Supporting Information

Nucleophilic Trifluoromethylthiolation of Bromoalkynones with $AgSCF_3$: C(sp)-SCF_3 Bond Formation towards Ynonyl Trifluoromethyl Sulfides

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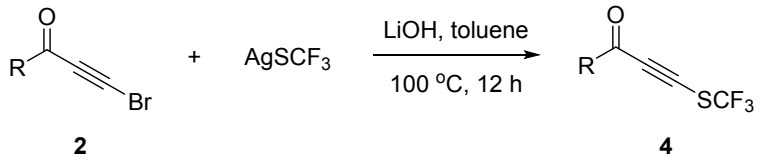
A. General Information

Melting points were measured using a melting point instrument and are uncorrected. Chemical shifts were reported in ppm from the solvent resonance as the internal standard ($CDCl_3$ δ_H = 7.26 ppm, δ_C = 77.00 ppm; DMSO-d_6 δ_H = 2.50 ppm, δ_C = 39.51 ppm). Multiplicity was indicated as follows: s (singlet), d (doublet), t (triplet), q (quartet), m (multiplet). Coupling constants were reported in Hertz (Hz). IR spectra were obtained with an infrared spectrometer on either potassium bromide pellets or liquid films between two potassium bromide pellets. GC-MS data were obtained using electron ionization. HRMS was carried out on a high-resolution mass spectrometer. TLC was performed using commercially available 100−400 mesh silica gel plates (GF_{254}).

Materials. Tetrahydrofuran (THF) and toluene were distilled from sodium/benzophenone; 1,2-dichloroethane (DCE) was distilled from calcium hydride; acetonitrile (CH_3CN) was distilled from phosphorus pentoxide. Other commercially available reagents were purchased and used without further purification. Analytical thin-layer chromatography was performed on 0.20 mm silica gel plates (GF_{254}) using UV light as a visualizing agent. Flash column chromatography was carried out using silica gel (200–300 mesh) with the indicated solvent system. All reactions were conducted in oven-dried Schlenk tubes. All the reaction temperatures reported are oil bath temperatures.

B. General Procedure for the Nucleophilic Trifluoromethylthiolation of Bromoalkynones with $AgSCF_3$

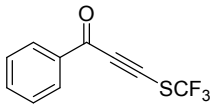


2 **4**

A 25 mL test tube placed with a magnetic stirring bar, bromoalkynones **2** (0.1 mmol), LiOH (0.1 mmol), $AgSCF_3$ (0.2 mmol), and toluene (2 mL) was vigorously stirred at 100 °C for 12 h in an oil bath. Then the resulting solution was cooled to room temperature, added water (20 mL), extracted with EtOAc (3 × 20 mL). The combined organic phases were dried over anhydrous Na_2SO_4, filtered and concentrated *in vacuo*. Further purification by flash column chromatography on silica gel (eluting with petroleum ether/ethyl acetate) provided the pure product **4**.

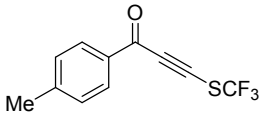
C. Analysis Data for the Products

1-Phenyl-3-((trifluoromethyl)thio)prop-2-yn-1-one (4a)



18.4 mg, 80% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 1:2 v/v): R_f = 0.40; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.05−8.02 (m, 1H), 7.77−7.73 (m, 1H), 7.62−7.58 (m, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 174.6, 135.1, 135.1, 129.1, 129.0, 127.4 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 100.6, 77.2; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1; IR (KBr): 2930, 1688, 1452, 1268, 750 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{10}H_5OSF_3$+Na, 252.9905; found, 252.9907.

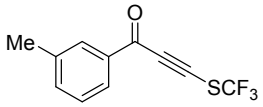
1-(*p*-Tolyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4b)



19.8 mg, 81% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.65; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.4 Hz, 2H), 7.29 (d, *J* = 8.0 Hz, 2H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.9, 145.9, 133.3, 129.5, 129.4, 127.3 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 102.3, 75.2 (q, $^3J_{F\text{-}C}$ = 3.9 Hz), 21.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ −41.9; IR (KBr): 2926, 2860, 2156,

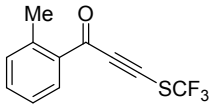
1604, 1508, 1380, 820 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{11}H_7OSF_3$+H, 245.0242; found, 245.0420.

1-(*m*-Tolyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4c)



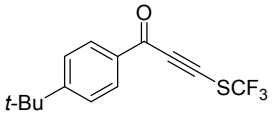
13.9 mg, 57% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.70; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.85 (d, J = 7.2 Hz, 2H), 7.58 (d, J = 7.6 Hz, 1H), 7.50 (t, J = 7.6 Hz, 1H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 174.8, 138.8, 135.8, 135.2, 129.3, 129.1, 127.5 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 126.3, 100.6, 77.2, 20.7; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1; IR (KBr): 2925, 2858, 1718, 1648, 1452, 728 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{11}H_7OSF_3$+Na, 267.0062; found, 267.0053.

1-(*o*-Tolyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4d)



18.5 mg, 76% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 50:1 v/v): R_f = 0.80; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.06 (d, J = 7.6 Hz, 1H), 7.58 (t, J = 7.2 Hz, 1H), 7.43 (t, J = 7.6 Hz, 1H), 7.38 (d, J = 7.2 Hz, 1H), 2.55 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 176.2, 139.8, 133.8, 133.7, 132.7, 132.3, 127.4 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 126.4, 125.9, 101.8, 75.8, 21.1; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.2; IR (KBr): 2926, 2860, 1660, 1457, 1379, 740 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{11}H_7OSF_3$+H, 245.0242; found, 245.0240.

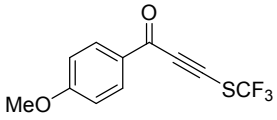
1-(4-*tert*-Butylphenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4e)



16.6 mg, 58% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.81; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.96 (d, J = 8.4 Hz, 2H), 7.62 (d, J = 8.4 Hz, 2H), 1.30 (s, 9H); ^{13}C NMR (400 MHz, DMSO-d_6) δ 174.2, 158.6, 132.8, 128.9, 127.4 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 126.0, 100.7, 76.6, 35.1, 30.6; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.2; IR (KBr): 2931, 12862, 1726,

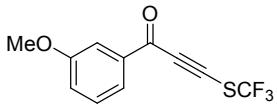
1645, 1463, 1395, 842 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{14}H_{13}OSF_3$+Na, 309.0531; found, 309.0536.

1-(4-Methoxyphenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4f)



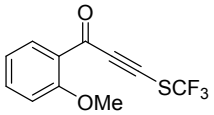
20.5 mg, 79% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.58; ^1H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, J = 8.8 Hz, 2H), 6.98 (d, J = 8.8 Hz, 2H), 3.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 174.1, 165.1, 132.0, 129.2, 127.6 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 114.3, 102.3, 74.9, 55.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ −42.0; IR (KBr): 2976, 2866, 2156, 1597, 1505, 802 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{11}H_7O_2SF_3$+Na, 283.0011; found, 283.0006.

1-(3-Methoxyphenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4g)



17.7 mg, 68% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.72; ^1H NMR (400 MHz, DMSO-d_6) δ 7.66−7.63 (m, 1H), 7.56−7.49 (m, 2H), 7.35−7.32 (m, 1H), 3.83 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 174.4, 159.6, 136.5, 130.4, 127.5 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 121.7, 121.4, 112.8, 100.5, 77.4, 50.4; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.2; IR (KBr): 2929, 2855, 1676, 1589, 1462, 788, 688 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{11}H_7O_2SF_3$+H, 261.0192; found, 261.0191.

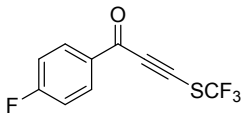
1-(2-Methoxyphenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4h)



16.4 mg, 63% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.63; ^1H NMR (400 MHz, DMSO-d_6) δ 7.66−7.64 (m, 1H), 7.54 (t, J = 8.0 Hz, 1H), 7.51−7.50 (m, 1H), 7.35−7.33 (m, 1H), 3.84 (s, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 174.4, 159.6, 136.5, 130.4, 127.4 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 121.7, 121.4, 100.5, 77.4 (q, $^3J_{F\text{-}C}$ = 4.2 Hz), 55.4; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1; IR (KBr): 2924, 2857, 1721, 1587, 1459, 1373, 775 cm^{-1}; HRMS (ESI,

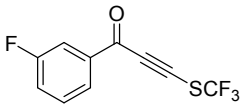
m/z): $[M+H]^+$ Calcd. for $C_{11}H_7OSF_3$+H, 261.0192; found, 261.0193.

1-(4-Fluorophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4i)



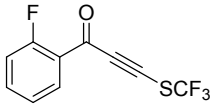
17.3 mg, 70% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.80; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.13 (dd, J = 8.5 Hz, J = 5.5 Hz, 2H), 7.47 (t, J = 8.7 Hz, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 173.2, 166.1 (d, $^1J_{F\text{-}C}$ = 253.0 Hz), 132.1 (d, $^2J_{F\text{-}C}$ = 10.0 Hz), 132.0 (d, $^3J_{F\text{-}C}$ = 2.0 Hz), 127.4 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 116.5 (d, $^2J_{F\text{-}C}$ = 22.0 Hz), 100.2, 77.8; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.0, −102.4 − −102.5 (m, 1F); IR (KBr): 1687, 1598, 1417, 844 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{10}H_4OSF_4$+H, 248.9992; found, 248.9993.

1-(3-Fluorophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4j)



15.6 mg, 63% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.78; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.91−7.89 (m, 1H), 7.82−7.79 (t, J = 8.0 Hz, 1H), 7.71−7.60 (m, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 173.4, 162.2 (d, $^1J_{F\text{-}C}$ = 245.0 Hz), 137.3 (d, $^3J_{F\text{-}C}$ = 6.0 Hz), 131.5 (d, $^3J_{F\text{-}C}$ = 8.0 Hz), 127.4 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 125.3 (d, $^4J_{F\text{-}C}$ = 2.0 Hz), 122.1 (d, $^2J_{F\text{-}C}$ = 22.0 Hz), 115.2 (d, $^2J_{F\text{-}C}$ = 23.0 Hz), 100.1, 78.5 (q, $^3J_{F\text{-}C}$ = 4.0 Hz); ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1, −111.5 − −111.5 (m, 1F); IR (KBr): 2925, 2858, 1657, 1589, 1445, 749 675 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{10}H_4OSF_4$+Na, 270.9811; found, 270.9808.

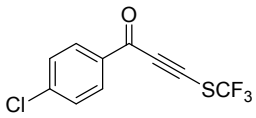
1-(2-Fluorophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4k)



12.8 mg, 52% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.81; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.99 (td, J = 7.6 Hz, J = 1.6 Hz, 1H), 7.82−7.76 (m, 1H), 7.44−7.39 (m, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 170.8, 161.2 (d, $^1J_{F\text{-}C}$ = 259.0 Hz), 137.2 (d, $^3J_{F\text{-}C}$ = 10.0 Hz), 131.4, 127.3 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 125.1 (d, $^4J_{F\text{-}C}$ = 3.0 Hz), 123.5 (d, $^3J_{F\text{-}C}$ = 8.0

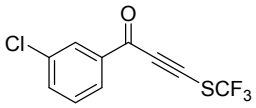
Hz), 117.3 (d, $^{2}J_{F\text{-}C}$ = 21.0 Hz), 101.8, 77.2; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1, −112.5 – −112.6 (m, 1F); IR (KBr): 1656, 1612, 1459, 759 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{10}H_4OSF_4$+Na, 270.9811; found, 270.9782.

1-(4-Chlorophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4l)



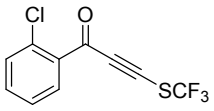
20.5 mg, 78% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.82; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, J = 8.8 Hz, 2H), 7.49 (d, J = 8.8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.9, 141.4, 134.1, 130.6, 129.3, 127.3 (q, $^{1}J_{F\text{-}C}$ = 312.0 Hz), 101.9, 77.2; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.0; IR (KBr): 2919, 1710, 1523, 1410, 834 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{10}H_4ClOSF_3$+H, 264.9696; found, 264.9691.

1-(3-Chlorophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4m)



16.0 mg, 61% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.88; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.00−7.97 (m, 2H), 7.82−7.79 (m, 1H), 7.63 (t, J = 8.0 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 173.3, 136.8, 134.6, 134.0, 131.1, 128.4, 127.5, 127.4 (q, $^{1}J_{F\text{-}C}$ = 312.0 Hz), 100.1, 78.62 (q, $^{3}J_{F\text{-}C}$ = 4.0 Hz); ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1; IR (KBr): 1660, 1572, 1421, 773, 692 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{10}H_4ClOSF_3$+H, 264.9696; found, 264.9692.

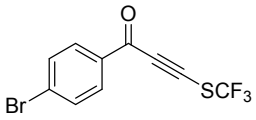
1-(2-Chlorophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4n)



13.2 mg, 50% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.72; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.03 (d, J = 7.6 Hz, 1H), 7.71−7.62 (m, 2H), 7.59−7.55 (m, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 173.4, 135.0, 133.4, 132.8, 132.1, 131.6, 127.8, 127.3 (q, $^{1}J_{F\text{-}C}$ = 313.0 Hz), 101.5, 78.5 (q, $^{3}J_{F\text{-}C}$ = 4.0 Hz); ^{19}F NMR (376 MHz, DMSO-d_6) δ −41.7; IR (KBr):

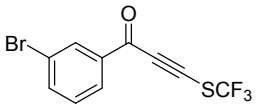
2925, 2857, 1703, 1588, 1449, 750 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{10}H_4ClOSF_3$+H, 264.9696; found, 264.9697.

1-(4-Bromophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4o)



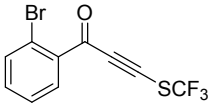
22.1 mg, 72% yield; viscous liquid; TLC (petroleum ether): R_f = 0.60; ^{1}H NMR (400 MHz, DMSO-d_6) δ 7.95 (d, J = 7.6 Hz, 2H), 7.82 (d, J = 8.0 Hz, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 173.7, 134.2, 132.3, 130.8, 129.5, 127.3 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 100.2, 78.1 (q, $^3J_{F\text{-}C}$ = 4.0 Hz); ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.0; IR (KBr): 2926, 1686, 1580, 1400, 830 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{10}H_4BrOSF_3$+H, 308.9191; found, 308.9191.

1-(3-bromophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4p)



18.4 mg, 60% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 20:1 v/v): R_f = 0.80; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.16 (t, J = 1.8 Hz, 1H), 8.05−8.02 (m, 1H), 7.98−7.95 (m, 1H), 7.58 (t, J = 7.9 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 173.2, 137.6, 137.0, 131.4, 131.3, 127.9, 127.4 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 122.4, 100.0, 78.8 cm^{-1}; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.0; IR (KBr): 2185, 1658, 1573, 1420, 760, 695 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{10}H_4BrOSF_3$+H, 308.9191; found, 308.9191.

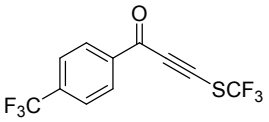
1-(2-bromophenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4q)



13.2 mg, 43% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.63; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.01 (dd, J = 7.2 Hz, J = 2.2 Hz, 1H), 7.83−7.81 (m, 1H), 7.63−7.58 (m, 2H).; ^{13}C NMR (100 MHz, DMSO-d_6) δ 172.2, 135.1, 134.9, 134.8, 133.0, 128.2, 127.3 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 20.0, 101.1, 78.7; ^{19}F NMR (376 MHz, DMSO-d_6) δ −41.7; IR (KBr): 2928, 1679, 1486, 730 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{10}H_4BrOSF_3$+H, 308.9191;

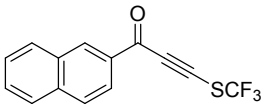
found, 308.9191.

1-(4-(Trifluoromethyl)phenyl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4r)



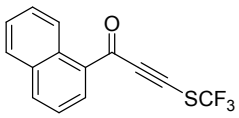
16.6 mg, 56% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.80; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.21 (d, J = 7.8 Hz, 2H), 7.96 (d, J = 7.8 Hz, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 173.7, 138.1, 134.0 (q, $^2J_{F\text{-}C}$ = 32.0 Hz), 129.7, 127.3 (q, $^1J_{F\text{-}C}$ = 313.0 Hz), 126.1 (q, $^3J_{F\text{-}C}$ = 3.0 Hz), 123.5 (q, $^1J_{F\text{-}C}$ = 271.0 Hz), 100.3, 79.1 (q, $^3J_{F\text{-}C}$ = 4.0 Hz); ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1, −62.0; IR (KBr): 2924, 1652, 1500, 750 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{11}H_4F_6OS$+H, 298.9887; found, 298.9891.

1-(Naphthalen-2-yl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4s)



16.0 mg, 57% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 14:1 v/v): R_f = 0.73; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.70 (d, J = 4.8 Hz, 1H), 8.10−7.99 (m, 4H), 7.72−7.64 (m, 2H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 174.5, 135.8, 132.7, 132.5, 131.9, 129.7, 129.6, 128.9, 127.9, 127.5 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 127.4, 122.8, 100.7, 77.1; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.0; IR (KBr): 2926, 2154, 1735, 1645, 1511, 1253, 1097 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{14}H_7OSF_3$+Na, 303.0062; found, 303.0060.

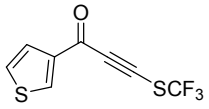
1-(Naphthalen-1-yl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4t)



9.5 mg, 34% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.73; ^{1}H NMR (400 MHz, DMSO-d_6) δ 9.03 (d, J = 8.6 Hz, 1H), 8.47 (d, J = 7.1 Hz, 1H), 8.32 (d, J = 8.1 Hz, 1H), 8.08 (d, J = 8.0 Hz, 1H), 7.75–7.63 (m, 3H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 176.1, 136.0, 135.0, 133.4, 130.5, 129.7, 129.3, 129.0, 127.5 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 127.0, 124.9, 124.8, 101.6, 75.6; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.0; IR (KBr): 2913, 2154, 1730, 1642, 1510,

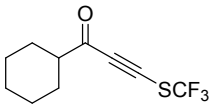
1253, 1066 cm^{-1}; HRMS (ESI, m/z): $[M+H]^+$ Calcd. for $C_{14}H_7OSF_3$+H, 281.0242; found, 281.0238.

1-(Thiophen-3-yl)-3-((trifluoromethyl)thio)prop-2-yn-1-one (4u)



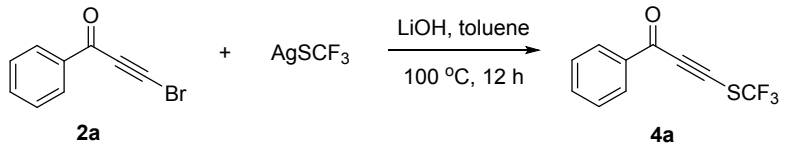
18.6 mg, 79% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.63; ^{1}H NMR (400 MHz, DMSO-d_6) δ 8.62 (dd, J = 2.8, J = 1.3 Hz, 1H), 7.74 (dd, J = 5.1, J = 2.9 Hz, 1H), 7.55 (dd, J = 5.1, J = 1.3 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 168.1, 140.8, 137.6, 129.0, 127.4 (q, $^1J_{F\text{-}C}$ = 312.3 Hz), 125.8, 100.5, 75.2 (q, $^3J_{F\text{-}C}$ = 4.0 Hz); ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.1; IR (KBr): 2926, 2154, 1735, 1645, 1156, 1097 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_8H_3OS_2F_3$+Na, 258.9470; found, 258.9467.

1-Cyclohexyl-3-((trifluoromethyl)thio)prop-2-yn-1-one (4v)



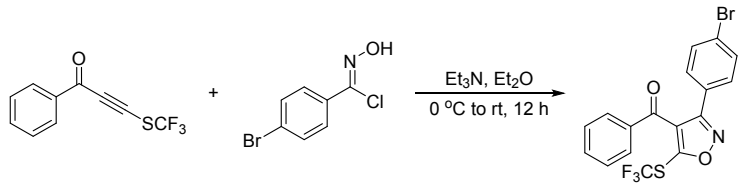
5.9 mg, 25% yield; viscous liquid; TLC (petroleum ether/ethyl acetate, 15:1 v/v): R_f = 0.72; ^{1}H NMR (400 MHz, DMSO-d_6) δ 1.89 (d, J = 10.6 Hz, 2H), 1.68 (dd, J = 8.6, J = 3.6 Hz, 4H), 1.39–1.24 (m, 6H), 0.84 (d, J = 7.3 Hz, 1H); ^{13}C NMR (100 MHz, DMSO-d_6) δ 188.4, 127.8 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 101.7, 75.8, 50.9, 27.8, 25.7, 25.1; ^{19}F NMR (376 MHz, DMSO-d_6) δ −42.5; IR (KBr): 2932, 2853, 2193, 1710, 1460 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{10}H_{11}OSF_3$+Na, 259.0379; found, 259.0375.

D. Procedure for the Gram-Scale Synthesis of 4a and transformations of 4a



2a **4a**

A 250 mL round bottom flask placed with a magnetic stirring bar, bromoalkynones **2a** (5 mmol), LiOH (5 mmol), $AgSCF_3$ (10 mmol), and toluene (100 mL) was vigorously stirred at 100 °C for 12 h in an oil bath. Then the resulting solution was cooled to room temperature, added water (100 mL), extracted with EtOAc (3 × 100 mL). The combined organic phases were dried over anhydrous Na_2SO_4, filtered and concentrated *in vacuo*. Further purification by flash column chromatography on silica gel (eluting with petroleum ether/ethyl acetate) provided the pure product **4a** (63%, 0.724 g).



4a **5a**

To a 25 mL round bottom flask placed with a magnetic stirring bar was added Et_3N (0.9 mmol), (*Z*)-4-bromo-*N*-hydroxybenzimidoyl chloride (0.6 mmol), and Et_2O (2 mL), the resulting mixture was stirred at 0 °C for 30 min, then **4a** (0.3 mmol) in Et_2O (1 mL) was added. The reaction mixture was left at room temperature for about 12 h. After completion of the reaction, the resulting solution added water (20 mL), extracted with EtOAc (3 × 20 mL). The combined organic phases were dried over anhydrous Na_2SO_4, filtered and concentrated *in vacuo*. Further purification by flash column chromatography on silica gel (eluting with petroleum ether/ethyl acetate) provided the pure product **5a**.

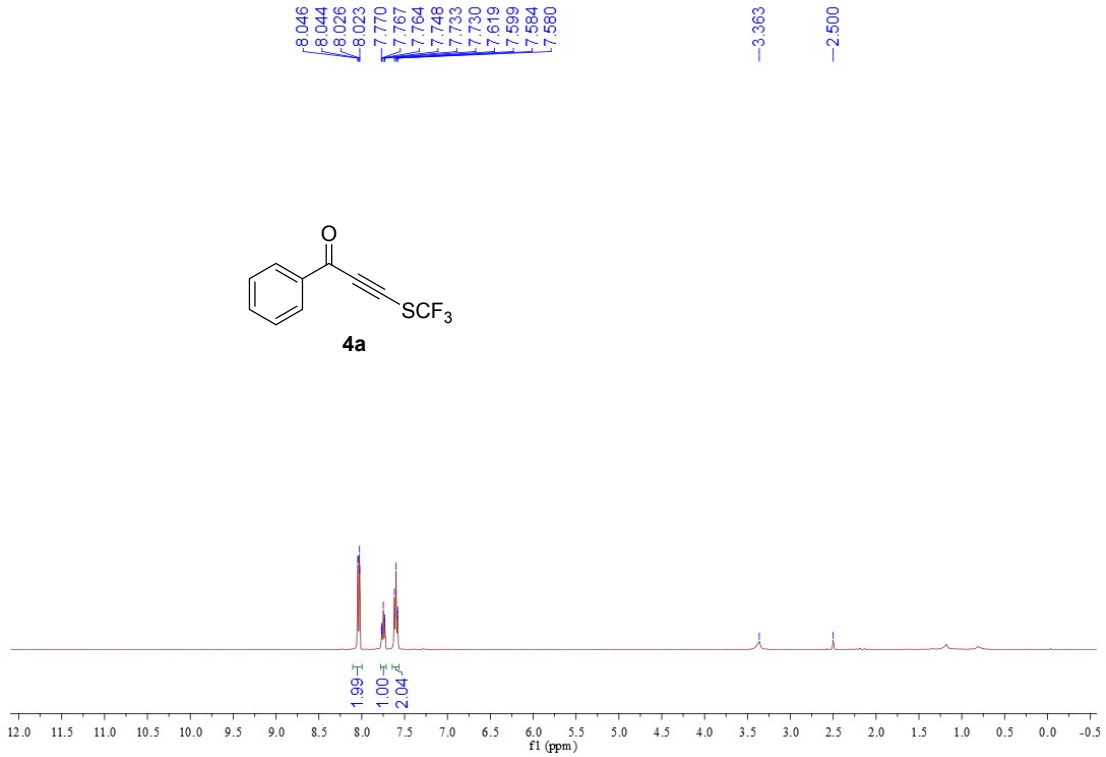
(3-(4-Bromophenyl)-5-((trifluoromethyl)thio)isoxazol-4-yl)(phenyl)methanone (5a)

80.5 mg, 63% yield; white solid, mp: 123–124 °C; TLC (petroleum ether/ethyl acetate, 50:1 v/v): R_f = 0.31; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.68 (d, *J* = 7.5 Hz, 2H), 7.57 (t, *J* = 7.4 Hz, 1H), 7.44 (d, *J* = 8.4 Hz, 2H), 7.40–7.36 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 187.6, 161.4, 158.2, 136.0, 134.5, 132.1, 129.8, 129.6, 128.8, 127.1 (q, $^1J_{F\text{-}C}$ = 312.0 Hz), 125.8, 125.5, 123.9; ^{19}F NMR (376

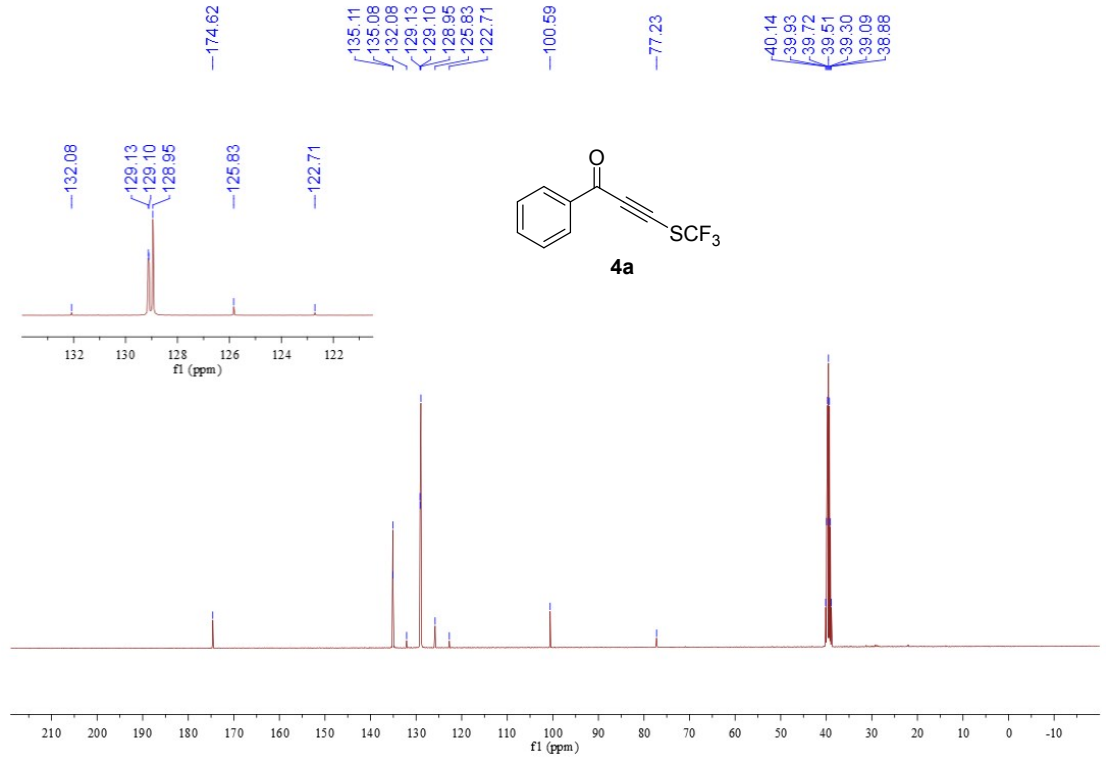
MHz, $CDCl_3$) δ −38.6; IR (KBr): 2922, 2854, 1731, 1663, 1592, 1456, 830, 753, 693 cm^{-1}; HRMS (ESI, m/z): $[M+Na]^+$ Calcd. for $C_{17}H_9BrF_3NO_2S$+Na, 449.9382; found, 449.9375.

