Supporting Information for

Iodine-mediated regioselective synthesis of vinyl triflones from styrenes with CF_3SO_2Na

Li-Na Hua,[a] Huan Li,[a] Feng-LingQing,[a,b] Yangen Huang,[a]* and Xiu-Hua Xu[b]*

[a] College of Chemistry, Chemical Engineering and Biotechnology, DonghuaUniversity, 2999 North Renmin Lu, Shanghai 201620, China

[b] Key Laboratory of Organofluorine Chemistry, Shanghai Institute of OrganicChemistry, Chinese Academy of Sciences, 345 Lingling Lu, Shanghai 200032, China

E-mail:hyg@dhu.edu.cn or xuxiuhua@sioc.ac.cn

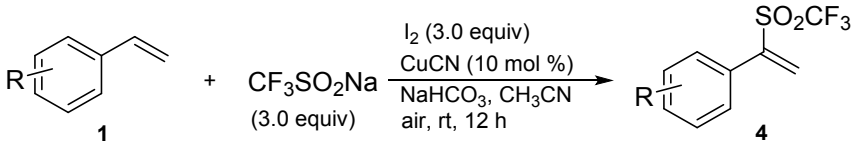
Table of Contents

1. General information.

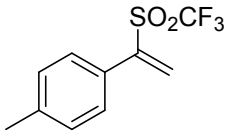
^{19}F (using trifluoromethylbenzene as an internal standard), ^{1}H, ^{13}C NMR spectra were recorded on a Bruker AM 400 spectrometer. Chemical shifts (δ) were reported in ppm, and coupling constants (*J*) were in Hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. The NMR yield was determined by ^{19}F NMR using trifluoromethylbenzene as an internal standard before working up the reaction. High-resolution mass spectra (HRMS) were recorded as electron ionization (EI/HRMS) utilizing a GC/MS TOF high-resolution mass spectrometer equipped with a liquid chromatography system or as electron spray ionization (ESI/HRMS) using a Thermo Fischer Scientific LTQ FT Ultra instrument in DART-positive mode.

Materials: Unless otherwise noted, all reagents were obtained commercially and used without further purification. CH_3CN and CH_2Cl_2 was distilled from CaH_2 and stored with 4 Å molecular sieves. Reactions were performed using glassware that was flame-dried under vacuum.

2. Synthesis of vinyl triflones

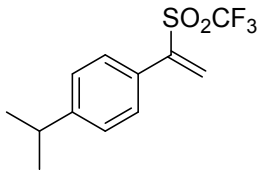


A 15 mL glass tube equipped with a magnetic stirring bar was charged with alkenes (0.5 mmol), CF_3SO_2Na (0.234 mg, 1.5 mmol), I_2 (0.380 mg, 1.5 mmol), $NaHCO_3$ (0.084 mg, 1.0 mmol), CuCN (0.004 mg, 0.05 mmol) and CH_3CN (2 mL). After stirring at rt for 12 hours, saturated aqueous $Na_2S_2O_3$ solution was added. Then, the reaction mixture was extracted with ethyl acetate. The organic phase was washed with H_2O and brine, dried by Na_2SO_4, concentrated in vacuo. The residue was purified by silica gel column chromatography to afford the corresponding vinyl triflones **4**.



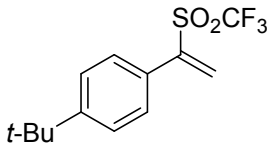
4a

Methyl-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4a**) (72.1 mg, 54%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (d, *J* = 7.8 Hz, 2H), 7.27 (d, *J* = 7.7 Hz, 2H), 6.82 (s, 1H), 6.46 (s, 1H), 2.42 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.1 141.0, 135.0, 129.5, 128.9, 127.6, 119.8 (q, *J* = 330.3 Hz), 21.6. ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.9 (s, 3F). IR (thin film) ν 2255, 1606, 1573, 1510, 1462, 1298, 904, 725 cm^{-1}. MS (ESI): *m/z* (%) 289 $[M+K]^+$. HRMS (ESI-TOF) m/z: $[M+NH_4]^+$ Calcd for $C_{10}H_{13}F_3NO_2S$: 268.0614; Found: 268.0612.



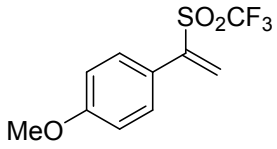
4b

Isopropyl-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4b**) (70.9 mg, 51%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 7.5 Hz, 2H), 7.33 (d, *J* = 7.6 Hz, 2H), 6.82 (s, 1H), 6.47 (s, 1H), 3.05–2.94 (m, 1H), 1.31 (d, *J* = 6.8 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 151.5, 144.1, 135.1, 129.1, 127.9, 126.9, 119.8 (q, *J* = 329.3 Hz), 33.9, 23.7. ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.1 (s, 3F). IR (thin film) ν 2965, 2349, 1610, 1508, 1411, 1208, 1019, 905, 726 cm^{-1}. MS (EI): *m/z* (%) 278 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{12}H_{13}F_3O_2S$: 278.0588; Found: 278.0585.



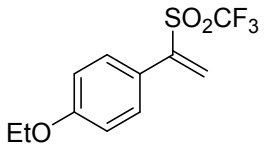
4c

1-(*Tert*-butyl)-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4c**) (83.5 mg, 57%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49–7.47 (m, 4H), 6.82 (s, 1H), 6.48 (s, 1H), 1.37 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 153.7, 144.1, 135.1, 128.8, 127.6, 125.7, 119.8 (q, *J* = 329.2 Hz), 34.8, 31.1. ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.9 (s, 3F). IR (thin film) ν 2255, 1711, 1606, 1485, 1509, 1361, 1209, 904, 840, 725 cm^{-1}. MS (EI): *m/z* (%) 292 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{13}H_{15}F_3O_2S$: 292.0745; Found: 292.0753.



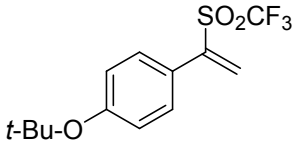
4d

1-Methoxy-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4d**) (59.8 mg, 45%): brown liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (d, *J* = 8.2 Hz, 2H), 6.96 (d, *J* = 8.2 Hz, 2H), 6.77 (s, 1H), 6.42 (s, 1H), 3.87 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.2, 143.7, 134.1, 130.6, 122.6, 119.8 (q, *J* = 328.9 Hz), 114.2, 55.3. ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.9 (s, 3F). IR (thin film) ν 2255, 1510, 1462, 1510, 1443, 1359, 837, 650 cm^{-1}. MS (ESI): *m/z* (%) 284 $[M+NH_4]^+$. HRMS (ESI-TOF) m/z: $[M+NH_4]^+$ Calcd for $C_{10}H_{13}F_3NO_2S$: 284.0563; Found: 284.0561.



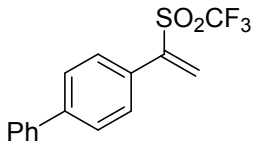
4e

1-Ethoxy-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4e**) (63.2 mg, 45%): brown liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.7 Hz, 2H), 6.94 (d, *J* = 7.8 Hz, 2H), 6.74 (s, 1H), 6.40 (s, 1H), 4.07 (q, *J* = 6.7 Hz, 2H), 1.44 (t, *J* = 6.4 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 160.7, 143.7, 134.1, 130.5, 122.4, 119.5 (q, *J* = 329.3 Hz), 114.6, 63.6, 14.5. ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.1 (s, 3F). IR (thin film) ν 2984, 1606, 1509, 1359, 1204, 1117, 907, 730 cm^{-1}. MS (ESI): *m/z* (%) 298 $[M+NH_4]^+$. HRMS (ESI-TOF) m/z: $[M+NH_4]^+$ Calcd for $C_{11}H_{15}F_3NO_3S$: 298.0719; Found: 298.0716.



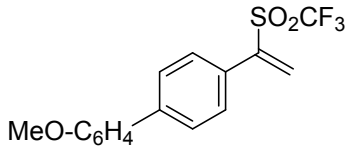
4f

1-(*Tert*-butoxy)-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4f**) (84.7 mg, 55%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48 (d, *J* = 7.7 Hz, 2H), 7.05 (d, *J* = 7.8 Hz, 2H), 6.78 (s, 1H), 6.44 (s, 1H), 1.41 (s, 9H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.8, 143.8, 134.5, 129.9, 124.7, 123.4, 119.8 (q, *J* = 328.9 Hz), 29.7, 28.8. ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.0 (s, 3F). IR (thin film) ν 2980, 2930, 2254, 1602, 1462, 1361, 1237, 904, 726 cm^{-1}. MS (EI): *m/z* (%) 308 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{13}H_{15}F_3O_3S$: 308.0694; Found: 308.0690.



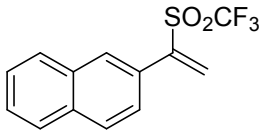
4g

4-(1-((Trifluoromethyl)sulfonyl)vinyl)-1,1'-biphenyl (**4g**) (77.8 mg, 50%): white solid, m.p. 62–64 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30–7.67 (m, 6H), 7.53 (t, *J* = 6.9 Hz, 2H), 7.47 (d, *J* = 6.5 Hz, 1H), 6.91 (s, 1H), 6.56 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.8, 143.2, 139.7, 135.6, 129.5, 129.4, 129.1, 128.1, 127.4, 127.1, 119.9 (q, *J* = 328.9 Hz). ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.8 (s, 3F). IR (thin film) ν 2254, 1599, 1486, 1361, 1209, 1118, 904, 846 cm^{-1}. MS (EI): *m/z* (%) 312 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{15}H_{11}F_3O_2S$: 312.0432; Found: 312.0439.



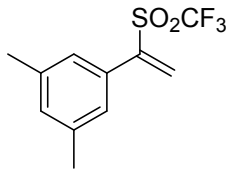
4h

4-Methoxy-4'-(1-((trifluoromethyl)sulfonyl)vinyl)-1,1'-biphenyl (**4h**) (111.1 mg, 65%): white solid, m.p. 84–86 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (s, 4H), 7.59 (d, *J* = 8.2 Hz, 2H), 7.03 (d, *J* = 8.0 Hz, 2H), 6.86 (s, 1H), 6.53 (s, 1H), 3.89 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.7, 143.9, 142.8, 135.2, 132.1, 129.4, 128.6, 128.3, 126.8, 119.8 (q, *J* = 328.9 Hz), 114.5, 55.0. ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.3 (s, 3F). IR (thin film) ν 2923, 1607, 1497, 1359, 1249, 1195, 1117, 1038, 822 cm^{-1}. MS (EI): *m/z* (%) 342 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{16}H_{13}F_3O_3S$: 342.0538; Found: 342.0532.



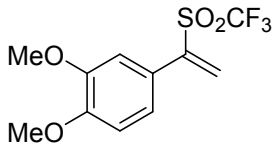
4i

2-(1-((Trifluoromethyl)sulfonyl)vinyl)naphthalene (**4i**) (60.1 mg, 42%): white solid, m.p. 58–60 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (s, 1H), 7.95–7.91 (m, 3H), 7.65 (d, *J* = 2.1 Hz, 1H), 7.61–7.60 (m, 2H), 6.95 (s, 1H), 6.60 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.1, 135.9, 133.7, 132.7, 129.3, 128.7, 128.6, 127.8, 127.7, 127.6, 127.0, 125.6, 119.8 (q, *J* = 329.3 Hz). ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.7 (s, 3F). IR (thin film) ν 2255, 1711, 1606, 1509, 1465, 1361, 1209, 904, 726 cm^{-1}. MS (EI): *m/z* (%) 286 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{13}H_9F_3O_2S$: 286.0275; Found: 286.0270.



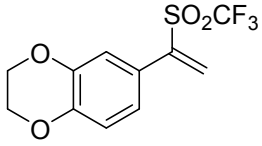
4j

1,3-Dimethyl-5-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4j**) (59.4 mg, 45%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 (s, 2H), 7.15 (s, 1H), 6.83 (s, 1H), 6.46 (s, 1H), 2.39 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 144.4, 138.4, 135.2, 132.1, 130.4, 126.8, 119.9 (q, *J* = 328.9 Hz), 29.7, 21.1. ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.8 (s, 3F). IR (thin film) ν 2925, 1599, 1360, 1217, 1197, 1236, 908, 728 cm^{-1}. MS (EI): *m/z* (%) 264 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{11}H_{11}F_3O_2S$: 264.0432; Found: 264.0435.



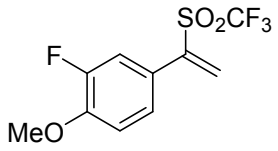
4k

1,2-Dimethoxy-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4k**) (59.2 mg, 40%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.09 (s, 2H), 6.90 (d, *J* = 8.4 Hz, 1H), 6.75 (s, 1H), 6.43 (s, 1H), 3.91 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 150.8, 148.7, 143.6, 134.3, 122.8, 122.3, 119.8 (q, *J* = 329.2 Hz), 111.7, 110.9, 55.9, 55.8. ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.9 (s, 3F). IR (thin film) ν 2932, 2254, 1596, 1508, 1482, 1246, 1025, 908, 728 cm^{-1}. MS (EI): *m/z* (%) 296 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{11}H_{11}F_3O_4S$: 296.0330; Found: 296.0328.



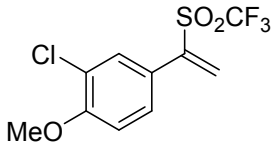
4l

6-(1-((Trifluoromethyl)sulfonyl)vinyl)-2,3-dihydrobenzo[b][1,4]dioxine (**4l**) (91.1 mg, 62%): brown liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.10 (s, 1H), 7.02 (d, *J* = 8.3 Hz, 1H), 6.89 (d, *J* = 8.3 Hz, 1H), 6.73 (s, 1H), 6.41 (s, 1H), 4.26 (s, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 145.6, 143.5, 143.3, 134.8, 123.3, 122.4, 118.1, 117.6, 119.8 (q, *J* = 329.2 Hz), 64.4, 64.1. ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.2 (s, 3F). IR (thin film) ν 2933, 2877, 1579, 1503, 1305, 1287, 1245, 903, 725 cm^{-1}. MS (EI): *m/z* (%) 294 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{11}H_9F_3O_4S$: 294.0174; Found: 294.0175.



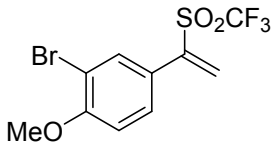
4m

2-Fluoro-1-methoxy-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4m**) (106.5 mg, 75%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (t, *J* = 10.7 Hz, 2H), 7.02 (t, *J* = 8.3 Hz, 1H), 6.79 (s, 1H), 6.47 (s, 1H), 3.93 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 151.7 (d, *J* = 248.4 Hz), 149.6 (d, *J* = 10.1 Hz), 142.6, 135.3, 125.6 (d, *J* = 4.0 Hz), 122.8 (d, *J* =7.1 Hz), 119.7 (q, *J* = 329.3 Hz), 116.8 (d, *J* = 20.3 Hz), 113.1 (d, *J* = 3.0 Hz), 56.1. ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.9 (s, 3F), -133.69 (t, *J* = 9.4 Hz, 1F). IR (thin film) ν 2843, 1603, 1514, 1473, 1302, 1264, 905, 725, 649 cm^{-1}. MS (EI): *m/z* (%) 284 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{10}H_8F_4O_3S$: 284.0130; Found: 284.0135.



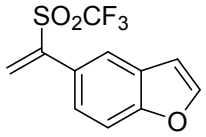
4n

2-Chloro-1-methoxy-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4n**) (120.1 mg, 80%): colourless liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (s, 1H), 7.45 (d, *J* = 8.6 Hz, 1H), 6.98 (d, *J* = 8.6 Hz, 1H), 6.77 (s, 1H), 6.46 (s, 1H), 3.92 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.7, 142.4, 135.4, 130.6, 128.9, 123.3, 122.8, 119.7 (q, *J* = 329.2 Hz), 111.9, 56.1. ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.1 (s, 3F). IR (thin film) ν 2933, 2255, 1597, 1502, 1361, 1206, 1196, 905, 727 cm^{-1}. MS (ESI): *m/z* (%) 339 $[M+K]^+$. HRMS (ESI-TOF) m/z: $[M+NH_4]^+$ Calcd for $C_{10}H_{12}ClF_3NO_3S$: 318.0173; Found: 318.0173.



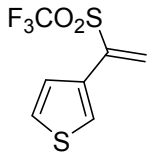
4o

2-Bromo-1-methoxy-4-(1-((trifluoromethyl)sulfonyl)vinyl)benzene (**4o**) (117.3 mg, 68%), yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (s, 1H), 7.50 (d, *J* = 8.5 Hz, 1H), 6.94 (d, *J* = 8.6 Hz, 1H), 6.76 (s, 1H), 6.46 (s, 1H), 3.90 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.5, 142.2, 135.5, 133.6, 129.6, 123.7, 119.7 (q, *J* = 329.2 Hz), 111.8, 111.7, 56.3. ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.1 (s, 3F). IR (thin film) ν 2931, 2845, 1596, 1496, 1454, 1341, 1185, 1116, 1009, 736 cm^{-1}. MS (EI): *m/z* (%) 343 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{10}H_8BrF_3O_3S$: 343.9330; Found: 343.9339.



4p

5-(1-((Trifluoromethyl)sulfonyl)vinyl)benzofuran (**4p**) (71.7 mg, 52%): colourless liquid, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (s, 1H), 7.69 (s, 1H), 7.55 (d, *J* = 8.4 Hz, 1H), 7.48 (d, *J* = 8.5 Hz, 1H), 6.87 (s, 1H), 6.81 (s, 1H), 6.48 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.7, 146.4, 144.2, 135.6, 127.9, 125.4, 125.3, 122.6, 119.9 (q, *J* = 329.3 Hz), 111.7, 106.7. ^{19}F NMR (377 MHz, $CDCl_3$) δ -75.9 (s, 3F). IR (thin film) ν 2929, 1360, 1222, 1207, 1110, 904, 726, 688, 649 cm^{-1}. MS (EI): *m/z* (%) 276 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_{11}H_7F_3O_3S$: 276.0068; Found: 276.0063.

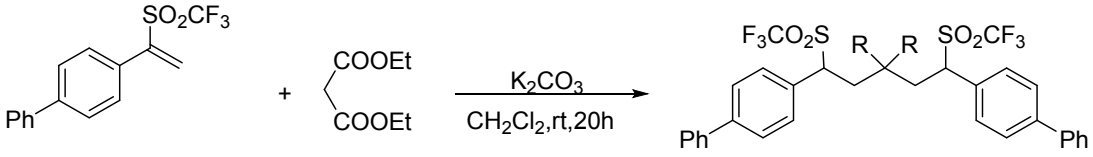


4q

3-(1-((Trifluoromethyl)sulfonyl)vinyl)thiophene (**4q**) (60.1 mg, 50%): yellow liquid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (s, 1H), 7.41 (s, 1H), 7.33 (s, 1H), 6.73 (s, 1H), 6.56 (s, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 138.9, 133.2, 130.1, 127.2, 127.1, 126.8, 119.7 (q, J = 328.5 Hz). ^{19}F NMR (377 MHz, $CDCl_3$) δ -76.4 (s, 3F). IR (thin film) ν 2928, 2253, 1459, 1339, 1204, 903, 723, 660 cm^{-1}. MS (EI): *m/z* (%) 241 (M^+). HRMS (EI-TOF) m/z: (M^+) Calcd for $C_7H_5F_3O_2S_2$: 241.9683; Found: 241.9684.

3. Michael addition of vinyl triflones

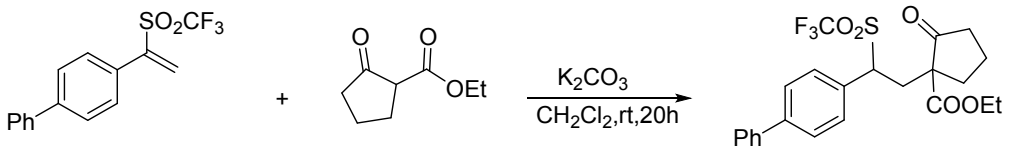
Diethyl 2,2-bis(2-([1,1'-biphenyl]-4-yl)-2-((trifluoromethyl)sulfonyl)ethyl)malonate (**5**)



4g **5** (R=COOEt)

A 15mL glass tube equipped with a magnetic stirring bar was charged with diethyl malonate (16.0 mg, 0.1 mmol) and K_2CO_3 (13.8 mg, 0.1 mmol) in dry CH_2Cl_2 (1 mL) and allowed to stired at room temperature for 20 minutes. Then **4g** (31.2 mg, 0.1 mmol) in dry CH_2Cl_2 (1 mL) was slowly added by a syringe. After stirring at rt for 20 hours, the reaction mixture was directly purified by flash chromatography on silica gel to give desired product as a white solid (35.3 mg, 90%). m.p. 180–182 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, J = 7.5 Hz, 4H), 7.61 (d, J = 7.2 Hz, 4H), 7.57–7.45 (m, 8H), 7.43 (d, J = 6.9 Hz, 2H), 4.71 (d, J = 11.4 Hz, 2H), 3.69–3.53 (m, 2H), 3.33–3.14 (m, 4H), 3.04–2.90 (m, 2H), 0.97 (s, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.1, 143.3, 139.5, 129.0, 128.1, 127.5, 127.0, 126.3, 119.7 (q, J = 330.9 Hz), 62.4, 62.1, 53.3, 29.2, 13.4. ^{19}F NMR (377 MHz, $CDCl_3$) δ -72.4 (s, 6F). IR (thin film) ν 2254, 1731, 1487, 1359, 1212, 1114, 903, 723, 649 cm^{-1}. MS (ESI): *m/z* (%) 807 $[M+Na]^+$.

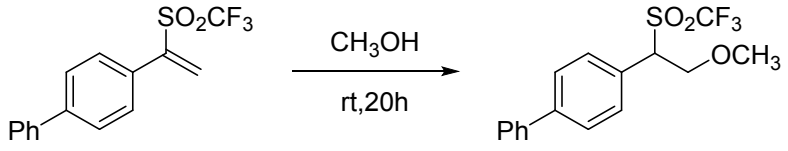
Ethyl 1-(2-([1,1'-biphenyl]-4-yl)-2-((trifluoromethyl)sulfonyl)ethyl)-2-oxocyclopentane-1-carboxylate (**6**)



4g **6**

A 15 mL glass tube equipped with a magnetic stirring bar was charged with ethyl 2-oxocyclopentane-1-carboxylate (15.6 mg, 0.1 mmol) and K_2CO_3 (13.2 mg, 0.1 mmol) in dry CH_2Cl_2 (1 mL) and allowed to stired at room temperature for 20 minutes. Then **4g** (31.2 mg, 0.1 mmol) in dry CH_2Cl_2 (1 mL) was slowly added by a syringe. After stirring at rt for 20 hours ,The reaction mixture was directly purified by flash chromatography on silica gel to give desired product as a white solid (39.7 mg, 85%): m.p.86–88 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 6.7 Hz, 2H), 7.61 (d, *J* = 7.5 Hz, 2H), 7.52–7.46 (m, 4H), 7.42 (d, *J* = 7.0 Hz, 1H), 5.21 (d, *J* = 10.9 Hz, 0.3H), 4.60 (d, *J* = 10.1 Hz, 0.7H), 4.02–3.90 (m, 0.5H), 3.90–3.76 (m, 1H), 3.61–3.50 (m, 0.5H), 3.06 (d, *J* = 9.1 Hz, 0.5H), 3.02 (s, 0.5H), 2.76–2.71 (m, 0.5H), 2.67 (d, *J* = 15.0 Hz, 1H), 2.56 (d, *J* = 12.6 Hz, 0.5H), 2.39 (d, *J* = 19.3 Hz, 0.5H), 2.22 (d, *J* = 9.1 Hz, 0.5H), 2.20–2.12 (m, 0.5H), 1.99 (d, *J* = 7.1 Hz, 1.5H), 1.91–1.81 (m, 1.5H), 1.52 (dd, *J* = 21.4, 9.2 Hz, 0.5H), 1.18 (t, *J* = 6.9 Hz, 1H), 1.05 (t, *J* = 6.9 Hz, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 213.1, 212.0, 169.9, 168.6, 143.0, 142.9, 131.0, 128.9, 128.0, 128.0, 127.6, 127.5, 127.4, 127.3, 127.0, 119.9 (q, *J* = 330.3.Hz), 119.8 (q, *J* = 330.9 Hz), 64.4, 63.4, 62.0, 61.9, 59.1, 58.1, 37.0, 37.0, 35.0, 32.6, 32.5, 32.4, 19.4, 19.1, 13.8, 13.6. ^{19}F NMR (377 MHz, $CDCl_3$) δ -72.62 (s, 2F), -73.10 (s, 1F). IR (thin film) ν 2254, 1724, 1363, 1210, 1115, 903, 724, 649 cm^{-1}. MS (ESI): *m/z* (%) 491 $[M+Na]^+$.

