



Supporting Information

for

Synthesis of fluoroalkenes and fluoroenynes via cross-coupling reactions using novel multihalogenated vinyl ethers

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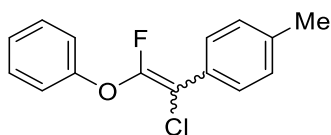
Characterization data for 2b–s and 3b–w, and copies of ^1H , ^{13}C , and ^{19}F NMR spectra

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Characterization data:

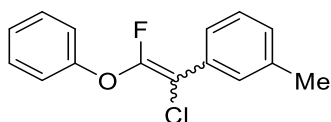
2-Chloro-1-fluoro-2-*p*-tolylethenyl phenyl ether (2b)



The title product (**2b**) was purified by column chromatography and preparative TLC (hexane only). **2b** was obtained in 98% yield (131.1 mg).

A pale yellow oil.; ^1H NMR (400 MHz, CDCl_3) δ : 2.31 (s) and 2.37 (s) (3H), 7.03-7.09 (2H, m), 7.10-7.17 (3H, m), 7.18-7.25 (1H, m), 7.30-7.40 (2H, m), 7.43-7.49 (2H, m), 7.52 (1H, d, $J = 8.0$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 21.3, 21.4, 101.5 (d, $J = 31.7$ Hz), 102.6 (d, $J = 48.2$ Hz), 116.4, 116.5, 124.6, 126.9, 127.8 (d, $J = 3.1$ Hz), 128.1 (d, $J = 5.3$ Hz), 129.1 (d, $J = 5.9$ Hz), 129.57, 129.64, 130.0 (d, $J = 3.7$ Hz), 138.6, 138.7, 151.1 (d, $J = 286.0$ Hz), 151.3 (d, $J = 286.4$ Hz), 154.4 (d, $J = 3.6$ Hz), 154.5 (d, $J = 3.6$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -81.7 (s) and -88.2 (s) (1F, 1:1); MS (EI) m/z : 262 (M^+); HRMS (EI) Calcd. for $\text{C}_{15}\text{H}_{12}\text{ClFO}$: 262.0561 (M^+), Found: 262.0562.

2-Chloro-1-fluoro-2-*m*-tolylethenyl phenyl ether (2c)

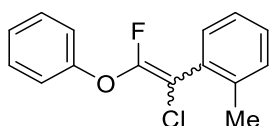


Multihalogenated vinyl ether (1.5 equiv) and *m*-tolylboronic acid (1.0 equiv) were used. Reaction time was 2.5 h.

The title product (**2c**) was purified by column chromatography and preparative TLC (hexane only). **2c** was obtained in 26% yield (33.9 mg).

A colorless oil.; ^1H NMR (400 MHz, CDCl_3) δ : 2.32 (s) and 2.40 (s) (3H), 7.04-7.11 (2H, m), 7.12-7.23 (3H, m), 7.27-7.48 (4H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 21.57, 21.60, 101.5 (d, $J = 31.2$ Hz), 102.6 (d, $J = 48.1$ Hz), 116.5, 124.7, 125.0 (d, $J = 2.7$ Hz), 125.3 (d, $J = 5.3$ Hz), 128.3, 128.4, 128.7 (d, $J = 3.2$ Hz), 128.8 (d, $J = 4.9$ Hz), 129.4, 129.5, 130.0, 130.1, 132.3, 132.4, 138.1, 138.2, 151.2 (d, $J = 285.3$ Hz), 151.4 (d, $J = 286.6$ Hz), 154.3 (d, $J = 3.2$ Hz), 154.5 (d, $J = 3.0$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -81.0 (s) and -87.7 (s) (1F, 1:1); MS (EI) m/z : 262 (M^+); HRMS (EI) Calcd. for $\text{C}_{15}\text{H}_{12}\text{ClFO}$: 262.0561 (M^+), Found: 262.0561.

2-Chloro-1-fluoro-2-*o*-tolylethenyl phenyl ether (2d)

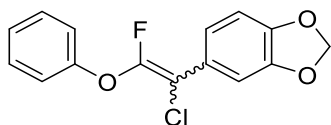


The title product (**2d**) was purified by column chromatography (hexane only). **2d** was obtained in 16% yield (52.6 mg).

A colorless oil.; ^1H NMR (400 MHz, CDCl_3) δ : 2.37 (s) and 2.44 (s) (3H), 6.33-6.99 (1H, m), 7.06-

7.16 (1H, m), 7.16-7.22 (2H, m), 7.22-7.33 (3.5H, m), 7.36-7.44 (1.5H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 19.7, 19.8, 99.3 (d, $J = 31.8$ Hz), 100.5 (d, $J = 55.8$ Hz), 116.5, 116.6, 124.6 (d, $J = 18.4$ Hz), 126.1 (d, $J = 16.3$ Hz), 129.6, 129.7, 129.9, 130.1, 130.3 (d, $J = 3.4$ Hz), 130.4, 130.5, 130.6, 132.1 (d, $J = 2.8$ Hz), 137.6, 138.0 (d, $J = 2.8$ Hz), 151.5 (d, $J = 280.8$ Hz), 151.6 (d, $J = 287.0$ Hz), 154.4 (d, $J = 3.1$ Hz), 154.7 (d, $J = 3.1$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -85.4 (s) and -87.5 (s) (1F, 1:1); MS (EI) m/z : 262 (M^+); HRMS (EI) Calcd. for $\text{C}_{15}\text{H}_{12}\text{ClFO}$: 262.0561 (M^+), Found: 262.0560.

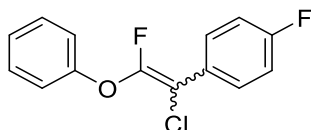
2-Chloro-1-fluoro-2-(3,4-methylenedioxyphenyl)ethenyl phenyl ether (2e)



The title product (**2e**) was purified by column chromatography and preparative TLC (hexane only). **2e** was obtained in 85% yield (278.9 mg).

A pale yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 5.95 (s) and 6.00 (s) (2H), 6.75 (d, $J = 8.0$ Hz) and 6.84 (d, $J = 8.0$ Hz) (1H), 7.03-7.09 (2H, m), 7.10-7.21 (3H, m), 7.30-7.44 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 101.3 (d, $J = 32.8$ Hz), 101.5, 101.6, 102.3 (d, $J = 48.2$ Hz), 108.2, 108.3, 108.6 (d, $J = 2.9$ Hz), 108.8 (d, $J = 5.8$ Hz), 116.4, 116.5, 122.4 (d, $J = 3.4$ Hz), 122.6 (d, $J = 5.1$ Hz), 124.7, 126.2, 126.25, 126.30, 130.0, 130.1, 147.8 (d, $J = 11.1$ Hz), 147.9 (d, $J = 7.8$ Hz), 151.0 (d, $J = 284.9$ Hz), 151.1 (d, $J = 285.4$ Hz), 154.4; ^{19}F NMR (376 MHz, CDCl_3) δ : -81.9 (s) and -88.2 (s) (1F, 1:1); MS (EI) m/z : 292, 294 (M^+); HRMS (EI) Calcd. for $\text{C}_{15}\text{H}_{10}\text{ClFO}_3$: 292.0303, 294.0273 (M^+), Found: 292.0301, 294.0278.

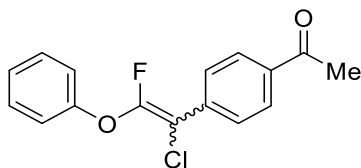
2-Chloro-1-fluoro-2-*p*-fluorophenylethenyl phenyl ether (2f)



The title product (**2f**) was purified by column chromatography (hexane only). **2f** was obtained in 94% yield (128.6 mg).

A colorless oil; ^1H NMR (400 MHz, CDCl_3) δ : 6.97-7.23 (5H, m), 7.32-7.43 (2H, m), 7.51-7.66 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 100.5 (d, $J = 31.7$ Hz), 101.5 (d, $J = 47.9$ Hz), 115.4 (d, $J = 6.5$ Hz), 115.6 (d, $J = 6.6$ Hz), 116.4, 116.5, 124.8, 124.9, 128.6 (m), 128.8, 129.9 (d, $J = 3.0$ Hz), 130.0 (d, $J = 3.1$ Hz), 130.1, 130.2, 151.3 (d, $J = 287.7$ Hz), 151.5 (d, $J = 285.9$ Hz), 152.2 (d, $J = 286.9$ Hz), 154.3, 161.3 (d, $J = 3.0$ Hz), 163.8 (d, $J = 3.7$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -81.1 (s) and -87.8 (s) (1F, 1:1), -112.2 (m), -112.4 (m) and -115.6 (m) (1F); MS (EI) m/z : 266 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_9\text{ClF}_2\text{O}$: 266.0310 (M^+), Found: 266.0314.

2-*p*-Acetylphenyl-2-chloro-1-fluoroethenyl phenyl ether (2g)



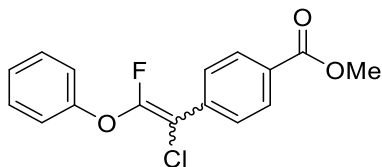
Reaction time was 2.5 h.

The title product (**2g**) was purified by column chromatography (pentane only to pentane:Et₂O = 4:1).

2g was obtained in 76% yield (112.3 mg).

A red oil; ¹H NMR (400 MHz, CDCl₃) δ: 2.58 (s) and 2.63 (s) (3H), 7.04-7.12 (1H, m), 7.13-7.25 (2H, m), 7.32-7.46 (2H, m), 7.71 (1H, d, *J* = 8.5 Hz), 7.75 (1H, d, *J* = 8.5 Hz), 7.91 (1H, d, *J* = 8.5 Hz), 7.99 (1H, d, *J* = 8.5 Hz); ¹³C NMR (100 MHz, CDCl₃) δ: 26.76, 26.81, 100.6 (d, *J* = 31.8 Hz), 101.3 (d, *J* = 46.7 Hz), 116.6, 116.8, 125.07, 125.11, 128.0 (d, *J* = 3.2 Hz), 128.2 (d, *J* = 6.2 Hz), 128.39, 128.44, 130.1, 130.2, 136.58, 136.62, 137.1 (d, *J* = 6.2 Hz), 137.2, 152.2 (d, *J* = 288.3 Hz), 152.4 (d, *J* = 290.0 Hz), 153.9, 154.0, 197.4, 197.5; ¹⁹F NMR (376 MHz, CDCl₃) δ: -77.2 (s) and -84.3 (s) (1F, 1:1); MS (EI) *m/z*: 290 (M⁺); HRMS (EI) Calcd. for C₁₆H₁₂ClFO₂: 290.0510 (M⁺), Found: 290.0508.

2-Chloro-1-fluoro-2-(*p*-methoxycarbonylphenyl)ethenyl phenyl ether (2h)

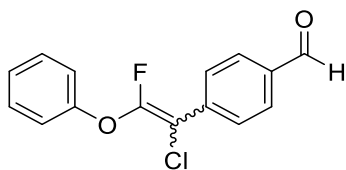


Reaction time was 1.5 h.

The title product (**2h**) was purified by column chromatography (hexane:AcOEt = 9:1). **2h** was obtained in 96% yield (149.9 mg).

A pale yellow oil; ¹H NMR (400 MHz, CDCl₃) δ: 3.90 (s) and 3.94 (s) (3H), 7.04-7.11 (1H, m), 7.13-7.24 (2H, m), 7.32-7.44 (2H, m), 7.68 (1H, d, *J* = 8.5 Hz), 7.73 (1H, d, *J* = 8.5 Hz), 7.99 (1H, d, *J* = 8.5 Hz), 8.06 (1H, d, *J* = 8.5 Hz); ¹³C NMR (100 MHz, CDCl₃) δ: 52.3, 52.4, 100.6 (d, *J* = 32.1 Hz), 101.4 (d, *J* = 46.6 Hz), 116.6, 116.8, 125.0, 125.1, 127.8 (d, *J* = 3.3 Hz), 128.0 (d, *J* = 6.2 Hz), 129.7 (d, *J* = 5.5 Hz), 129.85, 129.89, 130.2 (d, *J* = 9.1 Hz), 136.91, 136.97, 137.0, 152.1 (d, *J* = 287.9 Hz), 152.2 (d, *J* = 289.7 Hz), 154.03, 154.06, 166.6; ¹⁹F NMR (376 MHz, CDCl₃) δ: -77.5 (s) and -84.5 (s) (1F, 1:1); MS (EI) *m/z*: 306 (M⁺); HRMS (EI) Calcd. for C₁₆H₁₂ClFO₃: 306.0459 (M⁺), Found: 306.0459.

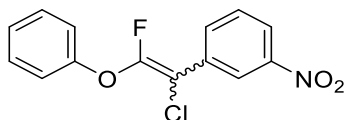
2-Chloro-1-fluoro-2-(*p*-formylphenyl)ethenyl phenyl ether (2i)



The title product (**2i**) was purified by column chromatography and preparative TLC (hexane:AcOEt = 9:1). **2i** was obtained in 77% yield (108.5 mg).

A pale yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.04-7.11 (1H, m), 7.12-7.23 (2H, m), 7.32-7.43 (2H, m), 7.74-7.87 (3H, m), 7.91 (1H, d, J = 8.4 Hz), 9.97 (s) and 10.0 (s) (1H); ^{13}C NMR (100 MHz, CDCl_3) δ : 100.3 (d, J = 32.3 Hz), 101.1 (d, J = 46.1 Hz), 116.6, 116.9, 125.16, 125.22, 128.4 (d, J = 3.3 Hz), 128.6 (d, J = 6.5 Hz), 129.7 (d, J = 4.5 Hz), 130.2 (d, J = 11.4 Hz), 135.78, 135.82, 138.41, 138.47, 138.5, 152.4 (d, J = 289.0 Hz), 152.6 (d, J = 290.7 Hz), 153.9, 191.5, 191.6; ^{19}F NMR (376 MHz, CDCl_3) δ : -76.3 (s) and -83.5 (s) (1F, 1:1); MS (EI) m/z : 276 (M^+); HRMS (EI) Calcd. for $\text{C}_{15}\text{H}_{10}\text{ClFO}_2$: 276.0353 (M^+), Found: 276.0352.

2-Chloro-1-fluoro-2-*m*-nitrophenylethenyl phenyl ether (2j)

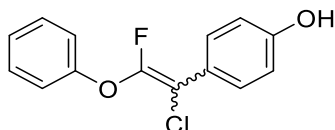


Reaction time was 3.0 h.

The title product (**2j**) was purified by column chromatography (hexane:AcOEt = 9:1). **2j** was obtained in 88% yield (131.8 mg).

A brown oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.07-7.13 (1H, m), 7.14-7.26 (2H, m), 7.34-7.45 (2H, m), 7.52 (t, J = 8.1 Hz) and 7.60 (t, J = 8.1 Hz) (1H), 7.94 (ddd, J = 7.8, 1.8, 1.8 Hz) and 7.96-8.01 (m) (1H), 8.14 (ddd, J = 8.2, 2.2, 0.9 Hz) and 8.20 (ddd, J = 8.2, 2.2, 2.2 Hz) (1H), 3.53 (1H, br s); ^{13}C NMR (100 MHz, CDCl_3) δ : 99.2 (d, J = 33.4 Hz), 99.9 (d, J = 46.5 Hz), 116.6, 116.9, 122.97, 123.00, 123.06, 123.1, 123.2, 125.28, 125.34, 129.5, 129.6, 130.2, 130.3, 133.5 (d, J = 3.1 Hz), 133.7 (d, J = 6.4 Hz), 134.38, 134.45, 148.34, 148.39, 152.5 (d, J = 287.5 Hz), 152.6 (d, J = 289.9 Hz), 153.8 (d, J = 2.5 Hz), 153.9 (d, J = 2.4 Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -76.5 (s) and -84.0 (s) (1F, 1:1.1); MS (EI) m/z : 293 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_9\text{ClFNO}_3$: 293.0255 (M^+), Found: 293.0255.

2-Chloro-1-fluoro-2-*p*-hydroxyphenylethenyl phenyl ether (2k)

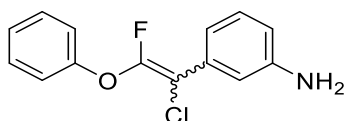


Reaction time was 6.5 h.

The title product (**2k**) was purified by column chromatography (hexane:AcOEt = 3:1) and preparative TLC (hexane:AcOEt = 7:3). **2k** was obtained in 9% yield (12.3 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 4.90 (s) and 4.97 (s) (1H), 6.76 (d, $J = 8.6$ Hz) and 6.86 (d, $J = 8.7$ Hz) (1H), 7.06 (1H, d, $J = 8.0$ Hz), 7.10-7.21 (2H, m), 7.34 (t, $J = 7.7$ Hz) and 7.38 (t, $J = 7.8$ Hz) (2H), 7.45 (d, $J = 8.6$ Hz) and 7.52 (d, $J = 8.4$ Hz) (2H); ^{13}C NMR (100 MHz, CDCl_3) δ : 101.3 (d, $J = 32.1$ Hz), 102.4 (d, $J = 48.4$ Hz), 115.3, 115.4, 116.35, 116.39, 124.6, 125.0 (d, $J = 5.6$ Hz), 125.1, 129.6 (d, $J = 3.2$ Hz), 129.8 (d, $J = 5.3$ Hz), 130.0, 130.1, 150.8 (d, $J = 284.7$ Hz), 151.0 (d, $J = 285.1$ Hz), 154.4 (d, $J = 3.3$ Hz), 154.5 (d, $J = 3.3$ Hz), 155.6, 155.7; ^{19}F NMR (376 MHz, CDCl_3) δ : -82.6 (s) and -89.03 (s) (1F, 1.4:1); MS (EI) m/z : 264 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_{10}\text{ClFO}_2$: 264.0353 (M^+), Found: 264.0354.

2-*m*-Aminophenyl-2-chloro-1-fluoroethenyl phenyl ether (2l)

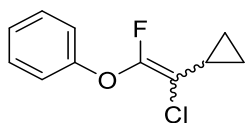


Reaction time was 4.0 h.

The title product (**2l**) was purified by column chromatography (hexane:AcOEt = 4:1). **2l** was obtained in 92% yield (123.5 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 3.72 (2H, br s), 6.57-6.70 (1H, m), 6.88-7.25 (6H, m), 7.31-7.58 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 101.6 (d, $J = 31.4$ Hz), 102.7 (d, $J = 47.7$ Hz), 114.6 (d, $J = 3.5$ Hz), 114.7 (d, $J = 5.1$ Hz), 115.4, 115.5, 116.46, 116.5, 118.3 (d, $J = 2.8$ Hz), 118.6 (d, $J = 5.9$ Hz), 124.66, 124.69, 129.3, 129.4, 130.0, 130.1, 133.38, 133.44, 133.5, 146.4, 146.5, 151.2 (d, $J = 285.3$ Hz), 151.4 (d, $J = 286.6$ Hz), 154.4 (d, $J = 3.4$ Hz), 154.5 (d, $J = 3.3$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -80.7 (s) and -87.0 (s) (1F, 1:1); MS (EI) m/z : 263 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_{11}\text{ClFNO}$: 263.0513 (M^+), Found: 263.0512.

2-Chloro-2-cyclopropyl-1-fluoroethenyl phenyl ether (2n)

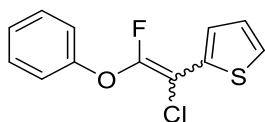


Reaction time was 5.0 h.

The title product (**2n**) was purified by column chromatography (hexane:AcOEt = 9:1). **2n** was obtained in 71% yield (77.4 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 0.65-0.84 (4H, m), 1.67-1.77 (m) and 1.84-1.95 (m) (1H), 7.08 (2H, d, $J = 8.0$ Hz), 7.10-7.18 (1H, m), 7.30-7.40 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 4.77, 4.98, 10.7, 10.9, 104.0 (d, $J = 28.8$ Hz), 105.3 (d, $J = 52.1$ Hz), 116.0, 116.2, 124.3, 129.9, 130.0, 150.8 (d, $J = 280.1$ Hz), 151.7 (d, $J = 278.5$ Hz), 155.1 (d, $J = 3.9$ Hz), 154.87 (d, $J = 3.9$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -85.6 (s) and -96.0 (s) (1F, 1:1); MS (EI) m/z : 212 (M^+); HRMS (EI) Calcd. for $\text{C}_{11}\text{H}_{10}\text{ClFO}_3$: 212.0404 (M^+), Found: 212.0404.

2-Chloro-1-fluoro-2-(thiophene-2-yl)ethenyl phenyl ether (2o)

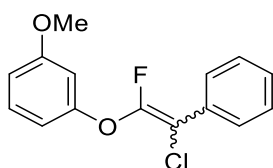


Reaction time was 4 h.

The title product (**2o**) was purified by column chromatography and preparative TLC (hexane only). **2o** was obtained in 31% yield (38.5 mg).

A colorless oil; ^1H NMR (400 MHz, CDCl_3) δ : 6.95-7.03 (m) and 7.06 (td, $J = 4.4, 1.3$ Hz) (1H), 7.13 (2H, d, $J = 8.1$ Hz), 7.15-7.21 (1H, m), 7.23-7.27 (m) and 7.31 (dd, $J = 3.7, 1.1$ Hz) (1H), 7.33-7.40 (3H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 98.1 (d, $J = 37.2$ Hz), 98.8 (d, $J = 51.0$ Hz), 116.5, 116.6, 124.2 (d, $J = 60.1$ Hz), 124.9, 125.1, 126.8 (d, $J = 5.5$ Hz), 126.8, 127.0, 127.1, 127.23 (d, $J = 15.4$ Hz), 130.09, 130.15, 134.5, 134.9 (d, $J = 9.4$ Hz), 137.5, 150.4 (d, $J = 287.3$ Hz), 150.8 (d, $J = 288.6$ Hz), 153.7 (d, $J = 3.6$ Hz), 154.4 (d, $J = 3.9$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -82.1 (s) and -84.5 (s) (1F, 1:1); MS (EI) m/z : 254 (M^+); HRMS (EI) Calcd. for $\text{C}_{12}\text{H}_8\text{ClFOS}$: 253.9968 (M^+), Found: 253.9972.

2-Chloro-1-fluoro-2-phenylethenyl 3-methoxyphenyl ether (2p)

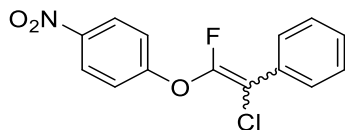


Reaction time was 3.5 h.

The title product (**2p**) was purified by column chromatography (hexane to hexane:AcOEt = 9:1). **2p** was obtained in 62% yield (92.3 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 3.78 (s) and 3.81(s) (3H), 6.57-6.79 (3H, m), 7.19-7.37 (3H, m), 7.41 (1H, t, $J = 7.6$ Hz), 7.57 (1H, t, $J = 7.6$ Hz), 7.64 (1H, t, $J = 7.6$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 55.6, 101.6 (d, $J = 31.7$ Hz), 102.7 (d, $J = 50.5$ Hz), 102.92, 102.93, 108.4, 110.3, 127.9 (d, $J = 3.2$ Hz), 128.17, 128.22, 128.4, 128.5 128.6 (d, $J = 12.1$ Hz), 130.48, 130.54, 132.45 (d, $J = 5.6$ Hz), 132.54, 151.2 (d, $J = 285.6$ Hz), 151.3 (d, $J = 286.9$ Hz), 155.4 (d, $J = 3.5$ Hz), 155.5 (d, $J = 3.4$ Hz), 161.1; ^{19}F NMR (376 MHz, CDCl_3) δ : -80.7 (s) and -87.5 (s) (1F, 1:1); MS (EI) m/z : 278 (M^+); HRMS (EI) Calcd. for $\text{C}_{15}\text{H}_{12}\text{ClFO}_2$: 278.0510 (M^+), Found: 278.0510.

2-Chloro-1-fluoro-2-phenylethenyl 4-nitrophenyl ether (2q)



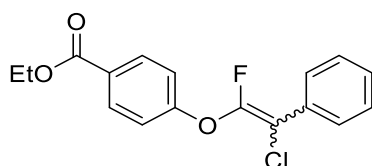
Reaction time was 5.5 h.

The title product (**2q**) was purified by column chromatography (hexane to hexane:AcOEt = 9:1). **2p**

was obtained in 85% yield (128.0 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.18 (1H, dd, $J = 9.1, 1.1$ Hz), 7.23-7.35 (3H, m), 7.38-7.53 (2H, m), 7.65 (1H, dt, $J = 8.0, 1.3$ Hz), 8.24 (1H, d, $J = 9.2$ Hz), 8.30 (1H, d, $J = 9.2$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 103.3 (d, $J = 29.6$ Hz), 104.5 (d, $J = 45.0$ Hz), 116.6, 116.7, 126.3, 128.0 (d, $J = 3.1$ Hz), 128.2 (d, $J = 5.4$ Hz), 128.6, 128.7, 129.2, 129.3, 131.6 (d, $J = 5.8$ Hz), 131.8, 144.5, 150.2 (d, $J = 285.8$ Hz), 150.3 (d, $J = 287.5$ Hz), 158.76 (d, $J = 4.3$ Hz), 158.81 (d, $J = 3.8$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -82.9 (s) and -88.9 (s) (1F, 1:1); MS (EI) m/z : 293 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_9\text{ClFNO}_3$: 293.0255 (M^+), Found: 293.0258.

2-Chloro-1-fluoro-2-phenylethenyl 4-ethoxycarbonylphenyl ether (2r)

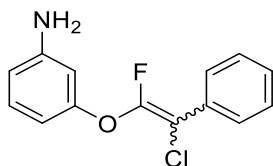


Reaction time was 3.5 h.

The title product (**2r**) was purified by column chromatography (hexane:AcOEt = 14:1) and preparative TLC (hexane:AcOEt = 39:1). **2r** was obtained in 45% yield (58.9 mg).

A pale yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 1.38 (t, $J = 6.9$ Hz) and 1.40 (t, $J = 7.1$ Hz) (3H), 4.36 (d, $J = 6.9$ Hz) and 4.38 (d, $J = 7.1$ Hz) (2H), 7.18 (1H, dd, $J = 8.8, 1.4$ Hz), 7.18 (1H, dd, $J = 9.1, 0.9$ Hz), 7.27-7.48 (3H, m), 7.52 (1H, dd, $J = 8.2, 1.3$ Hz), 7.65 (1H, dt, $J = 8.3, 1.2$ Hz), 8.04 (1H, d, $J = 8.9$ Hz), 8.09 (1H, d, $J = 8.9$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 14.5, 61.2, 102.4 (d, $J = 30.4$ Hz), 103.5 (d, $J = 46.6$ Hz), 115.98, 116.02, 127.02, 127.07, 128.0 (d, $J = 3.0$ Hz), 128.2 (d, $J = 5.5$ Hz), 128.5, 128.6, 128.8, 129.0, 131.97, 132.1 (d, $J = 5.8$ Hz), 132.2, 150.7 (d, $J = 286.0$ Hz), 150.8 (d, $J = 286.9$ Hz), 158.7 (d, $J = 3.8$ Hz), 157.8 (d, $J = 3.7$ Hz), 165.7, 165.8; ^{19}F NMR (376 MHz, CDCl_3) δ : -81.7 (s) and -88.1 (s) (1F, 1:1.6); MS (EI) m/z : 320 (M^+); HRMS (EI) Calcd. for $\text{C}_{17}\text{H}_{14}\text{ClFO}_3$: 320.0616 (M^+), Found: 320.0617.

3-Aminophenyl 2-chloro-1-fluoro-2-phenylethenyl ether (2s)



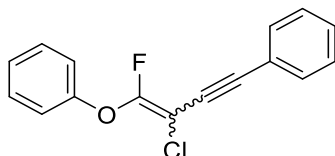
DME was used as a solvent. Reaction time was 21.5 h.

The title product (**2s**) was purified by column chromatography and preparative TLC (hexane:AcOEt = 4:1) and preparative TLC (hexane:AcOEt = 9:1). **2s** was obtained in 15% yield (20.0 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 3.77 (2H, br s), 6.35-6.59 (3H, m), 7.10 (t, $J = 8.2$ Hz) and 7.13 (t, $J = 8.0$ Hz) (1H), 7.26-7.36 (2H, m), 7.38-7.45 (1H, m), 7.55-7.67 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 101.3 (d, $J = 31.6$ Hz), 102.4 (d, $J = 47.9$ Hz), 103.0, 103.1, 106.1, 106.2, 111.42,

111.45, 127.9 (d, $J = 2.8$ Hz), 128.2 (d, $J = 5.5$ Hz), 128.4 (d, $J = 6.9$ Hz), 128.5 (d, $J = 13.1$ Hz), 130.6, 130.7, 132.5, 132.6, 148.3, 151.2 (d, $J = 285.1$ Hz), 151.5 (d, $J = 287.2$ Hz), 155.4 (d, $J = 3.2$ Hz), 155.5 (d, $J = 3.2$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -80.1 (s) and -87.0 (s) (1F, 1:1.2); MS (EI) m/z : 263 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_{11}\text{ClFNO}$: 263.0513 (M^+), Found: 263.0519.

2-Chloro-1-fluoro-1-phenoxy-4-phenylbut-1-en-3-yne (3b)

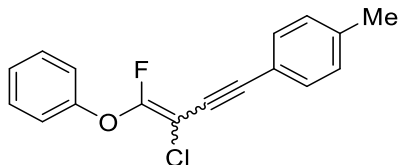


Reaction time was 18.5 h.

The title product (**3b**) was purified by column chromatography (pentane only). **3b** was obtained in 92% yield (125.4 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.10-7.24 (2H, m), 7.26-7.42 (6H, m), 7.33-7.42 (1H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 79.7 (d, $J = 7.1$ Hz), 80.1 (d, $J = 3.1$ Hz), 85.4 (d, $J = 39.0$ Hz), 85.9 (d, $J = 46.3$ Hz), 96.4 (d, $J = 6.3$ Hz), 97.2 (d, $J = 8.4$ Hz), 117.1, 117.2, 121.9, 122.0, 125.26, 125.29, 128.5 (d, $J = 10.6$ Hz), 128.6, 129.2 (d, $J = 11.3$ Hz), 129.4, 130.1 (d, $J = 3.4$ Hz), 131.7 (d, $J = 5.0$ Hz), 132.6, 153.8 (d, $J = 2.6$ Hz), 154.4 (d, $J = 2.8$ Hz), 157.3 (d, $J = 292.2$ Hz), 157.6 (d, $J = 291.2$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -74.7 (s) and -78.9 (s) (1F, 1.1:1); MS (EI) m/z : 272 (M^+); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_{10}\text{ClFO}$: 272.0404 (M^+), Found: 272.0407.

2-Chloro-1-fluoro-4-(4-methylphenyl)-1-phenoxybut-1-en-3-yne (3c)

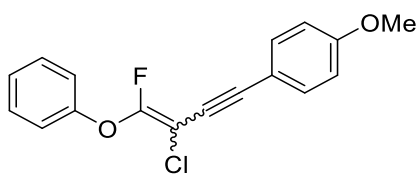


Multihalogenated vinyl ether (2.0 equiv) and 4-methylphenylacetylene (1.0 equiv) were used. Reaction time was 3.5 h.

The title product (**3c**) was purified by column chromatography (hexane only). **3c** was obtained in 74% yield (105.5 mg).

A yellow solid; ^1H NMR (400 MHz, CDCl_3) δ : 2.33 (s) and 2.37 (s) (3H), 7.06-7.26 (6H, m), 7.33-7.46 (3H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 21.69, 21.72, 79.1 (d, $J = 7.3$ Hz), 79.5 (d, $J = 2.9$ Hz), 85.87, 85.93 (d, $J = 98.7$ Hz), 96.7 (d, $J = 6.3$ Hz), 97.5 (d, $J = 8.2$ Hz), 117.0, 117.2, 118.8, 118.9, 125.19, 125.28, 129.2, 129.3, 130.05, 130.10, 131.56, 131.62, 132.5, 139.5, 139.6, 153.8 (d, $J = 2.9$ Hz), 154.4 (d, $J = 3.0$ Hz), 157.1 (d, $J = 289.9$ Hz), 157.4 (d, $J = 290.4$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -75.2 (s) and -79.3 (s) (1F, 1:1.4); MS (EI) m/z : 286 (M^+); HRMS (EI) Calcd. for $\text{C}_{17}\text{H}_{12}\text{ClFO}$: 286.0561 (M^+), Found: 286.0561; Mp: 153.5-154.5.

2-Chloro-1-fluoro-4-(4-methoxyphenyl)-1-phenoxybut-1-en-3-yne (3d)

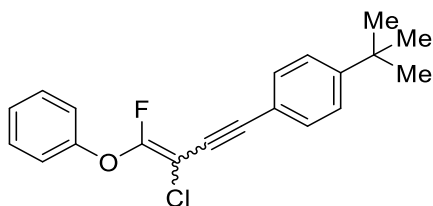


Multihalogenated vinyl ether (2.0 equiv) and 4-methoxyphenylacetylene (1.0 equiv) were used. Reaction time was 2.5 h.

The title product (**3d**) was purified by column chromatography (hexane:AcOEt = 19:1) and preparative TLC (hexane:AcOEt = 9:1). **3d** was obtained in 49% yield (76.7 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 3.80 (s) and 3.83 (s) (3H), 6.81 (d, $J = 8.7$ Hz) and 6.88 (d, $J = 8.7$ Hz) (2H), 7.10-7.24 (3H, m), 7.29 (1H, d, $J = 8.7$ Hz), 7.35-7.42 (2H, m), 7.44 (1H, d, $J = 8.7$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 55.43, 55.46, 78.5 (d, $J = 7.3$ Hz), 78.9 (d, $J = 2.5$ Hz), 85.8 (d, $J = 46.0$ Hz), 86.3 (d, $J = 53.6$ Hz), 96.6 (d, $J = 6.3$ Hz), 97.4 (d, $J = 8.4$ Hz), 114.01, 114.04, 114.1, 114.2, 117.0, 117.2, 125.16, 125.20, 130.0, 130.1, 133.29, 133.34, 153.9 (d, $J = 2.8$ Hz), 154.5 (d, $J = 3.2$ Hz), 156.9 (d, $J = 290.9$ Hz), 157.3 (d, $J = 290.3$ Hz), 160.3, 160.4; ^{19}F NMR (376 MHz, CDCl_3) δ : -75.6 (s) and -79.6 (s) (1F, 1.4:1); MS (EI) m/z : 302 (M^+); HRMS (EI) Calcd. for $\text{C}_{17}\text{H}_{12}\text{ClFO}_2$: 302.0510 (M^+), Found: 302.0500.

4-(4-*tert*-Butylphenyl)-2-chloro-1-fluoro-1-phenoxybut-1-en-3-yne (3e)

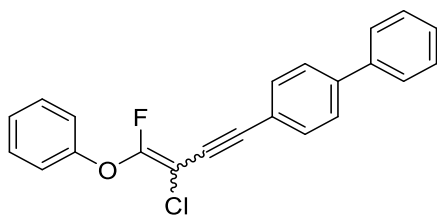


Multihalogenated vinyl ether (2.0 equiv) and 4-*tert*-butylphenylacetylene (1.0 equiv) were used. Reaction time was 4.5 h.

The title product (**3e**) was purified by column chromatography and preparative TLC (hexane only). **3e** was obtained in 70% yield (115.6 mg).

A pale yellow solid; ^1H NMR (400 MHz, CDCl_3) δ : 1.28 (s) and 1.31 (s) (3H), 7.10-7.22 (3H, m), 7.25-7.50 (6H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 31.23, 31.25, 34.97, 35.01, 79.1 (d, $J = 7.2$ Hz), 79.5 (d, $J = 2.8$ Hz), 85.7 (d, $J = 37.2$ Hz), 86.2 (d, $J = 44.8$ Hz), 96.7 (d, $J = 6.4$ Hz), 97.5 (d, $J = 8.4$ Hz), 117.05, 117.15, 118.9, 119.0, 125.2 (d, $J = 4.6$ Hz), 125.5, 125.57, 125.59 (d, $J = 4.1$ Hz), 130.06, 130.10, 131.44, 131.49, 132.4, 152.6, 152.7, 153.8 (d, $J = 2.2$ Hz), 154.4 (d, $J = 3.2$ Hz), 157.1 (d, $J = 291.6$ Hz), 157.5 (d, $J = 290.6$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -75.0 (s) and -79.3 (s) (1F, 1:1.4); MS (EI) m/z : 328 (M^+); HRMS (EI) Calcd. for $\text{C}_{20}\text{H}_{18}\text{ClFO}$: 328.1030 (M^+), Found: 328.1031; Mp: 192.2-193.3.

2-Chloro-1-fluoro-1-phenoxy-4-(4-phenylphenyl)but-1-en-3-yne (3f)

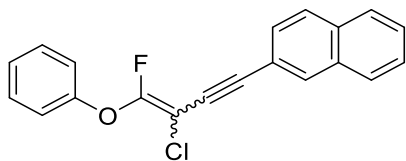


Reaction time was 4.5 h.

The title product (**3f**) was purified by column chromatography (hexane:AcOEt = 9:1) and preparative TLC (hexane:AcOEt = 14:1). **3f** was obtained in 43% yield (74.6 mg).

An orange solid; ^1H NMR (400 MHz, CDCl_3) δ : 7.10-7.23 (3H, m), 7.32-7.49 (6H, m), 7.50-7.65 (5H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 80.4 (d, $J = 7.3$ Hz), 80.8 (d, $J = 3.1$ Hz), 85.5 (d, $J = 39.5$ Hz), 86.0 (d, $J = 46.6$ Hz), 96.4 (d, $J = 6.4$ Hz), 97.1 (d, $J = 8.1$ Hz), 117.1, 117.2, 120.79, 120.85, 125.28, 125.30, 127.1, 127.16, 127.19, 128.0, 129.0, 130.11, 130.12, 132.08, 132.14, 140.2, 141.9, 142.0, 153.8 (d, $J = 2.4$ Hz), 154.4 (d, $J = 2.7$ Hz), 157.2 (d, $J = 291.7$ Hz), 157.6 (d, $J = 291.1$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -74.6 (s) and -78.7 (s) (1F, 1:1.1); MS (EI) m/z : 348 (M^+); HRMS (EI) Calcd. for $\text{C}_{22}\text{H}_{14}\text{ClFO}$: 348.0717 (M^+), Found: 348.0717; Mp: 61.2-61.8.

2-Chloro-1-fluoro-4-(2-naphthyl)-1-phenoxybut-1-en-3-yne (3g)

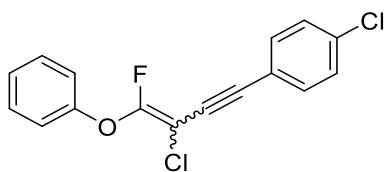


Reaction time was 17.5 h.

The title product (**3g**) was purified by column chromatography (hexane:AcOEt = 4:1) and preparative TLC (hexane only). **3g** was obtained in 59% yield (95.0 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.10-7.23 (3H, m), 7.32-7.41 (m) and 7.42-7.54 (m) (5H), 7.66-7.82 (3H, m), 7.85 (s) and 8.01 (s) (1H); ^{13}C NMR (100 MHz, CDCl_3) δ : 80.0 (d, $J = 7.3$ Hz), 80.4 (d, $J = 3.5$ Hz), 85.3, 85.7, 86.2, 96.9 (d, $J = 6.2$ Hz), 97.6 (d, $J = 8.5$ Hz), 117.0, 117.2, 119.16, 119.23, 125.3, 126.8 (d, $J = 5.2$ Hz), 127.2 (d, $J = 5.5$ Hz), 127.89, 127.93, 127.97, 128.1, 128.2, 128.3, 130.1, 131.87, 131.93, 132.9 (d, $J = 8.6$ Hz), 133.2 (d, $J = 8.5$ Hz), 153.8 (d, $J = 2.0$ Hz), 154.4 (d, $J = 2.7$ Hz), 157.3 (d, $J = 292.4$ Hz), 157.7 (d, $J = 290.8$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -74.4 (s) and -78.6 (s) (1F, 1.2:1); MS (EI) m/z : 322 (M^+); HRMS (EI) Calcd. for $\text{C}_{20}\text{H}_{12}\text{ClFO}$: 322.0561 (M^+), Found: 322.0561.

2-Chloro-4-(4-chlorophenyl)-1-fluoro-1-phenoxybut-1-en-3-yne (3h)

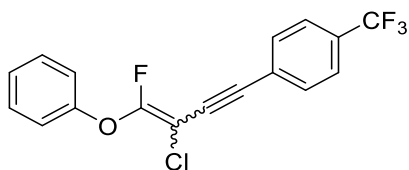


Multihalogenated vinyl ether (1.5 equiv) and 4-methylphenylacetylene (1.0 equiv) was used. Reaction time was 16 h.

The title product (**3h**) was purified by column chromatography and preparative TLC (hexane only). **3h** was obtained in 39% yield (59.9 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.11-7.17 (2H, m), 7.18-7.25 (1H, m), 7.27 (2H, s), 7.33 (1H, d, $J = 8.5$ Hz), 7.36-7.41 (2H, m), 7.43 (1H, d, $J = 8.5$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 80.7 (d, $J = 7.6$ Hz), 81.1 (d, $J = 3.6$ Hz), 84.9 (d, $J = 7.1$ Hz), 85.3 (d, $J = 7.9$ Hz), 95.3 (d, $J = 6.3$ Hz), 95.9 (d, $J = 8.0$ Hz), 117.17, 117.22, 120.4, 120.5, 125.35, 125.40, 128.8, 129.0, 130.12, 130.14, 132.86, 132.90, 135.3, 135.4, 153.7 (d, $J = 2.3$ Hz), 154.3 (d, $J = 2.9$ Hz), 157.4 (d, $J = 293.1$ Hz), 157.8 (d, $J = 291.4$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -74.1 (s) and -78.3 (s) (1F, 1:1); MS (EI) m/z : 306 (M^+); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_9\text{Cl}_2\text{FO}$: 306.0014 (M^+), Found: 306.0015.

2-Chloro-1-fluoro-1-phenoxy-4-(4-trifluoromethylphenyl)but-1-en-3-yne (3i)

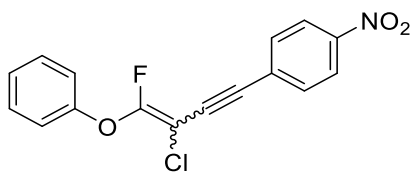


Reaction time was 14 h.

The title product (**3i**) was purified by column chromatography and preparative TLC (hexane only). **3i** was obtained in 49% yield (82.8 mg).

A colorless oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.11-7.18 (2H, m), 7.19-7.25 (1H, m), 7.40 (1H, t, $J = 7.9$ Hz), 7.44 (1H, d, $J = 8.3$ Hz), 7.55 (1H, d, $J = 8.1$ Hz), 7.61 (2H, s); ^{13}C NMR (100 MHz, CDCl_3) δ : 82.1 (d, $J = 7.3$ Hz), 82.5 (d, $J = 3.3$ Hz), 84.6 (d, $J = 31.6$ Hz), 85.1 (d, $J = 38.5$ Hz), 94.8 (d, $J = 6.0$ Hz), 95.5 (d, $J = 8.3$ Hz), 117.3, 123.9 (q, $J = 272.2$ Hz), 124.0 (q, $J = 272.2$ Hz), 125.38, 125.42, 125.46, 125.51, 125.7, 125.8, 130.2, 130.6 (d, $J = 9.4$ Hz), 130.9 (d, $J = 9.7$ Hz), 131.8, 131.9, 153.6 (d, $J = 1.9$ Hz), 154.2 (d, $J = 2.4$ Hz), 157.8 (d, $J = 294.2$ Hz), 158.1 (d, $J = 292.2$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -62.79 (s) and -62.82 (s) (3F), -73.0 (s) and -77.4 (s) (1F, 1:1.2); MS (EI) m/z : 340 (M^+); HRMS (EI) Calcd. for $\text{C}_{17}\text{H}_9\text{ClF}_4\text{O}$: 340.0278 (M^+), Found: 340.0279.

2-Chloro-1-fluoro-4-(4-nitrophenyl)-1-phenoxybut-1-en-3-yne (3j)

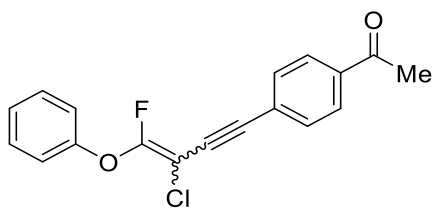


Reaction time was 17 h.

The title product (**3j**) was purified by column chromatography (hexane:AcOEt = 49:1 to 19:1). **3j** was obtained in 42% yield (66.9 mg).

A yellow solid; ^1H NMR (400 MHz, CDCl_3) δ : 7.15 (2H, t, $J = 6.7$ Hz), 7.24 (2H, t, $J = 7.3$ Hz), 7.41 (2H, t, $J = 7.7$ Hz), 7.47 (1H, d, $J = 8.7$ Hz), 7.64 (1H, d, $J = 8.7$ Hz), 8.16 (1H, d, $J = 8.7$ Hz), 8.22 (1H, d, $J = 8.7$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 84.1 (d, $J = 23.4$ Hz), 84.6 (d, $J = 30.1$ Hz), 84.9 (d, $J = 7.4$ Hz), 85.3 (d, $J = 3.6$ Hz), 117.3, 117.4, 123.7, 123.8, 125.6, 125.7, 128.7, 128.8, 130.2, 132.2, 132.3, 147.5, 147.6, 153.4 (d, $J = 1.7$ Hz), 154.0 (d, $J = 2.3$ Hz), 158.1 (d, $J = 294.5$ Hz), 158.4 (d, $J = 292.6$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -71.6 (s), -76.1 (s) (1F, 1:1.3); MS (EI) m/z : 340 (M^+); HRMS (EI) Calcd. for $\text{C}_{17}\text{H}_9\text{ClF}_4\text{O}$: 340.0278 (M^+), Found: 340.0279; Mp: 55.5-57.7.

4-(4-Acetylphenyl)-2-chloro-1-fluoro-1-phenoxybut-1-en-3-yne (3k)

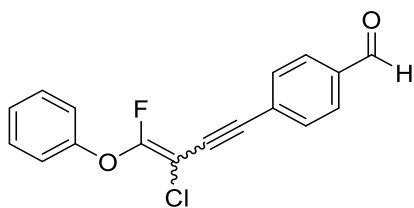


Reaction time was 16.5 h.

The title product (**3k**) was purified by column chromatography (hexane:AcOEt = 4:1). **3k** was obtained in 76% yield (119.7 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 2.59 (s) and 2.62 (s) (3H), 7.15 (2H, t, $J = 7.3$ Hz), 7.23 (1H, td, $J = 7.3, 1.0$ Hz), 7.39 (2H, d, $J = 7.5$ Hz), 7.40-7.43 (1H, m), 7.58 (1H, d, $J = 8.1$ Hz), 7.88 (1H, d, $J = 8.3$ Hz), 7.94 (1H, d, $J = 8.3$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 26.79, 26.82, 82.9 (d, $J = 7.3$ Hz), 83.3 (d, $J = 3.8$ Hz), 84.7 (d, $J = 33.6$ Hz), 85.2 (d, $J = 40.6$ Hz), 95.5 (d, $J = 5.9$ Hz), 96.1 (d, $J = 8.3$ Hz), 117.3, 125.46, 125.50, 126.7, 126.8, 128.3, 128.4, 130.2, 131.68, 131.72, 136.8, 136.9, 153.6 (d, $J = 2.3$ Hz), 154.2 (d, $J = 2.4$ Hz), 157.8 (d, $J = 293.1$ Hz), 158.0 (d, $J = 292.5$ Hz), 197.3, 197.4; ^{19}F NMR (376 MHz, CDCl_3) δ : -73.0 (s) and -77.3 (s) (1F, 1:1.1); MS (EI) m/z : 314 (M^+); HRMS (EI) Calcd. for $\text{C}_{18}\text{H}_{12}\text{ClFO}_2$: 314.0510 (M^+), Found: 314.0511.