E. NMR Spectra of New Compounds

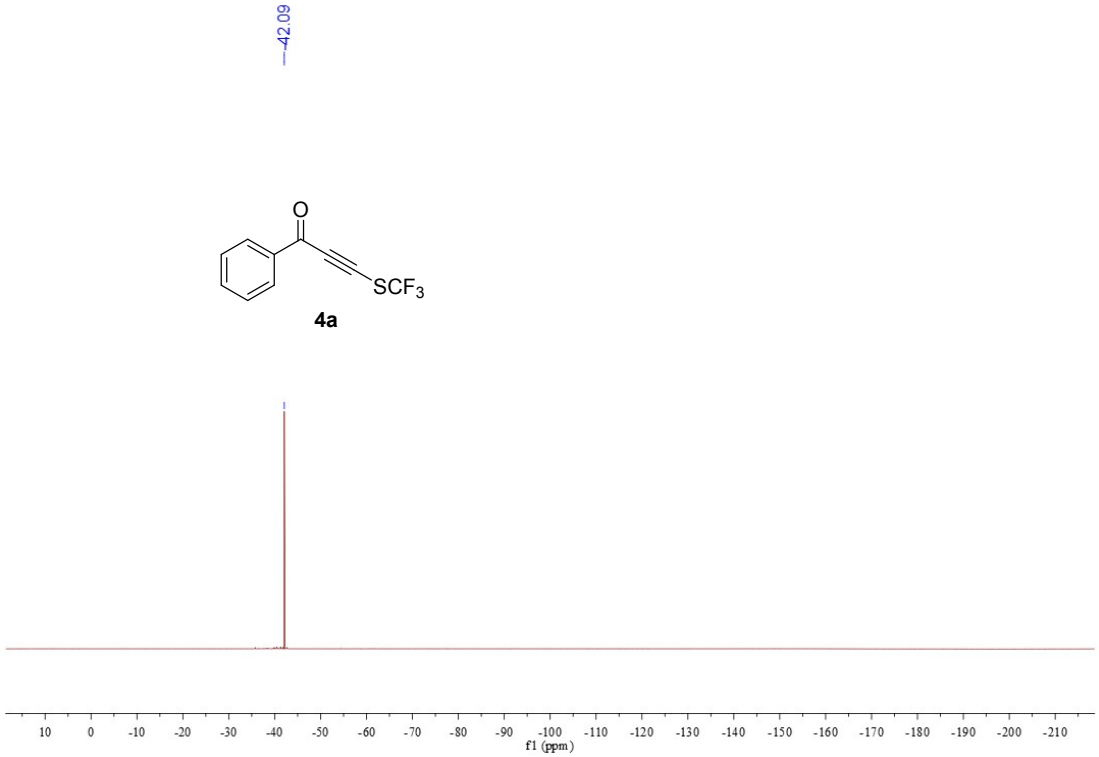
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4a



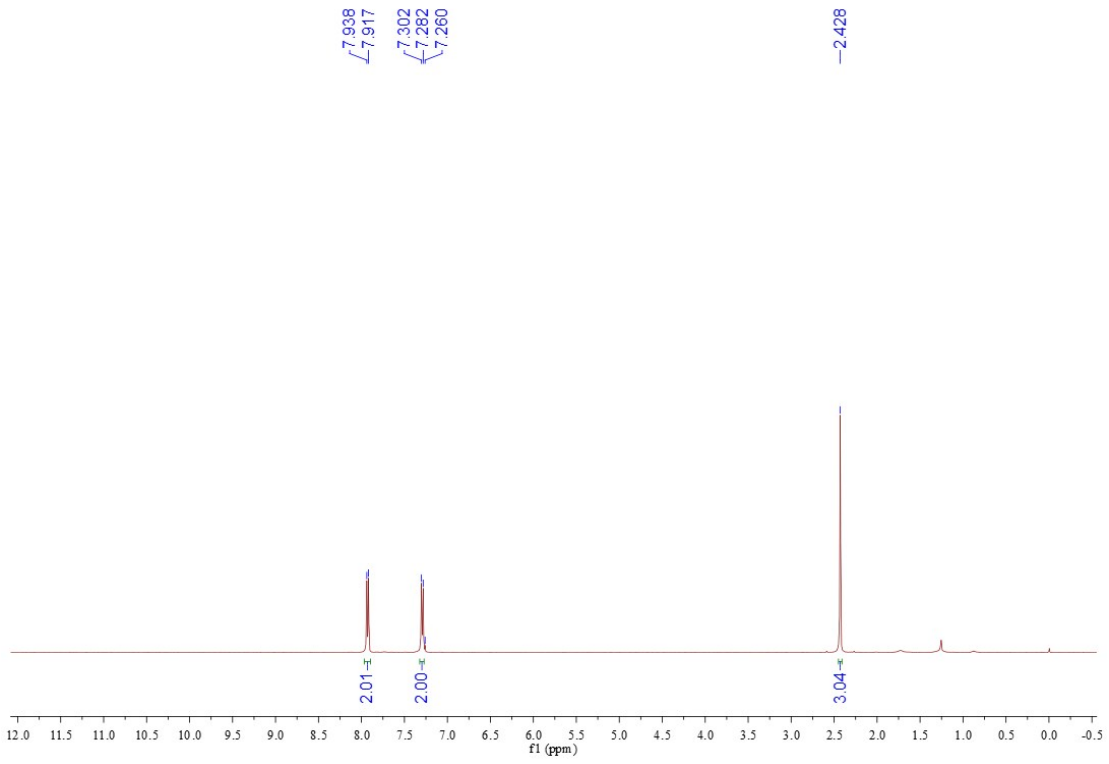
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4a



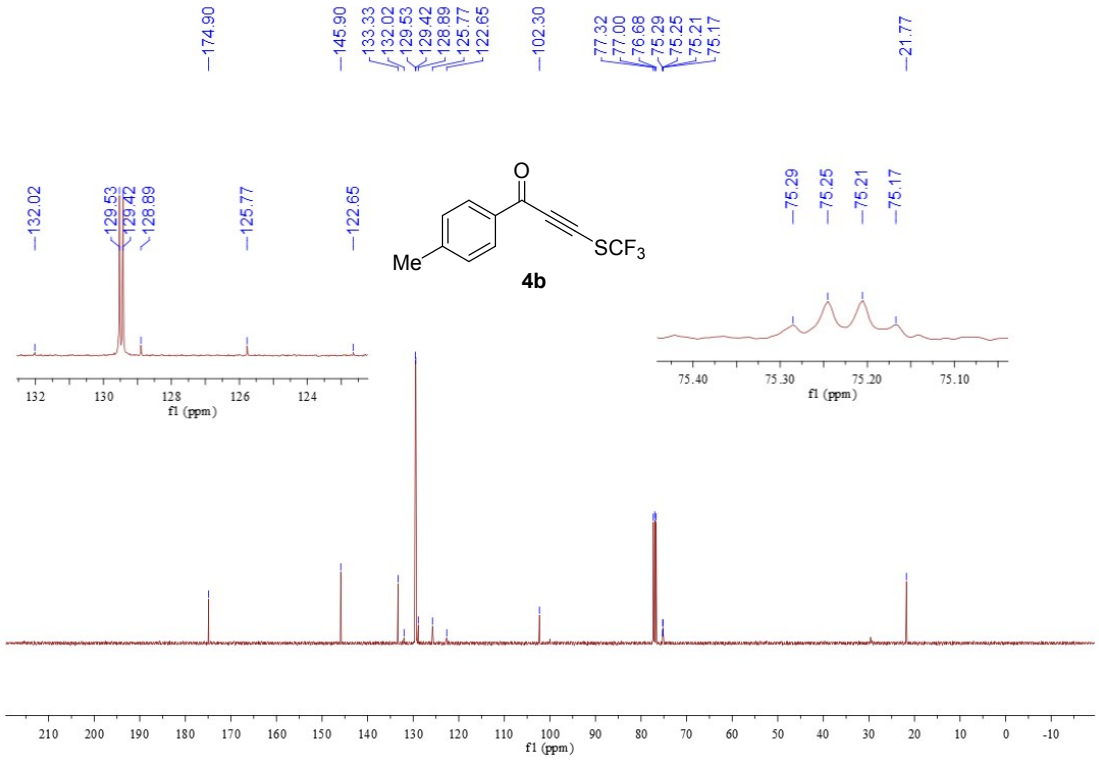
^{19}F NMR (100 MHz, DMSO-d_6) spectrum for 4a



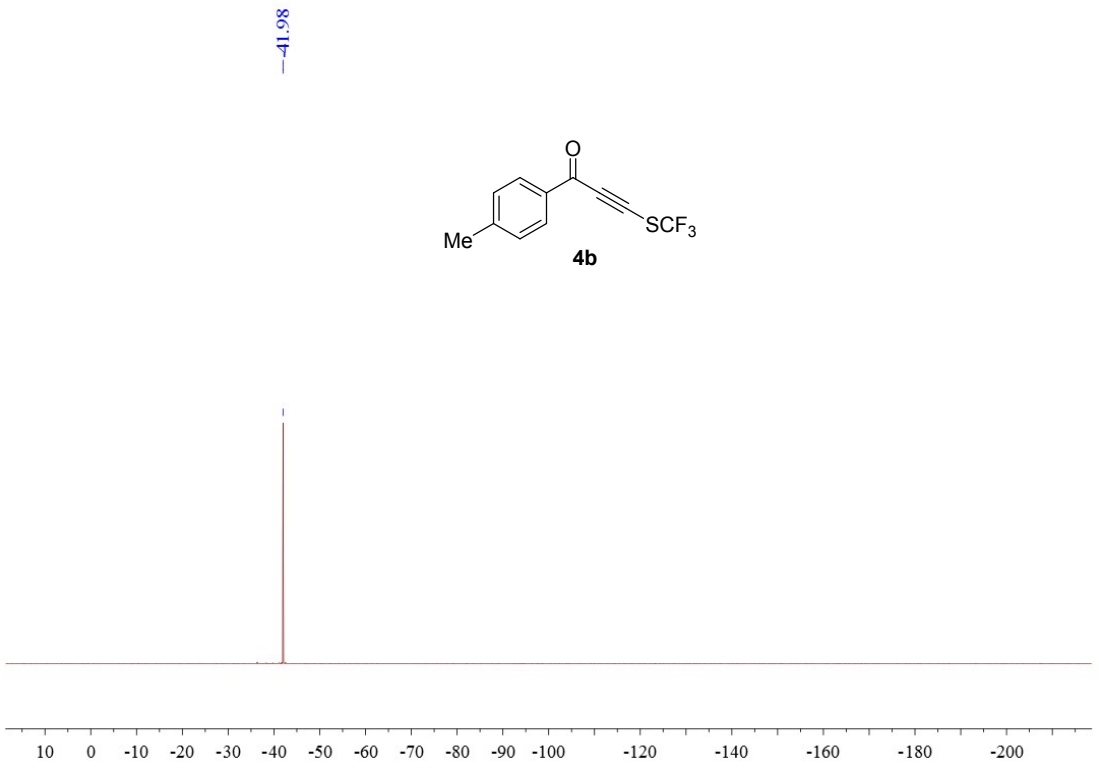
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4b



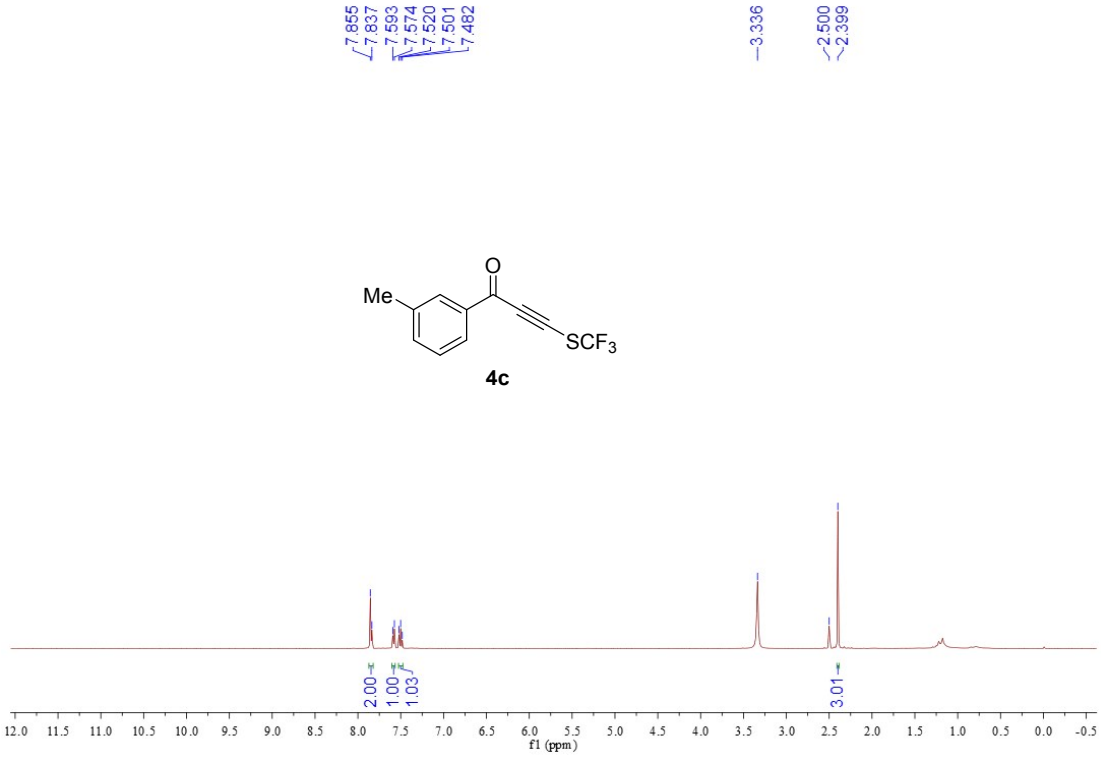
^{13}C NMR (100 MHz, $CDCl_3$) spectrum for 4b



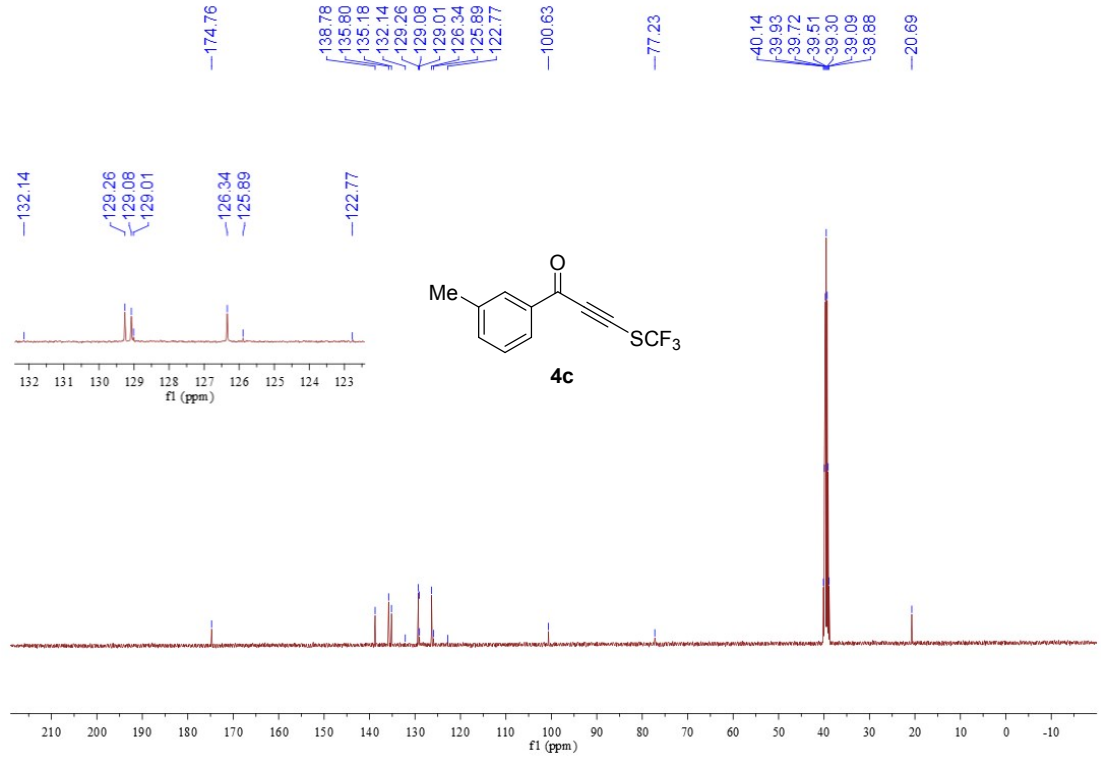
^{19}F NMR (100 MHz, $CDCl_3$) spectrum for 4b



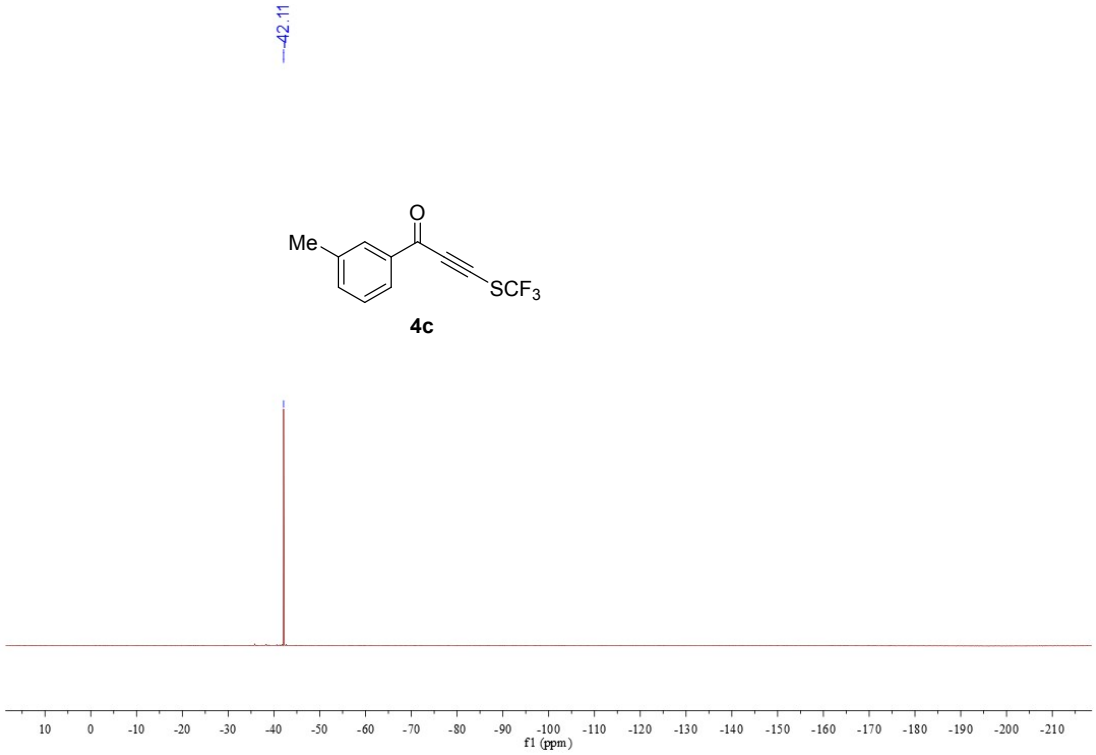
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4c



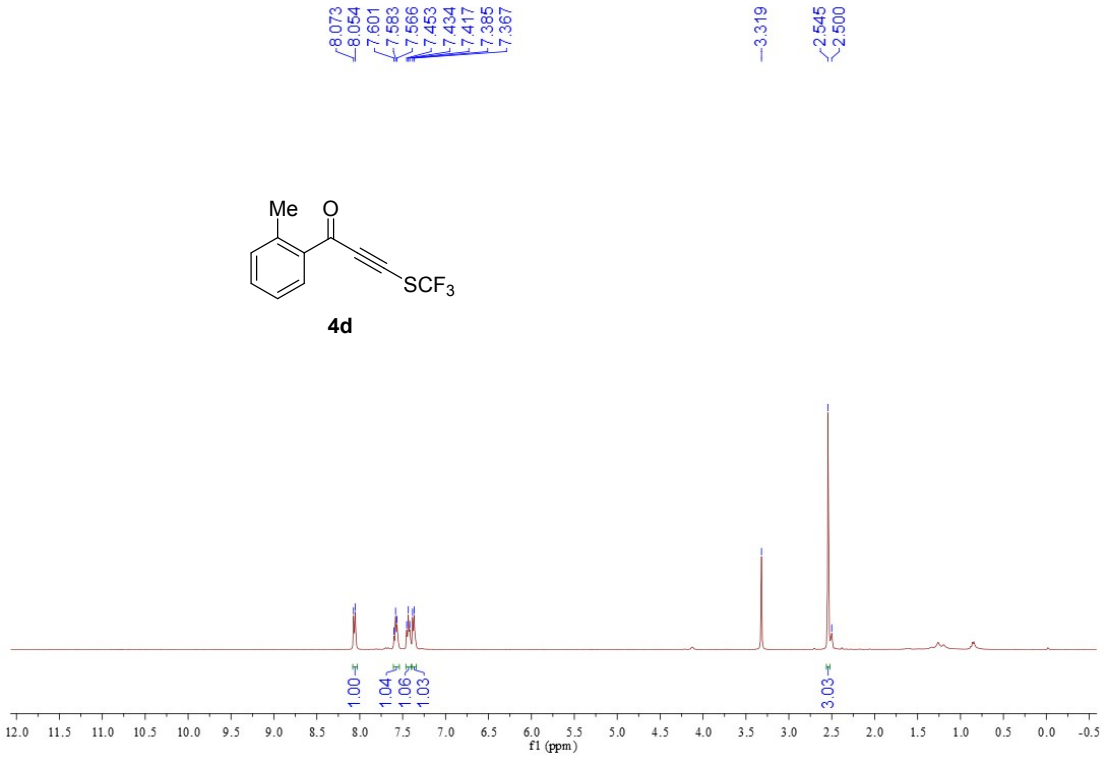
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4c



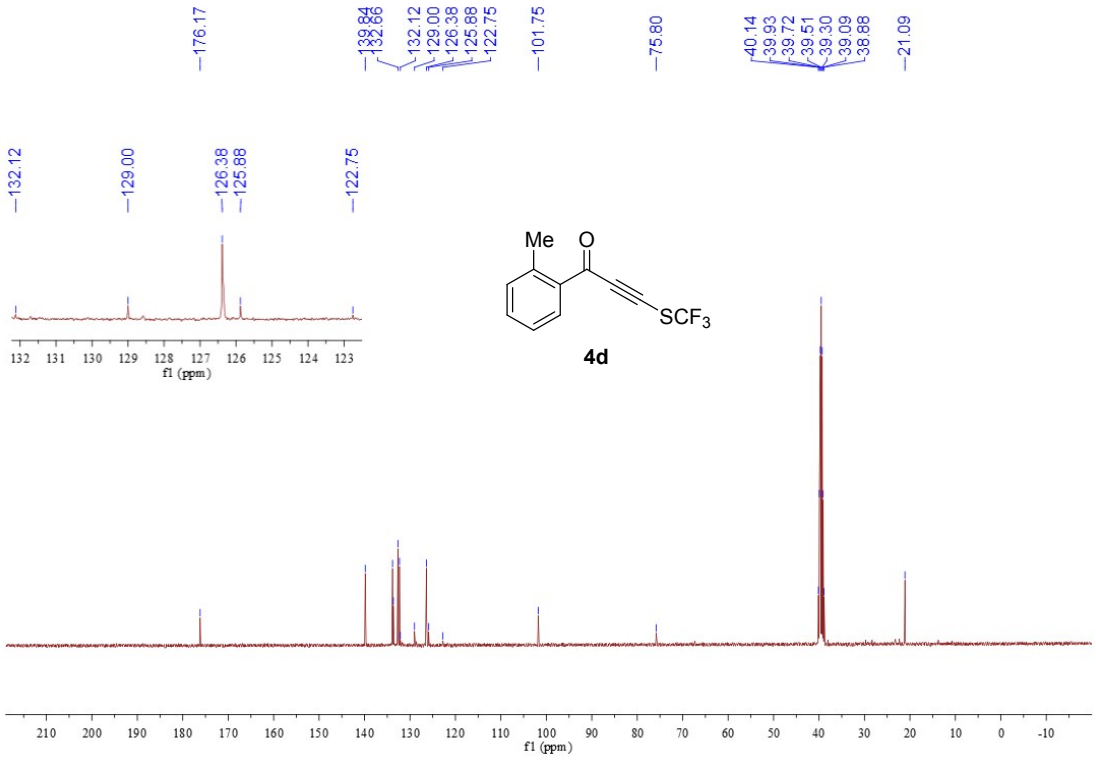
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4c



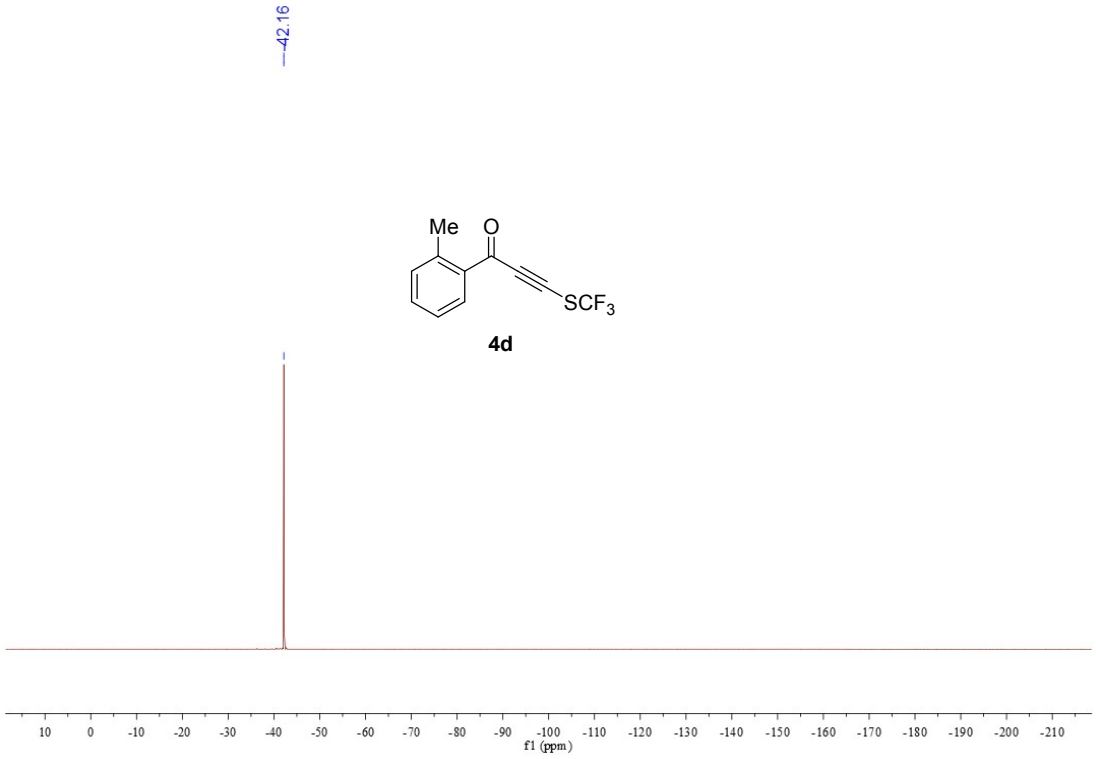
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4d



