

## **Supporting information**

# **Organocatalytic enantioselective cycloaddition of naphthoquinone methides**

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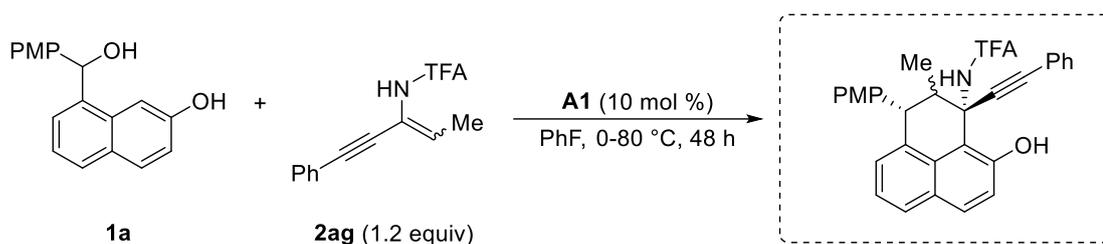
### **Table of contents**

<b>1) General Information.....</b>	<b>S2</b>
<b>2) Preparation of Starting Materials.....</b>	<b>S4</b>
<b>3) General Procedure for [4+2] Cycloaddition Reaction.....</b>	<b>S21</b>
<b>4) X-Ray Crystallographic Data.....</b>	<b>S78</b>
<b>5) References.....</b>	<b>S79</b>
<b>6) Copies of HPLC Chromatograms.....</b>	<b>S80</b>
<b>7) Copies of NMR Spectra.....</b>	<b>S151</b>

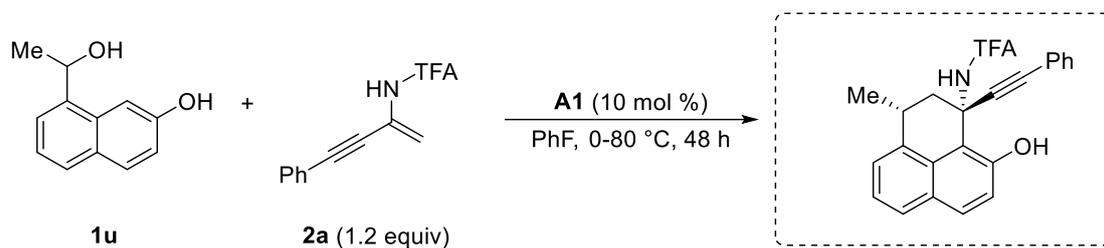
**General Information.** NMR spectra were recorded on AV2 400 or AV2 500 MHz Bruker spectrometers. Chemical shifts are given in ppm. The spectra are calibrated to the residual  $^1\text{H}$  and  $^{13}\text{C}$  signals of the solvents. Multiplicities are abbreviated as follows: singlet (s), doublet (d), triplet (t), quartet (q), doublet-doublet (dd), quintet (quint), sextet (sext), septet (sept), multiplet (m), and broad (b). Infrared spectra were recorded on a JASCO FT/IR-4100 spectrometer. Mass spectra were determined with a Waters ACQUITY H-class UPLC/MS ACQ-SQD by electron ionization (EI positive and negative) or a Finnigan TSQ7000 by electrospray ionization (ESI+). The accurate masses were measured by the mass spectrometry service of the EPFL by ESI-TOF using a QTOF Ultima from Waters or APPI-FT-ICR using a linear ion trap Fourier transform ion cyclotron resonance mass spectrometer from Thermo Scientific. Optical rotations  $\alpha_{\text{D}}$  were obtained with a Jasco P-2000 polarimeter (589 nm). Enantiomeric excesses were determined with a HPLC system using chiral stationary phase columns by comparing the samples with the appropriate racemic samples, column and elution details specified in each entry. Melting points were measured using a Stuart SMP30.

**Materials and Methods:** Unless otherwise stated, starting materials were purchased from commercial sources. More sensitive compounds were stored in a desiccator or in a glove-box if required. Solvents were purchased in HPLC quality, degassed by purging thoroughly with nitrogen and dried over activated molecular sieves of appropriate size. Alternatively, they were purged with argon and passed through alumina columns in a solvent purification system (Innovative Technology). Molecular sieves must be activated in 200 °C vacuum drying oven. Reactions were monitored by thin layer chromatography (TLC) using Merck TLC silica gel 60 F254. Compounds were visualized by UV-light at 254 nm and by dipping the plates in an ethanolic vanillin/sulfuric acid solution or an aqueous potassium permanganate solution followed by heating. Flash column chromatography was performed over silica gel (230-400 mesh). The  $\text{CDCl}_3$  used in the NMR experiments was stored over anhydrous  $\text{K}_2\text{CO}_3$  before use.

### More Reaction Condition and Scope



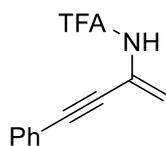
**Figure S1.** Reaction of the **1a** with 1-Me substituted enamide **2ag** gave only complex mixture of products, and no desired product was obtained.



**Figure S2.** Reaction of the Me-substituted naphthol **1u** with **2a** gave only complex mixture of products, and no desired product was obtained.



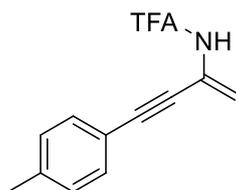
**2,2,2-trifluoro-*N*-(4-phenylbut-1-en-3-yn-2-yl)acetamide (2a)**



**2a**

70% Yield, White solid. M.p = 60 – 63 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.57– 7.47 (m, 2H), 7.45 (s, 1H), 6.30 (s, 1H), 5.47 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 154.9 (q, *J* = 37.5 Hz), 131.8, 129.4, 128.5, 122.1, 121.2, 115.3 (q, *J* = 286.2 Hz), 112.6, 89.0, 83.9; IR (neat): 3305, 3240, 1707, 1623, 1539, 1488, 1331, 1206, 1180, 1166, 880, 754, 687; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>12</sub>H<sub>9</sub>F<sub>3</sub>NO<sup>+</sup> 240.0631; Found 240.0630.

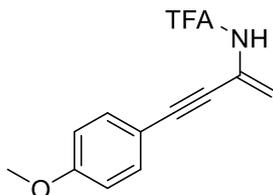
**2,2,2-trifluoro-*N*-(4-(*p*-tolyl)but-1-en-3-yn-2-yl)acetamide (2b)**



**2b**

63% Yield, White solid. M.p = 72 – 74 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.47 (s, 1H), 7.37 (d, *J* = 8.0 Hz, 2H), 7.15 (d, *J* = 8.0 Hz, 2H), 6.27 (s, 1H), 5.44 (s, 1H), 2.36 (s, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 37.0 Hz), 139.8, 131.6, 129.3, 122.2, 118.0, 115.3 (q, *J* = 286.2 Hz), 112.2, 89.2, 83.3, 21.5; IR (neat): 3277, 3227, 1707, 1627, 1549, 1508, 1336, 1209, 1194, 1179, 1160, 878, 812; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>13</sub>H<sub>11</sub>F<sub>3</sub>NO<sup>+</sup> 254.0787; Found 254.0786.

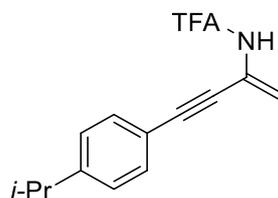
**2,2,2-trifluoro-*N*-(4-(4-methoxyphenyl)but-1-en-3-yn-2-yl)acetamide (2c)**



**2c**

48% Yield, Brown solid. M.p = 52 – 54 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.48 (s, 1H), 7.41 (d, *J* = 9.0 Hz, 2H), 6.87 (d, *J* = 9.0 Hz, 2H), 6.26 (s, 1H), 5.42 (s, 1H), 3.82 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 160.4, 154.9 (q, *J* = 37.5 Hz), 133.3, 122.2, 115.4 (q, *J* = 286.2 Hz), 114.2, 113.1, 111.9, 89.1, 82.8, 55.3; IR (neat): 3289, 2198, 1725, 1661, 1603, 1509, 1252, 1171, 1029, 883, 832; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>13</sub>H<sub>11</sub>F<sub>3</sub>NO<sub>2</sub><sup>+</sup> 270.0736; Found 270.0734.

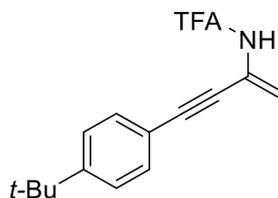
**2,2,2-trifluoro-*N*-(4-(4-isopropylphenyl)but-1-en-3-yn-2-yl)acetamide (2d)**



**2d**

62% Yield, Brown solid. M.p = 50 – 52 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.45 (s, 1H), 7.41 (d, *J* = 8.0 Hz, 2H), 7.21 (d, *J* = 8.5 Hz, 2H), 6.28 (s, 1H), 5.44 (s, 1H), 2.91 (p, *J* = 6.5 Hz, 1H), 1.25 (s, 3H), 1.24 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 37.5 Hz), 150.6, 131.8, 126.7, 122.2, 118.4, 115.3 (q, *J* = 287.5 Hz), 112.2, 89.3, 83.3, 34.1, 23.7; IR (neat): 3438, 3301, 2963, 2928, 1715, 1626, 1534, 1328, 1215, 1180, 1163, 1054, 883, 833; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>15</sub>F<sub>3</sub>NO<sup>+</sup> 280.1100; Found 280.1104.

***N*-(4-(4-(*tert*-butyl)phenyl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2e)**

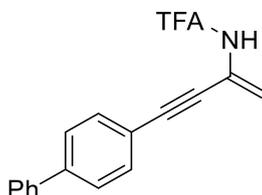


**2e**

43% Yield, Yellow solid. M.p = 46 – 49 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.40 (s, 1H), 7.33 (d, *J* = 8.5 Hz, 2H), 7.29 (d, *J* = 9.0 Hz, 2H), 6.21 (s, 1H), 5.36 (s, 1H), 1.23 (s, 9H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 37.5 Hz), 152.9, 131.5, 125.5, 122.2, 118.1, 115.3 (q, *J* = 286.2 Hz), 112.3, 89.2, 83.3, 34.9, 31.0; IR (neat): 2963, 2868,

1717, 1626, 1538, 1463, 1330, 1216, 1184, 1163, 1017, 883, 834; HRMS (ESI/QTOF) m/z: [M + H]<sup>+</sup> Calcd for C<sub>16</sub>H<sub>17</sub>F<sub>3</sub>NO<sup>+</sup> 296.1257; Found 296.1255.

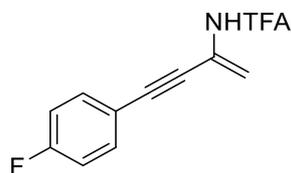
***N*-(4-([1,1'-biphenyl]-4-yl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2f)**



**2f**

66% Yield, Yellow solid. M.p = 107 – 108 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.63 – 7.48 (m, 7H), 7.46 – 7.39 (m, 2H), 7.38 – 7.29 (m, 1H), 6.29 (s, 1H), 5.47 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 37.5 Hz), 142.2, 140.0, 132.2, 128.9, 127.9, 127.1, 127.0, 122.2, 120.0, 115.4 (q, *J* = 287.5 Hz), 112.7, 89.0, 84.5; IR (neat): 3272, 3072, 2199, 1714, 1620, 1550, 1485, 1336, 1217, 1190, 1154, 893, 839, 763, 691; HRMS (ESI/QTOF) m/z: [M + H]<sup>+</sup> Calcd for C<sub>18</sub>H<sub>13</sub>F<sub>3</sub>NO<sup>+</sup> 316.0944; Found 316.0942.

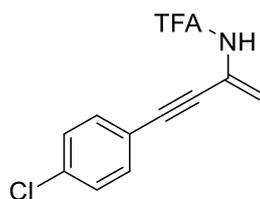
**2,2,2-trifluoro-*N*-(4-(4-fluorophenyl)but-1-en-3-yn-2-yl)acetamide (2g)**



**2g**

45% Yield, Yellow solid. M.p = 81 – 83 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.75 (s, 1H), 7.47 – 7.43 (m, 2H), 7.08 – 6.97 (m, 2H), 6.24 (s, 1H), 5.45 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 163.1 (d, *J* = 250.0 Hz), 154.9 (q, *J* = 37.5 Hz), 133.8 (d, *J* = 8.7 Hz), 121.9, 117.3 (d, *J* = 3.7 Hz), 116.2 (d, *J* = 22.5 Hz), 115.3 (q, *J* = 287.5 Hz), 112.7, 88.0, 83.6; IR (neat): 3296, 3247, 3085, 2223, 1711, 1629, 1598, 1548, 1505, 1341, 1220, 1172, 1157, 885, 836, 738; HRMS (ESI/QTOF) m/z: [M + H]<sup>+</sup> Calcd for C<sub>12</sub>H<sub>8</sub>F<sub>4</sub>NO<sup>+</sup> 258.0537; Found 258.0534.

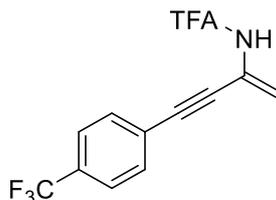
***N*-(4-(4-chlorophenyl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2h)**



**2h**

54% Yield, Yellow solid. M.p = 74 – 76 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.44 – 7.38 (m, 3H), 7.34 (d, *J* = 8.5 Hz, 2H), 6.29 (s, 1H), 5.47 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 37.5 Hz), 135.7, 133.0, 128.9, 121.9, 119.7, 115.3 (q, *J* = 287.5 Hz), 113.0, 88.0, 84.7; IR (neat): 3301, 2205, 1721, 1663, 1625, 1543, 1489, 1213, 1160, 1090, 1015, 882, 828, 721; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>12</sub>H<sub>8</sub>ClF<sub>3</sub>NO<sup>+</sup> 274.0241; Found 274.0240.

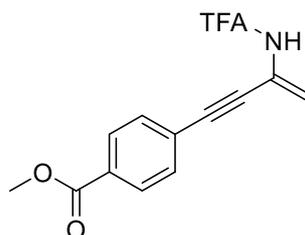
**2,2,2-trifluoro-*N*-(4-(4-(trifluoromethyl)phenyl)but-1-en-3-yn-2-yl)acetamide (2i)**



**2i**

51% Yield, Brown solid. M.p = 50 – 52 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.82 (s, 1H), 7.62 – 7.54 (m, 4H), 6.28 (s, 1H), 5.51 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.2 (q, *J* = 37.5 Hz), 133.1, 132.0, 131.1 (q, *J* = 32.5 Hz), 125.4 (q, *J* = 3.7 Hz), 123.8 (q, *J* = 270.0 Hz), 121.9, 115.4 (q, *J* = 286.2 Hz), 113.90, 87.61, 85.84; IR (neat): 3438, 3302, 2210, 1725, 1607, 1626, 1539, 1405, 1325, 1216, 1164, 1103, 1067, 1017, 885, 847; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>13</sub>H<sub>8</sub>F<sub>6</sub>NO<sup>+</sup> 308.0505; Found 308.0502.

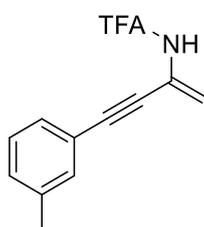
**methyl 4-(3-(2,2,2-trifluoroacetamido)but-3-en-1-yn-1-yl)benzoate (2j)**



## 2j

54% Yield, Yellow solid. M.p = 82 – 86 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 8.02 (s, 1H), 7.98 (d, *J* = 8.0 Hz, 2H), 7.49 (d, *J* = 8.0 Hz, 2H), 6.30 (s, 1H), 5.51 (s, 1H), 3.92 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 166.3, 155.0 (q, *J* = 37.5 Hz), 131.6, 130.4, 129.5, 125.9, 121.9, 115.2 (q, *J* = 287.5 Hz), 113.7, 88.0, 86.4, 52.2; IR (neat): 3438, 3294, 1725, 1623, 1544, 1436, 1309, 1277, 1214, 1159, 1107, 1017, 883, 768; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>14</sub>H<sub>11</sub>F<sub>3</sub>NO<sub>3</sub><sup>+</sup> 298.0686; Found 298.0685.

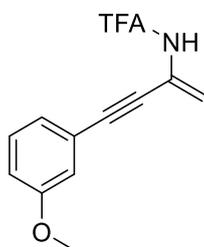
## 2,2,2-trifluoro-*N*-(4-(*m*-tolyl)but-1-en-3-yn-2-yl)acetamide (2k)



## 2k

60% Yield, Pale yellow oil. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.62 (s, 1H), 7.31 – 7.25 (m, 2H), 7.25 – 7.20 (m, 1H), 7.20 – 7.16 (m, 1H), 6.26 (s, 1H), 5.44 (s, 1H), 2.33 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 37.5 Hz), 138.2, 132.2, 130.2, 128.8, 128.3, 122.2, 121.0, 115.3 (q, *J* = 287.5 Hz), 112.5, 89.3, 83.5, 21.0; IR (neat): 3300, 2896, 1716, 1622, 1565, 1545, 1366, 1016, 864; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>13</sub>H<sub>11</sub>F<sub>3</sub>NO<sup>+</sup> 254.0787; Found 254.0785.

## 2,2,2-trifluoro-*N*-(4-(3-methoxyphenyl)but-1-en-3-yn-2-yl)acetamide (2l)

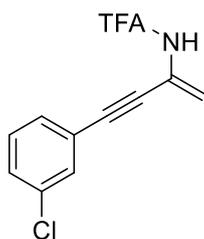


## 2l

50% Yield, Yellow solid. M.p = 58 – 64 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.86 (s, 1H), 7.26 – 7.19 (m, 1H), 7.07 – 7.03 (m, 1H), 6.99 – 6.96 (m, 1H), 6.94 – 6.88 (m, 1H),

6.25 (s, 1H), 5.45 (s, 1H), 3.77 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  159.3, 155.0 (q,  $J = 37.5$  Hz), 129.5, 124.2, 122.2, 122.1, 116.5, 115.8, 115.3 (q,  $J = 286.2$  Hz), 112.9, 88.9, 83.5, 55.1; IR (neat): 3302, 2241, 1720, 1623, 1576, 1541, 1332, 1283, 1246, 1209, 1168, 1042, 906, 878, 684; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{13}\text{H}_{11}\text{F}_3\text{NO}_2^+$  270.0736; Found 270.0733.

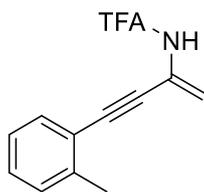
***N*-(4-(3-chlorophenyl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2m)**



**2m**

65% Yield, Yellow solid. M.p = 51 – 52 °C.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.61 (s, 1H), 7.52 – 7.43 (m, 1H), 7.42 – 7.32 (m, 2H), 7.31 – 7.22 (m, 1H), 6.29 (s, 1H), 5.48 (s, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  155.0 (q,  $J = 37.5$  Hz), 134.4, 131.6, 129.8, 129.7, 129.6, 122.9, 121.8, 115.3 (q,  $J = 287.5$  Hz), 113.4, 87.6, 84.8; IR (neat): 3305, 2942, 1715, 1644, 1523, 1206, 1188, 902, 743; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{12}\text{H}_8\text{ClF}_3\text{NO}^+$  274.0241; Found 274.0240.

**2,2,2-trifluoro-*N*-(4-(*o*-tolyl)but-1-en-3-yn-2-yl)acetamide (2n)**

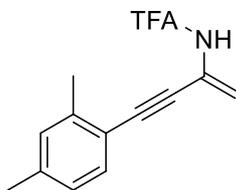


**2n**

68% Yield, Yellow solid. M.p = 48 – 51 °C.  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.44 (d,  $J = 7.5$  Hz, 1H), 7.39 (s, 1H), 7.31 – 7.21 (m, 2H), 7.20 – 7.14 (m, 1H), 6.28 (s, 1H), 5.46 (s, 1H), 2.45 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  154.9 (q,  $J = 37.5$  Hz), 140.6, 132.1, 129.7, 129.5, 125.7, 122.2, 121.0, 115.4 (q,  $J = 287.5$  Hz), 112.3, 88.2, 87.6, 20.5; IR (neat): 3306, 2927, 1717, 1623, 1539, 1214, 1189, 883, 756; HRMS

(ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{13}H_{11}F_3NO^+$  254.0787; Found 254.0788.

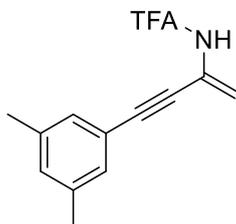
***N*-(4-(2,4-dimethylphenyl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2o)**



**2o**

52% Yield, Yellow solid. M.p = 53 – 55 °C.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.56 (s, 1H), 7.32 (d,  $J$  = 7.5 Hz, 1H), 7.10 – 6.91 (m, 2H), 6.24 (s, 1H), 5.43 (s, 1H), 2.40 (s, 3H), 2.32 (s, 3H);  $^{13}C$  NMR (125 MHz,  $CDCl_3$ )  $\delta$  155.0 (q,  $J$  = 37.5 Hz), 140.5, 139.7, 132.0, 130.5, 126.5, 122.4, 117.9, 115.1 (q,  $J$  = 286.2 Hz), 112.0, 88.4, 87.0, 21.4, 20.4; IR (neat): 3294, 2927, 1718, 1654, 1559, 1541, 1457, 1213, 764, 749; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{14}H_{13}F_3NO^+$  268.0944; Found 268.0945.

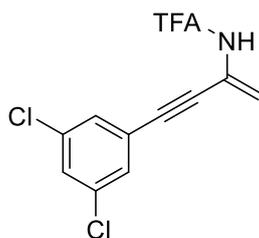
***N*-(4-(3,5-dimethylphenyl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2p)**



**2p**

54% Yield, Yellow solid. M.p = 65 – 69 °C.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.38 (s, 1H), 7.03 (s, 2H), 6.93 (s, 1H), 6.20 (s, 1H), 5.35 (s, 1H), 2.22 (s, 6H);  $^{13}C$  NMR (125 MHz,  $CDCl_3$ )  $\delta$  154.9 (q,  $J$  = 37.5 Hz), 138.2, 131.3, 129.4, 122.2, 120.8, 115.4 (q,  $J$  = 286.2 Hz), 112.2, 89.5, 83.3, 21.0; IR (neat): 3204, 2966, 1724, 1615, 1544, 1428, 1152, 1065, 917; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{14}H_{13}F_3NO^+$  268.0944; Found 268.0947.

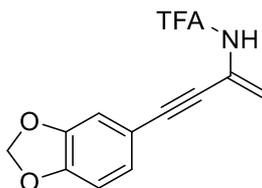
***N*-(4-(3,5-dichlorophenyl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2q)**



**2q**

73% Yield, Yellow solid. M.p = 68 – 71 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.59 (s, 1H), 7.45 – 7.31 (m, 3H), 6.29 (s, 1H), 5.50 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 37.5 Hz), 135.2, 129.8, 129.7, 124.1, 121.6, 115.3 (q, *J* = 287.5 Hz), 114.1, 86.3, 85.8; IR (neat): 3436, 3302, 1719, 1623, 1556, 1215, 1163, 859, 805, 669; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>12</sub>H<sub>7</sub>Cl<sub>2</sub>F<sub>3</sub>NO<sup>+</sup> 307.9851; Found 307.9856.

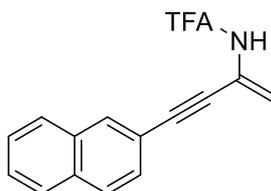
***N*-(4-(benzo[*d*][1,3]dioxol-5-yl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2r)**



**2r**

65% Yield, White solid. M.p = 78 – 79 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.53 (s, 1H), 7.01 (dd, *J* = 8.5, 1.5 Hz, 1H), 6.92 – 6.88 (m, 1H), 6.78 (d, *J* = 8.0 Hz, 1H), 6.25 (s, 1H), 5.99 (s, 2H), 5.42 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 154.9 (q, *J* = 37.5 Hz), 148.8, 147.6, 126.8, 122.2, 115.3 (q, *J* = 287.5 Hz), 114.4, 112.2, 111.5, 108.6, 101.5, 89.1, 82.4; IR (neat): 3441, 3314, 2291, 2211, 1724, 1621, 1541, 1489, 1443, 1242, 1161, 1038, 933, 811; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>13</sub>H<sub>9</sub>F<sub>3</sub>NO<sub>3</sub><sup>+</sup> 284.0529; Found 284.0527.

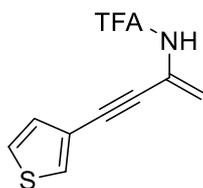
**2,2,2-trifluoro-*N*-(4-(naphthalen-2-yl)but-1-en-3-yn-2-yl)acetamide (2s)**



**2s**

78% Yield, Brown solid. M.p = 49 – 51 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.00 (s, 1H), 7.81 – 7.75 (m, 3H), 7.55 (s, 1H), 7.54 – 7.43 (m, 3H), 6.31 (s, 1H), 5.50 (s, 1H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 155.0 (q, *J* = 38.0 Hz), 133.2, 132.7, 132.2, 128.2, 127.8, 127.9, 127.3, 126.8, 122.1, 118.4, 115.3 (q, *J* = 287.0 Hz), 112.7, 89.4, 84.0; IR (neat): 3060, 2205, 1715, 1621, 1533, 1217, 1176, 1160, 816, 746; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>16</sub>H<sub>11</sub>F<sub>3</sub>NO<sup>+</sup> 290.0787; Found 290.0786.

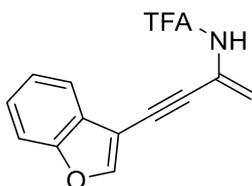
**2,2,2-trifluoro-*N*-(4-(thiophen-3-yl)but-1-en-3-yn-2-yl)acetamide (2t)**



**2t**

61% Yield, Yellow solid. M.p = 77 – 79 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.56 (dd, *J* = 3.0, 1.0 Hz, 1H), 7.41 (s, 1H), 7.31 (dd, *J* = 5.0, 3.0 Hz, 1H), 7.15 (dd, *J* = 5.0, 1.0 Hz, 1H), 6.29 (s, 1H), 5.45 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 154.9 (q, *J* = 37.5 Hz), 130.4, 129.6, 125.9, 122.1, 120.3, 115.4 (q, *J* = 287.5 Hz), 112.5, 84.4, 83.6; IR (neat): 3293, 3283, 2214, 1725, 1682, 1626, 1539, 1326, 1171, 1205, 875, 783, 624; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>10</sub>H<sub>7</sub>F<sub>3</sub>NOS<sup>+</sup> 246.0195; Found 246.0199.

***N*-(4-(benzofuran-3-yl)but-1-en-3-yn-2-yl)-2,2,2-trifluoroacetamide (2u)**

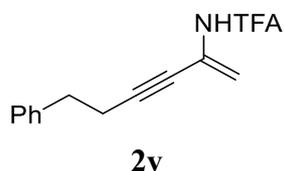


**2u**

64% Yield, Brown solid. M.p = 68 – 72 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.58 (d, *J* = 7.5 Hz, 1H), 7.51 (s, 1H), 7.47 (d, *J* = 8.5 Hz, 1H), 7.40 – 7.35 (m, 1H), 7.29 – 7.24 (m, 1H), 7.06 (s, 1H), 6.39 (s, 1H), 5.58 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.2, 155.0 (q, *J* = 37.5 Hz), 137.0, 127.2, 126.4, 123.6, 121.6, 121.4, 115.3 (q, *J* = 287.5 Hz), 114.4, 113.5, 111.4, 89.2, 79.5; IR (neat): 3477, 2922, 1718, 1626, 1542, 1448, 1384,

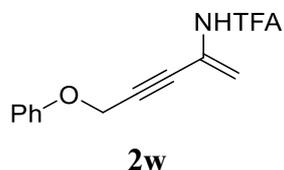
1207, 1165, 877, 750; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{14}H_9F_3NO_2^+$  280.0580; Found 280.0583.

**2,2,2-trifluoro-*N*-(6-phenylhex-1-en-3-yn-2-yl)acetamide (2v)**



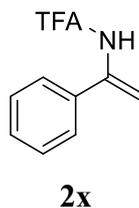
59% Yield, White solid. M.p = 45 – 48 °C.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.34 – 7.25 (m, 3H), 7.26 – 7.16 (m, 3H), 6.13 (s, 1H), 5.24 (s, 1H), 2.85 (t,  $J = 7.5$  Hz, 2H), 2.60 (t,  $J = 7.5$  Hz, 2H);  $^{13}C$  NMR (125 MHz,  $CDCl_3$ )  $\delta$  155.1 (q,  $J = 37.5$  Hz), 140.0, 128.5, 128.4, 126.5, 122.1, 115.3 (q,  $J = 287.5$  Hz), 111.1, 89.7, 81.8, 34.3, 21.1; IR (neat): 3441, 3301, 2235, 1725, 1626, 1533, 1207, 1166, 877, 750; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{20}H_{17}F_3NO^+$  344.1257; Found 344.1255.

**2,2,2-trifluoro-*N*-(5-phenoxy-1-en-3-yn-2-yl)acetamide (2w)**



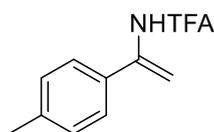
62% Yield, White solid. M.p = 62 – 64 °C.  $^1H$  NMR (500 MHz,  $CDCl_3$ )  $\delta$  7.35 – 7.30 (m, 3H), 7.06 – 6.99 (m, 1H), 6.99 – 6.93 (m, 2H), 6.27 (s, 1H), 5.41 (s, 1H), 4.81 (s, 2H);  $^{13}C$  NMR (125 MHz,  $CDCl_3$ )  $\delta$  157.4, 154.9 (q,  $J = 37.5$  Hz), 129.6, 121.9, 121.2, 115.2 (q,  $J = 287.5$  Hz), 114.9, 113.6, 84.2, 81.9, 56.0; IR (neat): 3439, 3306, 3241, 1726, 1626, 1599, 1539, 1495, 1374, 1330, 1212, 1169, 1012, 907, 753, 690; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{13}H_{11}F_3NO_2^+$  270.0736; Found 270.0741.

**2,2,2-trifluoro-*N*-(1-phenylvinyl)acetamide (2x)**



58% Yield. Pale white oil. M.p = 29 – 33 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.89 (s, 1H), 7.37 – 7.32(m, 1H), 5.78 (s, 1H), 5.30 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.6 (q, *J* = 37.5 Hz), 138.6, 136.2, 129.1, 128.7, 125.7, 115.6 (q, *J* = 286.2 Hz), 106.4; IR (neat): 3460, 1688, 1630, 1340, 1146, 843, 767; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>10</sub>H<sub>9</sub>F<sub>3</sub>NO<sup>+</sup> 216.0631; Found 216.0630.

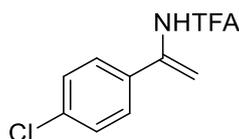
**2,2,2-trifluoro-*N*-(1-(*p*-tolyl)vinyl)acetamide (2y)**



**2y**

62% Yield, White solid. M.p = 87 – 89 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.55 (s, 1H), 7.28 (d, *J* = 8.2 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 5.91 (s, 1H), 5.31 (s, 1H), 2.37 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.4 (q, *J* = 37.5 Hz), 139.5, 138.4, 133.7, 129.6, 125.6, 115.6 (q, *J* = 287.5 Hz), 105.3, 77.0, 21.1; IR (neat): 3221, 1732, 1596, 1203, 1185, 912, 821; HRMS (ESI/QTOF) *m/z*: [M + Na]<sup>+</sup> Calcd for C<sub>11</sub>H<sub>10</sub>F<sub>3</sub>NNaO<sup>+</sup> 252.0607; Found 252.0605.

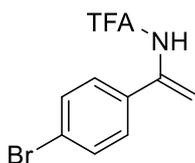
***N*-(1-(4-chlorophenyl)vinyl)-2,2,2-trifluoroacetamide (2z)**



**2z**

73% Yield, White solid. M.p = 94 – 85 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.54 (s, 1H), 7.37 (d, *J* = 8.5 Hz, 2H), 7.33 (d, *J* = 8.6 Hz, 2H), 5.91 (s, 1H), 5.35 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.5 (q, *J* = 37.5 Hz), 137.5, 135.4, 134.8, 129.2, 127.1, 115.5 (q, *J* = 287.5 Hz), 107.0; IR (neat): 3218, 1725, 1601, 1221, 1184, 1106, 908; HRMS (ESI/QTOF) *m/z*: [M + Na]<sup>+</sup> Calcd for C<sub>10</sub>H<sub>7</sub>F<sub>3</sub>NNaO<sup>+</sup> 272.0060; Found 272.0056.

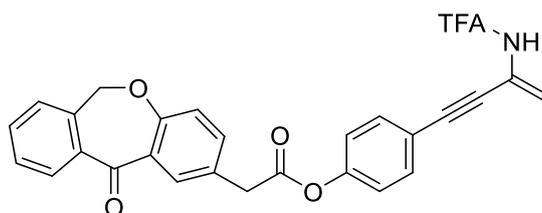
***N*-(1-(4-bromophenyl)vinyl)-2,2,2-trifluoroacetamide (2aa)**



**2aa**

16% Yield, White solid. M.p = 105 – 108 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.54 (d, *J* = 8.0 Hz, 2H), 7.28 (d, *J* = 8.0 Hz, 2H), 5.94 (s, 1H), 5.36 (s, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 155.5 (q, *J* = 37.5 Hz), 137.6, 135.3, 132.2, 127.4, 123.6, 115.6 (q, *J* = 286.2 Hz), 107.0; IR (neat): 3284, 1717, 1548, 1202, 1178, 889, 828; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>10</sub>H<sub>8</sub>BrF<sub>3</sub>NO<sup>+</sup> 293.9736; Found 293.9733.

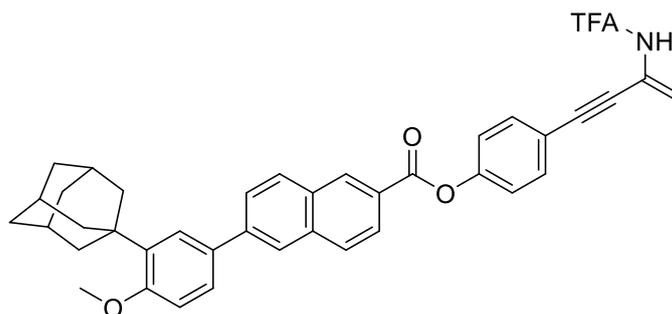
**4-(3-(2,2,2-trifluoroacetamido)but-3-en-1-yn-1-yl)phenyl 2-(11-oxo-6,11-dihydrodibenzo[*b,e*]oxepin-2-yl)acetate (2ac)**



**2ac**

34% Yield, White solid. M.p = 123 – 126 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ <sup>1</sup>H NMR (400 MHz, Chloroform-*d*) δ 8.21 (d, *J* = 2.0 Hz, 1H), 7.90 (d, *J* = 7.6 Hz, 1H), 7.60 – 7.43 (m, 6H), 7.36 (d, *J* = 7.6 Hz, 1H), 7.12 – 7.04 (m, 3H), 6.28 (s, 1H), 5.45 (s, 1H), 5.19 (s, 2H), 3.88 (s, 2H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 190.8, 169.4, 160.7, 154.9 (q, *J* = 37.0 Hz), 151.3, 140.3, 136.2, 133.0, 132.9, 132.6, 129.5, 129.3, 127.8, 126.8, 125.3, 121.9, 121.8, 121.3, 118.9, 115.3 (q, *J* = 287.0 Hz), 112.8, 88.1, 84.0, 73.6, 40.2; IR (neat): 3301, 1754, 1727, 1643, 1503, 1491, 1301, 1205, 1163, 1118, 1016, 908, 883, 761; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>28</sub>H<sub>19</sub>F<sub>3</sub>NO<sub>5</sub><sup>+</sup> 506.1210; Found 506.1204.

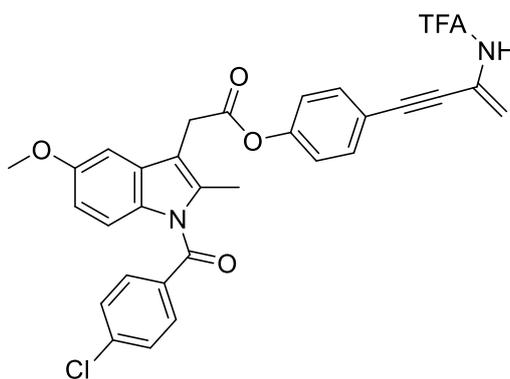
**4-(3-(2,2,2-trifluoroacetamido)but-3-en-1-yn-1-yl)phenyl 6-(3-(adamantan-1-yl)-4-methoxyphenyl)-2-naphthoate (2ad)**



**2ad**

73% Yield, White solid. M.p = 220 – 223 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.76 (s, 1H), 8.17 (d, *J* = 8.4 Hz, 1H), 8.08 – 7.95 (m, 3H), 7.84 (d, *J* = 8.4 Hz, 1H), 7.64 – 7.53 (m, 4H), 7.39 (s, 1H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.00 (d, *J* = 8.4 Hz, 1H), 6.32 (s, 1H), 5.49 (s, 1H), 3.91 (s, 3H), 2.19 (s, 6H), 2.11 (s, 3H), 1.81 (s, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 165.0, 159.1, 154.9 (q, *J* = 37.0 Hz), 151.8, 142.0, 139.1, 136.4, 133.1, 132.3, 131.9, 131.2, 129.8, 128.5, 126.8, 126.0, 125.8, 125.7(2), 125.6(7), 122.2, 121.9, 118.8, 115.3 (q, *J* = 288.0 Hz), 112.8, 112.1, 88.3, 84.0, 55.2, 40.6, 37.2, 37.1, 29.1; IR (neat): 3439, 3289, 2902, 2849, 1732, 1713, 1626, 1546, 1504, 1473, 1283, 1237, 1201, 1165, 882, 807, 740; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>40</sub>H<sub>35</sub>F<sub>3</sub>NO<sub>4</sub><sup>+</sup> 650.2513; Found 650.2510.

**4-(3-(2,2,2-trifluoroacetamido)but-3-en-1-yn-1-yl)phenyl 2-(1-(4-chlorobenzoyl)-5-methoxy-2-methyl-1*H*-indol-3-yl)acetate (2ae)**

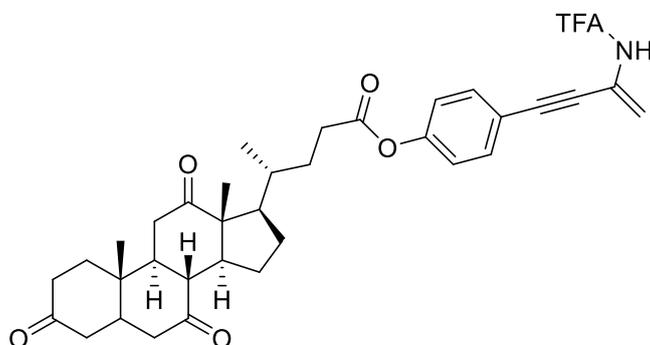


**2ae**

77% Yield, White solid. M.p = 52 – 53 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 7.67 (d, *J* = 8.5 Hz, 2H), 7.53 (s, 1H), 7.49 – 7.44 (m, 4H), 7.07 (d, *J* = 9.0 Hz, 2H), 7.04 (d, *J* = 2.2 Hz, 2H), 6.88 (d, *J* = 9.0 Hz, 1H), 6.70 (dd, *J* = 9.0, 2.0 Hz, 1H), 6.28 (s, 1H), 5.45 (s,

1H), 3.90 (s, 2H), 3.83 (s, 3H), 2.45 (s, 3H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>) δ 168.8, 168.3, 156.2, 154.9 (q, *J* = 37.5 Hz), 151.3, 139.4, 136.3, 133.8, 131.2, 130.9, 130.4, 129.1, 121.9, 121.7, 118.9, 115.3 (q, *J* = 289.3 Hz), 115.0, 112.8, 111.8, 111.6, 101.3, 88.1, 84.0, 55.7, 30.5, 13.3; IR (neat): 3307, 2928, 1753, 1728, 1879, 1503, 1478, 1458, 1322, 1203, 1163, 1125, 925, 846, 754; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>31</sub>H<sub>23</sub>ClF<sub>3</sub>N<sub>2</sub>O<sub>5</sub><sup>+</sup> 595.1242; Found 595.1241.

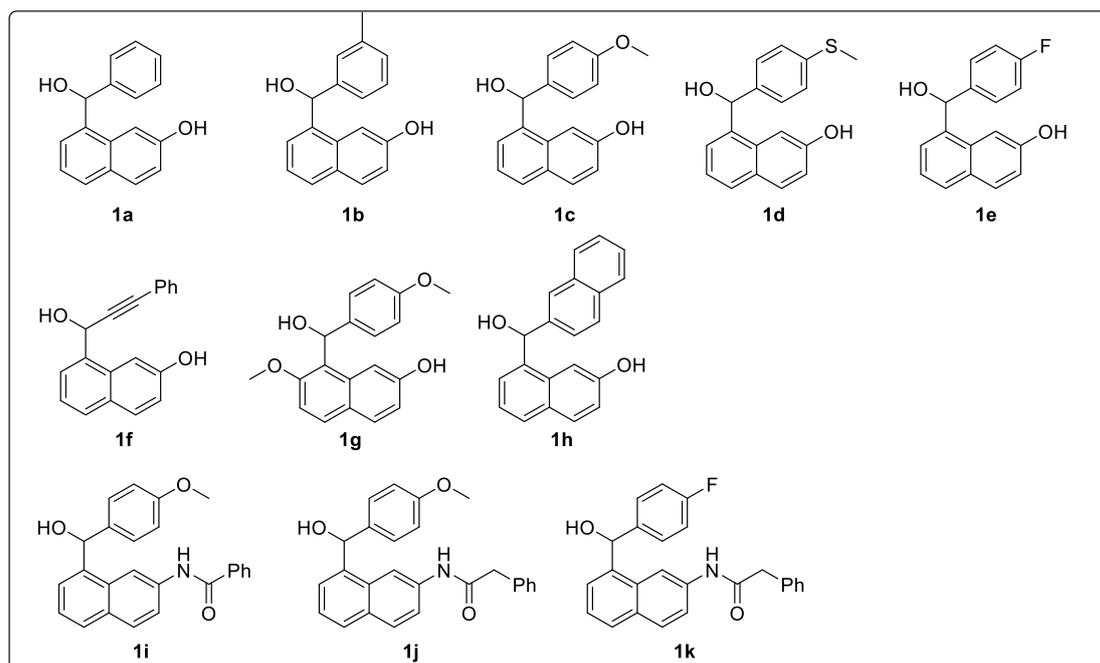
**4-(3-(2,2,2-trifluoroacetamido)but-3-en-1-yn-1-yl)phenyl** **(4R)-4-**  
**((8R,9S,10S,13R,14S,17R)-10,13-dimethyl-3,7,12-trioxohexadecahydro-1H-**  
**cyclopenta[*a*]phenanthren-17-yl)pentanoate (2af)**



**2af**

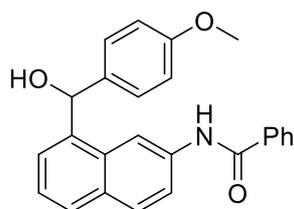
81% Yield, White solid. M.p = 138 – 141 °C. <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 11.13 (s, 1H), 7.57 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 8.8 Hz, 2H), 5.95 (s, 1H), 5.49 (s, 3H), 4.09 – 3.99 (m, 1H), 3.11 – 2.94 (m, 3H), 2.90 – 2.79 (m, 1H), 2.71 – 2.61 (m, 1H), 2.58 – 2.52 (m, 1H), 2.49 – 2.44 (m, 2H), 2.38 – 2.24 (m, 3H), 2.20 – 2.11 (m, 2H), 1.98 – 1.81 (m, 8H), 1.79 – 1.68 (m, 2H), 1.55 – 1.45 (m, 1H), 1.29 – 1.22 (m, 1H), 1.21 – 1.13 (m, 1H), 1.04 (s, 3H), 0.89 – 0.81 (m, 3H); <sup>13</sup>C NMR (100 MHz, DMSO-*d*<sub>6</sub>) δ 211.8, 209.5, 209.4, 173.1, 171.8, 155.1, 154.8, 154.4, 154.0, 151.0, 132.7, 122.7, 122.4, 119.7, 118.6, 116.8, 114.6, 113.9, 111.1, 88.0, 84.6, 59.6, 56.2, 51.2, 47.9, 46.0, 45.3, 44.5, 44.0, 42.5, 38.3, 36.1, 35.6, 35.0, 34.5, 30.9, 30.0, 27.2, 24.5, 21.1, 18.6, 11.4; IR (neat): 3285, 3140, 3060, 2961, 2874, 2203, 1755, 1713, 1624, 1544, 1381, 1273, 1207, 1163, 920, 882, 736, 527; HRMS (ESI/QTOF) *m/z*: [M + Na]<sup>+</sup> Calcd for C<sub>36</sub>H<sub>40</sub>F<sub>3</sub>NNaO<sub>6</sub><sup>+</sup> 662.2700; Found 662.2702.

## Preparation of 8-(hydroxyarylmethyl)naphthalen-2-ols and 2-naphthylamines **1**:



8-(hydroxyarylmethyl)naphthalen-2-ols and 2-naphthylamines **1** were prepared according to our previously reported procedure<sup>2</sup>. Dienes **1a–1h** are known compounds and their physical and spectroscopic data were reported in previous publication<sup>2</sup>.

### *N*-(8-(hydroxy(4-methoxyphenyl)methyl)naphthalen-2-yl)benzamide (**1i**)

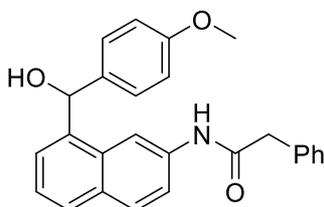


**1i**

68% Yield, Red solid. M.p = 160 – 164 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.40 (s, 1H), 8.03 (s, 1H), 7.86 – 7.78 (m, 3H), 7.73 (d, *J* = 8.0 Hz, 1H), 7.68 (dd, *J* = 8.8, 2.0 Hz, 1H), 7.62 (d, *J* = 7.2 Hz, 1H), 7.55 – 7.50 (m, 1H), 7.45 (d, *J* = 7.6 Hz, 2H), 7.43 – 7.37 (m, 2H), 7.34 (d, *J* = 8.8 Hz, 2H), 6.82 (d, *J* = 8.8 Hz, 2H), 6.46 (s, 1H), 3.73 (s, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 166.0, 159.1, 138.8, 135.8, 135.3, 135.0, 131.9, 131.3, 131.1, 129.7, 128.8, 128.5, 128.0, 127.1, 125.0, 124.6, 120.0, 113.9, 113.4, 73.2, 55.3; IR (neat): 3529, 3312, 3059, 1645, 1499, 1429, 1280, 1254, 1173, 1032, 870, 829, 764,

714, 570; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{25}H_{22}NO_3^+$  384.1594; Found 384.1592.

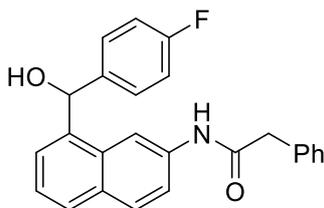
***N*-(8-(hydroxy(4-methoxyphenyl)methyl)naphthalen-2-yl)-2-phenylacetamide (1j)**



**1j**

64% Yield, White solid. M.p = 84 – 88 °C.  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  8.26 (s, 1H), 7.75 – 7.45 (m, 6H), 7.40 – 7.26 (m, 8H), 6.78 (d,  $J$  = 8.0 Hz, 2H), 6.36 (s, 1H), 3.71 (s, 3H), 3.62 (s, 2H);  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  169.4, 158.9, 138.8, 135.4, 135.2, 134.4, 131.0(4), 130.9(8), 129.5, 129.4, 129.1, 128.4, 127.8, 127.5, 124.8, 124.5, 119.5, 113.8, 112.9, 72.9, 55.2, 44.7; IR (neat): 3300, 3058, 2931, 1661, 1585, 1555, 1507, 1454, 1252, 1173, 1031, 832, 749, 573; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{26}H_{24}NO_3^+$  398.751; Found 398.750.

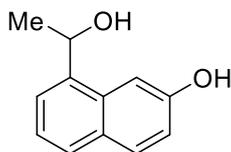
***N*-(8-((4-fluorophenyl)(hydroxy)methyl)naphthalen-2-yl)-2-phenylacetamide (1k)**



**1k**

70% Yield, White solid. M.p = 90 – 94 °C.  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  8.34 (s, 1H), 7.74 – 7.64 (m, 2H), 7.52 (d,  $J$  = 7.2 Hz, 1H), 7.40 – 7.31 (m, 6H), 7.31 – 7.23 (m, 3H), 7.00 – 6.89 (m, 2H), 6.39 (s, 1H), 3.65 (s, 2H);  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  169.4, 162.1 (d,  $J$  = 245.7 Hz), 138.8, 138.6, 135.4, 134.3, 131.1, 130.9, 129.5, 129.2, 128.0, 128.7 (d,  $J$  = 8.0 Hz), 127.6, 125.1, 124.5, 119.4, 115.2 (d,  $J$  = 22.0 Hz), 112.7, 72.7, 44.7; IR (neat): 3322, 3022, 1625, 1513, 1429, 1280, 1176, 1054, 997, 829, 686; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{25}H_{21}FNO_2^+$  386.1551; Found 386.1550.

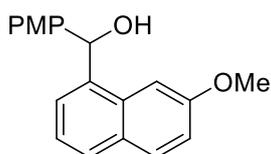
### 8-(1-hydroxyethyl)naphthalen-2-ol (**1u**)



**1u**

86% Yield, Brown solid. M.p = 129 – 132 °C. <sup>1</sup>H NMR (500 MHz, (CD<sub>3</sub>)<sub>2</sub>CO)) δ 8.69 (s, 1H), 7.90 – 7.45 (m, 5H), 7.32 – 7.05 (m, 2H), 5.48 (s, 1H), 4.35 (s, 1H), 1.55 (s, 3H); <sup>13</sup>C NMR (125 MHz, (CD<sub>3</sub>)<sub>2</sub>CO)) δ 155.9, 141.7, 132.7, 131.0, 129.6, 127.8, 123.2, 123.2, 118.4, 106.2, 67.1, 25.1; IR (neat): 3621, 1678, 1640, 1273, 750, 672; HRMS (ESI/QTOF) m/z: [M + Na]<sup>+</sup> Calcd for C<sub>12</sub>H<sub>12</sub>NaO<sub>2</sub><sup>+</sup> 211.0730; Found 211.0728.

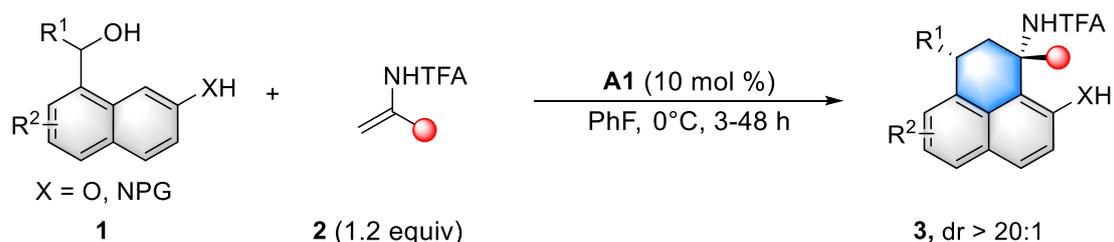
### (7-methoxynaphthalen-1-yl)(4-methoxyphenyl)methanol (**1a'**)



**1a'**

<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.51 – 7.44 (m, 2H), 7.38 (d, *J* = 7.2 Hz, 1H), 7.12 – 7.05 (m, 1H), 7.01 (d, *J* = 8.8 Hz, 2H), 6.97 (s, 1H), 6.86 (dd, *J* = 9.2, 2.4 Hz, 1H), 6.55 (d, *J* = 8.8 Hz, 2H), 5.96 (s, 1H), 3.47 (s, 3H), 3.44 (s, 3H), 3.13 (s, 1H). <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 158.6, 157.1, 137.7, 135.2, 131.4, 129.8, 129.1, 128.1, 127.6, 124.5, 122.8, 117.7, 113.5, 102.9, 73.2, 54.9. HRMS (ESI/QTOF) m/z: [M + Na]<sup>+</sup> Calcd for C<sub>19</sub>H<sub>18</sub>NaO<sub>3</sub><sup>+</sup> 317.1148; Found 317.1154.

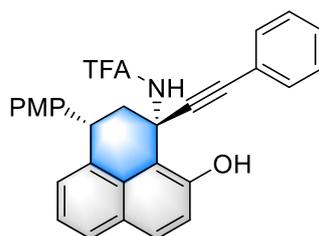
### General procedure for the synthesis of dihydrophenalenes **3**:



A 10 mL reaction tube was charged with chiral phosphoric acid **A1** (10 mol %, 0.02

mmol, 15 mg), **1** (0.2 mmol) and **2** (1.2 equiv, 0.24 mmol), PhF (2 mL) were added sequentially. The reaction mixture was then stirred at 0 °C. After completion of the reaction (monitored by TLC), the reaction mixture was concentrated under vacuum and purified by column chromatography on silica gel, eluting with EtOAc/hexane to afford the products **3**.

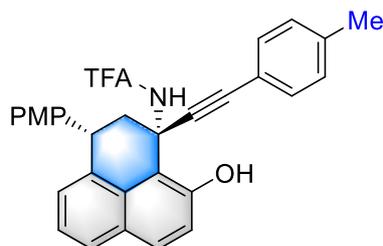
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(phenylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (**3a**)**



**3a**

Compound **3a** was prepared in 92% yield (92.2 mg) according to the general procedure. 7 h. Orange Solid. M.p = 75 – 79 °C.  $[\alpha]_D^{20} +75.2$  (*c* 0.47, DCM). 93% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 93/7, *v* = 1.0 mL · min<sup>-1</sup>,  $\lambda$  = 220 nm; TR = 8.47 min (major), 10.34 min (minor)). <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  8.25 (s, 1H), 7.85 (d, *J* = 9.0 Hz, 1H), 7.67 (d, *J* = 8.0 Hz, 1H), 7.54 – 7.43 (m, 2H), 7.37 – 7.29 (m, 3H), 7.26 – 7.17 (m, 4H), 6.96 (d, *J* = 7.5 Hz, 1H), 6.91 (d, *J* = 8.5 Hz, 2H), 6.67 (s, 1H), 4.22 (dd, *J* = 13.5, 4.0 Hz, 1H), 3.82 (s, 3H), 3.46 (dd, *J* = 14.0, 4.0 Hz, 1H), 2.75 (t, *J* = 13.5 Hz, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  158.8, 156.2 (q, *J* = 37.5 Hz), 153.3, 135.7, 134.8, 132.1, 130.0, 129.3, 129.2, 129.0, 128.4, 127.1, 126.8, 123.4, 120.9, 120.4, 115.4 (q, *J* = 287.5 Hz), 113.0, 87.3, 86.4, 55.3, 51.3, 42.1, 40.9; IR (neat): 3425, 3016, 2944, 1719, 1596, 1466, 1437, 1178, 842, 819, 761; HRMS (ESI/QTOF) *m/z*: [*M* + H]<sup>+</sup> Calcd for C<sub>30</sub>H<sub>23</sub>F<sub>3</sub>NO<sub>3</sub><sup>+</sup> 502.1625; Found 502.1620.

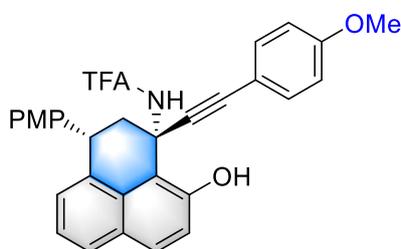
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(*p*-tolylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (**3b**)**



**3b**

Compound **3b** was prepared in 86% yield (88.5 mg) according to the general procedure. 7 h. Pale Orange oil.  $[\alpha]_{\text{D}}^{20} +86.1$  ( $c$  0.51, DCM). 94% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL}\cdot\text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 10.55 min (major), 14.27 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.84 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.66 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.37 (d,  $J = 7.6 \text{ Hz}$ , 2H), 7.26 – 7.16 (m, 5H), 7.11 (d,  $J = 7.2 \text{ Hz}$ , 2H), 6.95 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.91 (d,  $J = 7.6 \text{ Hz}$ , 2H), 6.75 – 6.66 (m, 1H), 4.21 (d,  $J = 13.6 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.46 (dd,  $J = 13.6, 4.0 \text{ Hz}$ , 1H), 2.74 (t,  $J = 13.6 \text{ Hz}$ , 1H), 2.33 (s, 3H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 156.1 (q,  $J = 37.0 \text{ Hz}$ ), 153.3, 139.6, 135.8, 134.8, 132.0, 131.9, 129.9, 129.1, 129.0, 127.0, 126.8, 123.4, 120.4, 117.7, 115.4 (q,  $J = 287.0 \text{ Hz}$ ), 116.0, 114.2, 113.0, 87.5, 85.7, 55.3, 51.3, 42.0, 40.9, 21.5; IR (neat): 3423, 3302, 2933, 1720, 1619, 1512, 1460, 1441, 1375, 1256, 1211, 1177, 1035, 831, 817, 764 ; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_3^+$  516.1781; Found 516.1791.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-((4-methoxyphenyl)ethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3c)**

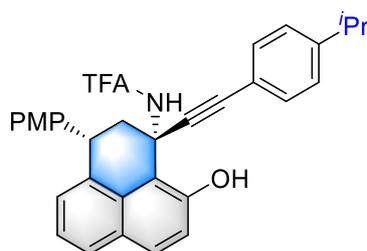


**3c**

Compound **3c** was prepared in 92% yield (97.6 mg) according to the general procedure. 7 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20} -40.9$  ( $c$  0.53, DCM). 94% ee (determined by HPLC, IE, *n*-

hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 12.98 min (major), 19.50 min (minor).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.85 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.67 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.41 (d,  $J = 8.4 \text{ Hz}$ , 2H), 7.26 – 7.16 (m, 4H), 6.98 – 6.89 (m, 3H), 6.82 (d,  $J = 8.4 \text{ Hz}$ , 2H), 6.65 (s, 1H), 4.20 (d,  $J = 11.2 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.79 (s, 3H), 3.47 (dd,  $J = 13.6, 3.6 \text{ Hz}$ , 1H), 2.73 (t,  $J = 13.6 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  160.4, 158.7, 156.1 (q,  $J = 37.5 \text{ Hz}$ ), 153.3, 135.8, 134.8, 133.6, 132.0, 130.0, 129.1, 128.9, 127.1, 126.8, 123.4, 120.4, 115.4 (q,  $J = 289.9 \text{ Hz}$ ), 114.2, 114.0, 113.1, 112.8, 87.5, 85.0, 55.3, 51.3, 42.0, 40.9, 25.5; IR (neat): 3346, 2863, 1735, 1602, 1515, 1444, 1206, 1187, 832, 698; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_4^+$  532.1730; Found 516.1733.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-1-((4-isopropylphenyl)ethynyl)-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3d)**

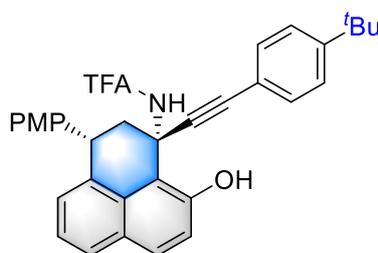


**3d**

Compound **3d** was prepared in 93% yield (100.9 mg) according to the general procedure. 8 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20} -68.1$  ( $c$  0.49, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 8.58 min (major), 12.36 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.30 (s, 1H), 7.85 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.67 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.42 (d,  $J = 8.0 \text{ Hz}$ , 2H), 7.27 – 7.15 (m, 6H), 6.95 (d,  $J = 7.0 \text{ Hz}$ , 1H), 6.91 (d,  $J = 9.0 \text{ Hz}$ , 2H), 6.64 (s, 1H), 4.21 (dd,  $J = 13.5, 3.5 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.47 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.88 (p,  $J = 7.0 \text{ Hz}$ , 1H), 2.73 (t,  $J = 13.5 \text{ Hz}$ , 1H), 1.23 (s, 3H), 1.21 (s, 3H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 156.1 (q,  $J = 37.5 \text{ Hz}$ ), 153.3, 150.1, 135.8, 134.8, 132.1, 132.0, 130.0, 129.1, 129.0, 127.1, 126.8, 126.5, 123.4, 120.4, 118.1, 115.7 (q,  $J = 287.5 \text{ Hz}$ ), 114.2, 113.1, 87.7, 85.7, 55.3, 51.3, 42.0, 40.9, 34.1, 23.7; IR (neat): 3424, 2960, 2929, 1720, 1619, 1512,

1461, 1441, 1256, 1211, 1177, 1035, 831, 765; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$   
Calcd for  $C_{33}H_{29}F_3NO_3^+$  544.2094; Found 544.2092.

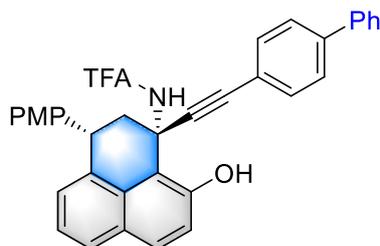
***N*-((1*R*,3*S*)-1-((4-*tert*-butyl)phenyl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3e)**



**3e**

Compound **3e** was prepared in 67% yield (74.6 mg) according to the general procedure. 9 h. Brown oil.  $[\alpha]_D^{20}$  -111.2 (c 0.31, DCM). 90% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 5.40 min (major), 6.61 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.36 (s, 1H), 7.83 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.65 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.42 (d,  $J = 8.4 \text{ Hz}$ , 2H), 7.33 (d,  $J = 8.4 \text{ Hz}$ , 2H), 7.24 – 7.16 (m, 4H), 6.95 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.90 (d,  $J = 8.4 \text{ Hz}$ , 2H), 6.73 (s, 1H), 4.22 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 3.80 (s, 3H), 3.47 (dd,  $J = 15.0, 4.0 \text{ Hz}$ , 1H), 2.74 (t,  $J = 13.6 \text{ Hz}$ , 1H), 1.29 (s, 9H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 155.5 (q,  $J = 37.0 \text{ Hz}$ ), 153.3, 152.8, 135.8, 134.8, 132.0, 131.8, 129.9, 129.1, 129.0, 127.0, 126.8, 125.4, 123.4, 120.4, 117.8, 115.4 (q,  $J = 288.0 \text{ Hz}$ ), 114.2, 113.0, 87.5, 85.7, 55.2, 51.3, 42.0, 40.9, 34.8, 31.0; IR (neat): 3289, 2926, 1720, 1611, 1513, 1465, 1241, 1215, 1176, 1106, 971, 823; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{34}H_{31}F_3NO_3^+$  558.2251; Found 558.2250.

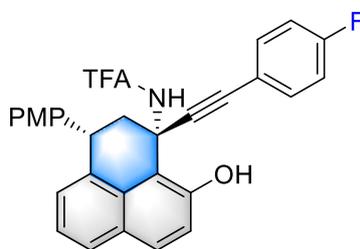
***N*-((1*R*,3*S*)-1-([1,1'-biphenyl]-4-ylethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3f)**



**3f**

Compound **3f** was prepared in 83% yield (95.8 mg) according to the general procedure. 5 h. Red Solid. M.p = 85 – 89 °C.  $[\alpha]_{\text{D}}^{20}$  -88.5 (*c* 0.2, DCM). 94% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 20.89 min (major), 28.94 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.88 (d,  $J = 9.2 \text{ Hz}$ , 1H), 7.82 (d,  $J = 8.0 \text{ Hz}$ , 2H), 7.71 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.61 (d,  $J = 7.6 \text{ Hz}$ , 4H), 7.46 – 7.30 (m, 4H), 7.27 – 7.18 (m, 1H), 7.18– 7.03 (m, 2H), 6.92 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.88 (d,  $J = 8.0 \text{ Hz}$ , 2H), 6.53 (s, 1H), 6.46 (s, 1H), 4.51 (d,  $J = 10.4 \text{ Hz}$ , 1H), 3.80 (s, 3H), 3.62 (dd,  $J = 12.8, 3.2 \text{ Hz}$ , 1H), 2.33 (t,  $J = 12.8 \text{ Hz}$ , 1H).  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 157.0, 155.5 (q,  $J = 37.0 \text{ Hz}$ ), 154.3, 140.6, 139.9, 135.5, 134.5, 132.8, 131.3, 130.0, 129.7, 128.7, 127.3, 127.0, 126.9, 126.5, 125.8, 125.0, 117.7, 115.8 (q,  $J = 288.0 \text{ Hz}$ ), 114.1, 111.8, 109.0, 60.5, 55.2, 42.7, 37.6; IR (neat): 3418, 2928, 1714, 1619, 1511, 1486, 1259, 1211, 1177, 1034, 881, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{36}\text{H}_{27}\text{F}_3\text{NO}_3^+$  578.1938; Found 578.1933.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-1-((4-fluorophenyl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3g)**

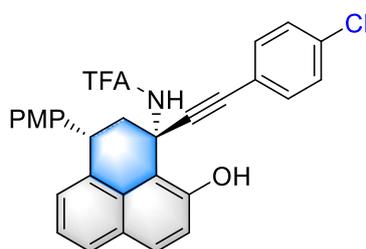


**3g**

Compound **3g** was prepared in 92% yield (95.5 mg) according to the general procedure. 7 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -54.1 (*c* 0.74, DCM). 96% ee (determined by HPLC, IE, *n*-

hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 11.00 min (major), 13.60 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.19 (s, 1H), 7.85 (d,  $J = 8.9 \text{ Hz}$ , 1H), 7.67 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.46 (dd,  $J = 9.0, 5.5 \text{ Hz}$ , 2H), 7.26 – 7.16 (m, 4H), 7.02 – 6.98 (m, 2H), 6.96 (d,  $J = 7.5 \text{ Hz}$ , 1H), 6.92 (d,  $J = 8.5 \text{ Hz}$ , 2H), 6.70 (s, 1H), 4.22 (dd,  $J = 13.0, 3.0 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.41 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.75 (t,  $J = 13.5 \text{ Hz}$ , 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  163.1 (d,  $J = 251.2 \text{ Hz}$ ), 158.8, 156.3 (q,  $J = 37.5 \text{ Hz}$ ), 153.2, 135.6, 134.7, 134.1 (d,  $J = 8.6 \text{ Hz}$ ), 132.1, 129.9, 129.2, 129.0, 127.1, 126.8, 117.1 (d,  $J = 3.5 \text{ Hz}$ ), 115.8 (d,  $J = 22.5 \text{ Hz}$ ), 115.4 (q,  $J = 286.2 \text{ Hz}$ ), 112.9, 86.2, 86.1, 55.3, 51.2, 42.2, 40.9; IR (neat): 3425, 2932, 1714, 1600, 1507, 1255, 1217, 1177, 1092, 1034, 833; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{22}\text{F}_4\text{NO}_3^+$  520.1530; Found 520.1534.

***N*-((1*R*,3*S*)-1-((4-chlorophenyl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3h)**

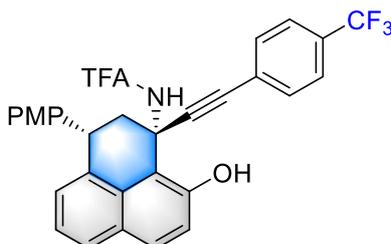


**3h**

Compound **3h** was prepared in 94% yield (100.6 mg) according to the general procedure. 7 h. Yellow Solid. M.p = 80 – 82 °C.  $[\alpha]_{\text{D}}^{20} -69.8$  ( $c$  0.2, DCM). 91% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 12.23 min (major), 15.00 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.24 (s, 1H), 7.83 (d,  $J = 9.2 \text{ Hz}$ , 1H), 7.66 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.37 (d,  $J = 8.4 \text{ Hz}$ , 2H), 7.28 – 7.24 (m, 2H), 7.19 (m, 3H), 6.95 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.90 (d,  $J = 8.8 \text{ Hz}$ , 2H), 6.80 (s, 1H), 4.23 (dd,  $J = 14.4, 4.0 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.39 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.76 (t,  $J = 13.6 \text{ Hz}$ , 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 156.3 (q,  $J = 37.0 \text{ Hz}$ ), 153.2, 135.6, 135.4, 134.7, 133.2, 132.1, 129.9, 129.1, 128.9, 128.7, 127.1, 126.8, 123.4, 120.3, 119.5, 115.4 (q,  $J = 287.0 \text{ Hz}$ ), 114.2, 112.9, 87.5, 85.7, 55.3, 51.21, 42.2, 40.8; IR

(neat): 3424, 2928, 1714, 1620, 1512, 1489, 1440, 1375, 1254, 1211, 1177, 1088, 944, 828; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{30}H_{22}F_3NO_3^+$  536.1235; Found 536.1238.

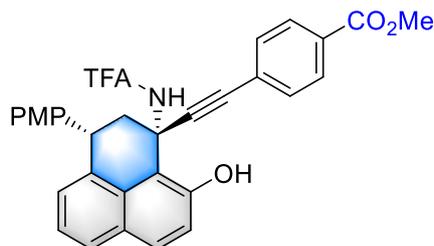
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-((4-(trifluoromethyl)phenyl)ethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3i)**



**3i**

Compound **3i** was prepared in 96% yield (109.2 mg) according to the general procedure. 6 h. Pale Orange oil.  $[\alpha]_D^{20}$  -75.8 ( $c$  0.44, DCM). 96% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 6.75 min (major), 8.22 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.20 (s, 1H), 7.86 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.69 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.62 – 7.52 (m, 4H), 7.27 – 7.16 (m, 4H), 6.97 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.92 (d,  $J = 8.0 \text{ Hz}$ , 2H), 6.82 (s, 1H), 4.25 (d,  $J = 12.8 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.38 (d,  $J = 13.6 \text{ Hz}$ , 1H), 2.81 (t,  $J = 13.2 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.5 (q,  $J = 37.0 \text{ Hz}$ ), 153.2, 135.5, 134.6, 132.3, 132.2, 130.9 (q,  $J = 32.3 \text{ Hz}$ ), 129.9, 129.1, 128.9, 127.2, 126.9, 125.3 (q,  $J = 3.0 \text{ Hz}$ ), 123.5, 120.4, 116.0, 115.4 (q,  $J = 287.0 \text{ Hz}$ ), 114.7, 114.3, 112.8, 88.9, 85.2, 55.3, 51.1, 42.3, 40.8; IR (neat): 3420, 2922, 1712, 1622, 1520, 1452, 1223, 1175, 1033, 830, 766; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{31}H_{22}F_6NO_3^+$  570.1498; Found 570.1490.

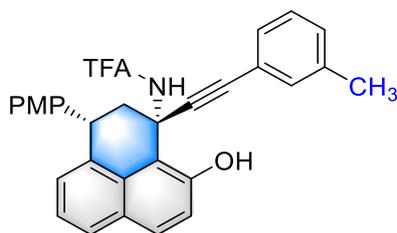
**Methyl 4-(((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(2,2,2-trifluoroacetamido)-2,3-dihydro-1*H*-phenalen-1-yl)ethynyl)benzoate (3j)**



**3j**

Compound **3j** was prepared in 96% yield (107.3 mg) according to the general procedure. 5 h. Pale Orange oil.  $[\alpha]_D^{20}$  -61.9 (*c* 0.45, DCM). 98% ee (determined by HPLC, IB, *n*-hexane/2-propanol = 94/6, *v* = 1.0 mL·min<sup>-1</sup>,  $\lambda$  = 220 nm; TR = 15.12 min (major), 21.3 min (minor)). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.92 (d, *J* = 8.4 Hz, 2H), 7.83 (d, *J* = 9.2 Hz, 1H), 7.66 (d, *J* = 8.0 Hz, 1H), 7.49 (d, *J* = 8.0 Hz, 2H), 7.26 – 7.15 (m, 4H), 7.01 – 6.93 (m, 2H), 6.90 (d, *J* = 8.4 Hz, 2H), 4.26 (dd, *J* = 13.2, 4.0 Hz, 1H), 3.87 (s, 3H), 3.80 (s, 3H), 3.40 (dd, *J* = 13.6, 3.6 Hz, 1H), 2.81 (t, *J* = 13.6 Hz, 1H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  166.3, 158.7, 156.4 (q, *J* = 37.0 Hz), 153.1, 135.5, 134.6, 132.1, 131.9, 130.2, 129.9, 129.4, 129.0, 129.0, 127.1, 126.8, 125.8, 123.4, 120.3, 115.4 (q, *J* = 288.0 Hz), 114.2, 112.8, 89.5, 85.5, 55.2, 52.3, 51.2, 42.1, 40.8; IR (neat): 3424, 3300, 2953, 1720, 1605, 1511, 1438, 1277, 1211, 1177, 1035, 830, 769; HRMS (ESI/QTOF) *m/z*: [M + H]<sup>+</sup> Calcd for C<sub>32</sub>H<sub>25</sub>F<sub>3</sub>NO<sub>5</sub><sup>+</sup> 560.1679; Found 560.1682.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(*m*-tolylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3k)**

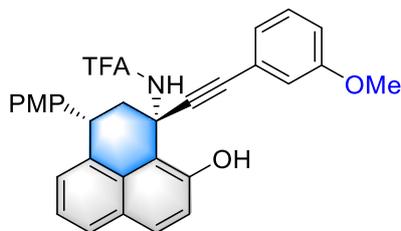


**3k**

Compound **3k** was prepared in 95% yield (97.8 mg) according to the general procedure. 6 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -47.2 (*c* 0.2, DCM). 85% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6, *v* = 1.0 mL·min<sup>-1</sup>,  $\lambda$  = 220 nm; TR = 8.62 min (major), 11.5 min (minor)). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.29 (s, 1H), 7.83 (d, *J* = 8.8 Hz, 1H), 7.65

(d,  $J = 8.0$  Hz, 1H), 7.29 – 7.12 (m, 8H), 6.95 (d,  $J = 7.2$  Hz, 1H), 6.90 (d,  $J = 8.8$  Hz, 2H), 6.74 (s, 1H), 4.22 (d,  $J = 10.0$  Hz, 1H), 3.80 (s, 3H), 3.46 (dd,  $J = 13.6, 4.0$  Hz, 1H), 2.75 (t,  $J = 13.6$  Hz, 1H), 2.30 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 156.1 (q,  $J = 37.0$  Hz), 153.2, 138.2, 135.7, 134.8, 132.5, 132.0, 130.2, 129.9, 129.1, 129.1(1), 129.0(8), 128.2, 127.1, 126.8, 123.4, 120.6, 120.4, 114.2, 113.0, 115.4 (q,  $J = 289.9$  Hz), 87.4, 86.0, 55.2, 51.3, 42.0, 40.9, 21.1; IR (neat): 3423, 2928, 1714, 1620, 1614, 1512, 1441, 1259, 1211, 1177, 1034, 830, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_3^+$  516.1781; Found 516.1771.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-((3-methoxyphenyl)ethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (31)**

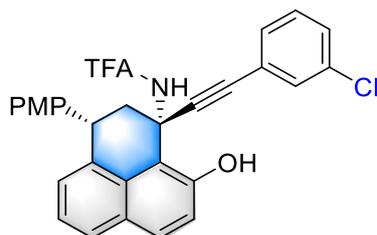


**31**

Compound **31** was prepared in 99% yield (105.1 mg) according to the general procedure. 7 h. Red Solid. M.p = 86 – 92 °C.  $[\alpha]_{\text{D}}^{20}$  -66.4 ( $c$  0.2, DCM). 97% ee (determined by HPLC, IE,  $n$ -hexane/2-propanol = 94/6,  $v = 1.0$  mL·min $^{-1}$ ,  $\lambda = 220$  nm; TR = 17.56 min (major), 20.50 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.32 (s, 1H), 7.82 (d,  $J = 8.8$  Hz, 1H), 7.65 (d,  $J = 8.0$  Hz, 1H), 7.24 – 7.15 (m, 5H), 7.06 (d,  $J = 7.6$  Hz, 1H), 6.98 – 6.85 (m, 5H), 6.81 (s, 1H), 4.23 (dd,  $J = 13.2, 2.8$  Hz, 1H), 3.80 (s, 3H), 3.74 (s, 3H), 3.45 (dd,  $J = 13.6, 3.6$  Hz, 1H), 2.76 (t,  $J = 13.6$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  159.2, 158.6, 156.2 (q,  $J = 37.0$  Hz), 153.2, 135.7, 134.7, 132.0, 129.9, 129.4, 129.1, 128.9, 127.1, 126.7, 124.6, 123.4, 121.8, 120.3, 116.6, 116.0, 115.4 (q,  $J = 289.9$  Hz), 114.2, 112.9, 86.9, 86.2, 55.2, 55.2, 51.2, 42.0, 40.9; IR (neat): 3424, 2934, 1714, 1603, 1512, 1463, 1259, 1206, 1177, 1038, 830, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_4^+$  532.1730; Found 532.1720.

***N*-((1*R*,3*S*)-1-((3-chlorophenyl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-**

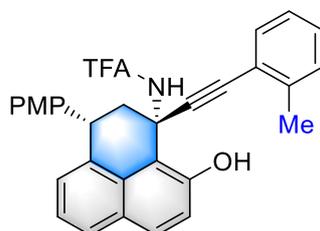
**dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3m)**



**3m**

Compound **3m** was prepared in 99% yield (105.8 mg) according to the general procedure. 7 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -71.6 ( $c$  0.27, DCM). 95% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v$  = 1.0 mL·min<sup>-1</sup>,  $\lambda$  = 220 nm; TR = 9.18 min (major), 11.60 min (minor)). <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  7.84 (d,  $J$  = 9.0 Hz, 1H), 7.67 (d,  $J$  = 8.0 Hz, 1H), 7.44 (s, 1H), 7.36 – 7.29 (m, 2H), 7.25 – 7.13 (m, 6H), 6.96 (d,  $J$  = 7.5 Hz, 1H), 6.91 (d,  $J$  = 8.5 Hz, 2H), 6.80 (s, 1H), 4.24 (dd,  $J$  = 13.0, 3.0 Hz, 1H), 3.81 (s, 3H), 3.39 (dd,  $J$  = 14.0, 4.0 Hz, 1H), 2.79 (t,  $J$  = 13.5 Hz, 1H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  158.7, 156.3 (q,  $J$  = 37.0 Hz), 153.1, 135.5, 134.6, 134.2, 132.1, 131.8, 130.2, 129.9, 129.6, 129.5, 129.1, 128.9, 127.1, 126.8, 123.5, 122.7, 120.4, 115.4 (q,  $J$  = 288.0 Hz), 114.2, 112.8, 87.7, 85.3, 55.3, 51.1, 42.2, 40.8; IR (neat): 3425, 2933, 1414, 1588, 1470, 1210, 1177, 1034, 830, 765; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for C<sub>30</sub>H<sub>22</sub>ClF<sub>3</sub>NO<sub>3</sub><sup>+</sup> 536.1235; Found 536.1245.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(*o*-tolylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3n)**

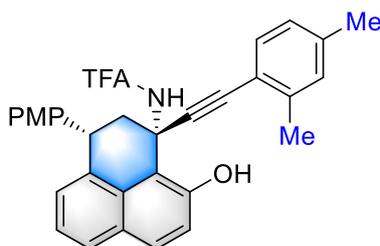


**3n**

Compound **3n** was prepared in 99% yield (101.9 mg) according to the general procedure. 6 h. Yellow Oil.  $[\alpha]_{\text{D}}^{20}$  -49.4 ( $c$  0.23, DCM). 90% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 99/1,  $v$  = 1.0 mL·min<sup>-1</sup>,  $\lambda$  = 220 nm; TR = 9.43 min (major), 11.1 min (minor)). <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  8.30 (s, 1H), 7.84 (d,  $J$  = 8.9 Hz, 1H),

7.66 (d,  $J = 8.0$  Hz, 1H), 7.43 (d,  $J = 8.0$  Hz, 1H), 7.25 – 7.15 (m, 6H), 7.15 – 7.08 (m, 1H), 6.95 (d,  $J = 7.5$  Hz, 1H), 6.91 (d,  $J = 9.0$  Hz, 2H), 6.75 (d,  $J = 12.0$  Hz, 1H), 4.24 (d,  $J = 13.0$  Hz, 1H), 3.80 (s, 3H), 3.50 (dd,  $J = 13.5, 3.5$  Hz, 1H), 2.76 (t,  $J = 13.5$  Hz, 1H), 2.45 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.2 (q,  $J = 37.5$  Hz), 153.3, 140.9, 135.8, 134.9, 132.4, 132.0, 130.0, 129.6, 129.3, 129.2, 129.0, 127.1, 126.8, 125.6, 123.4, 120.8, 120.3, 115.4 (q,  $J = 297.4$  Hz), 114.3, 113.1, 90.3, 86.4, 55.3, 51.6, 42.3, 41.0, 20.5; IR (neat): 3415, 2927, 1725, 1609, 1513, 1508, 1464, 1458, 1258, 1211, 1176, 1035, 831, 758; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_3^+$  516.1781; Found 516.1771.

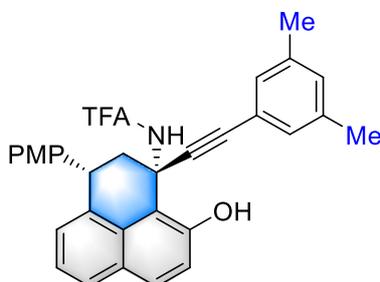
***N*-((1*R*,3*S*)-1-((2,4-dimethylphenyl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3o)**



**3o**

Compound **3o** was prepared in 86% yield (91.1 mg) according to the general procedure. 6 h. Yellow Oil.  $[\alpha]_{\text{D}}^{20}$  -48.3 ( $c$  0.37, DCM). 78% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0$  mL $\cdot$ min $^{-1}$ ,  $\lambda = 220$  nm; TR = 8.14 min (major), 10.48 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.31 (s, 1H), 7.86 (d,  $J = 9.0$  Hz, 1H), 7.67 (d,  $J = 8.0$  Hz, 1H), 7.33 (d,  $J = 8.0$  Hz, 1H), 7.28 – 7.20 (m, 4H), 7.02 (s, 1H), 6.97 – 6.88 (m, 4H), 6.61 (s, 1H), 4.22 (d,  $J = 13.0$  Hz, 1H), 3.82 (s, 3H), 3.51 (dd,  $J = 13.5, 3.0$  Hz, 1H), 2.73 (t,  $J = 13.5$  Hz, 1H), 2.41 (s, 3H), 2.30 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.0 (q,  $J = 37.5$  Hz), 153.3, 140.8, 139.7, 135.9, 134.9, 132.3, 132.1, 130.5, 130.0, 129.2, 129.0, 127.1, 126.8, 126.4, 123.4, 120.4, 117.6, 115.4 (q,  $J = 287.5$  Hz), 114.3, 113.1, 89.3, 87.0, 55.3, 51.5, 42.1, 41.0, 21.4, 20.5; IR (neat): 3414, 2927, 1720, 1611, 1512, 1460, 1441, 1256, 1210, 1177, 1035, 830, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{32}\text{H}_{27}\text{F}_3\text{NO}_3^+$  530.1938; Found 530.1937.

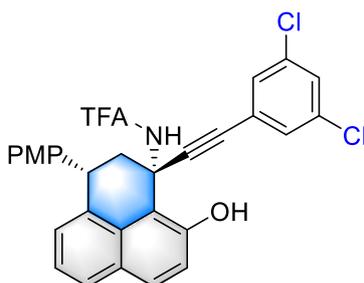
***N*-((1*R*,3*S*)-1-((3,5-dimethylphenyl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3p)**



**3p**

Compound **3p** was prepared in 95% yield (100.5 mg) according to the general procedure. 8 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -46.5 (*c* 0.41, DCM). 84% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.91 min (major), 11.74 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.28 (s, 1H), 7.84 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.66 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.31 – 7.15 (m, 4H), 7.12 (s, 2H), 7.03 – 6.83 (m, 4H), 6.62 (s, 1H), 4.21 (d,  $J = 16.0 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.47 (dd,  $J = 13.5, 3.5 \text{ Hz}$ , 1H), 2.73 (t,  $J = 13.5 \text{ Hz}$ , 1H), 2.27 (s, 6H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.1 (q,  $J = 37.5 \text{ Hz}$ ), 153.3, 138.1, 135.8, 134.9, 132.0, 131.3, 130.0, 129.7, 129.2, 129.0, 127.1, 126.8, 123.4, 120.5, 120.4, 115.4 (q,  $J = 287.5 \text{ Hz}$ ), 114.3, 113.1, 87.9, 85.6, 55.3, 51.4, 42.1, 41.0, 21.0; IR (neat): 3410, 2926, 1723, 1622, 1508, 1452, 1258, 1110, 1021, 800, 710; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{32}\text{H}_{27}\text{F}_3\text{NO}_3^+$  530.1938; Found 530.1936.

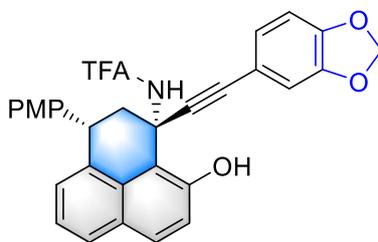
***N*-((1*R*,3*S*)-1-((3,5-dichlorophenyl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3q)**



### 3q

Compound **3q** was prepared in 82% yield (93.3 mg) according to the general procedure. 7 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -60.7 (*c* 0.77, DCM). 94% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.78 min (major), 9.59 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.01 (s, 1H), 7.87 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.69 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.33 (s, 3H), 7.26 – 7.23 (m, 2H), 7.18 (d,  $J = 8.5 \text{ Hz}$ , 2H), 6.97 (d,  $J = 7.5 \text{ Hz}$ , 1H), 6.92 (d,  $J = 9.0 \text{ Hz}$ , 2H), 6.76 (s, 1H), 4.23 (dd,  $J = 13.0, 3.5 \text{ Hz}$ , 1H), 3.83 (s, 3H), 3.32 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.80 (d,  $J = 13.0 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.9, 156.8 (q,  $J = 37.5 \text{ Hz}$ ), 153.1, 135.4, 135.0, 134.5, 132.2, 130.2, 129.9, 129.6, 129.2, 128.9, 127.2, 126.9, 124.0, 123.6, 120.4, 115.4 (q,  $J = 287.5 \text{ Hz}$ ), 114.3, 112.7, 88.9, 83.8, 55.3, 51.1, 42.4, 40.8; IR (neat): 3401, 2930, 1713, 1610, 1583, 1555, 1511, 1438, 1258, 1211, 1177, 830, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{21}\text{Cl}_2\text{F}_3\text{NO}_3^+$  570.0845; Found 570.0843.

### *N*-((1*R*,3*S*)-1-(benzo[*d*][1,3]dioxol-5-ylethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (**3r**)

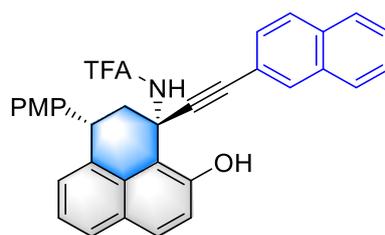


**3r**

Compound **3r** was prepared in 95% yield (103.5 mg) according to the general procedure. 5 h. Pale Pink oil.  $[\alpha]_D^{20}$  -55.3 (*c* 0.35, DCM). 89% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 24.88 min (major), 28.65 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.25 (s, 1H), 7.86 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.67 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.26 – 7.15 (m, 4H), 7.02 (dd,  $J = 8.5, 1.5 \text{ Hz}$ , 1H), 6.95 (d,  $J = 7.5 \text{ Hz}$ , 1H), 6.94 – 6.90 (m, 3H), 6.75 (d,  $J = 8.0 \text{ Hz}$ , 1H), 6.64 (s, 1H), 5.96 (s, 2H), 4.20 (d,  $J = 13.5 \text{ Hz}$ , 1H), 3.83 (s, 3H), 3.43 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.72 (t,  $J = 13.5 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.1 (q,  $J = 36.5 \text{ Hz}$ ), 153.3, 148.8, 147.5, 135.8, 134.8, 132.1, 130.0, 129.2, 129.0, 127.1, 126.8, 123.4, 120.4, 115.4

(q,  $J = 297.4$  Hz), 114.3, 114.0, 113.1, 111.9, 108.5, 101.5, 87.4, 84.8, 55.3, 51.3, 42.2, 41.0; IR (neat): 3413, 2924, 1722, 1612, 1511, 1491, 1441, 1377, 1251, 1213, 1178, 1038, 831, 784; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{31}H_{23}F_3NO_5^+$  546.1523; Found 546.1521.

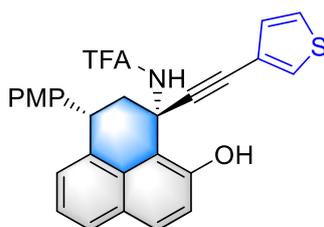
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(naphthalen-2-ylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3s)**



**3s**

Compound **3s** was prepared in 99% yield (109.1 mg) according to the general procedure. 7 h. Brown Solid. M.p = 92 – 96 °C.  $[\alpha]_D^{20}$  -37.1 ( $c$  0.2, DCM). 92% ee (determined by HPLC, IE,  $n$ -hexane/2-propanol = 96/4,  $v = 1.0$  mL·min<sup>-1</sup>,  $\lambda = 220$  nm; TR = 19.96 min (major), 27.16 min (minor)). <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>)  $\delta$  8.33 (s, 1H), 8.01 (s, 1H), 7.86 (d,  $J = 9.0$  Hz, 1H), 7.79 – 7.74 (m, 3H), 7.67 (d,  $J = 8.0$  Hz, 1H), 7.52 – 7.43 (m, 3H), 7.28 (d,  $J = 9.0$  Hz, 1H), 7.23 – 7.17 (m, 3H), 6.97 (d,  $J = 7.5$  Hz, 1H), 6.91 (d,  $J = 8.5$  Hz, 2H), 6.76 (s, 1H), 4.24 (d,  $J = 12.5$  Hz, 1H), 3.80 (s, 3H), 3.49 (dd,  $J = 14.0, 4.0$  Hz, 1H), 2.80 (t,  $J = 13.5$  Hz, 1H); <sup>13</sup>C NMR (125 MHz, CDCl<sub>3</sub>)  $\delta$  158.7, 156.2 (q,  $J = 37.5$  Hz), 153.3, 135.7, 134.8, 133.2, 132.7, 132.4, 132.1, 130.0, 129.2, 129.0, 128.1, 127.8, 127.7, 127.2, 127.1, 126.8, 126.7, 123.5, 120.4, 118.1, 115.5 (q,  $J = 287.5$  Hz), 114.3, 113.0, 87.6, 86.6, 55.3, 51.4, 42.2, 41.0; IR (neat): 3417, 3055, 1714, 1620, 1509, 1442, 1275, 1260, 1210, 1174, 832, 750, 690; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{34}H_{25}F_3NO_3^+$  552.1781; Found 552.1780.

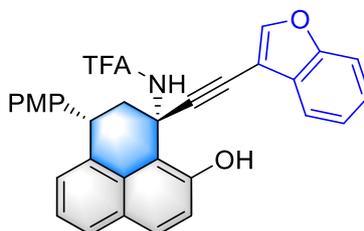
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(thiophen-3-ylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3t)**



**3t**

Compound **3t** was prepared in 99% yield (100.3 mg) according to the general procedure. 3 h. Pale Orange oil.  $[\alpha]_{\text{D}}^{20}$  -59.4 (*c* 0.38, DCM). 94% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.20 (s, 1H), 7.85 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.67 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.54 (s, 1H), 7.29 – 7.16 (m, 5H), 7.14 (d,  $J = 5.0 \text{ Hz}$ , 1H), 6.95 (d,  $J = 7.0 \text{ Hz}$ , 1H), 6.92 (d,  $J = 8.0 \text{ Hz}$ , 2H), 6.65 (d,  $J = 6.5 \text{ Hz}$ , 1H), 4.21 (d,  $J = 13.0 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.44 (dd,  $J = 13.5$ , 3.0 Hz, 1H), 2.74 (t,  $J = 14.0 \text{ Hz}$ , 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.2 (q,  $J = 37.5 \text{ Hz}$ ), 153.2, 135.7, 134.8, 132.1, 130.6, 129.9, 129.8, 129.2, 129.0, 127.1, 126.8, 125.7, 123.5, 120.4, 119.8, 115.4 (q,  $J = 297.4 \text{ Hz}$ ), 114.3, 113.0, 86.1, 82.6, 55.3, 51.3, 42.1, 40.9; IR (neat): 3420, 2928, 1714, 1619, 1511, 1461, 1441, 1259, 1210, 1177, 1034, 831, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{28}\text{H}_{21}\text{F}_3\text{NO}_3\text{S}^+$  508.1189; Found 508.1188.

***N*-((1*R*,3*S*)-1-((3*a*,7*a*-dihydrobenzofuran-3-yl)ethynyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (**3u**)**

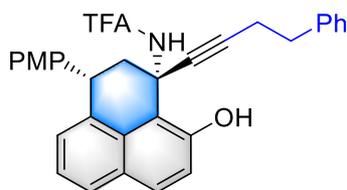


**3u**

Compound **3u** was prepared in 99% yield (107.1 mg) according to the general procedure. 8 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -64.6 (*c* 0.65, DCM). 98% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 25.15 min (major), 34.85 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.02 (s, 1H), 7.83 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.66 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.51 (d,  $J = 7.5 \text{ Hz}$ , 1H), 7.40 (d,  $J = 8.0 \text{ Hz}$ , 1H),

7.33 – 7.28 (m, 1H), 7.25 – 7.20 (m, 3H), 7.17 (d,  $J = 8.5$  Hz, 2H), 6.98 (s, 1H), 6.96 (d,  $J = 7.0$  Hz, 1H), 6.93 – 6.87 (m, 3H), 4.25 (dd,  $J = 13.0, 3.5$  Hz, 1H), 3.79 (s, 3H), 3.39 (dd,  $J = 14.0, 4.0$  Hz, 1H), 2.84 (t,  $J = 13.5$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.5 (q,  $J = 37.5$  Hz), 154.9, 153.0, 136.9, 135.4, 134.5, 132.2, 129.9, 129.2, 129.0, 127.2, 126.8, 126.0, 123.5, 123.4, 121.4, 120.4, 115.4 (q,  $J = 287.5$  Hz), 114.2, 113.3, 113.3, 112.7, 111.3, 92.8, 76.6, 55.2, 51.3, 42.2, 40.8; IR (neat): 3311, 2931, 1713, 1611, 1511, 1448, 1374, 1259, 1176, 1036, 830, 750; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{32}\text{H}_{23}\text{F}_3\text{NO}_4^+$  542.1574; Found 542.1573.

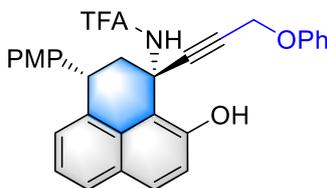
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(4-phenylbut-1-yn-1-yl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3v)**



**3v**

Compound **3v** was prepared in 77% yield (81.4 mg) according to the general procedure. 11 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -15.0 ( $c$  0.22, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0$  mL·min $^{-1}$ ,  $\lambda = 220$  nm; TR = 8.10 min (major), 9.92 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.99 (s, 1H), 7.82 (d,  $J = 9.0$  Hz, 1H), 7.64 (d,  $J = 8.0$  Hz, 1H), 7.28 – 7.22 (m, 2H), 7.22 – 7.12 (m, 7H), 6.95 – 6.86 (m, 3H), 6.43 (s, 1H), 4.11 (dd,  $J = 13.5, 3.5$  Hz, 1H), 3.83 (s, 3H), 3.37 (dd,  $J = 14.0, 4.0$  Hz, 1H), 2.86 (t,  $J = 7.5$  Hz, 2H), 2.61 (t,  $J = 7.5$  Hz, 2H), 2.52 (t,  $J = 13.5$  Hz, 1H).  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 155.8 (q,  $J = 37.5$  Hz), 153.1, 139.8, 135.9, 134.8, 131.9, 129.9, 129.1, 128.9, 128.4(4), 128.4(3), 127.0, 126.7, 126.5, 123.4, 120.3, 115.4 (q,  $J = 287.5$  Hz), 114.2, 113.2, 88.0, 79.1, 55.3, 50.9, 41.8, 40.8, 34.3, 20.9; IR (neat): 3423, 3302, 2933, 1720, 1619, 1512, 1460, 1441, 1375, 1256, 1211, 1177, 1035, 831, 817, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{32}\text{H}_{27}\text{F}_3\text{NO}_3^+$  530.1938; Found 530.1936.

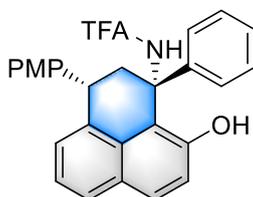
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(3-phenoxyprop-1-yn-1-yl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3w)**



**3w**

Compound **3w** was prepared in 98% yield (104.0 mg) according to the general procedure. 10 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -12.0 (*c* 0.51, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.61 min (major), 9.19 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.83 (s, 1H), 7.81 (s, 1H), 7.64 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.26 – 7.17 (m, 4H), 7.14 (d,  $J = 8.4 \text{ Hz}$ , 2H), 7.02 – 6.86 (m, 6H), 6.60 (s, 1H), 4.78 (s, 2H), 4.14 (t,  $J = 13.2, 2.8 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.28 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.63 (t,  $J = 13.6 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.3, 156.3 (q,  $J = 37.0 \text{ Hz}$ ), 153.0, 135.6, 134.5, 132.1, 129.9, 129.5, 129.1, 128.8, 127.1, 126.7, 123.4, 121.7, 120.5, 115.3 (q,  $J = 288.0 \text{ Hz}$ ), 115.0, 114.2, 112.7, 85.1, 82.0, 55.9, 55.3, 50.7, 41.8, 40.7; IR (neat): 3426, 3298, 2932, 1722, 1623, 1511, 1466, 1262, 1206, 1102, 826, 780; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_4^+$  532.1730; Found 532.1738.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-phenyl-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3x)**

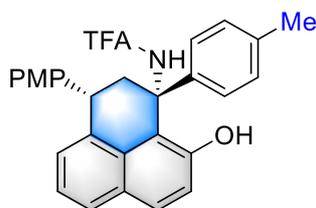


**3x**

Compound **3x** was prepared in 69% yield (65.8 mg) according to the general procedure. 43 h. Pale white oil.  $[\alpha]_D^{20}$  -48.6 (*c* 0.55, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 11.91 min (major), 20.24 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.84 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.71 (d,  $J$

= 8.0 Hz, 1H), 7.38 – 7.23 (m, 7H), 7.19 – 7.11 (m, 3H), 7.09 (d,  $J = 9.0$  Hz, 1H), 6.97 (d,  $J = 7.0$  Hz, 1H), 6.86 (d,  $J = 8.5$  Hz, 2H), 4.31 (d,  $J = 13.0$  Hz, 1H), 3.79 (s, 3H), 2.90 (d,  $J = 13.5$  Hz, 1H), 2.55 (t,  $J = 13.5$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.4 (q,  $J = 37.5$  Hz), 152.7, 142.0, 136.3, 134.7, 131.8, 130.8, 129.8, 129.5, 129.0, 127.7, 127.2, 126.3, 125.1, 123.1, 121.1, 116.3, 115.9 (q,  $J = 287.5$  Hz), 114.2, 62.3, 55.3, 47.8, 42.0; IR (neat): 3406, 3066, 2952, 2243, 1728, 1606, 1203, 1169, 714, 696; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{28}\text{H}_{22}\text{F}_3\text{NNaO}_3^+$  500.1444; Found 500.1442.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(*p*-tolyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3y)**

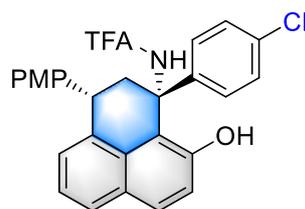


**3y**

Compound **3y** was prepared in 69% yield (67.8 mg) according to the general procedure. 48 h. Pale white oil.  $[\alpha]_{\text{D}}^{20}$  -49.3 (c 0.49, DCM). 80% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 8.33 min (major), 16.32 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.84 (d,  $J = 9.0$  Hz, 1H), 7.70 (d,  $J = 8.0$  Hz, 1H), 7.26 – 7.13 (m, 8H), 7.11 (d,  $J = 8.5$  Hz, 1H), 7.07 (s, 1H), 6.96 (d,  $J = 7.0$  Hz, 1H), 6.86 (d,  $J = 8.5$  Hz, 2H), 4.30 (d,  $J = 13.0$  Hz, 1H), 3.79 (s, 3H), 2.88 (d,  $J = 16.8$  Hz, 1H), 2.54 (t,  $J = 13.5$  Hz, 1H), 2.32 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.4 (q,  $J = 37.5$  Hz), 152.8, 138.7, 137.6, 136.4, 134.8, 131.7, 130.8, 129.8, 129.5, 127.2, 126.3, 125.0, 123.1, 121.2, 115.9 (q,  $J = 287.5$  Hz), 116.3, 114.2, 62.1, 55.3, 47.8, 42.0, 20.9; IR (neat): 3318, 3053, 2835, 1708, 1610, 1539, 1437, 1258, 1211, 1178, 1034, 908, 831, 734; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{29}\text{H}_{22}\text{F}_3\text{NNaO}_3^+$  514.1600; Found 514.1599.

