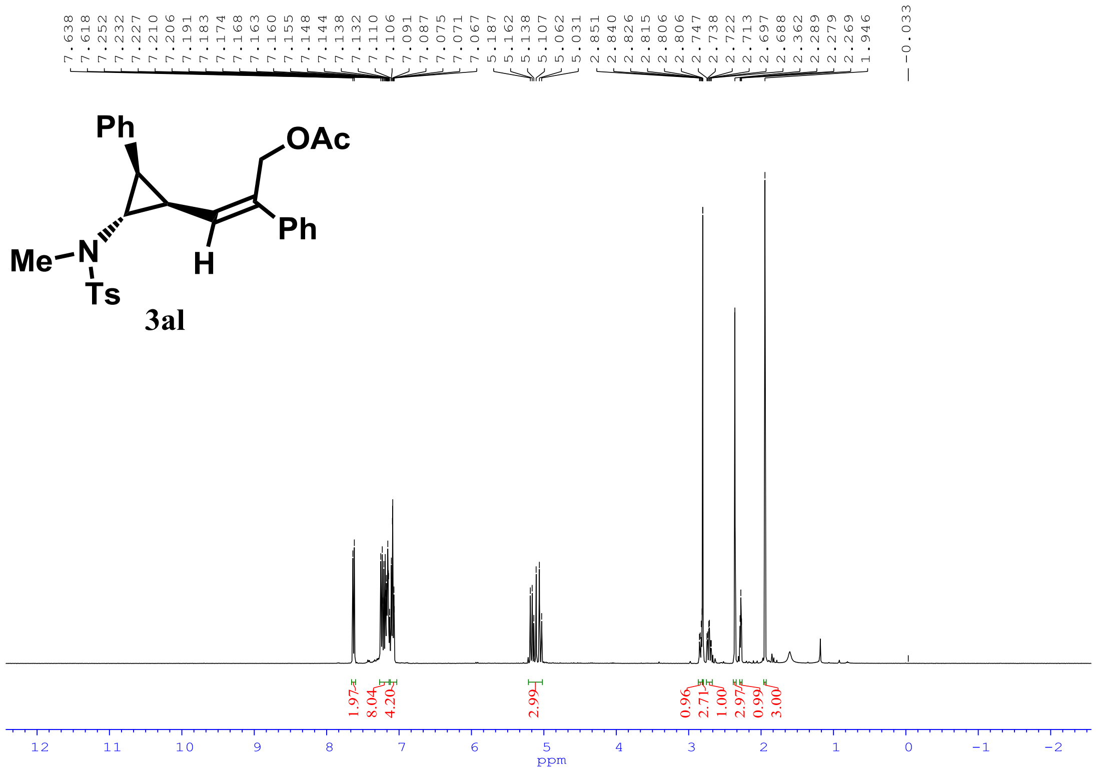

-62.180
-62.254
Ph
Me
Me
N
Ts
H
CF3
3aj
100
60
20
-20
-60
-100
-140
-180
-220
-260
-30
ppm

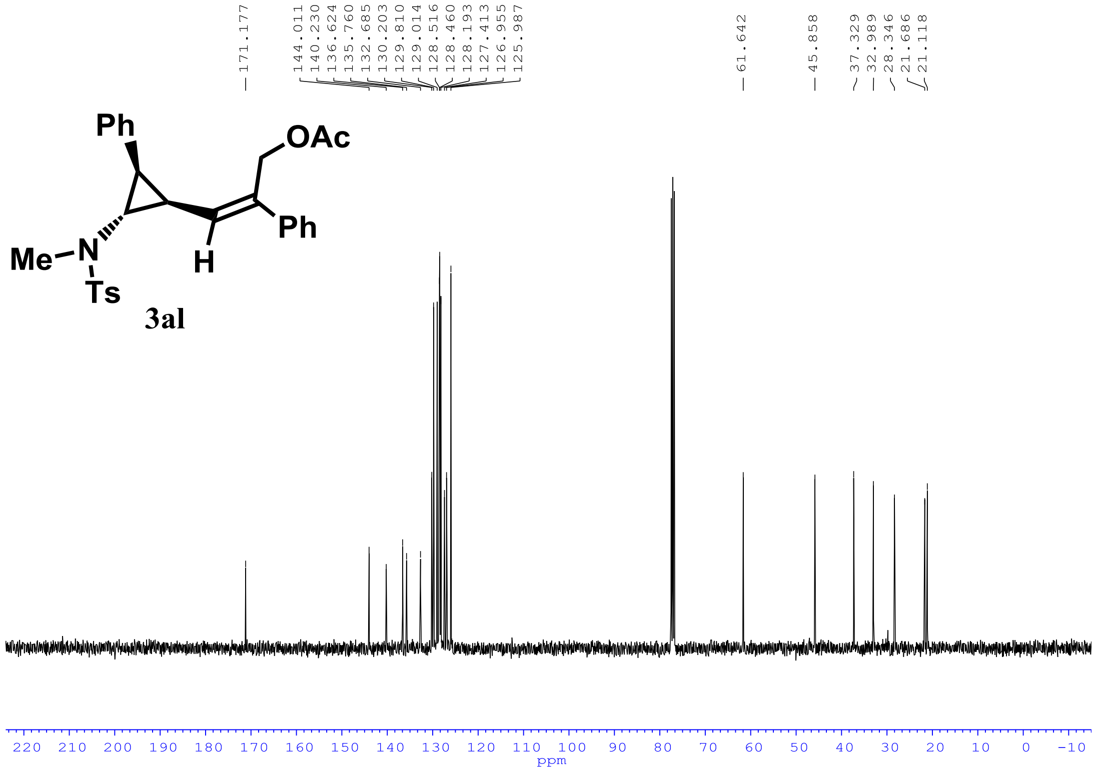

146.604
143.871
136.577
135.936
132.398
129.656
128.738
128.545
128.294
128.024
126.679
125.619
125.557
125.116
125.076
125.037
124.997
77.319
77.000
76.681
45.718
37.328
32.470
28.840
21.517
16.338
Ph
Me
Me
N
Ts
H
CF3
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
ppm

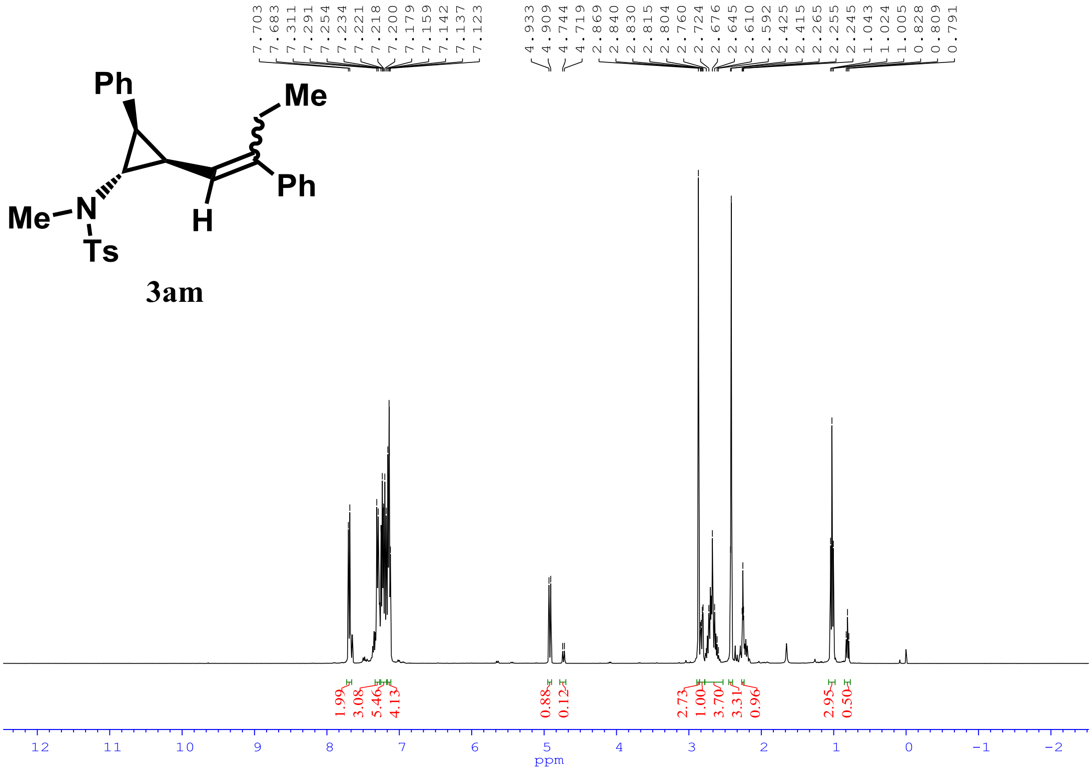
3aj

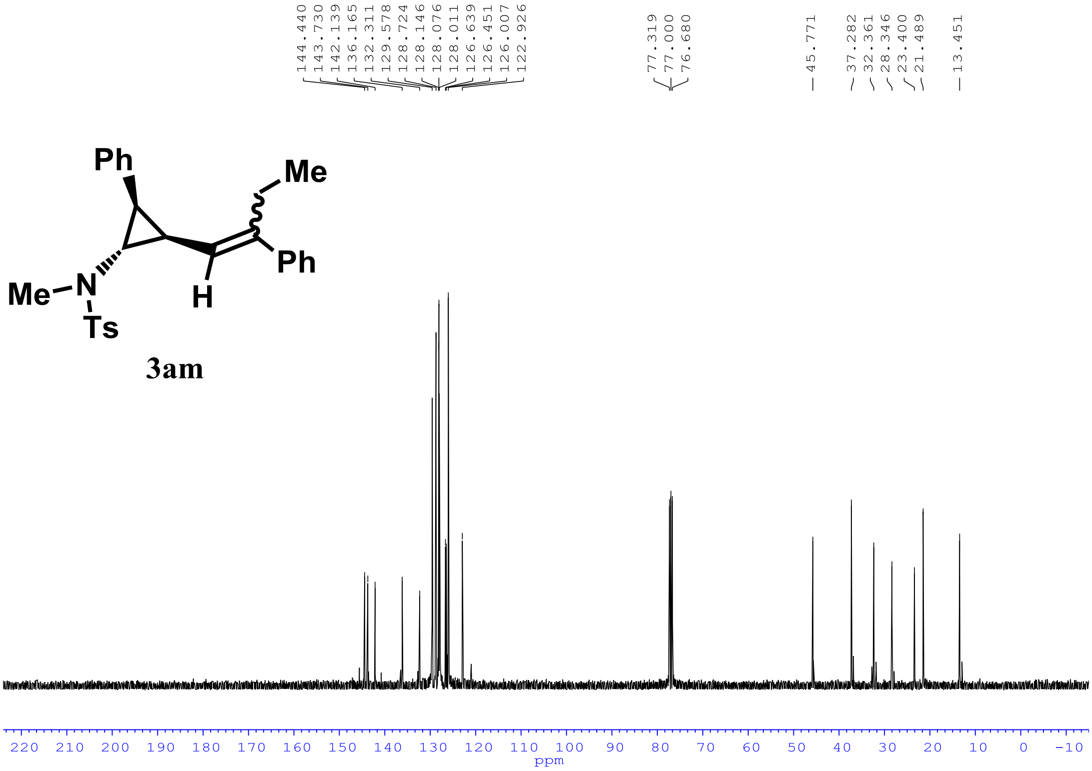

7.751
7.738
7.733
7.727
7.707
7.691
7.686
7.681
7.659
7.608
7.604
7.429
7.412
7.407
7.389
7.309
7.302
7.296
7.289
7.280
7.274
7.270
7.259
7.255
7.248
7.222
7.204
7.191
7.187
7.171
5.231
5.227
5.207
5.203
4.898
4.874
2.893
2.883
2.869
2.859
2.770
2.760
2.757
2.745
2.736
2.721
2.711
2.686
2.418
2.312
2.301
2.298
2.291
-0.002
Ph
Me
Me
N
Ts
H
3ak
5.29
1.09
2.29
4.27
1.24
3.30
0.98
0.02
2.98
0.91
1.25
3.25
4.09
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

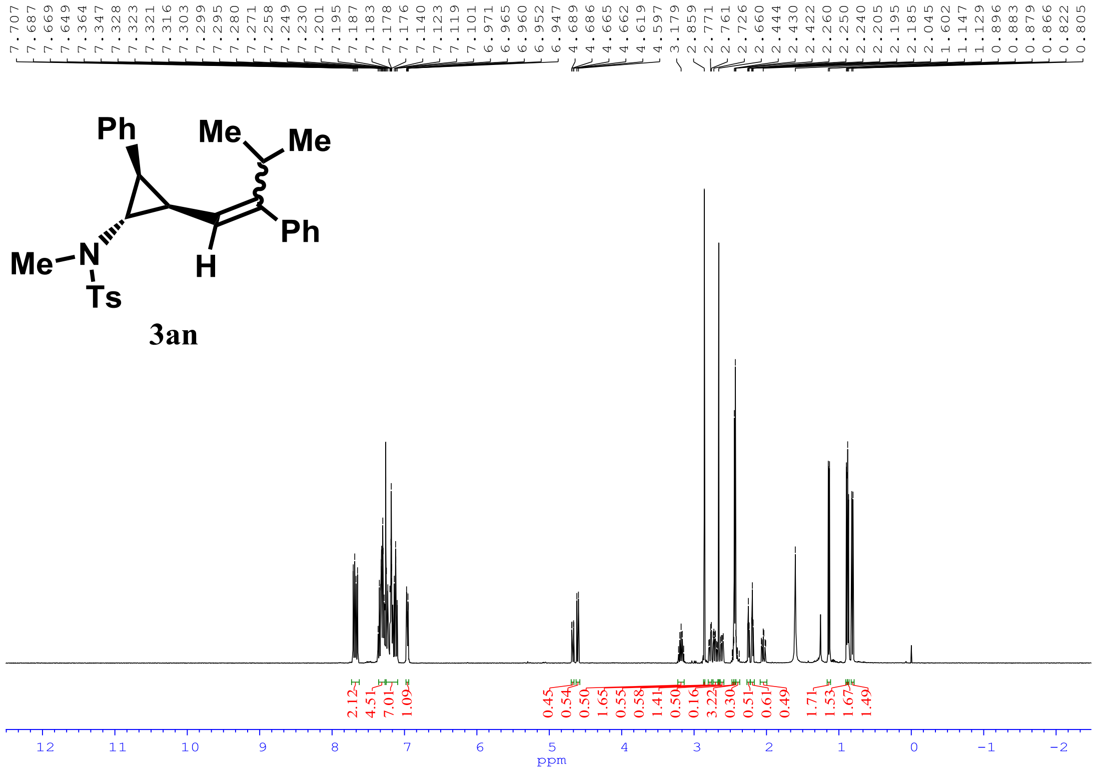

143.781
140.313
137.502
136.245
133.269
132.474
132.352
129.633
128.842
128.254
128.094
127.965
127.555
127.404
126.567
126.059
125.542
124.028
124.003
123.902
77.319
77.001
76.681
45.940
37.382
32.557
28.881
21.544
16.506
Ph
Me
Me
N
Ts
H
3ak
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm


7.638
7.618
7.252
7.232
7.227
7.210
7.206
7.191
7.183
7.174
7.168
7.163
7.160
7.155
7.148
7.144
7.138
7.132
7.110
7.106
7.091
7.087
7.075
7.071
7.067
5.187
5.162
5.138
5.107
5.062
5.031
2.851
2.840
2.826
2.815
2.806
2.806
2.747
2.738
2.722
2.713
2.697
2.688
2.362
2.289
2.279
2.269
1.946
-0.033
Ph
OAc
Ph
Me
N
H
Ts
3al
1.97
8.04
4.20
2.99
0.96
2.71
1.00
2.97
0.99
3.00
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm


171.177
144.011
140.230
136.624
135.760
132.685
130.203
129.810
129.014
128.516
128.460
128.193
127.413
126.955
125.987
61.642
45.858
37.329
32.989
28.346
21.686
21.118
Ph
OAc
Ph
Me
N
H
Ts
3al
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

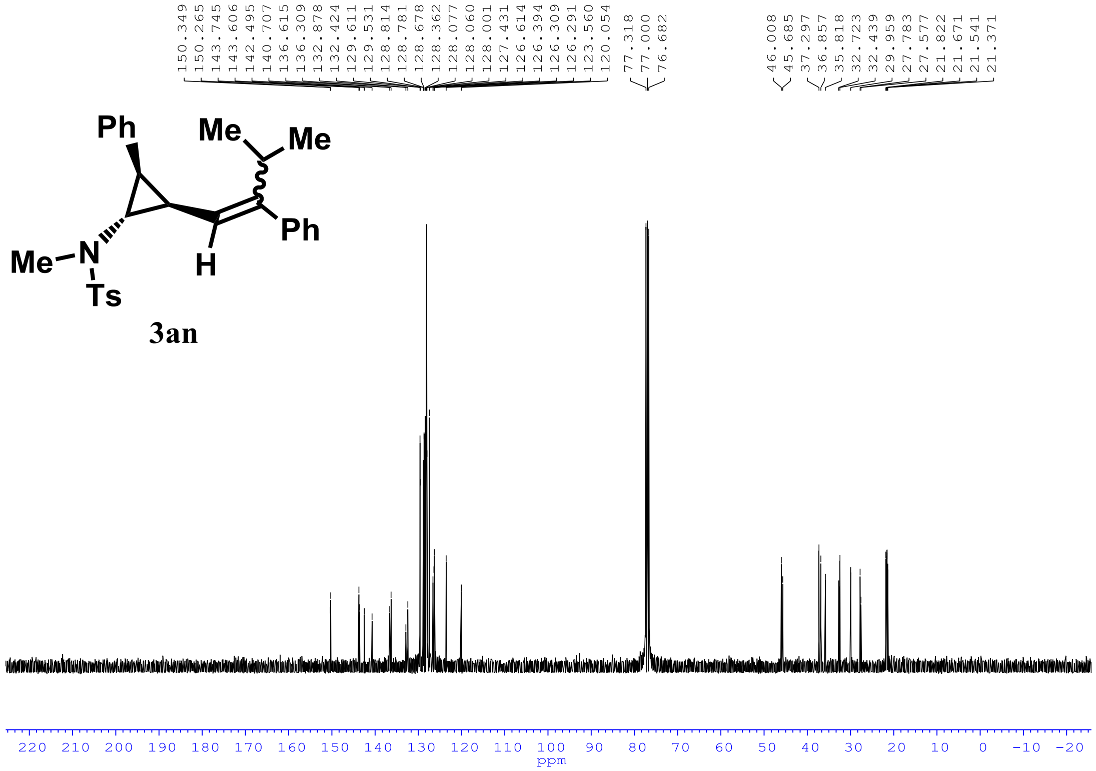

7.703
7.683
7.311
7.291
7.254
7.234
7.221
7.218
7.200
7.179
7.159
7.142
7.137
7.123
4.933
4.909
4.744
4.719
2.869
2.840
2.830
2.815
2.804
2.760
2.724
2.676
2.645
2.610
2.592
2.425
2.415
2.265
2.255
2.245
1.043
1.024
1.005
0.828
0.809
0.791
Ph
Me
Me
N
Ts
H
Ph
3am
1.99
3.08
5.46
4.13
0.88
0.12
2.73
1.00
3.70
3.31
0.96
2.95
0.50
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm


144.440
143.730
142.139
136.165
132.311
129.578
128.724
128.146
128.076
128.011
126.639
126.451
126.007
122.926
77.319
77.000
76.680
45.771
37.282
32.361
28.346
23.400
21.489
13.451
Ph
Me
Me
N
Ts
H
Ph
3am
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm