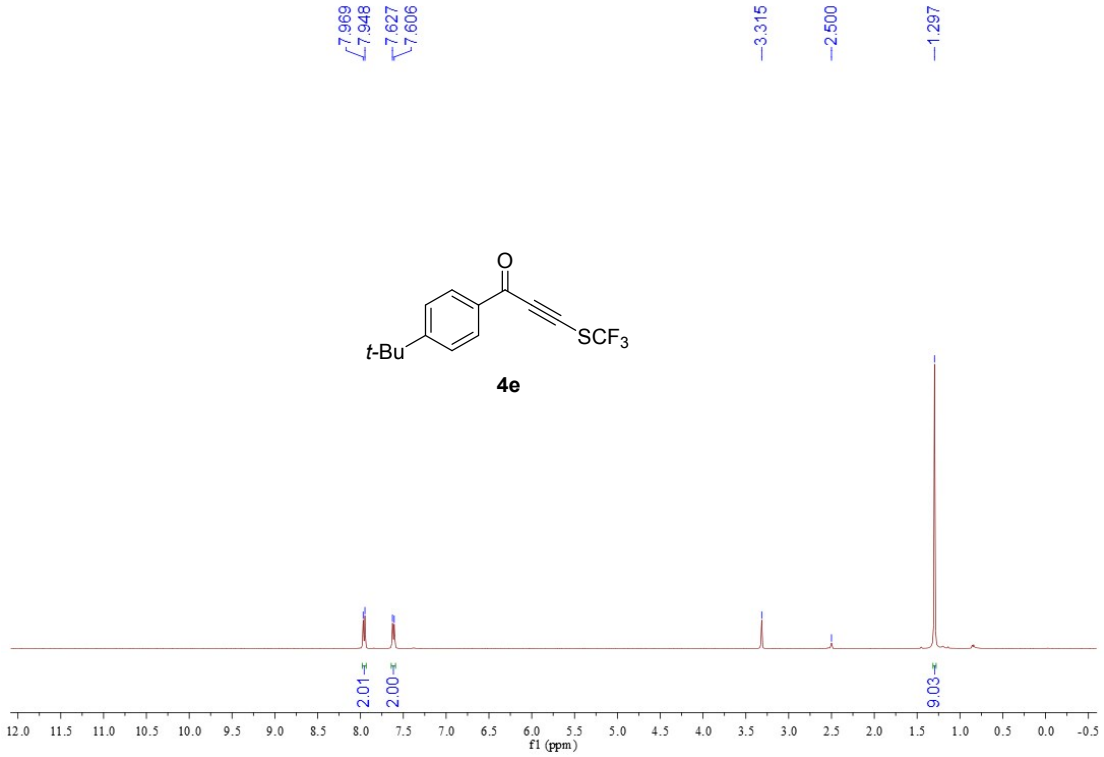
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4d



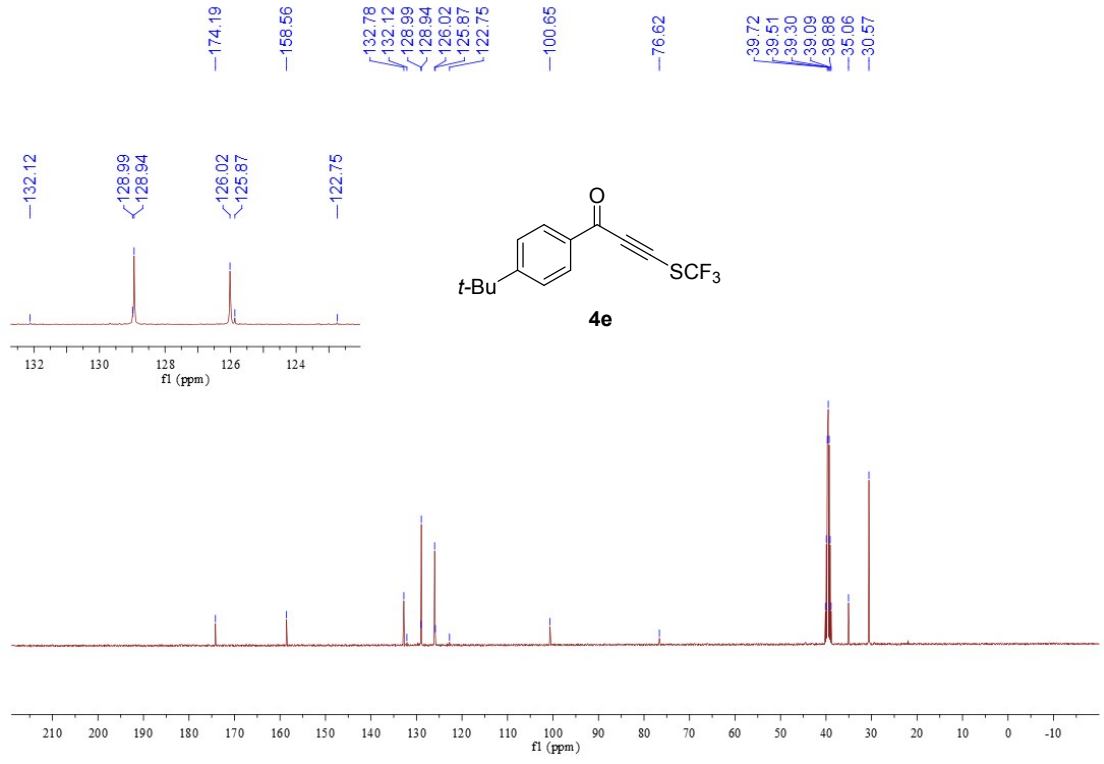
^{19}F NMR (400 MHz, DMSO-d_6) spectrum for 4d



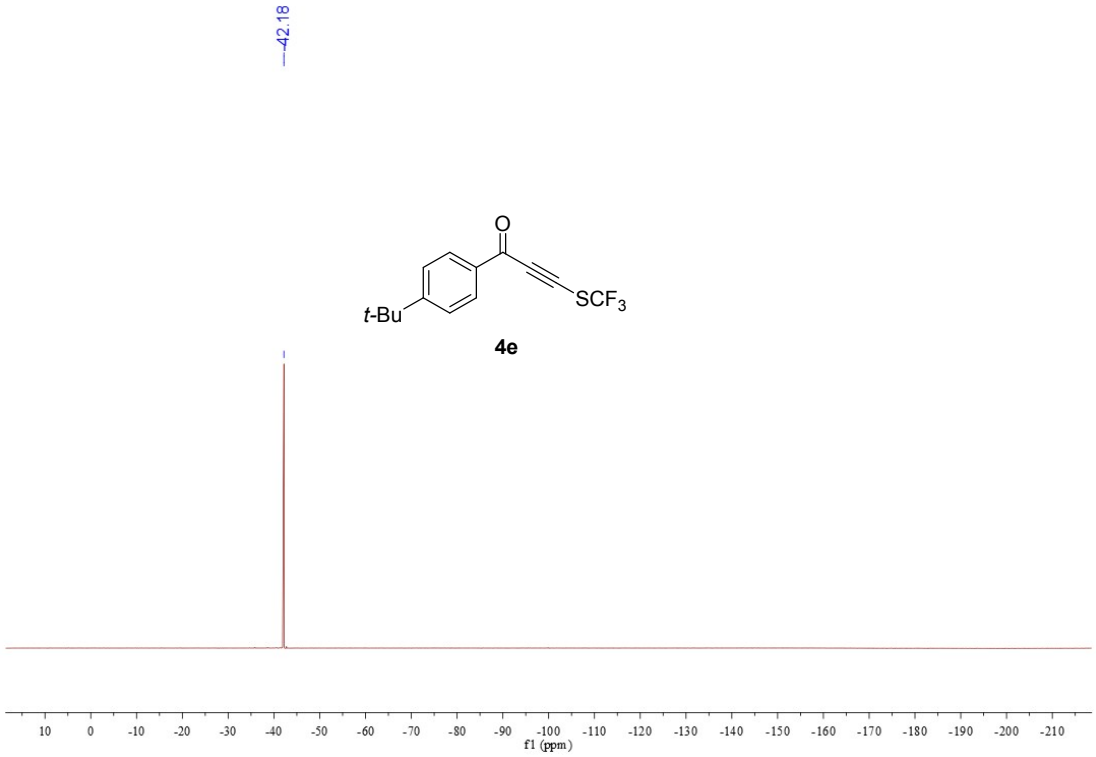
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4e



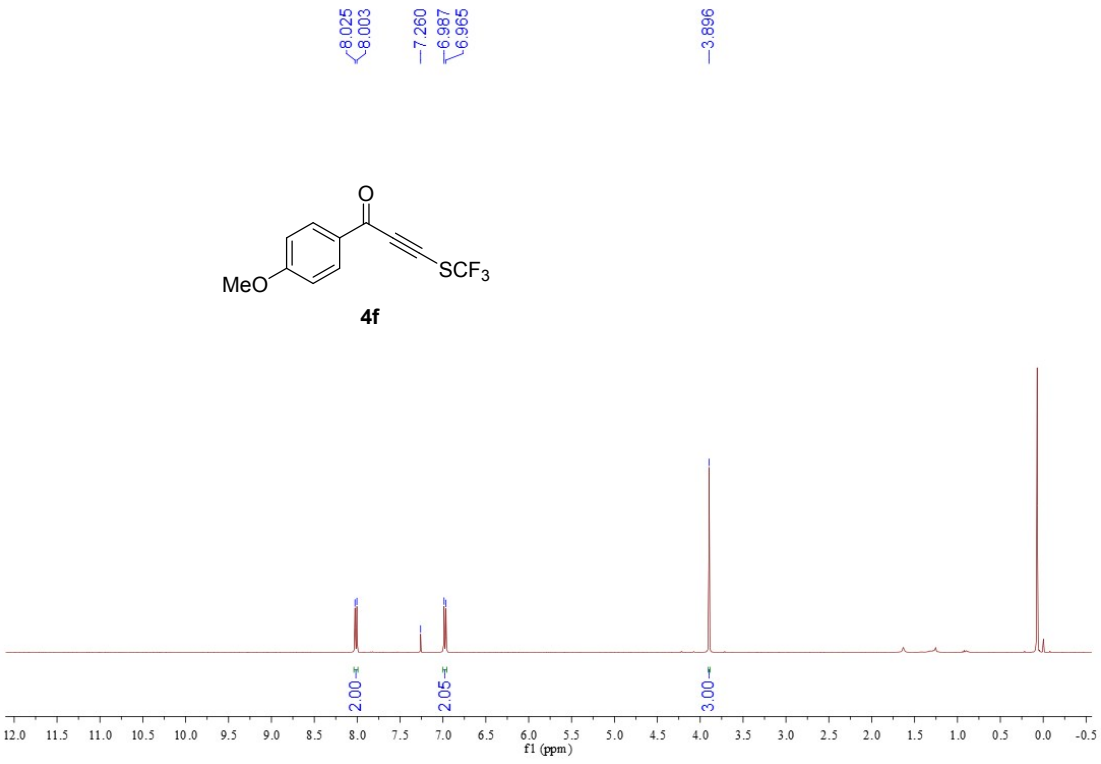
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4e



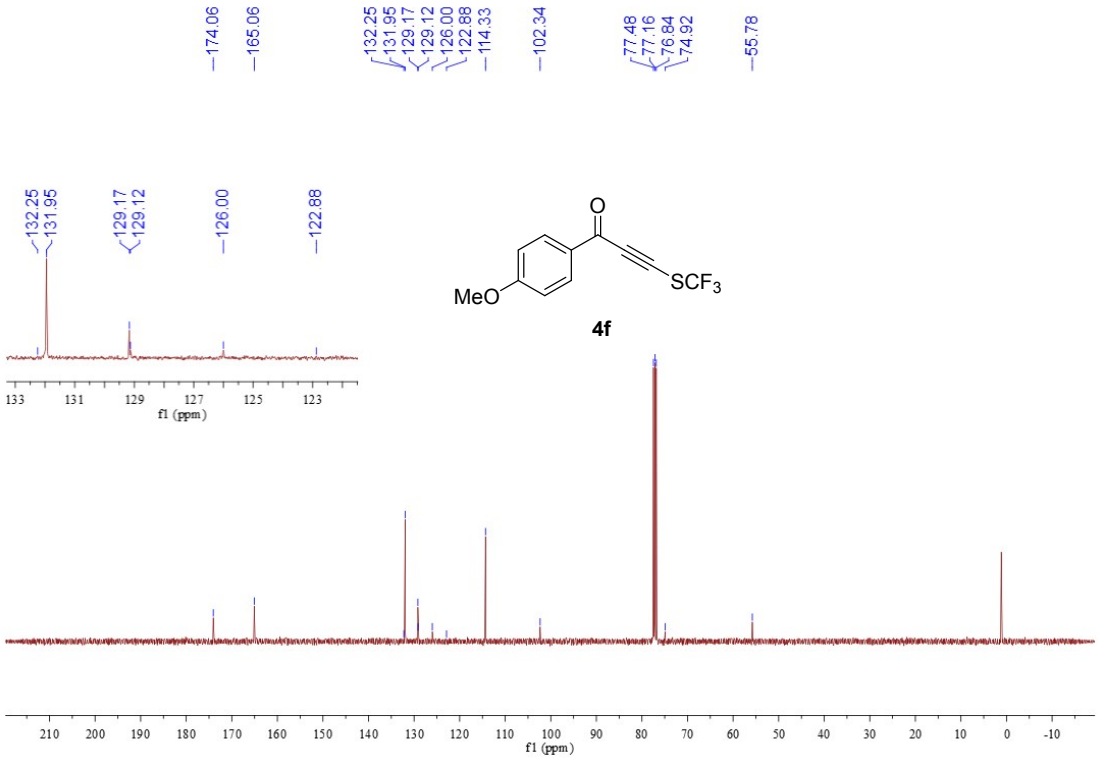
^{19}F NMR (100 MHz, DMSO-d_6) spectrum for 4e



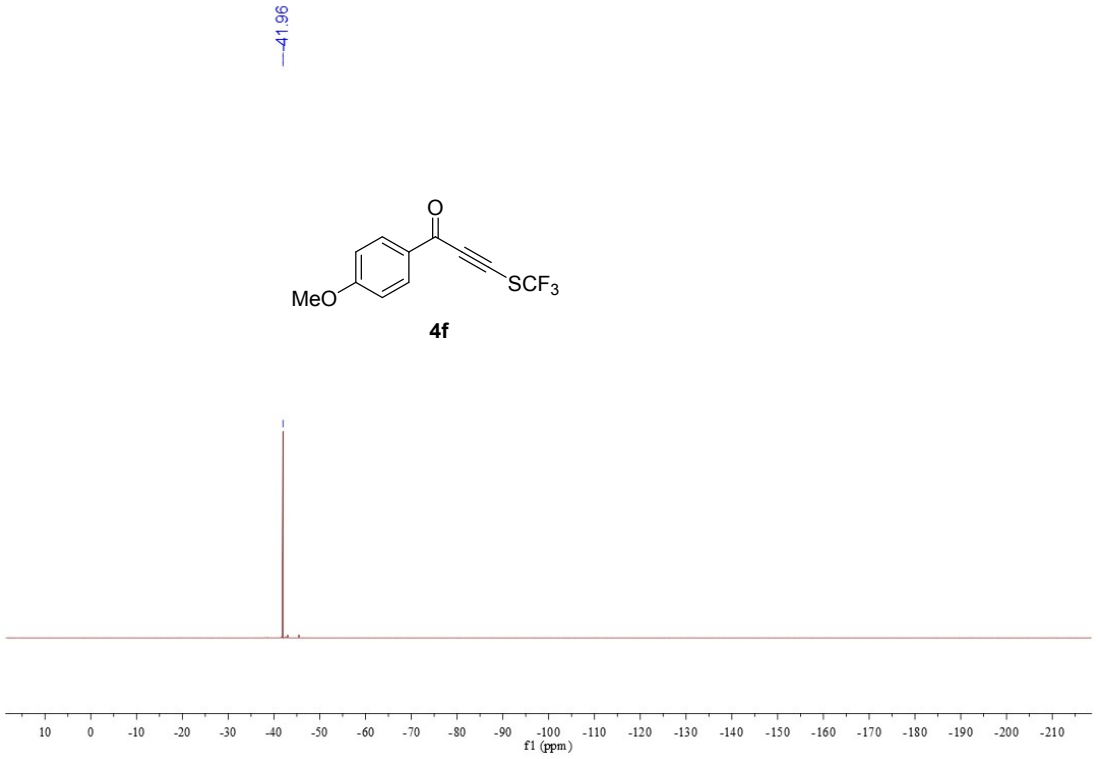
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4f



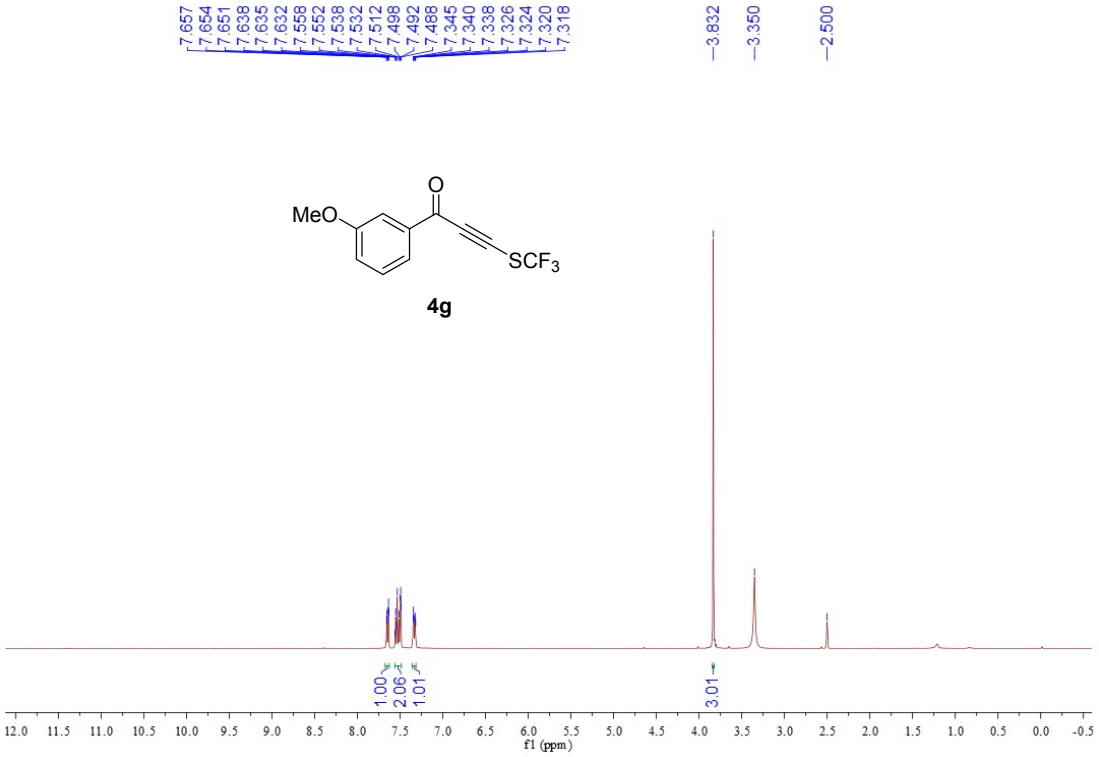
^{13}C NMR (100 MHz, $CDCl_3$) spectrum for 4f



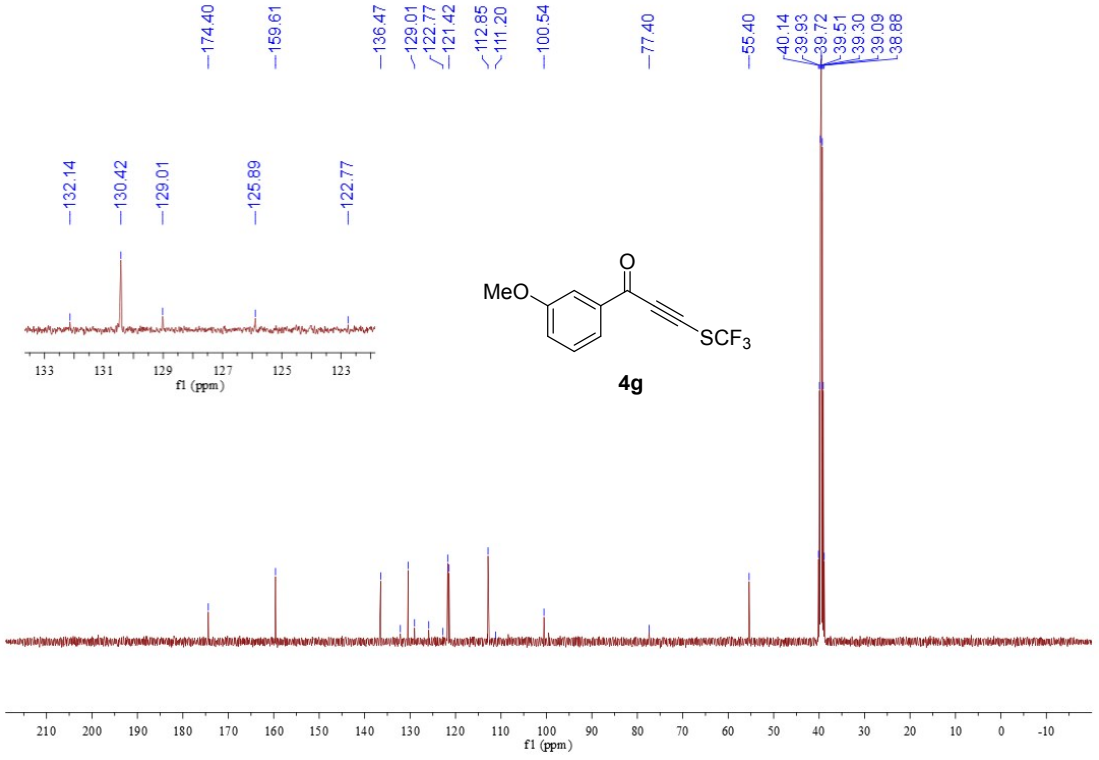
^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 4f



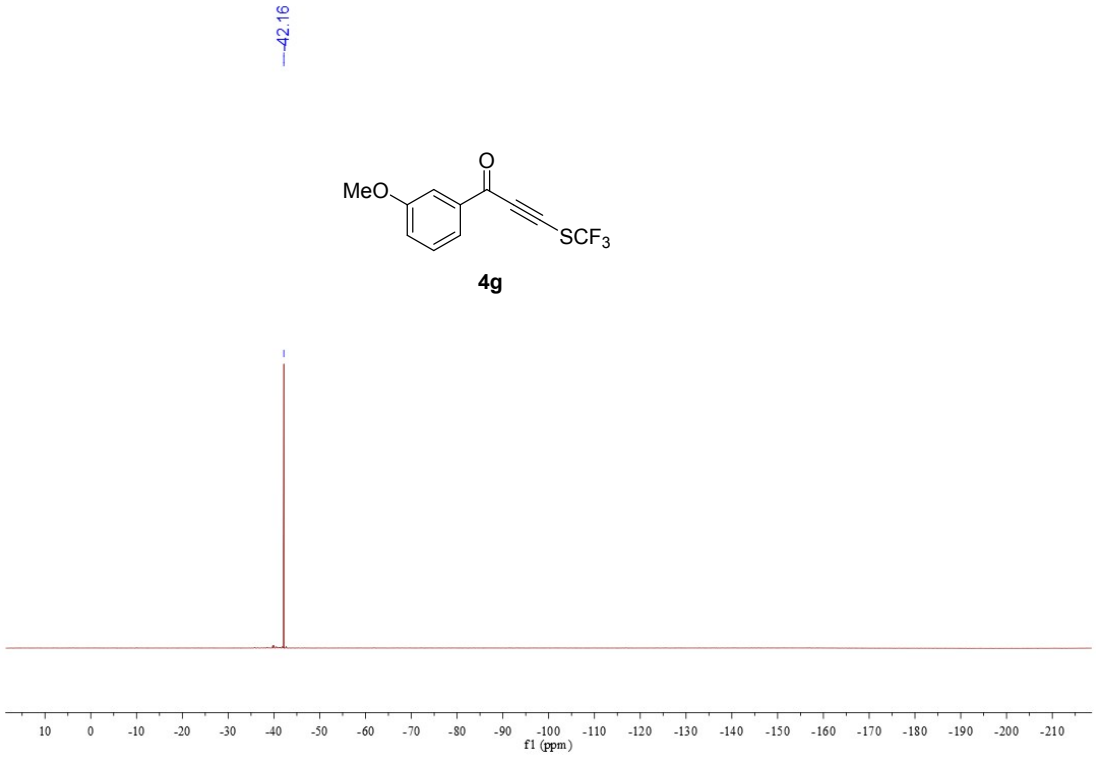
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4g