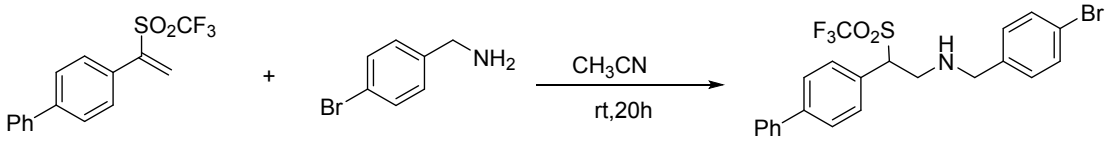
4-(2-Methoxy-1-((trifluoromethyl)sulfonyl)ethyl)-1,1'-biphenyl (**7**)



4g **7**

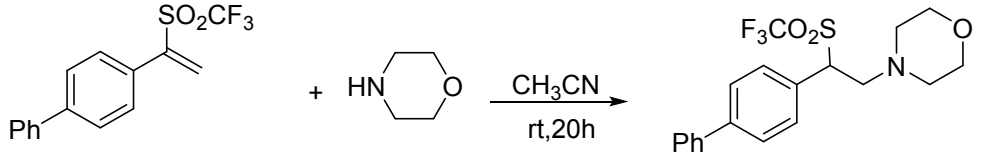
A 15 mL glass tube equipped with a magnetic stirring bar was charged with **4g** (31.2 mg, 0.1mmol) and in dry CH_3OH (2 mL) and allowed to stirred at room temperature for 20 h under N_2 atmosphere. The reaction mixture was directly purified by flash chromatography on silica gel to give desired product as a white solid (30.9 mg, 90%). m.p. 132–134 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.2 Hz, 2H), 7.62 (d, *J* = 6.6 Hz, 2H), 7.53 (d, *J* = 8.5 Hz, 2H), 7.48 (d, *J* = 6.9 Hz, 2H), 7.42 (d, *J* = 6.5 Hz, 1H), 4.76 (s, 1H), 4.31 (t, *J* = 8.3 Hz, 1H), 4.11 (d, *J* = 5.1 Hz, 1H), 3.46 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.1, 139.9, 130.4, 128.9, 127.9, 127.8, 127.1, 126.1, 119.6 (q, *J* = 329.5 Hz), 70.1, 67.4, 59.3. ^{19}F NMR (377 MHz, $CDCl_3$) δ -74.3 (s, 3F). IR (thin film) ν 2973, 1460, 1380, 1087, 1045, 903, 880, 723 cm^{-1}. MS (ESI): *m/z* (%) 367 $[M+Na]^+$.

2-([1,1'-Biphenyl]-4-yl)-N-(4-bromobenzyl)-2-((trifluoromethyl)sulfonyl)ethan-1-amine (**8**)



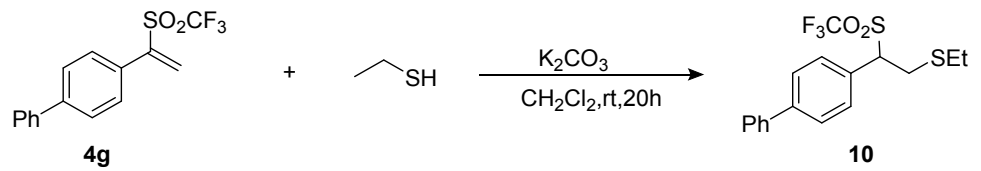
A 15 mL glass tube equipped with a magnetic stirring bar was charged with **4g** (31.2 mg, 0.1 mmol) and (4-bromophenyl)methanamine (37.2 mg, 0.2 mmol) in dry CH_3CN (2 mL) and allowed to stired at room temperature for 20 h under N_2 atmosphere. The reaction mixture was directly purified by flash chromatography on silica gel to give desired product as a white solid (44.7 mg, 90%). m.p. 84–86 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.1 Hz, 2H), 7.62 (d, *J* = 7.0 Hz, 2H), 7.53–7.39 (m, 7H), 7.15 (d, *J* = 7.3 Hz, 2H), 4.71 (s, 1H), 3.84–3.75 (m, 2H), 3.74–3.64 (m, 1H), 3.50–3.41 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.1, 139.7, 138.0, 131.6, 130.2 129.7, 128.9, 128.1, 128.2, 127.1, 126.8, 121.2, 119.7 (q, *J* = 328.9 Hz), 66.6, 52.5, 47.2. ^{19}F NMR (377 MHz, $CDCl_3$) δ -73.96 (s, 3F). IR (thin film) ν 2254, 1381, 1212, 1114, 1072, 903, 723, 649 cm^{-1}. MS (ESI): *m/z* (%) 498 $[M+H]^+$.

4-(2-([1,1'-Biphenyl]-4-yl)-2-((trifluoromethyl)sulfonyl)ethyl)morpholine (**9**)



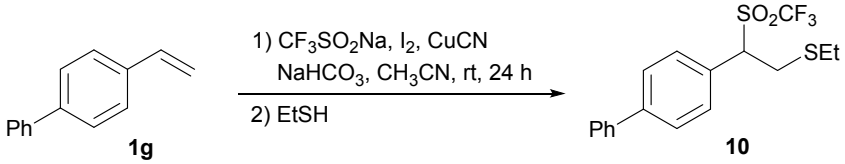
A 15 mL glass tube equipped with a magnetic stirring bar was charged with **4g** (31.2 mg, 0.1 mmol) and morpholine (17.4 mg, 0.2 mmol) in dry CH_3CN (2 mL) and allowed to stirred at room temperature for 20 h under N_2 atmosphere. The reaction mixture was directly purified by flash chromatography on silica gel to give desired product as a white solid (35.9 mg, 90%). m.p. 136–138 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.1 Hz, 2H), 7.63 (d, *J* = 6.9 Hz, 2H), 7.50 (d, *J* = 7.9 Hz, 4H), 7.42 (d, *J* = 6.6 Hz, 1H), 4.71 (d, *J* = 5.3 Hz, 1H), 3.68 (s, 4H), 3.57 (dd, *J* = 13.1 Hz, 6.9 Hz, 1H), 3.11 (dd, *J* = 13.7 Hz, 4.8 Hz, 1H), 2.56 (s, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.9, 139.8, 130.4, 128.9, 127.9, 127.8, 127.4, 127.1, 119.9 (q, *J* = 328.5 Hz), 66.6, 65.9, 57.8, 53.5. ^{19}F NMR (377 MHz, $CDCl_3$) δ -73.3 (s, 3F). IR (thin film) ν 2918, 2864, 1486, 1454, 1341, 1185, 1116, 1009, 736 cm^{-1}. MS (ESI): *m/z* (%) 400 $[M+H]^+$.

(2-([1,1'-Biphenyl]-4-yl)-2-((trifluoromethyl)sulfonyl)ethyl)(ethyl)sulfane (**10**)



A 15 mL glass tube equipped with a magnetic stirring bar was charged with ethanethiol (6.2 mg, 0.1 mmol) and K_2CO_3 (13.6 mg, 0.1 mmol) in dry CH_2Cl_2 (1 mL) and allowed to stirred at room temperature for 20 minutes. Then **4g** (31.2 mg, 0.1 mmol) in dry CH_2Cl_2 (1 mL) was slowly added by a syringe. After stirring at rt for 20 hours, the reaction mixture was directly purified by flash chromatography on silica gel to give desired product as white solid (32.1 mg, 86%). m.p. 90–92 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, *J* = 7.5 Hz, 2H), 7.64 (d, *J* = 7.3 Hz, 2H), 7.56–7.45 (m, 4H), 7.45–7.38 (m, 1H), 4.62 (d, *J* = 11.6 Hz, 1H), 3.53 (d, *J* = 13.5 Hz, 1H), 3.37 (t, *J* = 12.6 Hz, 1H), 2.48 (q, *J* = 7.0 Hz, 2H), 1.24 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.2, 139.7, 130.5, 128.9, 127.9, 127.8, 127.2, 126.7, 119.9 (q, *J* = 332.3 Hz), 67.5, 29.7, 26.9, 14.4. ^{19}F NMR (377 MHz, $CDCl_3$) δ -73.1 (s, 3F). IR (thin film) ν 2254, 1559, 1487, 1362, 1213, 1114, 903, 723 cm^{-1}. MS (ESI): *m/z* (%) 392 $[M+NH_4]^+$.

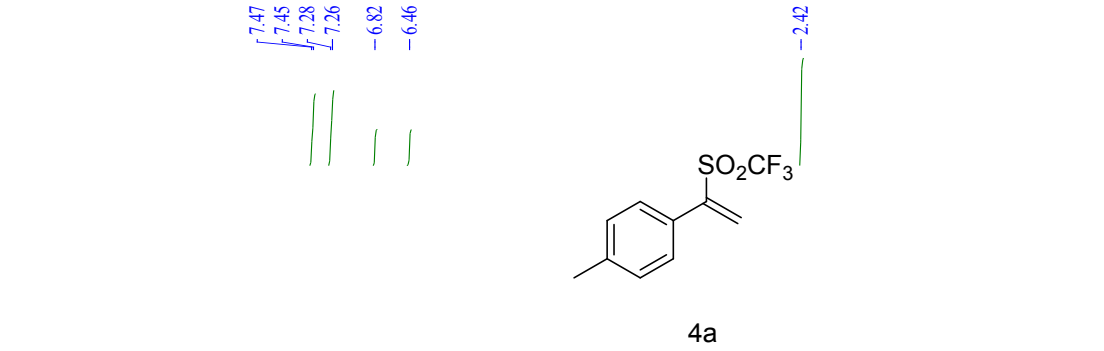
4. Gram-scale preparation of 10



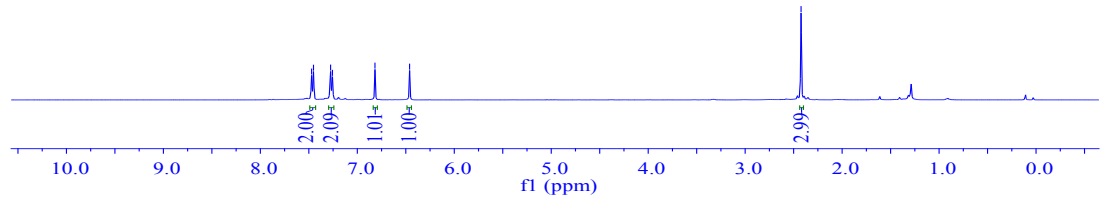
A 100 mL three neck flask equipped with a magnetic stirring bar was charged with **1g** (1.8 g, 10.0 mmol), CF_3SO_2Na (4.68 g, 30.0 mmol), I_2 (7.6 g, 30.0 mmol), $NaHCO_3$ (1.68 g, 20.0 mmol), CuCN (88.9 mg, 1.0 mmol) and CH_3CN (38.0 mL). After stirring at rt for 12 hours, saturated aqueous $Na_2S_2O_3$ solution was added. Then, the reaction mixture was extracted with ethyl acetate. The organic phase was washed with H_2O and brine, dried by Na_2SO_4, concentrated in vacuo to give the crude product.

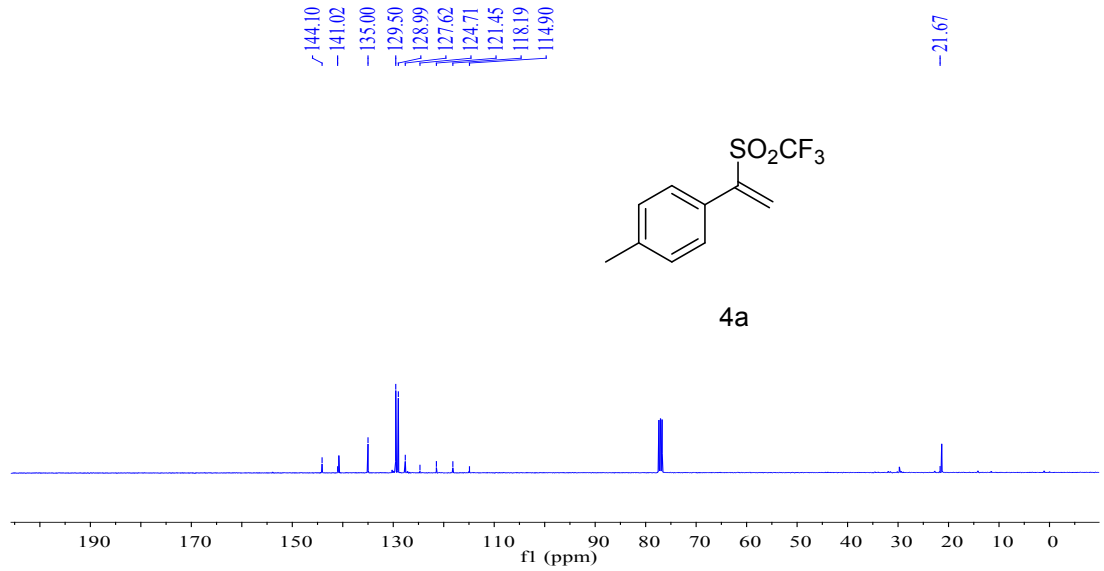
A100 mL three neck flask equipped with a magnetic stirring bar was charged with ethanethiol (372.6 mg, 6.0 mmol) and K_2CO_3 (829.2 mg, 6.0 mmol) in dry CH_2Cl_2 (60 ml) and allowed to stired at room temperature for 20 minutes. And then the crude product in dry CH_2Cl_2 (60 mL) was slowly added by a stringe. After stirring at rt for 20 hours, the reaction mixture was directly purified by flash chromatography on silica gel to give desired product **10** in as white solid (1.71 g, 46%).

