Supporting Information

Palladium-Catalyzed NHC Ligand-Controlled Regiodivergent Allyl-Fluoroallyl Cross-Couplings

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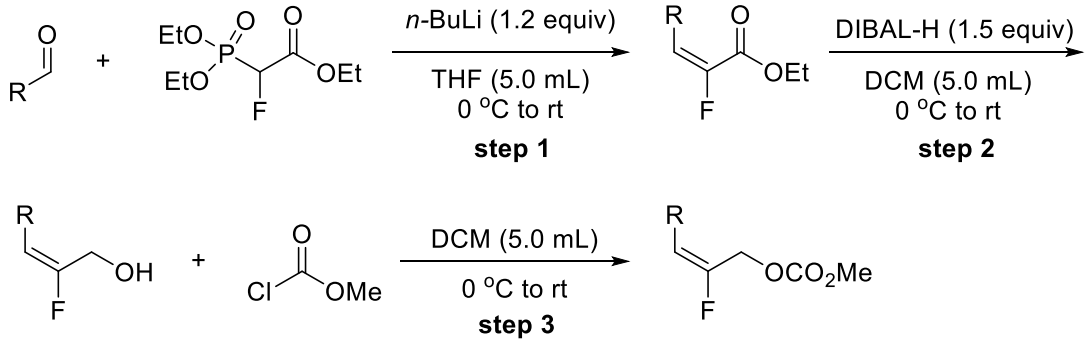
Contents

1. General information

^{1}H NMR spectra were recorded on Bruker 400 MHz or 600 MHz spectrometer and the chemical shifts were reported in parts per million (δ) relative to internal standard TMS (0 ppm) for $CDCl_3$. The peak patterns are indicated as follows: s, singlet; d, doublet; dd, doublet of doublet; t, triplet; m, multiplet; q, quartet. The coupling constants, *J*, are reported in Hertz (Hz). ^{13}C NMR spectra were obtained at Bruker 100 MHz or 150 MHz and referenced to the internal solvent signals (central peak is 77.0 ppm in $CDCl_3$), ^{19}F NMR spectra were obtained at Bruker 376 MHz or 564 MHz. $CDCl_3$ was used as the NMR solvent. $CDCl_3$ was used as the NMR solvent. APEX II (Bruker Inc.) was used for ESI-MS and EI-MS. Tetrahydrofuran (THF), n-butyllithium (*n*-BuLi), ethyl acetate (EtOAc), diisobutylaluminium hydride (DIBAL-H), dichloromethane (DCM), sodium sulfate (Na_2SO_4). Absorption spectra and fluorescence spectra were tested on Shimadzu UV-3600 UV-VIS-NIR spectrophotometer and HITACHI F-4600 fluorescence spectrophotometer, respectively. Flash column chromatography was performed over silica gel 200-300. All reagents were weighed and handled in air at room temperature. All chemical reagents were purchased from Alfa, Acros, Aldrich, TCI, Energy, and J&K and used without further purification.

2. Synthesis of (*E*)-2-fluoroallyl carbonate 1

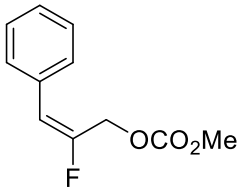


The (*E*)-2-fluoroallyl carbonates were prepared according to the known procedure.[1]

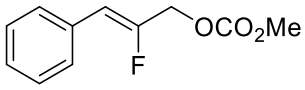
Step 1: Ethyl 2-(diethoxyphosphoryl)-2-fluoroacetate (1.2 equiv) was dissolved in dry THF under N_2. The solution was cooled to 0 °C and *n*-BuLi (2.5 M, 1.2 equiv) was added. The solution was stirred for 1 h at 0 °C. Aldehyde (1.0 equiv) was added and the solution was left overnight at room temperature. The reaction was quenched with water and extracted with EtOAc, dried over Na_2SO_4 and evaporated. The product was separated by column chromatography (petroleum ether/ethyl acetate).

Step 2: (*E*)-Ethyl 2-fluoro-3-phenylacrylate (1.0 equiv) was dissolved in dry DCM (5.0 mL) in dry glassware. DIBAL-H (1.0 M, 1.5 equiv) was added at 0 °C. The solution was stirred at room temperature overnight, quenched with water under vigorous stirring, extracted with DCM (3 × 50 mL), washed with water (2 × 50 mL), dried over Na_2SO_4 and evaporated. Product was separated by column chromatography (petroleum ether: ethyl acetate).

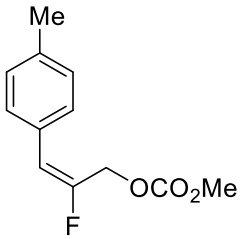
Step 3: (*E*)-2-Fluoro-3-phenylprop-2-en-1-ol (1.0 equiv) and pyridine (2.0 equiv) was dissolved in DCM (5.0 mL) at 0 °C. Methyl chloroformate (2.0 equiv) was added slowly at 0 °C. The solution was stirred at room temperature for 12 h and quenched with HCl (0.5 M). It was then diluted with water, extracted with DCM, dried over Na_2SO_4 and evaporated. Product was separated by column chromatography (petroleum ether/ethyl acetate).



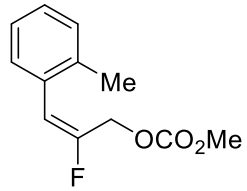
(*E*)-2-Fluoro-3-phenylallyl methyl carbonate (1a) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.37-7.34 (m, 2H), 7.31-7.28 (m, 1H), 7.24-7.23 (m, 2H), 6.55 (d, J = 19.0 Hz, 1H), 4.87 (d, J = 21.4 Hz, 2H), 3.83 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.4, 154.7 (d, $J_{C\text{-}F}$ = 254.2 Hz), 132.3 (d, $J_{C\text{-}F}$ = 11.0 Hz), 128.7, 128.6 (d, $J_{C\text{-}F}$ = 2.2 Hz), 127.9, 114.6 (d, $J_{C\text{-}F}$ = 24.6 Hz), 62.7 (d, $J_{C\text{-}F}$ = 29.0 Hz), 55.2; ^{19}F NMR (565 MHz, $CDCl_3$) δ -107.8. The characterization data were consistent with the literature.[1a]



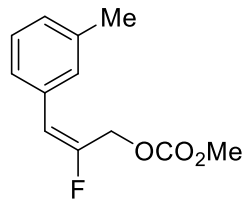
(*Z*)-2-fluoro-3-phenylallyl methyl carbonate (1a´) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.51 (d, J = 6.0 Hz, 2H), 7.23-7.35 (m, 3H), 5.86 (d, J = 29.8 Hz, 1H), 4.77 (d, J = 14.2 Hz, 2H), 3.80 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.3, 152.9 (d, $J_{C\text{-}F}$ = 266.2 Hz), 132.0 (d, $J_{C\text{-}F}$ = 3.6 Hz), 128.9 (d, $J_{C\text{-}F}$ = 7.2 Hz), 128.4, 128.0, 111.4 (d, $J_{C\text{-}F}$ = 6.6 Hz), 66.1 (d, $J_{C\text{-}F}$ = 31.2 Hz), 55.0; ^{19}F NMR (565 MHz, $CDCl_3$) δ -107.4. **1a´** was synthesized according to the literature and the characterization data were consistent.[1a]



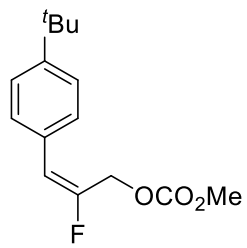
(*E*)-2-Fluoro-3-(*p*-tolyl)allyl methyl carbonate (1b) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.16 (d, J = 8.0 Hz, 2H), 7.12 (d, J = 8.0 Hz, 2H), 6.52 (d, J = 19.1 Hz, 1H), 4.86 (d, J = 21.4 Hz, 2H), 3.83 (s, 3H), 2.35 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.4, 154.4 (d, $J_{C\text{-}F}$ = 253.4 Hz), 137.8, 129.4, 128.5 (d, $J_{C\text{-}F}$ = 2.8 Hz), 114.6 (d, $J_{C\text{-}F}$ = 25.2 Hz), 62.8 (d, $J_{C\text{-}F}$ = 29.0 Hz), 55.1, 21.1; ^{19}F NMR (565 MHz, $CDCl_3$) δ -108.6. HRMS (ESI) calcd for $C_{12}H_{13}FNaO_3$ [M + Na $^+$], 247.0741; found: 247.0737.



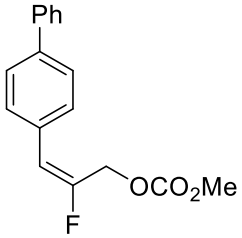
(*E*)-2-Fluoro-3-(*o*-tolyl)allyl methyl carbonate (1c) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.22-7.20 (m, 1H), 7.18-7.16 (m, 2H), 7.14-7.12 (m, 1H), 6.52 (d, J = 18.6 Hz, 1H), 4.76 (d, J = 20.4 Hz, 2H), 3.79 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.3, 154.6 (d, $J_{C\text{-}F}$ = 255.2 Hz), 136.9 (d, $J_{C\text{-}F}$ = 3.2 Hz), 131.3 (d, $J_{C\text{-}F}$ = 10.8 Hz), 129.9, 129.0, 128.2, 126.0, 113.1 (d, $J_{C\text{-}F}$ = 23.2 Hz), 62.3 (d, $J_{C\text{-}F}$ = 28.6 Hz), 55.0, 19.9; ^{19}F NMR (565 MHz, $CDCl_3$) δ -109.2. HRMS (ESI) calcd for $C_{12}H_{13}FNaO_3$ [M + Na $^+$], 247.0741; found: 247.0738.



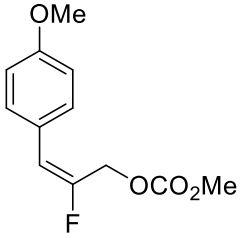
(*E*)-2-Fluoro-3-(*m*-tolyl)allyl methyl carbonate (1d) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.25-7.23 (m, 1H), 7.11 (d, J = 7.6 Hz, 1H), 7.03 (d, J = 7.6 Hz, 1H), 7.02 (s, 1H), 6.52 (d, J = 19.1 Hz, 1H), 4.87 (d, J = 21.2 Hz, 2H), 3.83 (s, 3H), 2.35 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.4, 154.6 (d, $J_{C\text{-}F}$ = 253.6 Hz), 138.4, 132.2 (d, $J_{C\text{-}F}$ = 11.6 Hz), 129.3 (d, $J_{C\text{-}F}$ = 2.2 Hz), 128.6 (d, $J_{C\text{-}F}$ = 5.2 Hz), 125.6 (d, $J_{C\text{-}F}$ = 2.8 Hz), 114.6 (d, $J_{C\text{-}F}$ = 24.4 Hz), 62.7 (d, $J_{C\text{-}F}$ = 28.6 Hz), 55.1, 21.3; ^{19}F NMR (565 MHz, $CDCl_3$) δ -108.2. HRMS (ESI) calcd for $C_{12}H_{13}FNaO_3$ [M + Na $^+$], 247.0741; found: 247.0737.



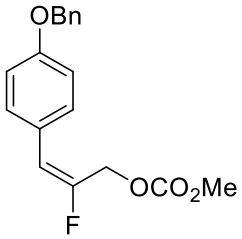
(*E*)-3-(4-(*tert*-Butyl)phenyl)-2-fluoroallyl methyl carbonate (1e) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.38 (d, J = 8.2 Hz, 2H), 7.17 (d, J = 8.2 Hz, 2H), 6.52 (d, J = 19.2 Hz, 1H), 4.88 (d, J = 21.5 Hz, 2H), 3.83 (s, 3H), 1.32 (s, 9H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.4, 154.4 (d, $J_{C\text{-}F}$ = 253.2 Hz), 151.0, 129.3 (d, $J_{C\text{-}F}$ = 11.6 Hz), 128.3 (d, $J_{C\text{-}F}$ = 2.2 Hz), 125.7, 114.5 (d, $J_{C\text{-}F}$ = 24.6 Hz), 62.8 (d, $J_{C\text{-}F}$ = 29.2 Hz), 55.1, 34.6, 31.2; ^{19}F NMR (565 MHz, $CDCl_3$) δ -108.4. HRMS (ESI) calcd for $C_{15}H_{19}FNaO_3$ [M + Na^+], 289.1210; found: 289.1211.



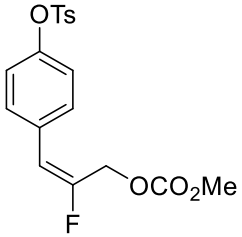
(*E*)-3-([1,1'-Biphenyl]-4-yl)-2-fluoroallyl methyl carbonate (1f) (petroleum ether: ethyl acetate = 10:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.59-7.58 (m, 4H), 7.46-7.43 (m, 2H), 7.37-7.34 (m, 1H), 7.31 (d, J = 8.2 Hz, 2H), 6.58 (d, J = 19.0 Hz, 1H), 4.92 (d, J = 21.4 Hz, 2H), 3.84 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.4, 154.8 (d, $J_{C\text{-}F}$ = 254.6 Hz), 140.7, 140.3, 131.2 (d, $J_{C\text{-}F}$ = 11.2 Hz), 129.0 (d, $J_{C\text{-}F}$ = 2.2 Hz), 128.8, 127.5, 127.4, 127.0, 114.3 (d, $J_{C\text{-}F}$ = 25.2 Hz), 62.8 (d, $J_{C\text{-}F}$ = 29.2 Hz), 55.2; ^{19}F NMR (565 MHz, $CDCl_3$) δ -107.1. HRMS (ESI) calcd for $C_{17}H_{15}FNaO_3$ [M + Na^+], 309.0897; found: 309.0895.



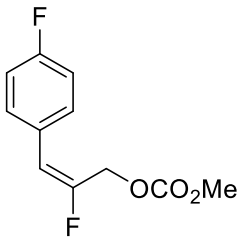
(*E*)-2-Fluoro-3-(4-methoxyphenyl)allyl methyl carbonate (1g) (petroleum ether: ethyl acetate = 10:1, R_f = 0.4); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.16 (d, J = 8.4 Hz, 2H), 6.89 (d, J = 8.4 Hz, 2H), 6.49 (d, J = 19.2 Hz, 1H), 4.86 (d, J = 21.6 Hz, 2H), 3.83 (s, 3H), 3.81 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.3, 155.4, 153.9 (d, $J_{C\text{-}F}$ = 252.2 Hz), 129.8, 124.5 (d, $J_{C\text{-}F}$ = 11.8 Hz), 114.3 (d, $J_{C\text{-}F}$ = 25.4 Hz), 62.8 (d, $J_{C\text{-}F}$ = 29.4 Hz), 55.2, 55.1; ^{19}F NMR (565 MHz, $CDCl_3$) δ -109.3. HRMS (ESI) calcd for $C_{12}H_{13}FNaO_4$ [M + Na^+], 263.0690; found: 263.0687.



(*E*)-3-(4-(Benzyloxy)phenyl)-2-fluoroallyl methyl carbonate (1h) (petroleum ether: ethyl acetate = 10:1, R_f = 0.4); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43-7.42 (m, 2H), 7.40-7.37 (m, 2H), 7.34-7.32 (m, 1H), 7.16 (d, J = 8.6 Hz, 2H), 6.96 (d, J = 8.6 Hz, 2H), 6.49 (d, J = 19.2 Hz, 1H), 5.07 (s, 2H), 4.86 (d, J = 21.6 Hz, 2H), 3.83 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 158.5, 155.4, 154.0 (d, $J_{C\text{-}F}$ = 252.0 Hz), 136.7, 129.8 (d, $J_{C\text{-}F}$ = 2.4 Hz), 128.6, 128.0, 127.4, 124.8 (d, $J_{C\text{-}F}$ = 11.0 Hz), 115.1, 114.3 (d, $J_{C\text{-}F}$ = 25.4 Hz), 70.0, 62.8 (d, $J_{C\text{-}F}$ = 29.8 Hz), 55.2; ^{19}F NMR (565 MHz, $CDCl_3$) δ -109.1. HRMS (ESI) calcd for $C_{18}H_{17}FNaO_4$ [M + Na $^+$], 339.1003; found: 339.1006.

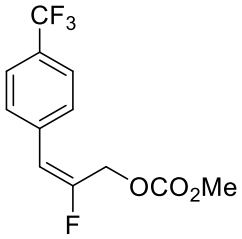


(*E*)-4-(2-Fluoro-3-((methoxycarbonyl)oxy)prop-1-en-1-yl)phenyl 4-methylbenzenesulfonate (1i) (petroleum ether: ethyl acetate = 5:1, R_f = 0.4); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.71 (d, J = 8.2 Hz, 2H), 7.32 (d, J = 8.2 Hz, 2H), 7.17 (d, J = 8.6 Hz, 2H), 6.98 (d, J = 8.6 Hz, 2H), 6.47 (d, J = 18.7 Hz, 1H), 4.80 (d, J = 21.2 Hz, 2H), 3.83 (s, 3H), 2.46 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.3, 155.2 (d, $J_{C\text{-}F}$ = 255.4 Hz), 149.1, 145.5, 132.3, 131.3 (d, $J_{C\text{-}F}$ = 11.8 Hz), 129.9, 129.8, 128.5, 122.8, 113.4 (d, $J_{C\text{-}F}$ = 26.2 Hz), 62.4 (d, $J_{C\text{-}F}$ = 29.4 Hz), 55.3, 21.7; ^{19}F NMR (565 MHz, $CDCl_3$) δ -105.9. HRMS (ESI) calcd for $C_{18}H_{17}FNaO_6S$ [M + Na $^+$], 403.0622; found: 403.0624.

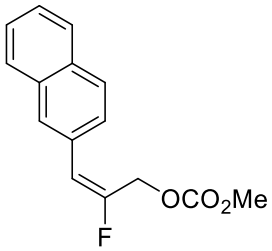


(*E*)-2-Fluoro-3-(4-fluorophenyl)allyl methyl carbonate (1j) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.23-7.20 (m, 2H), 7.07-7.04 (m, 2H), 6.51 (d, J = 18.6 Hz, 1H), 4.83 (d, J = 21.2 Hz, 2H), 3.83 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 162.4 (d, $J_{C\text{-}F}$ = 248.0 Hz), 155.4, 154.8 (d, $J_{C\text{-}F}$ = 255.3 Hz), 131.3 (d, $J_{C\text{-}F}$ = 2.2 Hz), 130.2 (d, $J_{C\text{-}F}$ = 2.8 Hz), 128.3 (d, $J_{C\text{-}F}$ = 3.2 Hz), 128.2 (d, $J_{C\text{-}F}$ = 3.4 Hz), 115.8 (d, $J_{C\text{-}F}$ = 21.4 Hz),

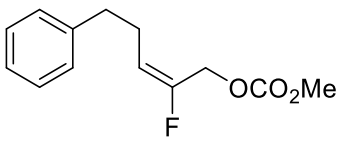
113.6 (d, $J_{C\text{-}F}$ = 25.6 Hz), 62.5 (d, $J_{C\text{-}F}$ = 29.6 Hz), 55.2; ^{19}F NMR (565 MHz, $CDCl_3$) δ -107.6, -113.6. HRMS (ESI) calcd for $C_{11}H_{10}F_2NaO_3$ [M + Na^+], 251.0490; found: 251.0489.



(*E*)-2-Fluoro-3-(4-(trifluoromethyl)phenyl)allyl methyl carbonate (1k) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.62 (d, J = 8.2 Hz, 2H), 7.37 (d, J = 8.2 Hz, 2H), 6.56 (d, J = 18.4 Hz, 1H), 4.84 (d, J = 21.0 Hz, 2H), 3.84 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 156.0 (d, $J_{C\text{-}F}$ = 258.2 Hz), 155.3, 136.0 (d, $J_{C\text{-}F}$ = 11.8 Hz), 130.0 (q, $J_{C\text{-}F}$ = 32.8 Hz), 128.9 (d, $J_{C\text{-}F}$ = 3.0 Hz), 125.7 (q, $J_{C\text{-}F}$ = 3.4 Hz), 123.9 (q, $J_{C\text{-}F}$ = 271.8 Hz), 113.4 (d, $J_{C\text{-}F}$ = 26.2 Hz), 62.3 (d, $J_{C\text{-}F}$ = 29.4 Hz), 55.3; ^{19}F NMR (565 MHz, $CDCl_3$) δ -62.7, -104.5. HRMS (ESI) calcd for $C_{12}H_{10}F_4NaO_3$ [M + Na^+], 301.0458; found: 301.0462.



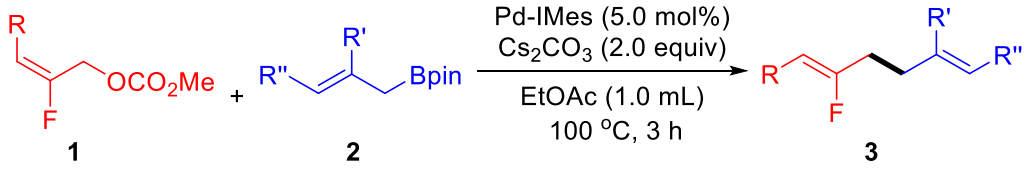
(*E*)-2-Fluoro-3-(naphthalen-2-yl)allyl methyl carbonate (1l) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.83-7.81 (m, 3H), 7.69 (s, 1H), 7.50-7.46 (m, 2H), 7.34 (dd, J = 8.4, 1.4 Hz, 1H), 6.69 (d, J = 19.0 Hz, 1H), 4.94 (d, J = 21.2 Hz, 2H), 3.84 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.4, 155.0 (d, $J_{C\text{-}F}$ = 255.0 Hz), 133.2, 132.6, 129.7 (d, $J_{C\text{-}F}$ = 11.2 Hz), 128.4, 128.0, 127.7, 127.6, 126.5, 126.4, 126.3 (d, $J_{C\text{-}F}$ = 2.0 Hz), 114.7 (d, $J_{C\text{-}F}$ = 25.2 Hz), 62.8 (d, $J_{C\text{-}F}$ = 29.3 Hz), 55.2; ^{19}F NMR (565 MHz, $CDCl_3$) δ -107.2. HRMS (ESI) calcd for $C_{15}H_{13}FNaO_3$ [M + Na^+], 283.0741; found: 283.0739.



(*E*)-2-Fluoro-5-phenylpent-2-en-1-yl methyl carbonate (1m) (petroleum ether: ethyl acetate = 20:1, R_f = 0.5); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.30-7.27 (m, 2H), 7.21-7.18 (m, 1H), 7.17-7.15 (m, 2H), 5.38 (dt, J = 16.8, 8.2 Hz, 1H),

4.57 (d, J = 20.9 Hz, 2H), 3.78 (s, 3H), 2.69 (t, J = 7.5 Hz, 2H), 2.40-2.36 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 155.4, 153.7 (d, $J_{C\text{-}F}$ = 248.4 Hz), 140.6, 128.5, 128.4, 126.1, 111.7 (d, $J_{C\text{-}F}$ = 19.5 Hz), 61.2 (d, $J_{C\text{-}F}$ = 30.4 Hz), 55.0, 35.8 (d, $J_{C\text{-}F}$ = 2.2 Hz), 27.3 (d, $J_{C\text{-}F}$ = 7.2 Hz); ^{19}F NMR (565 MHz, $CDCl_3$) δ -111.4. HRMS (ESI) calcd for $C_{13}H_{15}FNaO_3$ [M + Na $^+$], 261.0897; found: 261.0896.

3. General procedure and characterization data for product 3



A flame-dried reaction tube (10.0 cm^3) equipped with a magnetic stir bar was charged with Pd-PEPPSI-IMes (3.0 mg, 5.0 mol%). The reaction tube was transferred to the glovebox and charged with **1** (0.1 mmol), allylboronate **2** (0.2 mmol), Cs_2CO_3 (65.0 mg) and EtOAc (1.0 mL). After that, the reaction mixture was sealed with aluminum cap, moved out of glovebox, and stirred at 100 °C for 3 h. After the mixture was cooled to room temperature, the resulting solution was directly filtered through a pad of silica gel by EtOAc (3.0 mL). The solvent was evaporated *in vacuo* to give the crude product. The residue was purified by column chromatography on silica gel to give the pure product **3**. Products **3** is known compounds as the yellow oil, and the characterization data were consistent with the reported literature. [2]

1-(2-Fluorohexa-1,5-dien-1-yl)-3-methylbenzene (3a) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 15.3 mg (87%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.45 (d, J = 7.7 Hz, 2H), 7.31 (t, J = 7.6 Hz, 2H), 7.18 (t, J = 7.6 Hz, 1H), 5.89-5.87 (m. 1H), 5.46 (d, $J_{C\text{-}F}$ = 39.5 Hz, 1H), 5.09 (dd, J = 17.2, 1.5 Hz, 1H), 5.02 (dd, J = 10.2, 1.0 Hz, 1H), 2.43-2.38 (m, 2H), 2.37-2.33 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.2 (d, $J_{C\text{-}F}$ = 266.5 Hz), 136.8, 133.7, 128.4, 128.3 (d, $J_{C\text{-}F}$ = 6.7 Hz), 126.7, 126.6, 115.6, 106.1 (d, $J_{C\text{-}F}$ = 8.8 Hz), 32.7 (d, $J_{C\text{-}F}$ = 26.4 Hz), 30.5. ^{19}F NMR (565 MHz, $CDCl_3$) δ -101.3.

1-(2-Fluorohexa-1,5-dien-1-yl)-4-methylbenzene (3b) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 16.9 mg (89%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33 (d, J = 8.8 Hz, 2H), 6.77 (d, J = 8.8 Hz, 2H), 5.81-5.75 (m, 1H), 5.34 (d, $J_{C\text{-}F}$ = 39.5 Hz, 1H), 5.02 (dd, J = 17.2, 1.5 Hz, 1H), 4.95 (dd, J = 10.2, 1.0 Hz, 1H), 3.72 (s. 3H), 2.35-2.30 (m, 2H), 2.29-2.25 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 158.9 (d, $J_{C\text{-}F}$ = 263.4 Hz), 158.3, 158.2, 137.0, 129.5 (d, $J_{C\text{-}F}$ = 6.7 Hz), 126.5, 126.4, 115.5, 113.8, 105.5 (d, $J_{C\text{-}F}$ = 8.9 Hz), 55.2, 32.6 (d, $J_{C\text{-}F}$ = 26.4 Hz), 30.5. ^{19}F NMR (565 MHz, $CDCl_3$) δ -104.3.

1-(2-Fluorohexa-1,5-dien-1-yl)-2-methylbenzene (3c) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 12.9 mg (68%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.59 (d, J = 7.6 Hz, 1H), 7.18-7.11 (m, 3H), 5.90-5.84 (m, 1H), 5.60 (d, J_{C-F} = 38.6 Hz, 1H), 5.11 (dd, J = 17.2, 1.4 Hz, 1H), 5.05 (dd, J = 10.2, 1.0 Hz, 1H), 2.48-2.42 (m, 2H), 2.39-2.36 (m, 2H), 2.29 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.8 (d, J_{C-F} = 264.9 Hz), 136.9, 135.4, 132.2, 129.9, 129.1 (d, J_{C-F} = 9.9 Hz), 126.8, 125.8, 115.7, 103.6 (d, J_{C-F} = 9.9 Hz), 32.6 (d, J_{C-F} = 27.5 Hz), 30.6, 20.2. ^{19}F NMR (565 MHz, $CDCl_3$) δ -103.8.

1-(2-Fluorohexa-1,5-dien-1-yl)-3-methylbenzene (3d) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 16.7 mg (88%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.27 (d, J = 11.2 Hz, 2H), 7.20 (d, J = 7.6 Hz, 1H), 7.02 (d, J = 7.6 Hz, 1H), 5.89-5.82 (m, 1H), 5.44 (d, J_{C-F} = 39.6 Hz, 1H), 5.10 (dd, J = 17.2, 1.4 Hz, 1H), 5.03 (dd, J = 10.2, 1.0 Hz, 1H), 2.44-2.39 (m, 2H), 2.37-2.35 (m, 2H), 2.33 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.1 (d, J_{C-F} = 266.2 Hz), 137.9, 136.9, 133.6, 133.5, 129.0 (d, J_{C-F} = 7.8 Hz), 128.3, 127.5, 125.4, 125.3, 115.6, 106.2 (d, J_{C-F} = 8.8 Hz), 32.6 (d, J_{C-F} = 26.6 Hz), 30.5, 21.4. ^{19}F NMR (565 MHz, $CDCl_3$) δ -101.4.

1-(*Tert*-butyl)-4-(2-fluorohexa-1,5-dien-1-yl)benzene (3e) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 19.5 mg (84%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.41 (d, J = 8.4 Hz, 2H), 7.34 (d, J = 8.4 Hz, 2H), 5.89-5.82 (m, 1H), 5.46 (d, J_{C-F} = 39.8 Hz, 1H), 5.09 (dd, J = 17.1, 1.6 Hz, 1H), 5.02 (dd, J = 10.3, 1.3 Hz, 1H), 2.44-2.39 (m, 2H), 2.37-2.33 (m, 2H), 1.31 (s, 9H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.8 (d, J_{C-F} = 266.2 Hz), 149.7, 136.9, 130.9, 130.8, 128.0 (d, J_{C-F} = 7.7 Hz), 125.3, 115.6, 105.8 (d, J_{C-F} = 8.7 Hz), 34.5, 32.6 (d, J_{C-F} = 27.5 Hz), 31.3, 30.6. ^{9}F NMR (565 MHz, $CDCl_3$) δ -102.4.

4-(2-Fluorohexa-1,5-dien-1-yl)-1,1'-biphenyl (3f) Isolated by column chromatography (petroleum ether : ethyl acetate = 100:1, R_f = 0.4); yield: 18.4 mg (73%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.60 (d, J = 7.5 Hz, 2H), 7.56-7.53 (m, 4H), 7.43 (d, J = 7.8 Hz, 2H), 7.33 (d, J = 7.3 Hz, 1H), 5.90-5.83 (m, 1H), 5.52 (d, J_{C-F} = 39.5 Hz, 1H), 5.11 (dd, J = 17.1, 1.4 Hz, 1H), 5.04 (dd, J = 10.2, 1.0 Hz, 1H), 2.47-2.42 (m, 2H), 2.40-2.36 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.5 (d, J_{C-F} = 267.2 Hz), 140.7, 139.4, 139.3, 136.8, 132.8, 132.7, 128.7, 128.6 (d, J_{C-F} = 7.7 Hz), 115.7, 105.8 (d, J_{C-F} = 8.7 Hz), 32.7 (d, J_{C-F} = 26.3 Hz), 30.5. ^{19}F NMR (565 MHz, $CDCl_3$) δ -101.3.

1-(2-Fluorohexa-1,5-dien-1-yl)-4-methoxybenzene (3g) Isolated by column chromatography (petroleum ether : ethyl acetate = 50:1, R_f = 0.5); yield: 19.4 mg (94%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.40 (d, J = 8.8 Hz, 2H), 6.85 (d, J = 8.8 Hz, 2H), 5.89-5.82 (m, 1H), 5.41 (d, J_{C-F} = 39.5 Hz, 1H), 5.09 (dd, J = 17.1, 1.4 Hz, 1H), 5.02 (dd, J = 17.1, 1.4 Hz, 1H), 3.80 (s, 3H), 2.43-2.37 (m, 2H), 2.36-2.33 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 158.8 (d, J_{C-F}

= 262.9 Hz), 158.3, 158.2, 137.0, 129.4 (d, J_{C-F} = 6.7 Hz), 126.5, 126.4, 115.5, 113.8, 105.5 (d, J_{C-F} = 8.8 Hz), 55.2, 32.6 (d, J_{C-F} = 26.2 Hz), 30.6. ^{19}F NMR (565 MHz, $CDCl_3$) δ -101.3.

1-(Benzyloxy)-4-(2-fluorohexa-1,5-dien-1-yl)benzene (3h) Isolated by column chromatography (petroleum ether : ethyl acetate = 20:1, R_f = 0.5); yield: 27.1 mg (96%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.35-7.28 (m, 6H), 7.24 (d, J = 6.9 Hz, 1H), 6.84 (d, J = 7.8 Hz, 1H), 5.80-5.74 (m, 1H), 5.33 (d, J_{C-F} = 38.7 Hz, 1H), 5.01 (dd, J = 17.1, 1.4 Hz, 1H), 4.98 (s, 2H), 4.94 (dd, J = 10.2, 1.0 Hz, 1H), 2.34-2.30 (m, 2H), 2.29-2.26 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.0 (d, J_{C-F} = 263.9 Hz), 158.0, 157.5, 137.0, 136.9, 129.5 (d, J_{C-F} = 7.7 Hz), 129.2, 128.6, 128.5, 128.0, 127.9, 127.4, 126.7, 115.6, 114.9, 114.8, 105.5 (d, J_{C-F} = 7.8 Hz), 70.0, 69.9, 32.6 (d, J_{C-F} = 26.4 Hz), 30.6. ^{19}F NMR (565 MHz, $CDCl_3$) δ -104.1.

4-(2-Fluorohexa-1,5-dien-1-yl)phenyl 4-methylbenzenesulfonate (3i) Isolated by column chromatography (petroleum ether : ethyl acetate = 20:1, R_f = 0.4); yield: 22.8 mg (66%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.36 (d, J = 8.8 Hz, 2H), 7.30 (d, J = 8.1 Hz, 2H), 6.91 (d, J = 8.8 Hz, 2H), 5.86-5.80 (m, 1H), 5.43 (d, J_{C-F} = 38.9 Hz, 1H), 5.09 (dd, J = 17.1, 1.4 Hz, 1H), 5.03 (dd, J = 10.2, 1.0 Hz, 1H), 2.44 (s, 3H), 2.43-2.38 (m, 2H), 2.35-2.32 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.9 (d, J_{C-F} = 267.5 Hz), 147.9, 147.8, 145.3, 136.7, 132.7, 132.4, 129.7, 129.3 (d, J_{C-F} = 7.7 Hz), 128.5, 122.3, 115.8, 105.0 (d, J_{C-F} = 8.0 Hz), 32.5 (d, J_{C-F} = 26.5 Hz), 30.3, 21.7. ^{19}F NMR (565 MHz, $CDCl_3$) δ -100.5.

1-Fluoro-4-(2-fluorohexa-1,5-dien-1-yl)benzene (3j) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 15.1 mg (78%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.44-7.42 (m, 2H), 7.01-6.98 (m, 2H), 5.89-5.82 (m, 1H), 5.45 (d, J_{C-F} = 39.2 Hz, 1H), 5.10 (dd, J = 17.2, 1.4 Hz, 1H), 5.04 (dd, J = 10.2, 1.0 Hz, 1H), 2.44-2.39 (m, 2H), 2.37-2.34 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 161.5 (d, J_{C-F} = 245.7 Hz), 159.9 (d, J_{C-F} = 266.2 Hz), 136.8, 129.9 (d, J_{C-F} = 7.8 Hz), 129.8 (d, J_{C-F} = 7.8 Hz), 115.7, 115.3, 115.2, 105.1 (d, J_{C-F} = 8.8 Hz), 32.5 (d, J_{C-F} = 26.3 Hz), 30.5. ^{19}F NMR (565 MHz, $CDCl_3$) δ -102.6, -115.1.

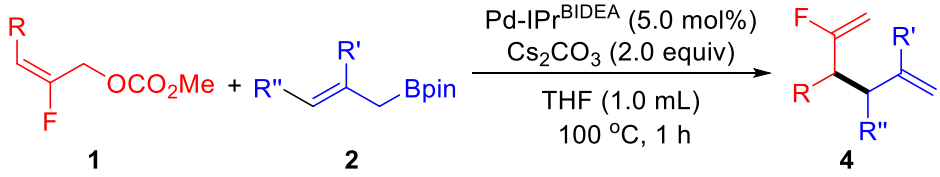
1-(2-Fluorohexa-1,5-dien-1-yl)-4-(trifluoromethyl)benzene (3k) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 15.4 mg (63%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.55 (s, 4H), 5.88-5.82 (m, 1H), 5.53 (d, J_{C-F} = 38.7 Hz, 1H), 5.11 (dd, J = 17.1, 1.4 Hz, 1H), 5.05 (dd, J = 10.2, 1.0 Hz, 1H), 2.48-2.42 (m, 2H), 2.39-2.36 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 162.1 (d, J_{C-F} = 269.7 Hz), 137.2, 136.5, 128.4 (d, J_{C-F} = 7.7 Hz), 125.3 (q, J_{C-F} = 3.4 Hz), 124.2 (q, J_{C-F} = 271.7 Hz), 115.9, 105.3 (d, J_{C-F} = 7.8 Hz), 48.5, 48.3, 32.6 (d, J_{C-F} = 26.4 Hz), 30.3. ^{19}F NMR (565 MHz, $CDCl_3$) δ -62.5 (3F), -97.9.

2-(2-Fluorohexa-1,5-dien-1-yl)naphthalene (3l) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 17.6 mg (78%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.87 (s, 1H), 7.78-7.75 (m, 3H), 7.63 (d, J = 8.6 Hz, 1H), 7.44-7.39 (m, 2H), 5.90-5.84 (m, 1H), 5.61 (d, $J_{C\text{-}F}$ = 39.4 Hz, 1H), 5.11 (d, J = 17.3 Hz, 1H), 5.04 (d, J = 10.4 Hz, 1H), 2.48-2.43 (m, 2H), 2.40-2.37 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.6 (d, $J_{C\text{-}F}$ = 267.4 Hz), 136.8, 133.5, 132.2, 131.3, 131.2, 127.9, 127.8, 127.5, 127.1, 127.0, 126.5 (d, $J_{C\text{-}F}$ = 7.7 Hz), 126.0, 125.7, 115.7, 106.3 (d, $J_{C\text{-}F}$ = 7.7 Hz), 32.7 (d, $J_{C\text{-}F}$ = 26.5 Hz), 30.5. ^{19}F NMR (565 MHz, $CDCl_3$) δ -100.7.

(*Z*)-(2-Fluorohexa-1,5-diene-1,5-diyl)dibenzene (3o) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 23.2 mg (92%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.45-7.43 (m, 2H), 7.42-7.40 (m, 2H), 7.35-7.33 (m, 2H), 7.31-7.27 (m, 3H), 7.21-7.18 (m, 1H), 5.41 (d, $J_{C\text{-}F}$ = 39.4 Hz, 1H), 5.32 (s, 1H), 5.13 (s, 1H), 2.83-2.80 (m, 2H), 2.49-2.44 (m, 2H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.1 (d, $J_{C\text{-}F}$ = 266.8 Hz), 146.9, 140.6, 133.7 (d, $J_{C\text{-}F}$ = 2.0 Hz), 128.4, 128.3 (d, $J_{C\text{-}F}$ = 7.6 Hz), 127.6, 126.7 (d, $J_{C\text{-}F}$ = 1.8 Hz), 126.1, 113.3, 106.2 (d, $J_{C\text{-}F}$ = 8.2 Hz), 32.3 (d, $J_{C\text{-}F}$ = 26.6 Hz), 32.2. ^{19}F NMR (565 MHz, $CDCl_3$) δ -101.8.

(*Z*)-(2-Fluoro-5-methylhexa-1,5-dien-1-yl)benzene (3p) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 10 mg (53%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.39-7.38 (m, 2H), 7.24-7.22 (m, 2H), 7.13-7.11 (m, 1H), 5.41 (d, $J_{C\text{-}F}$ = 39.4 Hz, 1H), 4.71 (s, 1H), 4.68 (s, 1H), 2.42-2.37 (m, 2H), 2.26-2.23 (m, 2H), 1.70 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.5 (d, $J_{C\text{-}F}$ = 266.6 Hz), 144.2, 133.8 (d, $J_{C\text{-}F}$ = 2.0 Hz), 128.4, 128.3 (d, $J_{C\text{-}F}$ = 7.6 Hz), 126.7, 110.8, 105.9 (d, $J_{C\text{-}F}$ = 8.8 Hz), 34.4, 31.6 (d, $J_{C\text{-}F}$ = 26.6 Hz), 22.4. ^{19}F NMR (565 MHz, $CDCl_3$) δ -101.1.

4. General procedure and characterization data for product 4



A flame-dried reaction tube (10.0 cm^3) equipped with a magnetic stir bar was charged with Pd-PEPPSI-IPr^{BIDEA} (4.3 mg, 5.0 mol%). The reaction tube was transferred to the glovebox and charged with **1** (0.1 mmol), allylboronate **2** (0.2 mmol), Cs_2CO_3 (65.0 mg) and THF (1.0 mL). After that, the reaction mixture was sealed with aluminum cap, moved out of glovebox, and stirred at 100 °C for 1 h. After the mixture was cooled to room temperature, the resulting solution was directly filtered through a pad of silica gel by EtOAc (3.0 mL). The solvent was evaporated *in vacuo* to give the crude product. The residue was purified by column chromatography on silica gel to give the pure product **4**.

Products **4** is known compounds as the yellow oil, and the characterization data were consistent with the reported literature. [2]

(2-Fluorohexa-1,5-dien-3-yl)benzene (4a) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 16.0 mg (91%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33-7.30 (d, J = 7.6 Hz, 2H), 7.27-7.24 (m, 3H), 5.75-5.58 (m, 1H), 5.06 (dd, J = 17.3, 1.3 Hz, 1H), 5.00 (dd, J = 10.2, 1.0 Hz, 1H), 4.62 (dd, $J_{C\text{-}F}$ = 17.8, J = 2.8 Hz, 1H), 4.36 (dd, $J_{C\text{-}F}$ = 49.9, J = 2.8 Hz, 1H), 3.48 (dt, J = 16.7, 7.6 Hz, 1H), 2.70-2.65 (m, 1H), 2.53-2.48 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.2 (d, $J_{C\text{-}F}$ = 260.4 Hz), 140.1, 135.5, 128.5, 127.9, 127.0, 116.8, 90.7 (d, $J_{C\text{-}F}$ = 19.9 Hz), 48.5 (d, $J_{C\text{-}F}$ = 25.3 Hz), 36.9 (d, $J_{C\text{-}F}$ = 3.3 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.1.

1-(2-Fluorohexa-1,5-dien-3-yl)-4-methylbenzene (4b) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 16.7 mg (88%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.16-7.12 (m ,4H), 5.75-5.68 (m, 1H), 5.06 (dd, J = 17.1, 1.3 Hz, 1H), 5.00 (dd, J = 10.2, 1.0 Hz, 1H), 4.60 (dd, $J_{C\text{-}F}$ = 17.7, J = 2.8 Hz, 1H), 4.41 (dd, $J_{C\text{-}F}$ = 50.0, J = 2.8 Hz, 1H), 3.44 (dt, J = 16.7, 7.6 Hz, 1H), 2.68-2.63 (m, 1H), 2.51-2.46 (m, 1H), 2.32 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.5 (d, $J_{C\text{-}F}$ = 260.5 Hz), 137.1, 136.6, 135.7, 129.2, 127.7, 116.8, 90.5 (d, $J_{C\text{-}F}$ = 19.9 Hz), 48.1 (d, $J_{C\text{-}F}$ = 26.1 Hz), 36.9 (d, $J_{C\text{-}F}$ = 3.3 Hz), 21.0. ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.2.

1-(2-Fluorohexa-1,5-dien-3-yl)-2-methylbenzene (4c) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 13.7 mg (72%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.30 (d, J = 7.8 Hz, 1H), 7.21-7.15 (m, 3H), 5.76-5.69 (m, 1H), 5.07 (dd, J = 17.1, 1.5 Hz, 1H), 5.00 (dd, J = 10.2, 1.0 Hz, 1H), 4.63 (dd, $J_{C\text{-}F}$ = 17.7, J = 3.0 Hz, 1H), 4.30 (dd, $J_{C\text{-}F}$ = 50.2, J = 3.0 Hz, 1H), 3.75 (dt, J = 17.5, 7.7 Hz, 1H), 2.71-2.66 (m, 1H), 2.52-2.47 (m, 1H), 2.34 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.2 (d, $J_{C\text{-}F}$ = 260.0 Hz), 138.1, 136.2, 135.6, 130.5, 126.8, 126.7, 126.2, 116.8, 90.7 (d, $J_{C\text{-}F}$ = 20.8 Hz), 43.7 (d, $J_{C\text{-}F}$ = 25.4 Hz), 36.7 (d, $J_{C\text{-}F}$ = 3.3 Hz), 19.6. ^{19}F NMR (565 MHz, $CDCl_3$) δ -97.9.

1-(2-Fluorohexa-1,5-dien-3-yl)-3-methylbenzene (4d) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 16.5 mg (87%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.21 (t, J = 7.6 Hz, 1H), 7.07 (d, J = 9.2 Hz, 3H), 5.75-5.69 (m, 1H), 5.07 (dd, J = 17.1, 1.5 Hz, 1H), 5.01 (dd, J = 10.2, 1.0 Hz, 1H), 4.62 (dd, $J_{C\text{-}F}$ = 17.7, J = 3.0 Hz, 1H), 4.37 (dd, $J_{C\text{-}F}$ = 50.2, J = 3.0 Hz, 1H), 3.44 (dt, J = 17.5, 7.7 Hz, 1H), 2.68-2.64 (m, 1H), 2.52-2.47 (m, 1H), 2.34 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.3 (d, $J_{C\text{-}F}$ = 260.9 Hz), 140.1, 138.1, 135.6, 128.6, 128.4, 127.8, 124.8, 116.8, 90.6 (d, $J_{C\text{-}F}$ = 20.0 Hz), 48.5 (d, $J_{C\text{-}F}$ = 25.4 Hz), 36.9 (d, $J_{C\text{-}F}$ = 3.3 Hz), 21.4. ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.1.

1-(*tert*-Butyl)-4-(2-fluorohexa-1,5-dien-3-yl)benzene (4e) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 20.6 mg (89%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33 (d, J = 8.2 Hz, 2H), 7.20 (d, J = 8.2 Hz, 2H), 5.77-

5.71 (m, 1H), 5.08 (dd, J = 17.7, 2.8 Hz, 1H), 5.01 (d, J = 10.0 Hz, 1H), 4.61 (dd, $J_{C\text{-}F}$ = 17.7, J = 2.8 Hz, 1H), 4.35 (dd, $J_{C\text{-}F}$ = 49.9, J = 2.8 Hz, 1H), 3.45 (dt, J = 18.5, 7.6 Hz, 1H), 2.68-2.64 (m, 1H), 2.53-2.48 (m, 1H), 1.31 (s, 9H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.3 (d, $J_{C\text{-}F}$ = 260.0 Hz), 149.8, 137.1, 135.8, 127.4, 125.4, 116.7, 90.6 (d, $J_{C\text{-}F}$ = 20.8 Hz), 48.1 (d, $J_{C\text{-}F}$ = 25.4 Hz), 36.9 (d, $J_{C\text{-}F}$ = 3.3 Hz), 34.4, 31.3. ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.6.

4-(2-Fluorohexa-1,5-dien-3-yl)-1,1'-biphenyl (4f) Isolated by column chromatography (petroleum ether : ethyl acetate = 100:1, R_f = 0.4); yield: 21.2 mg (84%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.58 (d, J = 7.5 Hz, 2H), 7.55 (d, J = 8.2 Hz, 2H), 7.43 (t, J = 7.8 Hz, 2H), 7.34 (d, J = 8.2 Hz, 3H), 5.79-5.72 (m, 1H), 5.09 (dd, J = 17.3, 1.3 Hz, 1H), 5.03 (d, J = 10.2 Hz, 1H), 4.66 (dd, $J_{C\text{-}F}$ = 17.8, J = 2.8 Hz, 1H), 4.40 (dd, $J_{C\text{-}F}$ = 49.9, J = 2.8 Hz, 1H), 3.53 (dt, J = 17.7, 7.6 Hz, 1H), 2.73-2.69 (m, 1H), 2.57-2.52 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.1 (d, $J_{C\text{-}F}$ = 260.0 Hz), 140.8, 140.0, 139.2, 135.5, 128.7, 128.3, 127.3, 127.2, 127.0, 117.0, 90.8 (d, $J_{C\text{-}F}$ = 20.8 Hz), 48.2 (d, $J_{C\text{-}F}$ = 25.4 Hz), 36.9 (d, $J_{C\text{-}F}$ = 3.3 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.2.

1-(2-Fluorohexa-1,5-dien-3-yl)-4-methoxybenzene (4g) Isolated by column chromatography (petroleum ether : ethyl acetate = 100:1, R_f = 0.5); yield: 19.4 mg (94%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.19 (d, J = 8.7 Hz, 2H), 6.86 (d, J = 8.7 Hz, 2H), 5.74-5.68 (m, 1H), 5.05 (dd, J = 17.3, 1.3 Hz, 1H), 5.00 (dd, J = 10.2, 1.0 Hz, 1H), 4.60 (dd, $J_{C\text{-}F}$ = 17.8, J = 2.8 Hz, 1H), 4.33 (dd, $J_{C\text{-}F}$ = 49.9, J = 2.8 Hz, 1H), 3.80 (s, 3H), 3.43 (dt, J = 17.7, 7.6 Hz, 1H), 2.68-2.63 (m, 1H), 2.50-2.45 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.6 (d, $J_{C\text{-}F}$ = 260.7 Hz), 158.6, 135.7, 132.2, 128.8, 116.8, 113.9, 90.4 (d, $J_{C\text{-}F}$ = 20.8 Hz), 55.2, 47.7 (d, $J_{C\text{-}F}$ = 25.1 Hz), 37.0 (d, $J_{C\text{-}F}$ = 3.3 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.4.

