Supporting Information

Facile, general allylation of unactivated alkyl halides via electrochemically enabled radical-polar crossover

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1. General Information

Unless otherwise noted, all commercially available compounds were used as provided without further purification. Solvents for chromatography were HPLC grade. Anhydrous and degassed DMF used in reactions was purchased from Sigma-Aldrich in Sure/Seal™ bottle. Analytical thin-layer chromatography (TLC) was performed on Merck silica gel aluminium plates with F-254 indicator, visualized by irradiation with UV light. Column chromatography was performed on silica gel (particle size 0.043–0.063 mm) by using Interchim PuriFlash®430 automatic purification system. ^{1}H-NMR and ^{13}C-NMR were recorded on Bruker DRX-500 and AMX-400 instruments in CDCl3 and are reported relative to the solvent residual peaks. Data are reported in the following order: chemical shift (δ) in ppm; multiplicities are indicated s (singlet), bs (broad singlet), d (doublet), t (triplet), m (multiplet); coupling constants (*J*) are in Hertz (Hz). Cyclic voltammetry (CV) was performed on BioLogic Potentiostat SP-50. Mass spectra (EI-MS, 70 eV) were conducted on an Agilent 7890 gas chromatograph equipped with 5975C EIMSD Triple-Axis Detector using DB5MS and HP5MS columns. HRMS-ESI analysis was performed using a Thermo LTQ Velos Orbitrap mass spectrometer (Thermo Scientific, Pittsburgh, PA, USA) equipped with an ESI source. HRMS-EI analysis was performed using Agilent 7890 gas chromatograph equipped with JEOL AccuTOF GCx-plus EI source. For the electrocatalyzed reactions at constant current modes, Matsusada R4K36-0.1-L (230V) was used as power supply.

2. General Procedure

A dry 5-mL vial equipped with a Teflon-coated magnetic stir bar (10mm*3mm) was charged with allylic carbonate (0.2 mmol, 1 equiv., if solid) and TBAB (0.8 mmol, 4 equiv) in glovebox. Anhydrous and degassed DMA (4.0 mL), alkyl bromide (0.4 mmol, 2 equiv., if liquid), were added via syringe. Then, it was capped with a Teflon lid equipped with iron rod (4×50 mm) as the anode and nickel foam (20×10×1 mm) as the cathode. The reaction mixture was stirred and electrolyzed at a constant current of 4 mA under room temperature for 16 h. After the reaction is completed, the mixture was transferred to a 50 mL round bottom flask, electrodes were washed with ethyl acetate. Then H_2O (20 mL) was added and the mixture was extracted with EtOAc (20 mL) for three times. The combined organic layer was washed with H_2O (20 mL) and brine (20 mL). The organic layer was dried with anhydrous Na_2SO_4, then concentrated under vacuum. The product was purified by flash column chromatography on silica gel using hexane/EtOAc as eluent.

3. Synthesis of Allylic Carbonate

Methyl chloroformate (200 mol%) was added to a solution of allylic alcohol (100 mol %) and pyridine (300 mol %) in DCM (0.4 M) at 0 ^oC. The reaction mixture was warmed to room temperature, and stirred overnight, at which point it was washed with brine and extracted with ethyl acetate. The combined organic layer was washed with HCl (1N), dried over $MgSO_4$. Silica gel was added, and the solvent was removed under reduced pressure. The residue was loaded to a silica column. Flash chromatography provided the desired allylic carbonate.

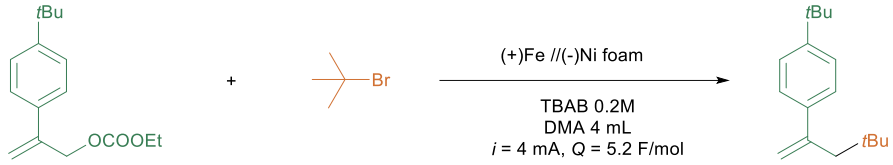
4. Preparation of Alkyl-Br

To a 50 mL sealed tube was added the corresponding alcohol (5 mmol, 1equiv), N-bromosuccinimide (NBS, 5 mmol, 1.0 equiv), triphenylphosphine (PPh_3, 5 mmol, 1.0 equiv), dry THF (40 mL) and magnetic stir bar. The tube was sealed and stirred at 60 ^oC for 12h. The reaction mixture was diluted with ethyl acetate (50 mL) and washed with water (30 mL×4). The organic layer was dried over Na_2SO_4. After filtration and evaporation of solvent under reduced pressure, the residue was purified by flash chromatography to afford the desired alkyl-Br.

5. Cyclic Voltammetry (CV) Measurements

All measurements were performed under anhydrous conditions in argon-filled glovebox. All supporting electrolytes were dried under dynamic vacuum (less than 0.1 mbar) over 24 h at 100 °C and stored inside the glovebox. The cell for the analysis was equipped with a glass vial (working volume is 10 mL) and Teflon cap, equipped with O-ring for tight sealing. Glassy carbon was used as a working electrode (circle, d = 3 mm), platinum wire as a counter electrode, and saturated calomel electrode (SCE) (CHI150 from CH Instruments, Inc.) as a reference electrode. All measurements were conducted in 0.1 M solutions of $^{n}Bu_4NPF_6$ in DMA. All analytic concentration was 10 mM. The scan rate was 100 mV/s.

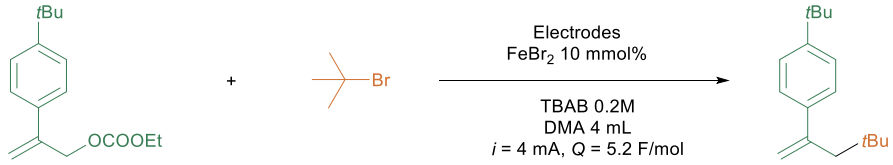
6. Control experiments



1a 2a 3a

Entry	Fe ion	Results
1	$FeBr_2$ 10%	64%
2	$FeBr_2$ 100%	60%
3	$FeBr_3$ 10%	62%

Figure S1. Control experiments with additional iron ions. The yield was detected with GC-FID.



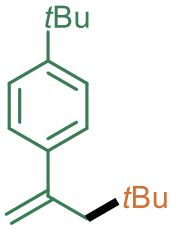
1a 2a 3a

Entry	Electrode	Results
1	RVC//Ni foam w/ TMEDA	11%
2	RVC//RVC w/ TMEDA	13%
3	Zn//Ni foam	27%

Figure S2. Control experiments. The yield was detected with GC-FID.

7. Spectroscopic Data of the Products

1-(*Tert*-butyl)-4-(4,4-dimethylpent-1-en-2-yl)benzene (3a)



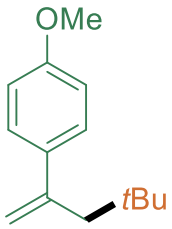
This compound was prepared according to General procedure, 30.0 mg, 65% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.31 (s, 4H), 5.25 (d, *J* = 2.1 Hz, 1H), 4.98 (d, *J* = 2.2 Hz, 1H), 2.46 (s, 2H), 1.32 (s, 9H), 0.81 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 149.83, 147.19, 140.52, 126.08, 124.91, 115.55, 48.68, 34.40, 31.70, 31.35, 30.10.

HRMS (EI) exact mass calculated for [M^+] ($C_{17}H_{26}^+$): m/z 230.20290; found: 230.20273.

1-(4,4-Dimethylpent-1-en-2-yl)-4-methoxybenzene (3b)



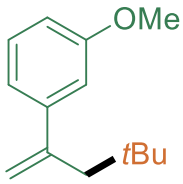
This compound was prepared according to General procedure, 29.0 mg, 71% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (d, *J* = 8.6 Hz, 2H), 6.84 (d, *J* = 8.6 Hz, 2H), 5.18 (d, *J* = 2.1 Hz, 1H), 4.93 (d, *J* = 2.1 Hz, 1H), 3.81 (s, 3H), 2.43 (s, 2H), 0.80 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.71, 146.86, 136.14, 127.55, 114.87, 113.41, 55.20, 48.87, 31.69, 30.09.

HRMS (EI) exact mass calculated for [M^+] ($C_{14}H_{20}O^+$): m/z 204.15087; found: 204.15019.

1-(4,4-Dimethylpent-1-en-2-yl)-3-methoxybenzene (3c)



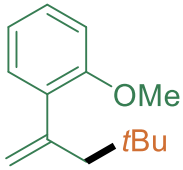
This compound was prepared according to General procedure, 25.7 mg, 63% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 (t, *J* = 7.9 Hz, 1H), 6.97 (d, *J* = 7.7 Hz, 1H), 6.92 (t, *J* = 2.1 Hz, 1H), 6.79 (dd, *J* = 8.1, 2.5 Hz, 1H), 5.25 (d, *J* = 2.0 Hz, 1H), 5.00 (d, *J* = 2.0 Hz, 1H), 3.82 (s, 3H), 2.44 (s, 2H), 0.80 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.34, 147.42, 145.25, 129.00, 119.17, 116.37, 112.53, 112.02, 55.19, 48.93, 31.73, 30.00.

HRMS (EI) exact mass calculated for [M^+] ($C_{14}H_{20}O^+$): m/z 204.15087; found: 204.15033.

1-(4,4-Dimethylpent-1-en-2-yl)-2-methoxybenzene (3d)



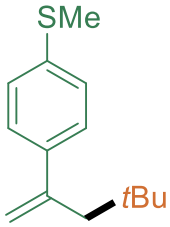
This compound was prepared according to General procedure, 19.2 mg, 47% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.24 – 7.20 (m, 1H), 7.17 (dd, *J* = 7.4, 1.7 Hz, 1H), 6.90 (t, *J* = 6.9 Hz, 1H), 6.84 (d, *J* = 8.1 Hz, 1H), 5.09 (d, *J* = 2.3 Hz, 1H), 5.07 (d, *J* = 2.5 Hz, 1H), 3.83 (s, 3H), 2.50 (s, 2H), 0.77 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 156.44, 147.29, 133.63, 130.26, 128.03, 120.49, 118.02, 110.64, 55.34, 49.88, 31.63, 29.87.

HRMS (EI) exact mass calculated for [M^+] ($C_{14}H_{20}O^+$): m/z 204.15087; found: 204.15091.

(4-(4,4-Dimethylpent-1-en-2-yl)phenyl)(methyl)sulfane (3e)



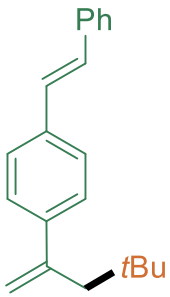
This compound was prepared according to General procedure, 33.9 mg, 77% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (d, *J* = 8.5 Hz, 2H), 7.19 (d, *J* = 8.4 Hz, 2H), 5.23 (d, *J* = 2.0 Hz, 1H), 4.98 (s, 1H), 2.48 (s, 3H), 2.44 (s, 2H), 0.80 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 146.80, 140.54, 136.82, 126.94, 126.31, 115.93, 48.70, 31.73, 30.06, 15.87.

HRMS (EI) exact mass calculated for [M^+] ($C_{14}H_{20}S^+$): m/z 220.12802; found: 220.12902.

(2-(4-(*Tert*-butyl) phenyl) allyl) trimethylgermane (3f)



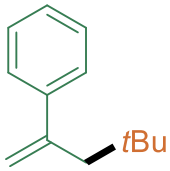
This compound was prepared according to General procedure, 24.3 mg, 44% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.45 (m, 4H), 7.40 – 7.34 (m, 4H), 7.28-7.24 (m, 1H), 7.11 (s, 2H), 5.30 (d, *J* = 2.0 Hz, 1H), 5.03 (d, *J* = 1.9 Hz, 1H), 2.48 (s, 2H), 0.82 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 147.08, 142.97, 137.44, 136.04, 128.70, 128.40, 128.31, 127.56, 126.85, 126.49, 126.34, 116.27, 48.71, 31.81, 30.11.

HRMS (EI) exact mass calculated for [M^+] ($C_{21}H_{24}^+$): m/z 276.18725; found: 276.18790.

(4,4-Dimethylpent-1-en-2-yl)benzene (3g)



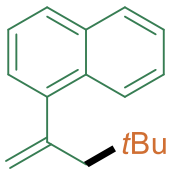
This compound was prepared according to General procedure, 17.8 mg, 51% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.37 (d, *J* = 7.0 Hz, 2H), 7.29 (t, *J* = 7.5 Hz, 2H), 7.25 – 7.21 (m, 1H), 5.24 (d, *J* = 2.0 Hz, 1H), 5.01 (s, 1H), 2.47 (s, 2H), 0.80 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 147.58, 143.69, 128.07, 126.90, 126.53, 116.27, 48.89, 31.73, 30.04.

HRMS (EI) exact mass calculated for [M^+] ($C_{13}H_{18}^+$): m/z 174.14030; found: 174.14040.

1-(4,4-Dimethylpent-1-en-2-yl)naphthalene (3h)



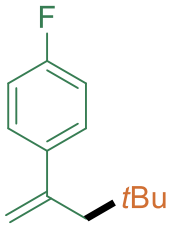
This compound was prepared according to General procedure, 25.1 mg, 56% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.20 (dd, *J* = 8.2, 1.7 Hz, 1H), 7.87 – 7.83 (m, 1H), 7.74 (d, *J* = 6.9 Hz, 1H), 7.51 – 7.45 (m, 2H), 7.45 – 7.37 (m, 2H), 5.42 (d, *J* = 2.4 Hz, 1H), 5.25 (d, *J* = 2.4 Hz, 1H), 2.61 (s, 2H), 0.83 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 146.58, 142.61, 133.96, 130.99, 128.38, 126.98, 126.16, 125.56, 125.43, 125.20, 125.07, 119.51, 52.34, 32.11, 29.90.

HRMS (EI) exact mass calculated for [M^+] ($C_{17}H_{20}^+$): m/z 224.15595; found: 224.15700.

1-(4,4-Dimethylpent-1-en-2-yl)-4-fluorobenzene (3i)



This compound was prepared according to General procedure, 21.2 mg, 55% yield as colorless oil.

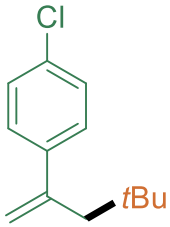
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (dd, *J* = 8.5, 5.6 Hz, 2H), 6.98 (t, *J* = 8.7 Hz, 2H), 5.20 (s, 1H), 5.00 (s, 1H), 2.43 (s, 2H), 0.79 (s, 9H).

^{19}F NMR (471 MHz, $CDCl_3$) δ -116.11.

^{13}C NMR (101 MHz, $CDCl_3$) δ 162.03 (d, *J* = 245.5 Hz), 146.54, 139.69 (d, *J* = 3.3 Hz), 128.00 (d, *J* = 7.9 Hz), 116.26, 114.88 (d, *J* = 21.2 Hz), 49.06, 31.73, 30.03.

HRMS (EI) exact mass calculated for [M^+] ($C_{13}H_{17}F^+$): m/z 192.13088; found: 192.13135.

1-Chloro-4-(4,4-dimethylpent-1-en-2-yl)benzene (3j)



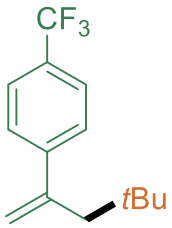
This compound was prepared according to General procedure, 21.3 mg, 51% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.29 (m, 2H), 7.29 – 7.25 (m, 2H), 5.24 (d, *J* = 1.9 Hz, 1H), 5.03 (s, 1H), 2.44 (s, 2H), 0.80 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 146.42, 142.14, 132.69, 128.24, 127.81, 116.81, 48.84, 31.76, 30.02.

HRMS (EI) exact mass calculated for [M^+] ($C_{13}H_{17}Cl^+$): m/z 208.10133; found: 208.10230.

1-(4,4-Dimethylpent-1-en-2-yl)-4-(trifluoromethyl)benzene (3k)



This compound was prepared according to General procedure, 20.8 mg, 43% yield as colorless oil.

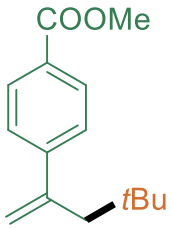
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.55 (d, *J* = 9.4 Hz, 2H), 7.48 (d, *J* = 8.1 Hz, 2H), 5.31 (s, 1H), 5.11 (s, 1H), 2.48 (s, 2H), 0.80 (s, 9H).

^{19}F NMR (471 MHz, CDCl3) δ -62.38.

^{13}C NMR (126 MHz, $CDCl_3$) δ 147.33, 146.50, 129.01 (q, *J* = 32.5 Hz), 126.77, 125.11 (q, *J* = 3.8 Hz), 124.28 (q, *J* = 270.7 Hz), 118.17, 48.80, 31.82, 30.00.

HRMS (EI) exact mass calculated for [M^+] ($C_{14}H_{17}F_3^+$): m/z 242.12769; found: 242.12689.

Methyl 4-(4,4-dimethylpent-1-en-2-yl)benzoate (3l)



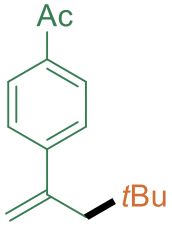
This compound was prepared according to General procedure, 28.8 mg, 62% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 8.4 Hz, 2H), 7.44 (d, *J* = 8.3 Hz, 2H), 5.32 (d, *J* = 1.8 Hz, 1H), 5.10 (s, 1H), 3.91 (s, 3H), 2.48 (s, 2H), 0.78 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 167.01, 148.39, 146.80, 129.51, 128.59, 126.48, 118.05, 52.02, 48.74, 31.80, 29.97.

HRMS (EI) exact mass calculated for [M^+] ($C_{15}H_{20}O_2^+$): m/z 232.14578; found: 232.14690.

1-(4-(4,4-Dimethylpent-1-en-2-yl)phenyl)ethan-1-one (3m)



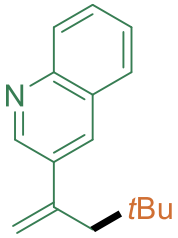
This compound was prepared according to General procedure, 16.4 mg, 38% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.3 Hz, 2H), 7.46 (d, *J* = 8.3 Hz, 2H), 5.33 (d, *J* = 1.7 Hz, 1H), 5.11 (d, *J* = 1.7 Hz, 1H), 2.59 (s, 3H), 2.48 (s, 2H), 0.79 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 197.71, 148.56, 146.70, 135.67, 128.35, 126.64, 118.22, 48.69, 31.81, 29.97, 26.57.

HRMS (EI) exact mass calculated for [M^+] ($C_{15}H_{20}O^+$): m/z 216.15087; found: 216.15033.

3-(4,4-Dimethylpent-1-en-2-yl)quinoline (3n)



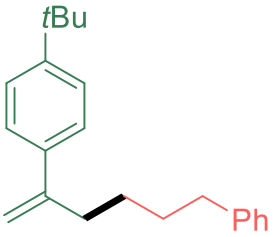
This compound was prepared according to General procedure, 15.8 mg, 35% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.99 (d, *J* = 2.2 Hz, 1H), 8.09 (d, *J* = 9.0 Hz, 2H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.67 (t, *J* = 7.6 Hz, 1H), 7.54 (d, *J* = 15.0 Hz, 1H), 5.45 (d, *J* = 1.5 Hz, 1H), 5.22 (s, 1H), 2.59 (s, 2H), 0.83 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 149.67, 147.13, 144.32, 136.21, 132.36, 129.09, 129.02, 127.88, 127.70, 126.80, 118.65, 48.70, 31.90, 30.09.

HRMS (EI) exact mass calculated for [M^+] ($C_{16}H_{19}N^+$): m/z 225.15120; found: 225.15211.

1-(*Tert*-butyl)-4-(6-phenylhex-1-en-2-yl)benzene (4a)



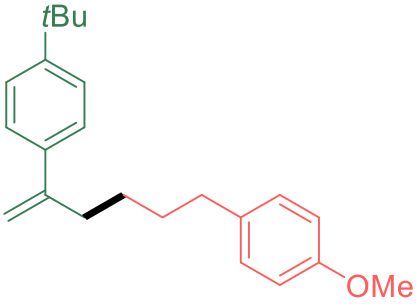
This compound was prepared according to General procedure, 33.3 mg, 57% yield as colorless oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34 (s, 4H), 7.28 – 7.25 (m, 2H), 7.19 – 7.14 (m, 3H), 5.26 (d, *J* = 1.6 Hz, 1H), 5.01 (t, *J* = 1.4 Hz, 1H), 2.61 (t, *J* = 7.8 Hz, 2H), 2.53 (t, *J* = 7.6 Hz, 2H), 1.70 – 1.63 (m, 2H), 1.52 (d, *J* = 7.7 Hz, 2H), 1.33 (s, 9H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 150.22, 148.03, 142.68, 138.28, 128.36, 128.22, 125.68, 125.58, 125.12, 111.51, 35.72, 35.03, 34.46, 31.32, 31.11, 27.93.

HRMS (EI) exact mass calculated for [M^+] ($C_{22}H_{28}^+$): m/z 292.21855; found: 292.21773.

1-(*Tert*-butyl)-4-(6-(4-methoxyphenyl)hex-1-en-2-yl)benzene (4b)



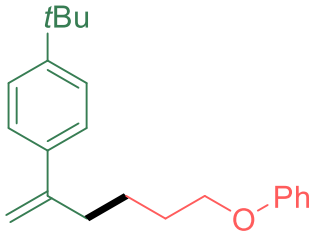
This compound was prepared according to General procedure, 31.6 mg, 49% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 (s, 4H), 7.08 (d, *J* = 8.3 Hz, 2H), 6.82 (d, *J* = 8.3 Hz, 2H), 5.27 (s, 1H), 5.01 (s, 1H), 3.79 (s, 3H), 2.54 (dt, *J* = 16.2, 7.6 Hz, 4H), 1.68 – 1.57 (m, 2H), 1.52 (p, *J* = 7.7, 7.3 Hz, 2H), 1.34 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 157.60, 150.21, 148.05, 138.29, 134.78, 129.21, 125.68, 125.11, 113.64, 111.48, 55.23, 35.03, 34.76, 34.45, 31.35, 31.32, 27.87.

HRMS (EI) exact mass calculated for [M^+] ($C_{23}H_{30}O^+$): m/z 322.22912; found: 322.22809.

1-(*Tert*-butyl)-4-(6-phenoxyhex-1-en-2-yl)benzene (4c)



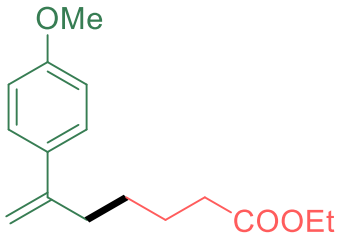
This compound was prepared according to General procedure, 51.2 mg, 83% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, *J* = 0.8 Hz, 4H), 7.29 (dd, *J* = 8.7, 7.3 Hz, 2H), 6.94 (tt, *J* = 7.3, 1.1 Hz, 1H), 6.91 – 6.87 (m, 2H), 5.31 (d, *J* = 1.5 Hz, 1H), 5.07 (d, *J* = 1.4 Hz, 1H), 3.97 (t, *J* = 6.5 Hz, 2H), 2.63 – 2.55 (m, 2H), 1.89 – 1.80 (m, 2H), 1.72 – 1.62 (m, 2H), 1.35 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.01, 150.28, 147.77, 138.09, 129.37, 125.69, 125.16, 120.45, 114.44, 111.76, 67.56, 34.87, 34.45, 31.31, 28.86, 24.66.

HRMS (EI) exact mass calculated for [M^+] ($C_{22}H_{28}O^+$): m/z 308.21347; found: 308.21215.

Ethyl 6-(4-methoxyphenyl)hept-6-enoate (4d)



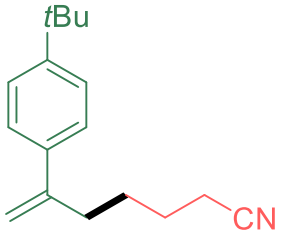
This compound was prepared according to General procedure, 22.0 mg, 42% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.4 Hz, 2H), 6.86 (d, *J* = 7.4 Hz, 2H), 5.20 (s, 1H), 4.97 (s, 1H), 4.11 (q, *J* = 7.1 Hz, 2H), 3.81 (s, 3H), 2.49 (t, *J* = 7.6 Hz, 2H), 2.29 (t, *J* = 7.5 Hz, 2H), 1.66 (p, *J* = 7.3 Hz, 2H), 1.48 (q, *J* = 8.3 Hz, 2H), 1.23 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 173.71, 158.98, 147.32, 133.51, 127.13, 113.60, 110.90, 60.19, 55.25, 35.00, 34.16, 27.69, 24.60, 14.21.

HRMS (EI) exact mass calculated for [M^+] ($C_{16}H_{22}O_3^+$): m/z 362.15635; found: 362.15627.

6-(4-(*Tert*-butyl)phenyl)hept-6-enenitrile (4e)



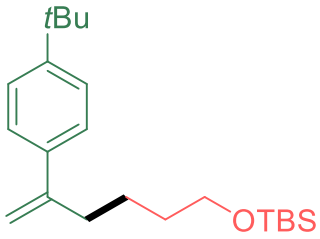
This compound was prepared according to General procedure, 29.5 mg, 61% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38 – 7.31 (m, 4H), 5.30 (s, 1H), 5.03 (s, 1H), 2.55 (t, *J* = 7.2 Hz, 2H), 2.33 (t, *J* = 7.0 Hz, 2H), 1.73 – 1.59 (m, 4H), 1.33 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 150.52, 146.99, 137.63, 125.64, 125.26, 119.67, 112.23, 34.46, 34.30, 31.27, 27.12, 24.90, 16.96.

HRMS (EI) exact mass calculated for [M^+] ($C_{17}H_{23}N^+$): m/z 241.18250; found: 241.18353.

***Tert*-butyl((5-(4-(tert-butyl)phenyl)hex-5-en-1-yl)oxy)dimethylsilane (4f)**



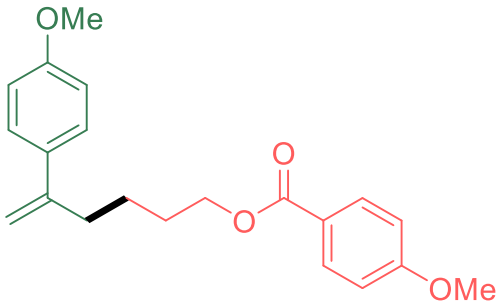
This compound was prepared according to General procedure, 42.3 mg, 61% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (s, 4H), 5.27 (d, *J* = 1.6 Hz, 1H), 5.02 (q, *J* = 1.4 Hz, 1H), 3.60 (t, *J* = 6.2 Hz, 2H), 2.51 (t, *J* = 6.8 Hz, 2H), 1.53 (dtt, *J* = 10.7, 5.1, 2.4 Hz, 4H), 1.32 (s, 9H), 0.88 (s, 9H), 0.03 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.17, 148.09, 138.25, 125.69, 125.10, 111.44, 63.00, 34.96, 34.44, 32.47, 31.31, 25.96, 24.47, 18.33, -5.28.

HRMS (EI) exact mass calculated for [M-CH_3^+] ($C_{21}H_{35}OSi^+$): m/z 331.24517; found: 331.24382.

5-(4-Methoxyphenyl)hex-5-en-1-yl 4-methoxybenzoate (4g)



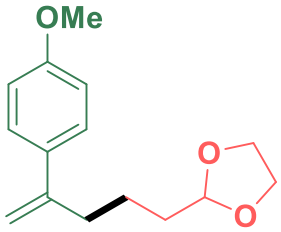
This compound was prepared according to General procedure, 49.7 mg, 73% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.9 Hz, 2H), 7.35 (d, *J* = 8.7 Hz, 2H), 6.90 (d, *J* = 8.6 Hz, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 5.22 (s, 1H), 5.00 (s, 1H), 4.30 – 4.25 (m, 2H), 3.86 (s, 3H), 3.81 (s, 3H), 2.56 (t, *J* = 7.5 Hz, 2H), 1.82 – 1.74 (m, 2H), 1.64 – 1.57 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.36, 163.21, 158.98, 147.30, 133.38, 131.50, 127.17, 122.84, 113.61, 113.50, 111.08, 64.41, 55.36, 55.20, 34.87, 28.21, 24.49.

HRMS (EI) exact mass calculated for [M^+] ($C_{21}H_{24}O_4^+$): m/z 340.16691; found: 340.16637.

2-(4-(4-Methoxyphenyl)pent-4-en-1-yl)-1,3-dioxolane (4h)



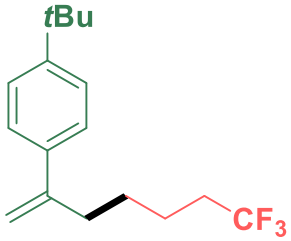
This compound was prepared according to General procedure, 26.3 mg, 53% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.6 Hz, 2H), 6.85 (d, *J* = 8.5 Hz, 2H), 5.21 (s, 1H), 4.99 (s, 1H), 4.84 (t, *J* = 4.7 Hz, 1H), 3.97 – 3.92 (m, 2H), 3.82 (d, *J* = 8.5 Hz, 5H), 2.52 (t, *J* = 7.6 Hz, 2H), 1.72 – 1.66 (m, 2H), 1.59 (q, *J* = 6.2, 5.0 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.97, 147.36, 133.58, 127.15, 113.60, 110.96, 104.48, 64.81, 55.25, 35.14, 33.41, 22.68.

HRMS (EI) exact mass calculated for [M^+] ($C_{15}H_{20}O_3^+$): m/z 248.14070; found: 248.14182.

1-(*Tert*-butyl)-4-(7,7,7-trifluorohept-1-en-2-yl)benzene (4i)



This compound was prepared according to General procedure, 31.3 mg, 55% yield as colorless oil.

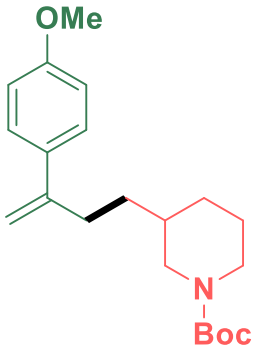
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.38 – 7.31 (m, 4H), 5.29 (s, 1H), 5.02 (s, 1H), 2.57 – 2.50 (m, 2H), 2.13 – 2.01 (m, 2H), 1.63 – 1.55 (m, 3H), 1.54 – 1.50 (m, 1H), 1.33 (s, 9H).

^{19}F NMR (471 MHz, $CDCl_3$) δ -66.41.

^{13}C NMR (126 MHz, $CDCl_3$) δ 150.45, 147.35, 137.86, 127.18 (q, *J* = 278.8 Hz), 125.66, 125.23, 111.99, 34.81, 34.48, 33.57 (q, *J* = 28.4 Hz), 31.31, 31.30, 27.25, 21.50 (q, *J* = 3.1 Hz).

HRMS (EI) exact mass calculated for [M^+] ($C_{27}H_{23}F_3^+$): m/z 284.17464; found: 284.17443.

***Tert*-butyl 3-(3-(4-methoxyphenyl)but-3-en-1-yl)piperidine-1-carboxylate (4j)**



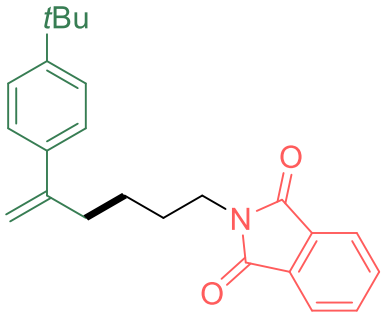
This compound was prepared according to General procedure, 31.8 mg, 46% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (d, *J* = 8.7 Hz, 2H), 6.86 (d, *J* = 8.7 Hz, 2H), 5.20 (s, 1H), 4.98 (s, 1H), 3.89 (dt, *J* = 13.2, 4.2 Hz, 1H), 3.81 (s, 3H), 2.75 (t, *J* = 12.1 Hz, 1H), 2.51 (t, *J* = 7.9 Hz, 2H), 1.82 (dd, *J* = 13.9, 4.2 Hz, 1H), 1.63 – 1.57 (m, 1H), 1.45 (s, 15H), 1.07 (q, *J* = 12.7, 11.9 Hz, 1H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.99, 154.88, 147.71, 133.47, 127.11, 113.62, 110.73, 79.17, 68.98, 64.09, 55.24, 49.48, 44.49, 35.62, 32.60, 31.01, 28.46.

HRMS (EI) exact mass calculated for [M^+] ($C_{21}H_{23}NO_3^+$): m/z 345.22985; found: 345.22891.

2-(5-(4-(*Tert*-butyl)phenyl)hex-5-en-1-yl)isoindoline-1,3-dione (4k)



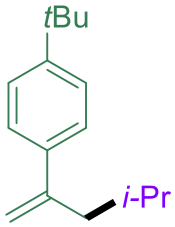
This compound was prepared according to General procedure, 36.9 mg, 51% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 7.4 Hz, 1H), 7.34 – 7.23 (m, 3H), 7.11 (d, *J* = 8.4 Hz, 2H), 6.84 (d, *J* = 8.4 Hz, 2H), 4.99 (d, *J* = 1.5 Hz, 1H), 4.82 (s, 1H), 4.29 – 4.19 (m, 2H), 3.93 (ddt, *J* = 12.0, 5.0, 1.8 Hz, 1H), 3.64 (d, *J* = 13.7 Hz, 1H), 3.26 (d, *J* = 13.8 Hz, 1H), 3.06 – 2.96 (m, 1H), 1.82 – 1.72 (m, 1H), 1.58 (ddq, *J* = 13.5, 4.3, 2.0 Hz, 1H), 1.26 (s, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.70, 149.92, 145.35, 142.62, 139.11, 131.93, 131.25, 129.21, 125.93, 124.73, 123.11, 122.34, 117.44, 90.01, 61.81, 37.02, 34.95, 34.34, 31.23, 24.77.

HRMS (EI) exact mass calculated for [M^+] ($C_{24}H_{27}NO_2^+$): m/z 361.20363; found: 361.20367.

1-(*Tert*-butyl)-4-(4-methylpent-1-en-2-yl)benzene (5a)



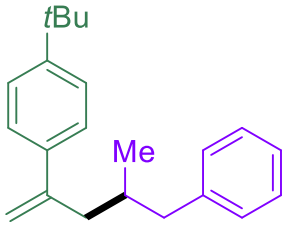
This compound was prepared according to General procedure, 20.8 mg, 48% yield as colorless oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34 (d, *J* = 1.0 Hz, 4H), 5.26 (d, *J* = 1.8 Hz, 1H), 4.98 (s, 1H), 2.37 (d, *J* = 7.2 Hz, 2H), 1.69 (dp, *J* = 13.6, 6.8 Hz, 1H), 1.32 (s, 9H), 0.88 (d, *J* = 6.6 Hz, 6H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 150.13, 147.37, 138.34, 125.84, 125.07, 112.70, 45.05, 34.44, 31.32, 26.33, 22.42.

HRMS (EI) exact mass calculated for [M^+] ($C_{16}H_{24}^+$): m/z 216.18725; found: 216.18825.

1-(*Tert*-butyl)-4-(4-methyl-5-phenylpent-1-en-2-yl)benzene (5b)



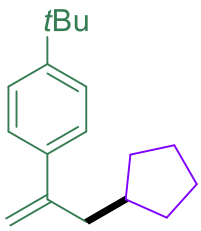
This compound was prepared according to General procedure, 32.2 mg, 55% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.32 (dd, *J* = 8.4, 1.8 Hz, 2H), 7.28 – 7.25 (m, 3H), 7.18 (ddd, *J* = 16.3, 8.1, 3.7 Hz, 2H), 7.10 (d, *J* = 7.5 Hz, 2H), 5.30 (s, 1H), 5.03 (s, 1H), 2.71 – 2.59 (m, 2H), 2.40 (ddd, *J* = 13.4, 8.1, 1.7 Hz, 1H), 2.26 (dd, *J* = 14.0, 8.5 Hz, 1H), 1.91 – 1.81 (m, 1H), 1.33 (s, 9H), 0.84 (d, *J* = 6.7 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 150.21, 147.04, 141.29, 138.04, 129.21, 128.06, 125.85, 125.67, 125.10, 113.10, 43.39, 42.75, 34.46, 33.28, 31.32, 19.32.

HRMS (EI) exact mass calculated for [M-CH_3^+] ($C_{21}H_{25}^+$): m/z 277.19508; found: 277.19455.

1-(*Tert*-butyl)-4-(3-cyclopentylprop-1-en-2-yl)benzene (5c)



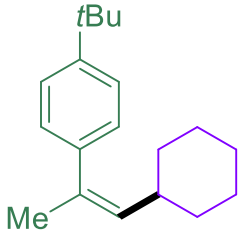
This compound was prepared according to General procedure, 28.1 mg, 58% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (s, 4H), 5.23 (d, *J* = 1.8 Hz, 1H), 5.00 (s, 1H), 2.49 (d, *J* = 7.4 Hz, 2H), 1.94 (hept, *J* = 7.6 Hz, 1H), 1.73 – 1.58 (m, 4H), 1.47 (dq, *J* = 8.6, 3.7 Hz, 2H), 1.32 (s, 9H), 1.16 (dt, *J* = 11.9, 7.3 Hz, 2H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.10, 147.93, 138.48, 125.77, 125.05, 112.00, 41.87, 38.11, 34.44, 32.44, 31.32, 25.05.

HRMS (EI) exact mass calculated for [M^+] ($C_{18}H_{26}^+$): m/z 242.20290; found: 242.20243.

(*Z*)-1-(*Tert*-butyl)-4-(1-cyclohexylprop-1-en-2-yl)benzene (5d)



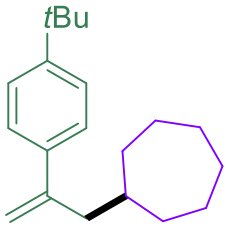
This compound was prepared according to General procedure, 28.2 mg, 55% yield as colorless oil, and the selective ratio is 1:18.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (s, 4H), 5.62 (dd, *J* = 9.1, 1.6 Hz, 1H), 2.35 (tdt, *J* = 10.7, 8.7, 5.8 Hz, 1H), 2.04 (d, *J* = 1.4 Hz, 3H), 1.78 – 1.65 (m, 5H), 1.32 (s, 11H), 1.23 – 1.10 (m, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 149.32, 141.04, 133.97, 132.32, 125.18, 125.00, 37.71, 34.37, 33.10, 31.34, 26.12, 26.02, 15.69.

HRMS (EI) exact mass calculated for [M^+] ($C_{19}H_{28}^+$): m/z 256.21855; found: 256.21728.

(2-(4-(*Tert*-butyl)phenyl)allyl)cycloheptane (5e)



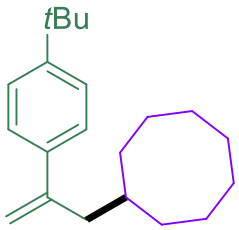
This compound was prepared according to General procedure, 20.6 mg, 38% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (s, 4H), 5.27 (s, 1H), 4.96 (s, 1H), 2.39 (d, *J* = 7.2 Hz, 2H), 1.71 (ddd, *J* = 13.8, 6.9, 3.2 Hz, 2H), 1.64 – 1.57 (m, 3H), 1.53 – 1.43 (m, 4H), 1.33 (d, *J* = 1.4 Hz, 11H), 1.22 – 1.14 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 150.08, 147.26, 138.38, 125.78, 125.07, 112.80, 43.87, 37.06, 34.45, 34.33, 31.33, 28.60, 26.13.

HRMS (EI) exact mass calculated for [M^+] ($C_{20}H_{30}^+$): m/z 270.23420; found: 270.23360.

(2-(4-(*Tert*-butyl)phenyl)allyl)cyclooctane (5f)



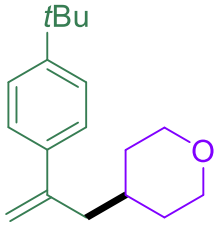
This compound was prepared according to General procedure, 22.8 mg, 40% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (s, 4H), 5.26 (s, 1H), 4.97 (s, 1H), 2.38 (d, *J* = 6.7 Hz, 2H), 1.65 – 1.62 (m, 4H), 1.53 – 1.49 (m, 2H), 1.48 – 1.40 (m, 4H), 1.34 – 1.25 (m, 14H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 150.08, 147.37, 138.43, 125.81, 125.07, 112.81, 43.64, 35.31, 34.45, 31.64, 31.33, 27.44, 26.07, 25.18.

HRMS (EI) exact mass calculated for [M^+] ($C_{21}H_{32}^+$): m/z 284.24985; found: 284.25092.

4-(2-(4-(*Tert*-butyl)phenyl)allyl)tetrahydro-2H-pyran (5g)



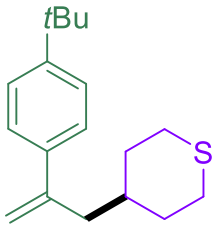
This compound was prepared according to General procedure, 31.5 mg, 61% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.31 (m, 4H), 5.30 (d, *J* = 1.7 Hz, 1H), 5.00 (d, *J* = 1.6 Hz, 1H), 3.91 (dd, *J* = 11.4, 4.4 Hz, 2H), 3.29 (td, *J* = 11.9, 2.1 Hz, 2H), 2.45 (d, *J* = 6.6 Hz, 2H), 1.63 – 1.57 (m, 3H), 1.33 (s, 11H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.37, 145.59, 137.86, 125.71, 125.21, 113.32, 67.96, 42.99, 34.47, 33.08, 33.02, 31.30.

HRMS (EI) exact mass calculated for [M^+] ($C_{18}H_{26}O^+$): m/z 258.19782; found: 258.19711.

4-(2-(4-(*Tert*-butyl)phenyl)allyl)tetrahydro-2*H*-thiopyran (5h)



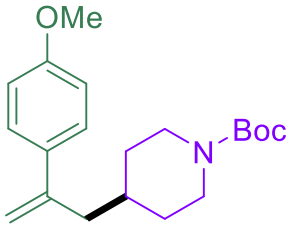
This compound was prepared according to General procedure, 36.2 mg, 66% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.29 (m, 4H), 5.30 (d, *J* = 1.7 Hz, 1H), 4.98 (s, 1H), 2.62 – 2.52 (m, 4H), 2.42 (d, *J* = 5.6 Hz, 2H), 2.01 (dt, *J* = 13.2, 2.9 Hz, 2H), 1.33 (s, 12H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.38, 145.59, 137.78, 125.71, 125.21, 113.53, 43.36, 35.08, 34.47, 34.00, 31.30, 28.60.

HRMS (EI) exact mass calculated for [M^+] ($C_{18}H_{26}S^+$): m/z 274.17497; found: 274.17596.

***Tert*-butyl 4-(2-(4-methoxyphenyl)allyl)piperidine-1-carboxylate (5i)**



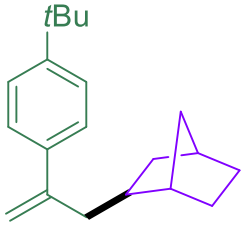
This compound was prepared according to General procedure, 34.5 mg, 52% yield as colorless oil, and the selective ratio is 1:1.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 2H), 6.85 (t, *J* = 8.3 Hz, 2H), 5.22 (d, *J* = 1.7 Hz, 1H), 4.94 (s, 1H), 4.06 (dd, *J* = 27.7, 13.2 Hz, 2H), 3.81 (d, *J* = 5.3 Hz, 3H), 2.87 – 2.75 (m, 1H), 2.57 (td, *J* = 13.4, 12.9, 2.7 Hz, 1H), 2.41 (d, *J* = 7.1 Hz, 1H), 2.04 (d, *J* = 1.4 Hz, 1H), 1.69 – 1.58 (m, 2H), 1.45 (d, *J* = 11.3 Hz, 9H), 1.33 (qd, *J* = 12.0, 4.2 Hz, 1H), 1.08 (qd, *J* = 12.4, 4.3 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.02, 158.54, 154.89, 154.81, 145.50, 136.06, 133.55, 133.31, 130.60, 127.22, 126.60, 113.64, 113.50, 112.54, 79.27, 55.26, 55.22, 43.86, 43.67, 42.72, 35.85, 34.19, 32.00, 31.93, 28.45, 28.43, 15.97.

HRMS (EI) exact mass calculated for [M^+] ($C_{20}H_{29}NO_3^+$): m/z 331.21420; found: 331.21381.

(1*S*,2*R*,4*R*)-2-(2-(4-(*Tert*-butyl)phenyl)allyl)bicyclo[*2.2.1*]heptane (5j)



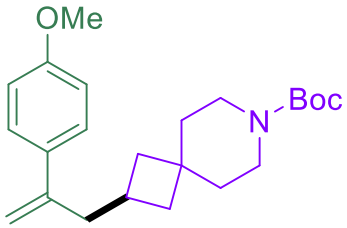
This compound was prepared according to General procedure, 30.6 mg, 57% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (s, 4H), 5.26 (d, *J* = 1.9 Hz, 1H), 4.98 (d, *J* = 1.5 Hz, 1H), 2.47 (ddd, *J* = 14.6, 7.5, 1.3 Hz, 1H), 2.25 (ddd, *J* = 14.6, 7.8, 1.2 Hz, 1H), 2.19 (d, *J* = 4.5 Hz, 1H), 2.04 – 2.00 (m, 1H), 1.51 – 1.42 (m, 2H), 1.33 (s, 12H), 1.09 (tq, *J* = 6.5, 2.3 Hz, 4H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 150.08, 147.01, 138.64, 125.74, 125.06, 112.23, 42.28, 40.86, 39.91, 37.79, 36.74, 35.31, 34.44, 31.32, 29.89, 28.81.

HRMS (EI) exact mass calculated for [M^+] ($C_{20}H_{28}^+$): m/z 268.21855; found: 268.21733.

***Tert*-butyl 2-(2-(4-methoxyphenyl)allyl)-7-azaspiro[*3.5*]nonane-7-carboxylate (5k)**



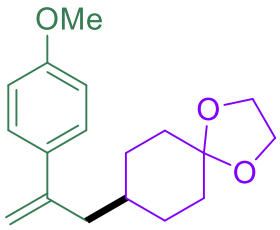
This compound was prepared according to General procedure, 49.0 mg, 66% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (d, *J* = 8.8 Hz, 2H), 6.85 (d, *J* = 8.9 Hz, 2H), 5.18 (s, 1H), 4.90 (s, 1H), 3.81 (s, 3H), 3.30 (t, *J* = 5.7 Hz, 2H), 3.25 (t, *J* = 5.8 Hz, 2H), 2.56 (d, *J* = 7.5 Hz, 2H), 2.38 (dt, *J* = 16.2, 8.2 Hz, 1H), 1.94 – 1.88 (m, 2H), 1.50 (t, *J* = 5.7 Hz, 2H), 1.44 (d, *J* = 1.1 Hz, 13H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.96, 154.97, 146.07, 133.79, 127.07, 113.54, 110.90, 79.12, 55.23, 43.49, 39.67, 37.88, 36.34, 33.87, 28.44, 27.22.

HRMS (EI) exact mass calculated for [M^+] ($C_{23}H_{33}NO_3^+$): m/z 371.24550; found: 371.24498.

8-(2-(4-methoxyphenyl)allyl)-1,4-dioxaspiro[*4.5*]decane (5l)



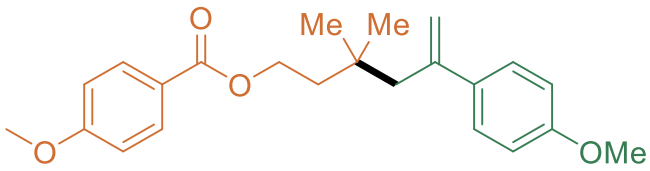
This compound was prepared according to General procedure, 46.7 mg, 81% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.7 Hz, 2H), 6.86 (d, *J* = 8.8 Hz, 2H), 5.21 (d, *J* = 1.7 Hz, 1H), 4.93 (d, *J* = 1.8 Hz, 1H), 3.92 (s, 4H), 3.81 (s, 3H), 2.41 (d, *J* = 7.4 Hz, 2H), 1.70 (q, *J* = 6.0, 5.5 Hz, 4H), 1.42 (qd, *J* = 13.6, 12.8, 4.4 Hz, 3H), 1.29 – 1.18 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.96, 146.25, 133.52, 127.23, 113.60, 112.14, 109.10, 64.14, 55.22, 42.42, 34.37, 34.28, 30.02.

HRMS (EI) exact mass calculated for [M^+] ($C_{18}H_{24}O_3^+$): m/z 288.17200; found: 288.17165.

5-(4-Methoxyphenyl)-3,3-dimethylhex-5-en-1-yl 4-methoxybenzoate (6a)



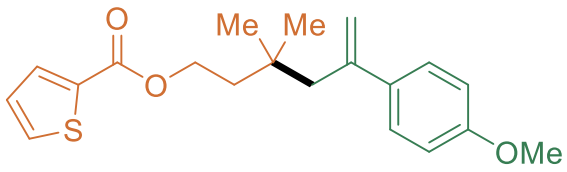
This compound was prepared according to General procedure, 50.1 mg, 68% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.96 (d, *J* = 8.8 Hz, 2H), 7.31 (d, *J* = 8.7 Hz, 2H), 6.91 (d, *J* = 8.8 Hz, 2H), 6.83 (d, *J* = 8.7 Hz, 2H), 5.21 (d, *J* = 1.9 Hz, 1H), 4.99 (d, *J* = 1.9 Hz, 1H), 4.30 (t, *J* = 7.2 Hz, 2H), 3.86 (s, 3H), 3.78 (s, 3H), 2.52 (s, 2H), 1.66 (t, *J* = 7.3 Hz, 2H), 0.85 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.41, 163.22, 158.79, 146.12, 136.02, 131.49, 127.55, 122.91, 115.74, 113.52, 62.01, 55.39, 55.17, 47.46, 40.38, 33.65, 27.73.

HRMS (EI) exact mass calculated for [M^+] ($C_{23}H_{28}O_4^+$): m/z 368.19821; found: 368.19979.

5-(4-Methoxyphenyl)-3,3-dimethylhex-5-en-1-yl thiophene-2-carboxylate (6b)



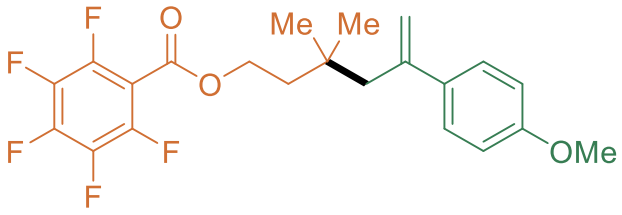
This compound was prepared according to General procedure, 48.9 mg, 71% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.76 (d, *J* = 3.7 Hz, 1H), 7.54 (d, *J* = 5.0 Hz, 1H), 7.30 (d, *J* = 8.8 Hz, 2H), 7.09 (t, *J* = 4.4 Hz, 1H), 6.83 (d, *J* = 8.9 Hz, 2H), 5.21 (d, *J* = 1.5 Hz, 1H), 4.99 (s, 1H), 4.31 (t, *J* = 7.2 Hz, 2H), 3.78 (s, 3H), 2.51 (s, 2H), 1.65 (t, *J* = 7.2 Hz, 2H), 0.85 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 162.28, 158.81, 146.09, 136.00, 134.10, 133.20, 132.16, 127.67, 127.56, 115.79, 113.53, 62.53, 55.19, 47.45, 40.27, 33.66, 27.72.

HRMS (EI) exact mass calculated for [M^+] ($C_{20}H_{24}O_3S^+$): m/z 344.14407; found: 344.14305.

5-(4-Methoxyphenyl)-3,3-dimethylhex-5-en-1-yl 2,3,4,5,6-pentafluorobenzoate (6c)



This compound was prepared according to General procedure, 34.3 mg, 40% yield as colorless oil.

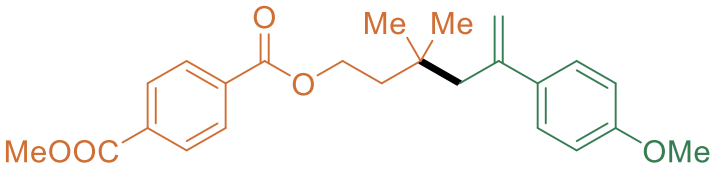
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (d, *J* = 8.8 Hz, 2H), 6.83 (d, *J* = 8.8 Hz, 2H), 5.21 (d, *J* = 2.0 Hz, 1H), 4.97 (d, *J* = 2.0 Hz, 1H), 4.37 (t, *J* = 7.5 Hz, 2H), 3.80 (s, 3H), 2.49 (s, 2H), 1.63 (t, *J* = 7.5 Hz, 2H), 0.84 (s, 6H).

^{19}F NMR (377 MHz, $CDCl_3$) δ -138.37 (d, *J* = 20.1 Hz), -148.90 (t, *J* = 20.8 Hz), -160.43 (t, *J* = 19.3 Hz).

^{13}C NMR (101 MHz, $CDCl_3$) δ 159.08, 158.86, 145.92, 135.87, 134.85, 127.53, 126.81, 115.90, 113.55, 113.36, 64.35, 55.19, 47.45, 39.84, 33.58, 27.61.

HRMS (EI) exact mass calculated for [M^+] ($C_{22}H_{21}F_5O_3^+$): m/z 428.14054; found: 428.14233.

5-(4-Methoxyphenyl)-3,3-dimethylhex-5-en-1-yl methyl terephthalate (6d)



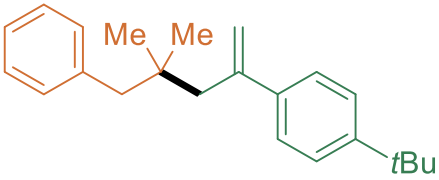
This compound was prepared according to General procedure, 52.3 mg, 66% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 – 8.04 (m, 4H), 7.30 (d, *J* = 8.7 Hz, 2H), 6.83 (d, *J* = 8.6 Hz, 2H), 5.21 (d, *J* = 2.0 Hz, 1H), 4.99 (d, *J* = 1.9 Hz, 1H), 4.35 (t, *J* = 7.3 Hz, 2H), 3.95 (s, 3H), 3.77 (s, 3H), 2.52 (s, 2H), 1.67 (t, *J* = 7.4 Hz, 2H), 0.86 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.32, 165.83, 158.82, 146.04, 135.96, 134.22, 133.77, 129.50, 129.47, 127.56, 126.93, 115.85, 113.53, 62.81, 55.18, 52.43, 47.46, 40.15, 33.66, 27.75.

HRMS (EI) exact mass calculated for [M^+] ($C_{24}H_{28}O_5^+$): m/z 396.19313; found: 396.19333.

1-(*Tert*-butyl)-4-(4,4-dimethyl-5-phenylpent-1-en-2-yl)benzene (6e)



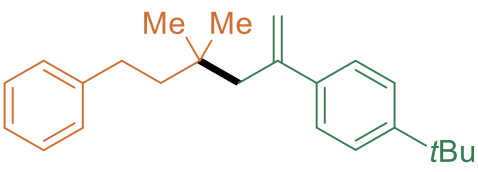
This compound was prepared according to General procedure, 38.6 mg, 63% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (s, 4H), 7.26 (t, *J* = 7.2 Hz, 2H), 7.20 (t, *J* = 7.3 Hz, 1H), 7.11 (d, *J* = 8.4 Hz, 2H), 5.30 (d, *J* = 2.6 Hz, 1H), 5.02 (s, 1H), 2.55 (s, 2H), 2.50 (s, 2H), 1.32 (s, 9H), 0.75 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 149.91, 146.69, 140.60, 139.27, 130.69, 127.55, 126.05, 125.71, 124.99, 116.23, 49.59, 47.84, 35.42, 34.40, 31.33, 26.87.

HRMS (EI) exact mass calculated for [M-CH_3^+] ($C_{22}H_{27}^+$): m/z 291.21073; found: 291.21216.

1-(*Tert*-butyl)-4-(4,4-dimethyl-6-phenylhex-1-en-2-yl)benzene (6f)



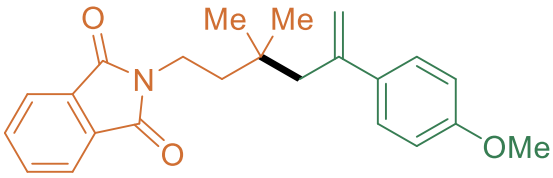
This compound was prepared according to General procedure, 35.3 mg, 55% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.34 (s, 4H), 7.20 (t, *J* = 7.5 Hz, 2H), 7.13 (t, *J* = 7.4 Hz, 1H), 6.93 (d, *J* = 8.1 Hz, 2H), 5.25 (d, *J* = 2.1 Hz, 1H), 5.04 (s, 1H), 2.54 (s, 2H), 2.51 – 2.45 (m, 2H), 1.43 – 1.37 (m, 2H), 1.34 (s, 9H), 0.88 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 149.96, 147.02, 143.37, 140.87, 128.23, 128.15, 126.27, 125.38, 125.04, 116.28, 46.32, 44.35, 34.38, 31.38, 30.78, 27.98, 21.19.

HRMS (EI) exact mass calculated for [M^+] ($C_{24}H_{32}^+$): m/z 320.24985; found: 320.25123.

2-(5-(4-Methoxyphenyl)-3,3-dimethylhex-5-en-1-yl)isoindoline-1,3-dione (6g)



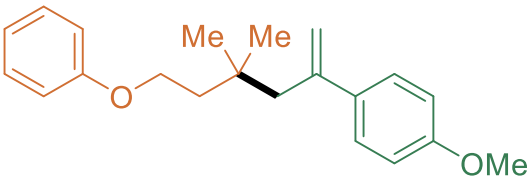
This compound was prepared according to General procedure, 34.2 mg, 47% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (dd, *J* = 5.4, 3.1 Hz, 2H), 7.70 (dd, *J* = 5.4, 3.0 Hz, 2H), 7.31 (d, *J* = 8.7 Hz, 2H), 6.83 (d, *J* = 8.7 Hz, 2H), 5.22 (d, *J* = 1.9 Hz, 1H), 5.03 (d, *J* = 1.9 Hz, 1H), 3.79 (s, 3H), 3.72 – 3.66 (m, 2H), 2.52 (s, 2H), 1.58 (dd, *J* = 11.9, 3.6 Hz, 2H), 0.84 (s, 6H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.29, 158.76, 145.88, 136.05, 133.79, 132.25, 127.56, 123.08, 115.82, 113.50, 55.21, 46.93, 40.48, 34.38, 33.75, 27.23.

HRMS (EI) exact mass calculated for [M^+] ($C_{23}H_{25}NO_3^+$): m/z 363.18290; found: 363.18325.

1-(4,4-Dimethyl-6-phenoxyhex-1-en-2-yl)-4-methoxybenzene (6h)



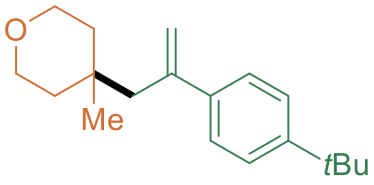
This compound was prepared according to General procedure, 31.7 mg, 51% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (d, *J* = 8.6 Hz, 2H), 7.30 – 7.26 (m, 2H), 6.93 (t, *J* = 7.3 Hz, 1H), 6.85 (dd, *J* = 12.4, 8.8 Hz, 4H), 5.22 (d, *J* = 1.9 Hz, 1H), 4.99 (s, 1H), 3.98 (t, *J* = 7.2 Hz, 2H), 3.80 (s, 3H), 2.53 (s, 2H), 1.71 (t, *J* = 7.2 Hz, 2H), 0.86 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.96, 158.79, 146.20, 136.09, 129.36, 127.57, 120.43, 115.73, 114.47, 113.51, 64.85, 55.20, 47.68, 40.93, 33.66, 27.81.

HRMS (EI) exact mass calculated for [M^+] ($C_{21}H_{26}O_2^+$): m/z 310.19273; found: 310.19308.

4-(2-(4-(*Tert*-butyl)phenyl)allyl)-4-methyltetrahydro-2*H*-pyran (6i)



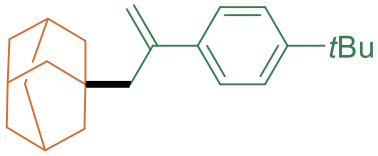
This compound was prepared according to General procedure, 24.5 mg, 45% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.30 (d, *J* = 1.7 Hz, 4H), 5.26 (d, *J* = 2.0 Hz, 1H), 5.00 (s, 1H), 3.65 (dt, *J* = 11.5, 4.6 Hz, 2H), 3.53 (ddd, *J* = 11.9, 9.5, 2.9 Hz, 2H), 2.54 (s, 2H), 1.46 (ddd, *J* = 13.3, 9.2, 3.9 Hz, 2H), 1.32 (s, 9H), 1.18 (dt, *J* = 14.0, 3.8 Hz, 2H), 0.86 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 150.09, 145.93, 140.53, 126.08, 125.03, 116.45, 63.97, 47.68, 37.99, 34.43, 31.89, 31.33, 24.06.

HRMS (EI) exact mass calculated for [M^+] ($C_{19}H_{28}O^+$): m/z 272.21347; found: 272.21235.

1-(2-(4-(*Tert*-butyl)phenyl)allyl)adamantane (6j)



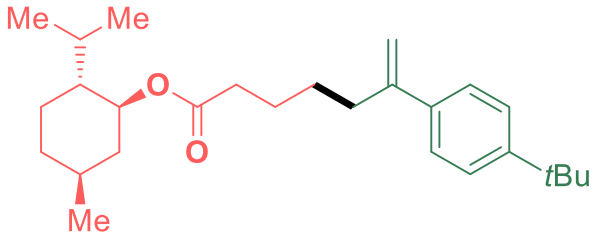
This compound was prepared according to General procedure, 24.7 mg, 40% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (q, *J* = 8.6 Hz, 4H), 5.27 (d, *J* = 2.1 Hz, 1H), 4.93 (d, *J* = 2.0 Hz, 1H), 2.32 (s, 2H), 1.86 (s, 3H), 1.64 – 1.60 (m, 3H), 1.54 – 1.51 (m, 2H), 1.39 (d, *J* = 2.9 Hz, 5H), 1.32 (s, 11H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 149.78, 145.45, 140.63, 125.89, 124.91, 115.37, 49.50, 42.97, 36.99, 34.41, 33.61, 31.35, 28.77.

HRMS (EI) exact mass calculated for [M^+] ($C_{23}H_{31}^+$): m/z 307.24203; found: 308.25013.