***N*-((1*R*,3*S*)-1-(4-chlorophenyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-**

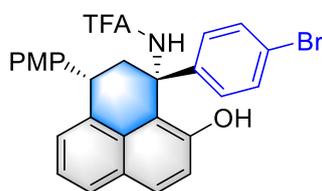
**phenalen-1-yl)-2,2,2-trifluoroacetamide (3z)**



**3z**

Compound **3z** was prepared in 66% yield (67.4 mg) according to the general procedure. 48 h. Pale white oil.  $[\alpha]_D^{20}$  -52.4 (*c* 0.33, DCM). 80% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.1 min (major), 13.32 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.85 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.72 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.30 – 7.18 (m, 5H), 7.16 – 7.10 (m, 4H), 7.07 (d,  $J = 9.0 \text{ Hz}$ , 1H), 6.97 (d,  $J = 7.5 \text{ Hz}$ , 1H), 6.85 (d,  $J = 8.5 \text{ Hz}$ , 2H), 4.32 (d,  $J = 13.0 \text{ Hz}$ , 1H), 3.79 (s, 3H), 2.87 (d,  $J = 14.0 \text{ Hz}$ , 1H), 2.51 (t,  $J = 13.5 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.5 (q,  $J = 37.0 \text{ Hz}$ ), 152.4, 141.2, 136.2, 134.6, 133.3, 131.9, 130.7, 129.8, 129.5, 128.9, 127.2, 126.6, 126.4, 123.3, 120.8, 116.0, 115.8 (q,  $J = 286.9 \text{ Hz}$ ), 114.2, 62.1, 55.3, 47.6, 42.0; IR (neat): 3321, 3025, 2865, 2537, 1712, 1609, 1539, 1510, 1436, 1258, 1178, 1034, 908, 830, 748; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{28}\text{H}_{21}\text{ClF}_3\text{NNaO}_3^+$  534.1054; Found 534.1053.

***N*-((1*R*,3*S*)-1-(4-bromophenyl)-9-hydroxy-3-(4-methoxyphenyl)-2,3-dihydro-1*H*-phenalen-1-yl)-2,2,2-trifluoroacetamide (3aa)**

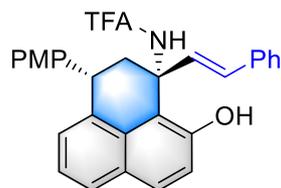


**3aa**

Compound **3aa** was prepared in 69% yield (76.5 mg) according to the general procedure. 48 h. Pale White oil.  $[\alpha]_D^{20}$  -55.8 (*c* 0.36, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 12.93 min (major), 20.28 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.85 (d,  $J = 8.5 \text{ Hz}$ ,

1H), 7.72 (d,  $J = 8.0$  Hz, 1H), 7.58 (s, 1H), 7.35 (d,  $J = 8.5$  Hz, 2H), 7.29 – 7.24 (m, 2H), 7.12 (d,  $J = 8.0$  Hz, 2H), 7.08 – 7.02 (m, 3H), 6.97 (d,  $J = 7.5$  Hz, 1H), 6.85 (d,  $J = 8.5$  Hz, 2H), 4.32 (dd,  $J = 13.0, 3.5$  Hz, 1H), 3.79 (s, 3H), 2.86 (dd,  $J = 14.0, 3.5$  Hz, 1H), 2.51 (d,  $J = 13.5$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.5 (q,  $J = 37.5$  Hz), 152.4, 141.7, 136.1, 134.5, 131.9, 131.8, 130.7, 129.8, 129.5, 127.2, 126.9, 126.4, 123.3, 121.3, 120.9, 115.9, 115.8 (q,  $J = 287.5$  Hz), 114.2, 62.1, 55.3, 47.5, 41.9; IR (neat): 3425, 3050, 2216, 1688, 1610, 1542, 1505, 1256, 755, 650; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{28}\text{H}_{22}\text{BrF}_3\text{NO}_3^+$  556.0730; Found 556.0729.

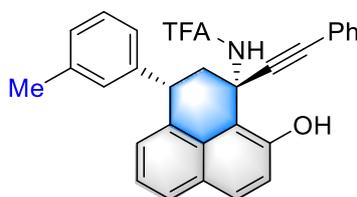
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-((*E*)-styryl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3ab)**



**3ab**

Compound **3ab** was prepared in 76% yield (76.4 mg) according to the general procedure. 7 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20} -11.6$  ( $c$  0.66, DCM). 76% ee (determined by HPLC, IB, *n*-hexane/2-propanol = 93/7,  $v = 1.0$  mL  $\cdot$  min $^{-1}$ ,  $\lambda = 220$  nm; TR = 13.67 min (major), 16.35 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.02 (s, 1H), 7.85 (d,  $J = 9.0$  Hz, 1H), 7.69 (d,  $J = 8.0$  Hz, 1H), 7.37 – 7.33 (m, 2H), 7.32 – 7.27 (m, 2H), 7.26 – 7.22 (m, 3H), 7.16 (d,  $J = 8.0$  Hz, 2H), 6.99 – 6.94 (m, 2H), 6.89 (d,  $J = 8.5$  Hz, 2H), 6.66 (d,  $J = 16.5$  Hz, 1H), 6.53 (d,  $J = 16.5$  Hz, 1H), 4.30 (dd,  $J = 13.0, 4.0$  Hz, 1H), 3.80 (s, 3H), 2.70 (dd,  $J = 14.0, 3.5$  Hz, 1H), 2.58 (t,  $J = 13.0$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 157.3 (q,  $J = 36.5$  Hz), 153.2, 135.8(4), 135.8(1), 134.9, 131.7, 130.7, 130.1, 129.8, 129.7, 129.5, 128.6, 128.1, 127.3, 126.7, 126.6, 123.2, 121.3, 115.8 (q,  $J = 286.2$  Hz), 115.6, 114.3, 59.1, 55.3, 44.6, 41.5; IR (neat): 3308, 2928, 1708, 1610, 1511, 1440, 1259, 1210, 1178, 1034, 829, 764, 750; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{25}\text{F}_3\text{NO}_3^+$  504.1781; Found 504.1780.

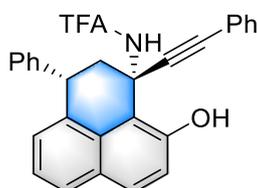
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-1-(phenylethynyl)-3-(*m*-tolyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3ac)**



**3ac**

Compound **3ac** was prepared in 91% yield (88.2 mg) according to the general procedure. 12 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -29.8 (*c* 0.43, DCM). 92% ee (determined by HPLC, IB, *n*-hexane/2-propanol = 97/3,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ,  $5^\circ\text{C}$ ; TR = 13.55 min (minor), 15.65 min (major)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.29 (s, 1H), 7.86 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.68 (d,  $J = 8.1 \text{ Hz}$ , 1H), 7.52 – 7.47 (m, 2H), 7.37 – 7.28 (m, 4H), 7.26 (s, 1H), 7.24 – 7.20 (m, 1H), 7.14 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.11 – 7.05 (m, 2H); 6.95 (d,  $J = 7.5 \text{ Hz}$ , 1H), 6.66 (s, 1H), 4.22 (dd,  $J = 13.5, 4.0 \text{ Hz}$ , 1H), 3.47 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.78 (t,  $J = 14.0 \text{ Hz}$ , 1H), 2.36 (s, 3H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  156.2 (q,  $J = 37.5 \text{ Hz}$ ), 153.3, 142.7, 138.5, 135.5, 132.1(3), 132.0(7), 129.7, 129.4, 129.2, 129.0, 128.7, 128.4, 128.0, 127.1, 126.9, 126.1, 123.5, 120.9, 120.5, 115.4 (q,  $J = 287.5 \text{ Hz}$ ), 113.0, 87.4, 86.4, 51.3, 42.0, 41.7, 21.4; IR (neat): 3428, 2923, 1720, 1619, 1513, 1490, 1443, 1375, 1261, 1211, 1175, 832, 756, 690; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{23}\text{F}_3\text{NO}_2^+$  486.1675; Found 486.1670.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-phenyl-1-(phenylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3ad)**

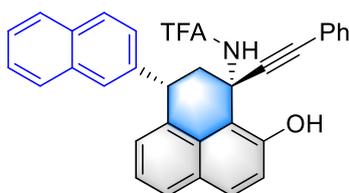


**3ad**

Compound **3ad** was prepared in 98% yield (92.3 mg) according to the general procedure. 16 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -41.6 (*c* 1.2, DCM). 70% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 98/2,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 18.34 min

(major), 23.67 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.26 (s, 1H), 7.86 (d,  $J = 9.0$  Hz, 1H), 7.68 (d,  $J = 8.0$  Hz, 1H), 7.51 – 7.47 (m, 2H), 7.41 – 7.37 (m, 2H), 7.36 – 7.26 (m, 7H), 7.24 – 7.19 (m, 1H), 6.93 (d,  $J = 7.0$  Hz, 1H), 6.64 (s, 1H), 4.26 (dd,  $J = 13.5, 4.0$  Hz, 1H), 3.49 (dd,  $J = 13.5, 3.5$  Hz, 1H), 2.78 (t,  $J = 14.0$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  156.2 (q,  $J = 39.1$  Hz), 153.3, 142.8, 135.4, 132.2, 132.1, 129.4, 129.2, 129.1, 129.0, 128.9, 128.4, 127.3, 127.2, 126.9, 123.5, 120.9, 120.5, 115.4 (q,  $J = 287.5$  Hz), 113.0, 87.4, 86.3, 51.3, 42.0, 41.8; IR (neat): 3424, 3060, 1719, 1619, 1600, 1509, 1442, 1374, 1262, 1211, 1175, 831, 757, 691; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{29}\text{H}_{21}\text{F}_3\text{NO}_2^+$  472.1519; Found 472.1519.

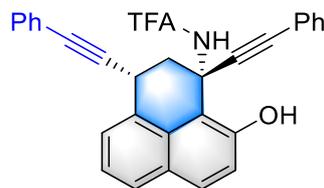
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-3-(naphthalen-2-yl)-1-(phenylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3ae)**



**3ae**

Compound **3ae** was prepared in 98% yield (102.1 mg) according to the general procedure. 8 h. Orange Solid. M.p = 95 – 99 °C.  $[\alpha]_{\text{D}}^{20} +78.5$  (c 0.77, DCM). 81% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 9.45 min (major), 13.70 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.24 (s, 1H), 7.90 – 7.79 (m, 5H), 7.69 (d,  $J = 8.0$  Hz, 1H), 7.53 – 7.44 (m, 4H), 7.36 – 7.26 (m, 5H), 7.21 – 7.17 (m, 1H), 6.94 (d,  $J = 7.0$  Hz, 1H), 6.67 (s, 1H), 4.45 (dd,  $J = 13.5, 4.0$  Hz, 1H), 3.55 (dd,  $J = 14.0, 4.0$  Hz, 1H), 2.90 (t,  $J = 13.5$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  156.2 (q,  $J = 37.5$  Hz), 153.3, 140.1, 135.1, 133.6, 132.7, 132.2, 132.0, 129.4, 129.2, 129.0, 128.7, 128.4, 128.2, 127.7(2), 127.7(0), 127.3, 127.2, 126.55 126.3, 125.9, 123.5, 120.8, 120.5, 115.4 (q,  $J = 286.2$  Hz), 112.9, 87.5, 86.3, 51.3, 41.9, 41.9; IR (neat): 3424, 3055, 1714, 1620, 1509, 1442, 1209, 1169, 832, 755; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{33}\text{H}_{23}\text{F}_3\text{NO}_2^+$  522.1675; Found 522.1674.

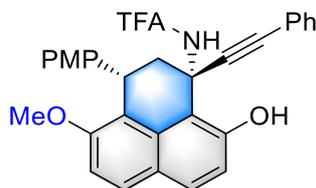
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-1,3-bis(phenylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3af)**



**3af**

Compound **3af** was prepared in 97% yield (96.0 mg) according to the general procedure. 10 h. Red Solid. M.p = 70 – 72 °C.  $[\alpha]_D^{20}$  -14.2 (c 0.2, DCM). 74% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 93/7,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 6.69 min (minor), 8.65 min (major)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.11 (s, 1H), 7.98 (d,  $J = 7.0 \text{ Hz}$ , 1H), 7.87 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.75 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.55 – 7.50 (m, 4H), 7.46 – 7.42 (m, 1H), 7.40 – 7.30 (m, 6H), 7.25 (d,  $J = 5.0 \text{ Hz}$ , 1H), 6.55 (s, 1H), 4.32 (dd,  $J = 13.5, 3.5 \text{ Hz}$ , 1H), 3.78 (dd,  $J = 13.5, 3.5 \text{ Hz}$ , 1H), 2.68 (d,  $J = 13.5 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  156.2 (q,  $J = 37.5 \text{ Hz}$ ), 153.4, 132.2, 132.1, 131.7, 130.9, 129.5, 129.1, 128.4, 128.3, 128.2, 128.0, 127.8, 126.0, 123.8, 123.0, 120.7, 115.3 (q,  $J = 287.5 \text{ Hz}$ ), 112.4, 88.8, 87.8, 85.7, 84.2, 51.0, 39.8, 28.9; IR (neat): 3418, 3055, 2928, 1714, 1621, 1512, 1490, 1443, 1260, 1221, 1170, 831, 755, 690; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{21}\text{F}_3\text{NO}_2^+$  496.1519; Found 496.1518.

**2,2,2-trifluoro-*N*-((1*R*,3*S*)-9-hydroxy-4-methoxy-3-(4-methoxyphenyl)-1-(phenylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3ag)**

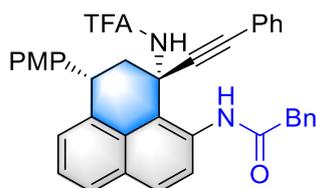


**3ag**

Compound **3ag** was prepared in 96% yield (101.8 mg) according to the general procedure. 7 h. Brown oil.  $[\alpha]_D^{20}$  +79.2 (c 0.52, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 9.76 min (minor), 10.91 min (major)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  9.30 (s, 1H), 7.84 – 7.77 (m, 2H),

7.47 (dd,  $J = 7.5, 1.5$  Hz, 2H), 7.34 – 7.25 (m, 3H), 7.18 (d,  $J = 9.0$  Hz, 1H), 7.12 (d,  $J = 9.0$  Hz, 1H), 6.96 (s, 2H), 6.82 (d,  $J = 8.5$  Hz, 2H), 6.70 (s, 1H), 4.96 (dd,  $J = 6.0, 2.0$  Hz, 1H), 3.81 (s, 3H), 3.75 (s, 3H), 3.35 (dd,  $J = 14.5, 2.0$  Hz, 1H), 2.90 (dd,  $J = 14.5, 6.0$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.9, 156.7 (q,  $J = 37.5$  Hz), 155.0, 154.6, 134.1, 132.0, 131.7, 130.2, 129.1, 128.8, 128.5, 128.3, 124.2, 121.9, 119.3, 117.0, 115.1 (q,  $J = 286.2$  Hz), 114.8, 112.6, 109.8, 86.8, 85.7, 56.2, 55.4, 50.6, 42.8, 34.5; IR (neat): 3341, 2934, 2839, 1713, 1617, 1509, 1463, 1443, 1260, 1211, 1175, 1079, 1033, 839, 757; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_4^+$  532.1730; Found 532.1729.

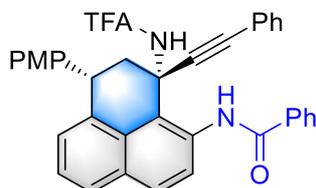
**2,2,2-trifluoro-*N*-((1*R*,3*S*)-3-(4-methoxyphenyl)-9-(2-phenylacetamido)-1-(phenylethynyl)-2,3-dihydro-1*H*-phenalen-1-yl)acetamide (3ah)**



**3ah**

Compound **3ah** was prepared in 81% yield (100.1 mg) according to the general procedure. Pale yellow oil.  $[\alpha]_{\text{D}}^{20} +75.5$  (c 0.26, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 85/15,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 9.20 min (major), 12.51 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.56 (s, 1H), 7.90 (d,  $J = 8.8$  Hz, 1H), 7.71 (d,  $J = 8.4$  Hz, 1H), 7.65 (d,  $J = 8.8$  Hz, 1H), 7.38 – 7.28 (m, 6H), 7.23 – 7.10 (m, 8H), 6.95 (d,  $J = 7.2$  Hz, 1H), 6.89 (d,  $J = 8.4$  Hz, 2H), 4.17 (d,  $J = 12.0$  Hz, 1H), 3.79 (s, 3H), 3.69 (dd,  $J = 15.6, 8.8$  Hz, 2H), 3.59 (dd,  $J = 14.0, 3.2$  Hz, 1H), 2.71 (t,  $J = 13.2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.2, 158.7, 155.8 (q,  $J = 37.0$  Hz), 137.9, 134.3, 133.7(3), 133.6(6), 132.4, 131.8, 130.8, 129.9, 129.3, 129.0, 128.9, 128.7, 128.3, 127.4, 126.8, 126.2, 125.9, 125.7, 125.1, 121.8, 115.4 (q,  $J = 289.9$  Hz), 114.2, 88.2, 85.4, 55.2, 52.4, 44.5, 42.5, 40.8; IR (neat): 3344, 3017, 2946, 2211, 1706, 1690, 1600, 1154, 714, 658; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{38}\text{H}_{30}\text{F}_3\text{N}_2\text{O}_3^+$  619.2203; Found 619.2202.

***N*-((1*R*,3*S*)-1-(4-methoxyphenyl)-3-(phenylethynyl)-3-(2,2,2-trifluoroacetamido)-2,3-dihydro-1*H*-phenalen-4-yl)benzamide (**3ai**)**



**3ai**

Compound **3ai** was prepared in 81% yield (97.8 mg) according to the general procedure. 48 h. Pale yellow oil.  $[\alpha]_D^{20} +71.2$  (c 0.65, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 13.92 min (major), 29.73 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  9.77 (s, 1H), 7.98 – 7.84 (m, 4H), 7.74 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.52 – 7.43 (m, 1H), 7.39 – 7.28 (m, 4H), 7.26 – 7.22 (m, 1H), 7.20 – 7.09 (m, 6H), 7.00 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.91 (d,  $J = 8.8 \text{ Hz}$ , 2H), 4.26 (dd,  $J = 13.2, 3.2 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.54 (d,  $J = 14.0 \text{ Hz}$ , 1H), 2.83 (t,  $J = 13.6 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  166.8, 158.7, 156.1 (q,  $J = 37.7 \text{ Hz}$ ), 137.5, 134.5, 134.2, 133.9, 132.3, 132.0, 131.7, 130.9, 129.9, 128.8, 128.6, 128.2, 127.3, 127.0, 126.5, 125.8, 125.6, 124.1, 121.3, 115.4 (q,  $J = 288.0 \text{ Hz}$ ), 114.2, 88.1, 86.1, 55.3, 52.3, 42.9, 40.8. IR (neat): 3346, 3026, 2953, 2198, 1724, 1645, 1614, 1466, 1262, 1076, 722; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{37}\text{H}_{28}\text{F}_3\text{N}_2\text{O}_3^+$  605.2047; Found 605.2045.

**((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(2,2,2-trifluoroacetamido)-2,3-dihydro-1*H*-phenalen-1-yl)ethynyl)phenyl 6-(3-((3*r*,5*r*,7*r*)-adamantan-1-yl)-4-methoxyphenyl)-2-naphthoate (**3aj**)**

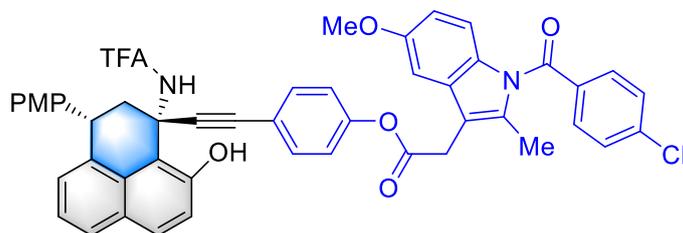


**3aj**

Compound **3aj** was prepared in 98% yield (178.6 mg) according to the general

procedure. 8 h. Orange Oil.  $[\alpha]_D^{20}$  -74.6 (c 0.76, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 70/30,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ,  $40^\circ\text{C}$ ; TR = 8.60 min (minor), 10.10 min (major)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.74 (s, 1H), 8.30 (s, 1H), 8.14 (dd,  $J = 8.5, 2.0 \text{ Hz}$ , 1H), 8.03 (s, 1H), 8.00 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.94 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.87 – 7.80 (m, 2H), 7.66 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.62 (d,  $J = 2.5 \text{ Hz}$ , 1H), 7.59 – 7.51 (m, 3H), 7.26 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.24 – 7.16 (m, 5H), 6.98 (d,  $J = 8.5 \text{ Hz}$ , 1H), 6.95 (d,  $J = 7.0 \text{ Hz}$ , 1H), 6.91 (d,  $J = 8.5 \text{ Hz}$ , 2H), 6.83 (s, 1H), 4.24 (dd,  $J = 13.0, 3.5 \text{ Hz}$ , 1H), 3.89 (s, 3H), 3.81 (s, 3H), 3.40 (dd,  $J = 14.0, 4.0 \text{ Hz}$ , 1H), 2.77 (t,  $J = 13.5 \text{ Hz}$ , 1H), 2.19 (s, 6H), 2.10 (s, 3H), 1.80 (s, 6H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  164.9, 159.0, 158.8, 156.3 (q,  $J = 36.5 \text{ Hz}$ ), 153.3, 151.7, 141.9, 139.1, 136.3, 135.7, 134.8, 133.3, 132.4, 132.1, 131.8, 131.2, 130.0, 129.8, 129.2, 129.0, 128.5, 127.1, 126.8, 126.7, 125.9, 125.8, 125.7(4), 125.6(6), 124.7, 123.4, 122.0, 120.4, 118.9, 115.5 (q,  $J = 287.5 \text{ Hz}$ ), 114.3, 112.2, 112.0, 86.8, 86.3, 55.3, 55.1, 51.3, 42.2, 40.9, 40.6, 37.2, 37.1, 29.1; IR (neat): 3424, 2903, 2848, 1731, 1626, 1511, 1473, 1256, 1201, 1176, 1062, 1031, 831, 809, 739; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{58}\text{H}_{49}\text{F}_3\text{NO}_3^+$  912.3506; Found 912.3505.

**4-(((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(2,2,2-trifluoroacetamido)-2,3-dihydro-1*H*-phenalen-1-yl)ethynyl)phenyl 2-(1-(4-chlorobenzoyl)-5-methoxy-2-methyl-1*H*-indol-3-yl)acetate (**3ak**)**

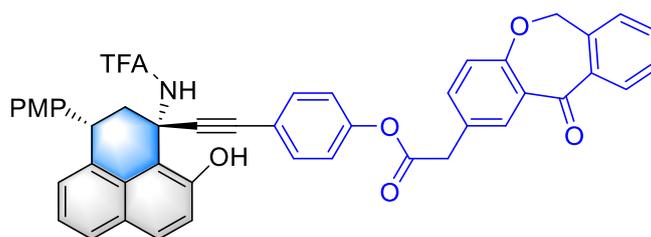


**3ak**

Compound **3ak** was prepared in 87% yield (148.9 mg) according to the general procedure. 8 h. Pale White oil.  $[\alpha]_D^{20}$  -64.2 (c 0.87, DCM). 92% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 70/30,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ,  $40^\circ\text{C}$ ; TR = 16.18 min (minor), 29.78 min (major)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.18 (s, 1H), 7.84 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.71 – 7.59 (m, 3H), 7.46 (dd,  $J = 8.8, 4.4 \text{ Hz}$ , 4H), 7.27 – 7.16

(m, 4H), 7.04 (d,  $J = 8.4$  Hz, 3H), 6.97 – 6.84 (m, 4H), 6.69 (dd,  $J = 8.4, 2.4$  Hz, 2H), 4.20 (dd,  $J = 13.2, 2.8$  Hz, 1H), 3.89 (s, 2H), 3.82 (s, 6H), 3.38 (dd,  $J = 14.0, 4.0$  Hz, 1H), 2.74 (t,  $J = 13.6$  Hz, 1H), 2.44 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  168.8, 168.2, 158.8, 156.2 (q,  $J = 37.0$  Hz), 156.1, 153.2, 151.3, 139.4, 136.3, 135.6, 134.7, 133.7, 133.3, 132.1, 131.2, 130.8, 130.4, 129.9, 129.4, 129.1, 128.9, 127.1, 126.8, 123.4, 121.7, 120.4, 118.7, 115.3 (q,  $J = 301.0$  Hz), 115.0, 114.3, 112.9, 111.8, 111.7, 101.2, 86.7, 86.2, 55.7, 55.3, 51.2, 42.1, 40.9, 30.5, 13.4; IR (neat): 3305, 3280, 2933, 1731, 1690, 1682, 1523, 1206, 1021, 750; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{49}\text{H}_{37}\text{ClF}_3\text{N}_2\text{O}_7^+$  857.2236 Found 857.2235.

**5-(((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(2,2,2-trifluoroacetamido)-2,3-dihydro-1*H*-phenalen-1-yl)ethynyl)phenyl 2-(11-oxo-6,11-dihydrodibenzo[*b,e*]oxepin-2-yl)acetate (**3al**)**

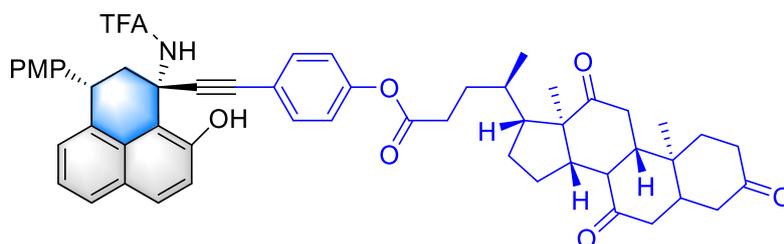


**3al**

Compound **3al** was prepared in 88% yield (135.0 mg) according to the general procedure. 8 h. Orange Solid. M.p = 119 – 124 °C.  $[\alpha]_{\text{D}}^{20}$  -49.5 (c 0.36, DCM). 92% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 70/30,  $v = 1.0$  mL·min<sup>-1</sup>,  $\lambda = 220$  nm, 40°C; TR = 24.80 min (minor), 31.15 min (major)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.23 – 8.15 (m, 2H), 7.87 (d,  $J = 7.6$  Hz, 1H), 7.84 (d,  $J = 9.2$  Hz, 1H), 7.66 (d,  $J = 8.4$  Hz, 1H), 7.58 – 7.52 (m, 1H), 7.50 – 7.44 (m, 5H), 7.35 (d,  $J = 7.2$  Hz, 1H), 7.26 – 7.15 (m, 3H), 7.08 – 7.02 (m, 3H), 6.94 (d,  $J = 7.2$  Hz, 1H), 6.91 (d,  $J = 8.0$  Hz, 2H), 6.74 (s, 1H), 5.18 (s, 2H), 4.21 (dd,  $J = 13.6, 4.0$  Hz, 1H), 3.86 (s, 2H), 3.81 (s, 3H), 3.40 (dd,  $J = 14.0, 4.0$  Hz, 1H), 2.74 (t,  $J = 13.6$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  190.7, 169.4, 160.7, 158.7, 156.2 (q,  $J = 37.0$  Hz), 153.2, 151.2, 140.3, 136.2, 135.7, 135.5, 134.7, 133.3, 132.8, 132.6, 132.1, 129.9, 129.5, 129.3, 129.1, 128.9, 127.8, 127.1, 126.8, 126.8, 125.2, 123.4, 121.7, 121.3, 120.4, 118.7, 115.4 (q,  $J = 288.0$  Hz), 114.2,

112.9, 86.6, 86.2, 73.6, 55.3, 51.2, 42.1, 40.9, 40.2; IR (neat): 3425, 3319, 2927, 2855, 1724, 1644, 1610, 1511, 1301, 1255, 1203, 1178, 1164, 1119, 1017, 831, 762; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{46}H_{33}F_3N_2O_7^+$  768.2204; Found 768.2203.

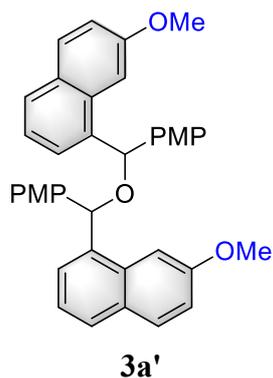
**4-(((1*R*,3*S*)-9-hydroxy-3-(4-methoxyphenyl)-1-(2,2,2-trifluoroacetamido)-2,3-dihydro-1*H*-phenalen-1-yl)ethynyl)phenyl (4*R*)-4-((9*S*,10*S*,13*R*,14*S*,17*R*)-10,13-dimethyl-3,7,12-trioxohexadecahydro-1*H*-cyclopenta[*a*]phenanthren-17-yl)pentanoate (**3am**)**



**3am**

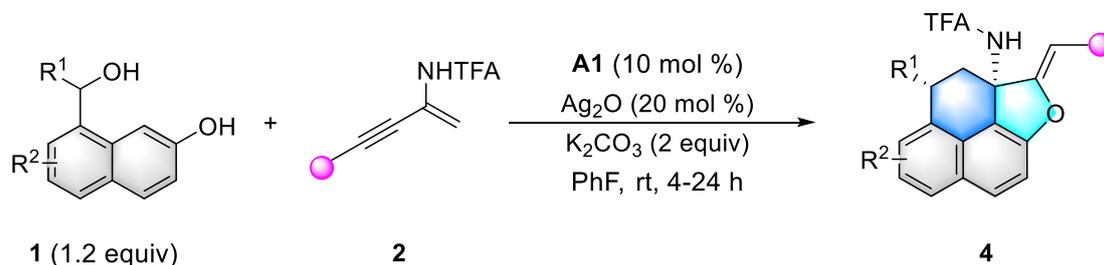
Compound **3am** was prepared in 67% yield (120.7 mg) according to the general procedure. 9 h. Pale yellow oil.  $[\alpha]_D^{20}$  -84.5 (c 0.62, DCM).  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  7.83 (d,  $J = 9.2$  Hz, 1H), 7.65 (d,  $J = 8.4$  Hz, 1H), 7.46 (d,  $J = 8.8$  Hz, 2H), 7.26 – 7.14 (m, 6H), 7.03 (d,  $J = 8.4$  Hz, 2H), 6.95 – 6.88 (m, 3H), 4.25 (t,  $J = 12.8, 2.8$  Hz, 1H), 3.81 (s, 3H), 3.40 (t,  $J = 14.0, 4.0$  Hz, 1H), 2.91 – 2.73 (m, 4H), 2.69 – 2.44 (m, 2H), 2.32 – 2.23 (m, 2H), 2.20 – 1.89 (m, 13H), 1.84 – 1.73 (m, 1H), 1.60 – 1.46 (m, 1H), 1.36 (s, 2H), 1.06 (s, 3H), 0.89 (d,  $J = 6.6$  Hz, 3H);  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  212.0, 209.2, 208.7, 172.0, 158.6, 153.2, 151.2, 135.8, 134.7, 133.1, 131.8, 129.9, 129.0, 128.9, 126.9, 126.5, 123.3, 121.7, 120.2, 118.6, 114.1, 113.0, 86.9, 85.7, 56.8, 55.2, 51.6, 51.2, 48.8, 46.6, 45.5, 45.4, 44.8, 42.6, 42.0, 40.7, 38.5, 36.3, 35.8, 35.3, 35.0, 31.4, 30.2, 29.6, 27.5, 25.0, 21.7, 18.6, 11.7; IR (neat): 3501, 3385, 3060, 2962, 2875, 2216, 1755, 1714, 1620, 1505, 1378, 1162, 991, 882, 770, 520; HRMS (ESI/QTOF)  $m/z$ :  $[M + Na]^+$  Calcd for  $C_{54}H_{54}F_3NNaO_8^+$  924.3694; Found 924.3693.

**8,8'-(oxybis((4-methoxyphenyl)methylene))bis(2-methoxynaphthalene) (**3a'**)**



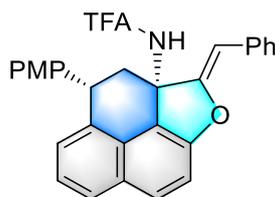
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.77 – 7.67 (m, 4H), 7.61 (d,  $J$  = 7.2 Hz, 2H), 7.34 (d,  $J$  = 8.0 Hz, 2H), 7.29 (d,  $J$  = 8.4 Hz, 4H), 7.23 (s, 2H), 7.08 (d,  $J$  = 10.0 Hz, 2H), 6.82 (d,  $J$  = 8.0 Hz, 4H), 6.33 (s, 2H), 3.74 (s, 12H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  159.0, 157.4, 137.78, 135.4, 131.6, 130.1, 129.4, 128.2, 128.0, 124.8, 122.9, 117.9, 113.8, 103.1, 73.7, 55.2, 55.1. HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{38}\text{H}_{34}\text{NaO}_5^+$  593.2298; Found 593.2292.

#### General procedure for the synthesis of chiral 1,2-dihydronaphtho[2,1-*b*]furans **4**:



A 10 mL reaction tube was charged with chiral phosphoric acid **A1** (10 mol %, 0.02 mmol, 15 mg), **1** (1.2 equiv, 0.24 mmol) and **2** (0.2 mmol),  $\text{PhF}$  (6 mL) were added sequentially. The reaction mixture was then stirred at 0 °C. After completion of the reaction (monitored by TLC),  $\text{Ag}_2\text{O}$  (20 mol %, 0.04 mmol, 9.3 mg) and  $\text{K}_2\text{CO}_3$  (2 equiv, 0.4 mmol, 55.3 mg) were added sequentially, the reaction mixture was then stirred at room temperature. After completion of the reaction (monitored by TLC), the reaction mixture was concentrated under vacuum and purified by column chromatography on silica gel, eluting with  $\text{EtOAc}$ /hexane to afford the products **4**

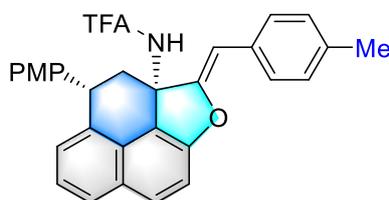
*N*-((2*aS*,4*S*)-2-((*Z*)-benzylidene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (**4a**)



**4a**

Compound **4a** was prepared in 89% yield (89.2 mg) according to the general procedure. 8 h. Orange Solid. M.p = 112 – 115 °C.  $[\alpha]_D^{20}$  -67.9 (c 0.56, DCM). 94% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 93/7,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 8.47 min (major), 10.34 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.88 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.74 (d,  $J = 7.6 \text{ Hz}$ , 2H), 7.70 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.40 – 7.33 (m, 3H), 7.30 – 7.23 (m, 2H), 7.17 – 7.08 (m, 2H), 6.91 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.88 (d,  $J = 8.4 \text{ Hz}$ , 2H), 6.50 (s, 1H), 6.41 (s, 1H), 4.50 (d,  $J = 10.0 \text{ Hz}$ , 1H), 3.79 (s, 3H), 3.61 (dd,  $J = 13.2, 3.6 \text{ Hz}$ , 1H), 2.32 (t,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 156.8, 155.5 (q,  $J = 37.0 \text{ Hz}$ ), 154.4, 135.5, 134.5, 133.7, 131.2, 130.0, 129.3, 128.8, 128.4, 127.4, 126.9, 126.5, 125.8, 125.0, 117.7, 115.3 (q,  $J = 288.0 \text{ Hz}$ ), 114.1, 111.8, 109.4, 60.5, 55.2, 42.7, 37.6; IR (neat): 3281, 3052, 2835, 1719, 1512, 1239, 1177, 1062, 971, 824, 750, 694; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{30}\text{H}_{22}\text{F}_3\text{NNaO}_3^+$  524.1444; Found 524.1442.

**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-4-(4-methoxyphenyl)-2-((*Z*)-4-methylbenzylidene)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4b)**

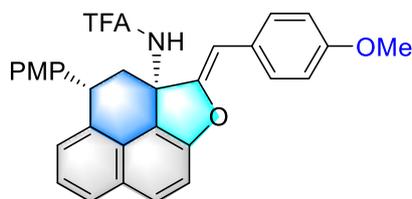


**4b**

Compound **4b** was prepared in 83% yield (85.5 mg) according to the general procedure. 8 h. Green oil.  $[\alpha]_D^{20}$  -125.8 (c 0.48, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.23 min (major), 10.34 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.72 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.63 (d,  $J = 8.0 \text{ Hz}$ , 2H), 7.37 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.30 – 7.25 (m, 1H),

7.18 (d,  $J = 8.0$  Hz, 2H), 7.16 – 7.09 (m, 2H), 6.92 (d,  $J = 7.5$  Hz, 1H), 6.89 (d,  $J = 8.5$  Hz, 2H), 6.46 (s, 1H), 6.38 (s, 1H), 4.50 (dd,  $J = 12.7, 4.0$  Hz, 1H), 3.81 (s, 3H), 3.61 (dd,  $J = 13.5, 4.0$  Hz, 1H), 2.40 – 2.26 (m, 4H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 156.2, 155.5 (q,  $J = 37.5$  Hz), 154.5, 137.3, 135.6, 134.6, 131.2, 131.0, 130.0, 129.3, 129.1, 128.8, 127.0, 126.5, 125.8, 125.0, 115.4 (q,  $J = 287.5$  Hz), 114.2, 111.9, 109.3, 60.5, 55.3, 42.8, 37.8, 21.3; IR (neat): 3283, 2927, 1719, 1647, 1610, 1512, 1465, 1239, 1177, 971, 824, 764, 749; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_3^+$  516.1781; Found 516.1782.

**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-2-((*Z*)-4-methoxybenzylidene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4c)**

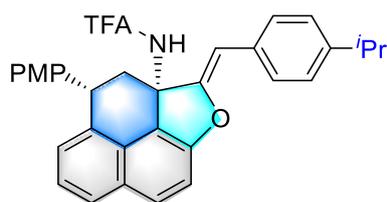


**4c**

Compound **4c** was prepared in 48% yield (50.9 mg) according to the general procedure. 8 h. Pink oil.  $[\alpha]_{\text{D}}^{20}$  -149.5 (c 0.31, DCM). 96% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0$  mL·min $^{-1}$ ,  $\lambda = 220$  nm; TR = 9.67 min (major), 14.46 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 (d,  $J = 8.8$  Hz, 1H), 7.75 – 7.65 (m, 3H), 7.36 (d,  $J = 8.8$  Hz, 1H), 7.28 (d,  $J = 7.2$  Hz, 1H), 7.19 – 7.09 (m, 2H), 6.95 – 6.85 (m, 5H), 6.50 (s, 1H), 6.36 (s, 1H), 4.49 (dd,  $J = 12.8, 4.0$  Hz, 1H), 3.81 (s, 6H), 3.60 (dd,  $J = 13.2, 4.0$  Hz, 1H), 2.32 (t,  $J = 12.8$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 158.6, 155.5 (q,  $J = 37.0$  Hz), 155.3, 154.4, 135.5, 134.6, 131.1, 130.7, 130.0, 128.7, 126.9, 126.5, 126.4, 125.7, 124.9, 117.7, 115.9, 115.3 (q,  $J = 288.0$  Hz), 114.1, 111.8, 109.0, 60.4, 55.3, 42.7, 37.7; IR (neat): 3279, 2932, 1722, 1710, 1610, 1528, 1511, 1466, 1238, 1177, 1033, 971, 824; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_4^+$  532.1730; Found 532.1729.

**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-2-((*Z*)-4-isopropylbenzylidene)-4-(4-methoxyphenyl)-**

### 3,4-dihydrophenaleno[1,9-bc]furan-2a(2*H*)-yl)acetamide (**4d**)

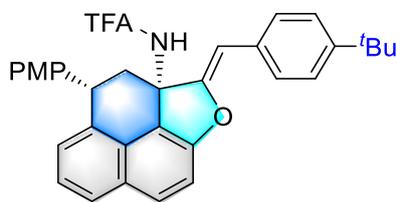


**4d**

Compound **4d** was prepared in 68% yield (73.8 mg) according to the general procedure. 9 h. Red oil.  $[\alpha]_{\text{D}}^{20}$  -113.1 (*c* 0.35, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 5.63 min (major), 7.09 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.72 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.68 (d,  $J = 8.0 \text{ Hz}$ , 2H), 7.37 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.30 – 7.25 (m, 3H), 7.18 – 7.09 (m, 2H), 6.92 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.89 (d,  $J = 8.8 \text{ Hz}$ , 2H), 6.46 (s, 1H), 6.40 (s, 1H), 4.50 (dd,  $J = 12.8, 4.0 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.61 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 2.91 (p,  $J = 6.9 \text{ Hz}$ , 1H), 2.32 (t,  $J = 12.8 \text{ Hz}$ , 1H), 1.26 (s, 3H), 1.25 (s, 3H).

$^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 156.3, 155.4 (q,  $J = 37.0 \text{ Hz}$ ), 154.4, 148.3, 135.5, 134.6, 131.3, 131.2, 130.0, 129.3, 128.7, 126.9, 126.5, 126.4, 125.7, 124.9, 117.7, 115.3 (q,  $J = 288.0 \text{ Hz}$ ), 114.1, 111.9, 109.3, 60.5, 55.3, 42.7, 37.7, 33.9, 23.9; IR (neat): 3268, 2957, 2867, 1718, 1647, 1610, 1512, 1465, 1239, 1176, 971, 823; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{33}\text{H}_{29}\text{F}_3\text{NO}_3^+$  544.2094; Found 544.2091.

### *N*-((2*aS*,4*S*)-2-((*Z*)-4-(tert-butyl)benzylidene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-bc]furan-2a(2*H*)-yl)-2,2,2-trifluoroacetamide (**4e**)

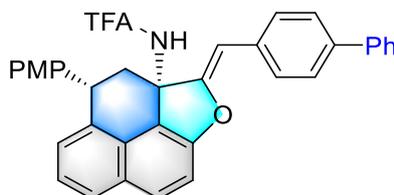


**4e**

Compound **4e** was prepared in 82% yield (91.2 mg) according to the general procedure. 8 h. Pale Orange oil.  $[\alpha]_{\text{D}}^{20}$  -73.2 (*c* 0.42, DCM). 90% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 8.17 min (major), 12.65 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.88 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.73 – 7.67 (m,

3H), 7.41 (d,  $J = 8.4$  Hz, 2H), 7.36 (d,  $J = 8.8$  Hz, 1H), 7.31 – 7.24 (m, 1H), 7.13 (d,  $J = 6.8$  Hz, 2H), 6.92 (d,  $J = 7.2$  Hz, 1H), 6.88 (d,  $J = 8.4$  Hz, 2H), 6.47 (s, 1H), 6.40 (s, 1H), 4.50 (dd,  $J = 12.4, 3.2$  Hz, 1H), 3.80 (s, 3H), 3.61 (dd,  $J = 13.2, 4.0$  Hz, 1H), 2.32 (t,  $J = 13.2$  Hz, 1H), 1.33 (s, 9H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 156.4, 155.4 (q,  $J = 37.0$  Hz), 154.4, 150.5, 131.2, 130.9, 130.0, 129.1, 128.7, 126.9, 126.4, 125.8, 125.4, 124.9, 117.7, 115.3 (q,  $J = 288.0$  Hz), 114.1, 111.9, 109.2, 60.5, 55.3, 42.8, 37.7, 34.6, 31.2; IR (neat): 3421, 3006, 2977, 1732, 1606, 1379, 1169, 1022, 826, 773; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{34}\text{H}_{31}\text{F}_3\text{NO}_3^+$  558.2251; Found 558.2250.

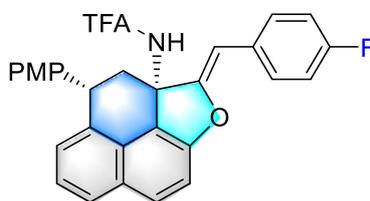
***N*-((2*aS*,4*S*,*Z*)-2-([1,1'-biphenyl]-4-ylmethylene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (4f)**



**4f**

Compound **4f** was prepared in 84% yield (96.9 mg) according to the general procedure. 6 h. Pale White oil.  $[\alpha]_{\text{D}}^{20}$  -223.4 (c 0.24, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 10.61 min (major), 15.78 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.88 (d,  $J = 9.2$  Hz, 1H), 7.82 (d,  $J = 8.0$  Hz, 2H), 7.71 (d,  $J = 8.4$  Hz, 1H), 7.61 (d,  $J = 7.6$  Hz, 4H), 7.47 – 7.24 (m, 5H), 7.18 – 7.08 (m, 2H), 6.92 (d,  $J = 7.2$  Hz, 1H), 6.88 (d,  $J = 8.4$  Hz, 2H), 6.53 (s, 1H), 6.46 (s, 1H), 4.51 (dd,  $J = 12.8, 4.0$  Hz, 1H), 3.80 (s, 3H), 3.62 (dd,  $J = 13.2, 4.0$  Hz, 1H), 2.33 (t,  $J = 13.0$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 157.0, 155.5 (q,  $J = 37.0$  Hz), 154.3, 140.6, 139.9, 135.5, 134.5, 132.8, 131.3, 130.0, 129.7, 128.7, 127.3, 127.0, 126.9, 126.5, 125.8, 125.0, 117.7, 115.3 (q,  $J = 288.0$  Hz), 114.1, 118.8, 109.0, 60.5, 55.2, 42.7, 37.6; IR (neat): 3280, 2933, 1733, 1710, 1625, 1598, 1466, 1160, 971, 824; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{36}\text{H}_{27}\text{F}_3\text{NO}_3^+$  578.1938; Found 578.1936.

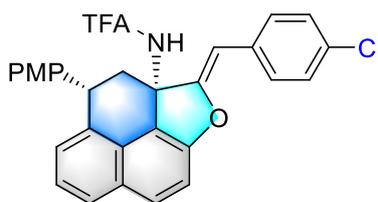
**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-2-((*Z*)-4-fluorobenzylidene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4g)**



**4g**

Compound **4g** was prepared in 94% yield (97.5 mg) according to the general procedure. 8 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -194.8 (c 0.39, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 6.47 min (major), 9.54 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.76 – 7.67 (m, 3H), 7.36 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.31– 7.25 (m, 1H), 7.18– 7.08 (m, 2H), 7.09 – 7.01 (m, 2H), 6.92 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.88 (d,  $J = 8.4 \text{ Hz}$ , 2H), 6.48 (s, 1H), 6.38 (s, 1H), 4.50 (dd,  $J = 12.4, 3.2 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.59 (dd,  $J = 13.2, 4.4 \text{ Hz}$ , 1H), 2.32 (t,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  161.88 (d,  $J = 247.7 \text{ Hz}$ ), 158.7, 156.5, 156.4, 155.6 (q,  $J = 37.0 \text{ Hz}$ ), 154.3, 135.5, 134.5, 131.3, 131.0 (d,  $J = 8.1 \text{ Hz}$ ), 129.9 (d,  $J = 3.0 \text{ Hz}$ ), 128.8, 126.9, 126.5, 125.8, 125.1, 117.7, 115.3 (q,  $J = 288.0 \text{ Hz}$ ), 115.3 (d,  $J = 21.2 \text{ Hz}$ ), 114.2, 111.8, 108.3, 60.5, 55.3, 42.7, 37.7; IR (neat): 3281, 2931, 1721, 1698, 1629, 1522, 1221, 1156, 966, 830; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{22}\text{F}_4\text{NO}_3^+$  520.1530; Found 520.1529.

***N*-((2*aS*,4*S*)-2-((*Z*)-4-chlorobenzylidene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (4h)**

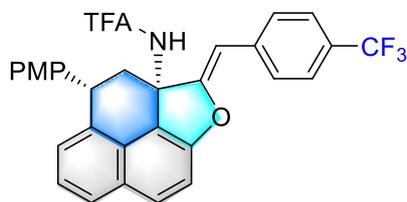


**4h**

Compound **4h** was prepared in 73% yield (78.1 mg) according to the general procedure.

8 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -191.6 (c 0.65, DCM). 92% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.25 min (major), 10.39 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.91 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.72 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.67 (d,  $J = 8.8 \text{ Hz}$ , 2H), 7.37 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.35 – 7.26 (m, 3H), 7.18 – 7.08 (m, 2H), 6.92 (d,  $J = 7.6 \text{ Hz}$ , 1H), 6.88 (d,  $J = 8.8 \text{ Hz}$ , 2H), 6.49 (s, 1H), 6.37 (s, 1H), 4.50 (dd,  $J = 12.4, 4.0 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.59 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 2.32 (t,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.2, 155.6 (q,  $J = 37.0 \text{ Hz}$ ), 154.2, 135.5, 134.4, 132.9, 132.2, 131.4, 130.5, 130.0, 128.8, 128.5, 126.9, 126.6, 125.8, 125.1, 117.6, 115.3 (q,  $J = 289.9 \text{ Hz}$ ), 114.1, 111.8, 108.2, 60.5, 55.3, 42.7, 37.6; IR (neat): 3288, 2988, 1716, 1662, 1633, 1525, 1232, 1166, 830, 760; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{22}\text{ClF}_3\text{NO}_3^+$  536.1235; Found 536.1233.

**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-4-(4-methoxyphenyl)-2-((*Z*)-4-(trifluoromethyl)benzylidene)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4i)**

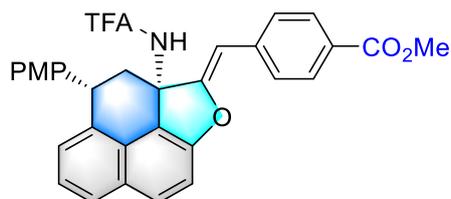


**4i**

Compound **4i** was prepared in 79% yield (89.9 mg) according to the general procedure. 7 h. Pale White oil.  $[\alpha]_D^{20}$  -103.8 (c 0.38, DCM). 97% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 5.64 min (major), 8.11 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.91 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.84 (d,  $J = 8.0 \text{ Hz}$ , 2H), 7.72 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.60 (d,  $J = 8.4 \text{ Hz}$ , 2H), 7.38 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.32 – 7.26 (m, 1H), 7.18 – 7.08 (m, 2H), 6.93 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.88 (d,  $J = 8.8 \text{ Hz}$ , 2H), 6.56 (s, 1H), 6.46 (s, 1H), 4.51 (dd,  $J = 12.4, 3.6 \text{ Hz}$ , 1H), 3.80 (s, 3H), 3.60 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 2.33 (t,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 158.6, 155.7 (q,  $J = 37.0 \text{ Hz}$ ), 154.1, 137.3, 135.5, 134.3, 131.5, 130.0, 128.9(4), 128.9 (q,  $J = 32.3 \text{ Hz}$ ), 126.9, 126.6, 125.8, 125.3, 125.2, 124.2 (q,  $J = 272.7 \text{ Hz}$ ), 117.6, 115.3

(q,  $J = 289.9$  Hz), 114.2, 111.7, 108.0, 60.6, 55.2, 42.7, 37.5; IR (neat): 3277, 2929, 2358, 1714, 1614, 1512, 1324, 1237, 1165, 1123, 1037, 971, 824; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{31}H_{22}F_6NO_3^+$  570.1498; Found 570.1496.

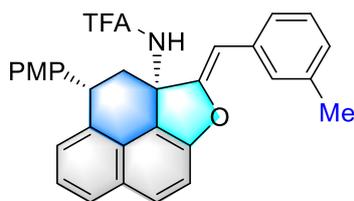
**4-((Z)-((2*aS*,4*S*)-4-(4-methoxyphenyl)-2*a*-(2,2,2-trifluoroacetamido)-3,4-dihydrophenaleno[1,9-*bc*]furan-2(2*aH*)-ylidene)methyl)benzoate (4j)**



**4j**

Compound **4j** was prepared in 86% yield (96.1 mg) according to the general procedure. 6 h. Red oil.  $[\alpha]_D^{20} +119.5$  (c 0.2, DCM). 96% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0$  mL·min<sup>-1</sup>,  $\lambda = 220$  nm; TR = 18.14 min (major), 25.19 min (minor)). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  7.99 (d,  $J = 8.4$  Hz, 2H), 7.88 (d,  $J = 8.8$  Hz, 1H), 7.78 (d,  $J = 8.4$  Hz, 2H), 7.70 (d,  $J = 8.4$  Hz, 1H), 7.36 (d,  $J = 8.8$  Hz, 1H), 7.31 – 7.25 (m, 1H), 7.18 – 7.08 (m, 2H), 6.92 (d,  $J = 7.2$  Hz, 1H), 6.88 (d,  $J = 8.8$  Hz, 2H), 6.73 (d,  $J = 7.6$  Hz, 1H), 6.46 (s, 1H), 4.52 (dd,  $J = 12.4, 4.0$  Hz, 1H), 3.85 (s, 3H), 3.80 (s, 3H), 3.61 (dd,  $J = 13.2, 4.0$  Hz, 1H), 2.33 (t,  $J = 12.8$  Hz, 1H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  166.8, 158.7, 155.7 (q,  $J = 36.6$  Hz), 154.2, 138.4, 135.5, 134.4, 131.4, 130.0, 129.6, 129.1, 128.9, 128.4, 126.9, 126.5, 125.8, 125.1, 117.6, 115.3 (q,  $J = 289.9$ Hz), 115.9, 114.2, 111.7, 108.4, 60.7, 55.2, 52.0, 42.7, 37.6; IR (neat): 3265, 2953, 1722, 1643, 1512, 1322, 1237, 1165, 1103, 1052, 971, 823; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{32}H_{25}F_3NO_5^+$  560.1679; Found 560.1677.

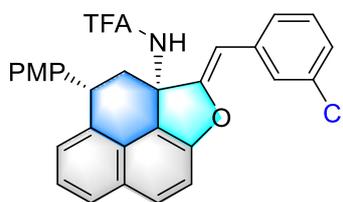
**2,2,2-trifluoro-N-((2*aS*,4*S*)-4-(4-methoxyphenyl)-2-((Z)-3-methylbenzylidene)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4k)**



**4k**

Compound **4k** was prepared in 70% yield (72.1 mg) according to the general procedure. 7 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -103.5 (c 0.59, DCM). 92% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 5.49 min (major), 9.51 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.91 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.73 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.59 (d,  $J = 7.5 \text{ Hz}$ , 1H), 7.52 (s, 1H), 7.39 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.30 – 7.25 (m, 2H), 7.18 – 7.08 (m, 2H), 7.07 (d,  $J = 7.5 \text{ Hz}$ , 1H), 6.92 (d,  $J = 7.0 \text{ Hz}$ , 1H), 6.89 (d,  $J = 8.5 \text{ Hz}$ , 2H), 6.46 (s, 1H), 6.39 (s, 1H), 4.50 (dd,  $J = 12.7, 4.0 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.61 (dd,  $J = 13.5, 4.0 \text{ Hz}$ , 1H), 2.38 (s, 3H), 2.33 (t,  $J = 13.0 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.7, 155.5 (q,  $J = 37.5 \text{ Hz}$ ), 154.5, 137.9, 135.6, 134.6, 133.7, 131.2, 130.1, 130.0, 128.8, 128.3, 128.2, 127.0, 126.5, 126.5, 125.8, 125.0, 117.8, 115.4 (q,  $J = 287.5 \text{ Hz}$ ), 114.2, 111.9, 109.5, 60.6, 55.3, 42.8, 37.8, 21.4; IR (neat): 3286, 2933, 1722, 1611, 1581, 1528, 1511, 1467, 1235, 1177, 971, 824, 763; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_3^+$  516.1781; Found 516.1780.

***N*-((2*aS*,4*S*)-2-((*Z*)-3-chlorobenzylidene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (**4l**)**

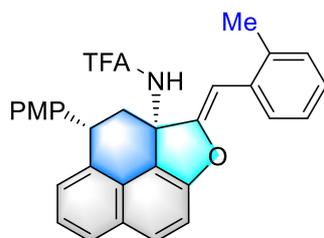


**4l**

Compound **4l** was prepared in 64% yield (68.4 mg) according to the general procedure. 8 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -112.4 (c 0.35, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.00 min (major), 10.59 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.91 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.81 (s, 1H), 7.72 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.54 (d,  $J = 7.6 \text{ Hz}$ , 1H), 7.40 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.31 –

7.25 (m, 2H), 7.24 – 7.19 (m, 1H), 7.18 – 7.08 (m, 2H), 6.92 (d,  $J = 7.2$  Hz, 1H), 6.88 (d,  $J = 8.4$  Hz, 2H), 6.52 (s, 1H), 6.36 (s, 1H), 4.50 (dd,  $J = 12.4, 4.0$  Hz, 1H), 3.81 (s, 3H), 3.59 (dd,  $J = 13.2, 4.0$  Hz, 1H), 2.31 (t,  $J = 12.8$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.7, 155.6 (q,  $J = 37.0$  Hz), 154.2, 135.5, 134.4, 134.2, 131.4, 129.9, 129.5, 129.0, 128.8, 127.5, 127.3, 126.8, 126.6, 125.8, 125.1, 117.5, 115.3 (q,  $J = 288.0$  Hz), 114.1, 111.8, 108.0, 60.5, 55.3, 42.7, 37.5; IR (neat): 3298, 2946, 1707, 1633, 1599, 1476, 1241, 1109, 823, 714; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{22}\text{ClF}_3\text{NO}_3^+$  536.1235; Found 536.1233.

**2,2,2-trifluoro-*N*-((2*S*,4*S*)-4-(4-methoxyphenyl)-2-((*Z*)-2-methylbenzylidene)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4m)**

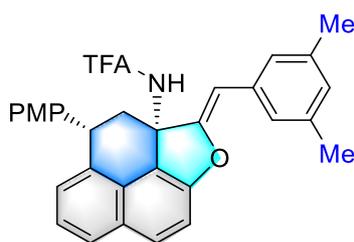


**4m**

Compound **4m** was prepared in 34% yield (35.0 mg) according to the general procedure. 7 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -114.2 (c 0.72, DCM). 90% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0$  mL $\cdot$ min $^{-1}$ ,  $\lambda = 220$  nm; TR = 4.24 min (major), 6.07 min (minor)).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.98 (d,  $J = 8.0$  Hz, 1H), 7.90 (d,  $J = 8.5$  Hz, 1H), 7.73 (d,  $J = 8.5$  Hz, 1H), 7.35 (d,  $J = 8.5$  Hz, 1H), 7.31 – 7.25 (m, 2H), 7.21 – 7.13 (m, 4H), 6.94 (d,  $J = 7.5$  Hz, 1H), 6.90 (d,  $J = 8.5$  Hz, 2H), 6.59 (s, 1H), 6.47 (s, 1H), 4.52 (dd,  $J = 12.5, 3.0$  Hz, 1H), 3.83 (s, 3H), 3.63 (dd,  $J = 13.0, 4.0$  Hz, 1H), 2.43 – 2.29 (m, 4H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.9, 155.5 (q,  $J = 37.5$  Hz), 154.5, 136.4, 135.5, 134.6, 132.3, 131.3, 130.1, 129.4, 128.8, 127.5, 127.0, 126.5, 125.81, 125.01, 117.9, 115.4 (q,  $J = 287.5$  Hz), 114.3, 112.0, 106.7, 60.5, 55.3, 42.8, 37.9, 20.1; IR (neat): 3346, 3060, 2944, 1724, 1633, 1466, 1382, 744, 712; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{25}\text{F}_3\text{NO}_3^+$  516.1781; Found 516.1780.

***N*-((2*S*,4*S*)-2-((*Z*)-3,5-dimethylbenzylidene)-4-(4-methoxyphenyl)-3,4-**

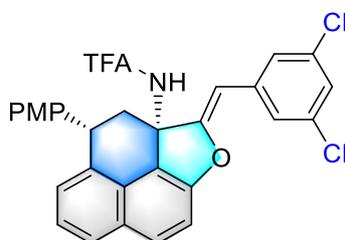
**dihydrophenaleno[1,9-bc]furan-2a(2H)-yl)-2,2,2-trifluoroacetamide (4n)**



**4n**

Compound **4n** was prepared in 66% yield (69.8 mg) according to the general procedure. 9 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -112.6 (c 0.22, DCM). 84% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 5.00 min (major), 10.23 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.90 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.71 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.44 – 7.34 (m, 3H), 7.30 – 7.24 (m, 1H), 7.18 – 7.08 (m, 2H), 6.96 – 6.83 (m, 4H), 6.44 (s, 1H), 6.35 (s, 1H), 4.50 (dd,  $J = 12.4, 4.0 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.60 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 2.37 – 2.26 (m, 7H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 156.6, 155.5 (q,  $J = 37.0 \text{ Hz}$ ), 154.5, 137.9, 135.7, 134.7, 133.6, 131.3, 130.1, 129.3, 128.9, 127.3, 127.0, 126.5, 125.8, 125.1, 117.8, 115.4 (q,  $J = 288.0 \text{ Hz}$ ), 114.2, 112.1, 109.6, 60.7, 55.4, 42.9, 37.8, 21.4; IR (neat): 3286, 3053, 2946, 1722, 1623, 1456, 1244, 1186, 812, 714; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{32}\text{H}_{27}\text{F}_3\text{NO}_3^+$  530.1938; Found 530.1936.

***N*-((2a*S*,4*S*)-2-((*Z*)-3,5-dichlorobenzylidene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-bc]furan-2a(2*H*)-yl)-2,2,2-trifluoroacetamide (4o)**

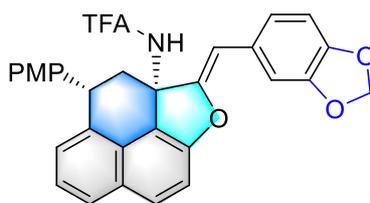


**4o**

Compound **4o** was prepared in 96% yield (109.2 mg) according to the general procedure. 8 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -108.6 (c 0.77, DCM). 95% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 6.60 min (major), 12.63 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (d,  $J = 9.0 \text{ Hz}$ , 1H),

7.74 (d,  $J = 8.0$  Hz, 1H), 7.62 (d,  $J = 1.5$  Hz, 2H), 7.42 (d,  $J = 9.0$  Hz, 1H), 7.30 (d,  $J = 7.8$  Hz, 1H), 7.24 – 7.21 (m, 1H), 7.18 – 7.08 (m, 2H), 6.93 (d,  $J = 7.5$  Hz, 1H), 6.89 (d,  $J = 8.5$  Hz, 2H), 6.52 (s, 1H), 6.31 (s, 1H), 4.50 (dd,  $J = 9.0, 3.5$  Hz, 1H), 3.82 (s, 3H), 3.57 (dd,  $J = 9.0, 4.0$  Hz, 1H), 2.30 (t,  $J = 12.5$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.8, 155.7 (q,  $J = 37.5$  Hz), 154.1, 136.6, 135.5, 134.9, 134.3, 131.5, 130.0, 129.0, 127.4, 127.1, 126.9, 126.7, 125.9, 125.3, 115.9 (q,  $J = 287.5$  Hz), 116.5, 114.3, 111.8, 106.9, 60.7, 55.3, 42.7, 37.5; IR (neat): 3405, 2929, 1724, 1687, 1584, 1558, 1513, 1465, 1237, 1216, 1176, 971, 824, 794, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{30}\text{H}_{21}\text{Cl}_2\text{F}_3\text{NO}_3^+$  570.0845; Found 570.0843.

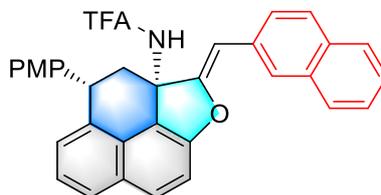
***N*-((2*aS*,4*S*,*Z*)-2-(benzo[*d*][1,3]dioxol-5-ylmethylene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (4*p*)**



**4*p***

Compound **4*p*** was prepared in 67% yield (73.0 mg) according to the general procedure. 6 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20}$  -114.5 (c 0.61, DCM). 92% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0$  mL·min $^{-1}$ ,  $\lambda = 220$  nm; TR = 11.90 min (major), 20.02 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 (d,  $J = 8.8$  Hz, 1H), 7.71 (d,  $J = 8.4$  Hz, 1H), 7.46 (d,  $J = 1.6$  Hz, 1H), 7.35 (d,  $J = 8.8$  Hz, 1H), 7.28 – 7.23 (m, 1H), 7.18 – 7.08 (m, 2H), 7.06 (dd,  $J = 8.0, 1.6$  Hz, 1H), 6.94 – 6.85 (m, 3H), 6.78 (d,  $J = 8.0$  Hz, 1H), 6.51 (s, 1H), 6.33 (s, 1H), 5.94 (dd,  $J = 4.8, 1.6$  Hz, 2H), 4.49 (dd,  $J = 12.8, 4.0$  Hz, 1H), 3.81 (s, 3H), 3.58 (dd,  $J = 13.4, 4.0$  Hz, 1H), 2.31 (t,  $J = 12.8$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 155.5 (q,  $J = 37.0$  Hz), 155.5, 154.3, 147.6, 146.7, 135.5, 134.5, 131.2, 130.0, 128.7, 128.0, 126.9, 126.4, 125.7, 125.0, 123.8, 115.8 (q,  $J = 203.0$  Hz), 116.8, 114.1, 111.8, 109.3, 109.2, 108.2, 101.0, 60.5, 55.3, 42.7, 37.6; IR (neat): 3342, 3023, 2953, 1728, 1632, 1409, 1244, 1186, 812, 714; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{23}\text{F}_3\text{NO}_5^+$  546.1523; Found 546.1522.

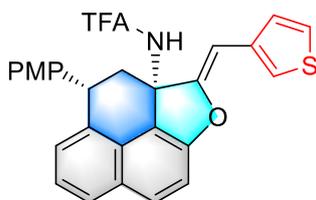
**2,2,2-trifluoro-*N*-((2*aS*,4*S*,*Z*)-4-(4-methoxyphenyl)-2-(naphthalen-2-ylmethylene)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4q)**



**4q**

Compound **4q** was prepared in 83% yield (91.4 mg) according to the general procedure. 8 h. Pale Red oil.  $[\alpha]_D^{20}$  -188.4 (c 0.32, DCM). 90% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 6.33 min (major), 15.32 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.13 (s, 1H), 7.94 (dd,  $J = 8.4, 1.6$  Hz, 1H), 7.89 (d,  $J = 8.8$  Hz, 1H), 7.85 – 7.80 (m, 2H), 7.79 – 7.76 (m, 1H), 7.70 (d,  $J = 8.4$  Hz, 1H), 7.47 – 7.39 (m, 3H), 7.30 – 7.24 (m, 1H), 7.18 – 7.08 (m, 2H), 6.92 (d,  $J = 7.2$  Hz, 1H), 6.88 (d,  $J = 8.4$  Hz, 2H), 6.57 (s, 1H), 6.53 (s, 1H), 4.52 (dd,  $J = 12.4, 3.6$  Hz, 1H), 3.79 (s, 3H), 3.65 (dd,  $J = 13.2, 4.0$  Hz, 1H), 2.35 (t,  $J = 13.0$  Hz, 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.1, 155.6 (q,  $J = 37.7$  Hz), 154.4, 135.5, 134.5, 133.4, 132.5, 131.3, 131.4, 130.0, 128.8, 128.6, 128.2, 127.9, 127.5, 127.1, 127.0, 126.5, 126.1, 126.0, 125.8, 125.1, 117.7, 115.4 (q,  $J = 289.9$  Hz), 114.2, 111.9, 109.5, 60.6, 55.2, 42.8, 37.7; IR (neat): 3296, 2987, 1724, 1623, 1466, 1243, 1154, 816, 798, 714; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{34}\text{H}_{25}\text{F}_3\text{NO}_3^+$  552.1781; Found 552.1780.

**2,2,2-trifluoro-*N*-((2*aS*,4*S*,*Z*)-4-(4-methoxyphenyl)-2-(thiophen-3-ylmethylene)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)acetamide (4r)**

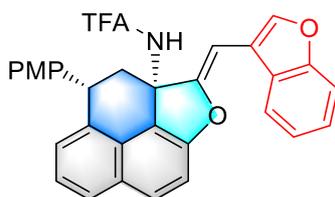


**4r**

Compound **4r** was prepared in 59% yield (59.8 mg) according to the general procedure. 4 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -175.2 (c 0.63, DCM). 92% ee (determined by HPLC, IG,

*n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 8.73 min (major), 10.64 min (minor).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.89 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.71 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.60 (d,  $J = 2.0 \text{ Hz}$ , 1H), 7.47 (d,  $J = 4.8 \text{ Hz}$ , 1H), 7.35 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.32 – 7.24 (m, 2H), 7.18 – 7.08 (m, 2H), 6.91 (d,  $J = 7.6 \text{ Hz}$ , 1H), 6.88 (d,  $J = 8.8 \text{ Hz}$ , 2H), 6.50 (s, 2H), 4.49 (dd,  $J = 12.4, 3.6 \text{ Hz}$ , 1H), 3.80 (s, 3H), 3.58 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 2.30 (t,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 155.9, 155.5 (q,  $J = 36.4 \text{ Hz}$ ), 154.2, 135.5, 134.5, 134.5, 131.3, 130.0, 128.7, 128.7, 126.9, 126.5, 125.7, 125.2, 125.0, 124.6, 115.3 (q,  $J = 289.9 \text{ Hz}$ ), 117.8, 114.1, 111.8, 104.0, 60.1, 55.2, 42.7, 37.6; IR (neat): 3288, 2986, 1712, 1624, 1458, 1244, 1168, 806, 716; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{28}\text{H}_{21}\text{F}_3\text{NO}_3\text{S}^+$  508.1189; Found 508.1188.

***N*-((2*aS*,4*S*,*Z*)-2-(benzofuran-3-ylmethylene)-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (4s)**

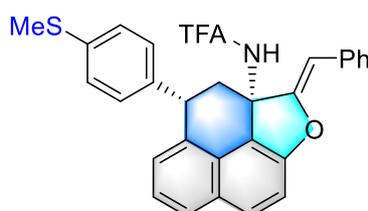


**4s**

Compound **4s** was prepared in 65% yield (70.3 mg) according to the general procedure. 9 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20} -166.5$  (c 0.90, DCM). 97% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 17.44 min (major), 19.95 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.73 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.58 (d,  $J = 7.3 \text{ Hz}$ , 1H), 7.46 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.42 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.32 – 7.25 (m, 2H), 7.23 – 7.08 (m, 4H), 6.92 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.89 (d,  $J = 8.8 \text{ Hz}$ , 2H), 6.59 (s, 1H), 6.55 (s, 1H), 4.51 (dd,  $J = 12.4, 3.2 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.58 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 2.32 (t,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.7, 157.8, 155.6 (q,  $J = 37.0\text{Hz}$ ), 154.3, 154.1, 151.0, 135.5, 134.3, 131.5, 130.0, 129.1, 128.9, 126.9, 126.6, 125.8, 125.2, 124.4, 122.8, 120.9, 117.7, 115.3 (q,  $J = 289.9\text{Hz}$ ), 114.2, 111.8, 111.1, 107.1, 99.3, 60.3, 55.3, 42.6, 37.4; IR (neat): 3302, 2948,

1732, 1633, 1466, 1261, 1187, 862, 742, 713; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{32}H_{23}F_3NO_4^+$  542.1574; Found 542.1573.

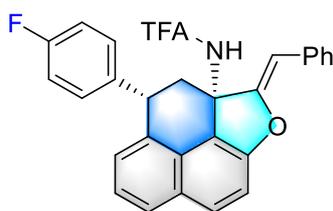
***N*-((2*aS*,4*S*)-2-((*Z*)-benzylidene)-4-(4-(methylthio)phenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (4t)**



**4t**

Compound **4t** was prepared in 47% yield (48.6 mg) according to the general procedure. 8 h. Yellow Solid. M.p = 137 – 142 °C.  $[\alpha]_D^{20}$  -160.6 (c 0.55, DCM). 93% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 6.80 min (major), 7.80 min (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.91 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.77 – 7.71 (m, 3H), 7.41 – 7.35 (m, 3H), 7.30 – 7.22 (m, 4H), 7.18 – 7.08 (m, 2H), 6.92 (d,  $J = 7.0 \text{ Hz}$ , 1H), 6.46 (s, 1H), 6.41 (s, 1H), 4.51 (d,  $J = 9.5 \text{ Hz}$ , 1H), 3.63 (dd,  $J = 13.0, 3.5 \text{ Hz}$ , 1H), 2.49 (s, 3H), 2.33 (d,  $J = 12.5 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  156.8, 155.5 (q,  $J = 37.5 \text{ Hz}$ ), 154.4, 139.4, 137.2, 135.0, 133.7, 131.3, 129.5, 129.3, 128.8, 128.4, 127.4, 127.1, 126.9, 126.5, 125.9, 125.0, 117.6, 115.3 (q,  $J = 287.5 \text{ Hz}$ ), 111.9, 109.4, 60.5, 43.1, 37.5, 15.9; IR (neat): 3463, 3006, 1714, 1582, 1466, 1274, 1260, 1163, 1092, 971, 764, 750; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{30}H_{23}F_3NO_2S^+$  518.1396; Found 518.1395.

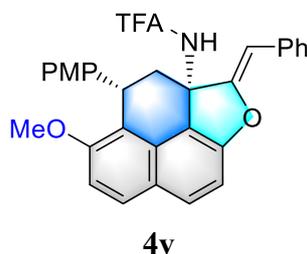
***N*-((2*aS*,4*S*)-2-((*Z*)-benzylidene)-4-(4-fluorophenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (4u)**



**4u**  
S64

Compound **4u** was prepared in 88% yield (94.8 mg) according to the general procedure. 24 h. Pale yellow oil.  $[\alpha]_D^{20}$  -136.5 (c 0.76, DCM). 80% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 92/8,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 5.98 min (major), 6.91 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.92 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.74 (d,  $J = 8.0 \text{ Hz}$ , 3H), 7.43 – 7.33 (m, 3H), 7.32 – 7.25 (m, 2H), 7.19 (s, 2H), 7.09 – 7.01 (m, 2H), 6.89 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.44 (s, 1H), 6.42 (s, 1H), 4.54 (d,  $J = 9.6 \text{ Hz}$ , 1H), 3.64 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 2.33 (t,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  162.0 (d,  $J = 244 \text{ Hz}$ ), 156.7, 155.6 (q,  $J = 37.0 \text{ Hz}$ ), 154.5, 135.0, 133.7, 131.4, 130.6, 129.4, 128.8, 128.4, 128.2 (d,  $J = 3.0 \text{ Hz}$ ), 127.5, 126.9, 126.4, 126.0, 125.0, 117.6, 115.7 (d,  $J = 22.0 \text{ Hz}$ ), 115.3 (q,  $J = 287.0 \text{ Hz}$ ), 112.0, 109.5, 60.5, 42.9, 37.7; IR (neat): 3409, 3283, 3042, 1714, 1650, 1509, 1466, 1266, 1238, 1160, 971, 824, 750, 693, 522; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{29}\text{H}_{19}\text{F}_4\text{NNaO}_2^+$  512.1244; Found 512.1243.

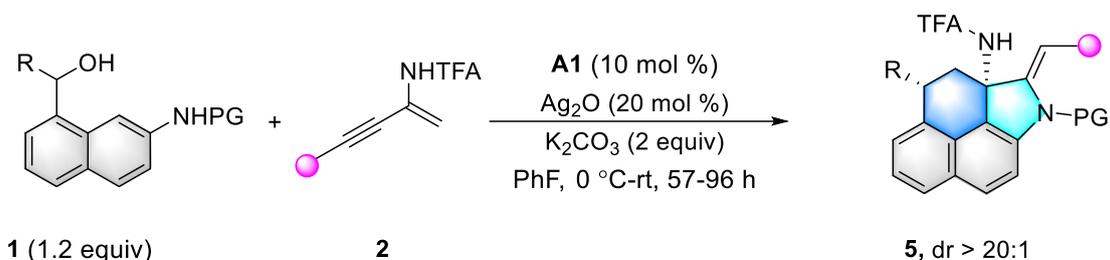
***N*-((2*aS*,4*S*)-2-((*Z*)-benzylidene)-5-methoxy-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (4v)**



Compound **4v** was prepared in 66% yield (70.3 mg) according to the general procedure. 8 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -175.2 (c 0.78, DCM). 94% ee (determined by HPLC, IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 15.13 min (major), 18.25 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.93 – 7.83 (m, 2H), 7.72 (d,  $J = 7.2 \text{ Hz}$ , 2H), 7.39 – 7.31 (m, 2H), 7.24 – 7.19 (m, 3H), 7.05 (s, 2H), 6.79 (d,  $J = 8.0 \text{ Hz}$ , 2H), 6.28 (s, 1H), 5.86 (s, 1H), 4.83 (d,  $J = 5.6 \text{ Hz}$ , 1H), 3.83 (s, 3H), 3.79 – 3.73 (m, 4H), 2.34 (dd,  $J = 14.0, 6.0 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.2, 157.8, 156.1, 155.4, 154.6 (q,  $J = 37.0 \text{ Hz}$ ), 135.0, 133.9, 131.2, 129.2, 128.8, 128.6, 128.5, 128.2, 127.1, 124.4, 116.1, 115.3 (q,  $J = 289.9 \text{ Hz}$ ), 114.0, 111.8, 109.6, 108.4, 59.8, 56.1, 55.3,

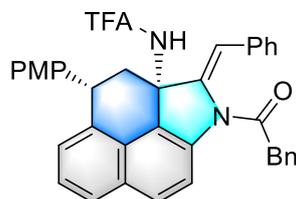
37.0, 35.7; IR (neat): 3286, 3048, 2963, 2833, 1724, 1598, 1233, 1177, 1061, 824, 716, 695; HRMS (ESI/QTOF)  $m/z$ :  $[M + H]^+$  Calcd for  $C_{31}H_{25}F_3NO_4^+$  532.1730; Found 532.1725.

### General procedure for the synthesis of chiral dihydrobenzo[*e*]indoles **5**.



A 10 mL reaction tube was charged with chiral phosphoric acid **A1** (10 mol %, 0.02 mmol, 15 mg), **1** (1.2 equiv, 0.24 mmol) and **2** (0.2 mmol), PhF (6 mL) were added sequentially. The reaction mixture was then stirred at 0 °C. After completion of the reaction (monitored by TLC),  $Ag_2O$  (20 mol %, 0.04 mmol, 9.3 mg) and  $K_2CO_3$  (2 equiv, 0.4 mmol, 55.3 mg) were added sequentially, the reaction mixture was then stirred at room temperature. After completion of the reaction (monitored by TLC), the reaction mixture was concentrated under vacuum and purified by column chromatography on silica gel, eluting with EtOAc/hexane to afford the products **5**.

### *N*-((2*aS*,4*S*)-2-((*Z*)-benzylidene)-4-(4-methoxyphenyl)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-*cde*]indol-2*a*-yl)-2,2,2-trifluoroacetamide (**5a**)

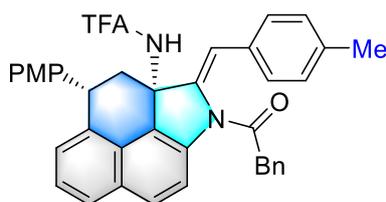


**5a**

Compound **5a** was prepared in 77% yield (95.2 mg) according to the general procedure. 68 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -103.2 (c 0.23, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.28 min (major), 11.35 min (minor)).  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  8.24 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.95 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.75 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.50 (d,  $J = 7.2 \text{ Hz}$ , 2H), 7.42 – 7.36 (m, 2H),

7.35 – 7.27 (m, 2H), 7.21 – 7.13 (m, 5H), 6.97 – 6.92 (m, 3H), 6.89 (d,  $J = 8.8$  Hz, 2H), 6.84 (s, 1H), 6.45 (s, 1H), 4.41 (dd,  $J = 12.8, 4.0$  Hz, 1H), 3.80 (s, 3H), 3.71 (d,  $J = 16.0$  Hz, 1H), 3.55 (dd,  $J = 13.2, 4.0$  Hz, 1H), 3.21 (d,  $J = 15.6$  Hz, 1H), 2.35 (t,  $J = 13.0$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.2, 158.7, 156.2 (q,  $J = 37.0$  Hz), 142.1, 139.8, 136.2, 134.7, 134.4, 134.1, 130.4, 130.3, 130.0, 129.3, 129.2, 128.8, 128.6, 128.3, 126.9, 126.4, 125.9, 125.9, 122.5, 120.2, 115.2 (q,  $J = 288.0$  Hz), 114.2, 59.1, 55.3, 42.4, 41.2, 36.9; IR (neat): 3288, 3209, 2964, 2928, 1694, 1633, 1604, 1366, 1195, 894, 716; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{38}\text{H}_{29}\text{F}_3\text{N}_2\text{NaO}_3^+$  641.2023; Found 641.2020.

**2,2,2-trifluoro-*N*-((2*S*,4*S*)-4-(4-methoxyphenyl)-2-((*Z*)-4-methylbenzylidene)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-cde]indol-2*a*-yl)acetamide (5b)**

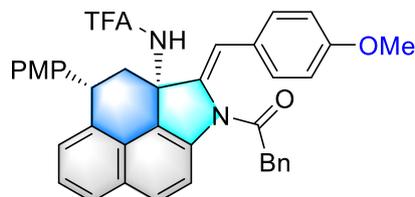


**5b**

Compound **5b** was prepared in 79% yield (99.8 mg) according to the general procedure. 68 h. Red oil.  $[\alpha]_{\text{D}}^{20} -126.4$  (c 0.63, DCM). 97% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0$  mL·min $^{-1}$ ,  $\lambda = 220$  nm; TR = 7.40 min (major), 13.50 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.25 (d,  $J = 8.8$  Hz, 1H), 7.94 (d,  $J = 8.8$  Hz, 1H), 7.74 (d,  $J = 8.4$  Hz, 1H), 7.39 (d,  $J = 7.6$  Hz, 2H), 7.32 (d,  $J = 7.6$  Hz, 1H), 7.22 – 7.12 (m, 7H), 6.98 – 6.93 (m, 3H), 6.89 (d,  $J = 8.8$  Hz, 2H), 6.80 (s, 1H), 6.42 (s, 1H), 4.40 (dd,  $J = 12.8, 3.6$  Hz, 1H), 3.80 (s, 3H), 3.72 (d,  $J = 15.6$  Hz, 1H), 3.54 (dd,  $J = 13.6, 4.4$  Hz, 1H), 3.26 (d,  $J = 16.0$  Hz, 1H), 2.39 – 2.30 (m, 4H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.3, 158.7, 156.5 (q,  $J = 37.0$  Hz), 141.4, 139.9, 138.6, 136.2, 134.7, 134.2, 131.4, 130.3, 130.0, 129.9, 129.3, 128.7, 128.3, 126.9, 126.3, 125.9, 125.8, 122.6, 120.24, 118.6, 115.2 (q,  $J = 288.0$  Hz), 114.2, 59.1, 55.3, 42.4, 41.2, 36.9, 21.3; IR (neat): 3304, 3066, 2958, 1614, 1482, 1382, 1196, 916, 854, 721; HRMS

(ESI/QTOF) m/z:  $[M + Na]^+$  Calcd for  $C_{39}H_{31}F_3N_2NaO_3^+$  655.2179; Found 655.2182.

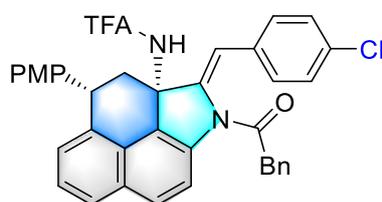
**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-2-((*Z*)-4-methoxybenzylidene)-4-(4-methoxyphenyl)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-*cde*]indol-2*a*-yl)acetamide (5c)**



**5c**

Compound **5c** was prepared in 56% yield (72.6 mg) according to the general procedure. 68 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -111.2 (c 0.86, DCM). 94% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 11.31 min (major), 19.86 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.24 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.95 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.75 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.45 (d,  $J = 8.8 \text{ Hz}$ , 2H), 7.33 (d,  $J = 7.6 \text{ Hz}$ , 1H), 7.23 – 7.13 (m, 5H), 7.02 – 6.97 (m, 2H), 6.97 – 6.87 (m, 5H), 6.77 (s, 1H), 6.40 (s, 1H), 4.40 (dd,  $J = 12.8, 4.0 \text{ Hz}$ , 1H), 3.82 (s, 3H), 3.81 (s, 3H), 3.75 (d,  $J = 15.6 \text{ Hz}$ , 1H), 3.54 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 3.32 (d,  $J = 15.6 \text{ Hz}$ , 1H), 2.35 (d,  $J = 13.2 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.4, 159.6, 158.7, 156.2 (q,  $J = 38.4 \text{ Hz}$ ), 140.4, 139.9, 136.2, 134.7, 134.2, 130.3, 130.0, 129.3, 128.3, 126.9, 126.7, 126.3, 125.9(3), 125.8(6), 122.7, 120.0, 118.7, 115.2 (q,  $J = 288.0 \text{ Hz}$ ), 114.6, 114.2, 59.2, 55.3, 42.5, 41.2, 37.0; IR (neat): 3318, 2966, 2840, 1483, 1384, 1627, 1264, 1185, 842, 652; HRMS (ESI/QTOF) m/z:  $[M + Na]^+$  Calcd for  $C_{39}H_{31}F_3N_2NaO_4^+$  671.2128; Found 671.2135.

***N*-((2*aS*,4*S*)-2-((*Z*)-4-chlorobenzylidene)-4-(4-methoxyphenyl)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-*cde*]indol-2*a*-yl)-2,2,2-trifluoroacetamide (5d)**

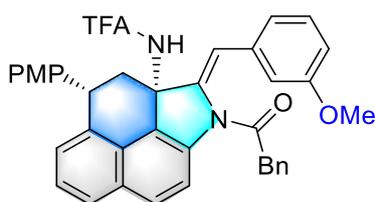


S68

## 5d

Compound **5d** was prepared in 59% yield (76.9 mg) according to the general procedure. 68 h. Pale Orange oil.  $[\alpha]_D^{20}$  -108.4 (c 0.51, DCM). 97% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 7.25 min (major), 11.11 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.22 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.95 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.75 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.44 (d,  $J = 8.4 \text{ Hz}$ , 2H), 7.39 – 7.30 (m, 3H), 7.22 – 7.14 (m, 5H), 6.99 – 6.94 (m, 3H), 6.90 (d,  $J = 8.8 \text{ Hz}$ , 2H), 6.79 (s, 1H), 6.47 (s, 1H), 4.40 (dd,  $J = 12.4, 3.2 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.71 (d,  $J = 15.6 \text{ Hz}$ , 1H), 3.53 (dd,  $J = 13.2, 4.0 \text{ Hz}$ , 1H), 3.24 (d,  $J = 15.6 \text{ Hz}$ , 1H), 2.33 (d,  $J = 12.8 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.0, 158.7, 156.3 (q,  $J = 38.4 \text{ Hz}$ ), 142.7, 139.7, 136.1, 134.6, 134.3, 134.2, 133.8, 132.8, 130.5, 130.3, 130.0, 129.4, 129.2, 129.0, 128.4, 127.0, 126.4, 126.0, 125.8, 122.4, 119.0, 118.5, 115.2 (q,  $J = 288.0 \text{ Hz}$ ), 114.2, 59.1, 55.3, 42.4, 41.1, 36.8; IR (neat): 3318, 2970, 2842, 1695, 1624, 1475, 1382, 1266, 1187, 894, 847; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{38}\text{H}_{28}\text{ClF}_3\text{N}_2\text{NaO}_3^+$  675.1633; Found 675.1630.

**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-2-((*Z*)-3-methoxybenzylidene)-4-(4-methoxyphenyl)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-*cde*]indol-2*a*-yl)acetamide (5e)**

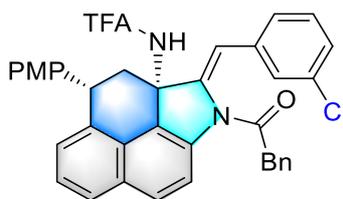


## 5e

Compound **5e** was prepared in 70% yield (90.7 mg) according to the general procedure. 68 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -115.4 (c 0.46, DCM). 92% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 8.92 min (major), 17.11 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.24 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.95 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.75 (d,  $J = 8.4 \text{ Hz}$ , 1H), 7.37 – 7.27 (m, 2H), 7.22 – 7.14 (m, 5H), 7.10 (d,  $J = 7.6 \text{ Hz}$ , 1H), 7.01 (s, 1H), 6.98 – 6.94 (m, 3H), 6.90 (d,  $J = 8.0 \text{ Hz}$ , 2H), 6.84 (d,

$J = 8.0$  Hz, 1H), 6.81 (s, 1H), 6.46 (s, 1H), 4.41 (dd,  $J = 13.2, 4.0$  Hz, 1H), 3.81 (s, 3H), 3.77 (s, 3H), 3.71 (d,  $J = 15.6$  Hz, 1H), 3.55 (dd,  $J = 13.2, 3.6$  Hz, 1H), 3.26 (d,  $J = 15.6$  Hz, 1H), 2.35 (t,  $J = 12.8$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.3, 160.1, 158.7, 156.2 (q,  $J = 37.0$  Hz), 142.3, 139.8, 136.2, 135.7, 134.7, 134.1, 130.4, 130.3(0), 130.2(6), 130.0, 129.3, 128.3, 126.9, 126.4, 126.0, 125.9, 122.5, 121.0, 120.1, 118.5, 115.1 (q,  $J = 289.9$  Hz), 114.7, 114.2, 113.8, 59.1, 55.3, 55.2, 42.4, 41.2, 36.8; IR (neat): 3284, 3009, 2956, 2844, 1728, 1714, 1624, 1240, 1196, 854, 796; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{39}\text{H}_{31}\text{F}_3\text{N}_2\text{NaO}_4^+$  671.2128; Found 671.2130.

***N*-((2*aS*,4*S*)-2-((*Z*)-3-chlorobenzylidene)-4-(4-methoxyphenyl)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-*cde*]indol-2*a*-yl)-2,2,2-trifluoroacetamide (5f)**

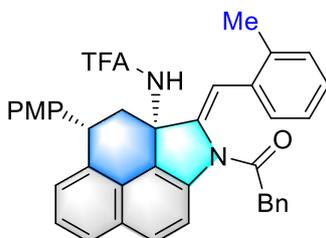


**5f**

Compound **5f** was prepared in 50% yield (65.4 mg) according to the general procedure. 68 h. Pale Yellow oil.  $[\alpha]_{\text{D}}^{20} -121.0$  (c 0.49, DCM). 98% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0$  mL·min $^{-1}$ ,  $\lambda = 220$  nm; TR = 7.04 min (major), 11.77 min (minor)).  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.22 (d,  $J = 8.8$  Hz, 1H), 7.96 (d,  $J = 8.8$  Hz, 1H), 7.75 (d,  $J = 8.4$  Hz, 1H), 7.48 (s, 1H), 7.40 (d,  $J = 7.6$  Hz, 1H), 7.37 – 7.26 (m, 3H), 7.22 – 7.14 (m, 5H), 7.00 – 6.94 (m, 3H), 6.90 (d,  $J = 8.8$  Hz, 2H), 6.78 (s, 1H), 6.47 (s, 1H), 4.41 (dd,  $J = 12.4, 3.6$  Hz, 1H), 3.81 (s, 3H), 3.71 (d,  $J = 15.6$  Hz, 1H), 3.53 (dd,  $J = 13.2, 4.0$  Hz, 1H), 3.26 (d,  $J = 15.6$  Hz, 1H), 2.33 (t,  $J = 13.2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ )  $\delta$  171.0, 158.7, 156.3 (q,  $J = 37.0$  Hz), 143.3, 139.7, 136.2, 136.1, 135.2, 134.5, 133.8, 130.5, 130.4, 130.4, 123.0, 129.2, 128.9, 128.6, 128.4, 127.0, 126.6, 126.4, 126.0, 125.9(8), 125.8, 122.4, 118.8, 118.6, 115.2 (q,  $J = 289.9$  Hz), 114.2, 59.2, 55.3, 42.4, 41.1, 36.8; IR (neat): 3322, 3050, 2958, 1694, 1483, 1256, 1185, 1020, 840, 764; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{38}\text{H}_{28}\text{ClF}_3\text{N}_2\text{NaO}_3^+$

675.1633; Found 675.1632.

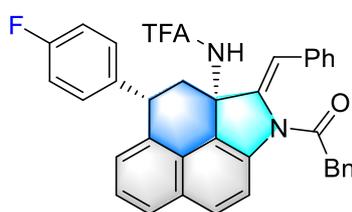
**2,2,2-trifluoro-*N*-((2*aS*,4*S*)-4-(4-methoxyphenyl)-2-((*Z*)-2-methylbenzylidene)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-*cde*]indol-2*a*-yl)acetamide (5g)**



**5g**

Compound **5g** was prepared in 89% yield (112.5 mg) according to the general procedure. 68 h. Pale Orange oil.  $[\alpha]_D^{20}$  -133.5 (c 0.55, DCM). 97% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 6.72 min (major), 8.72 min (minor)).  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.25 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.95 (d,  $J = 8.8 \text{ Hz}$ , 1H), 7.76 (d,  $J = 8.0 \text{ Hz}$ , 1H), 7.38 – 7.33 (m, 2H), 7.27 – 7.16 (m, 8H), 6.96 (d,  $J = 7.2 \text{ Hz}$ , 1H), 6.93 – 6.87 (m, 5H), 6.47 (s, 1H), 4.44 (dd,  $J = 12.8, 4.0 \text{ Hz}$ , 1H), 3.81 (s, 3H), 3.55 (d,  $J = 15.6 \text{ Hz}$ , 2H), 2.89 (d,  $J = 15.6 \text{ Hz}$ , 1H), 2.44 – 2.35 (m, 4H);  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  170.8, 158.7, 156.1 (q,  $J = 37.0 \text{ Hz}$ ), 142.2, 139.9, 136.9, 136.2, 134.6, 134.3, 133.6, 131.0, 130.4, 130.3, 130.0, 129.3, 128.6, 128.3, 127.8, 126.9, 126.5, 126.3, 126.0, 125.9, 125.8, 122.3, 119.0, 118.6, 115.2 (q,  $J = 288.0 \text{ Hz}$ ), 114.2, 59.0, 55.3, 42.4, 40.9, 37.0, 20.0; IR (neat): 3290, 3060, 2959, 1694, 1623, 1241, 1195, 842, 760, 712; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{39}\text{H}_{31}\text{F}_3\text{N}_2\text{NaO}_3^+$  655.2179; Found 655.2177.

***N*-((2*aS*,4*S*)-2-((*Z*)-benzylidene)-4-(4-fluorophenyl)-1-(2-phenylacetyl)-1,2,3,4-tetrahydro-2*aH*-naphtho[2,1,8-*cde*]indol-2*a*-yl)-2,2,2-trifluoroacetamide (5h)**

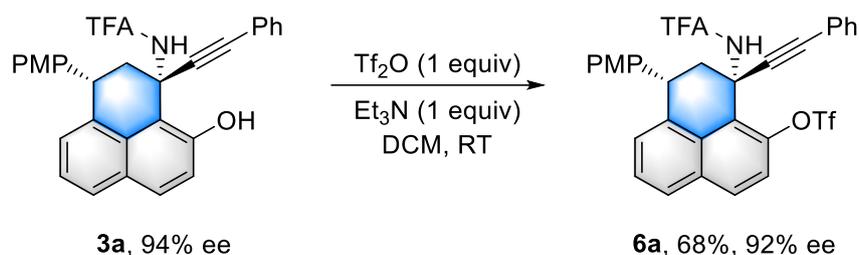


S71

## 5h

Compound **5h** was prepared in 79% yield (95.7 mg) according to the general procedure. 68 h. Pale Yellow oil.  $[\alpha]_D^{20}$  -117.4 (c 0.51, DCM). 70% ee (determined by HPLC, IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ; TR = 5.99 (major), 7.49 (minor)).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.27 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.97 (d,  $J = 9.0 \text{ Hz}$ , 1H), 7.77 (d,  $J = 8.5 \text{ Hz}$ , 1H), 7.51 (d,  $J = 8.0 \text{ Hz}$ , 2H), 7.44 – 7.38 (m, 2H), 7.38 – 7.29 (m, 2H), 7.27 – 7.15 (m, 5H), 7.10 – 7.04 (m, 2H), 6.96 – 6.90 (m, 3H), 6.84 (s, 1H), 6.36 (s, 1H), 4.46 (d,  $J = 10.0 \text{ Hz}$ , 1H), 3.70 (d,  $J = 16.0 \text{ Hz}$ , 1H), 3.57 (dd,  $J = 13.0, 3.5 \text{ Hz}$ , 1H), 3.22 (d,  $J = 16.0 \text{ Hz}$ , 1H), 2.36 (d,  $J = 13.0 \text{ Hz}$ , 1H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  171.2, 162.0 (d,  $J = 245.9 \text{ Hz}$ ), 156.3 (q,  $J = 37.5 \text{ Hz}$ ), 142.0, 140.0, 138.4 (d,  $J = 3.3 \text{ Hz}$ ), 135.7, 134.4, 134.1, 130.5, 130.4, 129.3 (d,  $J = 5.0 \text{ Hz}$ ), 128.8, 128.7, 128.4, 127.0, 126.4, 126.2, 125.9, 125.8, 122.4, 120.3, 118.8, 115.8 (d,  $J = 21.1 \text{ Hz}$ ), 115.2 (q,  $J = 287.5 \text{ Hz}$ ), 59.1, 42.6, 41.3, 36.9; IR (neat): 3316, 2970, 2844, 1698, 1606, 1244, 1185, 854, 712; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{37}\text{H}_{27}\text{F}_4\text{N}_2\text{O}_2^+$  607.2003; Found 607.2000.