2-Chloro-4-(4-formylphenyl)-1-fluoro-1-phenoxybut-1-en-3-yne (3l)

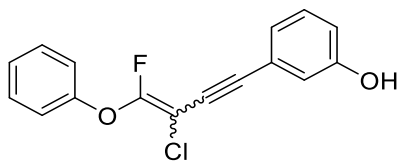


Reaction time was 28.5 h.

The title product (**3l**) was purified by column chromatography (hexane:AcOEt = 4:1). **3l** was obtained in 52% yield (77.5 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 7.15 (2H, td, $J = 7.5, 1.0$ Hz), 7.23 (1H, td, $J = 7.4, 1.0$ Hz), 7.41 (2H, t, $J = 8.0$ Hz), 7.49 (1H, d, $J = 8.2$ Hz), 7.64 (1H, d, $J = 8.1$ Hz), 7.81 (1H, d, $J = 8.2$ Hz), 7.87 (1H, d, $J = 8.1$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 83.6 (d, $J = 7.5$ Hz), 84.0 (d, $J = 3.4$ Hz), 84.6 (d, $J = 28.4$ Hz), 85.0 (d, $J = 35.0$ Hz), 117.3, 125.50, 125.54, 128.0, 128.1, 129.6, 129.7, 130.2, 132.03, 132.07, 135.9, 136.0, 153.5 (d, $J = 2.1$ Hz), 154.1 (d, $J = 2.4$ Hz), 157.9 (d, $J = 294.1$ Hz), 158.2 (d, $J = 292.7$ Hz), 191.4, 191.5; ^{19}F NMR (376 MHz, CDCl_3) δ : -72.5 (s) and -76.9 (s) (1F, 1:1.1); MS (EI) m/z : 300 (M^+); HRMS (EI) Calcd. for $\text{C}_{17}\text{H}_{10}\text{ClFO}_2$: 300.0353 (M^+), Found: 300.0351.

2-Chloro-1-fluoro-4-(3-hydroxyphenyl)-1-phenoxybut-1-en-3-yne (3m)

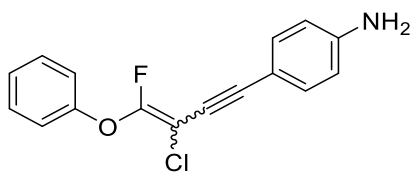


Reaction time was 15.5 h.

The title product (**3m**) was purified by column chromatography and preparative TLC (hexane:AcOEt = 3:1). **3m** was obtained in 38% yield (55.0 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 4.78 (br s) and 4.84 (br s) (1H), 6.77-6.89 (2H, m), 6.91-6.99 (1H, m), 7.06-7.25 (4H, m), 7.35-7.44 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 79.8 (d, $J = 7.5$ Hz), 80.2 (d, $J = 3.2$ Hz), 85.3 (d, $J = 35.9$ Hz), 85.8 (d, $J = 42.1$ Hz), 96.30 (d, $J = 67.6$ Hz), 96.31 (d, $J = 82.5$ Hz), 116.6, 116.7, 117.1, 117.2, 118.17, 118.21, 123.1, 123.2, 124.4, 124.5, 125.29, 125.32, 129.8, 129.9, 130.11, 130.12, 153.7 (d, $J = 2.3$ Hz), 154.3 (d, $J = 2.7$ Hz), 155.3, 155.4, 157.4 (d, $J = 292.1$ Hz), 157.7 (d, $J = 291.1$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -74.4 (s) and -78.6 (s) (1F, 1:1); MS (EI) m/z : 288 (M^+); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_{10}\text{ClFO}_2$: 288.0353 (M^+), Found: 288.0353.

4-(4-Aminophenyl)-2-chloro-1-fluoro-1-phenoxybut-1-en-3-yne (3n)

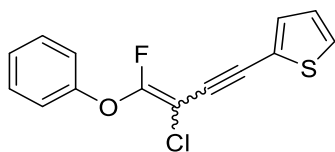


Reaction time was 15.5 h.

The title product (**3n**) was purified by column chromatography and preparative TLC (hexane:AcOEt = 4:1). **3n** was obtained in 87% yield (125.7 mg).

A brown oil; ^1H NMR (400 MHz, CDCl_3) δ : 3.84 (br s) and 3.88 (br s) (2H), 6.56 (1H, d, $J = 8.4$ Hz), 6.63 (1H, d, $J = 7.4$ Hz), 7.11-7.22 (4H, m), 7.31 (1H, d, $J = 8.4$ Hz), 7.35-7.41 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 77.7 (d, $J = 7.6$ Hz), 78.0 (d, $J = 2.5$ Hz), 86.2 (d, $J = 46.3$ Hz), 86.7 (d, $J = 53.9$ Hz), 97.5 (d, $J = 6.4$ Hz), 98.3 (d, $J = 8.2$ Hz), 111.1, 114.6, 114.7, 116.9, 117.1, 125.06, 125.09, 130.0, 130.1, 133.2, 133.3, 147.5, 147.6, 153.9 (d, $J = 2.8$ Hz), 154.5 (d, $J = 2.9$ Hz), 156.8 (d, $J = 290.1$ Hz), 157.0 (d, $J = 289.8$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -76.5 (s) and -80.3 (s) (1F, 1:1.1); MS (EI) m/z : 287 (M^+); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_{11}\text{ClFNO}$: 287.0513 (M^+), Found: 287.0513.

2-Chloro-1-fluoro-1-phenoxy-4-(thiophene-2-yl)-but-1-en-3-yne (3o)

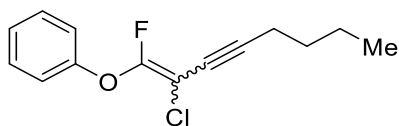


Multihalogenated vinyl ether (2.0 equiv) and 2-ethynylthiophene (1.0 equiv) was used. Reaction time was 15 h.

The title product (**3o**) was purified by column chromatography (hexane:AcOEt = 19:1) and preparative TLC (hexane only). **3o** was obtained in 37% yield (51.9 mg).

An orange oil; ^1H NMR (400 MHz, CDCl_3) δ : 6.94-7.05 (1H, m), 7.10-7.25 (3H, m), 7.28-7.45 (4H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 83.1 (d, $J = 7.2$ Hz), 83.6 (d, $J = 3.4$ Hz), 85.1 (d, $J = 45.4$ Hz), 85.8, 89.6 (d, $J = 6.4$ Hz), 90.3 (d, $J = 8.1$ Hz), 117.2, 117.3, 121.8, 122.0, 125.4, 127.3, 127.4, 128.8 (d, $J = 13.3$ Hz), 129.1, 130.09, 130.12, 133.3 (d, $J = 6.7$ Hz), 153.6 (d, $J = 1.7$ Hz), 154.2 (d, $J = 2.2$ Hz), 157.3 (d, $J = 292.5$ Hz), 157.6 (d, $J = 292.5$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -73.8 (s) and -77.8 (s) (1F, 1:1); MS (EI) m/z : 278 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_8\text{ClFOS}$: 277.9968 (M^+), Found: 277.9968.

2-Chloro-1-fluoro-1-phenoxy-oct-1-en-3-yne (3p)

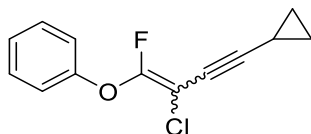


Reaction time was 15 h at 50 °C.

The title product (**3p**) was purified by column chromatography (hexane only). **3p** was obtained in 89% yield (112.0 mg).

An colorless oil; ^1H NMR (400 MHz, CDCl_3) δ : 0.85 (t, $J = 7.3$ Hz) and 0.94 (t, $J = 7.3$ Hz) (3H), 1.32 (tq, $J = 7.3$, 7.3 Hz) and 1.45 (tq, $J = 7.3$, 7.3 Hz) (2H), 1.44 (tt, $J = 7.3$, 7.3 Hz) and 1.58 (tt, $J = 7.3$, 7.3 Hz) (2H), 2.31 (td, $J = 6.9$, 1.5 Hz) and 2.43 (td, $J = 6.9$, 1.5 Hz) (2H), 7.10 (2H, d, $J = 7.9$ Hz), 7.18 (1H, t, $J = 7.4$ Hz), 7.37 (1H, t, $J = 7.9$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 13.66, 13.73, 19.4, 19.5, 21.9, 22.1, 30.3, 30.4, 71.3 (d, $J = 7.0$ Hz), 71.6 (d, $J = 2.3$ Hz), 86.2 (d, $J = 47.6$ Hz), 86.6 (d, $J = 54.3$ Hz), 98.7 (d, $J = 6.2$ Hz), 99.6 (d, $J = 9.0$ Hz), 116.9, 124.97, 125.05, 129.98, 130.05, 153.9 (d, $J = 2.4$ Hz), 154.5 (d, $J = 2.9$ Hz), 157.0 (d, $J = 289.3$ Hz), 157.2 (d, $J = 288.8$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -77.4 (s) and -82.0 (s) (1F, 1:1.1); MS (EI) m/z : 252 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_{14}\text{ClFO}$: 252.0717 (M^+), Found: 252.0715.

2-Chloro-4-cyclopropyl-1-fluoro-1-phenoxy-but-1-en-3-yne (3q)

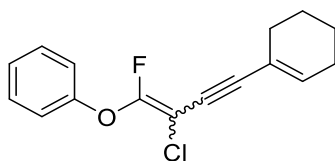


Reaction time was 14.5 h.

The title product (**3q**) was purified by column chromatography (hexane only). **3q** was obtained in 86% yield (102.3 mg).

A pale yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 0.61-1.00 (4H, m), 1.22-1.52 (1H, m), 7.05-7.12 (2H, m), 7.15-7.21 (1H, m), 7.32-7.41 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 0.39, 0.48, 9.04, 9.11, 66.3 (d, $J = 6.9$ Hz), 66.6 (d, $J = 2.9$ Hz), 86.1 (d, $J = 45.9$ Hz), 86.7 (d, $J = 53.8$ Hz), 101.8 (d, $J = 6.3$ Hz), 102.6 (d, $J = 8.3$ Hz), 116.9, 117.0, 125.0, 125.1, 129.98, 130.05, 153.9 (d, $J = 2.9$ Hz), 154.5 (d, $J = 3.1$ Hz), 157.3 (d, $J = 290.2$ Hz), 157.6 (d, $J = 289.2$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -76.7 (s) and -81.7 (s) (1F, 1:1.4); MS (EI) m/z : 236 (M^+); HRMS (EI) Calcd. for $\text{C}_{13}\text{H}_{10}\text{ClFO}$: 236.0404 (M^+), Found: 236.0404.

2-Chloro-4-(cyclohex-1-ene-1-yl)-1-fluoro-1-phenoxy-but-1-en-3-yne (3r)

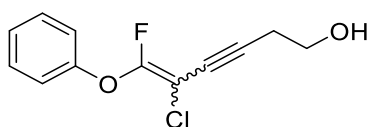


Reaction time was 15 h.

The title product (**3r**) was purified by column chromatography and preparative TLC (hexane only). **3r** was obtained in 52% yield (72.6 mg).

A yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 1.50-1.72 (4H, m), 2.00-2.23 (4H, m), 6.07-6.13 (m) and 6.22-6.28 (m) (1s), 7.07-7.14 (2H, m), 7.18 (1H, t, $J = 7.4$ Hz), 7.37 (1H, t, $J = 7.8$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : 21.4, 21.5, 22.2, 22.3, 25.8, 25.9, 28.6, 28.8, 86.0 (d, $J = 47.0$ Hz), 86.4 (d, $J = 54.1$ Hz), 98.5 (d, $J = 6.3$ Hz), 99.2 (d, $J = 8.4$ Hz), 116.9, 117.1, 119.9, 120.0, 125.06, 125.11, 130.0, 130.1, 137.2, 137.4, 138.3, 153.9 (d, $J = 2.8$ Hz), 154.5 (d, $J = 2.9$ Hz), 156.7 (d, $J = 291.3$ Hz), 157.1 (d, $J = 290.3$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -76.3 (s) and -80.3 (s) (1F, 1:1); MS (EI) m/z : 276 (M^+); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_{14}\text{ClFO}$: 276.0717 (M^+), Found: 276.0717.

5-Chloro-6-fluoro-6-phenoxy-hex-5-en-3-yn-1-ol (3s)

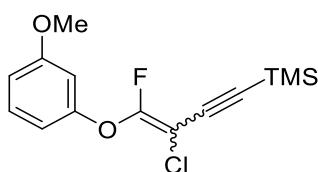


Reaction time was 13.5 h.

The title product (**3s**) was purified by column chromatography (hexane:AcOEt = 7:3). **3s** was obtained in 53% yield (65.3 mg).

An orange oil; ^1H NMR (400 MHz, CDCl_3) δ : 1.64 (br s) and 1.82 (br s) (1H), 2.58 (1H, td, $J = 6.3$, 1.5 Hz), 2.71 (1H, td, $J = 6.3$, 1.5 Hz), 3.66 (1H, t, $J = 6.3$ Hz), 3.81 (1H, t, $J = 6.3$ Hz), 7.07-7.13 (2H, m), 7.16-7.23 (1H, m), 7.33-7.42 (2H, m); ^{13}C NMR (100 MHz, CDCl_3) δ : 24.1, 24.2, 60.7, 60.8, 73.1 (d, $J = 7.1$ Hz), 73.5 (d, $J = 3.1$ Hz), 85.4 (d, $J = 37.2$ Hz), 85.9 (d, $J = 45.4$ Hz), 94.8 (d, $J = 6.2$ Hz), 95.6 (d, $J = 8.4$ Hz), 116.9, 117.0, 125.18, 125.22, 130.1, 153.7 (d, $J = 2.5$ Hz), 154.3 (d, $J = 3.0$ Hz), 157.4 (d, $J = 290.7$ Hz), 157.7 (d, $J = 289.1$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -75.9 (s) and -80.6 (s) (1F, 1:1); MS (EI) m/z : 240 (M^+); HRMS (EI) Calcd. for $\text{C}_{12}\text{H}_{10}\text{ClFO}_2$: 240.0353 (M^+), Found: 240.0350.

(3-Chloro-4-fluoro-4-(3-methoxyphenoxy)but-3-en-1-yn-1-yl)trimethylsilane (3t)



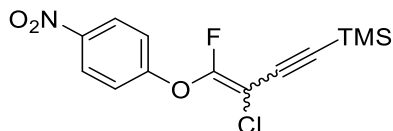
Reaction time was 12.5 h.

The title product (**3t**) was purified by column chromatography (pentane only). **3t** was obtained in 35% yield (51.6 mg).

A pale yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 0.14 (s) and 0.24 (s) (9H), 3.81 (3H, s), 6.62-6.72 (2H, m), 6.74 (1H, dd, $J = 8.5$, 2.3 Hz), 7.25 (d, $J = 8.2$ Hz) and 7.27 (d, $J = 8.3$ Hz) (1H); ^{13}C NMR (100 MHz, CDCl_3) δ : -0.35, -0.25, 55.6, 55.7, 85.4 (d, $J = 44.4$ Hz), 85.8 (d, $J = 52.9$ Hz), 94.3 (d, $J = 7.0$ Hz), 94.7 (d, $J = 2.4$ Hz), 103.44 (d, $J = 6.7$ Hz), 103.48, 103.7, 104.1 (d, $J = 8.0$ Hz), 109.1 (d,

$J = 26.1$ Hz), 110.9 (d, $J = 5.8$ Hz), 130.4, 130.5, 154.6 (d, $J = 2.5$ Hz), 155.3 (d, $J = 2.5$ Hz), 157.9 (d, $J = 292.8$ Hz), 158.6 (d, $J = 291.1$ Hz), 161.0, 161.1; ^{19}F NMR (376 MHz, CDCl_3) δ : -73.4 (s) and -78.3 (s) (1F, 1:1.1); MS (EI) m/z : 298 (M^+); HRMS (EI) Calcd. for $\text{C}_{14}\text{H}_{16}\text{ClFO}_2\text{Si}$: 298.0592 (M^+), Found: 298.0593.

(3-Chloro-4-fluoro-4-(4-nitrophenoxy)but-3-en-1-yn-1-yl)trimethylsilane (3u)

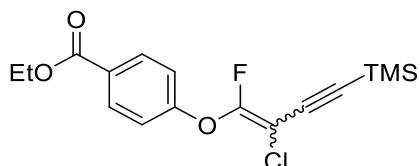


5a (1.3 equiv) was used. Reaction time was 22 h.

The title product (**3u**) was purified by column chromatography (pentane only). **3u** was obtained in 29% yield (38.0 mg).

A pale yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 0.10 (s) and 0.26 (s) (9H), 7.22 (dd, $J = 9.4$, 1.0 Hz) and 7.23 (dd, $J = 9.4$, 1.0 Hz) (2H), 8.29 (d, $J = 9.4$ Hz) and 8.30 (d, $J = 9.4$ Hz) (2H); ^{13}C NMR (100 MHz, CDCl_3) δ : -0.50, -0.36, 87.3 (d, $J = 43.2$ Hz), 87.9 (d, $J = 51.3$ Hz), 93.2 (d, $J = 7.0$ Hz), 93.7 (d, $J = 1.9$ Hz), 105.1 (d, $J = 5.5$ Hz), 105.7 (d, $J = 8.2$ Hz), 117.1, 117.2, 126.1, 126.2, 144.77, 144.84, 156.9 (d, $J = 293.0$ Hz), 157.3 (d, $J = 291.5$ Hz), 158.0 (d, $J = 3.8$ Hz), 158.6 (d, $J = 3.8$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -75.4 (s) and -79.9 (s) (1F, 1:1.2); MS (EI) m/z : 313 (M^+); HRMS (EI) Calcd. for $\text{C}_{13}\text{H}_{13}\text{ClFNO}_3\text{Si}$: 313.1337 (M^+), Found: 313.0334.

(3-Chloro-4-(4-ethoxycarbonylphenoxy)-4-fluorobut-3-en-1-yn-1-yl)trimethylsilane (3v)

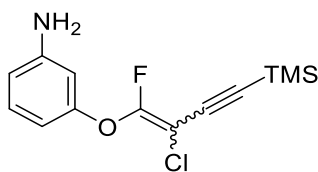


Reaction time was 20.5 h.

The title product (**3v**) was purified by column chromatography and preparative TLC (hexane:AcOEt = 14:1). **3v** was obtained in 35% yield (46.8 mg).

A pale yellow oil; ^1H NMR (400 MHz, CDCl_3) δ : 0.11 (s) and 0.25 (s) (9H), 1.40 (3H, t, $J = 7.1$ Hz), 4.379 (q, $J = 7.1$ Hz) and 4.381 (q, $J = 7.1$ Hz) (2H), 7.13 (dd, $J = 9.0$, 1.0 Hz) and 7.14 (dd, $J = 8.7$, 0.9 Hz) (2H), 8.076 (dd, $J = 9.0$, 1.0 Hz) and 8.078 (dd, $J = 8.7$, 0.9 Hz) (2H); ^{13}C NMR (100 MHz, CDCl_3) δ : -0.43, -0.30, 14.5, 61.3, 86.4 (d, $J = 44.9$ Hz), 86.9 (d, $J = 52.8$ Hz), 93.8 (d, $J = 7.1$ Hz), 94.2 (d, $J = 2.3$ Hz), 104.2 (d, $J = 5.3$ Hz), 104.8 (d, $J = 8.4$ Hz), 116.5, 116.6, 127.45, 127.55, 131.9, 132.0, 156.9 (d, $J = 2.9$ Hz), 157.4 (d, $J = 292.9$ Hz), 157.6 (d, $J = 3.8$ Hz), 158.0 (d, $J = 291.6$ Hz), 165.71, 165.74; ^{19}F NMR (376 MHz, CDCl_3) δ : -74.2 (s) and -79.0 (s) (1F, 1:1.6); MS (EI) m/z : 340 (M^+); HRMS (EI) Calcd. for $\text{C}_{16}\text{H}_{18}\text{ClFO}_3\text{Si}$: 340.0698 (M^+), Found: 340.0695.

(4-(3-Aminophenoxy)-3-chloro-4-fluorobut-3-en-1-yn-1-yl)trimethylsilane (3w)



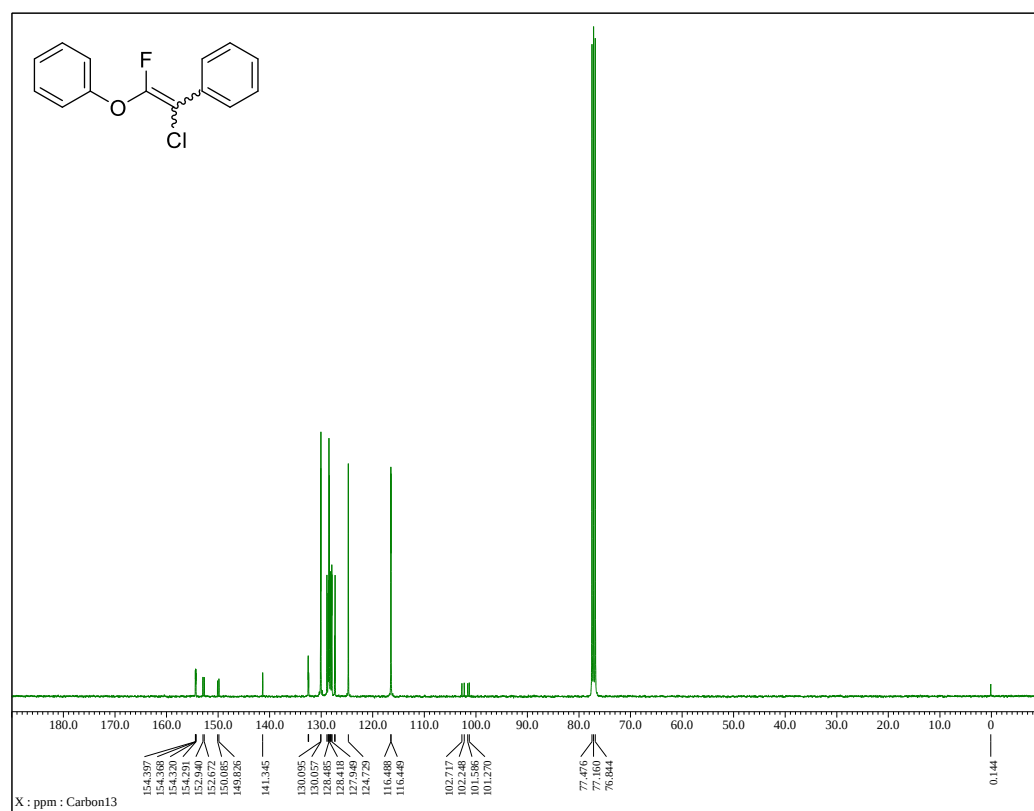
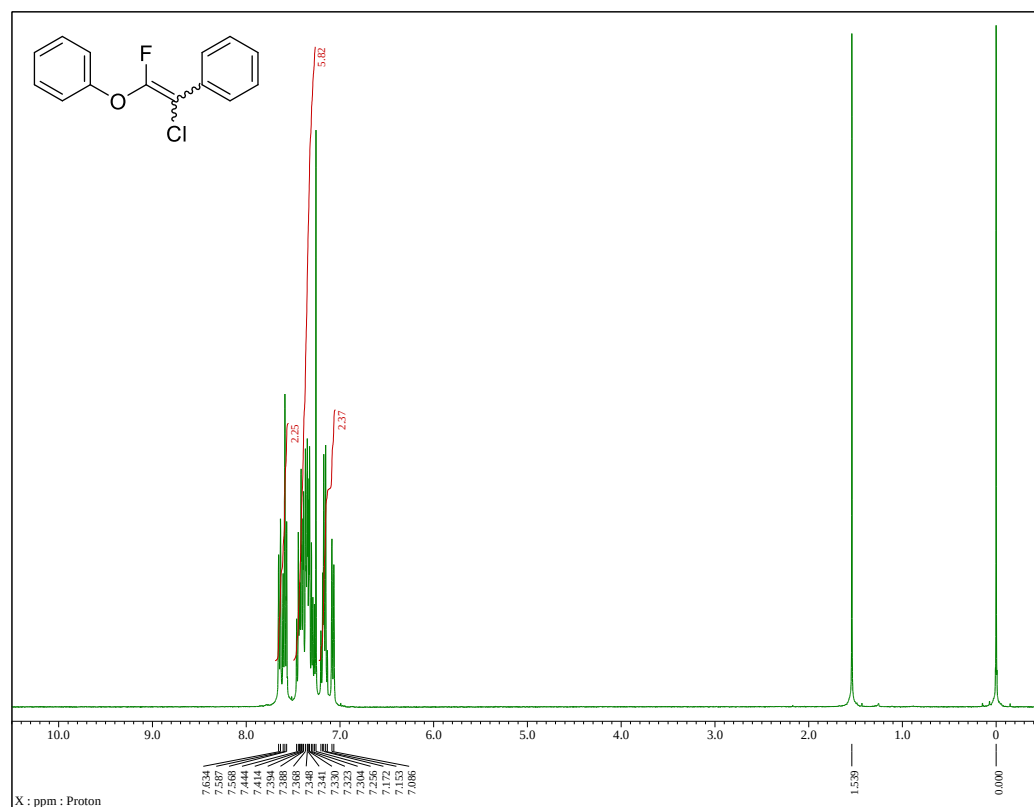
Reaction temperature was rt to 50 °C. Reaction time was 110 h.

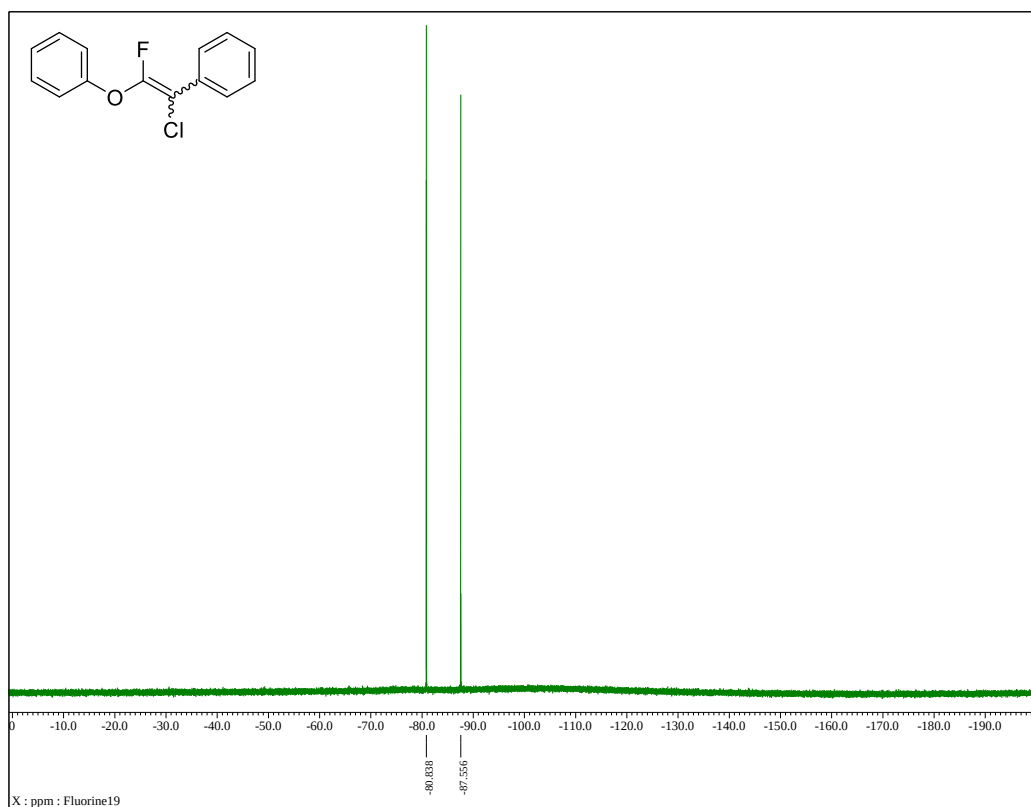
The title product (**3w**) was purified by preparative TLC (hexane:AcOEt = 7:3). **3w** was obtained in 7% yield (9.7 mg).

An orange oil; ^1H NMR (400 MHz, CDCl_3) δ : 0.15 (s) and 0.24 (s) (9H), 3.78 (2H, br s), 6.37-6.43 (1H, m), 6.44-6.52 (2H, m), 7.11 (1H, t, $J = 8.1$ Hz); ^{13}C NMR (100 MHz, CDCl_3) δ : -0.31, -0.23, 85.1 (d, $J = 46.6$ Hz), 85.6 (d, $J = 55.1$ Hz), 94.4 (d, $J = 7.9$ Hz), 94.9 (d, $J = 2.6$ Hz), 103.2 (d, $J = 6.1$ Hz), 103.6, 103.8, 103.9 (d, $J = 8.8$ Hz), 106.7, 107.0, 111.87, 111.92, 130.6, 130.7, 148.2, 148.3, 154.7 (d, $J = 2.9$ Hz), 155.4 (d, $J = 3.0$ Hz), 158.1 (d, $J = 293.2$ Hz), 158.6 (d, $J = 291.1$ Hz); ^{19}F NMR (376 MHz, CDCl_3) δ : -73.0 (s) and -77.8 (s) (1F, 1:1.3); MS (EI) m/z : 283 (M^+); HRMS (EI) Calcd. for $\text{C}_{13}\text{H}_{15}\text{ClFNO}_2\text{Si}$: 283.0595 (M^+), Found: 283.0591.

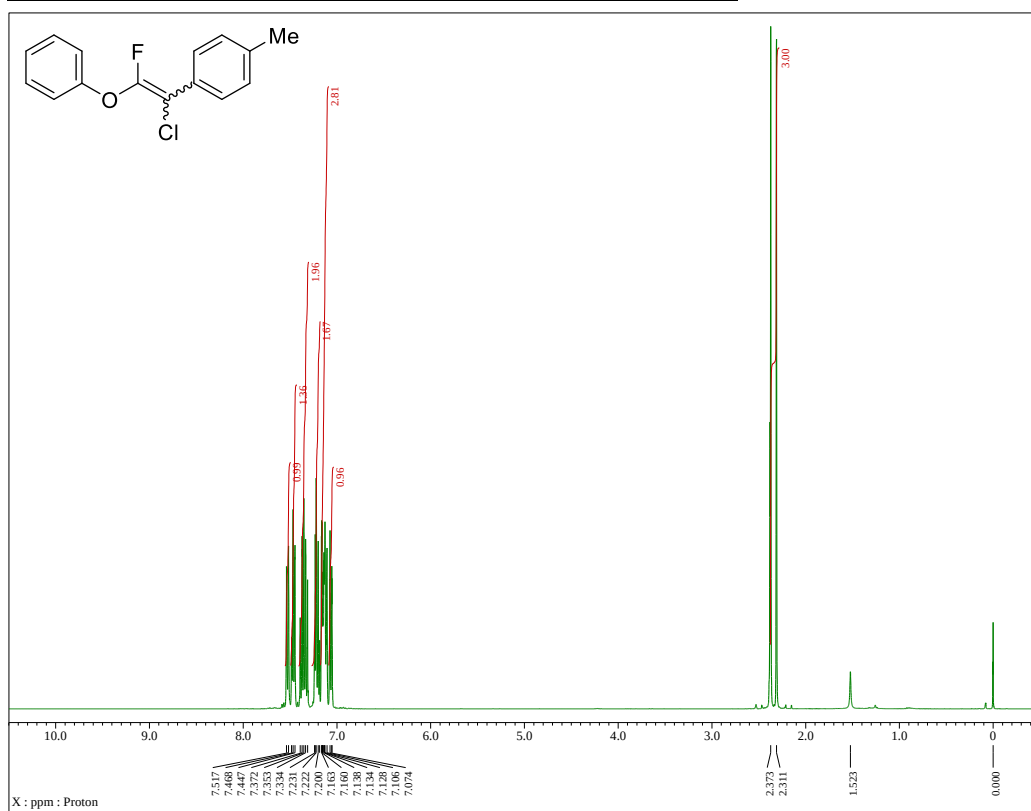
^1H and ^{13}C NMR charts

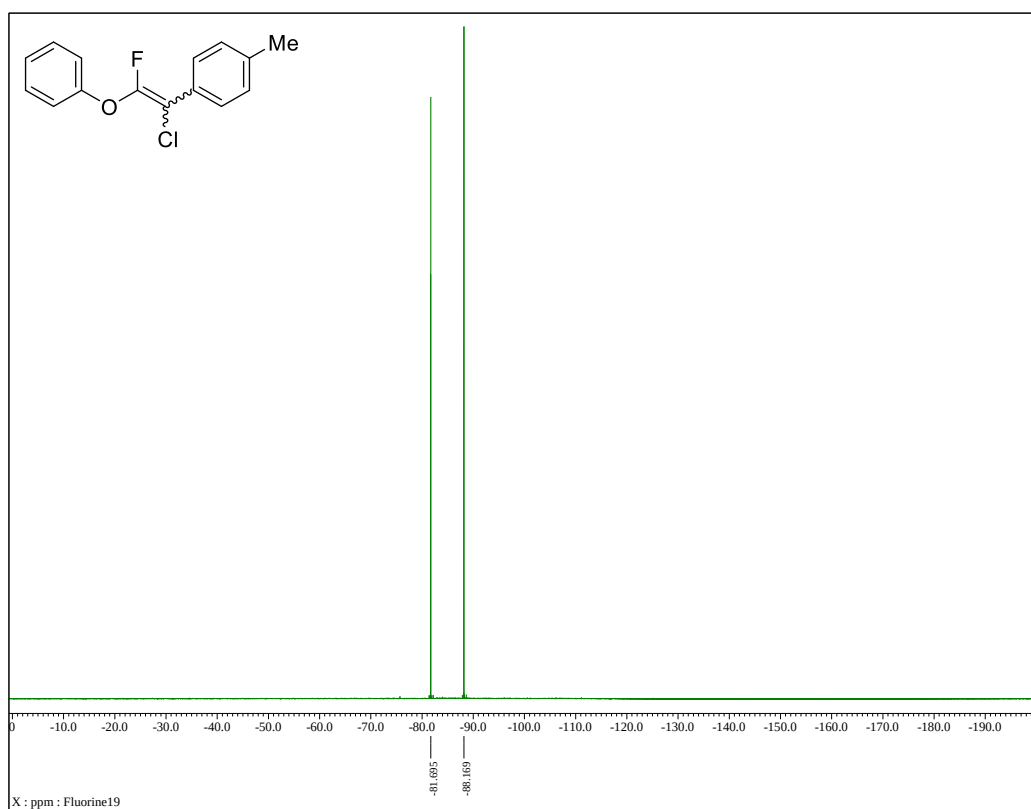
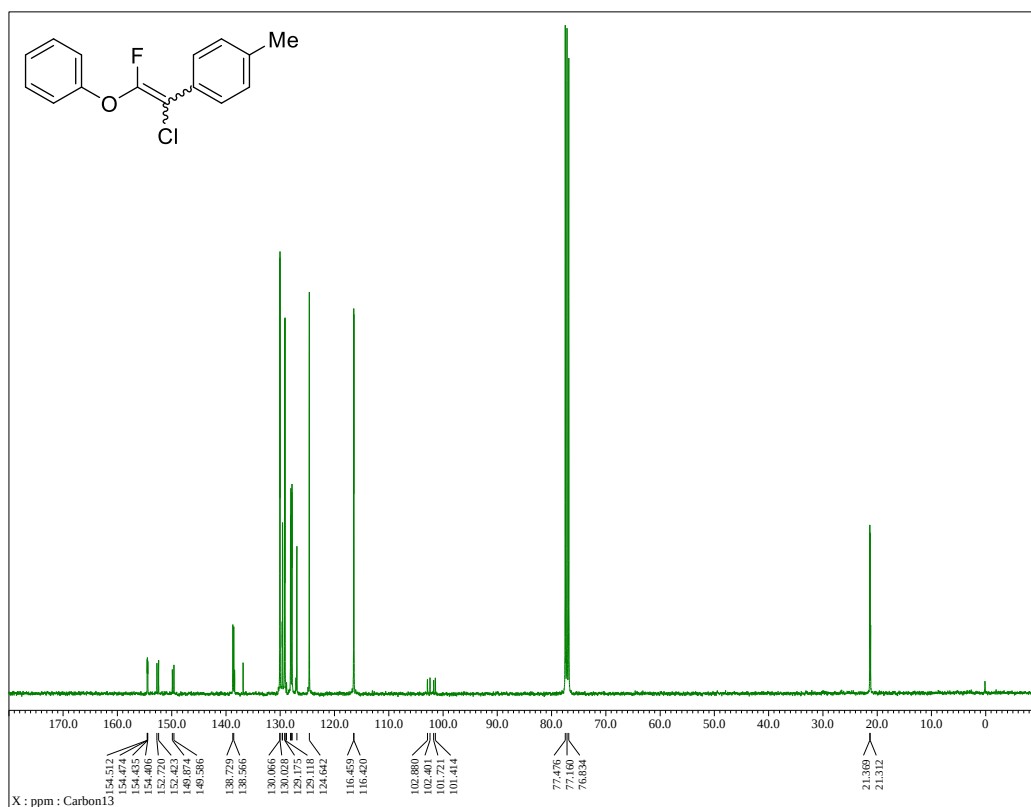
2-Chloro-1-fluoro-2-phenylethenyl phenyl ether (2a)



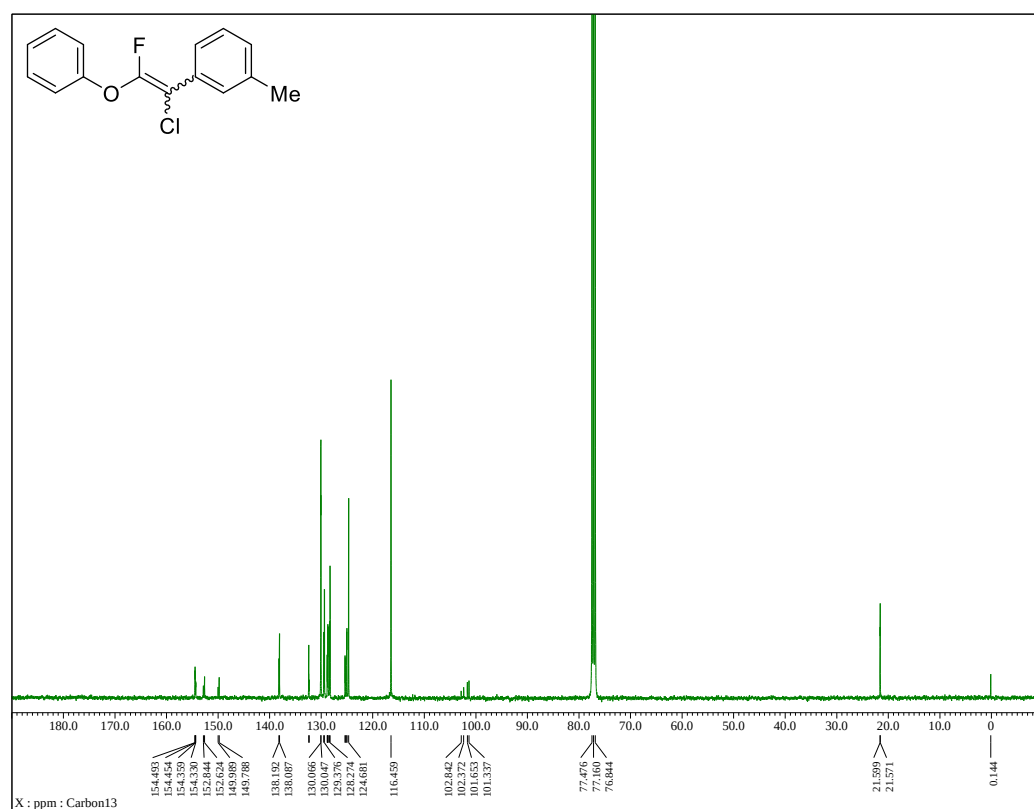
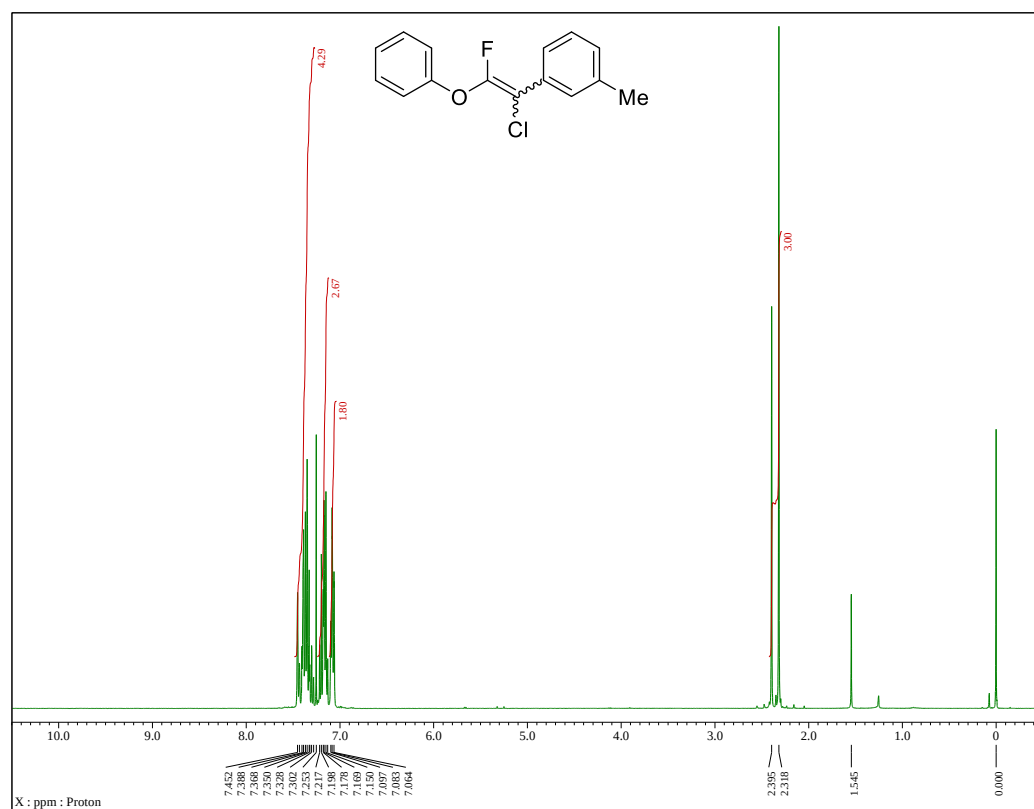


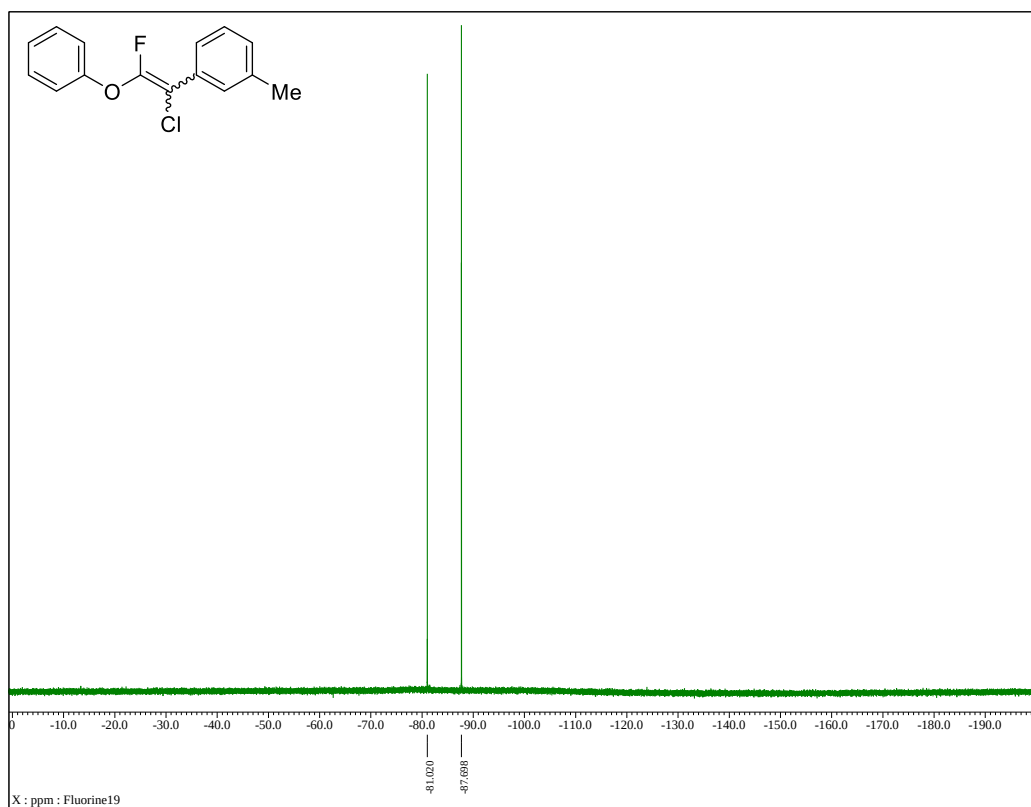
2-Chloro-1-fluoro-2-(4-tolyl)ethenyl phenyl ether (2b)