(1*S*,2*R*,5*S*)-2-Isopropyl-5-methylcyclohexyl 6-(4-(tert-butyl)phenyl)hept-6-enoate (7a)



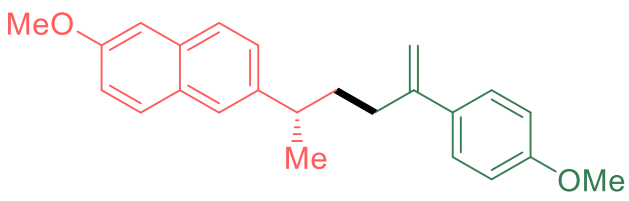
This compound was prepared according to General procedure, 32.7 mg, 41% yield as colorless oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.34 (s, 4H), 5.27 (d, *J* = 1.6 Hz, 1H), 5.02 (d, *J* = 1.5 Hz, 1H), 4.67 (td, *J* = 10.9, 4.4 Hz, 1H), 2.51 (t, *J* = 7.6 Hz, 2H), 2.29 (t, *J* = 7.5 Hz, 2H), 2.01 – 1.94 (m, 1H), 1.85 (dqd, *J* = 13.9, 6.8, 2.1 Hz, 1H), 1.67 (tdd, *J* = 11.8, 6.8, 2.8 Hz, 4H), 1.50 (dq, *J* = 11.0, 5.8, 3.9 Hz, 3H), 1.32 (s, 10H), 1.05 (qd, *J* = 13.4, 12.8, 3.8 Hz, 1H), 0.98 – 0.92 (m, 1H), 0.89 (dd, *J* = 10.0, 6.8 Hz, 7H), 0.74 (d, *J* = 7.0 Hz, 3H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 173.26, 150.26, 147.70, 138.10, 125.64, 125.15, 111.61, 47.00, 40.93, 34.88, 34.54, 34.45, 34.26, 31.36, 31.30, 27.82, 26.23, 24.86, 23.39, 22.02, 20.74, 16.25.

HRMS (EI) exact mass calculated for [M^+] ($C_{27}H_{42}O_2^+$): m/z 398.31793; found: 398.31646.

(*S*)-2-Methoxy-6-(5-(4-methoxyphenyl)hex-5-en-2-yl)naphthalene (7b)



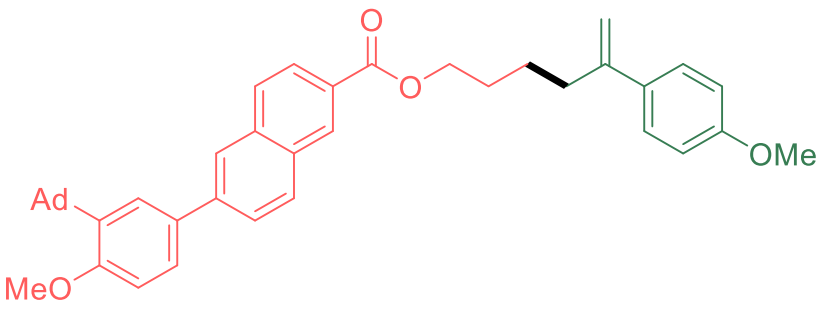
This compound was prepared according to General procedure, 50.6 mg, 73% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.71 (dd, *J* = 8.5, 3.2 Hz, 2H), 7.55 (d, *J* = 1.8 Hz, 1H), 7.35 – 7.27 (m, 3H), 7.17 – 7.13 (m, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 5.21 (d, *J* = 1.5 Hz, 1H), 4.96 (d, *J* = 1.5 Hz, 1H), 3.93 (s, 3H), 3.82 (s, 3H), 2.89 (dt, *J* = 8.1, 6.5 Hz, 1H), 2.49 – 2.36 (m, 2H), 1.92 – 1.77 (m, 2H), 1.34 (d, *J* = 6.9 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.92, 157.13, 147.83, 142.39, 133.60, 133.15, 129.05, 129.00, 127.13, 126.79, 126.27, 125.14, 118.57, 113.54, 110.62, 105.60, 55.26, 55.21, 39.56, 36.86, 33.51, 22.48.

HRMS (EI) exact mass calculated for [M^+] ($C_{24}H_{26}O_2^+$): m/z 346.19273; found: 346.19296.

5-(4-Methoxyphenyl)hex-5-en-1-yl 6-(3-(adamantan-1-yl)-4-methoxyphenyl)-2-naphthoate (7c)



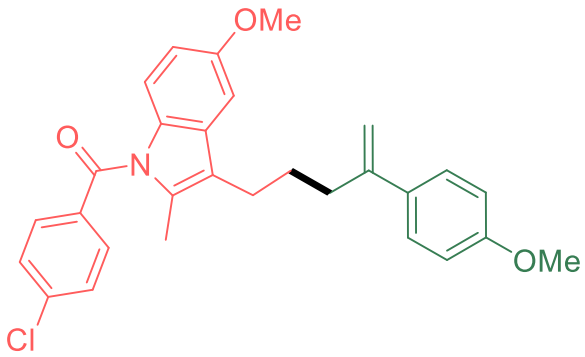
This compound was prepared according to General procedure, 61.3 mg, 51% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 8.56 (d, *J* = 1.7 Hz, 1H), 8.05 – 8.00 (m, 2H), 7.97 (d, *J* = 8.5 Hz, 1H), 7.90 (d, *J* = 8.6 Hz, 1H), 7.79 (dd, *J* = 8.5, 1.8 Hz, 1H), 7.60 (d, *J* = 2.3 Hz, 1H), 7.55 (dd, *J* = 8.4, 2.3 Hz, 1H), 7.37 (d, *J* = 8.7 Hz, 2H), 7.00 (d, *J* = 8.4 Hz, 1H), 6.85 (d, *J* = 8.7 Hz, 2H), 5.24 (d, *J* = 1.5 Hz, 1H), 5.03 (s, 1H), 4.38 (t, *J* = 6.5 Hz, 2H), 3.91 (s, 3H), 3.78 (s, 3H), 2.60 (t, *J* = 7.5 Hz, 2H), 2.19 (s, 6H), 2.11 (s, 3H), 1.90 – 1.79 (m, 8H), 1.67 (qd, *J* = 9.4, 8.7, 6.4 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.84, 159.02, 158.90, 147.33, 141.31, 138.99, 135.90, 133.40, 132.57, 131.22, 130.70, 129.69, 128.14, 127.20, 126.41, 125.97, 125.71, 125.59, 124.71, 113.64, 112.09, 111.15, 64.85, 55.22, 55.16, 40.60, 37.20, 37.12, 34.93, 29.10, 28.28, 24.56.

HRMS (ESI) exact mass calculated for [$M+Na^+$] ($C_{41}H_{44}O_4Na^+$): m/z 623.31318; found: 623.31355.

(4-Chlorophenyl)(5-methoxy-3-(4-(4-methoxyphenyl)pent-4-en-1-yl)-2-methyl-1H-indol-1-yl)methanone (7d)



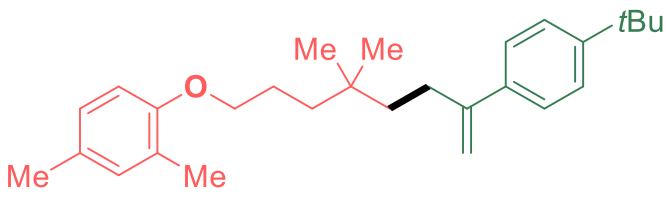
This compound was prepared according to General procedure, 61.6 mg, 65% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.62 (d, *J* = 8.4 Hz, 2H), 7.45 (d, *J* = 8.5 Hz, 2H), 7.34 (d, *J* = 8.7 Hz, 2H), 6.89 (d, *J* = 9.0 Hz, 1H), 6.85 (d, *J* = 8.7 Hz, 2H), 6.77 (d, *J* = 2.6 Hz, 1H), 6.63 (dd, *J* = 8.9, 2.5 Hz, 1H), 5.26 (d, *J* = 1.5 Hz, 1H), 5.03 (d, *J* = 1.6 Hz, 1H), 3.81 (s, 3H), 3.76 (s, 3H), 2.65 (t, *J* = 7.8 Hz, 2H), 2.59 (t, *J* = 7.4 Hz, 2H), 2.27 (s, 3H), 1.79 (h, *J* = 7.5, 6.8 Hz, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 168.26, 159.04, 155.80, 147.25, 138.88, 134.30, 133.83, 133.40, 131.18, 131.02, 130.97, 129.01, 127.18, 119.82, 114.92, 113.63, 111.12, 111.04, 101.31, 55.65, 55.23, 35.03, 27.79, 23.38, 13.26.

HRMS (EI) exact mass calculated for [M^+] ($C_{29}H_{28}ClNO_3^+$): m/z 473.17522; found: 473.17586.

1-((7-(4-(*Tert*-butyl)phenyl)-4,4-dimethyloct-7-en-1-yl)oxy)-2,4-dimethylbenzene (7e)



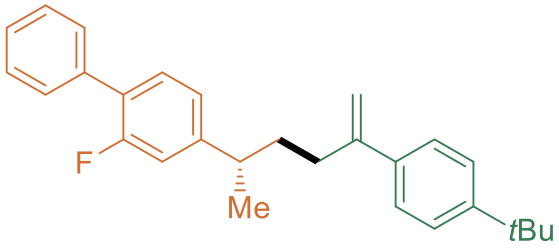
This compound was prepared according to General procedure, 39.3 mg, 50% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.36 (d, *J* = 2.2 Hz, 4H), 7.02 (d, *J* = 7.4 Hz, 1H), 6.67 (d, *J* = 7.6 Hz, 1H), 6.64 (s, 1H), 5.27 (s, 1H), 5.04 (s, 1H), 3.93 (t, *J* = 6.4 Hz, 2H), 2.51 – 2.44 (m, 2H), 2.32 (s, 3H), 2.19 (s, 3H), 1.75 (dq, *J* = 11.8, 6.4 Hz, 2H), 1.46 – 1.39 (m, 4H), 1.34 (s, 9H), 0.96 (s, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 157.08, 150.23, 148.91, 138.34, 136.43, 130.26, 125.58, 125.16, 123.58, 120.56, 111.96, 111.07, 68.58, 40.67, 37.86, 34.46, 32.63, 31.32, 29.84, 27.18, 24.30, 21.41, 15.81.

HRMS (EI) exact mass calculated for [M^+] ($C_{28}H_{40}O^+$): m/z 392.30737; found: 392.30781.

(*S*)-4-(5-(4-(*Tert*-butyl)phenyl)hex-5-en-2-yl)-2-fluoro-1,1'-biphenyl (7f)



This compound was prepared according to General procedure, 58.8 mg, 76% yield as colorless oil.

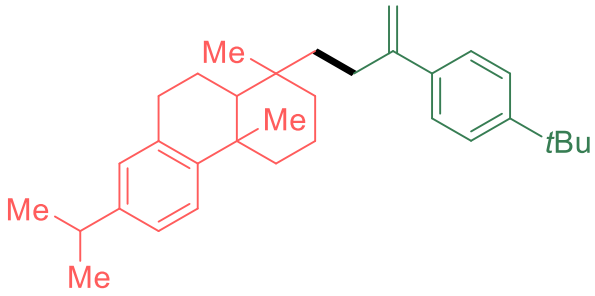
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 (d, *J* = 8.3 Hz, 2H), 7.46 (t, *J* = 7.5 Hz, 2H), 7.41 – 7.30 (m, 6H), 7.08 – 6.97 (m, 2H), 5.30 (d, *J* = 1.5 Hz, 1H), 5.03 (s, 1H), 2.81 (h, *J* = 7.0 Hz, 1H), 2.46 (h, *J* = 8.4, 7.9 Hz, 2H), 1.80 (dtd, *J* = 8.8, 6.8, 3.8 Hz, 2H), 1.35 (s, 9H), 1.30 (d, *J* = 6.9 Hz, 3H).

^{19}F NMR (377 MHz, $CDCl_3$) δ -118.48.

^{13}C NMR (101 MHz, $CDCl_3$) δ 160.98, 158.52, 150.32, 149.18 (d, *J* = 7.3 Hz), 147.89, 138.05, 135.89, 130.45 (d, *J* = 3.5 Hz), 128.92 (d, *J* = 2.9 Hz), 128.37, 127.37, 126.41 (d, *J* = 13.5 Hz), 125.64, 125.17, 123.11 (d, *J* = 3.1 Hz), 114.60, 114.37, 111.61, 39.25, 36.69, 34.46, 33.23, 31.30, 22.19.

HRMS (EI) exact mass calculated for [M^+] ($C_{28}H_{31}F^+$): m/z 386.24043; found: 386.23988.

1-(3-(4-(*Tert*-butyl)phenyl)but-3-en-1-yl)-7-isopropyl-1,4a-dimethyl-1,2,3,4,4a,9,10,10a-octahydrophenanthrene (7g)



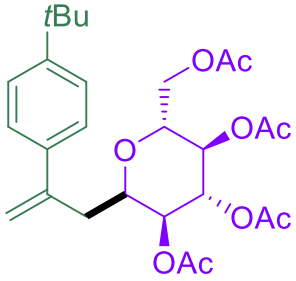
This compound was prepared according to General procedure, 55.8 mg, 63% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 (s, 4H), 7.19 (d, *J* = 8.2 Hz, 1H), 6.99 (dd, *J* = 8.2, 2.0 Hz, 1H), 6.89 (s, 1H), 5.27 (d, *J* = 1.6 Hz, 1H), 5.02 (s, 1H), 2.92 – 2.79 (m, 3H), 2.44 – 2.37 (m, 2H), 2.29 (d, *J* = 12.8 Hz, 1H), 1.84 – 1.76 (m, 2H), 1.67 (dh, *J* = 13.3, 3.8, 2.9 Hz, 2H), 1.51 – 1.38 (m, 6H), 1.33 (s, 9H), 1.23 (d, *J* = 7.2 Hz, 9H), 0.95 (s, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 150.25, 148.89, 147.70, 145.44, 138.23, 134.83, 126.80, 125.53, 125.16, 124.29, 123.80, 111.09, 47.32, 43.13, 38.65, 37.59, 37.04, 35.90, 34.47, 33.43, 31.32, 30.34, 29.04, 25.35, 23.99, 23.97, 21.00, 19.08, 18.72.

HRMS (EI) exact mass calculated for [M^+] ($C_{33}H_{46}^+$): m/z 442.35940; found: 442.35751.

(2*R*,3*R*,4*R*,5*S*,6*R*)-2-(acetoxymethyl)-6-(2-(4-(tert-butyl)phenyl)allyl)tetrahydro-2*H*-pyran-3,4,5-triyl triacetate (7h)



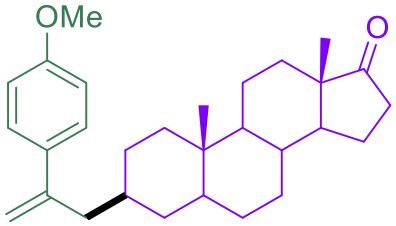
This compound was prepared according to General procedure, 57.5 mg, 57% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35 (d, *J* = 8.4 Hz, 2H), 7.27 (d, *J* = 6.2 Hz, 2H), 5.38 (t, *J* = 9.1 Hz, 1H), 5.34 (s, 1H), 5.14 (s, 1H), 5.08 (dd, *J* = 9.5, 5.8 Hz, 1H), 4.98 (t, *J* = 9.1 Hz, 1H), 4.33 (ddd, *J* = 10.3, 5.8, 4.4 Hz, 1H), 4.16 (dd, *J* = 11.9, 4.7 Hz, 1H), 3.96 – 3.88 (m, 2H), 2.92 (dd, *J* = 15.4, 10.4 Hz, 1H), 2.82 (dd, *J* = 15.4, 4.4 Hz, 1H), 2.07 (d, *J* = 4.4 Hz, 6H), 2.03 (d, *J* = 9.0 Hz, 6H), 1.32 (s, 9H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 170.63, 170.19, 169.55, 169.51, 150.79, 143.66, 137.18, 125.80, 125.38, 114.73, 71.00, 70.63, 70.25, 68.80, 68.75, 62.15, 34.49, 31.89, 31.25, 20.71, 20.68, 20.64.

HRMS (EI) exact mass calculated for [M-$C_2H_4O_2^+$] ($C_{25}H_{32}O_7^+$): m/z 444.21425; found: 444.21478.

(3*S*,10*S*,13*S*)-3-(2-(4-methoxyphenyl)allyl)-10,13-dimethylhexadecahydro-17*H*-cyclopenta[a]phenanthren-17-one (7i)



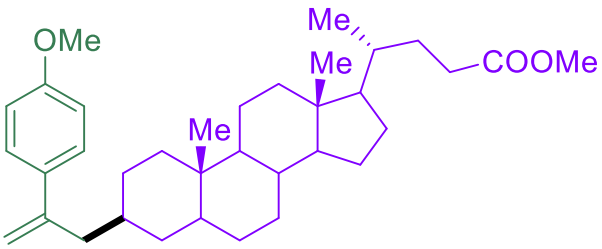
This compound was prepared according to General procedure, 36.2 mg, 43% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (dd, *J* = 8.8, 2.5 Hz, 2H), 6.85 (d, *J* = 8.7 Hz, 2H), 5.19 (t, *J* = 2.1 Hz, 1H), 4.93 (dd, *J* = 6.5, 1.8 Hz, 1H), 3.81 (d, *J* = 2.4 Hz, 3H), 2.56 (d, *J* = 7.7 Hz, 1H), 2.48 – 2.34 (m, 2H), 2.05 (ddt, *J* = 18.8, 15.9, 9.0 Hz, 1H), 1.92 (tdd, *J* = 14.6, 10.5, 5.8 Hz, 1H), 1.77 (dddd, *J* = 15.7, 12.6, 8.1, 3.7 Hz, 2H), 1.69 – 1.60 (m, 2H), 1.57 – 0.89 (m, 16H), 0.85 (d, *J* = 7.9 Hz, 3H), 0.78 (d, *J* = 5.5 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 221.57, 221.54, 158.91, 147.19, 146.30, 133.69, 133.63, 127.38, 127.25, 113.55, 112.02, 111.87, 55.23, 54.86, 54.70, 51.59, 51.48, 47.85, 47.80, 46.42, 43.64, 40.40, 38.42, 38.07, 36.52, 36.17, 36.09, 35.85, 35.44, 35.10, 35.07, 33.13, 32.25, 31.60, 31.57, 30.98, 30.93, 30.59, 28.75, 28.62, 24.67, 21.74, 20.24, 20.05, 13.82, 13.80, 12.29, 11.73.

HRMS (EI) exact mass calculated for [M^+] ($C_{29}H_{40}O_2^+$): m/z 420.30228; found: 420.30039.

Methyl (4*R*)-4-((3*S*,10*S*,13*R*)-3-(2-(4-methoxyphenyl)allyl)-10,13-dimethylhexadecahydro-1*H*-cyclopenta[*a*]phenanthren-17-yl)pentanoate (7j)



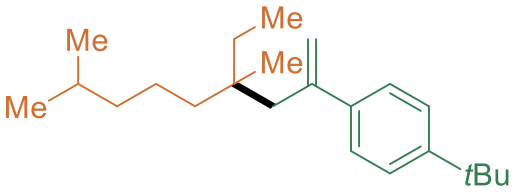
This compound was prepared according to General procedure, 42.7 mg, 41% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.31 (q, *J* = 8.6 Hz, 4H), 5.27 (d, *J* = 2.1 Hz, 1H), 4.93 (d, *J* = 2.0 Hz, 1H), 2.32 (s, 2H), 1.86 (s, 3H), 1.64 – 1.60 (m, 3H), 1.54 – 1.51 (m, 2H), 1.39 (d, *J* = 2.9 Hz, 5H), 1.32 (s, 11H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 149.78, 145.45, 140.63, 125.89, 124.91, 115.37, 49.50, 42.97, 36.99, 34.41, 33.61, 31.35, 28.77.

HRMS (EI) exact mass calculated for [M^+] ($C_{35}H_{52}O_3^+$): m/z 520.39110; found: 520.39129.

1-(*Tert*-butyl)-4-(4-ethyl-4,8-dimethylnon-1-en-2-yl)benzene (7k)



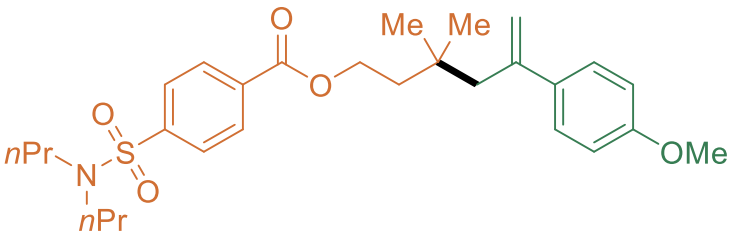
This compound was prepared according to General procedure, 26.4 mg, 42% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.27 (m, 4H), 5.18 (d, *J* = 2.2 Hz, 1H), 4.97 (d, *J* = 2.2 Hz, 1H), 2.47 – 2.37 (m, 2H), 1.41 (dt, *J* = 13.2, 6.6 Hz, 1H), 1.31 (s, 9H), 1.18 (p, *J* = 7.2 Hz, 2H), 1.08 (dtt, *J* = 11.1, 4.6, 2.4 Hz, 2H), 1.03 – 0.96 (m, 2H), 0.87 (ddd, *J* = 13.9, 7.7, 2.1 Hz, 2H), 0.80 (d, *J* = 6.6 Hz, 6H), 0.74 (t, *J* = 7.5 Hz, 3H), 0.66 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 149.68, 147.36, 141.22, 126.17, 124.86, 115.98, 44.17, 39.70, 38.61, 36.63, 34.40, 31.83, 31.36, 27.91, 25.00, 22.71, 22.62, 21.28, 8.07.

HRMS (EI) exact mass calculated for [M-CH_3^+] ($C_{22}H_{35}^+$): m/z 299.27333; found: 299.27378.

5-(4-Methoxyphenyl)-3,3-dimethylhex-5-en-1-yl 4-(*N*,*N*-dipropylsulfamoyl)benzoate (7l)



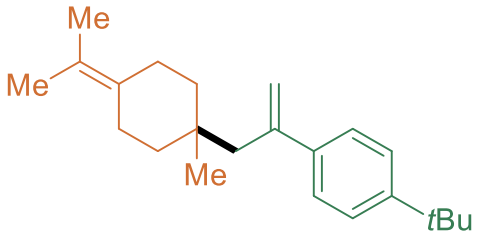
This compound was prepared according to General procedure, 47.2 mg, 47% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 (d, *J* = 8.5 Hz, 2H), 7.86 (d, *J* = 8.5 Hz, 2H), 7.30 (d, *J* = 8.8 Hz, 2H), 6.83 (d, *J* = 8.7 Hz, 2H), 5.22 (d, *J* = 2.0 Hz, 1H), 4.99 (d, *J* = 1.9 Hz, 1H), 4.35 (t, *J* = 7.3 Hz, 2H), 3.77 (s, 3H), 3.12 – 3.06 (m, 4H), 2.52 (s, 2H), 1.67 (t, *J* = 7.3 Hz, 2H), 1.59 – 1.50 (m, 4H), 0.89 – 0.84 (m, 12H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 165.28, 158.82, 145.99, 144.08, 135.91, 133.70, 130.11, 127.54, 126.94, 115.86, 113.53, 63.02, 55.18, 49.91, 47.46, 40.11, 33.65, 27.74, 21.92, 11.13.

HRMS (EI) exact mass calculated for [M^+] ($C_{28}H_{39}NO_5S^+$): m/z 501.25435; found: 501.25562.

1-(*Tert*-butyl)-4-(3-(1-methyl-4-(propan-2-ylidene)cyclohexyl)prop-1-en-2-yl)benzene (7m)



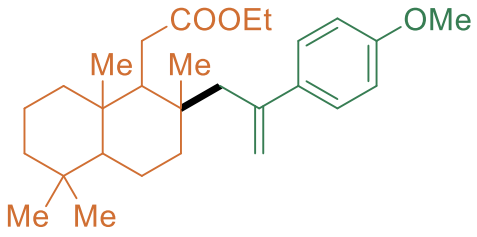
This compound was prepared according to General procedure, 24.8 mg, 40% yield as colorless oil.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (s, 4H), 5.22 (d, *J* = 2.1 Hz, 1H), 4.98 (d, *J* = 2.1 Hz, 1H), 2.50 (s, 2H), 2.26 – 2.18 (m, 2H), 2.03 – 1.94 (m, 2H), 1.62 (s, 6H), 1.32 (s, 9H), 1.24 (dt, *J* = 11.1, 5.0 Hz, 4H), 0.78 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 149.85, 146.83, 140.89, 131.58, 126.12, 124.94, 120.29, 115.96, 46.90, 39.12, 34.44, 34.05, 31.38, 25.59, 24.71, 19.95.

HRMS (EI) exact mass calculated for [M^+] ($C_{23}H_{34}^+$): m/z 310.26550; found: 310.26674.

Ethyl 2-((2*R*)-2-(2-(4-methoxyphenyl)allyl)-2,5,5,8a-tetramethyldecahydronaphthalen-1-yl)acetate (7n)



This compound was prepared according to General procedure, 42.7 mg, 50% yield as a white solid.

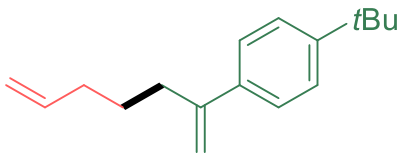
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.8 Hz, 2H), 5.16 (d, *J* = 2.0 Hz, 1H), 4.96 (s, 1H), 4.10 (qd, *J* = 7.1, 2.8 Hz, 2H), 3.81 (s, 3H), 3.05 (d, *J* = 13.7 Hz, 1H), 2.37 (dd, *J* = 16.9, 2.7 Hz, 1H), 2.03 – 1.90 (m, 2H), 1.58 – 1.27 (m, 6H), 1.24 (t, *J* = 7.1 Hz, 3H), 1.15 – 1.02 (m, 3H), 0.98 – 0.78 (m, 7H), 0.78 – 0.68 (m, 9H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 174.94, 158.85, 147.45, 133.97, 127.45, 113.52, 112.51, 60.24, 55.23, 53.33, 53.23, 42.05, 41.90, 41.09, 39.40, 38.98, 37.47, 34.55, 33.16, 33.03, 26.89, 21.62, 18.64, 17.15, 14.34, 14.19.

M.P.:93.3-94.7 ^{o}C.

HRMS (EI) exact mass calculated for [M^+] ($C_{28}H_{42}O_3^+$): m/z 426.31285; found: 426.31152.

1-(*Tert*-butyl)-4-(hepta-1,6-dien-2-yl)benzene (14)



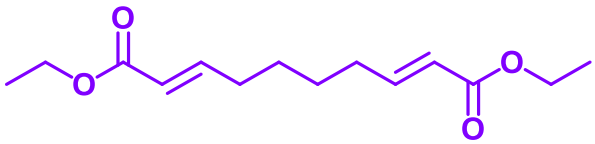
This compound was prepared according to General procedure, 25.1 mg, 55% yield as colorless oil.

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.35 (s, 4H), 5.82 (ddt, *J* = 16.9, 10.2, 6.7 Hz, 1H), 5.28 (d, *J* = 1.6 Hz, 1H), 5.05 – 4.94 (m, 3H), 2.54 – 2.48 (m, 2H), 2.10 (q, *J* = 7.9, 7.3 Hz, 2H), 1.61 – 1.55 (m, 2H), 1.33 (s, 9H).

^{13}C NMR (151 MHz, $CDCl_3$) δ 150.24, 147.95, 138.69, 138.23, 125.67, 125.13, 114.62, 111.56, 34.61, 33.38, 31.31, 27.51.

HRMS (EI) exact mass calculated for [M^+] ($C_{17}H_{24}^+$): m/z 228.18725; found: 228.18626.

Diethyl (2*E*,8*E*)-deca-2,8-dienedioate (15a)



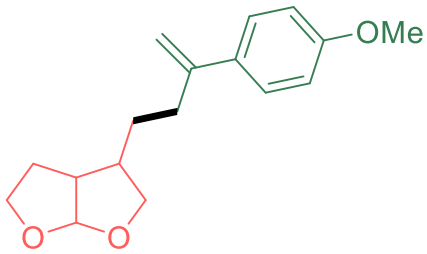
This compound was prepared according to General procedure, 22.9 mg, 45% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 6.93 (dt, *J* = 15.7, 7.0 Hz, 1H), 5.81 (d, *J* = 15.6 Hz, 1H), 4.18 (q, *J* = 7.1 Hz, 2H), 2.24 – 2.17 (m, 2H), 1.49 (p, *J* = 3.5 Hz, 2H), 1.28 (t, *J* = 7.2 Hz, 3H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 166.67, 148.64, 121.65, 60.21, 31.88, 27.48, 14.28.

HRMS (EI) exact mass calculated for [M^+] ($C_{14}H_{22}O_4^+$): m/z 254.15126; found: 254.15077.

3-(3-(4-Methoxyphenyl)but-3-en-1-yl)hexahydrofuro[2,3-*b*]furan (16)



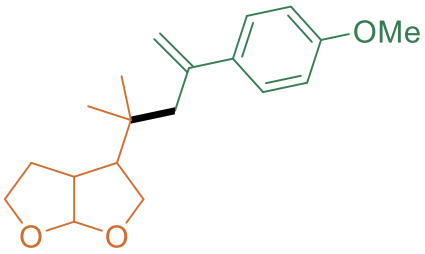
This compound was prepared according to General procedure, 36.8 mg, 61% yield as colorless oil.

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.33 (d, *J* = 8.8 Hz, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 5.72 (d, *J* = 5.0 Hz, 1H), 5.21 (d, *J* = 1.5 Hz, 1H), 5.00 (s, 1H), 3.97 – 3.92 (m, 1H), 3.84 (dd, *J* = 7.4, 6.3 Hz, 2H), 3.82 (s, 3H), 3.40 (dd, *J* = 11.4, 8.4 Hz, 1H), 2.80 (ddd, *J* = 13.9, 8.4, 5.4 Hz, 1H), 2.58 – 2.45 (m, 2H), 2.33 (dp, *J* = 11.4, 7.5 Hz, 1H), 1.87 – 1.77 (m, 2H), 1.60 – 1.49 (m, 2H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 159.12, 147.19, 133.06, 127.11, 113.71, 111.26, 109.69, 72.39, 69.07, 55.25, 45.28, 41.70, 34.23, 26.24, 24.94.

HRMS (EI) exact mass calculated for [M^+] ($C_{17}H_{22}O_3^+$): m/z 274.15635; found: 274.15616.

3-(4-(4-Methoxyphenyl)-2-methylpent-4-en-2-yl)hexahydrofuro[2,3-*b*]furan (17)



This compound was prepared according to General procedure, 18.7 mg, 31% yield as colorless oil.

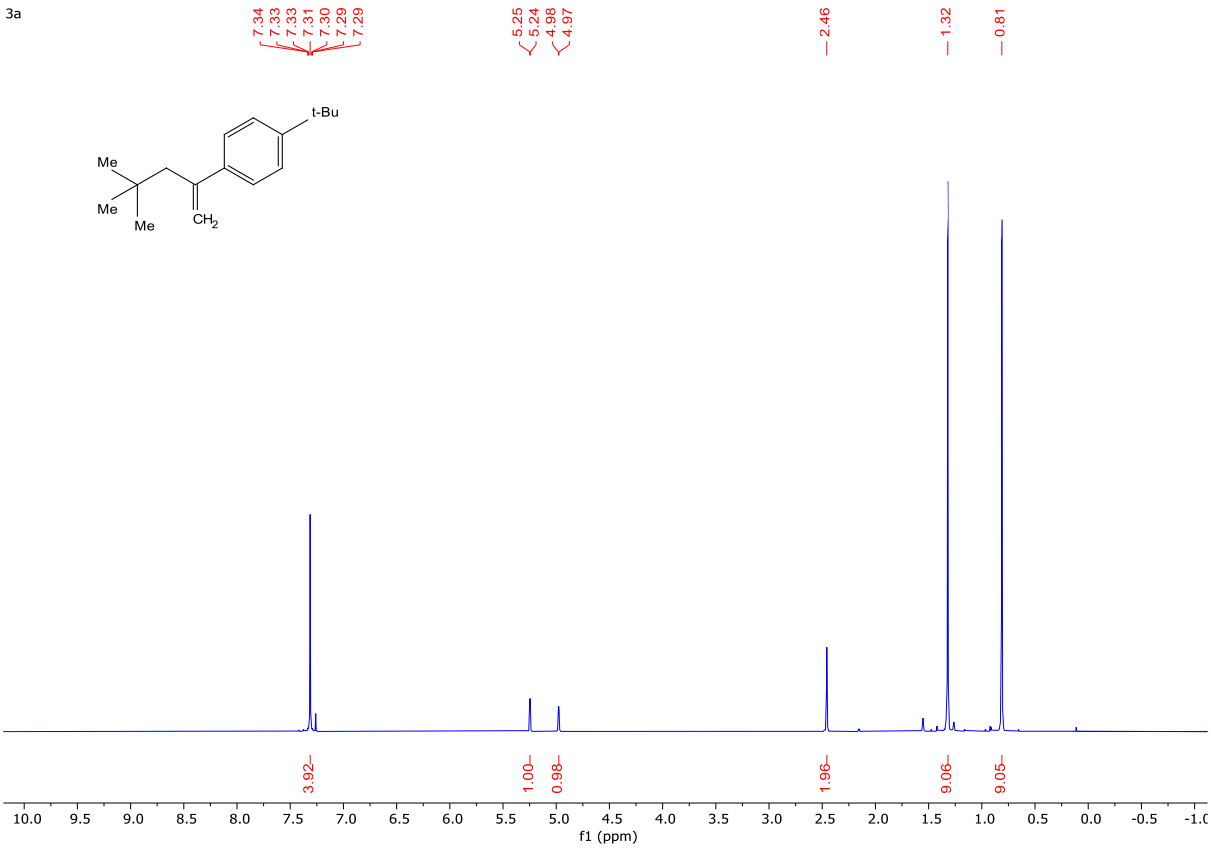
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.28 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.7 Hz, 2H), 5.57 (d, *J* = 4.7 Hz, 1H), 5.22 (d, *J* = 1.9 Hz, 1H), 4.98 (s, 1H), 4.08 (td, *J* = 8.1, 3.7 Hz, 1H), 3.87 (t, *J* = 7.5 Hz, 1H), 3.84 – 3.73 (m, 6H), 2.67 (tt, *J* = 9.0, 5.5 Hz, 1H), 2.53 (s, 1H), 2.25 (dt, *J* = 11.8, 6.6 Hz, 1H), 2.05 (dq, *J* = 12.4, 8.5 Hz, 1H), 1.85 (dddd, *J* = 12.4, 8.9, 6.2, 3.7 Hz, 1H), 0.83 (d, *J* = 10.9 Hz, 6H).

^{13}C NMR (126 MHz, $CDCl_3$) δ 158.90, 145.69, 136.01, 127.49, 116.32, 113.61, 109.65, 69.91, 66.99, 55.24, 51.29, 47.80, 45.19, 35.15, 27.12, 26.36, 25.84.

HRMS (EI) exact mass calculated for [M^+] ($C_{19}H_{26}O_3^+$): m/z 302.18765; found: 302.18736.

8. NMR Spectrum

3a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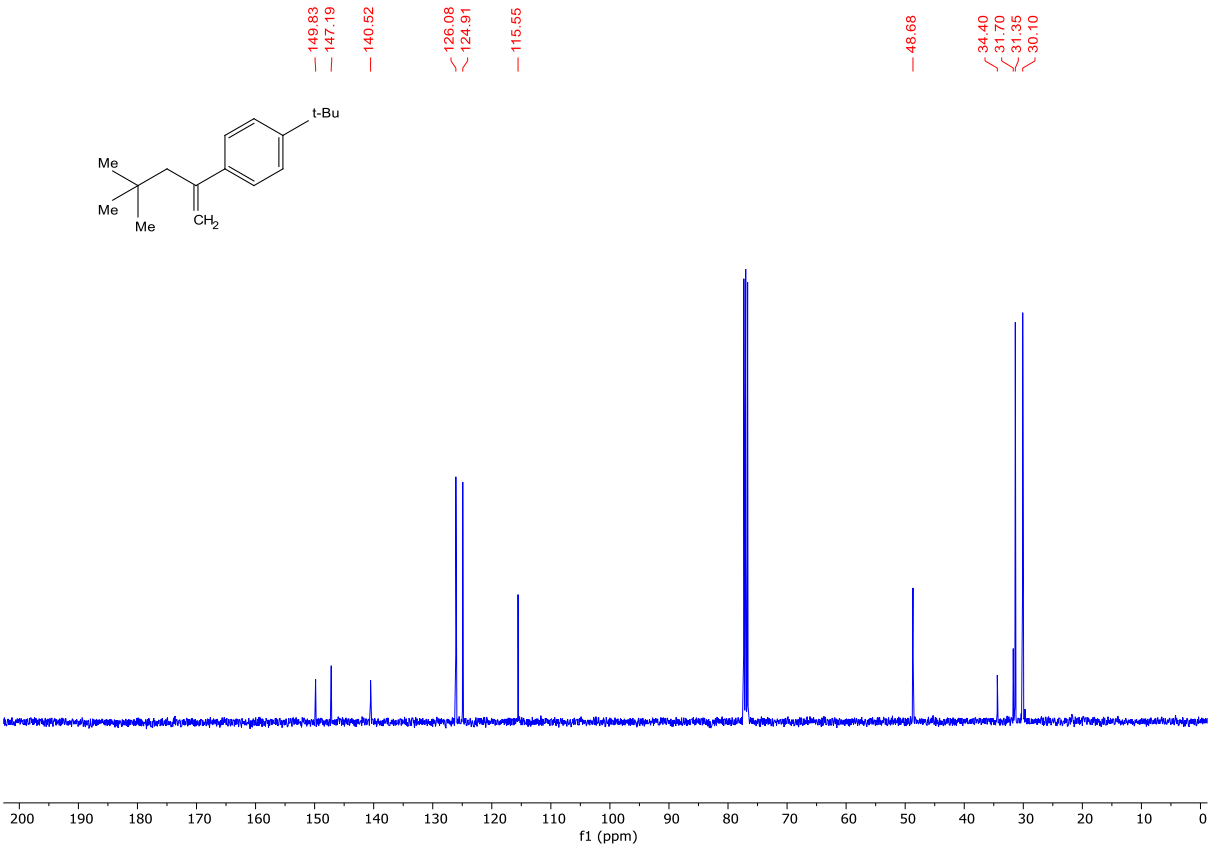
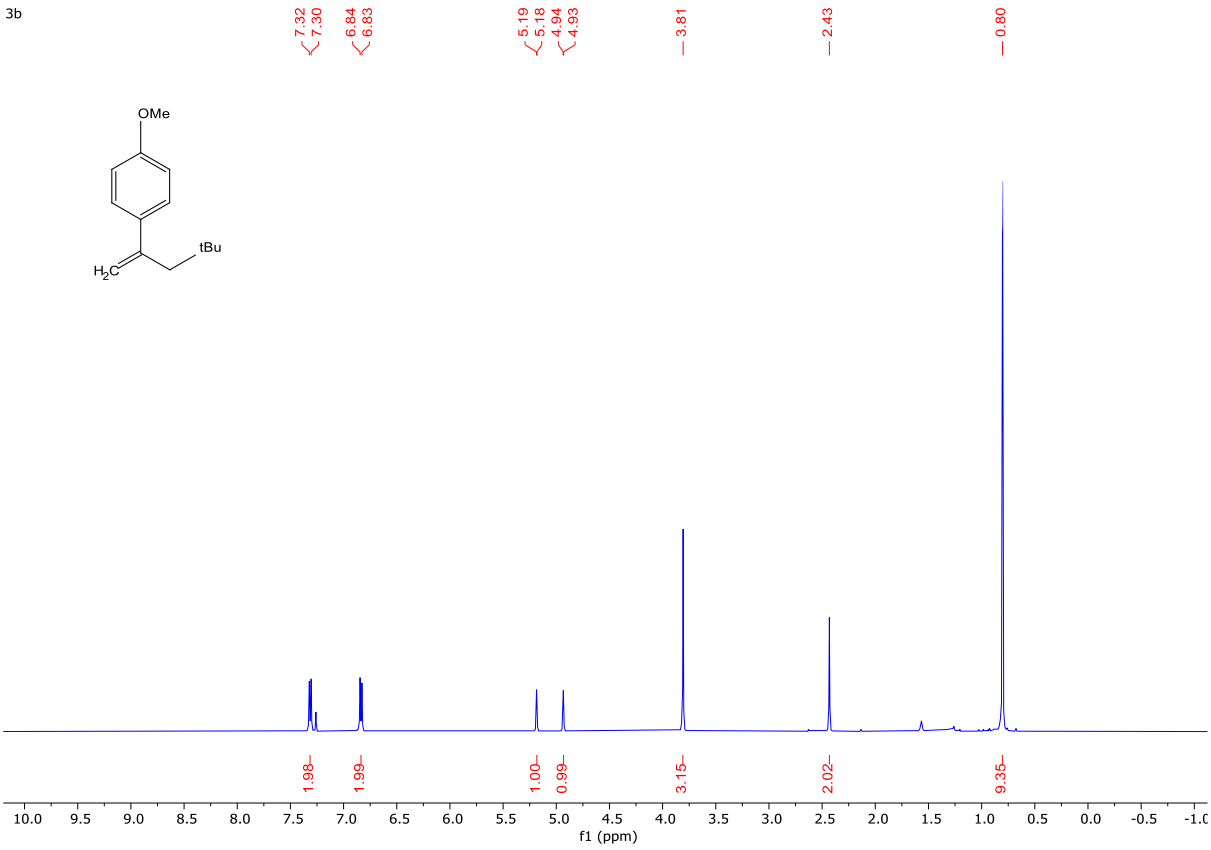
7.33
7.33
7.31
7.30
7.29
7.29
5.25
5.24
4.98
4.97
2.46
1.32
0.81
t-Bu
Me
Me
Me
CH2
3.92
1.00
0.98
1.96
9.06
9.05
f1 (ppm)


149.83
147.19
140.52
126.08
124.91
115.55
48.68
34.40
31.70
31.35
30.10
t-Bu
Me
Me
Me
CH2
f1 (ppm)

3b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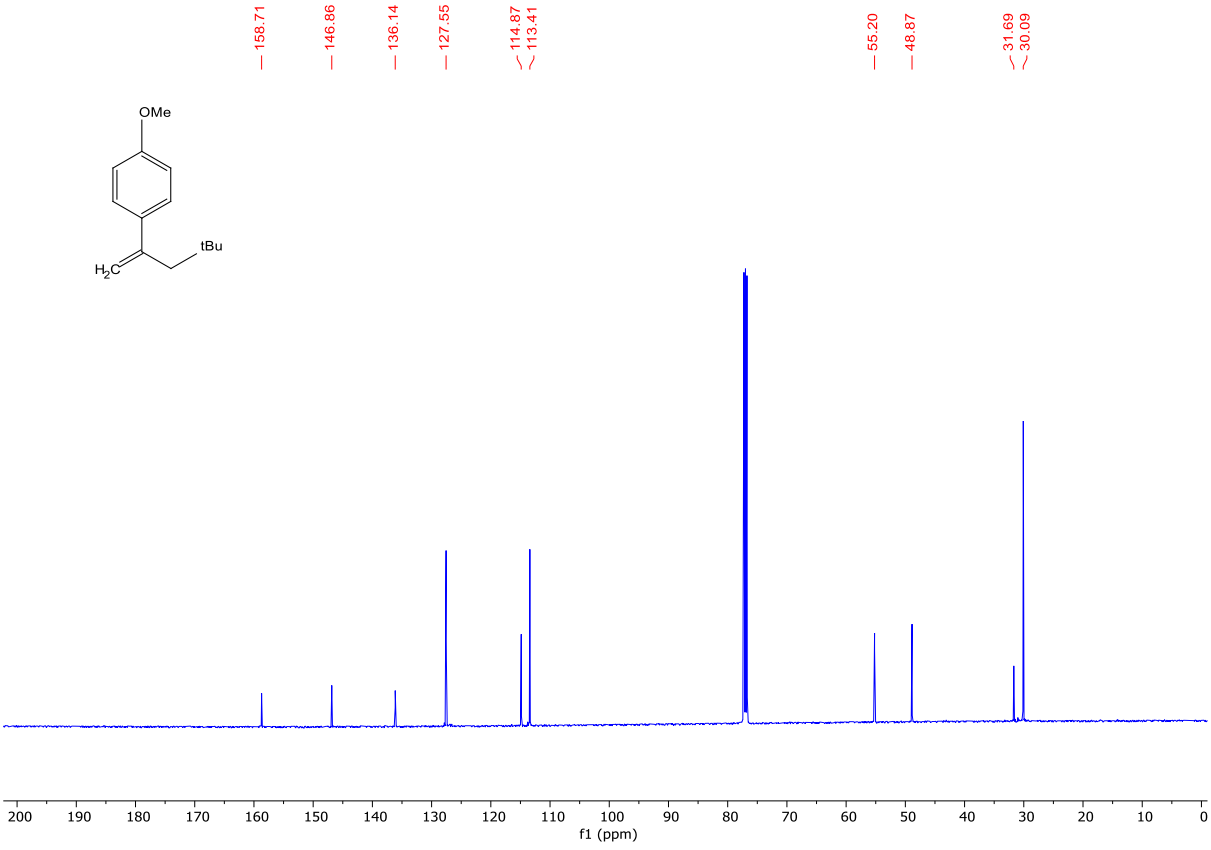
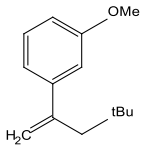
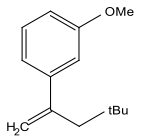
7.30
6.84
6.83
5.19
5.18
4.94
4.93
3.81
2.43
0.80
OMe
tBu
H2C
1.98
1.99
1.00
0.99
3.15
2.02
9.35
f1 (ppm)


158.71
146.86
136.14
127.55
114.87
113.41
55.20
48.87
31.69
30.09
OMe
tBu
H2C
f1 (ppm)

3c

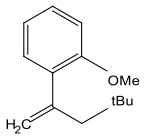

OMe
tBu
H2C

7.23
7.21
7.19
6.98
6.96
6.93
6.92
6.91
6.80
6.79
6.78
6.77
5.26
5.25
5.01
5.00
3.82
2.44
0.80
1.03
1.02
1.02
1.02
1.00
0.99
3.15
2.05
9.00
f1 (ppm)


OMe
tBu
H2C

159.34
147.42
145.25
129.00
119.17
116.37
112.53
112.02
55.19
48.93
31.73
30.00
f1 (ppm)

3d


OMe
tBu
H2C

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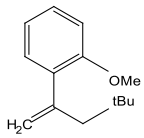
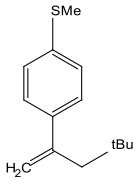
7.22
7.21
7.18
7.18
7.16
7.16
6.91
6.90
6.89
6.85
6.83
5.10
5.09
5.07
5.07
3.83
2.50
0.77
1.00
0.98
1.04
1.02
1.01
1.01
3.06
2.10
9.19
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


OMe
tBu
H2C

156.44
147.29
133.63
130.26
128.03
120.49
118.02
110.64
55.34
49.88
31.63
29.87
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

3e



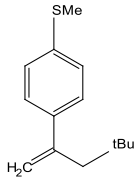
7.32
7.30
7.20
7.18
5.24
5.23
4.98
2.48
2.44
0.80

1.96
1.93
1.00
1.00
2.96
1.99
9.17

10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0

f1 (ppm)

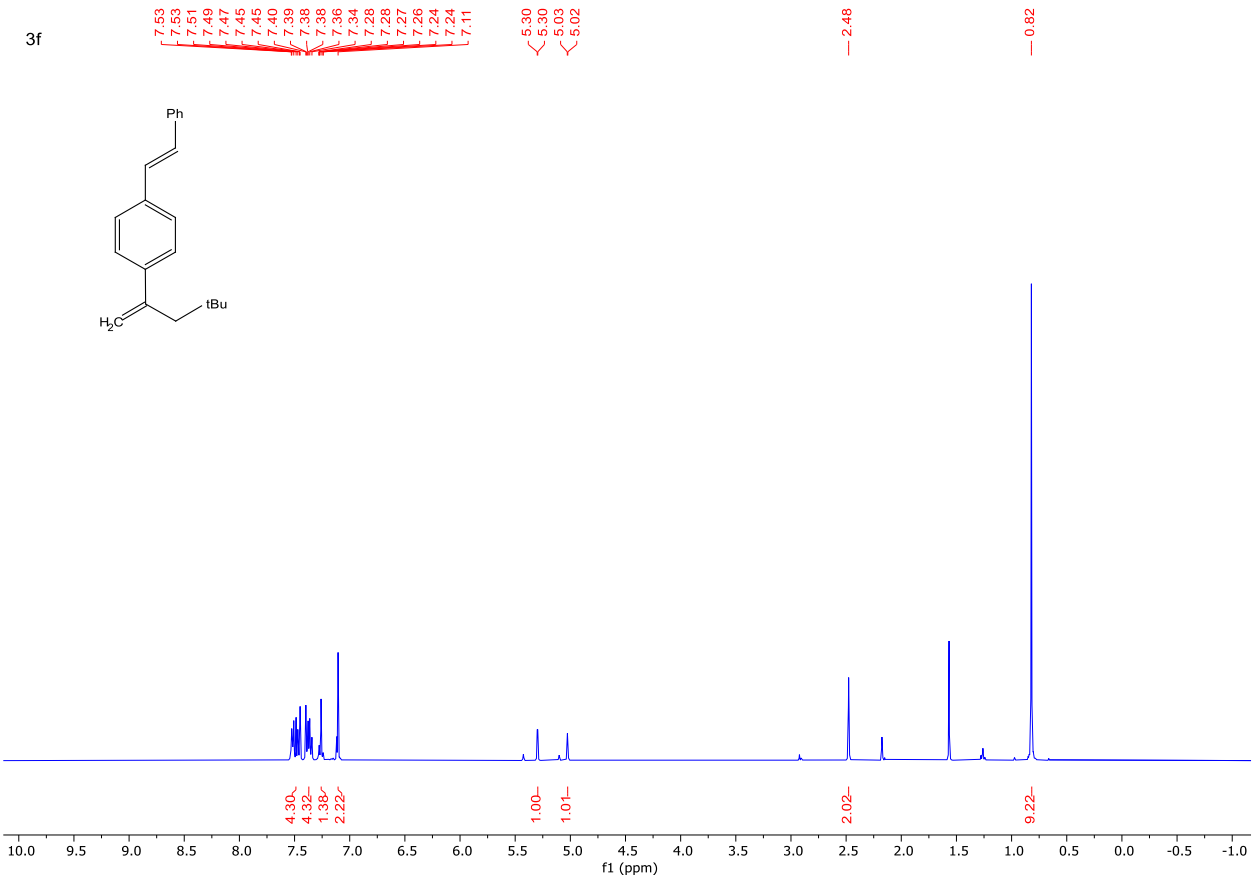
146.80
140.54
136.82
126.94
126.31
115.93
48.70
31.73
30.06
15.87



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

f1 (ppm)

3f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7.53
7.51
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7.47
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7.45
7.40
7.39
7.38
7.38
7.36
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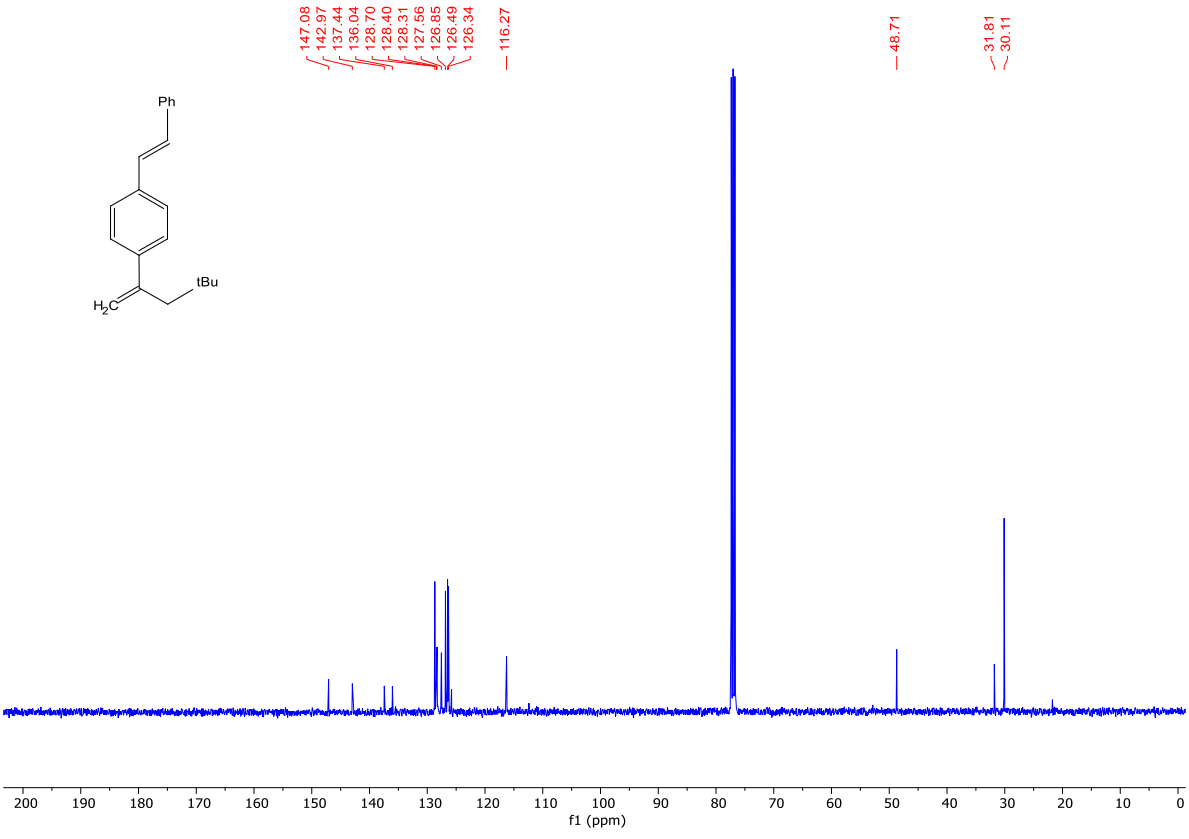
7.28
7.28
7.27
7.26
7.24
7.24
7.11
5.30
5.30
5.03
5.02
2.48
0.82
Ph
tBu
H2C
4.30
4.32
1.38
2.22
1.00
1.01
2.02
9.22
f1 (ppm)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142.97
137.44
136.04
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128.40
128.31
127.56
126.85
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126.34
116.27
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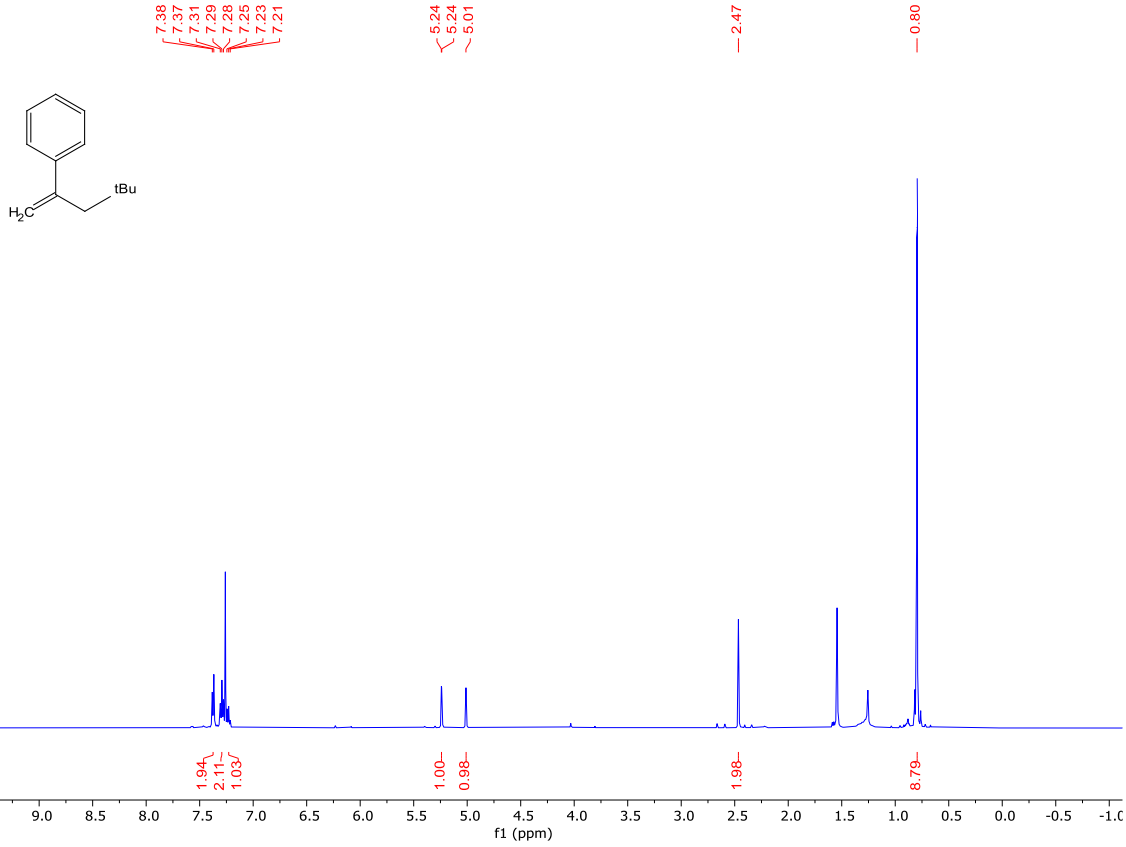
30.11
Ph
tBu
H2C
f1 (ppm)

3g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7.37
7.31
7.29
7.28
7.25
7.23
7.21
5.24
5.24
5.01
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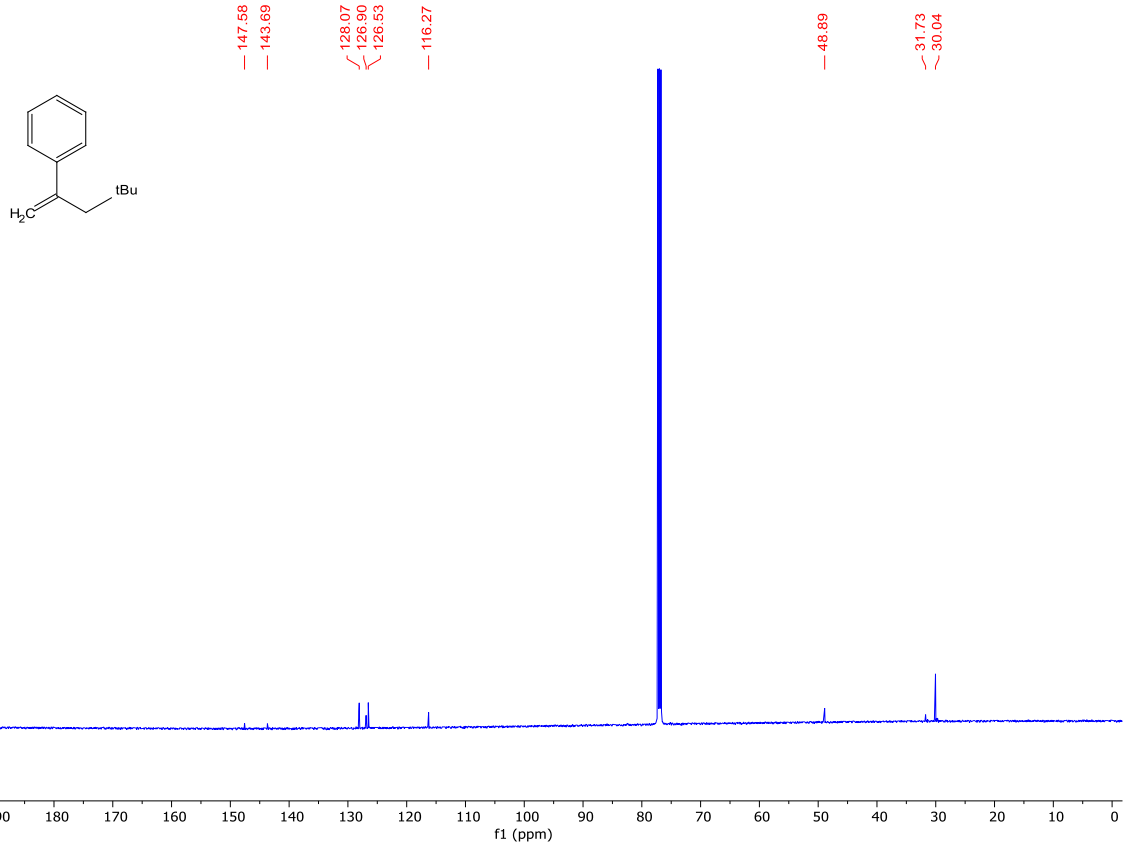
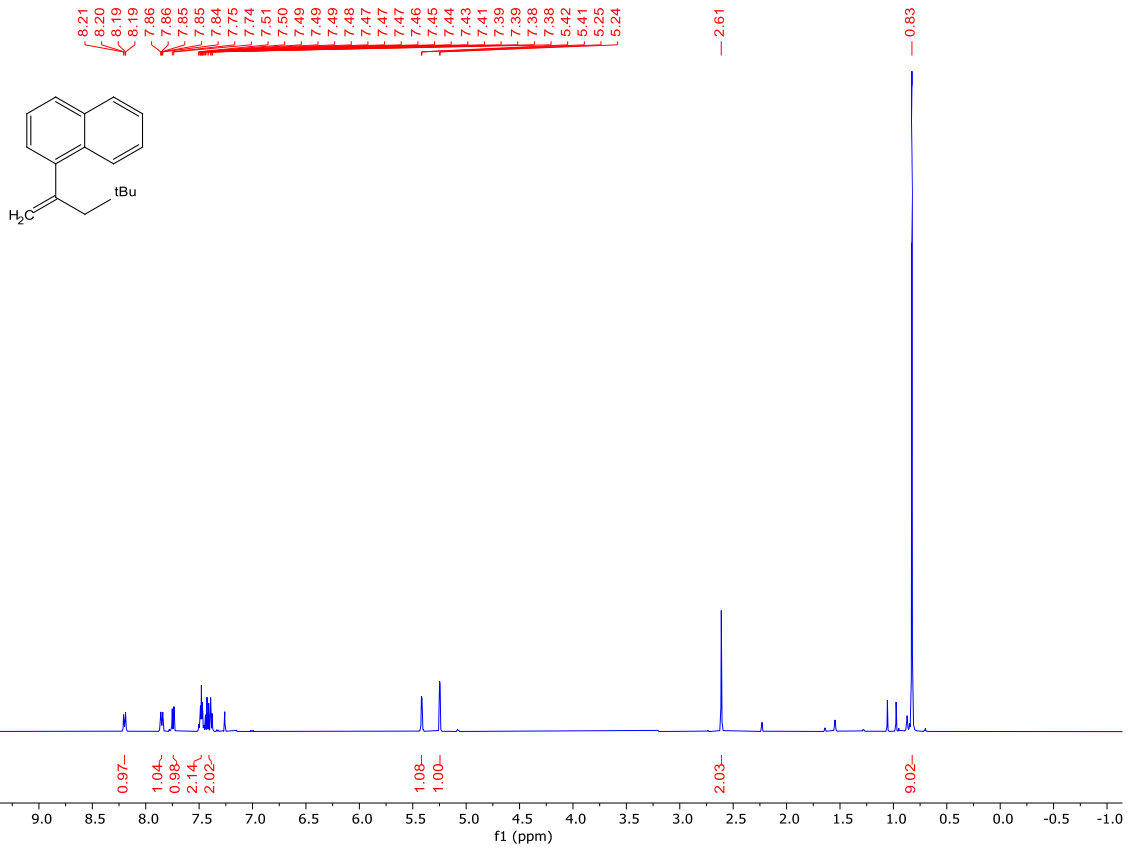
0.80
tBu
H2C
1.94
2.11
1.03
1.00
0.98
1.98
8.79
f1 (ppm)