1-(Benzyloxy)-4-(2-fluorohexa-1,5-dien-3-yl)benzene (4h) Isolated by column chromatography (petroleum ether : ethyl acetate = 50:1, R_f = 0.5); yield: 26.8 mg (95%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34 (d, J = 8.6 Hz, 2H), 7.29 (t, J = 7.5 Hz, 2H), 7.10 (d, J = 7.6 Hz, 2H), 6.85 (d, J = 6.9 Hz, 2H), 5.66-5.59 (m, 1H), 4.97 (dd, J = 17.1, 1.4 Hz, 1H), 4.93 (s, 2H), 4.92 (dd, J = 10.2, 1.0 Hz, 1H), 4.52 (dd, $J_{C\text{-}F}$ = 17.7, J = 3.0 Hz, 1H), 4.24 (dd, $J_{C\text{-}F}$ = 50.0, J = 3.0 Hz, 1H), 3.37-3.31 (m, 1H), 2.57-2.54 (m, 1H), 2.41-2.37 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.5 (d, $J_{C\text{-}F}$ = 259.8 Hz), 157.8, 137.0, 135.6, 132.4, 128.9, 128.5, 127.9, 127.5, 116.8, 114.8, 90.4 (d, $J_{C\text{-}F}$ = 19.8 Hz), 70.0, 47.7 (d, $J_{C\text{-}F}$ = 25.3 Hz), 37.0 (d, $J_{C\text{-}F}$ = 3.3 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.3.

4-(2-Fluorohexa-1,5-dien-3-yl)phenyl 4-methylbenzenesulfonate (4i) Isolated by column chromatography (petroleum ether : ethyl acetate = 10:1, R_f = 0.4); yield: 31.1 mg (90%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (d, J = 8.3 Hz, 2H), 7.30 (d, J = 8.3 Hz, 2H), 7.18 (d, J = 8.3 Hz, 2H), 6.94 (d, J = 8.7 Hz, 2H), 5.69-5.63 (m, 1H), 5.02 (dd,

J = 17.1, 1.4 Hz, 1H), 5.00 (dd, J = 10.2, 1.0 Hz, 1H), 4.63 (dd, $J_{C\text{-}F}$ = 17.7, J = 3.0 Hz, 1H), 4.34 (dd, $J_{C\text{-}F}$ = 50.0, J = 3.0 Hz, 1H), 3.44 (dt, J = 17.0, 7.6 Hz, 1H), 2.65-2.60 (m, 1H), 2.45 (s, 3H), 2.44-2.40 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 166.5 (d, $J_{C\text{-}F}$ = 259.9 Hz), 148.5, 145.3, 139.1, 135.0, 132.4, 129.7, 129.0, 128.5, 122.3, 117.2, 91.1 (d, $J_{C\text{-}F}$ = 19.8 Hz), 47.9 (d, $J_{C\text{-}F}$ = 25.6 Hz), 36.9 (d, $J_{C\text{-}F}$ = 3.3 Hz), 21.6. ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.5.

1-Fluoro-4-(2-fluorohexa-1,5-dien-3-yl)benzene (4j) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 15.9 mg (82%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.24-7.22 (m, 2H), 7.01 (t, J = 8.6 Hz, 2H), 5.72-5.65 (m, 1H), 5.05 (dd, J = 17.0, 1.3 Hz, 1H), 5.01 (dd, J = 10.2, 1.0 Hz, 1H), 4.63 (dd, $J_{C\text{-}F}$ = 17.7, J = 3.0 Hz, 1H), 4.35 (dd, $J_{C\text{-}F}$ = 50.0, J = 3.0 Hz, 1H), 3.47 (dt, J = 17.3, 7.9 Hz, 1H), 2.68-2.64 (m, 1H), 2.49-2.44 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.1 (d, $J_{C\text{-}F}$ = 259.8 Hz), 161.9 (d, $J_{C\text{-}F}$ = 245.0 Hz), 135.8 (d, $J_{C\text{-}F}$ = 3.3 Hz), 135.2, 129.4, 129.3, 117.1, 115.4, 115.3, 90.8 (d, $J_{C\text{-}F}$ = 20.9 Hz), 47.8 (d, $J_{C\text{-}F}$ = 25.1 Hz), 37.0 (d, $J_{C\text{-}F}$ = 3.3 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.4, -115.9.

1-(2-Fluorohexa-1,5-dien-3-yl)-4-(trifluoromethyl)benzene) (4k) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 17.3 mg (71%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.59 (d, J = 8.0 Hz, 2H), 7.39 (d, J = 8.0 Hz, 2H), 5.72-5.65 (m, 1H), 5.06 (d, J = 17.0 Hz, 1H), 5.03 (d, J = 10.2 Hz, 1H), 4.68 (dd, $J_{C\text{-}F}$ = 17.6, J = 2.8 Hz, 1H), 4.41 (dd, $J_{C\text{-}F}$ = 49.8, J = 2.8 Hz, 1H), 3.58-3.52 (m, 1H), 2.72-2.67 (m, 1H), 2.53-2.48 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 166.3 (d, $J_{C\text{-}F}$ = 260.6 Hz), 144.1, 134.8, 129.4 (q, $J_{C\text{-}F}$ = 32.2 Hz), 128.3, 125.5 (q, $J_{C\text{-}F}$ = 3.4 Hz), 124.1 (q, $J_{C\text{-}F}$ = 271.8 Hz), 117.5, 91.4 (d, $J_{C\text{-}F}$ = 19.8 Hz), 48.4 (d, $J_{C\text{-}F}$ = 25.9 Hz), 36.8 (d, $J_{C\text{-}F}$ = 3.6 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -62.5, -99.3.

2-(2-Fluorohexa-1,5-dien-3-yl)naphthalene (4l) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 19.4 mg (86%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.80 (d, J = 8.2 Hz, 3H), 7.70 (s, 1H), 7.47-7.42 (m, 2H), 7.40 (d, J = 8.6 Hz, 1H), 5.77-5.70 (m, 1H), 5.07 (dd, J = 17.3, 1.3 Hz, 1H), 5.00 (dd, J = 10.2, 1.0 Hz, 1H), 4.67 (dd, $J_{C\text{-}F}$ = 17.8, J = 2.8 Hz, 1H), 4.41 (dd, $J_{C\text{-}F}$ = 49.9, J = 2.8 Hz, 1H), 3.65 (dt, J = 16.7, 7.6 Hz, 1H), 2.78-2.74 (m, 1H), 2.63-2.58 (m, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.2 (d, $J_{C\text{-}F}$ = 260.0 Hz), 137.5, 135.4, 133.4, 133.0, 128.2, 127.8, 127.6, 126.7, 126.1, 126.0, 125.7, 117.0, 90.9 (d, $J_{C\text{-}F}$ = 19.6 Hz), 48.6 (d, $J_{C\text{-}F}$ = 25.4 Hz), 36.9 (d, $J_{C\text{-}F}$ = 3.3 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -98.5.

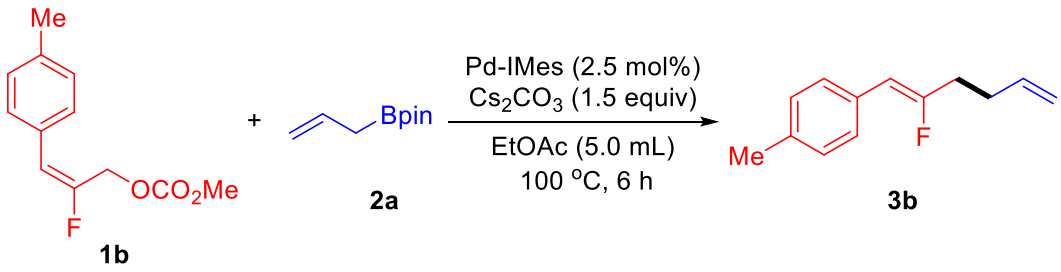
(3-(1-Fluorovinyl)hex-5-en-1-yl)benzene (4n) Isolated by column chromatography (petroleum ether, R_f = 0.4); yield: 15.9 mg (78%). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.28 (t, J = 8.0 Hz, 2H), 7.18 (t, J = 8.2 Hz, 3H), 5.78-5.71 (m, 1H), 5.05 (dd, J = 17.1, 1.4 Hz, 1H), 5.03 (dd, J = 10.2, 1.0 Hz, 1H), 4.62 (dd, $J_{C\text{-}F}$ = 17.7, J = 3.0 Hz, 1H), 4.25 (dd, $J_{C\text{-}F}$

= 50.0, J = 3.0 Hz, 1H), 2.73-2.69 (m, 1H), 2.60-2.55 (m, 1H), 2.31-2.18 (m, 2H), 1.83-1.70 (m, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.3 (d, $J_{C\text{-}F}$ = 260.7 Hz), 142.0, 135.7, 128.4, 128.3, 125.9, 116.6, 90.9 (d, $J_{C\text{-}F}$ = 20.9 Hz), 42.1 (d, $J_{C\text{-}F}$ = 25.5 Hz), 33.2, 32.9 (d, $J_{C\text{-}F}$ = 3.3 Hz), 29.7. ^{19}F NMR (565 MHz, CDCl3) δ -105.6.

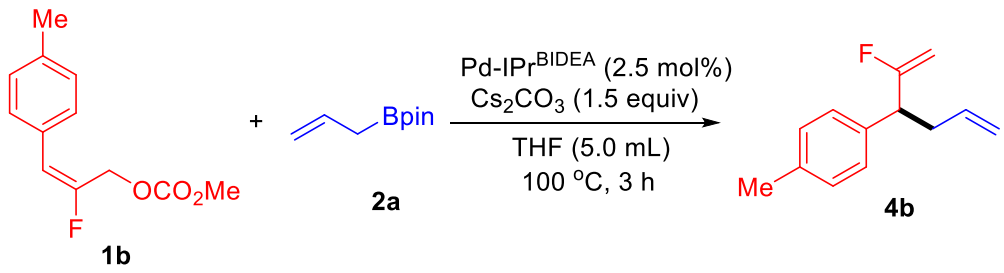
(5-Fluorohexa-1,5-diene-2,4-diyl)dibenzene (4o) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 22.7 mg (90%, *B*/*L* = 7:1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34-7.33 (m, 4H), 7.30-7.28 (m, 3H), 7.23-7.18 (m, 3H), 5.22 (s, 1H), 4.98 (s, 1H), 4.59 (dd, $J_{C\text{-}F}$ = 17.6, J = 2.8 Hz, 1H), 4.28 (dd, $J_{C\text{-}F}$ = 50.0, J = 2.8 Hz, 1H), 3.52 (dt, J = 18.8, 7.6 Hz, 1H), 3.17 (dd, J = 14.4, 7.6 Hz, 1H), 2.91 (dd, J = 14.4, 7.6 Hz, 1H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.0 (d, $J_{C\text{-}F}$ = 260.6 Hz), 145.4, 140.3 (d, $J_{C\text{-}F}$ = 56.4 Hz), 128.43, 128.41, 127.9, 127.6, 127.0, 126.4, 126.1, 115.3, 90.9 (d, $J_{C\text{-}F}$ = 20.6 Hz), 47.0 (d, $J_{C\text{-}F}$ = 25.6 Hz), 38.7 (d, $J_{C\text{-}F}$ = 3.0 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -100.1.

(2-Fluoro-5-methylhexa-1,5-dien-3-yl)benzene (4p) Isolated by column chromatography (petroleum ether, R_f = 0.5); yield: 16.7 mg (88%, *B*/*L* = 20:1). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33-7.29 (m, 2H), 7.28-7.26 (m, 2H), 7.25-7.24 (m, 1H), 4.75 (s, 1H), 4.67 (s, 1H), 4.60 (dd, $J_{C\text{-}F}$ = 17.6, J = 2.8 Hz, 1H), 4.35 (dd, $J_{C\text{-}F}$ = 50.0, J = 2.8 Hz, 1H), 3.64 (dt, J = 18.8, 7.6 Hz, 1H), 2.66 (dd, J = 14.4, 7.6 Hz, 1H), 2.46 (dd, J = 14.4, 7.6 Hz, 1H), 1.70 (s, 3H). ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.5 (d, $J_{C\text{-}F}$ = 260.6 Hz), 142.3, 140.4, 128.5, 127.8, 127.0, 112.9, 90.6 (d, $J_{C\text{-}F}$ = 20.6 Hz), 46.9 (d, $J_{C\text{-}F}$ = 25.4 Hz), 40.8 (d, $J_{C\text{-}F}$ = 3.0 Hz). ^{19}F NMR (565 MHz, $CDCl_3$) δ -99.2.

5. Scale-up synthesis of product 3b and 4b



A flame-dried reaction tube (50 cm^3) equipped with a magnetic stir bar was charged with Pd-PEPPSI-IMes (16.0 mg, 2.5 mol%). The reaction tube was transferred to the glovebox and charged with **1b** (1.0 mmol), allylboronate **2a** (1.5 mmol), Cs_2CO_3 (488.0 mg) and EtOAc (5.0 mL). After that, the reaction mixture was sealed with aluminum cap, moved out of glovebox, and stirred at 100 °C for 6 h. After the mixture was cooled to room temperature, the resulting solution was directly filtered through a pad of silica gel by EtOAc (10.0 mL). The solvent was evaporated *in vacuo* to give the crude product. ***L***/***B*** ratio was determined by ^{1}H NMR analysis. The residue was purified by column chromatography on silica gel to give the pure product **3b** (165 mg, 87% yield, ***L***/***B*** > 50:1).



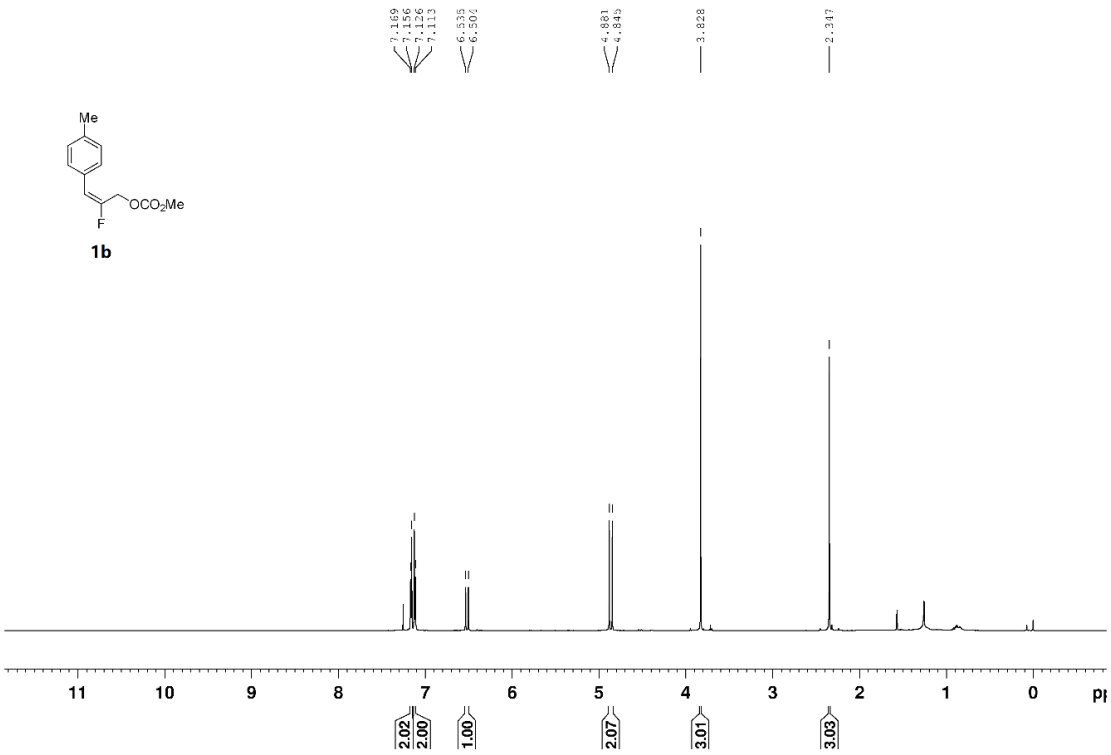
A flame-dried reaction tube (50 cm^3) equipped with a magnetic stir bar was charged with Pd-PEPPSI-IPr^{BIDEA} (21.4 mg, 2.5 mol%). The reaction tube was transferred to the glovebox and charged with **1b** (1.0 mmol), allylboronate **2a** (1.5 mmol), Cs_2CO_3 (488.0 mg) and THF (5.0 mL). After that, the reaction mixture was sealed with aluminum cap, moved out of glovebox, and stirred at 100 °C for 3 h. After the mixture was cooled to room temperature, the resulting solution was directly filtered through a pad of silica gel by EtOAc (10.0 mL). The solvent was evaporated *in vacuo* to give the crude product. ***B***/***L*** ratio was determined by ^{1}H NMR analysis. The residue was purified by column chromatography on silica gel to give the pure product **4b** (158 mg, 83% yield, ***B***/***L*** > 80:1).

6. References

[1] (a) M. Engman, J. S. Diesen, A. Paptchikhine, P. G. Andersson, *J. Am. Chem. Soc.* **2007**, *129*, 4536. (b) M. Yamamoto, S. Hayashi, K. Isa, M. Kawatsura, *Org. Lett.* **2014**, *16*, 700.

[2] (a) Lv, L.; Qian, H.; Crowell, A. B.; Chen, S.; Li, Z. *ACS Catal.* **2022,** *12*, 6495. (b) Wu, L.; Wang, M.; Liang, Y.; Shi, Z. *Chin. J. Chem.* **2022,** *40*, 2345.

7. Copies of ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra for all new compounds and products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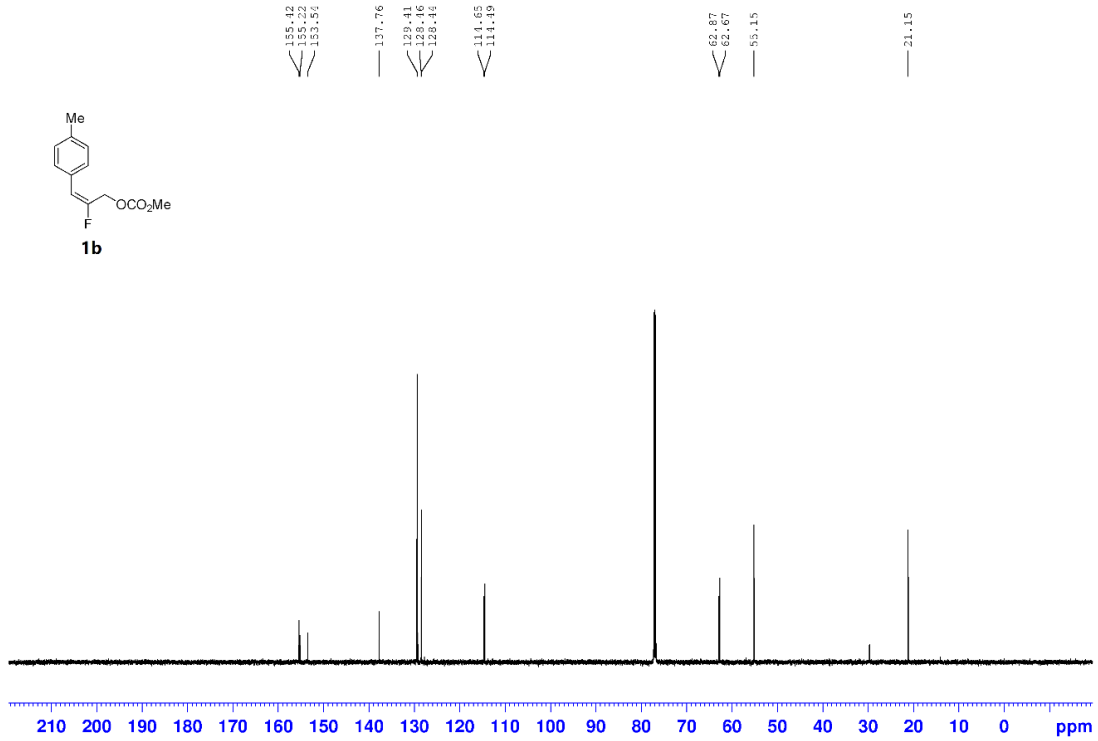
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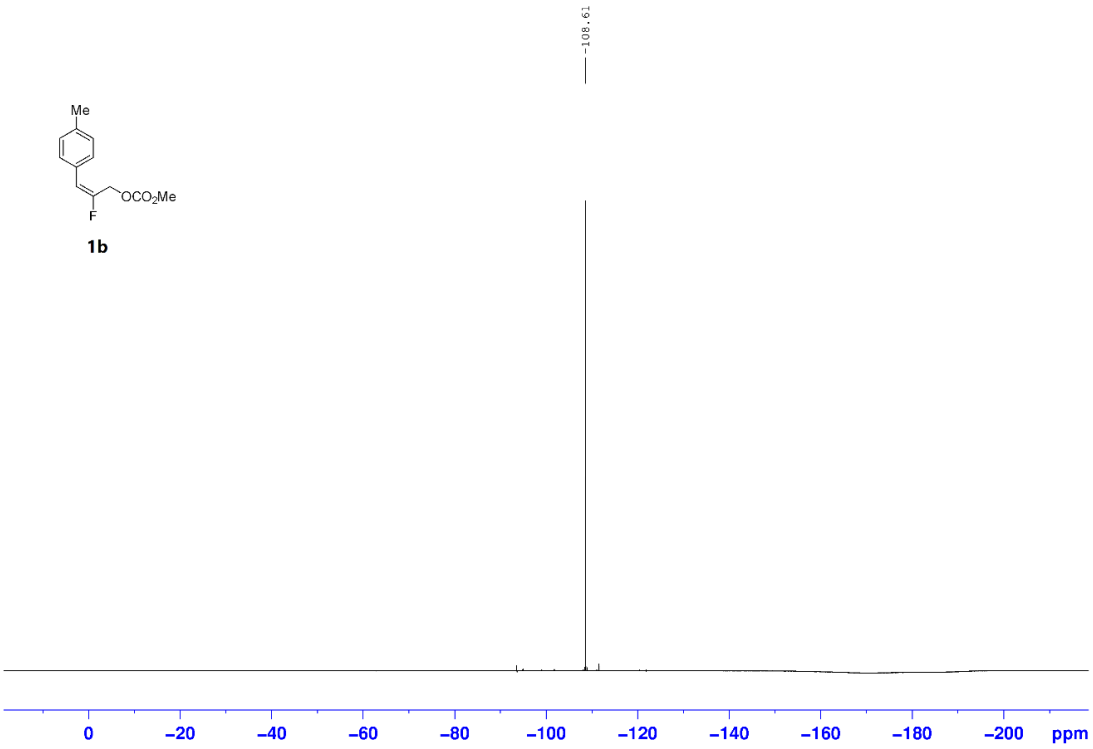
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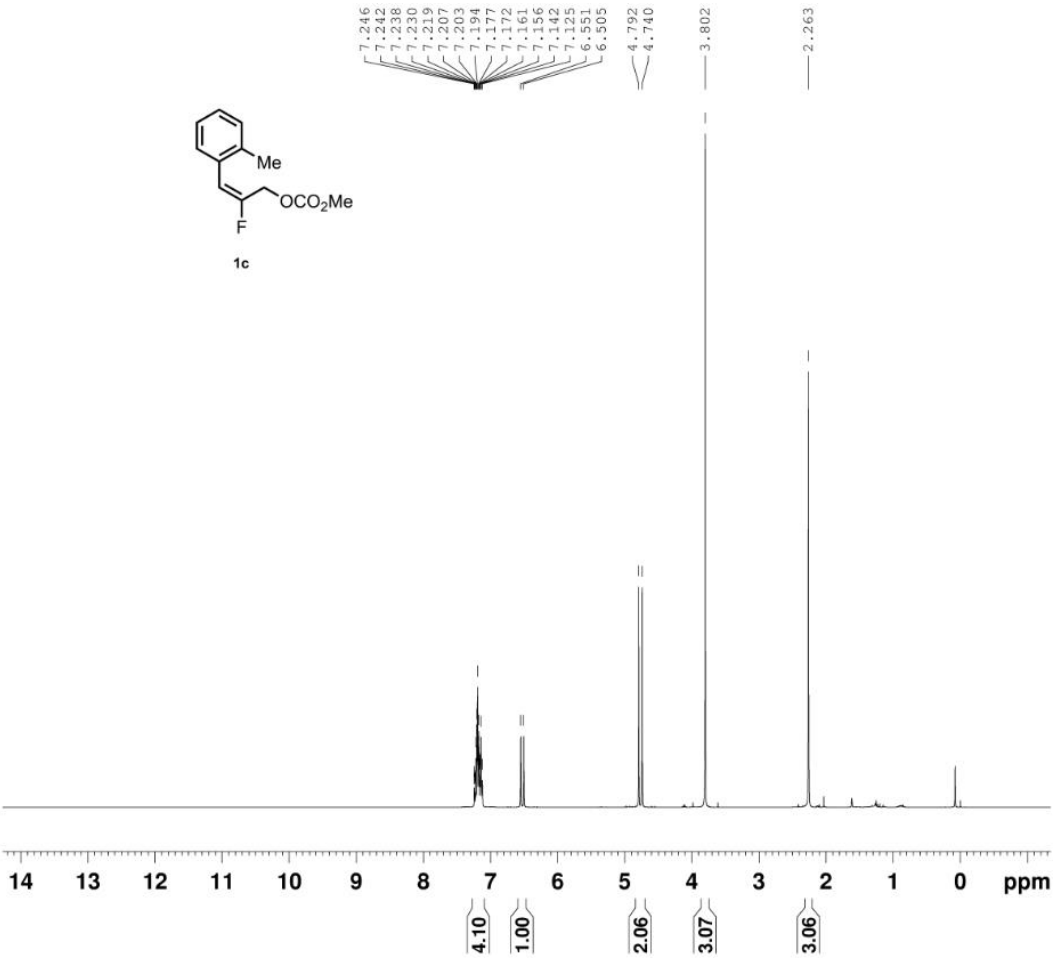
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6.505
4.792
4.740
3.802
2.263
Me
OCO2Me
F
1c
14
13
12
11
10
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5
4
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2
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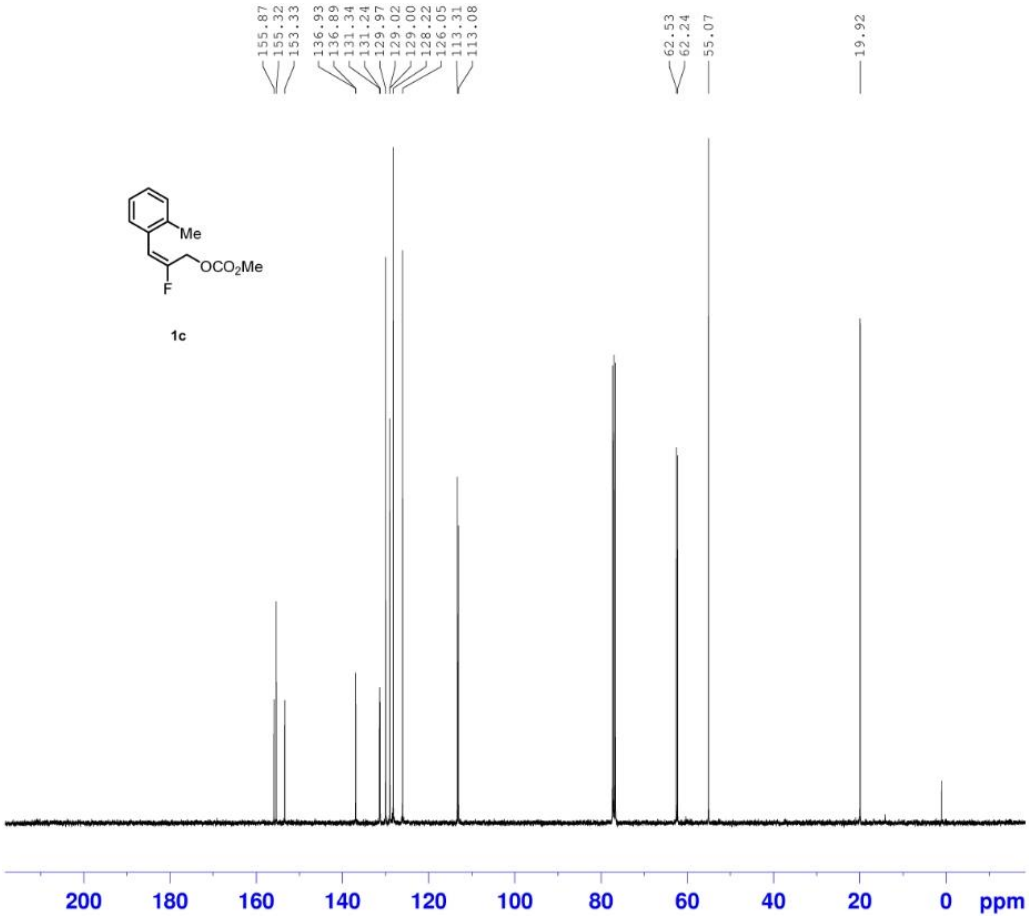
4.10
1.00
2.06
3.07
3.06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153.33
136.93
136.89
131.34
131.24
129.97
129.02
129.00
128.22
126.05
113.31
113.08
62.53
62.24
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0
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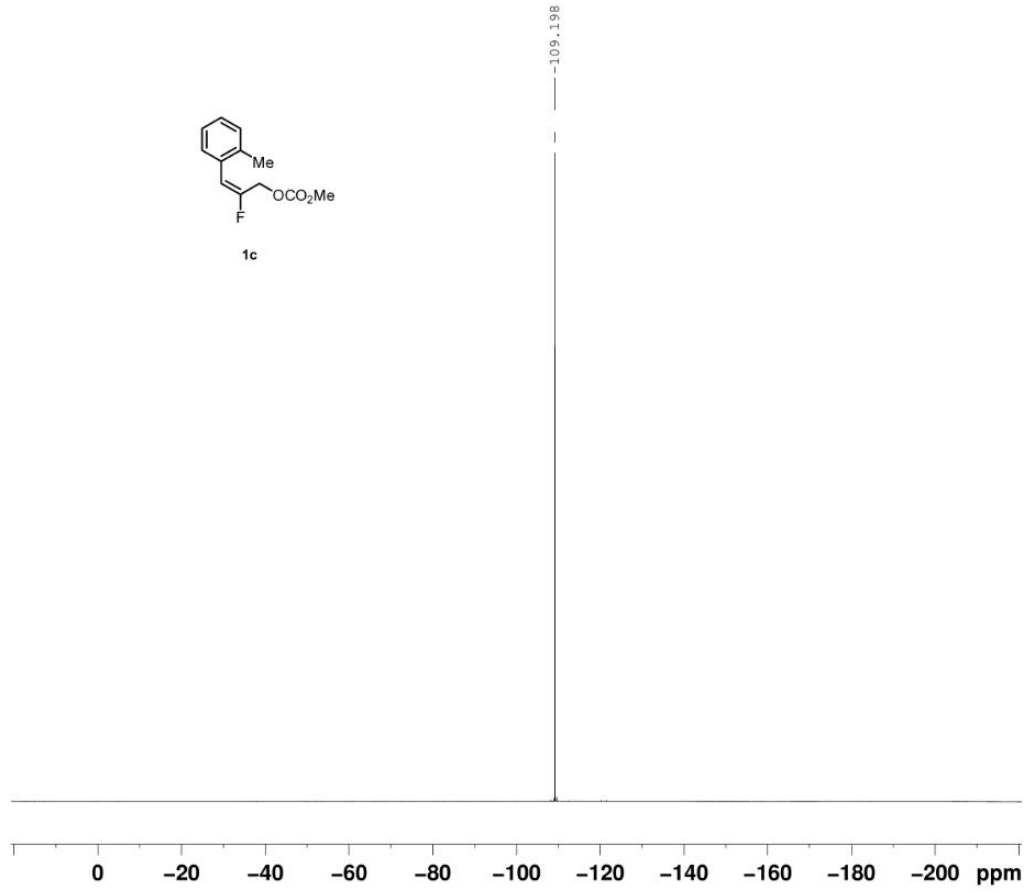
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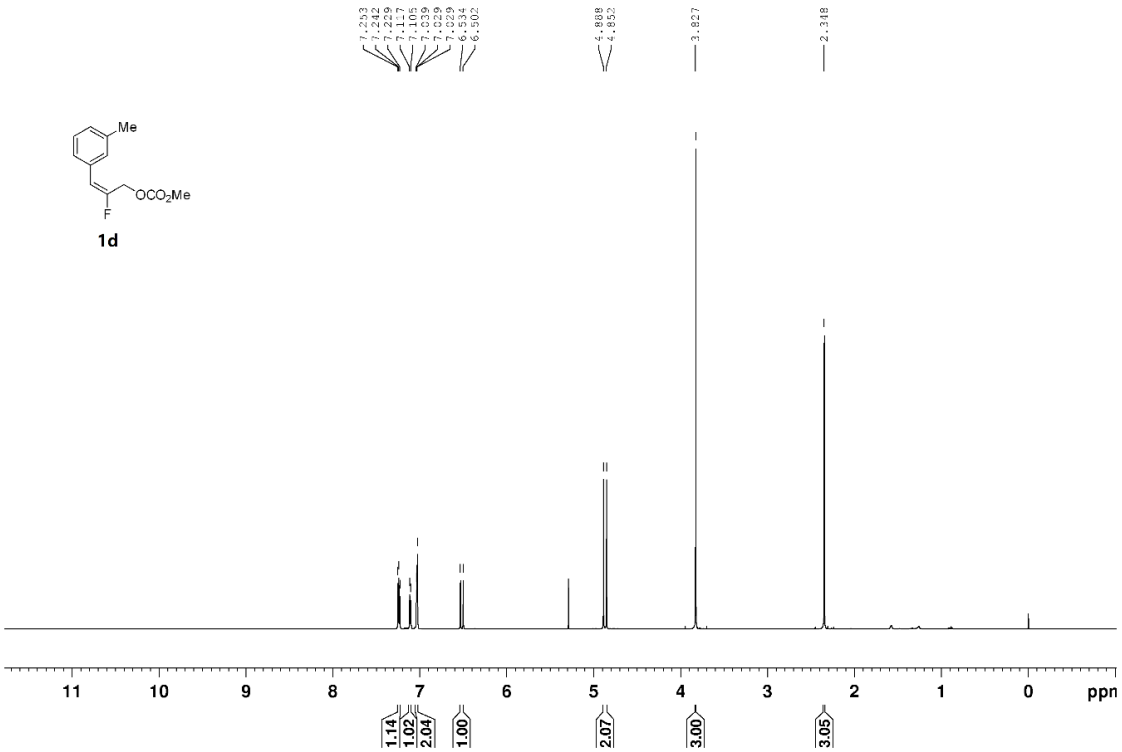
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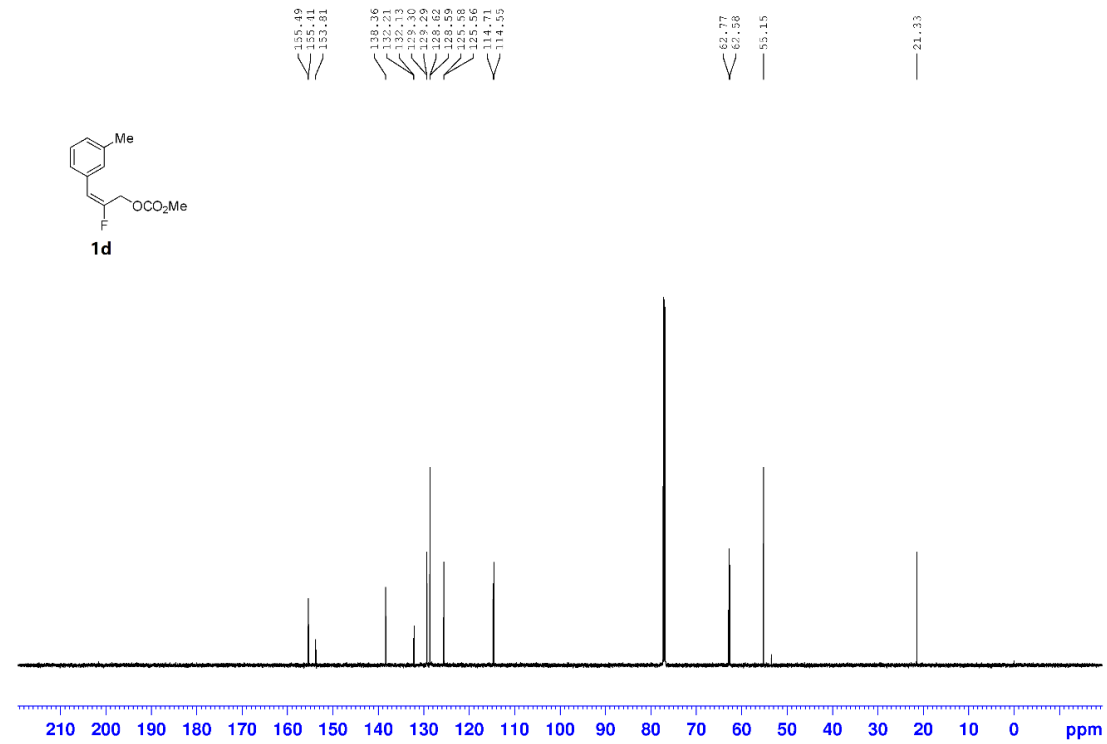
7.242
7.229
7.117
7.105
7.039
7.028
7.029
6.534
6.502
4.888
4.852
3.827
2.348
Me
OCO2Me
F
1d
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.14
1.02
2.04
1.00
2.07
3.00
3.05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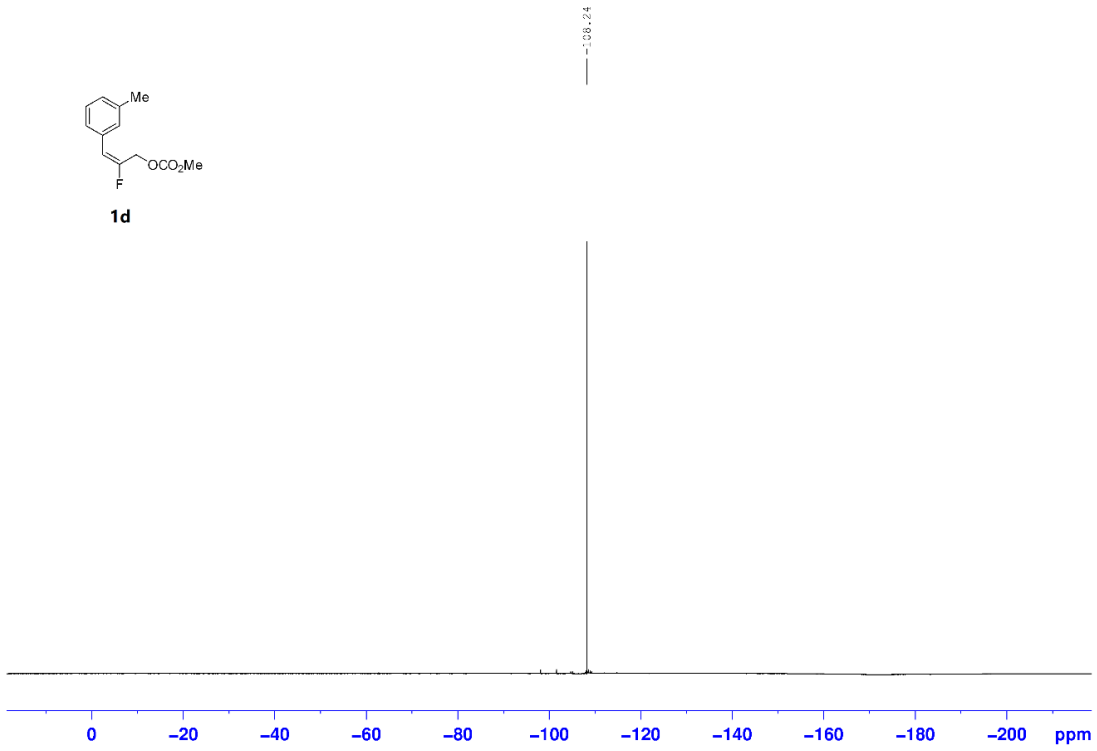
155.41
153.81
138.36
132.21
132.13
129.30
129.29
128.62
128.59
125.58
125.56
114.71
114.55
62.77
62.58
55.15
21.33
Me
OCO2Me
F
1d
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm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OCO2Me
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1d
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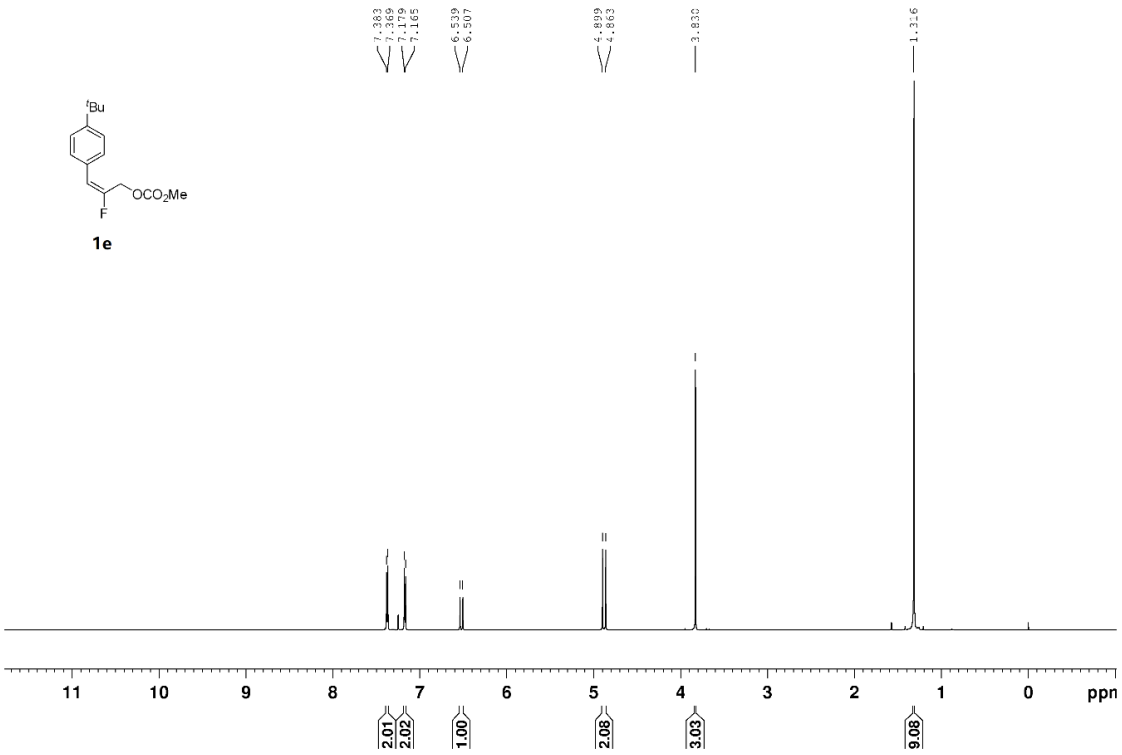
-60
-80
-100
-120
-140
-160
-180
-200
ppm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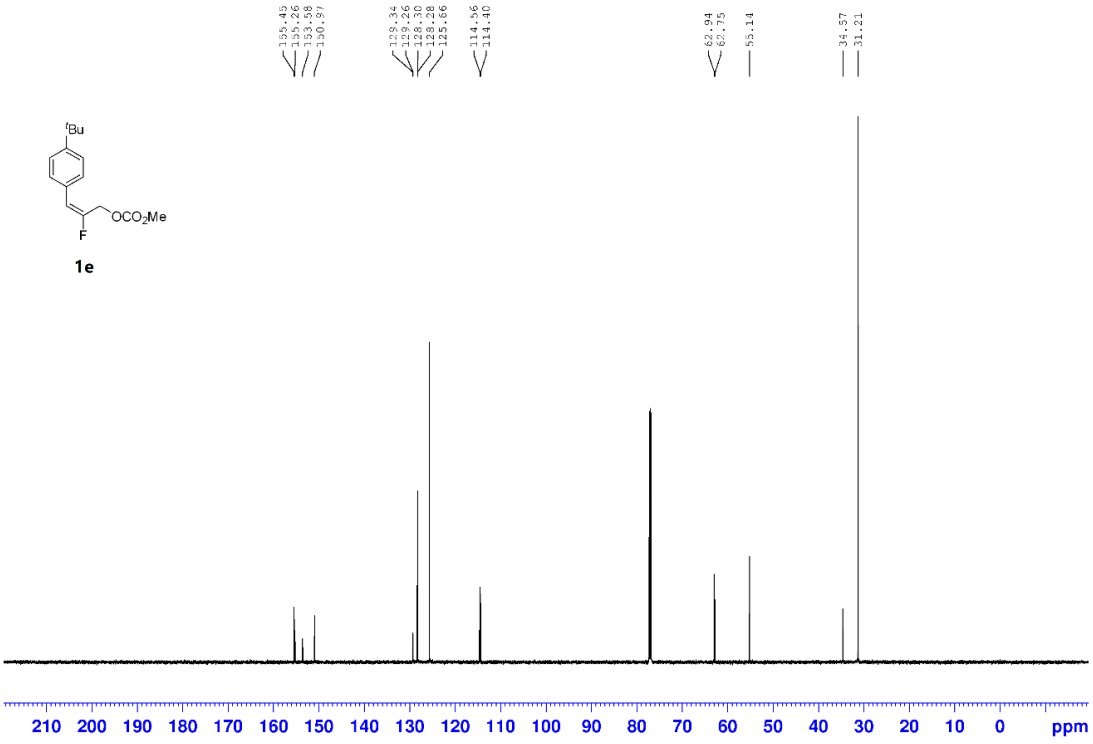
7.369
7.179
7.165
6.539
6.507
4.899
4.863
3.832
1.326
tBu
OCO2Me
F
1e
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.01
2.02
1.00
2.08
3.03
9.08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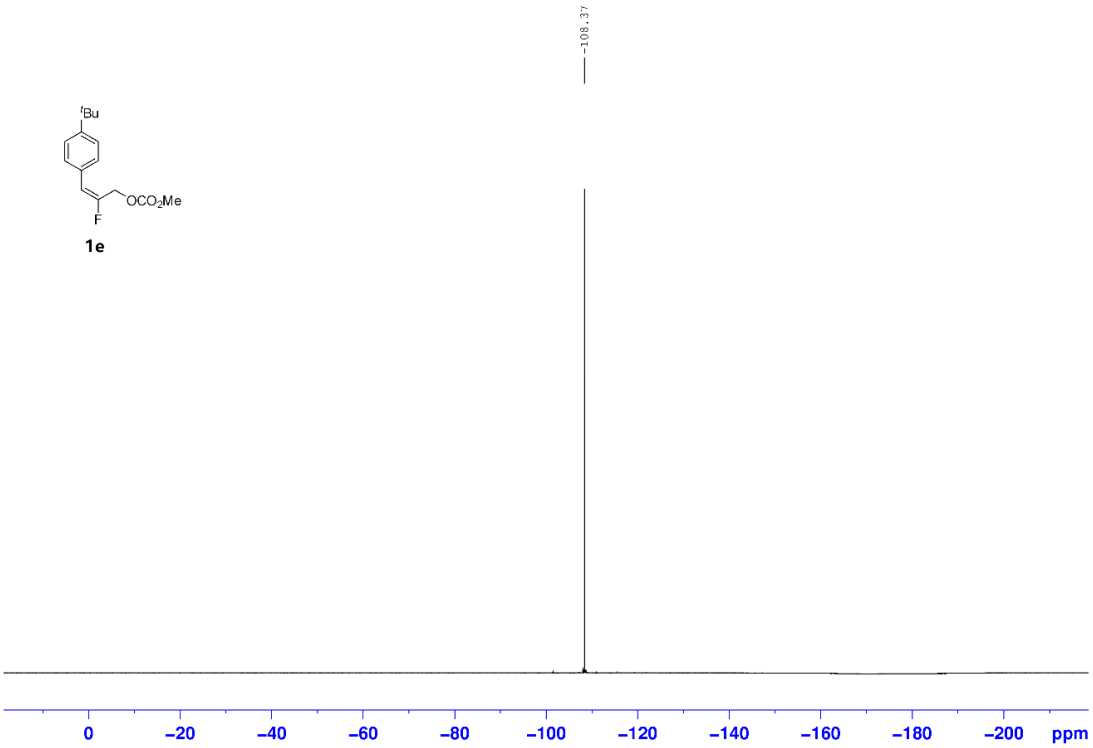
155.26
153.58
150.97
129.34
129.26
128.30
128.28
125.66
114.56
114.40
62.94
62.75
53.14
34.57
31.21
tBu
OCO2Me
F
1e
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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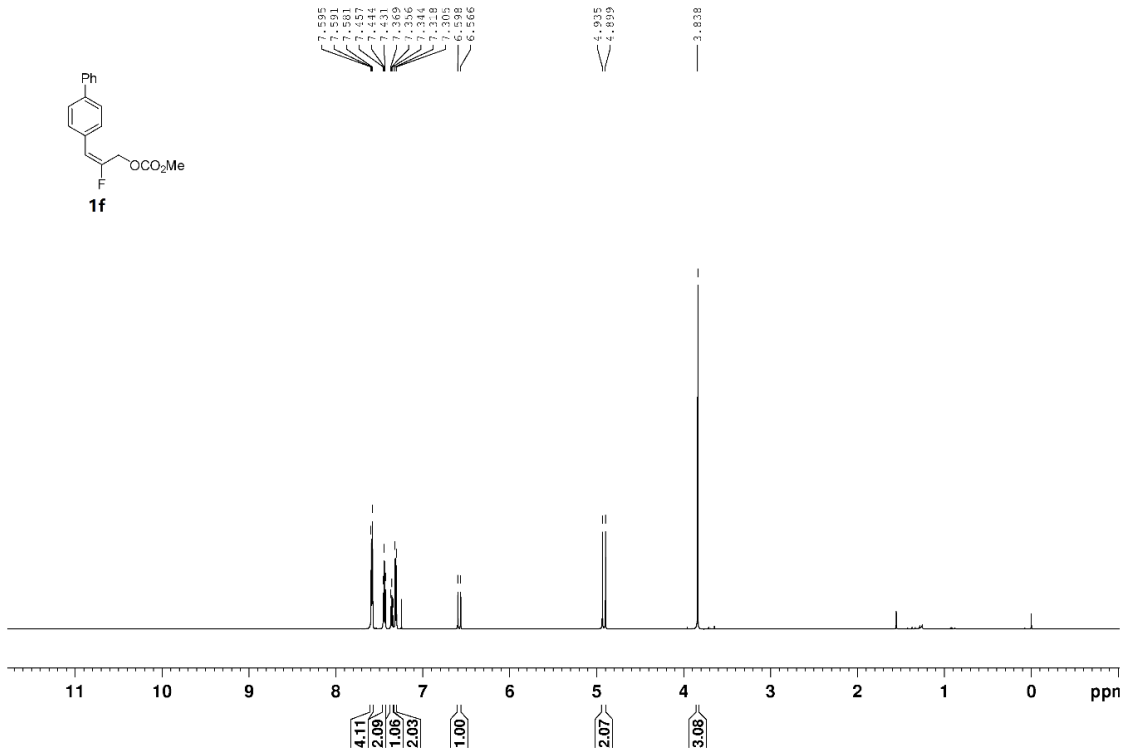
OCO2Me
F
1e
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm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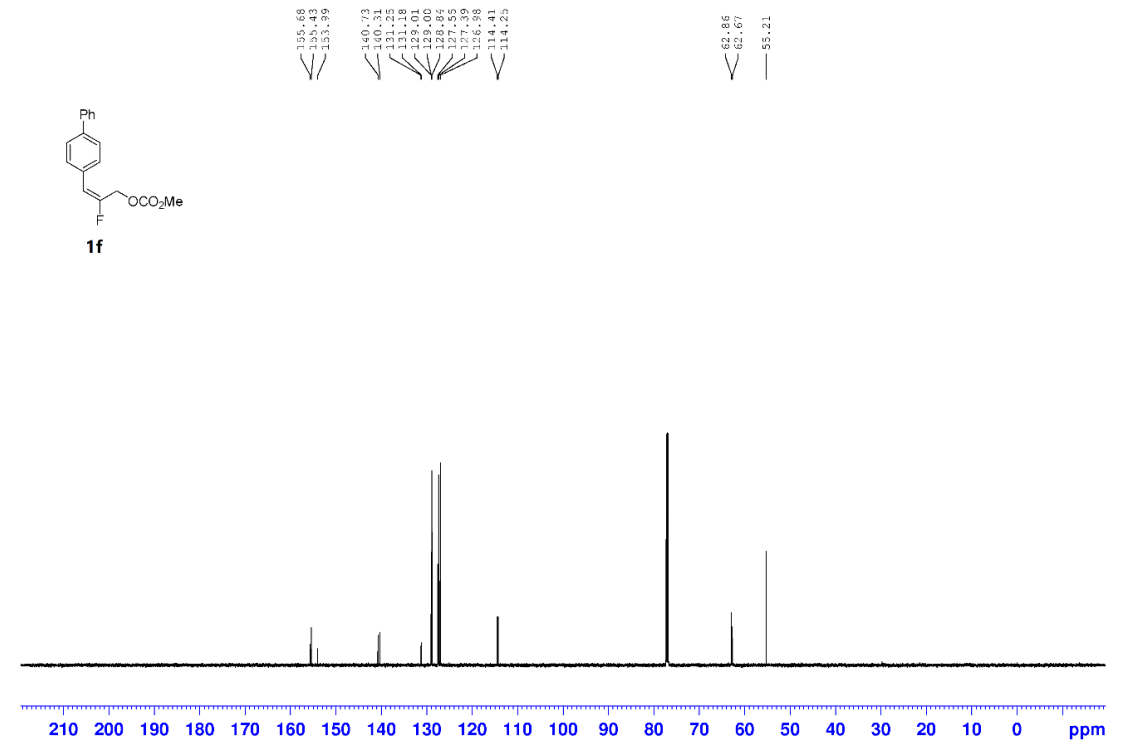
7.591
7.581
7.457
7.444
7.431
7.369
7.356
7.344
7.328
7.305
6.598
6.566
4.935
4.899
3.838
Ph
OCO2Me
F
1f
11
10
9
8
7
6
5
4
3
2
1
0
ppm
4.11
2.09
1.06
2.03
1.00
2.07
3.08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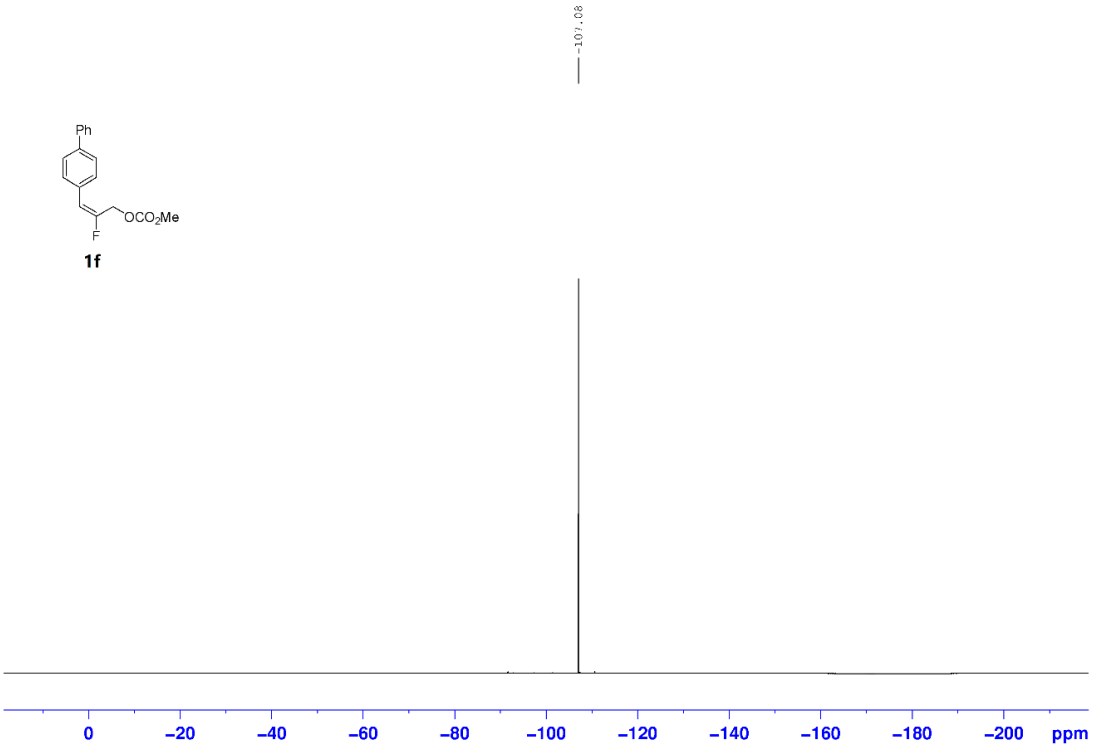
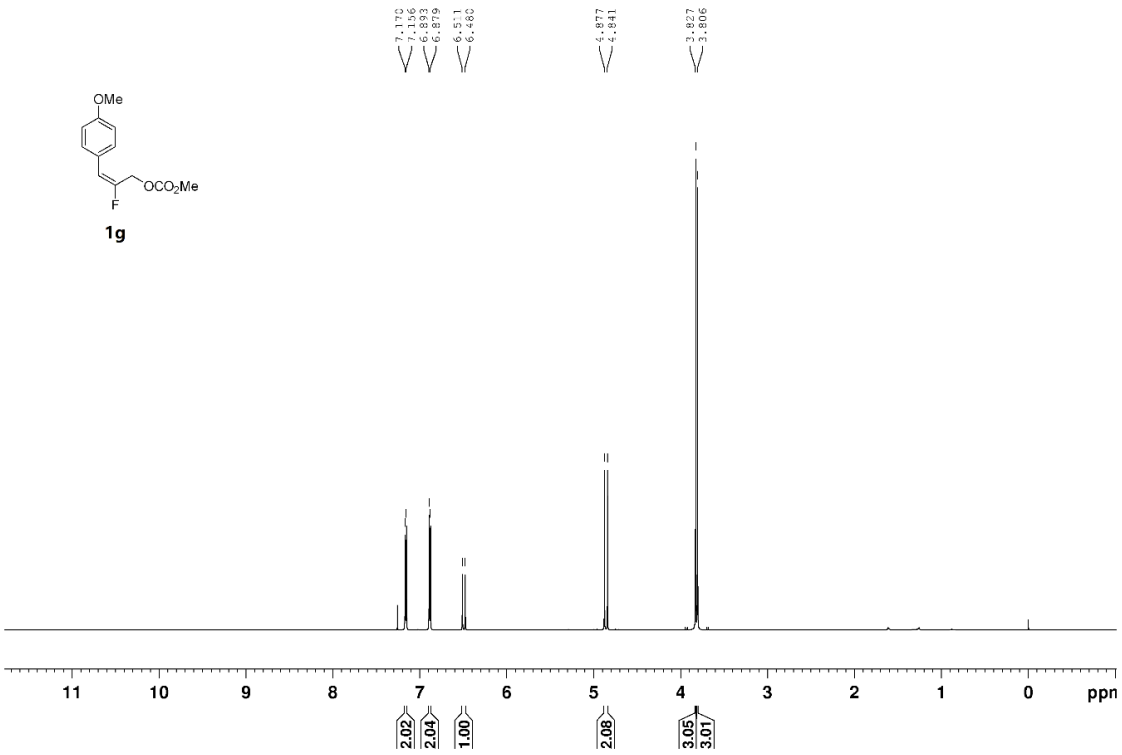
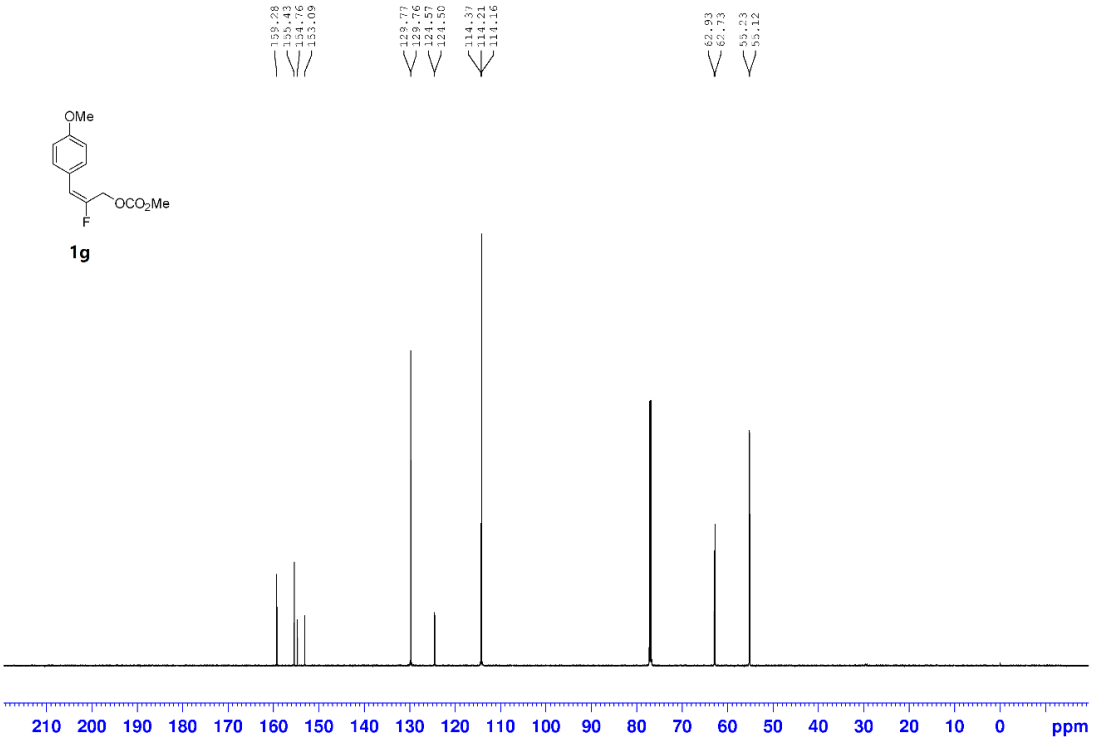
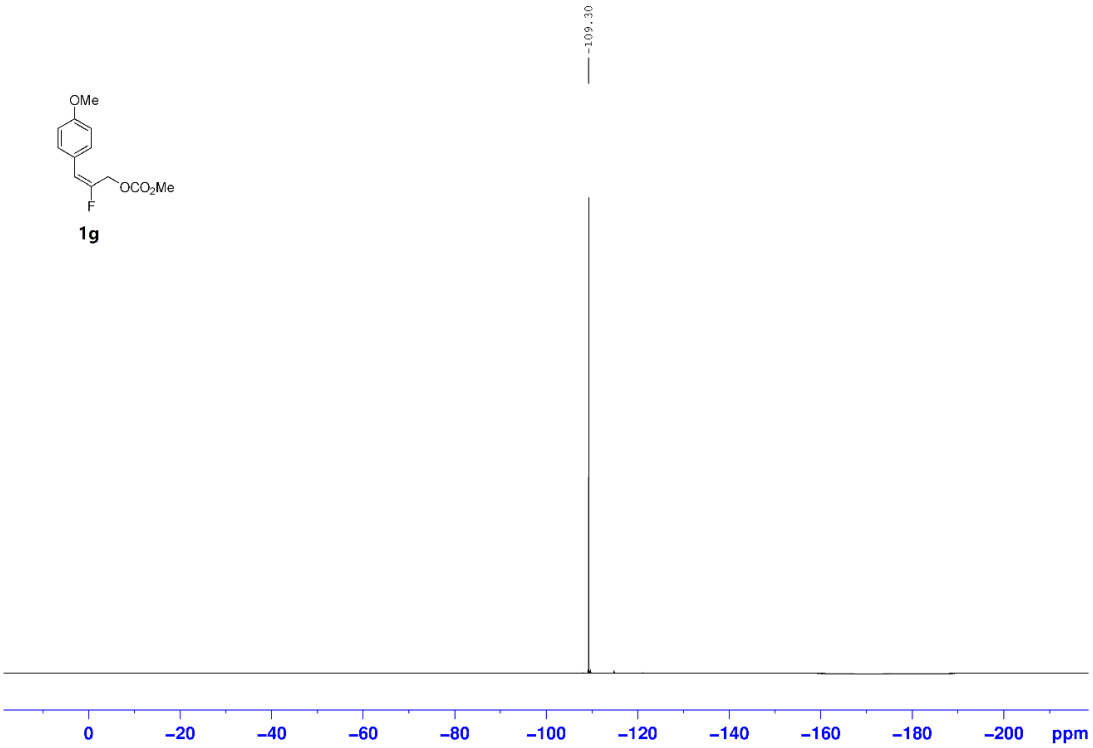
155.43
153.99
140.73
140.31
131.25
131.18
129.01
129.00
128.86
127.55
127.39
126.98
114.41
114.25
62.86
62.67
55.21
Ph
OCO2Me
F
1f
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