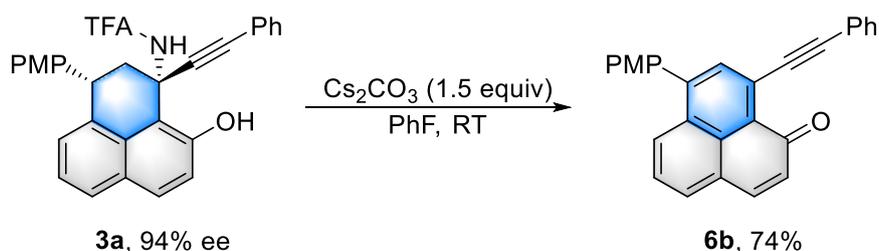
### (1*S*,3*R*)-1-(4-methoxyphenyl)-3-(phenylethynyl)-3-(2,2,2-trifluoroacetamido)-2,3-dihydro-1*H*-phenalen-4-yl trifluoromethanesulfonate (**6a**)



A 10 ml reaction tube was charged with **3a** (0.4 mmol, 200.468 mg) and  $\text{Tf}_2\text{O}$  (0.4 mmol, 66.4  $\mu\text{L}$ ),  $\text{Et}_3\text{N}$  (1 equiv, 55.68  $\mu\text{L}$ ) and DCM (8 ml) were added sequentially. The reaction mixture was stirred at room temperature for 50 min. The reaction mixture was then diluted with water, extracted with EtOAc. The organic phase was washed with brine, dried over anhydrous  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. The residue was purified by flash chromatography on silica gel, eluting with EtOAc/hexane to afford the product **6a** (173.5mg, 68% yield, 92% ee).

Pale yellow oil.  $[\alpha]_D^{20} +62.1$  (c 0.30, DCM).  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.04 (d,  $J = 9.0$  Hz, 1H), 7.83 (d,  $J = 8.0$  Hz, 1H), 7.53 (d,  $J = 9.5$  Hz, 1H), 7.51 – 7.47 (m, 1H), 7.35 – 7.22 (m, 5H), 7.19 (d,  $J = 7.0$  Hz, 1H), 7.09 (d,  $J = 8.5$  Hz, 2H), 7.00 (s, 1H), 6.85 (d,  $J = 9.0$  Hz, 2H), 4.42 (dd,  $J = 10.5, 3.5$  Hz, 1H), 3.75 (s, 3H), 3.66 (dd,  $J = 14.0, 4.5$  Hz, 1H), 2.77 (dd,  $J = 13.5, 10.5$  Hz, 1H).  $^{13}\text{C NMR}$  (100 MHz,  $\text{CDCl}_3$ )  $\delta$  158.6, 155.4 (q,  $J = 37.0$  Hz), 143.9, 138.0, 134.6, 132.9, 132.4, 131.9, 129.9, 129.4, 128.7, 128.0, 127.8, 127.1, 127.1, 125.0, 121.8, 119.9, 115.4 (q,  $J = 288.0$  Hz), 114.1, 86.6, 85.7, 55.2, 51.7, 42.2, 41.3;  $^{19}\text{F NMR}$  (471 MHz,  $\text{CDCl}_3$ )  $\delta$  -73.68, -75.88; IR (neat): 3205, 3052, 2206, 1687, 1505, 1782, 1226, 863, 742, 661; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{31}\text{H}_{22}\text{F}_6\text{NO}_5\text{S}^+$  634.1117; Found 634.1115.

#### 7-(4-methoxyphenyl)-9-(phenylethynyl)-1*H*-phenalen-1-one (6b)

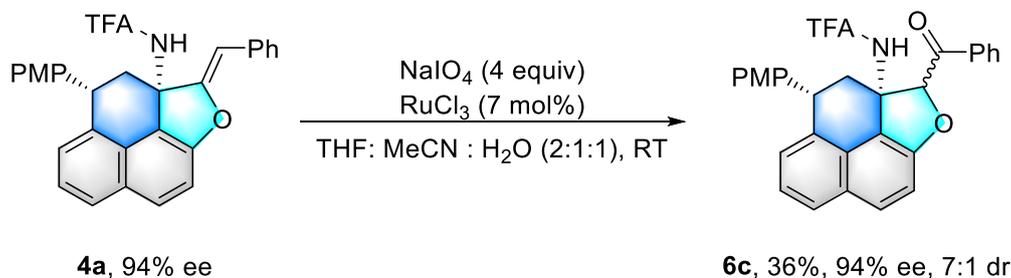


A 10 ml reaction tube was charged with **3a** (0.1 mmol, 50.106 mg) and  $\text{Cs}_2\text{CO}_3$  (0.15 mmol, 48.87 mg) and PhF (2 mL) were added sequentially. The reaction mixture was stirred at room temperature for 70 min. The reaction mixture was then diluted with water, extracted with EtOAc. The organic phase was washed with brine, dried over anhydrous  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. The residue was purified by flash chromatography on silica gel, eluting with EtOAc/hexane to afford the product **6b** (28.6mg, 74% yield).

Yellow oil.  $^1\text{H NMR}$  (500 MHz,  $\text{CDCl}_3$ )  $\delta$  8.06 (d,  $J = 8.5$  Hz, 1H), 7.84 (s, 1H), 7.79 – 7.69 (m, 4H), 7.55 – 7.49 (m, 1H), 7.45 (d,  $J = 8.5$  Hz, 2H), 7.42 – 7.36 (m, 3H), 7.06 (d,  $J = 8.5$  Hz, 2H), 6.78 (d,  $J = 9.5$  Hz, 1H), 3.90 (s, 3H);  $^{13}\text{C NMR}$  (125 MHz,  $\text{CDCl}_3$ )  $\delta$  184.2, 159.8, 146.1, 140.5, 133.7, 132.5, 131.4, 131.3, 130.9, 130.2, 130.1, 129.6, 129.0, 128.5, 128.4, 128.3, 128.0, 126.5, 125.9, 123.4, 114.0, 98.1, 91.9, 55.4; IR (neat): 3053, 2928, 2193, 1634, 1540, 1513, 1490, 1384, 1248, 1178, 1030, 836, 757, 690;

HRMS (ESI/QTOF)  $m/z$ :  $[M + Na]^+$  Calcd for  $C_{28}H_{18}O_2^+$  409.1199; Found 409.1196.

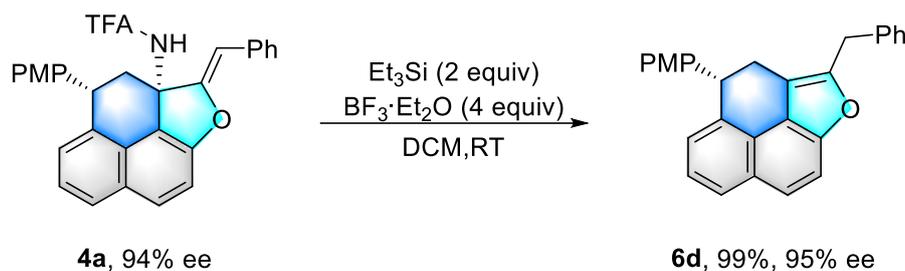
***N*-((2*aS*,4*S*)-2-benzoyl-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan-2*a*(2*H*)-yl)-2,2,2-trifluoroacetamide (6c)**



A 10 ml reaction tube was charged with **4a** (0.2 mmol, 100.2 mg) and  $NaIO_4$  (0.8 mmol, 171.1 mg),  $RuCl_3$  (0.014 mmol, 3 mg) and THF:MeCN:H<sub>2</sub>O (4:2:2 mL) were added sequentially. The reaction mixture was stirred at room temperature for 15 min. The reaction mixture was then diluted with water, extracted with EtOAc. The organic phase was washed with brine, dried over anhydrous  $Na_2SO_4$ , filtered, and concentrated in vacuo. The residue was purified by flash chromatography on silica gel, eluting with EtOAc/hexane to afford the product **6c** (37.2 mg, 36% yield, 94% ee, 7:1 dr).

Yellow oil.  $[\alpha]_D^{20}$  -124.2 (c 0.51, DCM).  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  7.96 (d,  $J$  = 8.8 Hz, 1H), 7.74 – 7.63 (m, 4H), 7.43 – 7.34 (m, 5H), 7.32 – 7.25 (m, 2H), 7.15 (d,  $J$  = 8.4 Hz, 2H), 6.94 (d,  $J$  = 7.2 Hz, 1H), 6.90 (d,  $J$  = 8.4 Hz, 2H), 6.60 (s, 1H), 4.13 (d,  $J$  = 11.2 Hz, 1H), 3.81 (s, 3H), 2.98 (dd,  $J$  = 14.4, 3.6 Hz, 1H), 2.51 (t,  $J$  = 14.0 Hz, 1H);  $^{13}C$  NMR (100 MHz,  $CDCl_3$ )  $\delta$  198.9, 158.7, 155.2 (q,  $J$  = 38.0 Hz), 150.2, 136.7, 136.5, 134.4, 132.8, 130.6, 130.2, 129.9, 129.8, 128.6, 128.4, 127.0, 126.7, 125.8, 125.2, 119.2, 117.5 (q,  $J$  = 287.0 Hz), 114.2, 112.5, 98.4, 57.8, 55.3, 40.2, 32.4; IR (neat): 3203, 3006, 2965, 1712, 1593, 1458, 1162, 1255, 706; HRMS (ESI/QTOF)  $m/z$ :  $[M + Na]^+$  Calcd for  $C_{30}H_{22}F_3NNaO_4^+$  540.1393; Found 540.1390.

***(S)*-2-benzyl-4-(4-methoxyphenyl)-3,4-dihydrophenaleno[1,9-*bc*]furan (6d)**



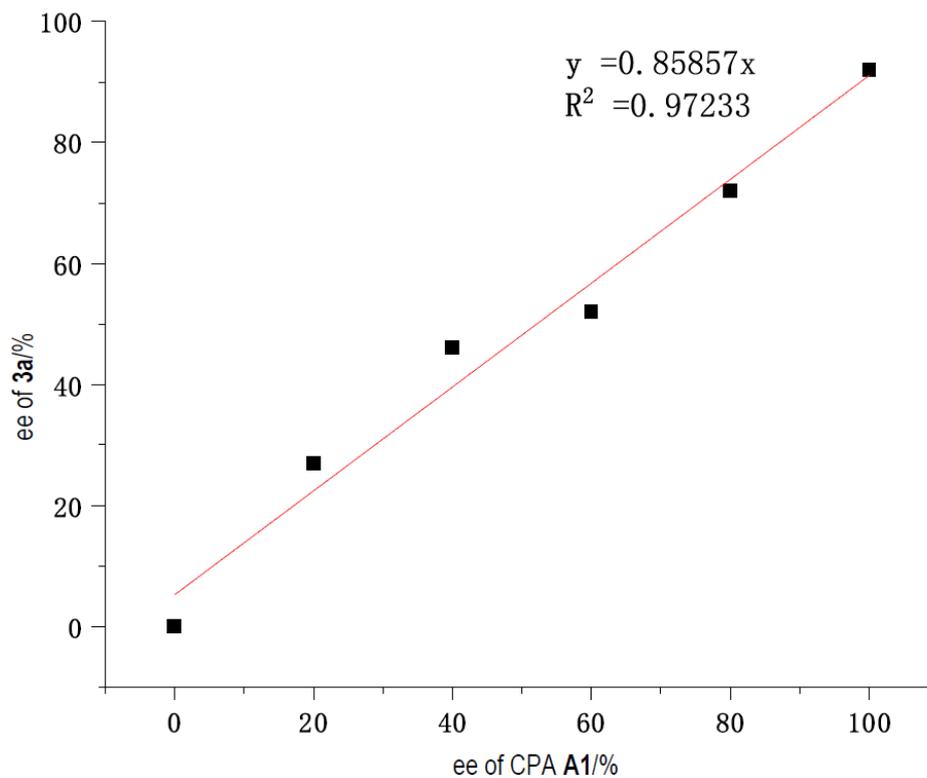
A 10 ml reaction tube was charged with **4a** (0.2 mmol, 100.2 mg) and  $\text{Et}_3\text{SiH}$  (0.4 mmol, 63.9  $\mu\text{L}$ ),  $\text{BF}_3\text{Et}_2\text{O}$  (0.8 equiv, 101.2  $\mu\text{L}$ ) and DCM (8 mL) were added sequentially. The reaction mixture was stirred at room temperature for 30 min. The reaction mixture was then diluted with water, extracted with EtOAc. The organic phase was washed with brine, dried over anhydrous  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated in vacuo. The residue was purified by flash chromatography on silica gel, eluting with EtOAc/hexane to afford the product **6d** (77 mg, 99% yield, 95% ee).

White solid. M.p = 108 – 114 °C.  $[\alpha]_{\text{D}}^{20} +56.4$  (c 0.55, DCM).  $^1\text{H}$  NMR (500 MHz,  $\text{CDCl}_3$ )  $\delta$  7.72 (d,  $J = 8.0$  Hz, 1H), 7.59 (d,  $J = 9.0$  Hz, 1H), 7.53 (d,  $J = 9.0$  Hz, 1H), 7.31 (d,  $J = 7.5$  Hz, 1H), 7.27 – 7.23 (m, 4H), 7.22 – 7.17 (m, 1H), 7.15 (d,  $J = 8.5$  Hz, 2H), 6.96 (d,  $J = 7.5$  Hz, 1H), 6.85 (d,  $J = 8.5$  Hz, 2H), 4.47 (dd,  $J = 9.5, 7.0$  Hz, 1H), 4.14 (s, 2H), 3.78 (s, 3H), 3.21 (dd,  $J = 16.0, 6.5$  Hz, 1H), 3.03 (dd,  $J = 16.0, 9.5$  Hz, 1H);  $^{13}\text{C}$  NMR (125 MHz,  $\text{CDCl}_3$ )  $\delta$  158.4, 150.2, 149.0, 137.7, 136.9, 135.9, 129.4, 128.7, 128.6, 128.1, 126.6, 125.2, 125.0, 124.7, 124.1, 122.4, 114.0, 112.1, 112.0, 55.2, 44.9, 33.9, 29.2; IR (neat): 2922, 1610, 1510, 1456, 1247, 1176, 1086, 1035, 986, 818, 784, 699; HRMS (ESI/QTOF)  $m/z$ :  $[\text{M} + \text{Na}]^+$  Calcd for  $\text{C}_{28}\text{H}_{22}\text{NaO}_2^+$  413.1512; Found 413.1510

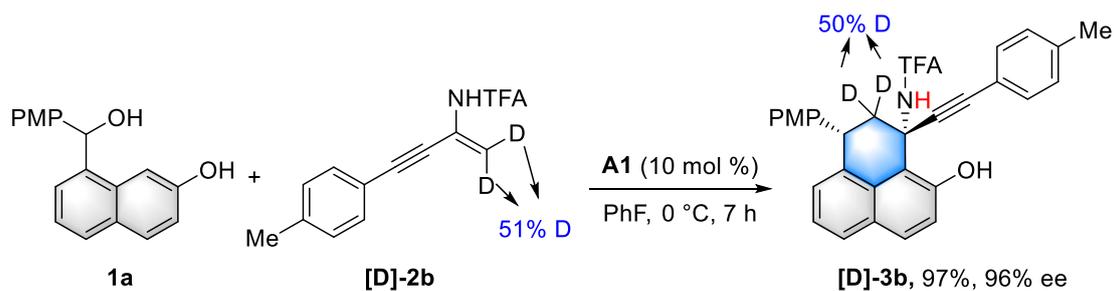
### Non-Linear Effects

Under the standard conditions, to a mixture of **1a** (14 mg, 0.05 mmol), and **2a** (0.06 mmol) in PhF was added (*R*)-**A1** (3.75 mg, 10 mol %) with different enantiopurities (1st run: 0% ee; 2nd run: 20% ee; 3rd run: 40% ee; 4th run: 60% ee; 5th run: 80% ee; 6th run: 100% ee) in PhF (0.05 ml). The reaction mixture was stirred at room temperature for 7 h. The ee value of the product **3a** was determined by HPLC.

ee% of <b>A1</b>	0	20	40	60	80	100
ee% of <b>3a</b>	0	27	46	52	72	93



### The reaction of [D]-2b with 1a



The reaction of [D]-2b under the standard reaction conditions resulted in [D]-3b in 97% yield with 96% ee. The deuterium atom was completely retained in product [D]-3b (Figure S3).

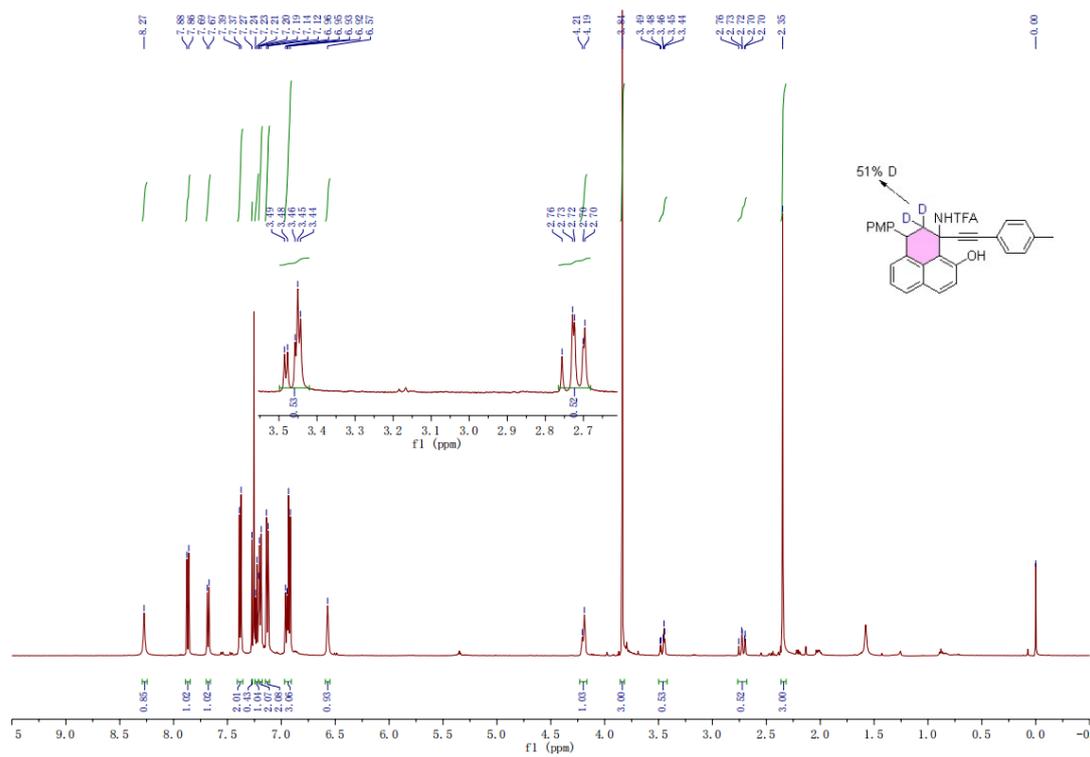
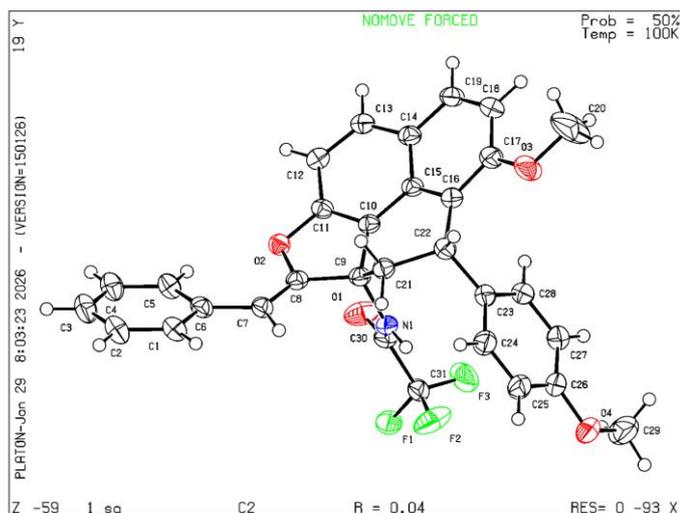


Figure S3. <sup>1</sup>H NMR of compound [D]-3b

## Crystal data and structure refinement for 4v. CCDC Number = 2528722



Bond precision:	C-C = 0.0034 Å	Wavelength=1.54178
Cell:	a=26.7645 (13) alpha=90	b=6.4512 (3) beta=94.632 (2)
Temperature:	100 K	c=16.2273 (8) gamma=90
	Calculated	Reported
Volume	2792.7 (2)	2792.7 (2)
Space group	C 2	C 2
Hall group	C 2y	C 2y
Moiety formula	C31 H24 F3 N O4 [+ solvent]	C31 H24 F3 N O4
Sum formula	C31 H24 F3 N O4 [+ solvent]	C31 H24 F3 N O4
Mr	531.51	531.51
Dx, g cm <sup>-3</sup>	1.264	1.264
Z	4	4
Mu (mm <sup>-1</sup> )	0.814	0.814
F000	1104.0	1104.0
F000'	1107.89	
h, k, lmax	33, 8, 20	33, 8, 20
Nref	5937 [ 3240]	5702
Tmin, Tmax	0.843, 0.900	0.633, 0.754
Tmin'	0.843	

Correction method= # Reported T Limits: Tmin=0.633 Tmax=0.754  
AbsCorr = MULTI-SCAN

Data completeness= 1.76/0.96

Theta (max)= 77.417

R(reflections)= 0.0377( 5461)

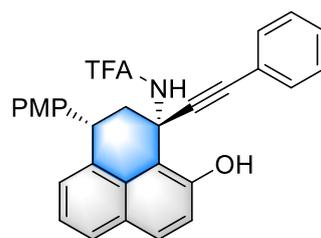
wR2 (reflections)=  
0.0991( 5702)

S = 1.031

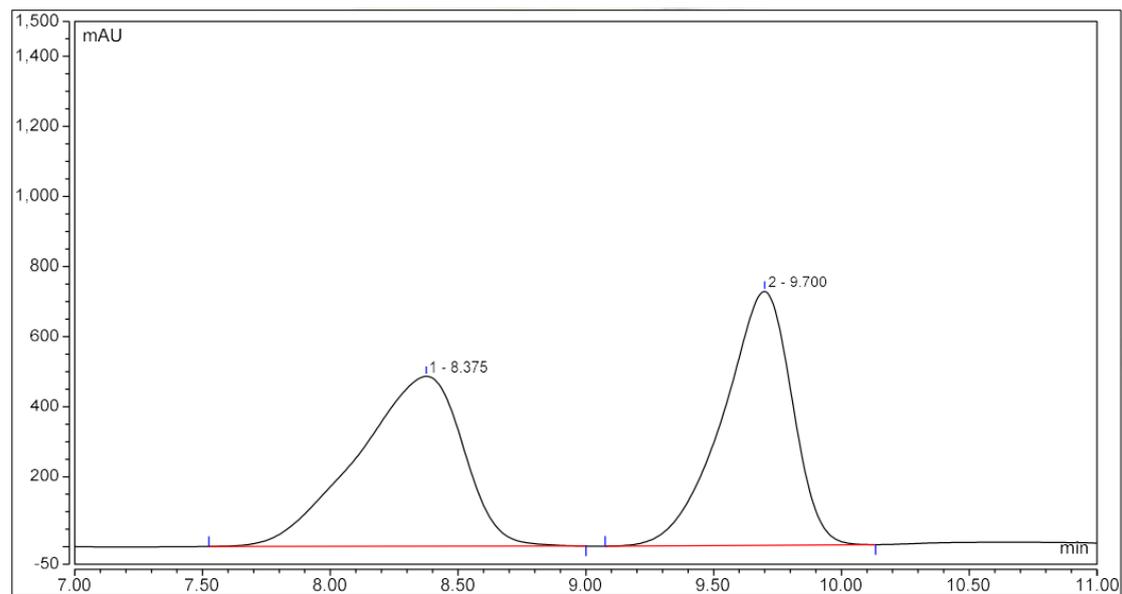
Npar= 353

## References

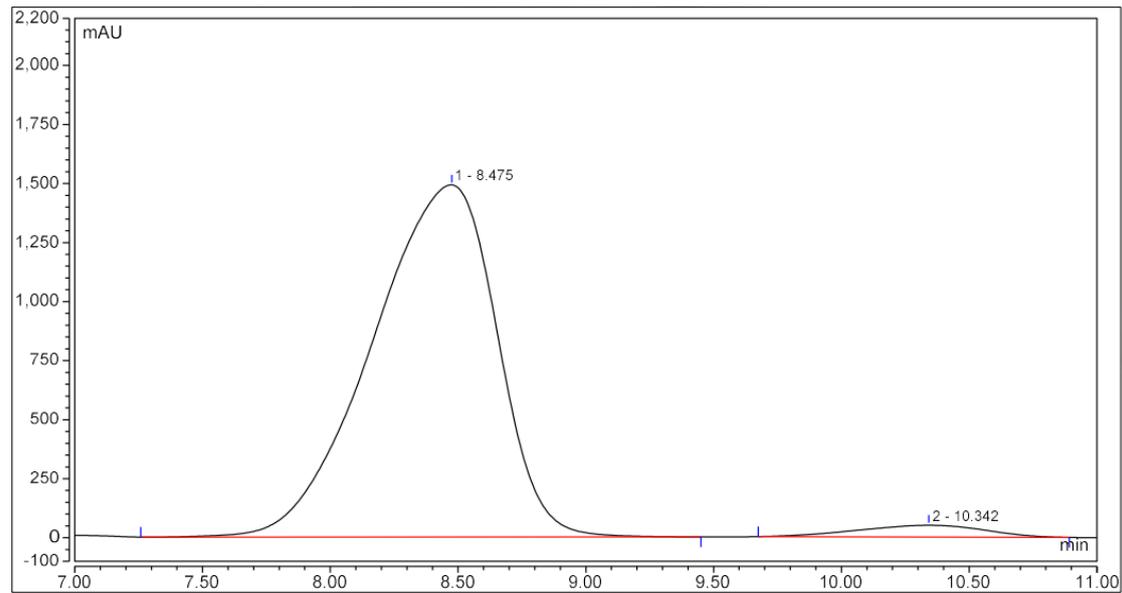
1. Zhu, X.-Q., Wang, Q. & Zhu, J. Organocatalytic enantioselective Diels-Alder reaction of 2-trifluoroacetamido-1,3-dienes with  $\alpha,\beta$ -unsaturated ketones. *Angew. Chem. Int. Ed.* **62**, e202214925 (2023).
2. Liu, S., Chan, K. L., Lin, Z. & Sun, J. Asymmetric synthesis of remotely chiral naphthols and naphthylamines via naphthoquinone methides. *J. Am. Chem. Soc.* **145**, 12802–12811 (2023).



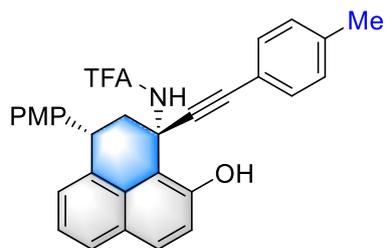
**3a:** IE, *n*-hexane/2-propanol = 93/7,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



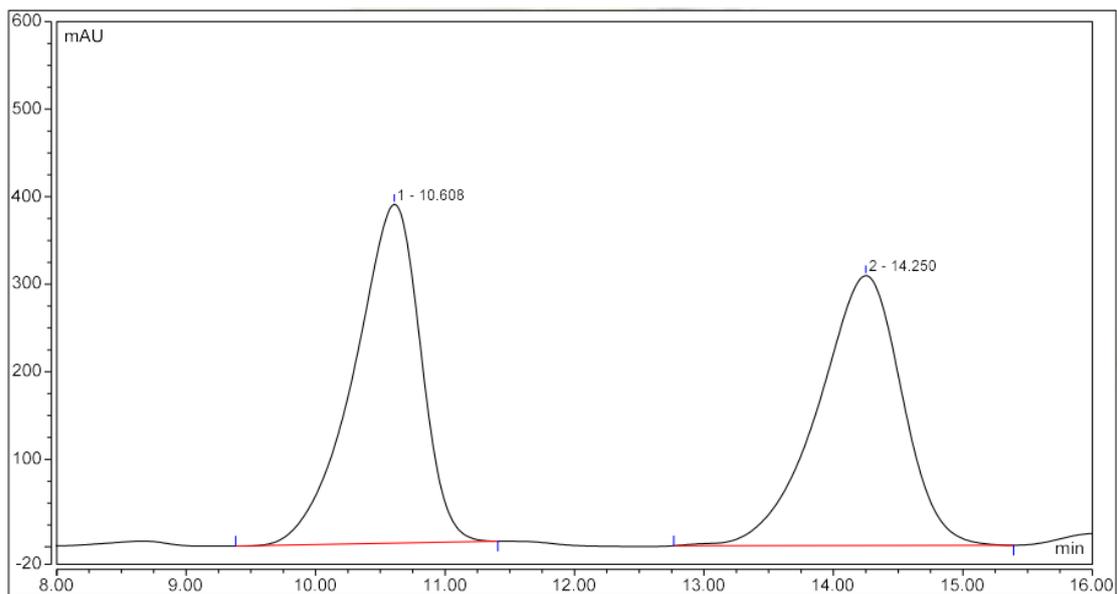
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1	8.375	232.463	484.815	50.54	40.10	
2	9.700	227.465	724.090	49.46	59.90	
<b>Sum:</b>		<b>459.929</b>	<b>1208.904</b>	<b>100.00</b>	<b>100.00</b>	



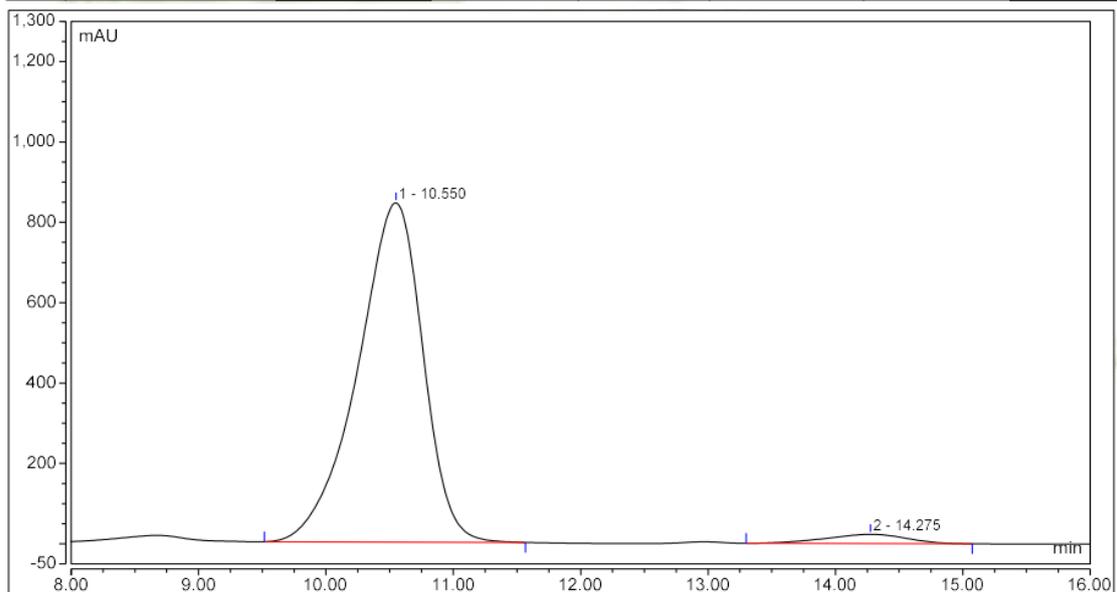
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height(%) %	
1	8.475	843.482	1491.235	96.72	96.77	
2	10.342	28.564	49.854	3.28	3.23	
<b>Sum:</b>		<b>872.046</b>	<b>1541.089</b>	<b>100.00</b>	<b>100.00</b>	



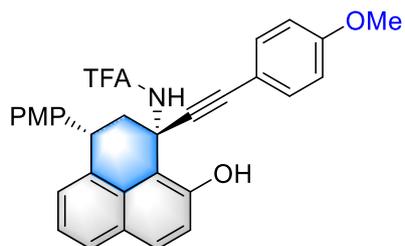
**3b:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



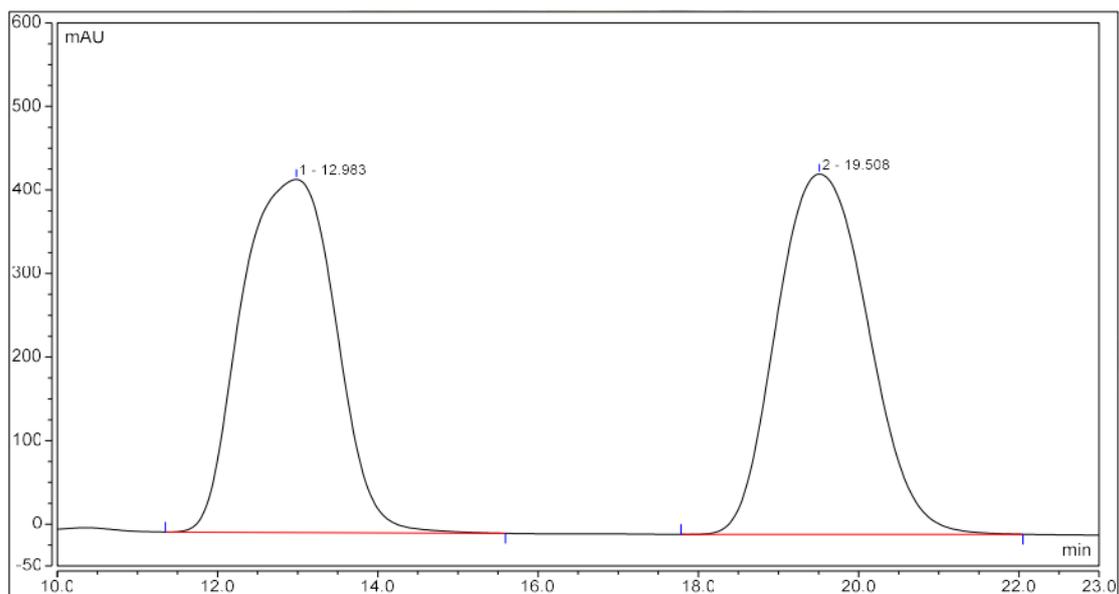
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	10.608	231.392	387.019	49.91	55.67	
2	14.250	232.259	308.202	50.09	44.33	
<b>Sum:</b>		<b>463.650</b>	<b>695.221</b>	<b>100.00</b>	<b>100.00</b>	



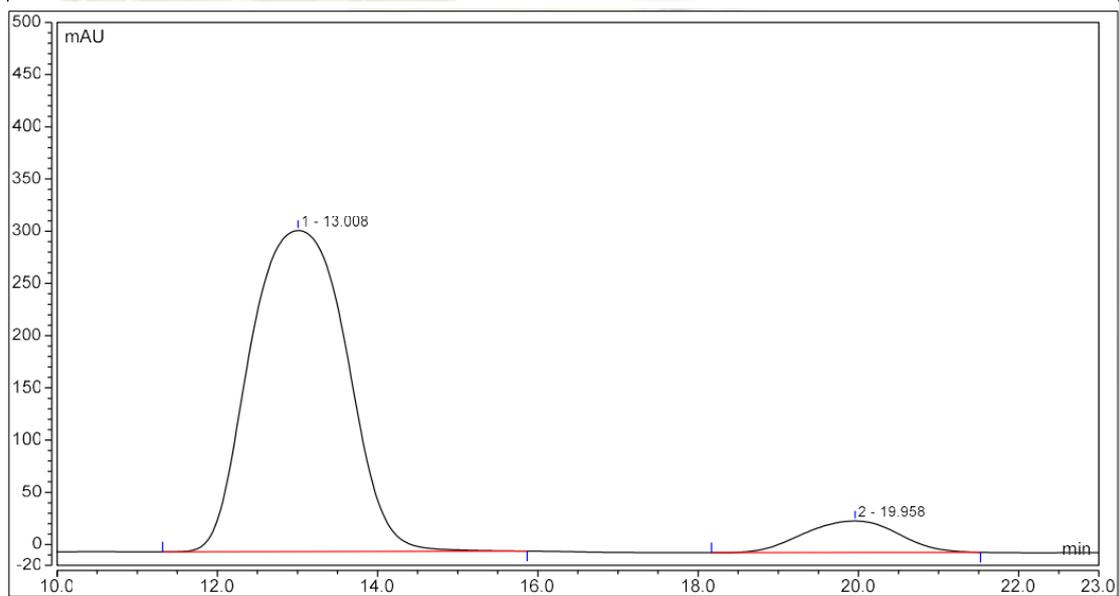
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	10.550	501.099	844.275	96.72	97.35	
2	14.275	16.981	22.993	3.28	2.65	
<b>Sum:</b>		<b>518.080</b>	<b>867.268</b>	<b>100.00</b>	<b>100.00</b>	



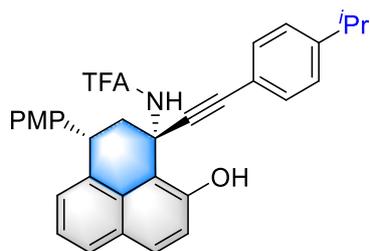
**3c:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



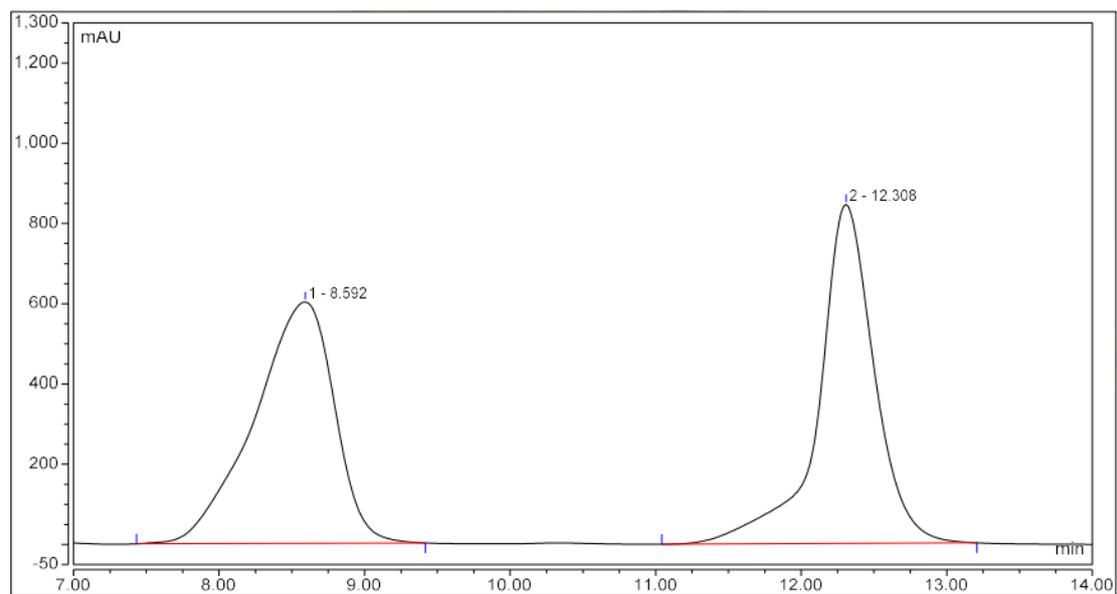
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	12.983	575.136	422.631	50.14	49.49	
2	19.508	571.828	431.264	49.86	50.51	
<b>Sum:</b>		<b>1146.964</b>	<b>853.895</b>	<b>100.00</b>	<b>100.00</b>	



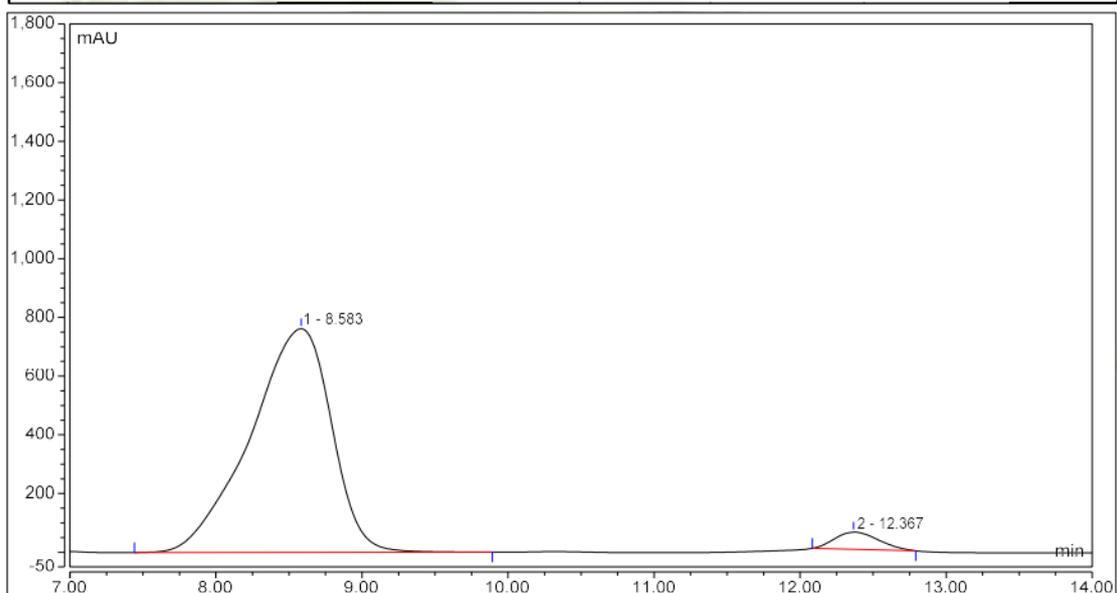
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	13.008	429.147	307.338	91.19	91.06	
2	19.958	41.446	30.166	8.81	8.94	
<b>Sum:</b>		<b>470.592</b>	<b>337.504</b>	<b>100.00</b>	<b>100.00</b>	



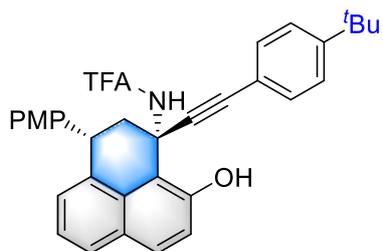
**3d:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



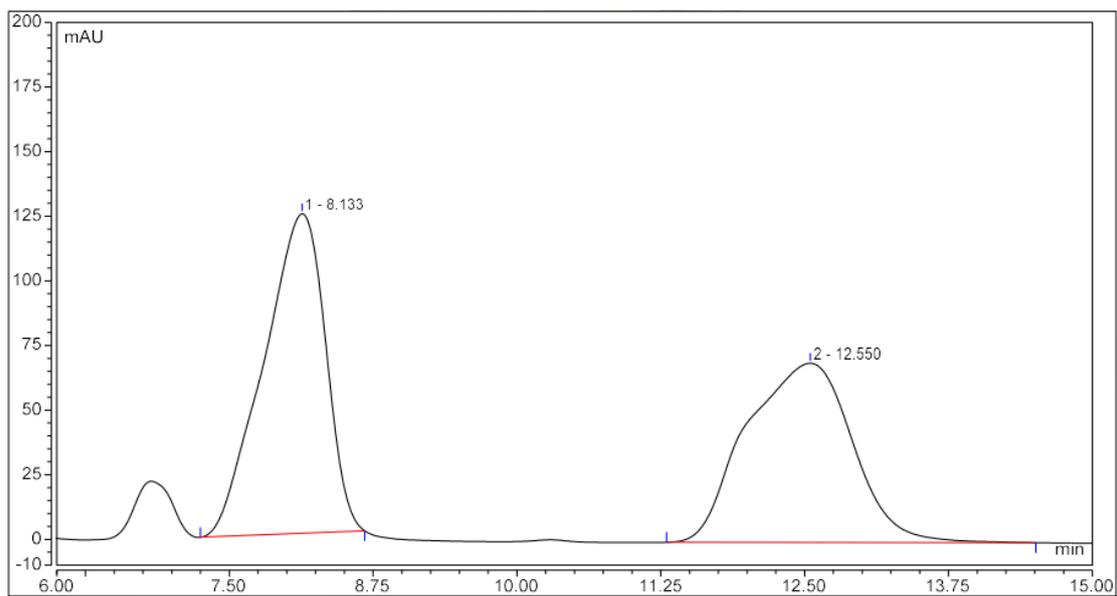
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.592	383.309	601.629	50.39	41.60	
2	12.308	377.391	844.643	49.61	58.40	
<b>Sum:</b>		<b>760.700</b>	<b>1446.273</b>	<b>100.00</b>	<b>100.00</b>	



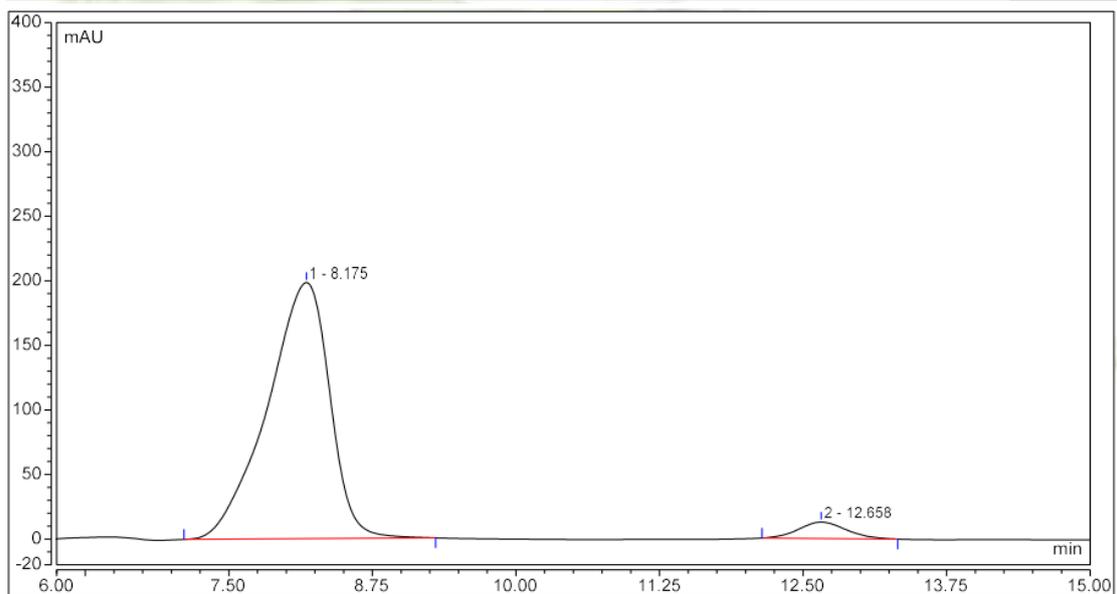
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.583	489.731	762.075	96.00	92.86	
2	12.367	20.416	58.553	4.00	7.14	
<b>Sum:</b>		<b>510.147</b>	<b>820.628</b>	<b>100.00</b>	<b>100.00</b>	



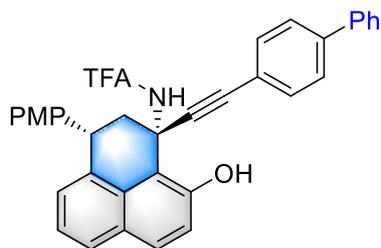
**3e:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



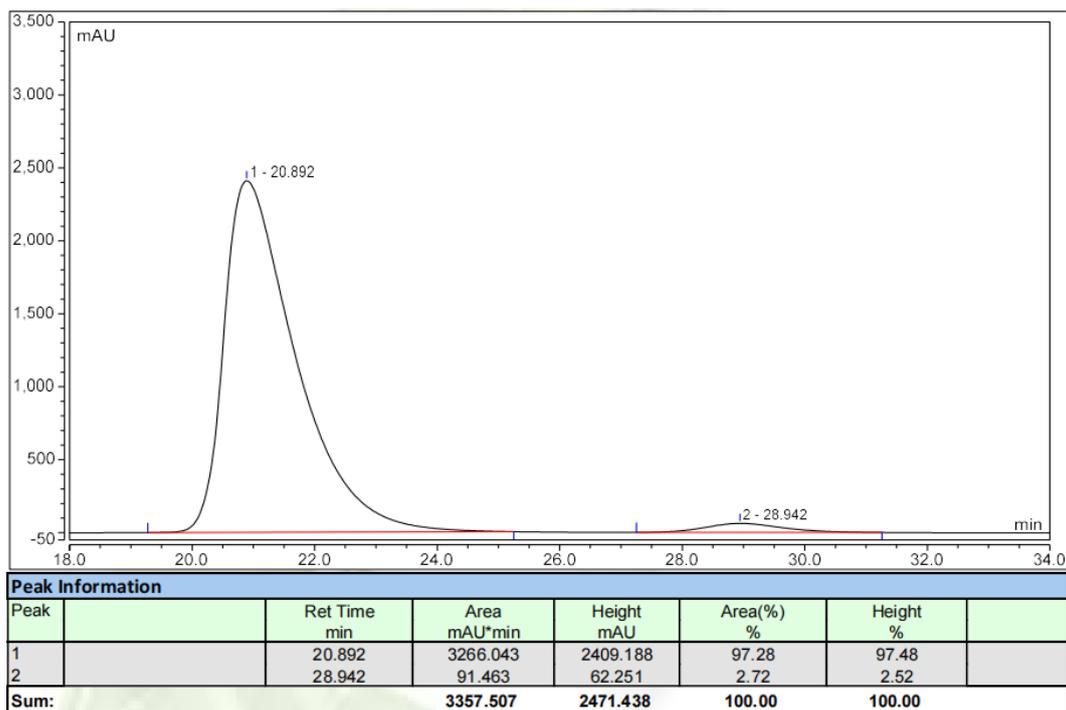
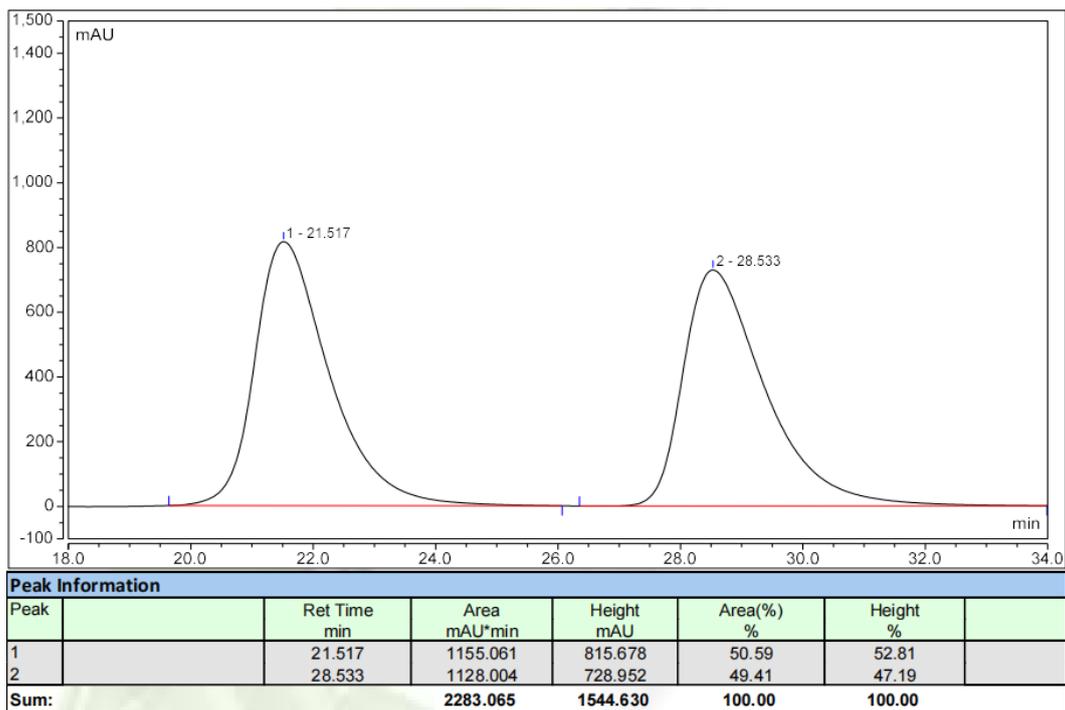
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.133	76.712	123.642	50.89	64.06	
2	12.550	74.033	69.358	49.11	35.94	
<b>Sum:</b>		<b>150.744</b>	<b>193.000</b>	<b>100.00</b>	<b>100.00</b>	

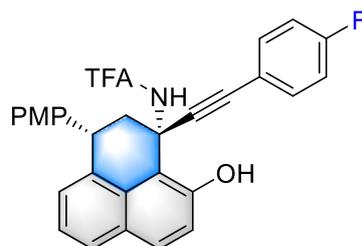


Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.175	124.762	198.439	95.32	93.99	
2	12.658	6.129	12.681	4.68	6.01	
<b>Sum:</b>		<b>130.891</b>	<b>211.120</b>	<b>100.00</b>	<b>100.00</b>	

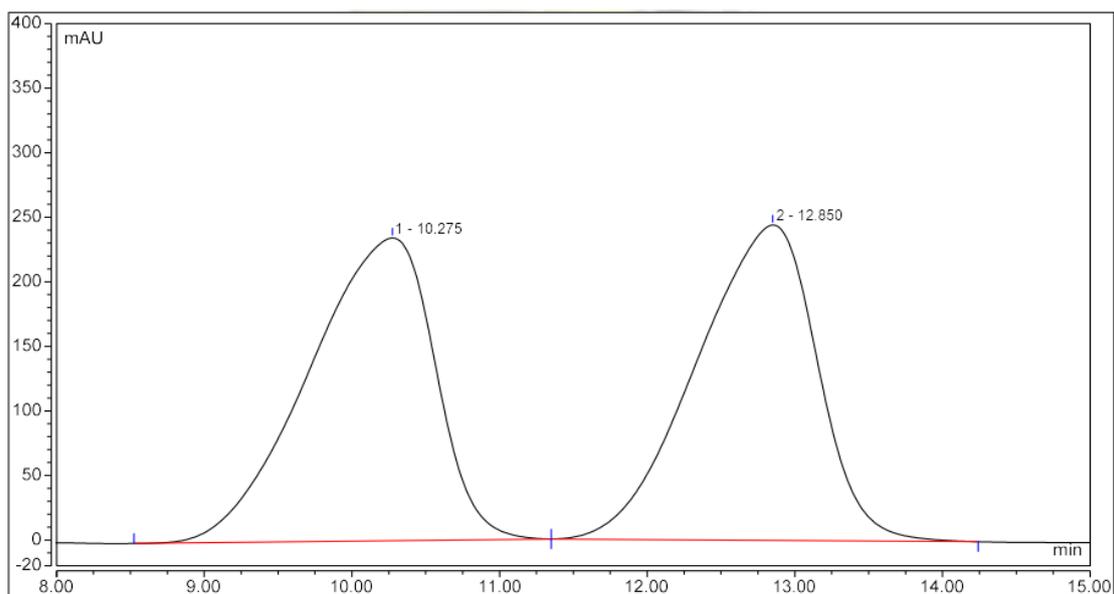


3f: IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$

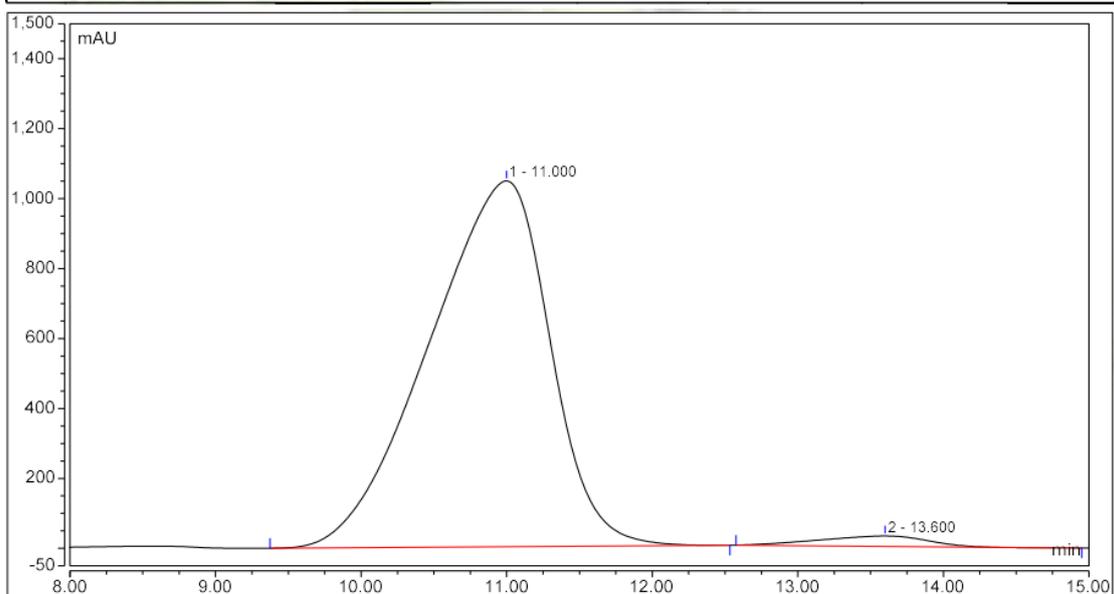




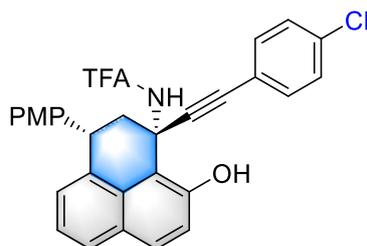
**3g:** IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



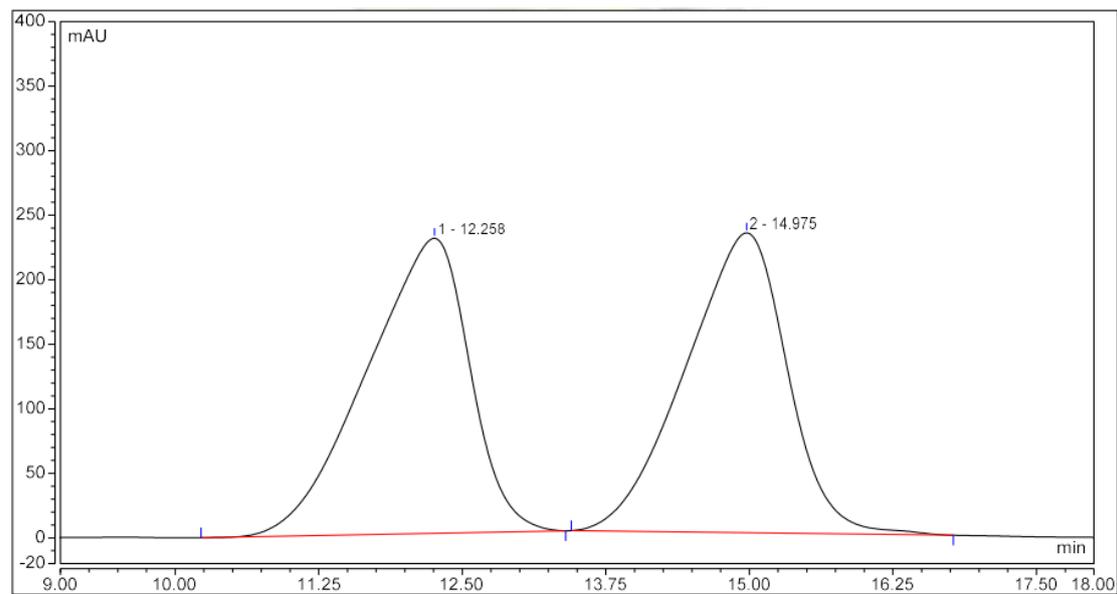
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	10.275	232.296	234.447	50.04	48.97	
2	12.850	231.938	244.294	49.96	51.03	
<b>Sum:</b>		<b>464.233</b>	<b>478.740</b>	<b>100.00</b>	<b>100.00</b>	



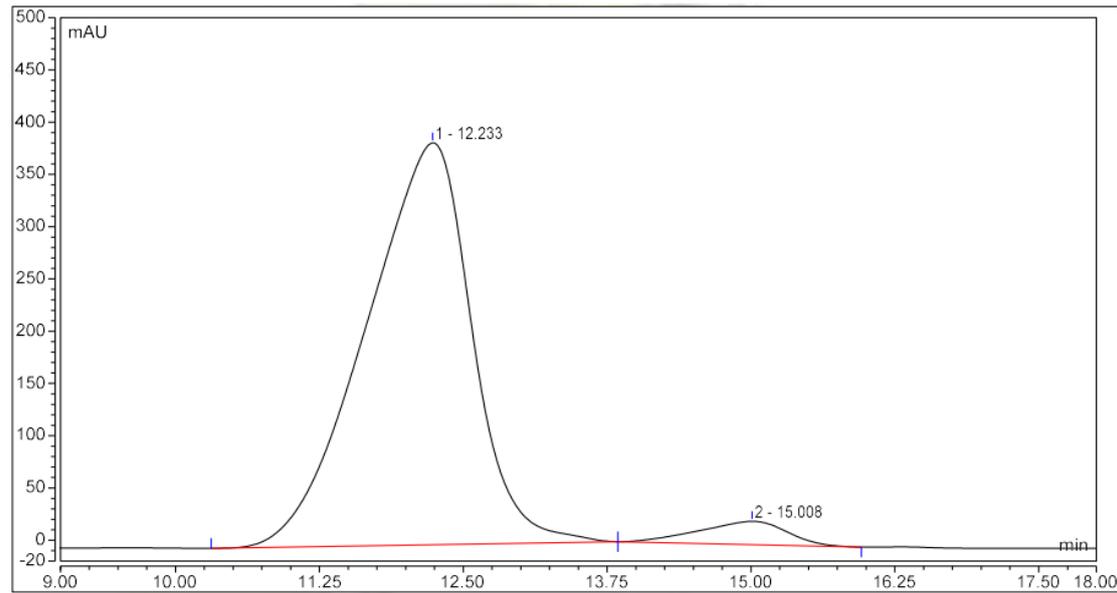
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	11.000	1009.759	1045.828	97.62	97.24	
2	13.600	24.666	29.670	2.38	2.76	
<b>Sum:</b>		<b>1034.425</b>	<b>1075.497</b>	<b>100.00</b>	<b>100.00</b>	



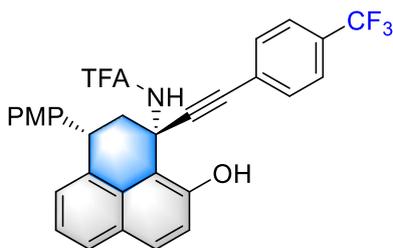
**3h:** IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



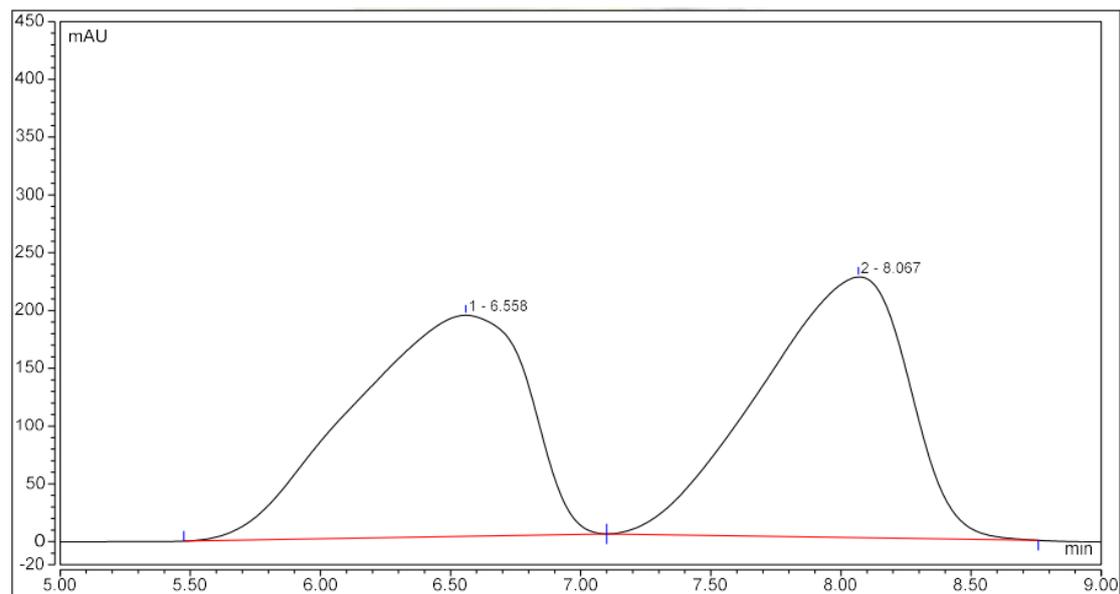
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	12.258	238.862	228.566	49.93	49.59	
2	14.975	239.572	232.317	50.07	50.41	
<b>Sum:</b>		<b>478.434</b>	<b>460.883</b>	<b>100.00</b>	<b>100.00</b>	



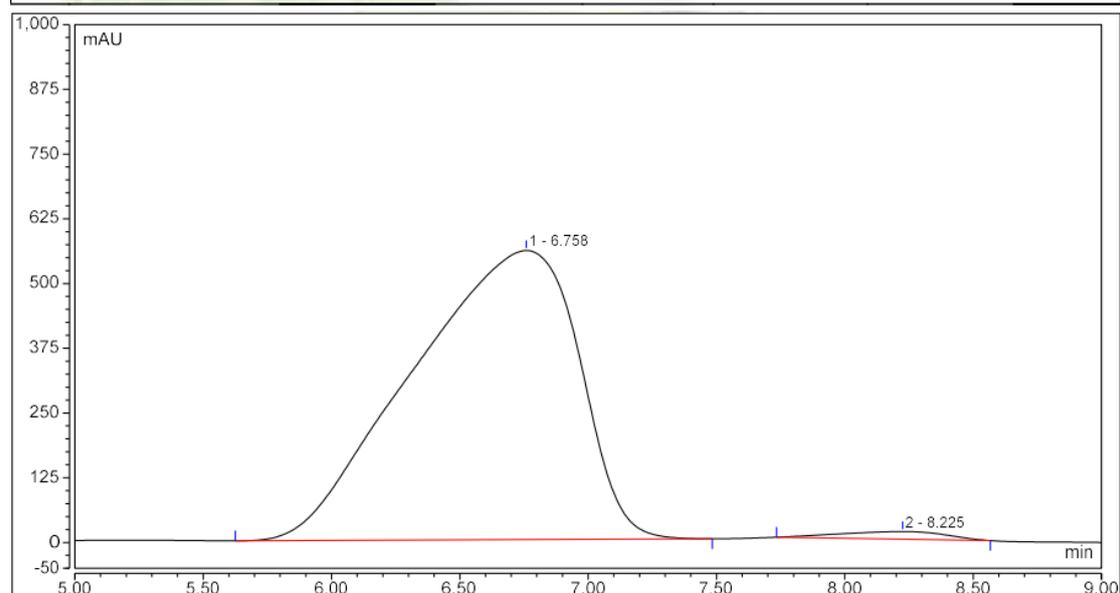
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	12.233	409.382	384.451	95.41	94.52	
2	15.008	19.690	22.298	4.59	5.48	
<b>Sum:</b>		<b>429.072</b>	<b>406.749</b>	<b>100.00</b>	<b>100.00</b>	



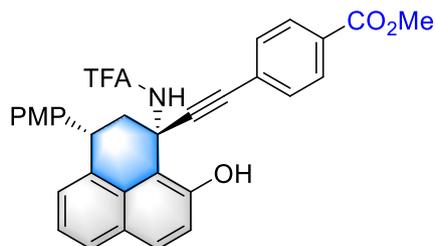
3i: IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



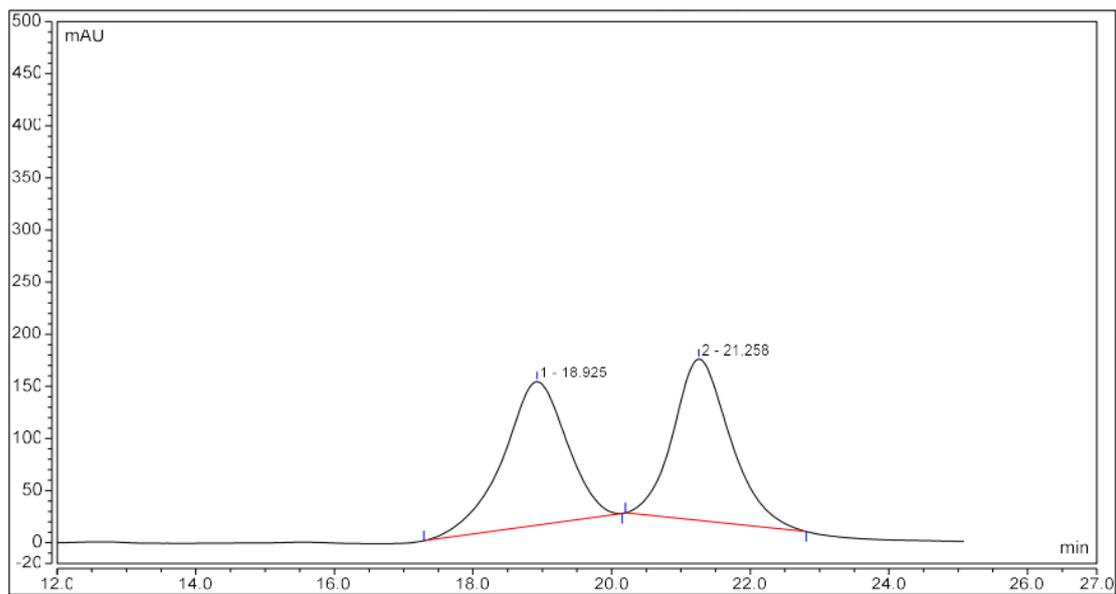
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.558	149.629	191.308	50.05	45.89	
2	8.067	149.310	225.610	49.95	54.11	
<b>Sum:</b>		<b>298.938</b>	<b>416.919</b>	<b>100.00</b>	<b>100.00</b>	



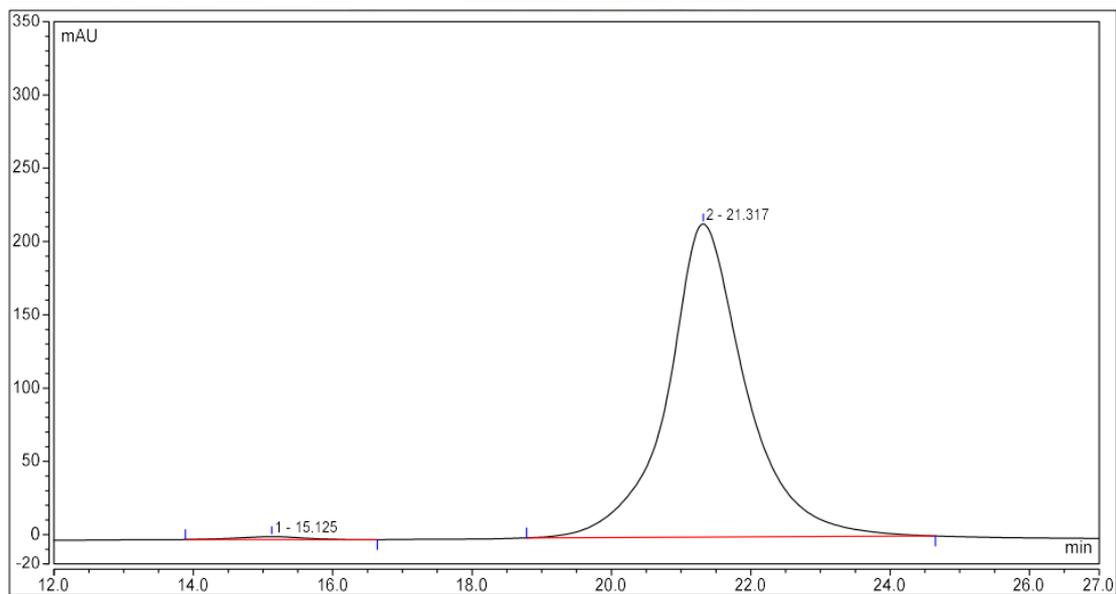
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.758	419.228	558.276	98.38	97.43	
2	8.225	6.899	14.754	1.62	2.57	
<b>Sum:</b>		<b>426.127</b>	<b>573.031</b>	<b>100.00</b>	<b>100.00</b>	



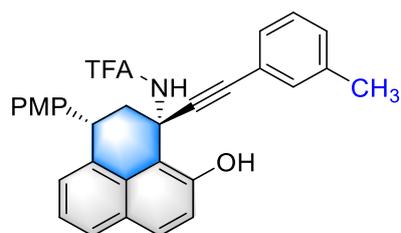
**3j:** IB, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



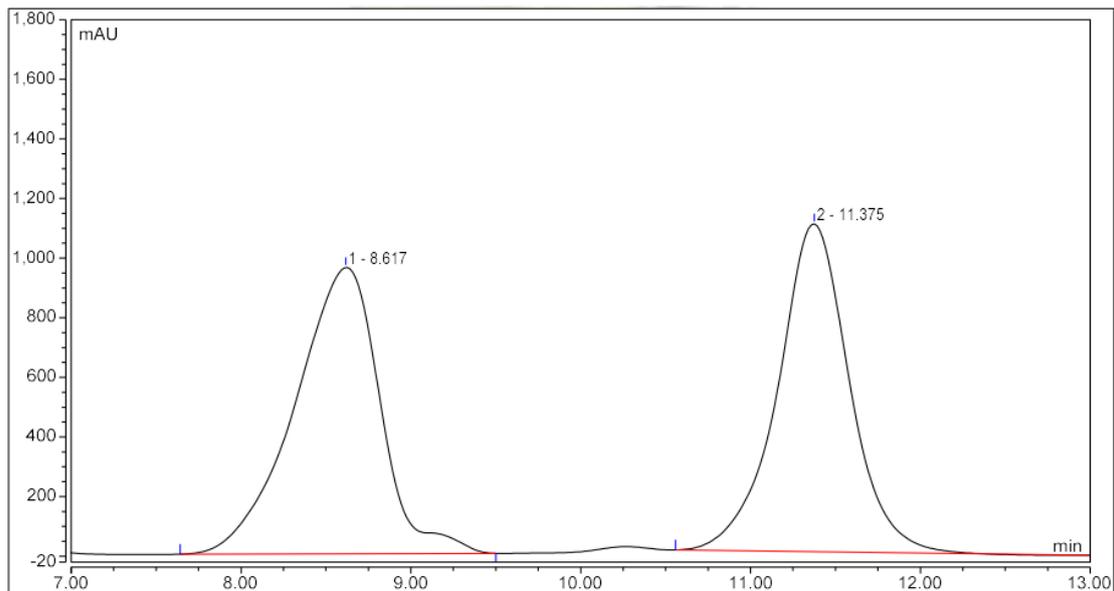
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	18.925	146.729	137.604	49.74	47.06	
2	21.258	148.286	154.797	50.26	52.94	
<b>Sum:</b>		<b>295.015</b>	<b>292.401</b>	<b>100.00</b>	<b>100.00</b>	



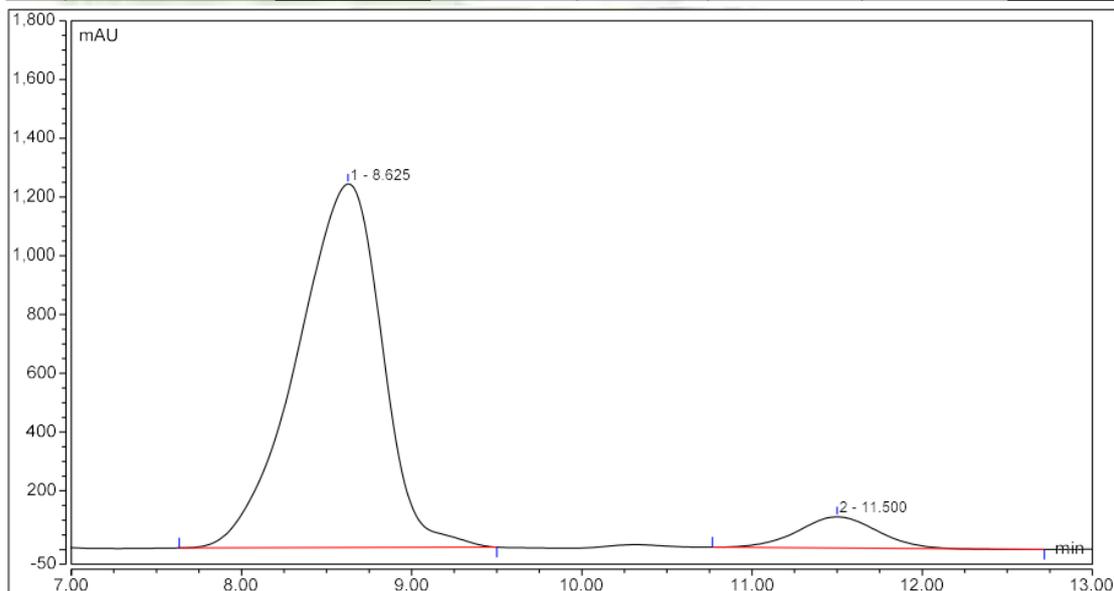
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	15.125	2.153	2.053	0.77	0.95	
2	21.317	279.139	213.660	99.23	99.05	
<b>Sum:</b>		<b>281.292</b>	<b>215.713</b>	<b>100.00</b>	<b>100.00</b>	



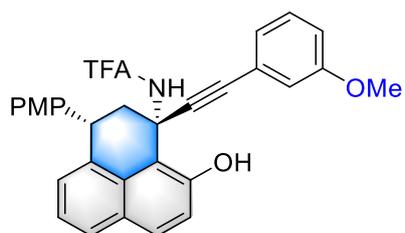
**3k:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



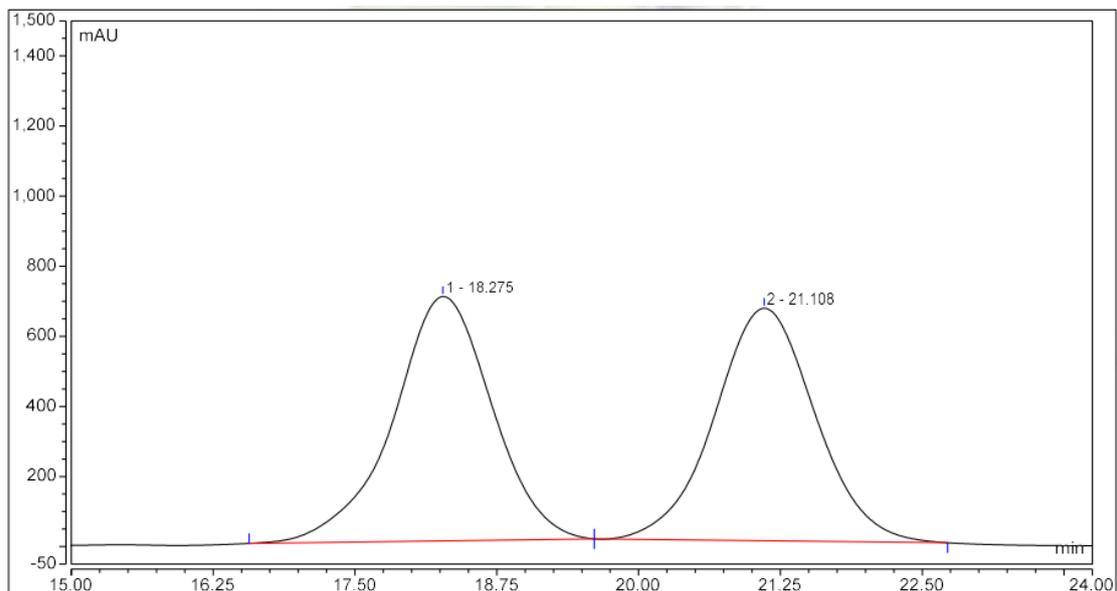
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.617	558.184	960.037	50.96	46.60	
2	11.375	537.142	1100.038	49.04	53.40	
<b>Sum:</b>		<b>1095.327</b>	<b>2060.075</b>	<b>100.00</b>	<b>100.00</b>	



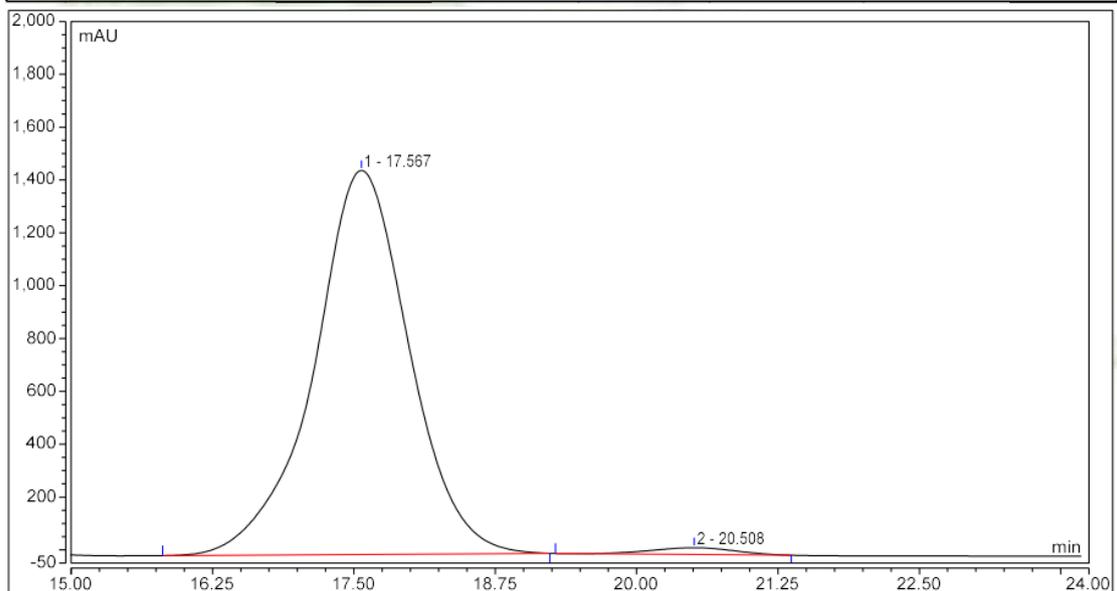
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.625	715.198	1237.650	92.56	92.10	
2	11.500	57.519	106.159	7.44	7.90	
<b>Sum:</b>		<b>772.718</b>	<b>1343.808</b>	<b>100.00</b>	<b>100.00</b>	



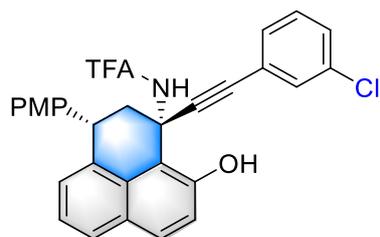
3I: IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



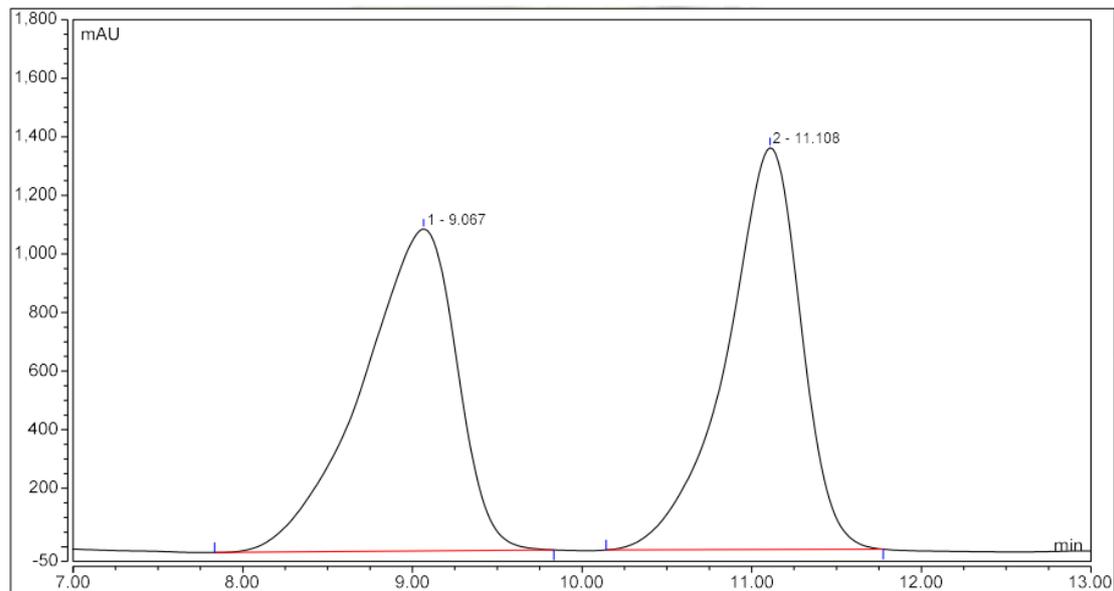
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	18.275	704.564	697.251	50.76	51.25	
2	21.108	683.537	663.355	49.24	48.75	
<b>Sum:</b>		<b>1388.102</b>	<b>1360.607</b>	<b>100.00</b>	<b>100.00</b>	



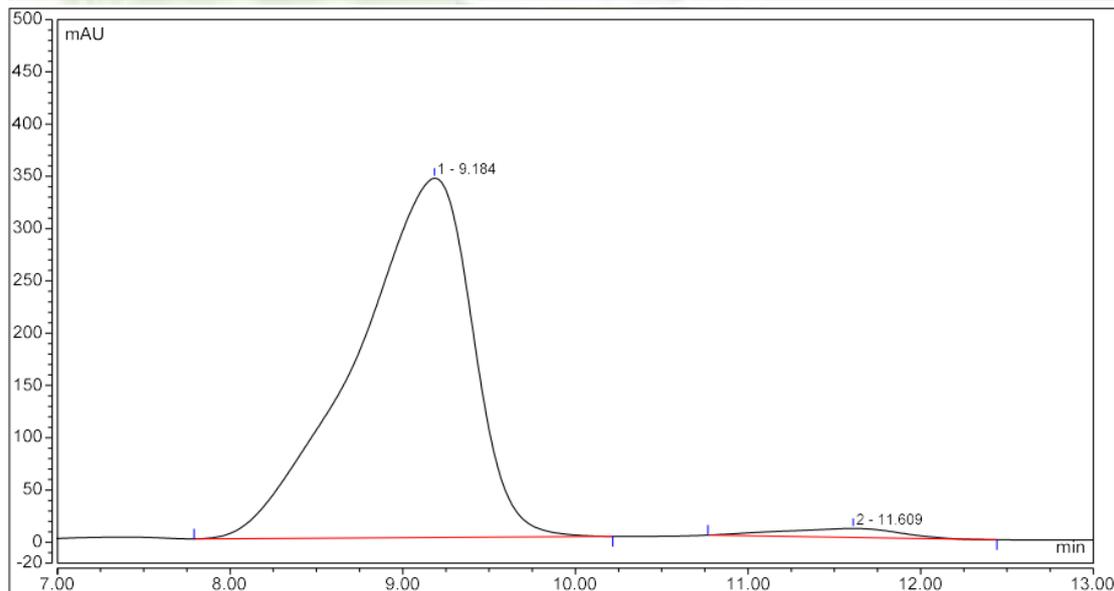
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	17.567	1417.114	1453.324	98.48	98.27	
2	20.508	21.921	25.611	1.52	1.73	
<b>Sum:</b>		<b>1439.035</b>	<b>1478.935</b>	<b>100.00</b>	<b>100.00</b>	



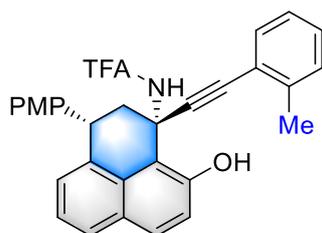
**3m:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



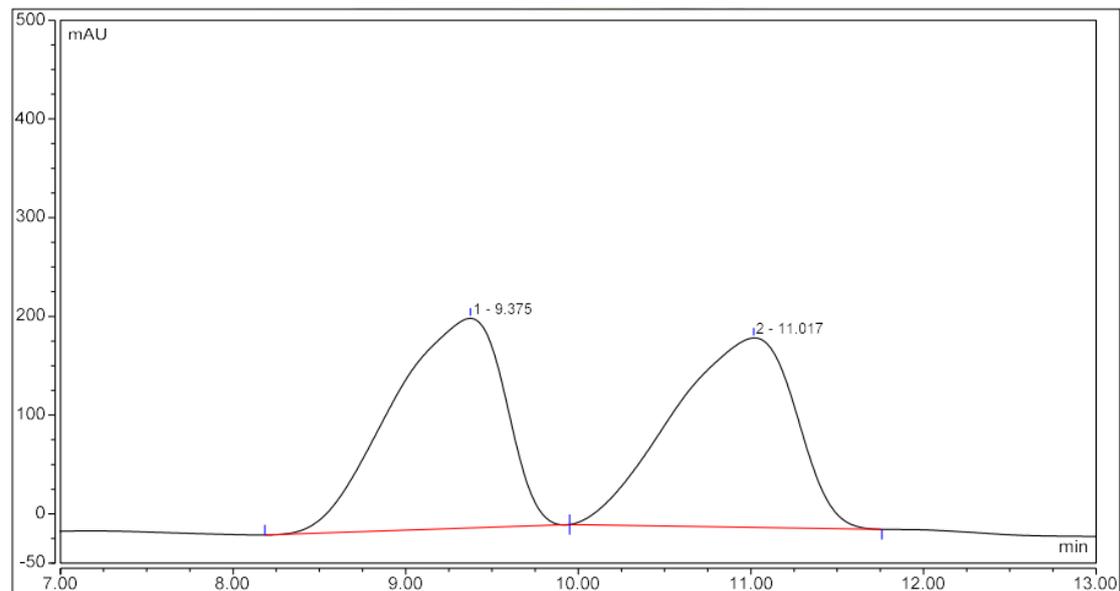
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.067	712.872	1099.232	50.44	44.48	
2	11.108	700.484	1371.998	49.56	55.52	
<b>Sum:</b>		<b>1413.356</b>	<b>2471.231</b>	<b>100.00</b>	<b>100.00</b>	



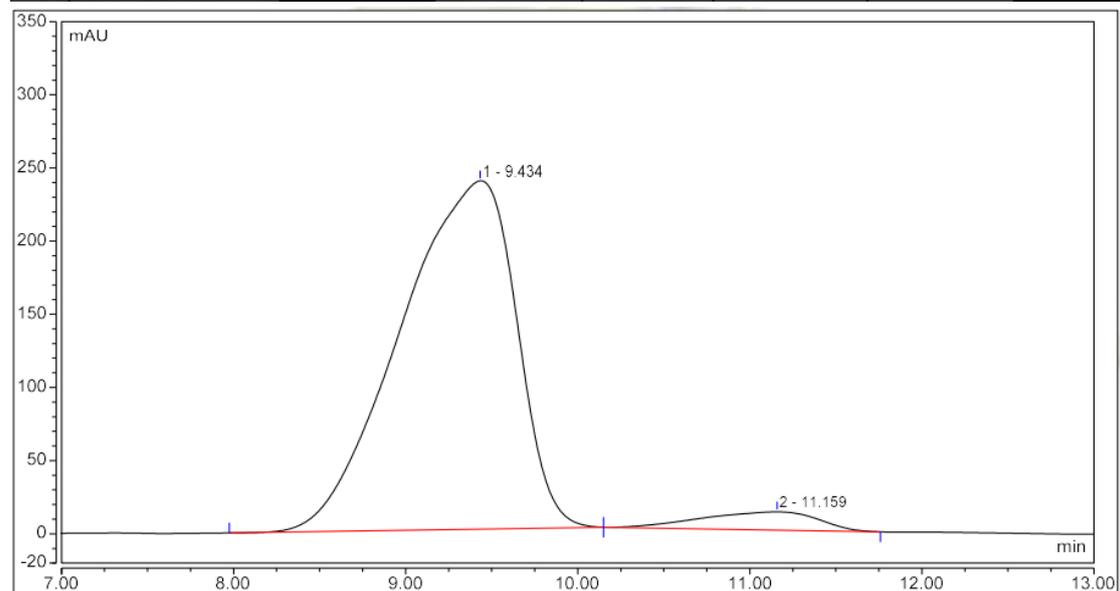
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.184	267.354	343.506	97.59	97.56	
2	11.609	6.615	8.583	2.41	2.44	
<b>Sum:</b>		<b>273.969</b>	<b>352.088</b>	<b>100.00</b>	<b>100.00</b>	



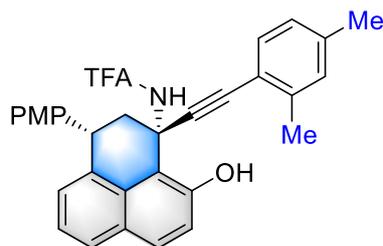
**3n:** IE, *n*-hexane/2-propanol = 99/1,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



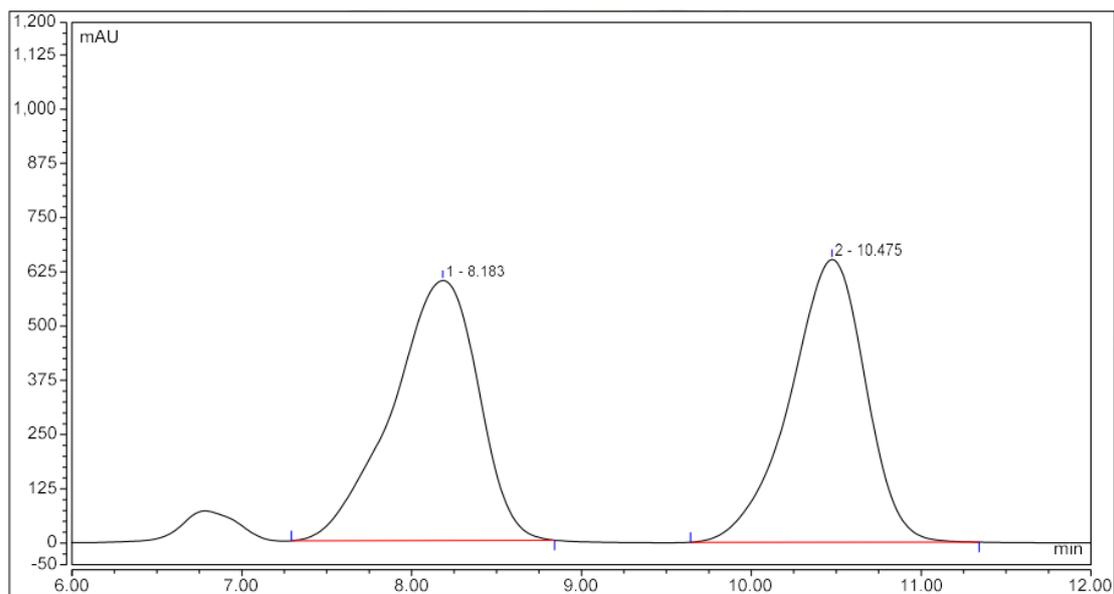
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.375	160.829	212.307	50.39	52.53	
2	11.017	158.316	191.844	49.61	47.47	
<b>Sum:</b>		<b>319.145</b>	<b>404.151</b>	<b>100.00</b>	<b>100.00</b>	



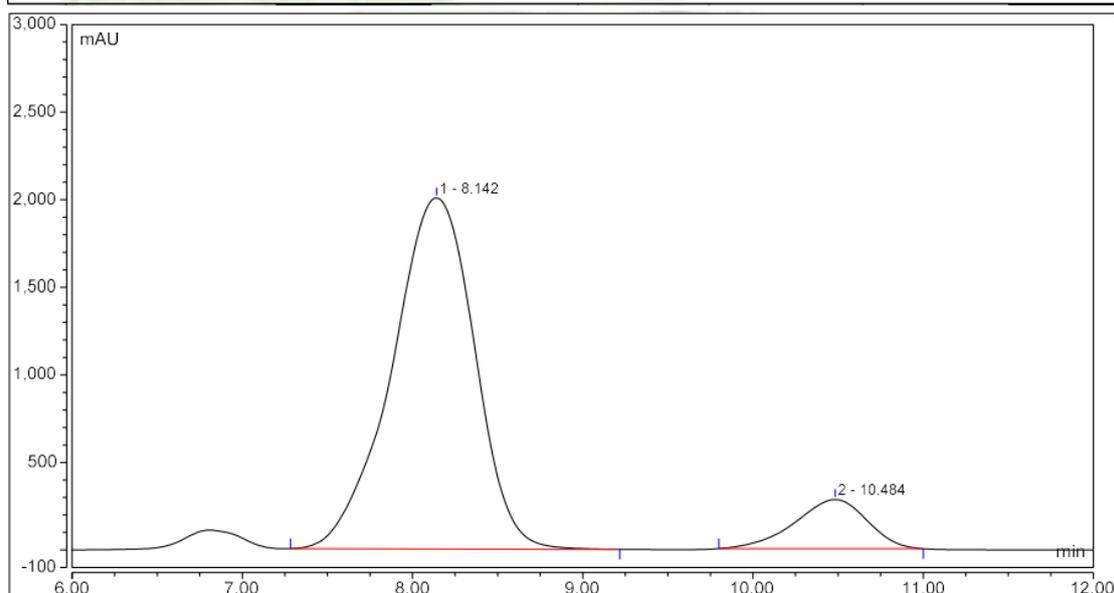
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.434	185.872	237.998	95.06	95.02	
2	11.159	9.650	12.475	4.94	4.98	
<b>Sum:</b>		<b>195.522</b>	<b>250.473</b>	<b>100.00</b>	<b>100.00</b>	



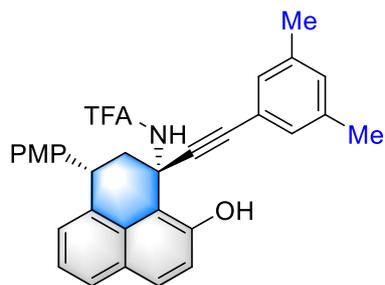
**3o:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



