Supporting information for:

Ligand-Controlled Cobalt-Catalyzed Isomerization and Reductive C-O Bond Cleavage of Allylic Ethers

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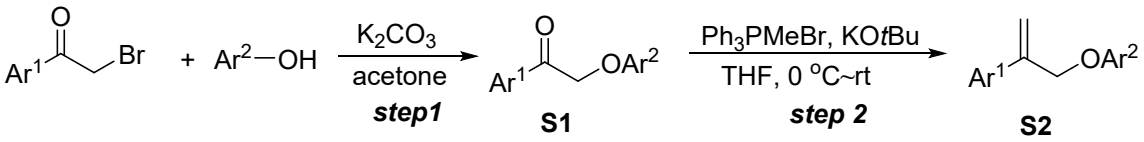
I. General information

THF, xylene, anisole, 1,4-dioxane, PhCl and Hexane were purchased from Energy Chemical and used as received. Toluene was distilled from sodium benzophenone ketyl prior to use. HBpin (98%), $NaBHEt_3$ (1.0 mol/L in THF), Xantphos, DPEPhos and $CoCl_2$ (99%) were purchased from Energy Chemical and used as received. Bis(2-(diphenylphosphanyl)phenyl)amine (**PNP**),[1] and phosphine-amido-oxazoline ligand (**PAO**)[2] were prepared according to previously reported procedures, respectively. The other commercially available chemicals were used as received. NMR spectra were recorded on a Bruker-400 or Bruker-500 instrument. ^{1}H NMR chemical shifts were referenced to tetramethylsilane signal (0 ppm), ^{13}C NMR chemical shifts were referenced to the solvent resonance (77.00 ppm, $CDCl_3$), ^{19}F NMR chemical shifts were referenced to the solvent resonance. The following abbreviations (or combinations thereof) were used to explain multiplicities: s = singlet, d = doublet, t = triplet, m = multiplet, br = broad, q = quadruplet. High-resolution mass spectra (HRMS) were recorded on a Bruker micrOTOF-Q II instrument (ESI). Melting points were obtained using a X-4 melting point apparatus (Laboratory Devices, beijing taike CO.; LTD.). In this report, all the reactions that require heating were using oil bath as the heating source.

II. Procedures for the synthesis of starting materials



Step 1: According to a previously reported procedure,[3] a 250 mL round bottom flask equipped with a reflux condenser and a dropping funnel was charged with phenol (22 mmol), K_2CO_3 (30 mmol) and acetone (50 mL). The mixture was added dropwisely with a solution of 2-bromoacetophenone (20 mmol in 50 mL of acetone) at room temperature over 30 mins. The resulting suspension was stirred at reflux overnight, cooled to room temperature, filtered and concentrated under reduced pressure. The residue was purified by recrystallization from petroleum ether to give the desired product **S1**.

Step 2: According to a previously reported procedure,[4] a 250 mL three-necked flask was charged with PPh_3MeBr (24 mmol), KO*t*Bu (24 mmol) and dried THF (50 mL) under argon. The mixture was stirred at 0 °C for 1 h, added

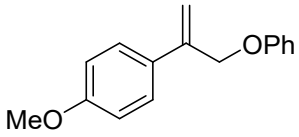
[1] L. Liang, P. Chien, J. Lin, M. Huang, Y. Huang, J. Liao. *Organometallics.* **2006**, *25,* 1399.

[2] H. Liu, C. Cai, Y. Ding, J. Chen, B. Liu, Y. Xia, *ACS Omega.* **2020**, *5*, 11655.

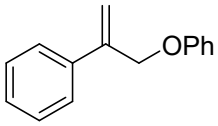
[3] T. Mete, D. Laha, R. Bhat, *ChemistrySelect* **2018**, *3*, 7656.

[4] G. Hoang, S. Zhang, J. Takacs, *Chem. Commun.* **2018**, *54*, 4838.

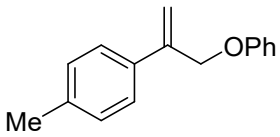
dropwisely with a solution of **S1** (20 mmol in 50 mL of dried THF). Then the resulted solution was stirred at room temperature overnight, passed through a pad of silica gel and washed with EA. The filtrate was concentrated and purified by flash column chromatography to give the desired product **S2**.



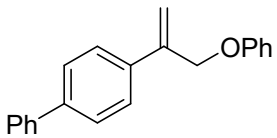
1-methoxy-4-(3-phenoxyprop-1-en-2-yl)benzene (1a).[5] White solid was obtained by silica gel column chromatography with PE/EA (50:1). 5.78 g, 24.1 mmol, 60% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.43 (d, J = 8.5 Hz, 2H), 7.26-7.32 (m, 2H), 6.94-6.99 (m, 3H), 6.89 (d, J = 8.5 Hz, 2H), 5.53 (s, 1H), 5.37 (s, 1H), 4.87 (s, 2H), 3.82 (s, 3H).



(3-phenoxyprop-1-en-2-yl)benzene (1b).[6] White solid was obtained by silica gel column chromatography with PE/EA (50:1). 1.51 g, 7.1 mmol, 60% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.45-7.50 (m, 2H), 7.32-7.38 (m, 2H), 7.25-7.32 (m, 3H), 6.93-6.98 (m, 3H), 5.60 (s, 1H), 5.46 (s, 1H), 4.89 (s, 2H).



1-methyl-4-(3-phenoxyprop-1-en-2-yl)benzene (1c). Colorless oil was obtained by silica gel column chromatography with PE/EA (50:1). 2.40 g, 10.6 mmol, 71% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.37 (d, J = 8.0 Hz, 2H), 7.25-7.30 (m, 2H), 7.15 (d, J = 8.0 Hz, 2H), 6.93-6.97 (m, 3H), 5.57 (s, 1H), 5.41 (s, 1H), 4.86 (s, 2H), 2.34 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.7, 142.9, 137.8, 135.5, 129.4, 129.1, 125.9, 120.9, 115.0, 113.9, 69.8, 21.1. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}O^+$ 225.1274, Found 225.1278.

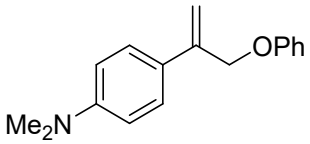


(3-phenoxyprop-1-en-2-yl)-1,1'-biphenyl (1d). White solid was obtained by silica gel column chromatography with PE/EA (50:1). 0.92 g, 3.2 mmol, 38% yield. M. P. 82.2-82.5 °C. ^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.63-7.54 (m,

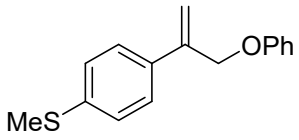
[5] M. Organ, E. Arvanitis, C. Dixon, J. Cooper, *J. Am. Chem. Soc.* **2002**, *124*, 1288.

[6] M. Czyz, M. Taylor, T. Horngren, A. Polyzos, *ACS Catal.* **2021**, *11*, 5472.

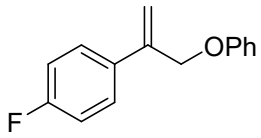
6H), 7.41-7.46 (m, 2H), 7.37-7.26 (m, 3H), 7.01 - 6.94 (m, 3H), 5.67 (s, 1H), 5.49 (s, 1H), 4.92 (s, 2H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.7, 142.6, 140.8, 140.6, 137.2, 129.5, 128.8, 127.4, 127.2, 126.9, 126.4, 121.1, 115.0, 114.8, 69.8. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}O^+$ 287.1430, Found 287.1439.



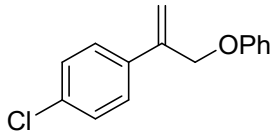
***N,N*-dimethyl-4-(3-phenoxyprop-1-en-2-yl)aniline (1e).** White solid was obtained by silica gel column chromatography with PE/EA (80:1). 0.46 g, 1.8 mmol, 46% yield. M. P. 52.7-53.0 °C. ^{1}H NMR: (400MHz, $CDCl_3$) δ 7.39 (d, J = 8.4 Hz, 2H), 7.23-7.31 (m, 2H), 6.92-7.00 (m, 3H), 6.70 (d, J = 8.8 Hz, 2H), 5.48 (s, 1H), 5.27 (s, 1H), 4.87 (s, 2H), 2.95 (s, 6H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.7, 150.2, 142.2, 129.3, 126.6, 126.1, 120.8, 114.9, 112.1, 111.1, 69.9, 40.4. HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{20}NO^+$ 254.1539, Found 254.1537.



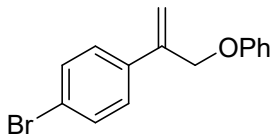
methyl(4-(3-phenoxyprop-1-en-2-yl)phenyl)sulfane (1f). White solid was obtained by silica gel column chromatography with PE/EA (50:1). 0.48 g, 1.9 mmol, 38 % yield. M. P. 39.8-40.5 °C. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.41 (d, J = 8.5 Hz, 2H), 7.26-7.31 (m, 2H), 7.23 (d, J = 8.5 Hz, 2H), 6.93-6.98 (m, 3H), 5.60 (s, 1H), 5.43 (s, 1H), 4.87 (s, 2H), 2.48 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.5, 142.2, 138.3, 134.9, 129.4, 126.3, 121.0, 114.8, 114.4, 69.7, 15.6; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}OS^+$ 257.0995, Found 257.0996.



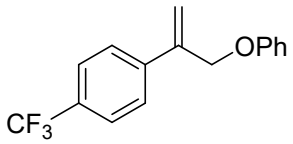
1-fluoro-4-(3-phenoxyprop-1-en-2-yl)benzene (1g). Colorless oil was obtained by silica gel column chromatography with PE/EA (50:1). 2.81 g, 12.2 mmol, 82% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.41-7.47 (m, 2H), 7.25-7.32 (m, 2H), 7.00-7.06 (m, 2H), 6.92-6.99 (m, 3H), 5.55 (s, 1H), 5.44 (s, 1H), 4.85 (s, 2H); ^{13}C NMR (125.8 MHz, $CDCl_3$) δ 162.6 (d, J = 247.0 Hz), 158.5, 142.2, 134.4 (d, J = 3.5 Hz), 129.5, 127.8 (d, J = 8.0 Hz), 121.1, 115.3 (d, J = 20.0 Hz), 114.9, 69.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ -114.1; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{13}FNaO^+$ 251.0843, Found 251.0853.



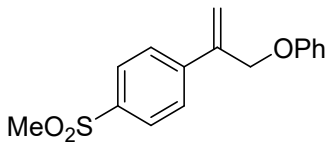
1-chloro-4-(3-phenoxyprop-1-en-2-yl)benzene (1h). Colorless oil was obtained by silica gel column chromatography with PE/EA (50:1). 2.04 g, 8.3 mmol, 88% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.40 (d, J = 8.5 Hz, 2H), 7.25-7.33 (m, 4H), 6.91-6.99 (m, 3H), 5.59 (s, 1H), 5.47 (s, 1H), 4.84 (s, 2H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.5, 142.1, 136.8, 133.8, 129.5, 128.6, 127.4, 121.2, 115.5, 114.9, 69.8; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}ClO^+$ 245.0728, Found 245.0728.



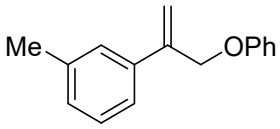
1-bromo-4-(3-phenoxyprop-1-en-2-yl)benzene (1i). Colorless oil was obtained by silica gel column chromatography with PE/EA (50:1). 2.71 g, 9.4 mmol, 94% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.45 (d, J = 8.0 Hz, 2H), 7.23-7.37 (m, 4H), 6.89-7.00 (m, 3H), 5.58 (s, 1H), 5.47 (s, 1H), 4.83 (s, 2H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.5, 142.2, 137.2, 131.6, 129.5, 127.7, 122.0, 121.2, 115.6, 114.9, 69.7; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}BrO^+$ 289.0223, Found 289.0232.



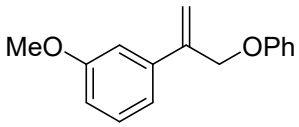
1-(3-phenoxyprop-1-en-2-yl)-4-(trifluoromethyl)benzene (1j). Colorless oil was obtained by silica gel column chromatography with PE. 0.29 g, 1.0 mmol, 26 % yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.54-7.65 (m, 4H), 7.27-7.34 (m, 2H), 6.91-7.02 (m, 3H), 5.69 (s, 1H), 5.58 (s, 1H), 4.90 (s, 2H); ^{13}C NMR (125.8 MHz,) δ 158.4, 142.1 (d, J = 46.5 Hz), 130.0 (d, J = 32.5 Hz), 129.5, 126.5, 125.4 (q, J = 3.5 Hz), 125.2, 123.1, 121.3, 117.1, 114.9, 69.7; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.6; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}F_3O^+$ 279.0991, Found 279.0987.



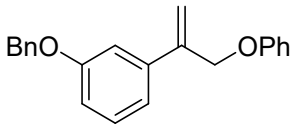
1-(methylsulfonyl)-4-(3-phenoxyprop-1-en-2-yl)benzene (1k). White solid was obtained by silica gel column chromatography with PE/EA (5:1). 0.42 g, 1.5 mmol, 48 % yield. M. P. 68.0-68.5 °C. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.93 (d, J = 8.4 Hz, 2H), 7.67 (d, J = 8.4 Hz, 2H), 7.28-7.34 (m, 2H), 6.91-7.03 (m, 3H), 5.74 (s, 1H), 5.64 (s, 1H), 4.91 (s, 2H), 3.06 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.2, 143.7, 141.8, 139.6, 129.5, 127.5, 127.0, 121.3, 118.4, 114.8, 69.5, 44.4; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}O_3S^+$ 289.0893, Found 289.0898.



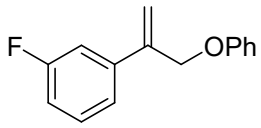
1-methyl-3-(3-phenoxyprop-1-en-2-yl)benzene (1l). Colorless oil was obtained by silica gel column chromatography with PE/EA (80:1). 2.34 g, 10.4 mmol, 70% yield. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.21 (m, 5H), 7.12 (d, J = 6.8 Hz, 1H), 6.97 (d, J = 8.0 Hz, 3H), 5.58 (s, 1H), 5.44 (s, 1H), 4.87 (s, 2H), 2.36 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.5, 143.0, 138.2, 137.8, 129.3, 128.6, 128.2, 126.6, 123.0, 120.8, 114.8, 114.2, 69.5, 21.4; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}O^+$ 225.1274, Found 225.1278.



1-methoxy-3-(3-phenoxyprop-1-en-2-yl)benzene (1m). Colorless oil was obtained by silica gel column chromatography with PE/EA (80:1). 2.04 g, 9.8 mmol, 66% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.20-7.31 (m, 3H), 6.98-7.08 (m, 2H), 6.96 (m, 3H), 6.85 (d, J = 9.0 Hz, 1H), 5.60 (s, 1H), 5.46 (s, 1H), 4.86 (s, 2H), 3.80 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 159.7, 158.6, 139.9, 129.4, 121.0, 118.5, 115.0, 114.9, 113.3, 112.1, 69.8, 55.2; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{16}NaO_2^+$ 263.1043, Found 263.1045.

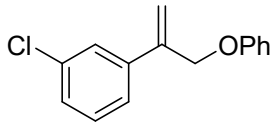


1-(benzyloxy)-3-(3-phenoxyprop-1-en-2-yl)benzene (1n). Colorless oil was obtained by silica gel column chromatography with PE/EA (100:1). 0.62 g, 2.0 mmol, 35% yield. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.21-7.48 (m, 8H), 7.05-7.15 (m, 2H), 7.02-6.90 (m, 4H), 5.59 (s, 1H), 5.46 (s, 1H), 5.06 (s, 2H), 4.85 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.7, 158.4, 142.7, 139.8, 136.8, 129.3, 128.5, 127.8, 127.4, 120.9, 118.6, 114.9, 114.8, 114.0, 112.9, 69.8, 69.5; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{21}O_2^+$ 317.1536, Found 317.1532.

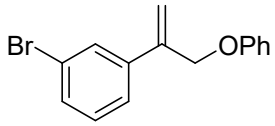


1-fluoro-3-(3-phenoxyprop-1-en-2-yl)benzene (1o). Colorless oil was obtained by silica gel column chromatography with PE. 1.02 g, 4.5 mmol, 64% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.21-7.34 (m, 4H), 7.18 (d, J = 10.0 Hz, 1H), 6.90-7.03 (m, 4H), 5.62 (s, 1H), 5.50 (s, 1H), 4.85 (s, 2H); ^{13}C NMR (125.8 MHz,) δ 162.9 (d, J = 245.5 Hz), 158.5, 142.2, 140.7 (d, J = 7.5 Hz), 129.9 (d, J = 8.5 Hz), 129.5, 121.7 (d, J = 3.5 Hz), 121.2, 116.0,

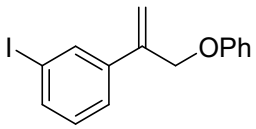
115.0, 114.8 (d, J = 21.5 Hz), 113.1 (d, J = 22.5 Hz), 69.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.1; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{13}FNaO^+$ 251.0843, Found 251.0853.



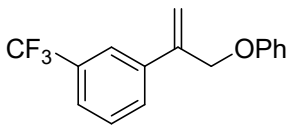
1-chloro-3-(3-phenoxyprop-1-en-2-yl)benzene (1p). Colorless oil was obtained by silica gel column chromatography with PE. 0.86 g, 3.5 mmol, 70% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.46 (s, 1H), 7.32-7.37 (s, 1H), 7.26-7.32 (m, 4H), 6.90-7.00 (m, 3H), 5.61 (s, 1H), 5.50 (s, 1H), 4.85 (s, 2H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.5, 142.2, 140.3, 134.5, 129.7, 129.5, 128.0, 126.3, 124.3, 121.2, 116.1, 115.0, 69.7; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}ClO^+$ 245.0728, Found 245.0728.



1-bromo-3-(3-phenoxyprop-1-en-2-yl)benzene (1q). Colorless oil was obtained by silica gel column chromatography with PE. 0.42 g, 1.5 mmol, 50% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.62 (s, 1H), 7.43 (d, J = 8.0 Hz, 1H), 7.39 (d, J = 8.0 Hz, 1H), 7.25-7.32 (m, 2H), 7.18-7.25 (m, 1H), 6.92-7.00 (m, 3H), 5.60 (s, 1H), 5.50 (s, 1H), 4.84 (s, 2H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.5, 142.1, 140.6, 130.9, 130.0, 129.5, 129.2, 124.7, 122.7, 121.2, 116.2, 115.0, 69.7; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}BrO^+$ 289.0223, Found 289.0232.

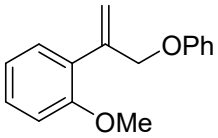


1-iodo-3-(3-phenoxyprop-1-en-2-yl)benzene (1r). Orange oil was obtained by silica gel column chromatography with PE/EA (25:1). 0.98 g, 2.9 mmol, 60% yield. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.82 (s, 1H), 7.64 (d, J = 8.0 Hz, 1H), 7.42 (d, J = 8.0 Hz, 1H), 7.23-7.33 (m, 2H), 7.04-7.12 (m, 1H), 6.92-7.01 (m, 3H), 5.58 (s, 1H), 5.48 (s, 1H), 4.83 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.3, 141.8, 140.5, 136.8, 135.0, 130.0, 129.4, 125.2, 121.1, 116.0, 114.8, 94.5, 69.4; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{13}INaO^+$ 358.9903, Found 358.9910.

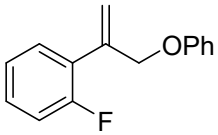


1-(3-phenoxyprop-1-en-2-yl)-3-(trifluoromethyl)benzene (1s). Colorless oil was obtained by silica gel column chromatography with PE/EA (50:1). 0.74 g, 2.7 mmol, 53% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.73 (s, 1H),

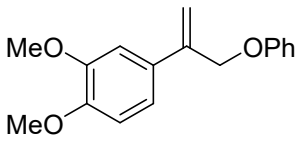
7.64 (d, J = 8.0 Hz, 1H), 7.56 (d, J = 8.0 Hz, 1H), 7.43-7.49 (m, 1H), 7.25-7.33 (m, 2H), 6.92-7.01 (m, 3H), 5.66 (s, 1H), 5.56 (s, 1H), 4.89 (s, 2H); ^{13}C NMR (125.8 MHz,) δ 158.4, 142.2, 139.2, 130.9 (q, J = 31.5 Hz), 129.5, 129.4 , 128.9, 125.2, 124.6 (q, J = 3.5 Hz), 122.9 (q, J = 8.0 Hz), 121.3, 116.7, 115.0, 69.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.6; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}F_3O^+$ 279.0991, Found 279.0987.



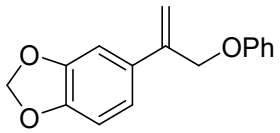
1-methoxy-2-(3-phenoxyprop-1-en-2-yl)benzene (1t). Colorless oil was obtained by silica gel column chromatography with PE/EA (50:1). 2.74 g, 11.4 mmol, 57% yield. ^{1}H NMR: (400 MHz, $CDCl_3$): δ 7.20-7.33 (m, 4H), 6.85-7.00 (m, 5H), 5.50 (s, 1H), 5.27 (s, 1H), 4.87 (s, 2H), 3.81 (s, 3H); ^{13}C NMR (125.8 MHz, $CDCl_3$) δ 158.7, 156.8, 143.9, 130.4, 129.2, 129.1, 128.9, 120.7, 120.6, 115.2, 114.9, 110.6, 69.6, 55.4; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}O_2^+$ 241.1223, Found 241.1221.



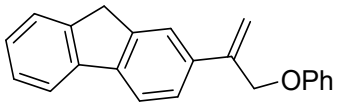
1-fluoro-2-(3-phenoxyprop-1-en-2-yl)benzene (1u). Colorless oil was obtained by silica gel column chromatography with PE/EA (80:1). 1.43 g, 6.3 mmol, 70% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.31-7.39 (m, 1H), 7.24-7.30 (m, 3H), 7.03-7.15 (m, 2H), 6.90-7.00 (m, 3H), 5.61 (s, 1H), 5.47 (s, 1H), 4.86 (s, 2H); ^{13}C NMR (125.8 MHz,) δ 160.1 (d, J = 247.5 Hz), 158.6 , 140.3, 130.2 (d, J = 4.5 Hz), 129.5, 129.4, 126.8 (d, J = 14.5 Hz), 124.2 (d, J = 3.5 Hz), 120.9, 117.5 (d, J = 3.0 Hz), 115.8 (d, J = 22.5 Hz), 114.9, 69.9 ; ^{19}F NMR (376 MHz, $CDCl_3$) δ -114.5; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{13}FNaO^+$ 251.0843, Found 251.0853.



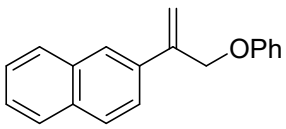
1,2-dimethoxy-4-(3-phenoxyprop-1-en-2-yl)benzene (1v). Colorless oil was obtained by silica gel column chromatography with PE/EA (20:1). 2.86 g, 10.5 mmol, 70% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.26-7.32 (m, 2H), 7.01-7.06 (m, 2H), 6.93-6.99 (m, 3H), 6.84 (d, J = 9.0 Hz, 1H), 5.53 (s, 1H), 5.39 (s, 1H), 4.86 (s, 2H), 3.87 (d, J = 2.5 Hz, 6H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.6, 149.1, 148.9, 142.6, 131.3, 129.4, 121.0, 118.5, 114.9, 113.5, 111.1, 109.6, 70.1, 55.8; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{18}NaO_3^+$ 293.1148, Found 293.1155.



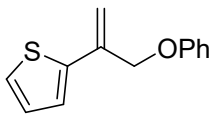
1-(3-phenoxyprop-1-en-2-yl)benzo[d][1,3]dioxole (1w). Colorless oil was obtained by silica gel column chromatography with PE/EA (150:1). 0.42 g, 1.7 mmol, 33% yield. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22-7.33 (m, 2H), 6.90-7.02 (m, 5H), 6.78 (d, J = 8.0 Hz, 1H), 5.95 (s, 2H), 5.50 (s, 1H), 5.37 (s, 1H), 4.82 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.5, 147.8, 147.4, 142.5, 132.6, 129.4, 121.0, 119.6, 114.9, 114.0, 108.2, 106.6, 101.1, 70.0; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{15}O_3^+$ 255.1016, Found 255.1024.



1-(3-phenoxyprop-1-en-2-yl)-9H-fluorene (1x). White solid was obtained by silica gel column chromatography with PE/EA (150:1). 0.61 g, 2.0 mmol, 34% yield. M. P. 92.1-92.4 °C.^{1}H NMR (400 MHz, $CDCl_3$): δ 7.80-7.73 (m, 2H), 7.67 (s, 1H), 7.53 (dd, J = 13.6, 8.0 Hz, 2H), 7.35-7.41 (m, 1H), 7.28-7.34 (m, 3H), 6.95-7.03 (m, 3H) 5.67 (s, 1H), 5.49 (s, 1H), 4.96 (s, 2H), 3.91 (s, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.6, 143.4, 143.2, 141.6, 141.2, 136.8, 129.4, 126.8, 125.0, 124.8, 122.6, 121.0, 119.9, 119.7, 114.9, 114.5, 69.9, 36.9; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{19}O^+$ 299.1430, Found 299.1427.

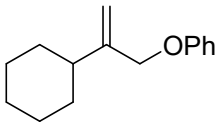


1-(3-phenoxyprop-1-en-2-yl)naphthalene (1y). White solid was obtained by silica gel column chromatography with PE/EA (50:1). 1.16 g, 4.4 mmol, 44% yield. M. P. 35.7-36.5 °C. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.89 (s, 1H), 7.76-7.85 (m, 3H), 7.63 (dd, J = 8.5, 1.5 Hz, 1H), 7.41-7.50 (m, 2H), 7.25-7.35 (m, 2H), 6.93-7.04 (m, 3H), 5.75 (s, 1H), 5.56 (s, 1H), 5.00 (s, 2H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.7, 143.0, 135.6, 133.4, 133.1, 129.5, 128.3, 128.0, 127.6, 126.2, 126.1, 124.9, 124.2, 121.1, 115.3, 115.1, 69.9; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{17}O^+$ 261.1274, Found 261.1277.

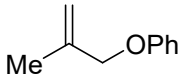


1-(3-phenoxyprop-1-en-2-yl)thiophene (1z). Yellow oil was obtained by silica gel column chromatography with PE. 0.91 g, 4.2 mmol, 52% yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.24-7.32 (m, 2H), 7.19 (d, J = 5.0 Hz, 1H), 7.12 (d, J = 5.0 Hz, 1H), 6.90-7.01 (m, 4H), 5.62 (s, 1H), 5.34 (s, 1H), 4.84 (s, 2H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ

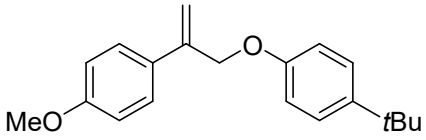
158.5, 141.9, 137.0, 129.5, 127.4, 124.7, 124.0, 121.2, 115.0, 113.3, 69.7; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{13}H_{12}NaOS^+$ 239.0501, Found 239.0507.



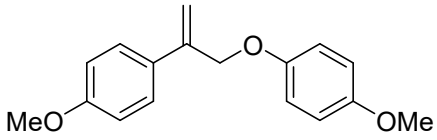
((2-cyclohexylallyl)oxy)benzene (1aa). Colorless oil was obtained by silica gel column chromatography with PE. 2.39 g, 11.7 mmol, 74% yield. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.23-7.31 (m, 2H), 6.89-6.96 (m, 3H), 5.11 (s, 1H), 4.98 (s, 1H), 4.48 (s, 2H), 2.20-2.12 (m, 1H), 1.75-1.89 (m, 4H), 1.70 (d, J = 12.0 Hz, 1H), 1.15-1.34 (m, 5H); ^{13}C NMR (126 MHz, $CDCl_3$) δ 158.8, 150.0, 129.3, 120.6, 114.7, 110.1, 70.0, 41.2, 32.2, 26.6, 26.2; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{20}NaO^+$ 239.1406, Found 239.1406.



((2-methylallyl)oxy)benzene (1ab).[7] Colorless oil was obtained by silica gel column chromatography with PE. 3.75 g, 25.3 mmol, 67% yield. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.22-7.31 (m, 2H), 6.89-6.98 (m, 3H), 5.09 (s, 1H), 4.98 (s, 1H), 4.42 (s, 2H), 1.82 (s, 3H).



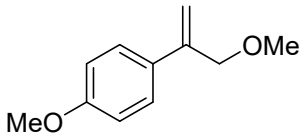
1-(tert-butyl)-4-((2-(4-methoxyphenyl)allyl)oxy)benzene (1ac). White solid was obtained by silica gel column chromatography with PE/EA (50:1). 0.30 g, 1.1 mmol, 25% yield. M. P. 62.0-62.5 °C. ^{1}H NMR: (500 MHz, $CDCl_3$): δ NMR (500 MHz,) δ 7.43 (d, J = 8.8 Hz, 2H), 7.30 (d, J = 8.8 Hz, 2H), 6.85-6.92 (m, 4H), 5.53 (s, 1H), 5.37 (s, 1H), 4.84 (s, 2H), 3.81 (s, 3H), 1.30 (s, 9H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 159.5, 156.5, 143.7, 142.6, 130.9, 127.2, 126.2, 114.4, 113.8, 113.2, 70.2, 55.3, 34.1, 31.5; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{25}O_2^+$ 297.1849, Found 297.1851.



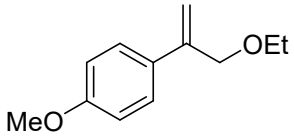
1-methoxy-4-(3-(4-methoxyphenoxy)prop-1-en-2-yl)benzene (1ad). White solid was obtained by silica gel column chromatography with PE/EA (50:1). 0.73 g, 2.7 mmol, 45% yield. M. P. 94.7-95.7 °C. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.43 (d, J = 9.0 Hz, 2H), 6.80-6.92 (m, 6H), 5.51 (s, 1H), 5.35 (s, 1H), 4.82 (s, 2H), 3.82 (s, 3H), 3.77 (s,

[7] W. Gao, X. Zhang, X. Xie, S. Ding, *Chem. Commun.* **2020**, *56*, 2012.

3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 159.5, 154.1, 152.9, 142.7, 130.9, 127.2, 116.1, 114.6, 113.8, 113.2, 70.9, 55.7, 55.3; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{18}NaO_3^+$ 293.1148, Found 293.1155.



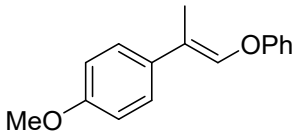
1-methoxy-4-(3-methoxyprop-1-en-2-yl)benzene (1ae).[8] Colorless oil was obtained by silica gel column chromatography with PE/EA (50:1). 1.21 g, 6.8 mmol, 72 % yield. ^{1}H NMR: (500 MHz, $CDCl_3$): δ 7.41 (d, J = 9.0 Hz, 2H), 6.87 (d, J = 9.0 Hz, 2H), 5.44 (s, 1H), 5.23 (s, 1H), 4.29 (s, 2H), 3.80 (s, 3H), 3.36 (s, 3H).



1-(3-ethoxyprop-1-en-2-yl)-4-methoxybenzene (1af).[9] Colorless oil was obtained by silica gel column chromatography with PE/EA (200:1). 0.0740 g, 0.41 mmol, 26% yield. ^{1}H NMR: (400 MHz, $CDCl_3$): δ 7.41 (dd, J = 8.8, 2.4 Hz, 2H), 6.86 (dd, J = 8.8, 2.4 Hz, 2H), 5.43 (s, 1H), 5.24 (s, 1H), 4.33 (s, 2H), 3.80 (s, 3H), 3.49-3.57 (m, 2H), 1.15-1.25 (m, 3H).

III. Cobalt-catalyzed isomerization of allyl ethers

General procedure for Co-catalyzed isomerization of allyl ethers: To a 10 mL flame-dried Schlenk flask cooled under argon, $CoCl_2$ (0.025 mmol), **PNP** (0.03 mmol), PhCl (1 mL), alkene **1** (0.5 mmol) and $NaBHEt_3$ (0.075 mmol, 1 M in THF) were added in sequence. Then the reaction mixture was stirred at rt for 1 h, purified by flash column chromatography using PE/EtOAc as the eluent to give the desired product **2**.

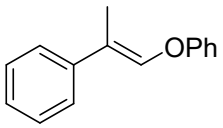


(*E*)-1-methoxy-4-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2a)]. Prepared according to the general procedure using 0.1187 g (0.50 mmol) of **1a**, 0.0161 g (0.03 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol, 1 M in THF) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^{1}H NMR), purified by flash column chromatography using PE as the eluent to give 0.0973 g (0.40 mmol, 82% yield, >20/1 *E/Z*) of **(*E*)-2a** as a white solid. M. P. 56.2-56.4 °C. ^{1}H NMR ($CDCl_3$, 500 MHz): δ

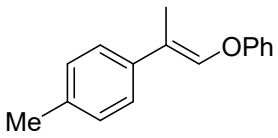
[8] W. Kirmse, J. Rode, *Chem. Ber*. **1986**, *119*, 3694.

[9] J. Gupton, J. Dicesare, J. Brown, J. Idoux, *Syn. Commun.* **1992**, *22,* 1067.

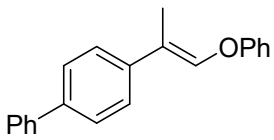
7.29-7.34 (m, 4H), 7.02-7.07 (m, 3H), 6.88 (d, J = 9.0 Hz, 2H), 6.76 (s, 1H), 3.80 (s, 3H), 2.11 (s, 3H); ^{13}C NMR (125.8 MHz, $CDCl_3$) δ 158.6, 157.7, 137.8, 132.3, 129.5, 126.5, 122.4, 120.4, 116.2, 113.9, 55.2, 13.2; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}O_2^+$ 241.1223, Found 241.1228.



(*E*)-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2b)]. Prepared according to the general procedure using 0.1040 g (0.50 mmol) of **1b**, 0.0162 g (0.03 mmol) of **PNP**, 0.0031 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^{1}H NMR), purified by flash column chromatography using PE as the eluent to give 0.0690 g (0.33 mmol, 79% yield, >20/1 *E/Z*) of **(*E*)-2b** as a colorless oil. ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.40 (d, J = 7.5 Hz, 2H), 7.29-7.36 (m, 4H), 7.21-7.27 (m, 1H), 7.03-7.09 (m, 3H), 6.85 (s, 1H), 2.14 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.6, 139.9, 139.0, 129.6, 128.5, 126.7, 125.5, 122.7, 120.6, 116.4, 13.0; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{14}NaO^+$ 233.0937, Found 233.0938.

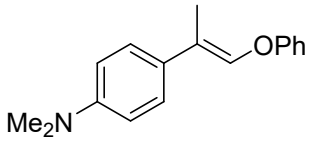


(*E*)-1-methyl-4-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2c)]. Prepared according to the general procedure using 0.1116 g (0.49 mmol) of **1c**, 0.0163 g (0.03 mmol) of **PNP**, 0.0033 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^{1}H NMR), purified by flash column chromatography using PE as the eluent to give 0.0889 g (0.39 mmol, 80% yield, >20/1 *E/Z*) of **(*E*)-2c** as a colorless oil. ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.26-7.35 (m, 4H), 7.14 (d, J = 8.0 Hz, 2H), 7.02-7.08 (m, 3H), 6.81 (s, 1H), 2.34 (s, 3H), 2.12 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.7, 138.4, 136.9, 136.4, 129.6, 129.1, 125.4, 122.6, 120.6, 116.3, 21.0, 13.1; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{16}NaO^+$ 247.1093, Found 247.1089.

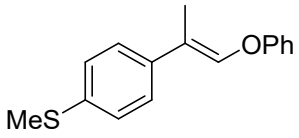


(*E*)-4-(1-phenoxyprop-1-en-2-yl)-1,1'-biphenyl [(*E*)-(2d)]. Prepared according to the general procedure using 0.1418 g (0.49 mmol) of **1d**, 0.0164 g (0.031 mmol) of **PNP**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol)

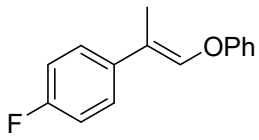
of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1168 g (0.41 mmol, 82% yield, >20/1 *E/Z*) of **(*E*)-2d** as a white solid. M. P. 122.5-122.7 °C. ^1H NMR ($CDCl_3$, 500 MHz): δ 7.55-7.63 (m, 4H), 7.41-7.51 (m, 4H), 7.31-7.37 (m, 3H), 7.05-7.11 (m, 3H), 6.93 (s, 1H), 2.18 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.6, 140.7, 139.5, 139.1, 138.8, 129.6, 128.8, 127.2, 127.1, 126.9, 125.8, 122.7, 120.1, 116.4, 12.9; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{19}O^+$ 287.1430, Found 287.1434.



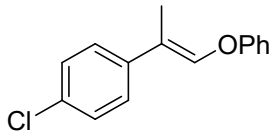
(*E*)-*N, N*-dimethyl-4-(1-phenoxyprop-1-en-2-yl)aniline [(*E*)-(2e)]. Prepared according to the general procedure using 0.0746 g (0.29 mmol) of **1e**, 0.0194 g (0.036 mmol) of **PNP**, 0.0042 g (0.03 mmol) of $CoCl_2$, 90 μL (0.090 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0605 g (0.24 mmol, 81% yield, >20/1 *E/Z*) of **(*E*)-2e** as a white solid. M. P. 75.6-77.3 °C. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.27-7.35 (m, 4H), 7.00-7.10 (m, 3H), 6.70-6.77 (m, 3H), 2.95 (s, 6H), 2.10 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.7, 136.7, 129.5, 126.2, 122.2, 120.9, 116.1, 112.7, 40.7, 13.0; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{17}H_{20}NO^+$ 254.1539, Found 254.1537.



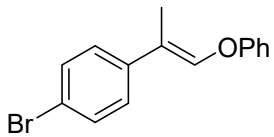
(*E*)-methyl(4-(1-phenoxyprop-1-en-2-yl)phenyl)sulfane [(*E*)-(2f)]. Prepared according to the general procedure using 0.1237 g (0.48 mmol) of **1f**, 0.0160 g (0.03 mmol) of **PNP**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 14/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1194 g (0.46 mmol, 95% yield, >20/1 *E/Z*) of **(*E*)-2f** as a white solid. M. P. 47.2-48.6 °C. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.30-7.35 (m, 3H), 7.22-7.27 (m, 3H), 7.03-7.10 (m, 3H), 6.84 (s, 1H), 2.49 (s, 3H), 2.12 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.5, 138.7, 136.7, 136.5, 129.6, 128.1, 126.9, 125.8, 122.7, 119.9, 116.3, 16.1, 12.9; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}OS^+$ 257.0995, Found 257.0997.



(*E*)-1-fluoro-4-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2g)]. Prepared according to the general procedure using 0.1139 g (0.50 mmol) of **1g**, 0.0161 g (0.03 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 5/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0917 g (0.40 mmol, 81% yield, >20/1 *E/Z*) of **(*E*)-2g** as a colorless oil. ^1H NMR ($CDCl_3$, 500 MHz): δ 7.29-7.37 (m, 4H), 6.98-7.10 (m, 5H), 6.77 (s, 1H), 2.12 (s, 3H); ^{13}C NMR (125.8 MHz,) δ 161.9 (d, J = 245.5 Hz), 157.6, 138.8 , 135.9 (d, J = 3.5 Hz), 129.7, 126.9 (d, J = 7.5 Hz), 122.8, 119.7, 116.4, 115.3 (d, J = 21.0 Hz), 13.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ -116.1; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}FO^+$ 229.1023, Found 229.1021.

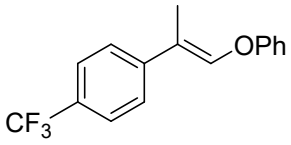


(*E*)-1-chloro-4-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2h)]. Prepared according to the general procedure using 0.1223 g (0.50 mmol) of **1h**, 0.0161 g (0.03 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 6/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0974 g (0.40 mmol, 82% yield, >20/1 *E/Z*) of **(*E*)-2h** as a colorless oil. ^1H NMR ($CDCl_3$, 500 MHz): δ 7.26-7.36 (m, 6H), 7.01-7.10 (m, 3H), 6.83 (s, 1H), 2.11 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.5, 139.4, 138.3, 132.3, 129.6, 128.5, 126.6, 122.8, 119.3, 116.4, 12.9; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}ClO^+$ 245.0728, Found 245.0728.

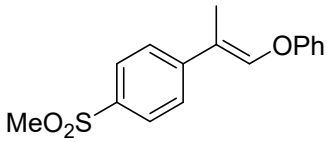


(*E*)-1-bromo-4-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2i)]. Prepared according to the general procedure using 0.1449 g (0.50 mmol) of **1i**, 0.0162 g (0.03 mmol) of **PNP**, 0.0033 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 6/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1115 g (0.38 mmol, 81% yield, >20/1 *E/Z*) of **(*E*)-2i** as a colorless oil. ^1H NMR ($CDCl_3$, 500 MHz): δ 7.44 (d, J = 8.5 Hz, 2H), 7.30-7.36 (m, 2H), 7.25 (d, J = 8.5 Hz, 2H), 7.02-7.11 (m, 3H), 6.84 (s, 1H), 2.12 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.5,

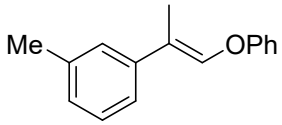
139.4, 138.8, 131.5, 129.7, 127.0, 122.9, 120.4, 119.4, 116.4, 12.9; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{13}BrNaO^+$ 311.0042, Found 311.0048.



(*E*)-1-(1-phenoxyprop-1-en-2-yl)-4-(trifluoromethyl)benzene [(*E*)-(2j)]. Prepared according to the general procedure using 0.1333 g (0.50 mmol) of **1j**, 0.0161 g (0.03 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 8/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1138 g (0.41 mmol, 85% yield, >20/1 *E/Z*) of **(*E*)-2j** as a colorless oil. ^1H NMR: (500 MHz, $CDCl_3$) δ 7.57 (d, J = 8.0 Hz, 2H), 7.48 (d, J = 8.0 Hz, 2H), 7.31-7.37 (m, 2H), 7.03-7.12 (m, 3H), 6.94 (s, 1H), 2.16 (s, 3H); ^{13}C NMR (125.8 MHz,) δ 157.4, 143.6, 140.7, 129.7, 128.6 (q, J = 32.5 Hz), 127.9, 125.5, 125.4 (q, J = 3.5 Hz), 123.1, 119.0, 116.6, 12.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.3; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}F_3O^+$ 279.0991, Found 279.1001.

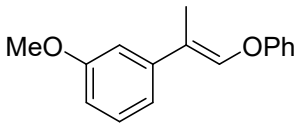


(*E*)-1-(methylsulfonyl)-4-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2k)]. Prepared according to the general procedure using 0.0860 g (0.30 mmol) of **1k**, 0.0194 g (0.036 mmol) of **PNP**, 0.0040 g (0.03 mmol) of $CoCl_2$, 90 μL (0.090 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 14/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0767 g (0.27 mmol, 89% yield, >20/1 *E/Z*) of **(*E*)-2k** as a white solid. M. P. 88.4-90.0 °C. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.89 (d, J = 8.4 Hz, 2H), 7.56 (d, J = 8.4 Hz, 2H), 7.33-7.40 (m, 2H), 7.04-7.15 (m, 3H), 7.10 (s, 1H), 3.05 (s, 3H), 2.18 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.2, 145.6, 141.8, 138.1, 129.7, 127.6, 125.8, 123.4, 118.2, 116.6, 44.6, 12.7; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}O_3S^+$ 289.0893, Found 289.0893.

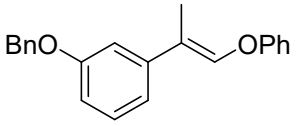


(*E*)-1-methyl-3-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2l)]. Prepared according to the general procedure using 0.1105 g (0.49 mmol) of **1l**, 0.0162 g (0.03 mmol) of **PNP**, 0.0035 g (0.027 mmol) of $CoCl_2$, 75 μL (0.075 mmol)

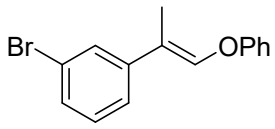
of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 14/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1013 g (0.45 mmol, 92% yield, >20/1 *E/Z*) of **(*E*)-2l** as a colorless oil. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.28-7.37 (m, 2H), 7.17-7.26 (m, 3H), 7.02-7.11 (m, 4H), 6.83 (s, 1H), 2.36 (s, 3H), 2.13 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.6, 139.8, 138.8, 138.0, 129.6, 128.4, 127.5, 126.3, 122.6, 120.7, 116.3, 21.5, 13.1; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{16}NaO^+$ 247.1093, Found 247.1097.



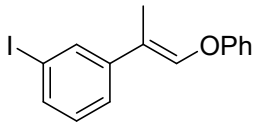
(*E*)-1-methoxy-3-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2m)]. Prepared according to the general procedure using 0.1210 g (0.50 mmol) of **1m**, 0.0161 g (0.03 mmol) of **PNP**, 0.0030 g (0.024 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 14/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0946 g (0.39 mmol, 86% yield, >20/1 *E/Z*) of **(*E*)-2m** as a colorless oil. ^1H NMR ($CDCl_3$, 500 MHz): δ 7.18-7.25 (m, 2H), 7.11-7.18 (m, 1H), 6.95 (m, 3H), 6.89 (d, J = 7.5 Hz, 1H), 6.84 (s, 1H), 6.77 (s, 1H), 6.70 (d, J = 8.5 Hz, 1H), 3.71 (s, 3H), 2.04 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 159.8, 157.6, 141.4, 139.2, 129.6, 129.4, 122.7, 120.4, 118.1, 116.4, 111.9, 111.6, 55.2, 13.1; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{17}O_2^+$ 241.1223, Found 241.1228.



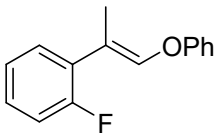
(*E*)-1-(benzyloxy)-3-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2n)]. Prepared according to the general procedure using 0.1446 g (0.46 mmol) of **1n**, 0.0160 g (0.03 mmol) of **PNP**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 13/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1356 g (0.43 mmol, 93% yield, >20/1 *E/Z*) of **(*E*)-2n** as a yellow oil. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.44 (d, J = 7.2 Hz, 2H), 7.35-7.41 (m, 2H), 7.28-7.35 (m, 3H), 7.20-7.26 (m, 1H), 6.99-7.07 (m, 5H), 6.87 (d, J = 7.2 Hz, 2H), 5.07 (s, 2H), 2.12 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.9, 157.5, 141.3, 139.2, 137.0, 129.6, 129.4, 128.5, 127.9, 127.5, 122.7, 120.2, 118.2, 116.3, 112.6, 112.5, 70.0, 13.0; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{21}O_2^+$ 317.1536, Found 317.1537.



(*E*)-1-bromo-3-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2o)]. Prepared according to the general procedure using 0.1434 g (0.50 mmol) of **1q**, 0.0161 g (0.03 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 11/1 *E/Z*, monitored by ^{1}H NMR, >20/1 *E/Z*), purified by flash column chromatography using PE as the eluent to give 0.1062 g (0.37 mmol, 83% yield) of **(*E*)-2o** as a colorless oil. ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.52 (s, 1H), 7.27-7.38 (m, 4H), 7.14-7.20 (m, 1H), 7.01-7.10 (m, 3H), 6.85 (s, 1H), 2.11 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.4, 142.1, 140.0, 129.9, 129.7, 129.5, 128.5, 124.0, 123.0, 122.7, 119.0, 116.5, 12.9; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{13}BrNaO^+$ 311.0042, Found 311.0048.

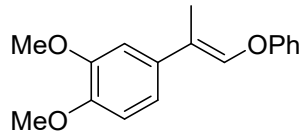


(*E*)-1-iodo-3-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2p)]. Prepared according to the general procedure using 0.1022 g (0.30 mmol) of **1r**, 0.0098 g (0.018 mmol) of **PNP**, 0.0020 g (0.015 mmol) of $CoCl_2$, 45 μL (0.045 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^{1}H NMR), purified by flash column chromatography using PE as the eluent to give 0.0903 g (0.27 mmol, 88% yield, >20/1 *E/Z*) of **(*E*)-2p** as a yellow oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.72 (s, 1H), 7.57 (d, J = 8.0 Hz, 1H), 7.30-7.37 (m, 3H), 7.04-7.11 (m, 4H), 6.83 (s, 1H), 2.10 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 157.4, 142.2, 139.9, 135.5, 134.4, 130.1, 129.7, 124.6, 122.9, 118.9, 116.5, 94.7, 12.9; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{13}NaIO^+$ 358.9903, Found 358.9910.

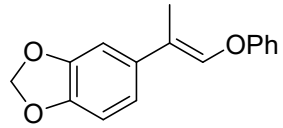


(*E*)-1-fluoro-2-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2q)]. Prepared according to the general procedure using 0.1163 g (0.49 mmol) of **1u**, 0.0164 g (0.031 mmol) of **PNP**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 11/1 *E/Z*, monitored by ^{1}H NMR), purified by flash column chromatography using PE as the eluent to give 0.0411 g (0.18 mmol, 57% yield, >20/1 *E/Z*) of **(*E*)-2q** as a colorless oil. ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.29-7.36 (m, 3H), 7.18-7.24 (m, 1H), 7.03-

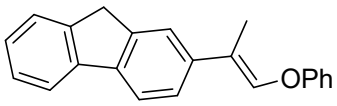
7.14 (m, 5H), 6.83 (s, 1H), 2.13 (s, 3H); ^{13}C NMR (125.8 MHz,) δ 160.4 (d, J = 247.5 Hz), 157.5, 141.5 (d, J = 6.5 Hz), 129.6, 129.4 (d, J = 4.5 Hz), 128.0 (d, J = 8.5 Hz), 127.8 (d, J = 13.5 Hz), 124.1 (d, J = 3.5 Hz), 122.7, 116.4, 115.9 (d, J = 23.5 Hz), 115.7, 13.8; ^{19}F NMR (376 MHz, $CDCl_3$) δ -114.5; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{15}H_{14}FO^+$ 229.1023, Found 229.1021.



(*E*)-1,2-dimethoxy-4-(1-phenoxyprop-1-en-2-yl)benzene [(*E*)-(2r)]. Prepared according to the general procedure using 0.1319 g (0.5 mmol) of **1v**, 0.0164 g (0.031 mmol) of **PNP**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^{1}H NMR), purified by flash column chromatography using PE as the eluent to give 0.1152 g (0.43 mmol, 87% yield, 10/1 *E/Z*) of **(*E*)-2r** as a colorless oil. ^{1}H NMR: (500 MHz, $CDCl_3$) δ 7.29-7.34 (m, 2H), 7.02-7.08 (m, 3H), 6.90-6.96 (m, 2H), 6.84 (d, J = 8.0 Hz, 1H), 6.77 (s, 1H), 3.89 (s, 3H), 3.87 (s, 3H), 2.12 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.6, 148.9, 148.2, 138.1, 132.8, 129.6, 122.5, 120.5, 117.9, 116.3, 111.4, 109.2, 55.91, 55.86, 13.3; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{18}NaO_3^+$ 293.1148, Found 293.1155.

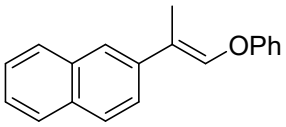


(*E*)-5-(1-phenoxyprop-1-en-2-yl)benzo[d][1,3]dioxole [(*E*)-(2s)]. Prepared according to the general procedure using 0.0756 g (0.30 mmol) of **1w**, 0.0098 g (0.018 mmol) of **PNP**, 0.0020 g (0.015 mmol) of $CoCl_2$, 45 μL (0.045 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 11/1 *E/Z*, monitored by ^{1}H NMR), purified by flash column chromatography using PE as the eluent to give 0.0597 g (0.24 mmol, 80% yield, >20/1 *E/Z*) of **(*E*)-2s** as a yellow oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.19-7.27 (m, 2H), 6.93-7.00 (m, 3H), 6.74-6.82 (m, 2H), 6.65-6.72 (m, 2H), 5.95 (s, 2H), 2.09 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.6, 147.8, 146.5, 138.2, 134.1, 129.6, 122.6, 120.5, 118.9, 116.3, 108.2, 106.1, 101.0, 29.7, 13.4; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{15}O_3^+$ 255.1016, Found 255.1016.

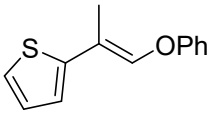


(*E*)-2-(1-phenoxyprop-1-en-2-yl)-9H-fluorene [(*E*)-(2t)]. Prepared according to the general procedure using 0.0891 g (0.30 mmol) of **1x**, 0.0098 g (0.018 mmol) of **PNP**, 0.0020 g (0.015 mmol) of $CoCl_2$, 45 μL (0.045 mmol)

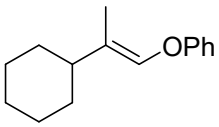
of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0853 g (0.28 mmol, 87% yield, >20/1 *E/Z*) of **(*E*)-2t** as a yellow oil. M. P. 109.1-109.5 °C. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.72-7.79 (m, 2H), 7.59 (s, 1H), 7.54 (d, J = 7.6 Hz, 1H), 7.43 (d, J = 8.4 Hz, 1H), 7.29-7.39 (m, 4H), 7.09 (d, J = 8.4 Hz, 3H), 6.93 (s, 1H), 3.91 (s, 2H), 2.20 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.6, 143.5, 143.2, 141.5, 140.4, 138.8, 138.4, 129.6, 126.7, 126.5, 125.0, 124.2, 122.6, 122.0, 120.8, 119.7, 116.6, 116.3, 36.9, 13.2; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{19}O^+$ 299.1430, Found 244.1426.



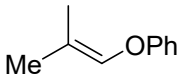
(*E*)-2-(1-phenoxyprop-1-en-2-yl)naphthalene [(*E*)-(2u)]. Prepared according to the general procedure using 0.1292 g (0.50 mmol) of **1y**, 0.0161 g (0.03 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at 60 °C for 12 h (> 99% conv., 5/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0759 g (0.30 mmol, 60% yield, >20/1 *E/Z*) of **(*E*)-2u** as a white solid. M. P. 66.8-66.9 °C. ^1H NMR: (500 MHz, $CDCl_3$) δ 7.74-7.84 (m, 4H), 7.55 (d, J = 8.5 Hz, 1H), 7.39-7.48 (m, 2H), 7.29-7.37 (m, 2H), 7.04-7.11 (m, 3H), 7.01 (s, 1H), 2.25 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.7, 139.7, 137.1, 133.7, 132.4, 129.7, 127.91, 127.90, 127.5, 126.2, 125.5, 123.9, 122.8, 120.3, 116.5, 13.0; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{19}H_{17}O^+$ 261.1274, Found 261.1284.



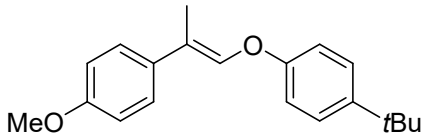
(*E*)-2-(1-phenoxyprop-1-en-2-yl)thiophene [(*E*)-(2v)]. Prepared according to the general procedure using 0.1081 g (0.50 mmol) of **1z**, 0.0164 g (0.031 mmol) of **PNP**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at 60 °C for 12 h (> 99% conv., 6/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0696 g (0.32 mmol, 64% yield, >20/1 *E/Z*) of **(*E*)-2v** as a yellow oil. ^1H NMR: (500 MHz, $CDCl_3$) δ 7.30-7.37 (m, 2H), 7.03-7.11 (m, 4H), 6.99 (s, 3H), 2.15 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.4, 143.4, 138.3, 129.7, 127.2, 122.9, 122.3, 122.3, 116.5, 115.6, 13.5; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{13}OS^+$ 217.0682, Found 217.0678.



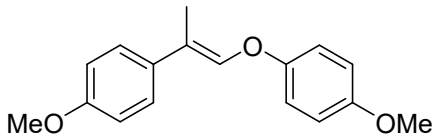
((2-cyclohexylprop-1-en-1-yl)oxy)benzene (2w). Prepared according to the general procedure using 0.1081 g (0.50 mmol) of **1aa**, 0.0161 g (0.030 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (70% conv., 3/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0487 g (0.23 mmol, 48% yield, 3/1 *E/Z*) of **2w** as a yellow oil. ^1H NMR (400 MHz, $CDCl_3$) δ 7.23-7.31 (m, 2H), 6.93-7.02 (m, 3H), 6.26 (s, 1H), 1.93 (s, 1H), 1.82-1.70 (m, 4H), 1.68 (s, 3H), 1.50-1.61 (m, 1H), 1.29 (dd, J = 17.2, 8.8 Hz, 4H), 1.13-1.21 (m, 1H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.8, 134.9, 129.4, 126.9, 121.8, 115.8, 42.4, 31.9, 26.6, 26.3, 11.2; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{15}H_{20}NaO^+$ 239.1406, Found 239.1406.



((2-methylprop-1-en-1-yl)oxy)benzene (2x).[7] Prepared according to the general procedure using 0.0741 g (0.50 mmol) of **1ab**, 0.0164 g (0.031 mmol) of **PNP**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (30 % conv., monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0138 g (0.09 mmol, 19% yield) of **2x** as a colorless oil. ^1H NMR (500 MHz, $CDCl_3$) δ 7.26-7.32 (m, 2H), 7.03 - 6.93 (m, 3H), 6.20 (s, 1H), 1.71 (d, J = 15.5 Hz, 6H).

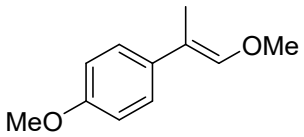


1-(tert-butyl)-4-((2-(4-methoxyphenyl)prop-1-en-1-yl)oxy)benzene (2y). Prepared according to the general procedure using 0.1423 g (0.48 mmol) of **1ac**, 0.0161 g (0.030 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1342 g (0.45 mmol, 88% yield, 10/1 *E/Z*) of **2y** as a yellow solid. M. P. 97.2-98.3 °C. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.29-7.37 (m, 4H), 6.98 (d, J = 8.0 Hz, 2H), 6.88 (d, J = 8.0 Hz, 2H), 6.76 (s, 1H), 3.81 (s, 3H), 2.10 (s, 3H), 1.31 (s, 9H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.5, 155.4, 145.3, 138.2, 132.4, 128.8, 126.5, 126.4, 119.9, 115.8, 113.9, 55.3, 34.2, 31.5, 13.1; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{20}H_{25}O_2^+$ 297.1849, Found 297.1848.

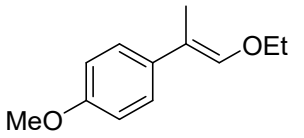


1-methoxy-4-(1-(4-methoxyphenoxy)prop-1-en-2-yl)benzene (2z). Prepared according to the general procedure using 0.1305 g (0.5 mmol) of **1ad**, 0.0161 g (0.030 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075

mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 10/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.1183 g (0.44 mmol, 88% yield, 10/1 *E/Z*) of **2z** as a yellow solid. M. P. 85.9-86.1 °C. ^1H NMR: (400 MHz, $CDCl_3$) δ 7.31 (d, J = 9.0 Hz, 2H), 6.98 (d, J = 9.0 Hz, 2H), 6.84-6.90 (m, 4H), 6.69 (s, 1H), 3.80 (d, J = 11.2 Hz, 6H), 2.10 (s, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.4, 155.1, 151.7, 138.8, 132.3, 126.4, 119.2, 117.3, 114.6, 113.8, 55.6, 55.3, 13.1; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{18}NaO_3^+$ 293.1148, Found 293.1155.



1-methoxy-4-(1-methoxyprop-1-en-2-yl)benzene (2aa). Prepared according to the general procedure using 0.0888 g (0.50 mmol) of **1ae**, 0.0161 g (0.030 mmol) of **PNP**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 1 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 9/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0764 g (0.43 mmol, 86% yield, 9/1 *E/Z*) of **2aa** as a colorless oil. ^1H NMR: (500 MHz, $CDCl_3$) δ 7.22 (d, J = 8.0 Hz, 2H), 6.83 (d, J = 8.0 Hz, 2H), 6.31 (s, 1H), 3.78 (s, 3H), 3.68 (s, 3H), 1.96 (s, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 158.1, 144.0, 133.2, 128.6, 126.1, 113.7, 59.7, 55.2, 12.7; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{11}H_{14}NaO_2^+$ 201.0886, Found 201.0896.

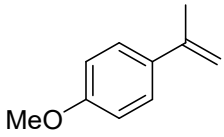


1-(1-ethoxyprop-1-en-2-yl)-4-methoxybenzene (2ab). Prepared according to the general procedure using 0.0228 g (0.12 mmol) of **1af**, 0.0039 g (0.0072 mmol) of **PNP**, 0.0008 g (0.006 mmol) of $CoCl_2$, 18 μL (0.018 mmol) of $NaBHEt_3$, 0.5 mL (0.5 M) of PhCl. Then the mixture was stirred at rt for 1 h (> 99% conv., 9/1 *E/Z*, monitored by ^1H NMR), purified by flash column chromatography using PE as the eluent to give 0.0194 g (0.010 mmol, 85% yield, 9/1 *E/Z*) of **2ab** as a colorless oil. ^1H NMR: (500 MHz, $CDCl_3$) δ 7.14 (d, J = 8.5 Hz, 2H), 6.75 (d, J = 8.5 Hz, 2H), 6.30 (s, 1H), 3.76-3.84 (m, 2H), 3.70 (s, 3H), 1.89 (s, 3H), 1.22 (t, J = 2.0 Hz, 3H); ^{13}C NMR: (125.8 MHz, $CDCl_3$) δ 157.9, 142.6, 133.4, 128.5, 126.0, 113.8, 67.8, 55.2, 15.4, 12.8; HRMS (ESI) m/z: $[M + Na]^+$ Calcd for $C_{12}H_{16}NaO_2^+$ 215.1043, Found 215.1044.

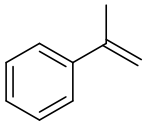
IV. Cobalt-catalyzed reductive C-O bond cleavage of allyl ethers

General procedure for cobalt-catalyzed reductive C-O bond cleavage of allyl ethers: To a 10 mL flame-dried Schlenk flask cooled under argon, added with **PAO^{Me}** (0.03mmol), $CoCl_2$ (0.025 mmol), THF (1 mL), alkene **1** (0.5

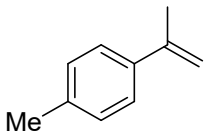
mmol), $NaBHEt_3$ (75 μL, 0.075 mmol, 1 M in THF) and HBpin (90 μL, 0.6 mmol) in sequence. Then the reaction mixture was stirred at rt for 1 h, purified by flash column chromatography using PE/EtOAc as the eluent to give the desired product **3**.



1-methoxy-4-(prop-1-en-2-yl)benzene (3a).[10] Prepared according to the general procedure using 0.1204 g (0.5 mmol) of **1a**, 0.0131 g (0.030 mmol) of **PAO^{Me}**, 0.0034 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0646 g (0.44 mmol, 87% yield) of **3a** as a colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (d, J = 8.8 Hz, 2H), 6.86 (d, J = 8.8 Hz, 2H), 5.28 (s, 1H), 4.99 (s, 1H), 3.81 (s, 3H), 2.12 (s, 3H).



prop-1-en-2-ylbenzene (3b).[11] Prepared according to the general procedure using 0.1051 g (0.5 mmol) of **1b**, 0.0134 g (0.030 mmol) of **PAO^{Me}**, 0.0034 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0557 g (0.47 mmol, 87% yield) of **3b** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.46 (d, J = 7.2 Hz, 2H), 7.28-7.35 (m, 2H), 7.22-7.28 (m, 1H), 5.35 (s, 1H), 5.07 (s, 1H), 2.14 (s, 3H).

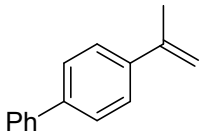


1-methyl-4-(prop-1-en-2-yl)benzene (3c).[11] Prepared according to the general procedure using 0.1109 g (0.50 mmol) of **1c**, 0.0140 g (0.032 mmol) of **PAO^{Me}**, 0.0032 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0521 g (0.39 mmol, 72% yield) of **3c** as a colorless oil.

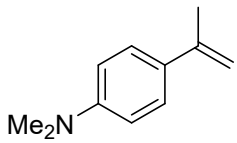
[10] C. Casadevall, D. Pascual, J. Aragon, A. Call, A. Casitas, I. Casademont-Reig. J. Lloret-Fillol, *Chem. Sci.* **2022**, *13*, 4270.

[11] X. Wang, Z. Wang, Y. Asanuma, Y. Nishihara, *Org. Lett*. **2019**, *21*, 3640.

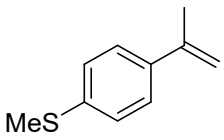
^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.19-7.30 (m, 3H), 7.08 (d, J = 7.6 Hz, 1H), 5.34 (s, 1H), 5.05 (s, 1H), 2.35 (s, 3H), 2.14 (s, 3H).



4-(prop-1-en-2-yl)-1,1'-biphenyl (3d).[11] Prepared according to the general procedure using 0.1405 g (0.49 mmol) of **1d**, 0.0140 g (0.032 mmol) of **PAO^{Me}**, 0.0033 g (0.025 mmol) of $CoCl_2$, 75 µL (0.075 mmol) of $NaBHEt_3$, 90 µL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0807 g (0.42 mmol, 84% yield) of **3d** as a white solid. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.50-7.60 (m, 6H), 7.48-7.45 (m, 2H), 7.26-7.35 (m, 1H), 5.42 (s, 1H), 5.10 (s, 1H), 2.17 (s, 3H).



***N,N*-dimethyl-4-(prop-1-en-2-yl)aniline (3e).**[13] Prepared according to the general procedure using 0.0776 g (0.31mmol) of **1e**, 0.0086 g (0.019 mmol) of **PAO^{Me}**, 0.0025 g (0.019 mmol) of $CoCl_2$, 45 µL (0.045 mmol) of $NaBHEt_3$, 50 µL of HBpin (0.36 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0394 g (0.24 mmol, 82% yield) of **3e** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.39 (d, J = 8.8 Hz, 2H), 6.70 (d, J = 8.8 Hz, 2H), 5.25 (s, 1H), 4.90 (s, 1H), 2.95 (s, 6H), 1.22 (s, 3H).



methyl(4-(prop-1-en-2-yl)phenyl)sulfane (3f).[12] Prepared according to the general procedure using 0.0757 g (0.30 mmol) of **1f**, 0.0081 g (0.018 mmol) of **PAO^{Me}**, 0.0023 g (0.017 mmol) of $CoCl_2$, 45 µL (0.045 mmol) of $NaBHEt_3$, 50 µL of HBpin (0.36 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0415 g (0.25 mmol, 84% yield) of **3f** as a white solid. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.40 (d, J = 8.4 Hz, 2H), 7.22 (d, J = 8.4 Hz, 2H), 5.35 (s, 1H), 5.05 (s, 1H), 2.48 (s, 3H), 2.13 (s, 3H).

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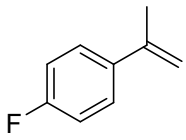
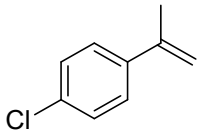
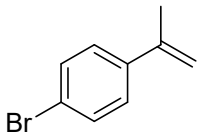
[12] U. Chakraborty, E. Reyes-Rodriguez, S. Demeshko, F. Meyer, A. Wangelin, *Angew. Chem. Int. Ed*. **2018**, *57*, 4970.



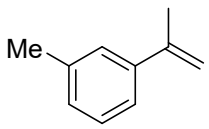
1-fluoro-4-(prop-1-en-2-yl)benzene (3g).[11] Prepared according to the general procedure using 0.1150 g (0.50 mmol) of **1g**, 0.0137 g (0.031 mmol) of **PAO^{Me}**, 0.0036 g (0.027 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0608 g (0.45 mmol, 89% yield) of **3g** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.39-7.47 (m, 2H), 6.95-7.05 (m, 2H), 5.29 (s, 1H), 5.05 (s, 1H), 2.13 (s, 3H).



1-chloro-4-(prop-1-en-2-yl)benzene (3h).[11] Prepared according to the general procedure using 0.1245 g (0.51 mmol) of **1h**, 0.0132 g (0.030 mmol) of **PAO^{Me}**, 0.0036 g (0.027 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0720 g (0.47 mmol, 94% yield) of **3h** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.38 (d, J = 8.4 Hz, 2H), 7.28 (d, J = 8.0 Hz, 2H), 5.34 (s, 1H), 5.08 (s, 1H), 2.11 (s, 3H).

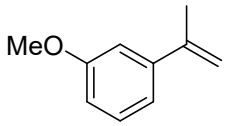


1-bromo-4-(prop-1-en-2-yl)benzene (3i).[11] Prepared according to the general procedure using 0.1475 g (0.51 mmol) of **1i**, 0.0133 g (0.030 mmol) of **PAO^{Me}**, 0.0034 g (0.026 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0916 g (0.46 mmol, 92% yield) of **3i** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.43 (d, J = 8.4 Hz, 2H), 7.31 (d, J = 8.4 Hz, 2H), 5.34 (s, 1H), 5.09 (s, 1H), 2.11 (s, 3H).

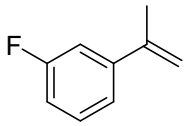


1-methyl-3-(prop-1-en-2-yl)benzene (3j).[13] Prepared according to the general procedure using 0.0672 g (0.30

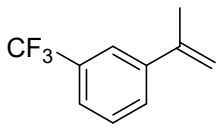
mmol) of **1l**, 0.0083 g (0.018 mmol) of **PAO^{Me}**, 0.0025 g (0.018 mmol) of $CoCl_2$, 45 μL (0.045 mmol) of $NaBHEt_3$, 50 μL of HBpin (0.36 mmol), 1 mL (0.3 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0311 g (0.24 mmol, 85% yield) of **3j** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.18-7.30 (m, 3H), 7.08 (d, J = 7.2 Hz, 1H), 5.34 (s, 1H), 5.06 (s, 1H), 2.35 (s, 3H), 2.14 (s, 3H).



1-methoxy-3-(prop-1-en-2-yl)benzene (3k).[15] Prepared according to the general procedure using 0.1208 g (0.50 mmol) of **1m**, 0.0136 g (0.032 mmol) of **PAO^{Me}**, 0.0035 g (0.027 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0640 g (0.43 mmol, 86% yield) of **3k** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.20-7.24 (m, 1H), 7.06 (d, J = 8.0 Hz, 1H), 6.99 (s, 1H), 6.81 (dd, J = 8.4, 8.0 Hz, 1H), 5.35 (s, 1H), 5.07 (s, 1H), 3.80 (s, 3H), 2.13 (s, 3H).



1-fluoro-3-(prop-1-en-2-yl)benzene (3l).[16] Prepared according to the general procedure using 0.1158 g (0.51 mmol) of **1o**, 0.0137 g (0.031 mmol) of **PAO^{Me}**, 0.0033 g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0613 g (0.45 mmol, 89% yield) of **3l** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.20-7.30 (m, 2H), 7.14 (d, J = 10.8 Hz, 1H), 6.90-7.00 (m, 1H), 5.37 (s, 1H), 5.11 (s, 1H), 2.12 (s, 3H).



1-(prop-1-en-2-yl)-3-(trifluoromethyl)benzene (3m).[14] Prepared according to the general procedure using 0.1378 g (0.49 mmol) of **1s**, 0.0131 g (0.030 mmol) of **PAO^{Me}**, 0.0035 g (0.027 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of

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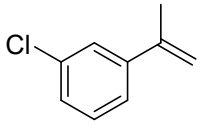
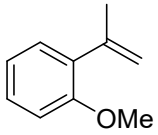
[13] J. Li, R. He, J. Liu, Y. Liu, L. Chen, Y. Huang, Y. Li, *Org. Lett.* **2022**, *24*, 1620.

[14] D. Phan, K. Kou, V. Dong, *J. Am. Chem. Soc.* **2010,** *132*, 16354.

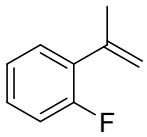
$NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0764 g (0.41 mmol, 82% yield) of **3m** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.69 (s, 1H), 7.63 (d, J = 8.0 Hz, 1H), 7.51 (d, J = 8.0 Hz, 1H), 7.39-7.45 (m, 1H), 5.41 (s, 1H), 5.17 (s, 1H), 2.12 (s, 3H);



1-chloro-3-(prop-1-en-2-yl)benzene (3n).[15] Prepared according to the general procedure using 0.1227 g (0.50 mmol) of **1p**, 0.0138 g (0.032 mmol) of **PAO^{Me}**, 0.0037 g (0.028 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0684 g (0.45 mmol, 88% yield) of **3n** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.42 (s, 1H), 7.29-7.35 (m, 1H), 7.20-7.25 (m, 2H), 5.36 (s, 1H), 5.11 (s, 1H), 2.11 (s, 3H).



1-methoxy-2-(prop-1-en-2-yl)benzene (3o).[16] Prepared according to the general procedure using 0.1208 g (0.50 mmol) of **1t**, 0.0140g (0.032 mmol) of **PAO^{Me}**, 0.0032g (0.025 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0523 g (0.35 mmol, 72% yield) of **3o** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.15-7.28 (m, 2H), 6.85-6.95 (m, 2H), 5.14 (s, 1H), 5.05 (s, 1H), 3.81 (s, 3H), 2.11 (s, 3H).

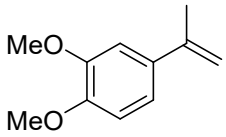


1-fluoro-2-(prop-1-en-2-yl)benzene (3p).[16] Prepared according to the general procedure using 0.1156 g (0.51 mmol) of **1u**, 0.0137 g (0.031 mmol) of **PAO^{Me}**, 0.0043 g (0.033 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash

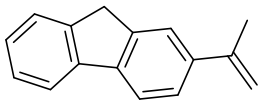
[15] P. Cooper, A. Dalling, E. Farrar, T. Aldhous, S. Grelaud, E. Lester, L. Feron, P. Kemmitt, M. Grayson, J. Bower, *Chem. Sci.* **2022**, *13*, 11183.

[16] M. Han, H. Pan, P. Li, L. Wang, *J. Org. Chem.* **2020,** *85*, 5825.

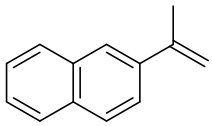
column chromatography using PE as the eluent to give 0.0574 g (0.41 mmol, 82% yield) of **3p** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.39-7.45 (m, 2H), 6.95-7.05 (m, 2H), 5.29 (s, 1H), 5.05 (s, 1H), 2.13 (s, 3H).



1,2-dimethoxy-4-(prop-1-en-2-yl)benzene (3q).[17] Prepared according to the general procedure using 0.0947 g (0.30 mmol) of **1v**, 0.0081 g (0.018 mmol) of **PAO^{Me}**, 0.0020 g (0.018 mmol) of $CoCl_2$, 45 μL (0.045 mmol) of $NaBHEt_3$, 50 μL of HBpin (0.36 mmol), 1 mL (0.3 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0580 g (0.26 mmol, 87% yield) of **3o** as a colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.05 - 6.99 (m, 2H), 6.83 (d, J = 8.8 Hz, 1H), 5.29 (s, 1H), 5.02 (s, 1H), 3.91 (s, 3H), 3.89 (s, 3H), 2.14 (s, 3H).



2-(prop-1-en-2-yl)-9H-fluorene (3r).[18] Prepared according to the general procedure using 0.0877 g (0.29 mmol) of **1x**, 0.0083 g (0.018 mmol) of **PAO^{Me}**, 0.0020 g (0.015 mmol) of $CoCl_2$, 45 μL (0.045 mmol) of $NaBHEt_3$, 50 μL of HBpin (0.36 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0540 g (0.26 mmol, 87% yield) of **3r** as a white solid. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.71-7.80 (m, 2H), 7.65 (s, 1H), 7.48-7.56 (m, 2H), 7.36 (d, J = 7.6 Hz, 1H), 7.30 (d, J = 7.6 Hz, 1H), 5.43 (s, 1H), 5.10 (s, 1H), 2.21 (s, 2H), (s, 3H).



2-(prop-1-en-2-yl)naphthalene (3s).[11] Prepared according to the general procedure using 0.1300 g (0.50 mmol) of **1y**, 0.0132 g (0.030 mmol) of **PAO^{Me}**, 0.0037 g (0.028mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0699 g (0.42 mmol, 85% yield) of **3s** as a white solid. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.74-7.86 (m, 4H), 7.61-7.68 (m, 1H), 7.39-7.46 (m, 2H), 5.51 (s, 1H), 5.17 (s, 1H), 2.25 (s, 3H).

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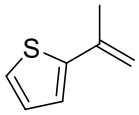
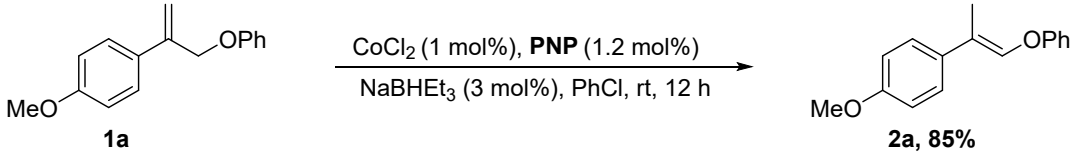
[17] J. Wu, L. Gong, Y. Xia, R. Song, Y. Xie, J. Li, *Angew. Chem. Int. Ed.* **2012**, *51*, 9909.

[18] L. Gao, X. Liu, G. Li, S. Chen, J. Cao, G. Wang, S. Li, *Org. Lett.* **2022**, *24*, 31, 5698.



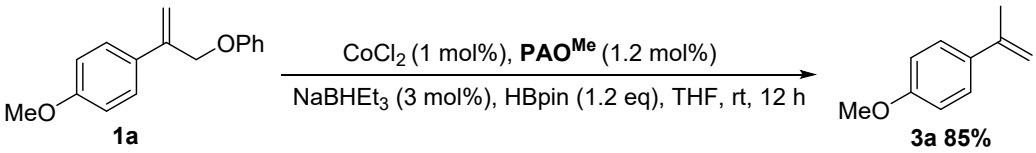
2-(prop-1-en-2-yl)thiophene (3t).[11] Prepared according to the general procedure using 0.1121 g (0.51 mmol) of **1z**, 0.0133 g (0.03 mmol) of **PAO^{Me}**, 0.0040 g (0.03 mmol) of $CoCl_2$, 75 μL (0.075 mmol) of $NaBHEt_3$, 90 μL of HBpin (0.6 mmol), 1 mL (0.5 M) of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give 0.0434 g (0.35 mmol, 87% yield) of **3t** as a colorless oil. ^{1}H NMR: (400 MHz, $CDCl_3$) δ 7.15 (s, 1H), 7.01 (s, 1H), 6.96 (s, 1H), 5.37 (s, 1H), 4.94 (s, 1H), 2.14 (s, 3H);

V. Gram-scale reactions.



1a **2a, 85%**

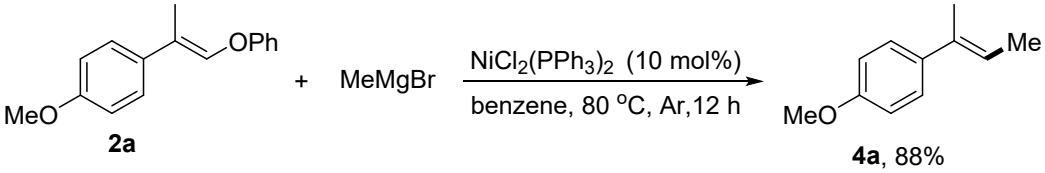
Performed according to the general procedure using 1.2026 g (5 mmol) of **1a**, 0.0323 g (0.06 mmol) of **PNP**, 0.0064 g (0.05 mmol) of $CoCl_2$, 150 μL (0.15 mmol) of $NaBHEt_3$ and 10 mL (1.0 M) of PhCl. The reaction mixture was stirred at rt for 12 h (> 99% conv., 10/1 *E/Z*, monitored by ^{1}H NMR), passed through a pad of silica gel and washed with EA, concentrated under reduced pressure. Then the residue was purified by flash column chromatography using PE/EtOAc as the eluent to give 1.0222 g (4.3 mmol, 85% yield, >20/1 *E/Z*) of **2a** as a white solid.



1a **3a 85%**

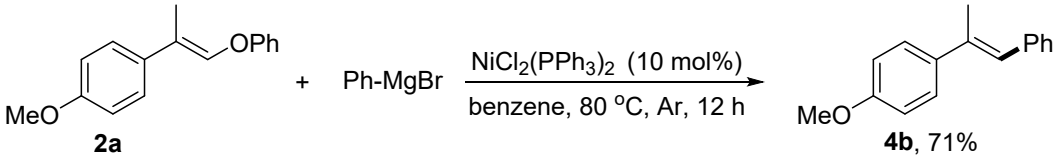
Performed according to the general procedure using 1.9233 g (8 mmol) of **1a**, 0.0419 g (0.096 mmol) of **PAO^{Me}**, 0.0108 g (0.08 mmol) of $CoCl_2$, 240 μL (0.24 mmol) of $NaBHEt_3$, 1.2290 g (9.6 mmol) of HBpin and 10 mL (1.0 M) of THF. The reaction mixture was stirred at rt for 12 h, passed through a pad of silica gel and washed with PE, concentrated under reduced pressure. Then the residue was purified by flash column chromatography using PE as the eluent to give 1.0200 g (6.9 mmol, 85% yield) of **3a** as a white solid.