-107.08
Ph
OCO2Me
F
1f
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm


7.170
7.156
6.893
6.879
6.511
6.480
4.877
4.841
3.827
3.806
OMe
OCO2Me
F
1g
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.02
2.04
1.00
2.08
3.05
3.01


159.28
155.43
154.76
153.09
129.77
129.76
124.57
124.50
114.37
114.21
111.16
62.93
62.73
55.23
55.12
OMe
OCO2Me
F
1g
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm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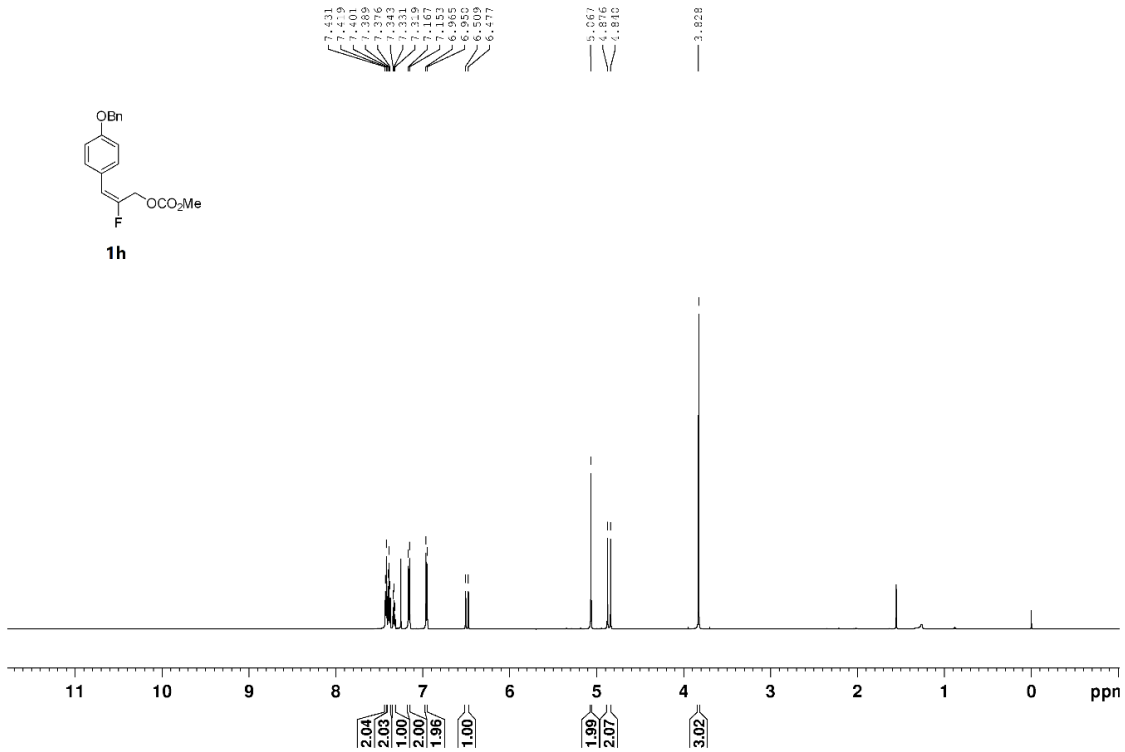
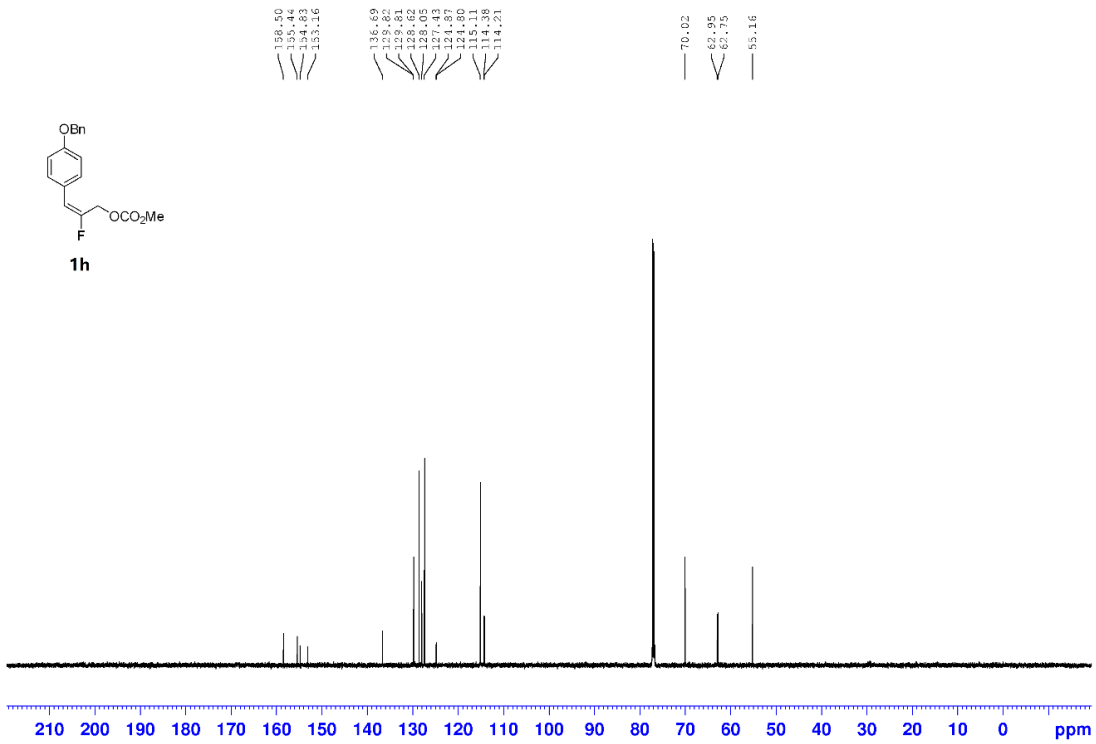
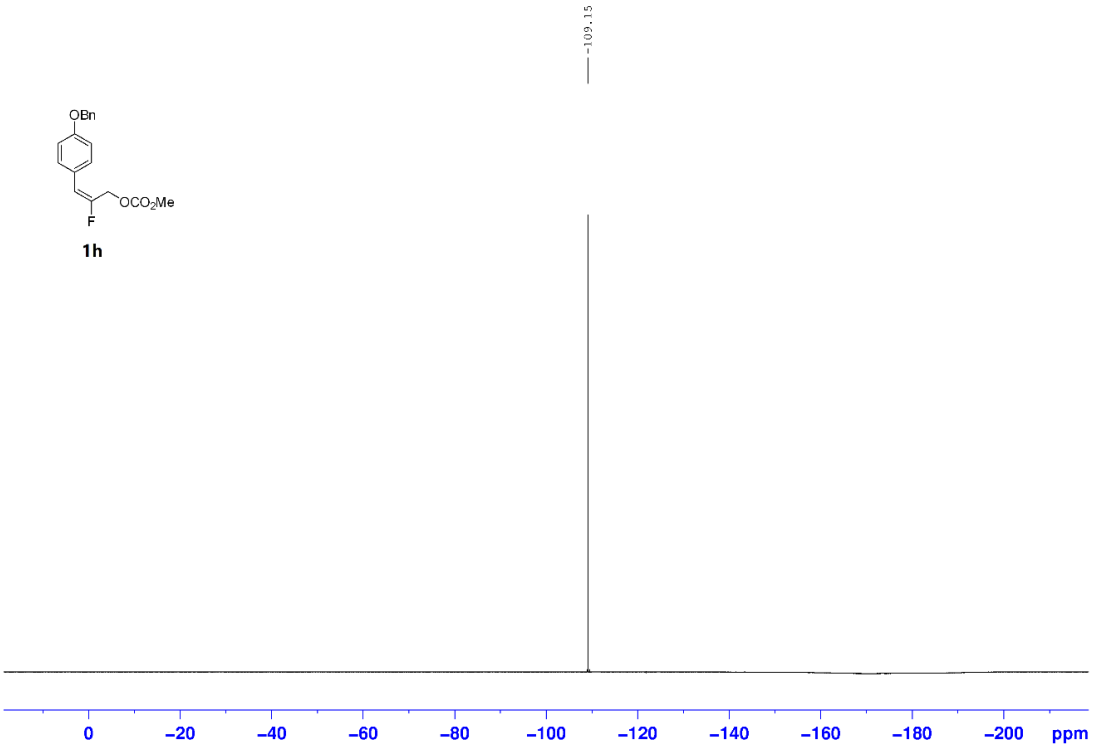
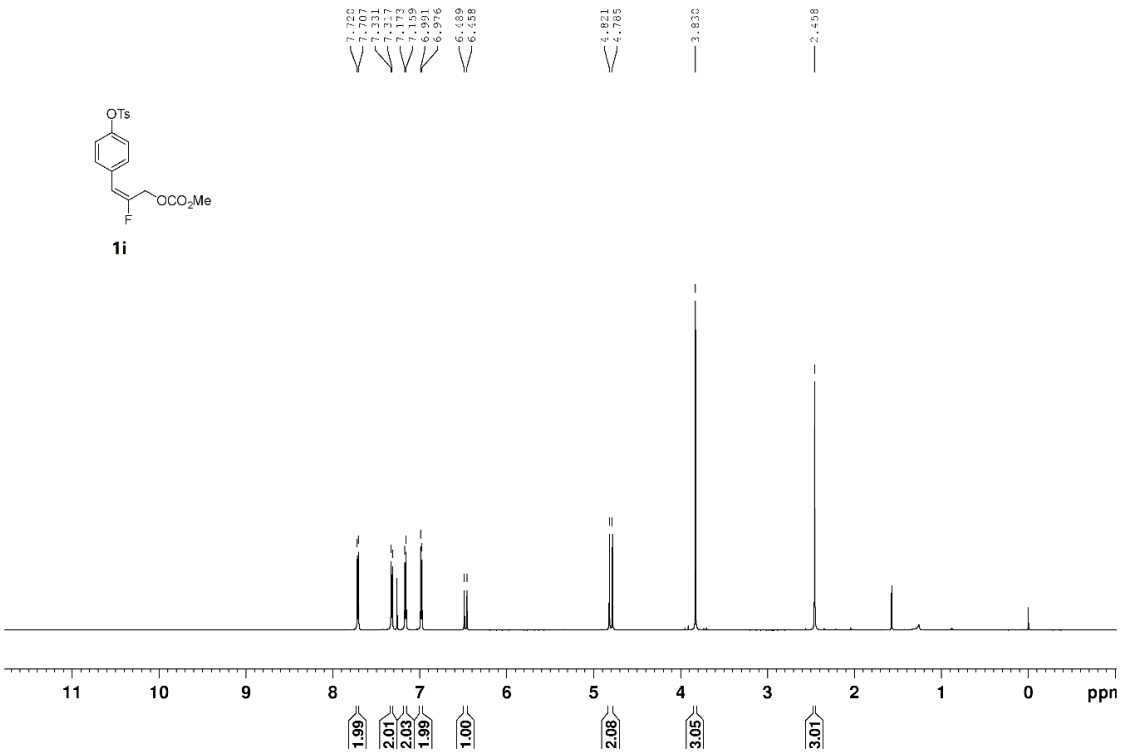
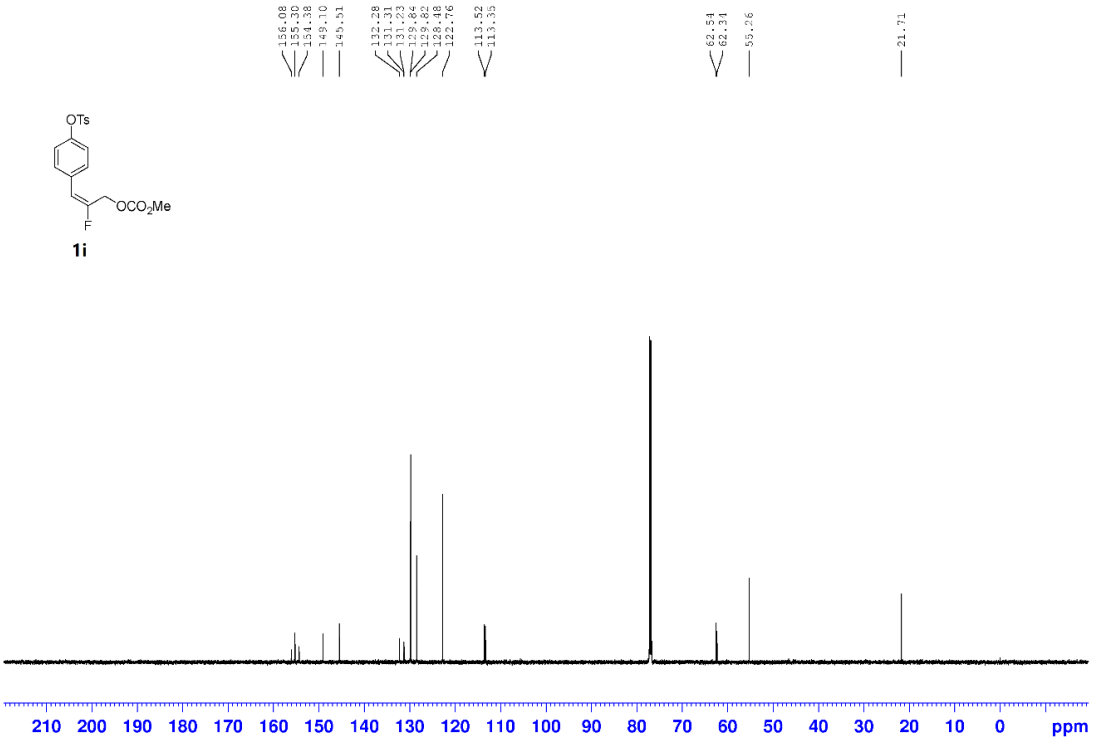
OMe
OCO2Me
F
1g
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm

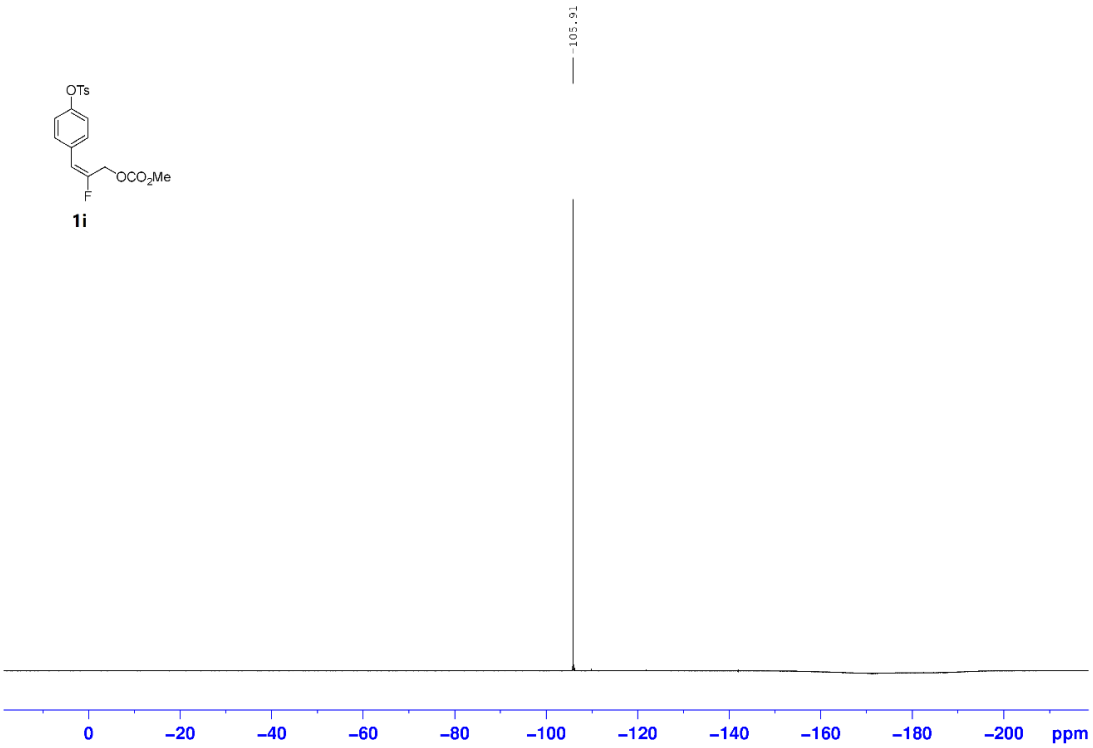

7.431
7.419
7.401
7.389
7.376
7.343
7.331
7.229
7.167
7.153
6.965
6.950
6.509
6.477
5.067
4.876
4.810
3.828
OBn
OCO2Me
F
1h
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.04
2.03
1.00
2.00
1.96
1.00
1.99
2.07
3.02

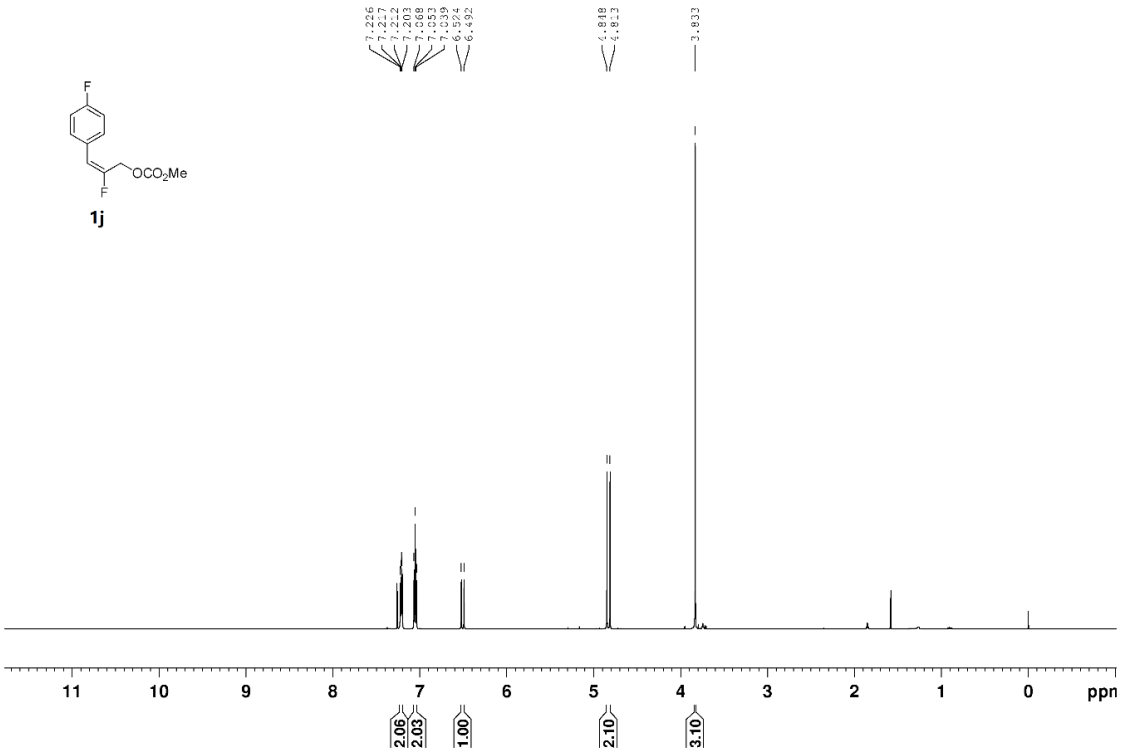

158.50
155.44
154.83
153.16
136.69
129.82
129.81
128.62
128.05
127.43
124.87
124.80
115.11
114.38
114.21
70.02
62.95
62.75
55.16
OBn
OCO2Me
F
1h
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


OBn
OCO2Me
F
1h
-109.15
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm


7.726
7.707
7.331
7.317
7.173
7.159
6.991
6.976
6.489
6.458
4.821
4.785
3.838
2.458
OTs
OCO2Me
F
1i
11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.99
2.01
2.03
1.99
1.00
2.08
3.05
3.01


156.08
155.30
154.38
149.10
145.51
132.28
131.31
131.23
129.64
129.22
128.48
122.76
113.52
113.35
62.54
62.31
55.26
21.71
OTs
OCO2Me
F
1i
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-105.91
OTs
OCO2Me
F
1i
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm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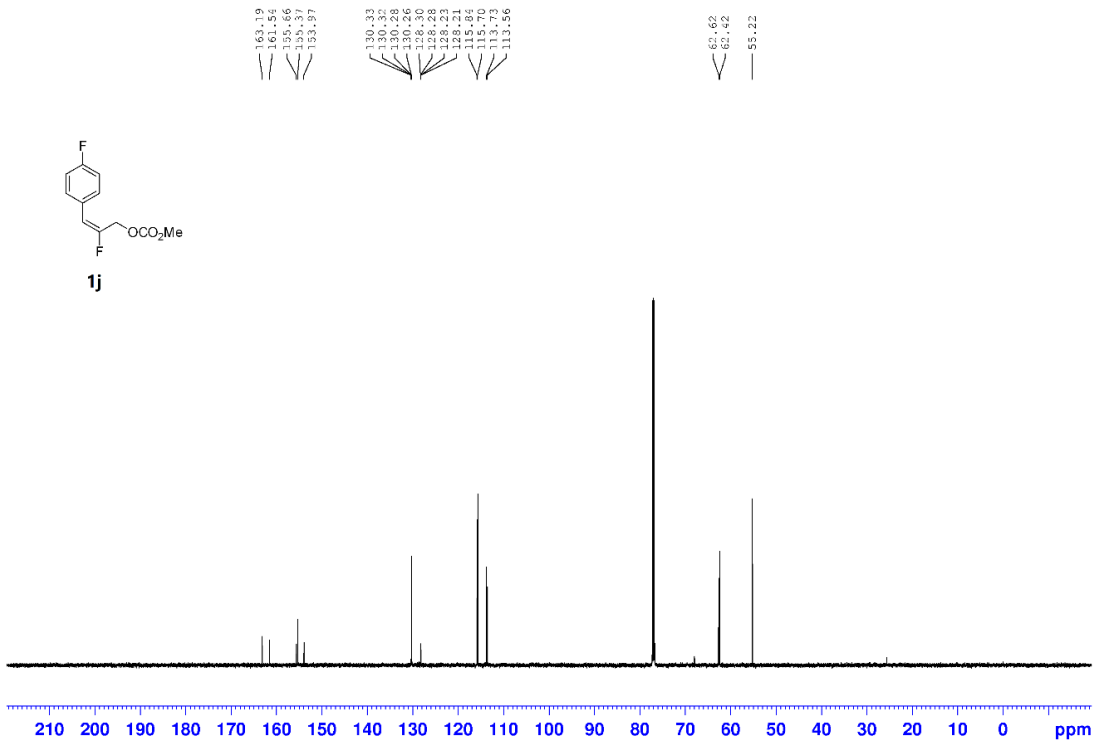
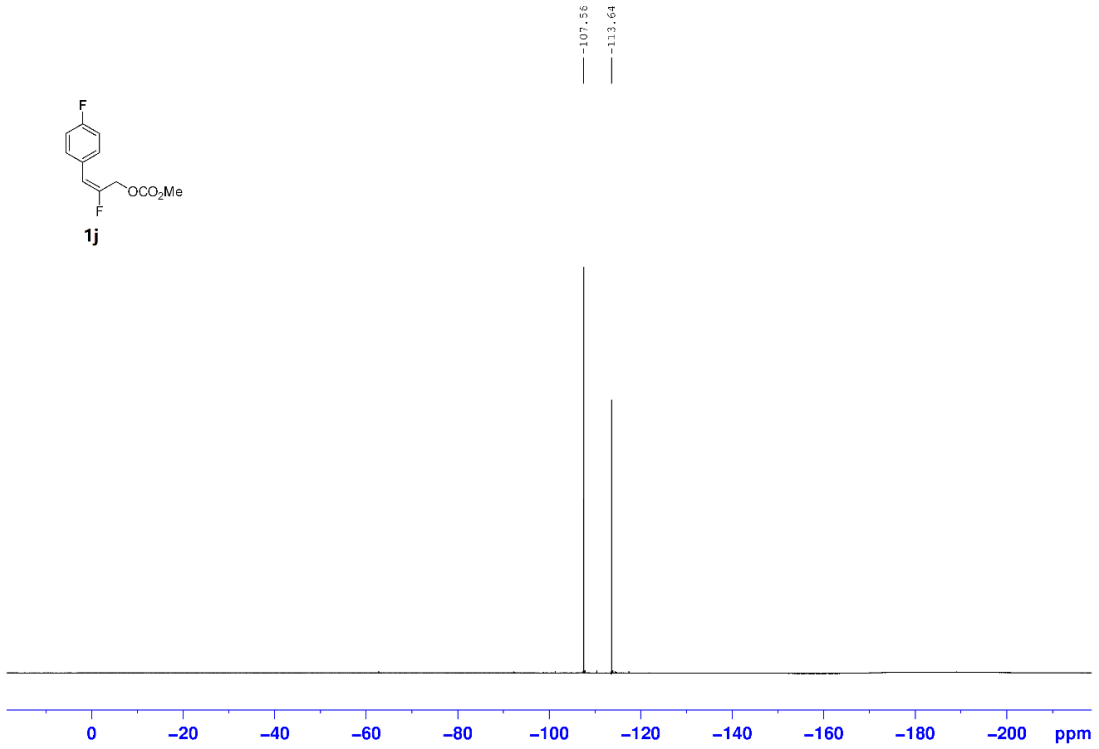
7.217
7.212
7.203
7.068
7.053
7.039
6.524
6.492
4.818
4.813
3.833
F
OCO2Me
F
1j
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.06
2.03
1.00
2.10
3.10


163.19
161.54
155.66
135.37
133.97
130.33
130.32
130.28
130.26
128.30
128.28
128.23
128.21
115.86
115.70
113.73
113.56
62.62
62.42
55.22
F
OCO2Me
F
1j
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


-107.56
-113.64
F
OCO2Me
F
1j
0
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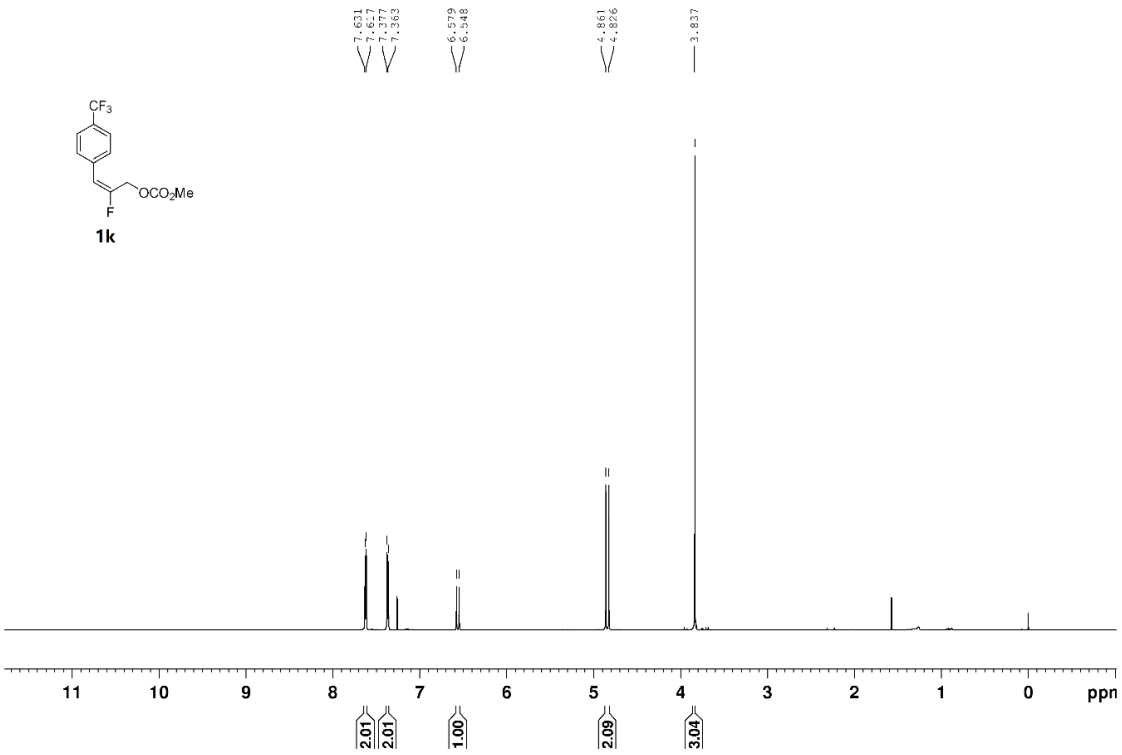
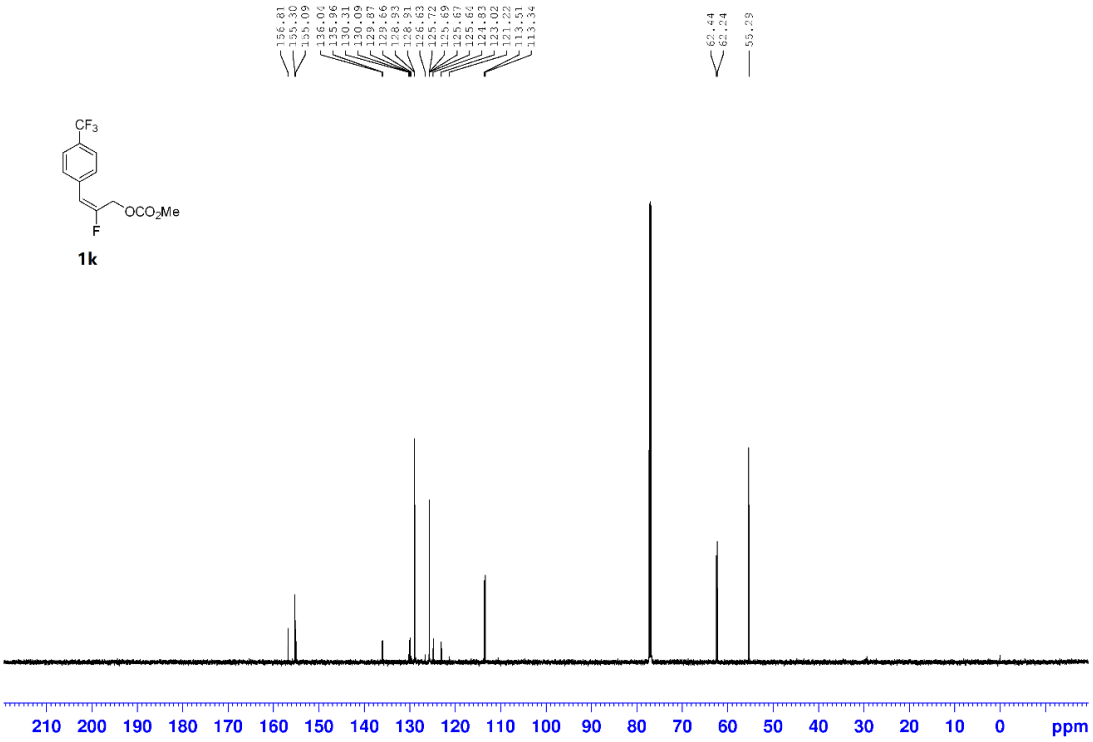
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm