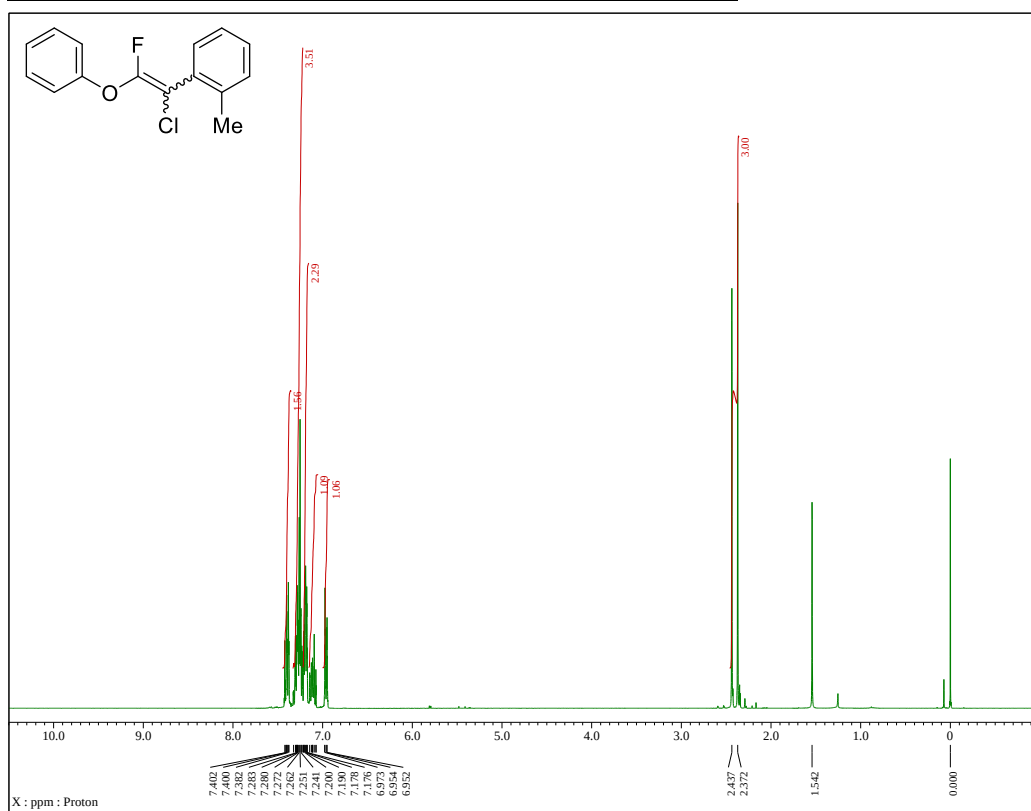


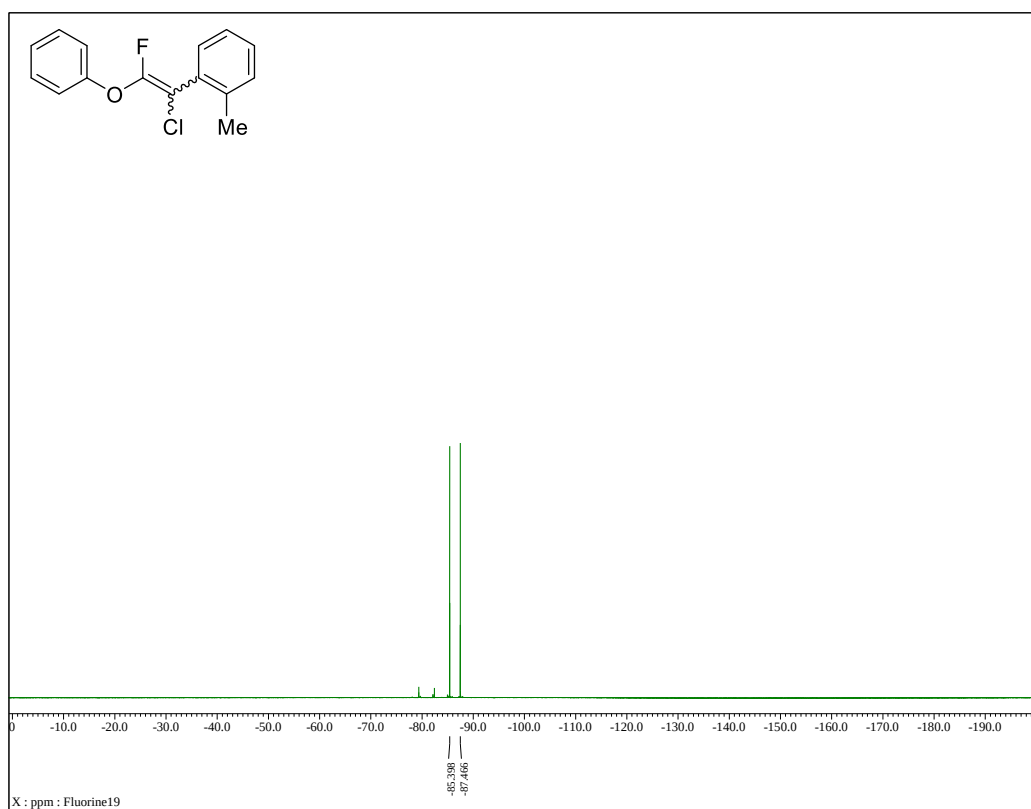
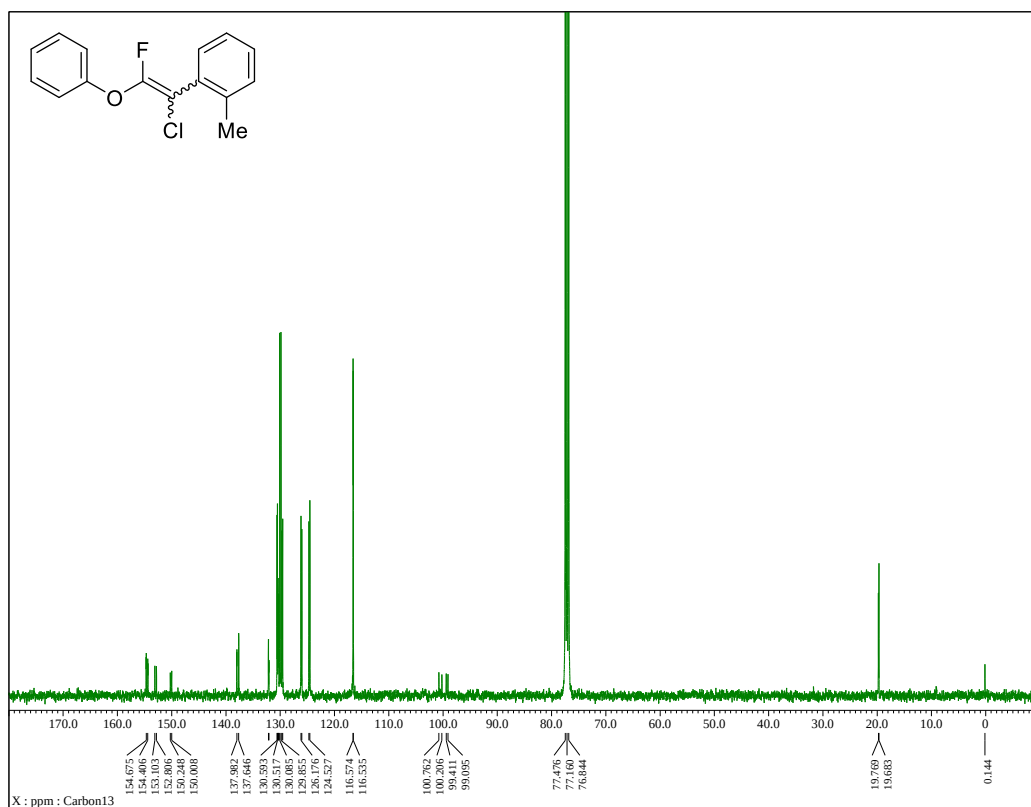
2-Chloro-1-fluoro-2-(3-tolyl)ethenyl phenyl ether (2c)



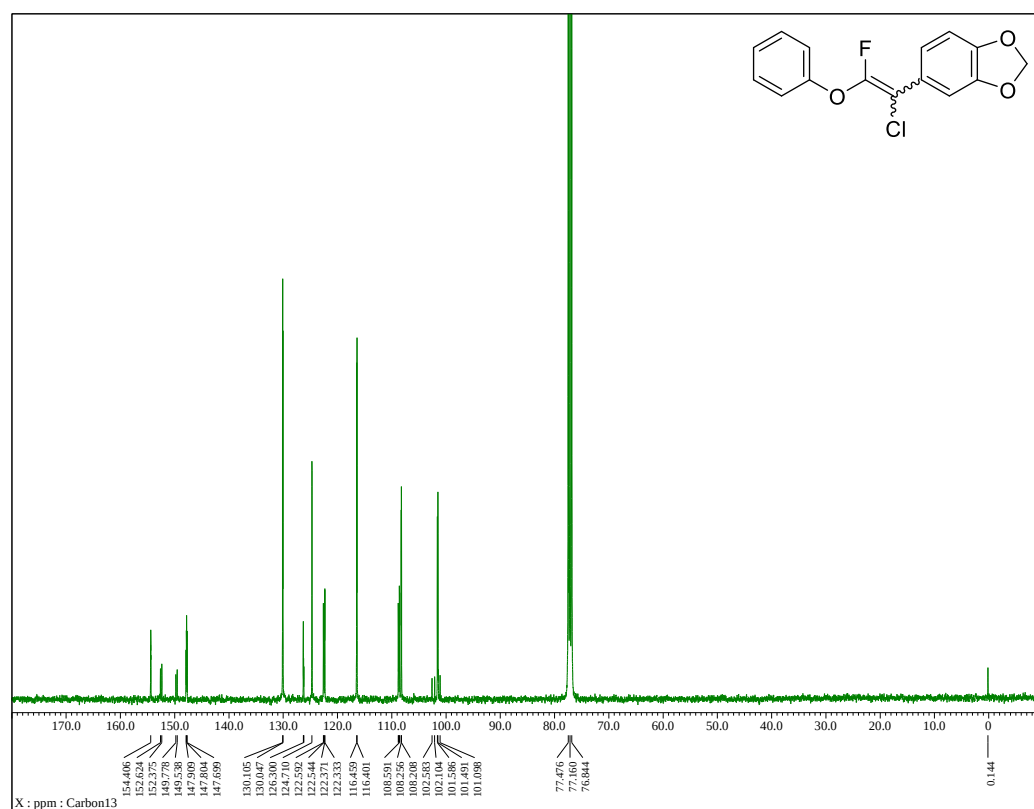
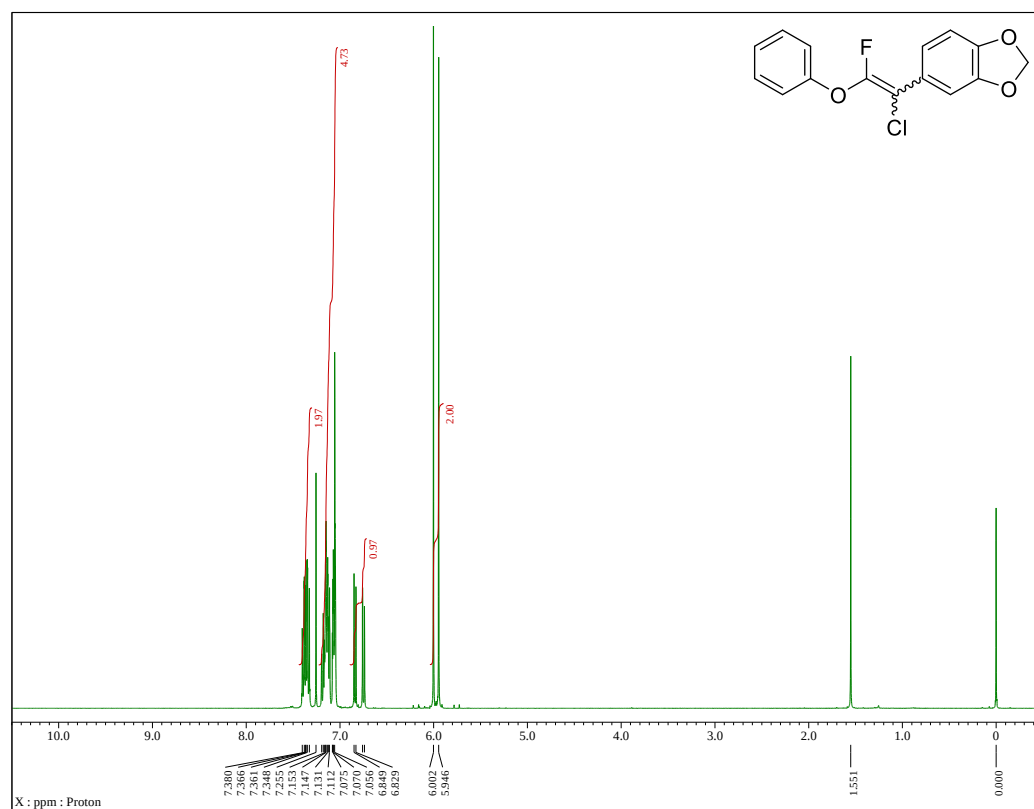


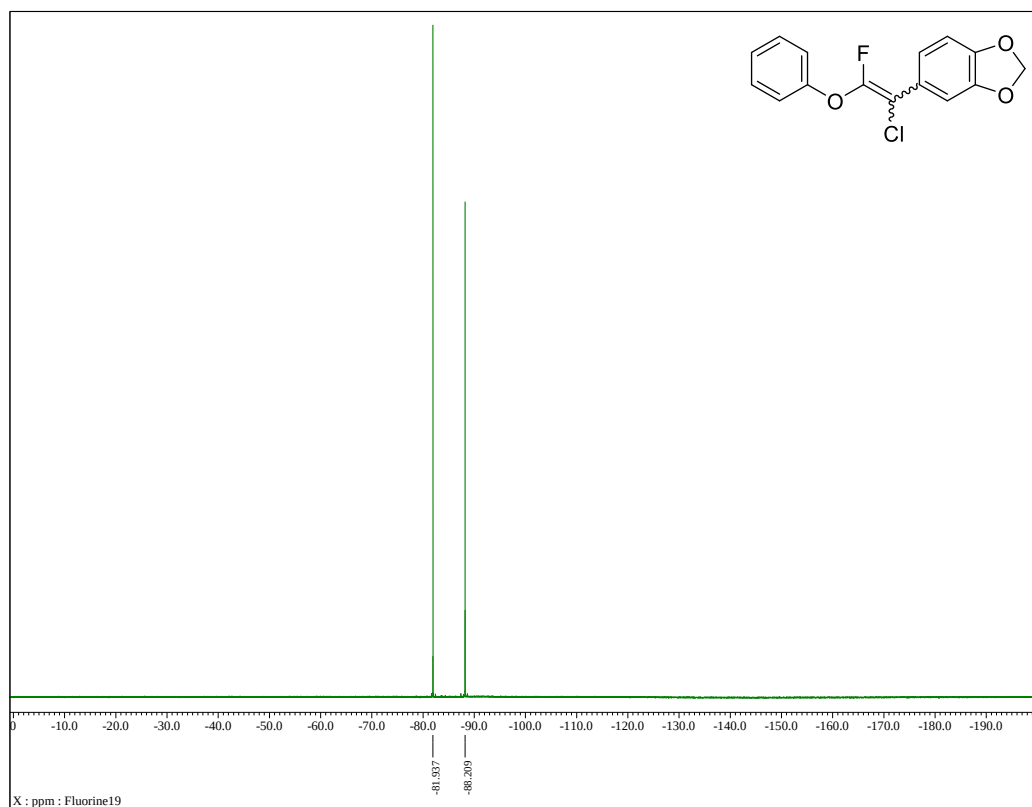
2-Chloro-1-fluoro-2-(2-tolyl)ethenyl phenyl ether (2d)



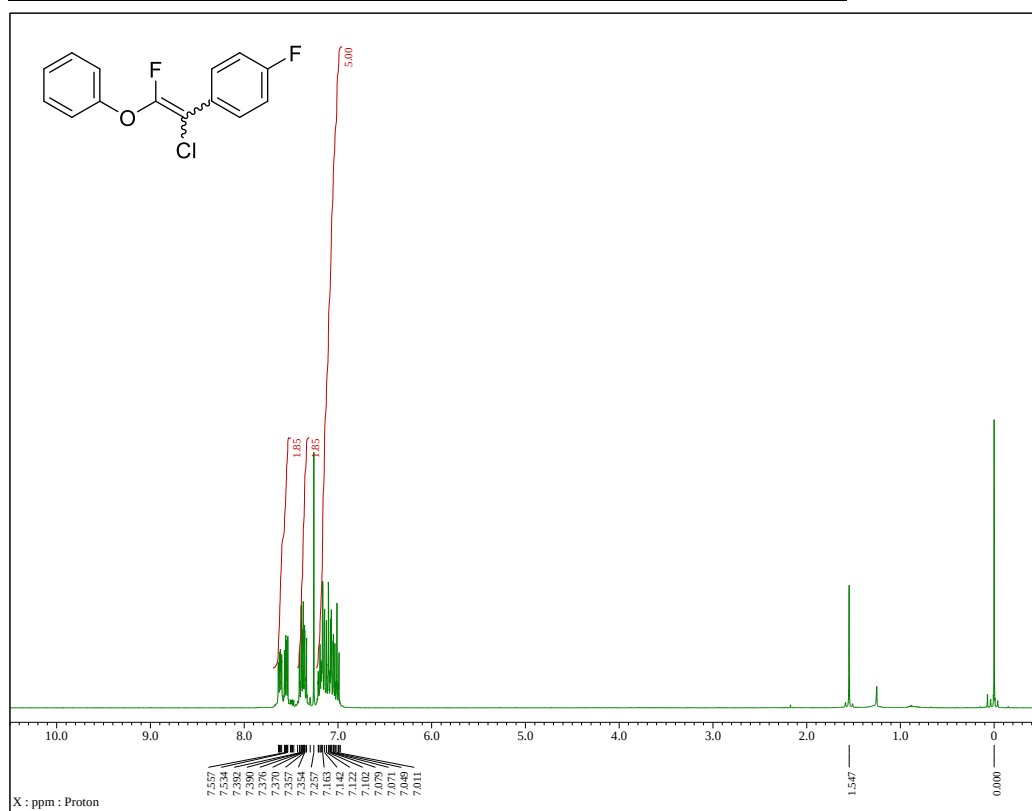


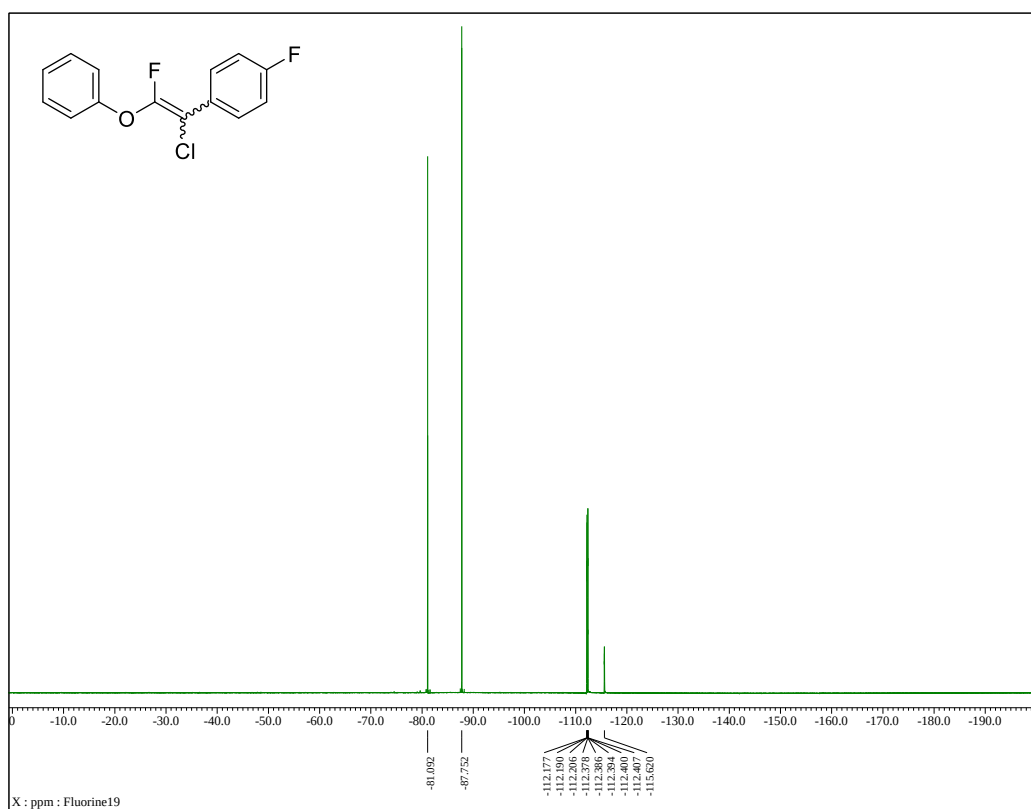
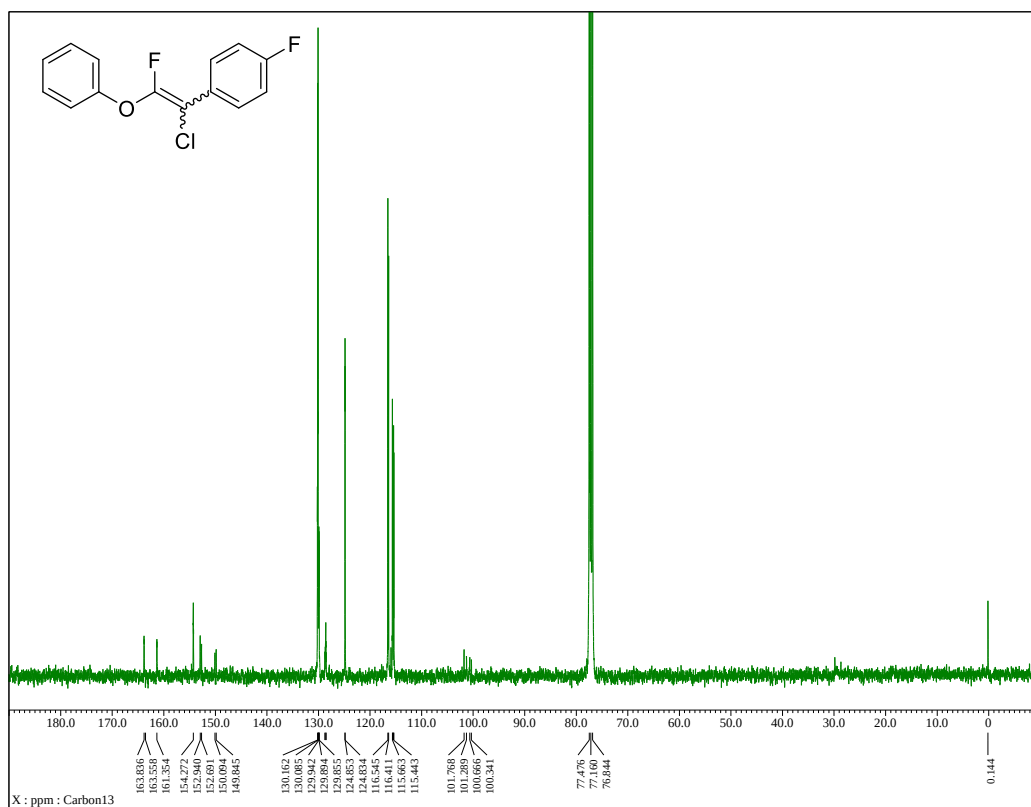
2-Chloro-1-fluoro-2-(3,4-methylenedioxyphenyl)ethenyl phenyl ether (2e)



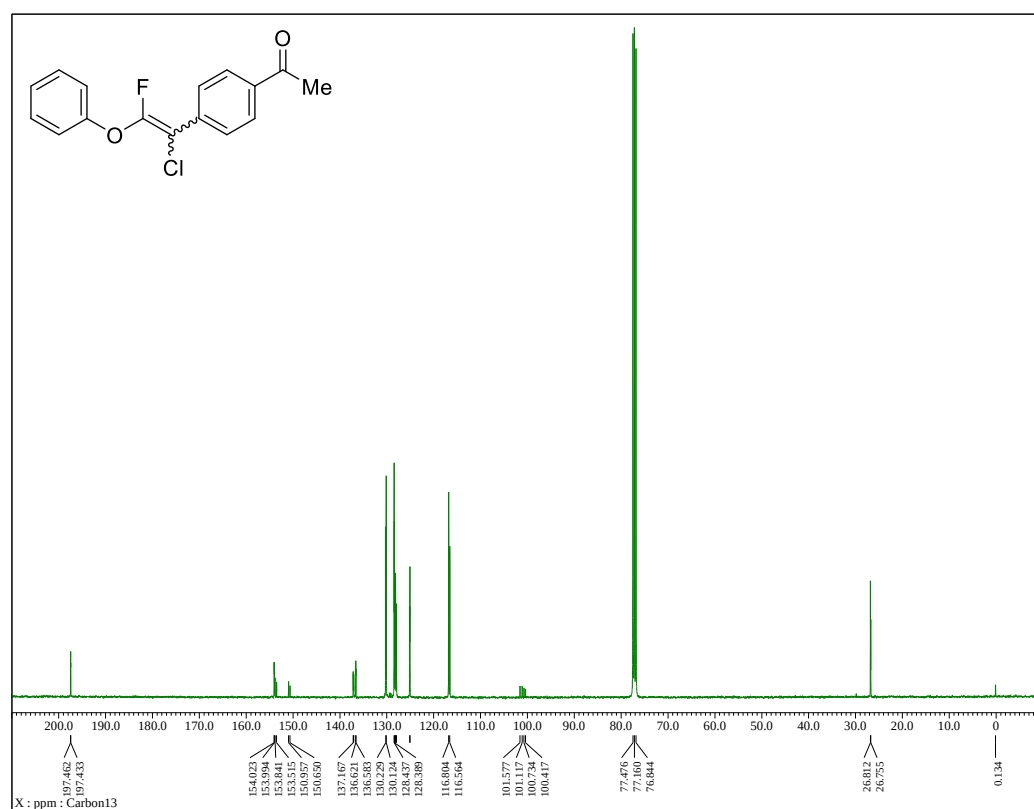
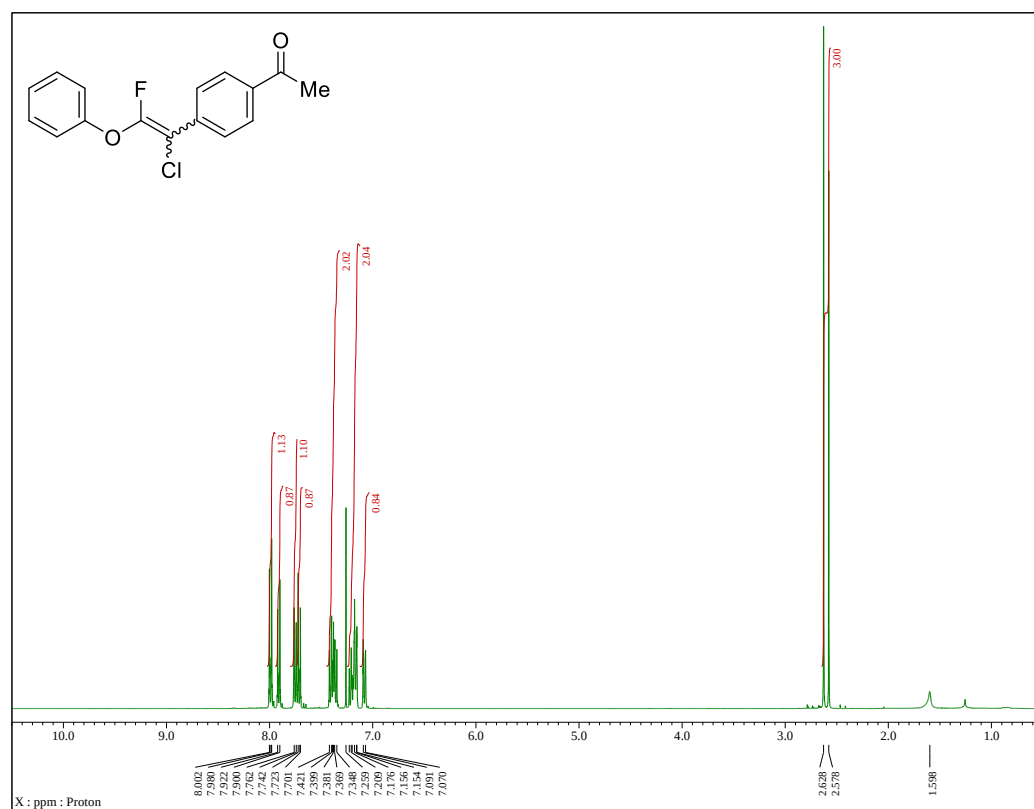


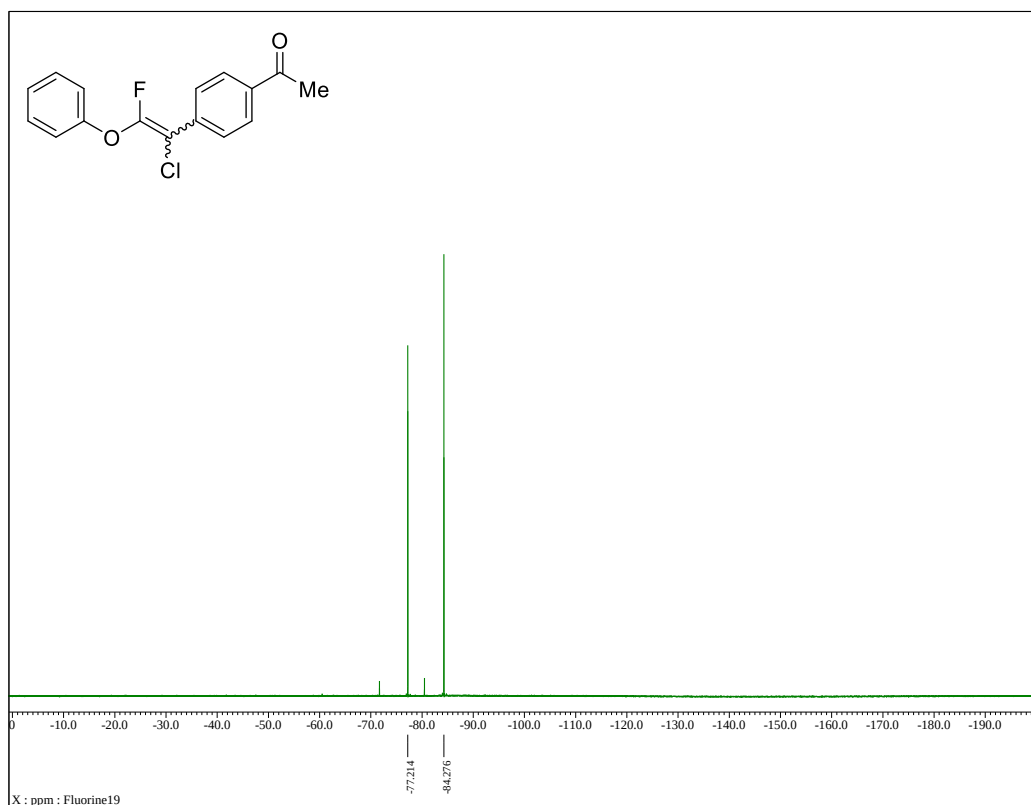
2-Chloro-1-fluoro-2-(4-fluorophenyl)ethenyl phenyl ether (2f)



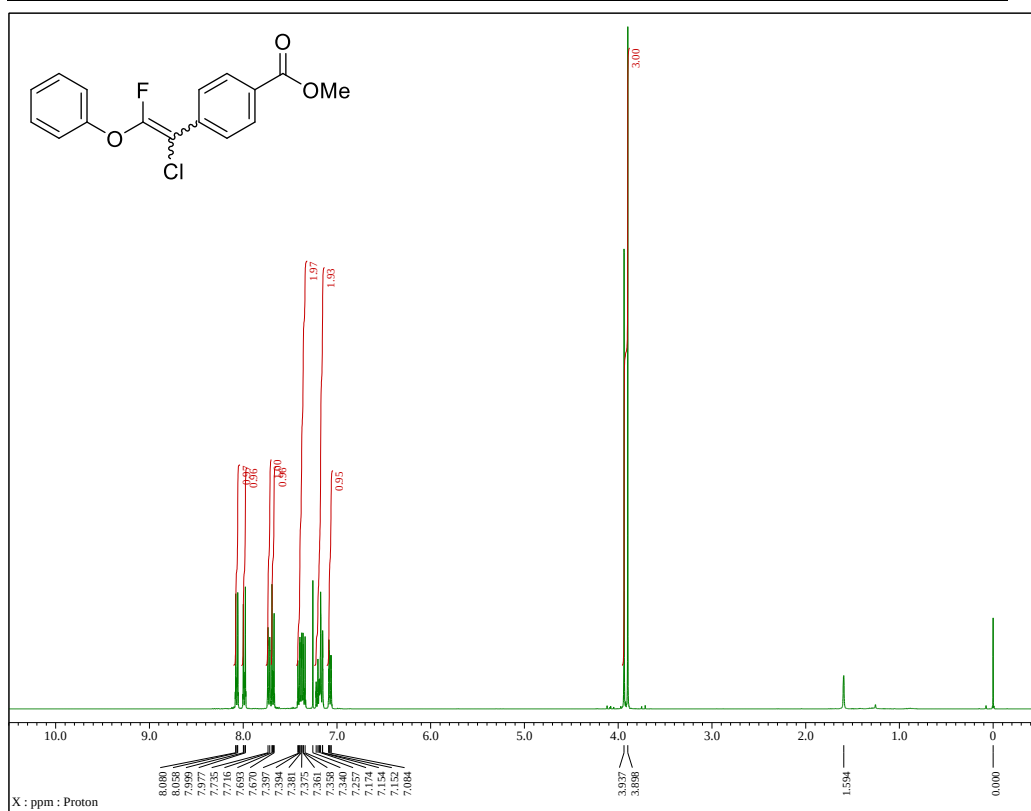


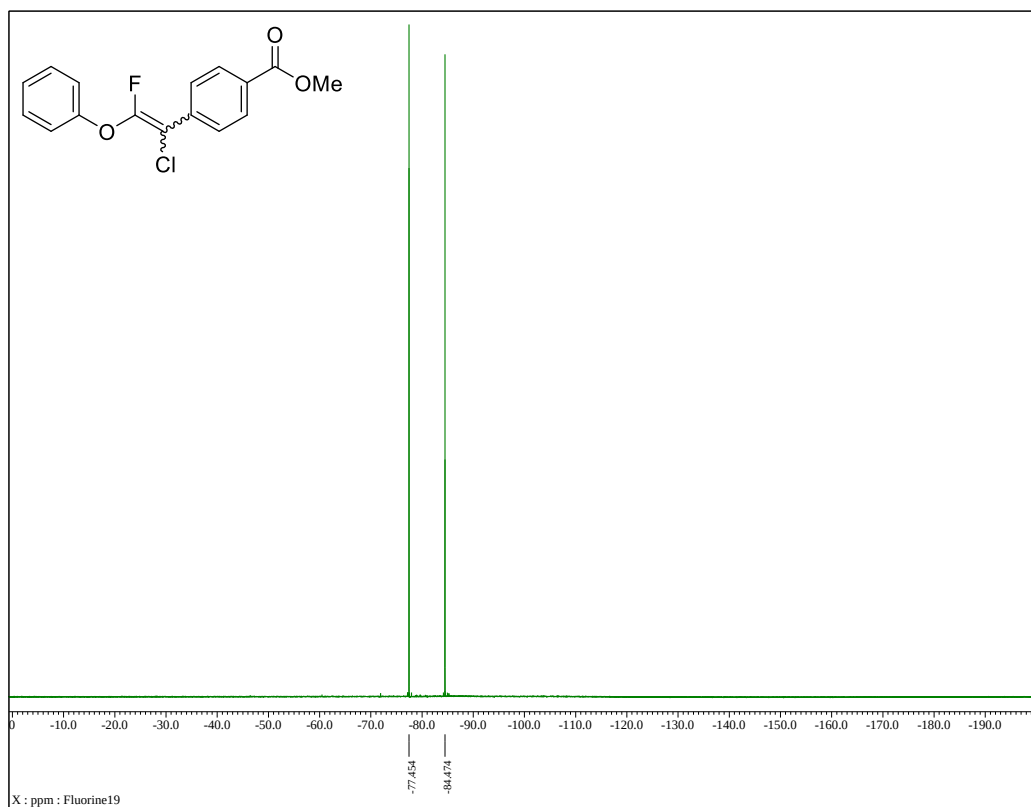
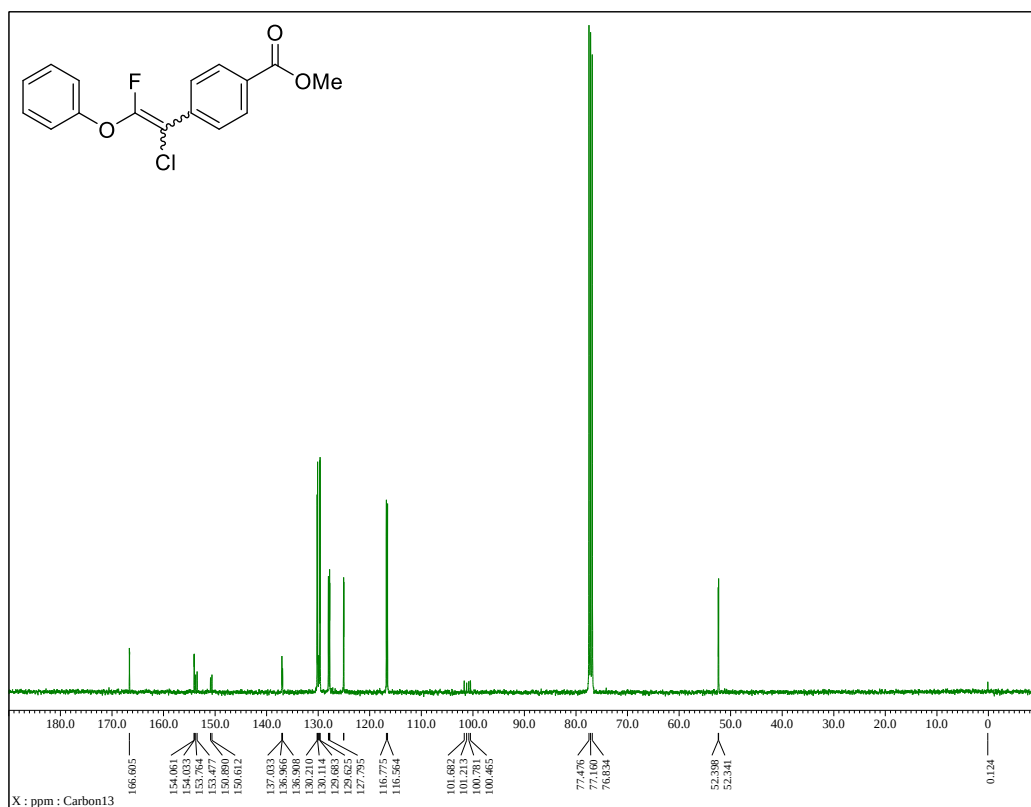
2-(4-Acetylphenyl)-2-chloro-1-fluoroethenyl phenyl ether (2g)



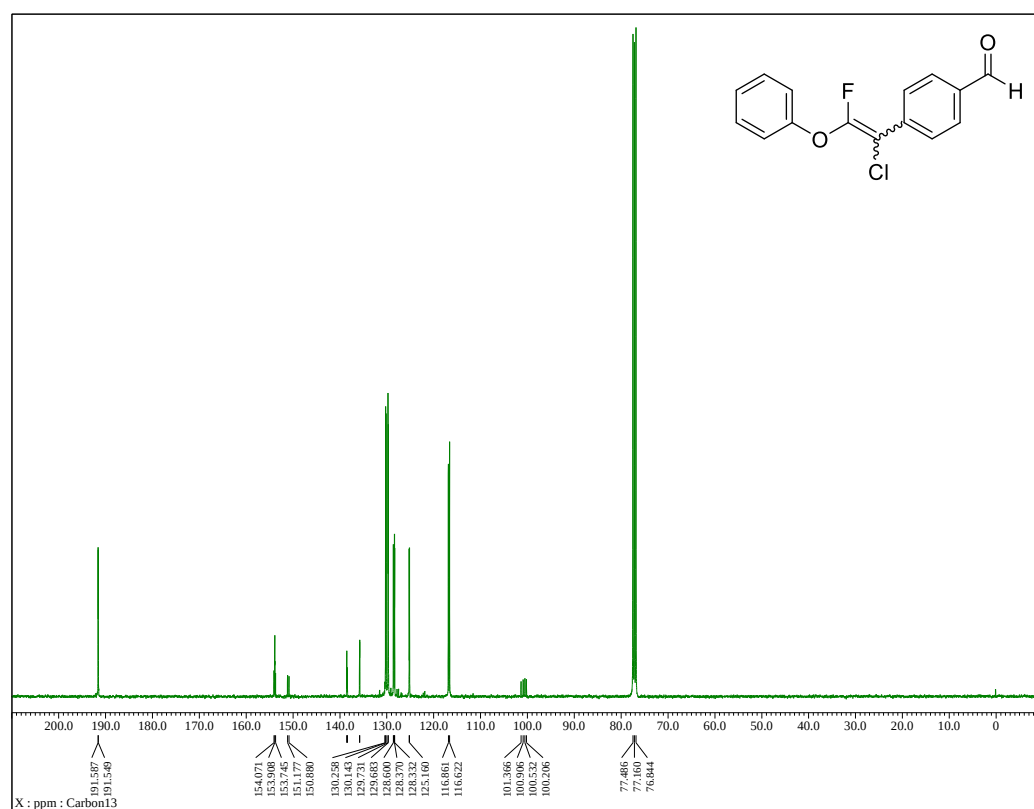
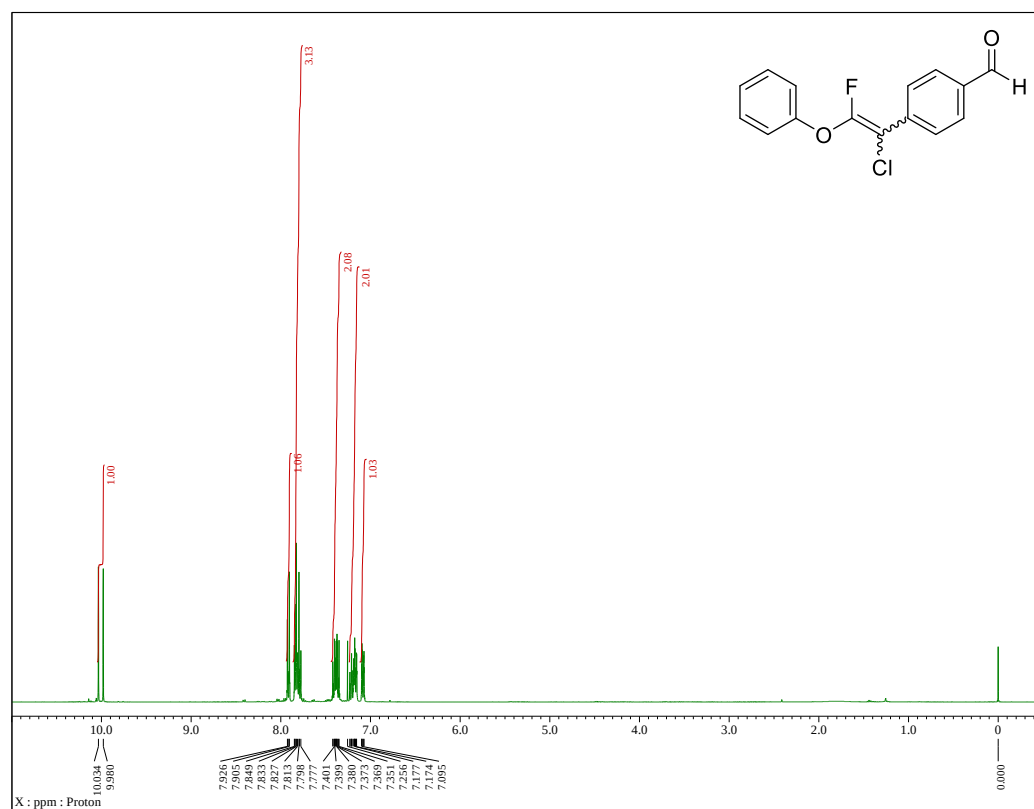


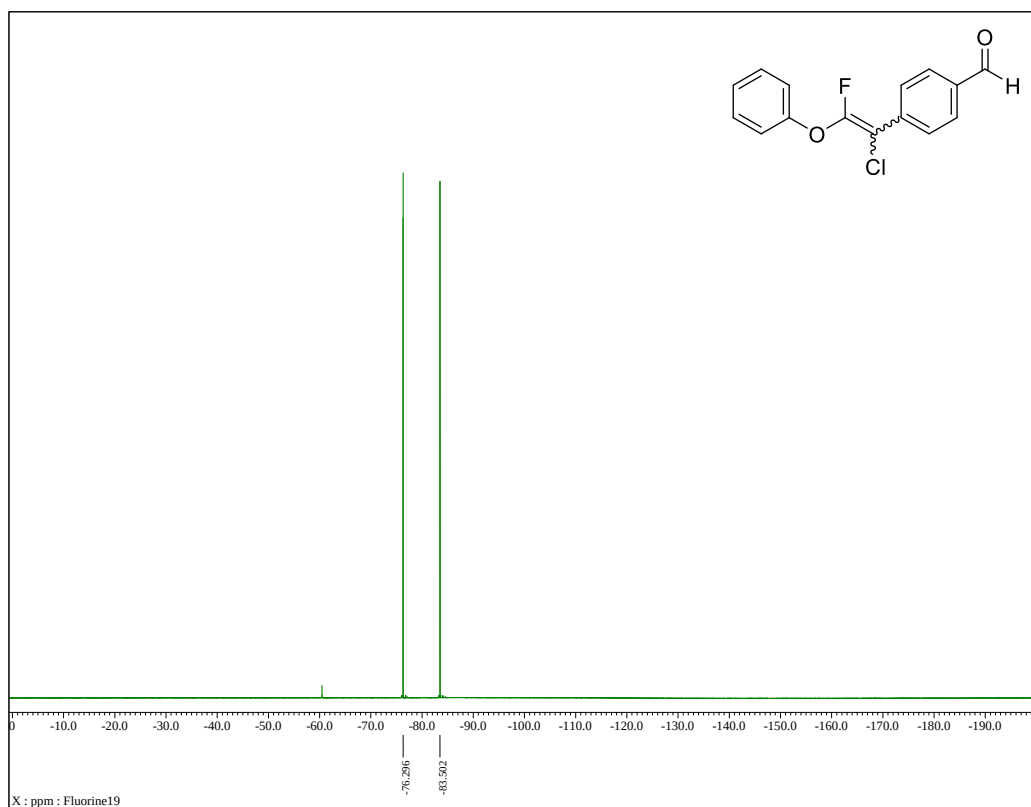
2-Chloro-1-fluoro-2-(4-methoxycarbonylphenyl)ethenyl phenyl ether (2h)