VI. Further derivatizations.



2a **4a**, 88%

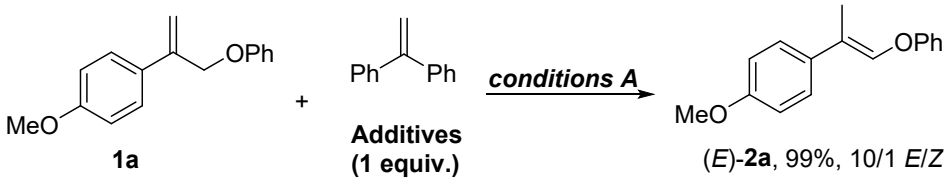
(*E*)-1-(but-2-en-2-yl)-4-methoxybenzene (4a):[2] Performed according to a previously reported procedure:[19] To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0597 g (0.25 mmol) of **2a**, 0.5 mL (0.5 mmol, 1 mmol/mL in THF) of MeMgBr, 0.0186 g (0.025 mmol) of $NiCl_2(PPh_3)_2$ and 1 mL (0.25 M) of benzene were added in sequence. Then the mixture was stirred at 80 °C for 12 h, cooled to room temperature, passed through a pad of silica gel, washed with EA, concentrated under reduced pressure. The residue was purified by flash column chromatography using PE/EtOAc as the eluent to give 0.0357 g (0.22mmol, 88% yield, >20/1 *E/Z*) of **4a** as a white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.30 (d, J = 8.5 Hz, 2H), 6.84 (d, J = 8.5 Hz, 2H), 5.74-5.80 (m, 1H), 3.80 (s, 3H), 2.00 (s, 3H), 1.78 (d, J = 6.5 Hz, 3H).



(*E*)-1-methoxy-4-(1-phenylprop-1-en-2-yl)benzene (4b):[20] Performed according to a previously reported procedure:[19] To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0599 g (0.25 mmol) of **2a**, 0.5 mL (0.5 mmol, 1 mmol/mL in THF) of PhMgBr, 0.0328 g (0.05 mmol) of $NiCl_2(PPh_3)_2$ and 1 mL (0.25 M) of benzene were added in sequence. Then the mixture was stirred at 80 °C for 12 h, cooled to room temperature, passed through a pad of silica gel, washed with EA, concentrated under reduced pressure. The residue was purified by flash column chromatography using PE/EtOAc as the eluent to give 0.0400 g (0.18mmol, 71% yield, 17/1 *E/Z*) of **4b** as a white solid. ^{1}H NMR (500 MHz, $CDCl_3$) δ 7.47 (d, J = 9.0 Hz, 2H), 7.33-7.38 (m, 4H), 6.91 (d, J = 9.0 Hz, 2H), 6.78 (s, 1H), 3.84 (s, 3H), 2.26 (s, 3H).

VII. Preliminary mechanistic studies

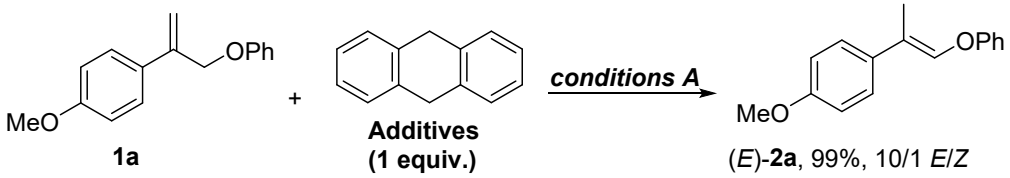
(a) Radical Trap Experiments:



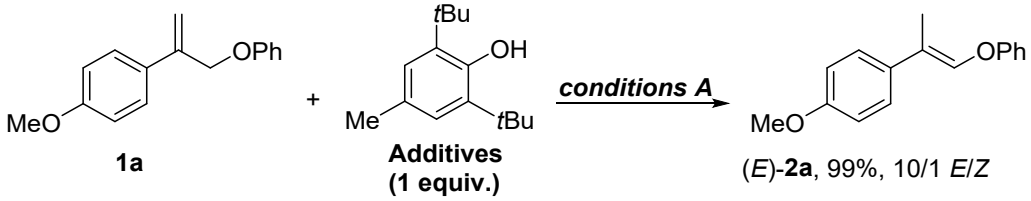
To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0034 g (0.026 mmol) of $CoCl_2$, 0.0164 g (0.031 mmol) of **PNP**, 1 mL of PhCl, 0.1195 g (0.5 mmol) of **1a** and 0.0898 g (0.5 mmol) of ethene-1,1-diyldibenzene were added in sequence. The mixture was stirred at room temperature for 5 minutes, then $NaBHEt_3$ (75 μL, 0.075 mmol)

[19] Y. Nassar, F. Rodier, V. Ferey, J. Cossy, *ACS Catal*. **2021**, *11*, 5736.
[20] X. Hu, J. He, Z. Ying, J. Zhou, J. Yu, *Chin. J. Chem.* **2021**, *39*, 2227.

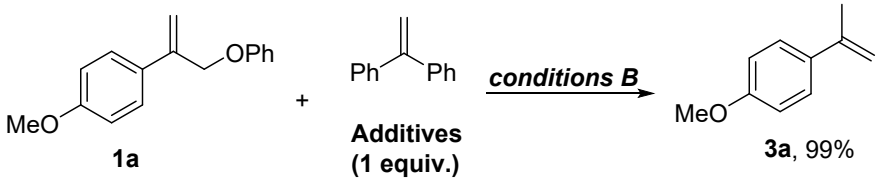
was added by dropwise. After stirring at room temperature for 1 h, the reaction was monitored by ^{1}H NMR (99% conv., 10/1 *E/Z*).



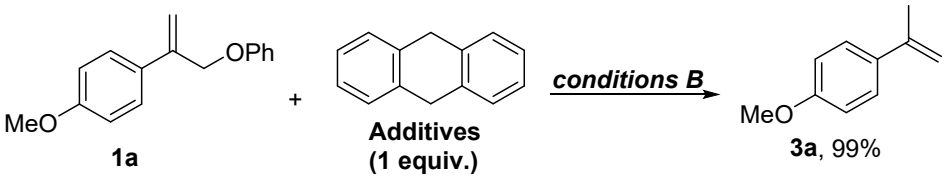
To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0033 g (0.025 mmol) of $CoCl_2$, 0.0168 g (0.031 mmol) of PNP, 1 mL of PhCl, 0.1202 g (0.5 mmol) of **1a** and 0.0896 g (0.5 mmol) of 9,10-dihydroanthracene were added in sequence. The mixture was stirred at room temperature for 5 minutes, then $NaBHEt_3$ (75 μL, 0.075 mmol) was added by dropwise. After stirring at room temperature for 1 h, After stirring at room temperature for 1 h, the reaction was monitored by ^{1}H NMR (99% conv., 10/1 *E/Z*).



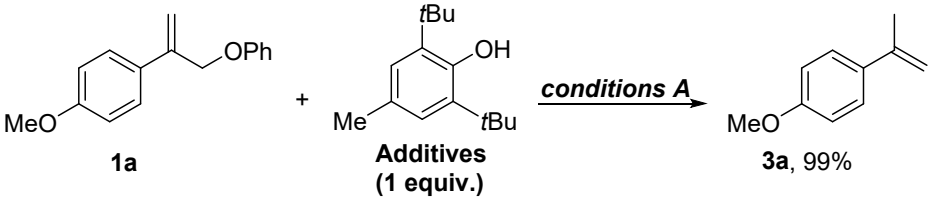
To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0032 g (0.025 mmol) of $CoCl_2$, 0.0164 g (0.031 mmol) of PNP, 1 mL of PhCl, 0.1205 g (0.5 mmol) of **1a** and 0.1082 g (0.49 mmol) of di-tert-butylhydroxytoluene were added in sequence. The mixture was stirred at room temperature for 5 minutes, then $NaBHEt_3$ (75 μL, 0.075 mmol) was added by dropwise. After stirring at room temperature for 1 h, the reaction was monitored by ^{1}H NMR (99% conv., 10/1 *E/Z*).



To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0036 g (0.027 mmol) of $CoCl_2$, 0.0134 g (0.031 mmol) of PAO^{Me}, 1 mL of THF, 0.1203 g (0.5 mmol) of **1a** and 0.0894 g (0.50 mmol) of ethene-1,1-diyldibenzene were added in sequence. The mixture was stirred at room temperature for 5 minutes, then $NaBHEt_3$ (75 μL, 0.075 mmol) and HBpin (90 μL, 0.60 mmol) was added by dropwise. After stirring at room temperature for 1 h, the reaction was monitored by ^{1}H NMR (99% conv.).

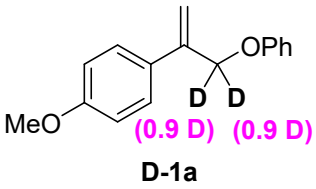


To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0035 g (0.027 mmol) of $CoCl_2$, 0.0134 g (0.031 mmol) of PAO^{Me}, 1 mL of THF, 0.1208 g (0.5 mmol) of **1a** and 0.0894 g (0.50 mmol) of 9,10-dihydroanthracene were added in sequence. The mixture was stirred at room temperature for 5 minutes, then $NaBHEt_3$ (75 μL, 0.075 mmol) and HBpin (90 μL, 0.60 mmol) was added by dropwise. After stirring at room temperature for 1 h, the reaction was monitored by ^1H NMR (99% conv.).



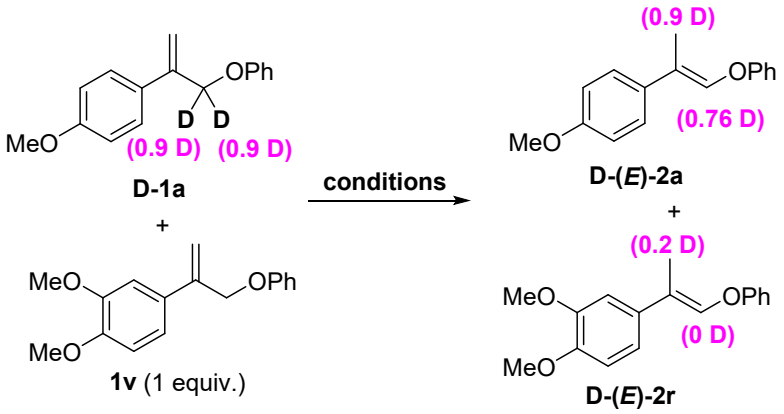
To a 10 mL flame-dried Schlenk flask cooled under argon, 0.0032 g (0.025 mmol) of $CoCl_2$, 0.0141 g (0.032 mmol) of PAO^{Me}, 1 mL of THF, 0.1205 g (0.5 mmol) of **1a** and 0.1095 g (0.50 mmol) of di-tert-butylhydroxytoluene were added in sequence. The mixture was stirred at room temperature for 5 minutes, then $NaBHEt_3$ (75 μL, 0.075 mmol) and HBpin (90 μL, 0.60 mmol) was added by dropwise. After stirring at room temperature for 1 h, the reaction was monitored by ^1H NMR (99% conv.).

(b) H/D scrambling experiments:

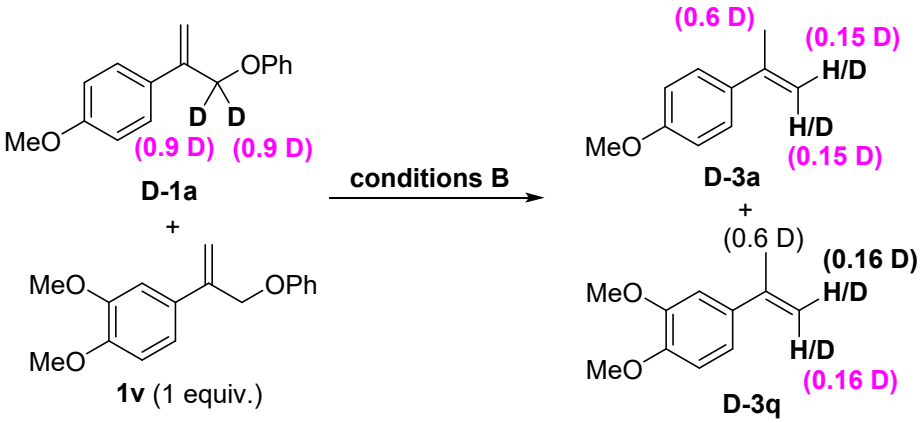


1-methoxy-4-(3-phenoxyprop-1-en-2-yl-3,3-d2)benzene (D-1a). Prepared according to the general procedure[21] of Witting reaction using Ph_3PMeBr and 1-(4-methoxyphenyl)-2-phenoxyethan-1-one-2,2-d2 (prepared according to a previously reported method, 100% D) as the starting materials, white solid. ^1H NMR (400 MHz, $CDCl_3$) δ 7.43 (d, J = 8.8 Hz, 2H), 7.27-7.31 (m, 2H), 6.94-6.99 (m, 3H), 6.89 (d, J = 8.8 Hz, 2H), 5.53 (s, 1H), 5.37 (s, 1H), 4.85 (s, 0.2H), 3.82 (s, 3H). ^2H NMR (61 MHz, $CDCl_3$): δ 4.85 (s, 1.8D).

[21] J. Zhao, B. Cheng, C. Chen, Z. Lu, *Org. Lett.* **2020**, *22*, 837.



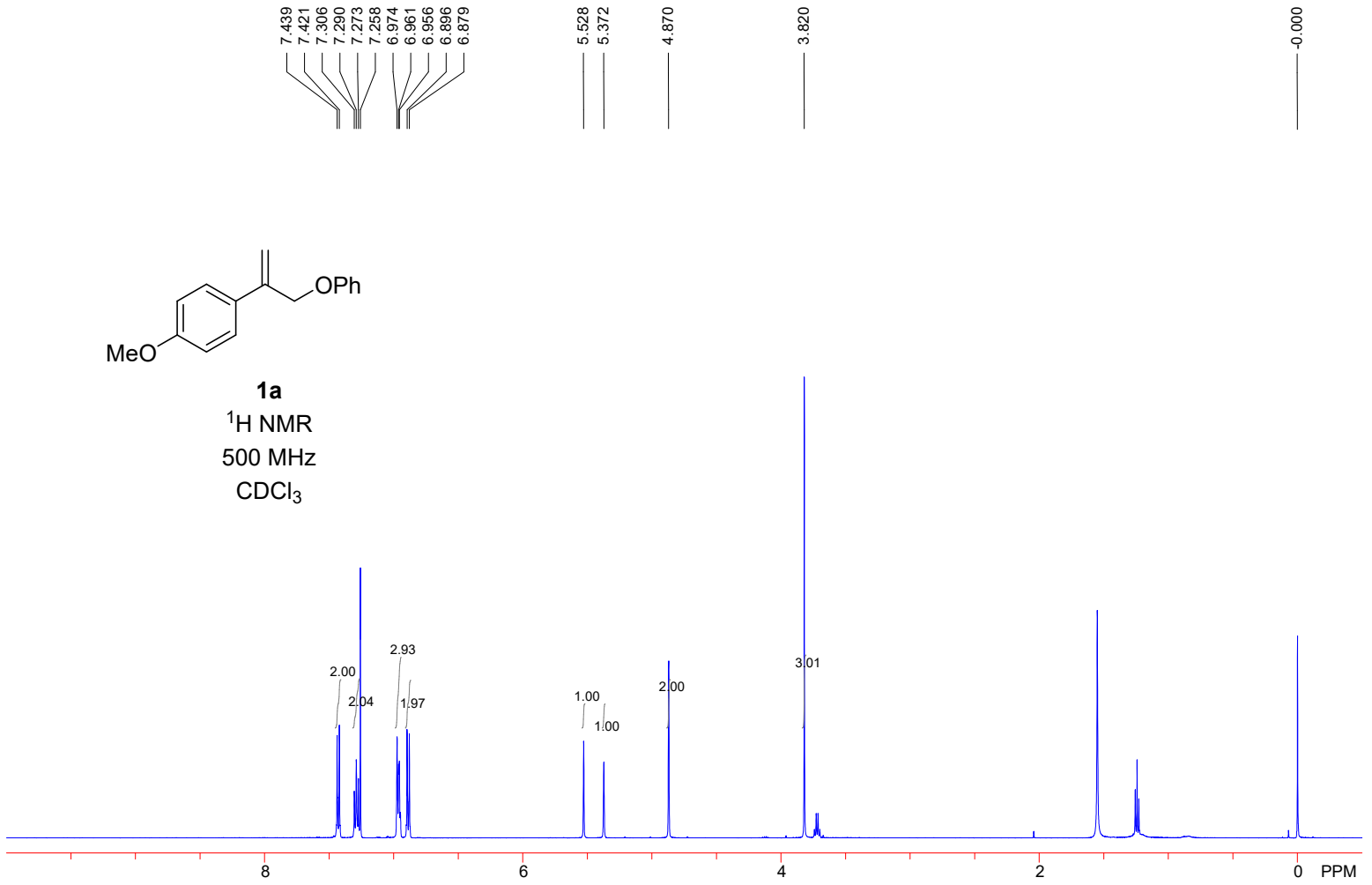
Performed according to the general procedure using 0.0603 g (0.25 mmol) of D-**1a**, 0.0681 g (0.25 mmol) of **1v**, 0.0043 g (0.030 mmol) of $CoCl_2$, 0.0179 g (0.033 mmol) of **PNP**, 75 μL (1 M in THF, 0.075 mmol) of $NaBHEt_3$ and 1 mL of PhCl. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give D-(*E*)-**2a** (0.0550 g, 0.23 mmol, 91%) and D-(*E*)-**2v** (0.0621 mg, 0.23 mmol, 91%), respectively. For D-(*E*)-**2a**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30-7.35 (m, 4H), 7.04 (d, J = 8.4 Hz, 3H), 6.88 (d, J = 8.4 Hz, 2H), 6.76 (s, 0.24H), 3.81 (s, 3H), 2.11 (s, 2.1H). ^{2}H NMR (400 MHz, $CHCl_3$): δ 4.85 (s, 1.8D). ^{2}H NMR (61 MHz, $CDCl_3$) δ 6.77 (s, 0.76D), 2.09 (d, J = 2.4 Hz, 0.9D). For D-(*E*)-**2v**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30-7.35 (m, 2H), 7.05 (d, J = 8.4 Hz, 3H), 6.95 (d, J = 8.4 Hz, 1H), 6.91 (s, 1H), 6.85 (d, J = 8.3 Hz, 1H), 6.77 (s, 1H), 3.90 (s, 3H), 3.88 (s, 3H), 2.13 (s, 3H). ^{2}H NMR (61 MHz, $CDCl_3$) δ 2.12 (s, 0.20D).

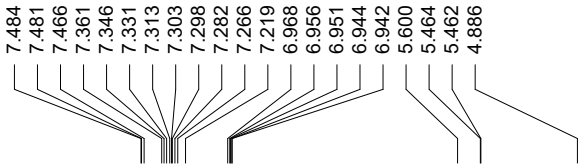


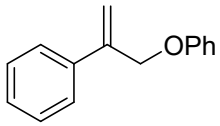
Prepared according to the general procedure using 0.0600 g (0.25 mmol) of D-**1a**, 0.0698 g (0.26 mmol) of **1v**, 0.0039 g (0.030 mmol) of $CoCl_2$, 0.0139 g (0.032 mmol) of **PAO^{Me}**, 75 μL (1 M in THF, 0.075 mmol) of $NaBHEt_3$ and 1 mL of THF. After 1 h, the crude reaction mixture was purified by flash column chromatography using PE as the eluent to give D-**3a** (0.0277 g, 0.19 mmol, 75%) and D-**3q** (0.0387 mg, 0.22 mmol, 87%), respectively. For D-**3a**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (d, J = 8.8 Hz, 2H), 6.86 (d, J = 8.8 Hz, 2H), 5.29 (s, 0.85H), 4.99 (s, 0.85H), 3.81 (s, 3H), 2.13 (s, 2.40H). ^{2}H NMR (61 MHz, $CDCl_3$) δ 5.29 (s, 0.15D), 4.99 (s, 0.15D), 2.08 (d, J = 2.0 Hz,

0.6D). For D-**3q**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.04 - 7.00 (m, 2H), 6.83 (d, J = 8.8 Hz, 1H), 5.29 (s, 0.84H), 5.01 (s, 0.84H), 3.91 (s, 3H), 3.89 (s, 3H), 2.14 (s, 2.40H). ^{2}H NMR (61 MHz, $CDCl_3$) δ 5.32 (s, 0.16D), 5.04 (s, 0.16D), 2.12 (s, 0.6D).

VIII. NMR Spectra





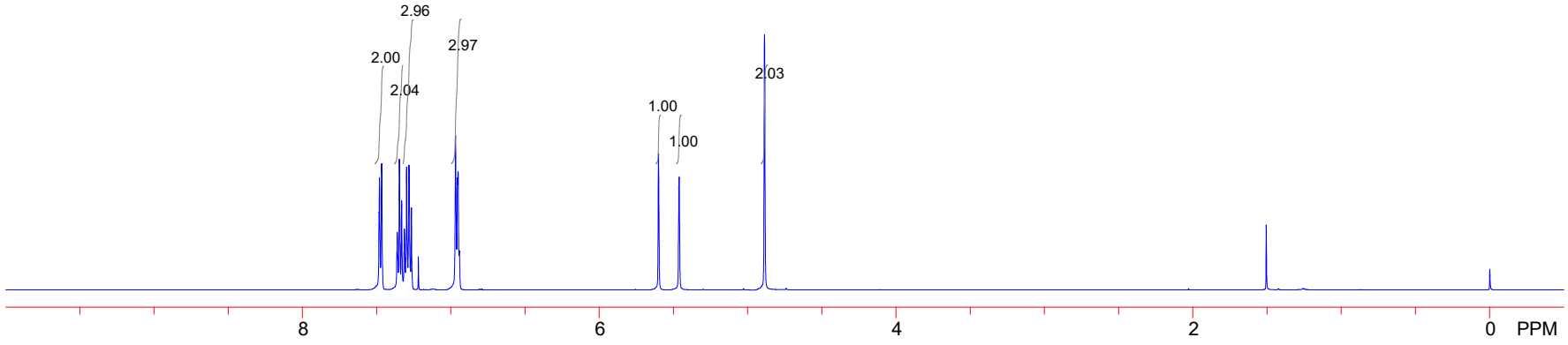


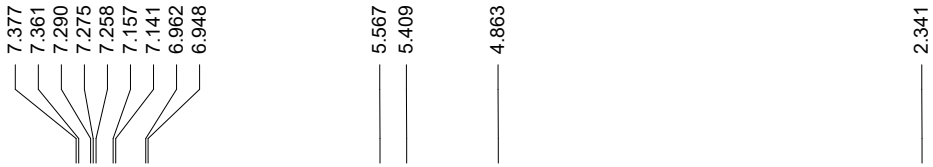
1b

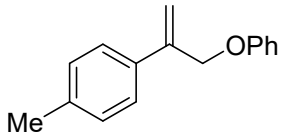
^{1}H NMR

500 MHz

$CDCl_3$





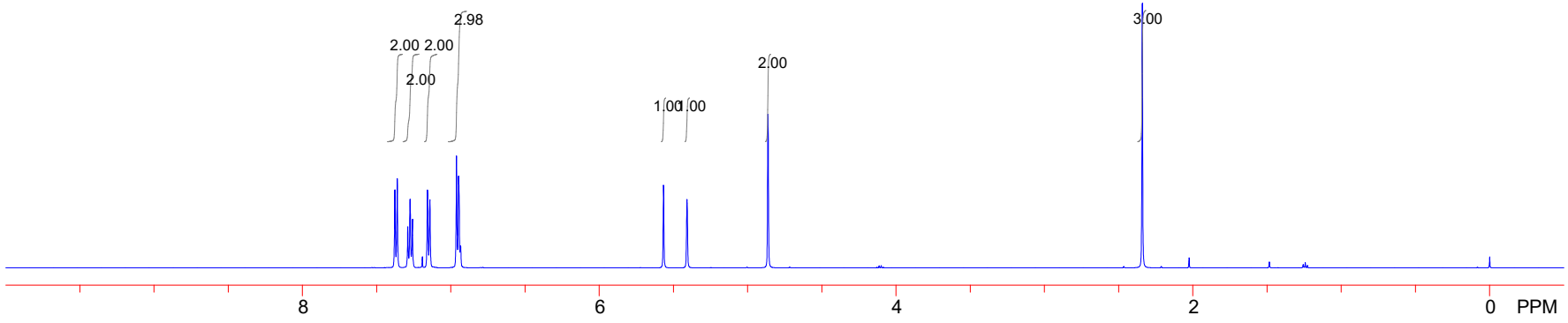


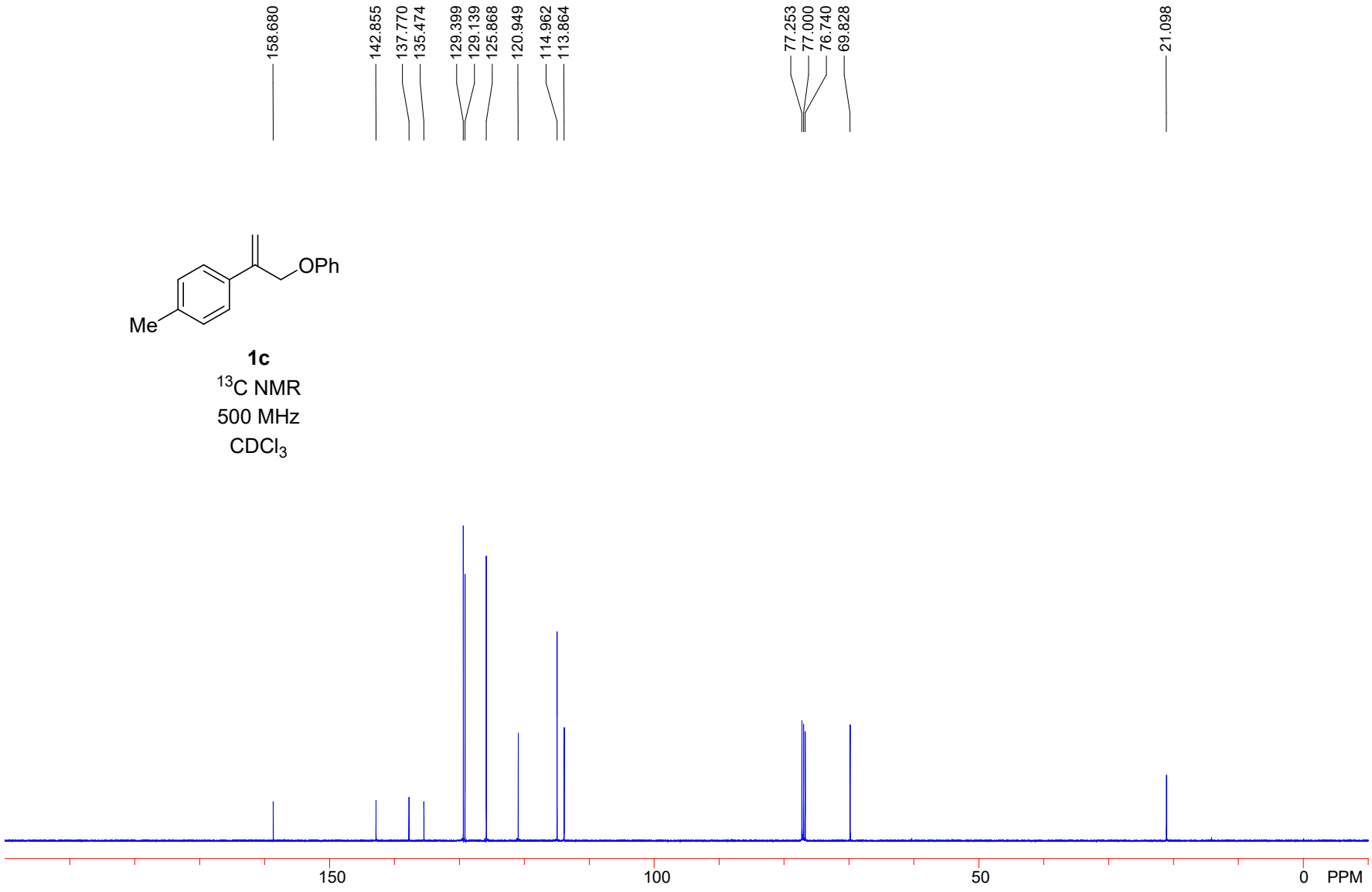
1c

^{1}H NMR

500 MHz

$CDCl_3$



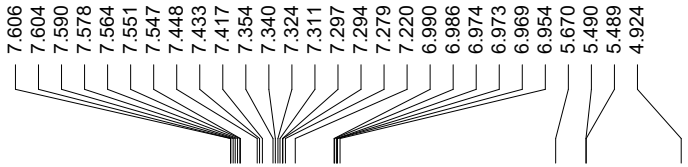


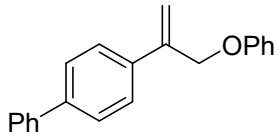
1c

^{13}C NMR

500 MHz

$CDCl_3$



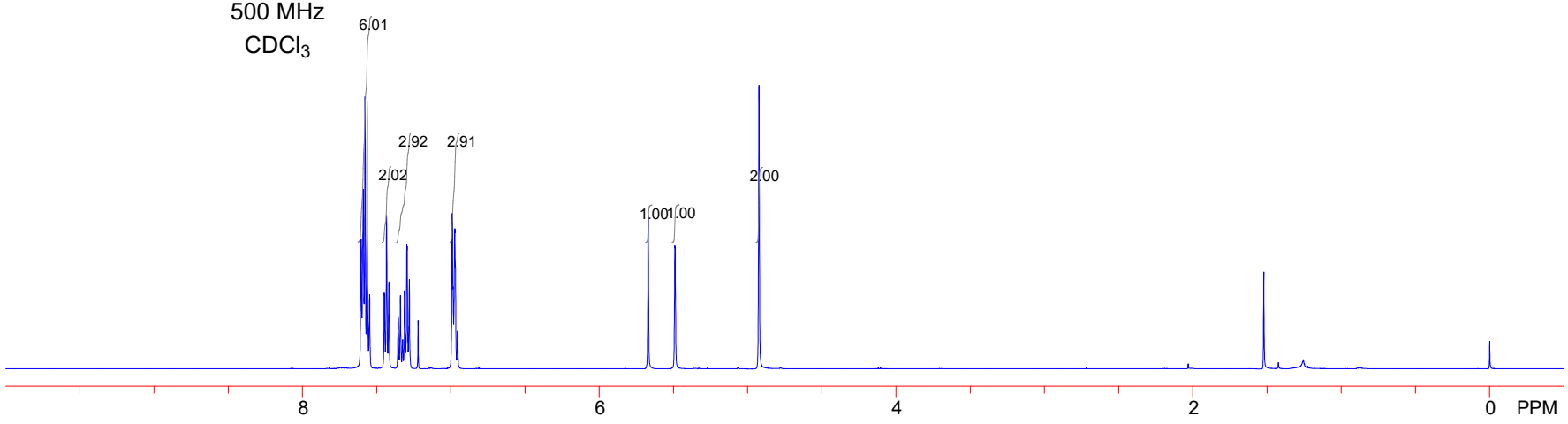


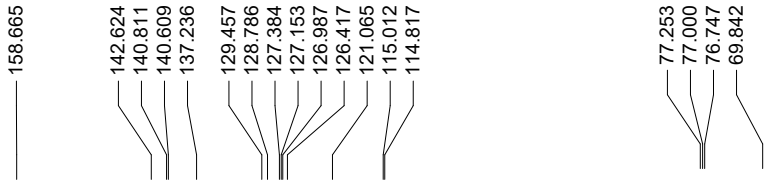
1d

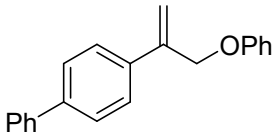
^{1}H NMR

500 MHz

$CDCl_3$





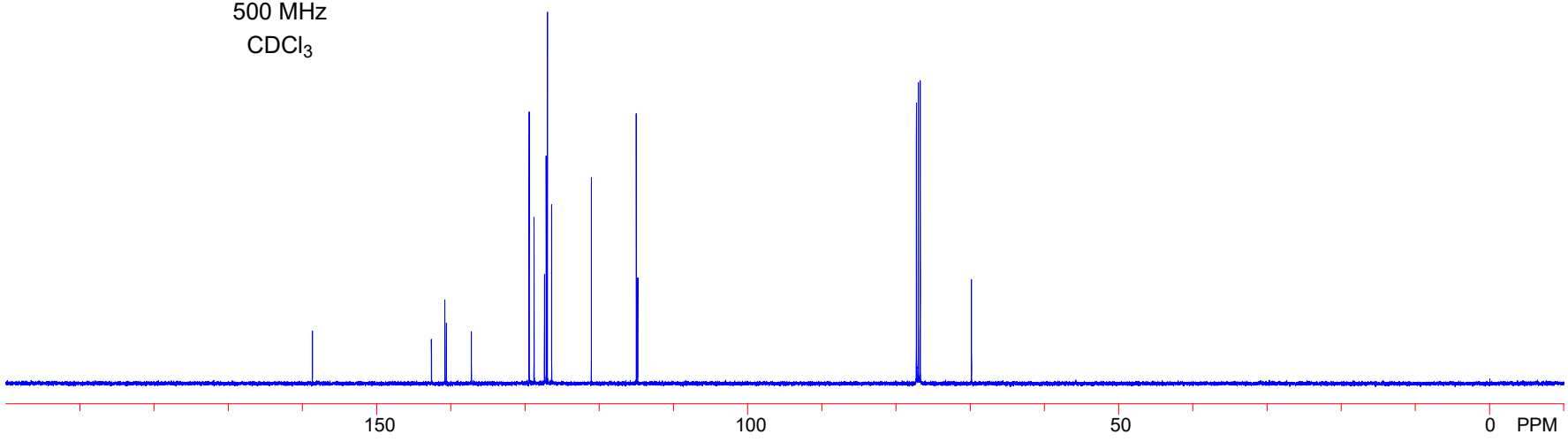


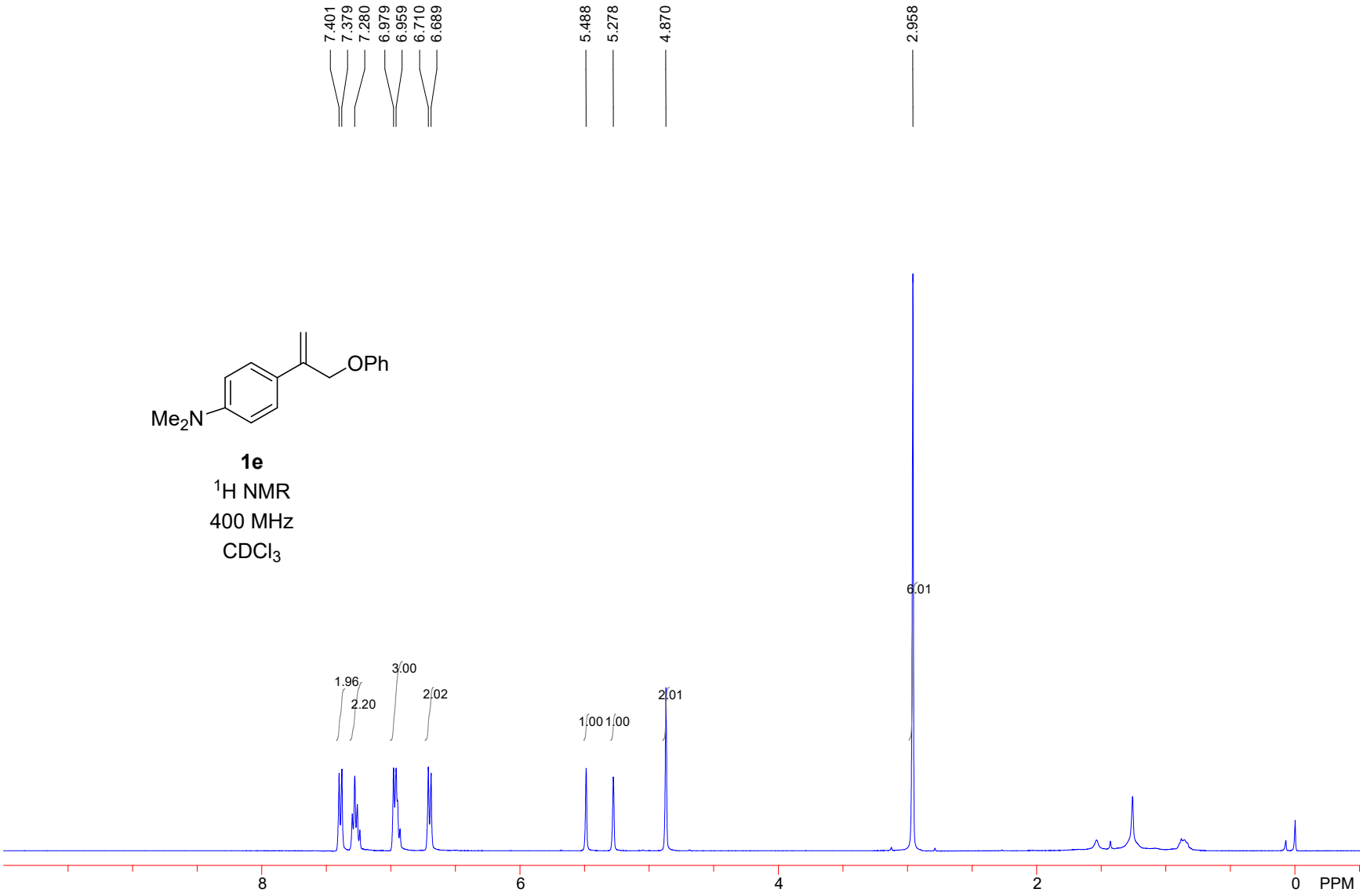
1d

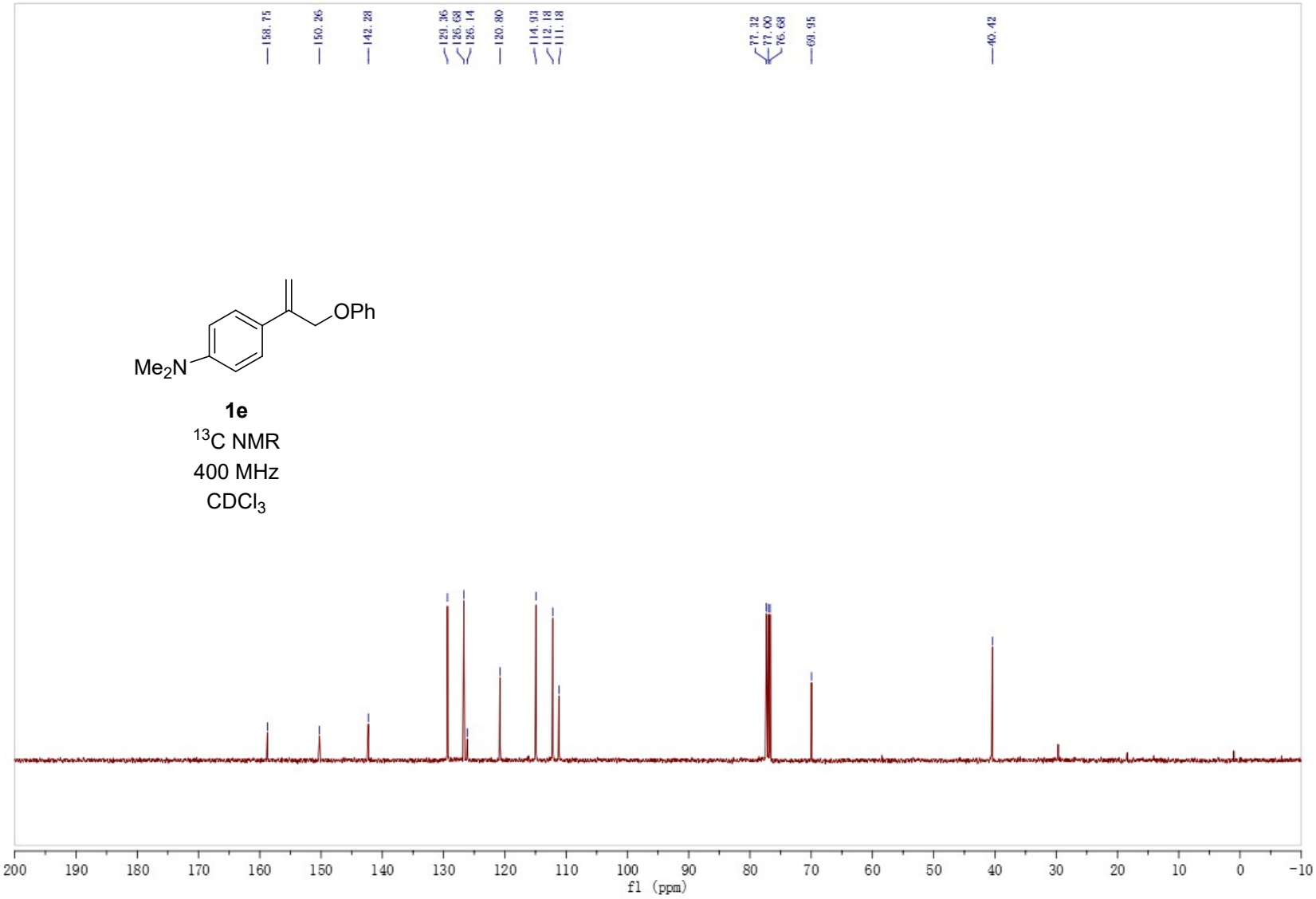
^{13}C NMR

500 MHz

$CDCl_3$




7.401
7.379
7.280
6.979
6.959
6.710
6.689
5.488
5.278
4.870
2.958
OPh
Me2N
1e
1H NMR
400 MHz
CDCl3
6.01
1.96
2.20
3.00
2.02
1.00
1.00
2.01
8
6
4
2
0
PPM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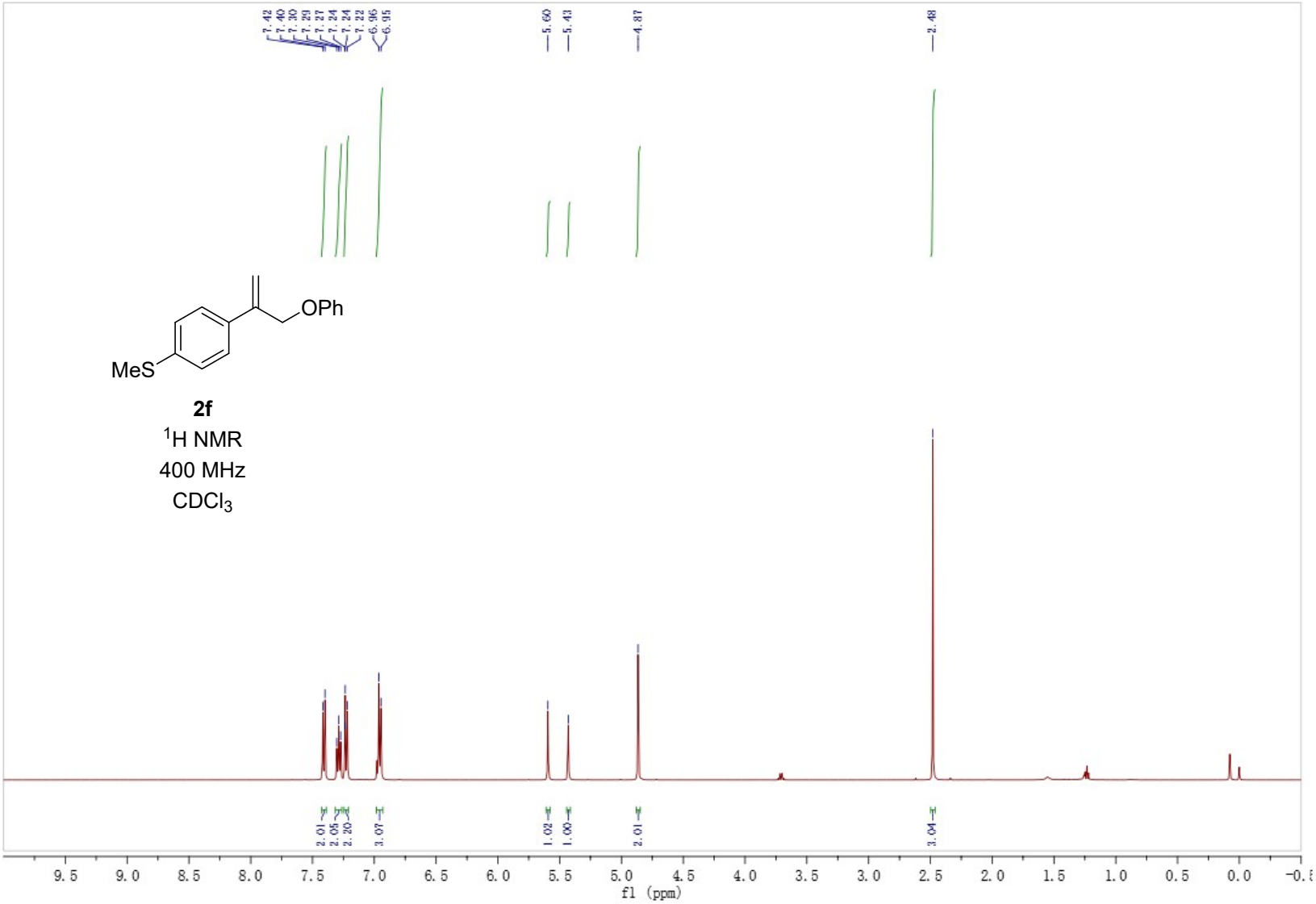
150.26
142.28
129.36
126.68
126.14
120.80
114.93
112.18
111.18
77.32
77.00
76.68
69.95
40.42
OPh
Me2N
1e
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

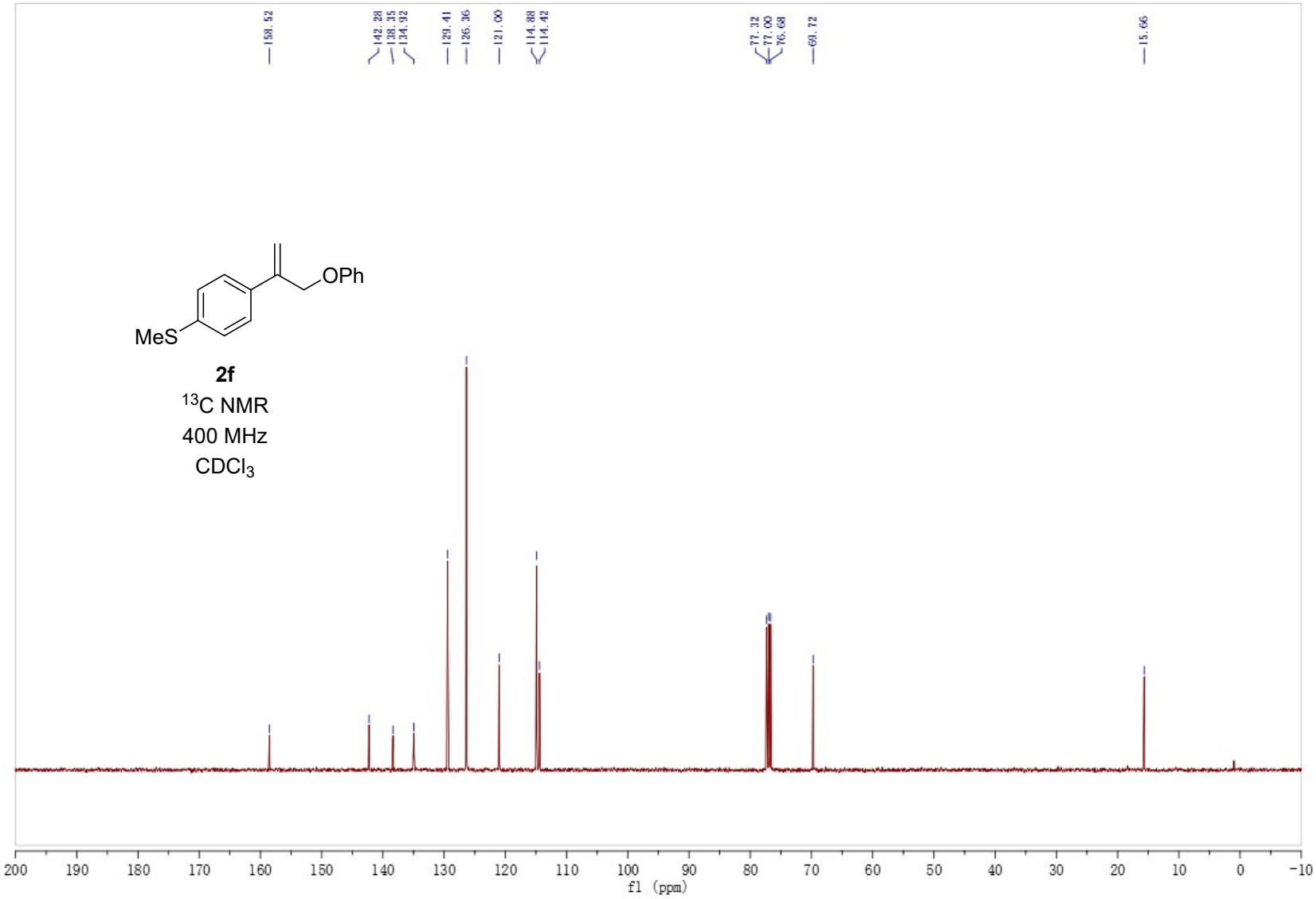


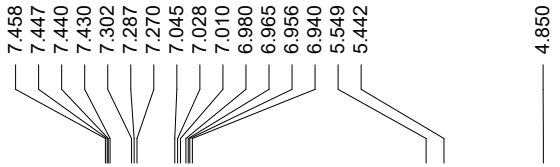
2f

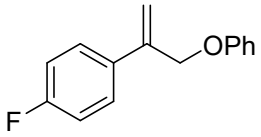
^{1}H NMR

400 MHz

$CDCl_3$


158.52
142.28
138.35
134.92
129.41
126.36
121.00
114.88
114.42
77.32
77.00
76.68
69.72
15.66
OPh
MeS
2f
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



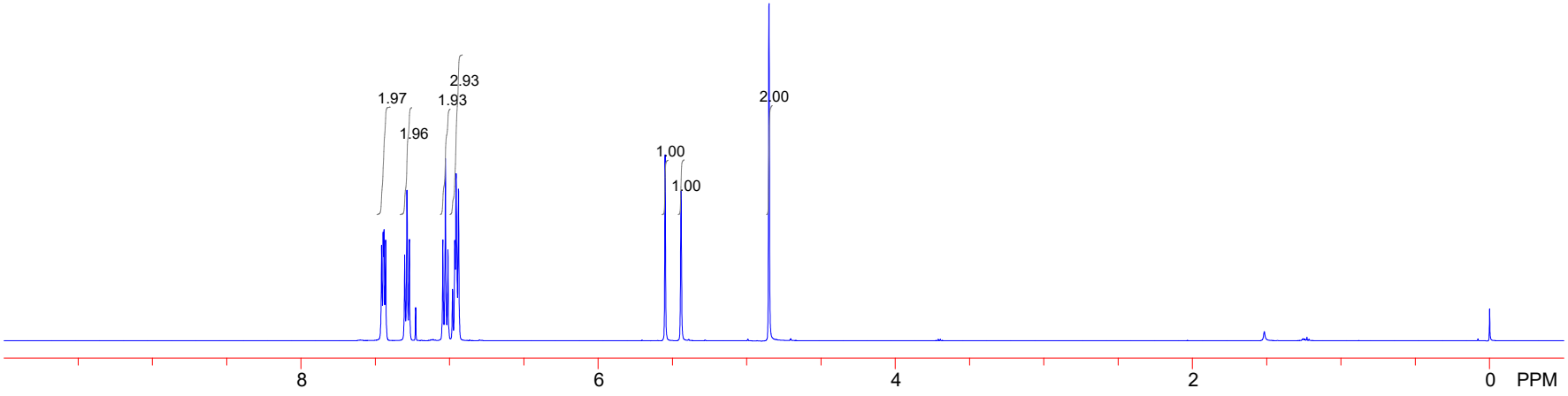


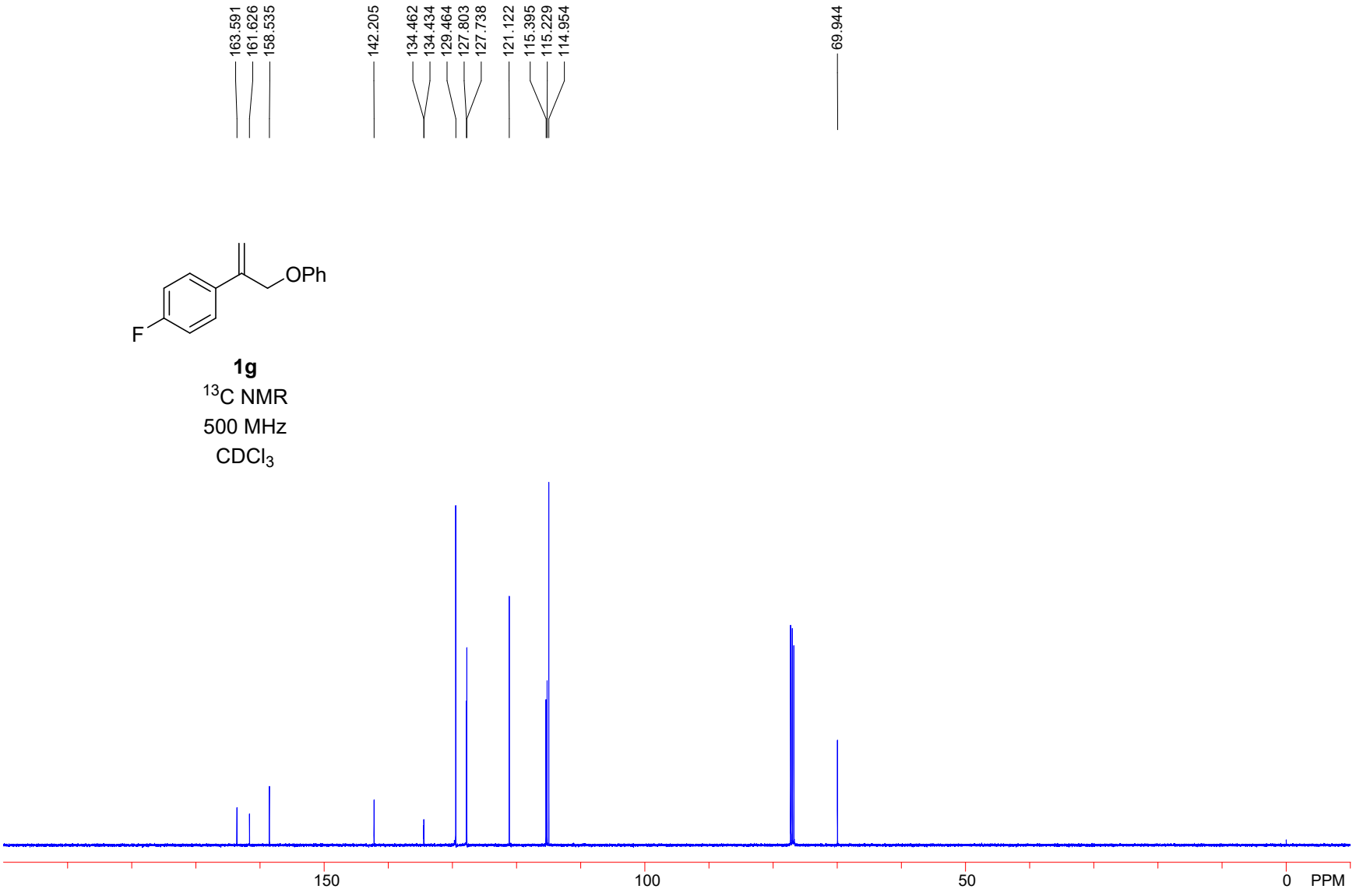
1g

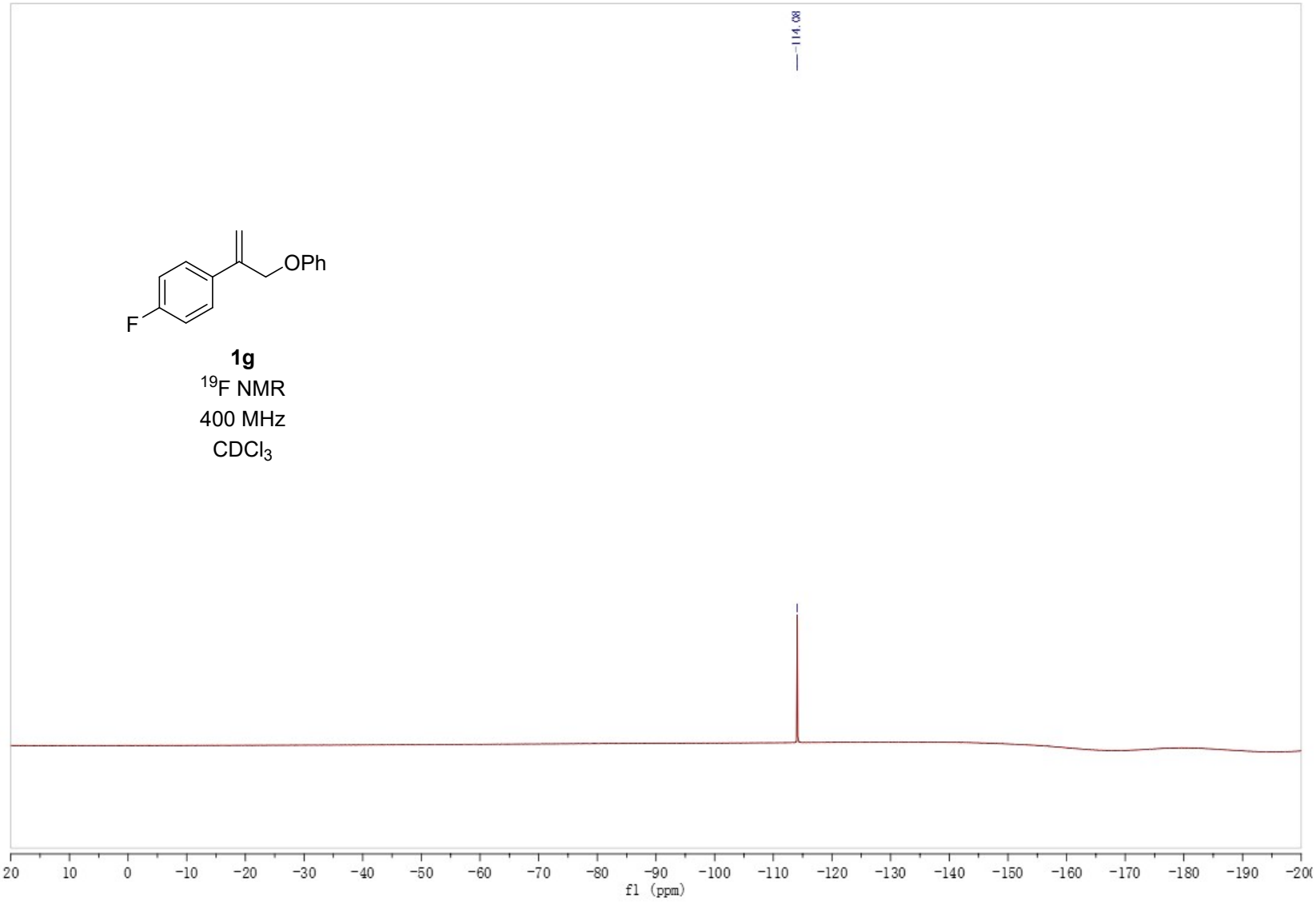
^{1}H NMR

500 MHz

$CDCl_3$




163.591
161.626
158.535
142.205
134.462
134.434
129.464
127.803
127.738
121.122
115.395
115.229
114.954
69.944
OPh
F
1g
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

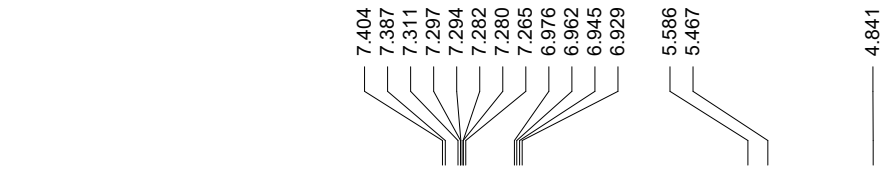


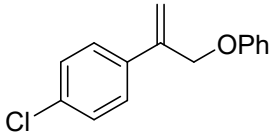
1g

^{19}F NMR

400 MHz

$CDCl_3$



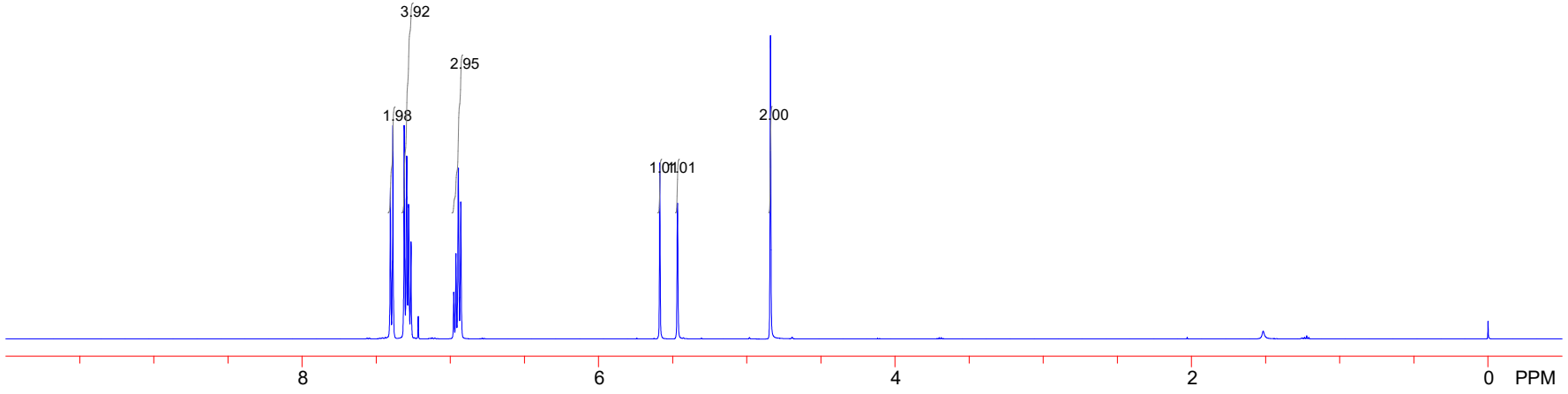


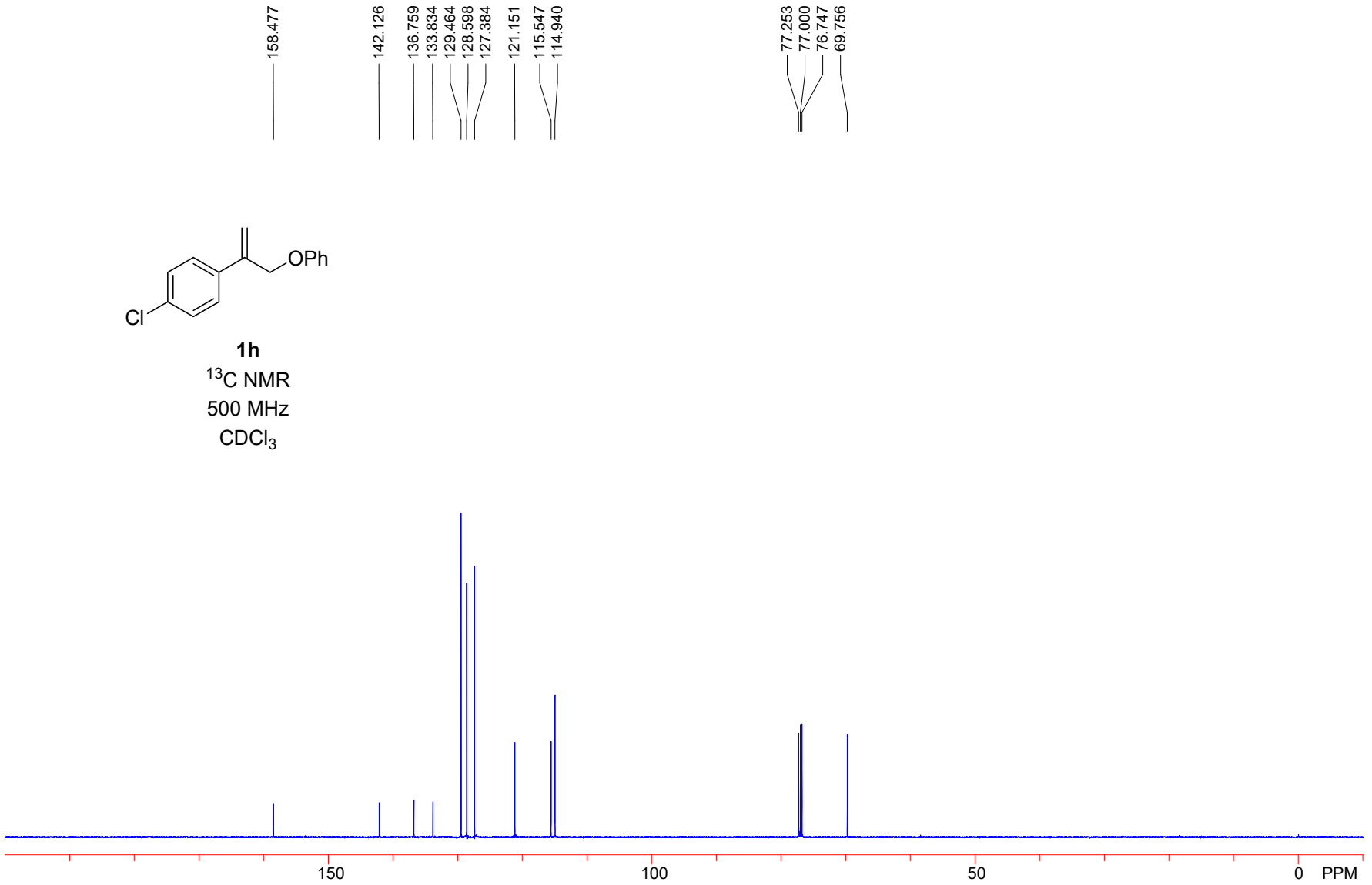
1h

^{1}H NMR

500 MHz

$CDCl_3$



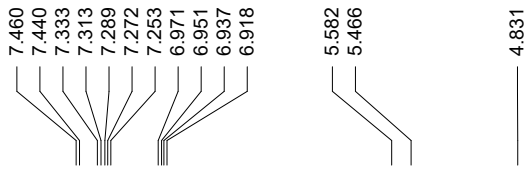


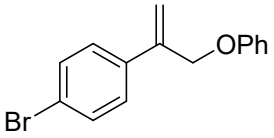
1h

^{13}C NMR

500 MHz

$CDCl_3$



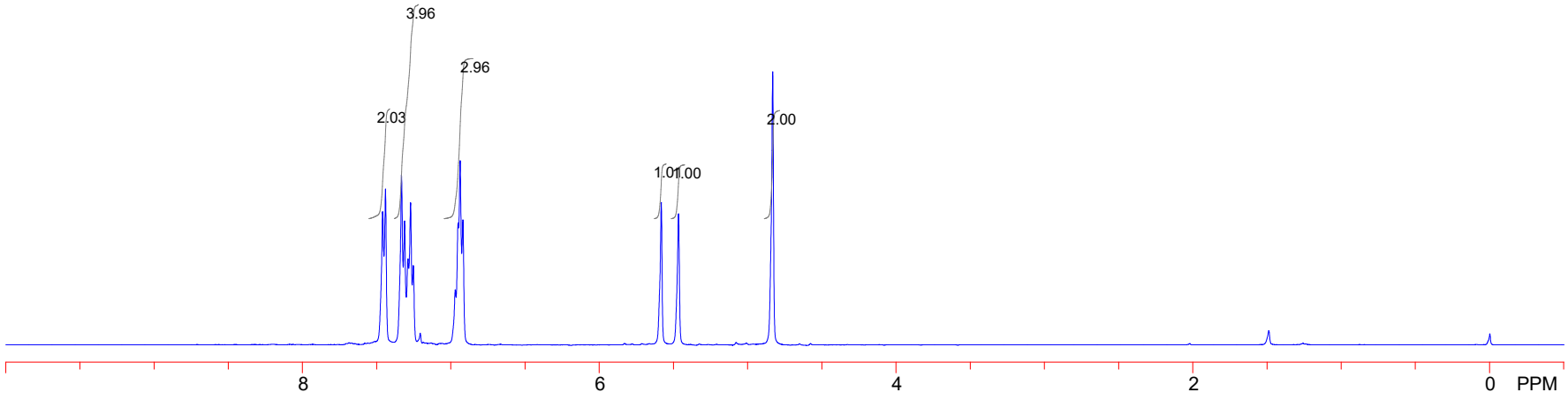


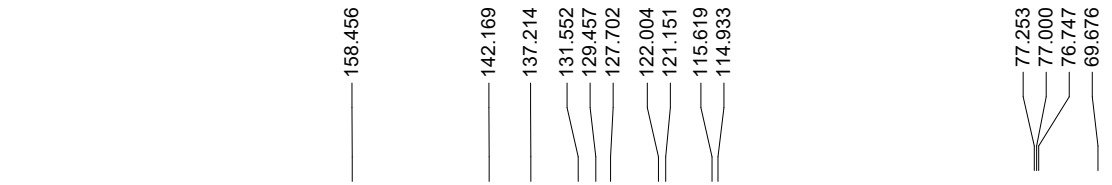
1i

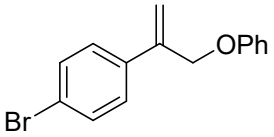
^{1}H NMR

500 MHz

$CDCl_3$





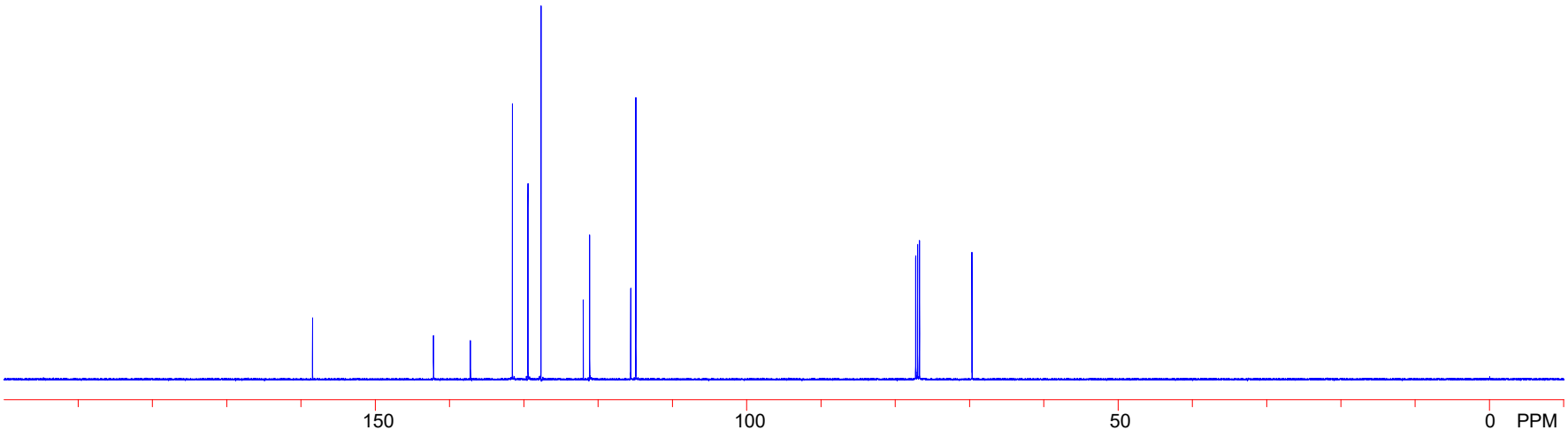


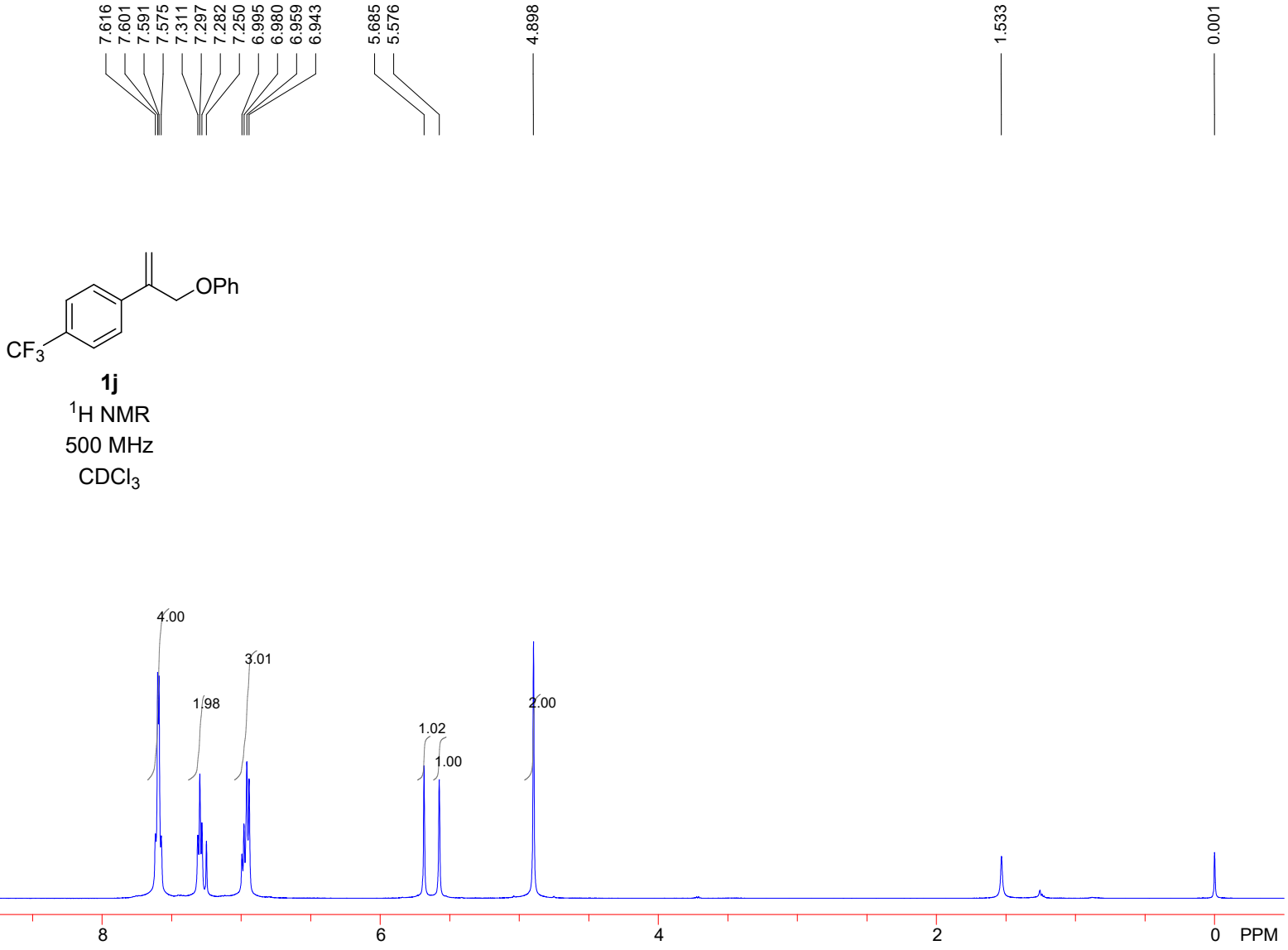
1i

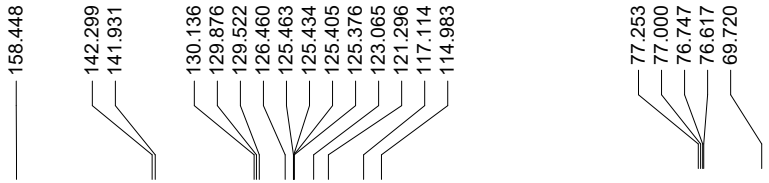
^{13}C NMR

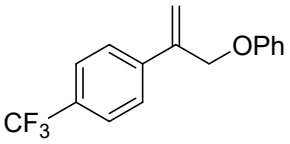
500 MHz

$CDCl_3$




7.616
7.601
7.591
7.575
7.311
7.297
7.282
7.250
6.995
6.980
6.959
6.943
5.685
5.576
4.898
1.533
0.001
OPh
CF3
1j
1H NMR
500 MHz
CDCl3
4.00
1.98
3.01
1.02
1.00
2.00
8
6
4
2
0
PPM