147.58
143.69
128.07
126.90
126.53
116.27
48.89
31.73
30.04
tBu
H2C
f1 (ppm)

3h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7.85
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7.74
7.51
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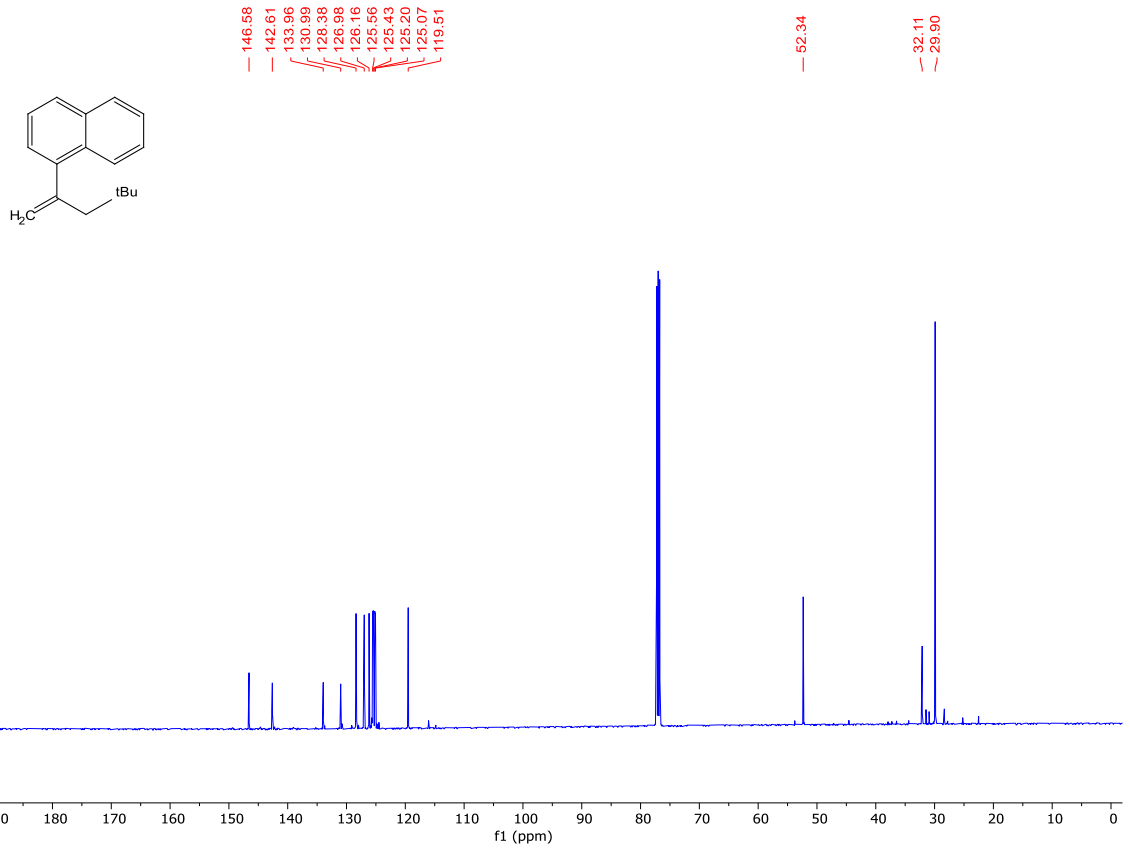
7.49
7.49
7.48
7.47
7.47
7.47
7.46
7.45
7.44
7.43
7.41
7.39
7.39
7.38
7.38
5.42
5.41
5.25
5.24
2.61
0.83
tBu
H2C
0.97
1.04
0.98
2.14
2.02
1.08
1.00
2.03
9.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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142.61
133.96
130.99
128.38
126.98
126.16
125.56
125.43
125.20
125.07
119.51
52.34
32.11
29.90
tBu
H2C
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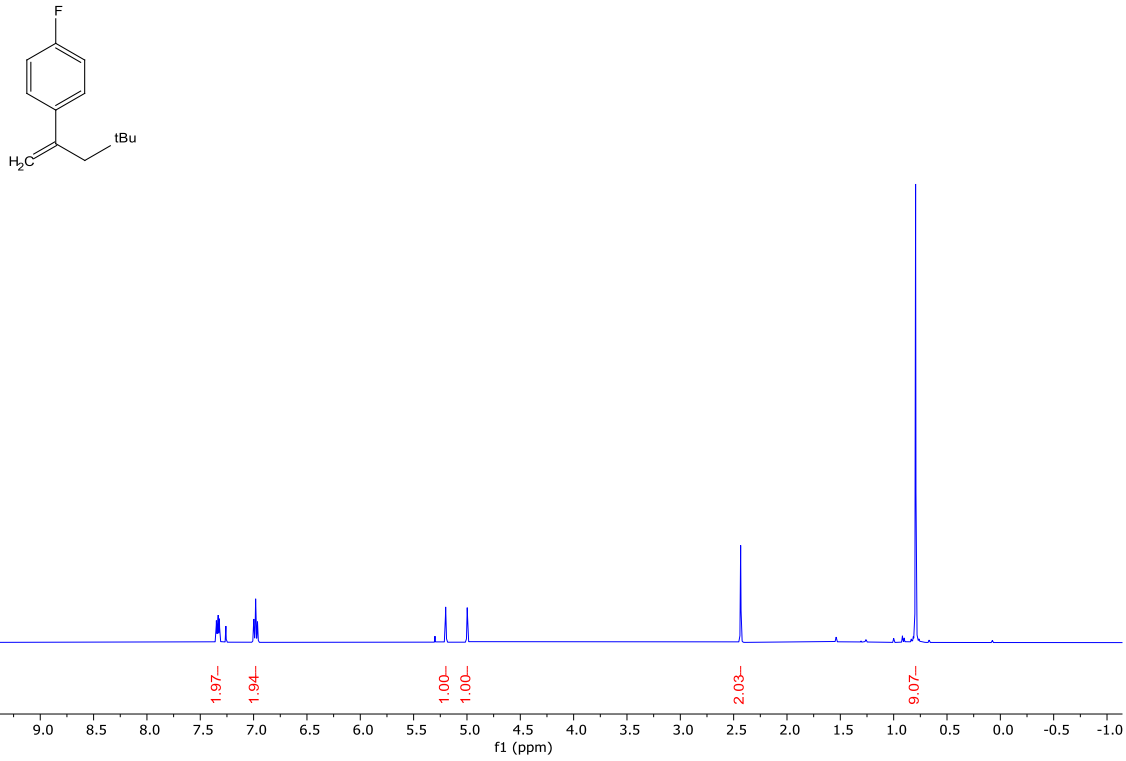
f1 (ppm)

3i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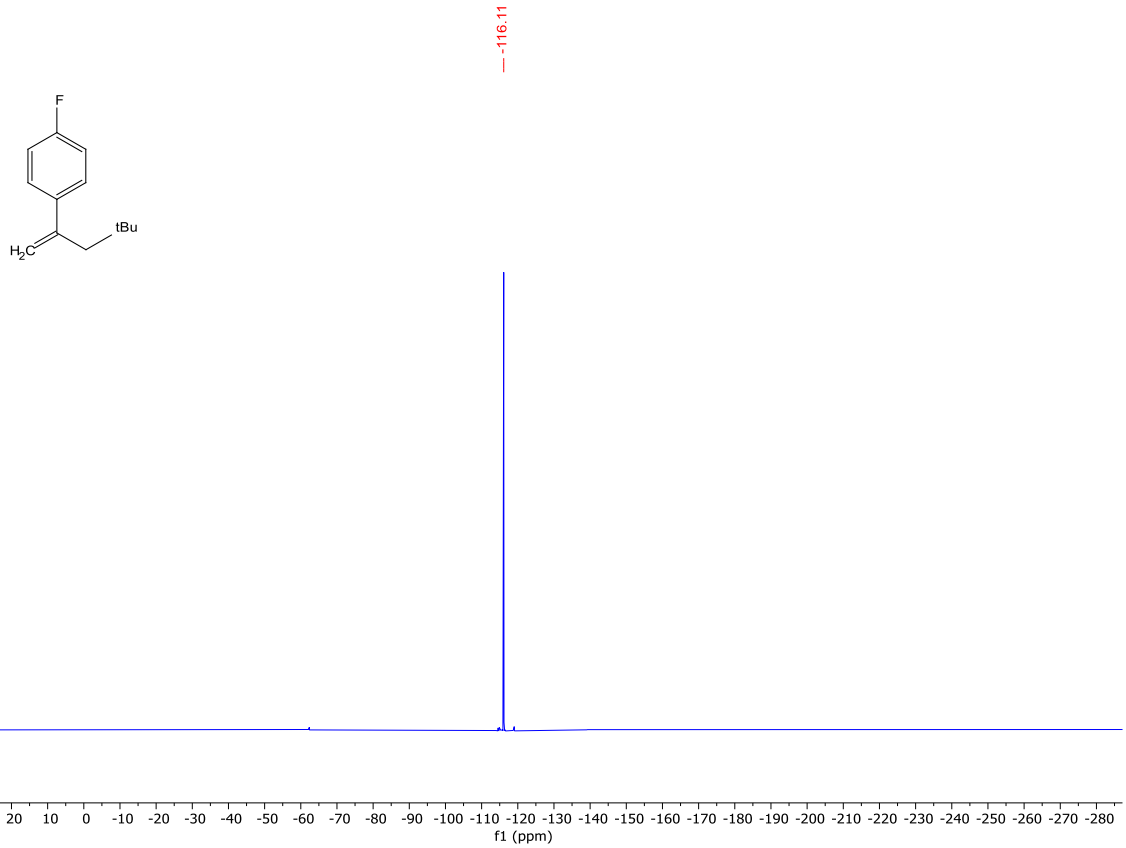
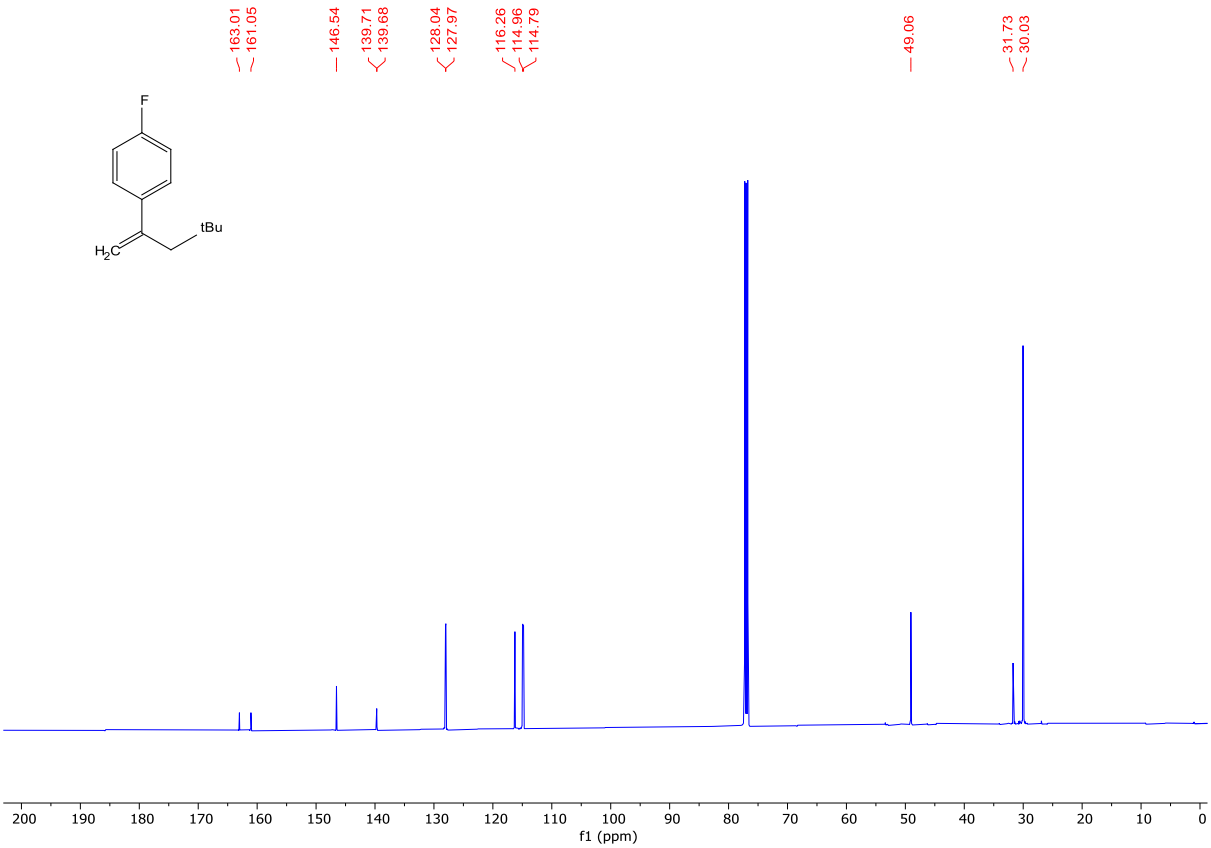
7.34
7.33
7.32
7.00
6.98
6.96
5.20
5.00
2.43
0.79
F
tBu
H2C
1.97
1.94
1.00
1.00
2.03
9.07
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


-116.11
F
tBu
H2C
40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220 -230 -240 -250 -260 -270 -280
f1 (ppm)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139.71
139.68
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127.97
116.26
114.96
114.79
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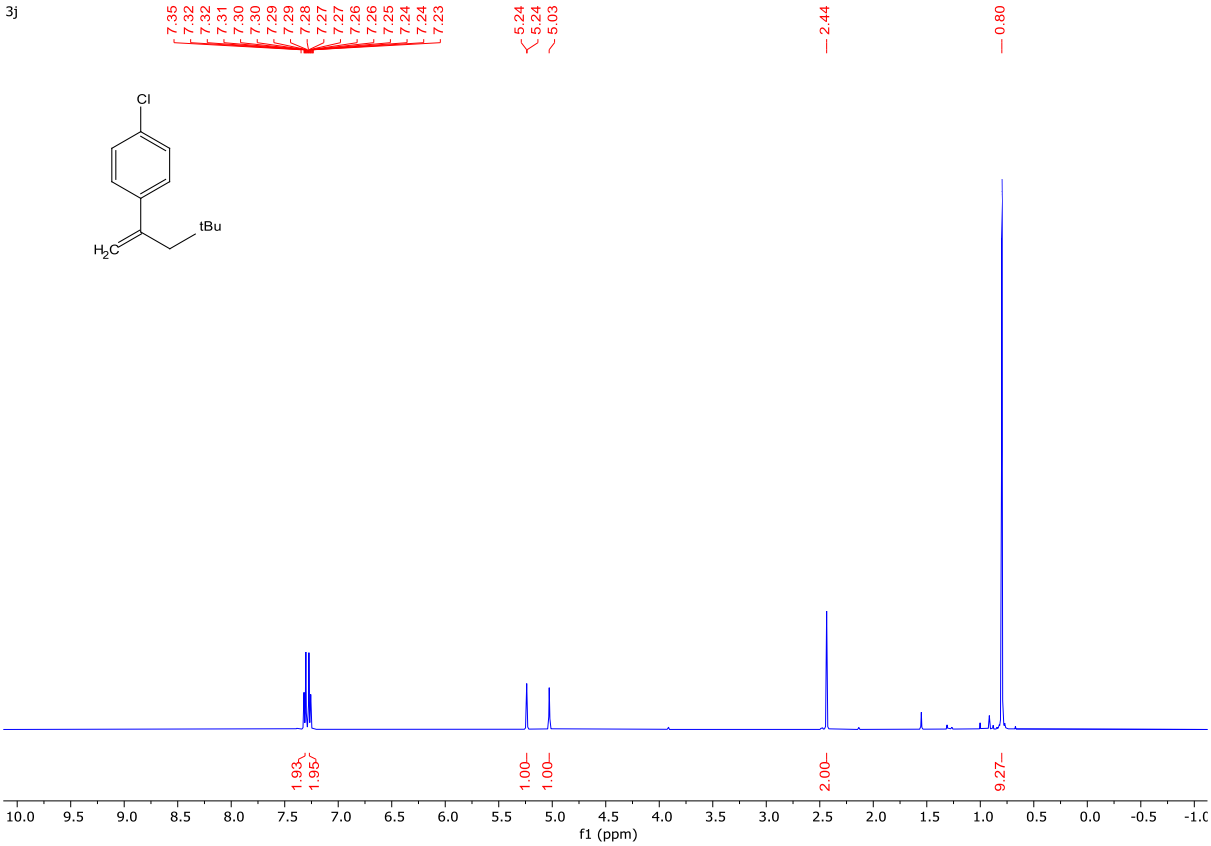
31.73
30.03
F
tBu
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

3j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7.31
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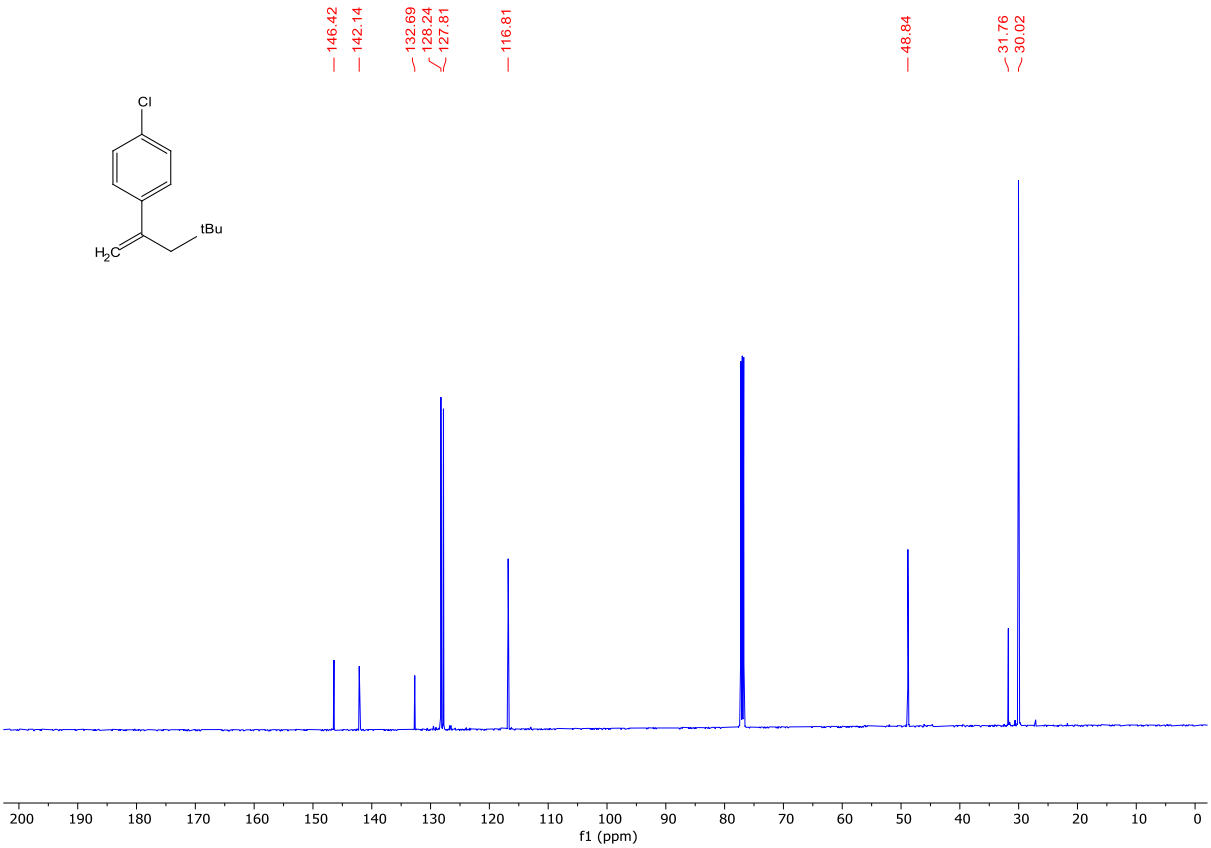
7.29
7.28
7.27
7.27
7.26
7.26
7.25
7.24
7.24
7.23
5.24
5.24
5.03
2.44
0.80
Cl
tBu
H2C
1.93
1.95
1.00
1.00
2.00
9.27
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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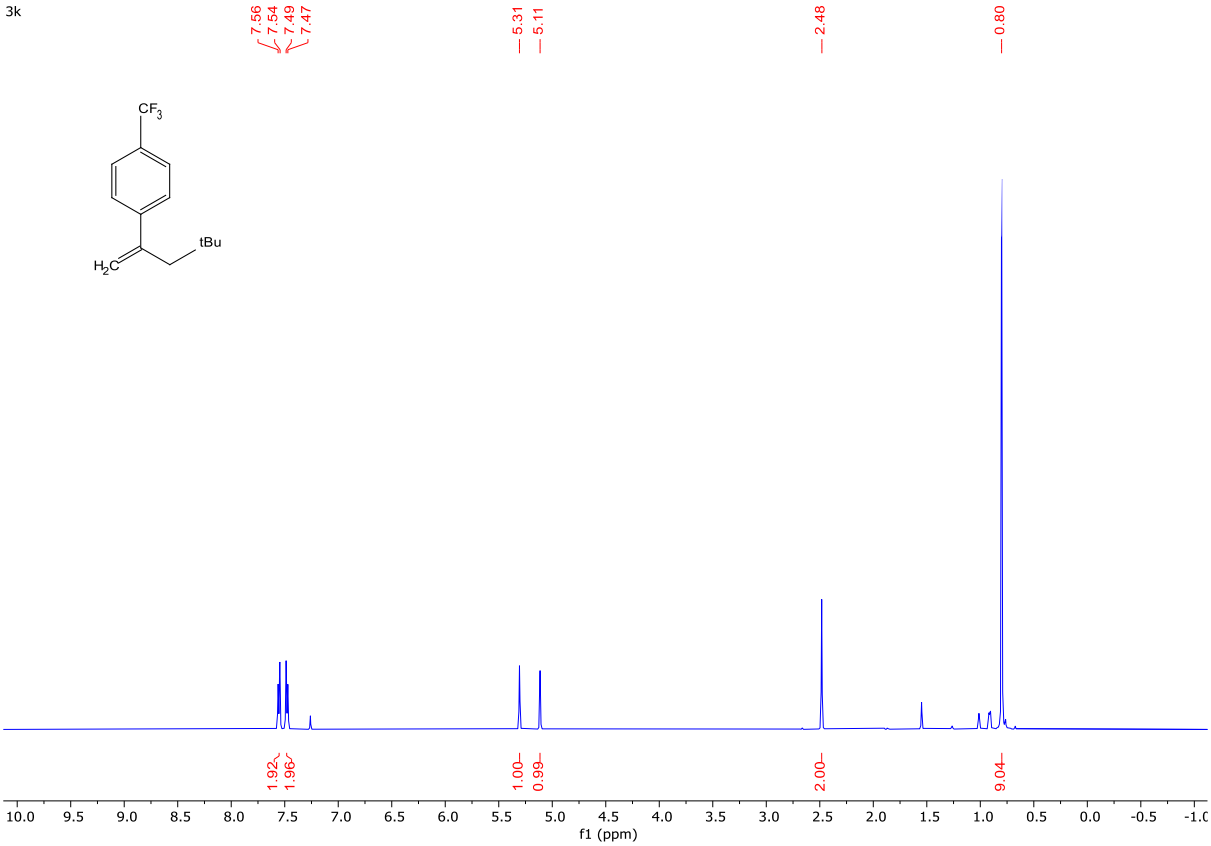
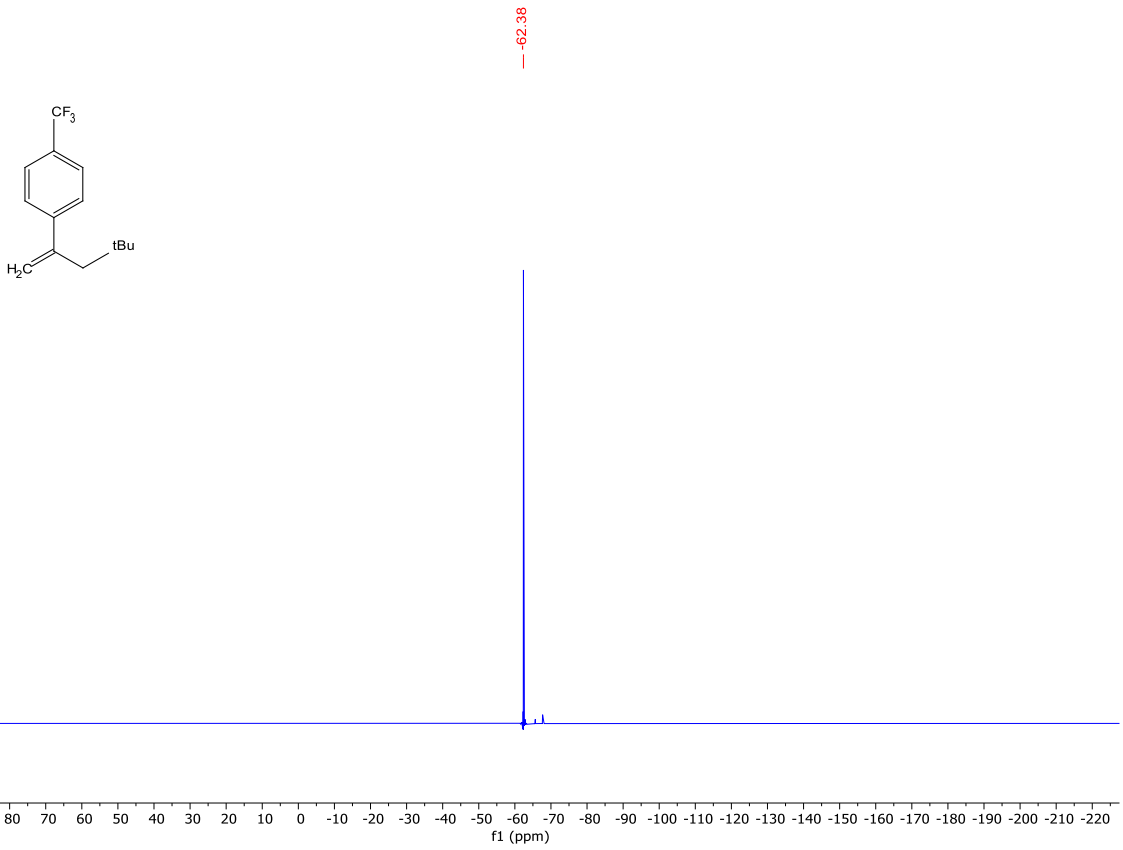
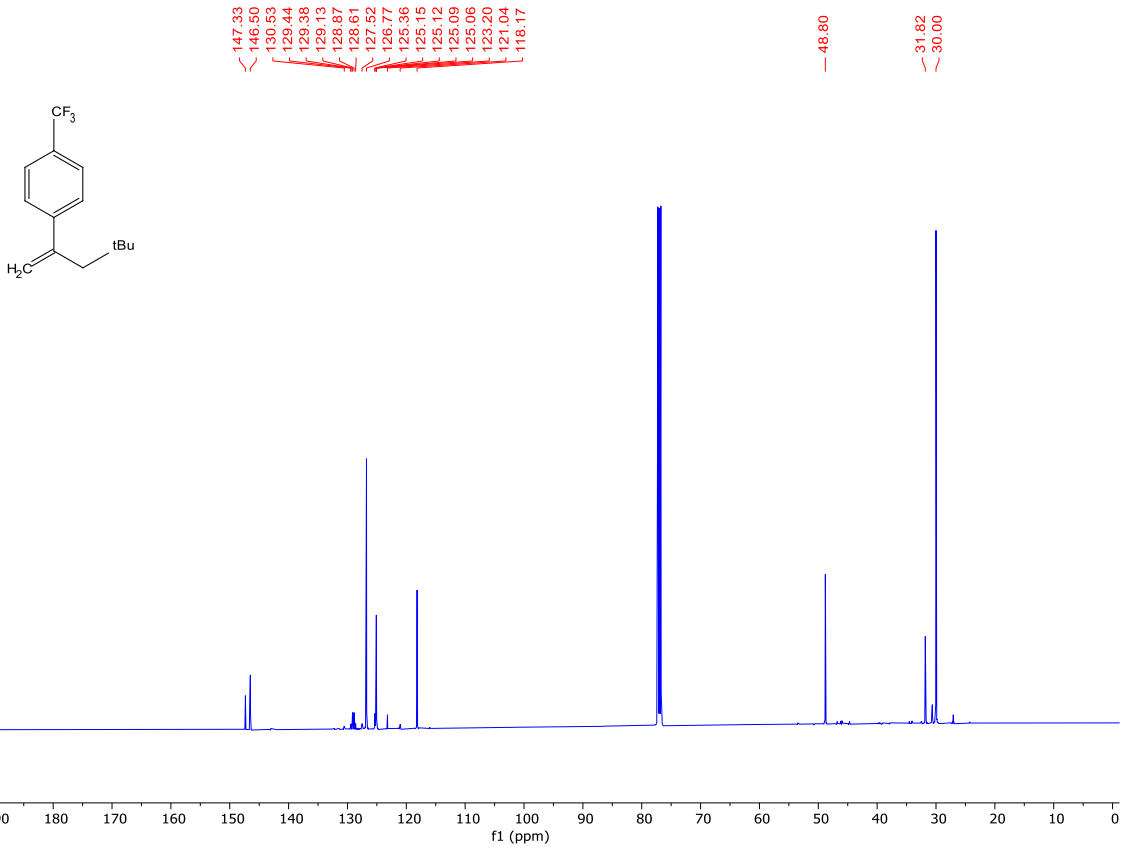
128.24
127.81
116.81
48.84
31.76
30.02
Cl
tBu
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

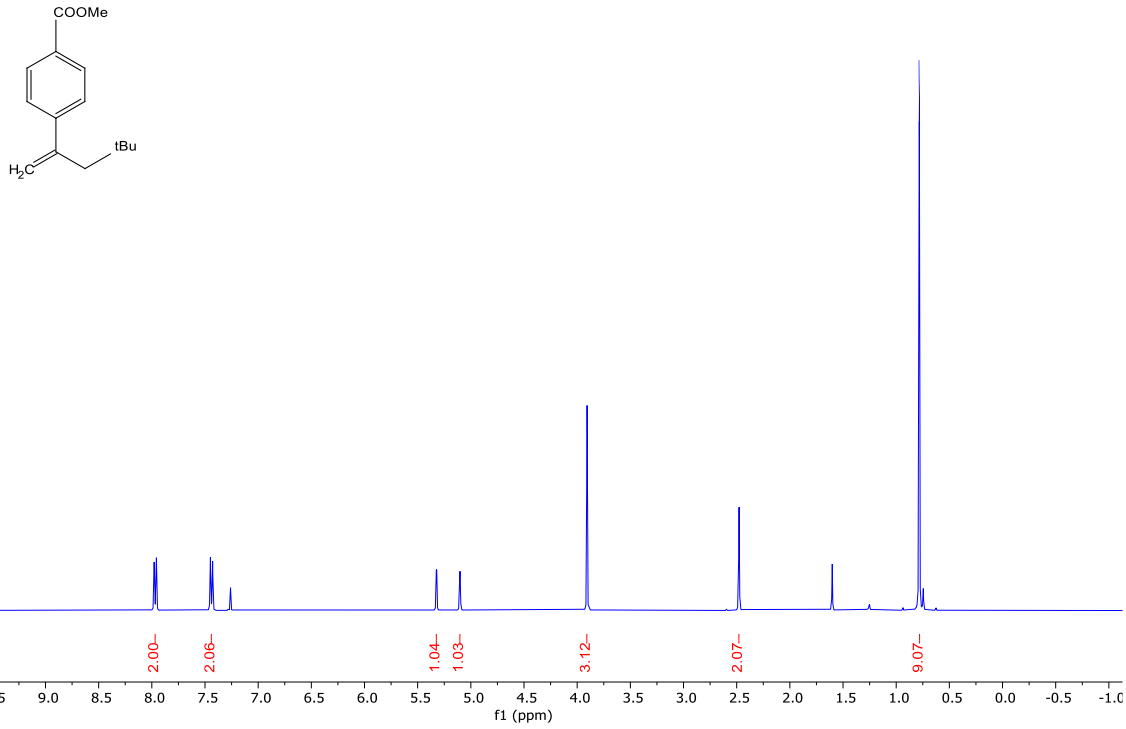
3k

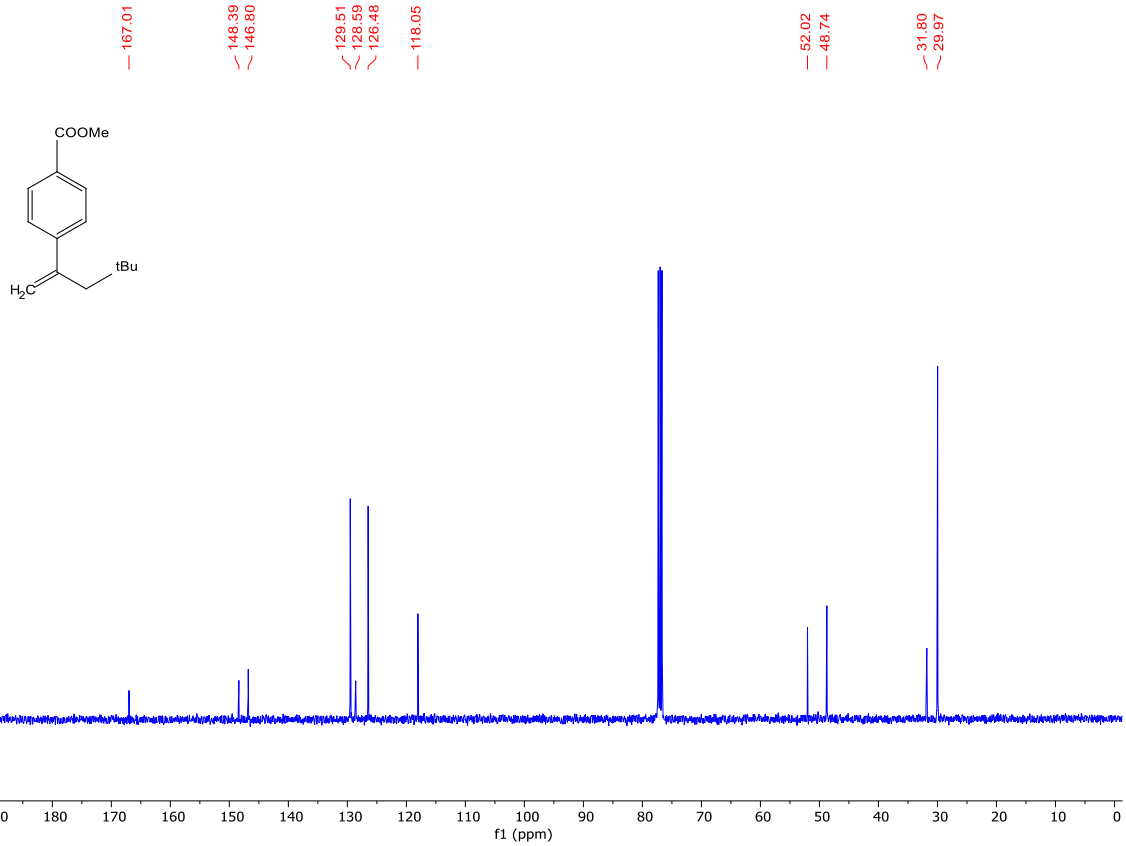

7.56
7.54
7.49
7.47
5.31
5.11
2.48
0.80
CF3
tBu
H2C
1.92
1.96
1.00
0.99
2.00
9.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


-62.38
CF3
tBu
H2C
100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220
f1 (ppm)

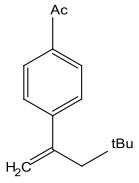

147.33
146.50
130.53
129.44
129.38
129.13
128.87
128.61
127.52
126.77
125.36
125.15
125.12
125.09
125.06
123.20
121.04
118.17
48.80
31.82
30.00
CF3
tBu
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

3l


7.98
7.96
7.45
7.43
5.32
5.32
5.10
3.91
2.48
0.78
COOMe
tBu
H_2C
2.00
2.06
1.04
1.03
3.12
2.07
9.07
f1 (ppm)


167.01
148.39
146.80
129.51
128.59
126.48
118.05
52.02
48.74
31.80
29.97
COOMe
tBu
H_2C
f1 (ppm)

3m

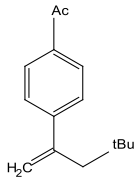


7.91
7.89
7.47
7.45
5.34
5.33
5.12
5.11
2.59
2.48
0.79

2.00
2.01
1.01
1.02
2.99
2.01
9.07

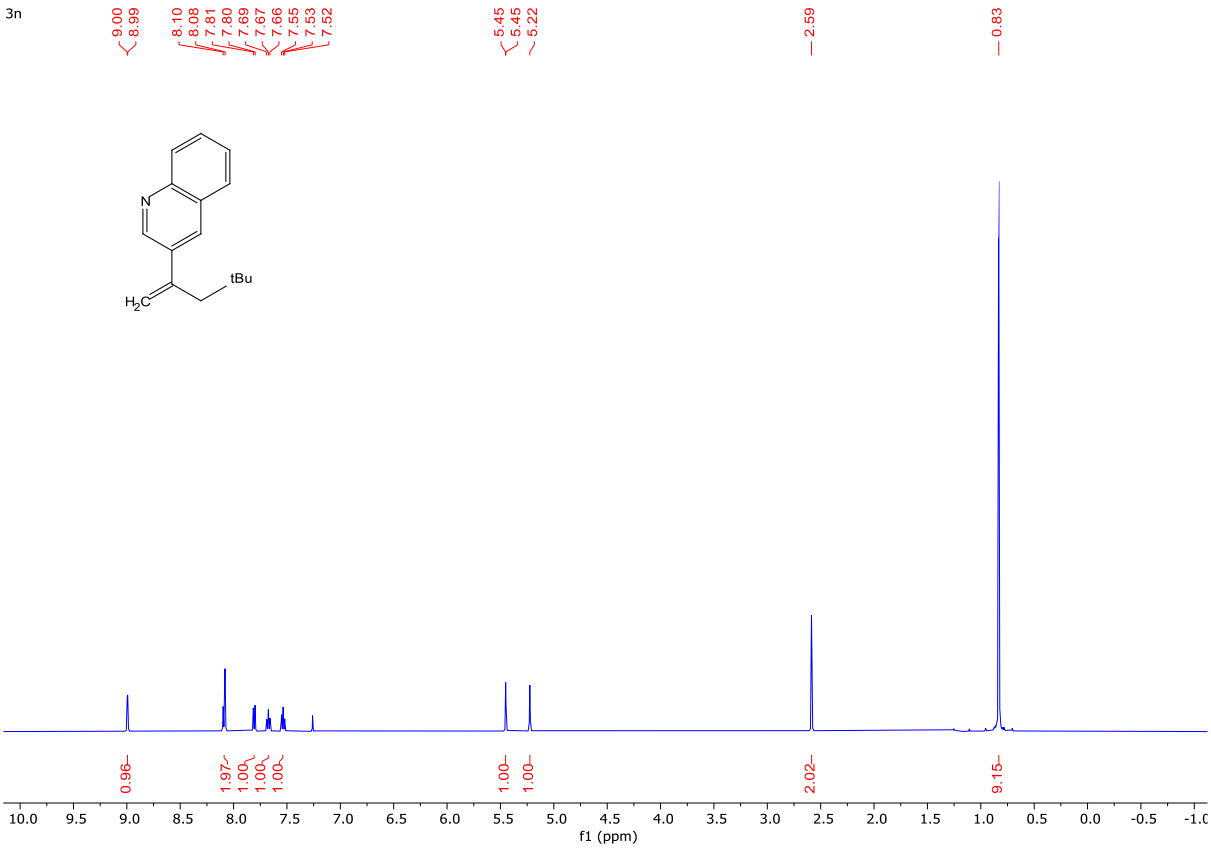
f1 (ppm)

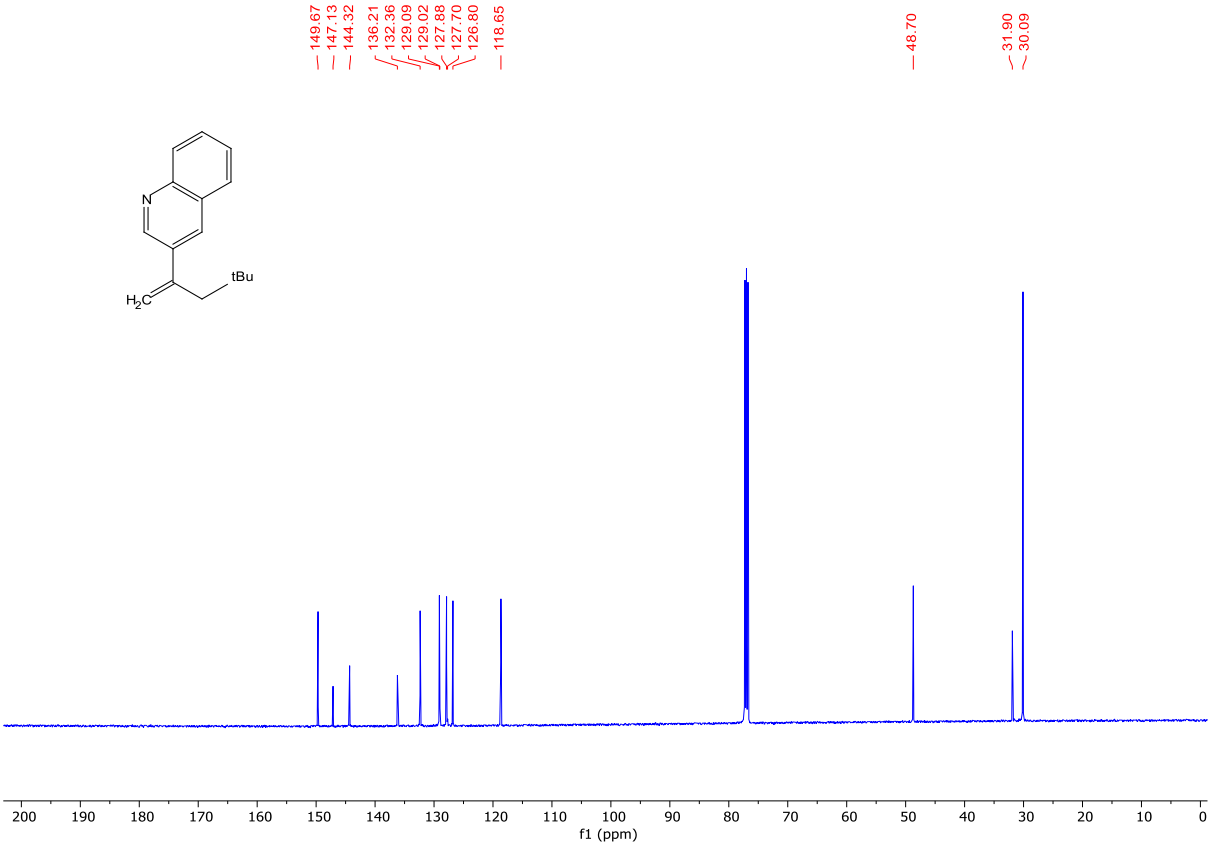
197.71
148.56
146.70
135.67
128.35
126.64
118.22
48.69
31.81
29.97
26.57



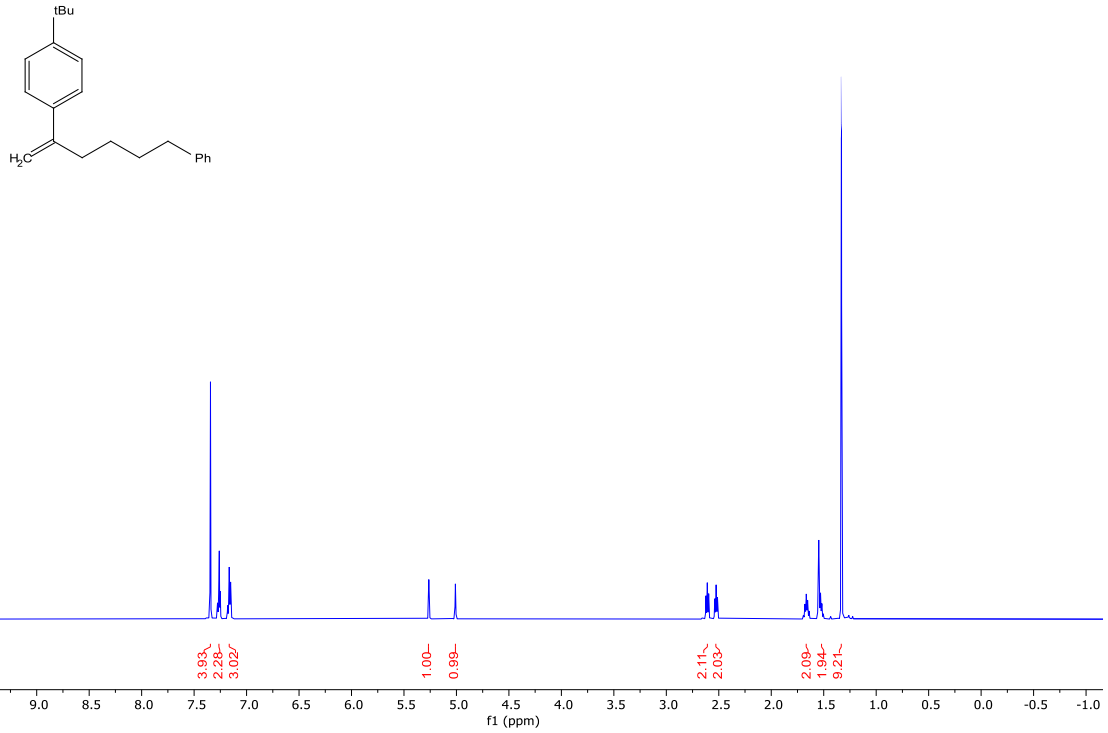
f1 (ppm)

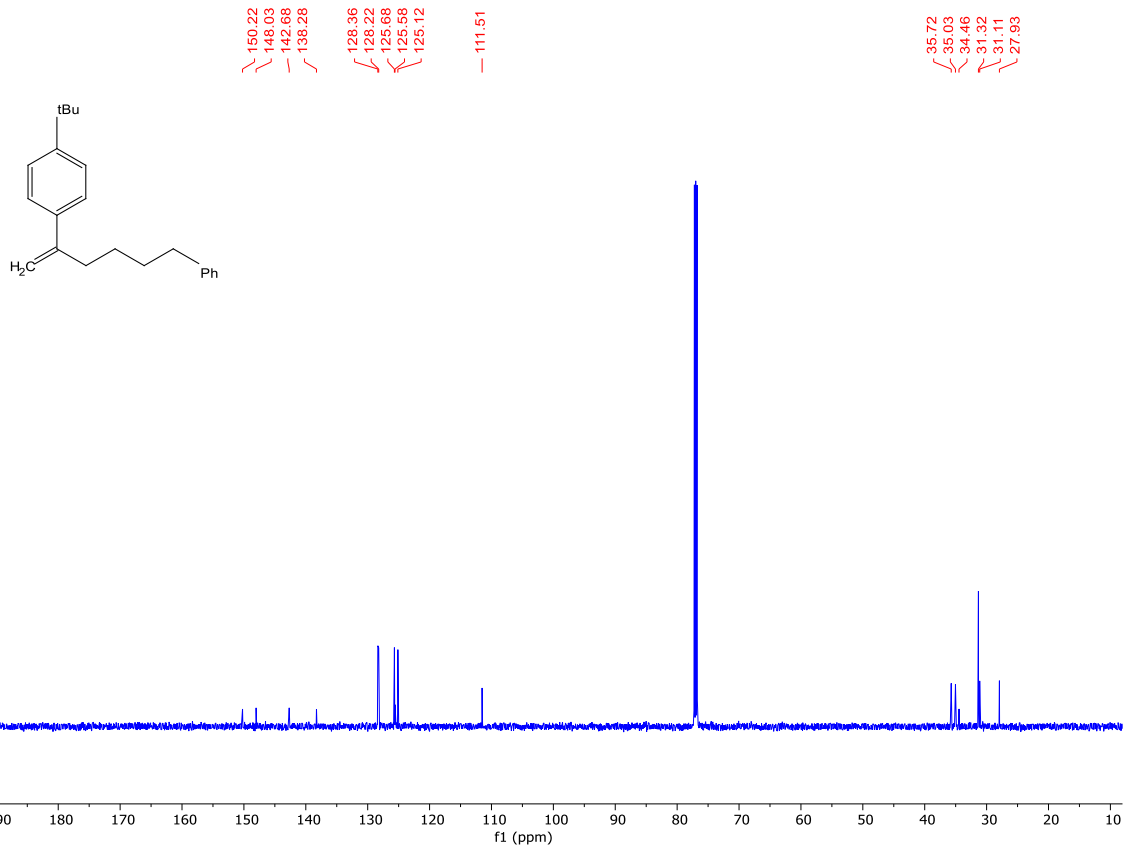
3n


9.00
8.99
8.10
8.08
7.81
7.80
7.69
7.67
7.66
7.55
7.53
7.52
5.45
5.45
5.22
2.59
0.83
N
tBu
H2C
0.96
1.97
1.00
1.00
1.00
1.00
1.00
2.02
9.15
f1 (ppm)

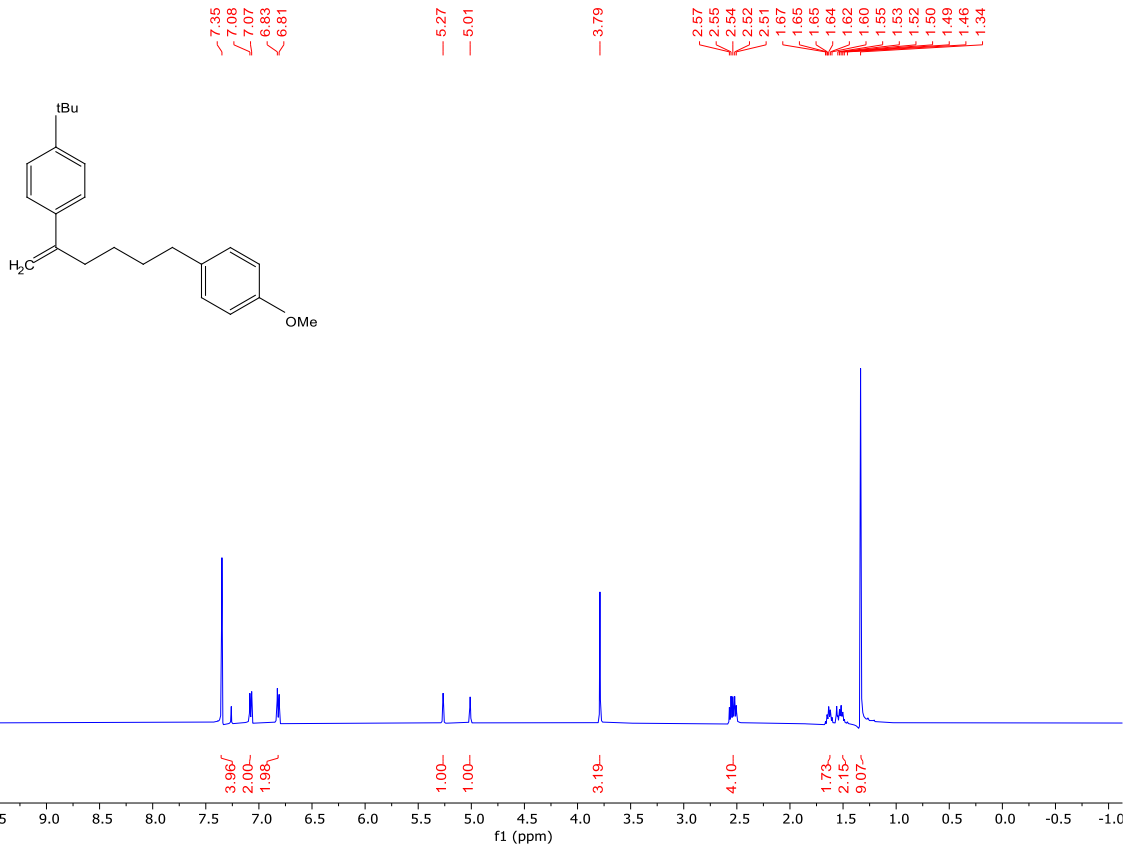

149.67
147.13
144.32
136.21
132.36
129.09
129.02
127.88
127.70
126.80
118.65
48.70
31.90
30.09
N
tBu
H2C
f1 (ppm)

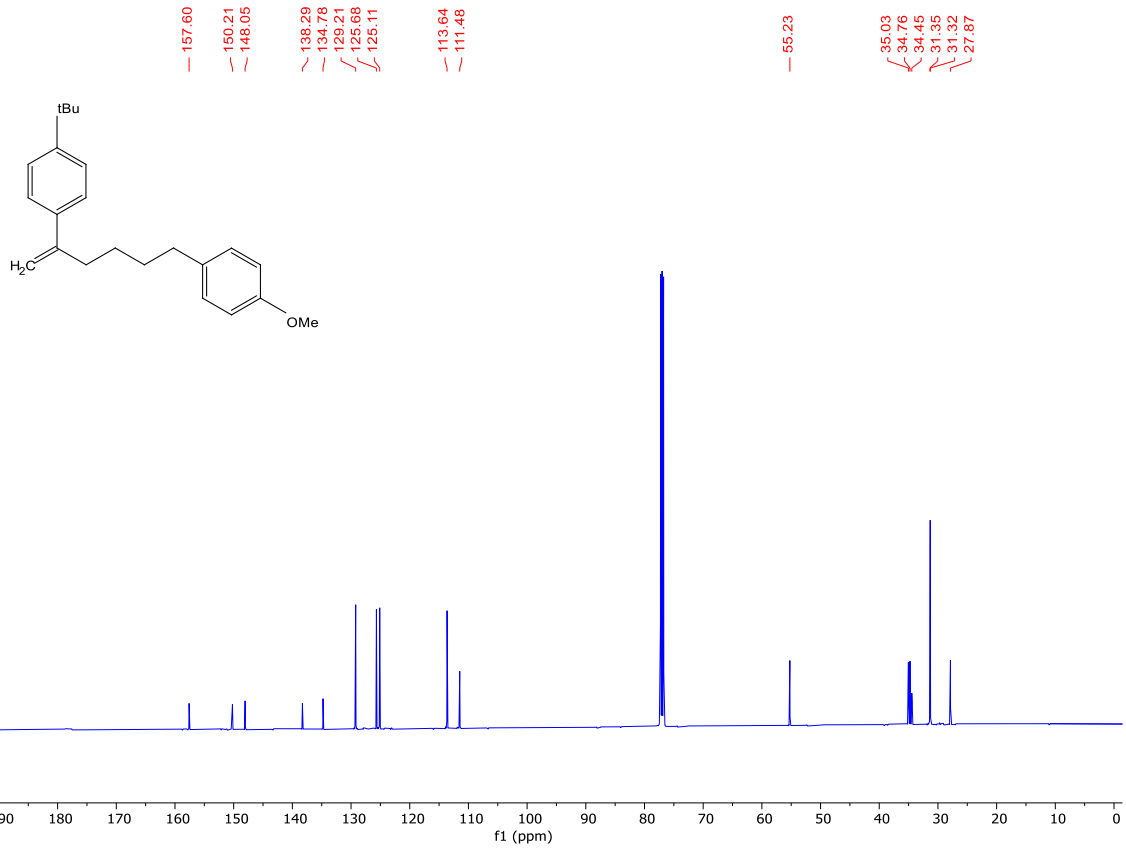
4a

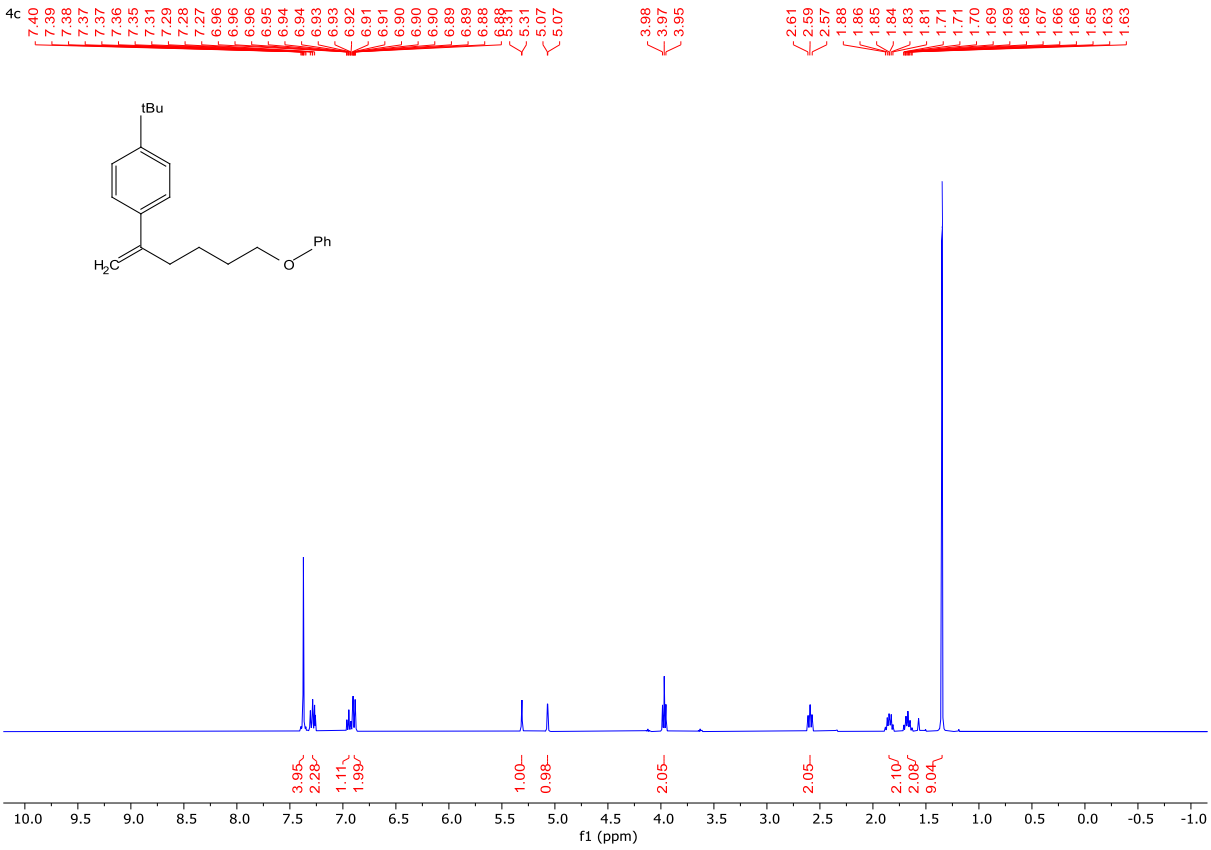

7.34
7.28
7.26
7.25
7.18
7.18
7.17
7.17
7.16
7.15
5.26
5.26
5.01
5.01
5.01
2.62
2.61
2.60
2.54
2.53
2.51
1.68
1.68
1.68
1.67
1.66
1.66
1.65
1.65
1.64
1.56
1.55
1.53
1.52
1.33
tBu
H2C
Ph
3.93
2.28
3.02
1.00
0.99
2.11
2.03
2.09
1.94
9.21
f1 (ppm)

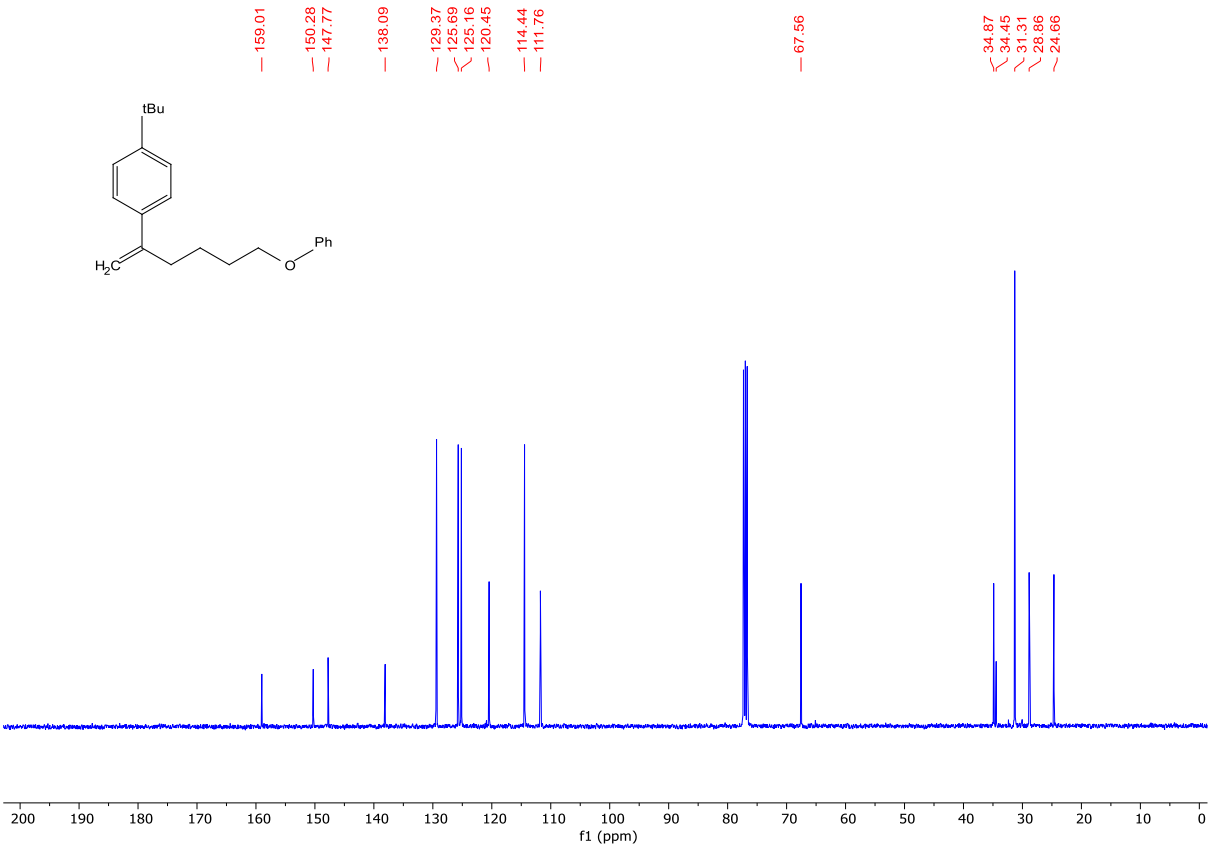

150.22
148.03
142.68
138.28
128.36
128.22
125.68
125.58
125.12
111.51
35.72
35.03
34.46
31.32
31.11
27.93
tBu
H2C
Ph
f1 (ppm)