5. Copies of ^{1}H,^{19}F and ^{13}C NMR spectra for the products.

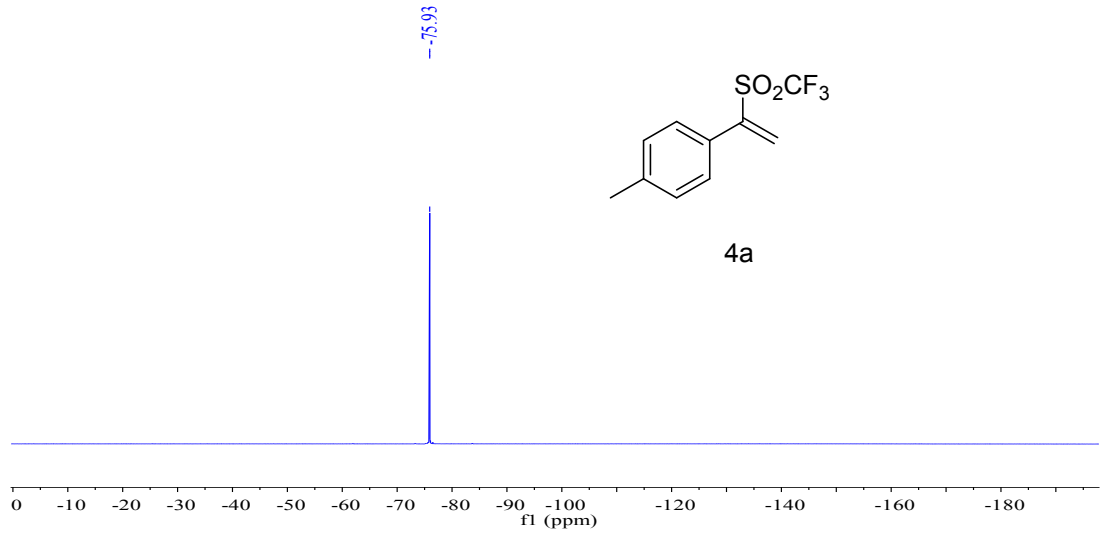


4a

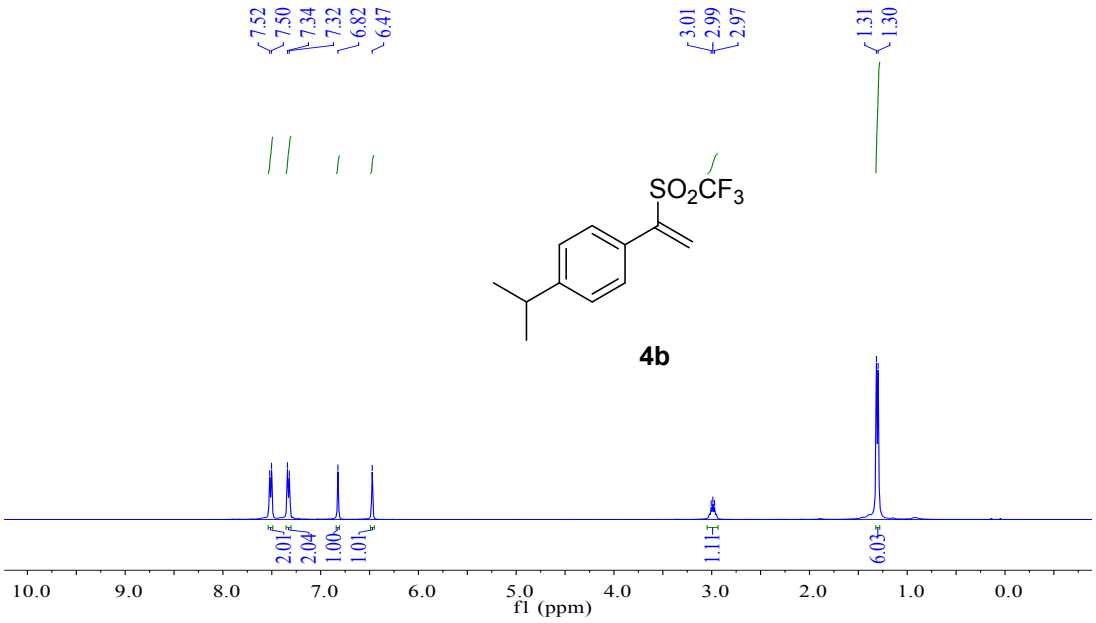


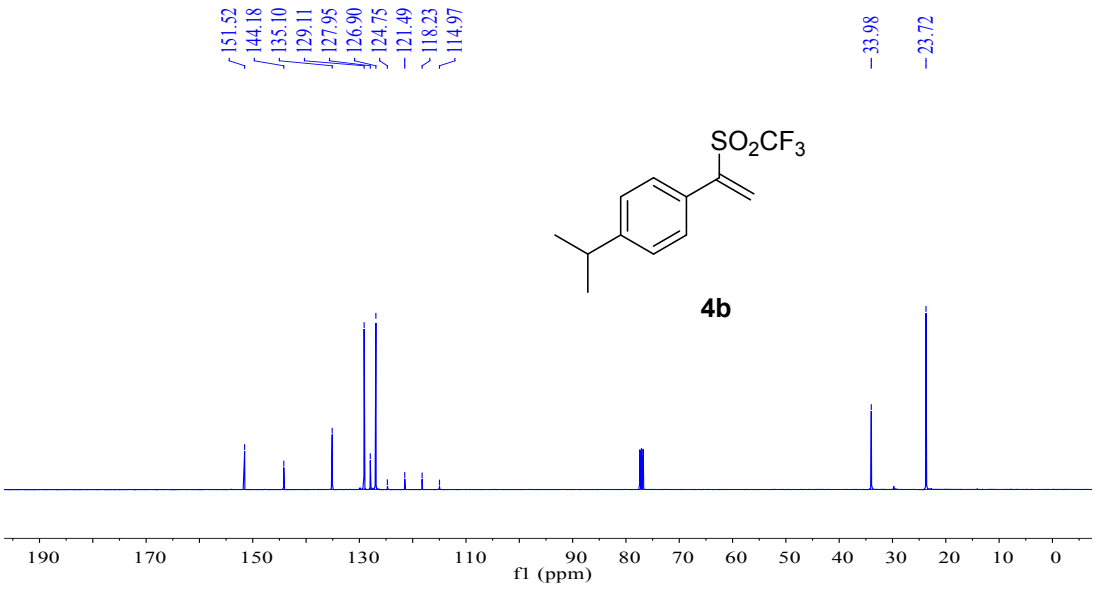


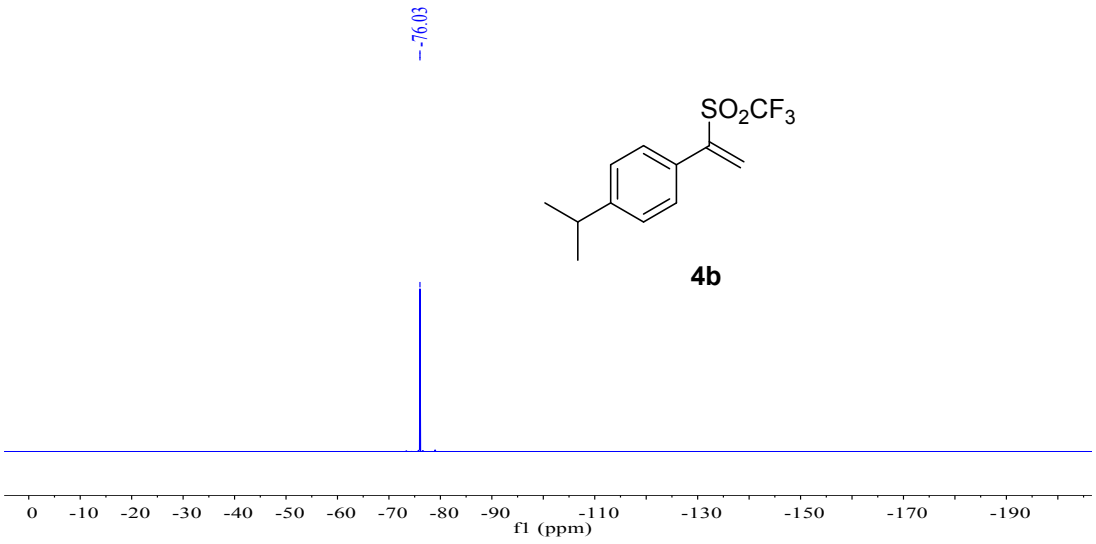
4a

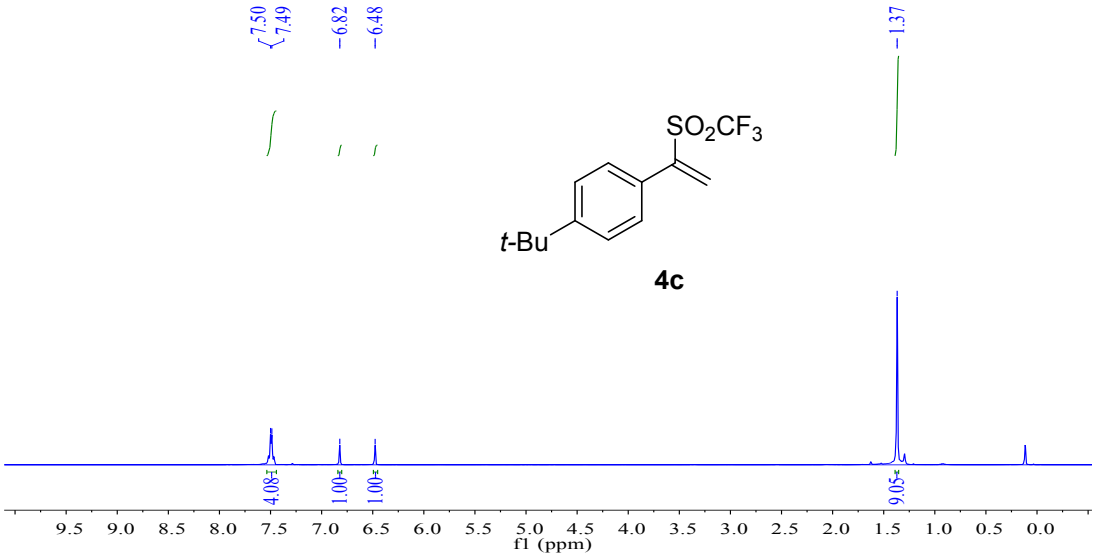


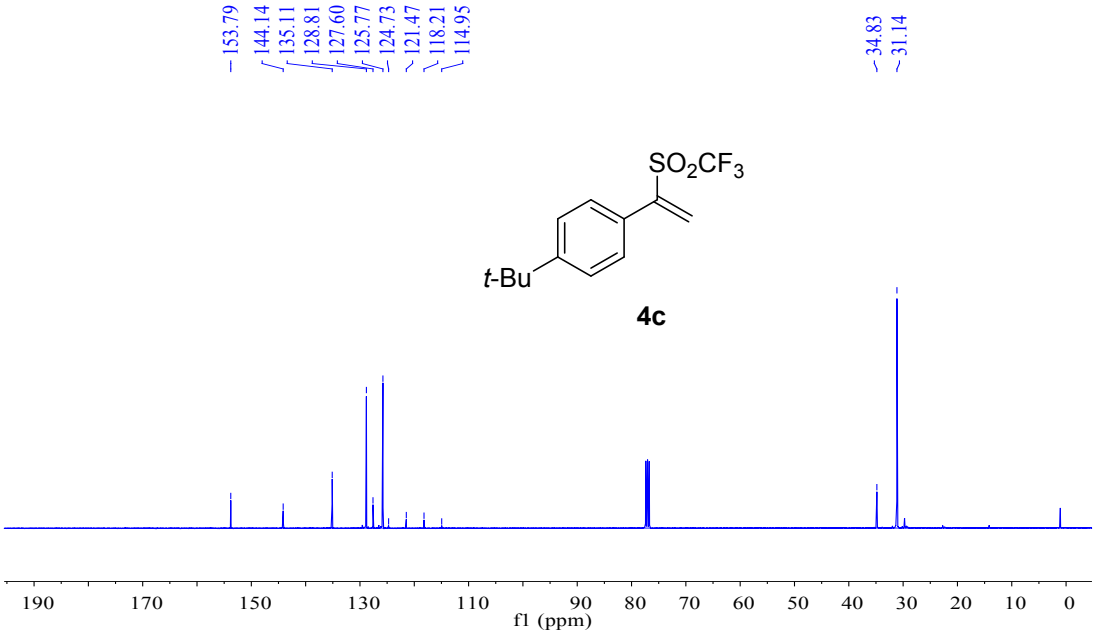
4a

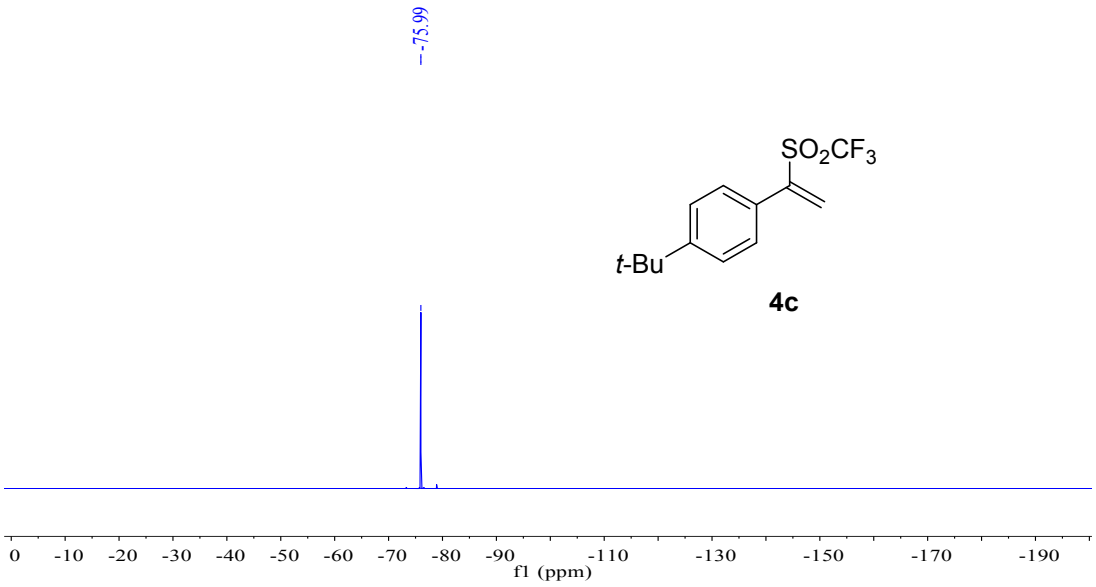

7.52
7.50
7.34
7.32
6.82
6.47
3.01
2.99
2.97
1.31
1.30
SO2CF3
4b
2.01
2.04
1.00
1.01
1.11
6.03
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

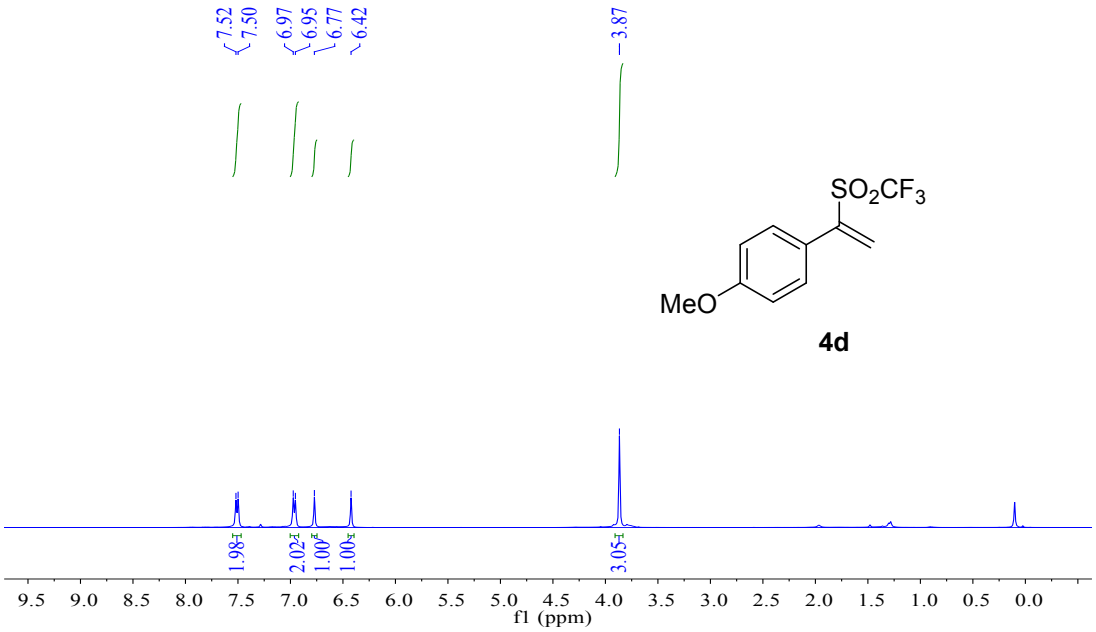

151.52
144.18
135.10
129.11
127.95
126.90
124.75
121.49
118.23
114.97
33.98
23.72
SO2CF3
4b
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

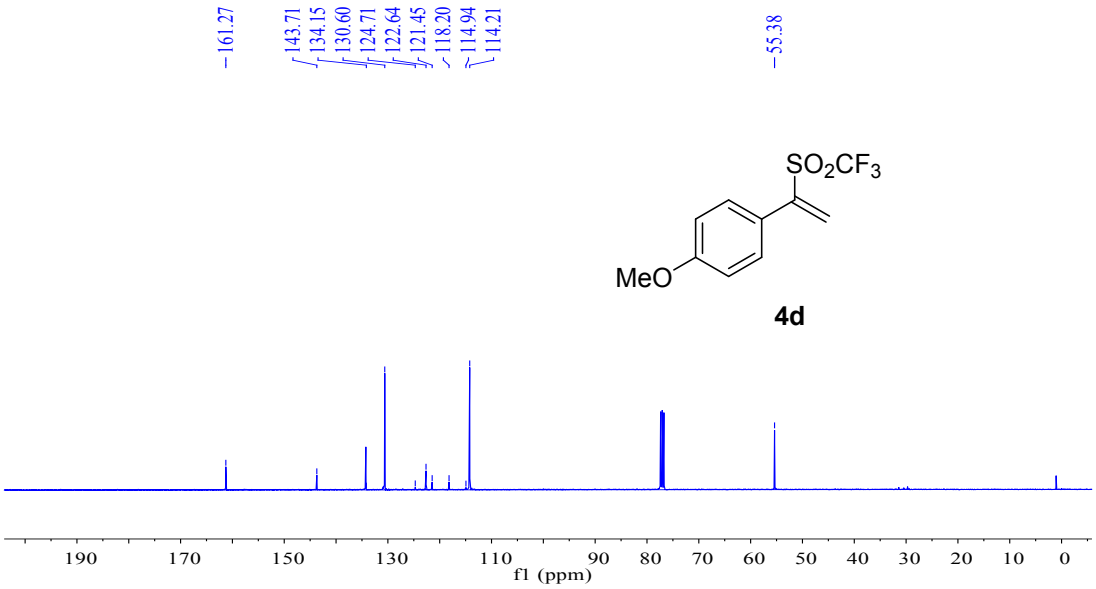

-76.03
SO2CF3
4b
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

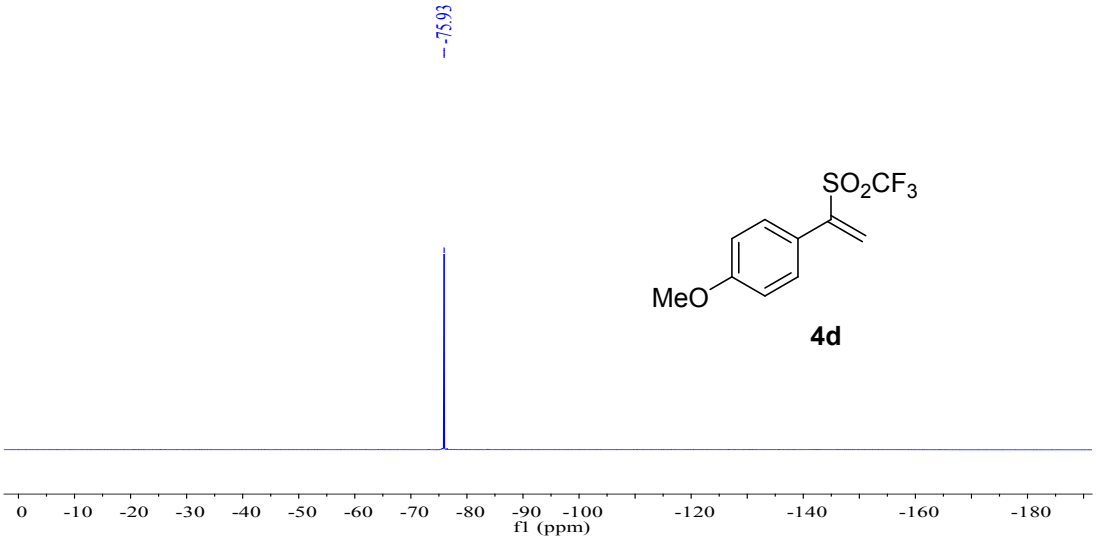

7.50
7.49
6.82
6.48
1.37
SO2CF3
t-Bu
4c
4.08
1.00
1.00
9.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

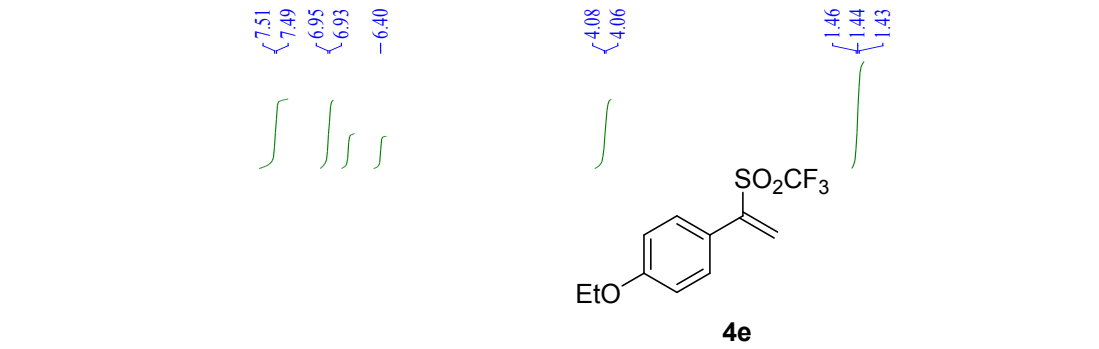

153.79
144.14
135.11
128.81
127.60
125.77
124.73
121.47
118.21
114.95
34.83
31.14
SO2CF3
t-Bu
4c
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-75.99
SO2CF3
t-Bu
4c
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

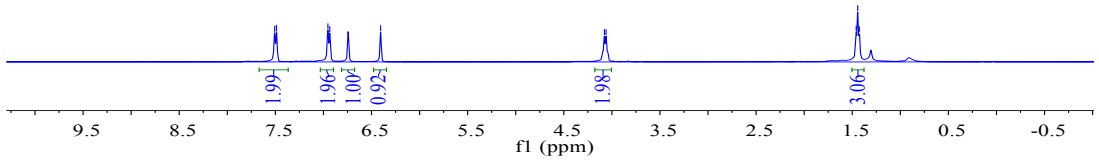

7.52
7.50
6.97
6.95
6.77
6.42
3.87
SO2CF3
MeO
4d
1.98
2.02
1.00
1.00
3.05
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

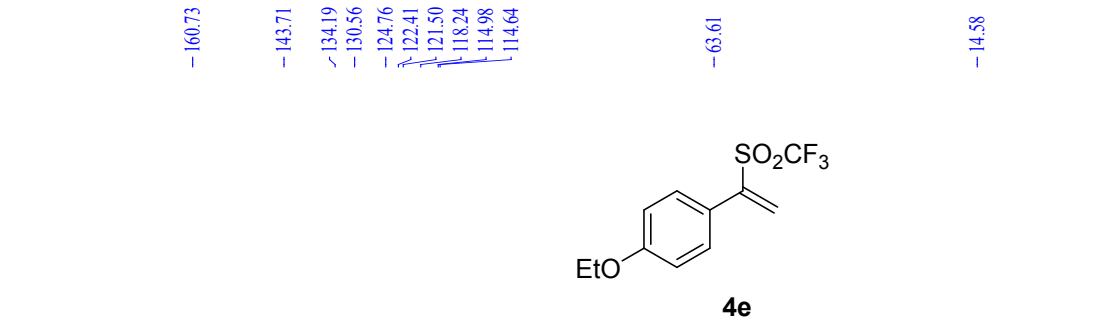

161.27
143.71
134.15
130.60
124.71
122.64
121.45
118.20
114.94
114.21
55.38
SO2CF3
MeO
4d
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-75.93
SO2CF3
MeO
4d
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -120 -140 -160 -180
f1 (ppm)

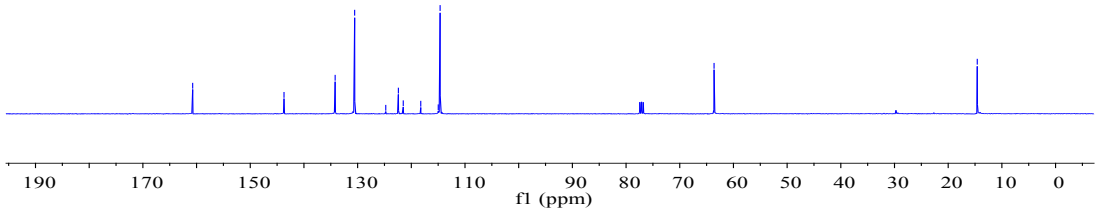

7.51
7.49
6.95
6.93
6.40
4.08
4.06
1.46
1.44
1.43
SO2CF3
EtO

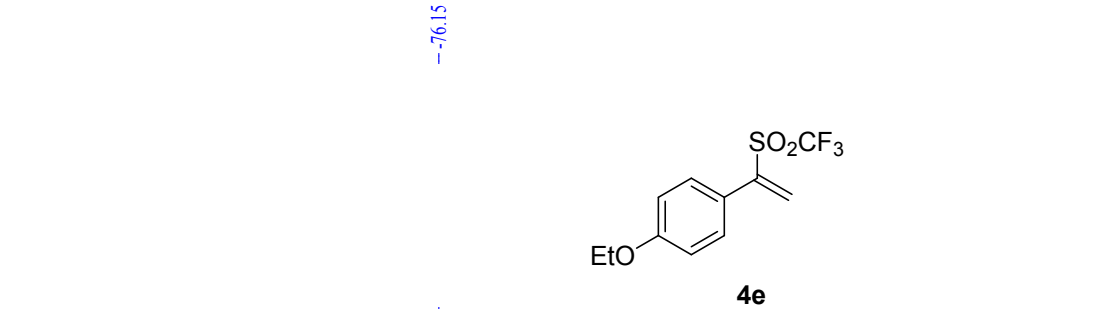
4e


1.99
1.96
1.00
0.92
1.98
3.06
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)

