Supplementary Information

for

# Transition-metal-free C($sp^3$)-C($sp^2$) couplings with secondary alcohols and boronic acids via neighboring group activation

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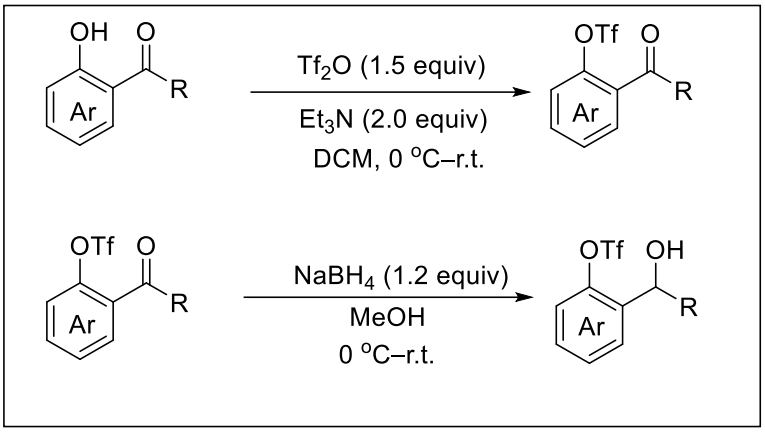
# 1. General information

Unless otherwise noted, commercialized reagents were used without further purifications. Toluene was purchased from Sigma-Aldrich Chemical Co. and Yonghua Chemical Co. 1,2-Dichloroethane was purchased from Sinopharm Group Co. All other solvents were purified and dried according to standard methods before use. Potassium phosphate was purchased from Shanghai Aladdin Biochemical Technology Co.

$^{1}$H NMR, $^{31}$P NMR, $^{19}$F NMR, and $^{13}$C NMR data were recorded on a Bruker-Ultrashield PLUS400 NMR or a 500 MHz Agilent spectrometer Bruker AVANCE NEO 600M with $CDCl_3$ as the solvent. $^{1}$H chemical shifts were referenced to $CDCl_3$ at 7.26 ppm. $^{13}$C chemical shifts were referenced to $CDCl_3$ at 77.16 ppm and obtained with $^{1}$H decoupling. Multiplicities are abbreviated as follows: singlet (s), doublet (d), triplet (t), quartet (q), doublet-doublet (dd), multiplet (m), and broad (br). HRMS was measured on GCTOF-HRMS, Waters GCT Premier or MALDI-TOF MS, Bruker Ultraflex.

# 2. General procedures for the synthesis of secondary alcohols

## 2.1 Preparation of 2-(1-hydroxyethyl)phenyl trifluoromethanesulfonate and its derivates

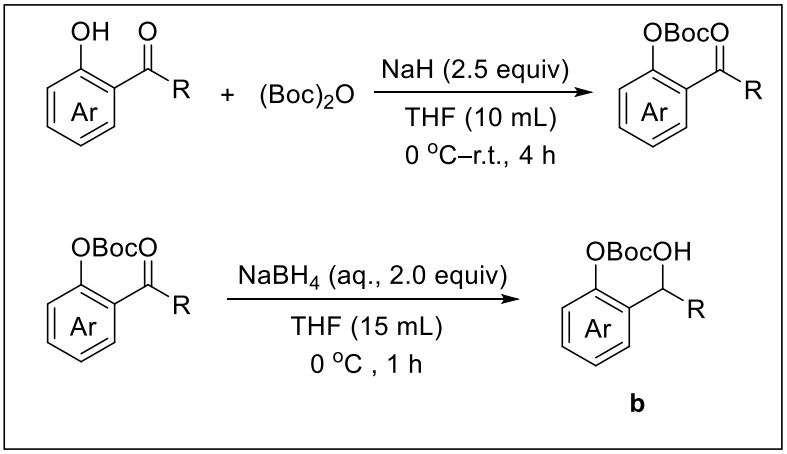



To a solution of ketone (5 mmol, 1.0 equiv) and $Et_3N$ (10 mmol, 2.0 equiv) in DCM (0.1 M) was added $Tf_2O$ (1.5 equiv) dropwise at 0 °C. The reaction mixture was then allowed to stir at room temperature for 8 h. Then the mixture was quenched by $H_2O$ and diluted by DCM. The solution was washed with brine, dried over $Na_2SO_4$, filtered, and concentrated in vacuo. The crude residue was purified by flash column

chromatography over silica gel (EtOAc/petroleum ether = 1/40) to provide the desired product.

To a solution of protected ketones (5 mmol, 1.0 equiv) in MeOH (0.1 M) was added $NaBH_4$ (6 mmol, 1.2 equiv) portion-wise at 0 °C. The reaction mixture was then allowed to stir at room temperature for 0.5 h. Then the mixture was quenched by $H_2O$ and diluted by EtOAc. The solution was washed with 0.5 N HCl, brine, dried over $Na_2SO_4$, filtered, and concentrated in vacuo. The crude residue was purified by flash column chromatography over silica gel (EtOAc/petroleum ether = 1/10) to provide the desired 2-(1-hydroxyethyl)phenyl trifluoromethanesulfonate and its derivates.

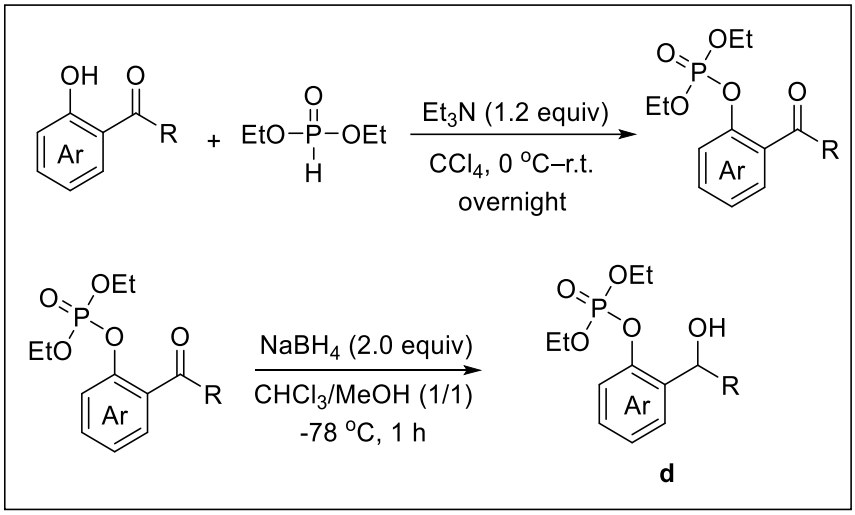
## 2.2 Preparation of *t*-butyl (2-(1-hydroxyethyl)phenyl) carbonate and its derivates




To a solution of the phenol (5 mmol, 1 equiv) at 0 °C was added the di-*tert*-butyl dicarbonate (2.73 g, 12.5 mmol, 2.5 equiv) followed by sodium hydride (0.50 g, 12.5 mmol, 60% in oil). The mixture was stirred at room temperature for 4 hours, after which the reaction was quenched by the addition of water, extracted with ethyl acetate, and washed with brine. The organic layers were dried over $Na_2SO_4$ and concentrated in vacuo. The residue was purified by chromatography with silica gel (EtOAc/petroleum ether = 1/10) to give the Boc-protected ketones.

The Boc-protected ketones (5 mmol, 1 equiv) were dissolved in 15 mL of THF and cooled down to 0 °C. A 15 mL solution of $NaBH_4$ (0.38 g, 10 mmol, 2 equiv) in water precooled to was then added with stirring. The reaction was then monitored by TLC. After 1 hour the reaction was quenched by 0.5 N HCl and then extracted with ethyl acetate, and washed with brine. The organic layers were dried over $Na_2SO_4$ and concentrated in vacuo. The residue was purified by flash chromatography with silica gel (EtOAc/petroleum ether = 1/5) to give the desired material.

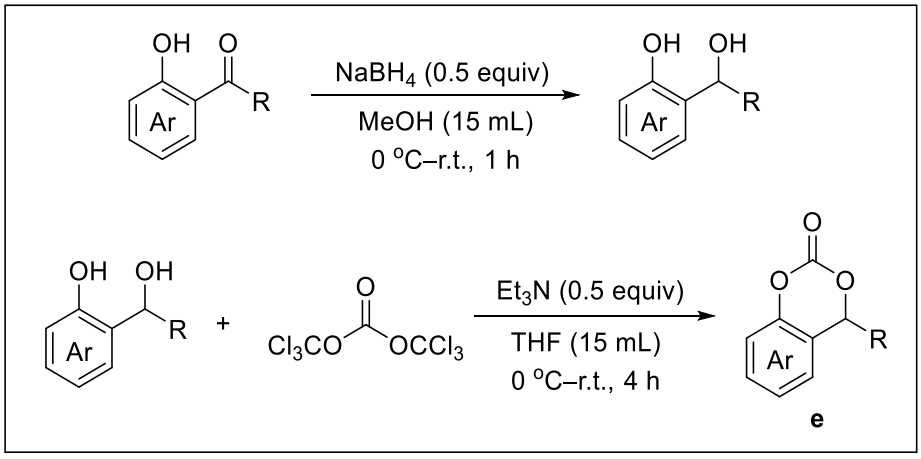
## 2.3 Preparation of diethyl (2-(1-hydroxyethyl)phenyl) phosphate and its derivates




$Et_3N$ (0.83 mL, 6.0 mmol, 1.2 equiv) was added dropwise to a solution of the phenol (5.0 mmol, 1 equiv, 1.0 M in $CCl_4$) at 0 °C, and diethyl phosphite (0.77 mL, 6 mmol, 1.2equiv.) was added very slowly at the same temperature. Then the mixture was moved to room temperature and stirred overnight. After that, the reaction was diluted with water, and the organic layer was washed with 1 N HCl, brine, and distilled water. The organic layers were dried over anhydrous $Na_2SO_4$ and concentrated in vacuo. The residue was purified by chromatography with silica gel (EtOAc/petroleum ether = 1/2) to give the corresponding diethyl phosphate ketones.

The obtained diethyl phosphate material (5.0 mmol, 1 equiv) was suspended in a 30 mL mixture of $CHCl_3$ and MeOH (v/v 1/1), and the reaction temperature was lowered to -78 °C. After stirring at the same temperature for a few minutes under the $N_2$ atmosphere, $NaBH_4$ (378.3 mg, 10 mmol, 2 equiv) was added in portions and the reaction was maintained at -78 °C for 1 hour. After completion, the reaction was diluted with DCM, and quenched by slow addition of 1 N HCl. The organic layer was separated, extracted with saturated $NaHCO_3$ solution and brine, and then dried over anhydrous $Na_2SO_4$. The organic layer was concentrated under reduced pressure and the product was purified by silica gel column chromatography (EtOAc/petroleum ether = 1/2).

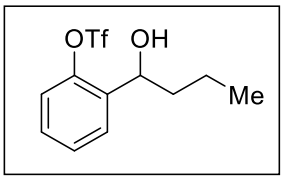
## 2.4 Preparation of 4-methyl-4*H*-benzo[*d*][1,3]dioxin-2-one and its derivates




To a stirred solution of the phenol (10 mmol, 1 equiv) dissolved in methanol (15 mL) at 0 °C was added sodium borohydride (5 mmol, 0.5 equiv). After 1h, the mixture was quenched by adding 1 N HCl and then extracted by ethyl acetate. The organic layer was separated and the aqueous layer was washed with ethyl acetate twice. The combined organic layer was washed with brine, dried over $Na_2SO_4$, and concentrated. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/10) to give the product.

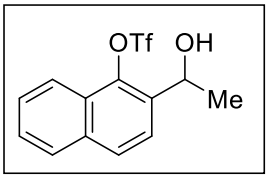
To a solution of secondary alcohol (5 mmol, 1 equiv) and $Et_3N$ (15 mmol, 3 equiv) in THF (15 mL) at 0 °C was added triphosgene (2.5-7.5 mmol, 0.5-1.5 equiv) in toluene dropwise and then stirred at rt. The reaction was then monitored by TLC. After the reaction was completed, the mixture was quenched with water at 0 ℃ and stirred for 10 minutes. After that, EtOAc was added to the mixture, and the organic phase was separated, the aqueous phase was washed with EtOAc twice. The organic phase was combined, washed with brine, and concentrated. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/10) to give the product.

## 2.5 Analytical data of substrates

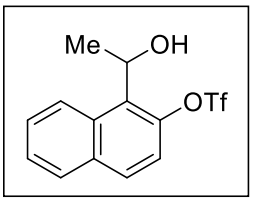



**2-(1-hydroxybutyl)phenyl trifluoromethanesulfonate：** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 7.65 (dd, $J$ = 7.7, 1.8 Hz, 1H), 7.41 (td, $J$ = 7.4, 1.0 Hz, 1H), 7.35 (td, $J$ = 8.2, 1.9 Hz, 1H), 7.24 (dd, $J$ = 8.2, 0.8 Hz, 1H), 5.05 (m, 1H), 2.12 (s, 1H), 1.84-1.63 (m, 2H), 1.55-1.29 (m, 2H), 0.95 (t, $J$ = 7.4 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 146.2, 137.7,

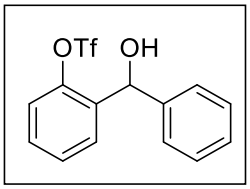
129.1, 128.8, 128.3, 121.1, 118.5 (q, $J$ = 318.4 Hz), 67.7, 40.0, 18.9, 13.7; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ 73.8; HRMS (EI) *m/z* calcd for $C_{11}H_{13}F_3O_4S$ ($M^+$): 298.0487, found: 298.0495.



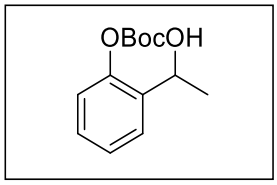

**2-(1-hydroxyethyl)naphthalen-1-yl trifluoromethanesulfonate：** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 8.10 (d, $J$ = 8.6 Hz, 1H), 7.94-7.88 (m, 2H), 7.77 (d, $J$ = 8.6 Hz, 1H), 7.65 (t, $J$ = 6.8 Hz, 1H), 7.59 (t, $J$ = 7.0 Hz, 1H), 5.48-5.45 (m, 1H), 2.23 (d, $J$ = 2.9 Hz, 1H), 1.58 (d, $J$ = 6.4 HZ, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 139.9, 135.6, 134.3, 129.3, 127.9, 127.2, 126.5, 124.0, 121.6, 118.7 (q, $J$ = 318.4 Hz), 63.8, 23.6; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ 73.0; HRMS (EI) m/z calcd for $C_{13}H_{11}F_3O_4S$ ($M^+$): 320.0330, found: 320.0318.



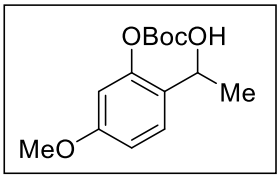

**1-(1-hydroxyethyl)naphthalen-2-yl trifluoromethanesulfonate：** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 8.79 (d, $J$ = 8.2 Hz, 1H), 7.89 (d, $J$ = 7.4 Hz, 1H), 7.84 (d, $J$ = 9.0 Hz, 1H), 7.60-7.56 (m, 2H), 7.31 (d, $J$ = 9.0 Hz, 1H), 5.78-5.83 (m, 1H), 2.38 (s, 1H), 1.80 (d, $J$ = 6.8 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 143.5, 133.4, 132.4, 131.5, 130.6, 128.9, 127.0, 126.8, 126.6, 119.2, 118.6 (q, $J$ = 318.5 HZ), 65.0, 23.0; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ 73.6; HRMS (EI) *m/z* calcd for $C_{13}H_{11}F_3O_4S$ ($M^+$): 320.0330, found: 320.0333.



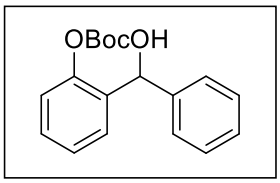

**2-(hydroxy(phenyl)methyl)phenyl trifluoromethanesulfonate：** $^1$H NMR (400 MHz, $CDCl_3$) $\delta$ 7.63-7.60 (m, 1H), 7.40-7.32 (m, 6H), 7.31-7.24 (m, 2H), 6.16 (d, $J$ = 3.3 Hz, 1H), 2.46 (d, $J$ = 3.6 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 146.7, 141.6, 136.5, 129.5, 129.1, 128.7, 128.6, 128.1, 126.6, 121.2, 118.5 (q, $J$ = 318.6 HZ), 70.2; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ 73.7; HRMS (EI) *m/z* calcd for $C_{14}H_{11}F_3O_4S$ ($M^+$): 332.0330, found: 332.0326.



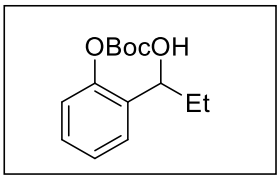

***tert*-butyl (2-(1-hydroxyethyl)phenyl) carbonate**: $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.55 (dd, $J$ = 7.3, 2.1 Hz, 1H), 7.32-7.26 (m, 2H), 7.10 (dd, $J$ = 7.7, 1.7 Hz, 1H), 5.08-5.04 (m, 1H), 2.21 (d, $J$ = 3.5 Hz, 1H), 1.56 (s, 9H), 1.49 (d, $J$ = 6.5 Hz, 3H); $^{13}$C NMR (151 MHz, $CDCl_3$) $\delta$ 152.3, 147.9, 137.4, 128.4, 126.62, 126.57, 122.1, 83.8, 64.7, 27.7, 23.2; HRMS (ESI) *m/z* calcd for $[C_{13}H_{18}O_4+Na]^+$: 261.1097, found: 261.1096.




***tert*-butyl (2-(1-hydroxyethyl)-5-methoxyphenyl) carbonate:** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.43 (d, $J$ = 8.7 Hz, 1H), 6.82 (dd, $J$ = 8.7, 2.5 Hz, 1H), 6.64 (d, $J$ = 2.4 Hz, 1H), 4.97 (q, $J$ = 6.6 Hz, 1H), 3.79 (s, 3H), 1.55 (s, 9H), 1.46 (d, $J$ = 6.6 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 159.7, 152.3, 148.7, 129.5, 127.4, 112.5, 107.8, 83.9, 64.2, 55.5, 27.7, 23.0; HRMS (ESI) *m/z* calcd for $[C_{14}H_{20}O_5+Na]^+$: 291.1203, found: 291.1202.

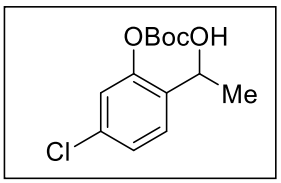



***tert*-butyl (2-(hydroxy(phenyl)methyl)phenyl) carbonate:** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.44 (d, $J$ = 7.6 Hz, 1H), 7.38-7.36 (m, 2H), 7.33-7.29 (m, 3H), 7.25-7.22 (m, 2H), 7.13 (d, $J$ = 8.0 Hz, 1H), 6.02 (d, $J$ = 3.6 Hz, 1H), 2.59 (s, 1H), 1.47 (s, 9H). $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 151.9, 148.4, 142.5, 135.9, 128.7, 128.4, 128.3, 127.5, 126.5, 126.4, 122.4, 83.8, 70.8, 27.6; HRMS (ESI) *m/z* calcd for $[C_{18}H_{20}O_4+Na]^+$: 323.1254, found: 323.1255.

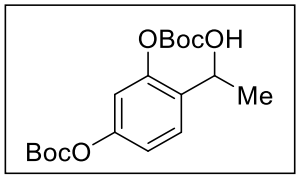



***tert*-butyl (2-(1-hydroxypropyl) phenyl) carbonate:** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.49 (dd, $J$ = 7.5, 2.0 Hz, 1H), 7.30-7.22 (m, 2H), 7.08 (dd, $J$ = 7.8, 1.6 Hz, 1H), 4.77-

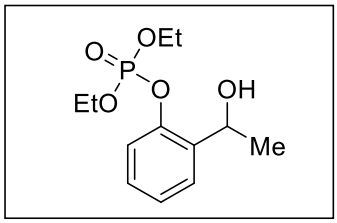
4.75 (m, 1H), 2.39 (d, $J$ = 3.7 Hz, 1H), 1.83-1.72 (m, 2H), 1.54 (s, 9H), 0.91 (t, $J$ = 7.4 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 152.3, 148.1, 136.5, 128.3, 127.2, 126.4, 122.1, 83.7, 70.0, 30.3, 27.7, 10.2; HRMS (ESI) *m/z* calcd for $[C_{14}H_{20}O_4+Na]^+$: 275.1254, found: 275.1252.



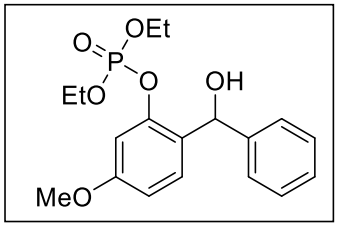

***tert*-butyl (5-chloro-2-(1-hydroxyethyl)phenyl) carbonate:** $^1$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.46 (d, $J$ = 8.4 Hz, 1H), 7.23 (dd, $J$ = 8.4, 2.1 Hz, 1H), 7.12 (d, $J$ = 2.1 Hz, 1H), 4.99 (q, $J$ = 6.5 Hz, 1H), 2.37 (s, 1H), 1.55 (s, 9H), 1.44 (d, $J$ = 6.5 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 151.8, 148.1, 136.2, 133.4, 127.7, 126.8, 122.6, 84.4, 64.3, 27.6, 23.3; HRMS (ESI) *m/z* calcd for $[C_{13}H_{17}ClO_4+Na]^+$: 295.0708, found: 295.0709.



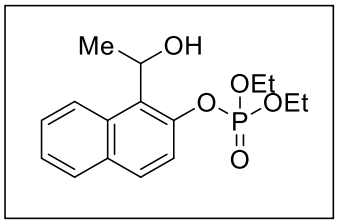

**di-*tert*-butyl (4-(1-hydroxyethyl)-1,3-phenylene) bis(carbonate):** $^1$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.51 (d, $J$ = 8.6 Hz, 1H), 7.08 (dd, $J$ = 8.6, 2.4 Hz, 1H), 6.99 (d, $J$ = 2.4 Hz, 1H), 5.00 (qd, $J$ = 6.5, 2.4 Hz, 1H), 2.41 (d, $J$ = 3.2 Hz, 1H), 1.53 (s, 9H), 1.52 (s, 9H), 1.43 (d, $J$ = 6.6 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 151.8, 151.4, 150.4, 147.9, 135.0, 127.1, 119.3, 115.4, 84.1, 83.8, 64.3, 27.7, 27.6, 23.3; HRMS (ESI) *m/z* calcd for $[C_{18}H_{26}O_7+Na]^+$: 377.1571, found: 377.1573.



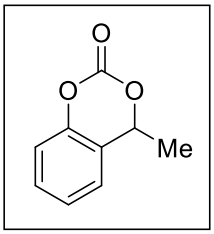

**diethyl (2-(1-hydroxyethyl)phenyl) phosphate**: $^1$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.51 (d, $J$ = 7.3 Hz, 1H), 7.22-7.19 (m, 2H), 7.18-7.15 (m, 1H), 5.19 (q, $J$ = 6.6 Hz, 1H), 4.26-4.09 (m, 4H), 3.60 (s, 1H), 1.46 (d, $J$ = 6.6 Hz, 3H), 1.34 (td, $J$ = 7.1, 1.1 Hz, 3H), 1.29 (td, $J$ = 7.1, 1.1 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 147.4 (d, $J$ = 7.1 Hz), 137.0 (d, $J$ = 5.9 Hz), 128.3, 126.9, 125.7, 120.1 (d, $J$ = 2.6 Hz), 64.9 (dd, $J$ = 13.4, 6.1 Hz), 63.5, 22.7, 16.1 (dd, $J$ = 6.6, 2.6 Hz). $^{31}$P NMR (243 MHz, $CDCl_3$) $\delta$ –5.68; HRMS (EI) *m/z* calcd for $C_{12}H_{19}O_5P$ ($M^+$): 274.0970, found: 274.0967.




**diethyl (2-(hydroxy(phenyl)methyl)-5-methoxyphenyl) phosphate**: $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.40-7.38 (m, 2H), 7.32-7.29 (m, 2H), 7.23 (t, $J$ = 7.3 Hz, 1H), 7.15 (d, $J$ = 8.6 Hz, 1H), 6.84-6.80 (m, 1H), 6.68 (dd, $J$ = 8.6, 2.2 Hz, 1H), 6.11 (s, 1H), 4.25-4.05 (m, 4H), 4.05-4.02 (m, 1H), 3.76 (s, 3H), 1.35 (td, $J$ = 7.1, 1.1 Hz, 3H), 1.28 (td, $J$ = 7.1, 1.1 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) δ 159.8, 148.7 (d, $J$ = 7.2 Hz), 143.0 (d, $J$ = 1.9 Hz), 130.1, 128.2 (d, $J$ = 5.7 Hz), 128.1, 127.0, 126.5, 111.3, 106.5 (d, $J$ = 2.5 Hz), 69.4, 65.0 (dd, $J$ = 9.3, 6.1 Hz), 55.5, 16.1 (dd, $J$ = 6.7, 4.3 Hz). $^{31}$P NMR (243 MHz, $CDCl_3$) $\delta$ –5.53; HRMS (EI) *m/z* calcd for $C_{18}H_{23}O_6P$ ($M^+$): 366.1232, found: 366.1226.

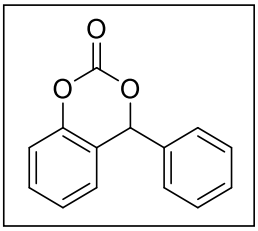



**diethyl (1-(1-hydroxyethyl)naphthalen-2-yl) phosphate**: $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 8.63 (d, $J$ = 8.6 Hz, 1H), 7.83-7.77 (m, 1H), 7.71 (d, $J$ = 9.0 Hz, 1H), 7.50-7.47 (m, 1H), 7.44-7.41 (m, 1H), 7.40-7.38 (m, 1H), 5.83 (d, $J$ = 7.1 Hz, 1H), 4.29-4.10 (m, 4H), 3.45 (s, 1H), 1.74 (d, $J$ = 6.9 Hz, 3H), 1.35 (td, $J$ = 7.1, 1.2 Hz, 3H), 1.30 (td, $J$ = 7.1, 1.2 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 145.0 (d, $J$ = 7.3 Hz), 132.1, 131.8, 129.9 (d, $J$ = 6.5 Hz), 129.5, 128.6, 126.3, 125.8, 125.2, 119.9 (d, $J$ = 2.0 Hz), 64.9 (t, $J$ = 6.1 Hz), 22.9, 16.1 (dd, $J$ = 6.2, 5.3 Hz); $^{31}$P NMR (243 MHz, $CDCl_3$) $\delta$ –5.66; HRMS (ESI) *m/z* calcd for $[C_{16}H_{21}O_5P+Na]^+$: 347.1019, found: 347.1020.

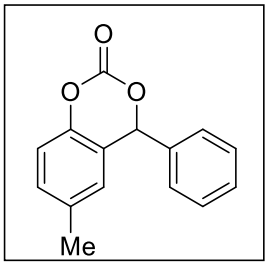



**4-methyl-4H-benzo[d][1,3]dioxin-2-one:** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.39-7.34 (m, 1H), 7.24-7.20 (m, 1H), 7.16 (d, $J$ = 7.6 Hz, 1H), 7.11 (d, $J$ = 8.2 Hz, 1H), 5.61 (q, $J$ = 6.6 Hz, 1H), 1.74 (d, $J$ = 6.6 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 148.8, 147.0,

129.9, 125.4, 123.8, 122.7, 116.2, 76.2, 20.9; HRMS (ESI) *m/z* calcd for $[C_9H_8O_3+Na]^+$: 187.0366, found: 187.0365.



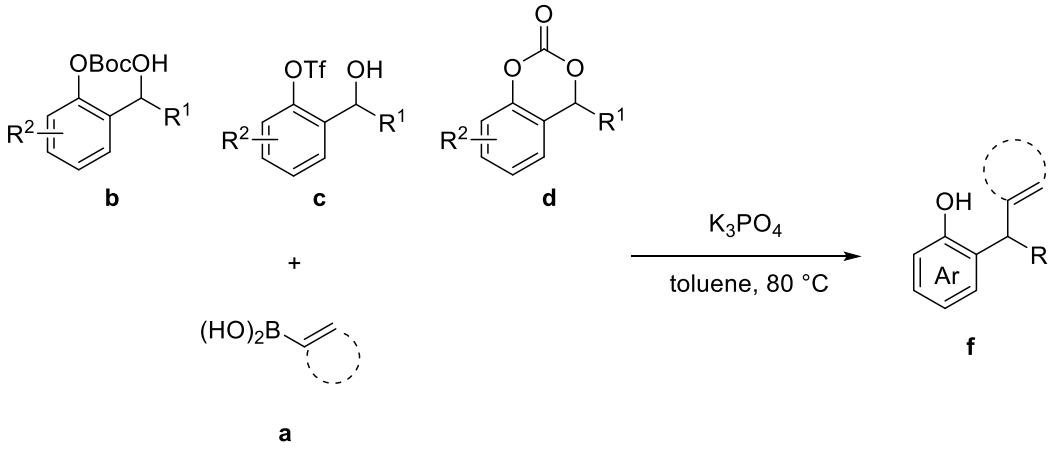
**4-phenyl-4H-benzo[d][1,3]dioxin-2-one:** $^1$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.47-7.37 (m, 4H), 7.36-7.31 (m, 2H), 7.21-7.13 (m, 2H), 6.97-6.90 (m, 1H), 6.45 (s, 1H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 149.2, 146.6, 136.3, 130.3, 129.8, 129.1, 127.8, 125.8, 125.3, 121.1, 116.3, 81.5; HRMS (ESI) *m/z* calcd for $[C_{14}H_{10}O_3+Na]^+$: 249.0522, found: 249.0521.



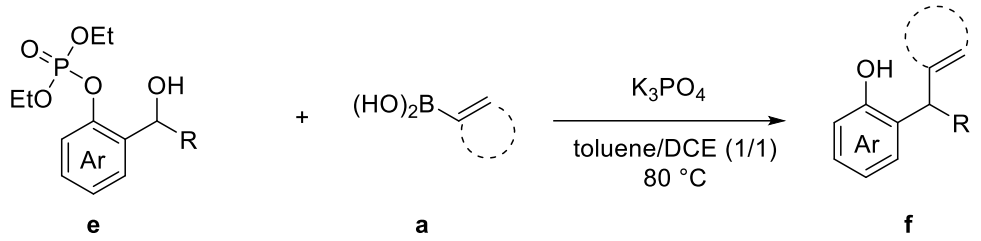

**6-methyl-4-phenyl-4H-benzo[d][1,3]dioxin-2-one:** $^1$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.44-7.40 (m, 3H), 7.36-7.32 (m, 2H), 7.18 (dd, $J$ = 8.4, 2.1 Hz, 1H), 7.05 (d, $J$ = 8.4 Hz, 1H), 6.72 (d, $J$ = 2.1 Hz, 1H), 6.40 (s, 1H), 2.28 (s, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 147.1, 146.8, 136.6, 135.2, 130.8, 129.8, 129.1, 127.8, 126.0, 120.7, 115.9, 81.6, 20.8; HRMS (ESI) *m/z* calcd for $[C_{15}H_{12}O_3+Na]^+$: 263.0679, found: 263.0680.

# 3. Metal-free couplings between secondary alcohols and boronic acids

## 3.1 General procedures

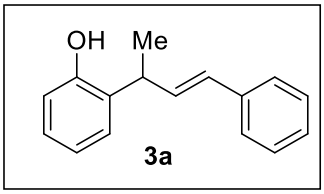



A mixture of boronic acid (0.3 mmol, 1.5 equiv) and potassium phosphate (0.4 mmol, 2 equiv) was charged with degassed toluene (2 mL). Then substrate (0.2 mmol, 1.0 equiv) was added. The resulting mixture was stirred at 80 °C for 4 h. The mixture was directly purified by silica gel column chromatography (EtOAc/petroleum ether = 1/10) to provide the coupling product.

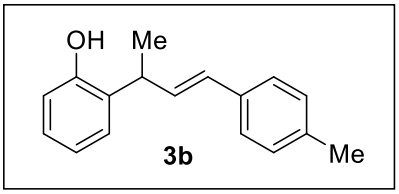



A mixture of boronic acid (0.3 mmol, 1.5 equiv) and potassium phosphate (0.4 mmol, 2 equiv) was charged degassed toluene with DCE as cosolvent (v/v = 1/1, 2 mL). Then substrate (0.2 mmol, 1.0 equiv) was added. The resulting mixture was stirred at 80 °C for 4 h. The mixture was directly purified by silica gel column chromatography (EtOAc/petroleum ether = 1/10) to provide the coupling product.

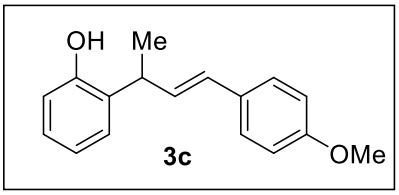
## 3.2 Analytical data of coupling products



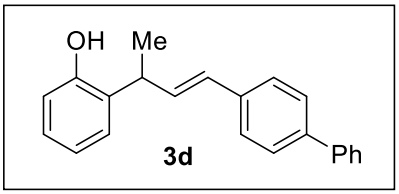

**(*E*)-2-(4-phenylbut-3-en-2-yl)phenol (3a):** $^{1}$H NMR (400 MHz, $CDCl_3$) $\delta$ 7.38-7.33 (m, 2H), 7.32-7.25 (m, 2H), 7.23-7.17 (m, 2H), 7.16-7.09 (m, 1H), 6.93 (t, $J$ = 7.5 Hz, 1H), 6.80 (d, $J$ = 8.0 Hz, 1H), 6.51 (d, $J$ = 16.0 Hz, 1H), 6.43 (dd, $J$ = 16.0, 5.9 Hz, 1H), 4.99 (s, 1H), 3.94-3.85 (m, 1H), 1.49 (d, $J$ = 7.0 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 153.5, 137.1, 133.9, 130.7, 129.4, 128.5, 127.9, 127.6, 127.3, 126.2, 121.0, 116.1, 36.8, 19.5; HRMS (EI) *m/z* calcd for $C_{16}H_{16}O$ ($M^+$): 224.1201, found: 224.1205.



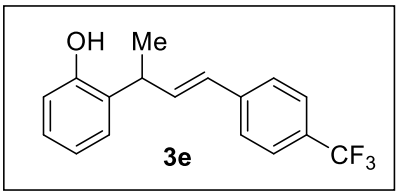

**(*E*)-2-(4-(p-tolyl)but-3-en-2-yl)phenol (3b)：** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.29-7.26 (d, $J$ = 8.8 Hz, 2H), 7.22 (dd, $J$ = 7.6 Hz, 1.3 Hz, 1H), 7.17-7.11 (m, 3H), 6.95 (t, $J$ = 7.4 Hz, 1H), 6.82 (d, $J$ = 7.5 Hz, 1H), 6.51 (d, $J$ = 16.1 Hz, 1H), 6.40 (dd, $J$ = 16.1, 6.3 Hz, 1H), 5.13 (br s, 1H), 3.92-3.86 (m, 1H), 2.34 (s, 3H), 1.51 (d, $J$ = 7.1 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 153.6, 137.1, 134.2, 132.8, 130.8, 129.3, 129.2, 128.0, 127.6, 126.1, 121.0, 116.1, 36.8, 21.2, 19.5; HRMS (EI) *m/z* calcd for $C_{17}H_{18}O$ ($M^+$): 238.1358, found: 238.1352.



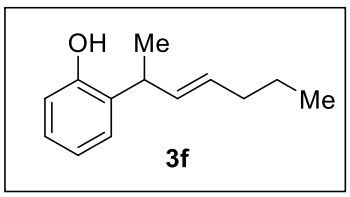

**(*E*)-2-(4-(4-methoxyphenyl)but-3-en-2-yl)phenol (3c):** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.34-7.29 (m, 2H), 7.24-7.20 (m, 1H), 7.18-7.11 m, 1H), 6.95 (t, $J$ = 7.5 Hz, 1H), 6.88-6.79 (m, 3H), 6.48 (d, $J$ =16.1 $H_Z$, 1H), 6.31 (dd, $J$ = 16.1, 6.4 Hz, 1H), 5.16 (s, 1H), 3.91-3.84 (m, 1H), 3.81 (s, 3H), 1.50 (d, $J$ = 7.0 $H_Z$, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 159.0, 153.6, 131.7, 130.9, 129.8, 128.9, 127.9, 127.6, 127.4, 121.0, 116.1, 113.9, 55.3, 36.8, 19.6; HRMS (EI) *m/z* calcd for $C_{17}H_{18}O_2$ ($M^+$): 254.1307, found: 254.1304.



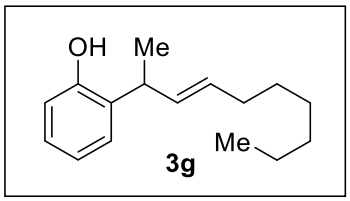

**(*E*)-2-(4-([1,1'-biphenyl]-4-yl)but-3-en-2-yl)phenol (3d)：** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.61-7.58 (m, 2H), 7.56-7.54 (m, 2H), 7.46-7.42 (m, 4H), 7.34 (t, *J* = 7.4, 1.2 Hz, 1H), 7.23 (dd, *J*= 7.7, 1.6 Hz, 1H), 7.15 (td, *J*= 7.8, 1.7 Hz, 1H), 6.95 (td, *J* = 7.6, 1.2 Hz, 1H), 6.83 (dd, *J* = 8.0, 1.2 Hz, 1H), 6.47-6.57 (m, 2H), 3.97-3.90 (m, 1H), 1.59 (br s, 1H), 1.52 (d, *J* = 7.1 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 153.5, 140.7, 140.1, 136.1, 134.1, 130.7, 128.9, 128.7, 128.0, 127.6, 127.22, 127.20, 126.9, 126.6, 121.1, 116.0, 36.8, 19.5; HRMS (EI) *m/z* calcd for $C_{22}H_{20}O$ ($M^+$): 300.1514, found: 300.1522.



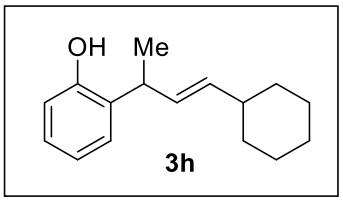

**(*E*)-2-(4-(4-(trifluoromethyl)phenyl)but-3-en-2-yl)phenol (3e)：** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.55 (d, *J* = 8.3 Hz, 2H), 7.46 (d, *J* = 8.3 Hz, 2H), 7.22 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.15 (td, *J* = 7.7, 1.6 Hz, 1H), 6.96 (td, *J* = 7.5, 1.0 Hz, 1H), 6.81 (dd, *J* = 8.0, 1.0 Hz, 1H), 6.49-6.59 (m, 2H), 4.96 (s, 1H), 4.02-3.94 (m, 1H), 1.51 (d, *J* = 7.1 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 153.2, 140.8, 136.9, 130.6, 128.9 (q, *J* = 32.2 Hz), 128.0, 127.8, 127.6, 126.3, 125.4 (q, *J* = 3.8 Hz), 124.2 (q, *J* = 270.4 Hz), 121.1, 115.9, 36.4, 19.4; $^{19}$F NMR (376 MHz, $CDCl_3$) $\delta$ -62.37; HRMS (EI) *m/z* calcd for $C_{17}H_{15}F_3O$ ($M^+$): 292.1075, found: 292.1077.



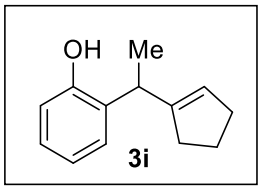

**(*E*)-2-(hept-3-en-2-yl)phenol (3f)：** $^{1}$H NMR (400 MHz, $CDCl_3$) $\delta$ 7.16-7.12 (m, 2H), 6.91 (td, *J* = 7.6, 1.2 Hz, 1H), 6.84-6.81 (m, 1H), 5.72-5.62 (m, 2H), 5.32 (br s, 1H), 3.64-3.58 (m, 1H), 2.07-2.02 (m, 2H), 1.46-1.37 (m, 5H), 0.91 (t, *J* = 7.3 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 154.1, 134.1, 131.1, 130.6, 127.8, 127.6, 120.9, 116.3, 37.3, 34.6, 22.5, 19.4, 13.7; HRMS (EI) *m/z* calcd for $C_{13}H_{18}O$ ($M^+$): 190.1358, found: 190.1365.



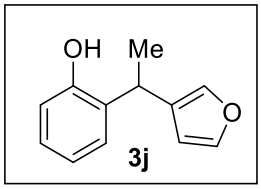

**(*E*)-2-(dec-3-en-2-yl)phenol (3g)：** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.15-7.12 (m, 2H), 6.91 (td, $J$ = 7.6, 1.2 Hz, 1H), 6.83-6.82 (m, 1H), 5.70-5.63 (m, 2H), 5.29 (br s, 1H), 3.63-3.58 (m, 1H), 2.08-2.04 (m, 2H), 1.40-1.35 (m, 5H), 1.34-1.23 (m, 6H), 0.89 (t, $J$ = 6.9 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 154.1, 133.7, 131.3, 130.6, 127.8, 127.6, 120.8, 116.3, 37.3, 32.5, 31.7, 29.3, 28.8, 22.6, 19.4, 14.1; HRMS (ESI) *m/z* calcd for $[C_{16}H_{24}O\text{-}H]^-$: 231.1754, found: 231.1752.



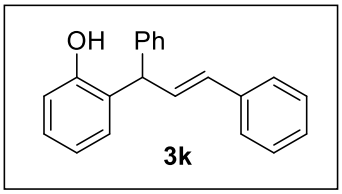

**(*E*)-2-(4-cyclohexylbut-3-en-2-yl)phenol (3h)：** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.15-7.12 (m, 2H), 6.90 (td, $J$ = 7.5, 1.2 Hz, 1H), 6.83-6.81 (m, 1H), 5.67-5.60 (m, 2H), 5.36 (br s, 1H), 3.58-3.56 (m, 1H), 2.20-1.97 (m, 1H), 1.74-1.71 (m, 4H), 1.66-1.64 (m, 1H), 1.38 (d, $J$ = 7.1 Hz, 3H), 1.31-1.23 (m, 2H), 1.20-1.05 (m, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 154.2, 137.3, 131.3, 130.5, 127.8, 127.6, 120.7, 116.4, 40.6, 37.6, 33.0, 26.1, 26.0, 19.3; HRMS (EI) *m/z* calcd for $C_{16}H_{22}O$ ($M^+$): 230.1671, found: 230.1666.



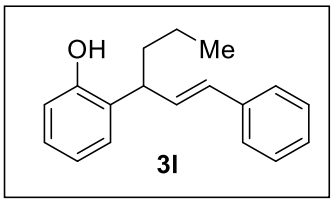

**2-(1-(cyclopent-1-en-1-yl)ethyl)phenol (3i)：** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.16-7.01 (m, 2H), 6.89 (t, $J$ = 7.4 Hz, 1H), 6.81 (d, $J$ = 8.0 Hz, 1H), 5.70 (s, 1H), 5.49 (br s, 1H), 3.64-3.61 (m, 1H), 2.42-2.39 (m, 2H), 2.22-2.12 (m, 2H), 1.92-1.86 (m, 2H), 1.47 (d, $J$ = 7.1 Hz, 3H); $^{13}$C NMR (125 MHz, $CDCl_3$) $\delta$ 154.4, 148.7, 129.8, 128.6, 127.6, 125.6, 120.7, 116.3, 37.6, 33.9, 32.4, 23.4, 18.7; HRMS (EI) *m/z* calcd for $C_{13}H_{16}O$ ($M^+$): 188.1201, found: 188.1198.



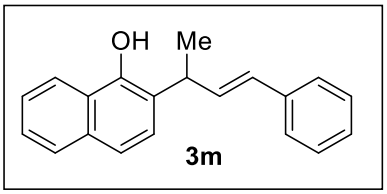

**2-(1-(furan-3-yl)ethyl)phenol (3j):** $^{1}$H NMR (500 MHz, $CDCl_3$) $\delta$ 7.34 (d, $J$ = 1.2 Hz, 1H), 7.14-7.08 (m, 2H), 6.90 (td, $J$ = 7.5, 1.0 Hz, 1H), 6.80 (dd, $J$ = 8.0, 1.0 Hz, 1H), 6.32 (dd, $J$ = 3.2, 1.9 Hz, 1H), 6.13 (d, $J$ = 3.2 Hz, 1H), 5.00 (s, 1H), 4.44-4.40 (m, 1H), 1.61 (d, $J$ = 1.6 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 158.1, 153.1, 141.6, 129.9, 128.2, 127.8, 121.1, 116.2, 110.0, 105.2, 33.3, 18.6; HRMS (EI) *m/z* calcd for $C_{12}H_{12}O_2$ ($M^+$): 188.0837, found: 188.0838.




**(*E*)-2-(1,3-diphenylallyl)phenol (3k):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.38-7.36 (m, 2H), 7.34-7.32 (m, 2H), 7.31-7.19 (m, 6H), 7.18-7.12 (m, 2H), 6.92 (td, $J$ = 7.5, 1.3 Hz, 1H), 6.80 (dd, $J$ = 8.4, 1.3 Hz, 1H), 6.70 (dd, $J$ = 15.9, 7.2 Hz, 1H), 6.36 (d, $J$ = 15.9 Hz, 1H), 5.14 (d, $J$ = 7.2 Hz, 1H), 4.95 (s, 1H). $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 153.5, 142.2, 137.1, 131.9, 131.3, 129.8, 129.5, 128.74, 128.70, 128.6, 128.1, 127.5, 126.8, 126.4, 121.1, 116.4, 48.4; HRMS (EI) *m/z* calcd for $C_{21}H_{18}O$ ($M^+$): 286.1358, found: 286.1350.

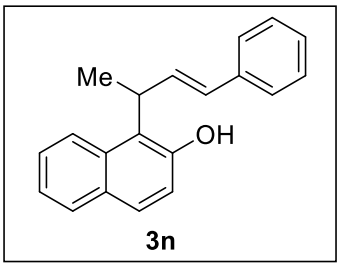



**(*E*)-2-(1-phenylhex-1-en-3-yl)phenol (3l):** $^{1}$H NMR (400 MHz, $CDCl_3$) $\delta$ 7.38-7.36 (m, 2H), 7.32-7.28 (m, 2H), 7.22 (m, 2H), 7.13 (td, $J$ = 7.7, 1.6 Hz, 1H), 6.95 (td, $J$ = 7.5, 1.0 Hz, 1H), 6.81 (dd, $J$ = 8.0, 1.0 Hz, 1H), 6.37-6.52 (m, 2H), 4.97 (s, 1H), 3.76-3.74 (m, 1H), 1.85 (q, $J$ = 7.6 Hz, 2H), 1.29-1.50 (m, 2H), 0.96 (t, $J$ = 7.3 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 153.5, 137.2, 133.2, 129.97, 129.90, 128.5, 128.4, 127.4, 127.2, 126.2, 121.0, 116.1, 42.5, 36.3, 20.8, 14.1; HRMS (EI) *m/z* calcd for $C_{18}H_{20}O$ ($M^+$): 252.1514, found: 252.1510.



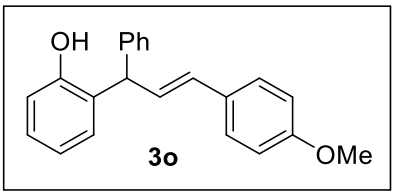

**3m**

**(*E*)-2-(4-phenylbut-3-en-2-yl)naphthalen-1-ol (3m):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 8.16-8.09 (m, 1H), 7.79-7.72 (m, 1H), 7.45-7.41 (m, 3H), 7.35-7.25 (m, 5H), 7.20 (t, *J* = 7.4 Hz, 1H), 6.57 (dd, *J* = 16.1, 1.8 Hz, 1H), 6.48 (dd, *J* = 16.1, 5.8 Hz, 1H), 5.67 (s, 1H), 3.97-3.90 (m, 1H), 1.55 (d, *J* = 7.0 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 148.9, 136.8, 133.6, 130.1, 128.7, 127.7, 127.6, 126.4, 126.1, 125.9, 125.4, 125.1, 123.5, 121.5, 120.7, 37.7, 19.5; HRMS (ESI) *m/z* calcd for $[C_{20}H_{18}O\text{-}H]^-$: 273.1285, found: 273.1285.



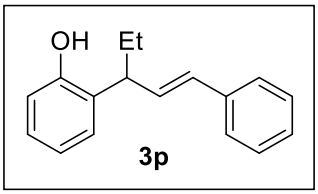

**3n**

**(*E*)-1-(4-phenylbut-3-en-2-yl)naphthalen-2-ol (3n):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 8.04 (d, *J* = 8.7 Hz, 1H), 7.79 (d, *J* = 8.1 Hz, 1H), 7.67 (d, *J* = 8.7 Hz, 1H), 7.50-7.46 (m, 1H), 7.41-7.37 (m, 2H), 7.36-7.28 (m, 3H), 7.26-7.21 (m, 1H), 7.07 (d, *J* = 8.8 Hz, 1H), 6.79-6.70 (m, 2H), 5.90 (s, 1H), 4.66-4.61 (m, 1H), 1.63 (d, *J* = 7.2 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 152.3, 136.7, 133.6, 132.5, 130.5, 129.7, 128.9, 128.8, 128.7, 127.7, 126.6, 126.4, 123.1, 122.5, 121.3, 119.3, 33.5, 17.3; HRMS (ESI) *m/z* calcd for $[C_{20}H_{18}O\text{-}H]^-$: 273.1285, found: 273.1285.

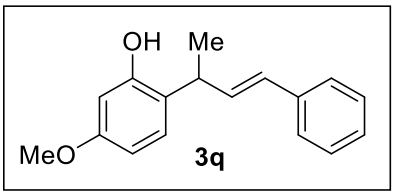



**3o**

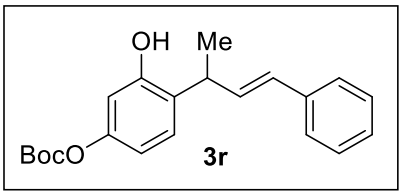
**(*E*)-2-(3-(4-methoxyphenyl)-1-phenylallyl)phenol (3o):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.36-7.30 (m, 4H), 7.30-7.24 (m, 3H), 7.19-7.12 (m, 2H), 6.93 (t, *J* = 7.5 Hz, 1H), 6.87-6.83 (m, 3H), 6.56 (dd, *J* = 15.9, 7.1 Hz, 1H), 6.32 (d, *J* = 15.9 Hz, 1H), 5.11 (d, *J* = 7.1 Hz, 1H), 4.93 (s, 1H), 3.81 (s, 3H). $^{13}$C NMR (150 MHz, $CDCl_3$) δ 159.2, 153.5, 142.2, 131.3, 129.9, 129.8, 129.6, 129.0, 128.74, 128.70, 128.0, 127.6, 126.8, 121.0, 116.4, 114.0, 55.3, 48.5; HRMS (EI) *m/z* calcd for $C_{22}H_{20}O_2$ ($M^+$): 316.1463, found: 316.1455.



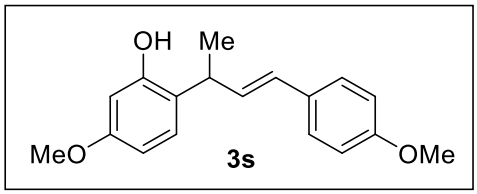

**(*E*)-2-(1-phenylpent-1-en-3-yl)phenol (3p):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.38-7.36 (m, 2H), 7.31-7.28 (m, 2H), 7.24-7.19 (m, 2H), 7.13 (td, *J* = 7.7, 1.7 Hz, 1H), 6.95 (t, *J* = 7.4 Hz, 1H), 6.81 (dd, *J* = 8.0, 1.3 Hz, 1H), 6.50 (d, *J* = 16.0 Hz, 1H), 6.39 (dd, *J* = 16.0, 7.3 Hz, 1H), 5.02 (s, 1H), 3.64 (q, *J* = 7.4 Hz, 1H), 1.93-1.88 (m, 2H), 0.98 (t, *J* = 7.4 Hz, 3H). $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 153.6, 137.3, 133.0, 130.1, 129.9, 128.52, 128.47, 127.4, 127.2, 126.2, 121.0, 116.1, 44.6, 27.1, 12.3; HRMS (EI) *m/z* calcd for $C_{17}H_{18}O$ ($M^+$): 238.1358, found: 238.1353.




**(*E*)-5-methoxy-2-(4-phenylbut-3-en-2-yl)phenol (3q):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.37-7.35 (m, 2H), 7.31-7.28 (m, 2H), 7.22 (t, *J* = 7.3 Hz, 1H), 7.10 (d, *J* = 8.5 Hz, 1H), 6.52-6.48 (m, 2H), 6.44-6.39 (m, 2H), 5.25-5.08 (m, 1H), 3.83-3.79 (m, 1H), 3.78 (s, 3H), 1.47 (d, *J* = 7.1 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 159.4, 154.6, 137.1, 134.3, 129.3, 128.6, 128.5, 127.3, 126.3, 123.0, 106.4, 102.3, 55.3, 36.4, 19.6; HRMS (EI) *m/z* calcd for $C_{17}H_{18}O_2$ ($M^+$): 254.1307, found: 254.1310.