^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4g

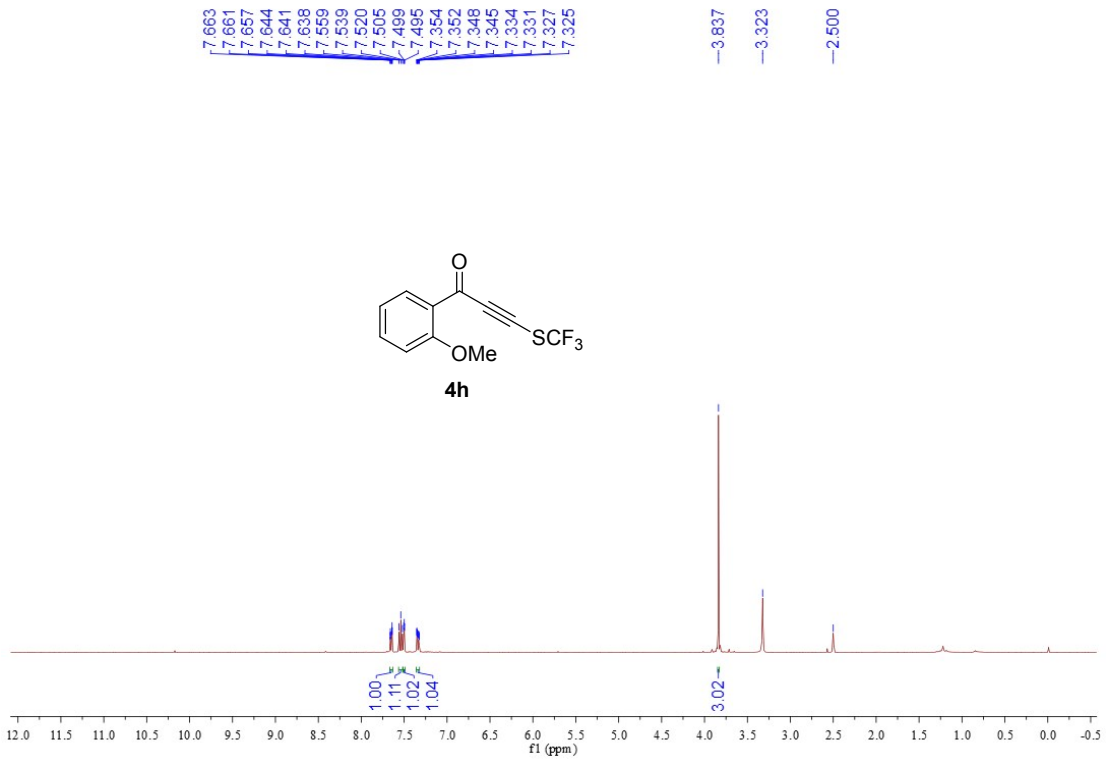


^{19}F NMR (100 MHz, DMSO-d_6) spectrum for 4g



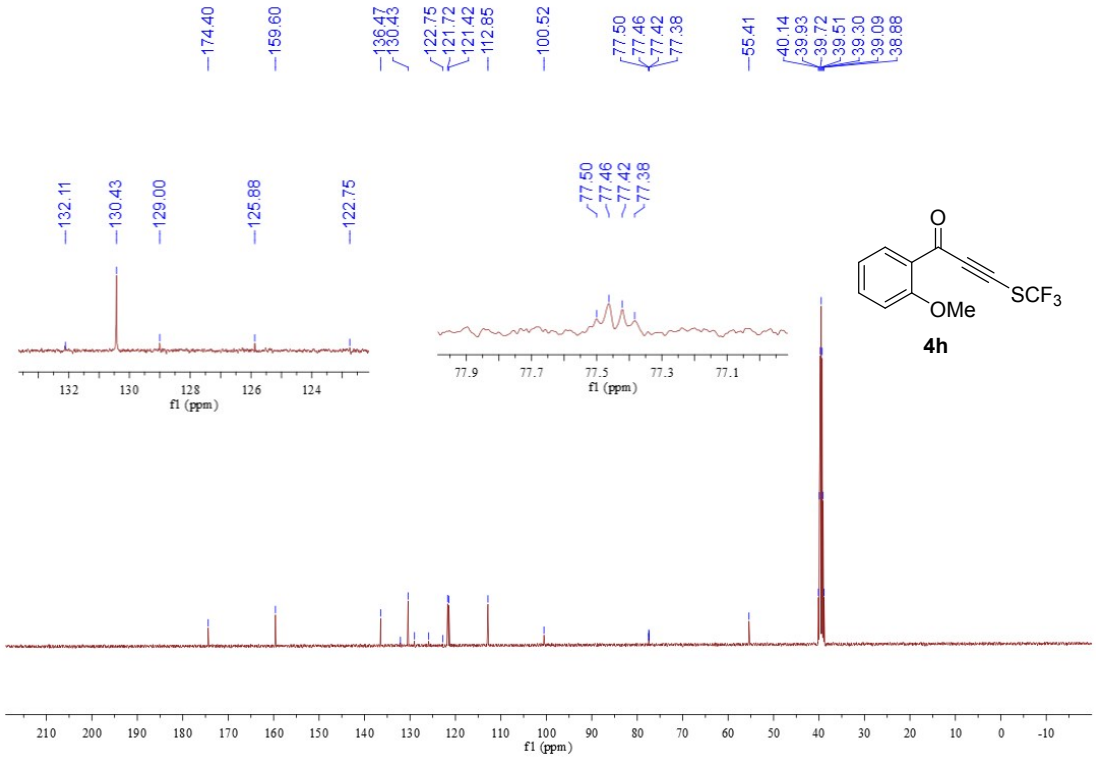
4g

^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4h

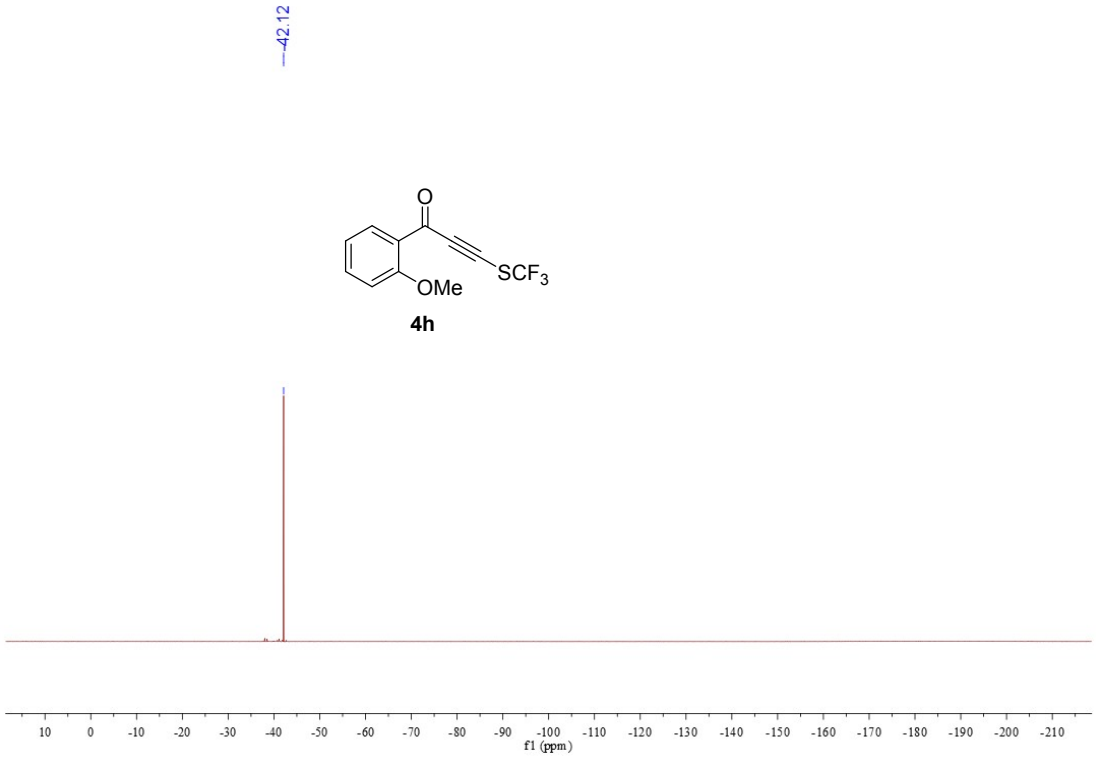


4h

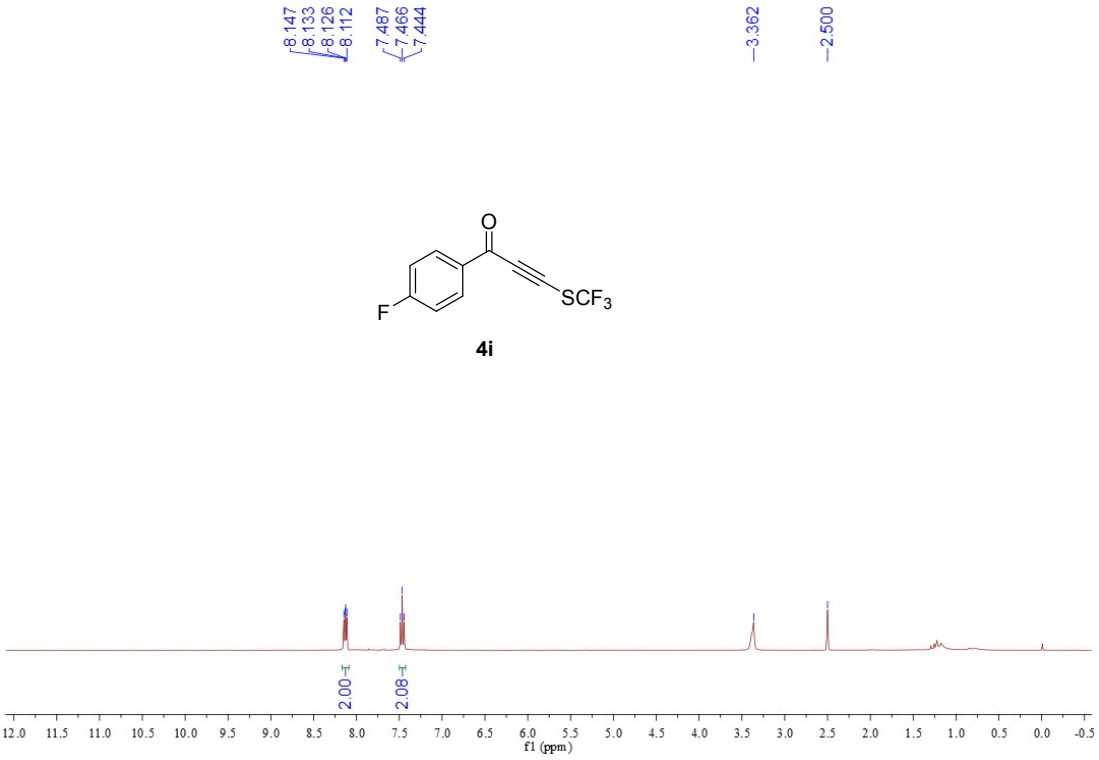
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4h



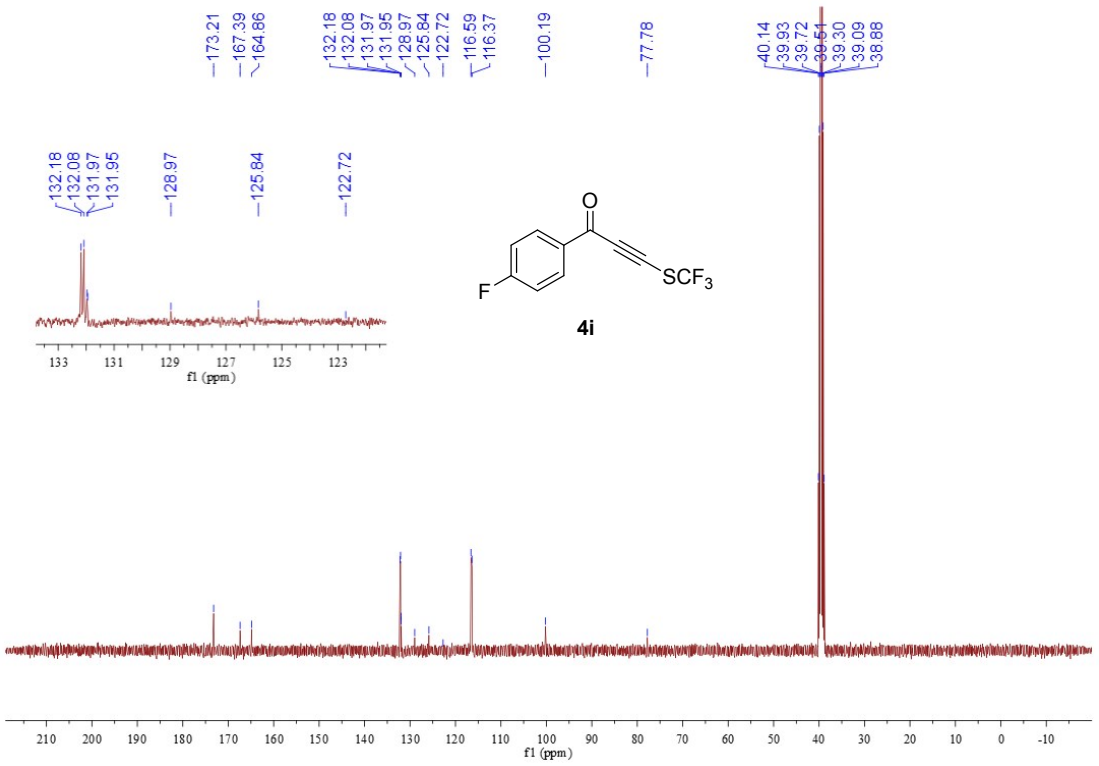
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4h



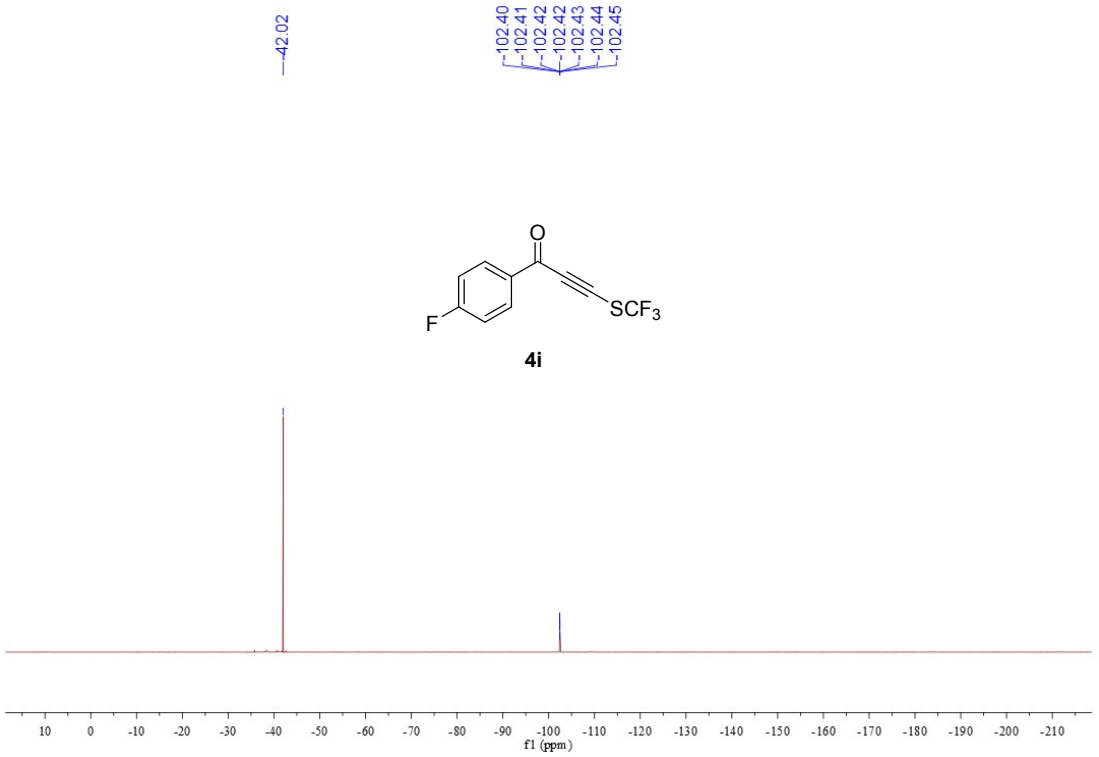
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4i



^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4i

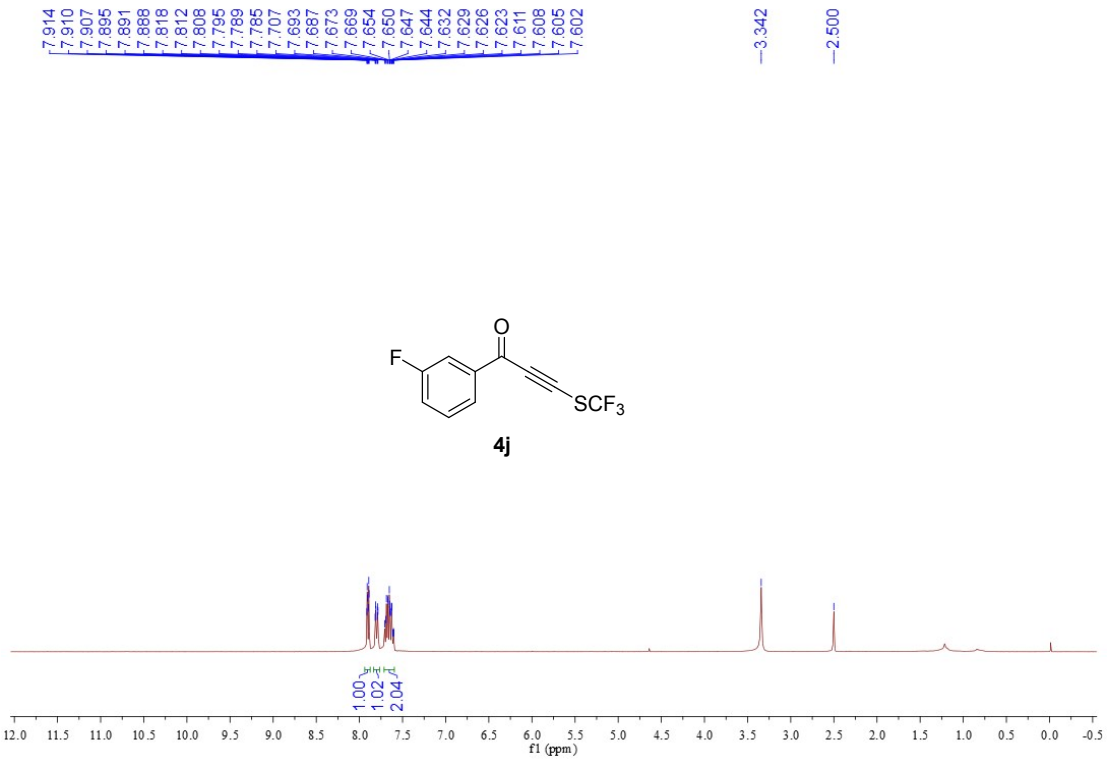


^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4i



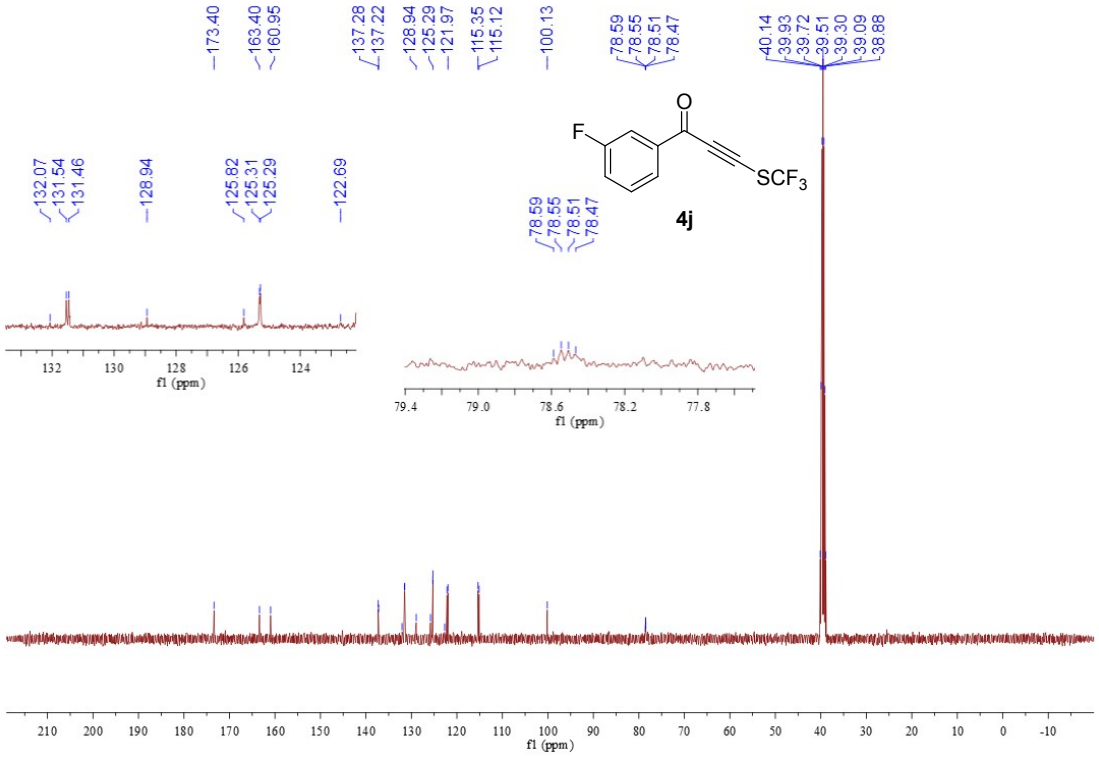
4i

^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4j

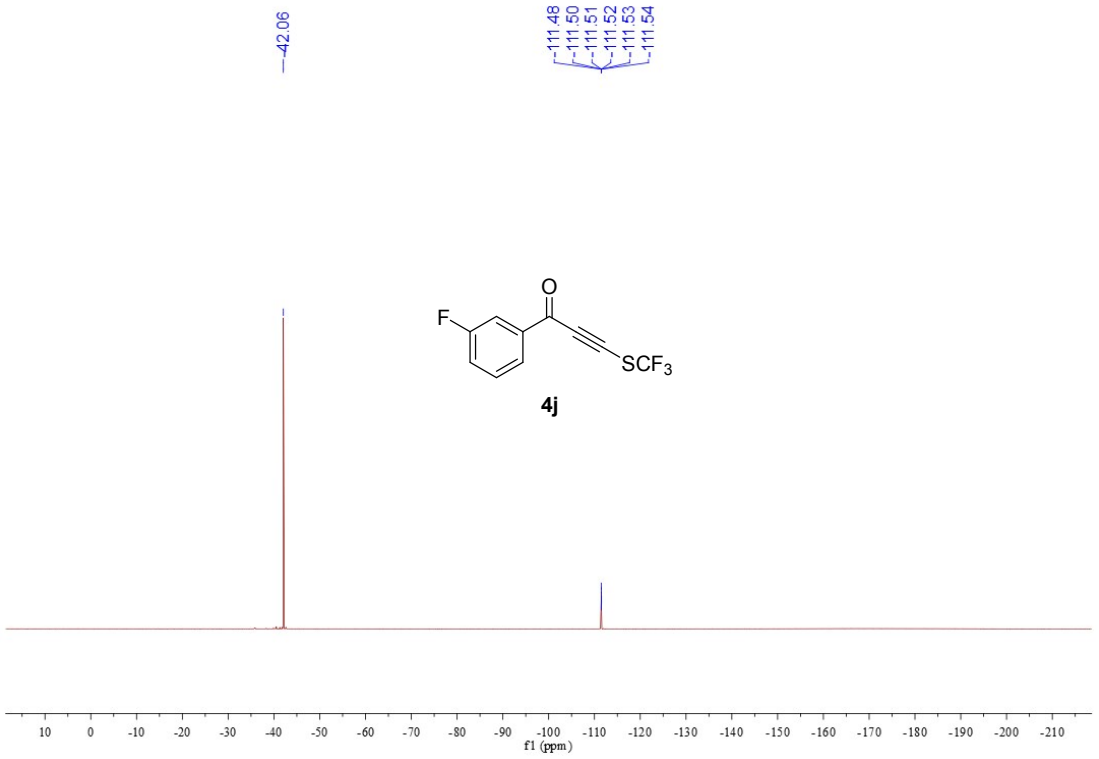


4j

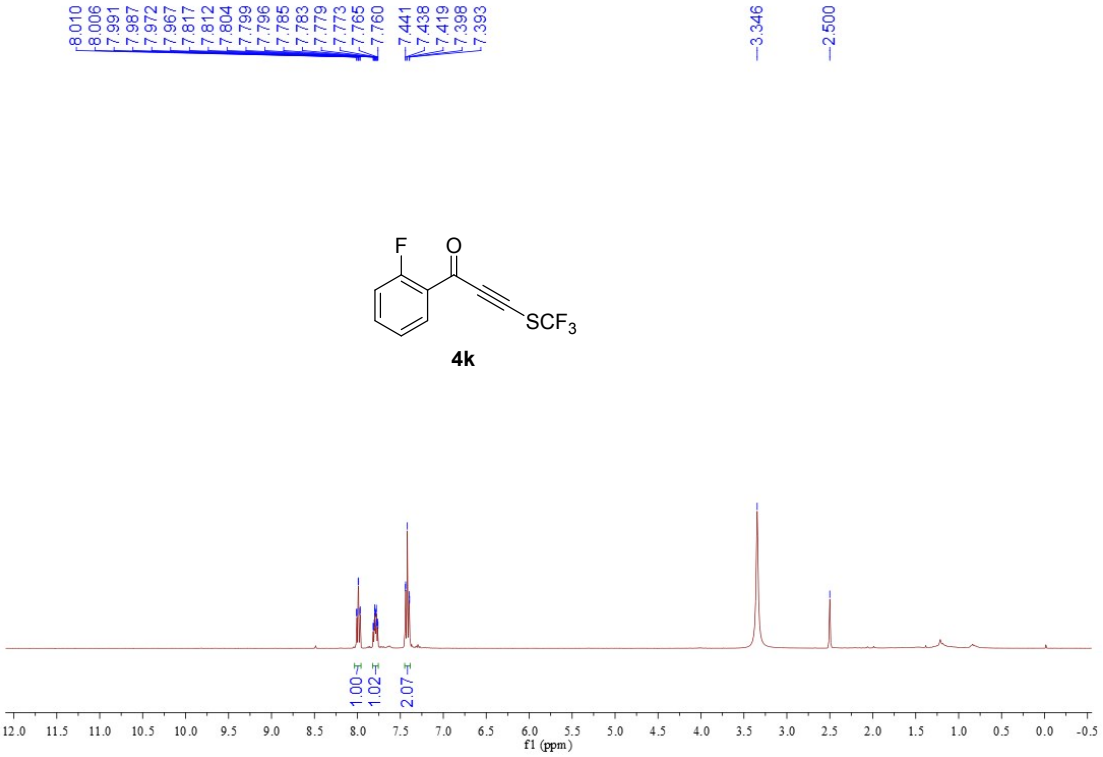
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4j



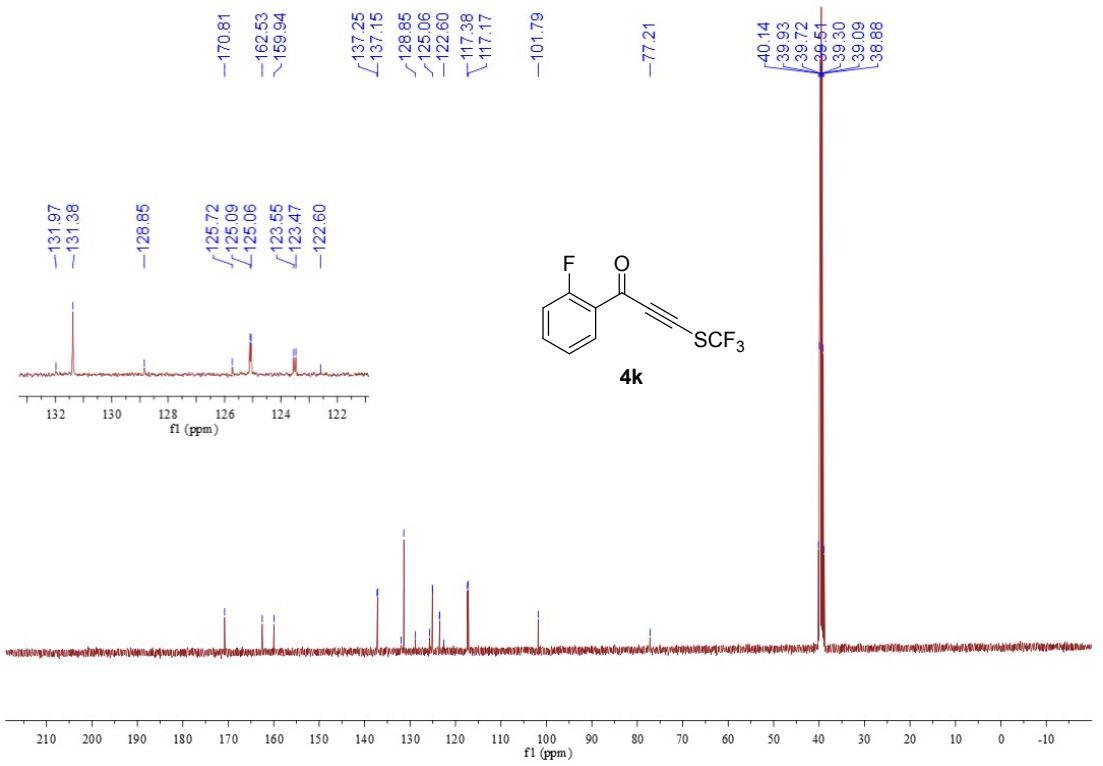
^{19}F NMR (400 MHz, DMSO-d_6) spectrum for 4j



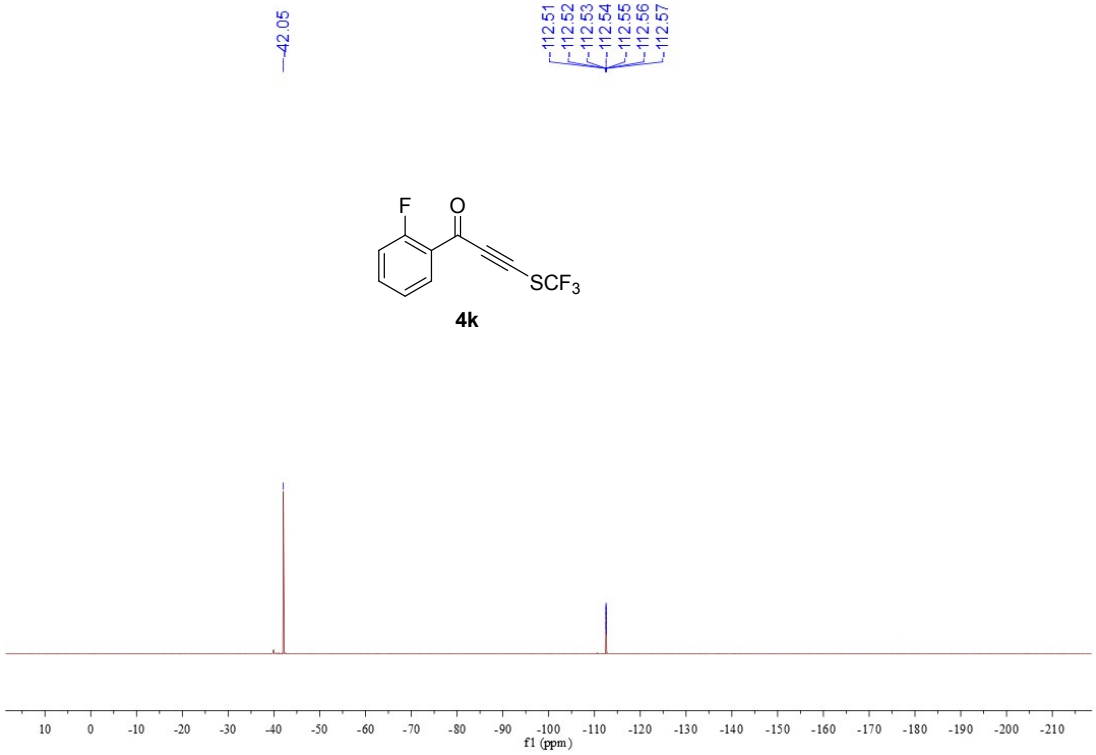
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4k