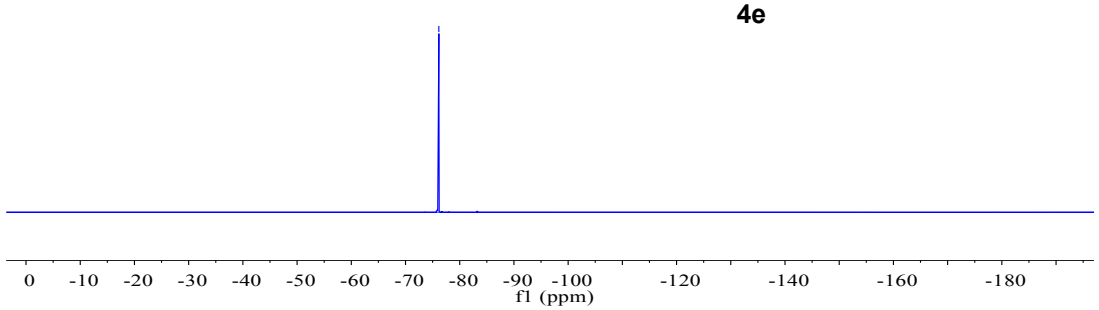

160.73
143.71
134.19
130.56
124.76
122.41
121.50
118.24
114.98
114.64
63.61
14.58
SO2CF3
EtO

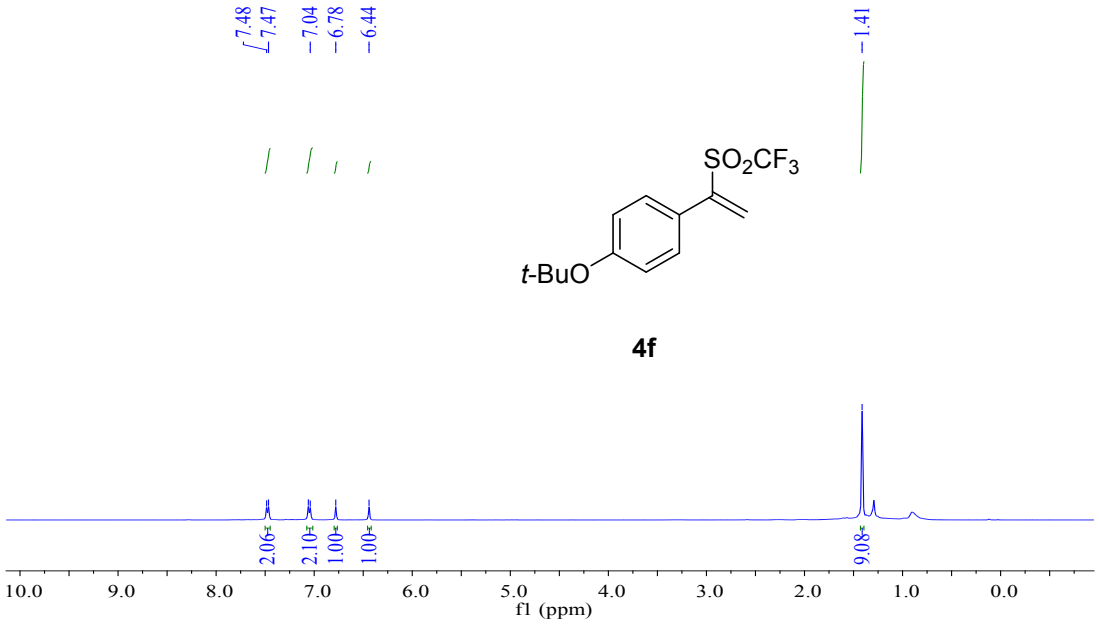
4e

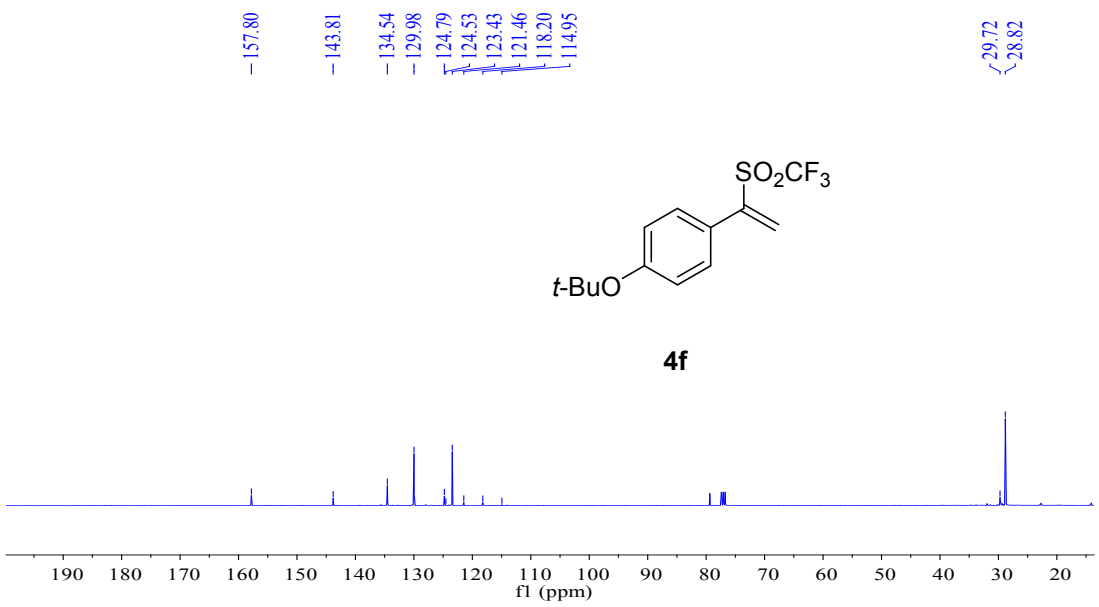

190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

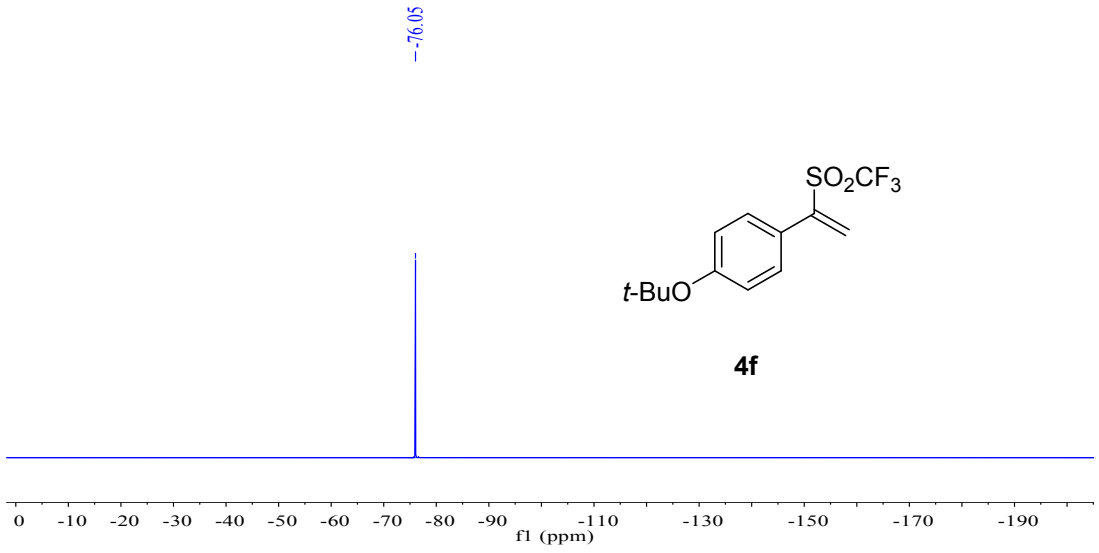

-76.15
SO2CF3
EtO

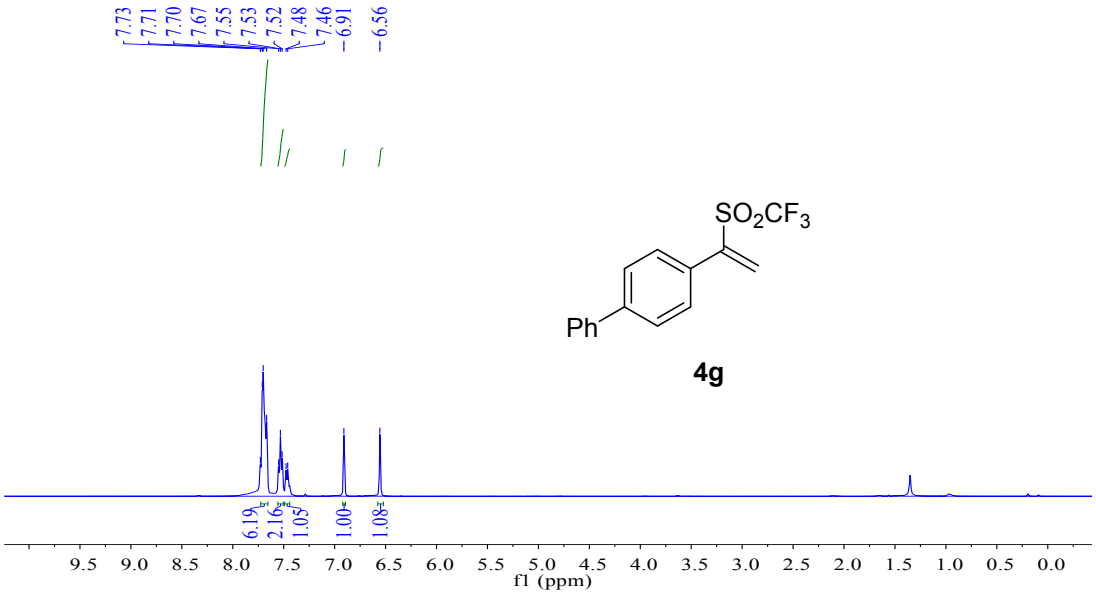
4e

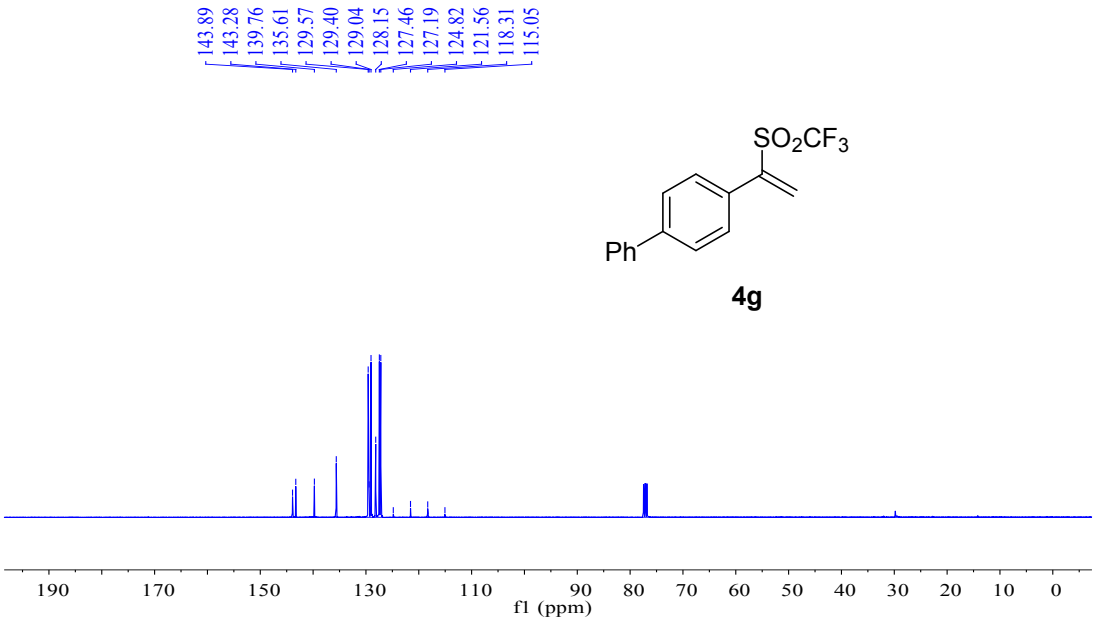

0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
f1 (ppm)

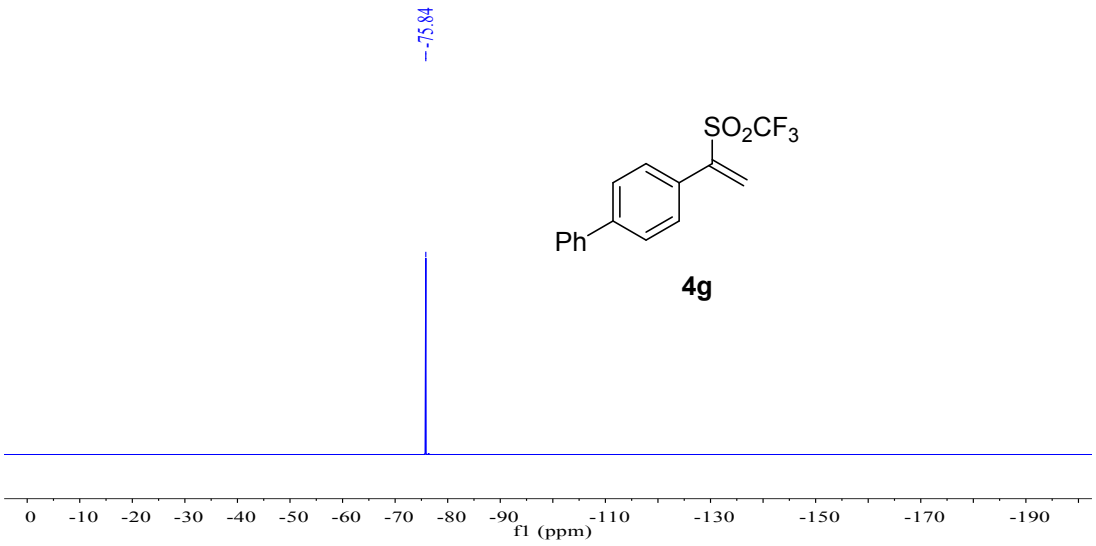

7.48
7.47
7.04
6.78
6.44
1.41
SO2CF3
t-BuO
4f
2.06
2.10
1.00
1.00
9.08
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

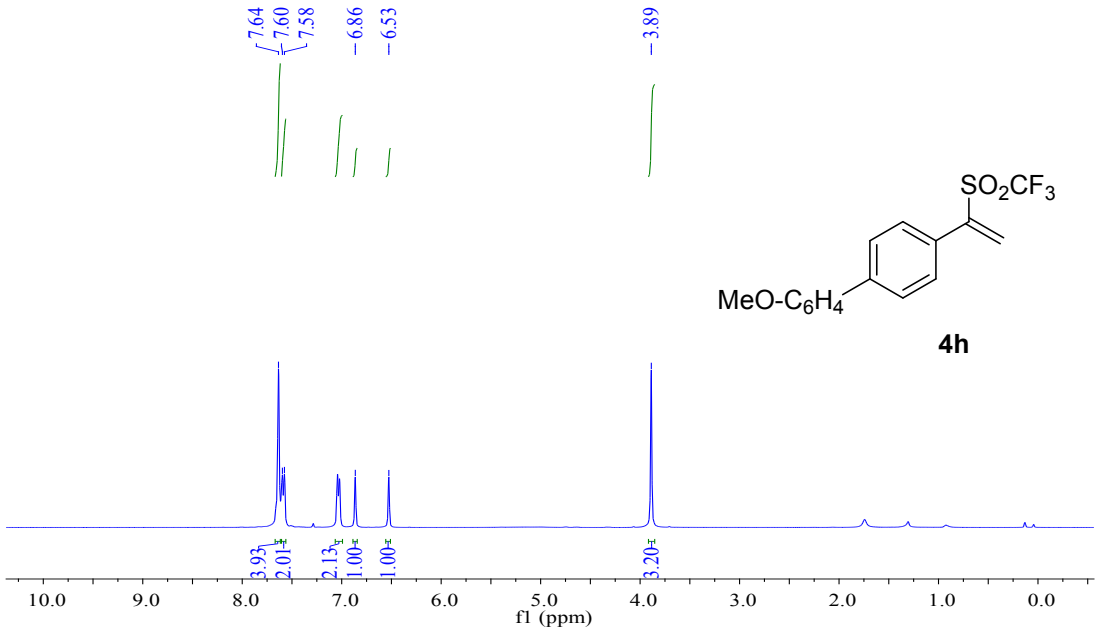

157.80
143.81
134.54
129.98
124.79
124.53
123.43
121.46
118.20
114.95
29.72
28.82
SO2CF3
t-BuO
4f
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
f1 (ppm)

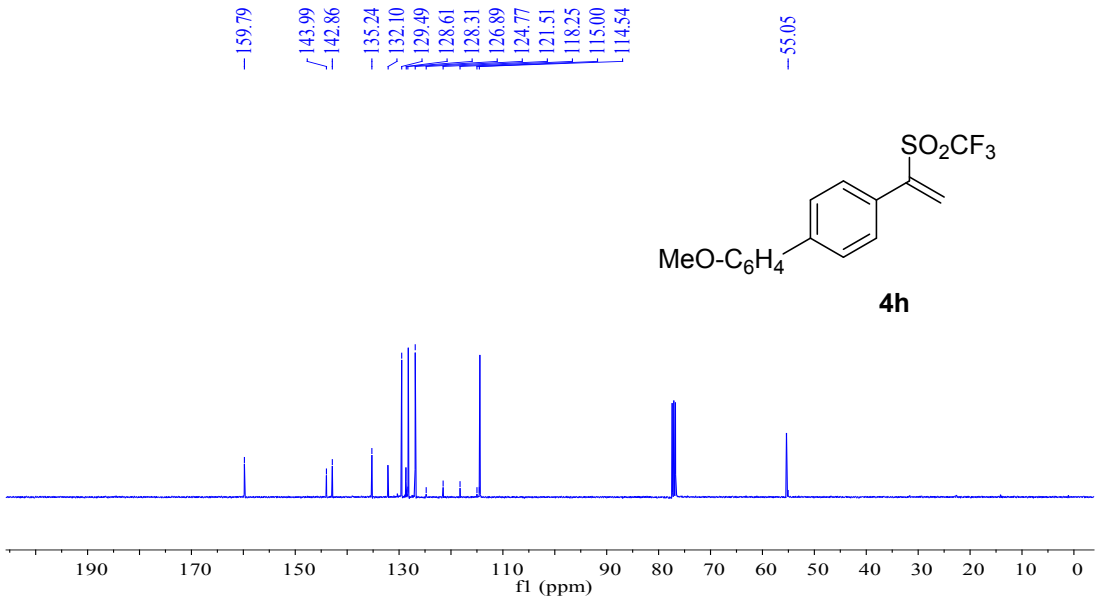

-76.05
SO2CF3
t-BuO
4f
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)

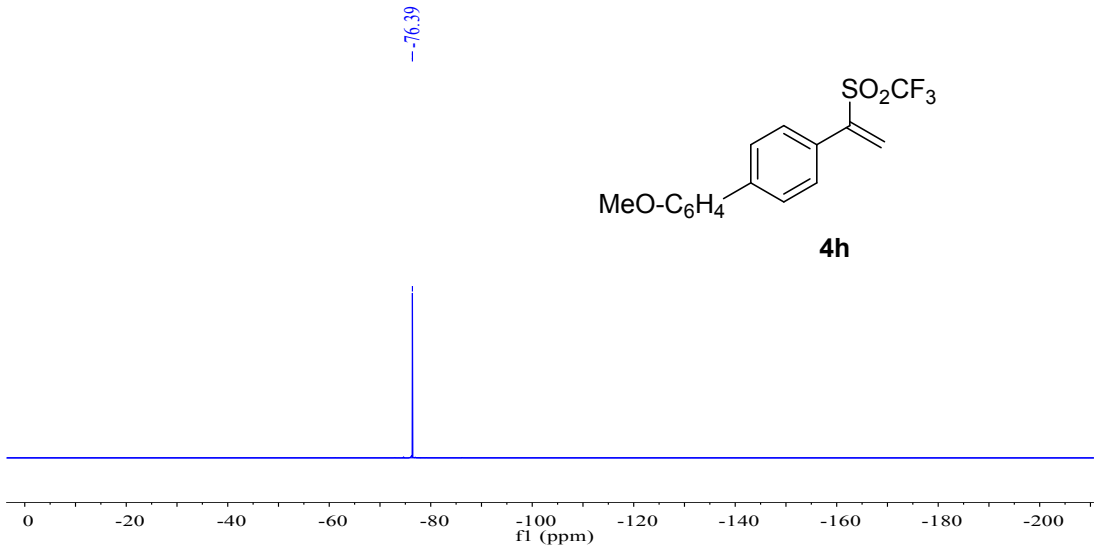

7.73
7.71
7.70
7.67
7.55
7.53
7.52
7.48
7.46
6.91
6.56
SO2CF3
Ph
4g
6.19
2.16
1.05
1.00
1.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

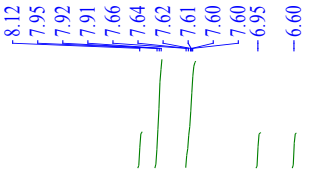

143.89
143.28
139.76
135.61
129.57
129.40
129.04
128.15
127.46
127.19
124.82
121.56
118.31
115.05
SO2CF3
Ph
4g
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

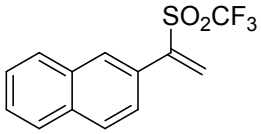

-75.84
SO2CF3
Ph
4g
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)


7.64
7.60
7.58
6.86
6.53
3.89
SO2CF3
MeO-C6H4
4h
3.93
2.01
2.13
1.00
1.00
3.20
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

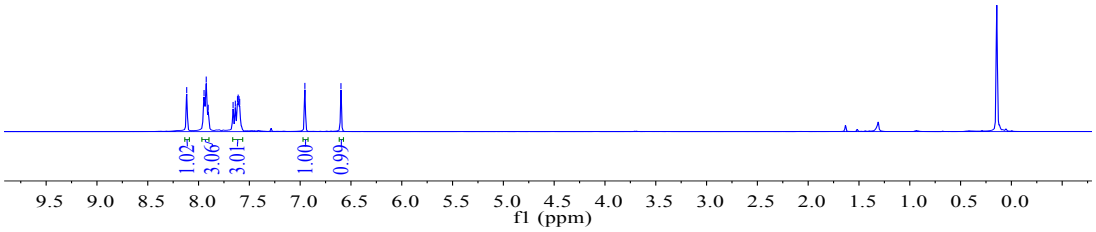

159.79
143.99
142.86
135.24
132.10
129.49
128.61
128.31
126.89
124.77
121.51
118.25
115.00
114.54
55.05
SO2CF3
MeO-C6H4
4h
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


-76.39
SO2CF3
MeO-C6H4
4h
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

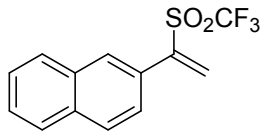

8.12
7.95
7.92
7.91
7.66
7.64
7.62
7.61
7.60
7.60
6.95
6.60


SO2CF3

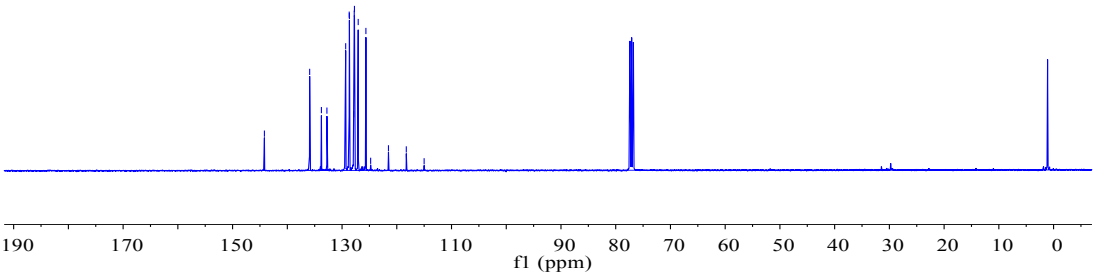
4i


1.02
3.06
3.01
1.00
0.99
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

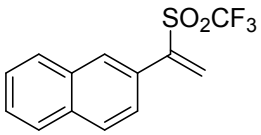

144.19
135.92
133.77
132.77
129.34
128.69
128.66
127.88
127.77
127.73
127.05
125.64
124.78
121.52
118.26
115.00