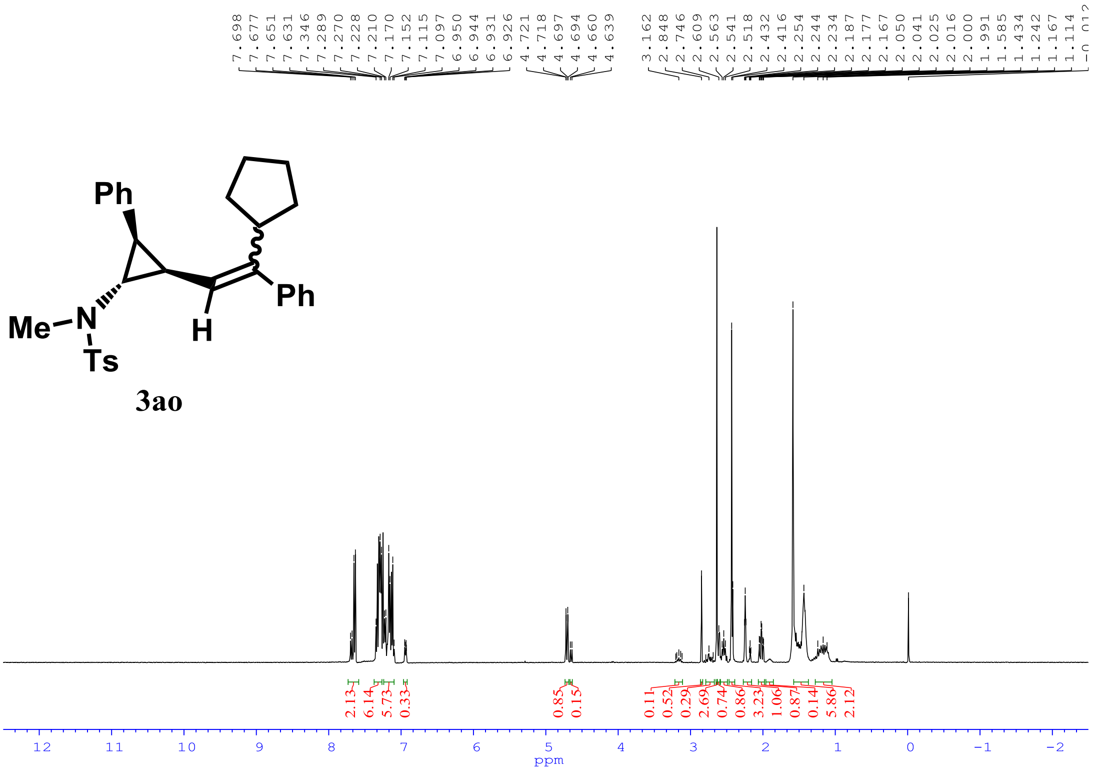
3an

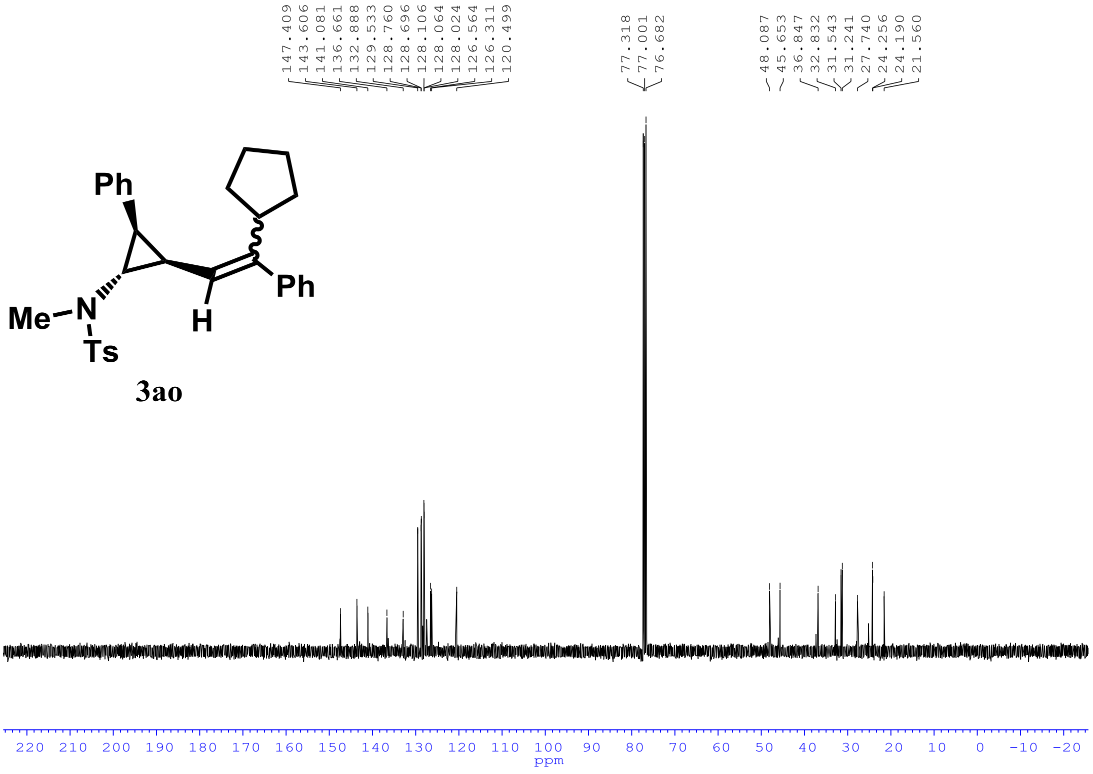
7.707
7.687
7.669
7.649
7.364
7.347
7.328
7.323
7.321
7.316
7.303
7.299
7.295
7.280
7.271
7.258
7.249
7.230
7.201
7.195
7.187
7.183
7.178
7.176
7.140
7.123
7.119
7.101
6.971
6.965
6.960
6.952
6.947
4.689
4.686
4.665
4.662
4.619
4.597
3.179
2.859
2.771
2.761
2.726
2.660
2.444
2.430
2.422
2.260
2.250
2.240
2.205
2.195
2.185
2.045
1.602
1.147
1.129
0.896
0.883
0.879
0.866
0.822
0.805
Ph
Me
Me
Ph
Me
N
Ts
H
2.12
4.51
7.01
1.09
0.45
0.54
0.50
1.65
0.55
0.58
1.41
0.50
0.16
3.22
0.30
0.51
0.61
0.49
1.71
1.53
1.67
1.49
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

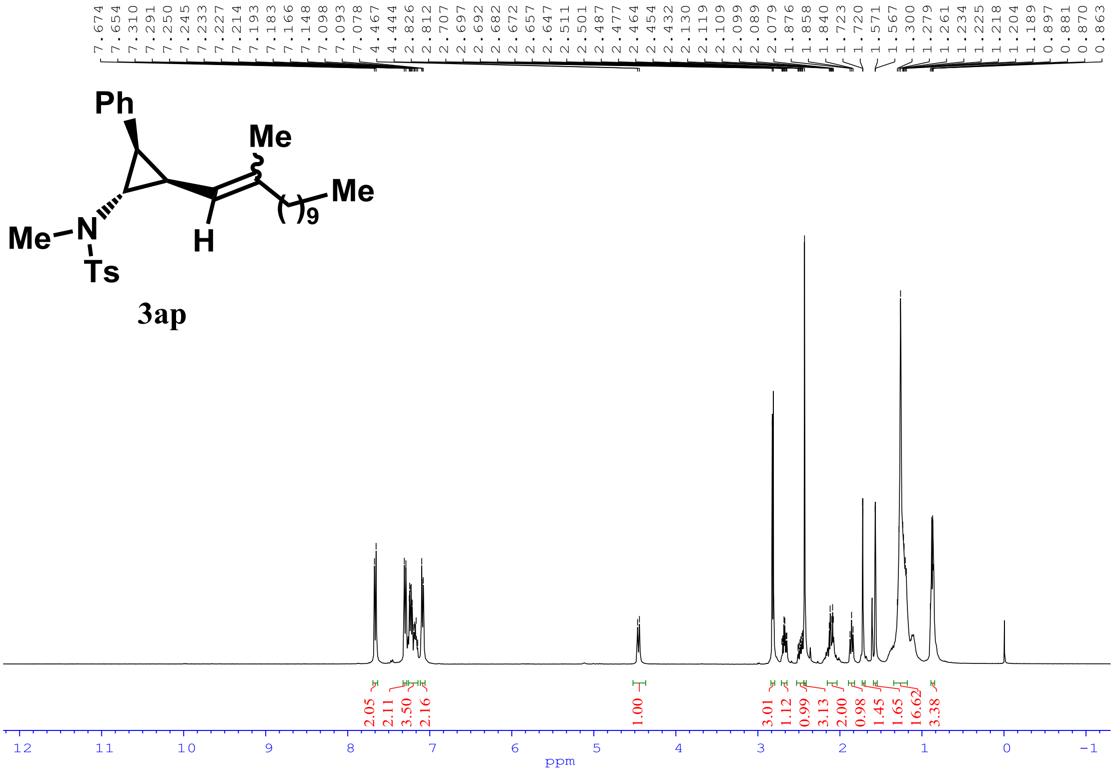


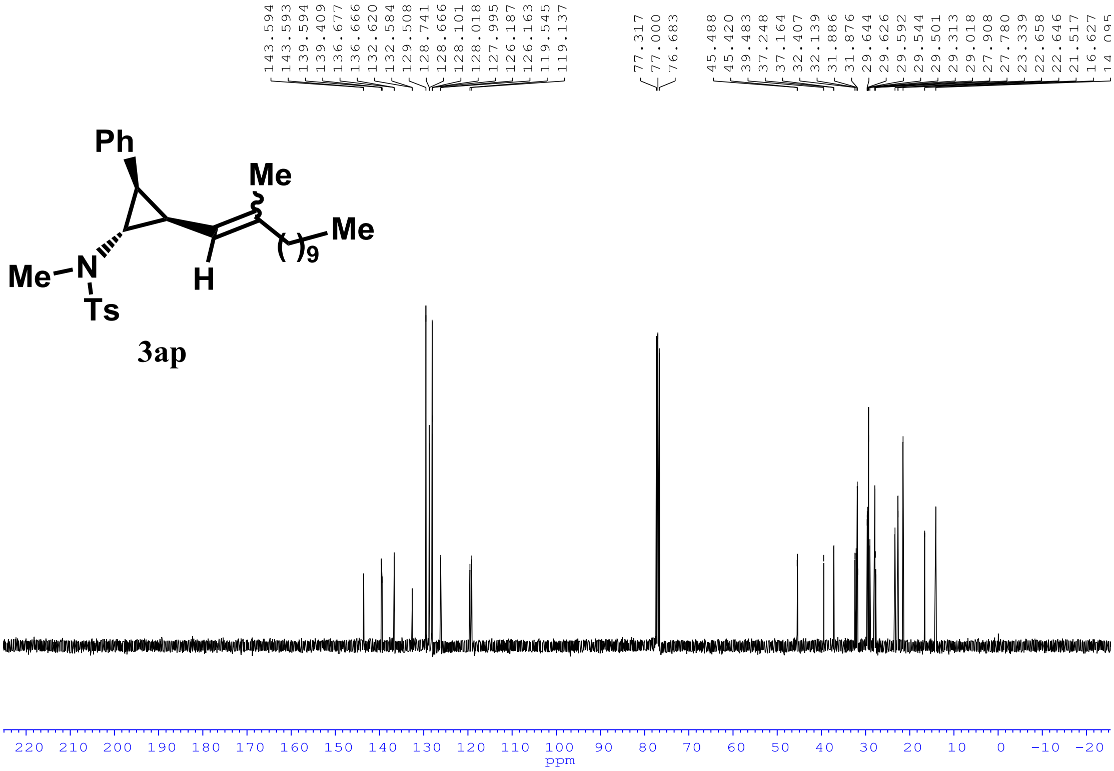
3an

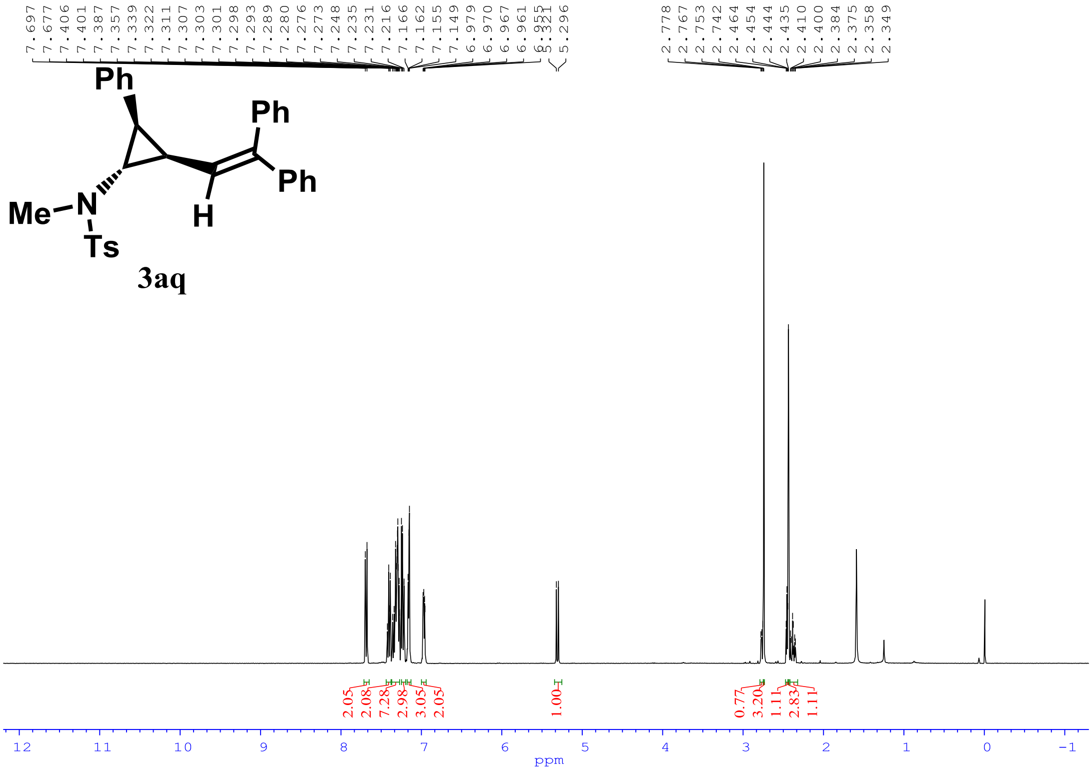
150.349
150.265
143.745
143.606
142.495
140.707
136.615
136.309
132.878
132.424
129.611
129.531
128.814
128.781
128.678
128.362
128.077
128.060
128.001
127.431
126.614
126.394
126.309
126.291
123.560
120.054
77.318
77.000
76.682
46.008
45.685
37.297
36.857
35.818
32.723
32.439
29.959
27.783
27.577
21.822
21.671
21.541
21.371
Ph
Me
Me
Ph
Me
N
Ts
H
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

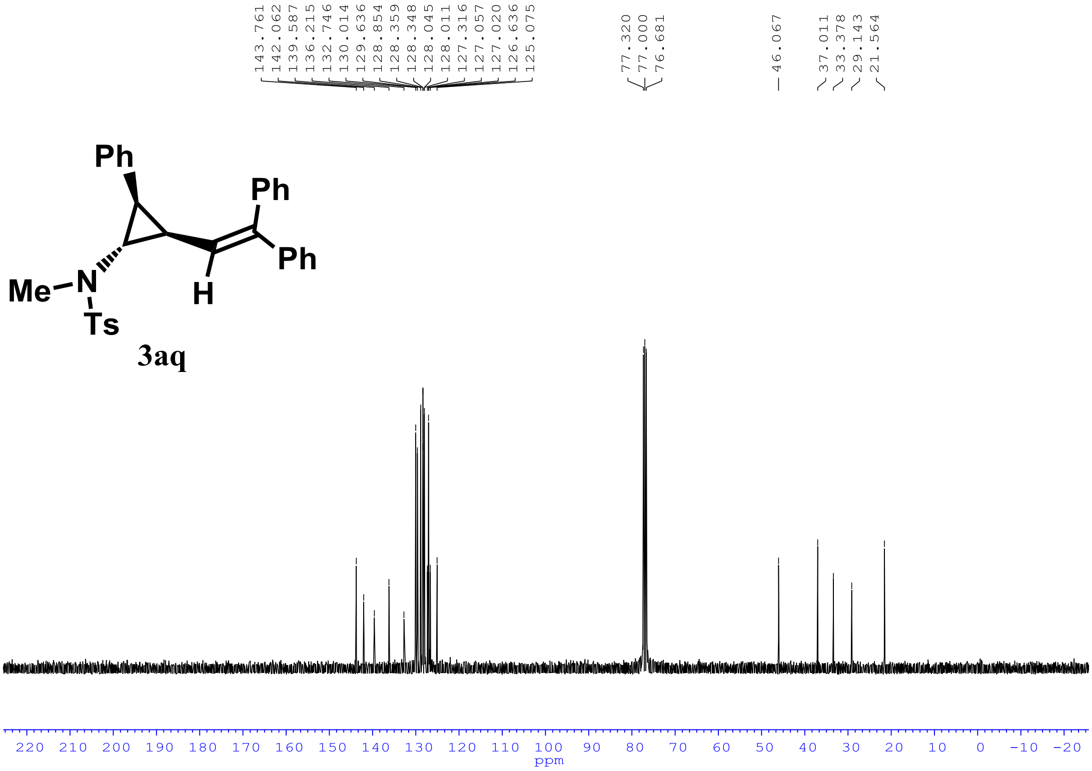

7.698
7.677
7.651
7.631
7.346
7.289
7.270
7.228
7.210
7.170
7.152
7.115
7.097
6.950
6.944
6.931
6.926
4.721
4.718
4.697
4.694
4.660
4.639
3.162
2.848
2.746
2.609
2.563
2.541
2.518
2.432
2.416
2.254
2.244
2.234
2.187
2.177
2.167
2.050
2.041
2.025
2.016
2.000
1.991
1.585
1.434
1.242
1.167
1.114
-0.01
Ph
Ph
Me
N
Ts
H
3ao
2.13
6.14
5.73
0.33
0.85
0.15
0.11
0.52
0.29
2.69
0.74
0.86
3.23
1.06
0.87
0.14
5.86
2.12
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
ppm

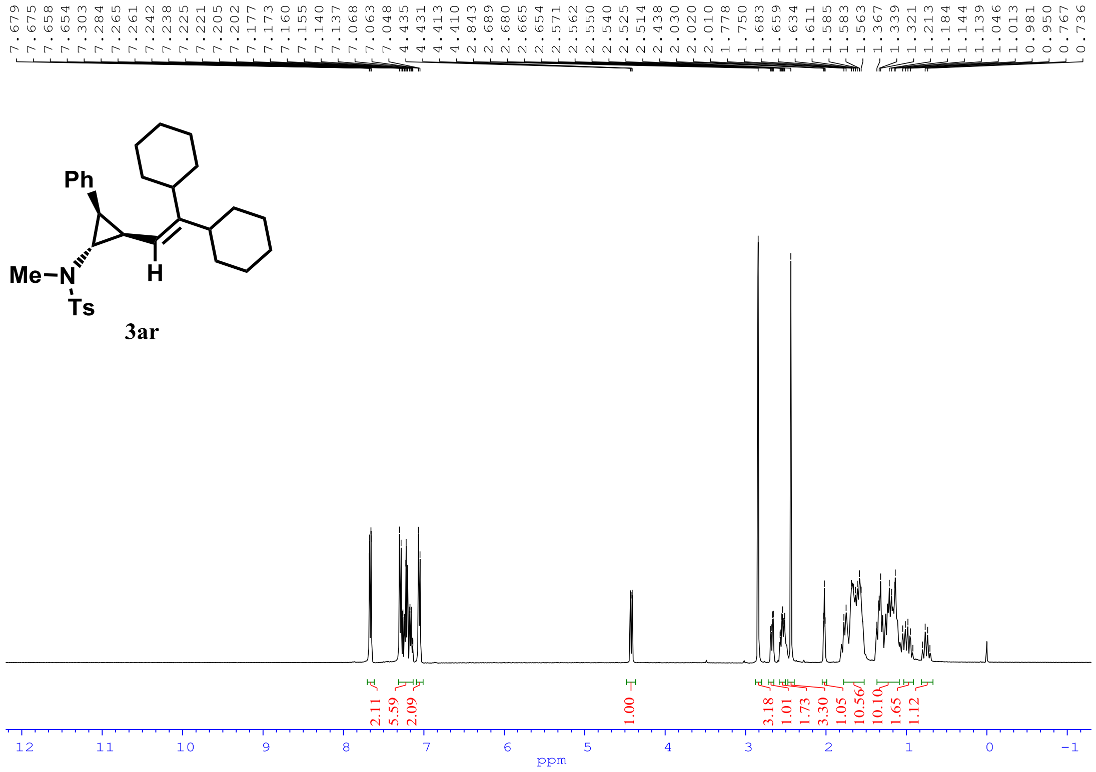

147.409
143.606
141.081
136.661
132.888
129.533
128.760
128.696
128.106
128.064
128.024
126.564
126.311
120.499
77.318
77.001
76.682
48.087
45.653
36.847
32.832
31.543
31.241
27.740
24.256
24.190
21.560
Ph
Ph
Me
N
Ts
H
3ao
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


7.674
7.654
7.310
7.291
7.250
7.245
7.233
7.227
7.214
7.193
7.183
7.166
7.148
7.098
7.093
7.078
4.467
4.444
2.826
2.812
2.707
2.697
2.692
2.682
2.672
2.657
2.647
2.511
2.501
2.487
2.477
2.464
2.454
2.432
2.130
2.119
2.109
2.099
2.089
2.079
1.876
1.858
1.840
1.723
1.720
1.571
1.567
1.300
1.279
1.261
1.234
1.225
1.218
1.204
1.189
0.897
0.881
0.870
0.863
Ph
Me
Me
Me
N
Ts
H
9
3ap
2.05
2.11
3.50
2.16
1.00
3.01
1.12
0.99
3.13
2.00
0.98
1.45
1.65
16.62
3.38
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