4b

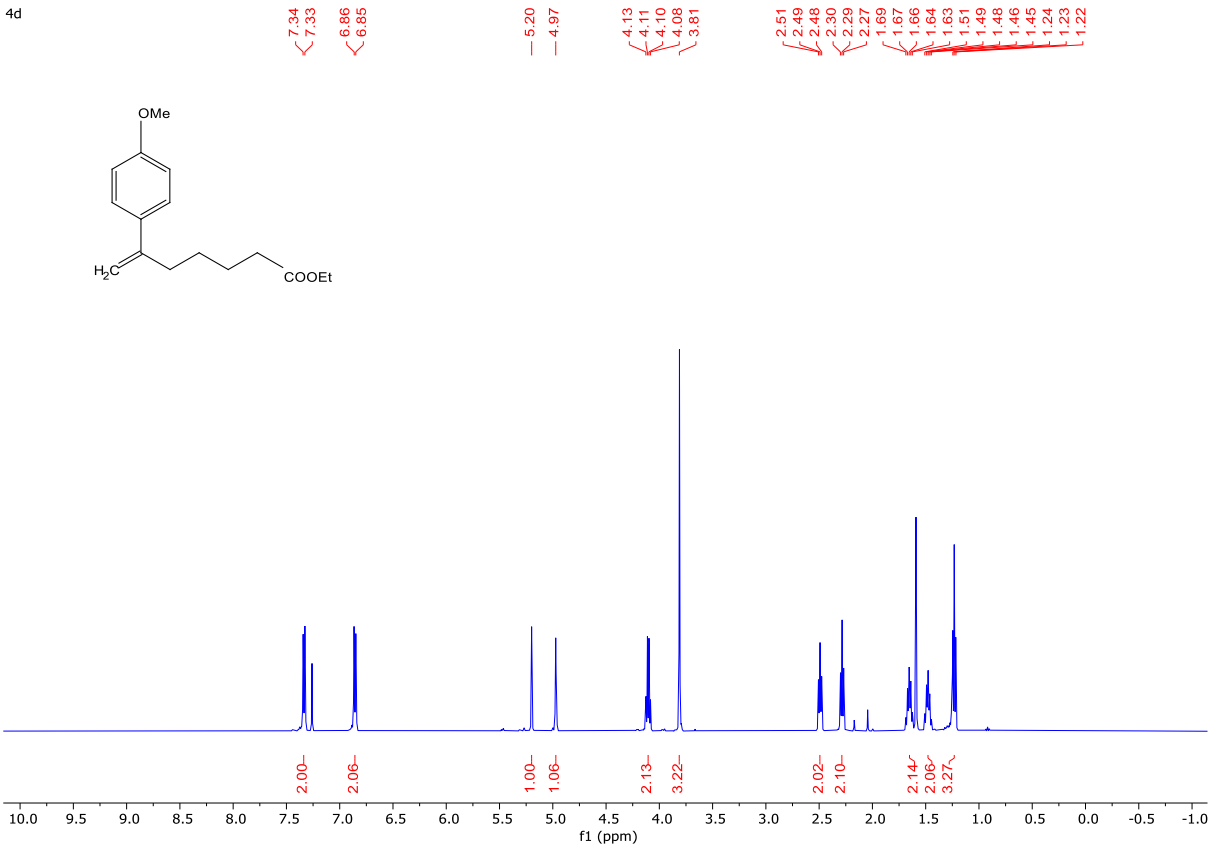

7.35
7.08
7.07
6.83
6.81
5.27
5.01
3.79
2.57
2.55
2.54
2.52
2.51
1.67
1.65
1.65
1.64
1.62
1.60
1.55
1.53
1.52
1.50
1.49
1.46
1.34
tBu
H2C
OMe
3.96
2.00
1.98
1.00
1.00
3.19
4.10
1.73
2.15
9.07
f1 (ppm)

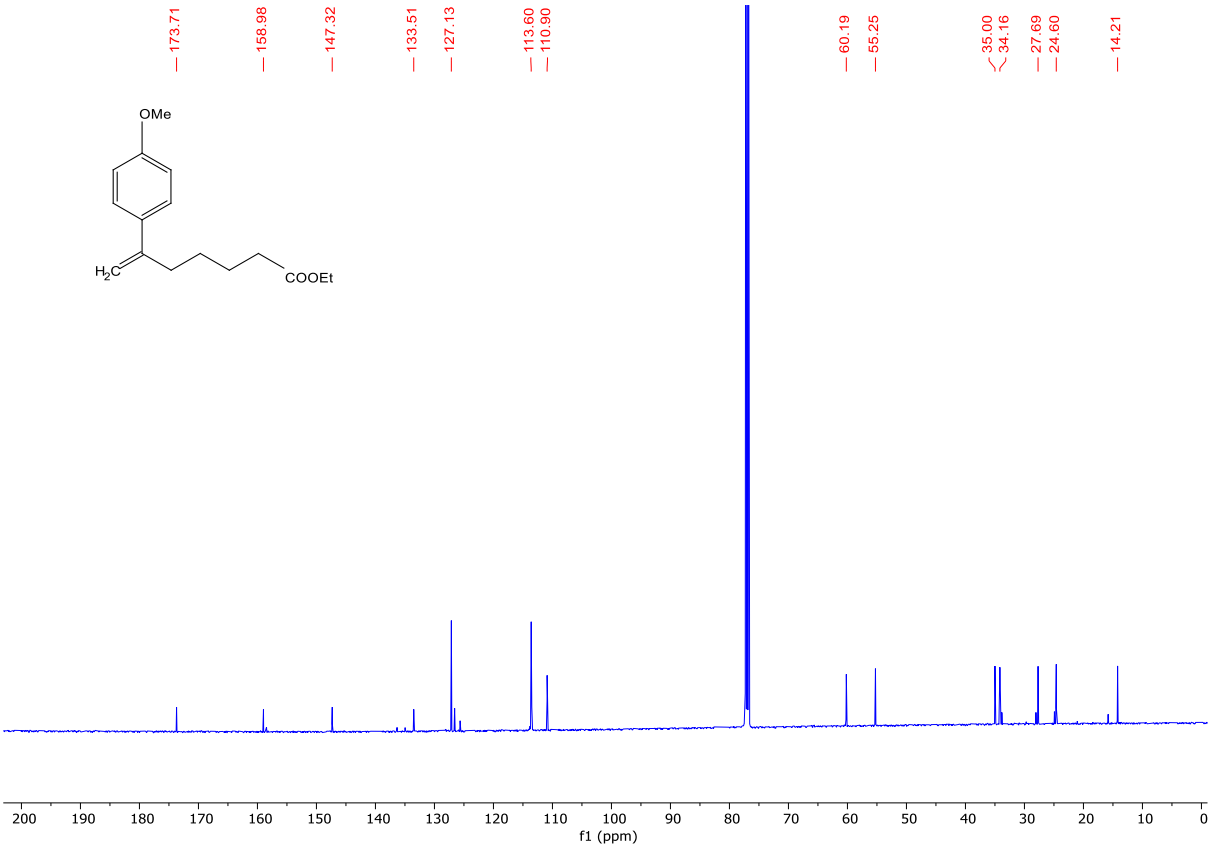

157.60
150.21
148.05
138.29
134.78
129.21
125.68
125.11
113.64
111.48
55.23
35.03
34.76
34.45
31.35
31.32
27.87
tBu
H2C
OMe
f1 (ppm)


4c
7.40 7.39 7.38 7.37 7.37 7.36 7.35 7.31 7.29 7.28 7.27 6.96 6.96 6.96 6.95 6.94 6.94 6.93 6.93 6.92 6.91 6.91 6.90 6.90 6.90 6.89 6.89 6.88 5.31 5.07 5.07
3.98 3.97 3.95
2.61 2.59 2.57 1.88 1.86 1.85 1.84 1.83 1.81 1.71 1.71 1.70 1.69 1.69 1.68 1.67 1.66 1.66 1.65 1.63 1.63
tBu
Ph
H2C
O
3.95 2.28 1.11 1.99 1.00 0.98 2.05 2.05 2.10 2.08 9.04
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

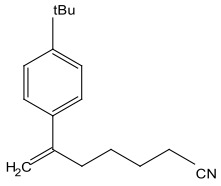

159.01 150.28 147.77 138.09 129.37 125.69 125.16 120.45 114.44 111.76 67.56 34.87 34.45 31.31 28.86 24.66
tBu
Ph
H2C
O
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

4d

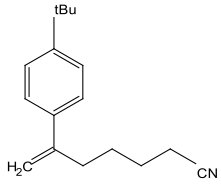

7.34
7.33
6.86
6.85
5.20
4.97
4.13
4.11
4.10
4.08
3.81
2.51
2.49
2.48
2.30
2.29
2.27
1.69
1.67
1.66
1.64
1.63
1.51
1.49
1.48
1.46
1.45
1.24
1.23
1.22
OMe
H2C
COOEt
2.00
2.06
1.00
1.06
2.13
3.22
2.02
2.10
2.14
2.06
3.27
f1 (ppm)


173.71
158.98
147.32
133.51
127.13
113.60
110.90
60.19
55.25
35.00
34.16
27.69
24.60
14.21
OMe
H2C
COOEt
f1 (ppm)

4e

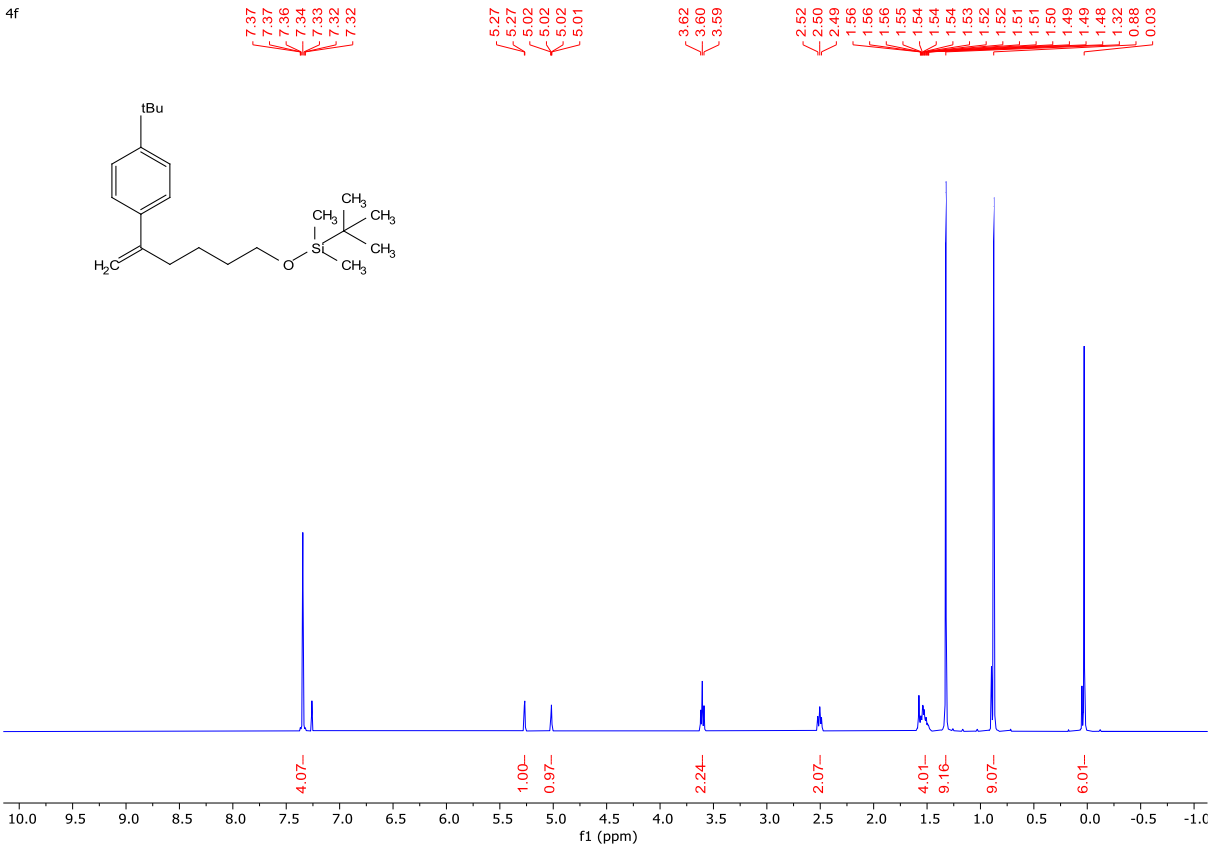

tBu
H2C
CN

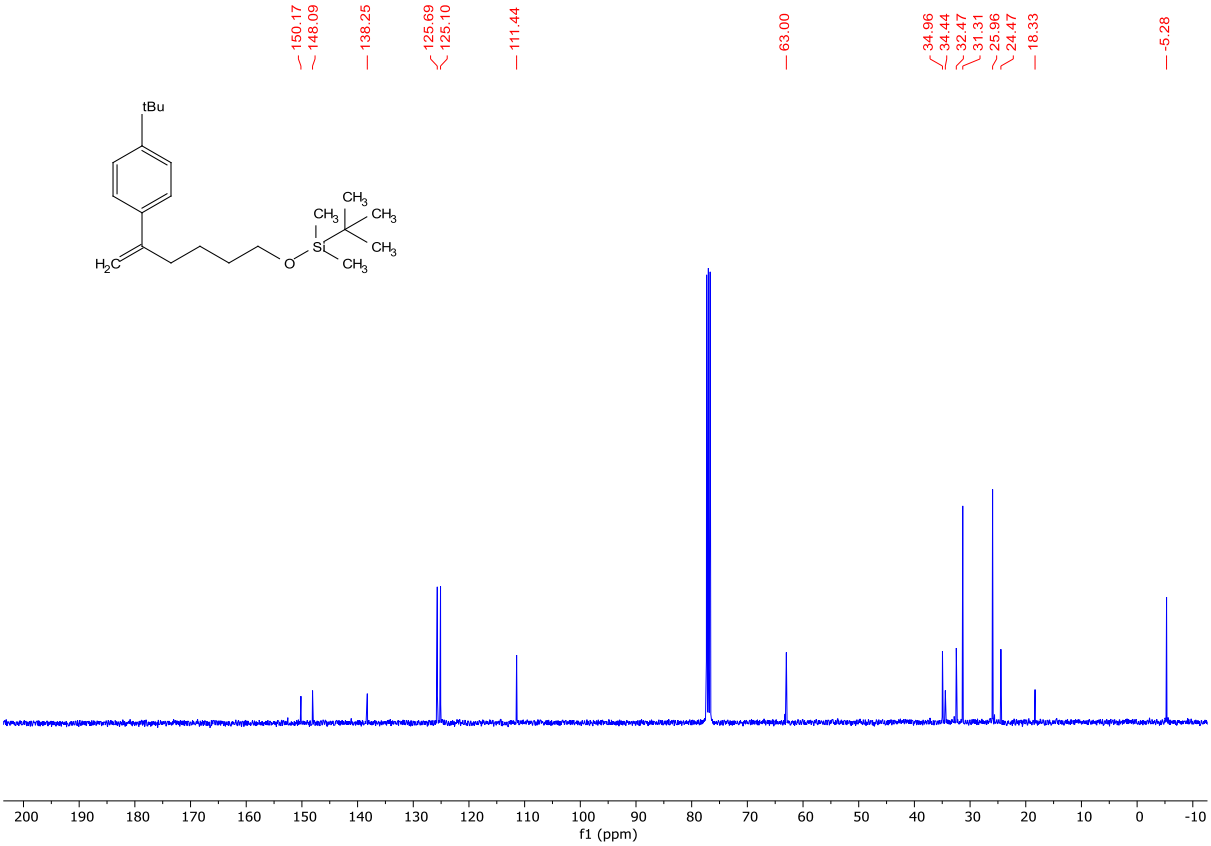
7.37
7.36
7.35
7.34
7.32
7.32
5.30
5.03
2.56
2.55
2.53
2.34
2.33
2.31
1.72
1.72
1.71
1.70
1.69
1.69
1.68
1.68
1.67
1.66
1.65
1.65
1.64
1.64
1.63
1.62
1.62
1.61
1.61
1.60
1.33
3.81
1.00
0.95
1.96
1.95
4.02
8.96
f1 (ppm)


tBu
H2C
CN

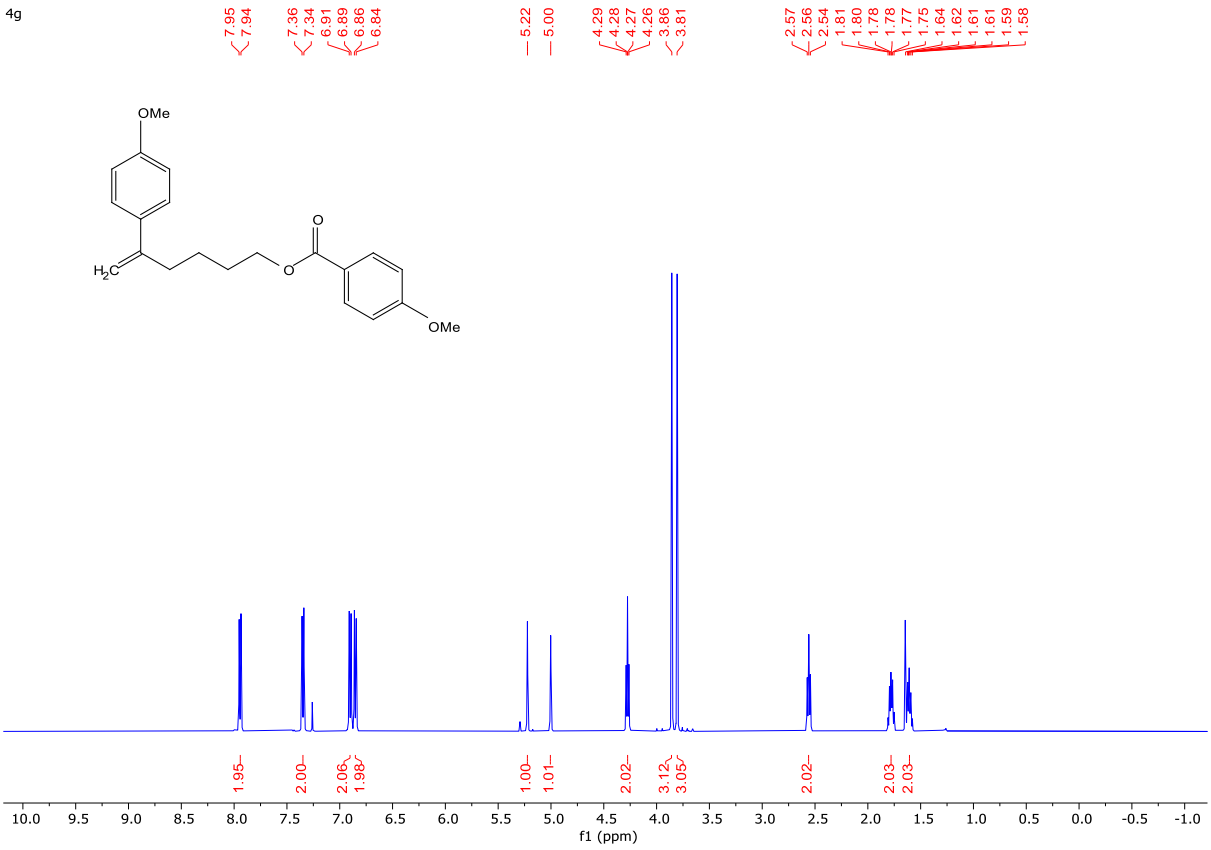
150.52
146.99
137.63
125.64
125.26
119.67
112.23
34.46
34.30
31.27
27.12
24.90
16.96
f1 (ppm)

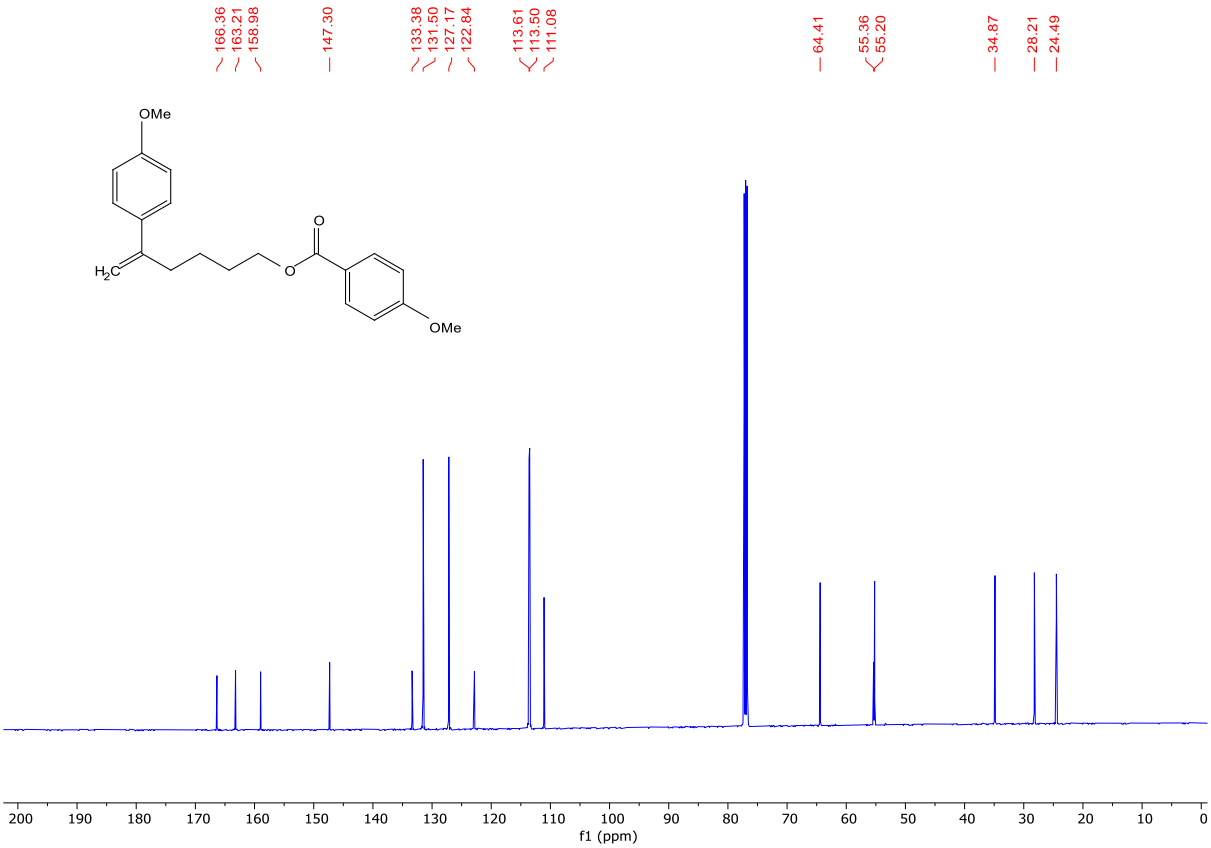
4f


7.37
7.37
7.36
7.34
7.33
7.32
7.32
5.27
5.27
5.02
5.02
5.02
5.01
3.62
3.60
3.59
2.52
2.50
2.49
1.56
1.56
1.56
1.55
1.54
1.54
1.54
1.53
1.52
1.52
1.51
1.51
1.50
1.49
1.49
1.48
1.32
0.88
0.03
tBu
CH3
CH3
CH3
Si
CH3
CH3
H2C
O
4.07
1.00
0.97
2.24
2.07
4.01
9.16
9.07
6.01
f1 (ppm)

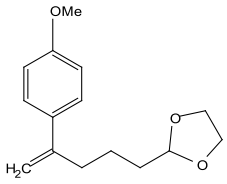

150.17
148.09
138.25
125.69
125.10
111.44
63.00
34.96
34.44
32.47
31.31
25.96
24.47
18.33
-5.28
tBu
CH3
CH3
CH3
Si
CH3
CH3
H2C
O
f1 (ppm)

4g

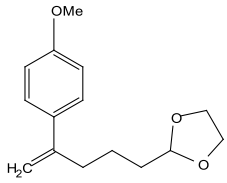

7.95
7.94
7.36
7.34
6.91
6.89
6.86
6.84
5.22
5.00
4.29
4.28
4.27
4.26
3.86
3.81
2.57
2.56
2.54
1.81
1.80
1.78
1.78
1.77
1.75
1.64
1.62
1.61
1.61
1.59
1.58
OMe
O
H2C
O
OMe
1.95
2.00
2.06
1.98
1.00
1.01
2.02
3.12
3.05
2.02
2.03
2.03
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


166.36
163.21
158.98
147.30
133.38
131.50
127.17
122.84
113.61
113.50
111.08
64.41
55.36
55.20
34.87
28.21
24.49
OMe
O
H2C
O
OMe
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

4h

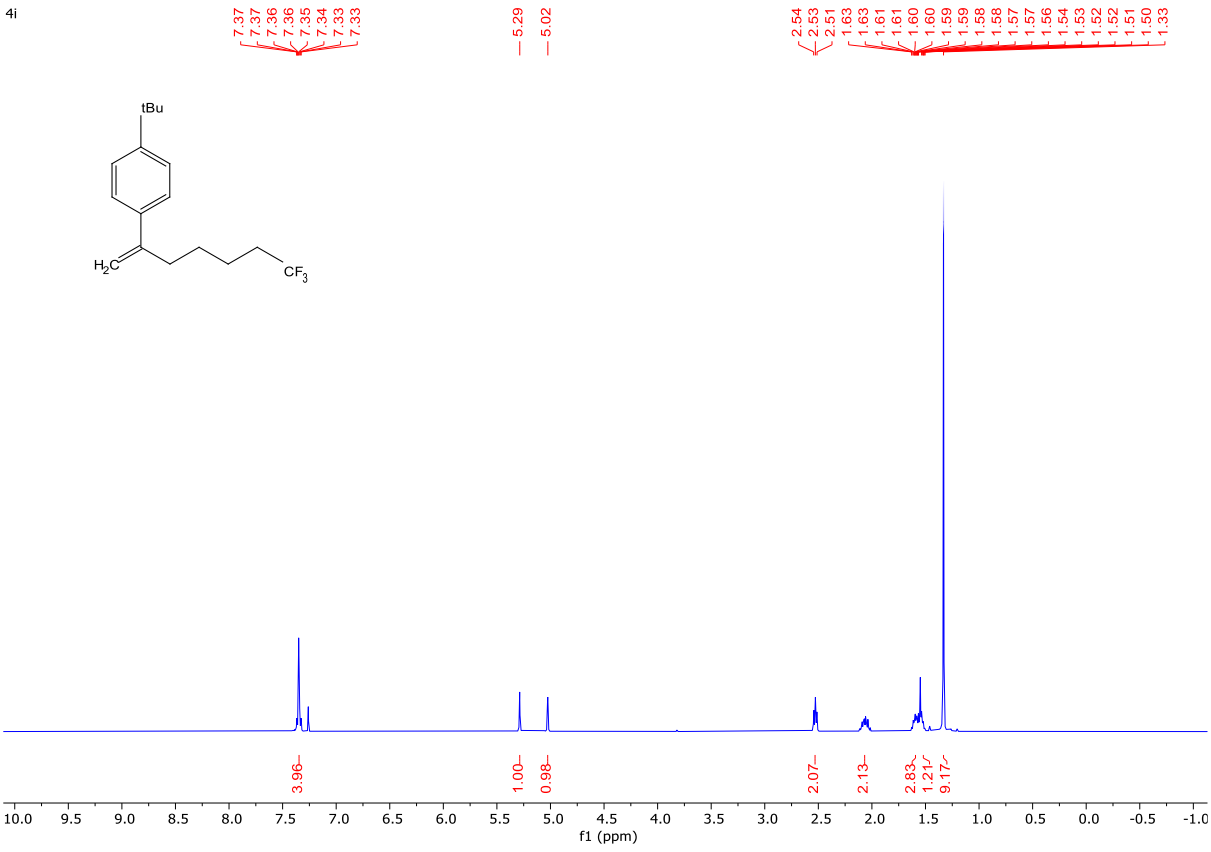

OMe
O
O
H2C

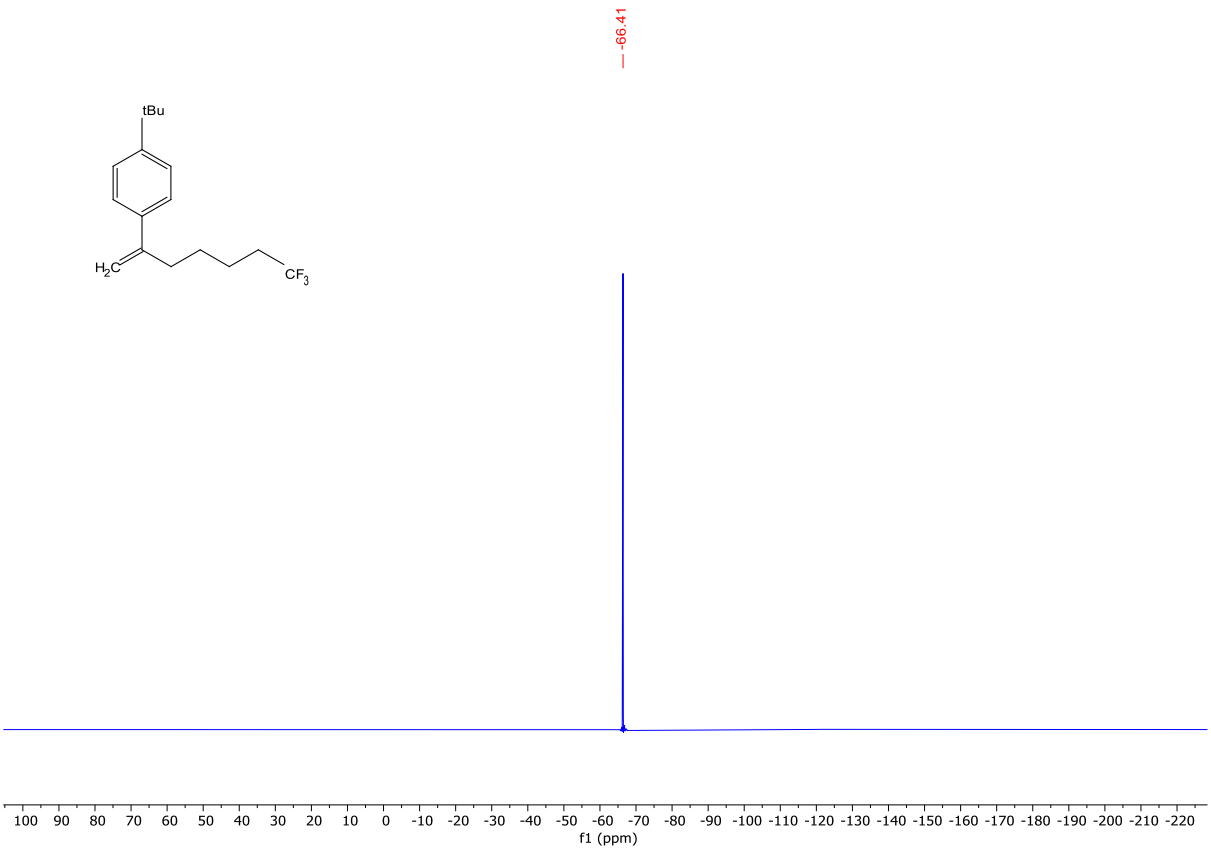
7.35
7.33
6.86
6.85
5.21
4.99
4.84
4.84
4.83
3.96
3.94
3.94
3.93
3.84
3.83
3.83
3.81
2.54
2.52
2.51
1.71
1.70
1.69
1.68
1.67
1.62
1.61
1.60
1.60
1.59
1.58
1.57
1.56
1.98
2.00
1.01
1.02
0.99
1.92
5.10
2.03
2.05
2.35
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

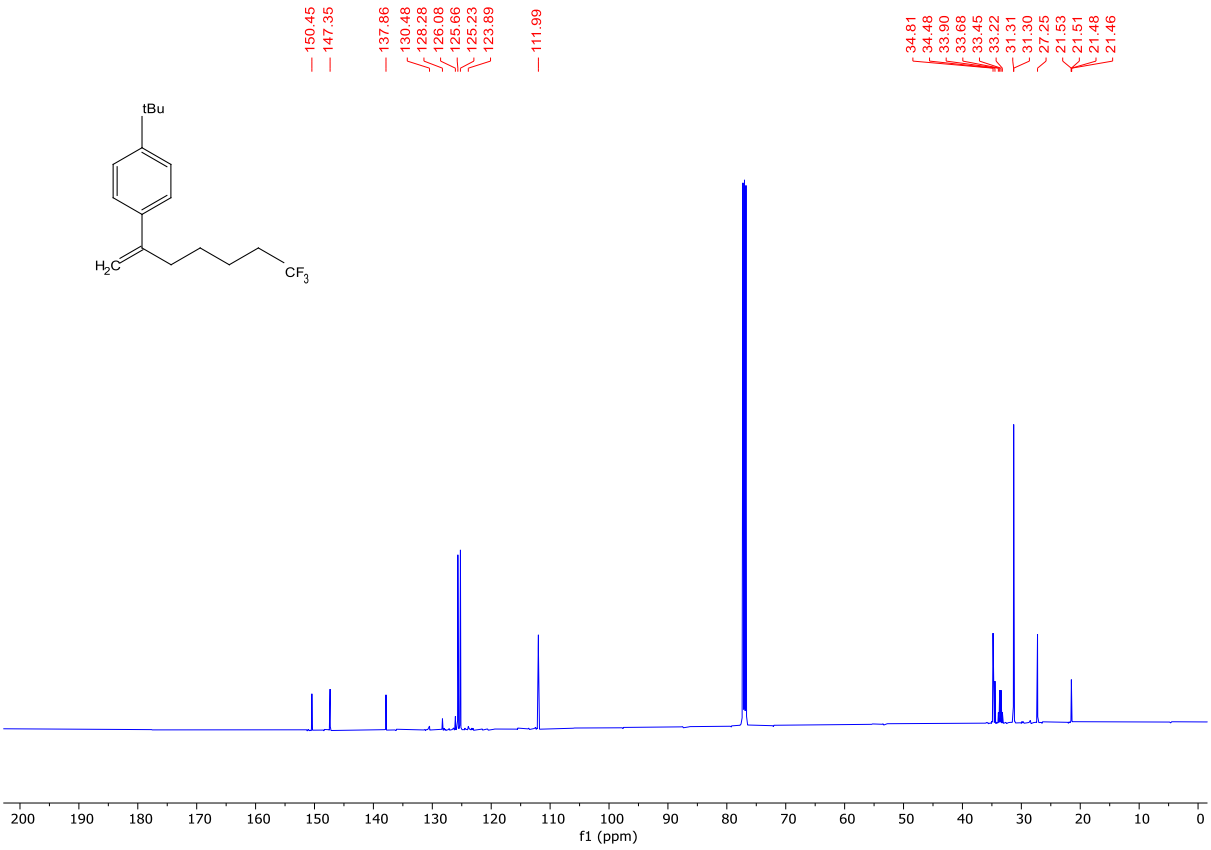

OMe
O
O
H2C

158.97
147.36
133.58
127.15
113.60
110.96
104.48
64.81
55.25
35.14
33.41
22.68
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

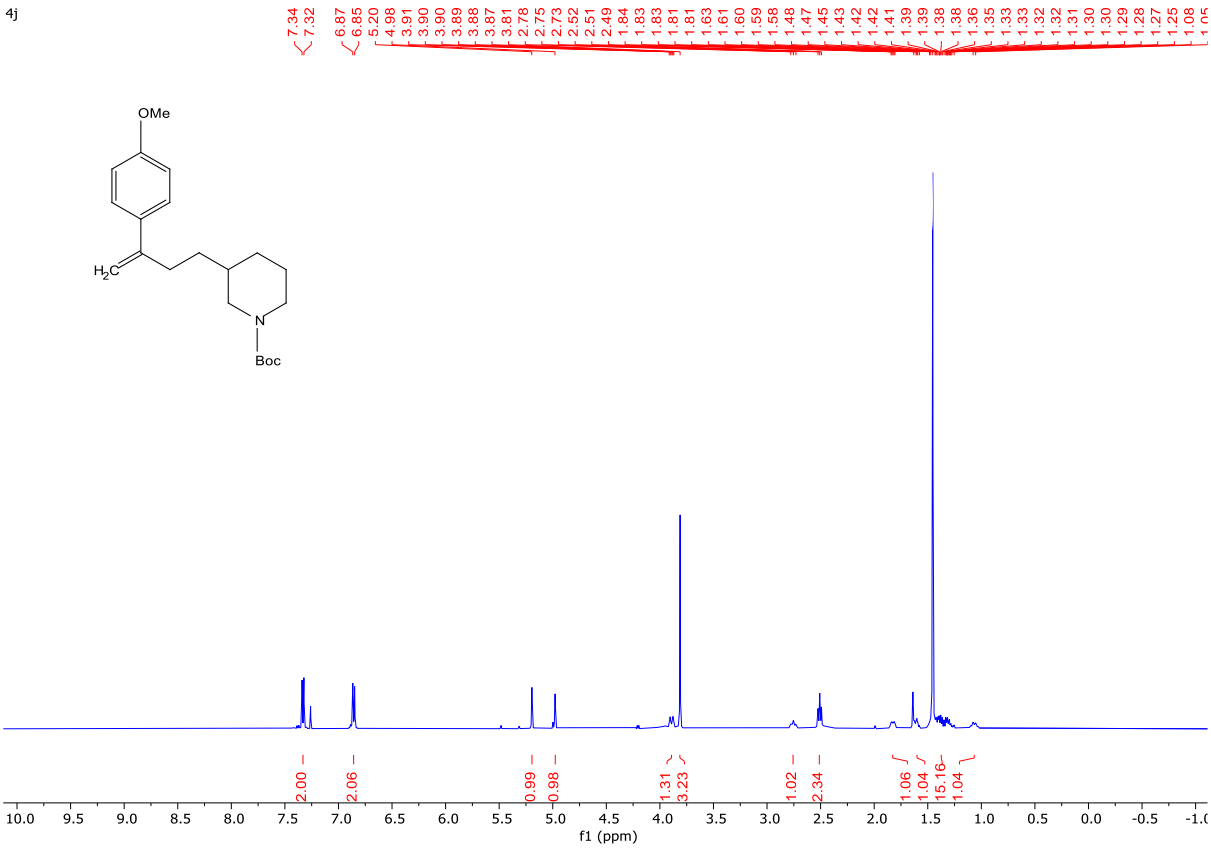
4i


7.37
7.37
7.36
7.36
7.35
7.34
7.33
7.33
5.29
5.02
2.54
2.53
2.51
1.63
1.63
1.61
1.61
1.60
1.60
1.59
1.59
1.58
1.58
1.57
1.57
1.56
1.54
1.53
1.52
1.52
1.51
1.50
1.33
tBu
H2C
CF3
3.96
1.00
0.98
2.07
2.13
2.83
1.21
9.17
f1 (ppm)


-66.41
tBu
H2C
CF3
f1 (ppm)


150.45
147.35
137.86
130.48
128.28
126.08
125.66
125.23
123.89
111.99
34.81
34.48
33.90
33.68
33.45
33.22
31.31
31.30
27.25
21.53
21.51
21.48
21.46
tBu
H2C
CF3
f1 (ppm)

4j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7.32
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6.85
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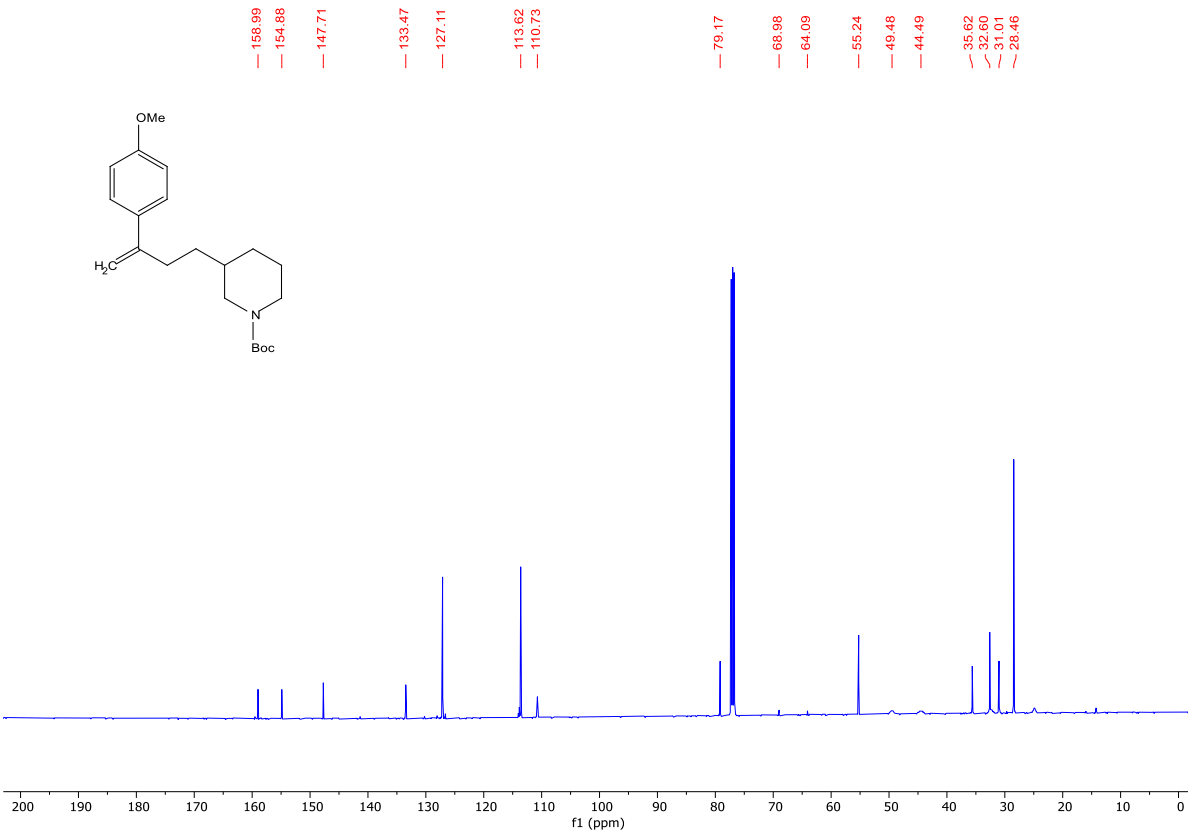
4.98
3.91
3.90
3.90
3.89
3.88
3.87
3.81
2.78
2.75
2.73
2.52
2.51
2.49
1.84
1.83
1.83
1.81
1.81
1.63
1.61
1.60
1.59
1.58
1.48
1.47
1.45
1.43
1.42
1.42
1.41
1.39
1.39
1.38
1.38
1.36
1.35
1.33
1.33
1.32
1.32
1.31
1.30
1.30
1.29
1.28
1.27
1.25
1.08
OMe
H2C
N
Boc
2.00
2.06
0.99
0.98
1.31
3.23
1.02
2.34
1.06
1.04
15.16
1.04
f1 (ppm)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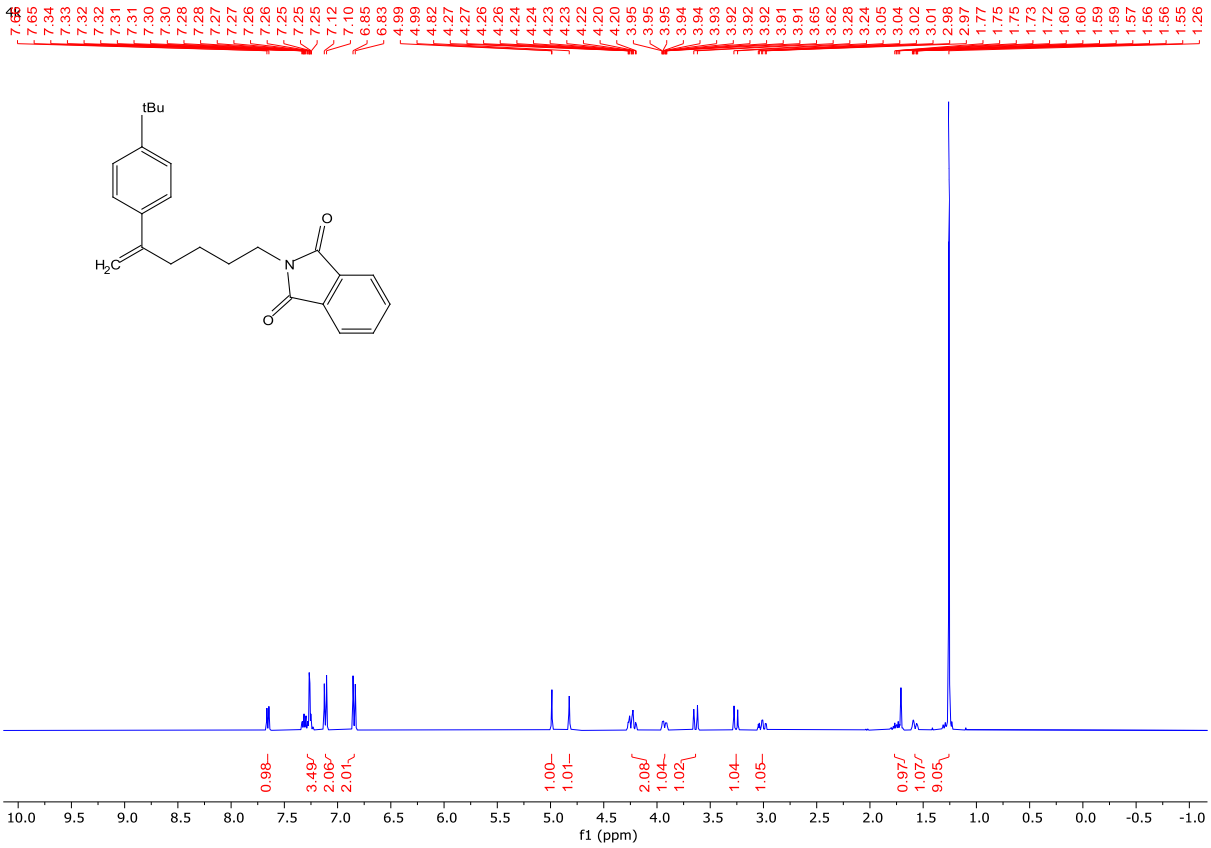
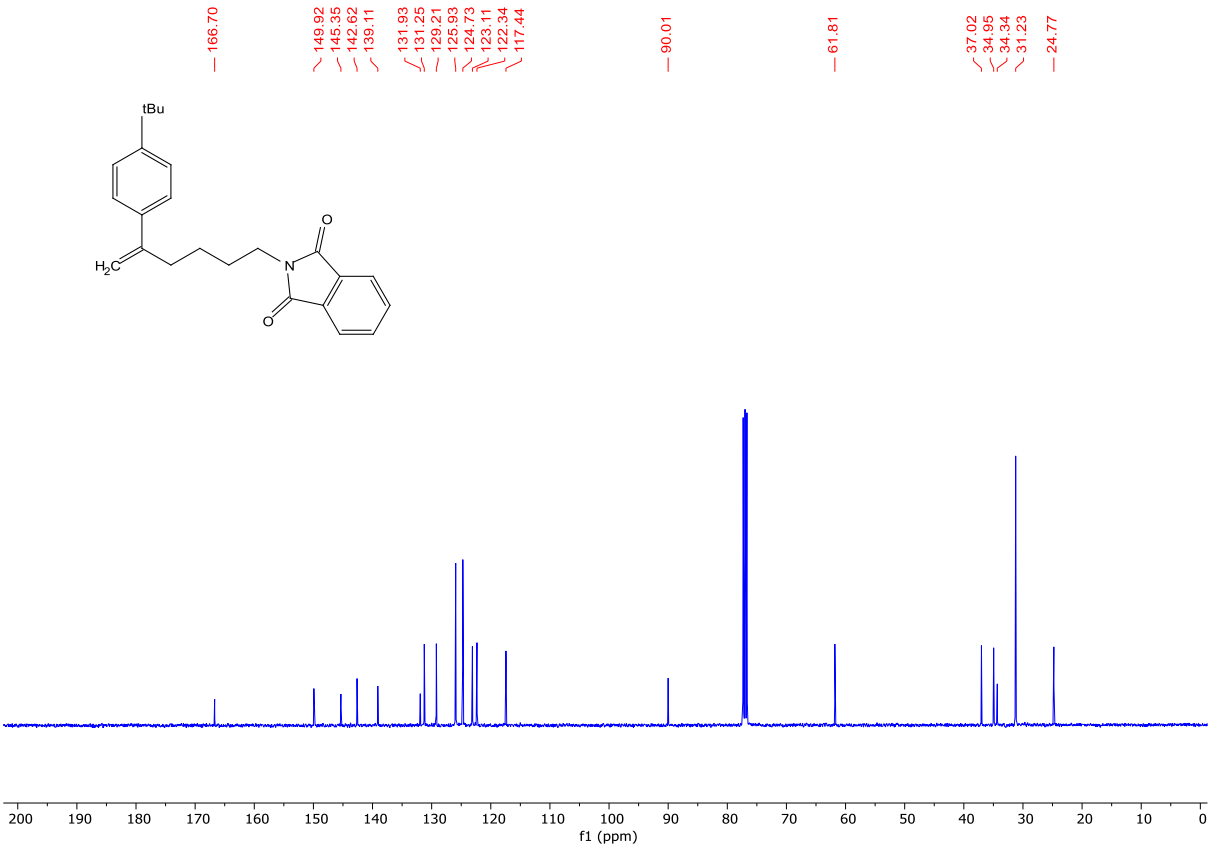
154.88
147.71
133.47
127.11
113.62
110.73
79.17
68.98
64.09
55.24
49.48
44.49
35.62
32.60
31.01
28.46
OMe
H2C
N
Boc
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


tBu
H2C
N
O
O
0.98
3.49
2.06
2.01
1.00
1.01
2.08
1.04
1.02
1.04
1.05
0.97
1.07
9.05
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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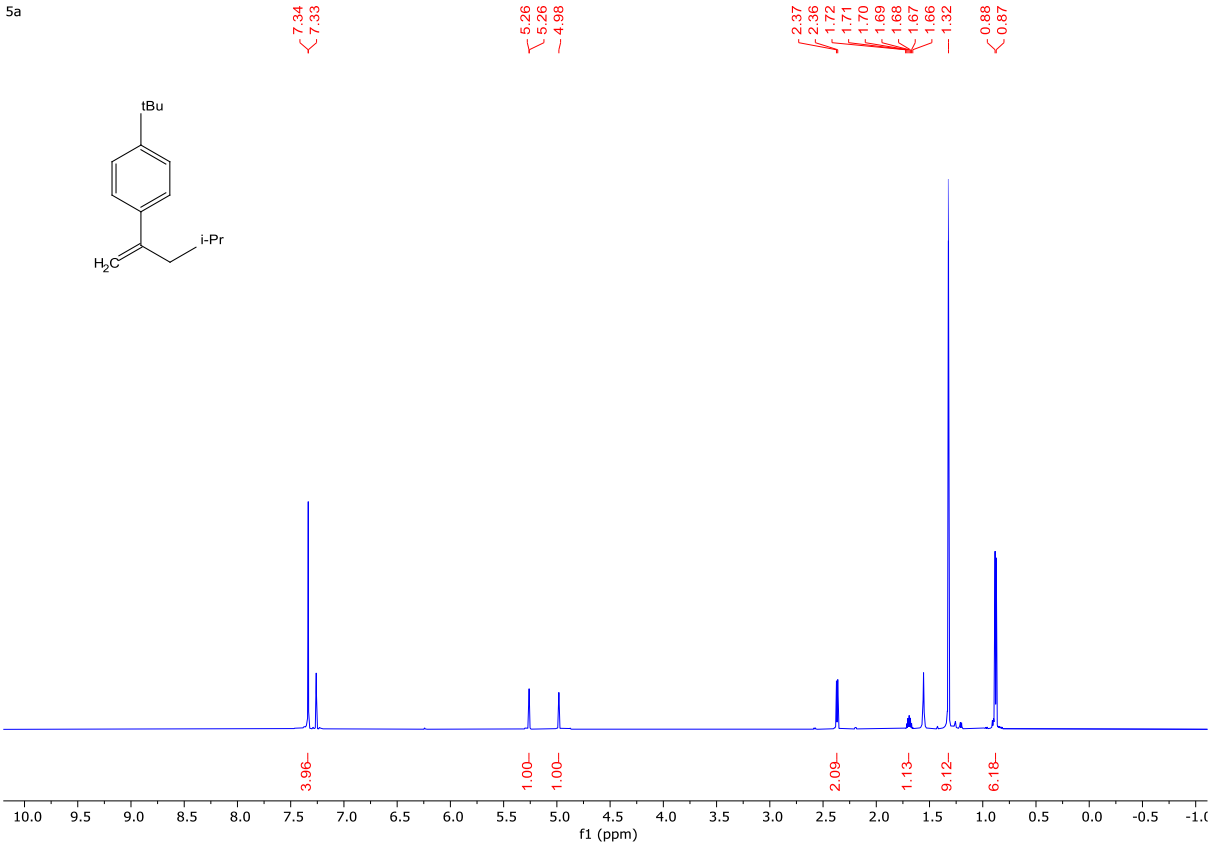
145.35
142.62
139.11
131.93
131.25
129.21
125.93
124.73
123.11
122.34
117.44
90.01
61.81
37.02
34.95
34.34
31.23
24.77
tBu
O
N
O
H2C
f1 (ppm)