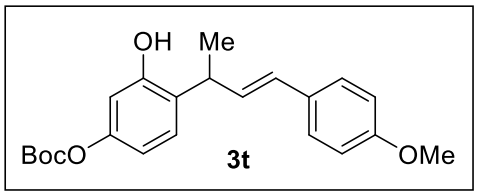



**(*E*)-tert-butyl (3-hydroxy-4-(4-phenylbut-3-en-2-yl)phenyl) carbonate (3r):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.35-7.33 (m, 2H), 7.30-7.27 (m, 2H), 7.20 (t, *J* = 7.3 Hz, 1H), 7.16 (d, *J* = 8.4 Hz, 1H), 6.75-6.69 (m, 1H), 6.64 (d, *J* = 1.9 Hz, 1H), 6.48 (d, *J* = 16.0 Hz, 1H), 6.38 (dd, *J* = 16.0, 6.3 Hz, 1H), 5.51 (s, 1H), 3.87-3.82 (m, 1H), 1.55 (s, 9H), 1.44 (d, *J* = 7.0 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 154.2, 152.1, 150.1, 137.1, 133.8, 129.4, 128.7, 128.5, 128.4, 127.3, 126.3, 113.5, 109.3, 83.7, 36.2, 27.7, 19.5; HRMS (ESI) *m/z* calcd for $[C_{21}H_{24}O_4+Na]^+$: 353.1567, found: 353.1567.



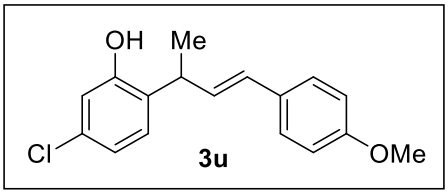

**3s**

**(*E*)-5-methoxy-2-(4-(4-methoxyphenyl)but-3-en-2-yl)phenol (3s):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.32-7.27 (m, 2H), 7.09 (d, $J$ = 8.5 Hz, 1H), 6.86-6.82 (m, 2H), 6.50 (dd, $J$ = 8.5, 2.6 Hz, 1H), 6.46 (dd, $J$ = 16.0, 1.6 Hz, 1H), 6.42 (d, $J$ = 2.6 Hz, 1H), 6.27 (dd, $J$ = 16.0, 6.3 Hz, 1H), 5.27-5.23 (m, 1H), 3.80 (s, 3H), 3.77 (s, 3H), 3.76 (t, $J$ = 7.0 Hz, 1H), 1.46 (d, $J$ = 7.0 Hz, 3H). $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 159.3, 159.1, 154.7, 132.1, 129.9, 128.8, 128.5, 127.4, 123.1, 114.0, 106.4, 102.3, 55.3, 36.5, 19.7; HRMS (EI) *m/z* calcd for $C_{18}H_{20}O_3$ ($M^+$): 284.1412, found: 284.1408.



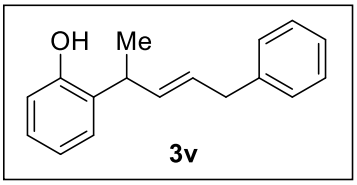

**3t**

**(*E*)-tert-butyl (3-hydroxy-4-(4-(4-methoxyphenyl)but-3-en-2-yl)phenyl) carbonate (3t):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.28-7.26 (m, 2H), 7.15 (d, $J$ = 8.4 Hz, 1H), 6.83-6.81 (m, 2H), 6.74-6.68 (m, 1H), 6.64 (d, $J$ = 1.8 Hz, 1H), 6.43 (d, $J$ = 16.0 Hz, 1H), 6.24 (dd, $J$ = 16.0, 6.4 Hz, 1H), 5.57 (s, 1H), 3.83-3.80 (m, 1H), 3.79 (s, 3H), 1.55 (s, 9H), 1.43 (d, $J$ = 7.0 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) δ 159.1, 154.3, 152.1, 150.1, 131.5, 129.9, 129.0, 128.8, 128.3, 127.4, 114.0, 113.4, 109.4, 83.6, 55.3, 36.4, 27.7, 19.6; HRMS (ESI) *m/z* calcd for $[C_{22}H_{26}O_5+Na]^+$: 393.1672, found: 393.1673.



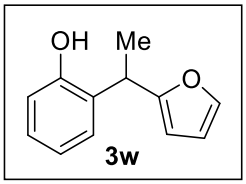

**3u**

***(E)*-5-chloro-2-(4-(4-methoxyphenyl)but-3-en-2-yl)phenol (3u):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.30-7.28 (m, 2H), 7.11 (d, $J$ = 8.2 Hz, 1H), 6.91 (dd, $J$ = 8.2, 2.1 Hz, 1H), 6.85-6.84 (m, 2H), 6.83 (d, $J$ = 2.1 Hz, 1H), 6.45 (d, $J$ = 16.0 Hz, 1H), 6.24 (dd, $J$ = 16.0, 6.4 Hz, 1H), 5.35 (s, 1H), 3.82-3.78 (m, 1H), 3.81 (s, 3H), 1.46 (d, $J$ = 7.1 Hz, 3H). $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 159.2, 154.4, 132.6, 131.0, 129.7, 129.6, 129.3, 128.9, 127.4, 121.1, 116.5, 114.0, 55.3, 36.5, 19.5; HRMS (EI) *m/z* calcd for $C_{17}H_{17}ClO_2$ ($M^+$): 288.0917, found: 288.0912.



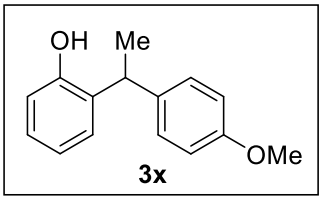

**3v**

**(*E*)-2-(5-phenylpent-3-en-2-yl)phenol (3v):** $^{1}$H NMR (400 MHz, $CDCl_3$) $\delta$ 7.29 (m, 2H), 7.21-7.09 (m, 5H), 6.90 (t, $J$ = 7.4 Hz, 1H), 6.79 (d, $J$ = 8.0 Hz, 1H), 5.82-5.72 (m, 2H), 5.09 (s, 1H), 3.75-3.71 (m, 1H), 3.43-3.34 (m, 2H), 1.38 (d, $J$ = 7.0 Hz, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) $\delta$ 153.8, 140.3, 135.4, 130.7, 129.4, 128.5 (2C), 127.9, 127.6, 126.1, 120.9, 116.2, 38.9, 36.8, 19.5; HRMS (EI) *m/z* calcd for $C_{17}H_{18}O$ ($M^+$): 238.1358, found: 238.1362.



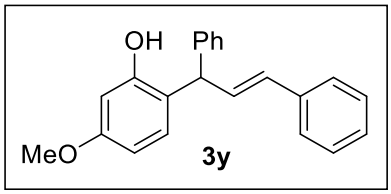

**3w**

**2-(1-(furan-2-yl)ethyl)phenol (3w)**: $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.33 (s, 1H), 7.13-7.07 (m, 2H), 6.89 (t, $J$ = 7.5 Hz, 1H), 6.79 (d, $J$ = 8.0 Hz, 1H), 6.31 (dd, $J$ = 3.2, 1.8 Hz, 1H), 6.12 (d, $J$ = 3.2 Hz, 1H), 5.09 (s, 1H), 4.45-4.41 (m, 1H), 1.61 (d, $J$ = 7.2 Hz, 3H). $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 158.2, 153.2, 141.6, 130.0, 128.3, 127.8, 121.1, 116.2, 110.1, 105.2, 33.3, 18.6; HRMS (EI) *m/z* calcd for $C_{12}H_{12}O_2$ ($M^+$): 188.0837, found: 188.0835.

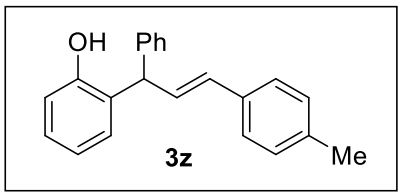



**3x**

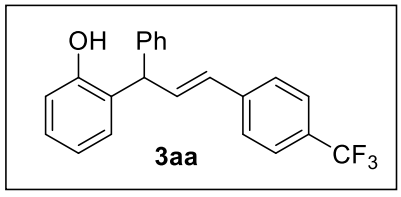
**2-(1-(4-methoxyphenyl)ethyl)phenol (3x)**: $^{1}$H NMR (600 MHz, $CDCl_3$) δ 7.24 (dd, $J$ = 7.7, 1.7 Hz, 1H), 7.17 (d, $J$ = 8.7 Hz, 2H), 7.12 (td, $J$ = 7.6, 1.6 Hz, 1H), 6.94 (td, $J$ = 7.5, 1.3 Hz, 1H), 6.84 (d, $J$ = 8.7 Hz, 2H), 6.76 (dd, $J$ = 7.9, 1.3 Hz, 1H), 4.70 (s, 1H), 4.31 (q, $J$ = 7.2 Hz, 1H), 3.78 (s, 3H), 1.61 (d, $J$ = 7.2 Hz, 3H). $^{13}$C NMR (151 MHz, $CDCl_3$) δ 158.2, 153.4, 137.2, 132.1, 128.5, 127.8, 127.5, 120.9, 116.1, 114.2, 55.3, 38.1, 21.2. HRMS (EI) m/z calcd for $C_{15}H_{16}O_2$ ($M^+$): 228.115, found: 228.1147.



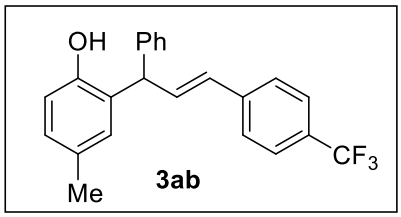

**(*E*)-2-(1,3-diphenylallyl)-5-methoxyphenol (3y)**: $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.37-7.20 (m, 10H), 7.00 (d, $J$ = 8.5 Hz, 1H), 6.66 (dd, $J$ = 15.9, 7.0 Hz, 1H), 6.47 (dd, $J$ = 8.5, 2.6 Hz, 1H), 6.40 (d, $J$ = 2.6 Hz, 1H), 6.34 (d, $J$ = 15.9 Hz, 1H), 5.03 (d, $J$ = 7.0 Hz, 1H), 4.95 (s, 1H), 3.75 (s, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 159.7, 154.5, 142.2, 137.1, 131.7, 131.5, 130.4, 128.7, 128.61, 128.57, 127.5, 126.8, 126.4, 121.7, 106.4, 102.5, 55.3, 48.0; HRMS (EI) *m/z* calcd for $C_{22}H_{20}O_2$ ($M^+$): 316.1463, found: 316.1460.




**(*E*)-2-(1-phenyl-3-(p-tolyl)allyl)phenol (3z):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.35-7.31 (m, 2H), 7.29-7.23 (m, 5H), 7.16-7.09 (m, 4H), 6.94-6.89 (m, 1H), 6.81 (dd, $J$ = 7.9, 1.3 Hz, 1H), 6.63 (dd, $J$ = 15.9, 7.2 Hz, 1H), 6.33 (d, $J$ = 15.9 Hz, 1H), 5.11 (d, $J$ = 7.2 Hz, 1H), 4.87 (s, 1H), 2.32 (s, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 153.5, 142.1, 137.3, 134.3, 131.8, 130.1, 129.8, 129.5, 129.2, 128.70, 128.66, 128.0, 126.8, 126.3, 121.0, 116.4, 48.5, 21.2; HRMS (EI) *m/z* calcd for $C_{22}H_{20}O$ ($M^+$): 300.1514, found: 300.1509.



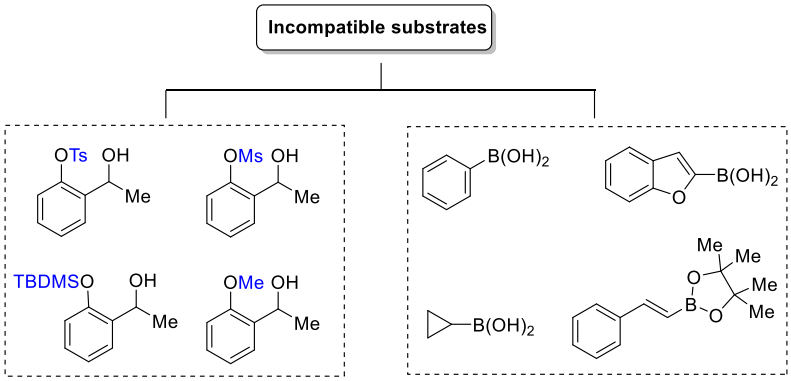

**(*E*)-2-(1-phenyl-3-(4-(trifluoromethyl)phenyl)allyl)phenol (3aa):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.55-7.50 (m, 2H), 7.46-7.42 (m, 2H), 7.35-7.30 (m, 2H), 7.27-7.22 (m, 3H), 7.18-7.12 (m, 2H), 6.95-6.90 (m, 1H), 6.83-6.75 (m, 2H), 6.35 (d, $J$ = 15.9 Hz, 1H), 5.17 (d, $J$ = 7.1 Hz, 1H), 4.76 (s, 1H). $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 153.3, 141.7, 140.6, 134.2, 130.5, 129.7, 129.2 (q, $J$ = 32.2 Hz), 129.1, 128.7, 128.6, 128.2, 126.9, 126.5, 125.5 (q, $J$ = 3.9 Hz), 124.2 (q, $J$ = 271.2 Hz), 121.1, 116.3, 48.2; $^{19}$F NMR (565 MHz, $CDCl_3$) $\delta$ –62.46; HRMS (EI) *m/z* calcd for $C_{22}H_{17}F_3O$ ($M^+$): 354.1231, found: 354.1229.




**(*E*)-4-methyl-2-(1-phenyl-3-(4-(trifluoromethyl)phenyl)allyl)phenol (3ab):** $^{1}$H NMR (600 MHz, $CDCl_3$) $\delta$ 7.56-7.51 (m, 2H), 7.48-7.43 (m, 2H), 7.36-7.31 (m, 2H), 7.27-7.24 (m, 3H), 6.98-6.90 (m, 2H), 6.83-6.77 (m, 1H), 6.72-6.68 (m, 1H), 6.36 (dd, $J$ = 15.9, 3.2 Hz, 1H), 5.15-5.10 (m, 1H), 4.57 (d, $J$ = 2.9 Hz, 1H), 2.26 (d, $J$ = 3.2 Hz, 3H); $^{13}$C NMR (150 MHz, $CDCl_3$) $\delta$ 151.1, 141.8, 140.7, 134.3, 130.4, 130.3, 130.2, 128.8, 129.2 (q, $J$ = 31.8 Hz), 128.7, 128.6, 128.5, 126.9, 126.5, 125.5 (q, $J$ = 3.74 Hz), 124.2 (q, $J$ = 271.4 Hz), 116.2, 48.4, 20.7; $^{19}$F NMR (565 MHz, $CDCl_3$) δ -62.41; HRMS (EI) *m/z* calcd for $C_{23}H_{19}F_3O$ ($M^+$): 368.1388, found: 368.1388.

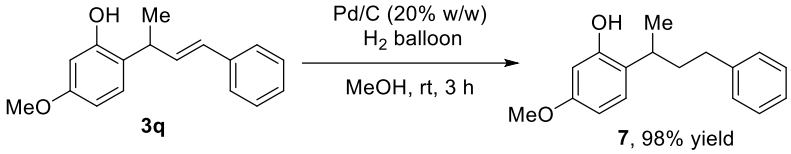
### 3.3 Incompatible substrate

In addition to the results we presented, we also tested other functional groups on the phenolic hydroxyl group, including *p*-toluenesulfonyl (Ts), mesyl (Ms), *tert*-butyldimethylsilyl (TBDMS), and a simple methyl group. These compounds were inert in our metal-free coupling reaction. Furthermore, aryl boronic acids, such as phenylboronic acid and benzofuran-2-boronic acid, exhibited low reactivity. Cyclopropylboronic acid, as well as phenylstyrylboronic ester, were also not tolerated in our reaction. The list of incompatible substrates is provided below.



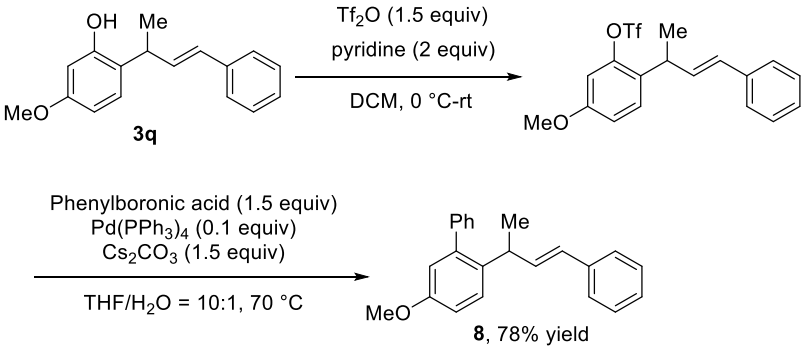

## 4. Product transformations

### 4.1 Hydrogenation




To a solution of compound **3q** (0.2 mmol, 50.8 mg) in MeOH (2 mL) was added Pd/C (20% w/w). The mixture was degassed and charged with a hydrogen balloon, followed by stirring at room temperature for 2 h. After the consumption of **7**, the reaction was filtered, concentrated, and purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/10) to deliver alkylphenol **g** (50.2 mg, 98% yield). $^{1}$H NMR (600 MHz, $CDCl_3$) δ 7.22-7.16 (m, 2H), 7.12-7.06 (m, 3H), 7.00 (d, *J* = 8.5 Hz, 1H), 6.42 (dd, *J* = 8.5, 2.4 Hz, 1H), 6.28 (d, *J* = 2.4 Hz, 1H), 4.61 (s, 1H), 3.69 (s, 3H), 2.87 (q, *J* = 7.0 Hz, 1H), 2.54-2.42 (m, 2H), 1.94-1.74 (m, 2H), 1.18 (d, *J* = 6.8 Hz, 3H). $^{13}$C NMR (151 MHz, $CDCl_3$) δ 158.6, 153.8, 142.6, 128.4, 128.4, 127.7, 125.7, 125.0, 106.3, 101.8, 55.3, 38.9, 33.9, 31.4, 21.2. HRMS (ESI) *m/z* calcd for $C_{17}H_{20}O_2$ ($M^-$): 256.1463, found: 255.1389.

### 4.2 Triflation/Suzuki-Miyaura coupling

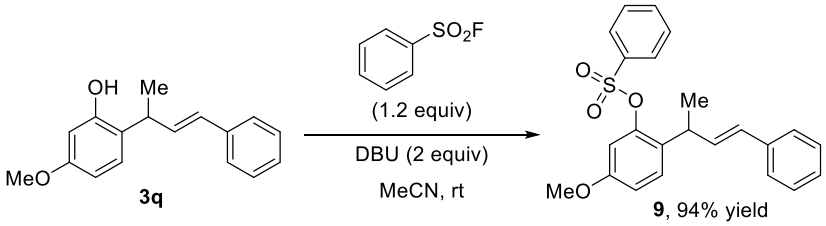



To a solution of compound **3q** (0.2 mmol, 50.8 mg) and pyridine (2 equiv, 0.4 mmol, 67 μL) in DCM (5 mL) was stirred at 0 °C, and $Tf_2O$ was added (1.5 equiv, 0.3 mmol, 32 μL) dropwise. The mixture was moved to room temperature and stirred for 0.5 h. The reaction was quenched with water and diluted with ethyl acetate. After extraction, the combined organic layer was dried and concentrated to crude triflate. The residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/20) and used for the next coupling reaction.

To an oven-dried Schlenk tube equipped with a stir bar was added triflate product and phenylboronic acid (1.5 equiv, 0.3 mmol, 36 mg), $Pd(PPh_3)_4$ (0.1 equiv, 0.02 mmol, 22 mg), $Cs_2CO_3$ (1.5 equiv, 0.3 mmol, 98 mg) in THF/$H_2O$ (10/1, 2 mL). The tube was evacuated and backfilled with nitrogen three times. The resulting mixture was heated to 70 °C for 12 h. After completion, the mixture was filtered through celite and concentrated. The crude residue was purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/50) to give coupling product **8** (49 mg, 78% yield) of two steps. $^{1}$H NMR (600 MHz, $CDCl_3$) δ 7.36-7.32 (m, 2H), 7.31-7.25 (m, 3H), 7.24-7.16 (m, 5H), 7.12-7.08 (m, 1H), 6.85 (dd, *J* = 8.6, 2.8 Hz, 1H), 6.70 (d, *J* = 2.8 Hz, 1H), 6.26 (dd, *J* = 16.0, 6.0 Hz, 1H), 6.09 (dd, *J* = 16.0, 1.7 Hz, 1H), 3.73 (s, 3H), 3.66-3.59

(m, 1H), 1.25 (d, *J* = 7.0 Hz, 3H). $^{13}$C NMR (151 MHz, $CDCl_3$) δ 157.3, 142.6, 141.7, 137.7, 136.0, 135.2, 129.3, 128.5, 128.3, 128.1, 128.1, 127.0, 126.9, 126.1, 115.0, 113.8, 55.3, 37.3, 21.8. HRMS (EI) *m/z* calcd for $C_{23}H_{22}O$ ($M^+$): 314.1671, found: 314.1657.

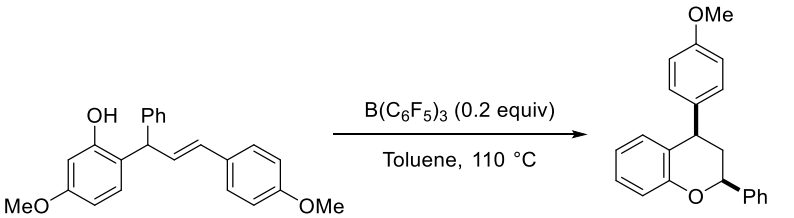
### 4.3 SuFEx reaction




**3q** **9**, 94% yield

To a solution of compound **3q** (0.2 mmol, 50.8 mg) in MeCN was added phenylsulfonyl fluoride (1.2 equiv, 0.24 mmol, 29 μL) and DBU (2 equiv, 0.4 mmol, 60 μL). The mixture was stirred at room temperature for overnight. After completion, the resulting mixture was concentrated and purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/20) to give the product **9** (74 mg, 94% yield). $^1$H NMR (600 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.6 Hz, 2H), 7.57 (t, *J* = 7.6 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 7.19 (d, *J* = 4.3 Hz, 4H), 7.11 (q, *J* = 4.3 Hz, 1H), 7.05 (d, *J* = 8.7 Hz, 1H), 6.71 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.58 (d, *J* = 2.5 Hz, 1H), 6.17-6.11 (m, 1H), 5.99 (dd, *J* = 16.0, 6.0 Hz, 1H), 3.66 (q, *J* = 7.0 Hz, 1H), 3.63 (s, 3H), 1.14 (d, *J* = 7.0 Hz, 3H). $^{13}$C NMR (151 MHz, $CDCl_3$) δ 158.4, 147.5, 137.4, 136.0, 134.3, 133.8, 130.4, 129.3, 129.0, 128.55, 128.53, 128.49, 127.11, 126.15, 113.69, 107.65, 55.50, 34.38, 20.40. $^{13}$C NMR (151 MHz, $CDCl_3$) δ 158.40, 147.53, 137.42, 136.00, 134.28, 133.80, 130.44, 129.29, 128.99, 128.6, 128.5, 128.5, 127.1, 126.1, 113.7, 107.6, 55.5, 34.4, 20.4. HRMS (ESI) *m/z* calcd for $C_{23}H_{22}O_4SNa$ ($M^+$): 417.1131, found: 417.1132.

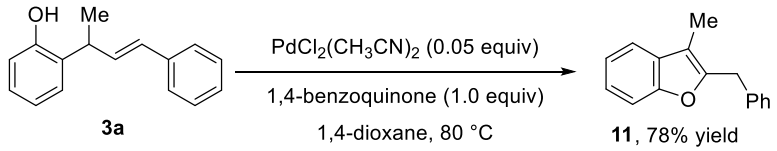
### 4.4 Intramolecular cyclization




**3o** **10**, 92% yield, 3:1 dr

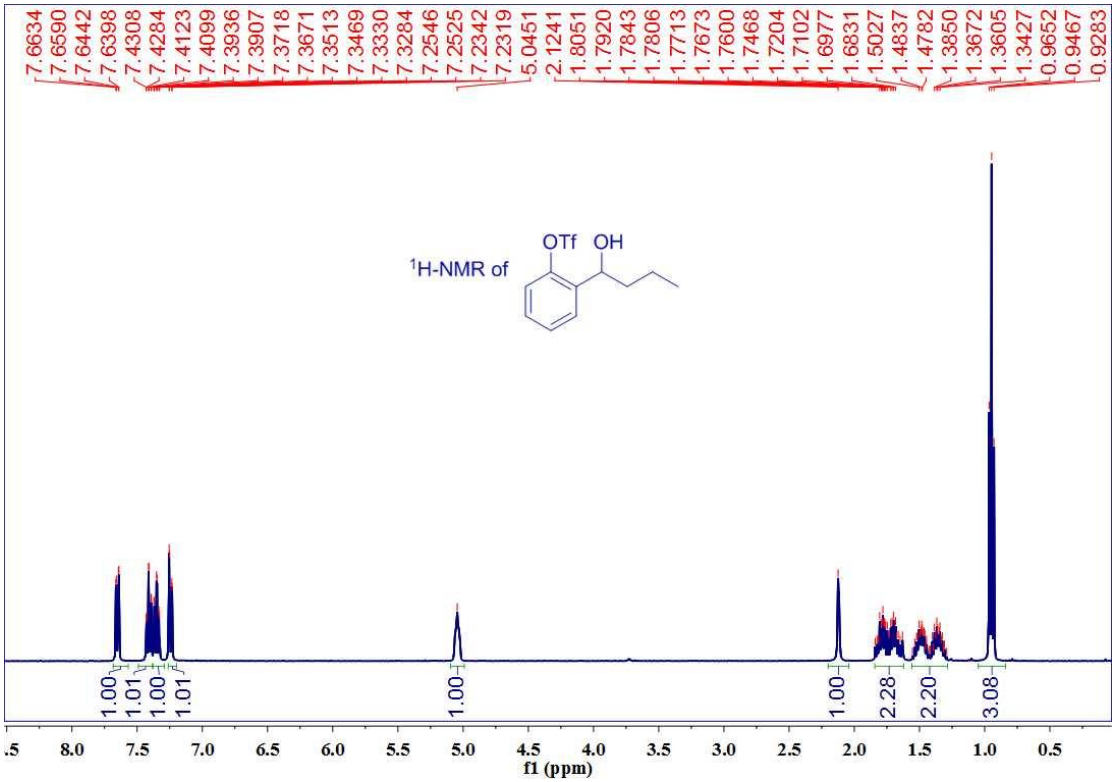
To a solution of compound **3o** (0.2 mmol, 63.2 mg) in toluene (2 mL) was added $B(C_6F_5)_3$ (0.2 equiv, 0.04 mmol, 10.2 mg) and was heated at 110 °C for 8 h. The resulting mixture was directly purified by flash chromatography on silica gel (EtOAc/petroleum ether = 1/50) to give chroman **10** (58 mg, 92% yield) with a 3:1 diastereomer ratio. $^1$H NMR (600 MHz, $CDCl_3$) δ 7.35-7.30 (m, 2H), 7.27-7.21 (m, 2H), 7.20-7.13 (m, 4H), 6.87-6.83 (m, 3H), 6.74-6.67 (m, 2H), 5.08 (dd, *J* = 11.8, 1.9 Hz, 1H), 4.27 (dd, *J* = 12.2, 5.9 Hz, 1H), 3.74 (s, 3H), 2.30 (ddd, *J* = 13.7, 5.9, 1.9 Hz, 1H), 2.21 (dt, *J* = 13.7, 11.8 Hz, 1H). $^{13}$C NMR (151 MHz, $CDCl_3$) δ 159.5, 155.6, 144.6, 133.3, 129.8, 128.7, 128.6, 127.8, 127.5, 126.8, 125.7, 120.5, 117.0, 114.0, 77.8, 55.4, 43.6, 40.4. HRMS (EI) *m/z* calcd for $C_{22}H_{20}O_2$ ($M^+$): 316.1463, found: 316.1453.

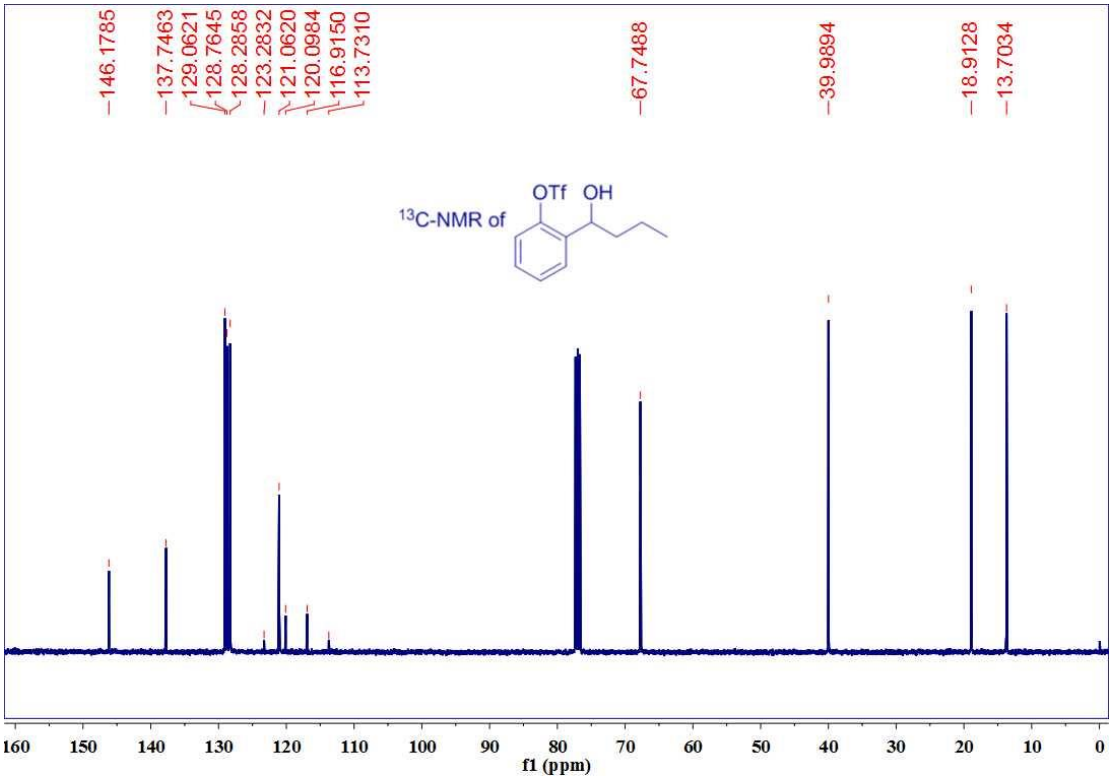
## 4.5 Oxidation cyclization

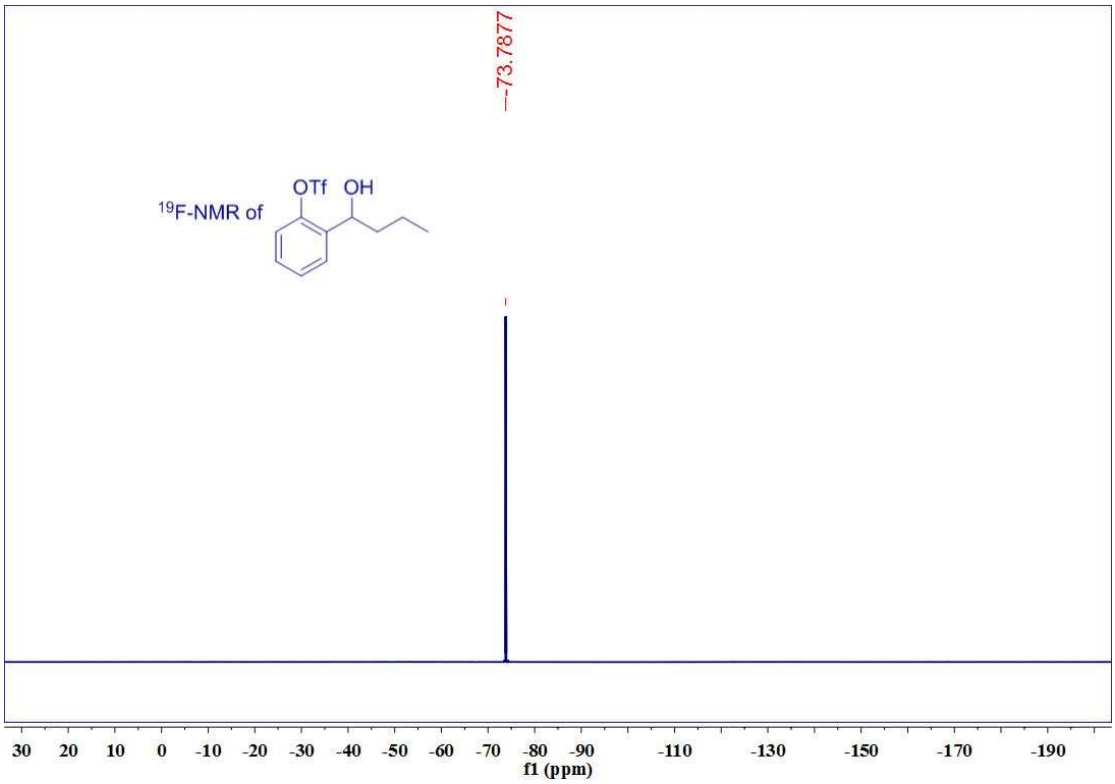



To a solution of compound **3a** (0.13 mmol, 29.0 mg) in 1,4-dioxane (1 mL) was added $PdCl_2(CH_3CN)_2$ (0.05 equiv, 0.0065 mmol, 1.7 mg) and 1,4-benzoquinone (1.0 equiv, 0.13 mmol, 14 mg). The mixture was heated at 80 °C and stirred at room temperature for 2 h. After completion, the dark solution was filtered by celite and the filtrate was concentrated. The residue was directly purified by flash chromatography on silica gel (DCM/petroleum ether = 1/100) to afford benzofuran **11** (58 mg, 82% yield). $^1$H NMR (600 MHz, $CDCl_3$) δ ppm 7.40-7.35 (m, 1H), 7.30-7.26 (m, 1H), 7.21 (t, *J* = 7.8 Hz, 2H), 7.17 (d, *J* = 7.8 Hz, 2H), 7.16-7.10 (m, 3H), 4.02 (s, 2H), 2.15 (d, *J* = 1.7 Hz, 3H). $^{13}$C NMR (151 MHz, $CDCl_3$) δ ppm 154.1, 152.2, 138.0, 130.3, 128.6, 128.5, 126.5, 123.5, 122.1, 118.9, 110.8, 110.8, 32.6, 8.1. HRMS (EI) *m/z* calcd for $C_{16}H_{14}O$ ($M^+$): 222.1045, found: 222.1034.

# 5. NMR spectra




-73.7877
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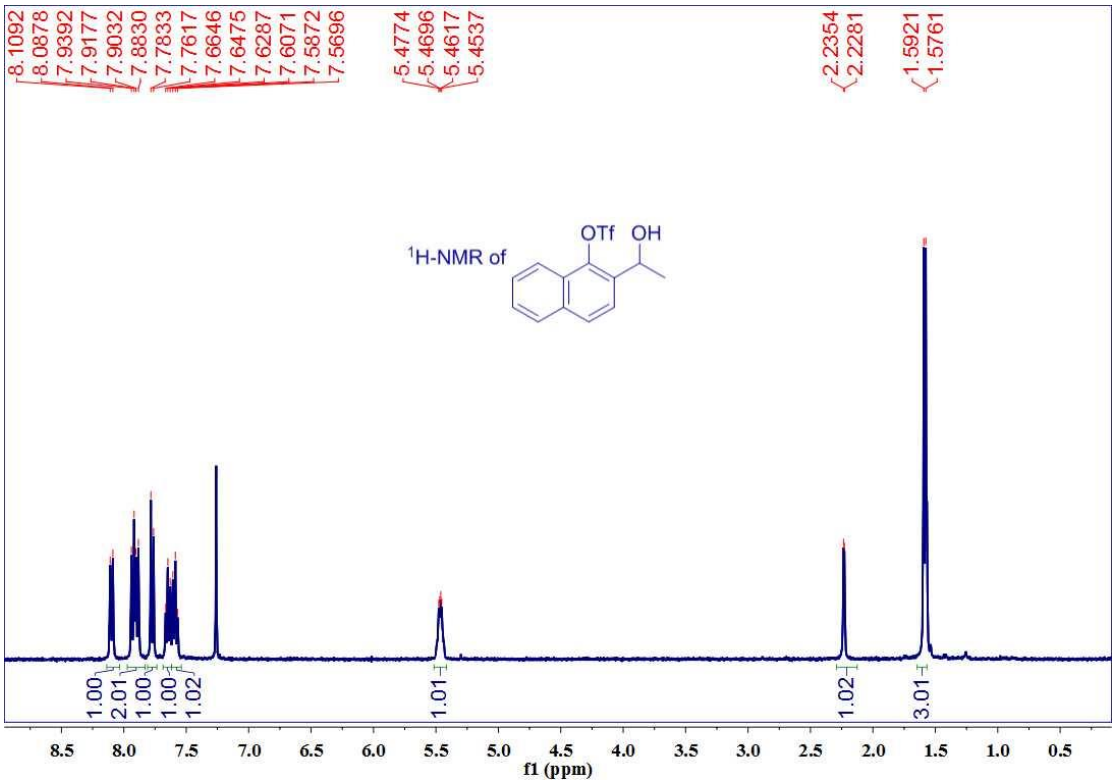
OTf
OH
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)


8.1092
8.0878
7.9392
7.9177
7.9032
7.8830
7.7833
7.7617
7.6646
7.6475
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7.6071
7.5872
7.5696
5.4774
5.4696
5.4617
5.4537
2.2354
2.2281
1.5921
1.5761
1H-NMR of
OTf
OH
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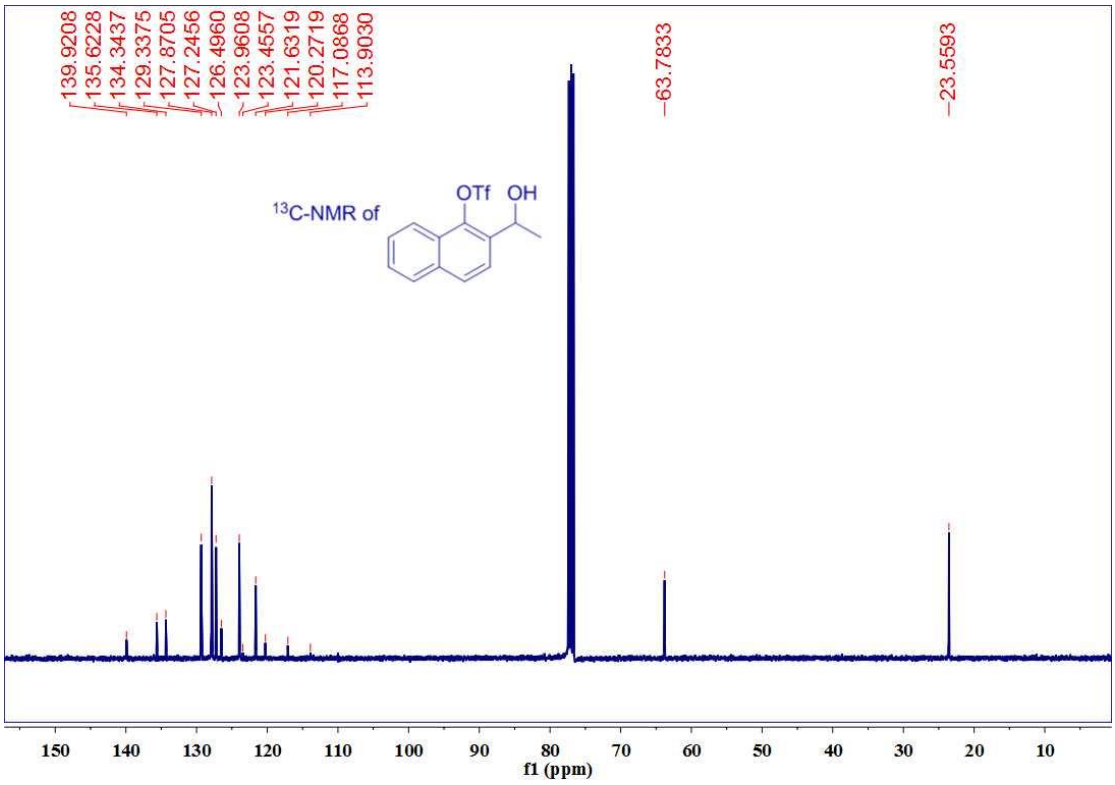
1.00
1.00
1.02
1.01
1.02
3.01
f1 (ppm)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134.3437
129.3375
127.8705
127.2456
126.4960
123.9608
123.4557
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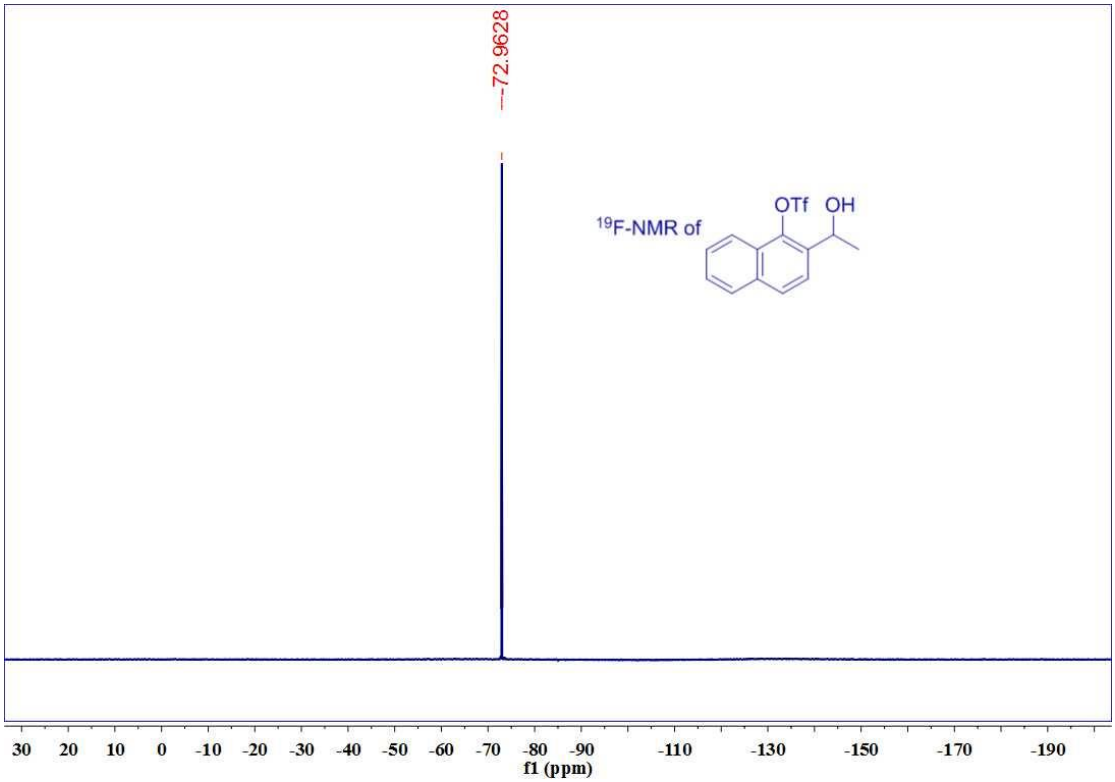
120.2719
117.0868
113.9030
63.7833
23.5593
13C-NMR of
OTf
OH
f1 (ppm)


-72.9628
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OTf
OH
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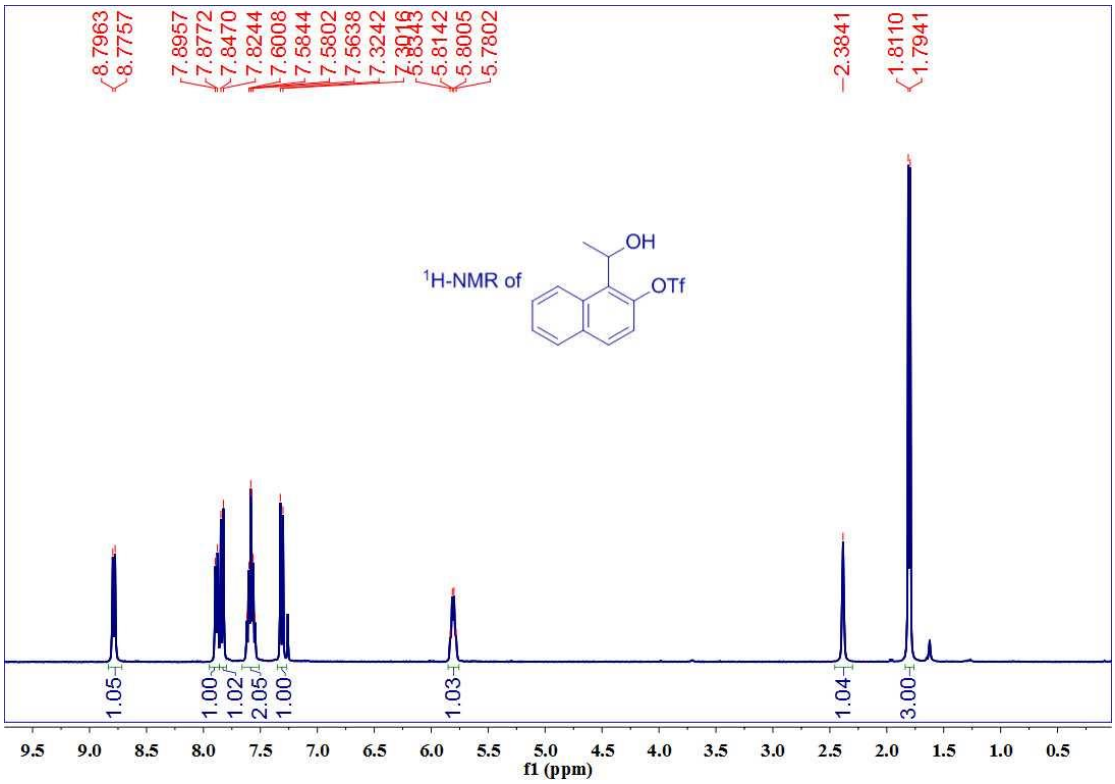
f1 (ppm)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7.8957
7.8772
7.8470
7.8244
7.6008
7.5844
7.5802
7.5638
7.3242
5.8142
5.8005
5.7802
2.3841
1.8110
1.7941
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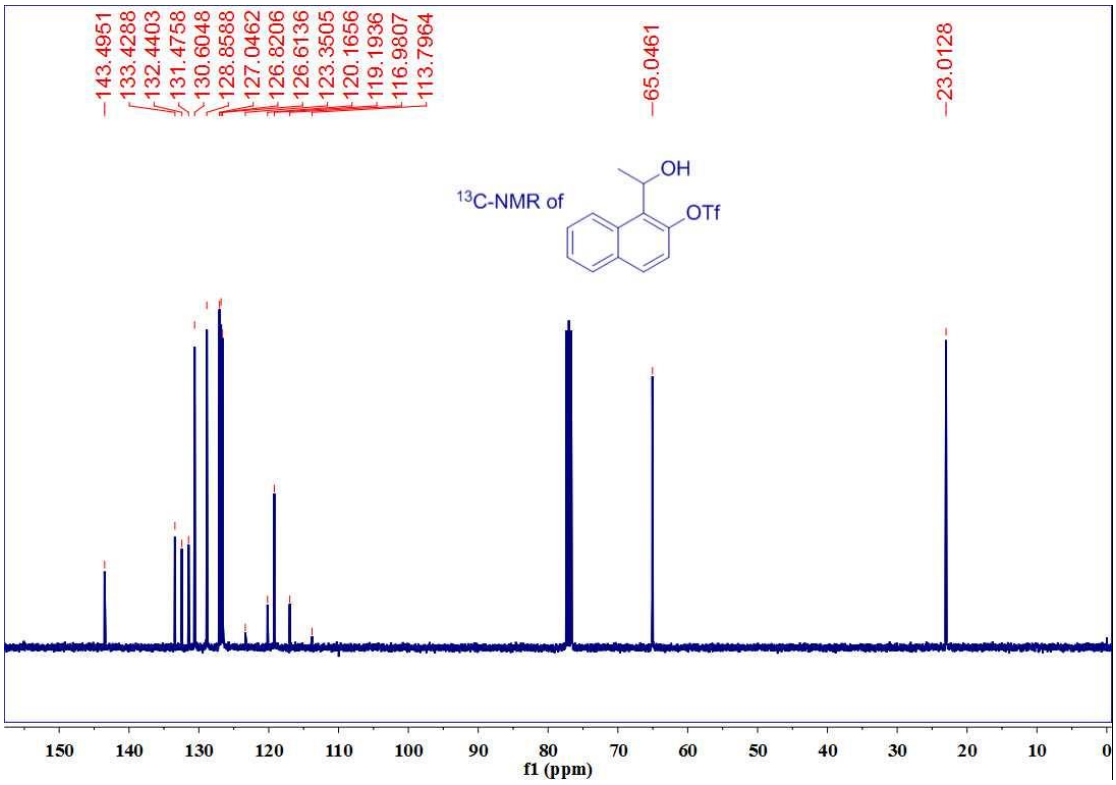
OTf
1H-NMR of
1.05
1.00
1.02
2.05
1.00
1.03
1.04
3.00
f1 (ppm)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132.4403
131.4758
130.6048
128.8588
127.0462
126.8206
126.6136
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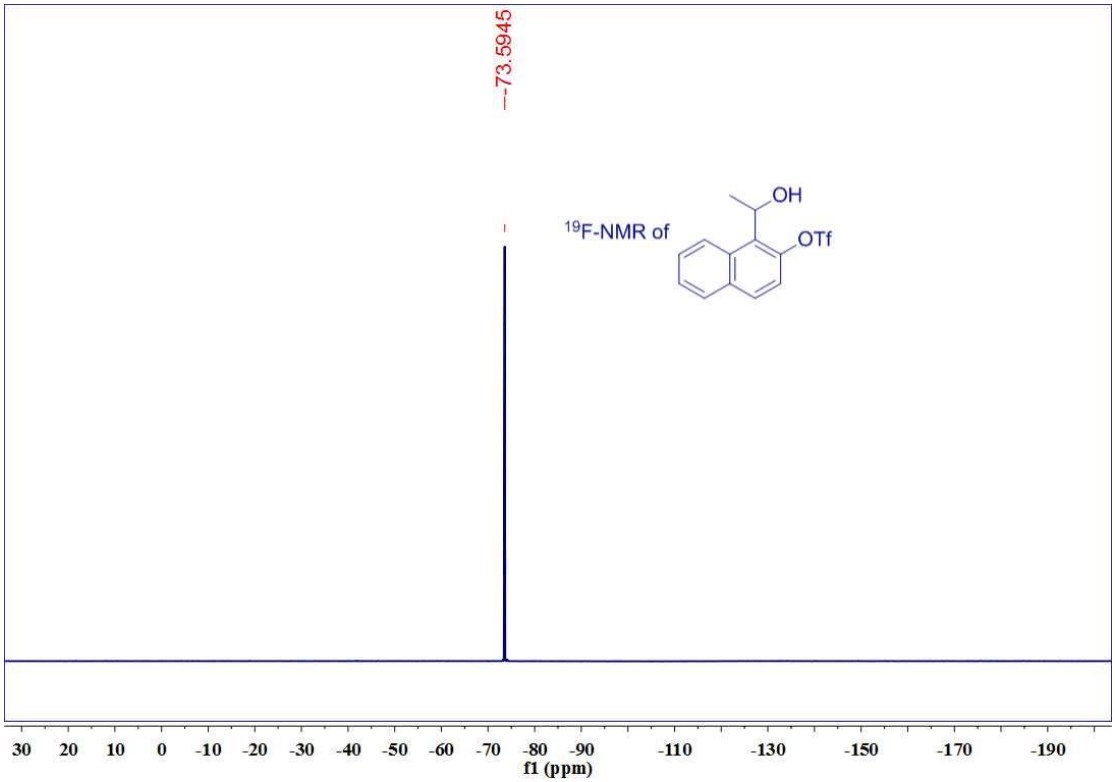
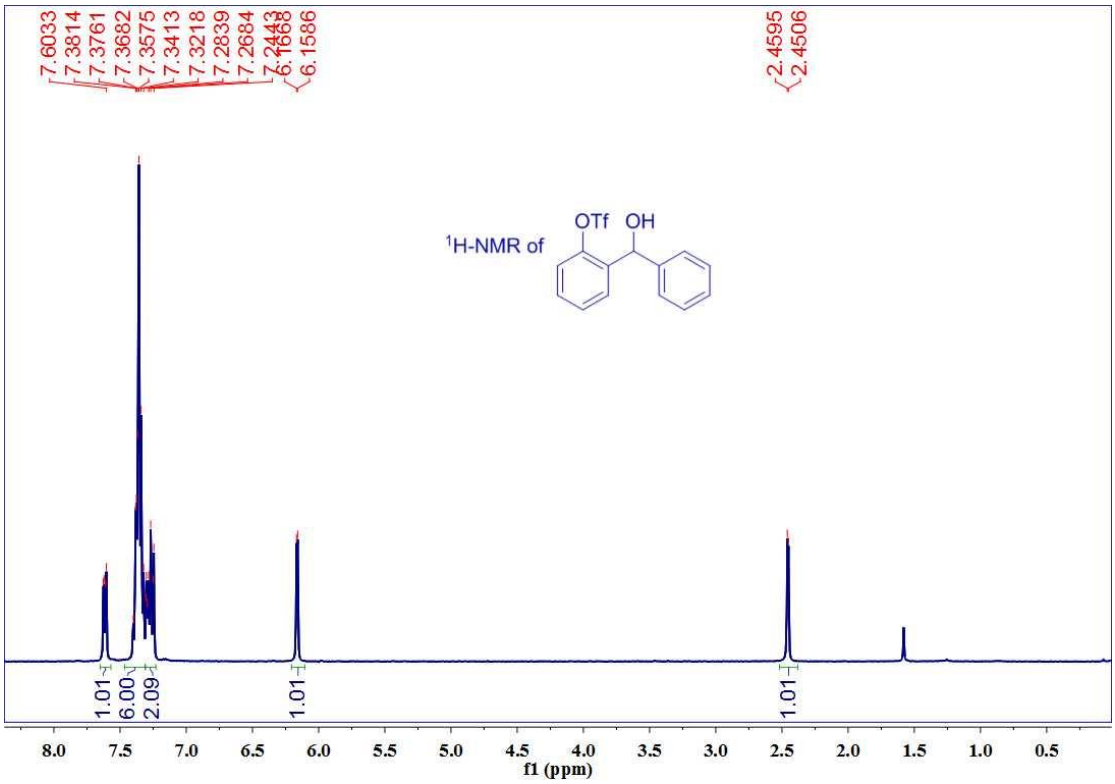
120.1656
119.1936
116.9807
113.7964
65.0461
23.0128
OH
OTf
13C-NMR of
f1 (ppm)