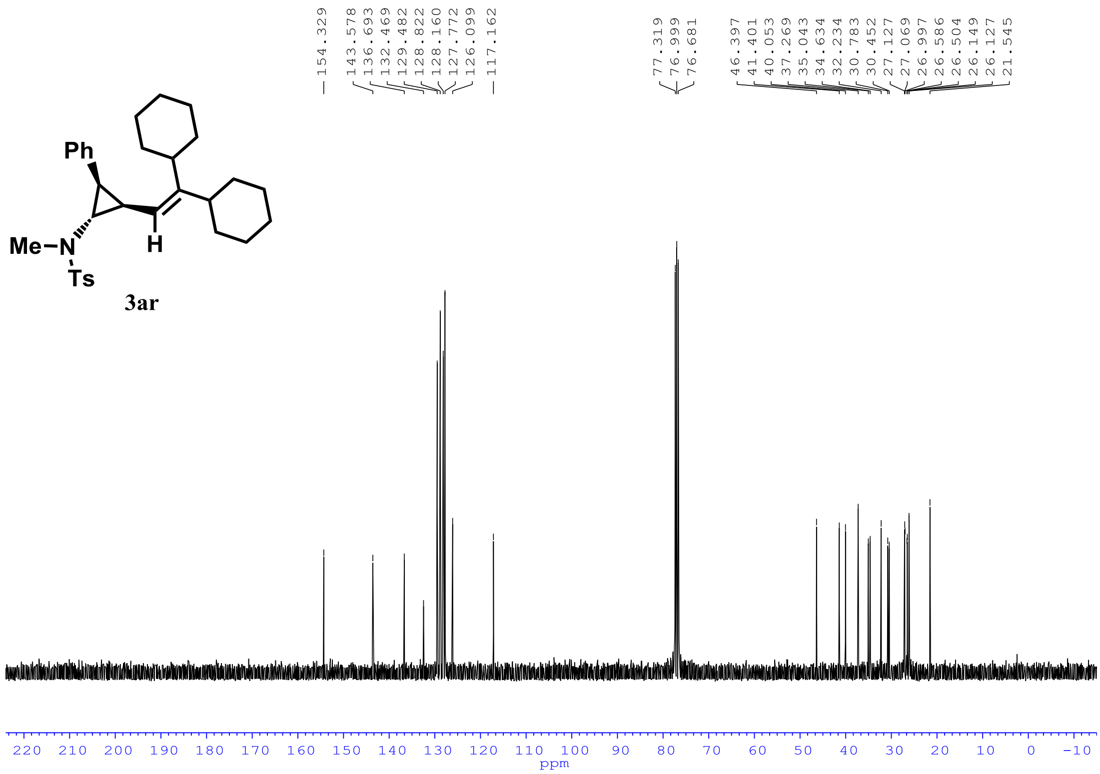

143.594
143.593
139.594
139.409
136.677
136.666
132.620
132.584
129.508
128.741
128.666
128.101
128.018
127.995
126.187
126.163
119.545
119.137
77.317
77.000
76.683
45.488
45.420
39.483
37.248
37.164
32.407
32.139
31.886
31.876
29.644
29.626
29.592
29.544
29.501
29.313
29.018
27.908
27.780
23.339
22.658
22.646
21.517
16.627
14.095
Ph
Me
Me
Me
N
Ts
H
9
3ap
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


7.697
7.677
7.406
7.401
7.387
7.357
7.339
7.322
7.311
7.307
7.303
7.301
7.298
7.293
7.289
7.280
7.276
7.273
7.248
7.235
7.231
7.216
7.166
7.162
7.155
7.149
6.979
6.970
6.967
6.961
6.955
5.321
5.296
2.778
2.767
2.753
2.742
2.464
2.454
2.444
2.435
2.410
2.400
2.384
2.375
2.358
2.349
Ph
Ph
Ph
Me
N
Ts
H
3aq
2.05
2.08
7.28
2.98
3.05
2.05
1.00
0.77
3.20
1.11
2.83
1.11
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

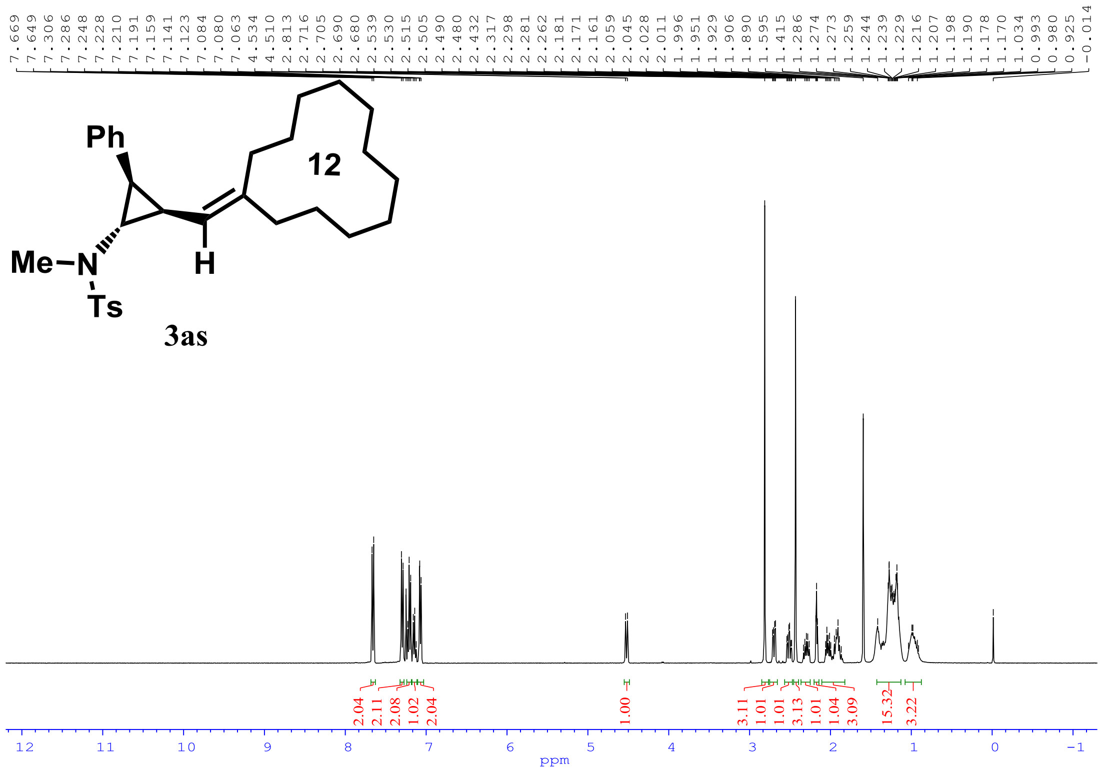

143.761
142.062
139.587
136.215
132.746
130.014
129.636
128.854
128.359
128.348
128.045
128.011
127.316
127.057
127.020
126.636
125.075
77.320
77.000
76.681
46.067
37.011
33.378
29.143
21.564
Ph
Ph
Ph
Me
N
Ts
H
3aq
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

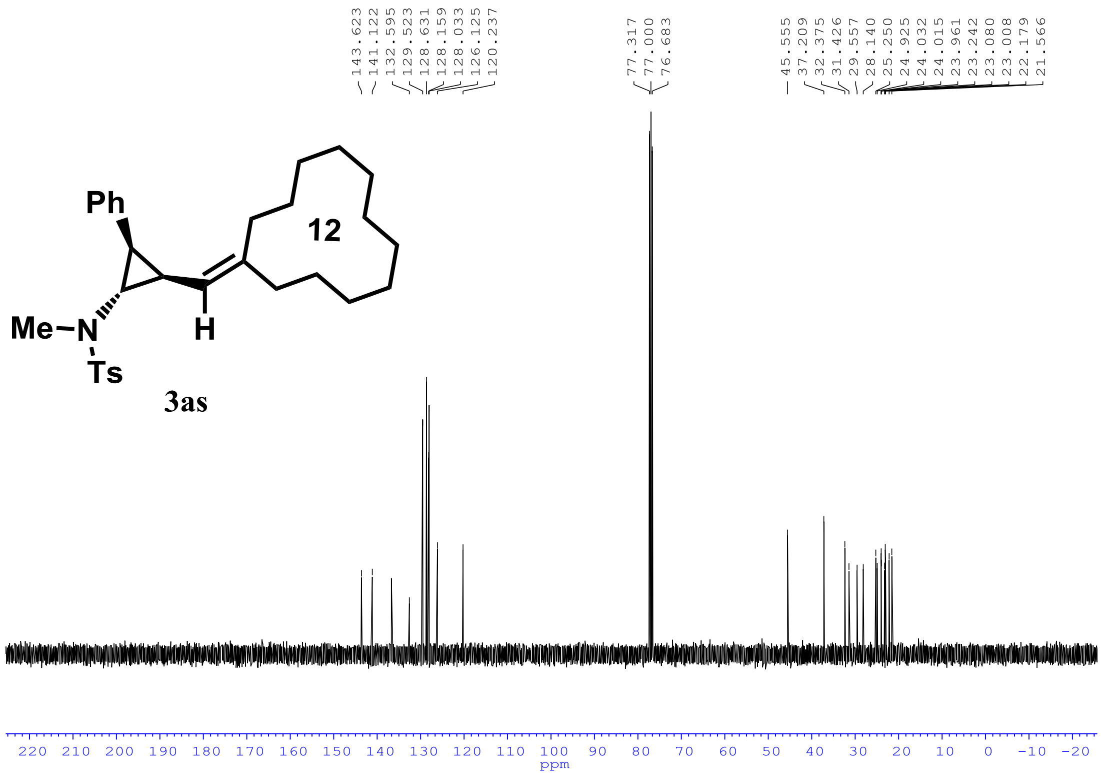

7.679
7.675
7.658
7.654
7.303
7.284
7.265
7.261
7.242
7.238
7.225
7.221
7.205
7.202
7.177
7.173
7.160
7.155
7.140
7.137
7.068
7.063
7.048
4.435
4.431
4.413
4.410
2.843
2.689
2.680
2.665
2.654
2.571
2.562
2.550
2.540
2.525
2.514
2.438
2.030
2.020
2.010
1.778
1.750
1.683
1.659
1.634
1.611
1.585
1.583
1.563
1.367
1.339
1.321
1.213
1.184
1.144
1.139
1.046
1.013
0.981
0.950
0.767
0.736
Ph
Me–N
Ts
H
2.11
5.59
2.09
1.00
3.18
1.01
1.73
3.30
1.05
10.56
10.10
1.65
1.12
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

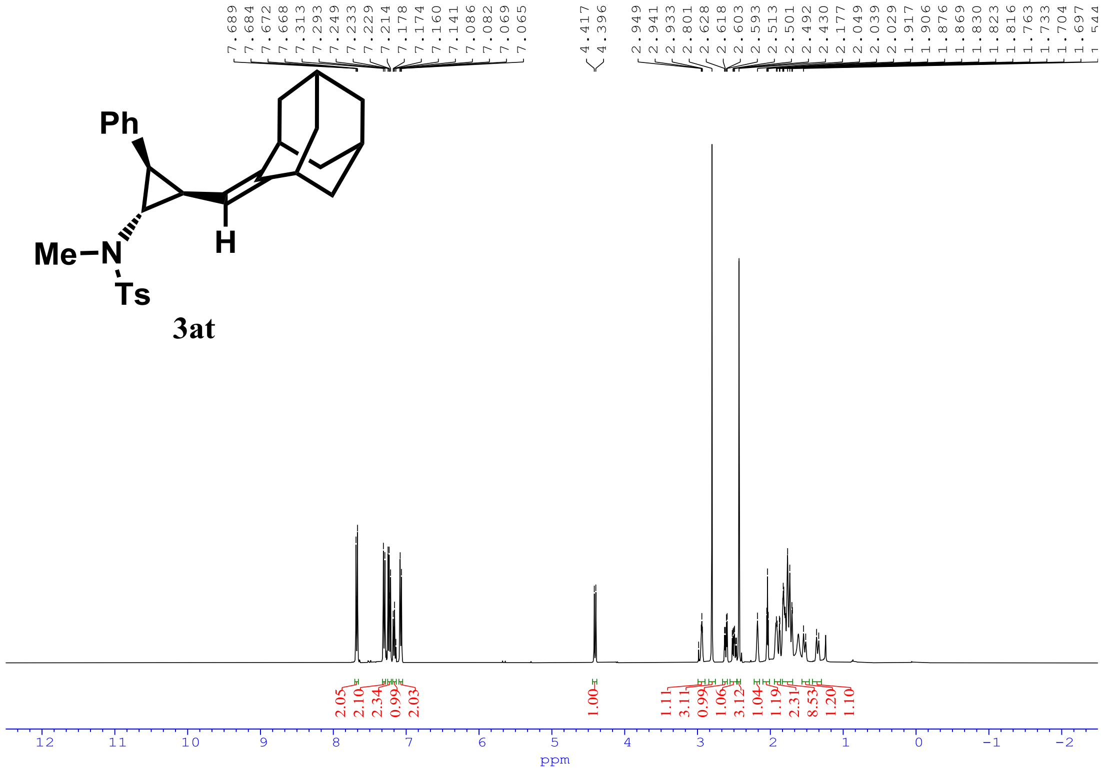
3ar

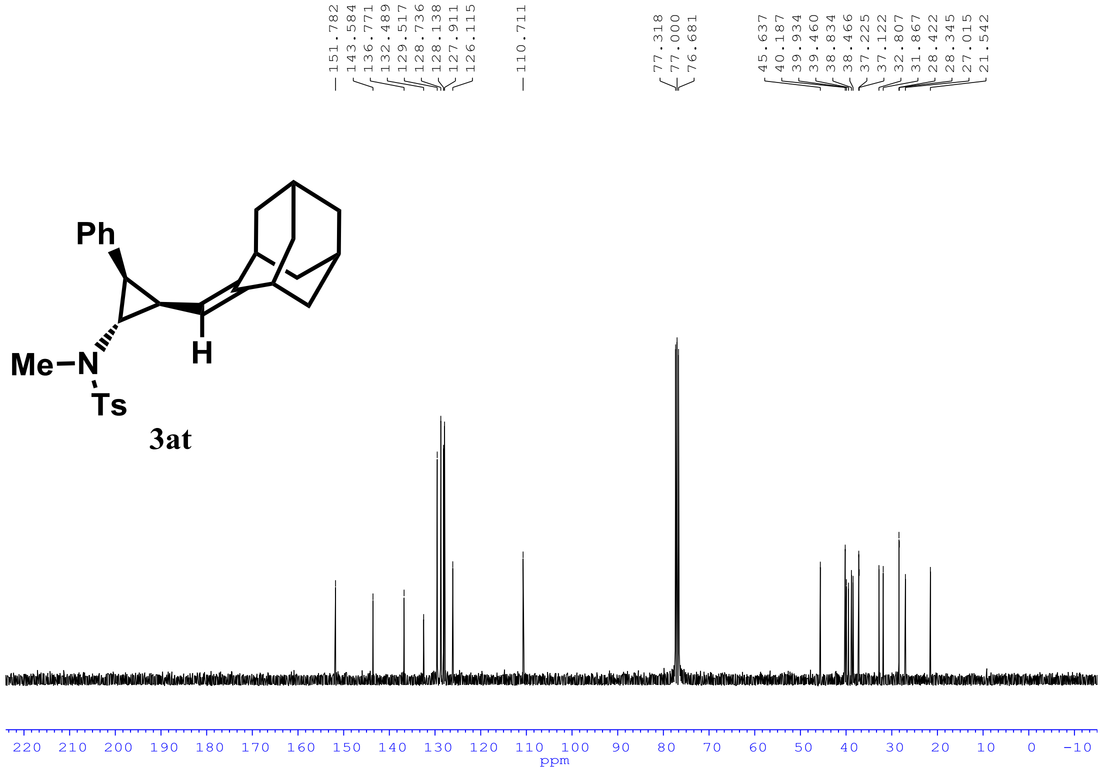

154.329
143.578
136.693
132.469
129.482
128.822
128.160
127.772
126.099
117.162
77.319
76.999
76.681
46.397
41.401
40.053
37.269
35.043
34.634
32.234
30.783
30.452
27.127
27.069
26.997
26.586
26.504
26.149
26.127
21.545
Ph
Me–N
Ts
H
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm

3ar

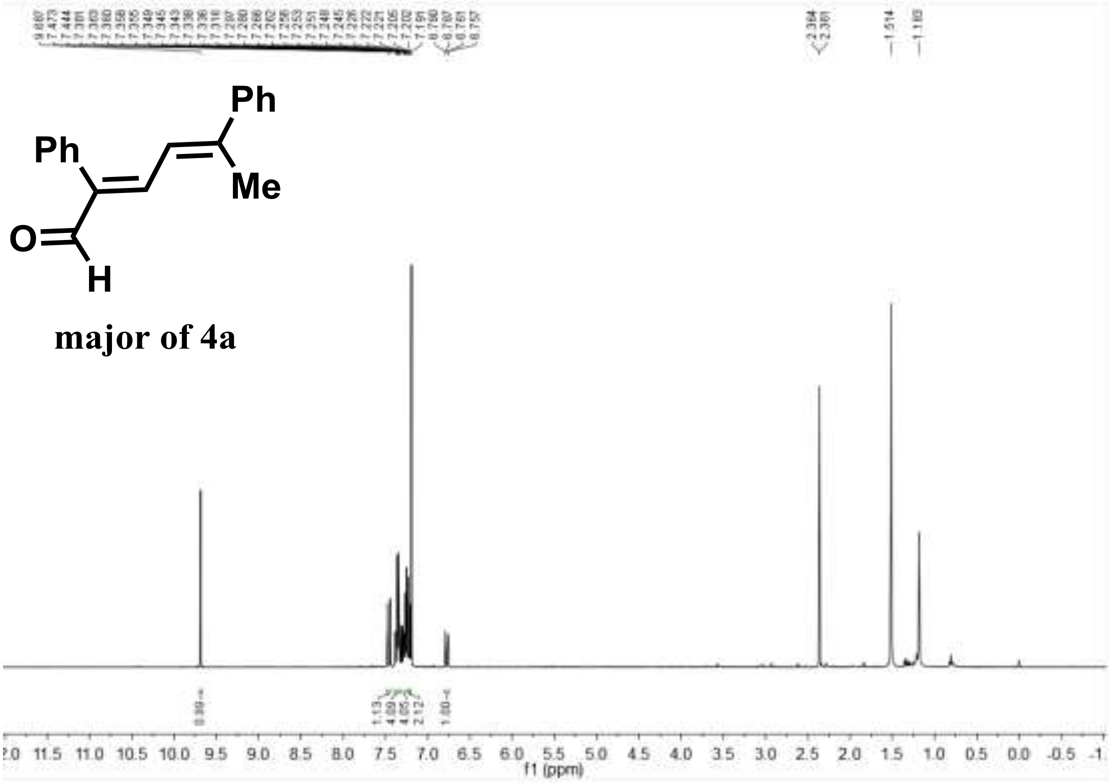

7.669
7.649
7.306
7.286
7.248
7.228
7.210
7.191
7.159
7.141
7.123
7.084
7.080
7.063
4.534
4.510
2.813
2.716
2.705
2.690
2.680
2.539
2.530
2.515
2.505
2.490
2.480
2.432
2.317
2.298
2.281
2.262
2.181
2.171
2.161
2.059
2.045
2.028
2.011
1.996
1.951
1.929
1.906
1.890
1.595
1.415
1.286
1.274
1.273
1.259
1.244
1.239
1.229
1.216
1.207
1.198
1.190
1.178
1.170
1.034
0.993
0.980
0.925
-0.014
Ph
12
Me
N
Ts
H
3as
2.04
2.11
2.08
1.02
2.04
1.00
3.11
1.01
1.01
3.13
1.01
1.04
3.09
15.32
3.22
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

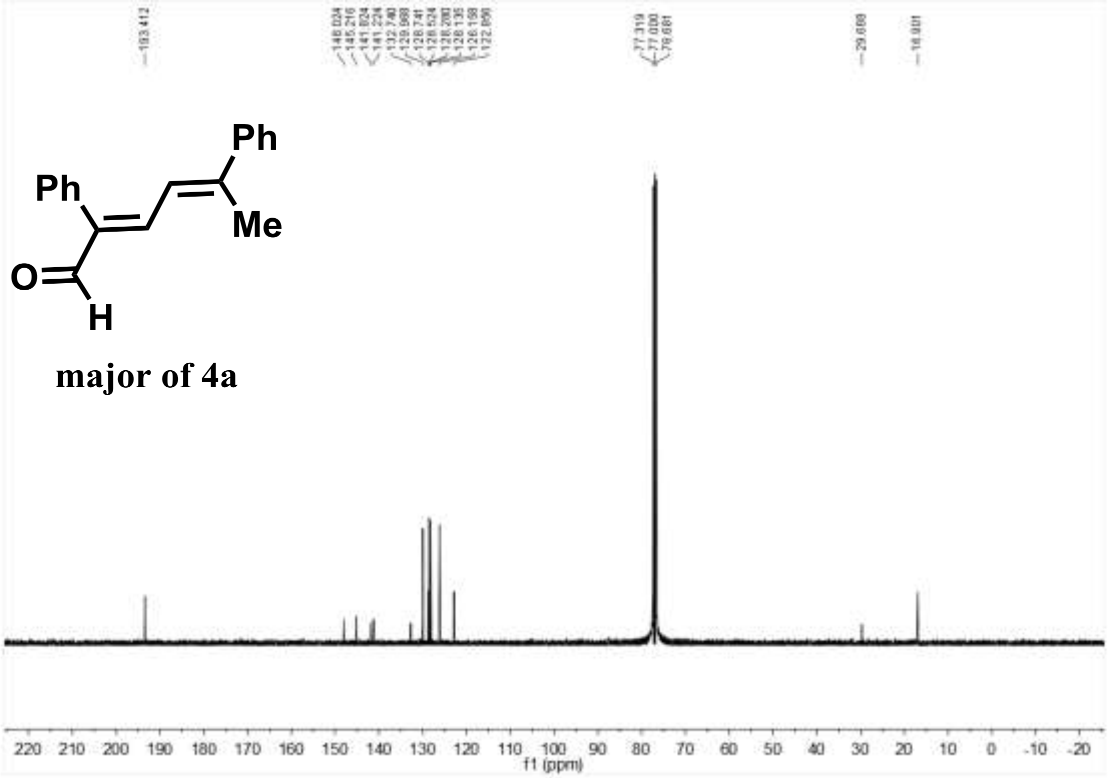

143.623
141.122
132.595
129.523
128.631
128.159
128.033
126.125
120.237
77.317
77.000
76.683
45.555
37.209
32.375
31.426
29.557
28.140
25.250
24.925
24.032
24.015
23.961
23.242
23.080
23.008
22.179
21.566
Ph
12
Me
N
Ts
H
3as
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