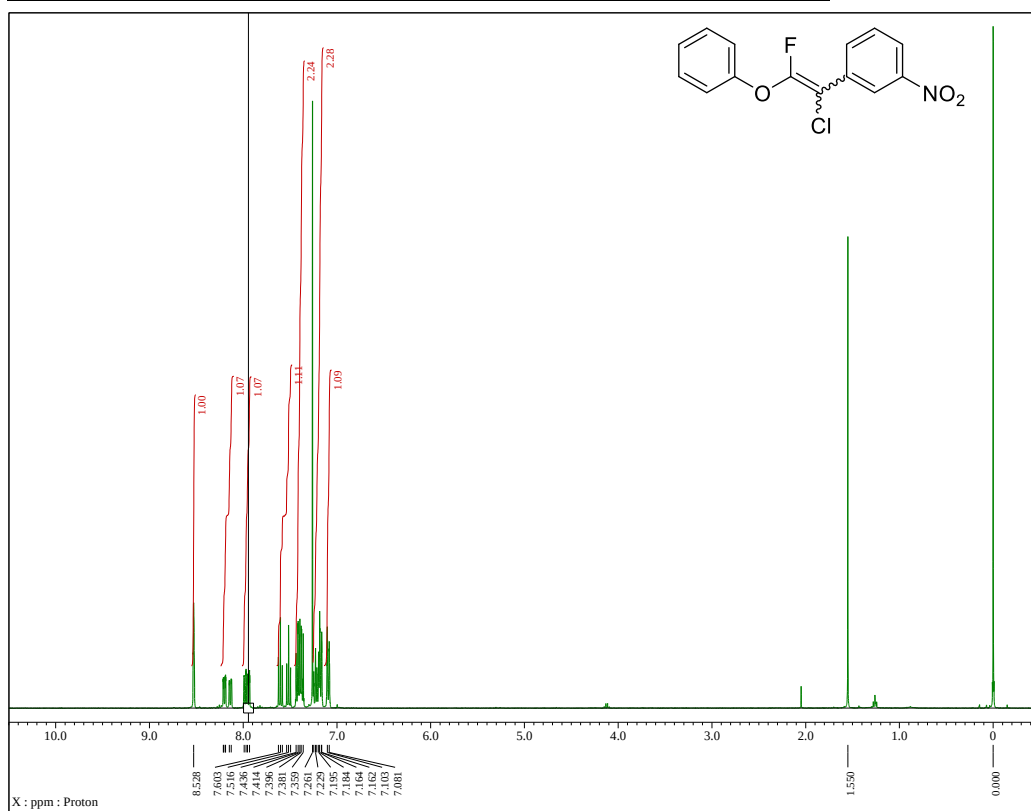


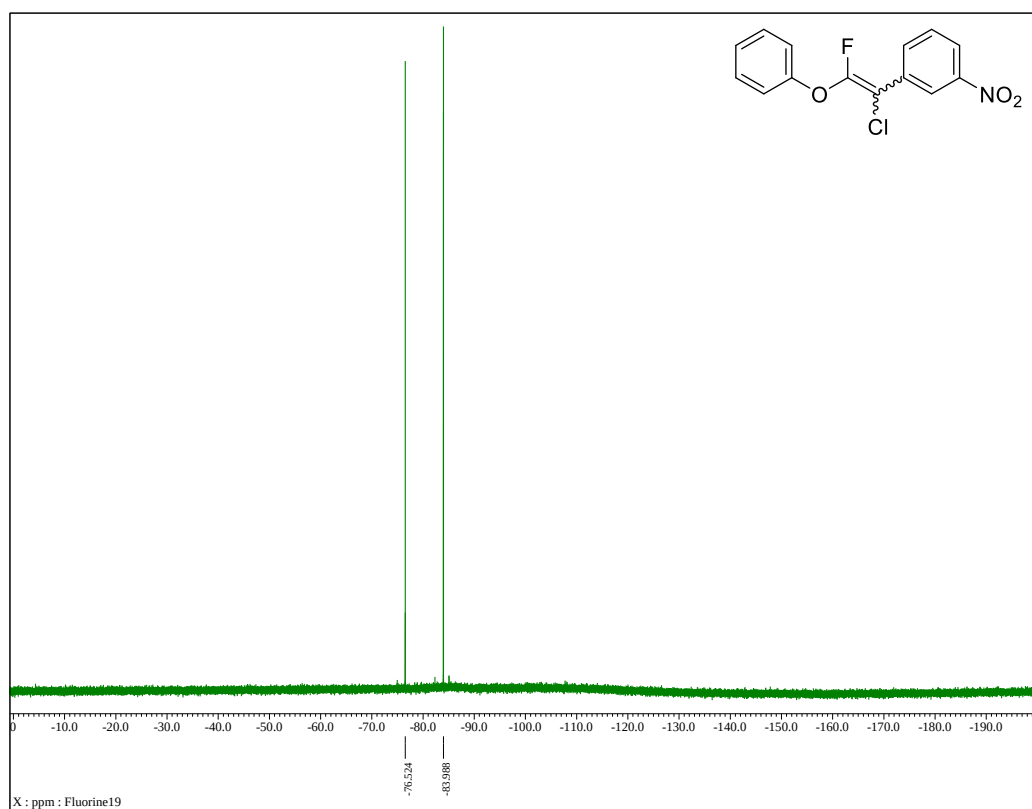
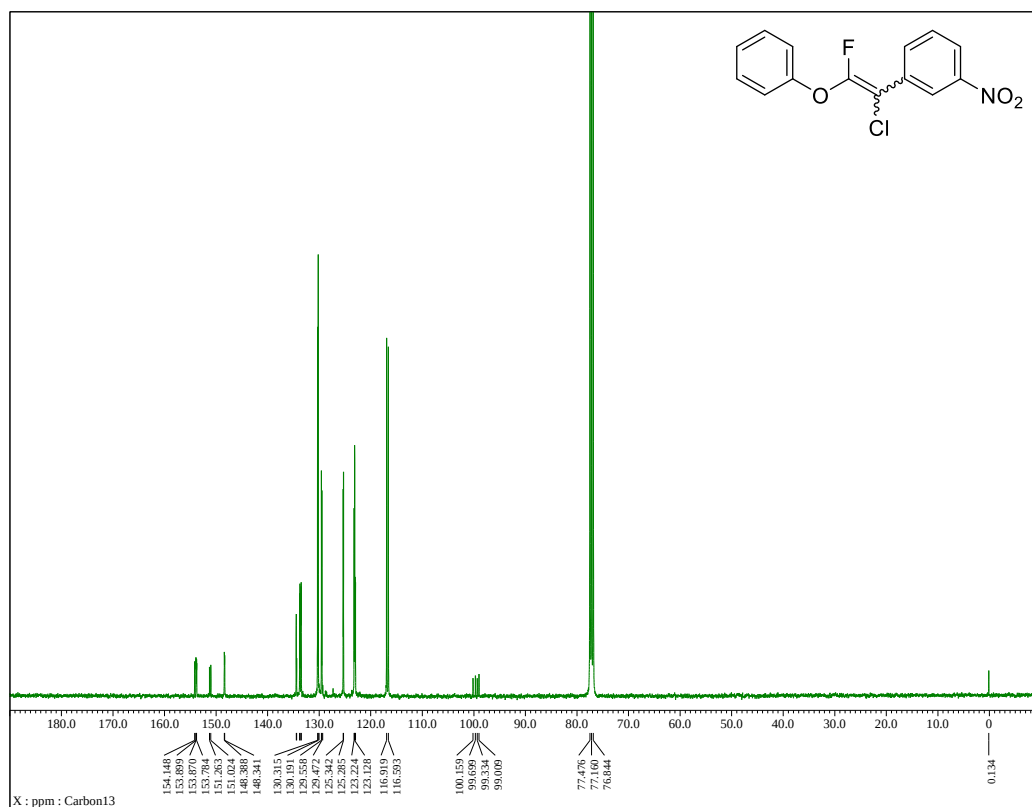
2-Chloro-1-fluoro-2-(4-formylphenyl)ethenyl phenyl ether (2i)



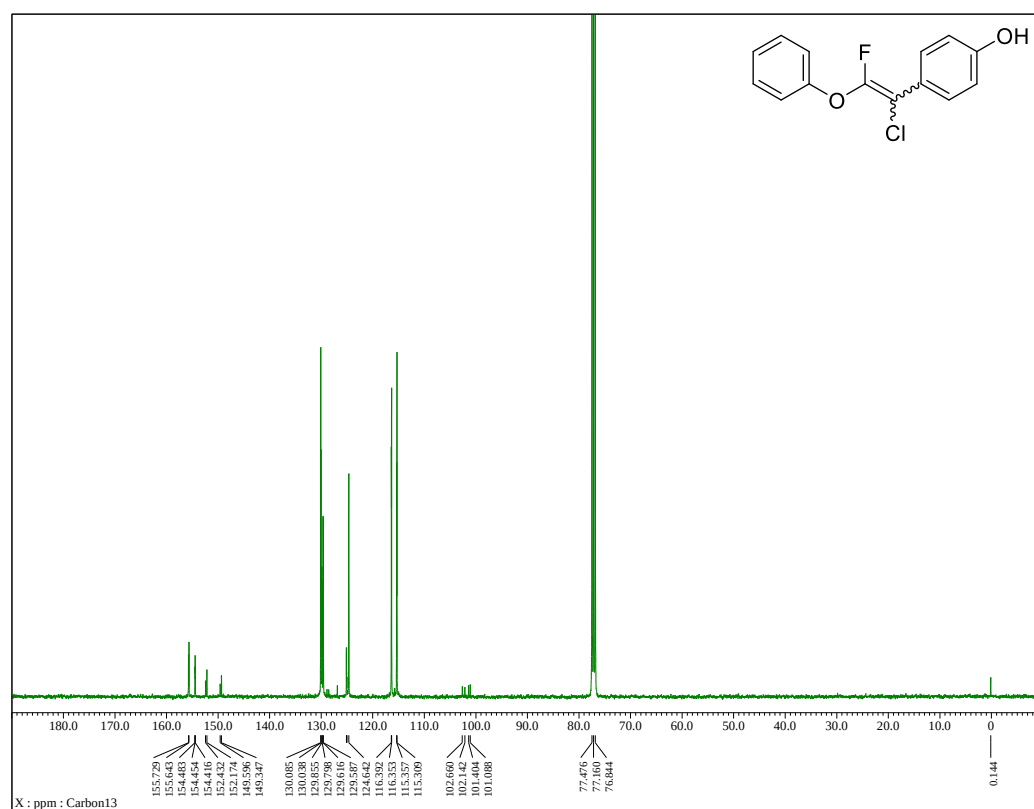
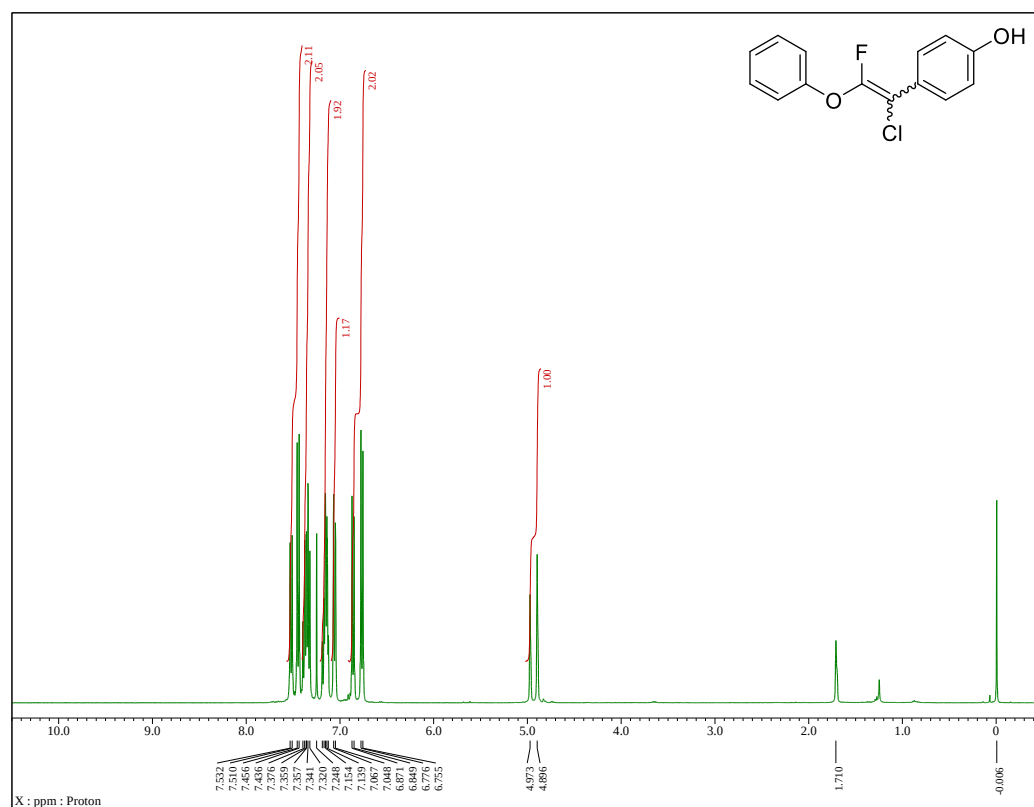


2-Chloro-1-fluoro-2-(3-nitrophenyl)ethenyl phenyl ether (2j)



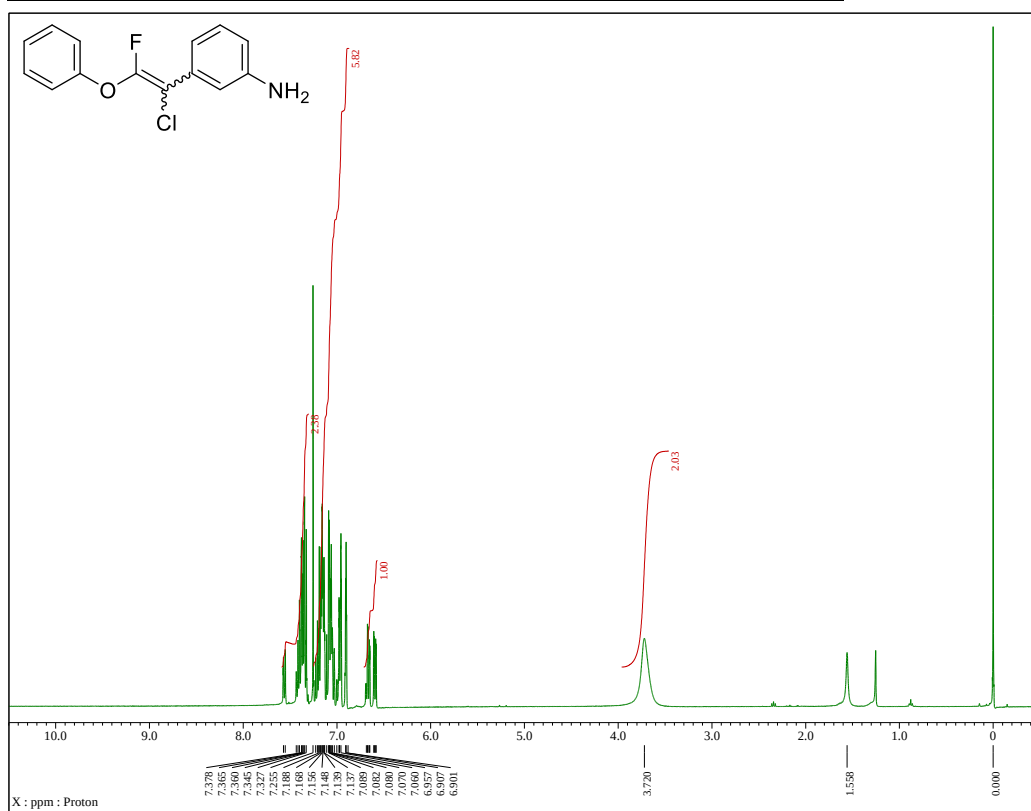


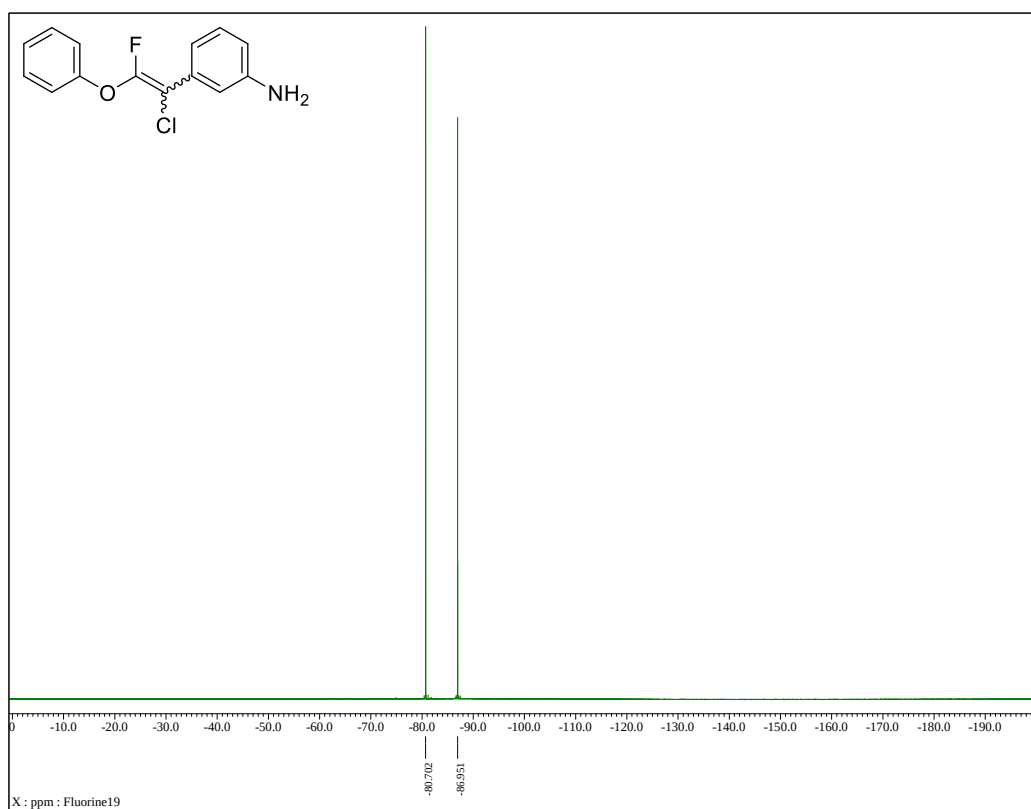
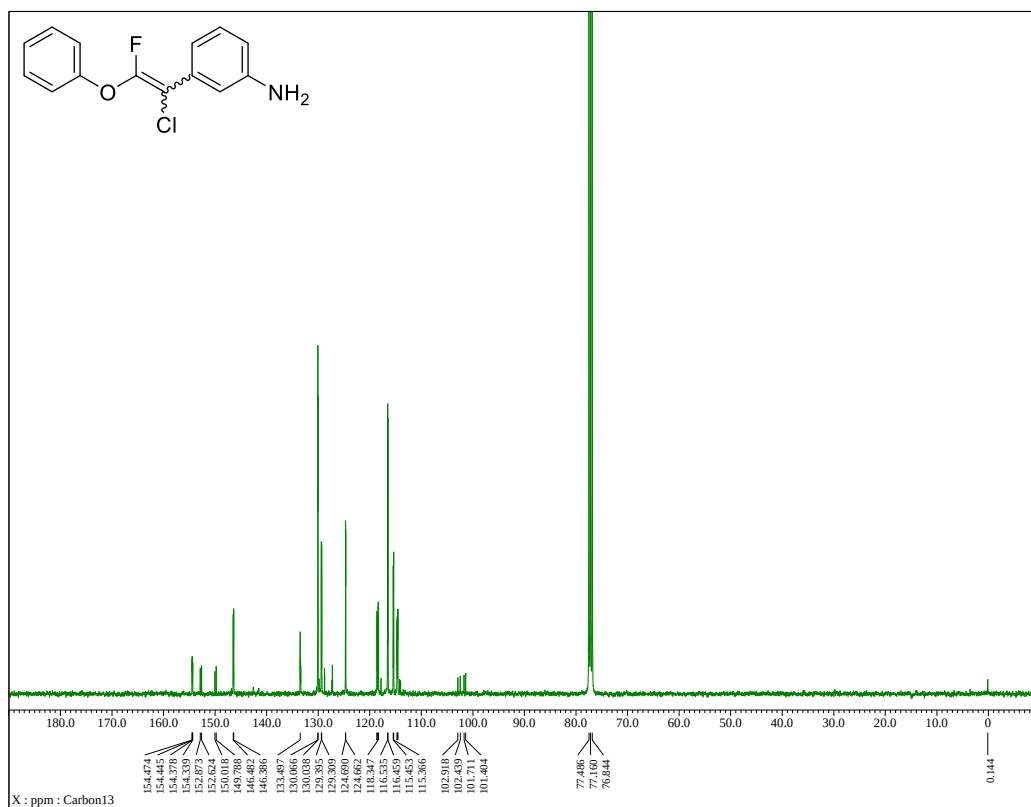
2-Chloro-1-fluoro-2-(4-hydroxyphenyl)ethenyl phenyl ether (2k)



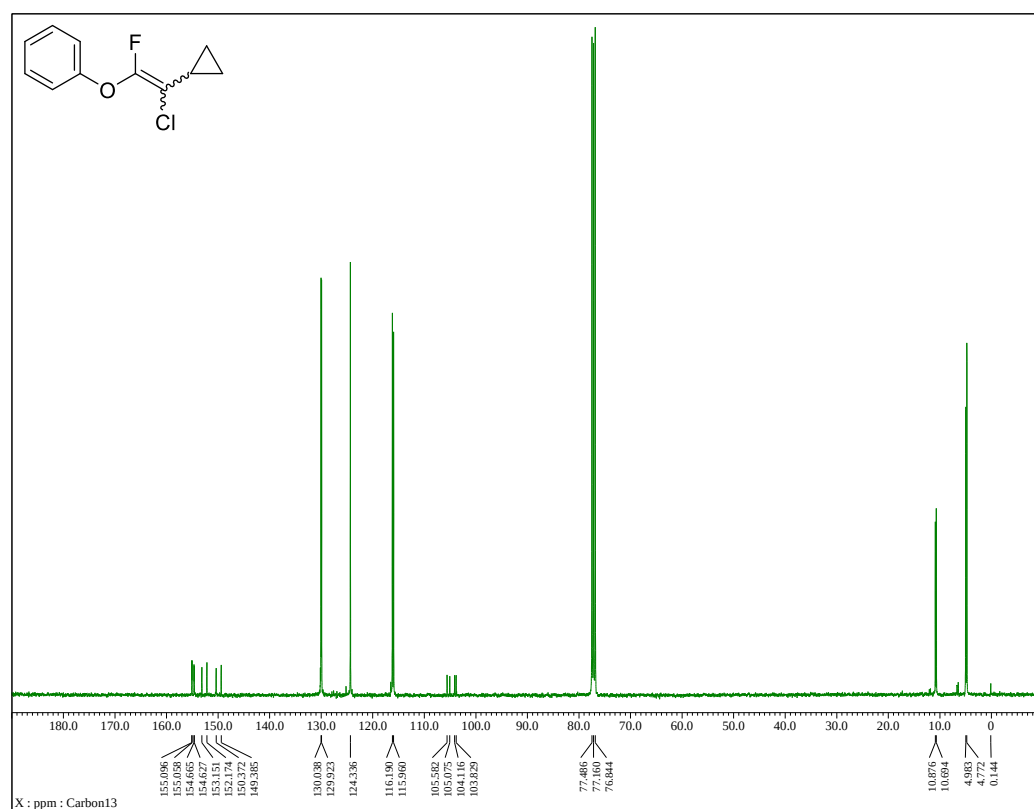
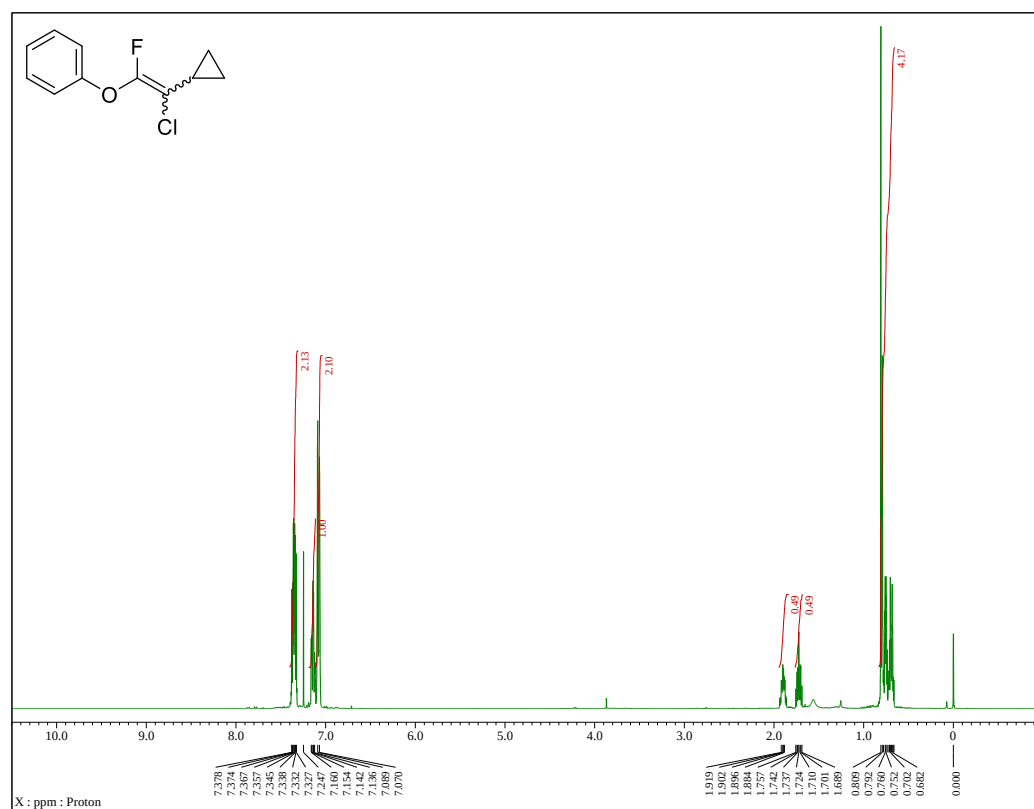


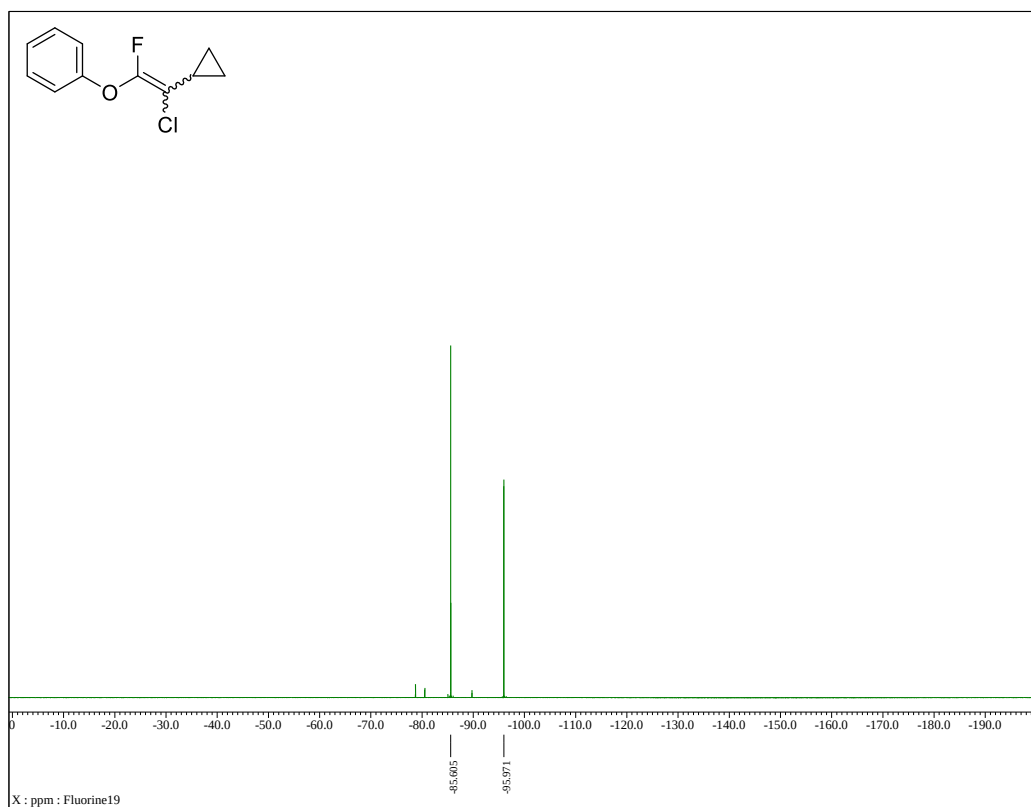
2-(3-Aminophenyl)-2-chloro-1-fluoroethyl phenyl ether (2l)



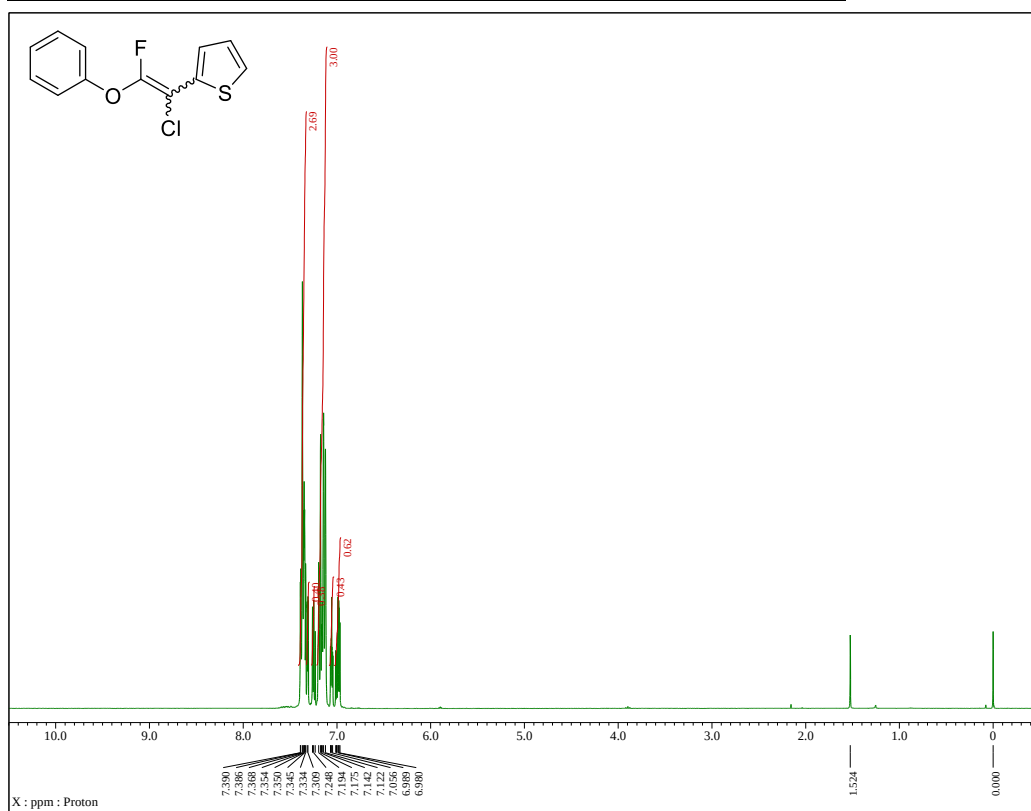


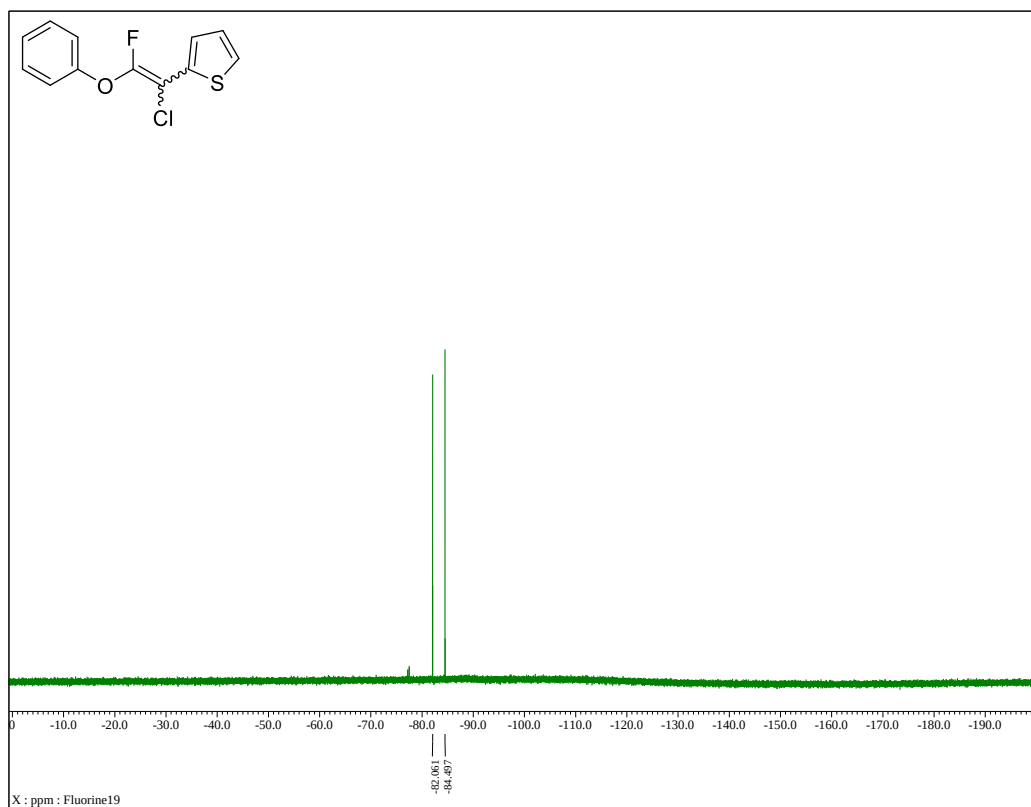
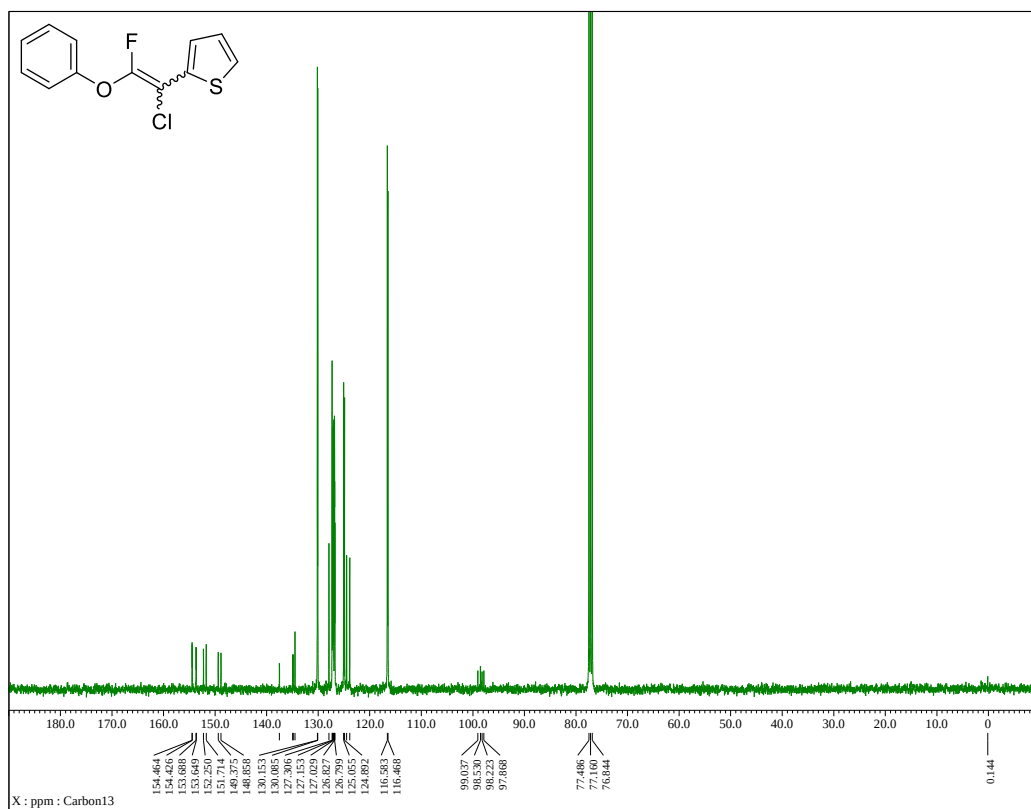
2-Chloro-2-cyclopropyl-1-fluoroethyl phenyl ether (2n)



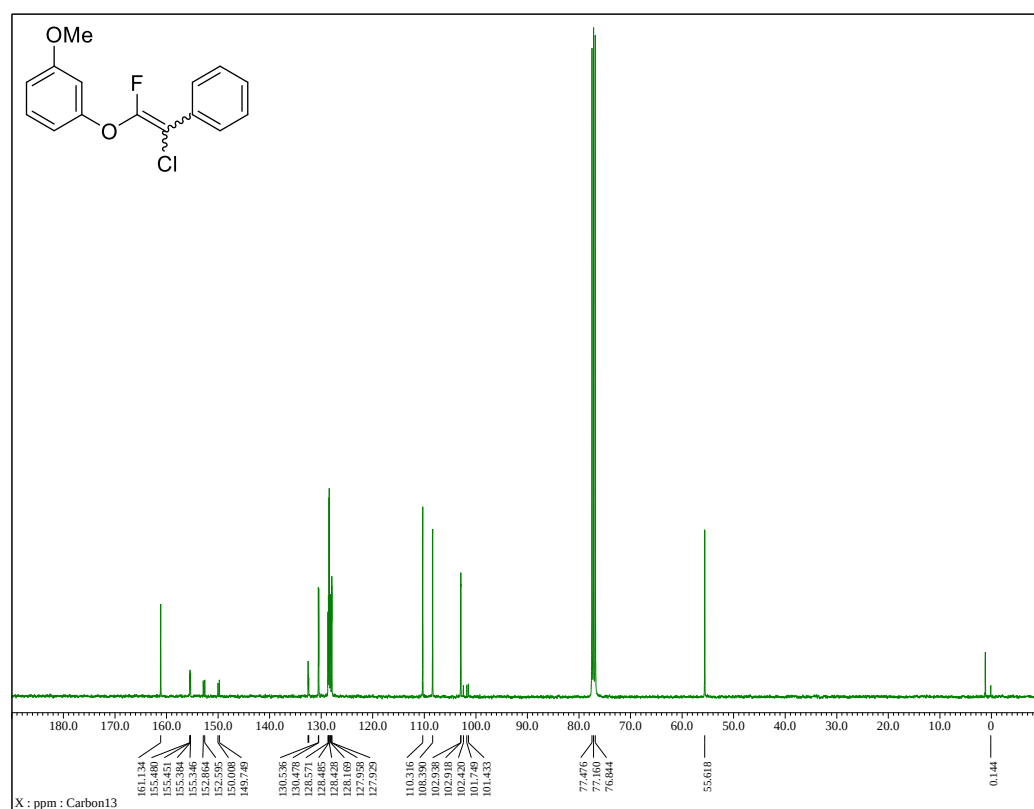
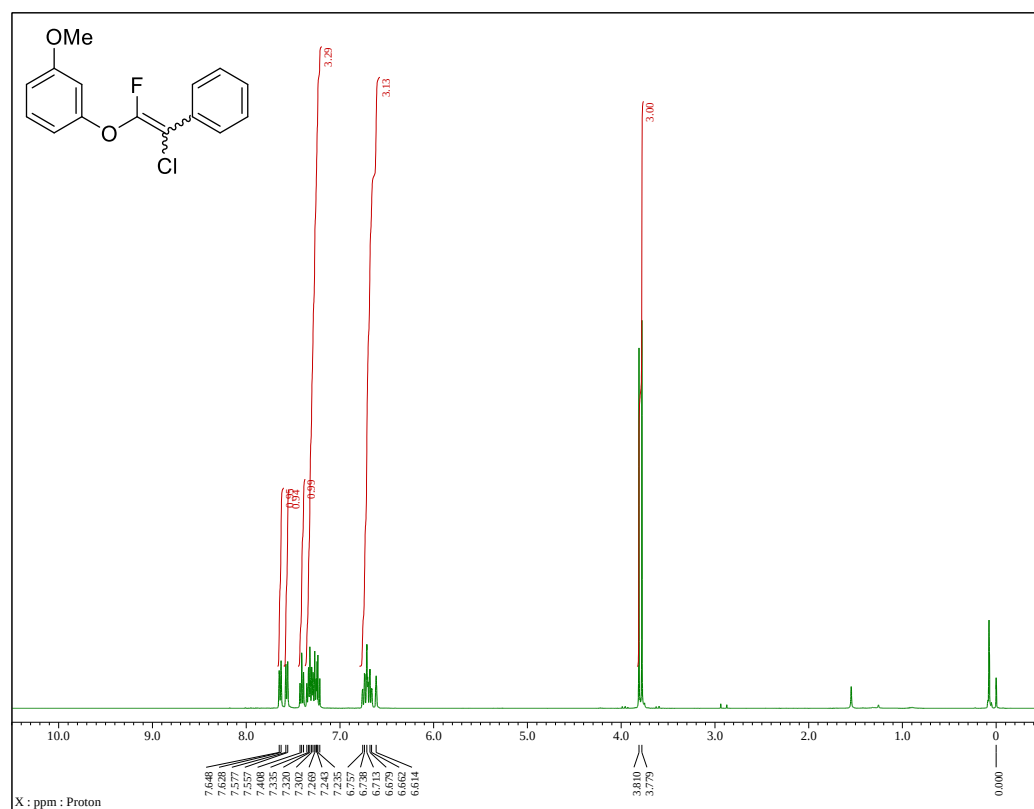


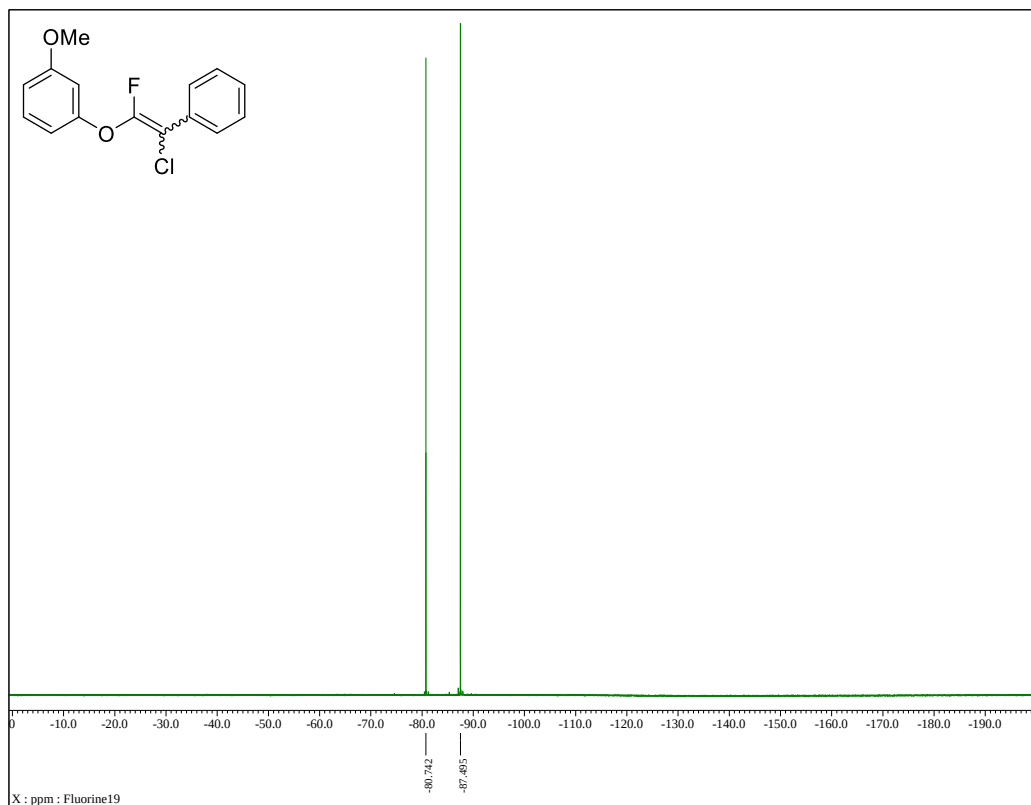
2-Chloro-1-fluoro-2-(thiophene-2-yl)ethenyl phenyl ether (2o)