-73.5945
$^{19}$F-NMR of
OH
OTf
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)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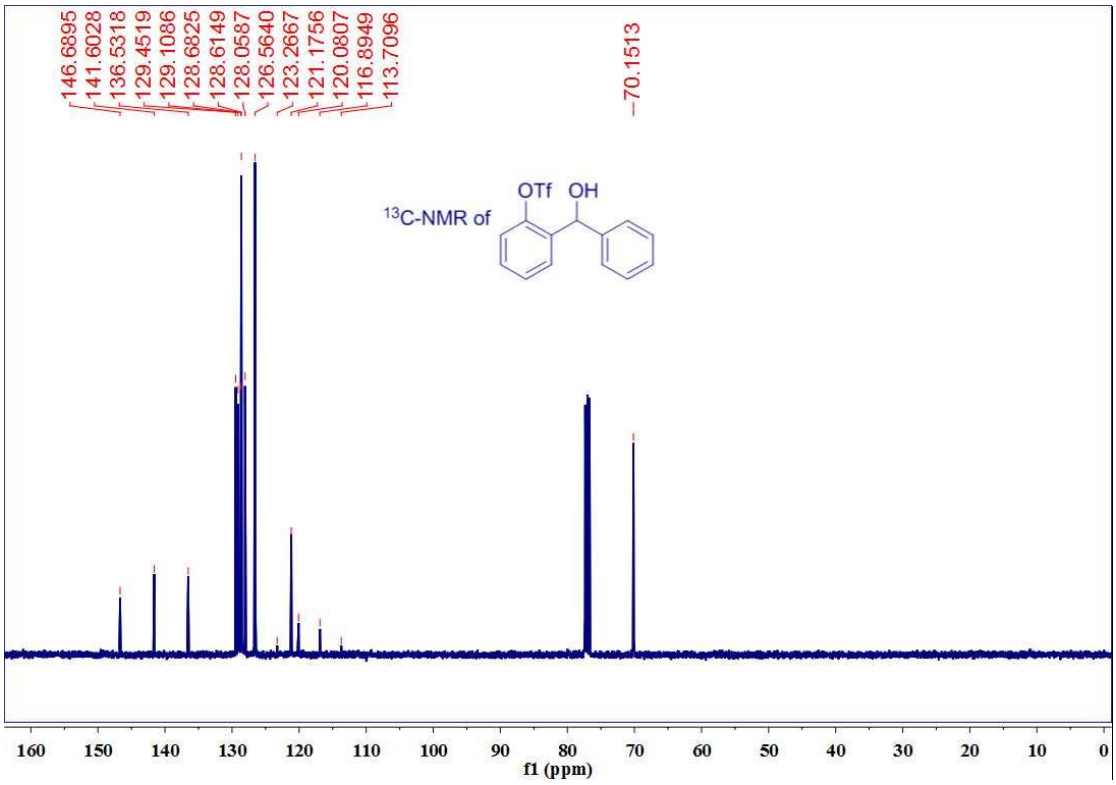
7.3814
7.3761
7.3682
7.3575
7.3413
7.3218
7.2839
7.2684
6.1668
6.1586
2.4595
2.4506
1H-NMR of
OTf OH
1.01
6.00
2.09
1.01
1.01
f1 (ppm)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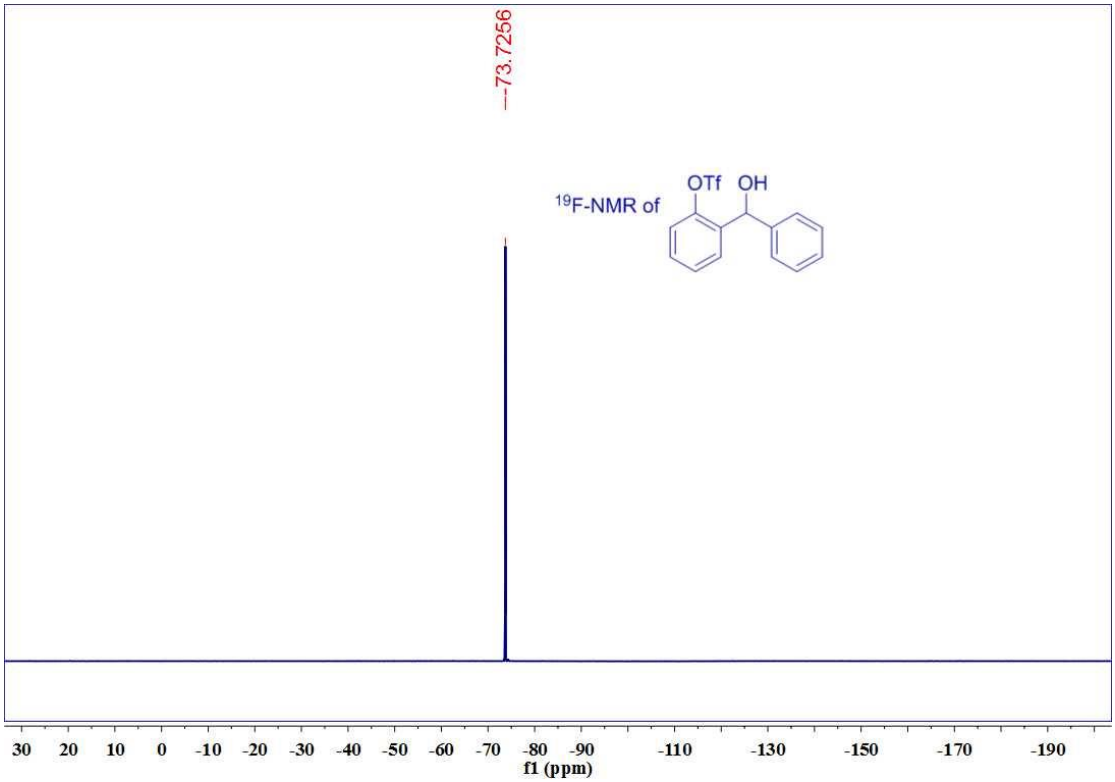
141.6028
136.5318
129.4519
129.1086
128.6825
128.6149
128.0587
126.5640
123.2667
121.1756
120.0807
116.8949
113.7096
70.1513
13C-NMR of
OTf OH
f1 (ppm)


-73.7256
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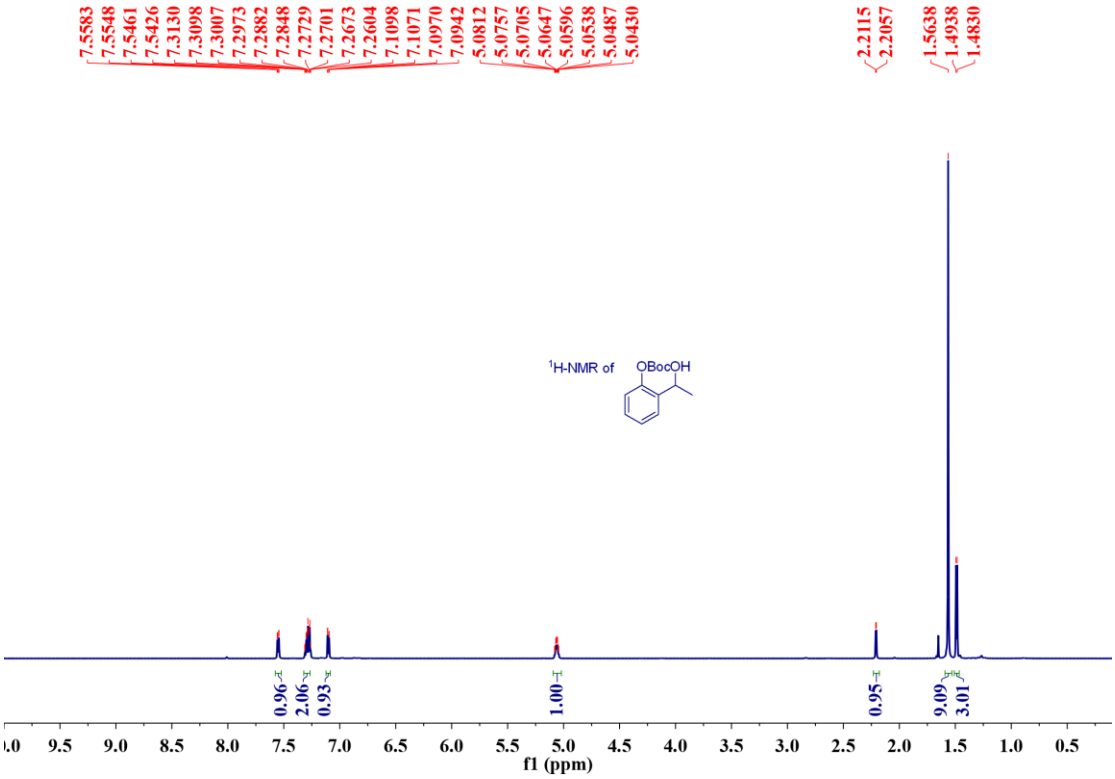
OTf
OH
30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -110 -130 -150 -170 -190
f1 (ppm)


7.5583
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7.5426
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7.3098
7.3007
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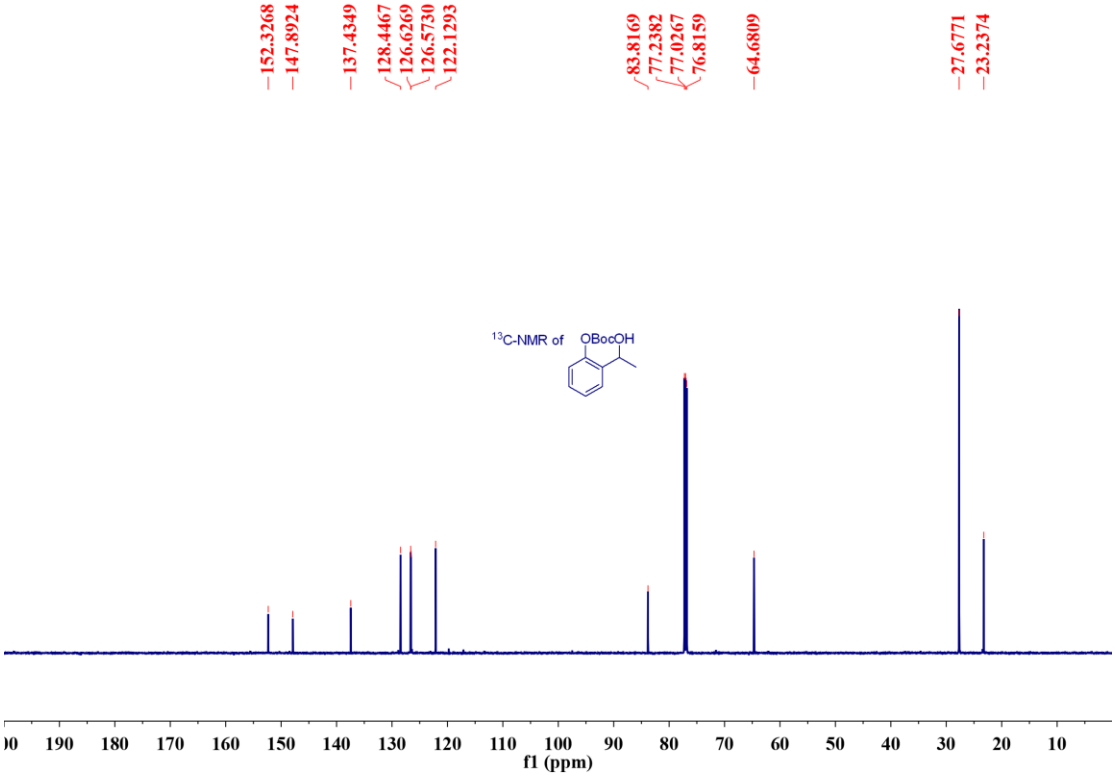
7.2701
7.2673
7.2604
7.1098
7.1071
7.0970
7.0942
5.0812
5.0757
5.0705
5.0647
5.0596
5.0538
5.0487
5.0430
2.2115
2.2057
1.5638
1.4938
1.4830
1H-NMR of
OBocOH
0.96
2.06
0.93
1.00
0.95
9.09
3.01
f1 (ppm)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147.8924
137.4349
128.4467
126.6269
126.5730
122.1293
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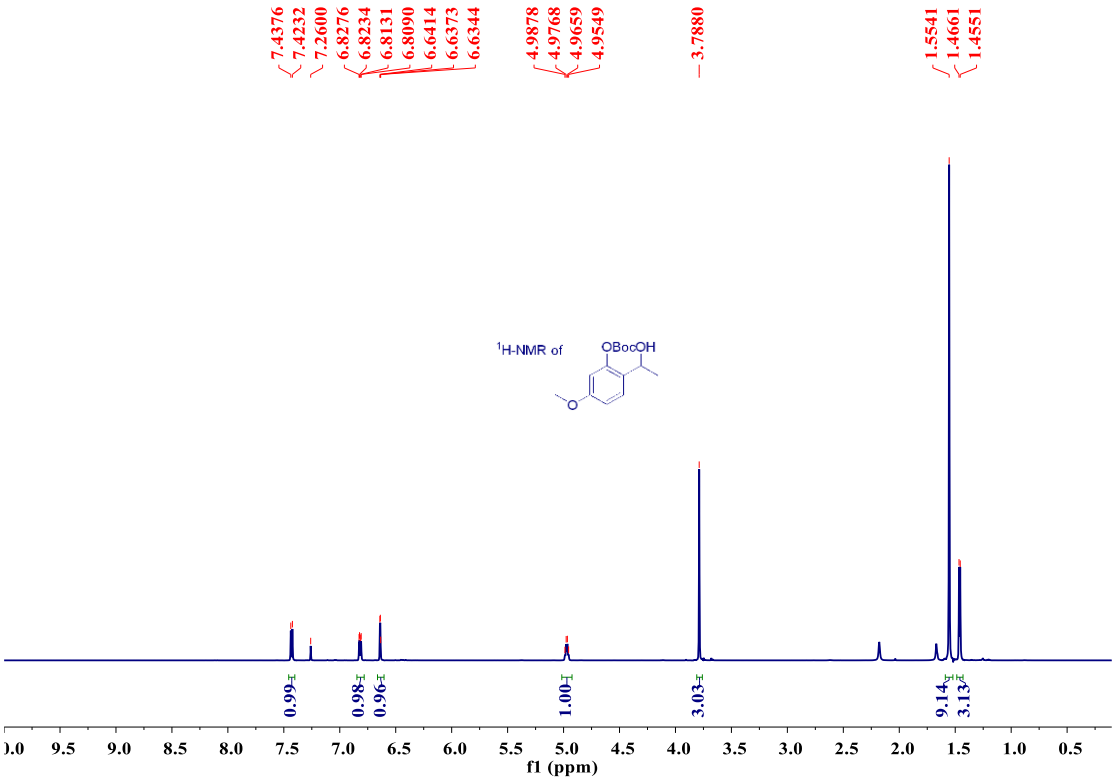
77.2382
77.0267
76.8159
64.6809
27.6771
23.2374
13C-NMR of
OBocOH
f1 (ppm)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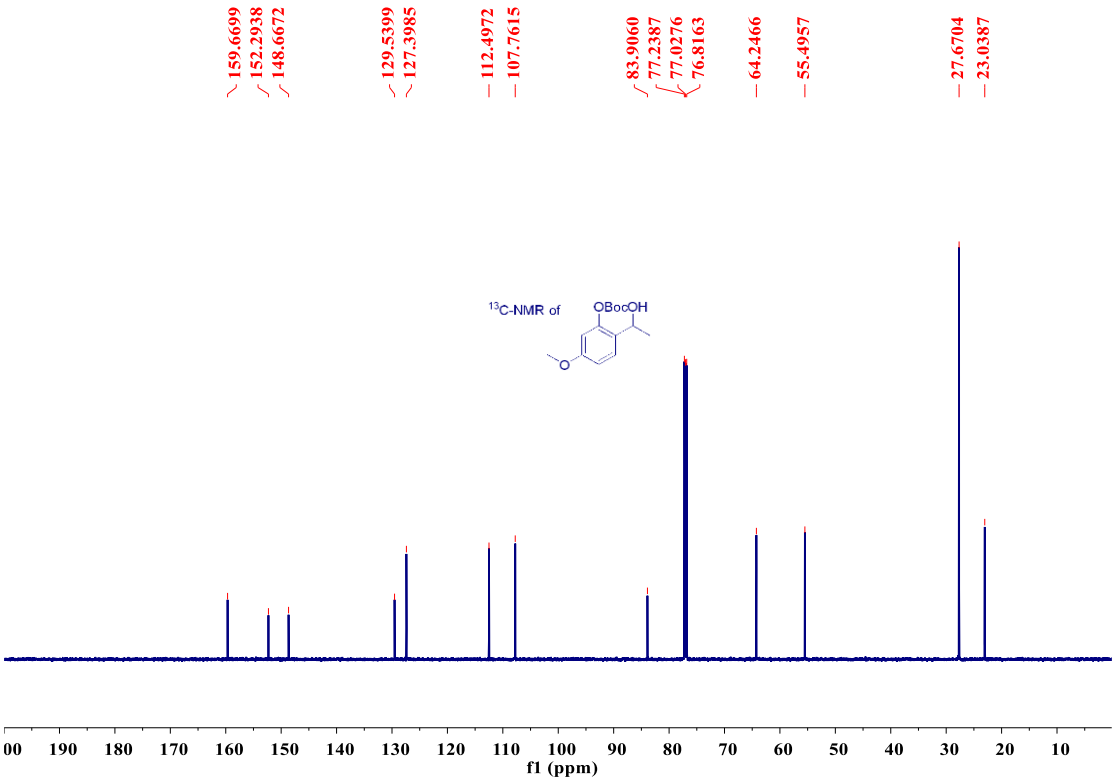
4.9768
4.9659
4.9549
3.7880
1.5541
1.4661
1.4551
$^{1}$H-NMR of
OBocOH
O
0.99
0.98
0.96
1.00
3.03
9.14
3.13
f1 (ppm)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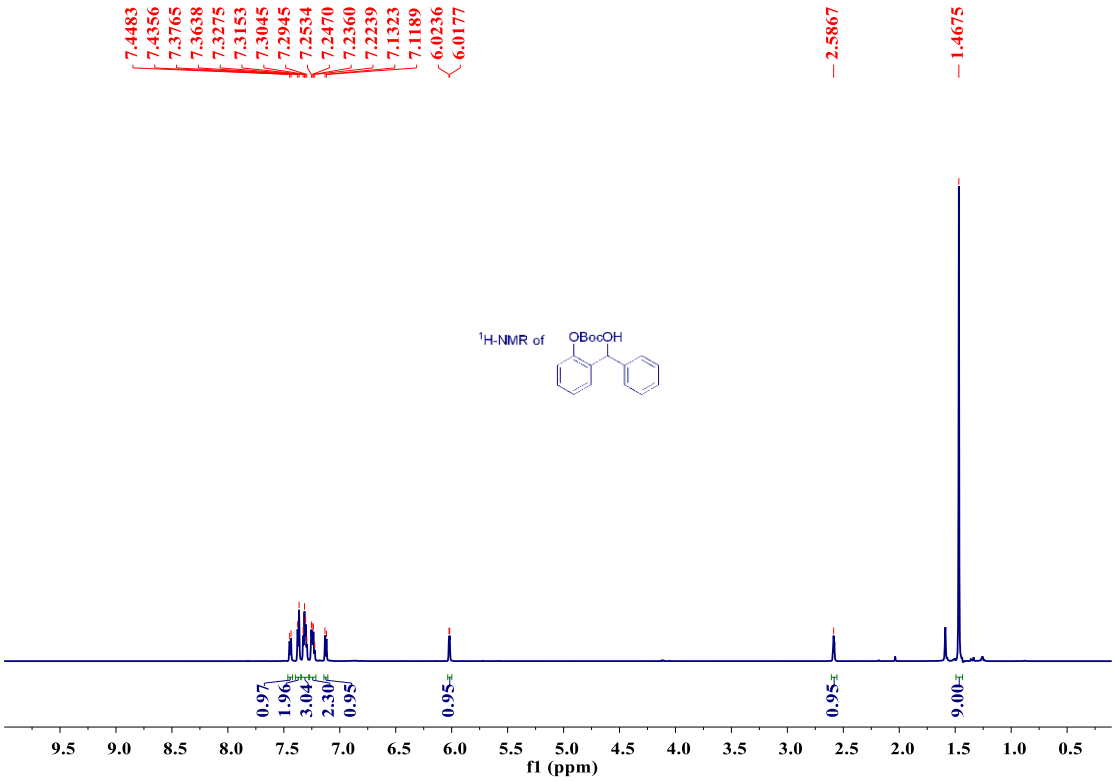
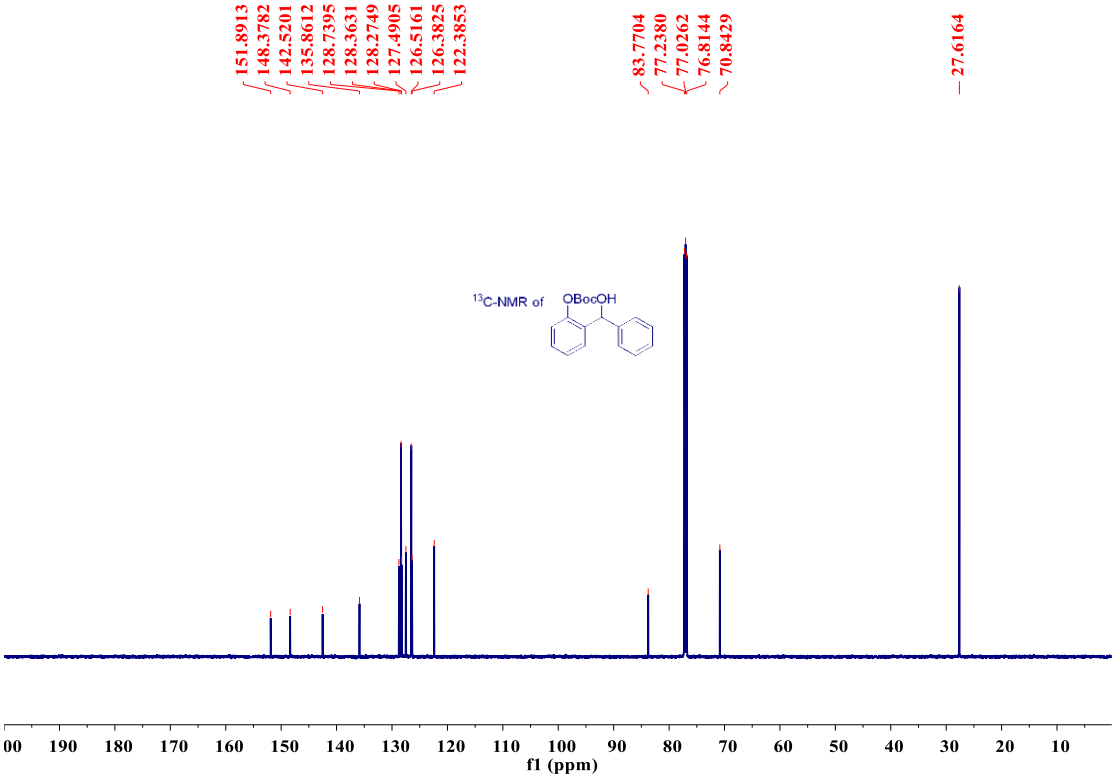
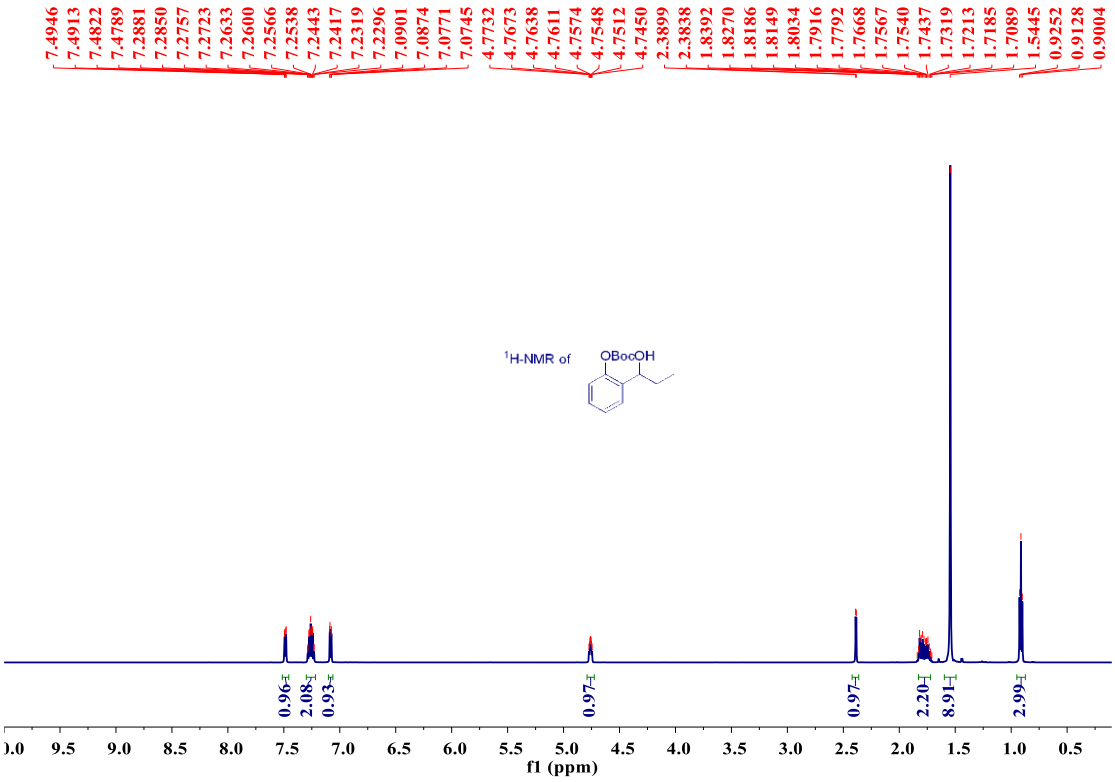
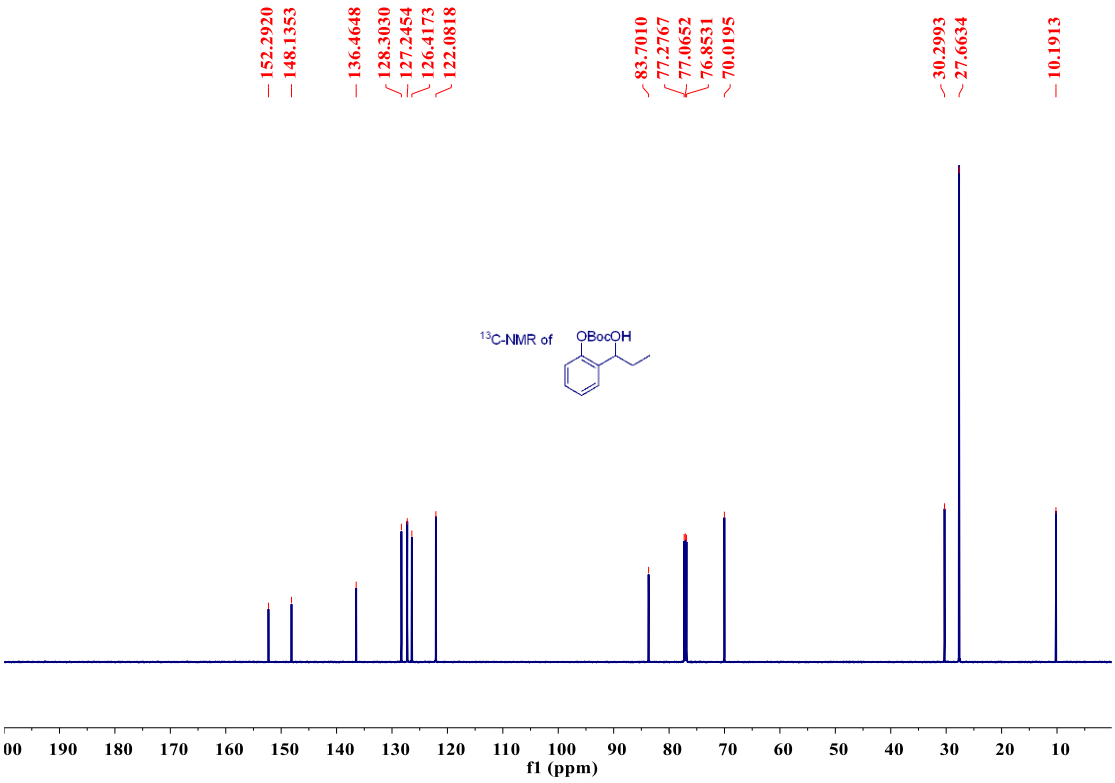
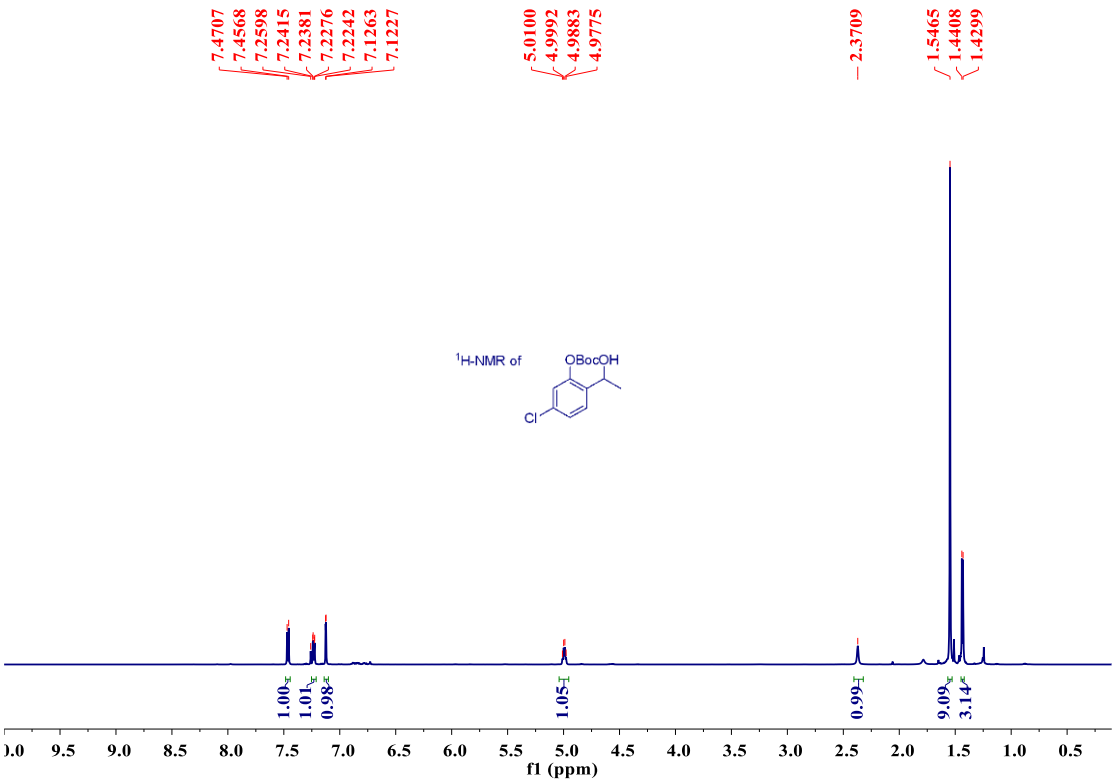
148.6672
129.5399
127.3985
112.4972
107.7615
83.9060
77.2387
77.0276
76.8163
64.2466
55.4957
27.6704
23.0387
$^{13}$C-NMR of
OBocOH
O
f1 (ppm)

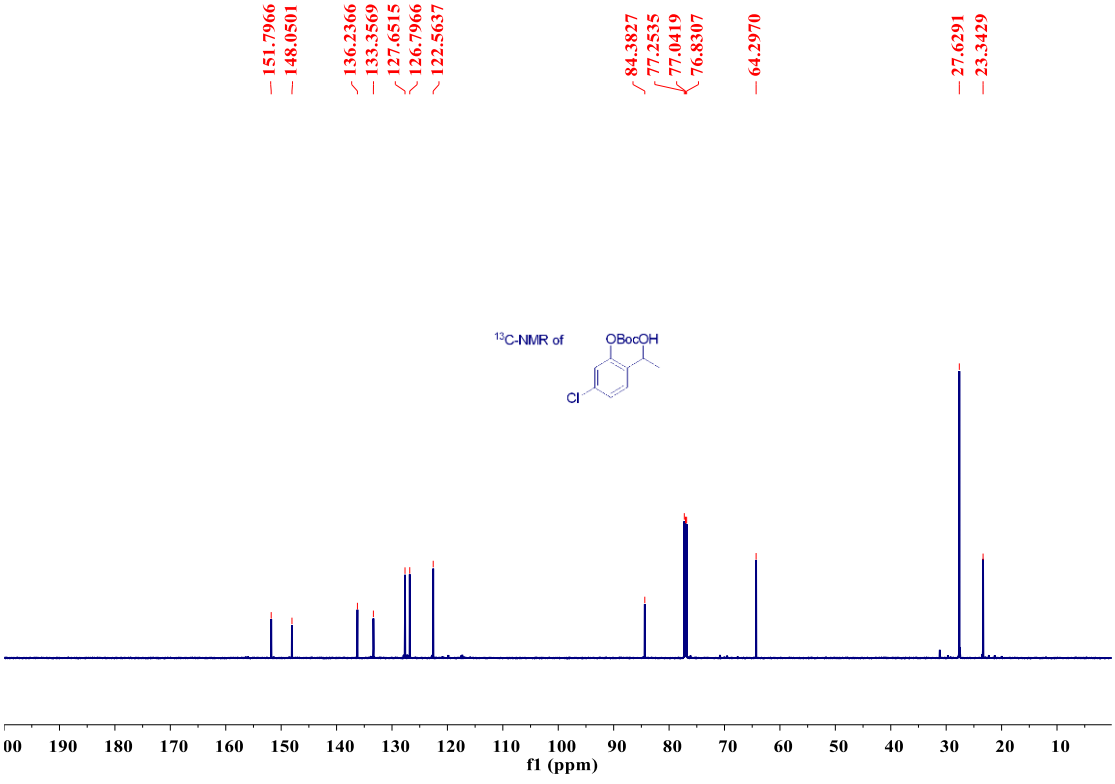

7.4483
7.4356
7.3765
7.3638
7.3275
7.3153
7.3045
7.2945
7.2534
7.2470
7.2360
7.2239
7.1323
7.1189
6.0236
6.0177
2.5867
1.4675
$^{1}$H-NMR of
OBocOH
0.97
1.96
3.04
2.30
0.95
0.95
0.95
9.00
f1 (ppm)

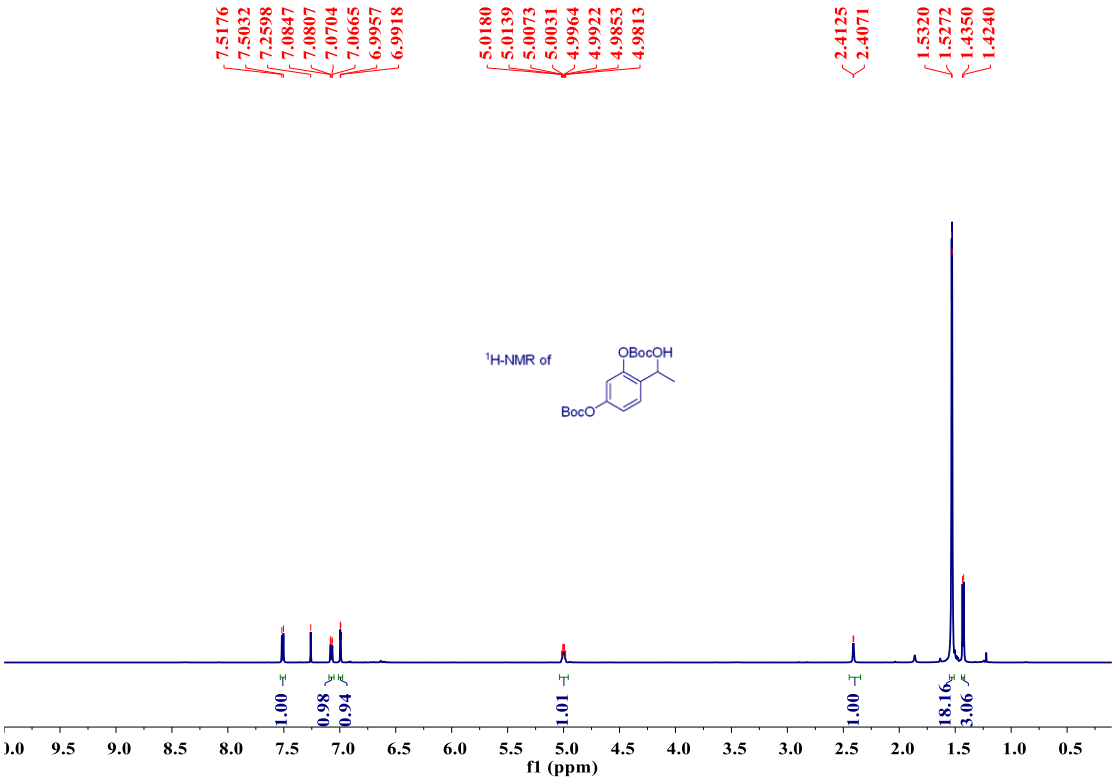

151.8913
148.3782
142.5201
135.8612
128.7395
128.3631
128.2749
127.4905
126.5161
126.3825
122.3853
83.7704
77.2380
77.0262
76.8144
70.8429
27.6164
$^{13}$C-NMR of
OBocOH
f1 (ppm)


7.4946
7.4913
7.4822
7.4789
7.2881
7.2850
7.2757
7.2723
7.2633
7.2600
7.2566
7.2538
7.2443
7.2417
7.2319
7.2296
7.0901
7.0874
7.0771
7.0745
4.7732
4.7673
4.7638
4.7611
4.7574
4.7548
4.7512
4.7450
2.3899
2.3838
1.8392
1.8270
1.8186
1.8149
1.8034
1.7916
1.7792
1.7668
1.7567
1.7540
1.7437
1.7319
1.7213
1.7185
1.7089
1.5445
0.9252
0.9128
0.9004
1H-NMR of
OBocOH
0.96
2.08
0.93
0.97
0.97
2.20
8.91
2.99
f1 (ppm)


152.2920
148.1353
136.4648
128.3030
127.2454
126.4173
122.0818
83.7010
77.2767
77.0652
76.8531
70.0195
30.2993
27.6634
10.1913
13C-NMR of
OBocOH
f1 (ppm)


7.4707
7.4568
7.2598
7.2415
7.2381
7.2276
7.2242
7.1263
7.1227
5.0100
4.9992
4.9883
4.9775
2.3709
1.5465
1.4408
1.4299
1H-NMR of
OBocOH
Cl
1.00
1.01
0.98
1.05
0.99
9.09
3.14
f1 (ppm)


151.7966
148.0501
136.2366
133.3569
127.6515
126.7966
122.5637
84.3827
77.2535
77.0419
76.8307
64.2970
27.6291
23.3429
13C-NMR of
OBocOH
Cl
f1 (ppm)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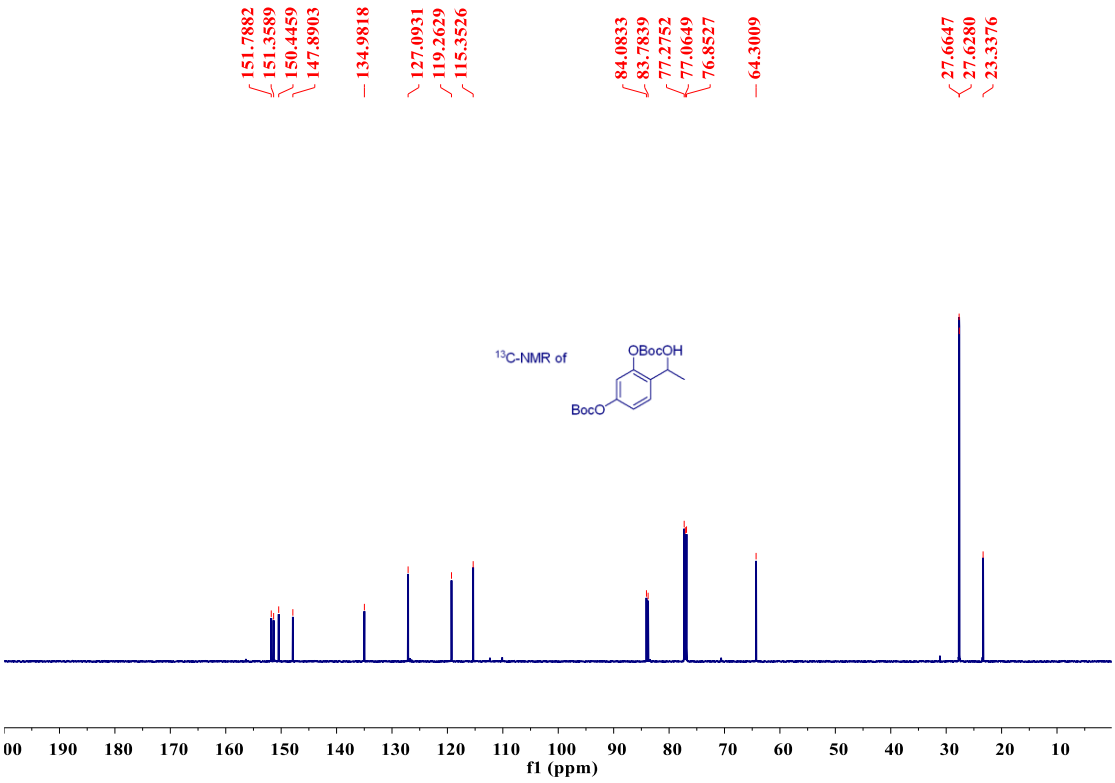
7.5032
7.2598
7.0847
7.0807
7.0704
7.0665
6.9957
6.9918
5.0180
5.0139
5.0073
5.0031
4.9964
4.9922
4.9853
4.9813
2.4125
2.4071
1.5320
1.5272
1.4350
1.4240
1H-NMR of
OBocOH
BocO
1.00
0.98
0.94
1.01
1.00
18.16
3.06
f1 (ppm)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151.3589
150.4459
147.8903
134.9818
127.0931
119.2629
115.3526
84.0833
83.7839
77.2752
77.0649
76.8527
64.3009
27.6647
27.6280
23.3376
13C-NMR of
OBocOH
BocO
f1 (ppm)


7.5117
7.4995
7.2056
7.2035
7.1976
7.1779
7.1764
7.1699
7.1651
7.1636
7.1565
5.1952
5.1842
4.2313
4.2283
4.2194
4.2166
4.2145
4.2076
4.2055
4.2027
4.1939
4.1908
4.1689
4.1605
4.1573
4.1556
4.1485
4.1458
4.1437
4.1367
4.1344
4.1317
4.1226
3.5976
1.4644
1.4643
1.4534
1.3524
1.3505
1.3406
1.3387
1.3288
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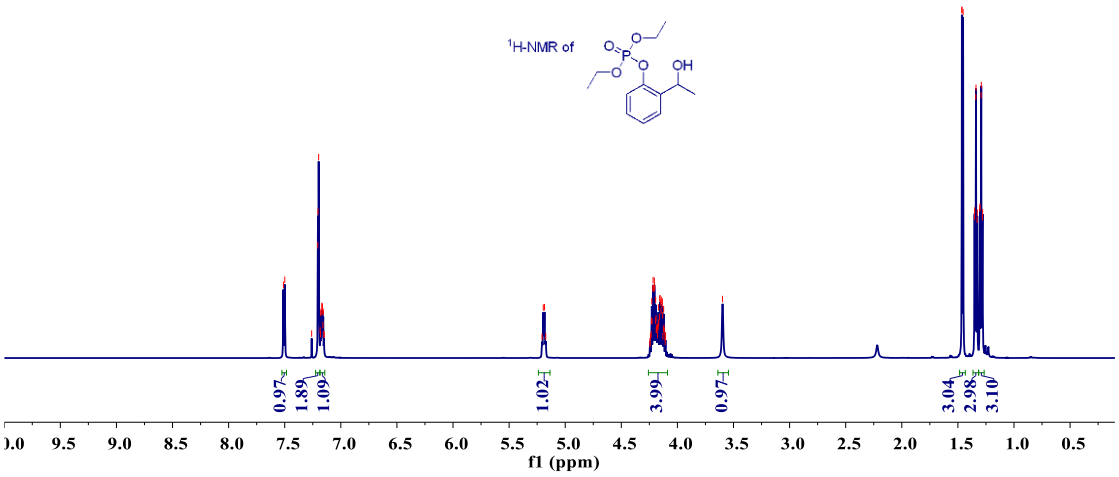
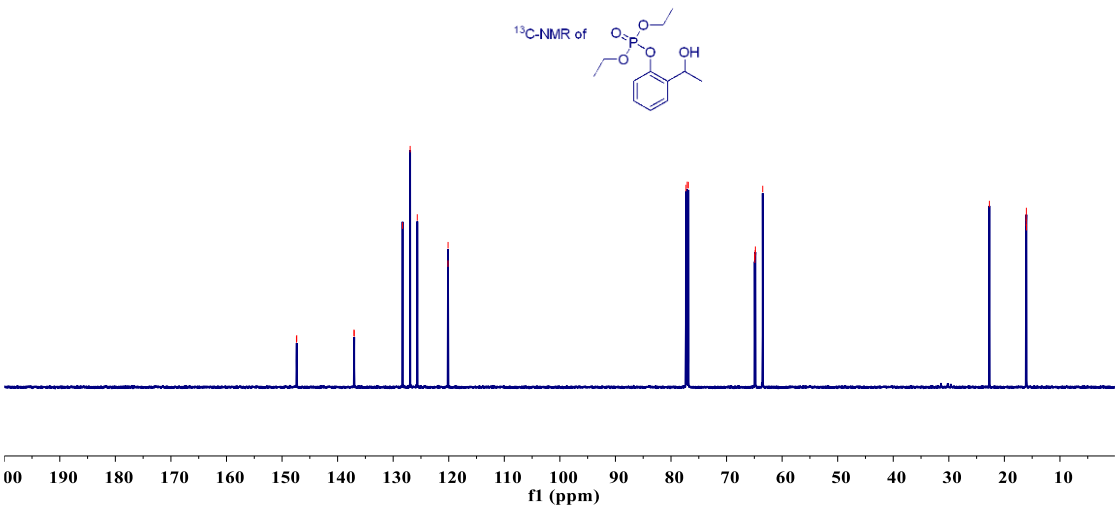
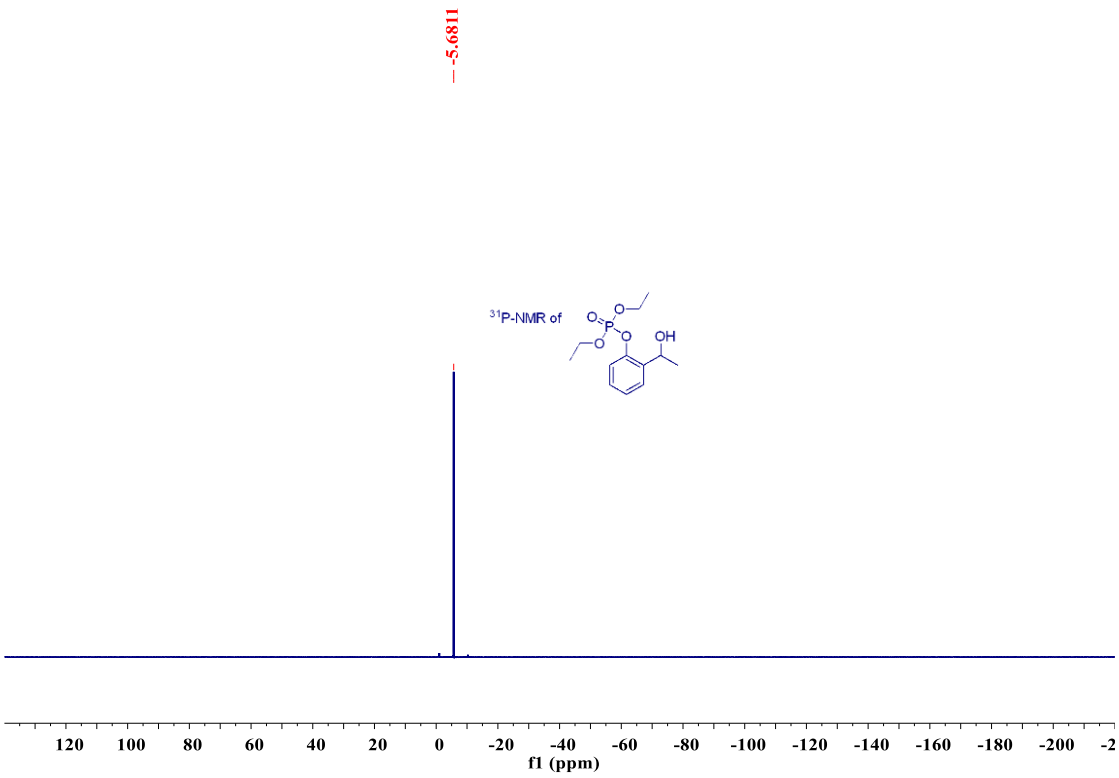
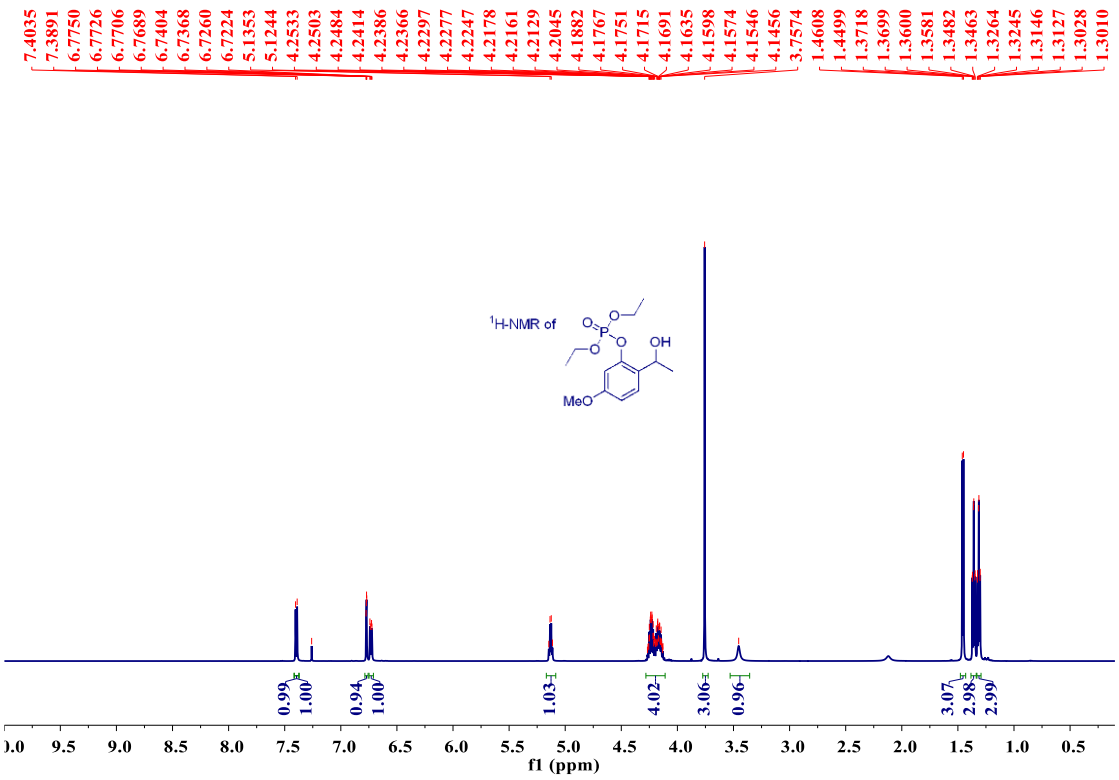
1.3030
1.2931
1.2912
1.2813
1.2794