5a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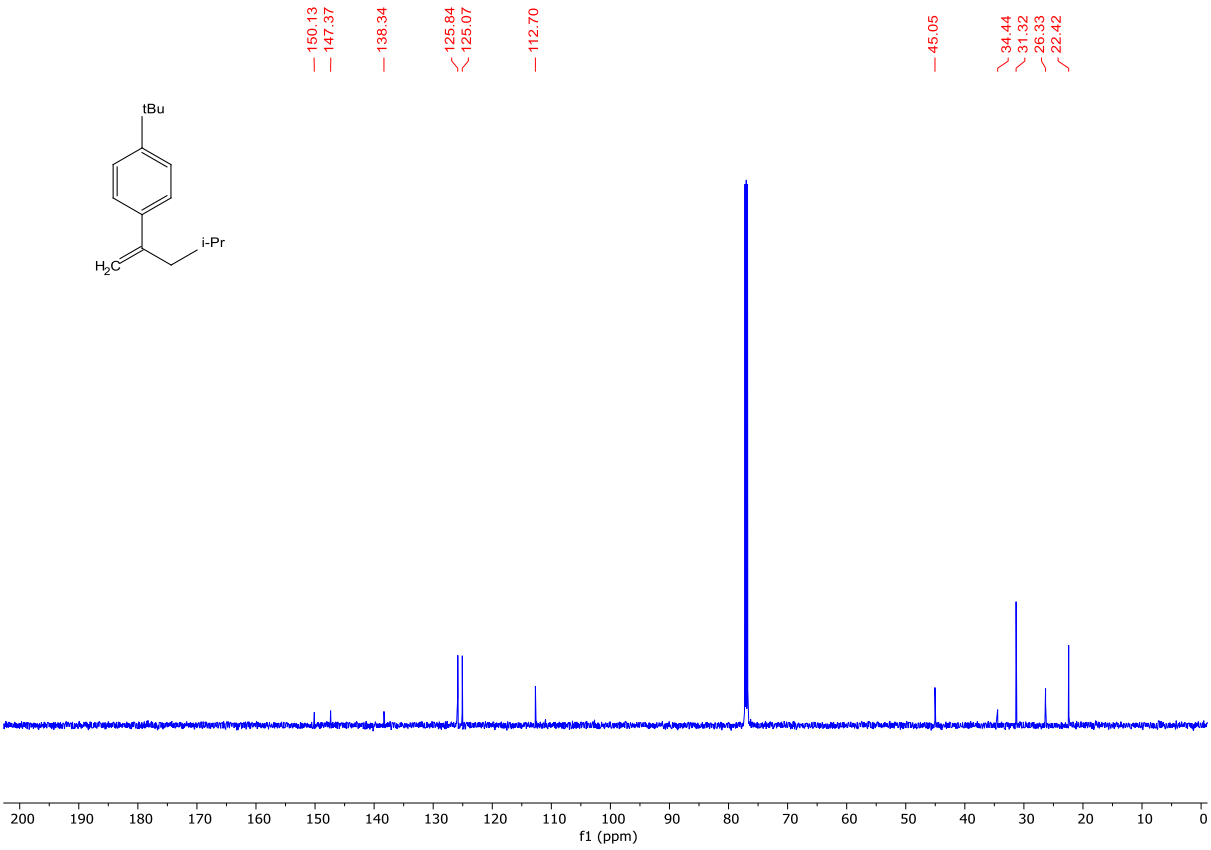
7.33
5.26
5.26
4.98
2.37
2.36
1.72
1.71
1.70
1.69
1.68
1.67
1.66
1.32
0.88
0.87
tBu
i-Pr
H2C
3.96
1.00
1.00
2.09
1.13
9.12
6.18
f1 (ppm)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147.37
138.34
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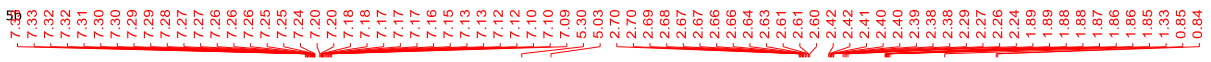
125.07
112.70
45.05
34.44
31.32
26.33
22.42
tBu
i-Pr
H2C
f1 (ppm)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7.32
7.31
7.30
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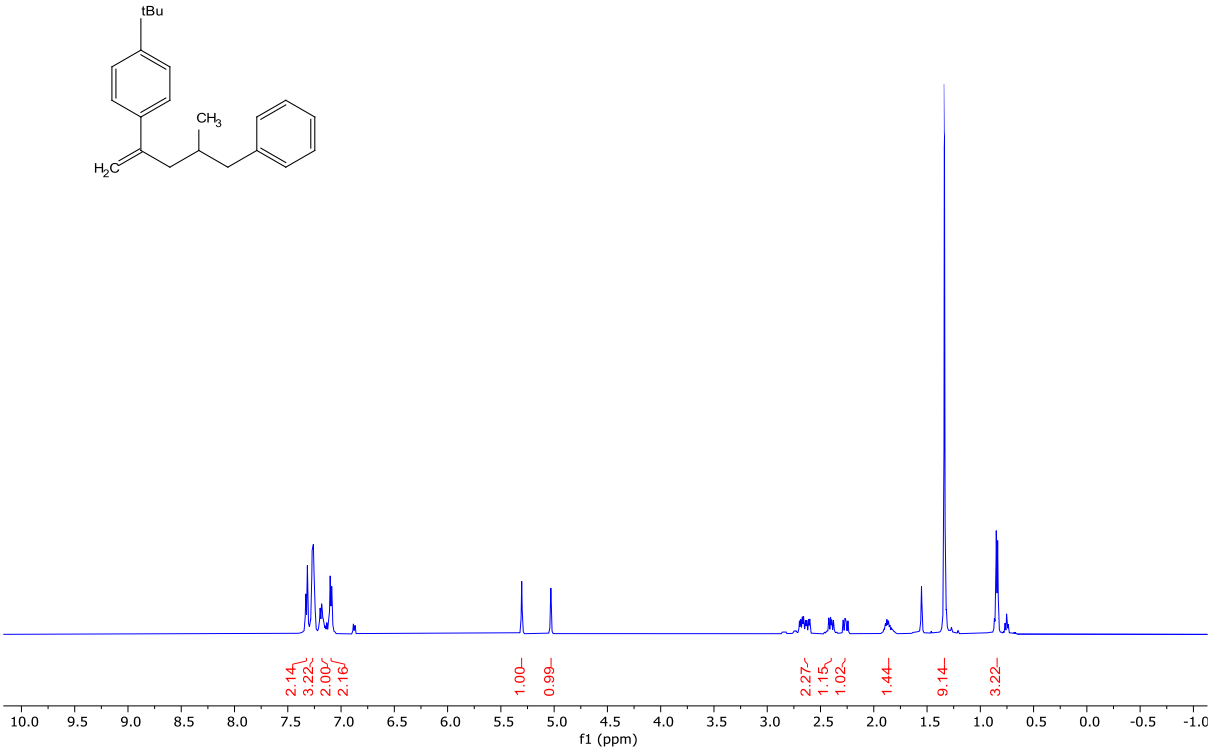
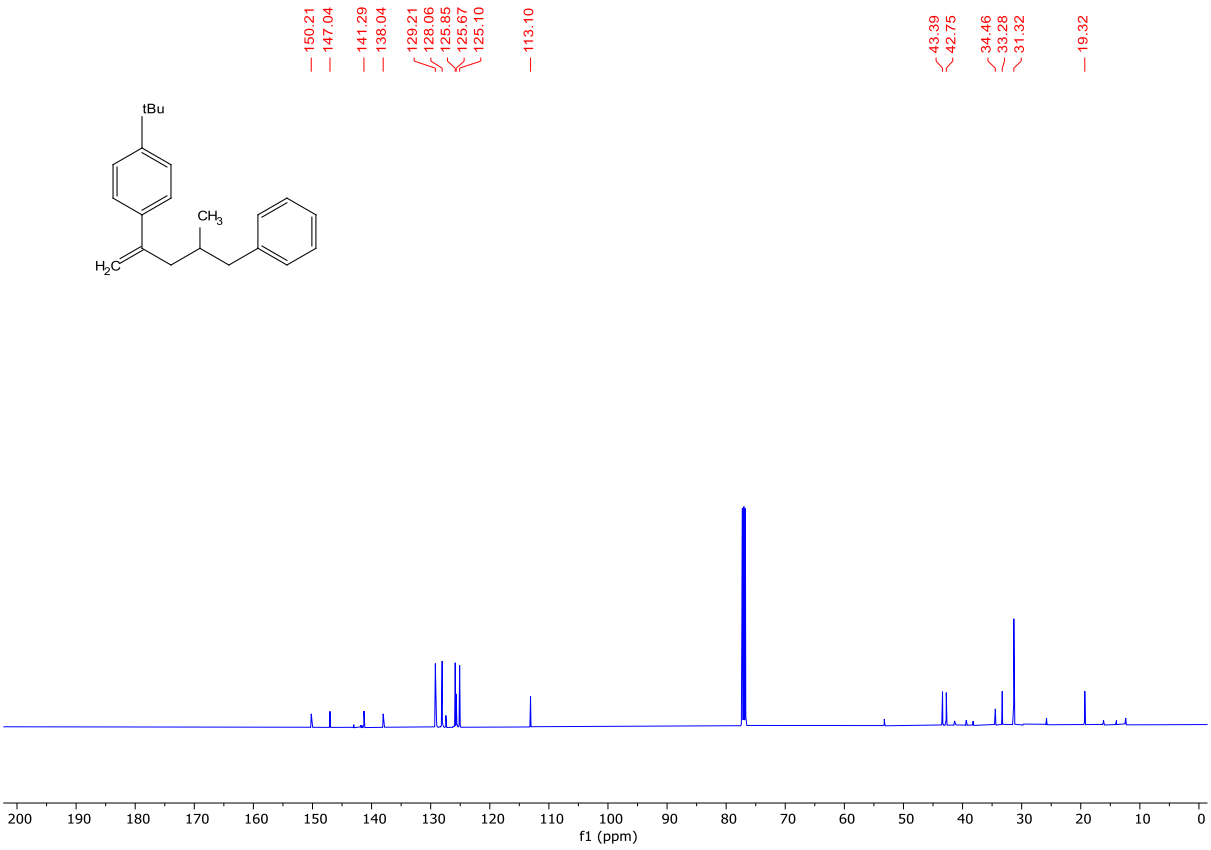
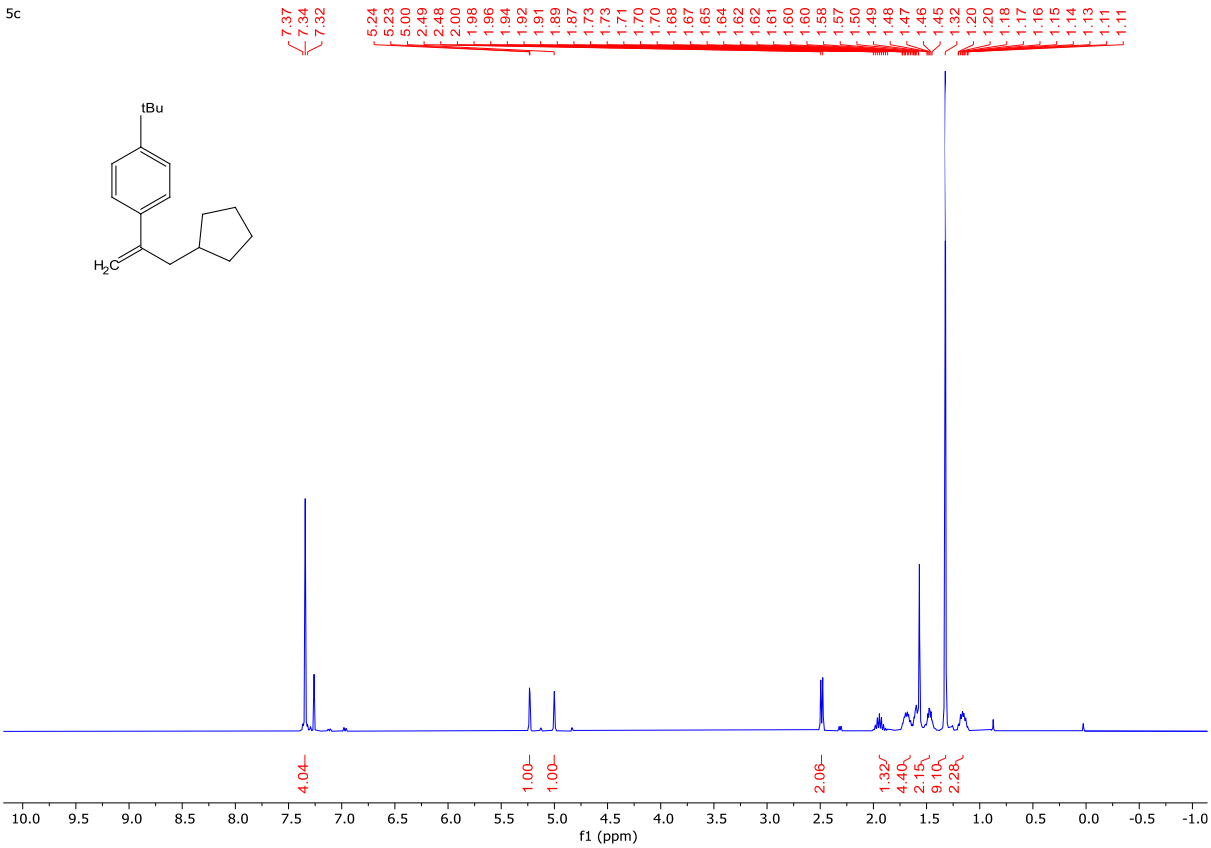
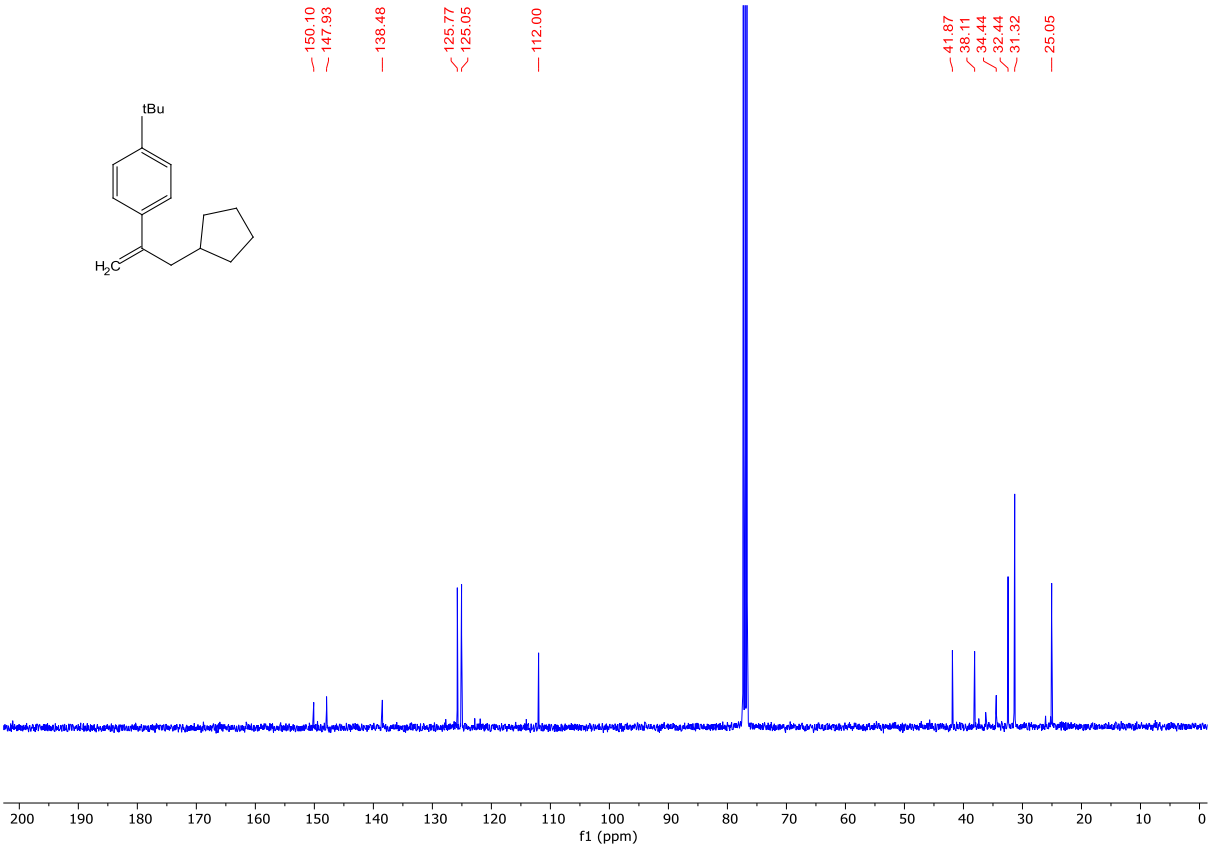
7.26
7.25
7.24
7.20
7.18
7.17
7.16
7.15
7.13
7.12
7.10
7.09
5.30
5.03
2.70
2.69
2.68
2.67
2.66
2.64
2.63
2.61
2.60
2.42
2.41
2.40
2.39
2.38
2.29
2.27
2.26
2.24
1.89
1.88
1.87
1.86
1.85
1.33
0.85
0.84


tBu
CH3
H2C
2.14
3.22
2.00
2.16
1.00
0.99
2.27
1.15
1.02
1.44
9.14
3.22
f1 (ppm)


150.21
147.04
141.29
138.04
129.21
128.06
125.85
125.67
125.10
113.10
43.39
42.75
34.46
33.28
31.32
19.32
tBu
CH3
H2C
f1 (ppm)

5c


7.37
7.34
7.32
5.24
5.23
5.00
2.49
2.48
2.00
1.98
1.96
1.94
1.92
1.91
1.89
1.87
1.73
1.71
1.70
1.70
1.68
1.67
1.65
1.64
1.62
1.62
1.61
1.60
1.60
1.58
1.57
1.50
1.49
1.48
1.47
1.46
1.45
1.32
1.20
1.18
1.17
1.16
1.15
1.14
1.13
1.11
1.11
tBu
H2C
4.04
1.00
1.00
2.06
1.32
4.40
2.15
9.10
2.28
f1 (ppm)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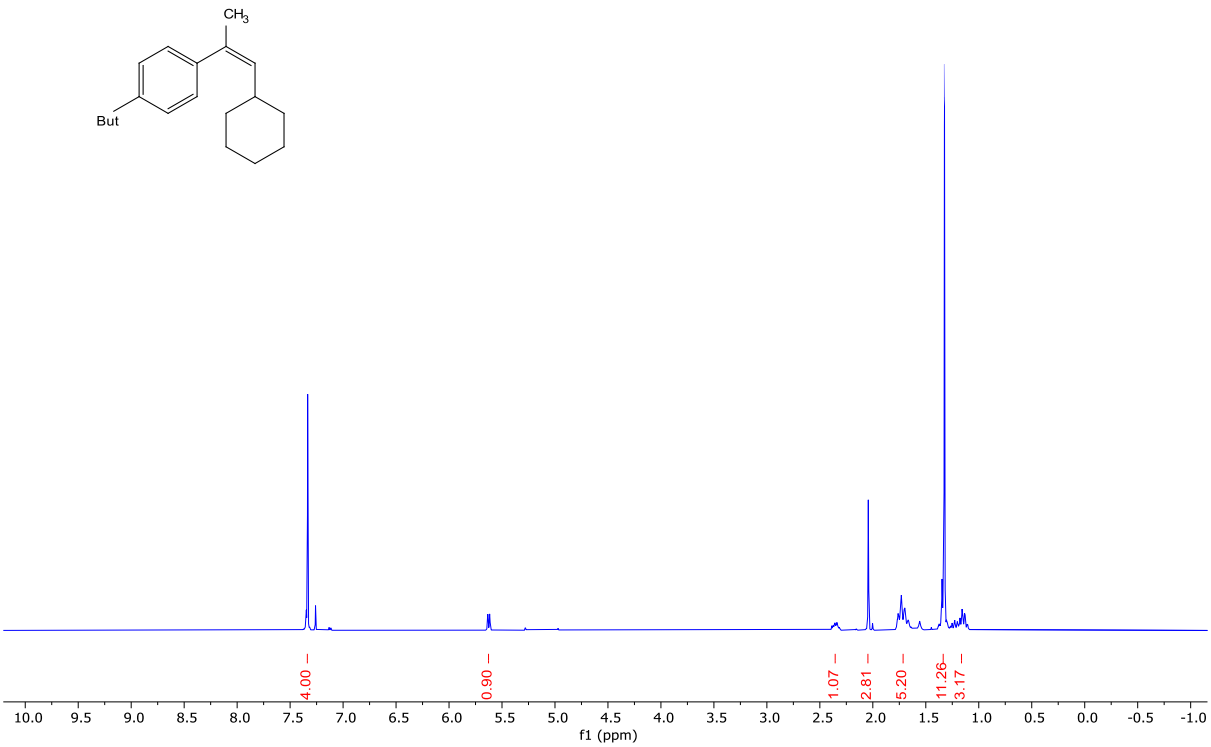
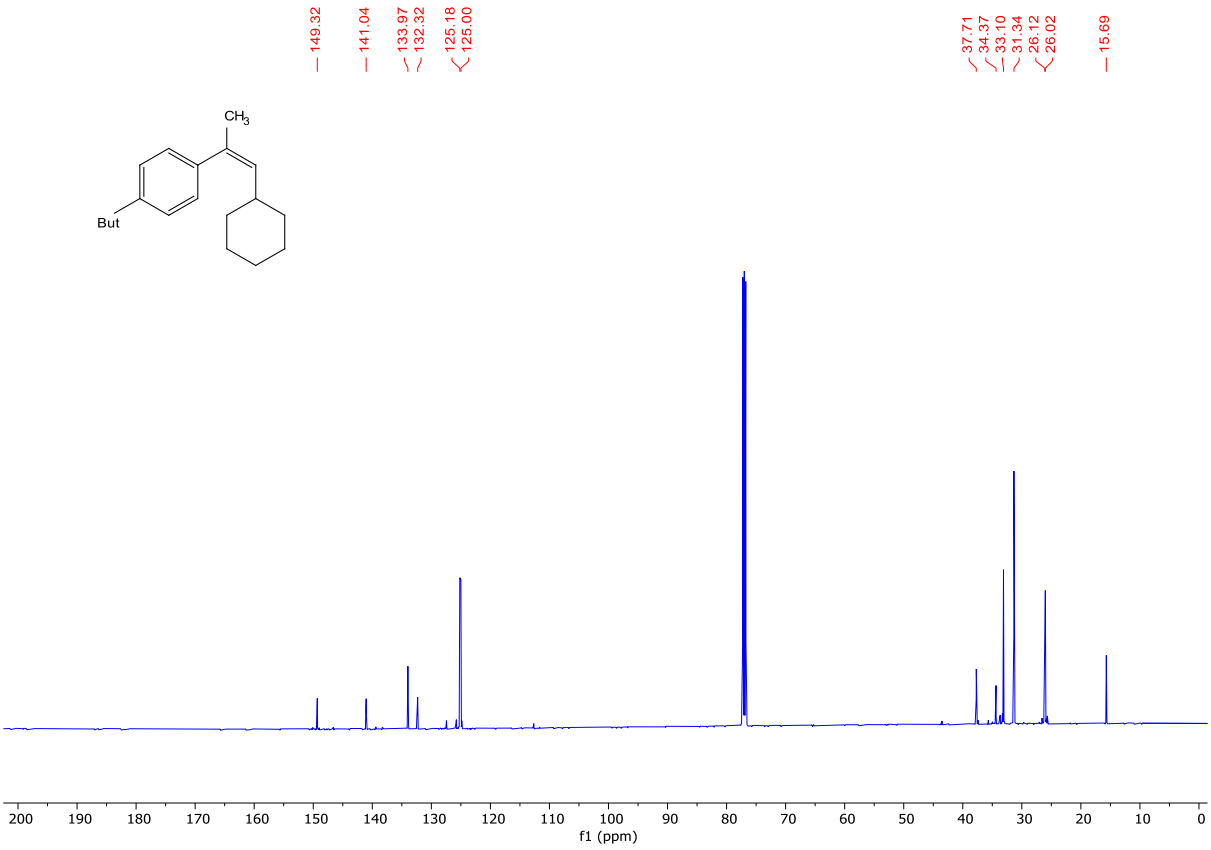
147.93
138.48
125.77
125.05
112.00
41.87
38.11
34.44
32.44
31.32
25.05
tBu
H2C
f1 (ppm)


CH3
But
4.00
0.90
1.07
2.81
5.20
11.26
3.17
f1 (ppm)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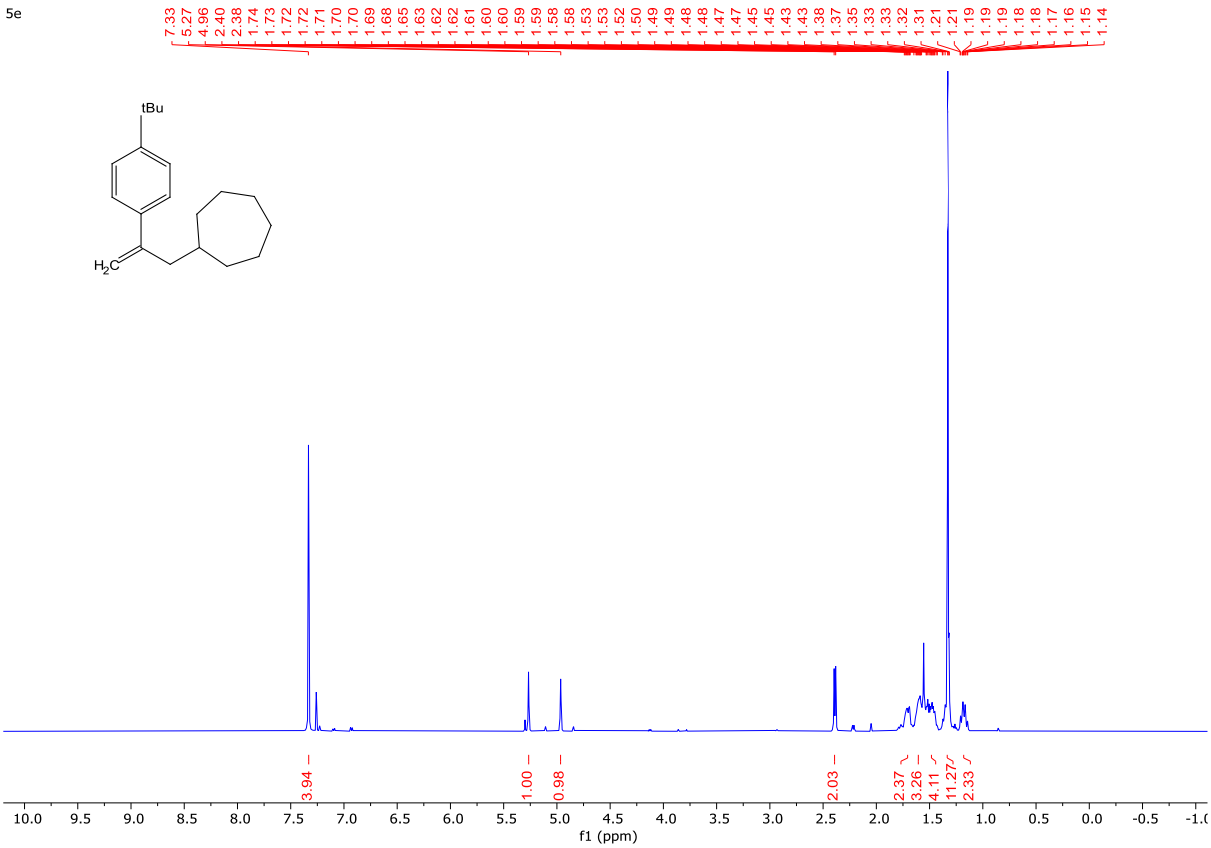
141.04
133.97
132.32
125.18
125.00
37.71
34.37
33.10
31.34
26.12
26.02
15.69
CH3
But
f1 (ppm)

5e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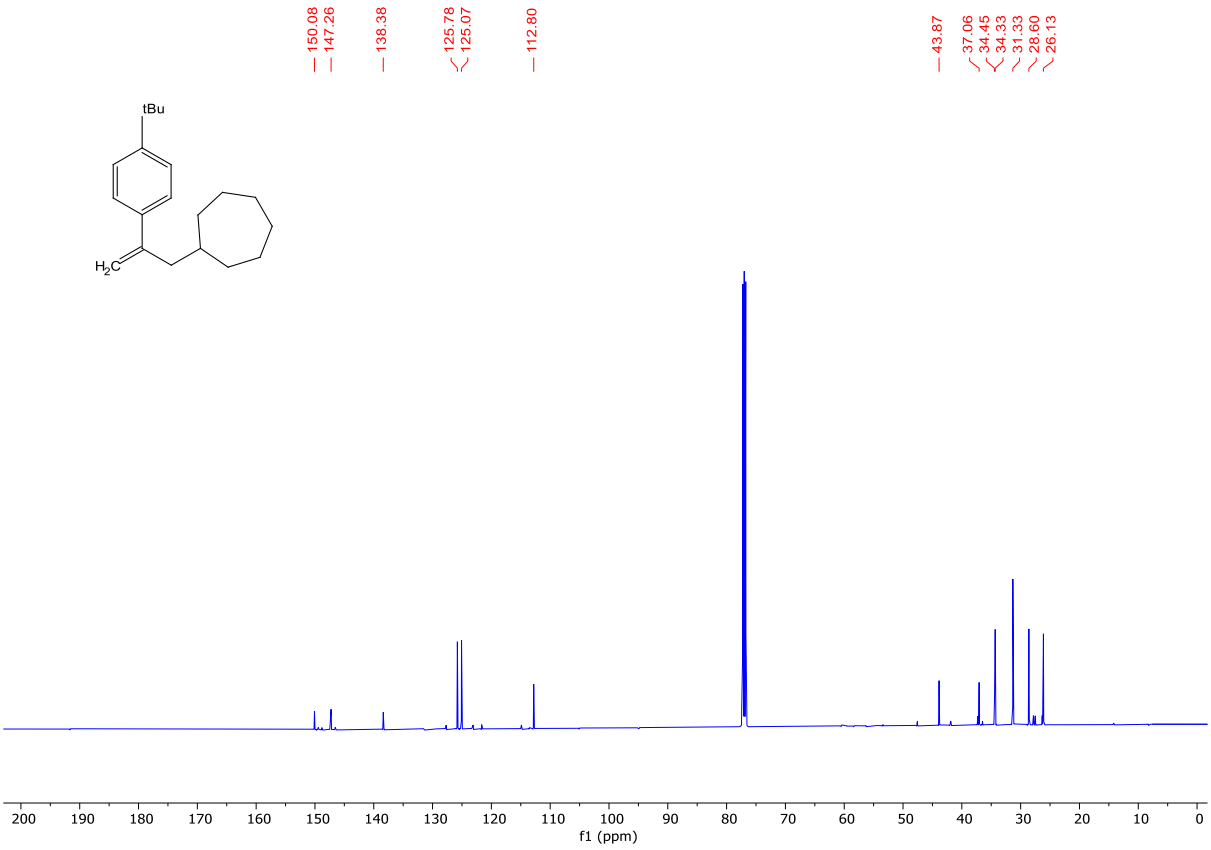
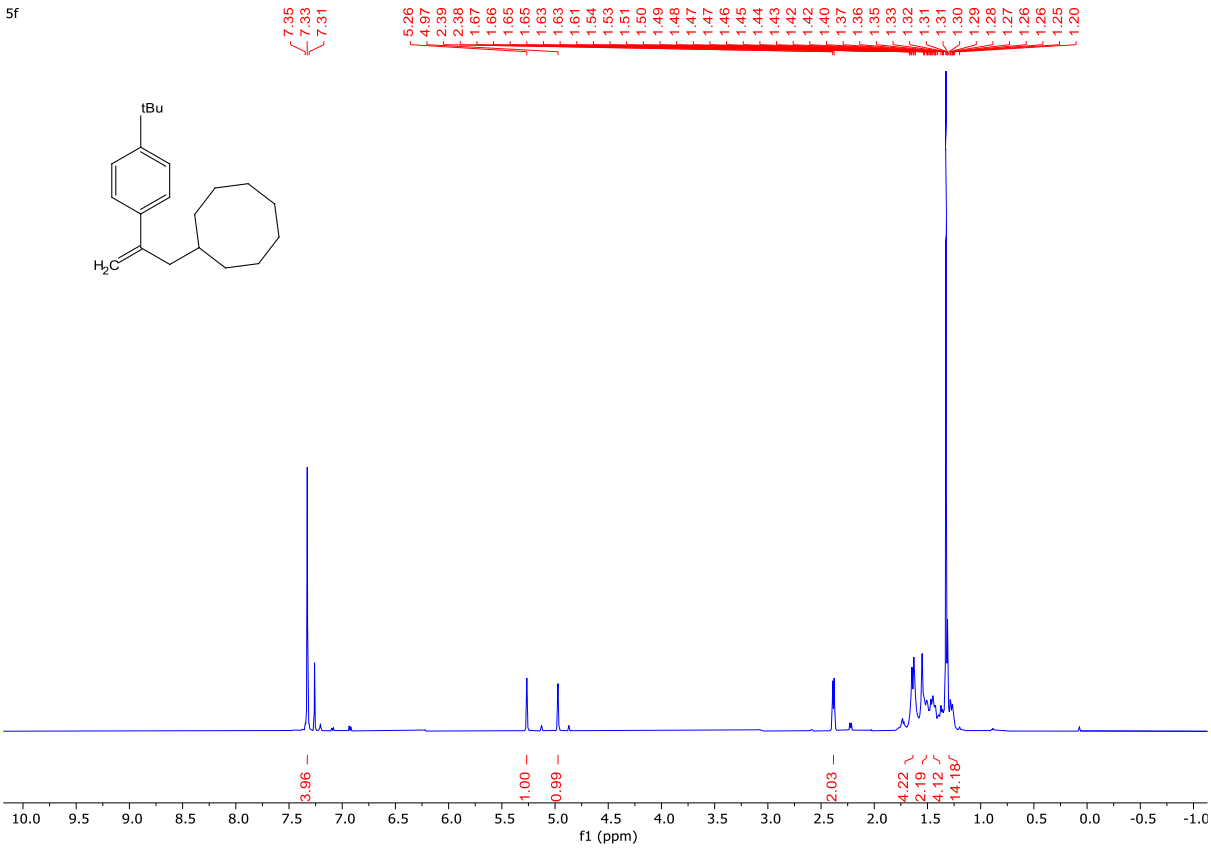
5.27
4.96
2.40
2.38
1.74
1.73
1.72
1.72
1.71
1.70
1.70
1.69
1.68
1.65
1.63
1.62
1.62
1.61
1.60
1.60
1.59
1.59
1.58
1.58
1.53
1.53
1.52
1.50
1.49
1.49
1.48
1.48
1.47
1.47
1.45
1.45
1.43
1.43
1.38
1.37
1.35
1.33
1.33
1.32
1.31
1.21
1.21
1.19
1.19
1.19
1.18
1.18
1.17
1.16
1.15
1.14
tBu
H2C
3.94
1.00
0.98
2.03
2.37
3.26
4.11
11.27
2.33
f1 (ppm)


150.08
147.26
138.38
125.78
125.07
112.80
43.87
37.06
34.45
34.33
31.33
28.60
26.13
tBu
H2C
f1 (ppm)

5f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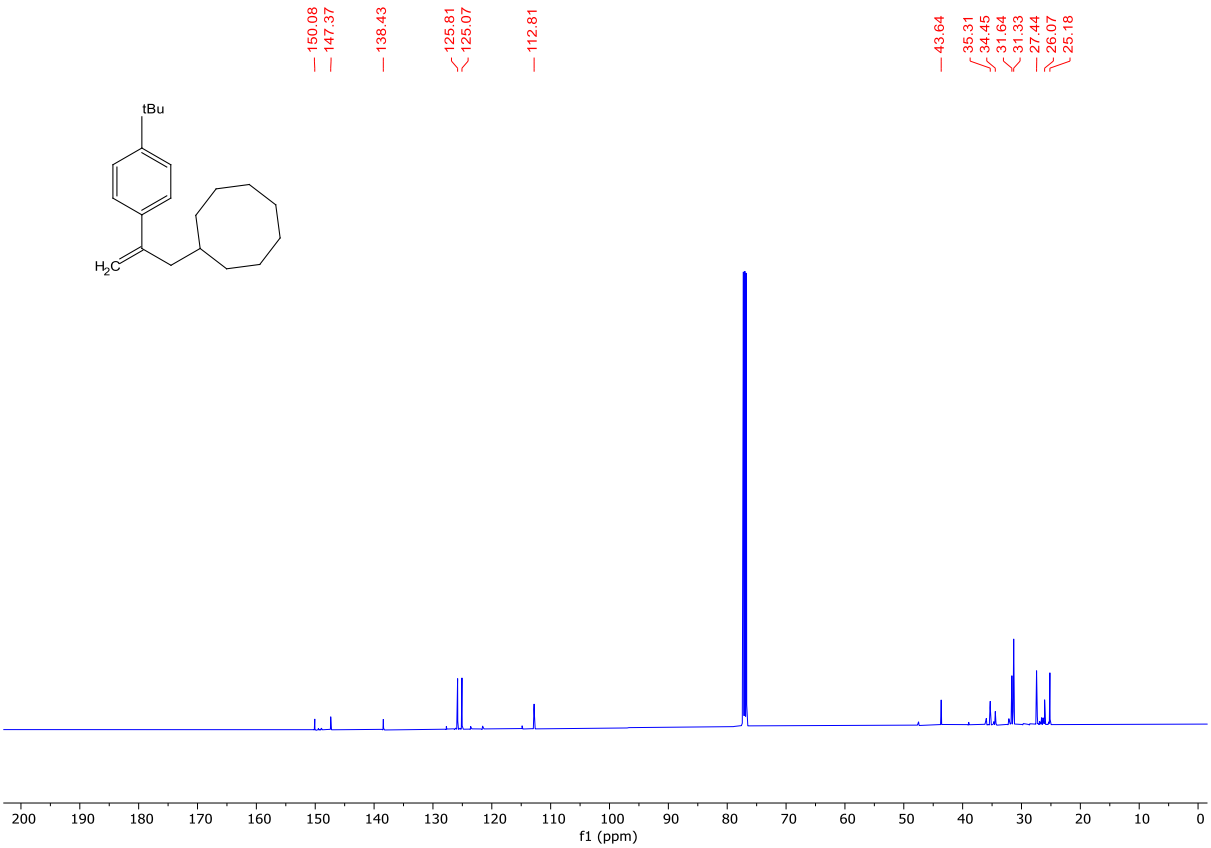
7.33
7.31
5.26
4.97
2.39
2.38
1.67
1.66
1.65
1.65
1.63
1.63
1.61
1.54
1.53
1.51
1.50
1.49
1.48
1.47
1.47
1.46
1.45
1.44
1.43
1.42
1.42
1.40
1.37
1.36
1.35
1.33
1.32
1.31
1.31
1.30
1.29
1.28
1.27
1.26
1.26
1.25
1.20
tBu
H2C
3.96
1.00
0.99
2.03
4.22
2.19
4.12
14.18
f1 (ppm)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147.37
138.43
125.81
125.07
112.81
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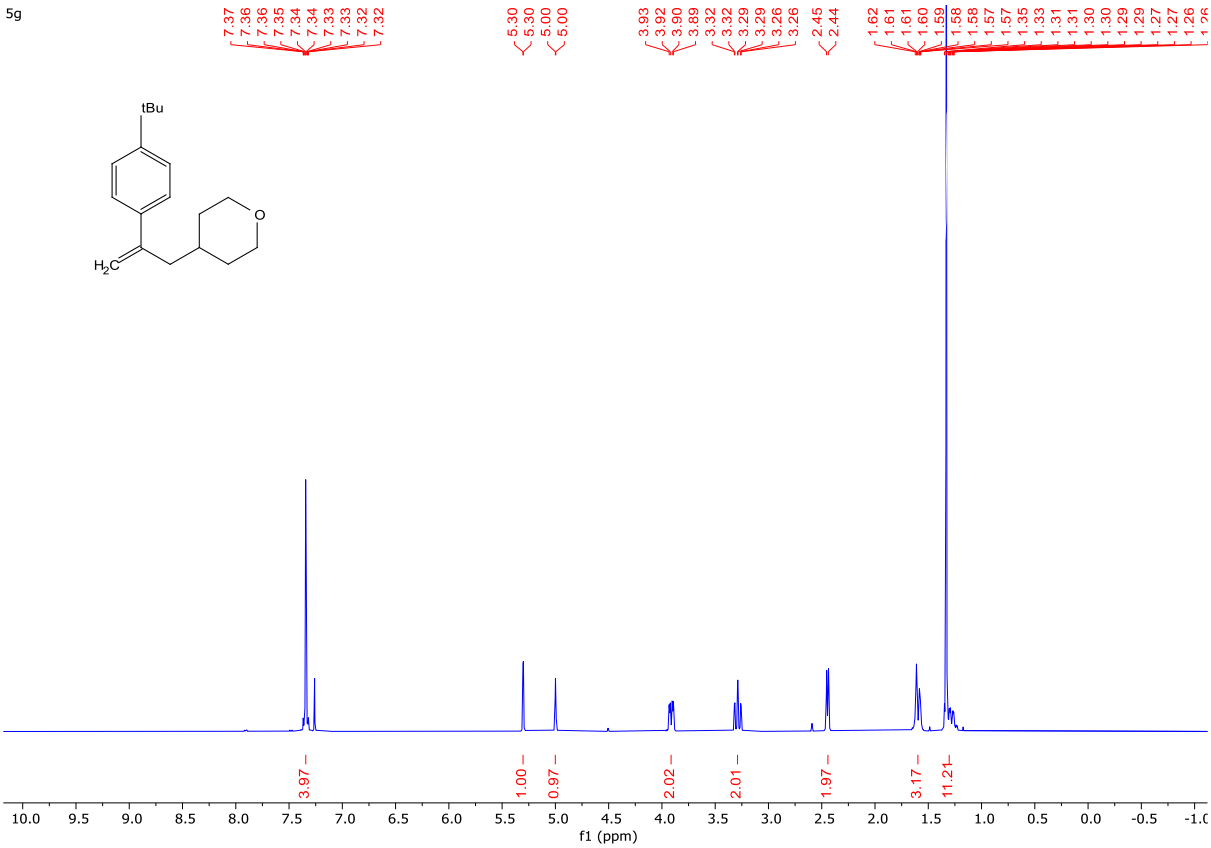
35.31
34.45
31.64
31.33
27.44
26.07
25.18
tBu
H2C
f1 (ppm)


5g
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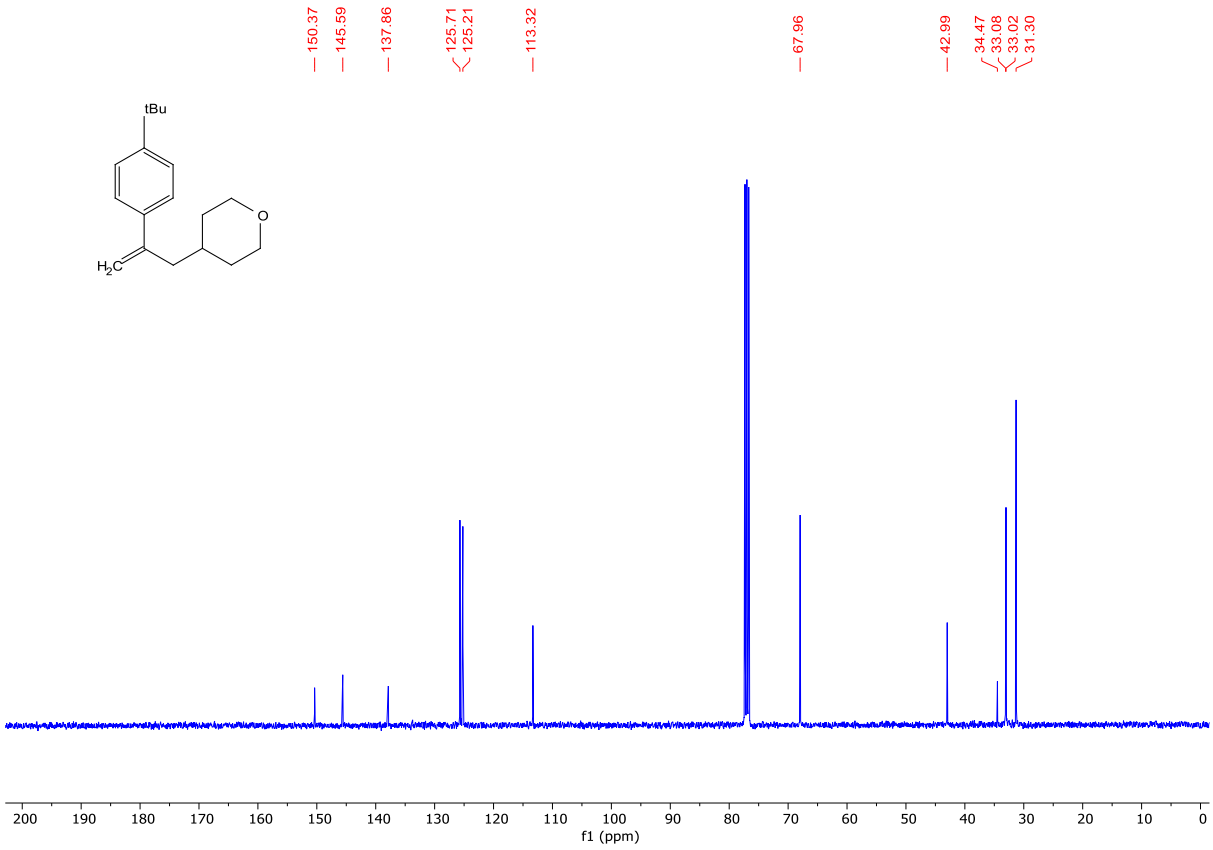
7.32
7.32
5.30
5.30
5.00
5.00
3.93
3.92
3.90
3.89
3.32
3.32
3.29
3.29
3.26
3.26
2.45
2.44
1.62
1.61
1.61
1.60
1.59
1.58
1.58
1.57
1.57
1.35
1.33
1.31
1.30
1.30
1.29
1.29
1.27
1.27
1.26
tBu
O
H2C
3.97
1.00
0.97
2.02
2.01
1.97
3.17
11.21
f1 (ppm)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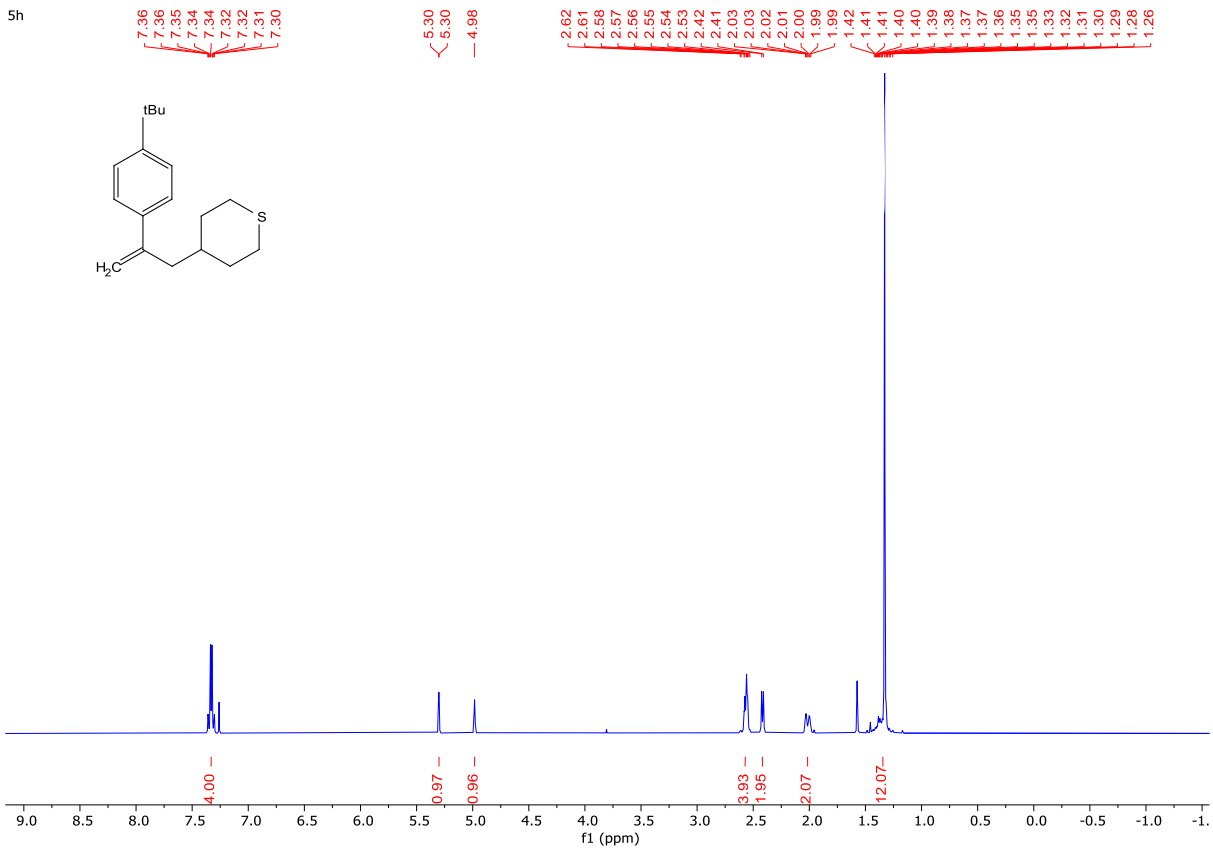
145.59
137.86
125.71
125.21
113.32
67.96
42.99
34.47
33.08
33.02
31.30
tBu
O
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

5h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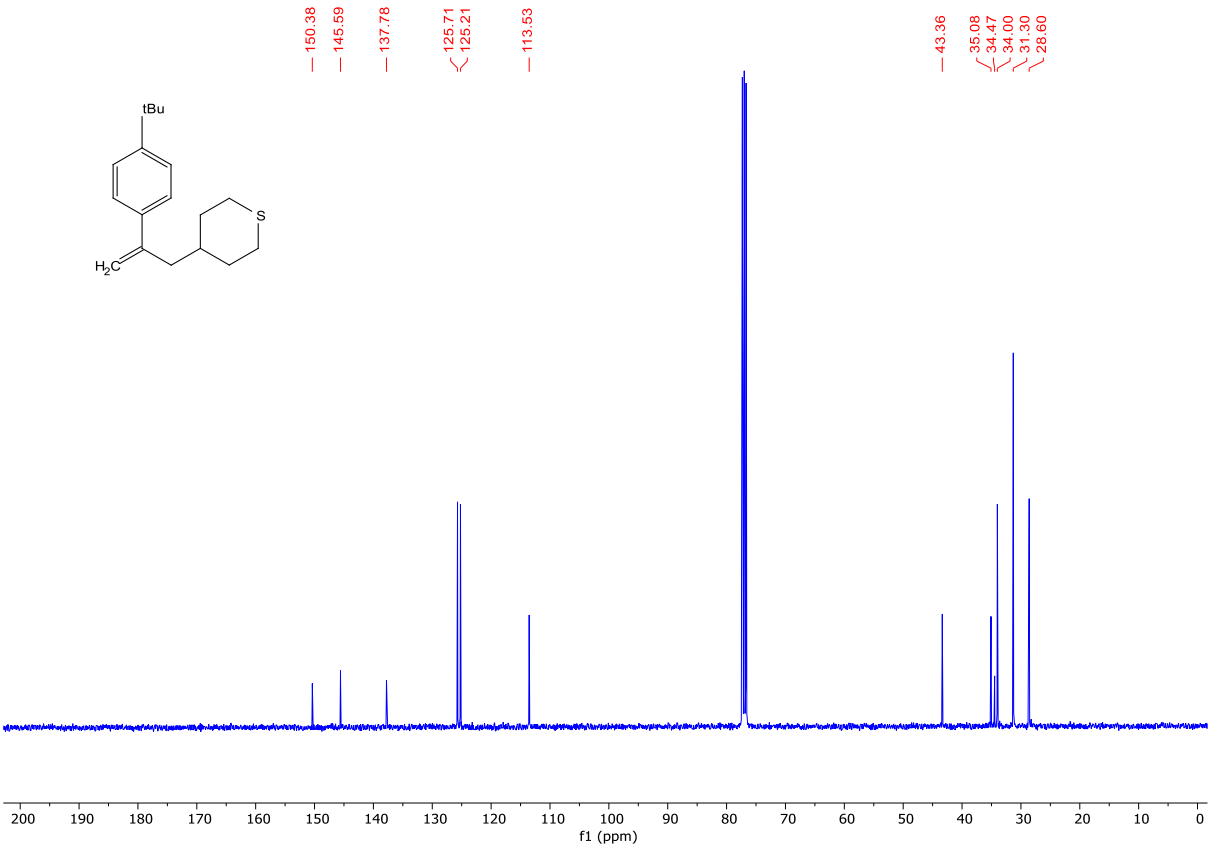
7.36
7.35
7.34
7.34
7.32
7.32
7.31
7.30
5.30
5.30
4.98
2.62
2.61
2.58
2.57
2.56
2.55
2.54
2.53
2.42
2.41
2.03
2.03
2.02
2.01
2.00
1.99
1.99
1.42
1.41
1.41
1.40
1.40
1.39
1.38
1.37
1.37
1.36
1.35
1.35
1.33
1.32
1.31
1.30
1.29
1.28
1.26
tBu
S
H2C
4.00
0.97
0.96
3.93
1.95
2.07
12.07
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.
f1 (ppm)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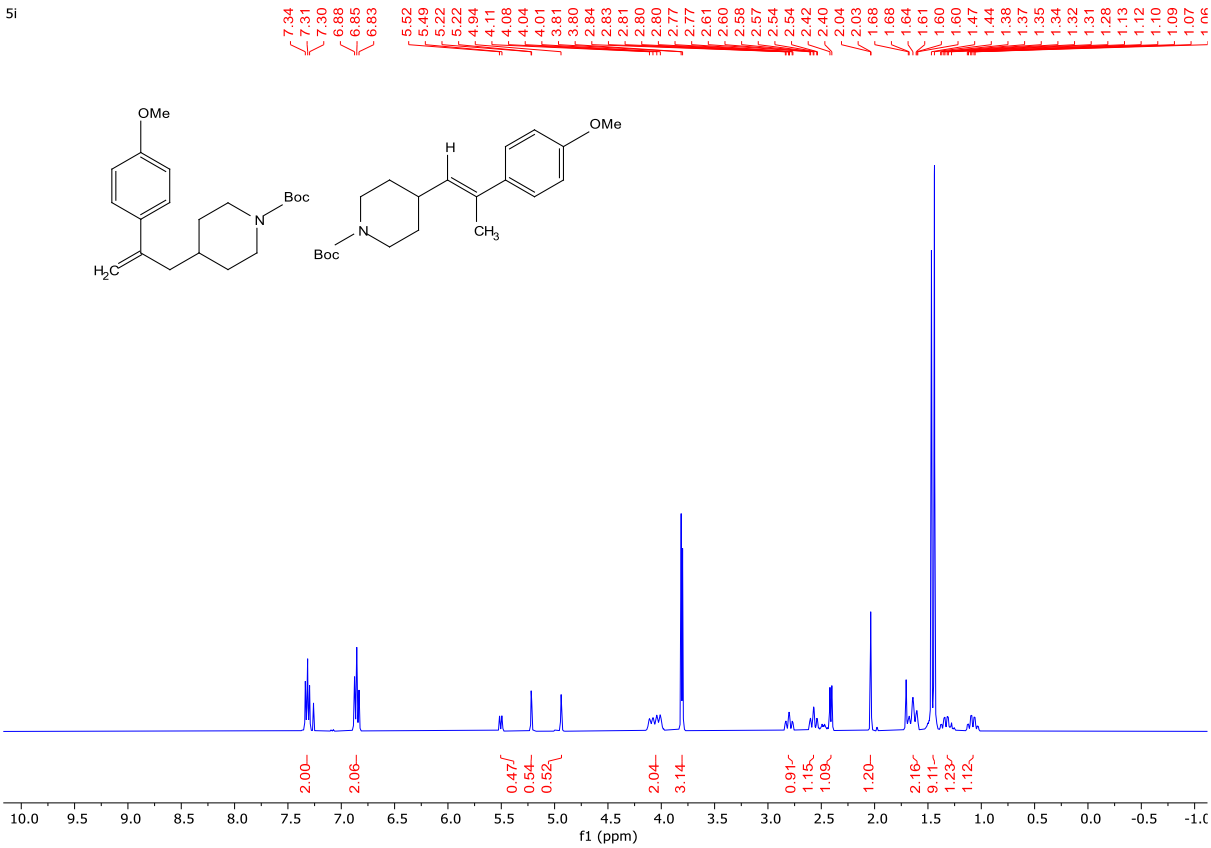
145.59
137.78
125.71
125.21
113.53
43.36
35.08
34.47
34.00
31.30
28.60
tBu
S
H2C
f1 (ppm)

5i


7.34
7.31
7.30
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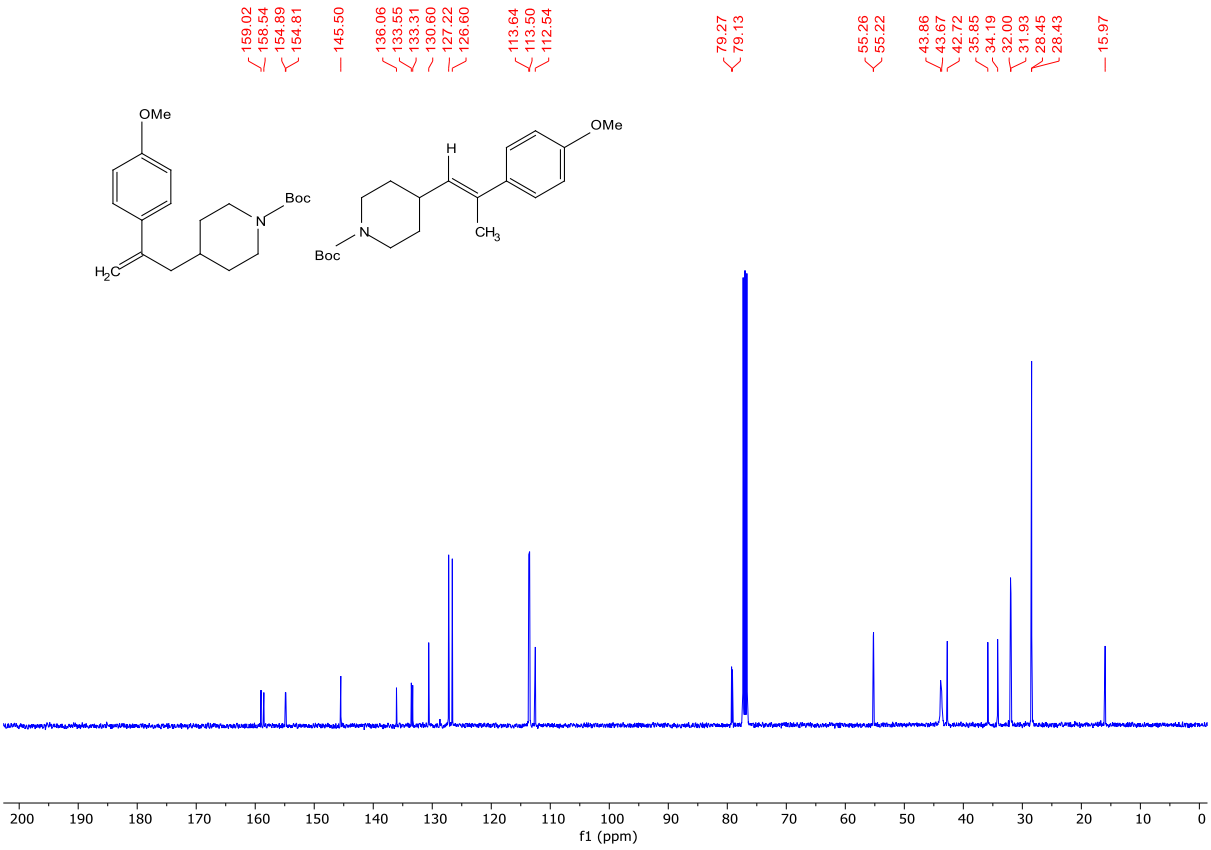
6.85
6.83
5.52
5.49
5.22
4.94
4.11
4.08
4.04
4.01
3.81
3.80
2.84
2.83
2.81
2.80
2.80
2.77
2.77
2.61
2.60
2.58
2.57
2.54
2.54
2.42
2.40
2.04
2.03
1.68
1.68
1.64
1.61
1.60
1.60
1.47
1.44
1.38
1.37
1.35
1.34
1.32
1.31
1.28
1.13
1.12
1.10
1.09
1.07
OMe
Boc
N
H2C
H
CH3
2.00
2.06
0.47
0.54
0.52
2.04
3.14
0.91
1.15
1.09
1.20
2.16
9.11
1.23
1.12
f1 (ppm)


159.02
158.54
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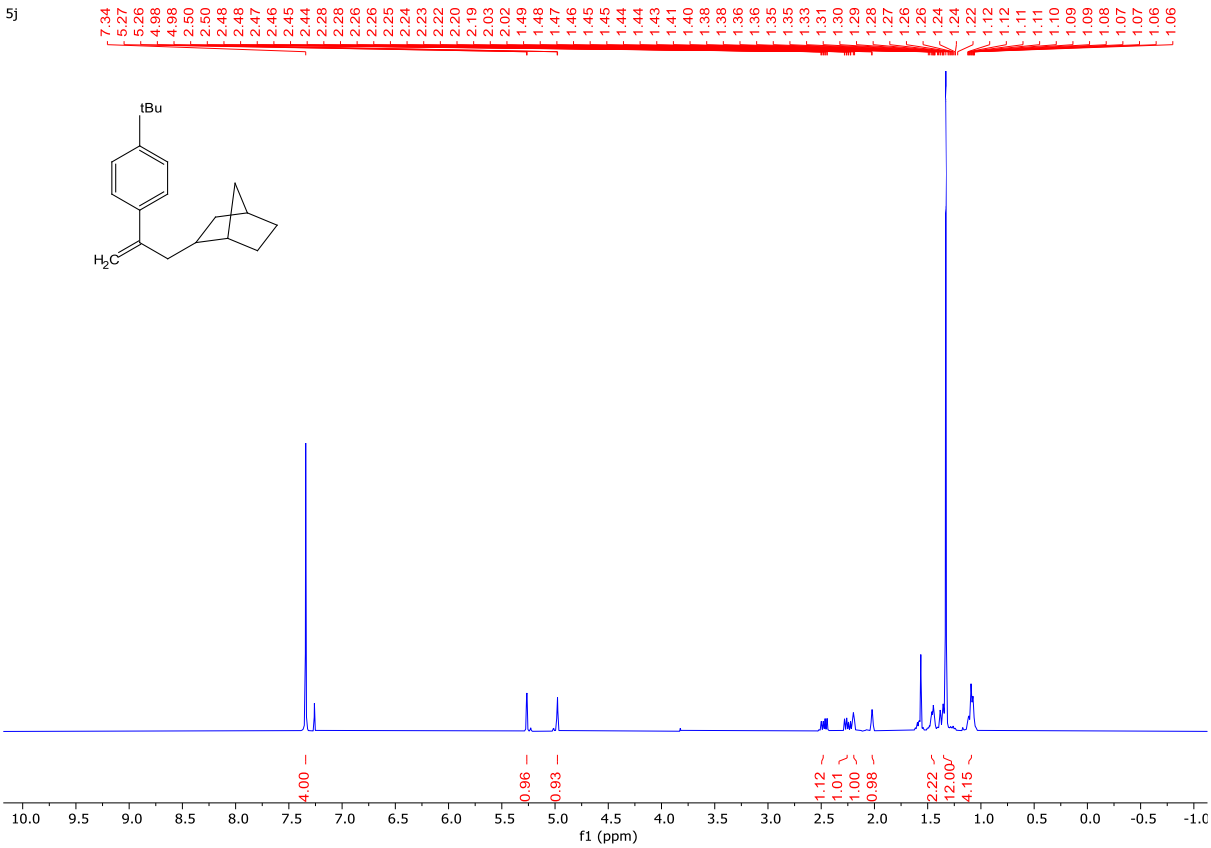
154.81
145.50
136.06
133.55
133.31
130.60
127.22
126.60
113.64
113.50
112.54
79.27
79.13
55.26
55.22
43.86
43.67
42.72
35.85
34.19
32.00
31.93
28.45
28.43
15.97
OMe
Boc
N
H2C
H
CH3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


5j
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5.26
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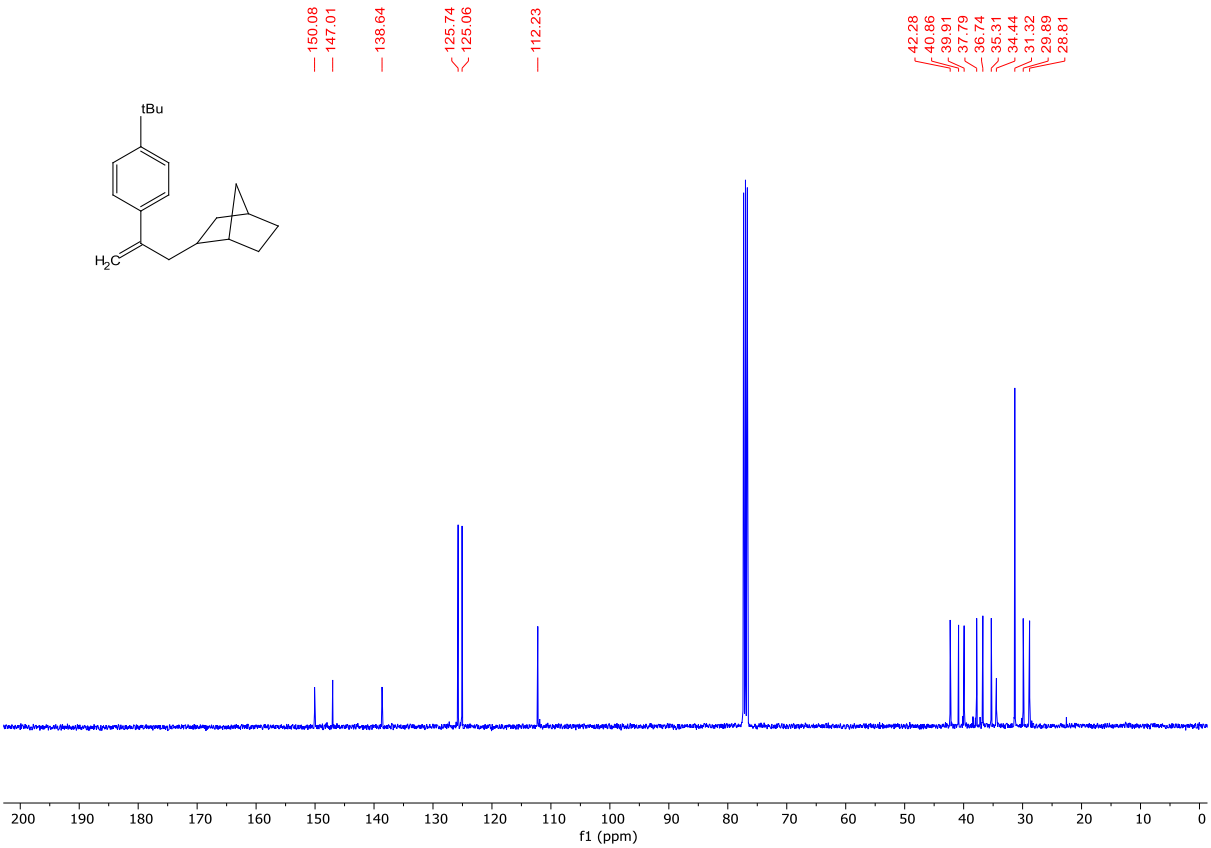
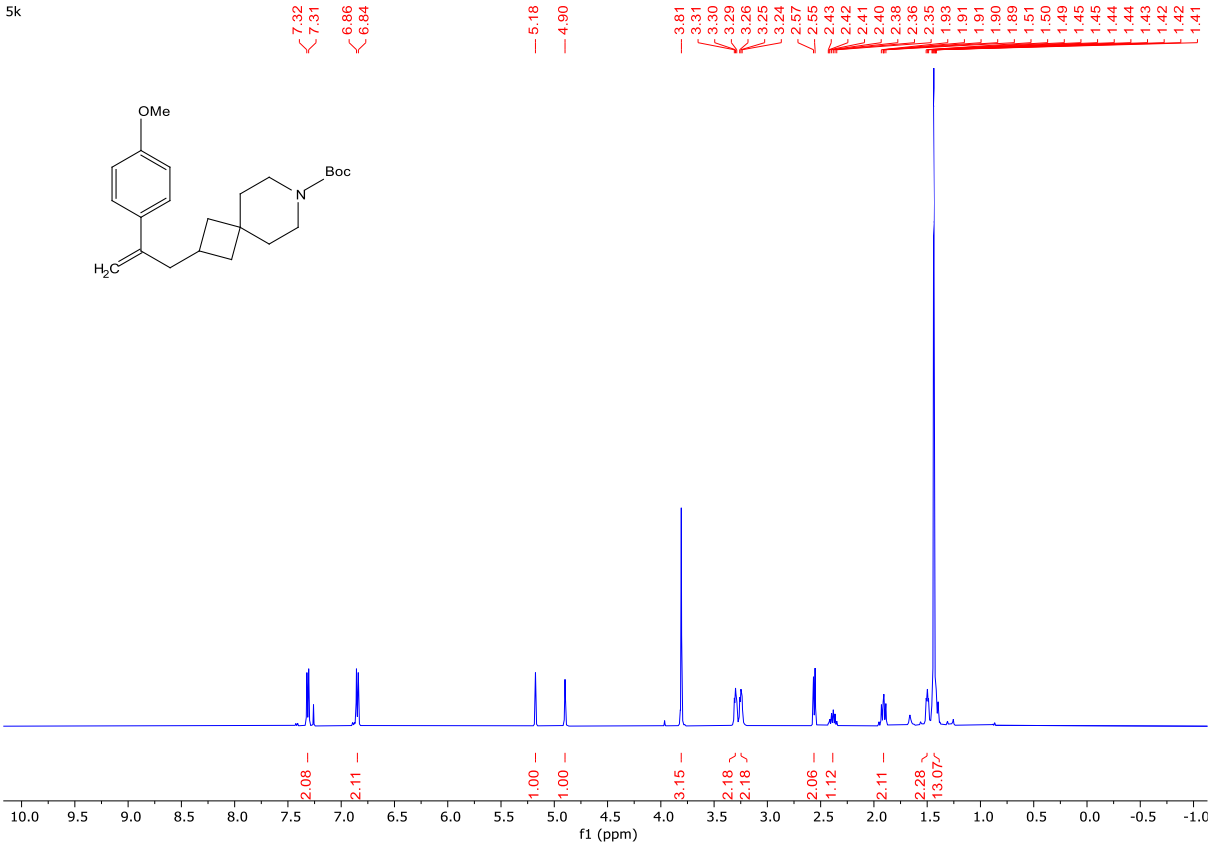
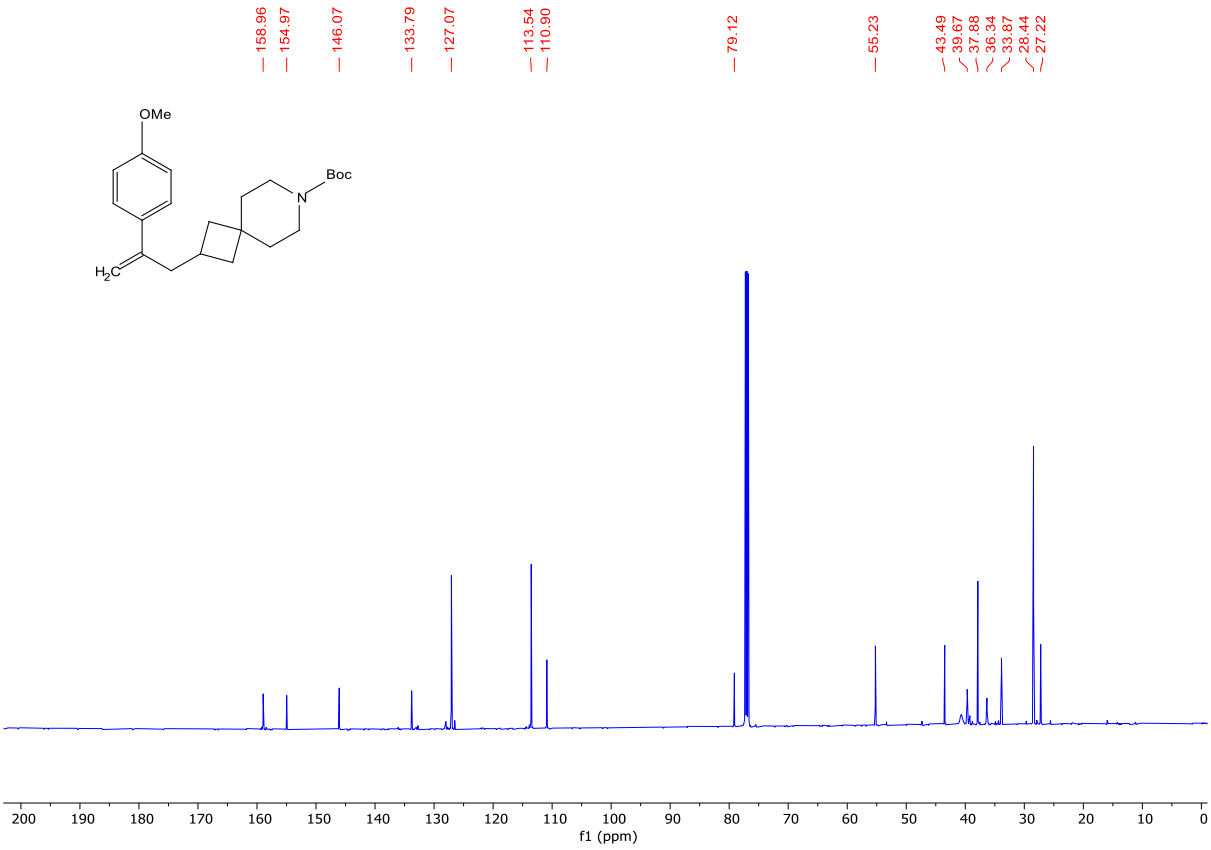
4.98
2.50
2.48
2.48
2.47
2.46
2.45
2.44
2.28
2.28
2.26
2.26
2.25
2.24
2.23
2.22
2.20
2.19
2.03
2.02
1.49
1.48
1.47
1.46
1.45
1.45
1.44
1.44
1.43
1.41
1.40
1.38
1.38
1.36
1.36
1.35
1.35
1.33
1.31
1.30
1.29
1.28
1.27
1.26
1.26
1.24
1.24
1.22
1.12
1.12
1.11
1.11
1.10
1.09
1.09
1.08
1.07
1.07
1.06
1.06
tBu
H2C
4.00
0.96
0.93
1.12
1.01
1.00
0.98
2.22
12.00
4.15
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