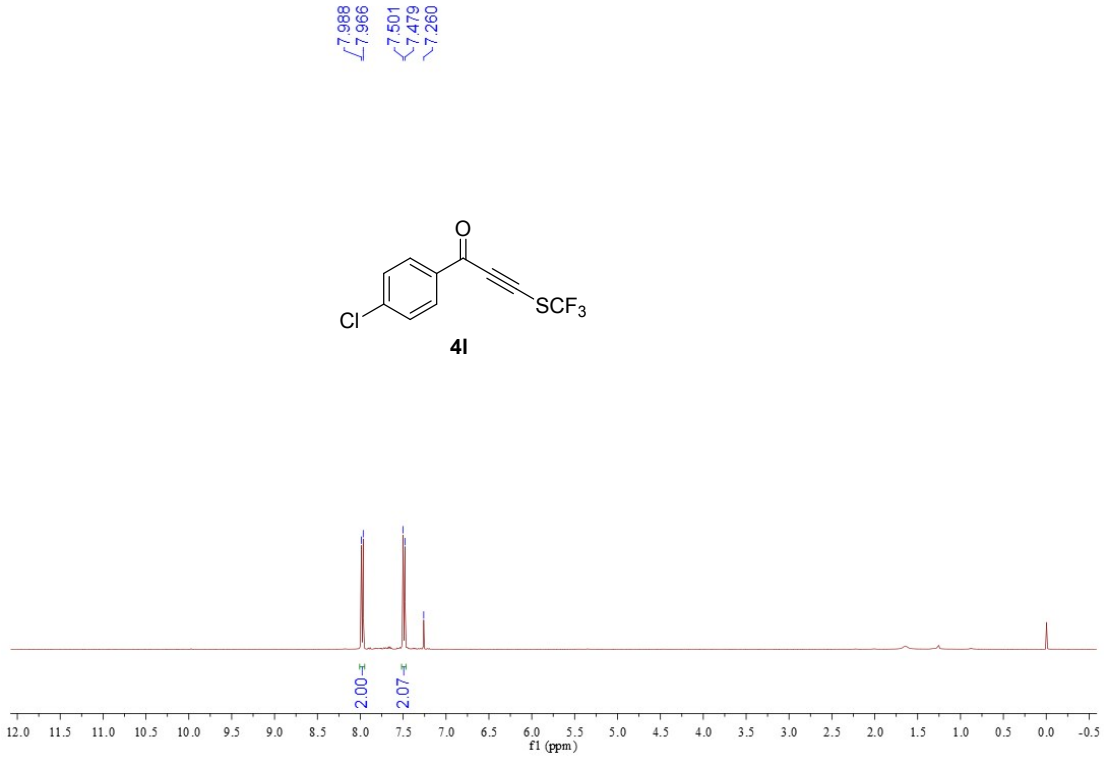
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4k



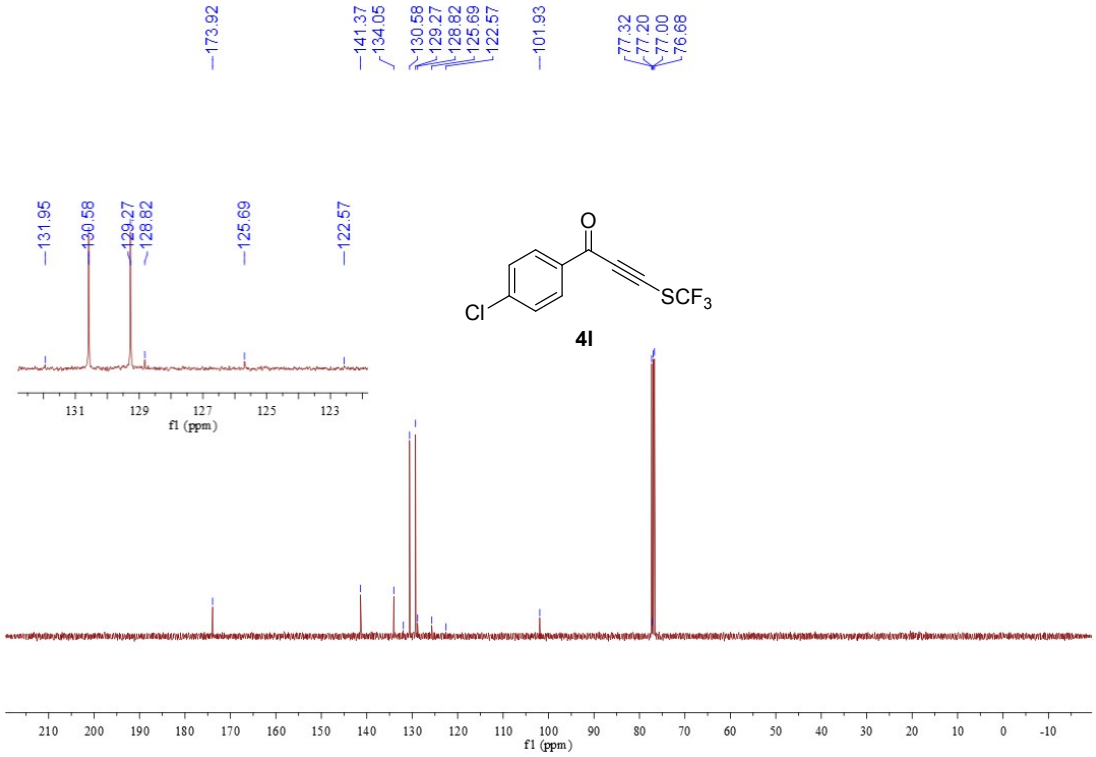
^{19}F NMR (100 MHz, DMSO-d_6) spectrum for 4k



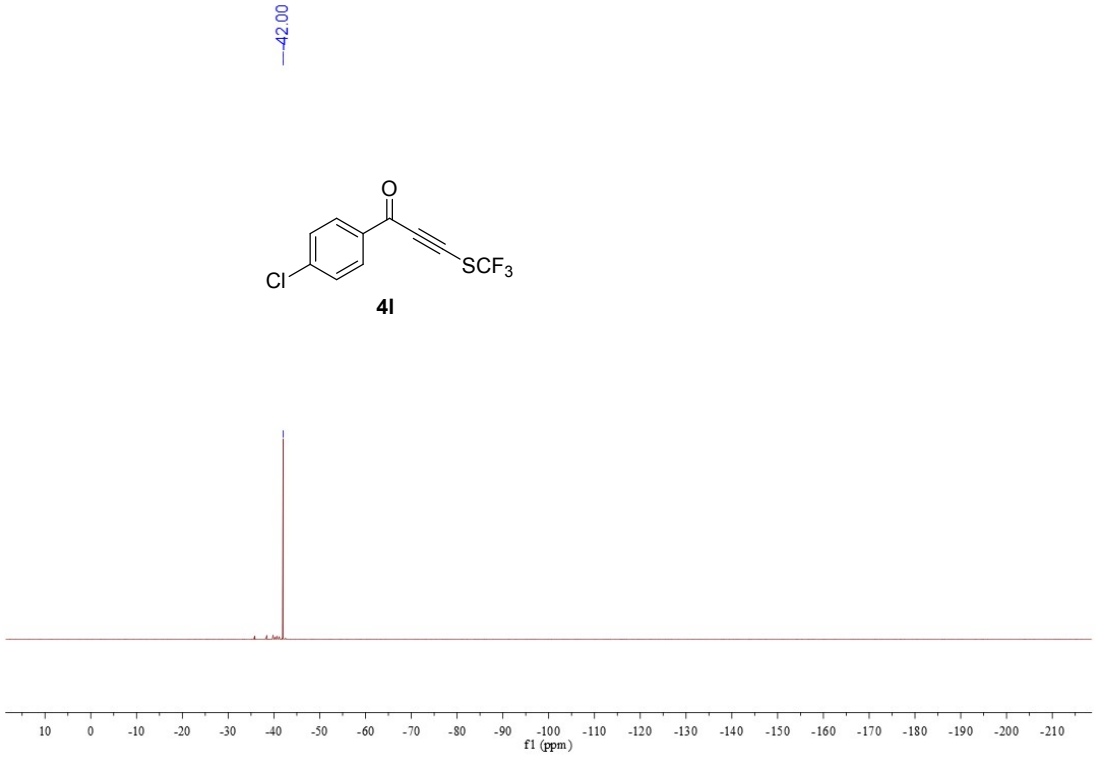
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 4l



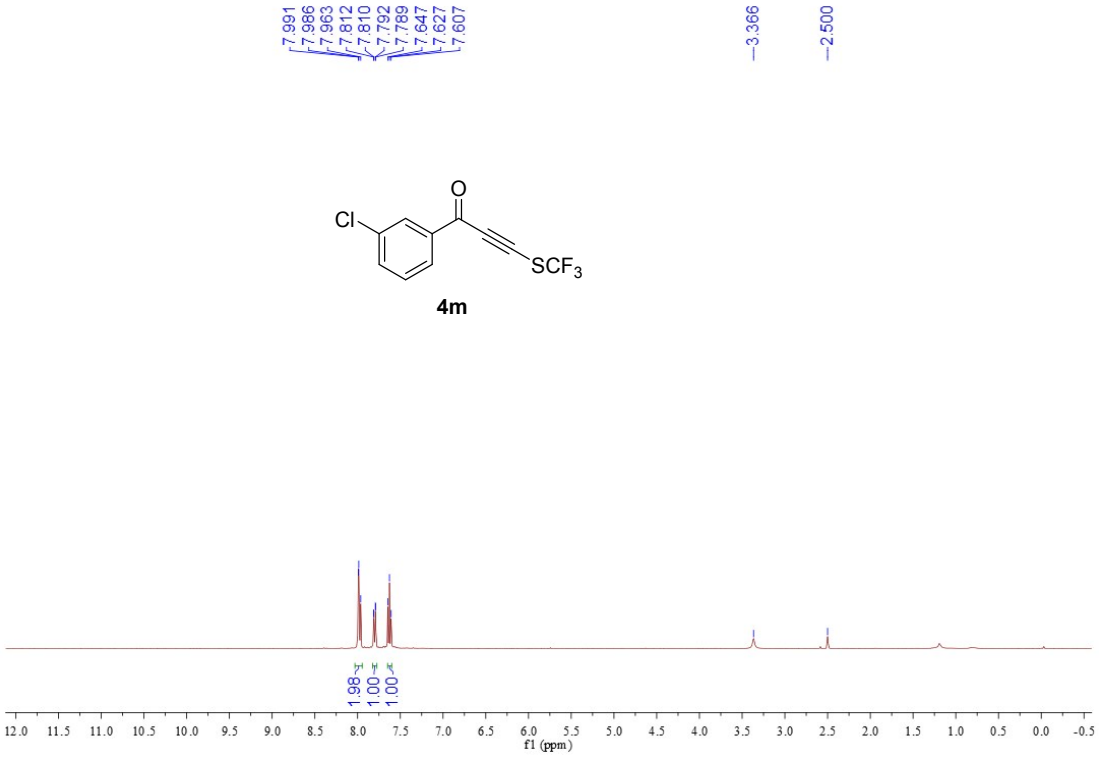
^{13}C NMR (100 MHz, $CDCl_3$) spectrum for 4l



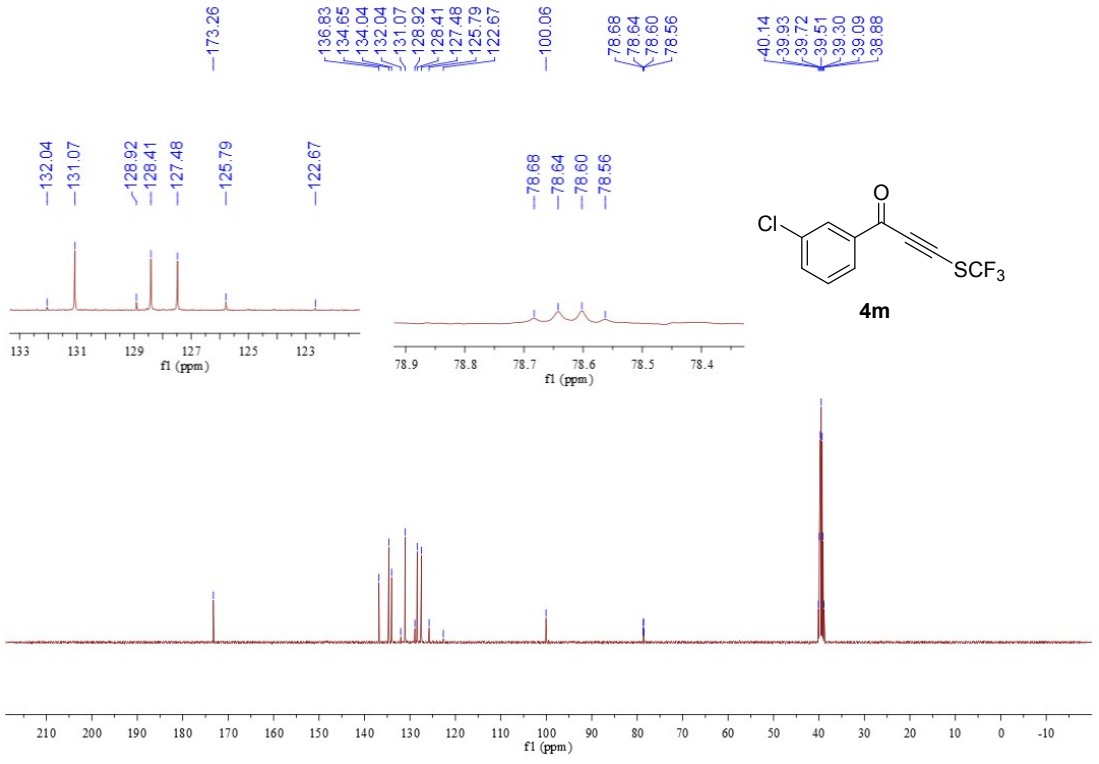
^{19}F NMR (100 MHz, $CDCl_3$) spectrum for 4l



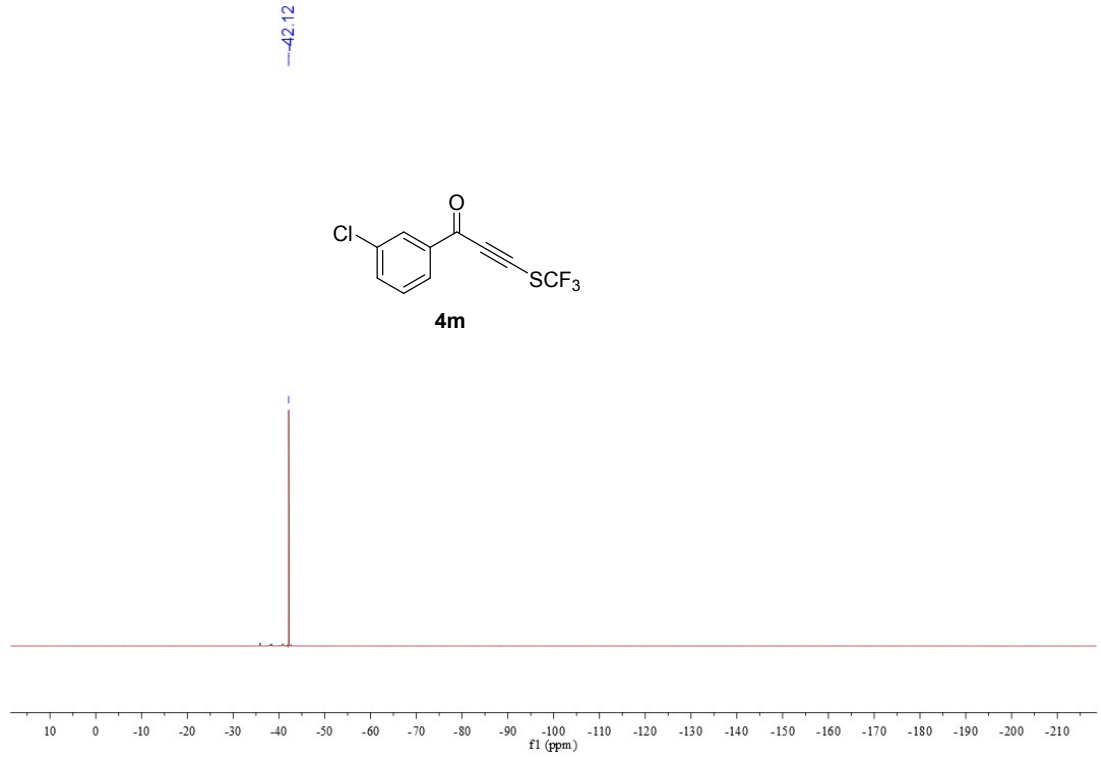
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4m



^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4m

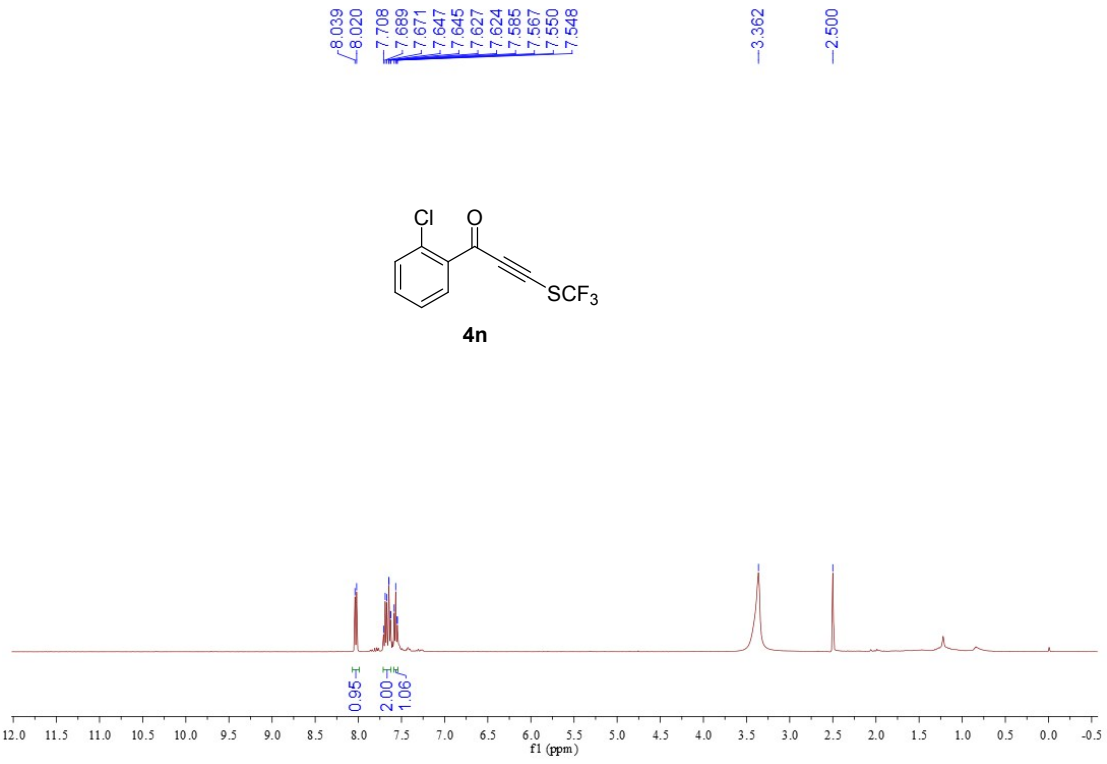


^{19}F NMR (100 MHz, DMSO-d_6) spectrum for 4m



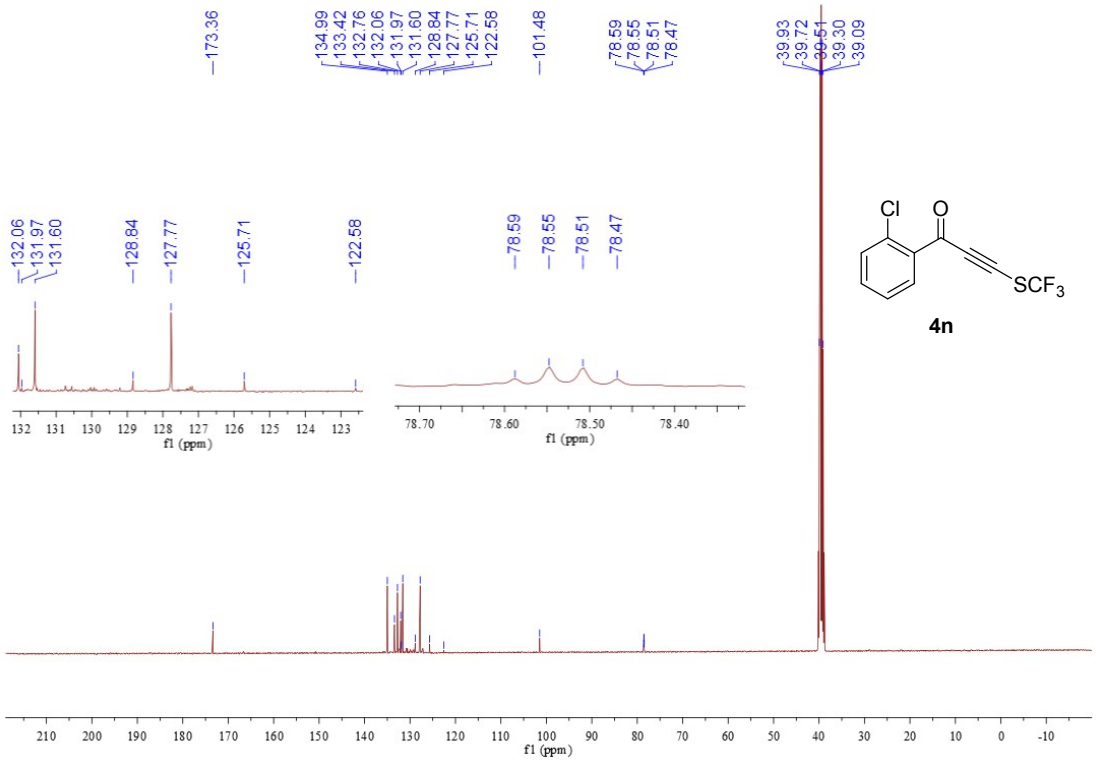
4m

^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4n

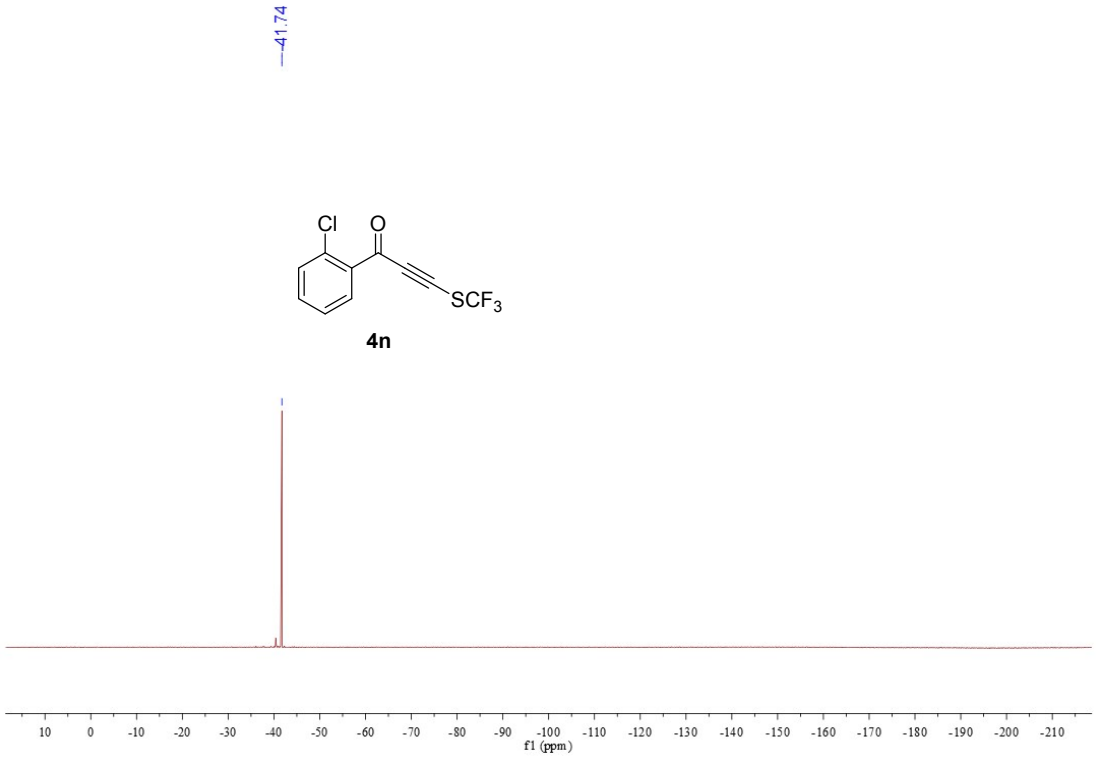


4n

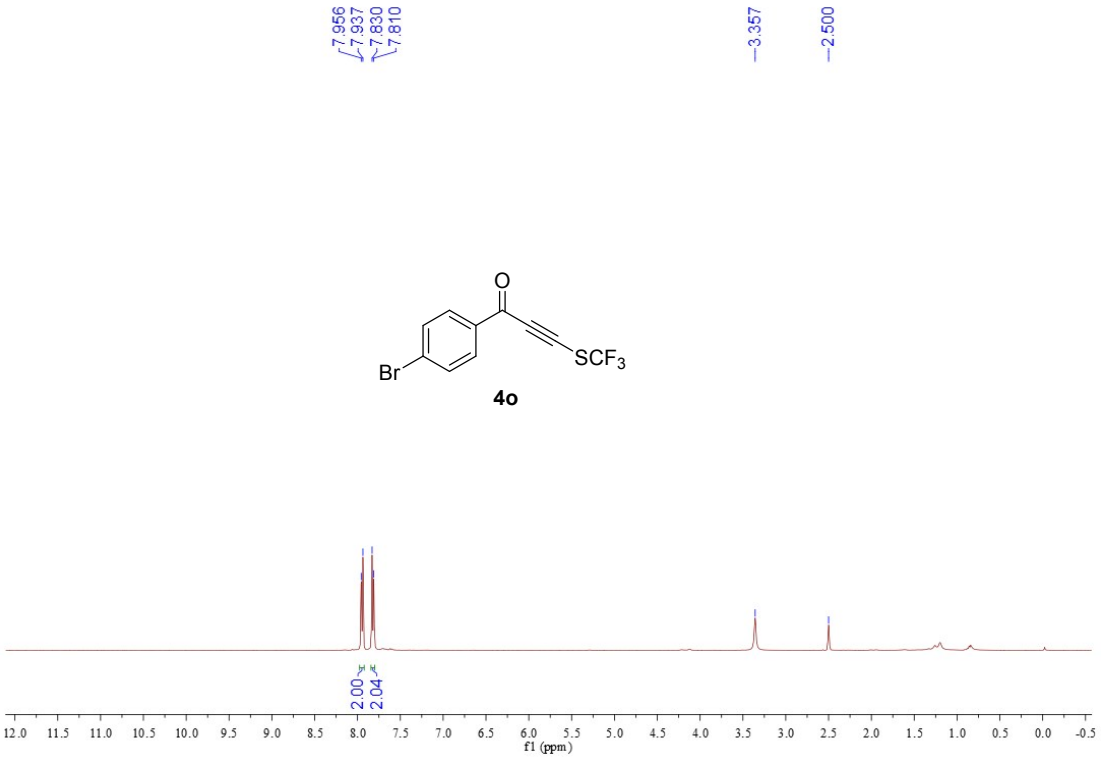
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4n