1H-NMR of
OH
0.97
1.89
1.09
1.02
3.99
0.97
3.04
2.98
3.10
f1 (ppm)


147.4071
147.3597
137.0528
137.0137
128.3151
126.9492
125.6600
120.1402
120.1227
77.3135
77.1015
76.8889
64.9470
64.9066
64.8582
64.8175
63.4924
22.6997
16.0823
16.0659
16.0390
16.0214


13C-NMR of
OH
f1 (ppm)


-5.6811
31P-NMR of
OH
120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -2
f1 (ppm)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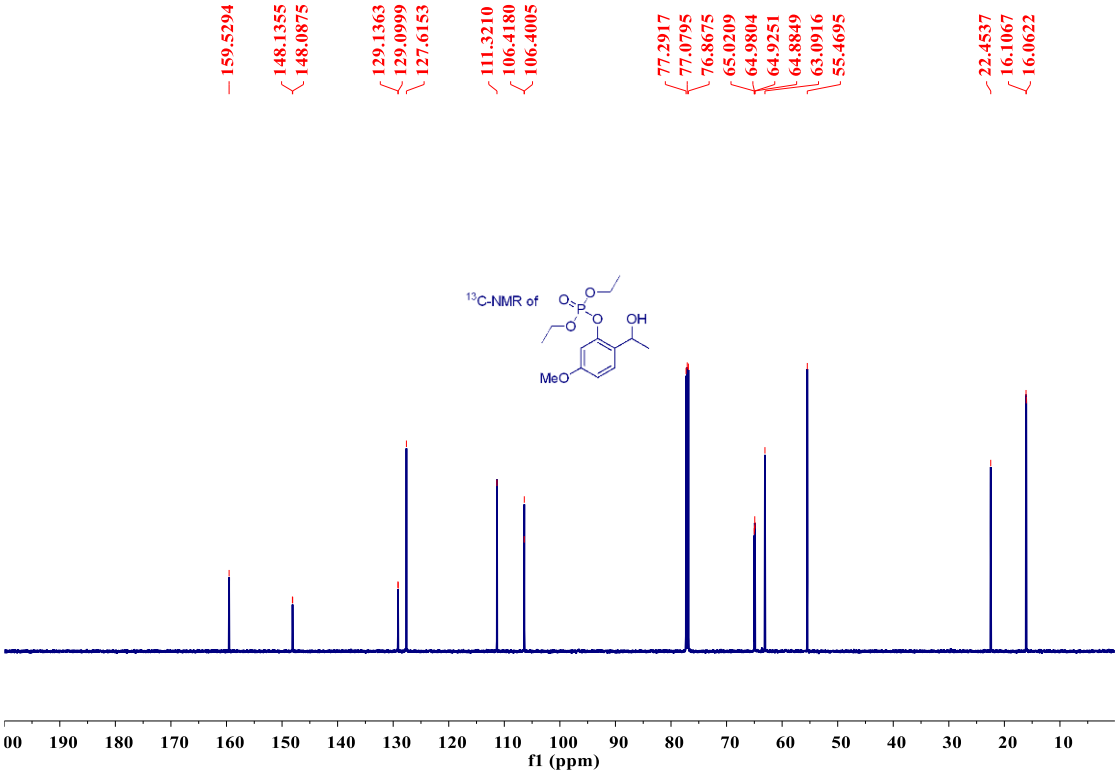
7.3891
6.7750
6.7726
6.7706
6.7689
6.7404
6.7368
6.7260
6.7224
5.1353
5.1244
4.2533
4.2503
4.2484
4.2414
4.2386
4.2366
4.2297
4.2277
4.2247
4.2178
4.2161
4.2129
4.2045
4.1882
4.1767
4.1751
4.1715
4.1691
4.1635
4.1598
4.1574
4.1546
4.1456
3.7574
1.4608
1.4499
1.3718
1.3699
1.3600
1.3581
1.3482
1.3463
1.3264
1.3245
1.3146
1.3127
1.3028
1.3010
1H-NMR of
OH
MeO
0.99
1.00
0.94
1.00
1.03
4.02
3.06
0.96
3.07
2.98
2.99
f1 (ppm)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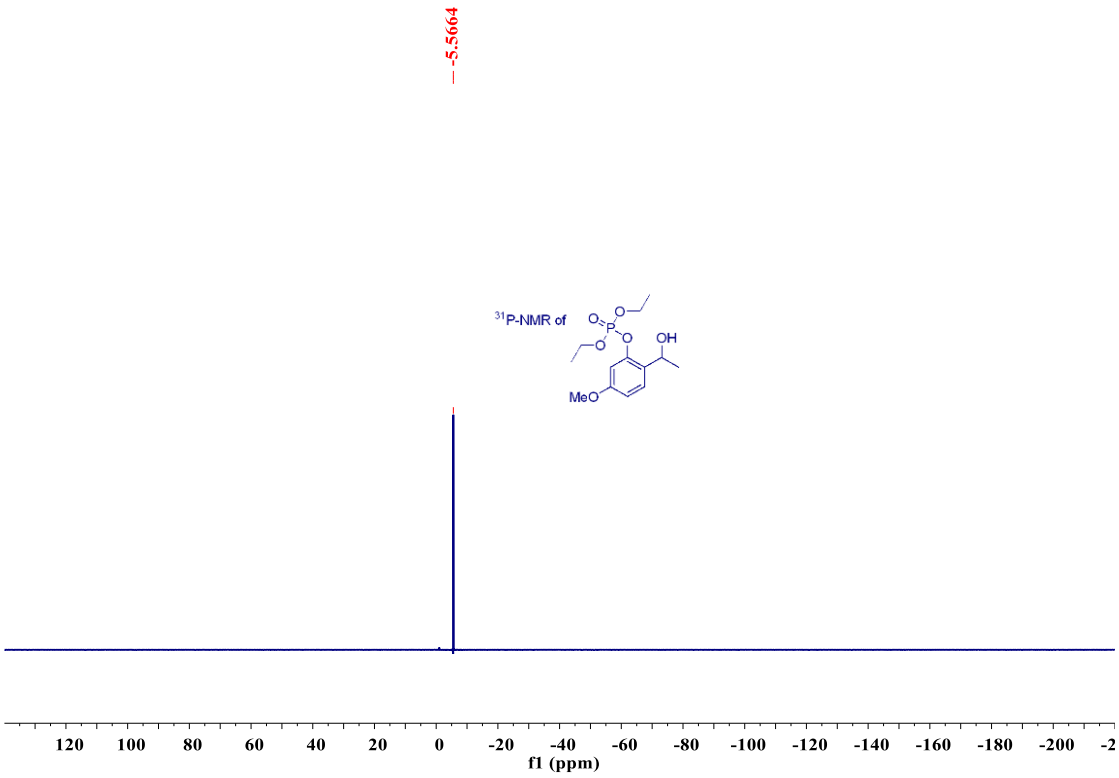
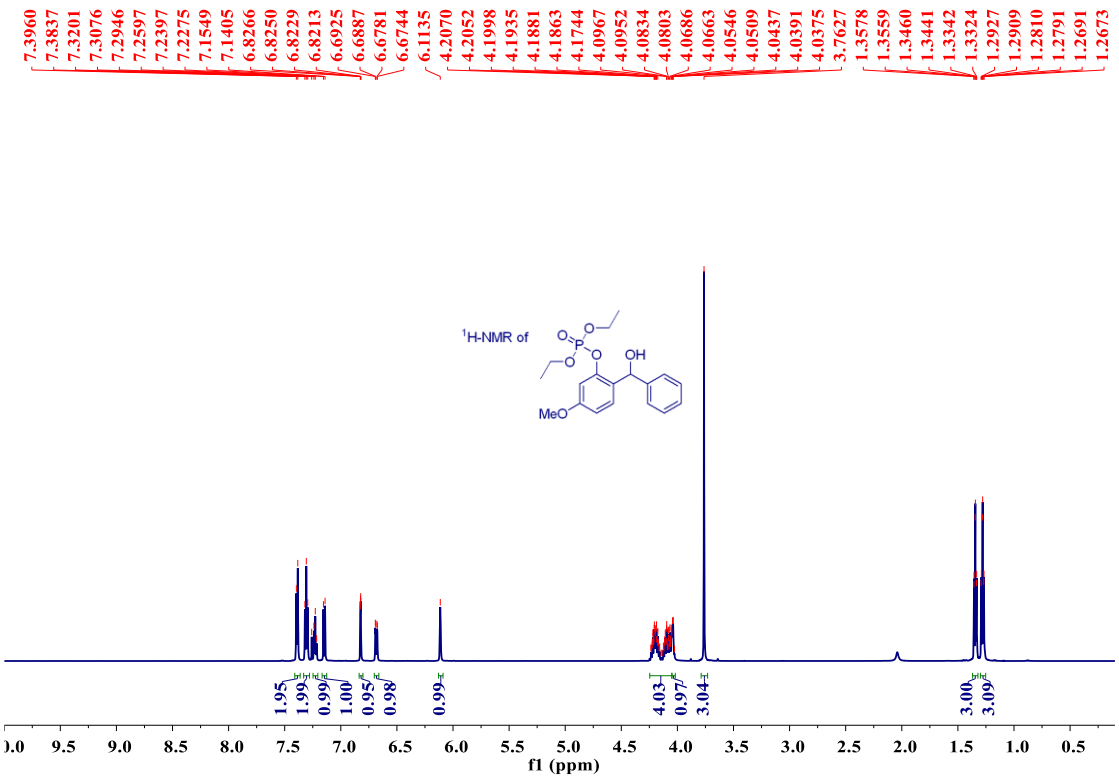
148.1355
148.0875
129.1363
129.0999
127.6153
111.3210
106.4180
106.4005
77.2917
77.0795
76.8675
65.0209
64.9804
64.9251
64.8849
63.0916
55.4695
22.4537
16.1067
16.0622
13C-NMR of
OH
MeO
f1 (ppm)


-5.5664
31P-NMR of
OH
MeO
120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -2
f1 (ppm)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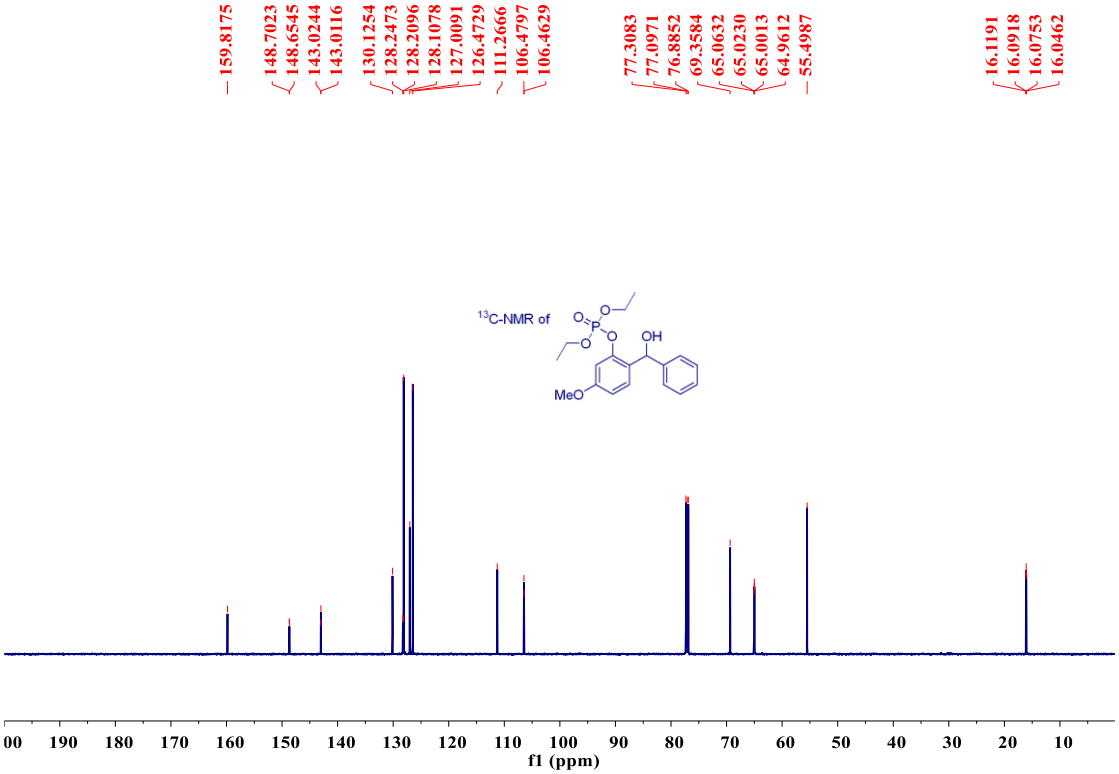
7.3837
7.3201
7.3076
7.2946
7.2597
7.2397
7.2275
7.1549
7.1405
6.8266
6.8250
6.8229
6.8213
6.6925
6.6887
6.6781
6.6744
6.1135
4.2070
4.2052
4.1998
4.1935
4.1881
4.1863
4.1744
4.0967
4.0952
4.0834
4.0803
4.0686
4.0663
4.0546
4.0509
4.0437
4.0391
4.0375
3.7627
1.3578
1.3559
1.3460
1.3441
1.3342
1.3324
1.2927
1.2909
1.2810
1.2791
1.2691
1.2673
1H-NMR of
OH
MeO
1.95
1.99
0.99
1.00
0.95
0.98
0.99
4.03
0.97
3.04
3.00
3.09
f1 (ppm)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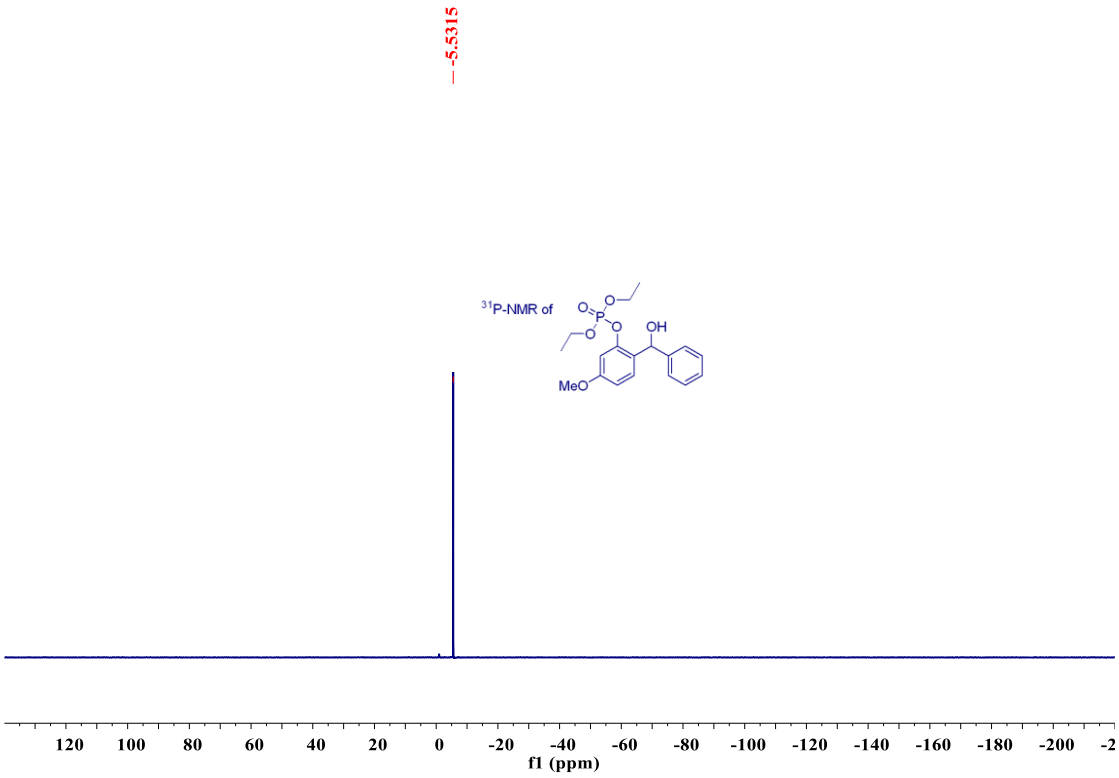
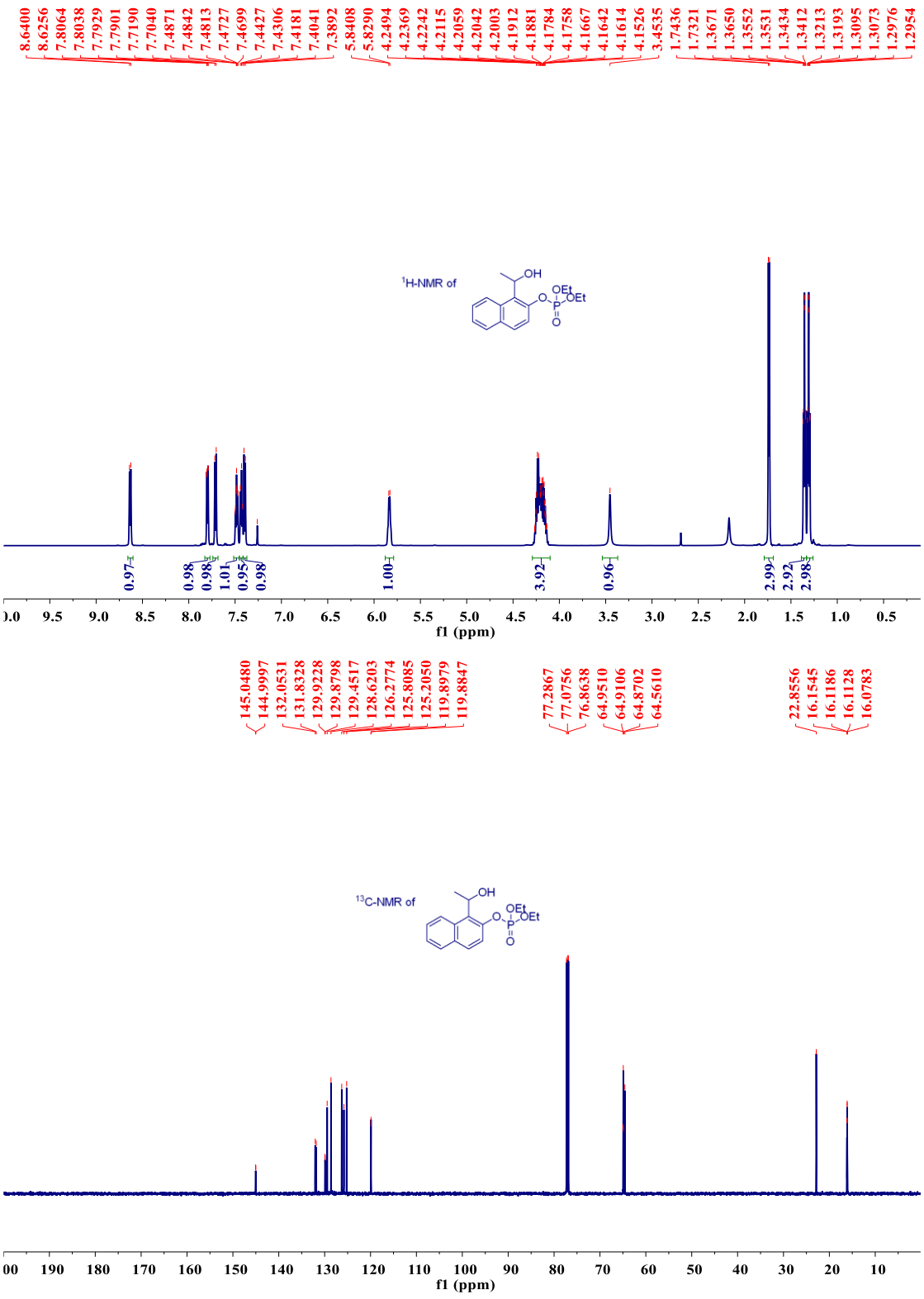
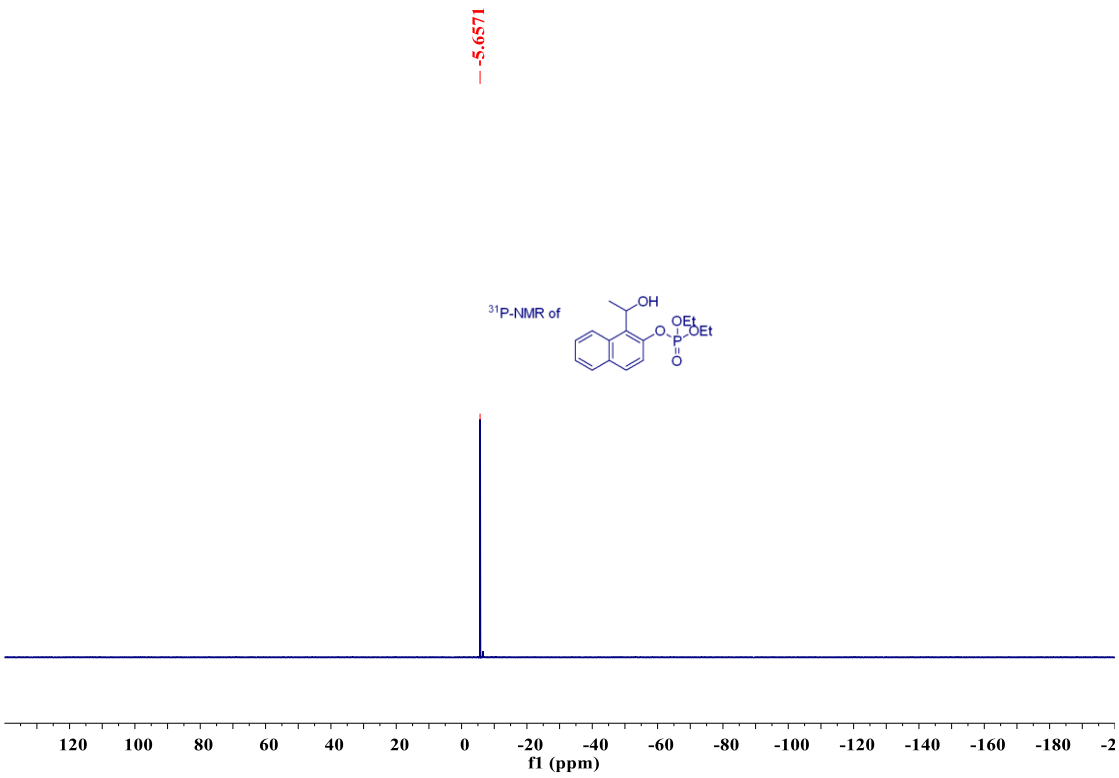
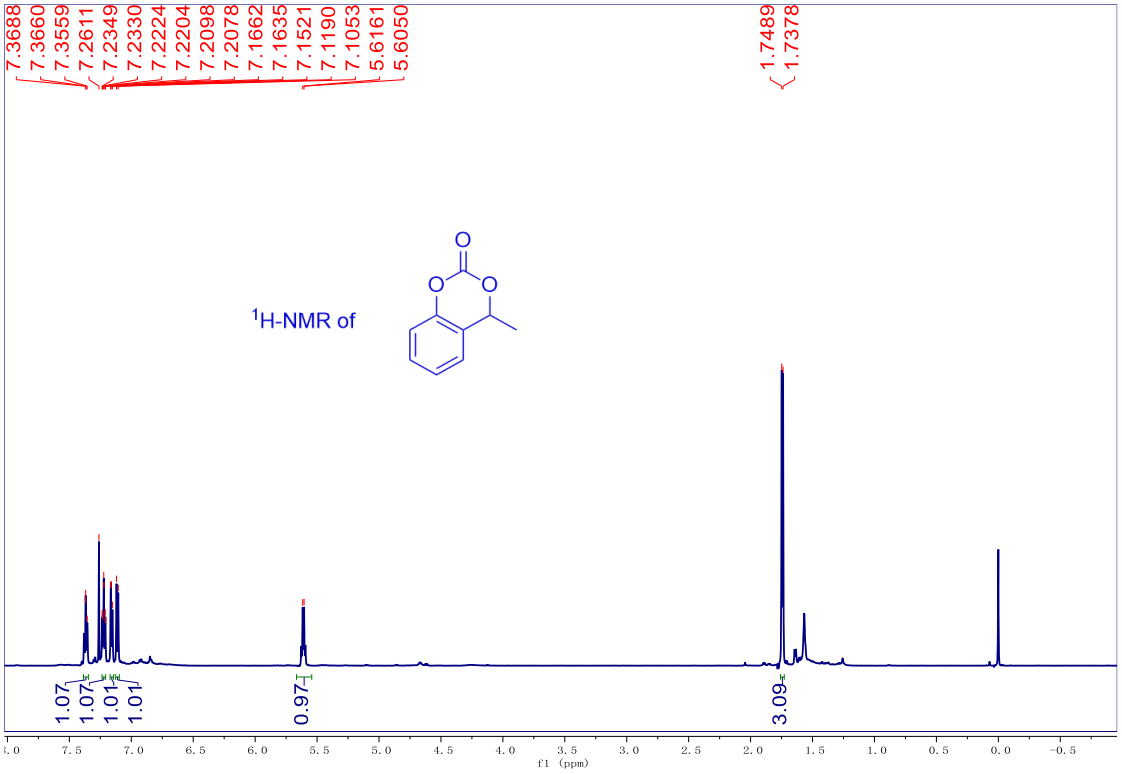
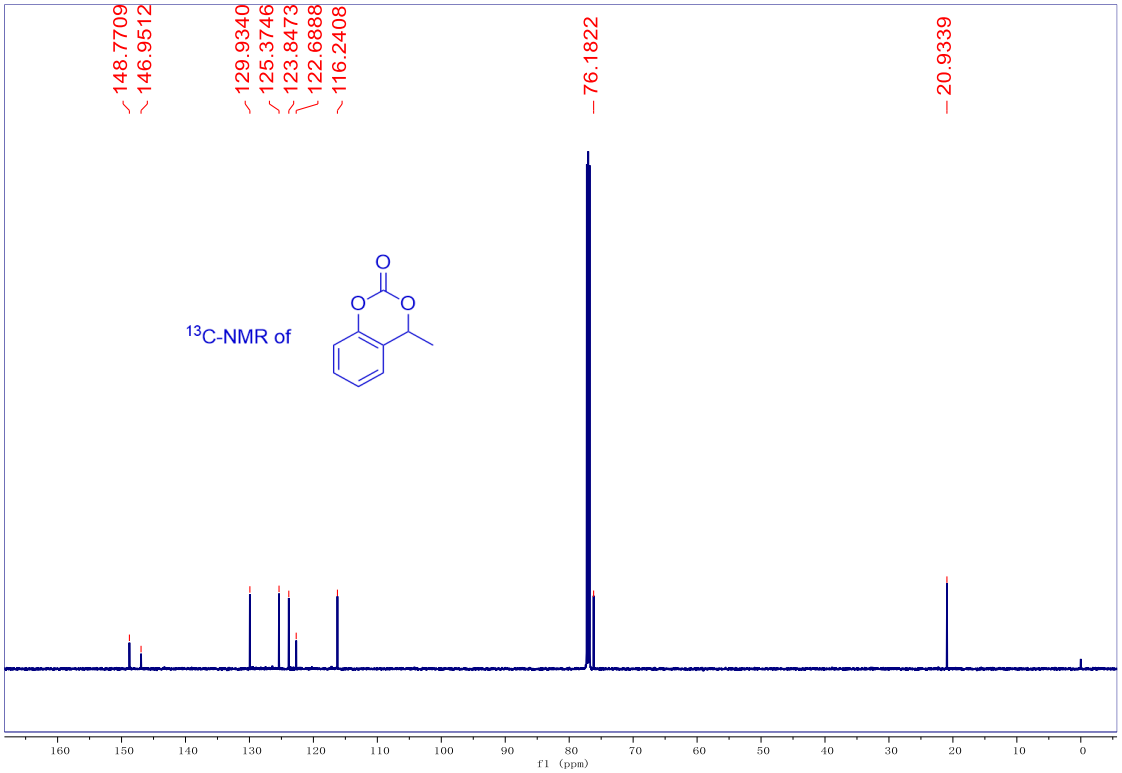
148.7023
148.6545
143.0244
143.0116
130.1254
128.2473
128.2096
128.1078
127.0091
126.4729
111.2666
106.4797
106.4629
77.3083
77.0971
76.8852
69.3584
65.0632
65.0230
65.0013
64.9612
55.4987
16.1191
16.0918
16.0753
16.0462
13C-NMR of
OH
MeO
f1 (ppm)

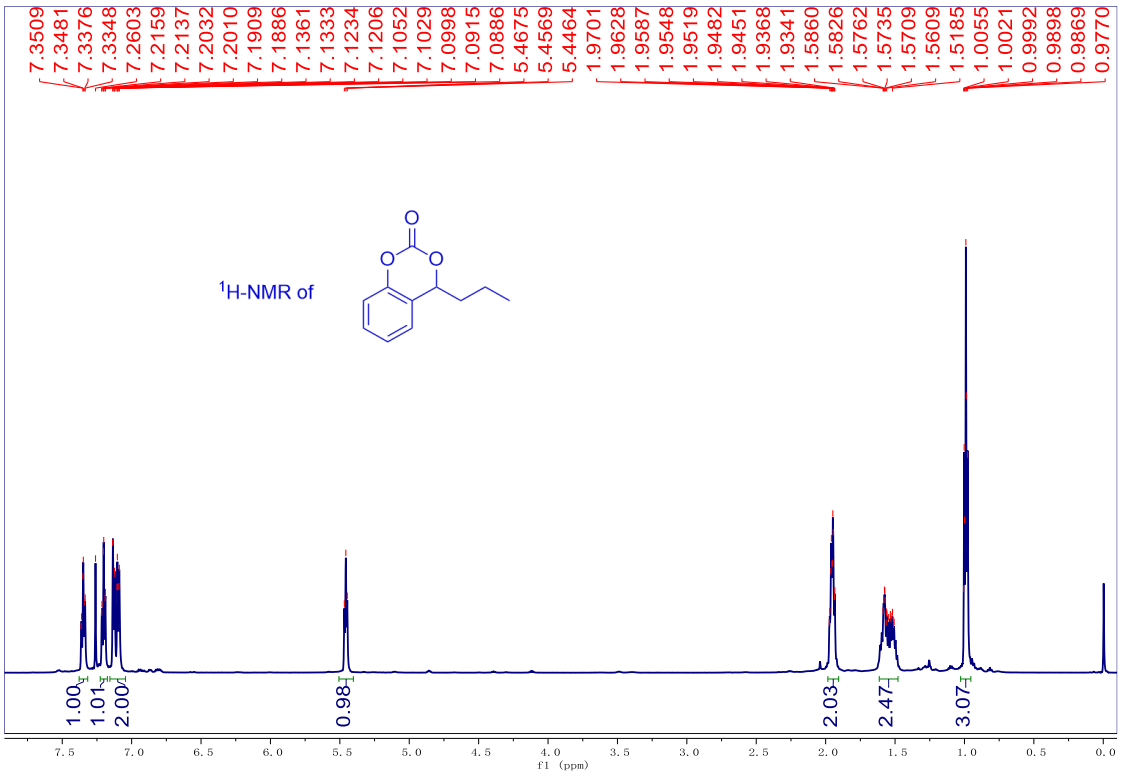

-5.5315
31P-NMR of
OH
MeO
120 100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -2
f1 (ppm)


8.6400
8.6256
7.8064
7.8038
7.7929
7.7901
7.7190
7.7040
7.4871
7.4842
7.4813
7.4727
7.4699
7.4427
7.4306
7.4181
7.4041
7.3892
5.8408
5.8290
4.2494
4.2369
4.2242
4.2115
4.2059
4.2042
4.2003
4.1912
4.1881
4.1784
4.1758
4.1667
4.1642
4.1614
4.1526
3.4535
1.7436
1.7321
1.3671
1.3650
1.3552
1.3531
1.3434
1.3412
1.3213
1.3193
1.3095
1.3073
1.2976
1.2954
1H-NMR of
OH
OEt
OEt
O
P
O
0.97
0.98
0.98
1.01
0.95
0.98
1.00
3.92
0.96
2.99
2.92
2.98
f1 (ppm)
145.0480
144.9997
132.0531
131.8328
129.9228
129.8798
129.4517
128.6203
126.2774
125.8085
125.2050
119.8979
119.8847
77.2867
77.0756
76.8638
64.9510
64.9106
64.8702
64.5610
22.8556
16.1545
16.1186
16.1128
16.0783
13C-NMR of
OH
OEt
OEt
O
P
O
f1 (ppm)


-5.6571
31P-NMR of
OH
OEt
OEt
O
P
O
120
100
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-2
f1 (ppm)


7.3688
7.3660
7.3559
7.2611
7.2349
7.2330
7.2224
7.2204
7.2098
7.2078
7.1662
7.1635
7.1521
7.1190
7.1053
5.6161
5.6050
1.7489
1.7378
1H-NMR of
1.07
1.07
1.01
1.01
0.97
3.09
f1 (ppm)


148.7709
146.9512
129.9340
125.3746
123.8473
122.6888
116.2408
76.1822
20.9339
13C-NMR of
f1 (ppm)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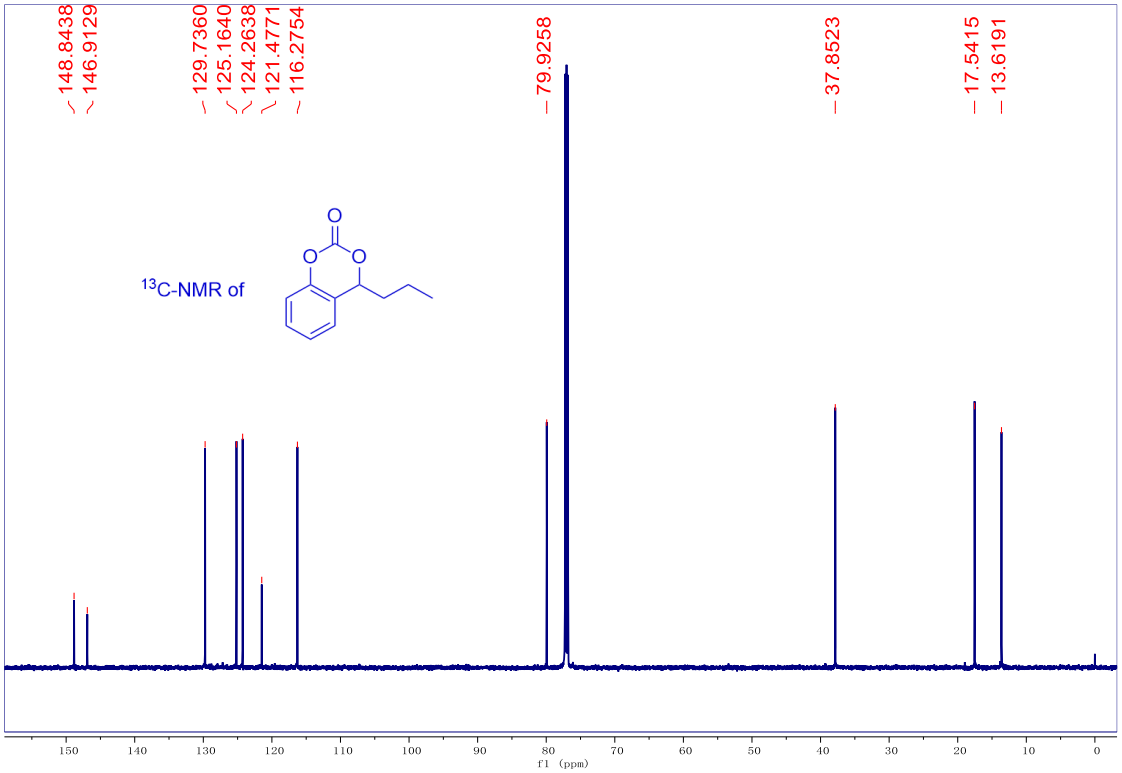
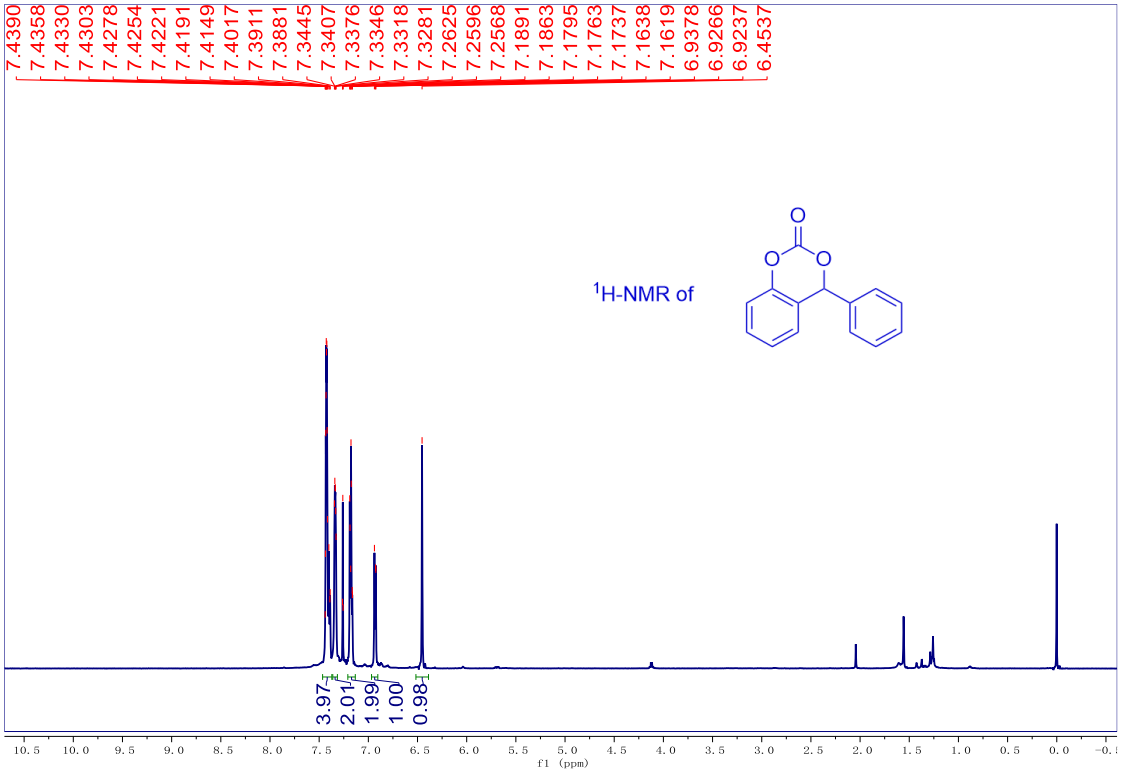
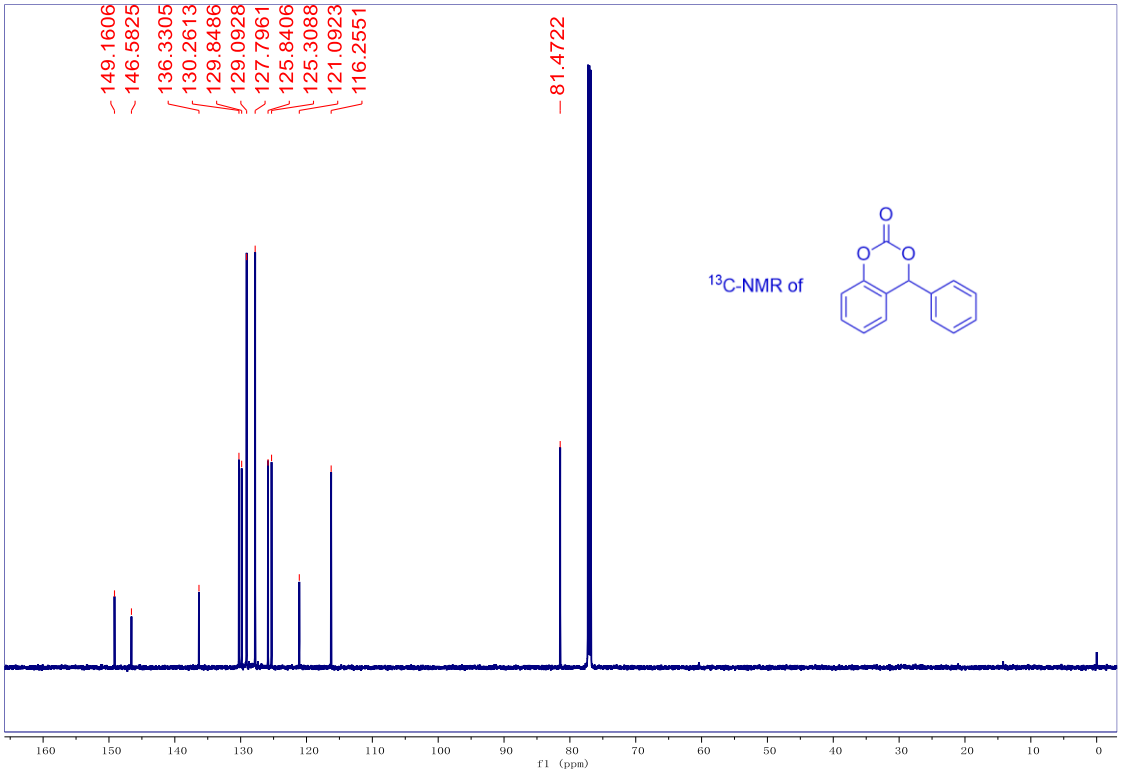
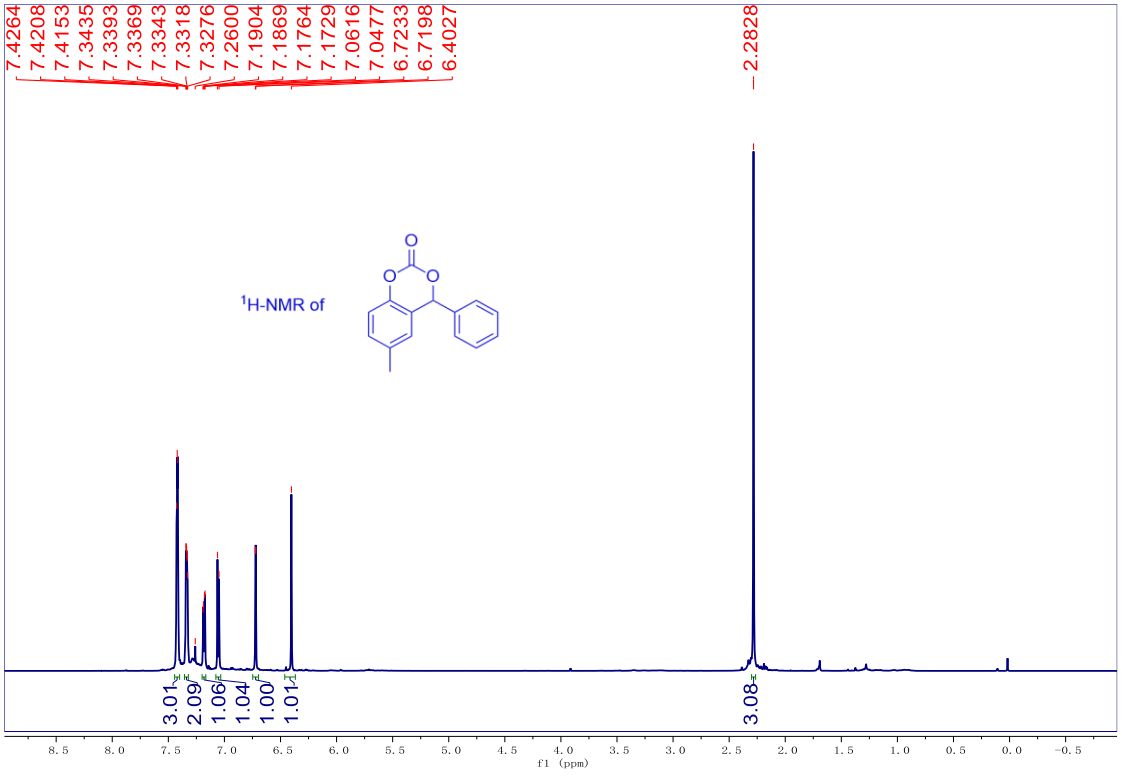
7.3481
7.3376
7.3348
7.2603
7.2159
7.2137
7.2032
7.2010
7.1909
7.1886
7.1361
7.1333
7.1234
7.1206
7.1052
7.1029
7.0998
7.0915
7.0886
5.4675
5.4569
5.4464
1.9701
1.9628
1.9587
1.9548
1.9519
1.9482
1.9451
1.9368
1.9341
1.5860
1.5826
1.5762
1.5735
1.5709
1.5609
1.5185
1.0055
1.0021
0.9992
0.9898
0.9869
0.9770
1H-NMR of
1.00
1.01
2.00
0.98
2.03
2.47
3.07
f1 (ppm)


148.8438
146.9129
129.7360
125.1640
124.2638
121.4771
116.2754
79.9258
37.8523
17.5415
13.6191
13C-NMR of
f1 (ppm)


7.4390
7.4358
7.4330
7.4303
7.4278
7.4254
7.4221
7.4191
7.4149
7.4017
7.3911
7.3881
7.3445
7.3407
7.3376
7.3346
7.3318
7.3281
7.2625
7.2596
7.2568
7.1891
7.1863
7.1795
7.1763
7.1737
7.1638
7.1619
6.9378
6.9266
6.9237
6.4537
$^{1}$H-NMR of
3.97
2.01
1.99
1.00
0.98
f1 (ppm)


149.1606
146.5825
136.3305
130.2613
129.8486
129.0928
127.7961
125.8406
125.3088
121.0923
116.2551
81.4722
$^{13}$C-NMR of
f1 (ppm)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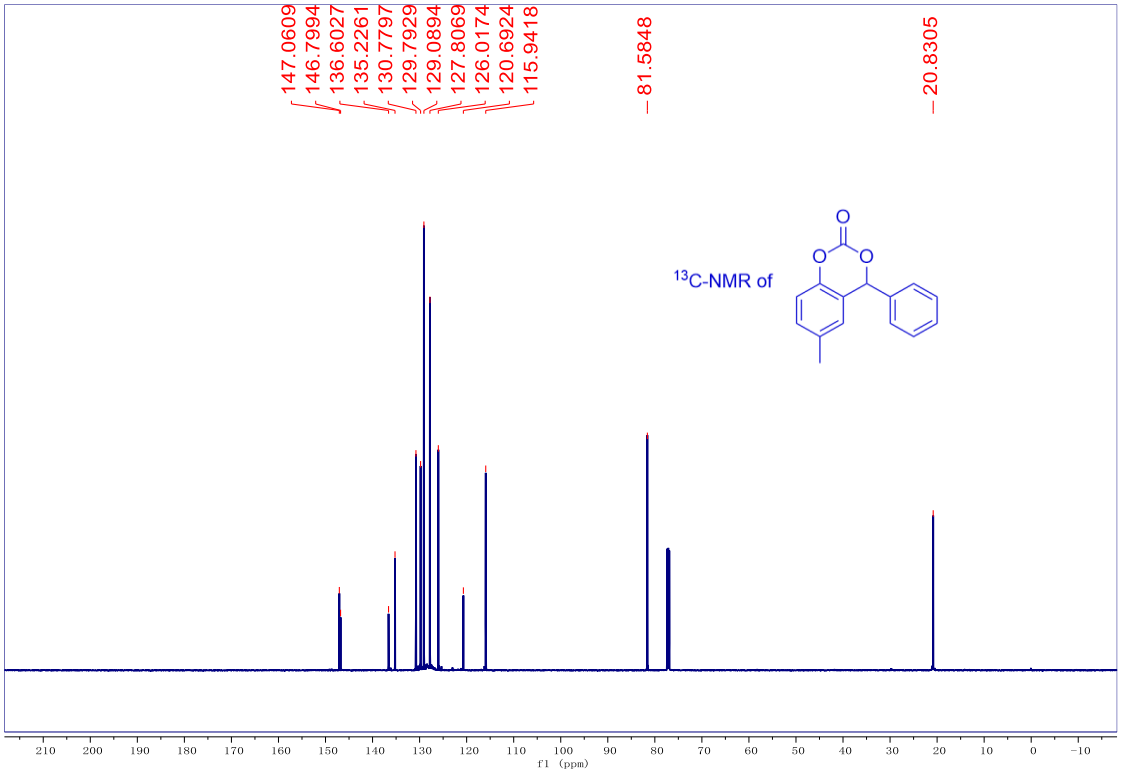
7.4208
7.4153
7.3435
7.3393
7.3369
7.3343
7.3318
7.3276
7.2600
7.1904
7.1869
7.1764
7.1729
7.0616
7.0477
6.7233
6.7198
6.4027
2.2828
$^{1}$H-NMR of
3.01
2.09
1.06
1.04
1.00
1.01
3.08
f1 (ppm)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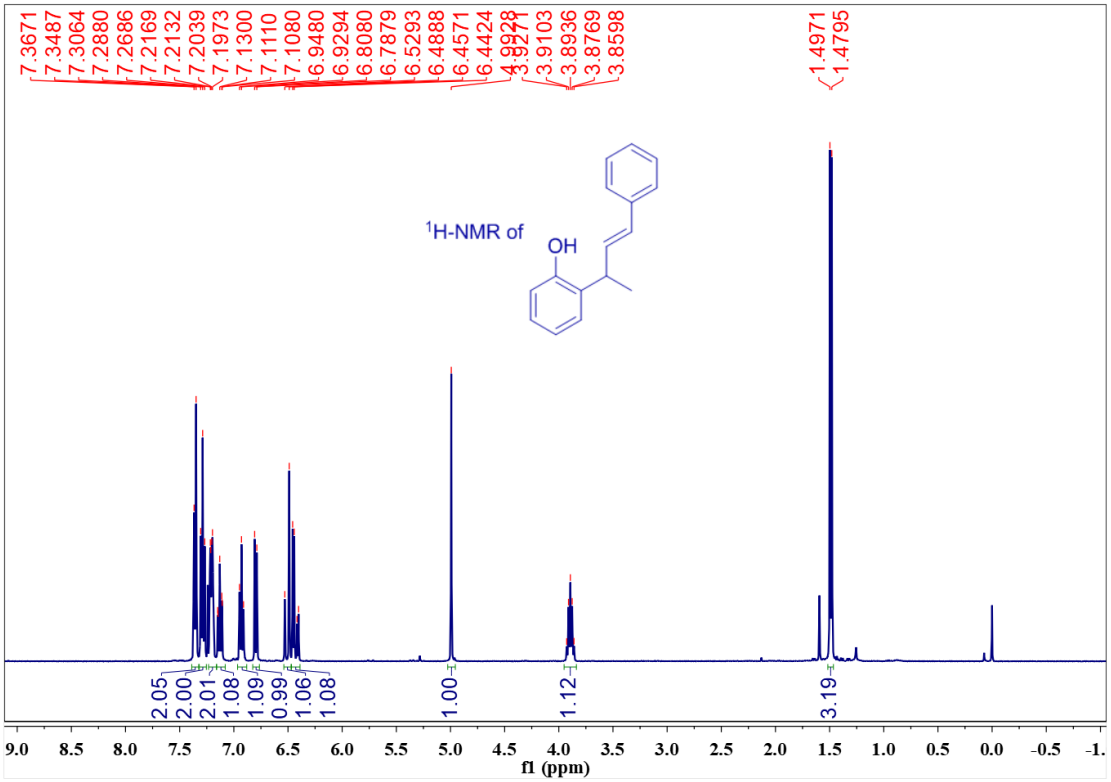
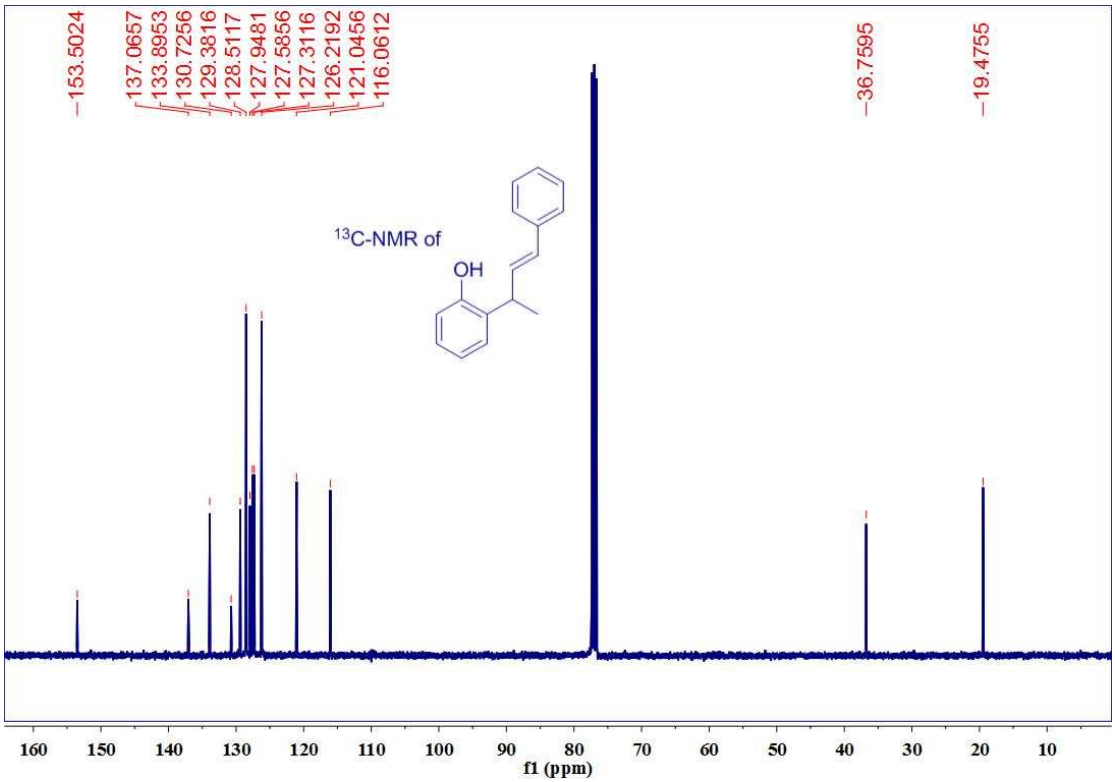
146.7994
136.6027
135.2261
130.7797
129.7929
129.0894
127.8069
126.0174
120.6924
115.9418
81.5848
20.8305
$^{13}$C-NMR of
f1 (ppm)