7.631
7.627
7.373
7.369
6.579
6.548
4.861
4.826
3.837
CF3
OCO2Me
F
1k
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.01
2.01
1.00
2.09
3.04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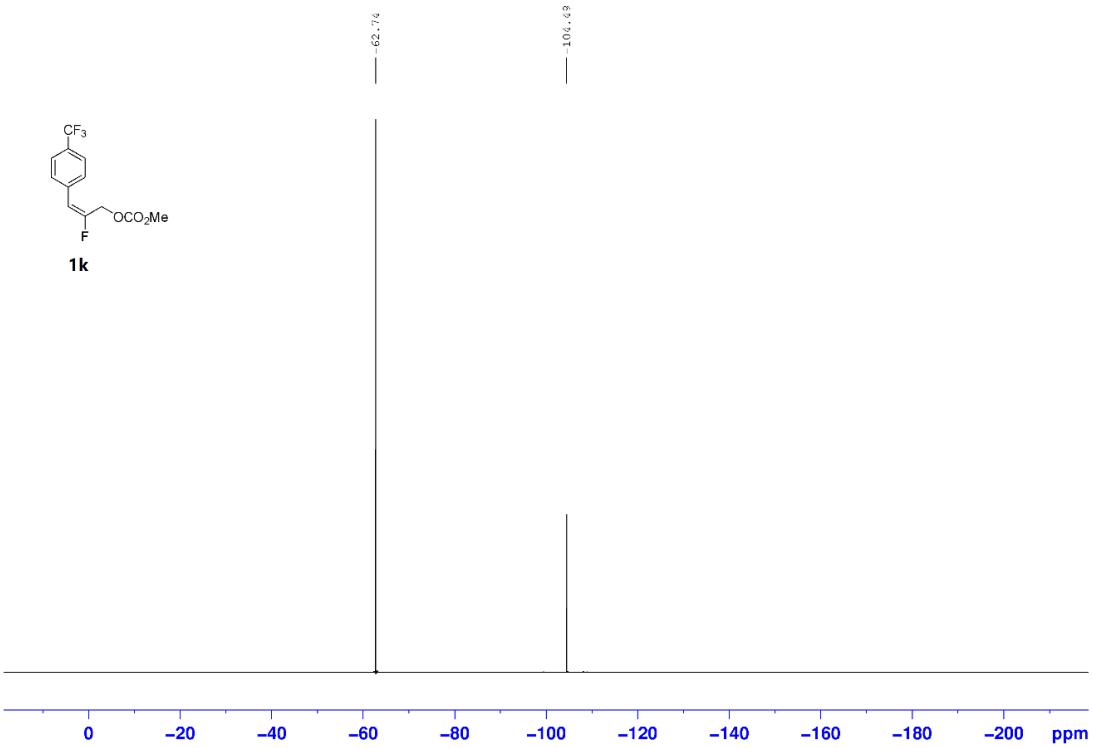
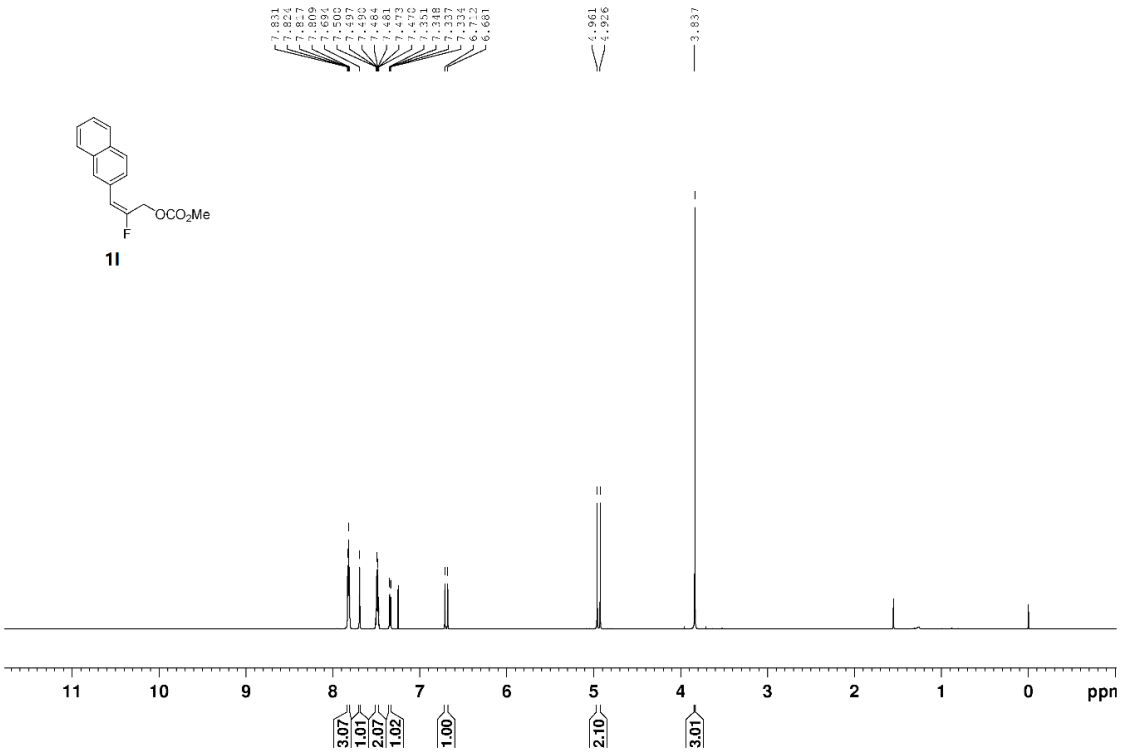
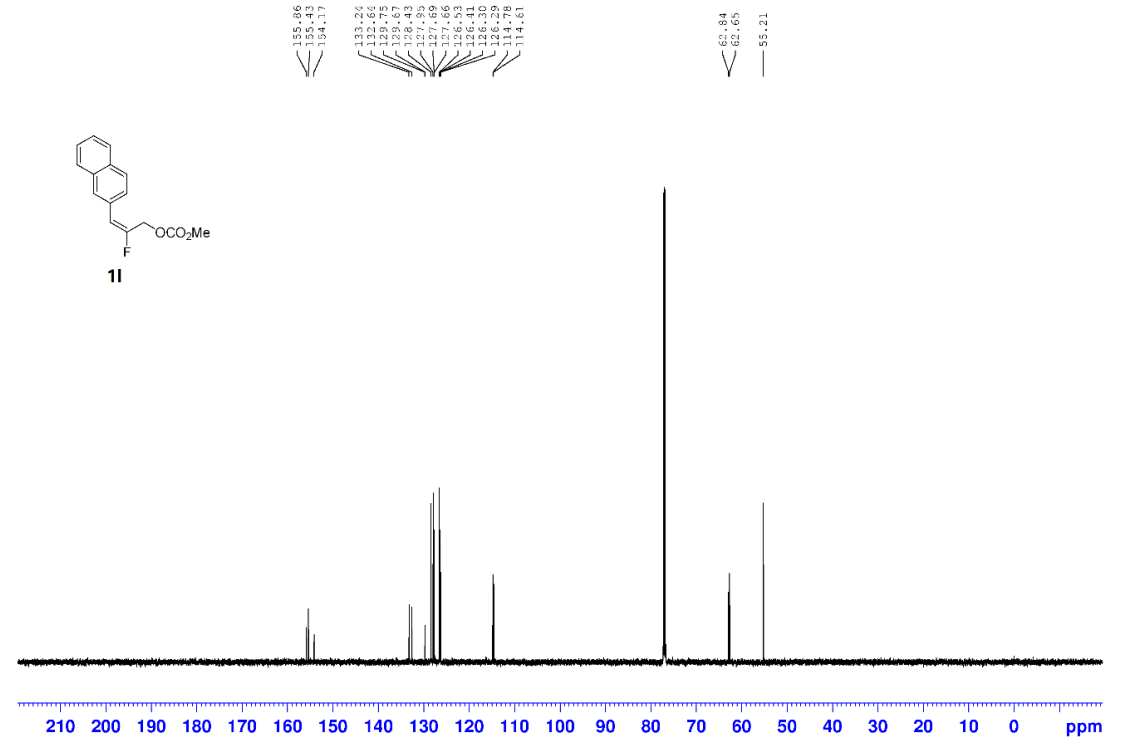
155.30
155.09
136.04
135.96
130.31
130.09
129.87
129.66
128.93
128.91
126.63
125.72
125.69
125.67
125.64
121.83
121.02
121.22
113.51
113.34
62.44
62.24
53.29
CF3
OCO2Me
F
1k
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-62.74
-104.49
CF3
OCO2Me
F
1k
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm


7.831
7.824
7.817
7.809
7.694
7.500
7.497
7.490
7.484
7.481
7.473
7.470
7.351
7.348
7.337
7.334
6.732
6.681
4.961
4.926
3.837
OCO2Me
F
1l
11 10 9 8 7 6 5 4 3 2 1 0 ppm
3.07 1.01 2.07 1.02 1.00 2.10 3.01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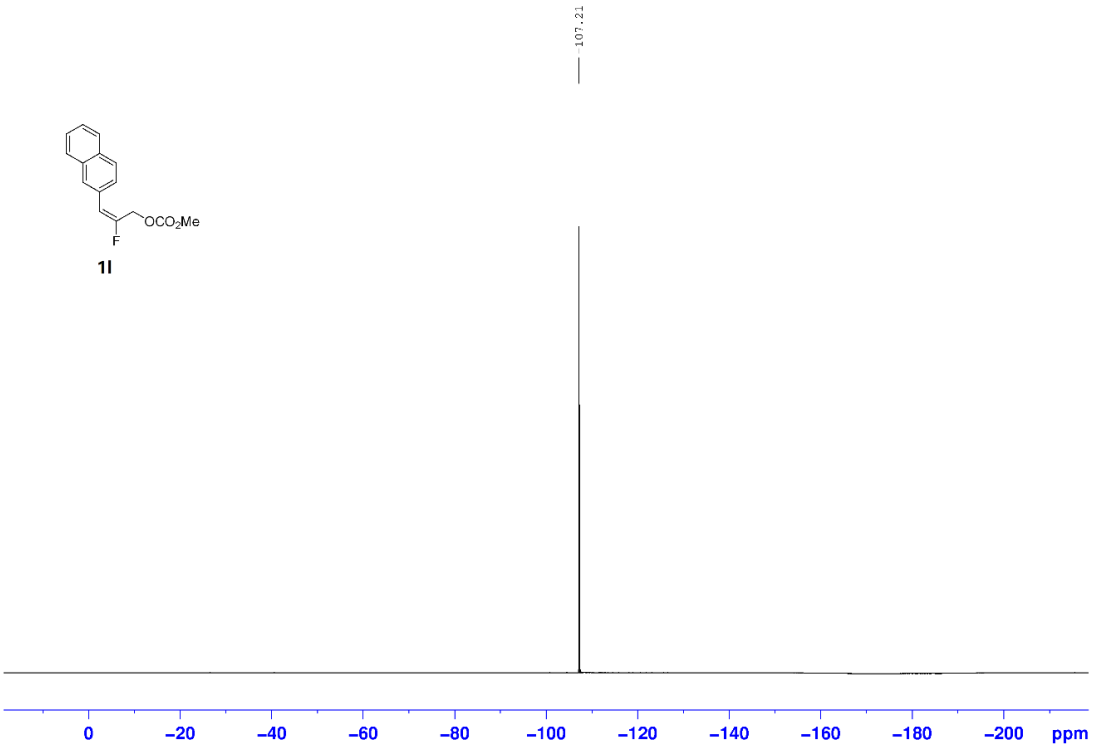
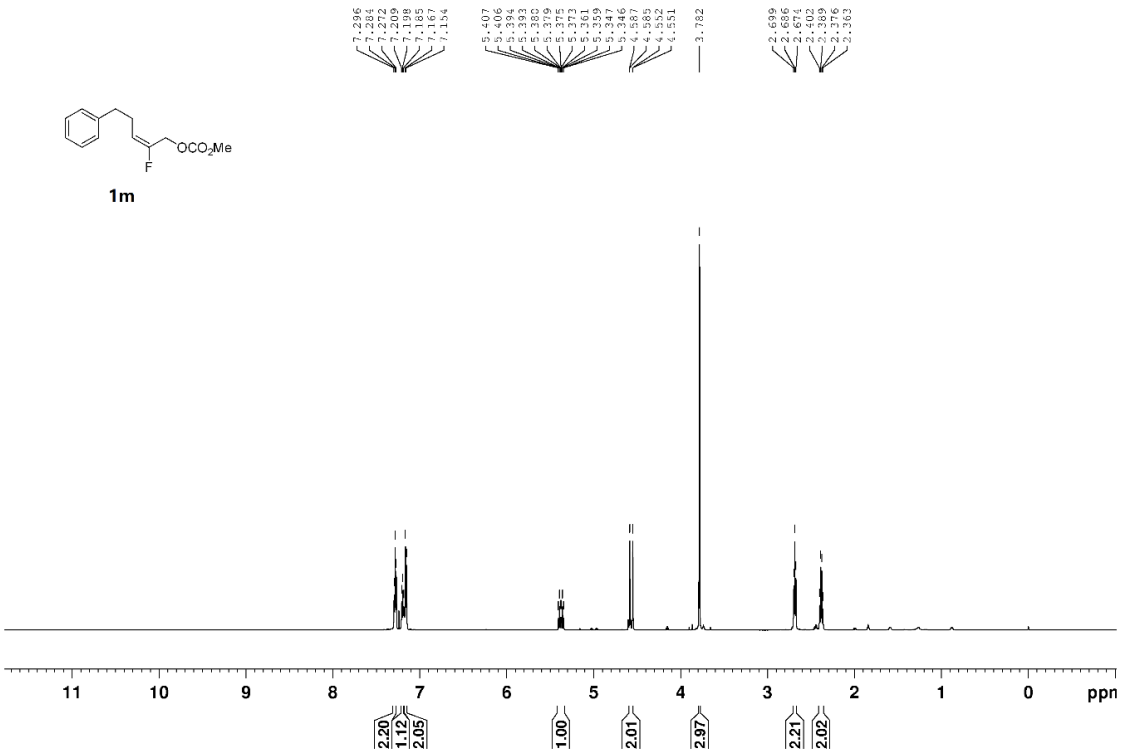
155.43
154.17
133.24
132.66
129.75
129.67
128.43
127.95
127.89
127.66
126.53
126.41
126.30
126.29
114.78
114.61
62.84
62.65
55.21
OCO2Me
F
1l
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


107.21
OCO2Me
F
1l
0
−20
−40
−60
−80
−100
−120
−140
−160
−180
−200
ppm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7.185
7.167
7.154
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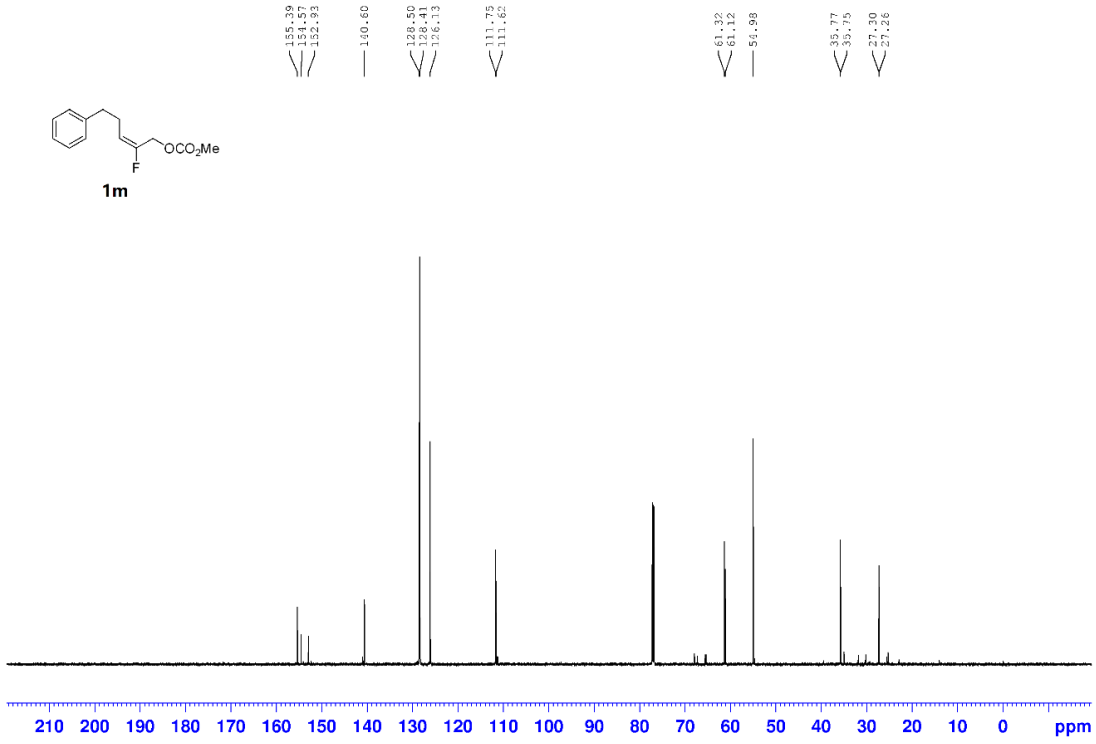
5.406
5.394
5.383
5.379
5.375
5.373
5.361
5.359
5.347
5.346
4.588
4.585
4.552
4.551
3.782
2.699
2.686
2.674
2.402
2.389
2.376
2.363
OCO2Me
F
1m
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.20
1.12
2.05
1.00
2.01
2.97
2.21
2.02


155.59
154.57
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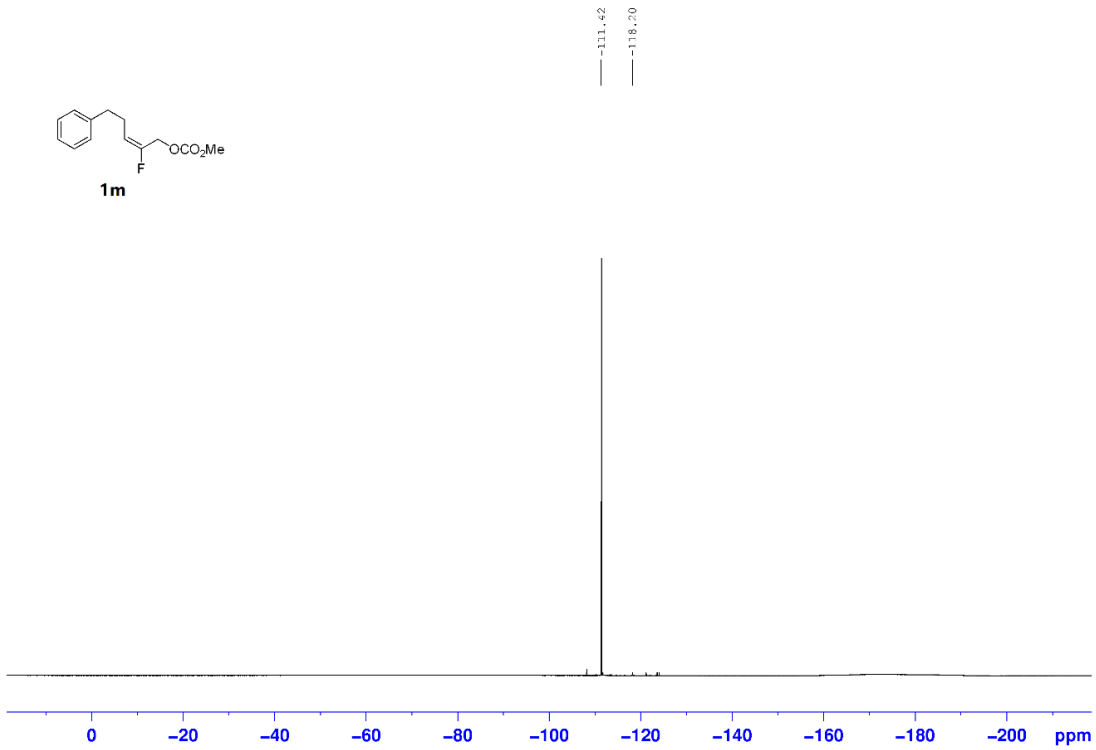
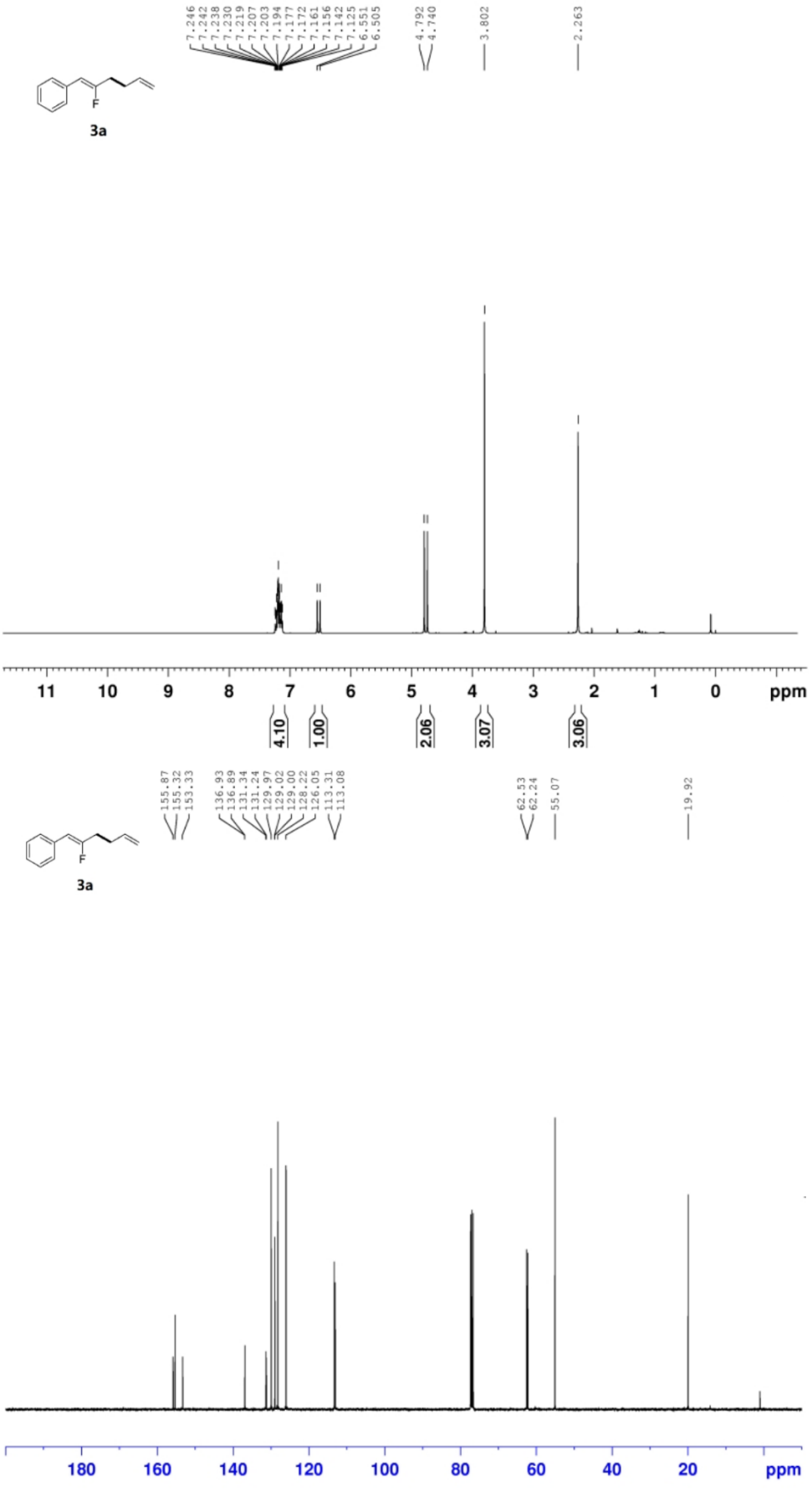
140.60
128.50
128.41
126.13
111.75
111.62
61.32
61.12
56.98
35.77
35.75
27.30
27.26
OCO2Me
F
1m
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-111.42
-118.20
OCO2Me
F
1m
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm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7.238
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7.203
7.194
7.177
7.172
7.161
7.156
7.142
7.125
6.551
6.505
4.792
4.740
3.802
2.263
F
3a
11
10
9
8
7
6
5
4
3
2
1
0
ppm
4.10
1.00
2.06
3.07
3.06
155.87
155.32
153.33
136.93
136.89
131.34
131.24
129.97
129.02
129.00
128.22
126.05
113.31
113.08
62.53
62.24
55.07
19.92
F
3a
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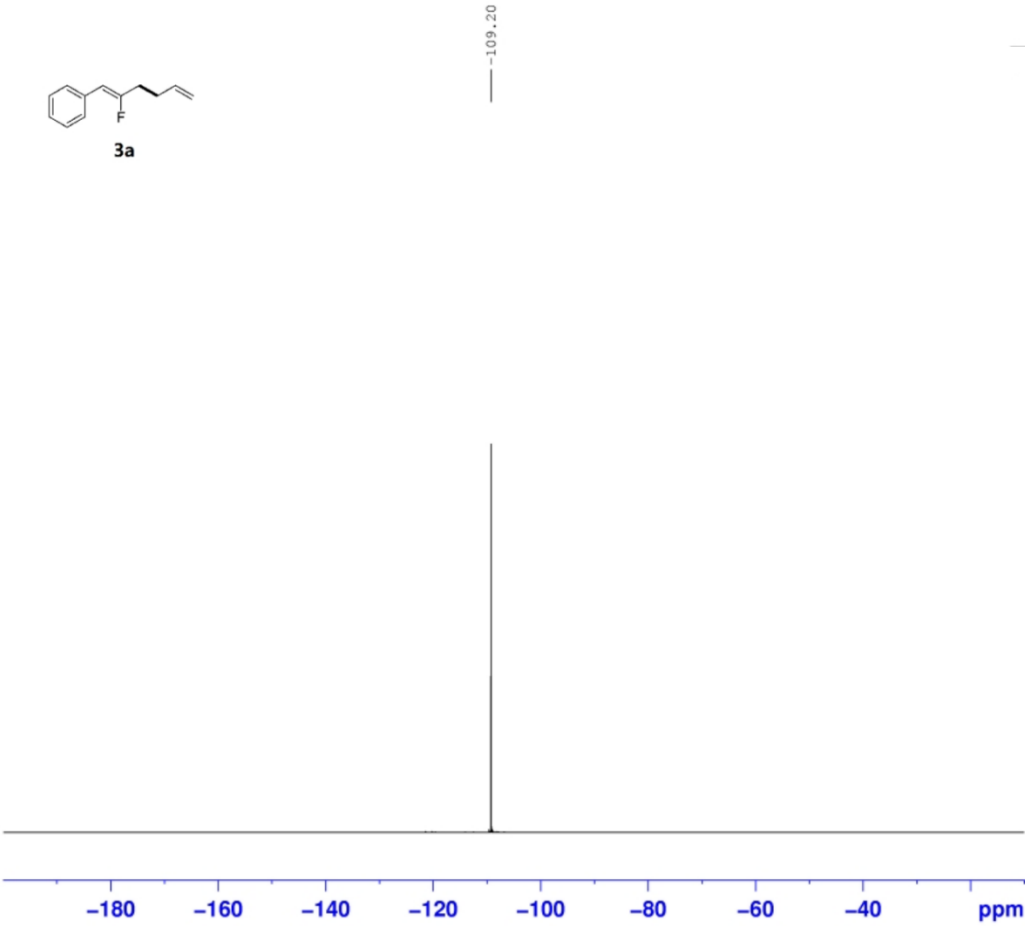
160
140
120
100
80
60
40
20
ppm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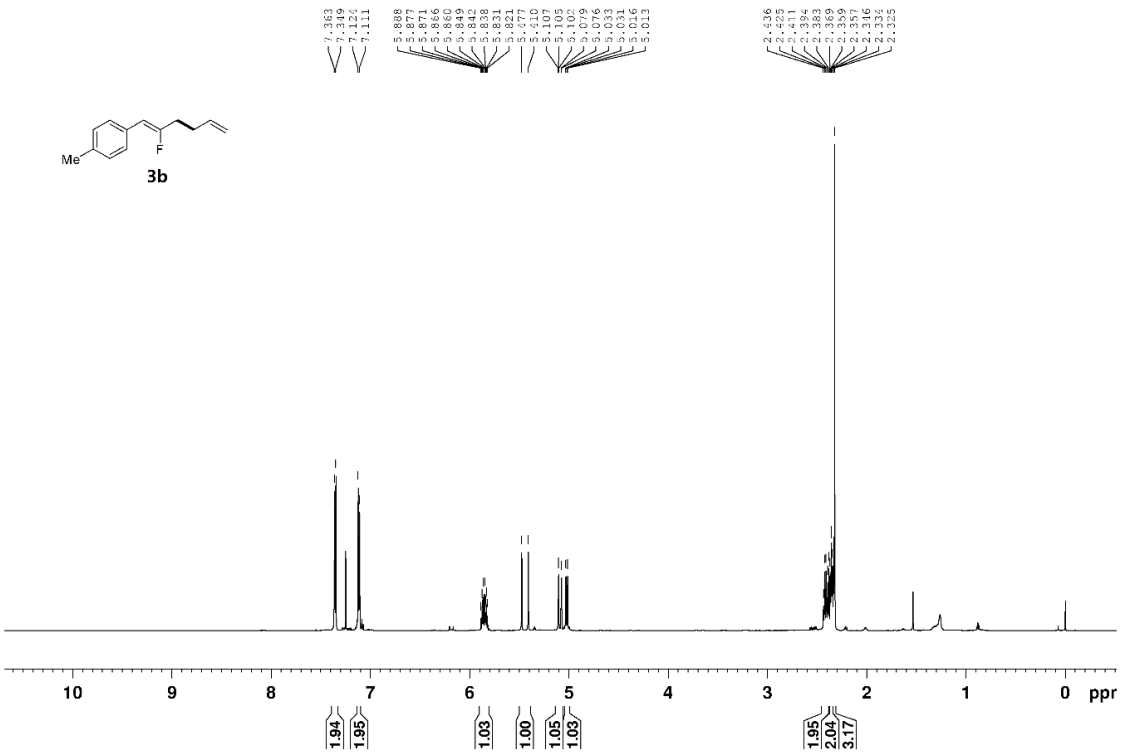
3a
-180
-160
-140
-120
-100
-80
-60
-40
ppm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7.129
7.111
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5.877
5.871
5.866
5.860
5.849
5.842
5.838
5.831
5.421
5.417
5.410
5.107
5.105
5.102
5.079
5.076
5.033
5.031
5.016
5.013
2.436
2.425
2.411
2.394
2.383
2.363
2.359
2.357
2.346
2.334
2.325
Me
F
3b
10
9
8
7
6
5
4
3
2
1
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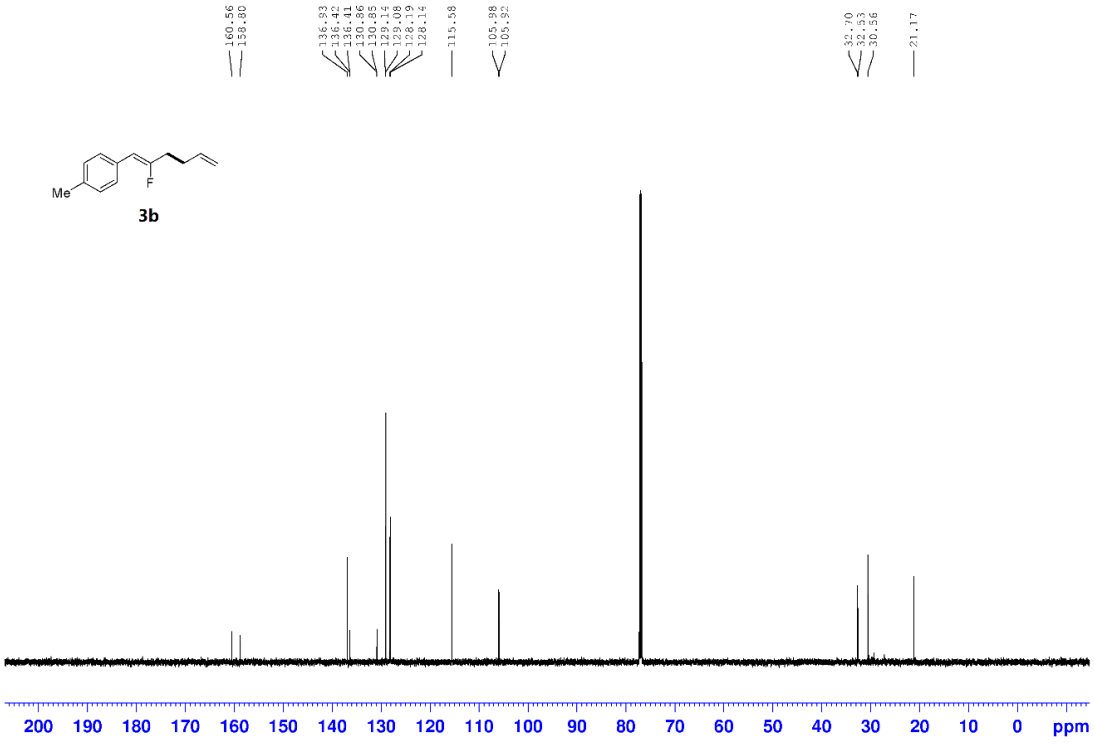
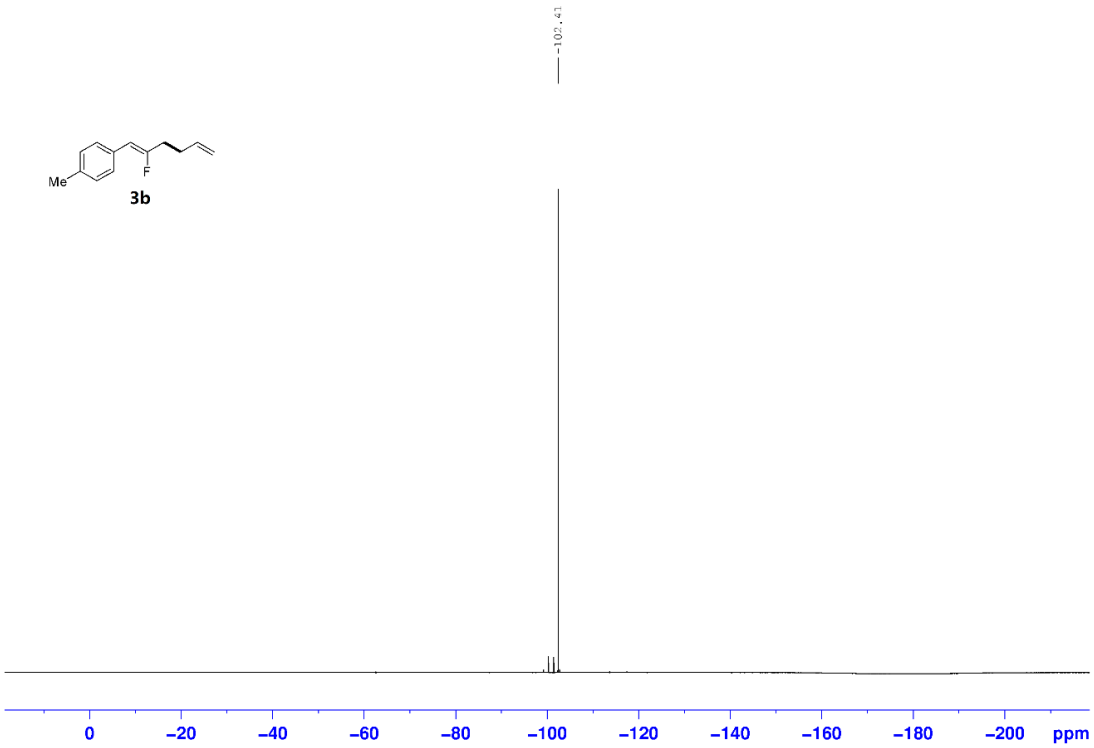
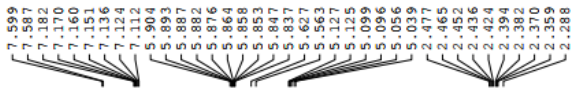
ppm
1.94
1.95
1.03
1.00
1.05
1.03
1.95
2.04
3.17


160.56
158.80
136.93
136.42
136.41
130.86
130.85
129.15
128.98
128.19
128.14
115.58
105.98
105.92
32.70
32.53
30.56
21.17
Me
F
3b
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-102.41
Me
F
3b
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm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7.182
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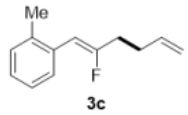
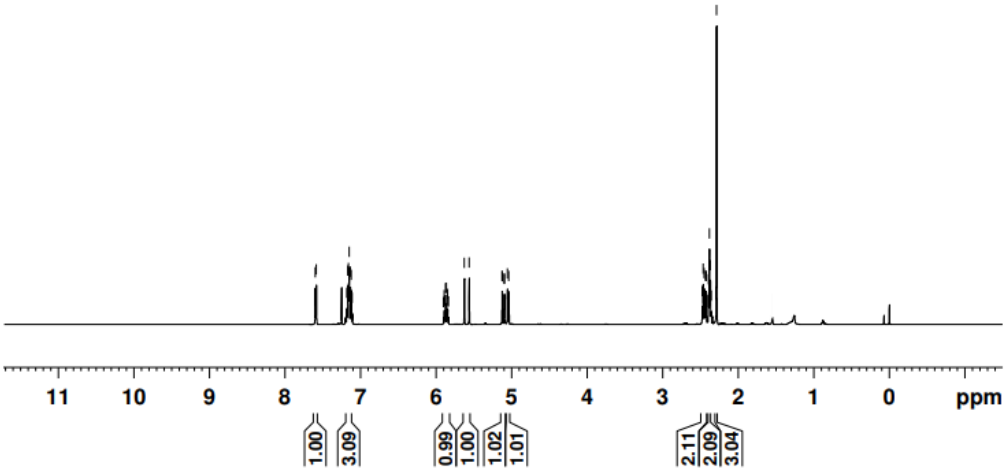
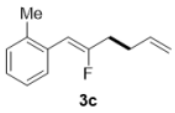
7.160
7.151
7.136
7.124
7.112
5.904
5.893
5.887
5.882
5.876
5.864
5.858
5.853
5.847
5.837
5.627
5.563
5.127
5.125
5.099
5.096
5.056
5.039
2.477
2.465
2.452
2.436
2.424
2.394
2.382
2.370
2.359
2.288


Me
F

3c

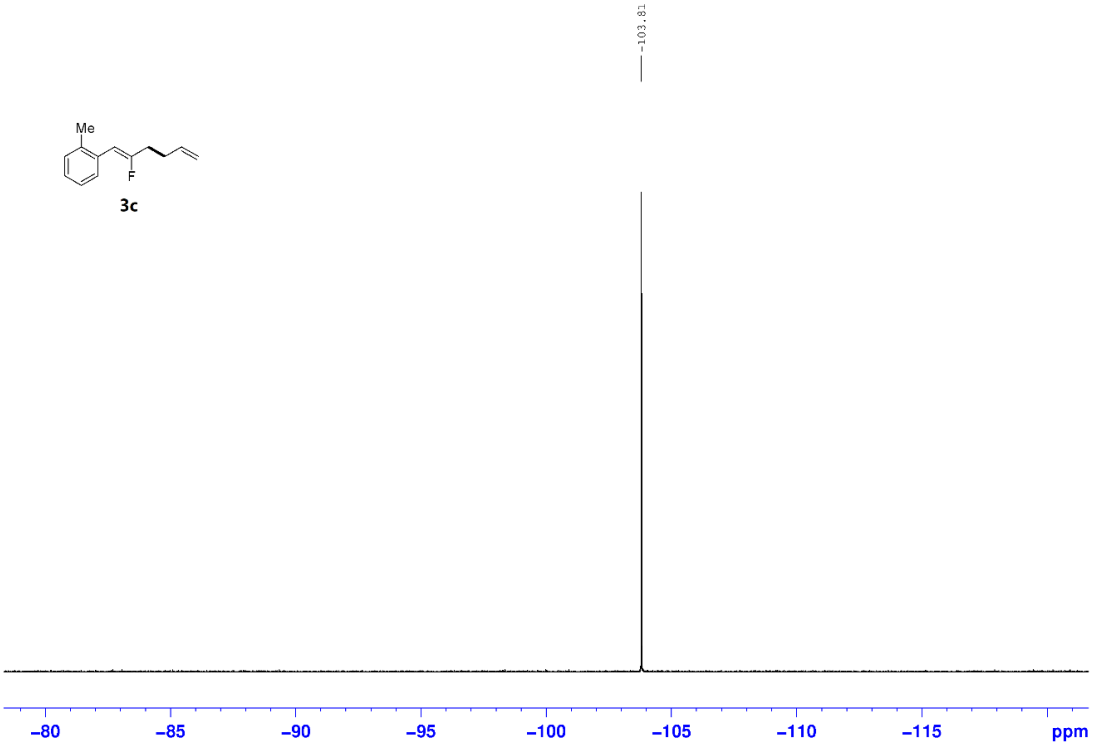

11
10
9
8
7
6
5
4
3
2
1
0
ppm
1.00
3.09
0.99
1.00
1.02
1.01
2.11
2.09
3.04

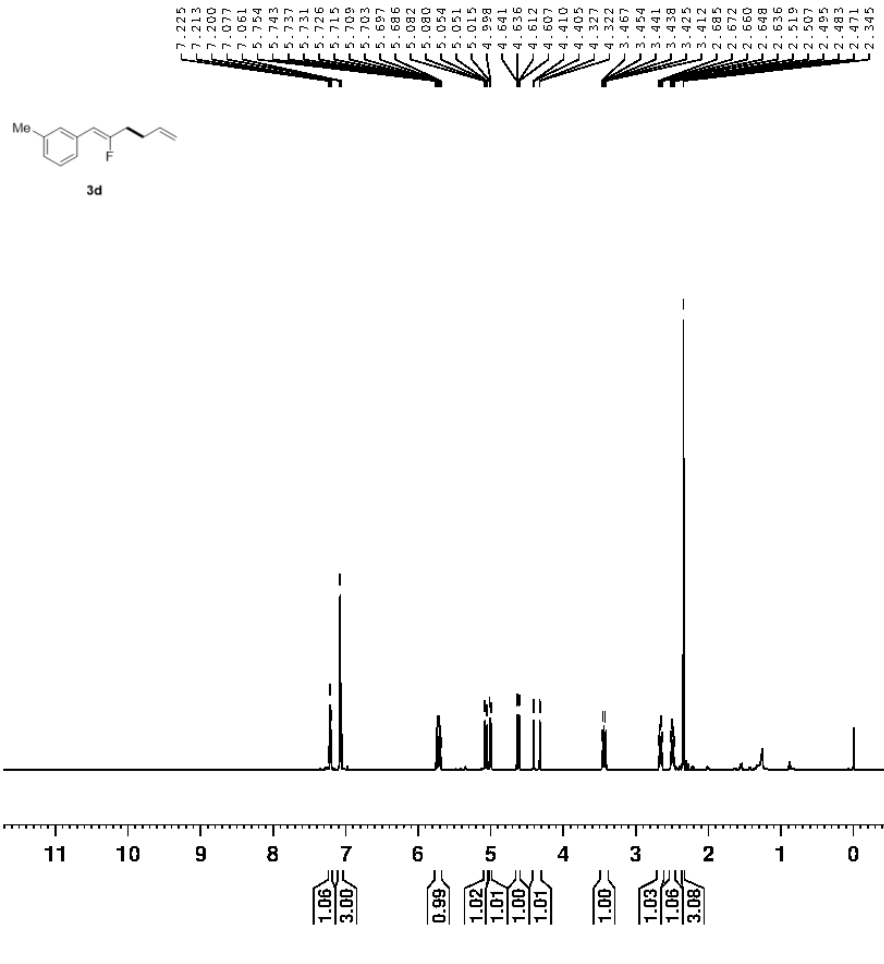

160.68
158.92
136.86
135.39
132.19
129.92
129.18
129.11
126.82
125.78
115.68
103.64
103.57
32.65
32.46
30.55
20.16


Me
F

3c

180
160
140
120
100
80
60
40
20
ppm


Me
F
3c
-103.81
-80
-85
-90
-95
-100
-105
-110
-115
ppm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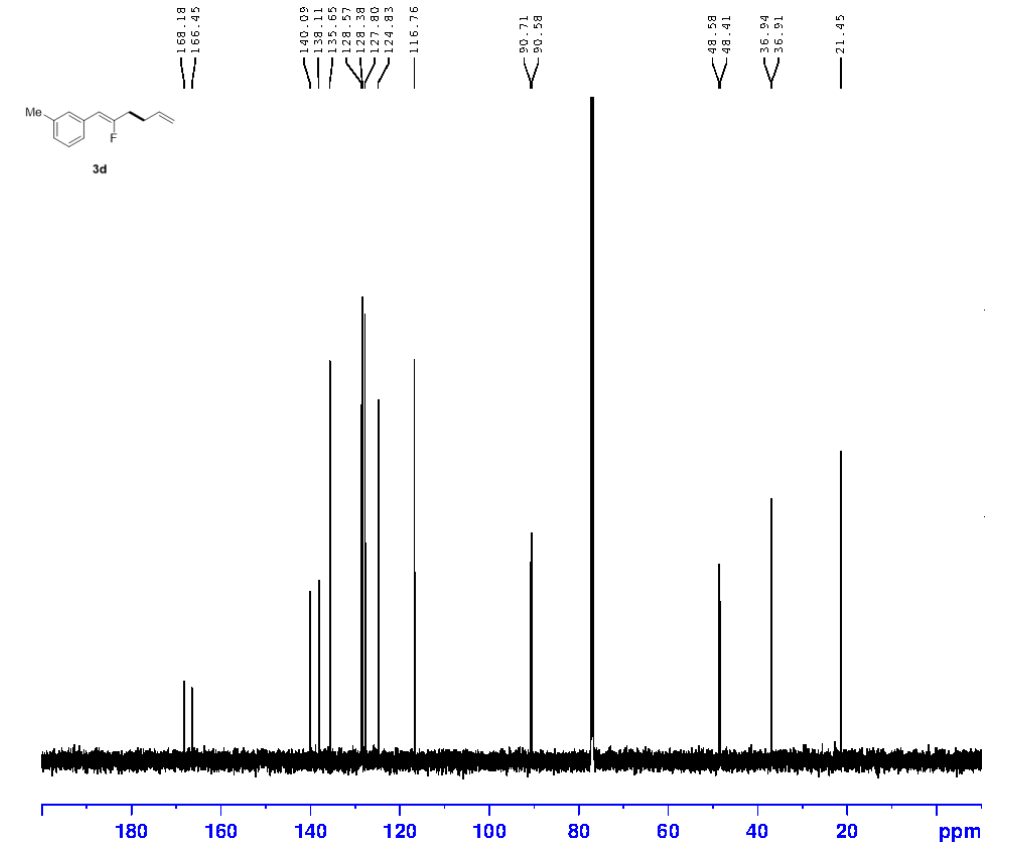
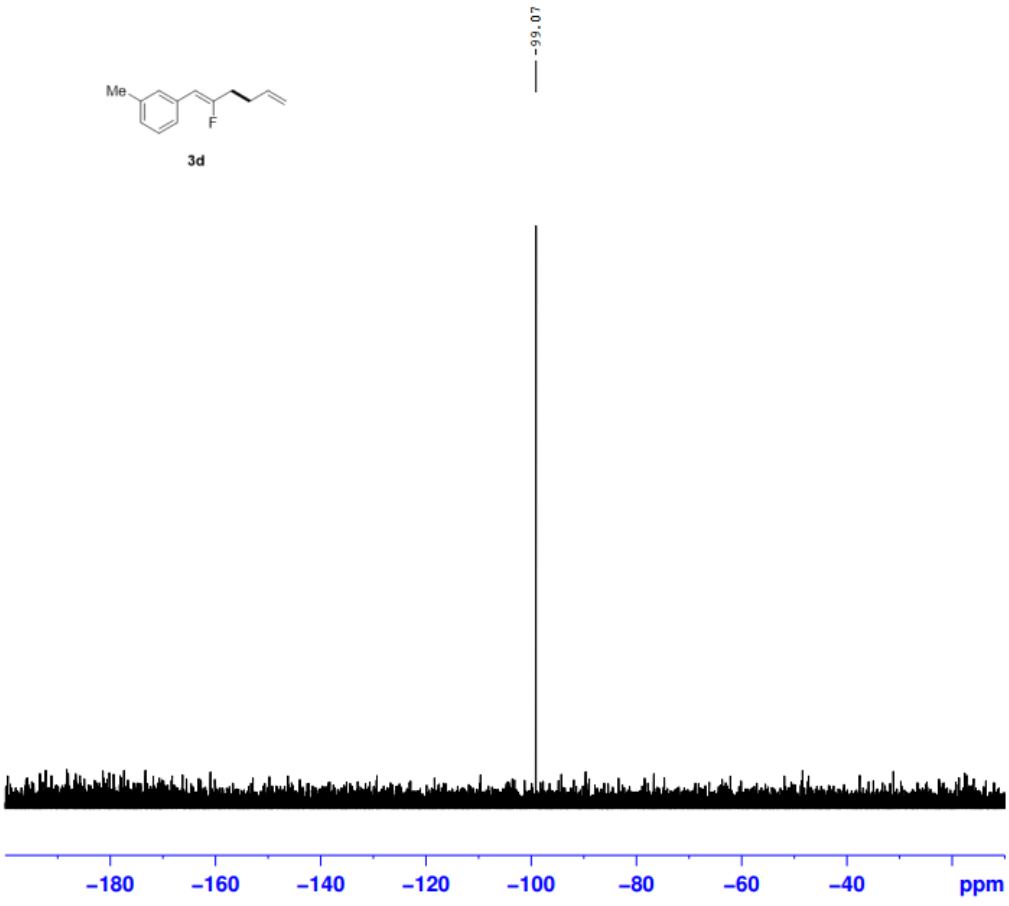
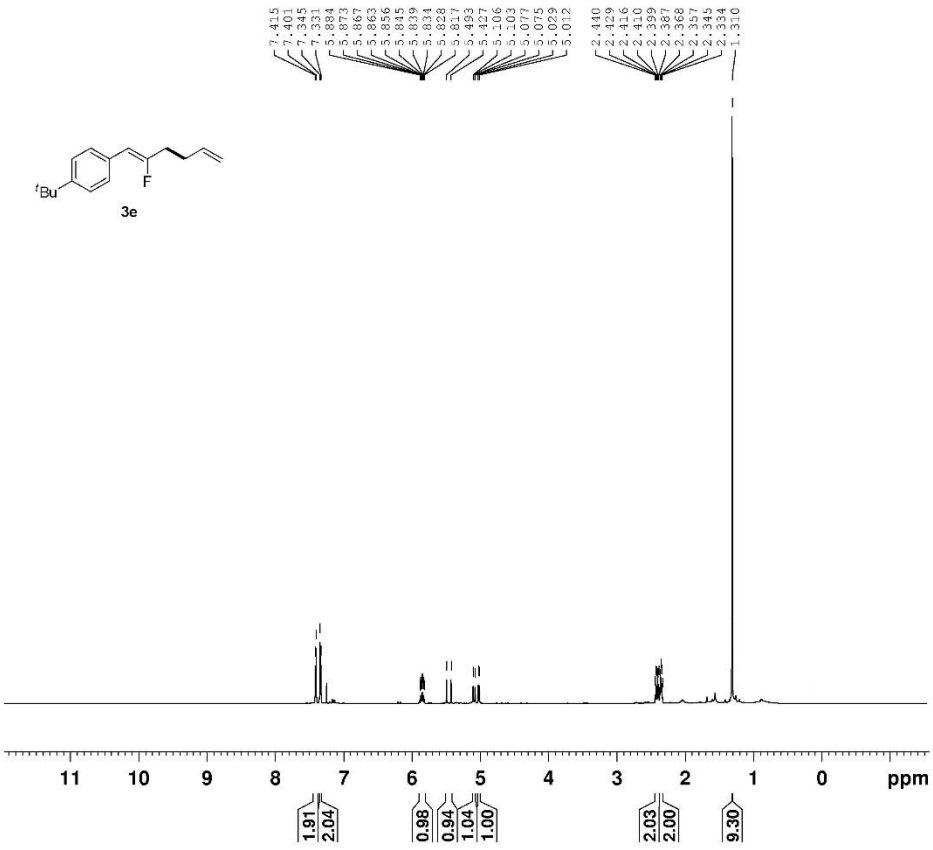
7.200
7.077
7.061
5.754
5.743
5.737
5.731
5.726
5.715
5.709
5.703
5.697
5.686
5.082
5.080
5.054
5.051
5.015
4.998
4.641
4.636
4.612
4.607
4.410
4.405
4.327
4.322
3.467
3.454
3.441
3.438
3.425
3.412
2.685
2.672
2.660
2.648
2.636
2.519
2.507
2.495
2.483
2.471
2.345
Me
F
3d
11
10
9
8
7
6
5
4
3
2
1
0
-1
ppm
1.06
3.00
0.99
1.02
1.01
1.00
1.01
1.00
1.03
1.06
3.08