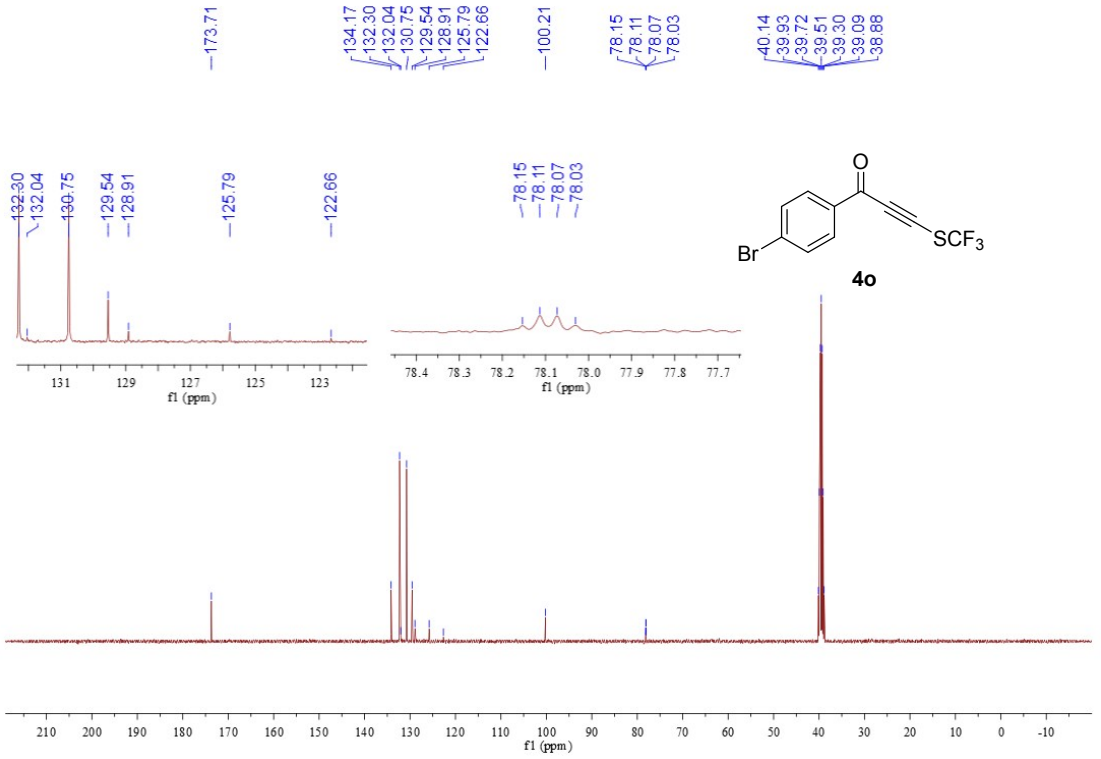
^{19}F NMR (100 MHz, DMSO-d_6) spectrum for 4n



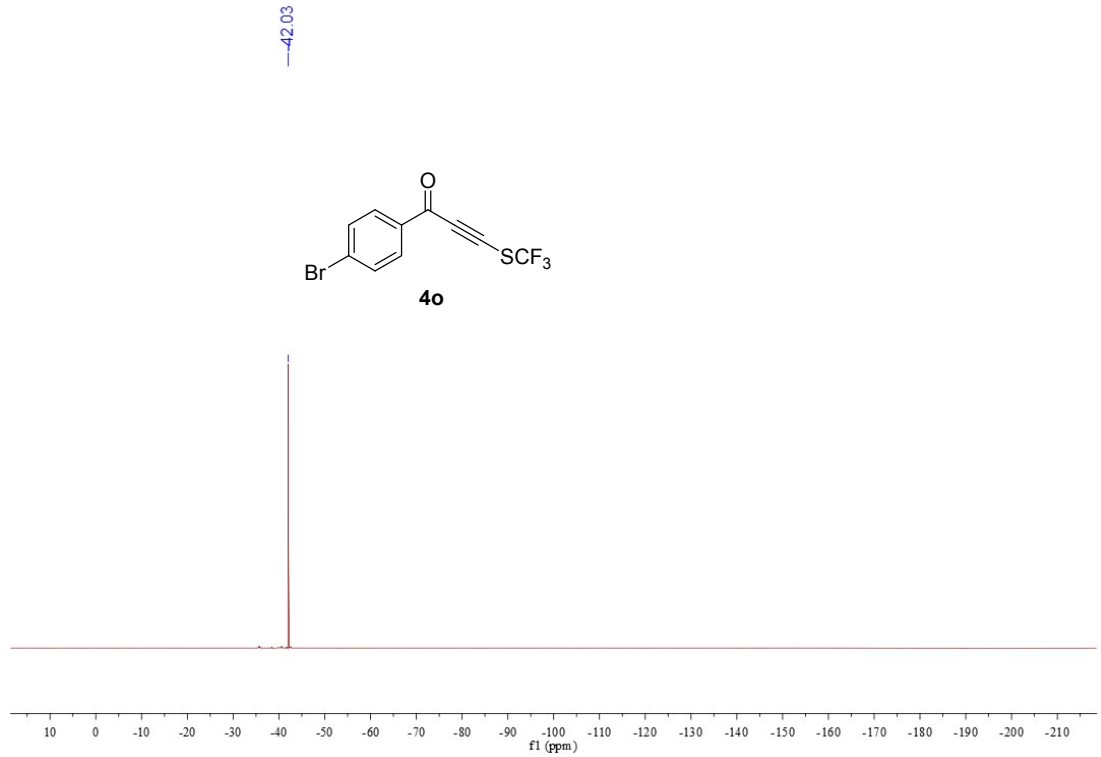
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4o



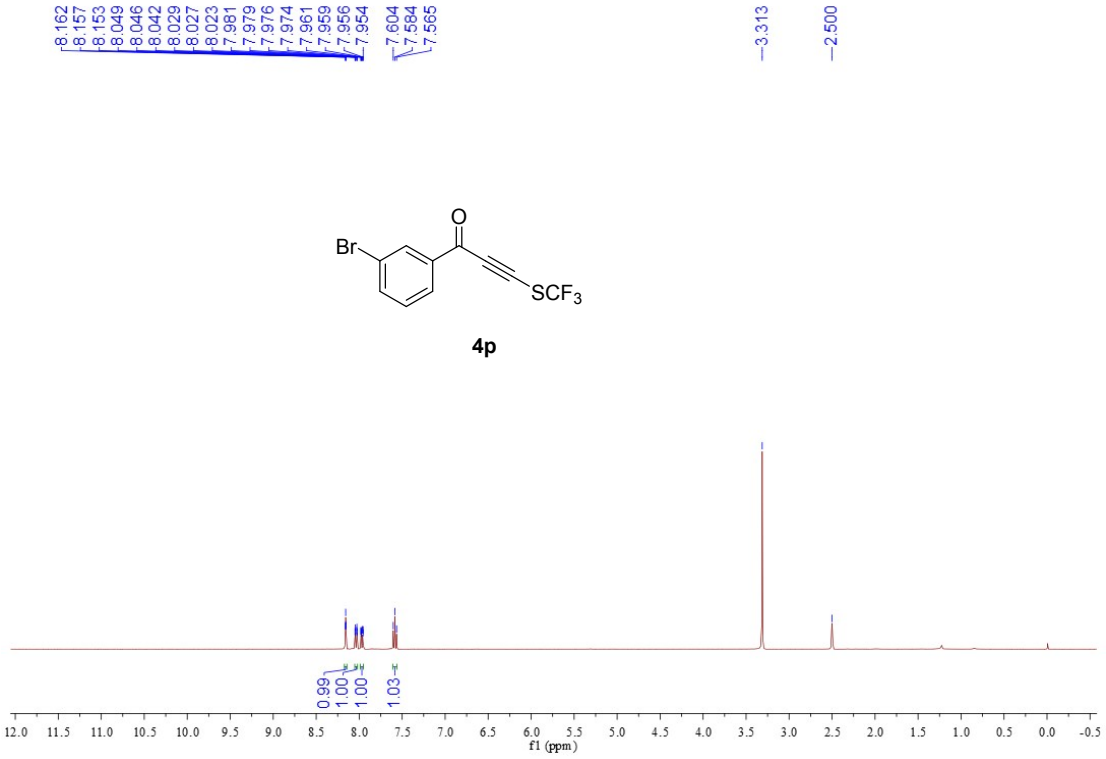
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4o



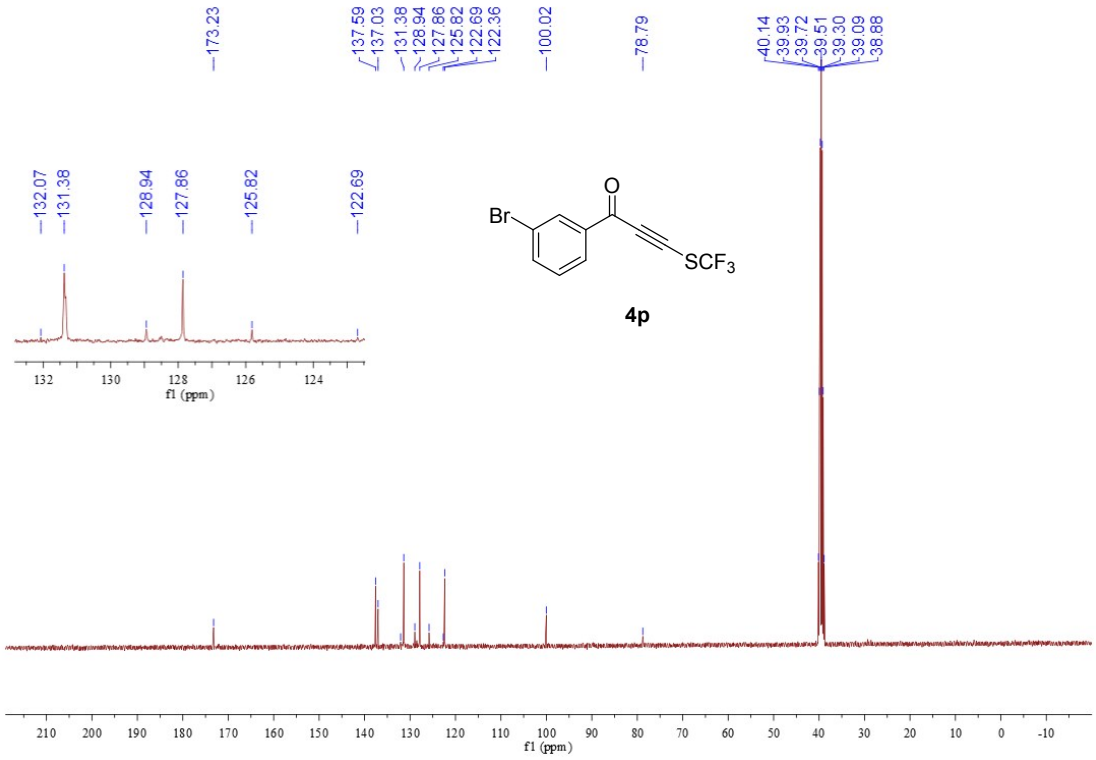
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4o



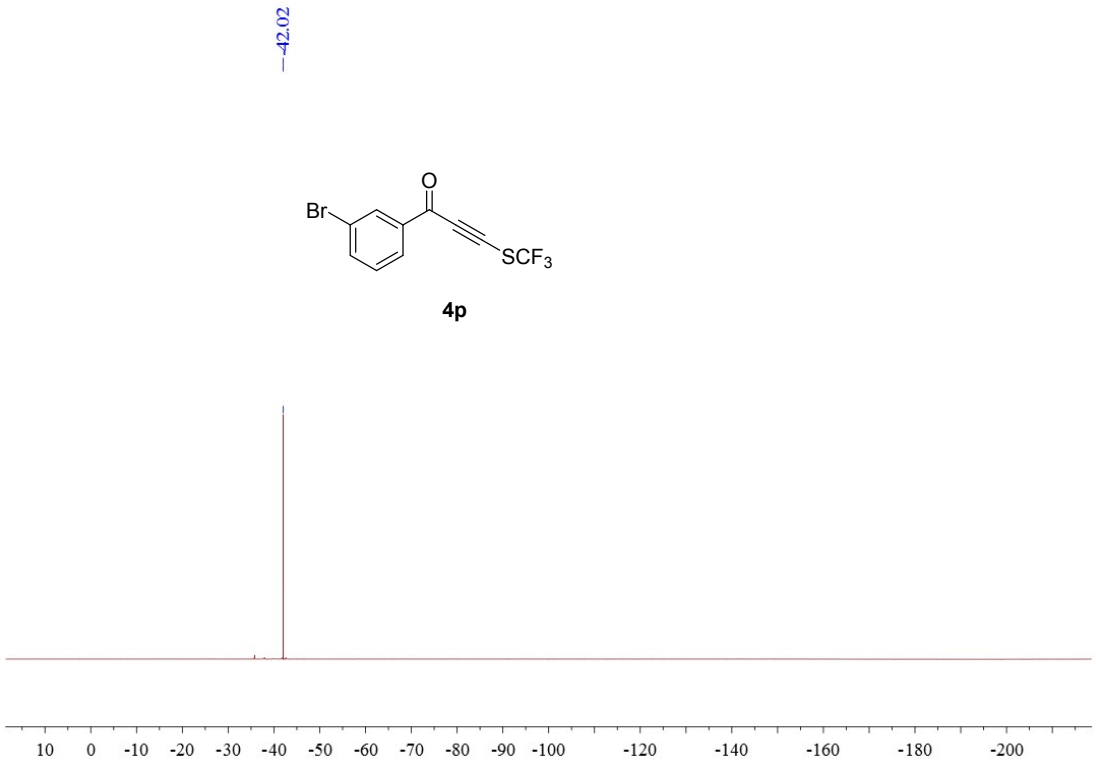
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4p



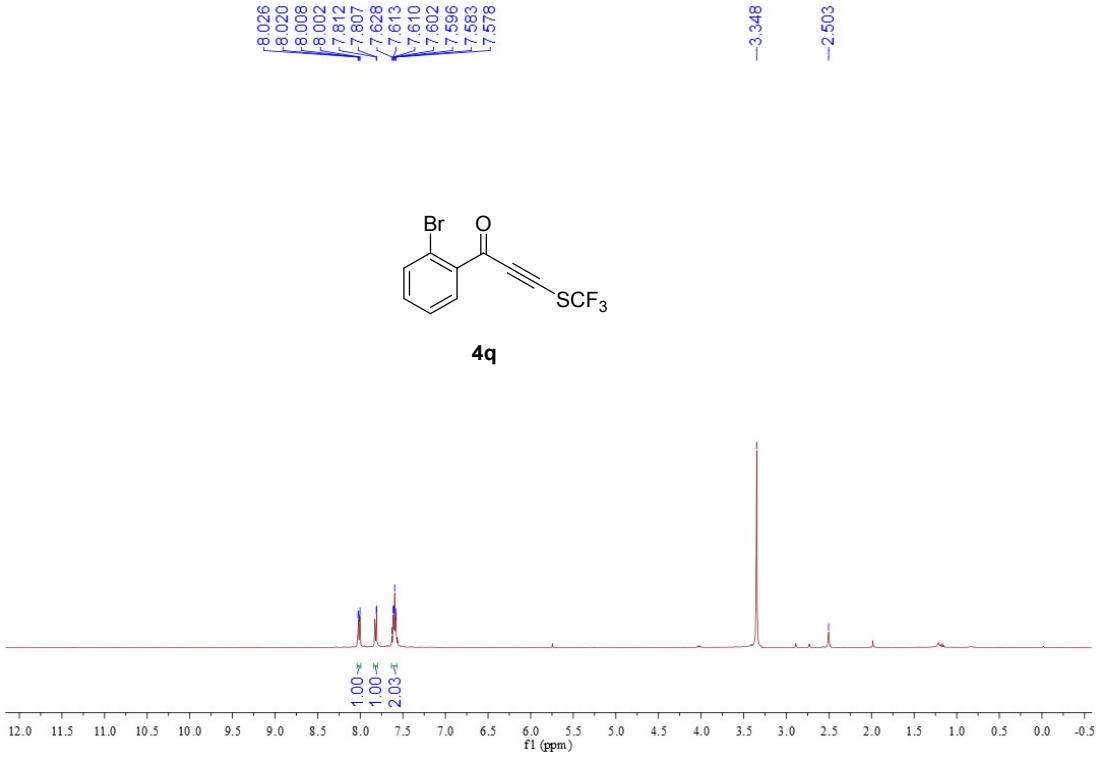
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4p



^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4p

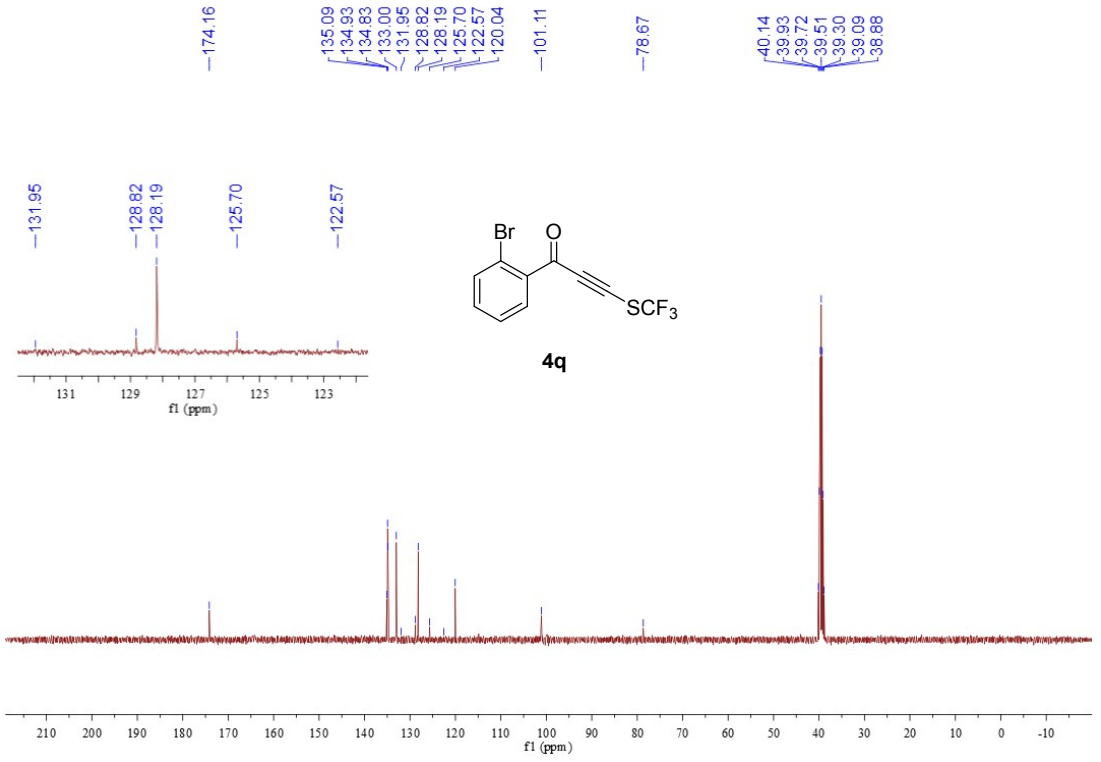


^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4q



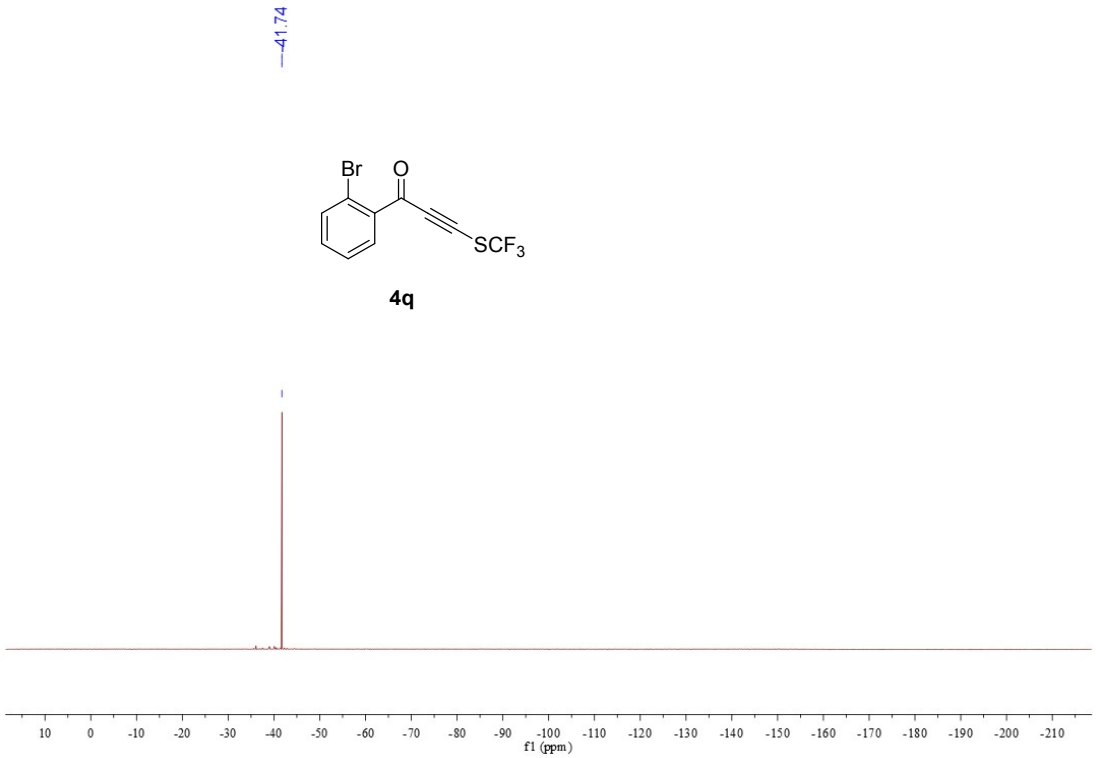
4q

^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4q

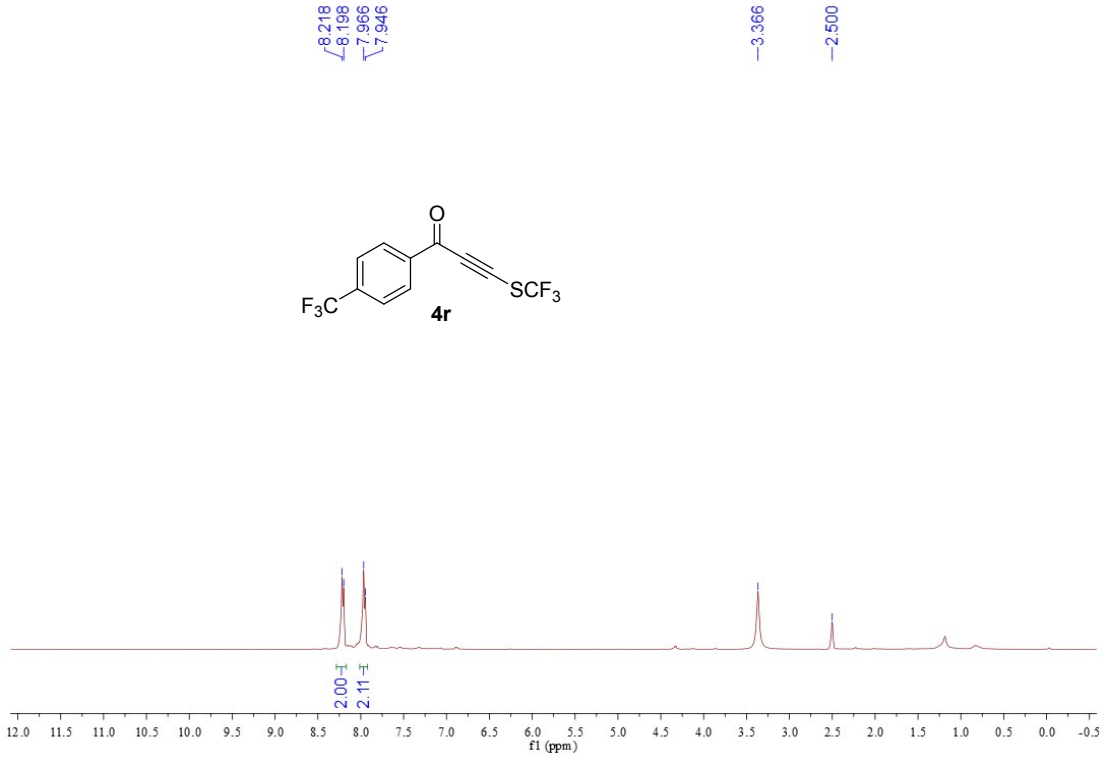


4q

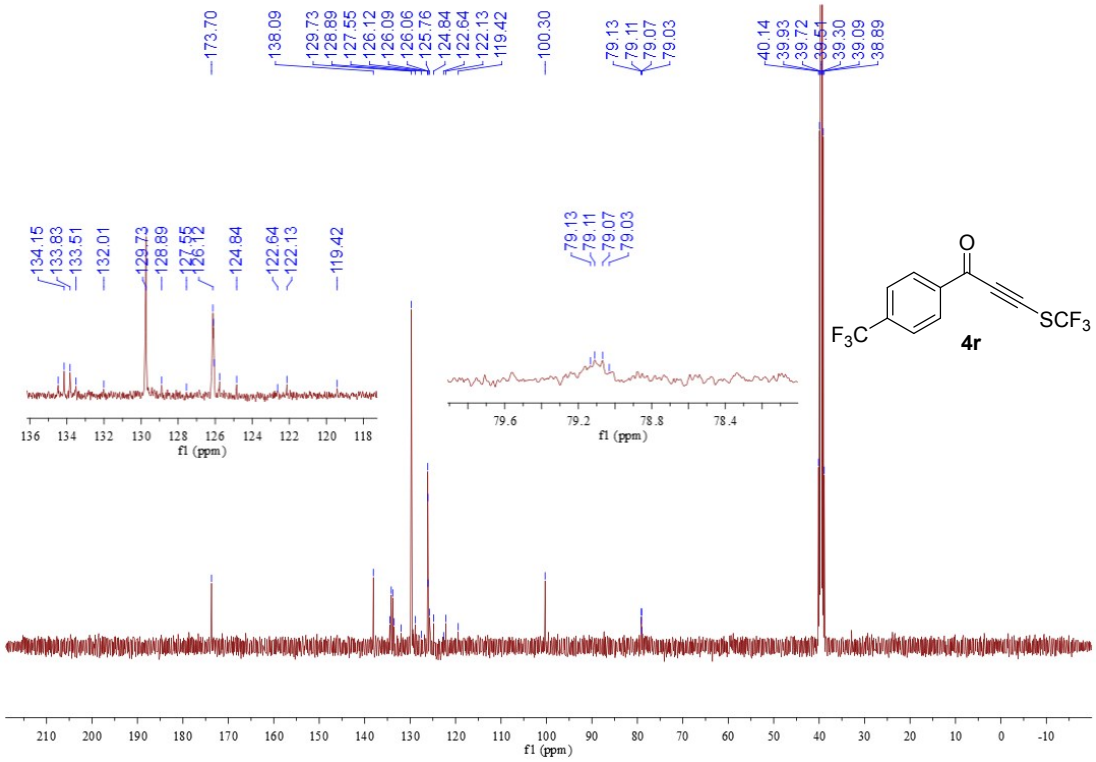
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4q



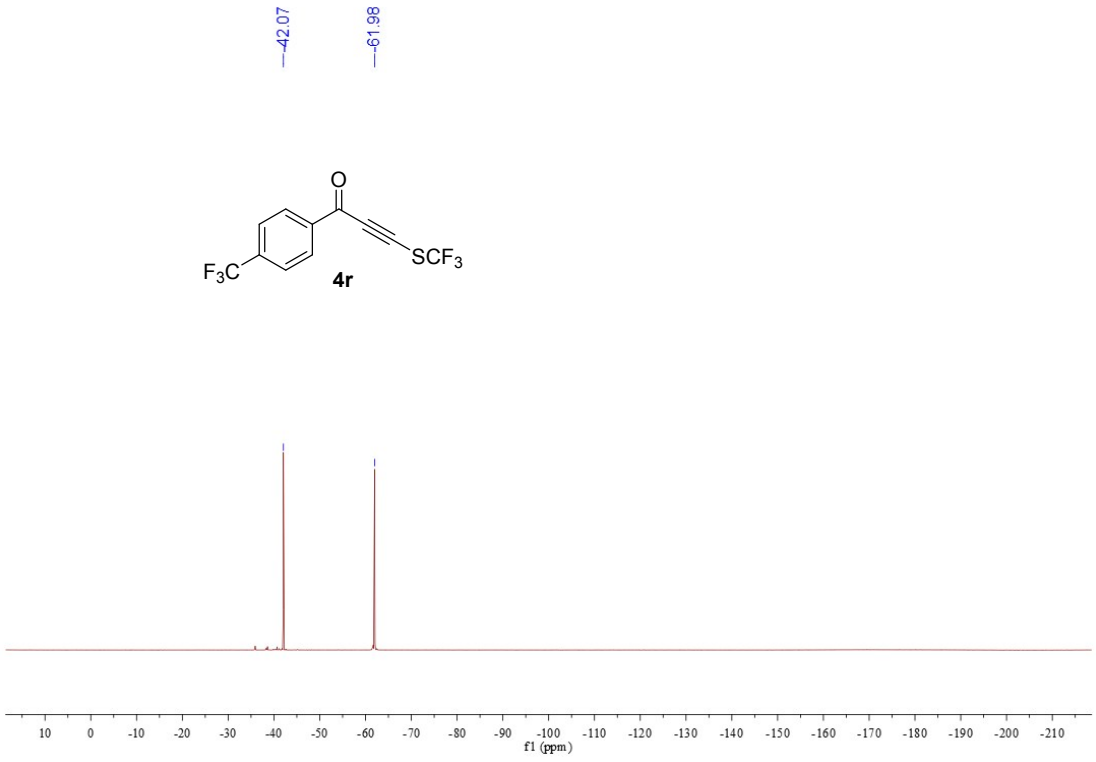
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4r