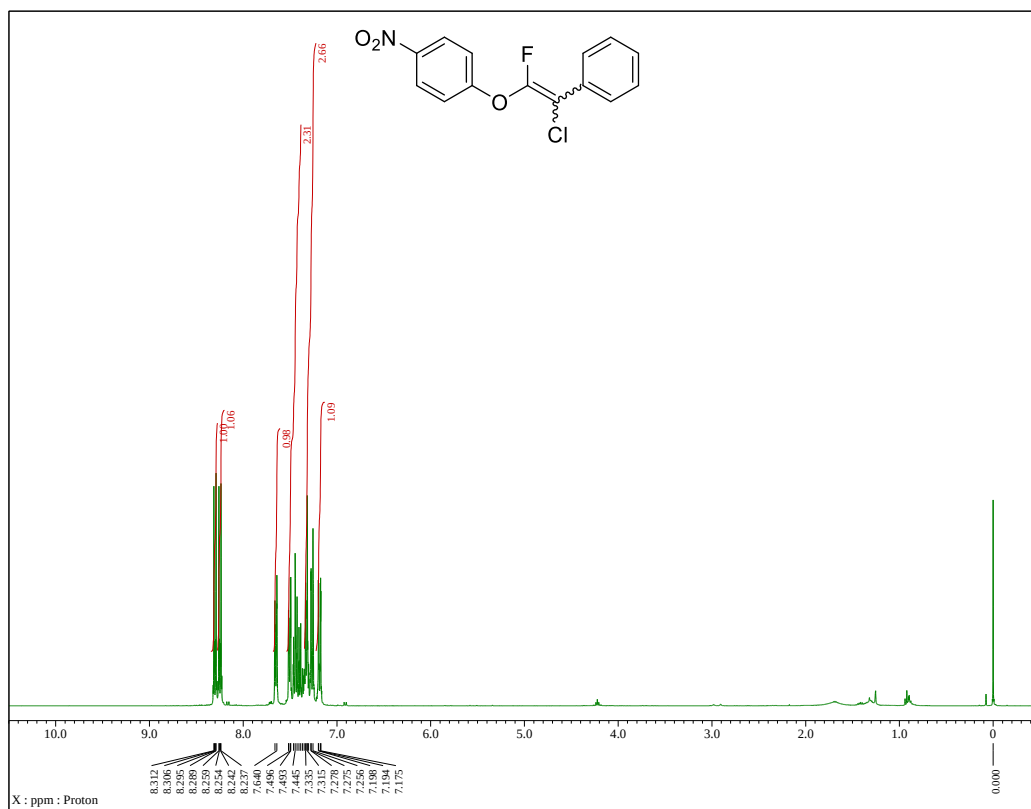


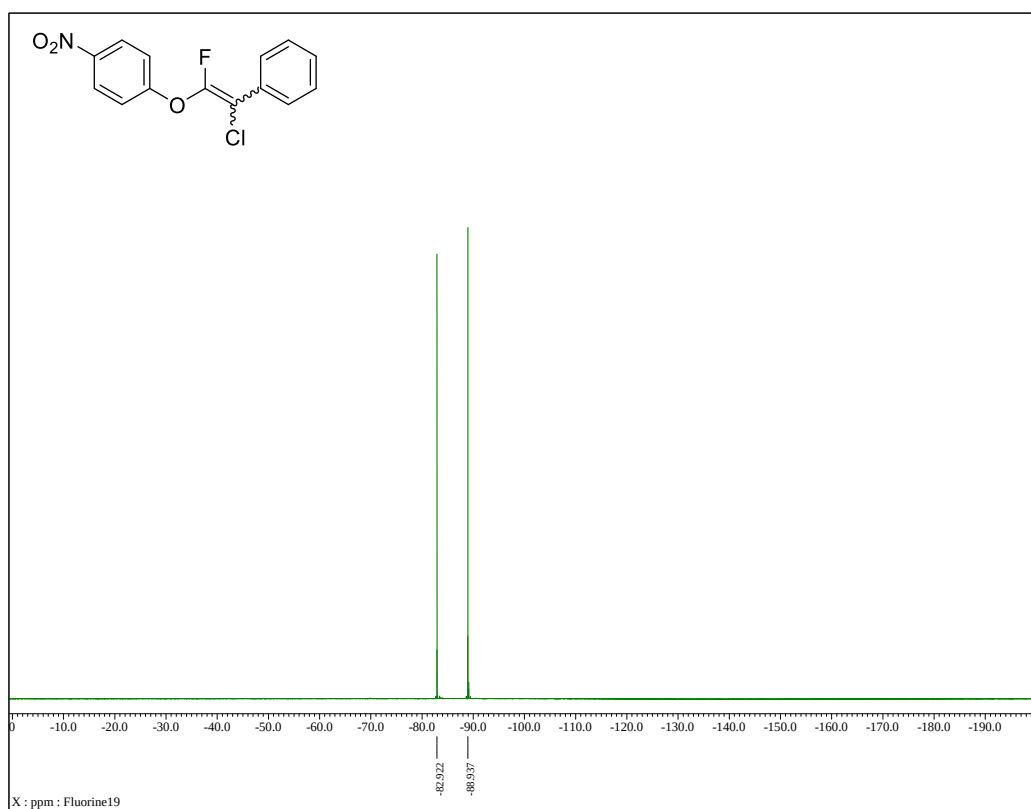
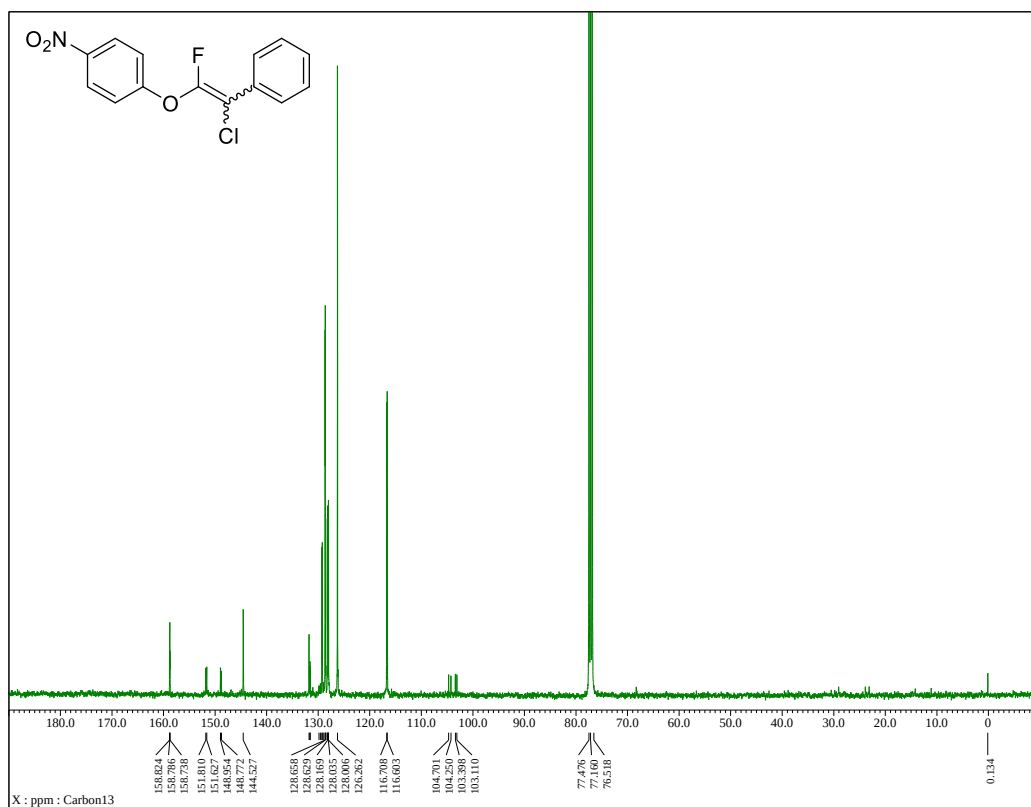
2-Chloro-1-fluoro-2-phenylethenyl 3-methoxyphenyl ether (2p)



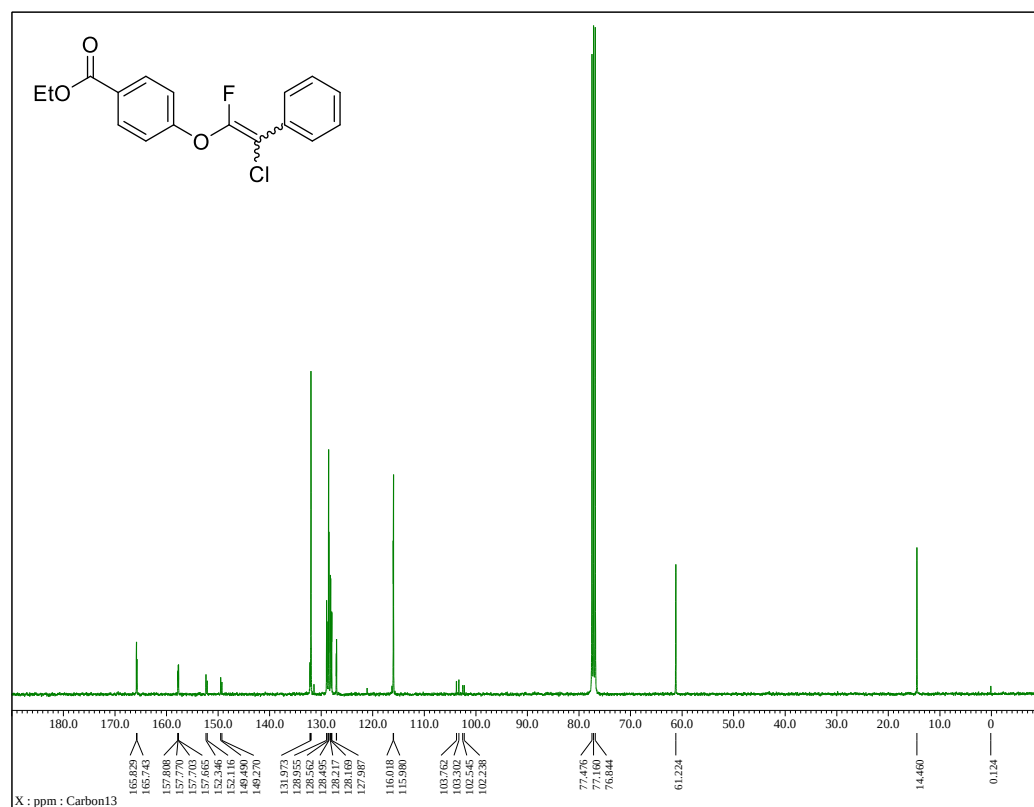
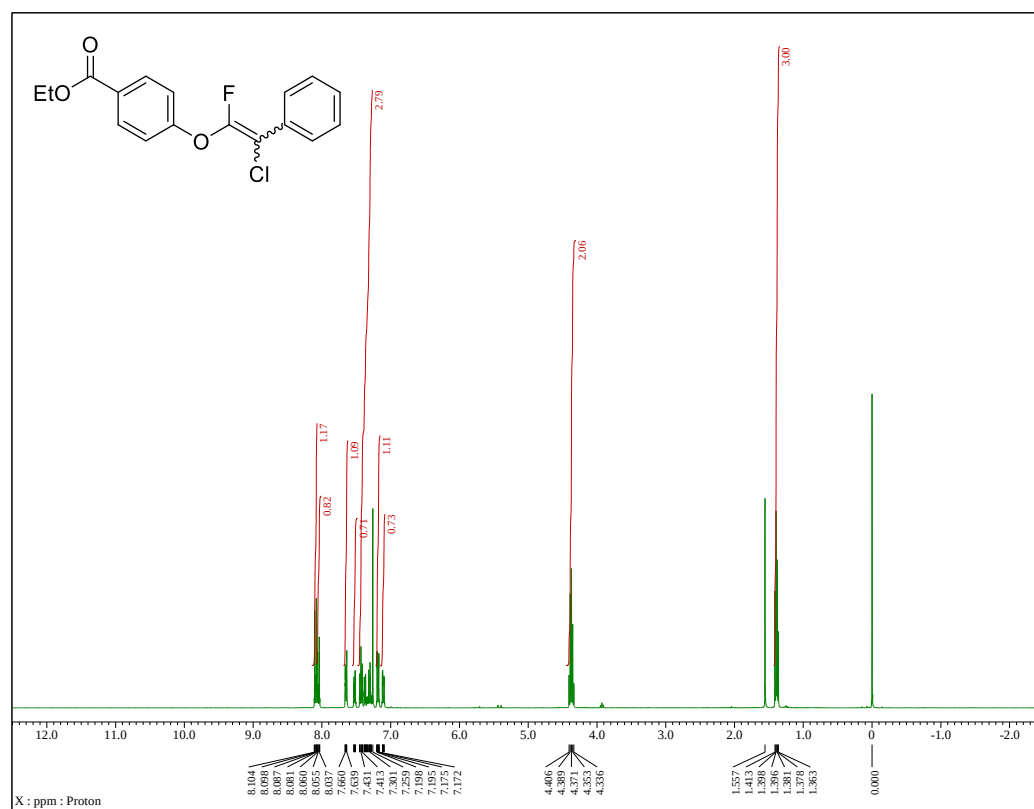


2-Chloro-1-fluoro-2-phenylethenyl 4-nitrophenyl ether (2q)



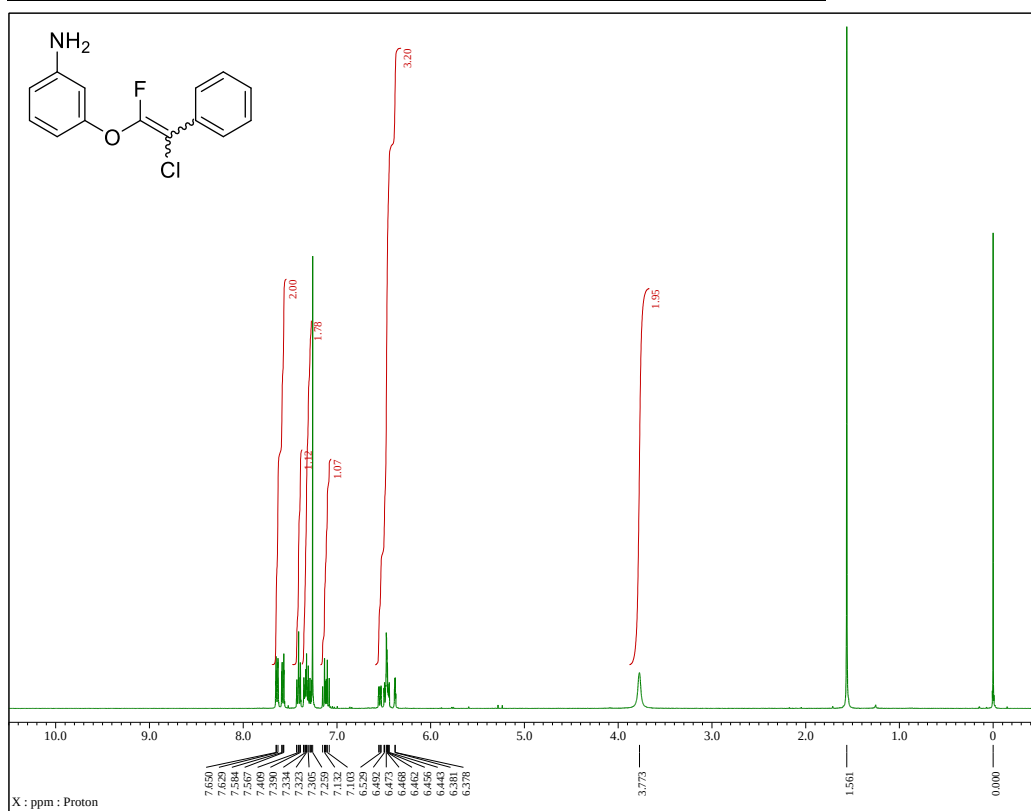


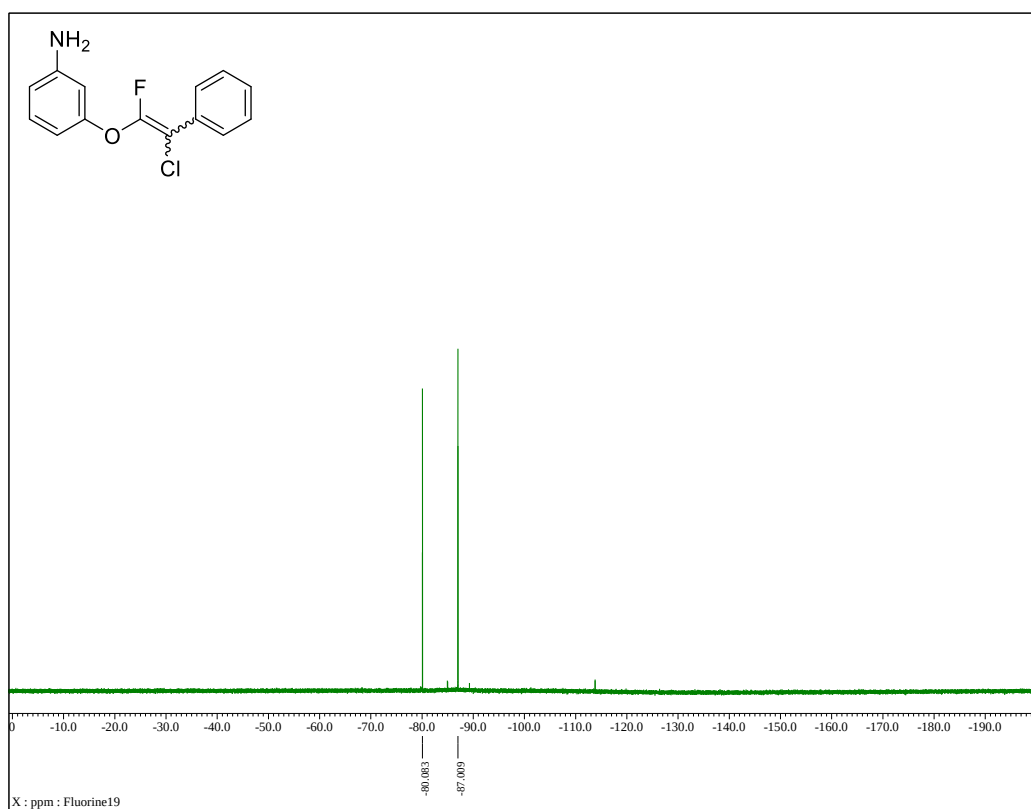
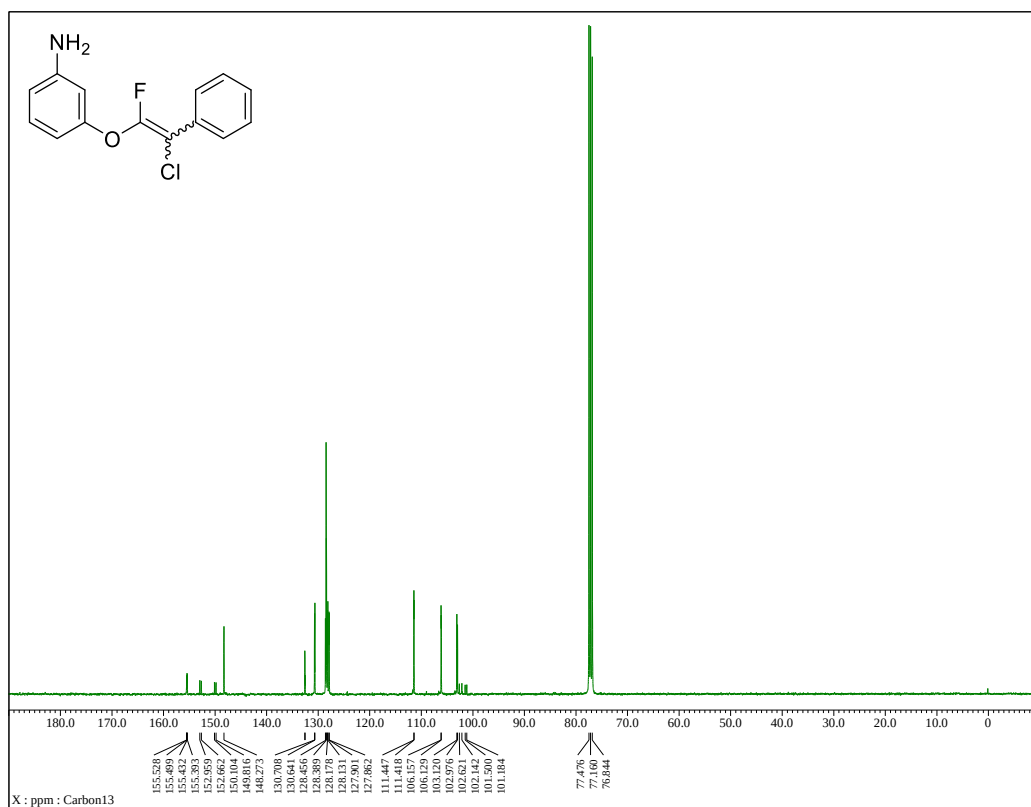
2-Chloro-1-fluoro-2-phenylethenyl 4-ethoxycarbonylphenyl ether (2r)



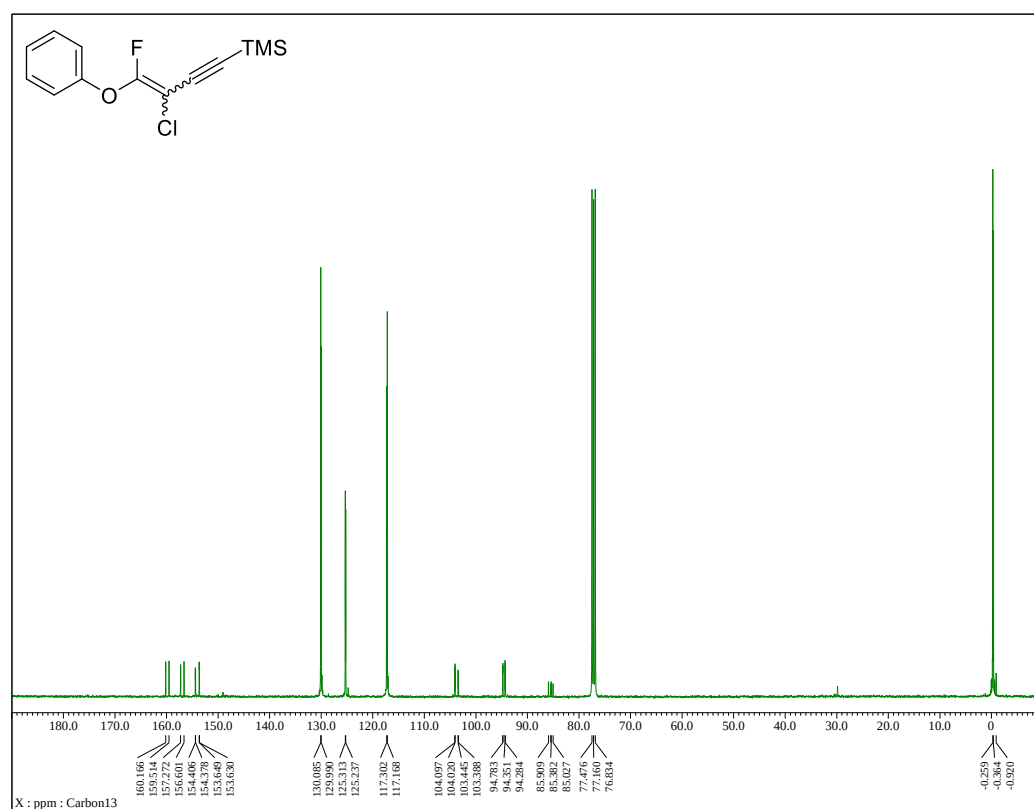
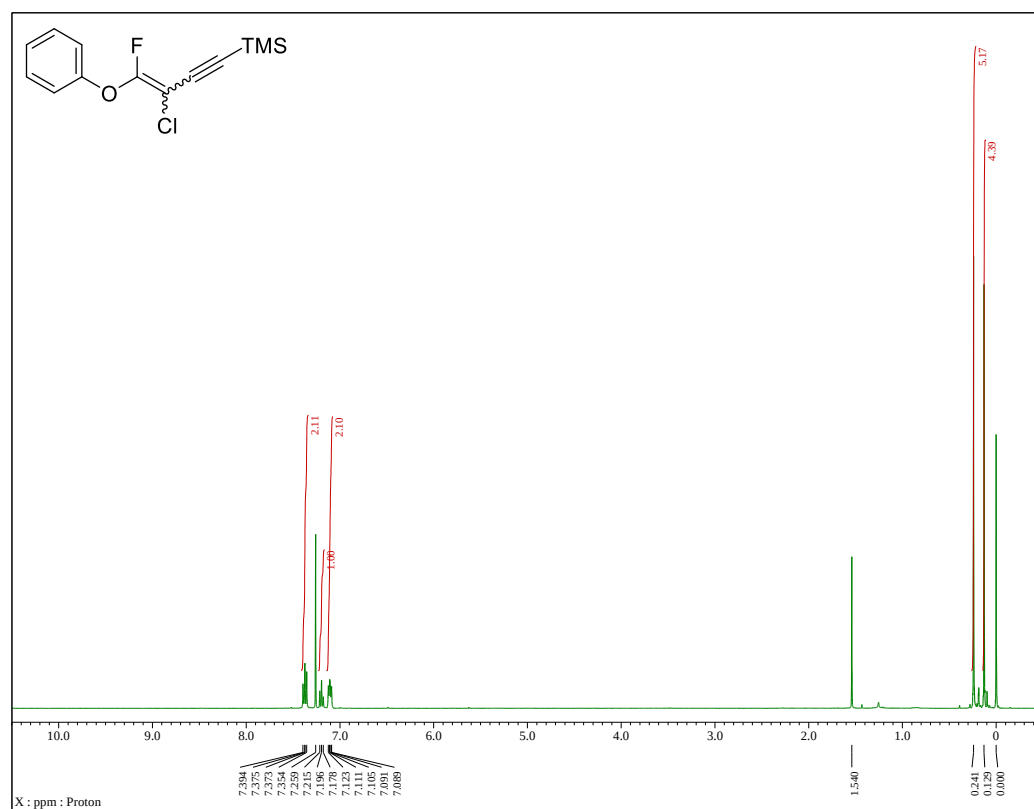


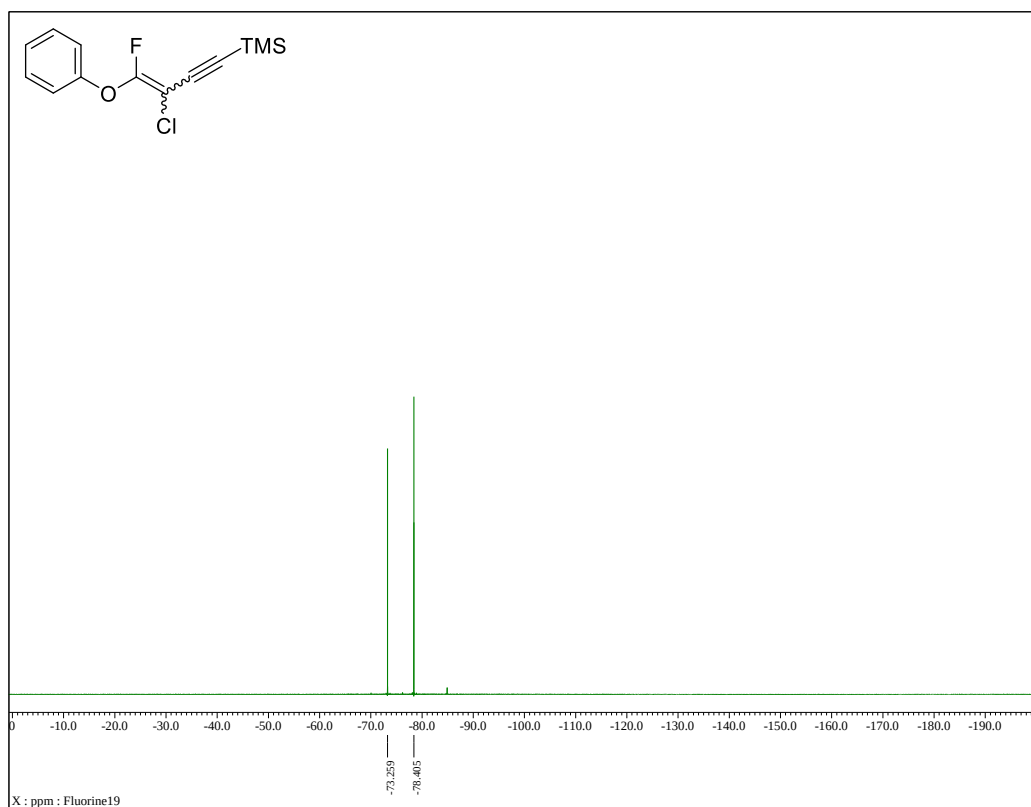
3-Aminophenyl 2-chloro-1-fluoro-2-phenylethenyl ether (2s)



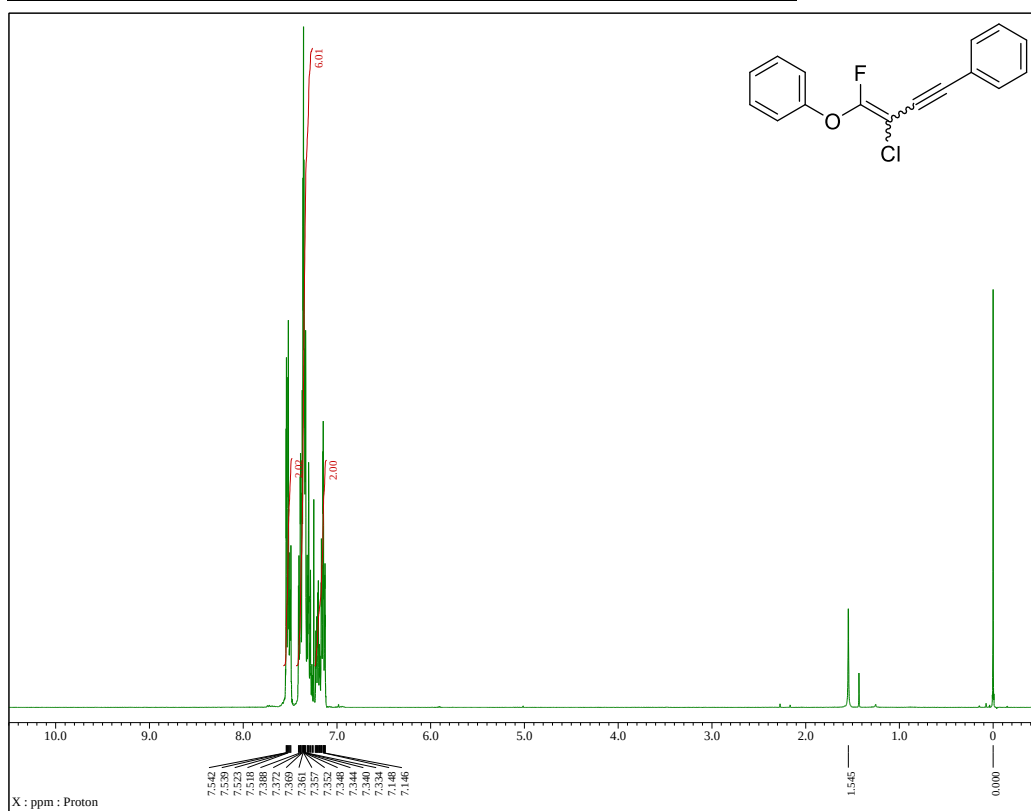


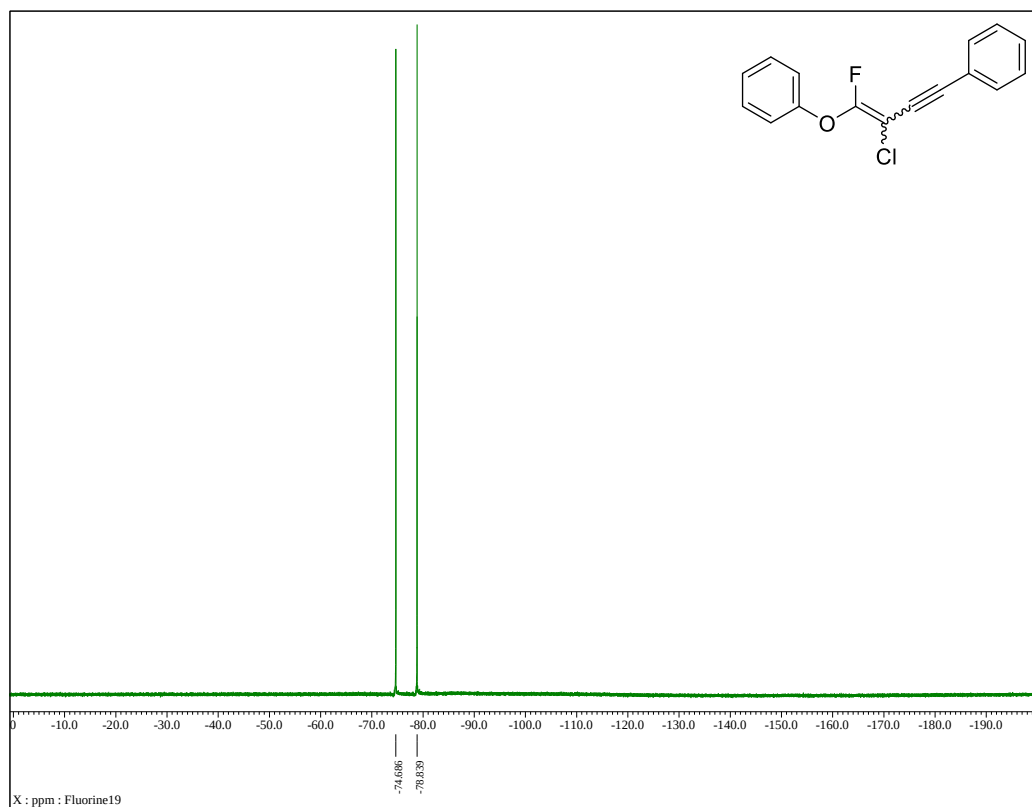
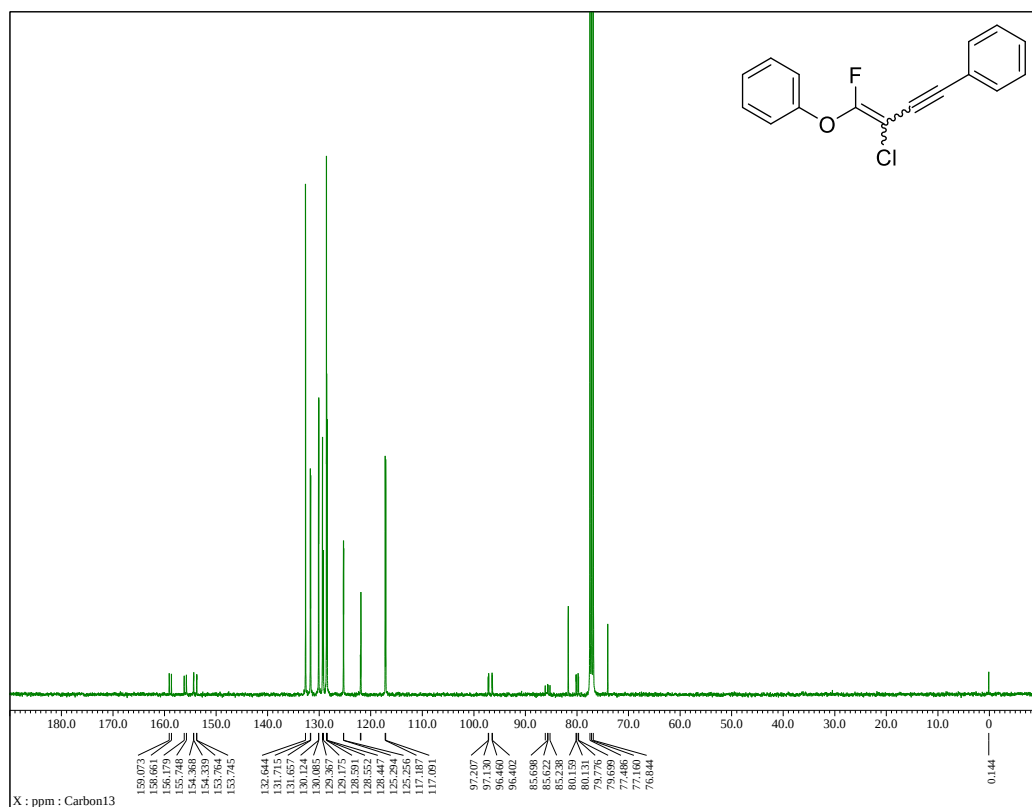
(3-Chloro-4-fluoro-4-phenoxybut-3-en-1-yn-1-yl)trimethylsilane (3a)



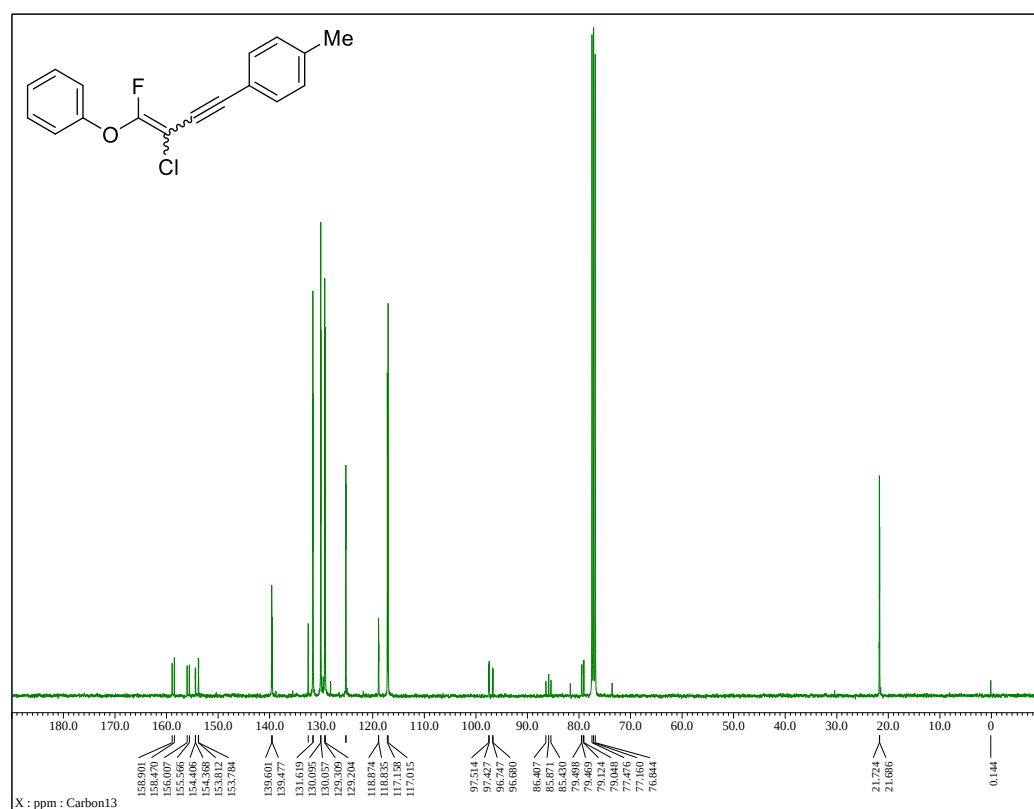
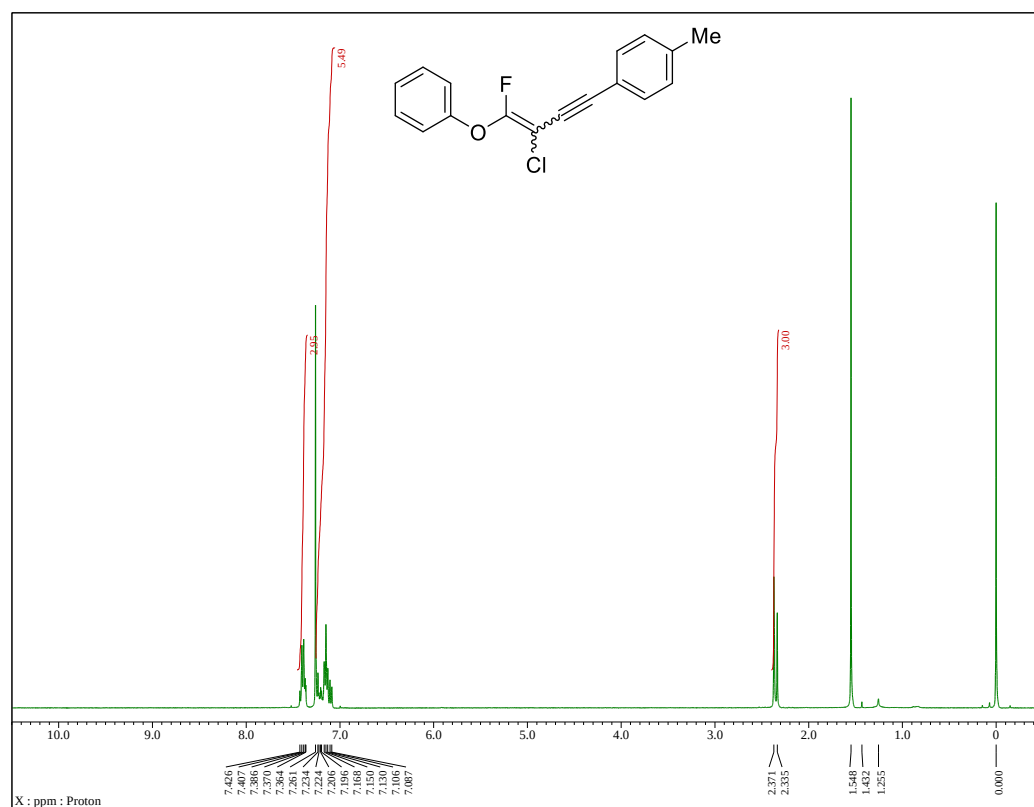


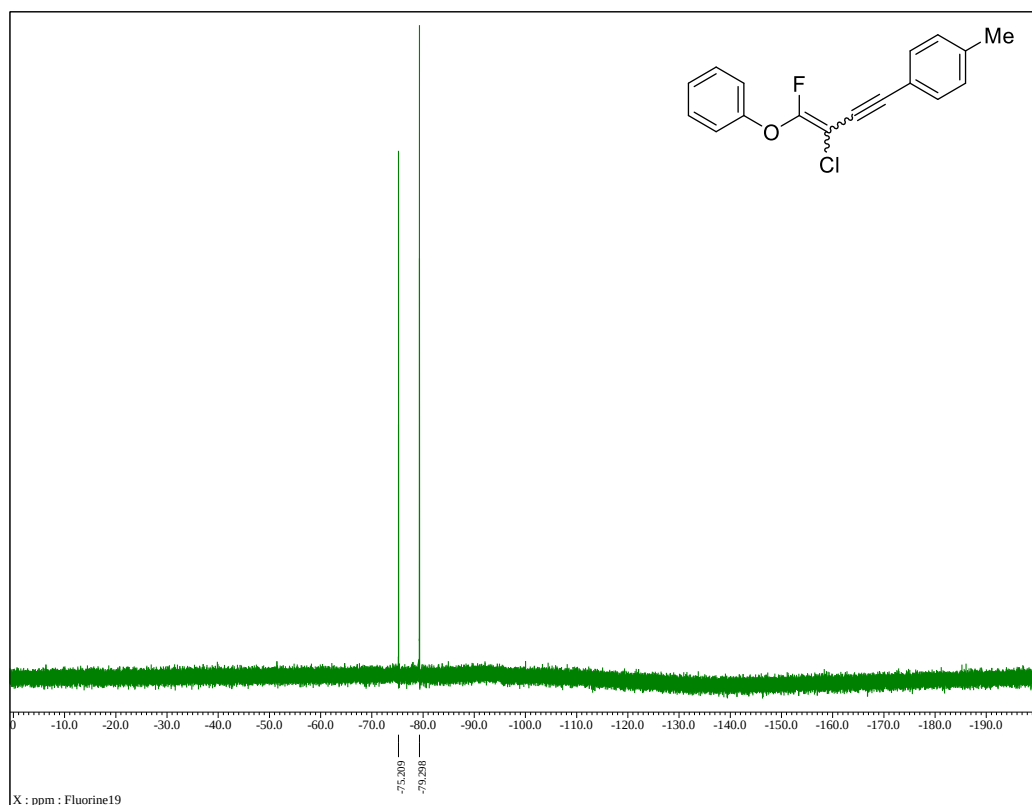
2-Chloro-1-fluoro-1-phenoxy-4-phenylbut-1-en-3-yne (3b)



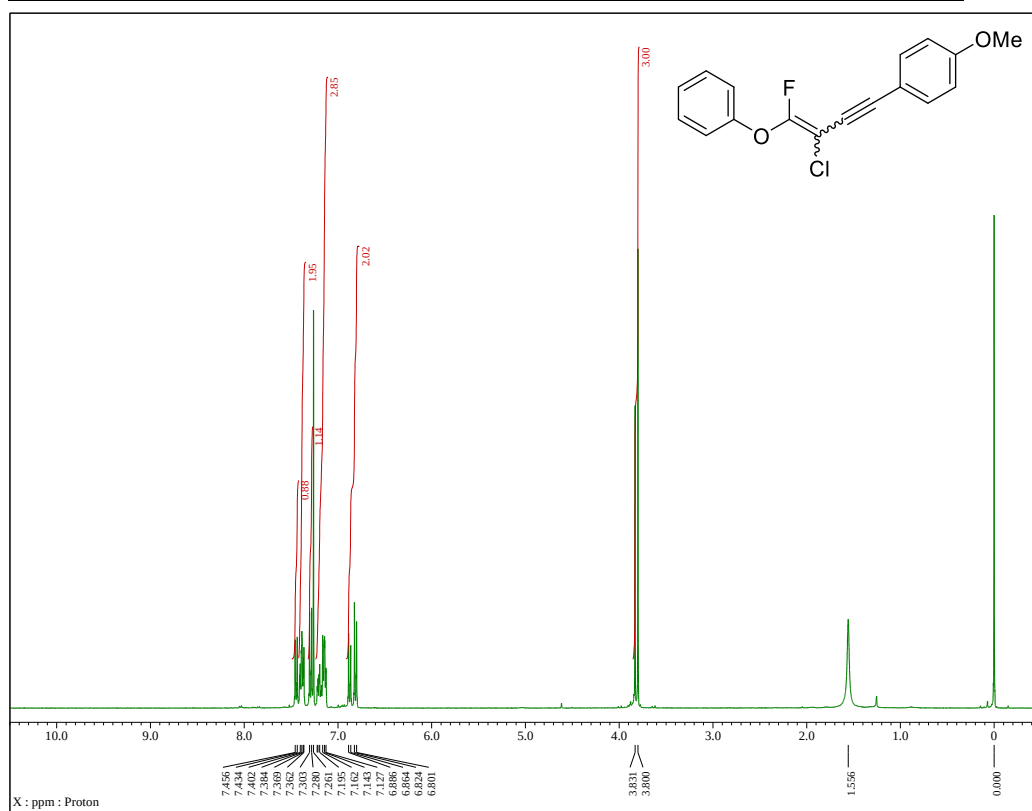


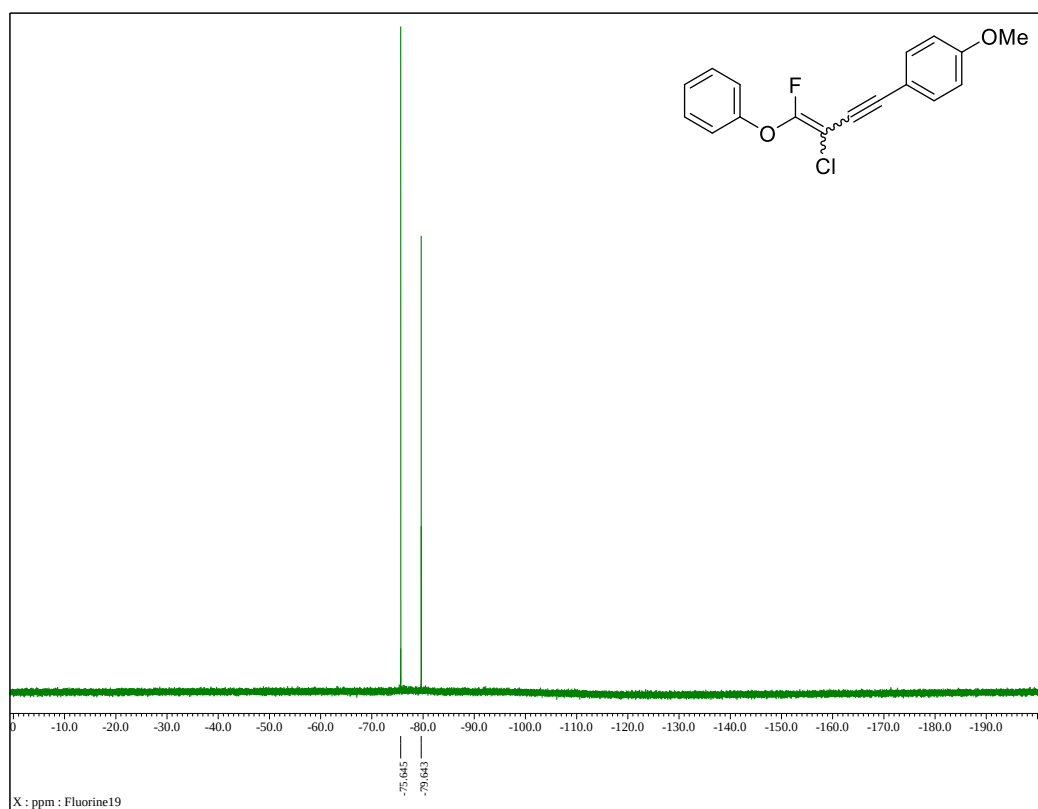
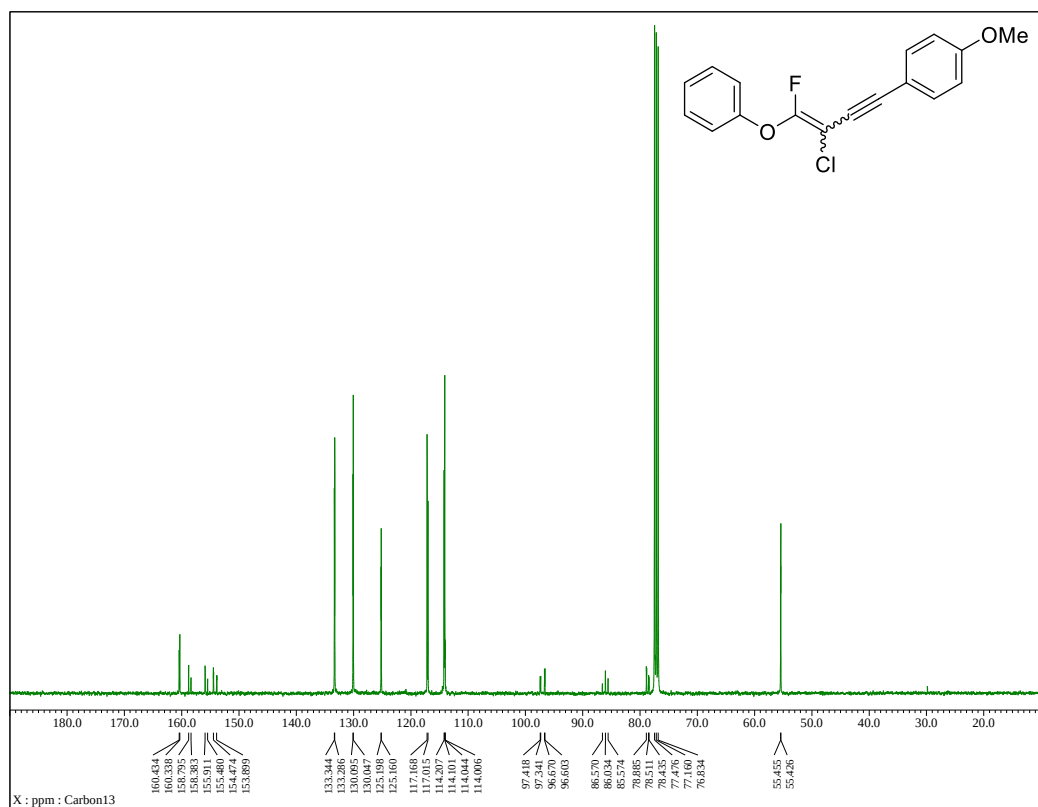
2-Chloro-1-fluoro-4-(4-methylphenyl)-1-phenoxybut-1-en-3-yne (3c)