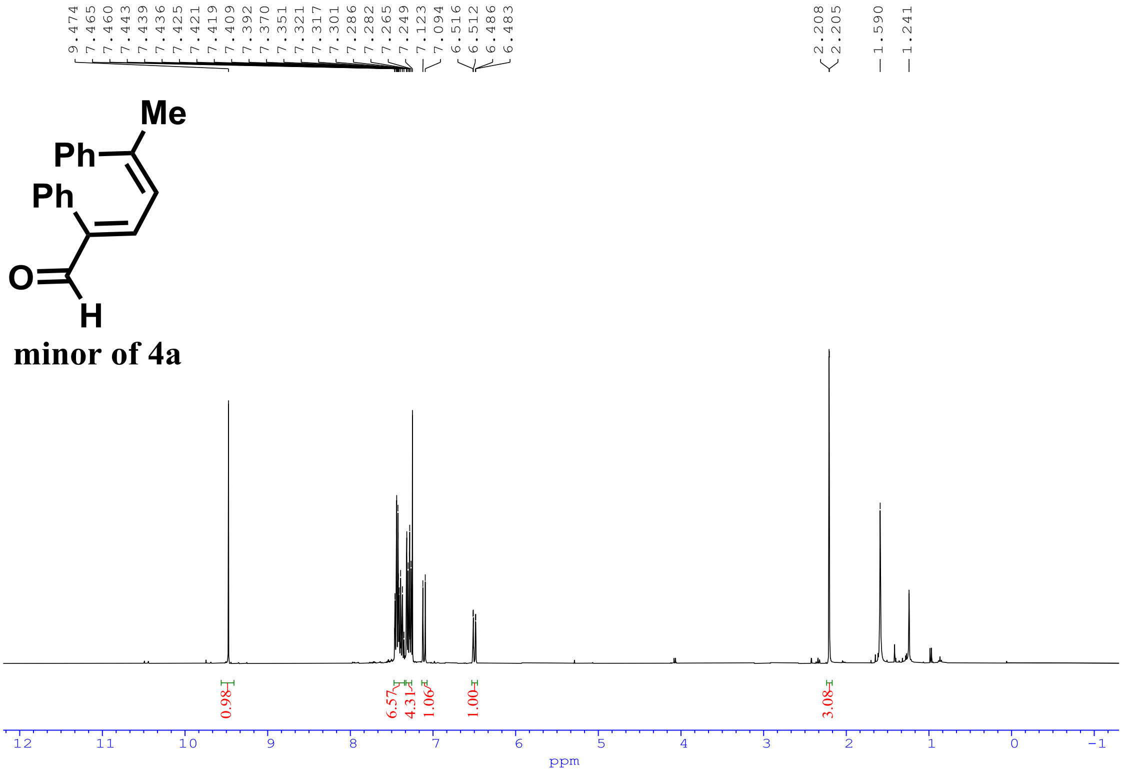

7.689
7.684
7.672
7.668
7.313
7.293
7.249
7.233
7.229
7.214
7.178
7.174
7.160
7.141
7.086
7.082
7.069
7.065
4.417
4.396
2.949
2.941
2.933
2.801
2.628
2.618
2.603
2.593
2.513
2.501
2.492
2.430
2.177
2.049
2.039
2.029
1.917
1.906
1.876
1.869
1.830
1.823
1.816
1.763
1.733
1.704
1.697
Ph
Me−N
Ts
H
3at
2.05
2.10
2.34
0.99
2.03
1.00
1.11
3.11
0.99
1.06
3.12
1.04
1.19
2.31
8.53
1.20
1.10
12
11
10
9
8
7
6
5
4
3
2
1
0
−1
−2
ppm

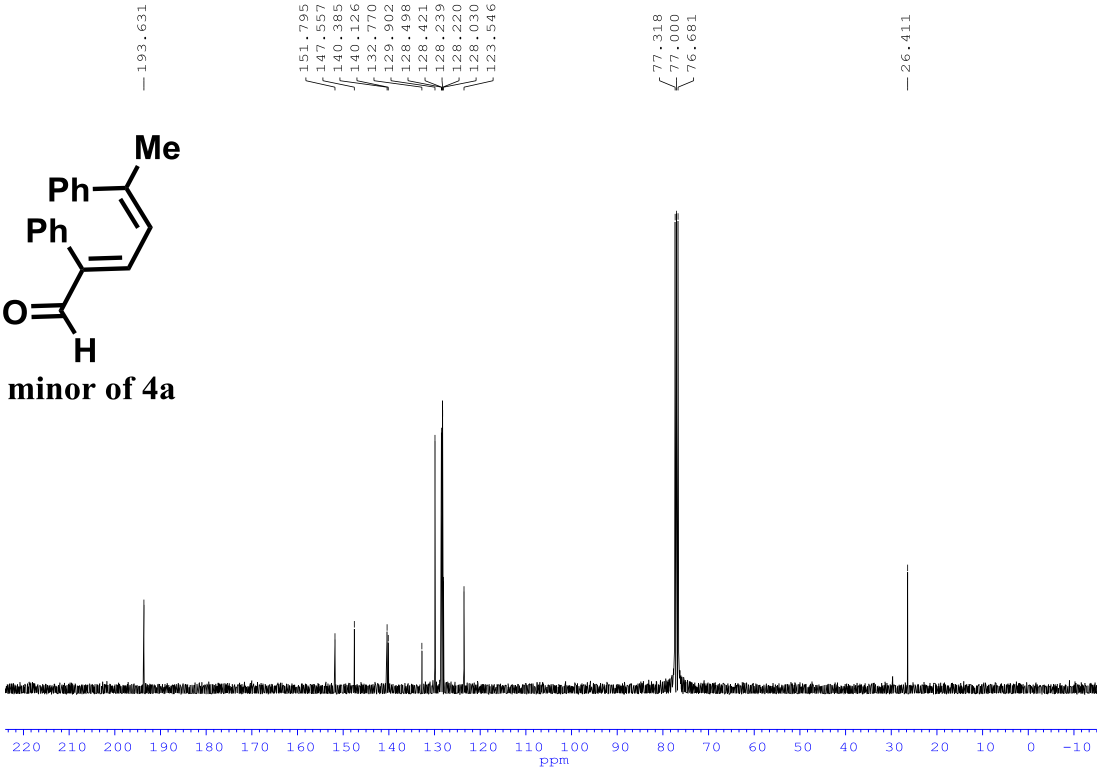

151.782
143.584
136.771
132.489
129.517
128.736
128.138
127.911
126.115
110.711
77.318
77.000
76.681
45.637
40.187
39.934
39.460
38.834
38.466
37.225
37.122
32.807
31.867
28.422
28.345
27.015
21.542
Ph
Me−N
Ts
H
3at
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
−10
ppm

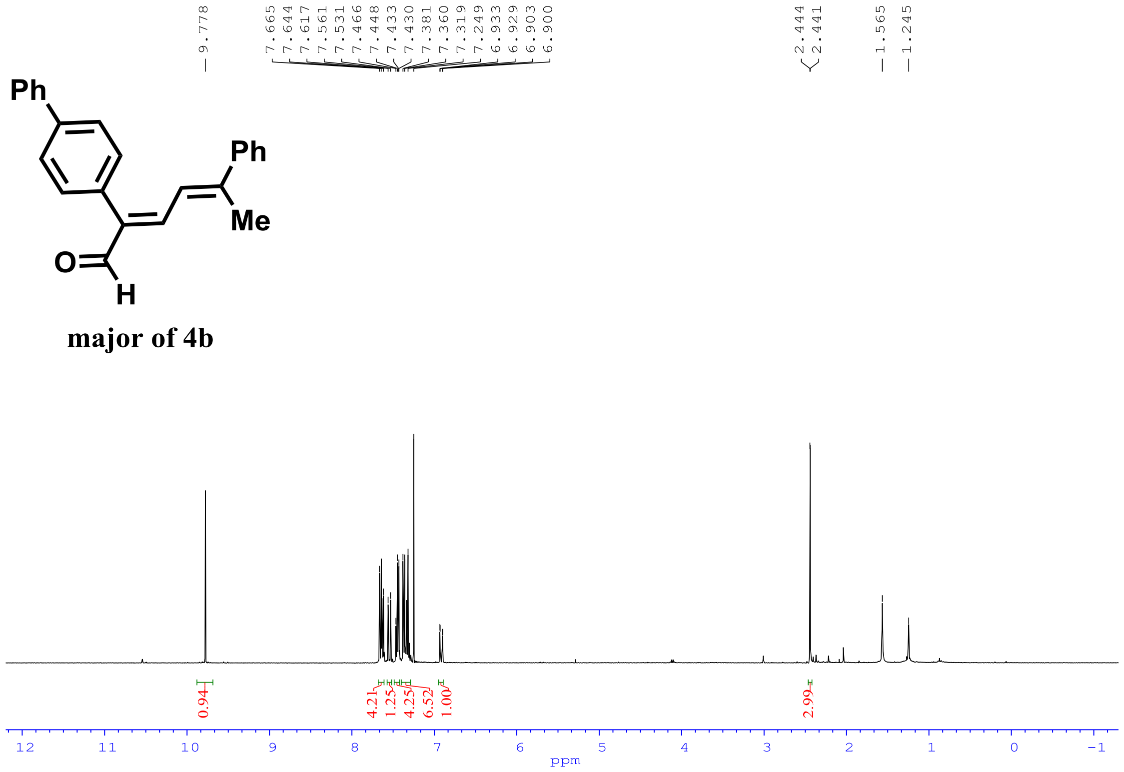
NMR Spectra for 1,3-diene aldehydes:



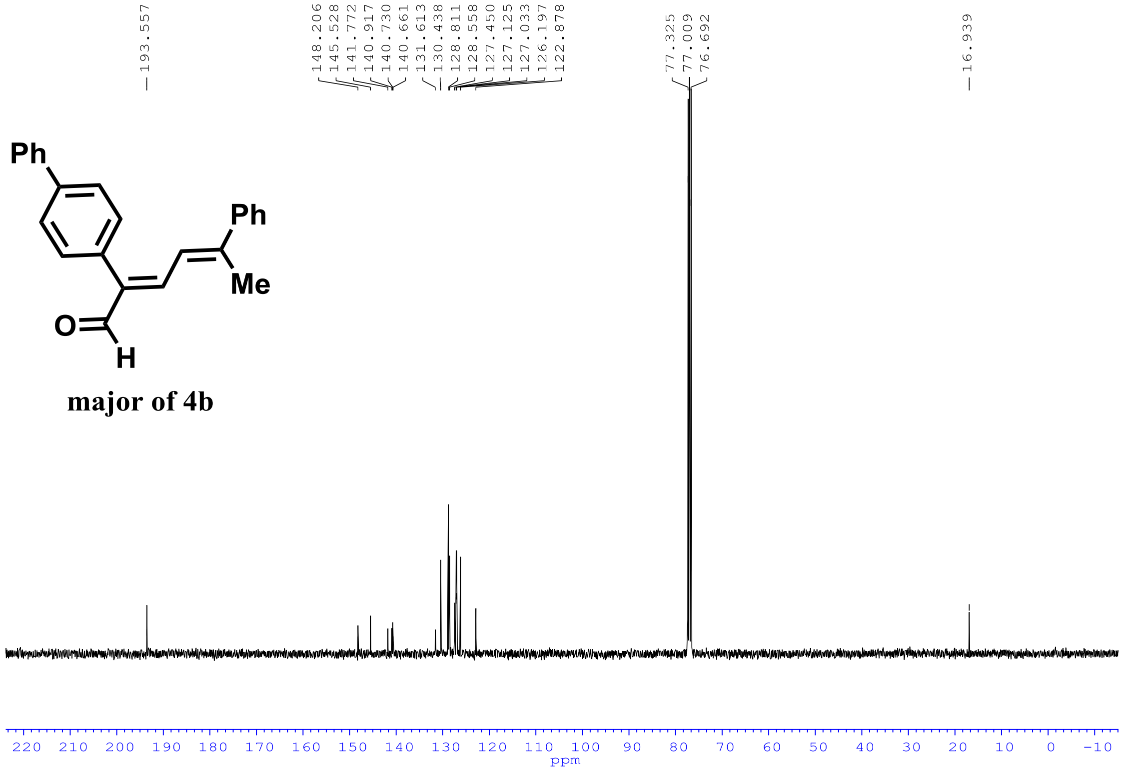



9.474
7.465
7.460
7.443
7.439
7.436
7.425
7.421
7.419
7.409
7.392
7.370
7.351
7.321
7.317
7.301
7.286
7.282
7.265
7.249
7.123
7.094
6.516
6.512
6.486
6.483
2.208
2.205
1.590
1.241
Me
Ph
Ph
O
H
minor of 4a
0.98
6.57
4.31
1.06
1.00
3.08
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

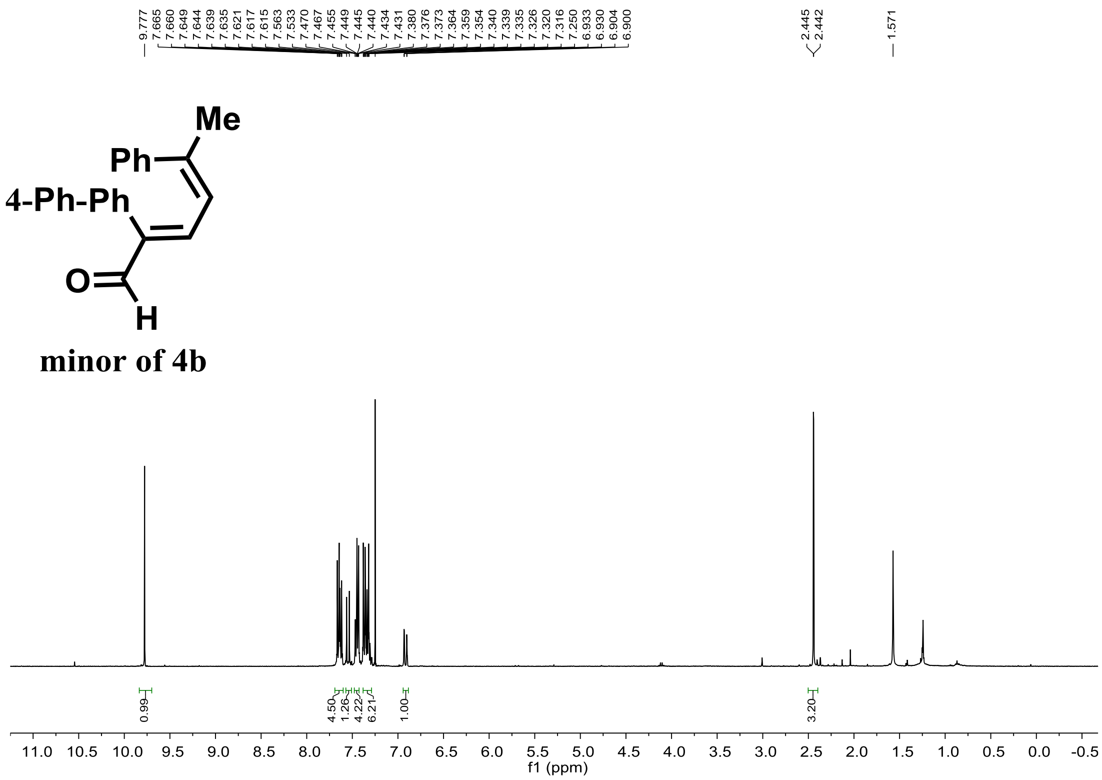

193.631
151.795
147.557
140.385
140.126
132.770
129.902
128.498
128.421
128.239
128.220
128.030
123.546
77.318
77.000
76.681
26.411
Me
Ph
Ph
O
H
minor of 4a
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
ppm