168.18
166.45
140.09
138.11
135.65
128.57
128.38
127.80
124.83
116.76
90.71
90.58
48.58
48.41
36.94
36.91
21.45
Me
F
3d
180
160
140
120
100
80
60
40
20
ppm


-99.07
Me
F
3d
-180
-160
-140
-120
-100
-80
-60
-40
ppm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7.345
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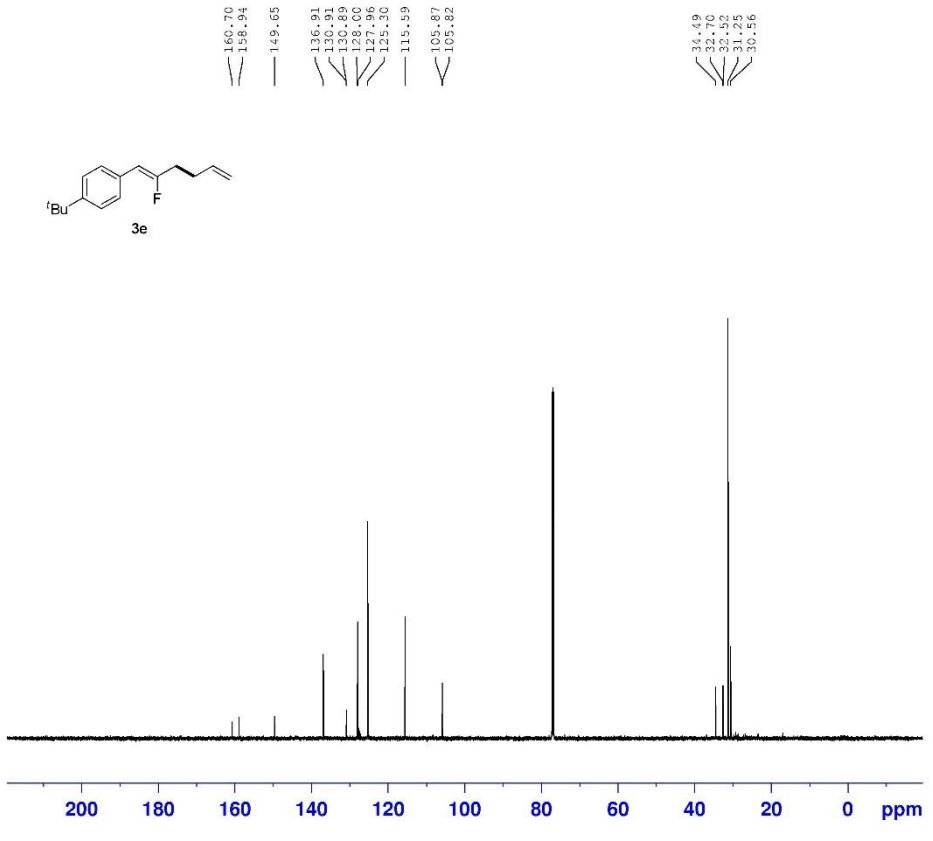
5.873
5.867
5.863
5.856
5.845
5.839
5.834
5.828
5.817
5.493
5.427
5.106
5.103
5.077
5.075
5.029
5.012
2.440
2.429
2.416
2.410
2.399
2.387
2.368
2.357
2.345
2.334
1.310
tBu
F
3e
11 10 9 8 7 6 5 4 3 2 1 0 ppm
1.91
2.04
0.98
0.94
1.04
1.00
2.03
2.00
9.30


160.70
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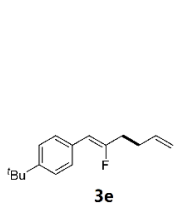
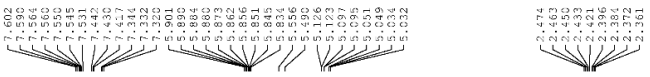
130.91
130.89
128.00
127.96
125.30
115.59
105.87
105.82
34.49
32.70
32.52
31.25
30.56
tBu
F
3e
200 180 160 140 120 100 80 60 40 20 0 ppm


tBu
F

3e

-102.37
-80
-85
-90
-95
-100
-105
-110
-115
-120
ppm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7.550
7.545
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7.442
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7.427
7.344
7.332
7.328
5.901
5.890
5.884
5.880
5.873
5.862
5.856
5.851
5.845
5.834
5.556
5.490
5.126
5.123
5.097
5.095
5.051
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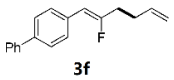
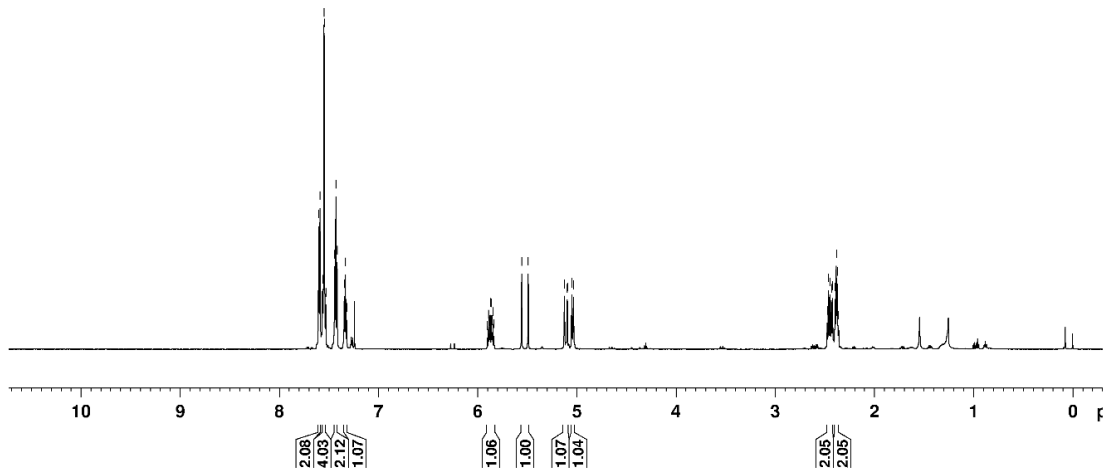
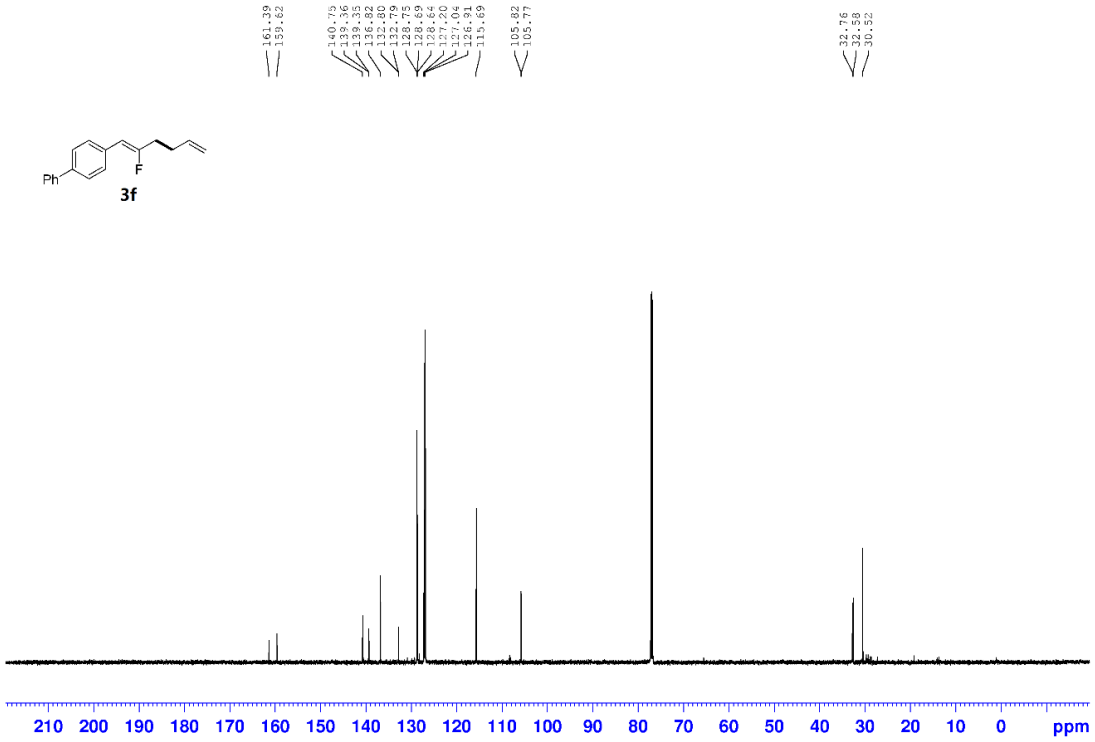
2.361


Ph
F

3f


10
9
8
7
6
5
4
3
2
1
0
2.08
4.03
2.12
1.07
1.06
1.00
1.07
1.04
2.05
2.05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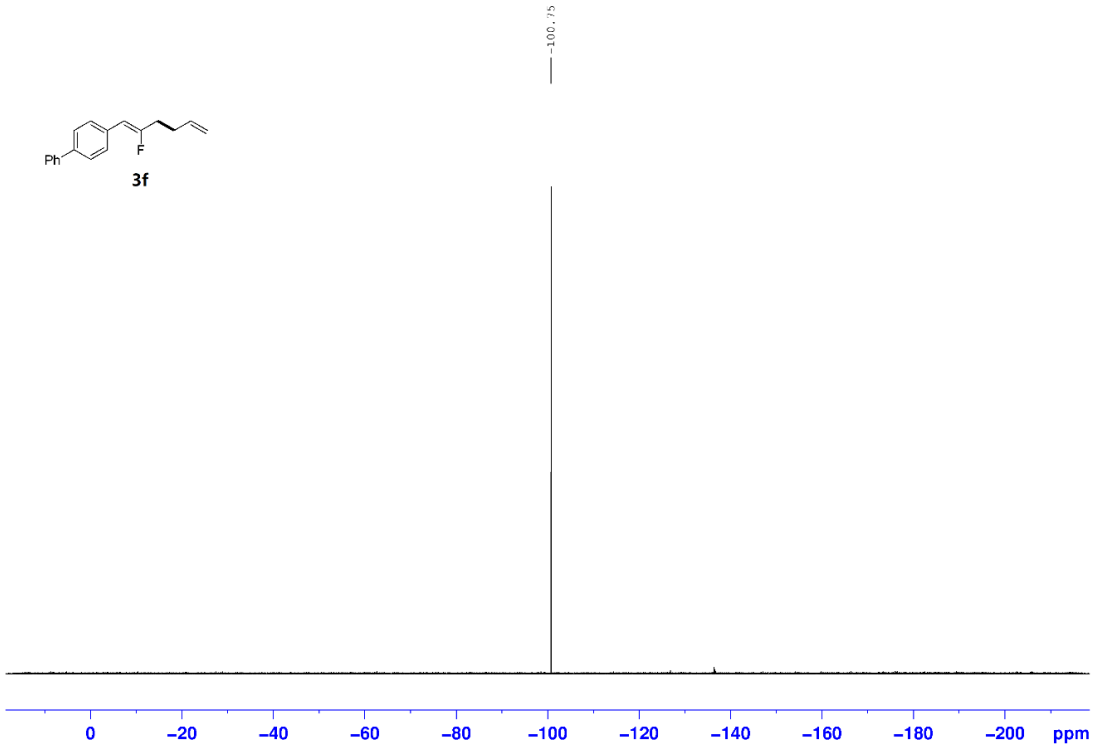
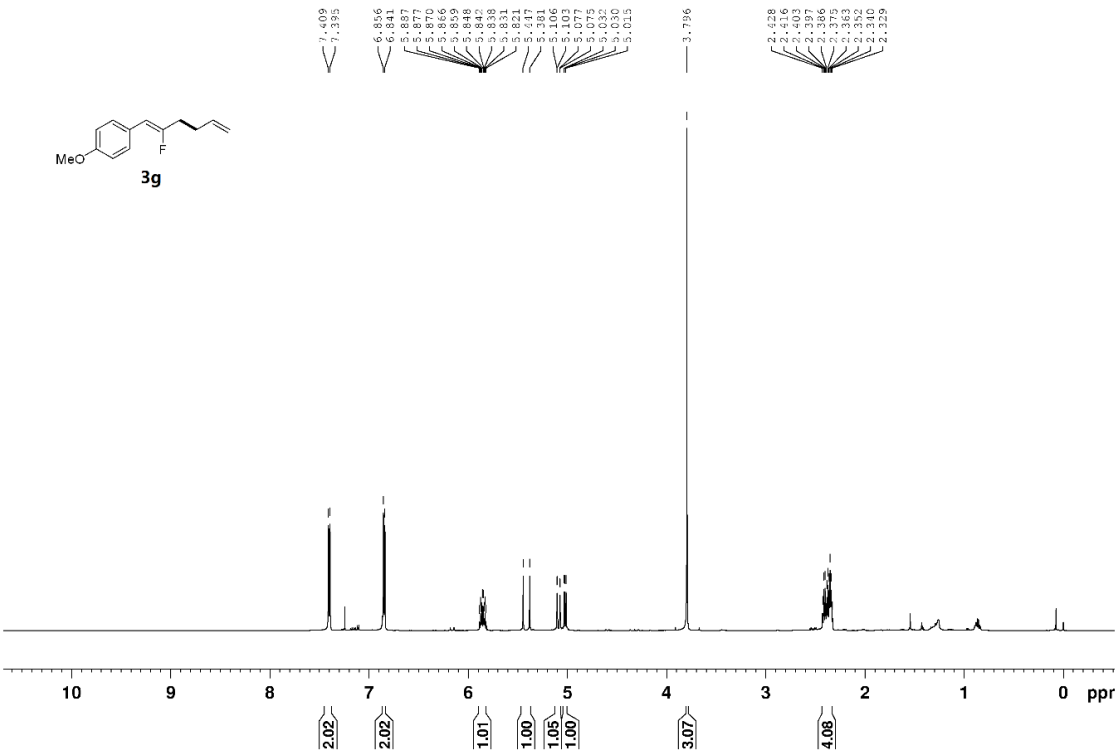
139.35
136.82
132.80
132.79
128.75
128.69
128.64
127.70
127.04
126.91
115.69
105.82
105.77
32.76
32.58
30.52
Ph
F
3f
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-100.75
Ph
F
3f
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm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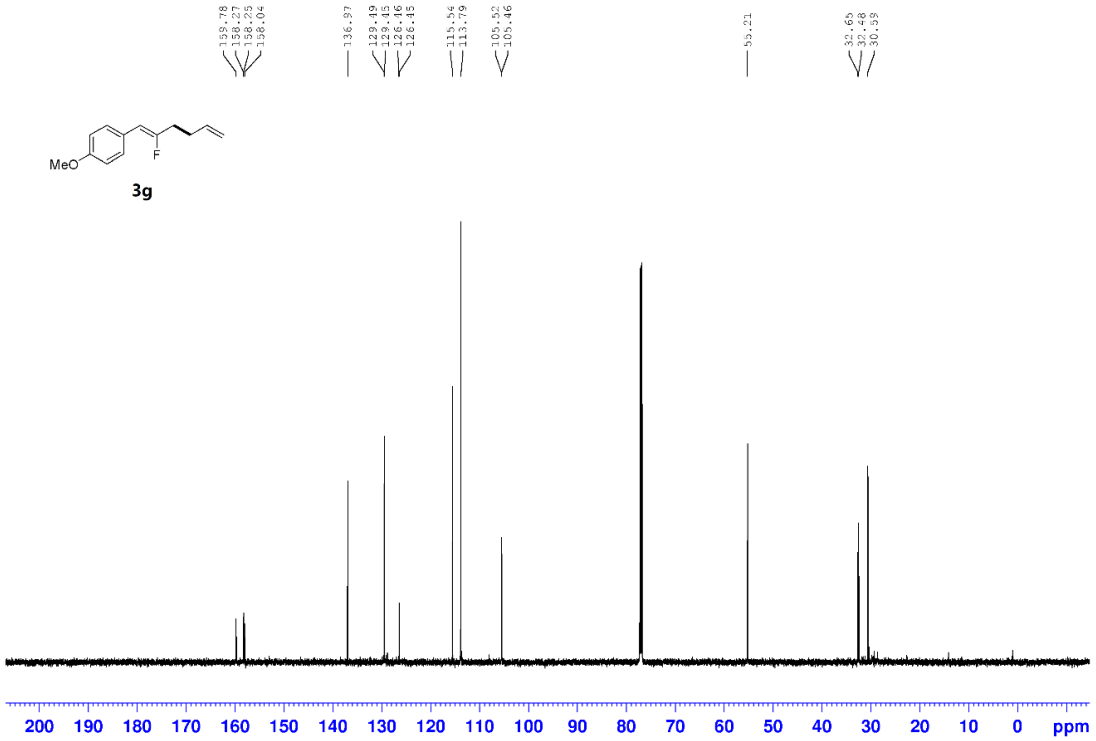
5.848
5.842
5.838
5.831
5.821
5.147
5.101
5.106
5.103
5.077
5.075
5.032
5.030
5.015
3.796
2.428
2.416
2.403
2.397
2.386
2.375
2.363
2.352
2.340
2.329
MeO
F
3g
10
9
8
7
6
5
4
3
2
1
0
ppm
2.02
2.02
1.01
1.00
1.05
1.00
3.07
4.08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129.45
126.16
126.45
115.54
113.79
105.52
105.46
53.21
32.65
32.48
30.59
MeO
F
3g
200
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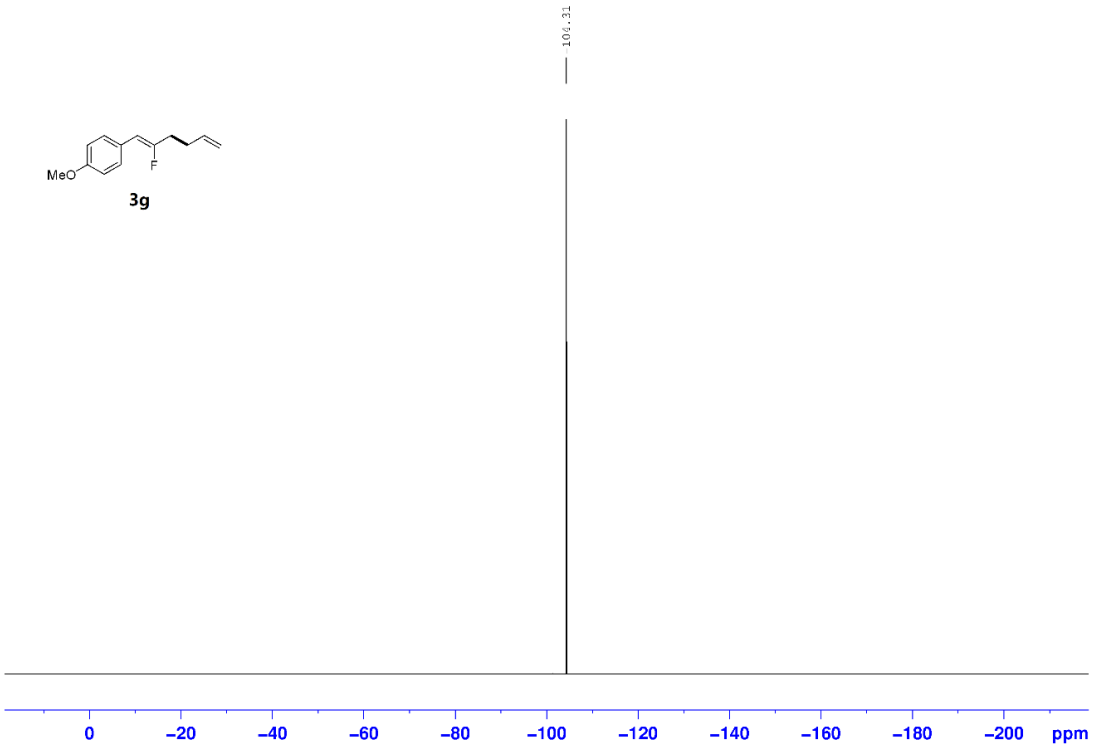
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm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MeO
F
3g
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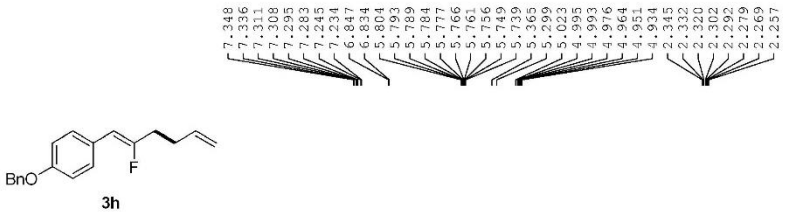
−20
−40
−60
−80
−100
−120
−140
−160
−180
−200
ppm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7.308
7.295
7.283
7.245
7.234
6.847
6.834
6.804
5.793
5.789
5.784
5.777
5.766
5.761
5.756
5.749
5.739
5.365
5.299
5.023
4.995
4.993
4.976
4.964
4.951
4.934
2.345
2.332
2.320
2.302
2.292
2.279
2.269
2.257
BnO
F
3h
12
11
10
9
8
7
6
5
4
3
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1
0
ppm
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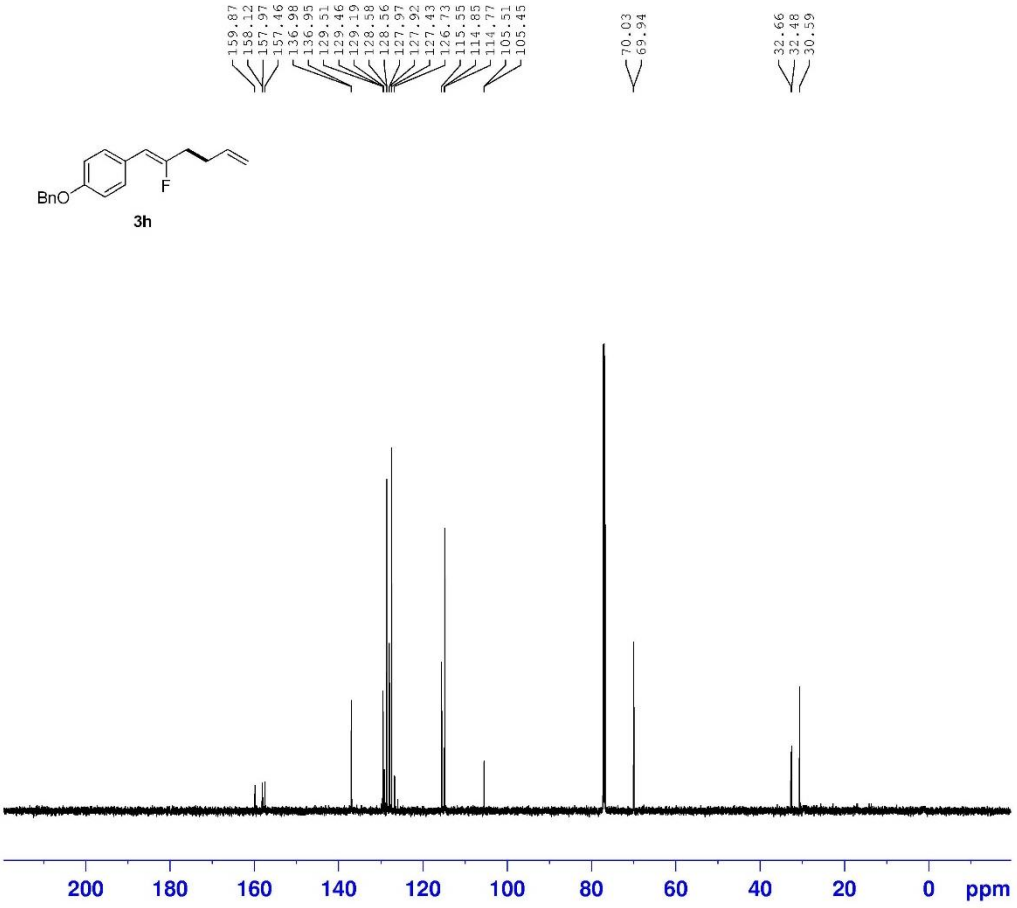
1.15
2.08
1.00
1.00
4.14
1.99
2.11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136.95
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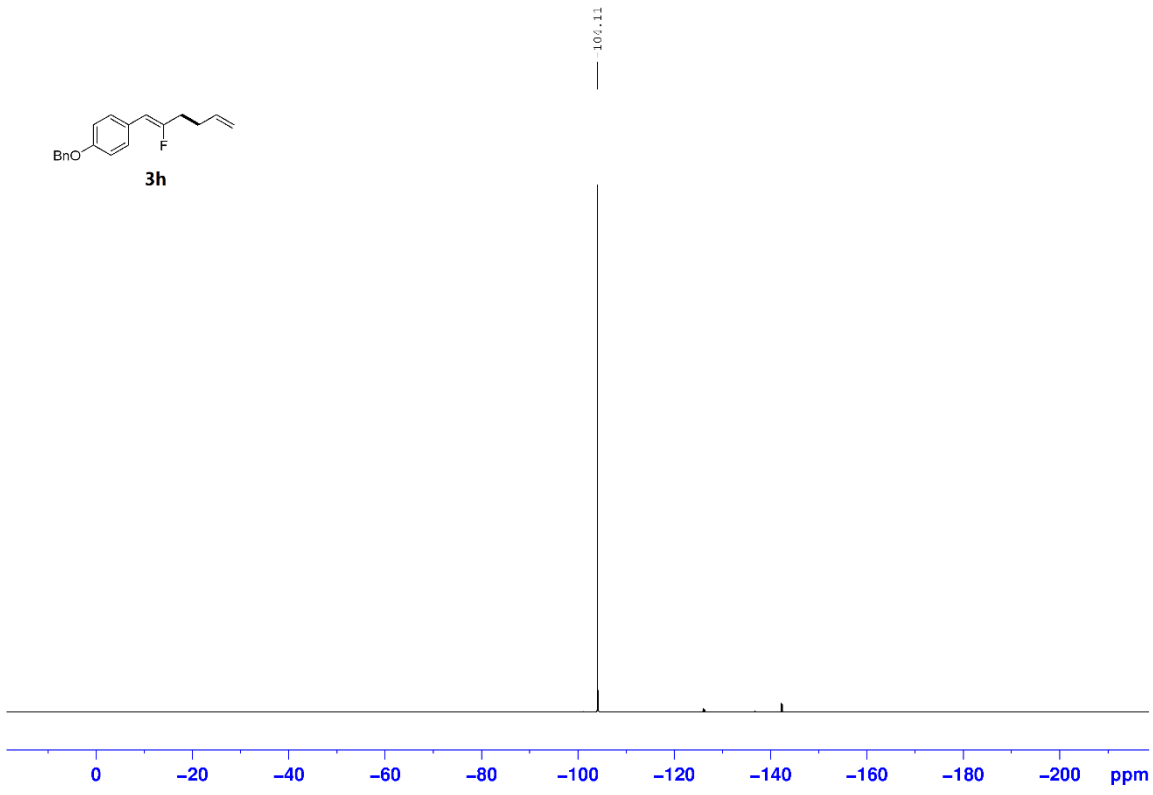
129.46
129.19
128.58
128.56
127.97
127.92
127.43
126.73
115.55
114.85
114.77
105.51
105.45
70.03
69.94
32.66
32.48
30.59
BnO
F
3h
200
180
160
140
120
100
80
60
40
20
0
ppm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BnO
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3h
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-60
-80
-100
-120
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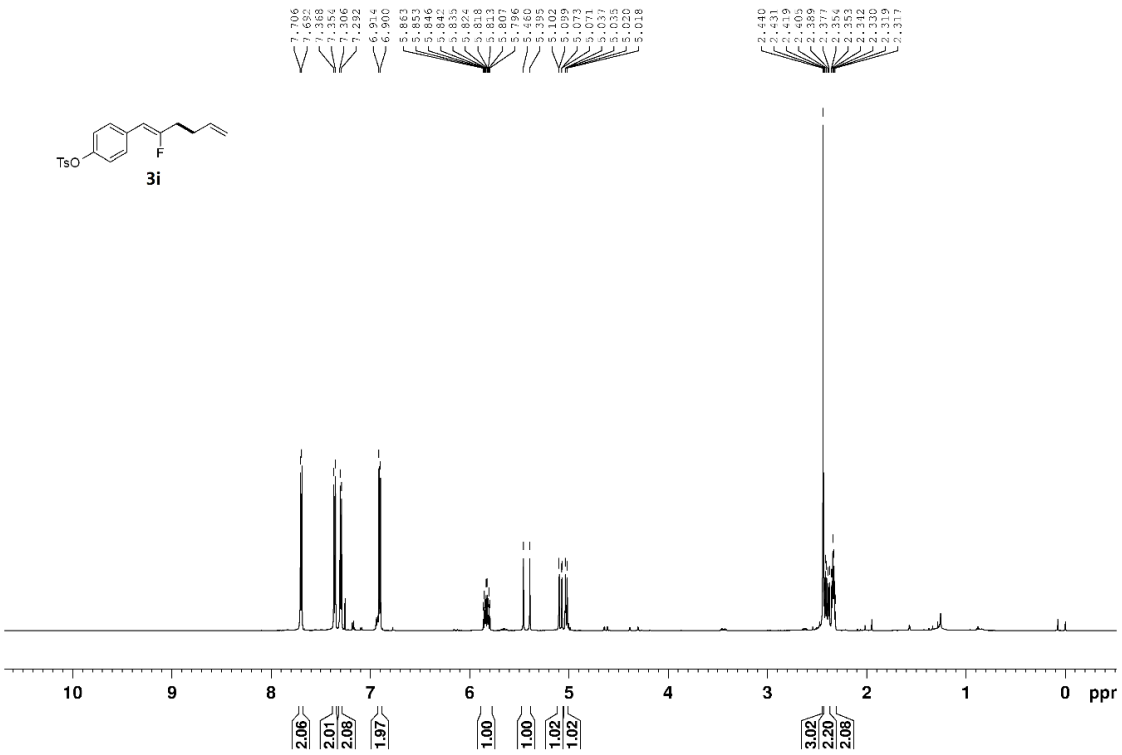
-160
-180
-200
ppm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7.292
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6.900
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5.853
5.846
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5.825
5.824
5.818
5.813
5.807
5.796
5.460
5.395
5.102
5.099
5.073
5.071
5.037
5.035
5.020
5.018
2.440
2.431
2.419
2.405
2.389
2.377
2.354
2.353
2.312
2.310
2.319
2.317
TsO
F
3i
10
9
8
7
6
5
4
3
2
1
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ppr
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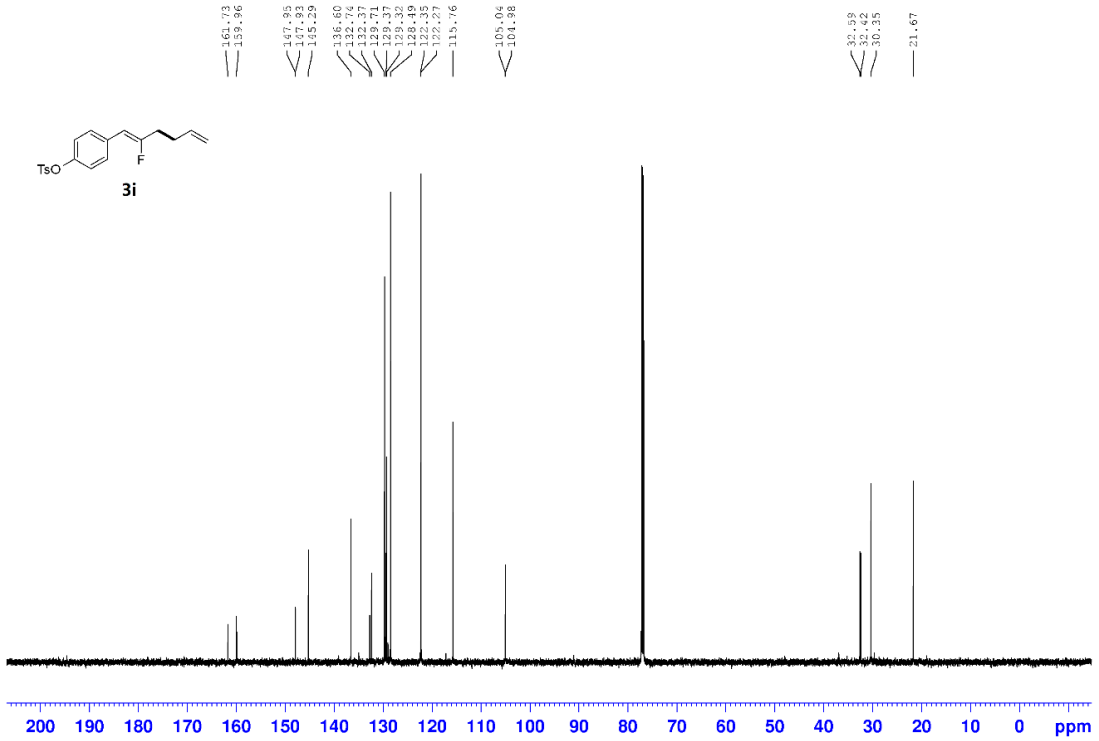
2.01
2.08
1.97
1.00
1.00
1.02
1.02
3.02
2.20
2.08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132.37
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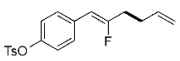
129.37
129.33
128.49
122.35
122.27
115.76
105.04
104.98
32.58
32.42
30.35
21.67
TsO
F
3i
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm


TsO
F

3i

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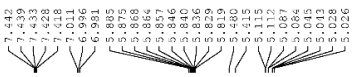
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm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7.433
7.428
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7.011
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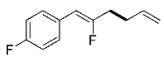
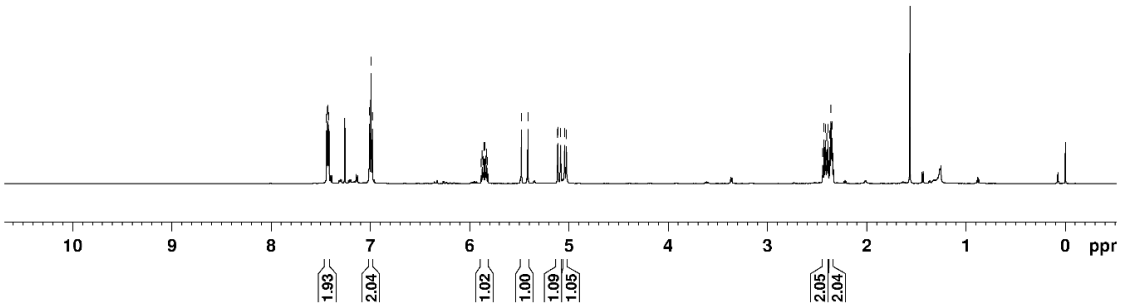
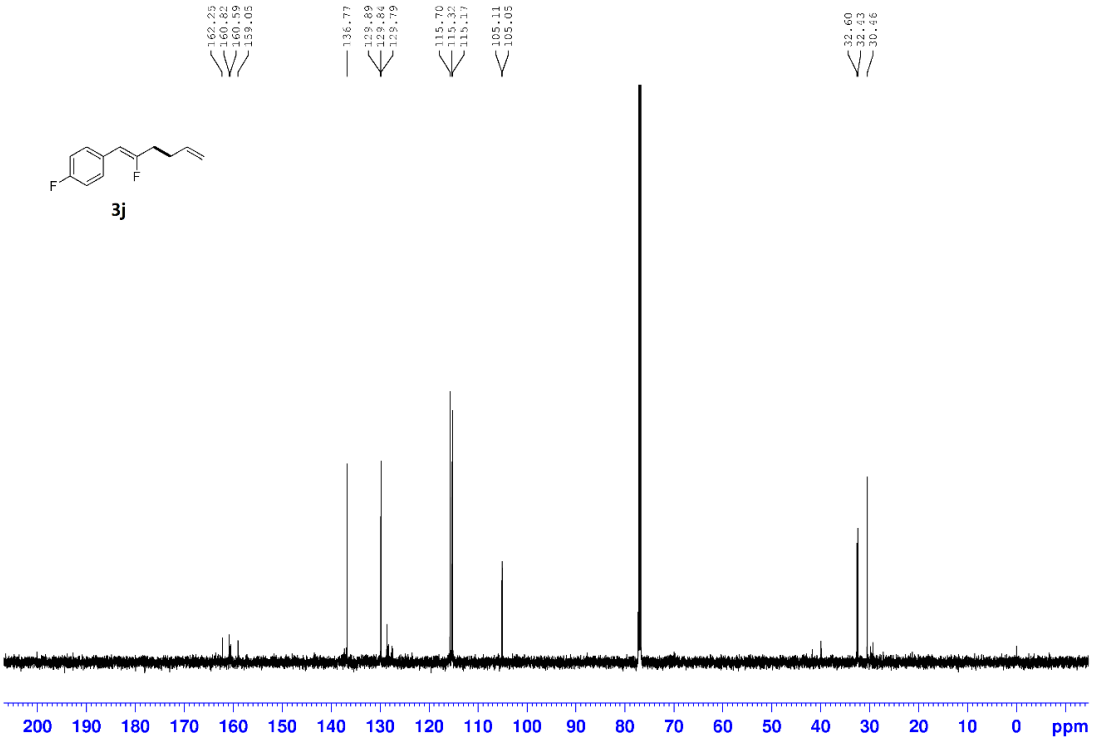
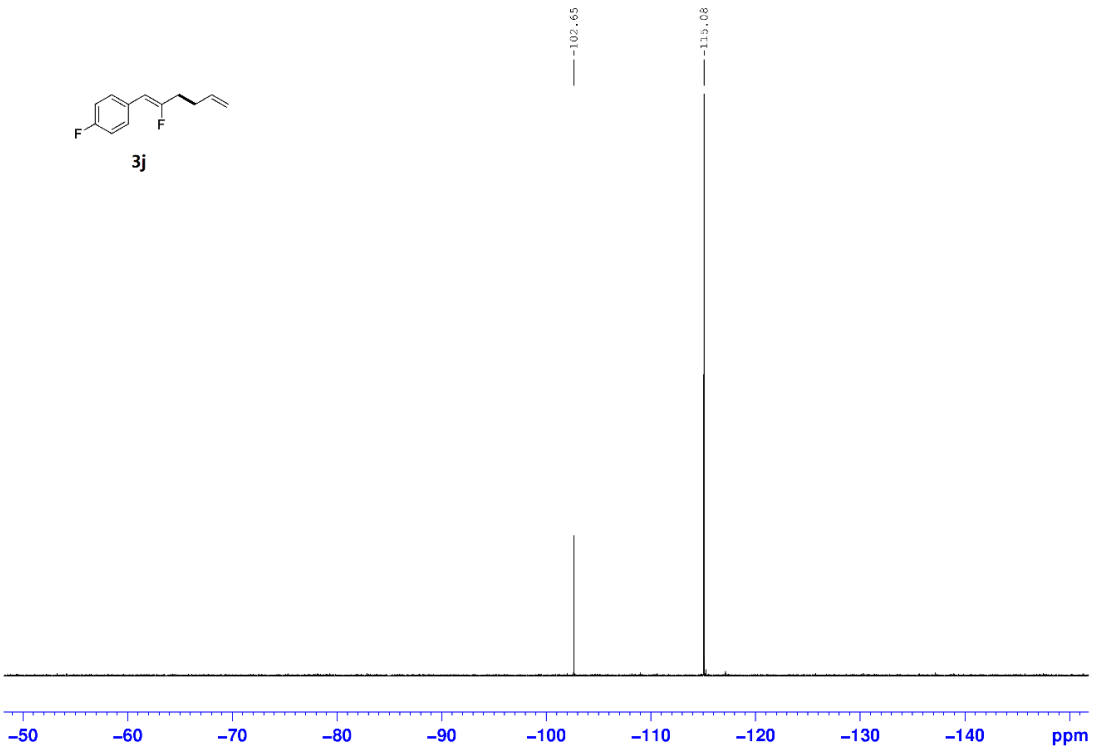
6.981
5.885
5.875
5.868
5.857
5.846
5.840
5.836
5.829
5.819
5.480
5.415
5.115
5.112
3.087
3.085
3.045
3.013
3.028
3.026
2.443
2.432
2.418
2.402
2.390
2.373
2.361
2.350
2.339
2.337