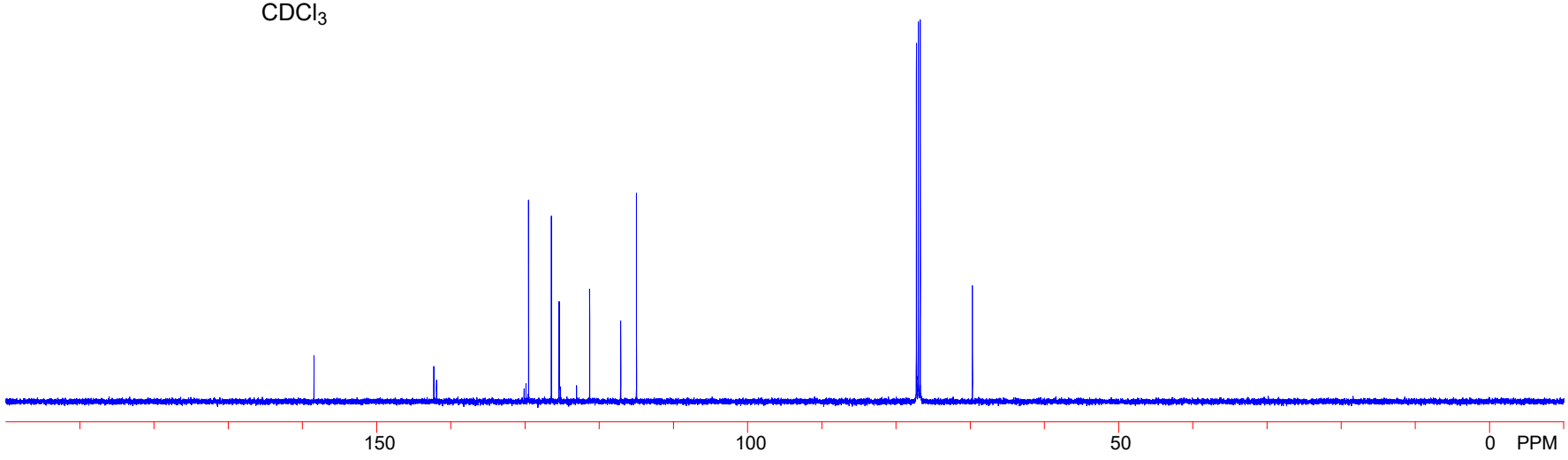


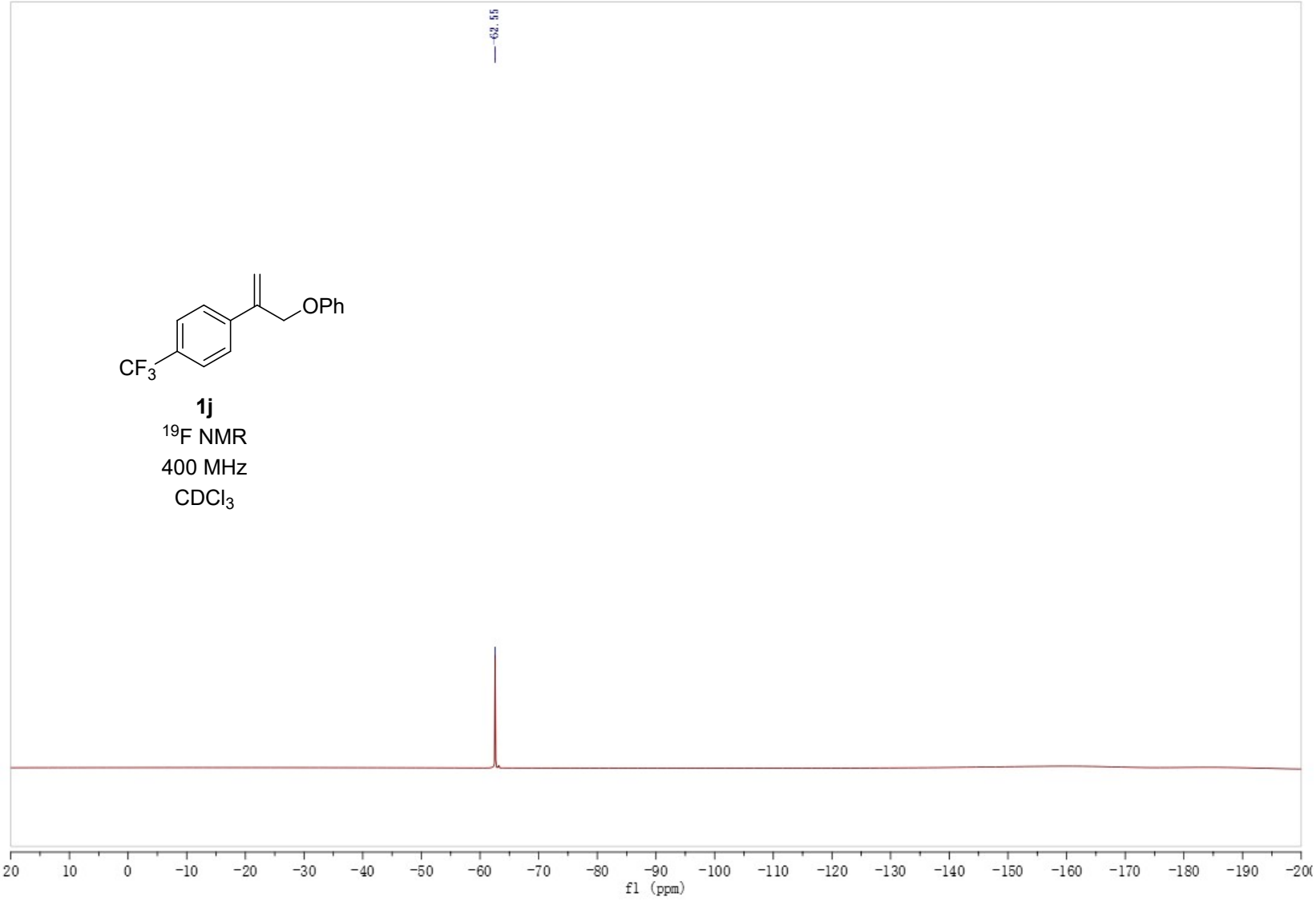
1j

^{13}C NMR

500 MHz

$CDCl_3$



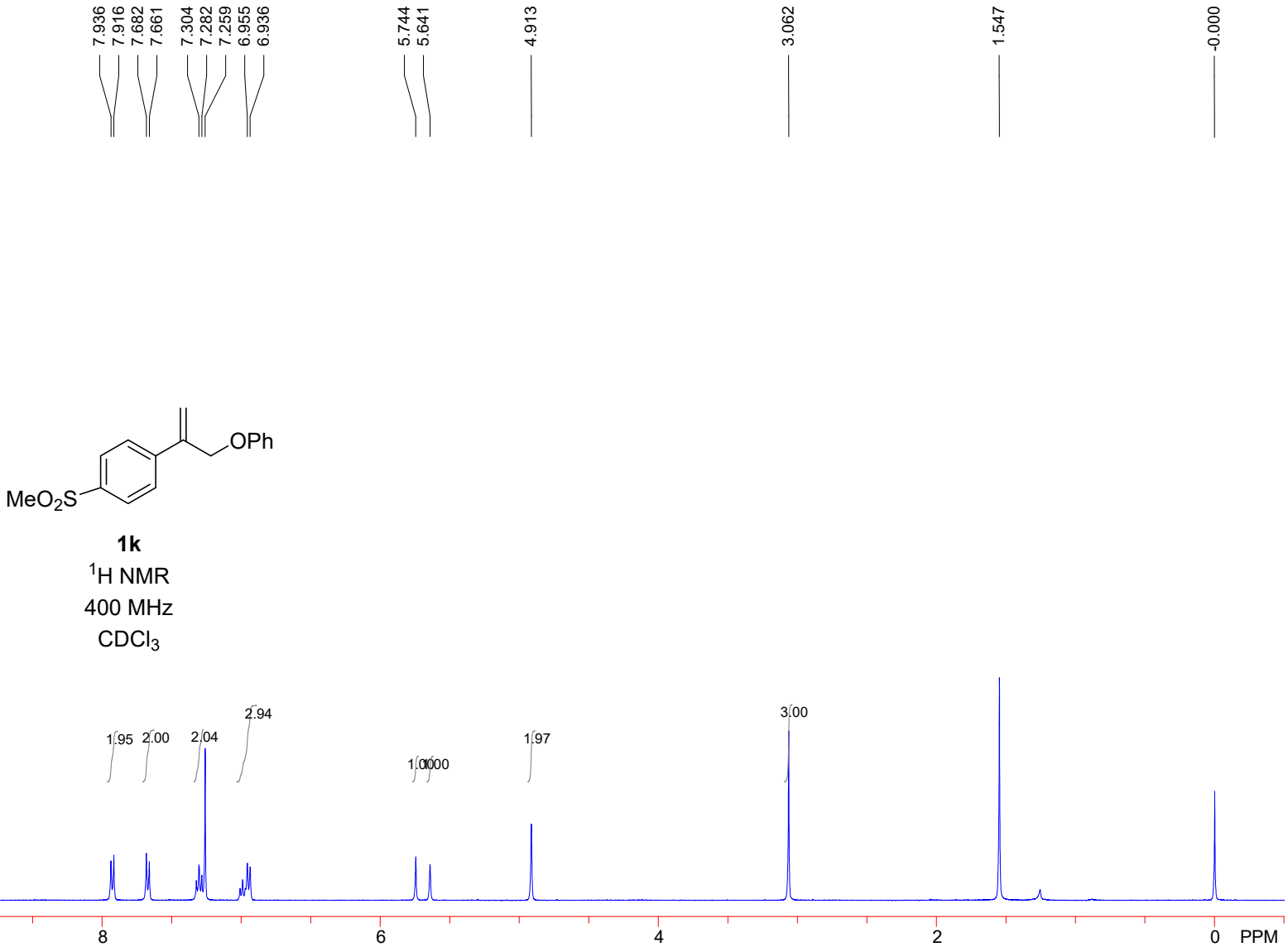


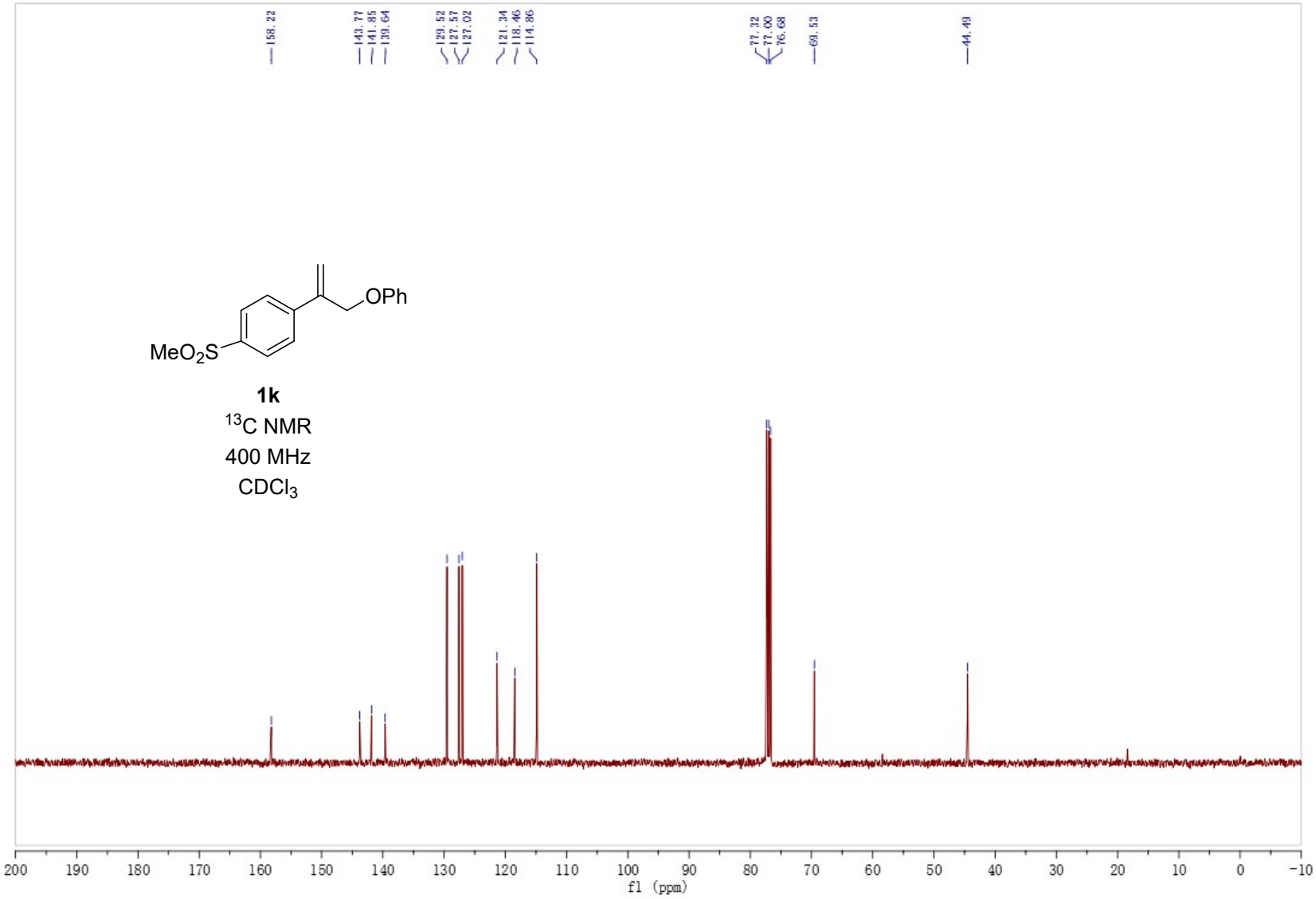
1j

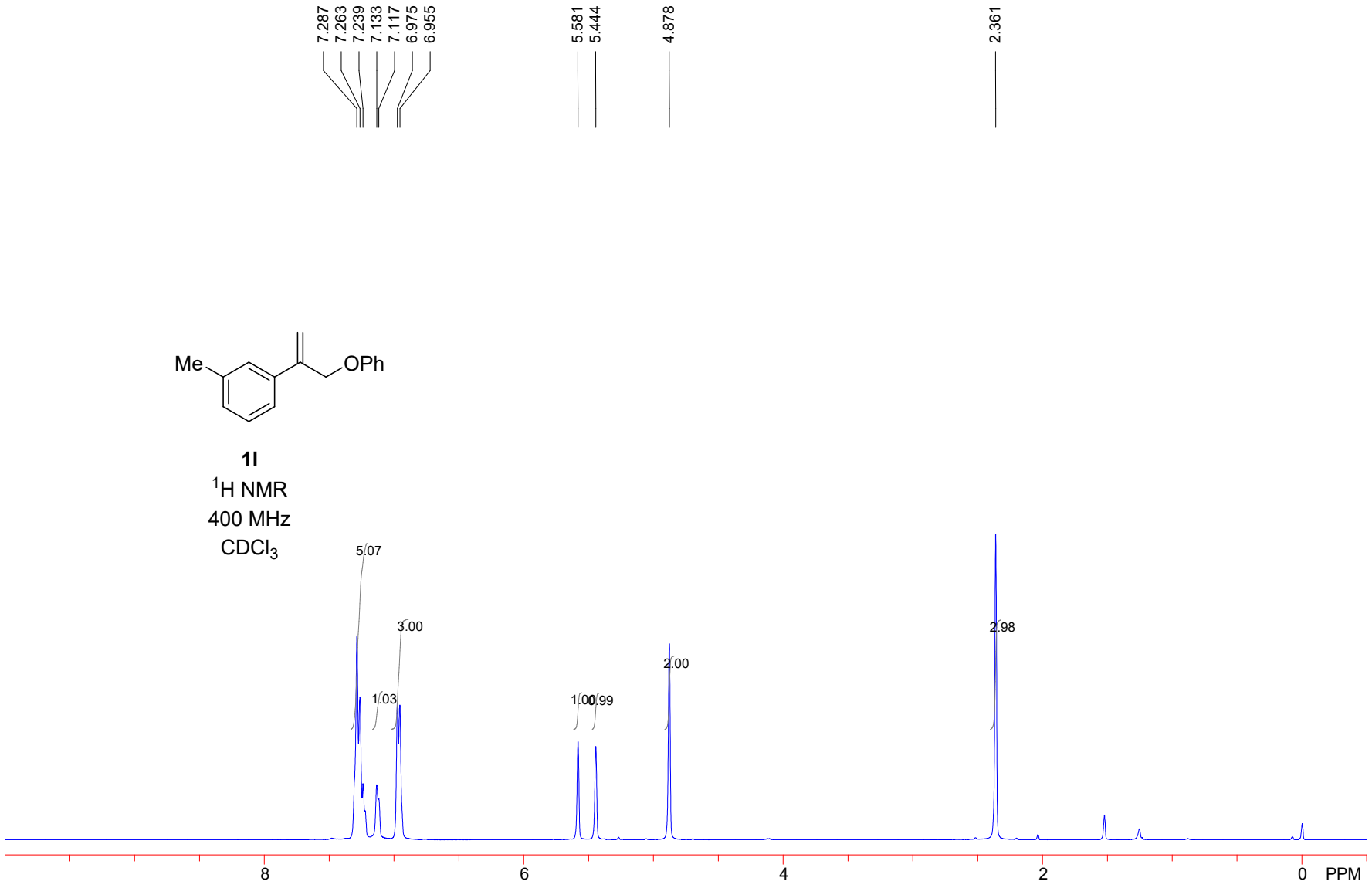
^{19}F NMR

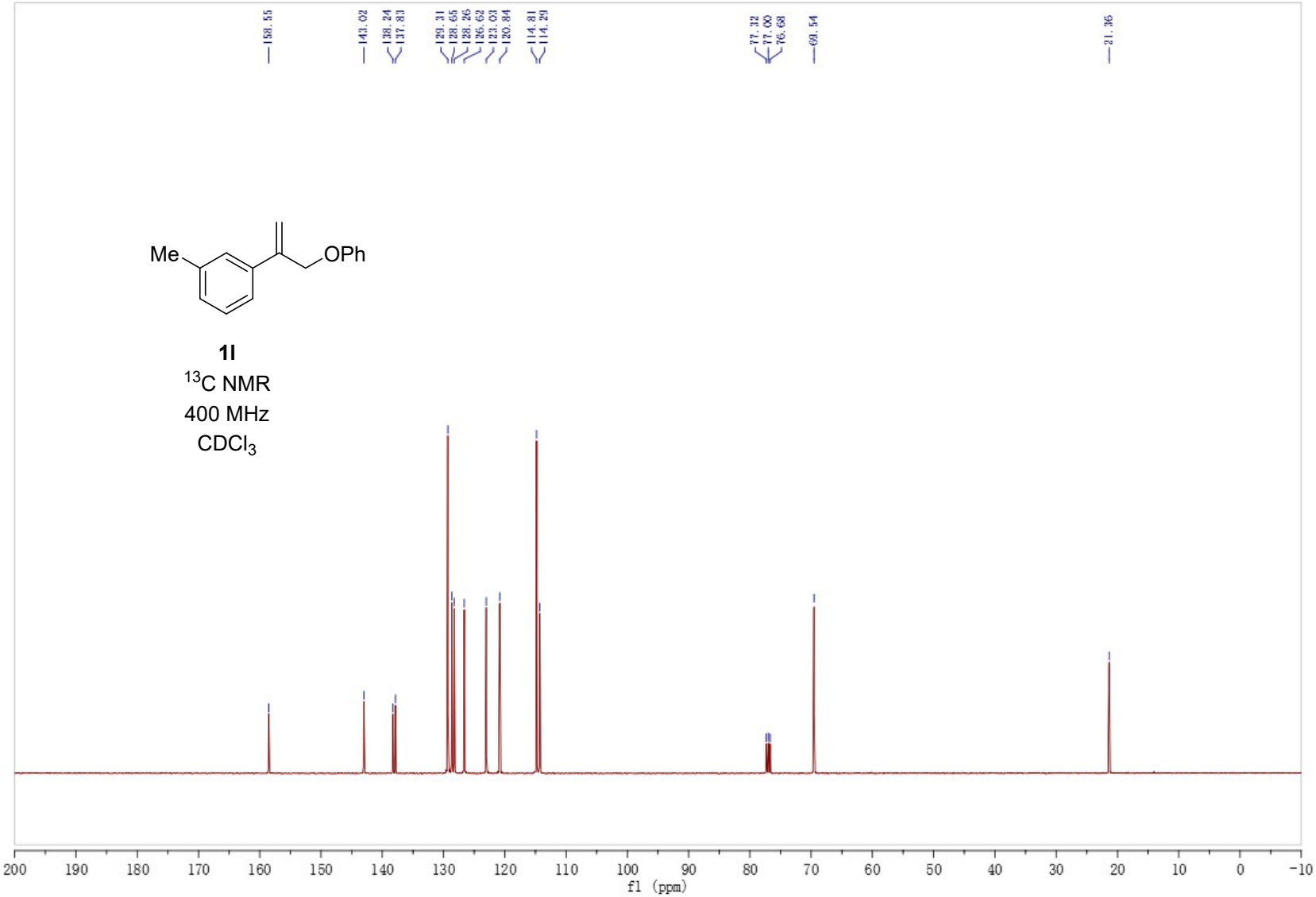
400 MHz

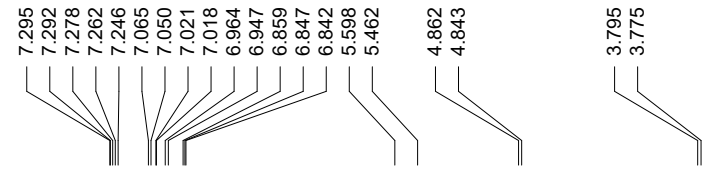
$CDCl_3$

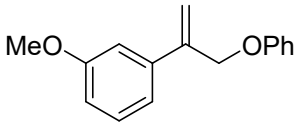

7.936
7.916
7.682
7.661
7.304
7.282
7.259
6.955
6.936
5.744
5.641
4.913
3.062
1.547
-0.000
OPh
MeO2S
1k
1H NMR
400 MHz
CDCl3
1.95
2.00
2.04
2.94
1.00
1.00
1.97
3.00
8
6
4
2
0
PPM


158.22
143.77
141.85
139.64
129.52
127.57
127.02
121.34
118.46
114.86
77.32
77.00
76.68
69.53
44.49
OPh
MeO2S
1k
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.287
7.263
7.239
7.133
7.117
6.975
6.955
5.581
5.444
4.878
2.361
Me
OPh
1l
1H NMR
400 MHz
CDCl3
5.07
3.00
1.03
1.00
0.99
2.00
2.98
8
6
4
2
0
PPM


158.55
143.02
138.24
137.83
129.31
128.65
128.26
126.62
123.03
120.84
114.81
114.29
77.32
77.00
76.68
69.54
21.36
Me
OPh
1l
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



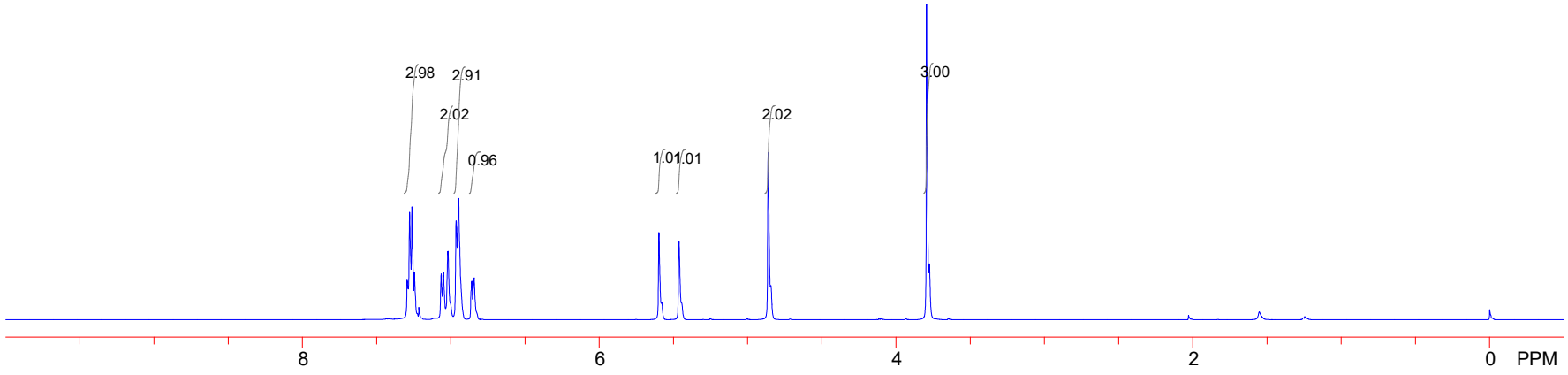


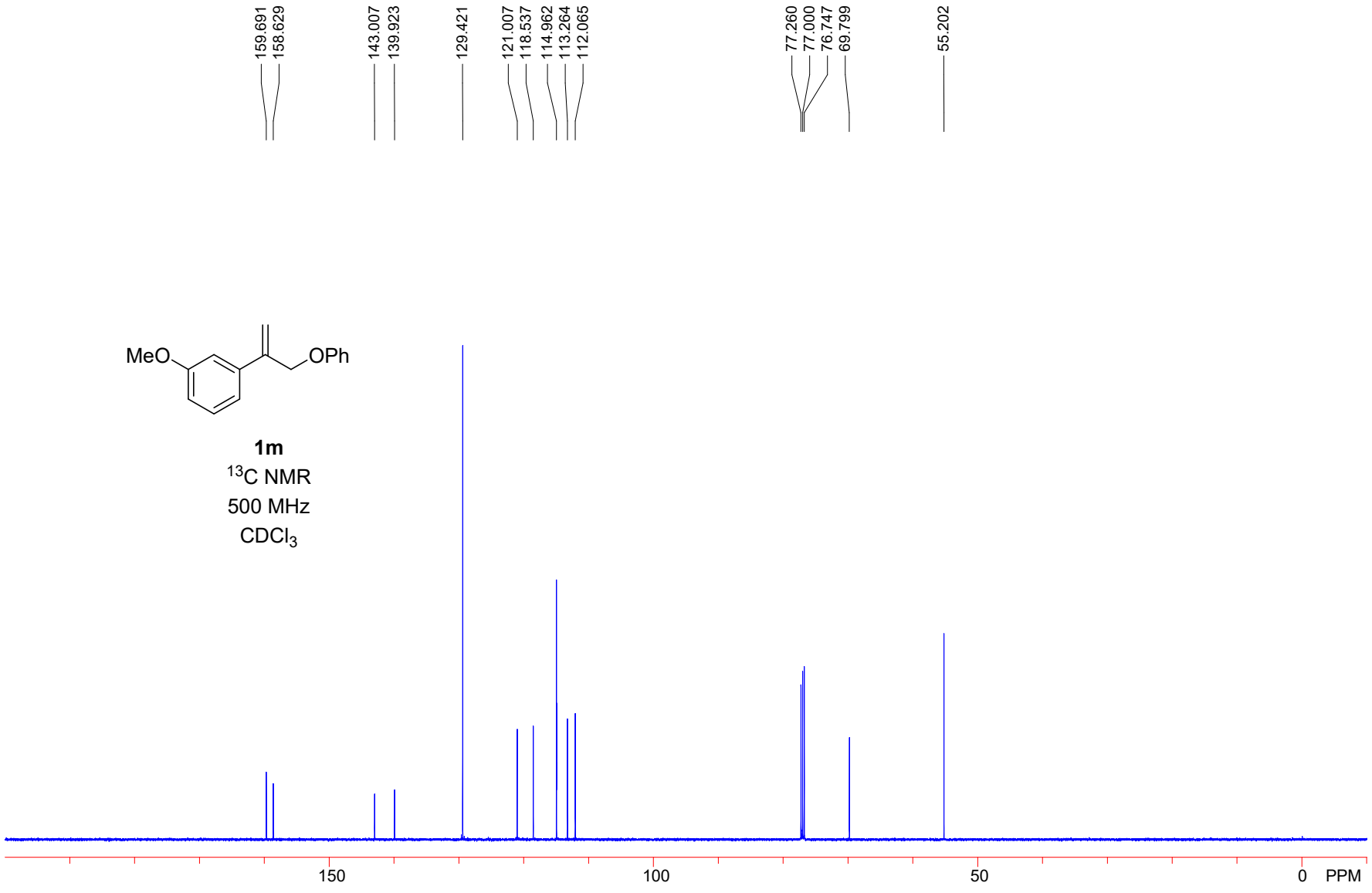
1m

^{1}H NMR

500 MHz

$CDCl_3$

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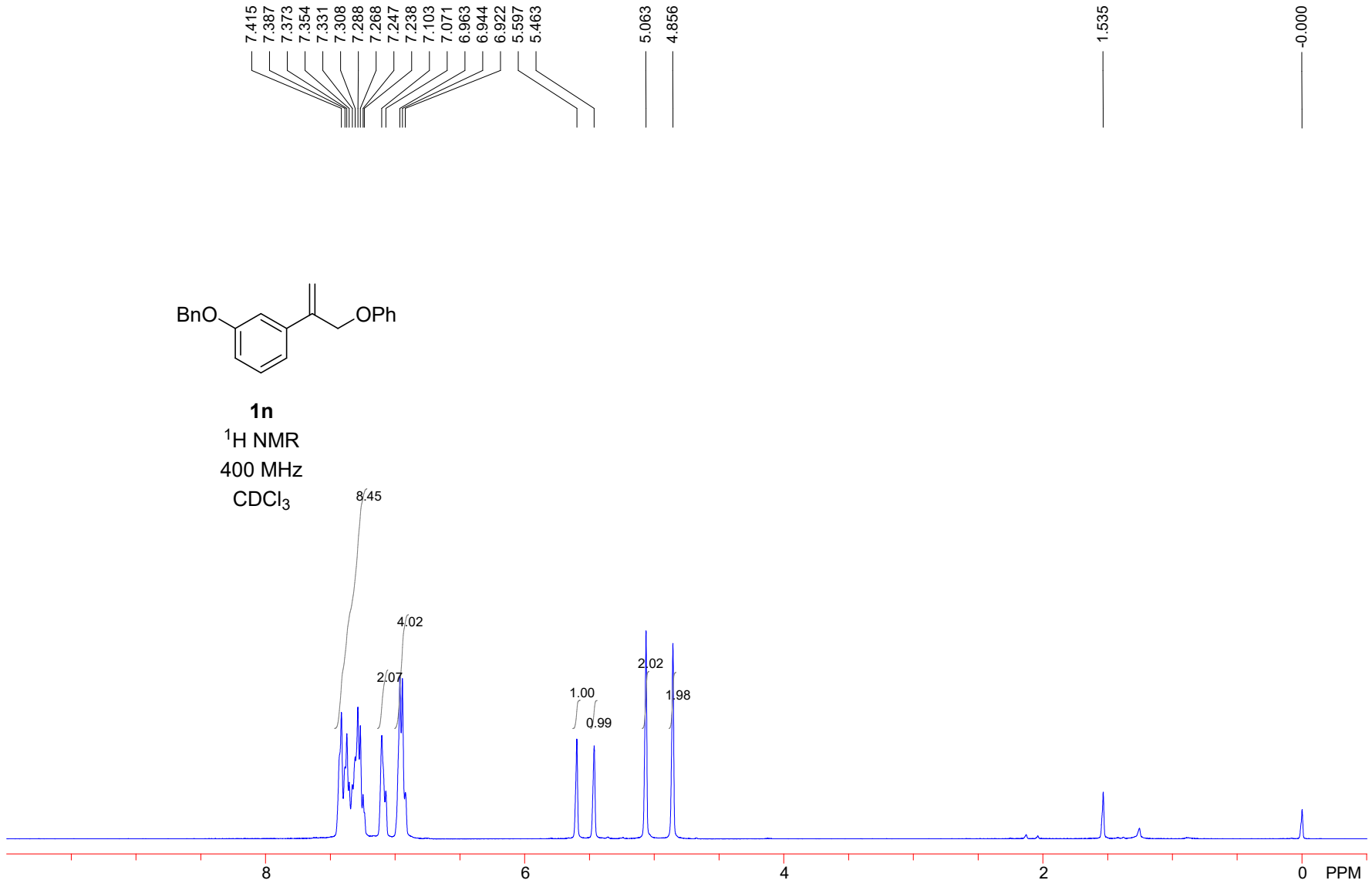
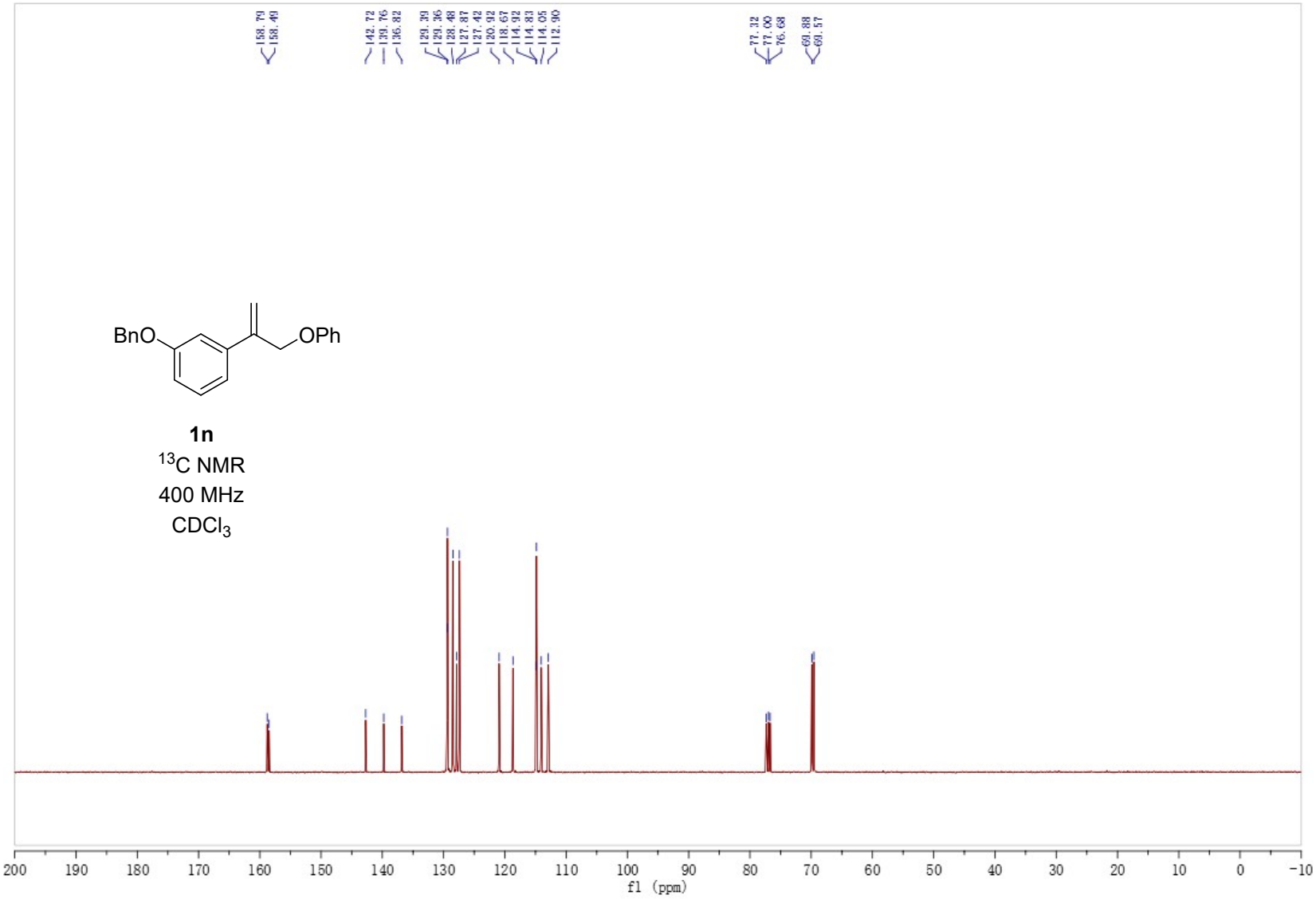
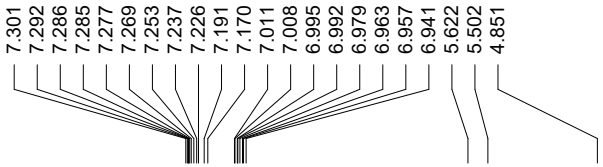
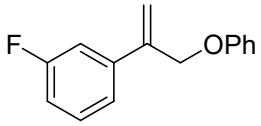
143.007
139.923
129.421
121.007
118.537
114.962
113.264
112.065
77.260
77.000
76.747
69.799
55.202
MeO
OPh
1m
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM


7.415
7.387
7.373
7.354
7.331
7.308
7.288
7.268
7.247
7.238
7.103
7.071
6.963
6.944
6.922
5.597
5.463
5.063
4.856
1.535
-0.000
BnO
OPh
1n
1H NMR
400 MHz
CDCl3
8.45
4.02
2.07
1.00
0.99
2.02
1.98
8
6
4
2
0
PPM


158.79
158.49
142.72
139.76
136.82
129.39
129.36
128.48
127.87
127.42
120.92
118.67
114.92
114.83
114.05
112.90
77.32
77.00
76.68
69.88
69.57
BnO
OPh
1n
13C NMR
400 MHz
CDCl3
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



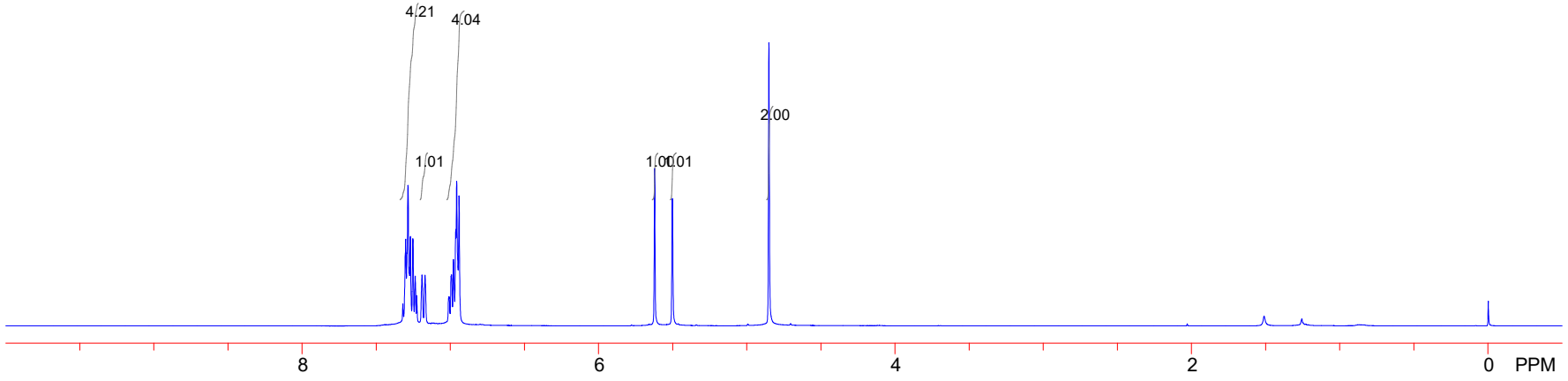


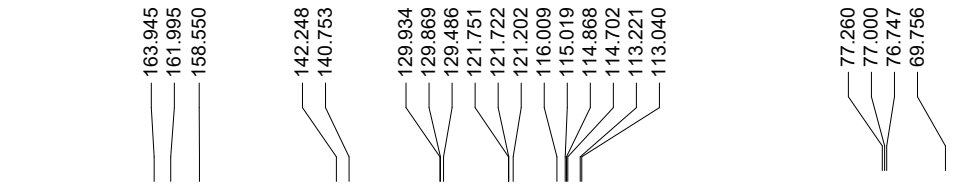
1o

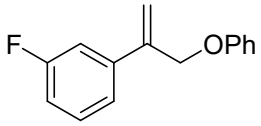
^{1}H NMR

500 MHz

$CDCl_3$





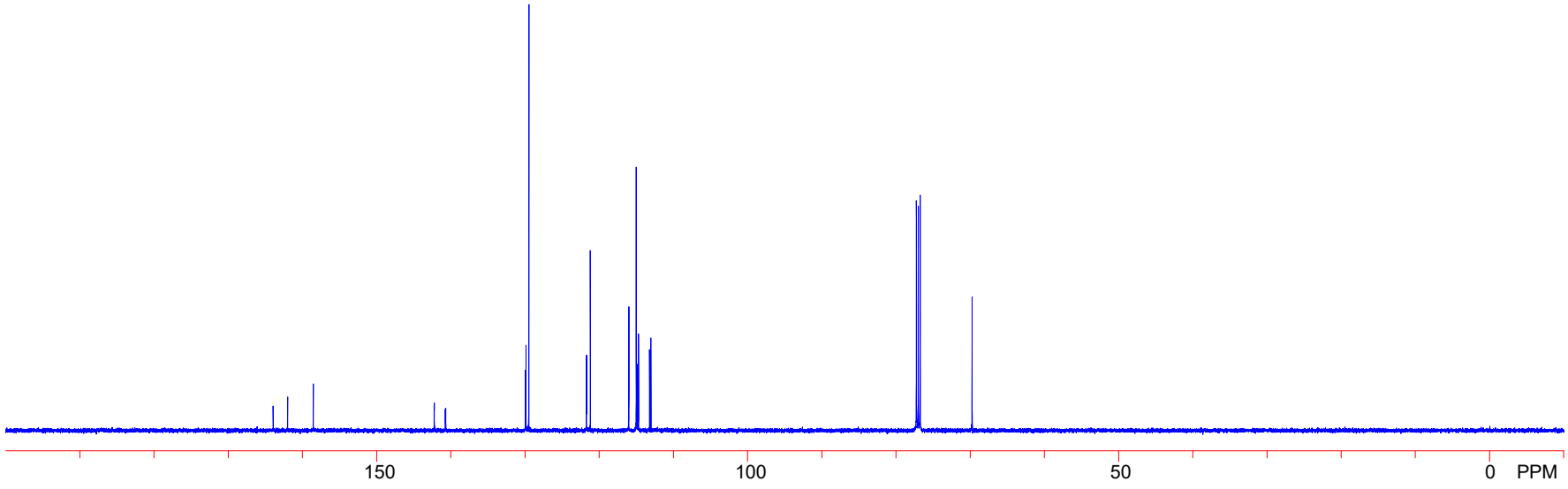


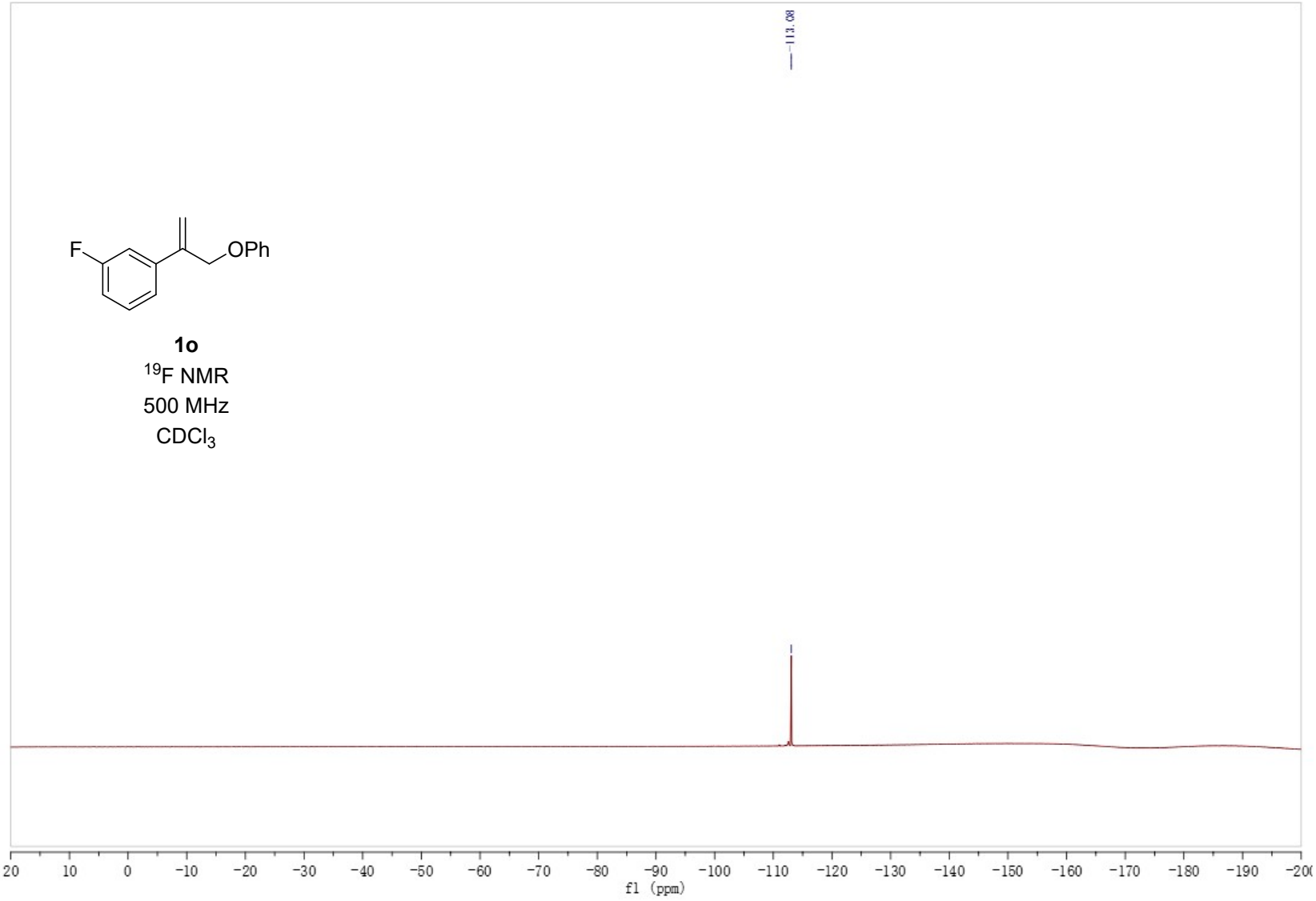
1o

^{13}C NMR

500 MHz

$CDCl_3$



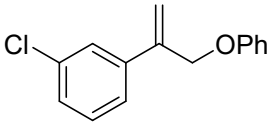


1o

^{19}F NMR

500 MHz

$CDCl_3$

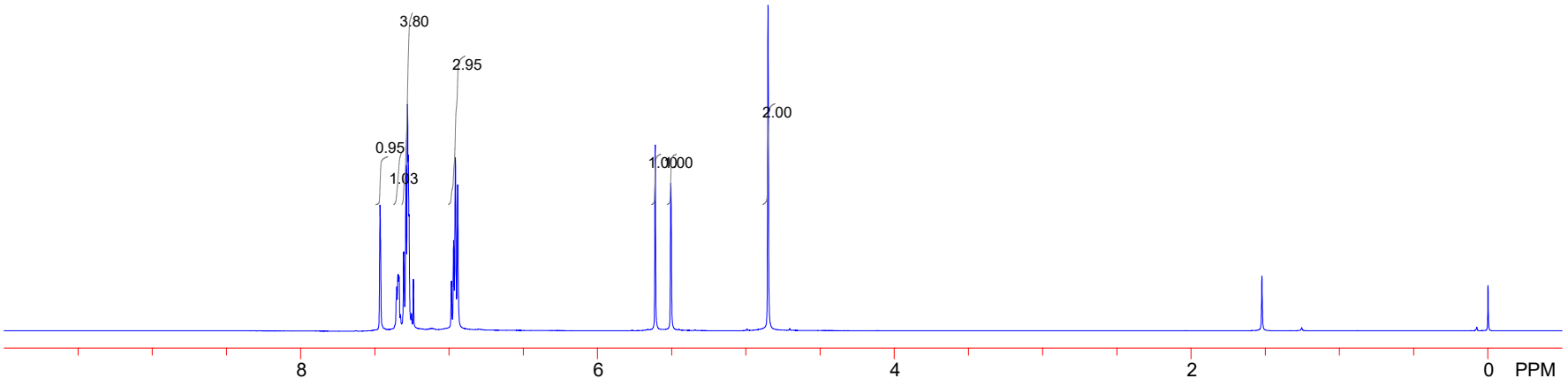


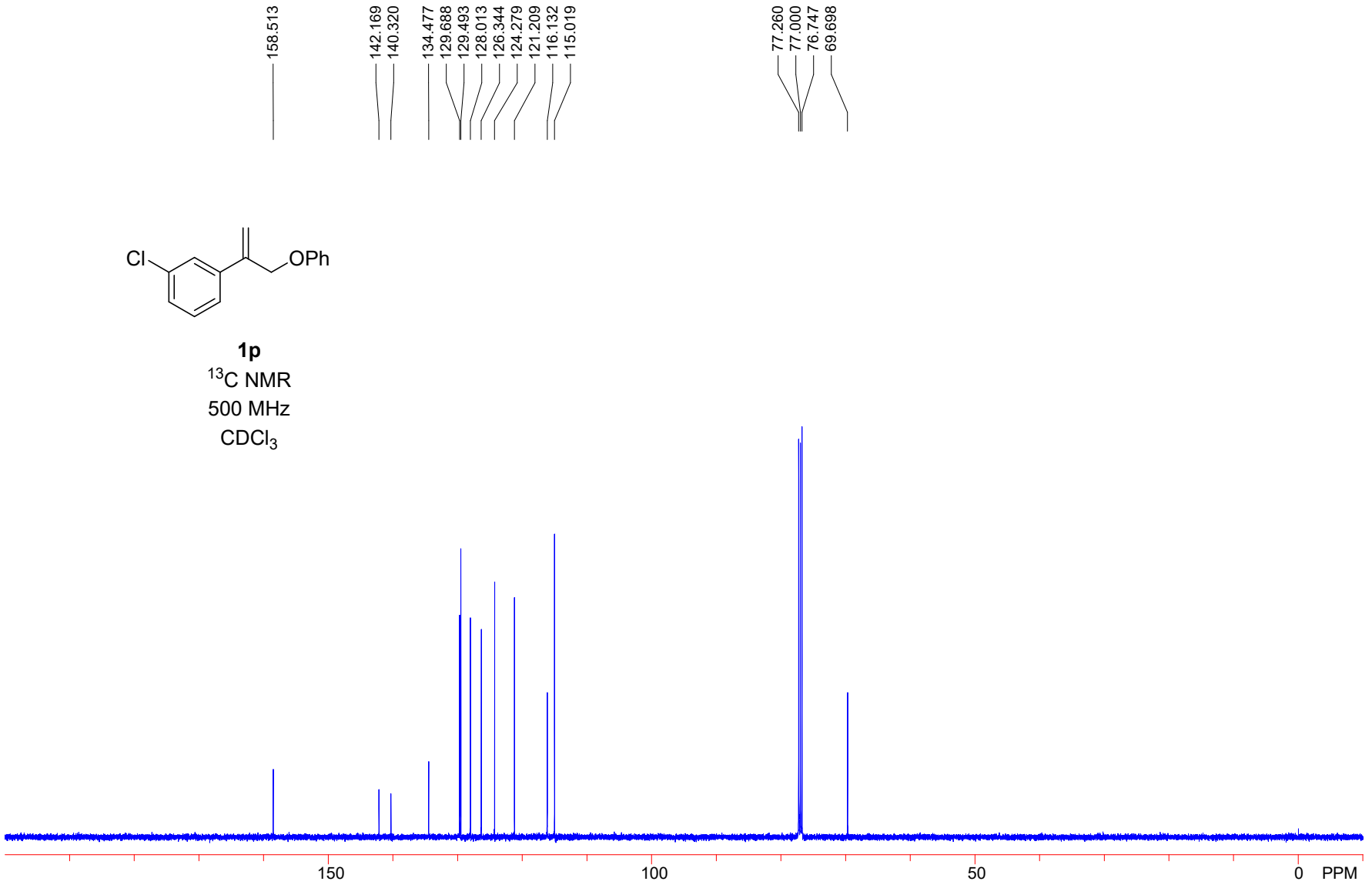
1p

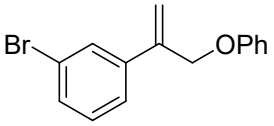
^{1}H NMR

500 MHz

$CDCl_3$




158.513
142.169
140.320
134.477
129.688
129.493
128.013
126.344
124.279
121.209
116.132
115.019
77.260
77.000
76.747
69.698
Cl
OPh
1p
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

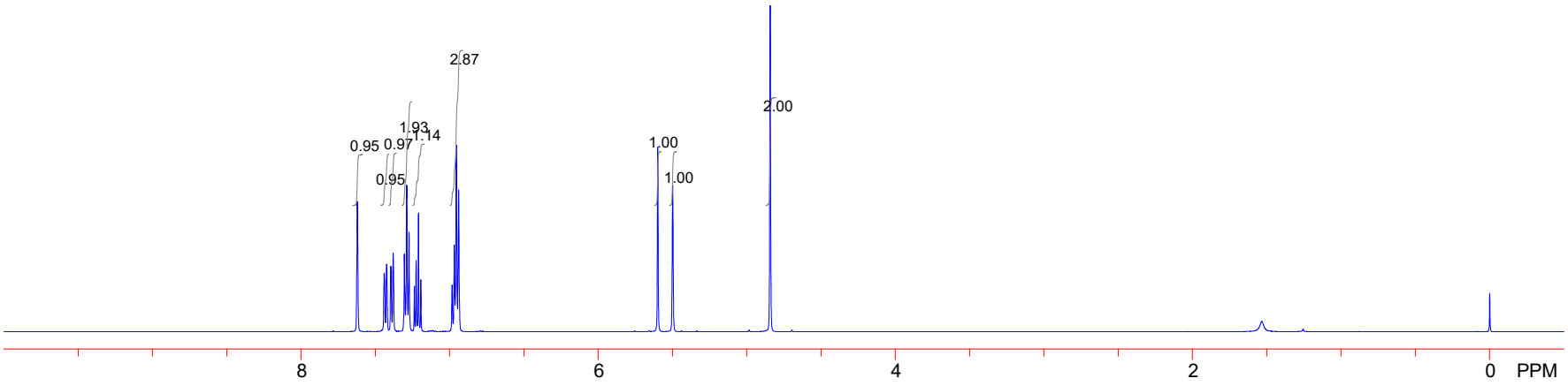


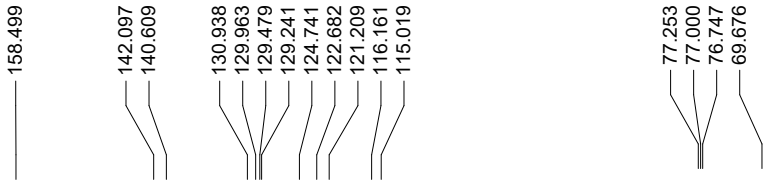
1q

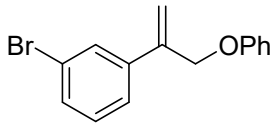
^{1}H NMR

500 MHz

$CDCl_3$





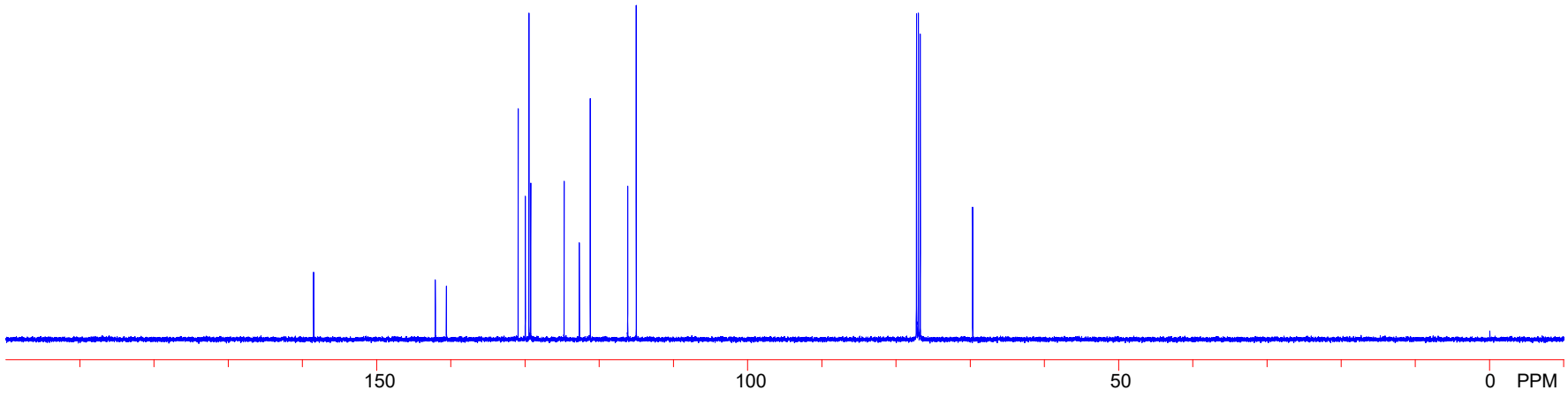


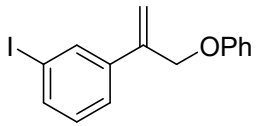
1q

^{13}C NMR

500 MHz

$CDCl_3$



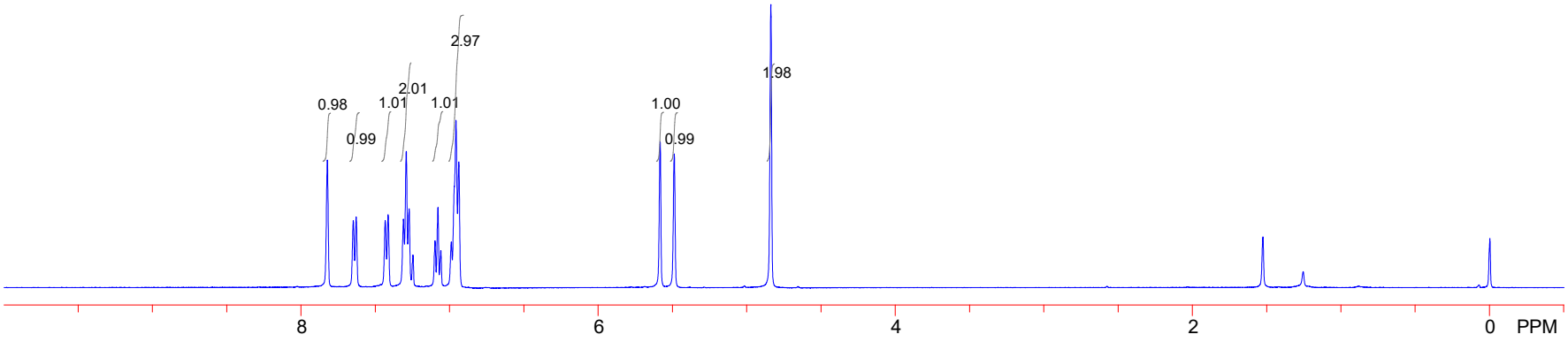


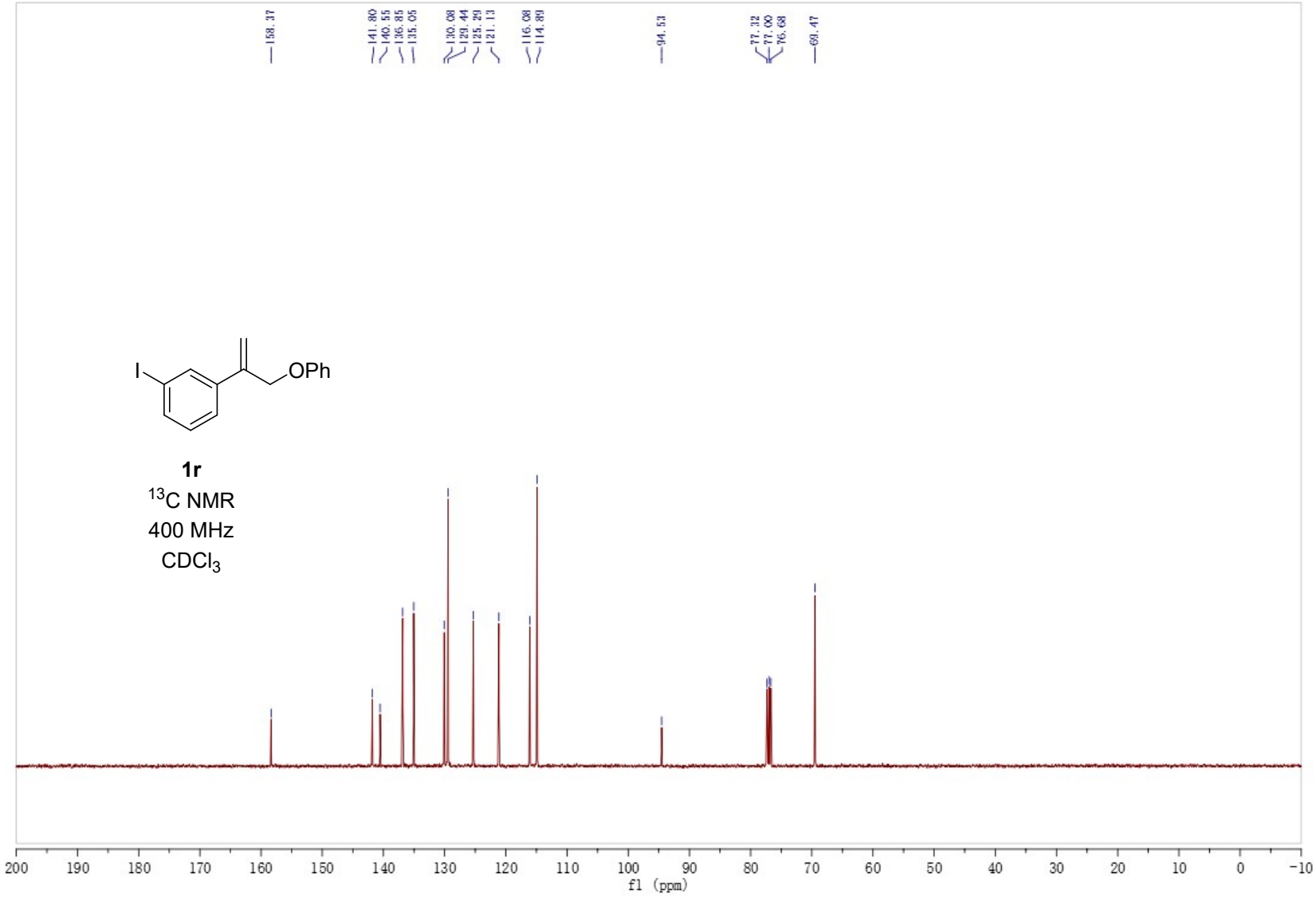
1r

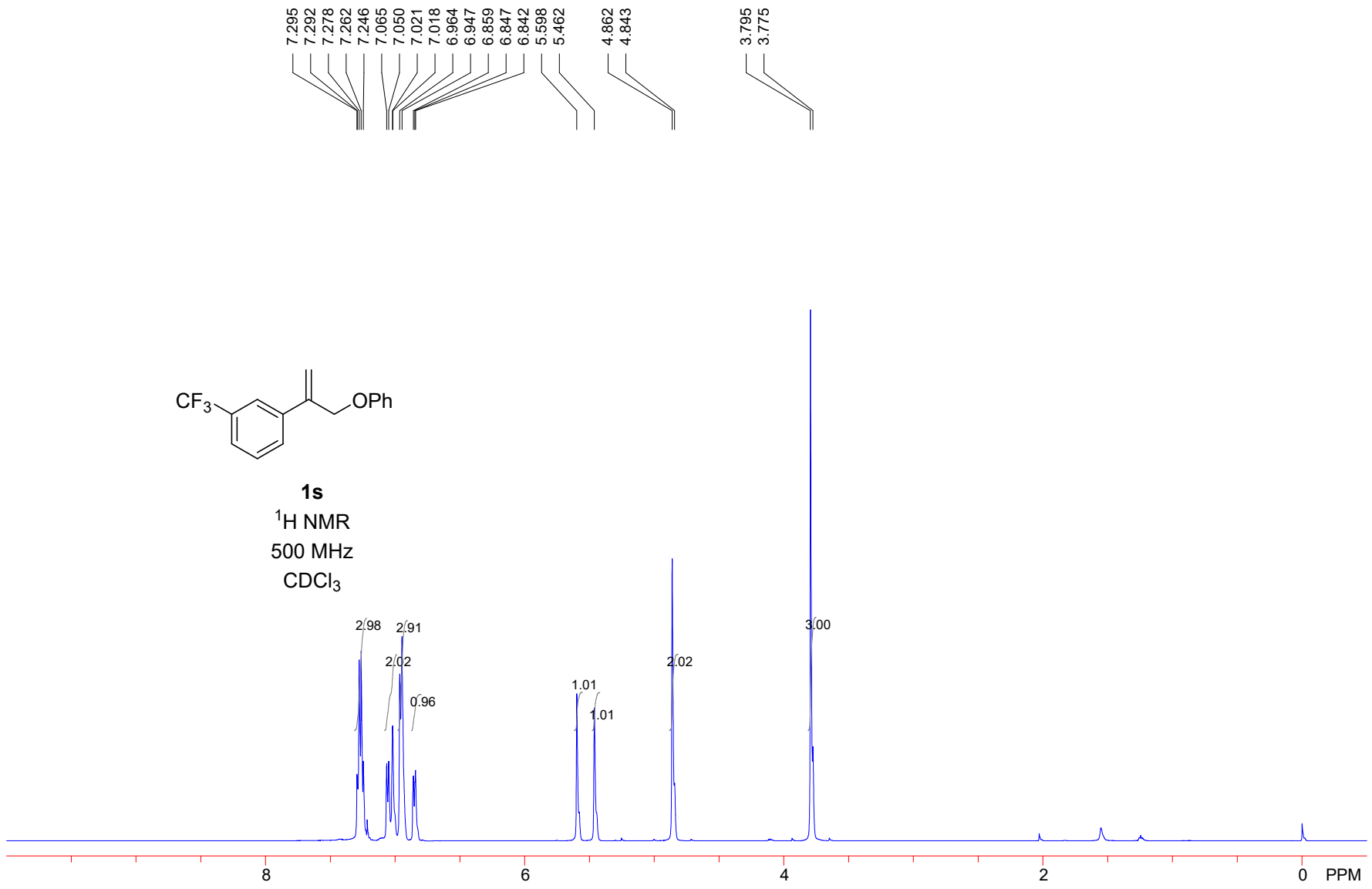
^{1}H NMR

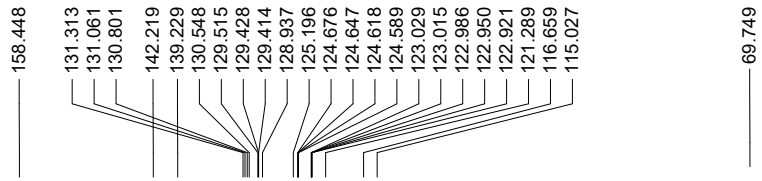
400 MHz

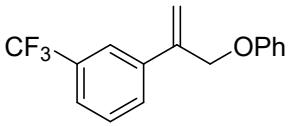
$CDCl_3$




158.37
141.80
140.55
136.85
135.05
130.08
129.44
125.29
121.13
116.08
114.89
94.53
77.32
77.00
76.68
69.47
I
OPh
1r
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.295
7.292
7.278
7.262
7.246
7.065
7.050
7.021
7.018
6.964
6.947
6.859
6.847
6.842
5.598
5.462
4.862
4.843
3.795
3.775
CF3
OPh
1s
1H NMR
500 MHz
CDCl3
2.98
2.91
2.02
0.96
1.01
1.01
2.02
3.00
8
6
4
2
0
PPM



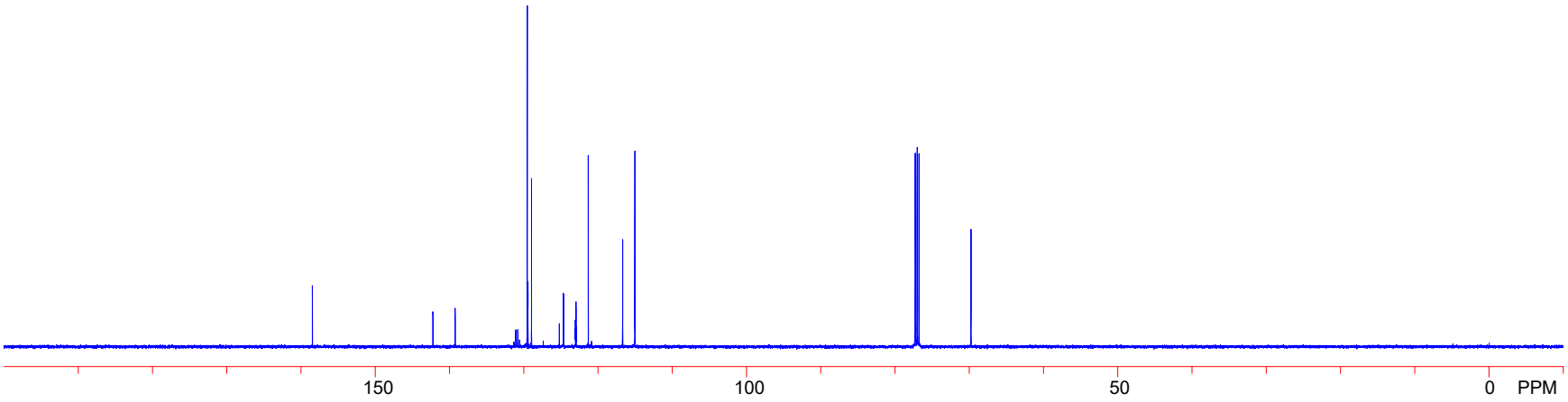


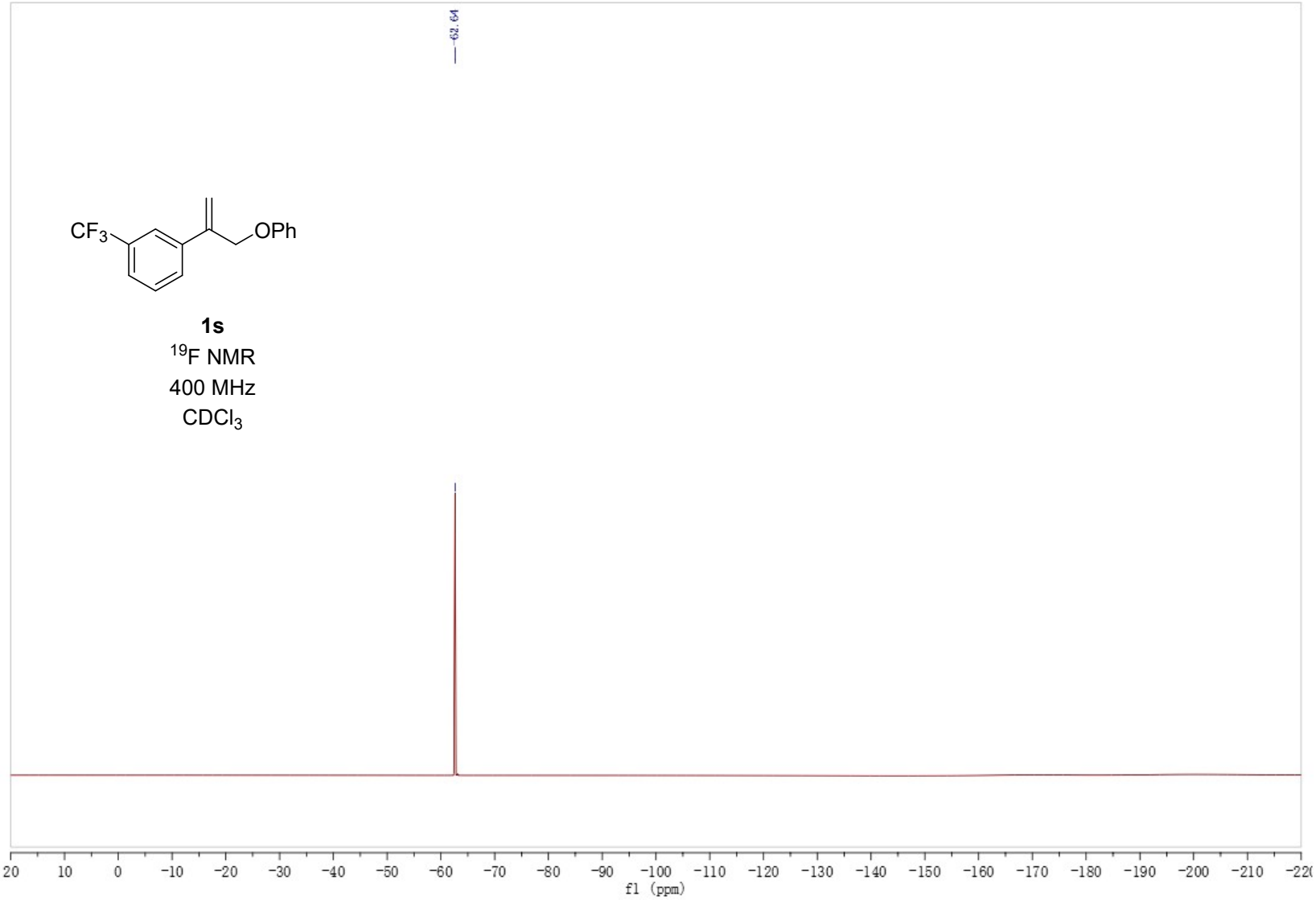
1s

^{13}C NMR

500 MHz

$CDCl_3$



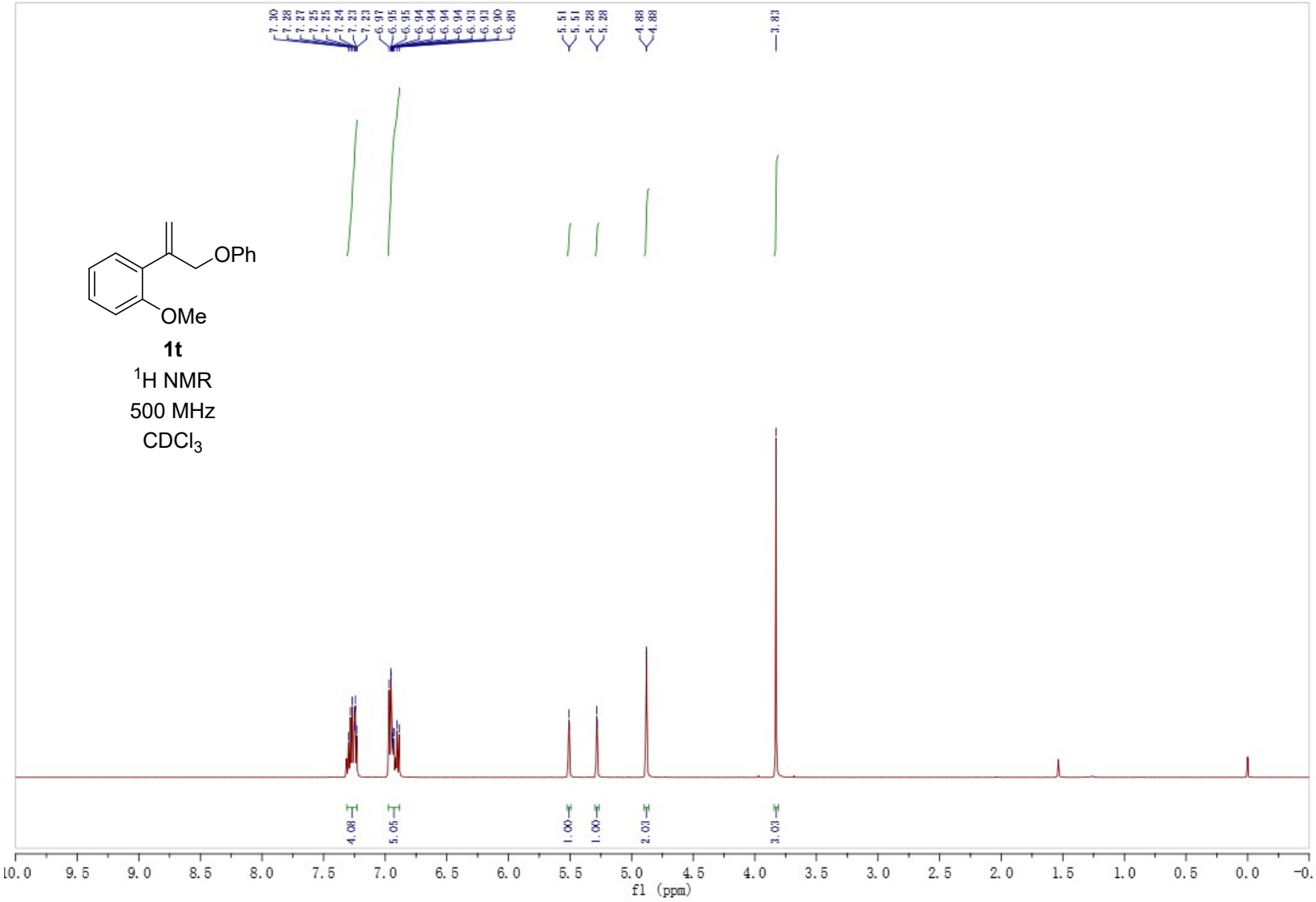


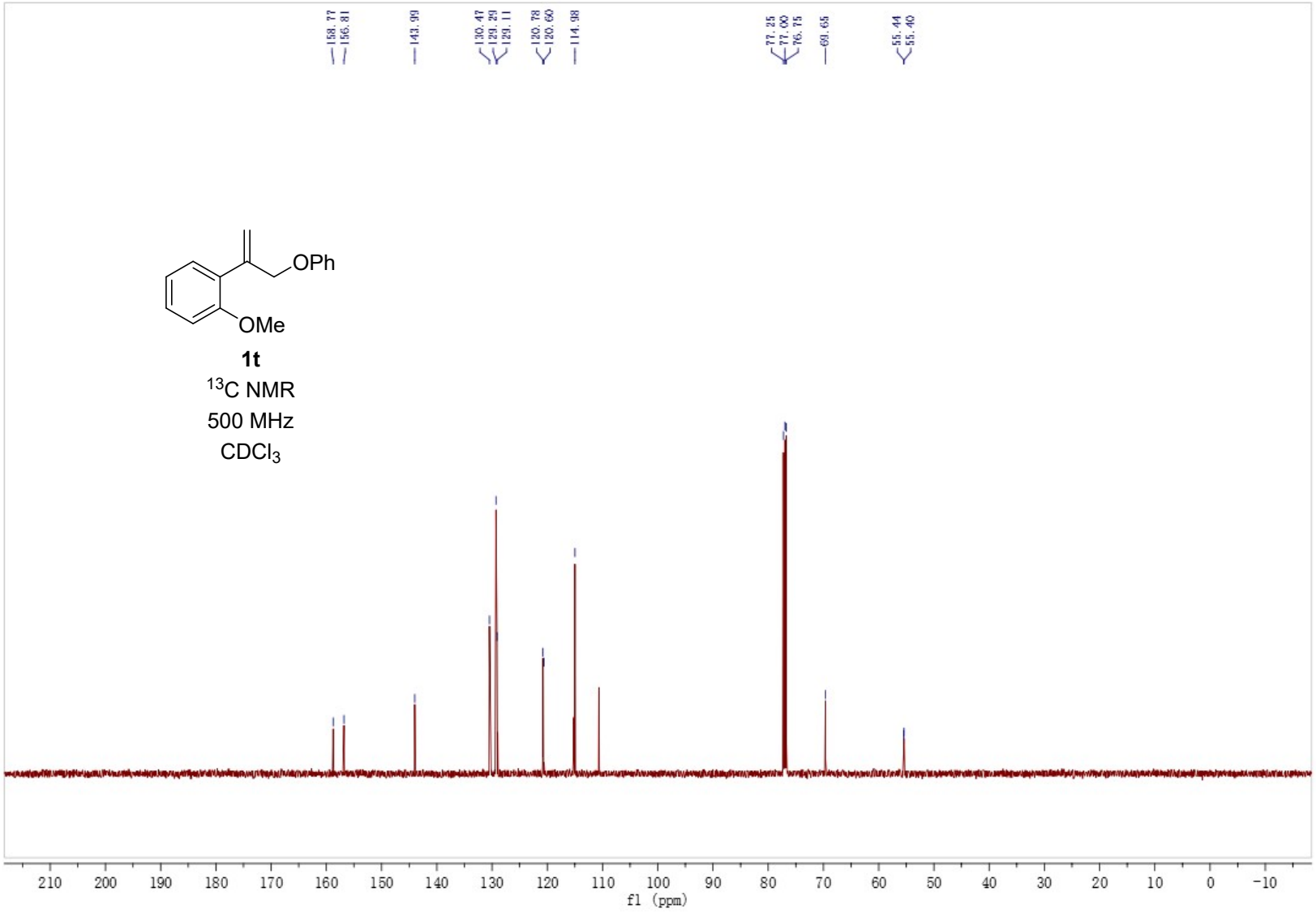
1s

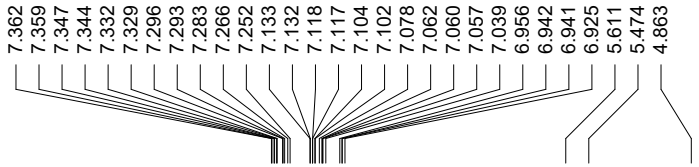
^{19}F NMR

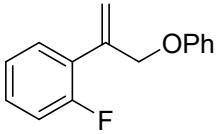
400 MHz

$CDCl_3$


OPh
OMe
1t
1H NMR
500 MHz
CDCl3
f1 (ppm)


158.77
156.81
143.99
130.47
129.29
129.11
120.78
120.60
114.98
77.25
77.00
76.75
69.65
55.44
55.40
OPh
OMe
1t
13C NMR
500 MHz
CDCl3
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)