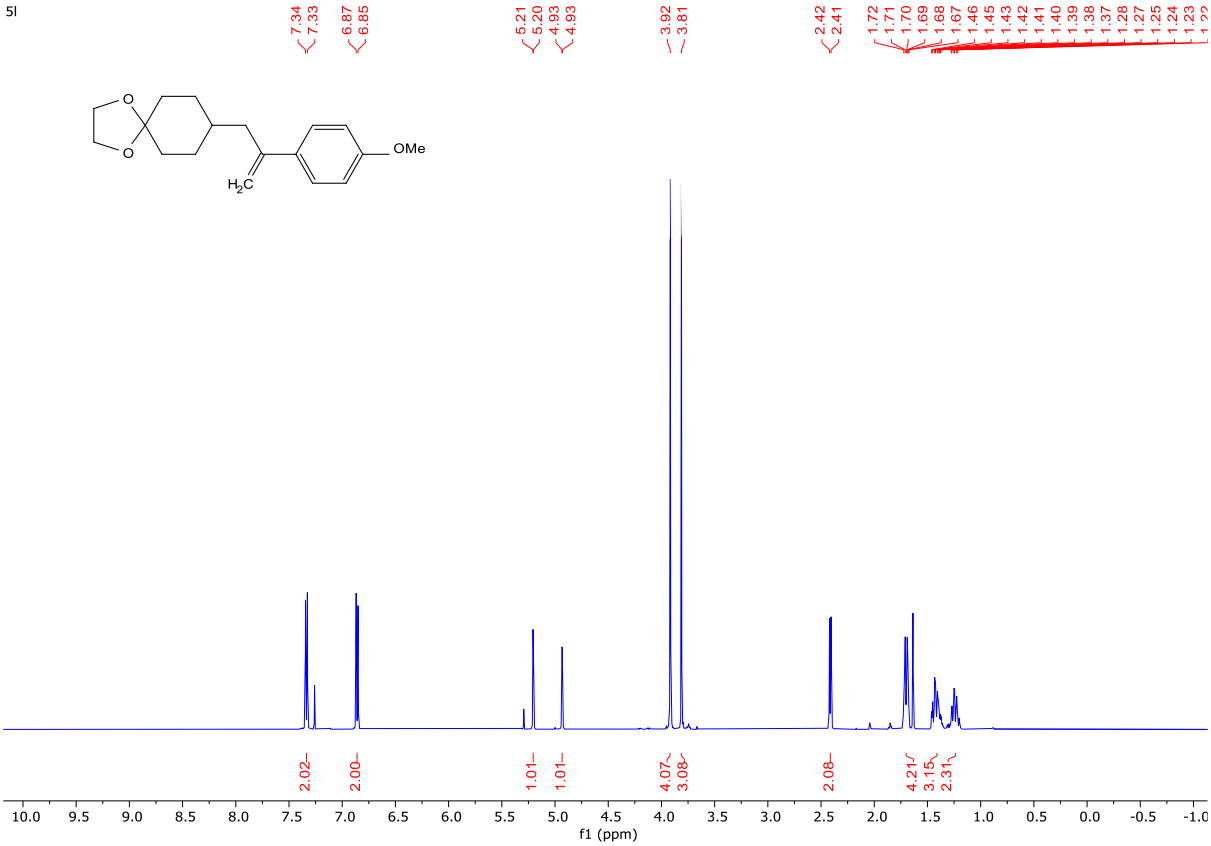

150.08
147.01
138.64
125.74
125.06
112.23
42.28
40.86
39.91
37.79
36.74
35.31
34.44
31.32
29.89
28.81
tBu
H2C
f1 (ppm)

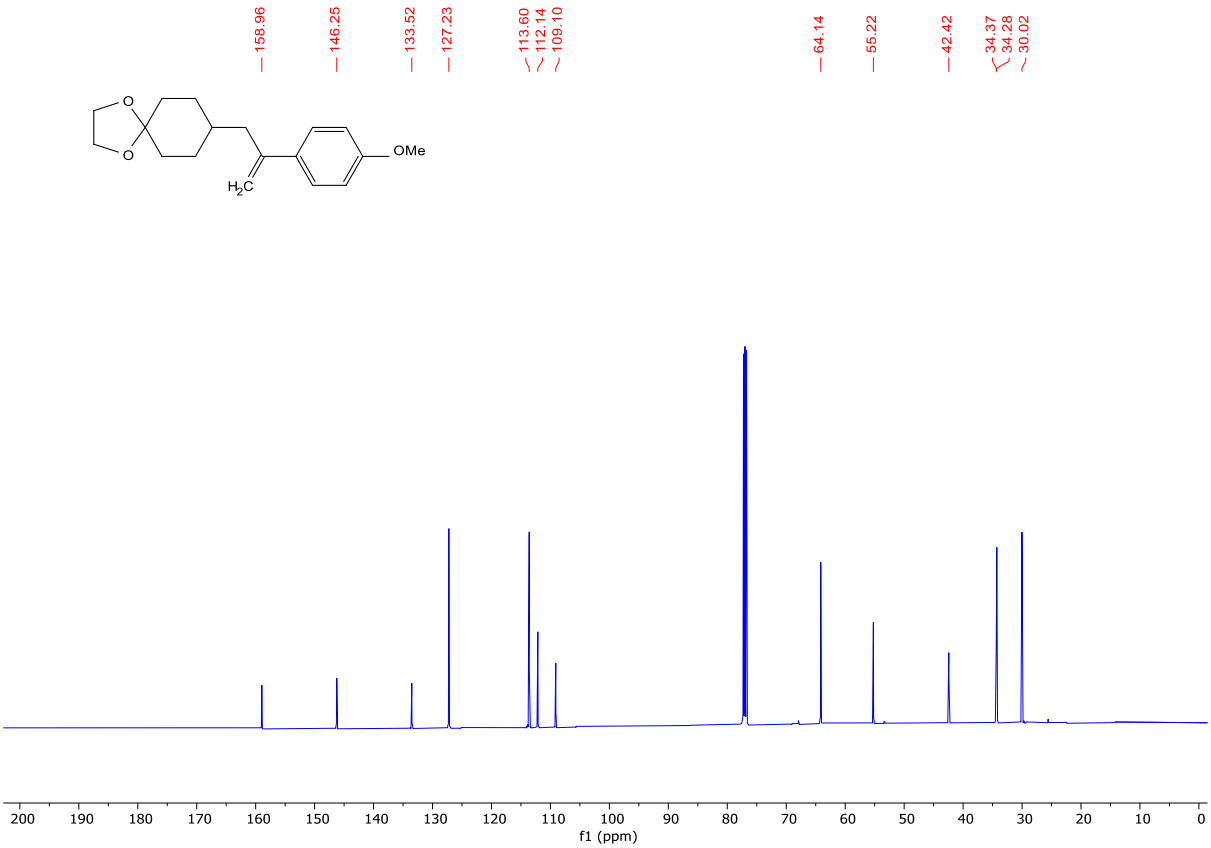
5k


7.32
7.31
6.86
6.84
5.18
4.90
3.81
3.31
3.30
3.29
3.26
3.25
3.24
2.57
2.55
2.43
2.42
2.41
2.40
2.38
2.36
2.35
1.93
1.91
1.91
1.90
1.89
1.51
1.50
1.49
1.45
1.45
1.44
1.44
1.43
1.42
1.42
1.41
OMe
Boc
N
H2C
2.08
2.11
1.00
1.00
3.15
2.18
2.18
2.06
1.12
2.11
2.28
13.07
f1 (ppm)

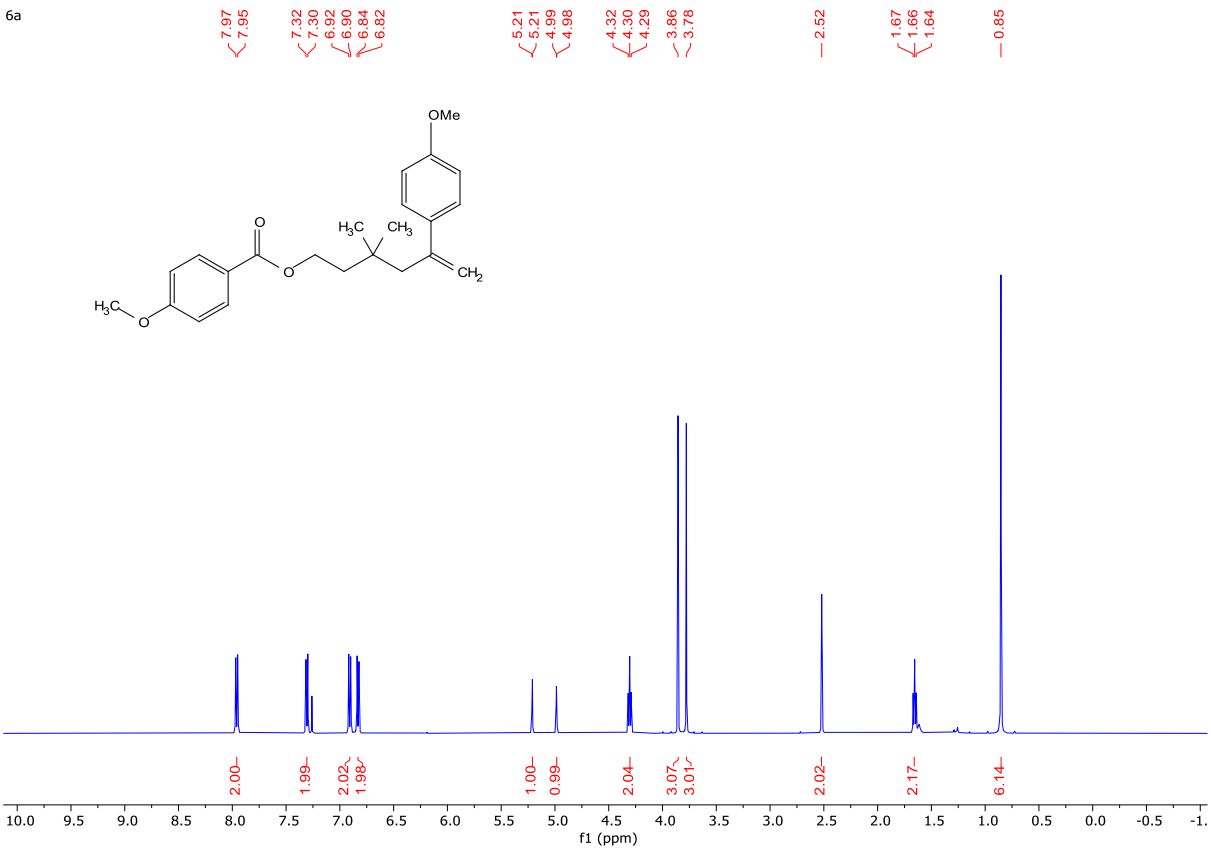

158.96
154.97
146.07
133.79
127.07
113.54
110.90
79.12
55.23
43.49
39.67
37.88
36.34
33.87
28.44
27.22
OMe
Boc
N
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

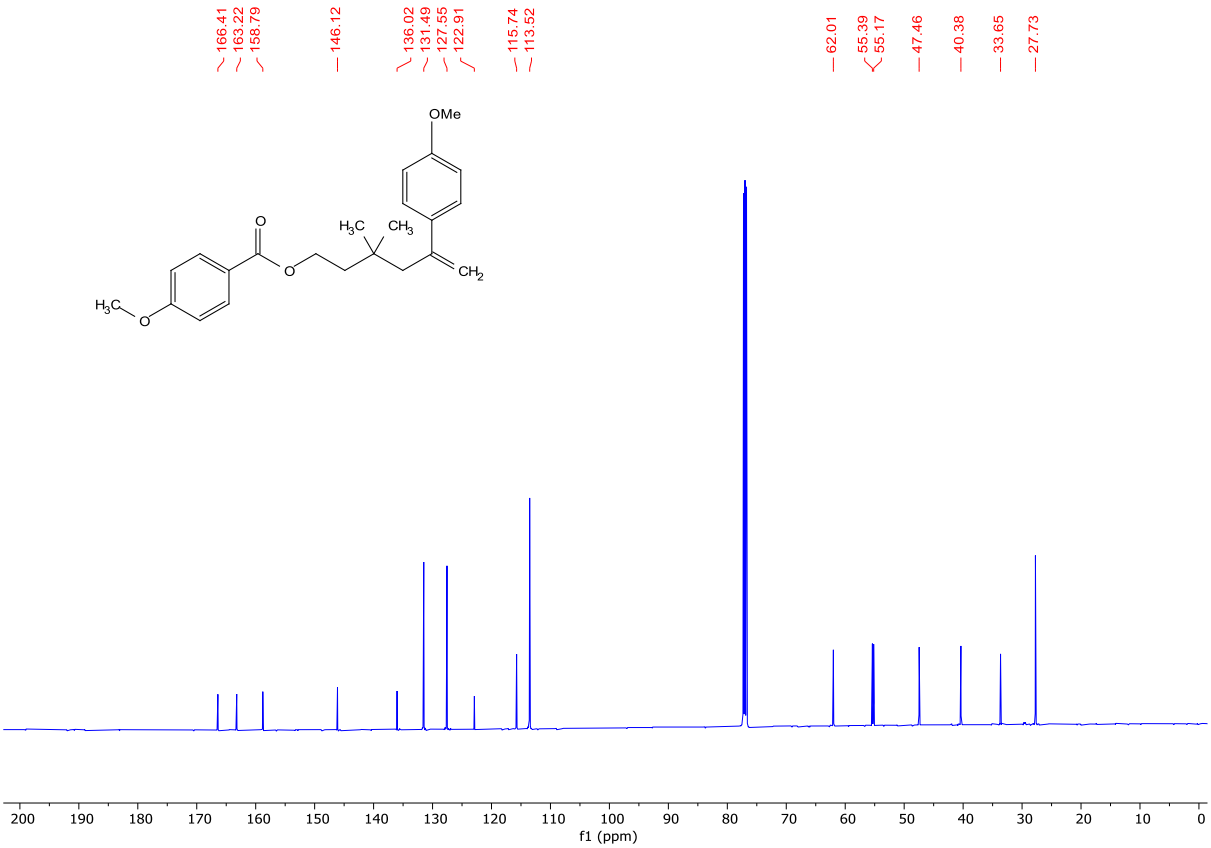
5l


7.34
7.33
6.87
6.85
5.21
5.20
4.93
4.93
3.92
3.81
2.42
2.41
1.72
1.71
1.70
1.69
1.68
1.67
1.46
1.45
1.43
1.42
1.41
1.40
1.39
1.38
1.37
1.28
1.27
1.25
1.24
1.23
O
O
OMe
H2C
2.02
2.00
1.01
1.01
4.07
3.08
2.08
4.21
3.15
2.31
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

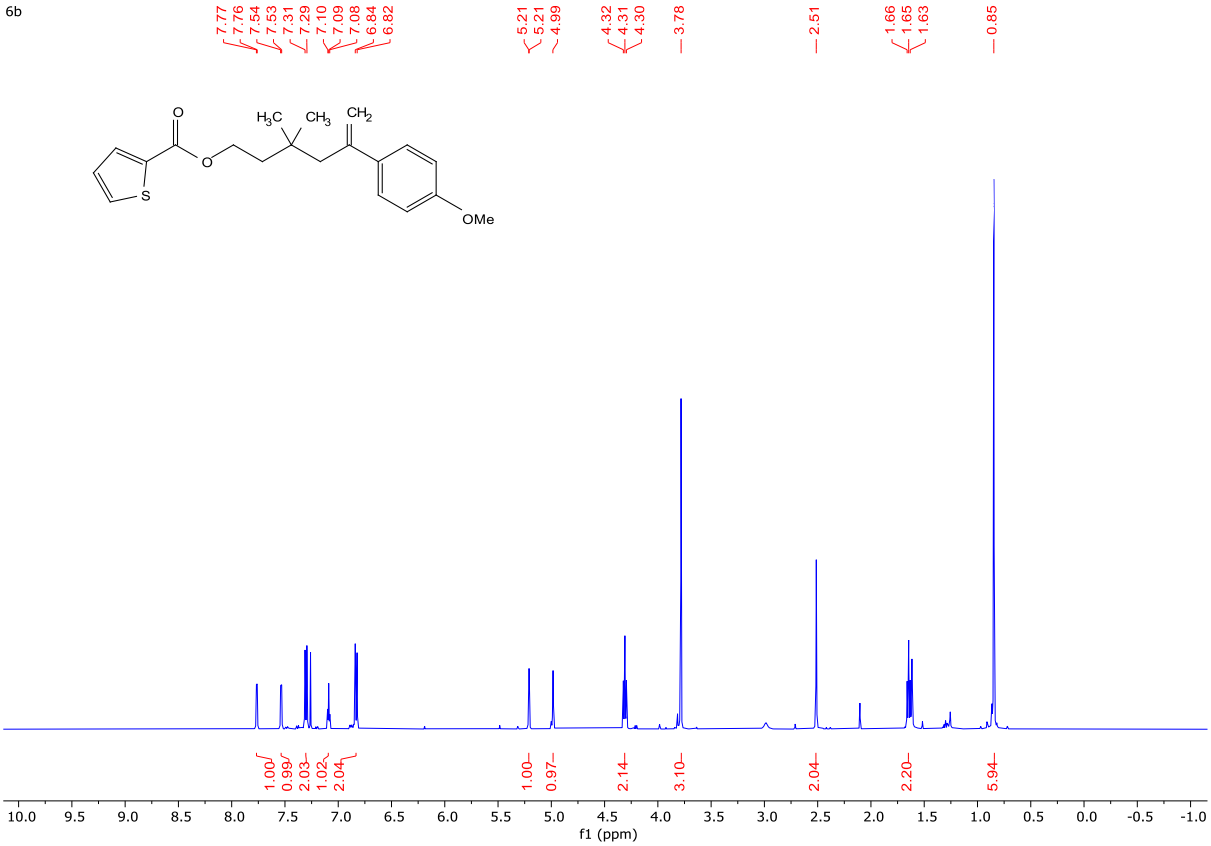

158.96
146.25
133.52
127.23
113.60
112.14
109.10
64.14
55.22
42.42
34.37
34.28
30.02
O
O
OMe
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

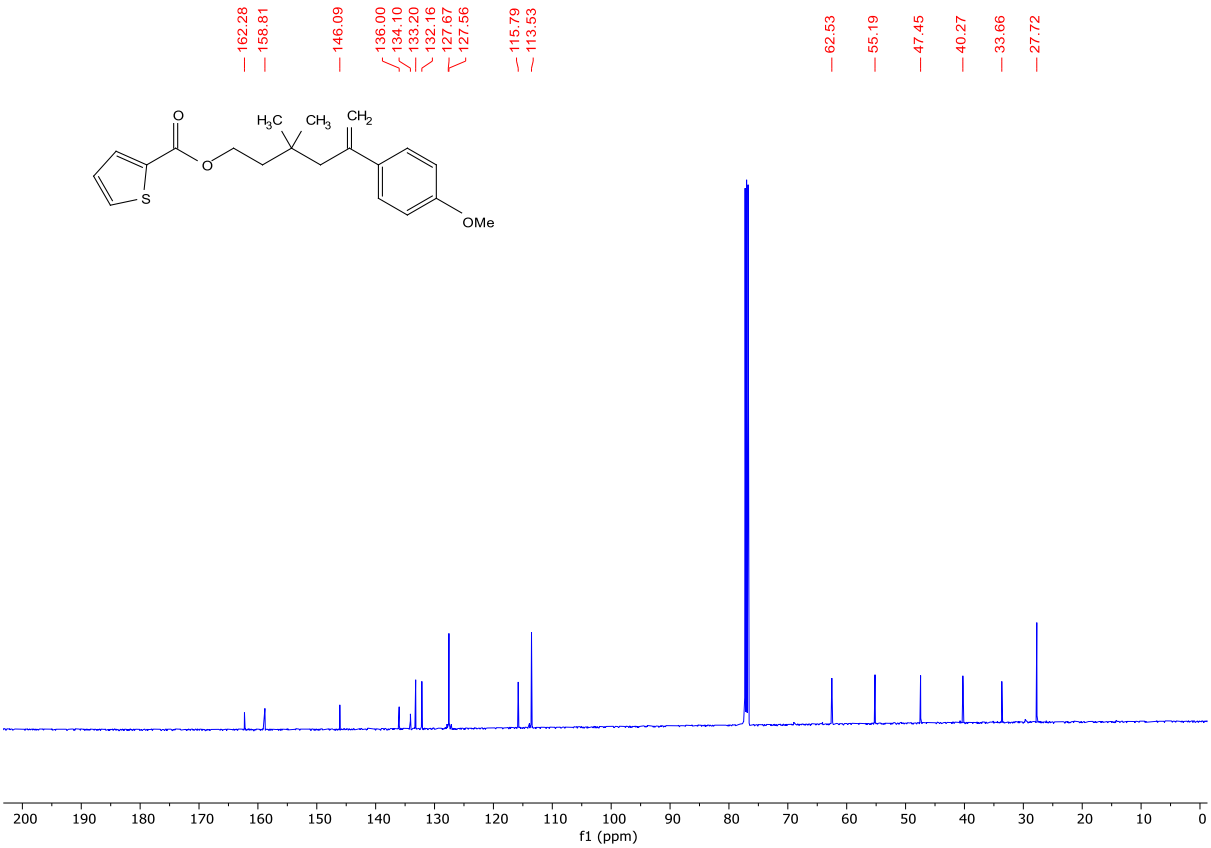
6a


7.97
7.95
7.32
7.30
6.92
6.90
6.84
6.82
5.21
5.21
4.99
4.98
4.32
4.30
4.29
3.86
3.78
2.52
1.67
1.66
1.64
0.85
OMe
O
H3C
CH3
O
CH2
H3C
O
2.00
1.99
2.02
1.98
1.00
0.99
2.04
3.07
3.01
2.02
2.17
6.14
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.
f1 (ppm)

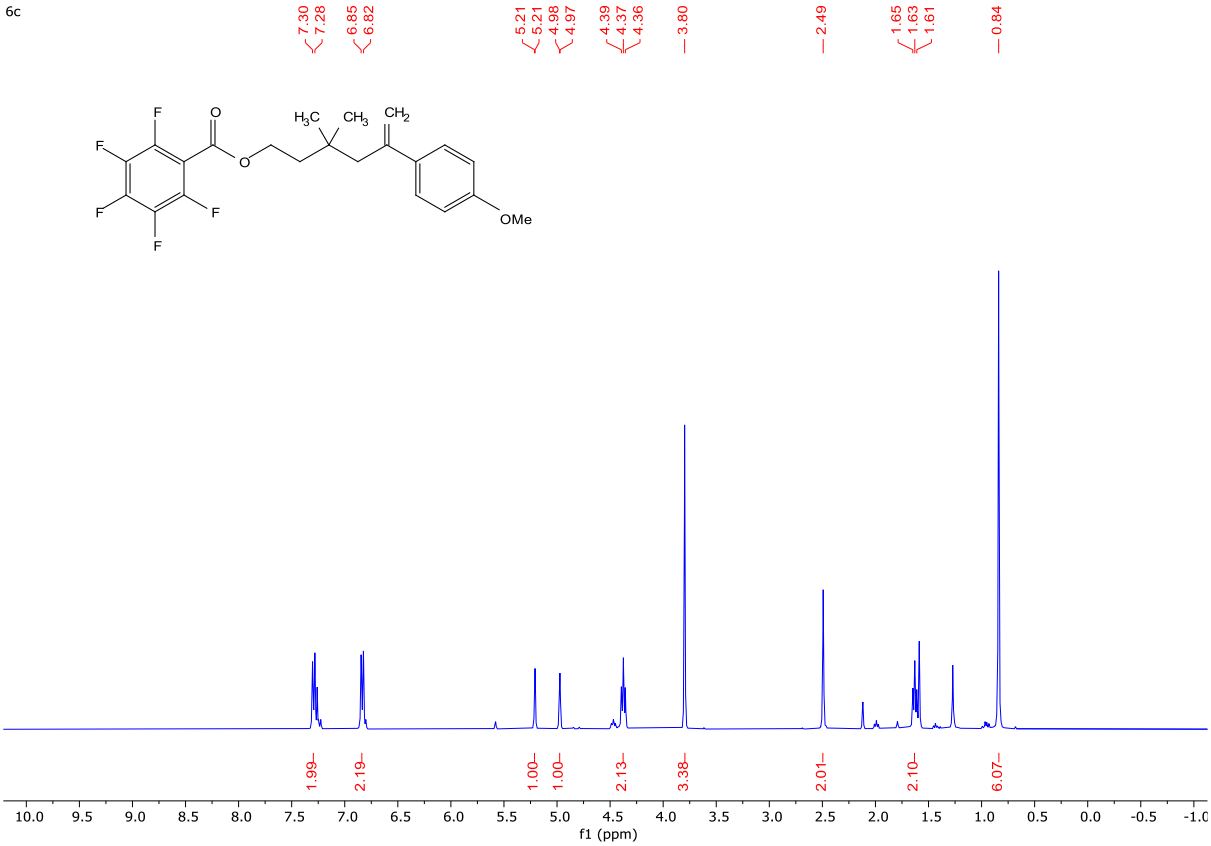

166.41
163.22
158.79
146.12
136.02
131.49
127.55
122.91
115.74
113.52
62.01
55.39
55.17
47.46
40.38
33.65
27.73
OMe
O
O
H3C
CH3
CH2
H3C
O
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

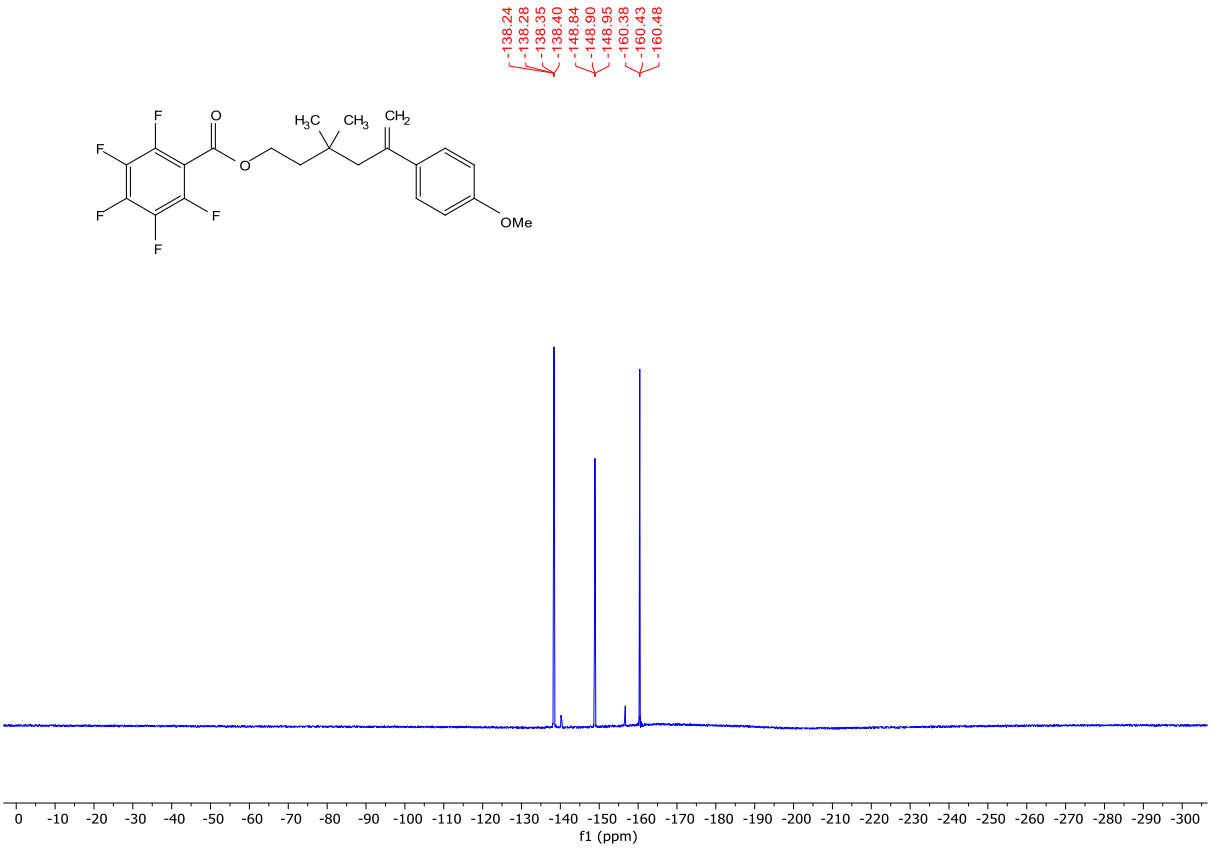
6b

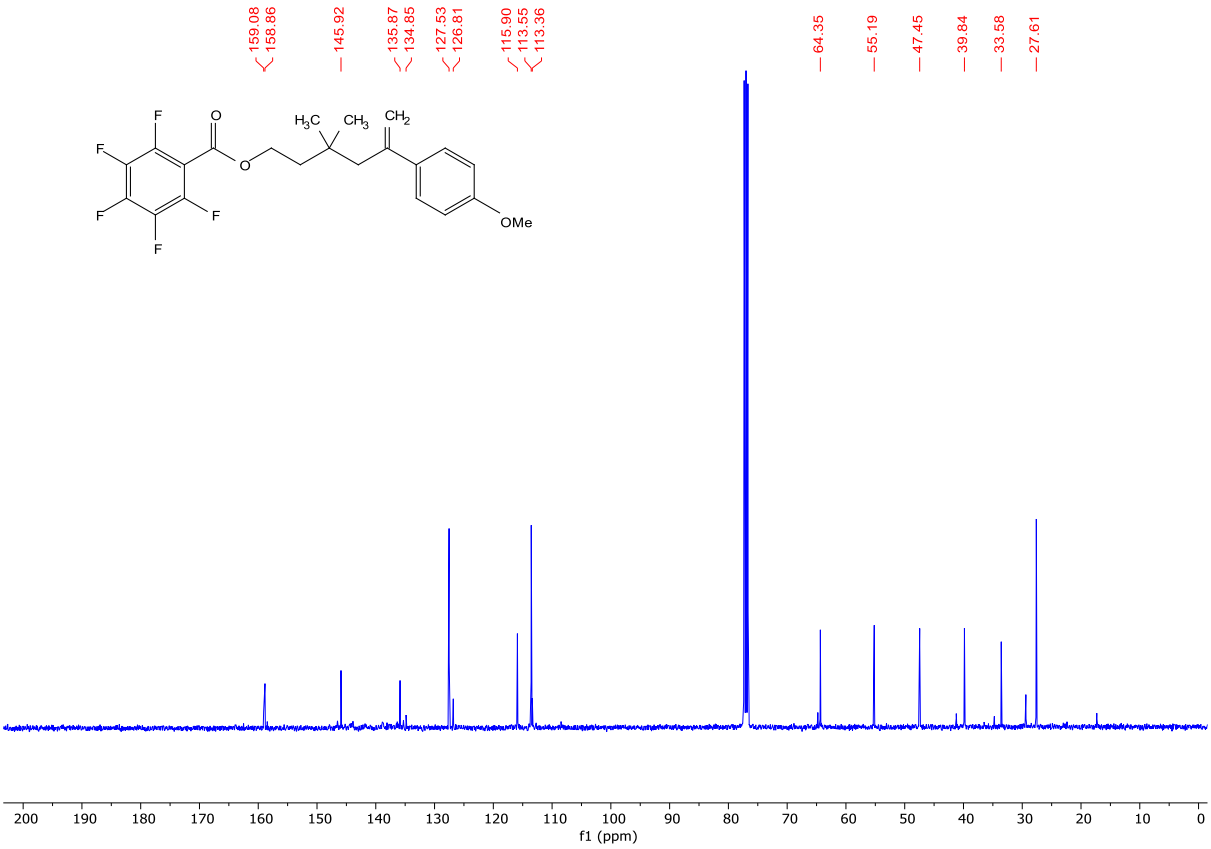

7.77
7.76
7.54
7.53
7.31
7.29
7.10
7.09
7.08
6.84
6.82
5.21
5.21
4.99
4.32
4.31
4.30
3.78
2.51
1.66
1.65
1.63
0.85
O
O
S
H3C
CH3
CH2
OMe
1.00
0.99
2.03
1.02
2.04
1.00
0.97
2.14
3.10
2.04
2.20
5.94
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


162.28
158.81
146.09
136.00
134.10
133.20
132.16
127.67
127.56
115.79
113.53
62.53
55.19
47.45
40.27
33.66
27.72
O
H3C
CH3
CH2
O
S
OMe
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

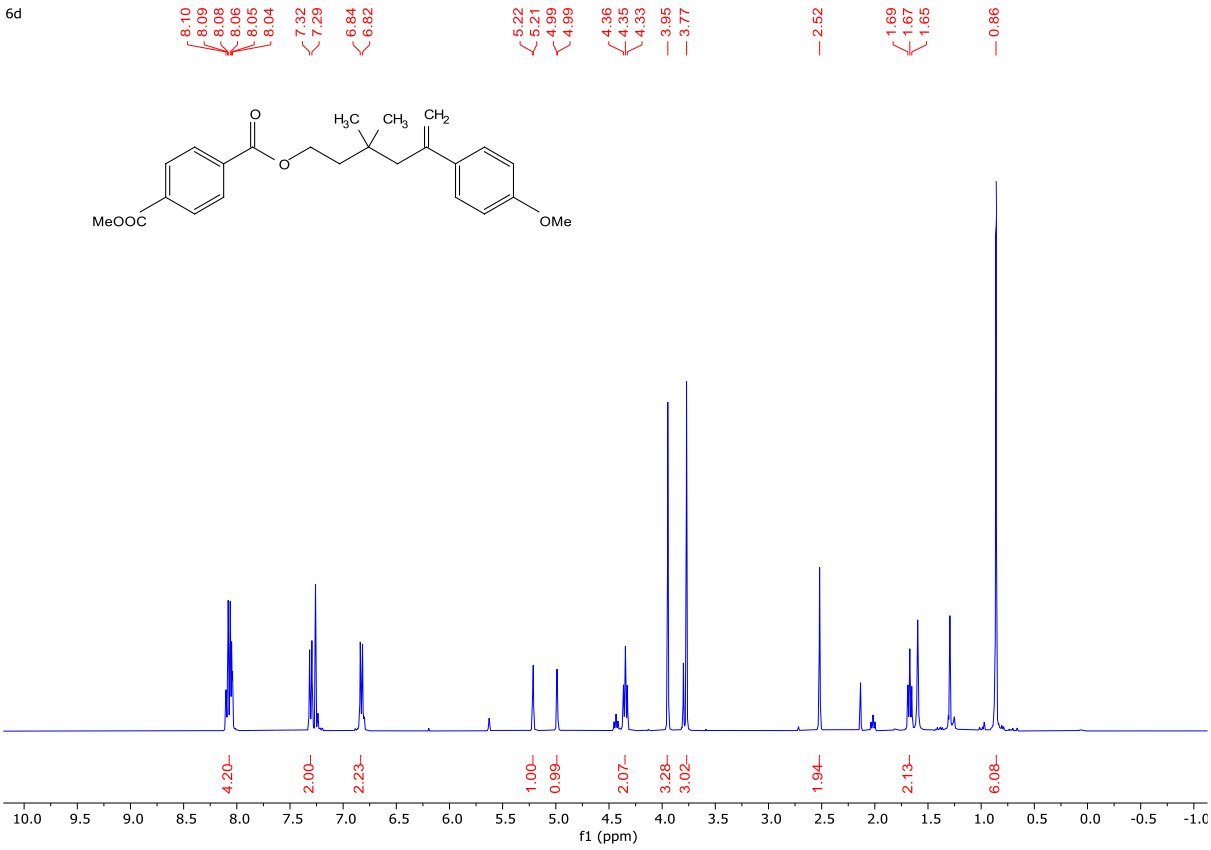
6c

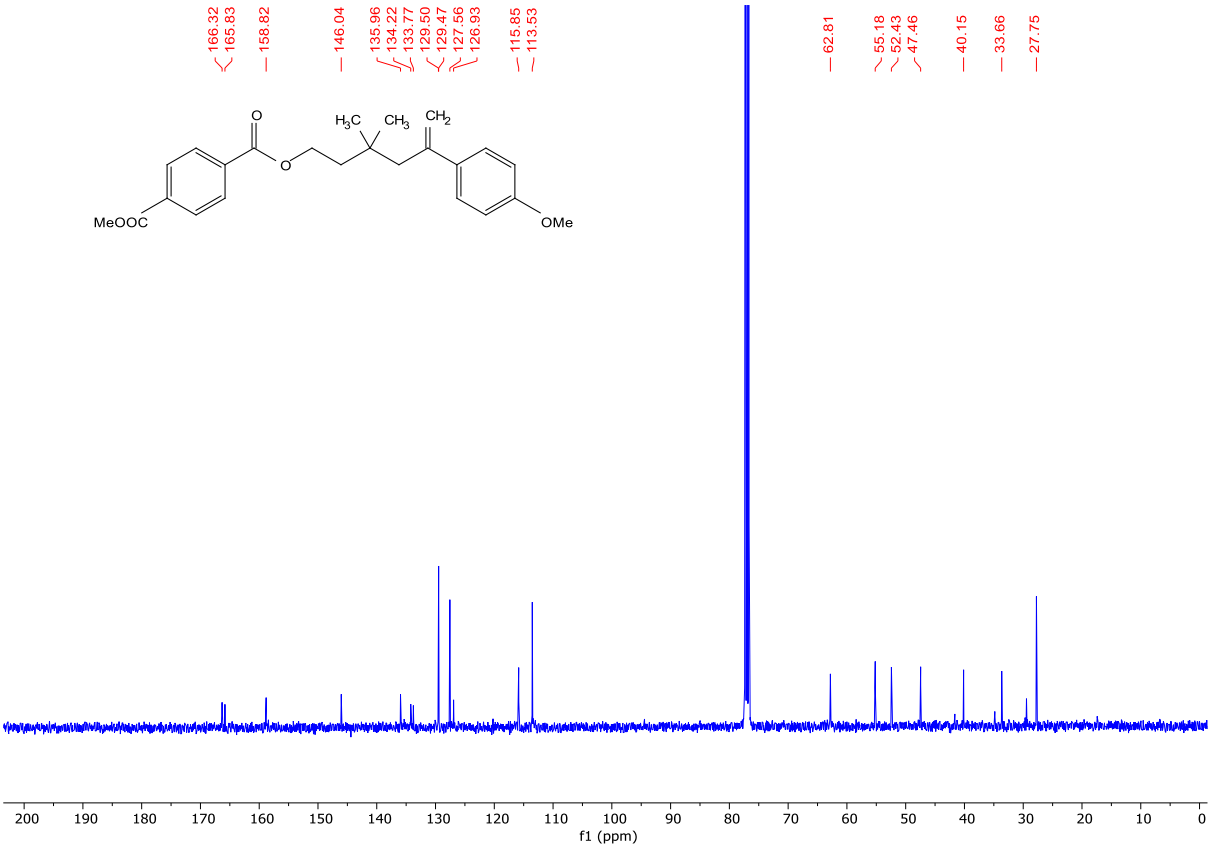

7.30
7.28
6.85
6.82
5.21
5.21
4.98
4.97
4.39
4.37
4.36
3.80
2.49
1.65
1.63
1.61
0.84
F
O
H3C
CH3
CH2
F
F
F
F
O
OMe
1.99
2.19
1.00
1.00
2.13
3.38
2.01
2.10
6.07
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


-138.24
-138.28
-138.35
-138.40
-148.84
-148.90
-148.95
-160.38
-160.43
-160.48
F
O
H3C
CH3
CH2
F
O
F
F
F
OMe
0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220 -230 -240 -250 -260 -270 -280 -290 -300
f1 (ppm)

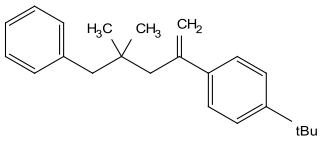

159.08
158.86
145.92
135.87
134.85
127.53
126.81
115.90
113.55
113.36
64.35
55.19
47.45
39.84
33.58
27.61
F
O
H3C
CH3
CH2
F
O
F
F
F
OMe
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

6d

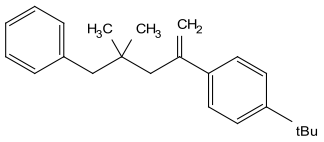

8.10
8.09
8.08
8.06
8.05
8.04
7.32
7.29
6.84
6.82
5.22
5.21
4.99
4.99
4.36
4.35
4.33
3.95
3.77
2.52
1.69
1.67
1.65
0.86
O
O
H3C
CH3
CH2
MeOOC
OMe
4.20
2.00
2.23
1.00
0.99
2.07
3.28
3.02
1.94
2.13
6.08
f1 (ppm)


166.32
165.83
158.82
146.04
135.96
134.22
133.77
129.50
129.47
127.56
126.93
115.85
113.53
62.81
55.18
52.43
47.46
40.15
33.66
27.75
O
O
H3C
CH3
CH2
MeOOC
OMe
f1 (ppm)

6e

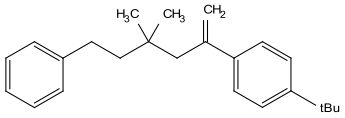

H3C
CH3
CH2
tBu

7.32
7.28
7.26
7.24
7.22
7.20
7.18
7.12
7.10
5.30
5.29
5.02
2.55
2.50
1.32
0.75
4.06
2.24
1.22
2.09
1.11
1.00
2.10
2.07
9.13
6.21
f1 (ppm)

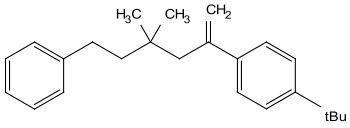

H3C
CH3
CH2
tBu

149.91
146.69
140.60
139.27
130.69
127.55
126.05
125.71
124.99
116.23
49.59
47.84
35.42
34.40
31.33
26.87
f1 (ppm)

6f

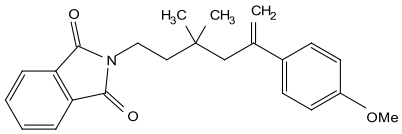

H3C
CH3
CH2
tBu

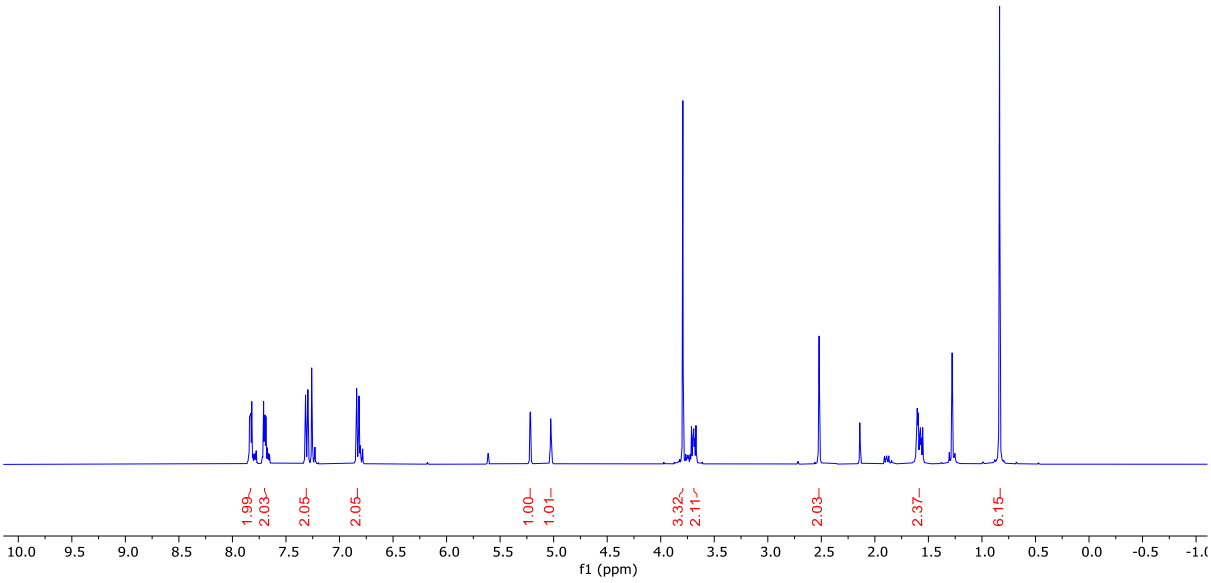
7.34
7.22
7.20
7.19
7.14
7.13
7.11
6.94
6.92
5.25
5.24
5.04
2.54
2.50
2.49
2.48
2.47
2.47
1.41
1.41
1.40
1.39
1.38
1.34
0.88
3.98
2.16
0.98
1.94
1.00
0.98
2.22
2.06
2.15
9.17
5.88
f1 (ppm)

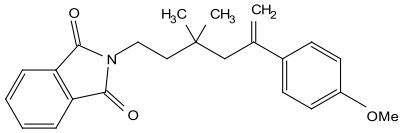

H3C
CH3
CH2
tBu

149.96
147.02
143.37
140.87
128.23
128.15
126.27
125.38
125.04
116.28
46.32
44.35
34.38
31.38
30.78
27.98
21.19
f1 (ppm)

6g

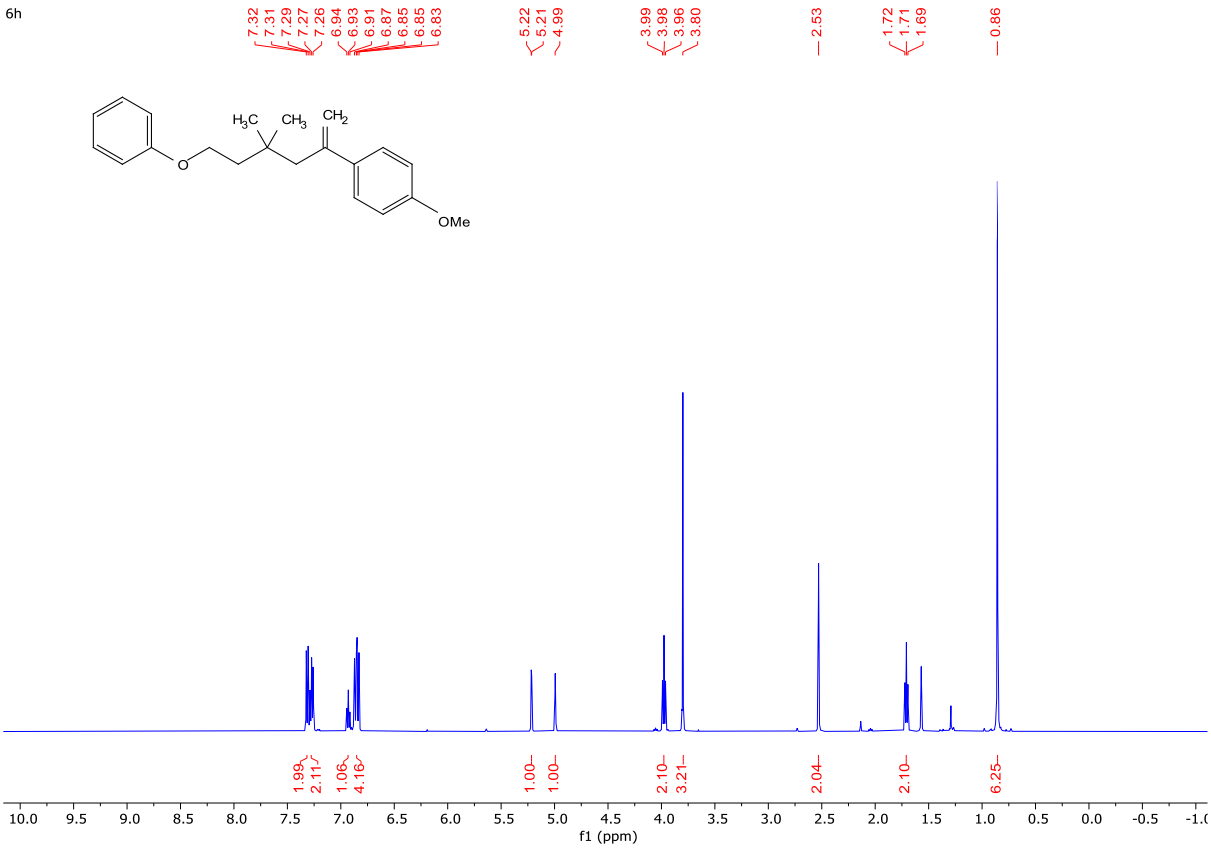

O
N
O
H3C
CH3
CH2
OMe

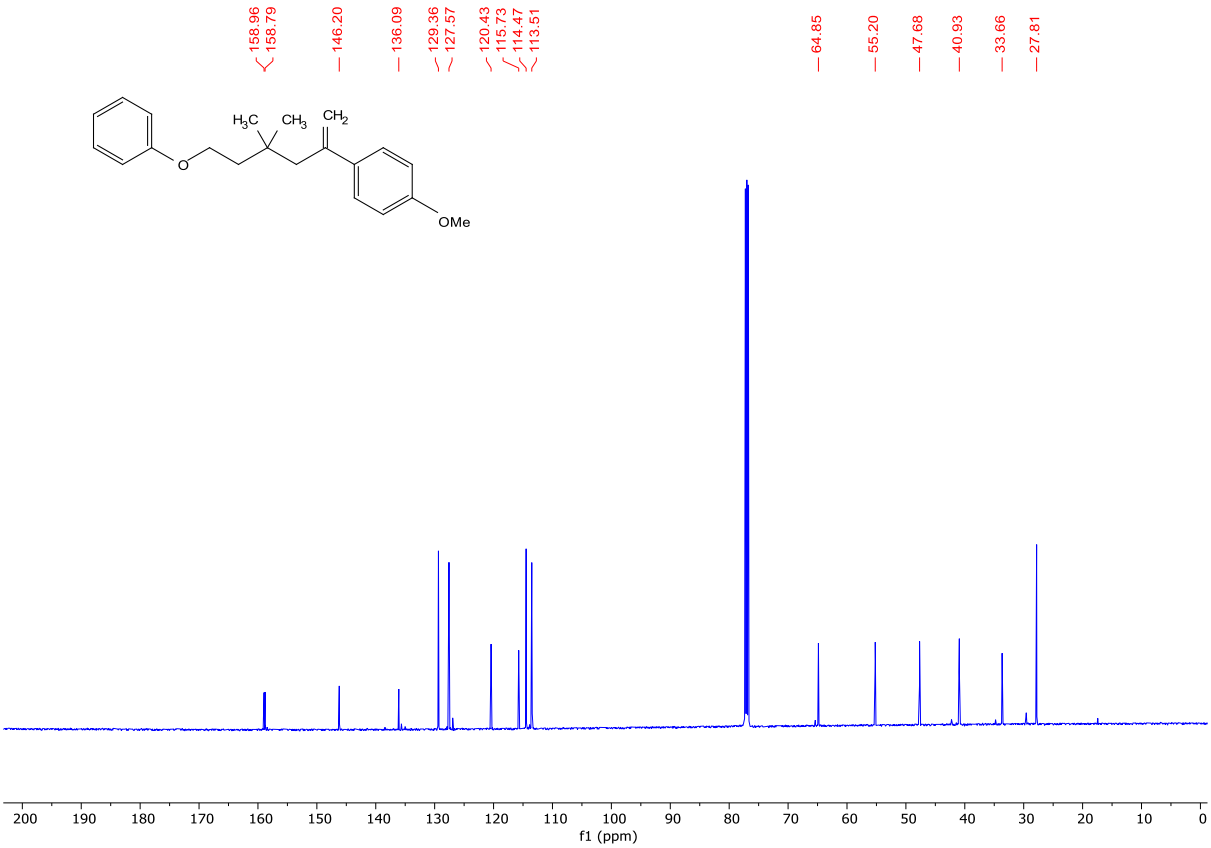

7.84
7.83
7.83
7.82
7.71
7.70
7.70
7.69
7.32
7.30
6.84
6.82
5.22
5.22
5.03
5.02
3.79
3.71
3.70
3.69
3.68
3.67
2.52
1.60
1.60
1.58
1.57
1.57
0.84
1.99
2.03
2.05
2.05
1.00
1.01
3.32
2.11
2.03
2.37
6.15
f1 (ppm)


O
N
O
H3C
CH3
CH2
OMe

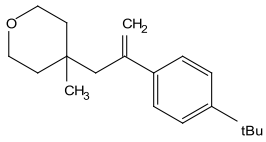
168.29
158.76
145.88
136.05
133.79
132.25
127.56
123.08
115.82
113.50
55.21
46.93
40.48
34.38
33.75
27.23
f1 (ppm)

6h

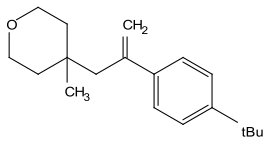

7.32
7.31
7.29
7.27
7.26
6.94
6.93
6.91
6.87
6.85
6.85
6.83
5.22
5.21
4.99
3.99
3.98
3.96
3.80
2.53
1.72
1.71
1.69
0.86
H3C
CH3
CH2
O
OMe
1.99
2.11
1.06
4.16
1.00
1.00
2.10
3.21
2.04
2.10
6.25
f1 (ppm)


158.96
158.79
146.20
136.09
129.36
127.57
120.43
115.73
114.47
113.51
64.85
55.20
47.68
40.93
33.66
27.81
H3C
CH3
CH2
O
OMe
f1 (ppm)

6i

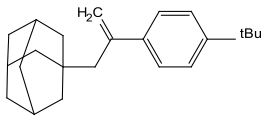

O
CH2
CH3
tBu

7.32
7.31
7.30
7.30
7.29
7.28
5.26
5.25
5.00
3.68
3.67
3.66
3.65
3.64
3.63
3.56
3.55
3.54
3.53
3.53
3.52
3.51
2.54
1.49
1.48
1.47
1.46
1.46
1.44
1.44
1.32
1.20
1.19
1.19
1.17
1.17
1.16
3.97
1.00
1.00
2.06
2.06
2.00
2.15
9.05
2.13
3.13
f1 (ppm)

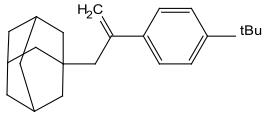

O
CH2
CH3
tBu

150.09
145.93
140.53
126.08
125.03
116.45
63.97
47.68
37.99
34.43
31.89
31.33
24.06
f1 (ppm)

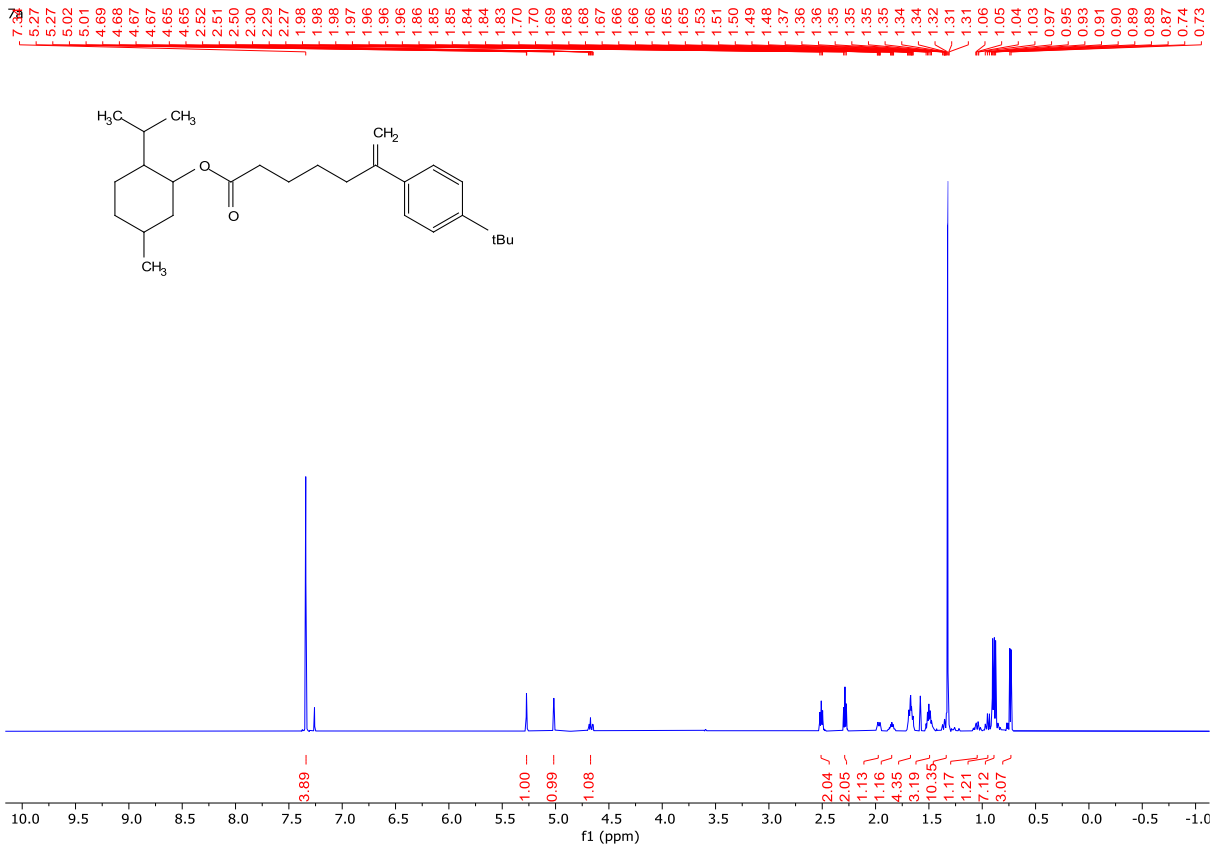
6j


H2C
tBu

7.34
7.32
7.31
7.29
5.27
5.26
4.93
4.92
2.32
1.86
1.63
1.61
1.61
1.60
1.53
1.52
1.40
1.39
1.33
1.33
1.33
1.32
1.31
1.31
1.31
1.30
3.97
1.00
0.99
1.88
3.10
3.20
1.74
5.13
11.06
f1 (ppm)


H2C
tBu

149.78
145.45
140.63
125.89
124.91
115.37
49.50
42.97
36.99
34.41
33.61
31.35
28.77
f1 (ppm)