7.3671
7.3487
7.3064
7.2880
7.2686
7.2169
7.2132
7.2039
7.1973
7.1300
7.1110
7.1080
6.9480
6.9294
6.8080
6.7879
6.5293
6.4888
6.4571
6.4424
4.9928
4.9271
3.9103
3.8936
3.8769
3.8598
1.4971
1.4795
1H-NMR of
OH
2.05
2.00
2.01
1.08
1.09
0.99
1.06
1.08
1.00
1.12
3.19
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)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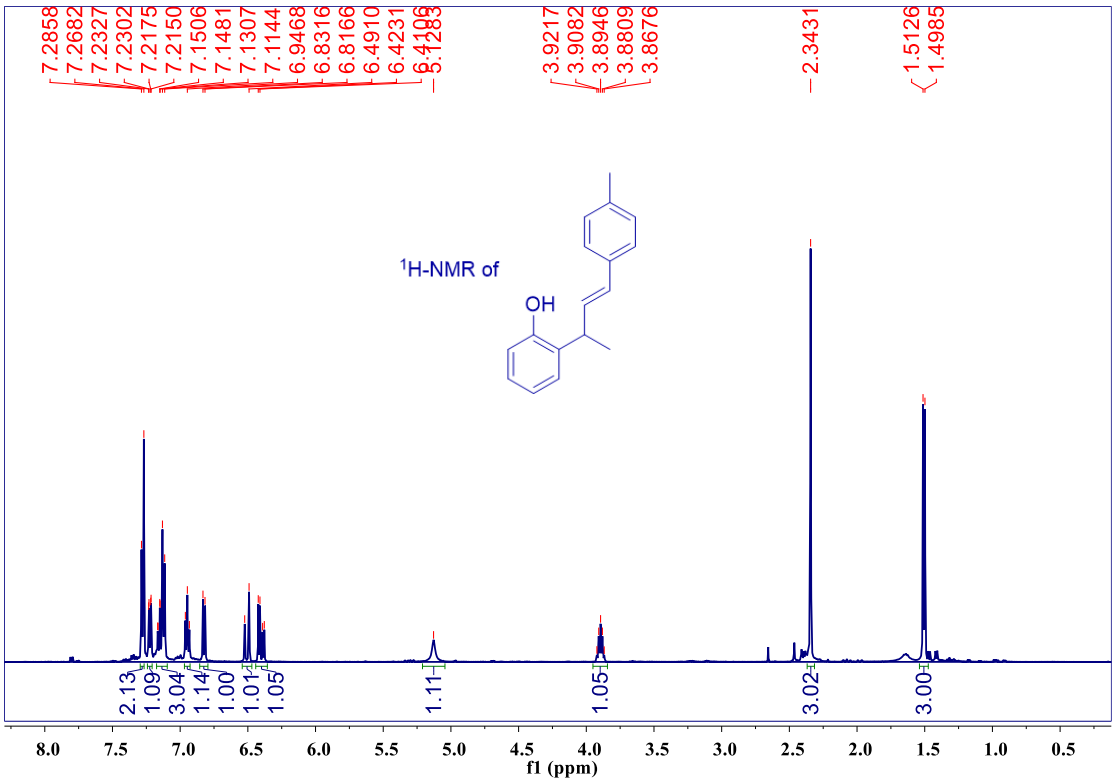
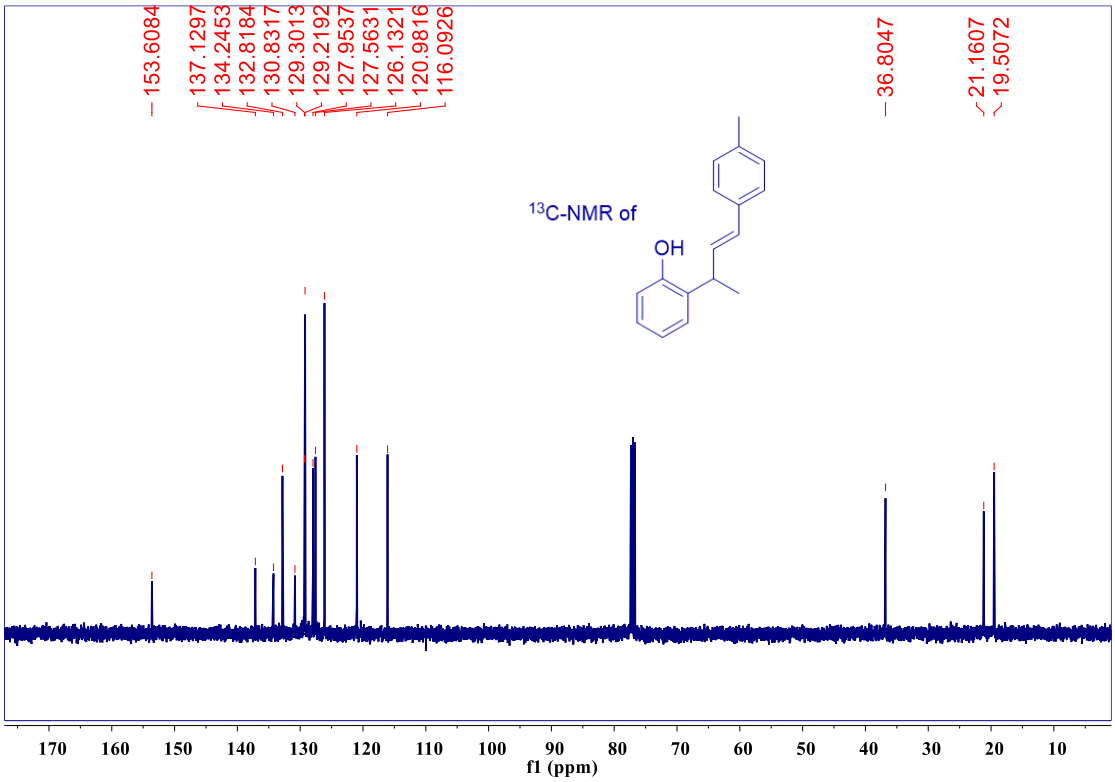
137.0657
133.8953
130.7256
129.3816
128.5117
127.9481
127.5856
127.3116
126.2192
121.0456
116.0612
36.7595
19.4755
13C-NMR of
OH
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)


7.2858
7.2682
7.2327
7.2302
7.2175
7.2150
7.1506
7.1481
7.1307
7.1144
6.9468
6.8316
6.8166
6.4910
6.4231
6.4106
5.1283
3.9217
3.9082
3.8946
3.8809
3.8676
2.3431
1.5126
1.4985
1H-NMR of
OH
2.13
1.09
3.04
1.14
1.00
1.01
1.05
1.11
1.05
3.02
3.00
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
f1 (ppm)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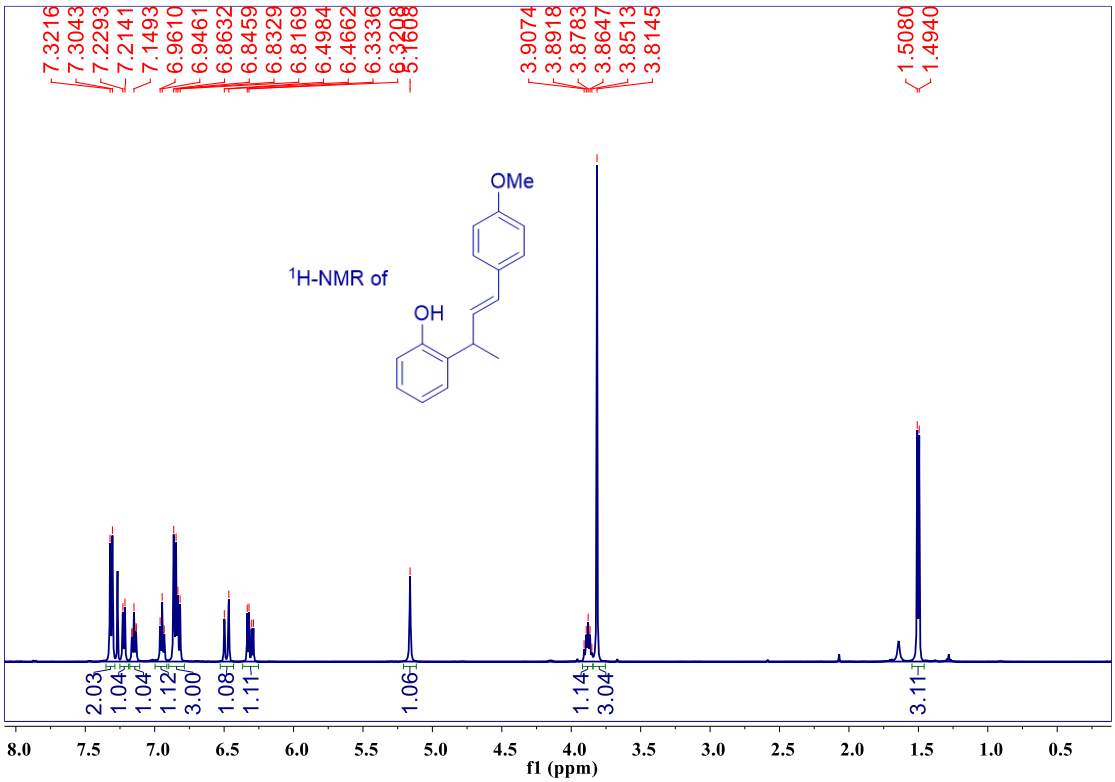
137.1297
134.2453
132.8184
130.8317
129.3013
129.2192
127.9537
127.5631
126.1321
120.9816
116.0926
36.8047
21.1607
19.5072
13C-NMR of
OH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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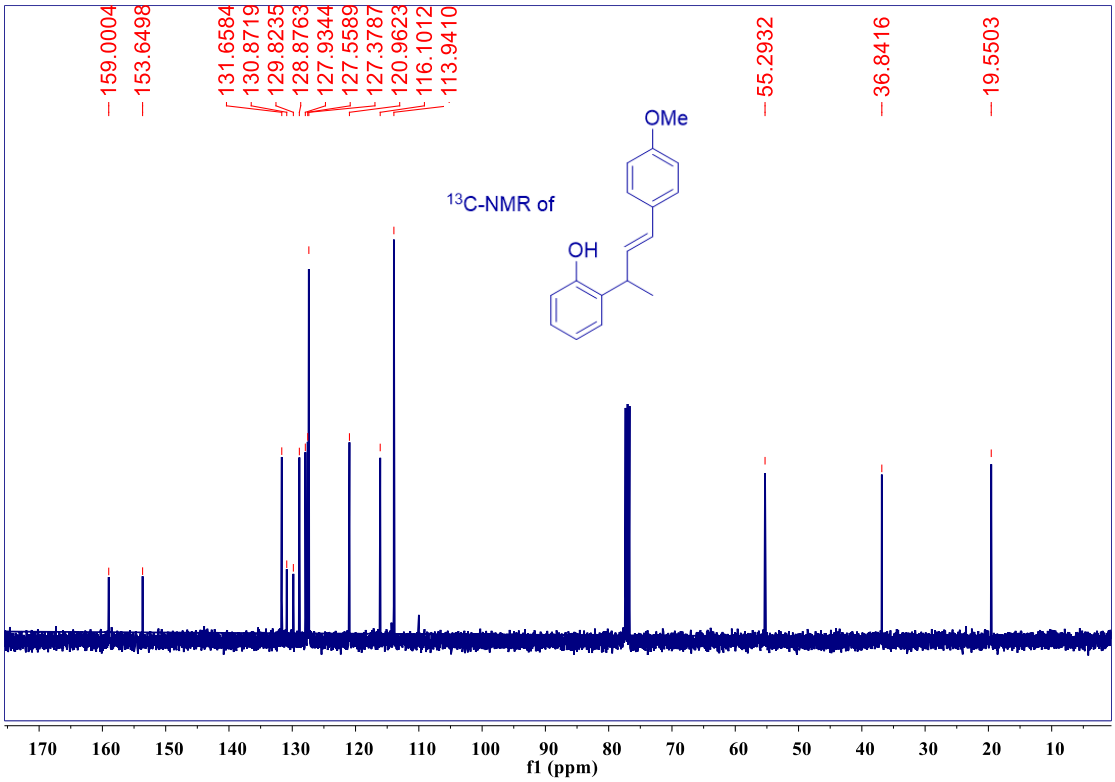
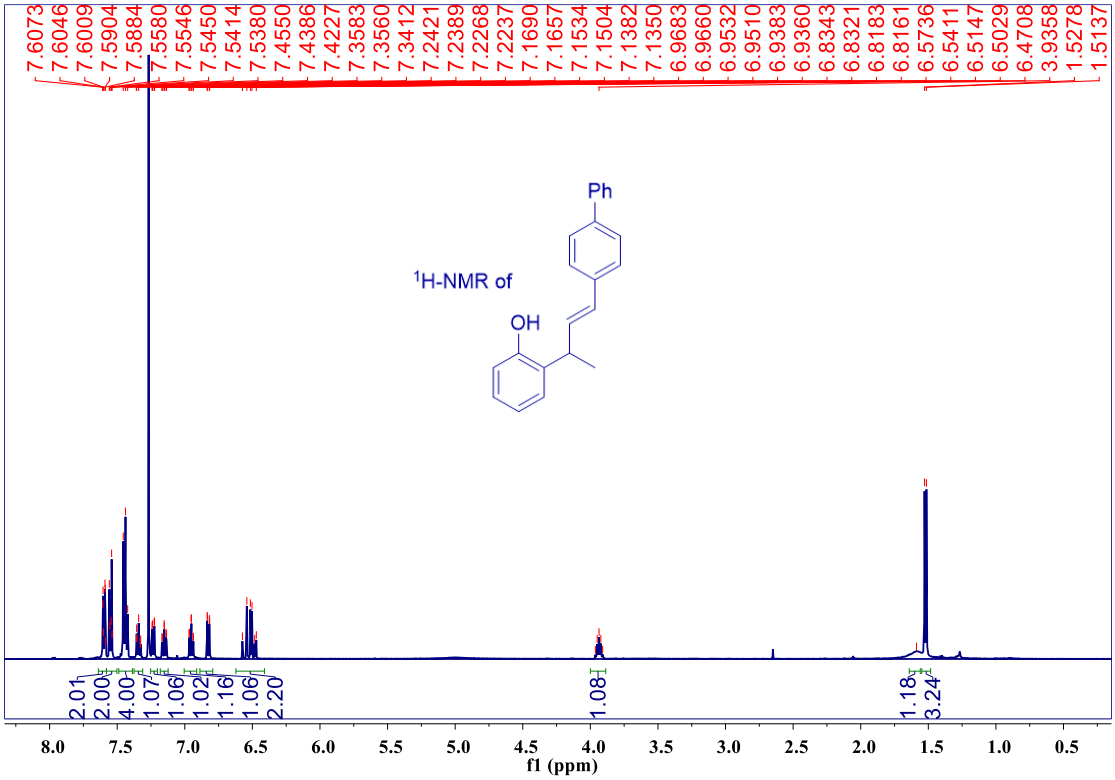
7.3043
7.2293
7.2141
7.1493
6.9610
6.9461
6.8632
6.8459
6.8329
6.8169
6.4984
6.4662
6.3336
5.1608
3.9074
3.8918
3.8783
3.8647
3.8513
3.8145
1.5080
1.4940
OMe
OH
1H-NMR of
2.03
1.04
1.04
1.12
3.00
1.08
1.11
1.06
1.14
3.04
3.11
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


159.0004
153.6498
131.6584
130.8719
129.8235
128.8763
127.9344
127.5589
127.3787
120.9623
116.1012
113.9410
55.2932
36.8416
19.5503
OMe
OH
13C-NMR of
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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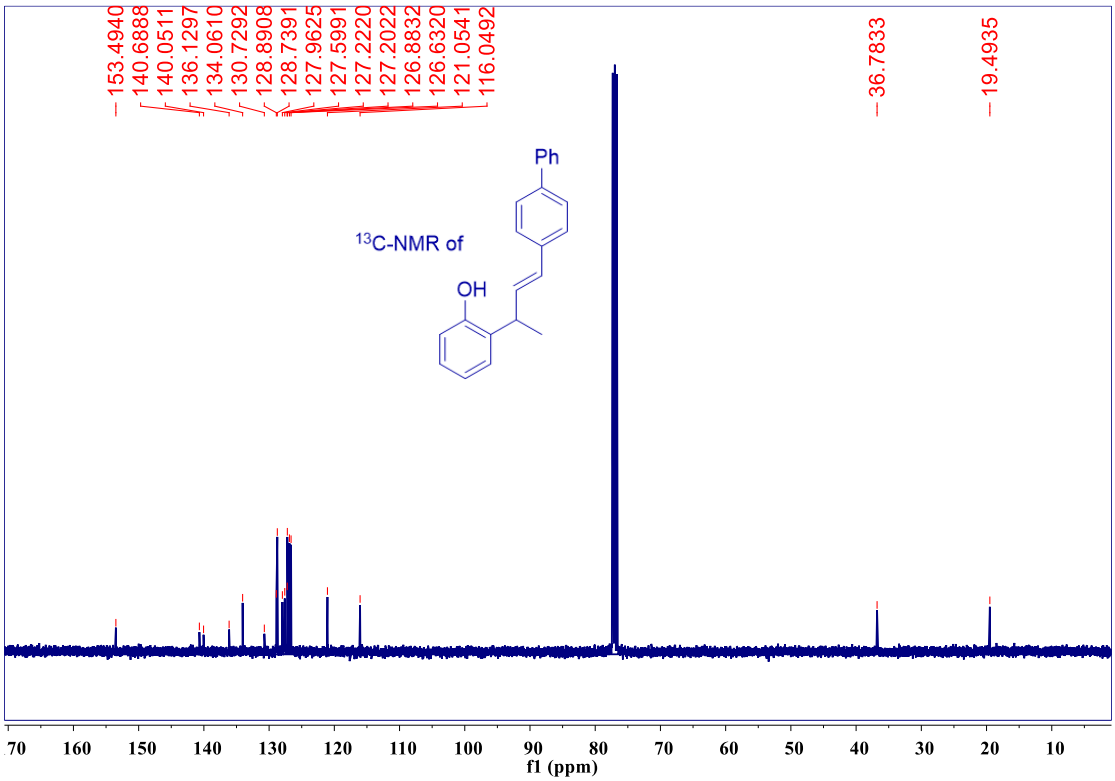
7.6046
7.6009
7.5904
7.5884
7.5580
7.5546
7.5450
7.5414
7.5380
7.4550
7.4386
7.4227
7.3583
7.3560
7.3412
7.2421
7.2389
7.2268
7.2237
7.1690
7.1657
7.1534
7.1504
7.1382
7.1350
6.9683
6.9660
6.9532
6.9510
6.9383
6.9360
6.8343
6.8321
6.8183
6.8161
6.5736
6.5411
6.5147
6.5029
6.4708
3.9358
1.5278
1.5137
Ph
1H-NMR of
OH
2.01
2.00
4.00
1.07
1.06
1.02
1.16
1.06
2.20
1.08
1.18
3.24
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
f1 (ppm)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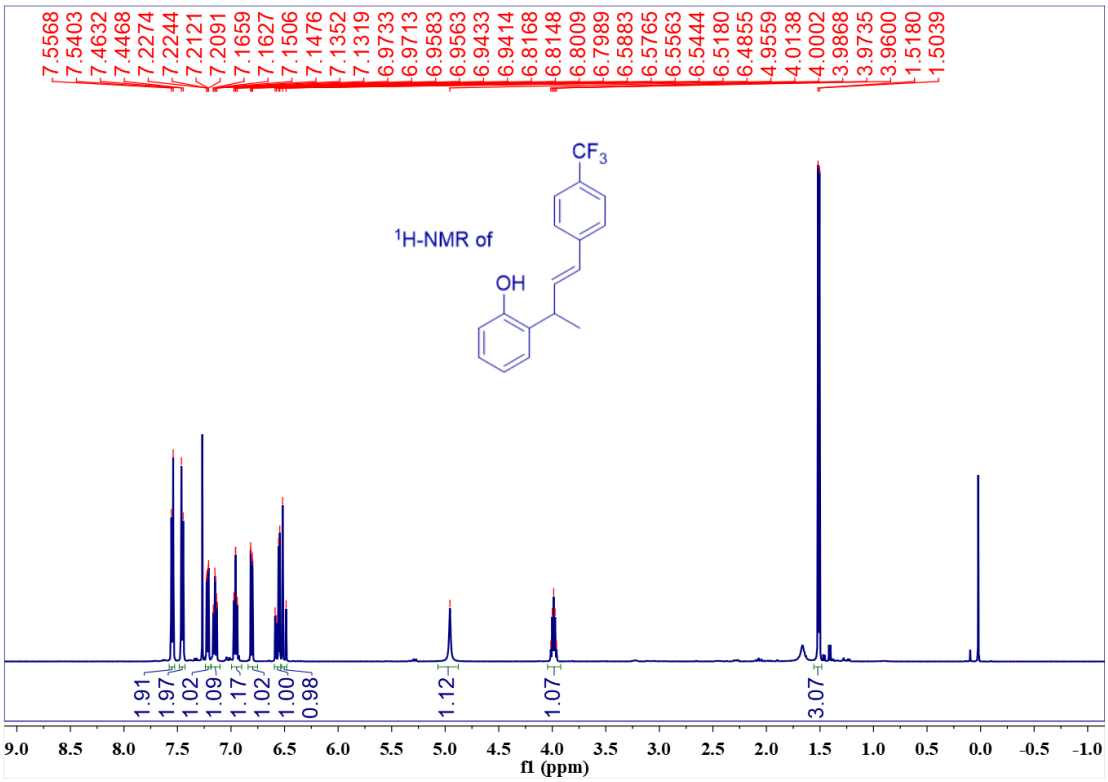
140.6888
140.0511
136.1297
134.0610
130.7292
128.8908
128.7391
127.9625
127.5991
127.2220
127.2022
126.8832
126.6320
121.0541
116.0492
36.7833
19.4935
Ph
13C-NMR of
OH
70
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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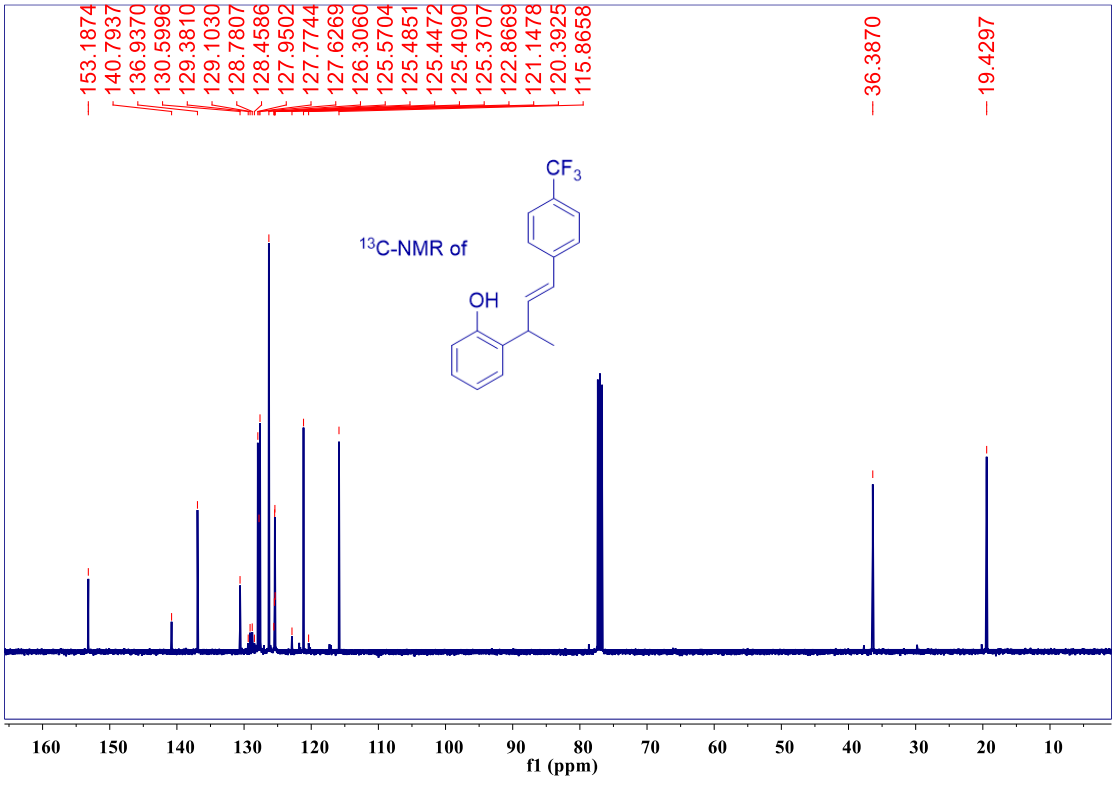
7.5403
7.4632
7.4468
7.2274
7.2244
7.2121
7.2091
7.1659
7.1627
7.1506
7.1476
7.1352
7.1319
6.9733
6.9713
6.9583
6.9563
6.9433
6.9414
6.8168
6.8148
6.8009
6.7989
6.5883
6.5765
6.5563
6.5444
6.5180
6.4855
4.9559
4.0138
4.0002
3.9868
3.9735
3.9600
1.5180
1.5039
CF3
1H-NMR of
OH
1.91
1.97
1.02
1.09
1.17
1.02
1.00
0.98
1.12
1.07
3.07
f1 (ppm)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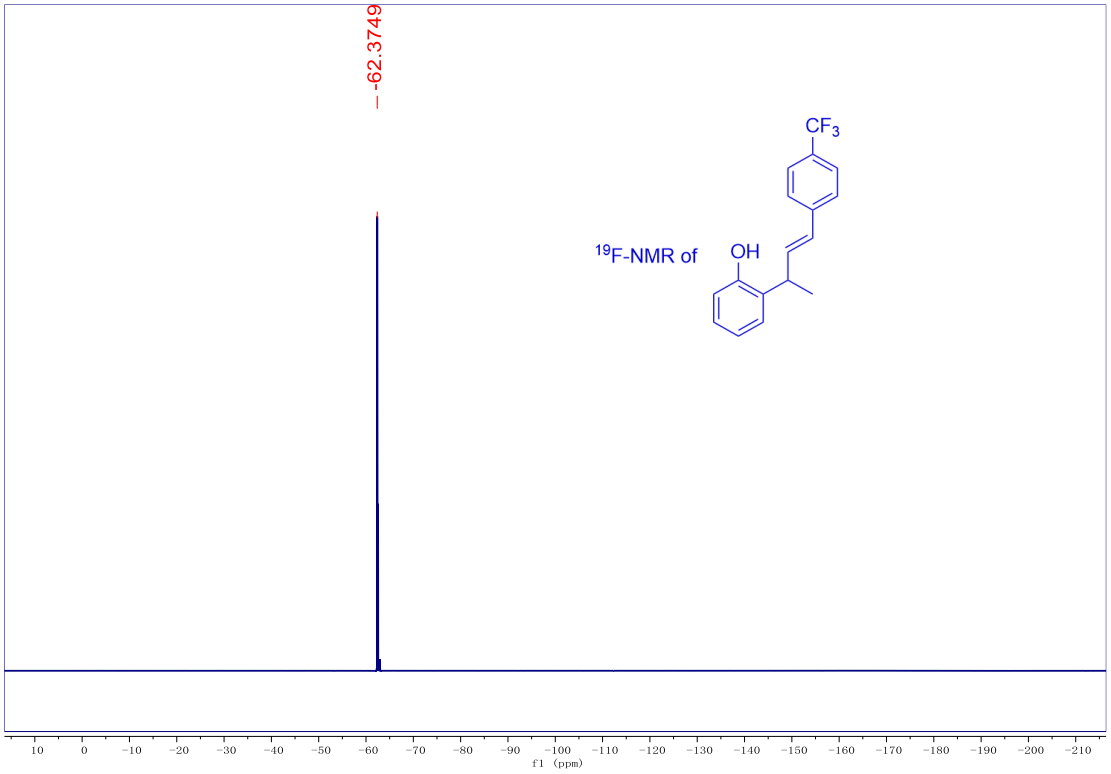
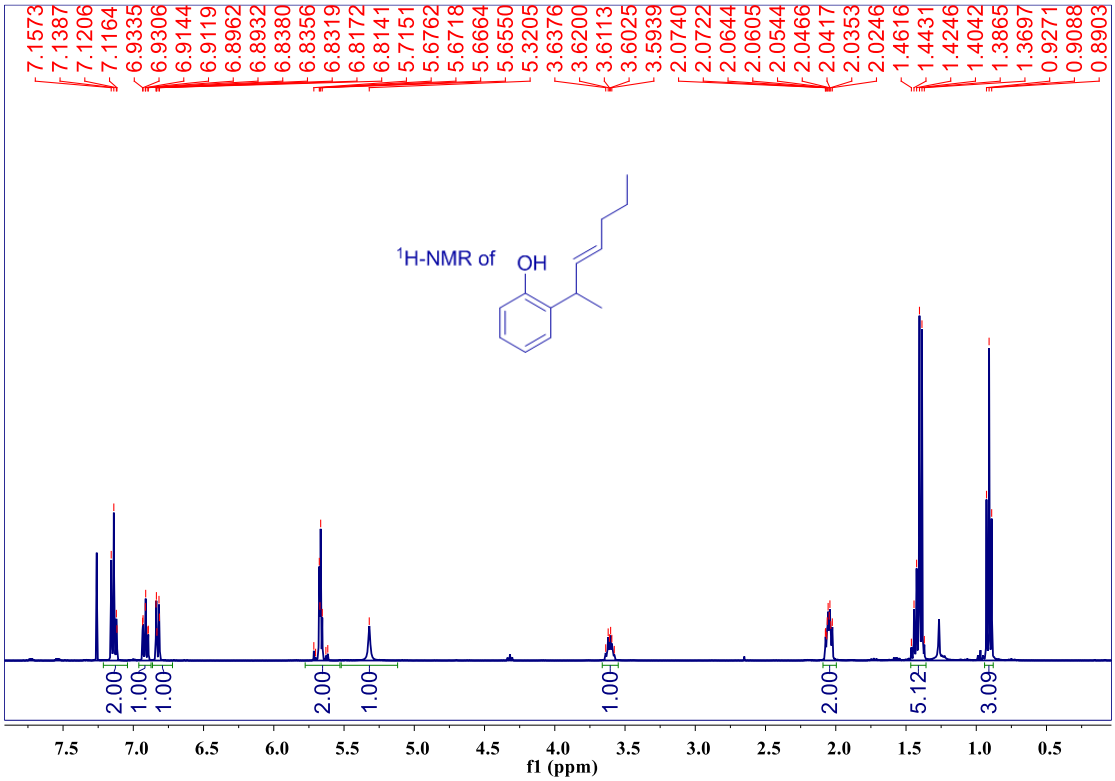
140.7937
136.9370
130.5996
129.3810
129.1030
128.7807
128.4586
127.9502
127.7744
127.6269
126.3060
125.5704
125.4851
125.4472
125.4090
125.3707
122.8669
121.1478
120.3925
115.8658
36.3870
19.4297
CF3
13C-NMR of
OH
f1 (ppm)


-62.3749
$^{19}$F-NMR of
OH
$CF_3$
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)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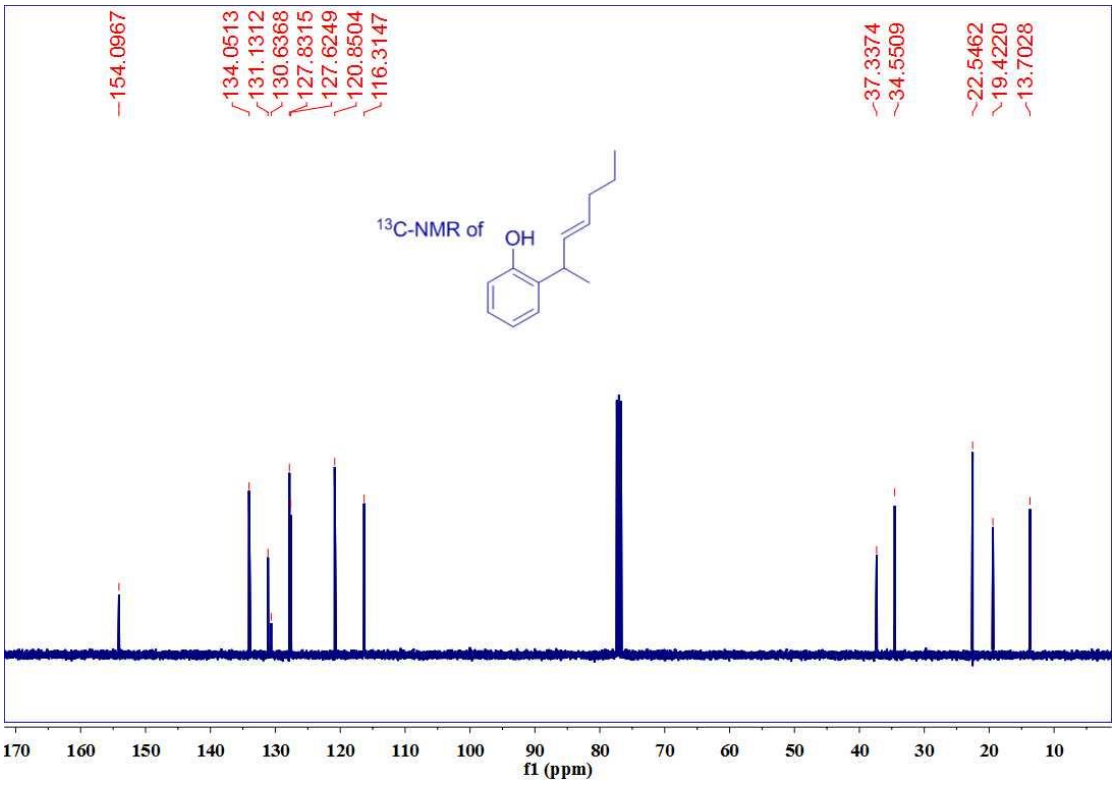
7.1387
7.1206
7.1164
6.9335
6.9306
6.9144
6.9119
6.8962
6.8932
6.8380
6.8356
6.8319
6.8172
6.8141
5.7151
5.6762
5.6718
5.6664
5.6550
5.3205
3.6376
3.6200
3.6113
3.6025
3.5939
2.0740
2.0722
2.0644
2.0605
2.0544
2.0466
2.0417
2.0353
2.0246
1.4616
1.4431
1.4246
1.4042
1.3865
1.3697
0.9271
0.9088
0.8903
1H-NMR of
OH
2.00
1.00
1.00
2.00
1.00
1.00
2.00
5.12
3.09
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
f1 (ppm)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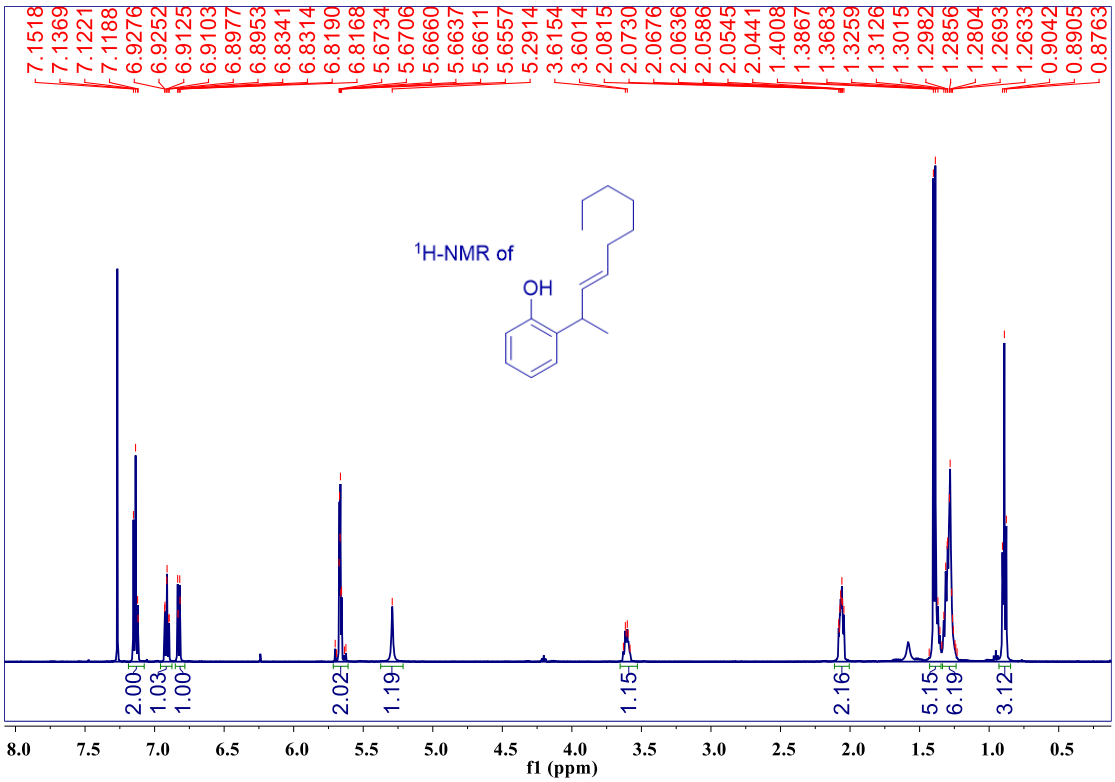
131.1312
130.6368
127.8315
127.6249
120.8504
116.3147
37.3374
34.5509
22.5462
19.4220
13.7028
13C-NMR of
OH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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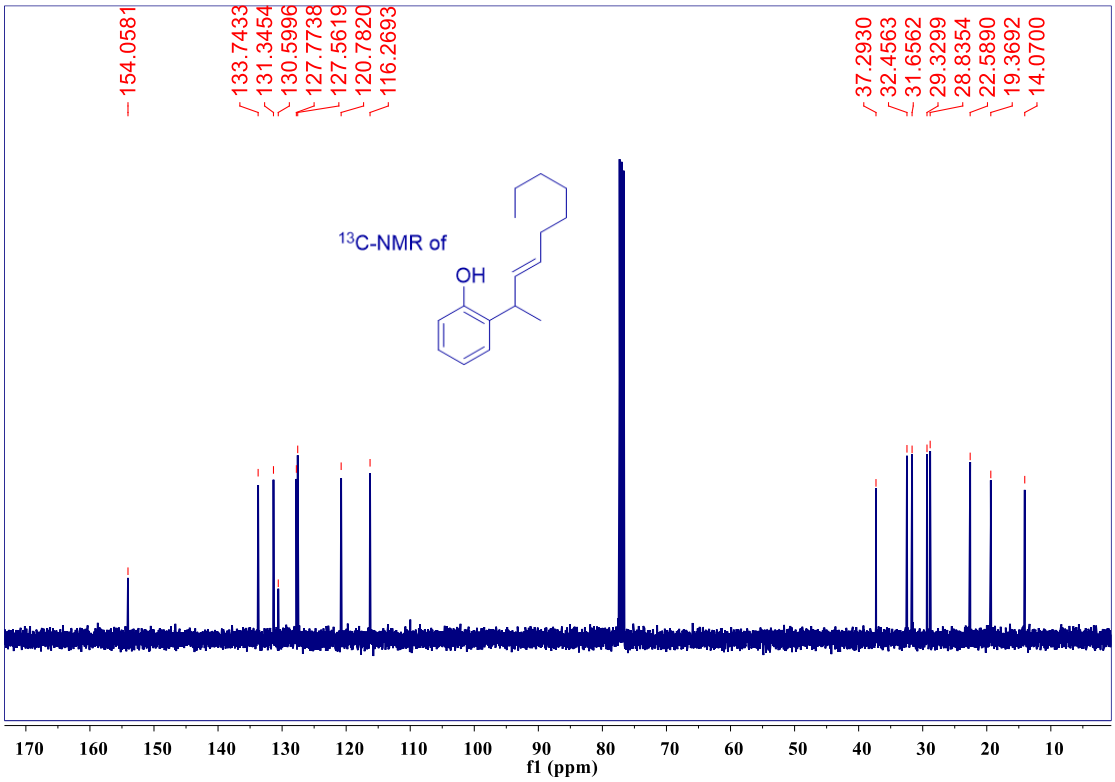
7.1369
7.1221
7.1188
6.9276
6.9252
6.9125
6.9103
6.8977
6.8953
6.8341
6.8314
6.8190
6.8168
5.6734
5.6706
5.6660
5.6637
5.6611
5.6557
5.2914
3.6154
3.6014
2.0815
2.0730
2.0676
2.0636
2.0586
2.0545
2.0441
1.4008
1.3867
1.3683
1.3259
1.3126
1.3015
1.2982
1.2856
1.2804
1.2693
1.2633
0.9042
0.8905
0.8763
1H-NMR of
OH
2.00
1.03
1.00
2.02
1.19
1.15
2.16
5.15
6.19
3.12
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
f1 (ppm)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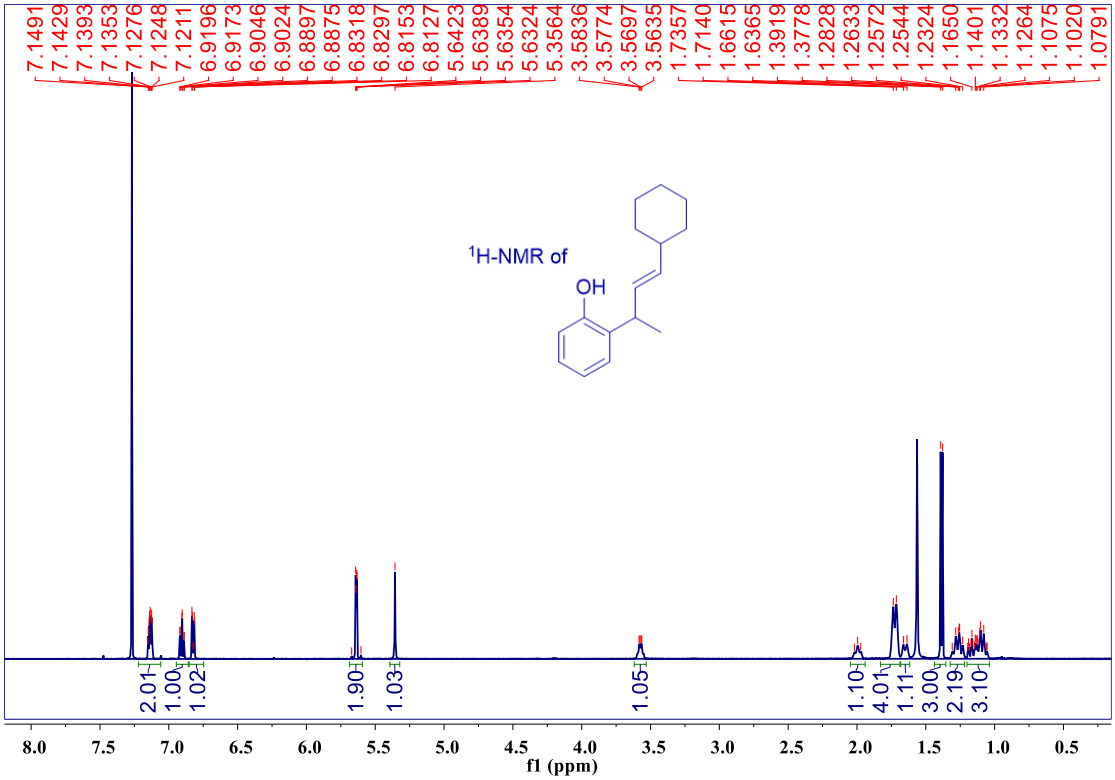
131.3454
130.5996
127.7738
127.5619
120.7820
116.2693
37.2930
32.4563
31.6562
29.3299
28.8354
22.5890
19.3692
14.0700
13C-NMR of
OH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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7.1393
7.1353
7.1276
7.1248
7.1211
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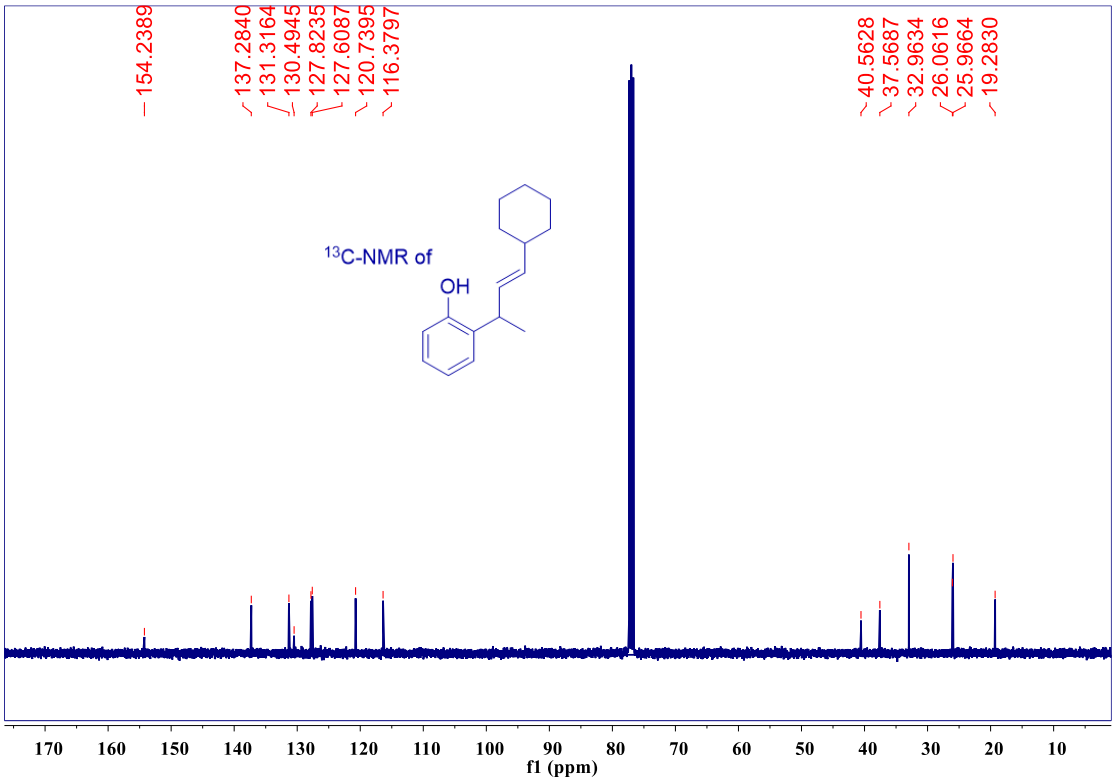
6.9173
6.9046
6.9024
6.8897
6.8875
6.8318
6.8297
6.8153
6.8127
5.6423
5.6389
5.6354
5.6324
5.3564
3.5836
3.5774
3.5697
3.5635
1.7357
1.7140
1.6615
1.6365
1.3919
1.3778
1.2828
1.2633
1.2572
1.2544
1.2324
1.1650
1.1401
1.1332
1.1264
1.1075
1.1020
1.0791
1H-NMR of
OH
2.01
1.00
1.02
1.90
1.03
1.05
1.10
4.01
1.11
3.00
2.19
3.10
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
f1 (ppm)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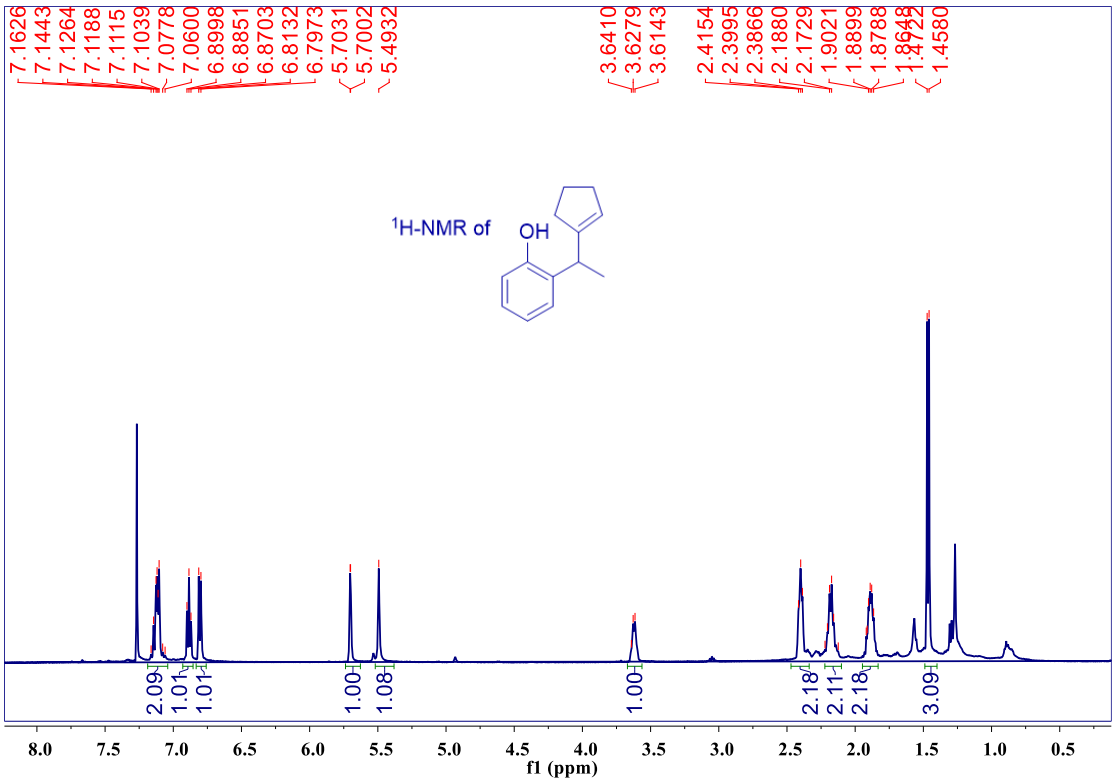
131.3164
130.4945
127.8235
127.6087
120.7395
116.3797
40.5628
37.5687
32.9634
26.0616
25.9664
19.2830
13C-NMR of
OH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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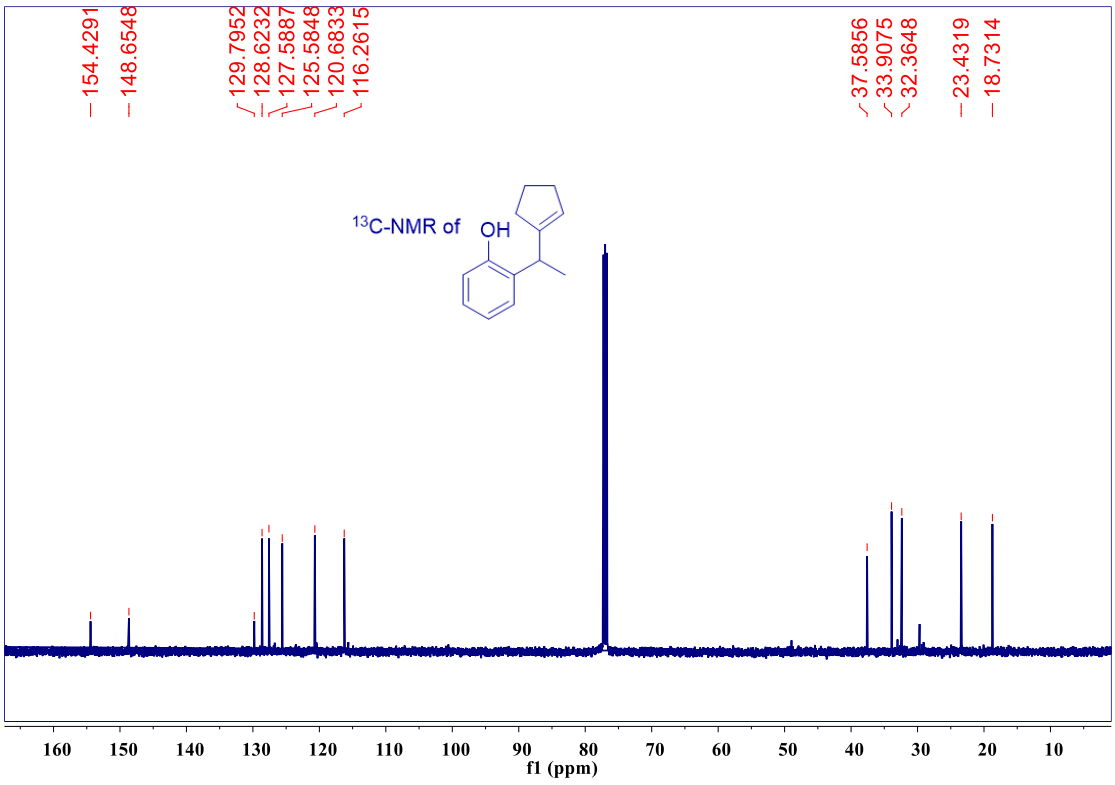
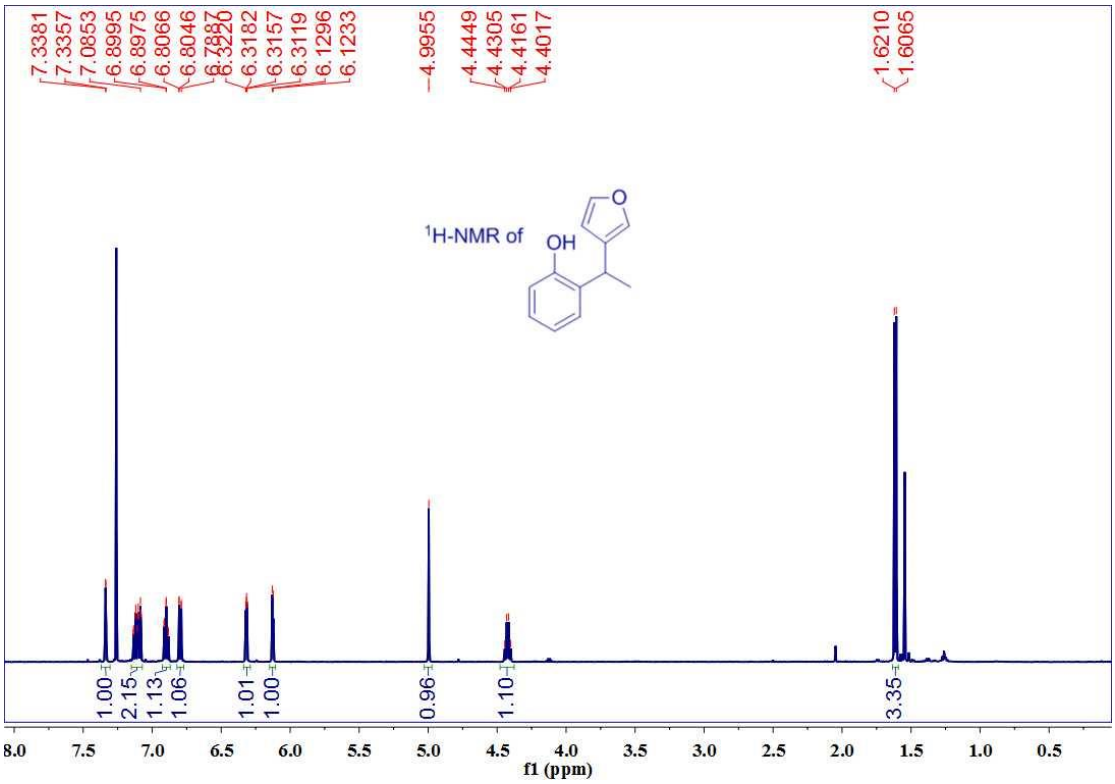
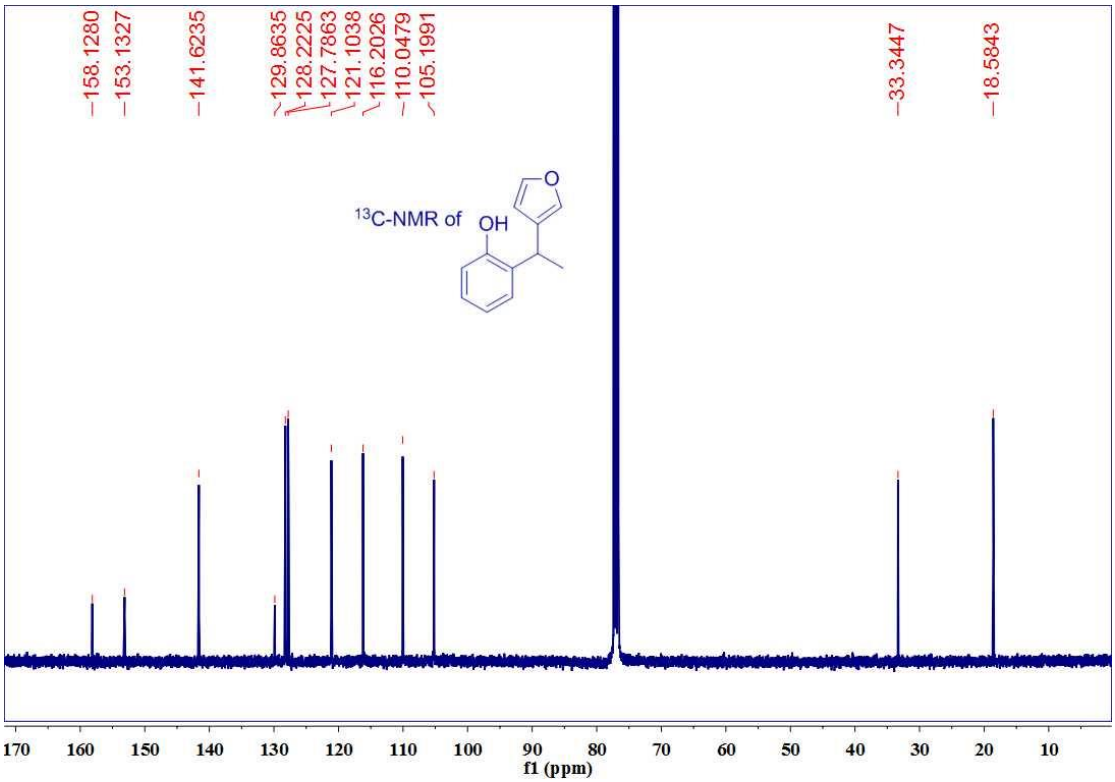
7.1443
7.1264
7.1188
7.1115
7.1039
7.0778
7.0600
6.8998
6.8851
6.8703
6.8132
6.7973
5.7031
5.7002
5.4932
3.6410
3.6279
3.6143
2.4154
2.3995
2.3866
2.1880
2.1729
1.9021
1.8899
1.8788
1.4722
1.4580
1H-NMR of
OH
2.09
1.01
1.01
1.00
1.08
1.00
2.18
2.11
2.18
3.09
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