SO2CF3

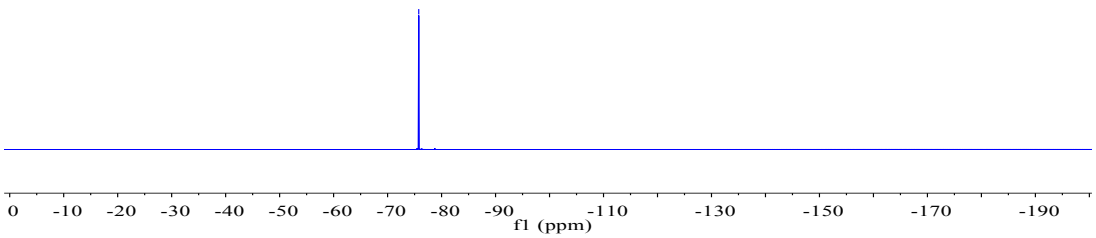
4i

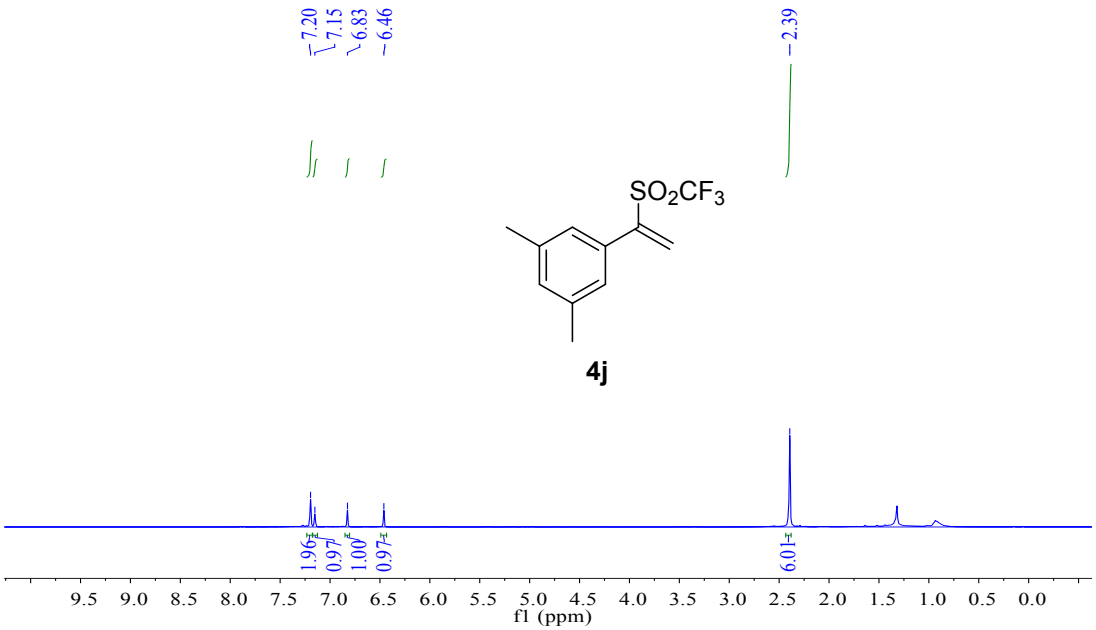

190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

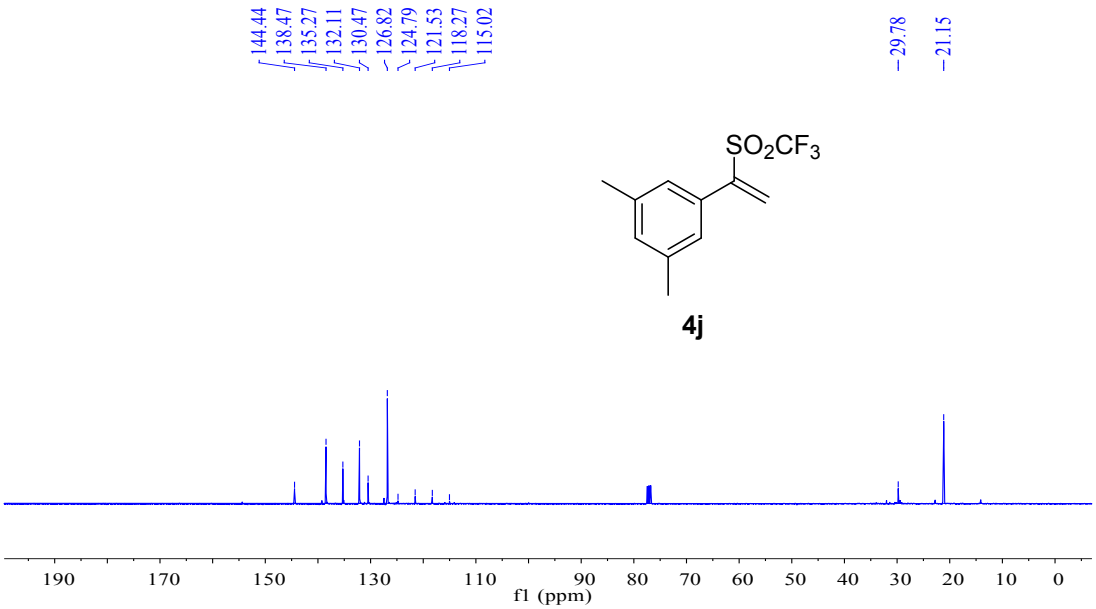

-75.77

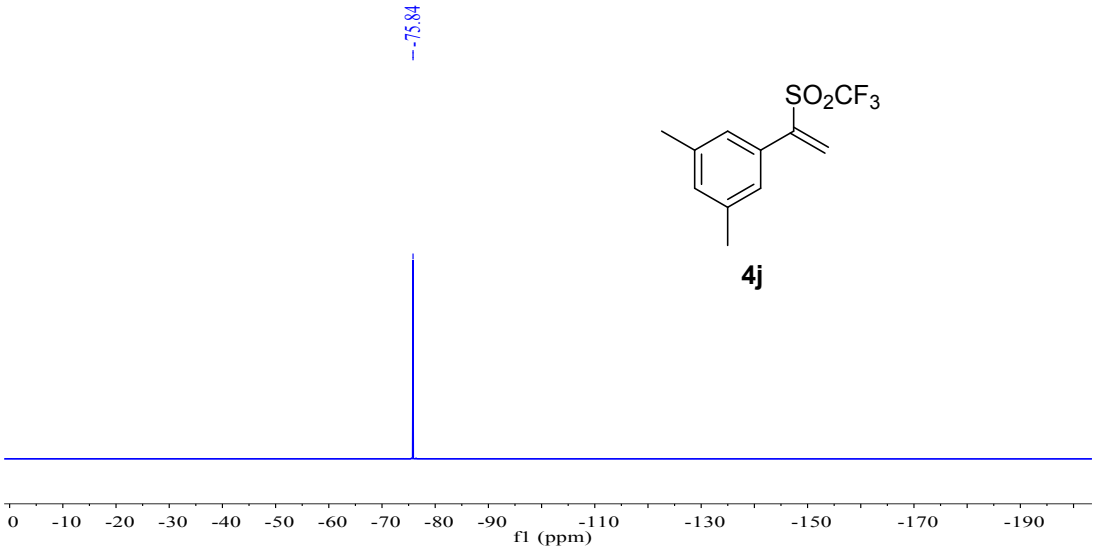

SO2CF3

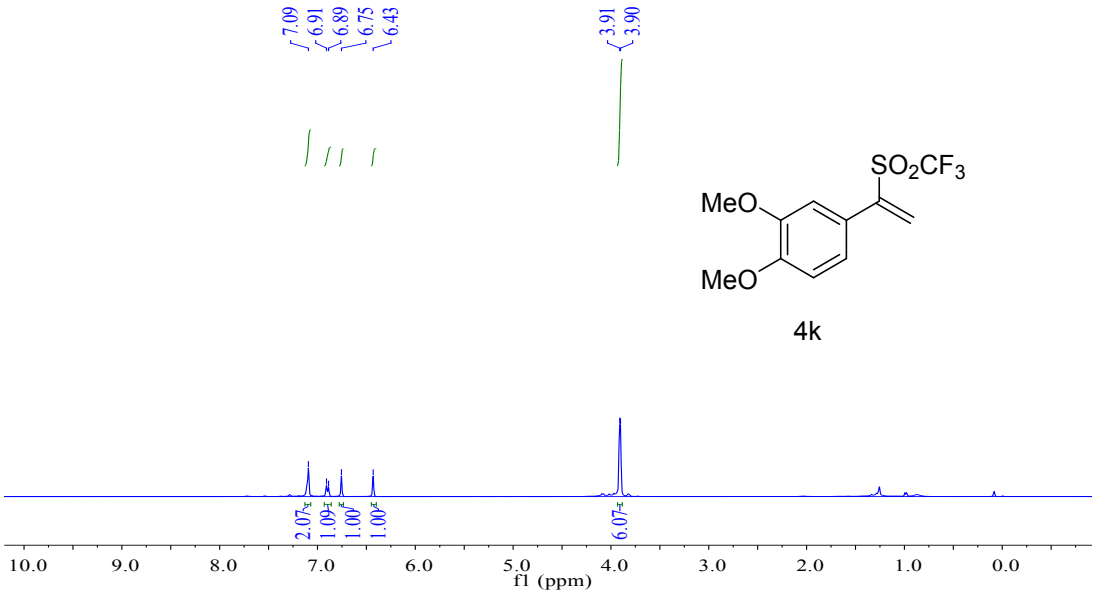
4i

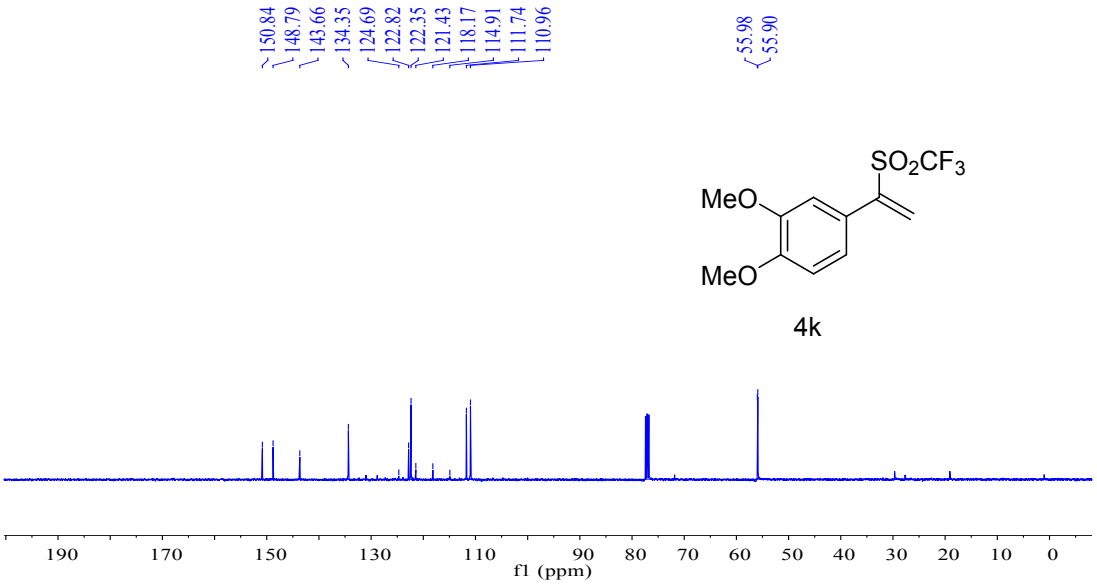

0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

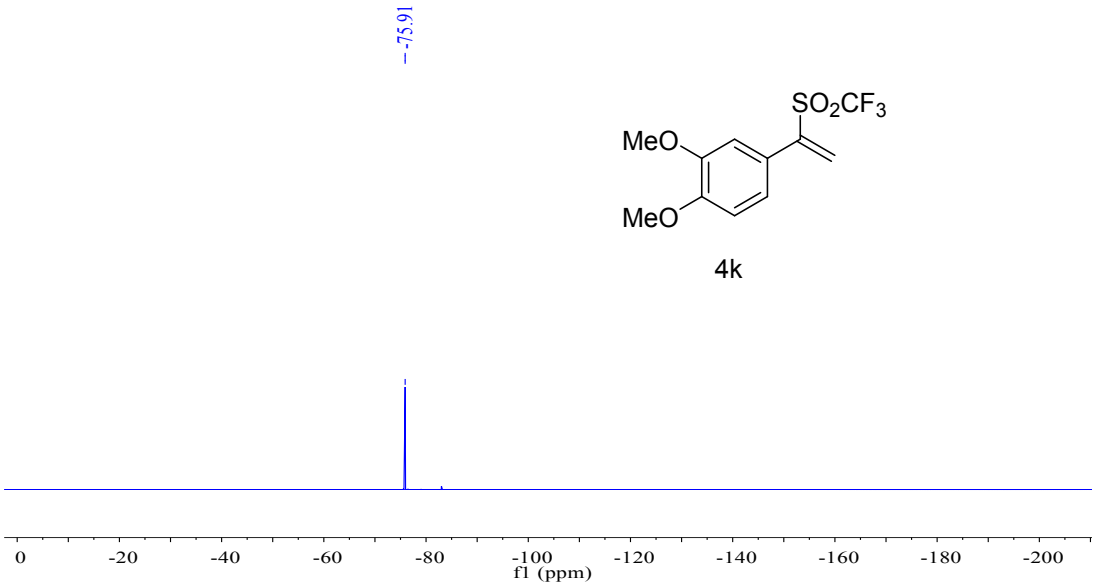

7.20
7.15
6.83
6.46
2.39
SO2CF3
4j
1.96
0.97
1.00
0.97
6.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

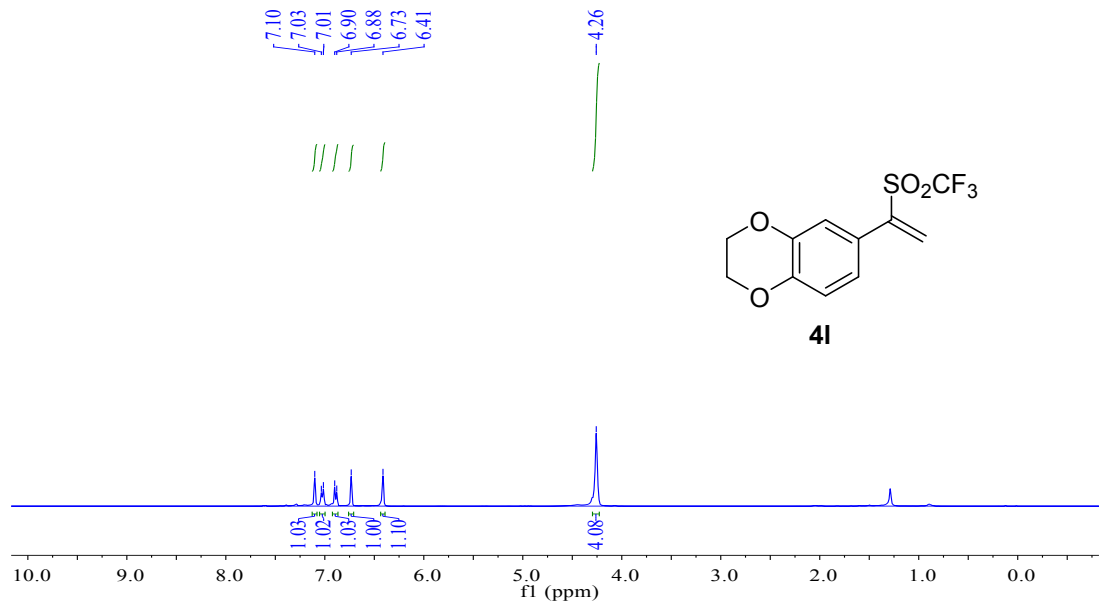

144.44
138.47
135.27
132.11
130.47
126.82
124.79
121.53
118.27
115.02
29.78
21.15
SO2CF3
4j
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-75.84
SO2CF3
4j
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

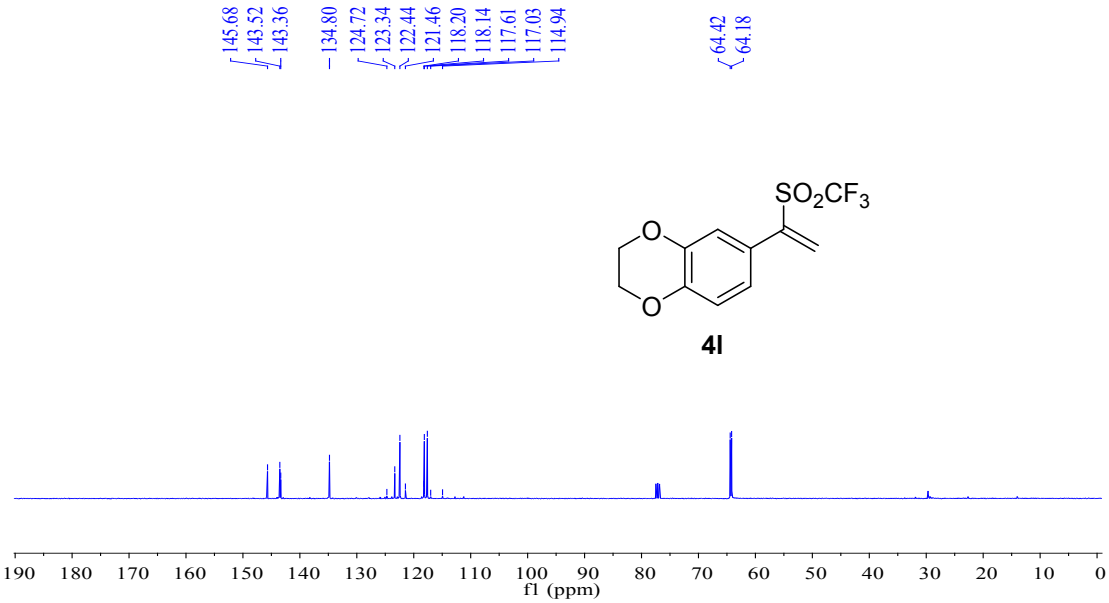

7.09
6.91
6.89
6.75
6.43
3.91
3.90
SO2CF3
MeO
MeO
4k
2.07
1.09
1.00
1.00
6.07
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


150.84
148.79
143.66
134.35
124.69
122.82
122.35
121.43
118.17
114.91
111.74
110.96
55.98
55.90
SO2CF3
MeO
MeO
4k
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

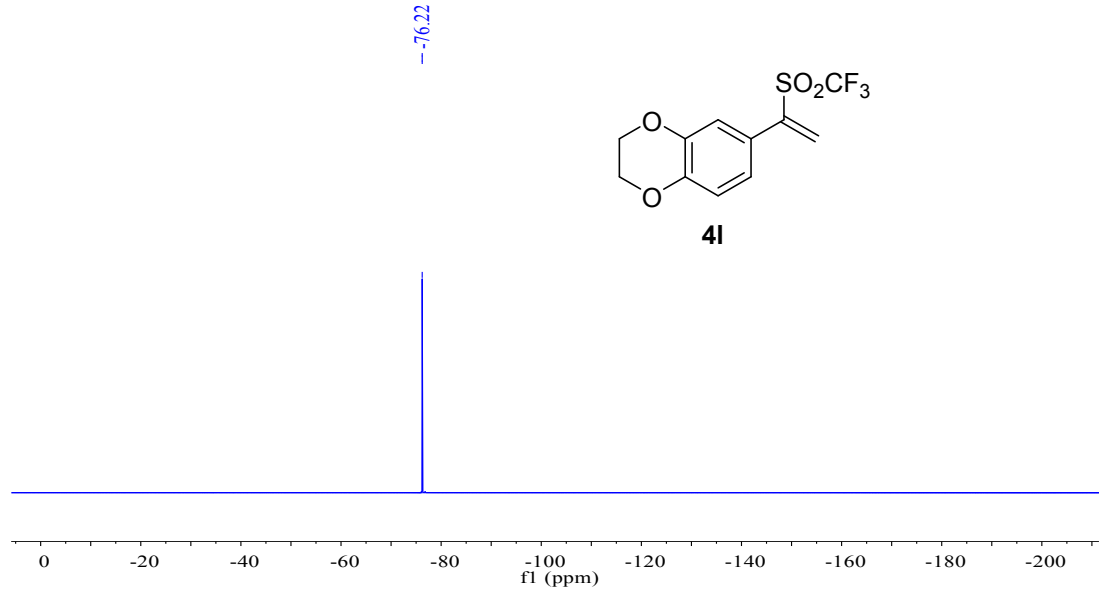

-75.91
SO2CF3
MeO
MeO
4k
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)


7.10
7.03
7.01
6.90
6.88
6.73
6.41
4.26
SO2CF3
O
O
1.03
1.02
1.03
1.00
1.10
4.08
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

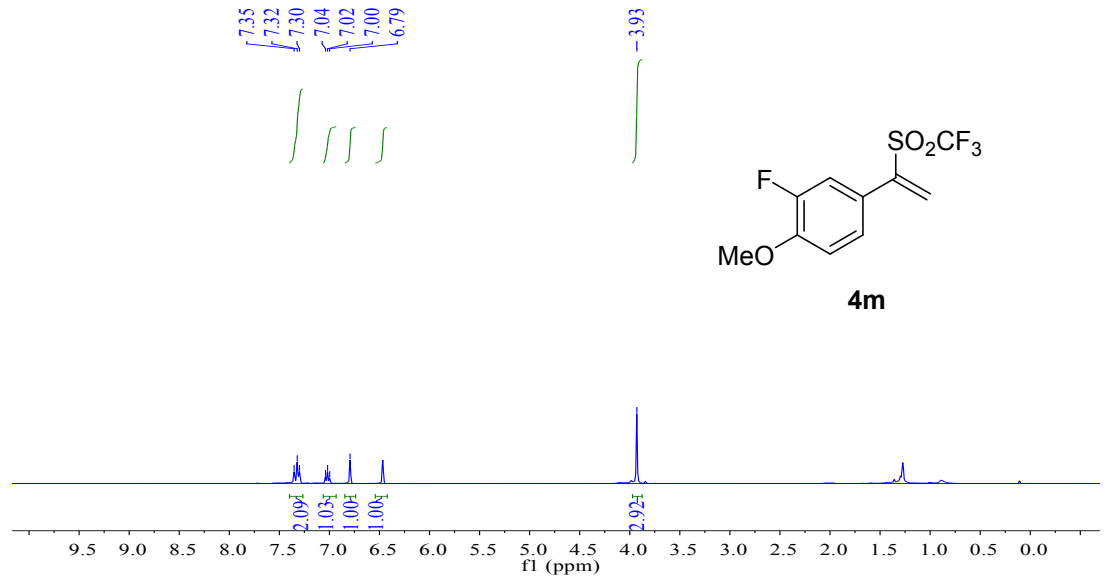
4l

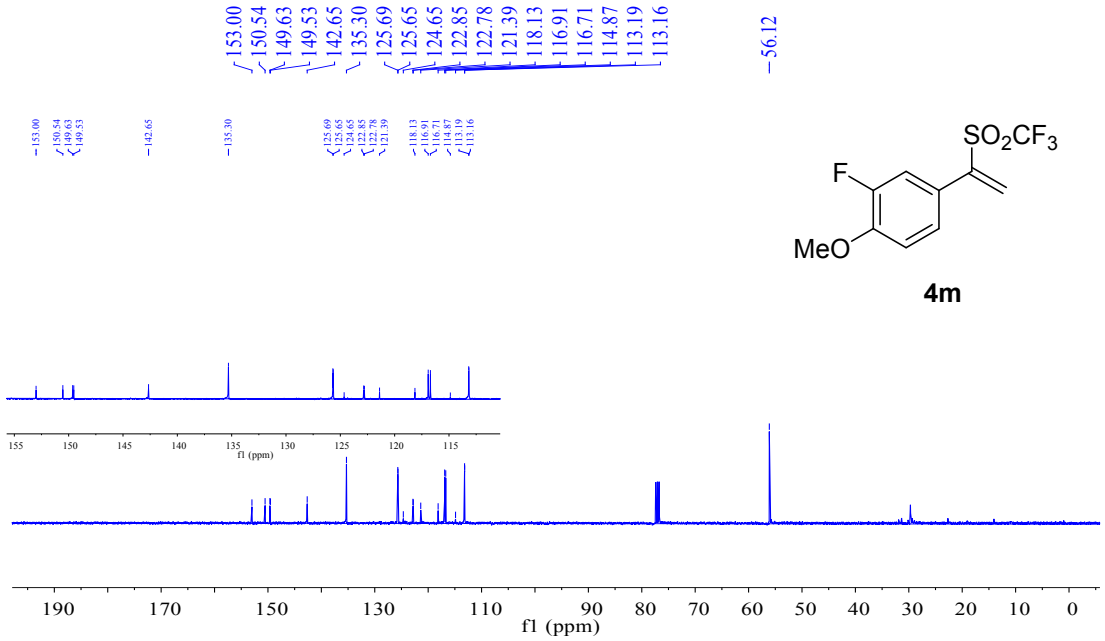

145.68
143.52
143.36
134.80
124.72
123.34
122.44
121.46
118.20
118.14
117.61
117.03
114.94
64.42
64.18
SO2CF3
O
O
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

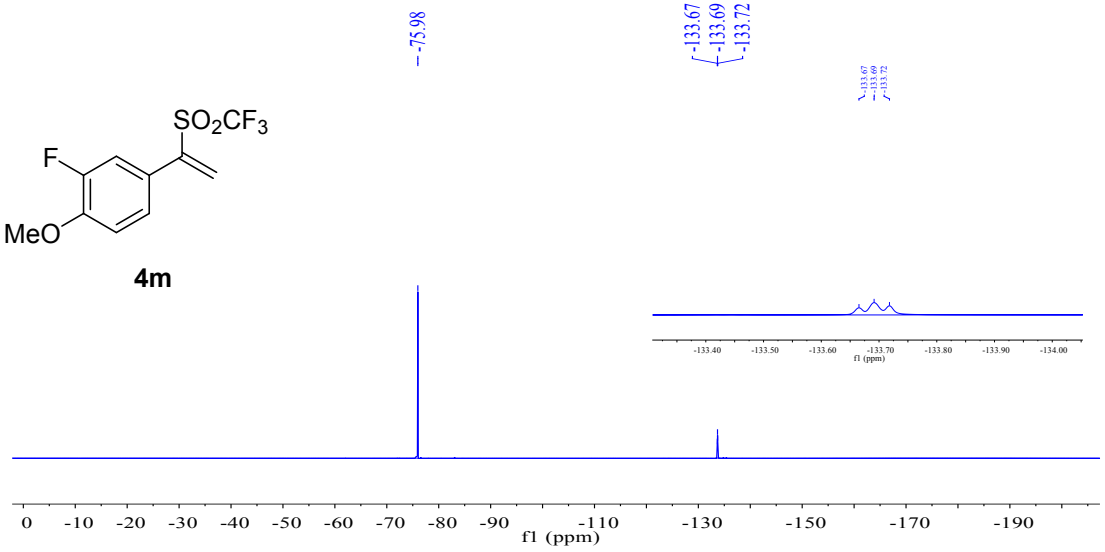
4l

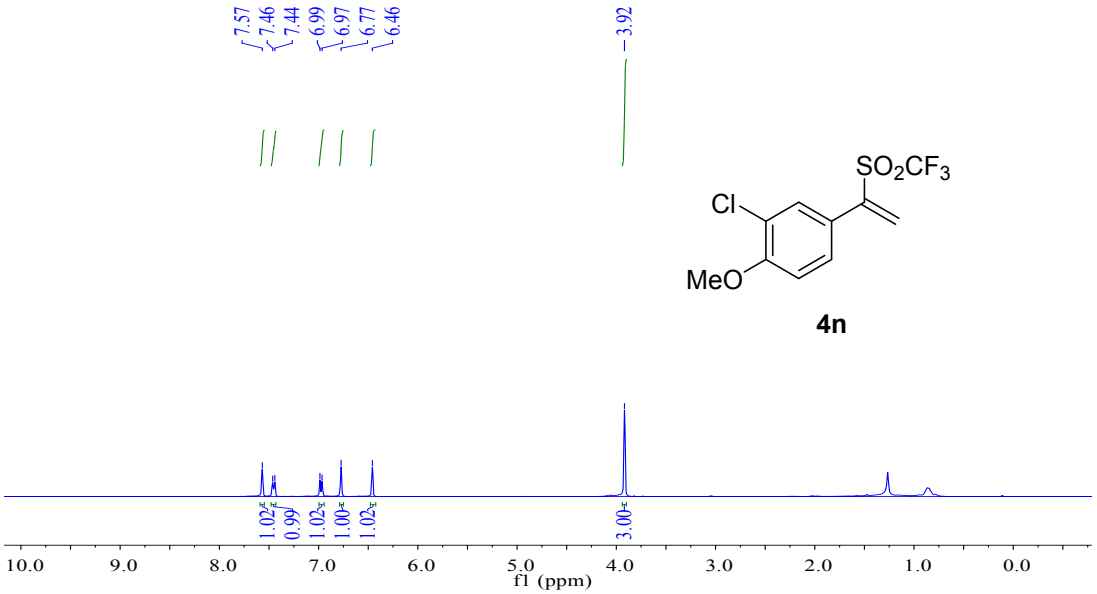

-76.22
SO2CF3
O
O
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
f1 (ppm)