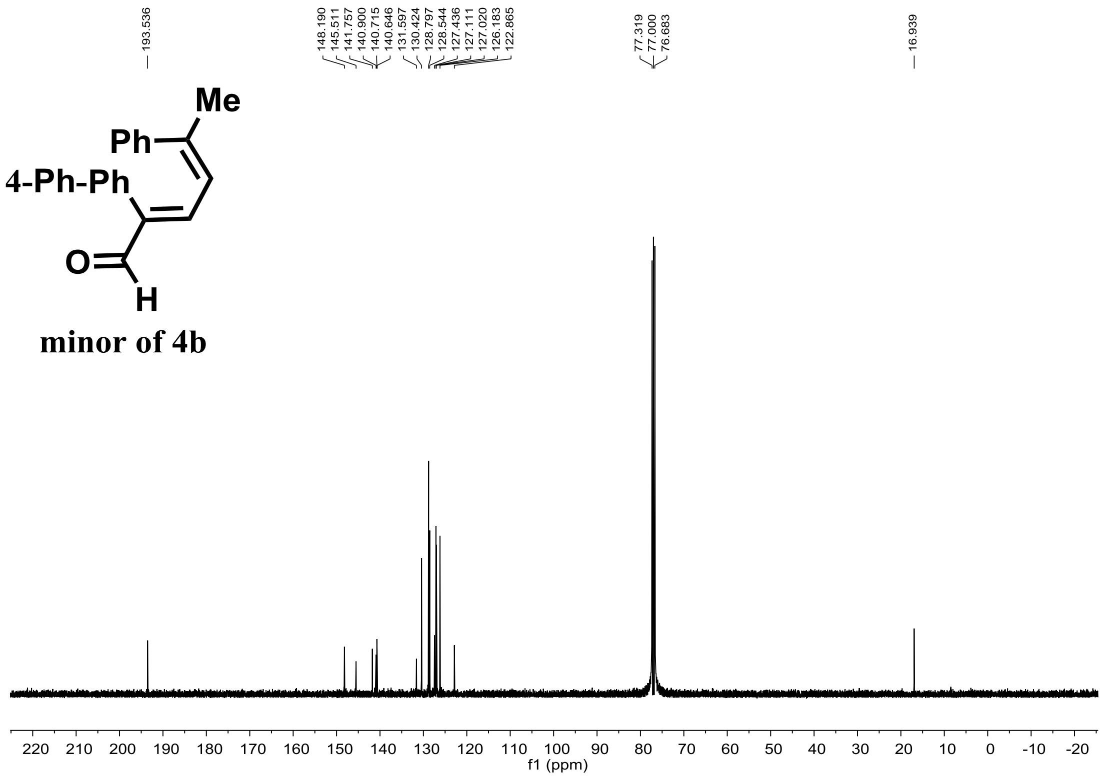
major of 4b



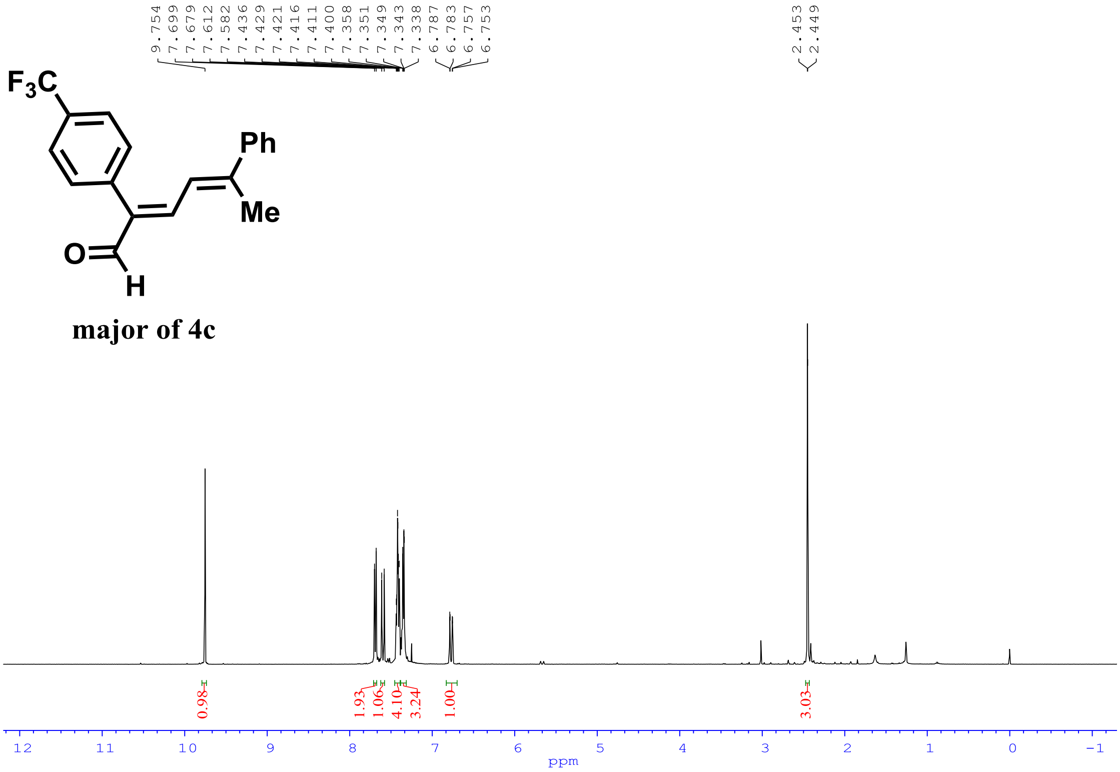
major of 4b



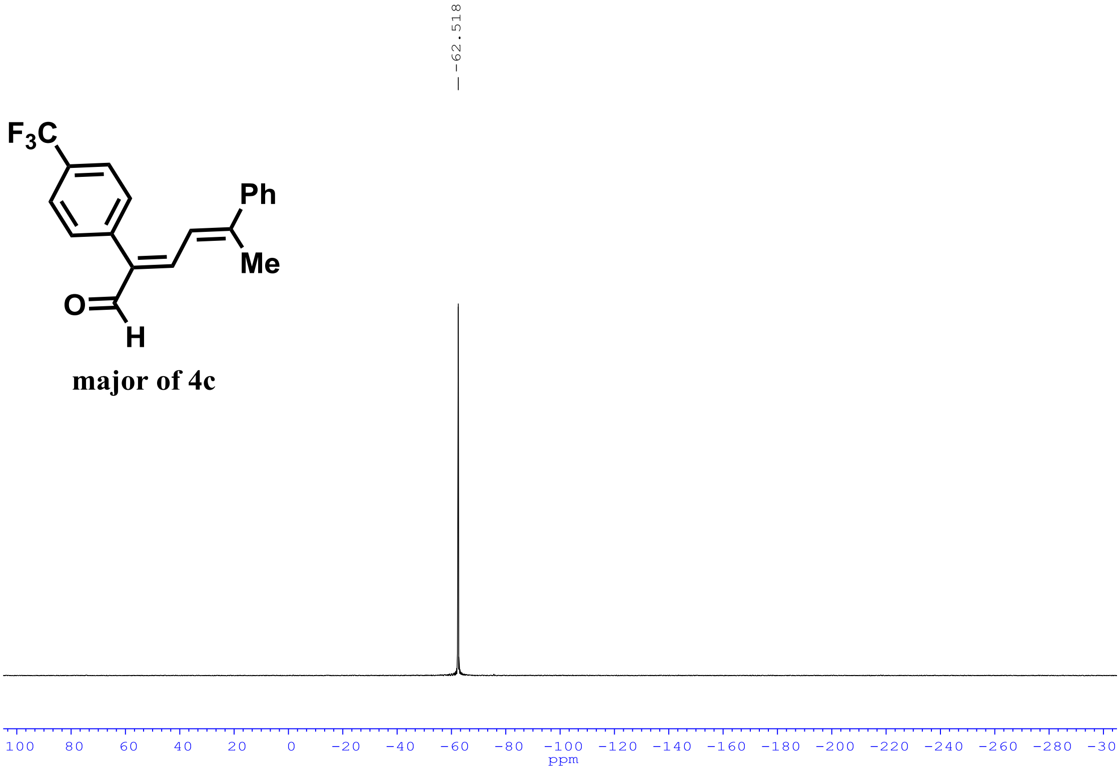
minor of 4b



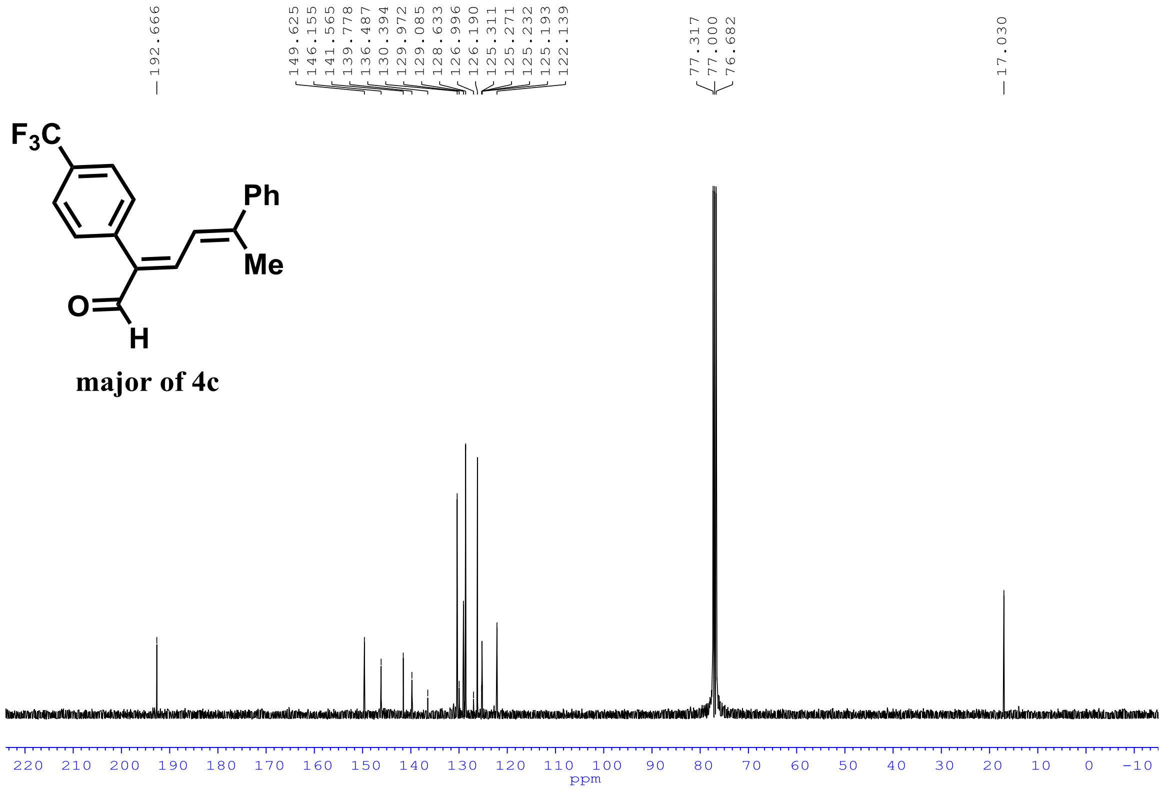
minor of 4b



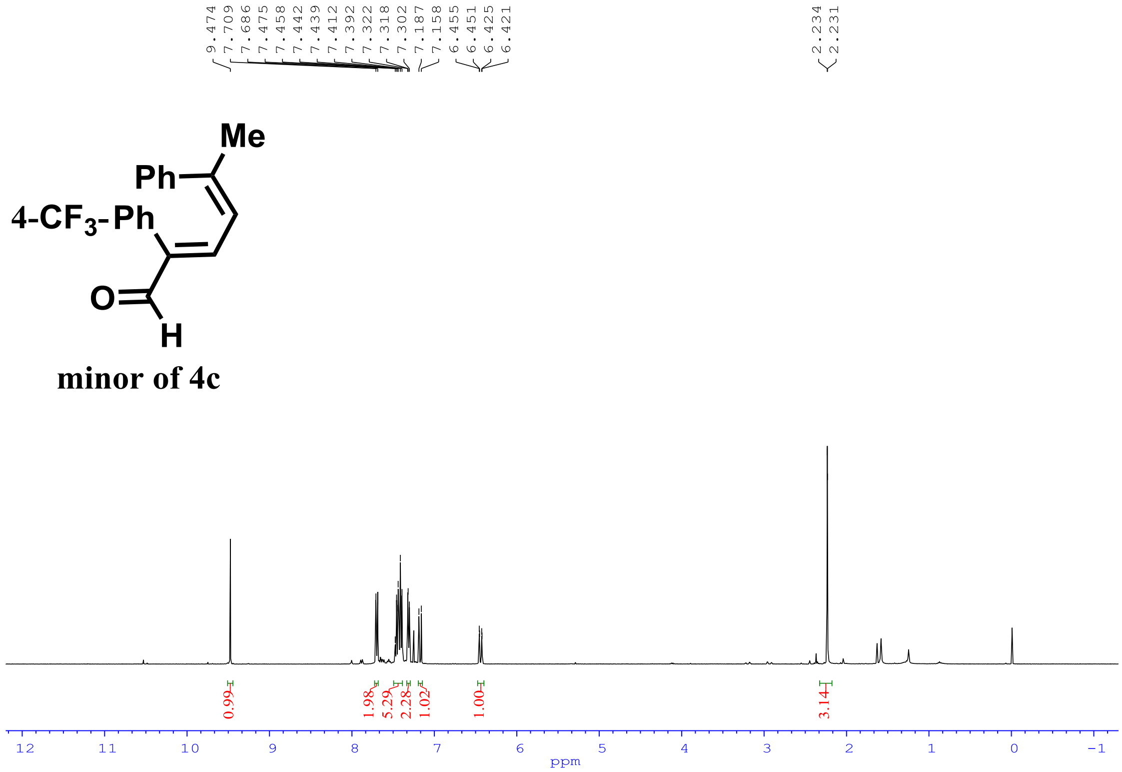
major of 4c



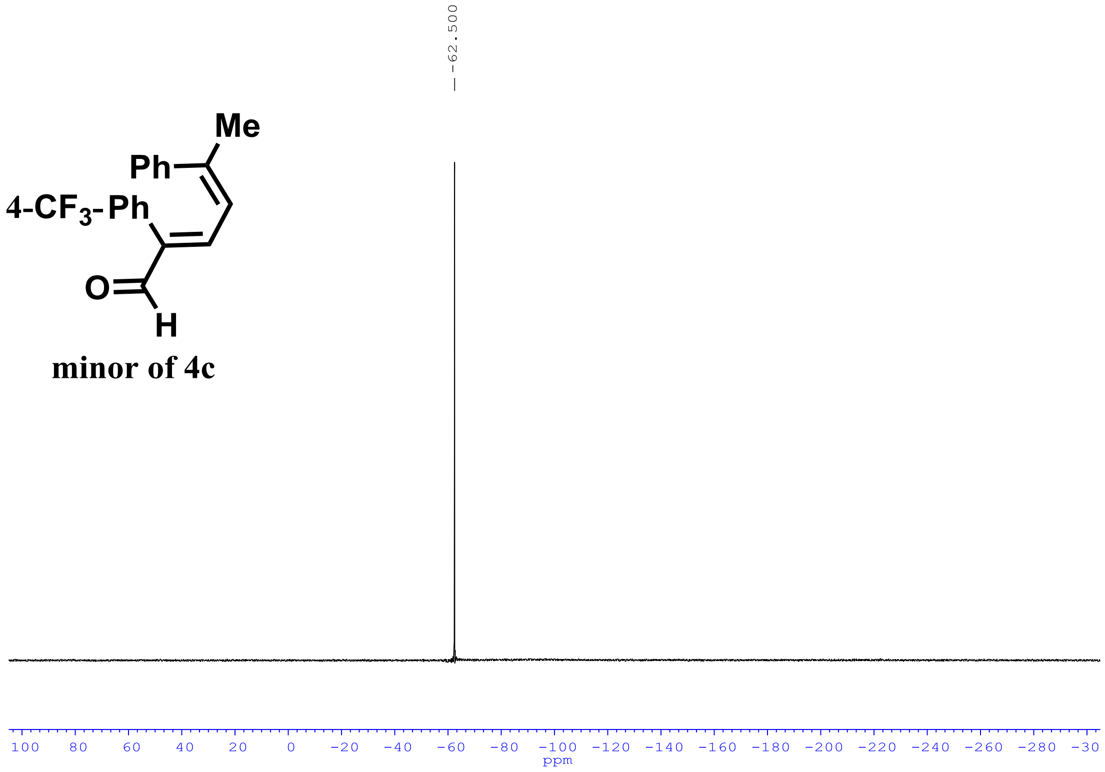
major of 4c



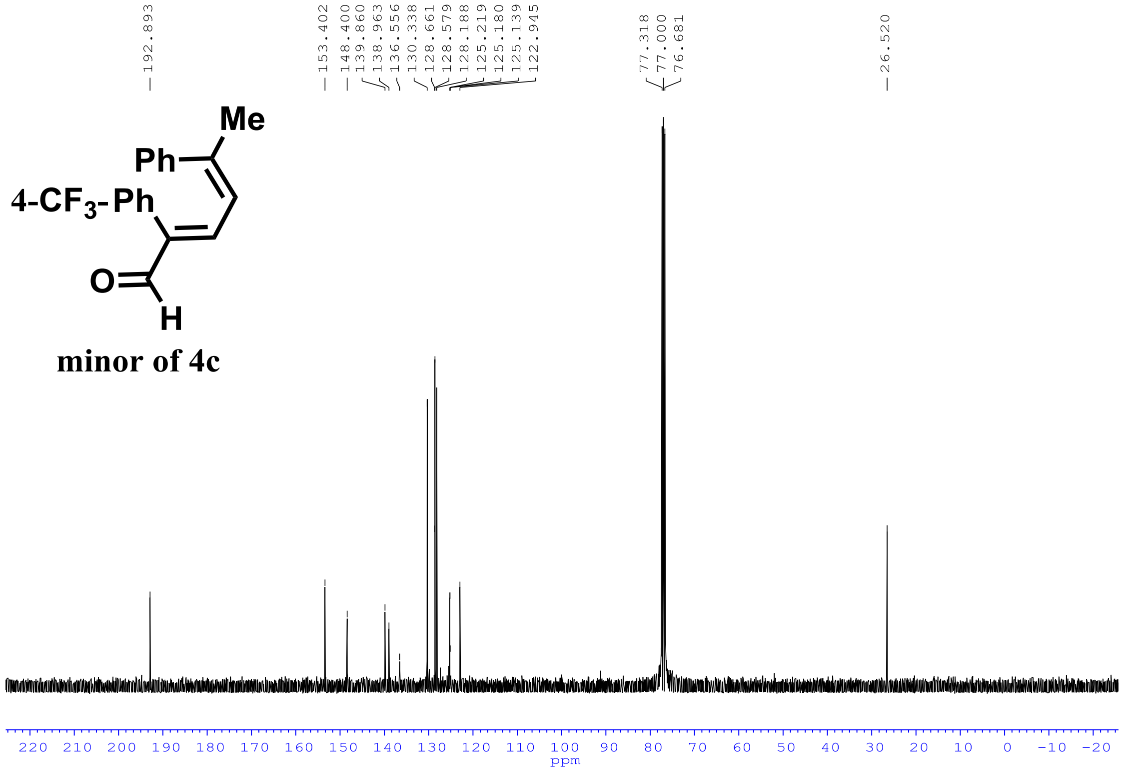
major of 4c



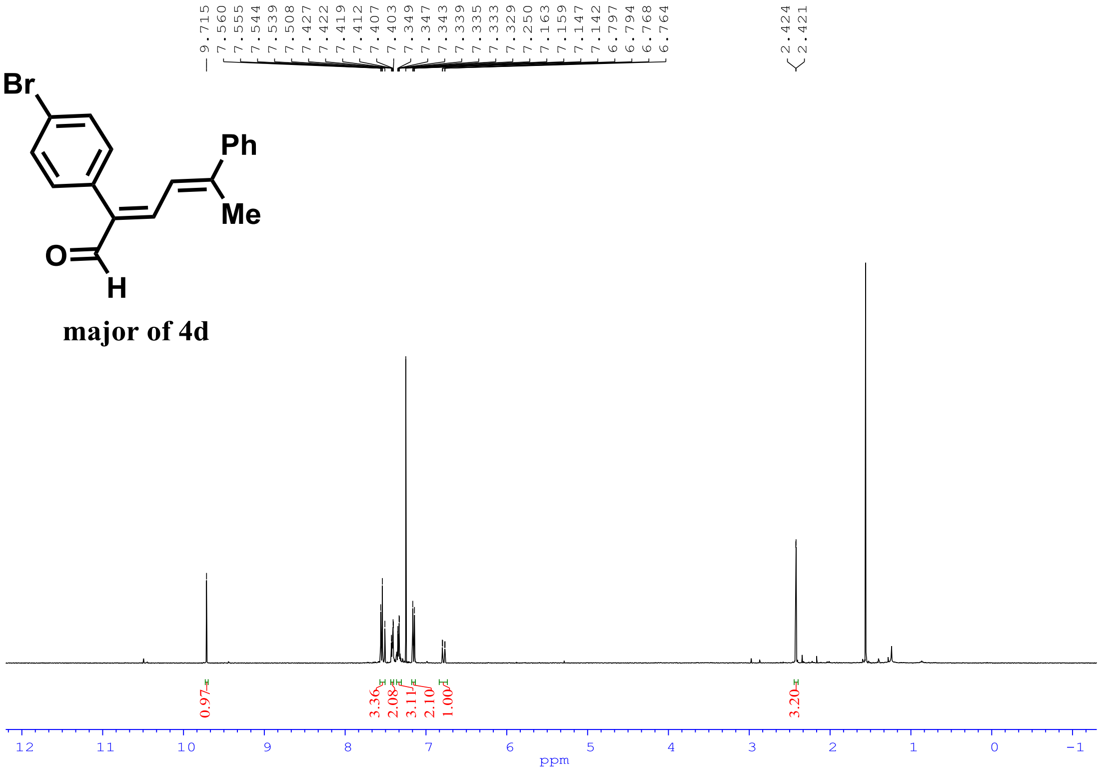
minor of 4c

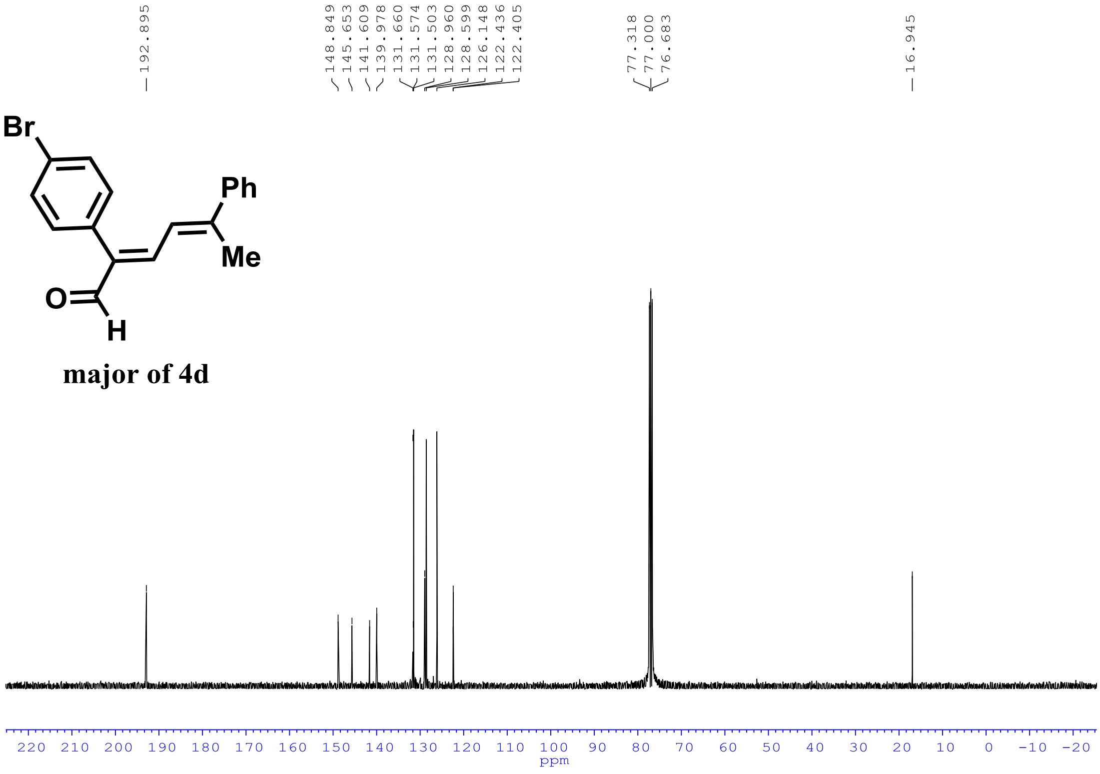


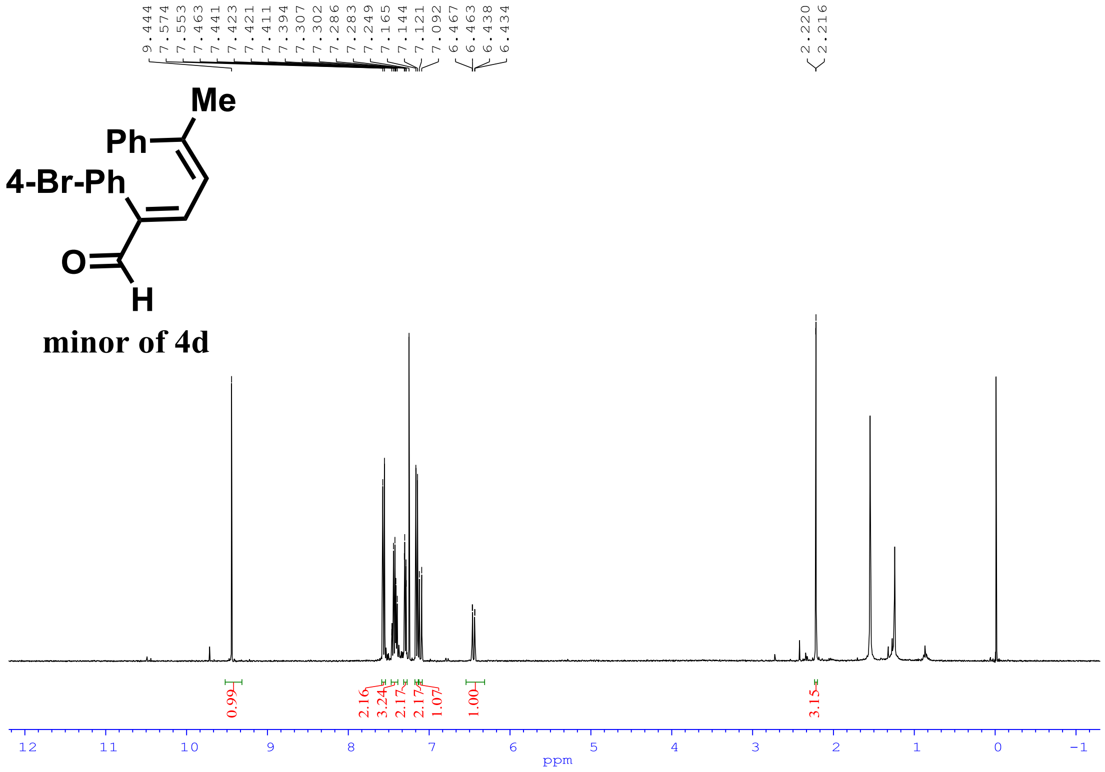
-62.500
Me
Ph
4-CF3-Ph
O
H
minor of 4c
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-30
ppm