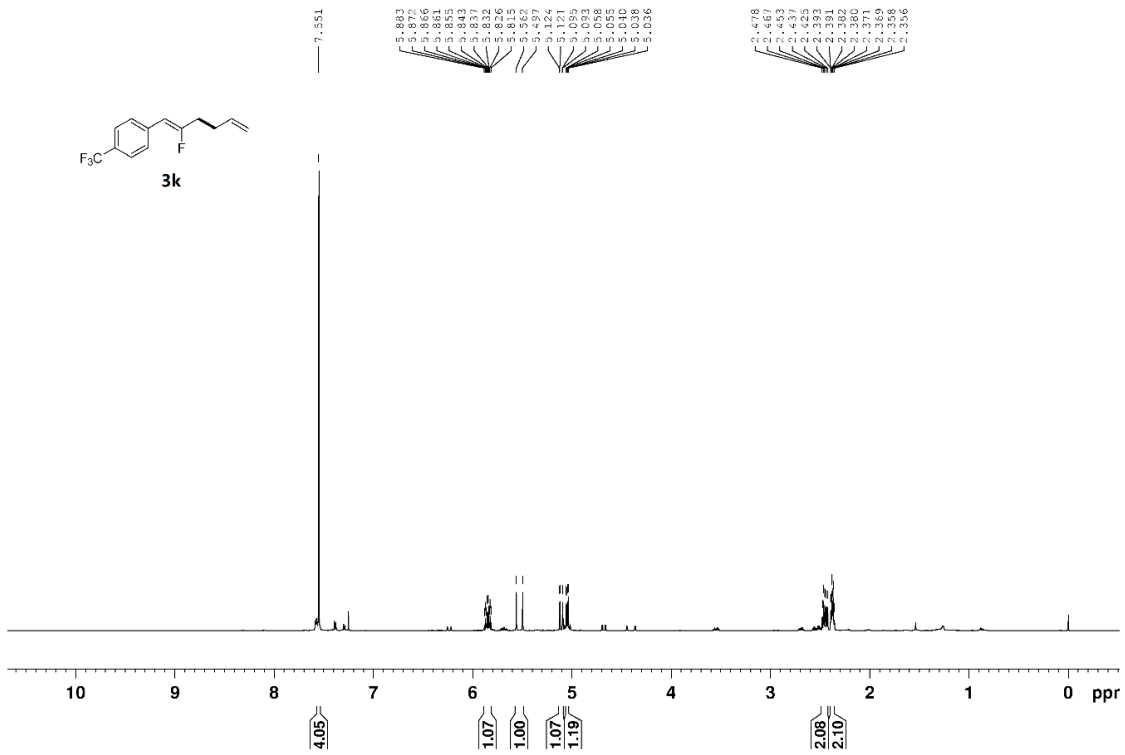

F
F

3j


10
9
8
7
6
5
4
3
2
1
0
ppr
1.93
2.04
1.02
1.00
1.09
1.05
2.05
2.04


162.25
160.82
160.59
159.05
136.77
129.89
129.84
129.79
115.70
115.32
115.17
105.11
105.05
32.60
32.43
30.46
F
F
3j
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-102.65
-113.08
F
F
3j
-50 -60 -70 -80 -90 -100 -110 -120 -130 -140 ppm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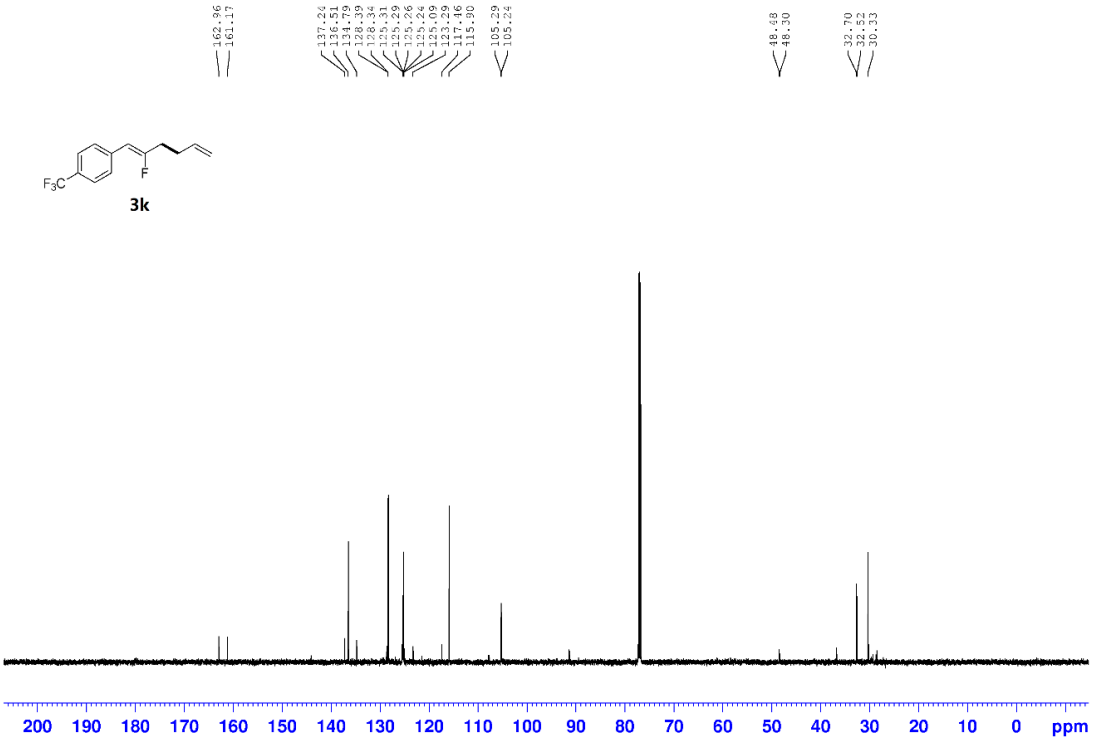
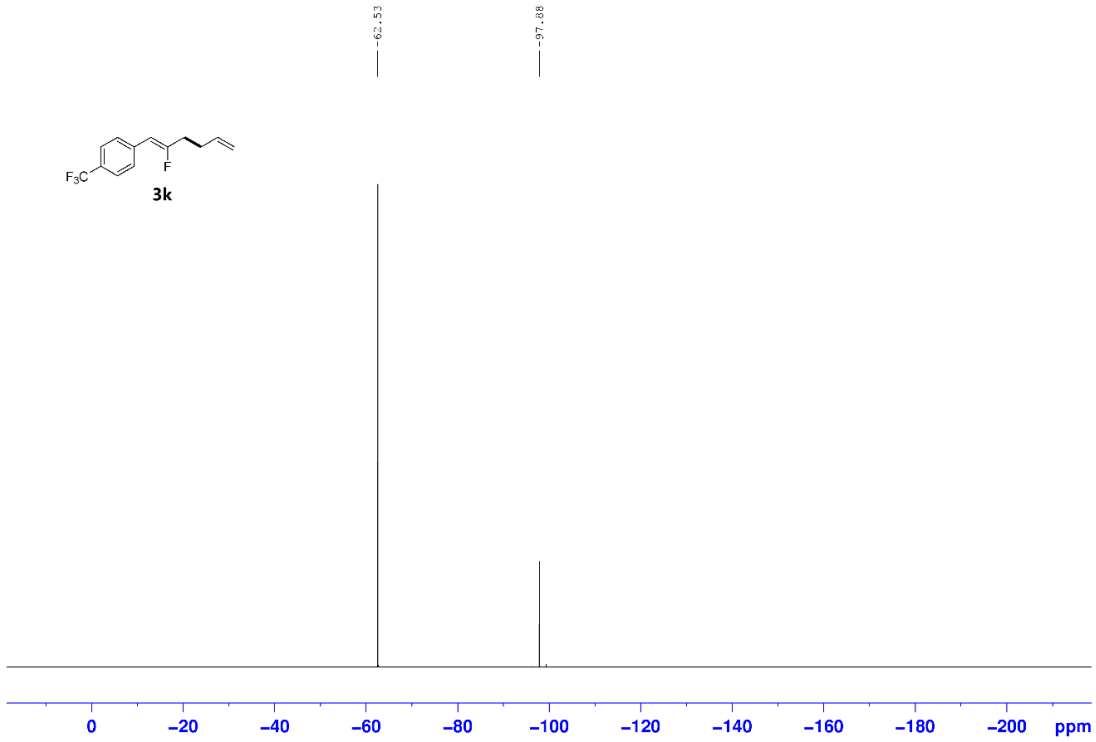
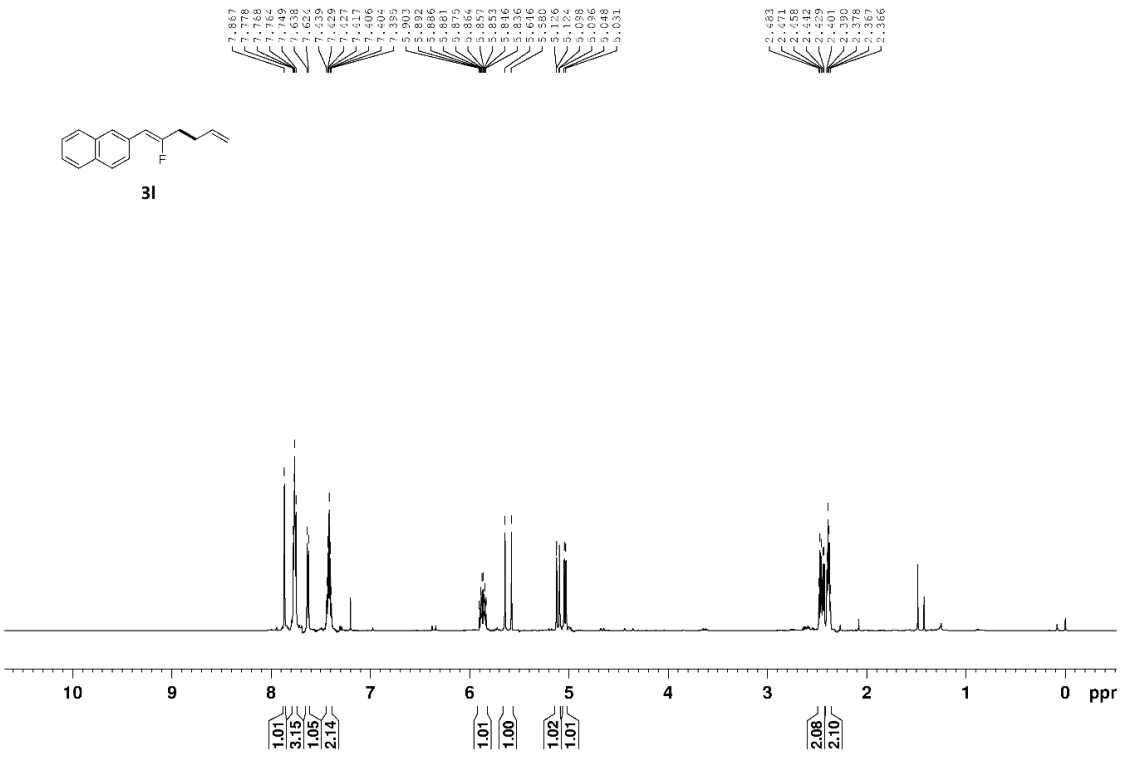
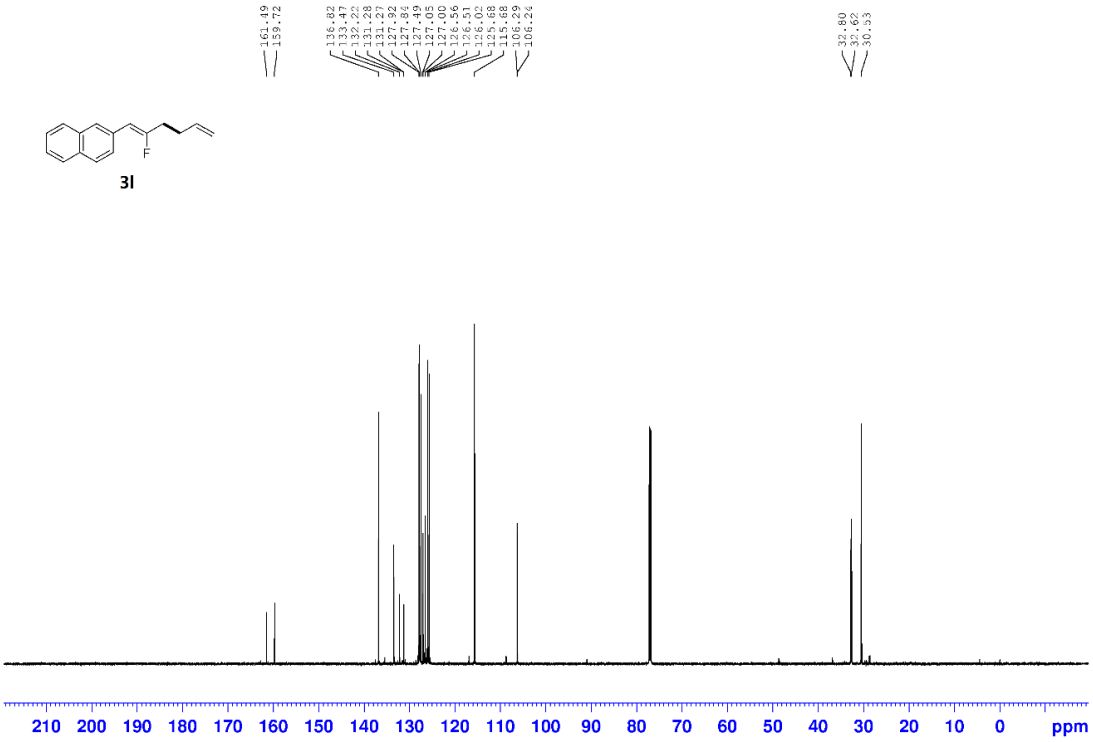
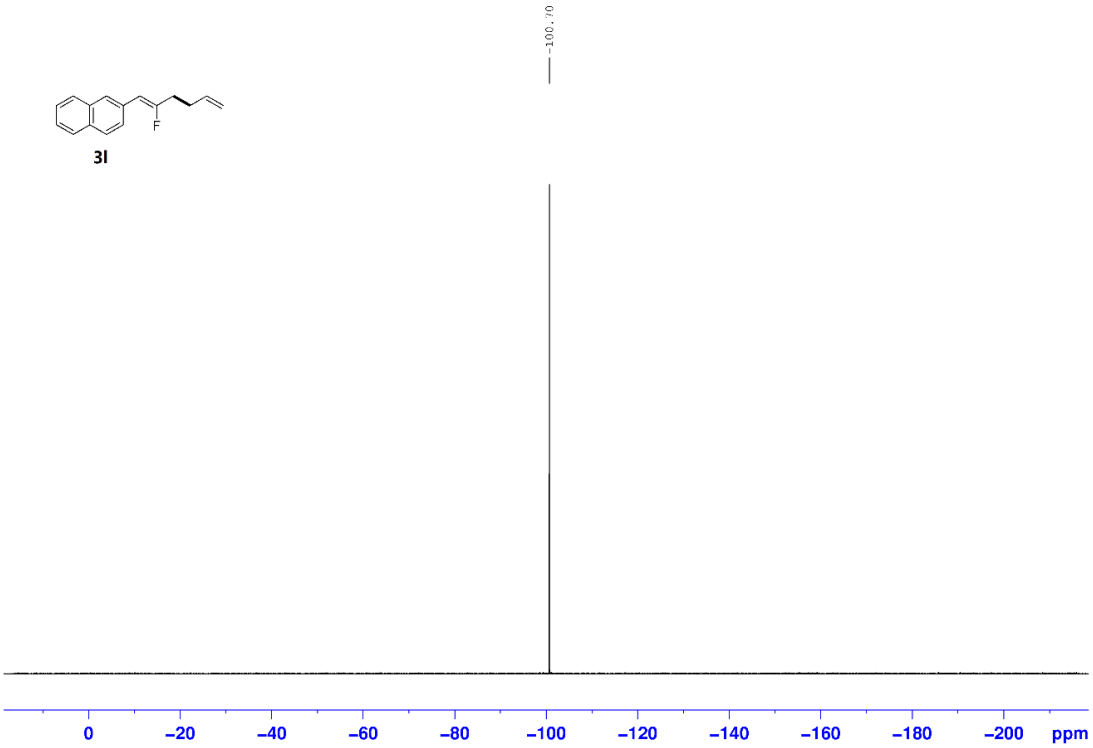
5.883
5.872
5.866
5.861
5.855
5.843
5.837
5.832
5.826
5.815
5.562
5.497
5.124
5.121
5.095
5.093
5.058
5.055
5.040
5.038
5.036
2.478
2.467
2.453
2.437
2.426
2.393
2.391
2.382
2.380
2.371
2.369
2.358
2.356
F3C
F
3k
10
9
8
7
6
5
4
3
2
1
0
ppr
4.05
1.07
1.00
1.07
1.19
2.08
2.10

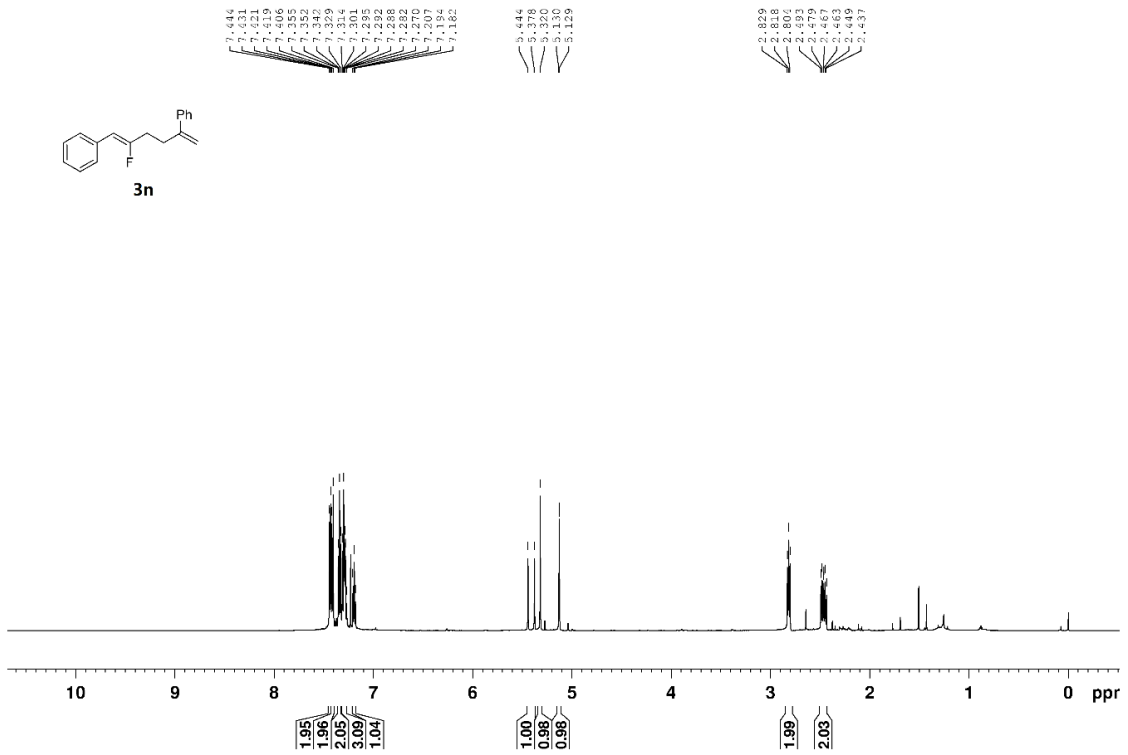

162.96
161.17
137.24
136.51
134.79
128.39
128.34
126.31
125.29
125.26
125.24
125.09
123.29
117.46
115.90
105.29
105.24
48.68
48.30
32.70
32.52
30.33
F3C
F
3k
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

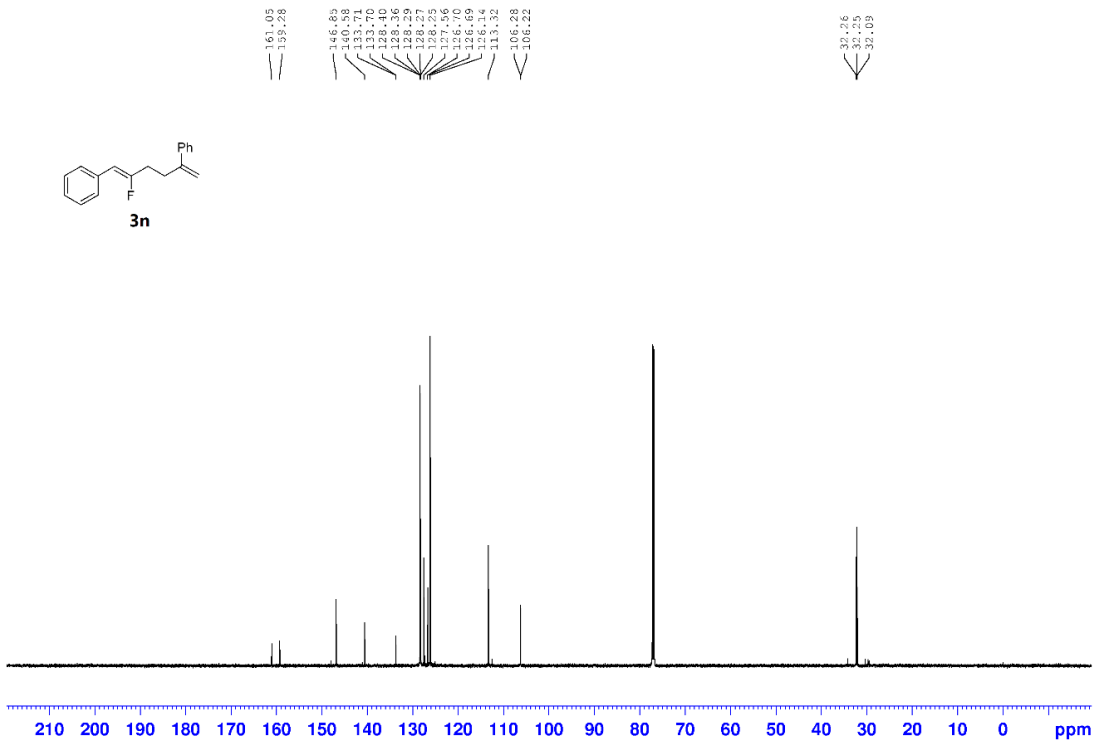

-62.53
-97.88
F3C
F
3k
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm

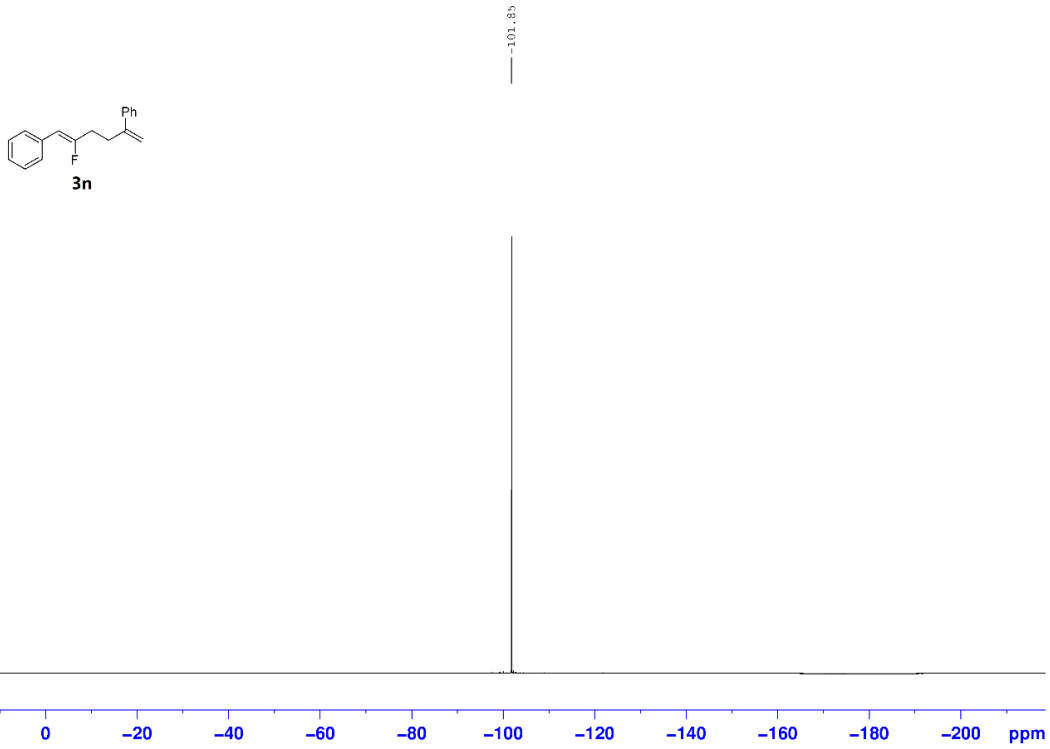

7.867
7.778
7.768
7.766
7.749
7.638
7.624
7.439
7.427
7.417
7.406
7.405
7.395
5.903
5.892
5.886
5.881
3.875
3.864
3.857
3.853
5.846
5.836
5.616
5.580
5.126
5.124
3.098
3.096
3.048
3.031
2.483
2.471
2.458
2.442
2.429
2.401
2.390
2.378
2.367
2.366
F
3l
10
9
8
7
6
5
4
3
2
1
0
ppr
1.01
3.15
1.05
2.14
1.01
1.00
1.02
1.01
2.08
2.10

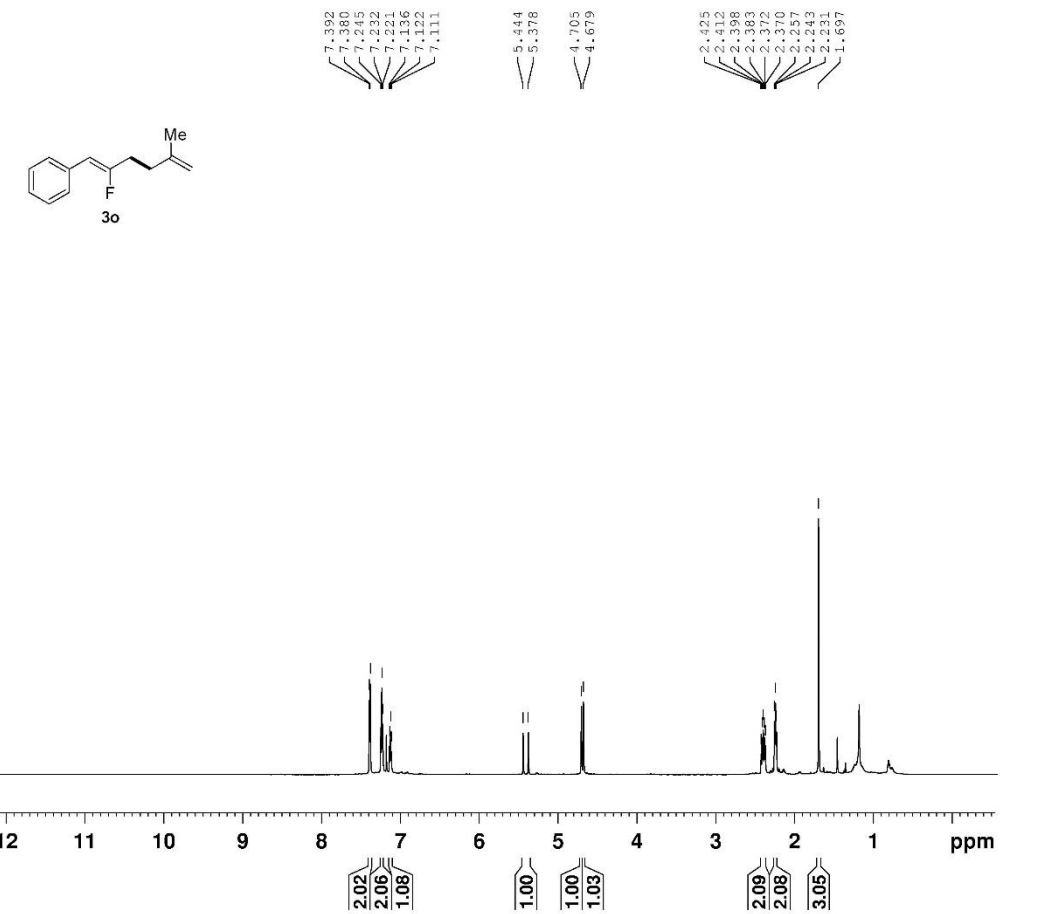

161.49
159.72
136.82
133.47
132.22
131.28
131.27
127.92
127.84
127.49
127.05
127.00
126.56
126.51
126.01
125.68
115.68
106.29
106.24
32.80
32.62
30.53
F
3l
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

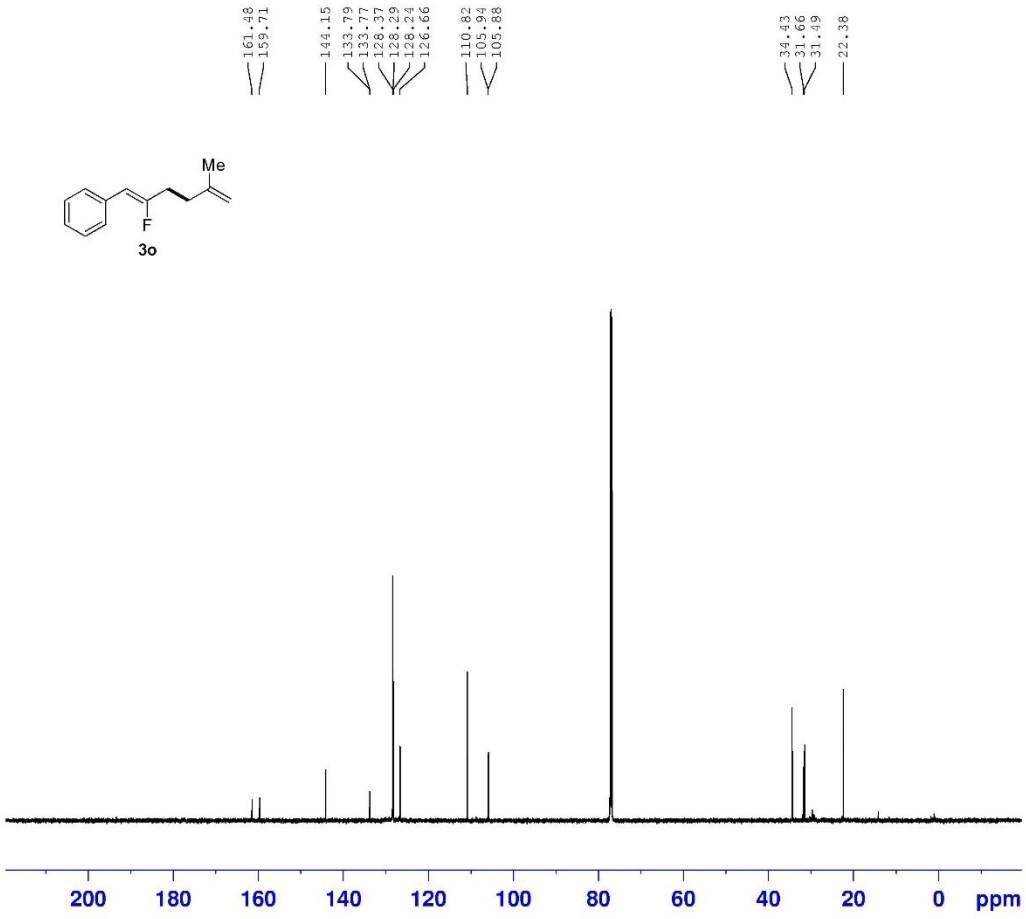

-100.70
F
3l
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm

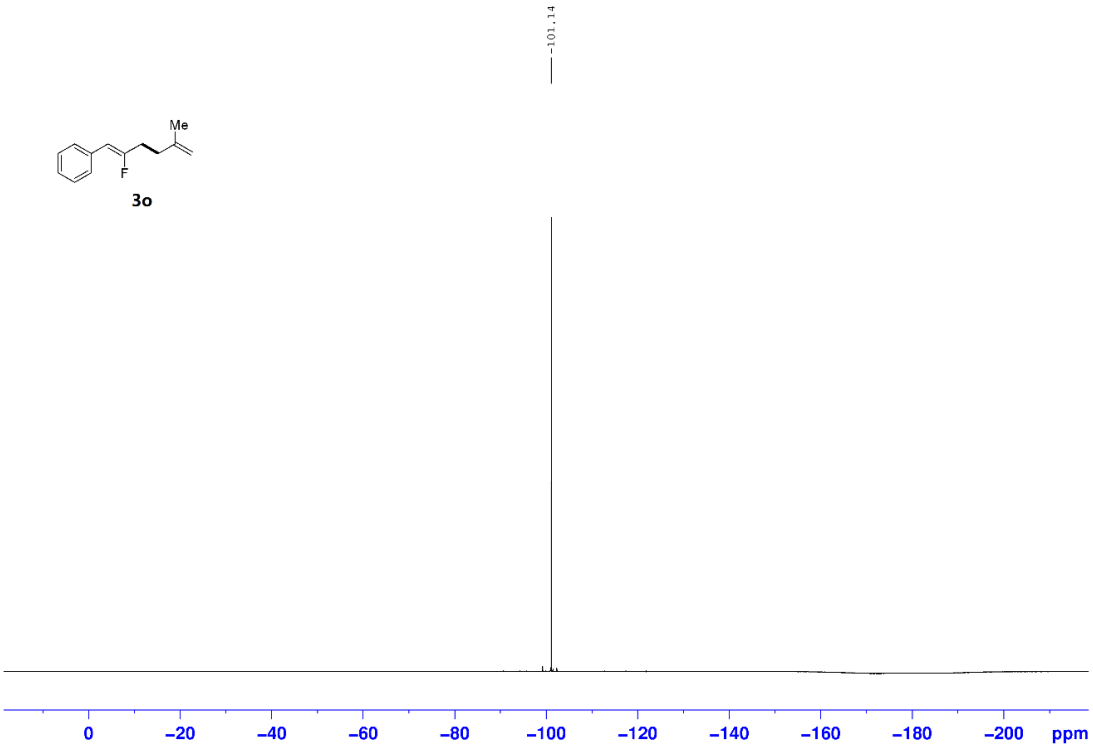

7.444
7.431
7.421
7.419
7.406
7.355
7.352
7.343
7.329
7.314
7.301
7.295
7.292
7.288
7.282
7.270
7.207
7.192
7.182
5.444
5.378
5.320
5.130
5.129
2.829
2.818
2.804
2.493
2.479
2.467
2.463
2.449
2.437
Ph
F
3n
10
9
8
7
6
5
4
3
2
1
0
ppm
1.95
1.96
2.05
3.09
1.04
1.00
0.98
0.98
1.99
2.03

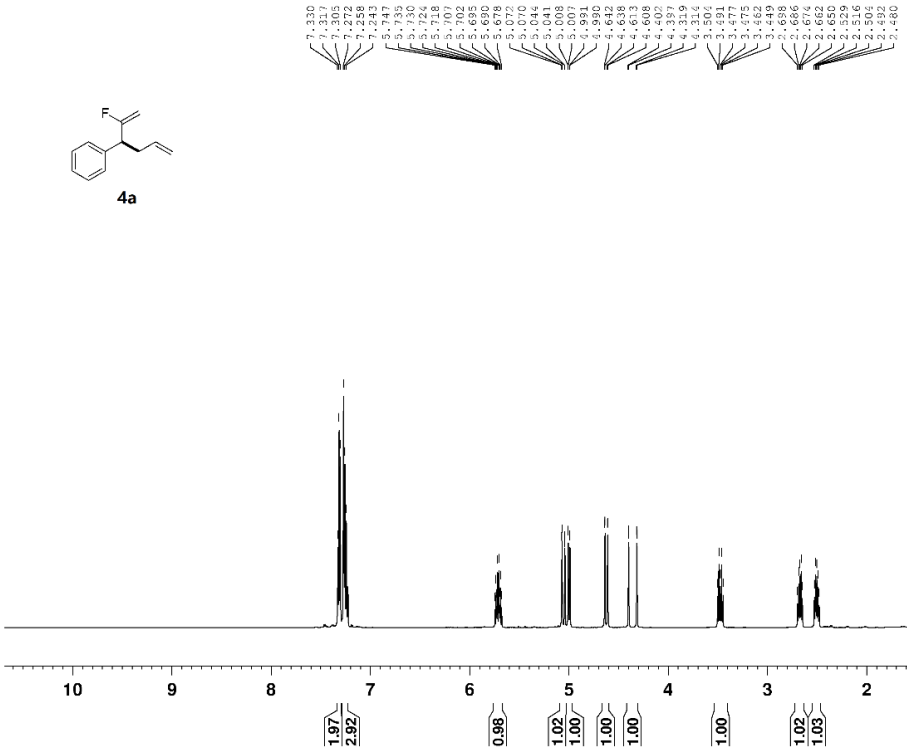

161.05
159.28
146.89
140.58
133.71
133.70
128.40
128.36
128.29
128.27
128.25
127.56
126.70
126.69
126.14
113.32
106.28
106.22
32.26
32.25
32.03
Ph
F
3n
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
ppm

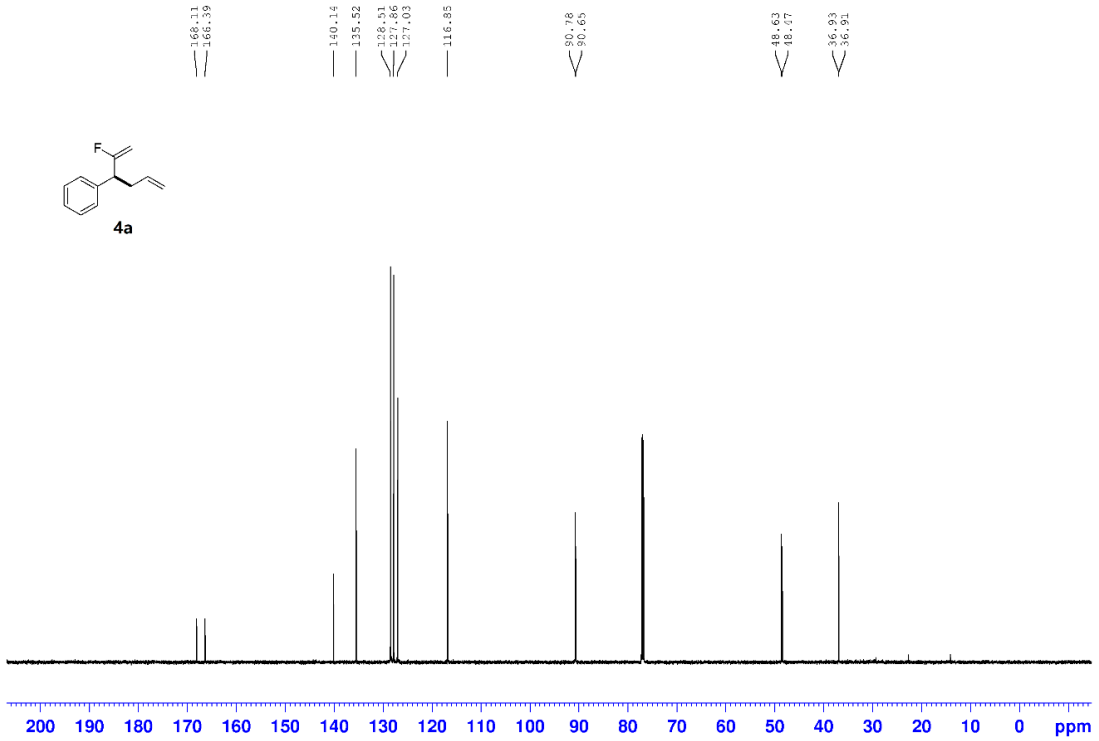

-101.85
Ph
F
3n
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm

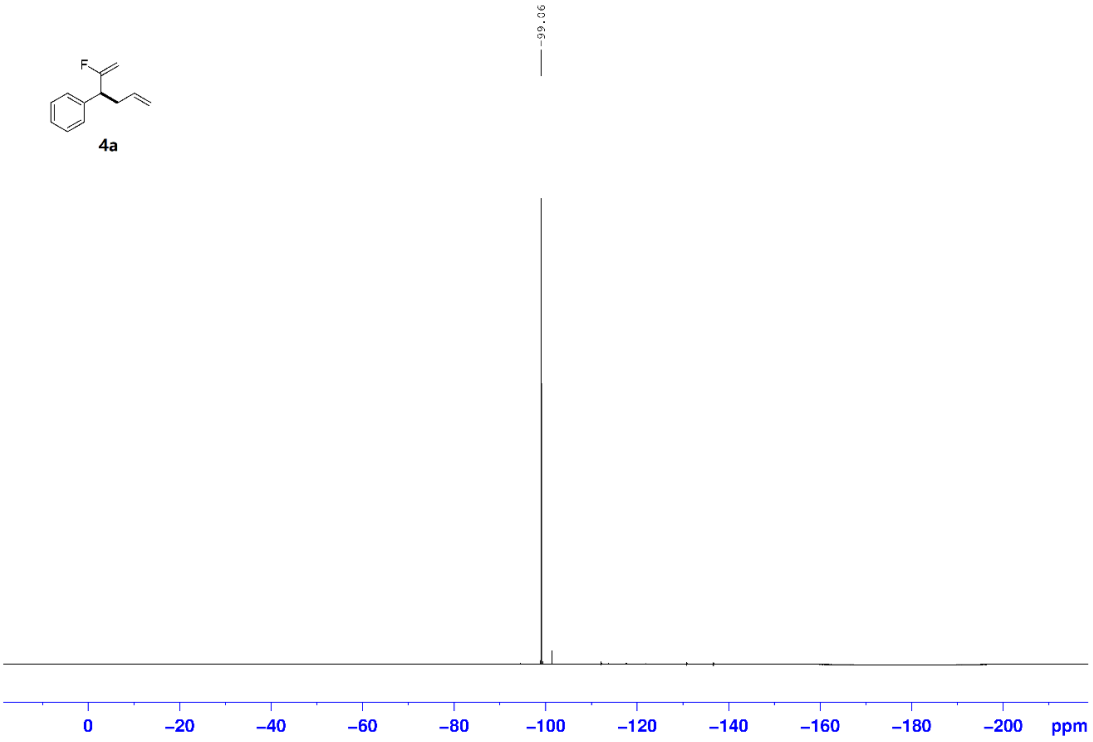

7.392
7.380
7.245
7.232
7.221
7.136
7.122
7.111
5.444
5.378
4.705
4.679
2.425
2.412
2.398
2.383
2.372
2.370
2.257
2.243
2.231
1.697
Me
F
3o
12
11
10
9
8
7
6
5
4
3
2
1
ppm
2.02
2.06
1.08
1.00
1.00
1.03
2.09
2.08
3.05

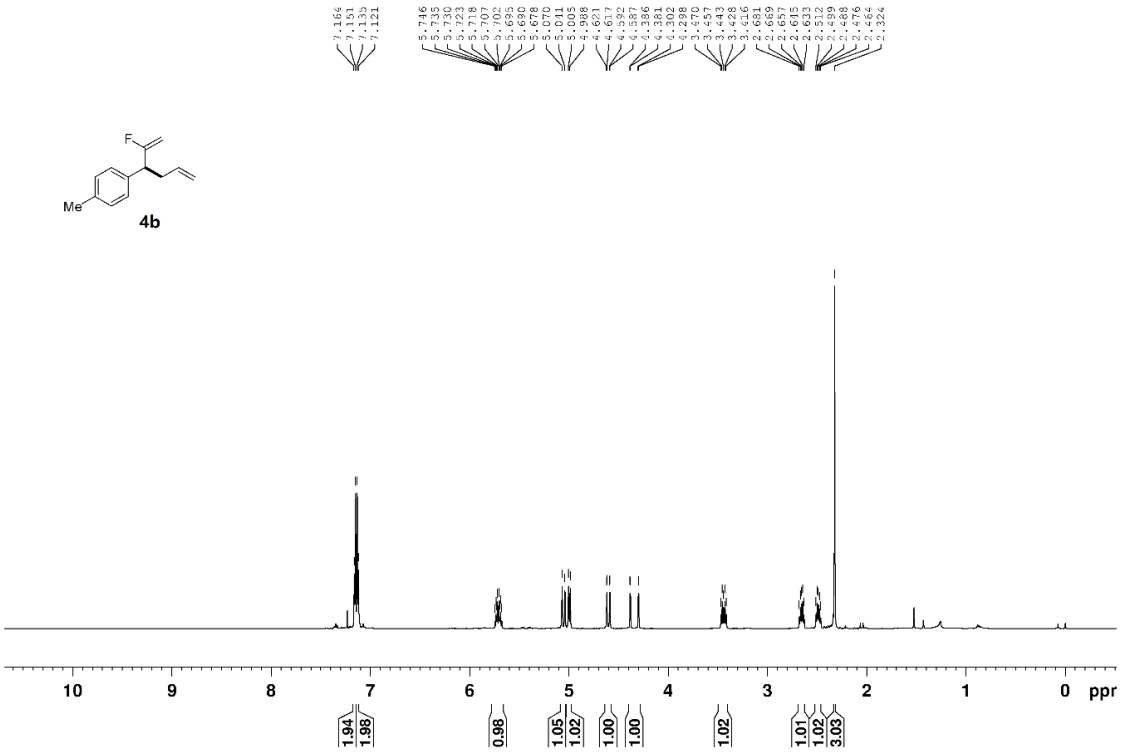

161.48
159.71
144.15
133.79
133.77
128.37
128.29
128.24
126.66
110.82
105.94
105.88
34.43
31.66
31.49
22.38
Me
F
3o
200
180
160
140
120
100
80
60
40
20
0
ppm

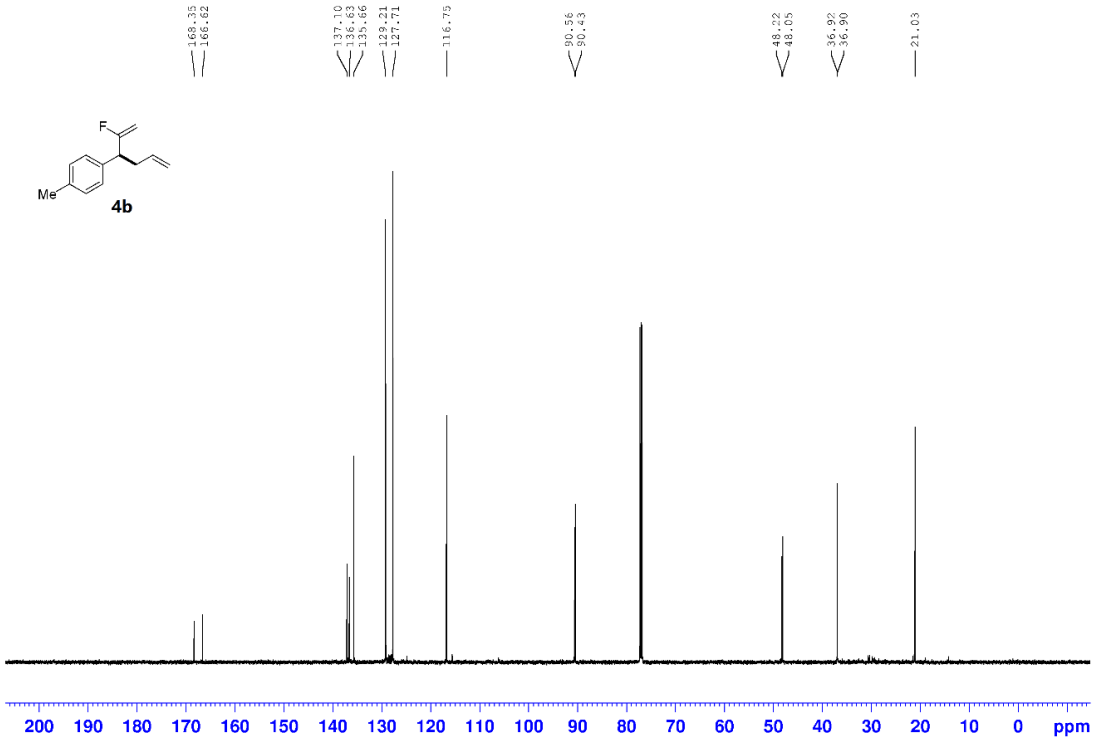

-101.14
Me
F
3o
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm

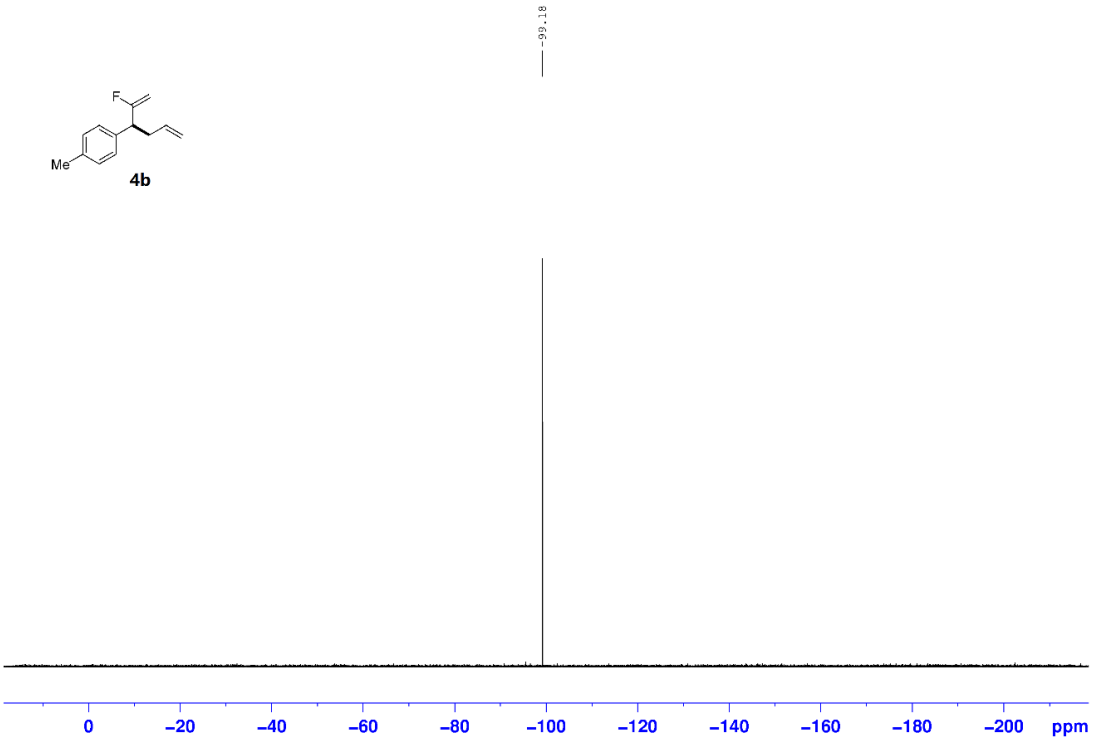

4a
10 9 8 7 6 5 4 3 2 1 0 ppr
1.97 2.92 0.98 1.02 1.00 1.00 1.00 1.00 1.02 1.03

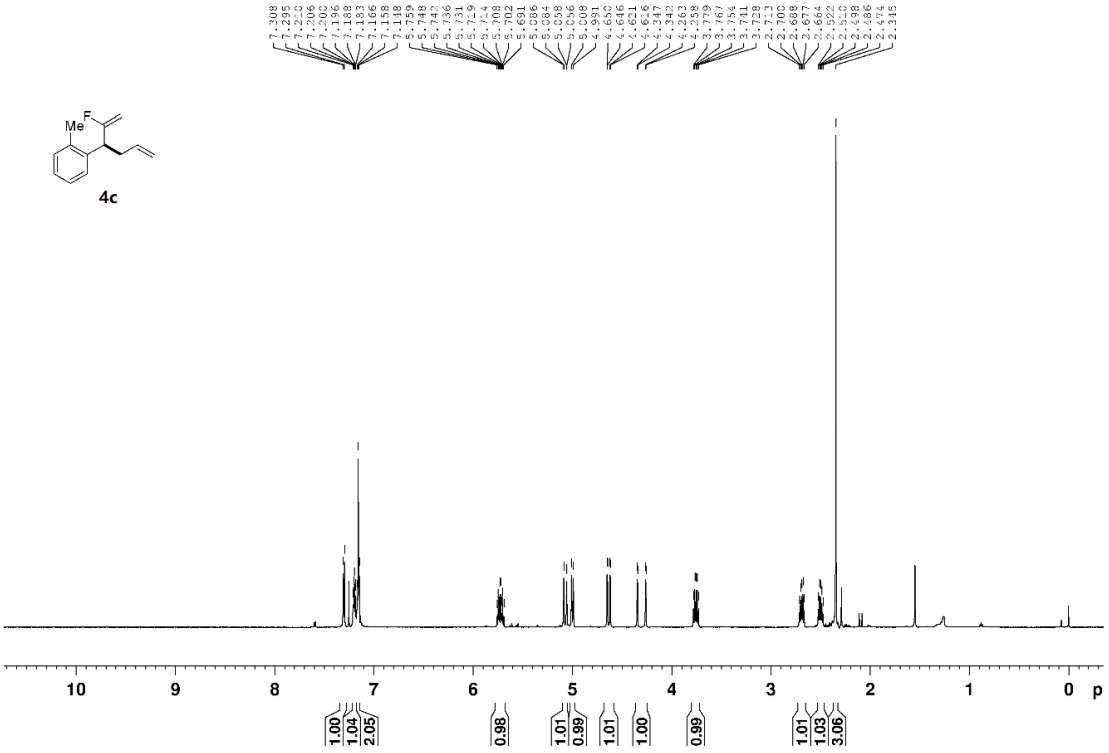

4a
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

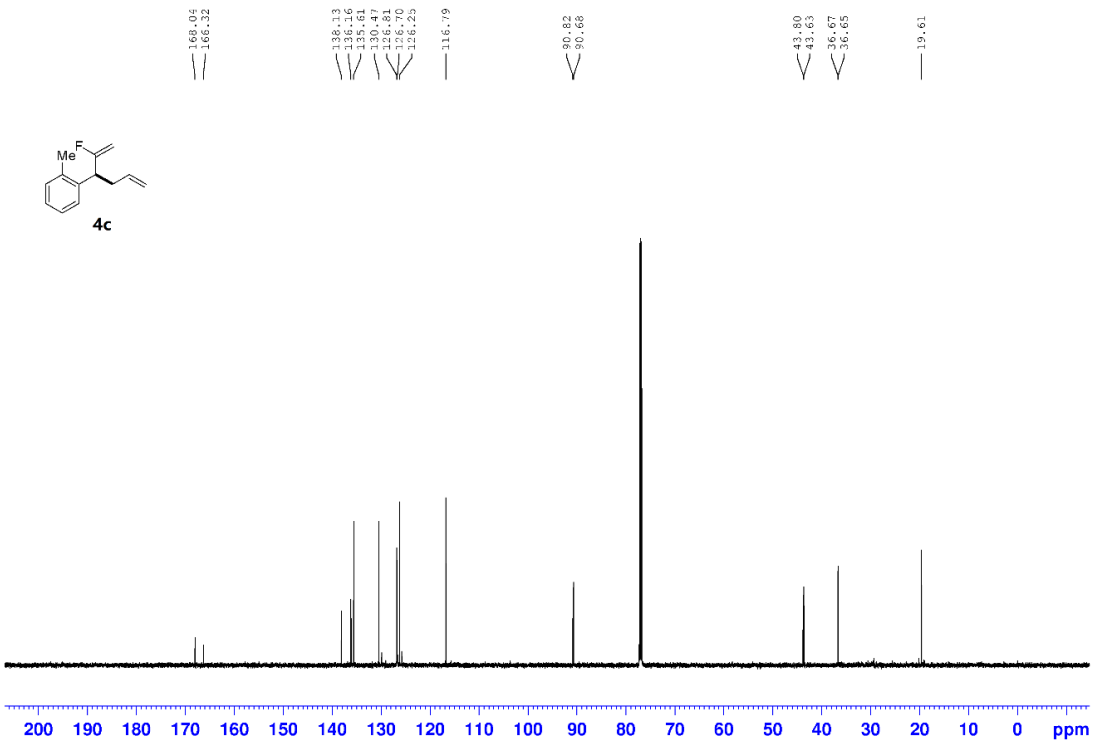

F
4a
-99.06
0
−20
−40
−60
−80
−100
−120
−140
−160
−180
−200
ppm

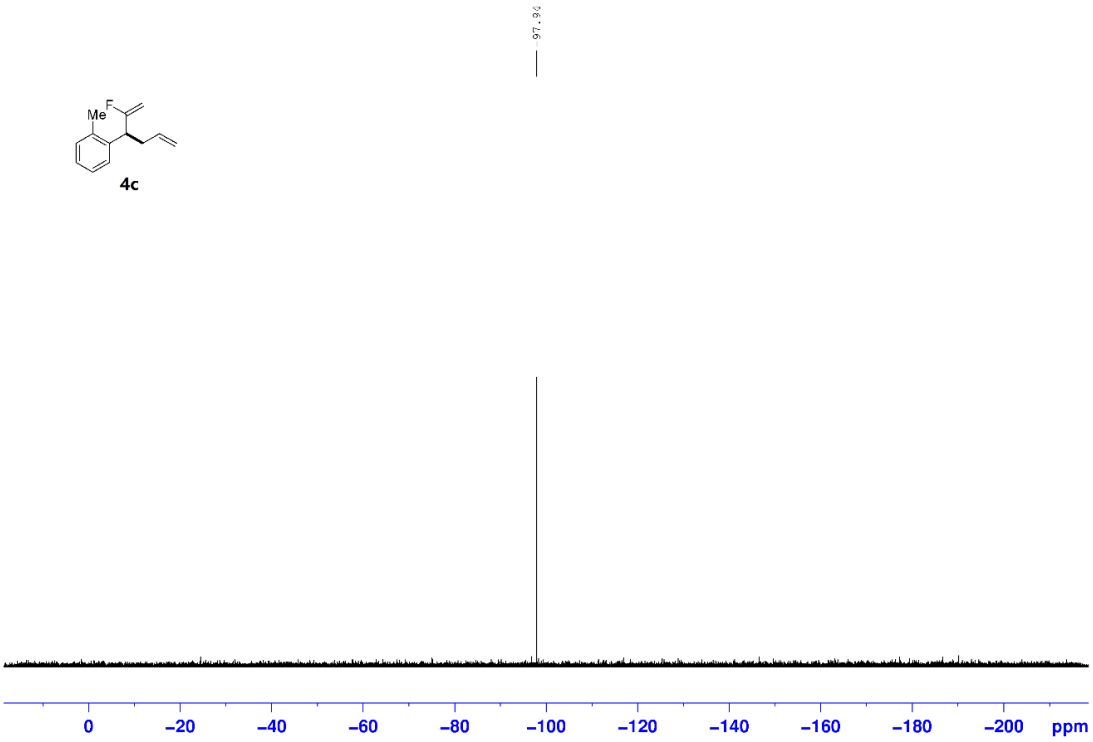

7.164
7.151
7.135
7.121
5.746
5.735
5.730
5.723
5.718
5.707
5.702
5.695
5.690
5.678
5.070
5.011
5.005
4.988
4.621
4.617
4.382
4.377
4.386
4.381
4.302
4.298
3.570
3.457
3.443
3.428
3.416
2.631
2.669
2.657
2.615
2.633
2.512
2.489
2.468
2.476
2.464
2.324
F
Me
4b
10
9
8
7
6
5
4
3
2
1
0
ppm
1.94
1.98
0.98
1.05
1.02
1.00
1.00
1.02
1.01
1.02
3.03