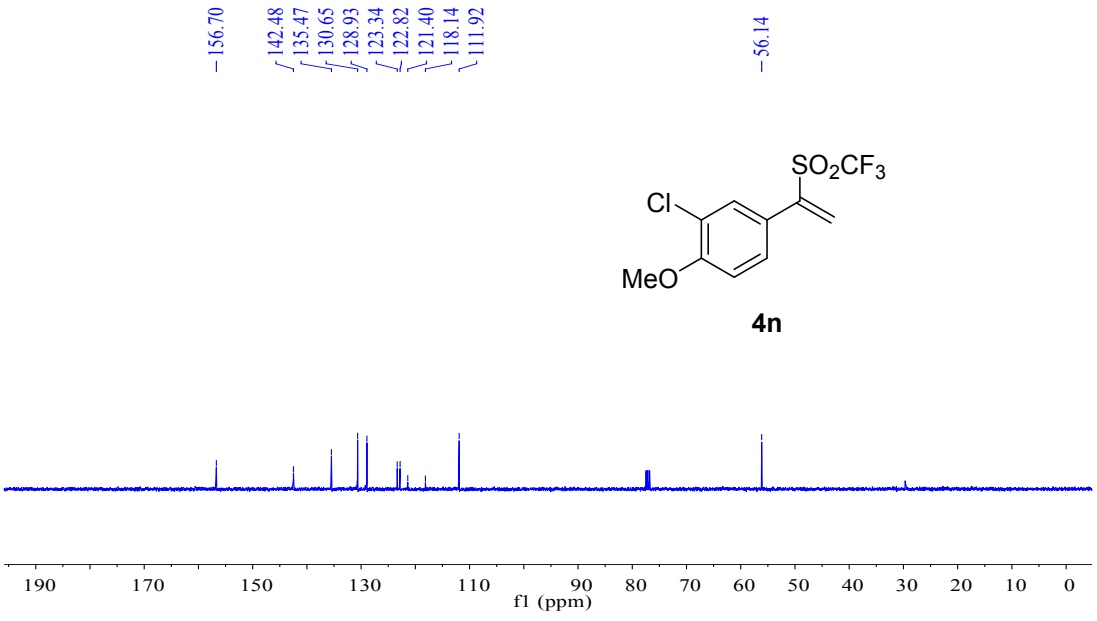
4l

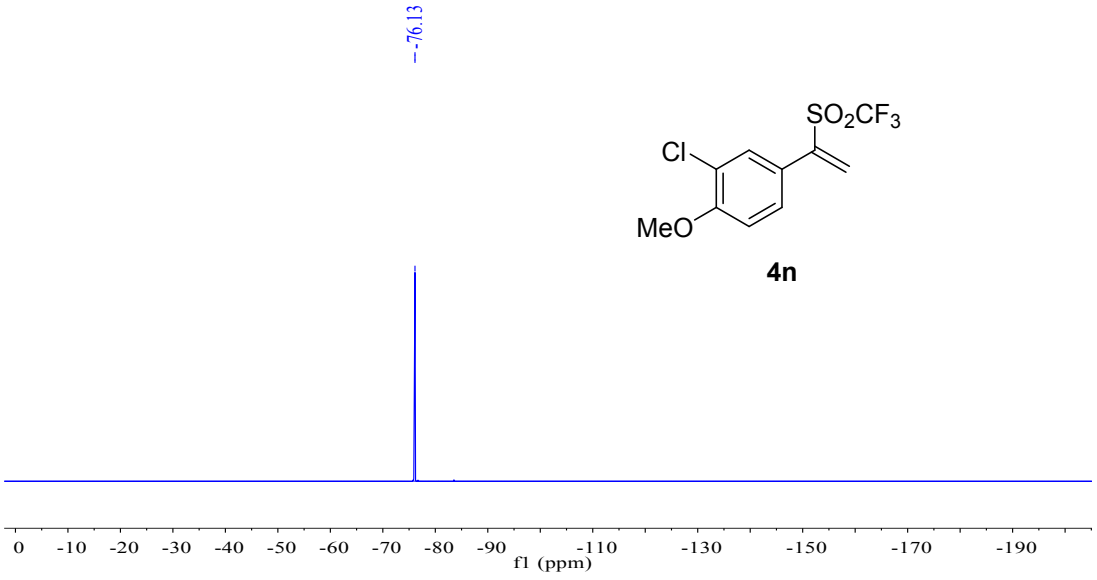

7.35
7.32
7.30
7.04
7.02
7.00
6.79
3.93
SO2CF3
F
MeO
4m
2.09
1.03
1.00
1.00
2.92
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

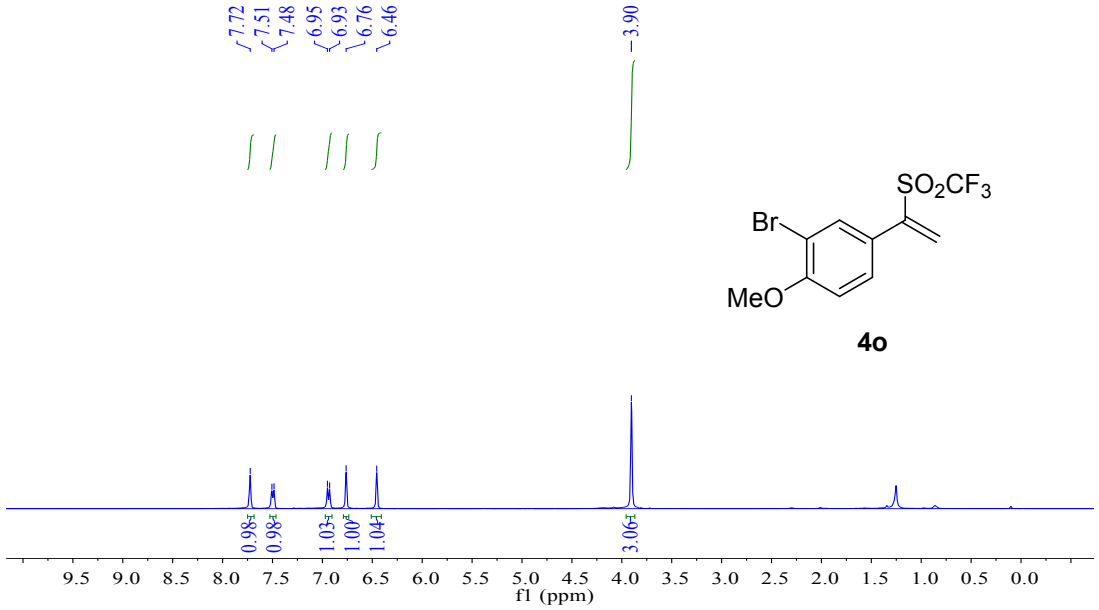

153.00
150.54
149.63
149.53
142.65
135.30
125.69
125.65
124.65
122.85
122.78
121.39
118.13
116.91
116.71
114.87
113.19
113.16
56.12
SO2CF3
F
MeO
4m
155 150 145 140 135 130 125 120 115
f1 (ppm)
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-75.98
-133.67
-133.69
-133.72
SO2CF3
F
MeO
4m
-133.40 -133.50 -133.60 -133.70 -133.80 -133.90 -134.00
f1 (ppm)
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

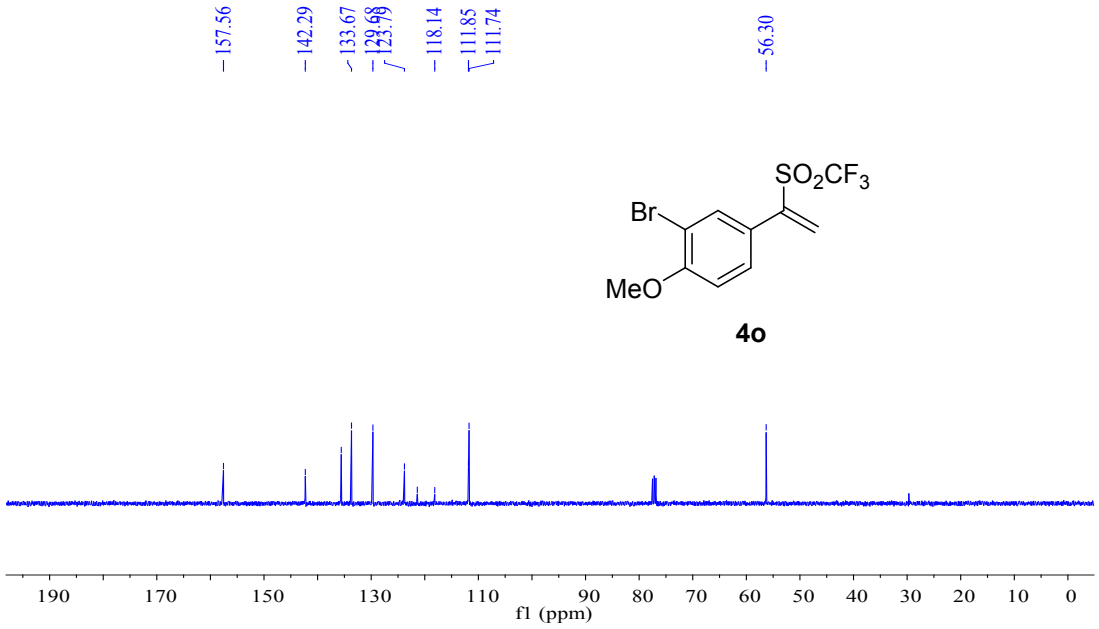

7.57
7.46
7.44
6.99
6.97
6.77
6.46
3.92
SO2CF3
Cl
MeO
4n
1.02
0.99
1.02
1.00
1.02
3.00
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


156.70
142.48
135.47
130.65
128.93
123.34
122.82
121.40
118.14
111.92
56.14
SO2CF3
Cl
MeO
4n
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

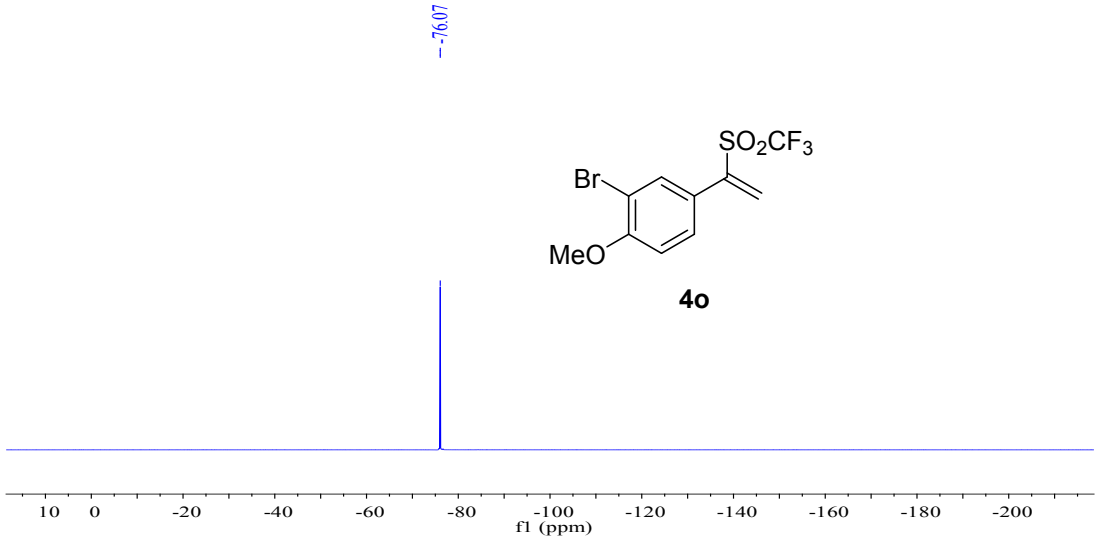

-76.13
SO2CF3
Cl
MeO
4n
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
-190
f1 (ppm)


7.72
7.51
7.48
6.95
6.93
6.76
6.46
3.90
SO2CF3
Br
MeO
0.98
0.98
1.03
1.00
1.04
3.06
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

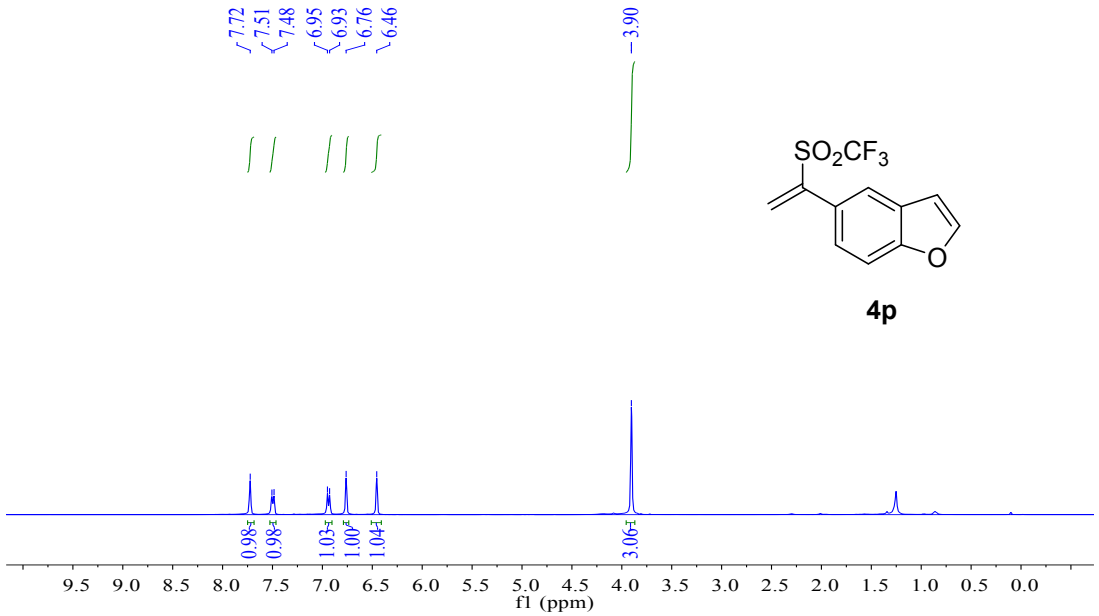
4o

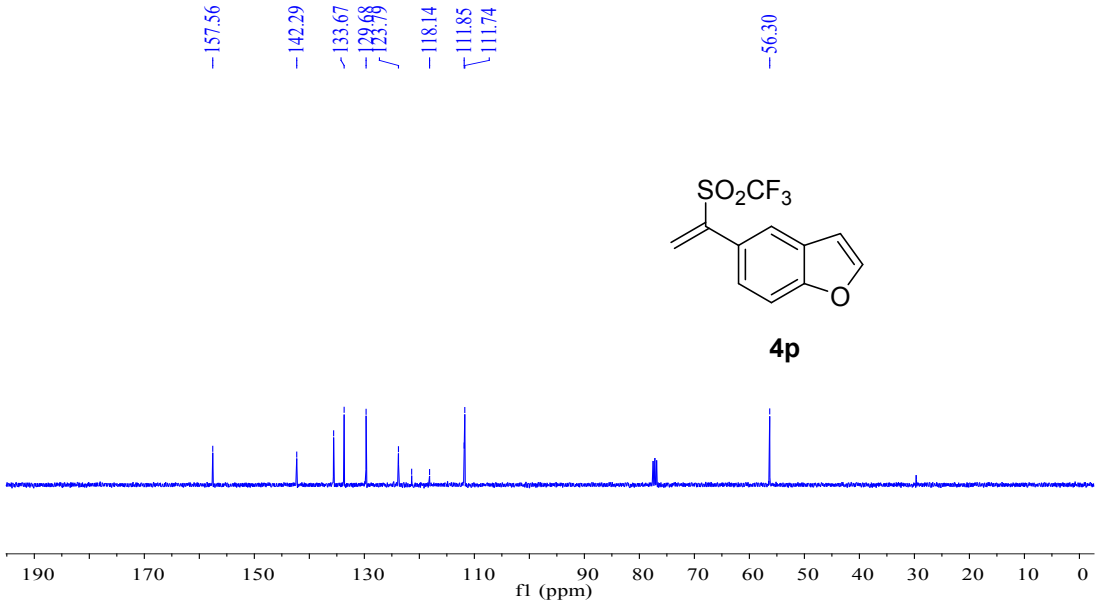

157.56
142.29
133.67
129.68
123.79
118.14
111.85
111.74
56.30
SO2CF3
Br
MeO
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

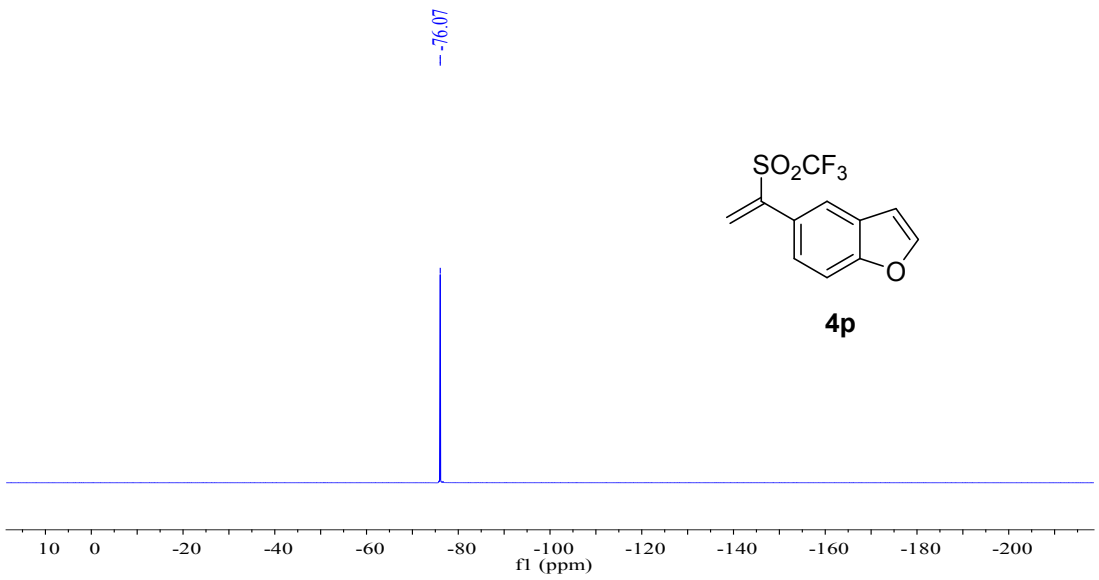
4o

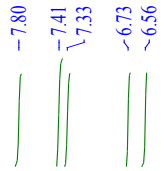

-76.07
SO2CF3
Br
MeO
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

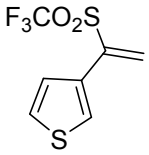
4o


7.72
7.51
7.48
6.95
6.93
6.76
6.46
3.90
SO2CF3
O
4p
0.98
0.98
1.03
1.00
1.04
3.06
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

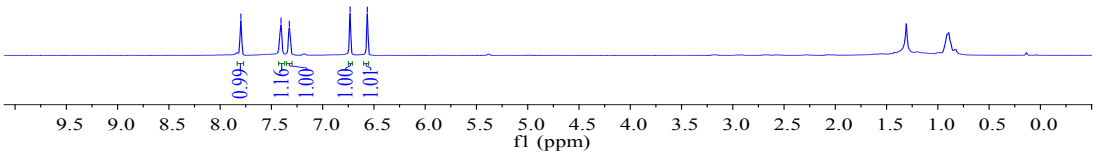

157.56
142.29
133.67
129.68
123.79
118.14
111.85
111.74
56.30
SO2CF3
O
4p
190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