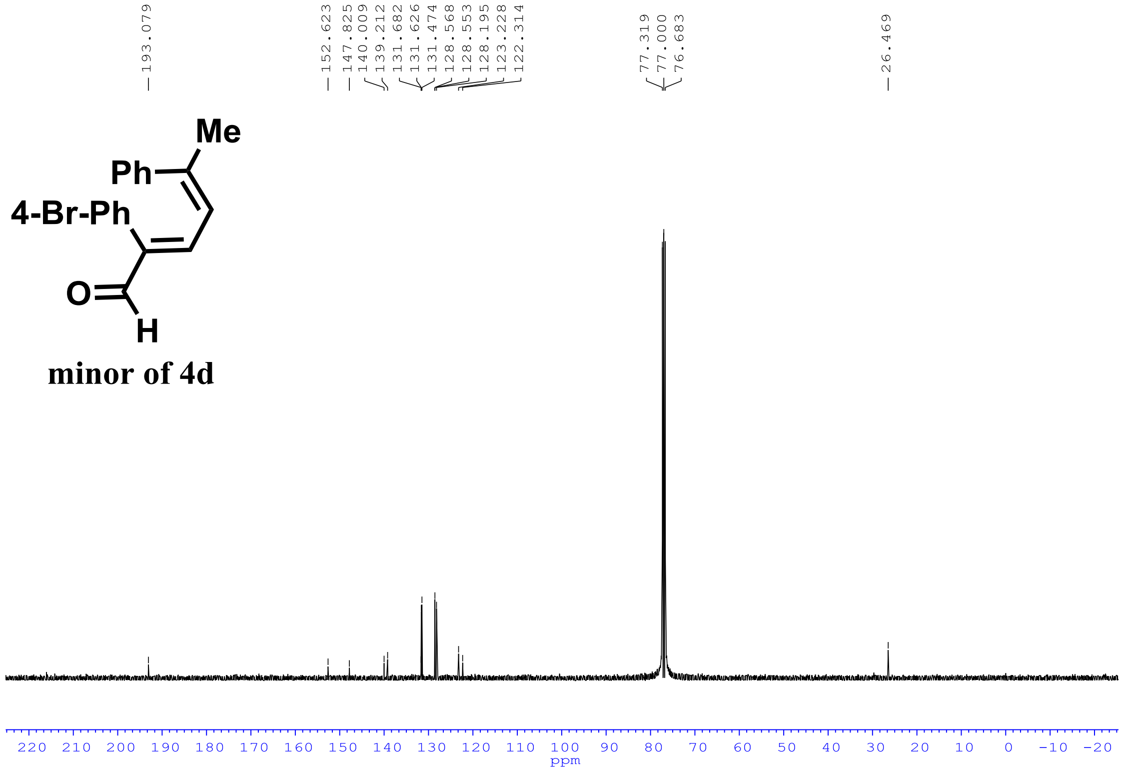


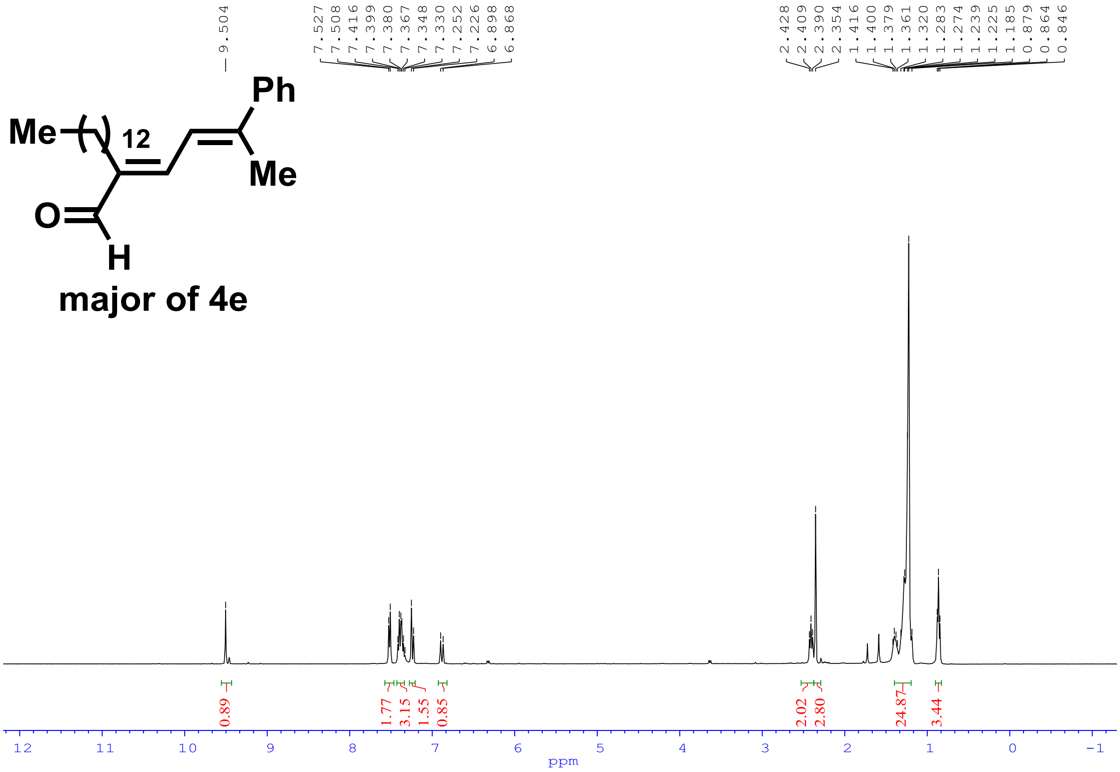
192.893
153.402
148.400
139.860
138.963
136.556
130.338
128.661
128.579
128.188
125.219
125.180
125.139
122.945
77.318
77.000
76.681
26.520
Me
Ph
4-CF3-Ph
O
H
minor of 4c
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

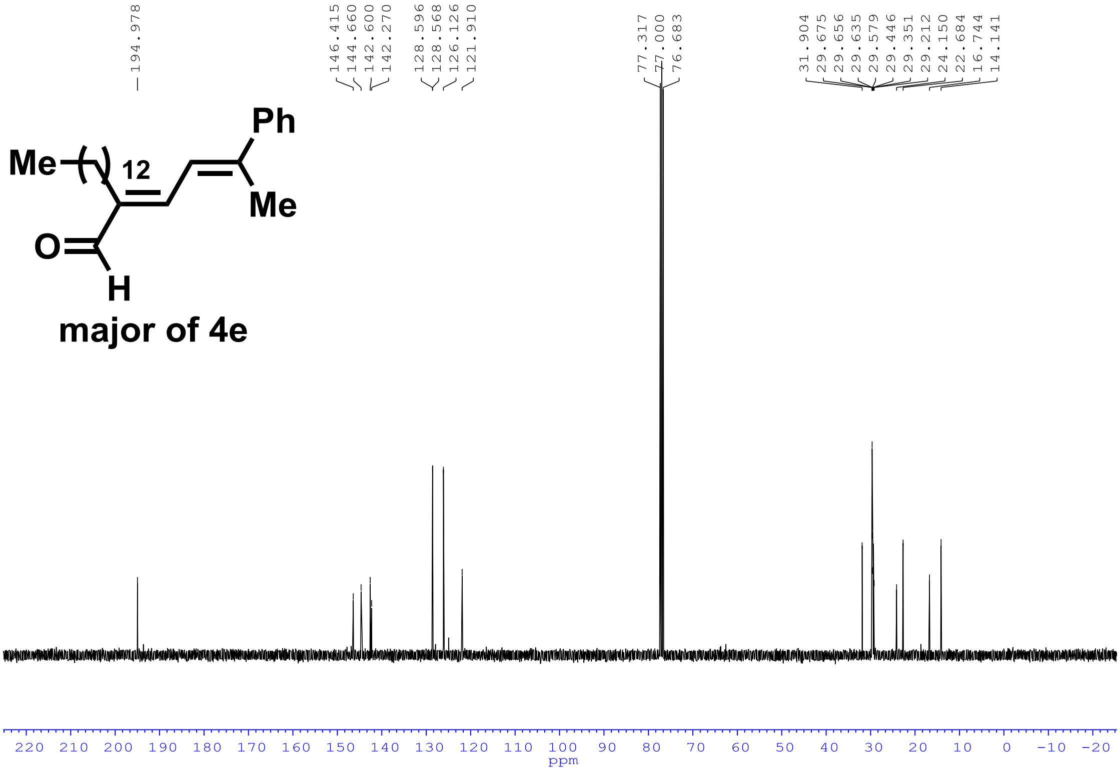

9.715
7.560
7.555
7.544
7.539
7.508
7.427
7.422
7.419
7.412
7.407
7.403
7.349
7.347
7.343
7.339
7.335
7.333
7.329
7.250
7.163
7.159
7.147
7.142
6.797
6.794
6.768
6.764
2.424
2.421
Br
Ph
Me
O
H
major of 4d
0.97
3.36
2.08
3.11
2.10
1.00
3.20
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

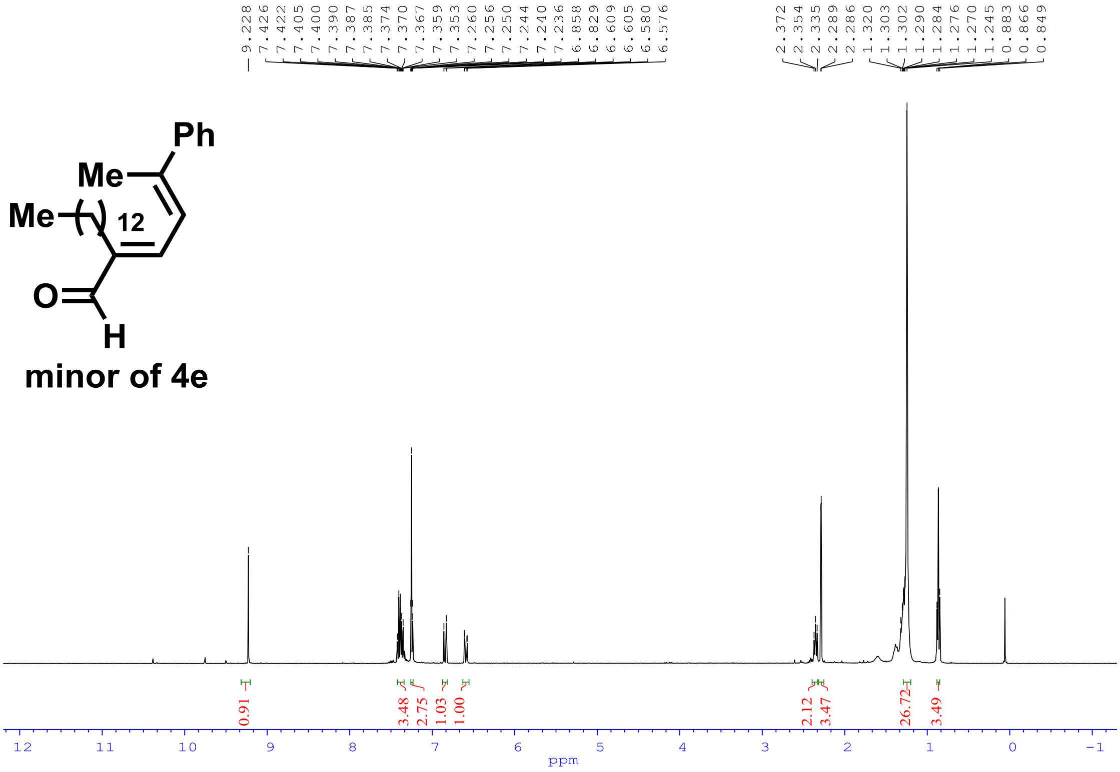

192.895
148.849
145.653
141.609
139.978
131.660
131.574
131.503
128.960
128.599
126.148
122.436
122.405
77.318
77.000
76.683
16.945
Br
Ph
Me
O
H
major of 4d
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

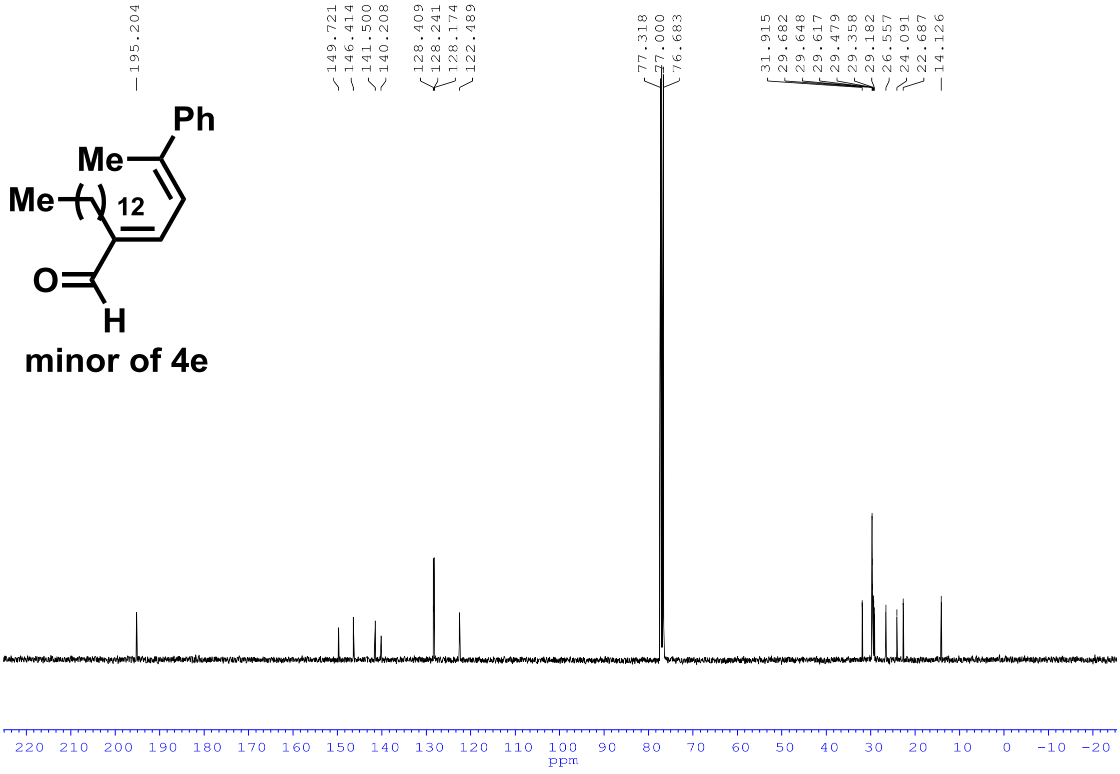

9.444
7.574
7.553
7.463
7.441
7.423
7.421
7.411
7.394
7.307
7.302
7.286
7.283
7.249
7.165
7.144
7.121
7.092
6.467
6.463
6.438
6.434
2.220
2.216
Me
Ph
4-Br-Ph
O
H
minor of 4d
0.99
2.16
3.24
2.17
2.17
1.07
1.00
3.15
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

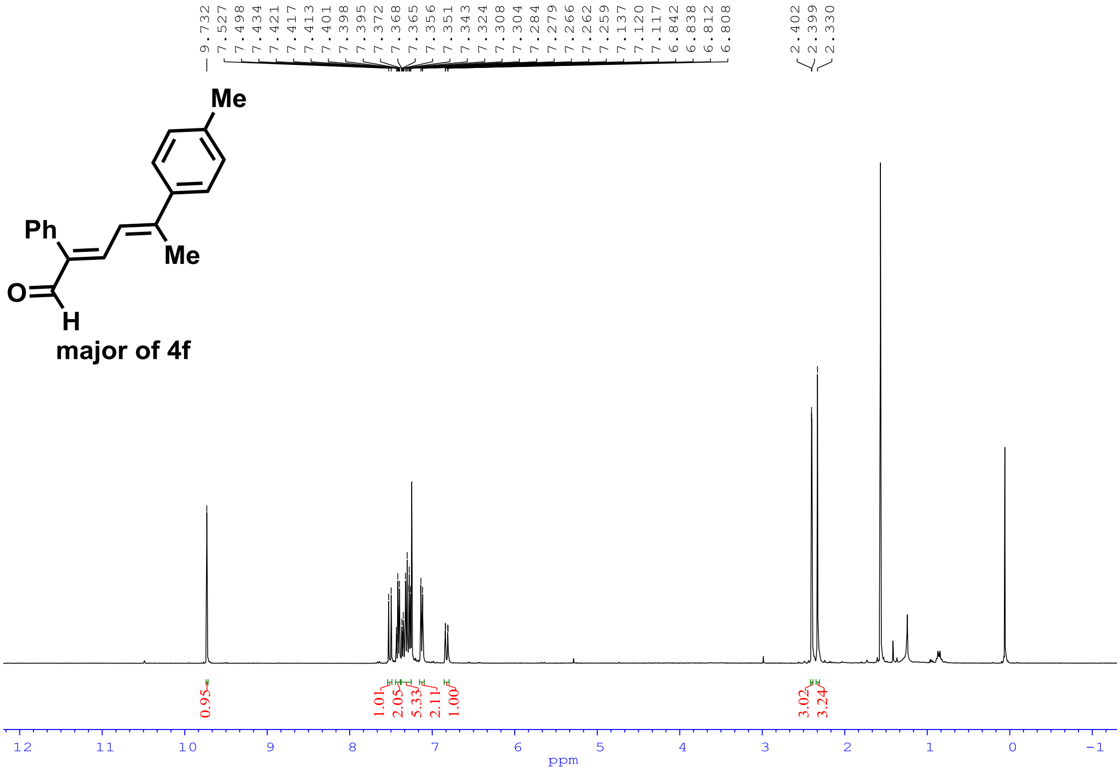

193.079
152.623
147.825
140.009
139.212
131.682
131.626
131.474
128.568
128.553
128.195
123.228
122.314
77.319
77.000
76.683
26.469
Me
Ph
4-Br-Ph
O
H
minor of 4d
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