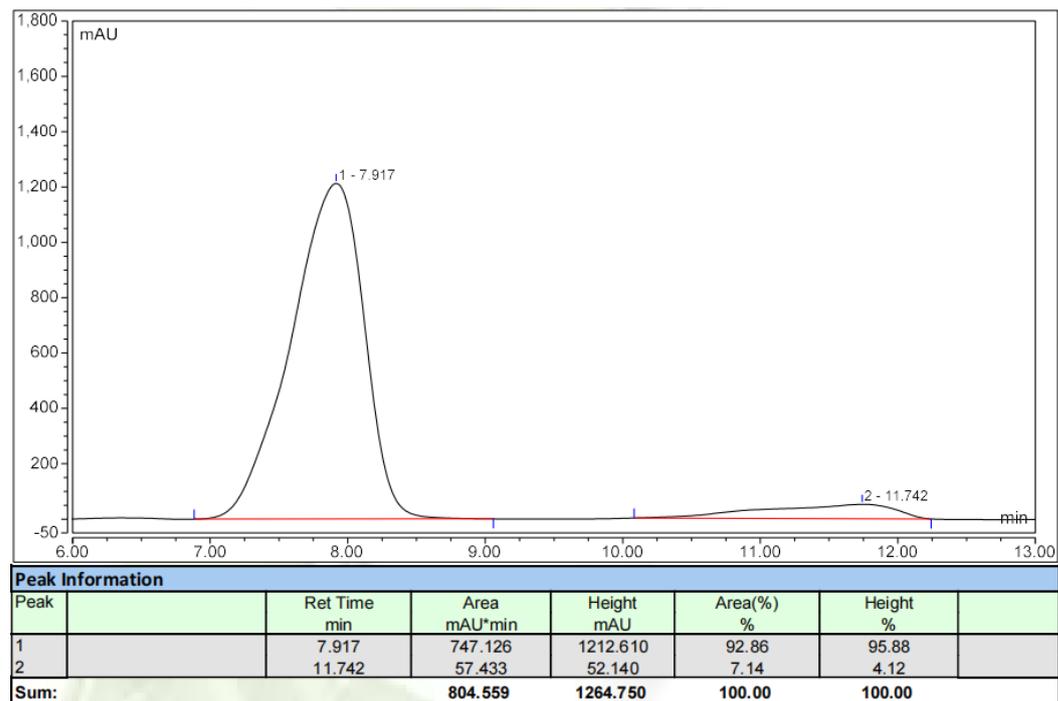
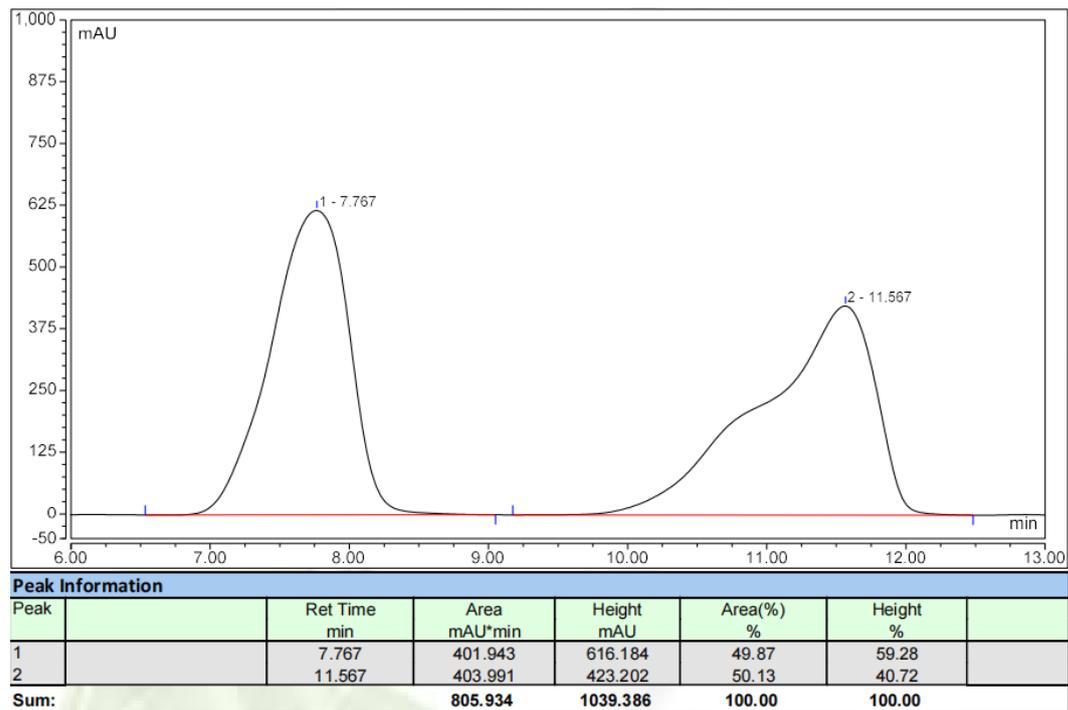
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.183	351.662	599.104	51.15	47.90	
2	10.475	335.871	651.739	48.85	52.10	
<b>Sum:</b>		<b>687.533</b>	<b>1250.844</b>	<b>100.00</b>	<b>100.00</b>	

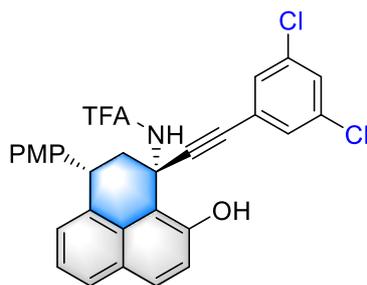


Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.142	1126.007	2004.348	89.08	87.72	
2	10.484	138.036	280.675	10.92	12.28	
<b>Sum:</b>		<b>1264.043</b>	<b>2285.023</b>	<b>100.00</b>	<b>100.00</b>	

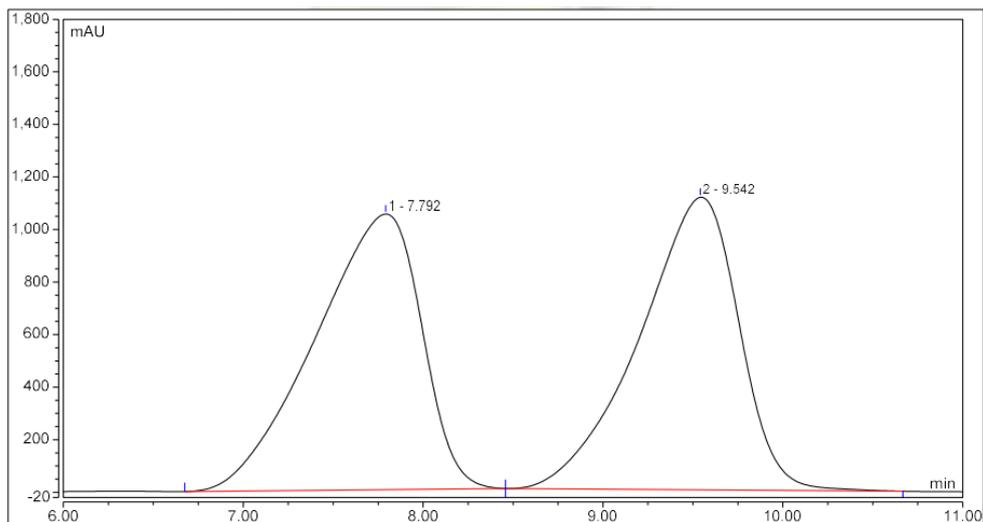


**3p:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$

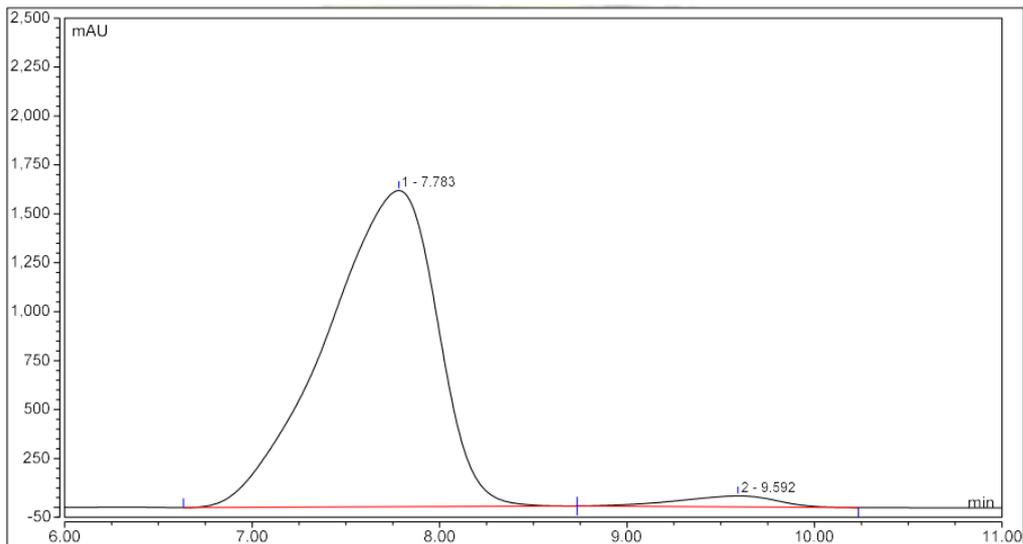




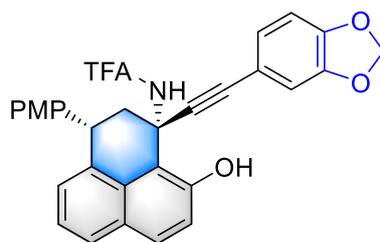
**3q:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



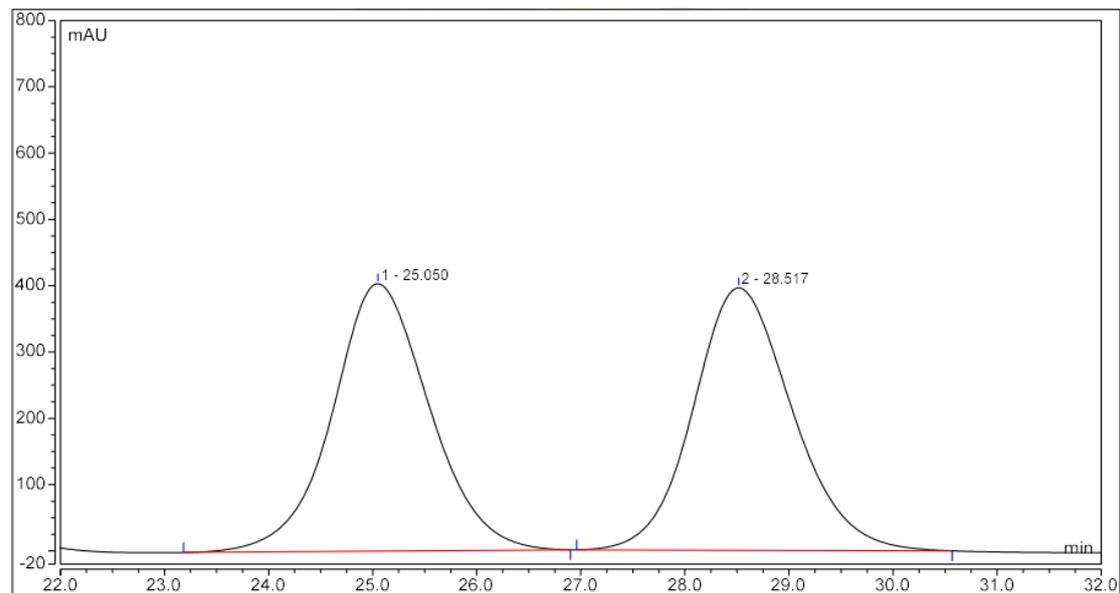
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.792	720.843	1049.419	50.21	48.51	
2	9.542	714.829	1113.816	49.79	51.49	
<b>Sum:</b>		<b>1435.672</b>	<b>2163.235</b>	<b>100.00</b>	<b>100.00</b>	



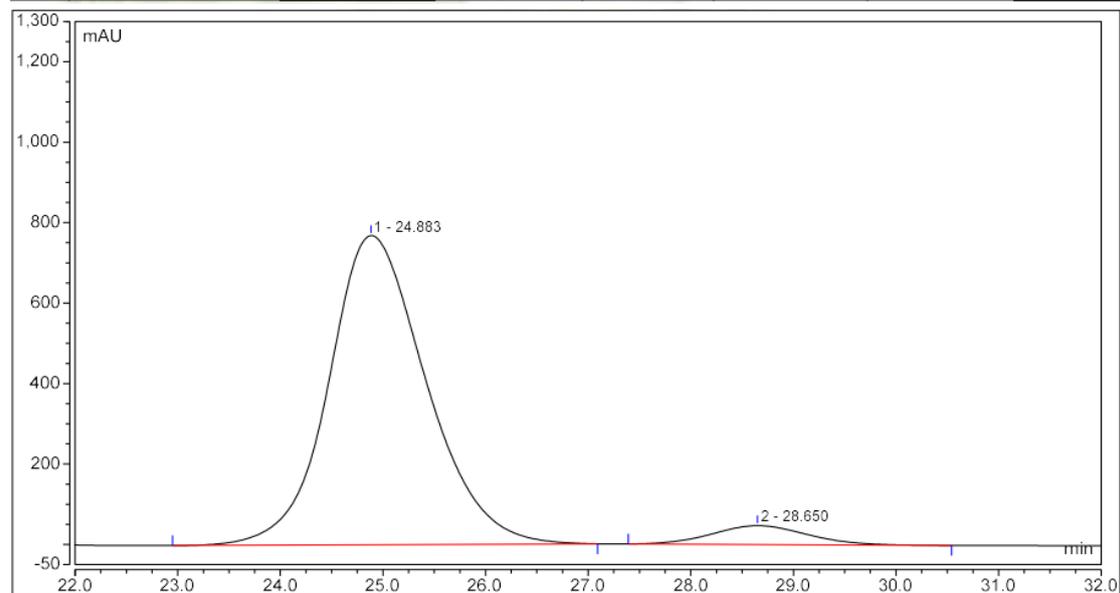
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.783	1109.113	1615.540	97.02	96.65	
2	9.592	34.032	56.083	2.98	3.35	
<b>Sum:</b>		<b>1143.144</b>	<b>1671.623</b>	<b>100.00</b>	<b>100.00</b>	



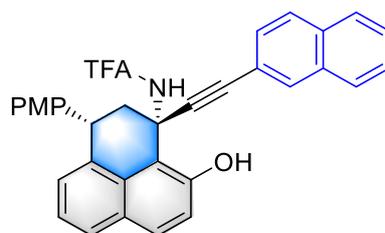
**3r:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



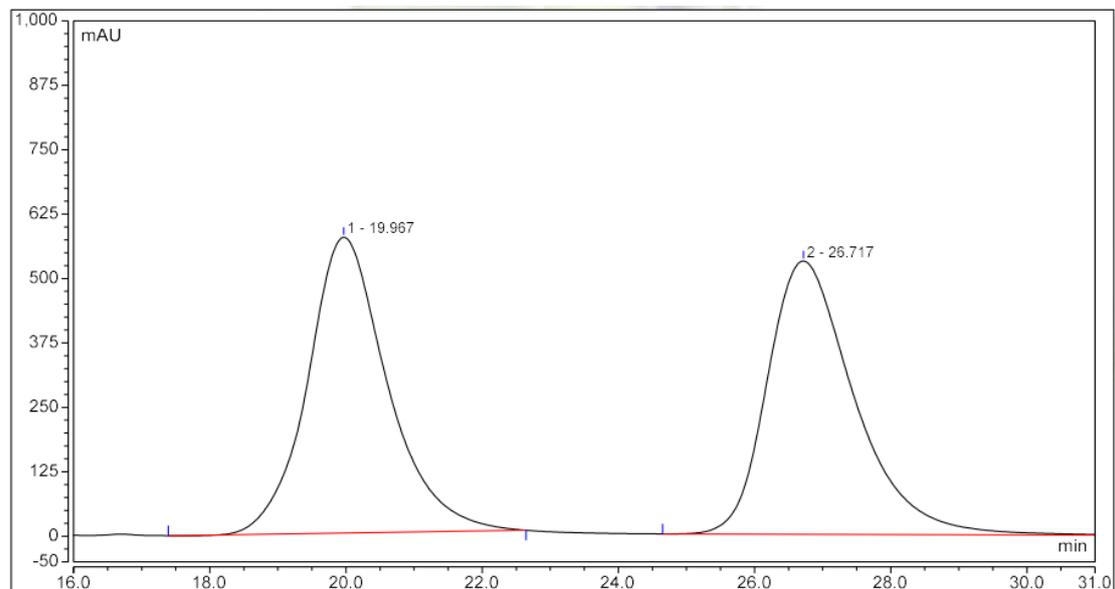
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	25.050	436.585	403.271	50.02	50.48	
2	28.517	436.319	395.637	49.98	49.52	
<b>Sum:</b>		<b>872.904</b>	<b>798.908</b>	<b>100.00</b>	<b>100.00</b>	



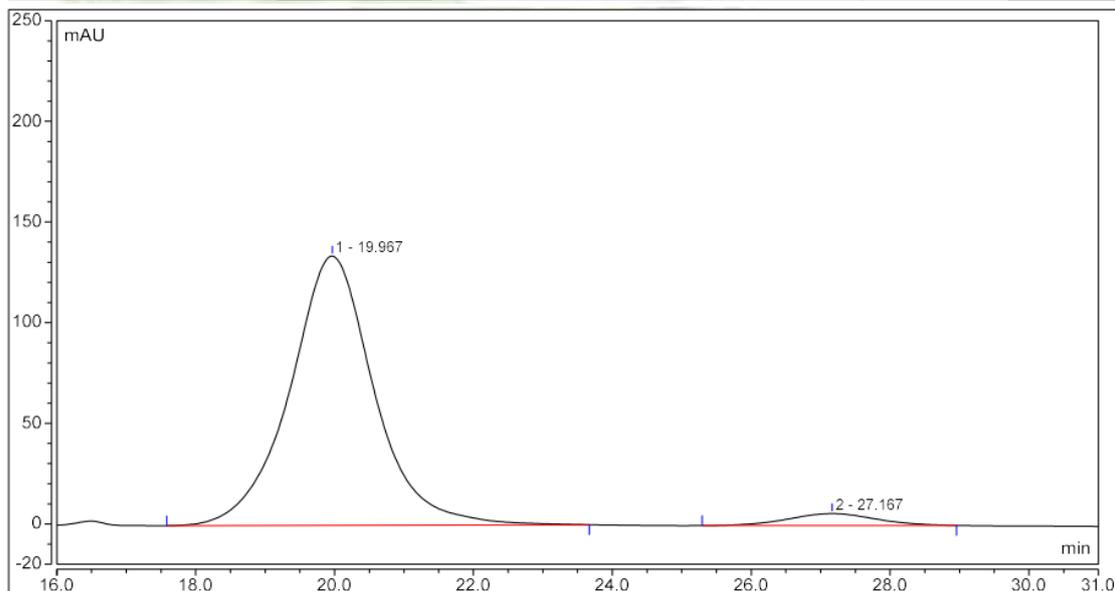
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	24.883	844.813	768.429	94.35	94.24	
2	28.650	50.582	46.931	5.65	5.76	
<b>Sum:</b>		<b>895.395</b>	<b>815.360</b>	<b>100.00</b>	<b>100.00</b>	



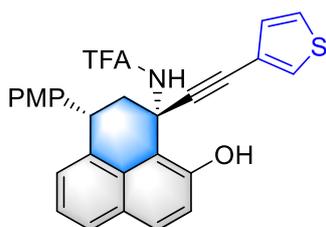
**3s:** IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



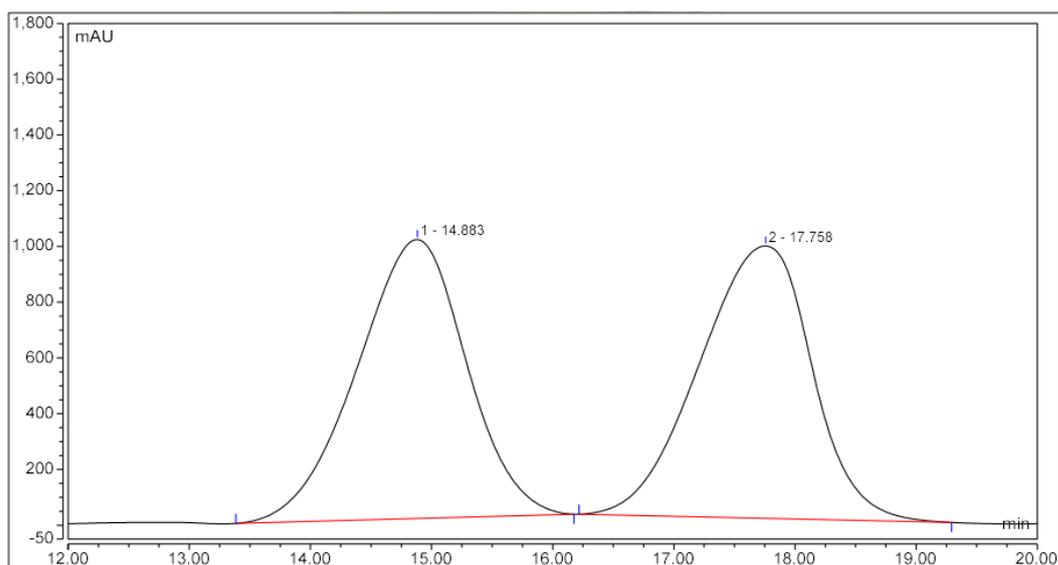
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	19.967	778.772	573.963	49.80	51.98	
2	26.717	784.888	530.310	50.20	48.02	
<b>Sum:</b>		<b>1563.660</b>	<b>1104.273</b>	<b>100.00</b>	<b>100.00</b>	



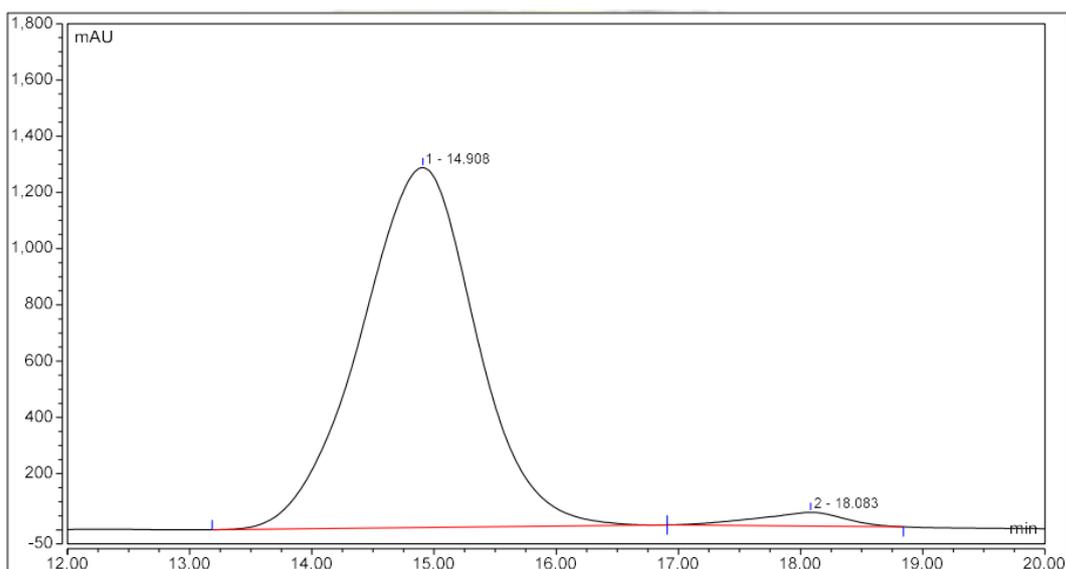
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	19.967	187.996	133.707	95.61	95.77	
2	27.167	8.626	5.902	4.39	4.23	
<b>Sum:</b>		<b>196.622</b>	<b>139.610</b>	<b>100.00</b>	<b>100.00</b>	



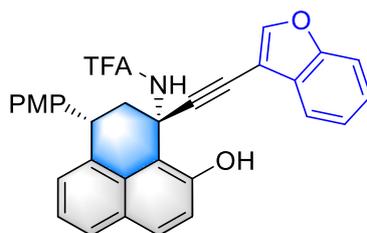
**3t:** IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



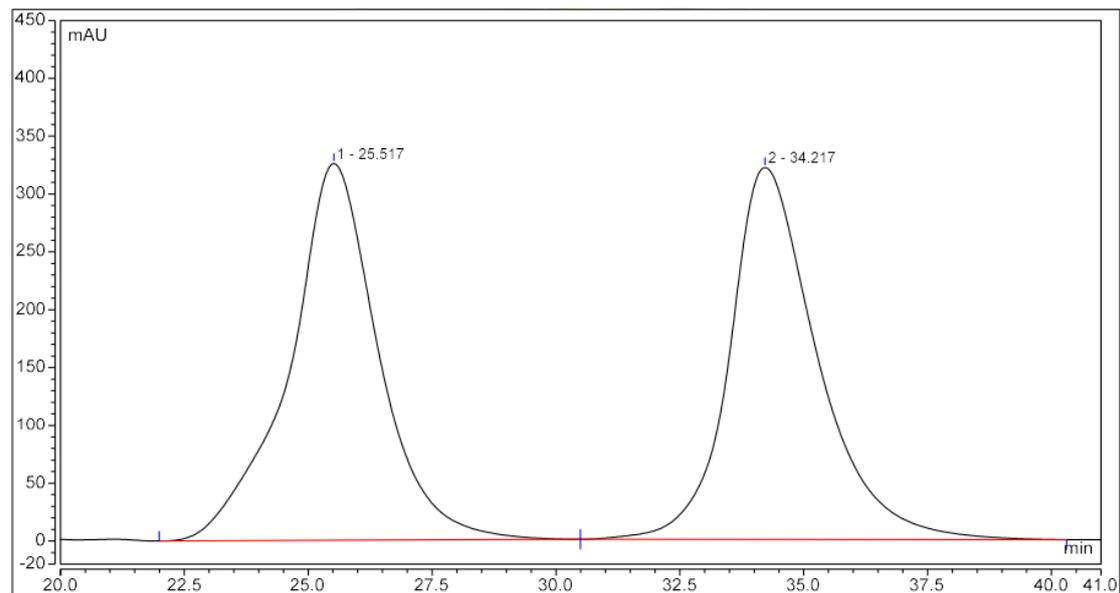
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	14.883	1047.179	1000.210	49.81	50.60	
2	17.758	1055.219	976.668	50.19	49.40	
<b>Sum:</b>		<b>2102.398</b>	<b>1976.878</b>	<b>100.00</b>	<b>100.00</b>	



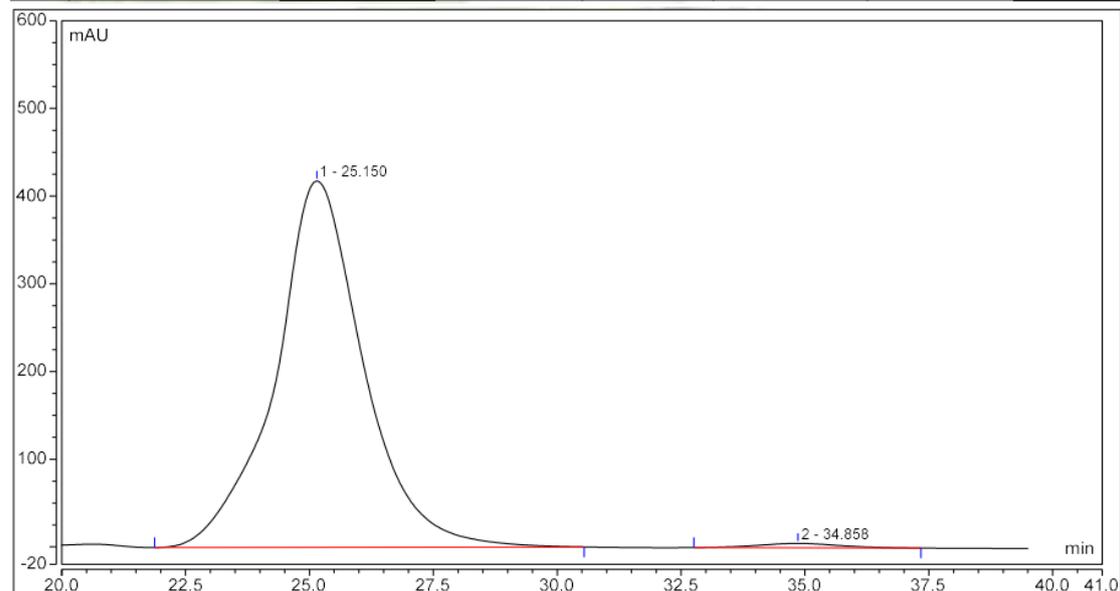
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	14.908	1401.431	1279.791	97.17	96.33	
2	18.083	40.769	48.825	2.83	3.67	
<b>Sum:</b>		<b>1442.201</b>	<b>1328.616</b>	<b>100.00</b>	<b>100.00</b>	



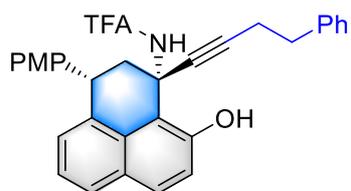
**3u:** IE, *n*-hexane/2-propanol = 96/4,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



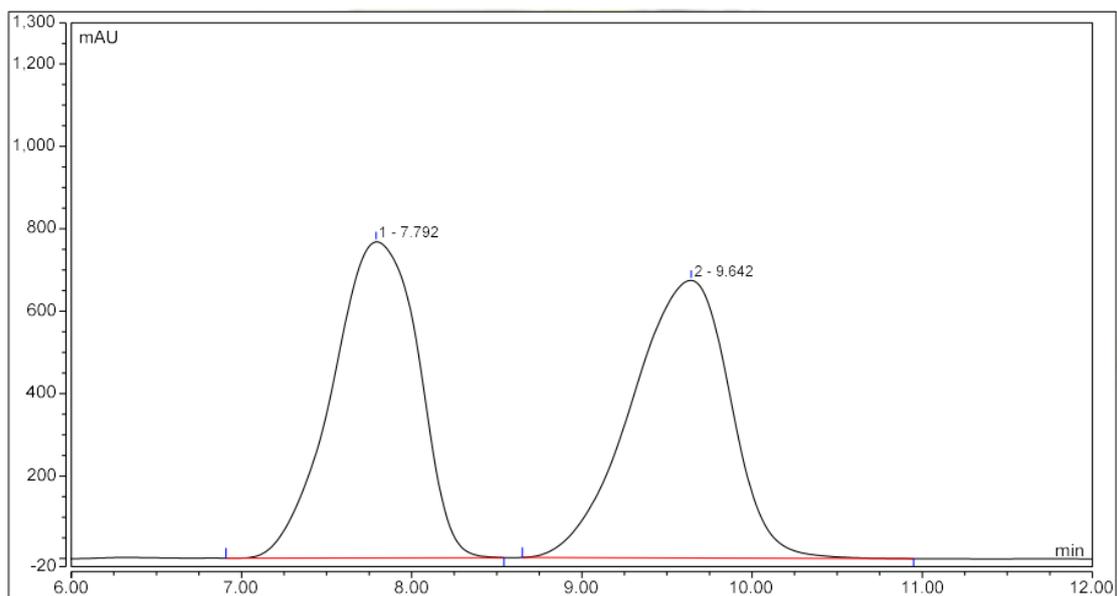
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	25.517	681.018	325.696	50.65	50.33	
2	34.217	663.568	321.480	49.35	49.67	
<b>Sum:</b>		<b>1344.586</b>	<b>647.175</b>	<b>100.00</b>	<b>100.00</b>	



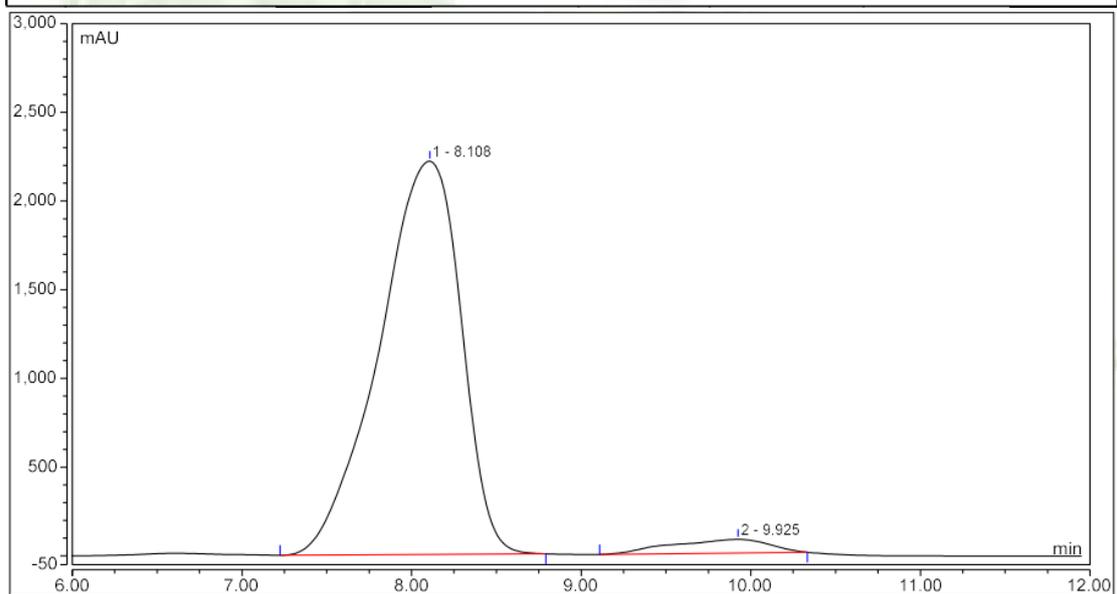
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	25.150	862.666	417.661	98.91	98.82	
2	34.858	9.520	5.004	1.09	1.18	
<b>Sum:</b>		<b>872.186</b>	<b>422.665</b>	<b>100.00</b>	<b>100.00</b>	



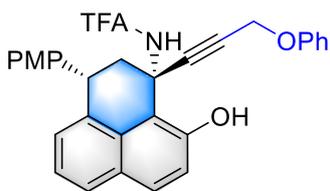
**3v:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



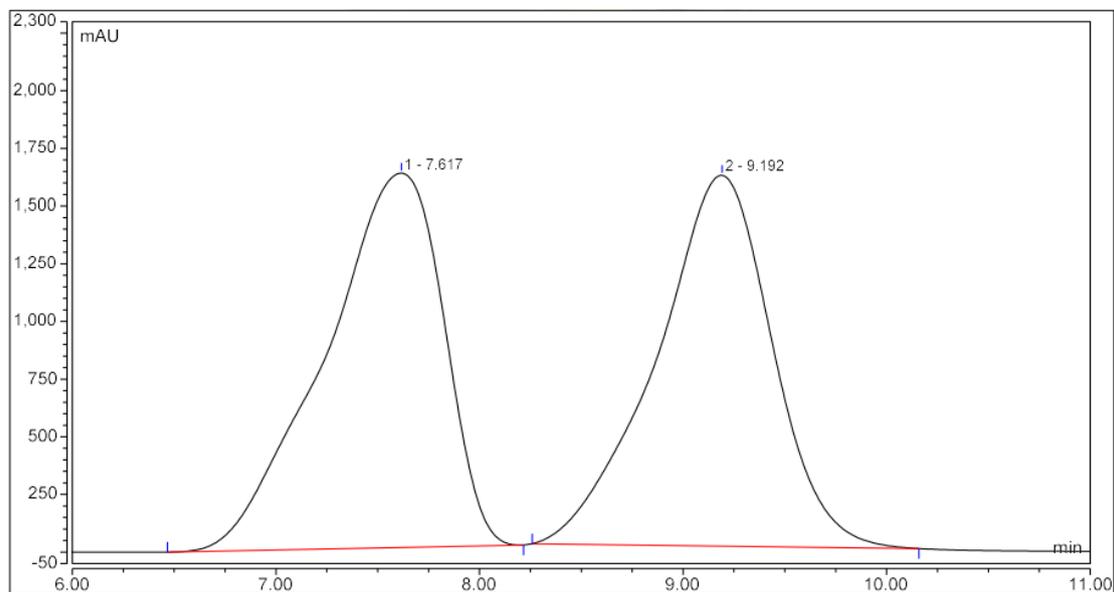
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.792	450.710	766.936	49.77	53.23	
2	9.642	454.846	673.795	50.23	46.77	
<b>Sum:</b>		<b>905.557</b>	<b>1440.731</b>	<b>100.00</b>	<b>100.00</b>	



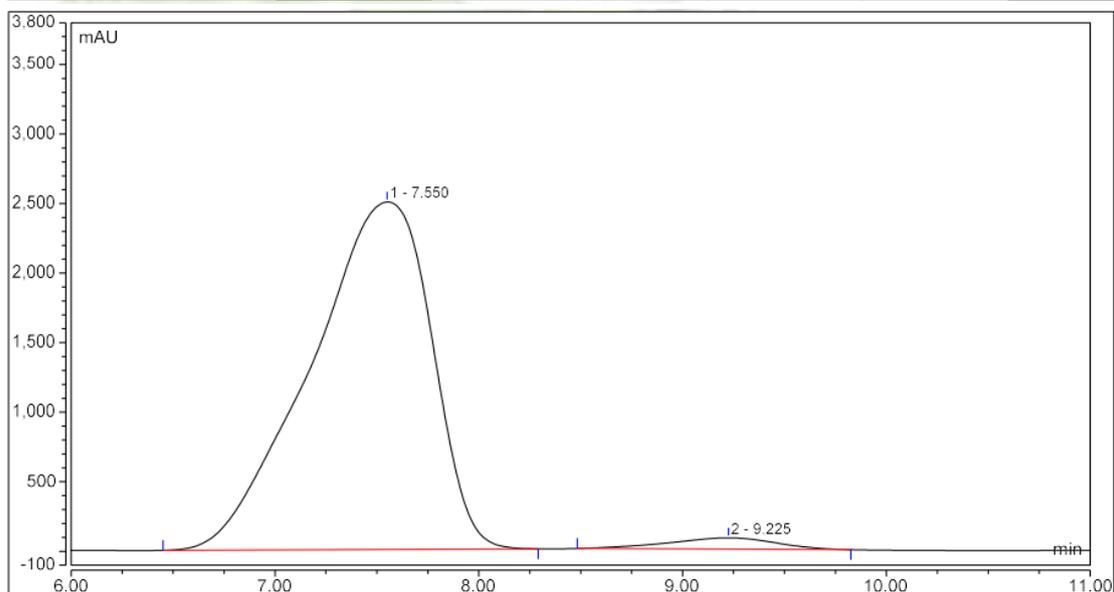
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.108	1237.206	2216.534	96.01	96.66	
2	9.925	51.445	76.594	3.99	3.34	
<b>Sum:</b>		<b>1288.652</b>	<b>2293.128</b>	<b>100.00</b>	<b>100.00</b>	



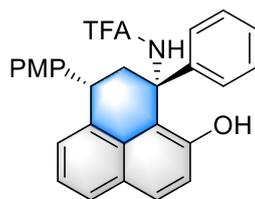
**3w**: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



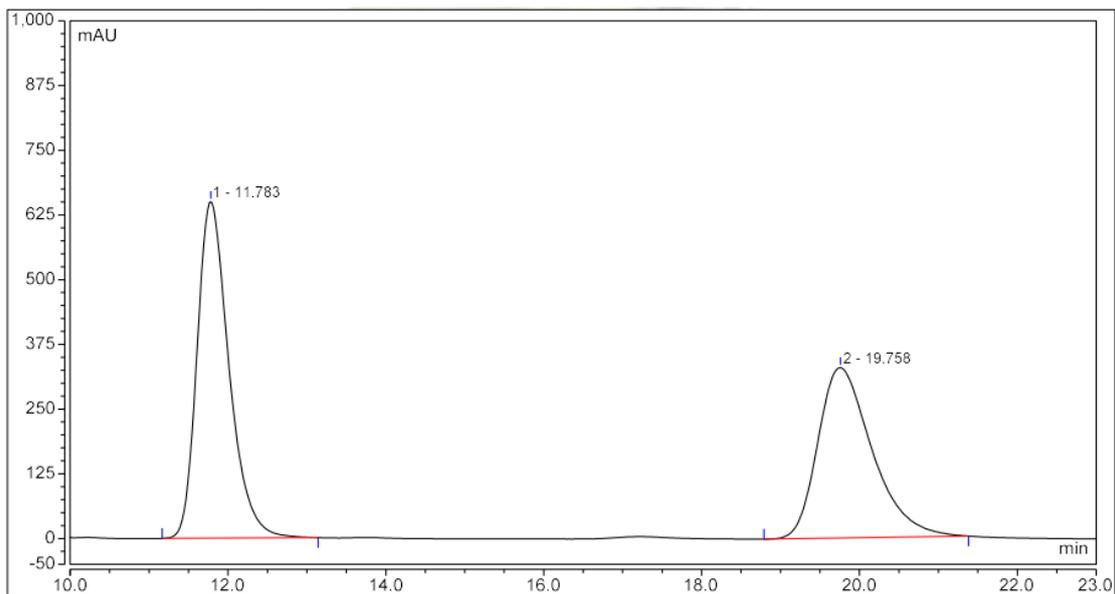
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.617	1091.858	1622.407	50.79	50.23	
2	9.192	1057.924	1607.356	49.21	49.77	
<b>Sum:</b>		<b>2149.782</b>	<b>3229.763</b>	<b>100.00</b>	<b>100.00</b>	



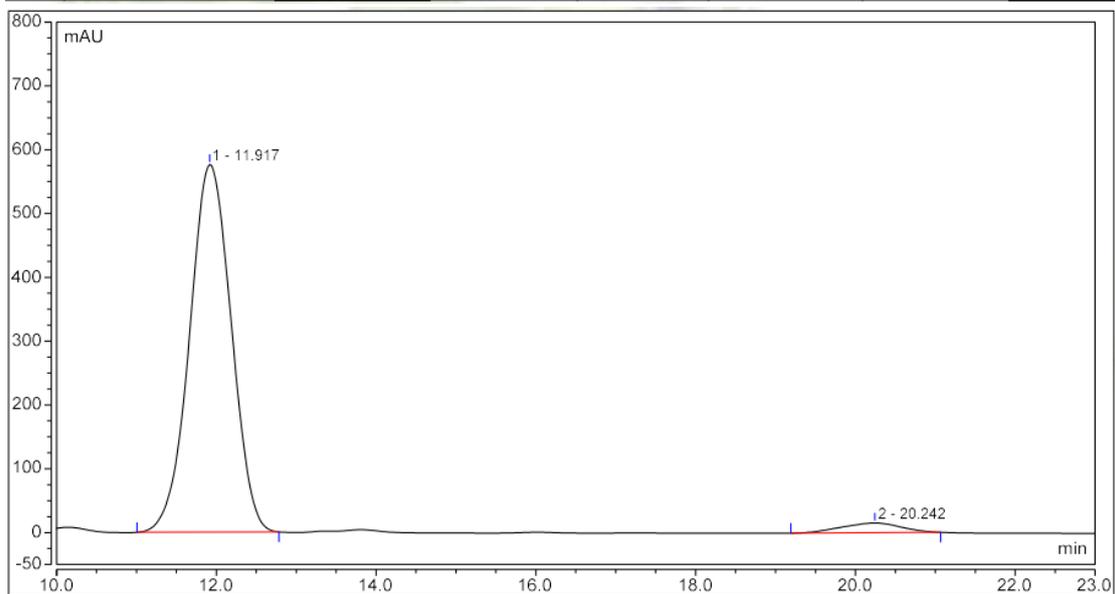
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.550	1711.919	2498.662	97.20	96.85	
2	9.225	49.341	81.299	2.80	3.15	
<b>Sum:</b>		<b>1761.260</b>	<b>2579.961</b>	<b>100.00</b>	<b>100.00</b>	



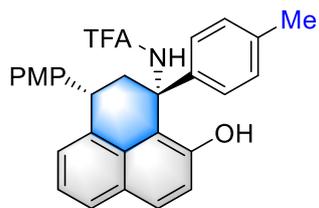
**3x:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



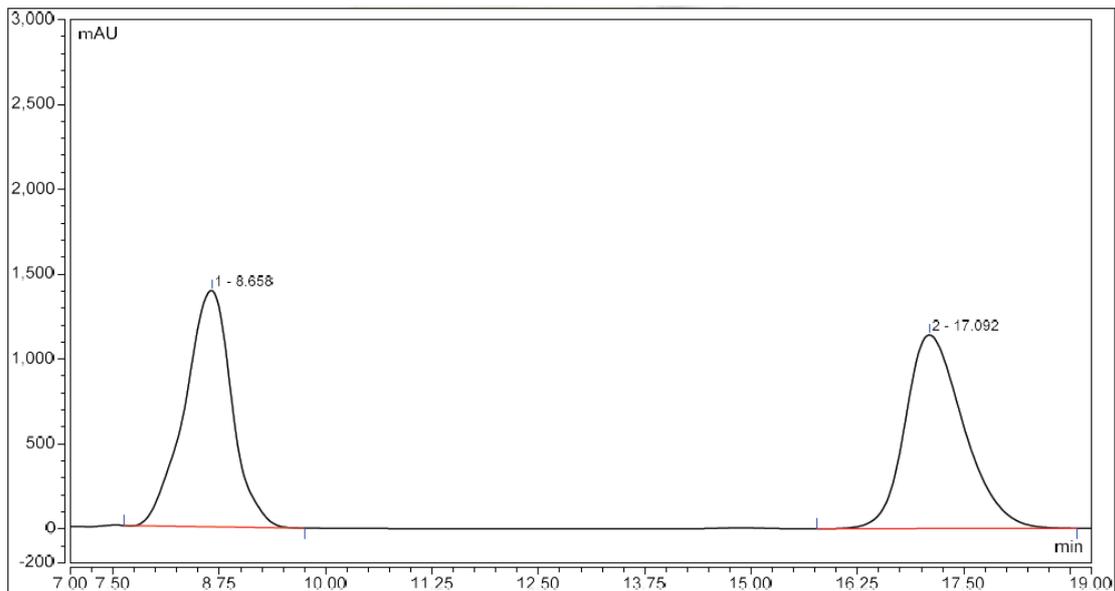
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	11.783	304.419	650.821	53.73	66.41	
2	19.758	262.200	329.204	46.27	33.59	
<b>Sum:</b>		<b>566.619</b>	<b>980.025</b>	<b>100.00</b>	<b>100.00</b>	



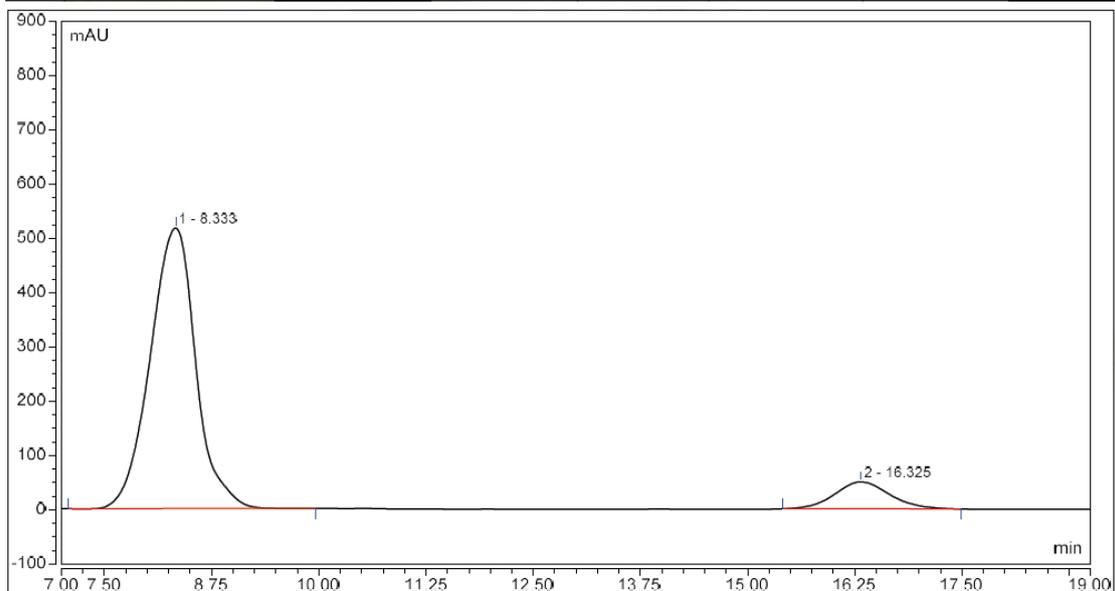
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	11.917	347.242	575.942	96.37	97.44	
2	20.242	13.067	15.133	3.63	2.56	
<b>Sum:</b>		<b>360.308</b>	<b>591.075</b>	<b>100.00</b>	<b>100.00</b>	



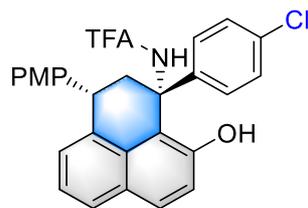
**3y:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



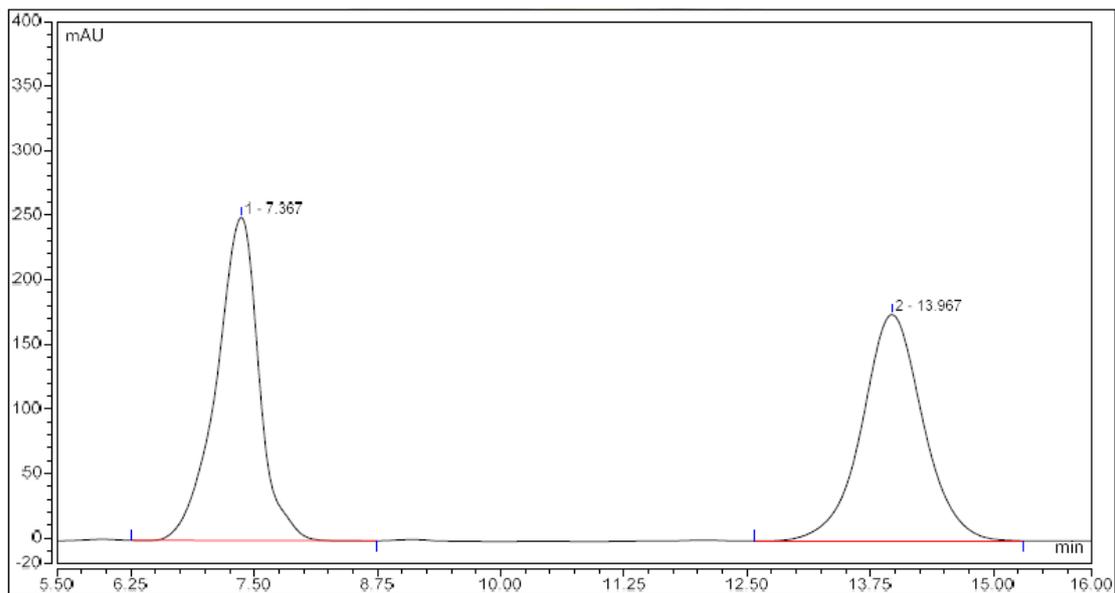
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	8.658	891.893	1391.390	49.58	54.96	
2	17.092	907.117	1140.399	50.42	45.04	
<b>Sum:</b>		<b>1799.010</b>	<b>2531.789</b>	<b>100.00</b>	<b>100.00</b>	



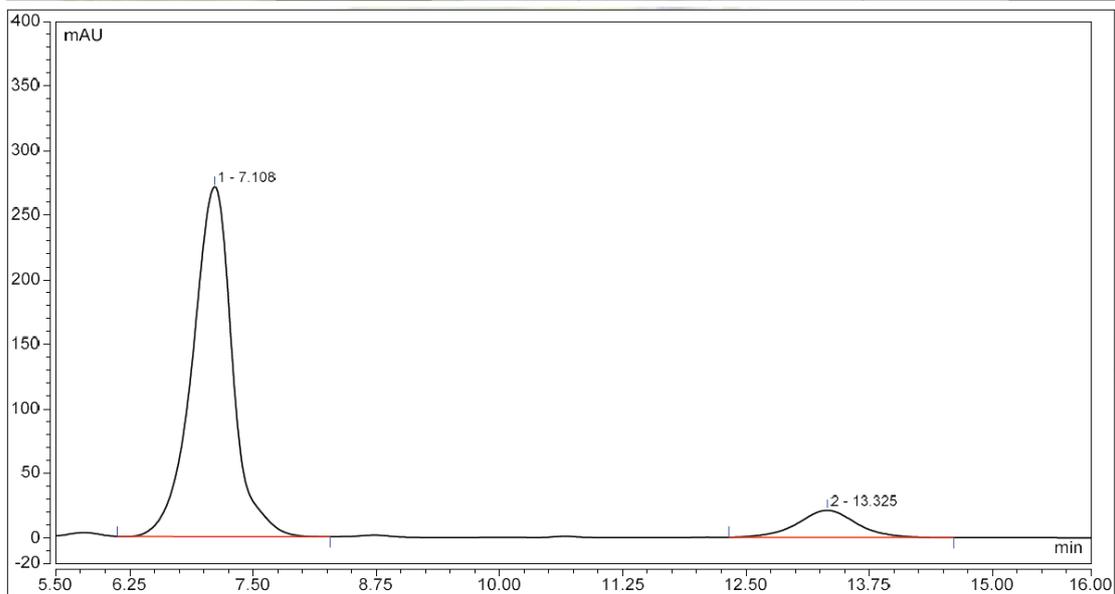
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	8.333	318.402	516.998	89.64	91.25	
2	16.325	36.789	49.544	10.36	8.75	
<b>Sum:</b>		<b>355.191</b>	<b>566.543</b>	<b>100.00</b>	<b>100.00</b>	



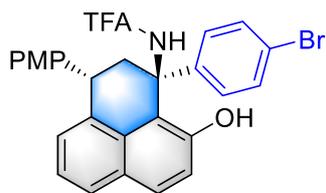
**3z:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



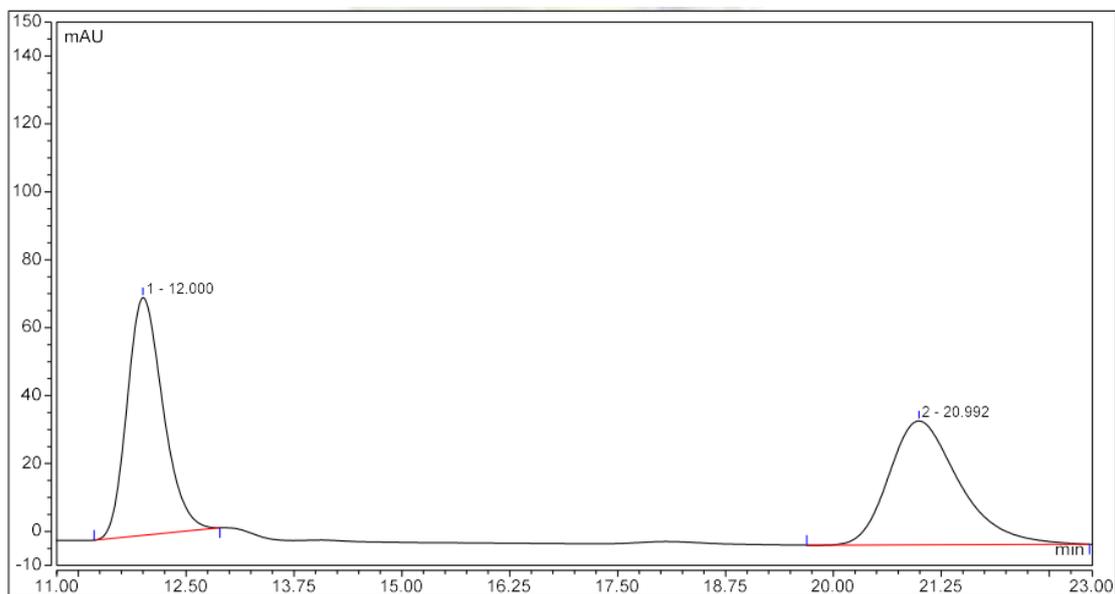
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	7.367	125.675	250.254	49.99	58.83	
2	13.967	125.738	175.143	50.01	41.17	
<b>Sum:</b>		<b>251.412</b>	<b>425.396</b>	<b>100.00</b>	<b>100.00</b>	



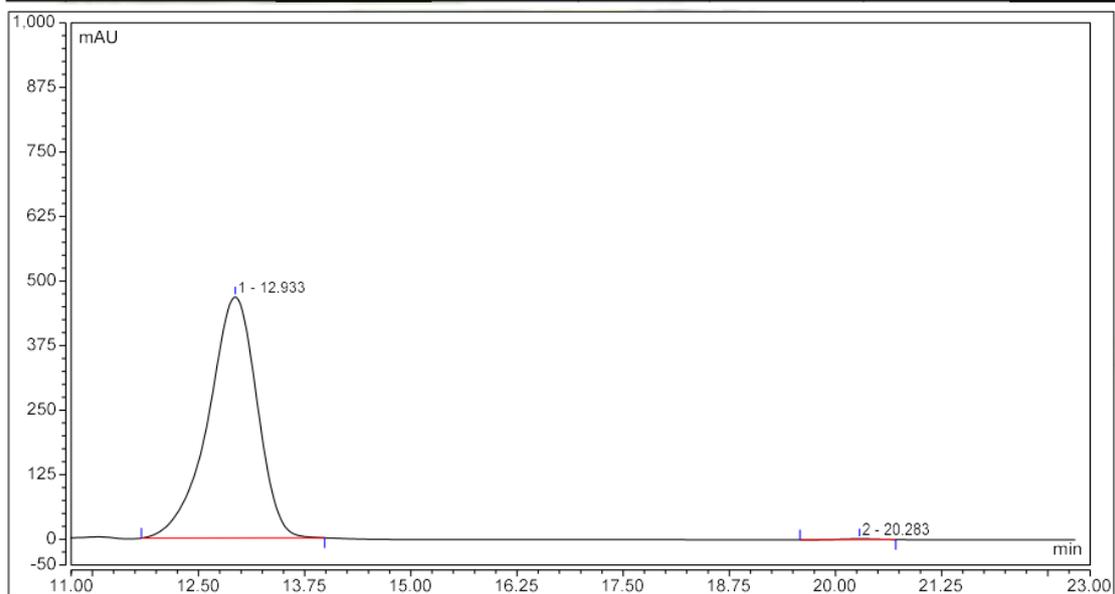
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	7.108	127.468	270.814	89.72	92.83	
2	13.325	14.604	20.923	10.28	7.17	
<b>Sum:</b>		<b>142.072</b>	<b>291.737</b>	<b>100.00</b>	<b>100.00</b>	



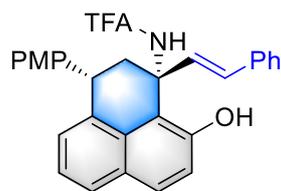
**3aa:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



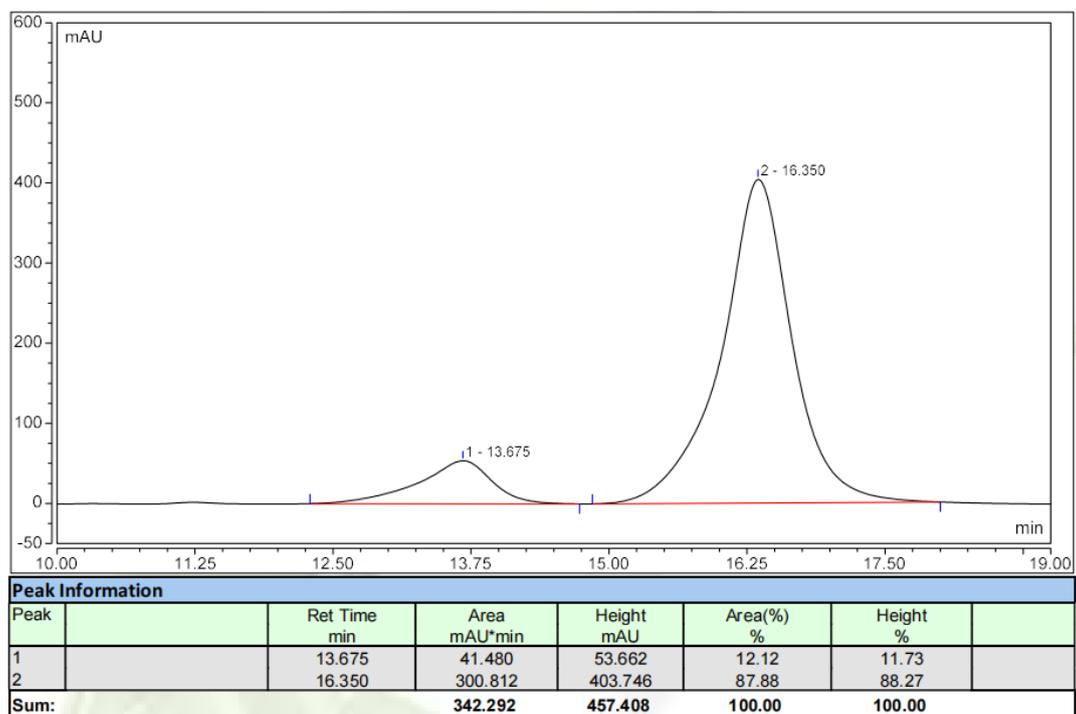
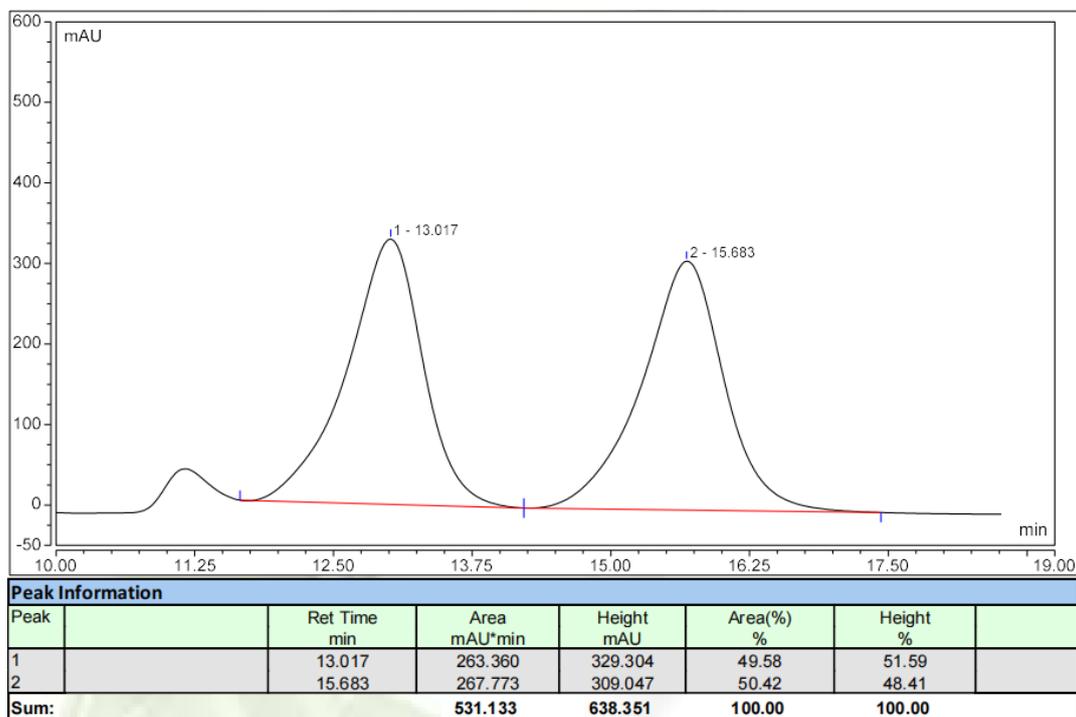
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	12.000	33.779	70.008	49.53	65.74	
2	20.992	34.426	36.478	50.47	34.26	
<b>Sum:</b>		<b>68.205</b>	<b>106.486</b>	<b>100.00</b>	<b>100.00</b>	

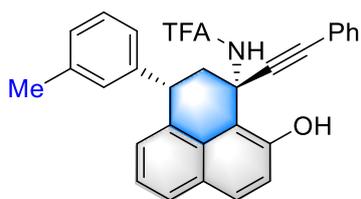


Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	12.933	310.560	466.933	99.74	99.65	
2	20.283	0.802	1.624	0.26	0.35	
<b>Sum:</b>		<b>311.362</b>	<b>468.557</b>	<b>100.00</b>	<b>100.00</b>	

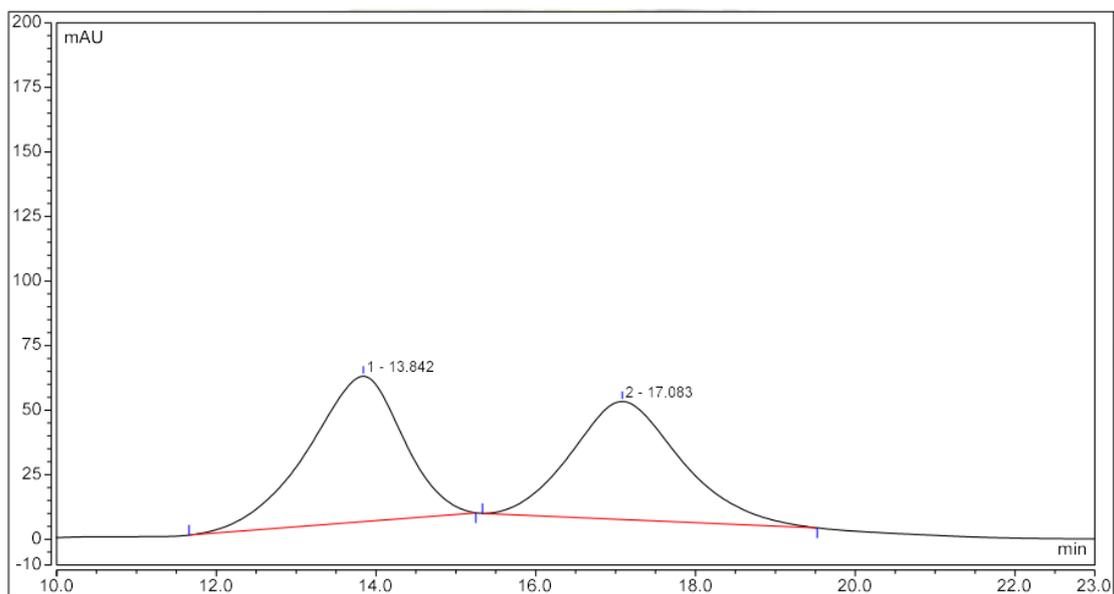


**3ab:** IB, *n*-hexane/2-propanol = 93/7,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$

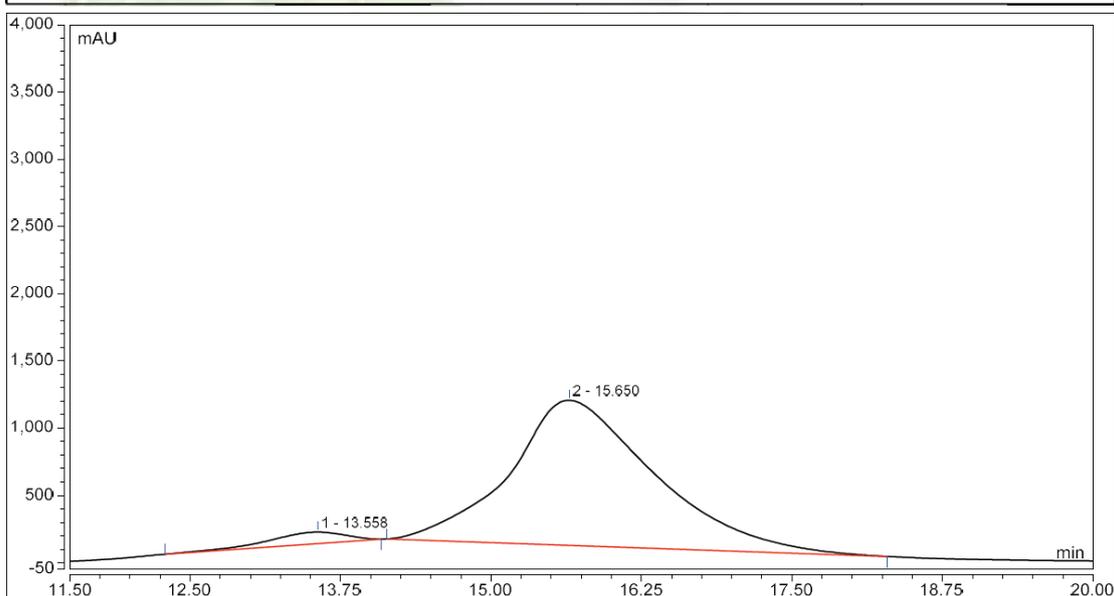




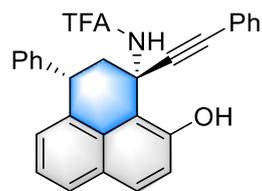
**3ac:** IB, *n*-hexane/2-propanol = 97/3,  $v = 1.0 \text{ mL}\cdot\text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ,  $5^\circ\text{C}$



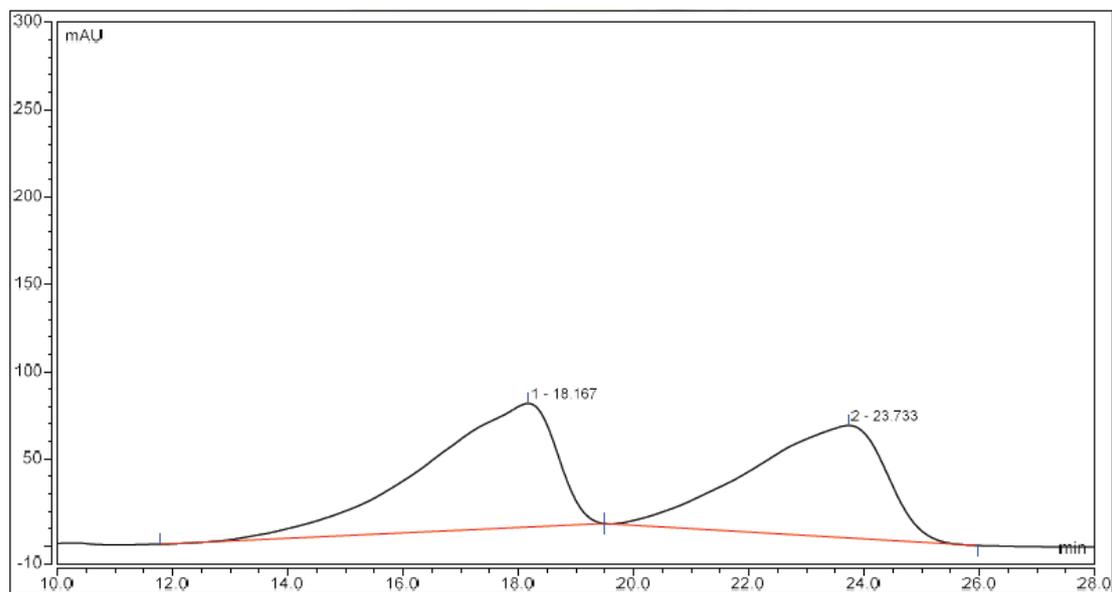
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	13.842	77.879	56.266	51.64	55.19	
2	17.083	72.923	45.679	48.36	44.81	
<b>Sum:</b>		<b>150.802</b>	<b>101.945</b>	<b>100.00</b>	<b>100.00</b>	



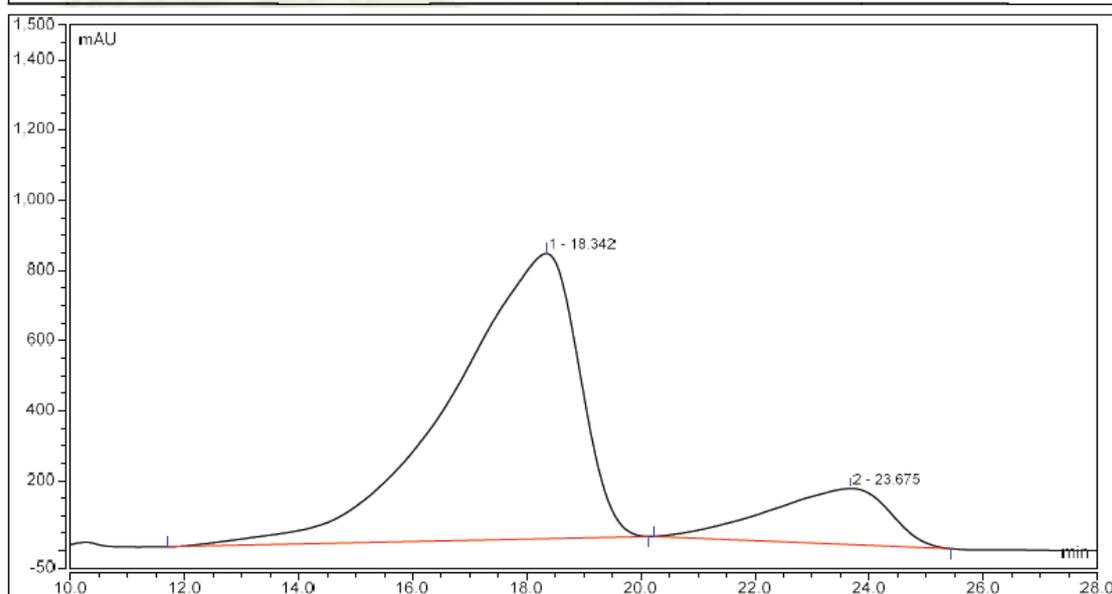
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	13.558	64.570	85.424	4.12	7.34	
2	15.650	1503.638	1078.996	95.88	92.66	
<b>Sum:</b>		<b>1568.208</b>	<b>1164.420</b>	<b>100.00</b>	<b>100.00</b>	



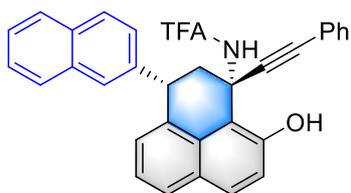
**3ad:** IG, *n*-hexane/2-propanol = 98/2,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



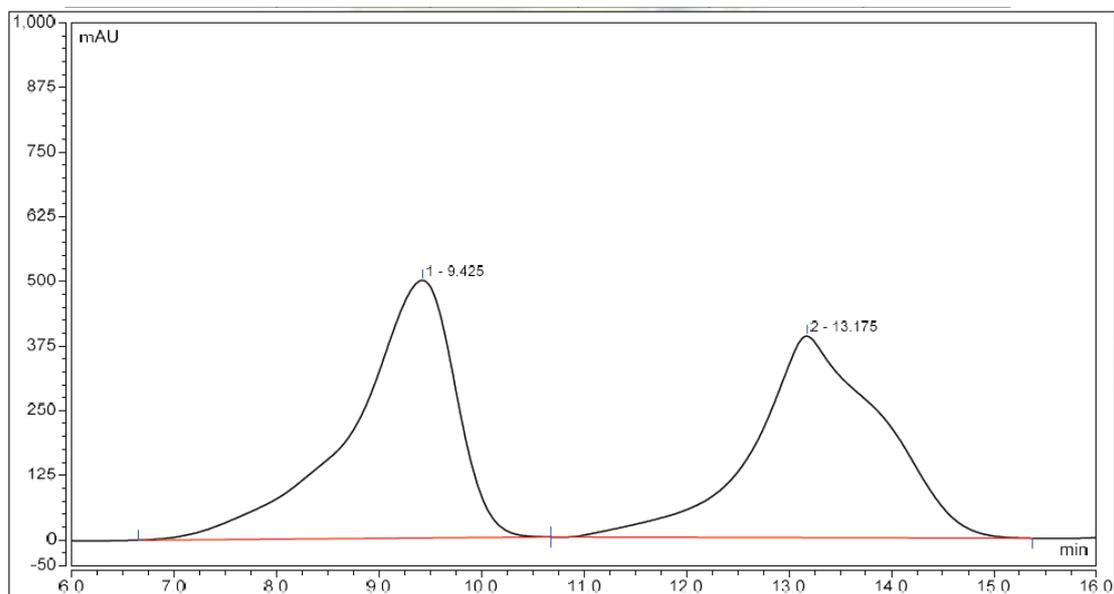
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	18.167	188.495	70.762	51.95	52.38	
2	23.733	174.325	64.338	48.05	47.62	
<b>Sum:</b>		<b>362.820</b>	<b>135.101</b>	<b>100.00</b>	<b>100.00</b>	



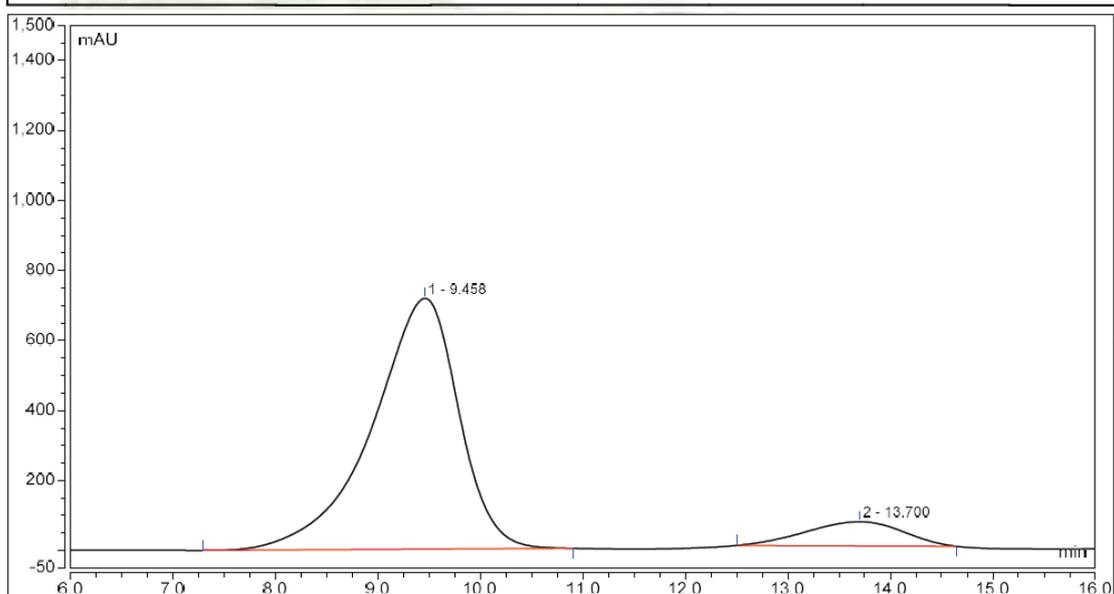
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	18.342	2114.725	813.184	84.56	83.56	
2	23.675	385.992	160.030	15.44	16.44	
<b>Sum:</b>		<b>2500.717</b>	<b>973.214</b>	<b>100.00</b>	<b>100.00</b>	



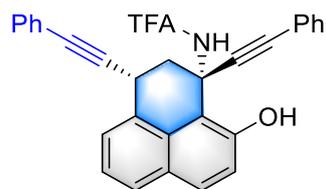
**3ae:** IG, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



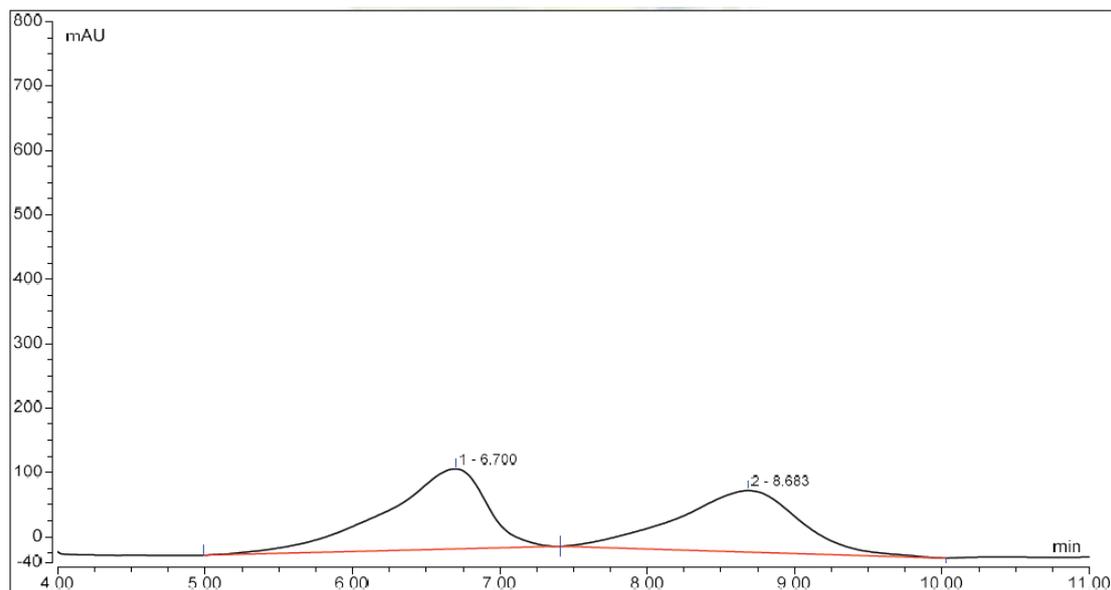
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.425	575.823	498.358	50.36	56.11	
2	13.175	567.619	389.776	49.64	43.89	
<b>Sum:</b>		<b>1143.441</b>	<b>888.133</b>	<b>100.00</b>	<b>100.00</b>	



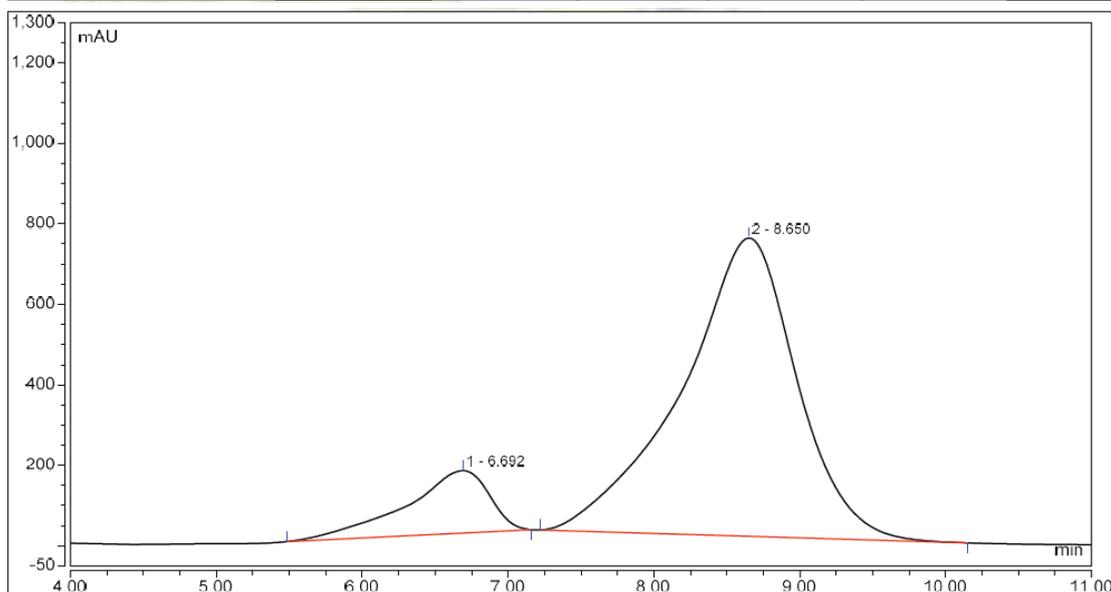
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.458	699.967	716.843	90.26	91.18	
2	13.700	75.545	69.366	9.74	8.82	
<b>Sum:</b>		<b>775.511</b>	<b>786.209</b>	<b>100.00</b>	<b>100.00</b>	



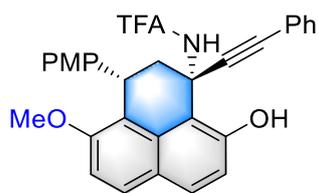
**3af:** IG, *n*-hexane/2-propanol = 93/7,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



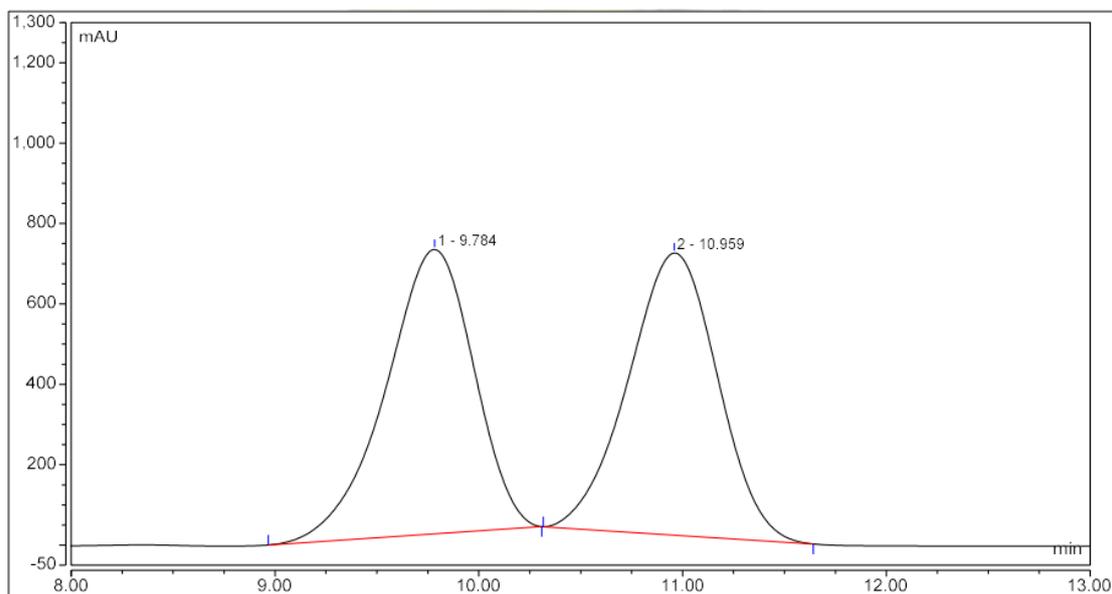
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.700	98.770	124.406	51.79	56.60	
2	8.683	91.936	95.390	48.21	43.40	
<b>Sum:</b>		<b>190.707</b>	<b>219.796</b>	<b>100.00</b>	<b>100.00</b>	



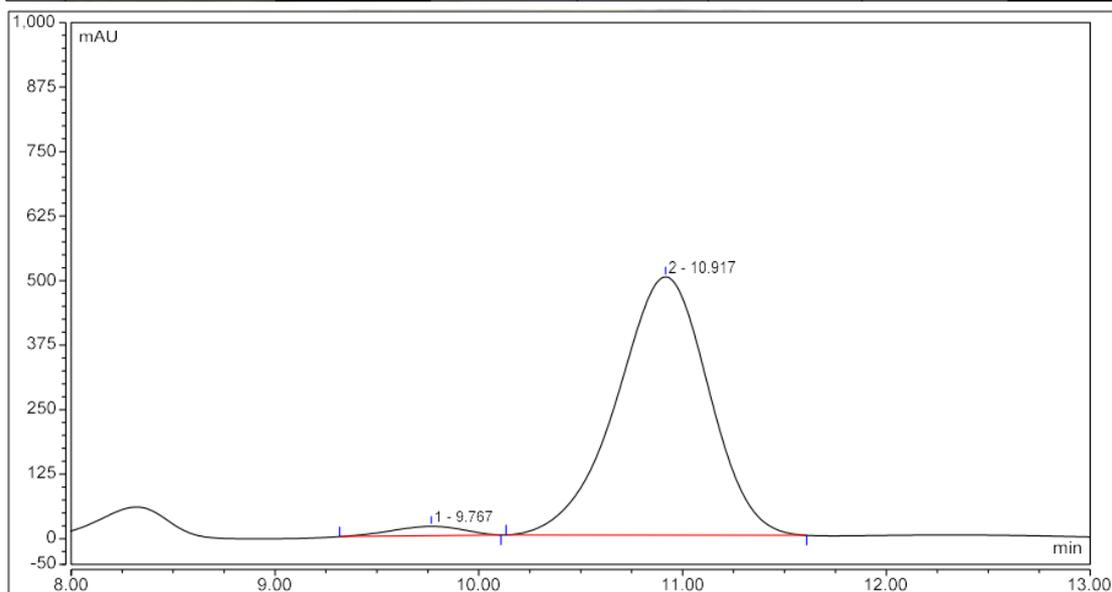
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.692	102.257	154.994	13.13	17.30	
2	8.650	676.381	741.147	86.87	82.70	
<b>Sum:</b>		<b>778.639</b>	<b>896.141</b>	<b>100.00</b>	<b>100.00</b>	



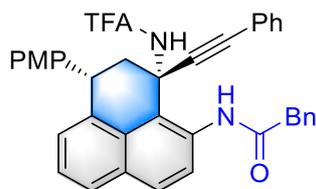
**3ag:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



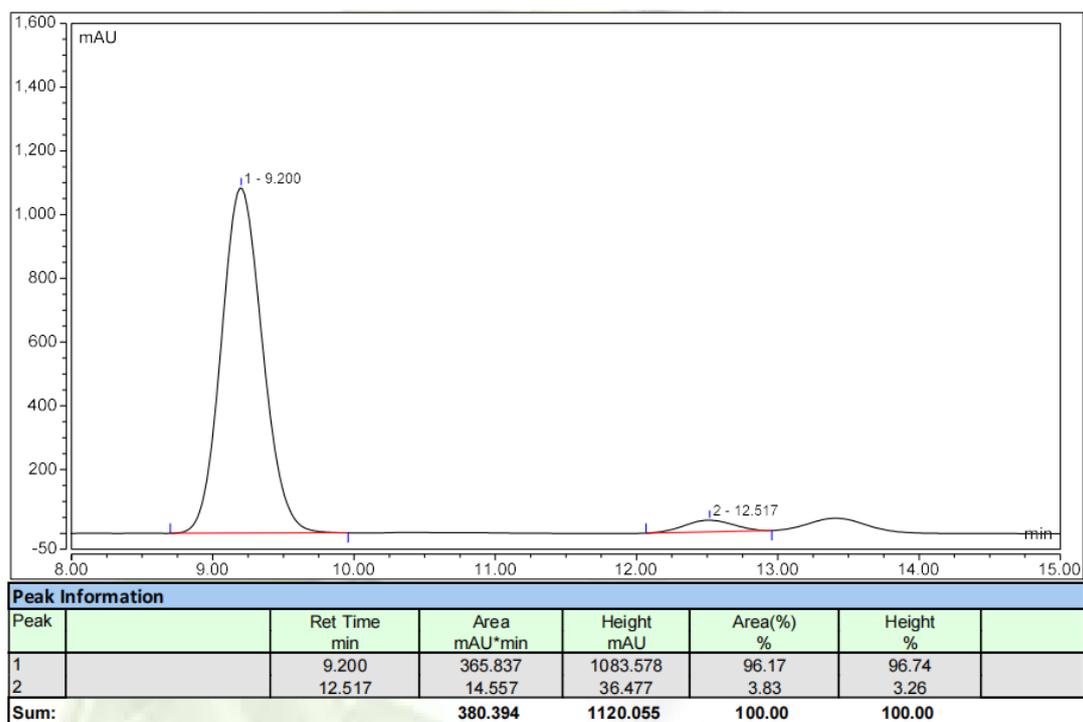
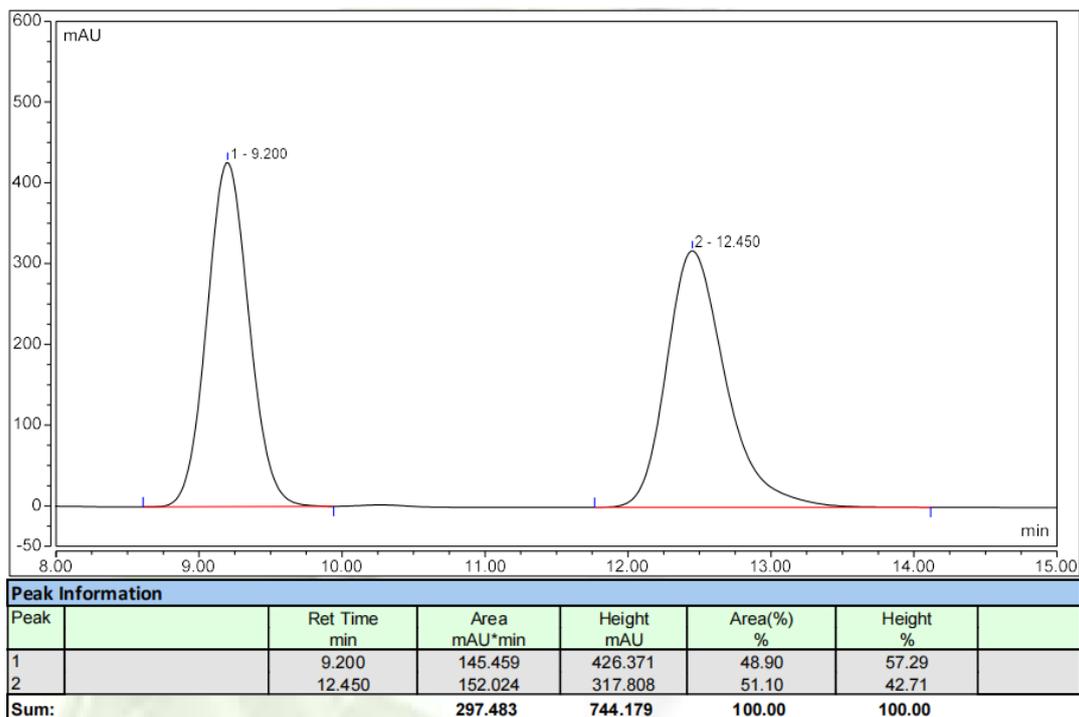
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.784	353.622	707.238	49.80	50.21	
2	10.959	356.445	701.440	50.20	49.79	
<b>Sum:</b>		<b>710.067</b>	<b>1408.678</b>	<b>100.00</b>	<b>100.00</b>	

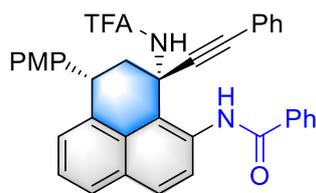


Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.767	7.308	18.028	2.72	3.48	
2	10.917	261.825	500.252	97.28	96.52	
<b>Sum:</b>		<b>269.134</b>	<b>518.280</b>	<b>100.00</b>	<b>100.00</b>	

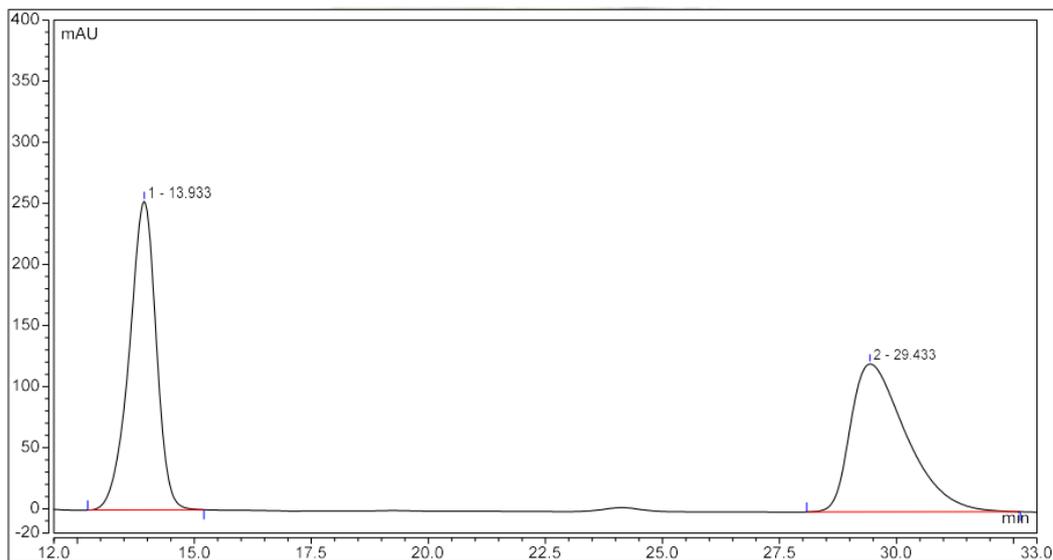


**3ah:** IE, *n*-hexane/2-propanol = 85/15,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$

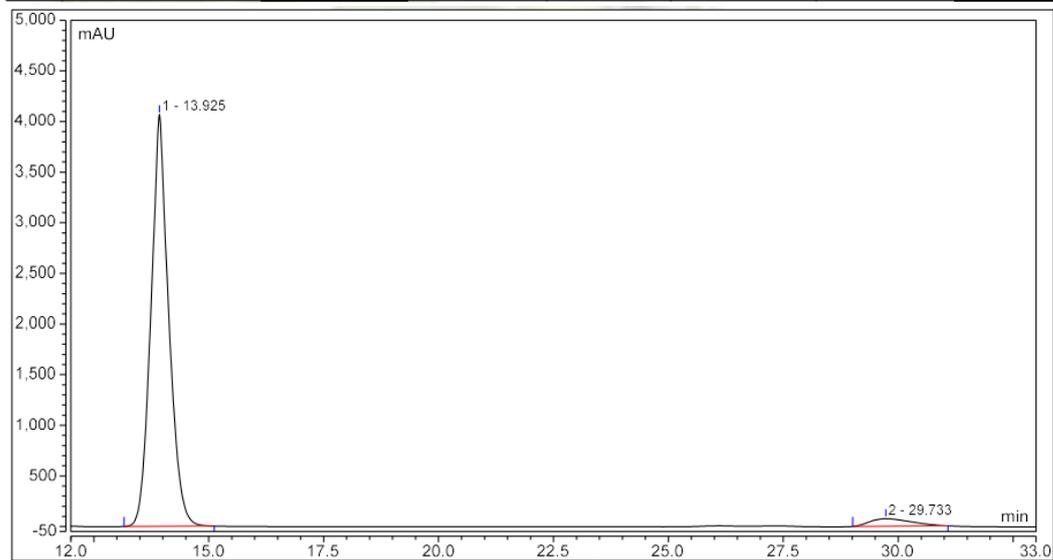




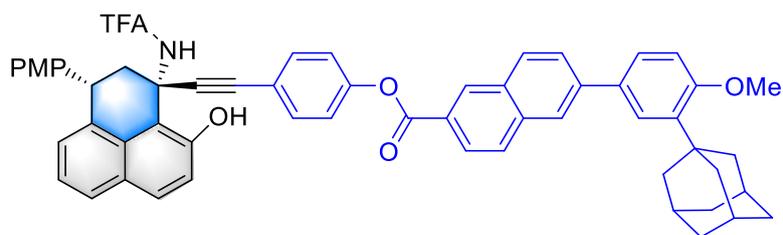
**3ai:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



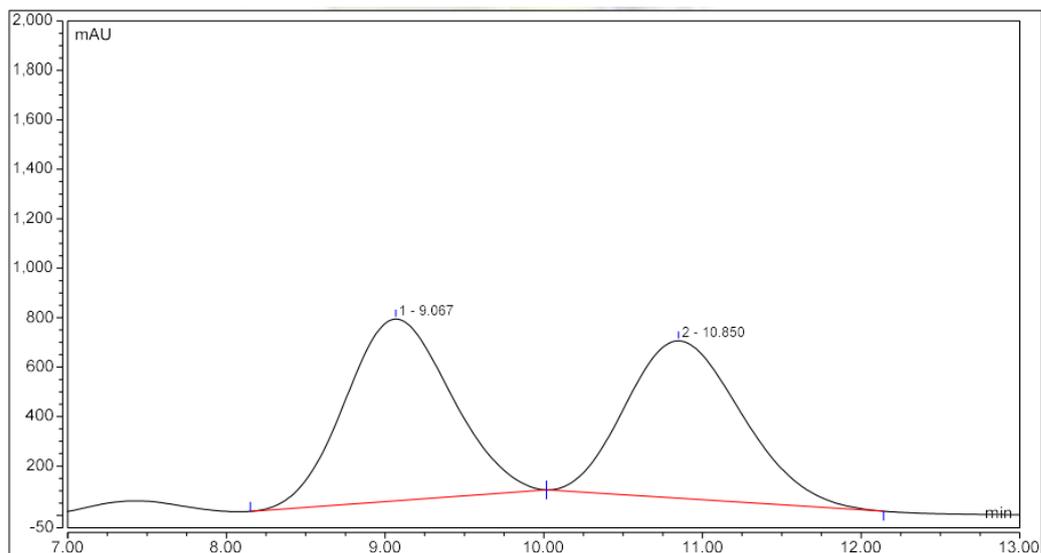
Peak Information							
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %		
1	13.933	168.730	252.515	50.24	67.58		
2	29.433	167.099	121.133	49.76	32.42		
<b>Sum:</b>		<b>335.829</b>	<b>373.648</b>	<b>100.00</b>	<b>100.00</b>		