7.38
7.27
5.27
5.02
5.01
4.69
4.68
4.67
4.67
4.65
4.65
2.52
2.51
2.50
2.30
2.29
2.27
1.98
1.98
1.98
1.97
1.96
1.96
1.96
1.86
1.85
1.85
1.84
1.84
1.83
1.70
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1.69
1.68
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1.66
1.66
1.66
1.65
1.65
1.53
1.51
1.50
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1.48
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1.36
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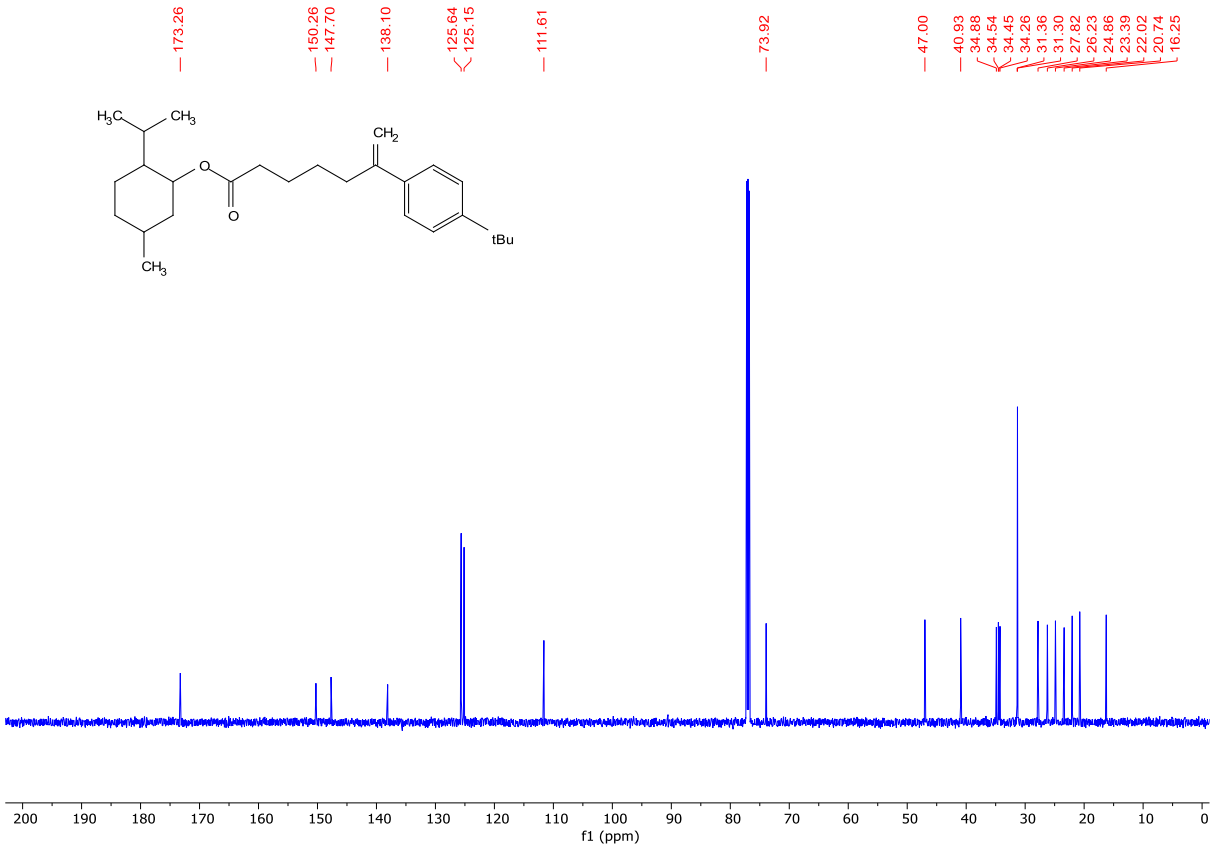
1.35
1.35
1.34
1.34
1.32
1.31
1.31
1.06
1.05
1.04
1.03
0.97
0.95
0.93
0.91
0.90
0.89
0.89
0.87
0.74
0.73
H3C
CH3
O
O
CH2
tBu
CH3
3.89
1.00
0.99
1.08
2.04
2.05
1.13
1.16
4.35
3.19
10.35
1.17
1.21
7.12
3.07
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)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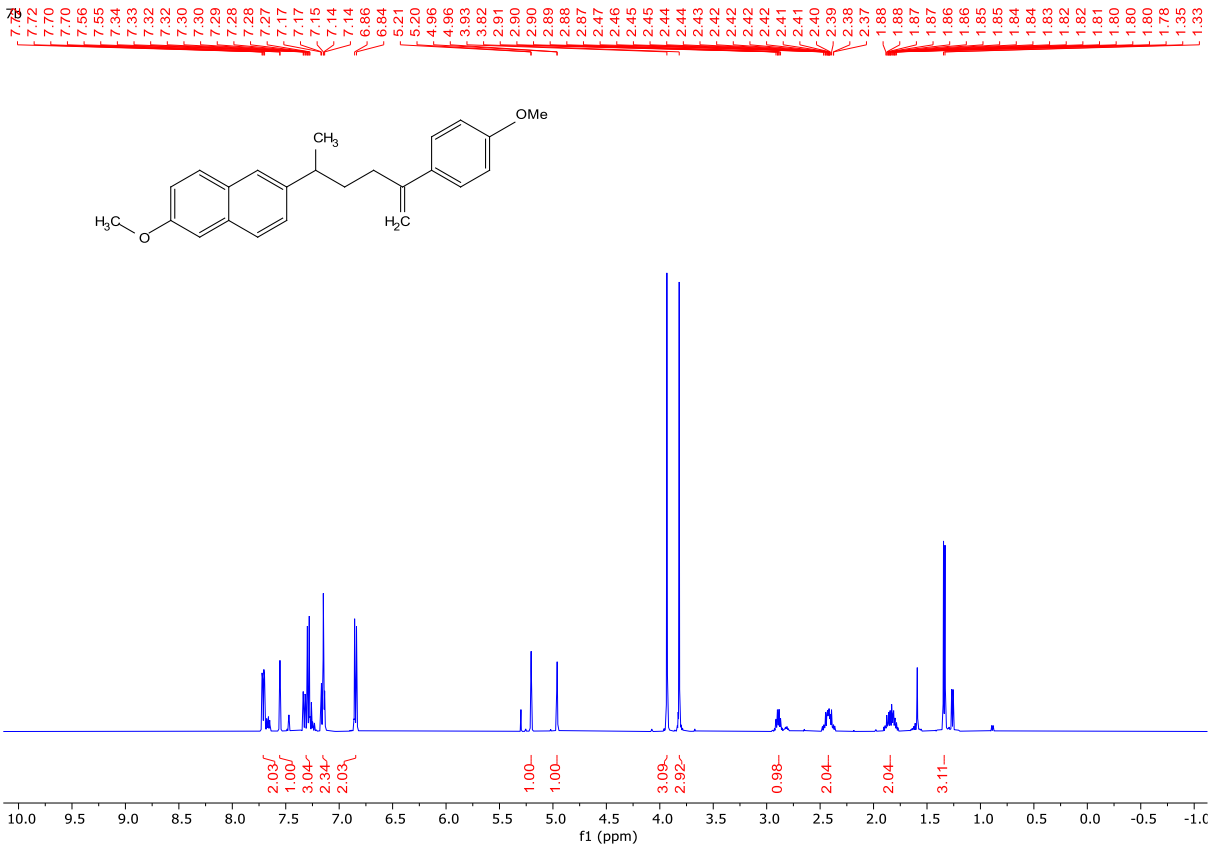
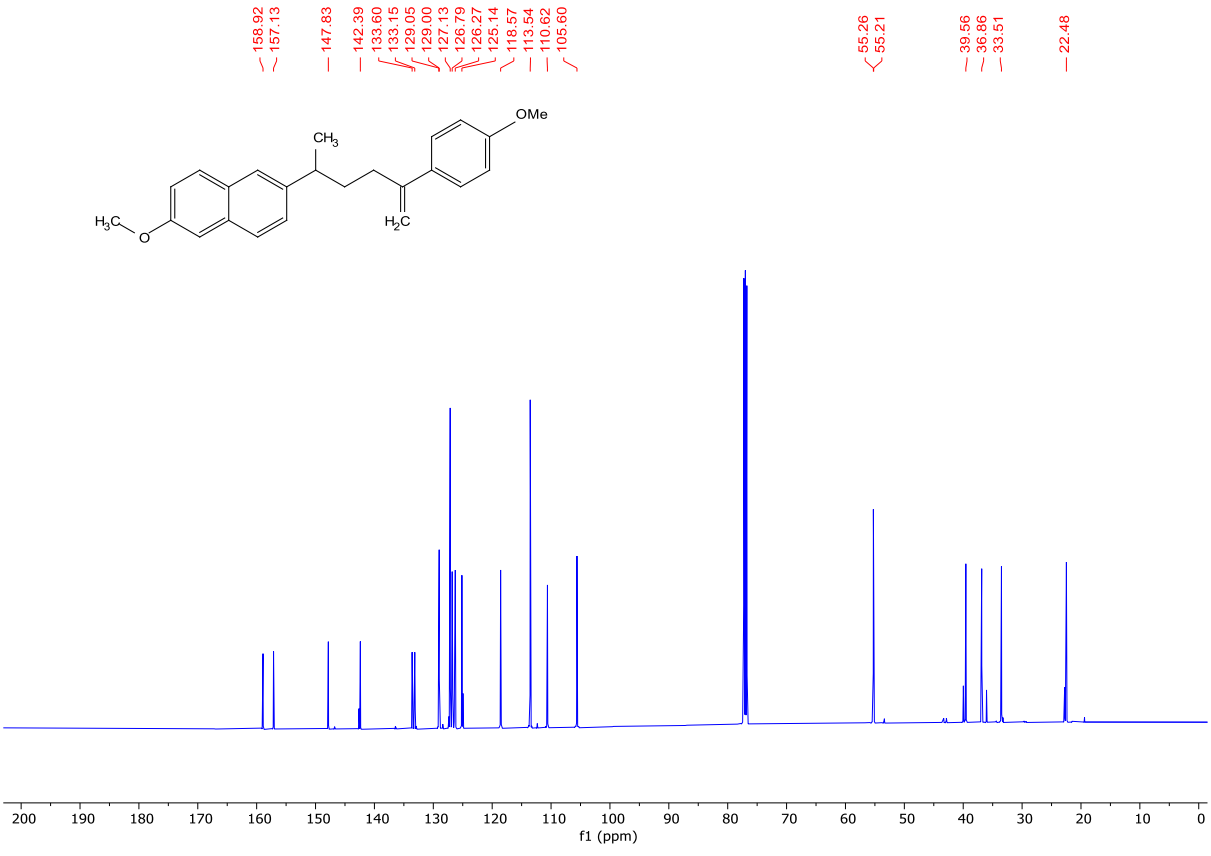
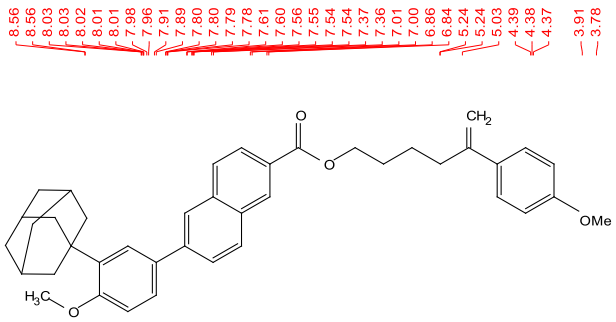
150.26
147.70
138.10
125.64
125.15
111.61
73.92
47.00
40.93
34.88
34.54
34.45
34.26
31.36
31.30
27.82
26.23
24.86
23.39
22.02
20.74
16.25
H3C
CH3
O
O
CH2
tBu
CH3
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

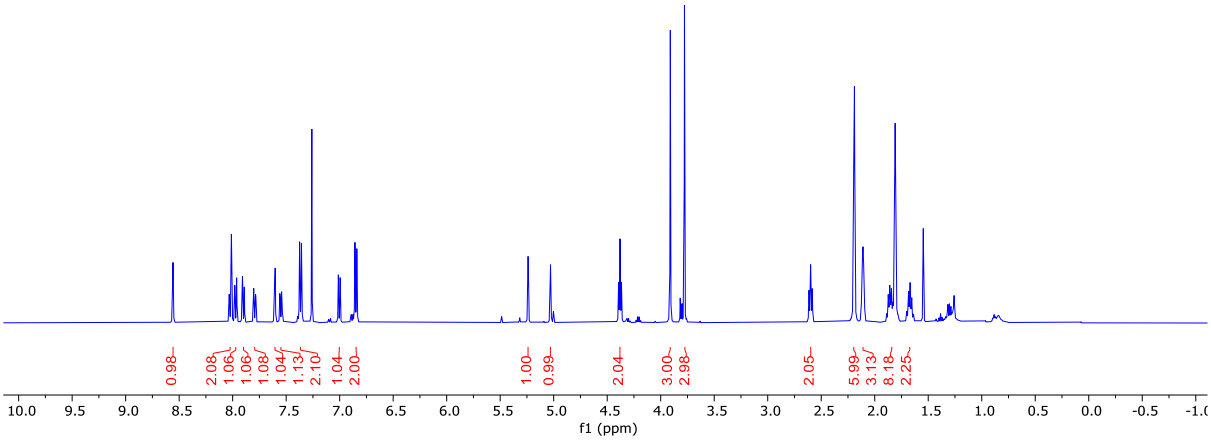
7g

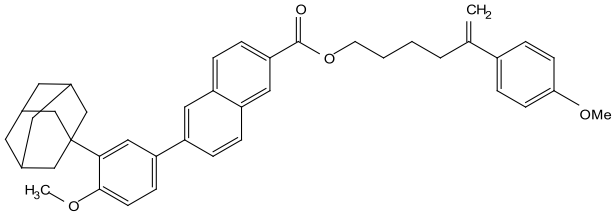

7.73 7.72 7.70 7.70 7.56 7.55 7.34 7.33 7.32 7.32 7.30 7.30 7.29 7.28 7.28 7.27 7.17 7.17 7.15 7.14 7.14 6.86 6.84 5.21 5.20 4.96 4.96 3.93 3.82 2.91 2.90 2.90 2.89 2.88 2.87 2.47 2.46 2.45 2.45 2.44 2.44 2.43 2.42 2.42 2.42 2.42 2.41 2.41 2.40 2.39 2.38 2.37 1.88 1.88 1.87 1.87 1.86 1.86 1.85 1.85 1.84 1.84 1.83 1.82 1.82 1.81 1.80 1.80 1.80 1.78 1.35 1.33
OMe
CH3
H3C
O
H2C
2.03 1.00 3.04 2.34 2.03 1.00 1.00 3.09 2.92 0.98 2.04 2.04 3.11
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


158.92 157.13 147.83 142.39 133.60 133.15 129.05 129.00 127.13 126.79 126.27 125.14 118.57 113.54 110.62 105.60 55.26 55.21 39.56 36.86 33.51 22.48
OMe
CH3
H3C
O
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

7c

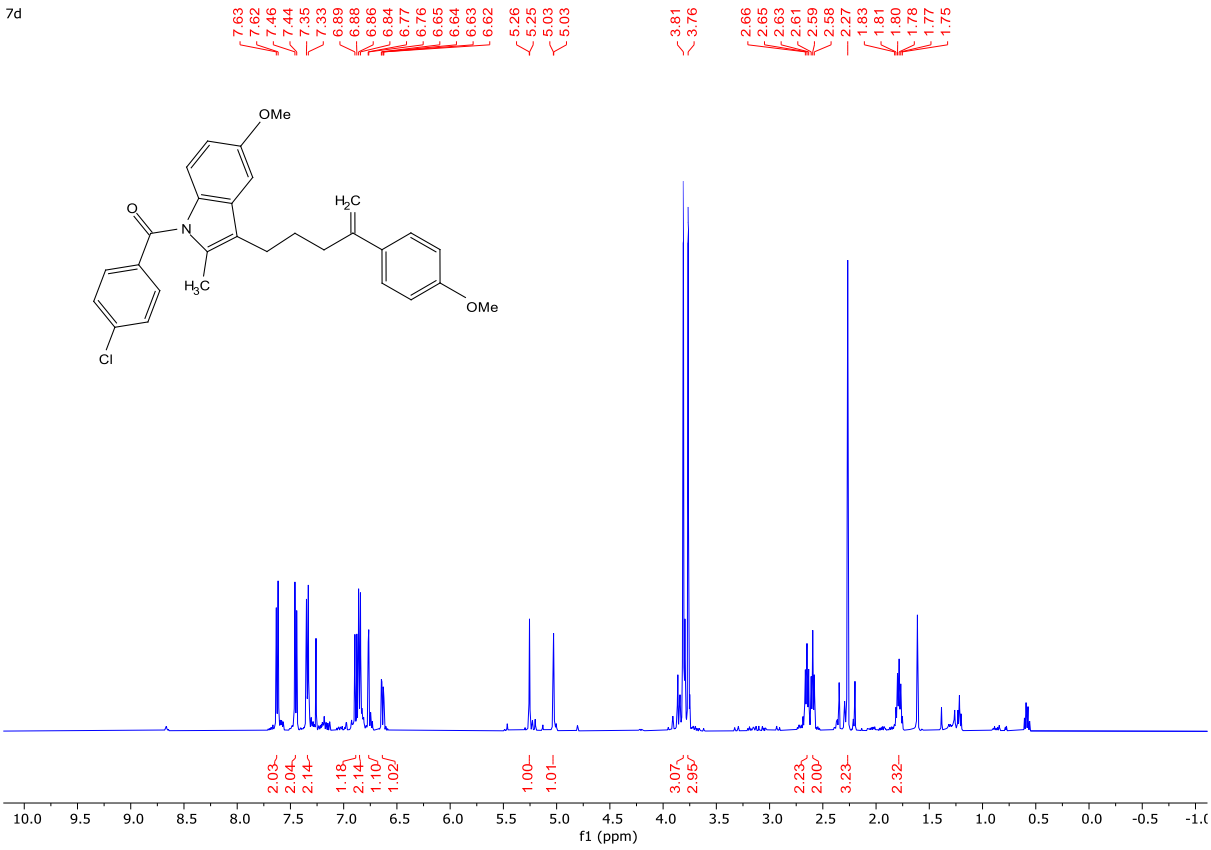

O
CH2
O
OMe
H3C
O

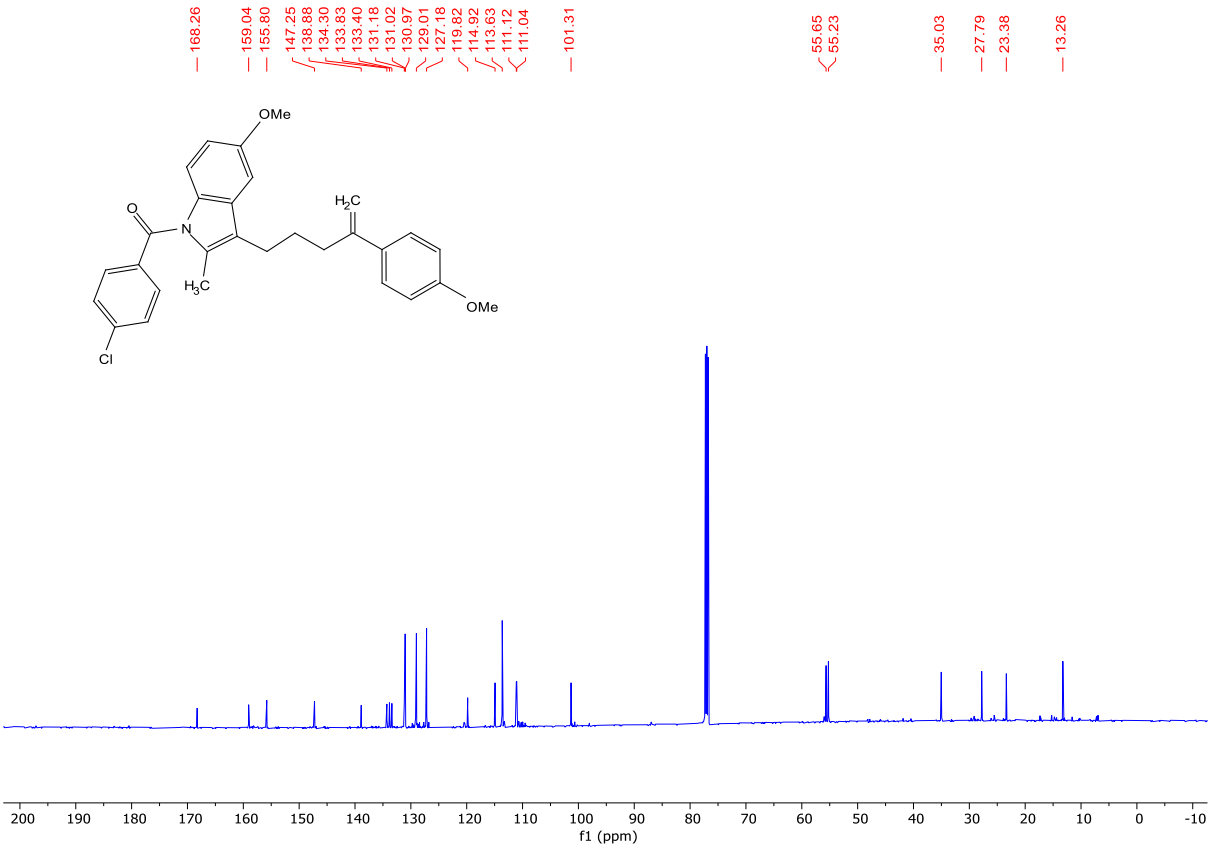

0.98
2.08
1.06
1.06
1.08
1.04
1.13
2.10
1.04
2.00
1.00
0.99
2.04
3.00
2.98
2.05
5.99
3.13
8.18
2.25
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


O
CH2
O
OMe
H3C
O

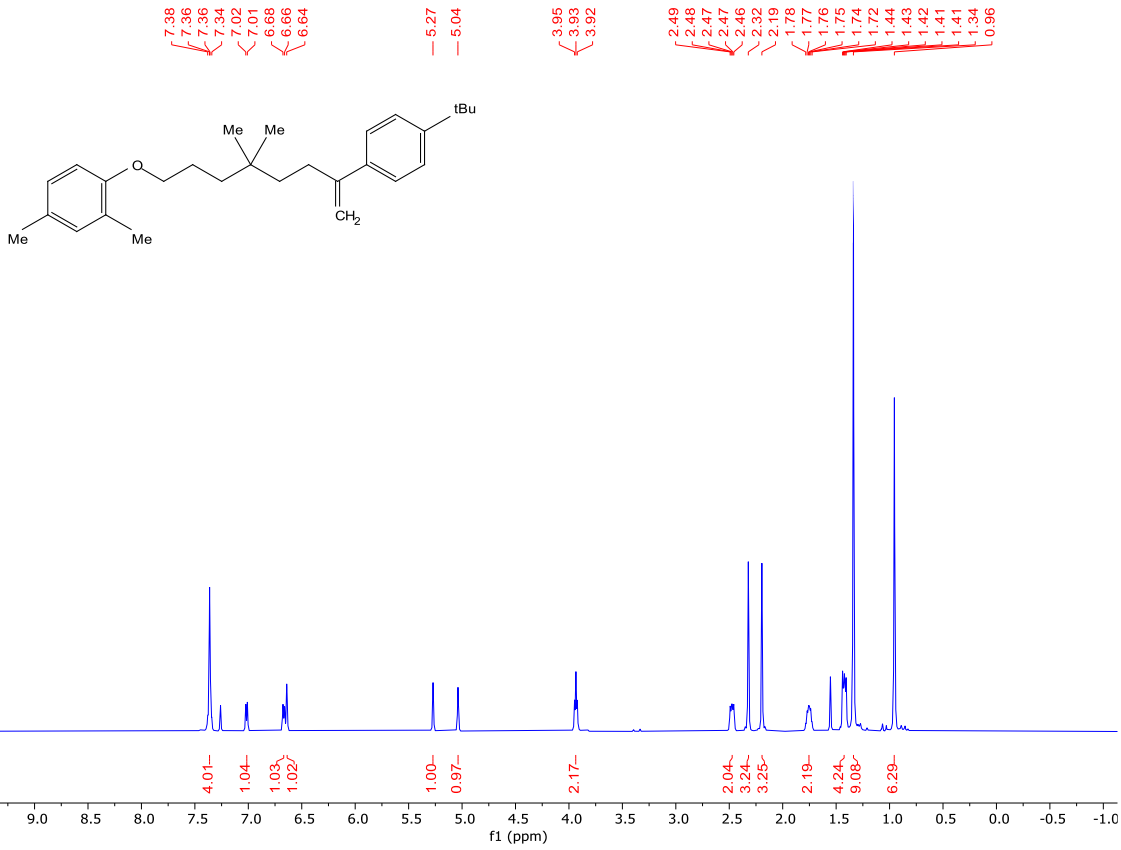
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

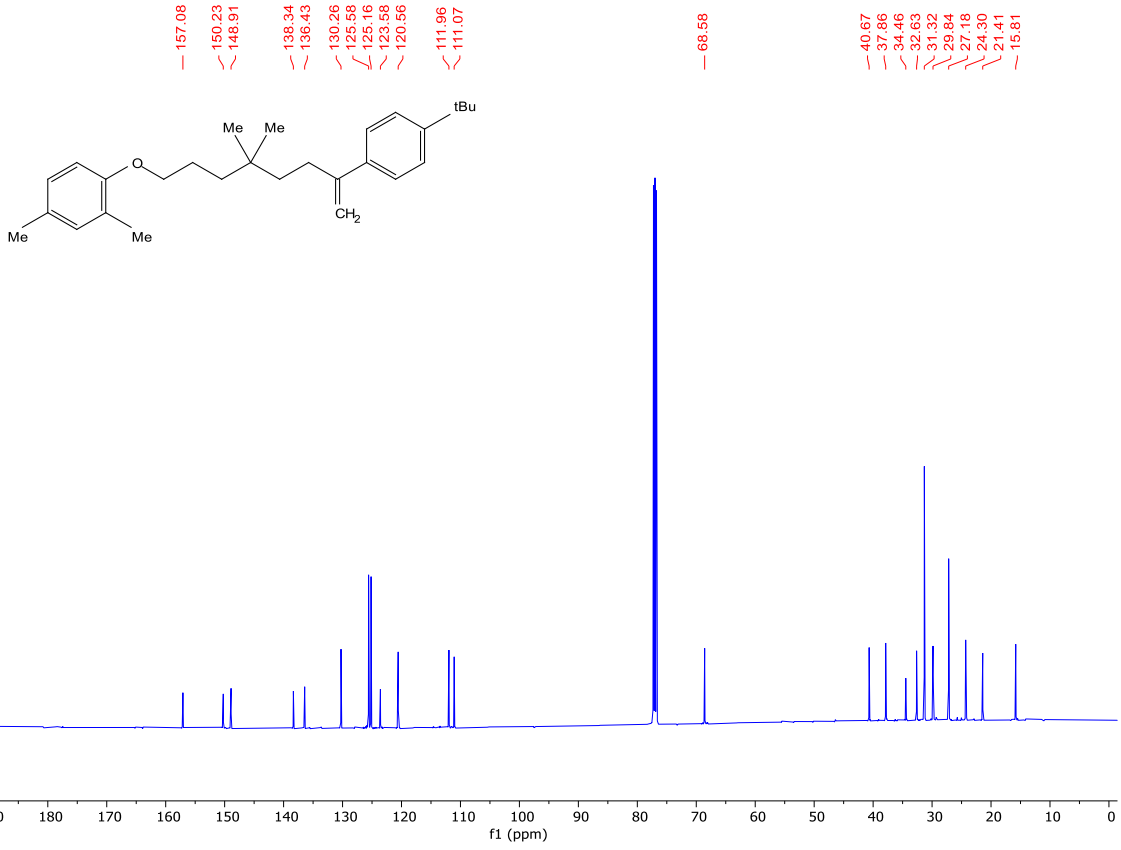
7d


7.63
7.62
7.46
7.44
7.35
7.33
6.89
6.88
6.86
6.84
6.77
6.76
6.65
6.64
6.63
6.62
5.26
5.25
5.03
5.03
3.81
3.76
2.66
2.65
2.63
2.61
2.59
2.58
2.27
1.83
1.81
1.80
1.78
1.77
1.75
OMe
O
N
H2C
H3C
OMe
Cl
2.03
2.04
2.14
1.18
2.14
1.10
1.02
1.00
1.01
3.07
2.95
2.23
2.00
3.23
2.32
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

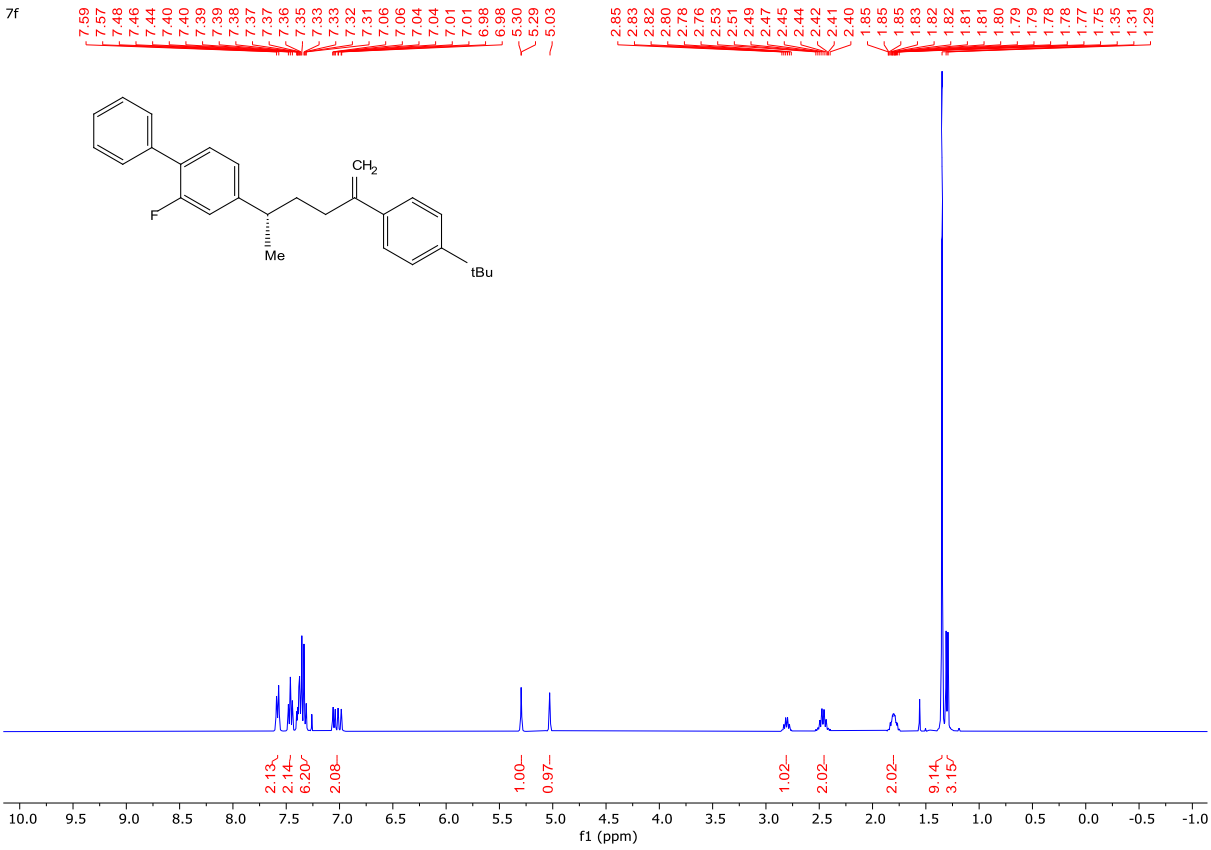

168.26
159.04
155.80
147.25
138.88
134.30
133.83
133.40
131.18
131.02
130.97
129.01
127.18
119.82
114.92
113.63
111.12
111.04
101.31
55.65
55.23
35.03
27.79
23.38
13.26
OMe
O
N
H2C
H3C
OMe
Cl
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

7e

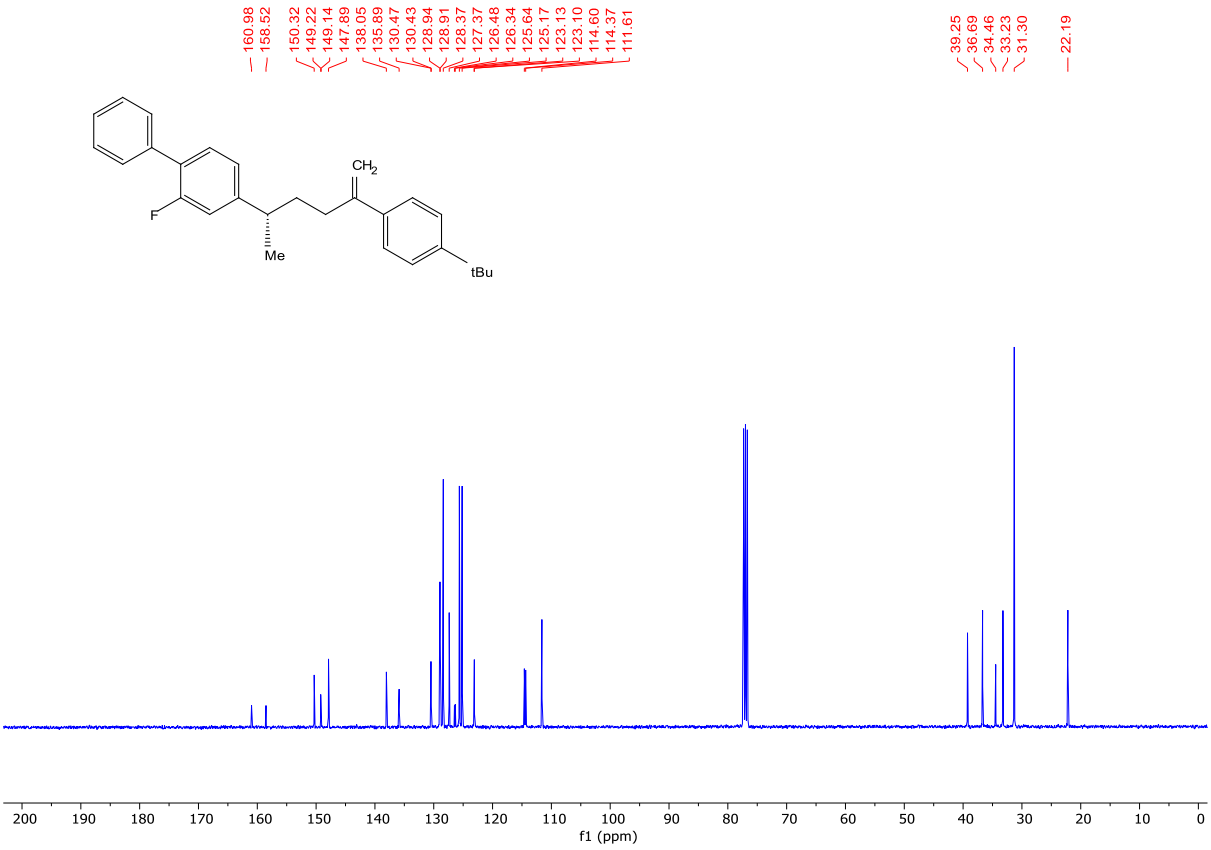

7.38
7.36
7.36
7.34
7.02
7.01
6.68
6.66
6.64
5.27
5.04
3.95
3.93
3.92
2.49
2.48
2.47
2.47
2.46
2.32
2.19
1.78
1.77
1.76
1.75
1.74
1.72
1.44
1.43
1.42
1.41
1.41
1.34
0.96
tBu
Me
Me
O
CH2
Me
Me
4.01
1.04
1.03
1.02
1.00
0.97
2.17
2.04
3.24
3.25
2.19
4.24
9.08
6.29
f1 (ppm)

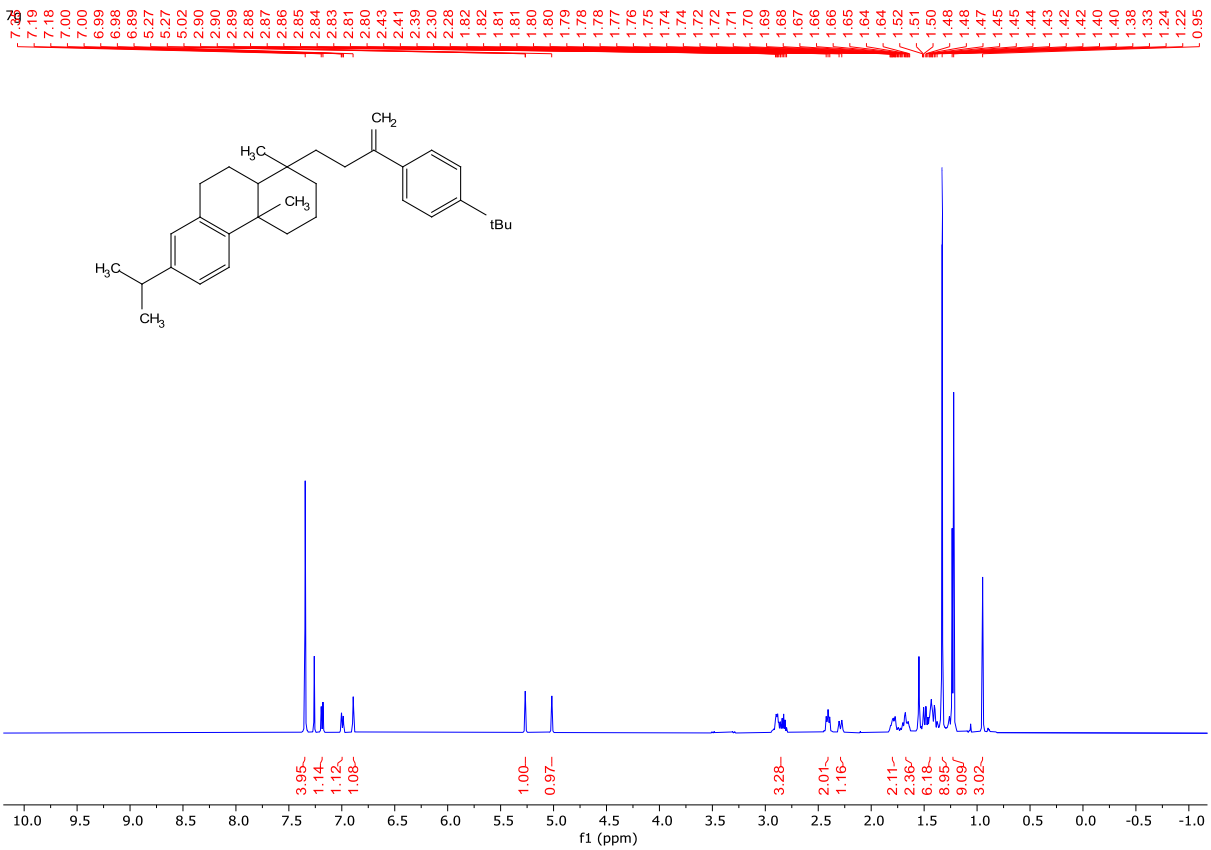

157.08
150.23
148.91
138.34
136.43
130.26
125.58
125.16
123.58
120.56
111.96
111.07
68.58
40.67
37.86
34.46
32.63
31.32
29.84
27.18
24.30
21.41
15.81
tBu
Me
Me
O
CH2
Me
Me
f1 (ppm)

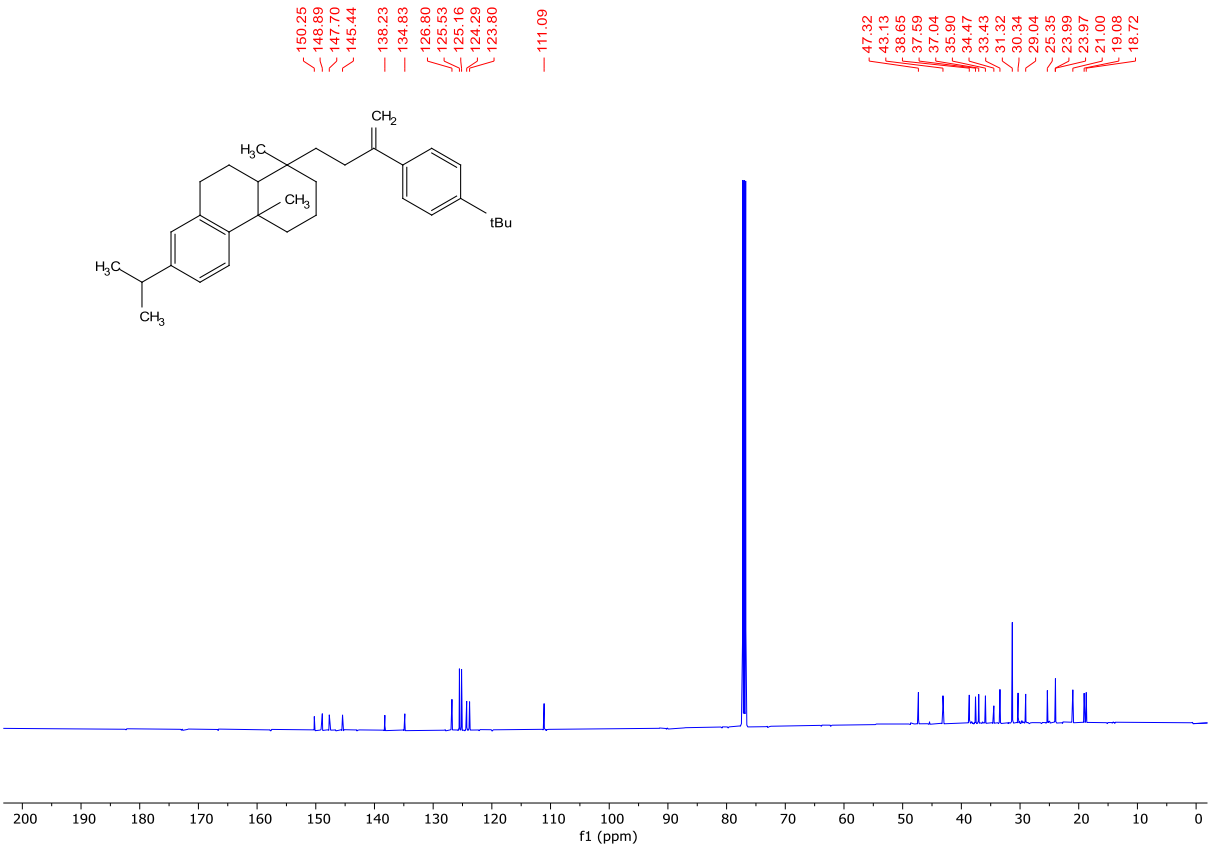
7f


7.59 7.57 7.48 7.46 7.44 7.40 7.40 7.39 7.39 7.38 7.37 7.37 7.36 7.35 7.33 7.33 7.32 7.31 7.06 7.06 7.04 7.04 7.01 7.01 6.98 6.98 5.30 5.29 5.03
2.85 2.83 2.82 2.80 2.78 2.76 2.53 2.51 2.49 2.47 2.45 2.44 2.42 2.41 2.40 1.85 1.85 1.85 1.83 1.82 1.82 1.81 1.81 1.80 1.79 1.79 1.78 1.78 1.77 1.75 1.35 1.31 1.29
CH2
F
Me
tBu
2.13 2.14 6.20 2.08 1.00 0.97 1.02 2.02 2.02 9.14 3.15
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

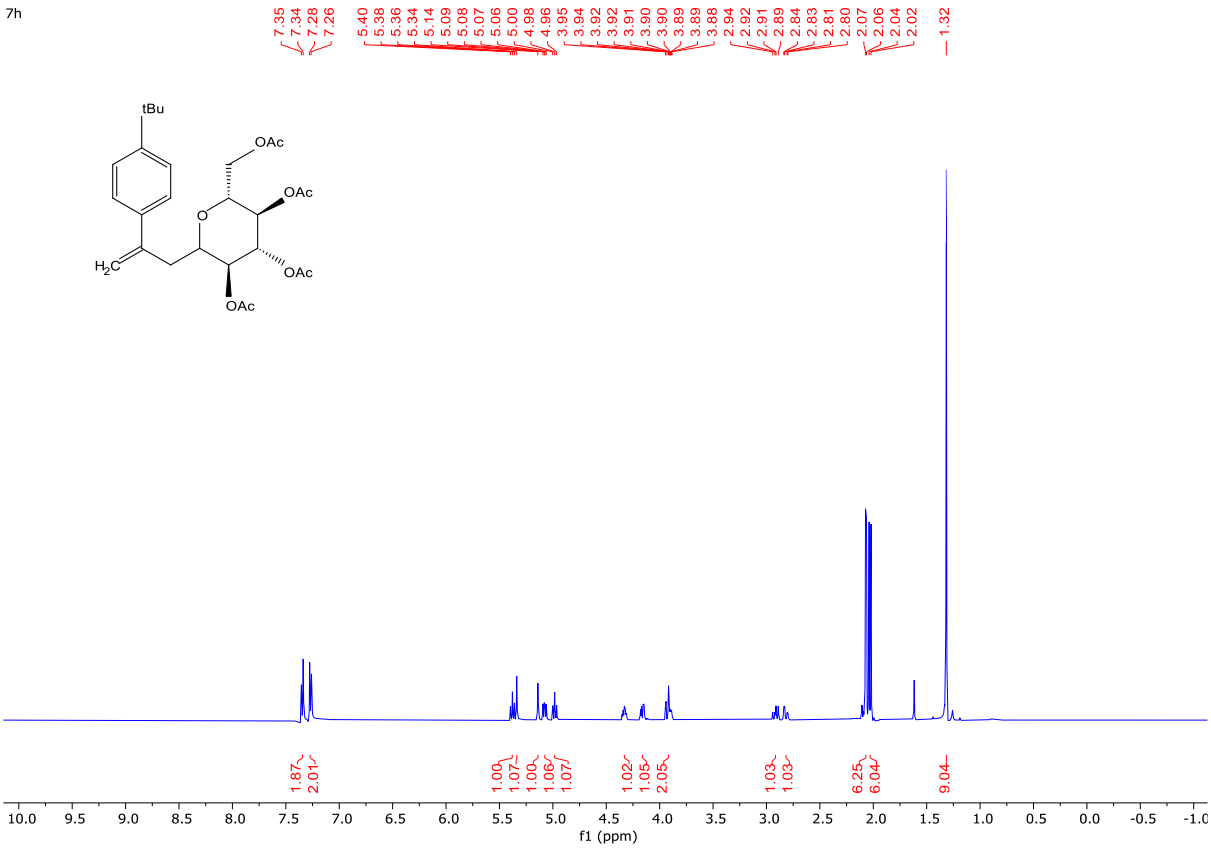

-118.48
CH2
F
Me
tBu
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

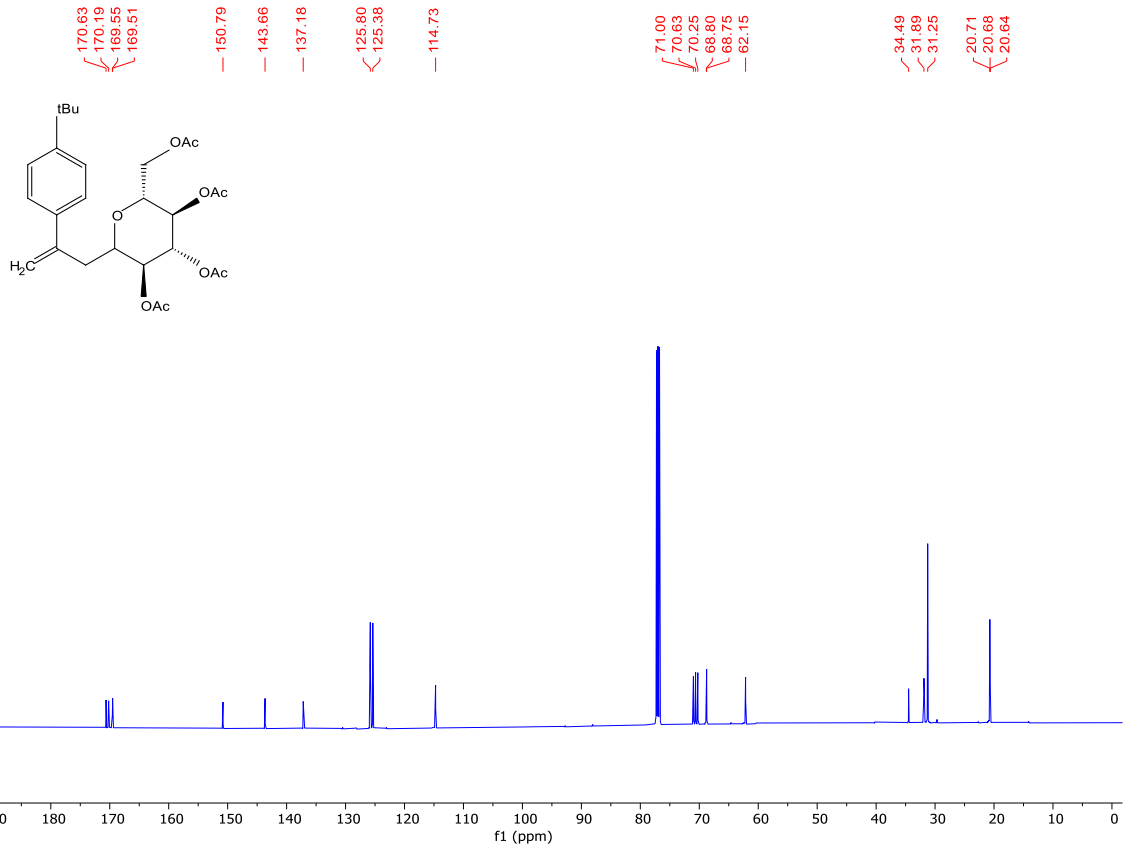

160.98
158.52
150.32
149.22
149.14
147.89
138.05
135.89
130.47
130.43
128.94
128.91
128.37
127.37
126.48
126.34
125.64
125.17
123.13
123.10
114.60
114.37
111.61
39.25
36.69
34.46
33.23
31.30
22.19
CH2
F
Me
tBu
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.20
7.19
7.18
7.00
7.00
6.99
6.98
6.89
5.27
5.27
5.02
2.90
2.90
2.89
2.89
2.88
2.87
2.86
2.85
2.84
2.83
2.81
2.80
2.43
2.41
2.39
2.30
2.28
1.82
1.82
1.81
1.81
1.80
1.80
1.79
1.78
1.78
1.77
1.76
1.75
1.74
1.74
1.72
1.72
1.71
1.70
1.69
1.68
1.67
1.66
1.66
1.65
1.64
1.64
1.52
1.51
1.50
1.48
1.48
1.47
1.45
1.45
1.44
1.43
1.42
1.42
1.40
1.40
1.38
1.33
1.24
1.22
0.95
CH2
H3C
CH3
tBu
H3C
CH3
3.95
1.14
1.12
1.08
1.00
0.97
3.28
2.01
1.16
2.11
2.36
6.18
8.95
9.09
3.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

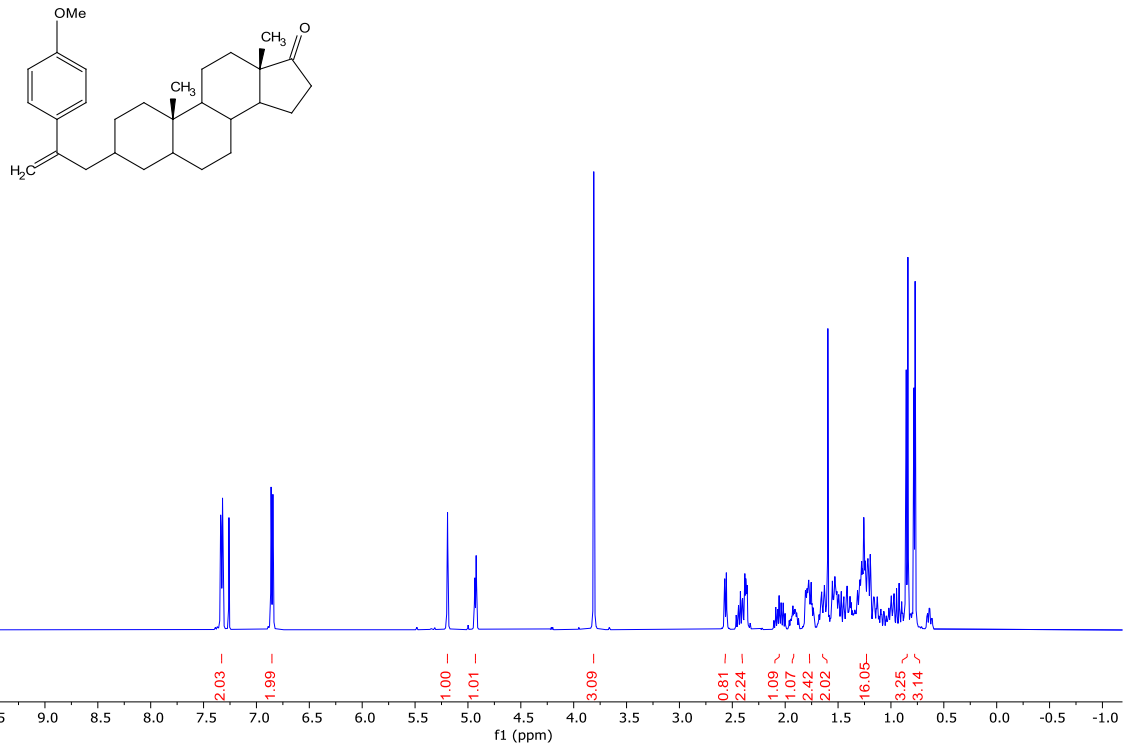

150.25
148.89
147.70
145.44
138.23
134.83
126.80
125.53
125.16
124.29
123.80
111.09
47.32
43.13
38.65
37.59
37.04
35.90
34.47
33.43
31.32
30.34
29.04
25.35
23.99
23.97
21.00
19.08
18.72
CH2
H3C
CH3
tBu
H3C
CH3
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

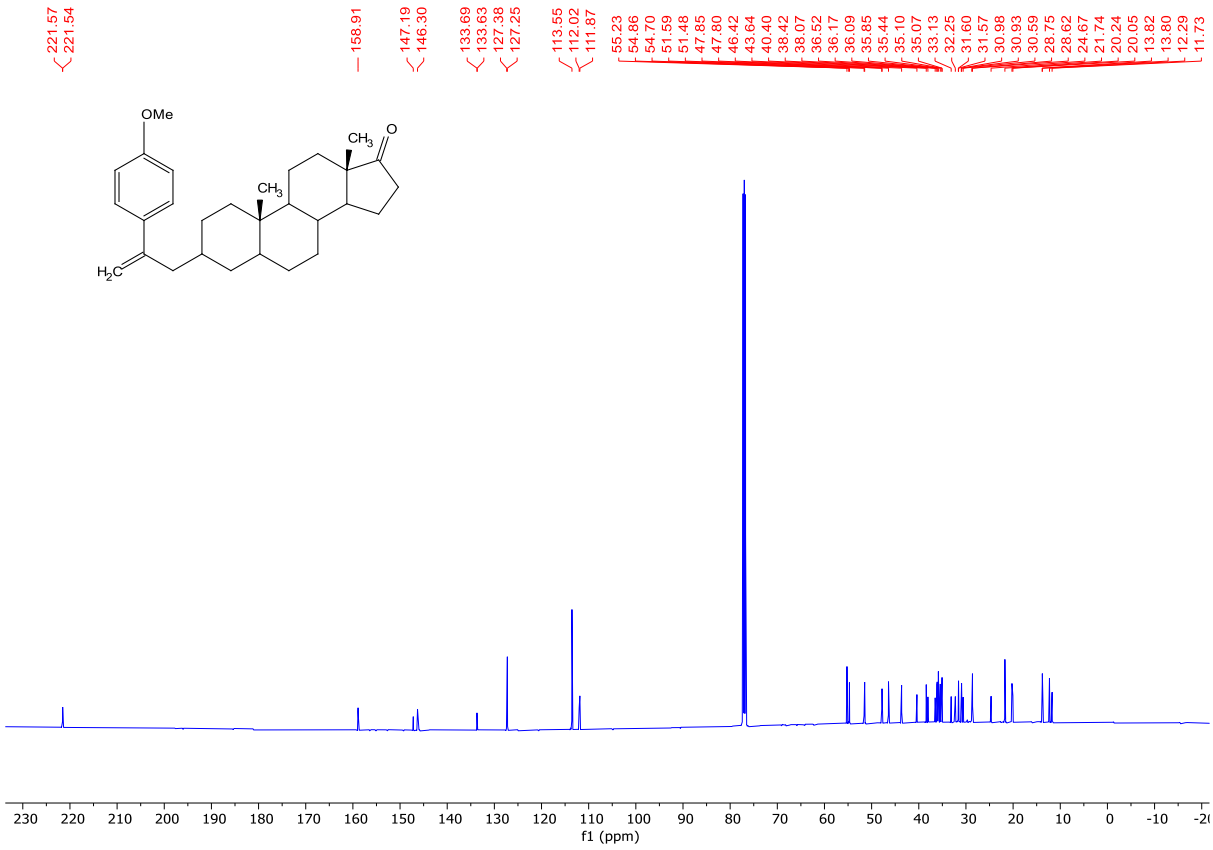
7h

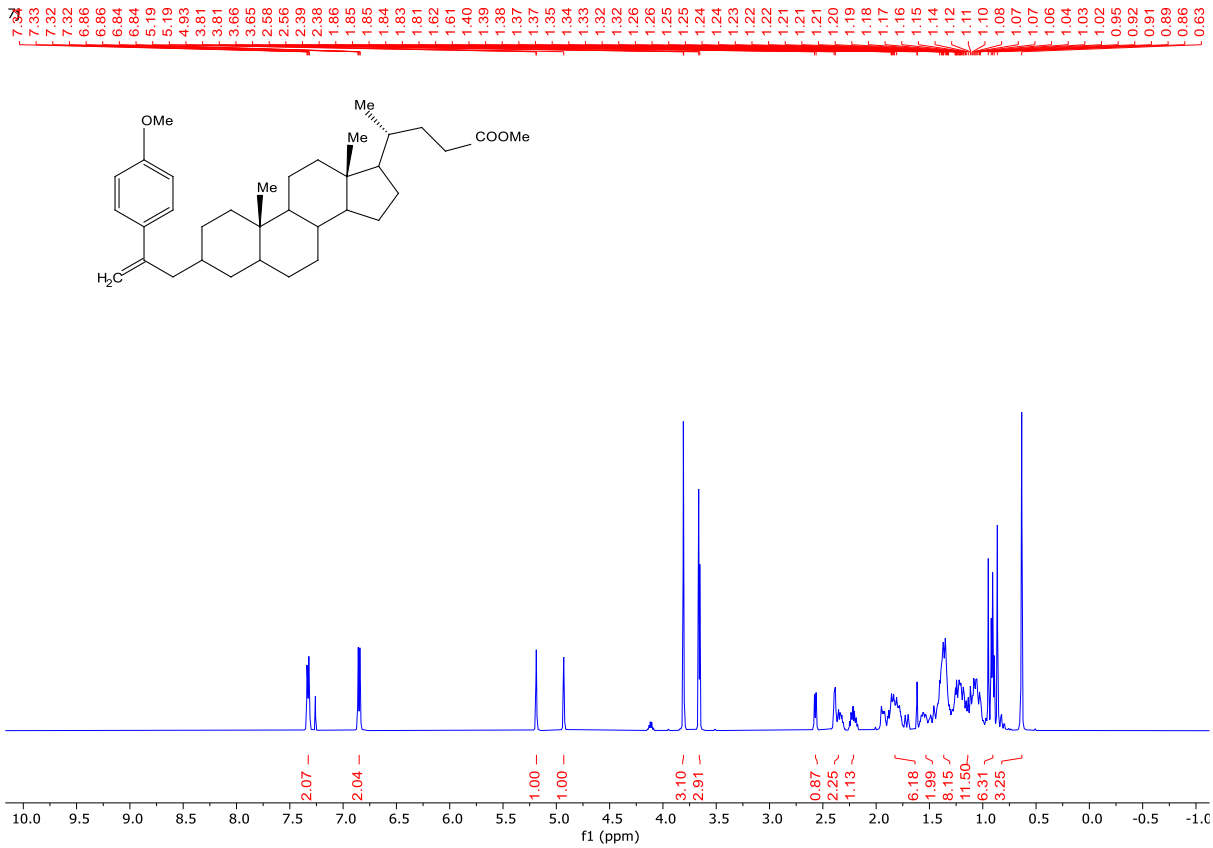

7.35
7.34
7.28
7.26
5.40
5.38
5.36
5.34
5.14
5.09
5.08
5.07
5.06
5.00
4.98
4.96
3.95
3.94
3.92
3.92
3.91
3.90
3.90
3.89
3.89
3.88
2.94
2.92
2.91
2.89
2.84
2.83
2.81
2.80
2.07
2.06
2.04
2.02
1.32
tBu
OAc
OAc
OAc
OAc
O
H2C
1.87
2.01
1.00
1.07
1.00
1.06
1.07
1.02
1.05
2.05
1.03
1.03
6.25
6.04
9.04
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