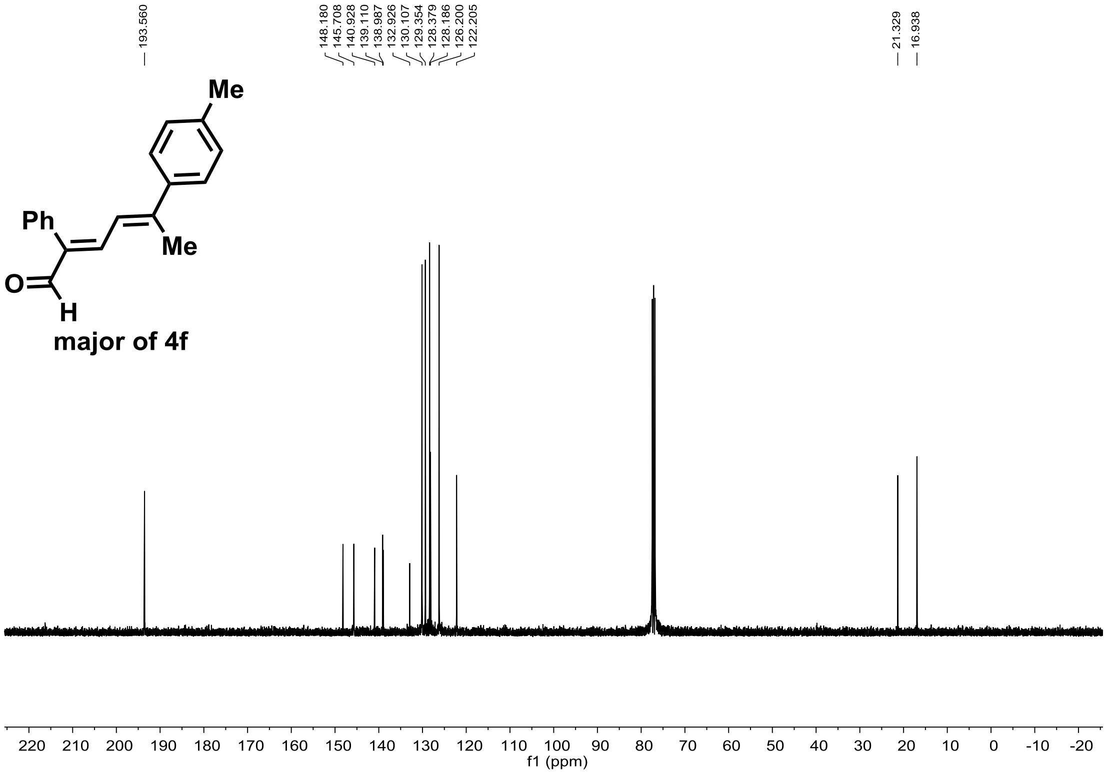

major of 4e

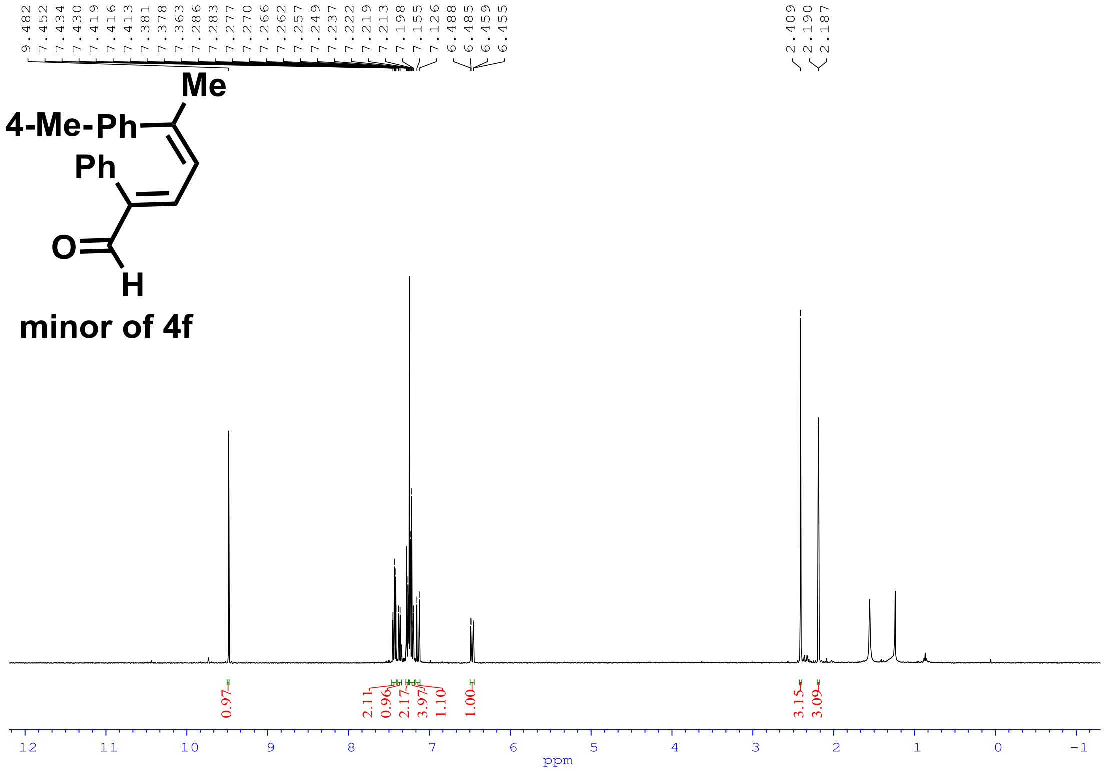

major of 4e

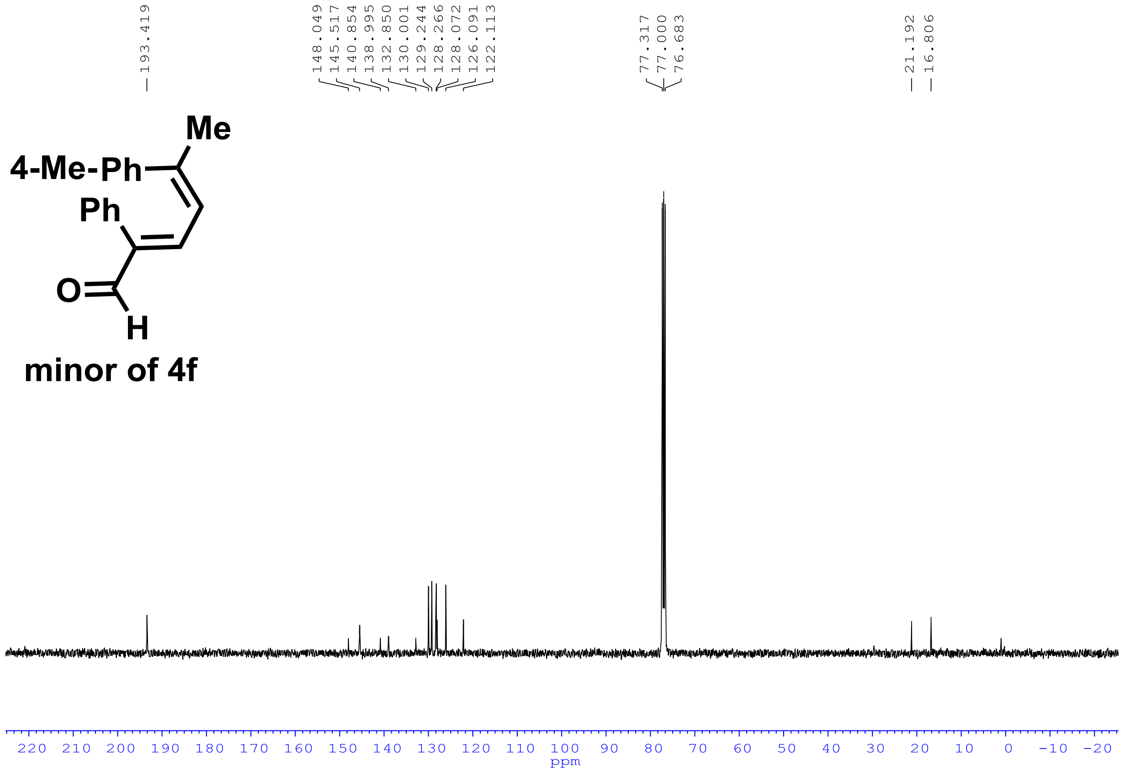

9.228
7.426
7.422
7.405
7.400
7.390
7.387
7.385
7.374
7.370
7.367
7.359
7.353
7.260
7.256
7.250
7.244
7.240
7.236
6.858
6.829
6.609
6.605
6.580
6.576
2.372
2.354
2.335
2.289
2.286
1.320
1.303
1.302
1.290
1.284
1.276
1.270
1.245
0.883
0.866
0.849
Ph
Me
Me
12
O
H
minor of 4e
0.91
3.48
2.75
1.03
1.00
2.12
3.47
26.72
3.49
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

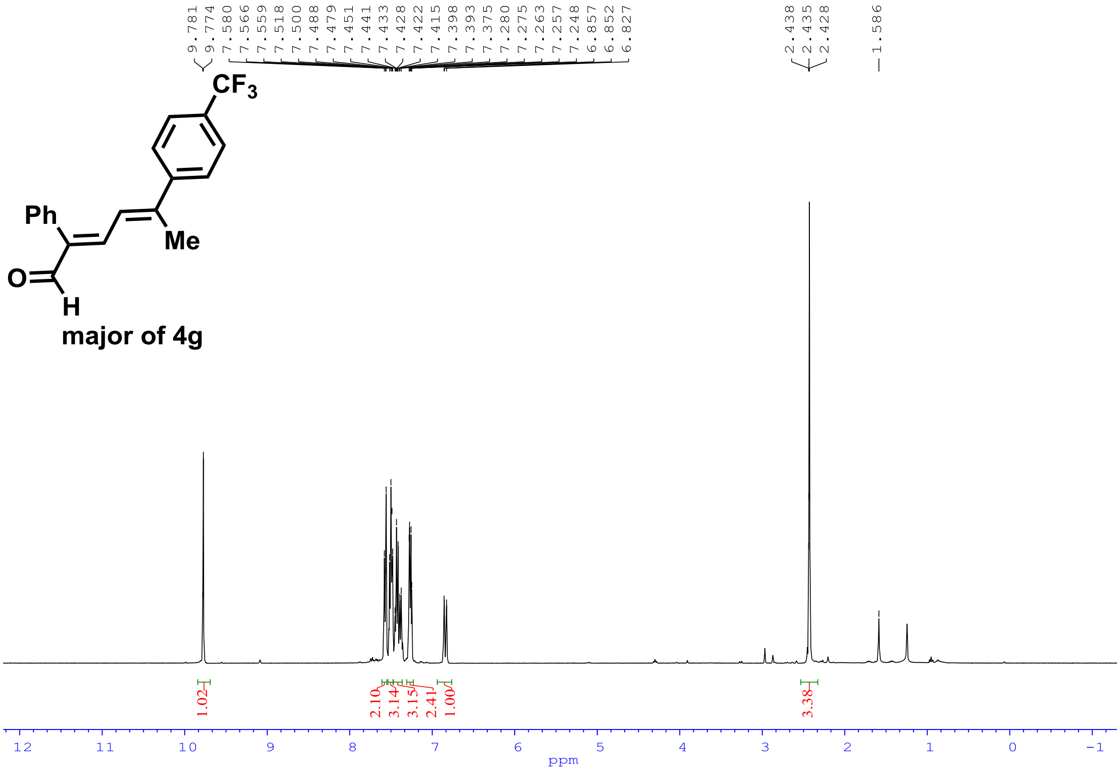

195.204
149.721
146.414
141.500
140.208
128.409
128.241
128.174
122.489
77.318
77.000
76.683
31.915
29.682
29.648
29.617
29.479
29.358
29.182
26.557
24.091
22.687
14.126
Ph
Me
Me
12
O
H
minor of 4e
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm

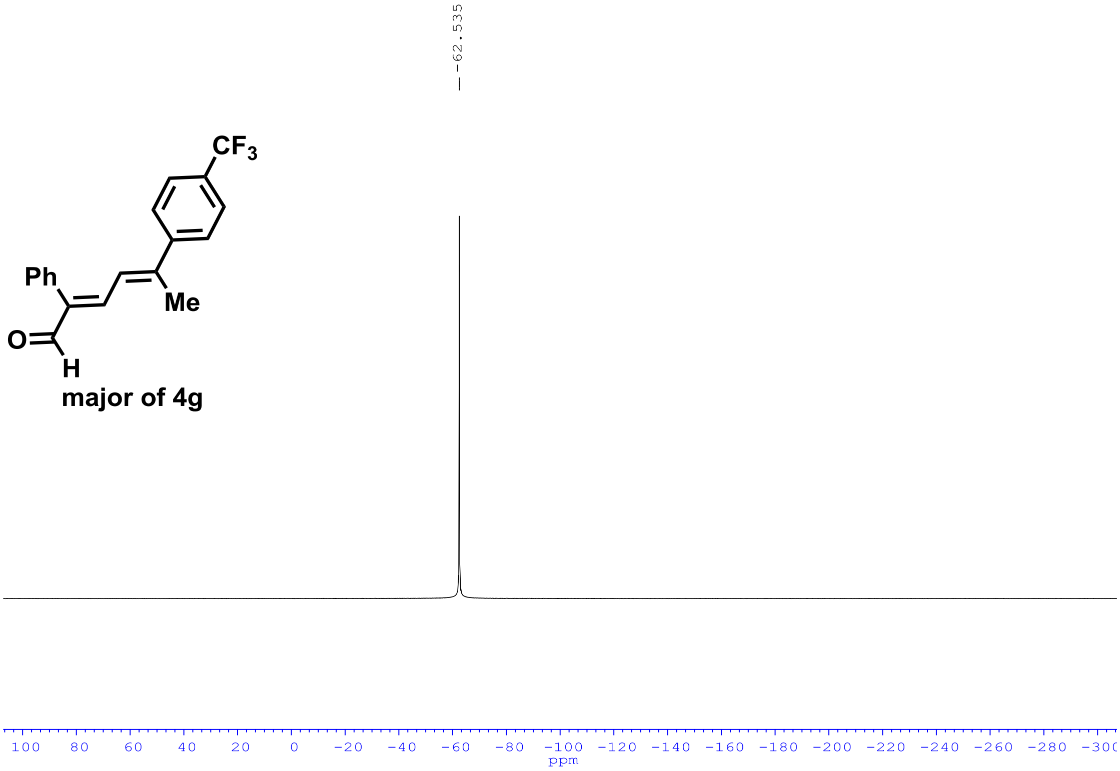

9.732
7.527
7.498
7.434
7.421
7.417
7.413
7.401
7.398
7.395
7.372
7.368
7.365
7.356
7.351
7.343
7.324
7.308
7.304
7.284
7.279
7.266
7.262
7.259
7.137
7.120
7.117
6.842
6.838
6.812
6.808
2.402
2.399
2.330
Me
Ph
Me
O
H
major of 4f
0.95
1.01
2.05
5.33
2.11
1.00
3.02
3.24
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

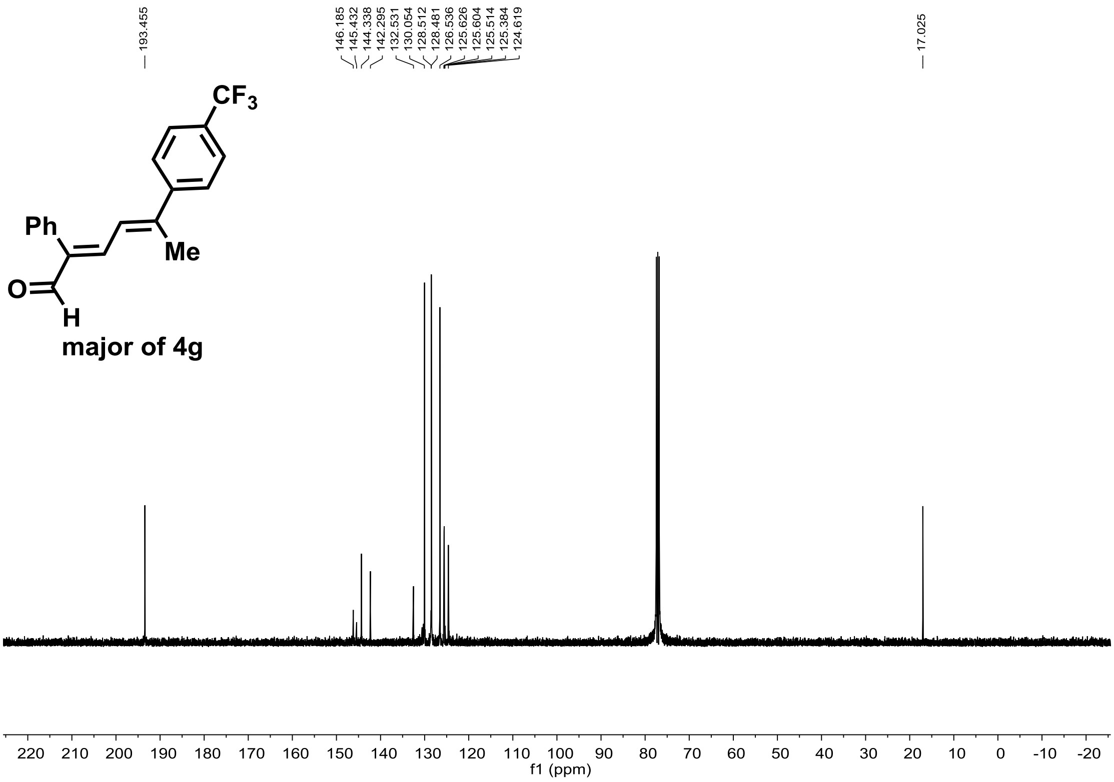

193.560
148.180
145.708
140.928
139.110
138.987
132.926
130.107
129.354
128.379
128.186
126.200
122.205
21.329
16.938
Me
Ph
Me
O
H
major of 4f
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
f1 (ppm)


9.482
7.452
7.434
7.430
7.419
7.416
7.413
7.381
7.378
7.363
7.286
7.283
7.277
7.270
7.266
7.262
7.257
7.249
7.237
7.222
7.219
7.213
7.198
7.155
7.126
6.488
6.485
6.459
6.455
2.409
2.190
2.187
Me
4-Me-Ph
Ph
O
H
minor of 4f
0.97
2.11
0.96
2.17
3.97
1.10
1.00
3.15
3.09
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

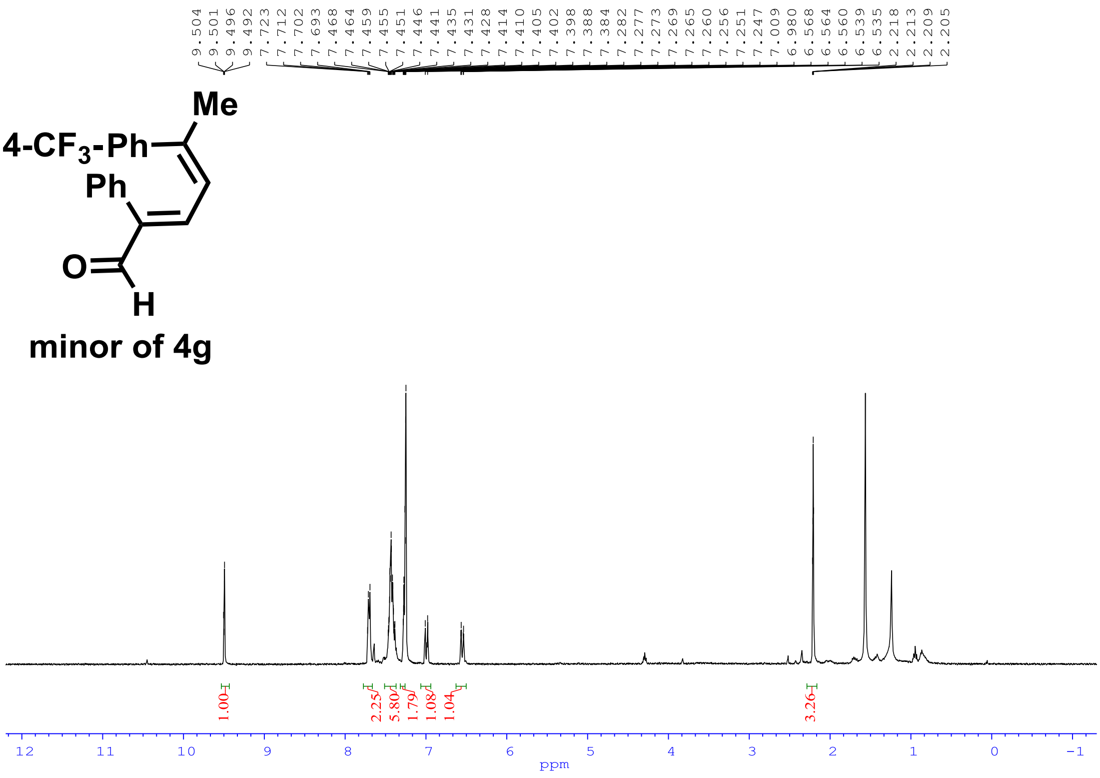

193.419
148.049
145.517
140.854
138.995
132.850
130.001
129.244
128.266
128.072
126.091
122.113
77.317
77.000
76.683
21.192
16.806
Me
4-Me-Ph
Ph
O
H
minor of 4f
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


9.781
9.774
7.580
7.566
7.559
7.518
7.500
7.488
7.479
7.451
7.441
7.433
7.428
7.422
7.415
7.398
7.393
7.375
7.280
7.275
7.263
7.257
7.248
6.857
6.852
6.827
2.438
2.435
2.428
1.586
CF3
Ph
Me
O
H
major of 4g
1.02
2.10
3.14
3.15
2.41
1.00
3.38
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm

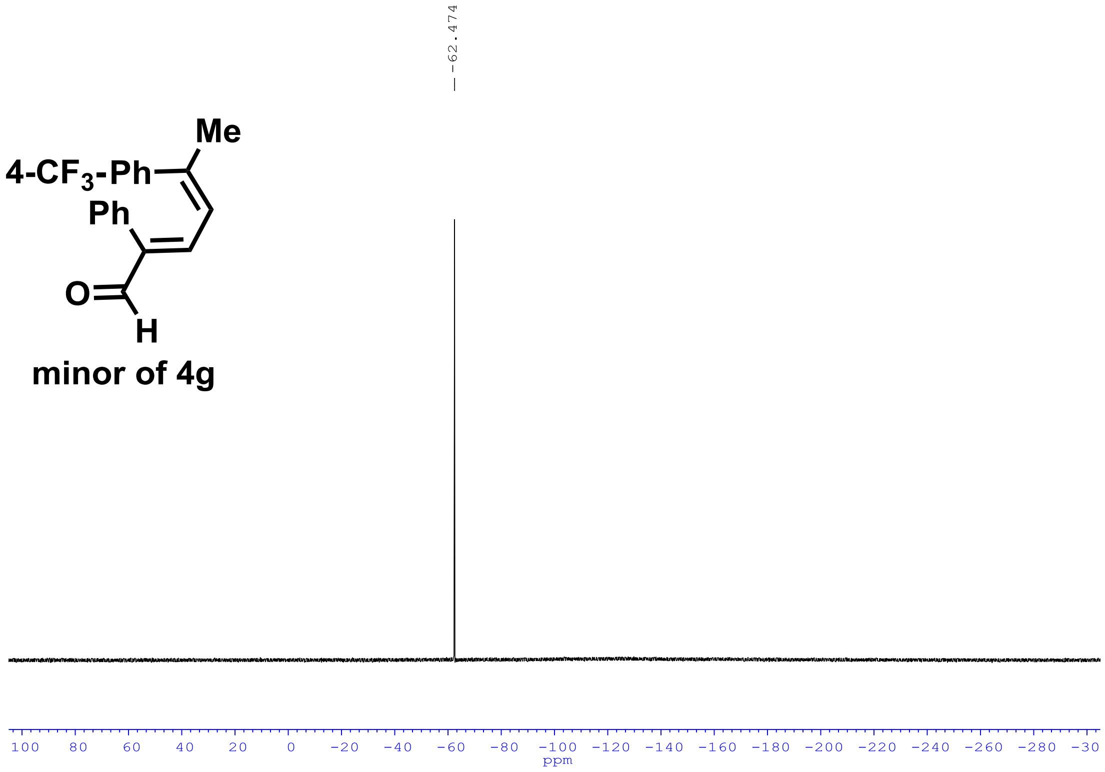

-62.535
CF3
Ph
Me
O
H
major of 4g
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
-300
ppm