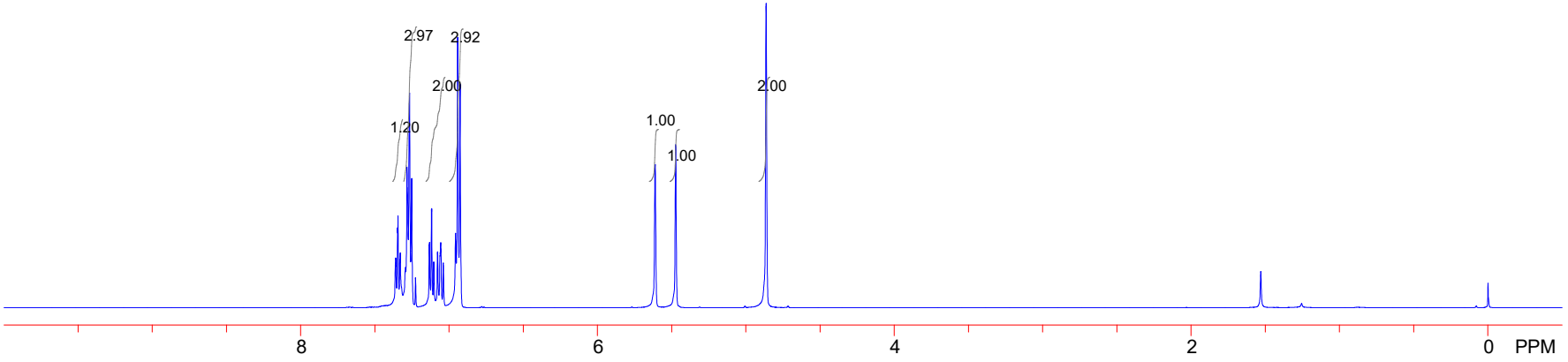


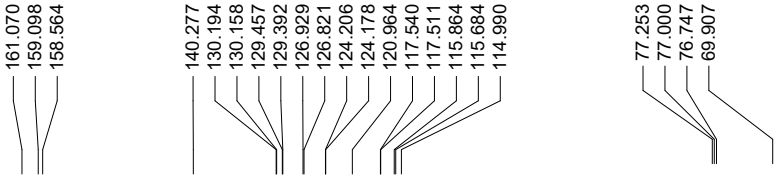
1u

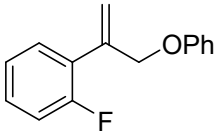
^{1}H NMR

500 MHz

$CDCl_3$





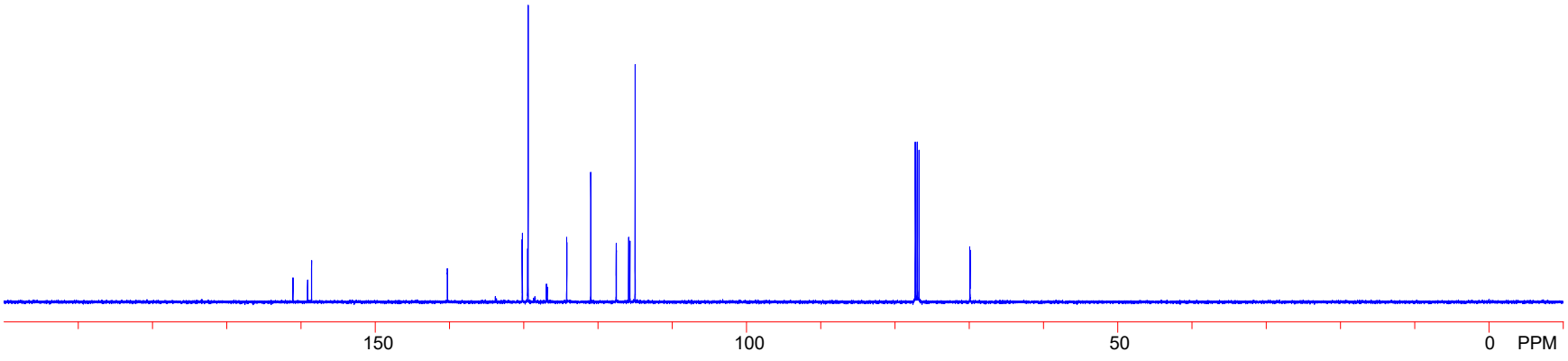


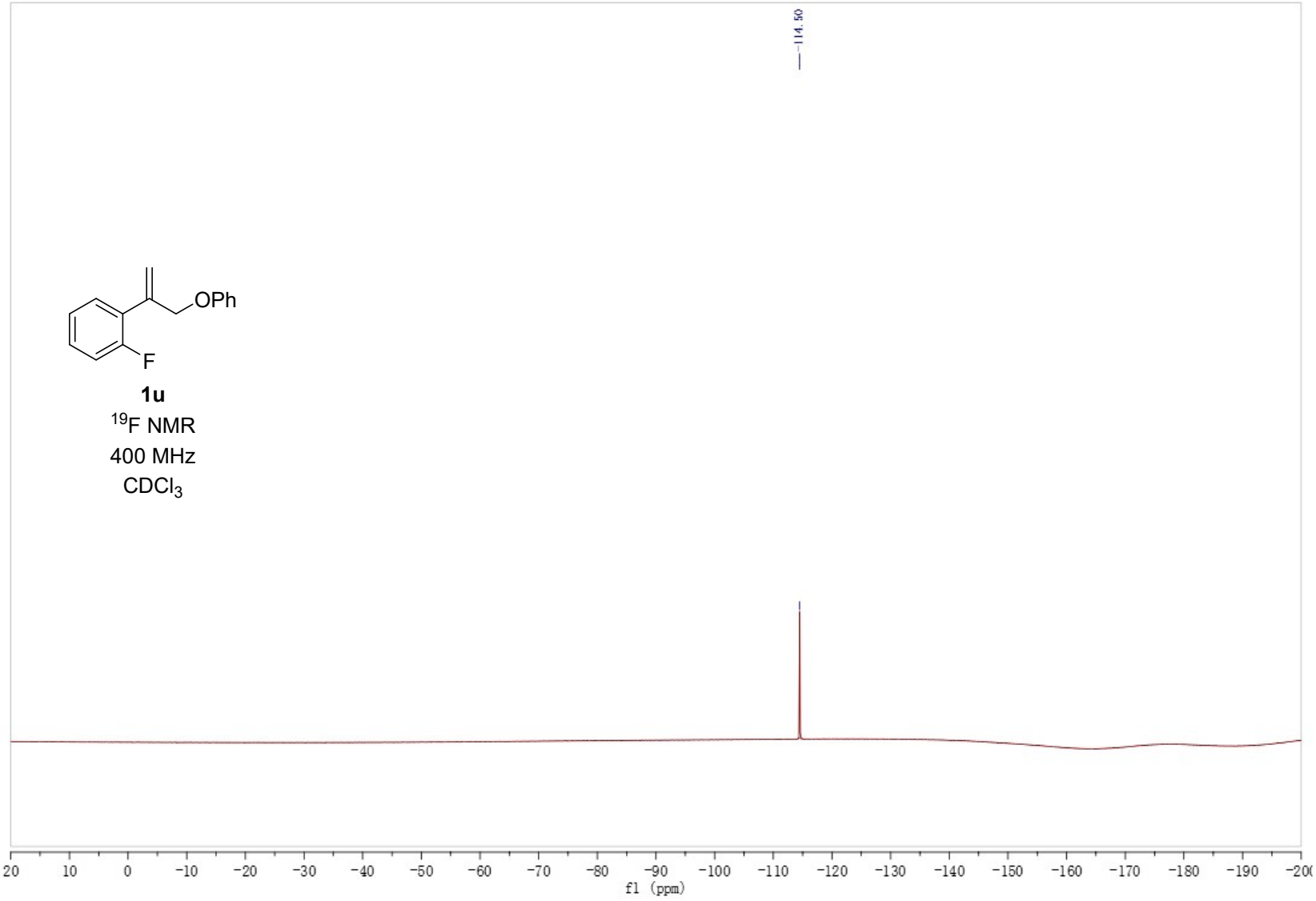
1u

^{13}C NMR

500 MHz

$CDCl_3$



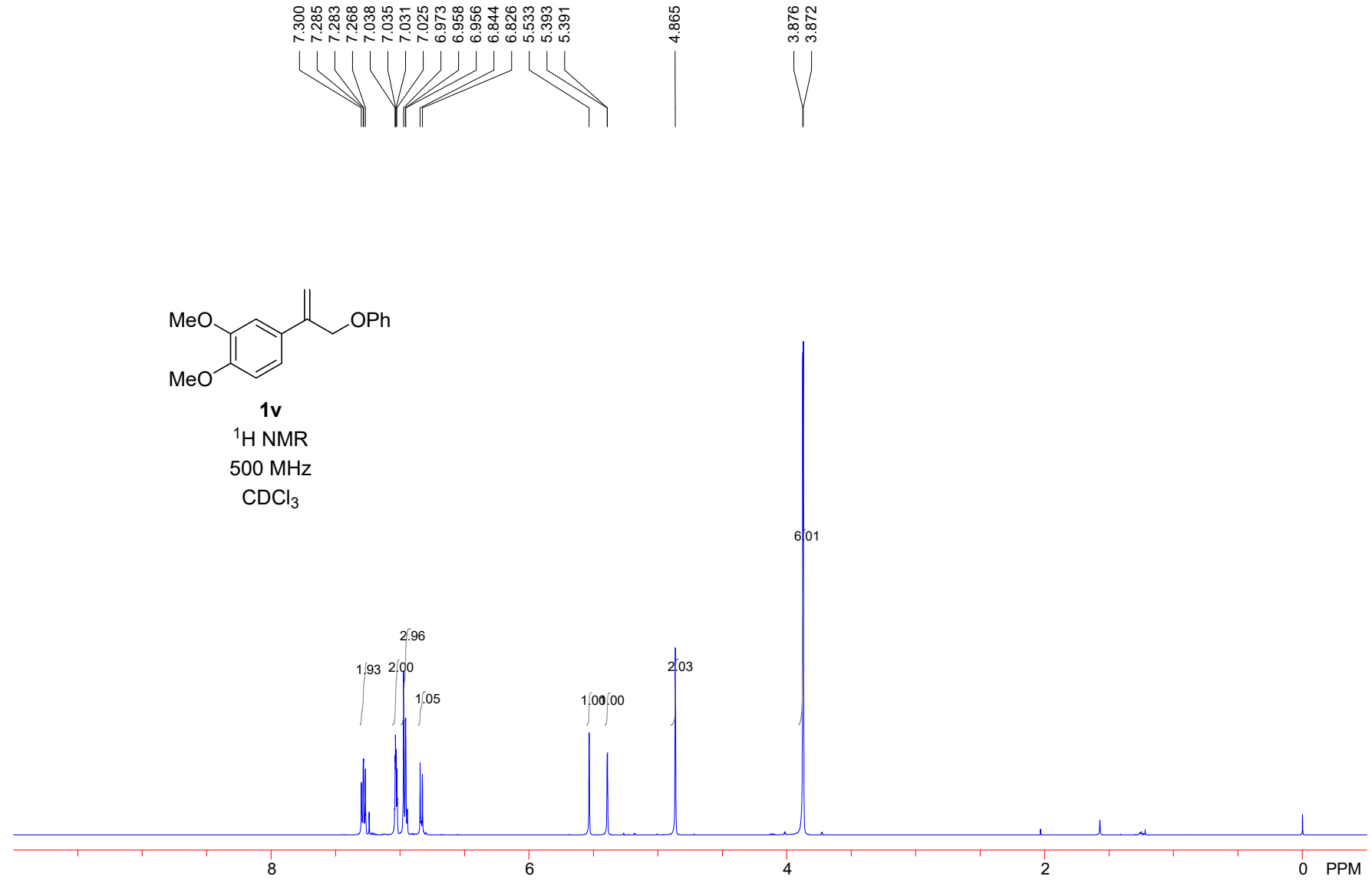


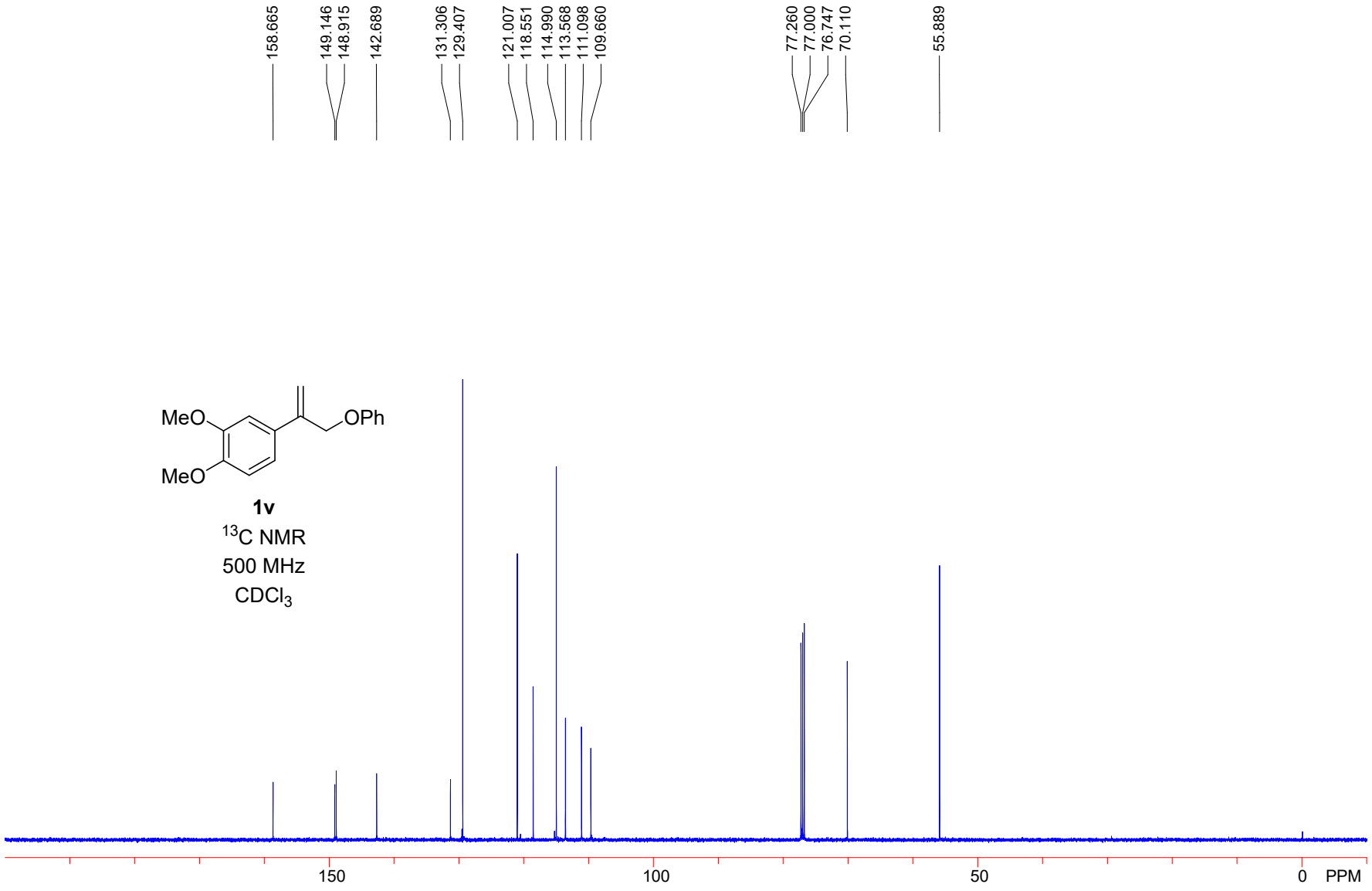
1u

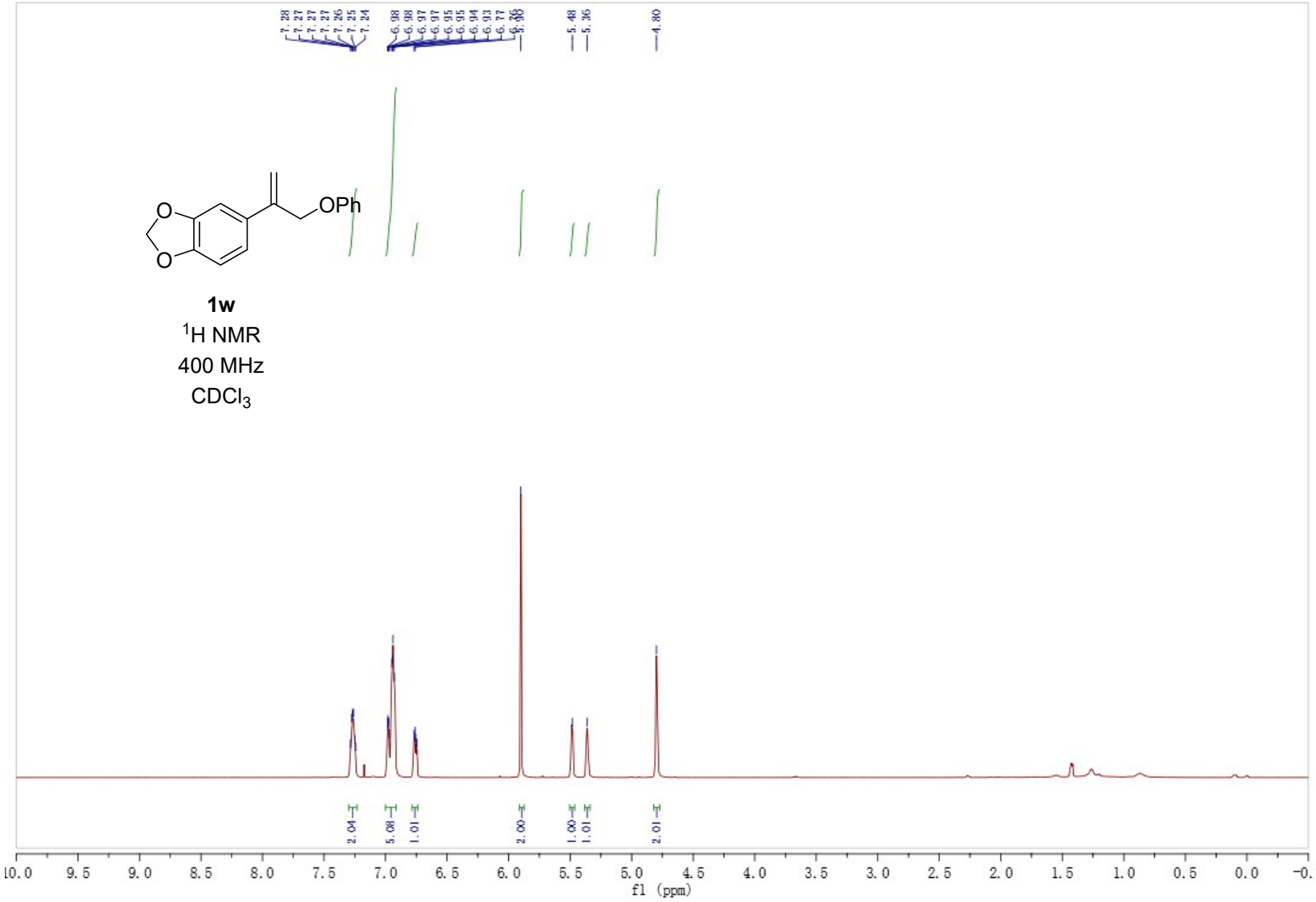
^{19}F NMR

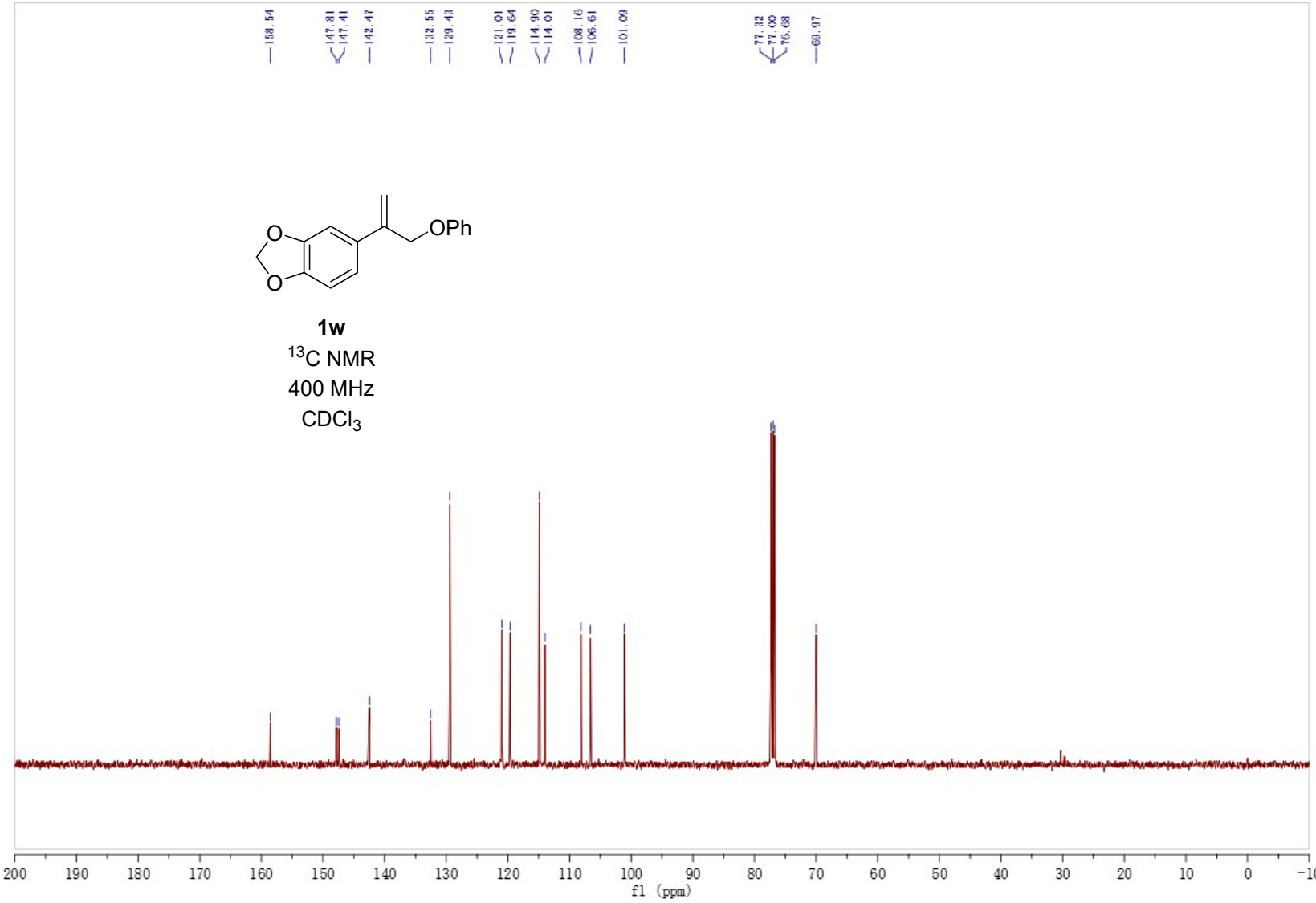
400 MHz

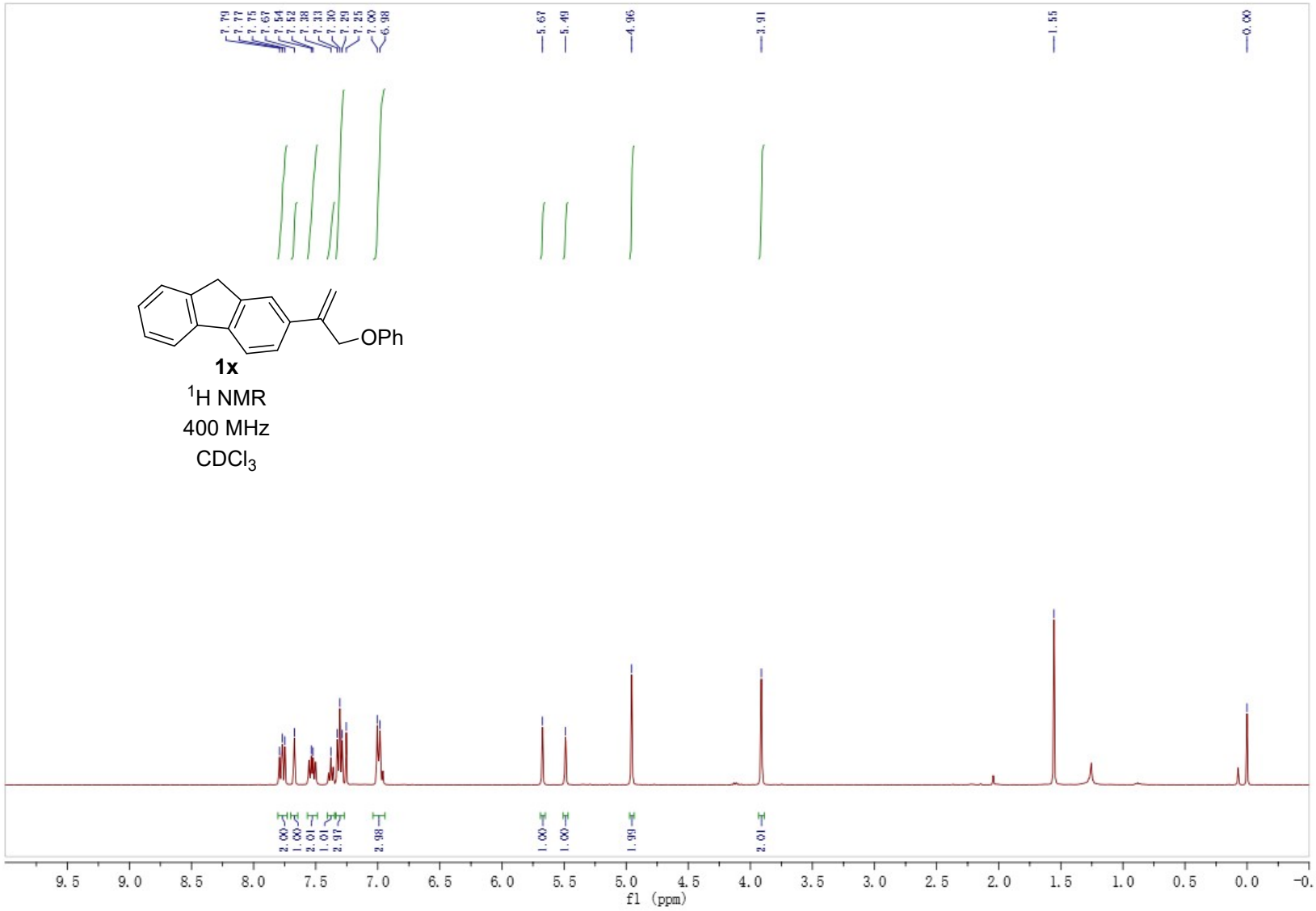
$CDCl_3$

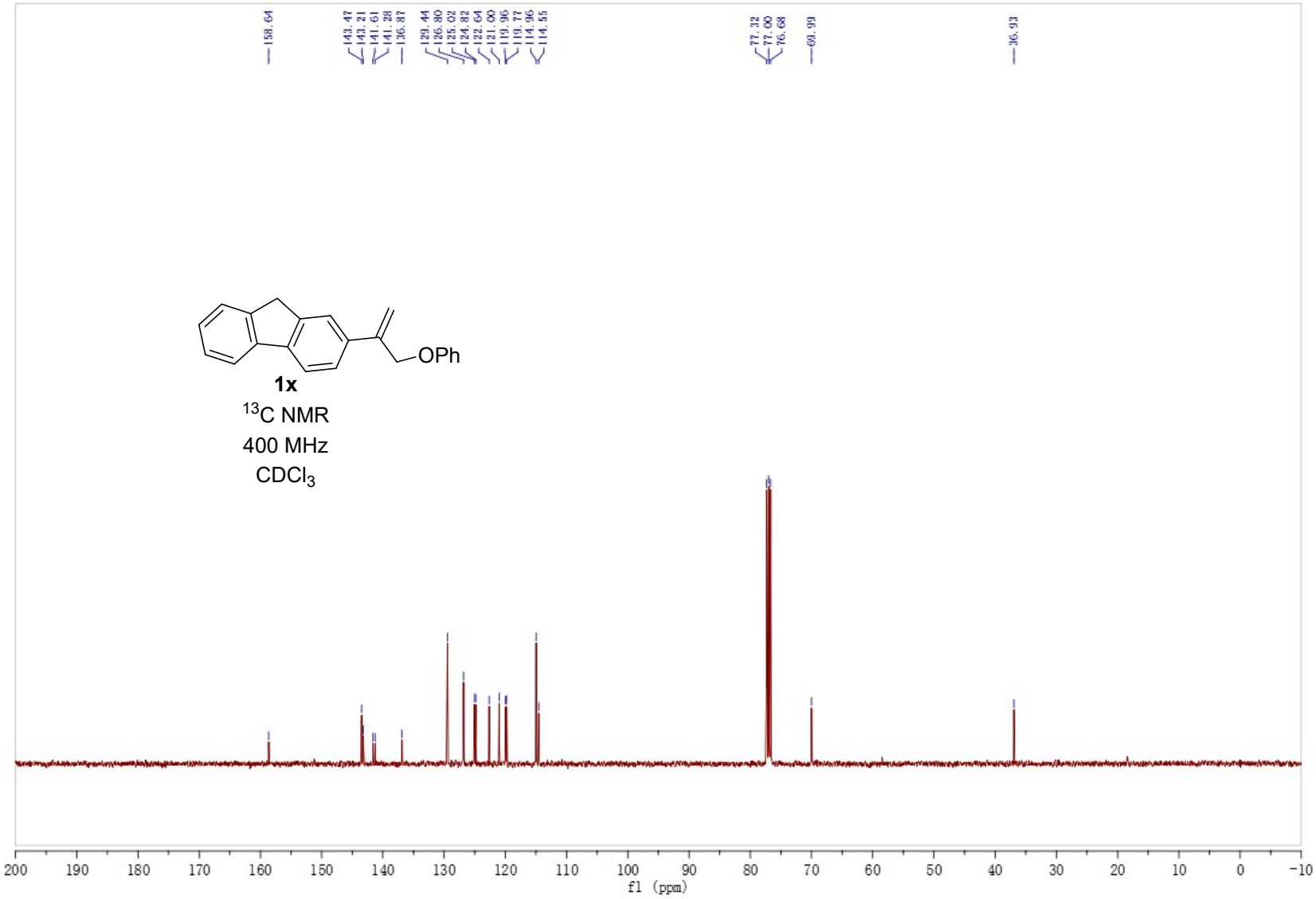

7.300
7.285
7.283
7.268
7.038
7.035
7.031
7.025
6.973
6.958
6.956
6.844
6.826
5.533
5.393
5.391
4.865
3.876
3.872
MeO
MeO
OPh
1v
1H NMR
500 MHz
CDCl3
6.01
2.96
2.03
1.93
2.00
1.05
1.00
1.00
8
6
4
2
0
PPM

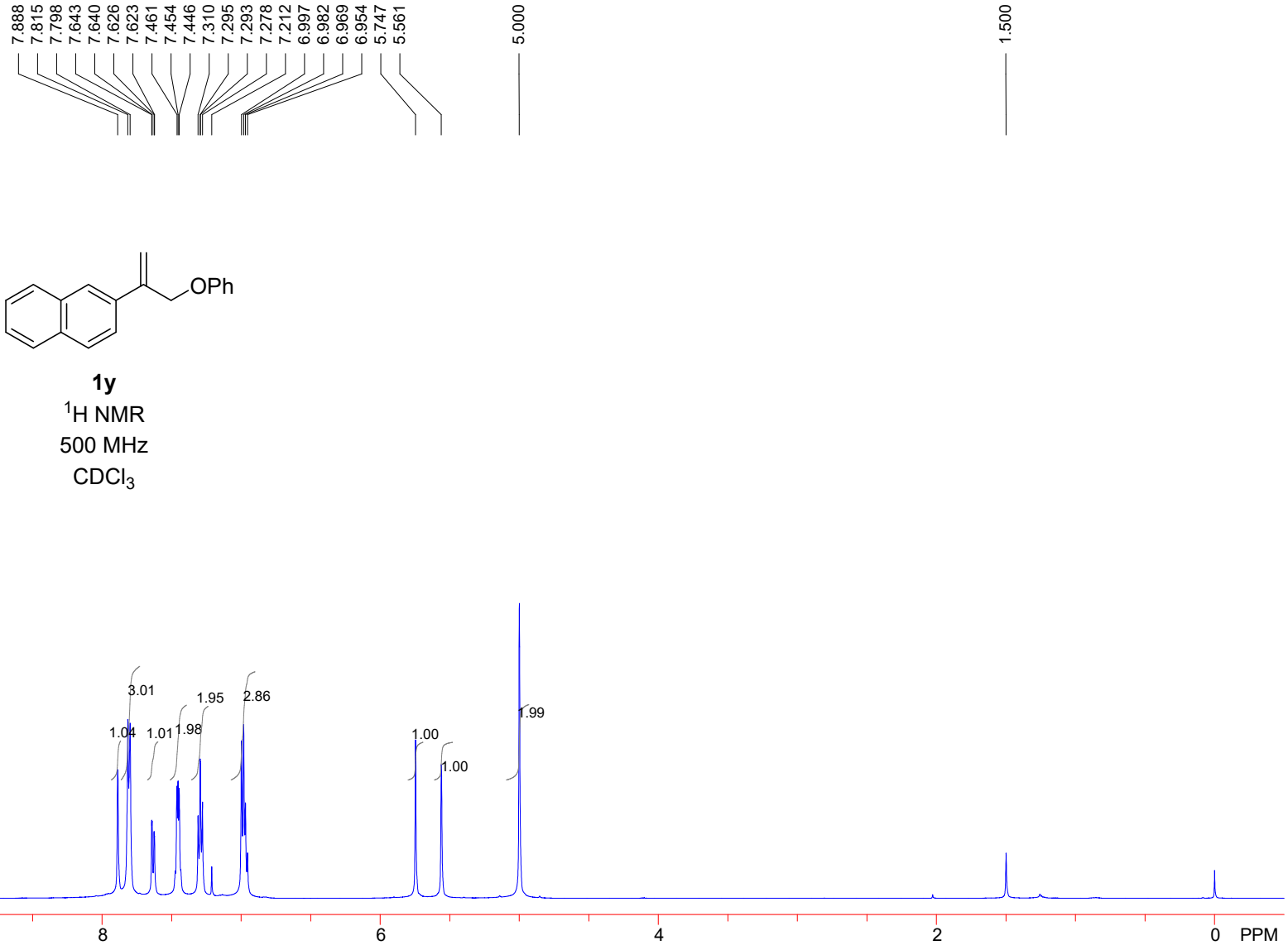

158.665
149.146
148.915
142.689
131.306
129.407
121.007
118.551
114.990
113.568
111.098
109.660
77.260
77.000
76.747
70.110
55.889
MeO
MeO
OPh
1v
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

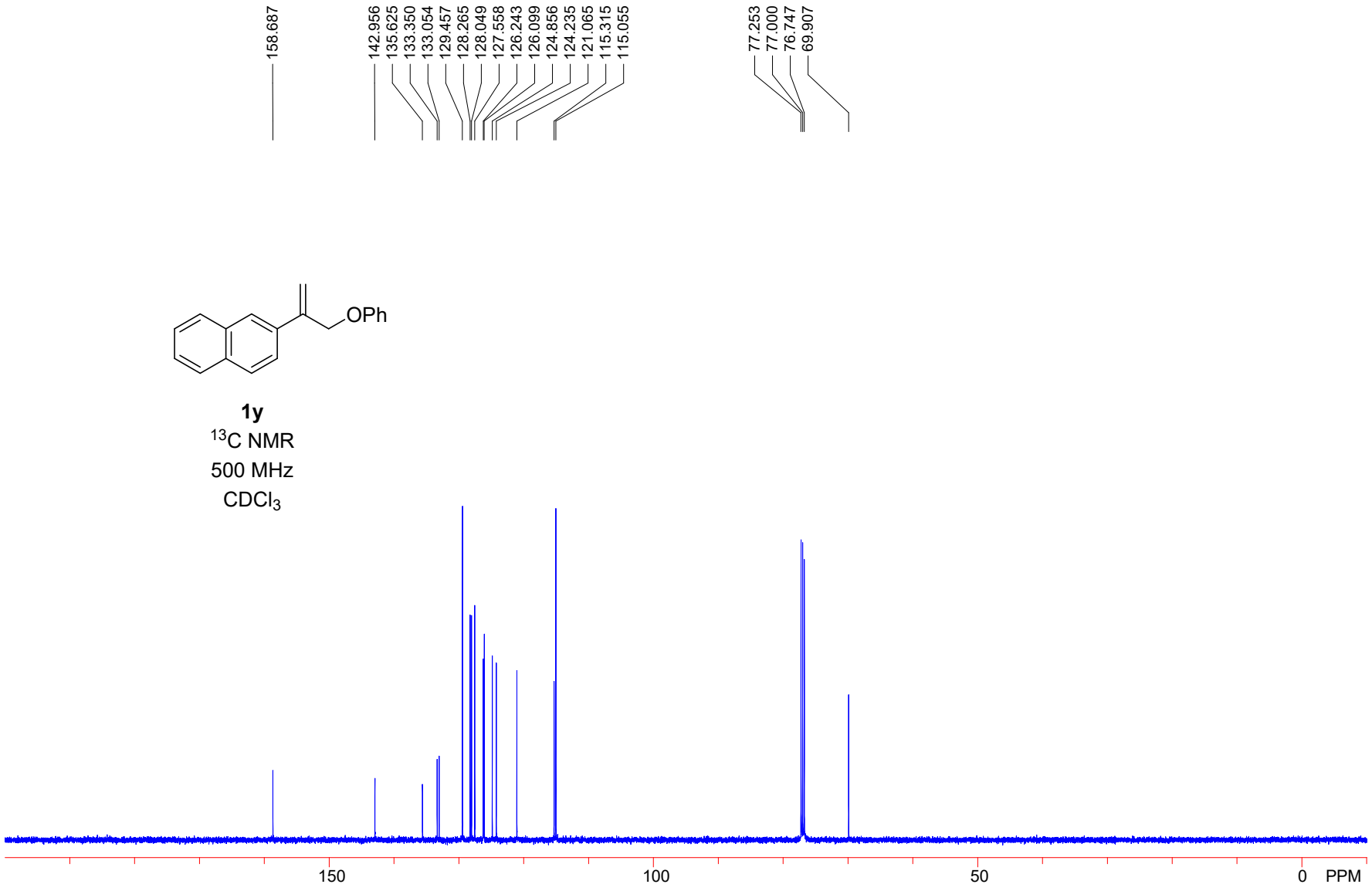

OPh
1w
1H NMR
400 MHz
CDCl3
f1 (ppm)

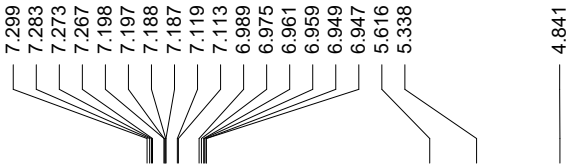

158.54
147.81
147.41
142.47
132.55
129.43
121.01
119.64
114.90
114.01
108.16
106.61
101.09
77.32
77.00
76.68
69.97
OPh
O
O
1w
13C NMR
400 MHz
CDCl3
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

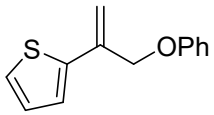

7.79
7.77
7.75
7.67
7.54
7.52
7.38
7.33
7.30
7.29
7.25
7.00
6.98
5.67
5.49
4.96
3.91
1.55
0.00
OPh
1x
1H NMR
400 MHz
CDCl3
2.00
1.00
2.01
1.01
2.97
2.98
1.00
1.00
1.99
2.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


158.64
143.47
143.21
141.61
141.28
136.87
129.44
126.80
125.02
124.82
122.64
121.00
119.96
119.77
114.96
114.55
77.32
77.00
76.68
69.99
36.93
OPh
1x
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.888
7.815
7.798
7.643
7.640
7.626
7.623
7.461
7.454
7.446
7.310
7.295
7.293
7.278
7.212
6.997
6.982
6.969
6.954
5.747
5.561
5.000
1.500
OPh
1y
1H NMR
500 MHz
CDCl3
3.01
1.04
1.01
1.98
1.95
2.86
1.00
1.00
1.99
8
6
4
2
0
PPM


158.687
142.956
135.625
133.350
133.054
129.457
128.265
128.049
127.558
126.243
126.099
124.856
124.235
121.065
115.315
115.055
77.253
77.000
76.747
69.907
OPh
1y
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM



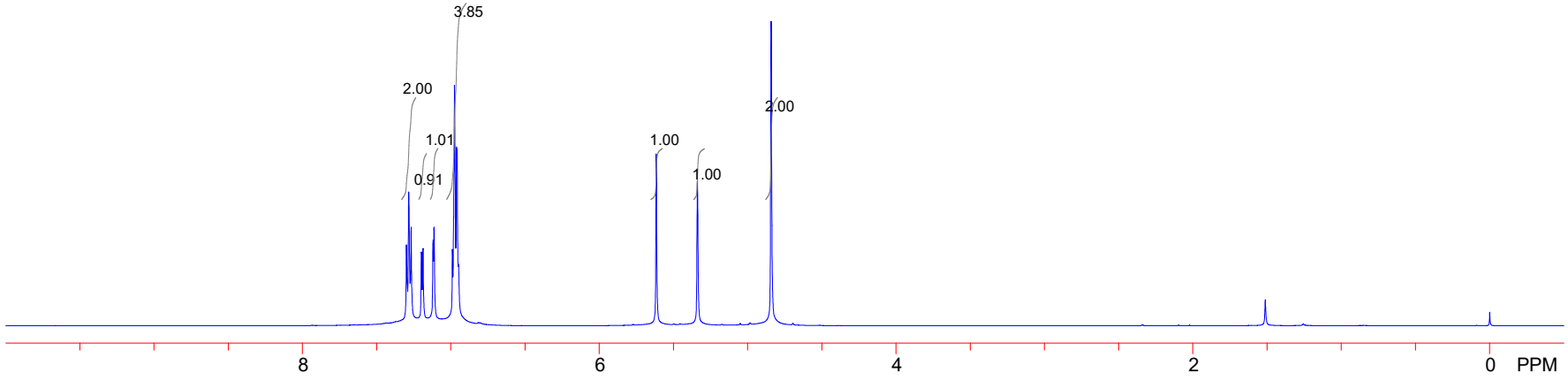


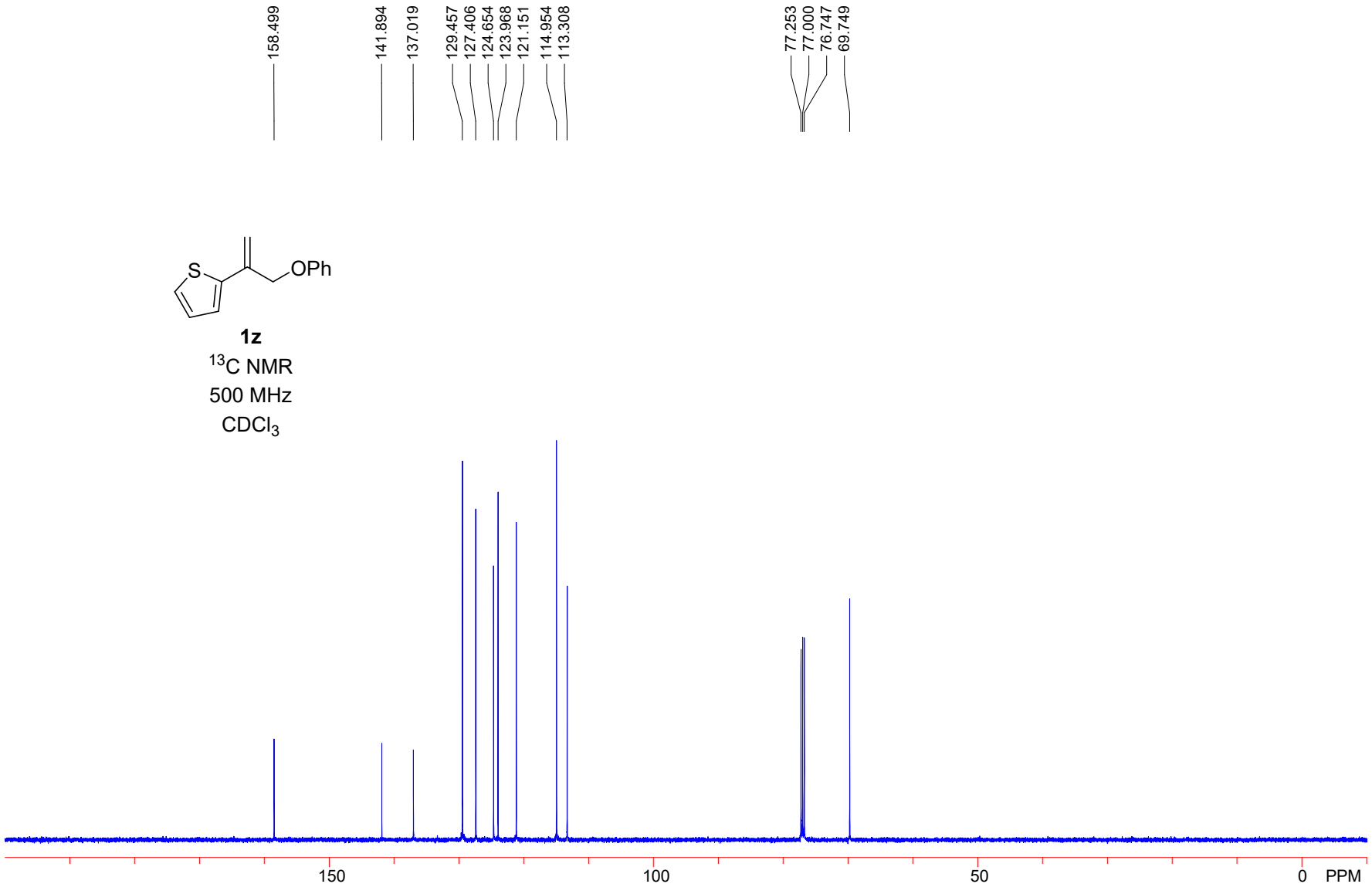
1z

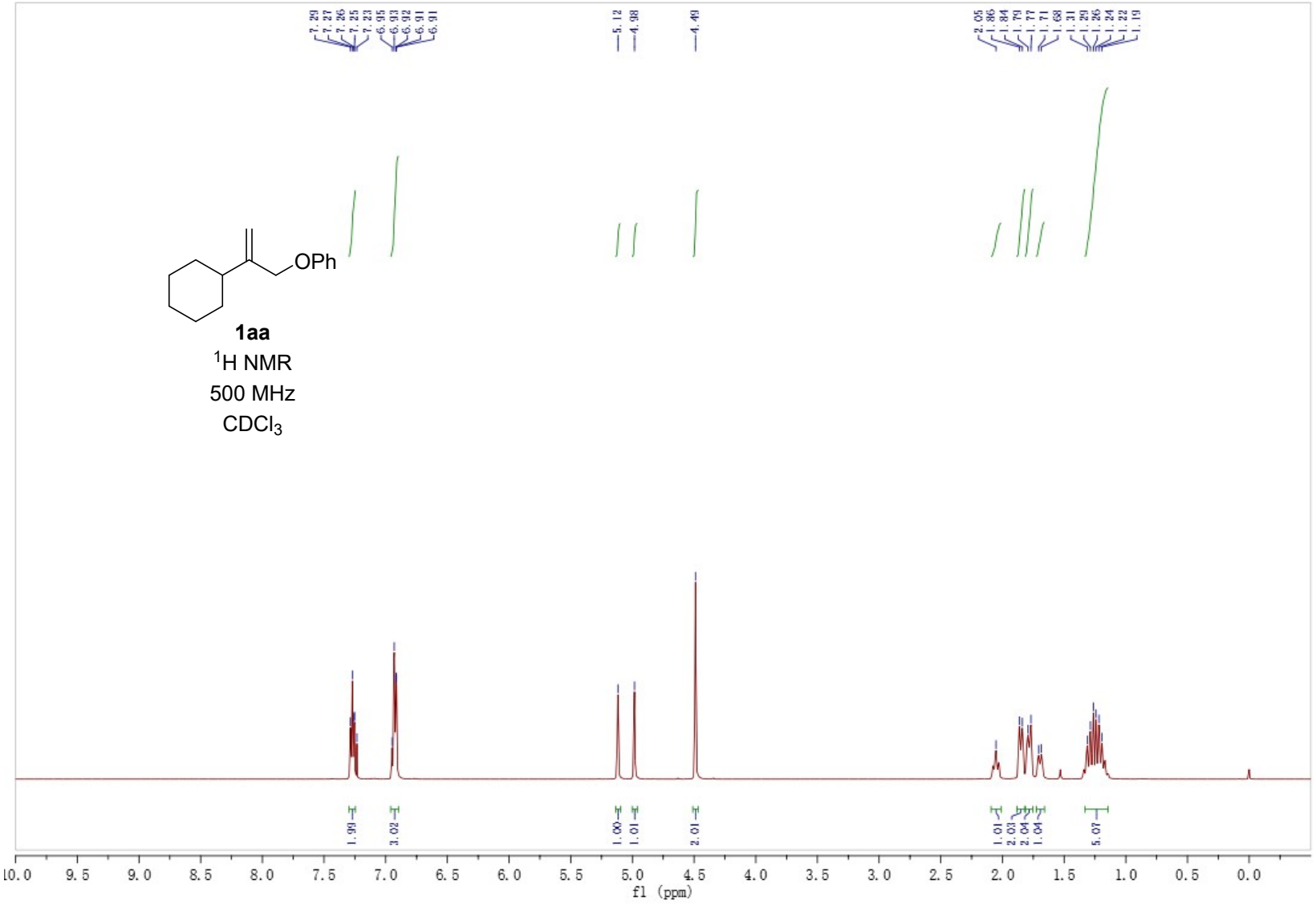
^{1}H NMR

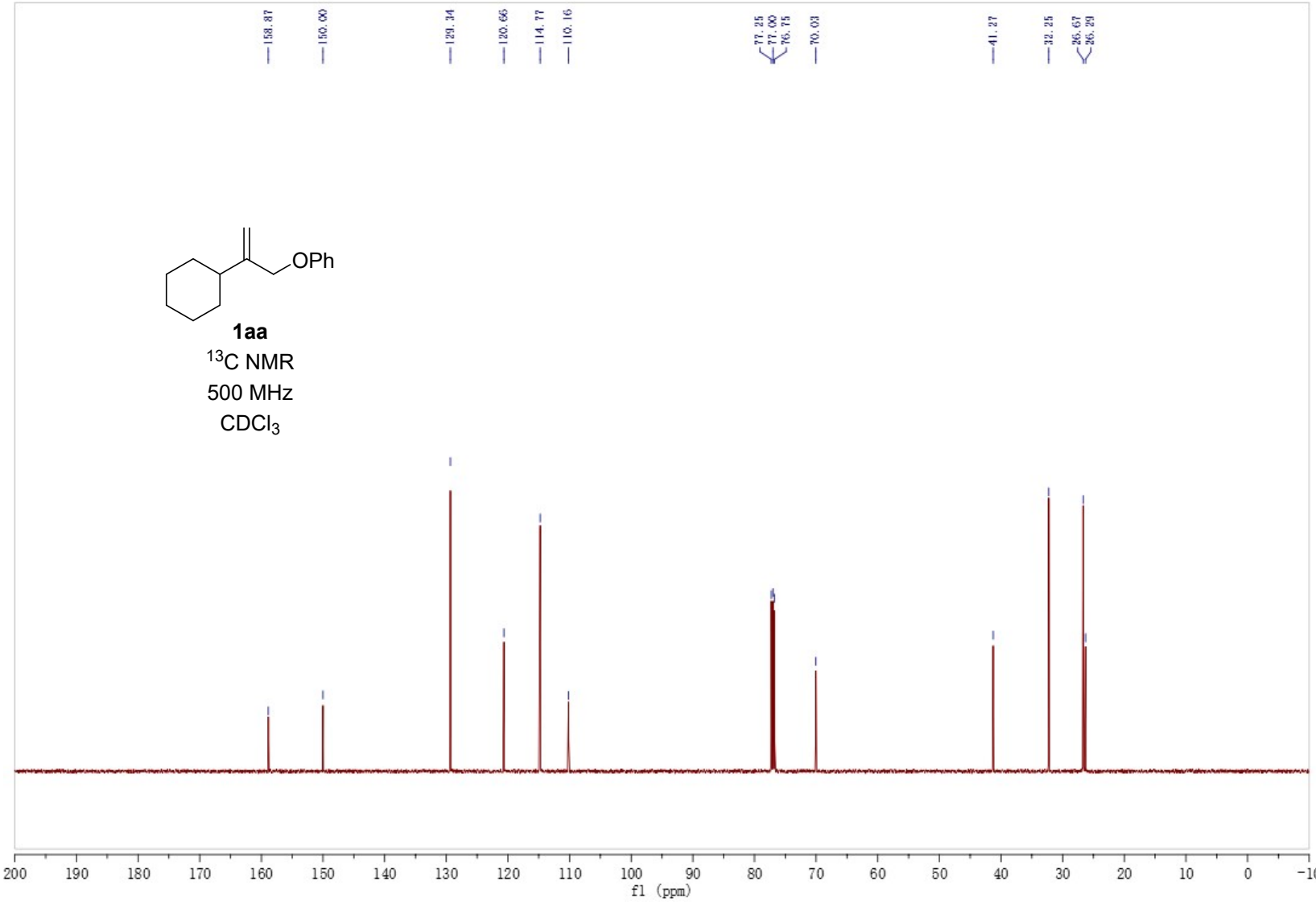
500 MHz

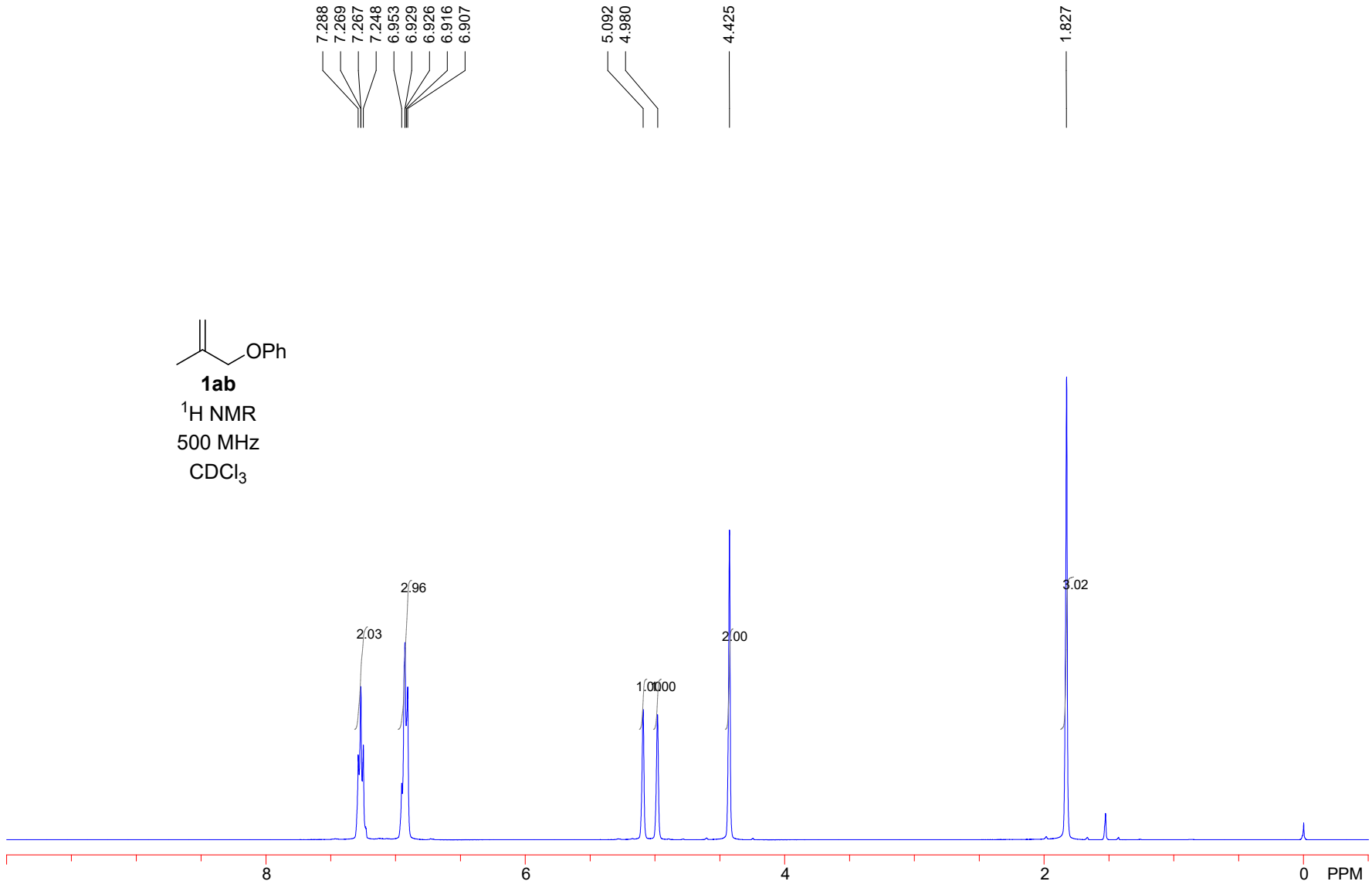
$CDCl_3$

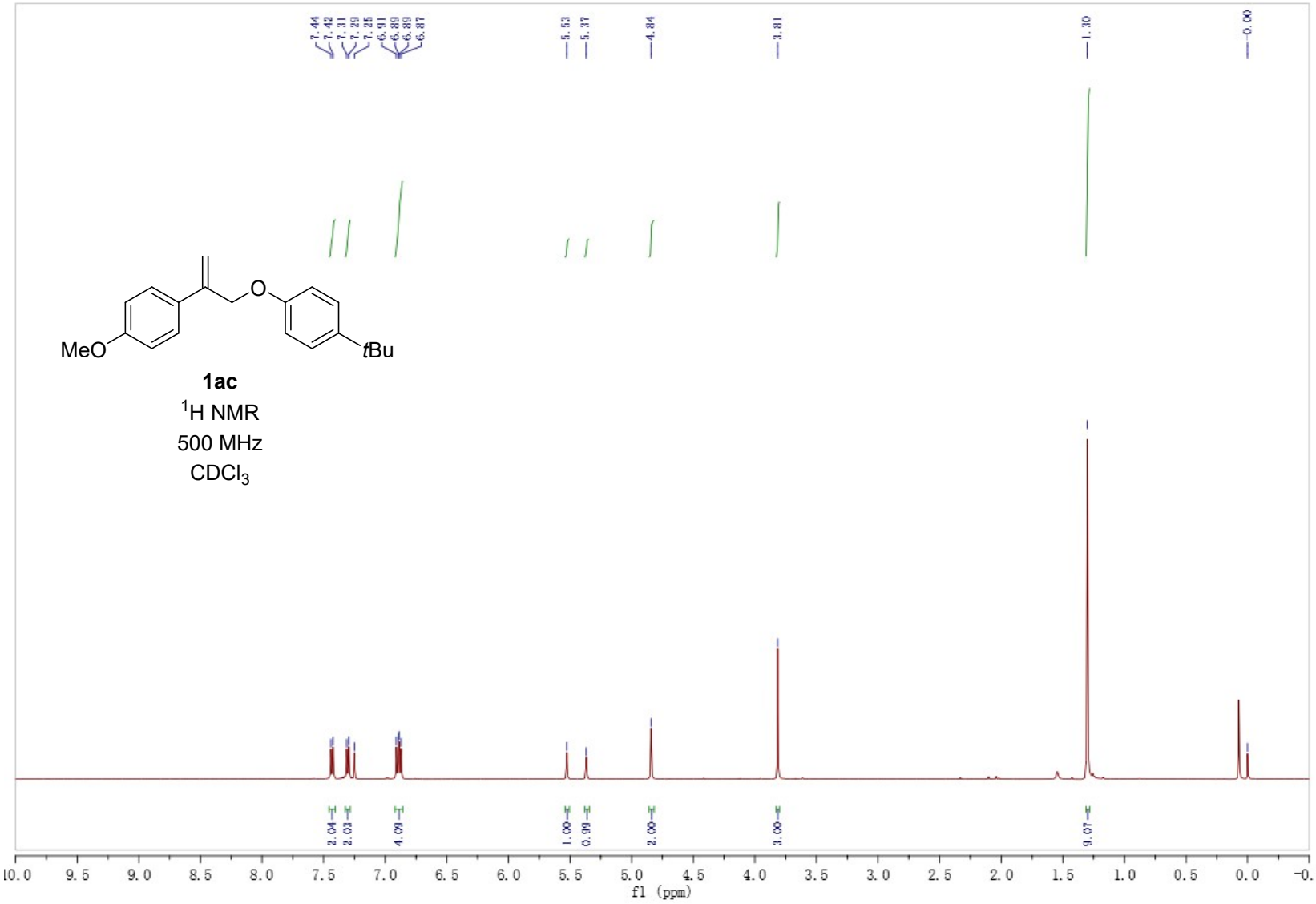


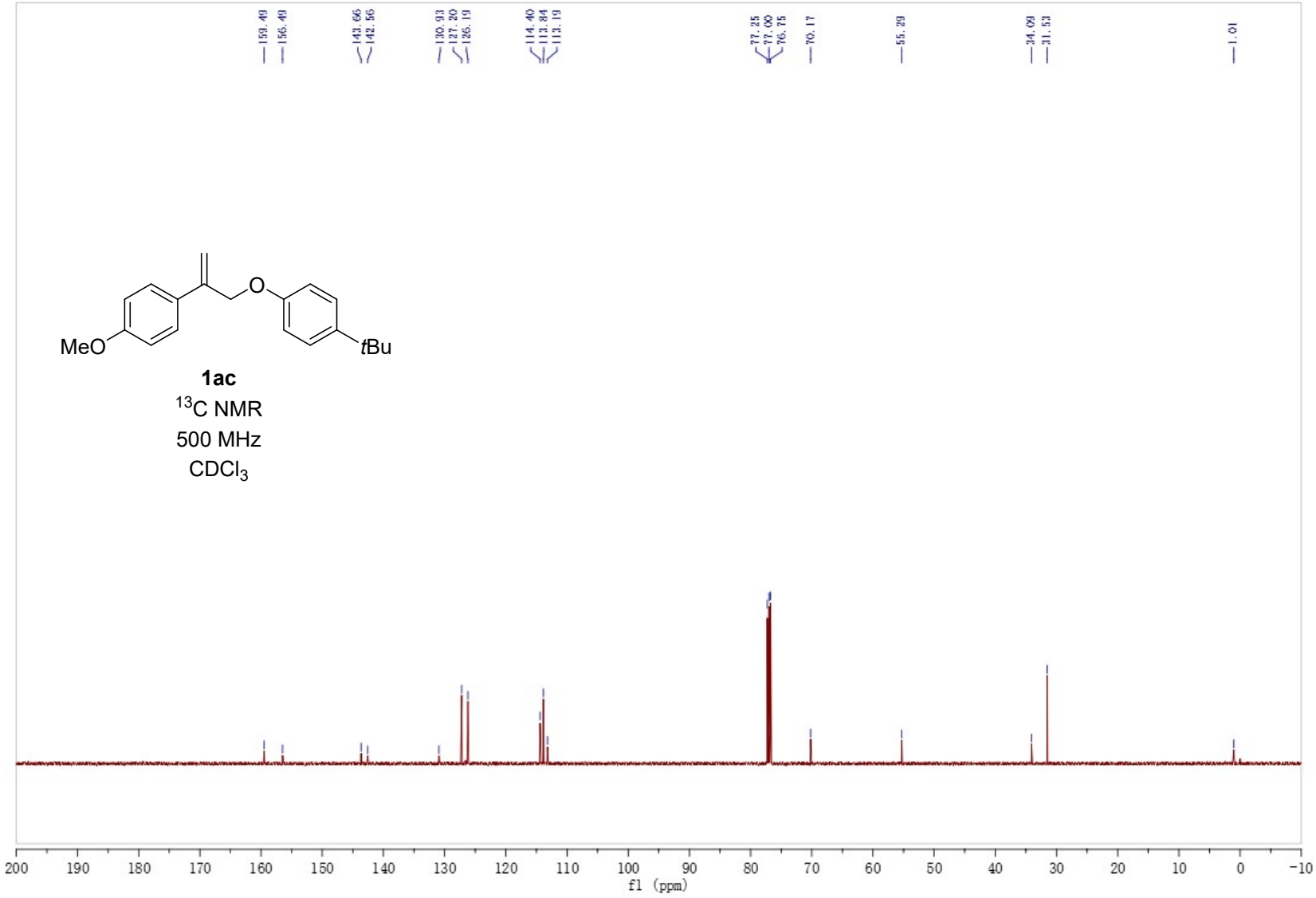

158.499
141.894
137.019
129.457
127.406
124.654
123.968
121.151
114.954
113.308
77.253
77.000
76.747
69.749
S
OPh
1z
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

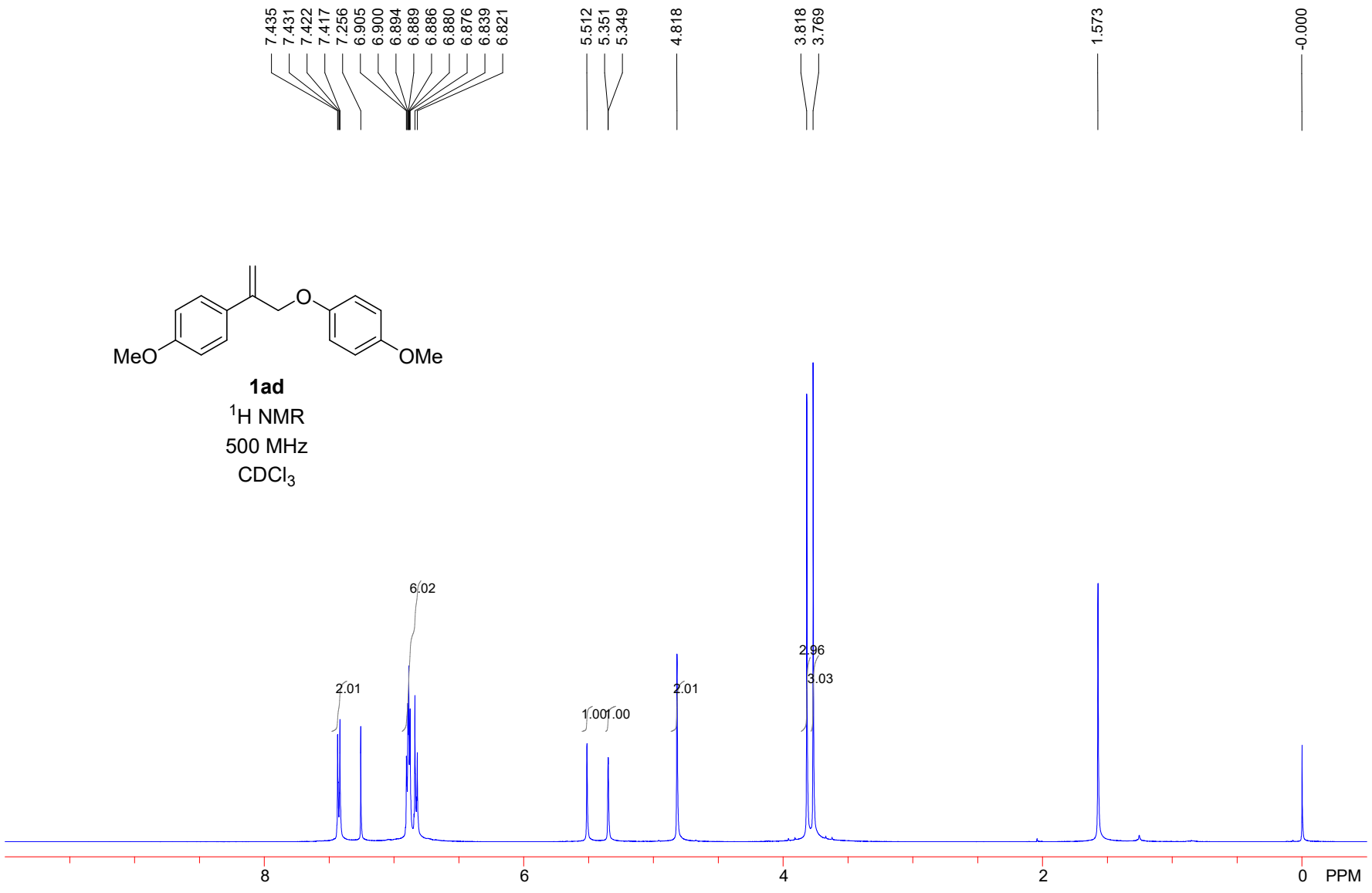

OPh
1aa
1H NMR
500 MHz
CDCl3
f1 (ppm)

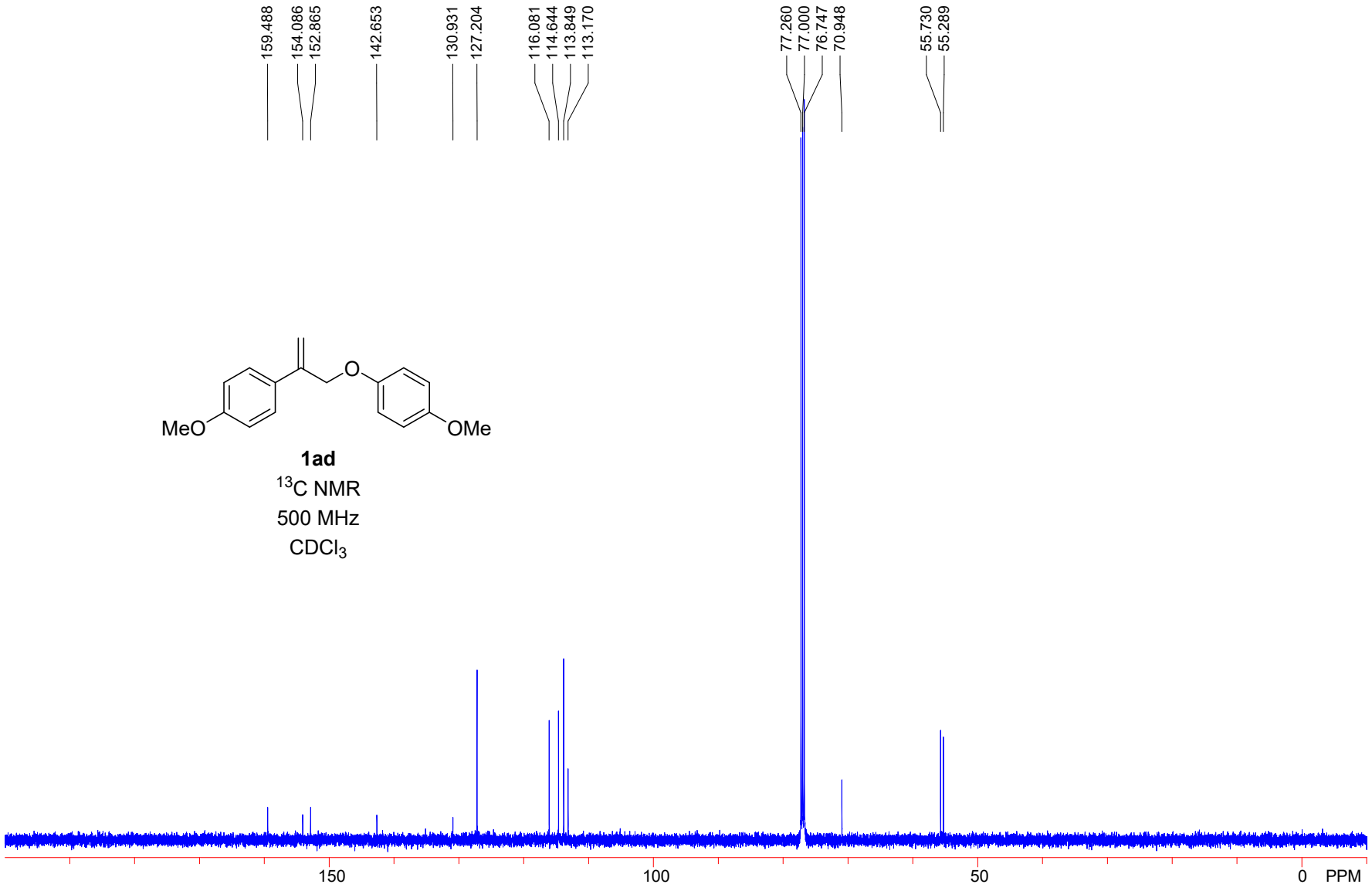

158.87
150.00
129.34
120.66
114.77
110.16
77.25
77.00
76.75
70.03
41.27
32.25
26.67
26.29
OPh
1aa
13C NMR
500 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.288
7.269
7.267
7.248
6.953
6.929
6.926
6.916
6.907
5.092
4.980
4.425
1.827
OPh
1ab
1H NMR
500 MHz
CDCl3
2.03
2.96
1.00
1.00
2.00
3.02
8
6
4
2
0
PPM


MeO
O
tBu
1ac
1H NMR
500 MHz
CDCl3
f1 (ppm)


159.49
156.49
143.66
142.56
130.93
127.29
126.19
114.49
113.84
113.19
77.25
77.00
76.75
70.17
55.29
34.09
31.53
1.01
MeO
O
tBu
1ac
13C NMR
500 MHz
CDCl3
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.435
7.431
7.422
7.417
7.256
6.905
6.900
6.894
6.889
6.886
6.880
6.876
6.839
6.821
5.512
5.351
5.349
4.818
3.818
3.769
1.573
-0.000
MeO
O
OMe
1ad
1H NMR
500 MHz
CDCl3
6.02
2.01
1.00
1.00
2.01
2.96
3.03
8
6
4
2
0
PPM

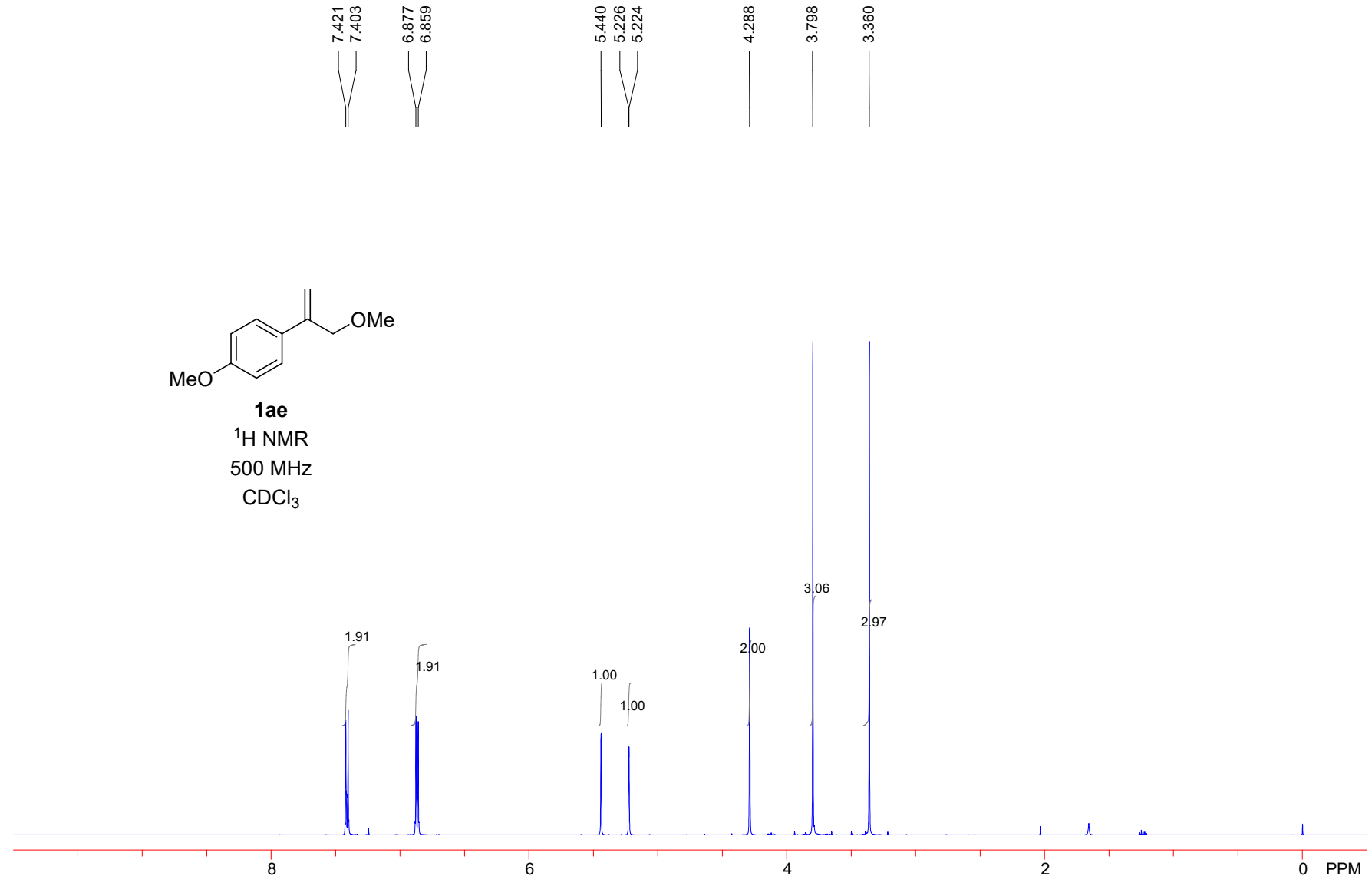


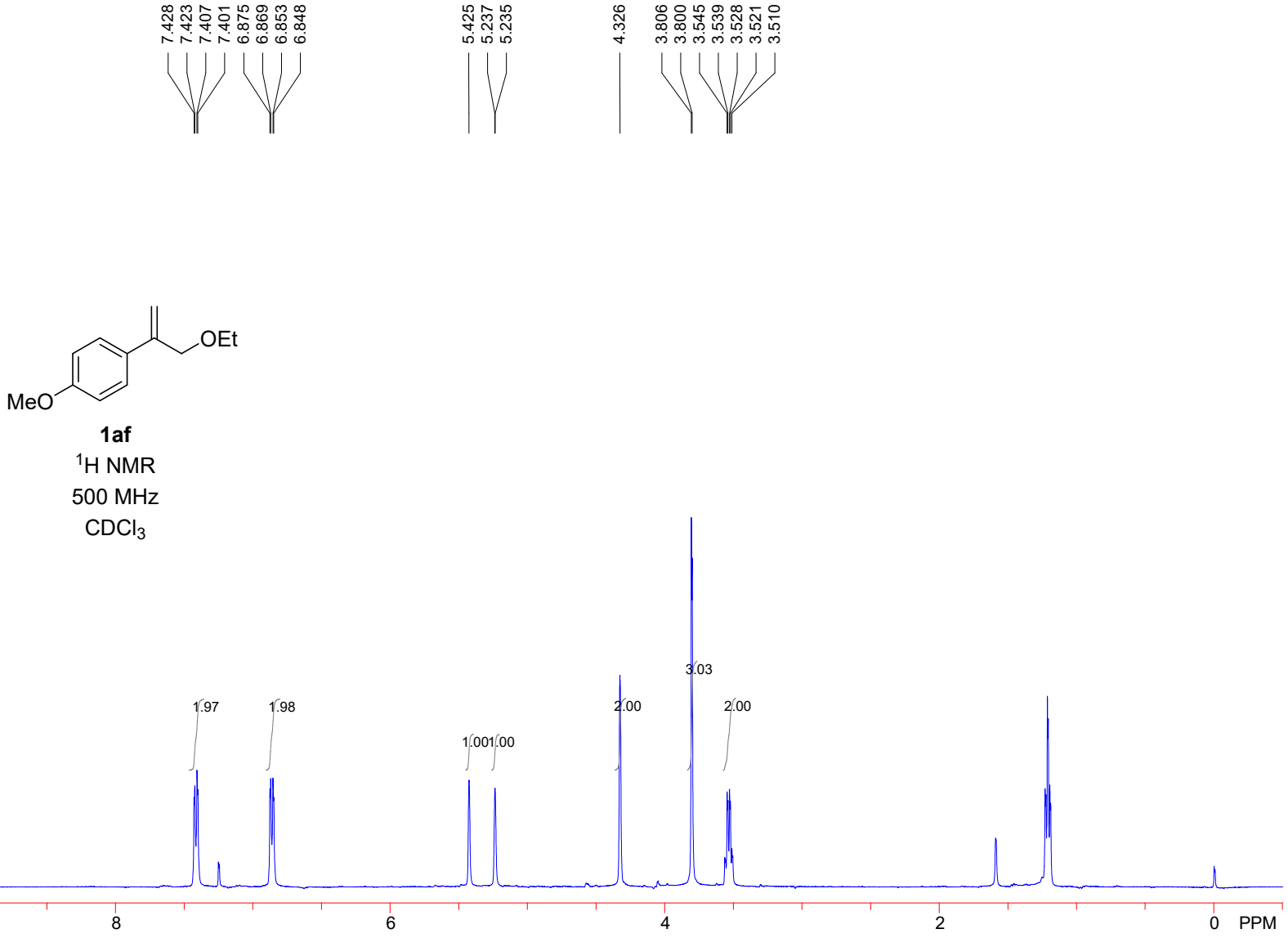
1ad

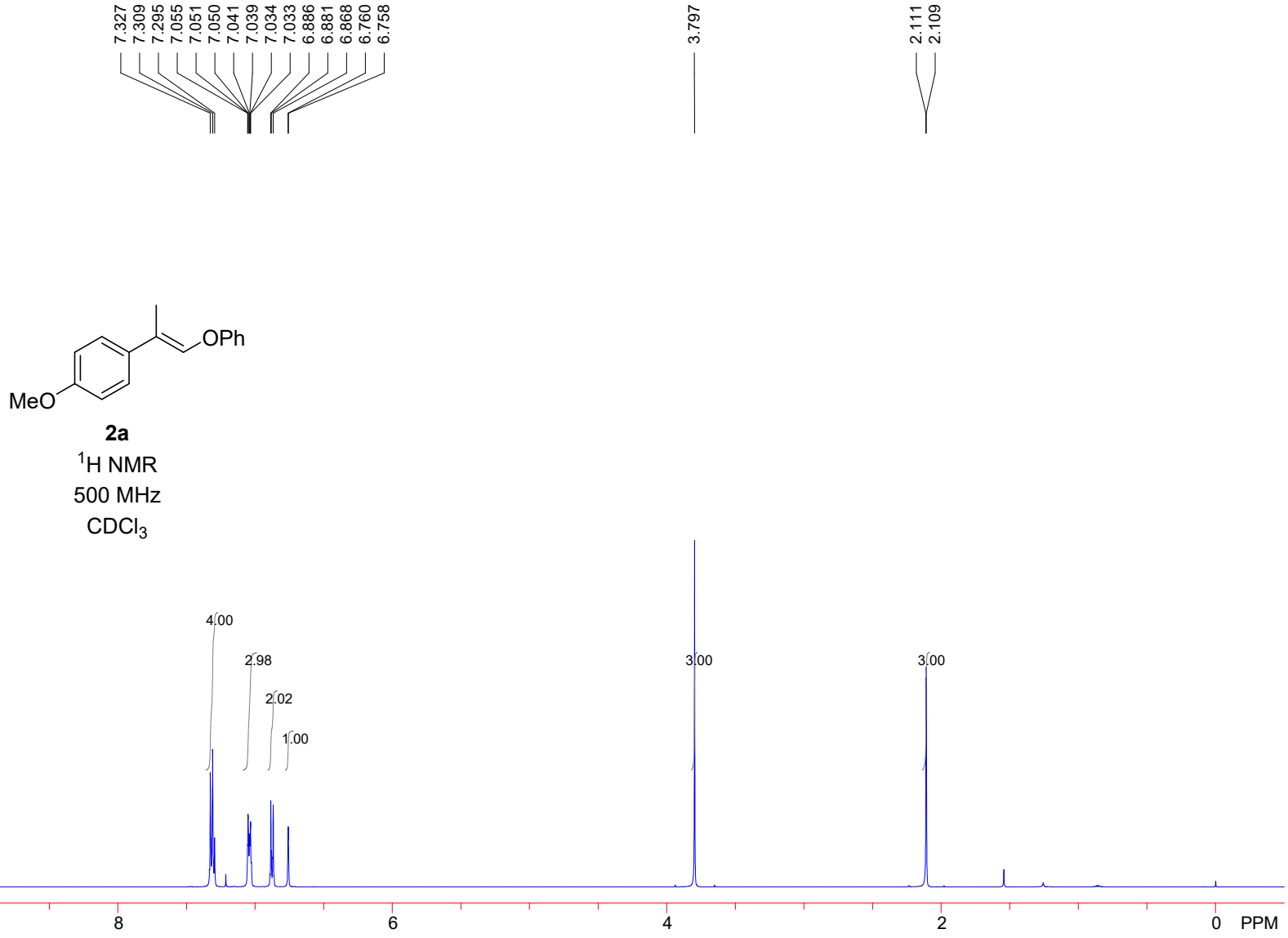
^{13}C NMR

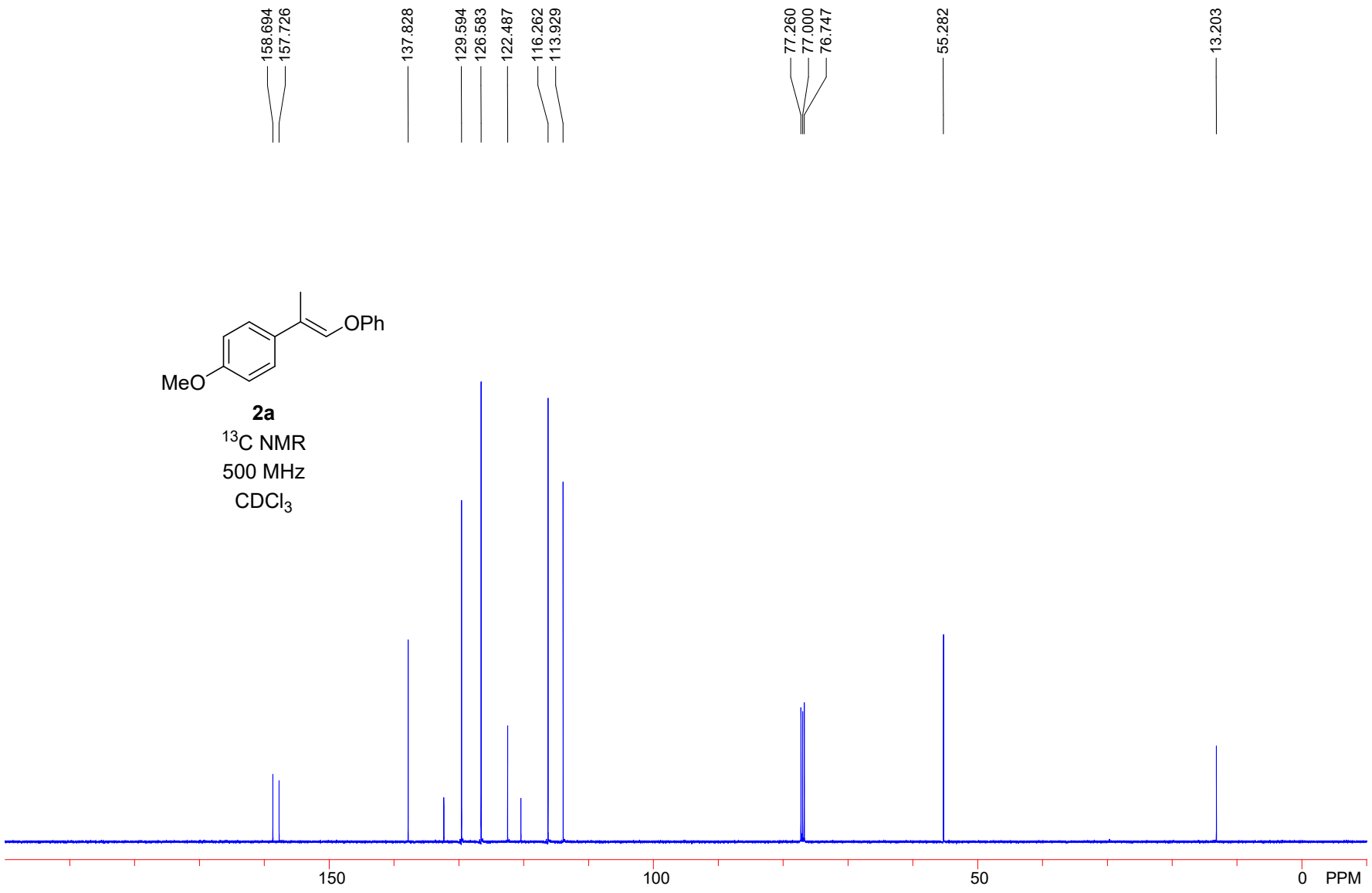
500 MHz

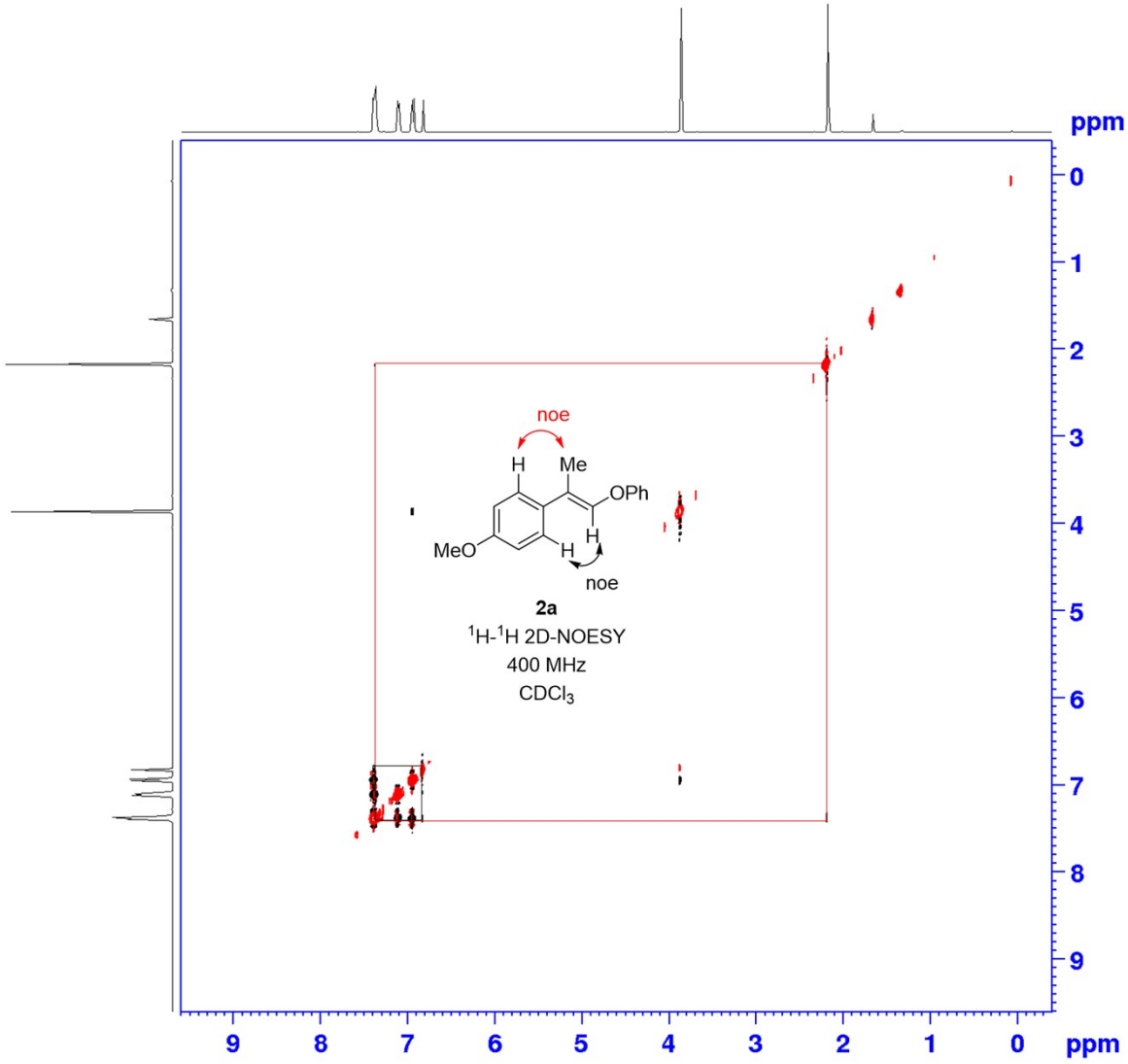
$CDCl_3$

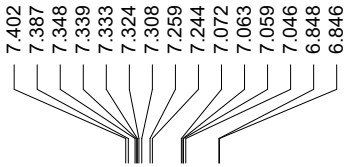

7.421
7.403
6.877
6.859
5.440
5.226
5.224
4.288
3.798
3.360
OMe
MeO
1ae
1H NMR
500 MHz
CDCl3
1.91
1.91
1.00
1.00
2.00
3.06
2.97
8
6
4
2
0
PPM