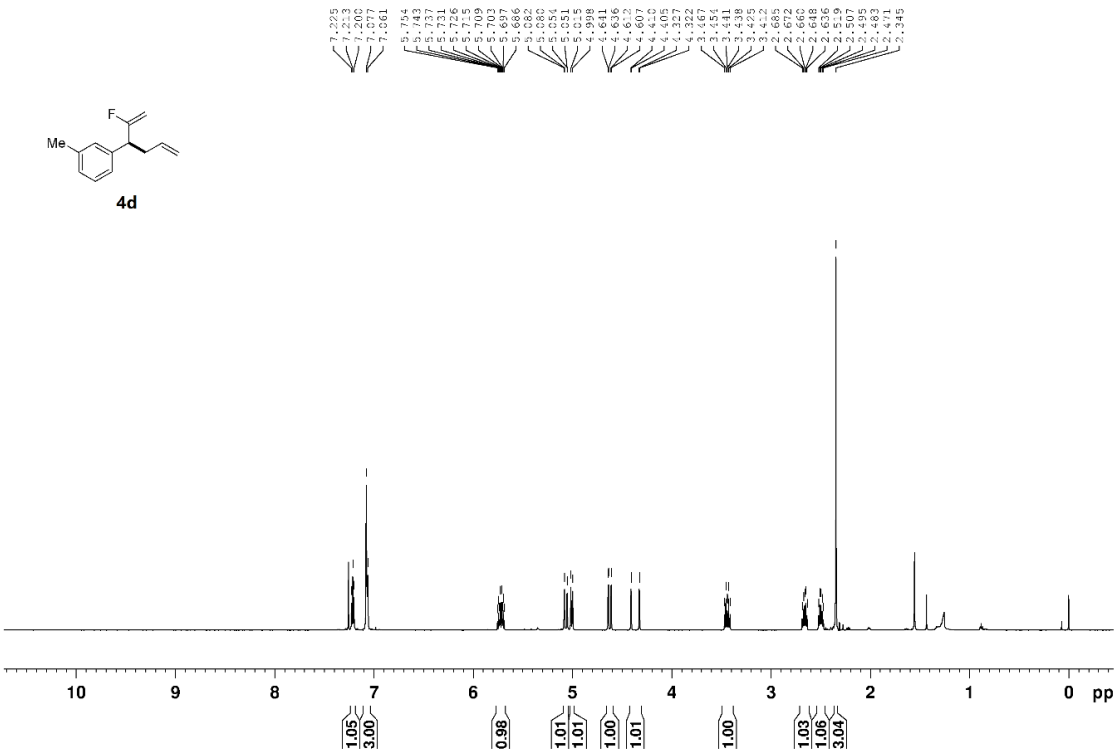

168.35
166.62
137.10
136.63
135.66
129.21
127.71
116.75
90.56
90.43
48.22
48.05
36.92
36.90
21.03
F
Me
4b
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

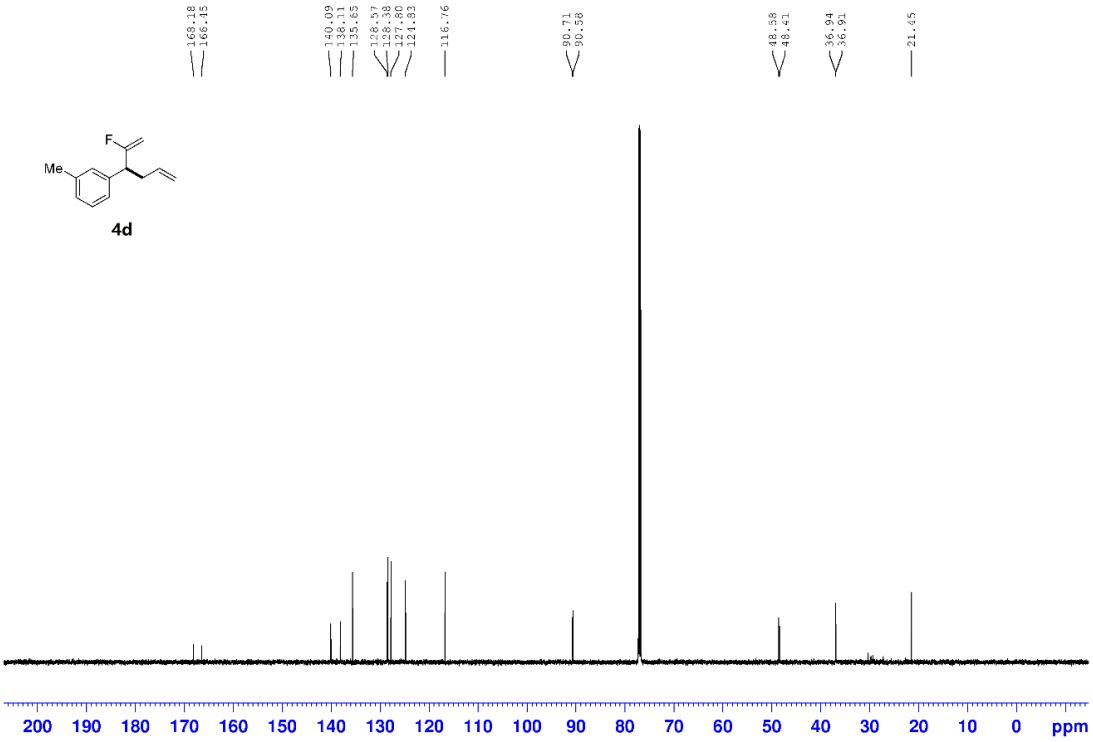

-99.18
F
Me
4b
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm

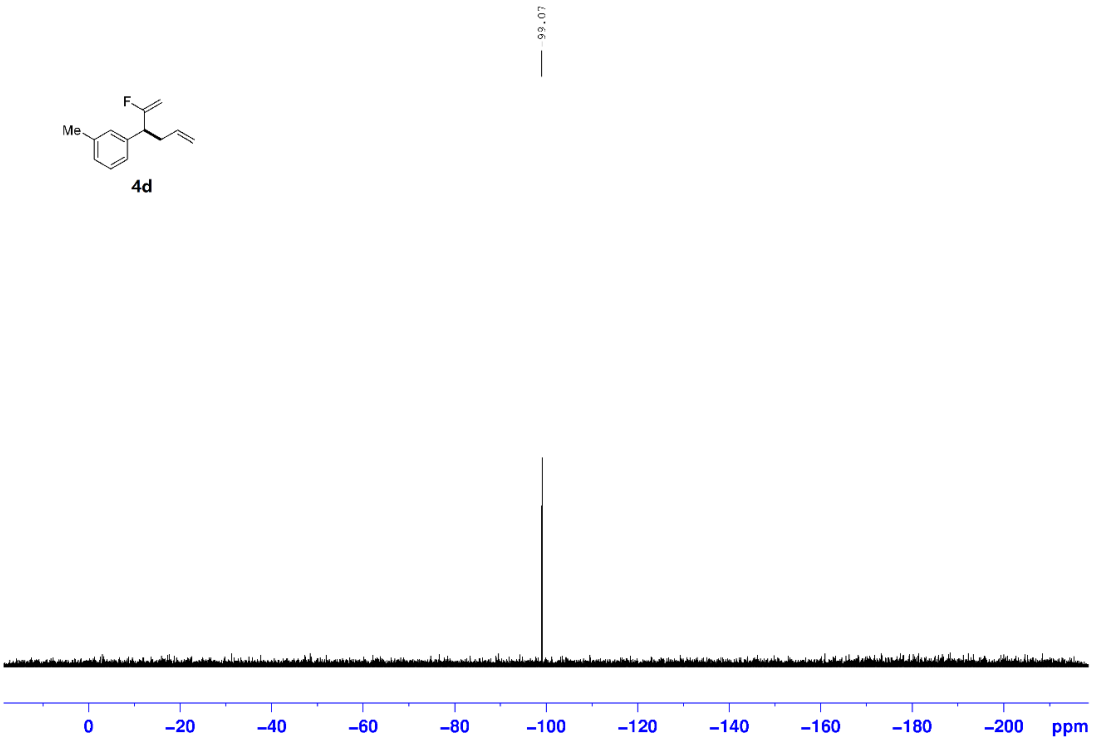

4c
10 9 8 7 6 5 4 3 2 1 0 p
1.00 1.04 2.05 0.98 1.01 0.99 1.01 1.00 0.99 1.01 1.03 3.06

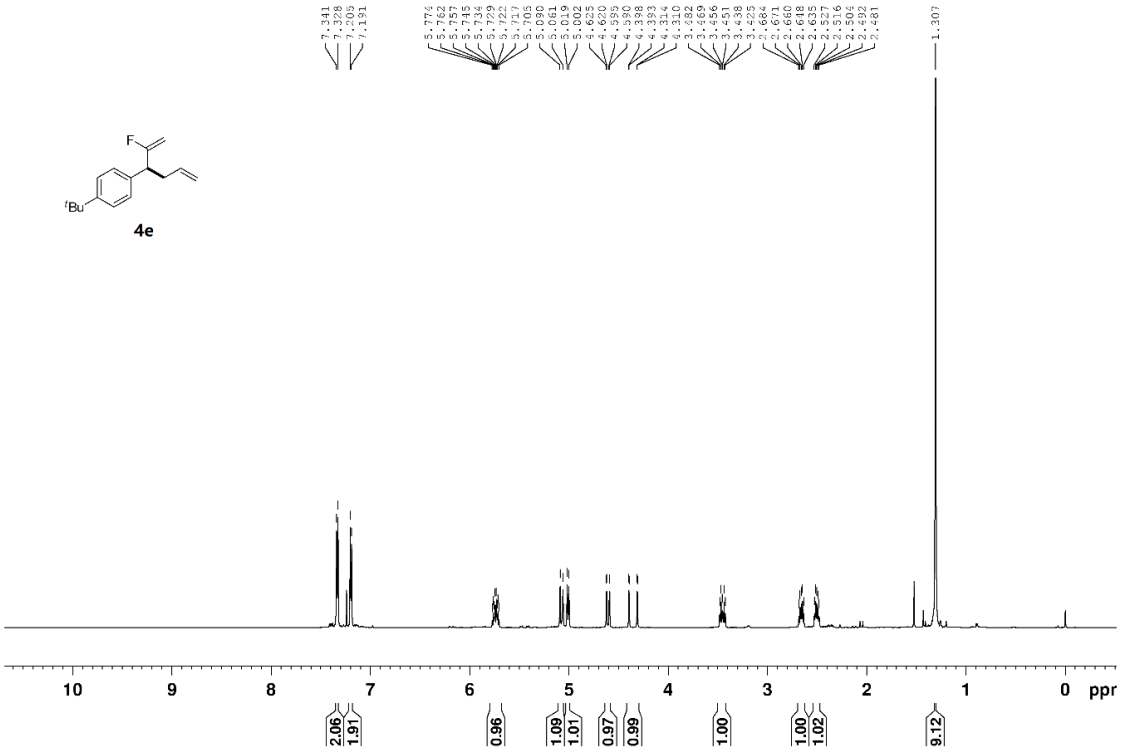

4c
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

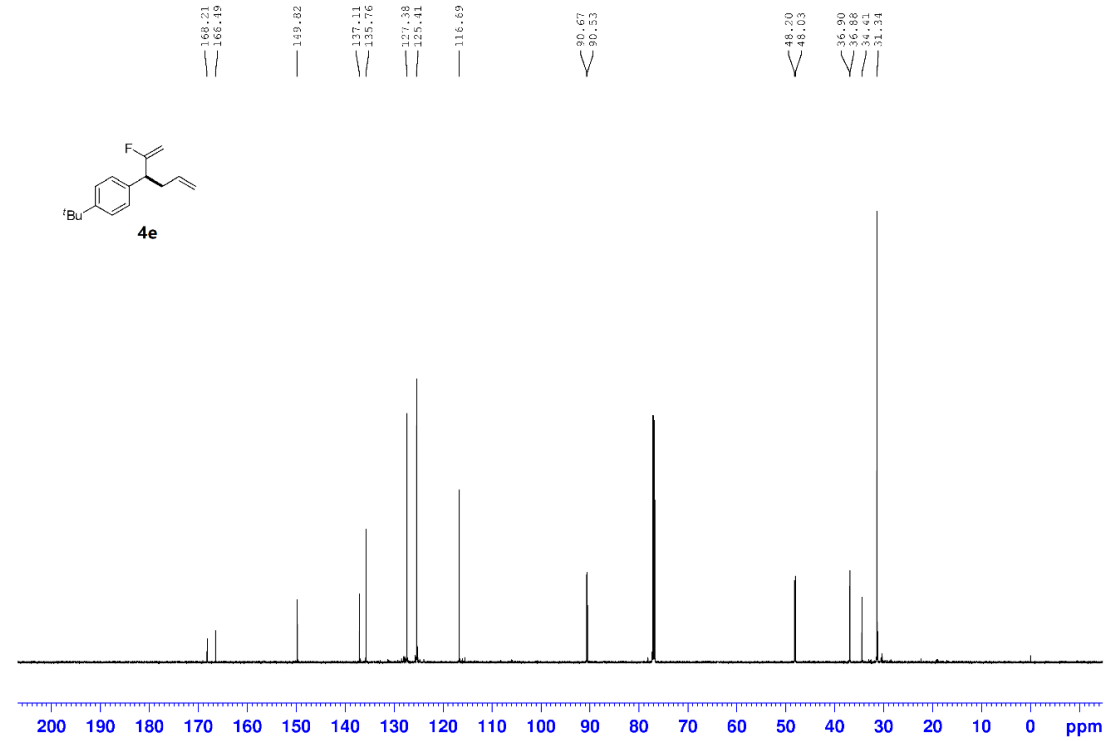

97.96
Me
F
4c
0
−20
−40
−60
−80
−100
−120
−140
−160
−180
−200
ppm

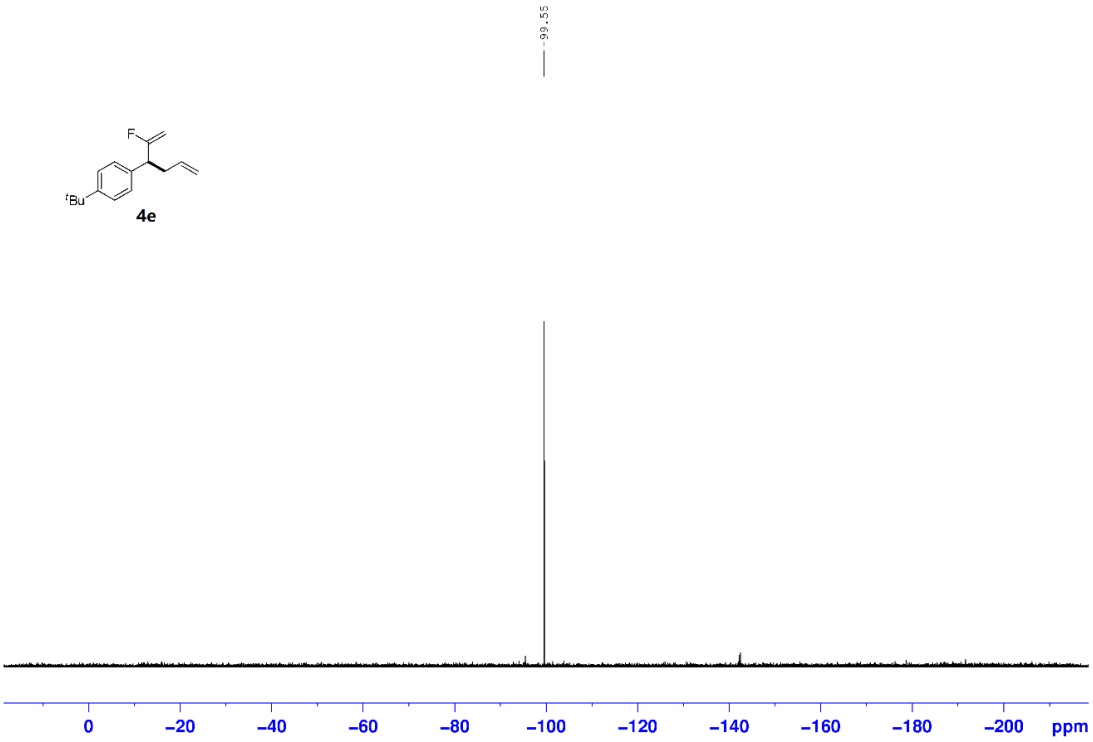

Me
F
4d
10
9
8
7
6
5
4
3
2
1
0
pp
1.05
3.00
0.98
1.01
1.01
1.00
1.01
1.00
1.03
1.06
3.04

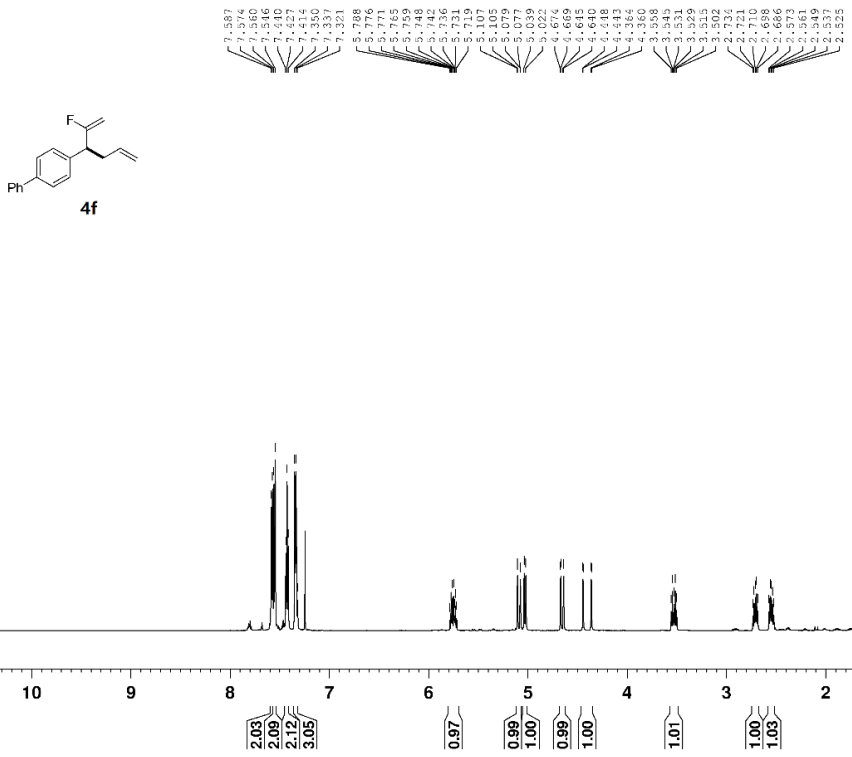

168.18
166.45
140.09
138.71
135.65
128.57
128.38
127.80
121.83
116.76
90.71
90.58
48.58
48.41
36.94
36.91
21.45
F
Me
4d
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

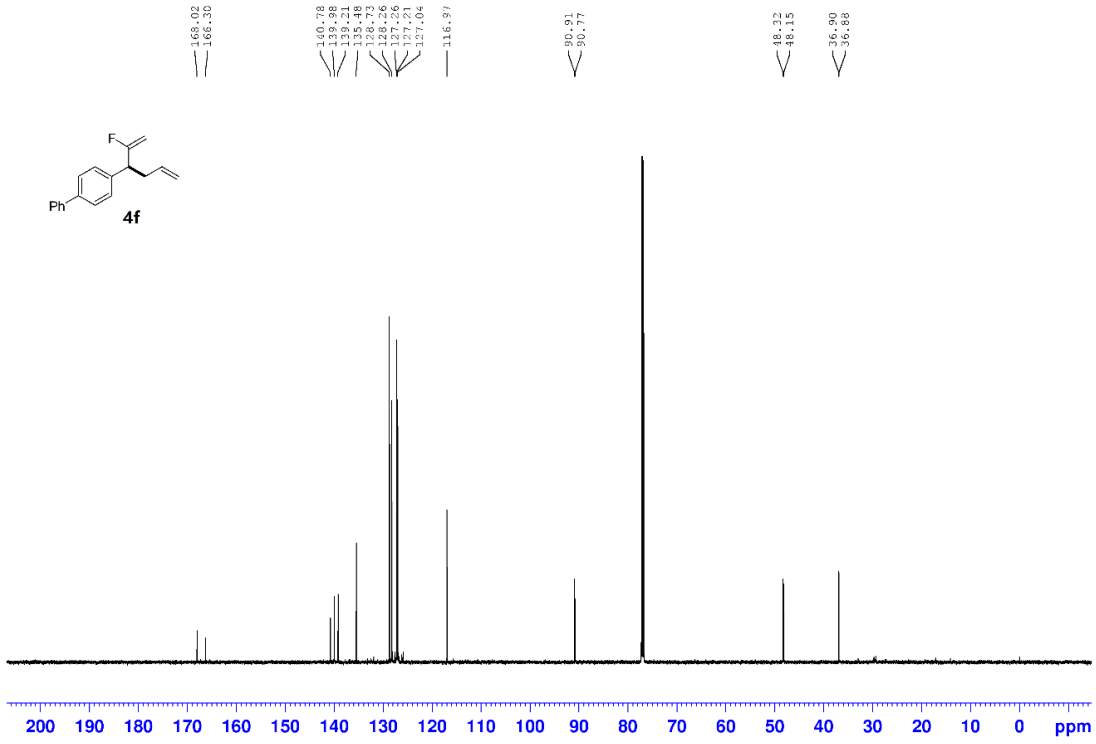

99.07
F
Me
4d
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm

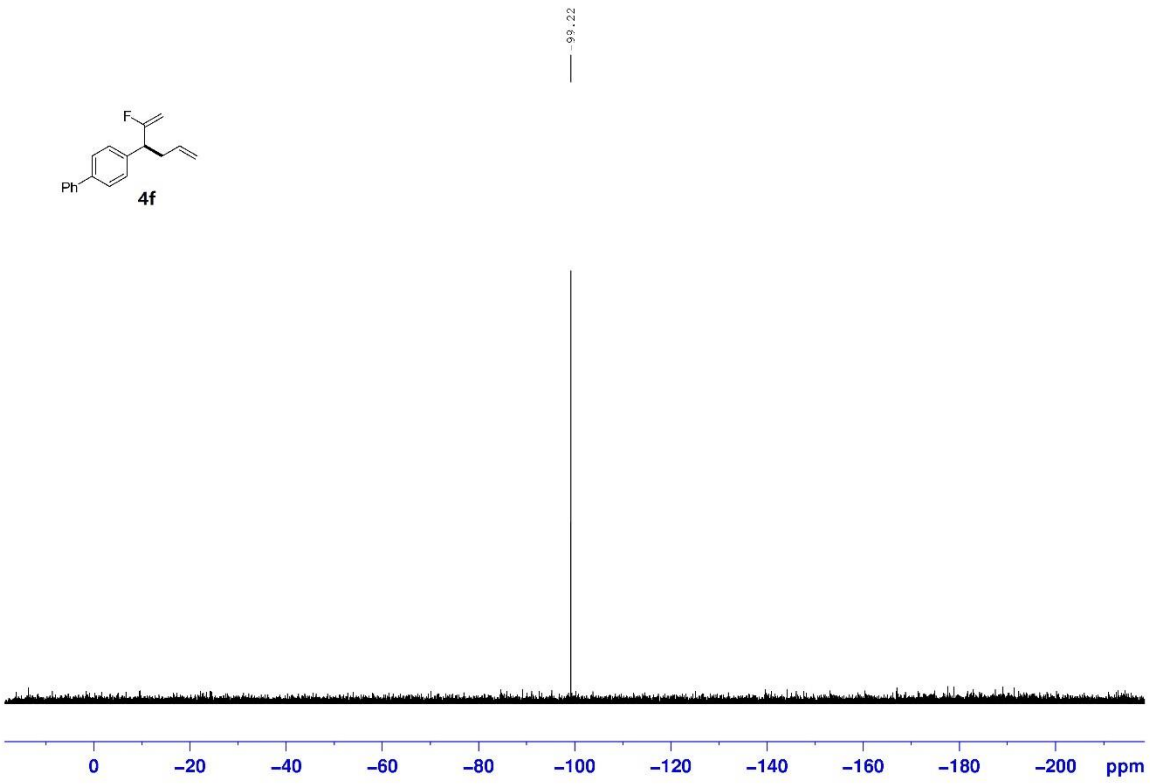

4e
ppm

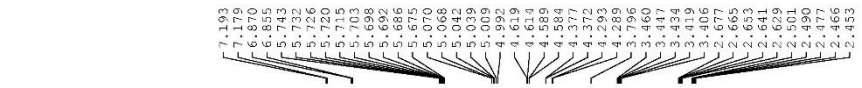

4e
ppm


99.55
F
tBu
4e
0
−20
−40
−60
−80
−100
−120
−140
−160
−180
−200
ppm


F
Ph
4f
10
9
8
7
6
5
4
3
2
1
0
ppm
2.03
2.09
2.12
3.05
0.97
0.99
1.00
0.99
1.00
1.01
1.00
1.03


168.02
166.30
140.78
139.98
139.21
138.48
128.73
128.26
127.26
127.21
127.04
116.97
90.91
90.77
48.32
48.15
36.90
36.88
F
Ph
4f
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-99.22
F
Ph
4f
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm


7.193
7.179
6.870
6.855
5.743
5.732
5.726
5.720
5.715
5.703
5.698
5.692
5.686
5.675
5.070
5.068
5.042
5.039
5.009
4.992
4.619
4.614
4.589
4.584
4.377
4.372
4.293
4.289
3.796
3.460
3.447
3.434
3.419
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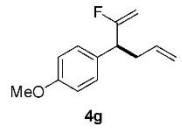
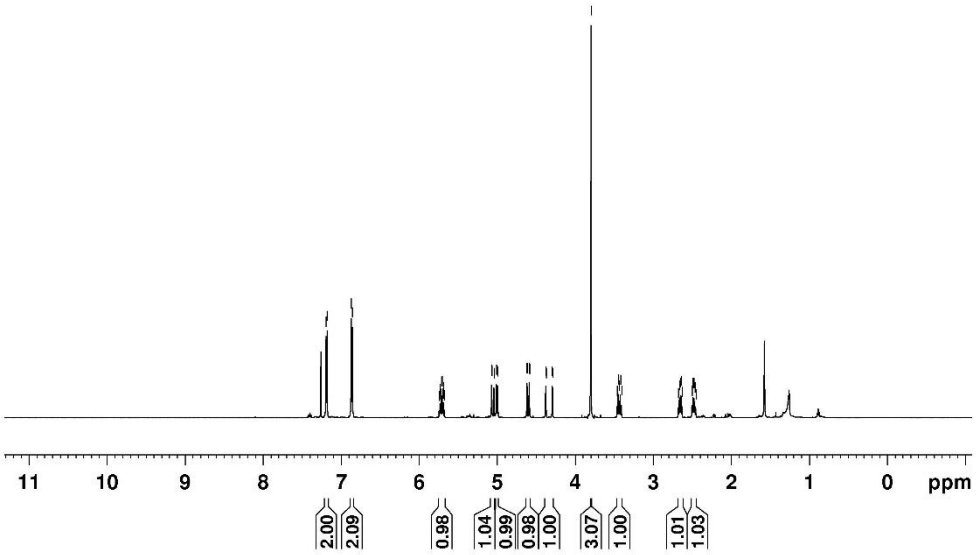
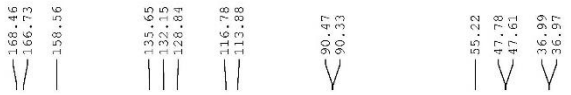
2.629
2.501
2.490
2.477
2.466
2.453


F
MeO

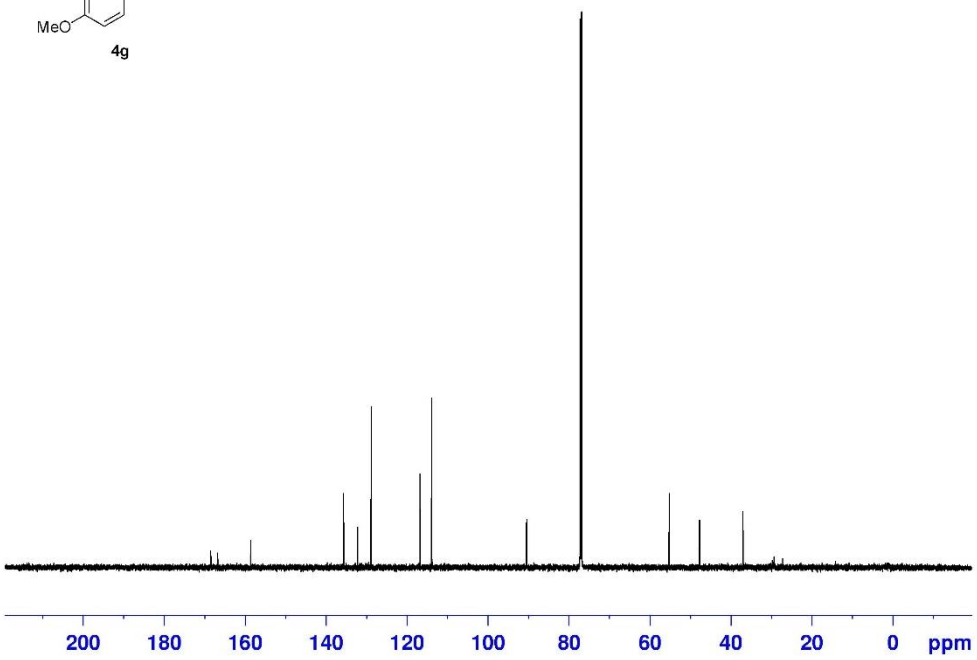
4g

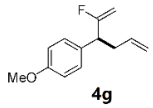

11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.00
2.09
0.98
1.04
0.99
0.98
1.00
3.07
1.00
1.01
1.03


168.46
166.73
158.56
135.65
132.15
128.84
116.78
113.88
90.47
90.33
55.22
47.78
47.61
36.99
36.97


F
MeO

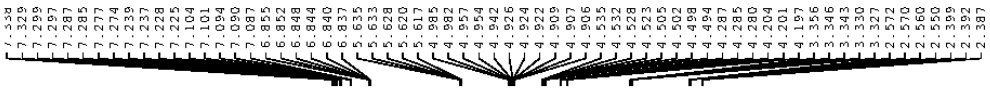
4g

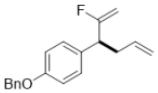

200
180
160
140
120
100
80
60
40
20
0
ppm


F
MeO

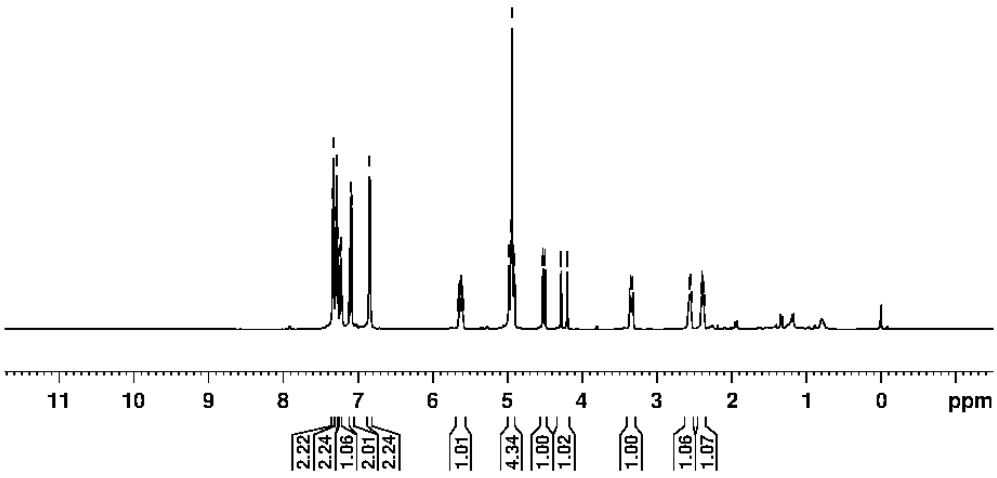
4g

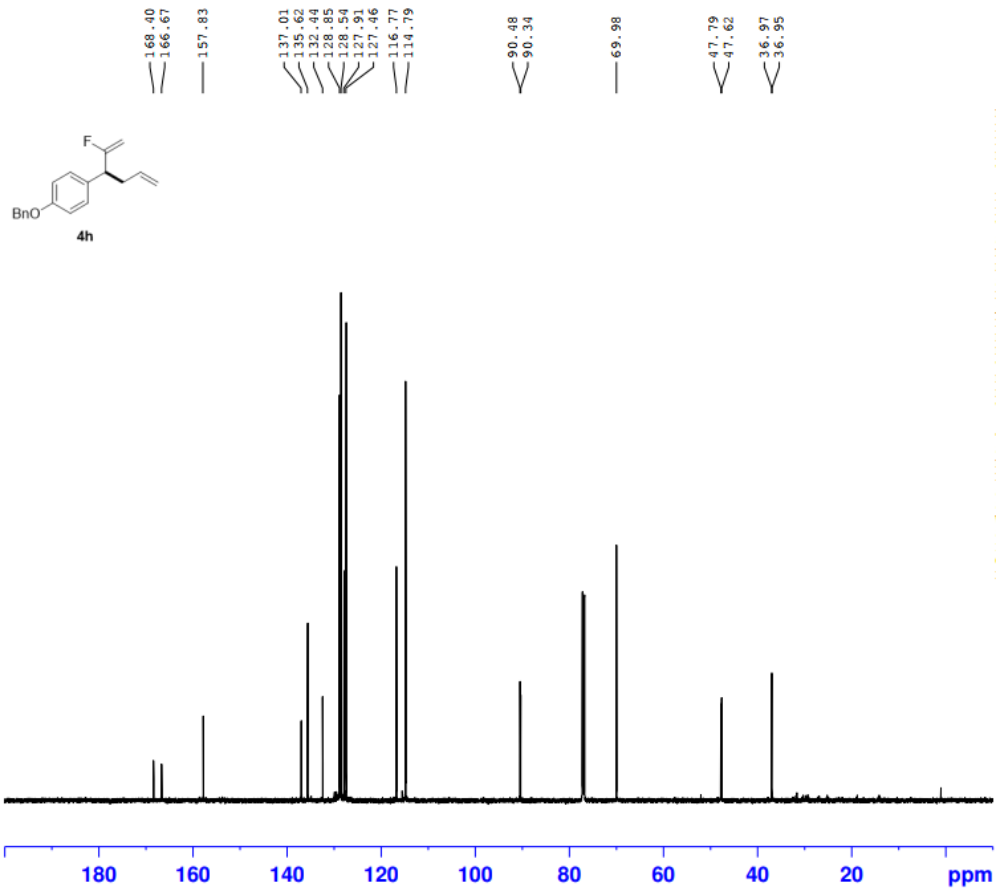
-99.40
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm

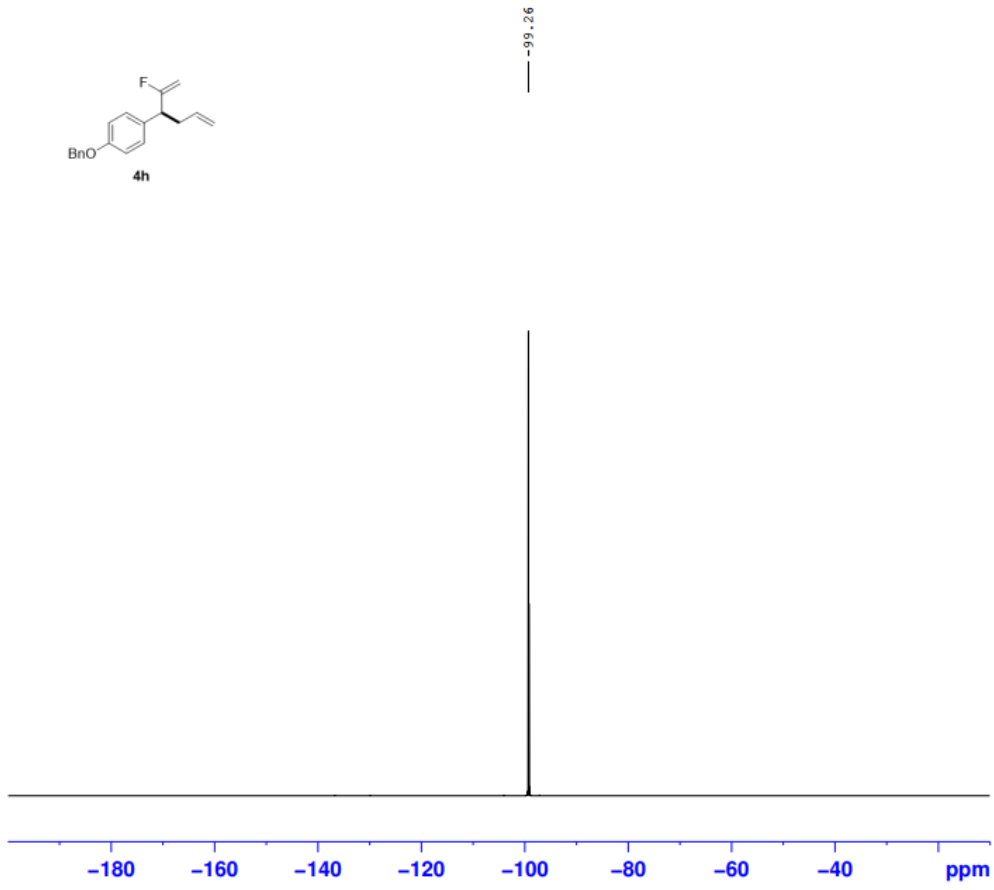


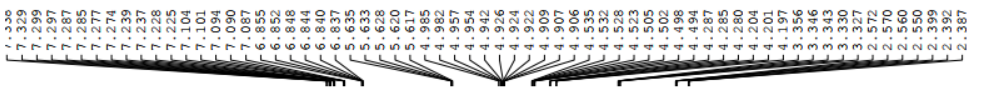

F
BnO

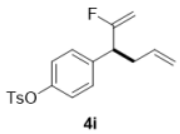
4h


11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.22
2.24
1.06
2.01
2.24
1.01
4.34
1.00
1.02
1.00
1.06
1.07

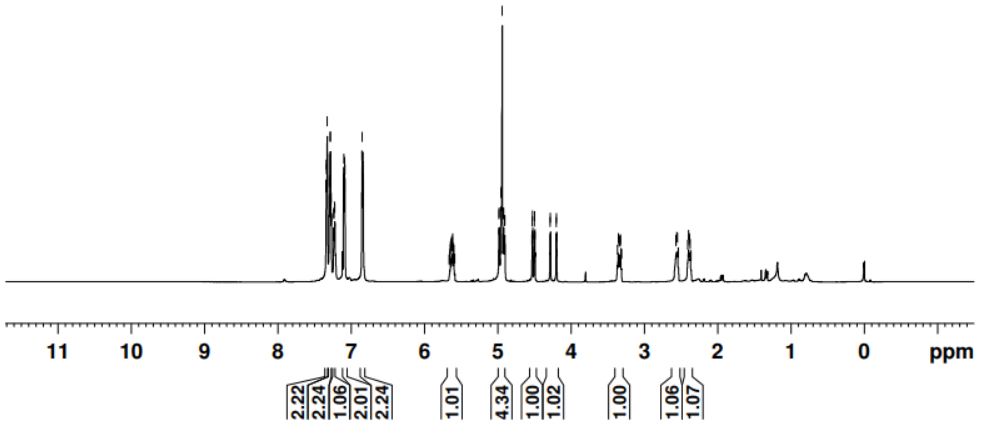

168.40
166.67
157.83
137.01
135.62
132.44
128.85
128.54
127.91
127.46
116.77
114.79
90.48
90.34
69.98
47.79
47.62
36.97
36.95
F
BnO
4h
180
160
140
120
100
80
60
40
20
ppm

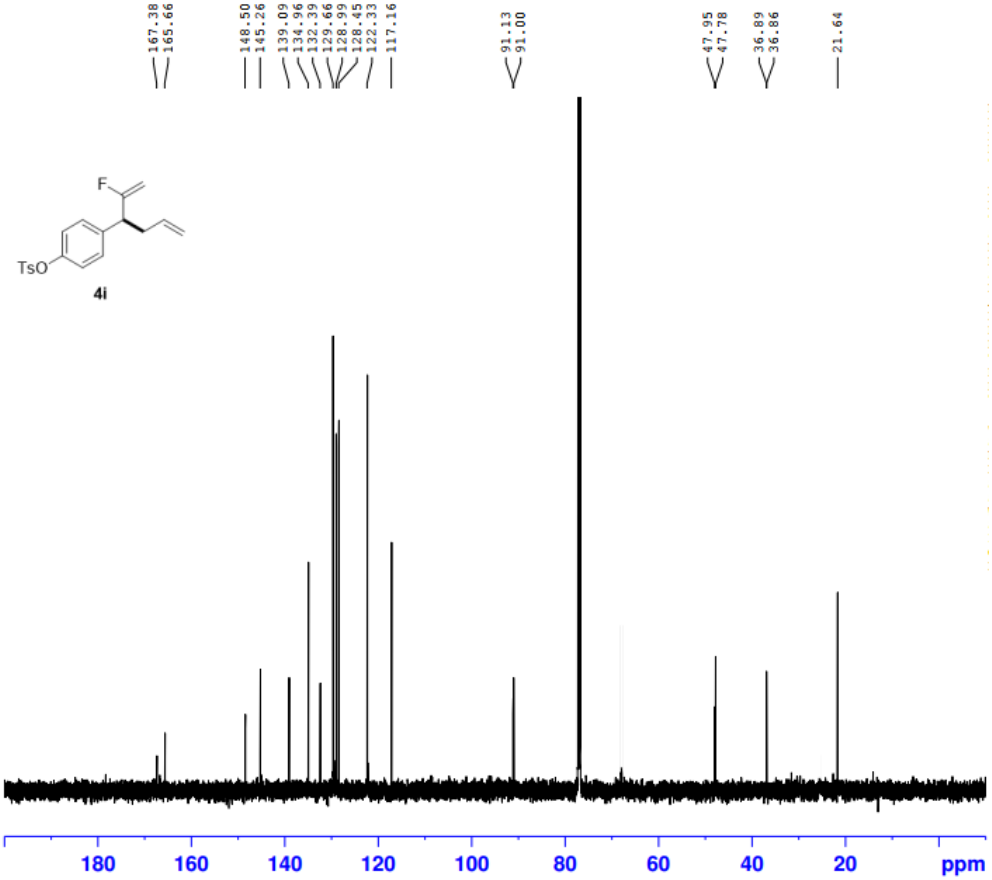

-99.26
F
BnO
4h
-180
-160
-140
-120
-100
-80
-60
-40
ppm



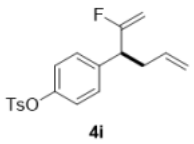

F
TsO

4i


11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.22
2.24
1.06
2.01
2.24
1.01
4.34
1.00
1.02
1.00
1.06
1.07

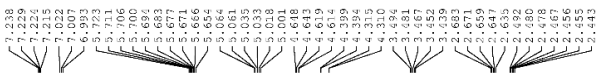

167.38
165.66
148.50
145.26
139.09
134.96
132.39
129.66
128.99
128.45
122.33
117.16
91.13
91.00
47.95
47.78
36.89
36.86
21.64
F
TsO
180
160
140
120
100
80
60
40
20
ppm