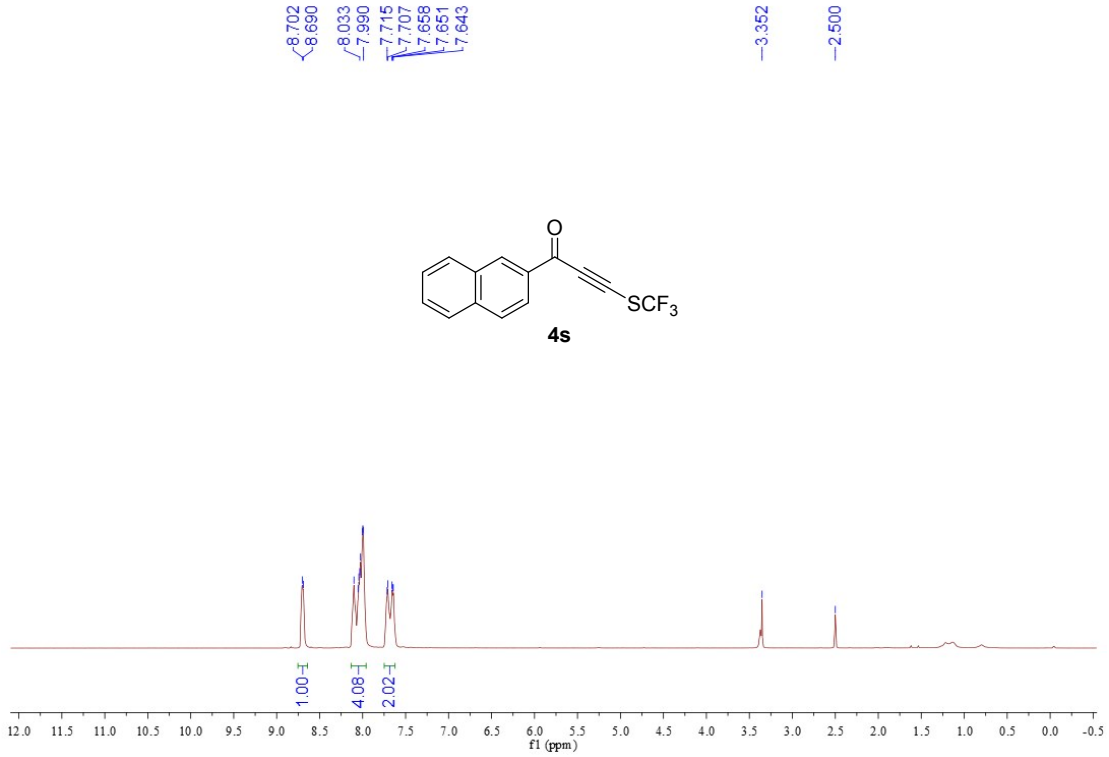
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4r



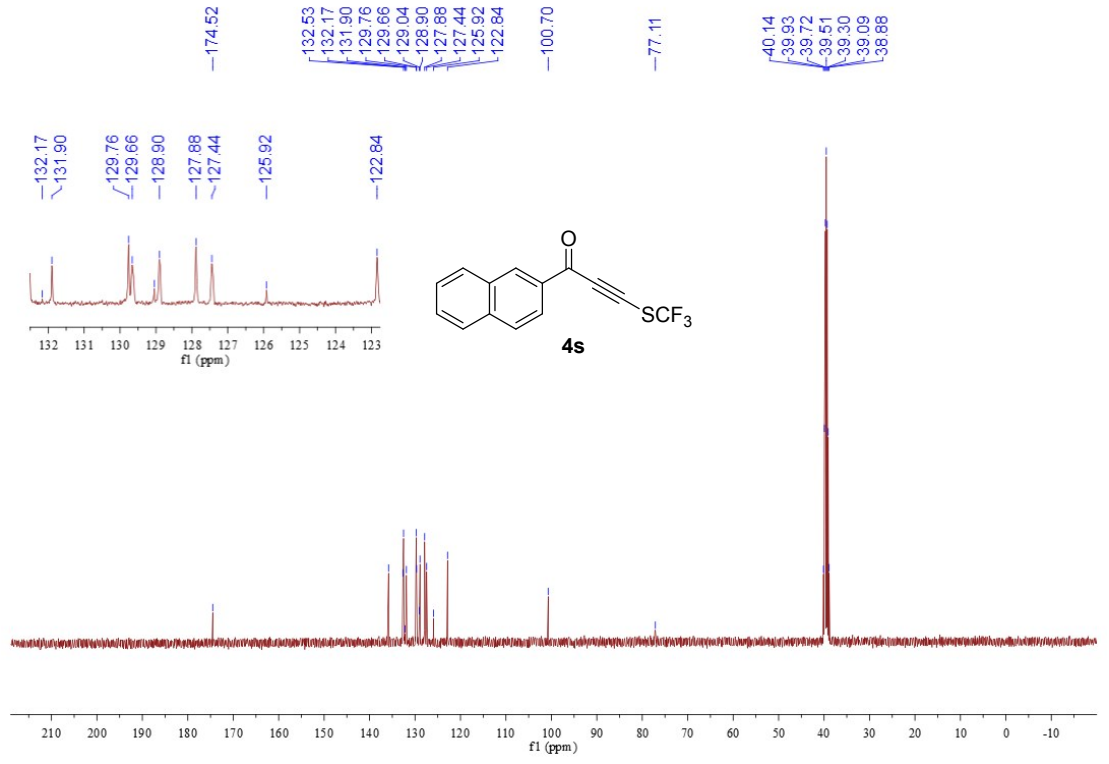
^{19}F NMR (100 MHz, DMSO-d_6) spectrum for 4r



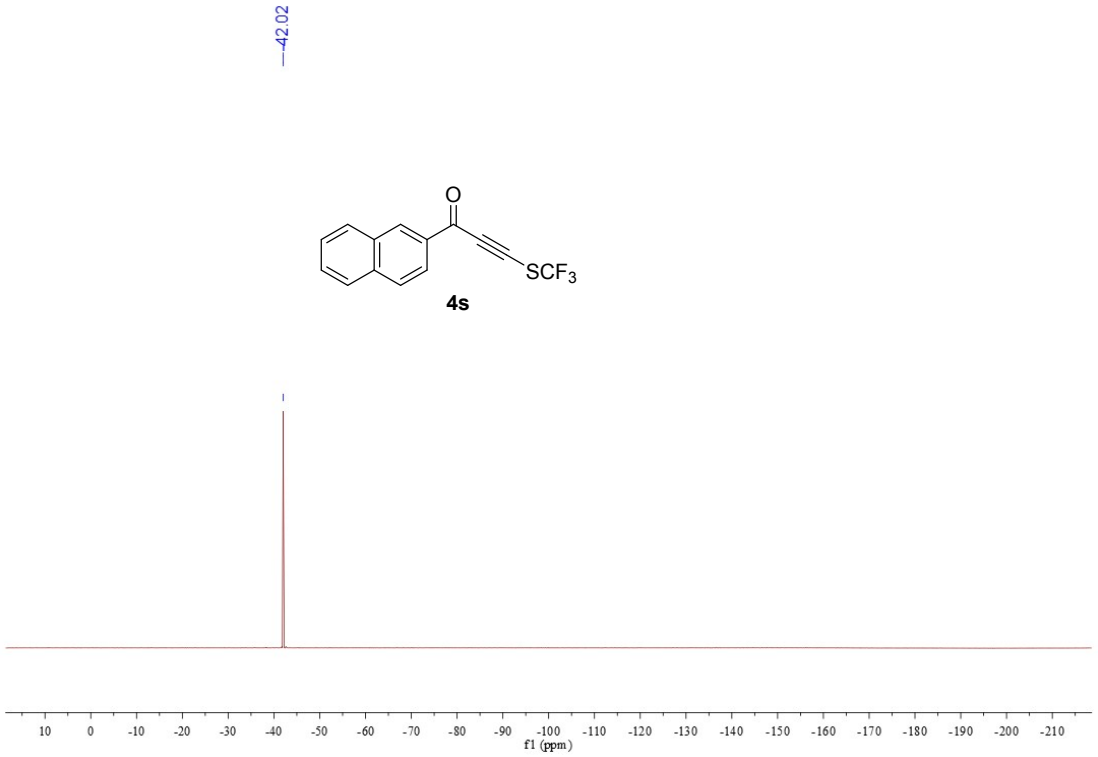
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4s



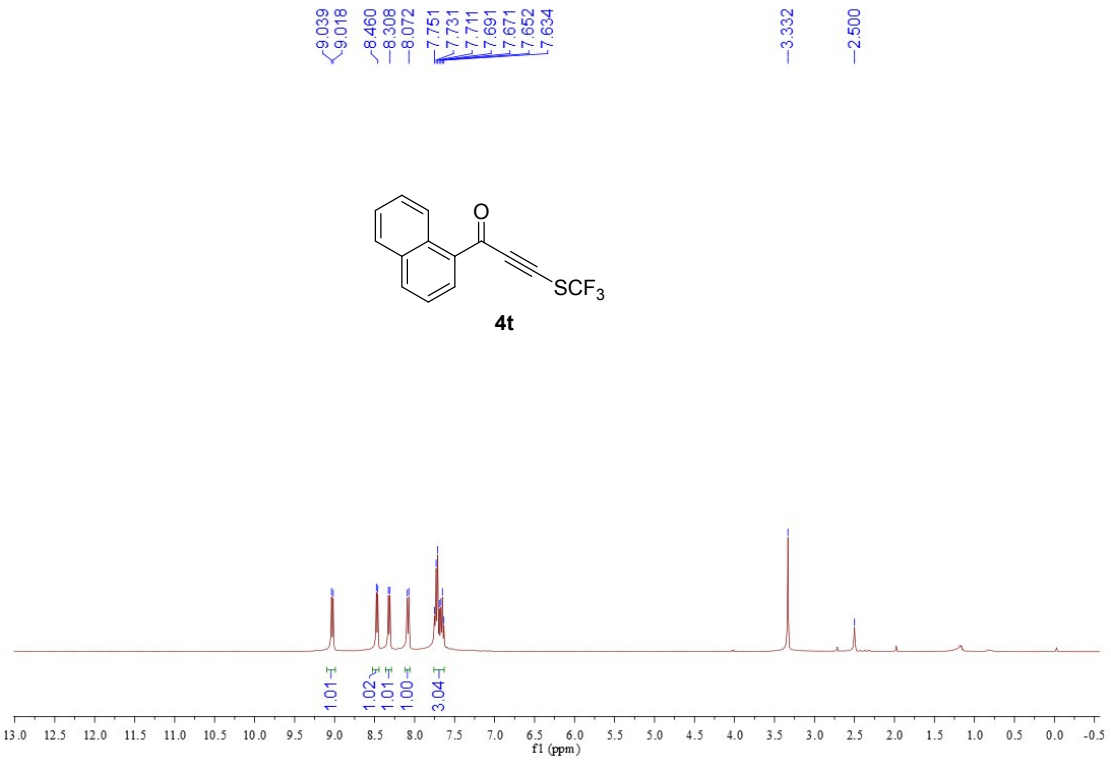
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4s



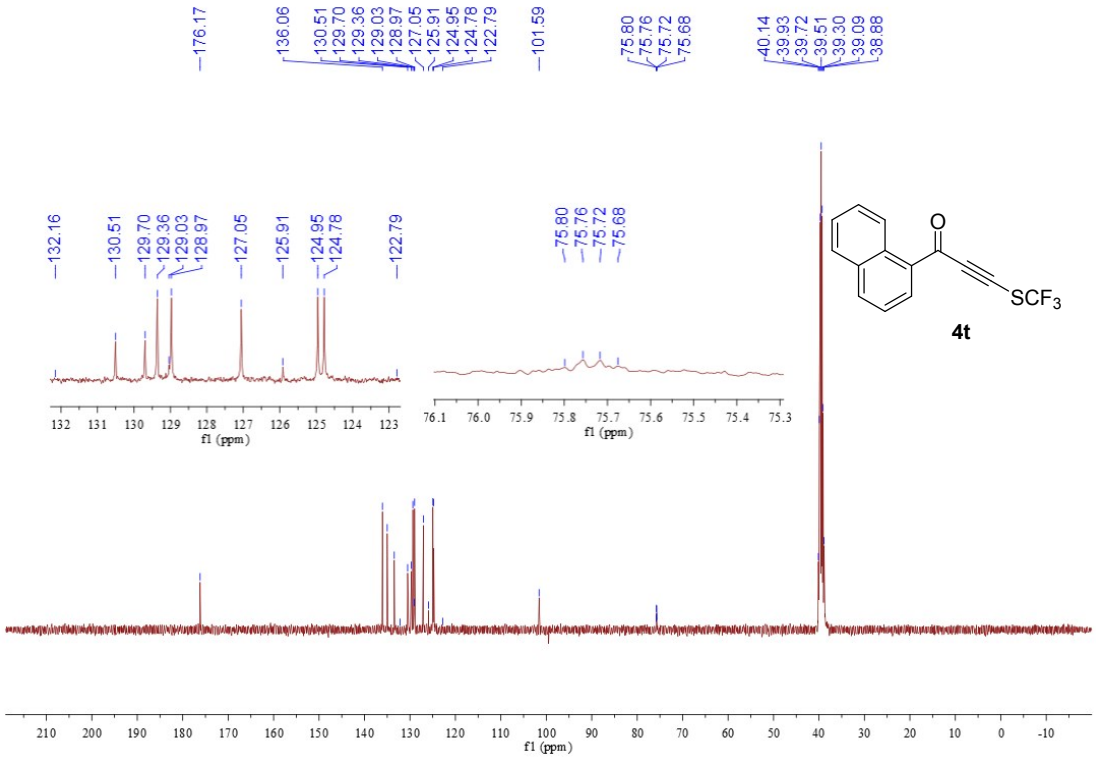
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4s



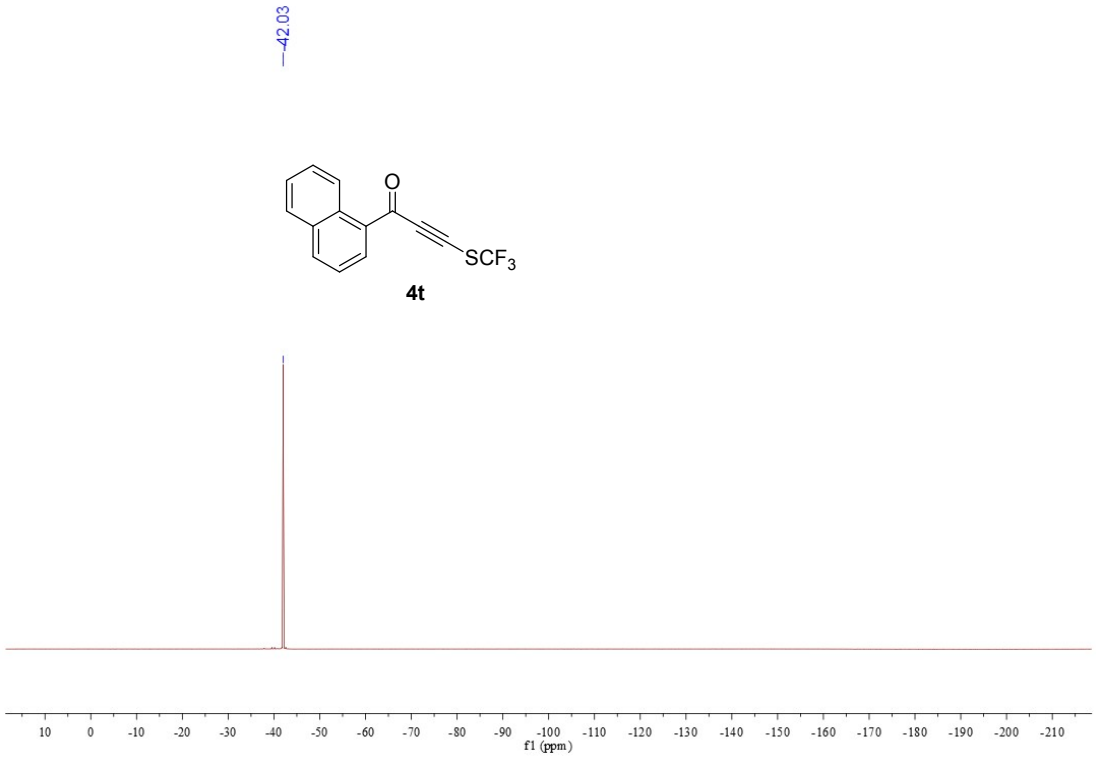
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4t



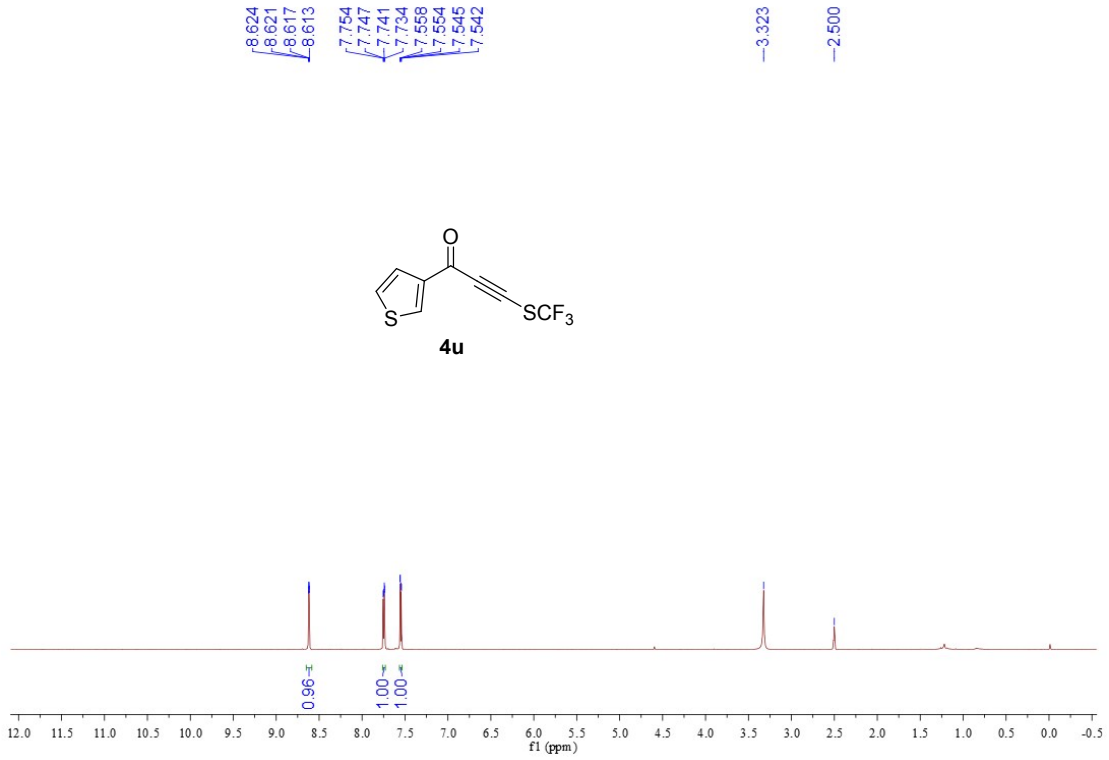
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4t



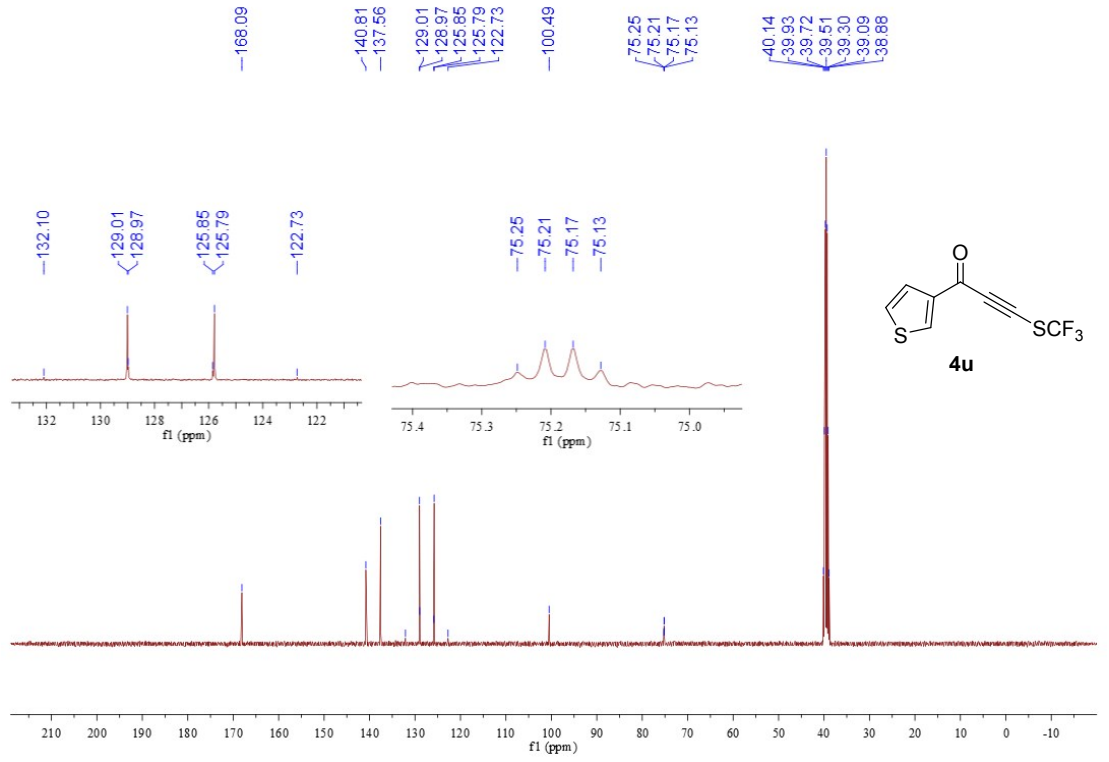
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4t



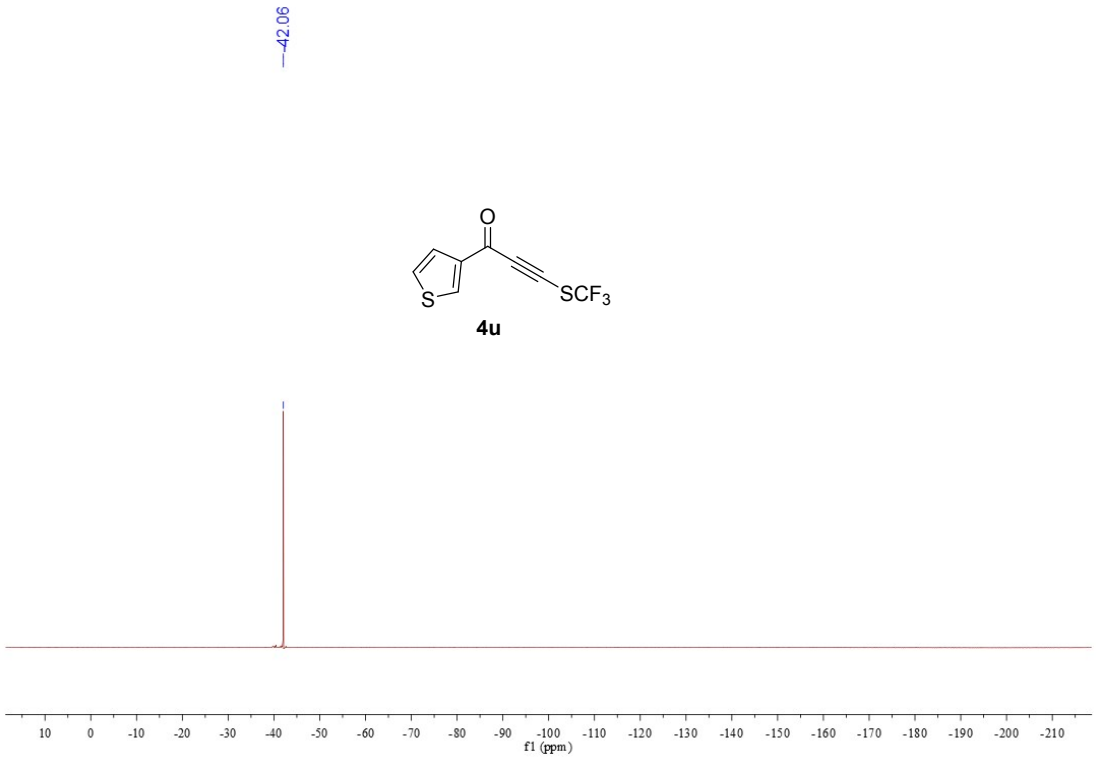
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4u



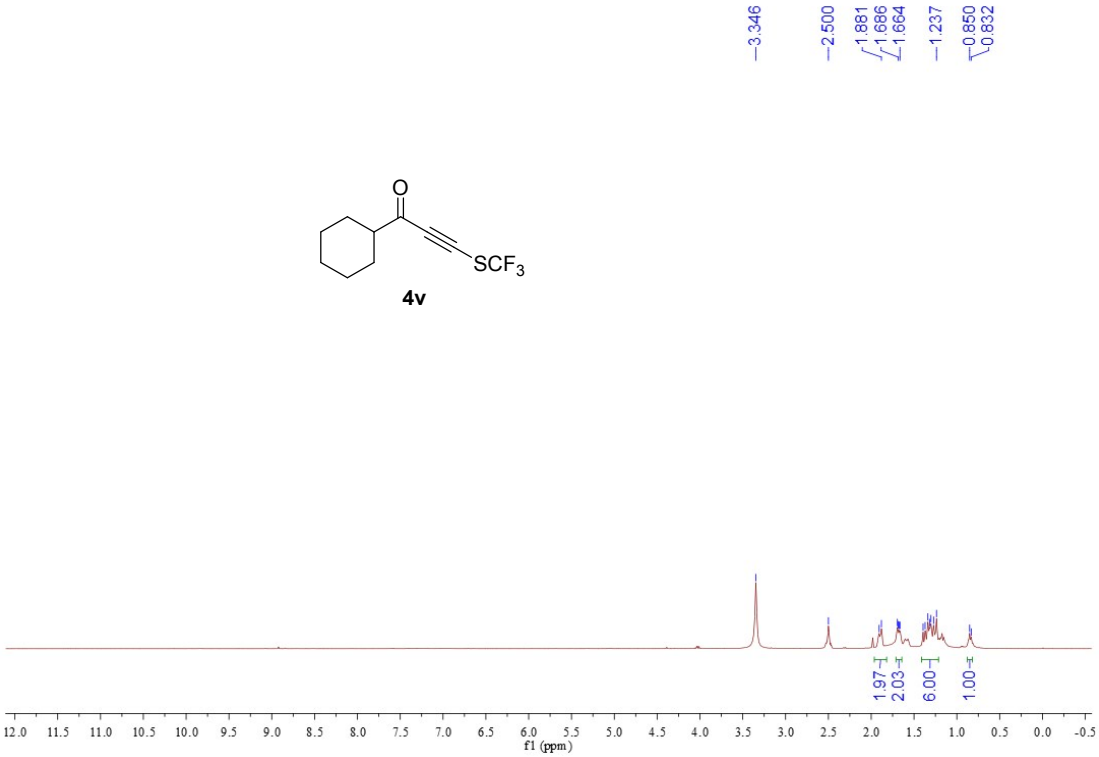
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 4u