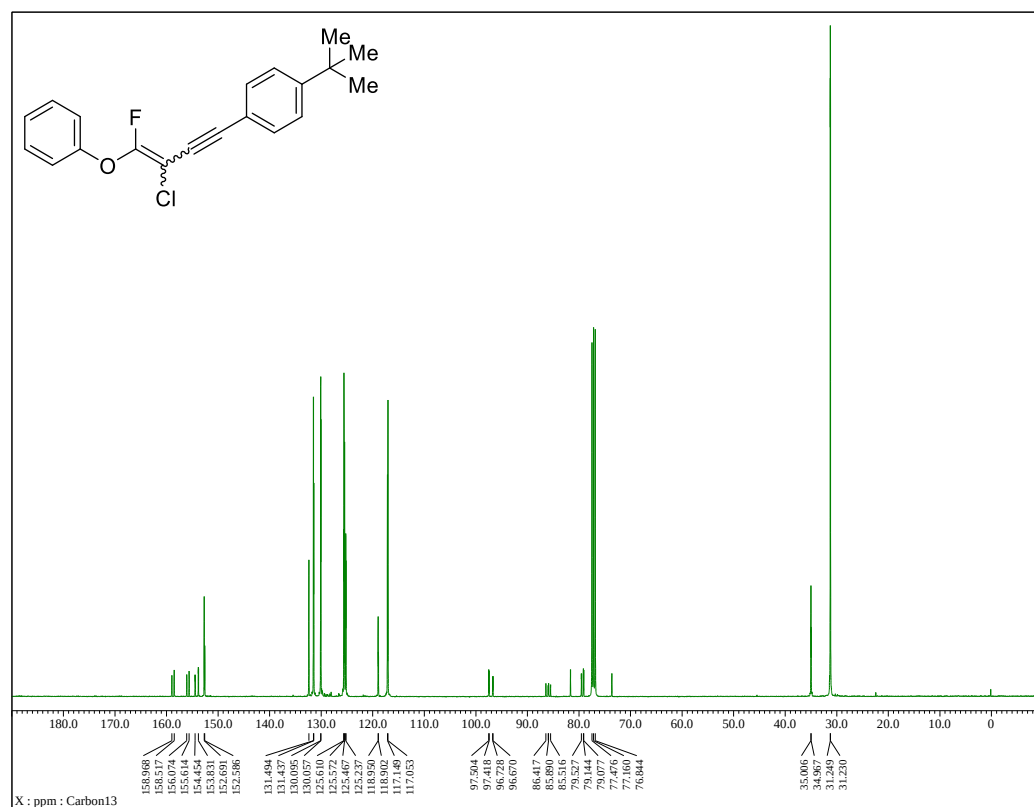
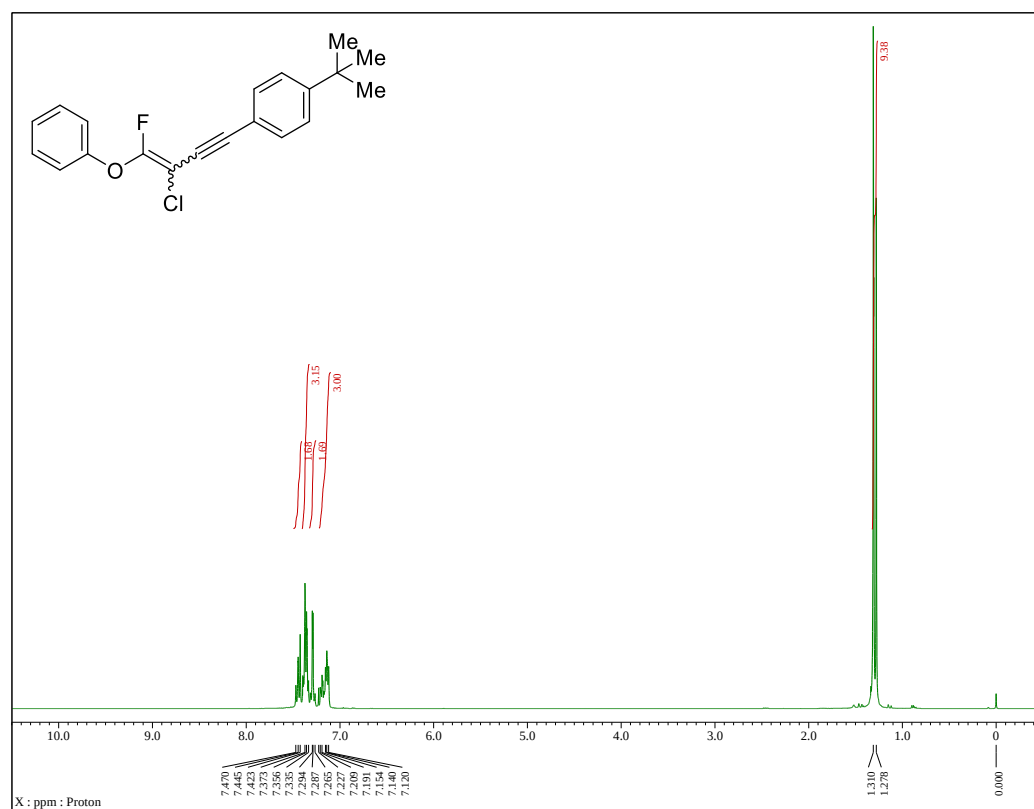


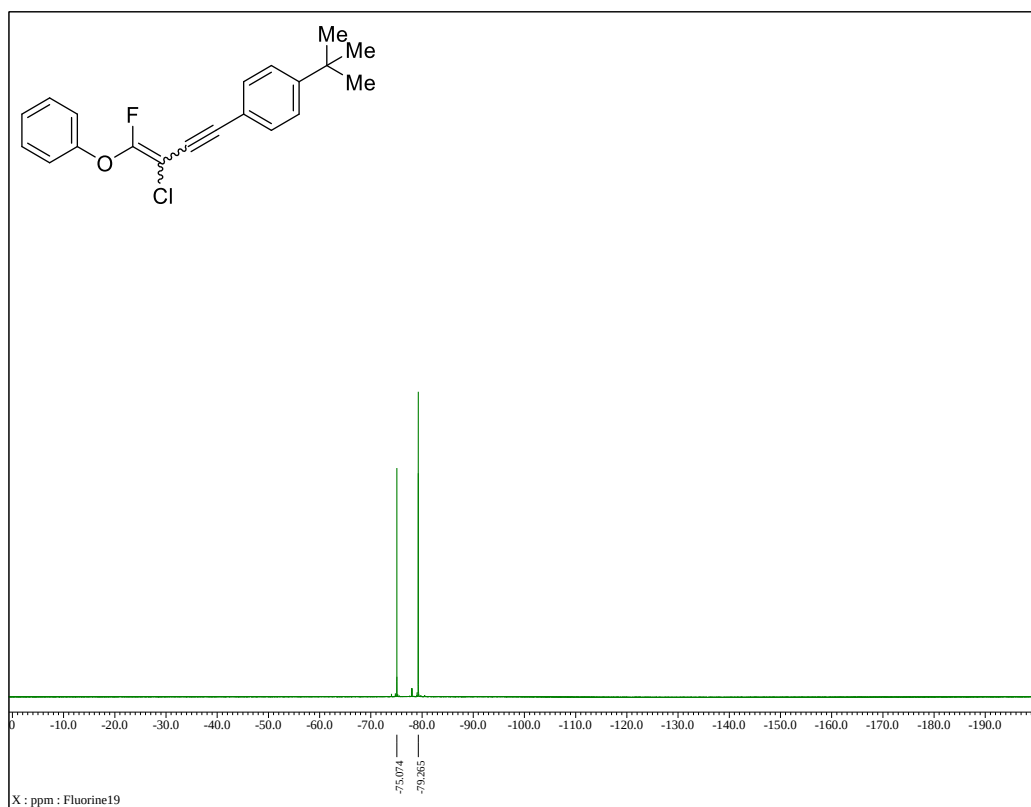
2-Chloro-1-fluoro-4-(4-methoxyphenyl)-1-phenoxybut-1-en-3-yne (3d)



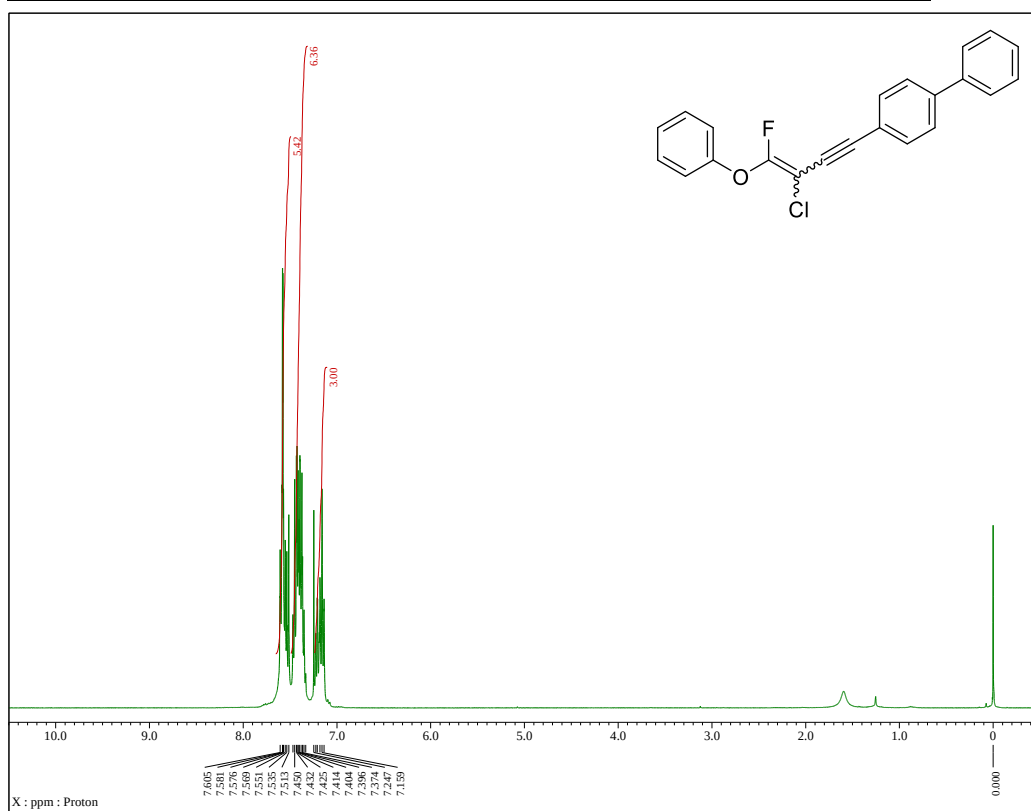


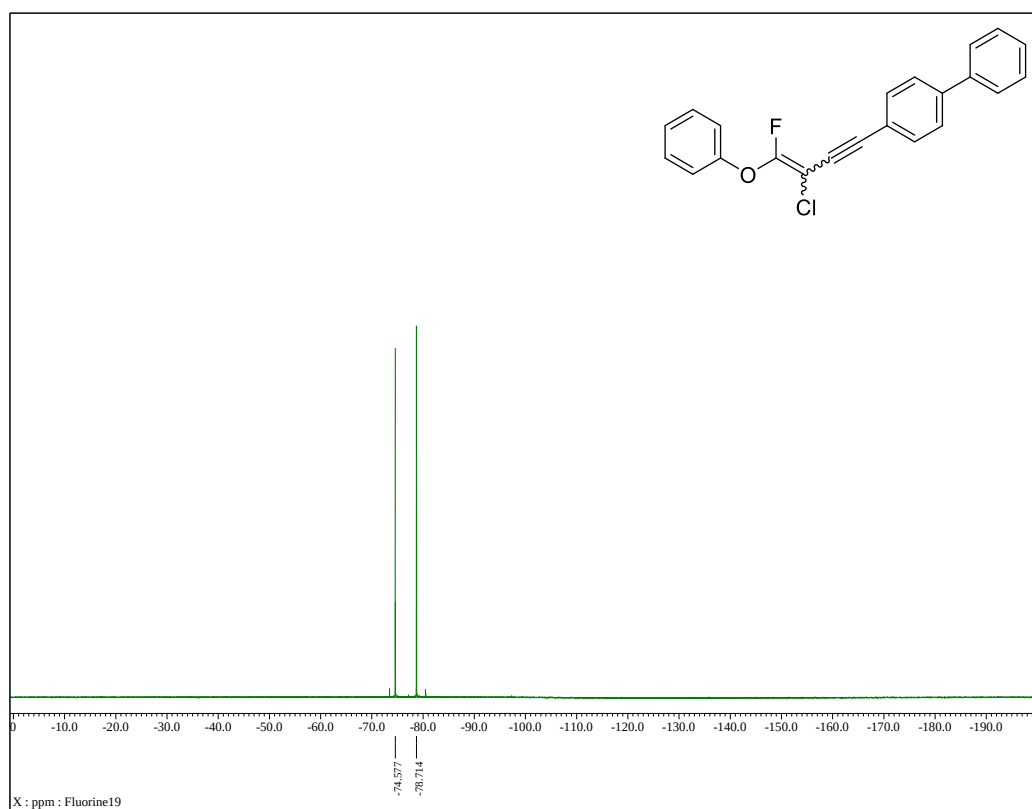
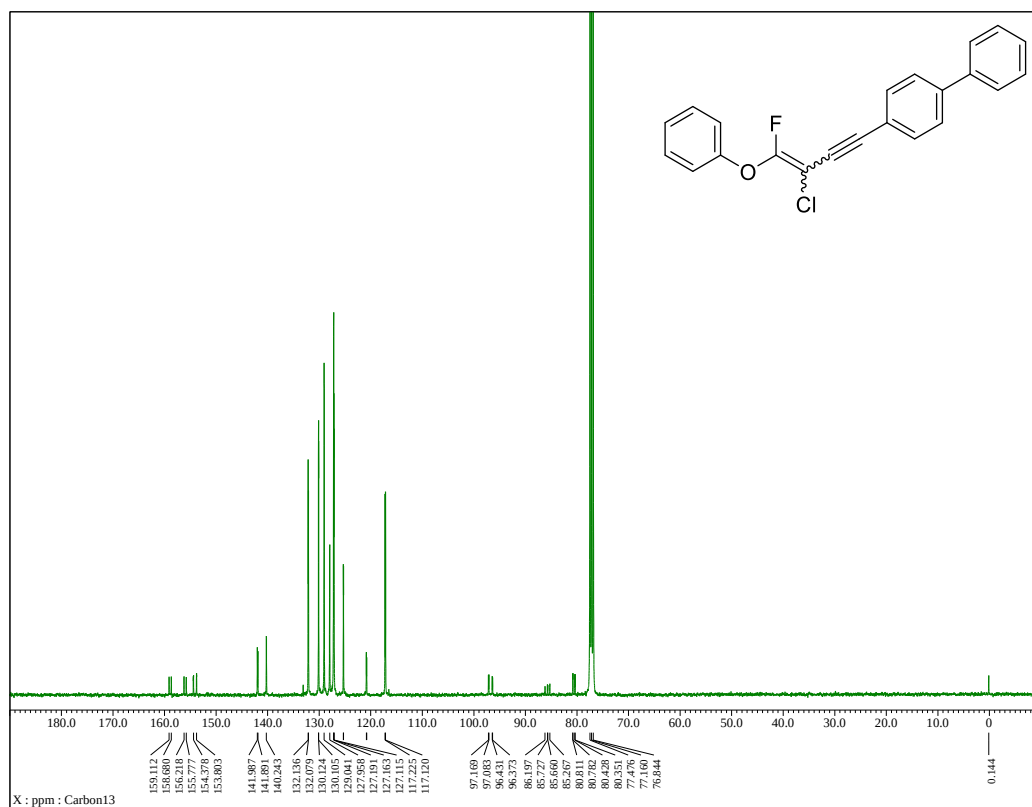
4-(4-*tert*-Butylphenyl)-2-chloro-1-fluoro-1-phenoxybut-1-en-3-yne (3e)



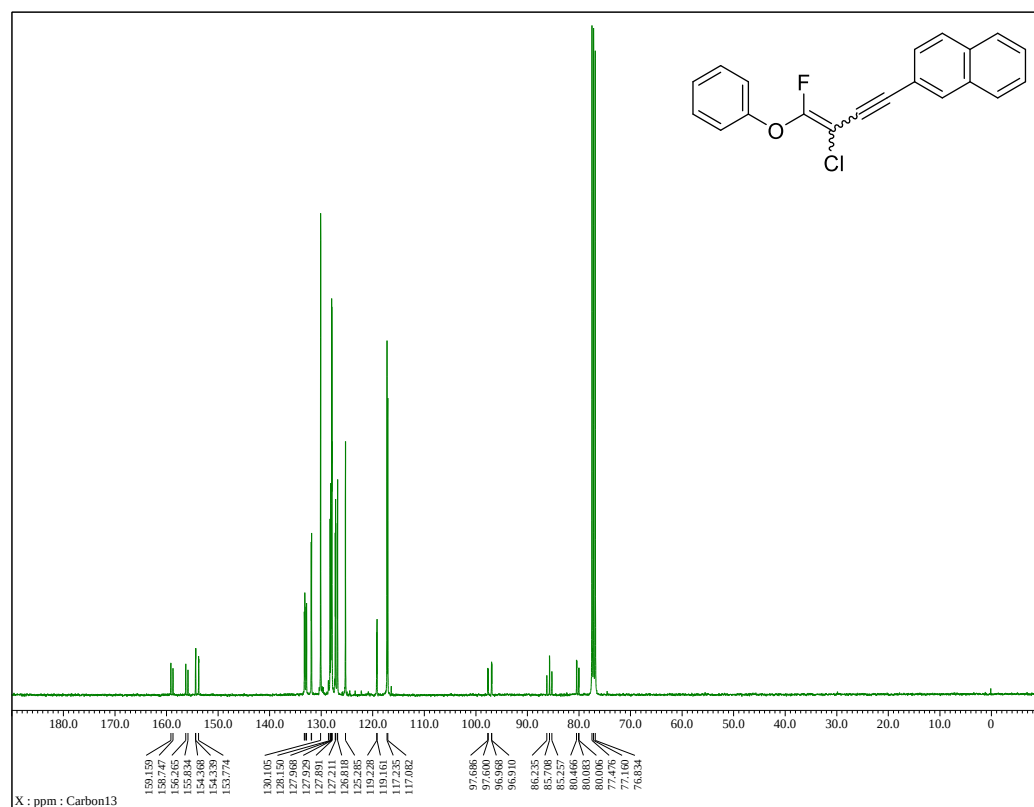
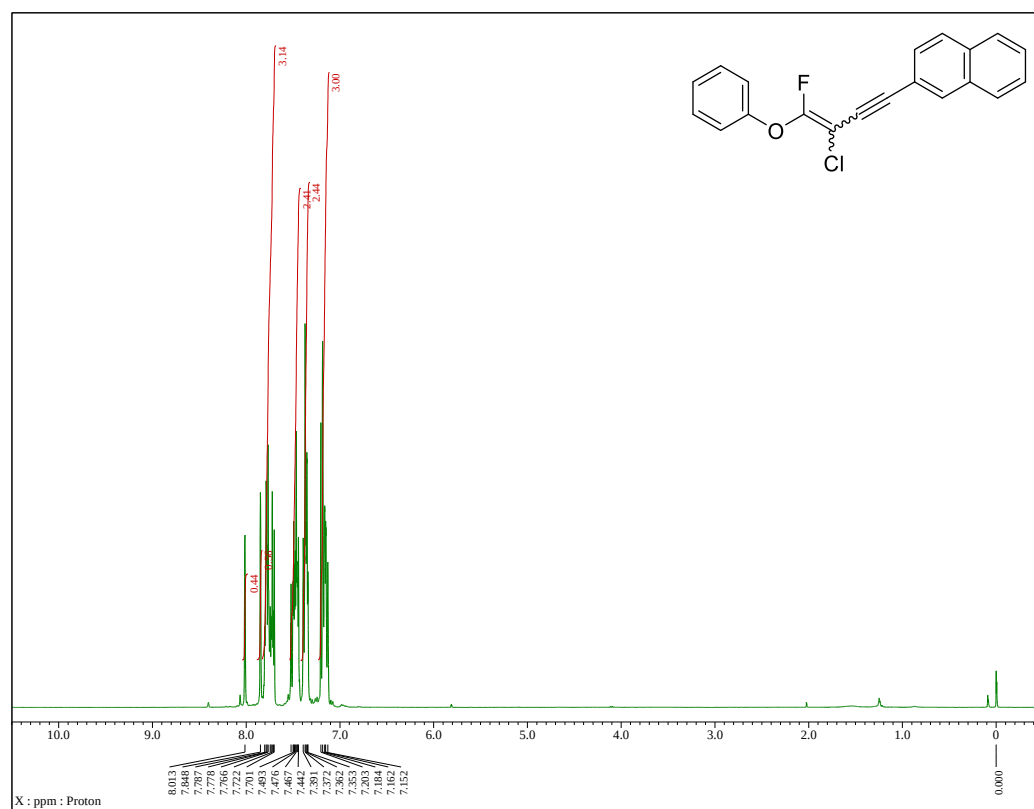


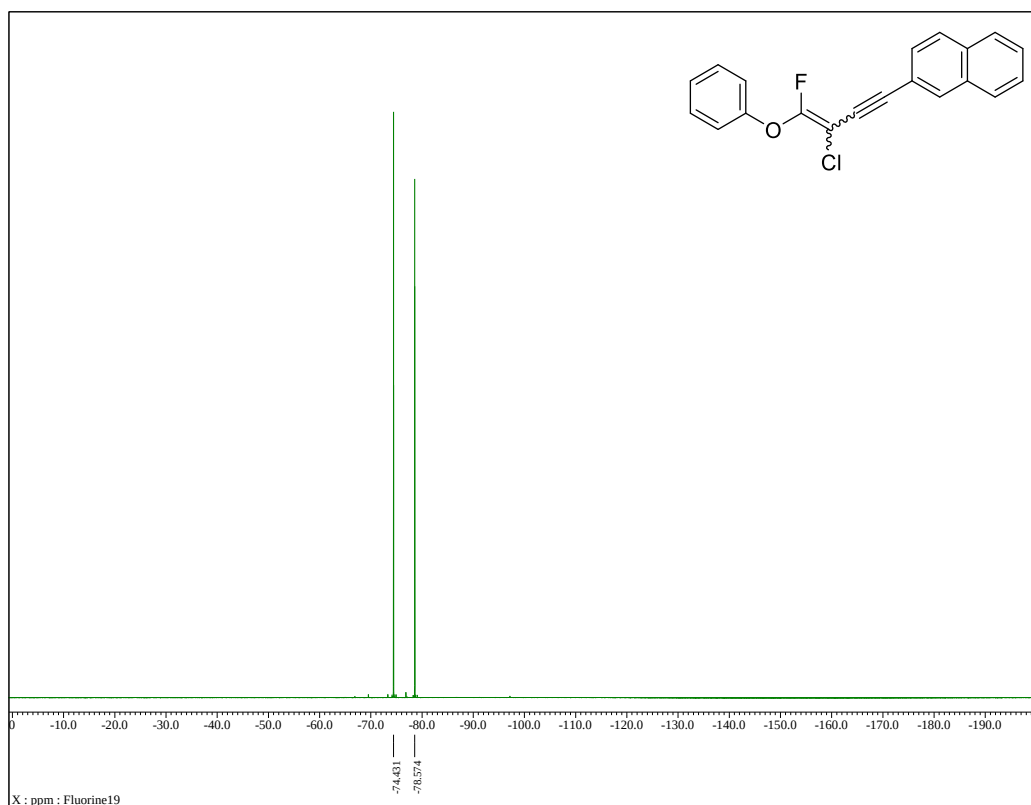
2-Chloro-1-fluoro-1-phenoxy-4-(4-phenylphenyl)but-1-en-3-yne (3f)



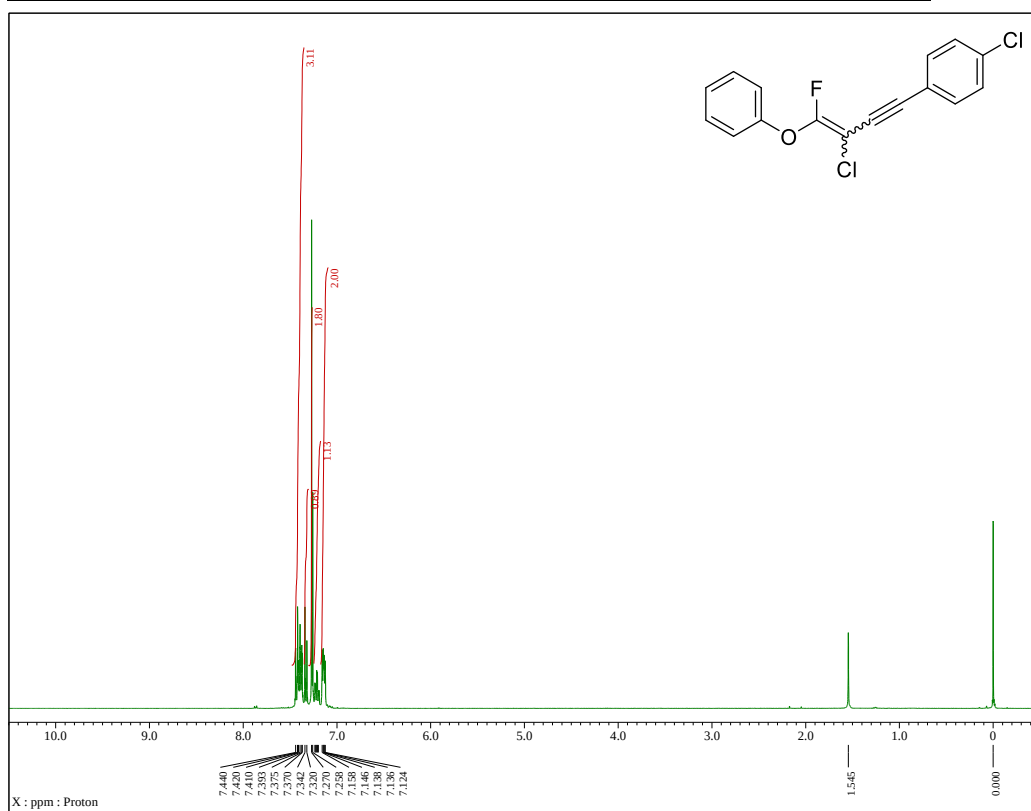


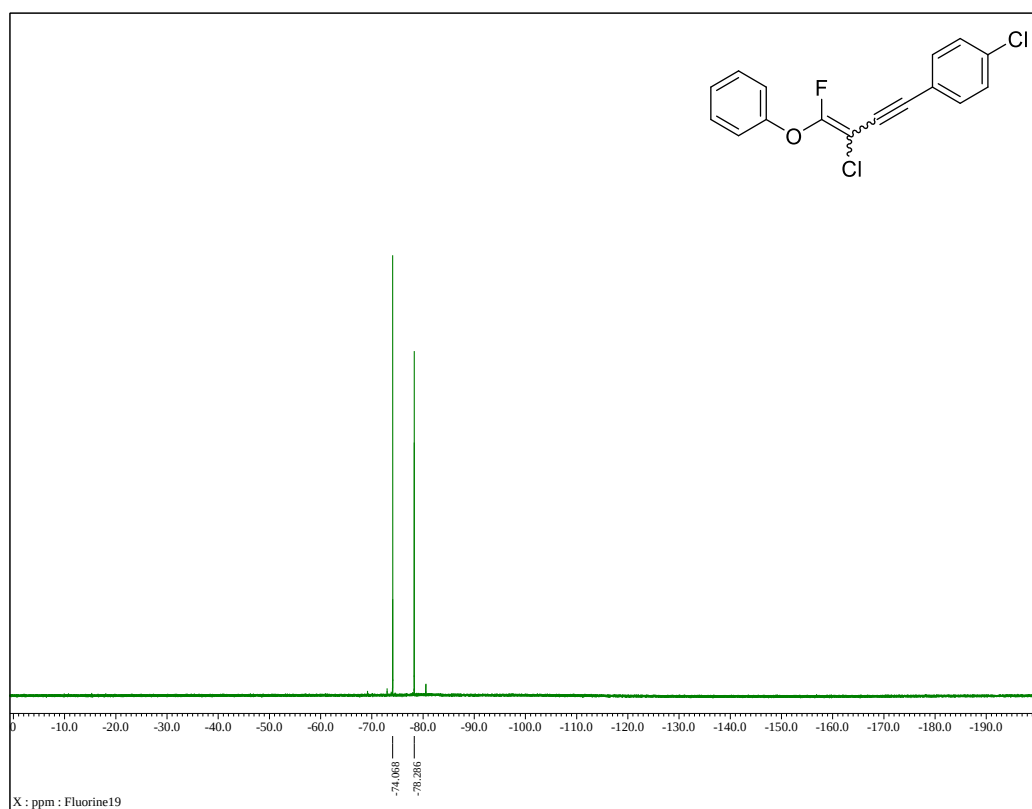
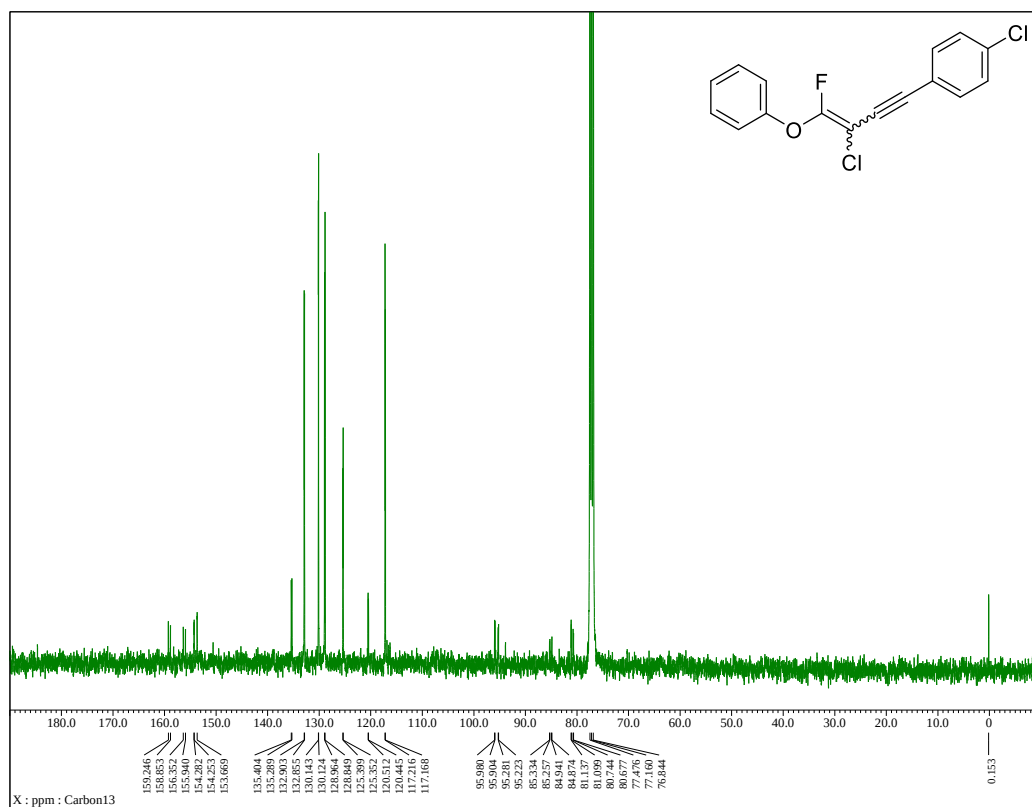
2-Chloro-1-fluoro-4-(2-naphthyl)-1-phenoxybut-1-en-3-yne (3g)



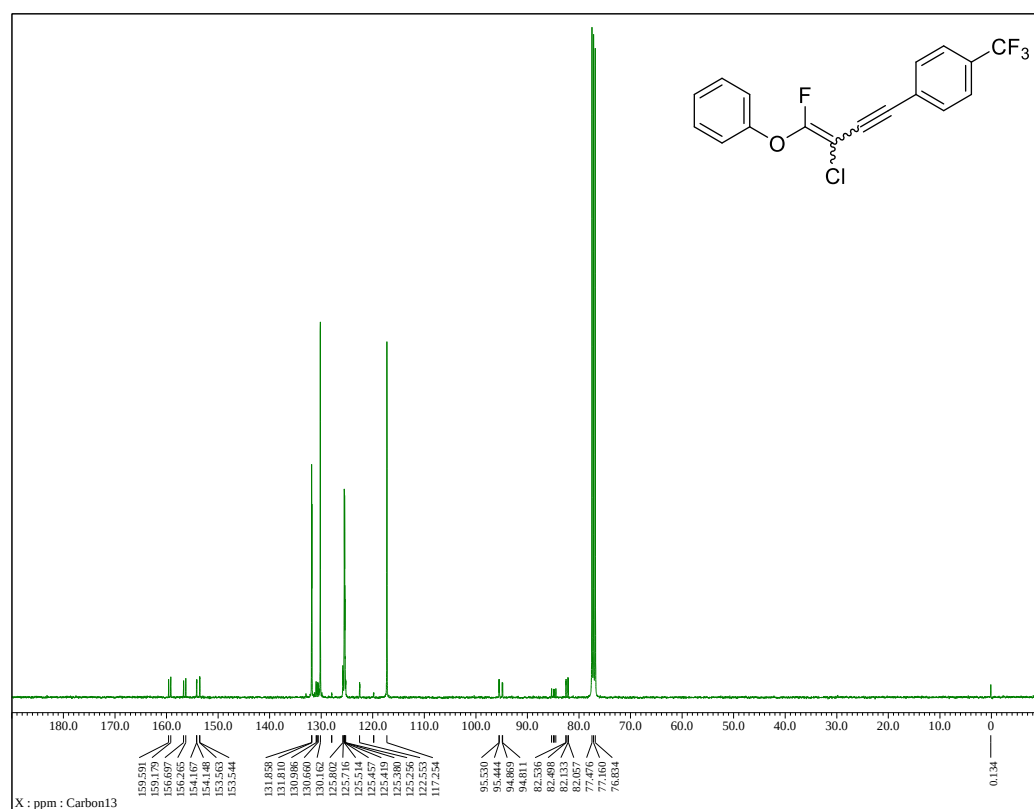
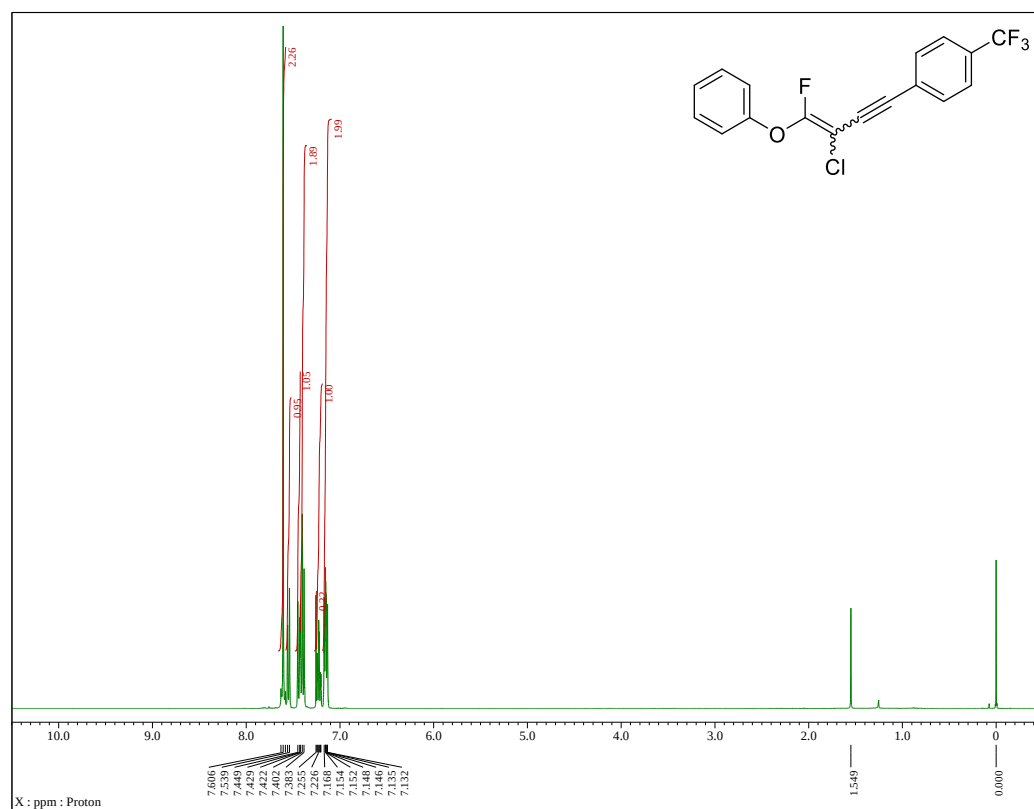


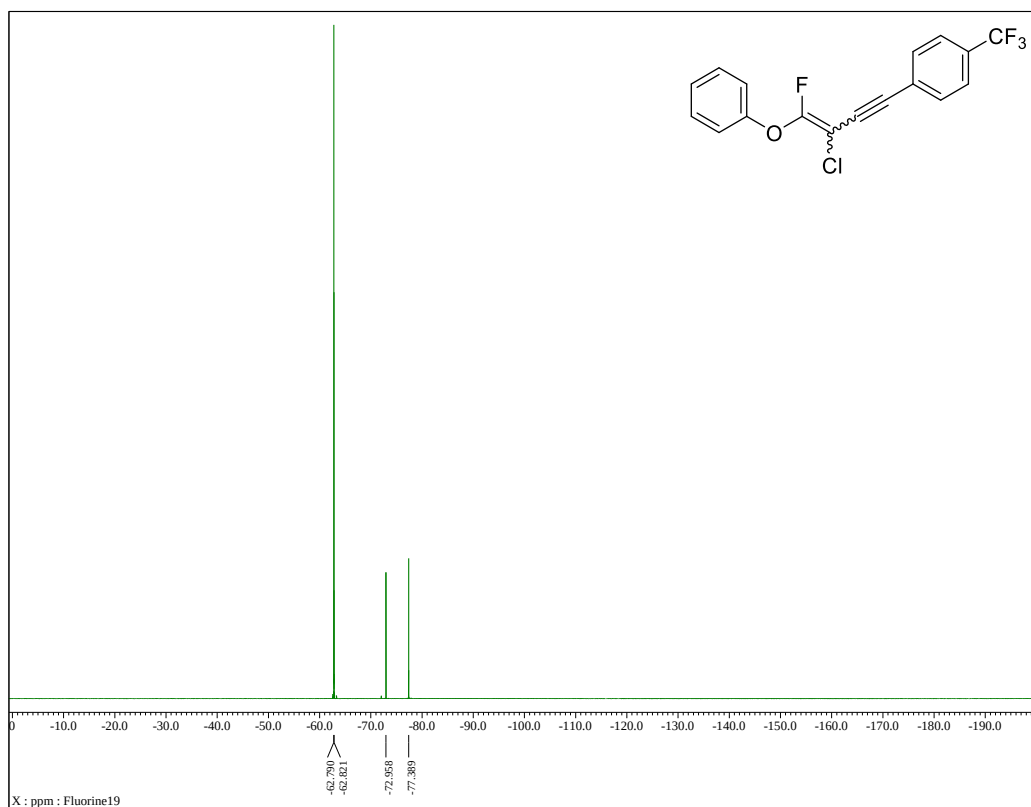
2-Chloro-4-(4-chlorophenyl)-1-fluoro-1-phenoxybut-1-en-3-yne (3h)



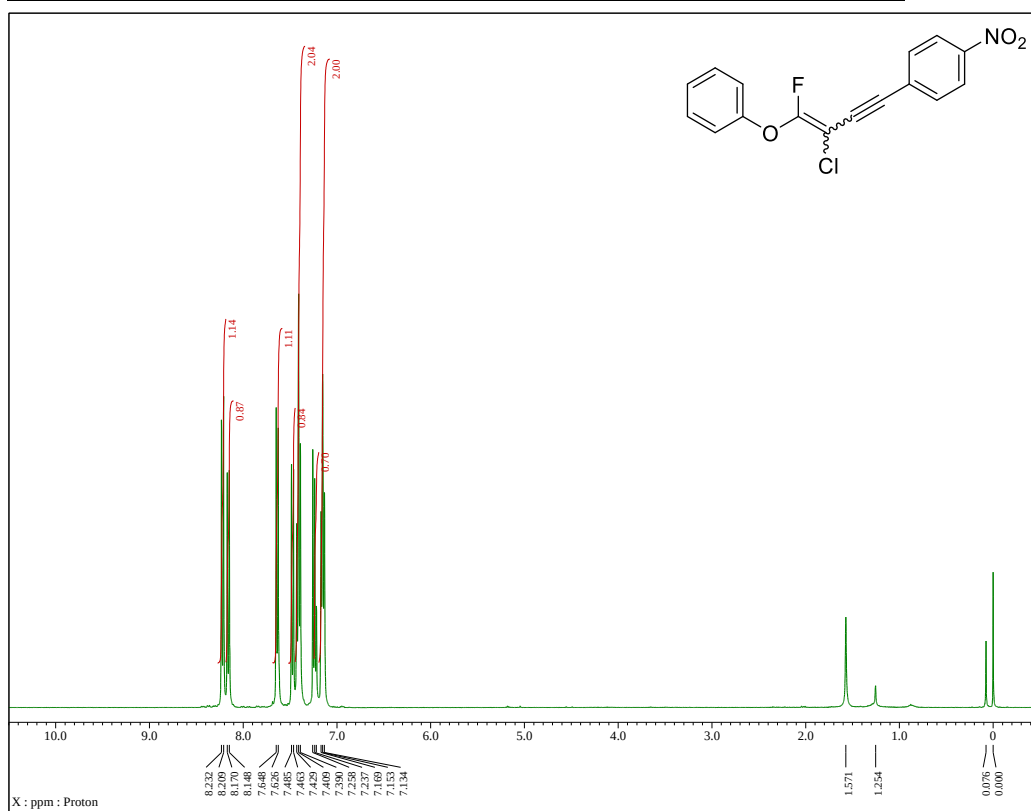


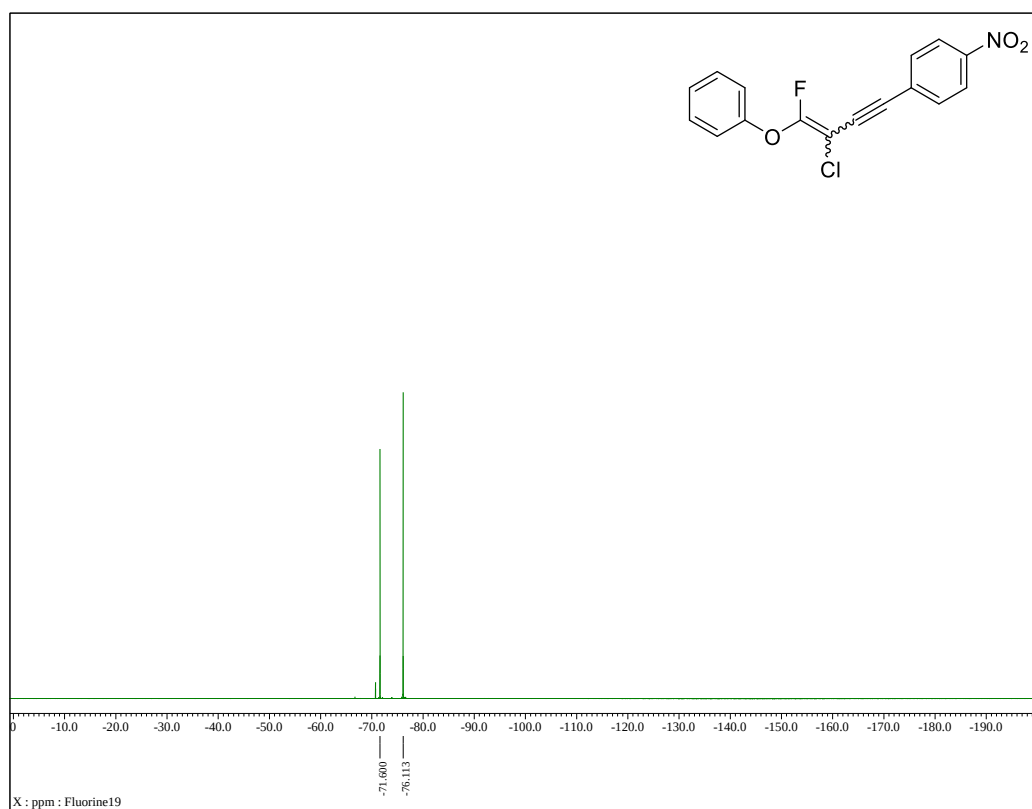
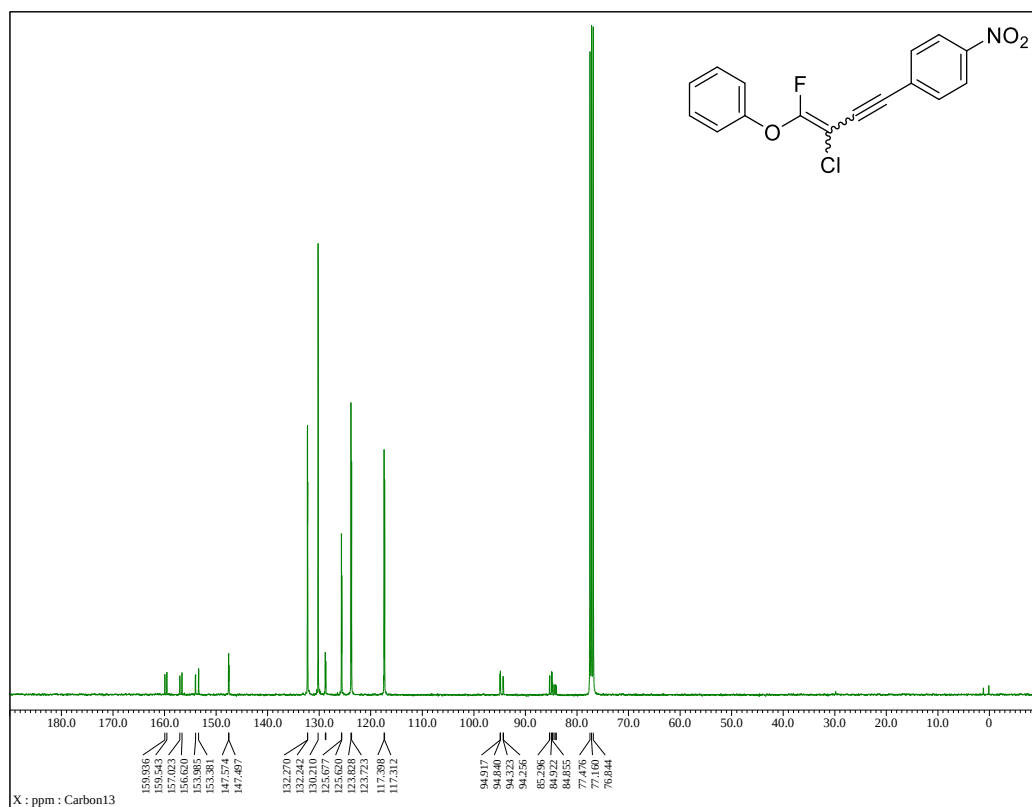
2-Chloro-1-fluoro-1-phenoxy-4-(4-trifluoromethylphenyl)but-1-en-3-yne (3i)