154.4291
148.6548
129.7952
128.6232
127.5887
125.5848
120.6833
116.2615
37.5856
33.9075
32.3648
23.4319
18.7314
13C-NMR of
OH
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.3381
7.3357
7.0853
6.8995
6.8975
6.8066
6.8046
6.3220
6.3182
6.3157
6.3119
6.1296
6.1233
4.9955
4.4449
4.4305
4.4161
4.4017
1.6210
1.6065
1H-NMR of
OH
O
1.00
2.15
1.13
1.06
1.01
1.00
0.96
1.10
3.35
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
f1 (ppm)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141.6235
129.8635
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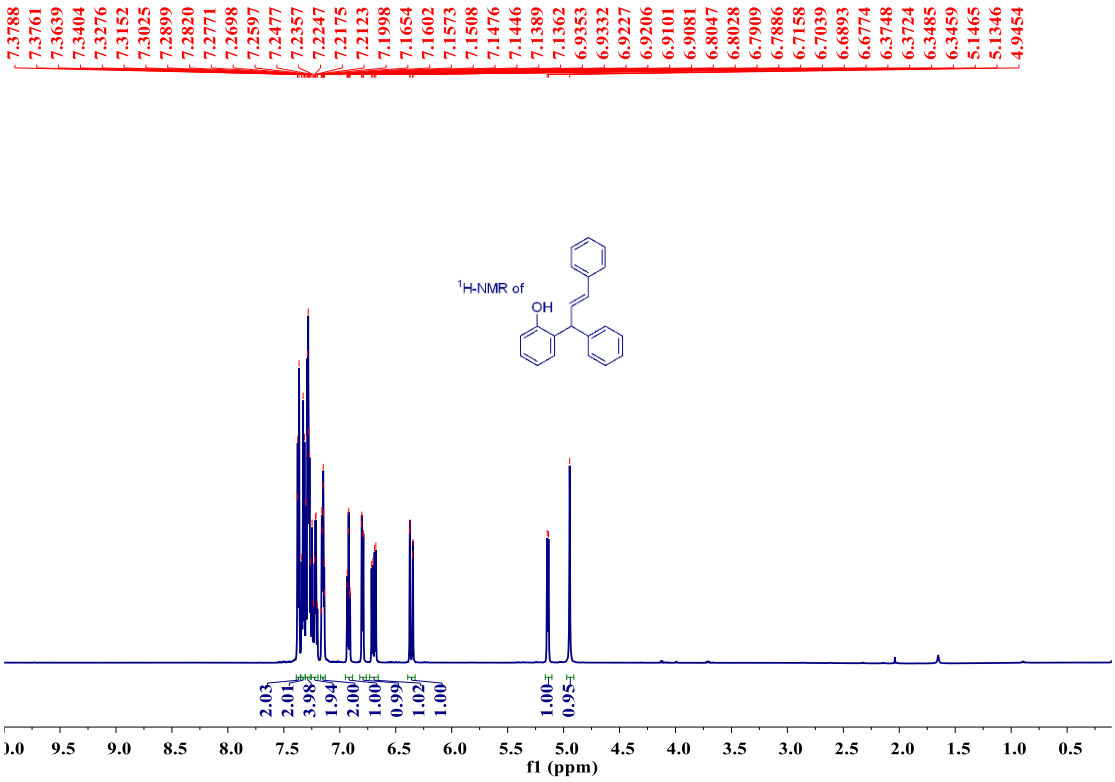
121.1038
116.2026
110.0479
105.1991
33.3447
18.5843
13C-NMR of
OH
O
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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7.3152
7.3025
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7.2820
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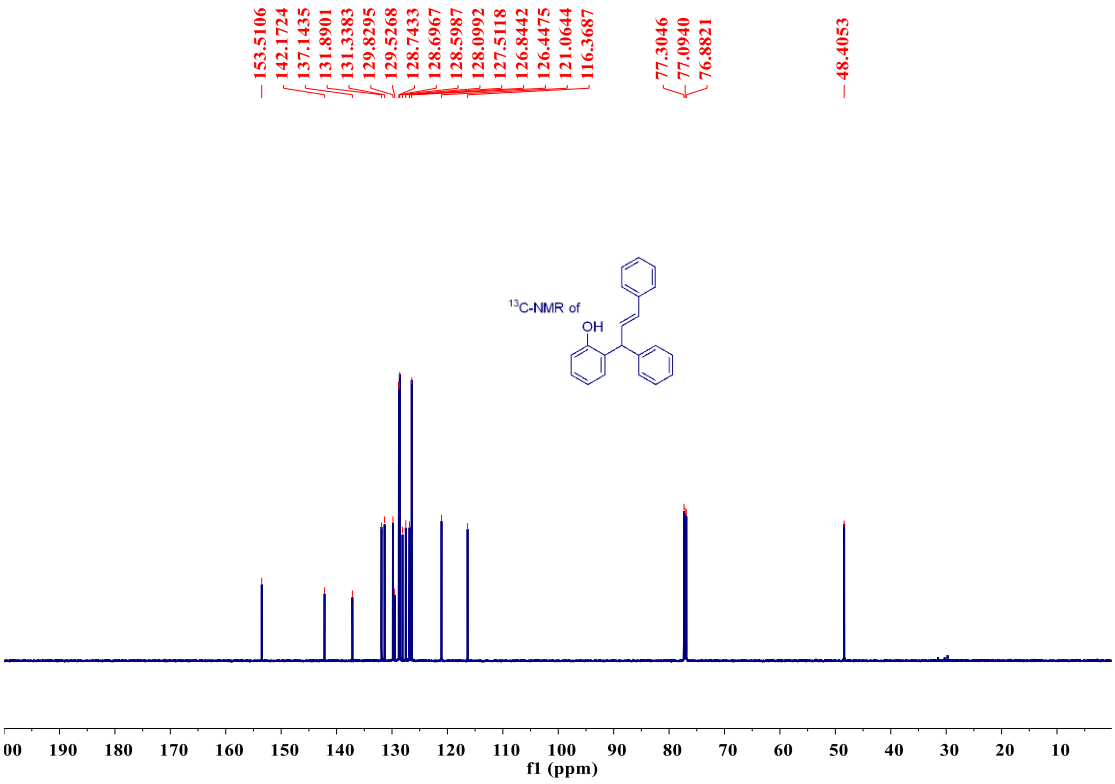
7.2698
7.2597
7.2477
7.2357
7.2247
7.2175
7.2123
7.1998
7.1654
7.1602
7.1573
7.1508
7.1476
7.1446
7.1389
7.1362
6.9353
6.9332
6.9227
6.9206
6.9101
6.9081
6.8047
6.8028
6.7909
6.7886
6.7158
6.7039
6.6893
6.6774
6.3748
6.3724
6.3485
6.3459
5.1465
5.1346
4.9454
1H-NMR of
OH
2.03
2.01
3.98
1.94
2.00
1.00
0.99
1.02
1.00
1.00
0.95
f1 (ppm)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127.5118
126.8442
126.4475
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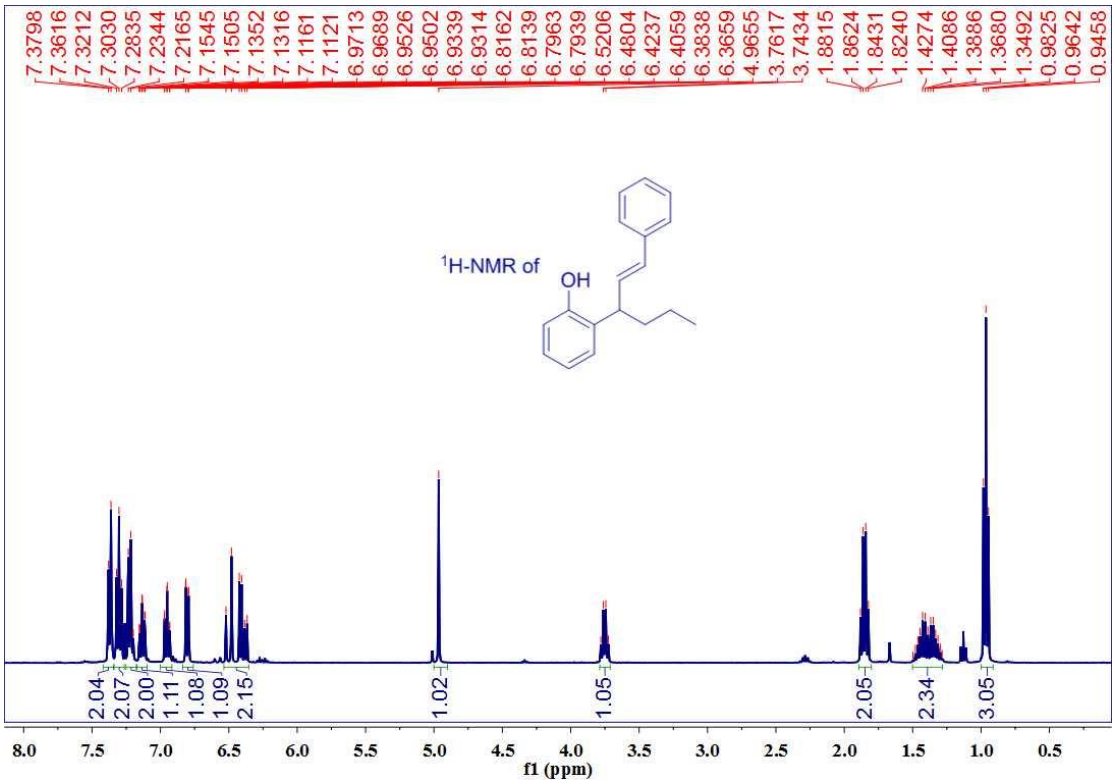
116.3687
77.3046
77.0940
76.8821
48.4053
13C-NMR of
OH
f1 (ppm)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7.3212
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7.2344
7.2165
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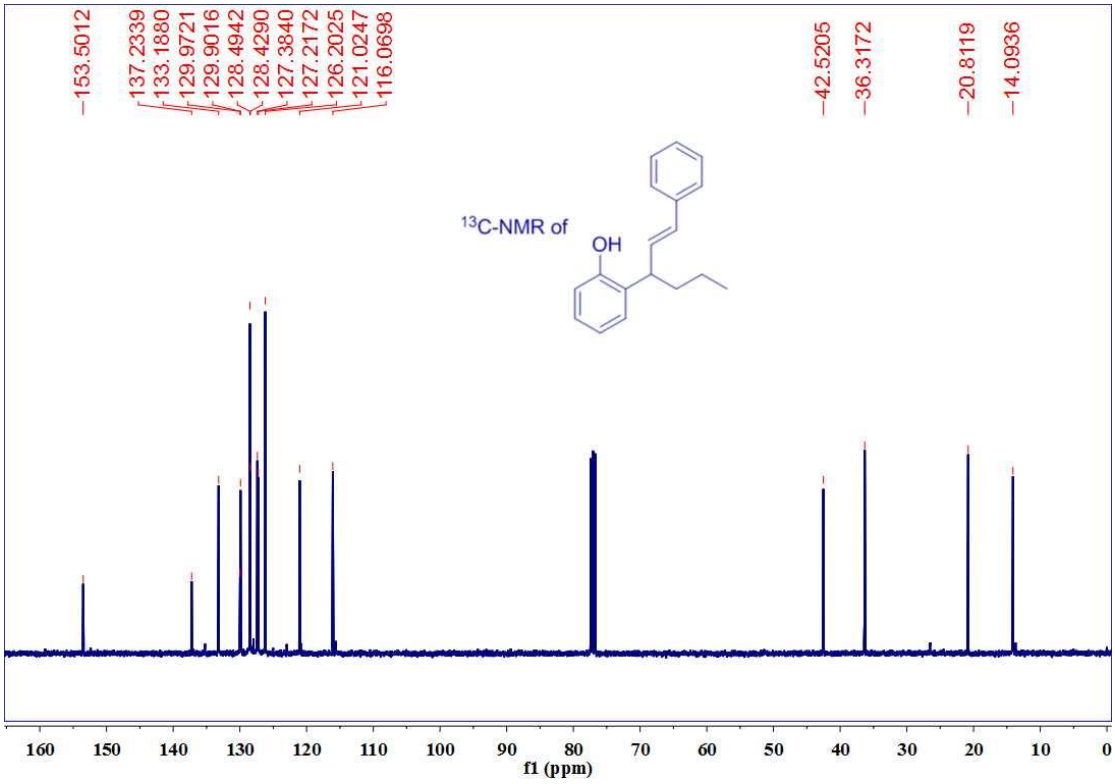
7.1505
7.1352
7.1316
7.1161
7.1121
6.9713
6.9689
6.9526
6.9502
6.9339
6.9314
6.8162
6.8139
6.7963
6.7939
6.5206
6.4804
6.4237
6.4059
6.3838
6.3659
4.9655
3.7617
3.7434
1.8815
1.8624
1.8431
1.8240
1.4274
1.4086
1.3886
1.3680
1.3492
0.9825
0.9642
0.9458
1H-NMR of
OH
2.04
2.07
2.00
1.11
1.08
1.09
2.15
1.02
1.05
2.05
2.34
3.05
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
f1 (ppm)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137.2339
133.1880
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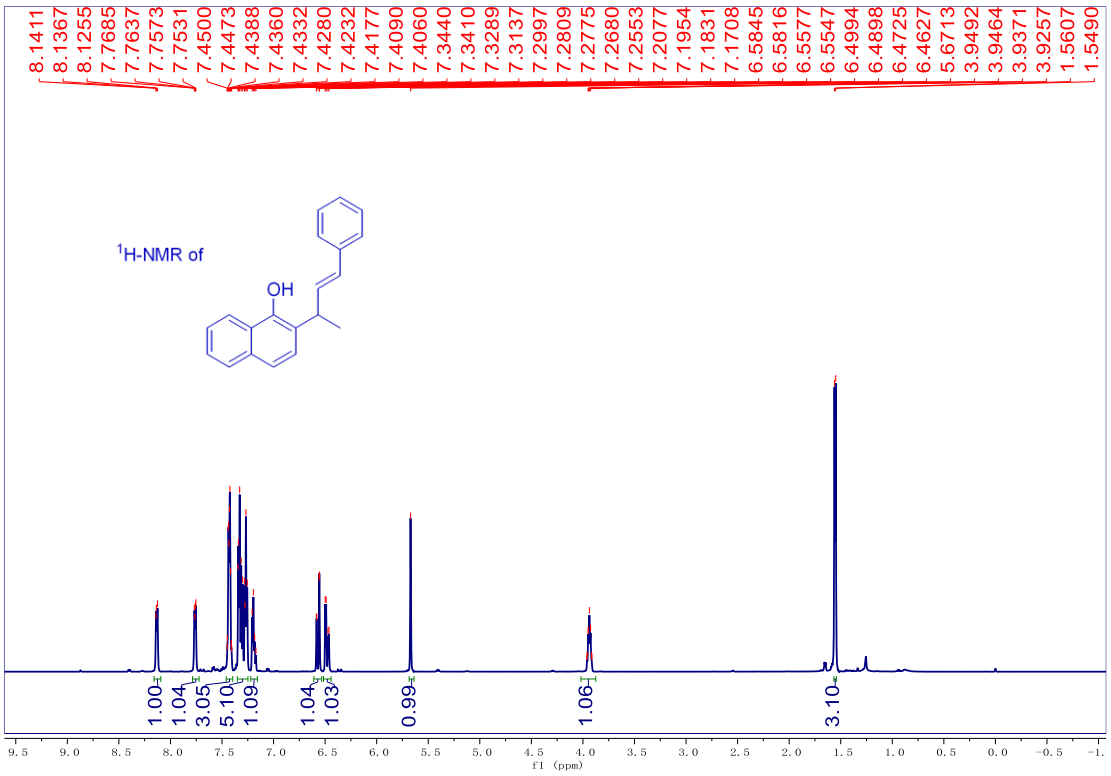
128.4290
127.3840
127.2172
126.2025
121.0247
116.0698
42.5205
36.3172
20.8119
14.0936
13C-NMR of
OH
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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8.1255
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7.7637
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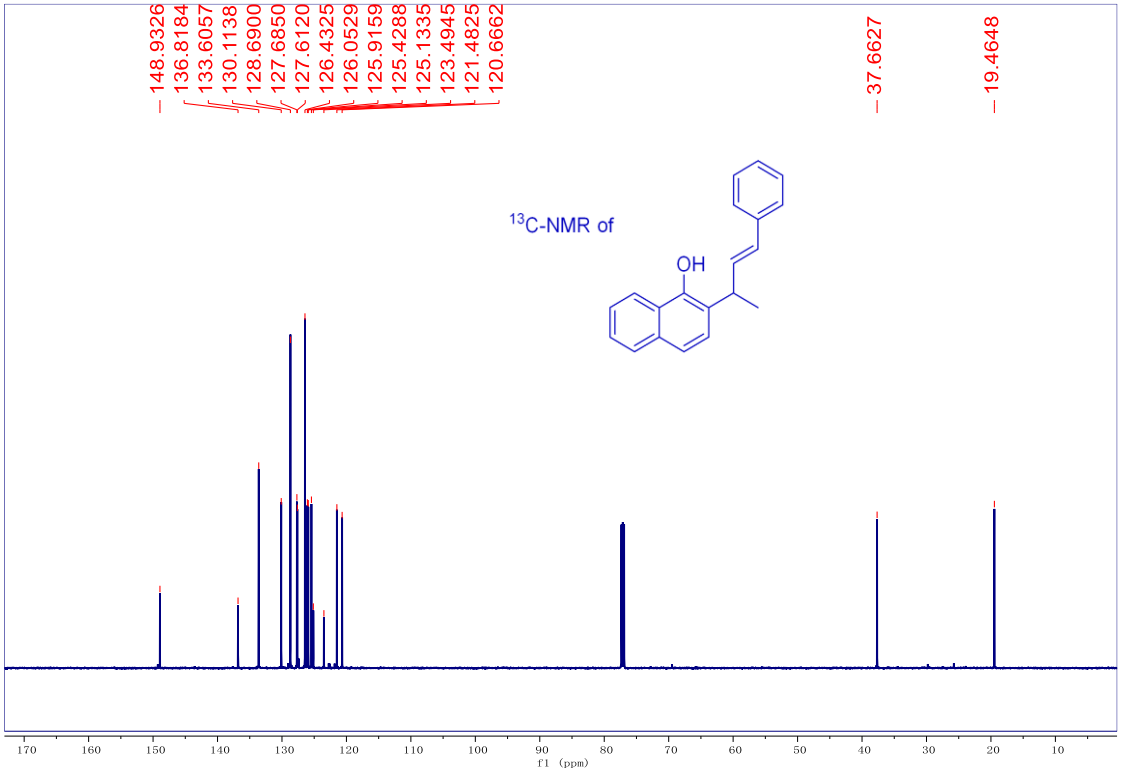
7.7531
7.4500
7.4473
7.4388
7.4360
7.4332
7.4280
7.4232
7.4177
7.4090
7.4060
7.3440
7.3410
7.3289
7.3137
7.2997
7.2809
7.2775
7.2680
7.2553
7.2077
7.1954
7.1831
7.1708
6.5845
6.5816
6.5577
6.5547
6.4994
6.4898
6.4725
6.4627
5.6713
3.9492
3.9464
3.9371
3.9257
1.5607
1.5490
1H-NMR of
OH
1.00
1.04
3.05
5.10
1.09
1.04
1.03
0.99
1.06
3.10
f1 (ppm)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136.8184
133.6057
130.1138
128.6900
127.6850
127.6120
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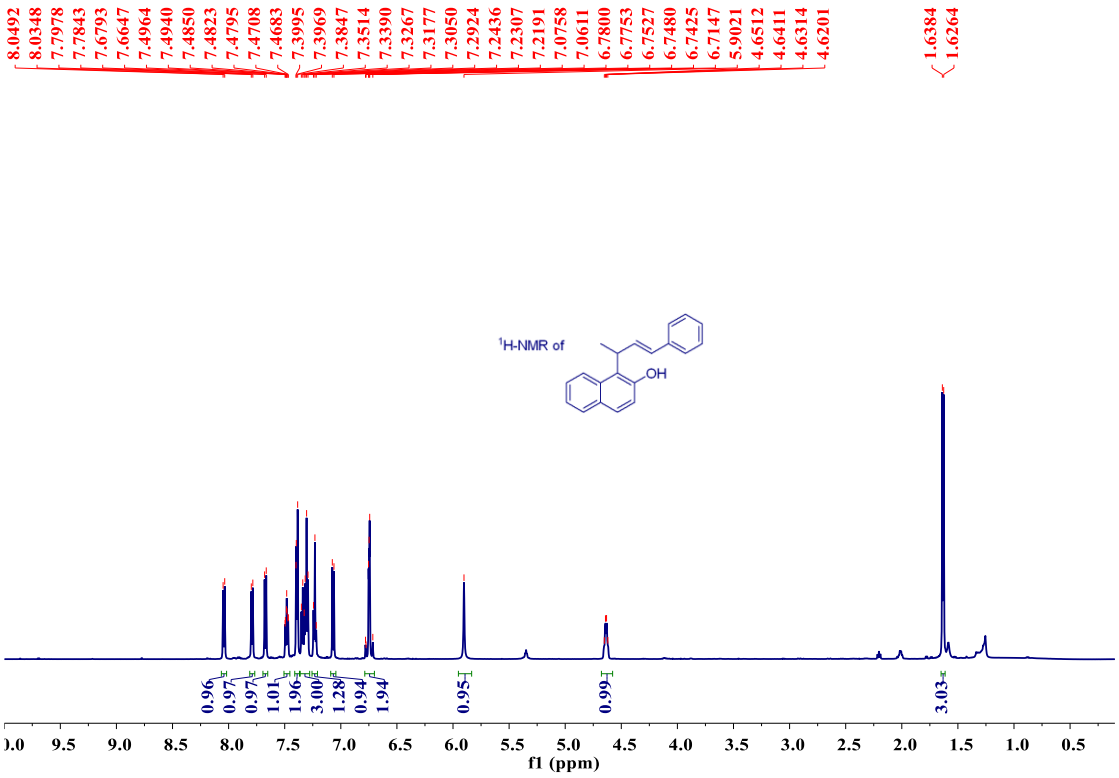
126.0529
125.9159
125.4288
125.1335
123.4945
121.4825
120.6662
37.6627
19.4648
13C-NMR of
OH
f1 (ppm)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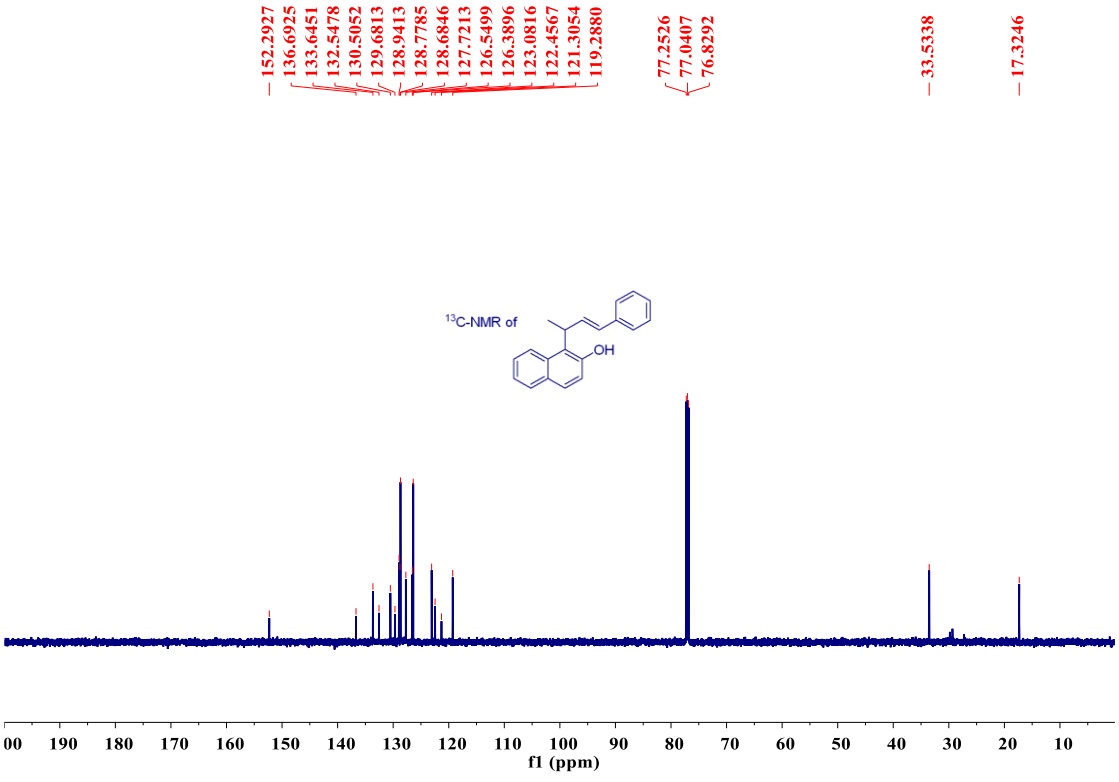
8.0348
7.7978
7.7843
7.6793
7.6647
7.4964
7.4940
7.4850
7.4823
7.4795
7.4708
7.4683
7.3995
7.3969
7.3847
7.3514
7.3390
7.3267
7.3177
7.3050
7.2924
7.2436
7.2307
7.2191
7.0758
7.0611
6.7800
6.7753
6.7527
6.7480
6.7425
6.7147
5.9021
4.6512
4.6411
4.6314
4.6201
1.6384
1.6264
1H-NMR of
OH
0.96
0.97
0.97
1.01
1.96
3.00
1.28
0.94
1.94
0.95
0.99
3.03
f1 (ppm)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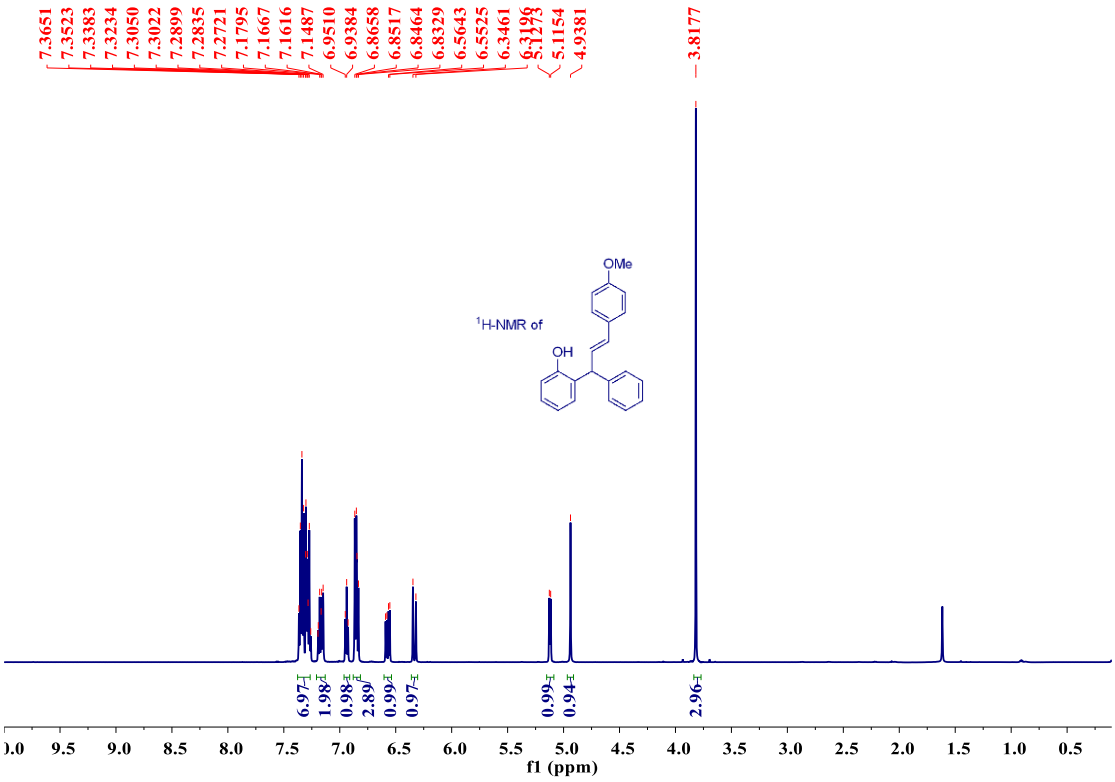
133.6451
132.5478
130.5052
129.6813
128.9413
128.7785
128.6846
127.7213
126.5499
126.3896
123.0816
122.4567
121.3054
119.2880
77.2526
77.0407
76.8292
33.5338
17.3246
13C-NMR of
OH
f1 (ppm)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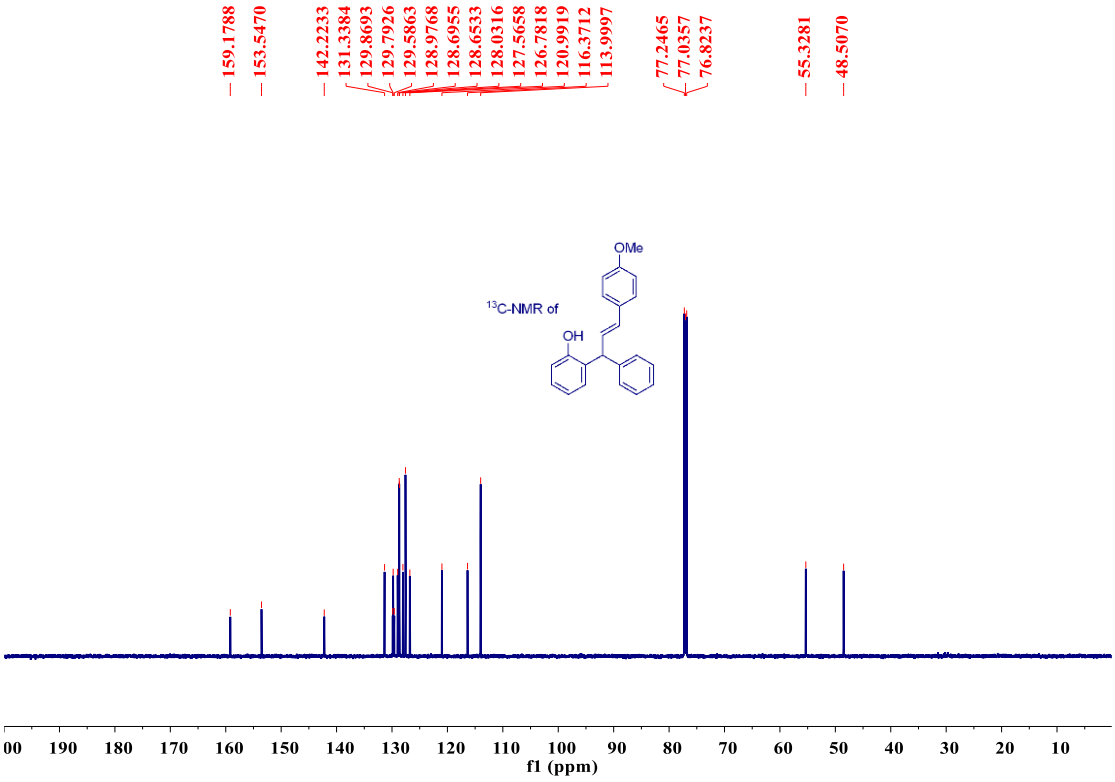
7.3523
7.3383
7.3234
7.3050
7.3022
7.2899
7.2835
7.2721
7.1795
7.1667
7.1616
7.1487
6.9510
6.9384
6.8658
6.8517
6.8464
6.8329
6.5643
6.5525
6.3461
6.3196
5.1273
5.1154
4.9381
3.8177
OMe
1H-NMR of
OH
6.97
1.98
0.98
2.89
0.99
0.97
0.99
0.94
2.96
f1 (ppm)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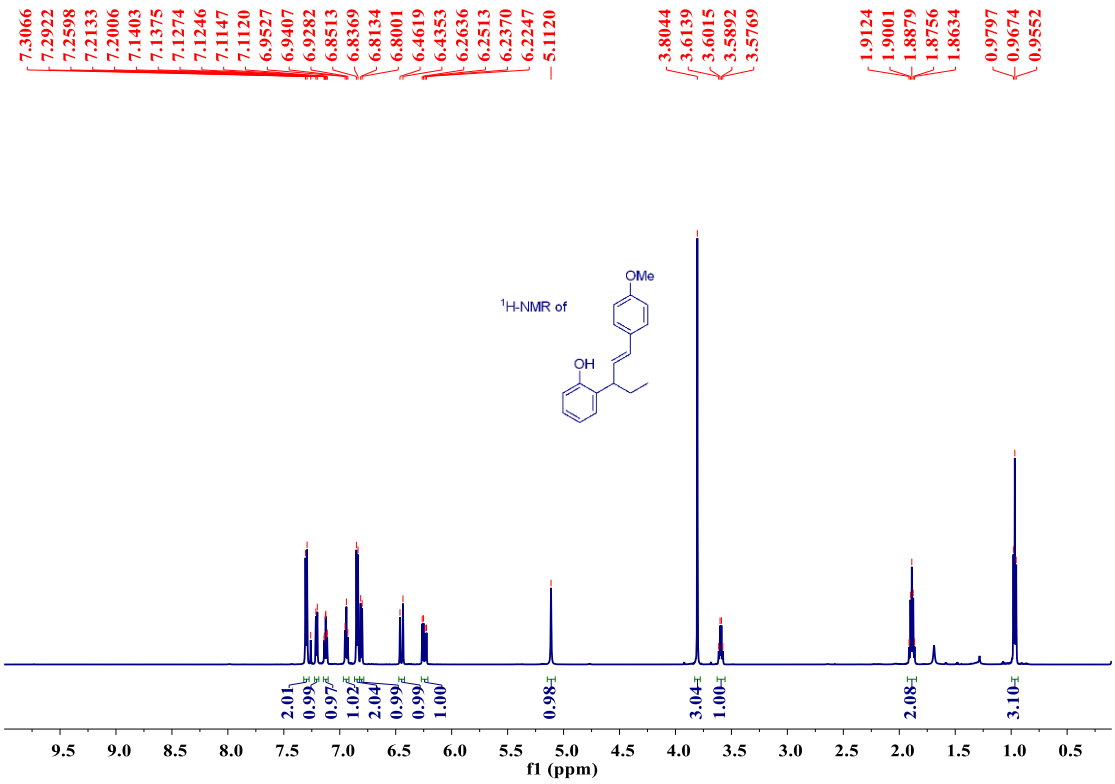
129.8693
129.7926
129.5863
128.9768
128.6955
128.6533
128.0316
127.5658
126.7818
120.9919
116.3712
113.9997
77.2465
77.0357
76.8237
55.3281
48.5070
OMe
13C-NMR of
OH
f1 (ppm)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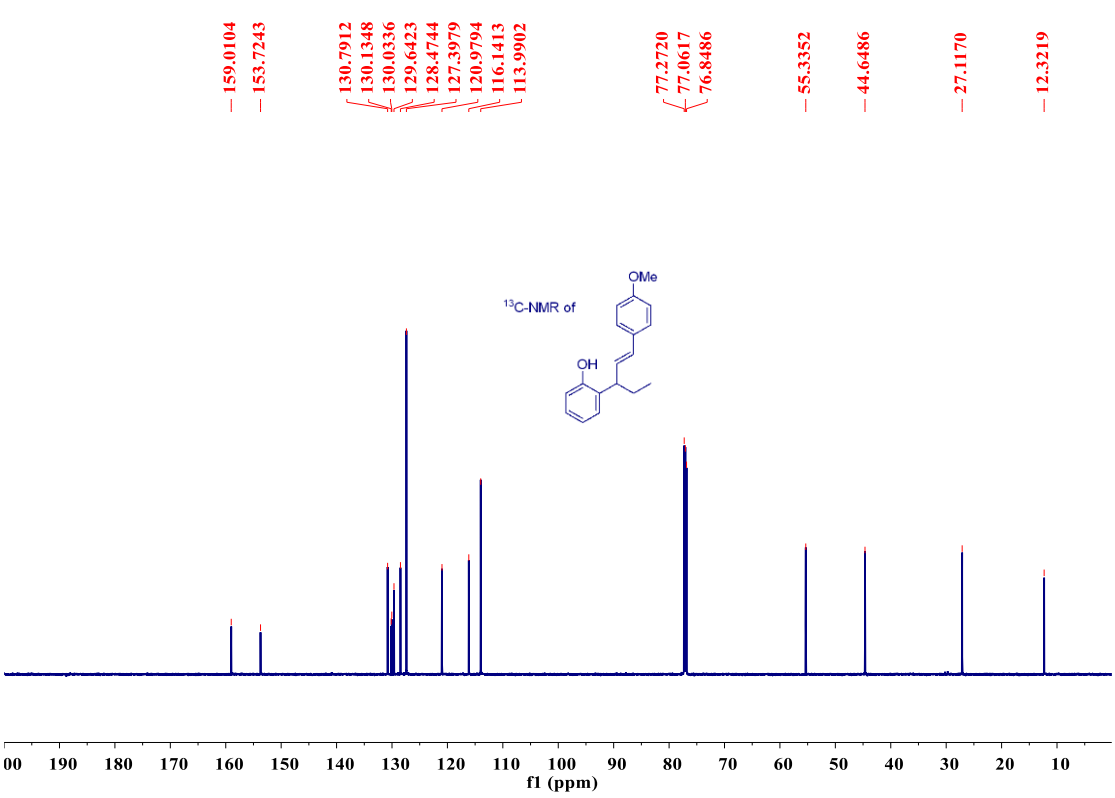
7.2922
7.2598
7.2133
7.2006
7.1403
7.1375
7.1274
7.1246
7.1147
7.1120
6.9527
6.9407
6.9282
6.8513
6.8369
6.8134
6.8001
6.4619
6.4353
6.2636
6.2513
6.2370
6.2247
5.1120
3.8044
3.6139
3.6015
3.5892
3.5769
1.9124
1.9001
1.8879
1.8756
1.8634
0.9797
0.9674
0.9552
1H-NMR of
OMe
OH
2.01
0.99
0.97
1.02
2.04
0.99
0.99
1.00
0.98
3.04
1.00
2.08
3.10
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
f1 (ppm)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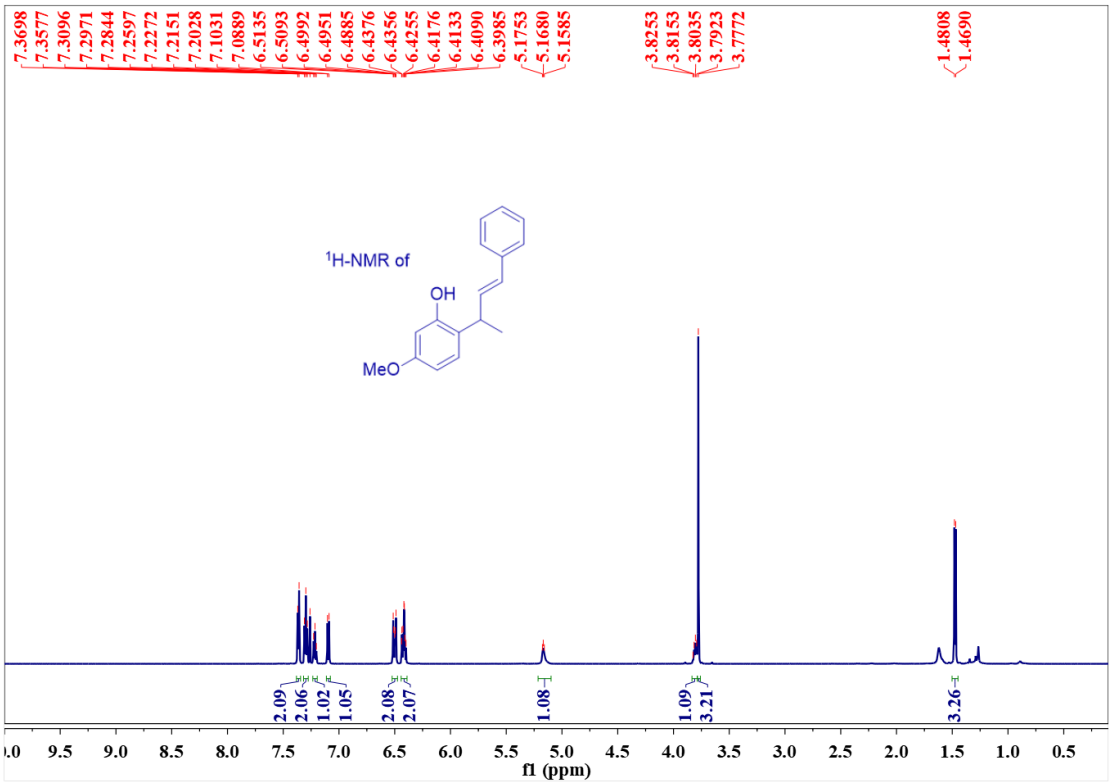
130.0336
129.6423
128.4744
127.3979
120.9794
116.1413
113.9902
77.2720
77.0617
76.8486
55.3352
44.6486
27.1170
12.3219
13C-NMR of
OMe
OH
00 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)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7.2272
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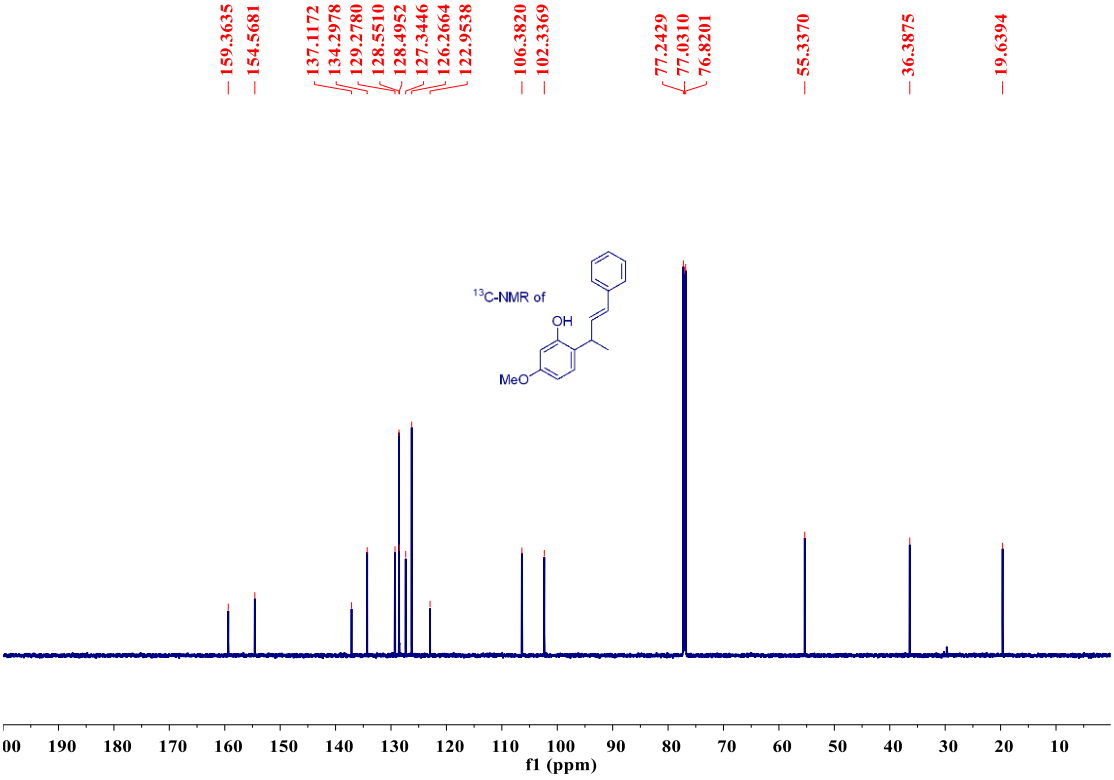
7.2028
7.1031
7.0889
6.5135
6.5093
6.4992
6.4951
6.4885
6.4376
6.4356
6.4255
6.4176
6.4133
6.4090
6.3985
5.1753
5.1680
5.1585
3.8253
3.8153
3.8035
3.7923
3.7772
1.4808
1.4690
1H-NMR of
OH
MeO
2.09
2.06
1.02
1.05
2.08
2.07
1.08
1.09
3.21
3.26
f1 (ppm)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128.5510
128.4952
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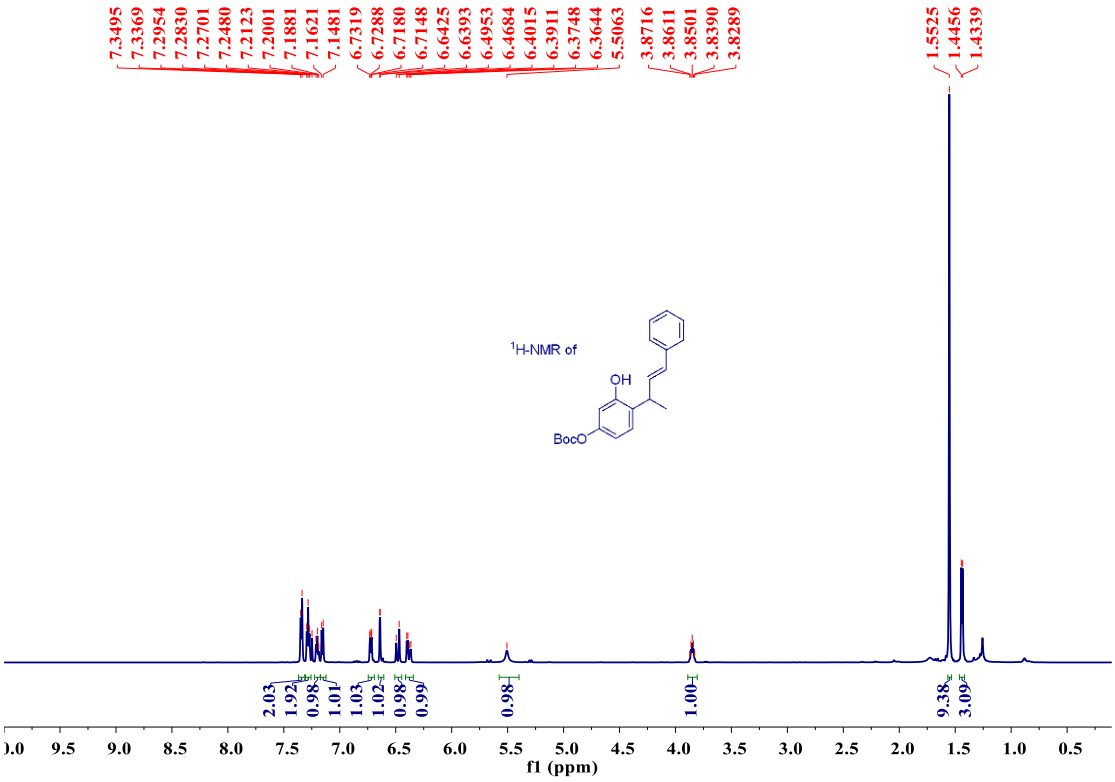
126.2664
122.9538
106.3820
102.3369
77.2429
77.0310
76.8201
55.3370
36.3875
19.6394
13C-NMR of
OH
MeO
f1 (ppm)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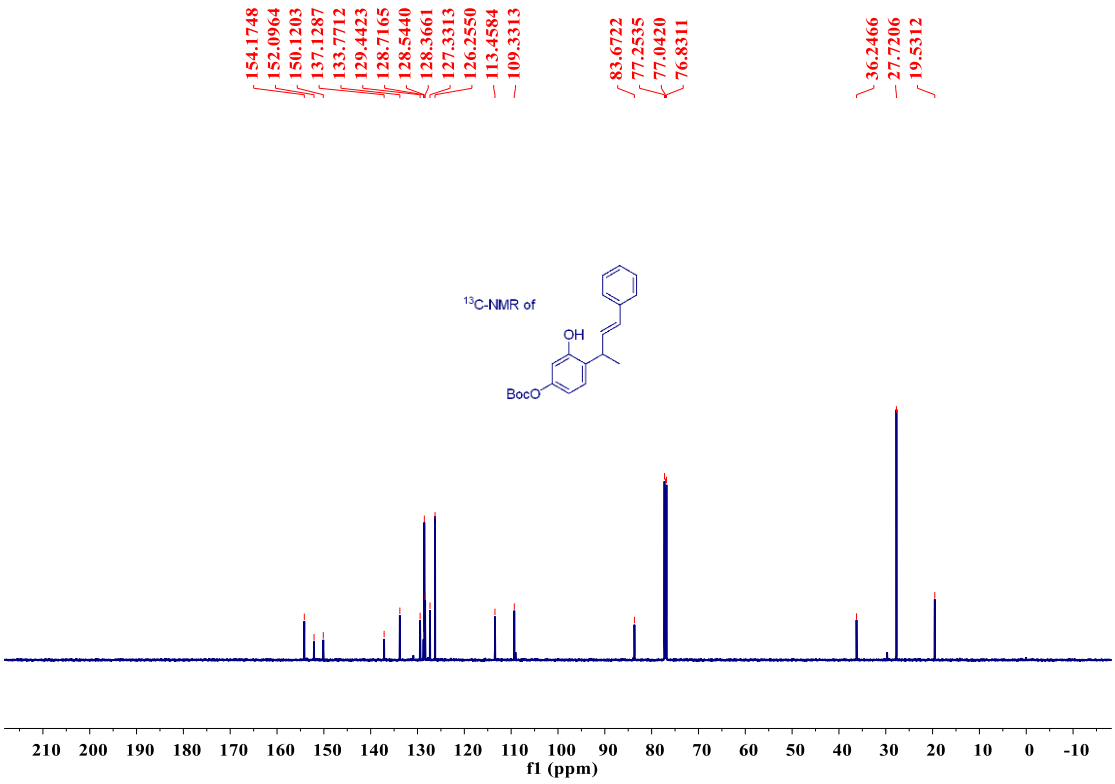
7.1481
6.7319
6.7288
6.7180
6.7148
6.6425
6.6393
6.4953
6.4684
6.4015
6.3911
6.3748
6.3644
5.5063
3.8716
3.8611
3.8501
3.8390
3.8289
1.5525
1.4456
1.4339
1H-NMR of
OH
BocO
2.03
1.92
0.98
1.01
1.03
1.02
0.98
0.99
0.98
1.00
9.38
3.09
f1 (ppm)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113.4584
109.3313
83.6722
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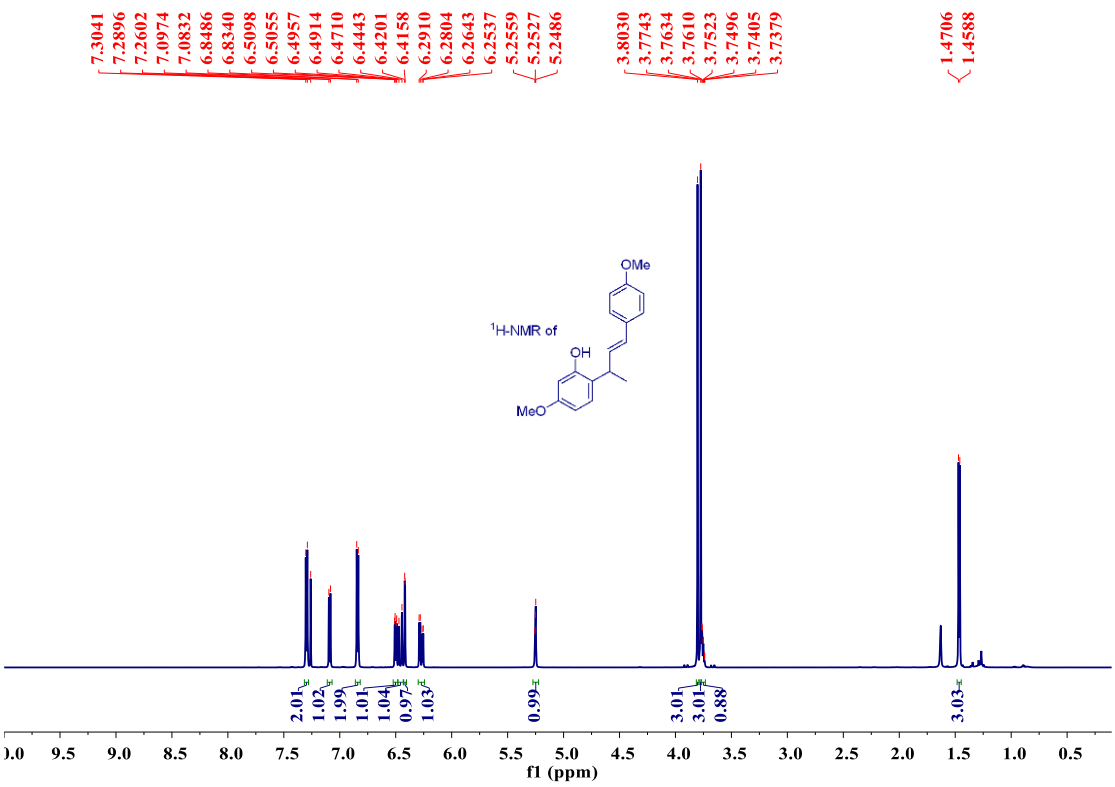
77.0420
76.8311
36.2466
27.7206
19.5312
13C-NMR of
OH
BocO
f1 (ppm)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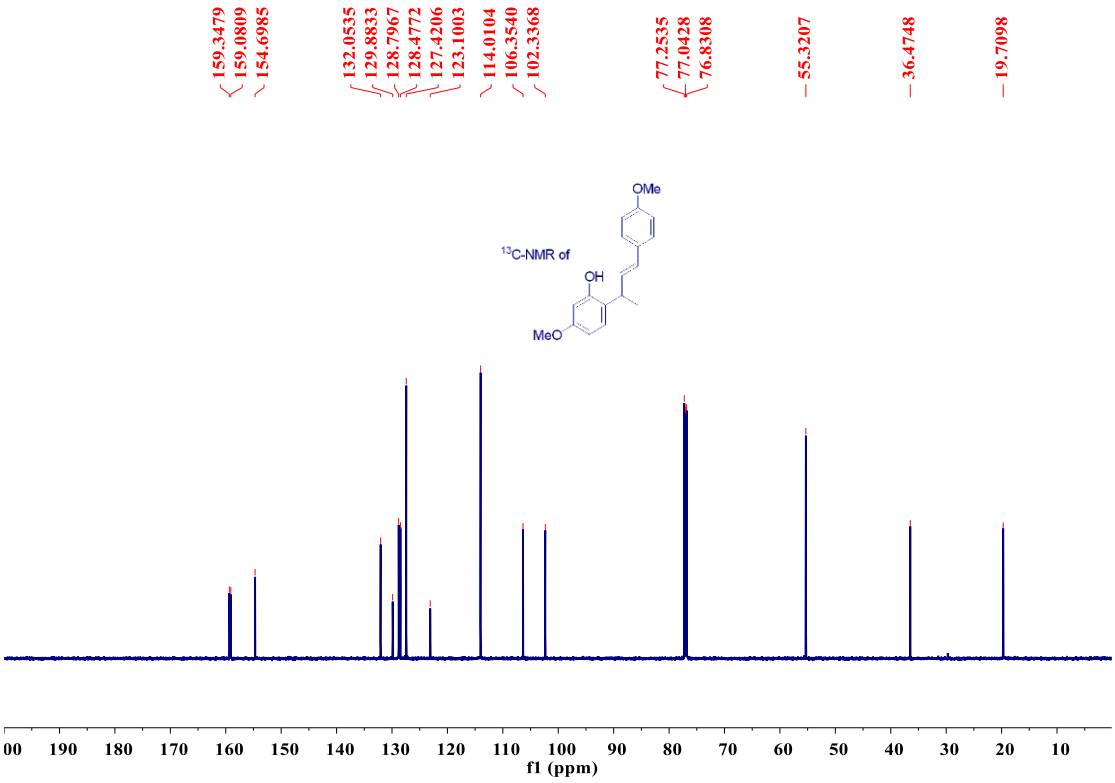
6.4914
6.4710
6.4443
6.4201
6.4158
6.2910
6.2804
6.2643
6.2537
5.2559
5.2527
5.2486
3.8030
3.7743
3.7634
3.7610
3.7523
3.7496
3.7405
3.7379
1.4706
1.4588
OMe
1H-NMR of
OH
MeO
2.01
1.02
1.99
1.01
1.04
0.97
1.03
0.99
3.01
3.01
0.88
3.03
f1 (ppm)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114.0104
106.3540
102.3368
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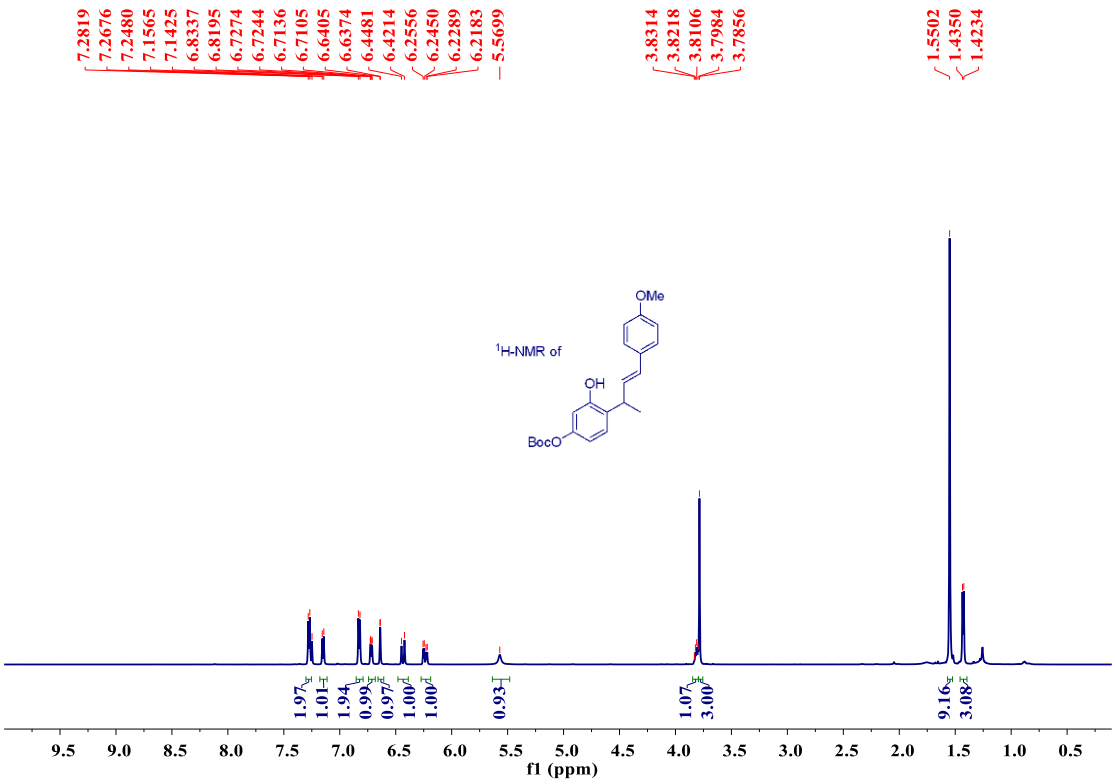
55.3207
36.4748
19.7098
OMe
13C-NMR of
OH
MeO
f1 (ppm)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6.7244
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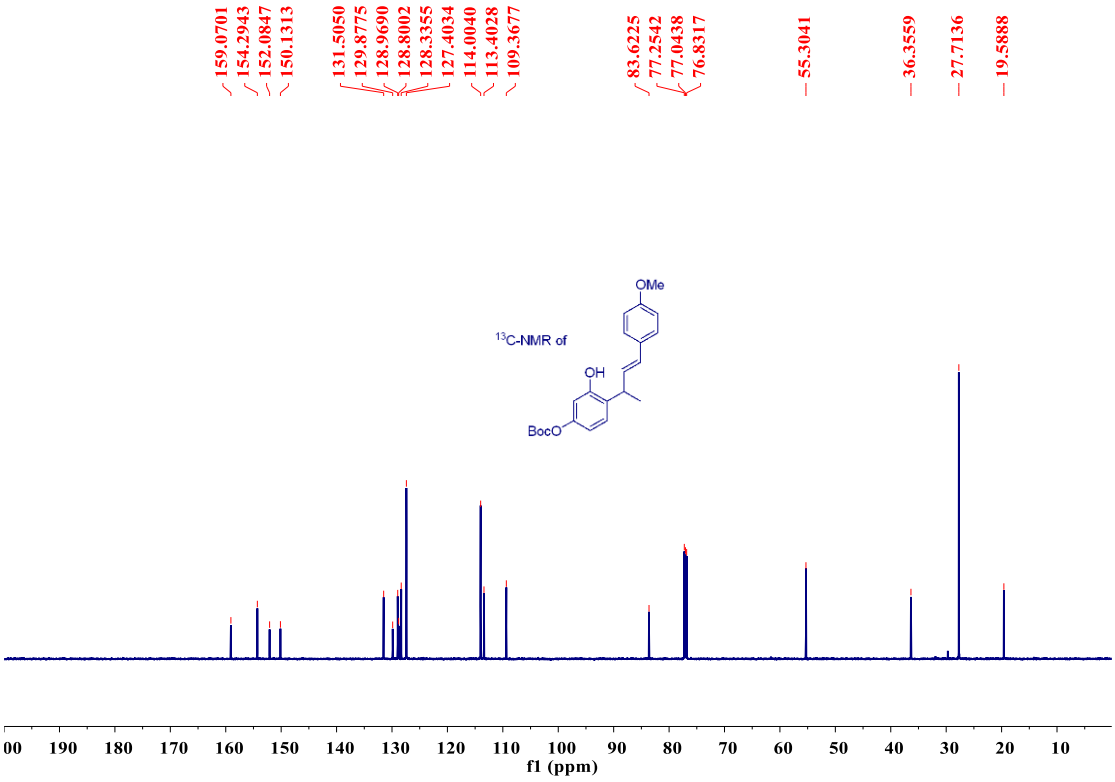
6.7105
6.6405
6.6374
6.4481
6.4214
6.2556
6.2450
6.2289
6.2183
5.5699
3.8314
3.8218
3.8106
3.7984
3.7856
1.5502
1.4350
1.4234
OMe
1H-NMR of
OH
BocO
1.97
1.01
1.94
0.99
0.97
1.00
1.00
0.93
1.07
3.00
9.16
3.08
f1 (ppm)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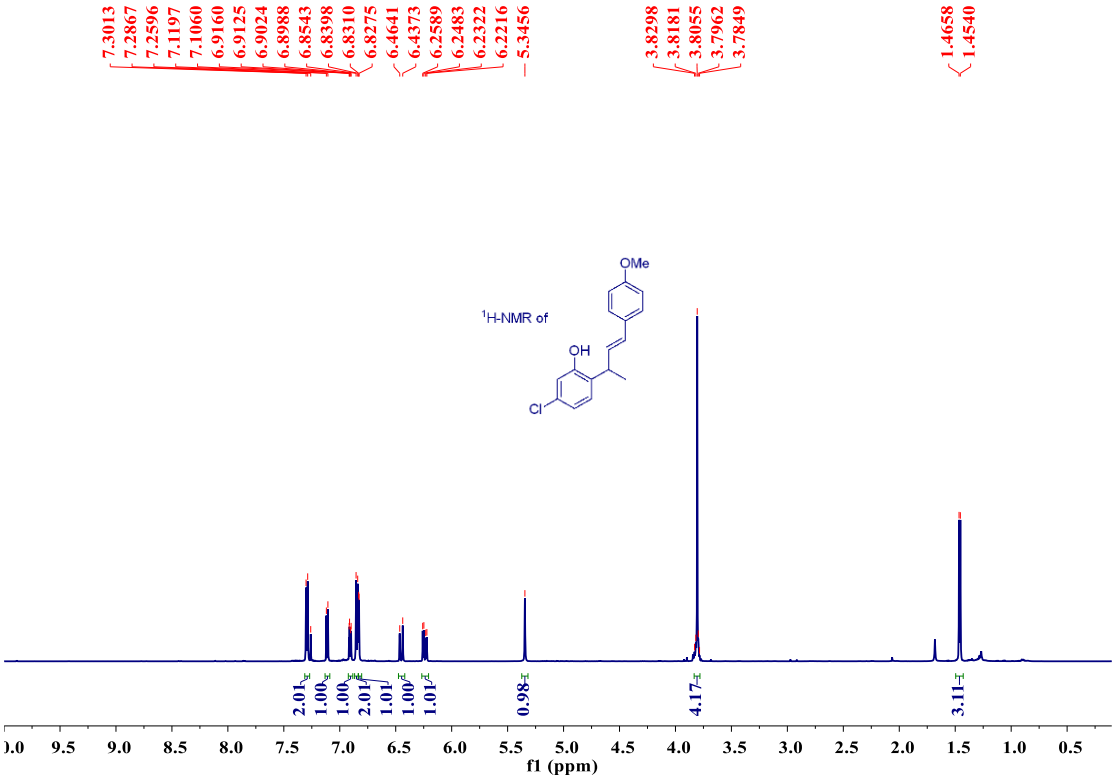
114.0040
113.4028
109.3677
83.6225
77.2542
77.0438
76.8317
55.3041
36.3559
27.7136
19.5888
OMe
13C-NMR of
OH
BocO
f1 (ppm)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6.9125
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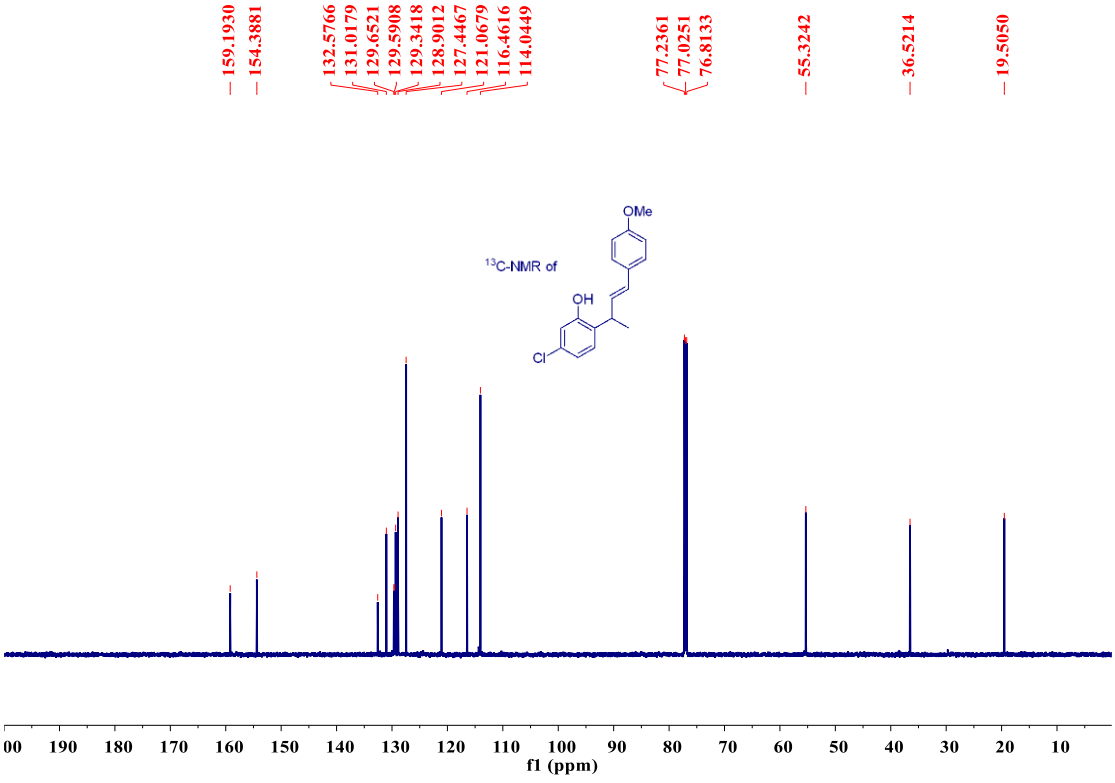
6.8988
6.8543
6.8398
6.8310
6.8275
6.4641
6.4373
6.2589
6.2483
6.2322
6.2216
5.3456
3.8298
3.8181
3.8055
3.7962
3.7849
1.4658
1.4540
OMe
1H-NMR of
OH
Cl
2.01
1.00
1.00
2.01
1.01
1.00
1.01
0.98
4.17
3.11
f1 (ppm)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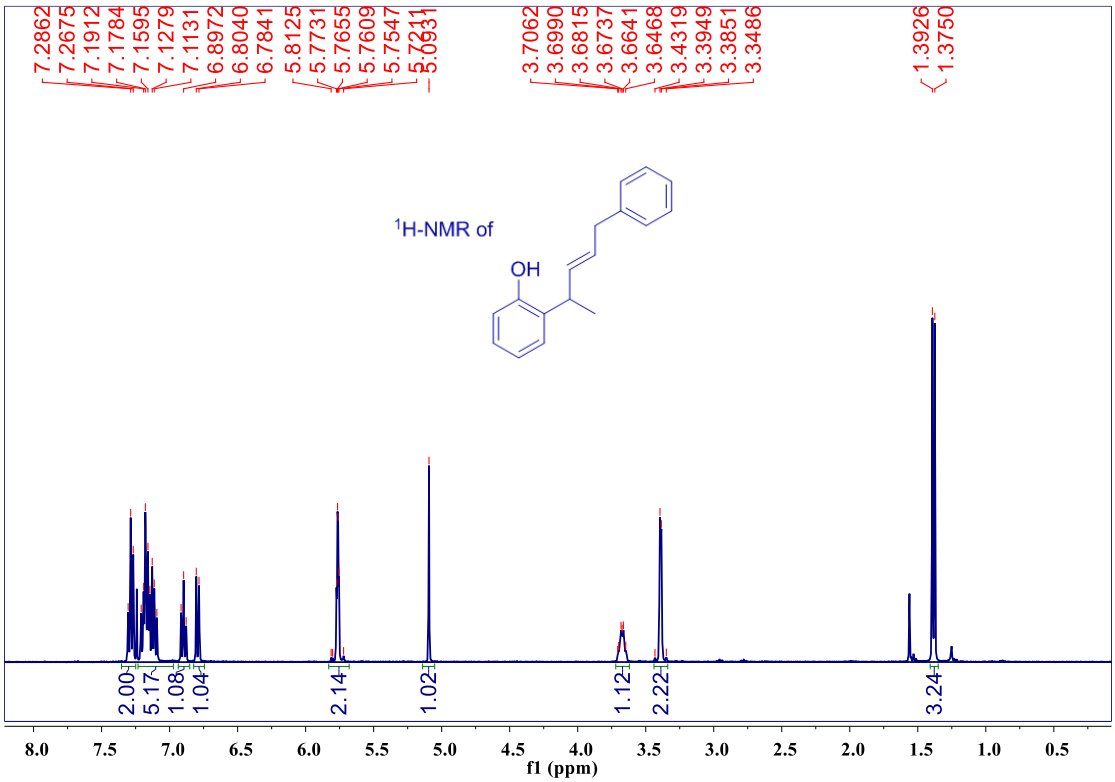
127.4467
121.0679
116.4616
114.0449
77.2361
77.0251
76.8133
55.3242
36.5214
19.5050
OMe
13C-NMR of
OH
Cl
f1 (ppm)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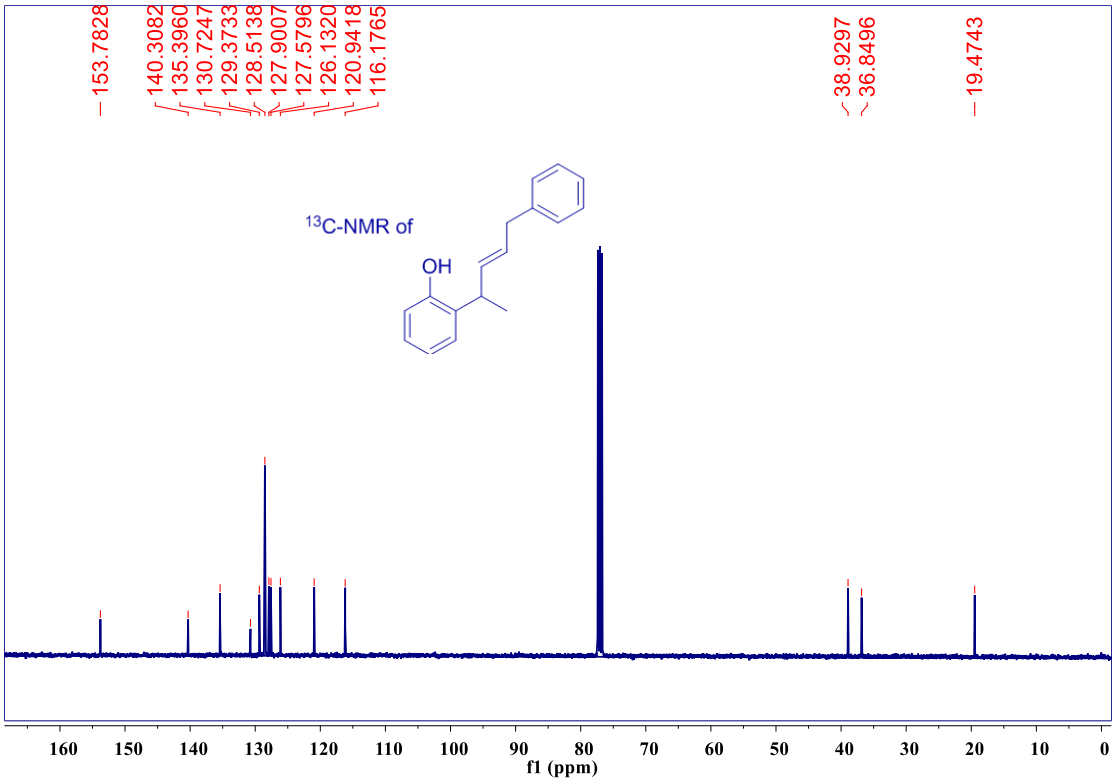
7.1912
7.1784
7.1595
7.1279
7.1131
6.8972
6.8040
6.7841
5.8125
5.7731
5.7655
5.7609
5.7547
5.7211
5.0931
3.7062
3.6990
3.6815
3.6737
3.6641
3.6468
3.4319
3.3949
3.3851
3.3486
1.3926
1.3750
1H-NMR of
OH
2.00
5.17
1.08
1.04
2.14
1.02
1.12
2.22
3.24
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5
f1 (ppm)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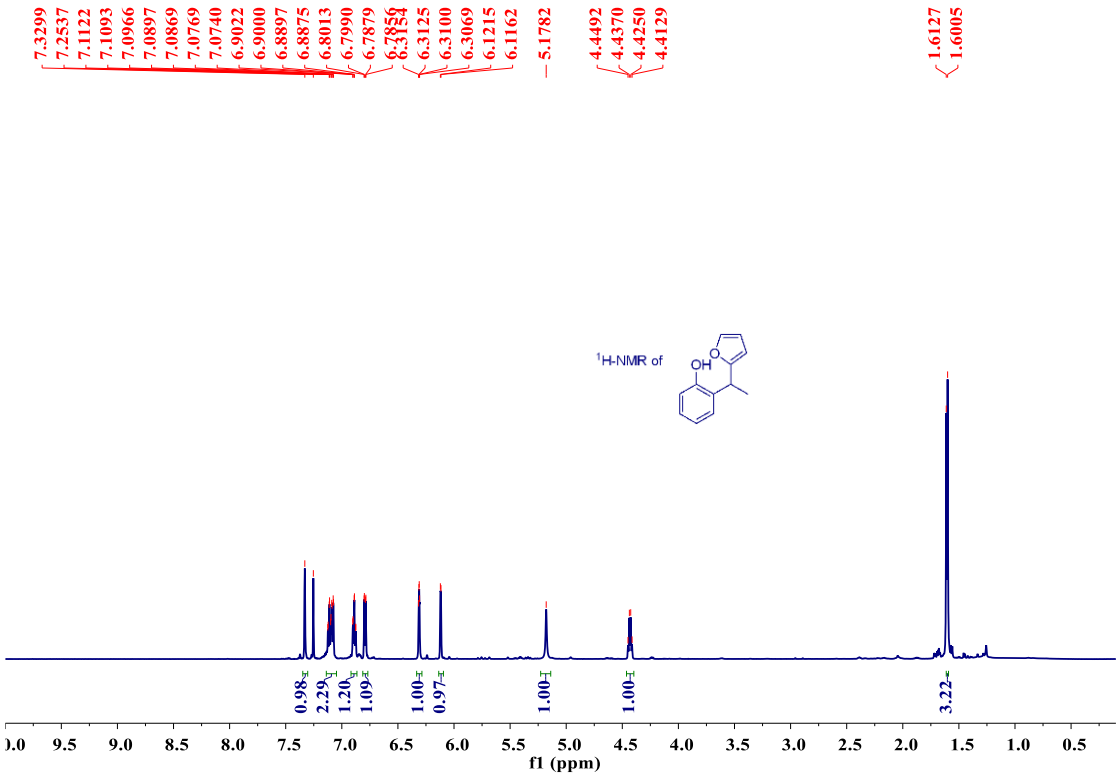
140.3082
135.3960
130.7247
129.3733
128.5138
127.9007
127.5796
126.1320
120.9418
116.1765
38.9297
36.8496
19.4743
13C-NMR of
OH
160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)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7.2537
7.1122
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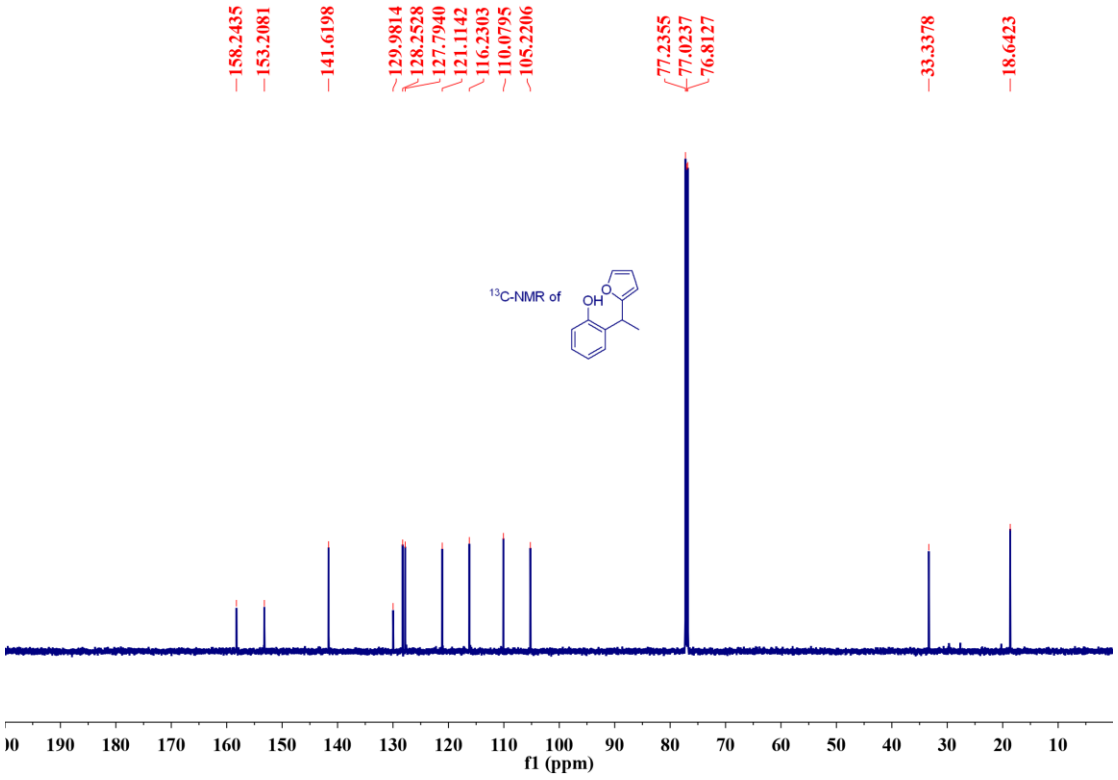
7.0966
7.0897
7.0869
7.0769
7.0740
6.9022
6.9000
6.8897
6.8875
6.8013
6.7990
6.7879
6.7856
6.3154
6.3125
6.3100
6.3069
6.1215
6.1162
5.1782
4.4492
4.4370
4.4250
4.4129
1.6127
1.6005
1H-NMR of
OH
0.98
2.29
1.20
1.09
1.00
0.97
1.00
1.00
3.22
f1 (ppm)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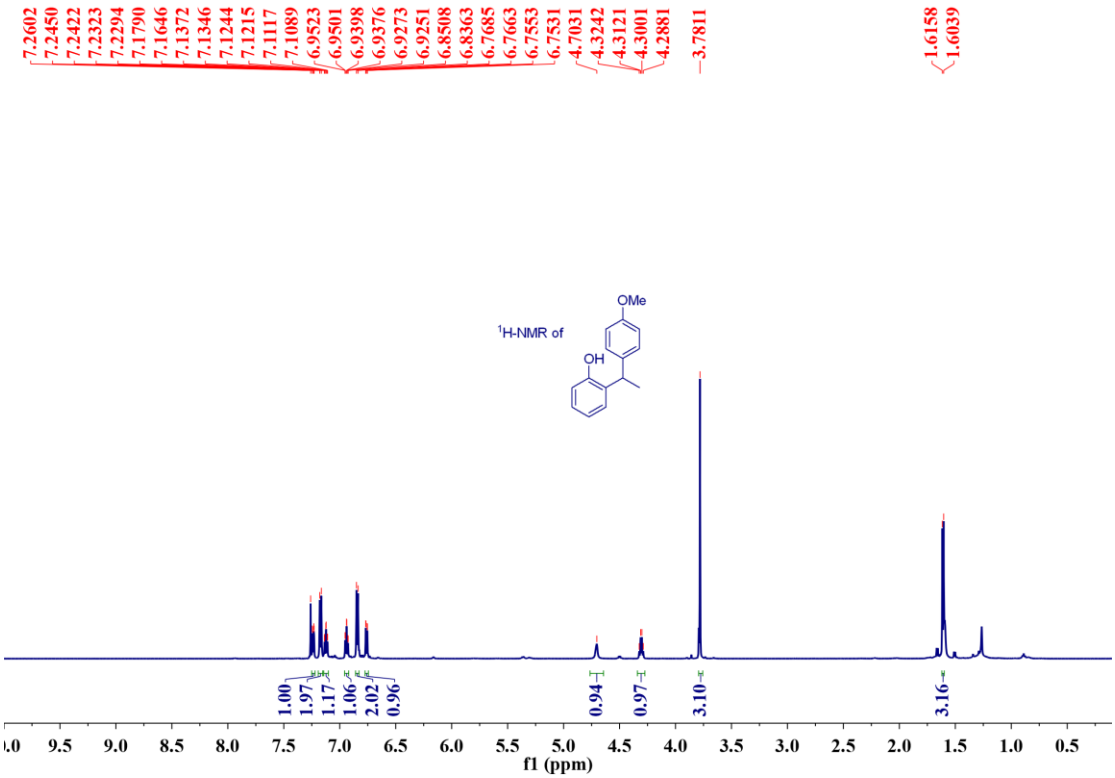
153.2081
141.6198
129.9814
128.2528
127.7940
121.1142
116.2303
110.0795
105.2206
77.2355
77.0237
76.8127
33.3378
18.6423
13C-NMR of
OH
f1 (ppm)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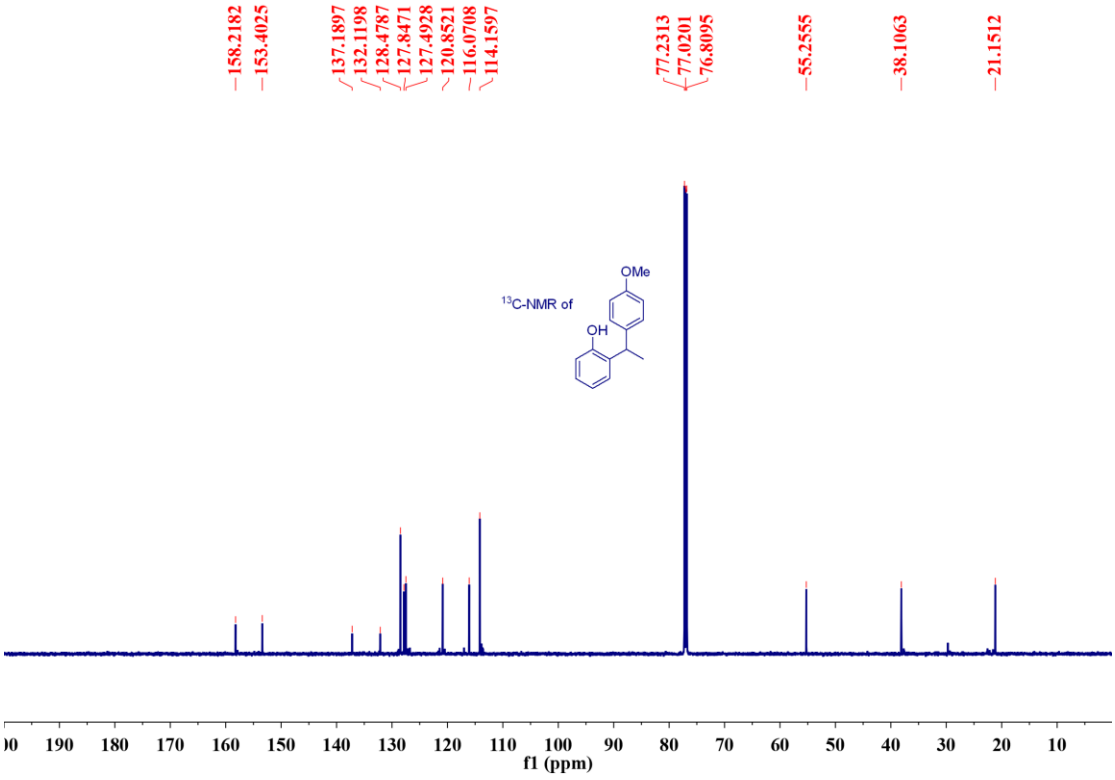
7.2450
7.2422
7.2323
7.2294
7.1790
7.1646
7.1372
7.1346
7.1244
7.1215
7.1117
7.1089
6.9523
6.9501
6.9398
6.9376
6.9273
6.9251
6.8508
6.8363
6.7685
6.7663
6.7553
6.7531
4.7031
4.3242
4.3121
4.3001
4.2881
3.7811
1.6158
1.6039
1H-NMR of
OMe
OH
1.00
1.97
1.17
1.06
2.02
0.96
0.94
0.97
3.10
3.16
f1 (ppm)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132.1198
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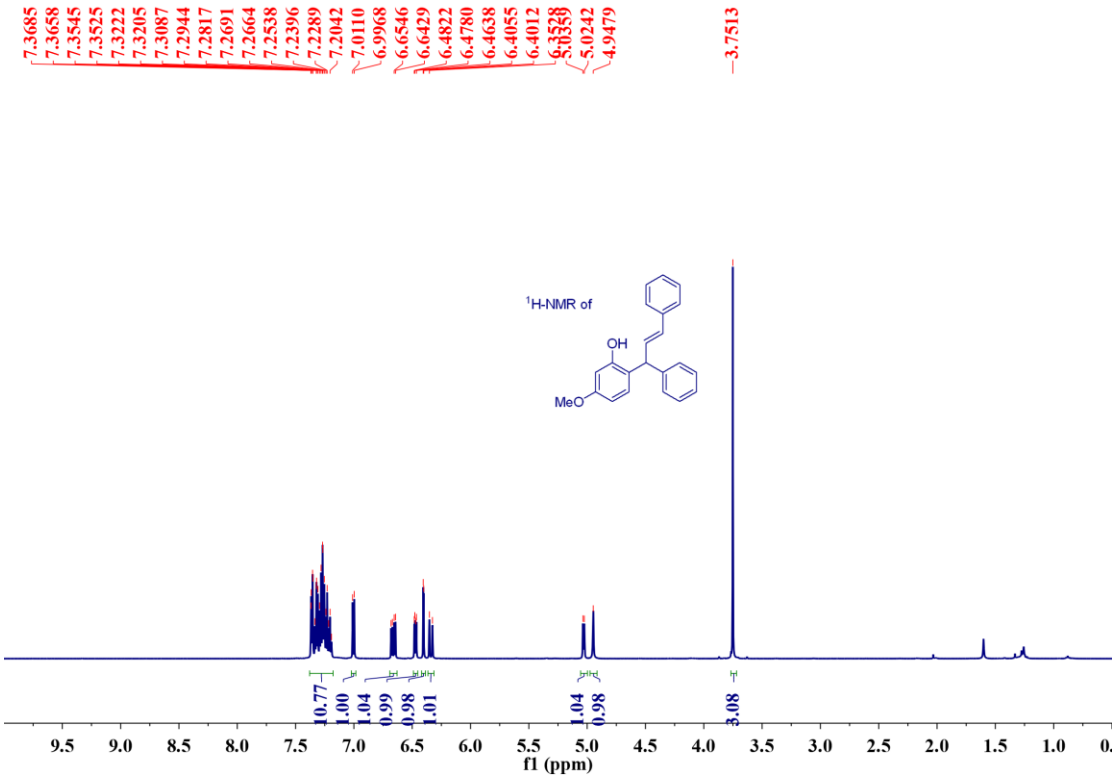
127.4928
120.8521
116.0708
114.1597
77.2313
77.0201
76.8095
55.2555
38.1063
21.1512
13C-NMR of
OMe
OH
f1 (ppm)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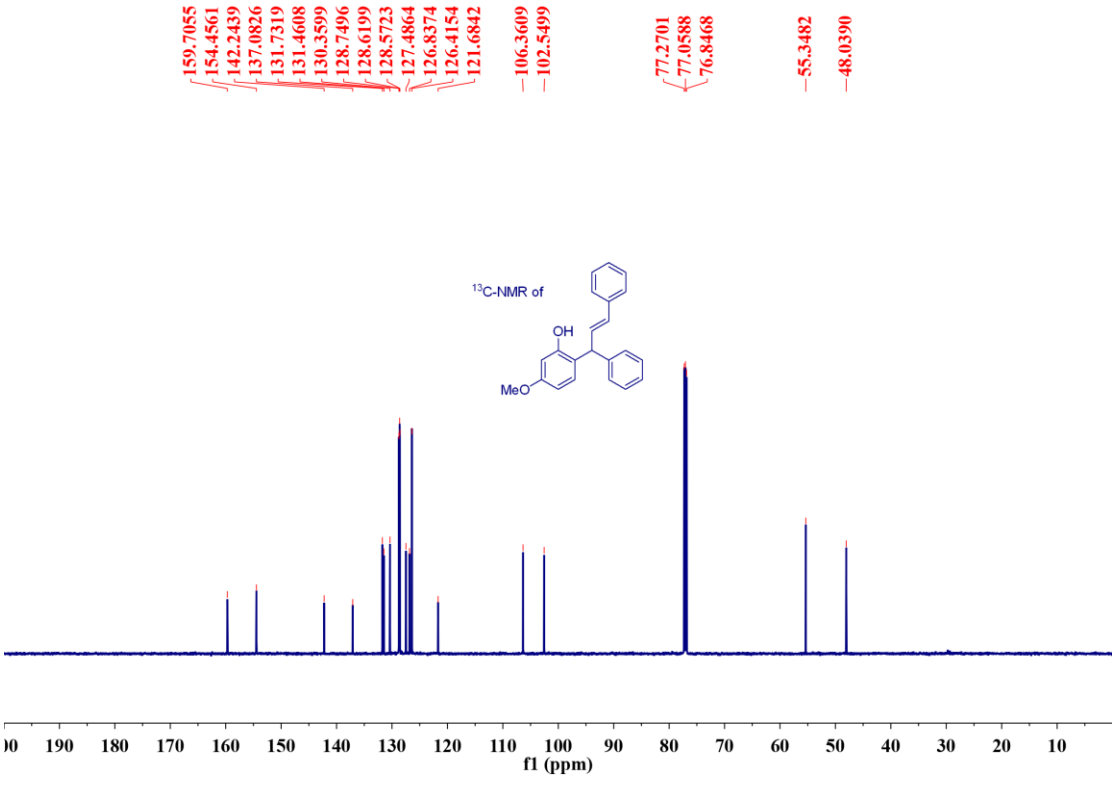
7.3658
7.3545
7.3525
7.3222
7.3205
7.3087
7.2944
7.2817
7.2691
7.2664
7.2538
7.2396
7.2289
7.2042
7.0110
6.9968
6.6546
6.6429
6.4822
6.4780
6.4638
6.4055
6.4012
5.0359
5.0242
4.9479
3.7513
1H-NMR of
OH
MeO
10.77
1.00
1.04
0.99
0.98
1.01
1.04
0.98
3.08
f1 (ppm)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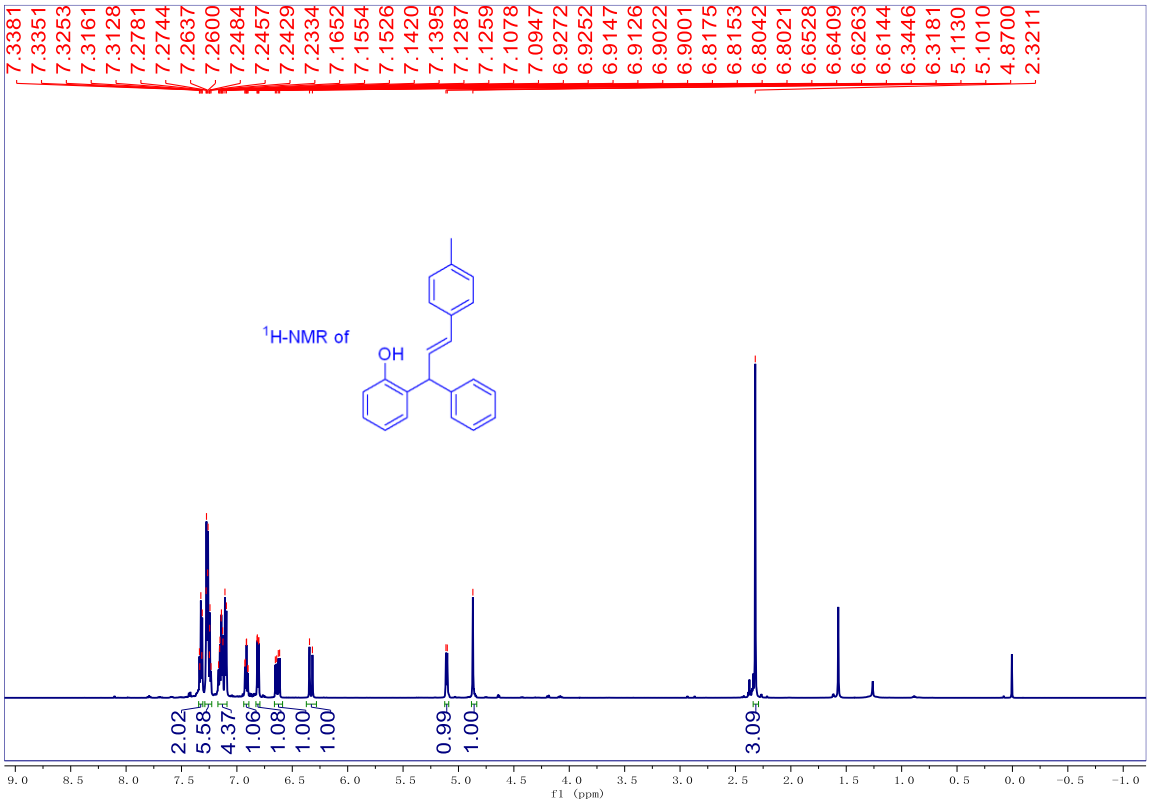
154.4561
142.2439
137.0826
131.7319
131.4608
130.3599
128.7496
128.6199
128.5723
127.4864
126.8374
126.4154
121.6842
106.3609
102.5499
77.2701
77.0588
76.8468
55.3482
48.0390
13C-NMR of
OH
MeO
f1 (ppm)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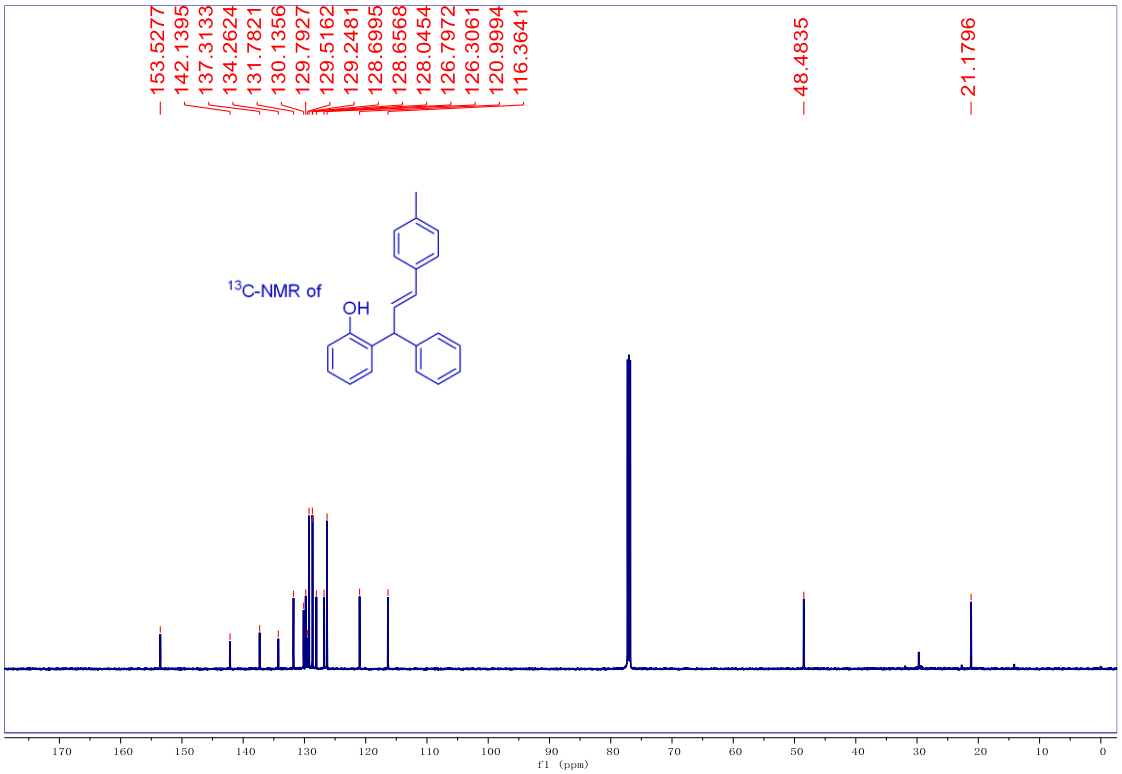
7.3351
7.3253
7.3161
7.3128
7.2781
7.2744
7.2637
7.2600
7.2484
7.2457
7.2429
7.2334
7.1652
7.1554
7.1526
7.1420
7.1395
7.1287
7.1259
7.1078
7.0947
6.9272
6.9252
6.9147
6.9126
6.9022
6.9001
6.8175
6.8153
6.8042
6.8021
6.6528
6.6409
6.6263
6.6144
6.3446
6.3181
5.1130
5.1010
4.8700
2.3211
1H-NMR of
OH
2.02
5.58
4.37
1.06
1.08
1.00
1.00
0.99
1.00
3.09
f1 (ppm)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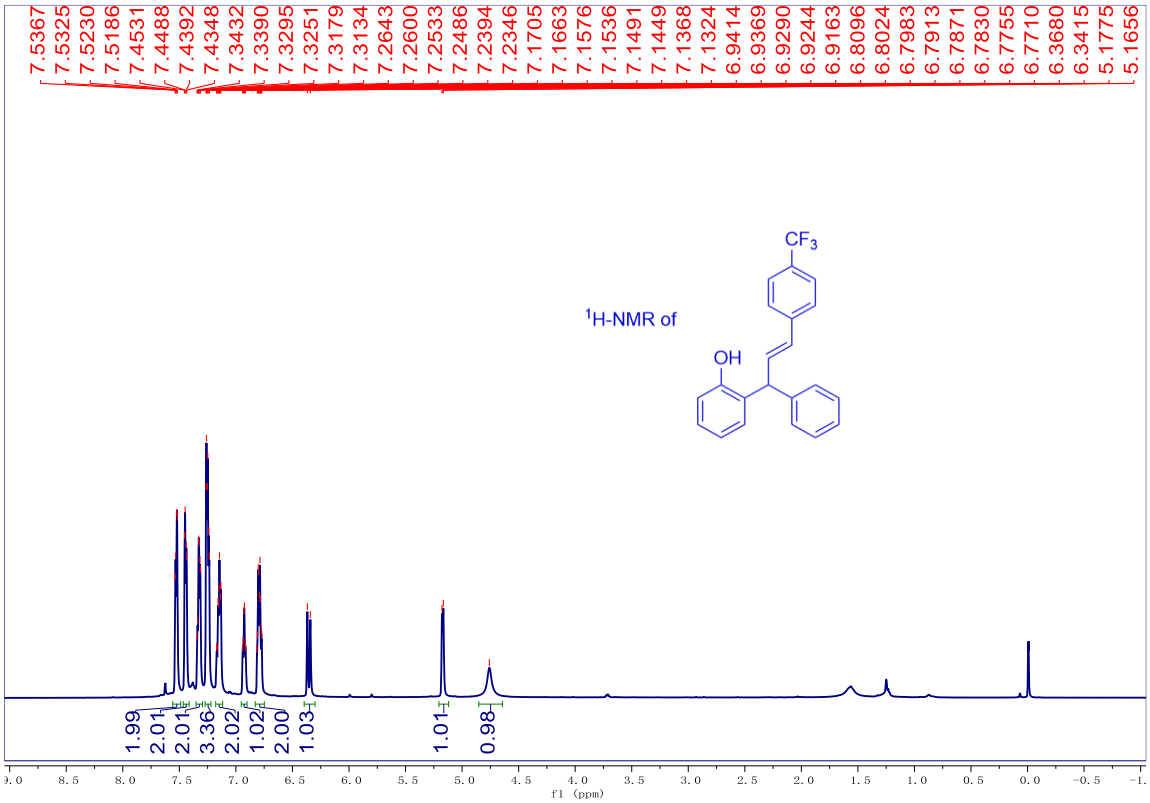
137.3133
134.2624
131.7821
130.1356
129.7927
129.5162
129.2481
128.6995
128.6568
128.0454
126.7972
126.3061
120.9994
116.3641
48.4835
21.1796
13C-NMR of
OH
f1 (ppm)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7.5230
7.5186
7.4531
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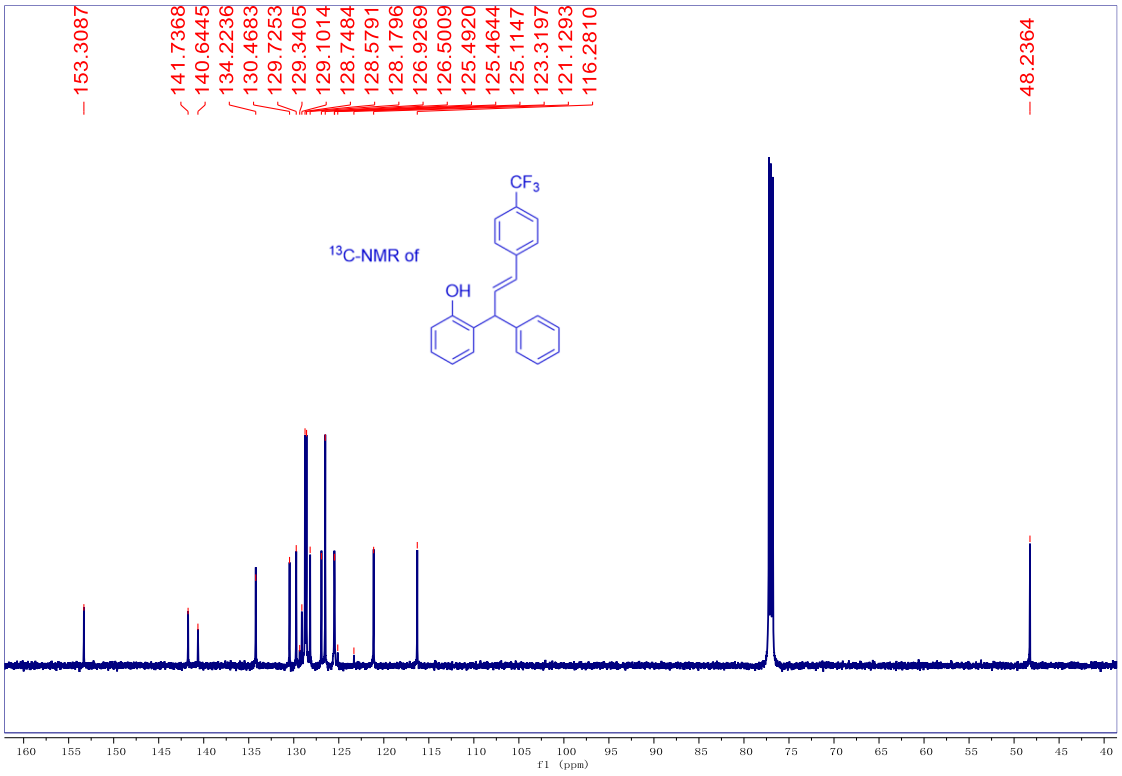
7.4392
7.4348
7.3432
7.3390
7.3295
7.3251
7.3179
7.3134
7.2643
7.2600
7.2533
7.2486
7.2394
7.2346
7.1705
7.1663
7.1576
7.1536
7.1491
7.1449
7.1368
7.1324
6.9414
6.9369
6.9290
6.9244
6.9163
6.8096
6.8024
6.7983
6.7913
6.7871
6.7830
6.7755
6.7710
6.3680
6.3415
5.1775
5.1656
1H-NMR of
CF3
OH
1.99
2.01
2.01
3.36
2.02
1.02
2.00
1.03
1.01
0.98
f1 (ppm)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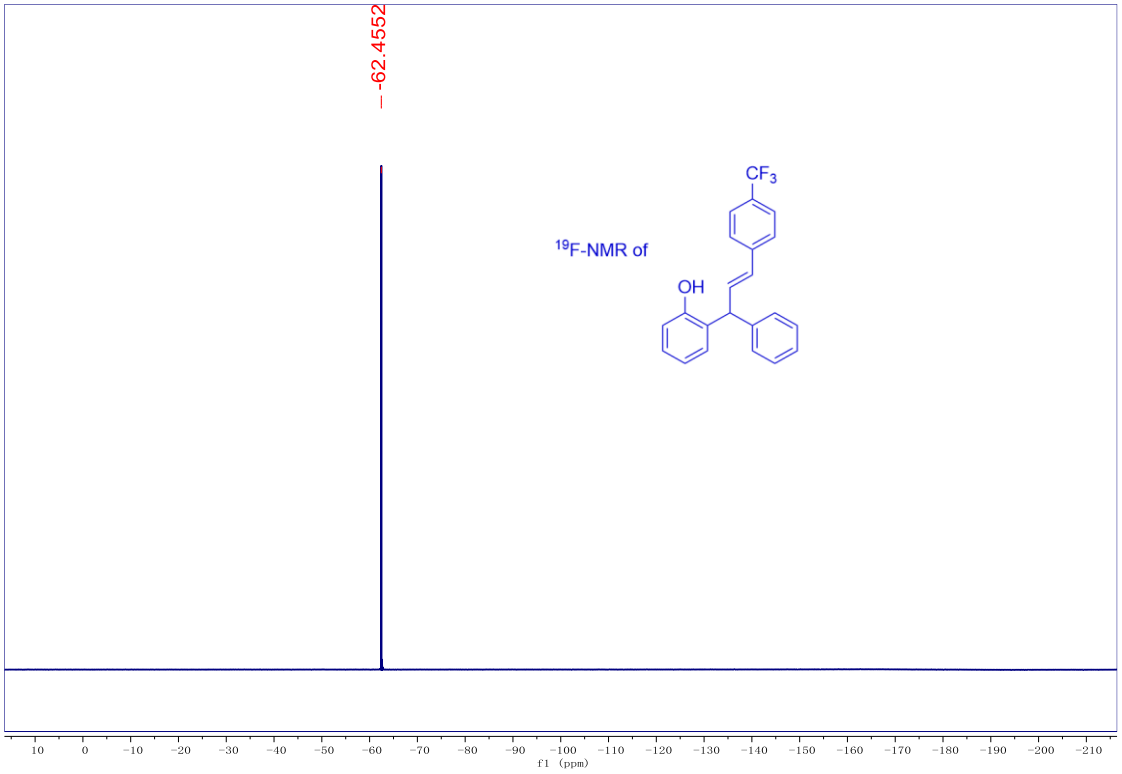
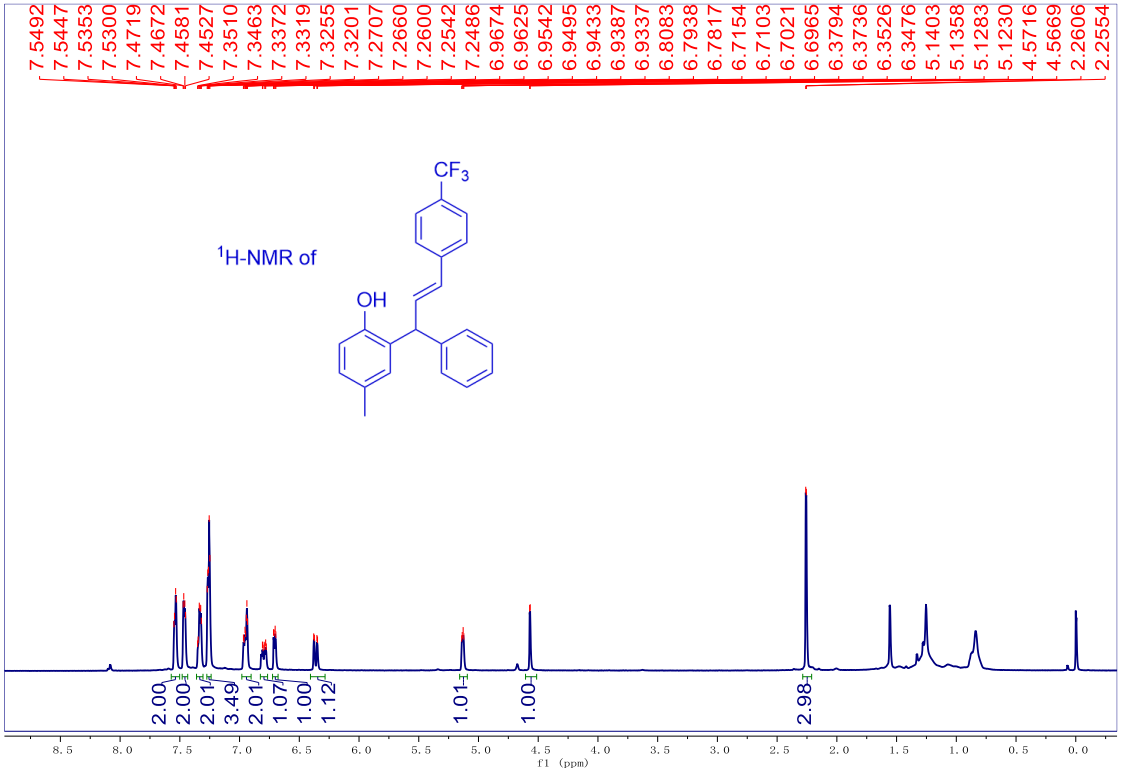
140.6445
134.2236
130.4683
129.7253
129.3405
129.1014
128.7484
128.5791
128.1796
126.9269
126.5009
125.4920
125.4644
125.1147
123.3197
121.1293
116.2810
48.2364
13C-NMR of
CF3
OH
f1 (ppm)