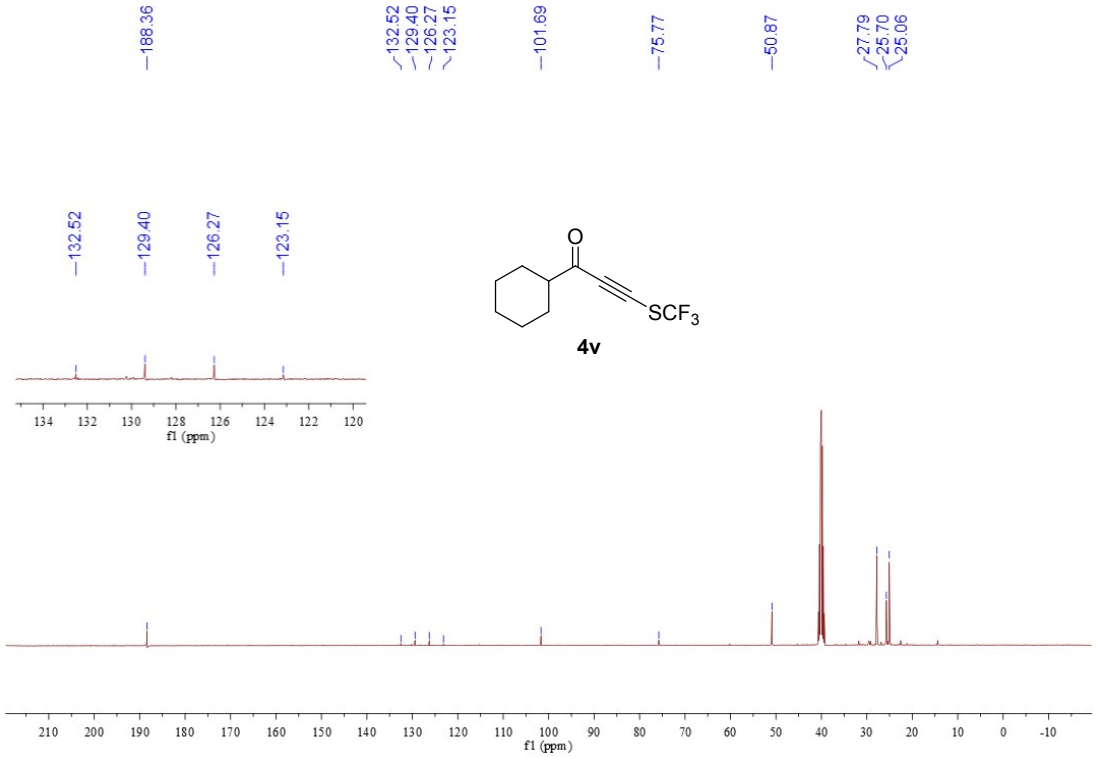
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4u



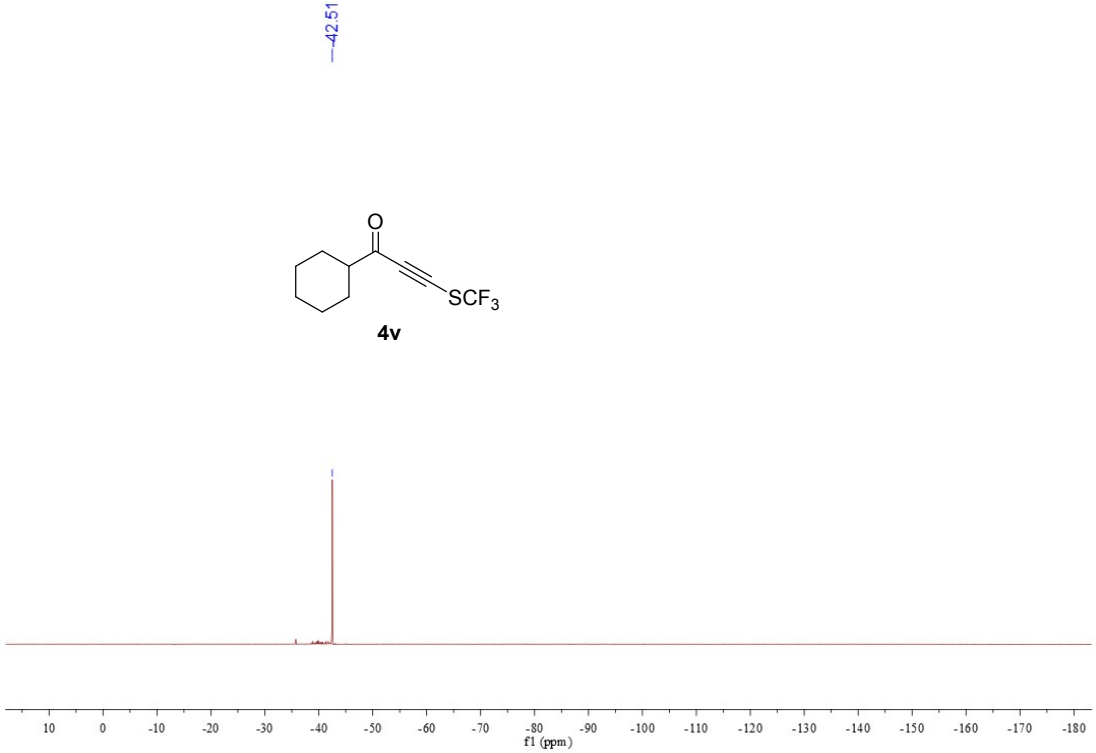
^{1}H NMR (400 MHz, DMSO-d_6) spectrum for 4v



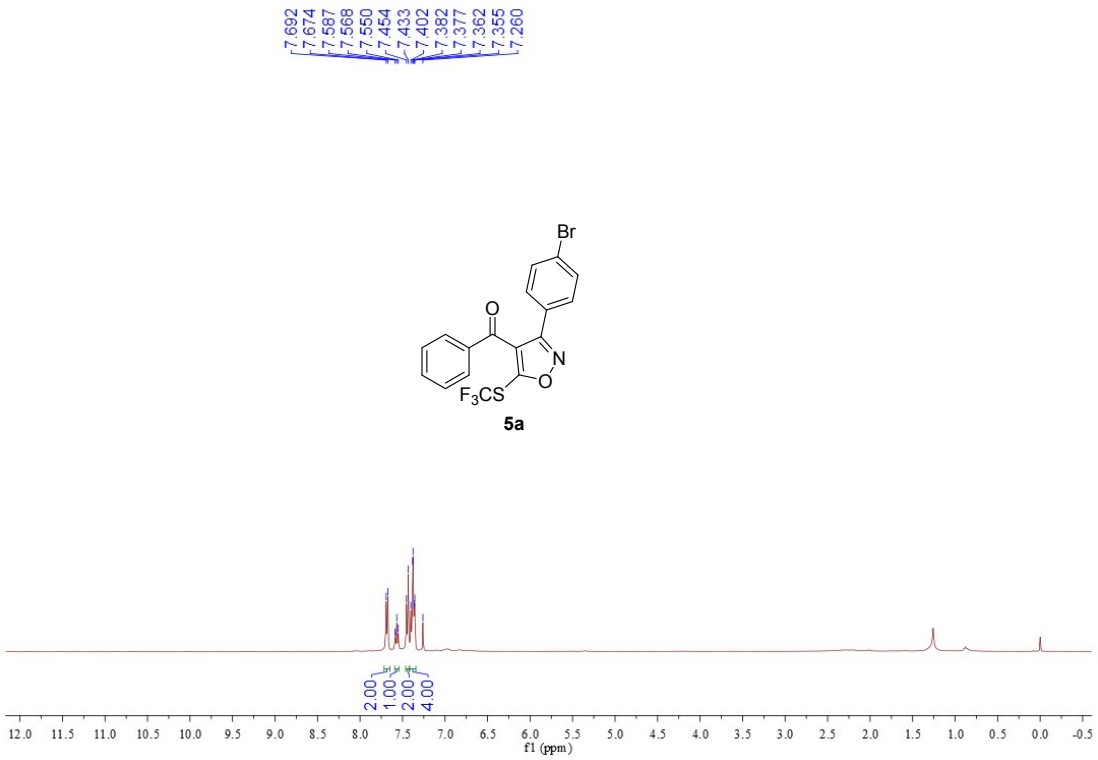
^{13}C NMR (100 MHz, DMSO-d_6) spectrum for 5v



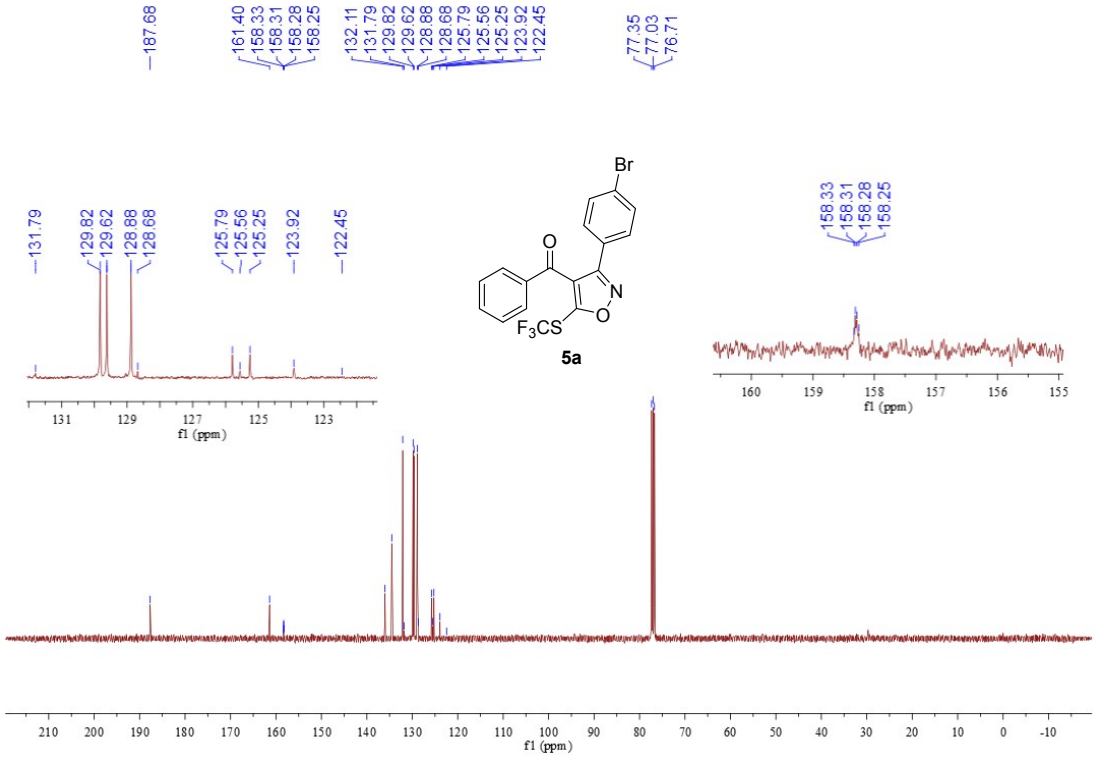
^{19}F NMR (376 MHz, DMSO-d_6) spectrum for 4v



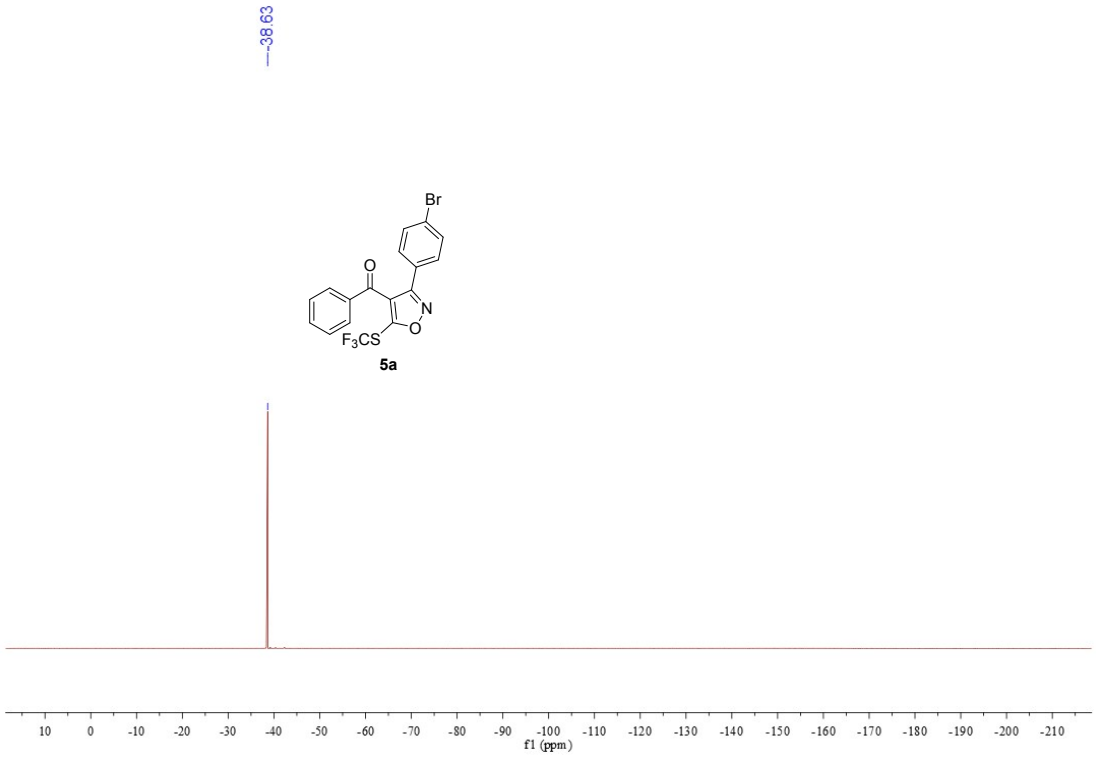
^{1}H NMR (400 MHz, $CDCl_3$) spectrum for 5a



^{13}C NMR (100 MHz, $CDCl_3$) spectrum for 5a

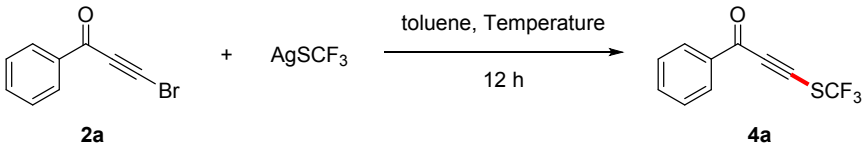


^{19}F NMR (376 MHz, $CDCl_3$) spectrum for 5a



F. Complementary Explanations

In our manuscript, in the reaction optimization progress, we said "The desired product **4a** was not detected by GC-MS or ^{19}F-NMR, meanwhile 90% of the bromoalkynone **2a** was recovered. These results indicated that $AgSCF_3$ was a poor nucleophilic reagent and the energy barrier for this nucleophilic trifluoromethylthiolation reaction was very high, thus the nucleophilic addition process of $AgSCF_3$ to bromoalkynone **2a** did not happen at room temperature. In this sense, increasing the reaction temperature became the logical follow-up consideration to overcome the high energy barrier of this reaction. To our delight, a temperature of 80 ^{o}C gave the desired product **4a** in 43% isolated yield." While there is no yield under 50 degree, but 43% yield under 80 degree.



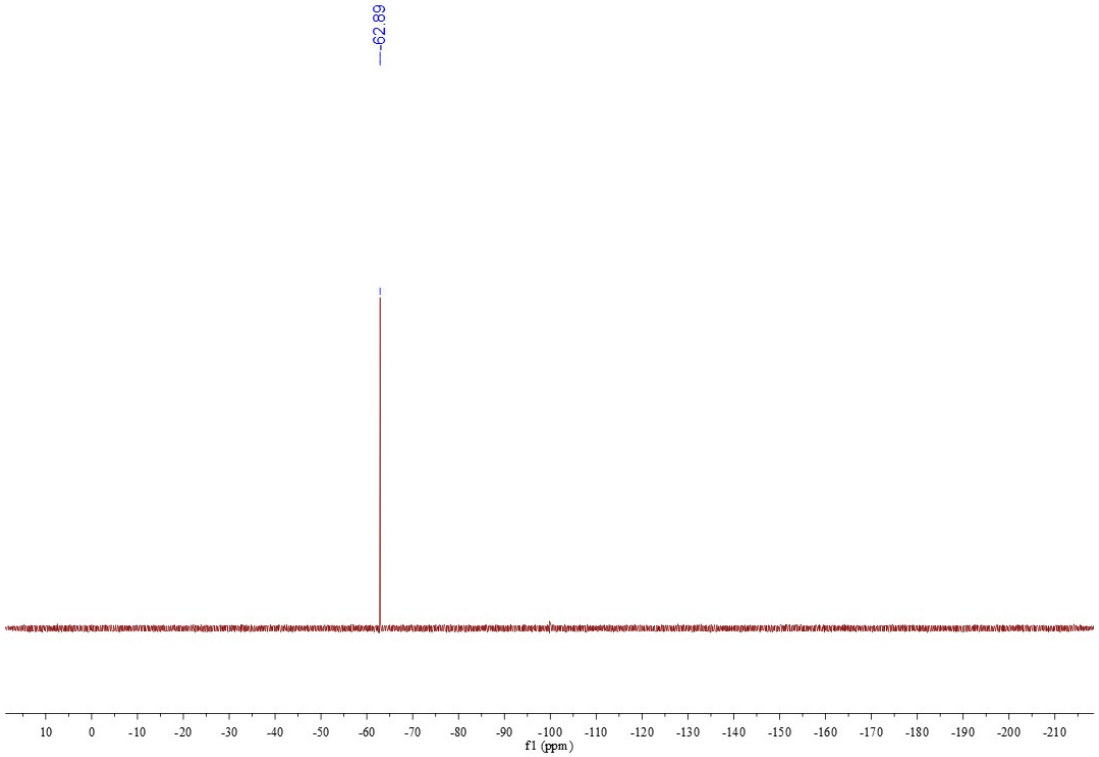
2a **4a**

temperature (^{o}C)	yield (%)
50	0
80	46 (43)

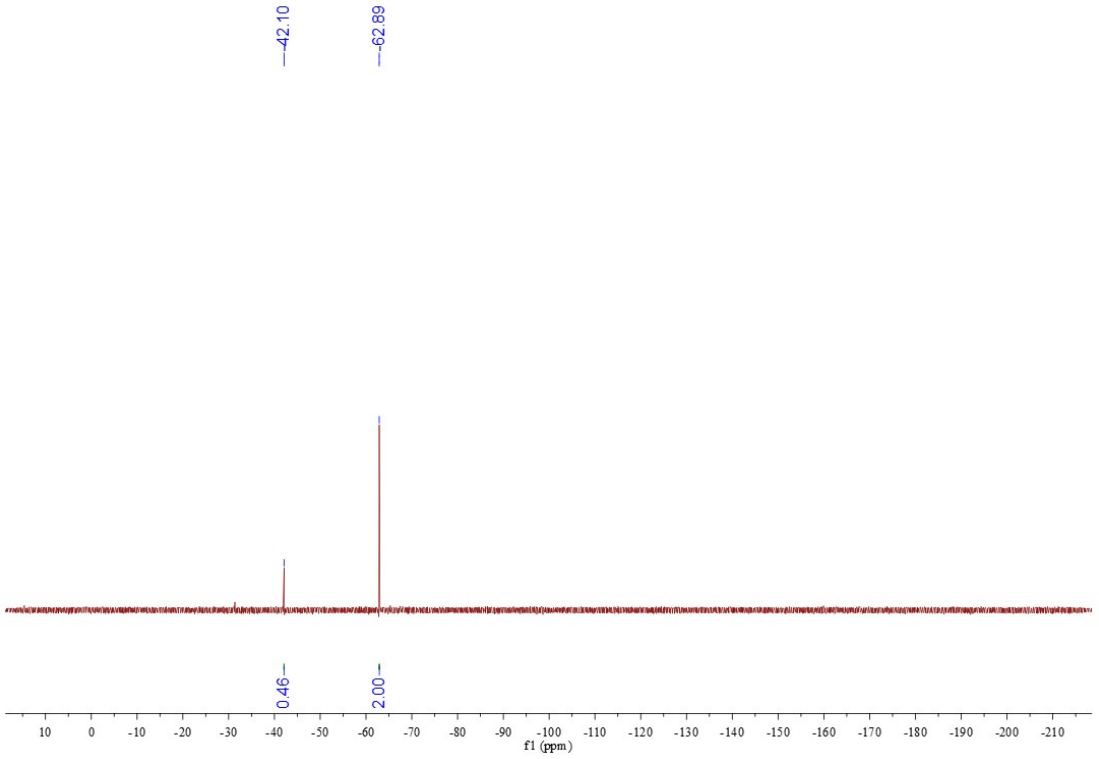
As the requested by the reviewers and the editor, the ^{19}F-NMR analysis spectra of the crude mixture at 50 degree and at 80 degree were showed below to support our results. The ^{19}F-NMR

signal of **4a** is at δ = -42.09 ppm. The ^{19}F-NMR signal of internal standard ($PhCF_3$) is at δ = -62.89 ppm.

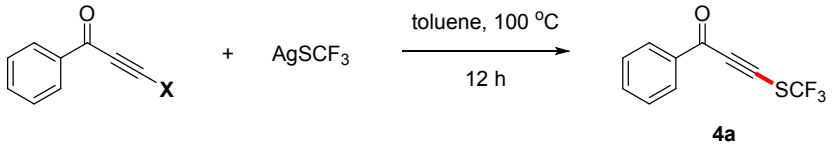
For the ^{19}F-NMR analysis (376 MHz, $CDCl_3$) of the crude mixture at 50 degree



For the ^{19}F-NMR analysis (376 MHz, $CDCl_3$) of the crude mixture at 80 degree



In our manuscript, we said “Interestingly, with chloroakynone **1a** or iodoakynone **3a** as the reactants, the desired product **4a** was not detected, which indicated that the reactivity and stability of C(sp)-X (X = Cl, Br, I) bonds were very critical for the success of this transformation”. Thus, no desired product **4a** was detected with chloroakynone or iodoakynone as the reactant, while bromoalkynone gave the desired product **4a** in 66% yield.

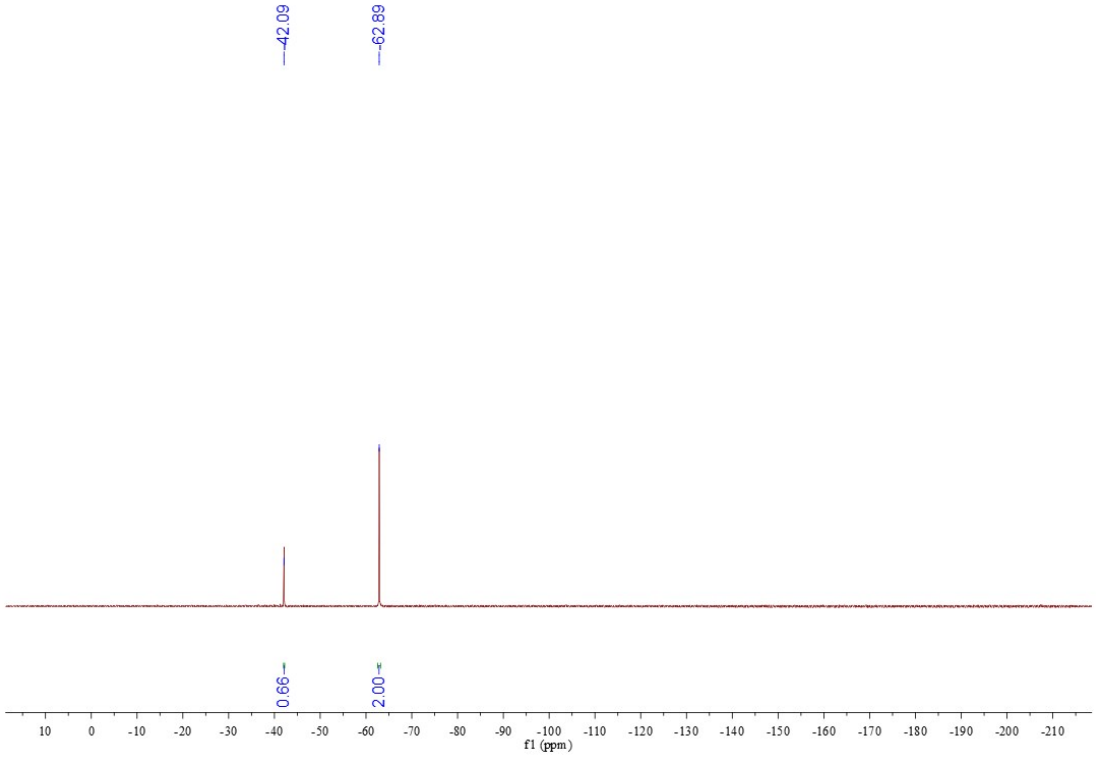


4a

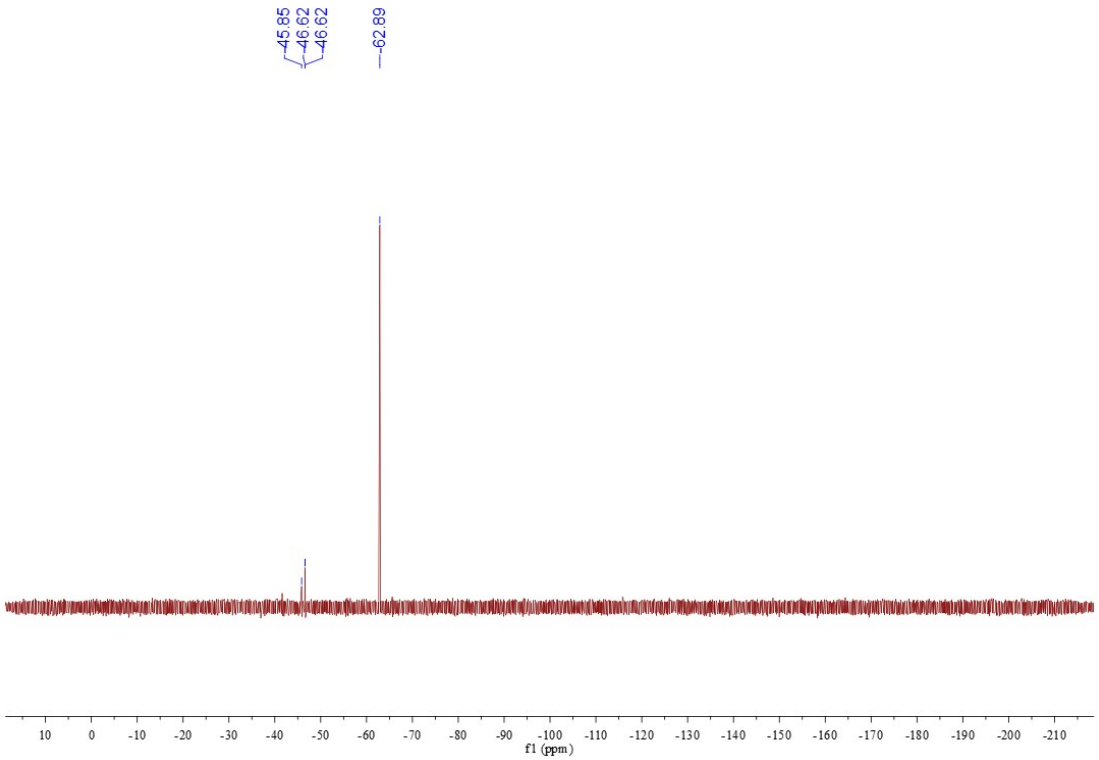
X	yield (%)
Cl	0
Br	66
I	0

As the requested by the reviewers and the editor, the ^{19}F-NMR analysis spectra of the crude mixture of bromoalkynone, chloroalkynone, and iodoalkynone were given below to support our results. The ^{19}F-NMR signal of **4a** is at δ = -42.09 ppm. The ^{19}F-NMR signal of internal standard ($PhCF_3$) is at δ = -62.89 ppm.

For the ^{19}F-NMR analysis (376 MHz, $CDCl_3$) of the crude mixture of bromoalkynone



For the ^{19}F-NMR analysis (376 MHz, $CDCl_3$) of the crude mixture of chloroalkynone



For the ^{19}F-NMR analysis (376 MHz, $CDCl_3$) of the crude mixture of iodoalkynone