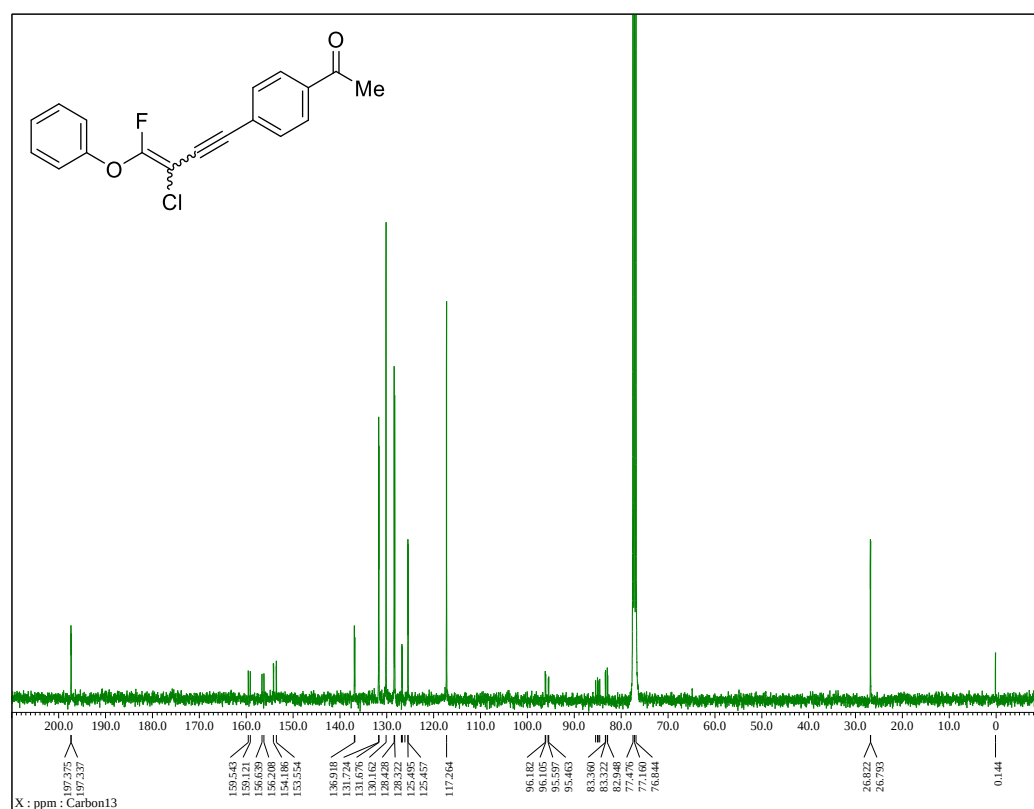
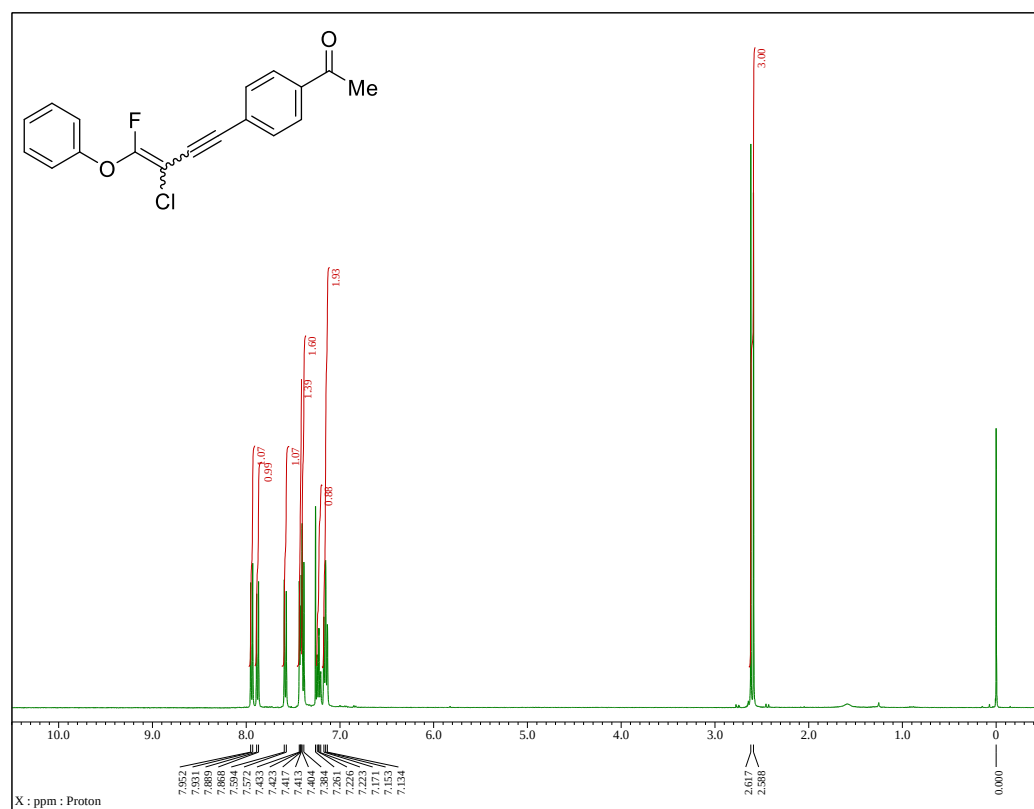


2-Chloro-1-fluoro-4-(4-nitrophenyl)-1-phenoxybut-1-en-3-yne (3j)



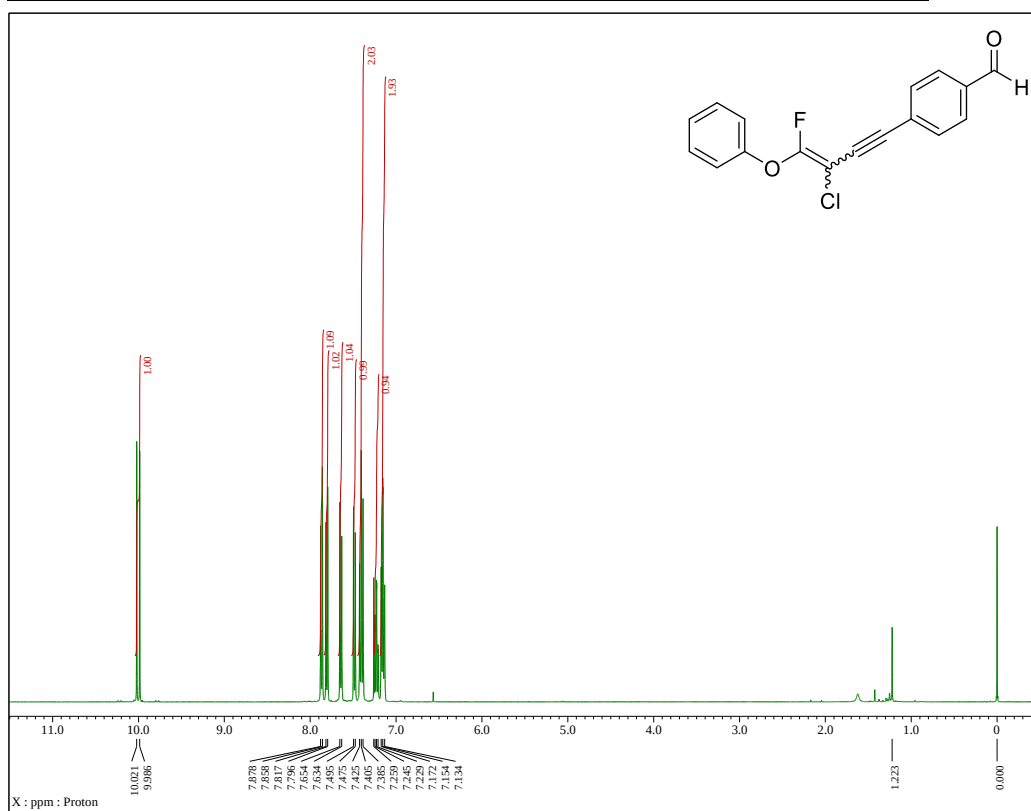


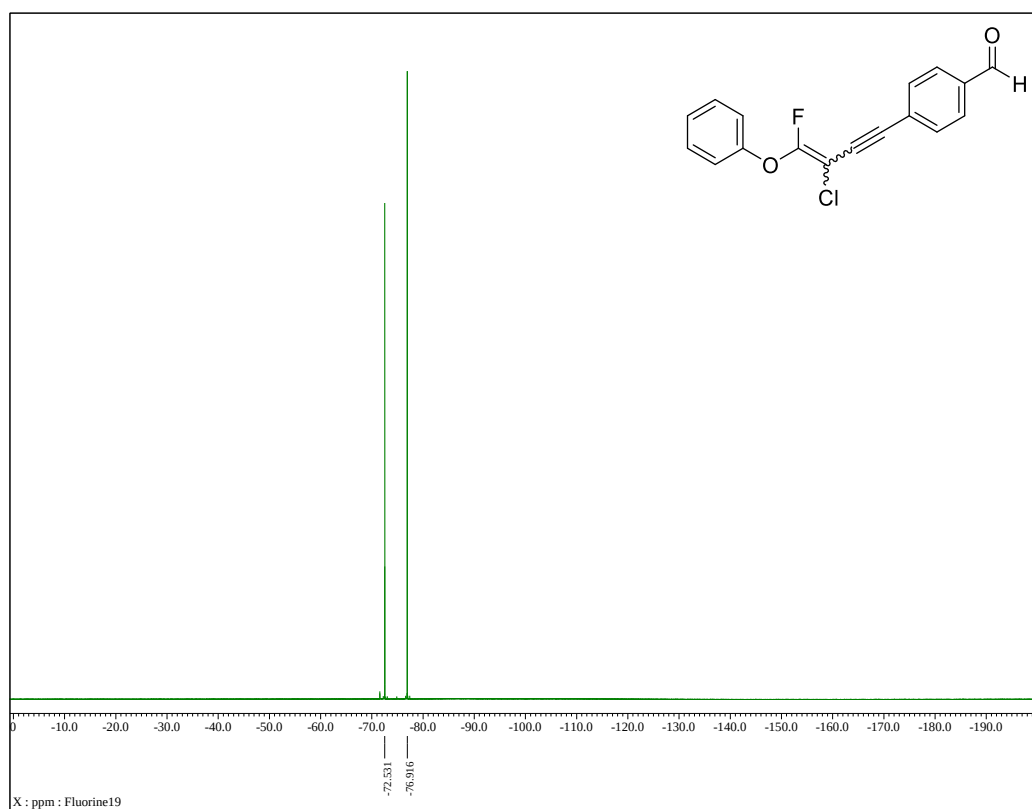
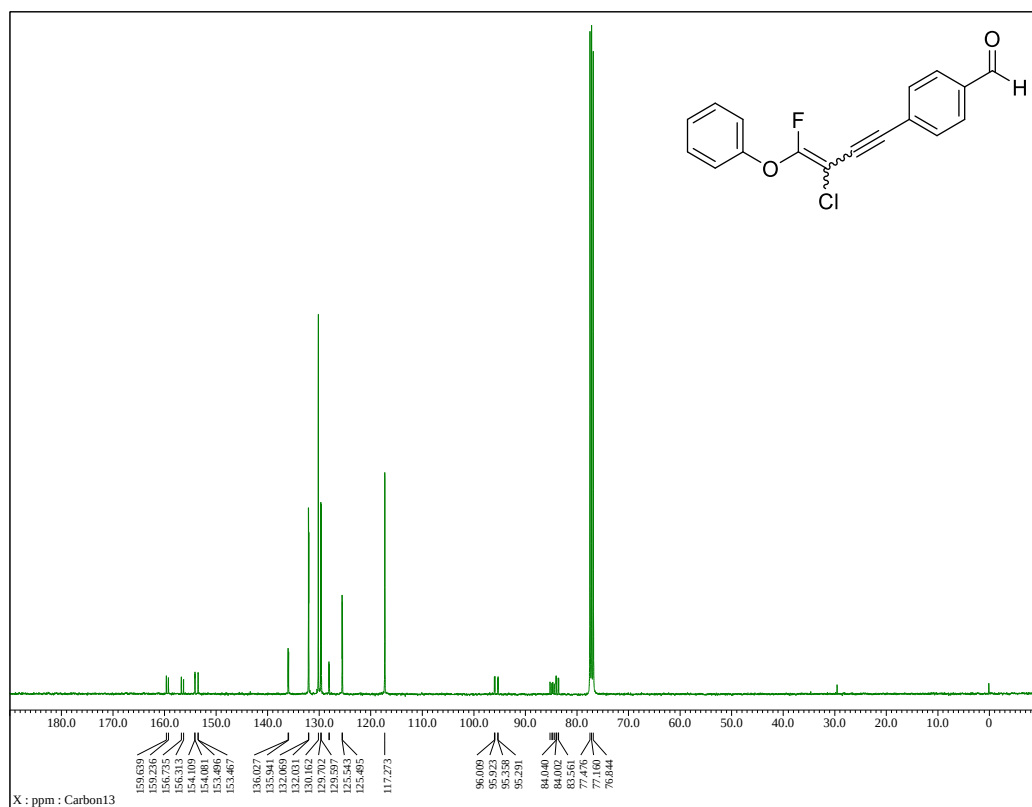
4-(4-Acetylphenyl)-2-chloro-1-fluoro-1-phenoxybut-1-en-3-yne (3k)



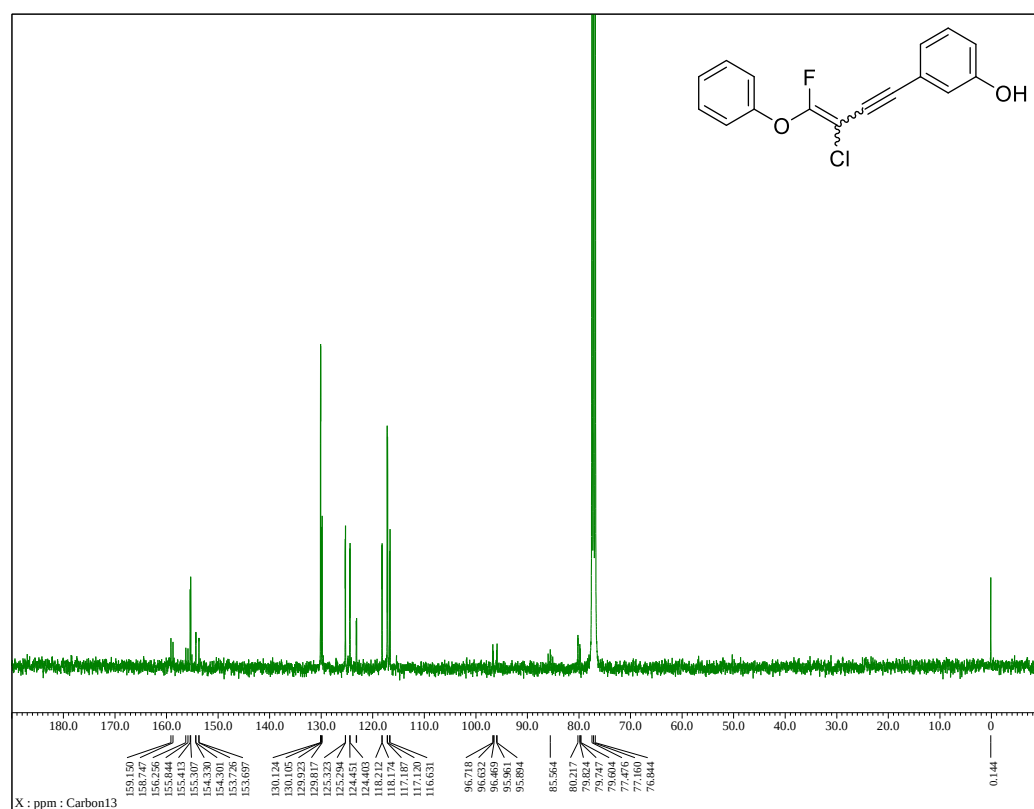
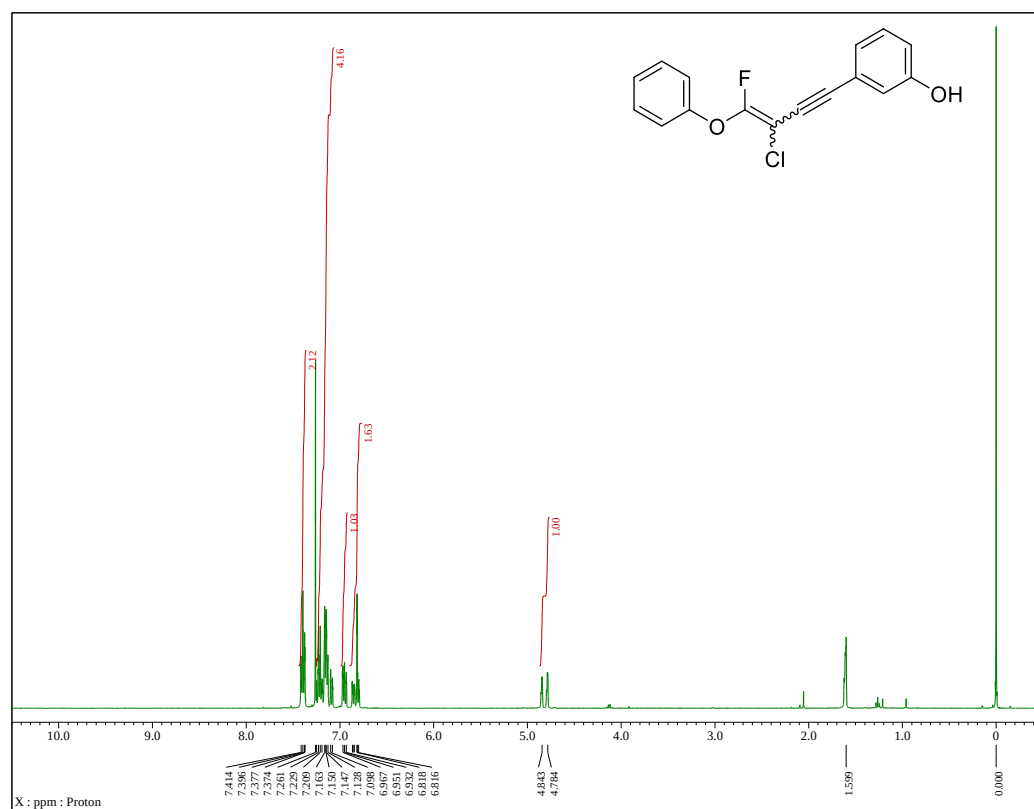


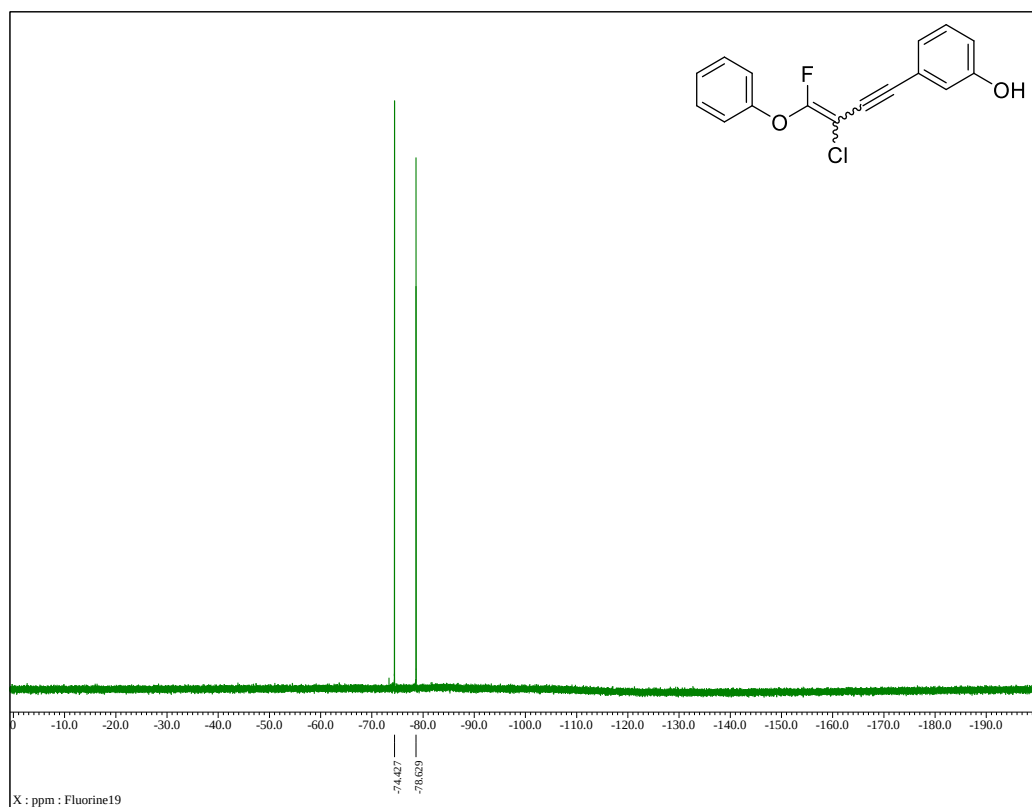
2-Chloro-1-fluoro-4-(4-formylphenyl)-1-phenoxybut-1-en-3-yne (3l)



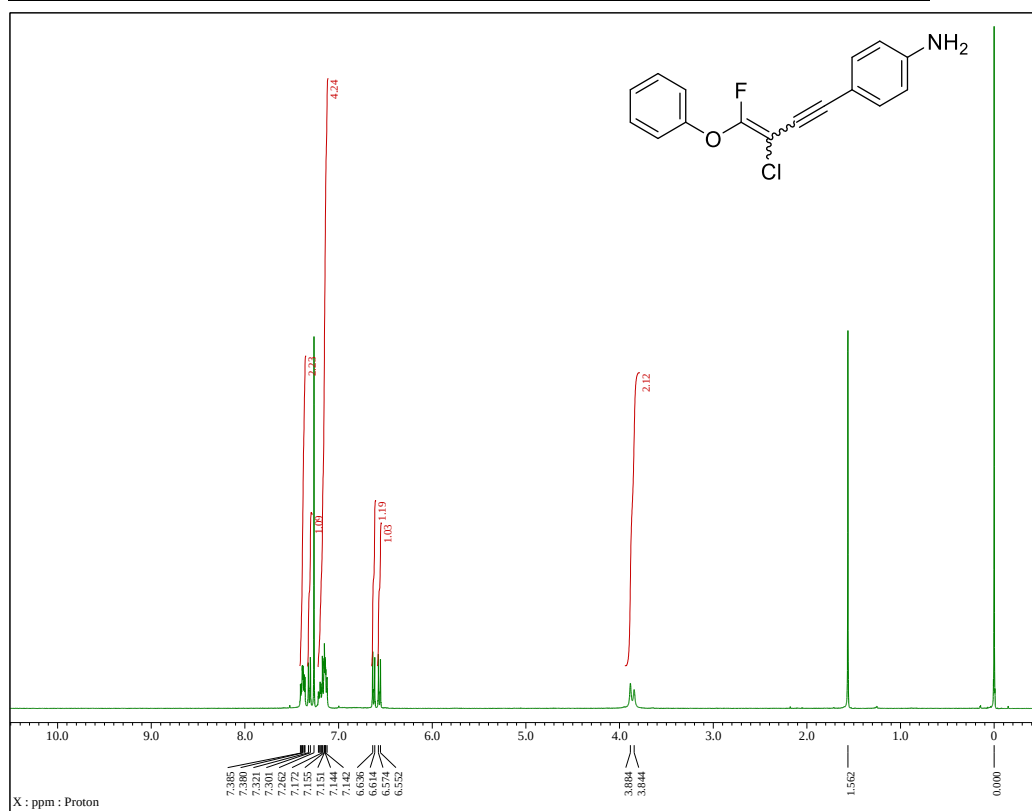


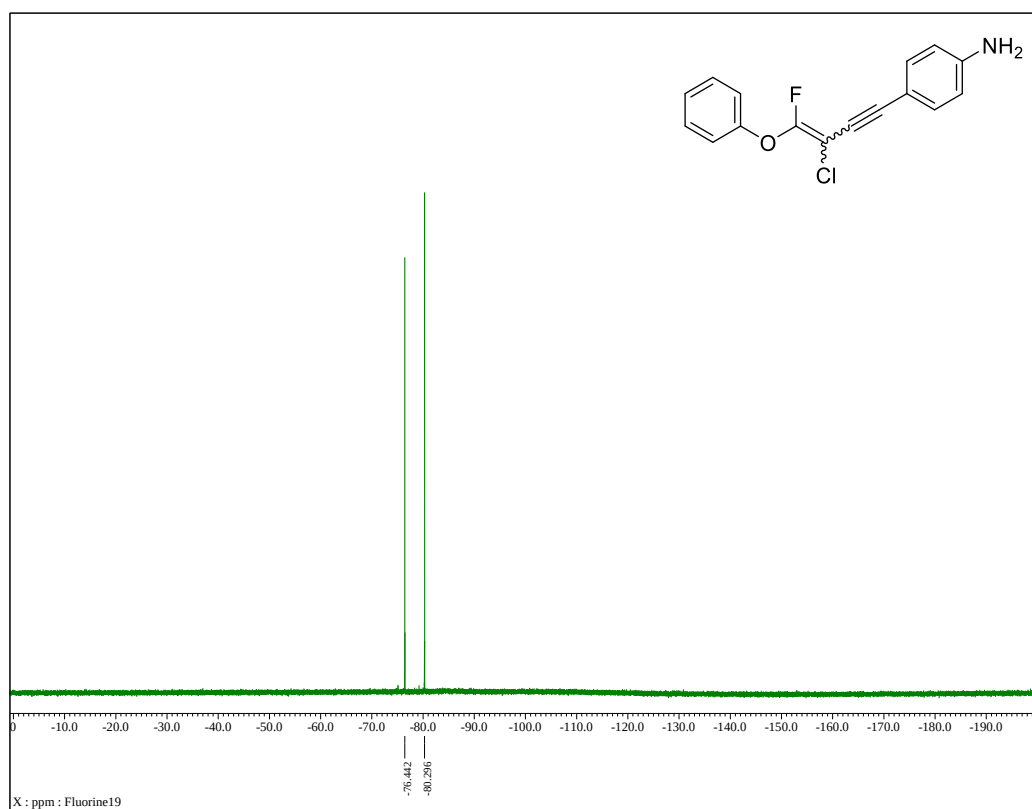
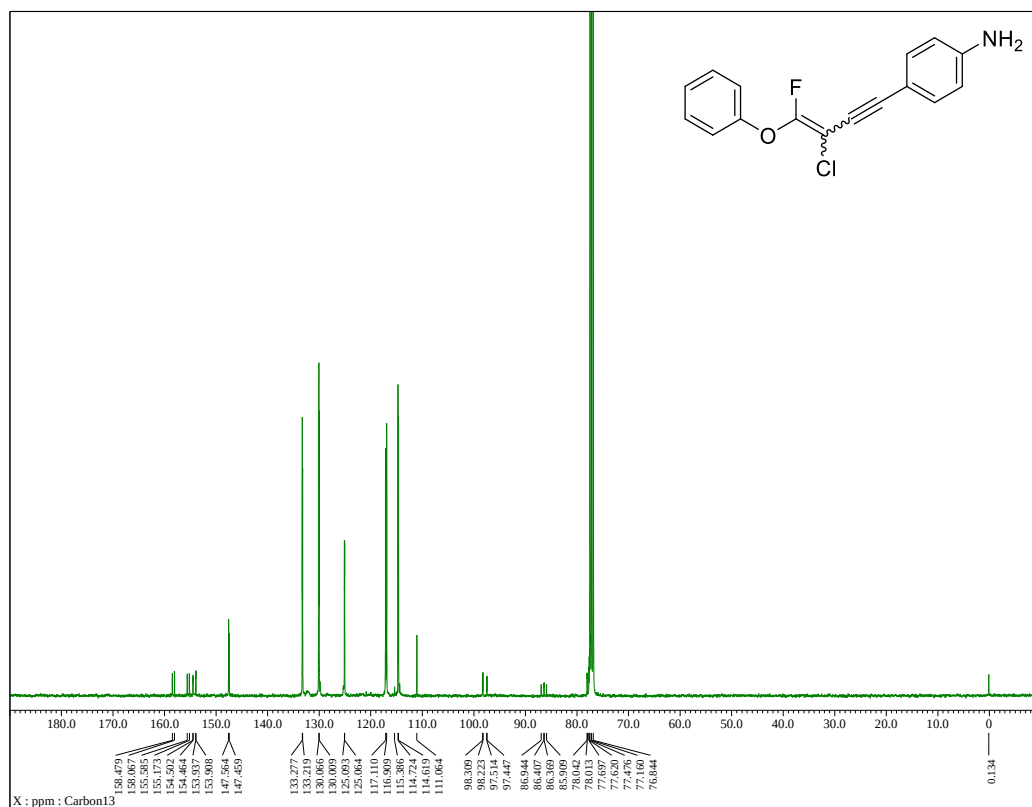
2-Chloro-1-fluoro-4-(3-hydroxyphenyl)-1-phenoxybut-1-en-3-yne (3m)



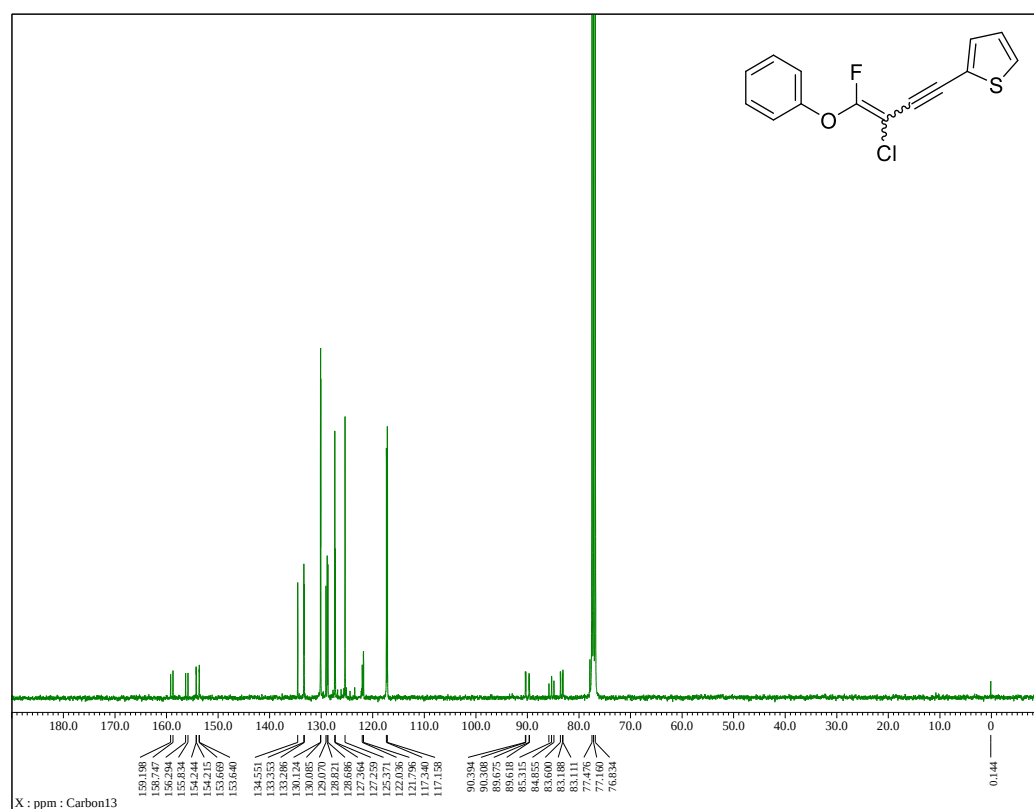
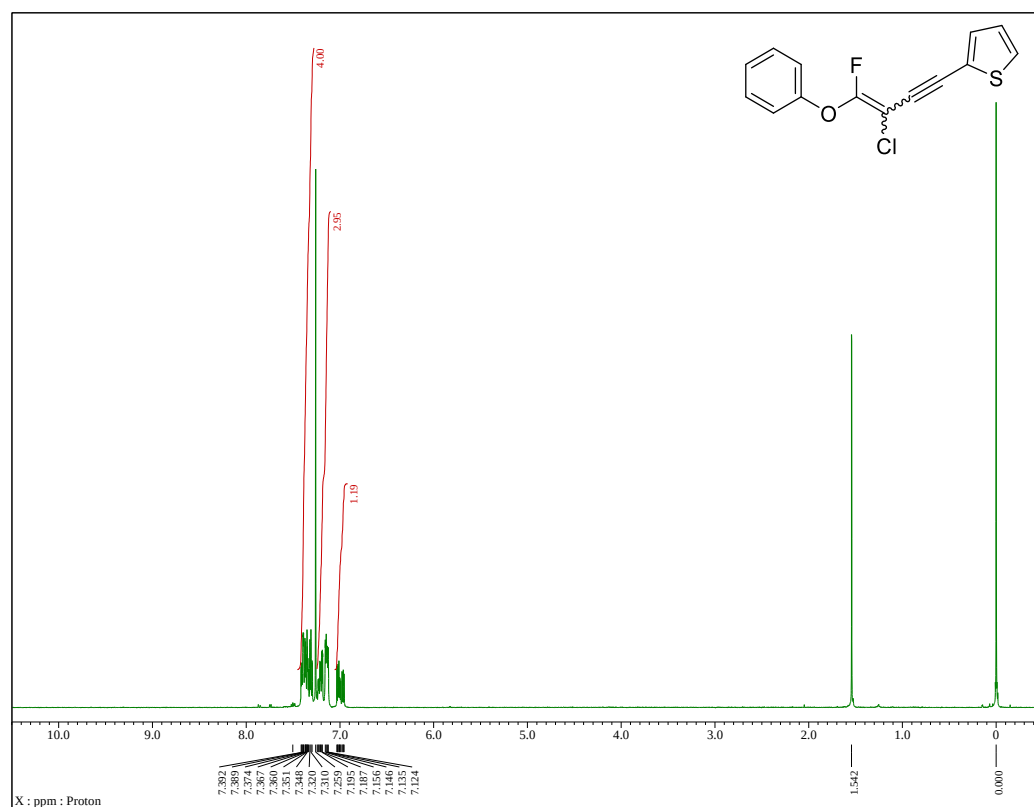


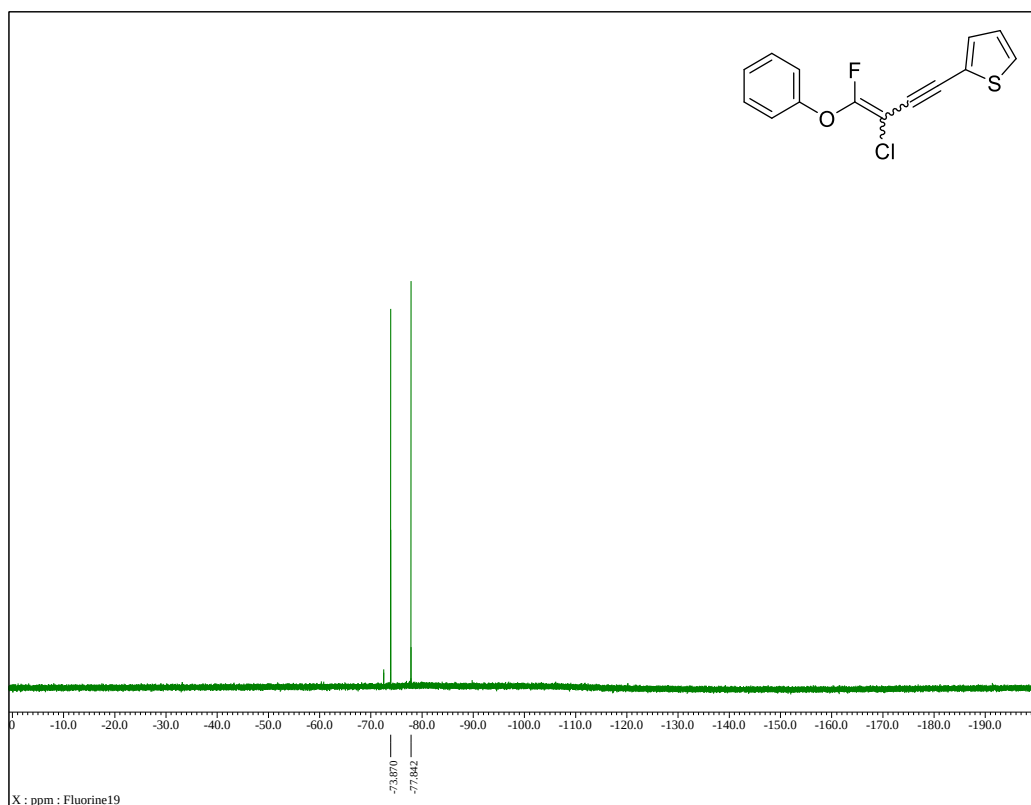
4-(4-Aminophenyl)-2-chloro-1-fluoro-1-phenoxybut-1-en-3-yne (3n)



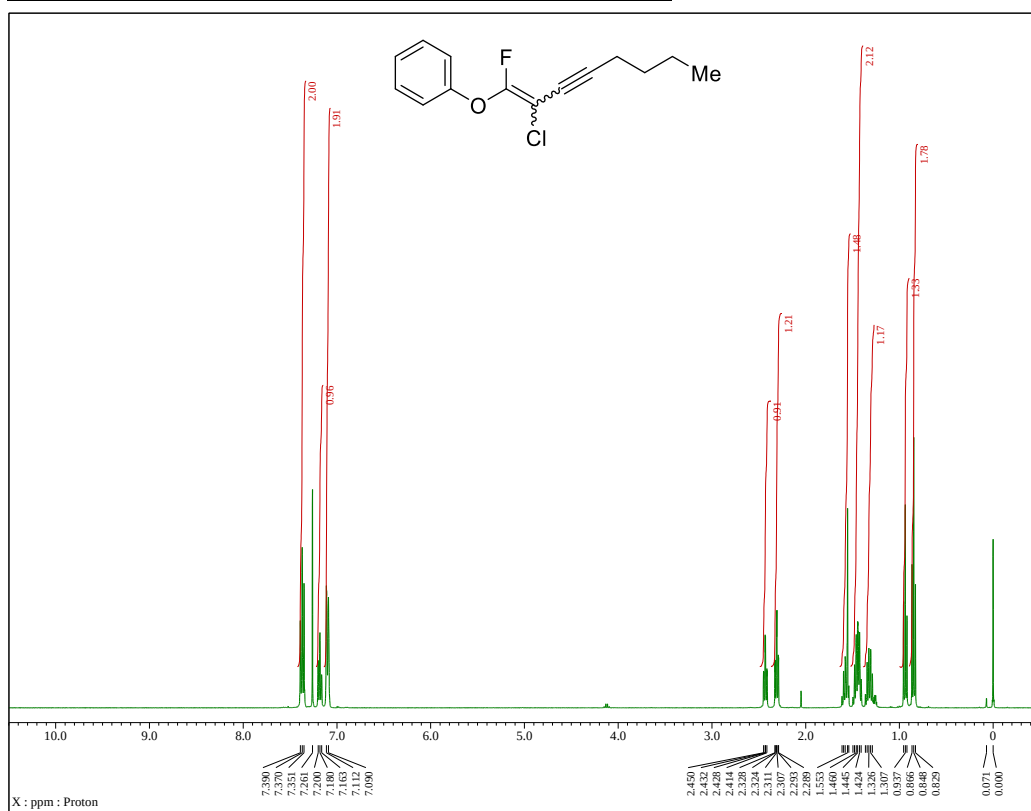


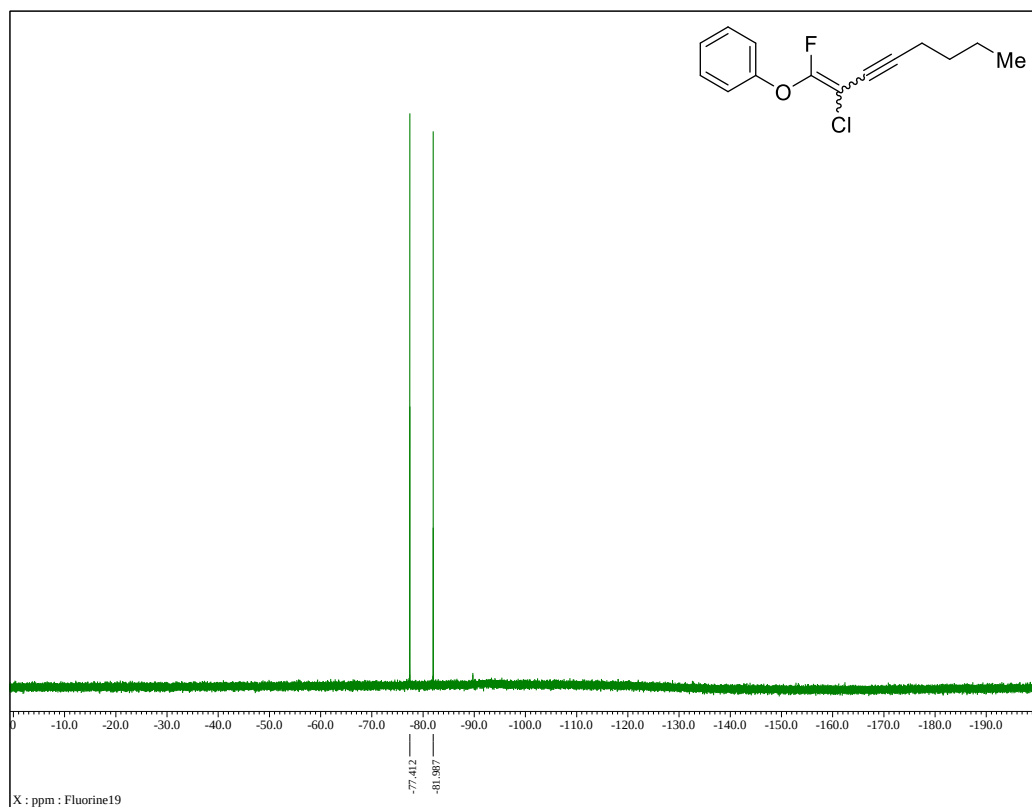
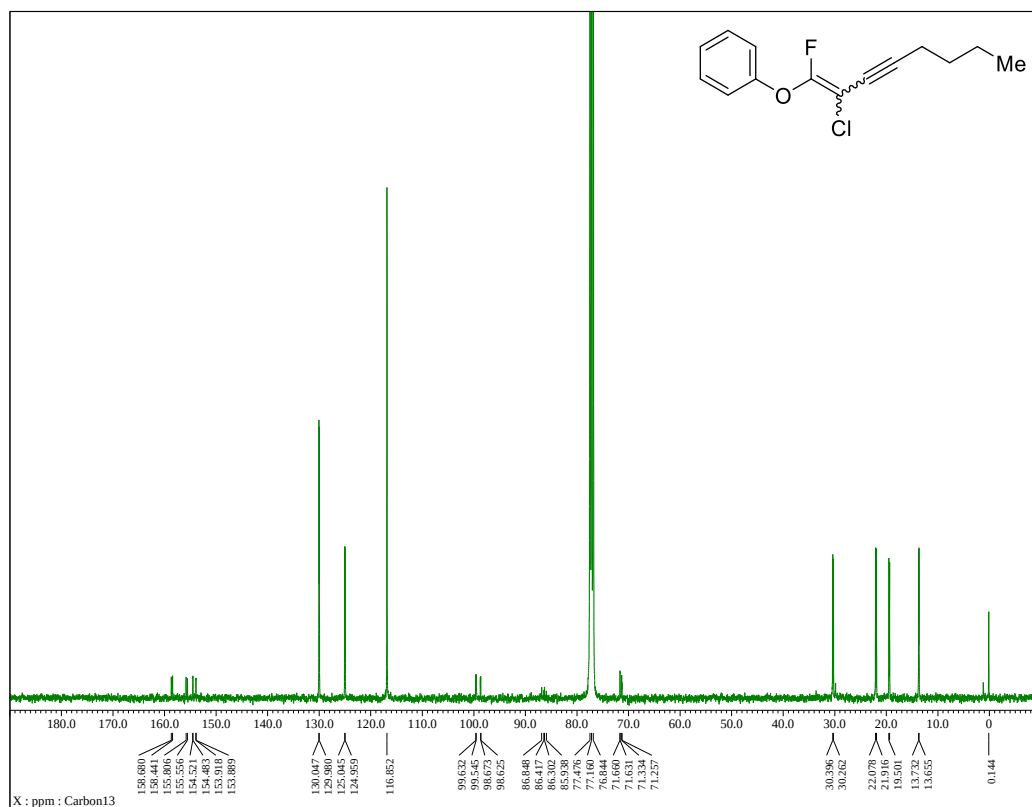
2-Chloro-1-fluoro-1-phenoxy-4-(thiophene-2-yl)-but-1-en-3-yne (3o)