-62.4552
$^{19}$F-NMR of
$CF_3$
OH
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)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7.5353
7.5300
7.4719
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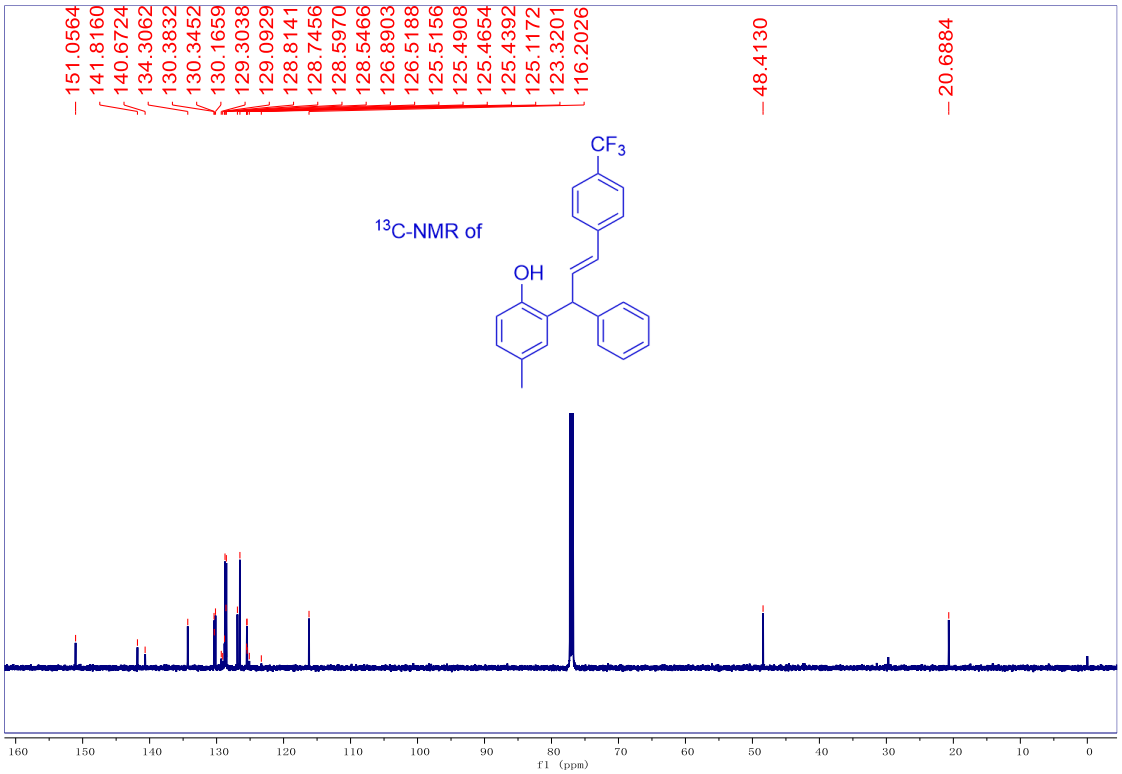
7.4581
7.4527
7.3510
7.3463
7.3372
7.3319
7.3255
7.3201
7.2707
7.2660
7.2600
7.2542
7.2486
6.9674
6.9625
6.9542
6.9495
6.9433
6.9387
6.9337
6.8083
6.7938
6.7817
6.7154
6.7103
6.7021
6.6965
6.3794
6.3736
6.3526
6.3476
5.1403
5.1358
5.1283
5.1230
4.5716
4.5669
2.2606
2.2554
CF3
1H-NMR of
OH
2.00
2.00
2.01
3.49
2.01
1.07
1.00
1.12
1.01
1.00
2.98
f1 (ppm)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134.3062
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130.1659
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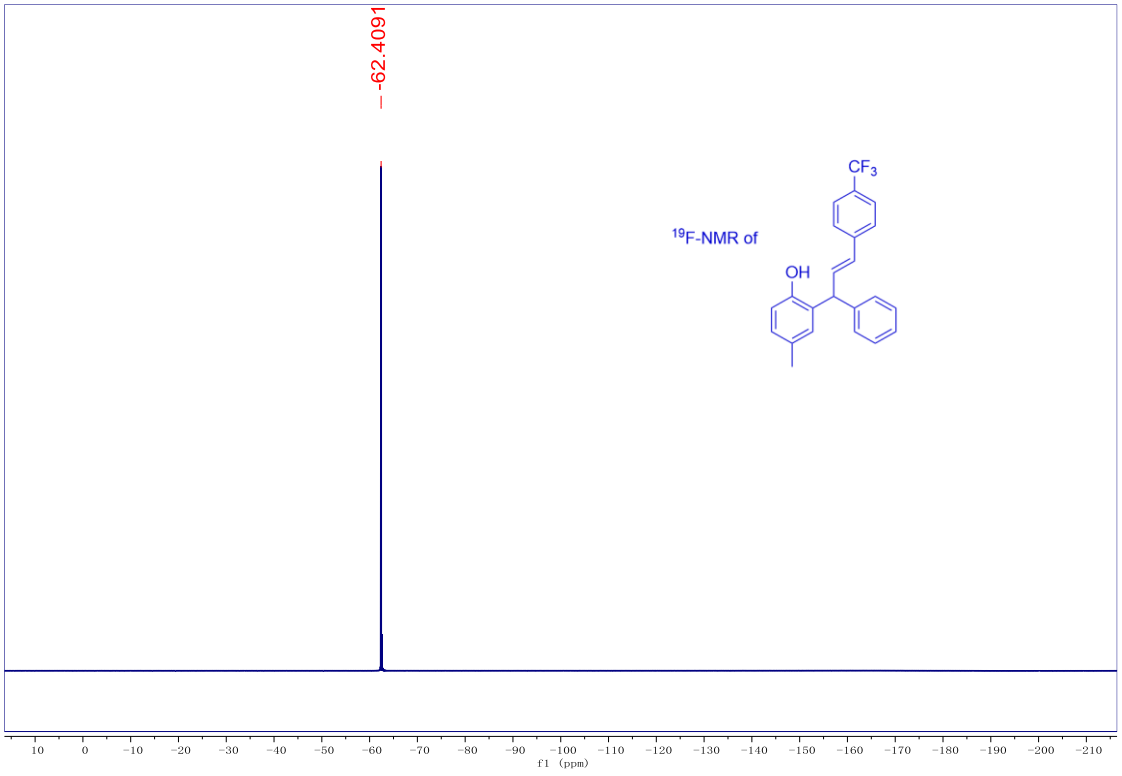
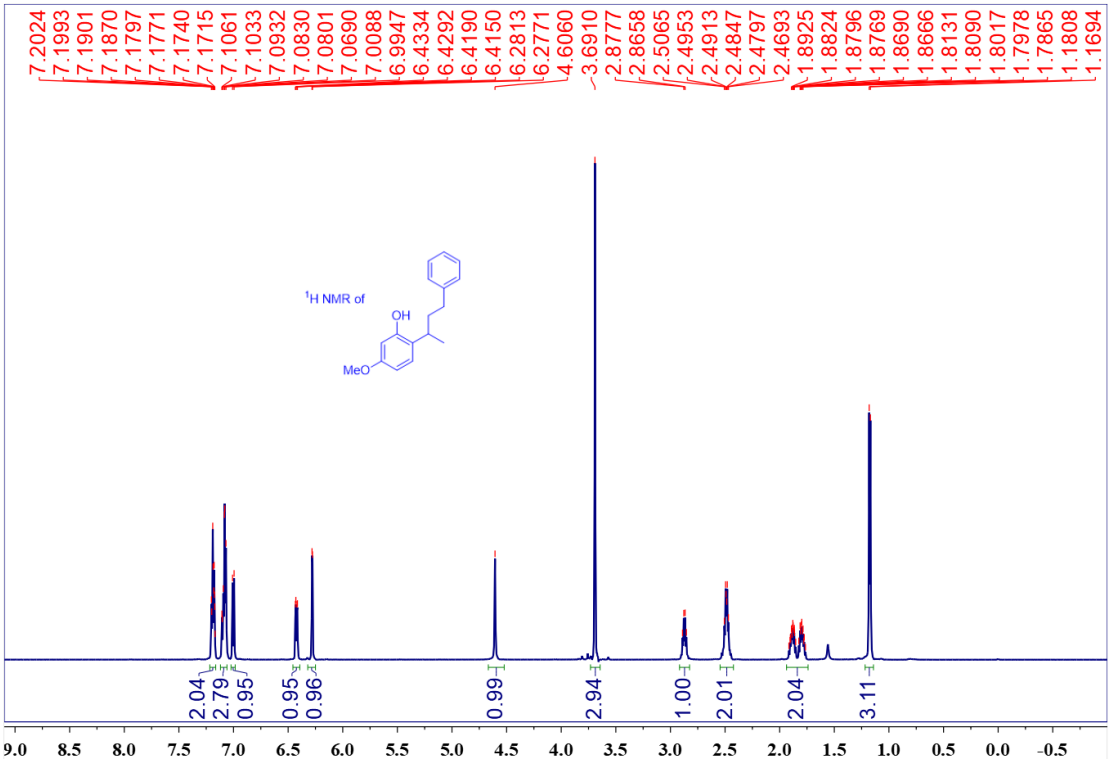
129.0929
128.8141
128.7456
128.5970
128.5466
126.8903
126.5188
125.5156
125.4908
125.4654
125.4392
125.1172
123.3201
116.2026
48.4130
20.6884
CF3
13C-NMR of
OH
f1 (ppm)