-76.07
SO2CF3
O
4p
10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

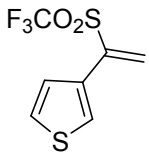

7.80
7.41
7.33
6.73
6.56


F3CO2S
S

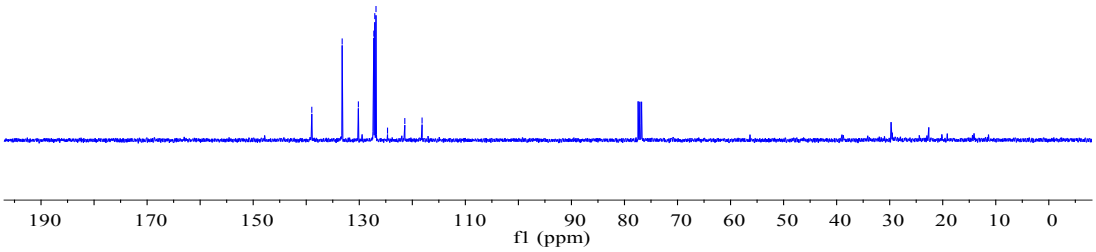
4q


0.99
1.16
1.00
1.00
1.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

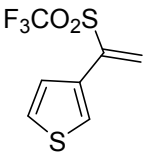

138.95
133.22
130.17
127.26
127.08
126.85
124.67
121.42
118.16


F3CO2S
S

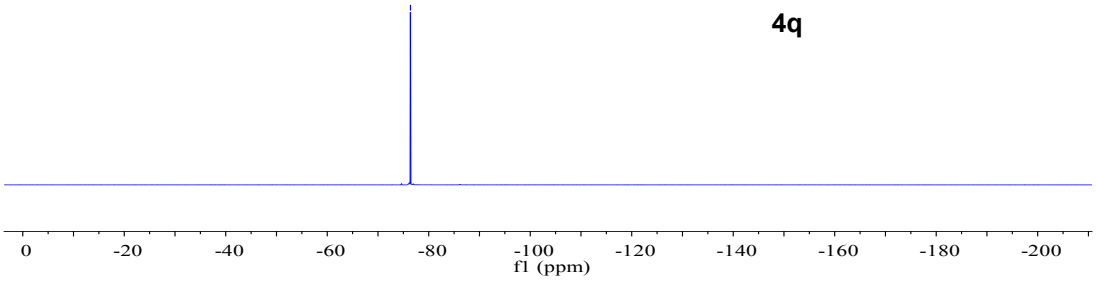
4q

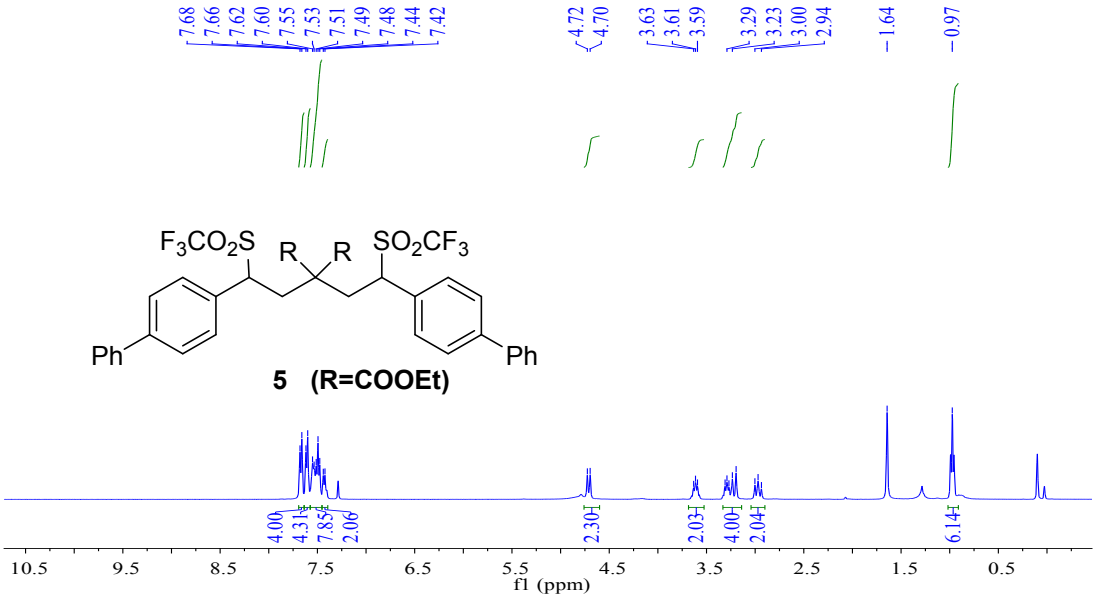

190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

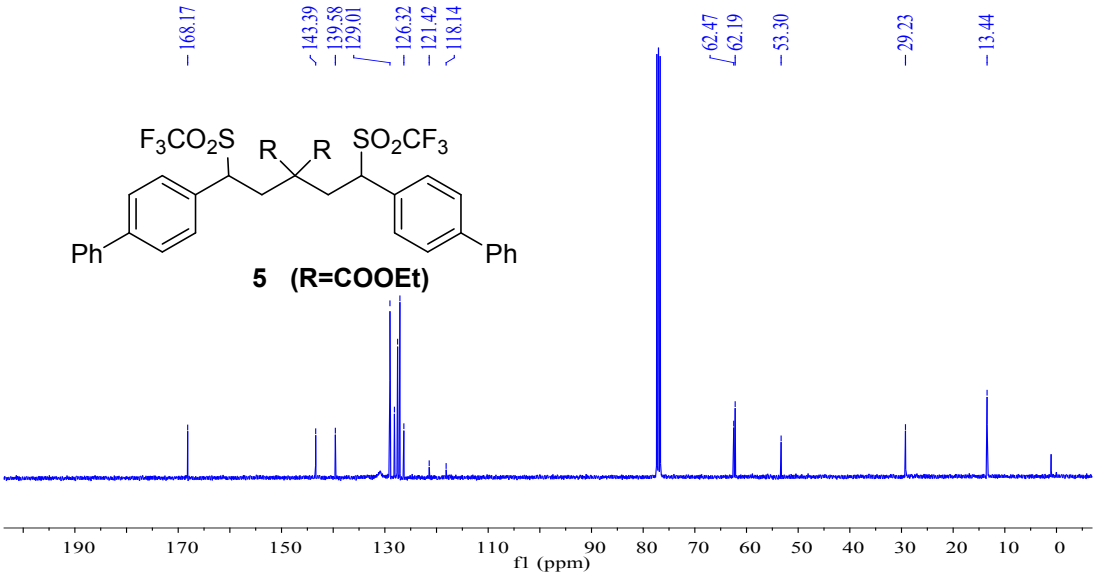

-76.39

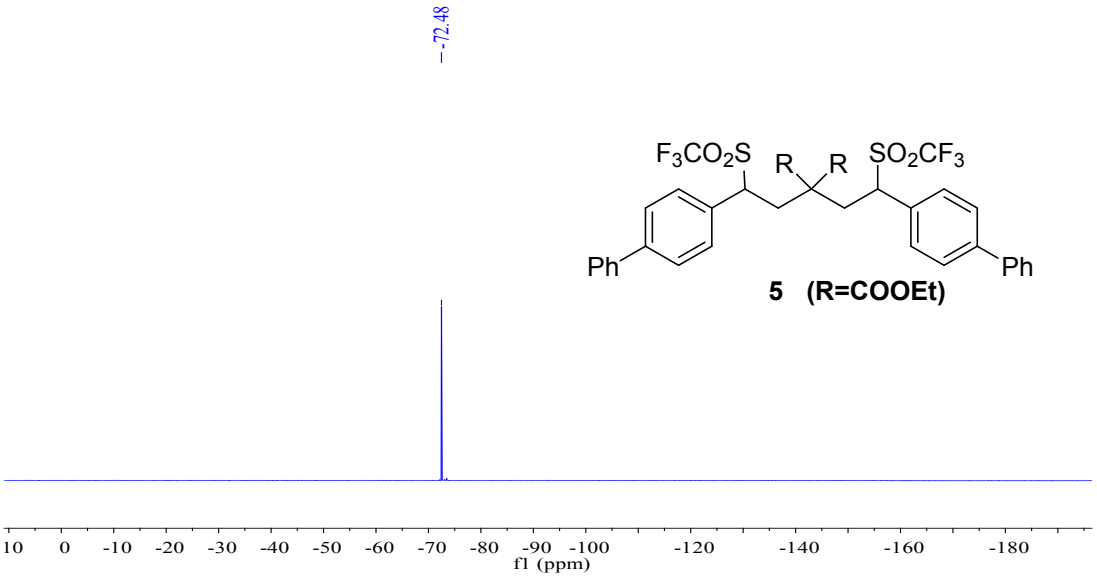

F3CO2S
S

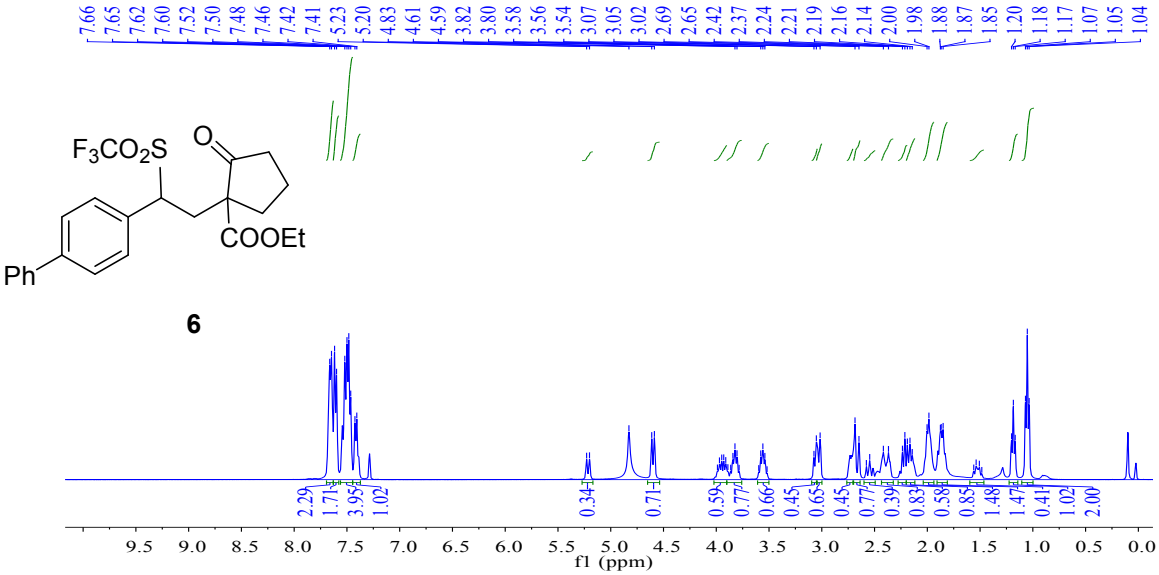
4q


0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200
f1 (ppm)

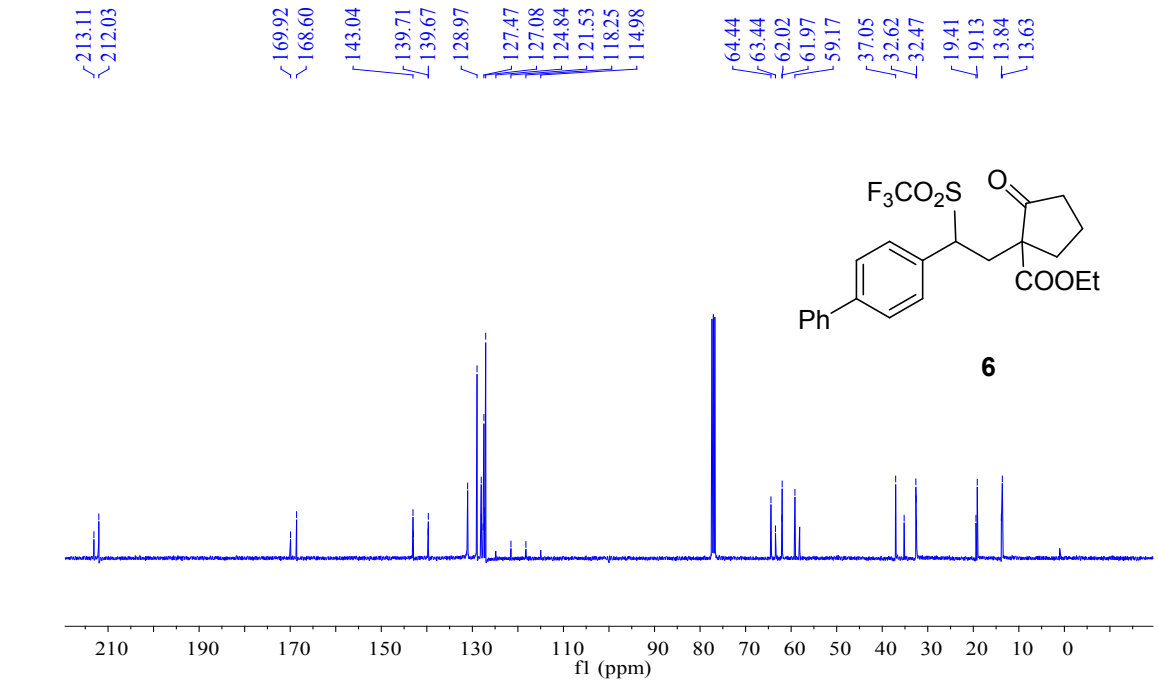

7.68
7.66
7.62
7.60
7.55
7.53
7.51
7.49
7.48
7.44
7.42
4.72
4.70
3.63
3.61
3.59
3.29
3.23
3.00
2.94
1.64
0.97
F3CO2S
R
R
SO2CF3
Ph
Ph
5 (R=COOEt)
4.00
4.31
7.85
2.06
2.30
2.03
4.00
2.04
6.14
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)


168.17
143.39
139.58
129.01
126.32
121.42
118.14
62.47
62.19
53.30
29.23
13.44
F3CO2S
R
R
SO2CF3
Ph
Ph
5 (R=COOEt)
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

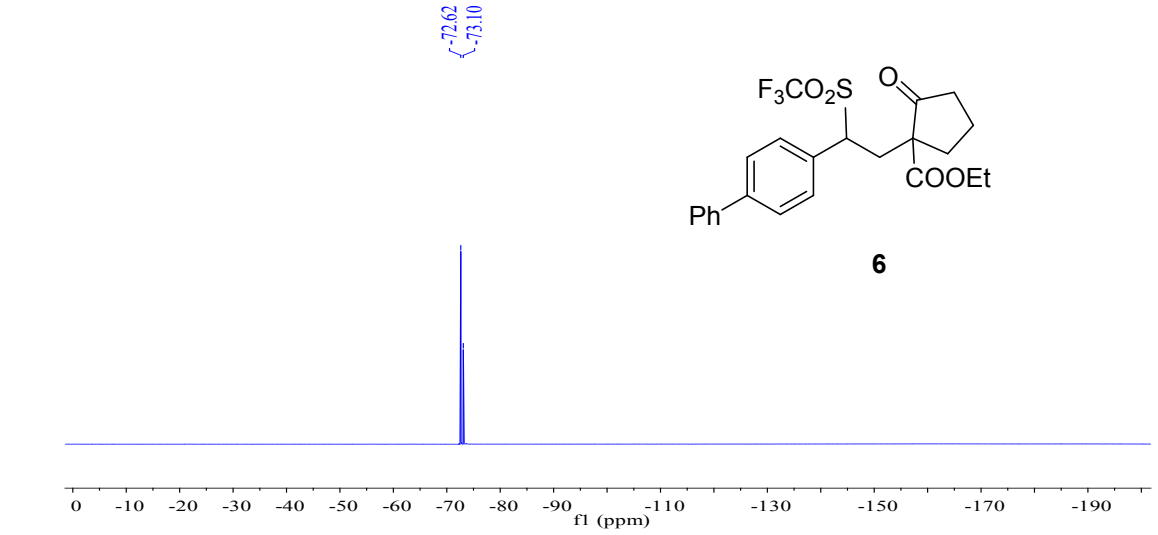

-72.48
F3CO2S
R
R
SO2CF3
Ph
Ph
5 (R=COOEt)
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
f1 (ppm)


7.66 7.65 7.62 7.60 7.52 7.50 7.48 7.46 7.42 7.41 5.23 5.20 4.83 4.61 4.59 3.82 3.80 3.58 3.56 3.54 3.07 3.05 3.02 2.69 2.65 2.42 2.37 2.24 2.21 2.19 2.16 2.14 2.00 1.98 1.88 1.87 1.85 1.20 1.18 1.17 1.07 1.05 1.04
F3CO2S
O
COOEt
Ph
2.29 1.71 3.95 1.02 0.34 0.71 0.59 0.77 0.66 0.45 0.65 0.45 0.77 0.39 0.83 0.58 0.85 1.48 1.47 0.41 1.02 2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

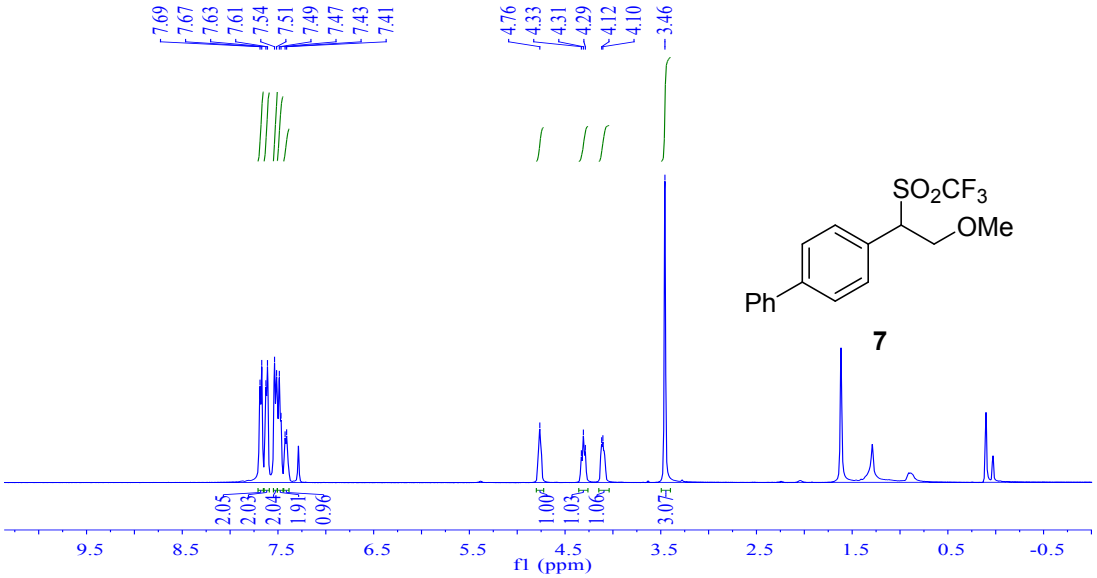
6

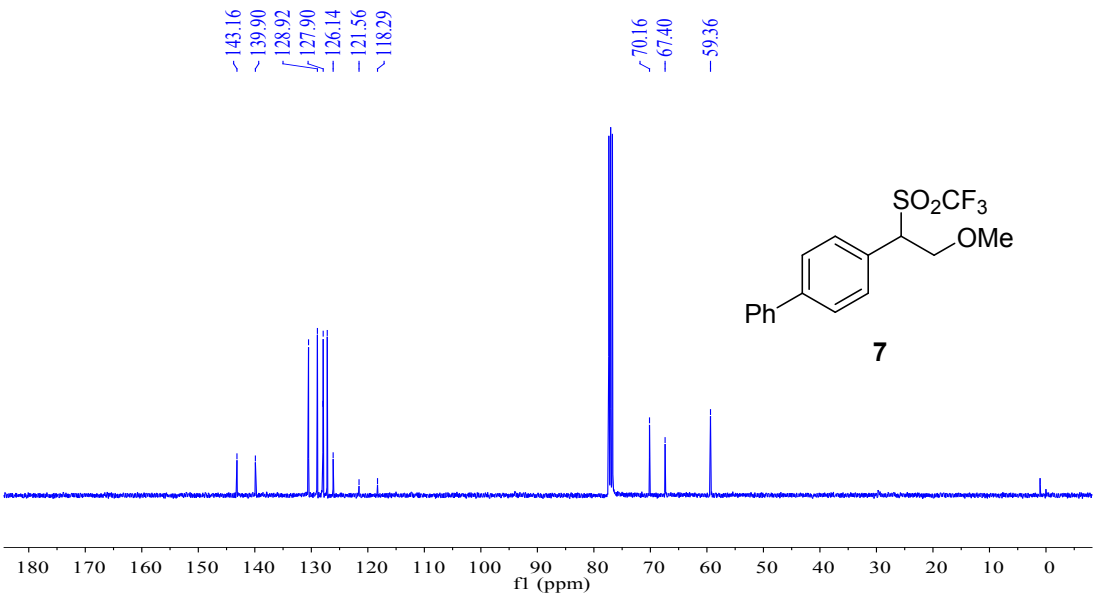

213.11 212.03 169.92 168.60 143.04 139.71 139.67 128.97 127.47 127.08 124.84 121.53 118.25 114.98 64.44 63.44 62.02 61.97 59.17 37.05 32.62 32.47 19.41 19.13 13.84 13.63
F3CO2S
O
COOEt
Ph
210 190 170 150 130 110 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

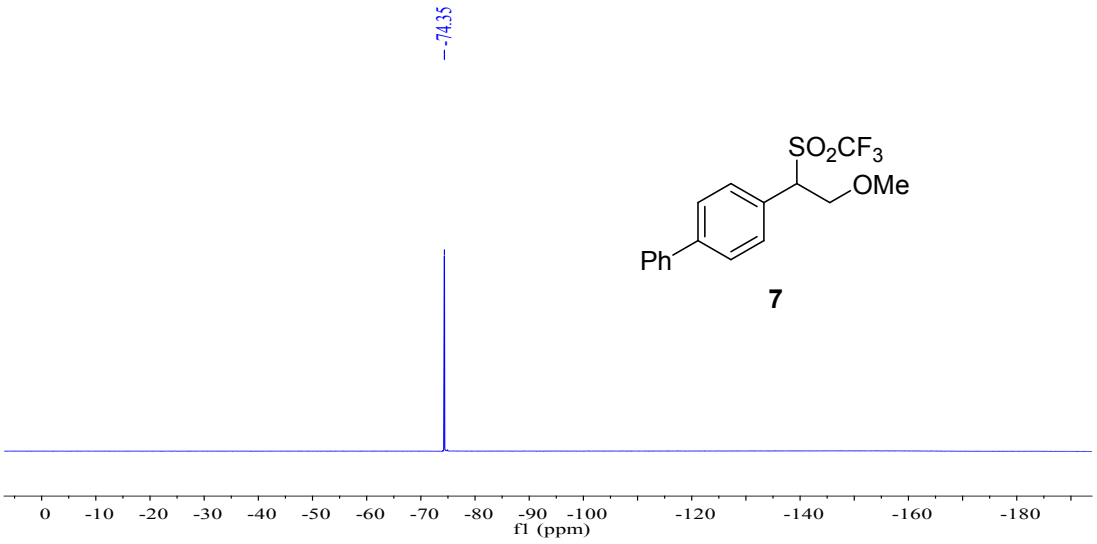
6

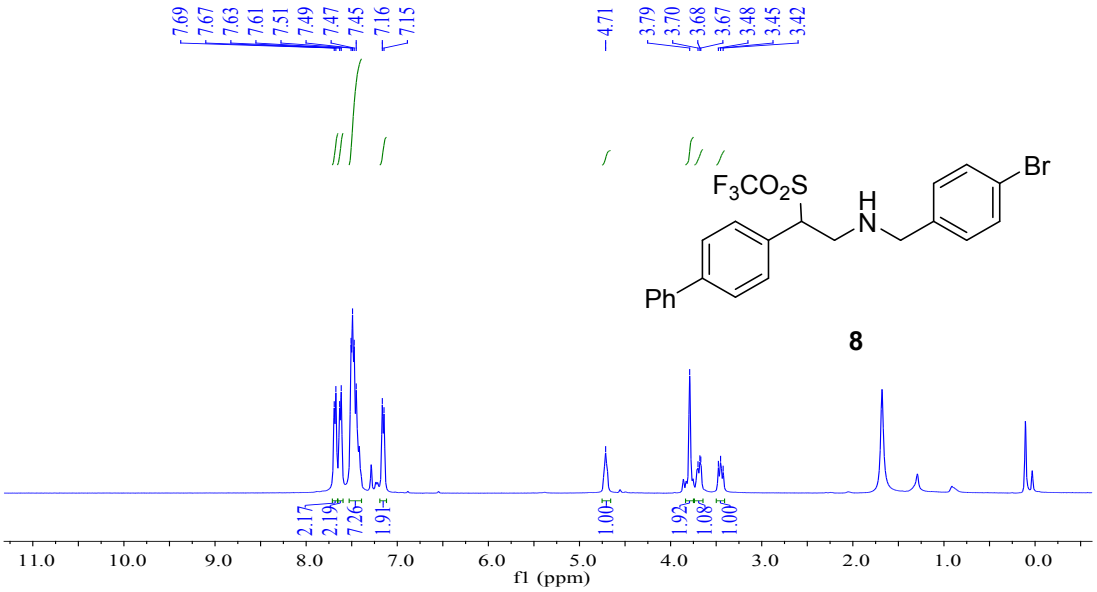

-72.62 -73.10
F3CO2S
O
COOEt
Ph
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)

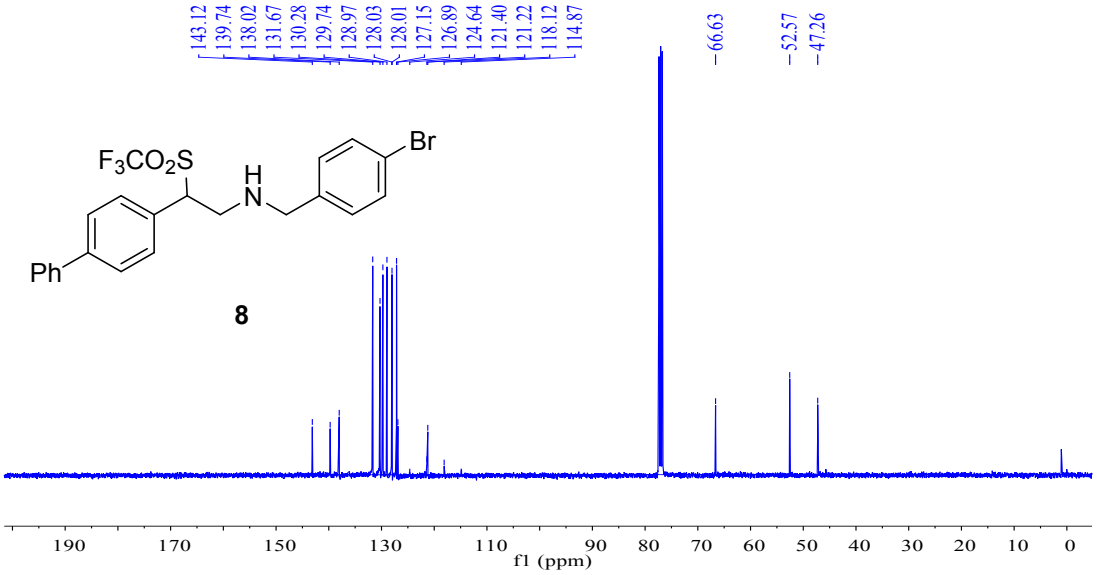
6

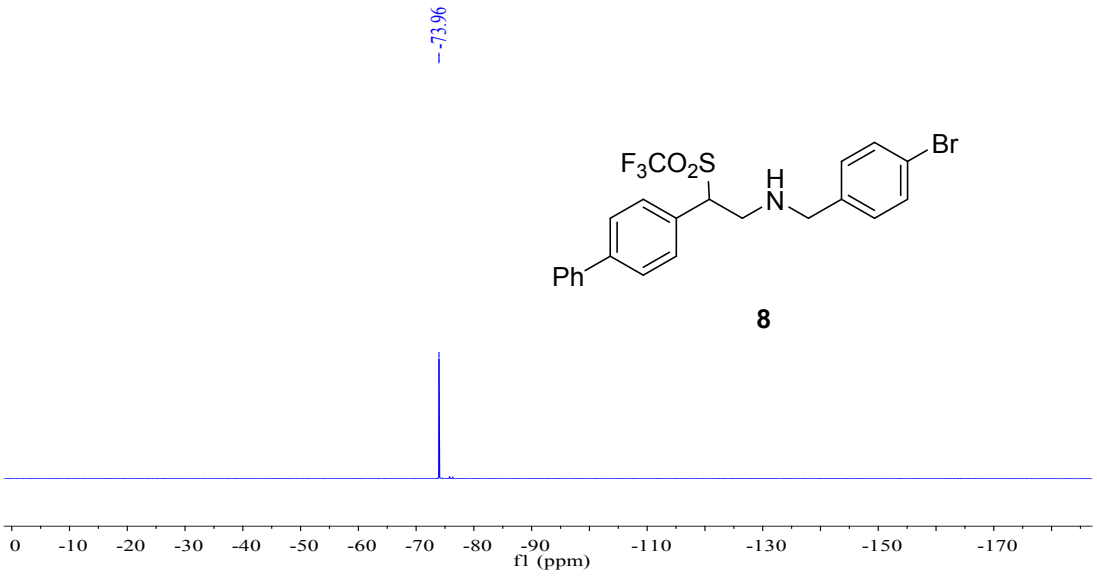

7.69
7.67
7.63
7.61
7.54
7.51
7.49
7.47
7.43
7.41
4.76
4.33
4.31
4.29
4.12
4.10
3.46
2.05
2.03
2.04
1.91
0.98
1.00
1.03
1.06
3.07
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
-0.5
f1 (ppm)
SO2CF3
OMe
Ph
7

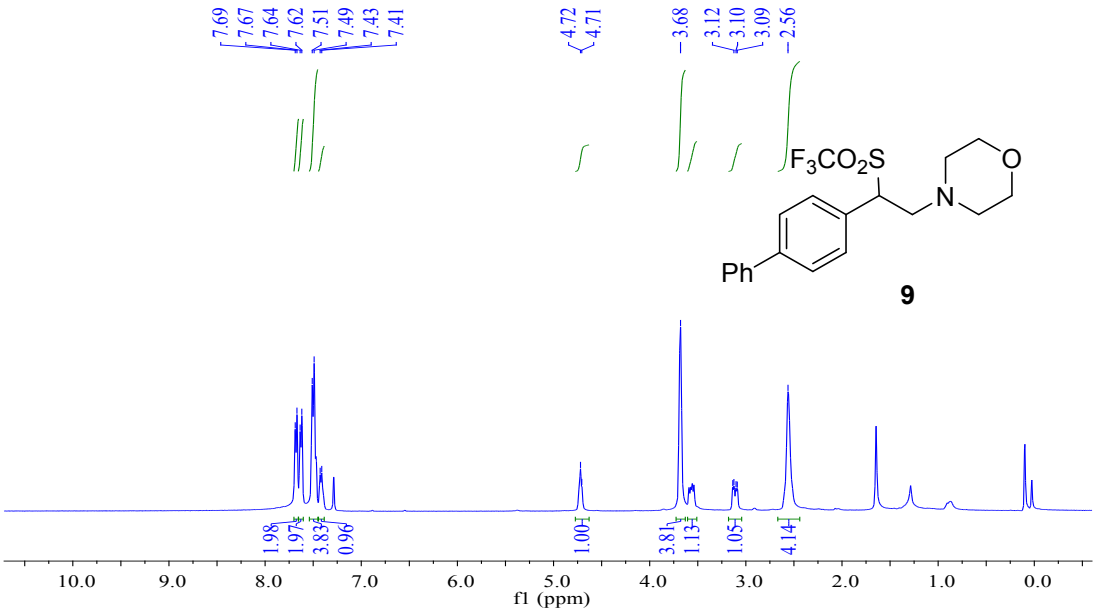

143.16
139.90
128.92
127.90
126.14
121.56
118.29
70.16
67.40
59.36
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)
SO2CF3
OMe
Ph
7