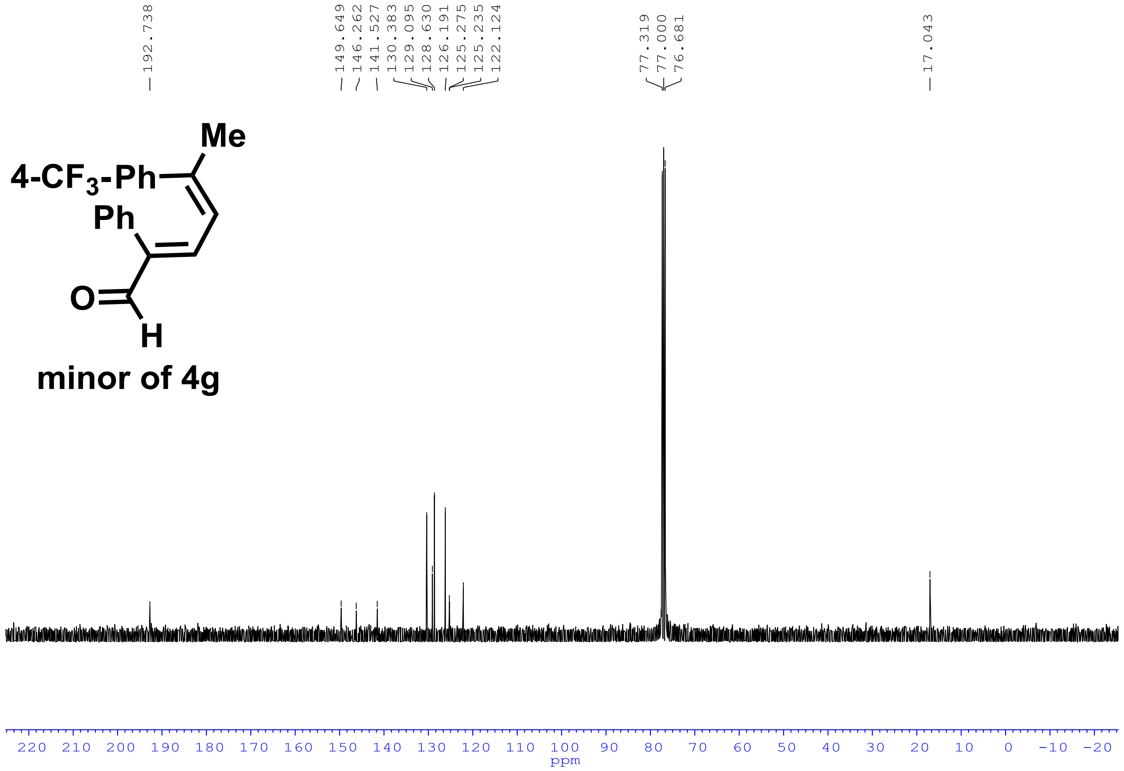


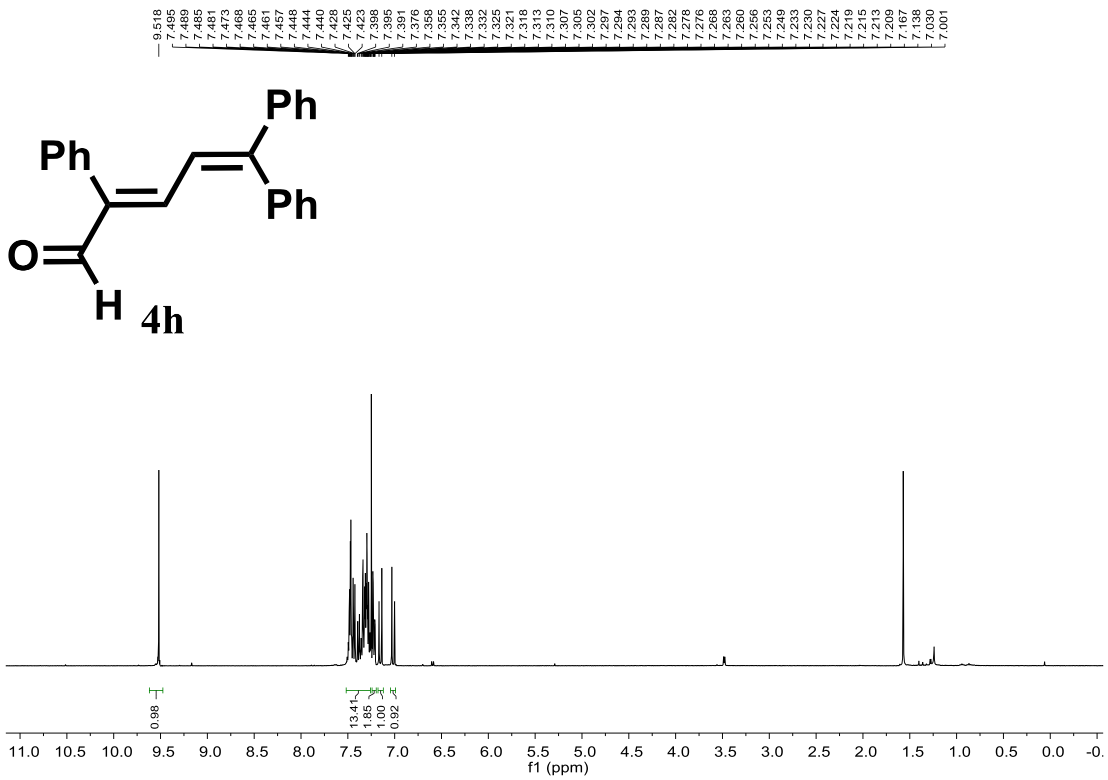
major of 4g

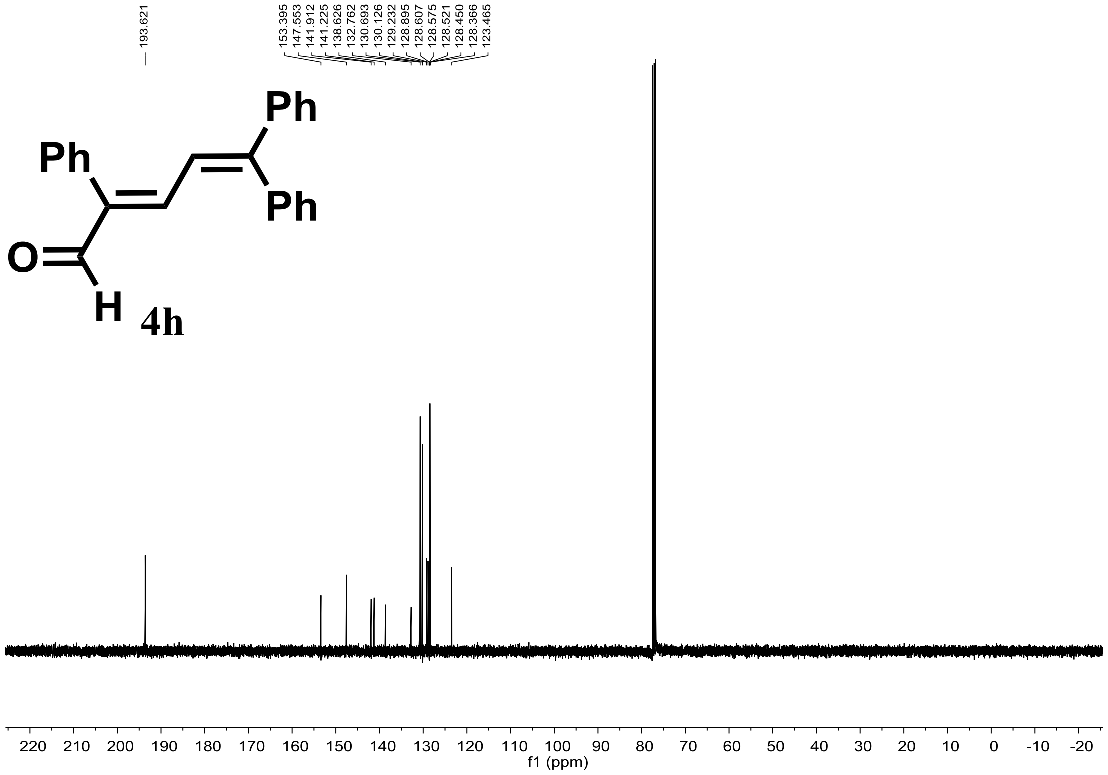


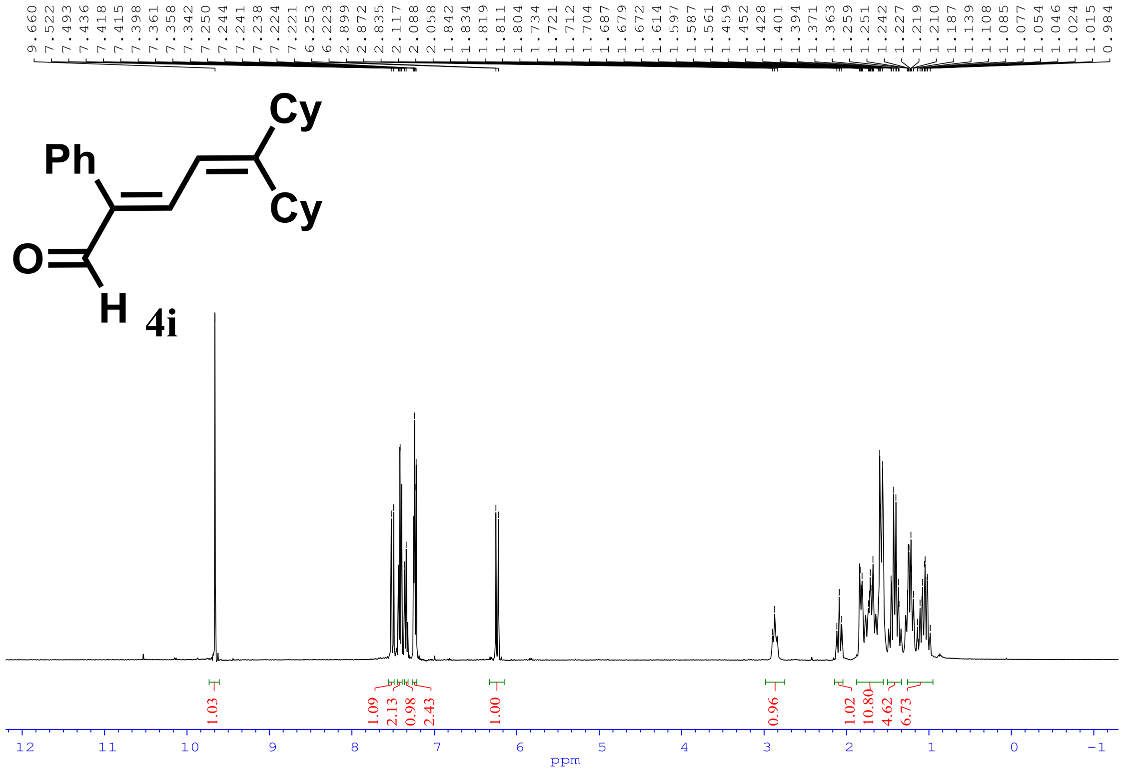
minor of 4g

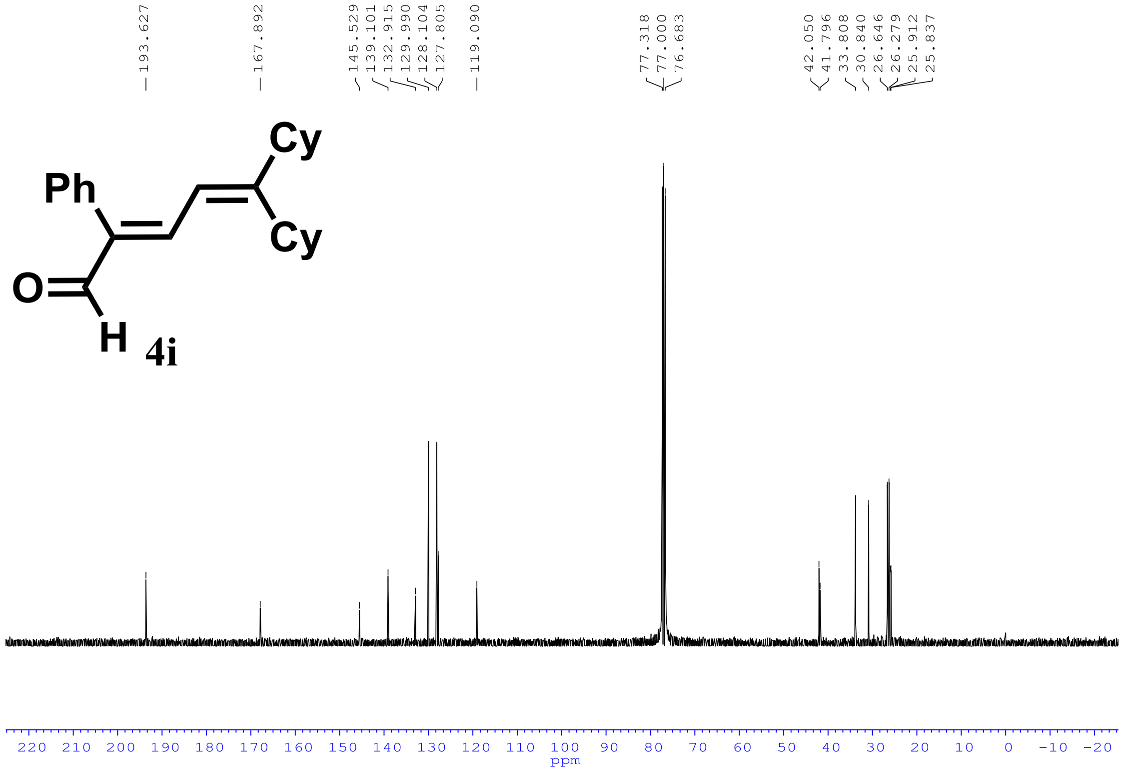

-62.474
Me
4-CF3-Ph
Ph
O
H
minor of 4g
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -30
ppm

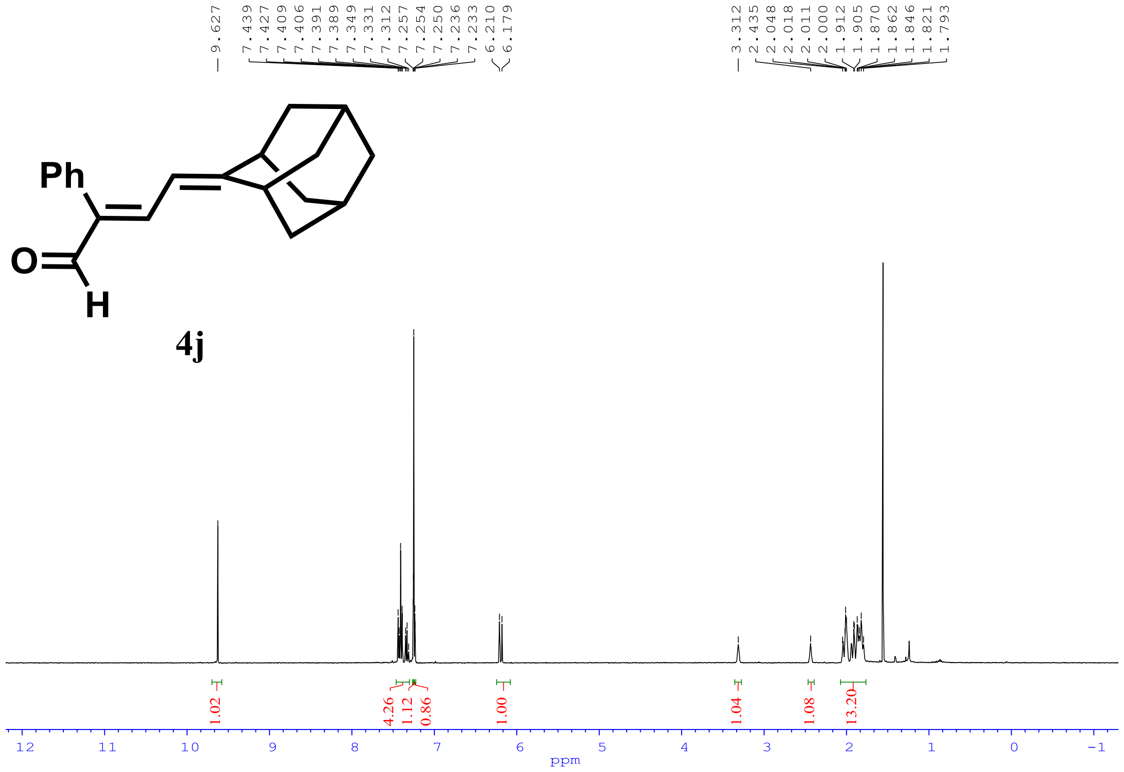

192.738
149.649
146.262
141.527
130.383
129.095
128.630
126.191
125.275
125.235
122.124
77.319
77.000
76.681
17.043
Me
4-CF3-Ph
Ph
O
H
minor of 4g
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
ppm

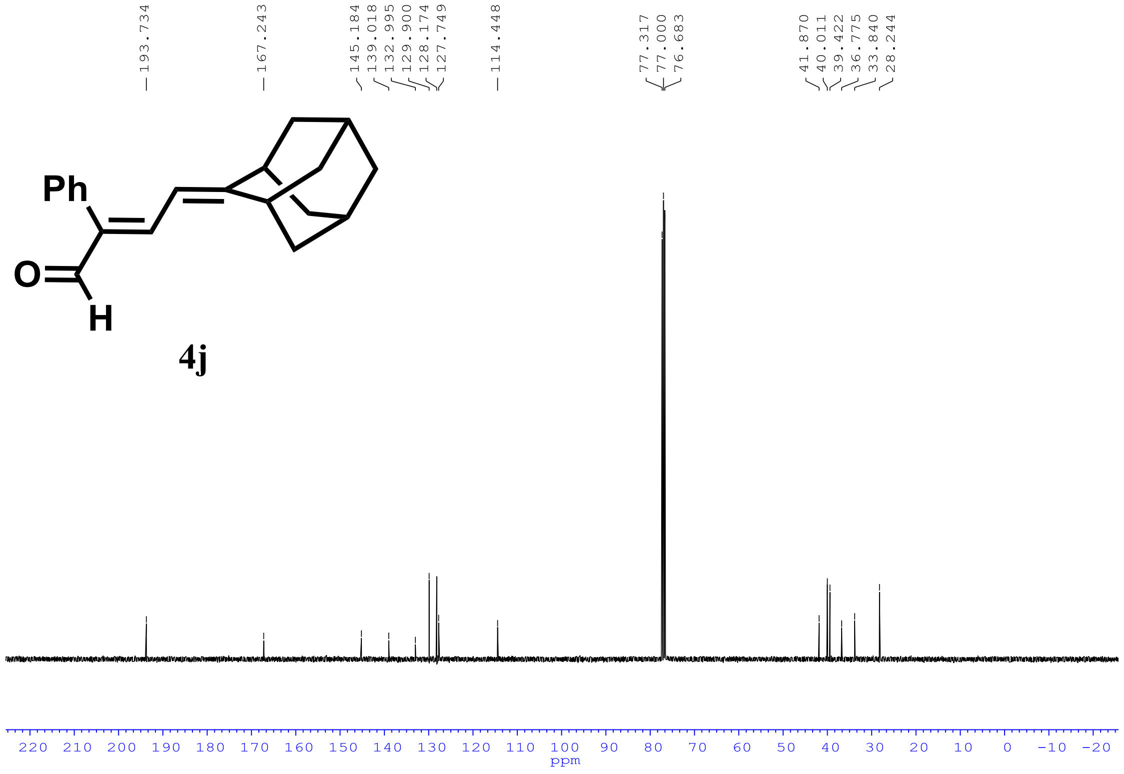

9.518
7.495
7.489
7.485
7.481
7.473
7.468
7.465
7.461
7.457
7.448
7.444
7.440
7.428
7.425
7.423
7.398
7.395
7.391
7.376
7.358
7.355
7.342
7.338
7.332
7.325
7.321
7.318
7.313
7.310
7.307
7.305
7.302
7.297
7.294
7.293
7.289
7.287
7.282
7.278
7.276
7.268
7.263
7.260
7.256
7.253
7.249
7.233
7.230
7.227
7.224
7.219
7.215
7.213
7.209
7.167
7.138
7.030
7.001
Ph
Ph
Ph
O
H
4h
0.98
13.41
1.85
1.00
0.92
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.
f1 (ppm)


193.621
153.395
147.553
141.912
141.225
138.626
132.762
130.693
130.126
129.232
128.895
128.607
128.575
128.521
128.450
128.366
123.465
Ph
Ph
Ph
O
H
4h
220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20
f1 (ppm)


9.660
7.522
7.493
7.436
7.418
7.415
7.398
7.361
7.358
7.342
7.250
7.244
7.241
7.238
7.224
7.221
6.253
6.223
2.899
2.872
2.835
2.117
2.088
2.058
1.842
1.834
1.819
1.811
1.804
1.734
1.721
1.712
1.704
1.687
1.679
1.672
1.614
1.597
1.587
1.561
1.459
1.452
1.428
1.401
1.394
1.371
1.363
1.259
1.251
1.242
1.227
1.219
1.210
1.187
1.139
1.108
1.085
1.077
1.054
1.046
1.024
1.015
0.984
Cy
Ph
Cy
O
H
4i
1.03
1.09
2.13
0.98
2.43
1.00
0.96
1.02
10.80
4.62
6.73
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm


193.627
167.892
145.529
139.101
132.915
129.990
128.104
127.805
119.090
77.318
77.000
76.683
42.050
41.796
33.808
30.840
26.646
26.279
25.912
25.837
Cy
Ph
Cy
O
H
4i
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm


9.627
7.439
7.427
7.409
7.406
7.391
7.389
7.349
7.331
7.312
7.257
7.254
7.250
7.236
7.233
6.210
6.179
3.312
2.435
2.048
2.018
2.011
2.000
1.912
1.905
1.870
1.862
1.846
1.821
1.793
Ph
O
H
4j
1.02
4.26
1.12
0.86
1.00
1.04
1.08
13.20
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm


193.734
167.243
145.184
139.018
132.995
129.900
128.174
127.749
114.448
77.317
77.000
76.683
41.870
40.011
39.422
36.775
33.840
28.244
Ph
O
H
4j
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
-20
ppm