-62.4091
$^{19}$F-NMR of
CF$_3$
OH
10 0 −10 −20 −30 −40 −50 −60 −70 −80 −90 −100 −110 −120 −130 −140 −150 −160 −170 −180 −190 −200 −210
f1 (ppm)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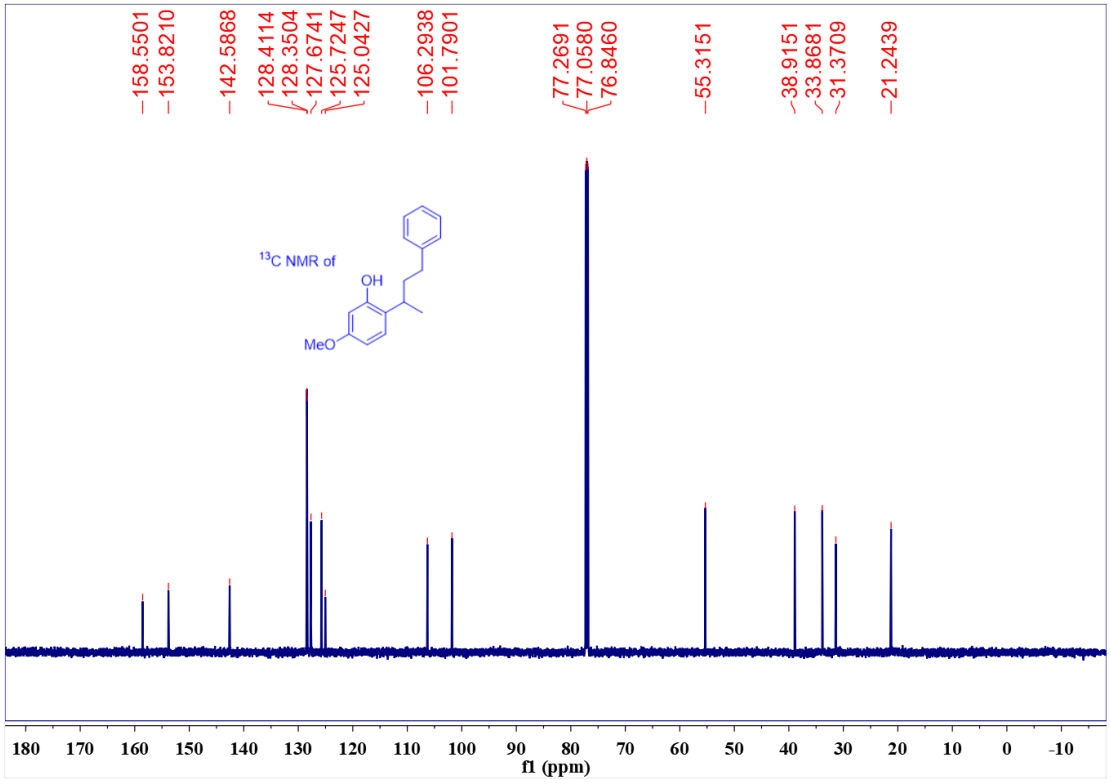
7.1033
7.0932
7.0830
7.0801
7.0690
7.0088
6.9947
6.4334
6.4292
6.4190
6.4150
6.2813
6.2771
4.6060
3.6910
2.8777
2.8658
2.5065
2.4953
2.4913
2.4847
2.4797
2.4693
1.8925
1.8824
1.8796
1.8769
1.8690
1.8666
1.8131
1.8090
1.8017
1.7978
1.7865
1.1808
1.1694
$^1$H NMR of
OH
MeO
2.04
2.79
0.95
0.95
0.96
0.99
2.94
1.00
2.01
2.04
3.11
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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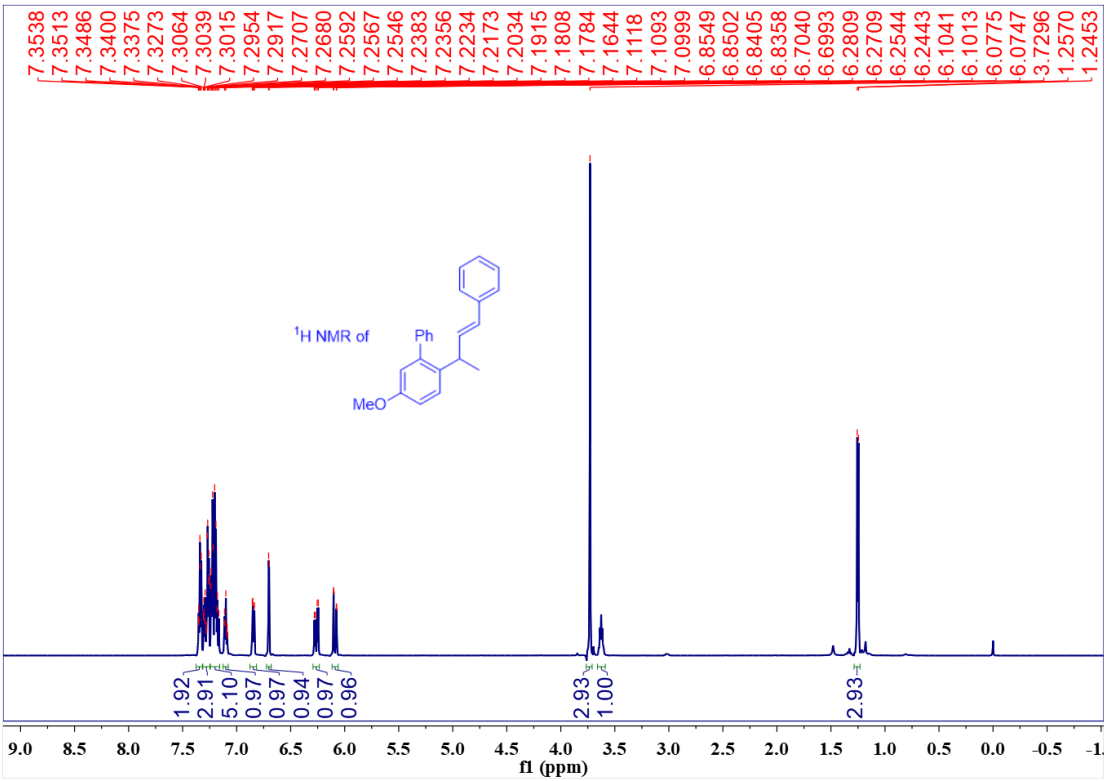
128.3504
127.6741
125.7247
125.0427
106.2938
101.7901
77.2691
77.0580
76.8460
55.3151
38.9151
33.8681
31.3709
21.2439
$^{13}$C NMR of
OH
MeO
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.3486
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7.3375
7.3273
7.3064
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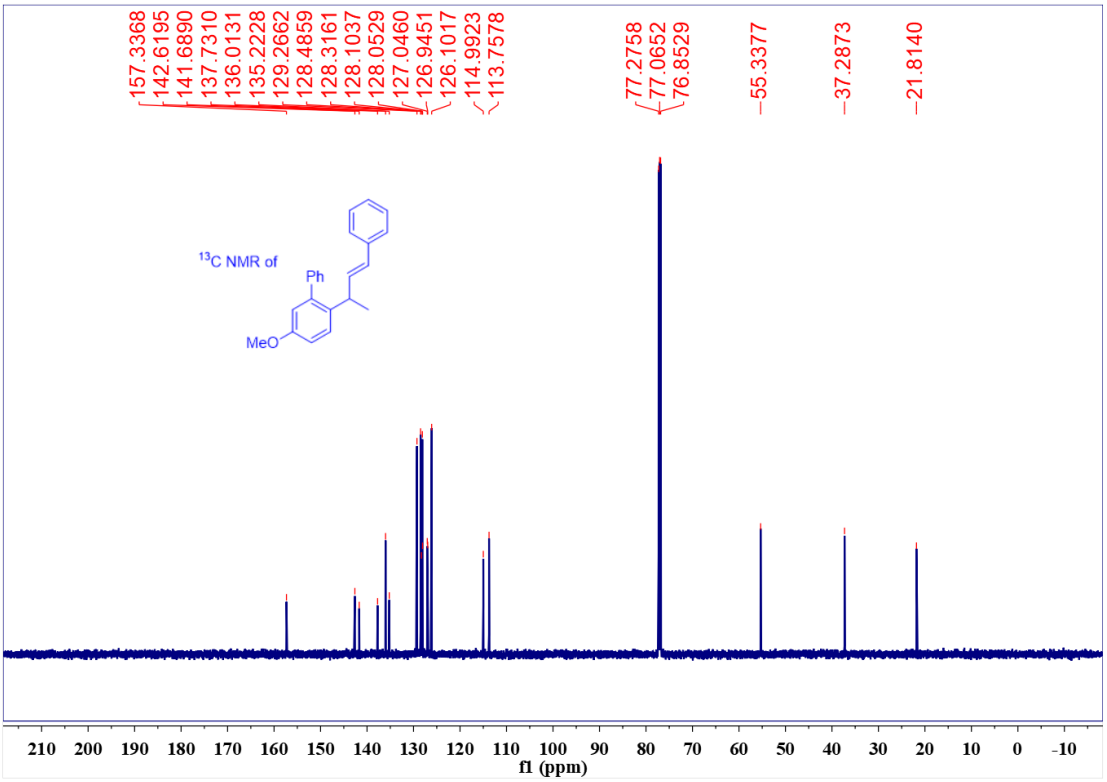
7.2954
7.2917
7.2707
7.2680
7.2592
7.2567
7.2546
7.2383
7.2356
7.2234
7.2173
7.2034
7.1915
7.1808
7.1784
7.1644
7.1118
7.1093
7.0999
6.8549
6.8502
6.8405
6.8358
6.7040
6.6993
6.2809
6.2709
6.2544
6.2443
6.1041
6.1013
6.0775
6.0747
3.7296
1.2570
1.2453
$^1$H NMR of
Ph
MeO
1.92
2.91
5.10
0.97
0.97
0.94
0.97
0.96
2.93
1.00
2.93
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)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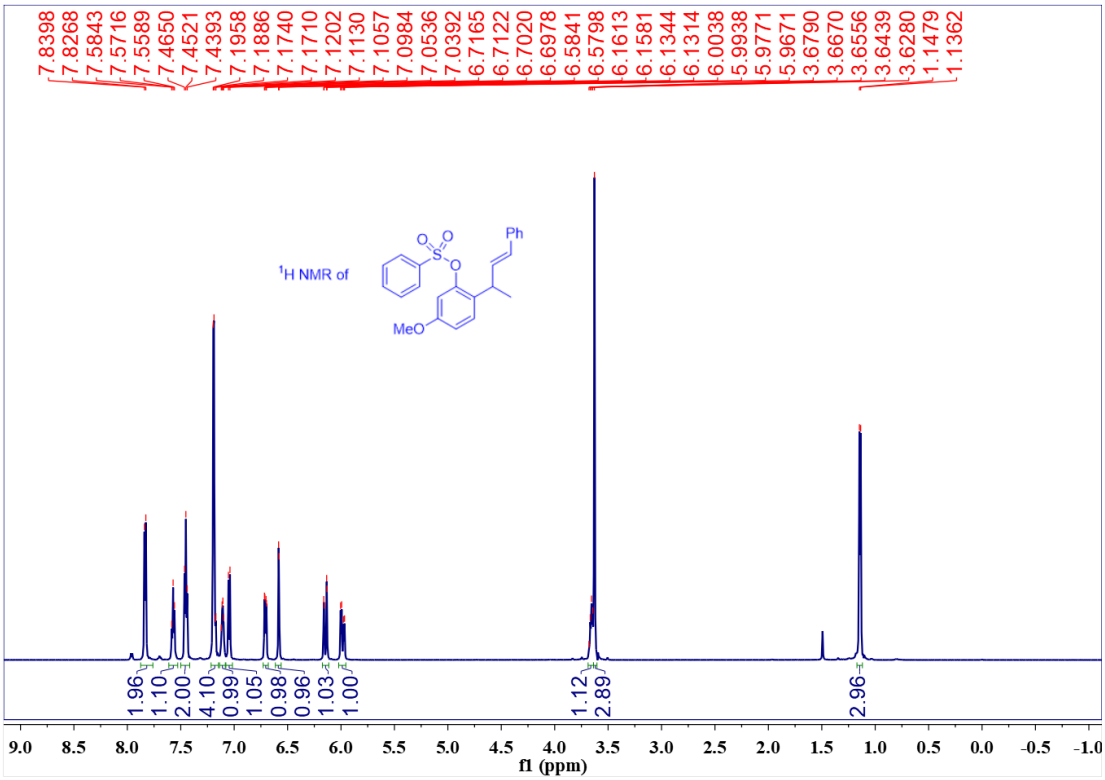
127.0460
126.9451
126.1017
114.9923
113.7578
77.2758
77.0652
76.8529
55.3377
37.2873
21.8140
$^{13}$C NMR of
Ph
MeO
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.5716
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7.4521
7.4393
7.1958
7.1886
7.1740
7.1710
7.1202
7.1130
7.1057
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6.7122
6.7020
6.6978
6.5841
6.5798
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6.1581
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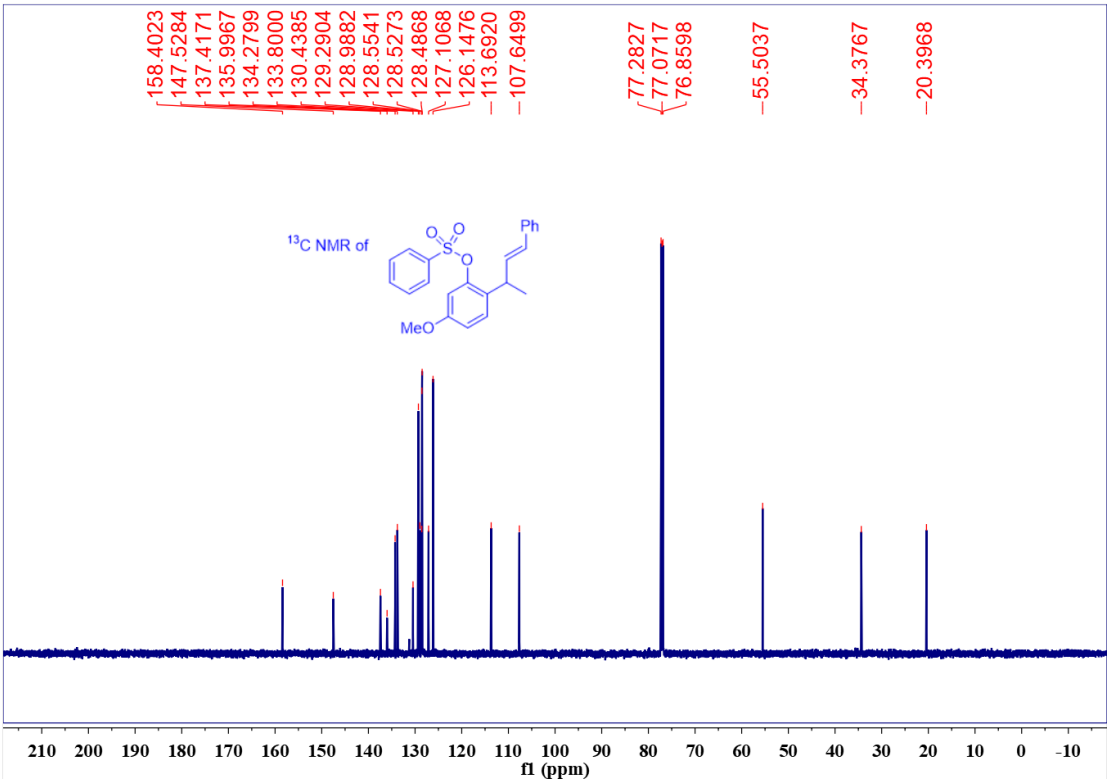
6.1314
6.0038
5.9938
5.9771
5.9671
3.6790
3.6670
3.6556
3.6439
3.6280
1.1479
1.1362
$^{1}$H NMR of
Ph
MeO
1.96
1.10
2.00
4.10
0.99
1.05
0.98
0.96
1.03
1.00
1.12
2.89
2.96
f1 (ppm)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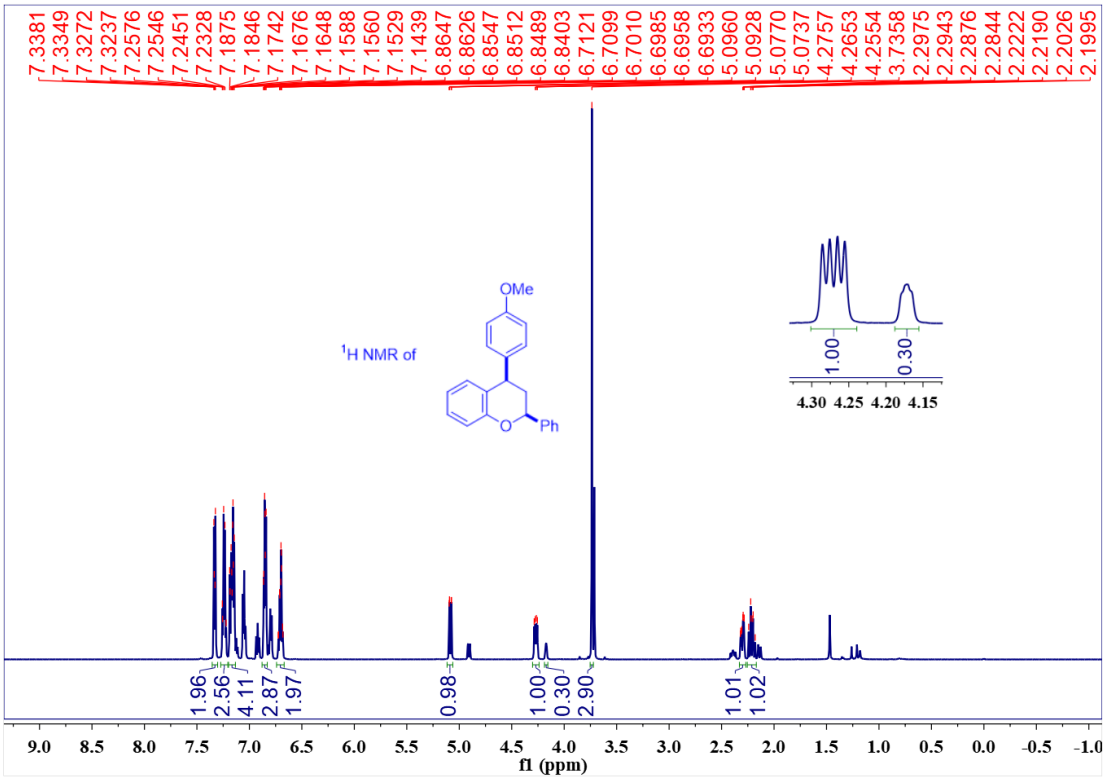
128.4868
127.1068
126.1476
113.6920
107.6499
77.2827
77.0717
76.8598
55.5037
34.3767
20.3968
$^{13}$C NMR of
Ph
MeO
f1 (ppm)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7.2451
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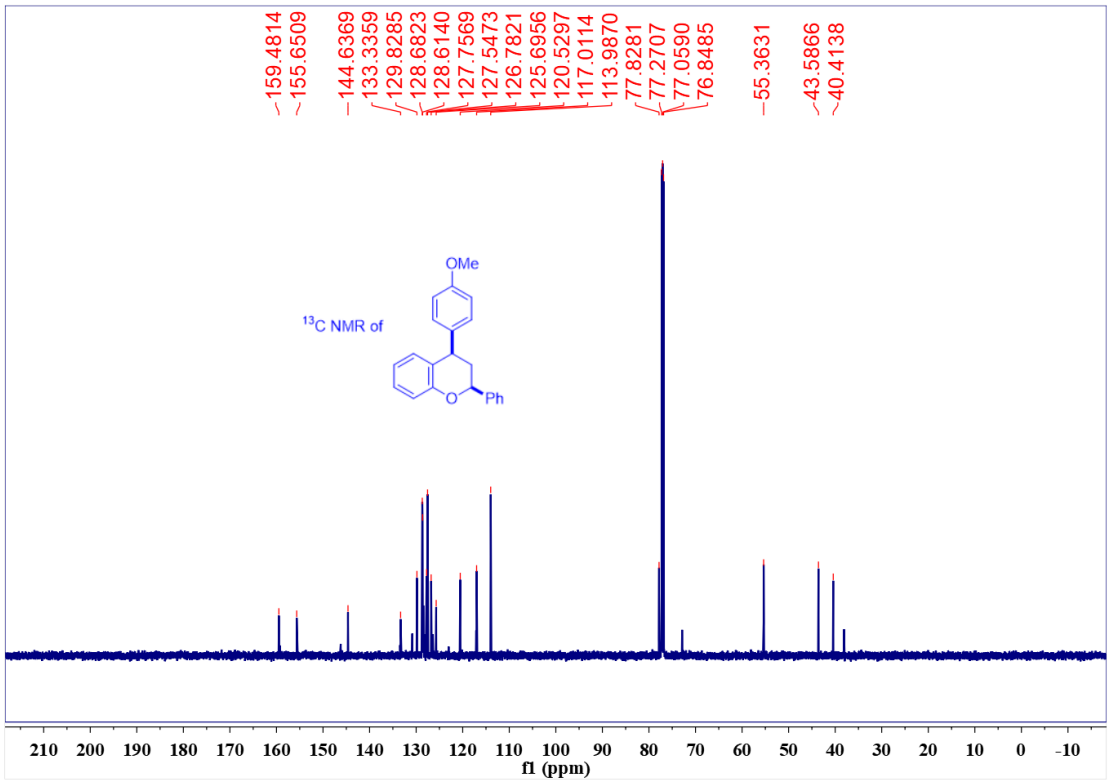
7.1846
7.1742
7.1676
7.1648
7.1588
7.1560
7.1529
7.1439
6.8647
6.8626
6.8547
6.8512
6.8489
6.8403
6.7121
6.7099
6.7010
6.6985
6.6958
6.6933
5.0960
5.0928
5.0770
5.0737
4.2757
4.2653
4.2554
3.7358
2.2975
2.2943
2.2876
2.2844
2.2222
2.2190
2.2026
2.1995
OMe
$^{1}$H NMR of
Ph
1.00
0.30
4.30 4.25 4.20 4.15
1.96
2.56
4.11
2.87
1.97
0.98
1.00
0.30
2.90
1.01
1.02
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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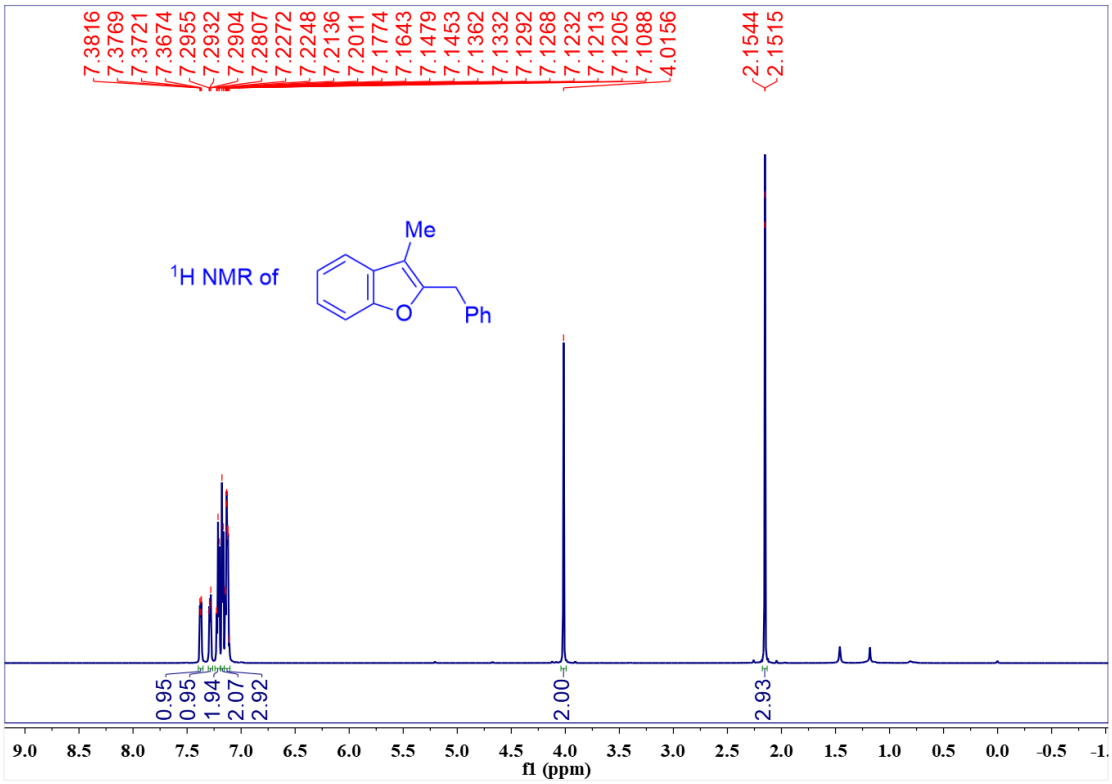
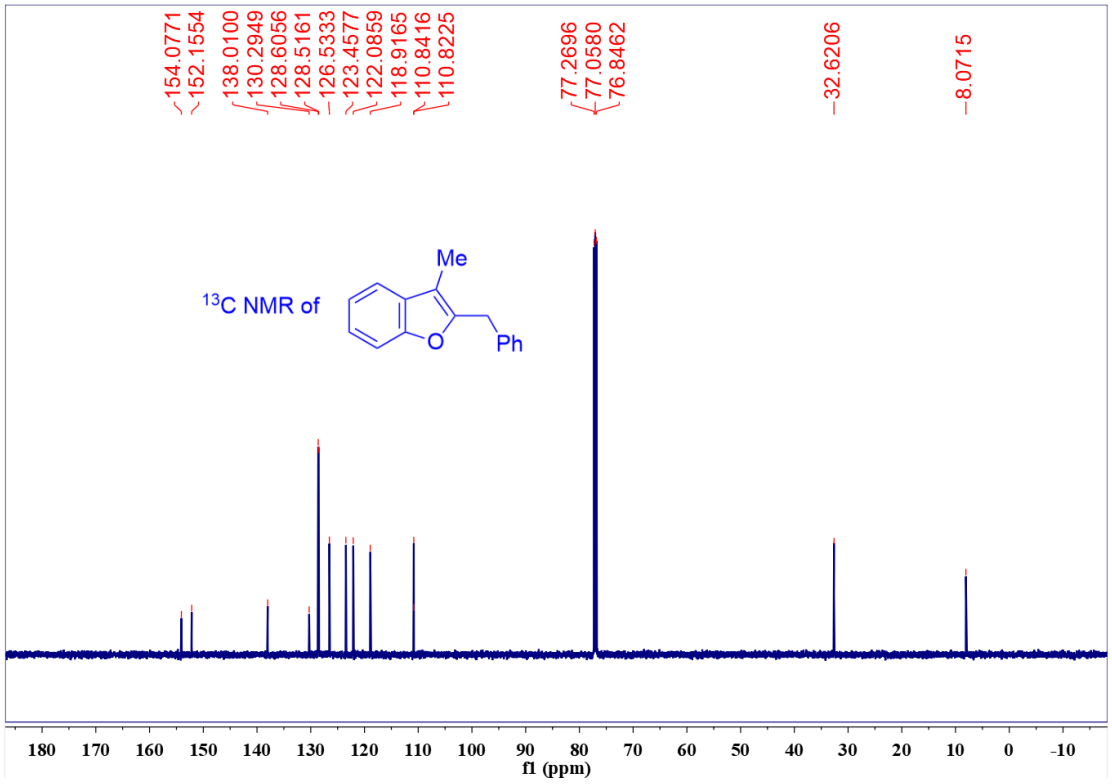
155.6509
144.6369
133.3359
129.8285
128.6823
128.6140
127.7569
127.5473
126.7821
125.6956
120.5297
117.0114
113.9870
77.8281
77.2707
77.0590
76.8485
55.3631
43.5866
40.4138
OMe
$^{13}$C NMR of
Ph
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.3816
7.3769
7.3721
7.3674
7.2955
7.2932
7.2904
7.2807
7.2272
7.2248
7.2136
7.2011
7.1774
7.1643
7.1479
7.1453
7.1362
7.1332
7.1292
7.1268
7.1232
7.1213
7.1205
7.1088
4.0156
2.1544
2.1515
1H NMR of
Me
Ph
O
0.95
0.95
1.94
2.07
2.92
2.00
2.93
f1 (ppm)


154.0771
152.1554
138.0100
130.2949
128.6056
128.5161
126.5333
123.4577
122.0859
118.9165
110.8416
110.8225
77.2696
77.0580
76.8462
32.6206
8.0715
13C NMR of
Me
Ph
O
f1 (ppm)