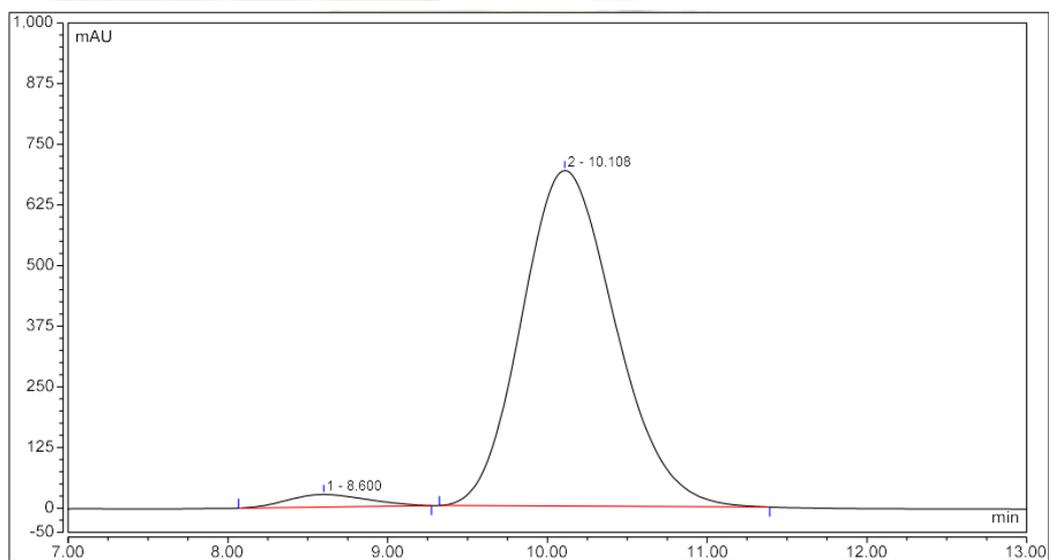
Peak Information							
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %		
1	13.925	1822.267	4065.161	95.98	98.22		
2	29.733	76.230	73.745	4.02	1.78		
<b>Sum:</b>		<b>1898.496</b>	<b>4138.906</b>	<b>100.00</b>	<b>100.00</b>		



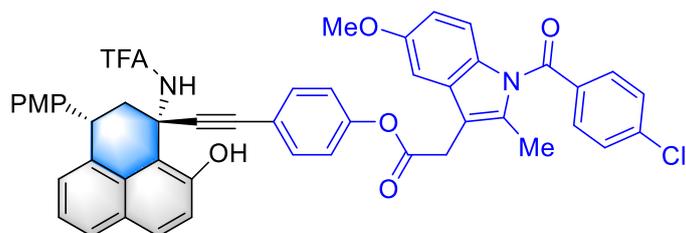
**3aj**: IG, *n*-hexane/2-propanol = 70/30,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ,  $40 \text{ }^\circ\text{C}$



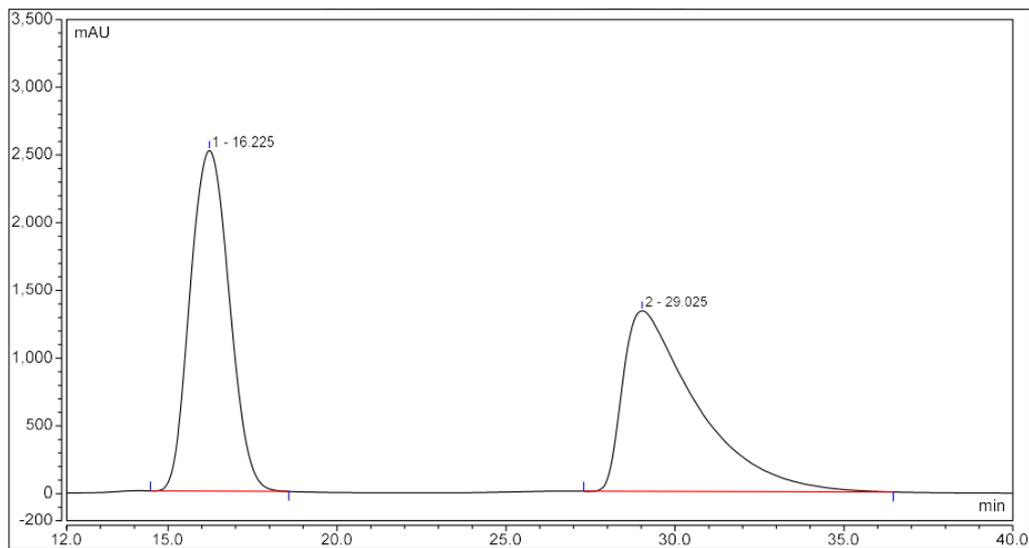
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.067	570.466	735.009	51.39	53.58	
2	10.850	539.618	636.798	48.61	46.42	
<b>Sum:</b>		<b>1110.085</b>	<b>1371.807</b>	<b>100.00</b>	<b>100.00</b>	



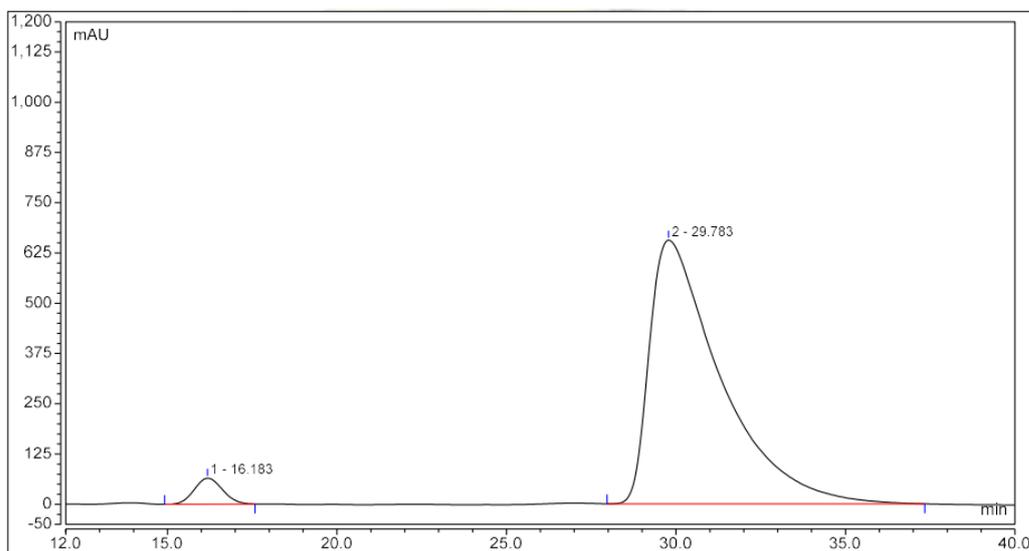
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.600	15.003	25.924	3.10	3.61	
2	10.108	469.606	691.584	96.90	96.39	
<b>Sum:</b>		<b>484.609</b>	<b>717.508</b>	<b>100.00</b>	<b>100.00</b>	



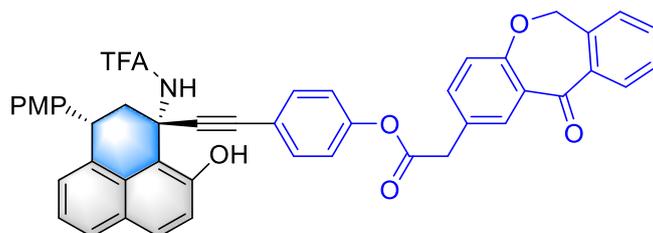
**3ak:** IG, *n*-hexane/2-propanol = 70/30,  $v = 1.0 \text{ mL}\cdot\text{min}^{-1}$ ,  $\lambda = 220\text{nm}$ ,  $40^\circ\text{C}$



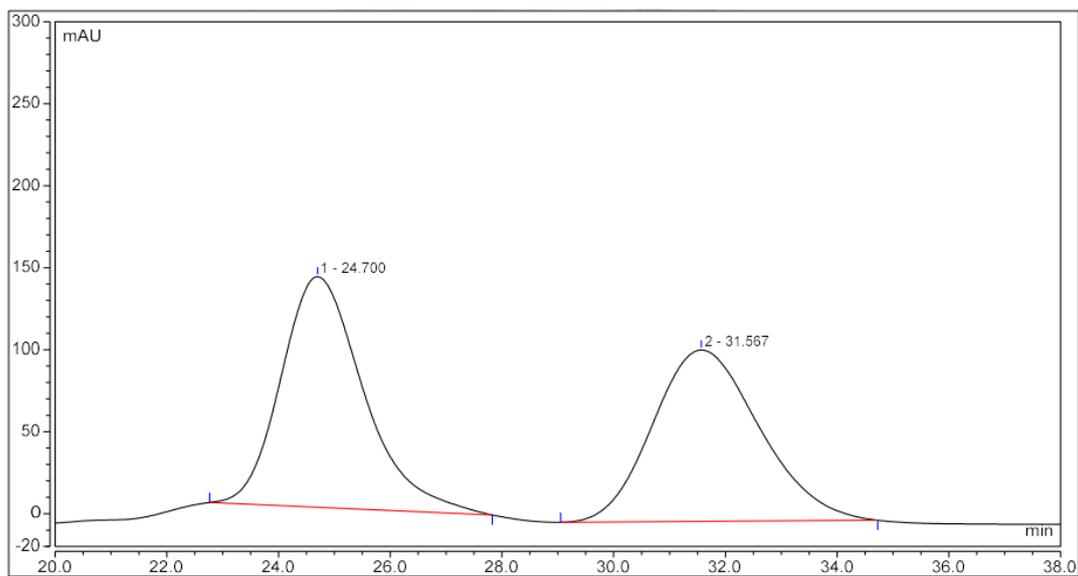
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	16.225	3377.139	2514.465	50.01	65.35	
2	29.025	3375.425	1333.084	49.99	34.65	
<b>Sum:</b>		<b>6752.564</b>	<b>3847.549</b>	<b>100.00</b>	<b>100.00</b>	



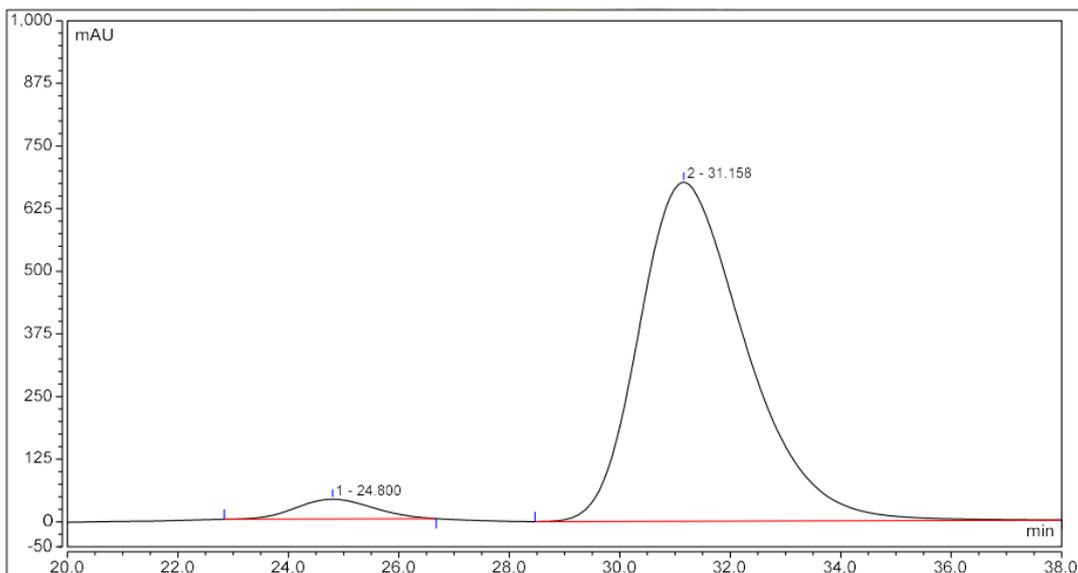
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	16.183	62.700	64.877	3.78	9.00	
2	29.783	1594.102	655.822	96.22	91.00	
<b>Sum:</b>		<b>1656.802</b>	<b>720.699</b>	<b>100.00</b>	<b>100.00</b>	



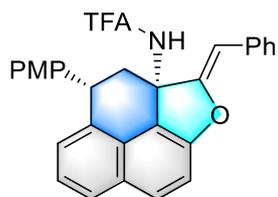
**3al:** IG, *n*-hexane/2-propanol = 70/30,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$ ,  $40^\circ\text{C}$



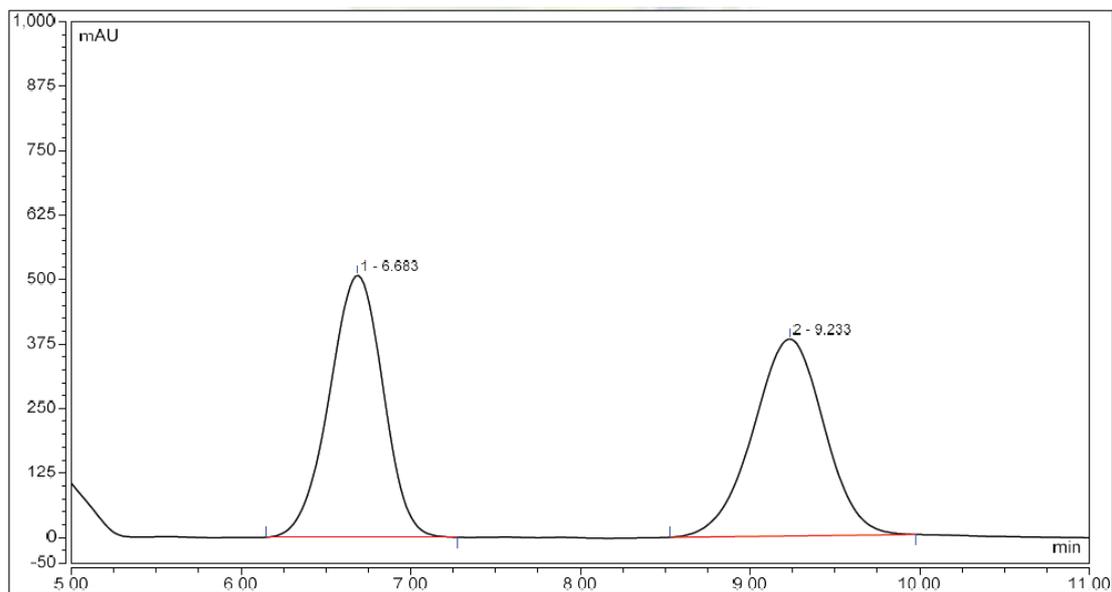
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	24.700	240.840	140.524	51.00	57.36	
2	31.567	231.379	104.469	49.00	42.64	
<b>Sum:</b>		<b>472.218</b>	<b>244.993</b>	<b>100.00</b>	<b>100.00</b>	



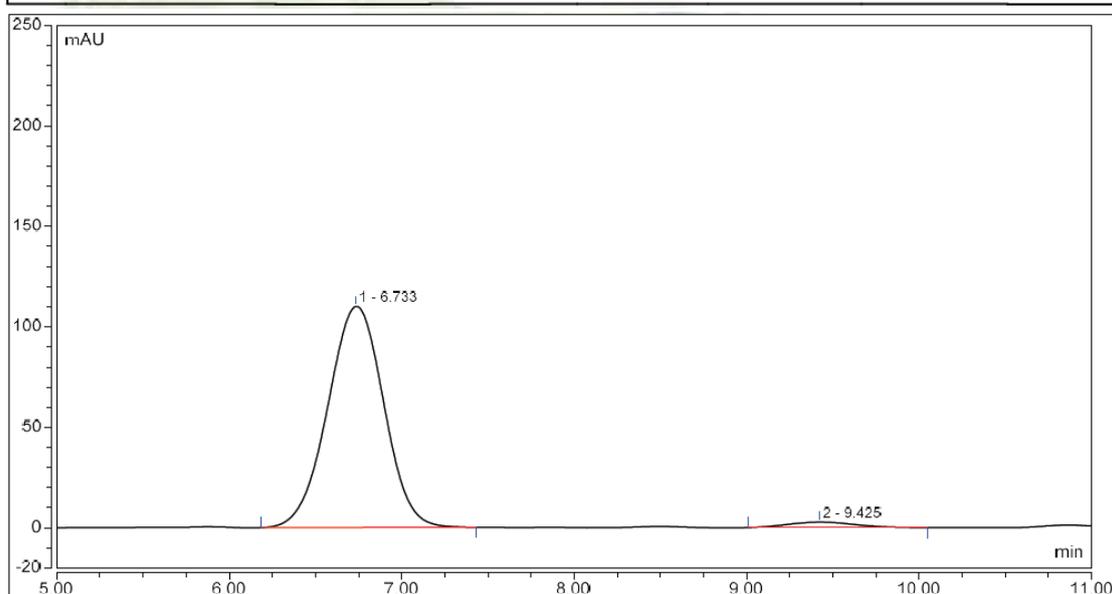
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	24.800	63.934	39.409	4.06	5.51	
2	31.158	1509.129	676.317	95.94	94.49	
<b>Sum:</b>		<b>1573.063</b>	<b>715.726</b>	<b>100.00</b>	<b>100.00</b>	



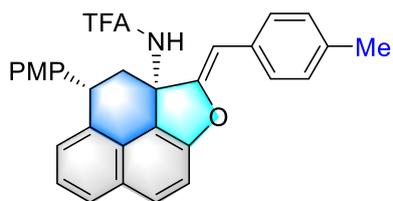
4a: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



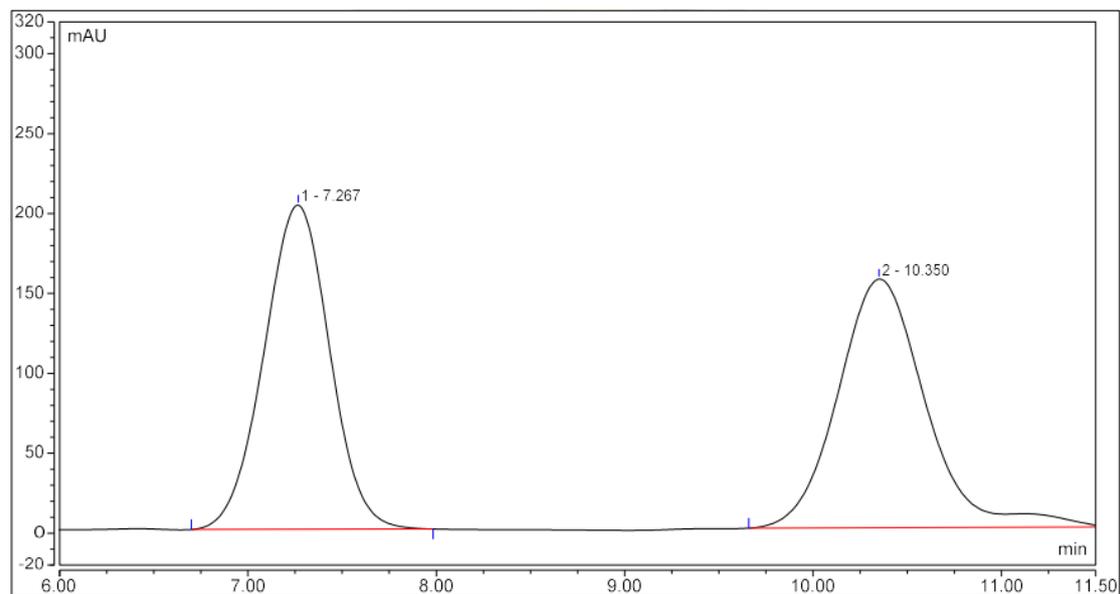
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.683	186.506	507.531	50.19	57.06	
2	9.233	185.129	381.957	49.81	42.94	
<b>Sum:</b>		<b>371.635</b>	<b>889.488</b>	<b>100.00</b>	<b>100.00</b>	



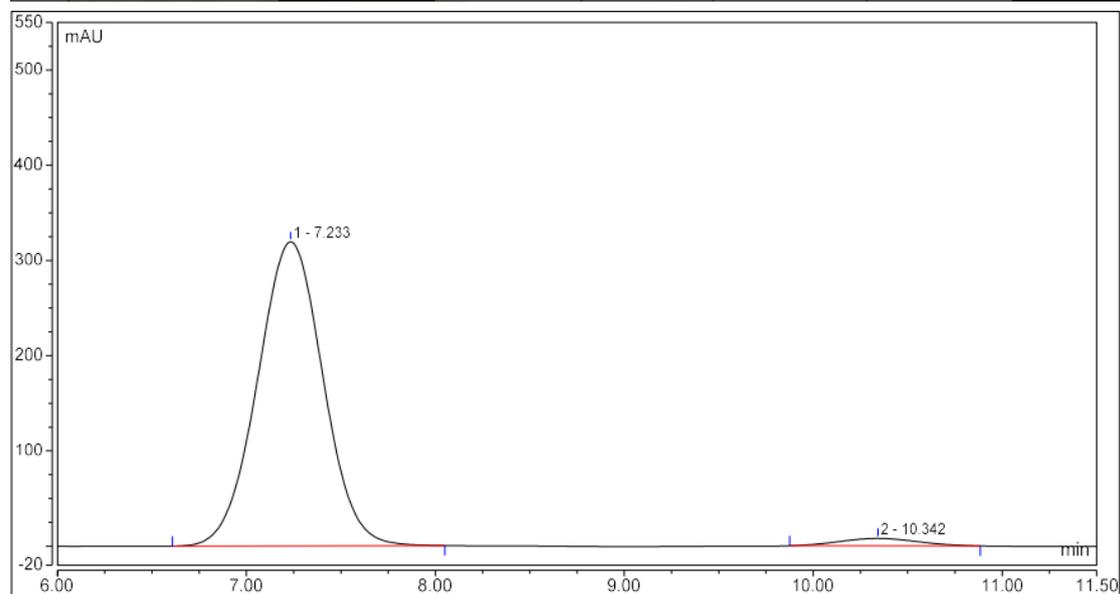
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.733	41.435	110.045	97.14	97.56	
2	9.425	1.219	2.750	2.86	2.44	
<b>Sum:</b>		<b>42.654</b>	<b>112.795</b>	<b>100.00</b>	<b>100.00</b>	



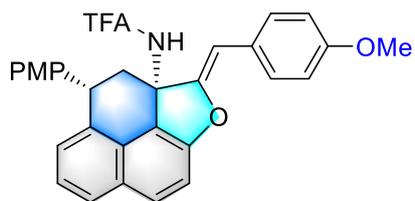
**4b:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



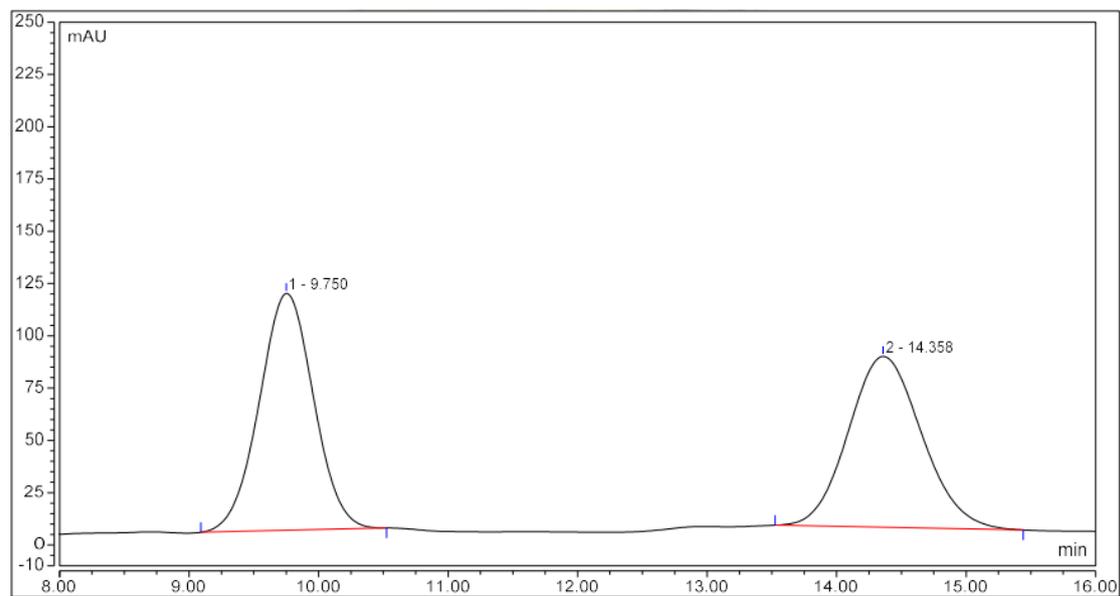
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.267	82.013	202.785	49.37	56.59	
2	10.350	84.108	155.536	50.63	43.41	
<b>Sum:</b>		<b>166.121</b>	<b>358.321</b>	<b>100.00</b>	<b>100.00</b>	



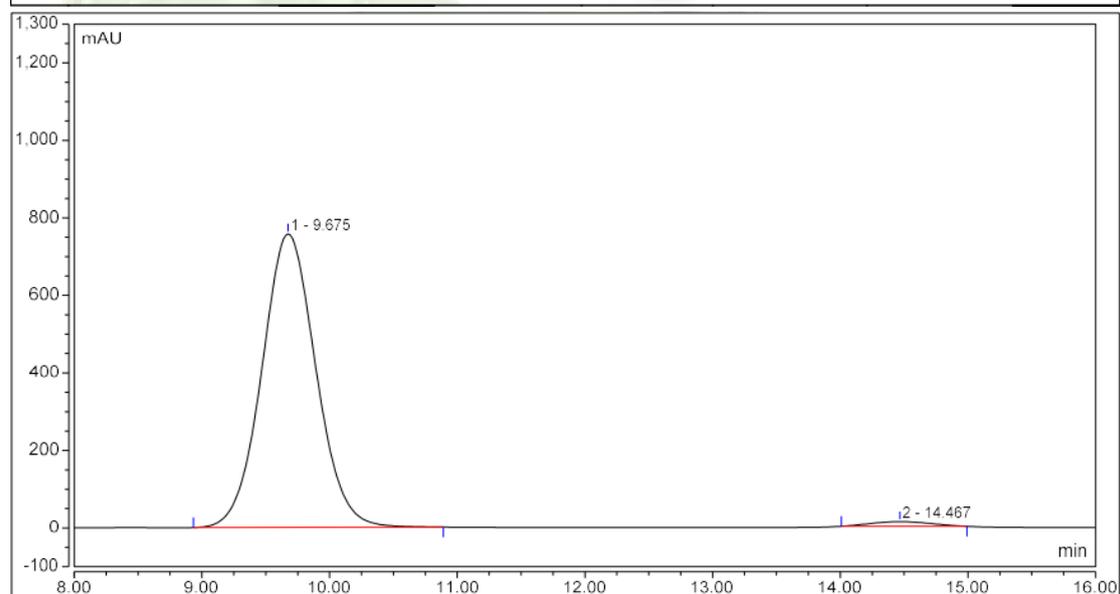
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.233	128.326	319.286	97.19	97.62	
2	10.342	3.712	7.781	2.81	2.38	
<b>Sum:</b>		<b>132.039</b>	<b>327.068</b>	<b>100.00</b>	<b>100.00</b>	



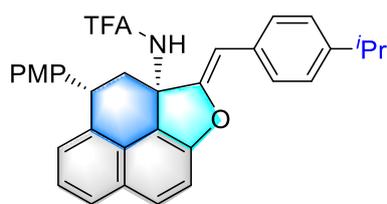
4c: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



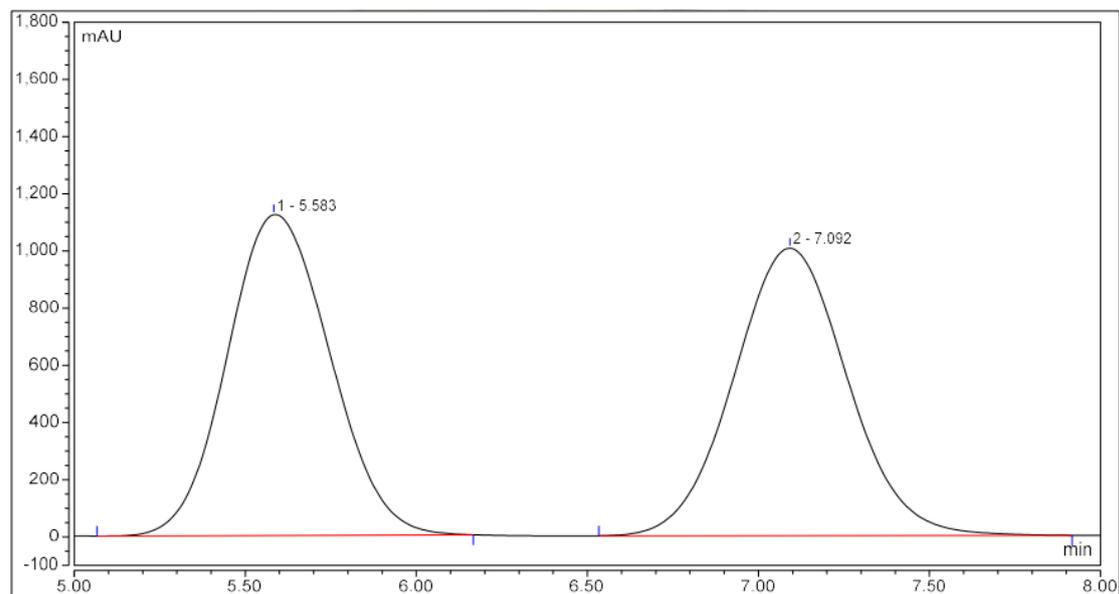
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.750	55.098	113.315	50.61	58.10	
2	14.358	53.780	81.710	49.39	41.90	
<b>Sum:</b>		<b>108.879</b>	<b>195.025</b>	<b>100.00</b>	<b>100.00</b>	



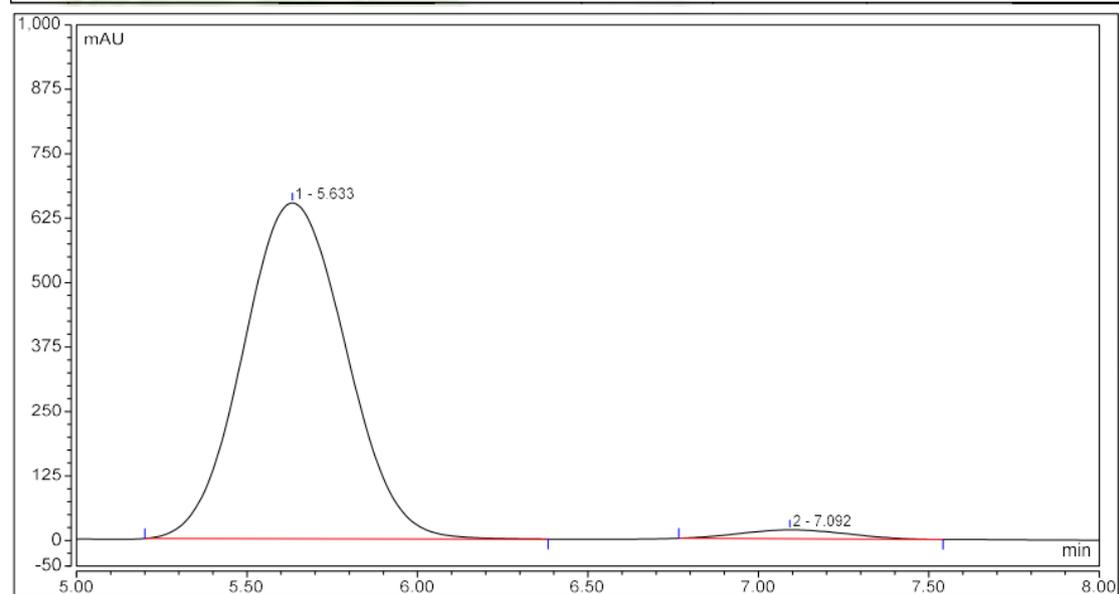
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	9.675	371.168	757.385	98.28	98.45	
2	14.467	6.483	11.958	1.72	1.55	
<b>Sum:</b>		<b>377.651</b>	<b>769.343</b>	<b>100.00</b>	<b>100.00</b>	



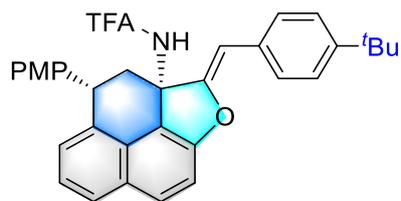
**4d:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



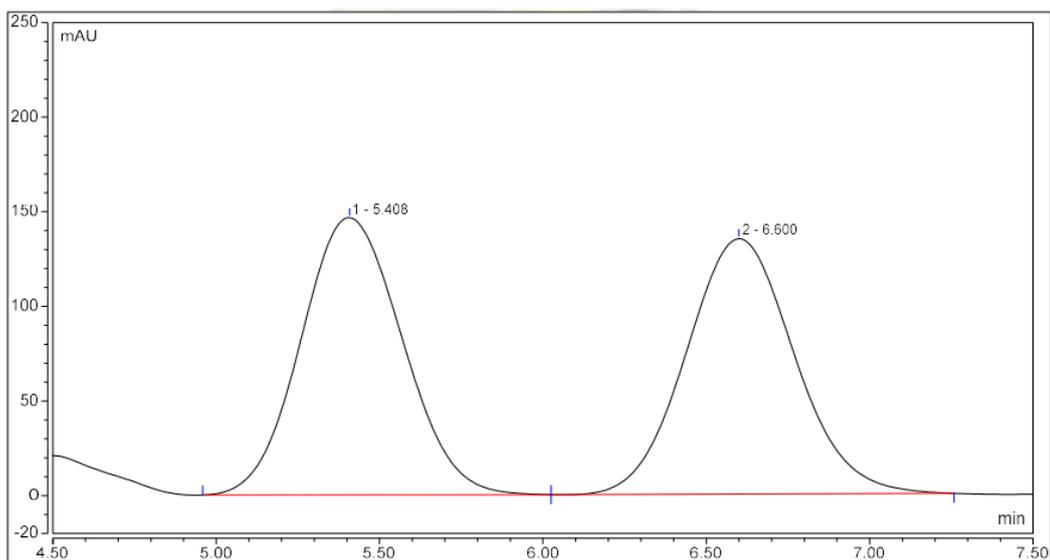
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	5.583	391.057	1121.979	50.22	52.75	
2	7.092	387.630	1005.071	49.78	47.25	
<b>Sum:</b>		<b>778.687</b>	<b>2127.050</b>	<b>100.00</b>	<b>100.00</b>	



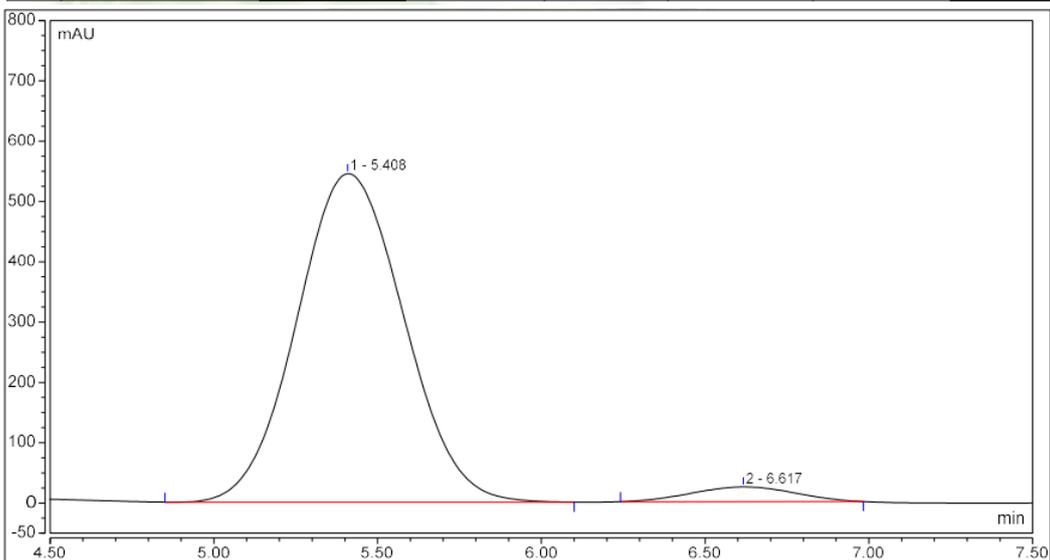
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	5.633	227.582	651.377	97.32	97.41	
2	7.092	6.261	17.319	2.68	2.59	
<b>Sum:</b>		<b>233.843</b>	<b>668.696</b>	<b>100.00</b>	<b>100.00</b>	



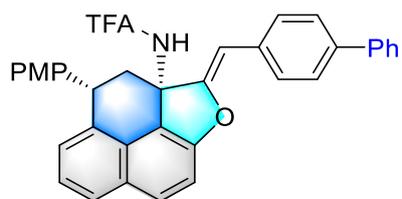
4e: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



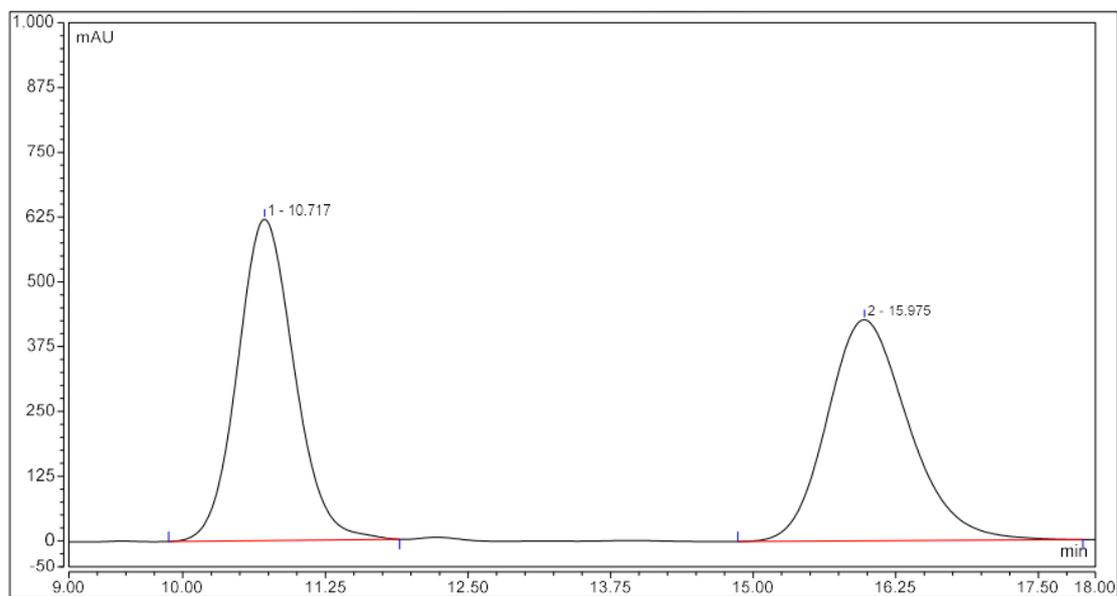
Peak Information							
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %		
1	5.408	52.608	146.505	50.43	52.06		
2	6.600	51.705	134.928	49.57	47.94		
<b>Sum:</b>		<b>104.313</b>	<b>281.433</b>	<b>100.00</b>	<b>100.00</b>		



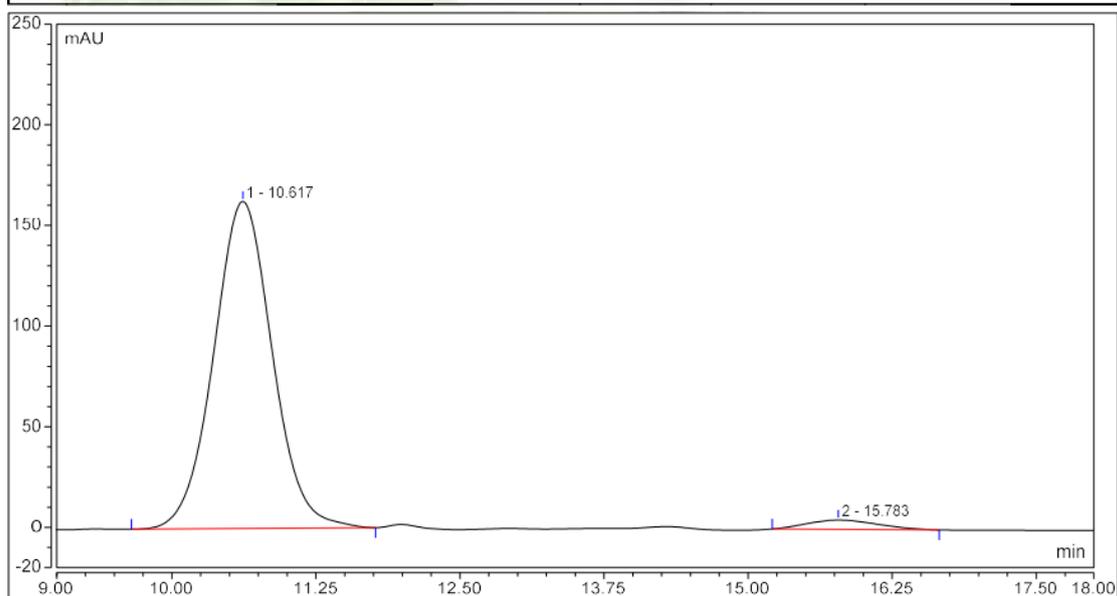
Peak Information							
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %		
1	5.408	206.294	544.463	95.88	95.72		
2	6.617	8.875	24.346	4.12	4.28		
<b>Sum:</b>		<b>215.169</b>	<b>568.809</b>	<b>100.00</b>	<b>100.00</b>		



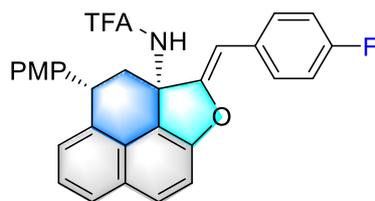
4f: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



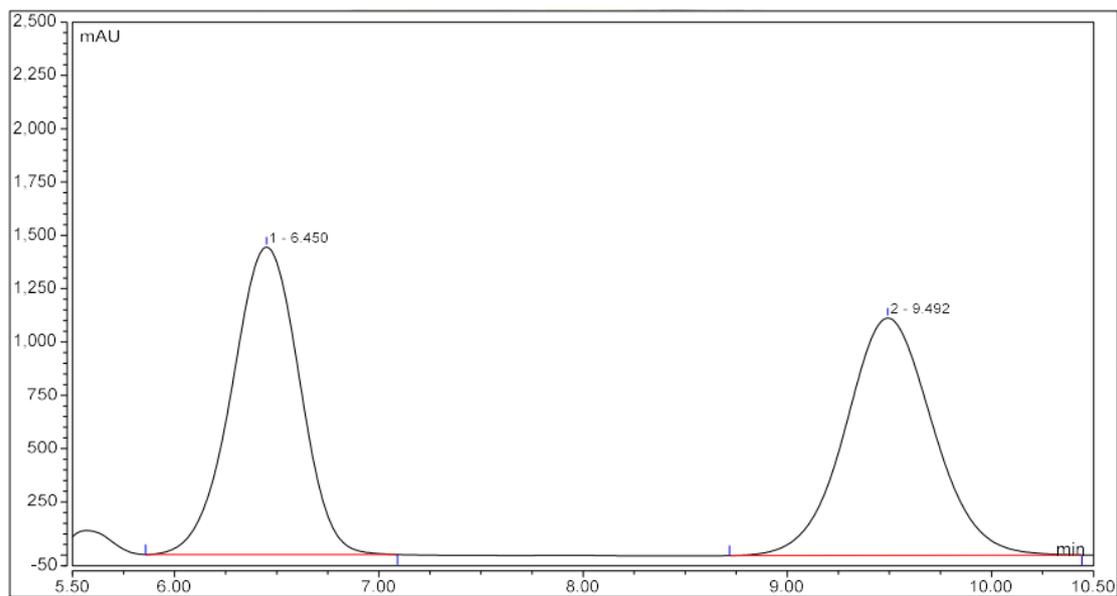
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	10.717	357.879	620.259	50.31	59.24	
2	15.975	353.451	426.689	49.69	40.76	
<b>Sum:</b>		<b>711.329</b>	<b>1046.949</b>	<b>100.00</b>	<b>100.00</b>	



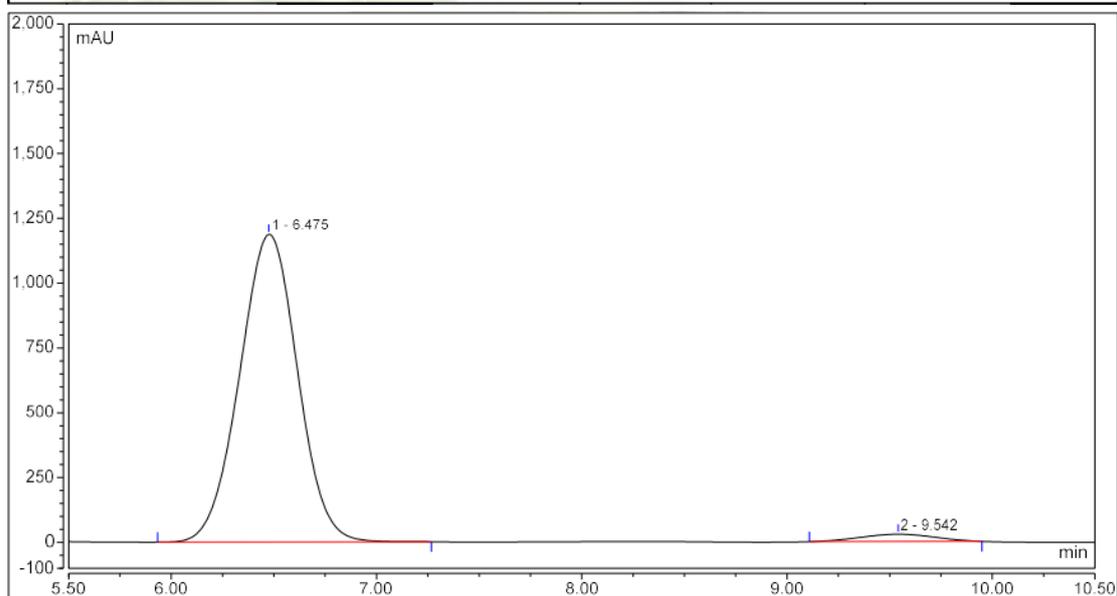
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	10.617	95.863	162.521	96.71	97.25	
2	15.783	3.265	4.591	3.29	2.75	
<b>Sum:</b>		<b>99.128</b>	<b>167.112</b>	<b>100.00</b>	<b>100.00</b>	



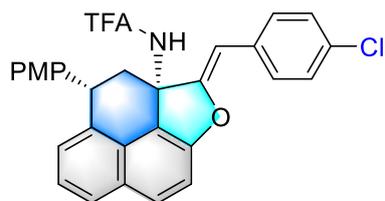
**4g:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



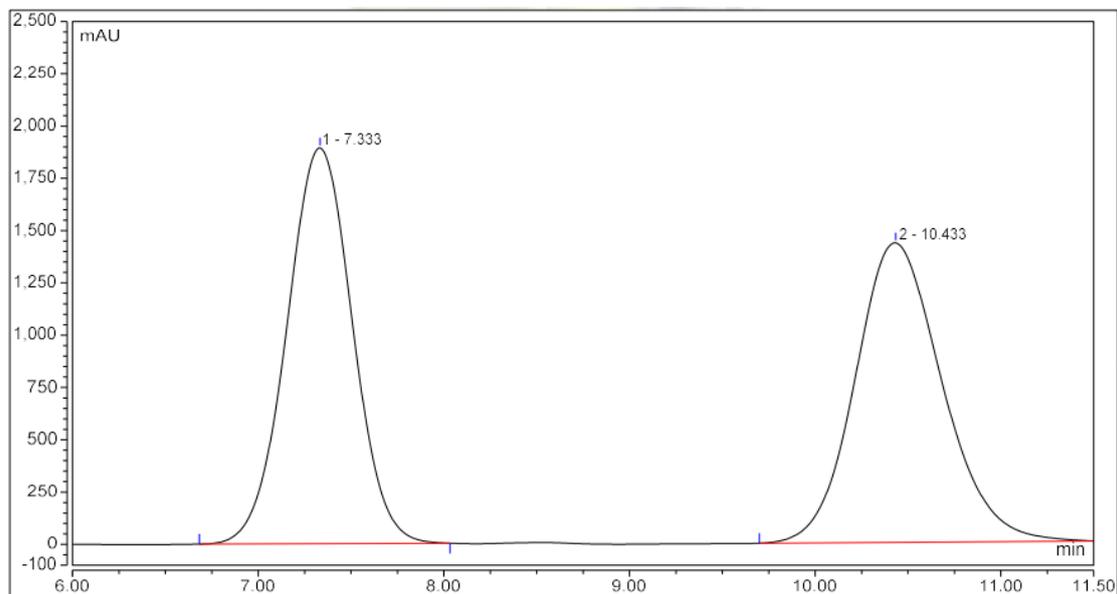
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.450	554.219	1441.568	50.04	56.43	
2	9.492	553.270	1112.957	49.96	43.57	
<b>Sum:</b>		<b>1107.490</b>	<b>2554.525</b>	<b>100.00</b>	<b>100.00</b>	



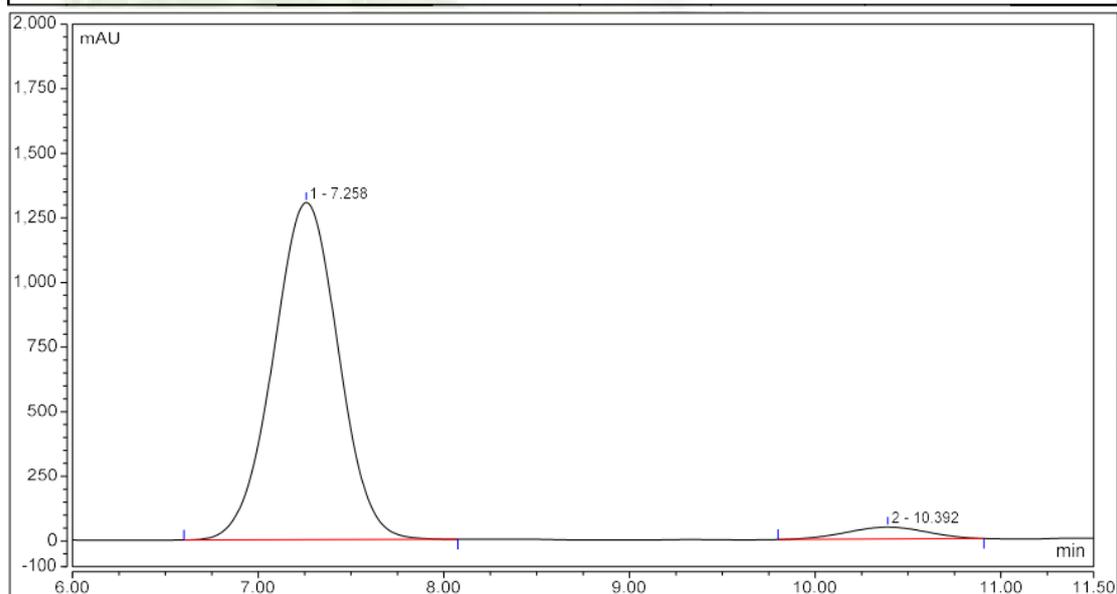
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.475	388.793	1186.954	97.06	97.68	
2	9.542	11.779	28.187	2.94	2.32	
<b>Sum:</b>		<b>400.572</b>	<b>1215.141</b>	<b>100.00</b>	<b>100.00</b>	



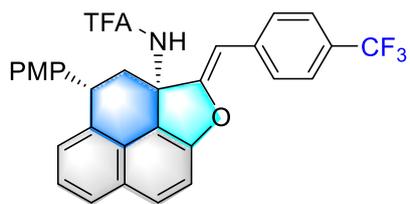
**4h:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



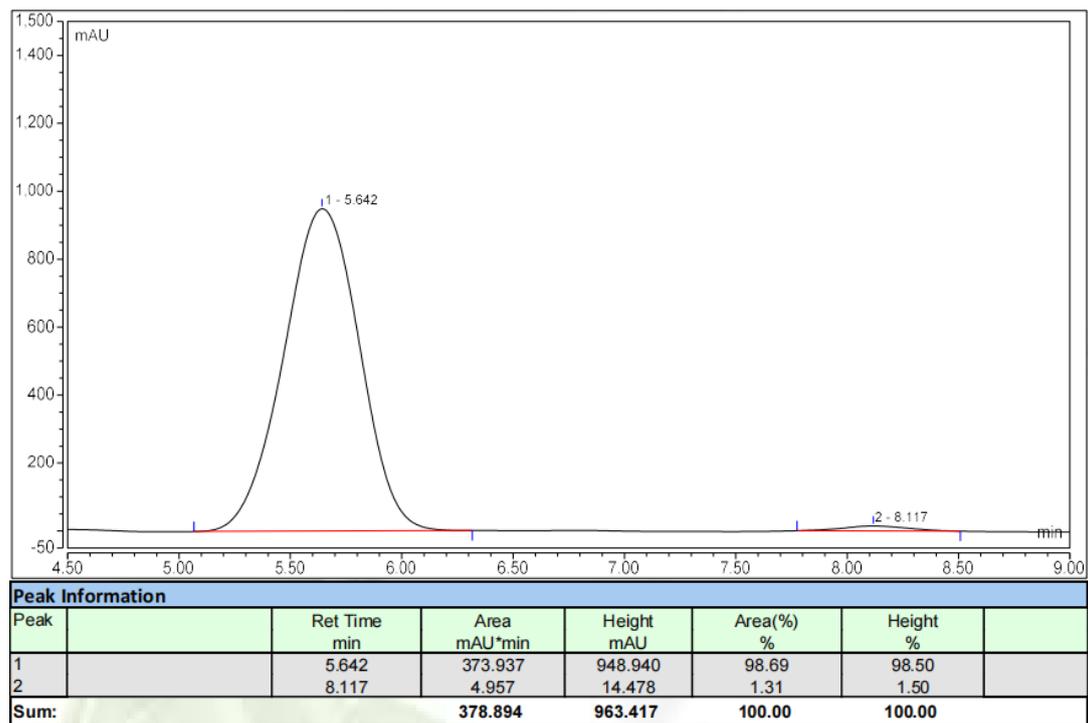
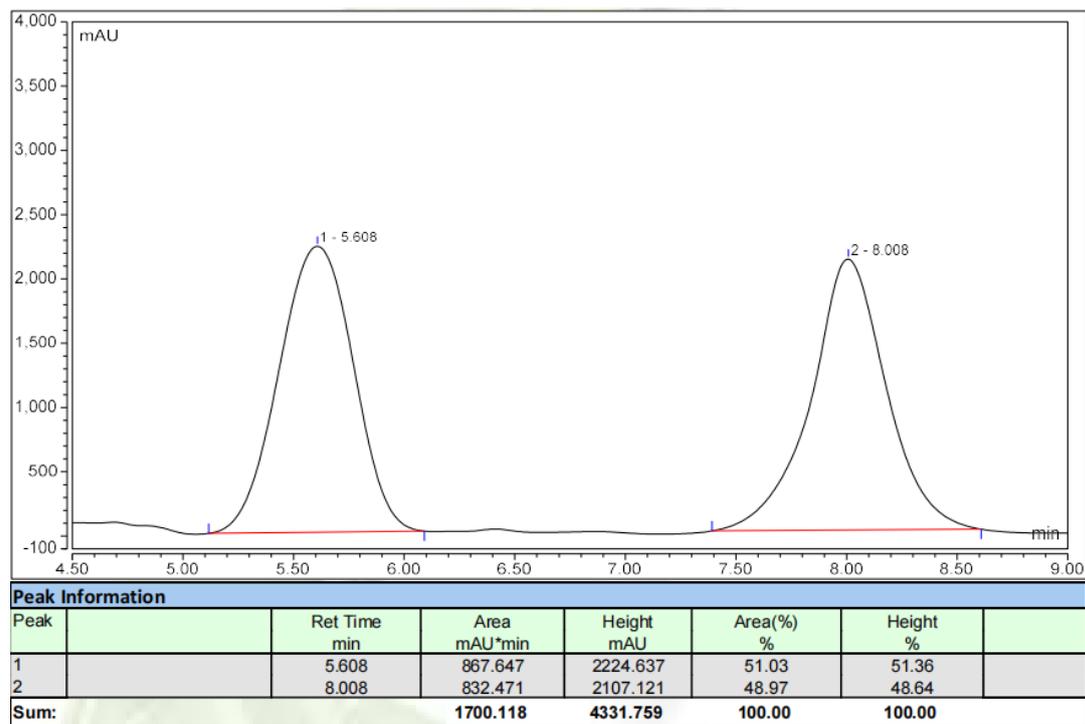
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.333	775.491	1891.149	49.97	56.92	
2	10.433	776.272	1431.412	50.03	43.08	
<b>Sum:</b>		<b>1551.763</b>	<b>3322.561</b>	<b>100.00</b>	<b>100.00</b>	

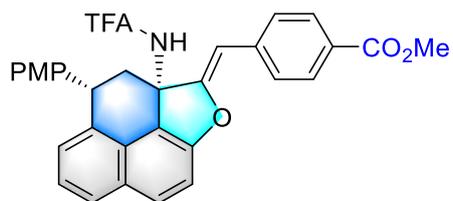


Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.258	532.291	1305.026	95.83	96.60	
2	10.392	23.166	45.873	4.17	3.40	
<b>Sum:</b>		<b>555.457</b>	<b>1350.900</b>	<b>100.00</b>	<b>100.00</b>	

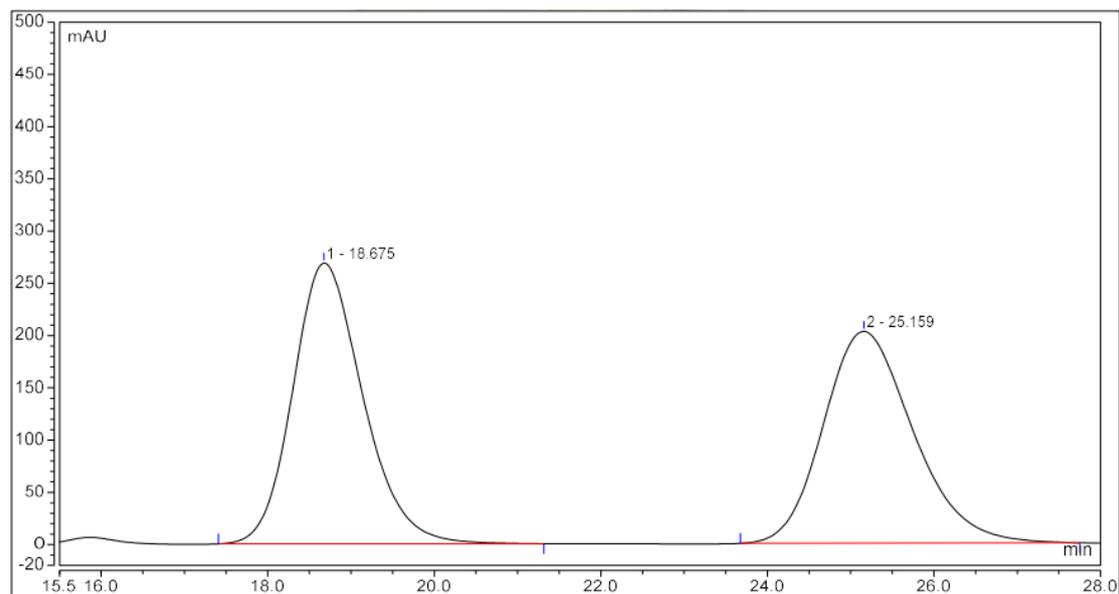


4i: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$

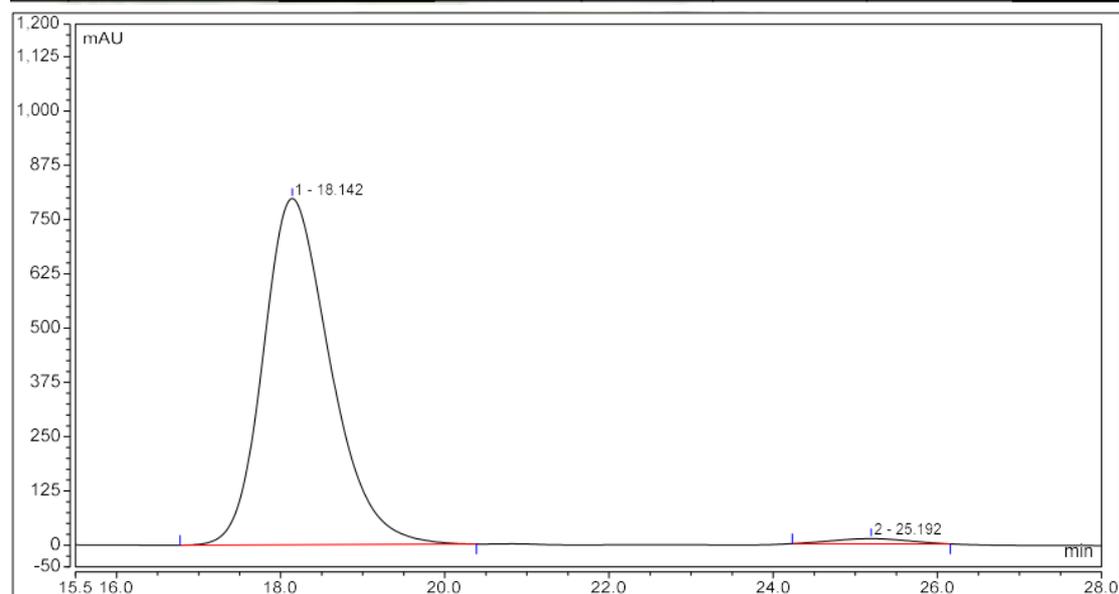




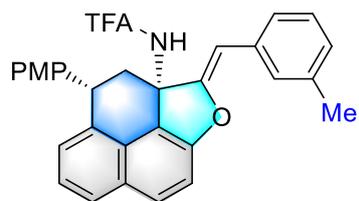
4j: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



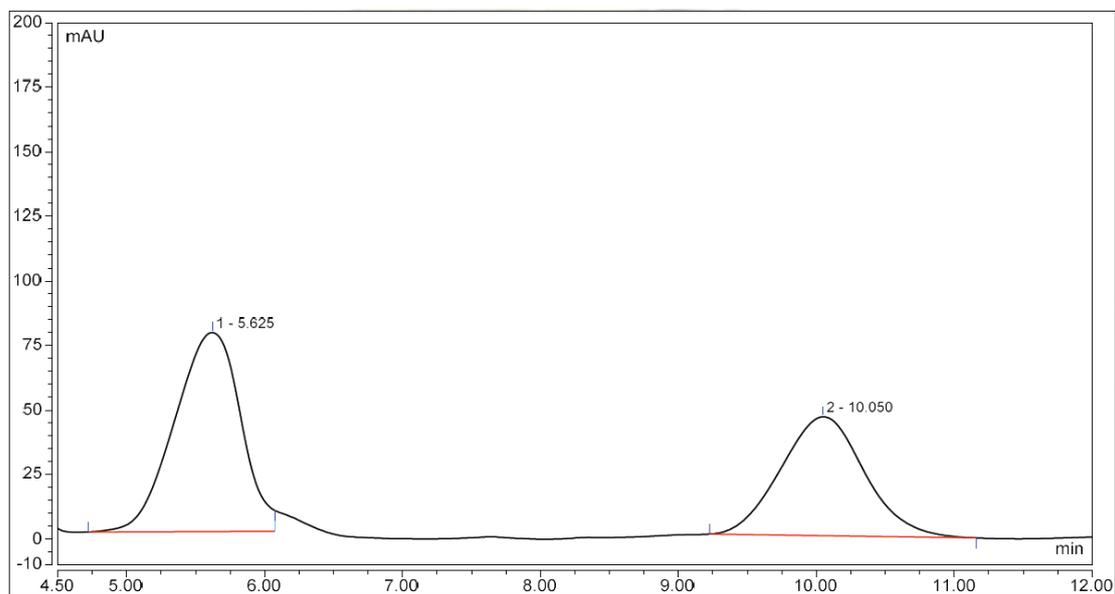
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	18.675	262.078	268.743	50.87	57.00	
2	25.159	253.117	202.699	49.13	43.00	
<b>Sum:</b>		<b>515.196</b>	<b>471.443</b>	<b>100.00</b>	<b>100.00</b>	



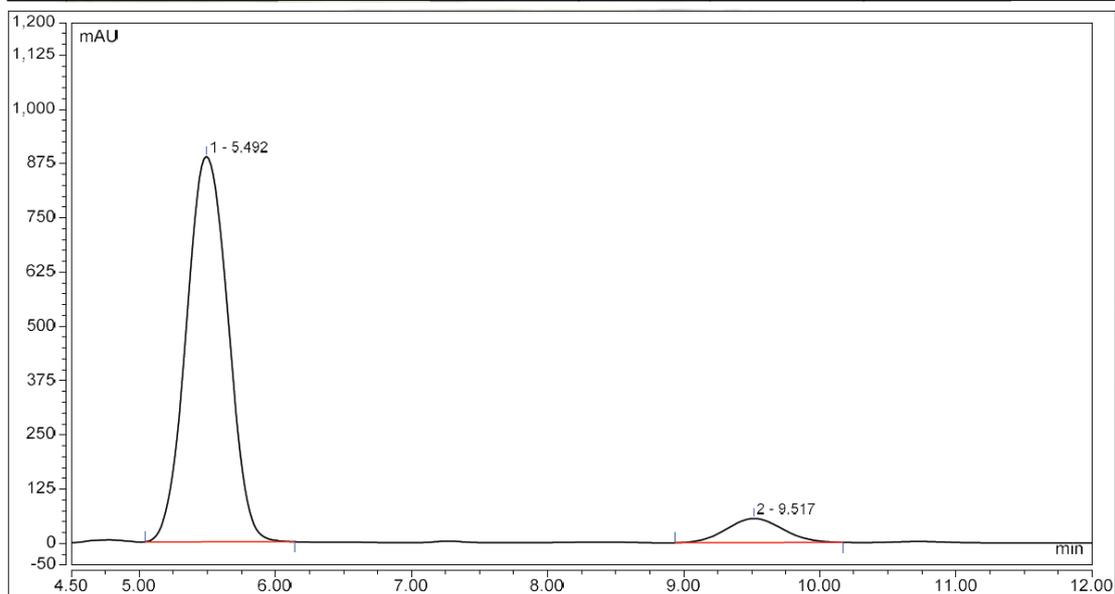
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	18.142	756.605	797.453	98.38	98.55	
2	25.192	12.459	11.752	1.62	1.45	
<b>Sum:</b>		<b>769.064</b>	<b>809.205</b>	<b>100.00</b>	<b>100.00</b>	



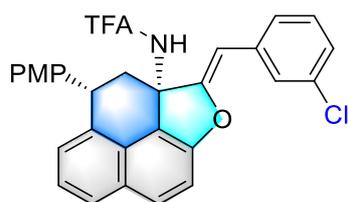
**4k:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



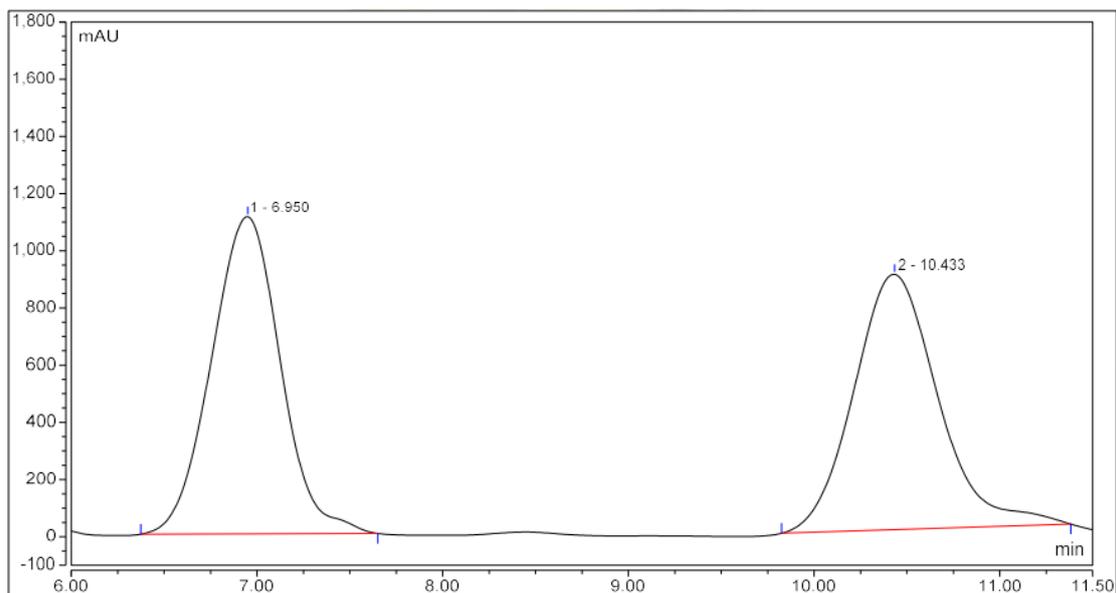
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	5.625	42.635	76.997	56.89	62.57	
2	10.050	32.309	46.056	43.11	37.43	
<b>Sum:</b>		<b>74.944</b>	<b>123.053</b>	<b>100.00</b>	<b>100.00</b>	



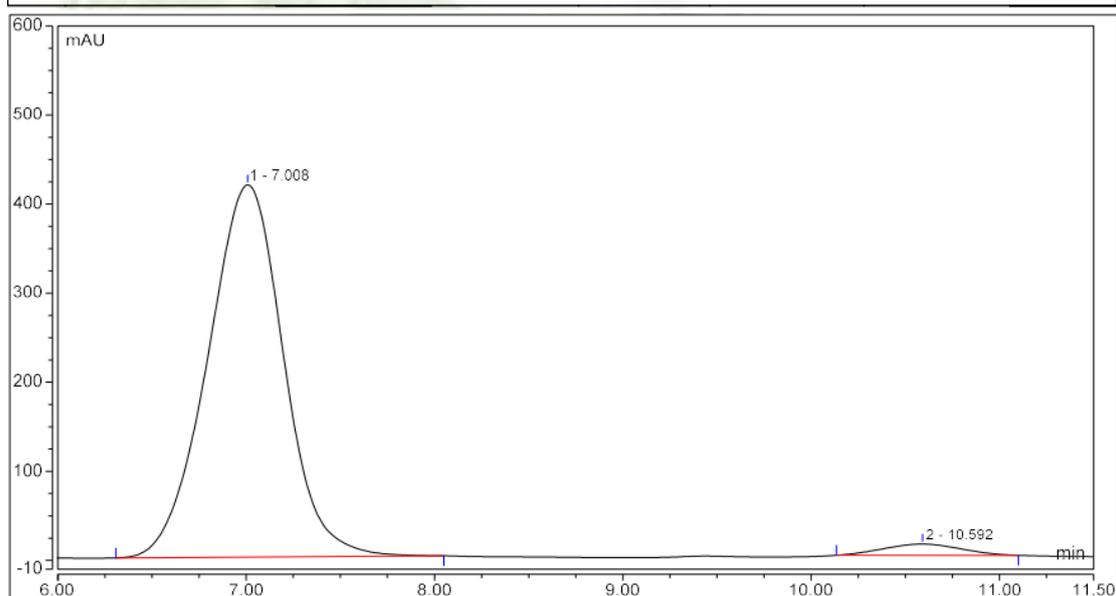
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	5.492	314.373	887.817	92.16	94.09	
2	9.517	26.759	55.741	7.84	5.91	
<b>Sum:</b>		<b>341.132</b>	<b>943.558</b>	<b>100.00</b>	<b>100.00</b>	



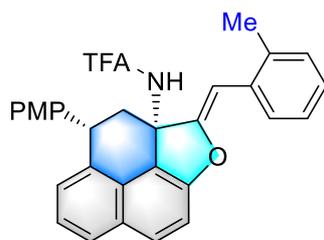
4I: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



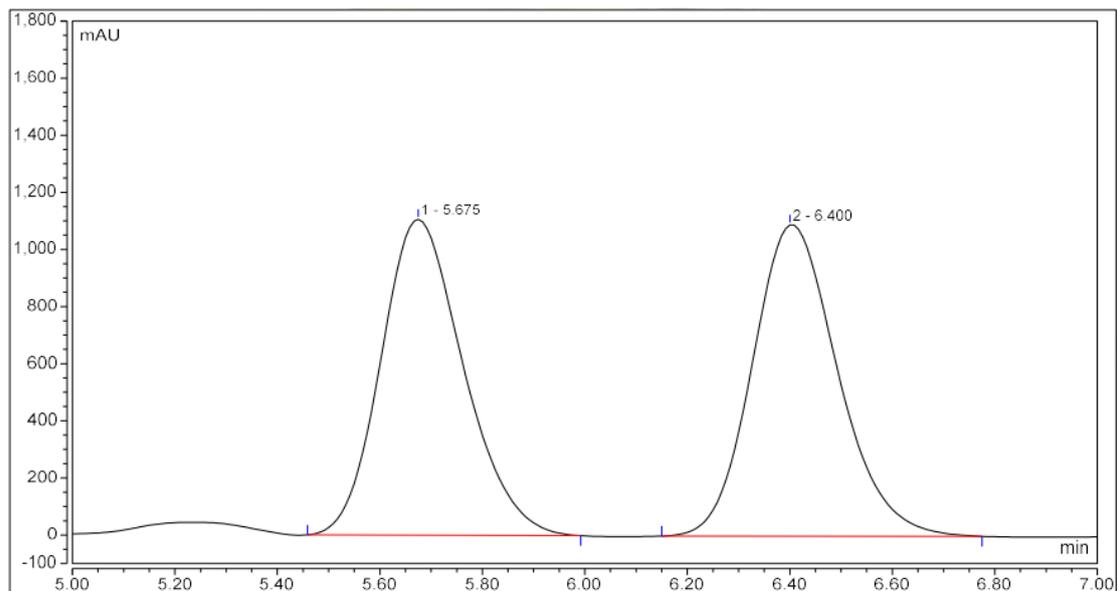
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.950	477.261	1109.081	50.39	55.40	
2	10.433	469.846	892.969	49.61	44.60	
<b>Sum:</b>		<b>947.108</b>	<b>2002.050</b>	<b>100.00</b>	<b>100.00</b>	



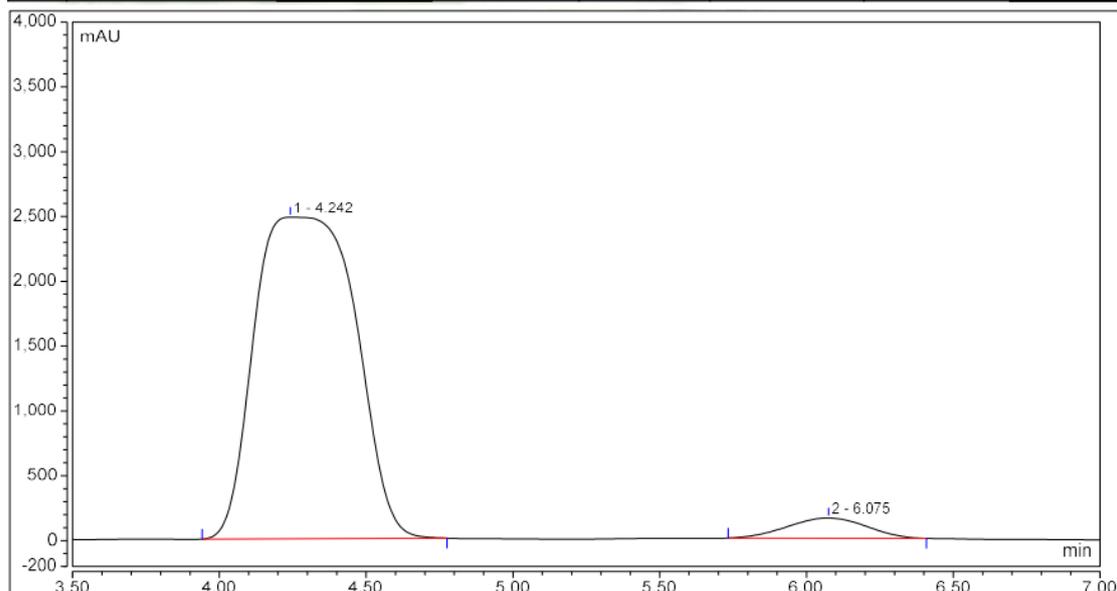
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.008	194.404	417.859	97.00	97.07	
2	10.592	6.013	12.629	3.00	2.93	
<b>Sum:</b>		<b>200.417</b>	<b>430.488</b>	<b>100.00</b>	<b>100.00</b>	



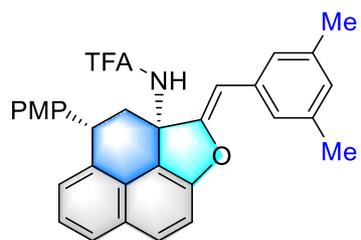
4m: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



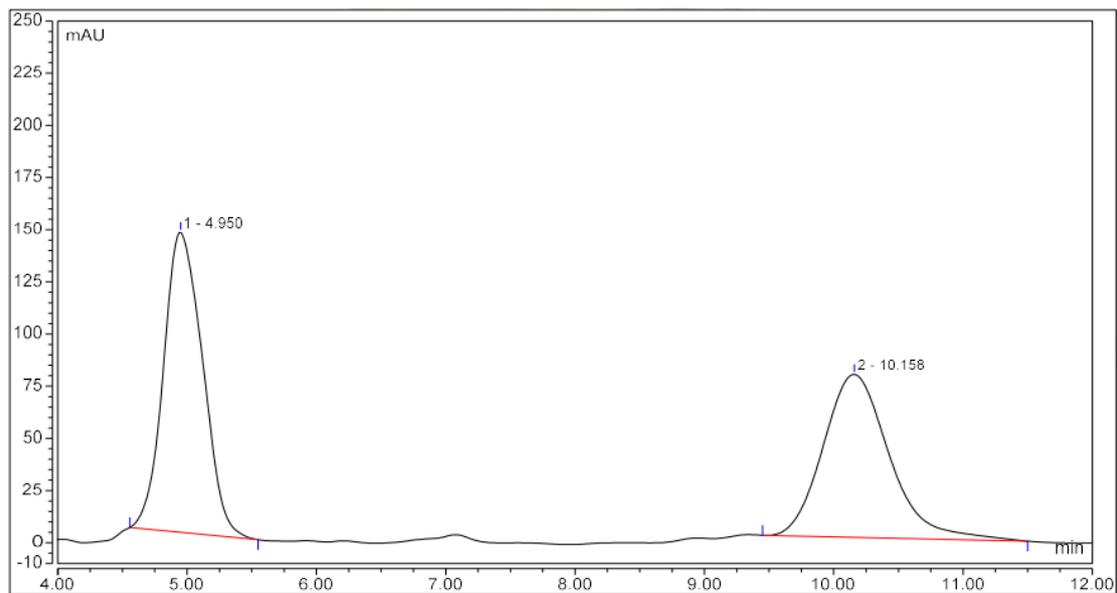
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	5.675	206.175	1106.322	49.50	50.37	
2	6.400	210.324	1089.908	50.50	49.63	
<b>Sum:</b>		<b>416.498</b>	<b>2196.230</b>	<b>100.00</b>	<b>100.00</b>	



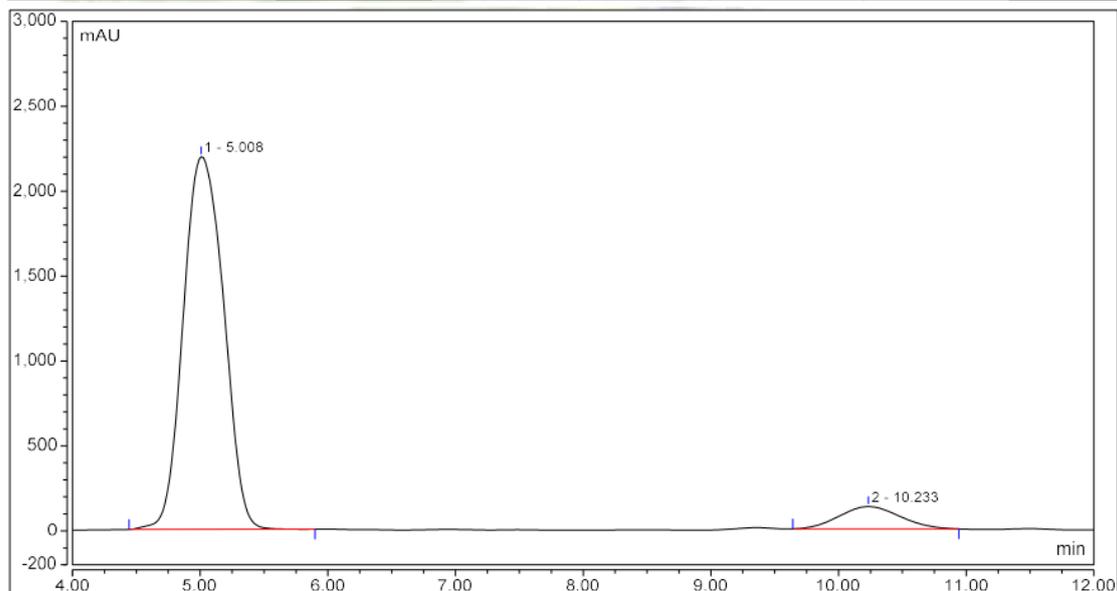
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	4.242	986.625	2480.750	95.30	94.08	
2	6.075	48.670	156.187	4.70	5.92	
<b>Sum:</b>		<b>1035.295</b>	<b>2636.938</b>	<b>100.00</b>	<b>100.00</b>	



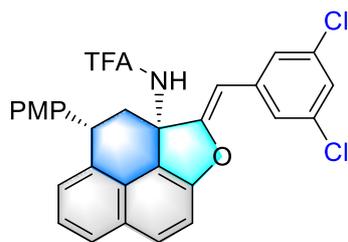
**4n:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



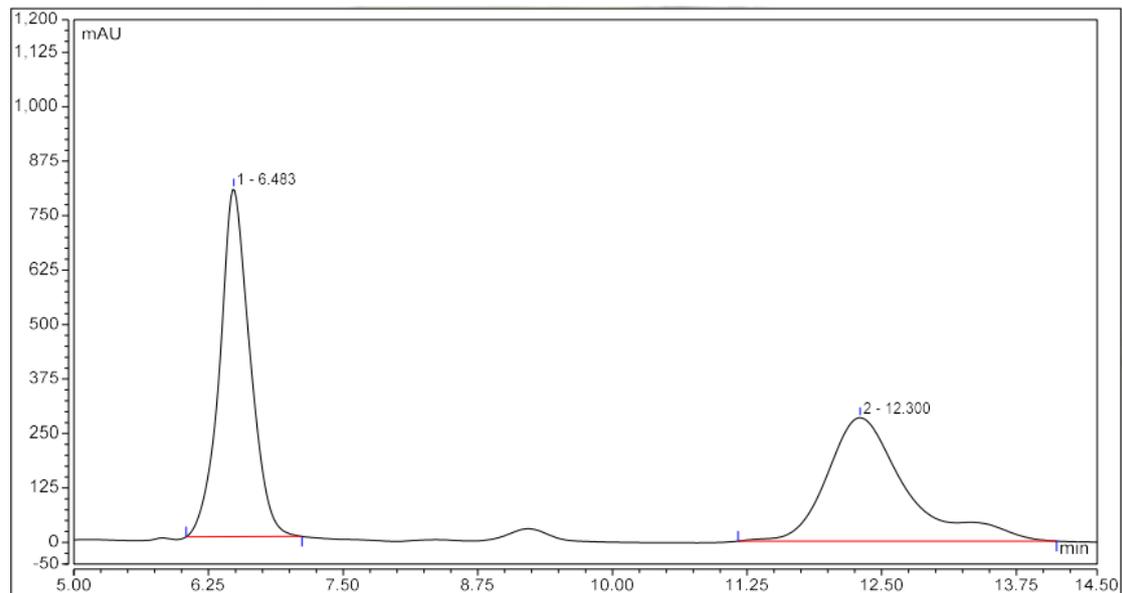
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	4.950	50.280	143.723	52.07	64.79	
2	10.158	46.285	78.103	47.93	35.21	
<b>Sum:</b>		<b>96.565</b>	<b>221.826</b>	<b>100.00</b>	<b>100.00</b>	



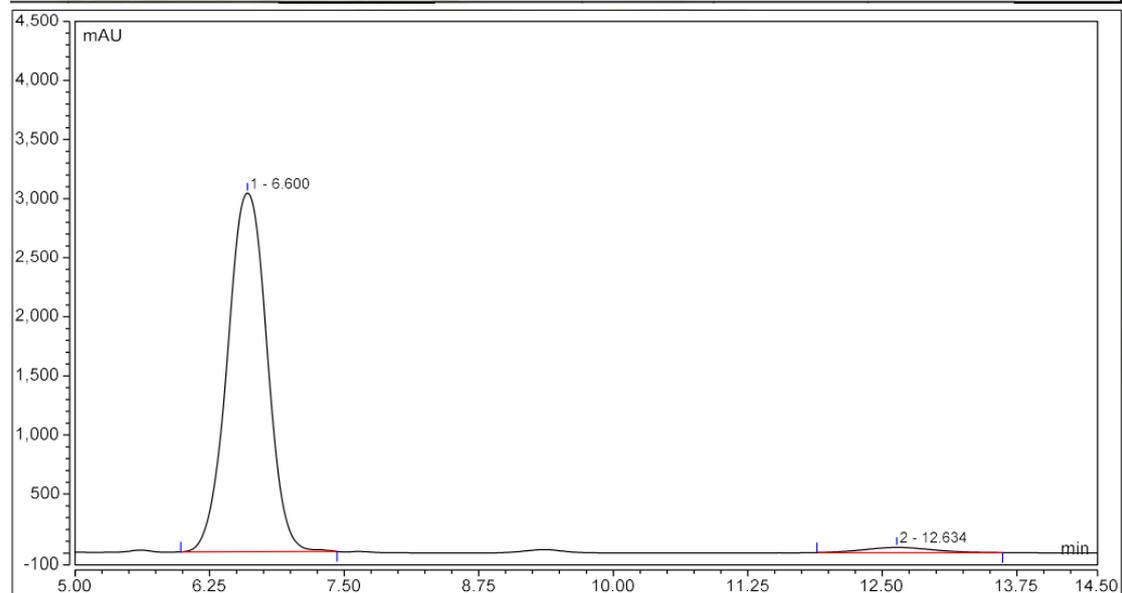
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	5.008	804.771	2194.355	91.68	94.33	
2	10.233	73.001	131.778	8.32	5.67	
<b>Sum:</b>		<b>877.773</b>	<b>2326.133</b>	<b>100.00</b>	<b>100.00</b>	



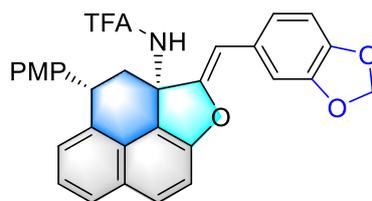
4o: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



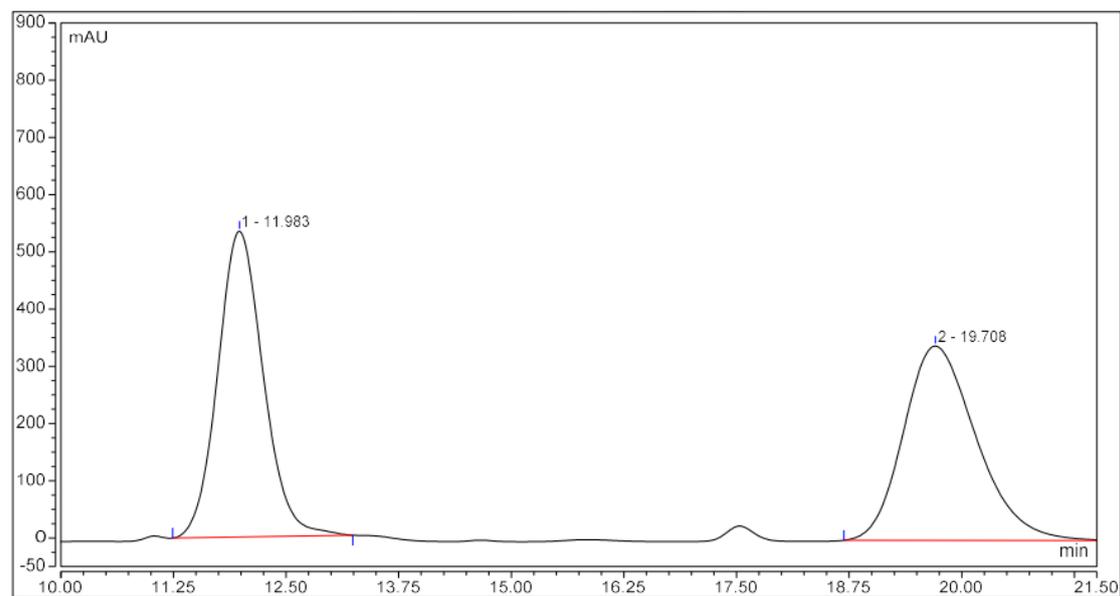
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	6.483	259.832	798.262	51.74	73.81	
2	12.300	242.322	283.301	48.26	26.19	
<b>Sum:</b>		<b>502.154</b>	<b>1081.563</b>	<b>100.00</b>	<b>100.00</b>	



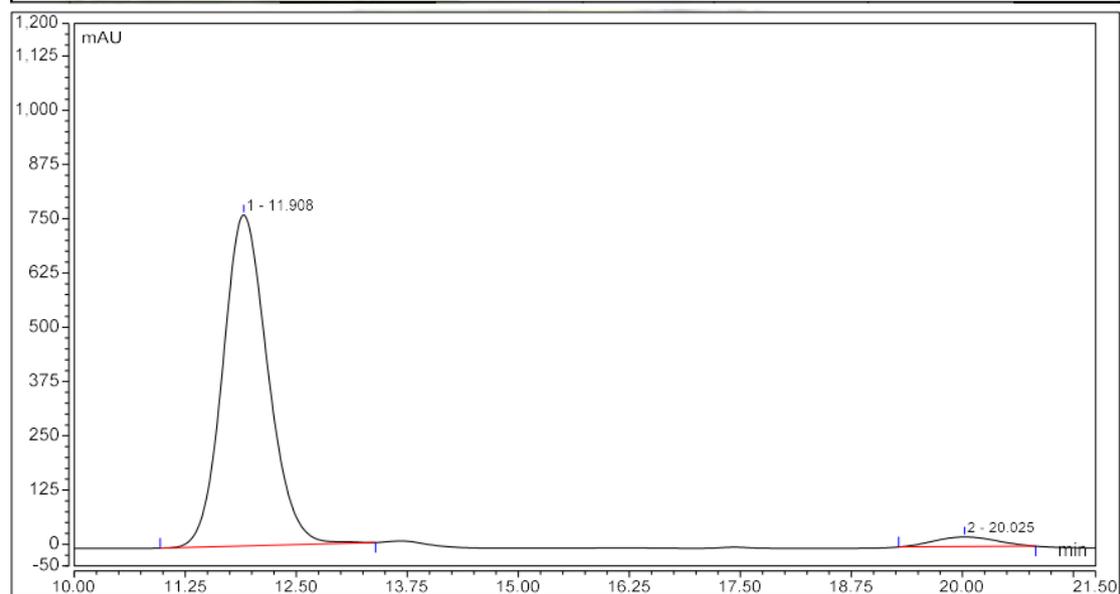
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	6.600	1292.923	3035.537	97.54	98.56	
2	12.634	32.566	44.264	2.46	1.44	
<b>Sum:</b>		<b>1325.489</b>	<b>3079.801</b>	<b>100.00</b>	<b>100.00</b>	



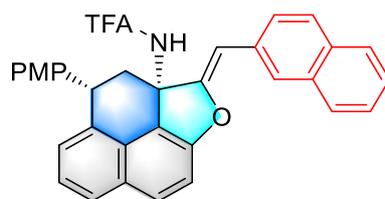
**4p:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



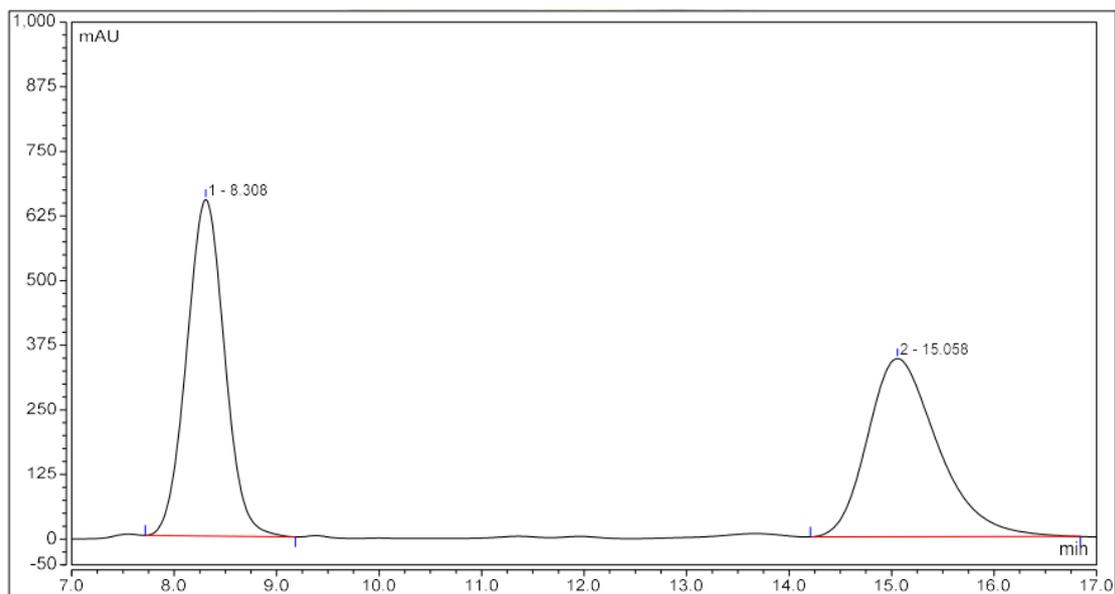
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	11.983	312.548	534.249	49.59	61.15	
2	19.708	317.718	339.438	50.41	38.85	
<b>Sum:</b>		<b>630.266</b>	<b>873.687</b>	<b>100.00</b>	<b>100.00</b>	



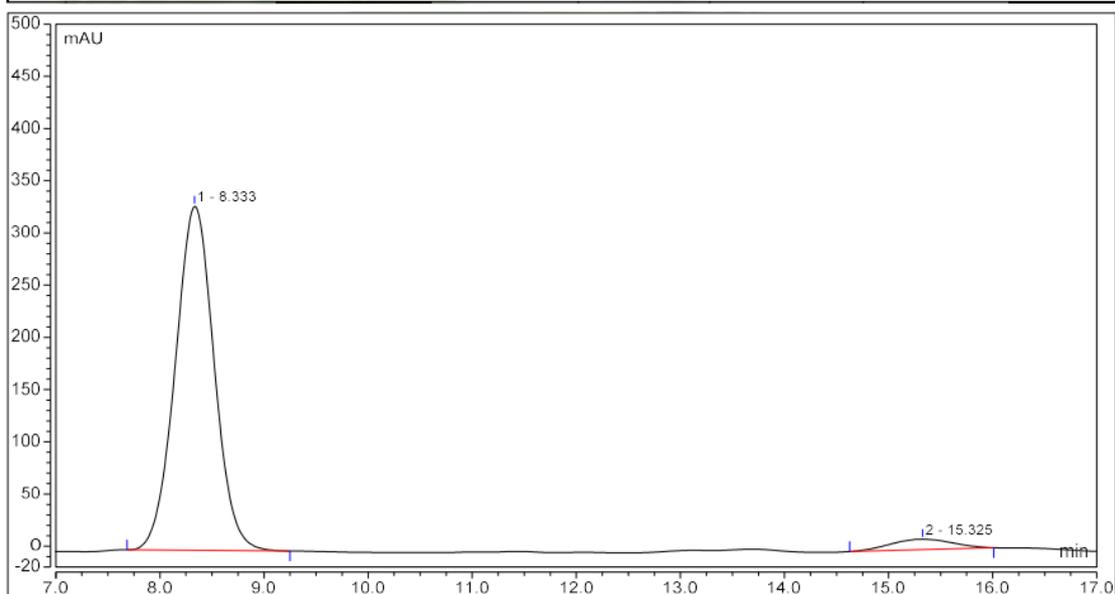
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	11.908	448.049	762.672	96.14	97.18	
2	20.025	17.979	22.113	3.86	2.82	
<b>Sum:</b>		<b>466.028</b>	<b>784.786</b>	<b>100.00</b>	<b>100.00</b>	



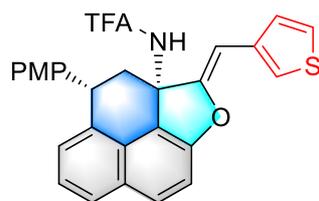
**4q:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



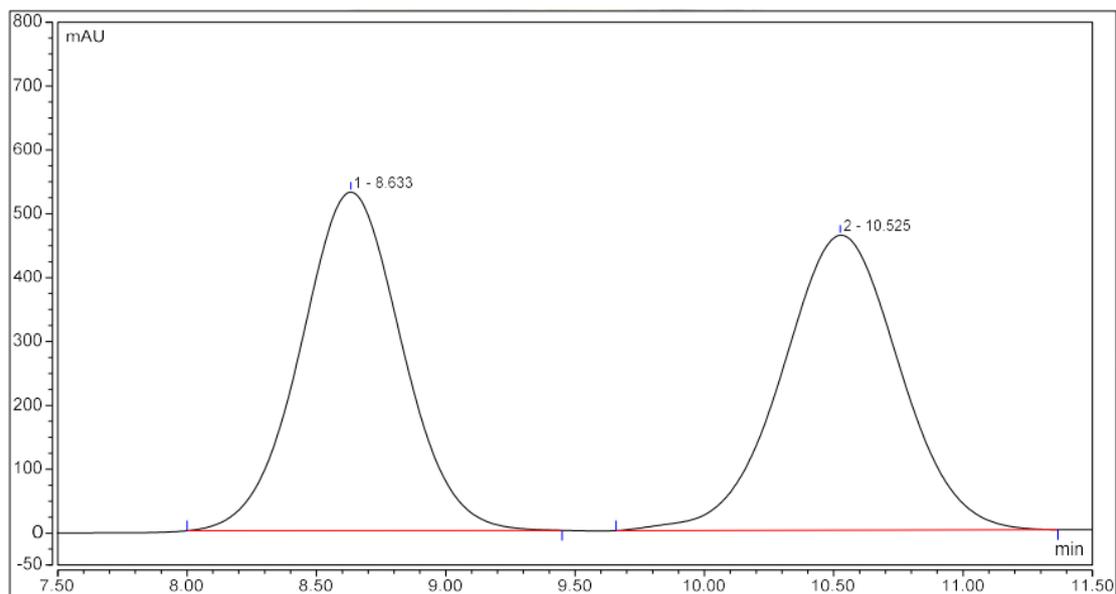
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.308	279.423	651.055	50.46	65.38	
2	15.058	274.342	344.726	49.54	34.62	
<b>Sum:</b>		<b>553.765</b>	<b>995.782</b>	<b>100.00</b>	<b>100.00</b>	