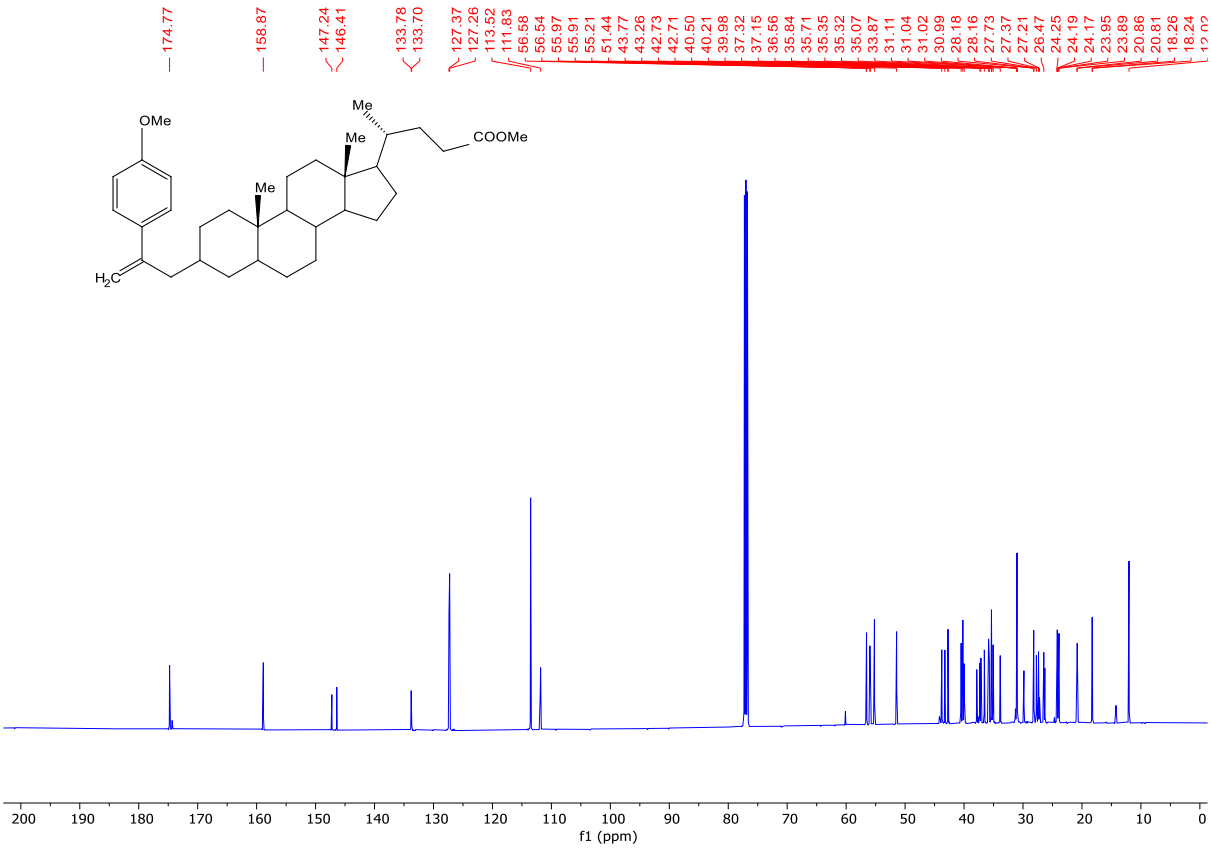

170.63
170.19
169.55
169.51
150.79
143.66
137.18
125.80
125.38
114.73
71.00
70.63
70.25
68.80
68.75
62.15
34.49
31.89
31.25
20.71
20.68
20.64
tBu
OAc
OAc
OAc
OAc
O
H2C
f1 (ppm)


7.34
7.33
7.32
7.32
6.86
6.84
5.20
5.19
5.19
4.94
4.93
4.92
4.92
3.81
3.81
2.57
2.56
2.42
2.38
2.37
2.37
2.36
2.06
1.81
1.79
1.79
1.78
1.78
1.77
1.76
1.75
1.66
1.65
1.63
1.60
1.55
1.54
1.53
1.52
1.52
1.51
1.49
1.47
1.42
1.41
1.39
1.32
1.30
1.30
1.29
1.29
1.28
1.28
1.27
1.26
1.25
1.24
1.24
1.22
1.22
1.21
1.21
1.20
1.19
1.00
0.97
0.95
0.92
0.86
0.84
0.78
0.77


OMe
CH3
CH3
O
H2C
2.03
1.99
1.00
1.01
3.09
0.81
2.24
1.09
1.07
2.42
2.02
16.05
3.25
3.14
f1 (ppm)


221.57
221.54
158.91
147.19
146.30
133.69
133.63
127.38
127.25
113.55
112.02
111.87
55.23
54.86
54.70
51.59
51.48
47.85
47.80
46.42
43.64
40.40
38.42
38.07
36.52
36.17
36.09
35.85
35.44
35.10
35.07
33.13
32.25
31.60
31.57
30.98
30.93
30.59
28.75
28.62
24.67
21.74
20.24
20.05
13.82
13.80
12.29
11.73
OMe
CH3
O
CH3
H2C
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.34
7.33
7.32
7.32
6.86
6.86
6.84
6.84
6.84
5.19
5.19
4.93
3.81
3.81
3.66
3.65
2.58
2.56
2.39
2.38
1.86
1.85
1.85
1.84
1.83
1.81
1.62
1.61
1.40
1.39
1.38
1.37
1.37
1.35
1.34
1.33
1.32
1.32
1.26
1.26
1.25
1.25
1.24
1.24
1.23
1.22
1.22
1.21
1.21
1.21
1.20
1.19
1.18
1.17
1.16
1.15
1.14
1.12
1.11
1.10
1.08
1.07
1.07
1.06
1.04
1.03
1.02
0.95
0.92
0.91
0.89
0.86
0.63
OMe
Me
Me
Me
COOMe
H2C
2.07
2.04
1.00
1.00
3.10
2.91
0.87
2.25
1.13
6.18
1.99
8.15
11.50
6.31
3.25
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


174.77
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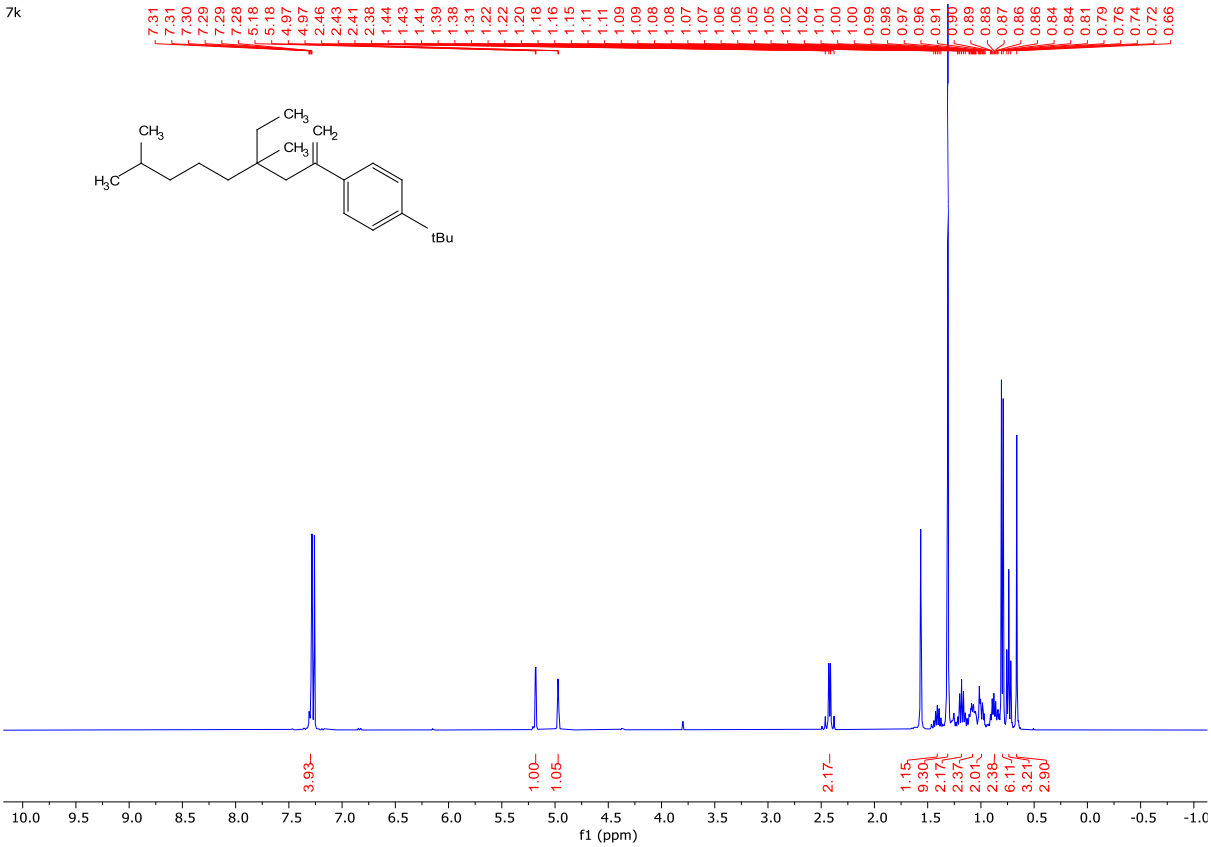
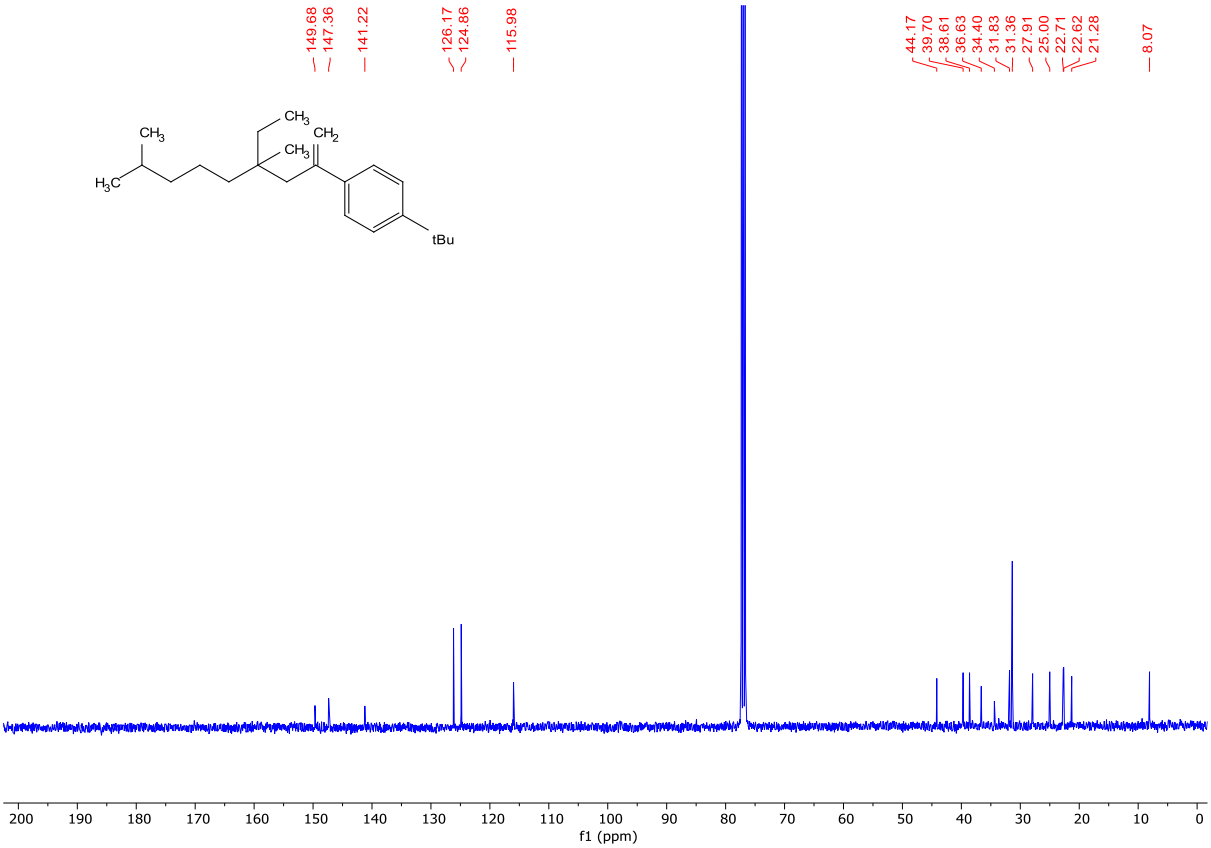
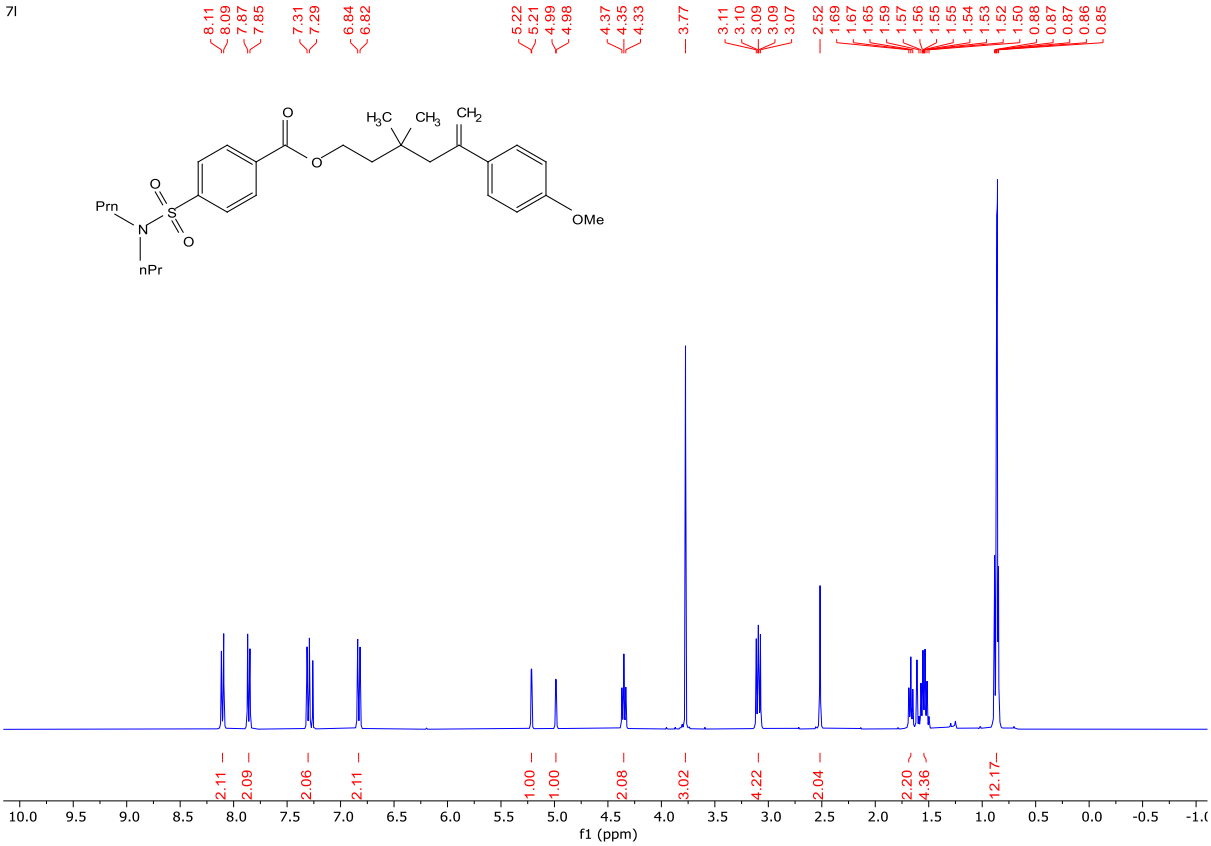
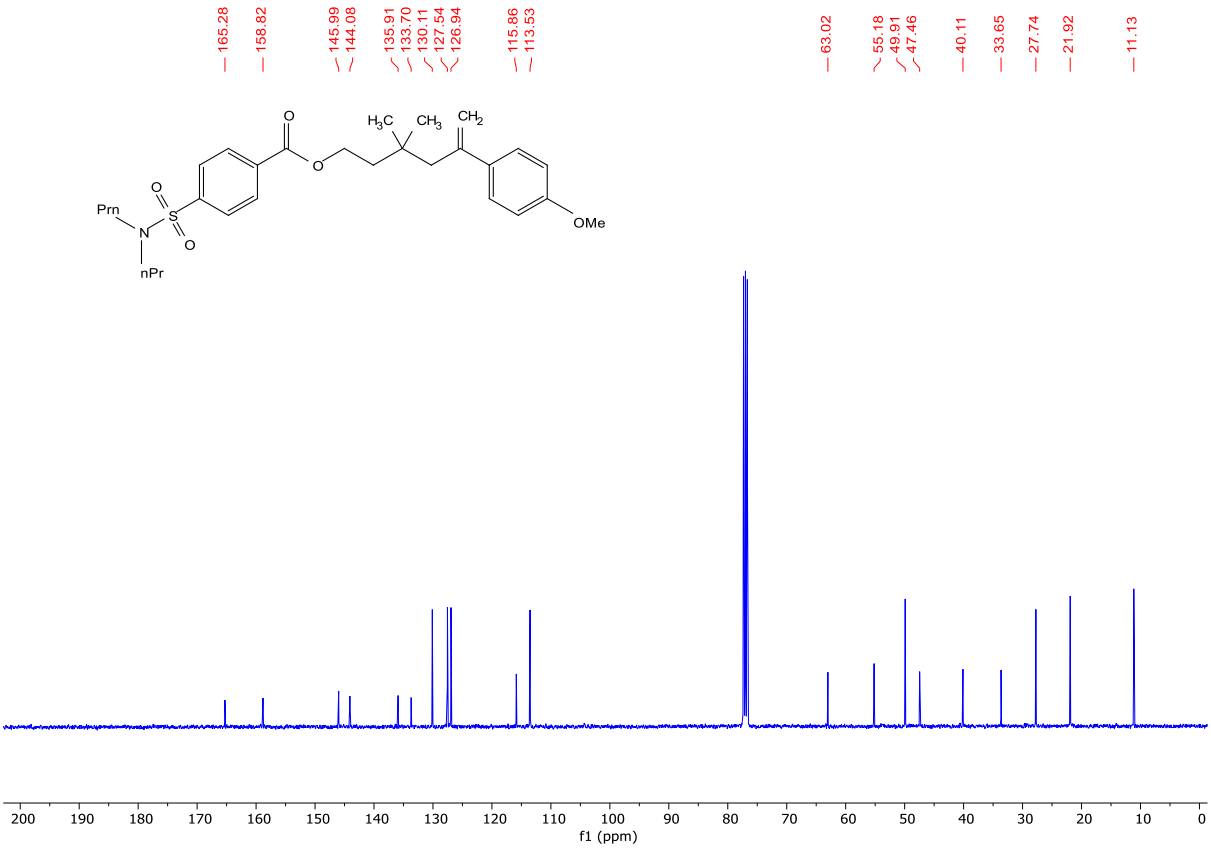
146.41
133.78
133.70
127.37
127.26
113.52
111.83
56.58
56.54
55.97
55.91
55.21
51.44
43.77
43.26
42.73
42.71
40.50
40.21
39.98
37.32
37.15
36.56
35.84
35.71
35.35
35.32
35.07
33.87
31.11
31.04
31.02
30.99
28.18
28.16
27.73
27.37
27.21
26.47
24.25
24.19
24.17
23.95
23.89
20.86
20.81
18.26
18.24
OMe
Me
Me
Me
COOMe
H2C
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7k
7.31
7.31
7.30
7.29
7.29
7.28
5.18
5.18
4.97
4.97
2.46
2.43
2.41
2.38
1.44
1.43
1.41
1.39
1.38
1.31
1.22
1.20
1.18
1.16
1.15
1.11
1.11
1.09
1.09
1.08
1.08
1.07
1.07
1.06
1.06
1.05
1.05
1.02
1.02
1.01
1.00
1.00
0.99
0.98
0.97
0.96
0.91
0.90
0.89
0.88
0.87
0.86
0.86
0.84
0.84
0.81
0.79
0.76
0.74
0.72
0.66
CH3
CH3
CH2
CH3
H3C
tBu
3.93
1.00
1.05
2.17
1.15
9.30
2.17
2.37
2.01
2.38
6.11
3.21
2.90
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

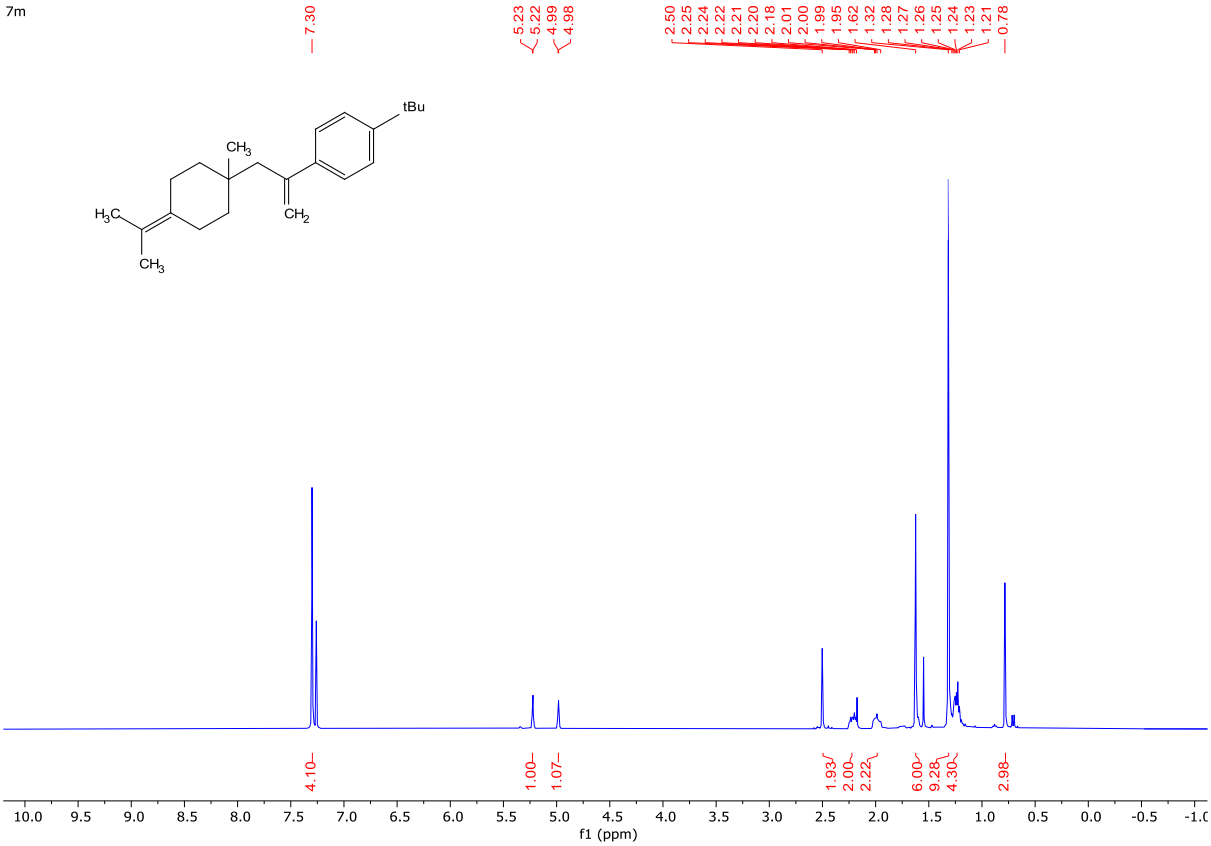

149.68
147.36
141.22
126.17
124.86
115.98
44.17
39.70
38.61
36.63
34.40
31.83
31.36
27.91
25.00
22.71
22.62
21.28
8.07
CH3
CH3
CH2
CH3
H3C
tBu
f1 (ppm)

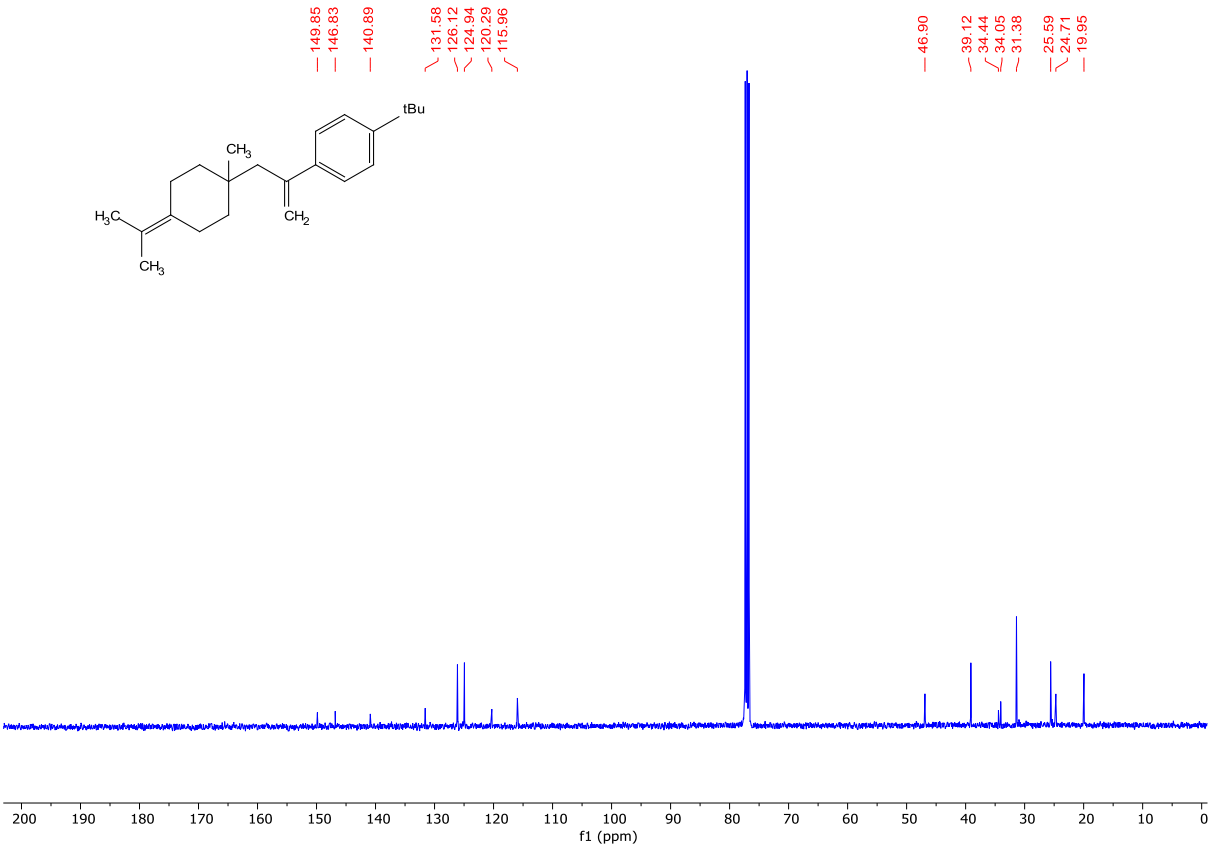
7l


8.11
8.09
7.87
7.85
7.31
7.29
6.84
6.82
5.22
5.21
4.99
4.98
4.37
4.35
4.33
3.77
3.11
3.10
3.09
3.09
3.07
2.52
1.69
1.67
1.65
1.59
1.57
1.56
1.55
1.55
1.54
1.53
1.52
1.50
0.88
0.87
0.87
0.86
0.85
O
H3C
CH3
CH2
O
O
Prn
N
S
O
nPr
OMe
2.11
2.09
2.06
2.11
1.00
1.00
2.08
3.02
4.22
2.04
2.20
4.36
12.17
f1 (ppm)

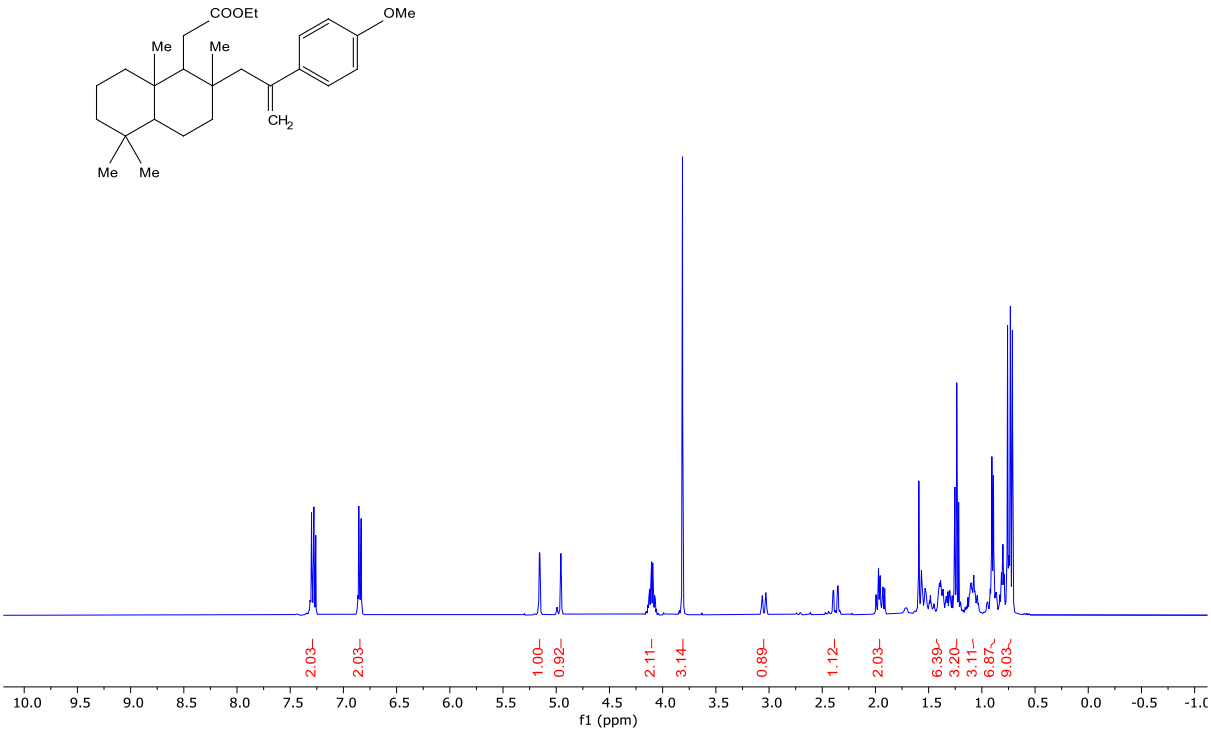

165.28
158.82
145.99
144.08
135.91
133.70
130.11
127.54
126.94
115.86
113.53
63.02
55.18
49.91
47.46
40.11
33.65
27.74
21.92
11.13
Prn
nPr
OMe
f1 (ppm)

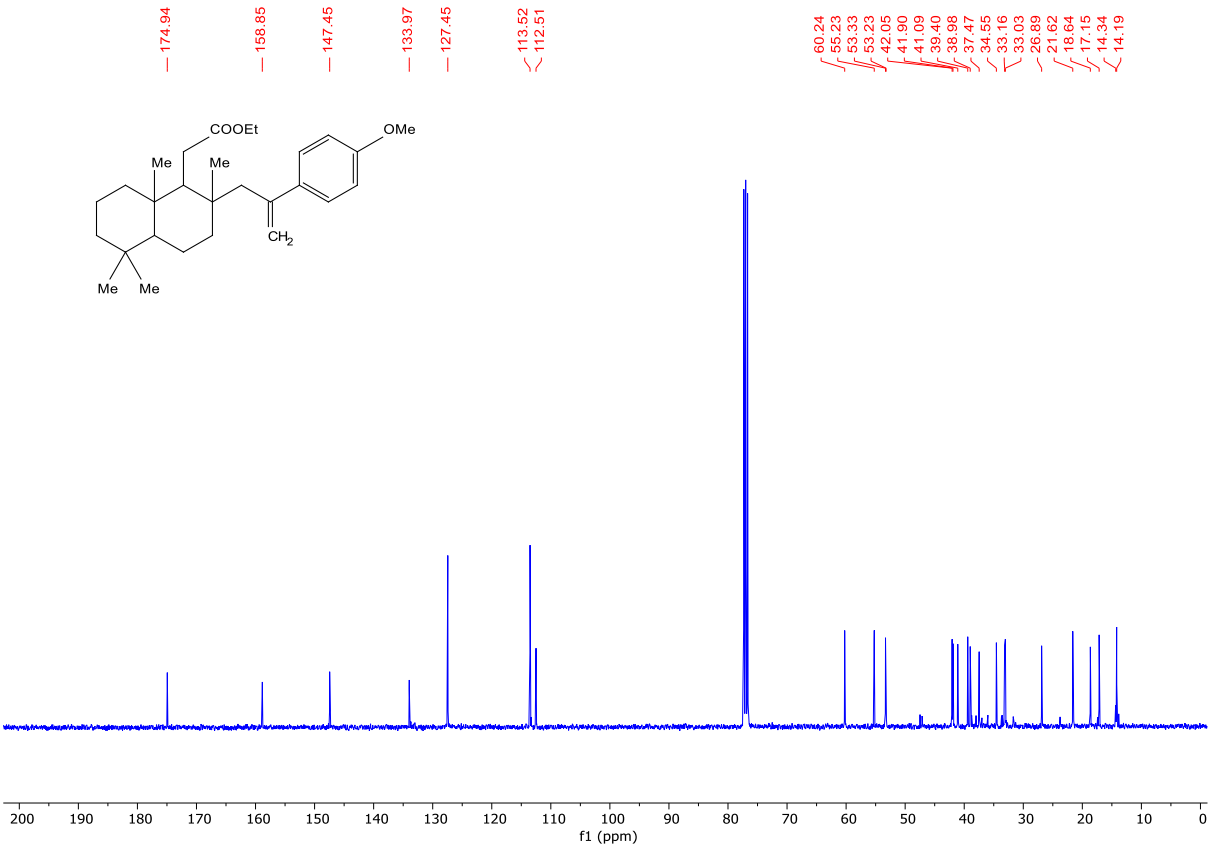
7m


7.30
5.23
5.22
4.99
4.98
2.50
2.25
2.24
2.22
2.21
2.20
2.18
2.01
2.00
1.99
1.95
1.62
1.32
1.28
1.27
1.26
1.25
1.24
1.23
1.21
0.78
tBu
4.10
1.00
1.07
1.93
2.00
2.22
6.00
9.28
4.30
2.98
f1 (ppm)

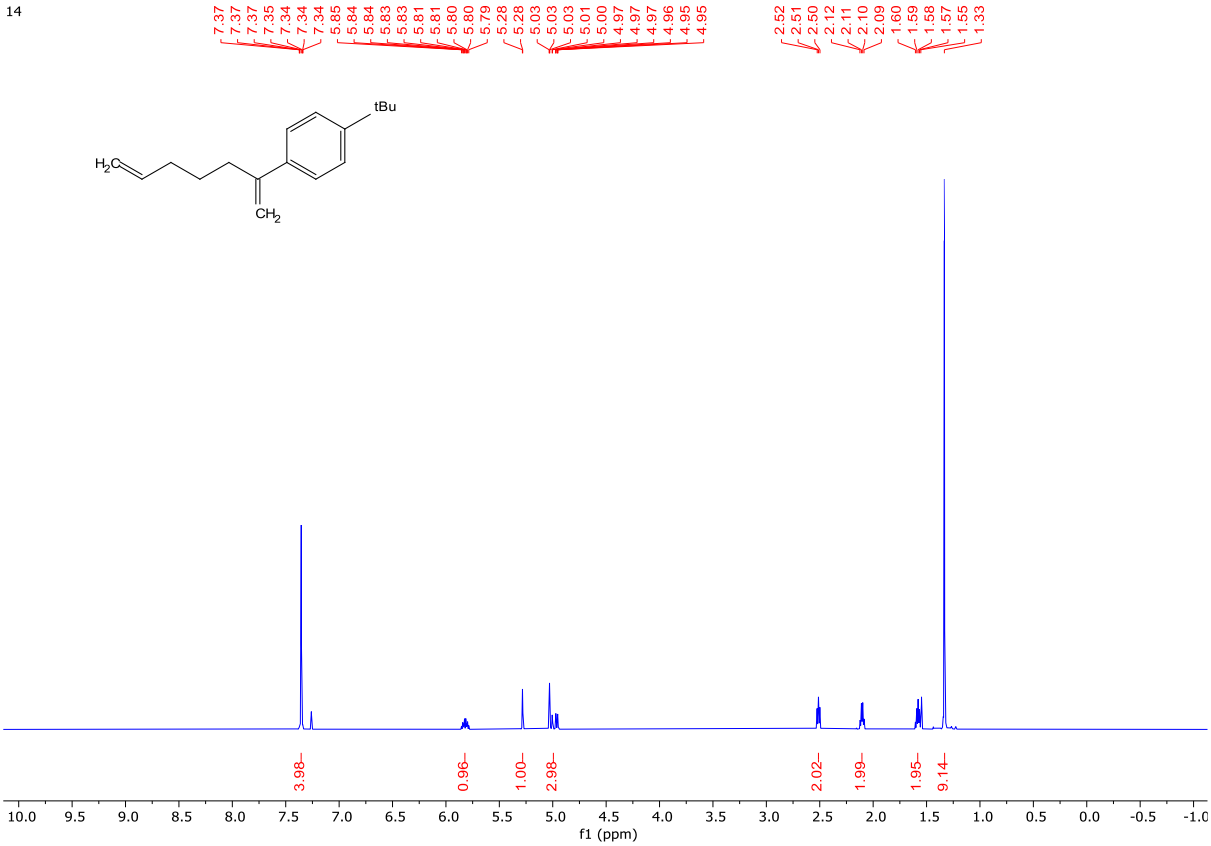

149.85
146.83
140.89
131.58
126.12
124.94
120.29
115.96
46.90
39.12
34.44
34.05
31.38
25.59
24.71
19.95
tBu
CH3
H3C
CH3
CH2
f1 (ppm)

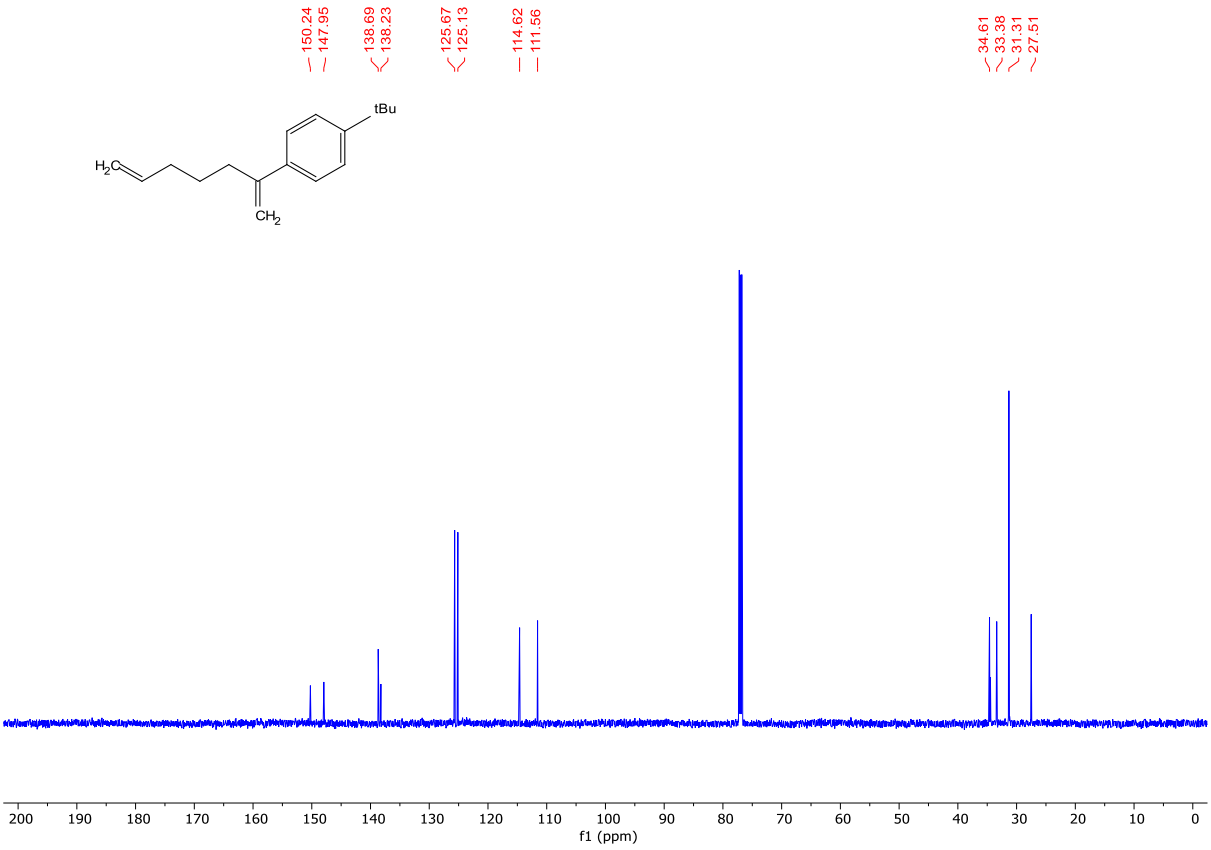

7.30
7.28
6.86
6.83
5.16
5.15
4.96
4.12
4.11
4.10
4.09
4.09
4.08
3.81
3.03
2.40
2.39
2.36
2.35
1.99
1.97
1.96
1.96
1.94
1.93
1.91
1.57
1.56
1.53
1.53
1.52
1.48
1.41
1.41
1.40
1.39
1.38
1.37
1.36
1.32
1.30
1.30
1.26
1.25
1.24
1.24
1.22
1.12
1.11
1.10
1.09
1.08
1.07
1.04
0.92
0.91
0.91
0.89
0.87
0.86
0.83
0.82
0.80
0.79
0.79
0.77
0.76
0.75
0.74
0.73
0.71


COOEt
OMe
Me
Me
CH2
Me
Me
2.03
2.03
1.00
0.92
2.11
3.14
0.89
1.12
2.03
6.39
3.20
3.11
6.87
9.03
f1 (ppm)

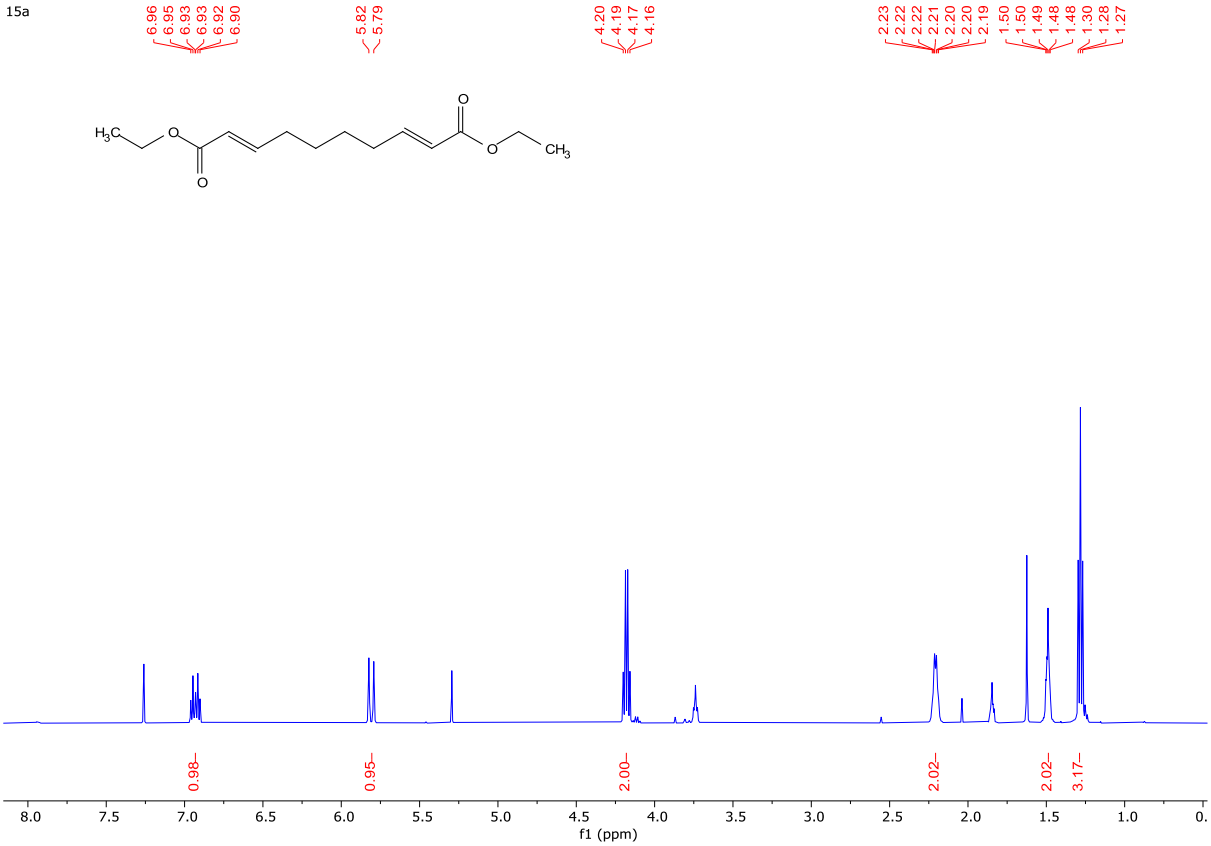

174.94
158.85
147.45
133.97
127.45
113.52
112.51
60.24
55.23
53.33
53.23
42.05
41.90
41.09
39.40
38.98
37.47
34.55
33.16
33.03
26.89
21.62
18.64
17.15
14.34
14.19
COOEt
OMe
Me
Me
CH2
Me
Me
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

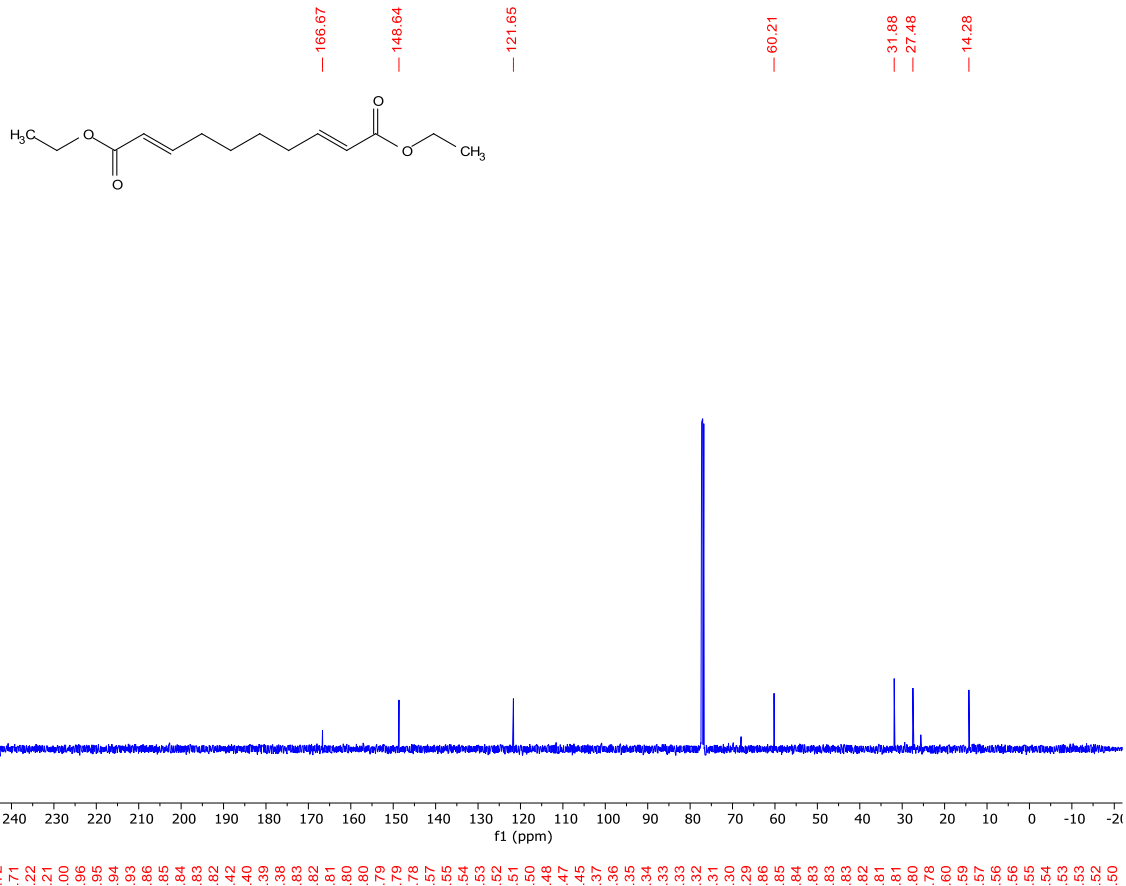
14

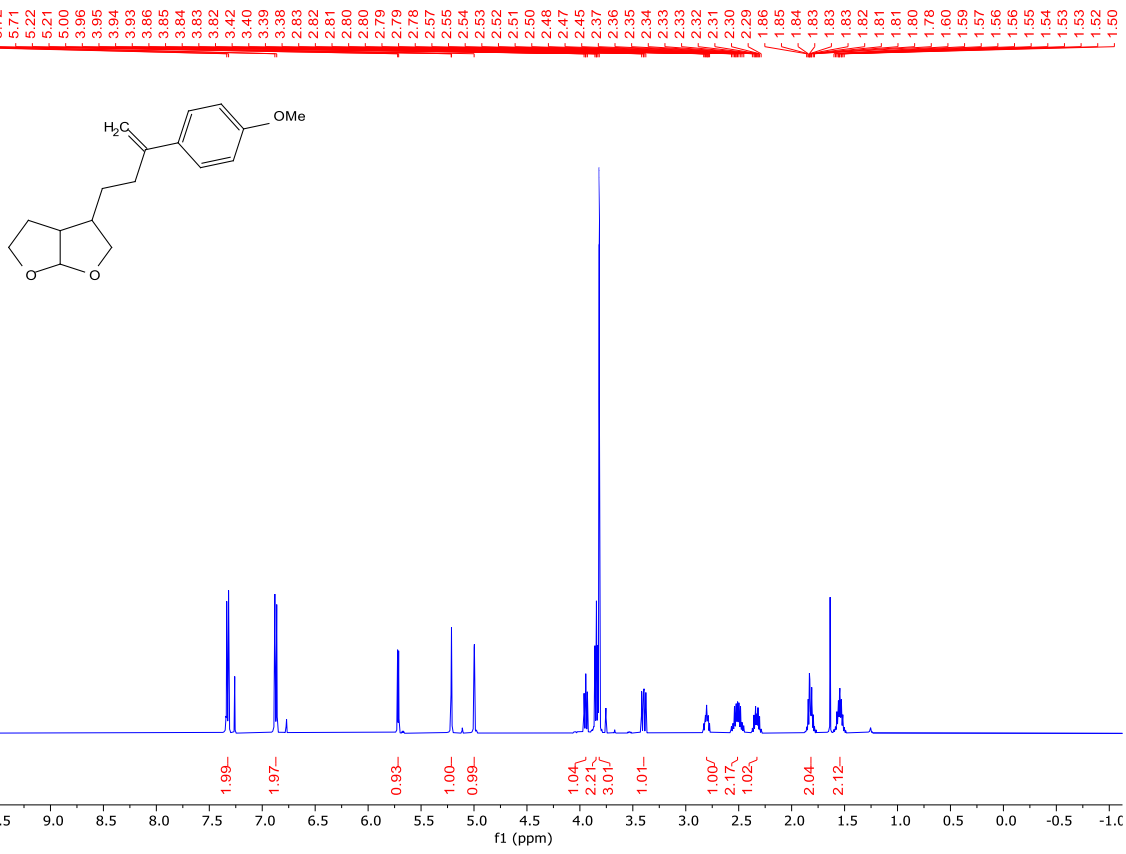

7.37
7.37
7.37
7.35
7.34
7.34
7.34
5.85
5.84
5.84
5.83
5.83
5.81
5.81
5.80
5.80
5.79
5.28
5.03
5.03
5.03
5.01
5.00
4.97
4.97
4.97
4.96
4.95
4.95
2.52
2.51
2.50
2.12
2.11
2.10
2.09
1.60
1.59
1.58
1.57
1.55
1.33
tBu
H2C
CH2
3.98
0.96
1.00
2.98
2.02
1.99
1.95
9.14
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

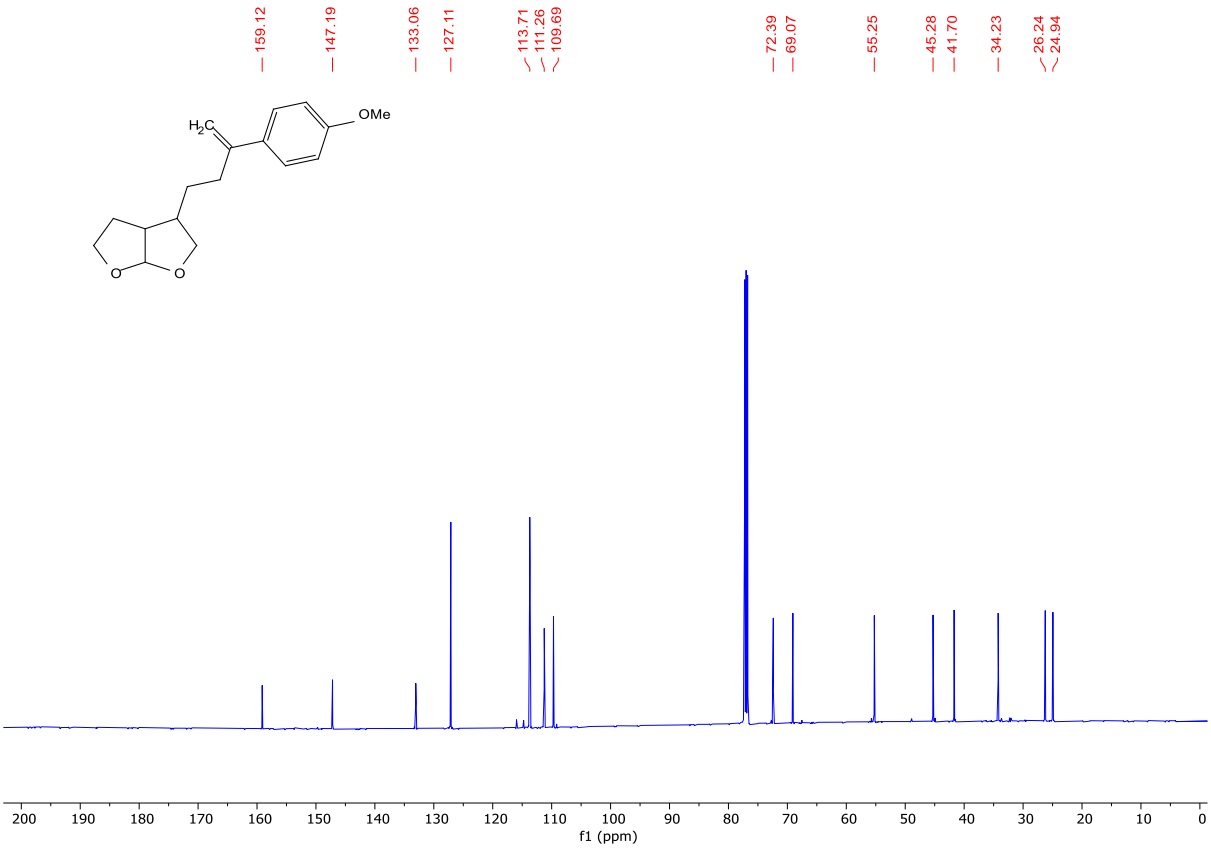

150.24
147.95
138.69
138.23
125.67
125.13
114.62
111.56
34.61
33.38
31.31
27.51
tBu
H2C
CH2
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

15a


6.96
6.95
6.93
6.93
6.92
6.90
5.82
5.79
4.20
4.19
4.17
4.16
2.23
2.22
2.22
2.21
2.20
2.20
2.19
1.50
1.50
1.49
1.48
1.48
1.30
1.28
1.27
H3C
O
O
O
O
CH3
0.98
0.95
2.00
2.02
2.02
3.17
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.
f1 (ppm)

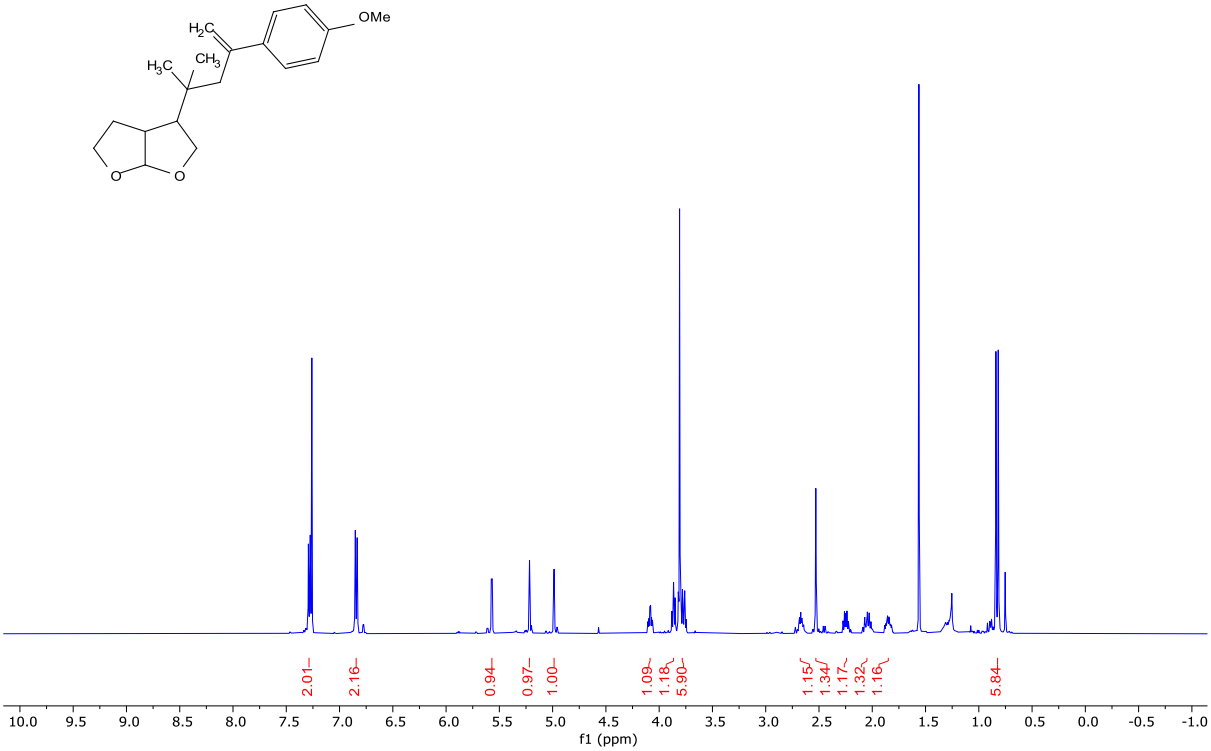

166.67
148.64
121.65
60.21
31.88
27.48
14.28
H3C
O
O
O
O
CH3
260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

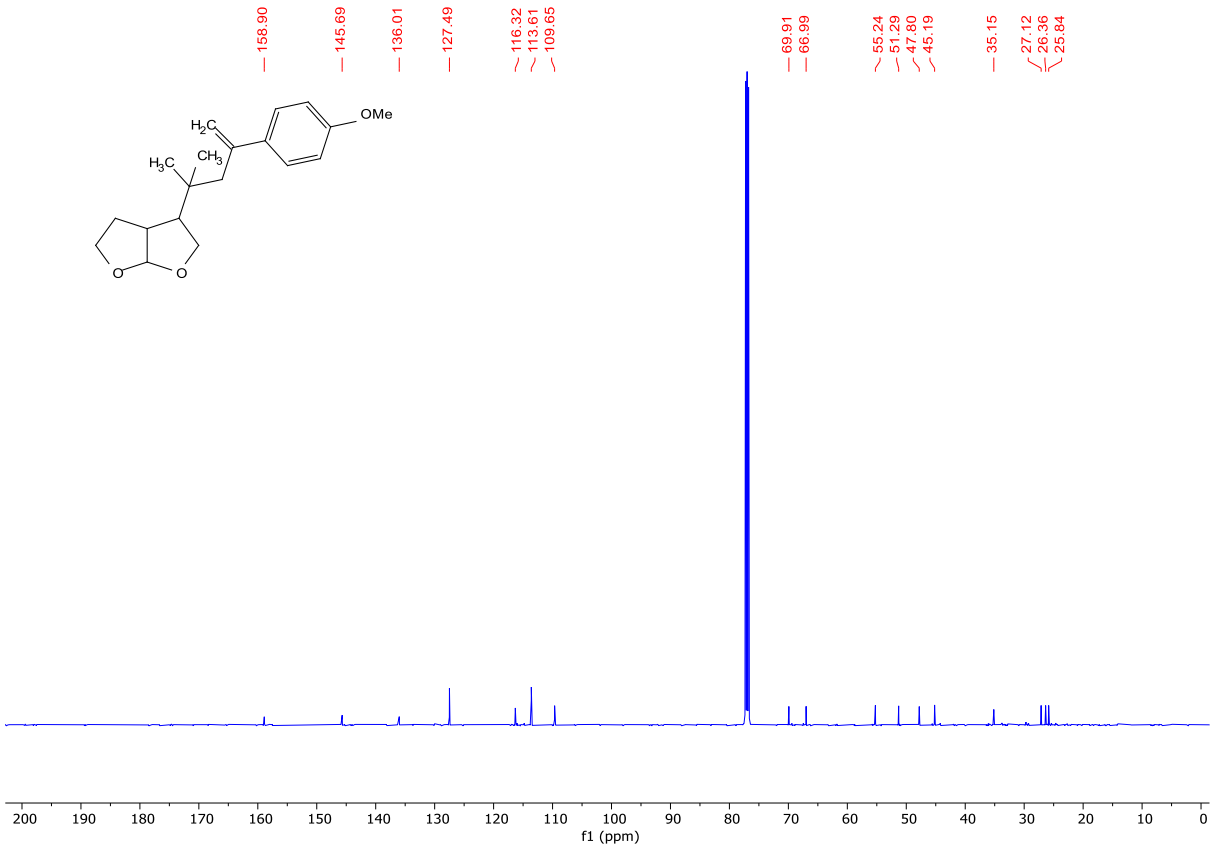

H2C
OMe
O
O
1.99
1.97
0.93
1.00
0.99
1.04
2.21
3.01
1.01
1.00
2.17
1.02
2.04
2.12
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


159.12
147.19
133.06
127.11
113.71
111.26
109.69
72.39
69.07
55.25
45.28
41.70
34.23
26.24
24.94
OMe
H_2C
O
O
f1 (ppm)

17


7.29
7.28
6.85
6.83
5.58
5.57
5.22
5.22
4.98
4.10
4.10
4.09
4.08
4.07
4.06
3.88
3.86
3.85
3.82
3.81
3.80
3.80
3.78
3.78
3.77
3.76
3.76
3.75
2.70
2.69
2.68
2.68
2.67
2.67
2.66
2.65
2.64
2.53
2.27
2.26
2.25
2.25
2.24
2.23
2.22
2.09
2.07
2.06
2.05
2.05
2.04
2.03
2.01
2.01
2.00
1.88
1.87
1.87
1.86
1.86
1.86
1.85
1.84
1.84
1.84
1.83
1.83
1.82
0.84
0.82


OMe
H_2C
H_3C
CH_3
O
O
2.01
2.16
0.94
0.97
1.00
1.09
1.18
5.90
1.15
1.34
1.17
1.32
1.16
5.84
f1 (ppm)


158.90
145.69
136.01
127.49
116.32
113.61
109.65
69.91
66.99
55.24
51.29
47.80
45.19
35.15
27.12
26.36
25.84
OMe
H2C
H3C
CH3
O
O
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)