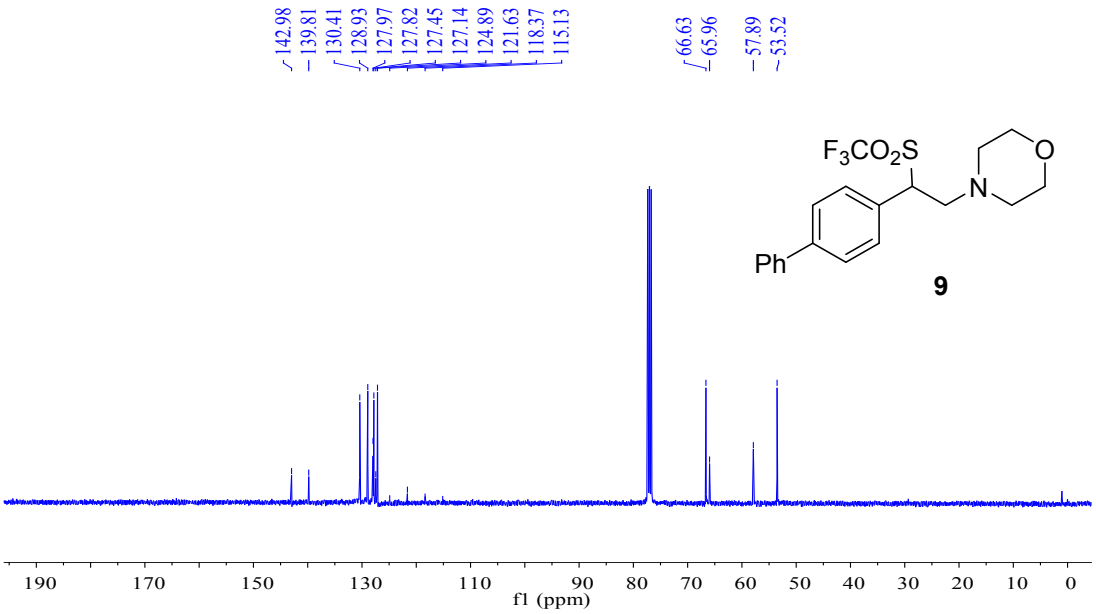

-74.35
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
f1 (ppm)
SO2CF3
OMe
Ph
7

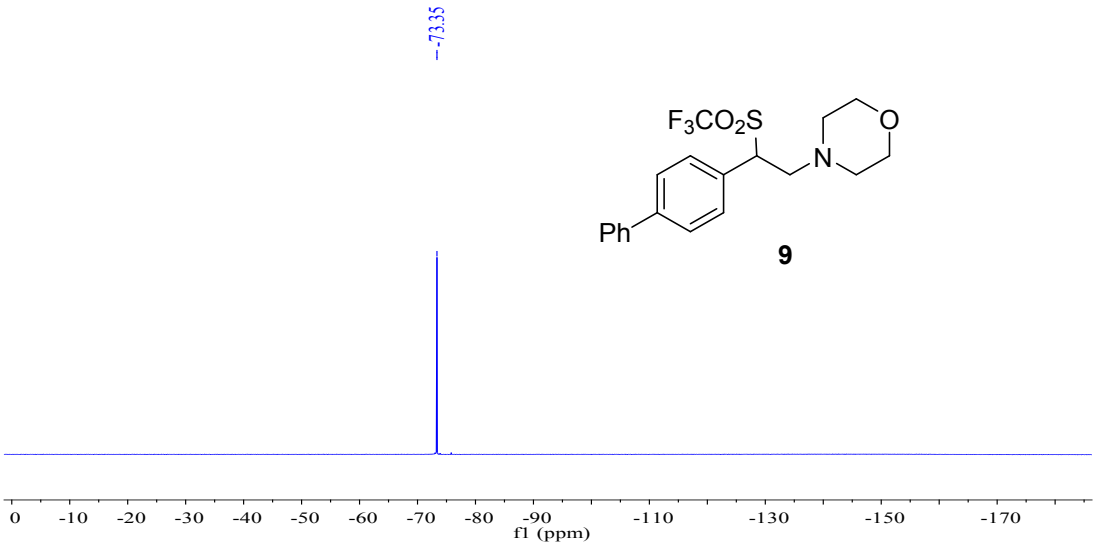

7.69
7.67
7.63
7.61
7.51
7.49
7.47
7.45
7.16
7.15
4.71
3.79
3.70
3.68
3.67
3.48
3.45
3.42
F3CO2S
H
N
Br
Ph
8
2.17
2.19
7.26
1.91
1.00
1.92
1.08
1.00
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)

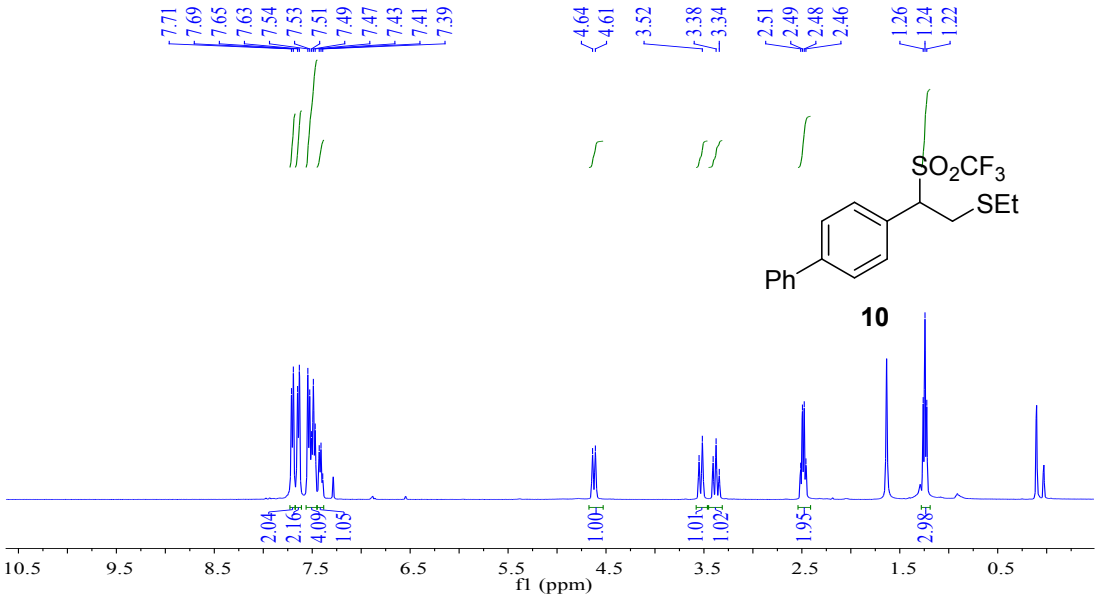

143.12
139.74
138.02
131.67
130.28
129.74
128.97
128.03
128.01
127.15
126.89
124.64
121.40
121.22
118.12
114.87
66.63
52.57
47.26
F3CO2S
H
N
Br
Ph
8
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

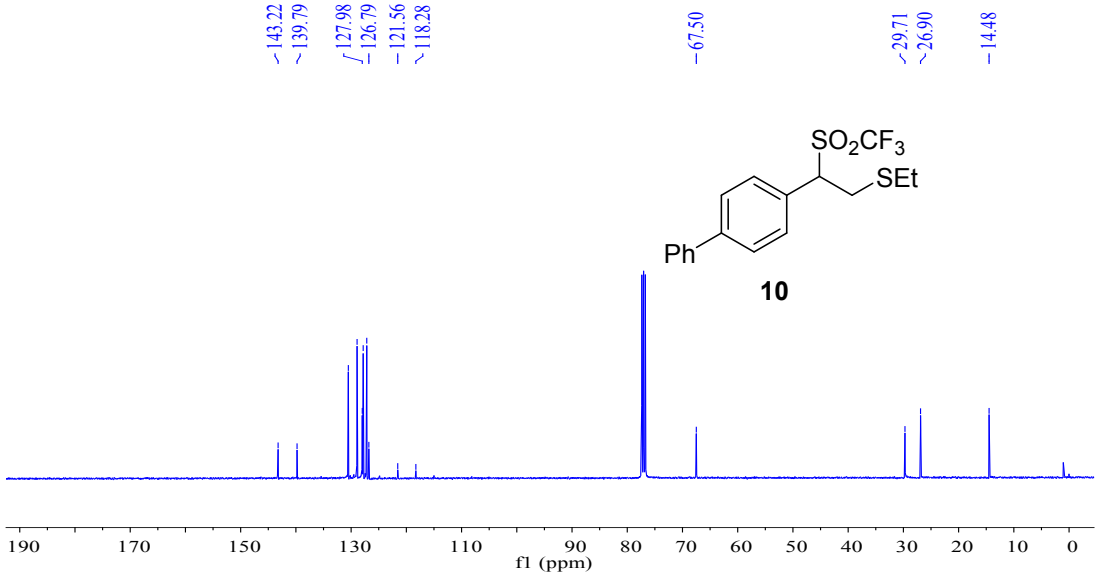

-73.96
F3CO2S
H
N
Br
Ph
8
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
f1 (ppm)

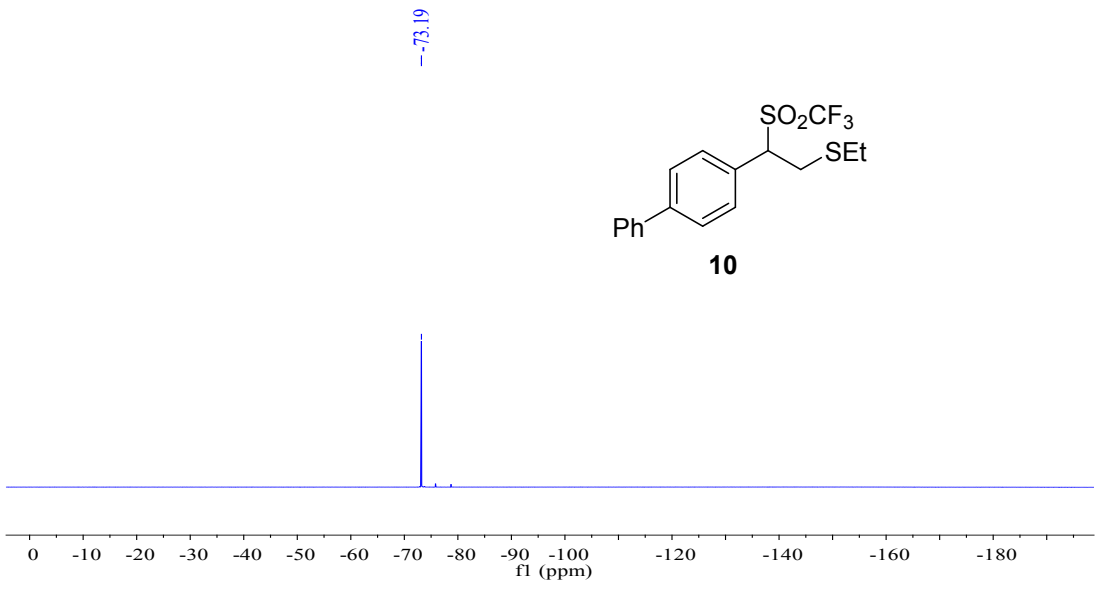

7.69
7.67
7.64
7.62
7.51
7.49
7.43
7.41
4.72
4.71
3.68
3.12
3.10
3.09
2.56
F3CO2S
O
N
Ph
9
1.98
1.97
3.82
0.96
1.00
3.81
1.13
1.05
4.14
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
f1 (ppm)


142.98
139.81
130.41
128.93
127.97
127.82
127.45
127.14
124.89
121.63
118.37
115.13
66.63
65.96
57.89
53.52
F3CO2S
O
N
Ph
9
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

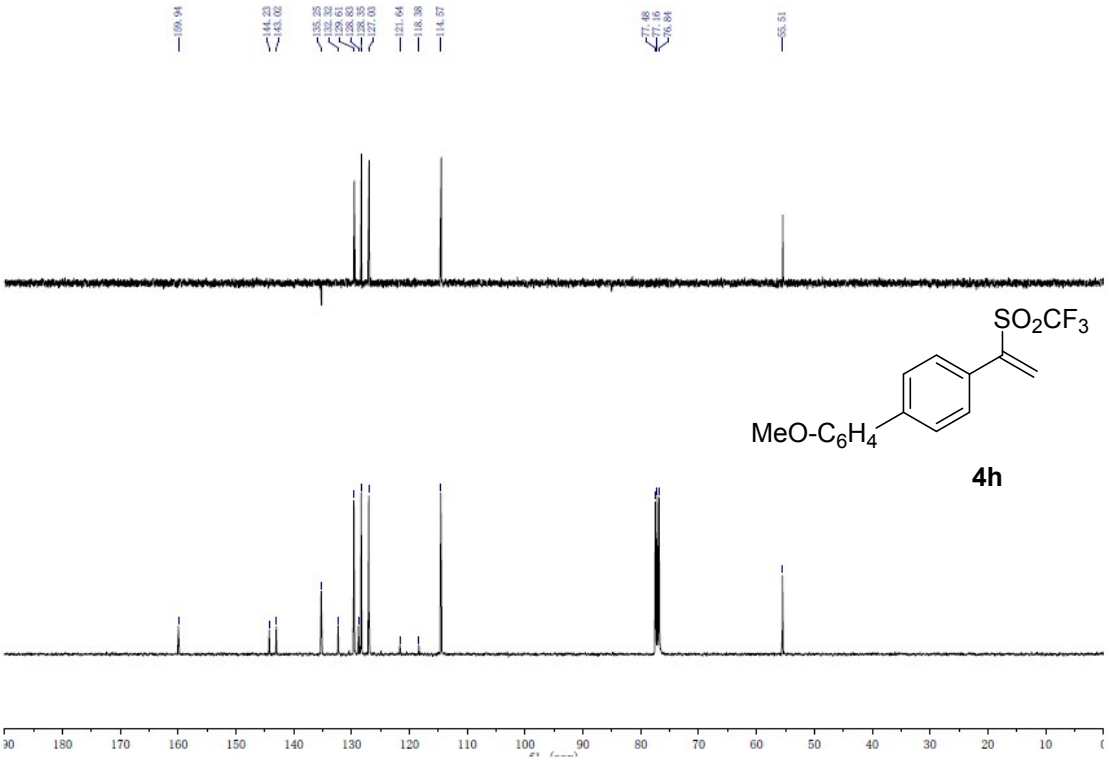

-73.35
F3CO2S
O
N
Ph
9
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-130
-150
-170
f1 (ppm)

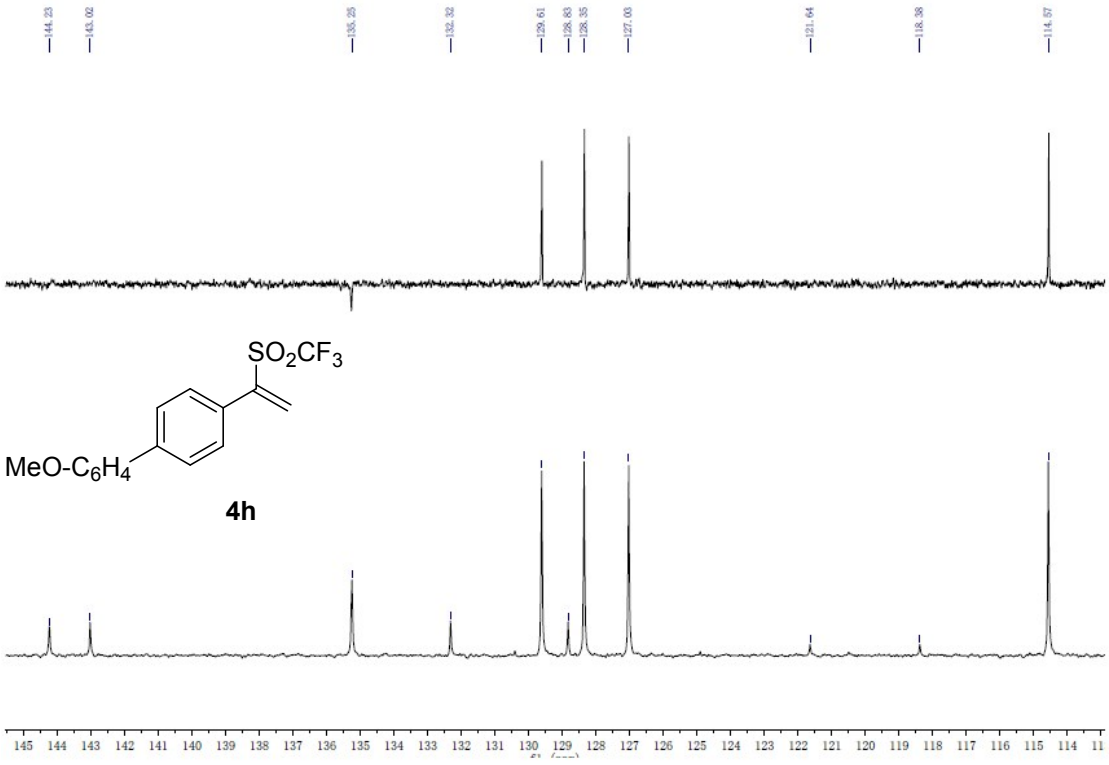

7.71
7.69
7.65
7.63
7.54
7.53
7.51
7.49
7.47
7.43
7.41
7.39
4.64
4.61
3.52
3.38
3.34
2.51
2.49
2.48
2.46
1.26
1.24
1.22
SO2CF3
SEt
Ph
10
2.04
2.16
4.09
1.05
1.00
1.01
1.02
1.95
2.98
10.5
9.5
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
0.5
f1 (ppm)

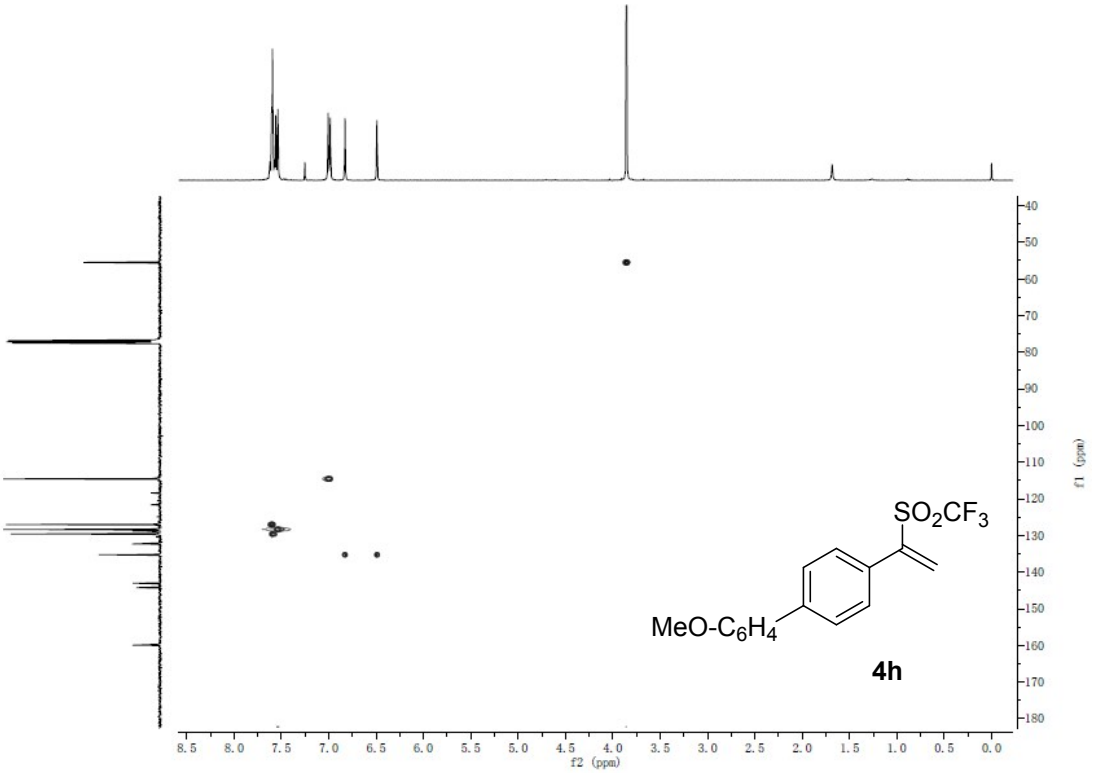

143.22
139.79
127.98
126.79
121.56
118.28
67.50
29.71
26.90
14.48
SO2CF3
SEt
Ph
10
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

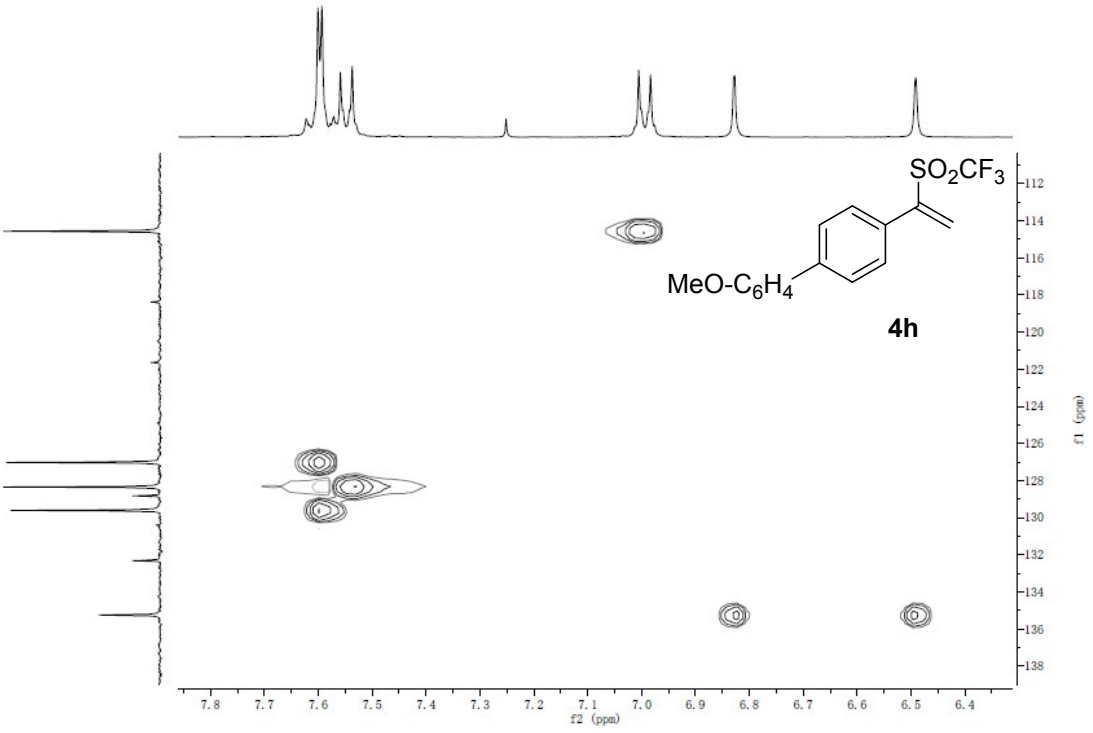

-73.19
SO2CF3
SEt
Ph
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
f1 (ppm)

6. Copies of DEPT135 and HMQC NMR spectra for product 4h.






SO2CF3
MeO-C6H4
4h
f2 (ppm)
f1 (ppm)


SO2CF3
MeO-C6H4
4h
f2 (ppm)
f1 (ppm)