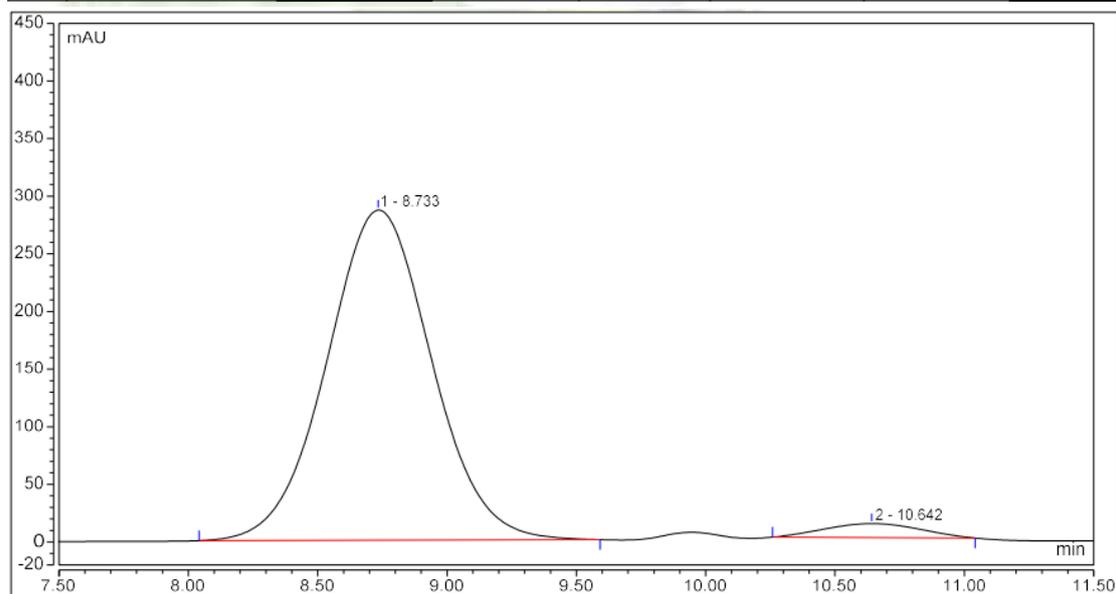
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.333	142.391	329.609	95.37	97.06	
2	15.325	6.914	9.974	4.63	2.94	
<b>Sum:</b>		<b>149.305</b>	<b>339.583</b>	<b>100.00</b>	<b>100.00</b>	



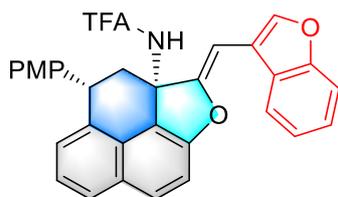
**4r:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



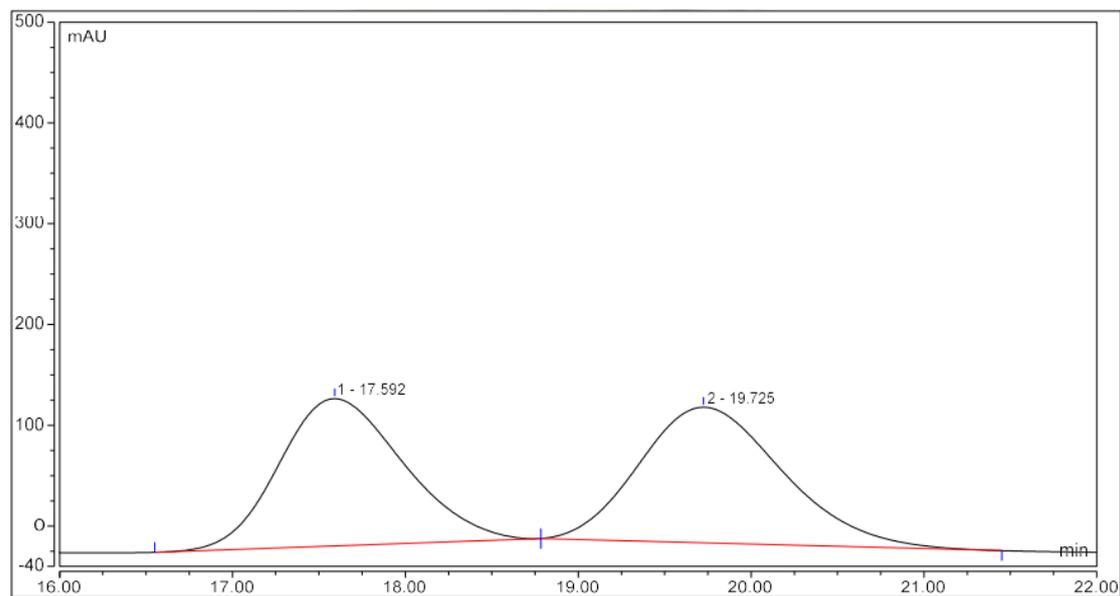
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.633	241.257	529.878	49.71	53.44	
2	10.525	244.063	461.701	50.29	46.56	
<b>Sum:</b>		<b>485.320</b>	<b>991.579</b>	<b>100.00</b>	<b>100.00</b>	



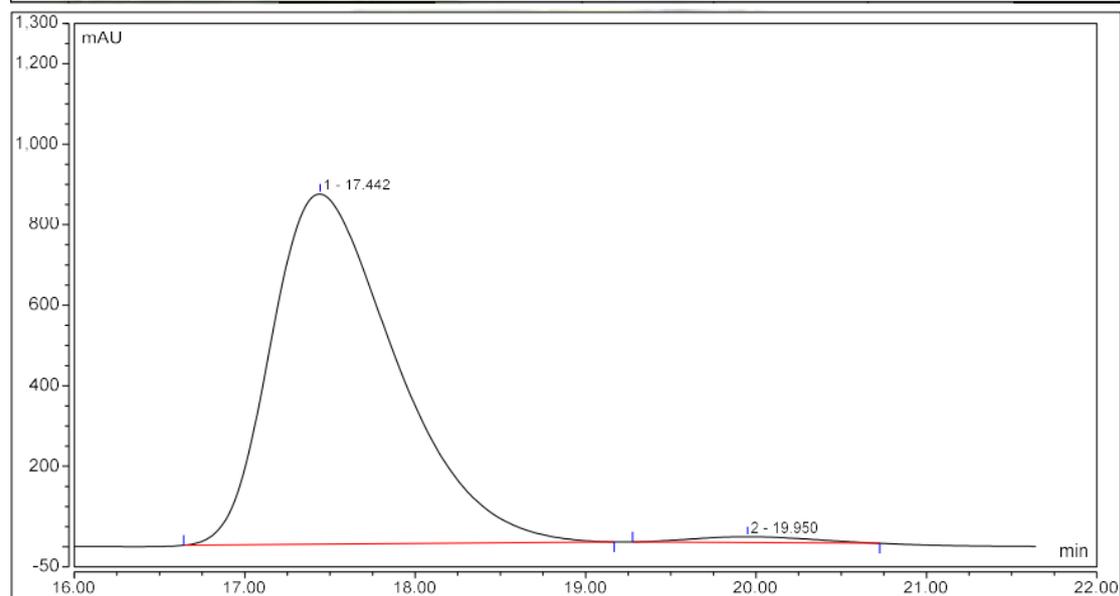
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.733	134.580	286.449	96.29	95.94	
2	10.642	5.191	12.111	3.71	4.06	
<b>Sum:</b>		<b>139.771</b>	<b>298.560</b>	<b>100.00</b>	<b>100.00</b>	



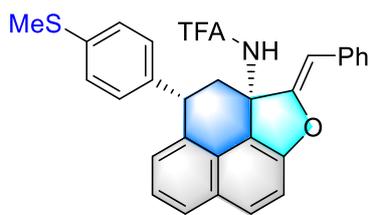
4s: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



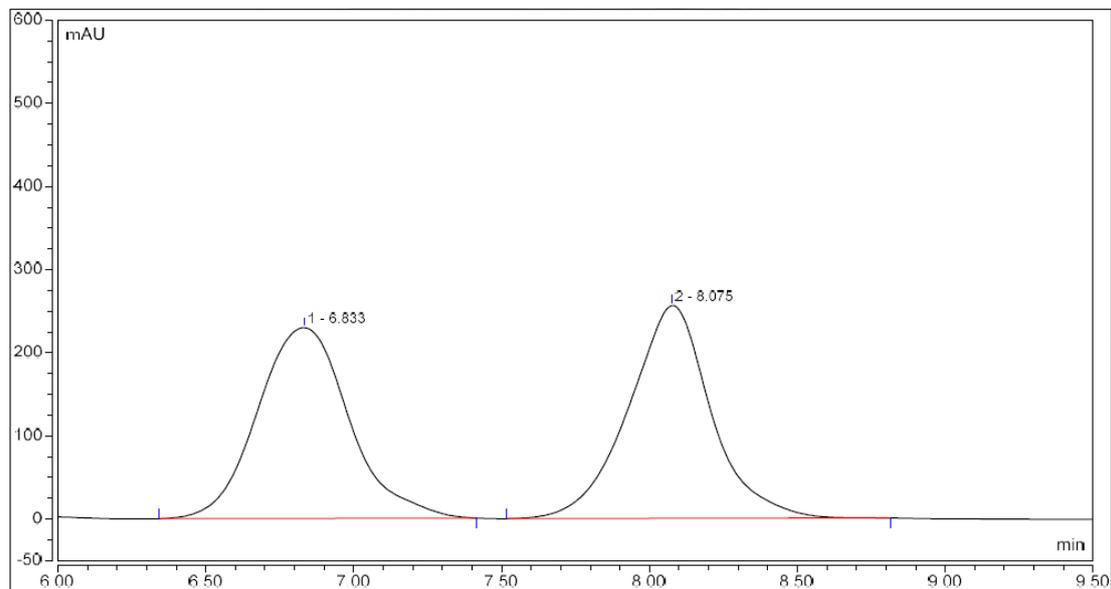
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	17.592	121.246	146.061	48.39	52.06	
2	19.725	129.331	134.491	51.61	47.94	
<b>Sum:</b>		<b>250.577</b>	<b>280.552</b>	<b>100.00</b>	<b>100.00</b>	



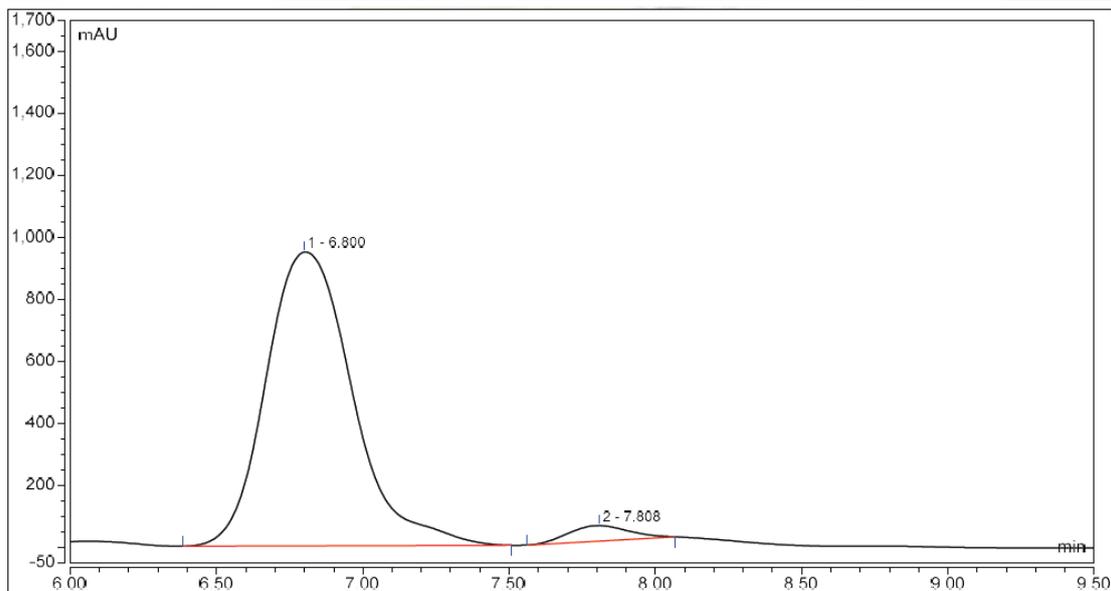
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	17.442	739.038	869.777	98.46	98.36	
2	19.950	11.534	14.540	1.54	1.64	
<b>Sum:</b>		<b>750.572</b>	<b>884.316</b>	<b>100.00</b>	<b>100.00</b>	



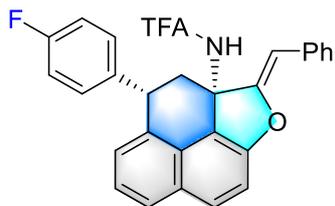
**4t:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



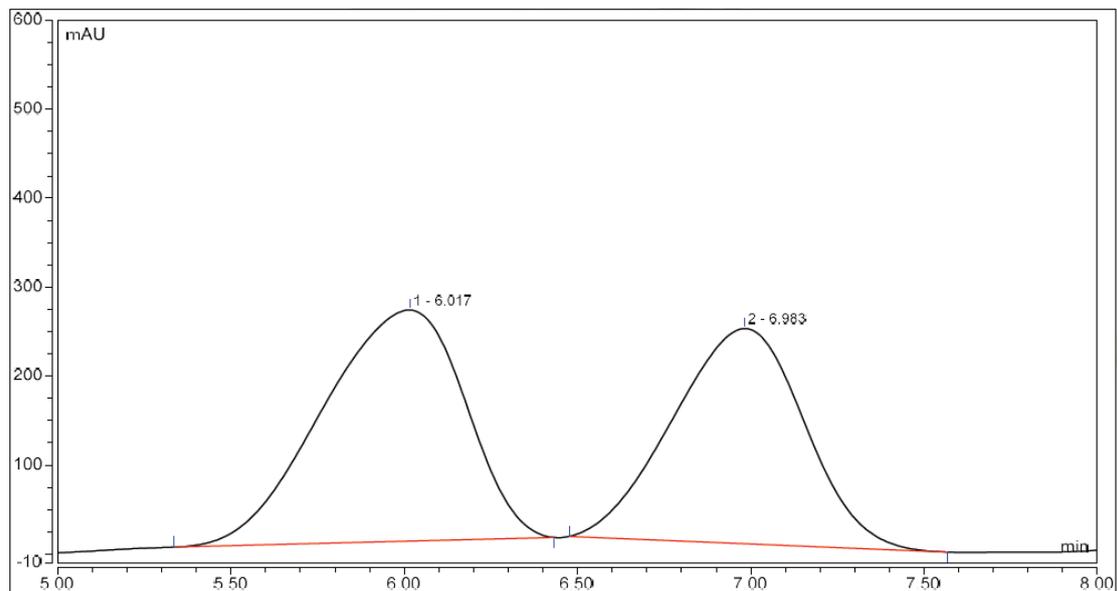
Peak Information						
Peak	Ret Time (min)	Area (mAU*min)	Height (mAU)	Area(%)	Height (%)	
1	6.833	82.495	229.266	49.89	47.26	
2	8.075	82.868	255.879	50.11	52.74	
<b>Sum:</b>		<b>165.363</b>	<b>485.145</b>	<b>100.00</b>	<b>100.00</b>	



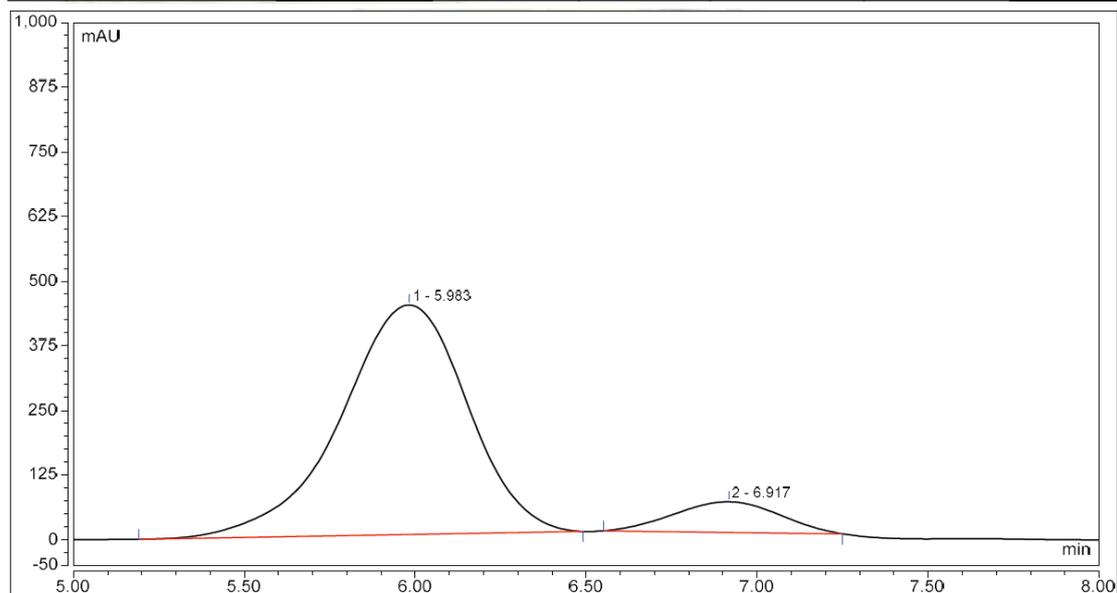
Peak Information						
Peak	Ret Time (min)	Area (mAU*min)	Height (mAU)	Area(%)	Height (%)	
1	6.800	324.387	948.443	96.45	95.00	
2	7.808	11.953	49.912	3.55	5.00	
<b>Sum:</b>		<b>336.339</b>	<b>998.355</b>	<b>100.00</b>	<b>100.00</b>	



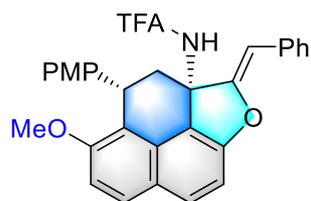
**4u:** IG, *n*-hexane/2-propanol = 92/8,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



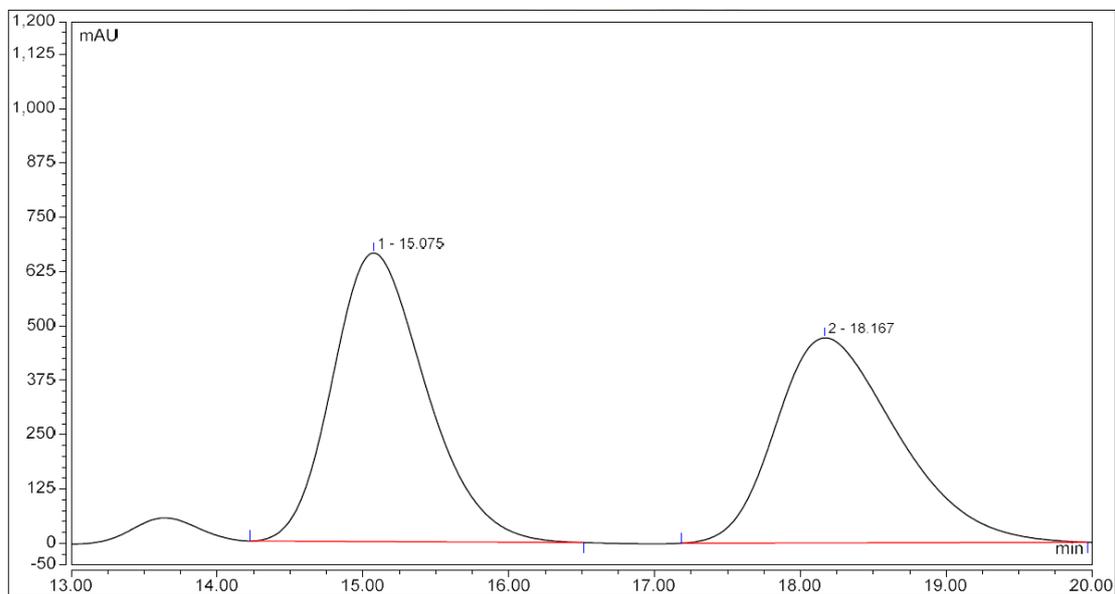
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.017	123.648	259.844	53.74	51.78	
2	6.983	106.418	241.933	46.26	48.22	
<b>Sum:</b>		<b>230.067</b>	<b>501.777</b>	<b>100.00</b>	<b>100.00</b>	



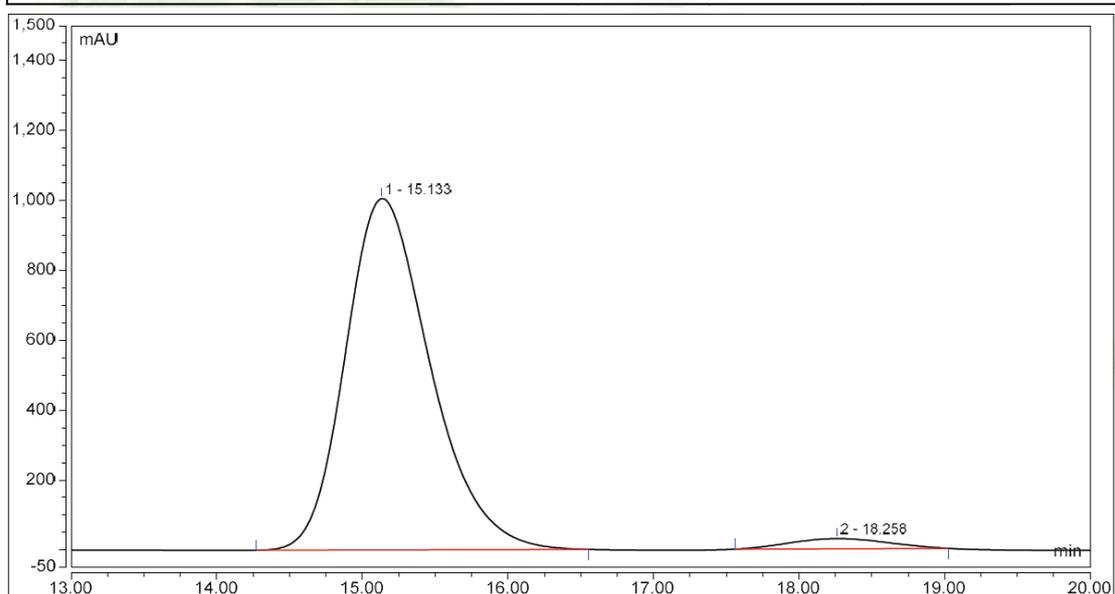
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	5.983	190.170	443.522	90.03	88.22	
2	6.917	21.069	59.236	9.97	11.78	
<b>Sum:</b>		<b>211.239</b>	<b>502.758</b>	<b>100.00</b>	<b>100.00</b>	



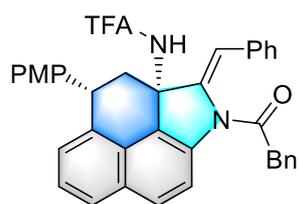
**4v:** IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



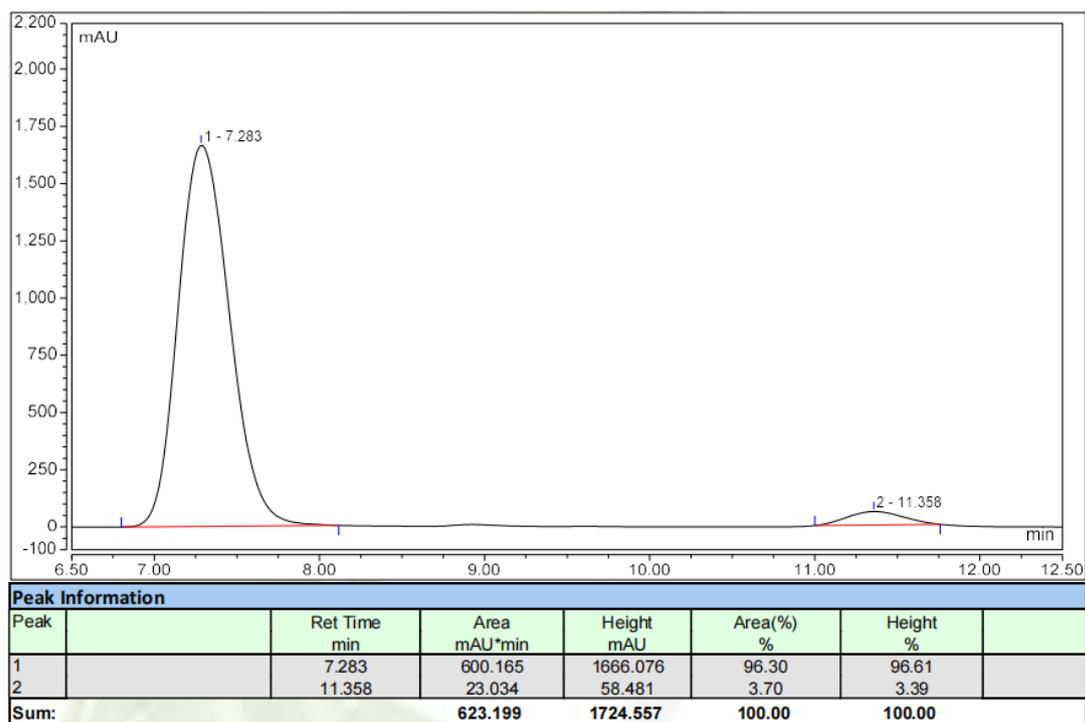
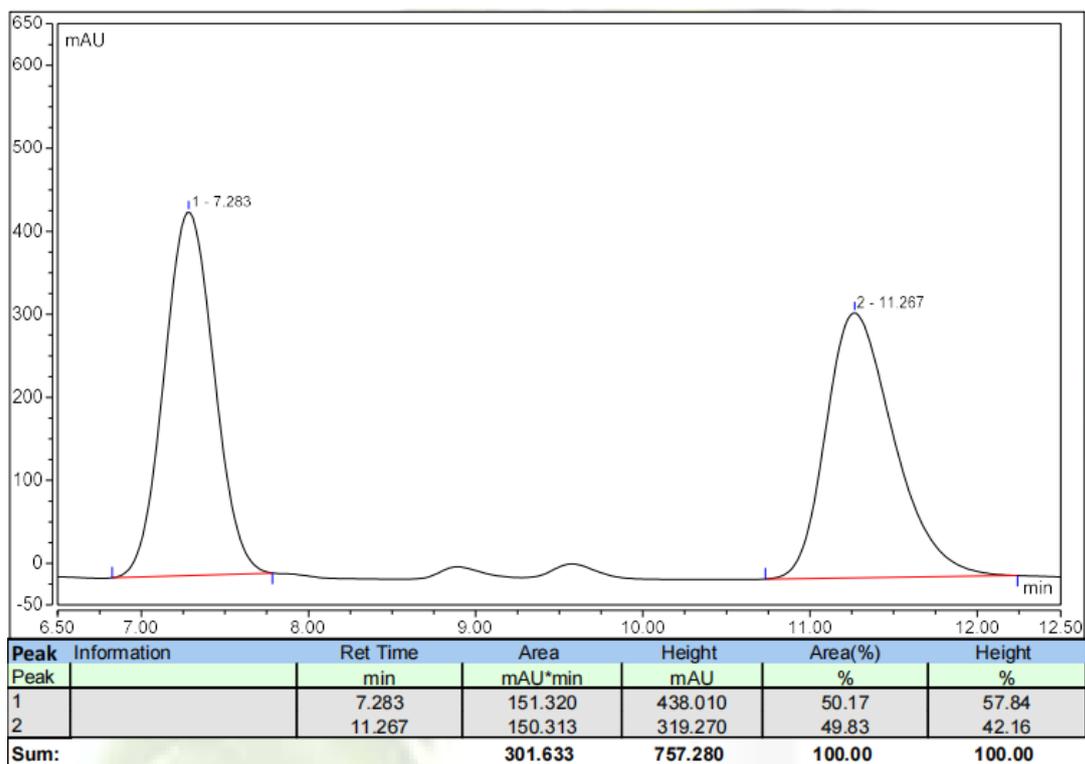
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	15.075	494.997	663.915	52.01	58.47	
2	18.167	456.783	471.546	47.99	41.53	
<b>Sum:</b>		<b>951.780</b>	<b>1135.461</b>	<b>100.00</b>	<b>100.00</b>	

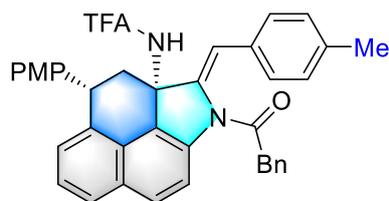


Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area (%) %	Height %	
1	15.133	680.161	1005.508	96.80	97.18	
2	18.258	22.454	29.196	3.20	2.82	
<b>Sum:</b>		<b>702.614</b>	<b>1034.703</b>	<b>100.00</b>	<b>100.00</b>	

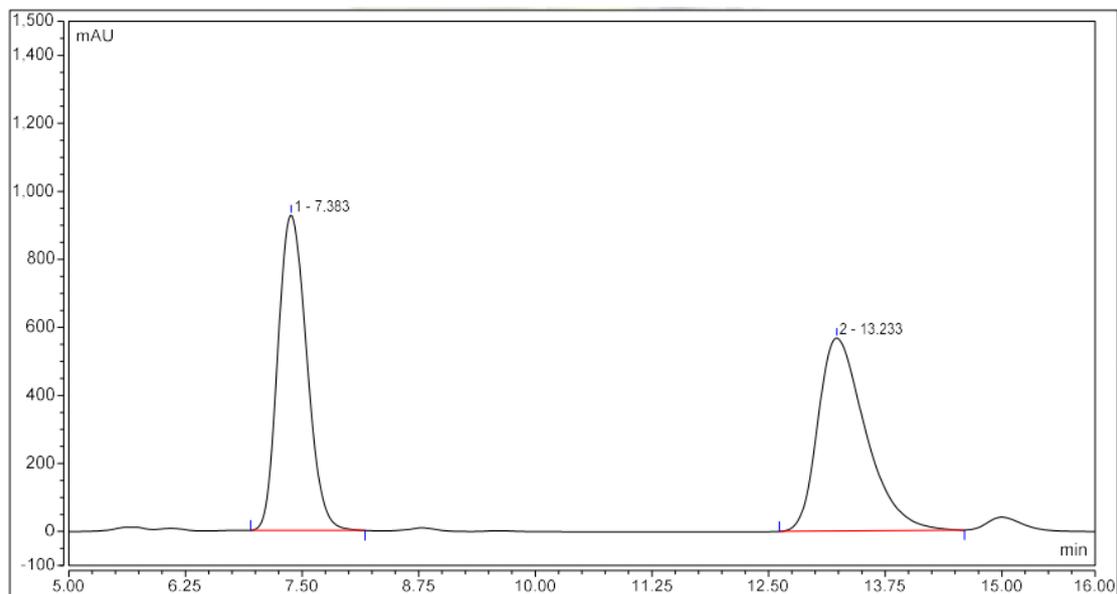


**5a:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$

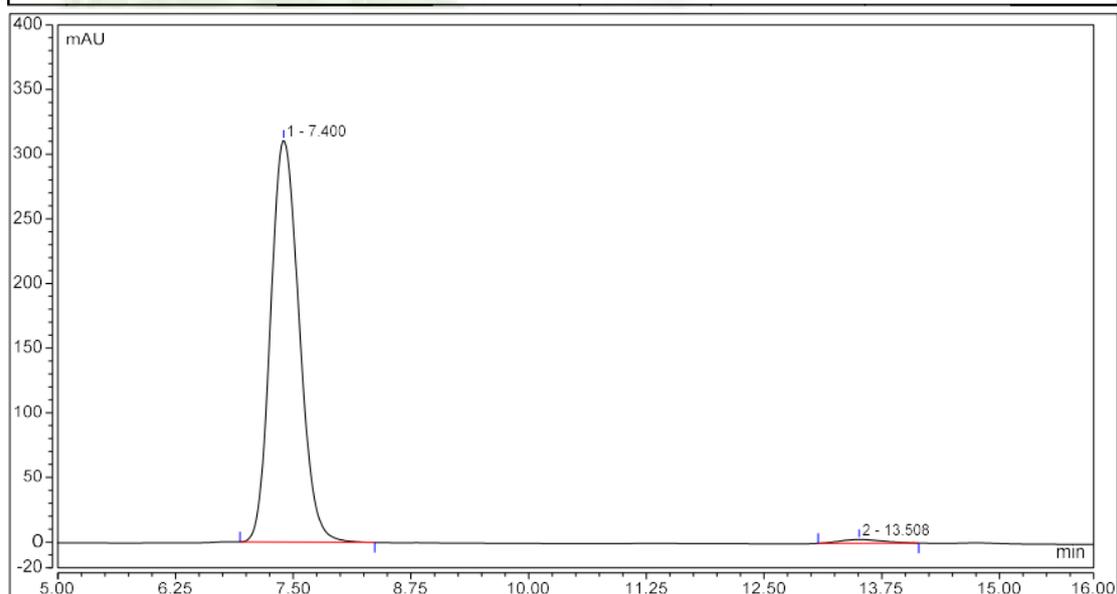




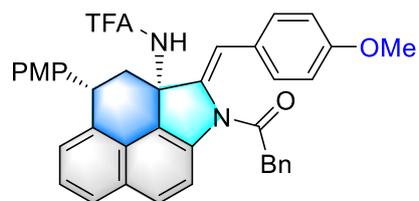
**5b:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



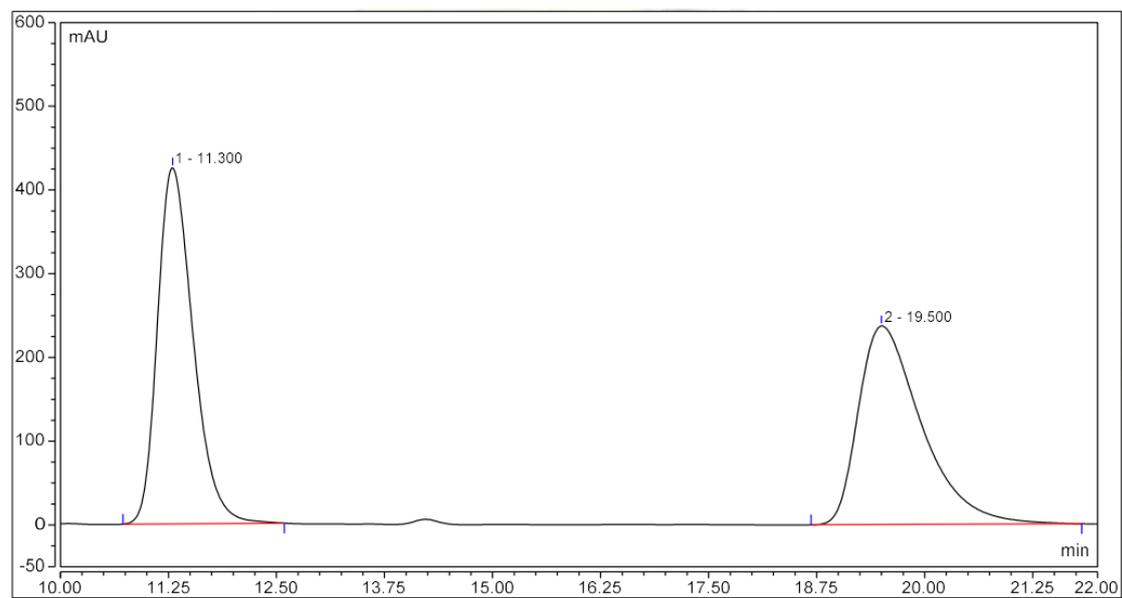
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.383	331.676	927.152	49.67	62.04	
2	13.233	336.111	567.263	50.33	37.96	
<b>Sum:</b>		<b>667.786</b>	<b>1494.415</b>	<b>100.00</b>	<b>100.00</b>	



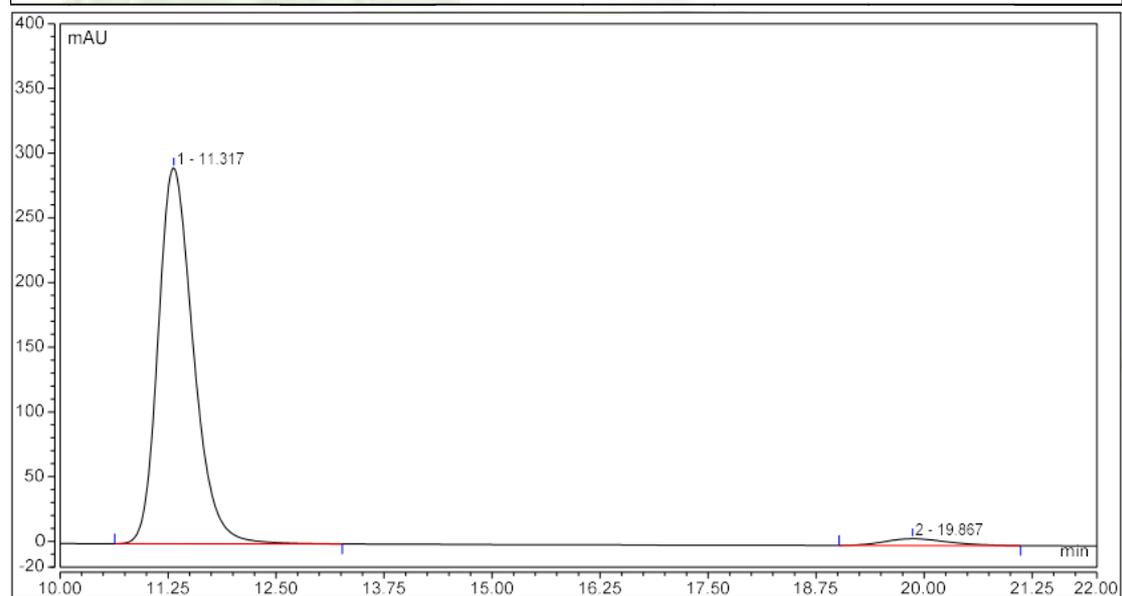
Peak Information						
Peak	Peak min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.400	109.315	310.755	98.61	99.08	
2	13.508	1.538	2.898	1.39	0.92	
<b>Sum:</b>		<b>110.853</b>	<b>313.652</b>	<b>100.00</b>	<b>100.00</b>	



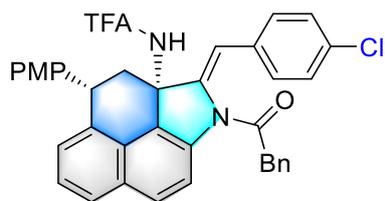
**5c:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



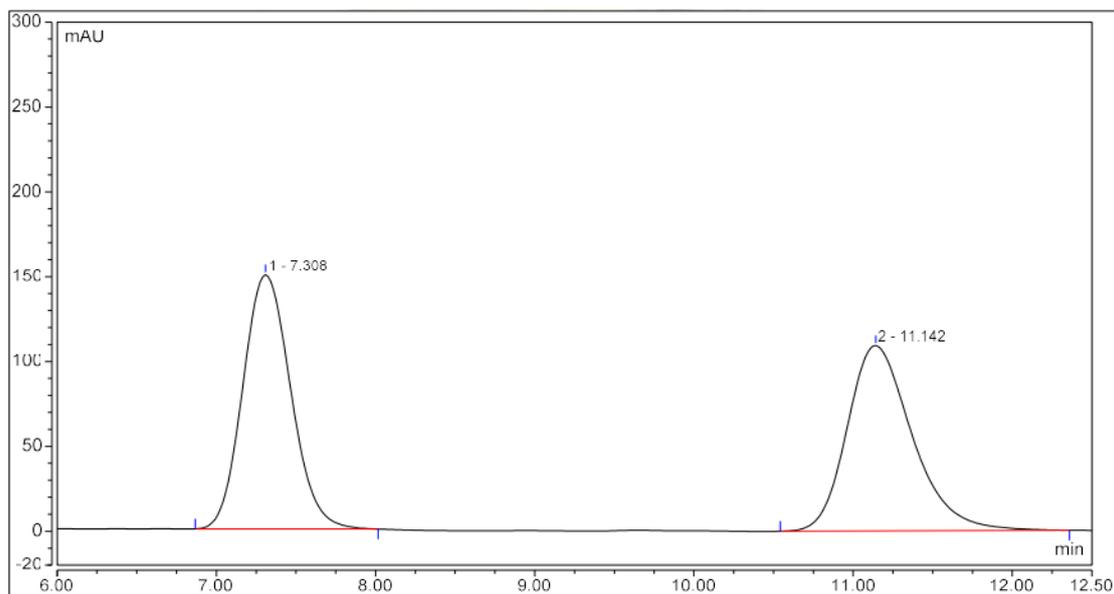
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	11.300	203.162	425.162	50.30	64.19	
2	19.500	200.739	237.168	49.70	35.81	
<b>Sum:</b>		<b>403.901</b>	<b>662.330</b>	<b>100.00</b>	<b>100.00</b>	



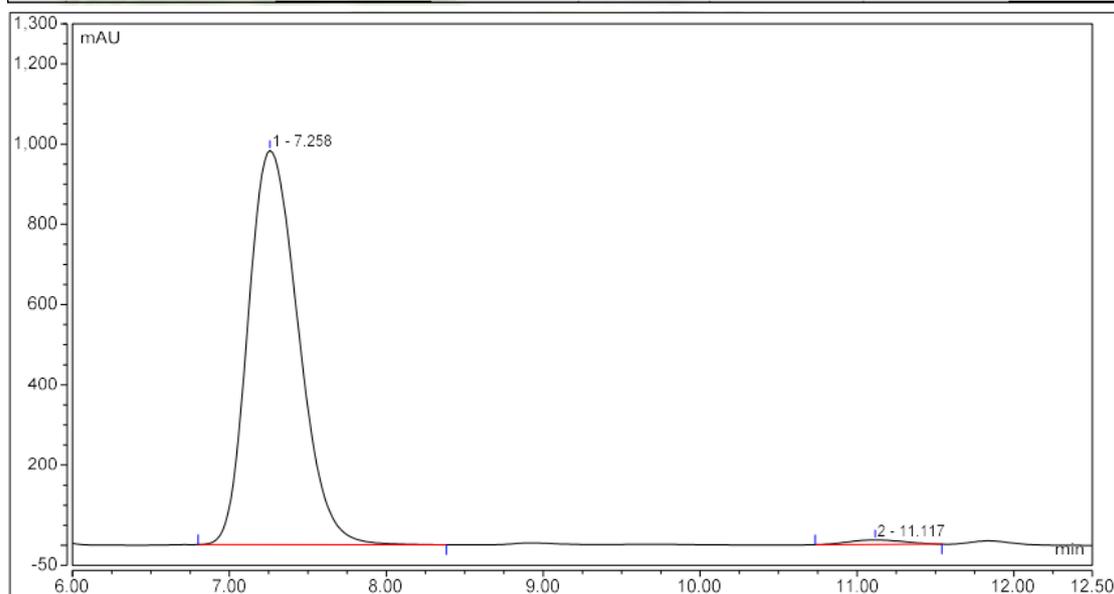
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	11.317	137.088	290.508	96.87	98.23	
2	19.867	4.437	5.245	3.13	1.77	
<b>Sum:</b>		<b>141.524</b>	<b>295.753</b>	<b>100.00</b>	<b>100.00</b>	



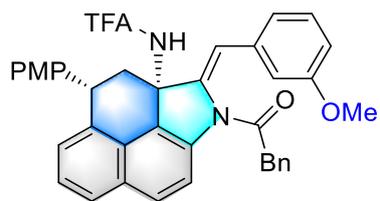
**5d:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



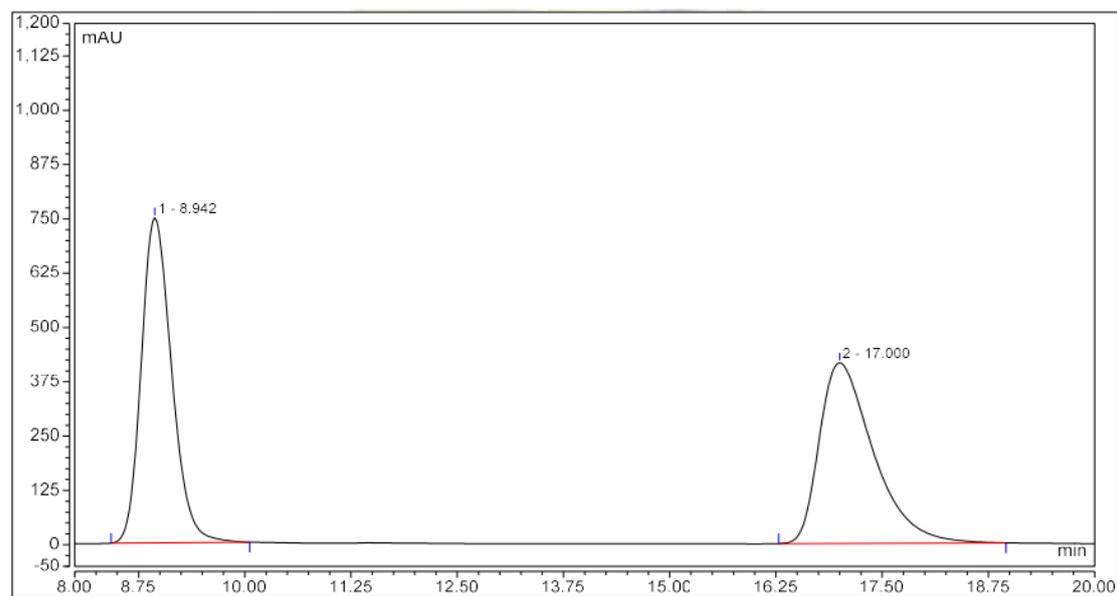
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.308	52.279	149.789	50.24	57.81	
2	11.142	51.771	109.318	49.76	42.19	
<b>Sum:</b>		<b>104.051</b>	<b>259.107</b>	<b>100.00</b>	<b>100.00</b>	



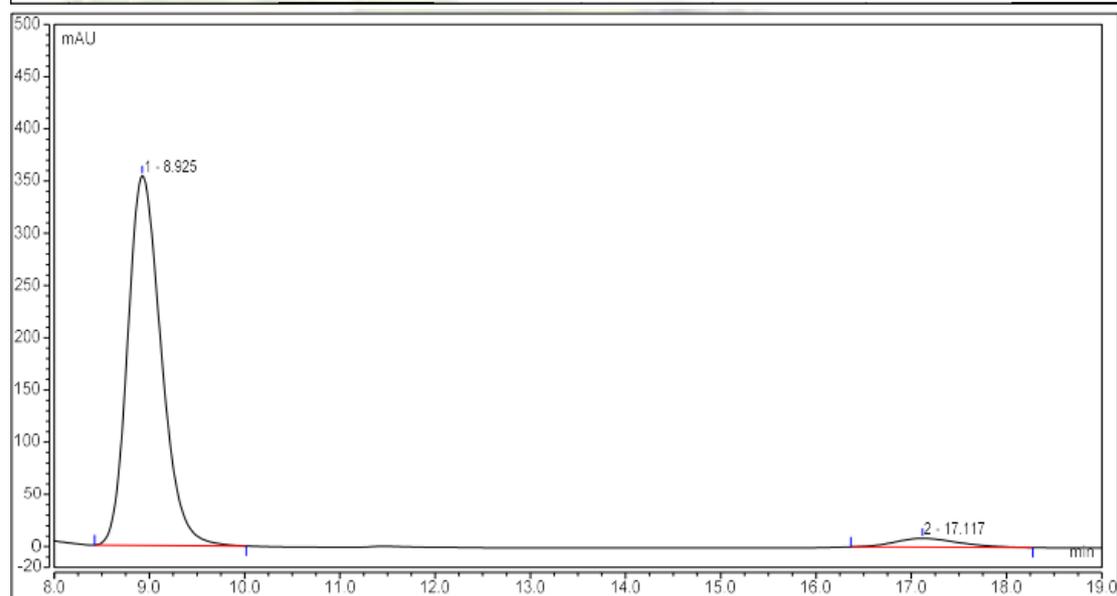
Peak Information						
Peak	Ret min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	7.258	363.868	982.459	98.75	98.86	
2	11.117	4.611	11.340	1.25	1.14	
<b>Sum:</b>		<b>368.479</b>	<b>993.799</b>	<b>100.00</b>	<b>100.00</b>	



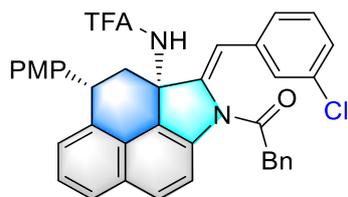
5e: IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



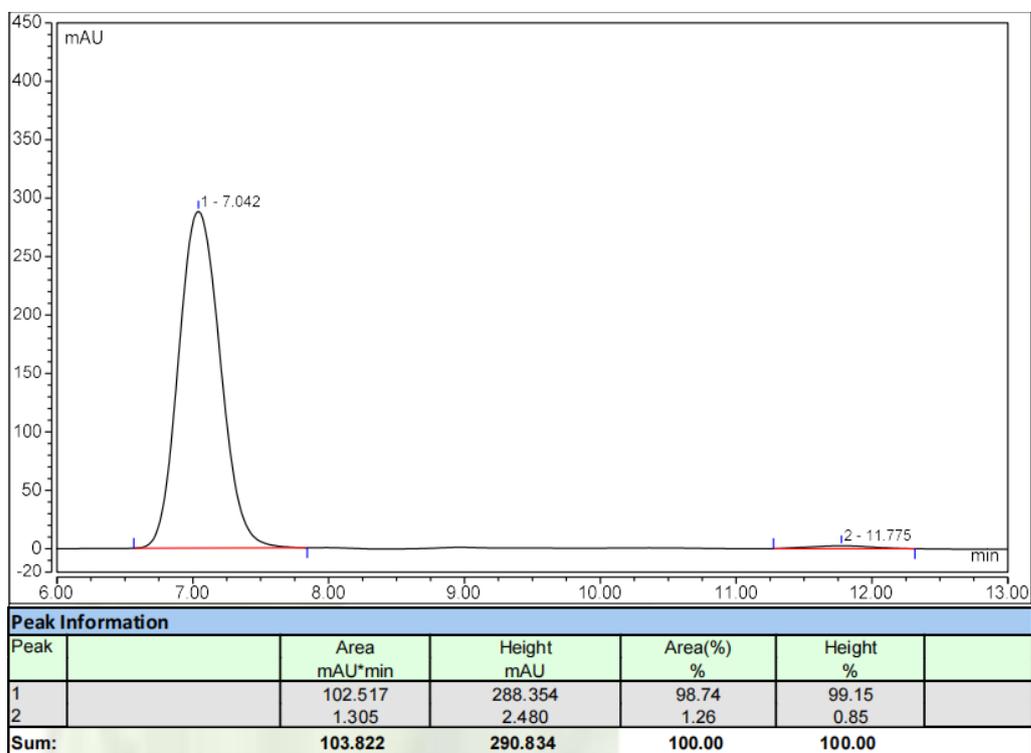
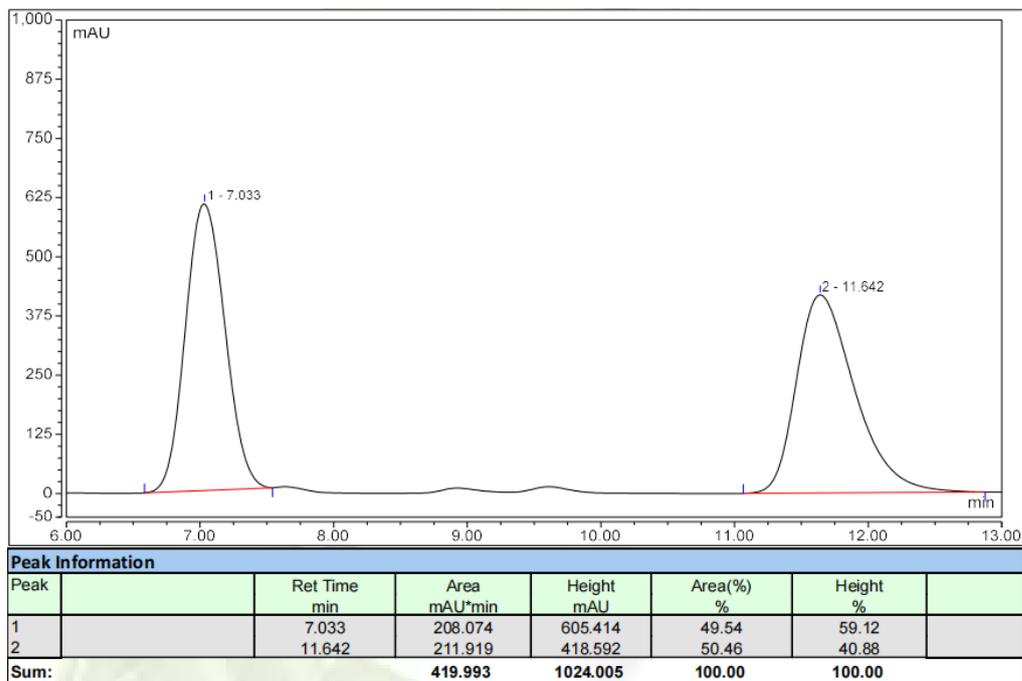
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.942	310.275	748.437	50.35	64.28	
2	17.000	306.012	415.857	49.65	35.72	
<b>Sum:</b>		<b>616.287</b>	<b>1164.294</b>	<b>100.00</b>	<b>100.00</b>	

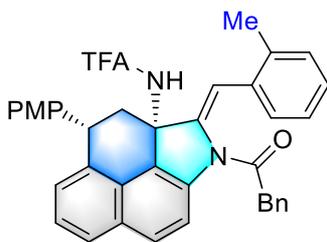


Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	8.925	144.088	353.916	95.62	97.68	
2	17.117	6.605	8.403	4.38	2.32	
<b>Sum:</b>		<b>150.693</b>	<b>362.319</b>	<b>100.00</b>	<b>100.00</b>	

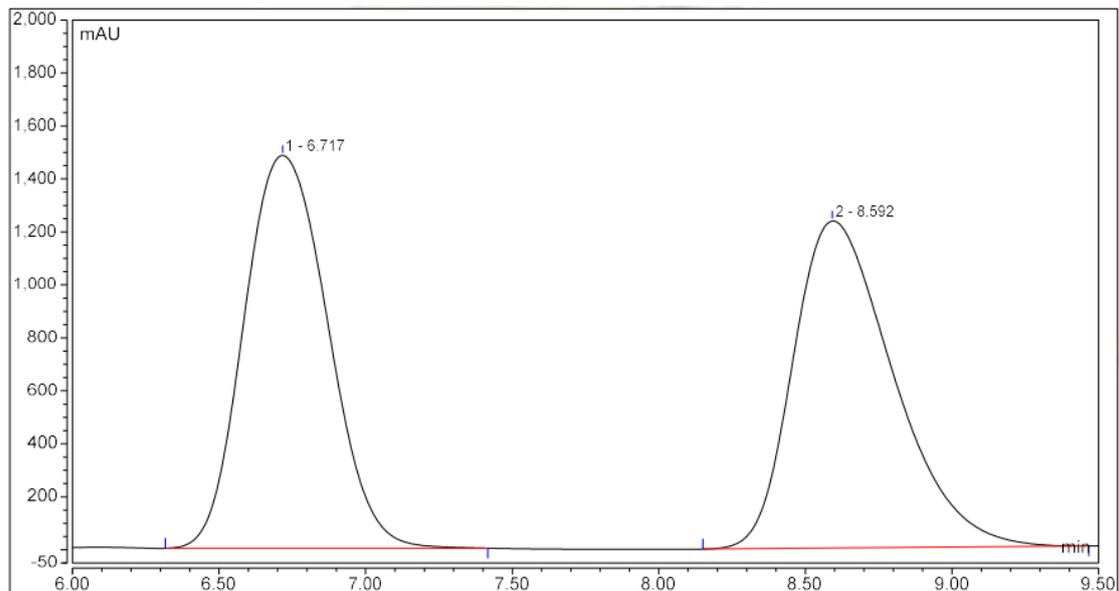


5f: IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$

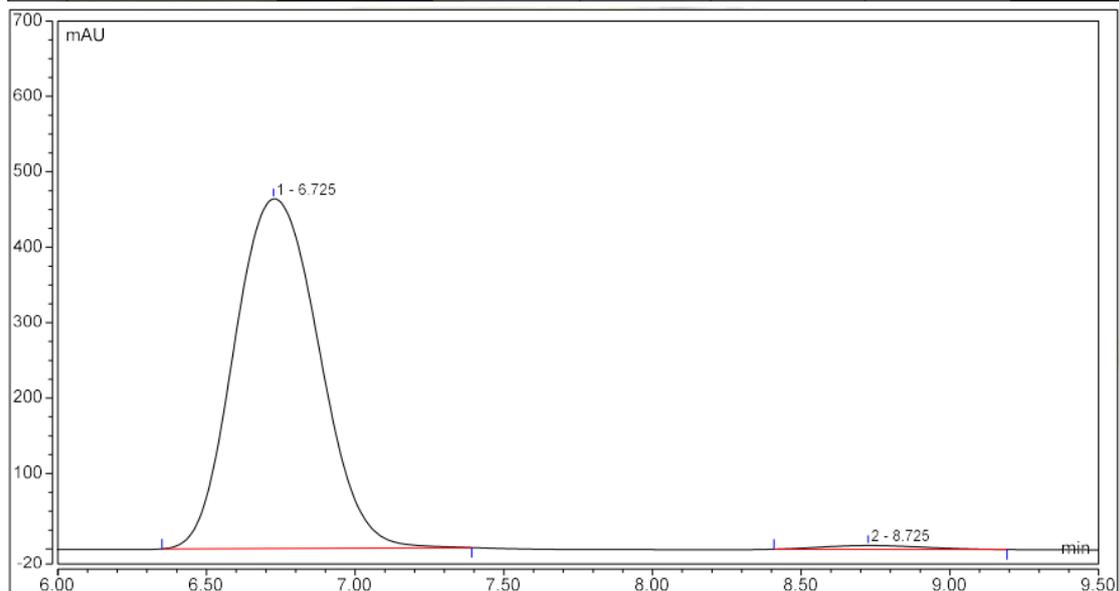




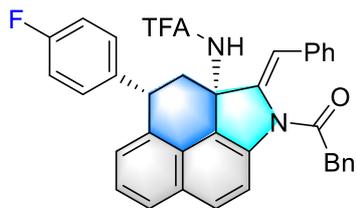
**5g:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



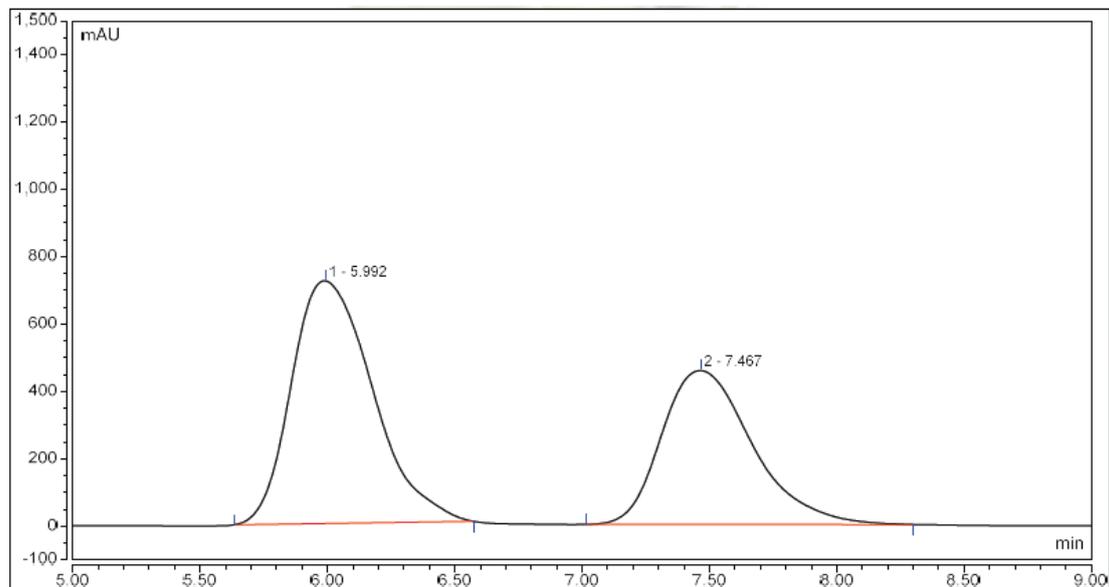
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	6.717	491.657	1483.096	50.18	54.57	
2	8.592	488.209	1234.851	49.82	45.43	
<b>Sum:</b>		<b>979.866</b>	<b>2717.948</b>	<b>100.00</b>	<b>100.00</b>	



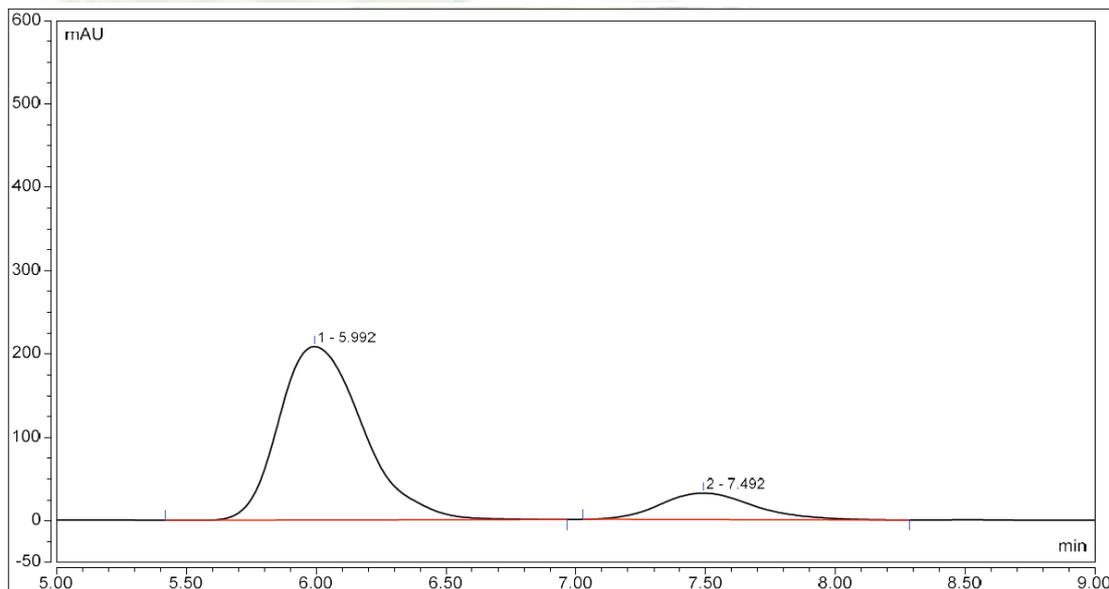
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	6.725	152.730	463.382	98.71	98.92	
2	8.725	1.994	5.075	1.29	1.08	n.a.
<b>Sum:</b>		<b>154.724</b>	<b>468.456</b>	<b>100.00</b>	<b>100.00</b>	



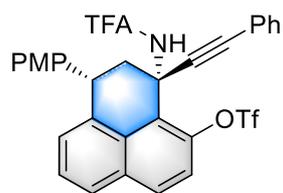
**5h:** IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



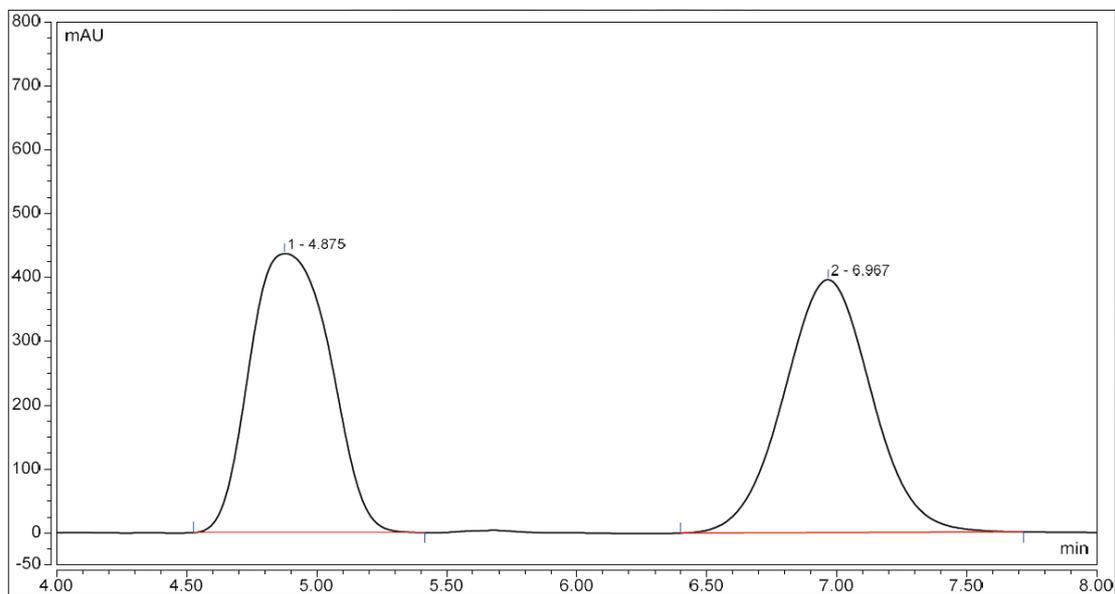
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	5.992	266.293	719.795	58.54	61.20	
2	7.467	188.607	456.369	41.46	38.80	
<b>Sum:</b>		<b>454.900</b>	<b>1176.164</b>	<b>100.00</b>	<b>100.00</b>	



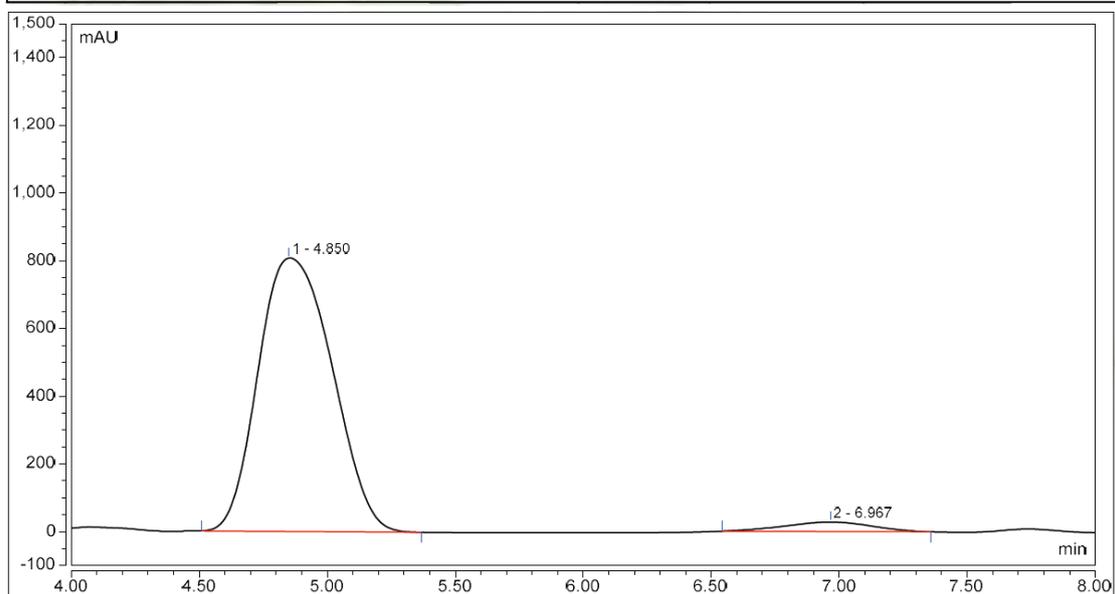
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(% %)	Height %	
1	5.992	78.028	207.870	85.32	86.75	
2	7.492	13.426	31.751	14.68	13.25	
<b>Sum:</b>		<b>91.454</b>	<b>239.621</b>	<b>100.00</b>	<b>100.00</b>	



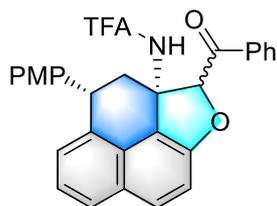
6a: IG, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



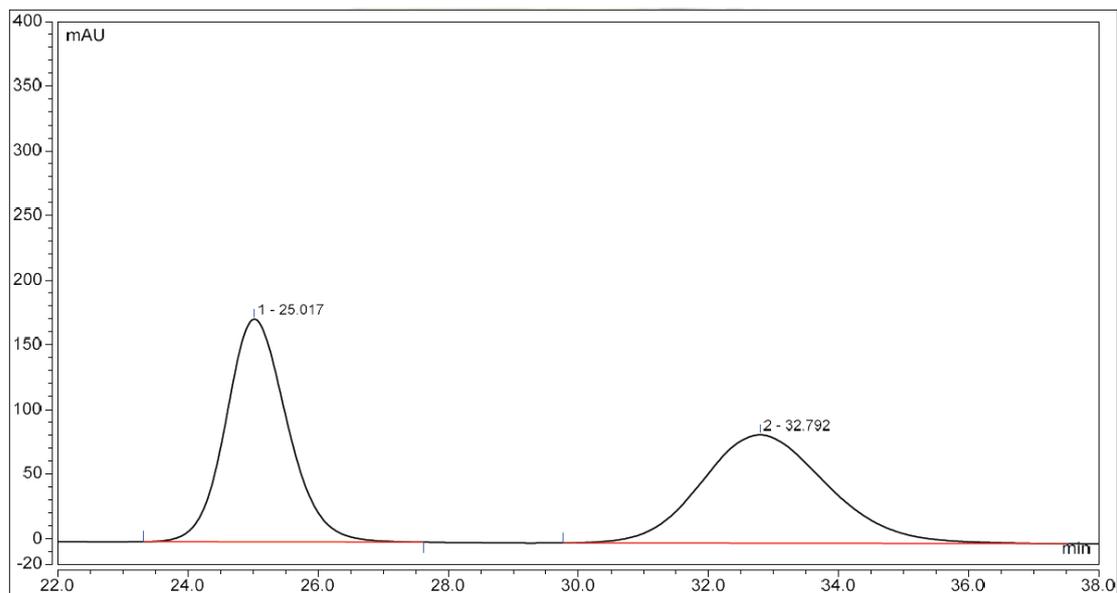
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	4.875	156.603	436.527	50.24	52.47	
2	6.967	155.076	395.401	49.76	47.53	
<b>Sum:</b>		<b>311.679</b>	<b>831.928</b>	<b>100.00</b>	<b>100.00</b>	



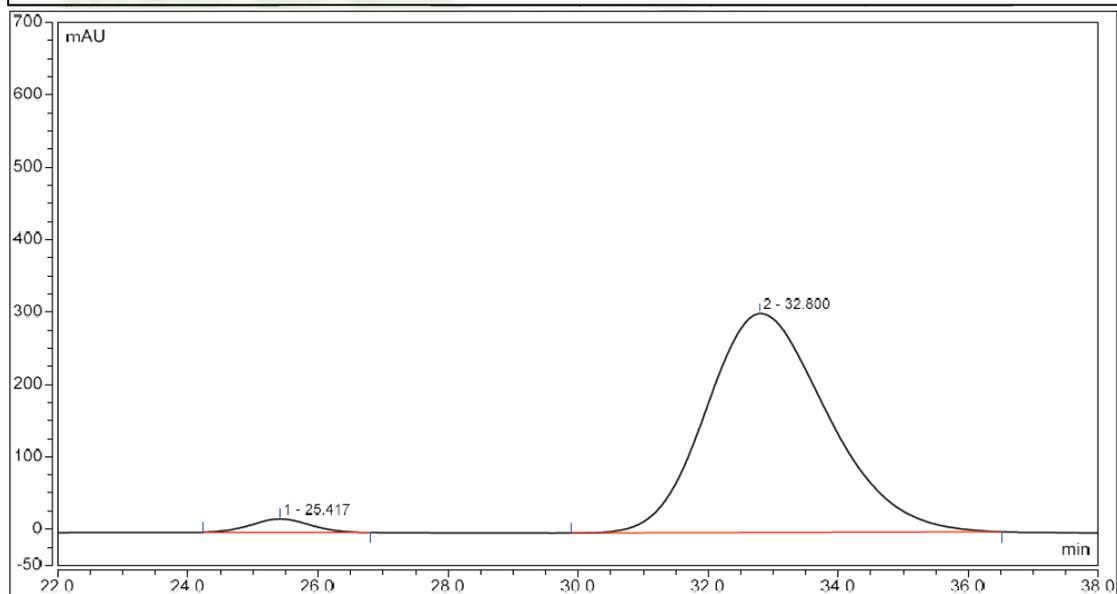
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	4.850	270.657	807.251	96.10	96.68	
2	6.967	10.979	27.722	3.90	3.32	
<b>Sum:</b>		<b>281.636</b>	<b>834.972</b>	<b>100.00</b>	<b>100.00</b>	



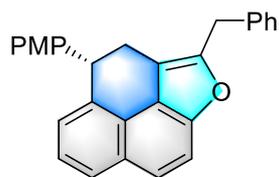
6c: IE, *n*-hexane/2-propanol = 90/10,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



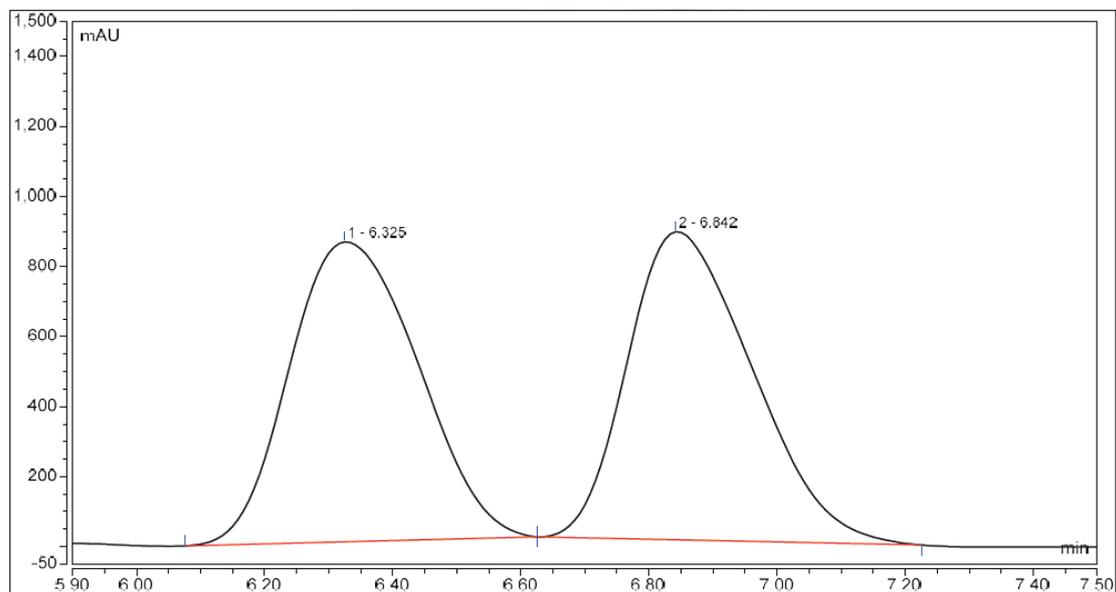
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	25.017	188.832	172.141	50.04	67.29	
2	32.792	188.504	83.688	49.96	32.71	
<b>Sum:</b>		<b>377.336</b>	<b>255.829</b>	<b>100.00</b>	<b>100.00</b>	



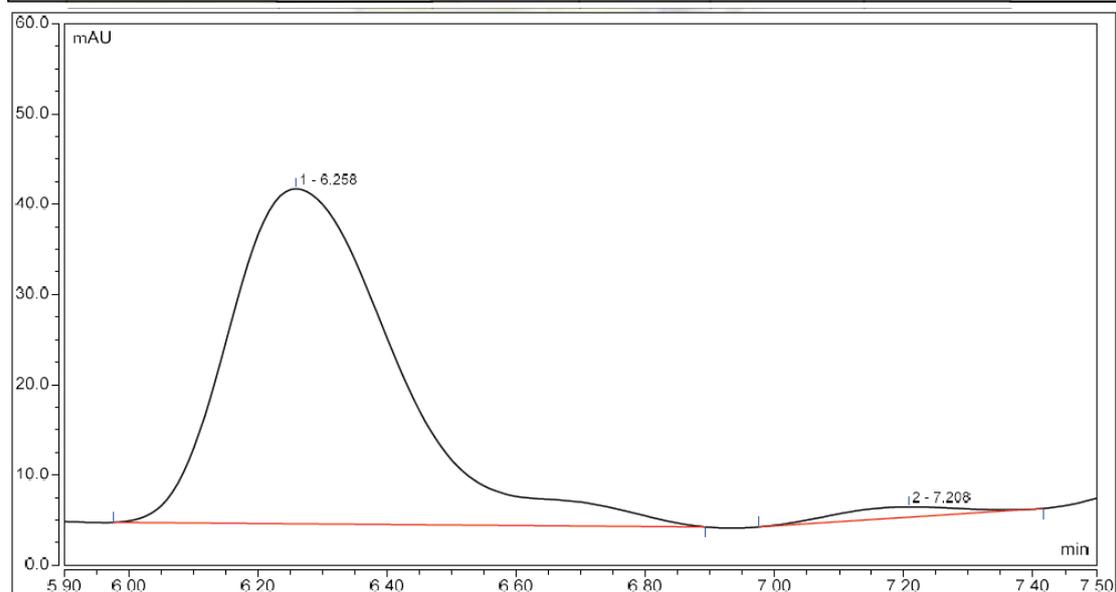
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	25.417	19.482	18.531	2.89	5.77	
2	32.800	654.474	302.374	97.11	94.23	
<b>Sum:</b>		<b>673.956</b>	<b>320.905</b>	<b>100.00</b>	<b>100.00</b>	



**6d:** IE, *n*-hexane/2-propanol = 94/6,  $v = 1.0 \text{ mL} \cdot \text{min}^{-1}$ ,  $\lambda = 220 \text{ nm}$



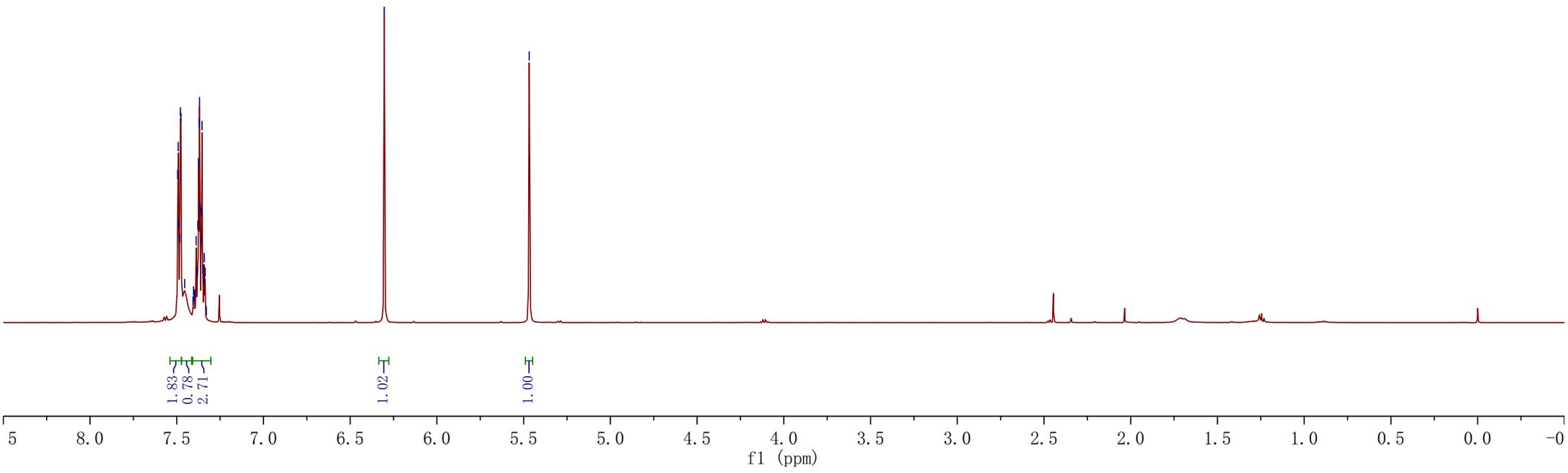
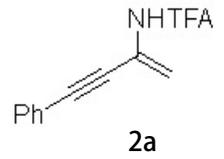
Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.325	198.542	856.225	50.01	49.33	
2	6.842	198.428	879.617	49.99	50.67	
<b>Sum:</b>		<b>396.970</b>	<b>1735.842</b>	<b>100.00</b>	<b>100.00</b>	



Peak Information						
Peak	Ret Time min	Area mAU*min	Height mAU	Area(%) %	Height %	
1	6.258	11.058	37.106	97.68	97.01	
2	7.208	0.262	1.144	2.32	2.99	
<b>Sum:</b>		<b>11.321</b>	<b>38.250</b>	<b>100.00</b>	<b>100.00</b>	

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.494  
7.491  
7.488  
7.483  
7.479  
7.475  
7.454  
7.406  
7.403  
7.400  
7.396  
7.388  
7.382  
7.378  
7.374  
7.370  
7.368  
7.365  
7.359  
7.357  
7.354  
7.349  
7.344  
7.341  
7.336  
7.329  
6.304  
5.468

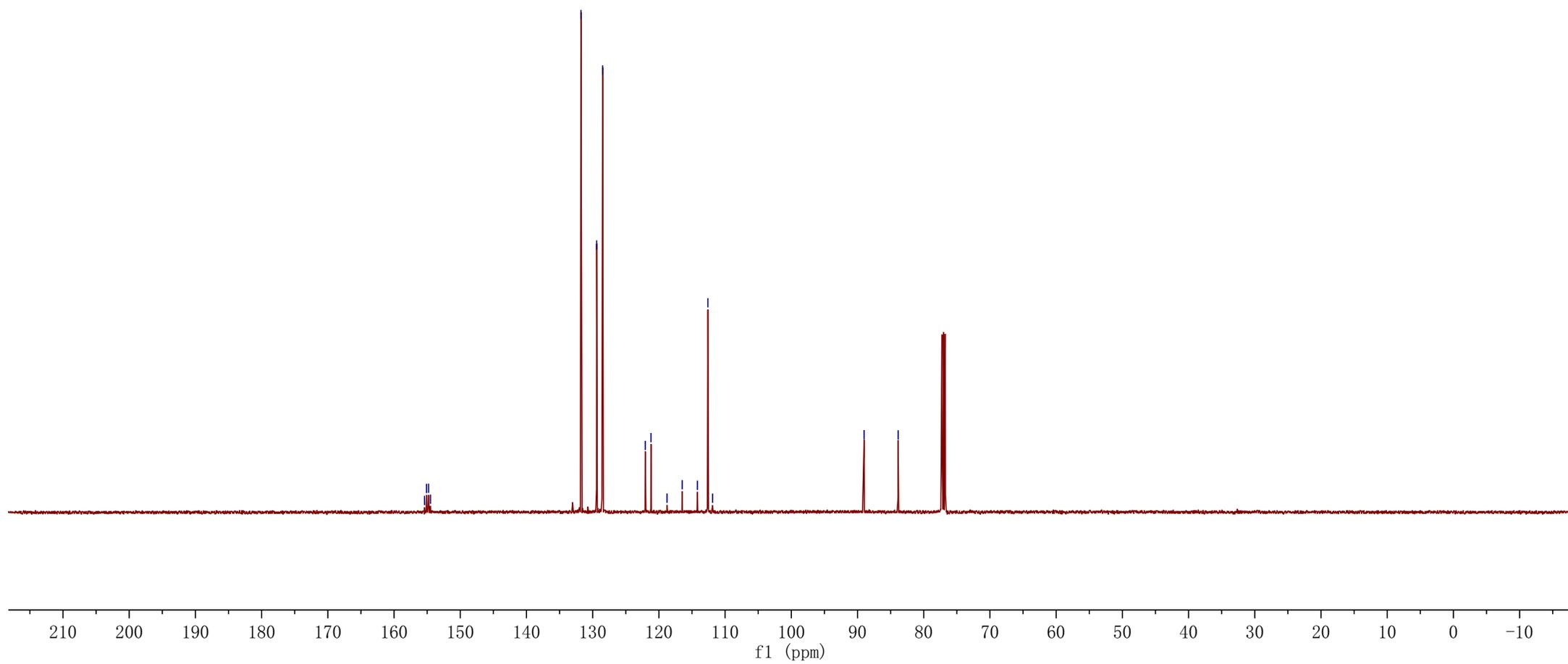
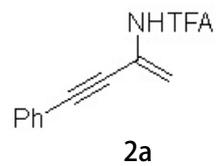


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.39  
155.09  
154.79  
154.49

131.77  
129.40  
128.50  
122.06  
121.20  
118.77  
116.48  
114.18  
112.60  
111.89

89.01  
83.86



7.467  
7.379  
7.359  
7.164  
7.144

6.273

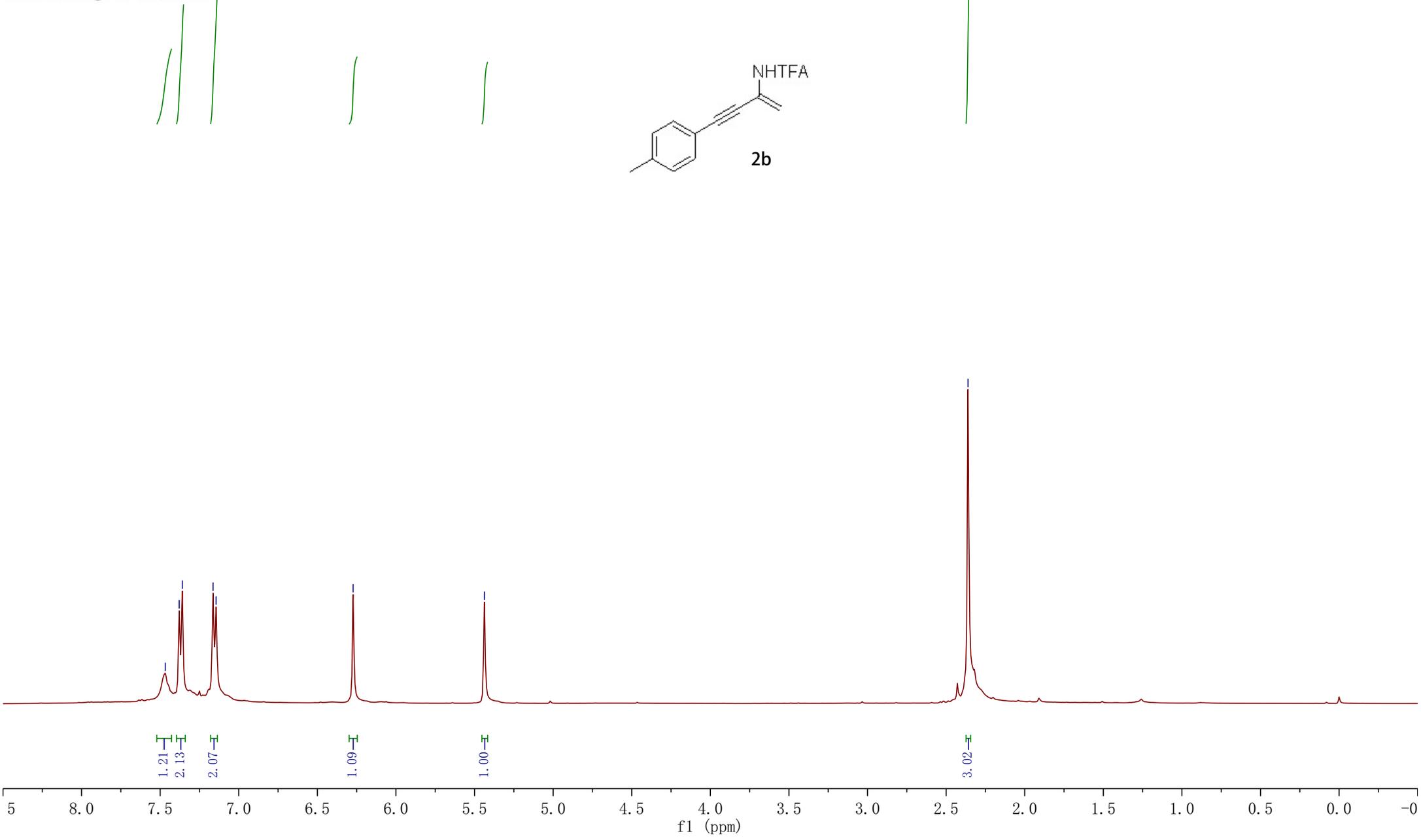
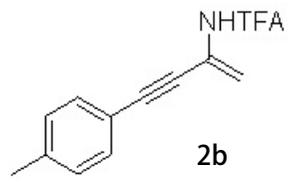
5.438

2.361

Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



1.21  
2.13  
2.07

1.09

1.00

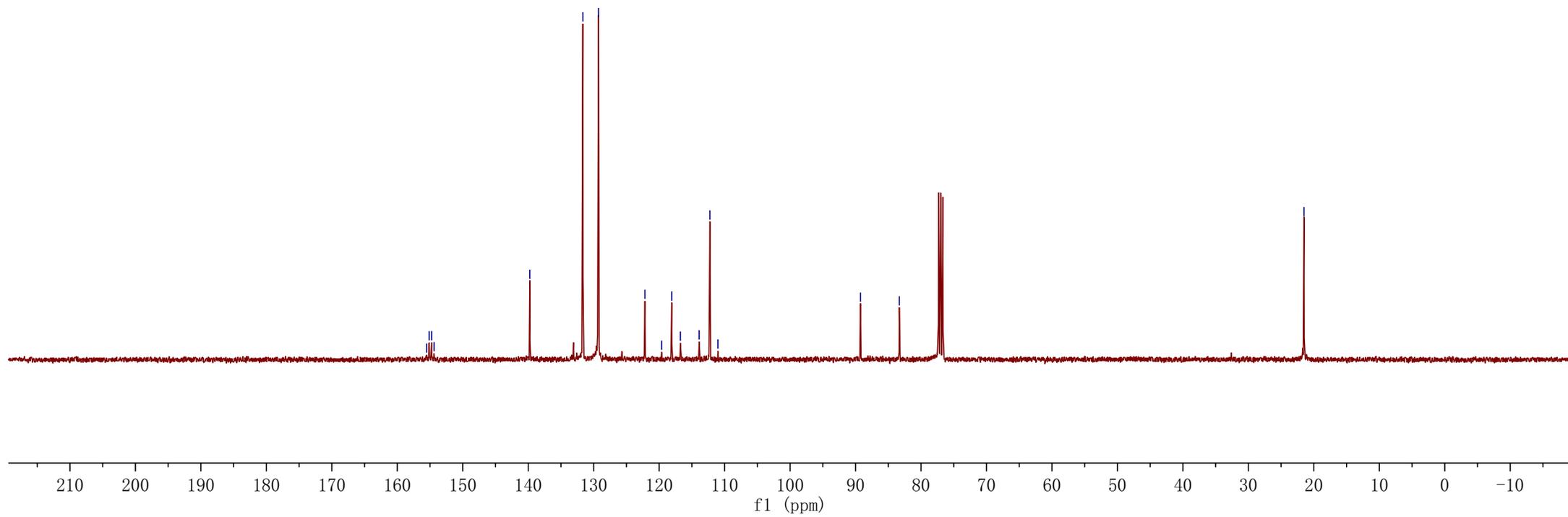
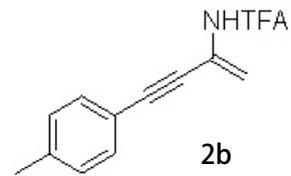
3.02

5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0

f1 (ppm)

Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

155.50  
155.13  
154.76  
154.38  
—  
139.76  
—  
131.65  
—  
129.26  
122.18  
119.63  
118.08  
116.76  
113.89  
112.25  
111.02  
—  
89.25  
—  
83.32  
—  
21.50



7.481  
7.423  
7.405

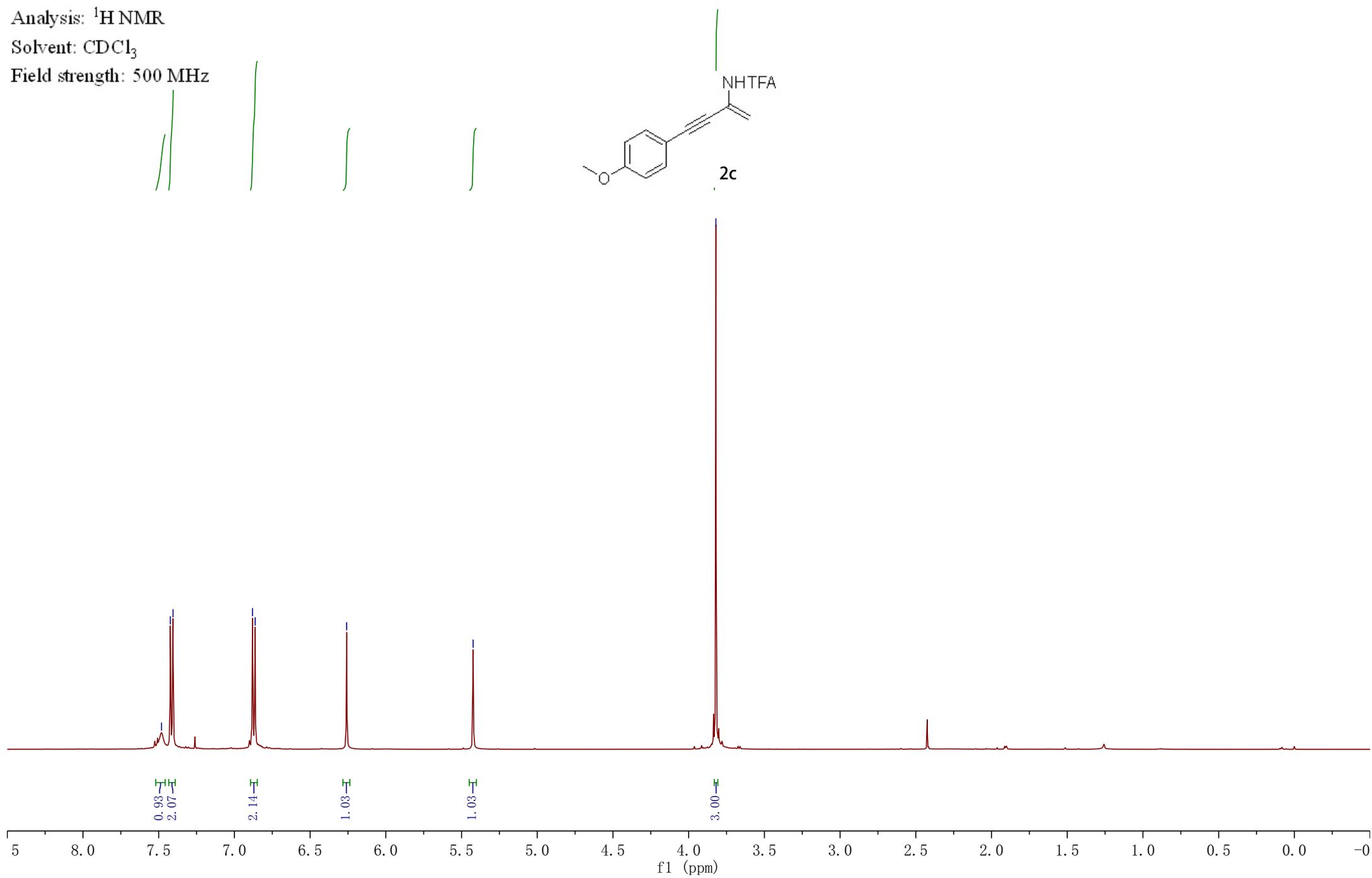
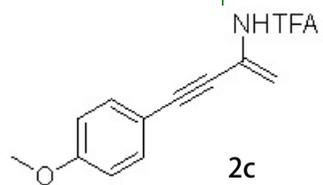
6.881  
6.863

6.259

5.424

3.820

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

160.43  
155.37  
155.07  
154.77  
154.47

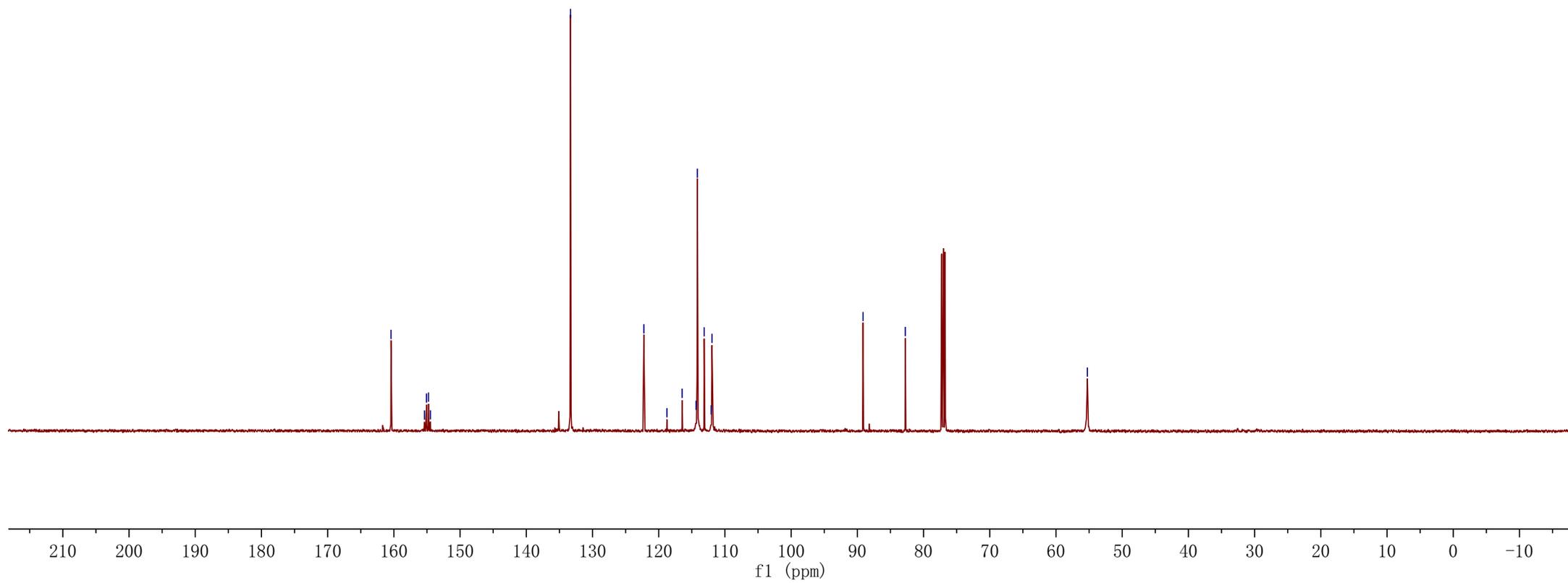
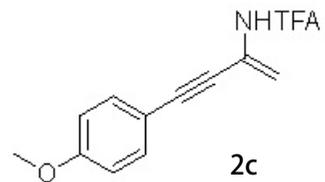
133.32