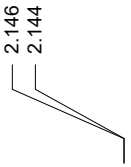

7.428
7.423
7.407
7.401
6.875
6.869
6.853
6.848
5.425
5.237
5.235
4.326
3.806
3.800
3.545
3.539
3.528
3.521
3.510
OEt
MeO
1af
1H NMR
500 MHz
CDCl3
1.97
1.98
1.00
1.00
2.00
3.03
2.00
8
6
4
2
0
PPM

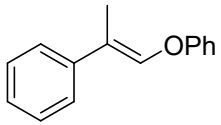

7.327
7.309
7.295
7.055
7.051
7.050
7.041
7.039
7.034
7.033
6.886
6.881
6.868
6.760
6.758
3.797
2.111
2.109
OPh
MeO
2a
1H NMR
500 MHz
CDCl3
4.00
2.98
2.02
1.00
3.00
3.00
8
6
4
2
0
PPM


158.694
157.726
137.828
129.594
126.583
122.487
116.262
113.929
77.260
77.000
76.747
55.282
13.203
OPh
MeO
2a
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM


noe
H
Me
OPh
H
MeO
H
noe
2a
^{1}H-^{1}H 2D-NOESY
400 MHz
$CDCl_3$
ppm
0
1
2
3
4
5
6
7
8
9
9
8
7
6
5
4
3
2
1
0
ppm





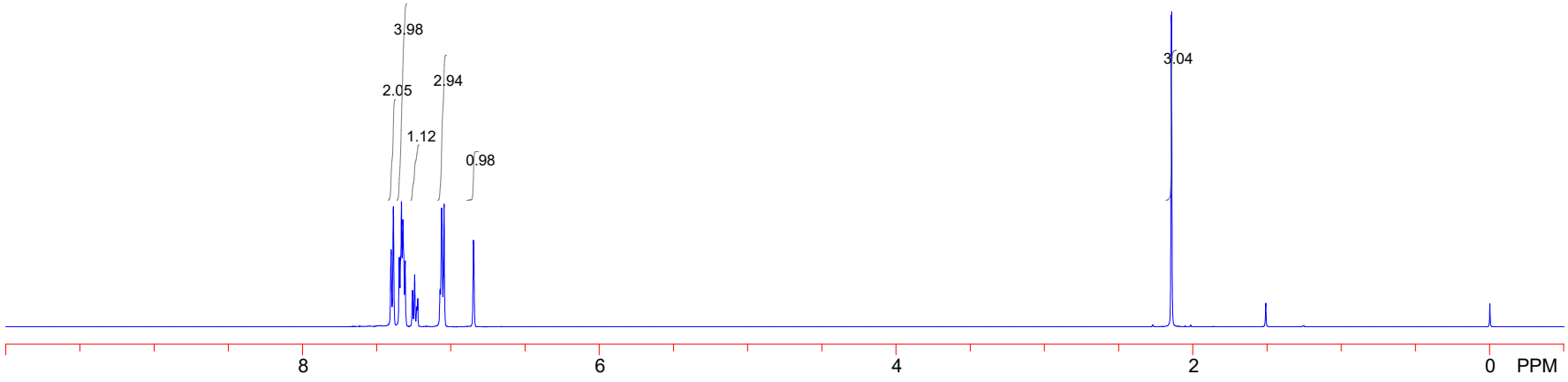


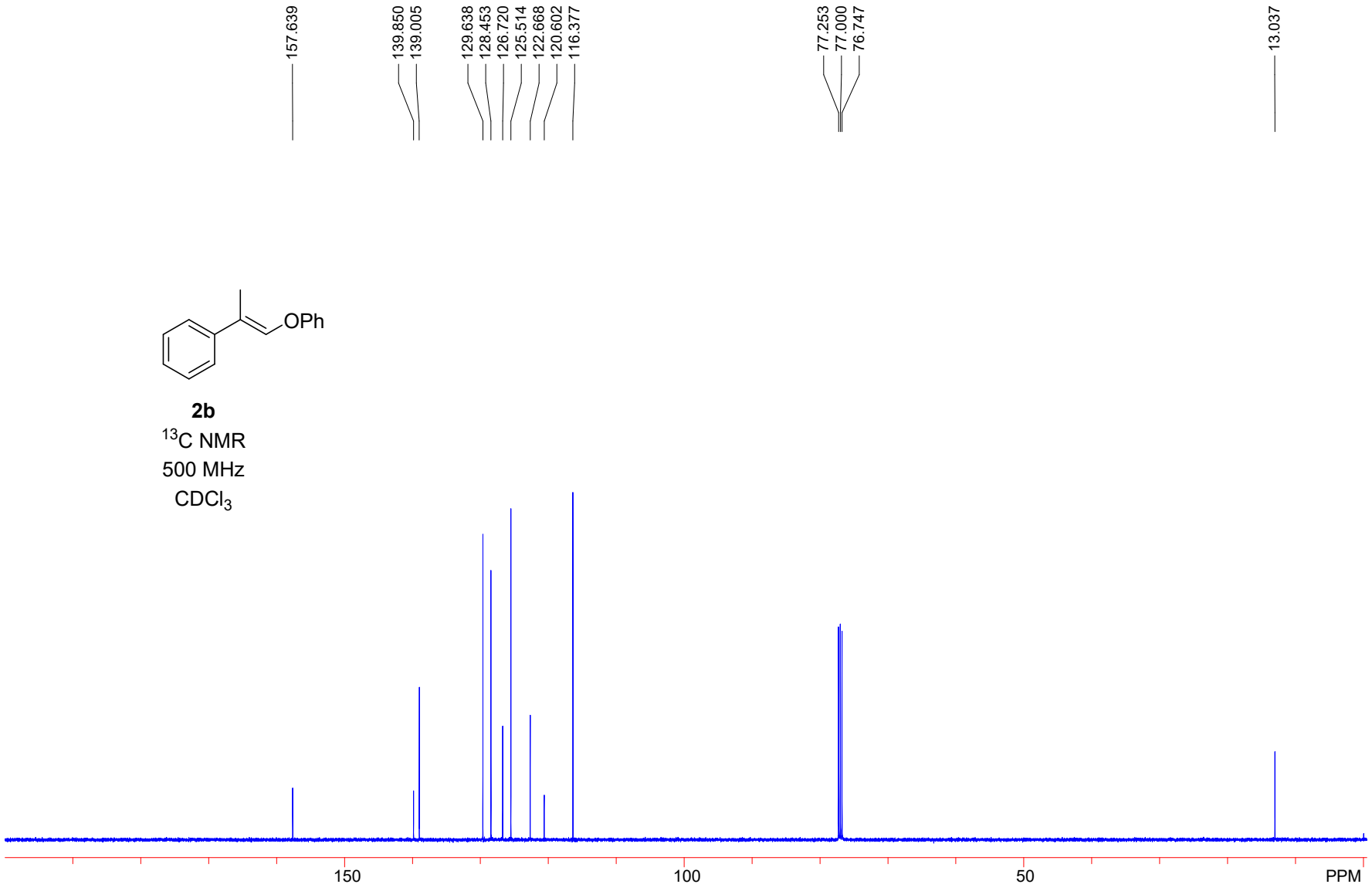
2b

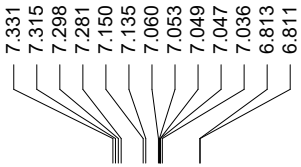
^{1}H NMR

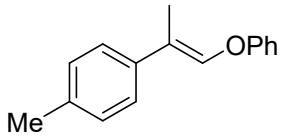
500 MHz

$CDCl_3$




157.639
139.850
139.005
129.638
128.453
126.720
125.514
122.668
120.602
116.377
77.253
77.000
76.747
13.037
OPh
2b
13C NMR
500 MHz
CDCl3
150
100
50
PPM



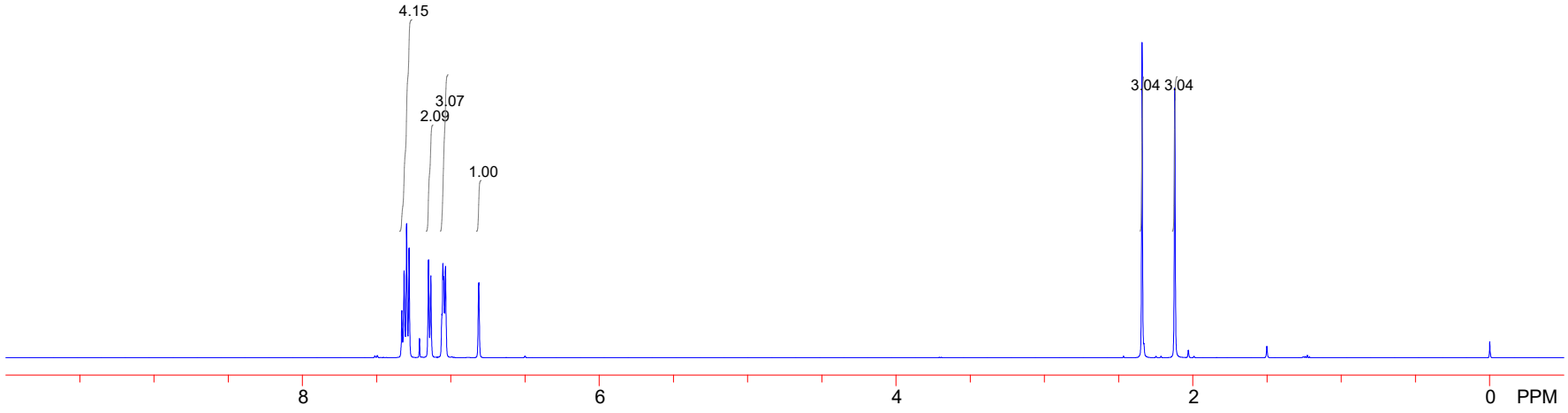


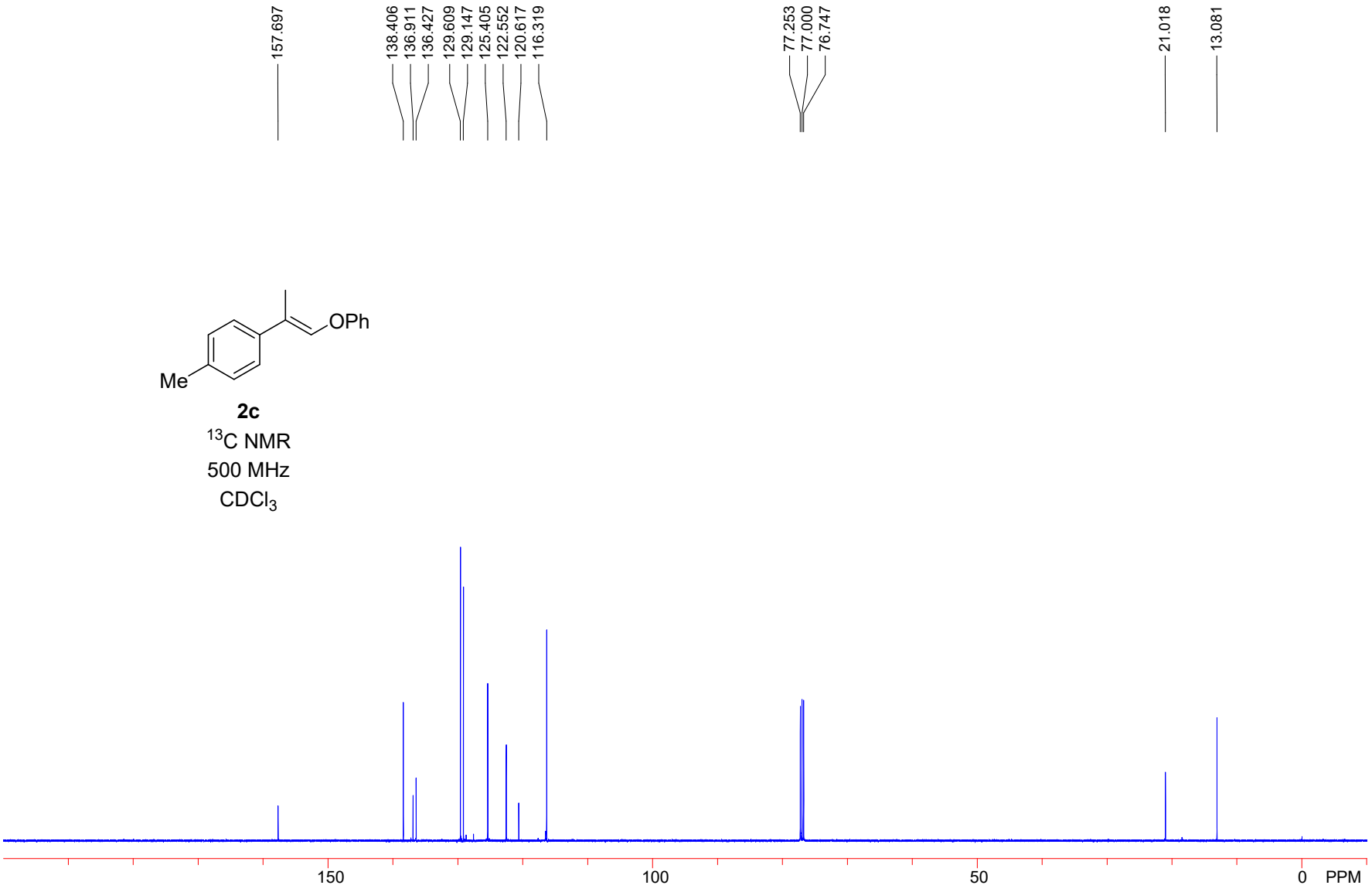
2c

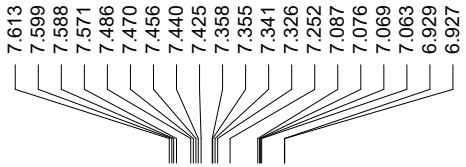
^{1}H NMR

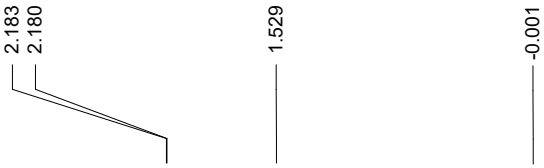
500 MHz

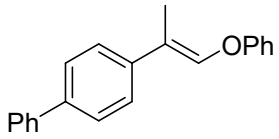
$CDCl_3$




157.697
138.406
136.911
136.427
129.609
129.147
125.405
122.552
120.617
116.319
77.253
77.000
76.747
21.018
13.081
OPh
Me
2c
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM





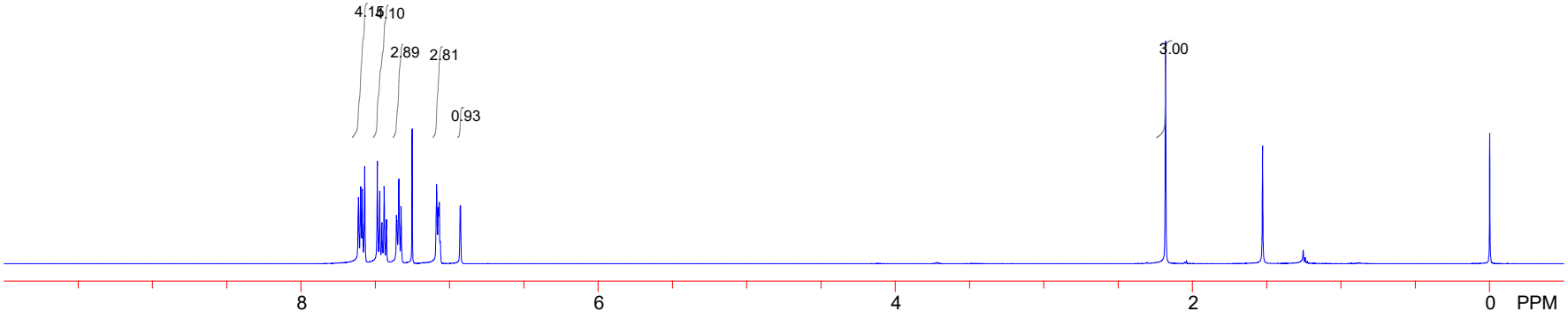


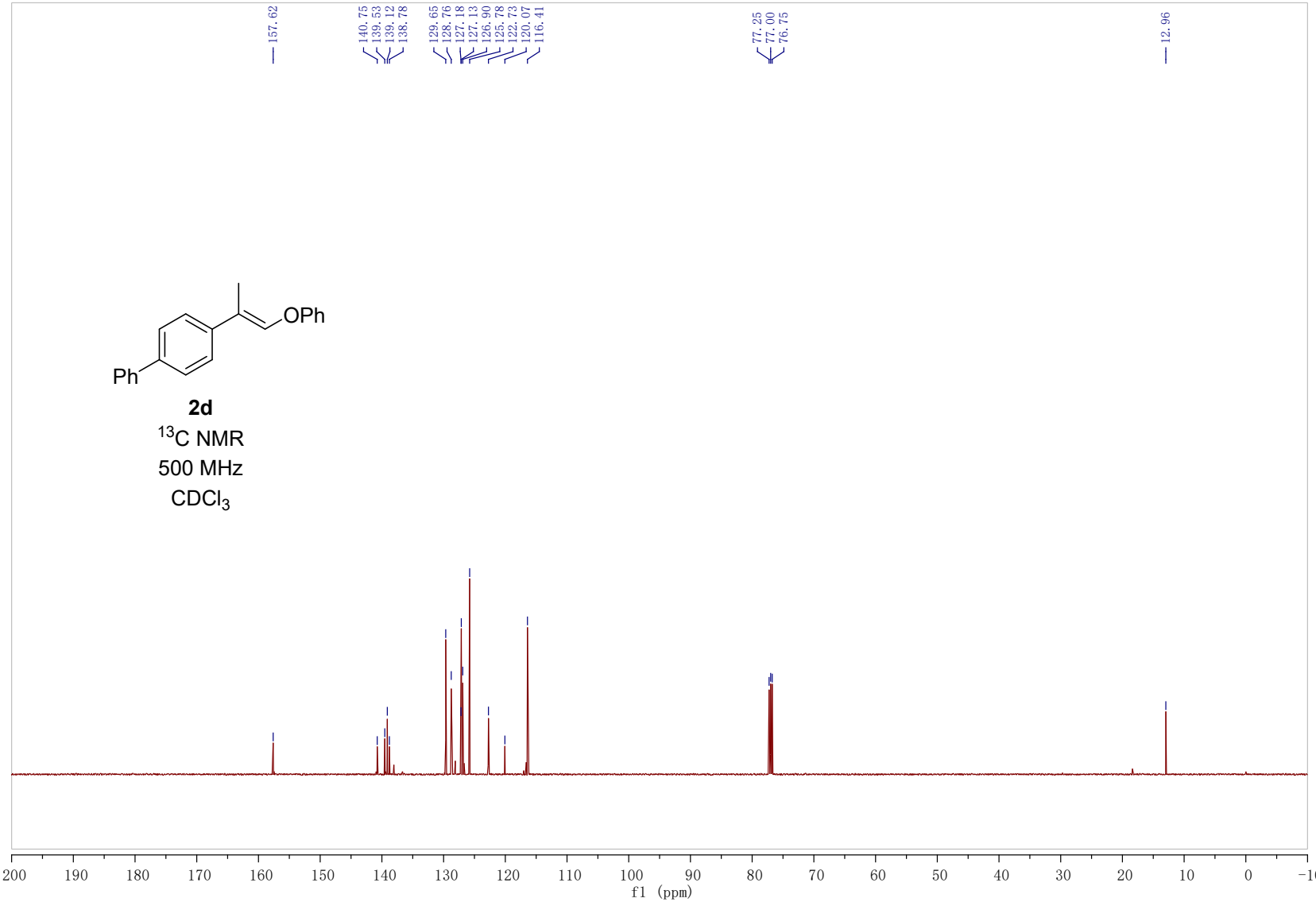
2d

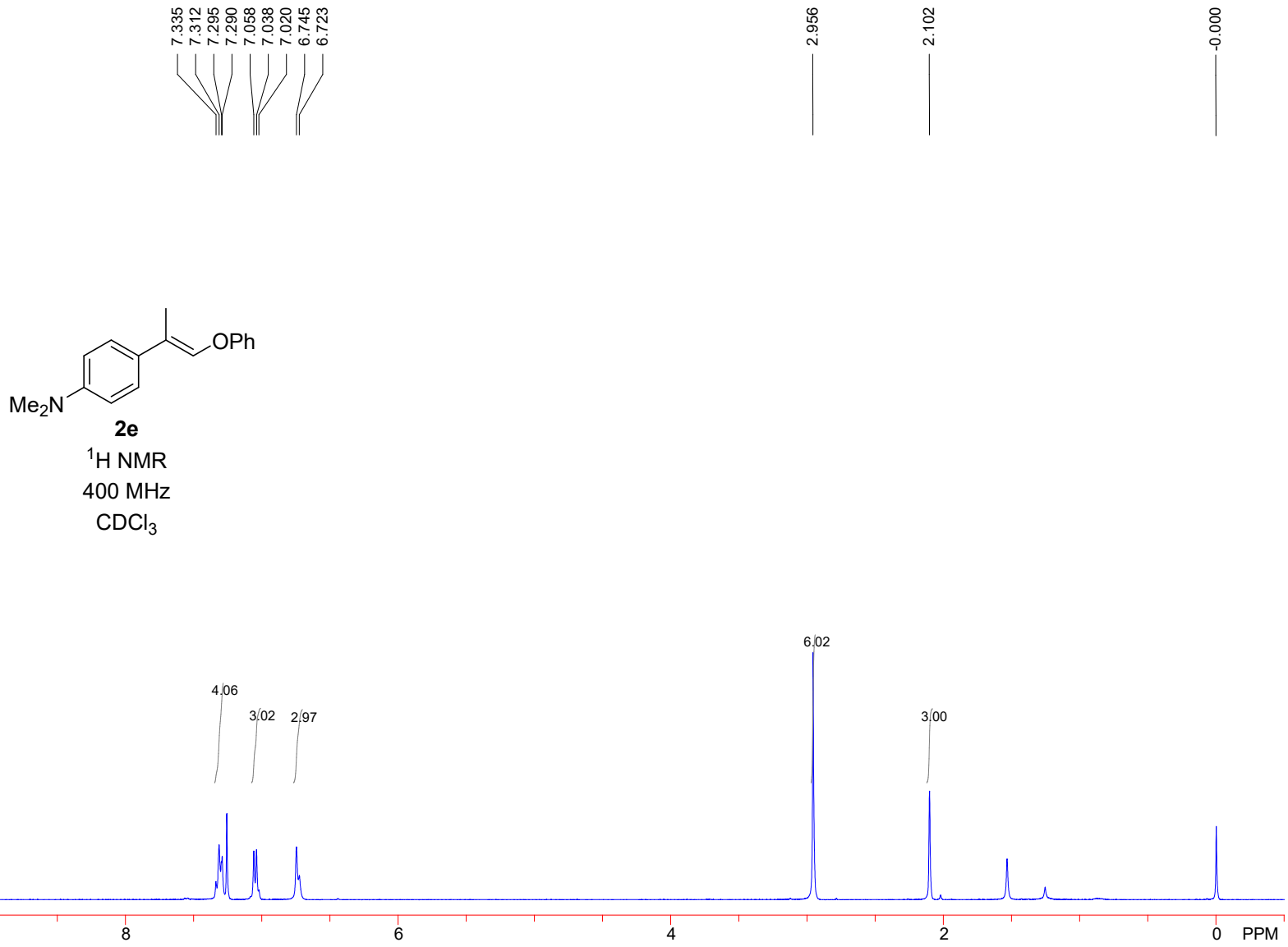
^{1}H NMR

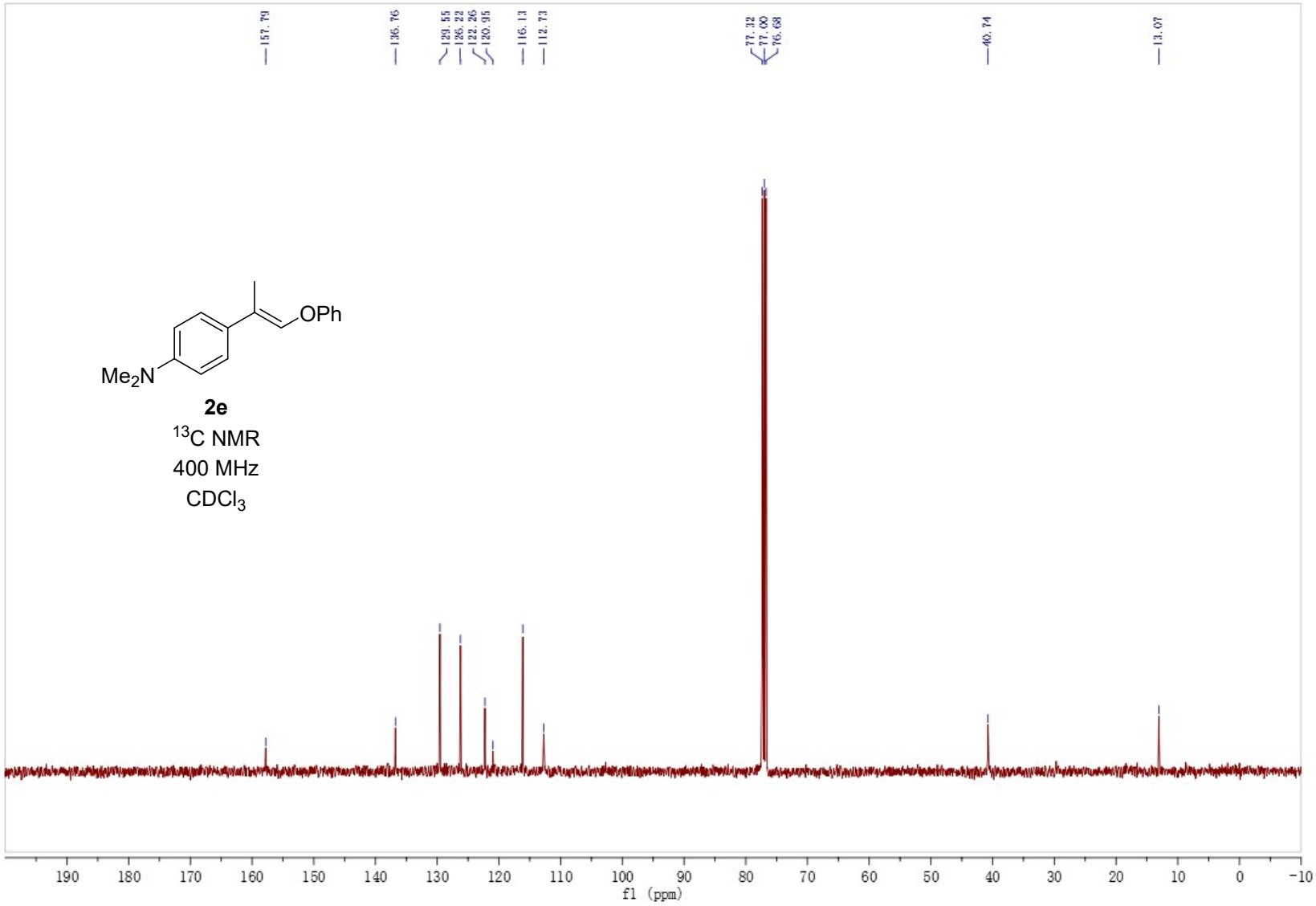
500 MHz

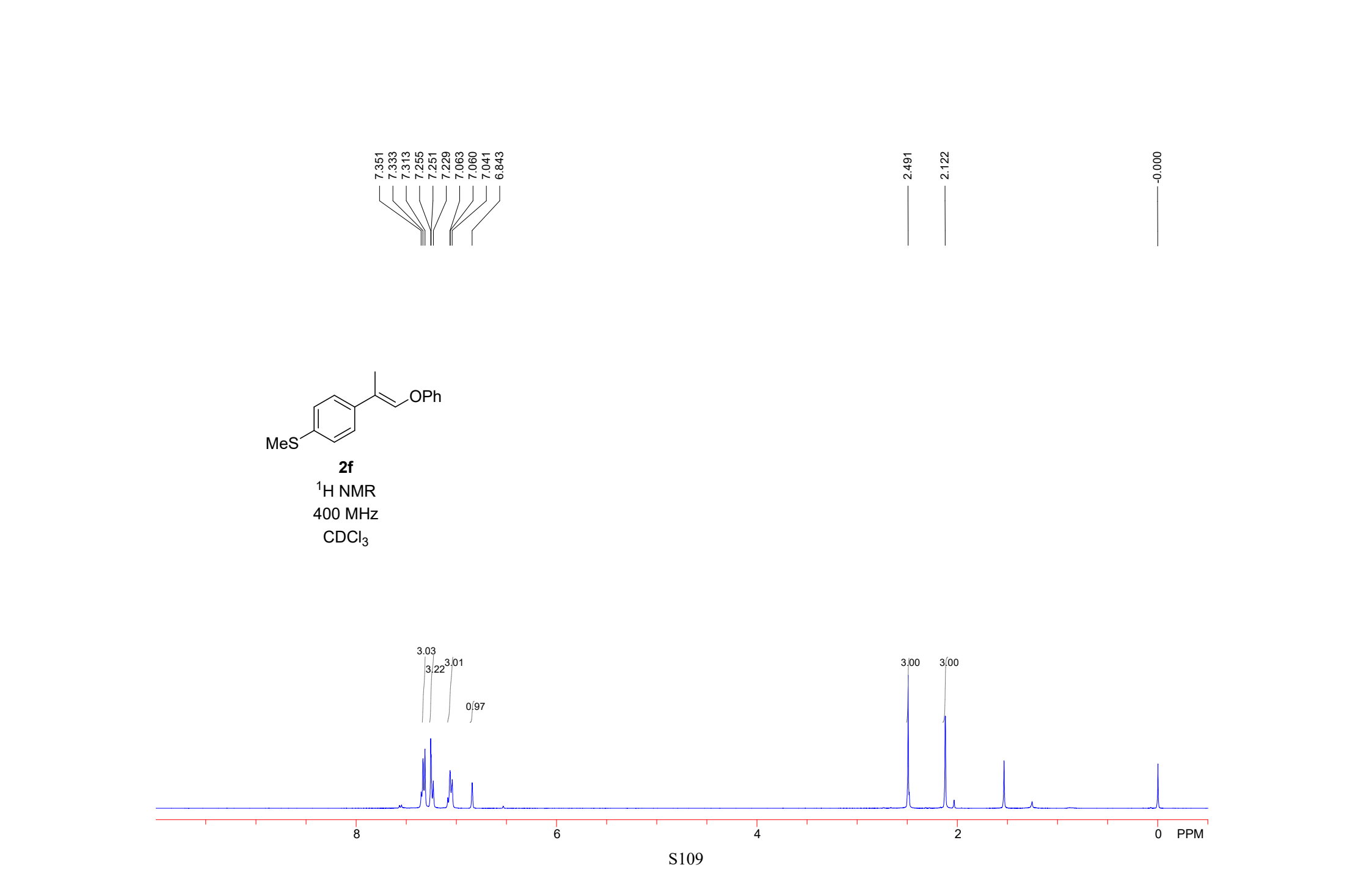
$CDCl_3$

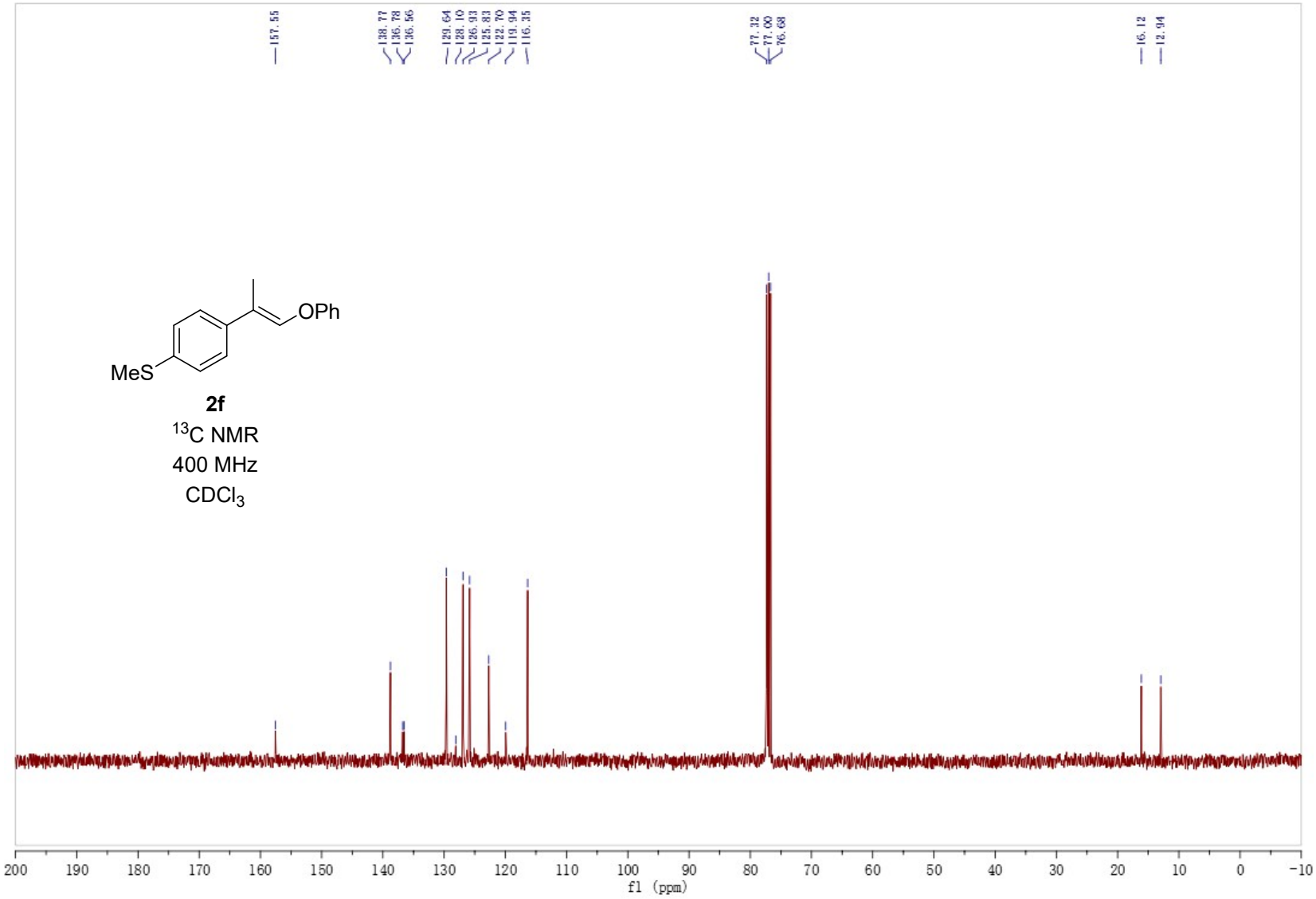


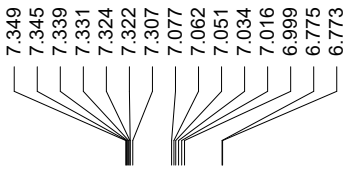

157.62
140.75
139.53
139.12
138.78
129.65
128.76
127.18
127.13
126.90
125.78
122.73
120.07
116.41
77.25
77.00
76.75
12.96
OPh
Ph
2d
13C NMR
500 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

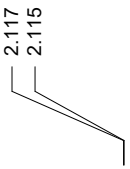

7.335
7.312
7.295
7.290
7.058
7.038
7.020
6.745
6.723
2.956
2.102
-0.000
OPh
Me2N
2e
1H NMR
400 MHz
CDCl3
6.02
4.06
3.02
2.97
3.00
8
6
4
2
0
PPM

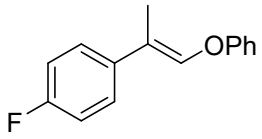

157.79
136.76
129.55
126.22
122.26
120.95
116.13
112.73
77.32
77.00
76.68
40.74
13.07
OPh
Me2N
2e
13C NMR
400 MHz
CDCl3
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.351
7.333
7.313
7.255
7.251
7.229
7.063
7.060
7.041
6.843
2.491
2.122
-0.000
OPh
MeS
2f
1H NMR
400 MHz
CDCl3
3.03
3.22
3.01
0.97
3.00
3.00
8
6
4
2
0
PPM


157.55
138.77
136.78
136.56
129.64
128.10
126.93
125.83
122.70
119.94
116.35
77.32
77.00
76.68
16.12
12.94
OPh
MeS
2f
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)





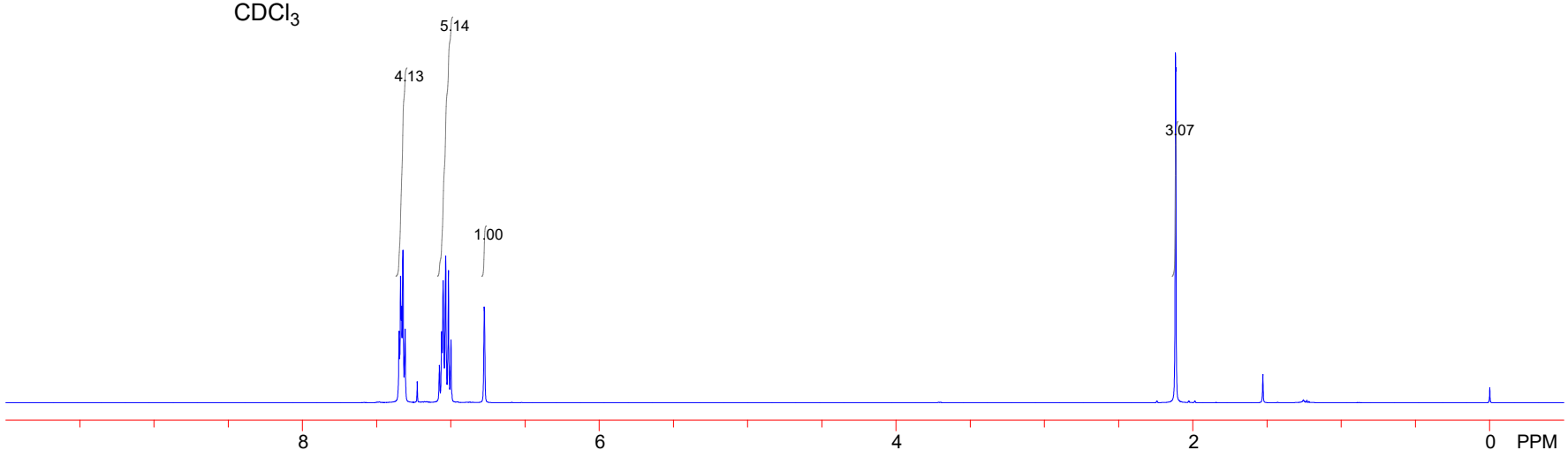


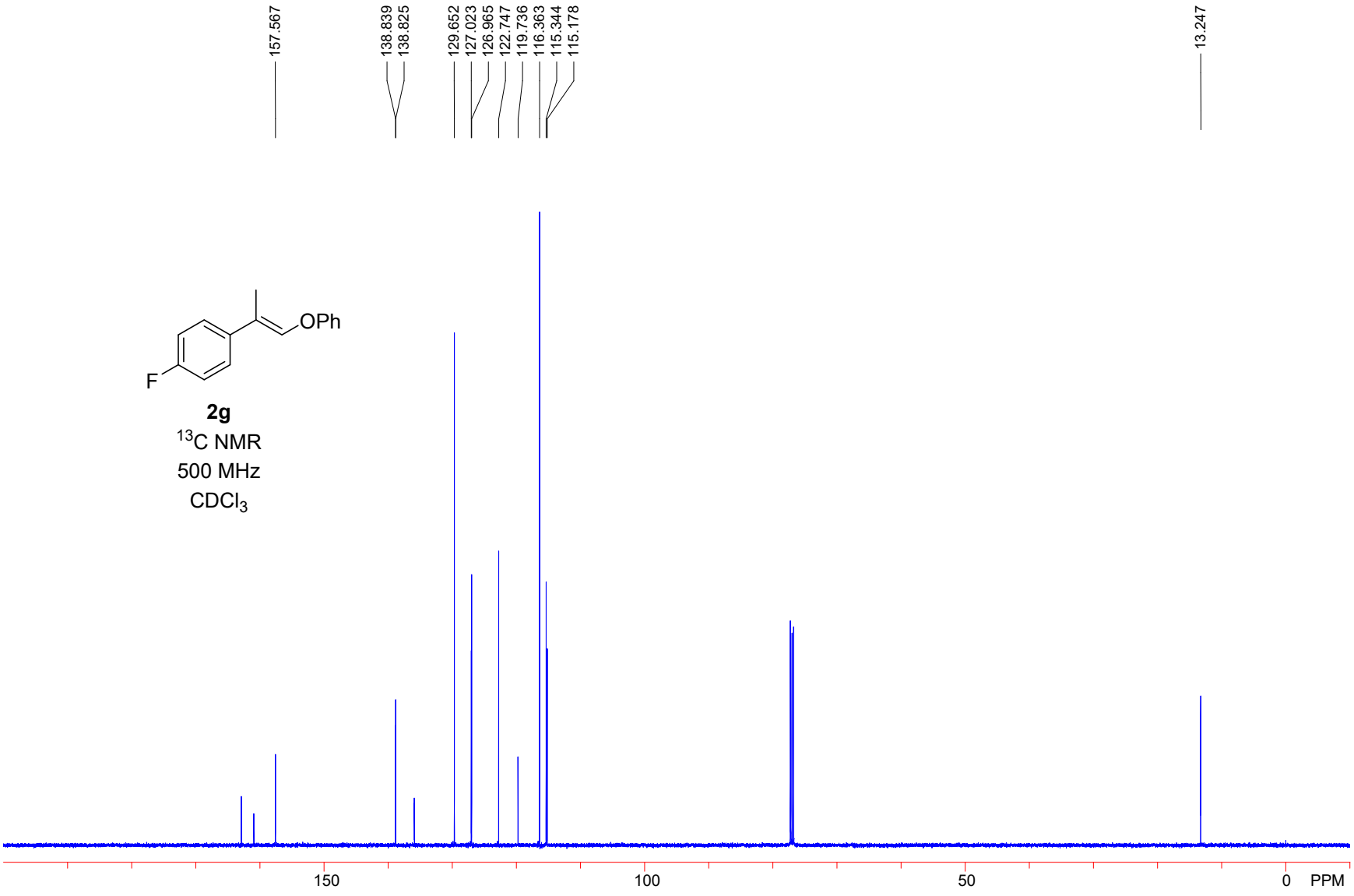
2g

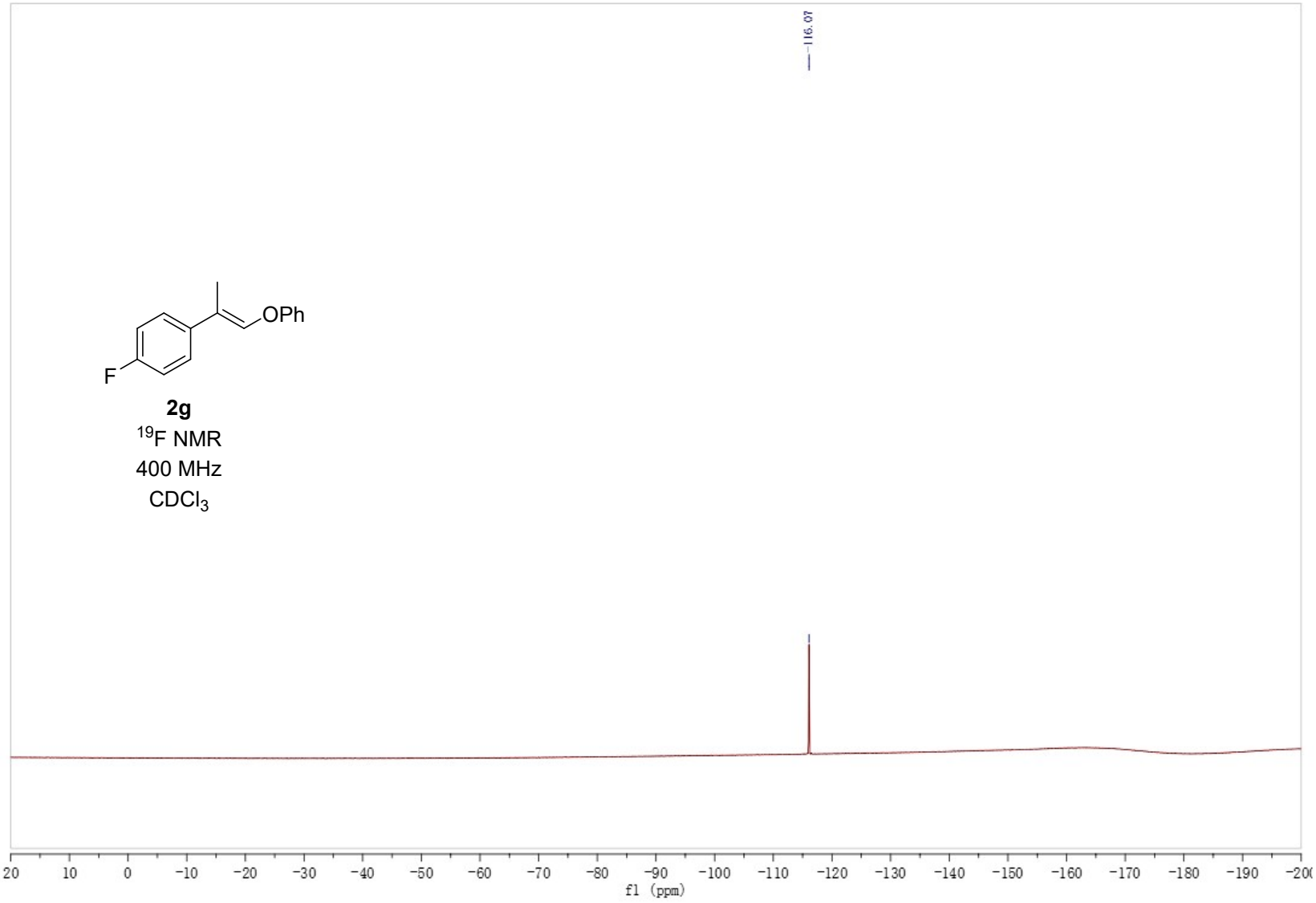
^{1}H NMR

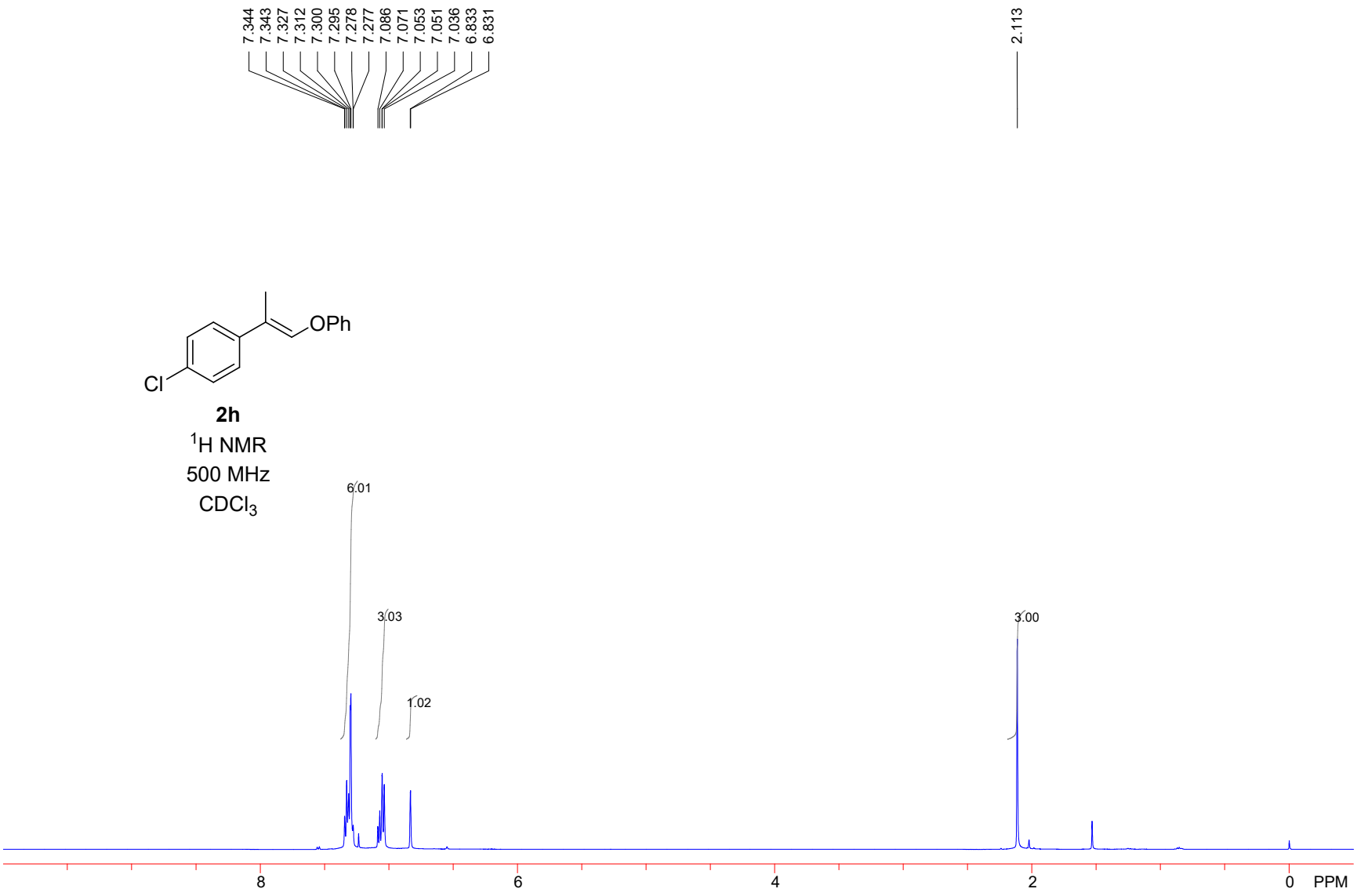
500 MHz

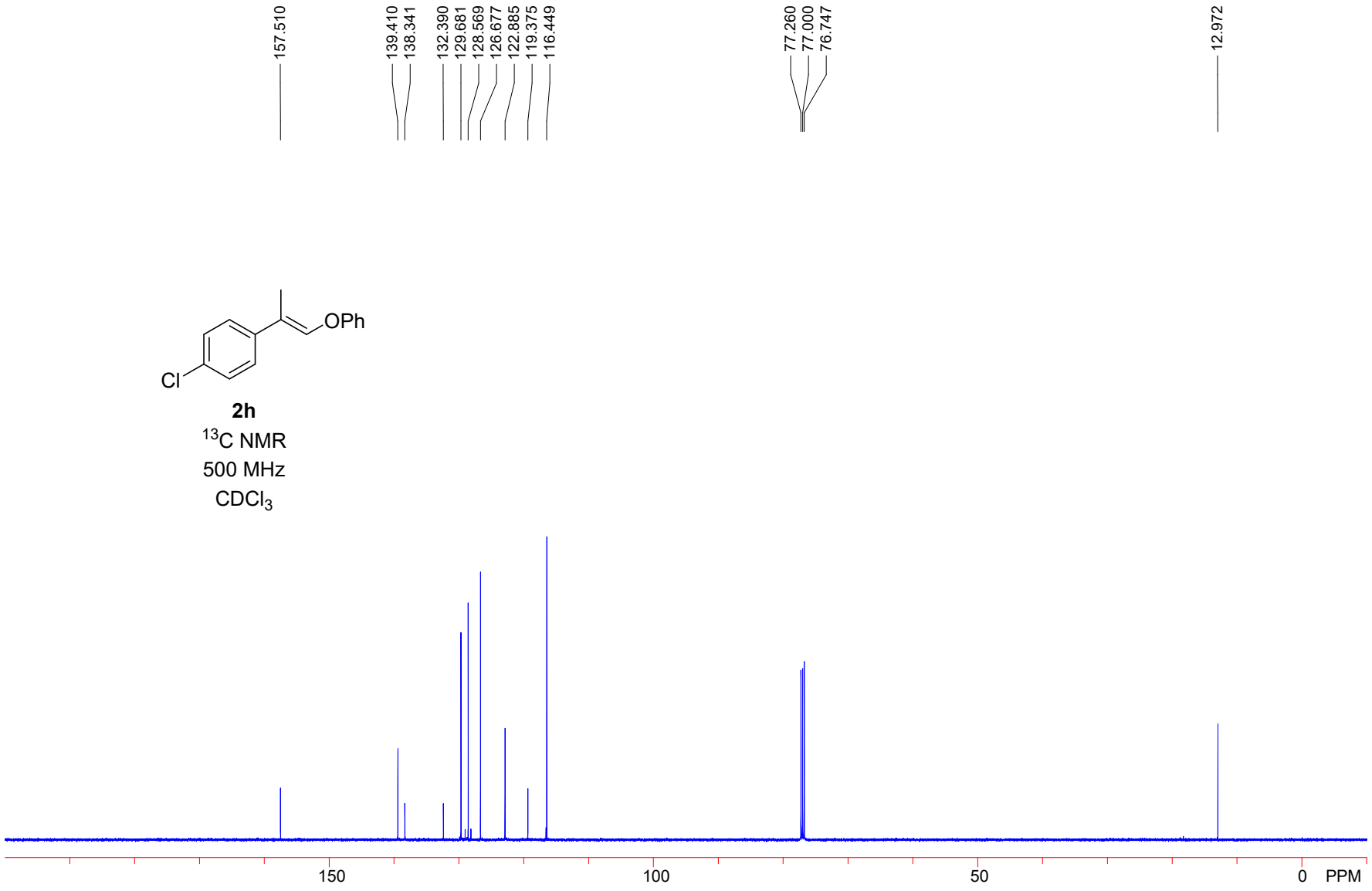
$CDCl_3$

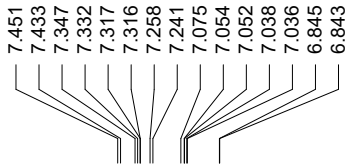


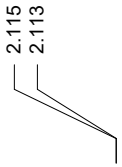

157.567
138.839
138.825
129.652
127.023
126.965
122.747
119.736
116.363
115.344
115.178
13.247
OPh
F
2g
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

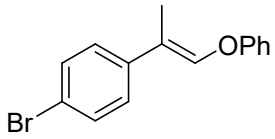

-116.07
OPh
F
2g
19F NMR
400 MHz
CDCl3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)


7.344
7.343
7.327
7.312
7.300
7.295
7.278
7.277
7.086
7.071
7.053
7.051
7.036
6.833
6.831
2.113
OPh
Cl
2h
1H NMR
500 MHz
CDCl3
6.01
3.03
1.02
3.00
8
6
4
2
0
PPM


157.510
139.410
138.341
132.390
129.681
128.569
126.677
122.885
119.375
116.449
77.260
77.000
76.747
12.972
OPh
Cl
2h
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM





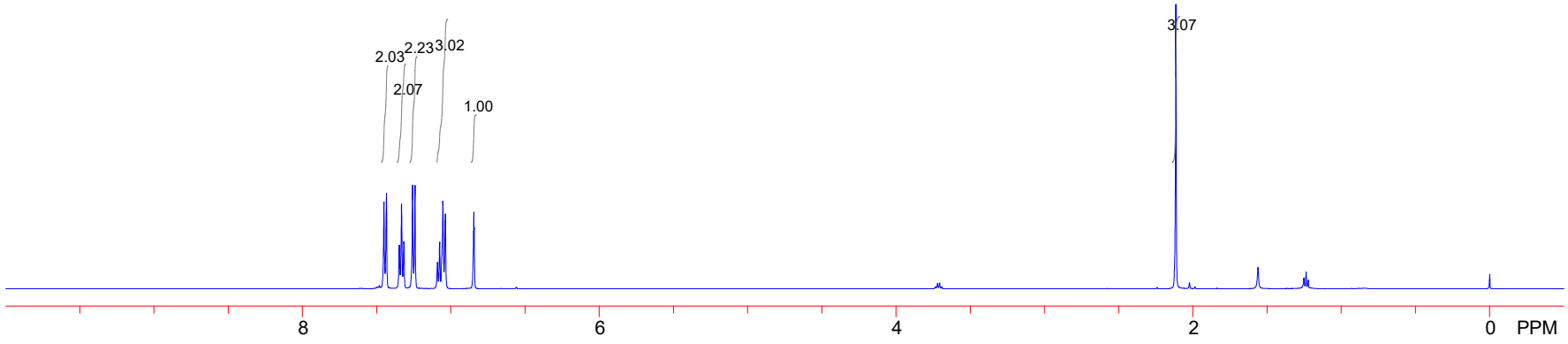


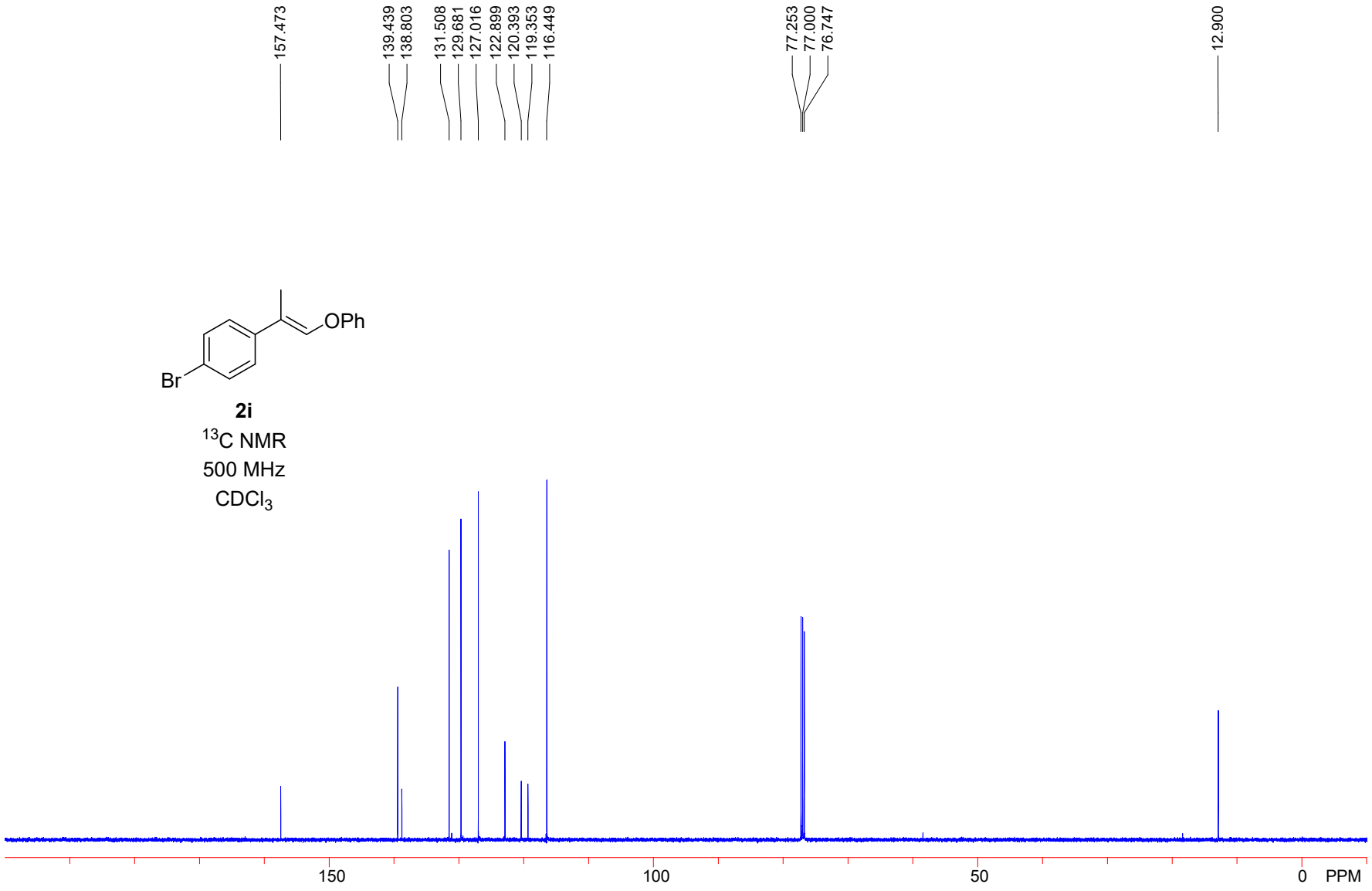
2i

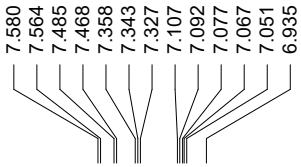
^{1}H NMR

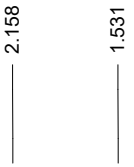
500 MHz

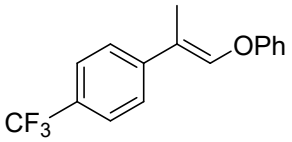
$CDCl_3$




157.473
139.439
138.803
131.508
129.681
127.016
122.899
120.393
119.353
116.449
77.253
77.000
76.747
12.900
OPh
Br
2i
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM





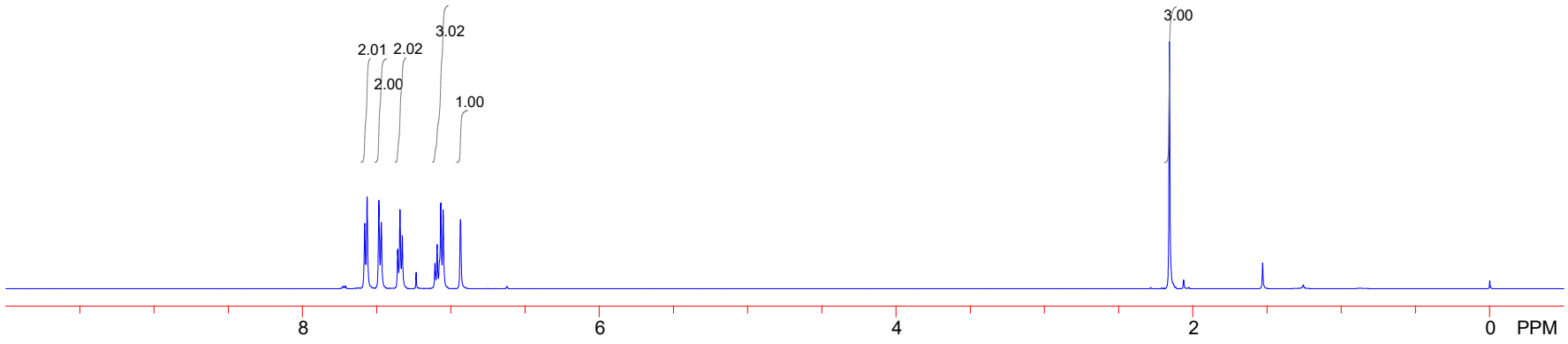


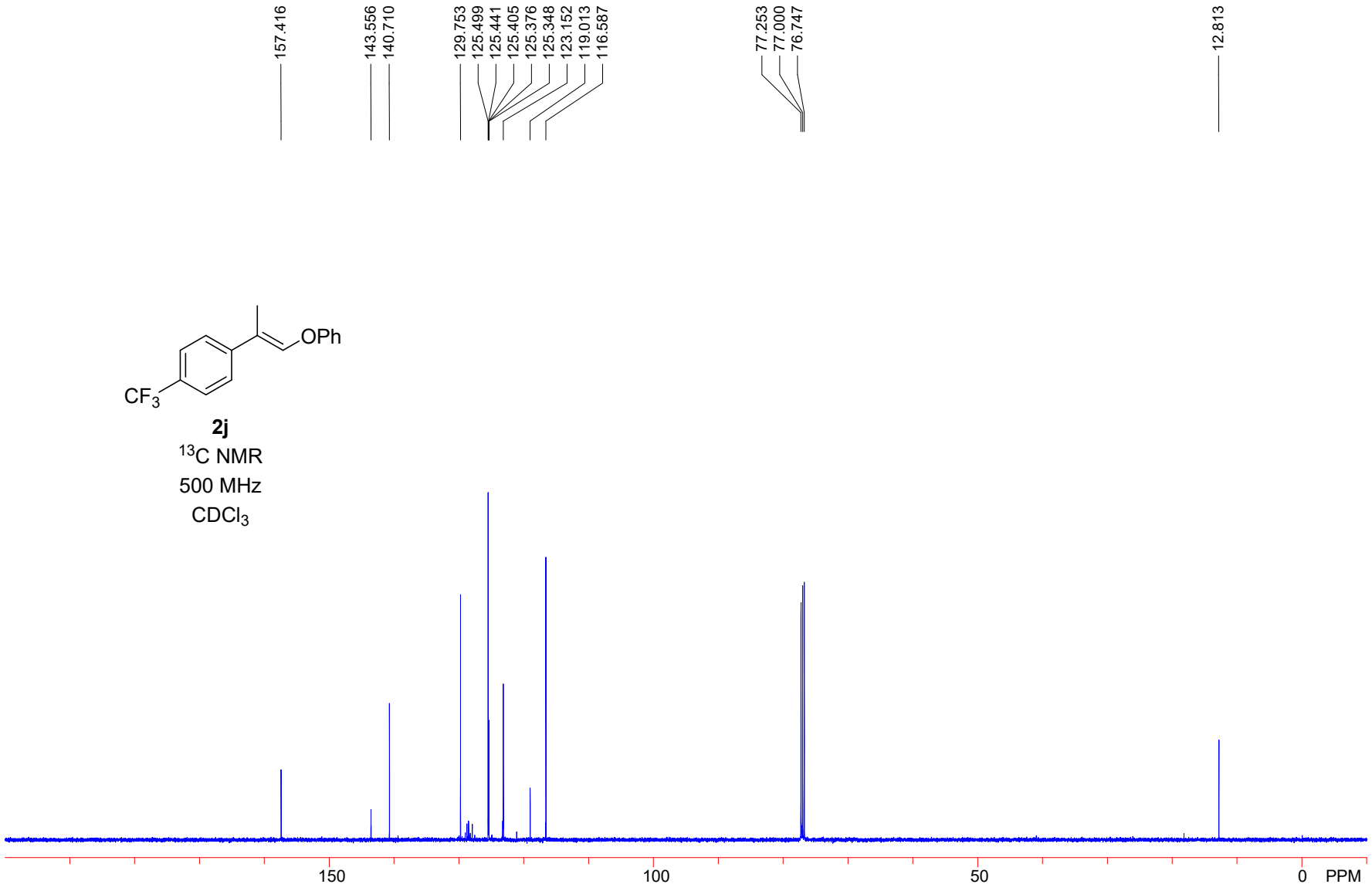
2j

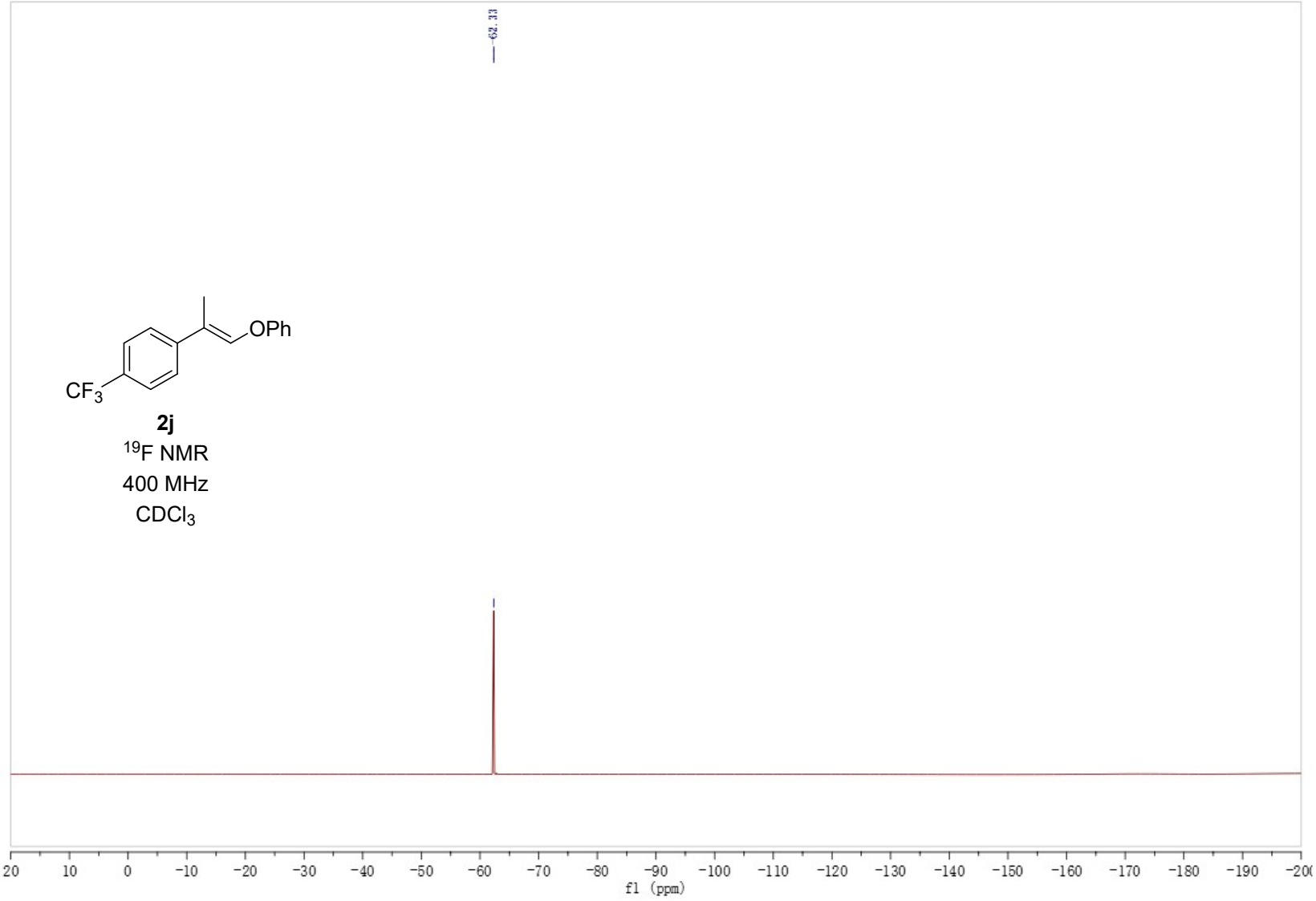
^{1}H NMR

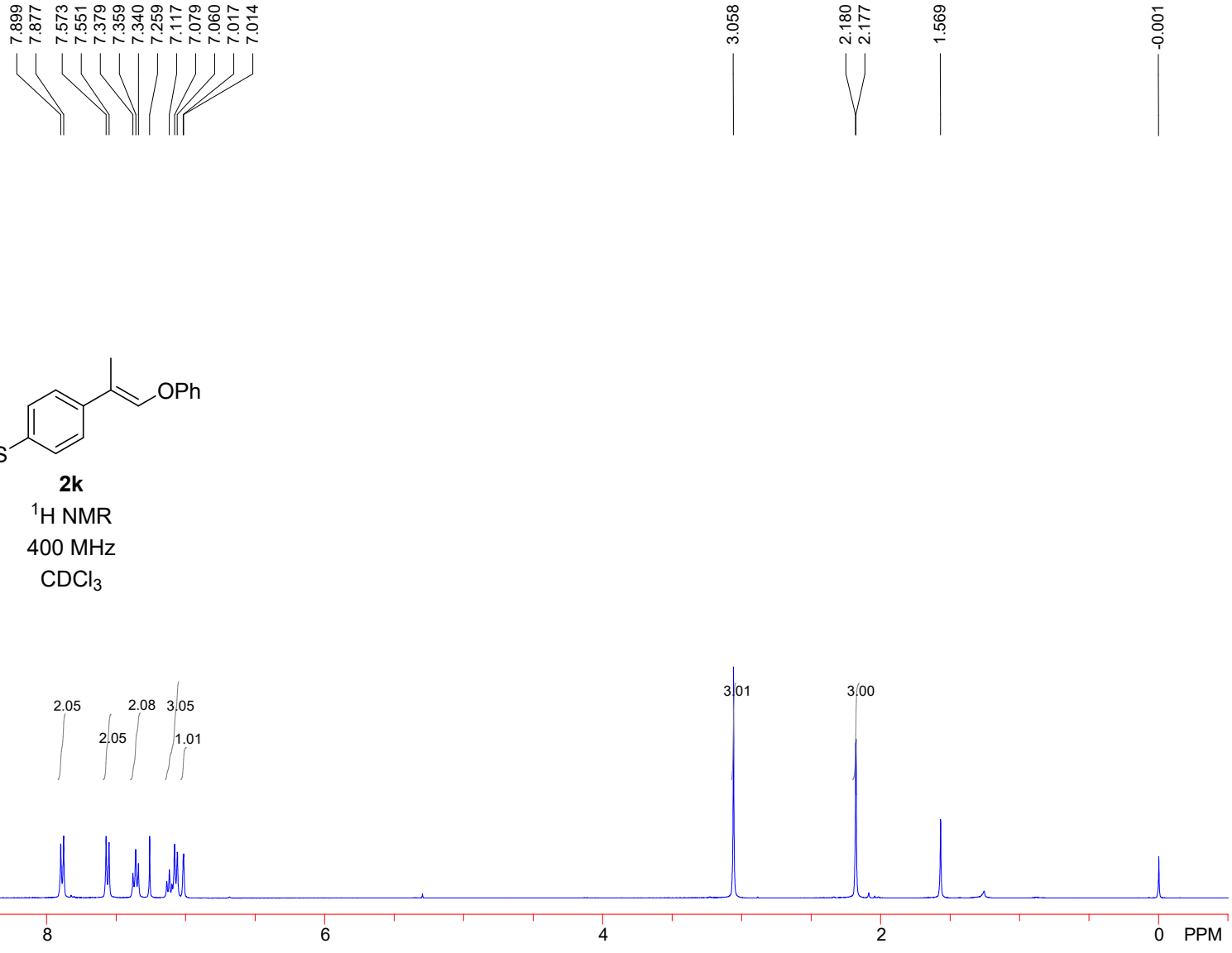
500 MHz

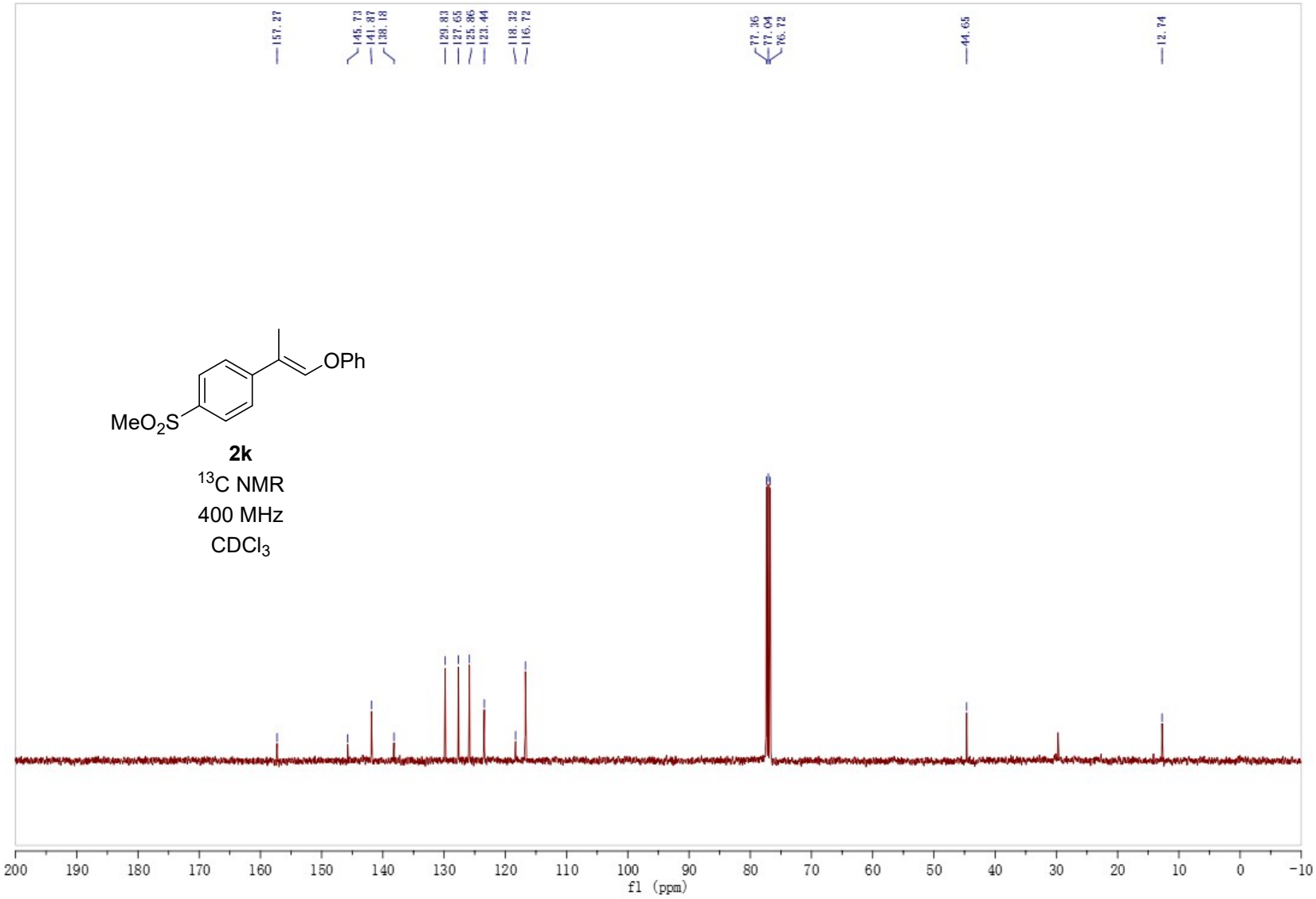
$CDCl_3$

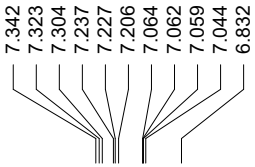


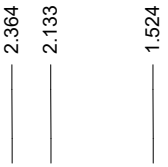

157.416
143.556
140.710
129.753
125.499
125.441
125.405
125.376
125.348
123.152
119.013
116.587
77.253
77.000
76.747
12.813
OPh
CF3
2j
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