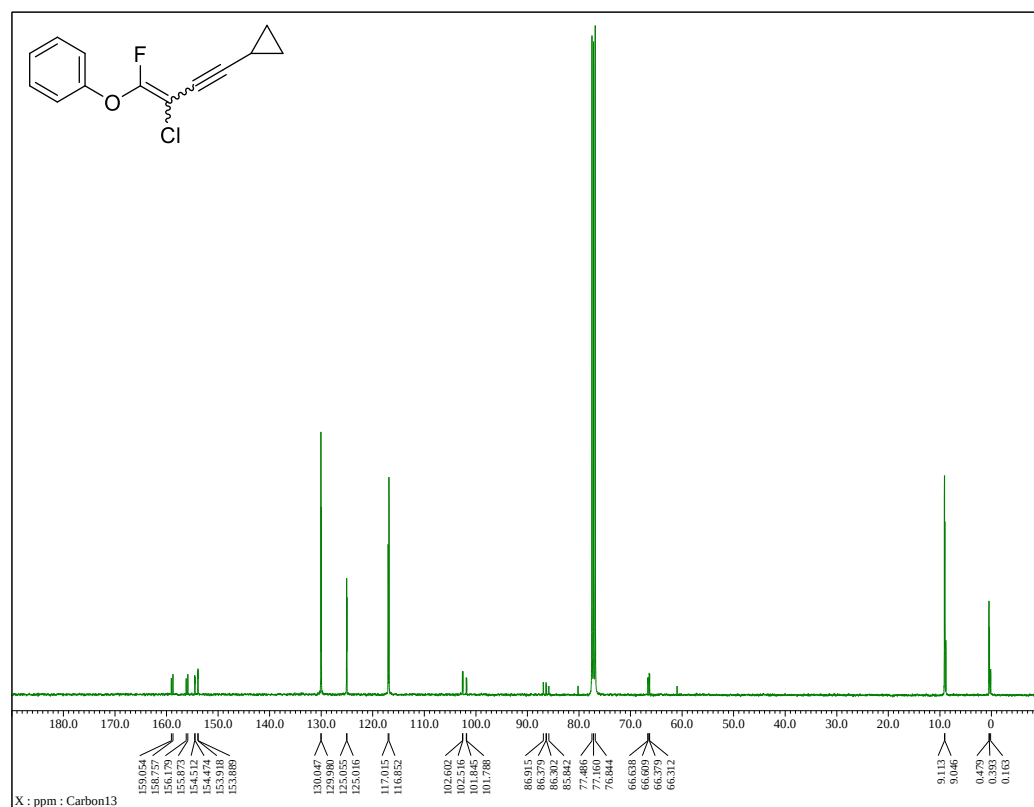
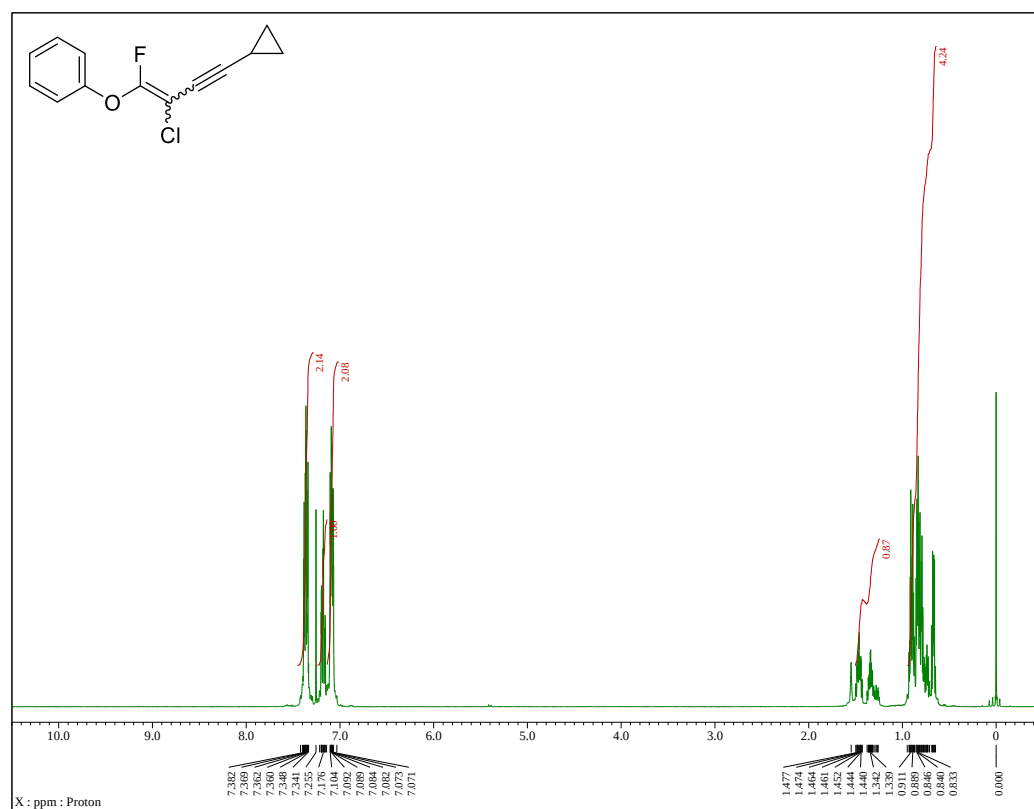


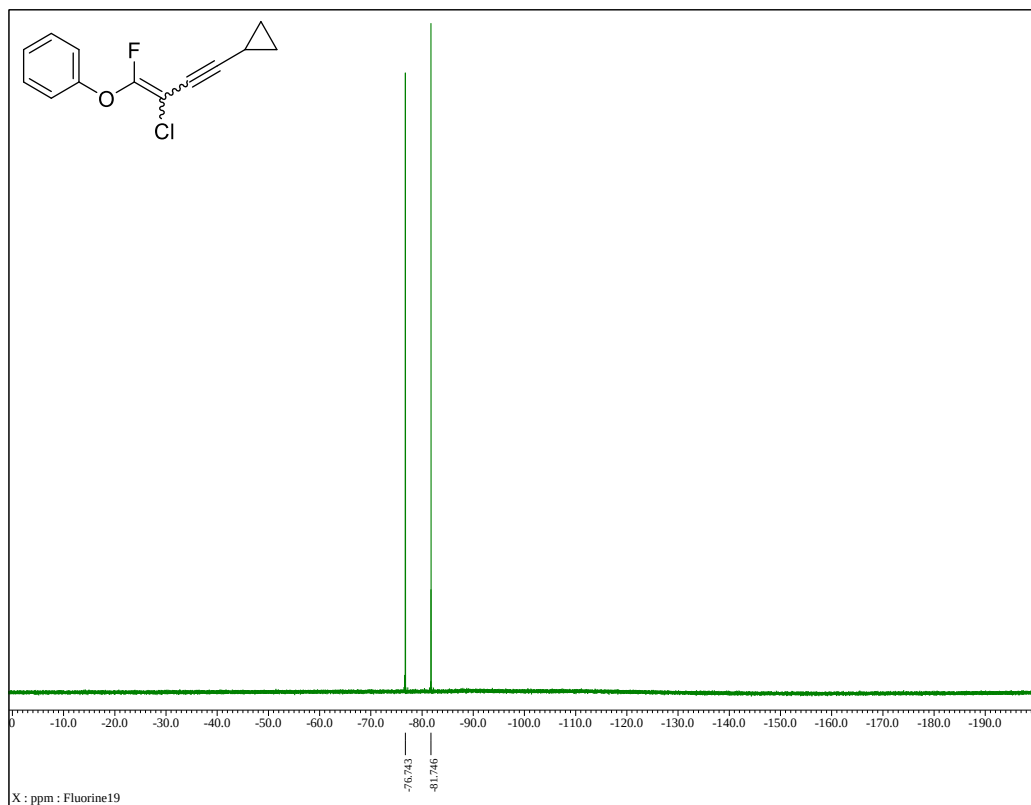
2-Chloro-1-fluoro-1-phenoxy-oct-1-en-3-yne (3p)



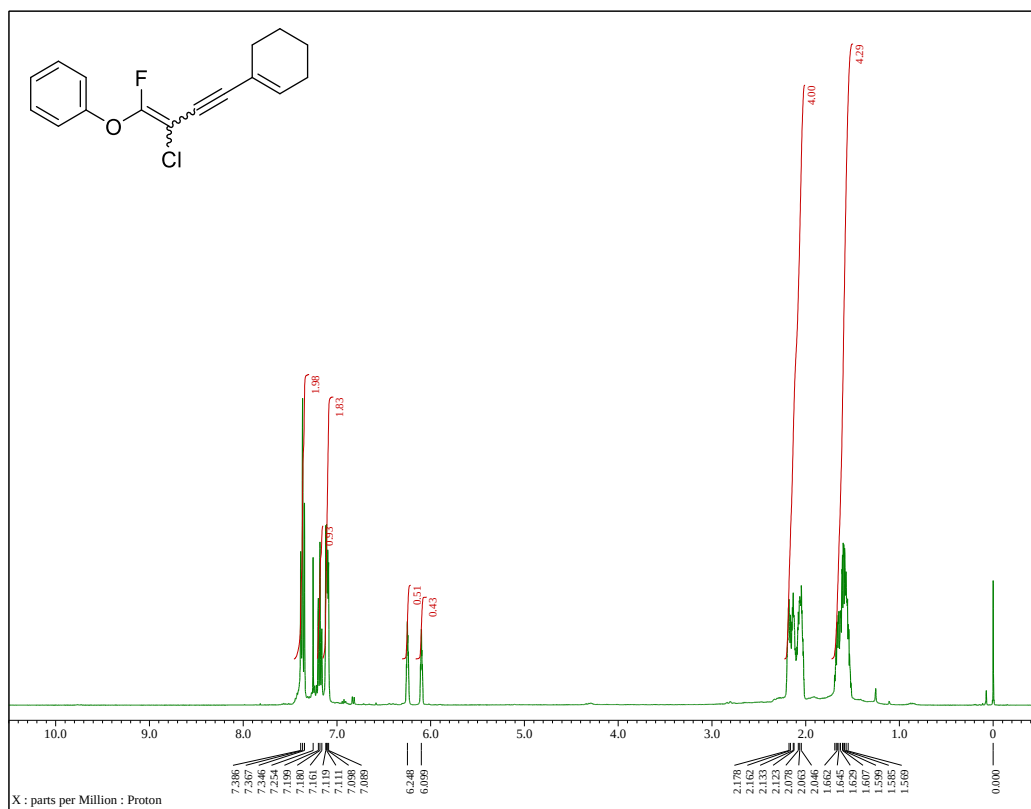


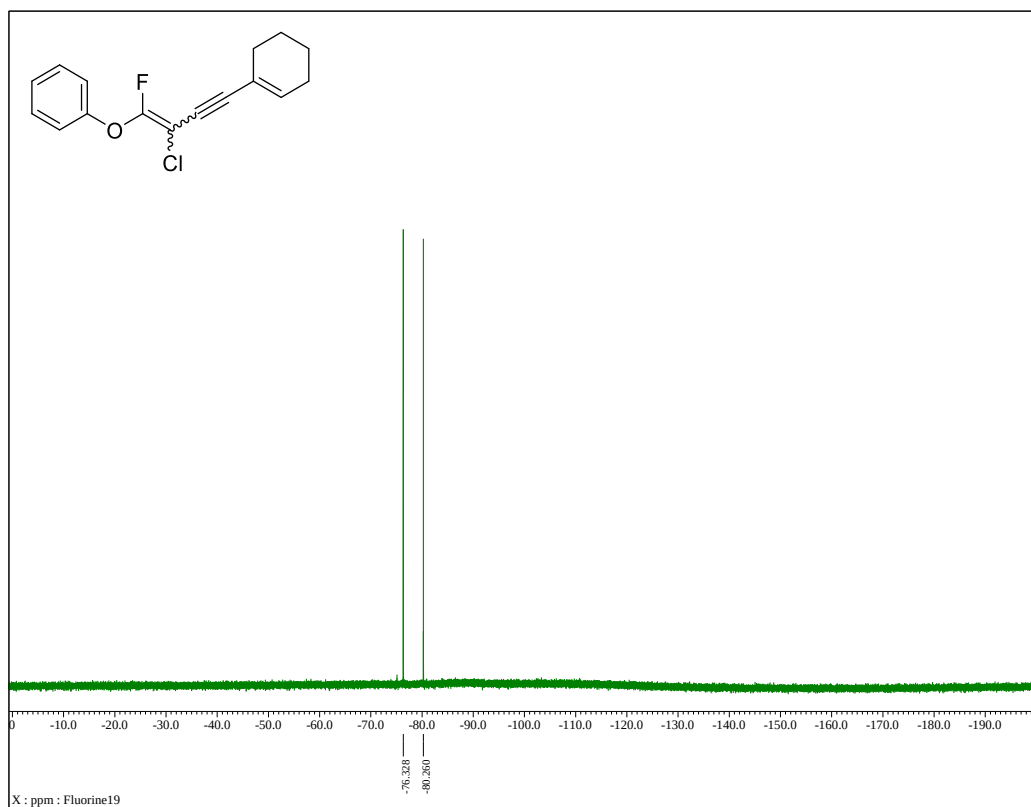
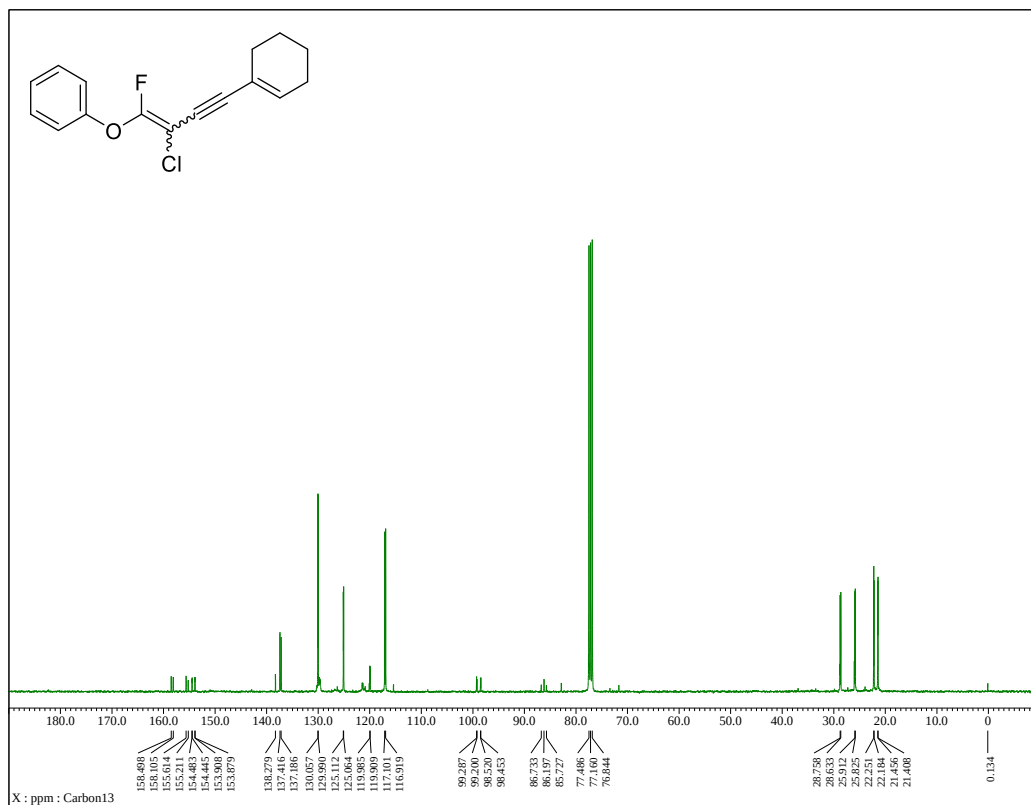
2-Chloro-4-cyclopropyl-1-fluoro-1-phenoxy-but-1-en-3-yne (3q)



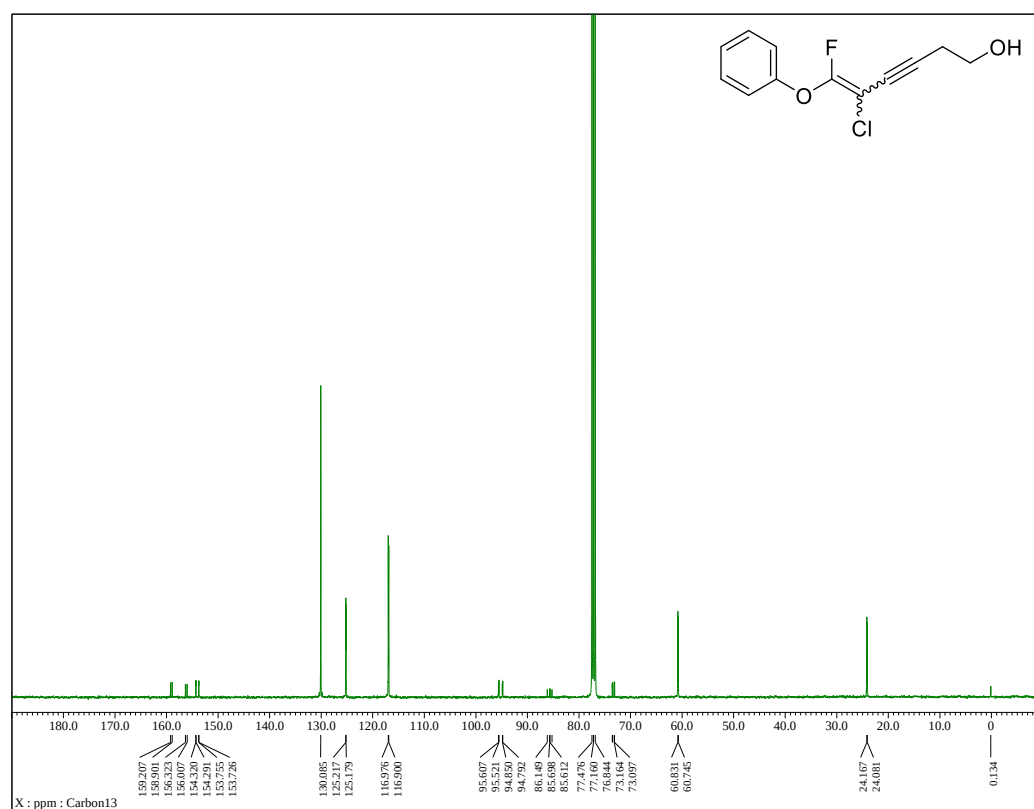
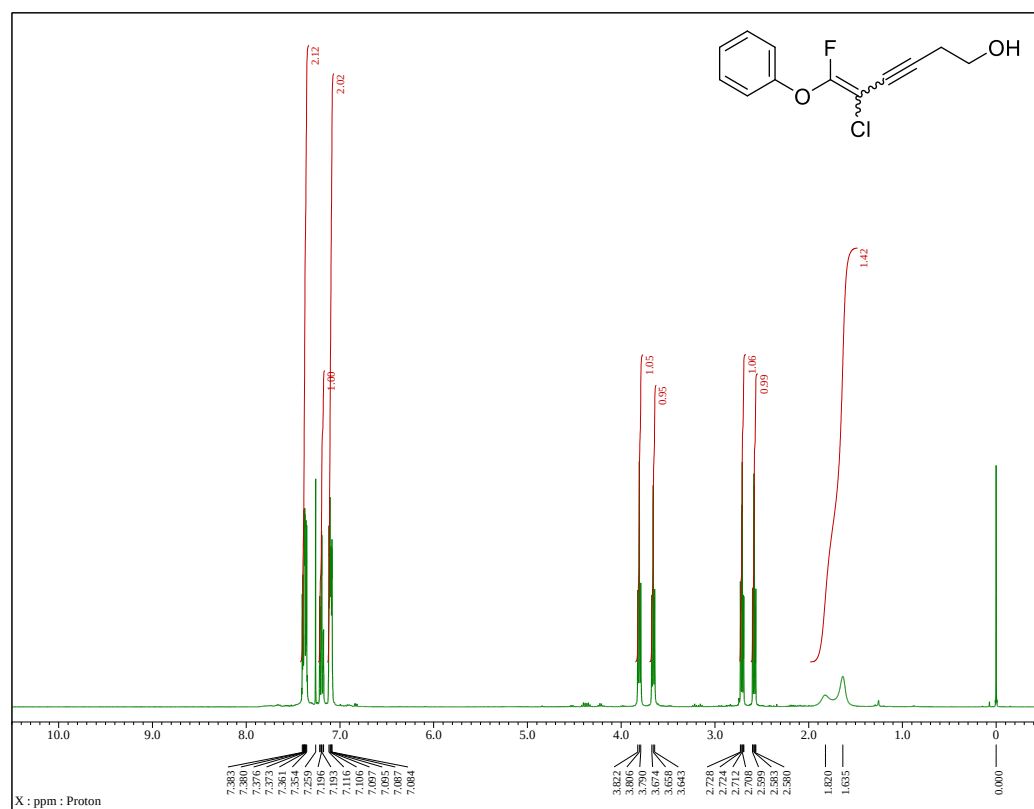


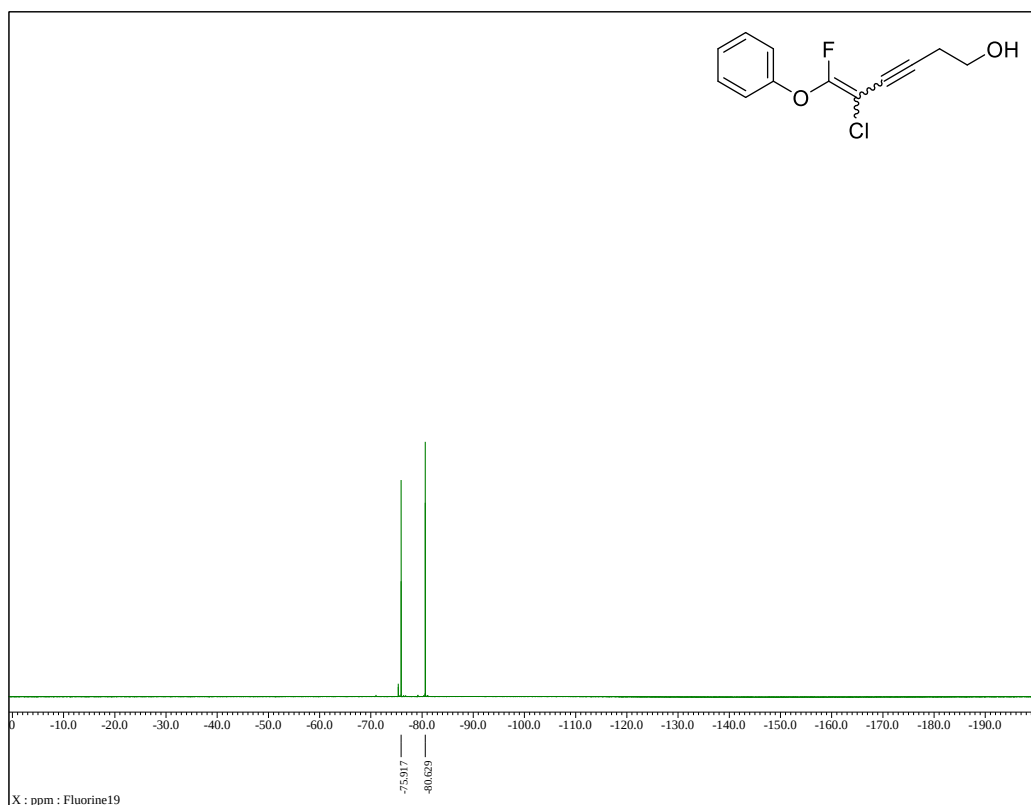
2-Chloro-4-cyclohex-1-yl-1-fluoro-1-phenoxy-but-1-en-3-yne (3r)



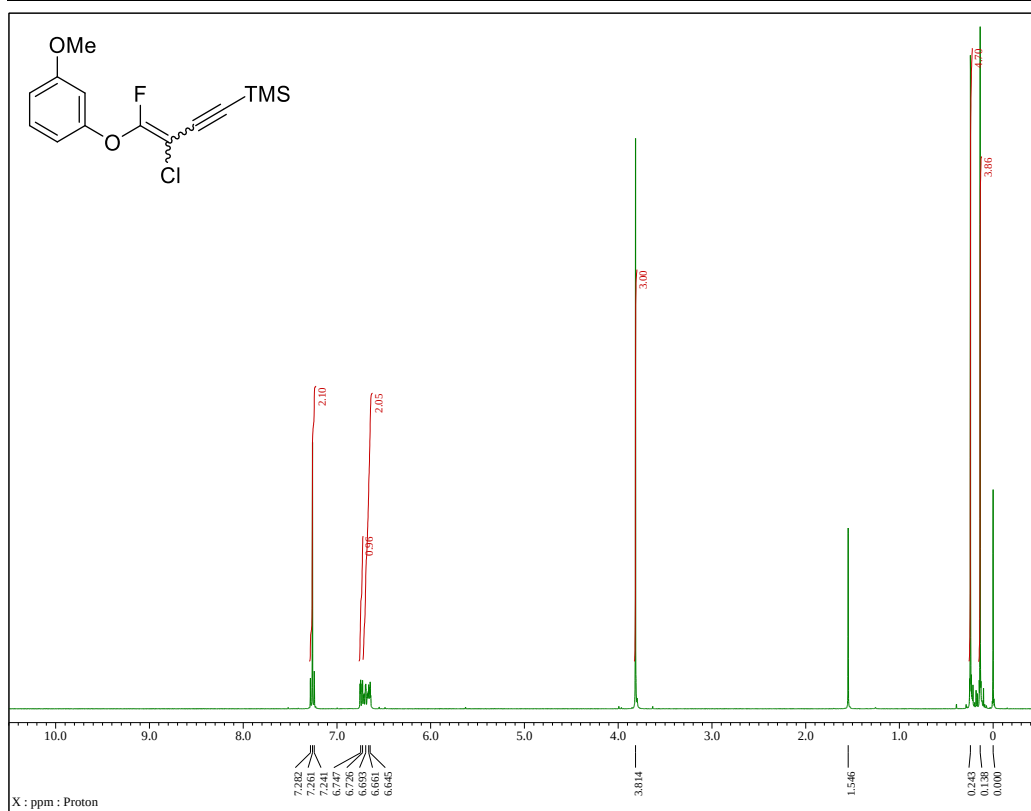


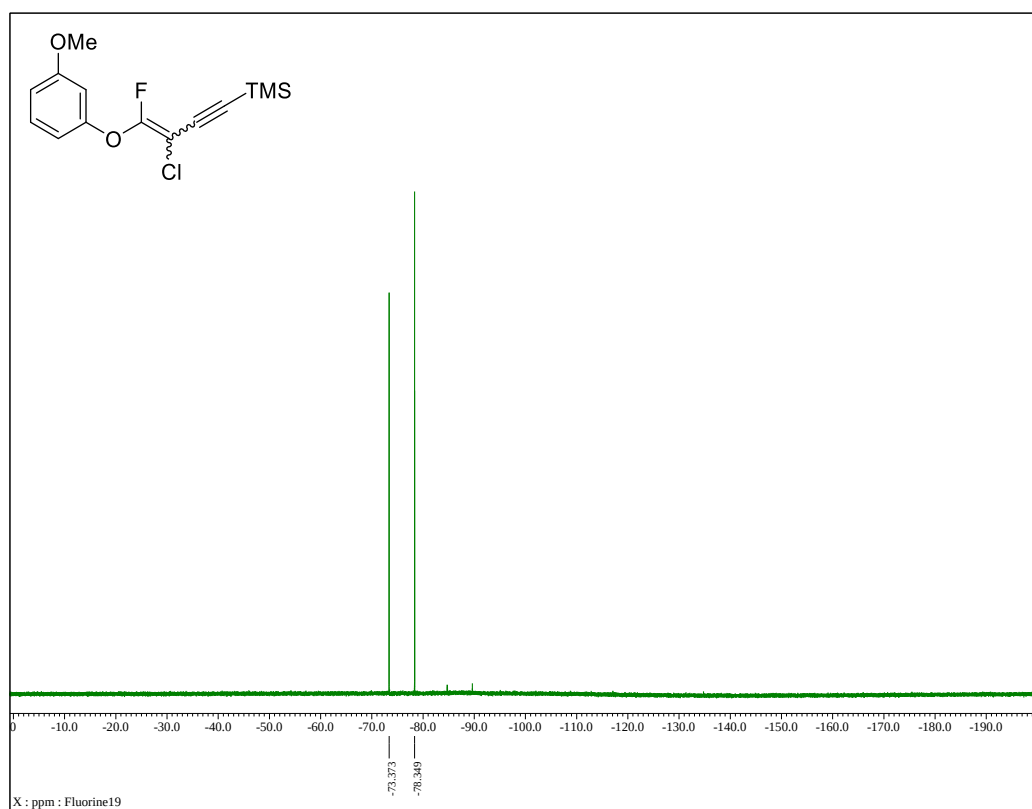
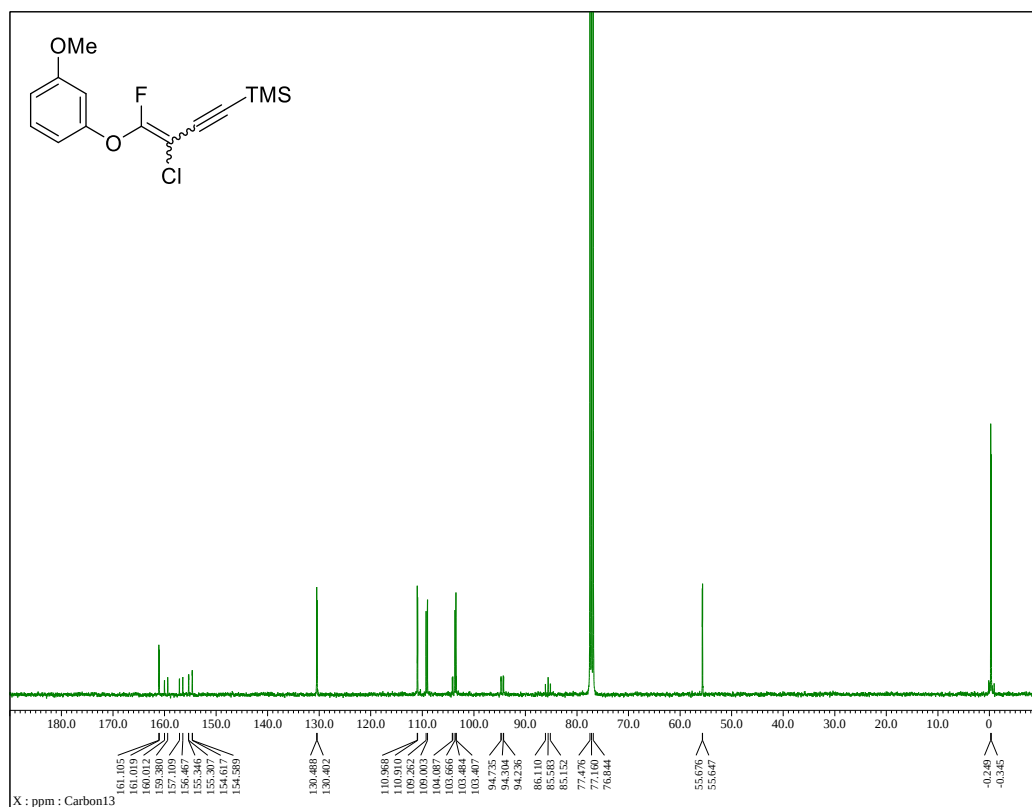
5-Chloro-6-fluoro-6-phenoxy-hex-5-en-3-yn-1-ol (3s)



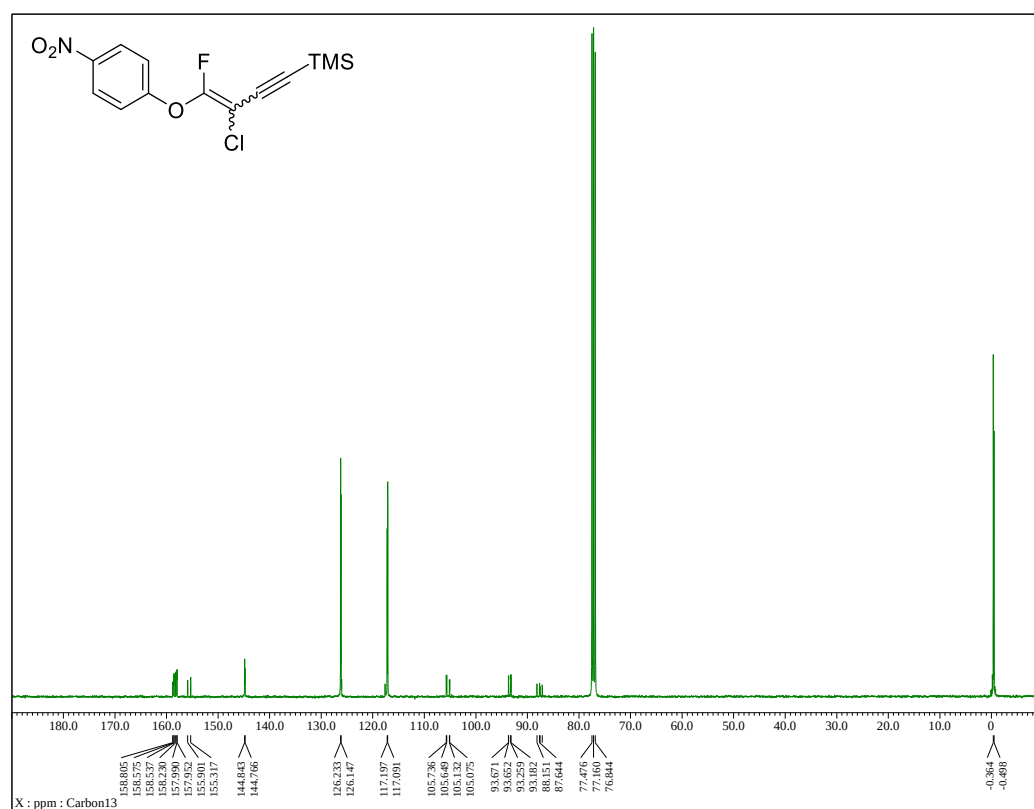
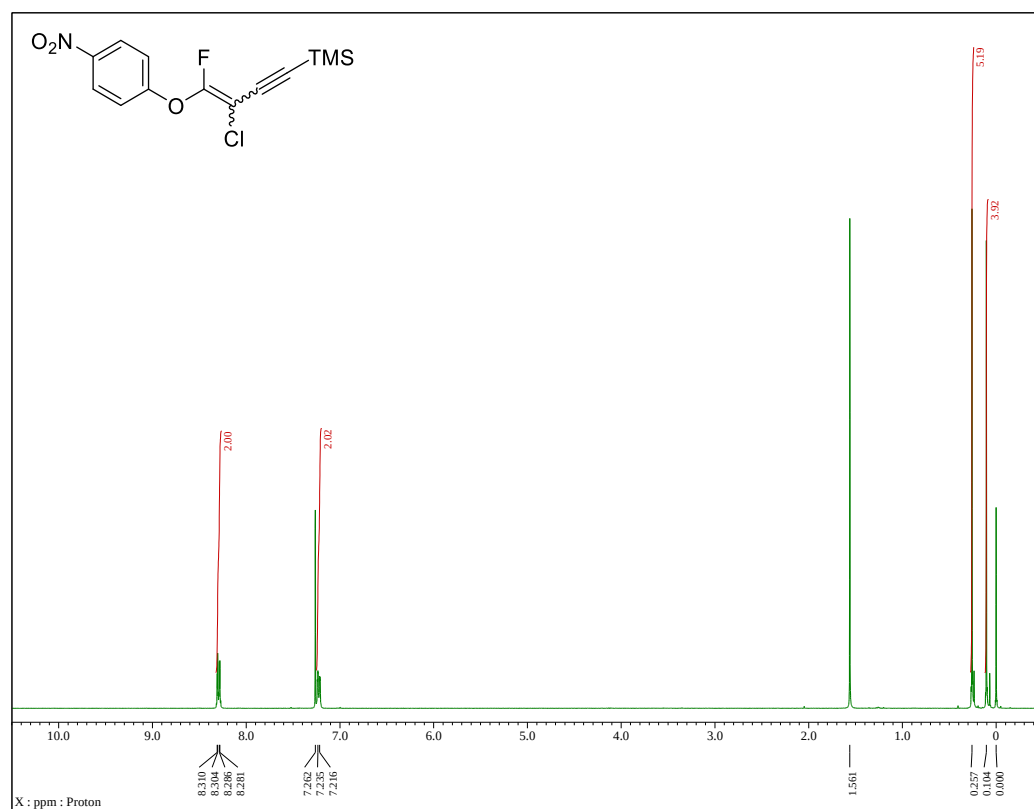


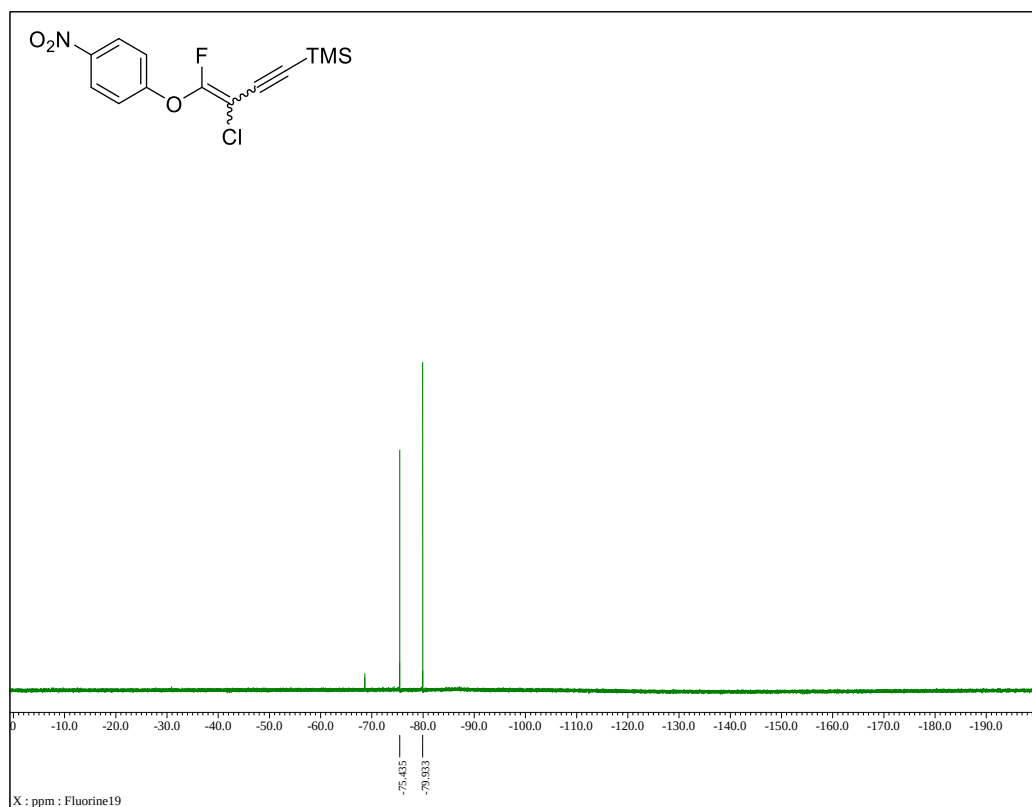
(3-Chloro-4-fluoro-4-(3-methoxyphenoxy)but-3-en-1-yn-1-yl)trimethylsilane (3t)



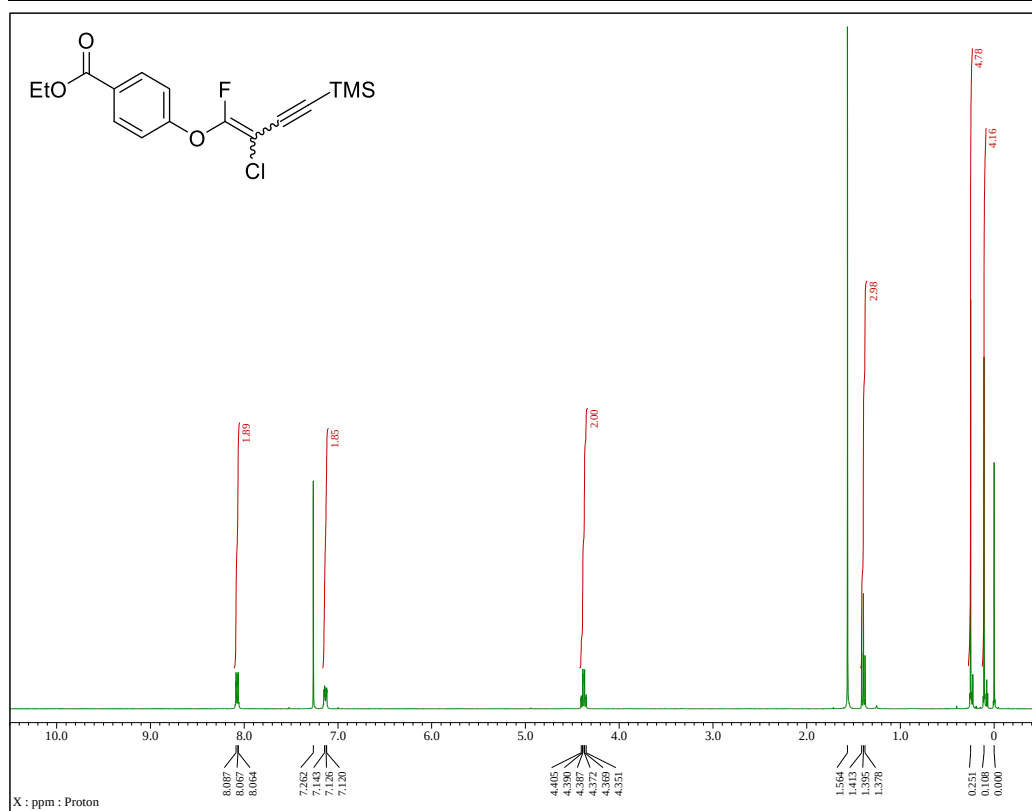


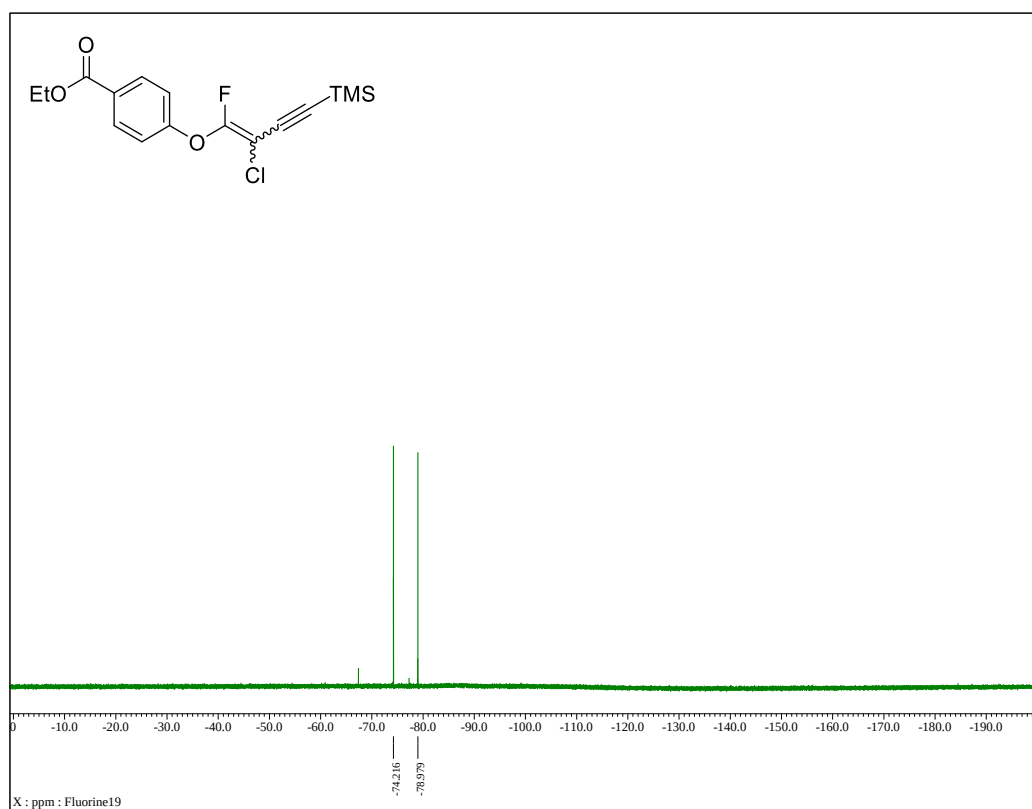
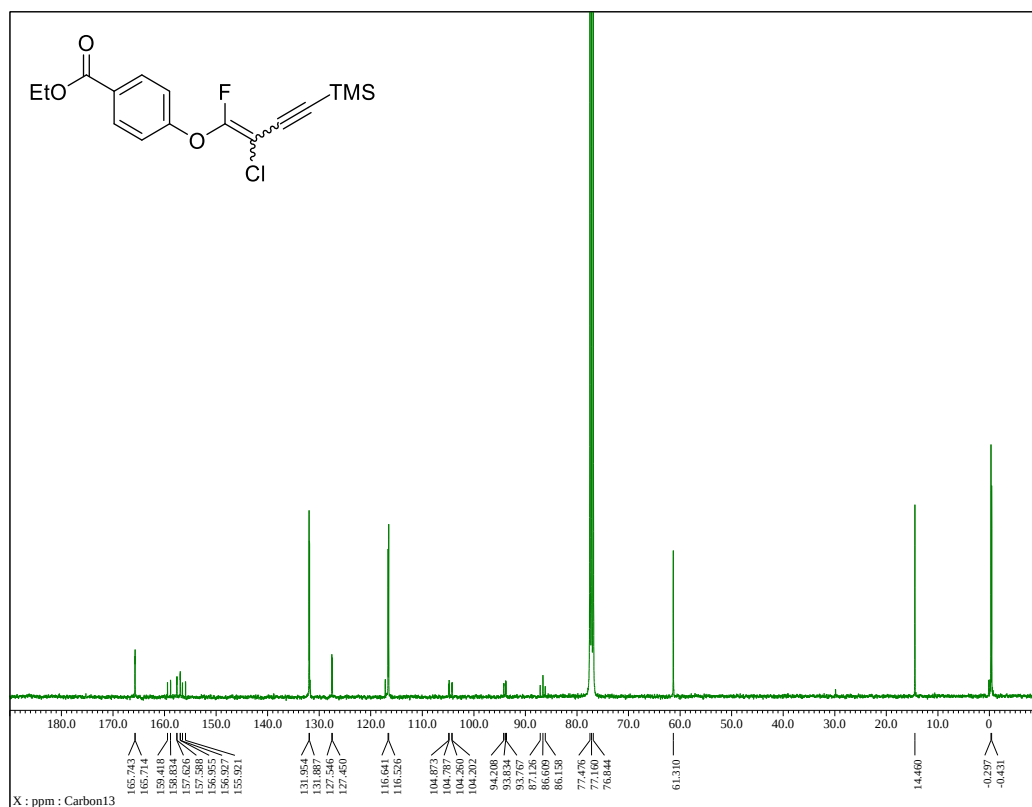
(3-Chloro-4-fluoro-4-(4-nitrophenoxy)but-3-en-1-yn-1-yl)trimethylsilane (3u)





(3-Chloro-4-(4-ethoxycarbonylphenoxy)-4-fluorobut-3-en-1-yn-1-yl)trimethylsilane (3v)





(4-(3-Aminophenoxy)-3-chloro-4-fluorobut-3-en-1-yn-1-yl)trimethylsilane (3w)