122.24  
118.76  
116.47  
114.35  
114.16  
113.13  
112.07  
111.95

89.14

82.76

55.26



7.454  
7.414  
7.398  
7.220  
7.203

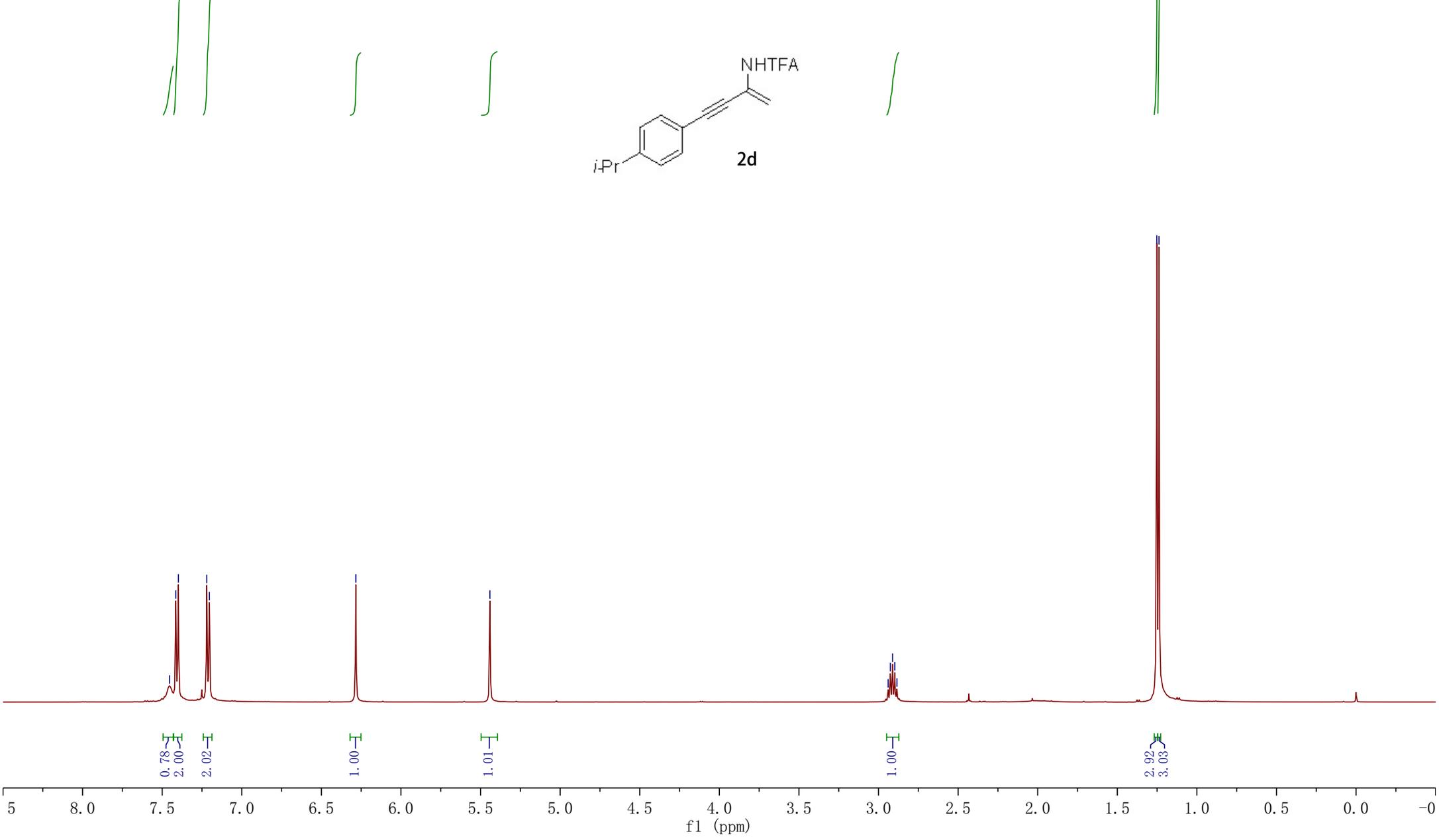
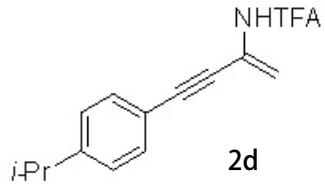
6.283

5.441

2.939  
2.926  
2.912  
2.898  
2.884

1.252  
1.238

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

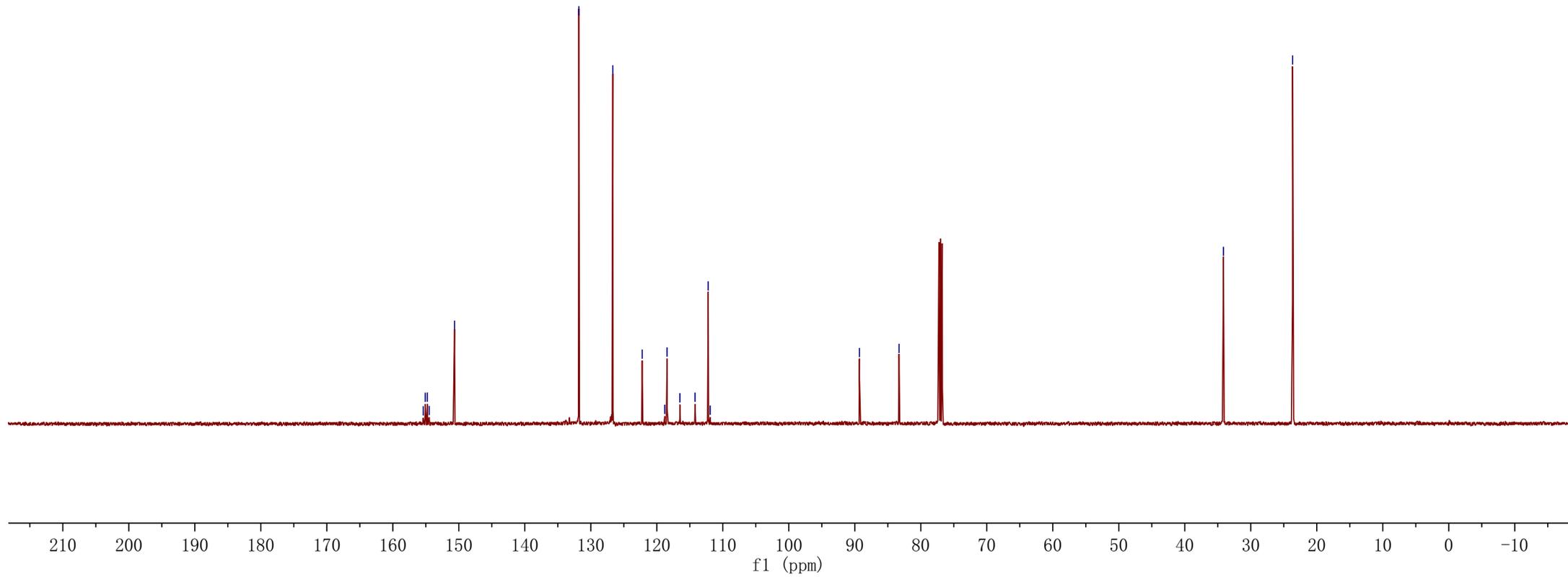
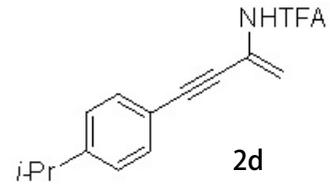
155.38  
155.08  
154.78  
154.48  
150.65

131.81  
126.67  
122.21  
118.80  
118.45  
116.50  
114.21  
112.22  
111.91

89.29  
83.29

34.14

23.66



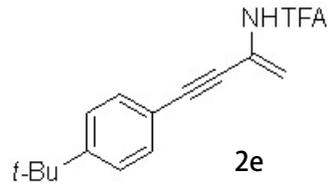
7.400  
7.342  
7.325  
7.297  
7.279

6.208

5.363

1.231

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



1.86  
1.86  
2.01

0.94

0.92

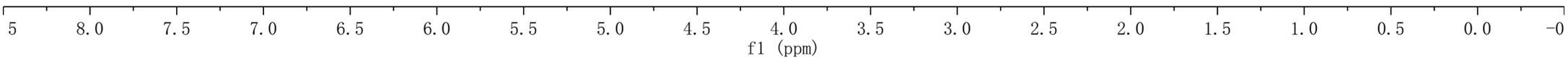
8.95

0.86  
1.86  
2.01

0.94

0.92

8.95



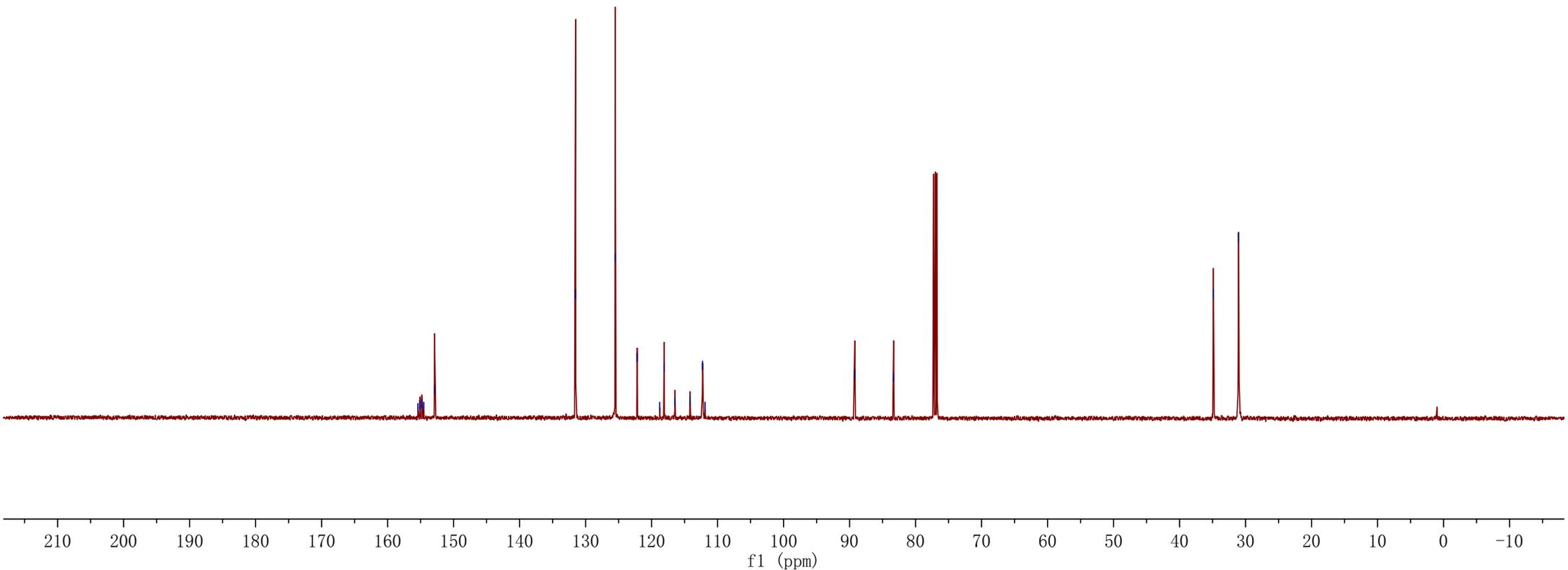
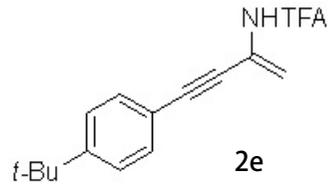
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.41  
155.11  
154.81  
154.51  
152.90

131.54  
125.53  
122.19  
118.78  
118.10  
116.49  
114.19  
112.27  
111.89

89.23  
83.34

34.88  
31.08

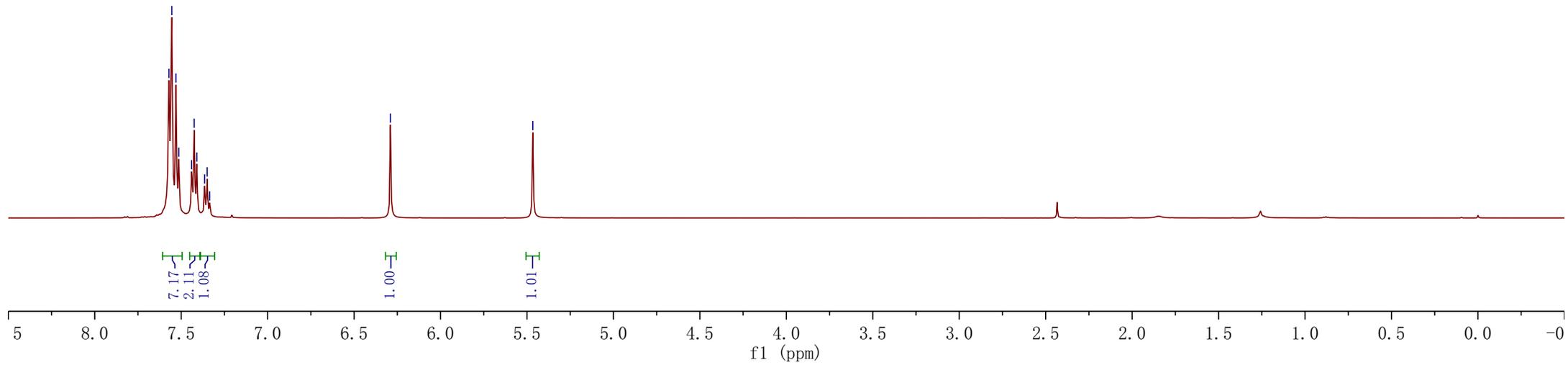
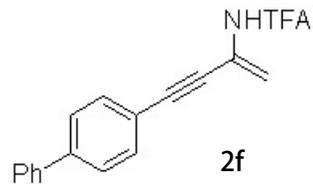
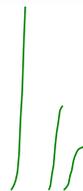


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.571  
7.554  
7.530  
7.514  
7.440  
7.425  
7.409  
7.364  
7.350  
7.335

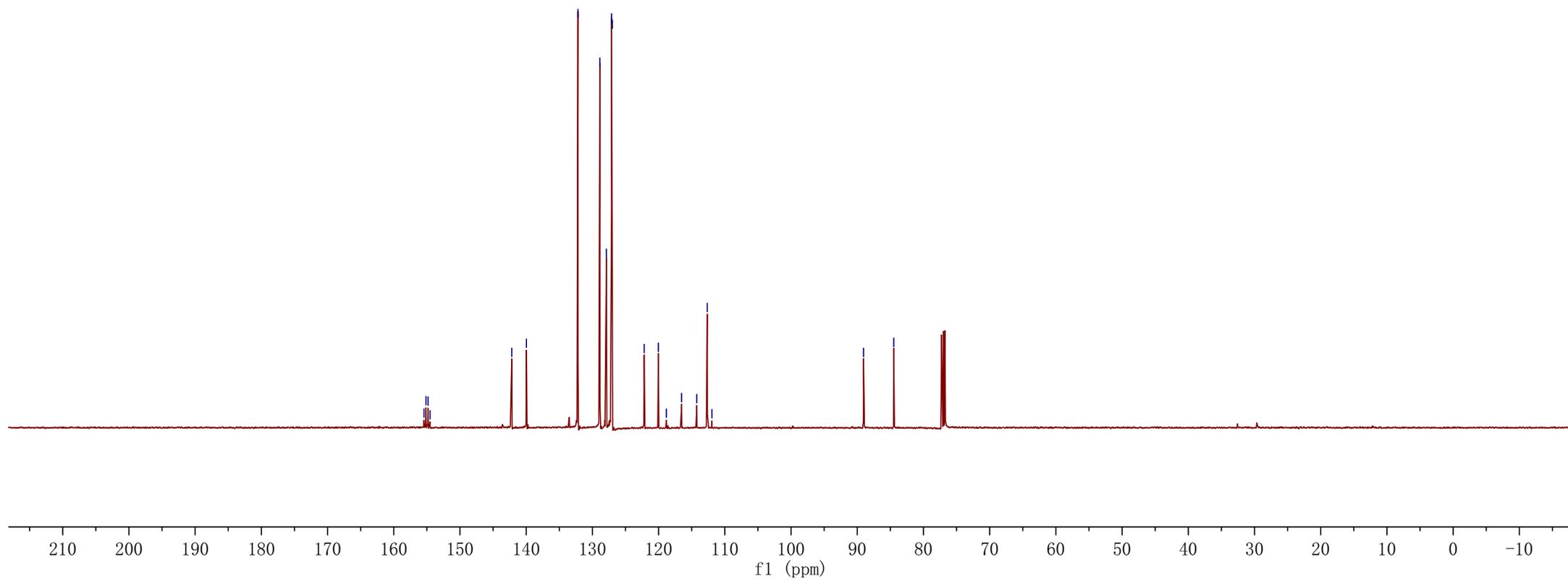
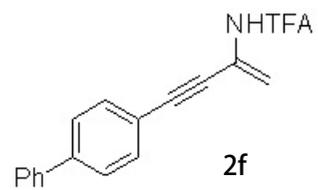
6.290

5.466



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.43  
155.12  
154.82  
154.52  
142.18  
139.96  
132.19  
128.88  
127.89  
127.11  
126.99  
122.17  
120.04  
118.83  
116.53  
114.24  
112.66  
111.94  
89.05  
84.49



Analysis:  $^1\text{H}$  NMR

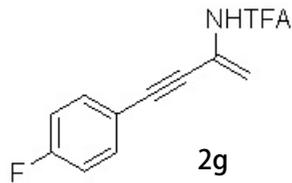
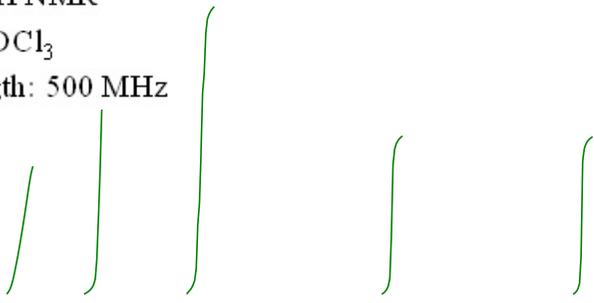
Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz

7.754  
7.462  
7.460  
7.451  
7.450  
7.444  
7.434  
7.047  
7.029  
7.012

6.237

5.446



0.89

1.95

2.00

1.10

1.09

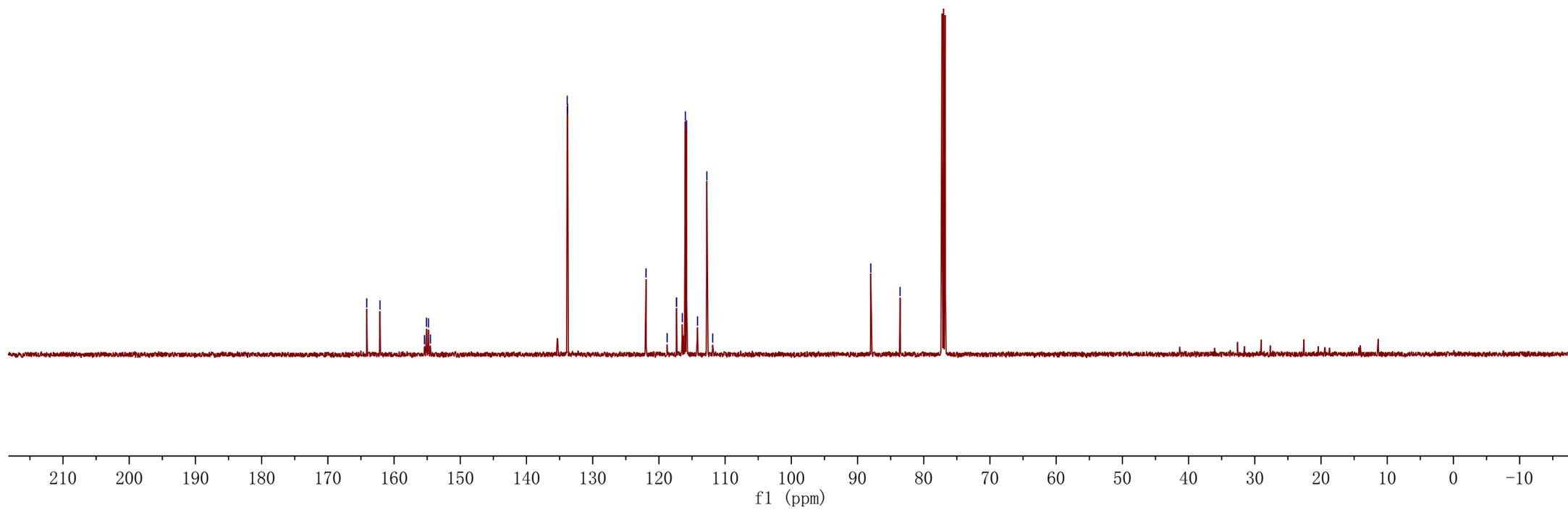
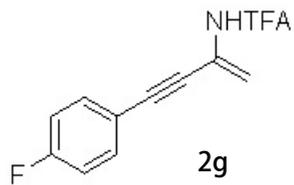
8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0

f1 (ppm)

Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 125 MHz

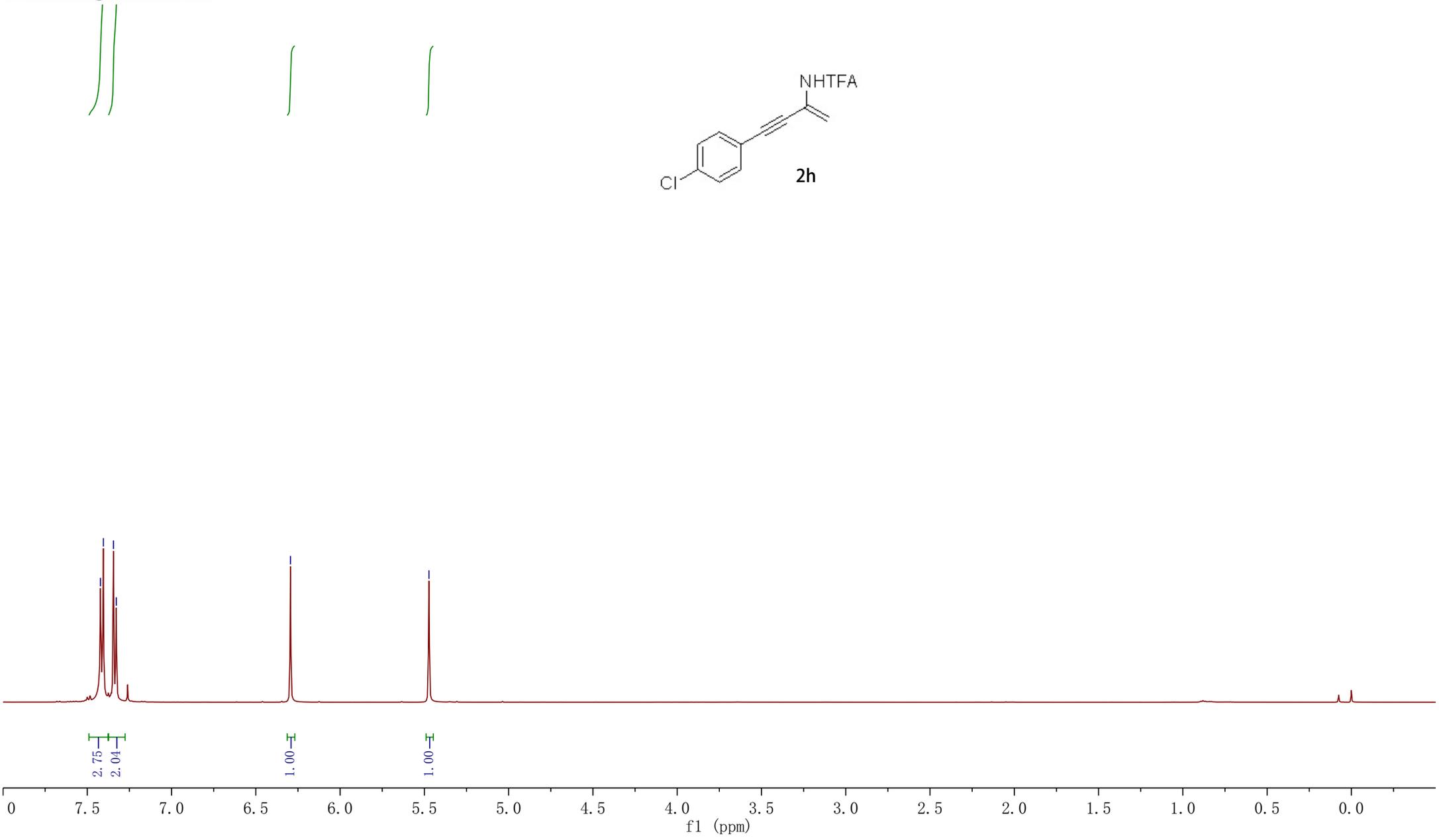
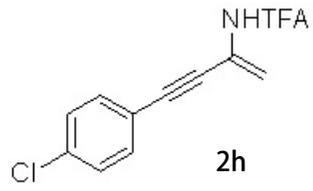


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.422  
7.405  
7.345  
7.328

6.294

5.473



Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

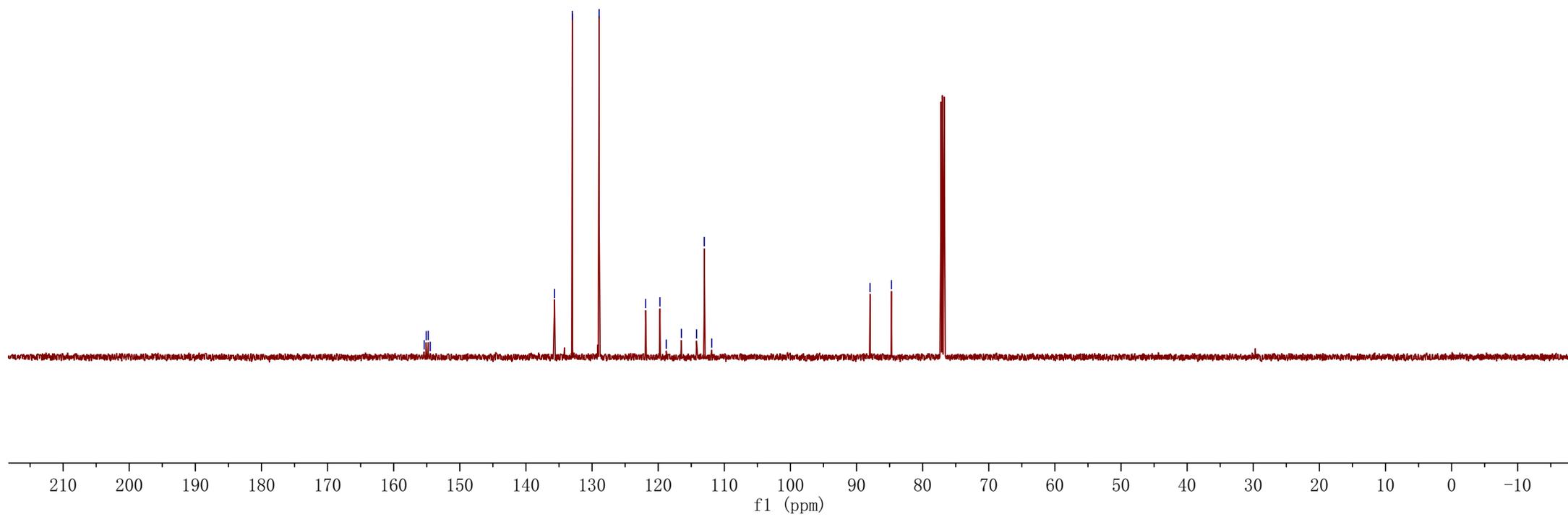
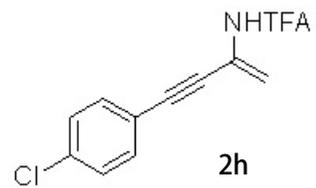
Field strength: 125 MHz

155.38  
155.08  
154.78  
154.48

135.67  
132.99  
128.93

121.91  
119.73  
118.78  
116.48  
114.19  
113.03  
111.90

87.96  
84.72

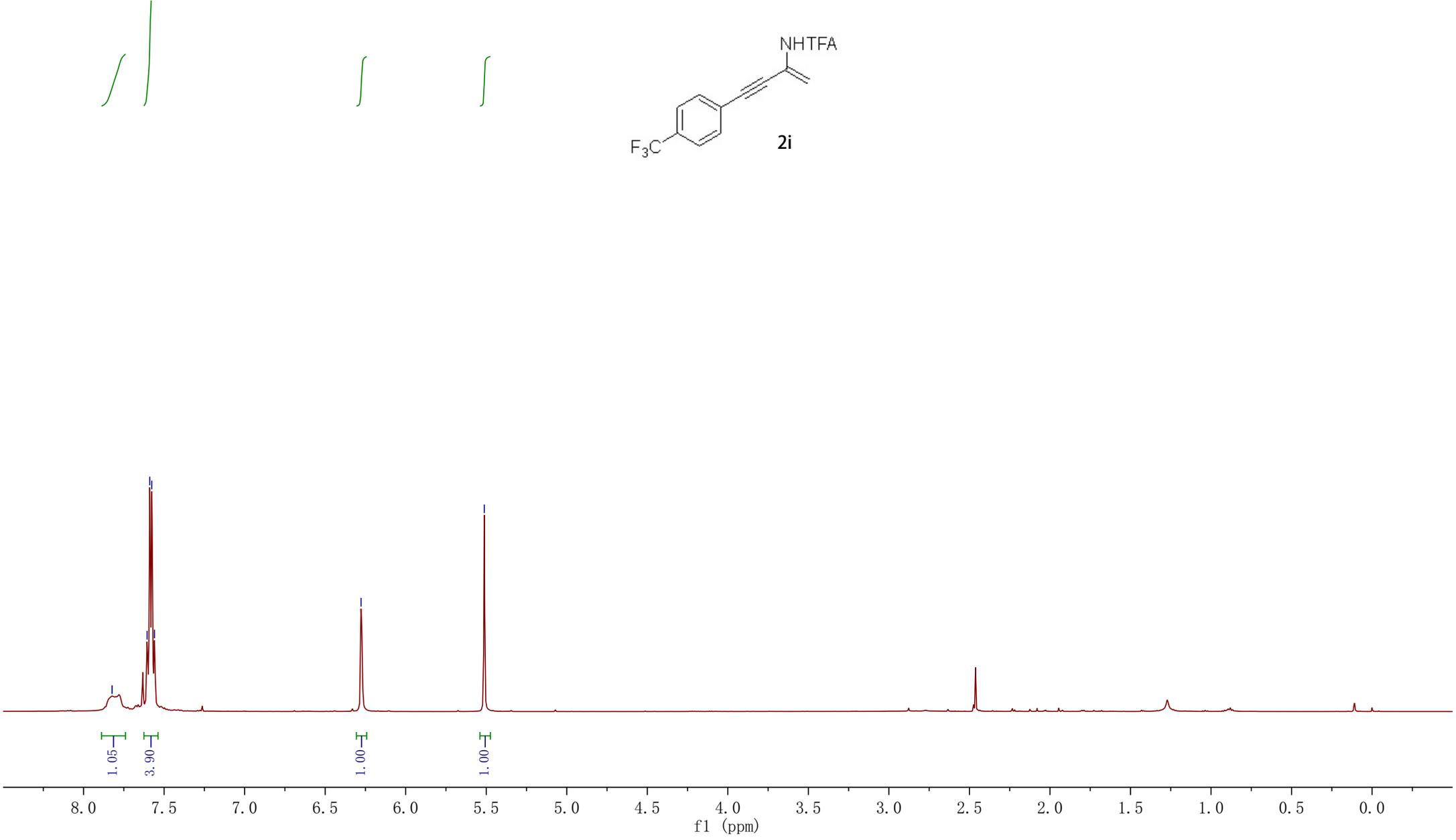
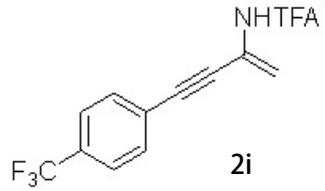


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.823  
7.605  
7.589  
7.576  
7.560

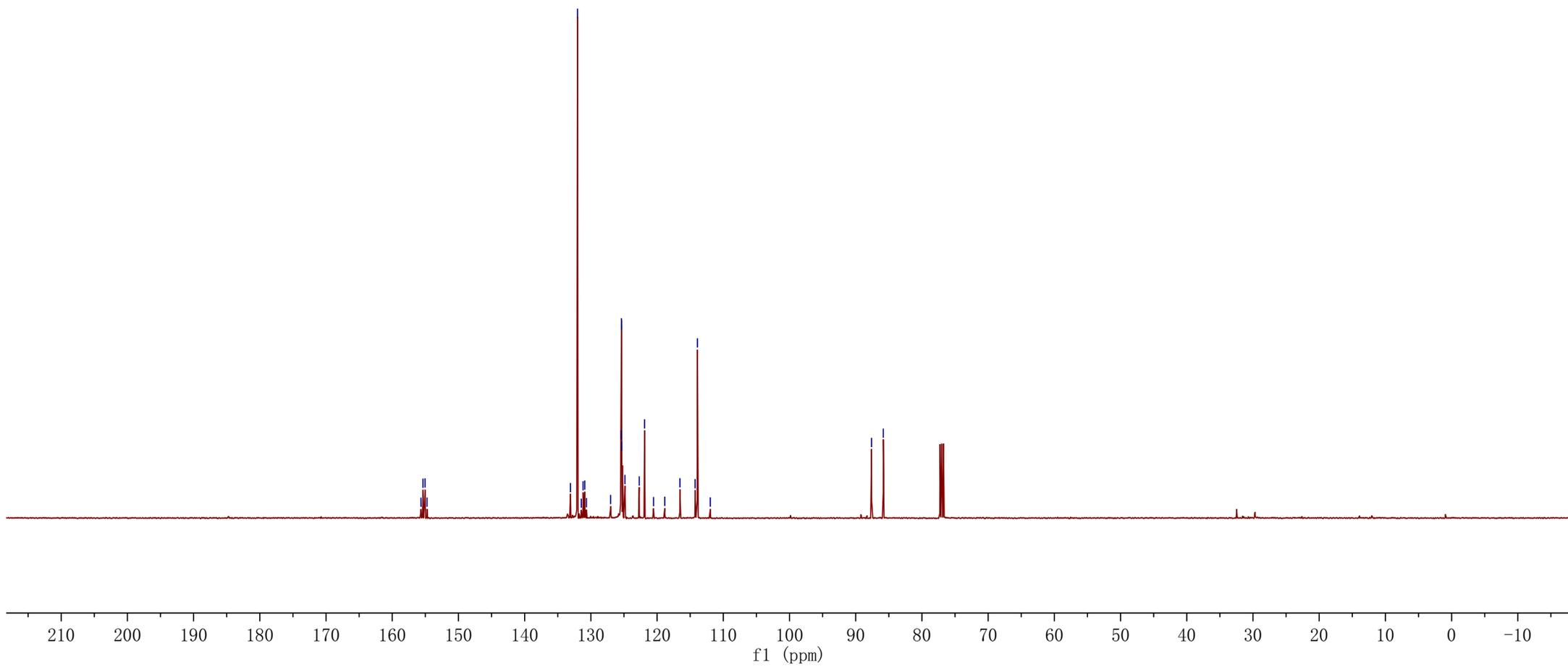
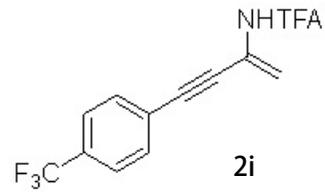
6.277

5.512



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.65  
155.35  
155.05  
154.74  
133.08  
132.02  
131.45  
131.19  
130.93  
130.66  
127.02  
125.42  
125.39  
125.36  
125.33  
124.86  
122.69  
121.89  
120.53  
118.84  
116.55  
114.26  
113.90  
111.96  
87.61  
85.84



8.024  
7.989  
7.973

7.493  
7.477

6.300

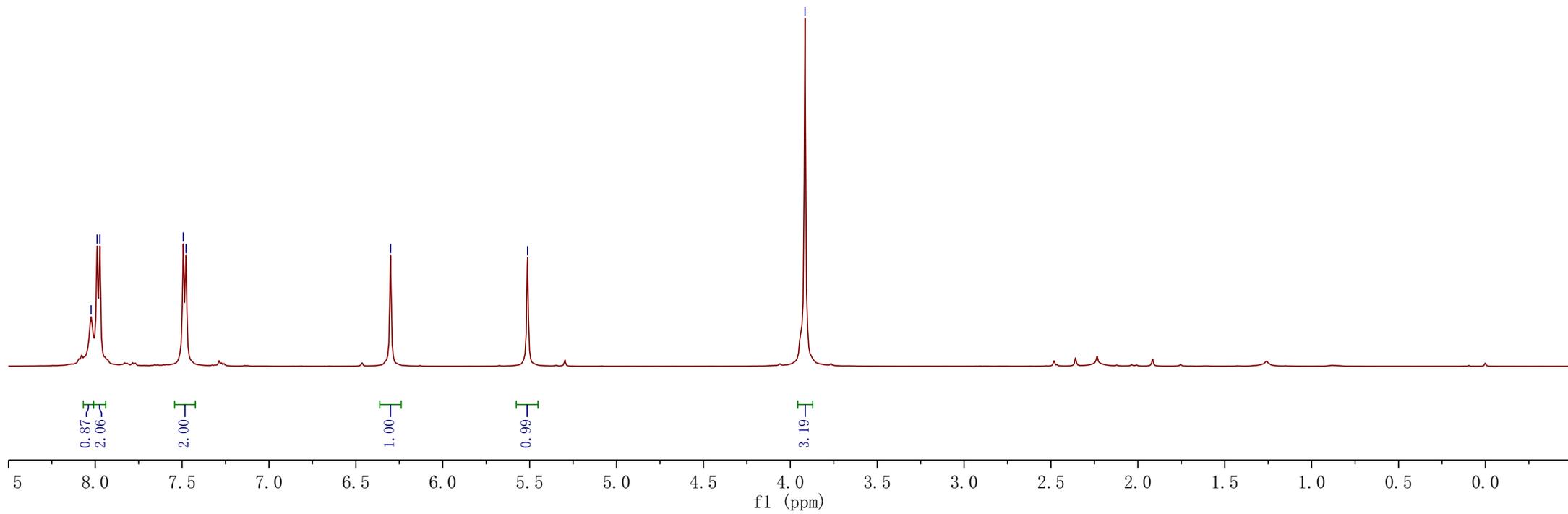
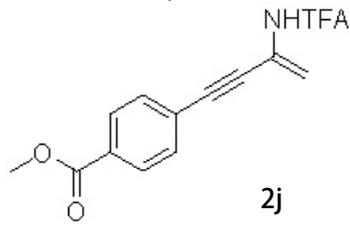
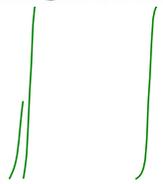
5.512

3.915

Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

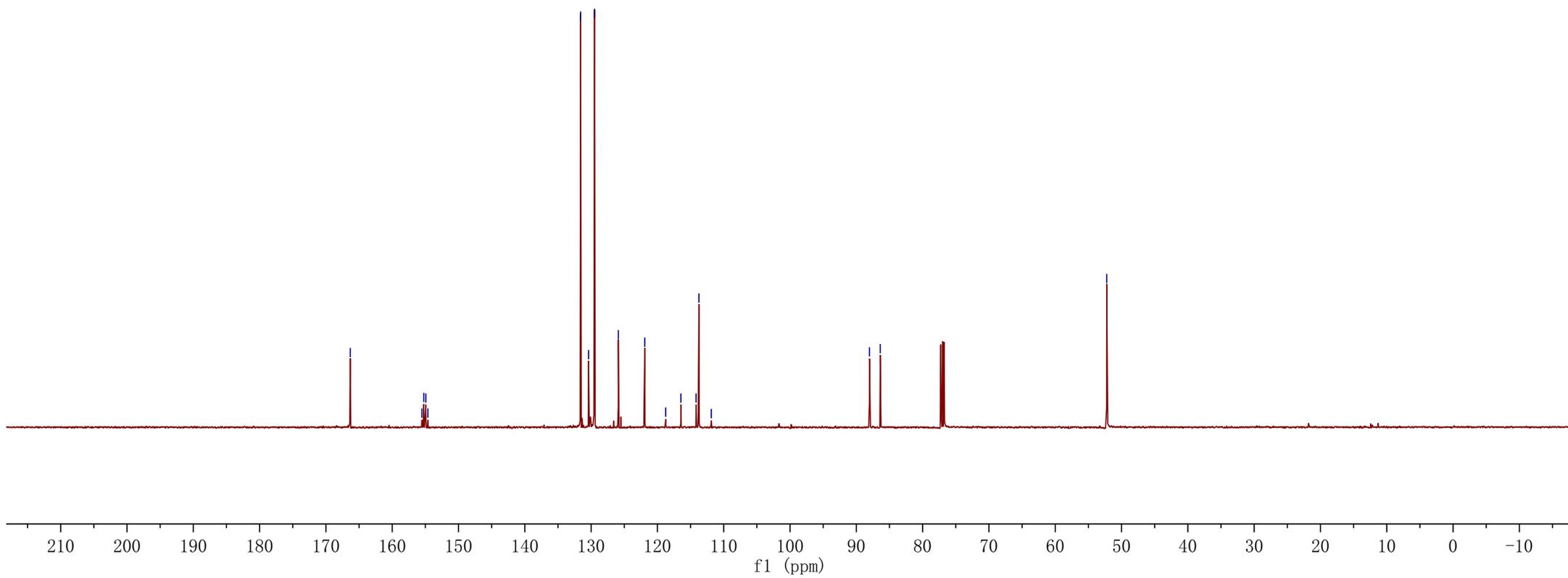
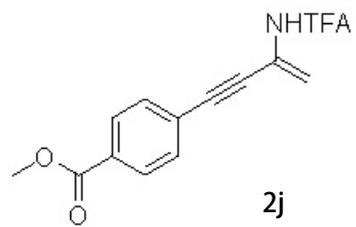
166.33

155.53  
154.93  
154.62

131.58  
130.39  
129.48  
125.89  
121.91  
118.76  
116.46  
114.17  
113.74  
111.87

88.02  
86.40

52.23



7.623  
7.298  
7.285  
7.270  
7.241  
7.226  
7.211  
7.185  
7.170

6.262

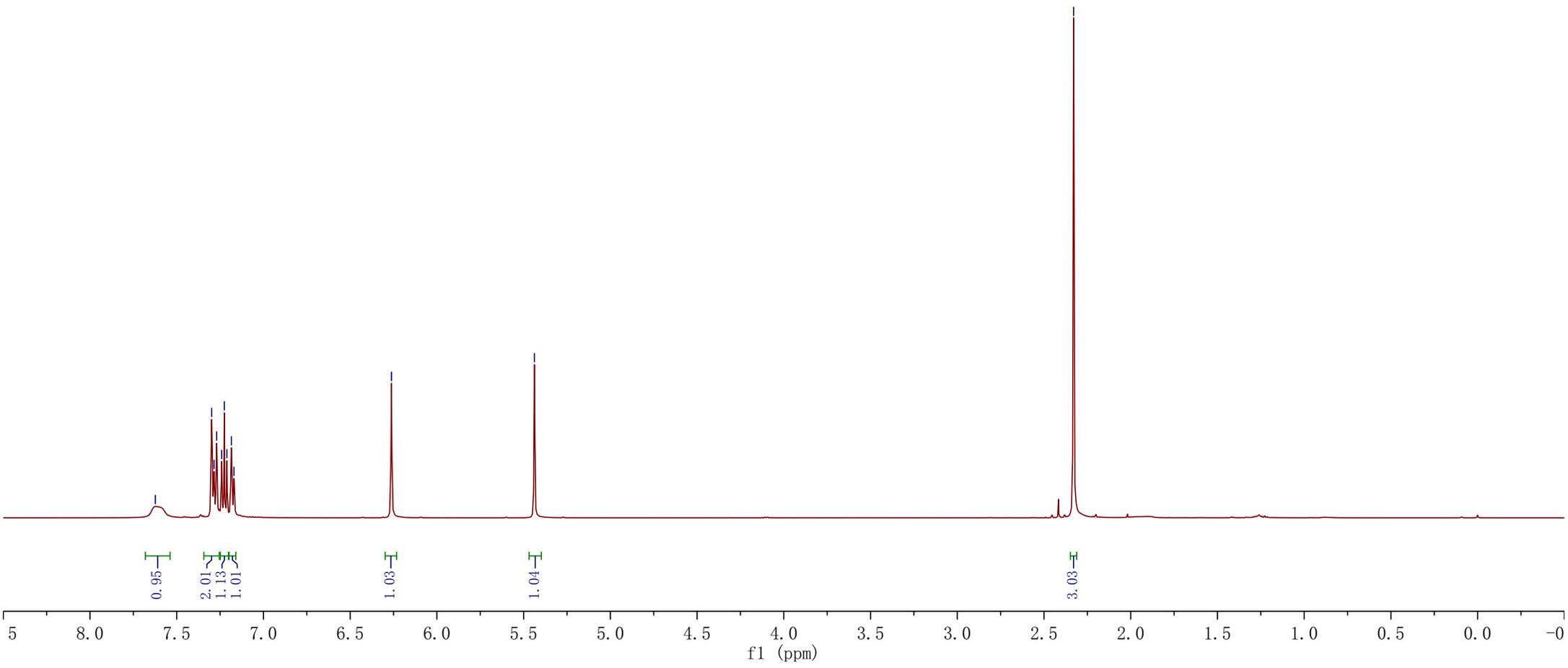
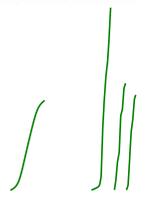
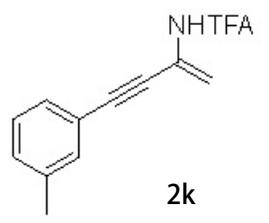
5.438

2.329

Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



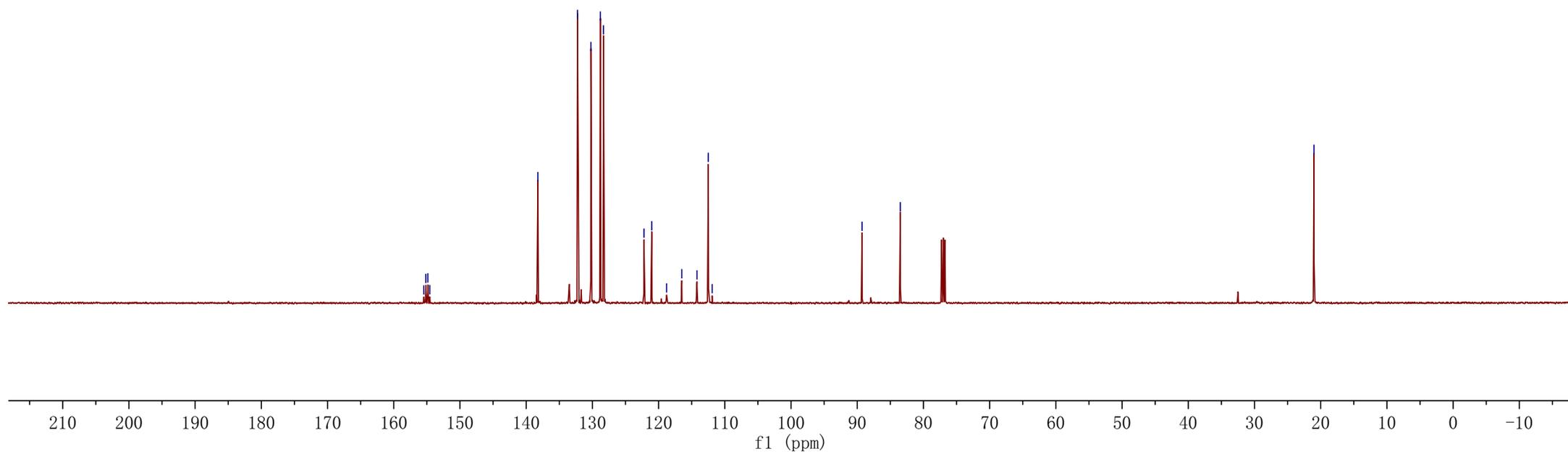
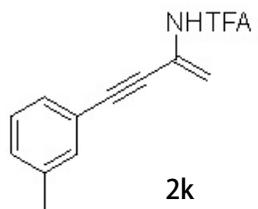
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.45  
155.15  
154.85  
154.55

138.23  
132.25  
130.23  
128.80  
128.33  
122.21  
121.04  
118.79  
116.49  
114.20  
112.49  
111.91

89.27  
83.49

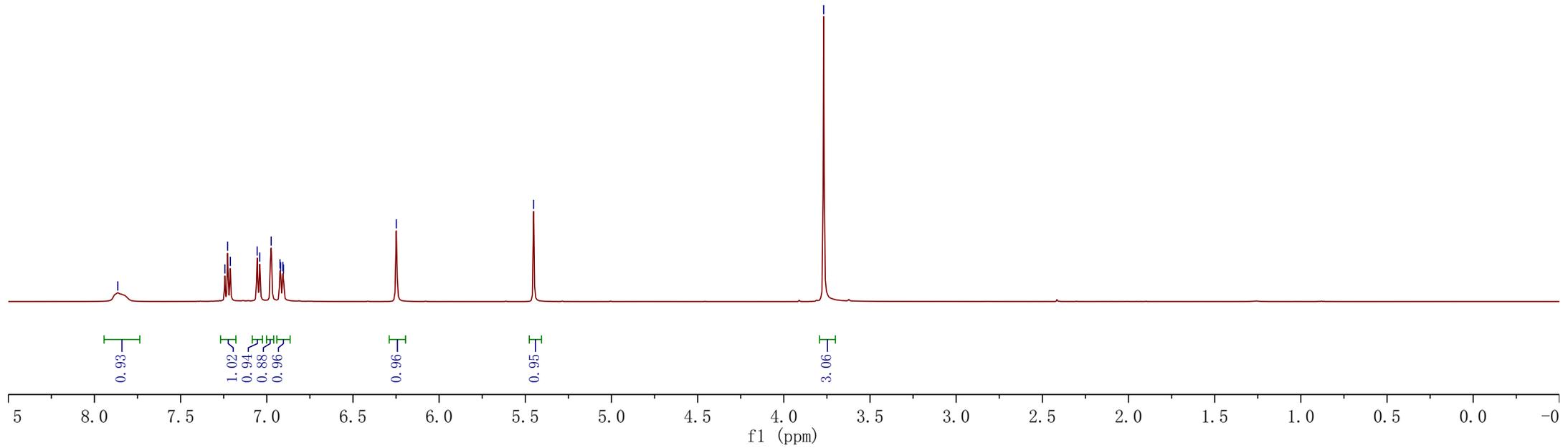
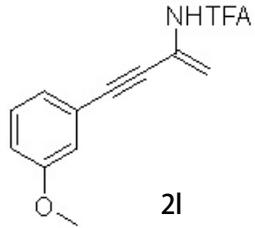
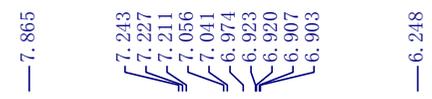
21.01



Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



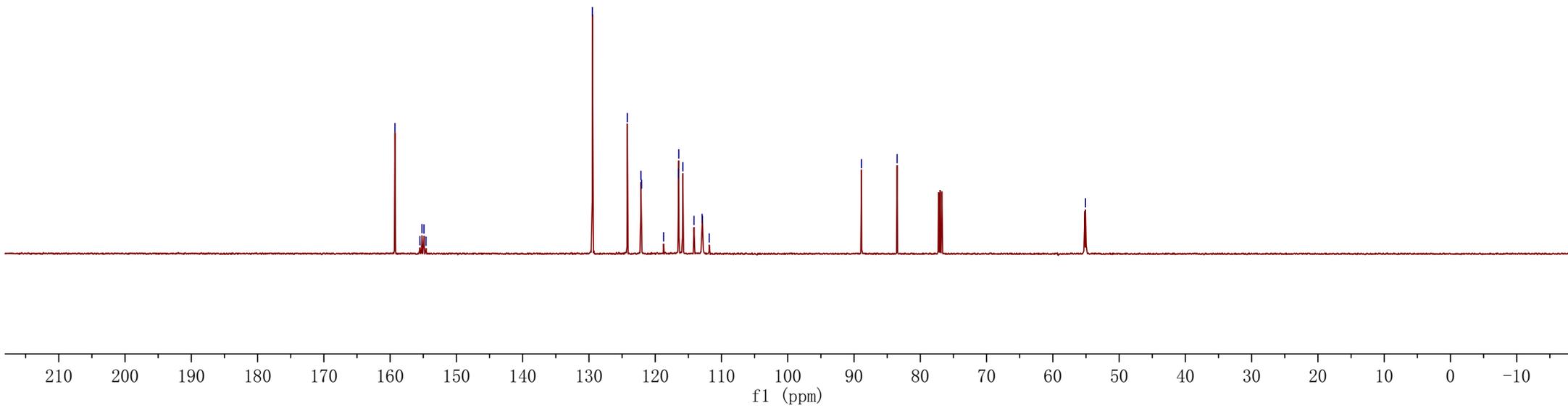
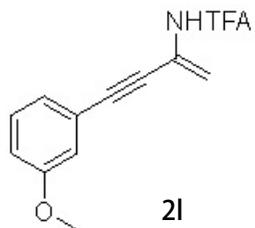
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

159.27  
155.50  
155.19  
154.90  
154.59

129.49  
124.21  
122.16  
122.06  
118.73  
116.48  
116.44  
115.83  
114.14  
112.93  
111.85

88.87  
83.50

55.07

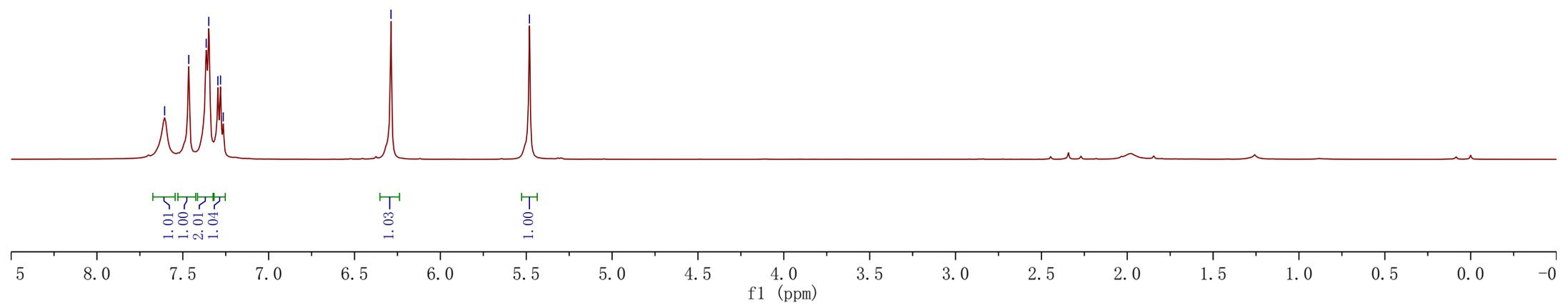
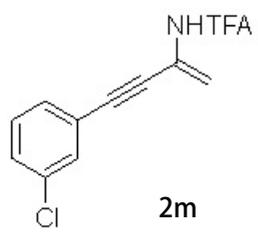
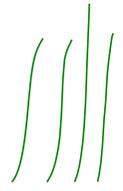


Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 500 MHz

7.606  
7.465  
7.364  
7.349  
7.296  
7.280  
7.264

6.288

5.481

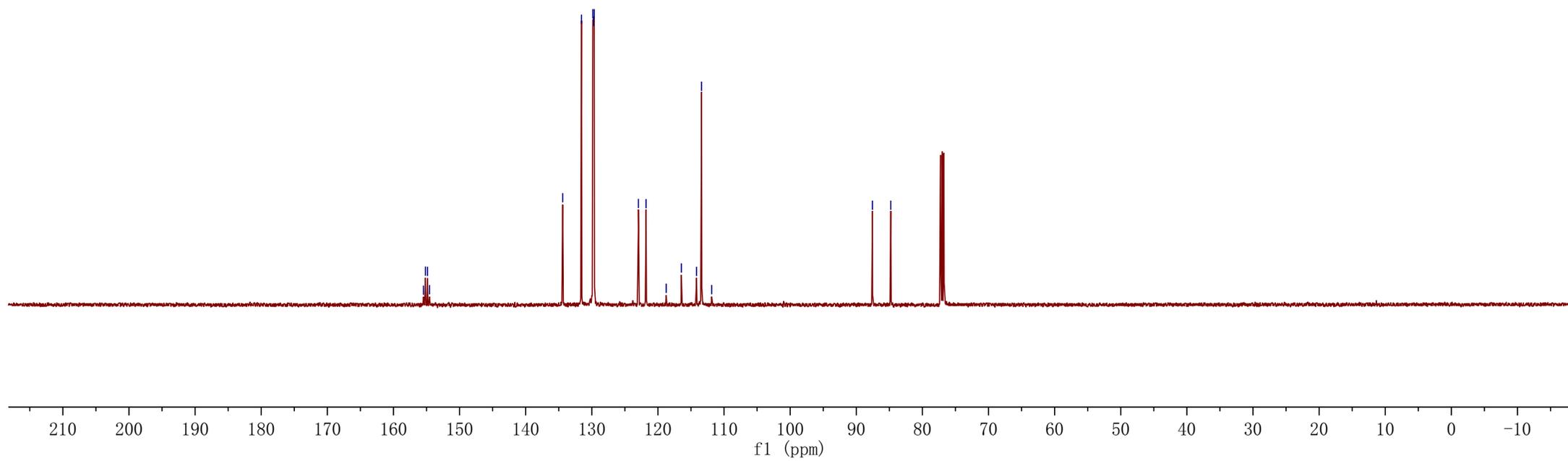
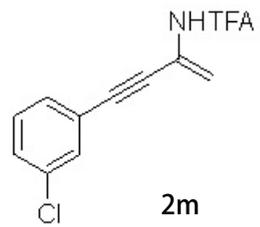


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

155.46  
155.16  
154.86  
154.55

134.40  
131.56  
129.84  
129.72  
129.63  
122.95  
121.80  
118.75  
116.45  
114.16  
113.40  
111.86

87.56  
84.79



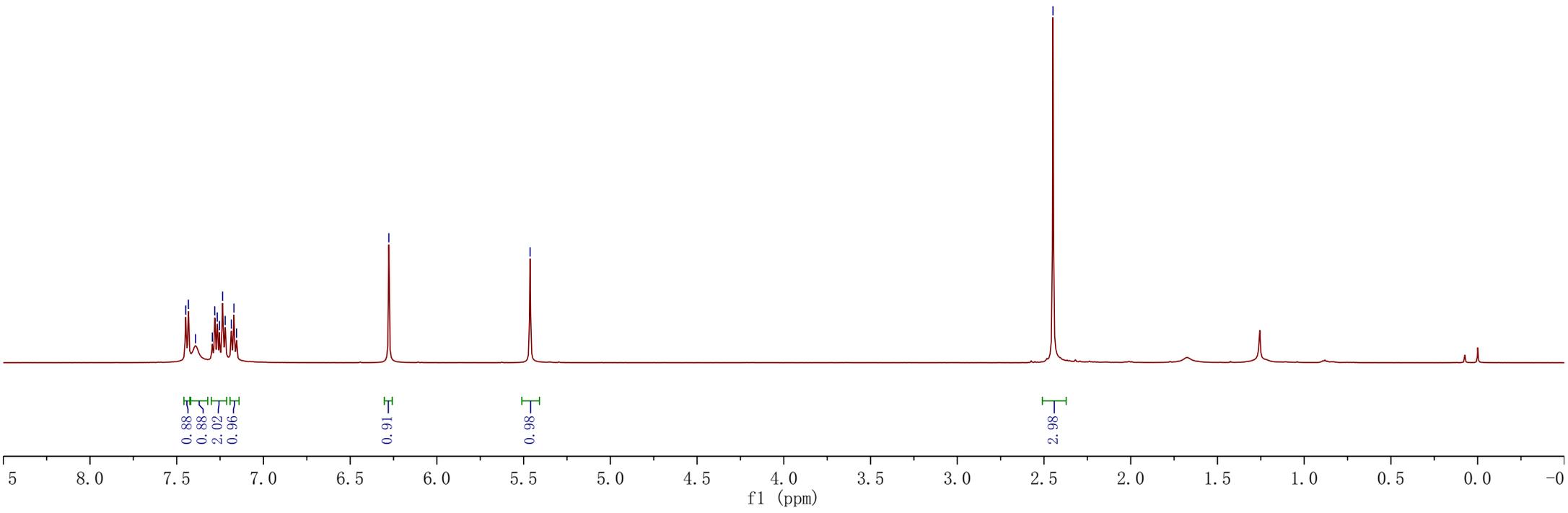
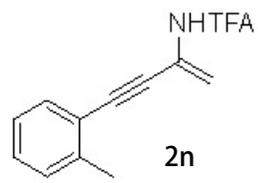
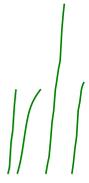
Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.448  
7.433  
7.392  
7.294  
7.281  
7.266  
7.254  
7.235  
7.220  
7.185  
7.170  
7.155

6.277

5.463

2.448

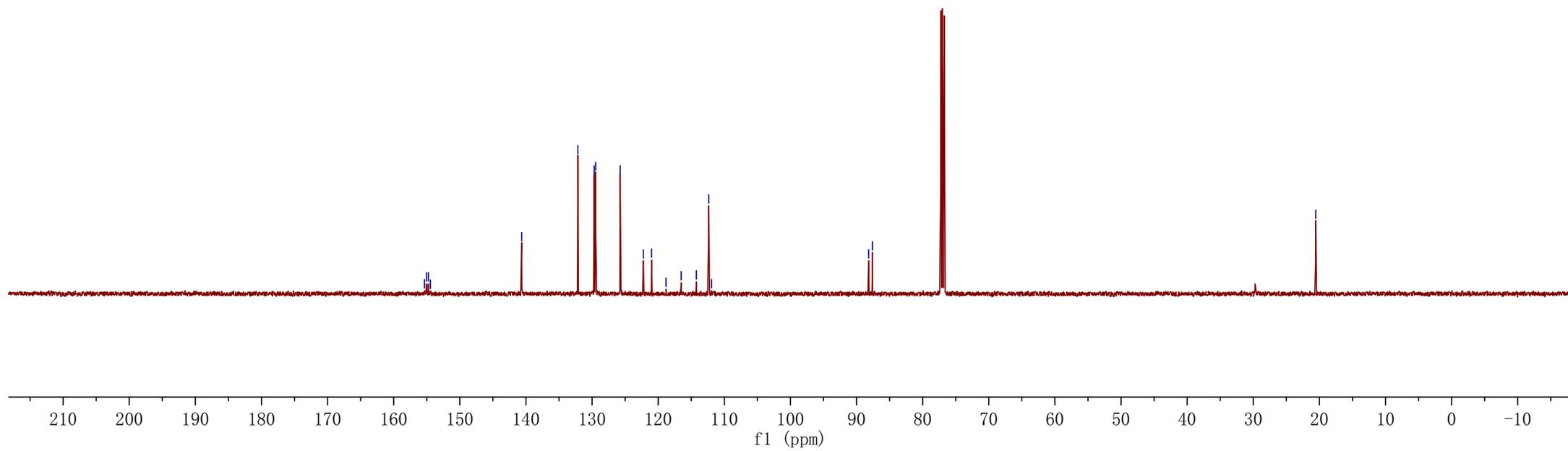
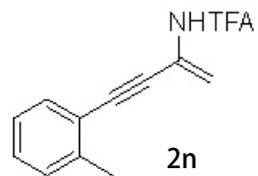


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.35  
155.05  
154.74  
154.45  
140.65  
132.15  
129.69  
129.46  
125.75  
122.24  
121.01  
118.82  
116.52  
114.23  
112.35  
111.93

88.17  
87.60

20.55



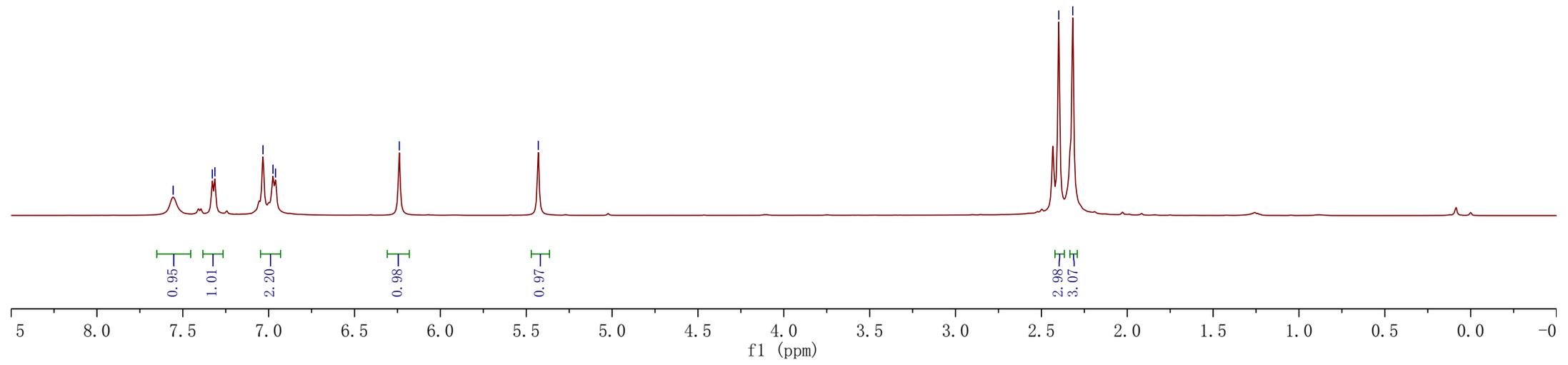
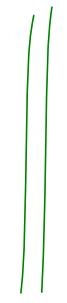
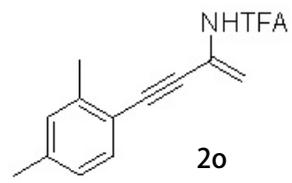
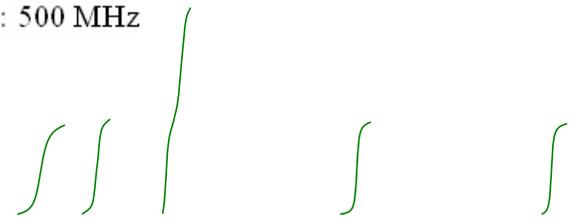
7.556  
7.328  
7.313  
7.033  
6.975  
6.960

6.239

5.430

2.399  
2.317

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

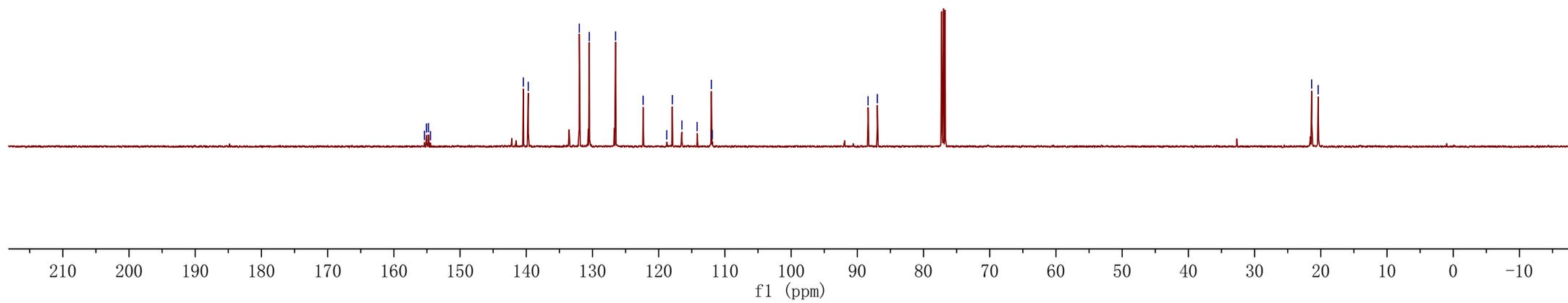
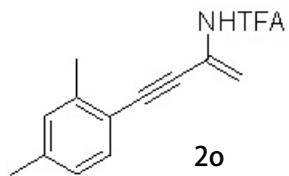


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.37  
155.07  
154.77  
154.47  
140.44  
139.70  
131.99  
130.48  
126.52  
122.36  
118.79  
117.94  
116.49  
114.20  
112.04  
111.90

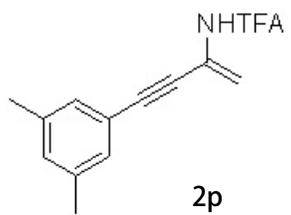
88.38  
86.98

21.38  
20.40

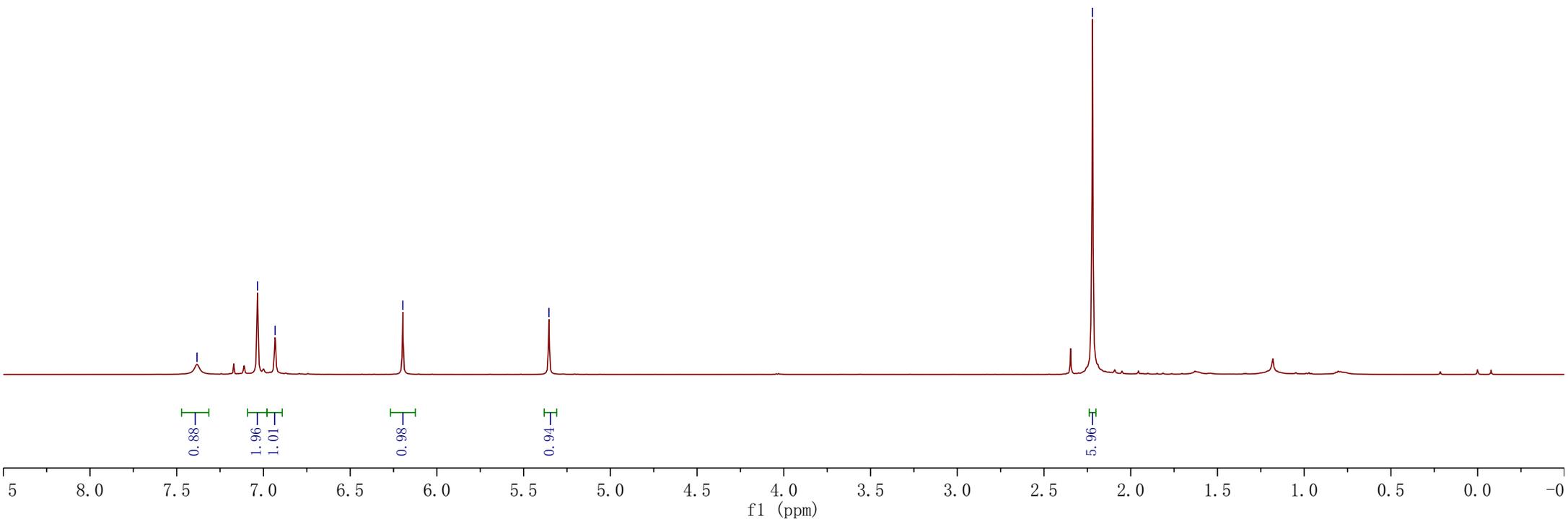


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

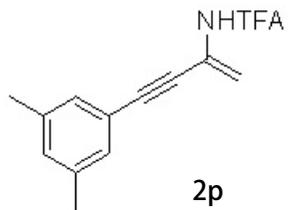
7.383  
7.034  
6.933  
6.197  
5.354



2.220



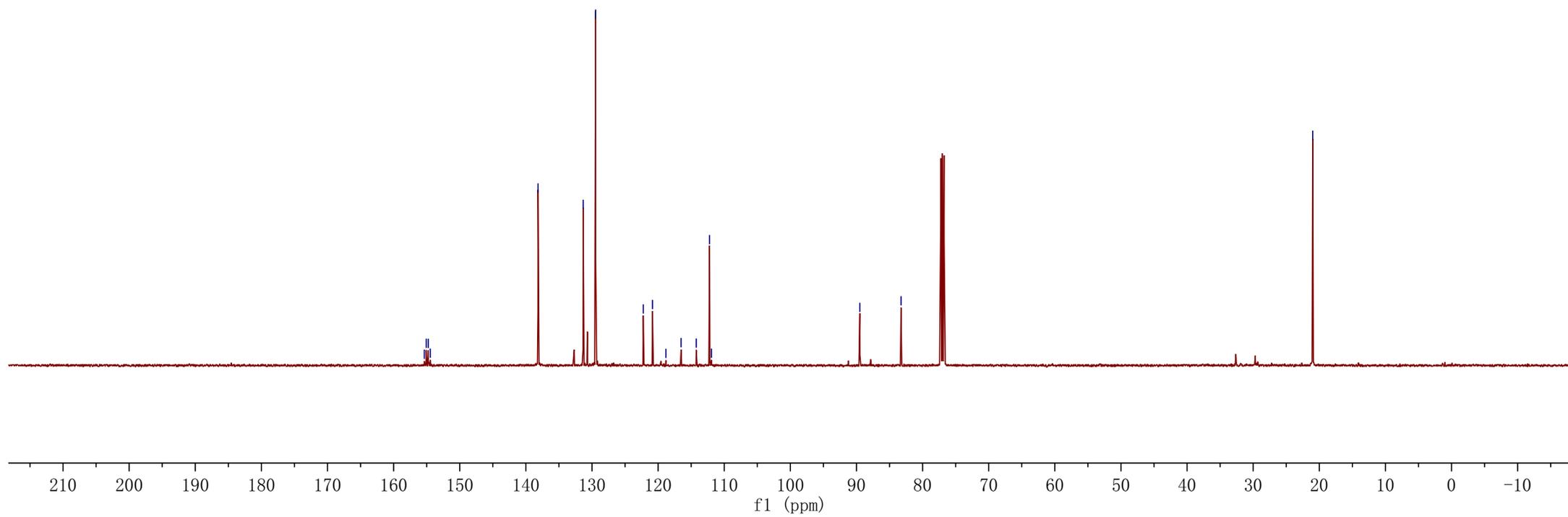
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



155.36  
155.06  
154.76  
154.46  
138.16  
131.33  
129.45  
122.24  
120.85  
118.82  
116.53  
114.23  
112.22  
111.94

89.50  
83.26

20.99

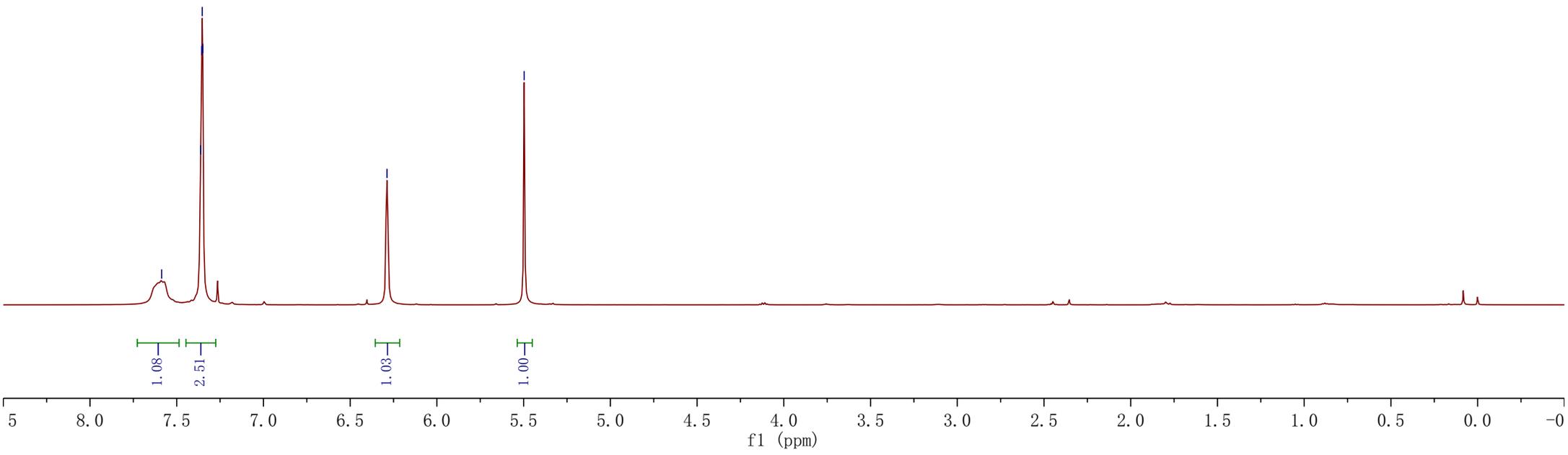
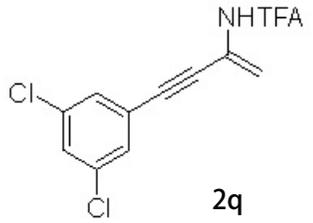
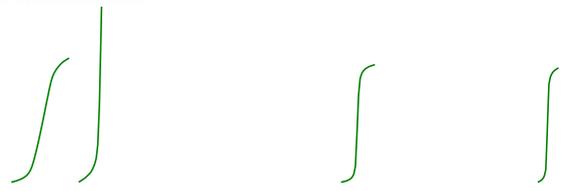


7.587  
7.362  
7.355  
7.353  
7.350

6.288

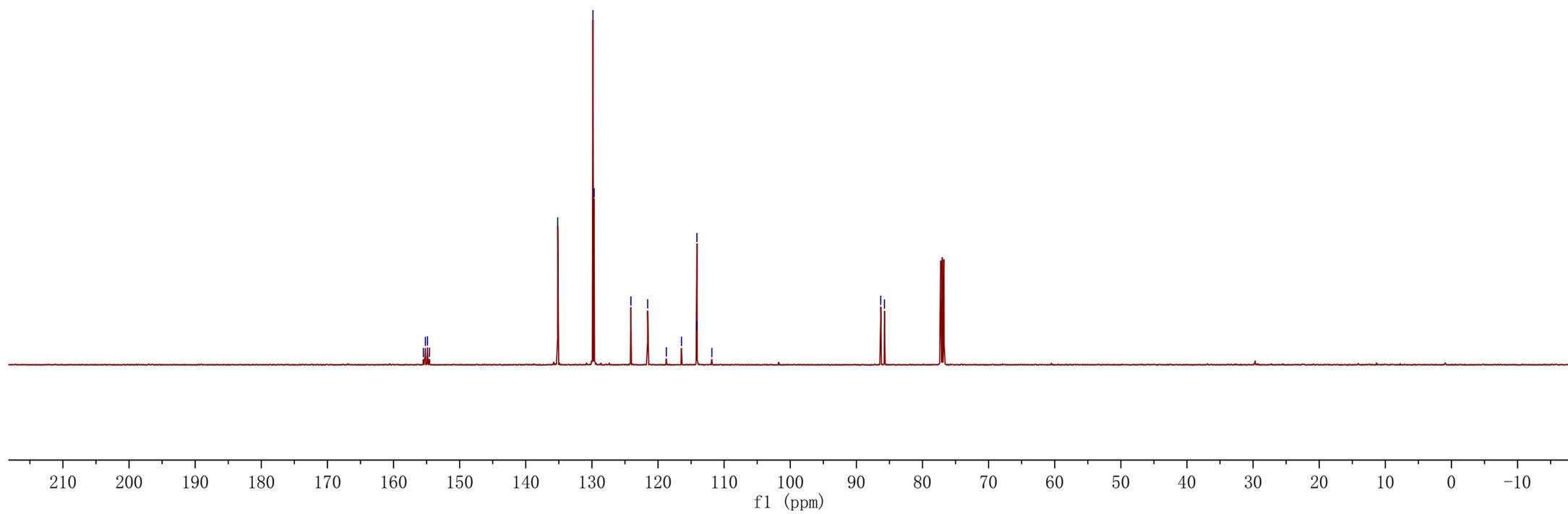
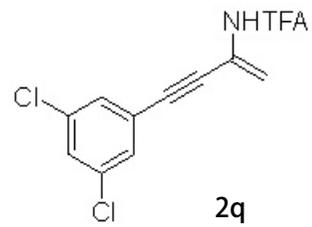
5.497

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



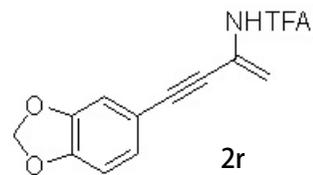
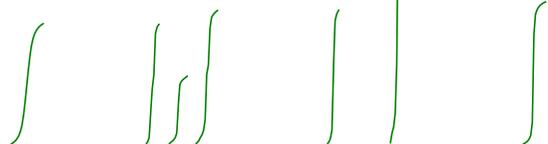
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.48  
155.18  
154.87  
154.57  
135.17  
129.84  
129.66  
124.10  
121.56  
118.74  
116.44  
114.14  
114.12  
111.85  
86.32  
85.76

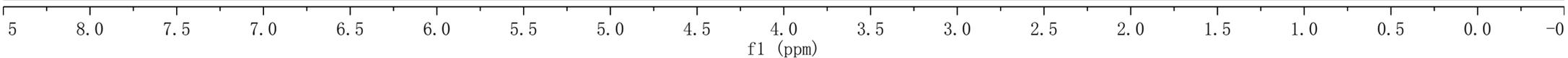


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.531  
7.016  
7.013  
6.999  
6.997  
6.901  
6.785  
6.769  
6.254  
5.989  
5.422



0.90  
0.89  
0.51  
1.00  
1.00  
2.14  
1.06

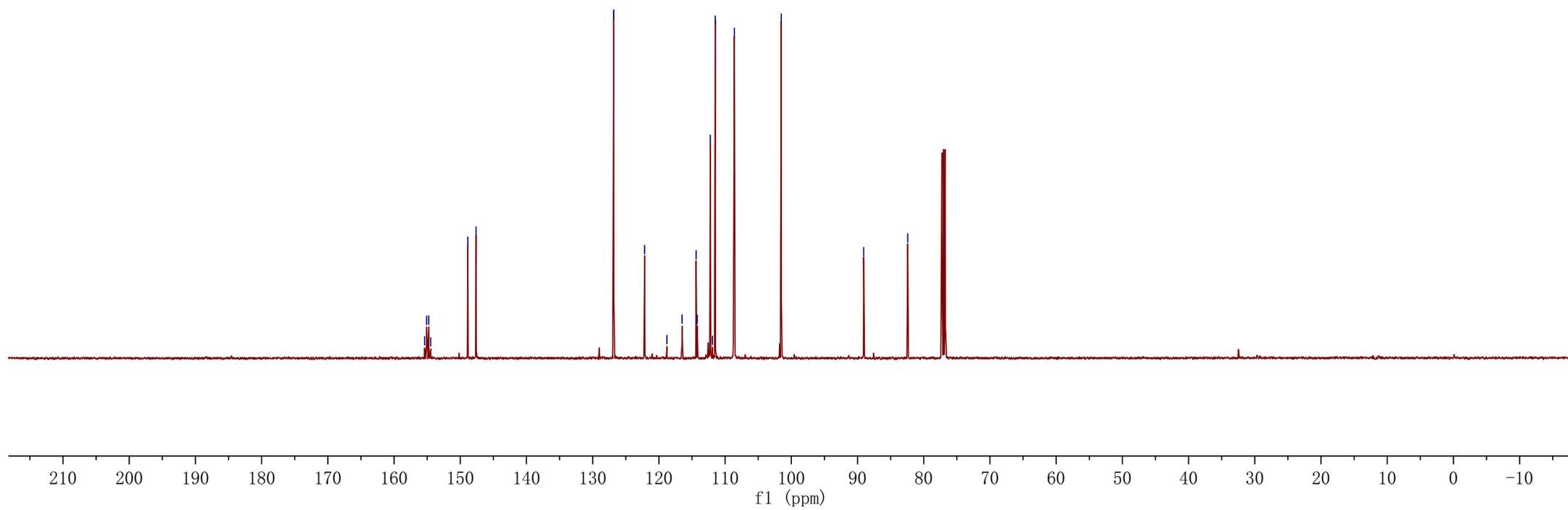
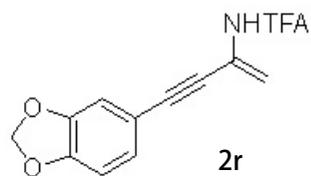


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.37  
155.07  
154.77  
154.47  
148.85  
147.61

126.82  
122.16  
118.80  
116.50  
114.37  
114.21  
112.23  
111.91  
111.49  
108.59  
101.51

89.07  
82.42



8.000  
7.798  
7.778  
7.549  
7.505  
7.490  
7.469

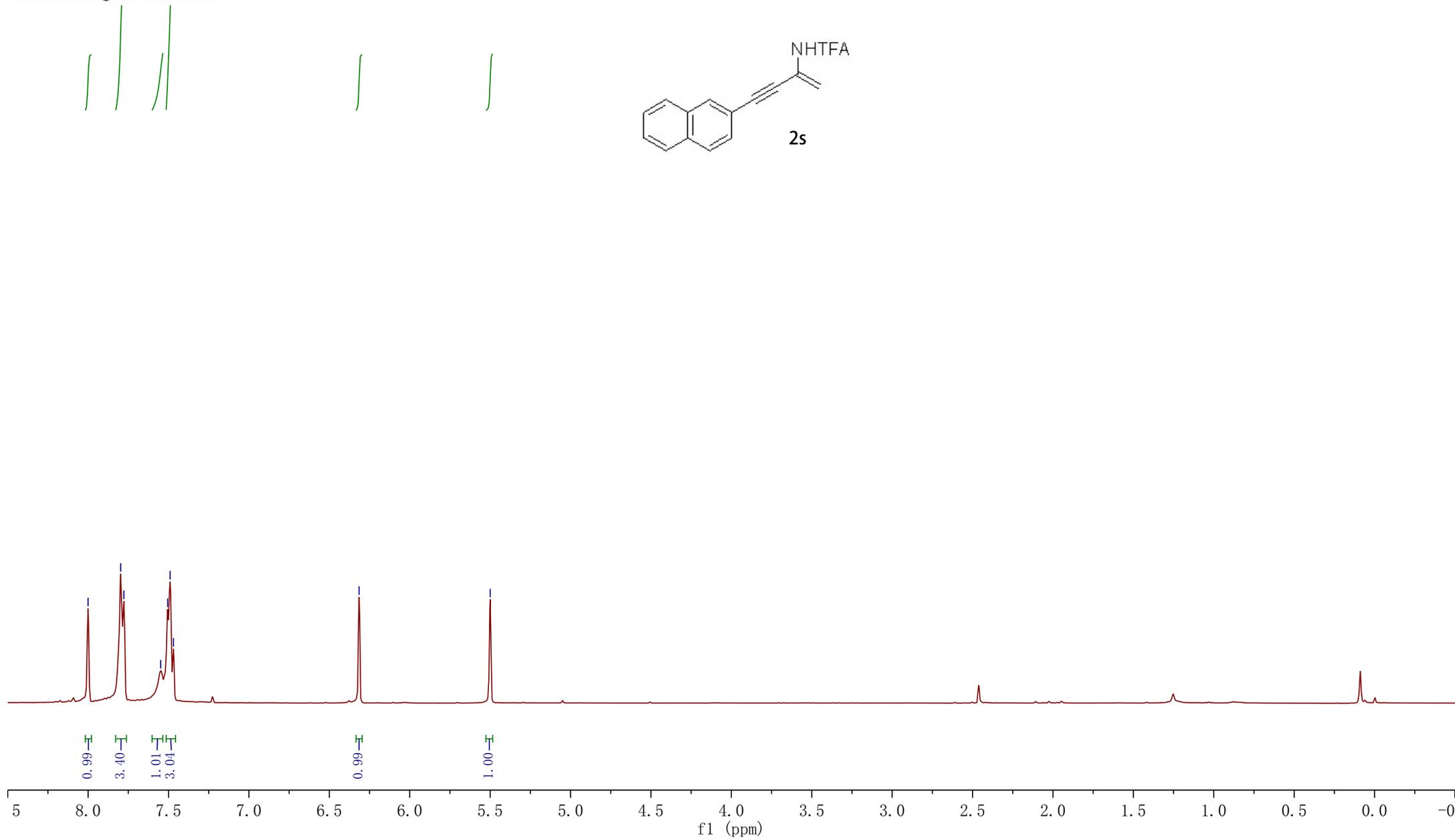
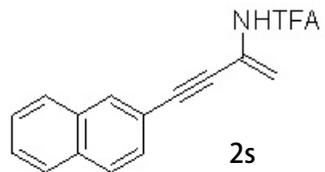
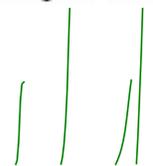
6.315

5.500

Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



155.56  
155.18  
154.81  
154.43

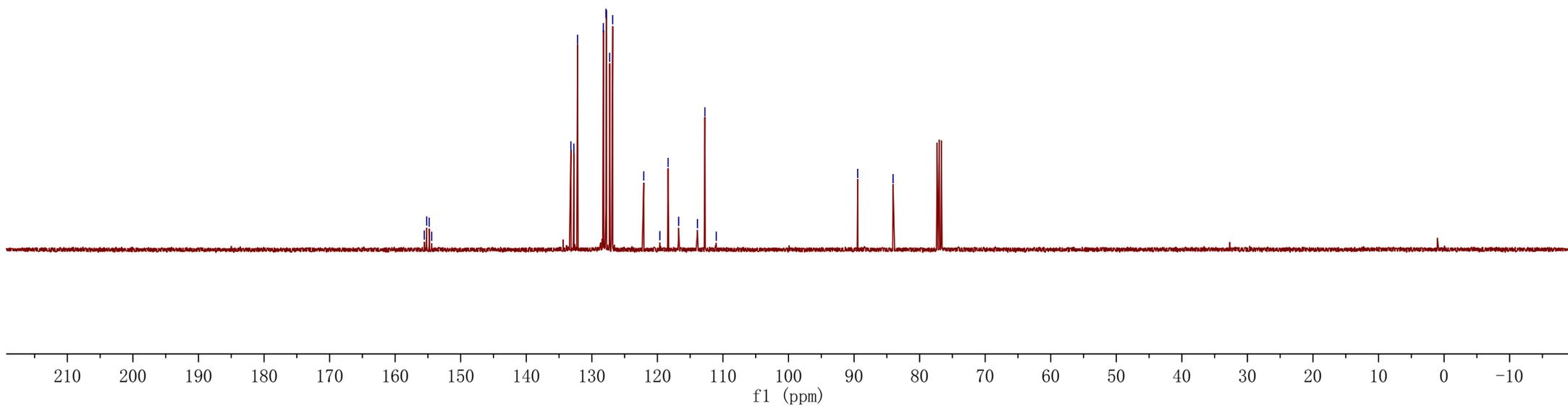
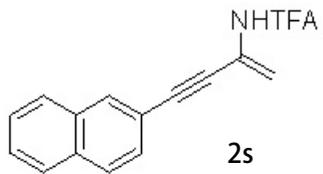
133.20  
132.74  
132.18  
128.25  
127.85  
127.79  
127.28  
126.82  
122.09  
119.62  
118.37  
116.75  
113.88  
112.75  
111.01

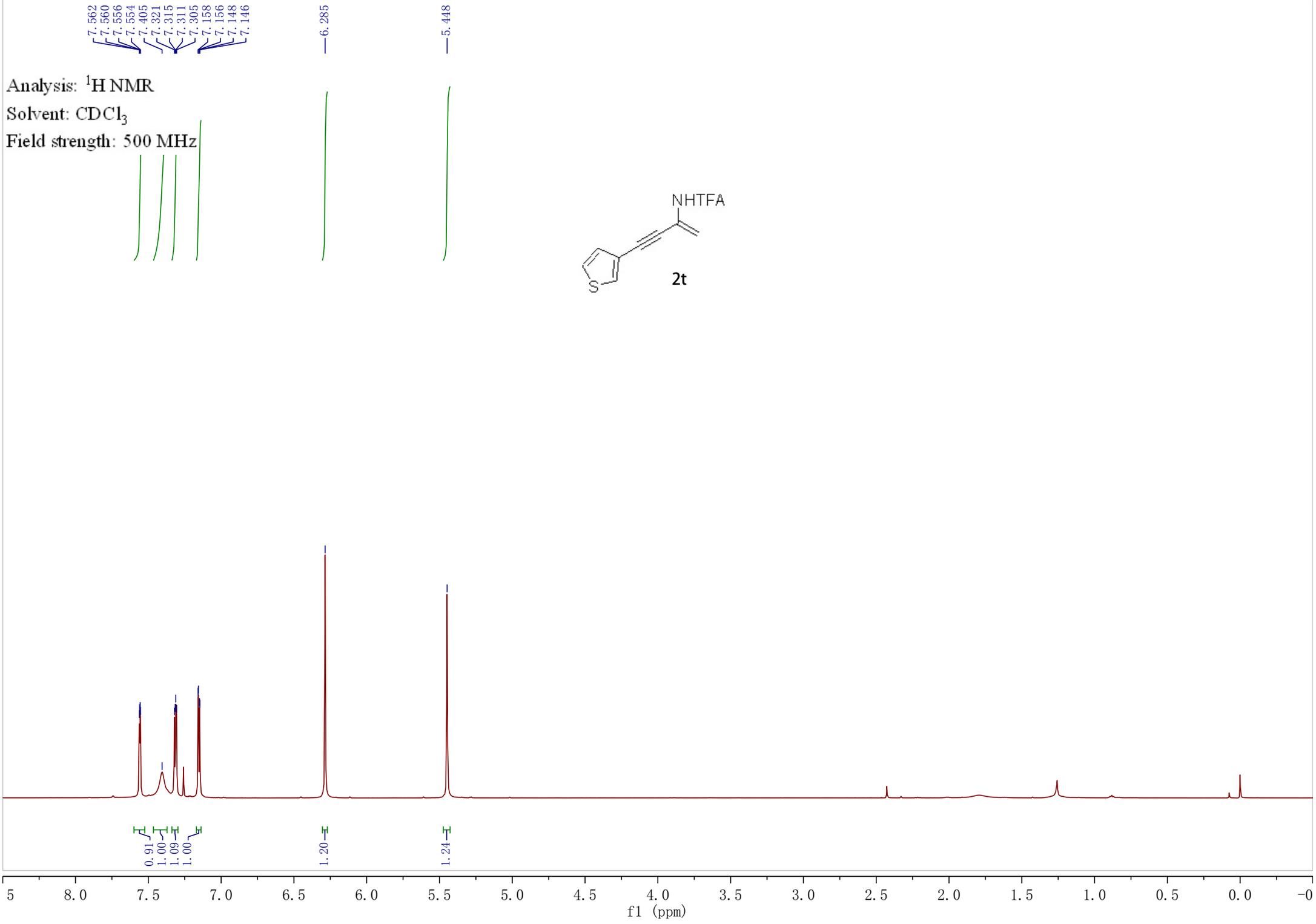
89.45  
84.05

Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 100 MHz



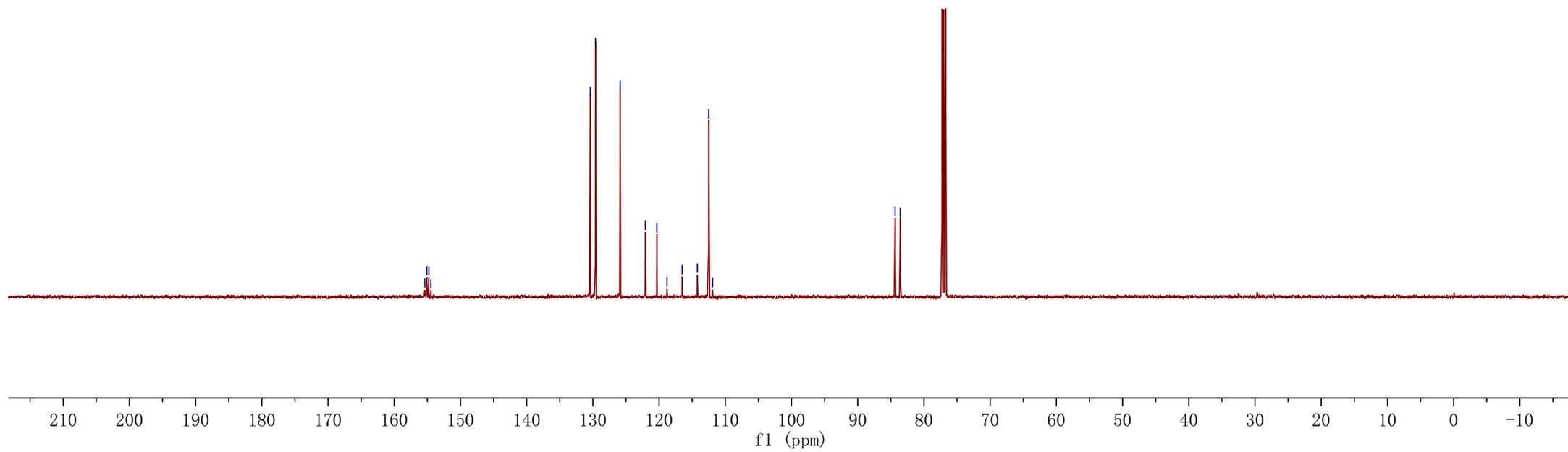
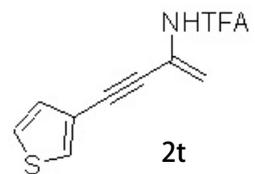


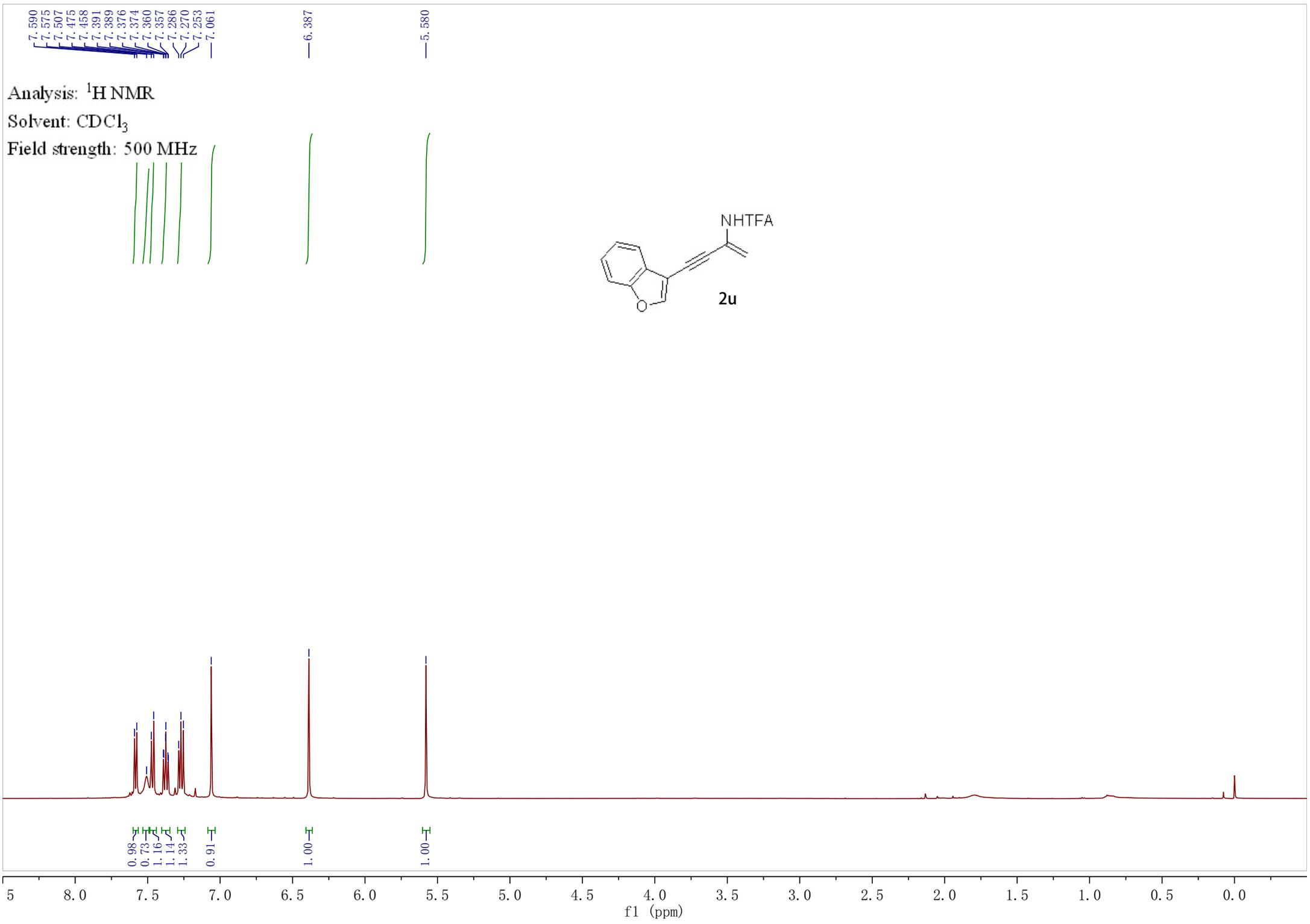
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.38  
155.07  
154.77  
154.47