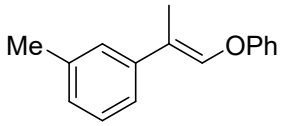

-62.33
OPh
CF3
2j
19F NMR
400 MHz
CDCl3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190
f1 (ppm)


7.899
7.877
7.573
7.551
7.379
7.359
7.340
7.259
7.117
7.079
7.060
7.017
7.014
3.058
2.180
2.177
1.569
-0.001
OPh
MeO2S
2k
1H NMR
400 MHz
CDCl3
2.05
2.05
2.08
3.05
1.01
3.01
3.00
8
6
4
2
0
PPM


157.27
145.73
141.87
138.18
129.83
127.65
125.86
123.44
118.32
116.72
77.36
77.04
76.72
44.65
12.74
OPh
MeO2S
2k
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)





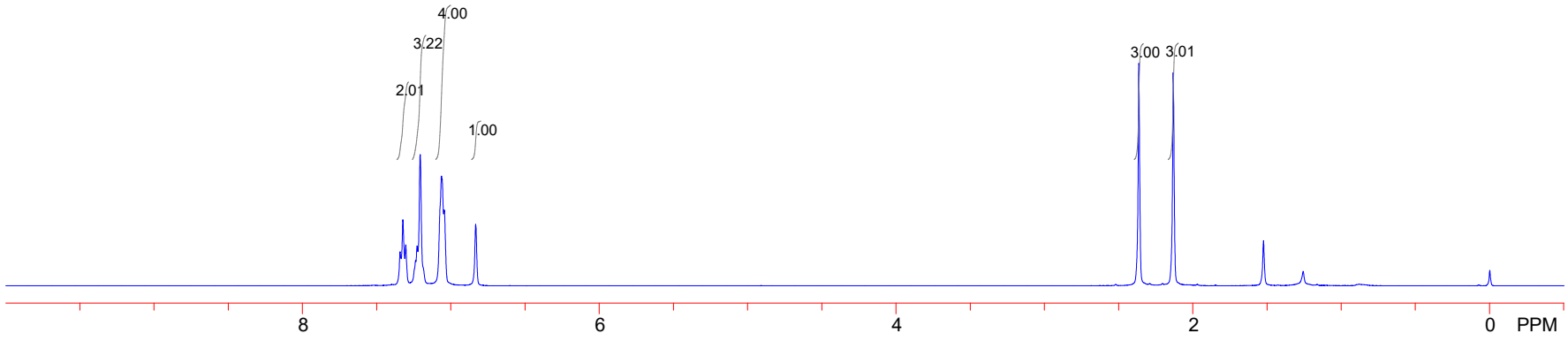


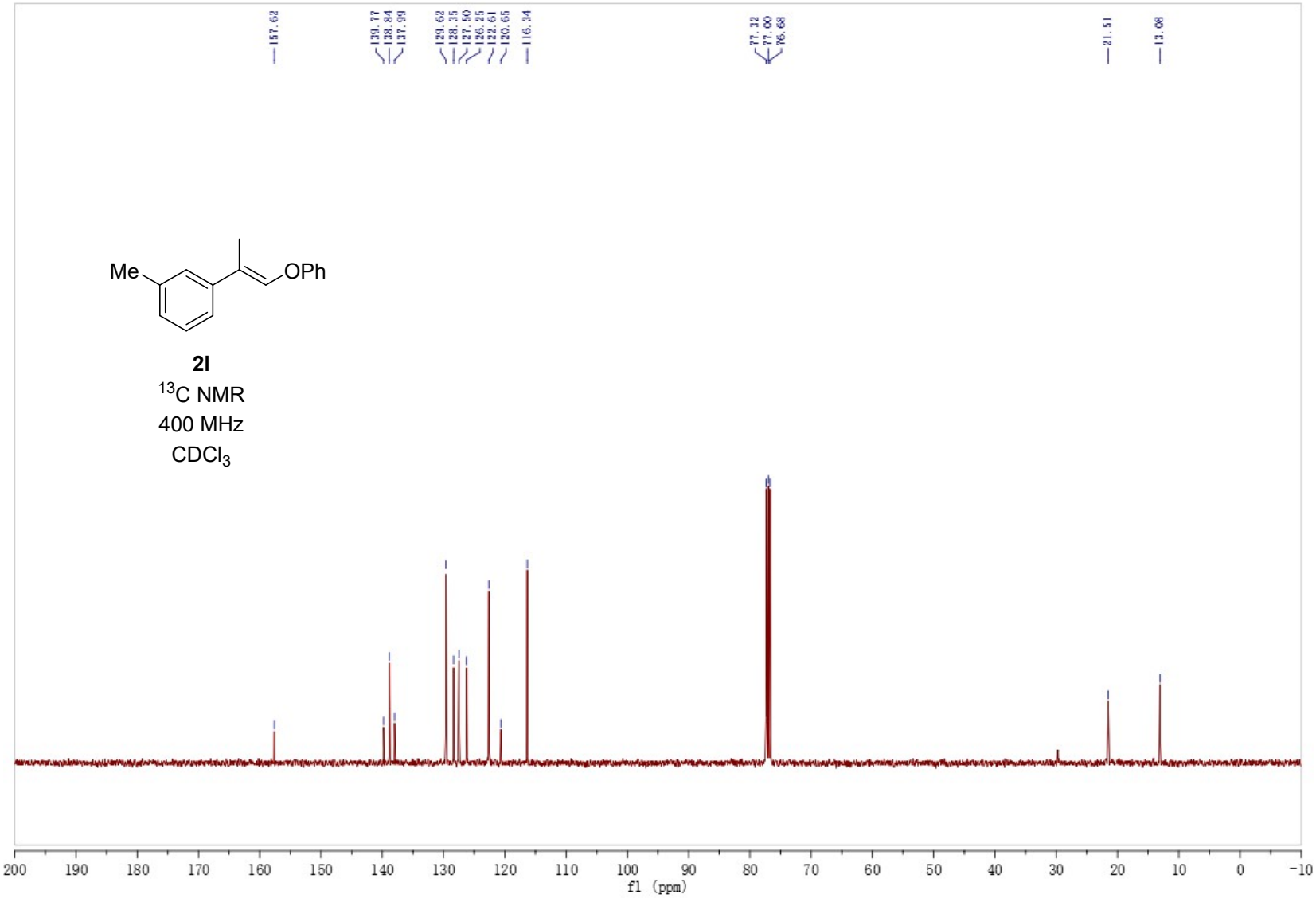
2l

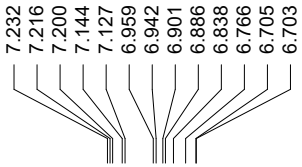
^{1}H NMR

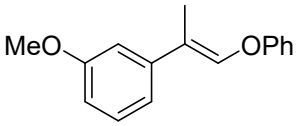
400 MHz

$CDCl_3$




157.62
139.77
138.84
137.99
129.62
128.35
127.50
126.25
122.61
120.65
116.34
77.32
77.00
76.68
21.51
13.08
Me
OPh
2l
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



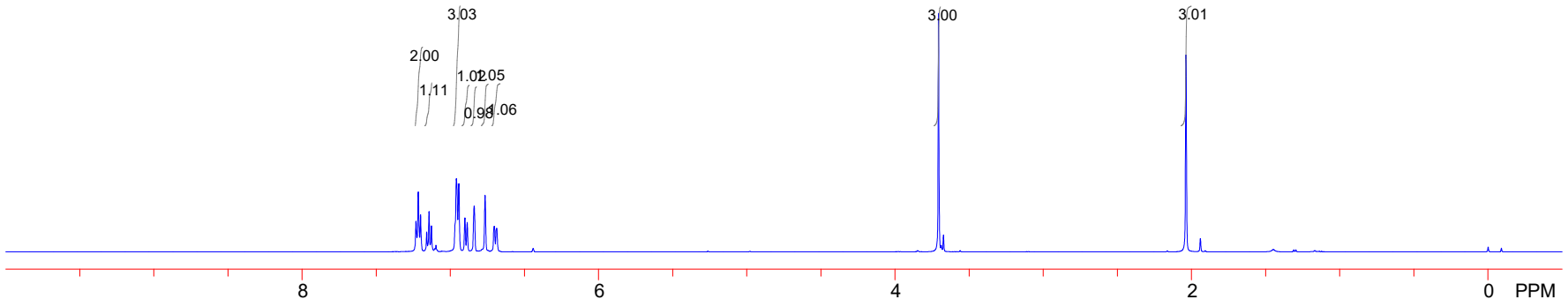


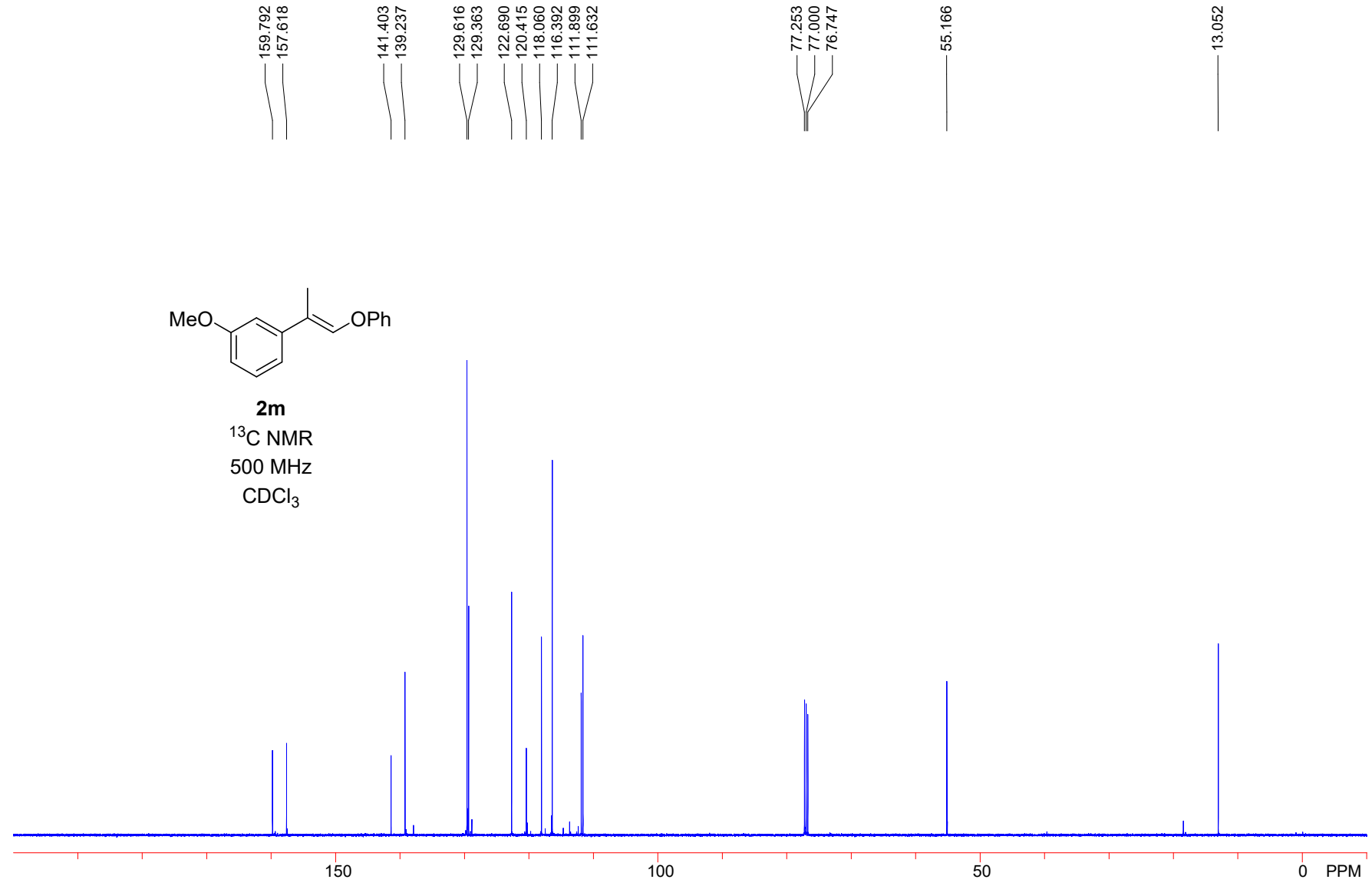
2m

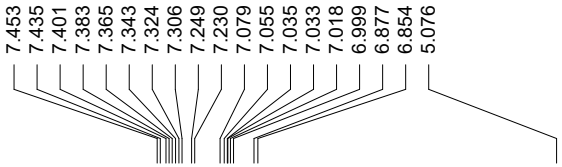
^{1}H NMR

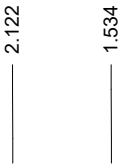
500 MHz

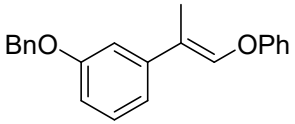
$CDCl_3$




159.792
157.618
141.403
139.237
129.616
129.363
122.690
120.415
118.060
116.392
111.899
111.632
77.253
77.000
76.747
55.166
13.052
MeO
OPh
2m
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM





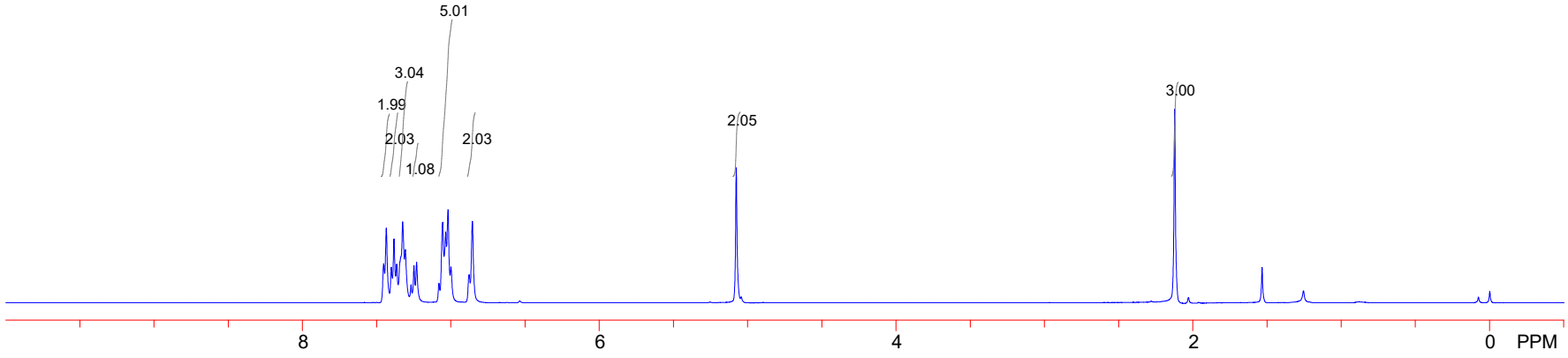


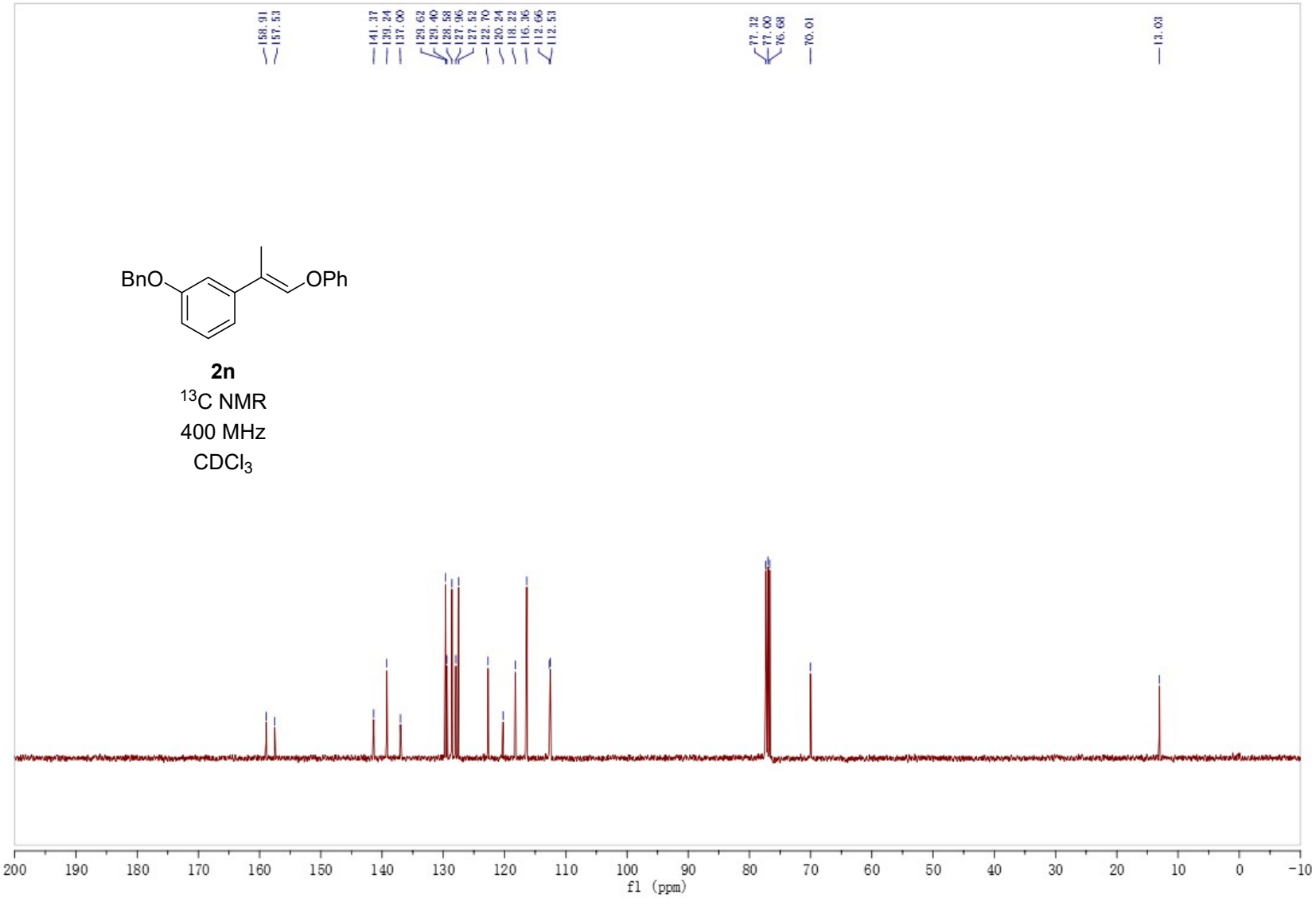
2n

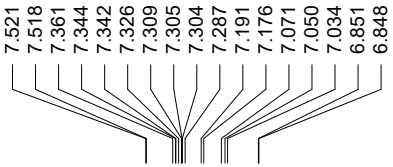
^{1}H NMR

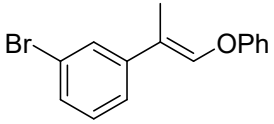
400 MHz

$CDCl_3$




158.91
157.53
141.37
139.24
137.00
129.62
129.40
128.58
127.96
127.52
122.70
120.24
118.22
116.36
112.66
112.53
77.32
77.00
76.68
70.01
13.03
BnO
OPh
2n
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



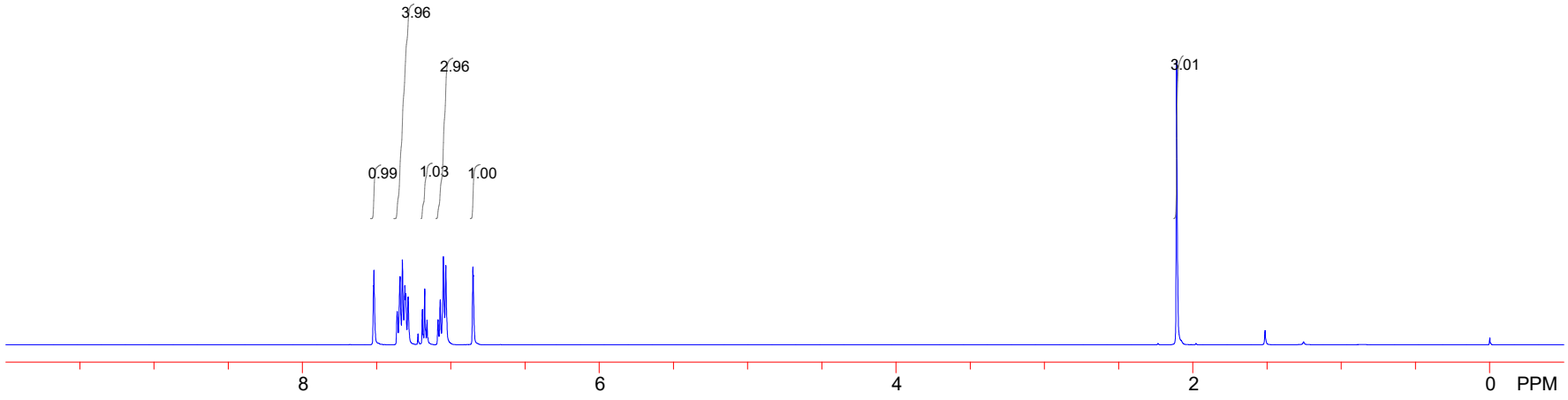


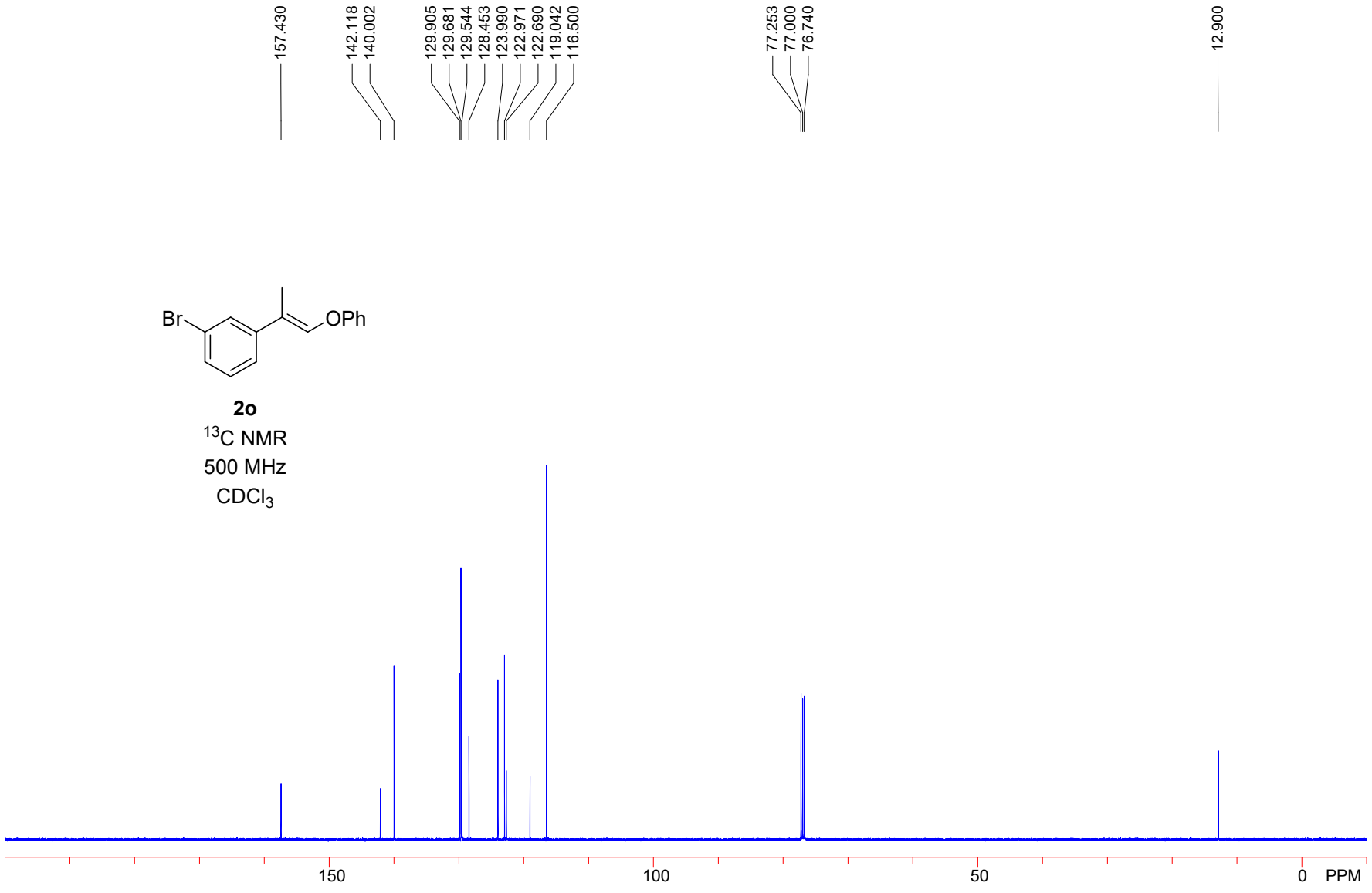
2o

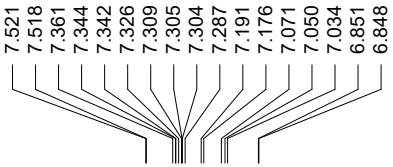
^{1}H NMR

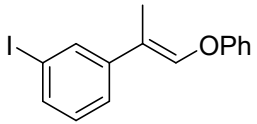
500 MHz

$CDCl_3$




157.430
142.118
140.002
129.905
129.681
129.544
128.453
123.990
122.971
122.690
119.042
116.500
77.253
77.000
76.740
12.900
Br
OPh
2o
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM



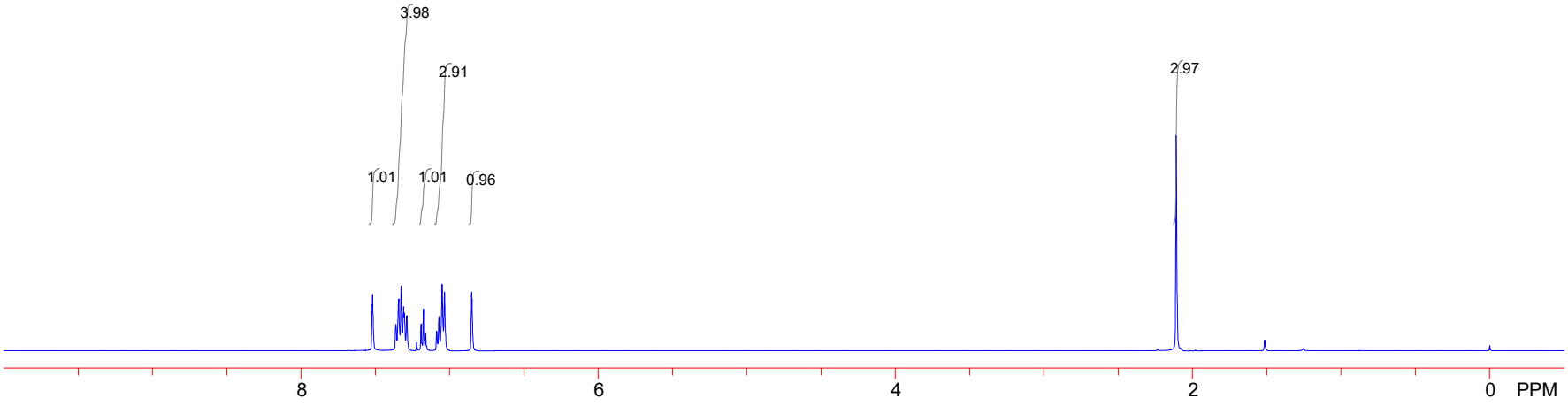


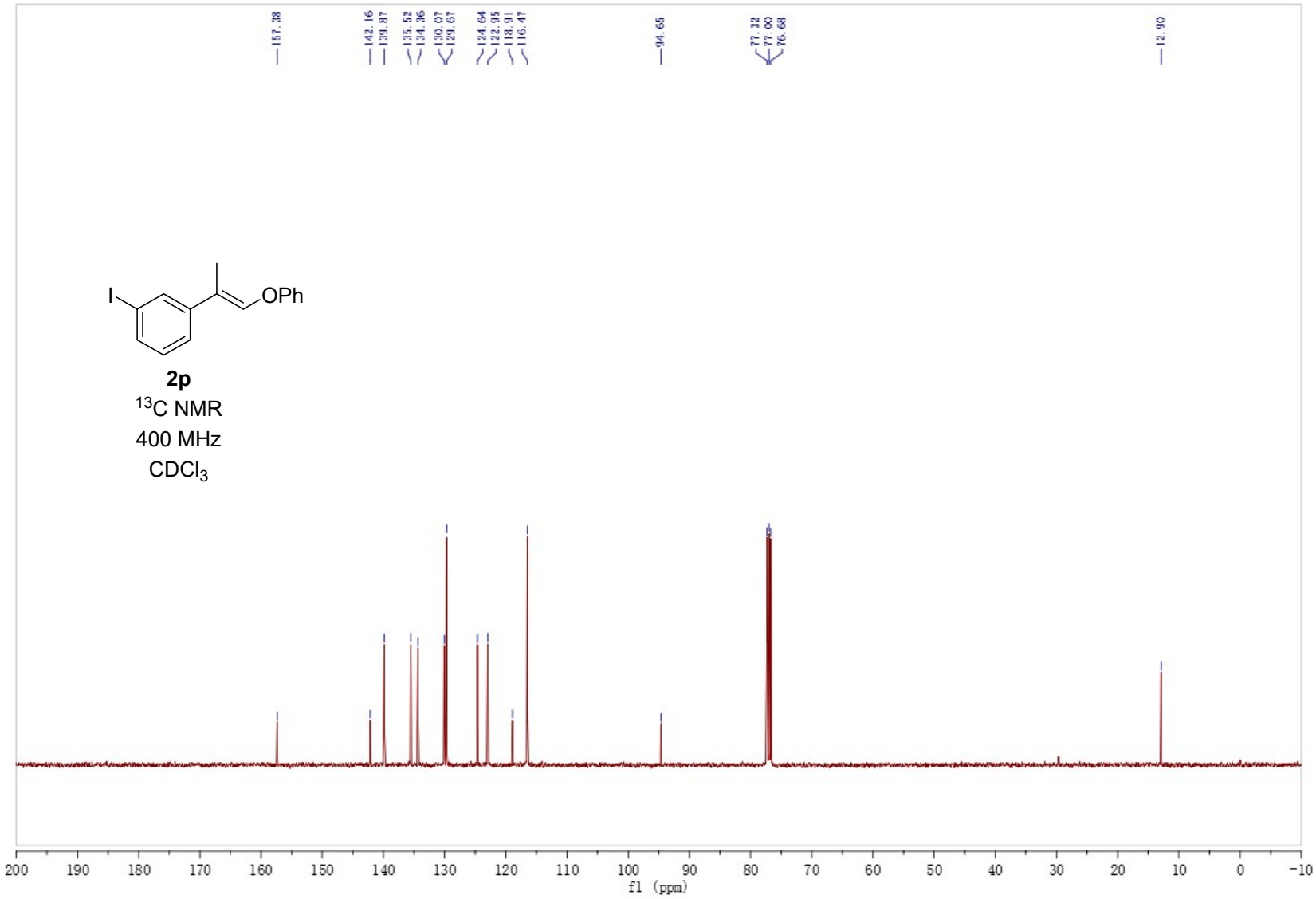
2p

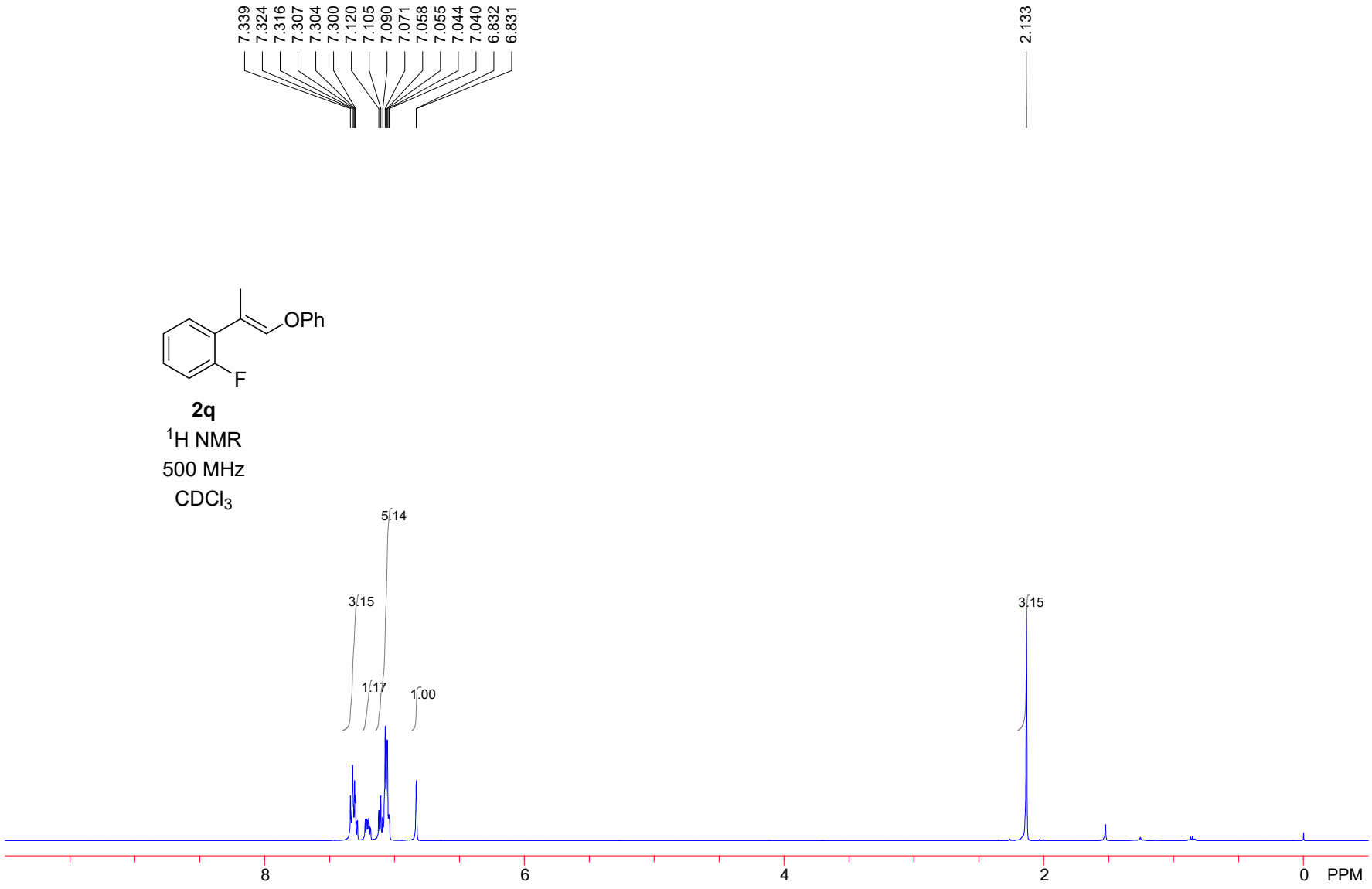
^{1}H NMR

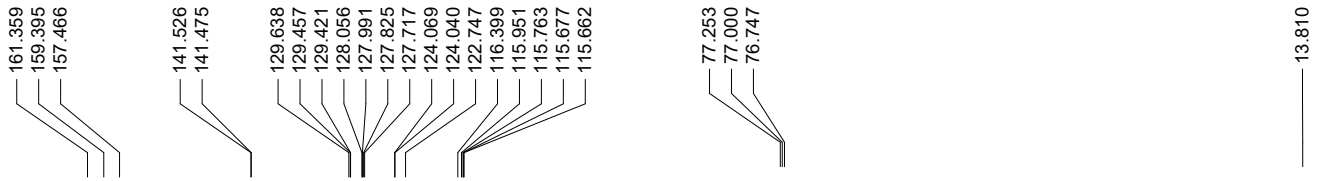
500 MHz

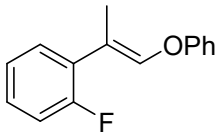
$CDCl_3$




157.38
142.16
139.87
135.52
134.36
130.07
129.67
124.64
122.95
118.91
116.47
94.65
77.32
77.00
76.68
12.90
I
OPh
2p
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.339
7.324
7.316
7.307
7.304
7.300
7.120
7.105
7.090
7.071
7.058
7.055
7.044
7.040
6.832
6.831
2.133
OPh
F
2q
1H NMR
500 MHz
CDCl3
5.14
3.15
1.17
1.00
3.15
8
6
4
2
0
PPM



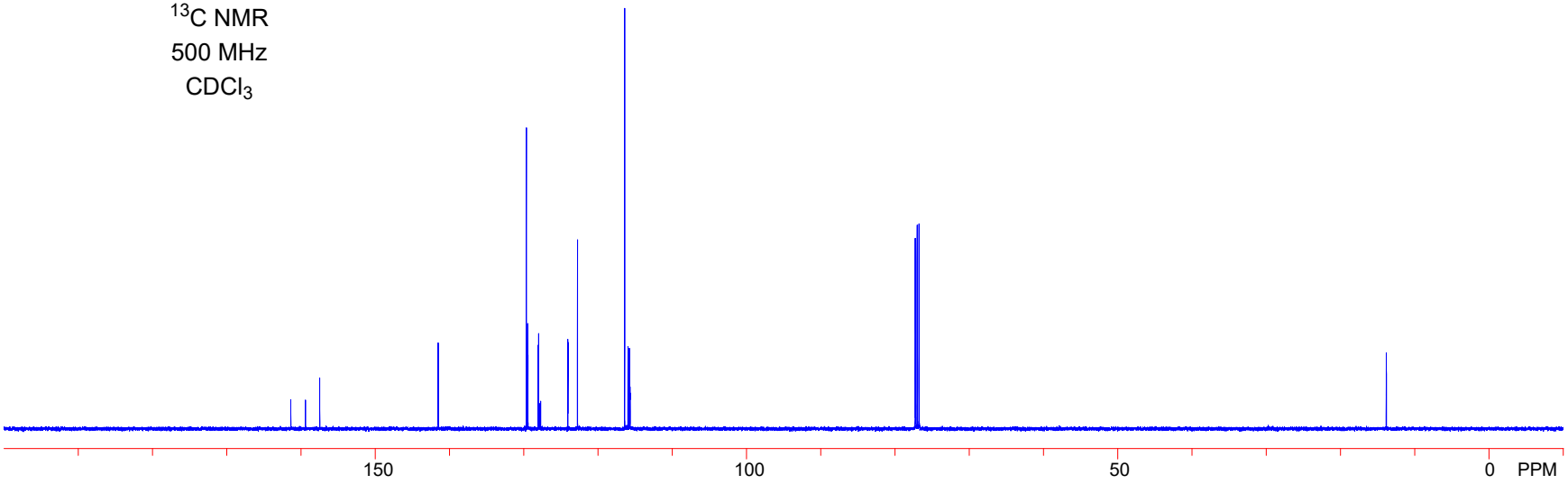


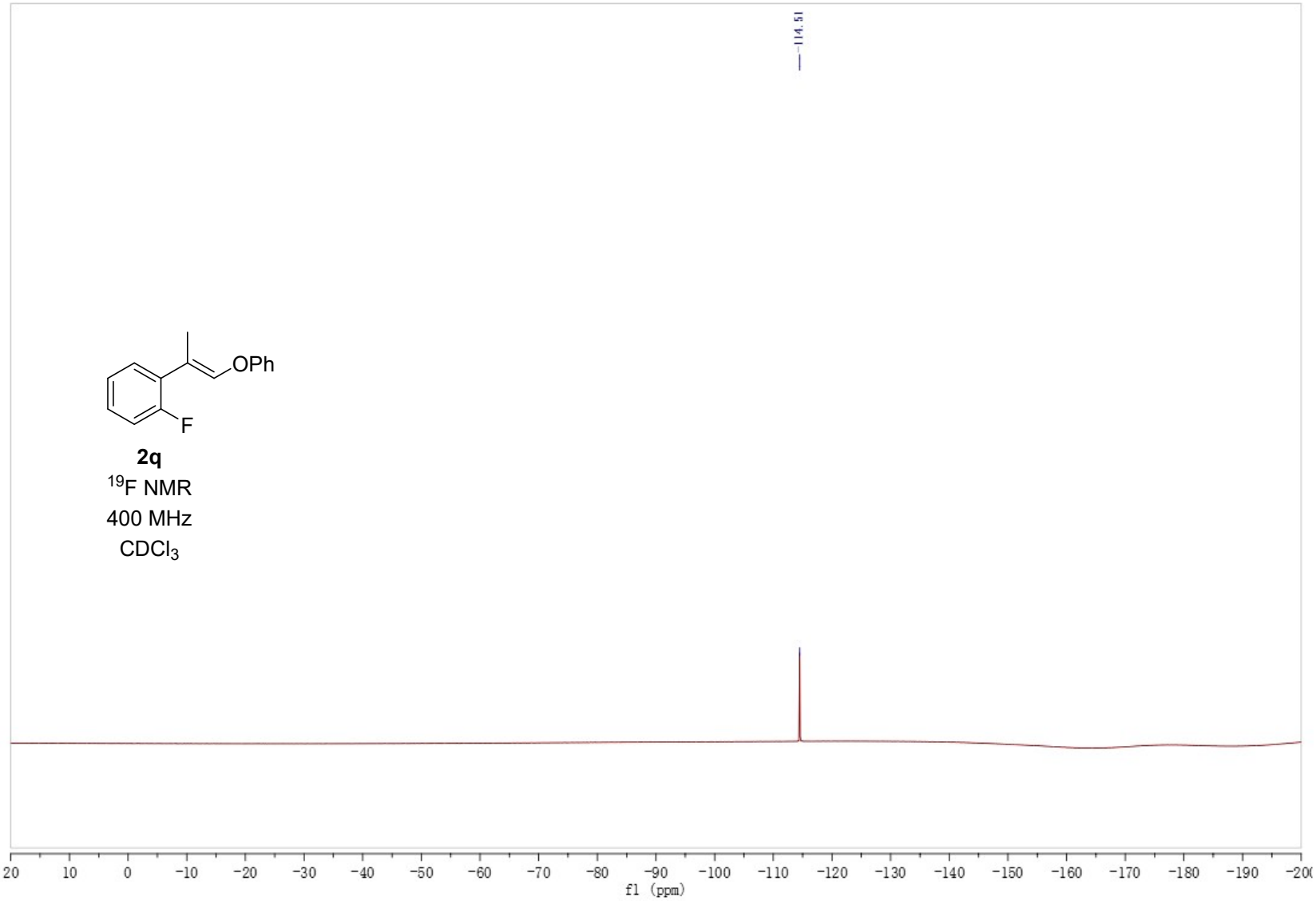
2q

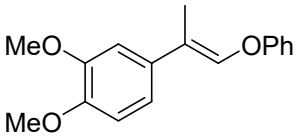
^{13}C NMR

500 MHz

$CDCl_3$




-114.51
OPh
F
2q
19F NMR
400 MHz
CDCl3
20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200
f1 (ppm)

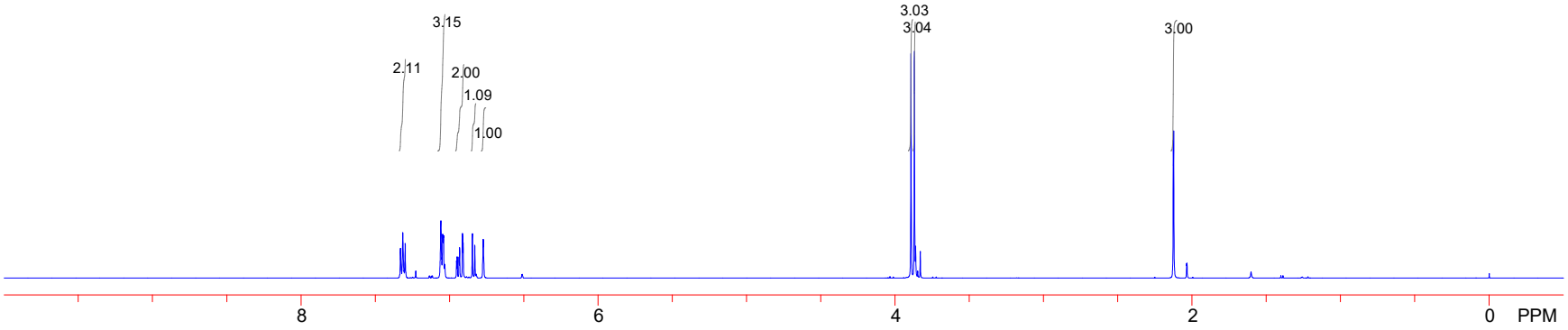


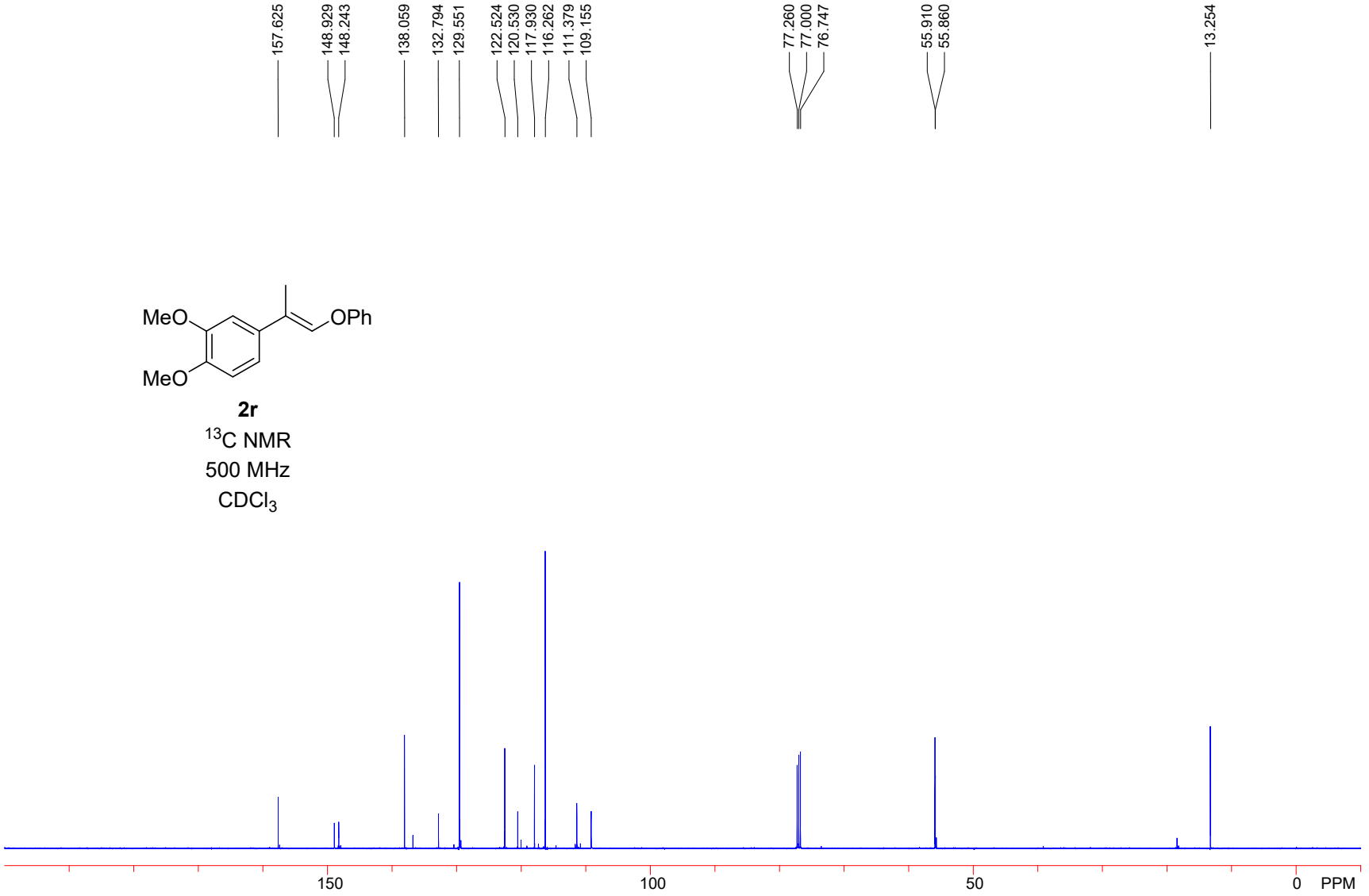
2r

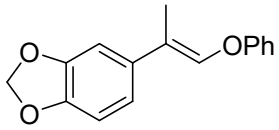
^{1}H NMR

500 MHz

$CDCl_3$




157.625
148.929
148.243
138.059
132.794
129.551
122.524
120.530
117.930
116.262
111.379
109.155
77.260
77.000
76.747
55.910
55.860
13.254
MeO
MeO
OPh
2r
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

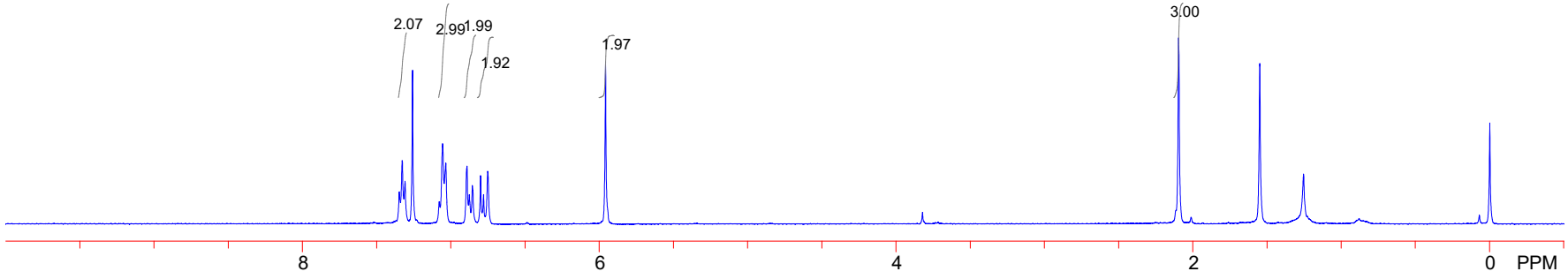


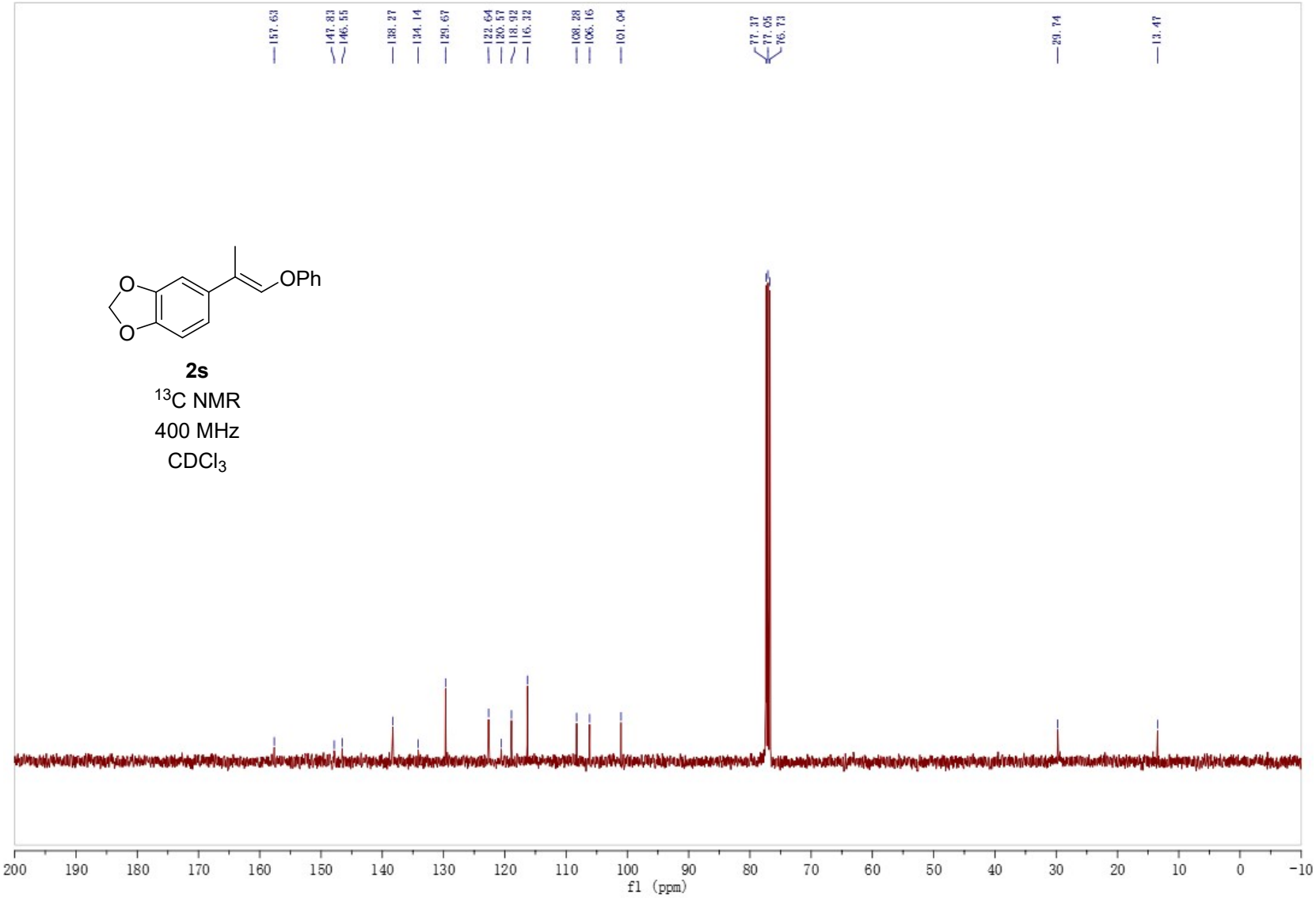
2s

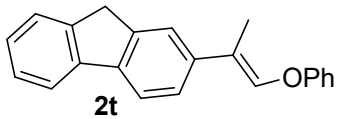
^{1}H NMR

400 MHz

$CDCl_3$




157.63
147.83
146.55
138.27
134.14
129.67
122.64
120.57
118.92
116.32
108.28
106.16
101.04
77.37
77.05
76.73
29.74
13.47
OPh
O
O
2s
13C NMR
400 MHz
CDCl3
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

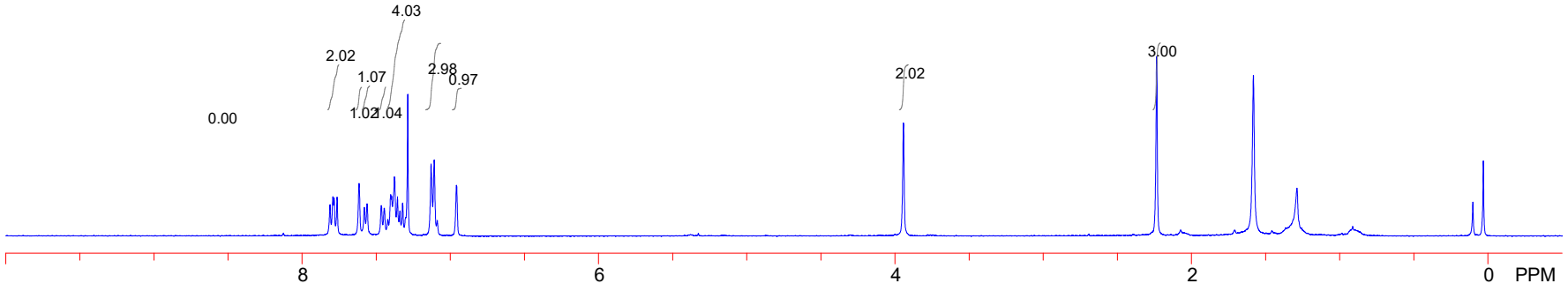


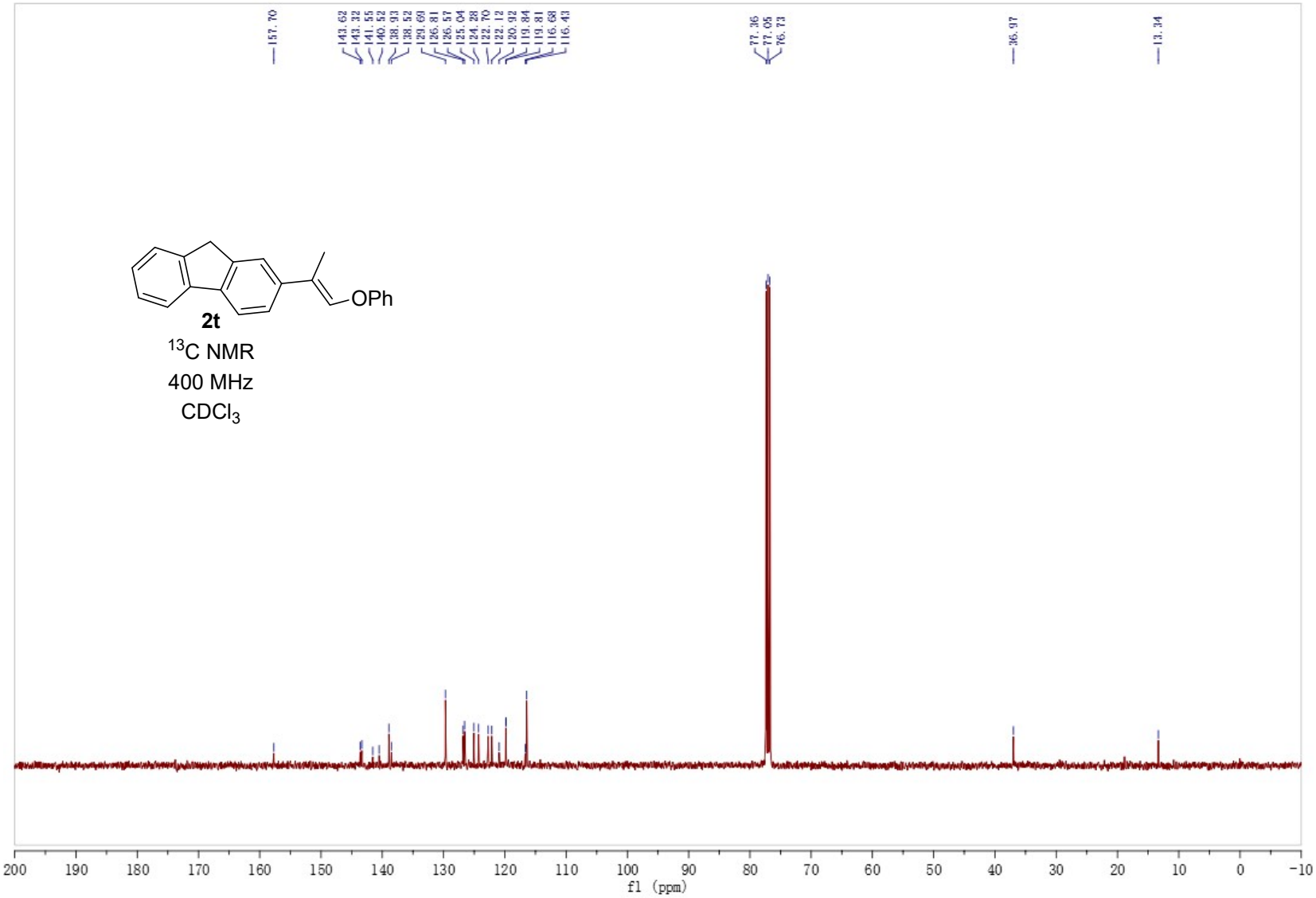
2t

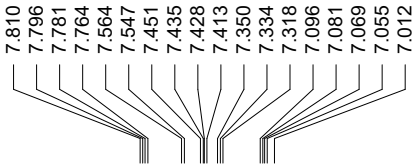
^{1}H NMR

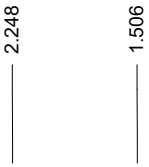
400 MHz

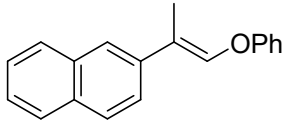
$CDCl_3$




157.70
143.62
143.32
141.55
140.52
138.93
138.52
129.69
126.81
126.57
125.04
124.28
122.70
122.12
120.92
119.84
119.81
116.68
116.43
77.36
77.05
76.73
36.97
13.34
OPh
2t
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)





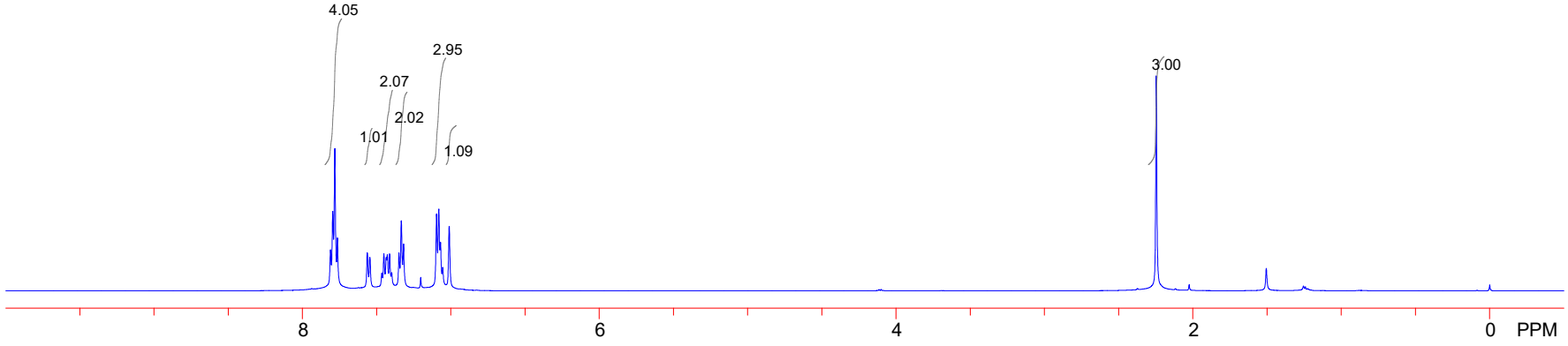


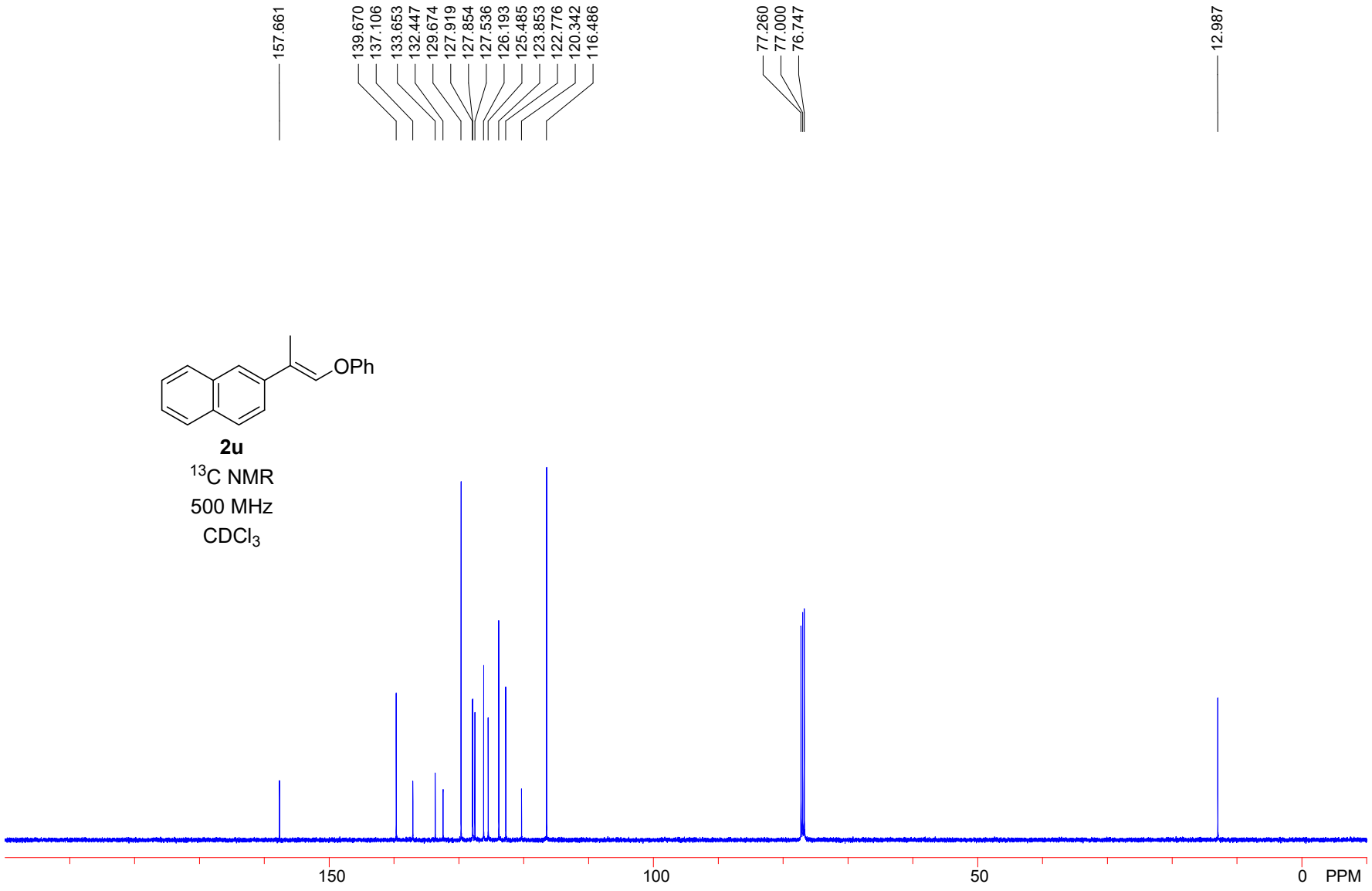
2u

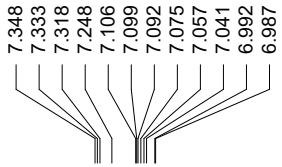
^{1}H NMR

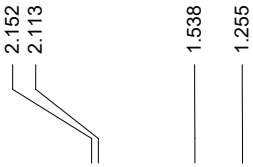
500 MHz

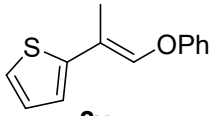
$CDCl_3$




157.661
139.670
137.106
133.653
132.447
129.674
127.919
127.854
127.536
126.193
125.485
123.853
122.776
120.342
116.486
77.260
77.000
76.747
12.987
OPh
2u
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM