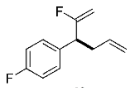
4i


F
TsO

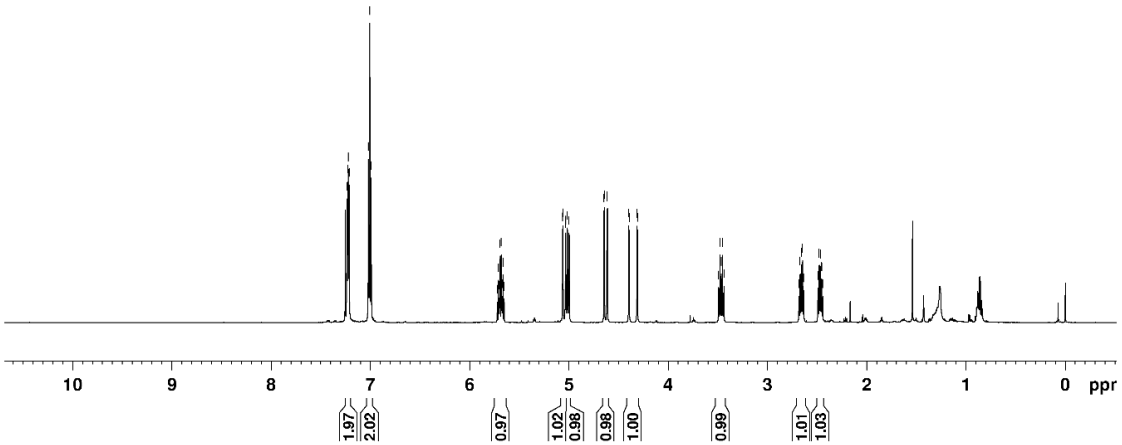
4i

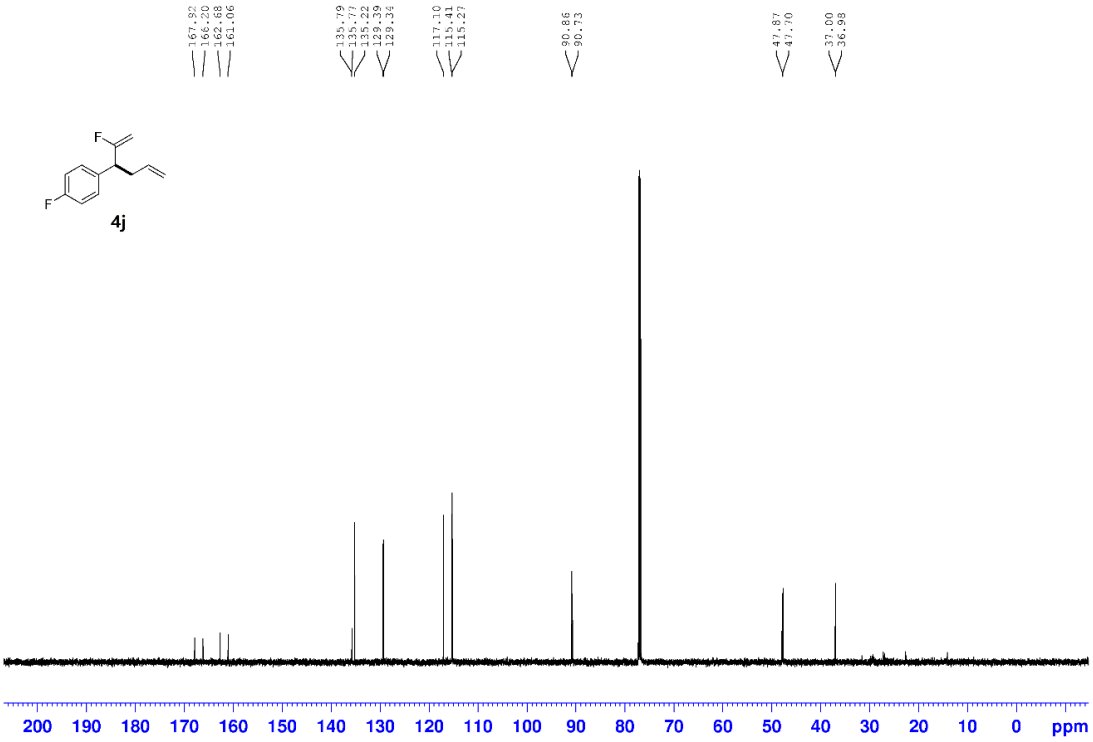
-99.49
-180
-160
-140
-120
-100
-80
-60
-40
ppm

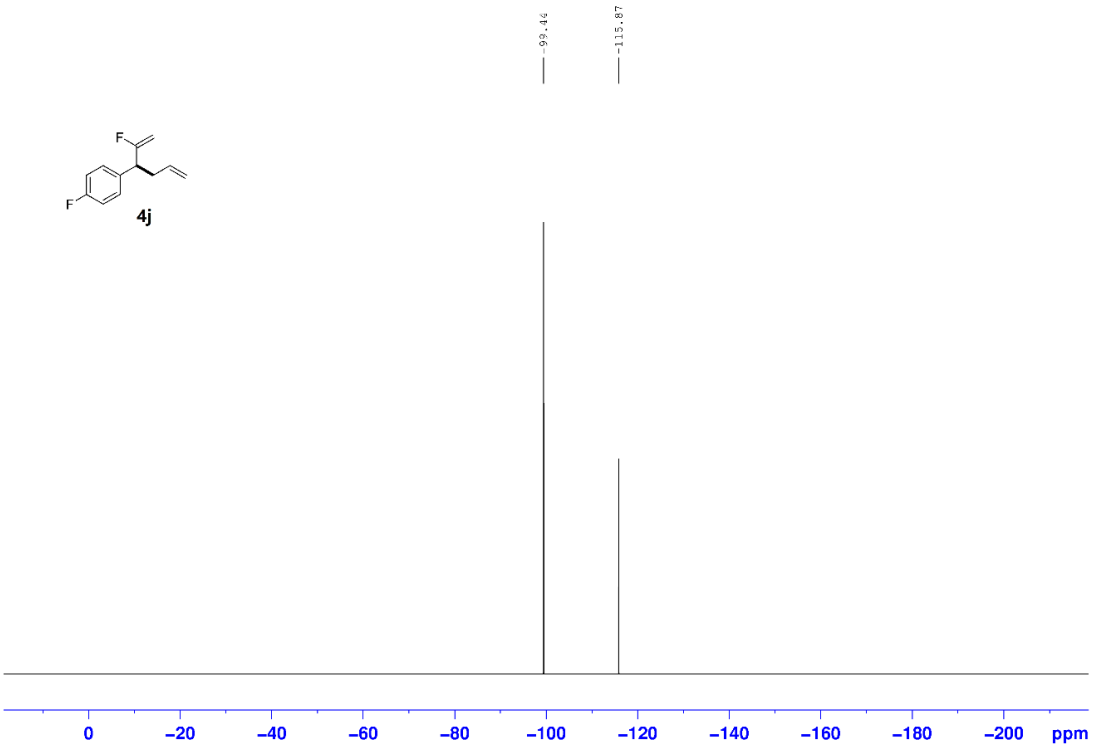


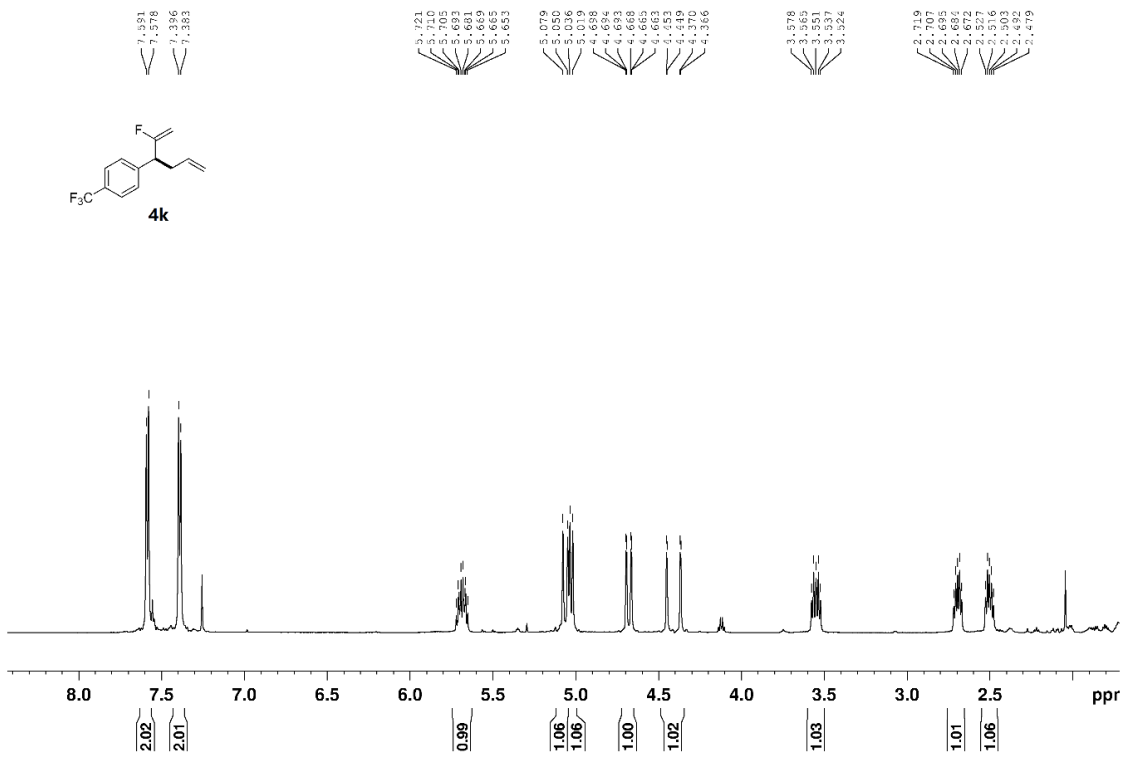

F
F

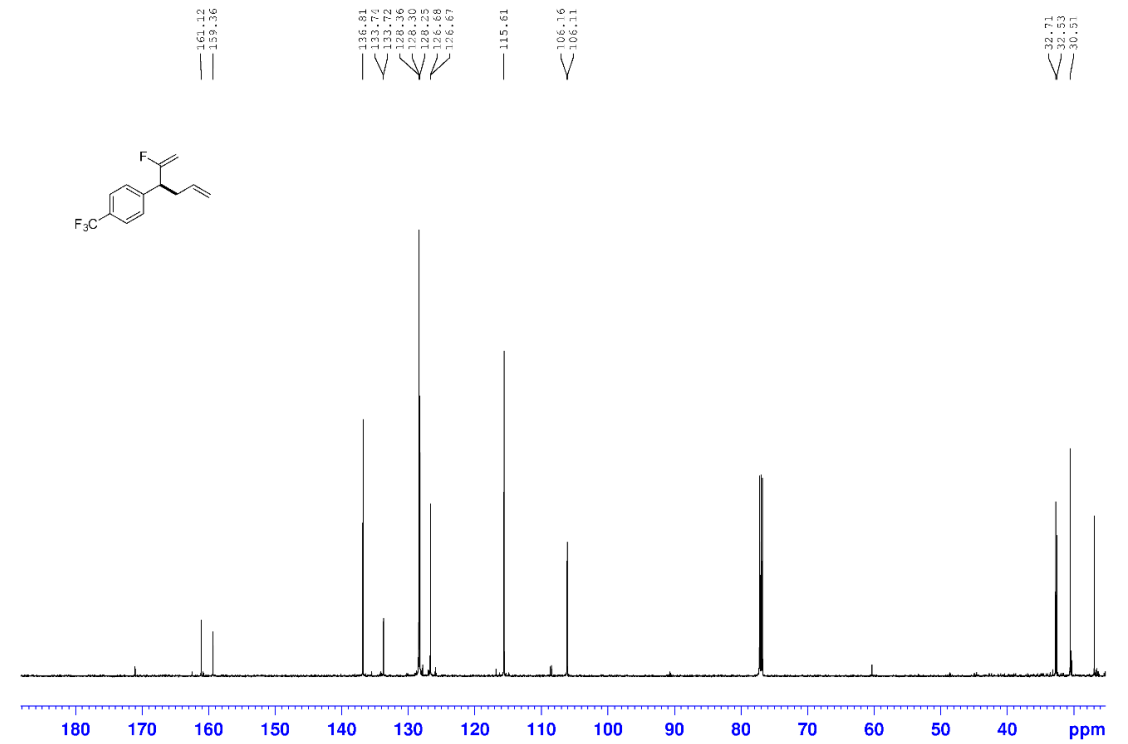
4j

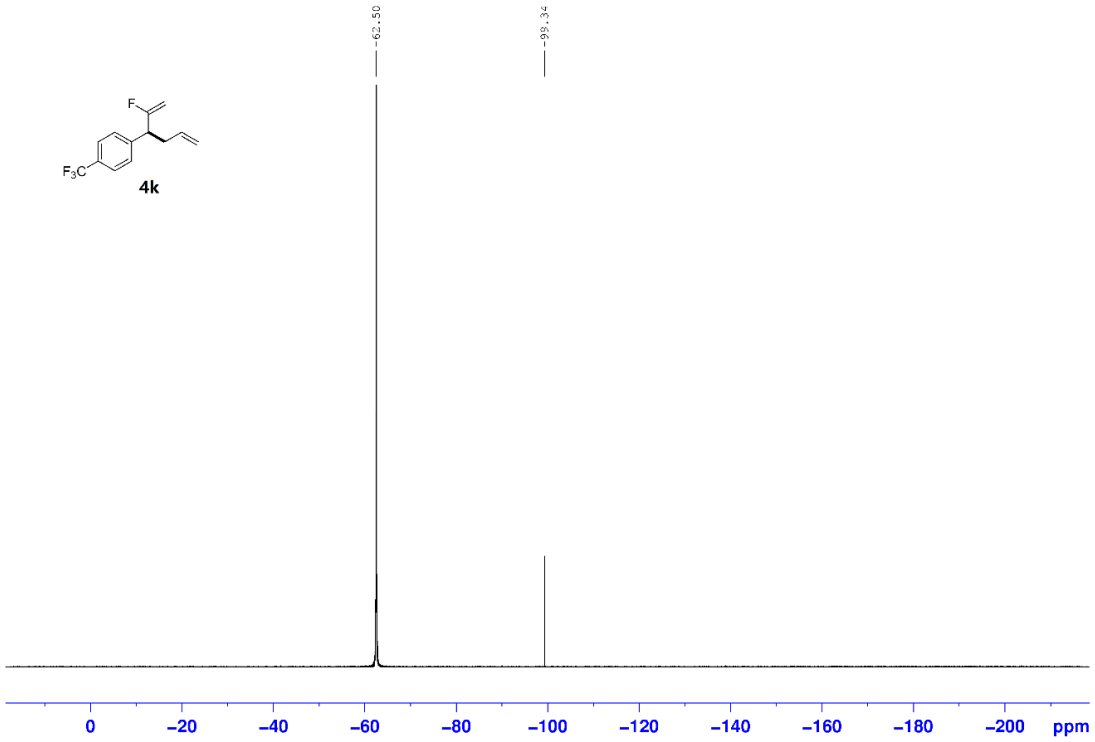

10
9
8
7
6
5
4
3
2
1
0
ppr
1.97
2.02
0.97
1.02
0.98
0.98
1.00
0.99
1.01
1.03

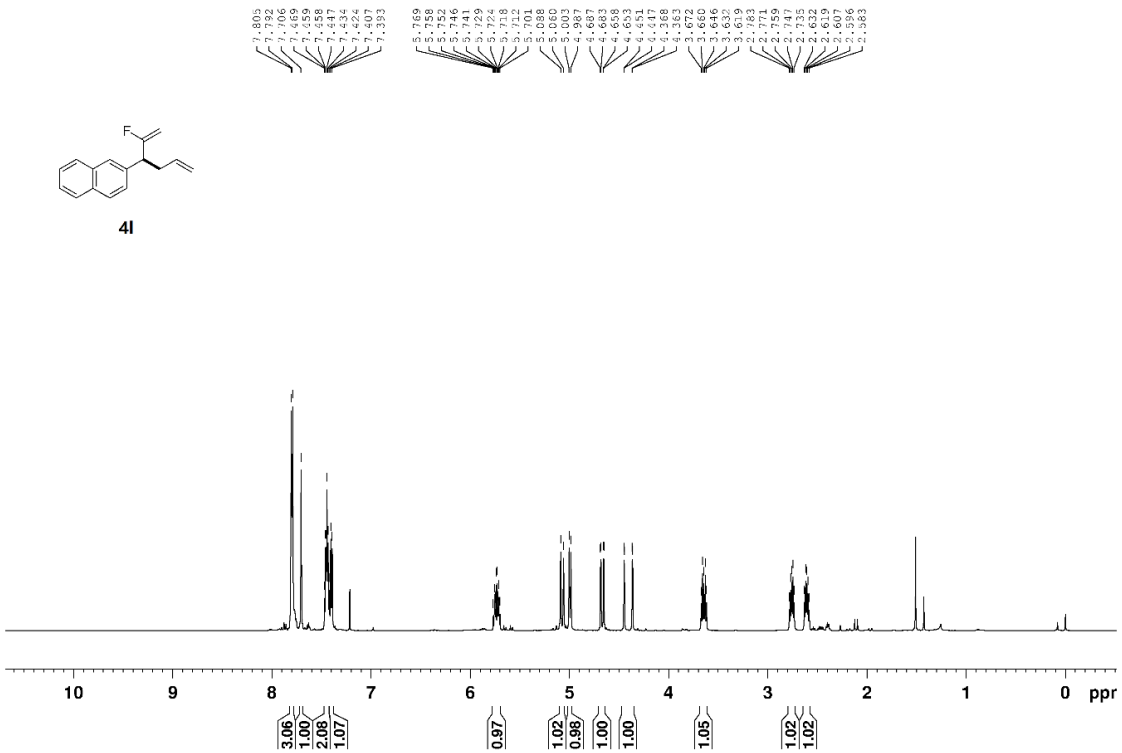

167.92
166.20
162.68
161.06
135.79
135.72
135.22
129.39
129.36
117.10
115.41
115.27
90.86
90.73
47.87
47.70
37.00
36.98
F
F
4j
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

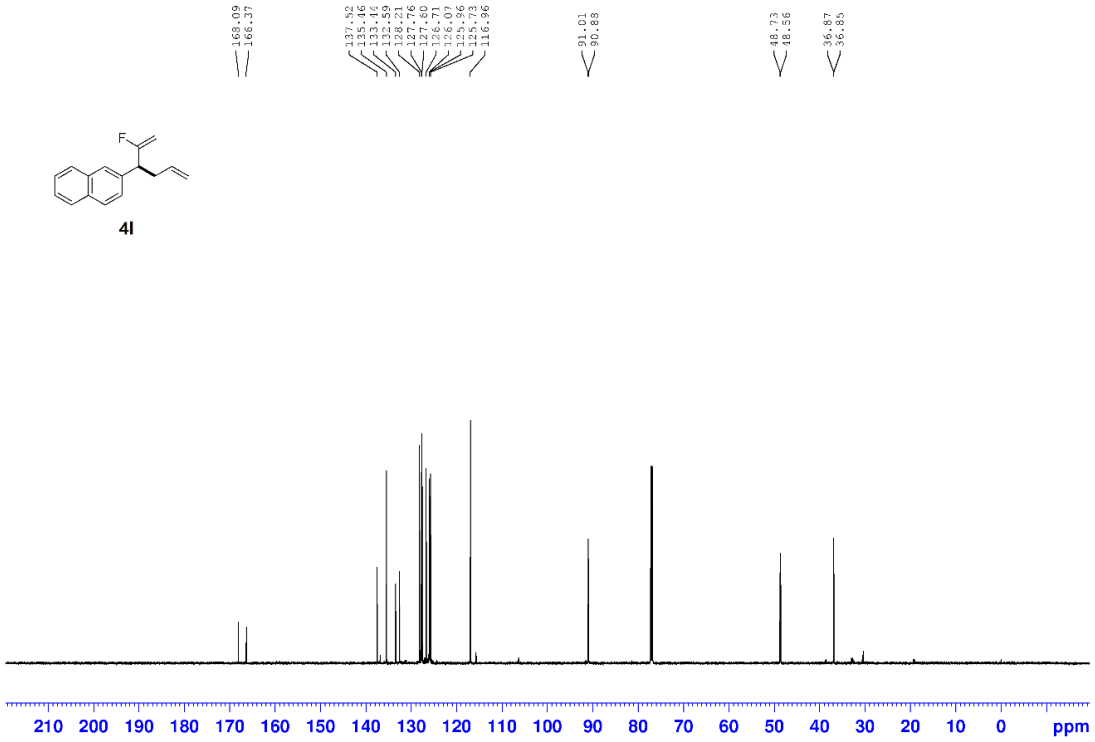

-99.44
-115.87
F
F
4j
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm

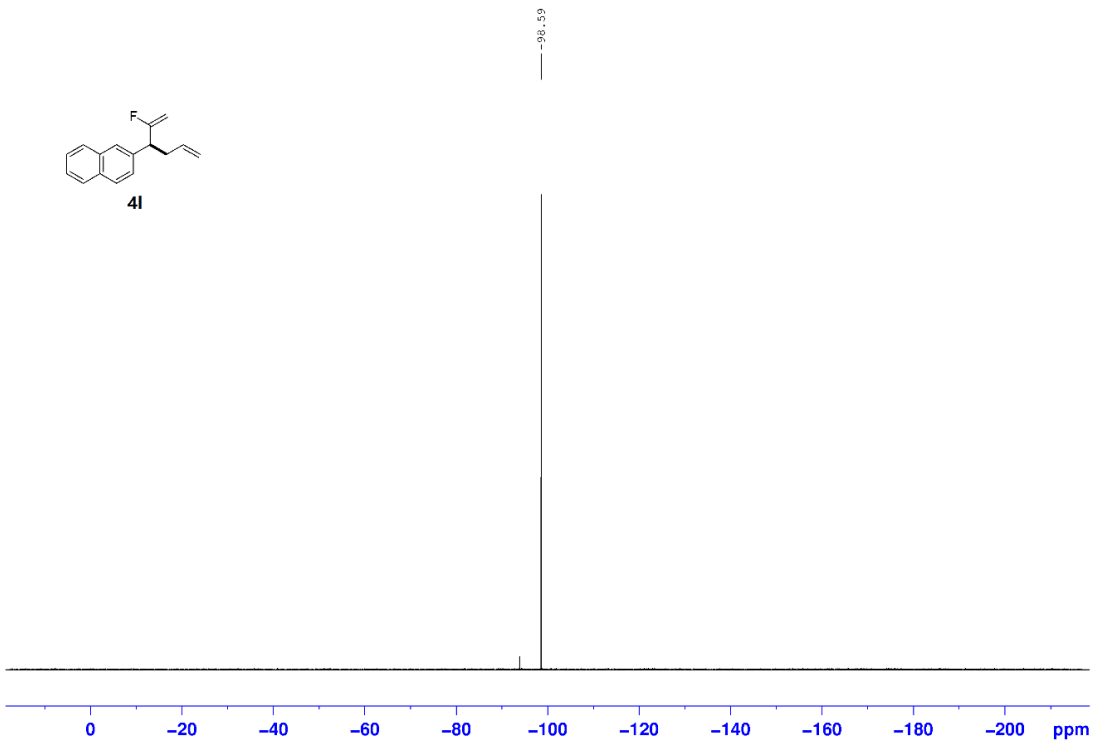

7.591
7.578
7.396
7.383
5.721
5.710
5.705
5.693
5.681
5.669
5.665
5.653
5.079
5.050
5.036
5.019
4.698
4.694
4.693
4.668
4.665
4.663
4.453
4.449
4.370
4.366
3.578
3.569
3.551
3.537
3.524
2.719
2.707
2.695
2.684
2.672
2.527
2.516
2.503
2.492
2.479
F
F3C
4k
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
ppr
2.02
2.01
0.99
1.06
1.06
1.00
1.02
1.03
1.01
1.06

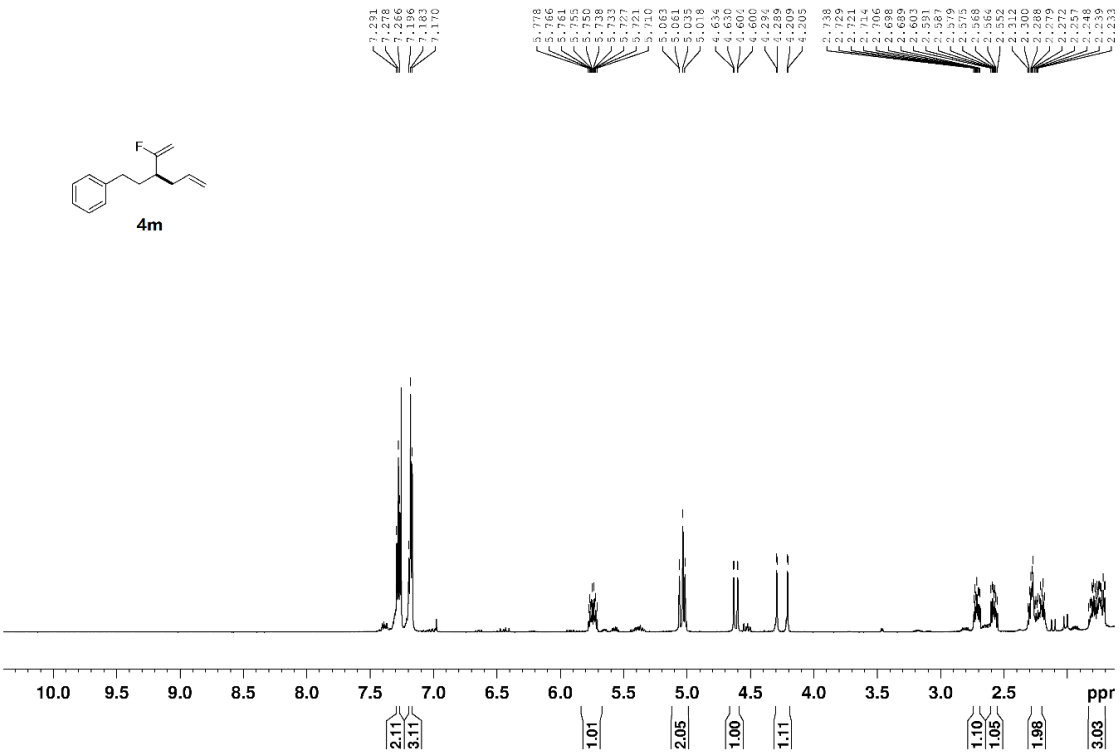

161.12
159.36
136.81
133.72
133.72
128.36
128.30
128.25
126.68
126.67
115.61
106.16
106.11
32.71
32.53
30.51
F
F3C
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
ppm

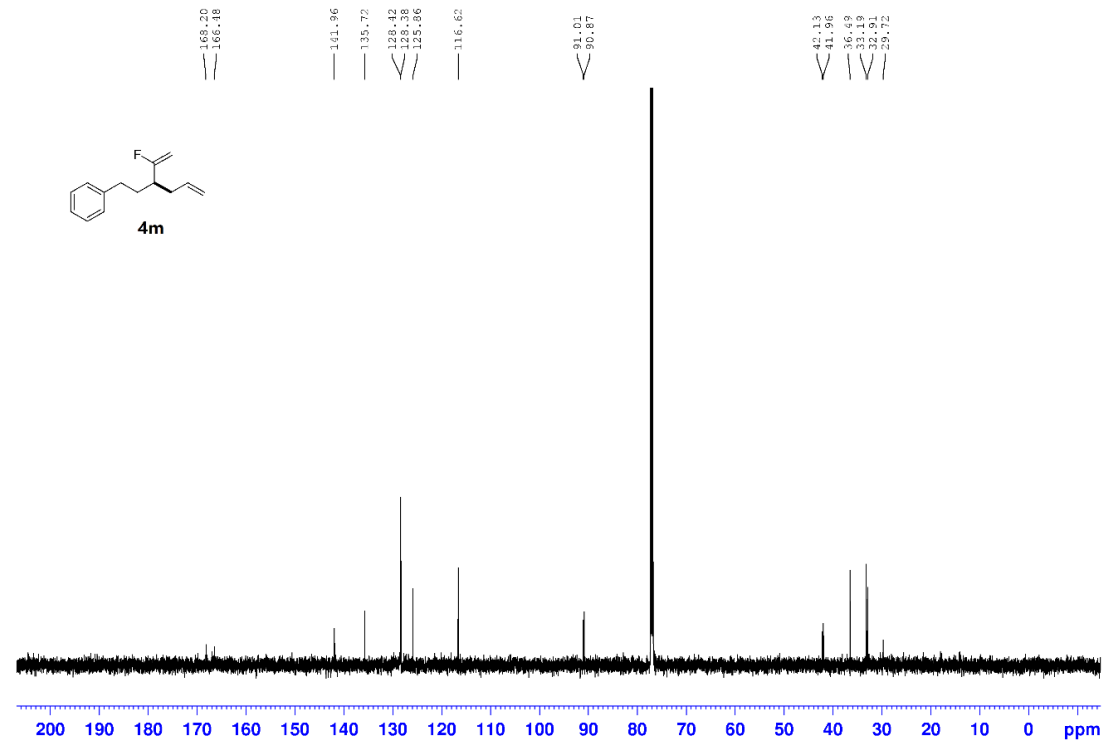

-62.50
-99.34
F
F3C
4k
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm

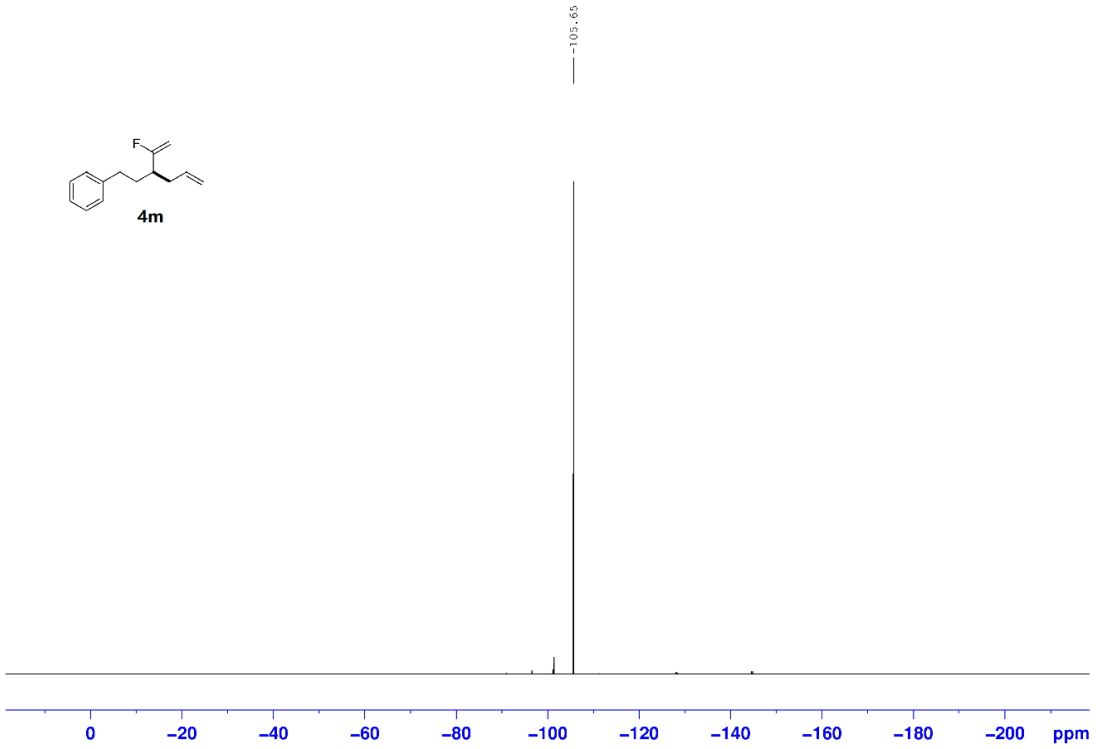

7.805
7.792
7.706
7.469
7.459
7.458
7.447
7.434
7.424
7.407
7.393
5.769
5.758
5.752
5.746
5.741
5.729
5.724
5.718
5.712
5.701
5.688
5.680
5.003
4.987
4.687
4.683
4.658
4.653
4.651
4.407
4.368
4.363
3.672
3.660
3.646
3.632
3.619
3.283
2.771
2.759
2.747
2.735
2.632
2.619
2.607
2.396
2.383
F
4l
10
9
8
7
6
5
4
3
2
1
0
ppm
3.06
1.00
2.08
1.07
0.97
1.02
0.98
1.00
1.00
1.05
1.02
1.02

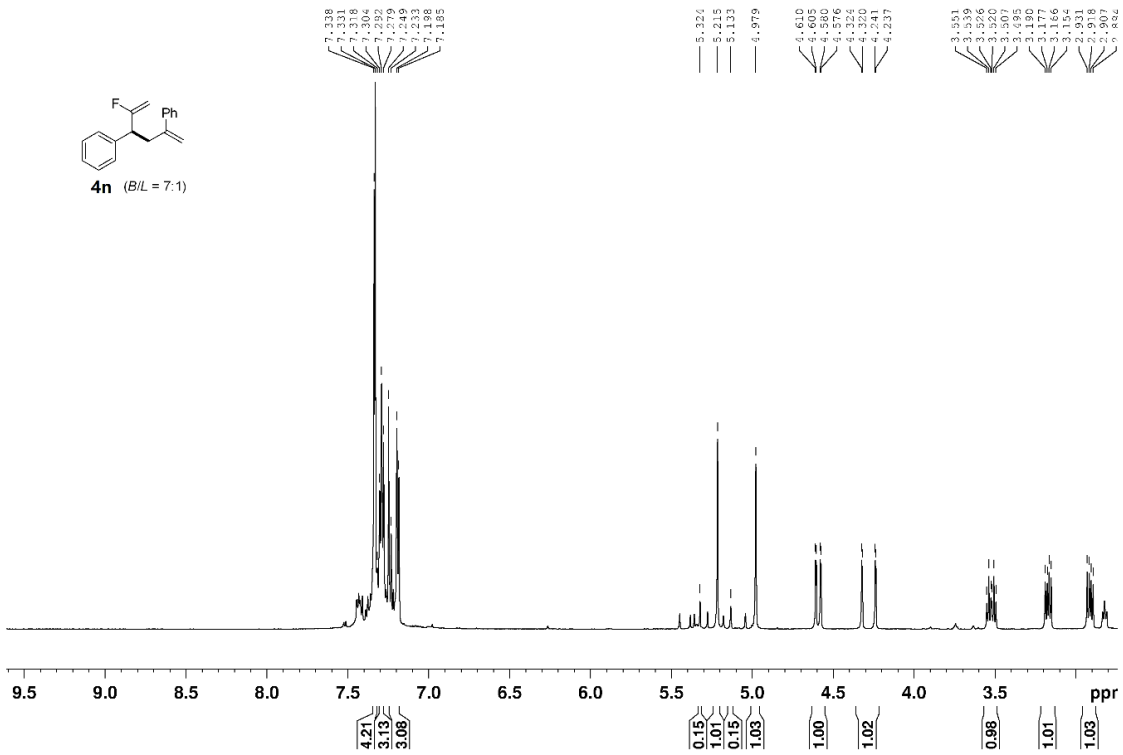

168.09
166.37
137.52
135.46
133.46
132.59
128.21
127.76
127.60
126.71
126.07
125.96
125.73
116.96
91.01
90.88
48.73
48.56
36.87
36.85
F
4l
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

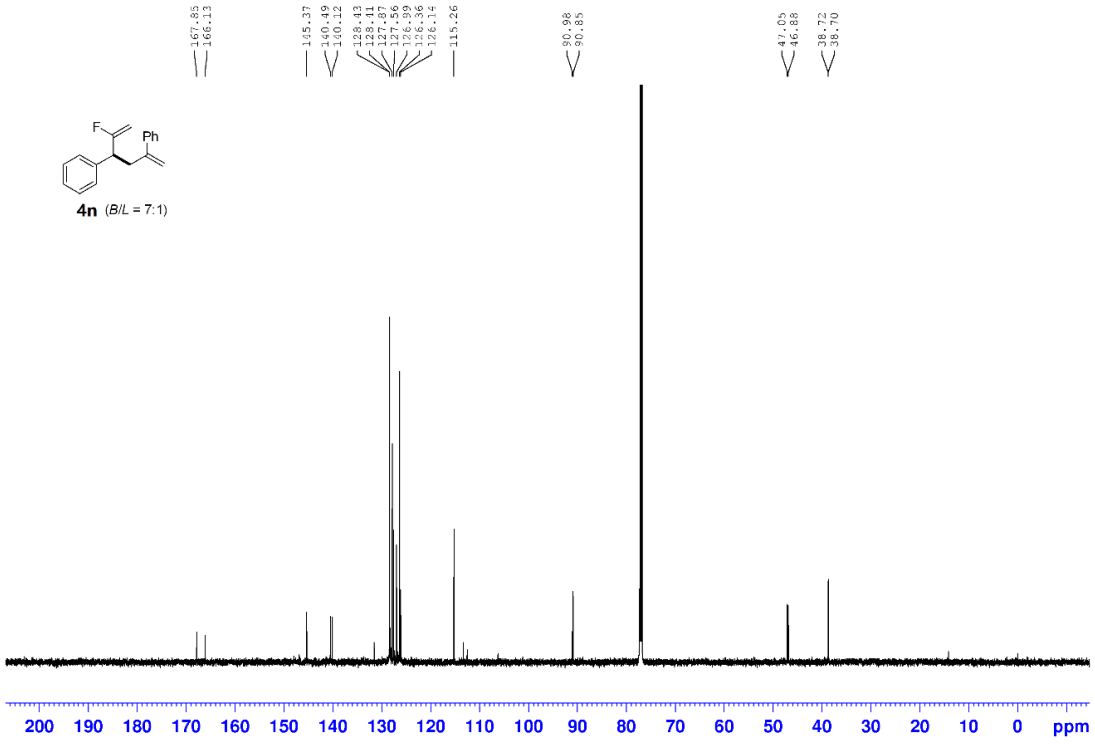

-98.59
F
4l
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm

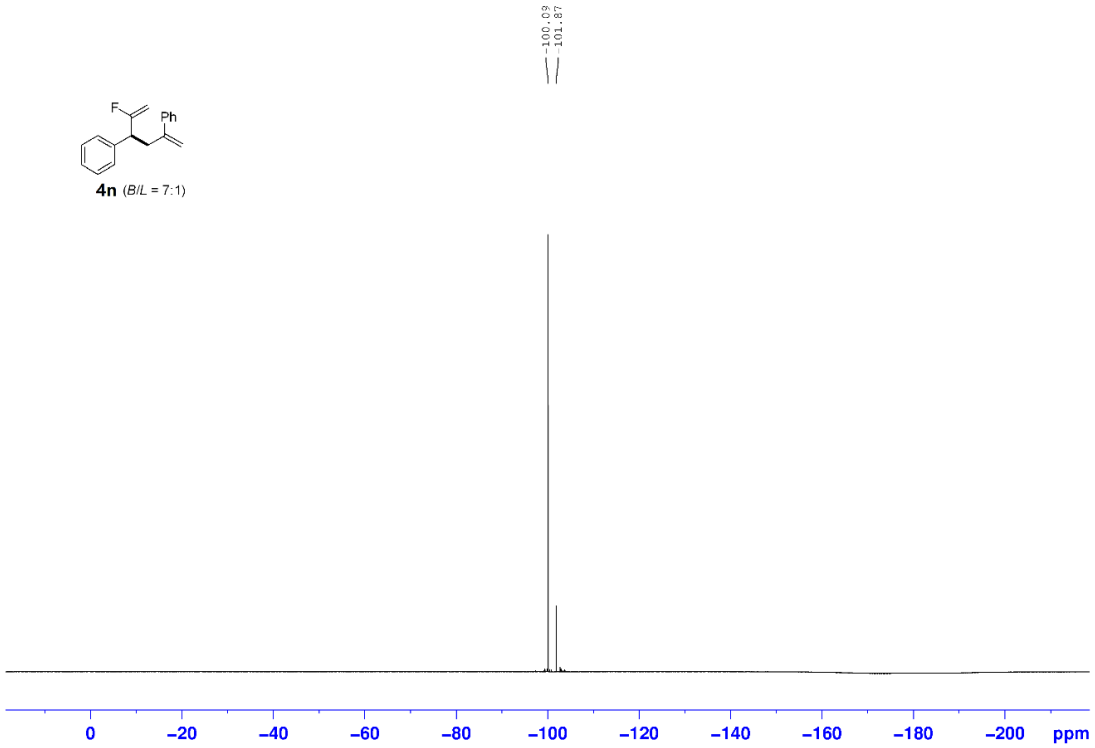

4m
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 ppr
2.11 3.11 1.01 2.05 1.00 1.11 1.10 1.05 1.98 3.03

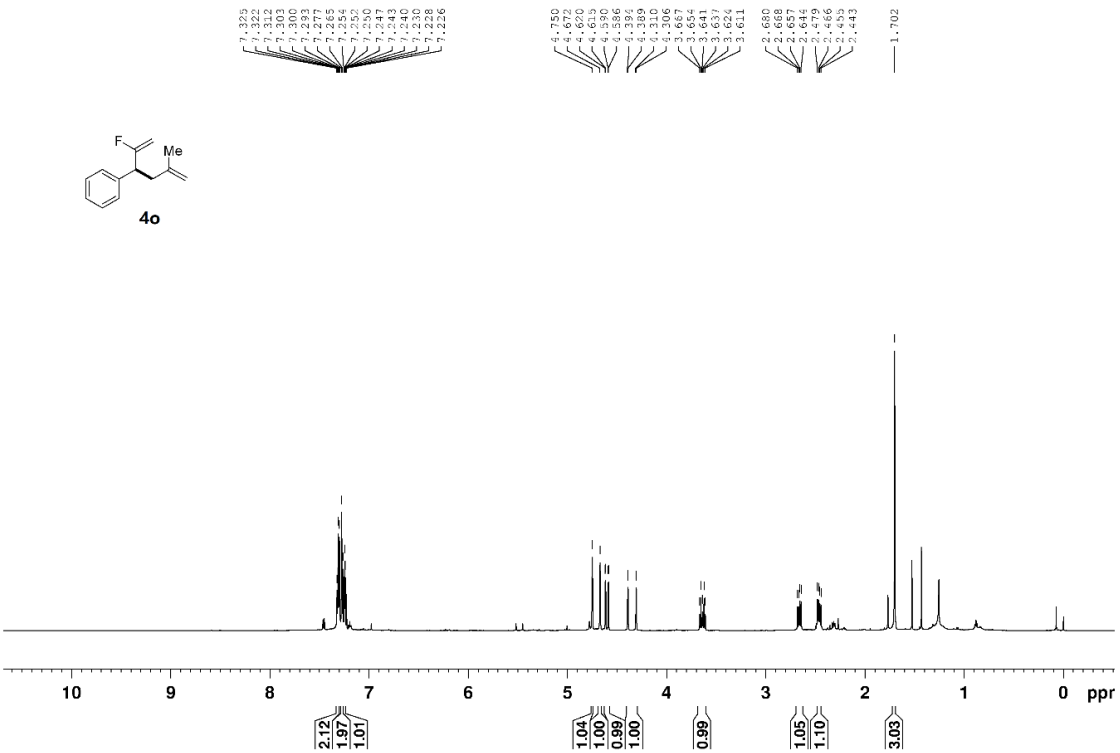

4m
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-105.65
F
4m
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
ppm


7.338
7.331
7.318
7.304
7.292
7.279
7.249
7.233
7.198
7.185
5.322
5.215
5.133
4.979
4.610
4.605
4.580
4.576
4.326
4.320
4.241
4.237
3.551
3.539
3.526
3.520
3.507
3.495
3.190
3.177
3.166
3.154
2.931
2.918
2.907
2.892
F
Ph
4n (B/L = 7:1)
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
ppr
4.21
3.13
3.08
0.15
1.01
0.15
1.03
1.00
1.02
0.98
1.01
1.03


167.85
166.13
145.37
140.49
140.12
128.43
128.11
127.87
127.56
126.99
126.36
126.15
115.26
90.98
90.85
47.05
46.88
38.72
38.70
F
Ph
4n (B/L = 7:1)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm


-100.09
-101.87
F
Ph
4n (B/L = 7:1)
0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 ppm


F
Me
4o
7.325
7.322
7.312
7.303
7.300
7.293
7.277
7.265
7.256
7.250
7.247
7.243
7.240
7.230
7.228
7.226
4.750
4.677
4.670
4.613
4.590
4.586
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4.310
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3.641
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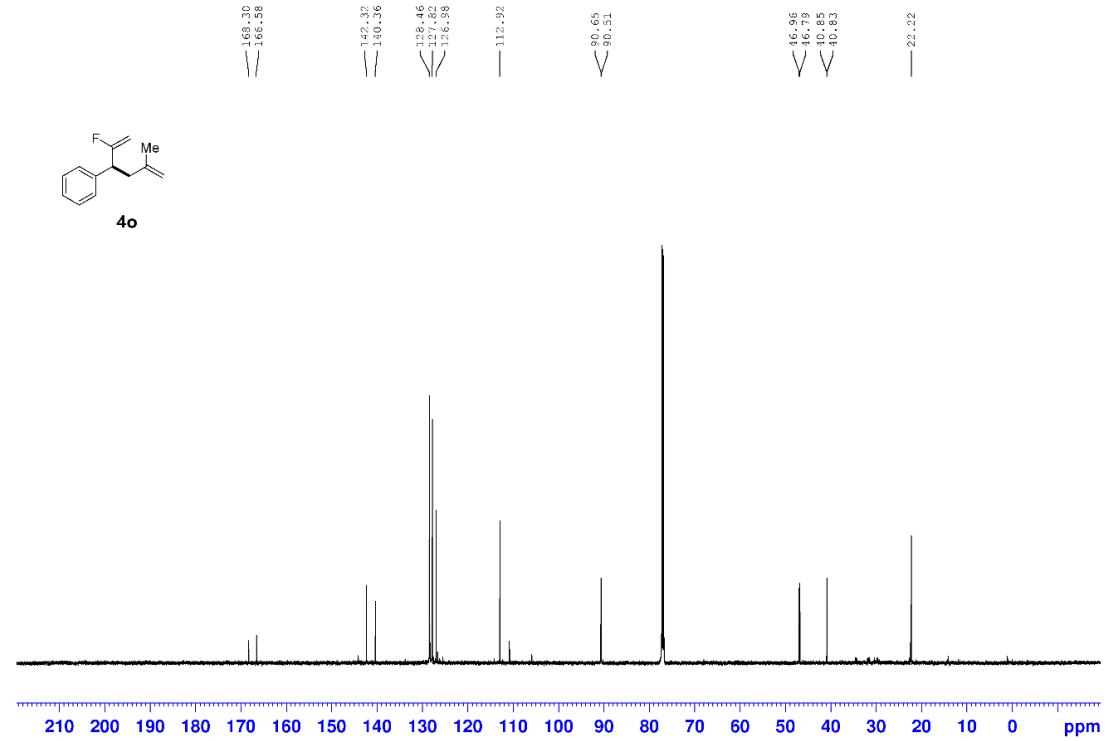
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22.22
F
Me
4o
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200
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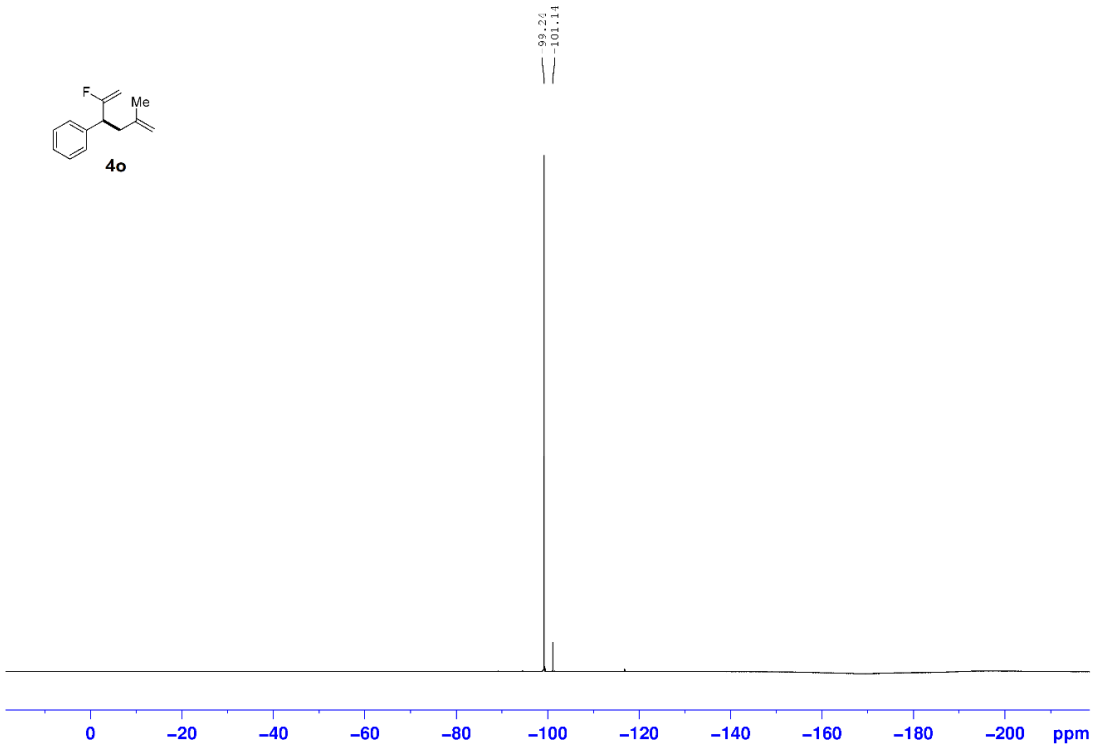
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