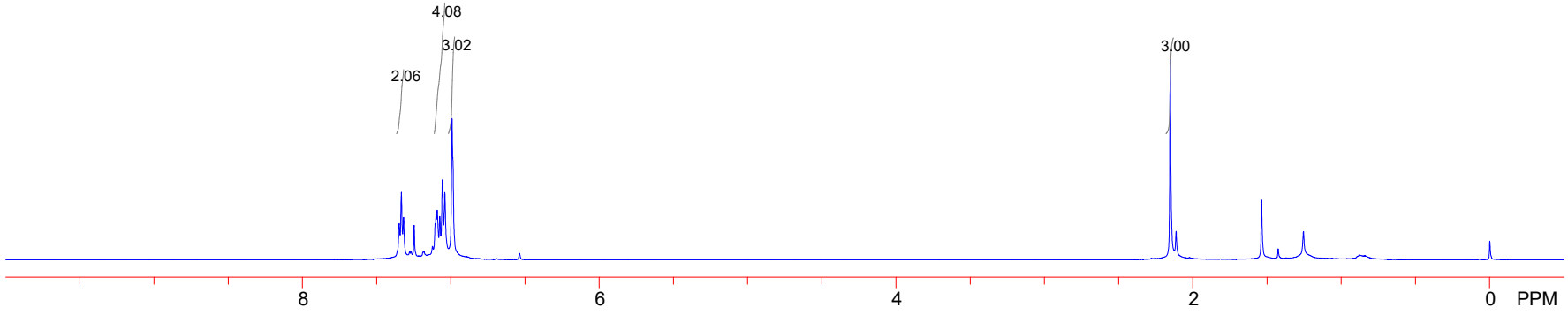


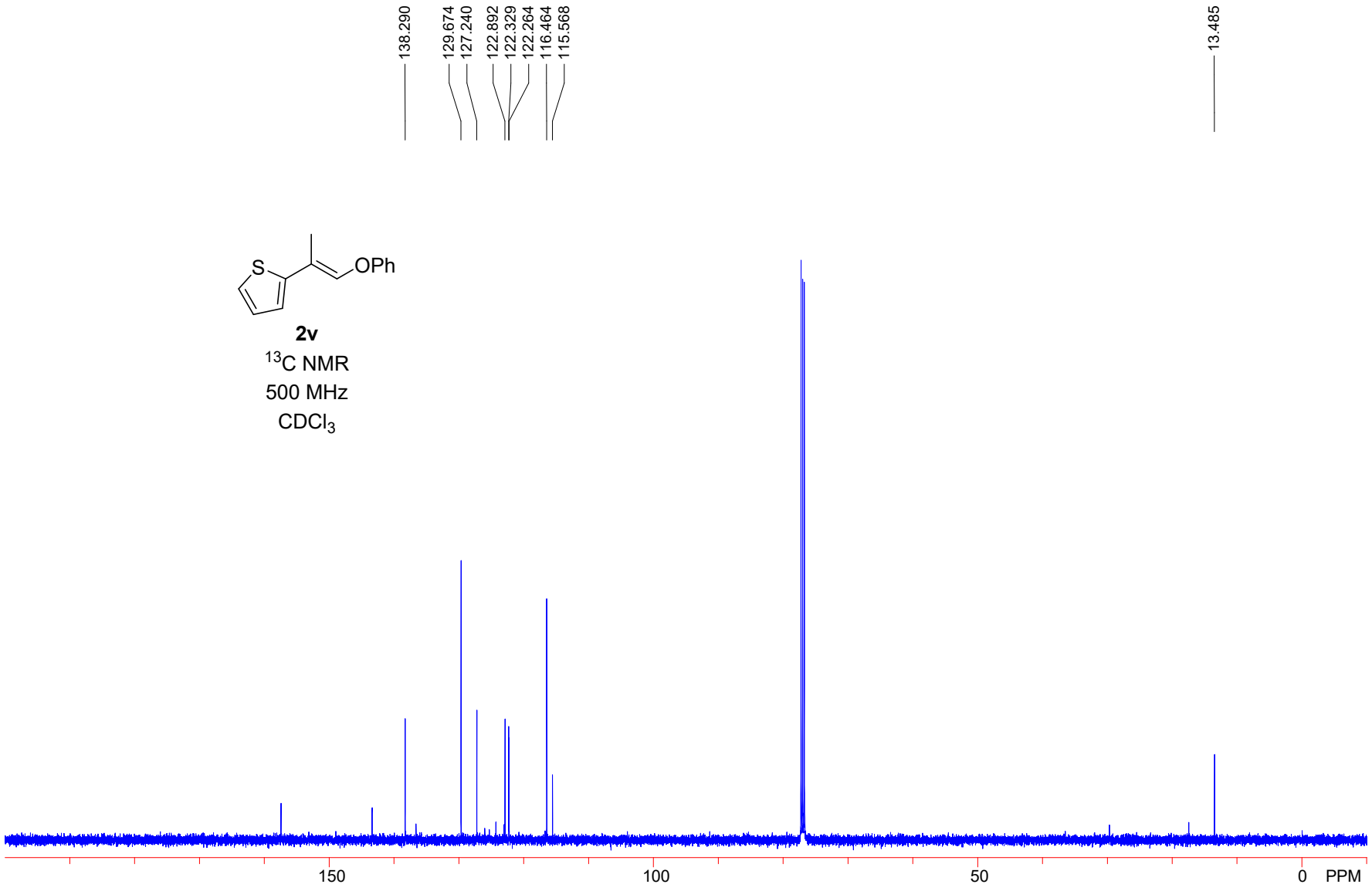
2v

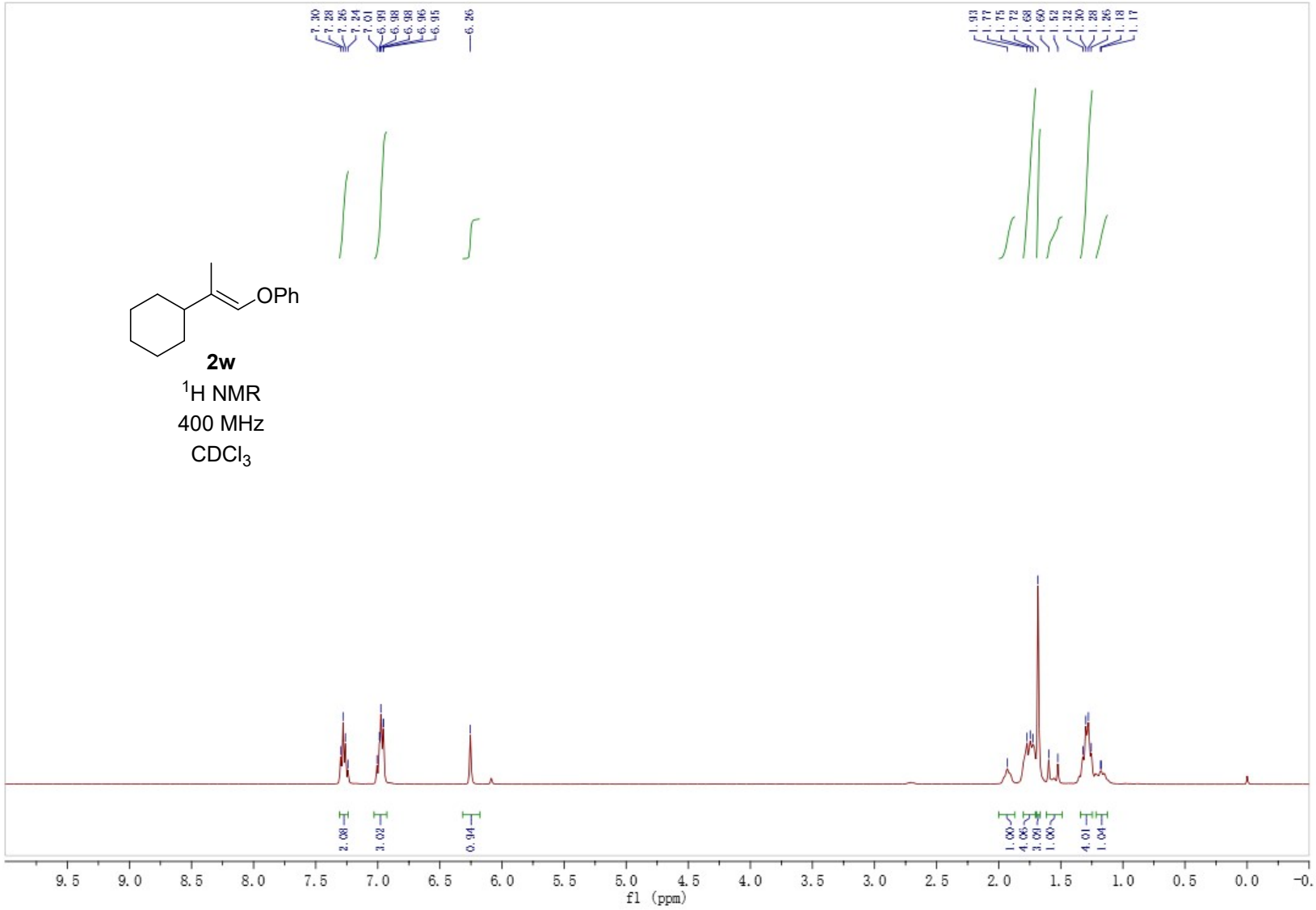
^{1}H NMR

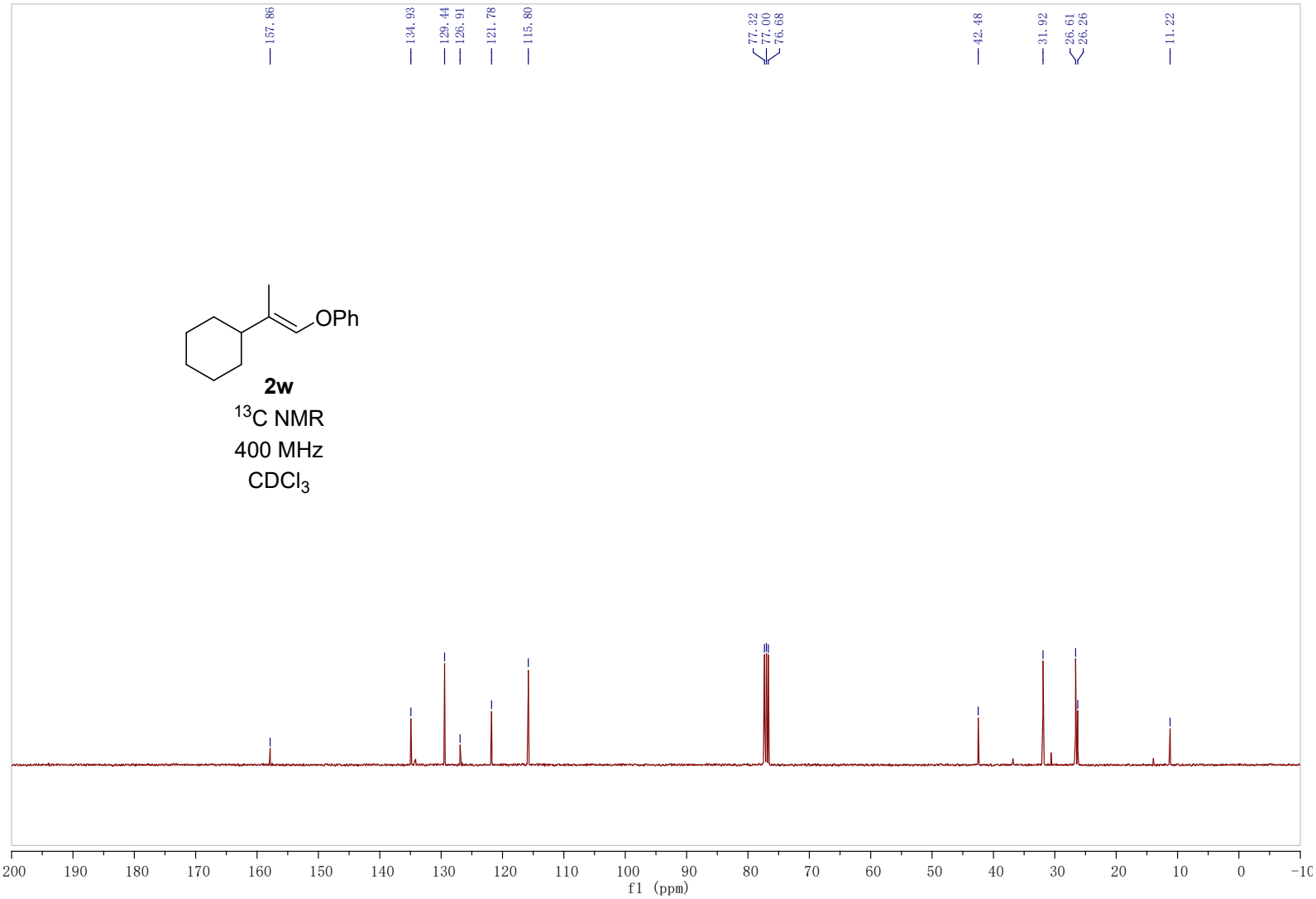
500 MHz

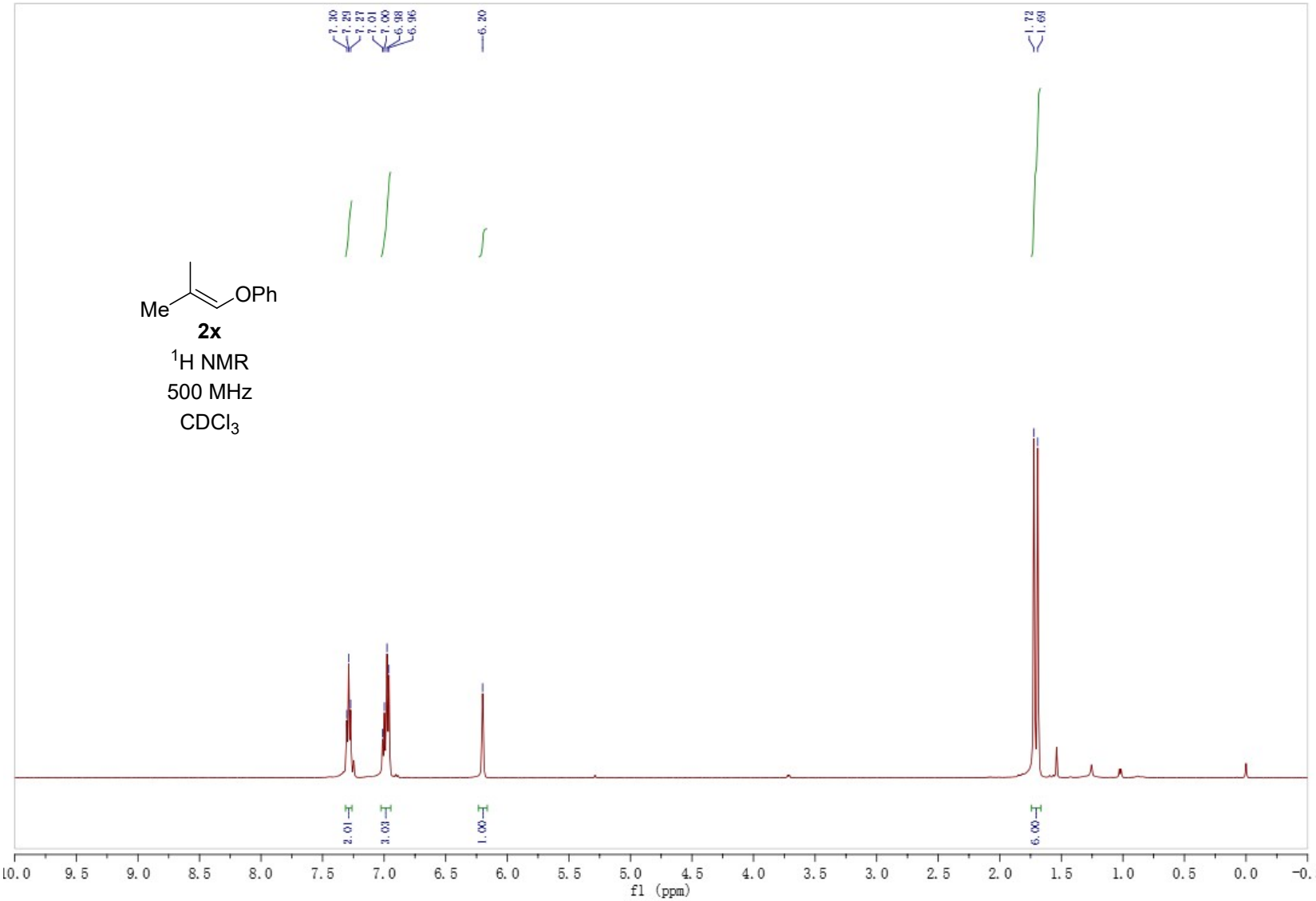
$CDCl_3$

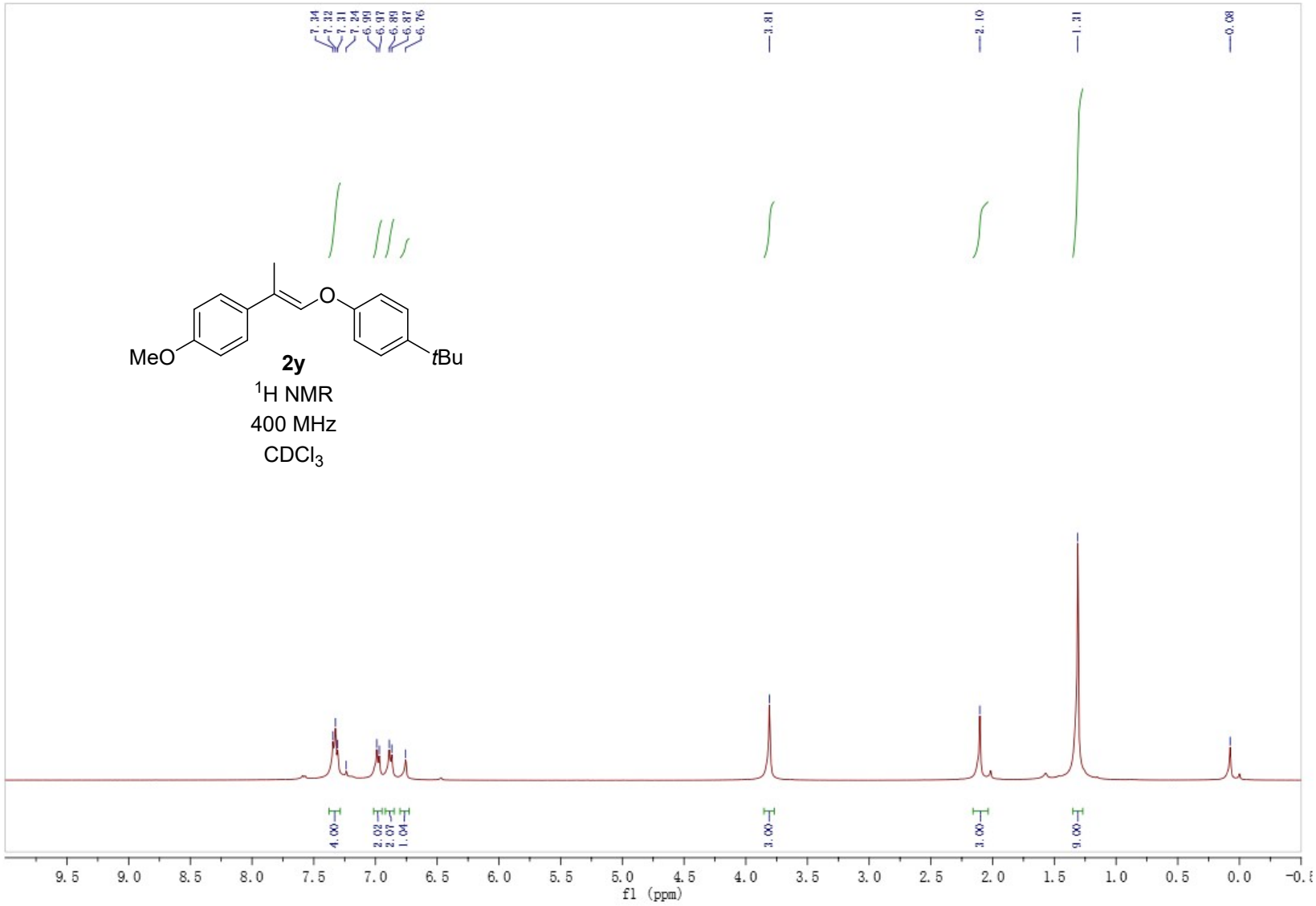


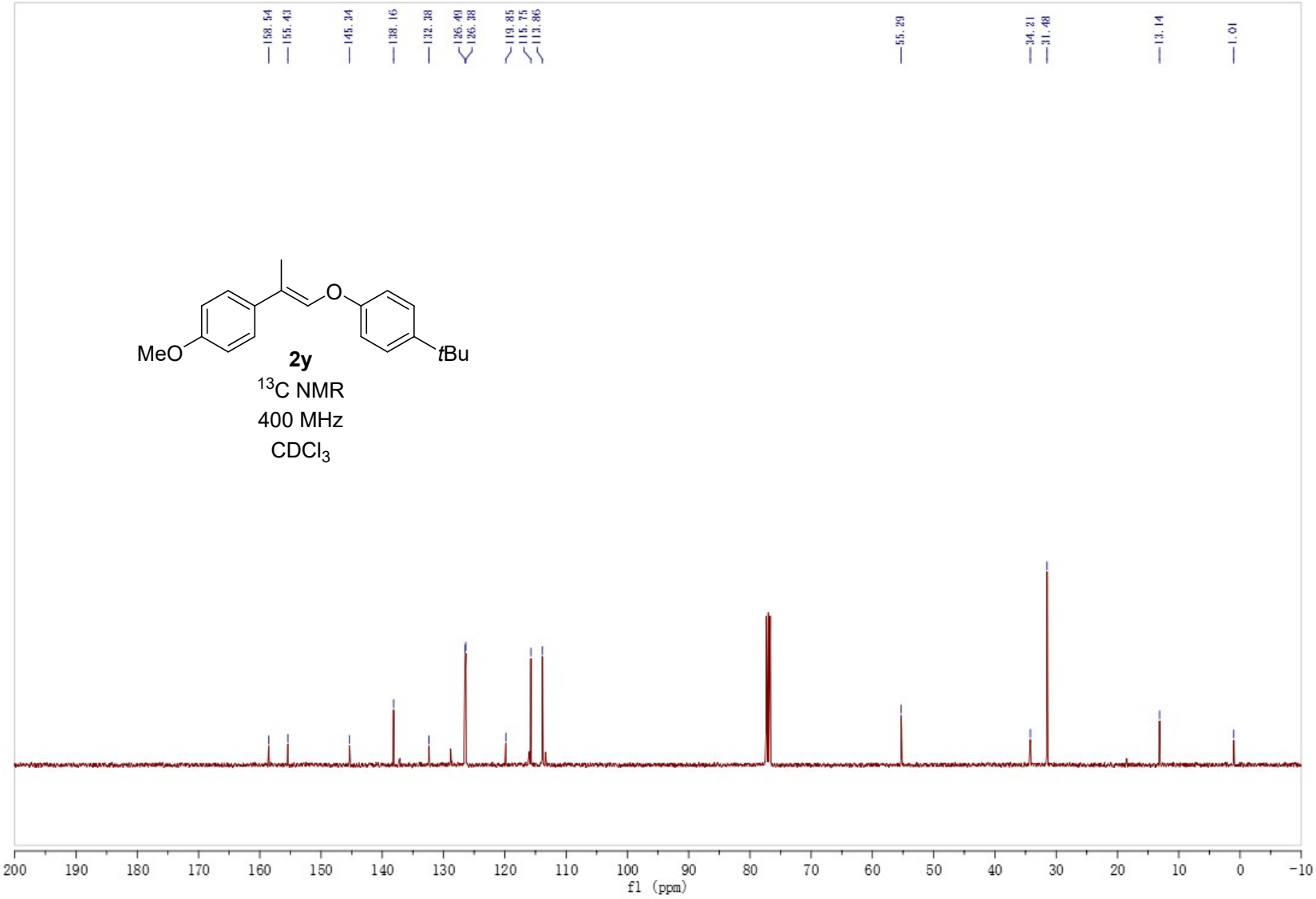

138.290
129.674
127.240
122.892
122.329
122.264
116.464
115.568
13.485
S
OPh
2v
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM

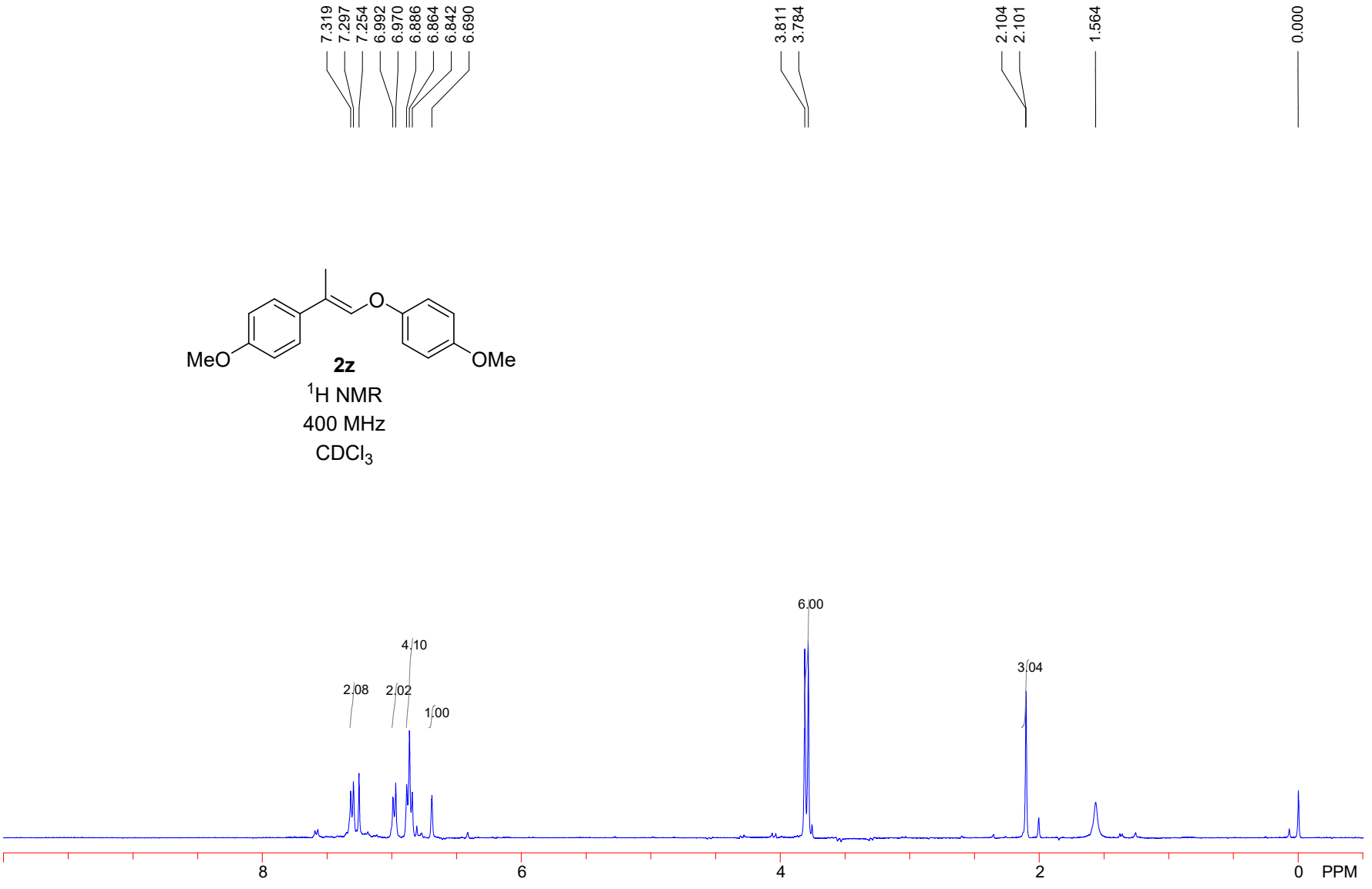

OPh
2w
1H NMR
400 MHz
CDCl3
f1 (ppm)

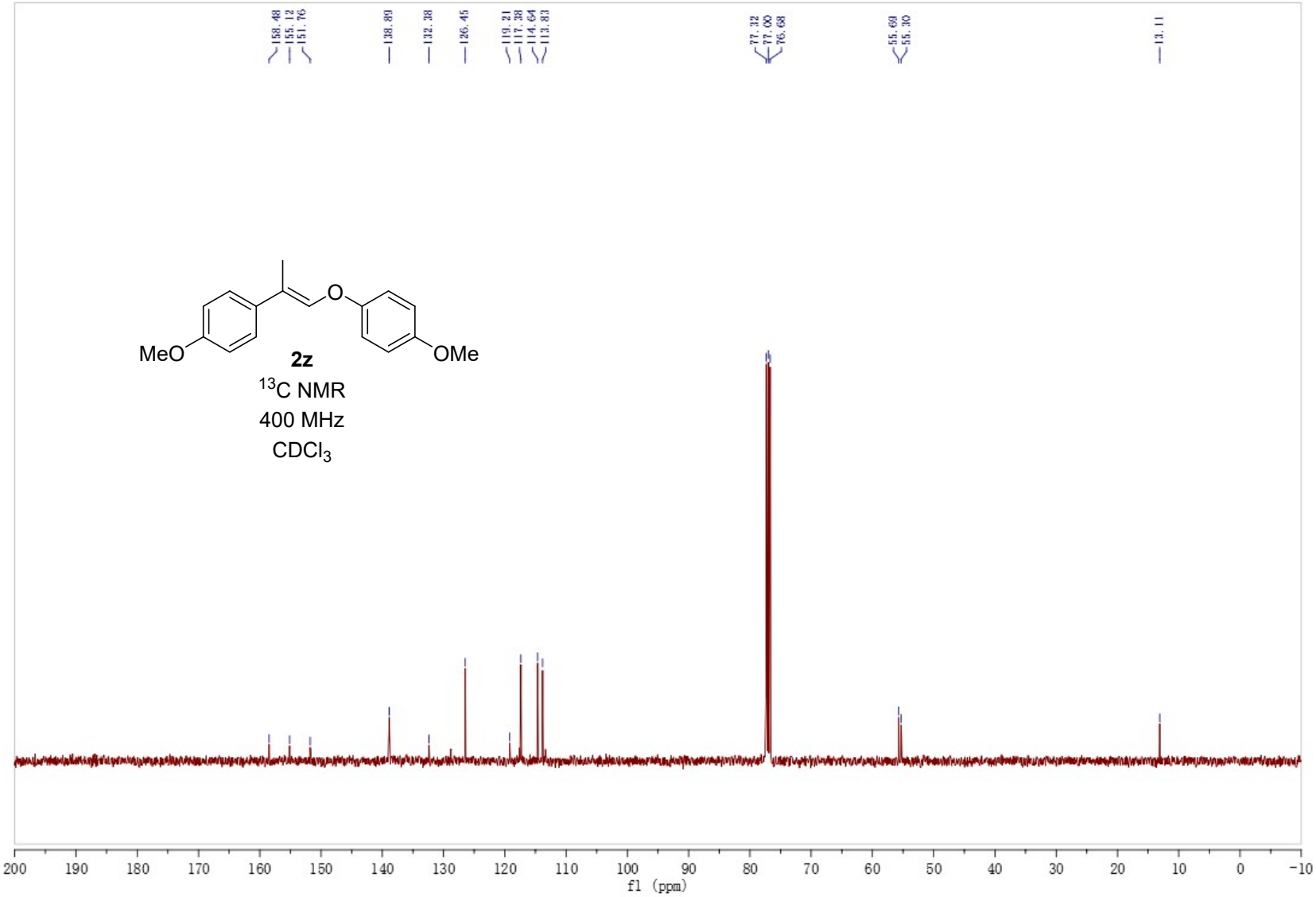

157.86
134.93
129.44
126.91
121.78
115.80
77.32
77.00
76.68
42.48
31.92
26.61
26.26
11.22
OPh
2w
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

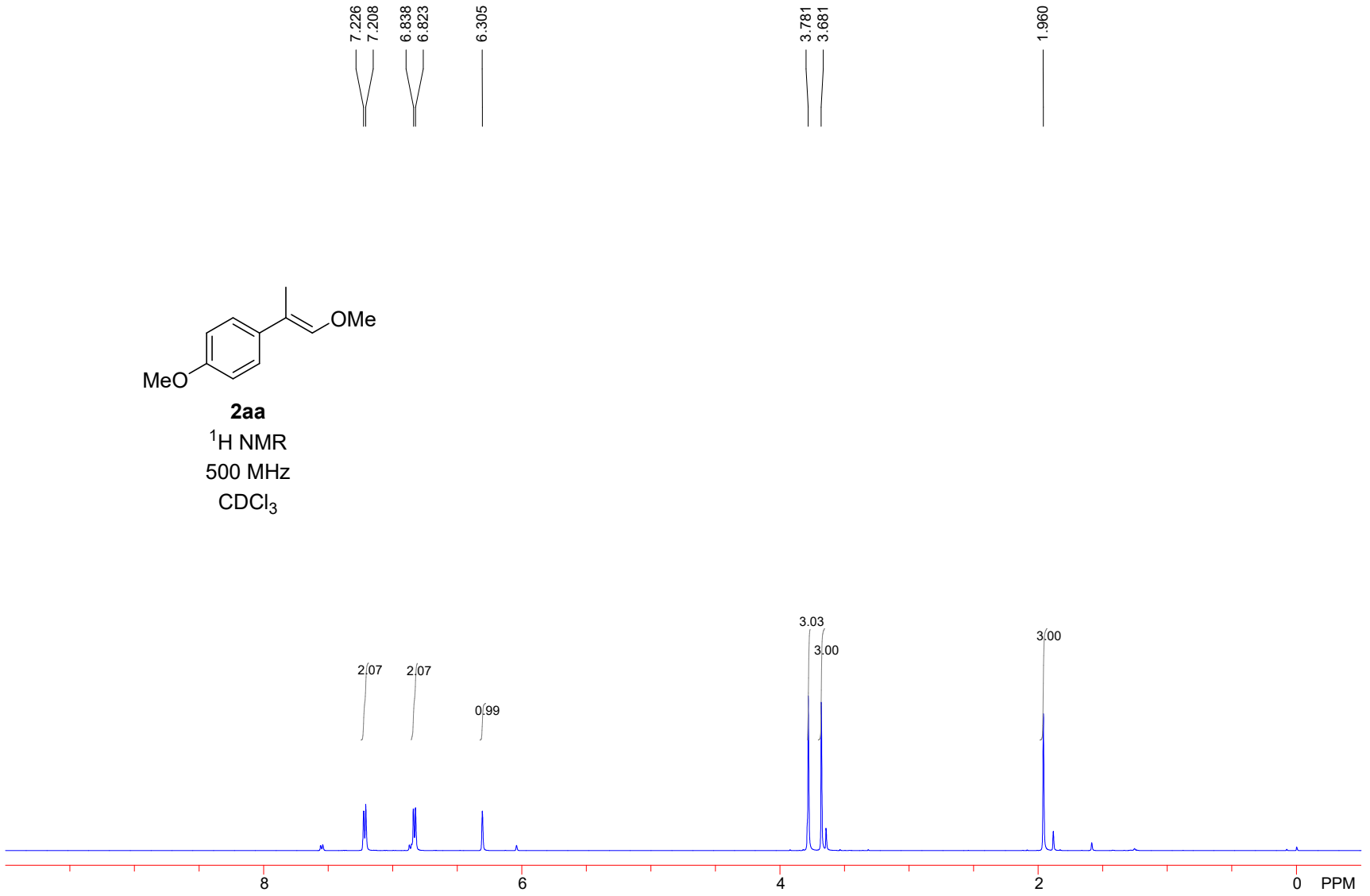

Me
OPh
2x
1H NMR
500 MHz
CDCl3
7.30
7.29
7.27
7.01
7.00
6.98
6.96
6.80
1.72
1.69
2.01
3.03
1.00
6.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

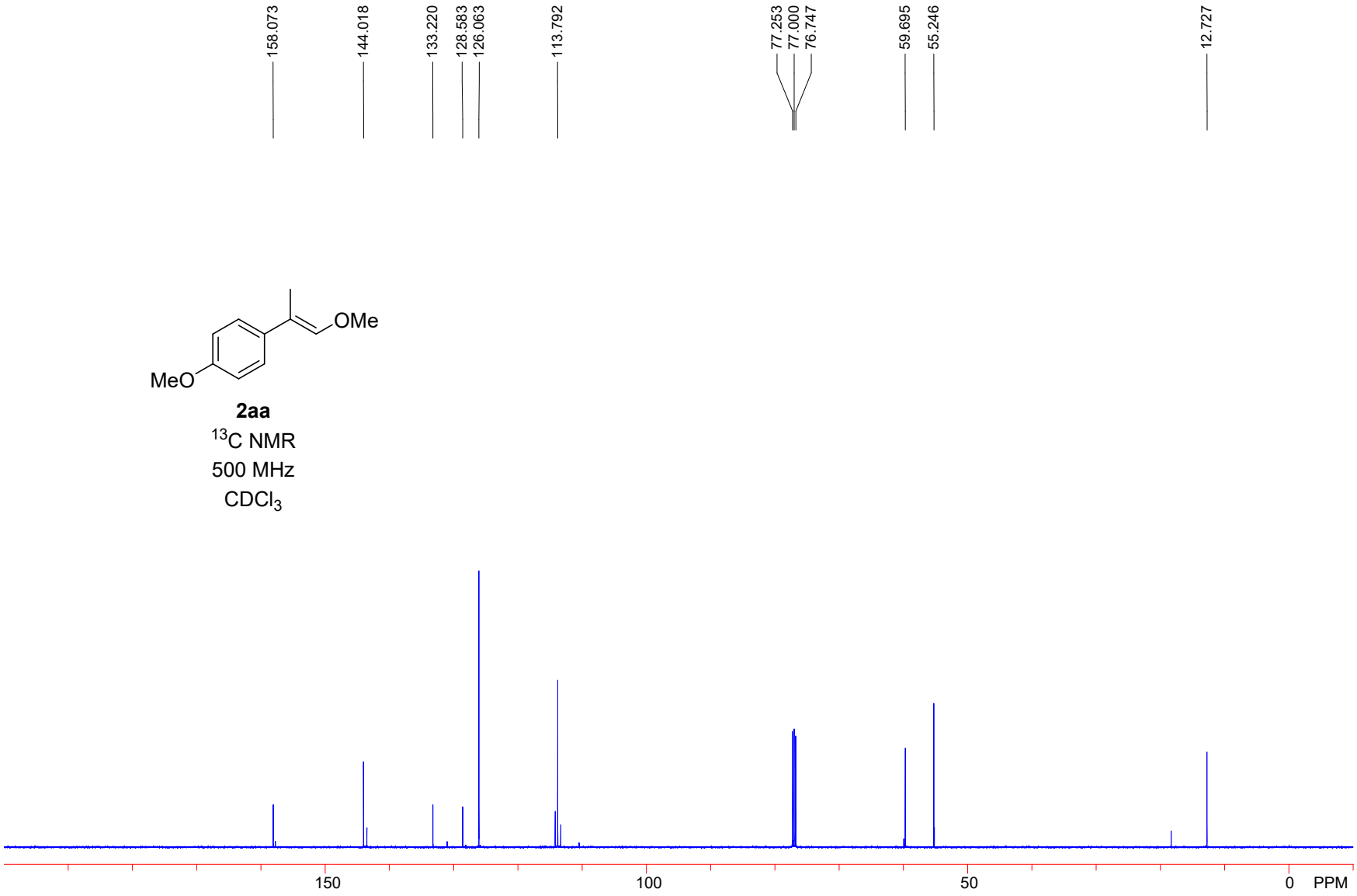

7.34
7.32
7.31
7.24
6.99
6.97
6.89
6.87
6.76
3.81
2.10
1.31
0.08
MeO
O
tBu
2y
1H NMR
400 MHz
CDCl3
4.00
2.02
2.07
1.04
3.00
3.00
9.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

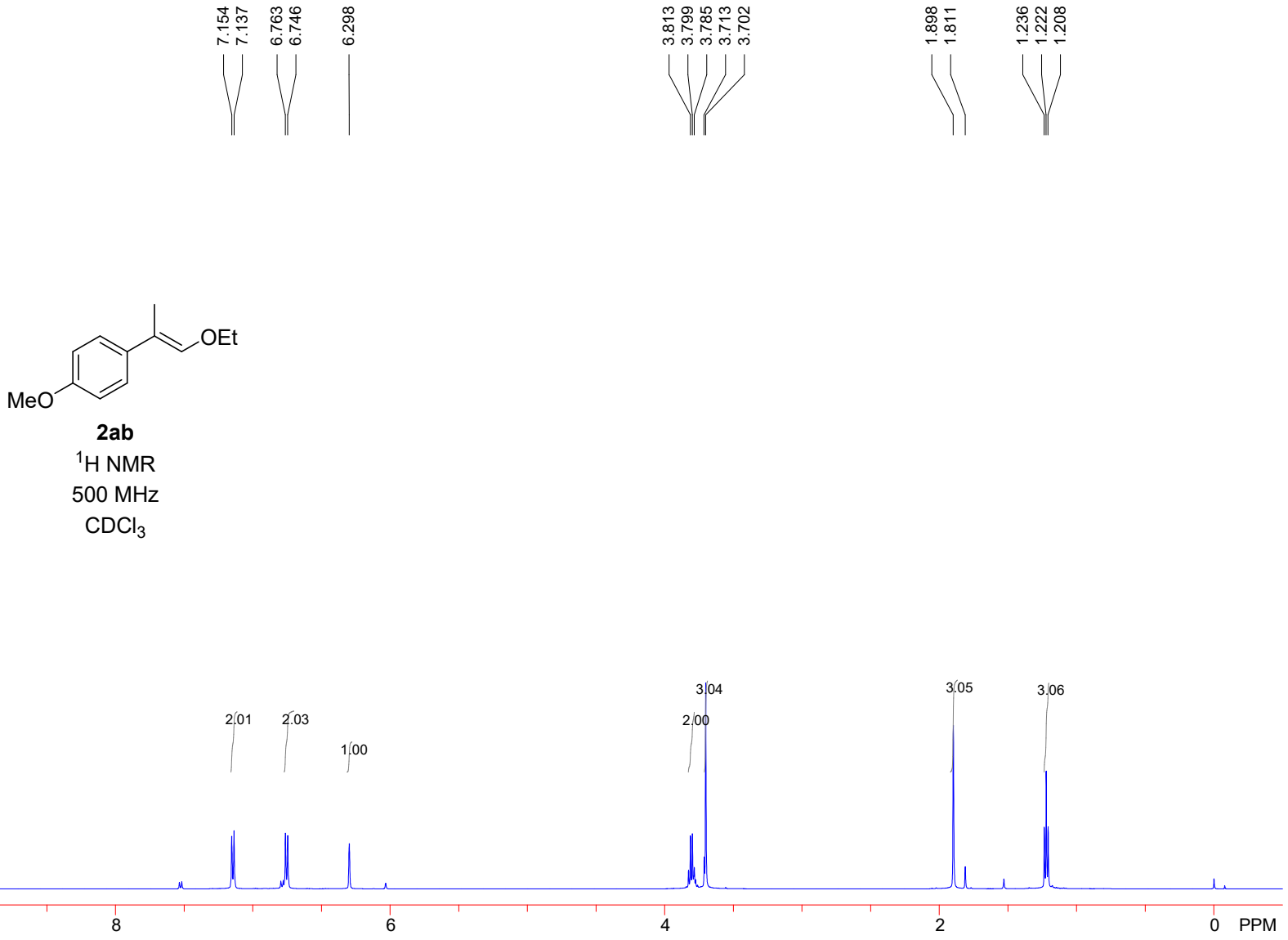

158.54
155.43
145.34
138.16
132.38
126.40
126.38
119.85
115.75
113.86
55.29
34.21
31.48
13.14
1.01
MeO
O
tBu
2y
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

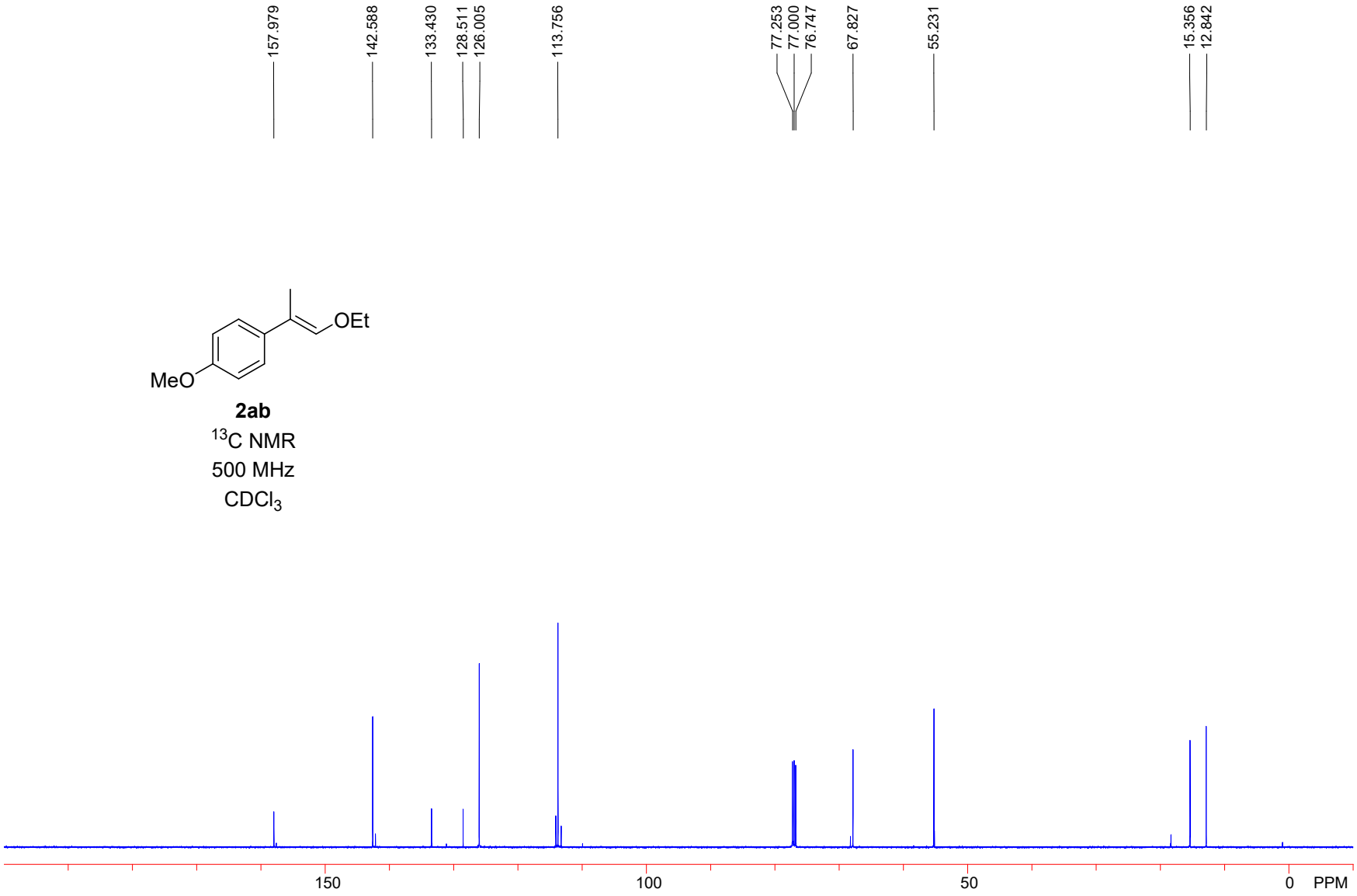

7.319
7.297
7.254
6.992
6.970
6.886
6.864
6.842
6.690
3.811
3.784
2.104
2.101
1.564
0.000
MeO
O
OMe
2z
1H NMR
400 MHz
CDCl3
6.00
4.10
3.04
2.08
2.02
1.00
8
6
4
2
0
PPM

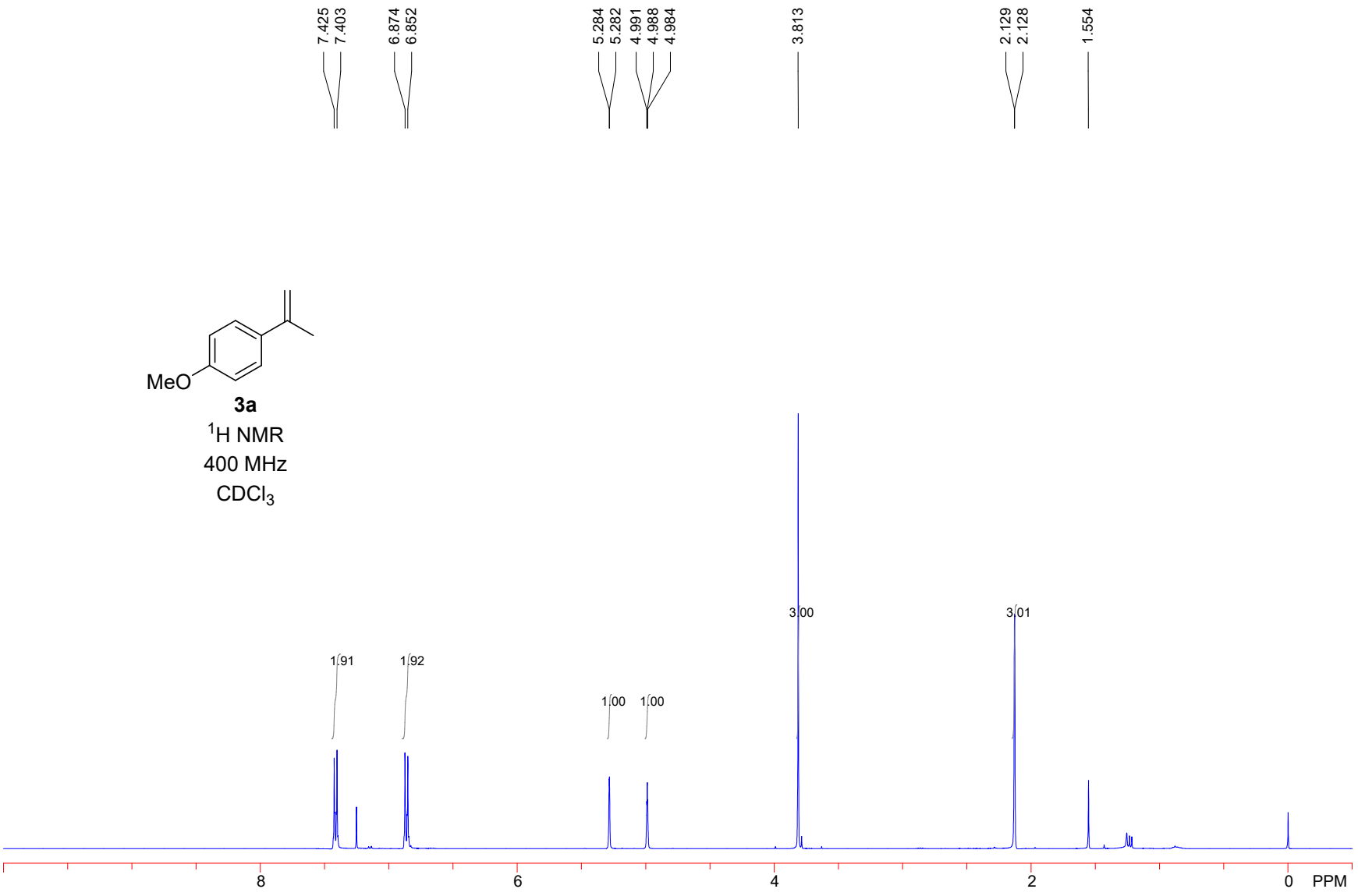

158.48
155.12
151.76
138.89
132.38
126.45
119.21
117.38
114.64
113.83
77.32
77.00
76.68
55.69
55.30
13.11
MeO
O
OMe
2z
13C NMR
400 MHz
CDCl3
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

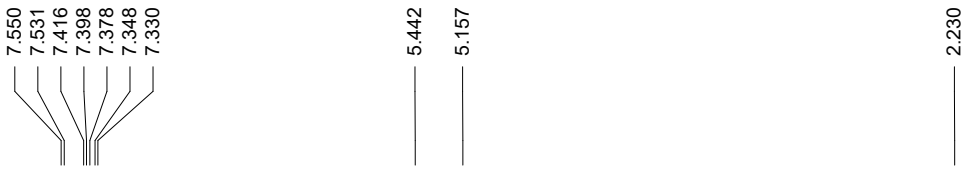

7.226
7.208
6.838
6.823
6.305
3.781
3.681
1.960
OMe
MeO
2aa
1H NMR
500 MHz
CDCl3
2.07
2.07
0.99
3.03
3.00
3.00
8
6
4
2
0
PPM

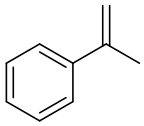

158.073
144.018
133.220
128.583
126.063
113.792
77.253
77.000
76.747
59.695
55.246
12.727
OMe
MeO
2aa
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM


7.154
7.137
6.763
6.746
6.298
3.813
3.799
3.785
3.713
3.702
1.898
1.811
1.236
1.222
1.208
OEt
MeO
2ab
1H NMR
500 MHz
CDCl3
2.01
2.03
1.00
2.00
3.04
3.05
3.06
8
6
4
2
0
PPM


157.979
142.588
133.430
128.511
126.005
113.756
77.253
77.000
76.747
67.827
55.231
15.356
12.842
OEt
MeO
2ab
13C NMR
500 MHz
CDCl3
150
100
50
0
PPM


7.425
7.403
6.874
6.852
5.284
5.282
4.991
4.988
4.984
3.813
2.129
2.128
1.554
MeO
3a
1H NMR
400 MHz
CDCl3
1.91
1.92
1.00
1.00
3.00
3.01
8
6
4
2
0
PPM



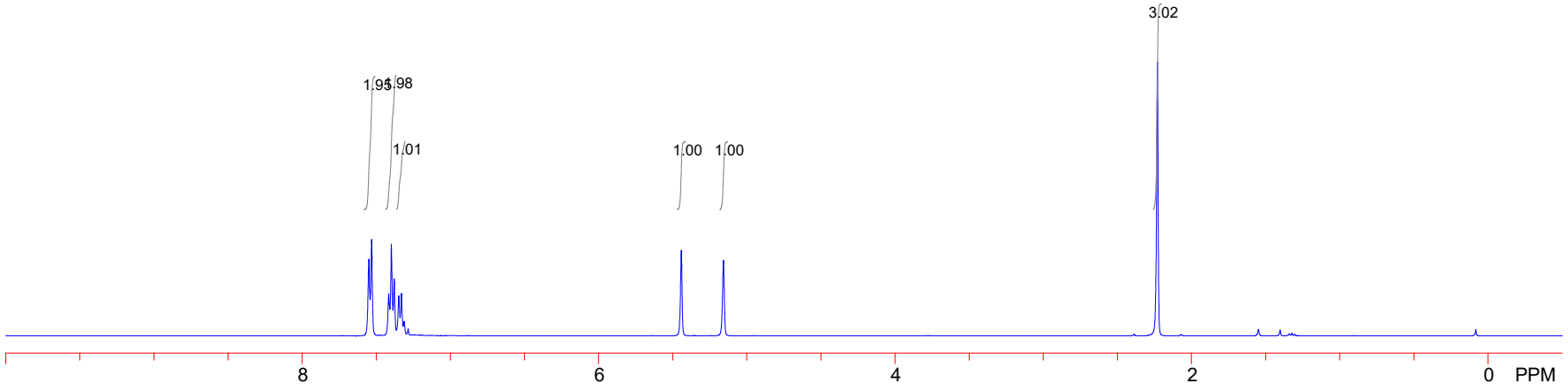


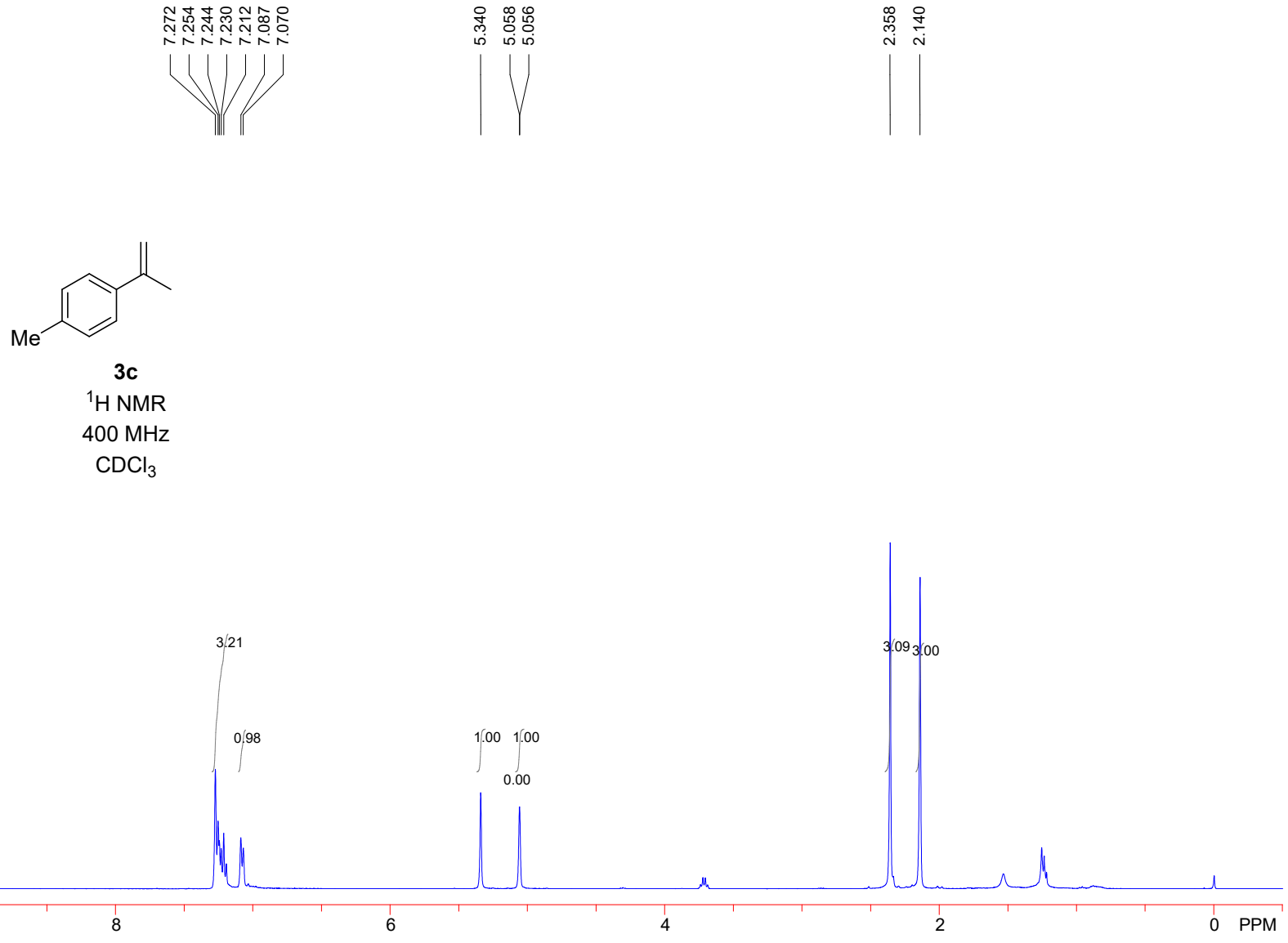
3b

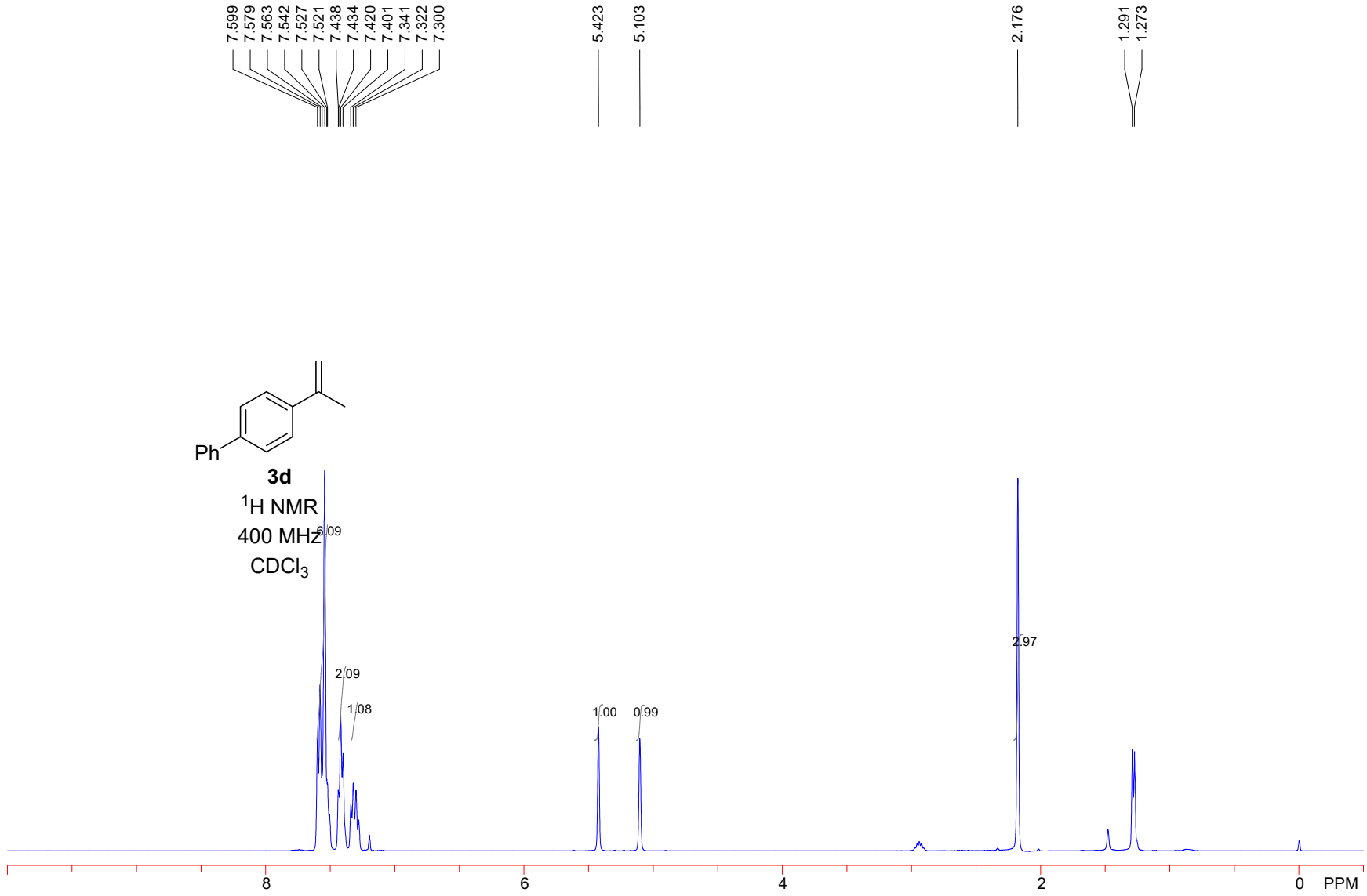
^{1}H NMR

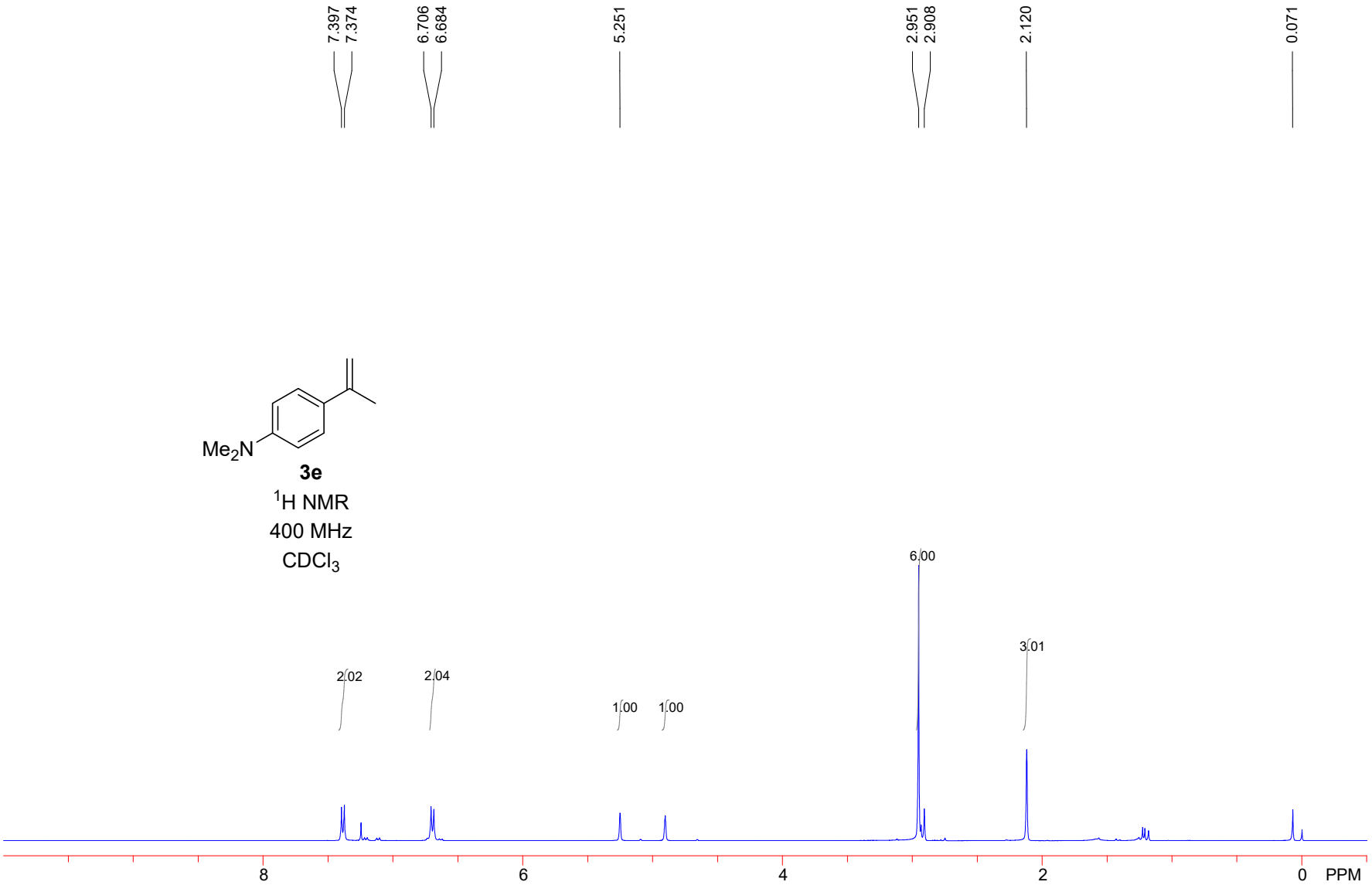
400 MHz

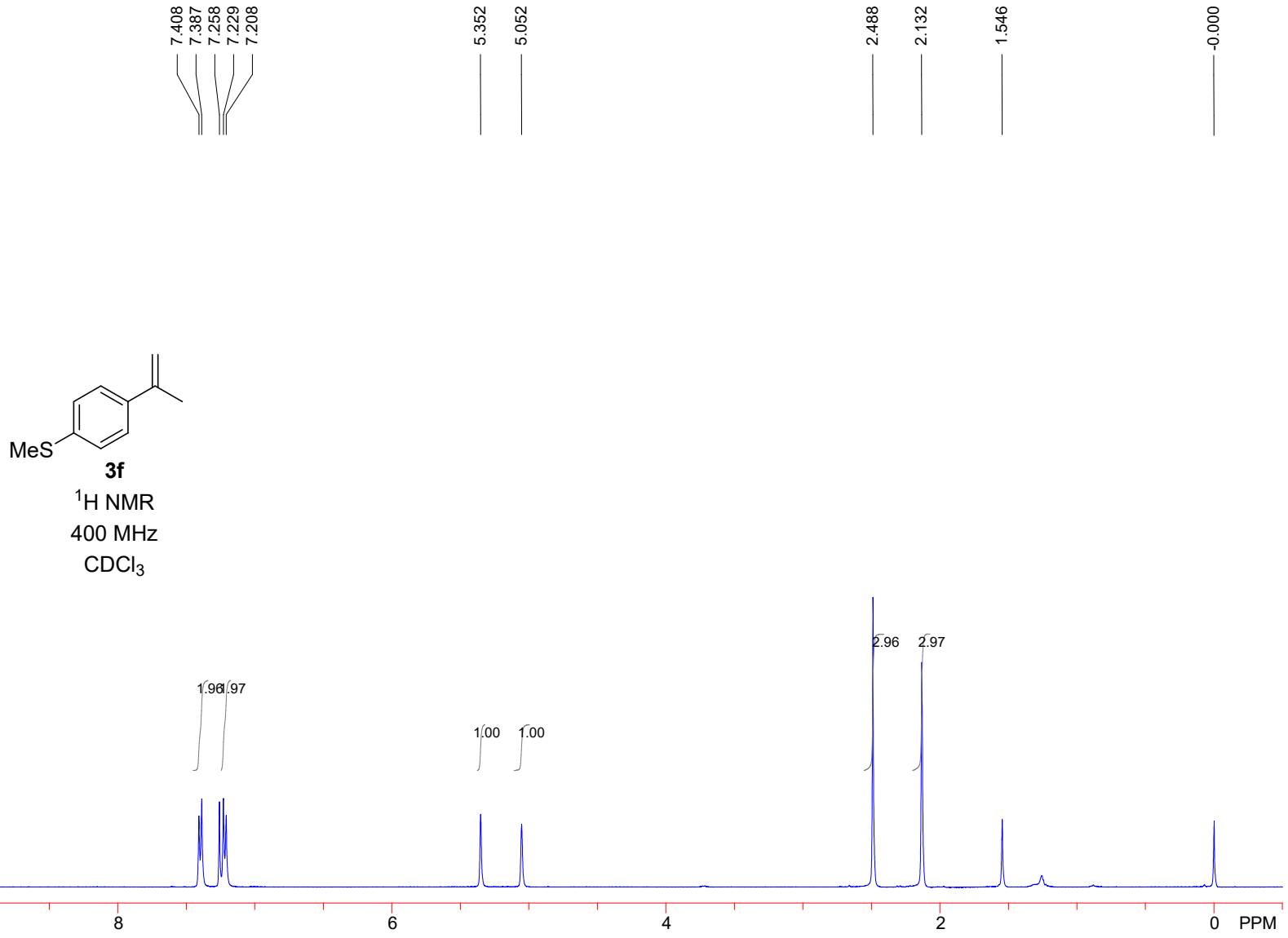
$CDCl_3$

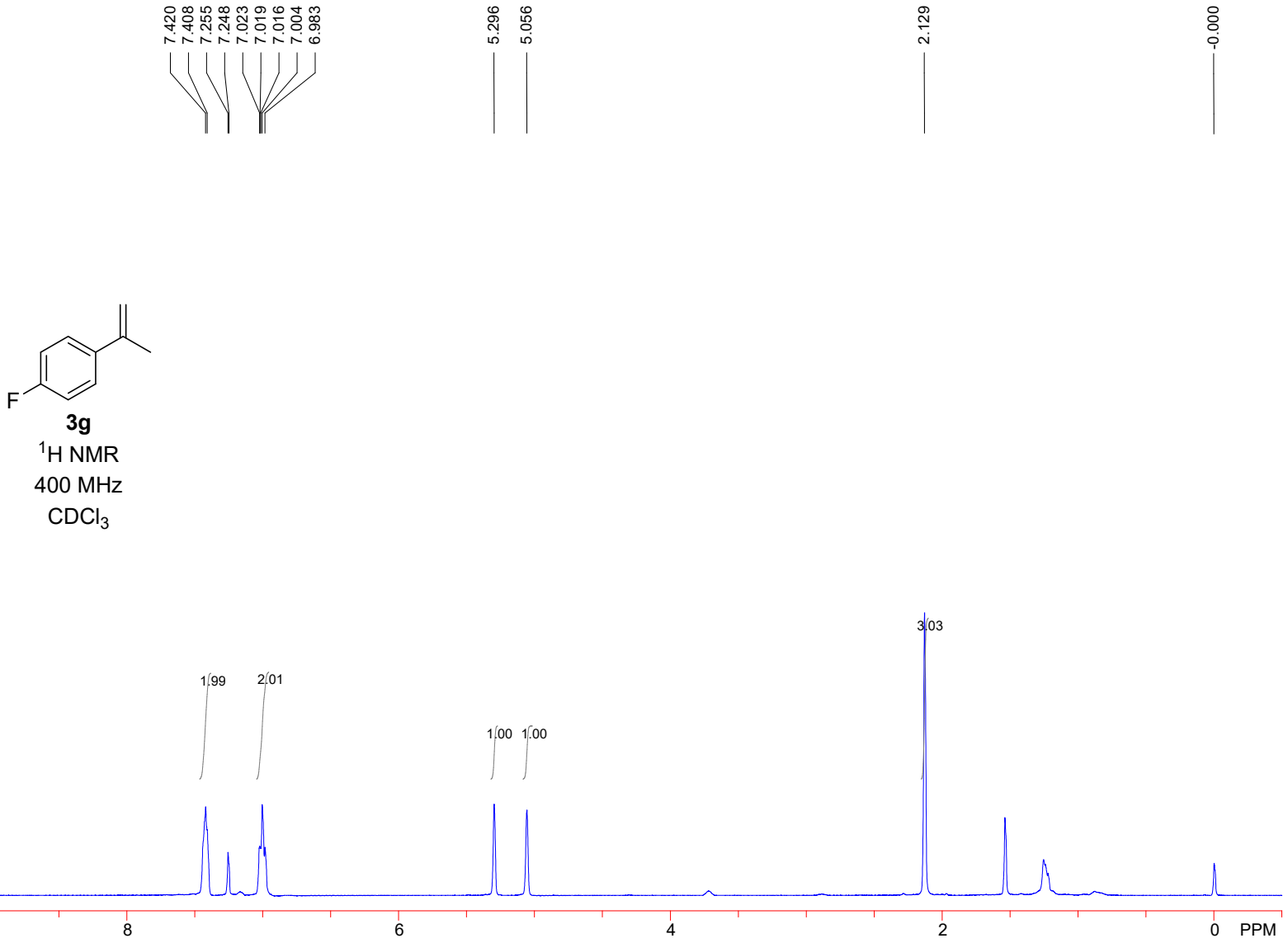


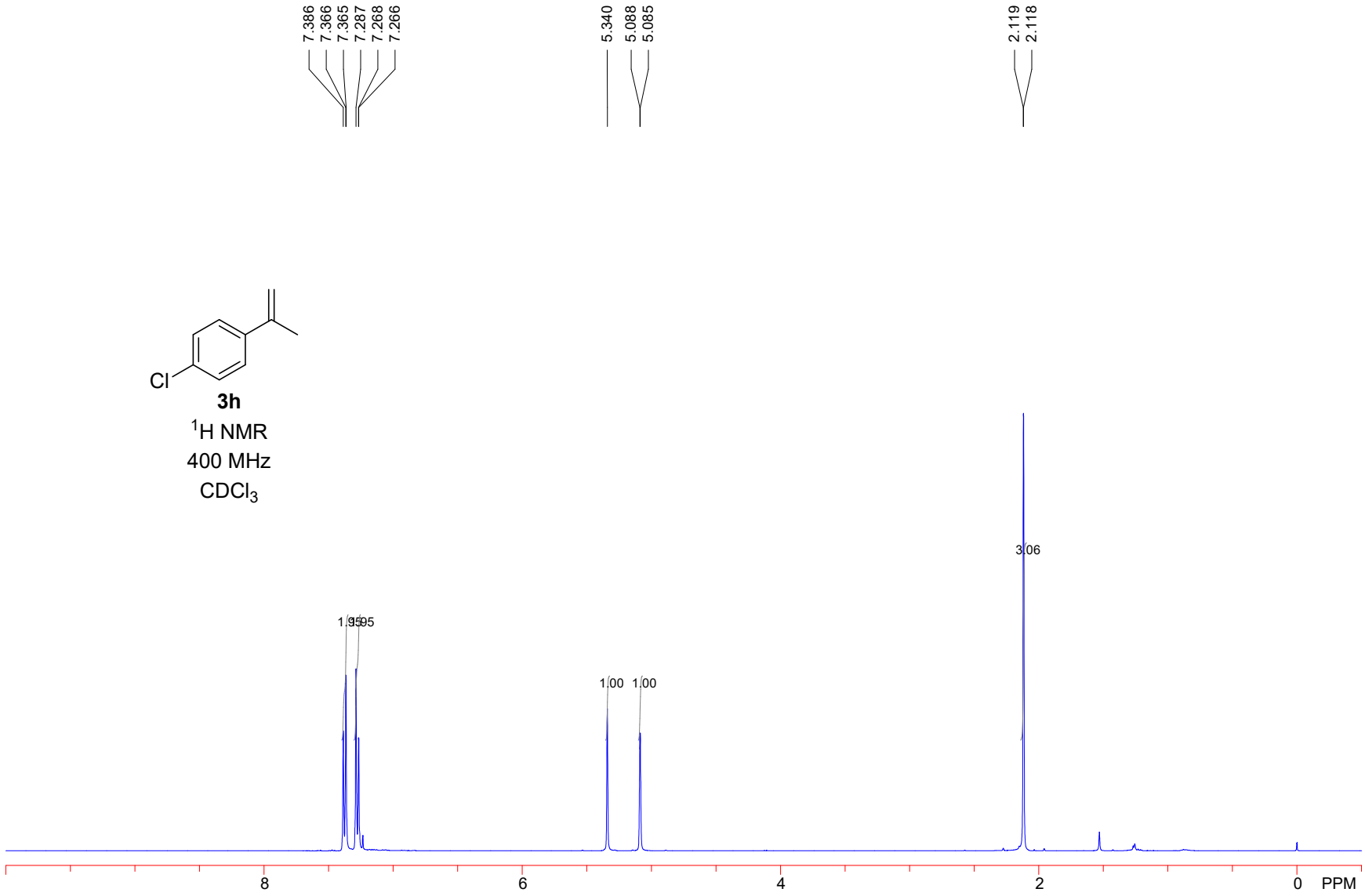

7.272
7.254
7.244
7.230
7.212
7.087
7.070
5.340
5.058
5.056
2.358
2.140
Me
3c
1H NMR
400 MHz
CDCl3
3.21
0.98
1.00
1.00
0.00
3.09
3.00
8
6
4
2
0
PPM

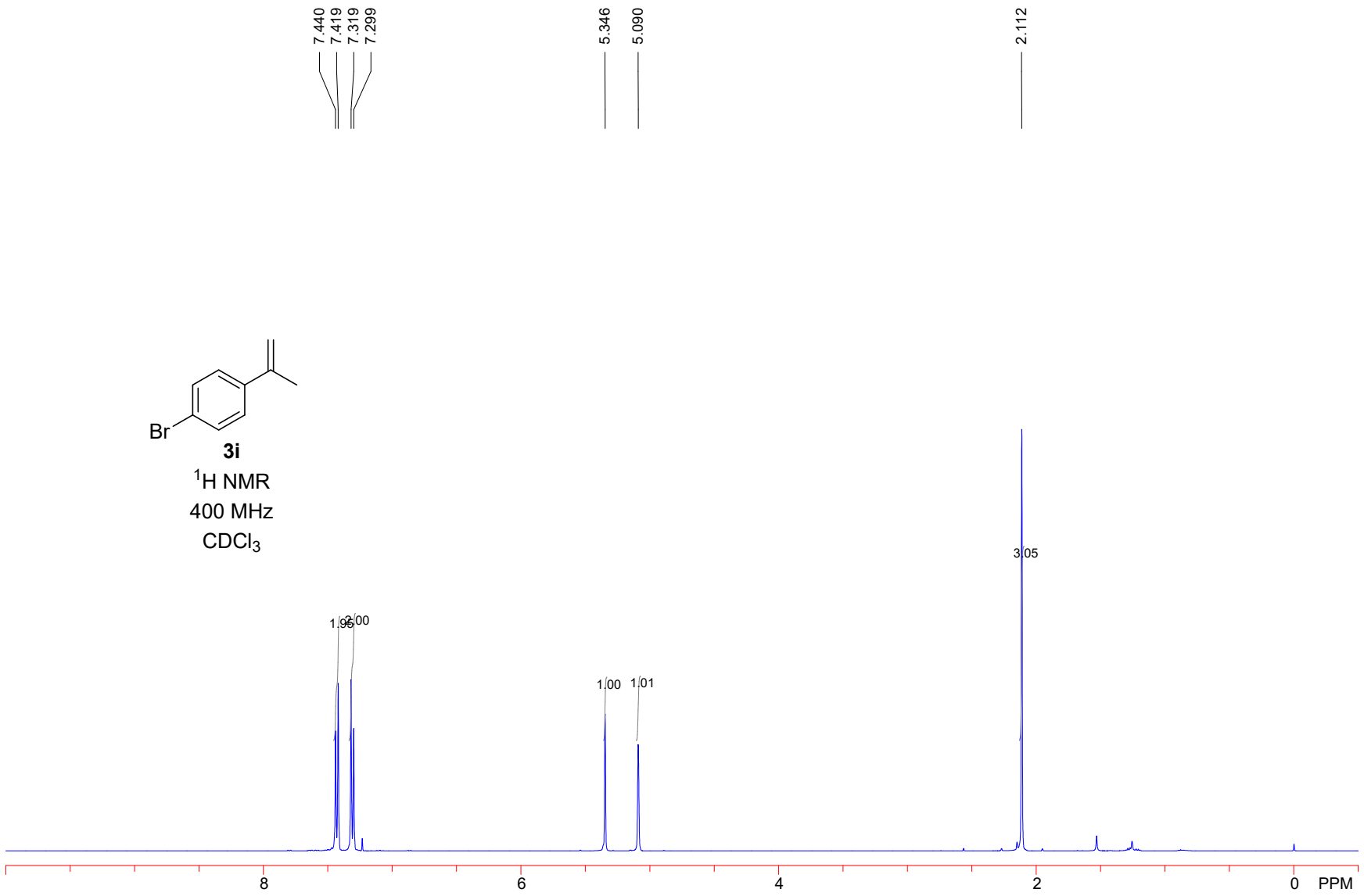

7.599
7.579
7.563
7.542
7.527
7.521
7.438
7.434
7.420
7.401
7.341
7.322
7.300
5.423
5.103
2.176
1.291
1.273
Ph
3d
1H NMR
400 MHz
CDCl3
6.09
2.09
1.08
1.00
0.99
2.97
8
6
4
2
0
PPM

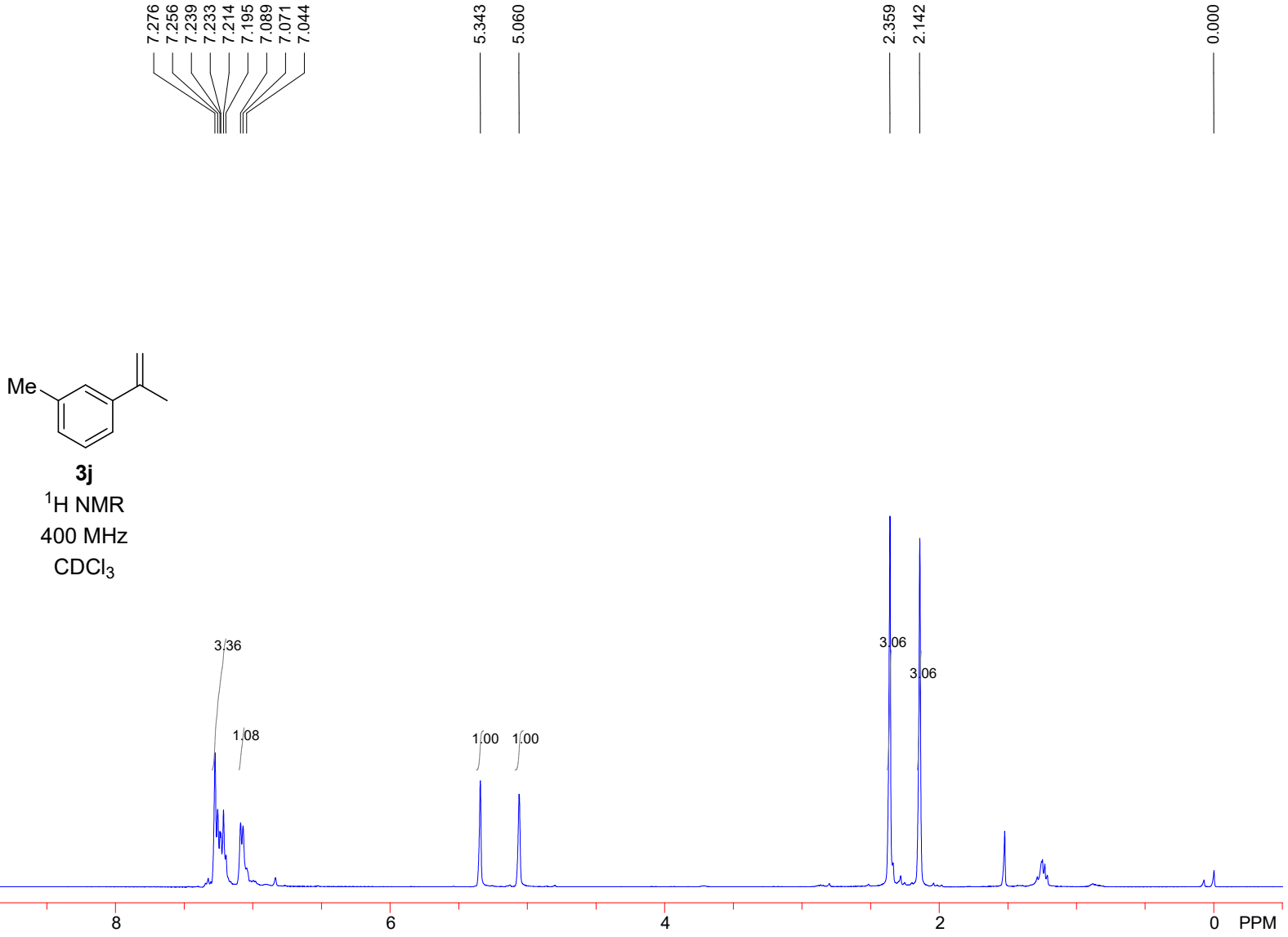

7.397
7.374
6.706
6.684
5.251
2.951
2.908
2.120
0.071
Me2N
3e
1H NMR
400 MHz
CDCl3
6.00
3.01
2.02
2.04
1.00
1.00
8
6
4
2
0
PPM

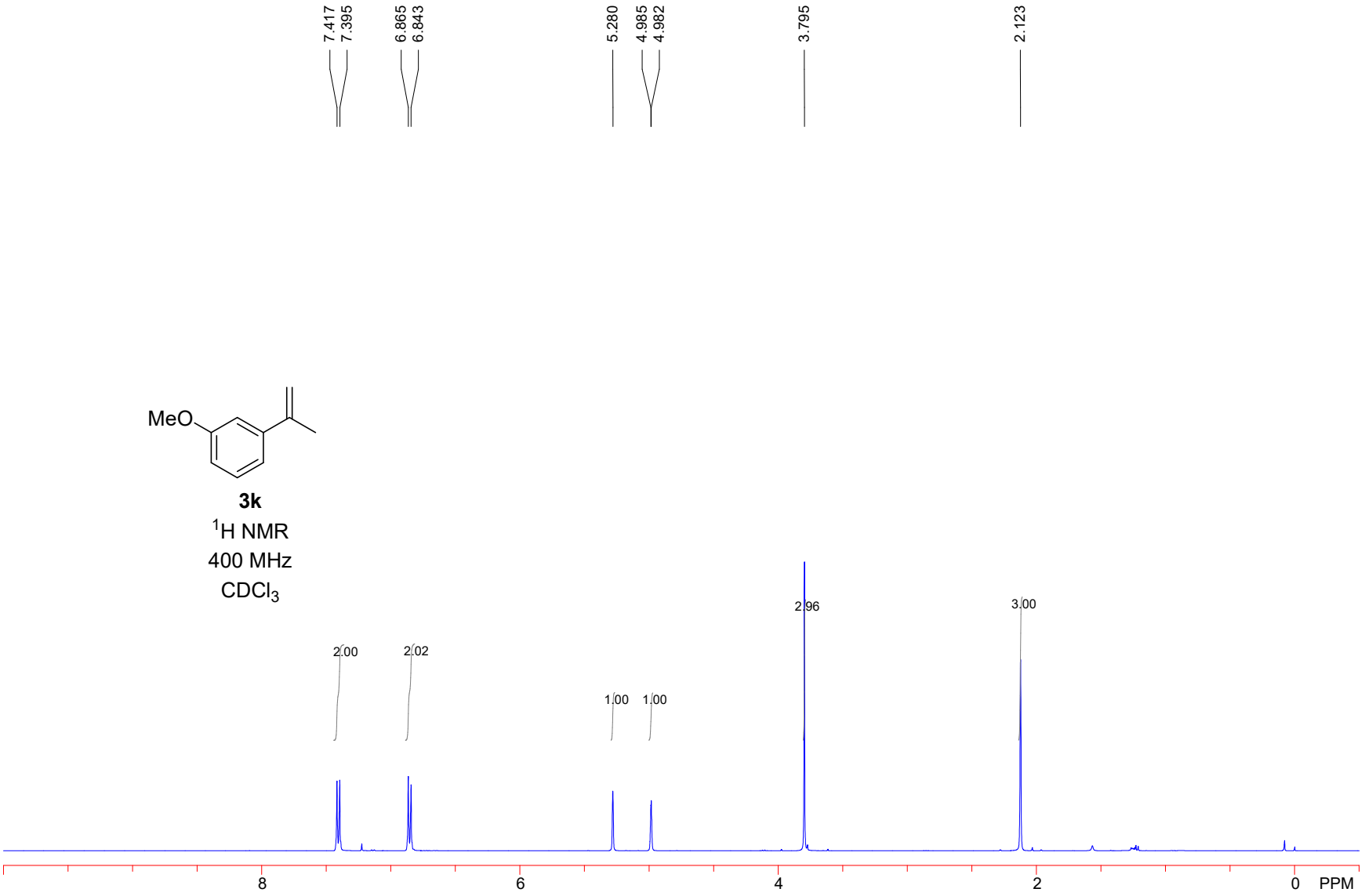

7.408
7.387
7.258
7.229
7.208
5.352
5.052
2.488
2.132
1.546
-0.000
MeS
3f
1H NMR
400 MHz
CDCl3
1.96
1.97
1.00
1.00
2.96
2.97
8
6
4
2
0
PPM

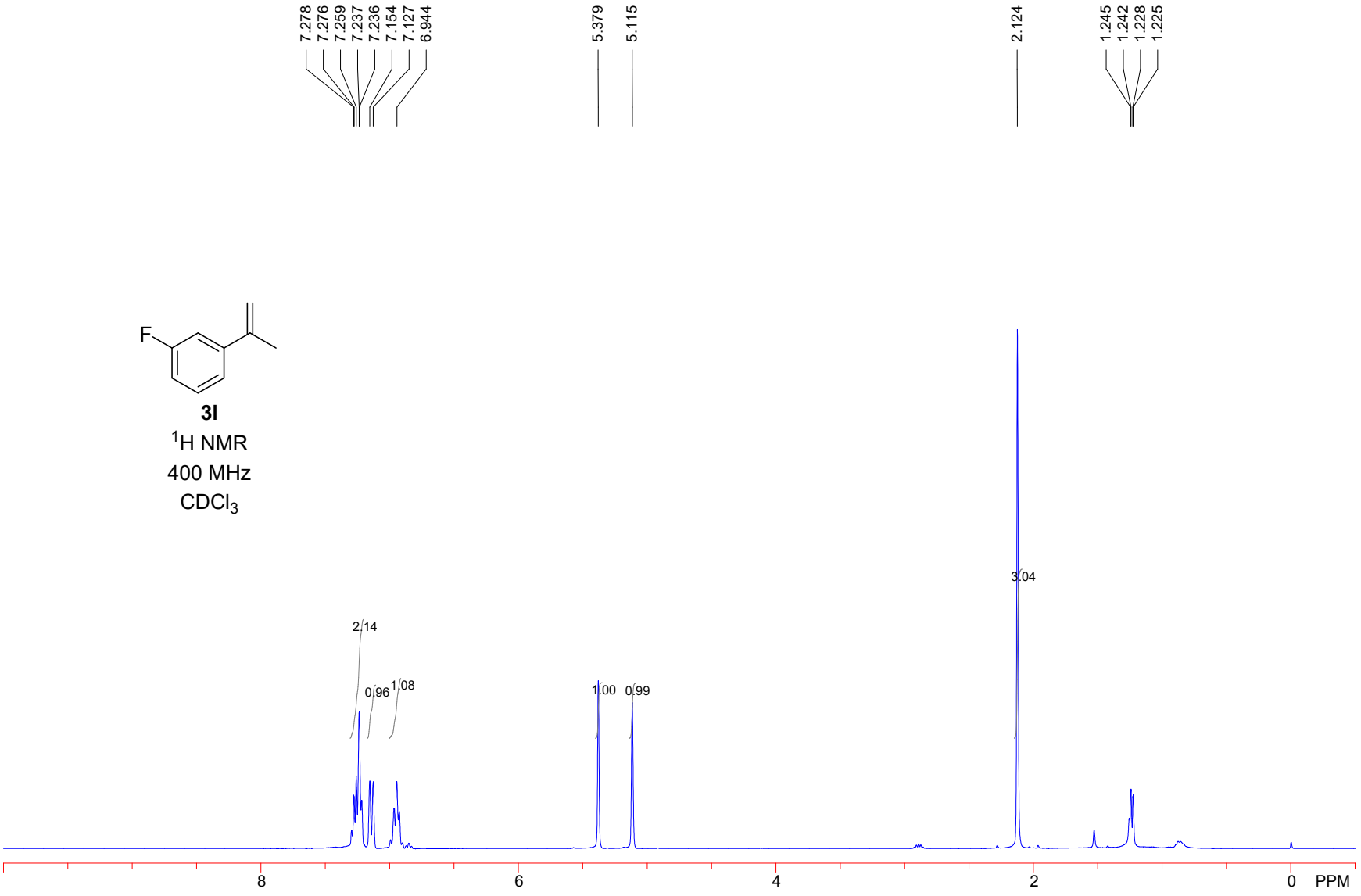

7.420
7.408
7.255
7.248
7.023
7.019
7.016
7.004
6.983
5.296
5.056
2.129
-0.000
F
3g
1H NMR
400 MHz
CDCl3
1.99
2.01
1.00
1.00
3.03
8
6
4
2
0
PPM

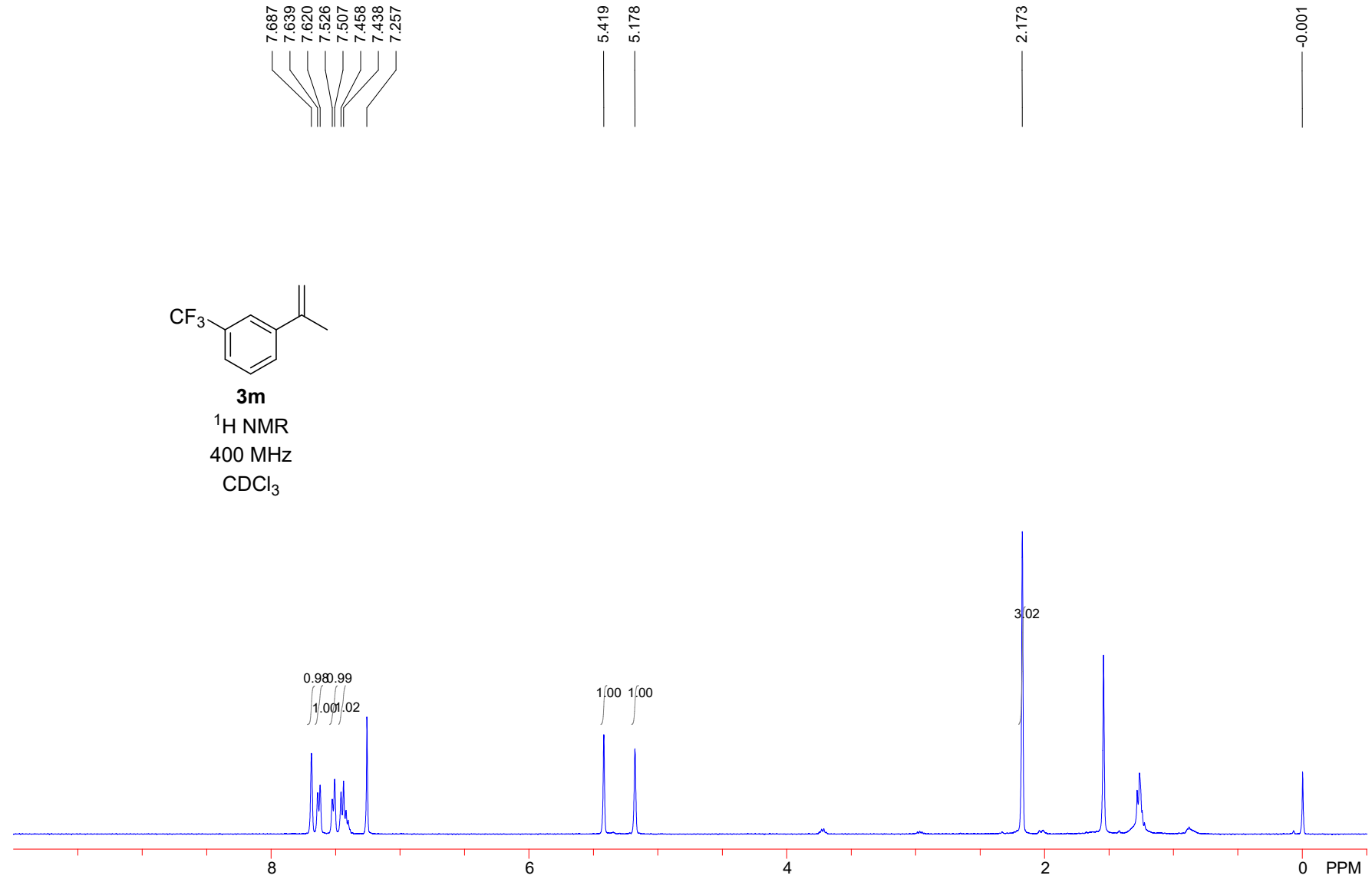

7.386
7.366
7.365
7.287
7.268
7.266
5.340
5.088
5.085
2.119
2.118
Cl
3h
1H NMR
400 MHz
CDCl3
1.95
1.95
1.00
1.00
3.06
8
6
4
2
0
PPM

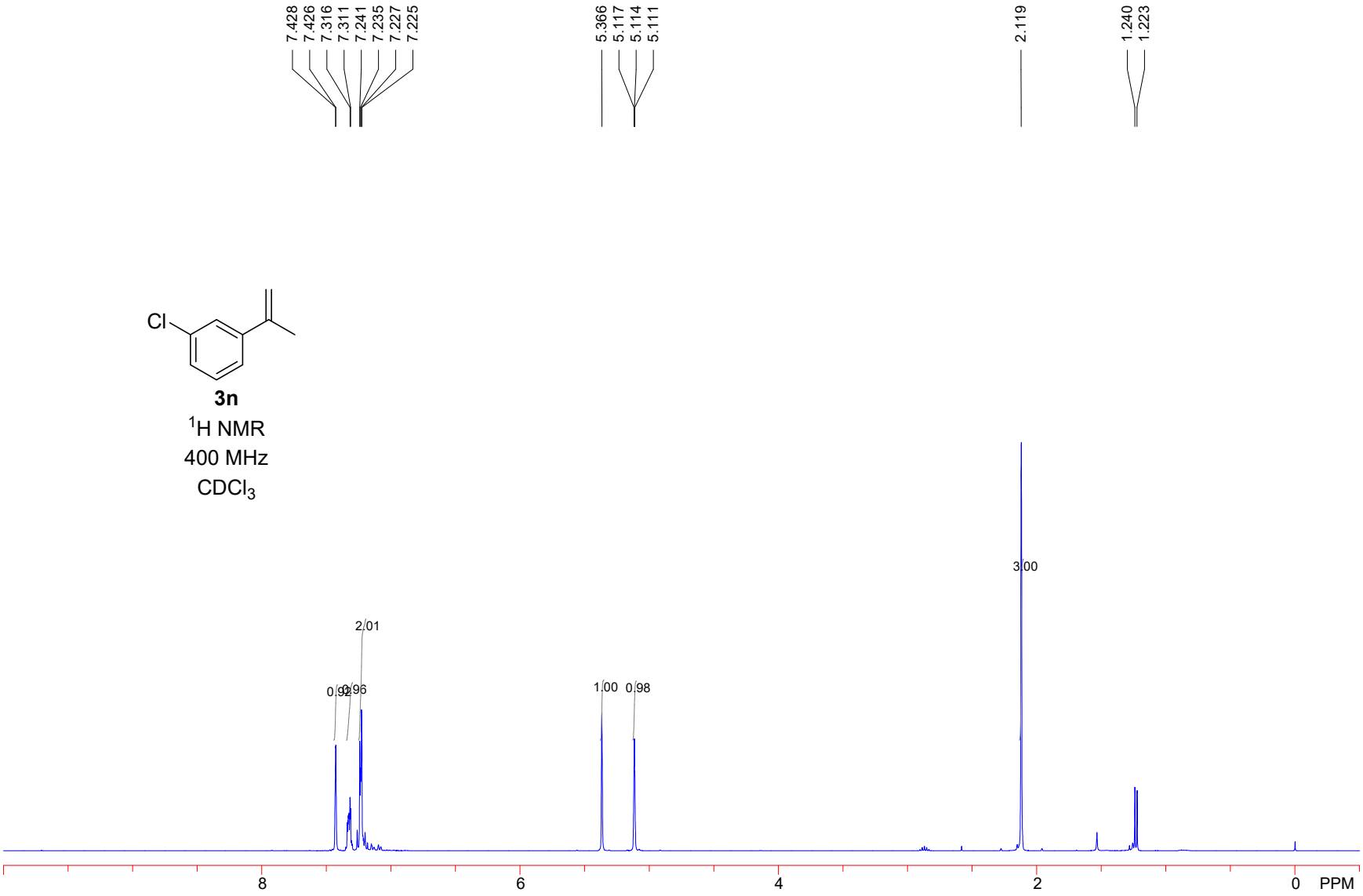

7.440
7.419
7.319
7.299
5.346
5.090
2.112
Br
3i
1H NMR
400 MHz
CDCl3
1.95
2.00
1.00
1.01
3.05
8
6
4
2
0
PPM

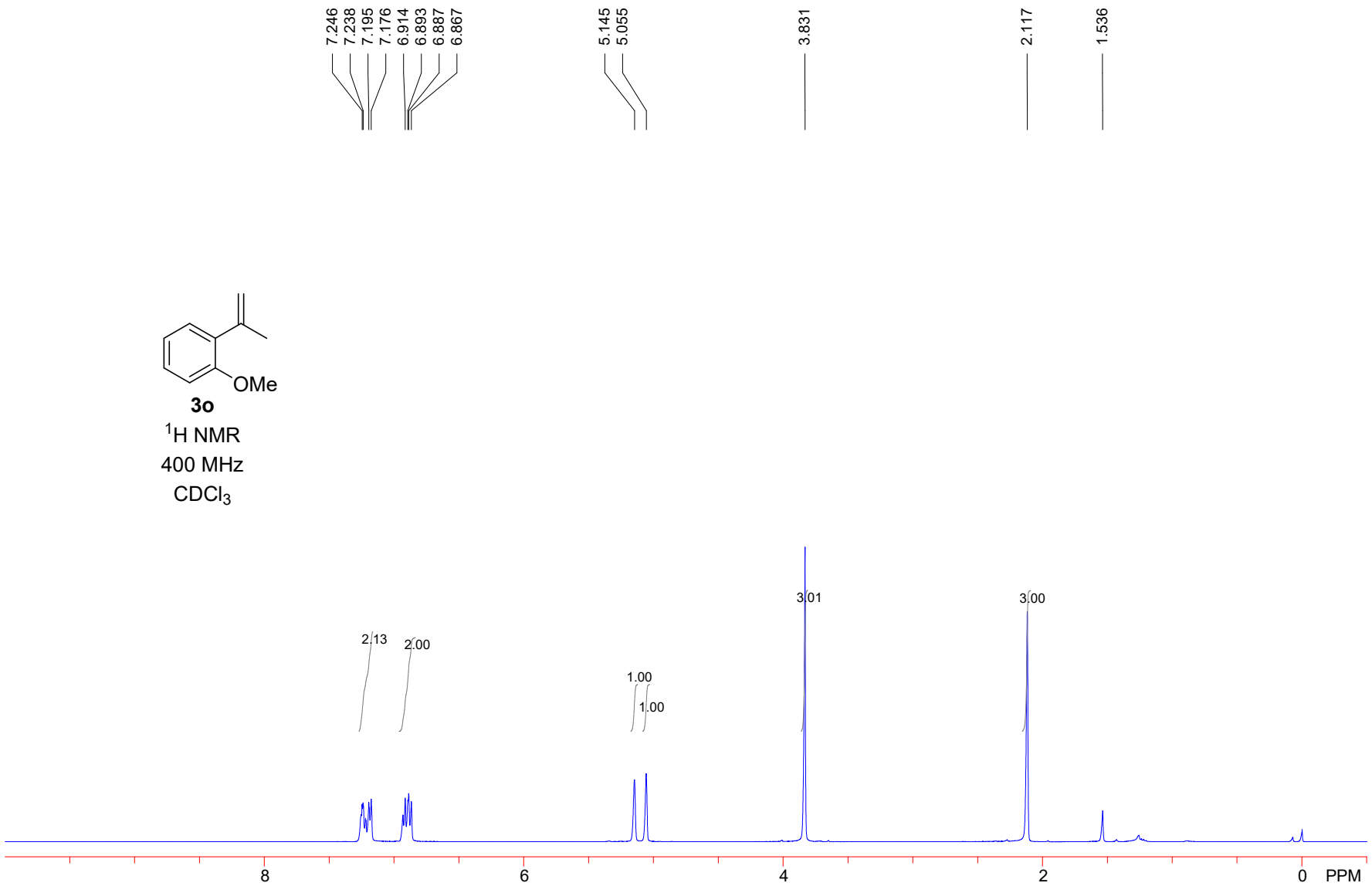

7.276
7.256
7.239
7.233
7.214
7.195
7.089
7.071
7.044
5.343
5.060
2.359
2.142
0.000
Me
3j
1H NMR
400 MHz
CDCl3
3.36
1.08
1.00
1.00
3.06
3.06
8
6
4
2
0
PPM

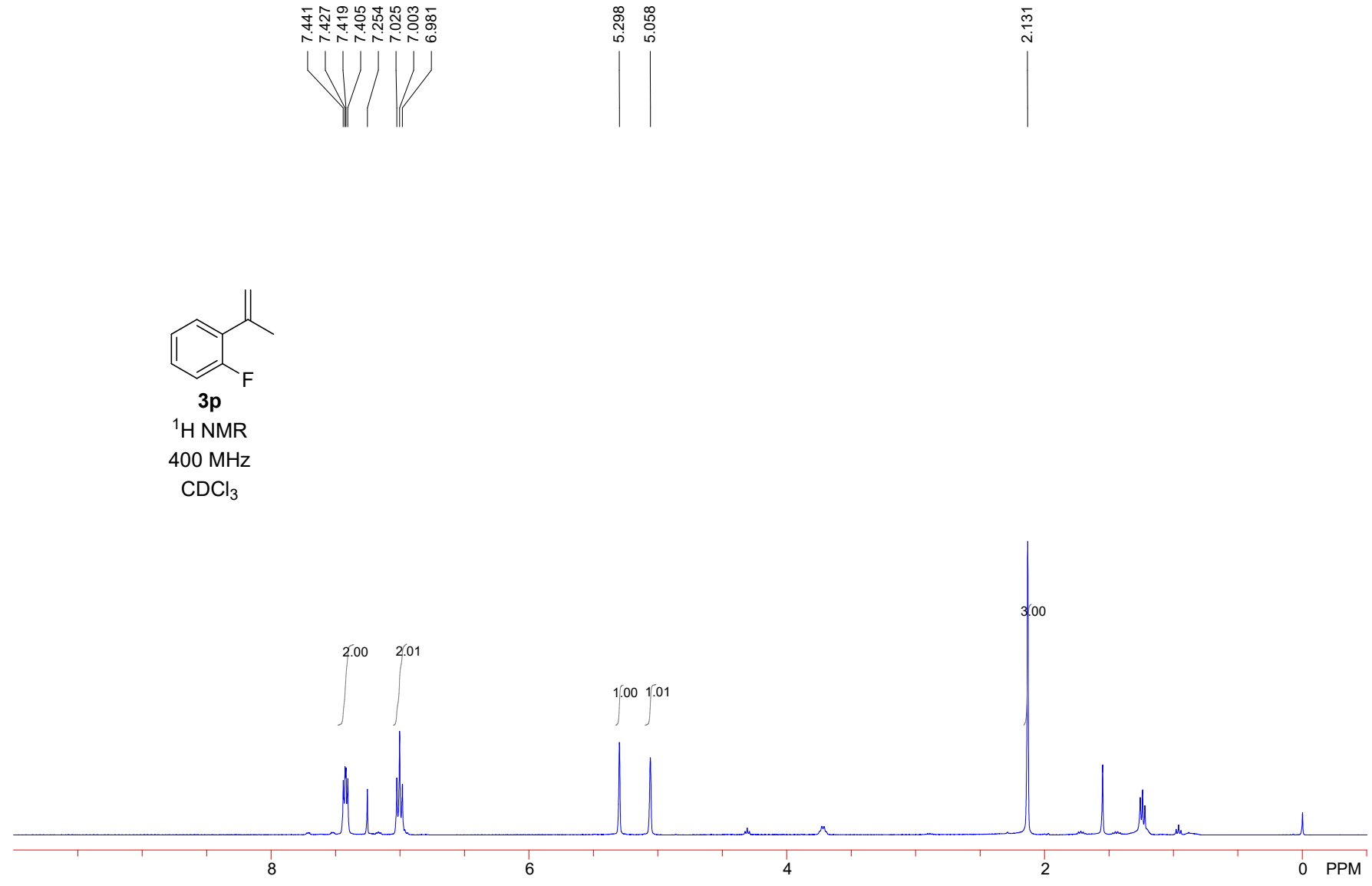

7.417
7.395
6.865
6.843
5.280
4.985
4.982
3.795
2.123
MeO
3k
1H NMR
400 MHz
CDCl3
2.00
2.02
1.00
1.00
2.96
3.00
8
6
4
2
0
PPM

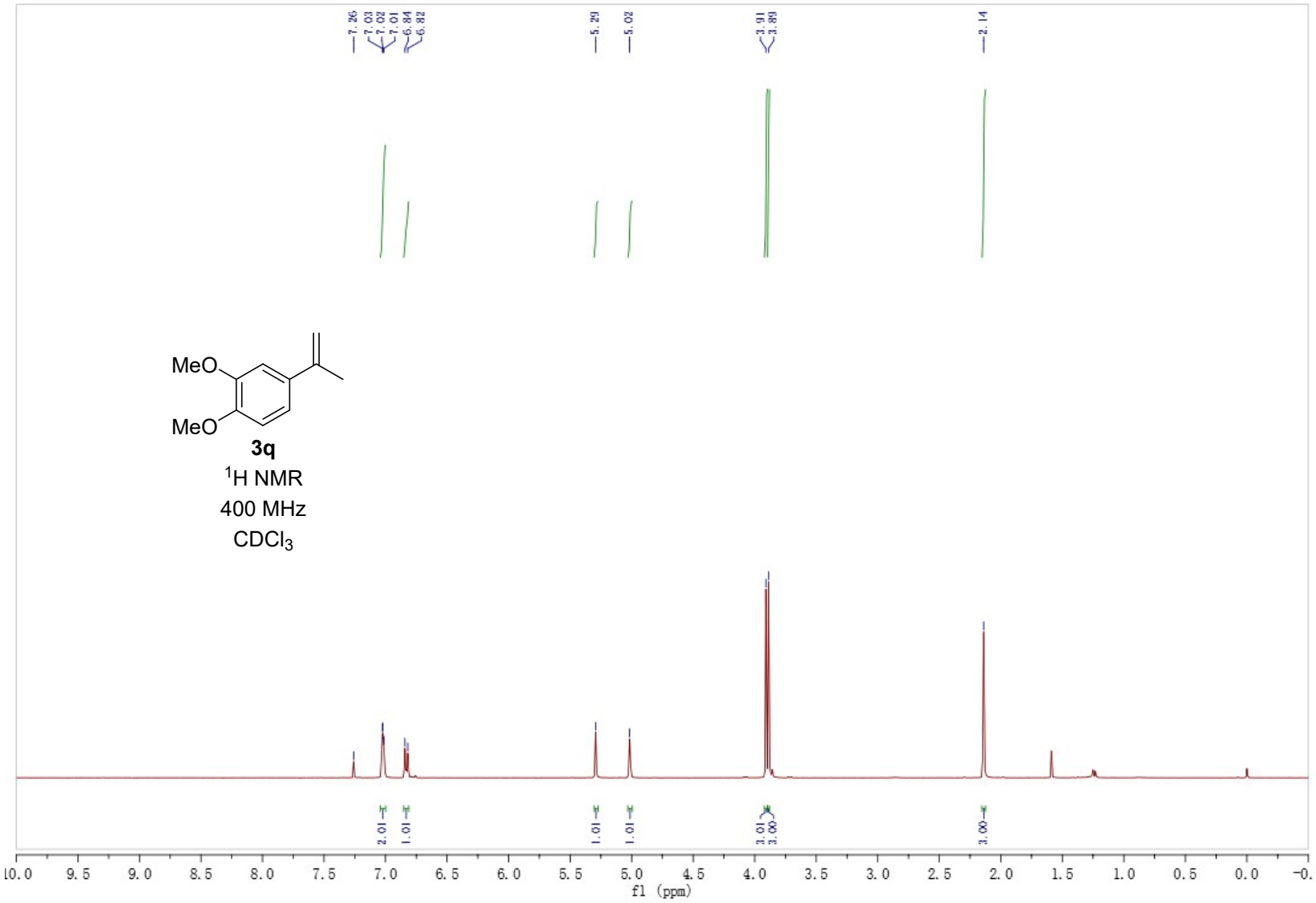

7.278
7.276
7.259
7.237
7.236
7.154
7.127
6.944
5.379
5.115
2.124
1.245
1.242
1.228
1.225
F
3l
1H NMR
400 MHz
CDCl3
2.14
0.96
1.08
1.00
0.99
3.04
8
6
4
2
0
PPM

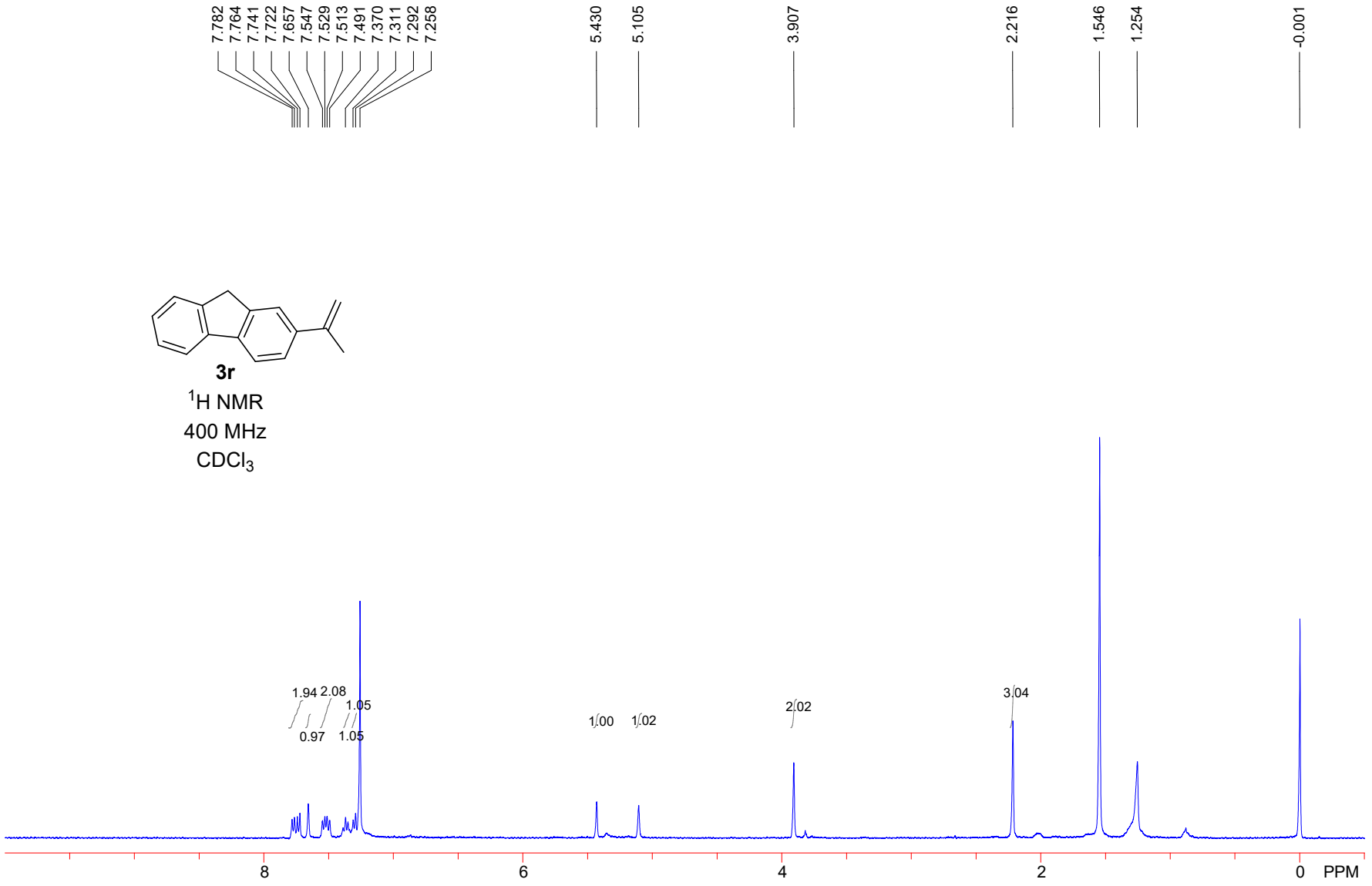

7.687
7.639
7.620
7.526
7.507
7.458
7.438
7.257
5.419
5.178
2.173
-0.001
CF3
3m
1H NMR
400 MHz
CDCl3
0.98
0.99
1.00
1.02
1.00
1.00
3.02
8
6
4
2
0
PPM

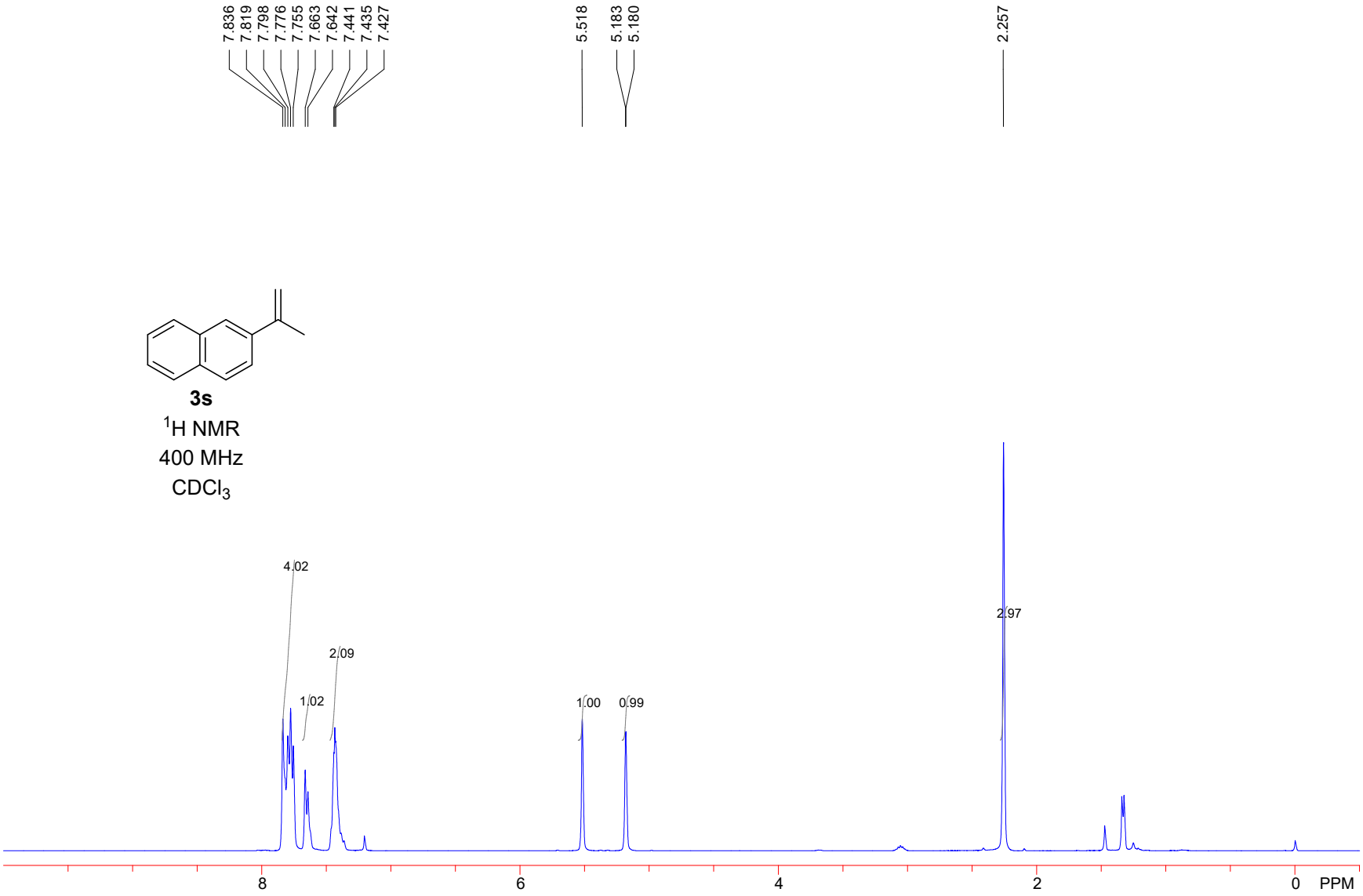

7.428
7.426
7.316
7.311
7.241
7.235
7.227
7.225
5.366
5.117
5.114
5.111
2.119
1.240
1.223
Cl
3n
1H NMR
400 MHz
CDCl3
3.00
2.01
0.92
0.96
1.00
0.98
8
6
4
2
0
PPM

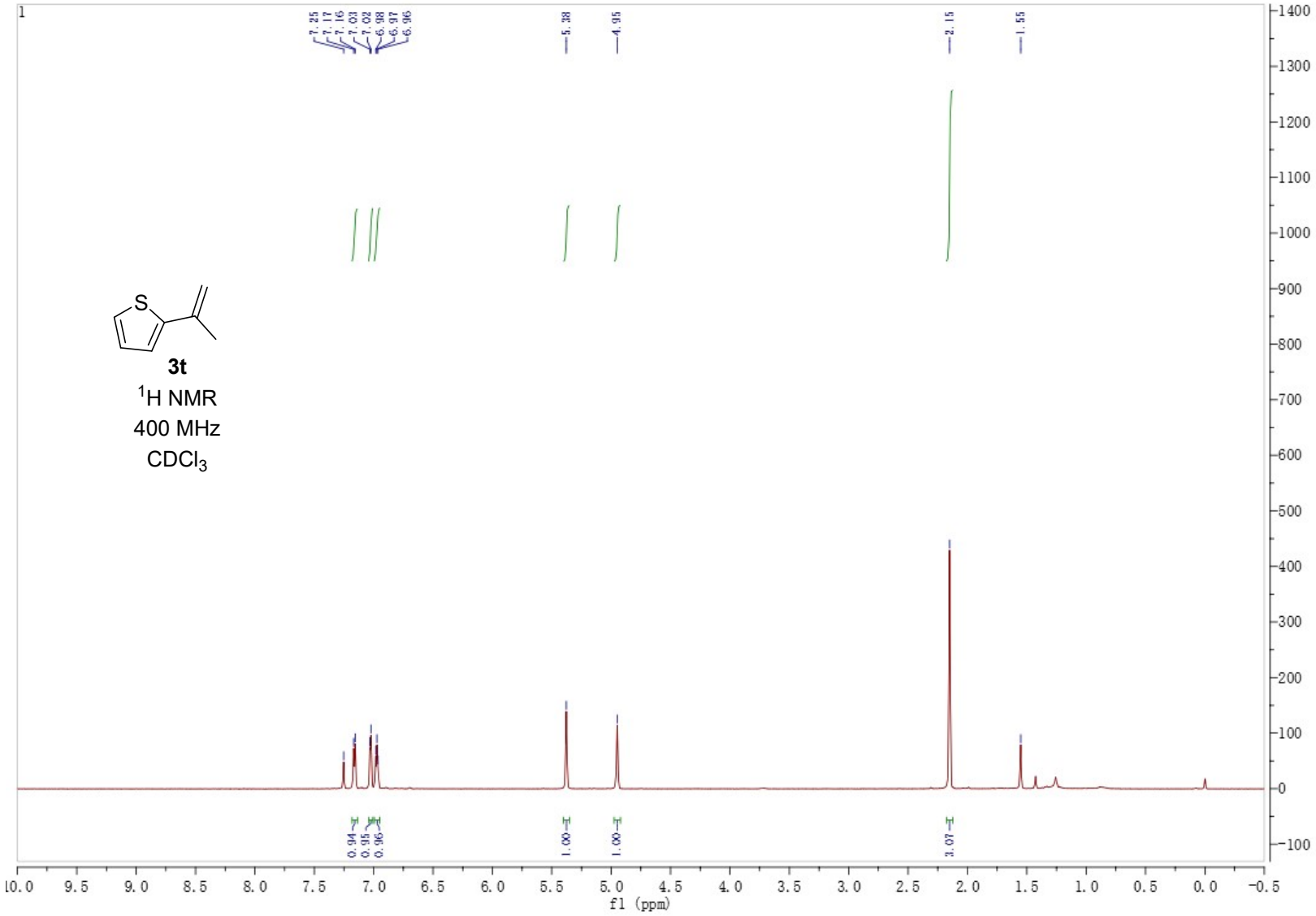

7.246
7.238
7.195
7.176
6.914
6.893
6.887
6.867
5.145
5.055
3.831
2.117
1.536
OMe
3o
1H NMR
400 MHz
CDCl3
2.13
2.00
1.00
1.00
3.01
3.00
8
6
4
2
0
PPM

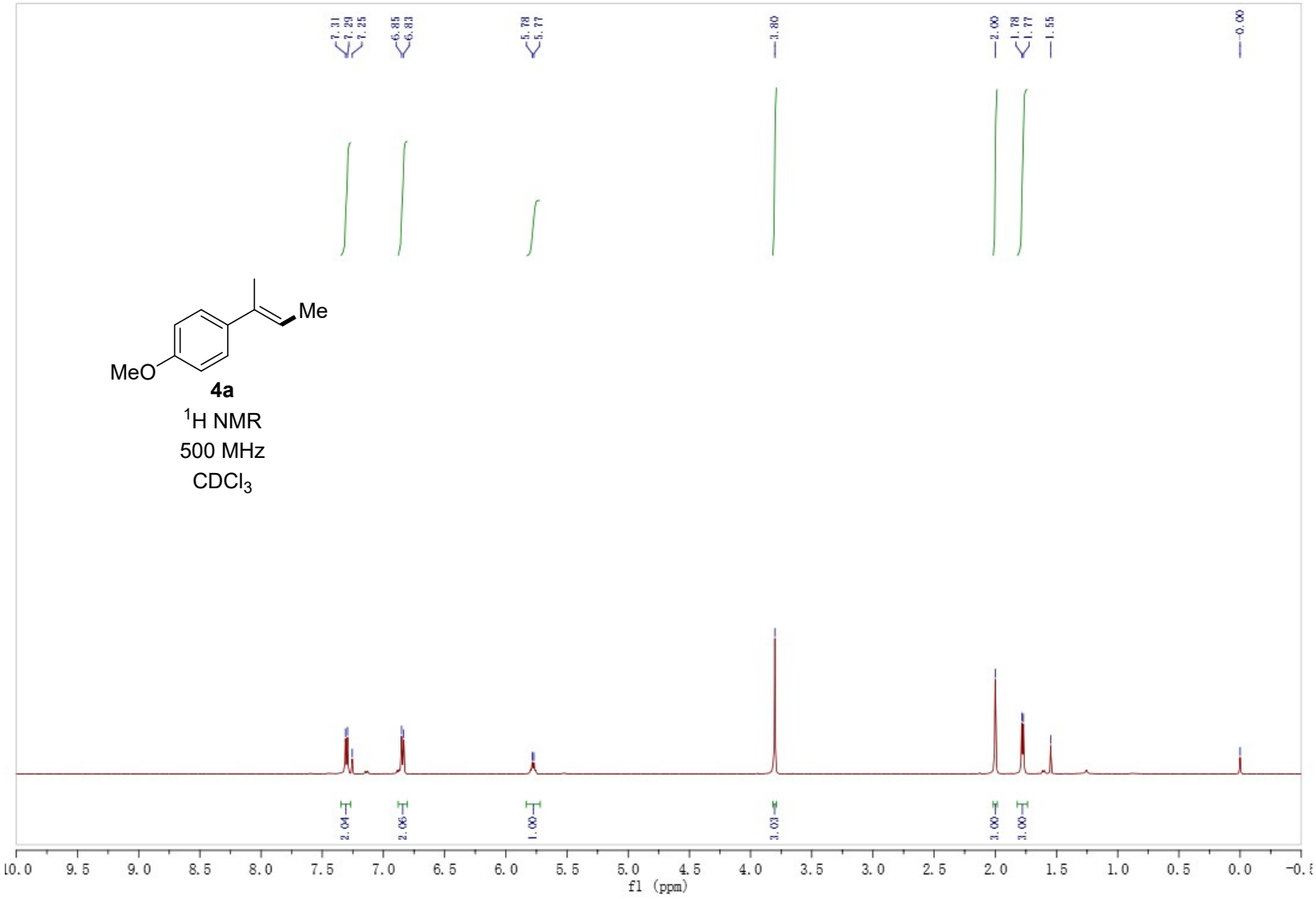

7.441
7.427
7.419
7.405
7.254
7.025
7.003
6.981
5.298
5.058
2.131
F
3p
1H NMR
400 MHz
CDCl3
2.00
2.01
1.00
1.01
3.00
8
6
4
2
0
PPM


MeO
MeO
3q
1H NMR
400 MHz
CDCl3
f1 (ppm)


7.782
7.764
7.741
7.722
7.657
7.547
7.529
7.513
7.491
7.370
7.311
7.292
7.258
5.430
5.105
3.907
2.216
1.546
1.254
-0.001
3r
1H NMR
400 MHz
CDCl3
1.94
2.08
1.05
0.97
1.05
1.00
1.02
2.02
3.04
8
6
4
2
0
PPM


7.836
7.819
7.798
7.776
7.755
7.663
7.642
7.441
7.435
7.427
5.518
5.183
5.180
2.257
3s
1H NMR
400 MHz
CDCl3
4.02
2.09
1.02
1.00
0.99
2.97
8
6
4
2
0
PPM


1
7.25
7.17
7.16
7.03
7.02
6.98
6.97
6.96
5.38
4.95
2.15
1.55
S
3t
1H NMR
400 MHz
CDCl3
0.94
0.95
0.96
1.00
1.00
3.07
f1 (ppm)

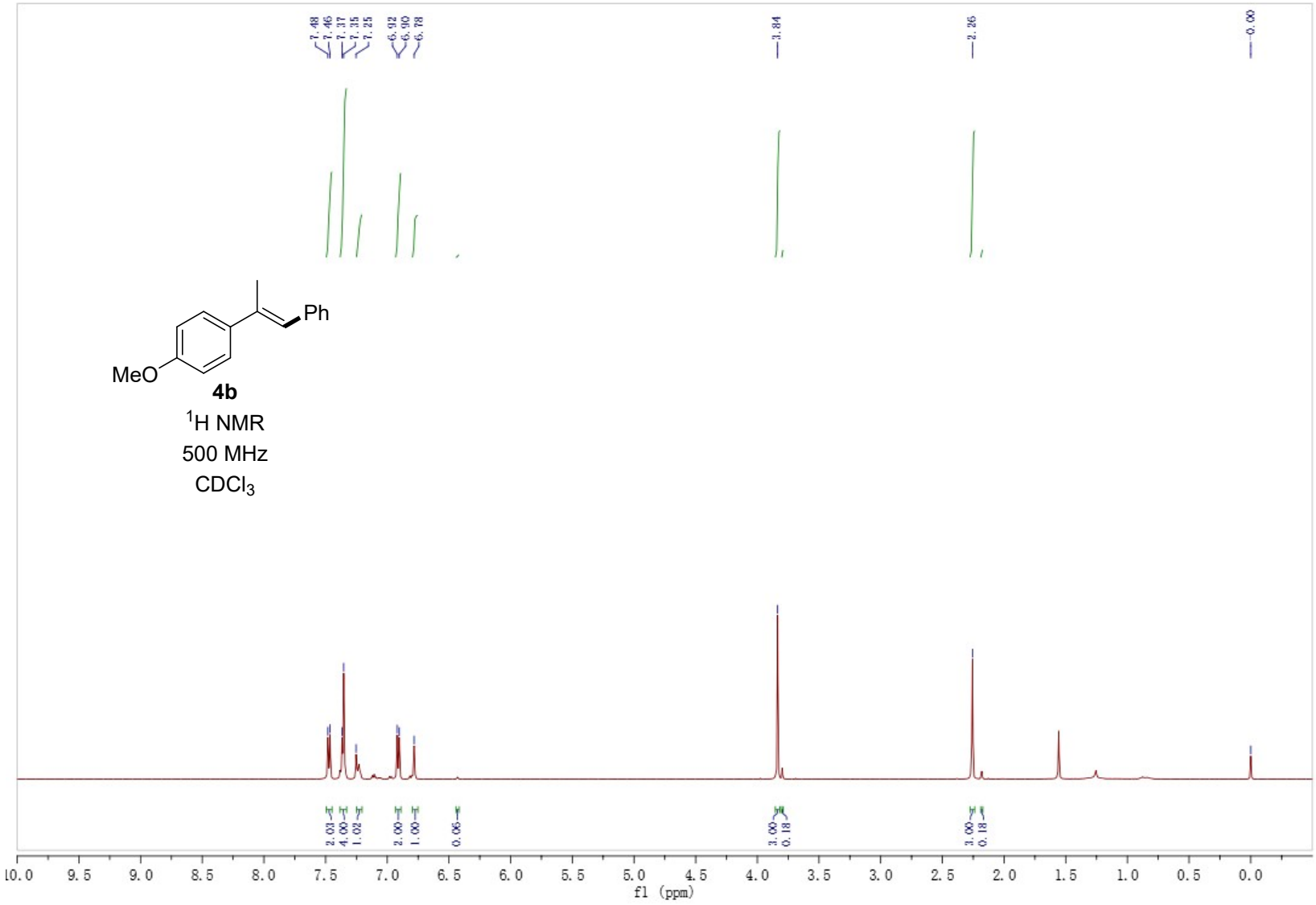


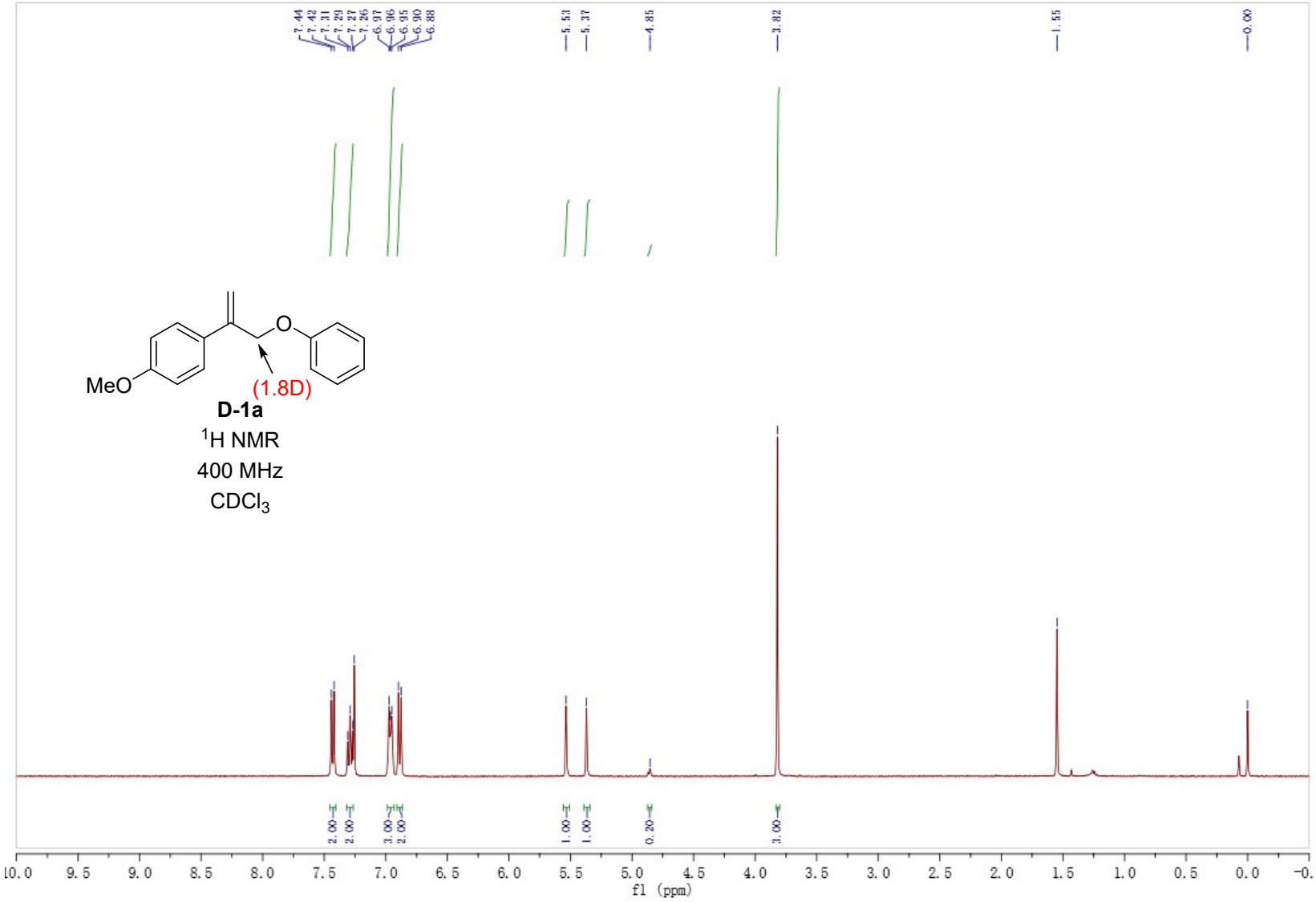
4a

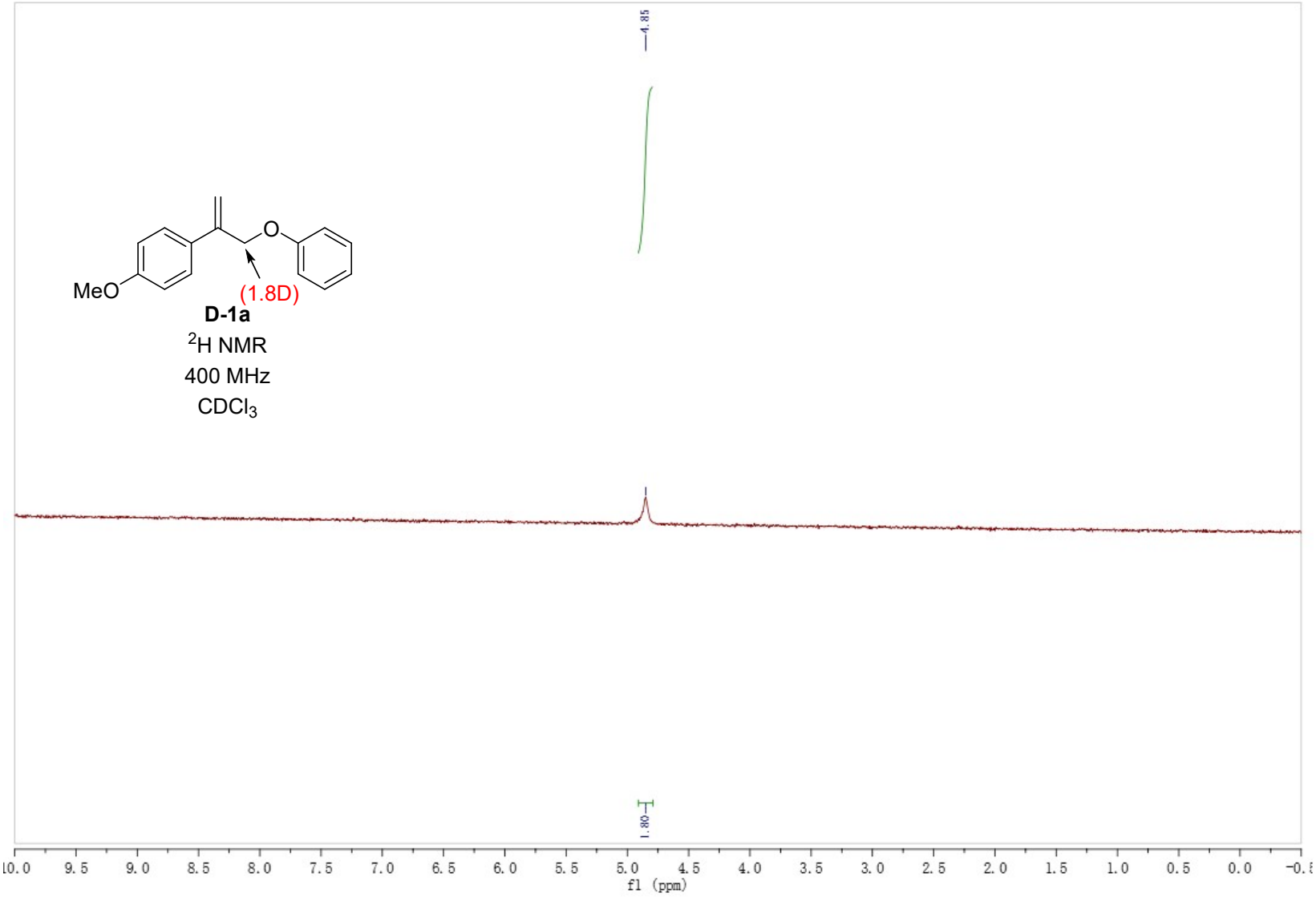
^{1}H NMR

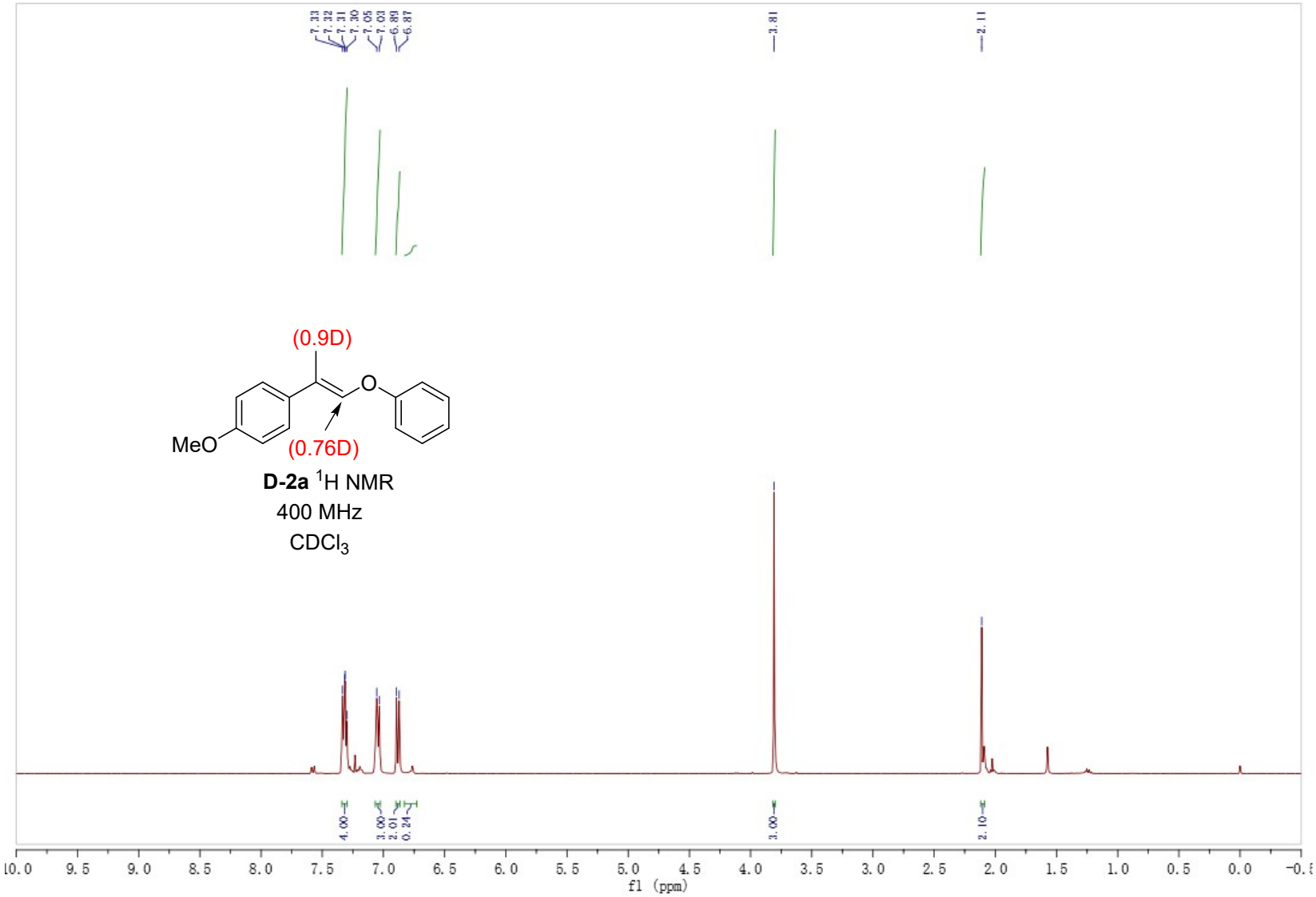
500 MHz

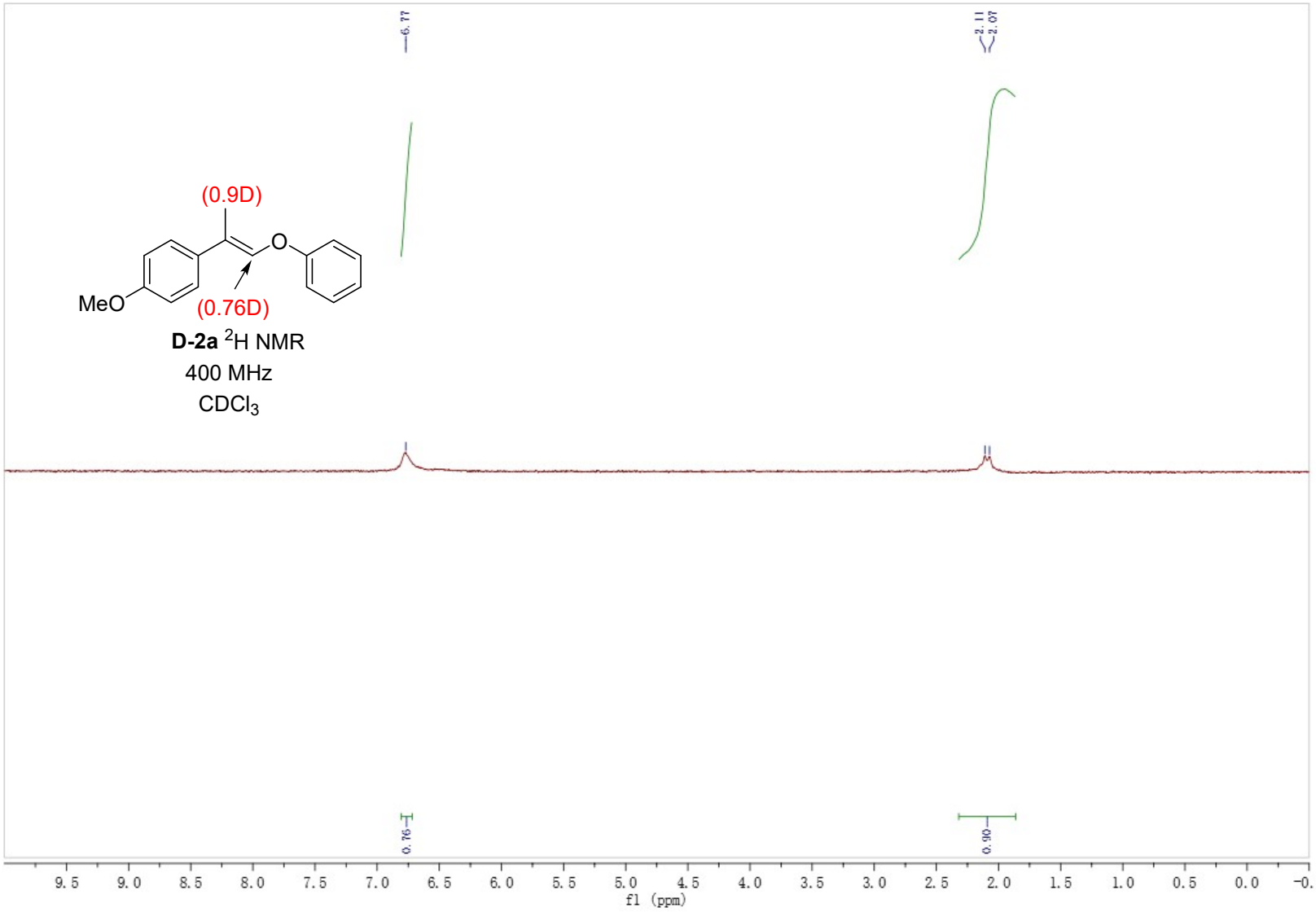
$CDCl_3$

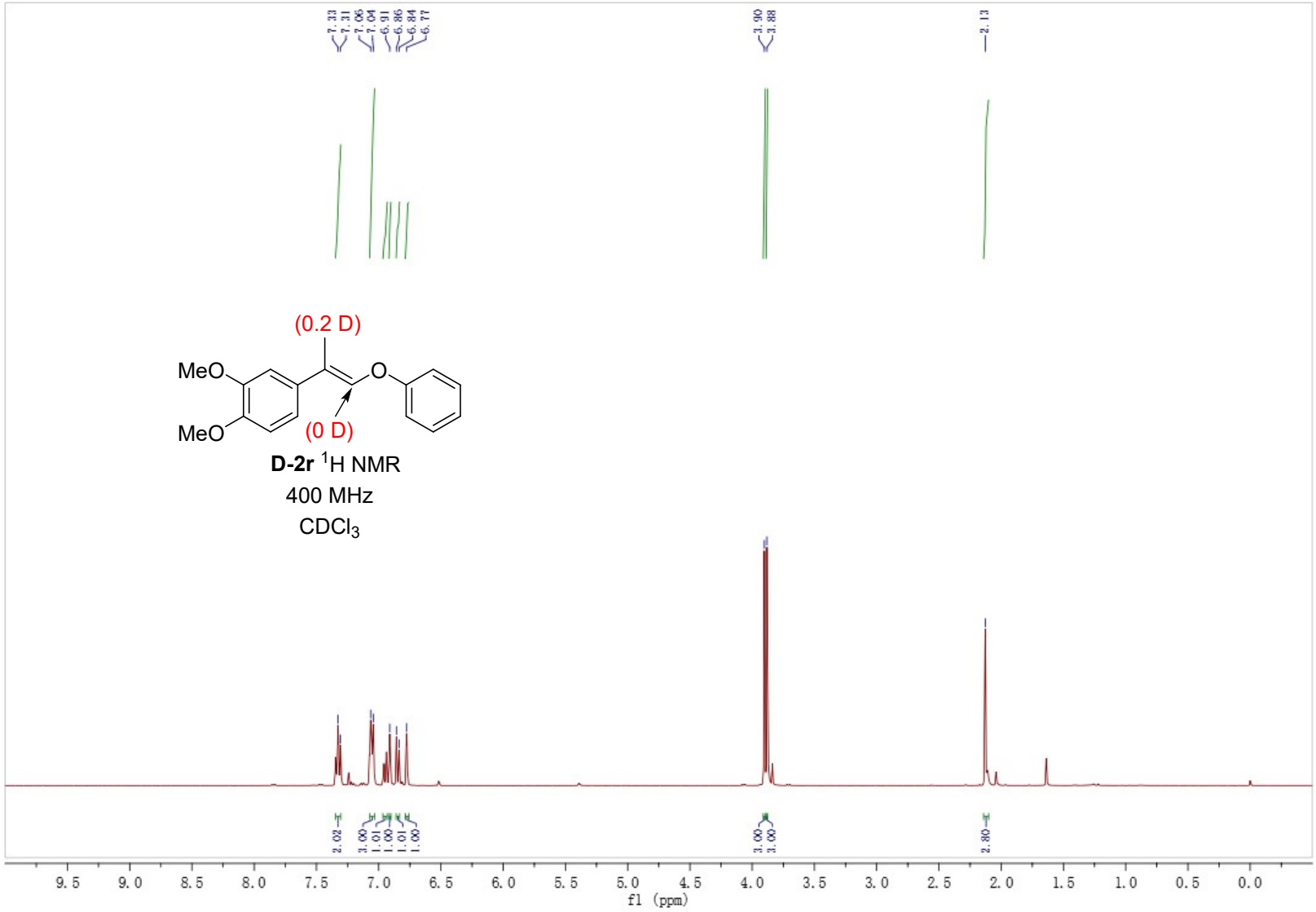

7.48
7.46
7.37
7.35
7.25
6.92
6.90
6.78
3.84
2.26
0.00
Ph
MeO
4b
1H NMR
500 MHz
CDCl3
2.03
4.00
1.02
2.00
1.00
0.06
3.00
0.18
3.00
0.18
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

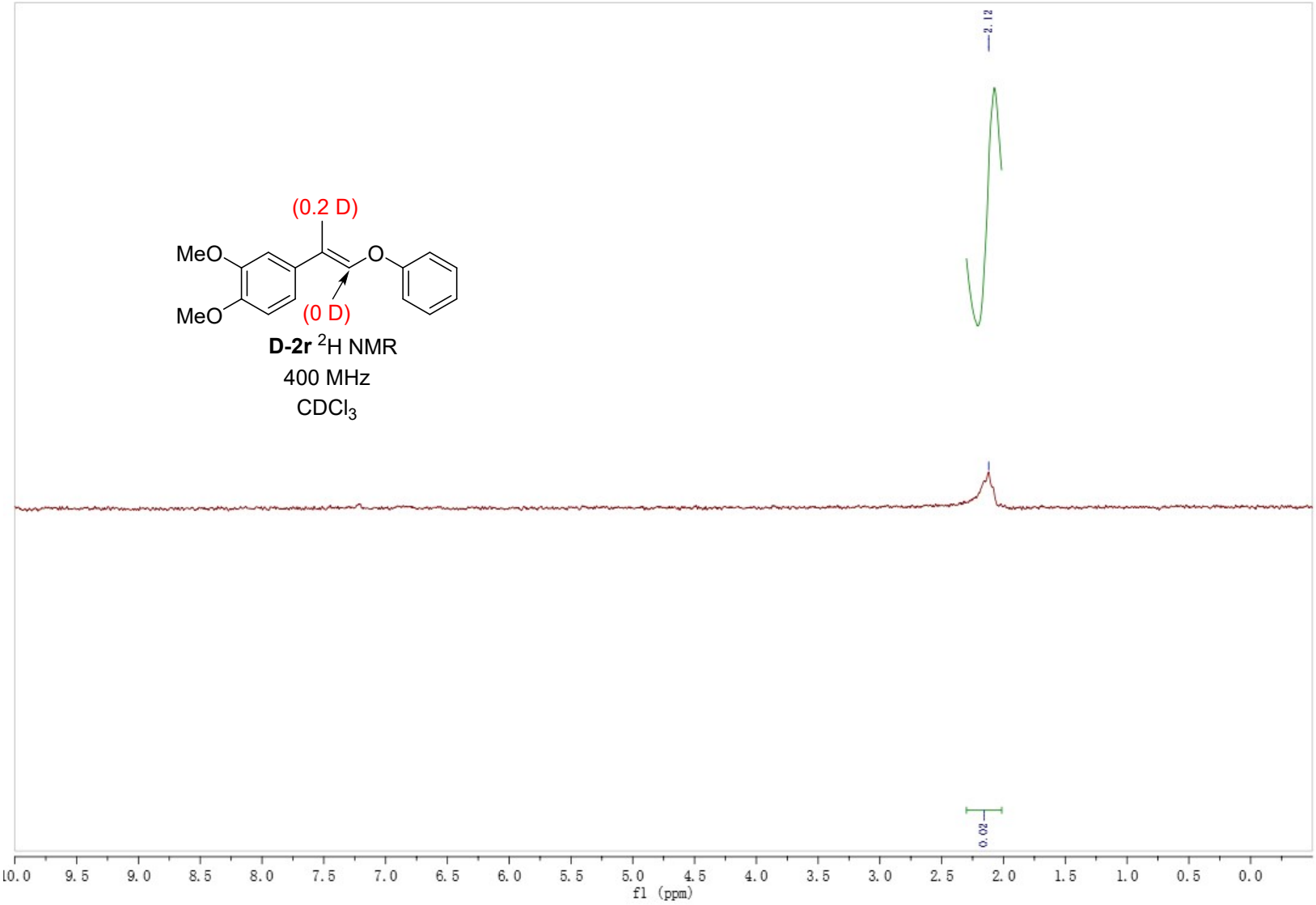

MeO
O
(1.8D)
D-1a
1H NMR
400 MHz
CDCl3
f1 (ppm)

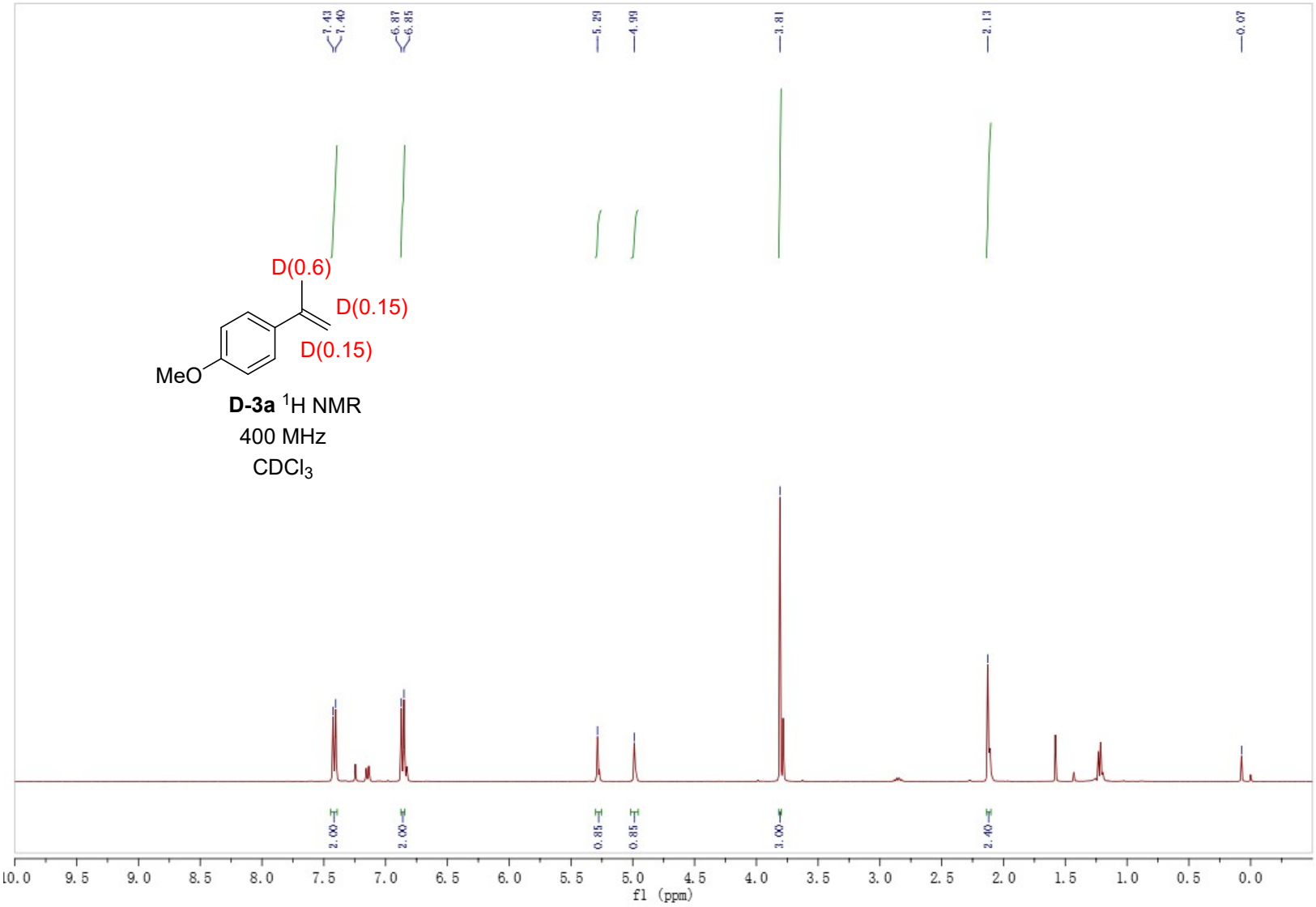

4.85
MeO
O
(1.8D)
D-1a
2H NMR
400 MHz
CDCl3
1.80
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


7.33
7.32
7.31
7.30
7.05
7.03
6.89
6.87
3.81
2.11
(0.9D)
O
MeO
(0.76D)
D-2a 1H NMR
400 MHz
CDCl3
4.00
3.00
2.01
0.24
3.00
2.10
f1 (ppm)

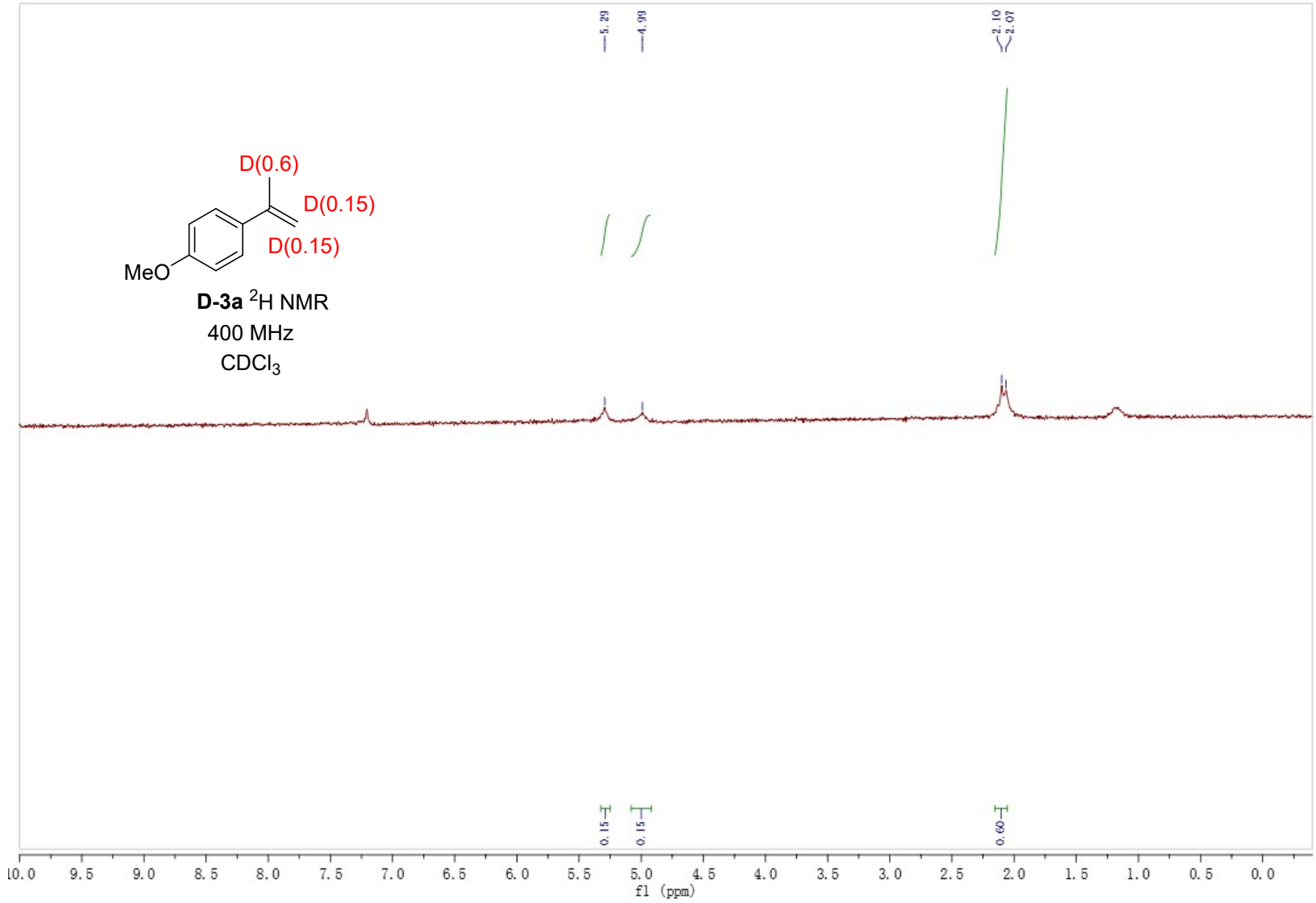

(0.9D)
O
MeO
(0.76D)
D-2a ^{2}H NMR
400 MHz
$CDCl_3$
6.77
2.11
2.07
0.76
0.90
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

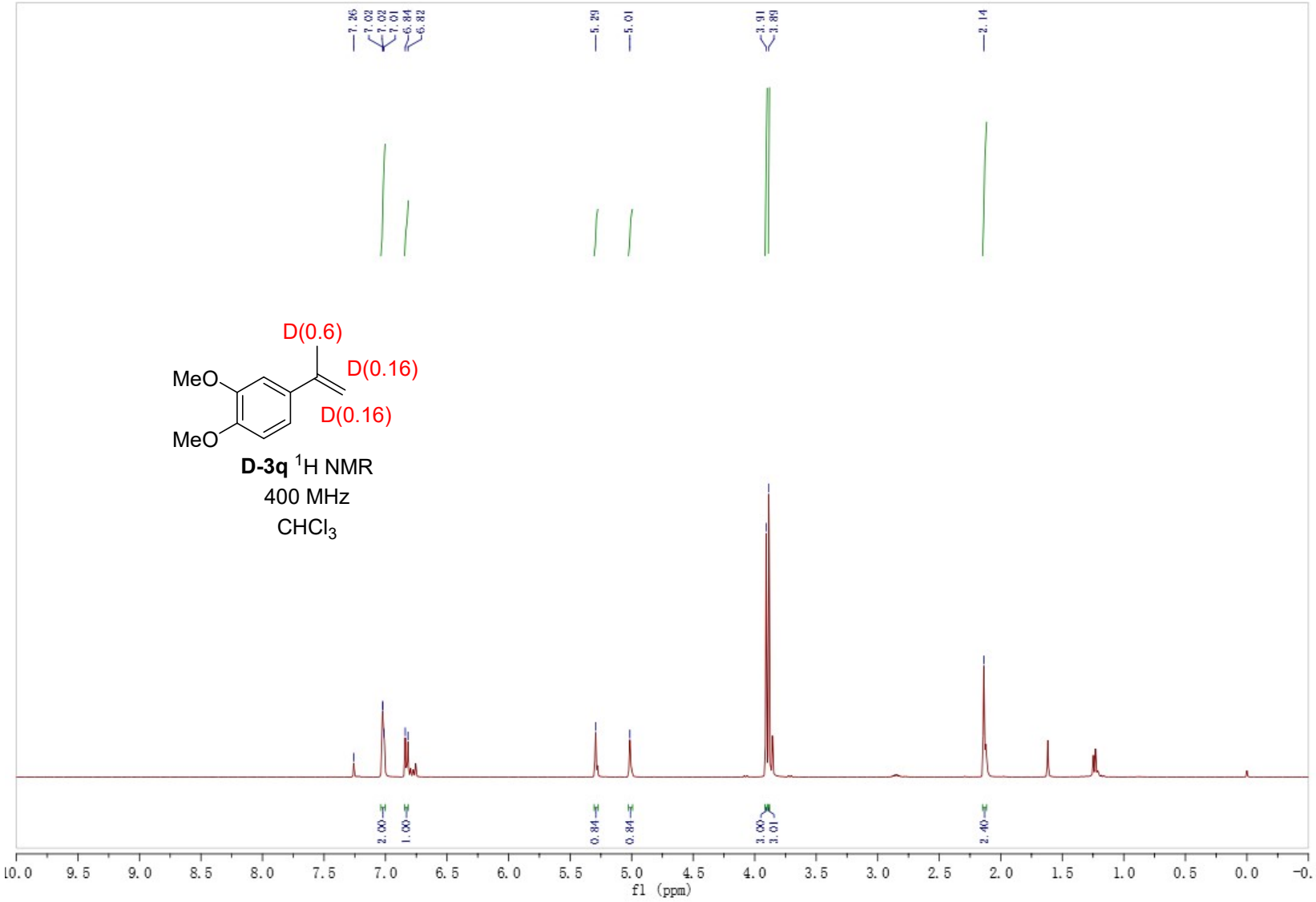

7.33
7.31
7.06
7.04
6.91
6.86
6.84
6.77
3.90
3.88
2.13
(0.2 D)
MeO
MeO
O
(0 D)
D-2r 1H NMR
400 MHz
CDCl3
2.02
3.00
1.01
1.00
1.01
1.00
3.00
3.00
2.80
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

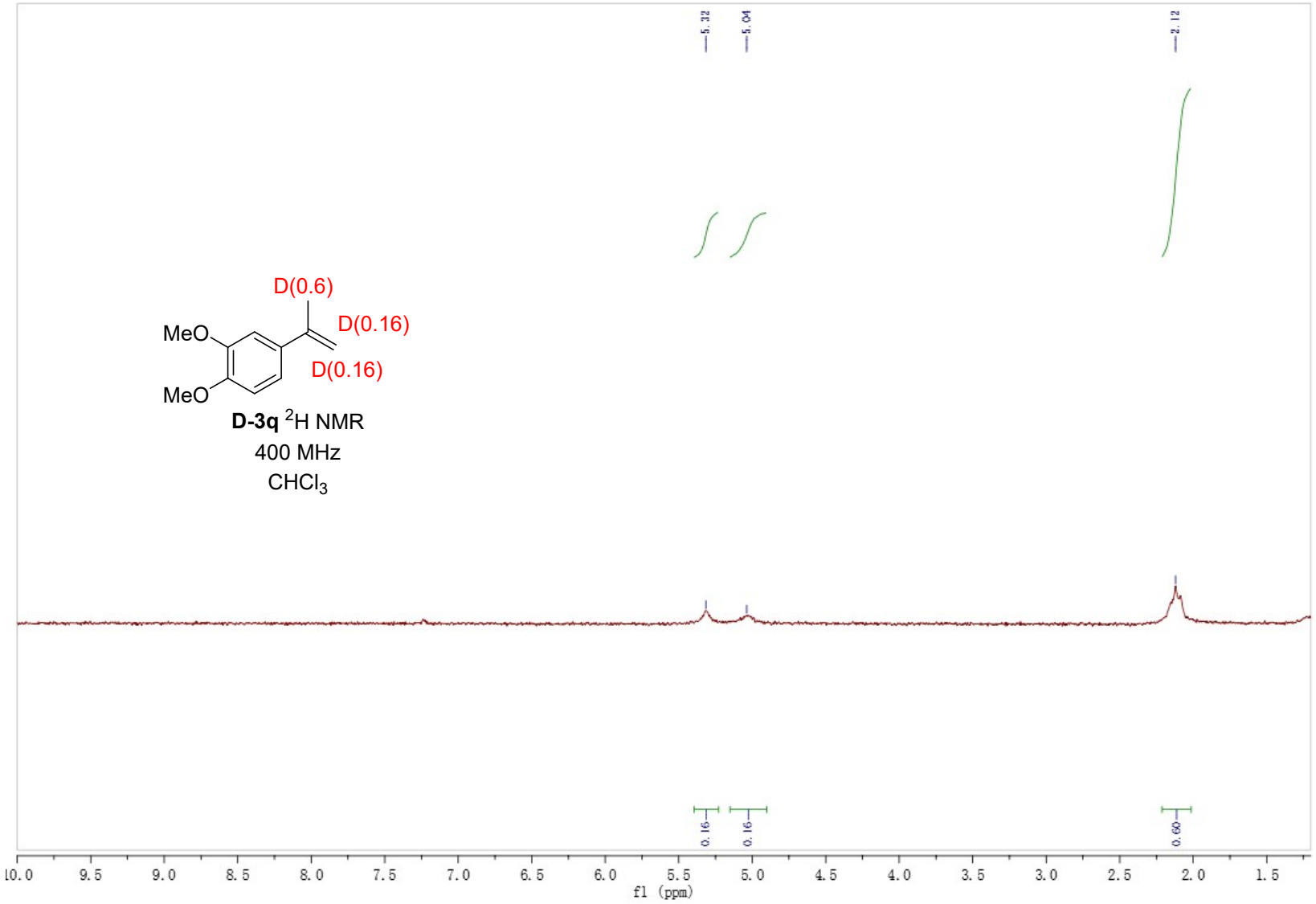

(0.2 D)
MeO
MeO
O
(0 D)
D-2r ^{2}H NMR
400 MHz
$CDCl_3$
2.12
0.02
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)



D-3a ^{1}H NMR
400 MHz
$CDCl_3$


D(0.6)
D(0.15)
D(0.15)
MeO
D-3a 2H NMR
400 MHz
CDCl3
5.29
4.99
2.10
2.07
0.15
0.15
0.60
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


D(0.6)
D(0.16)
D(0.16)
MeO
MeO
D-3q 1H NMR
400 MHz
CHCl3
f1 (ppm)


5.32
5.04
2.12
D(0.6)
D(0.16)
D(0.16)
MeO
MeO
D-3q 2H NMR
400 MHz
CHCl3
0.16
0.16
0.60
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
f1 (ppm)