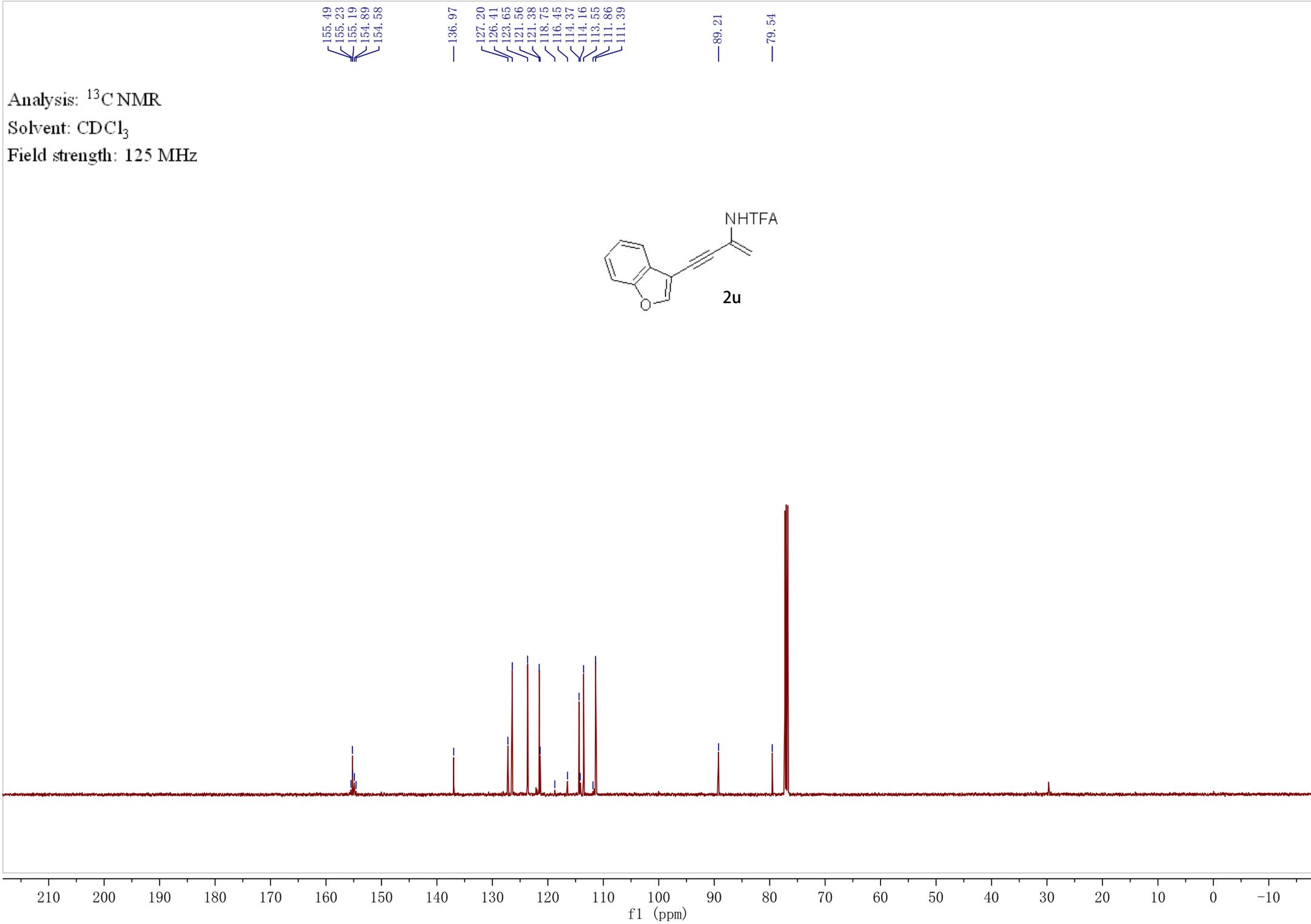
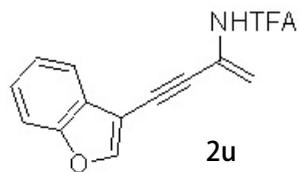
130.40  
129.61  
125.88  
122.07  
120.34  
118.81  
116.51  
114.22  
112.51  
111.92

84.36  
83.57





Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



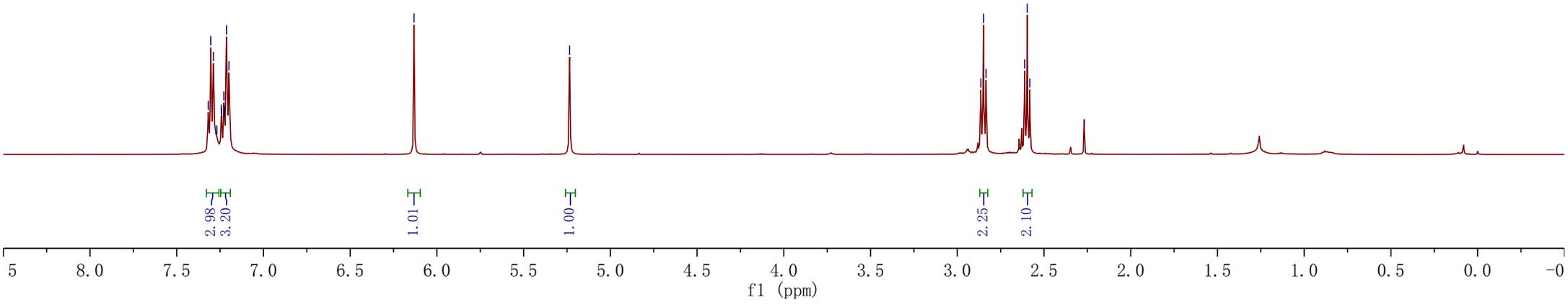
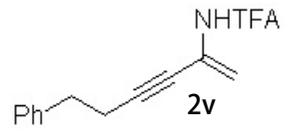
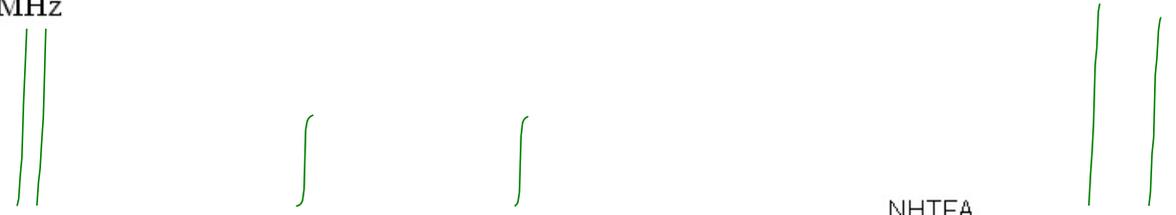
7.318  
7.304  
7.289  
7.269  
7.243  
7.241  
7.228  
7.224  
7.213  
7.199

6.132

5.235

2.864  
2.849  
2.834  
2.611  
2.597  
2.582

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



155.24  
154.94  
154.64  
154.34

139.95

128.48  
128.40  
126.52  
122.07  
118.70  
116.41  
114.11  
111.82  
111.12

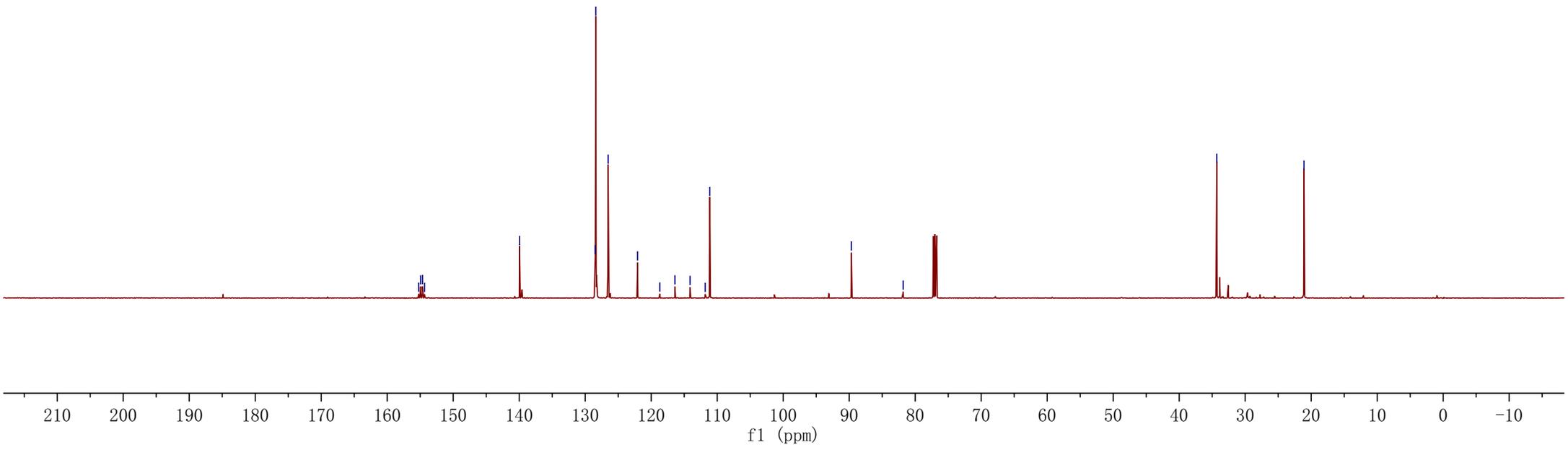
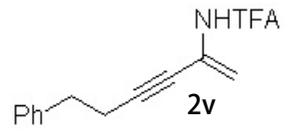
89.67

81.82

34.31

21.09

Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



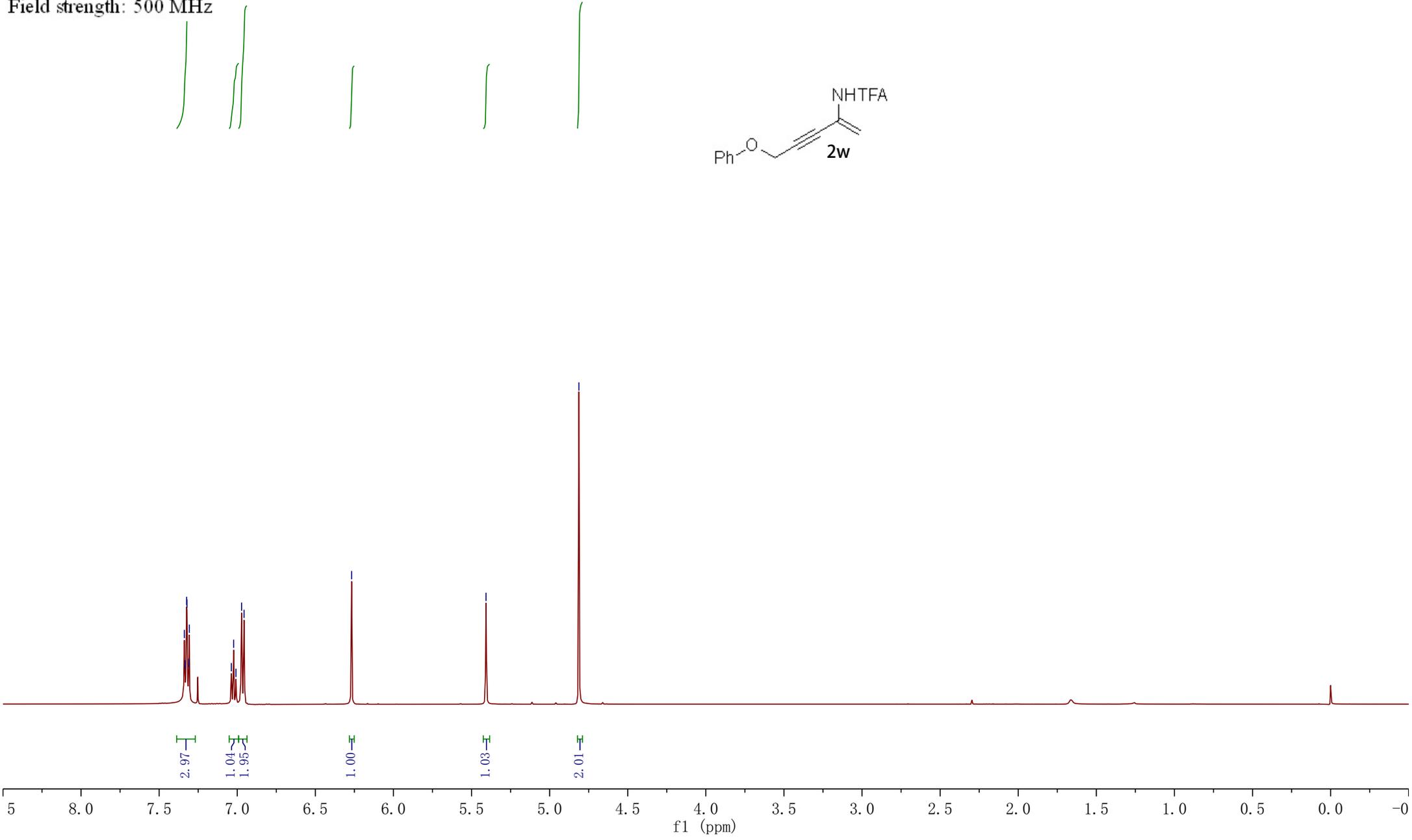
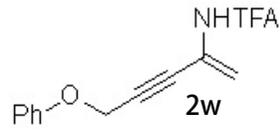
7.339  
7.335  
7.324  
7.322  
7.310  
7.307  
7.038  
7.023  
7.008  
6.972  
6.956

6.268

5.407

4.813

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



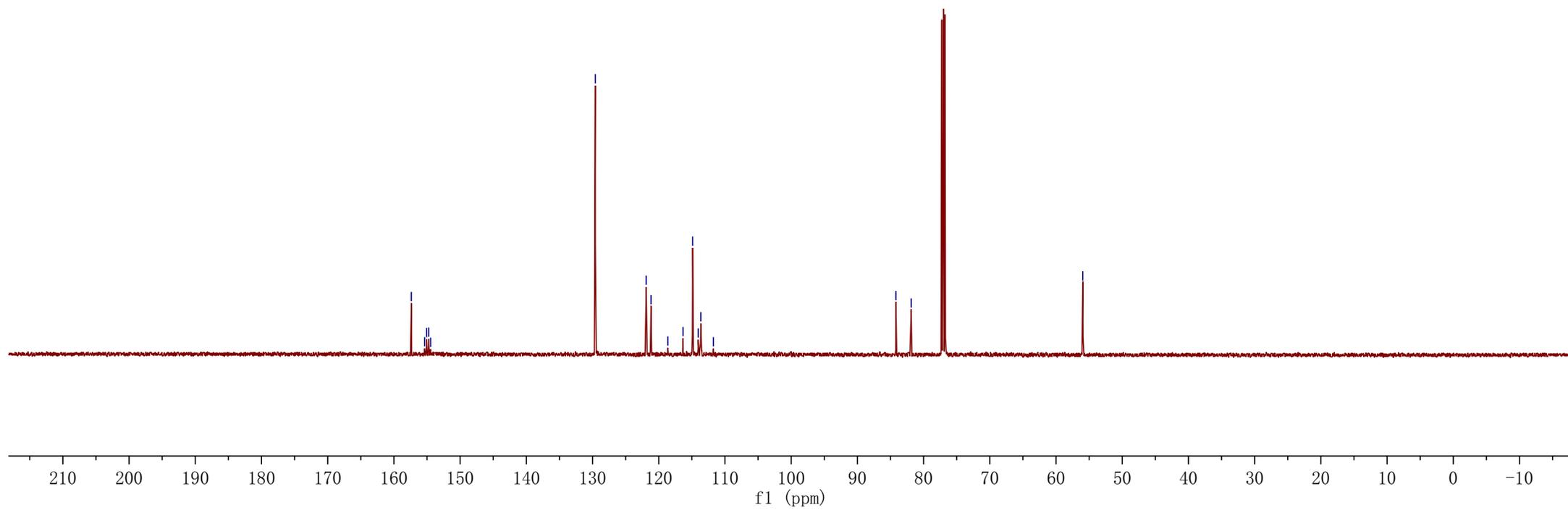
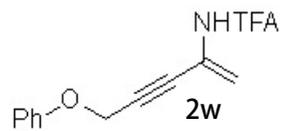
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

157.37  
155.35  
155.05  
154.75  
154.45

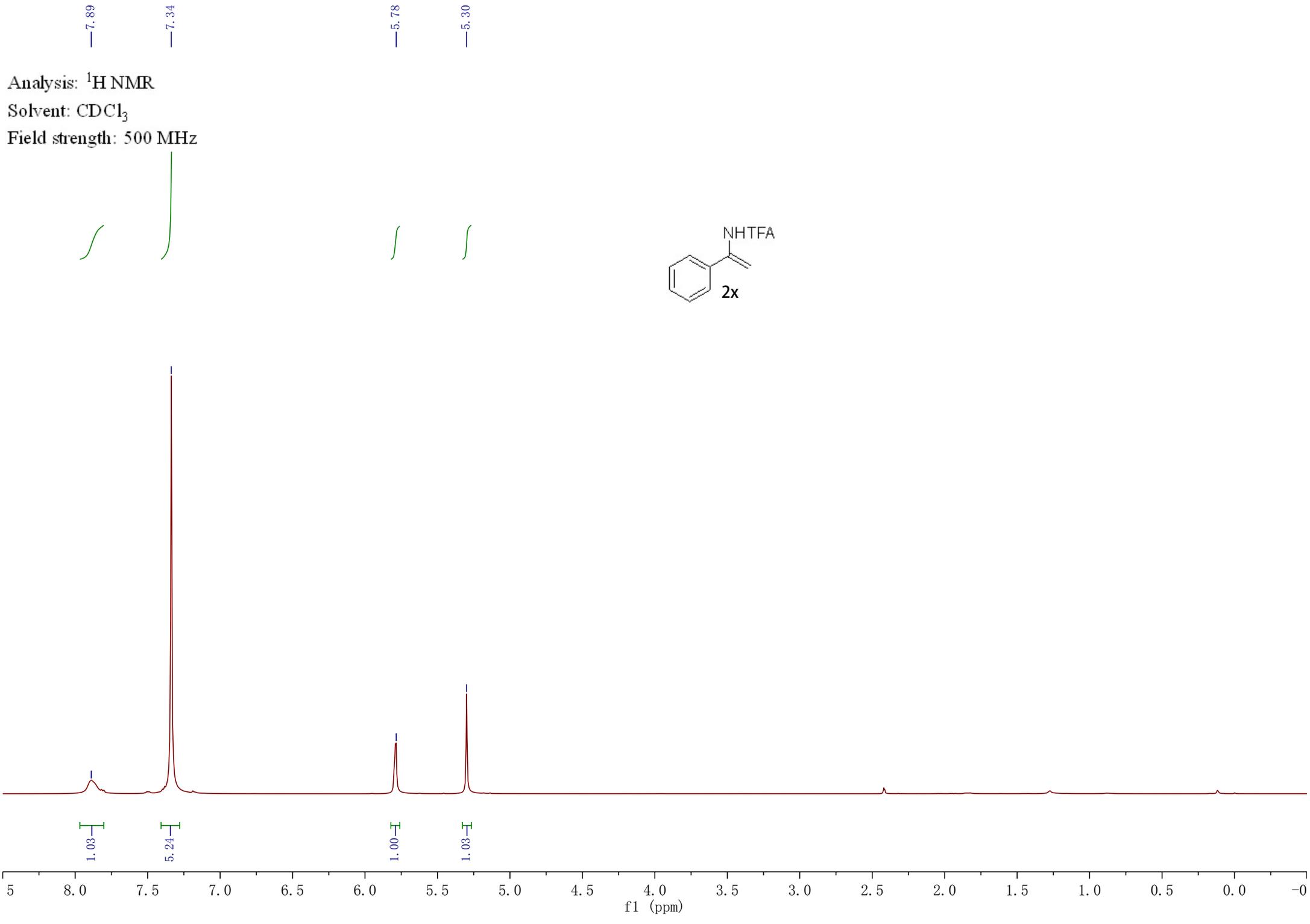
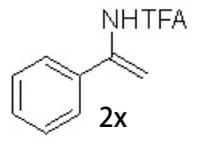
129.58  
121.90  
121.17  
118.63  
116.33  
114.88  
114.04  
113.65  
111.74

84.18  
81.87

55.96



Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

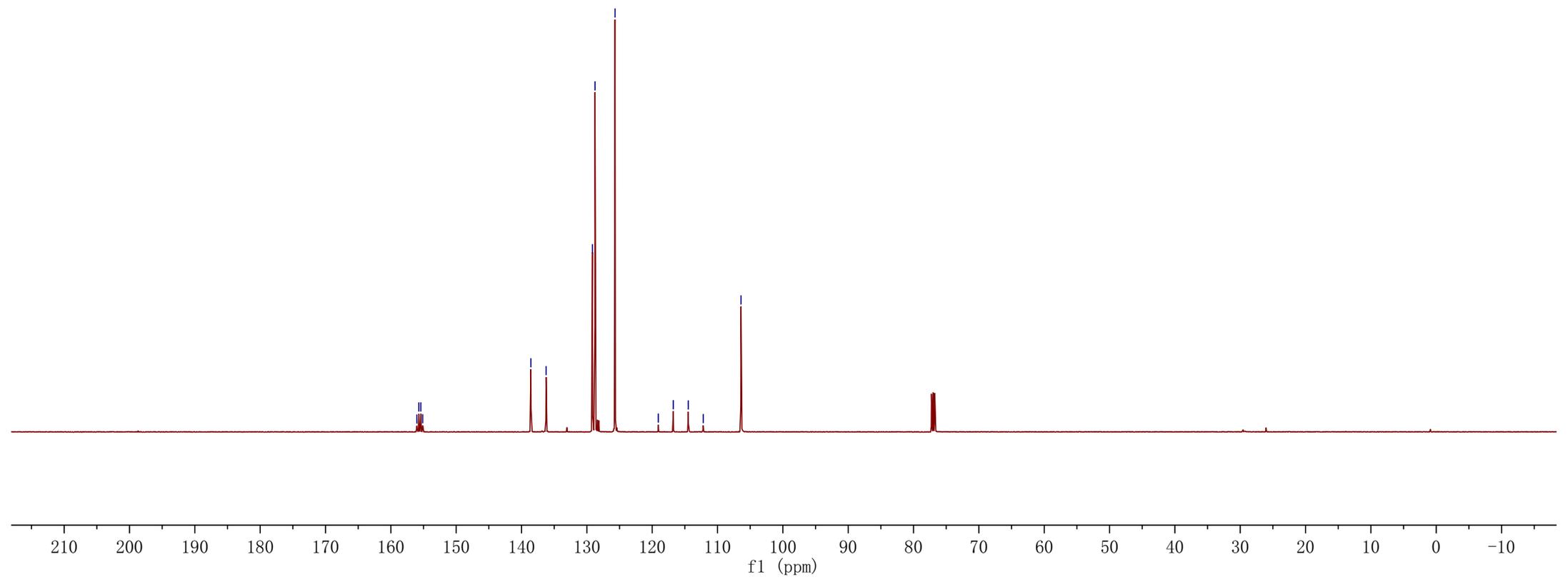
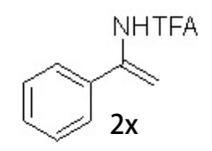
156.01  
155.71  
155.42  
155.12

138.56  
136.24

129.15  
128.75  
125.68

119.06  
116.77  
114.47  
112.18

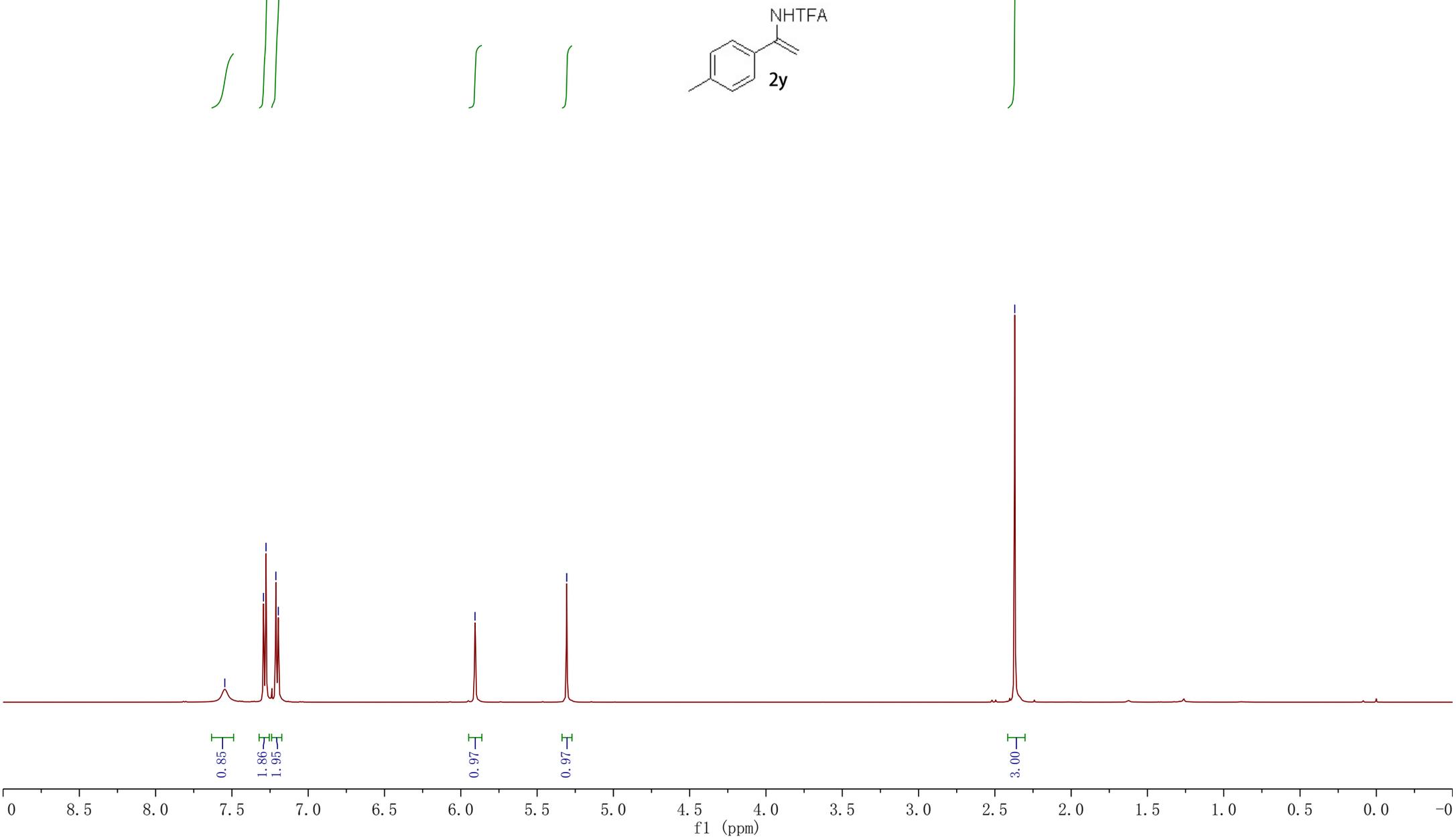
106.40



Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.83  
155.54  
155.24  
154.95

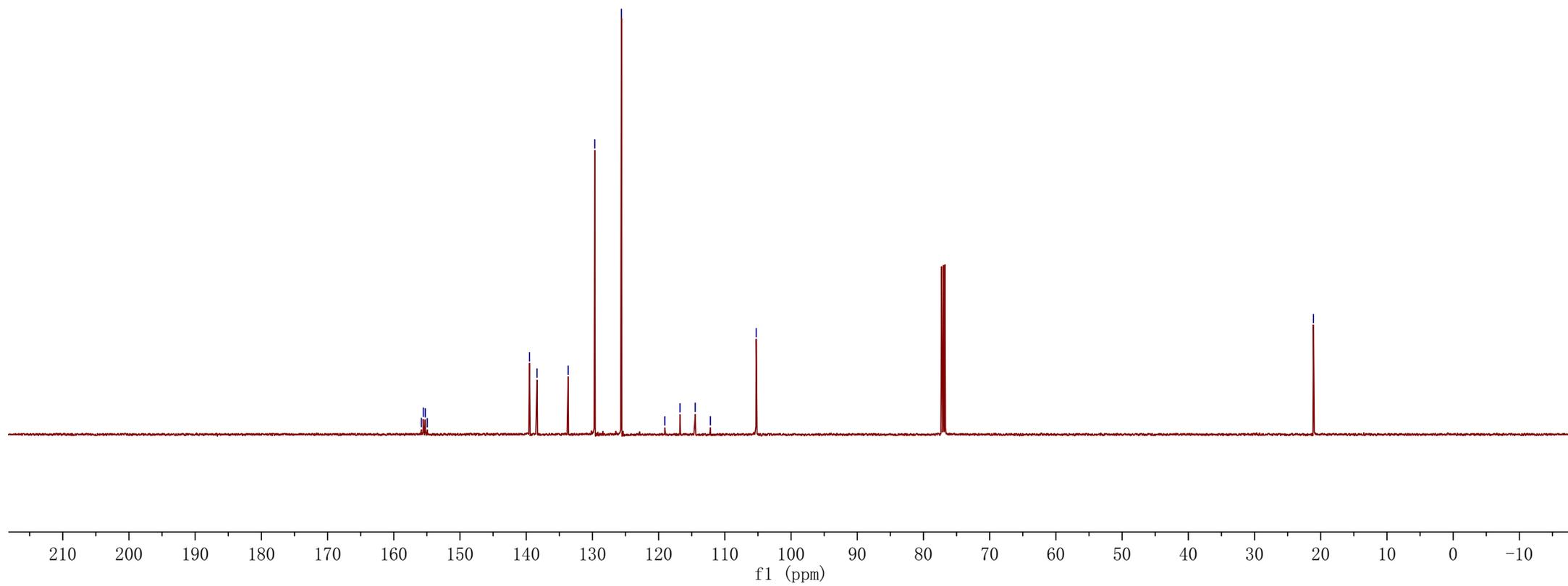
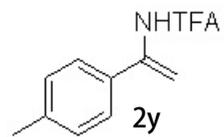
139.50  
138.37

133.67  
129.65  
125.63

119.07  
116.77  
114.48  
112.18

105.26

21.10

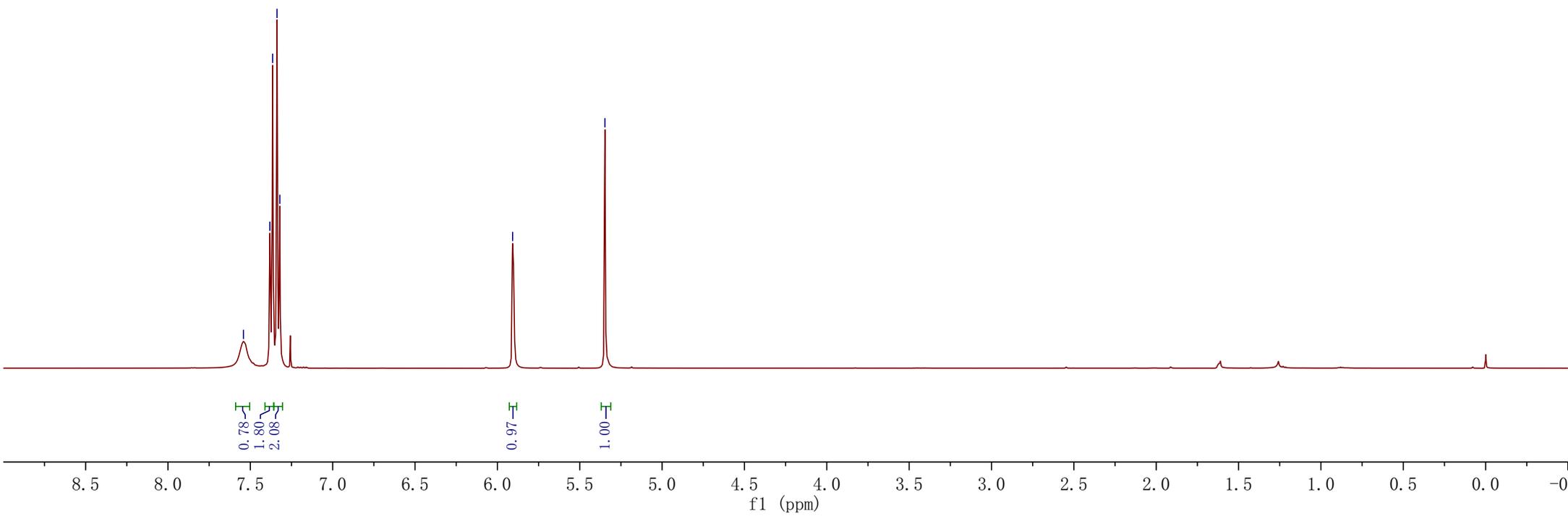
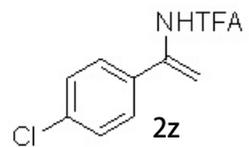


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.542  
7.382  
7.365  
7.338  
7.321

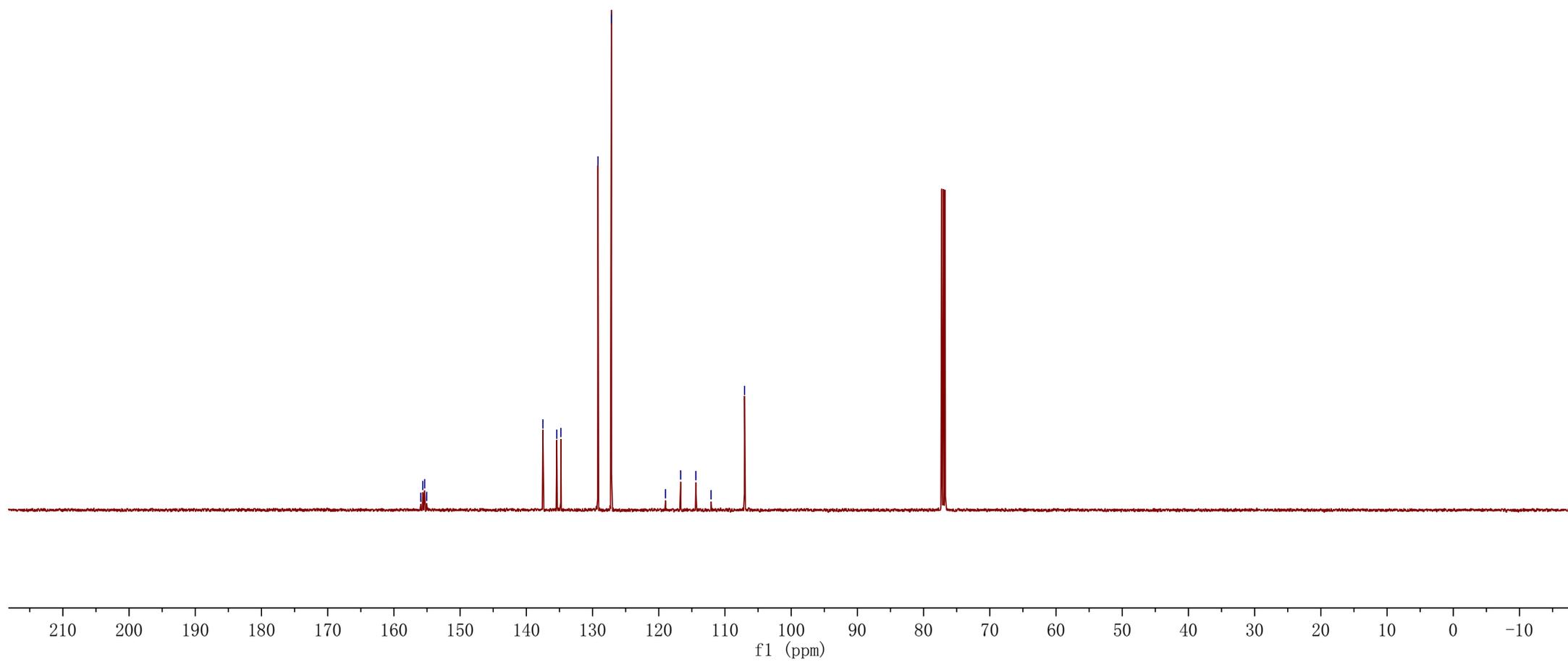
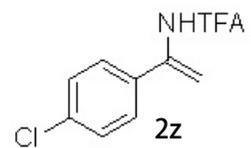
5.908

5.347



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

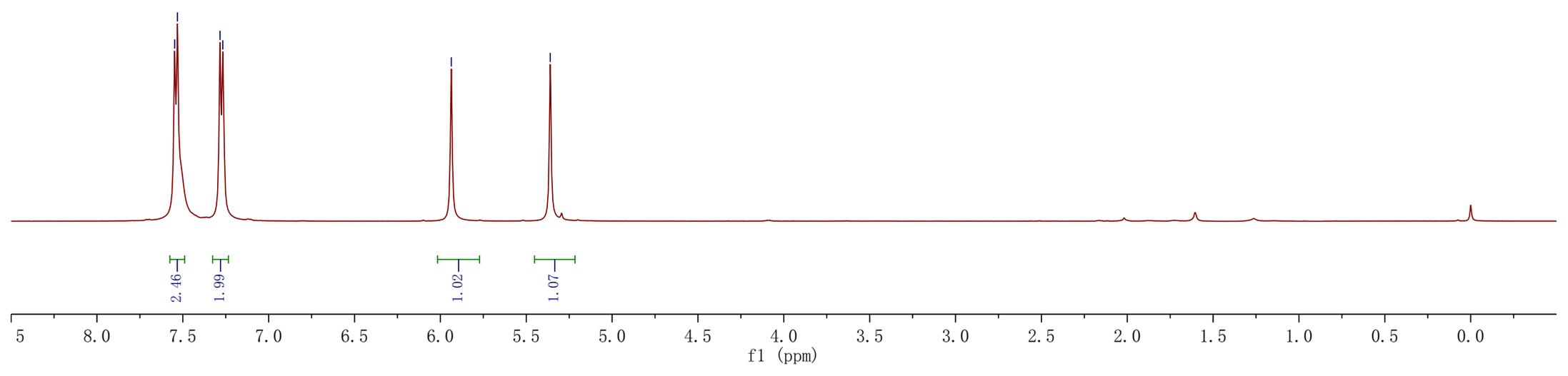
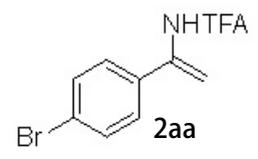
155.94  
155.64  
155.35  
155.05  
137.50  
135.40  
134.78  
129.18  
127.15  
118.99  
116.69  
114.39  
112.10  
107.04



7.547  
7.531  
7.288  
7.267

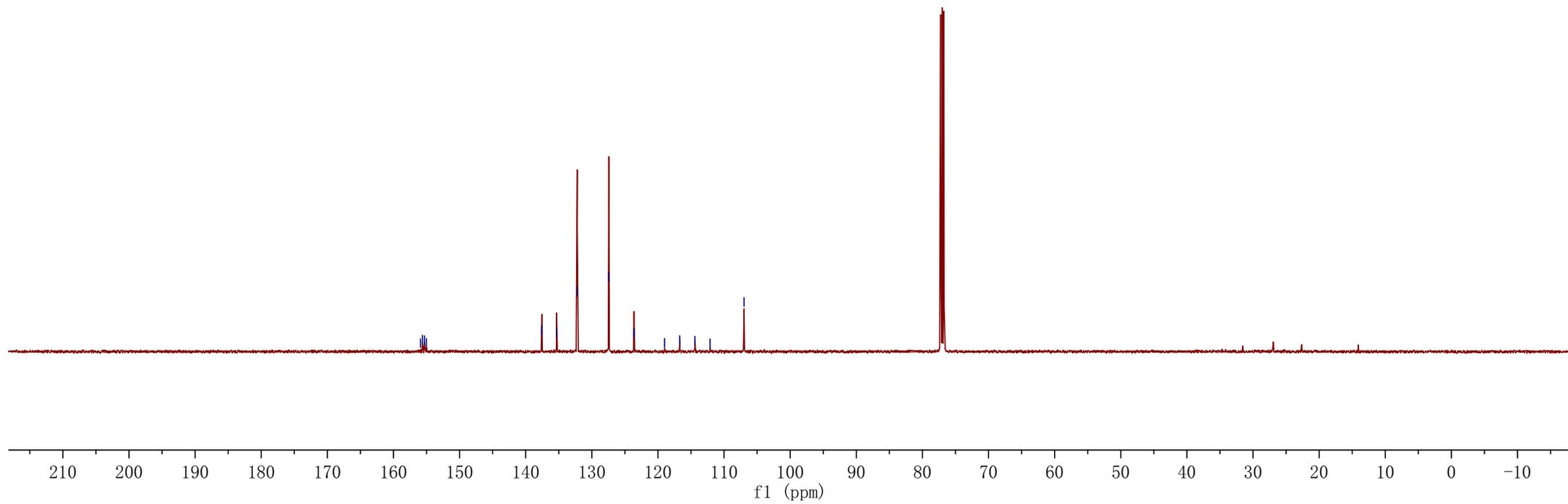
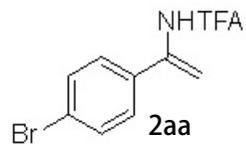
5.936  
5.360

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



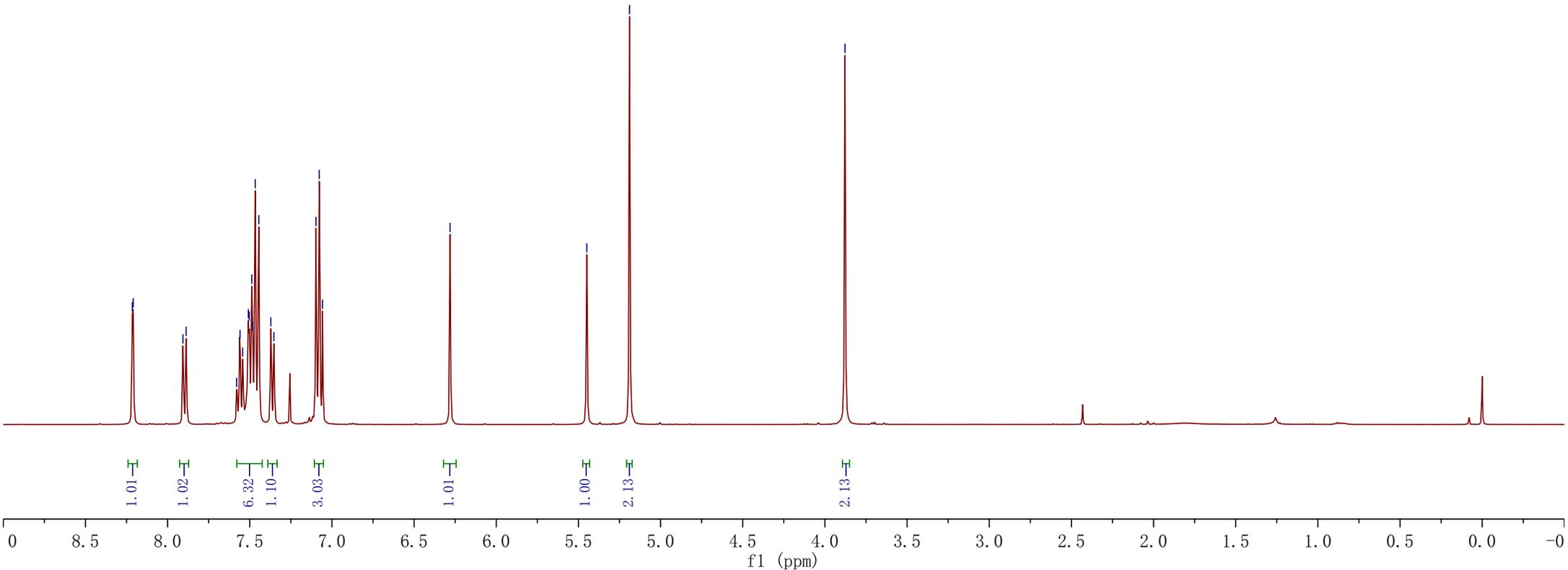
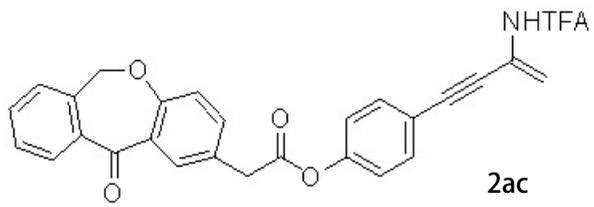
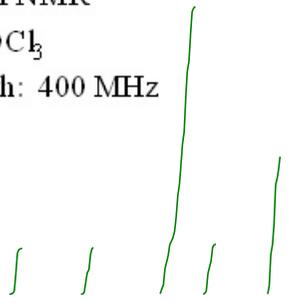
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

155.91  
155.61  
155.31  
155.02  
137.57  
135.33  
132.23  
127.44  
123.63  
119.00  
116.71  
114.41  
112.12  
106.98

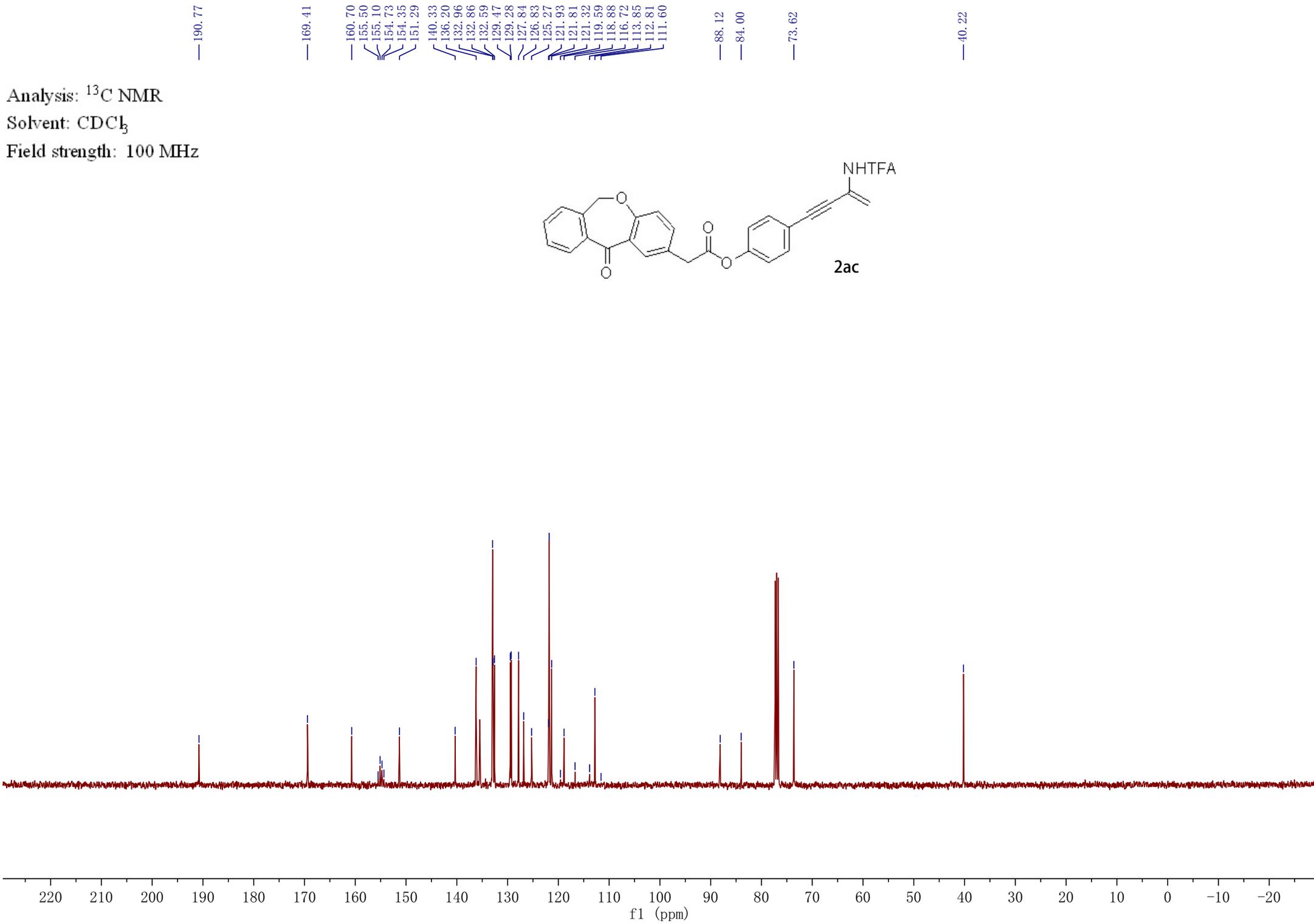
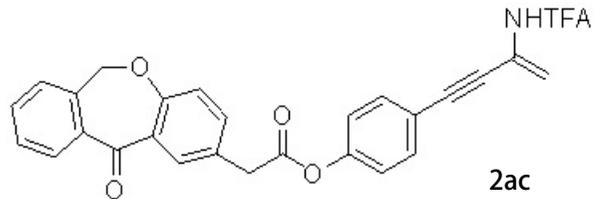


8.214  
8.209  
7.906  
7.887  
7.580  
7.559  
7.543  
7.509  
7.503  
7.488  
7.482  
7.467  
7.445  
7.372  
7.353  
7.097  
7.077  
7.057  
6.281  
5.449  
5.189  
3.878

Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 400 MHz



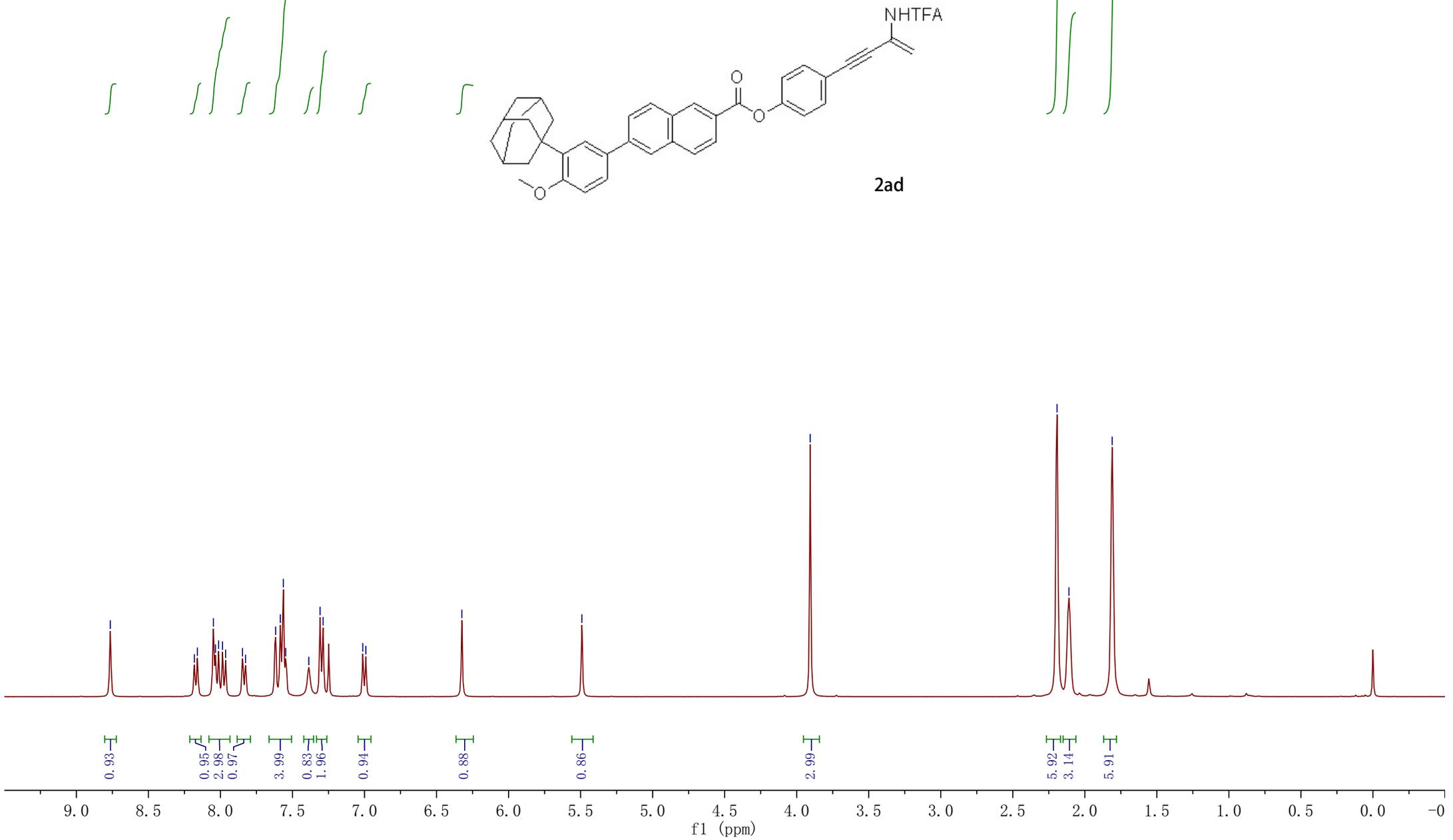
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



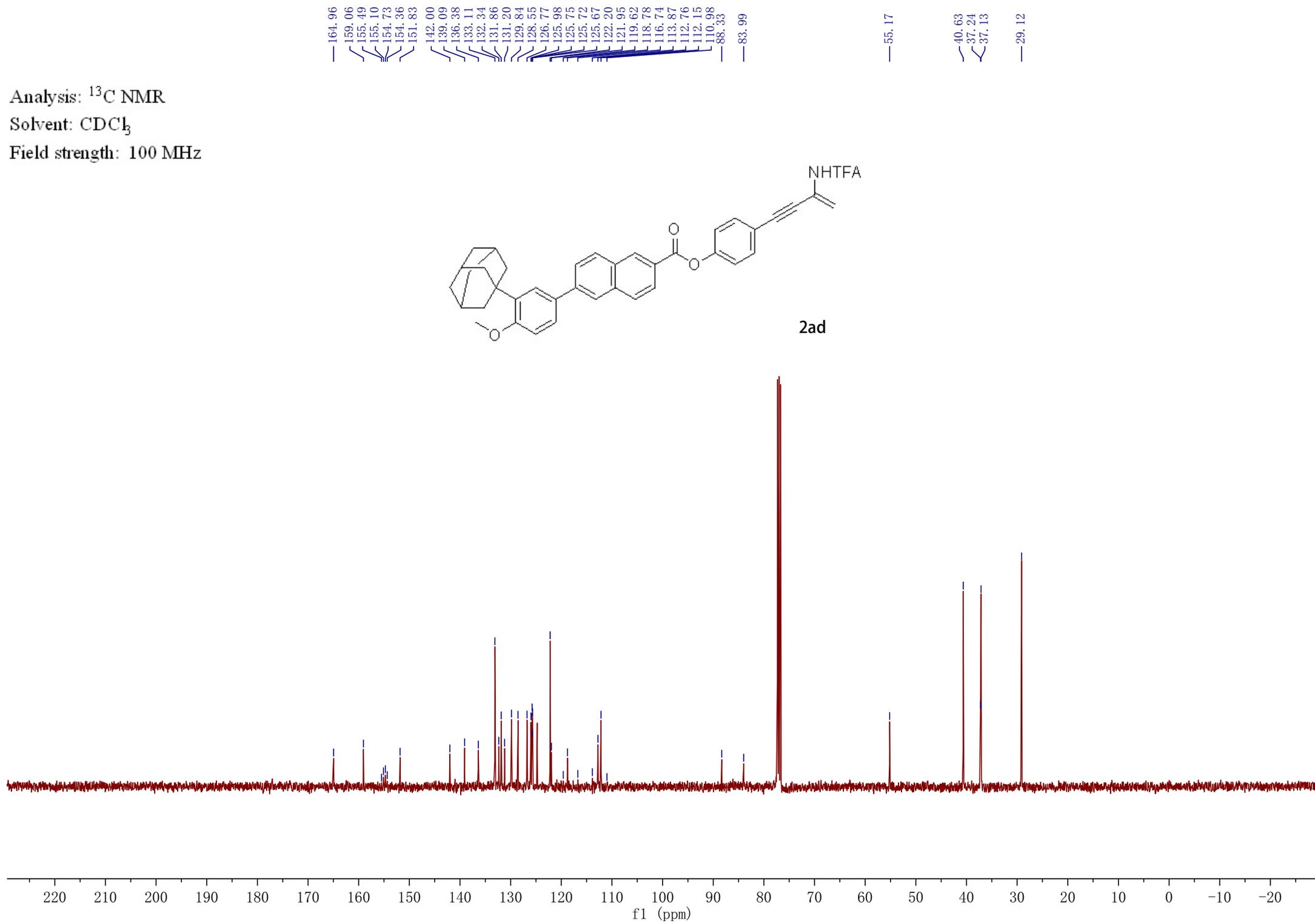
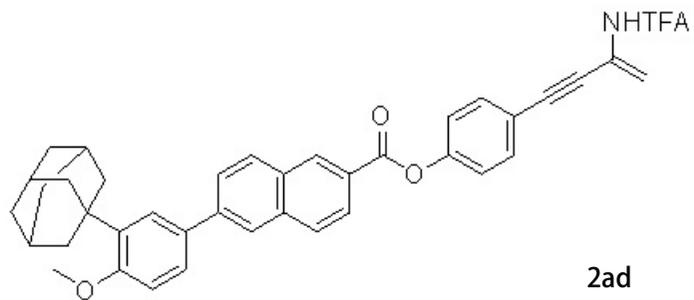
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



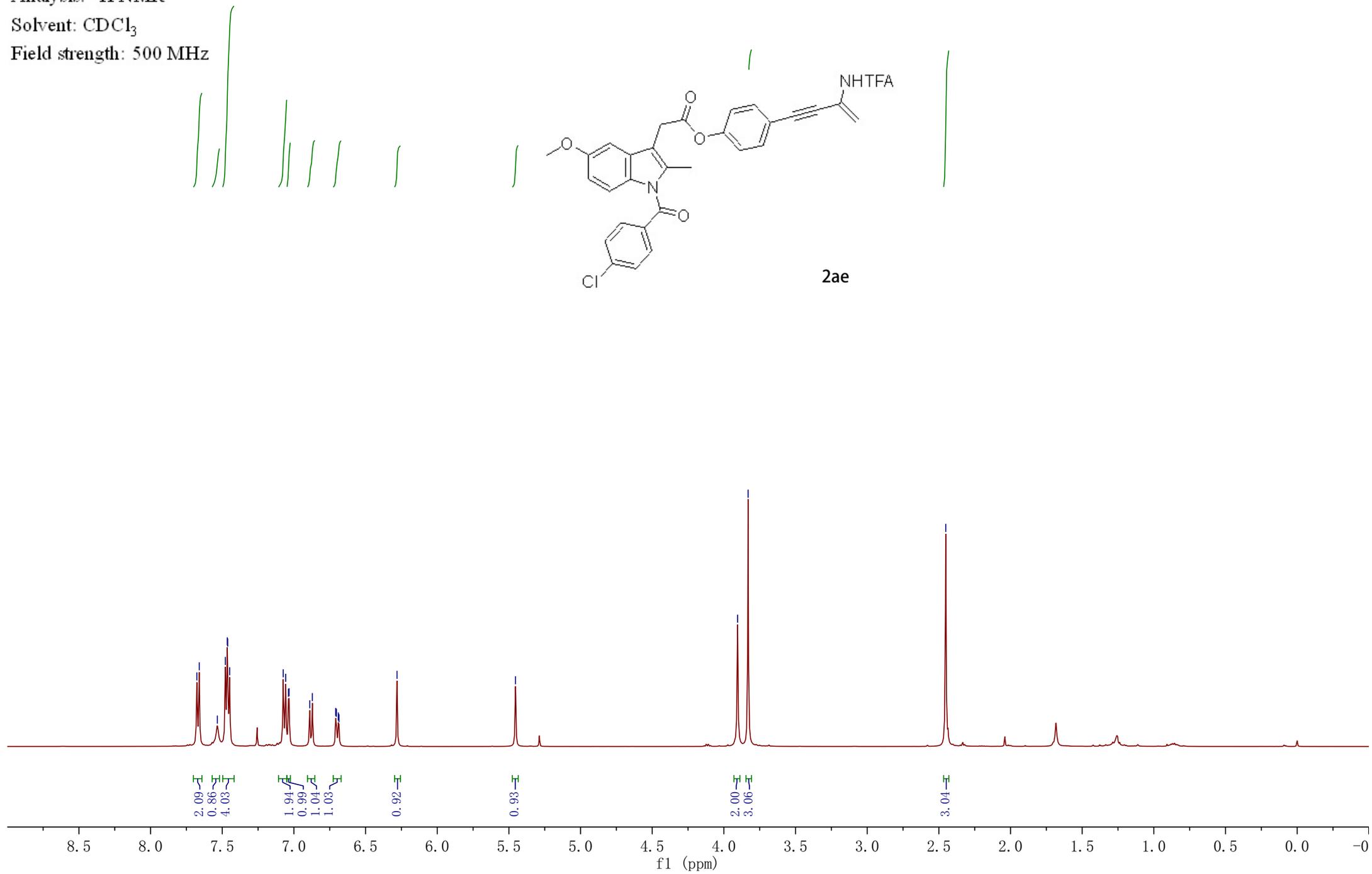
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

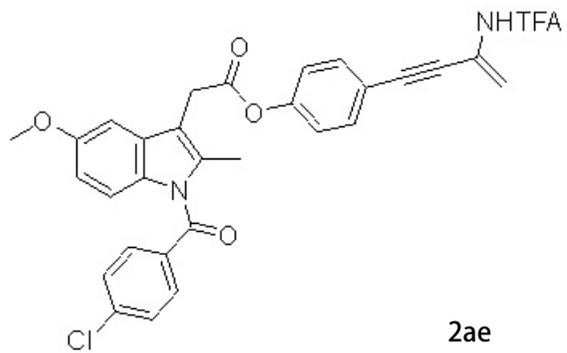
Field strength: 500 MHz



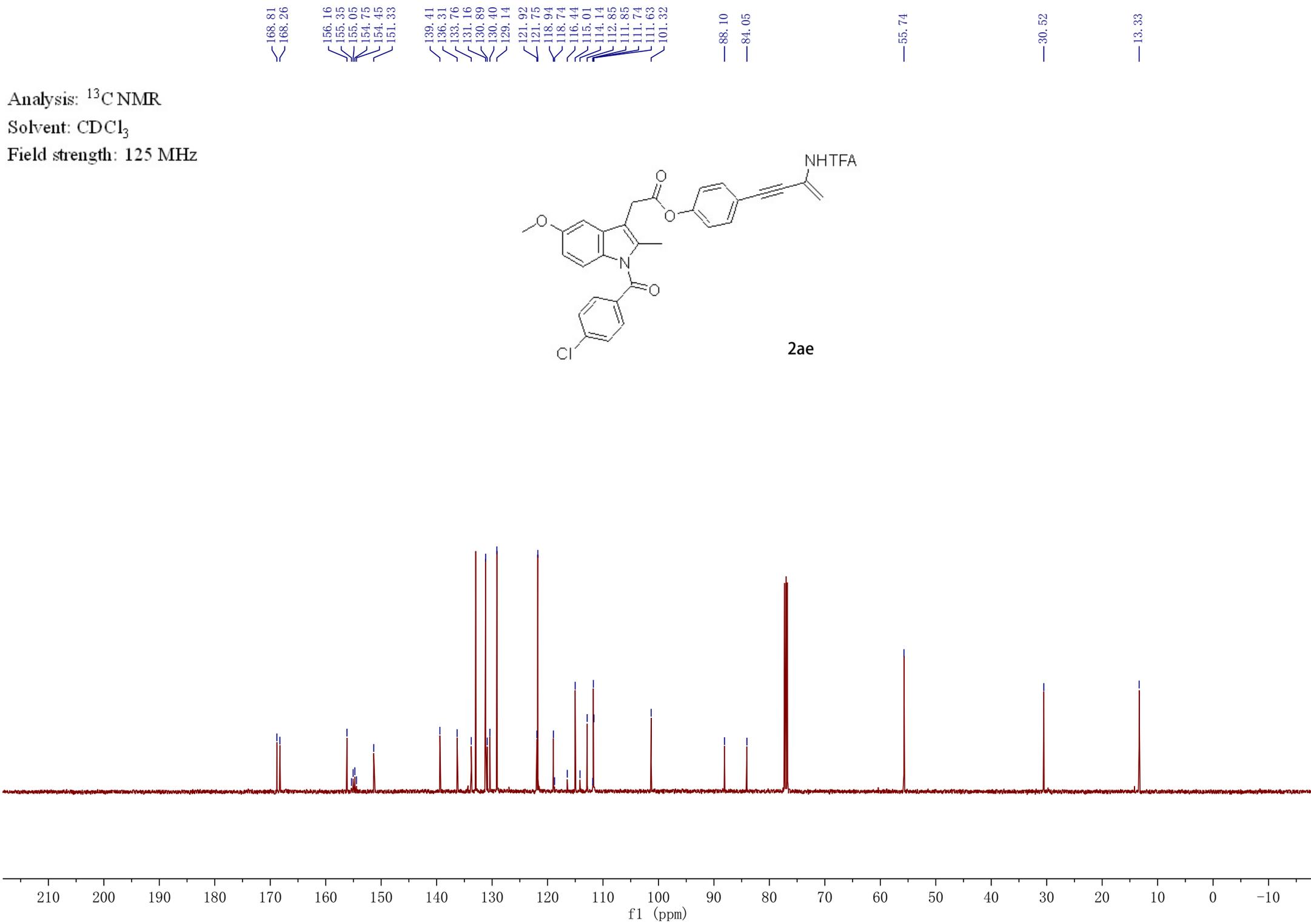
Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

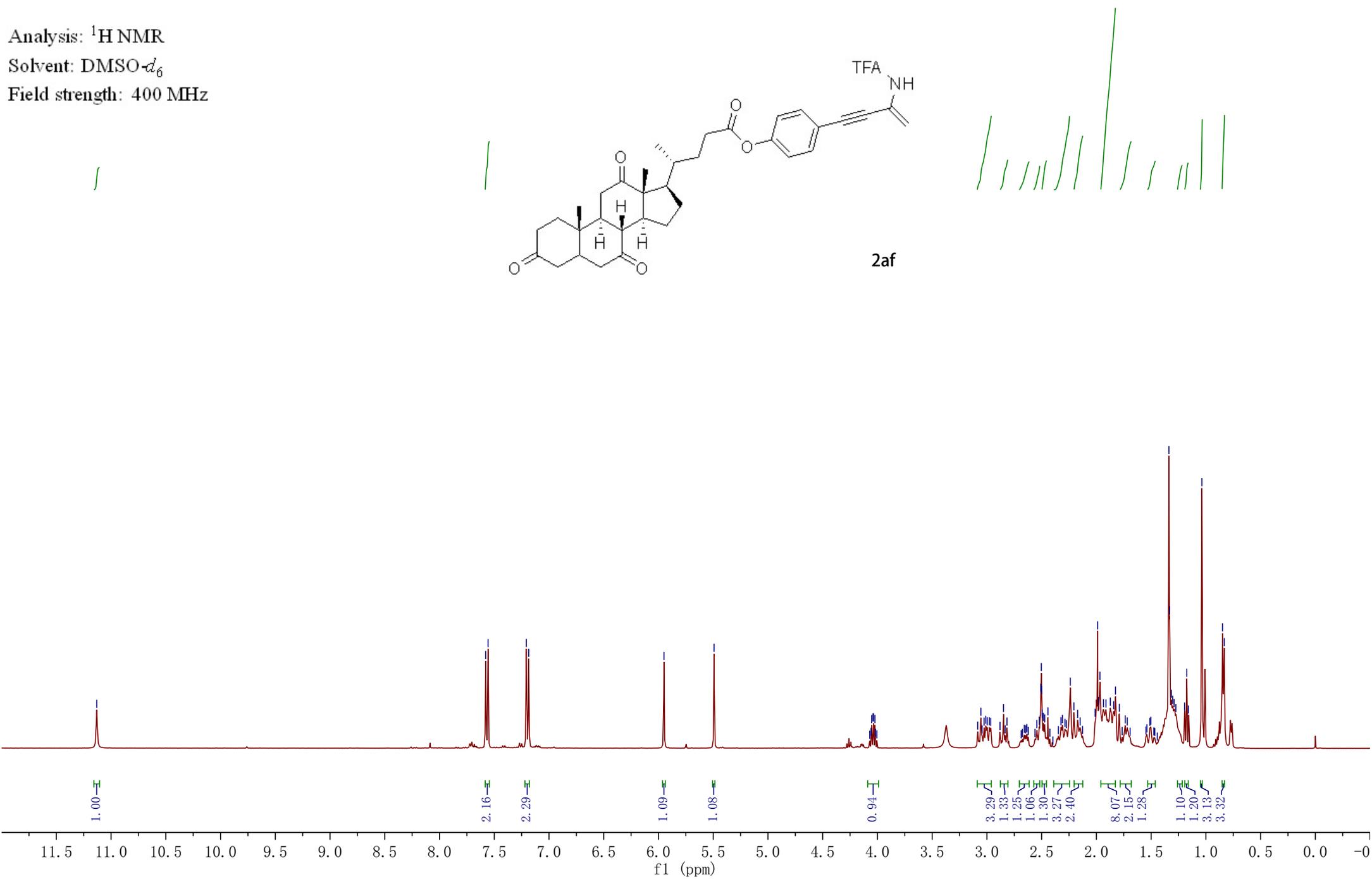
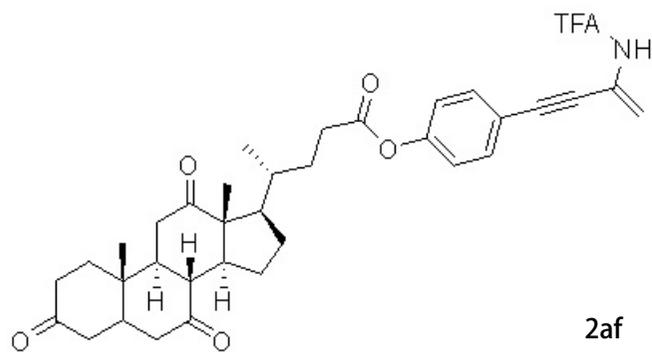
Field strength: 125 MHz



2ae



Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{DMSO-}d_6$   
Field strength: 400 MHz



211.84  
209.46  
209.40

173.09  
171.76

155.13  
154.76  
154.39  
154.01  
151.01

132.75  
122.66  
122.39  
119.66  
118.63  
116.81  
114.57  
113.94  
111.11

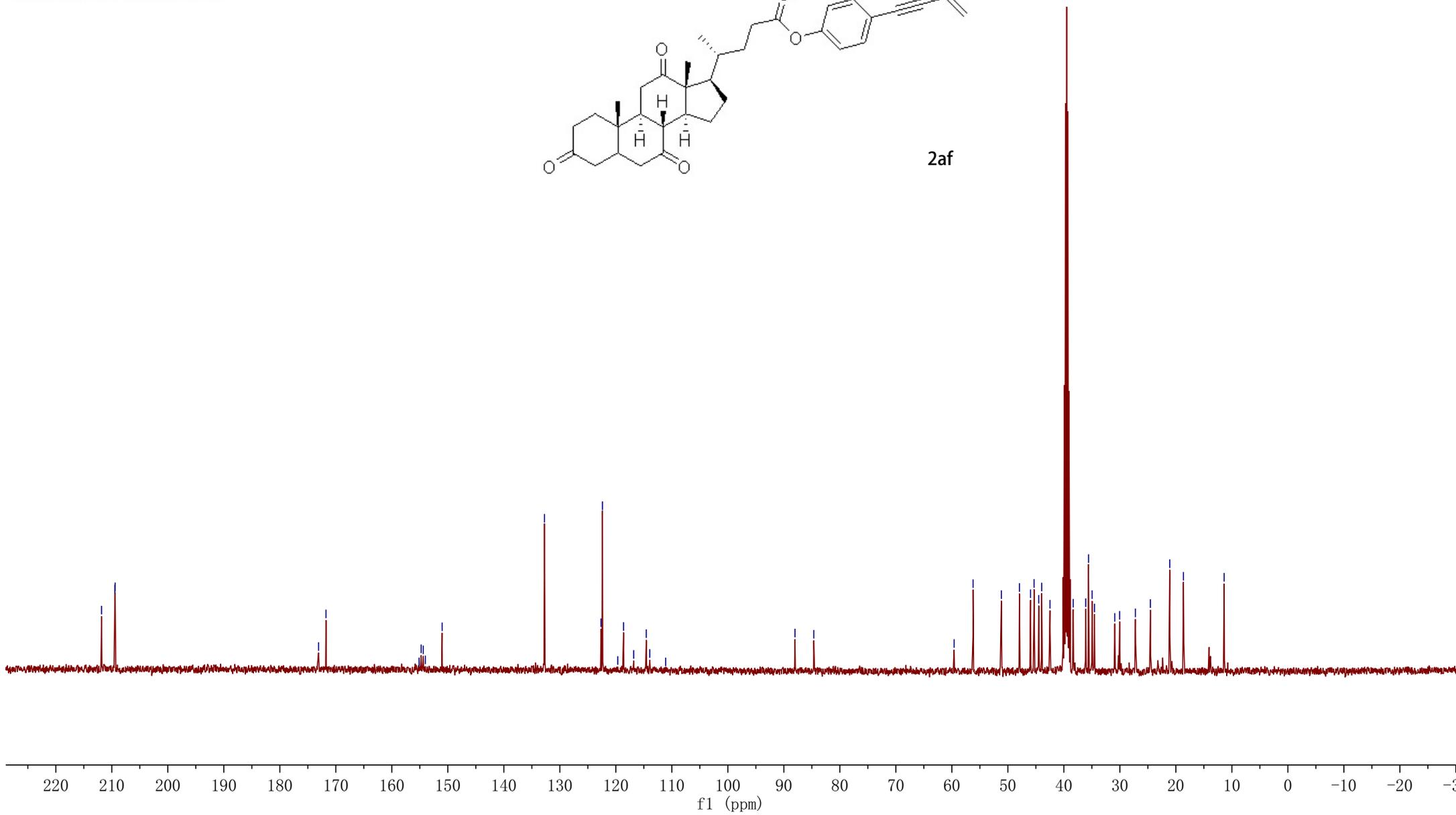
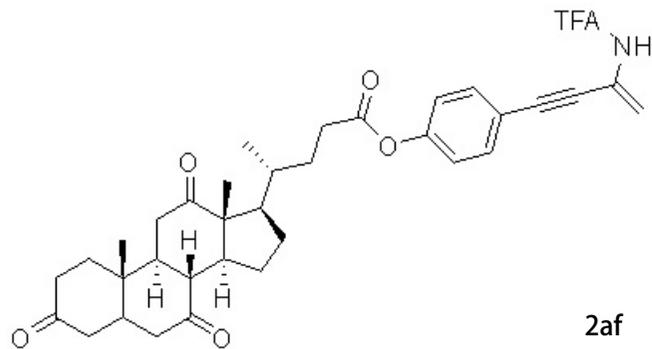
88.02  
84.65

59.59  
56.21  
51.16  
47.94  
45.96  
45.33  
44.49  
43.96  
42.48  
38.33  
36.10  
35.59  
34.96  
34.54  
30.91  
30.05  
27.22  
24.55  
21.09  
18.65  
11.38

Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{DMSO-}d_6$

Field strength: 100 MHz

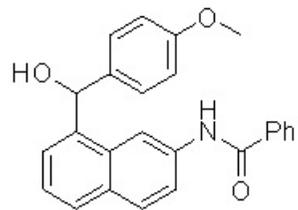
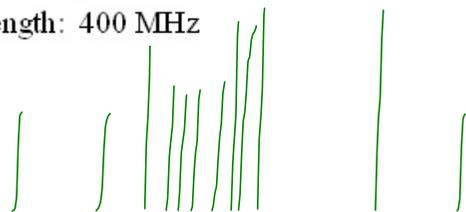


Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

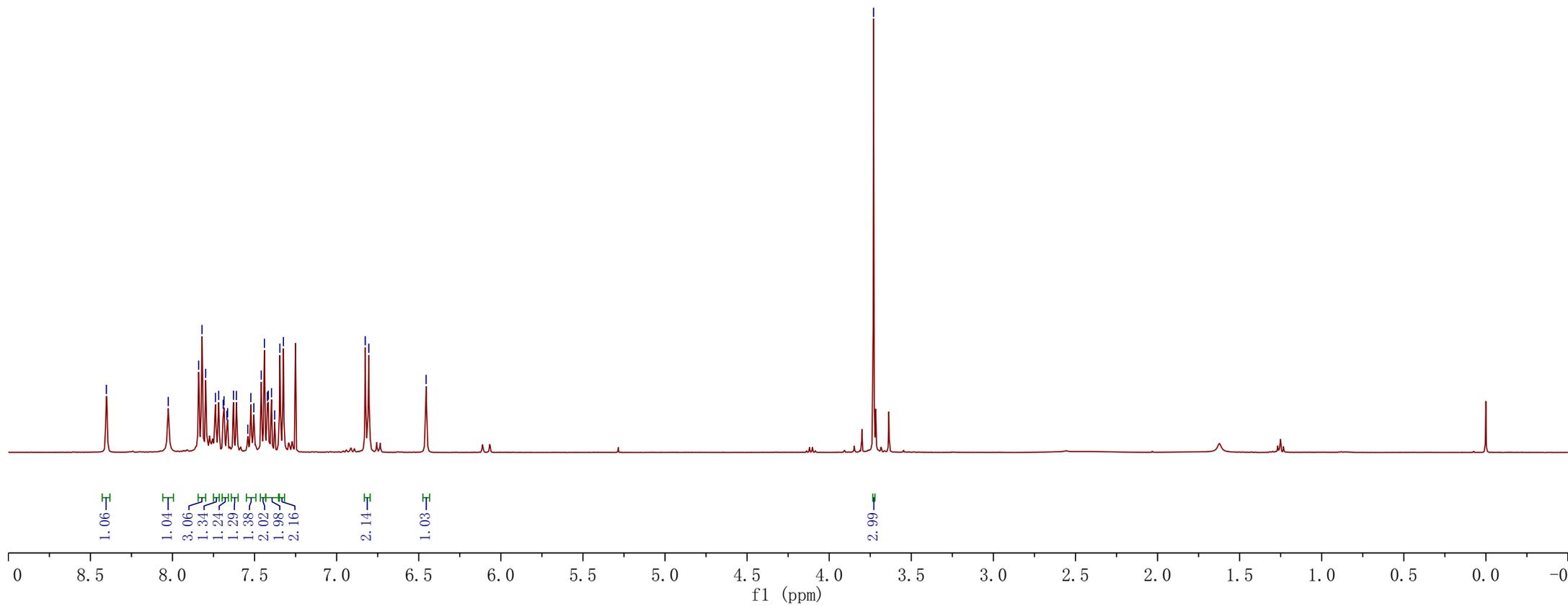
Field strength: 400 MHz

8.403  
7.840  
7.820  
7.798  
7.738  
7.718  
7.691  
7.686  
7.669  
7.664  
7.629  
7.611  
7.541  
7.523  
7.505  
7.459  
7.440  
7.422  
7.417  
7.397  
7.378  
7.346  
7.324  
6.826  
6.804  
6.455



**1i**

3.730

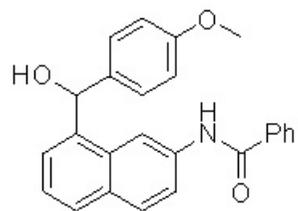


Analysis:  $^{13}\text{C}$  NMR

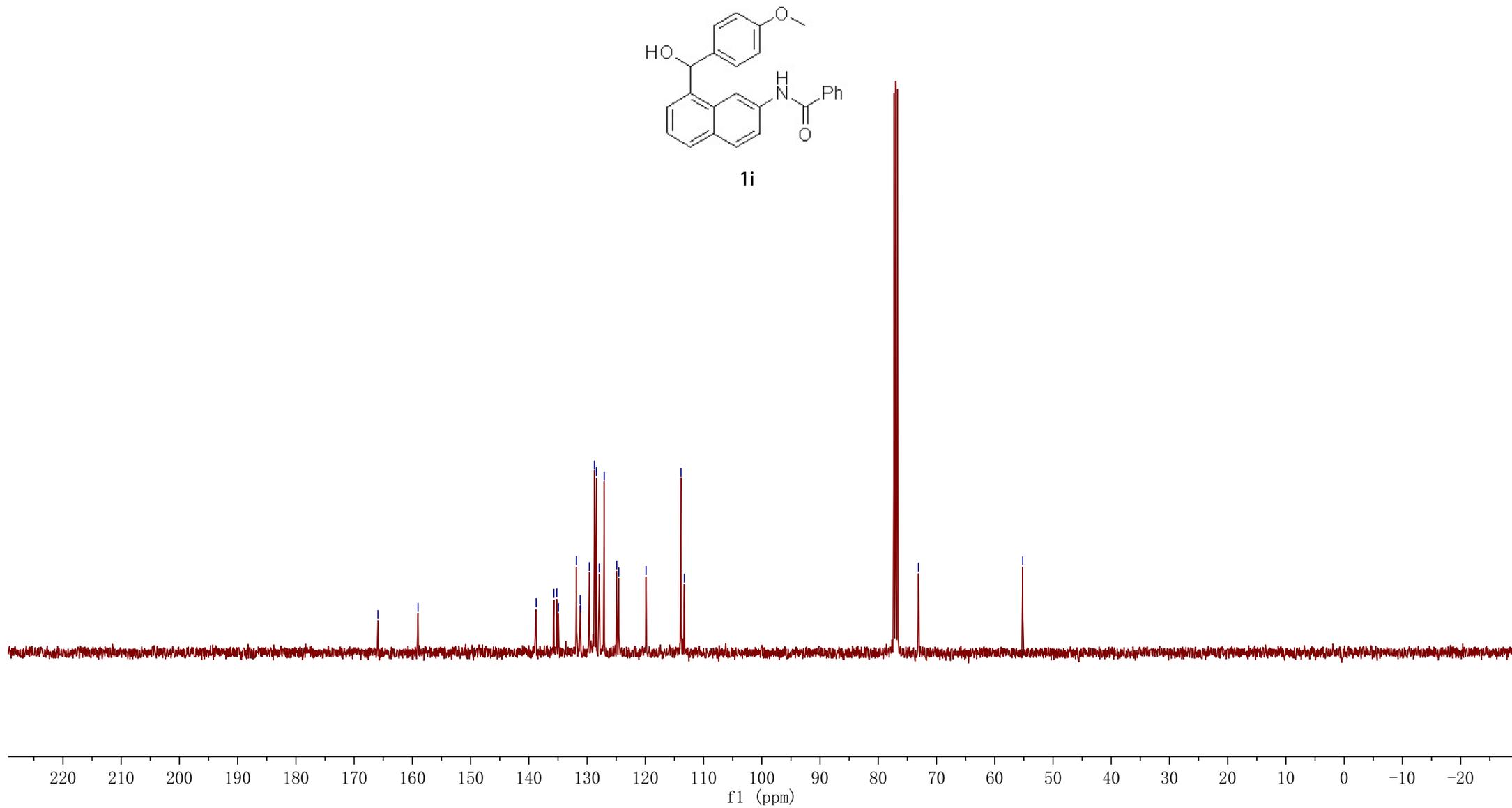
Solvent:  $\text{CDCl}_3$

Field strength: 100 MHz

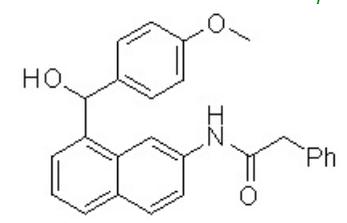
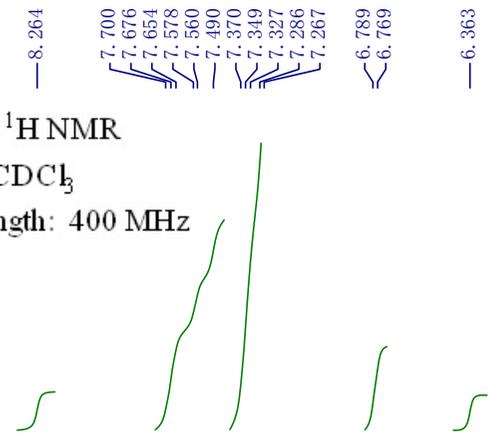
165.91  
159.03  
138.75  
135.71  
135.21  
134.93  
131.83  
131.19  
131.09  
129.62  
128.74  
128.42  
127.90  
127.05  
124.91  
124.56  
119.87  
113.87  
113.30  
73.09  
55.19



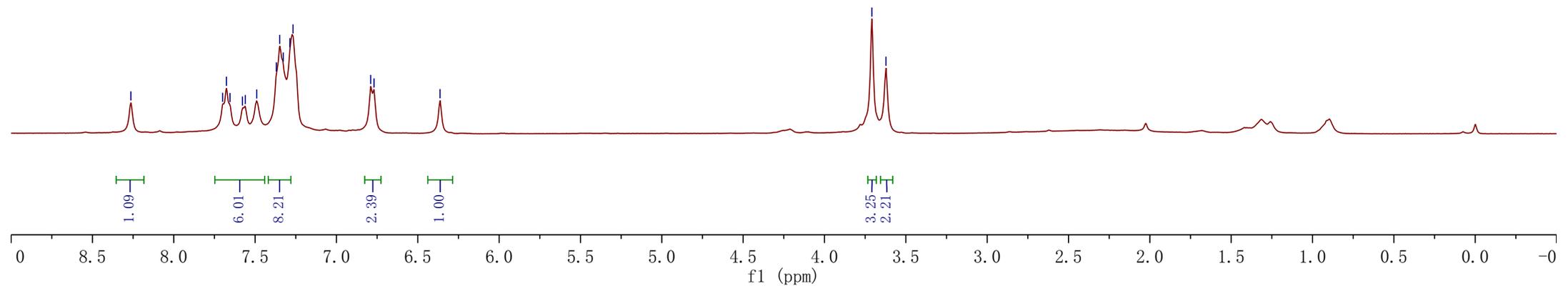
**1i**



Analysis:  $^1\text{H NMR}$   
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

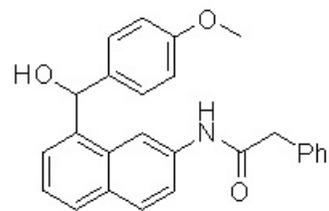


1j

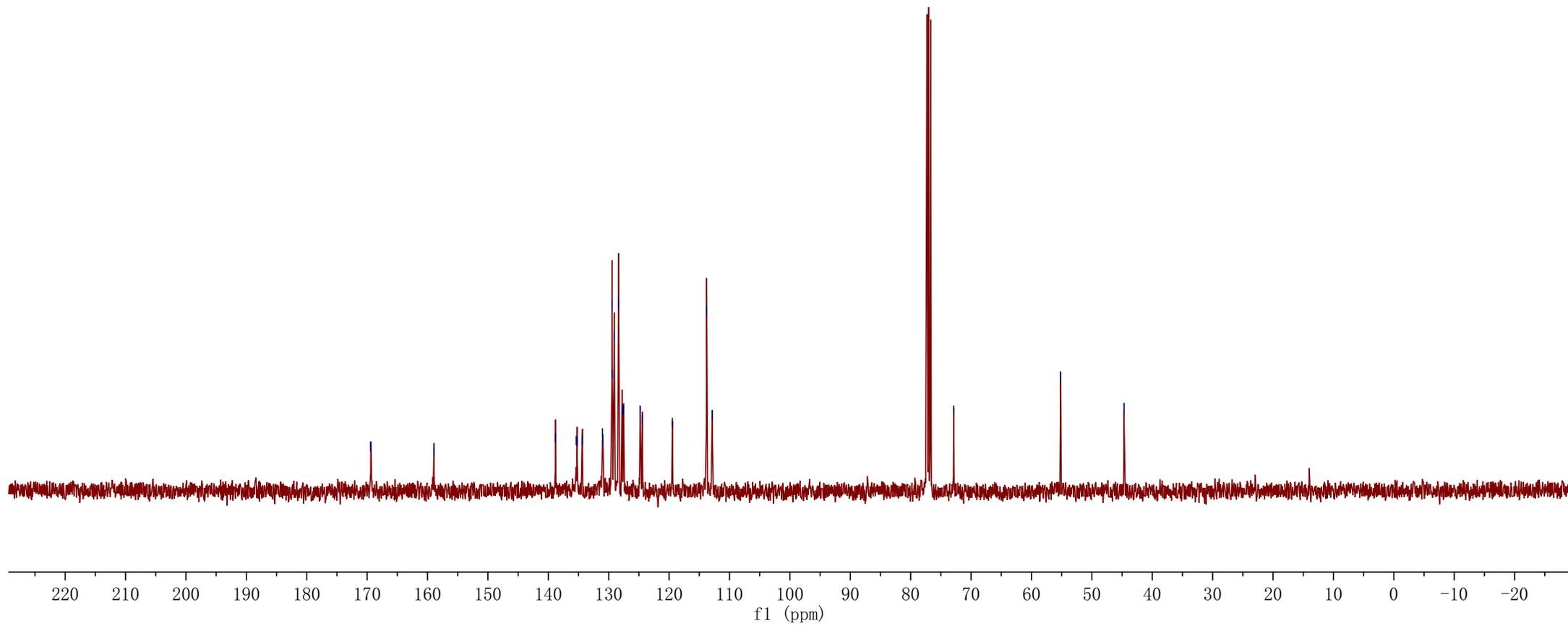


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

169.40  
158.95  
138.83  
135.39  
135.25  
134.39  
131.04  
130.98  
129.47  
129.40  
129.10  
128.36  
127.78  
127.54  
124.81  
124.47  
119.47  
113.80  
112.88  
72.89  
55.17  
44.67

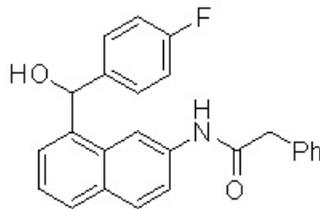
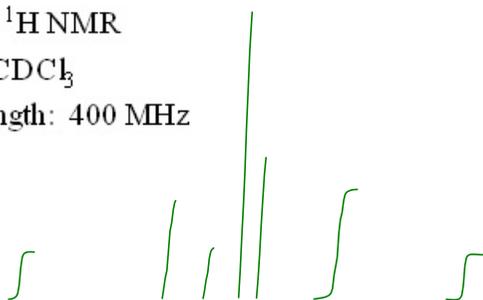


1j

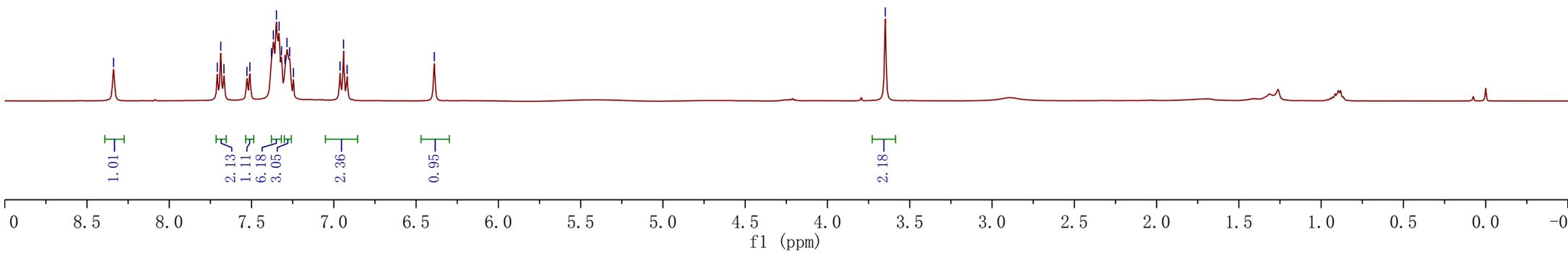


Analysis:  $^1\text{H NMR}$   
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

8.339  
7.708  
7.687  
7.668  
7.528  
7.510  
7.379  
7.367  
7.349  
7.333  
7.318  
7.297  
7.285  
7.269  
7.245  
6.962  
6.941  
6.919  
6.389  
3.649

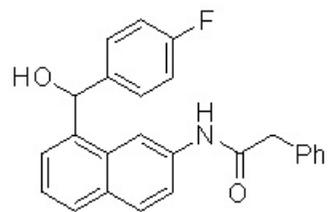


1k

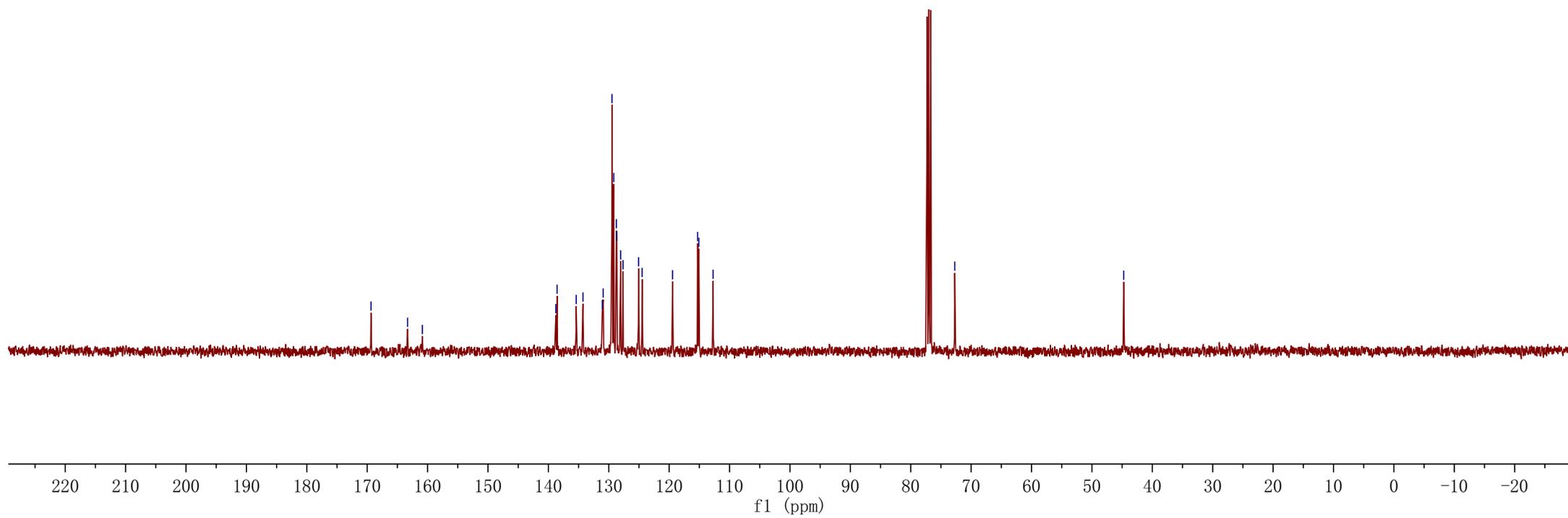


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

169.37  
163.31  
160.87  
138.77  
138.56  
135.40  
134.27  
131.08  
130.93  
129.47  
129.17  
128.75  
128.67  
128.04  
127.64  
125.07  
124.48  
119.44  
115.30  
115.08  
112.72  
72.71  
44.74



1k

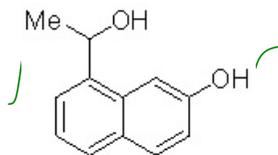
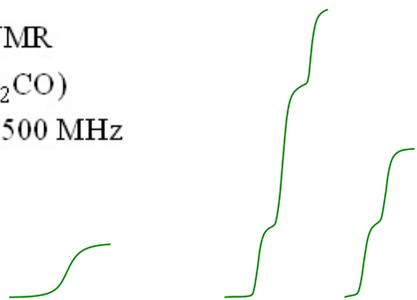


Analysis:  $^1\text{H}$  NMR  
Solvent:  $(\text{CD}_3)_2\text{CO}$   
Field strength: 500 MHz

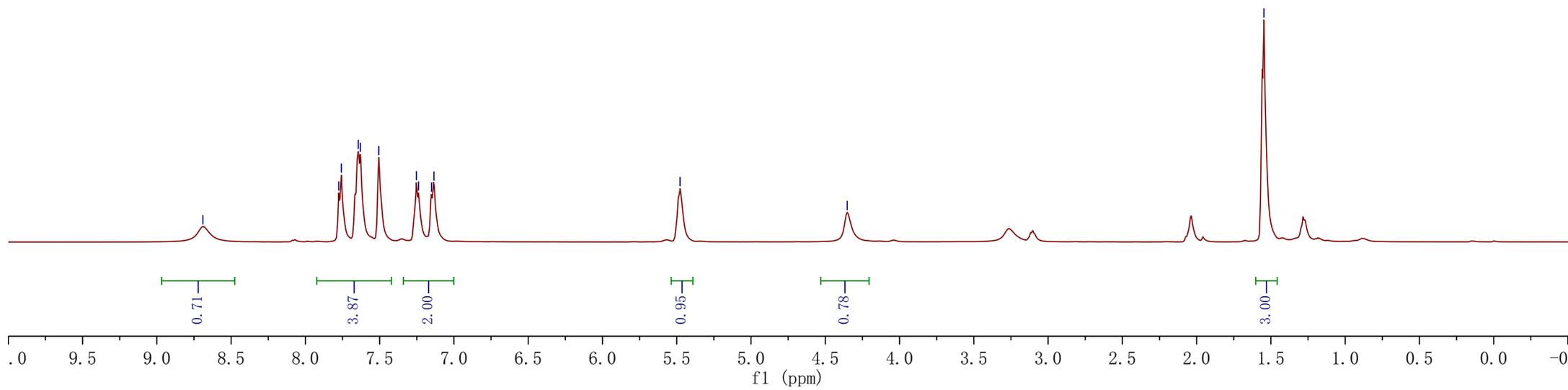
8.690  
7.775  
7.758  
7.644  
7.630  
7.506  
7.253  
7.238  
7.151  
7.134

5.478  
4.353

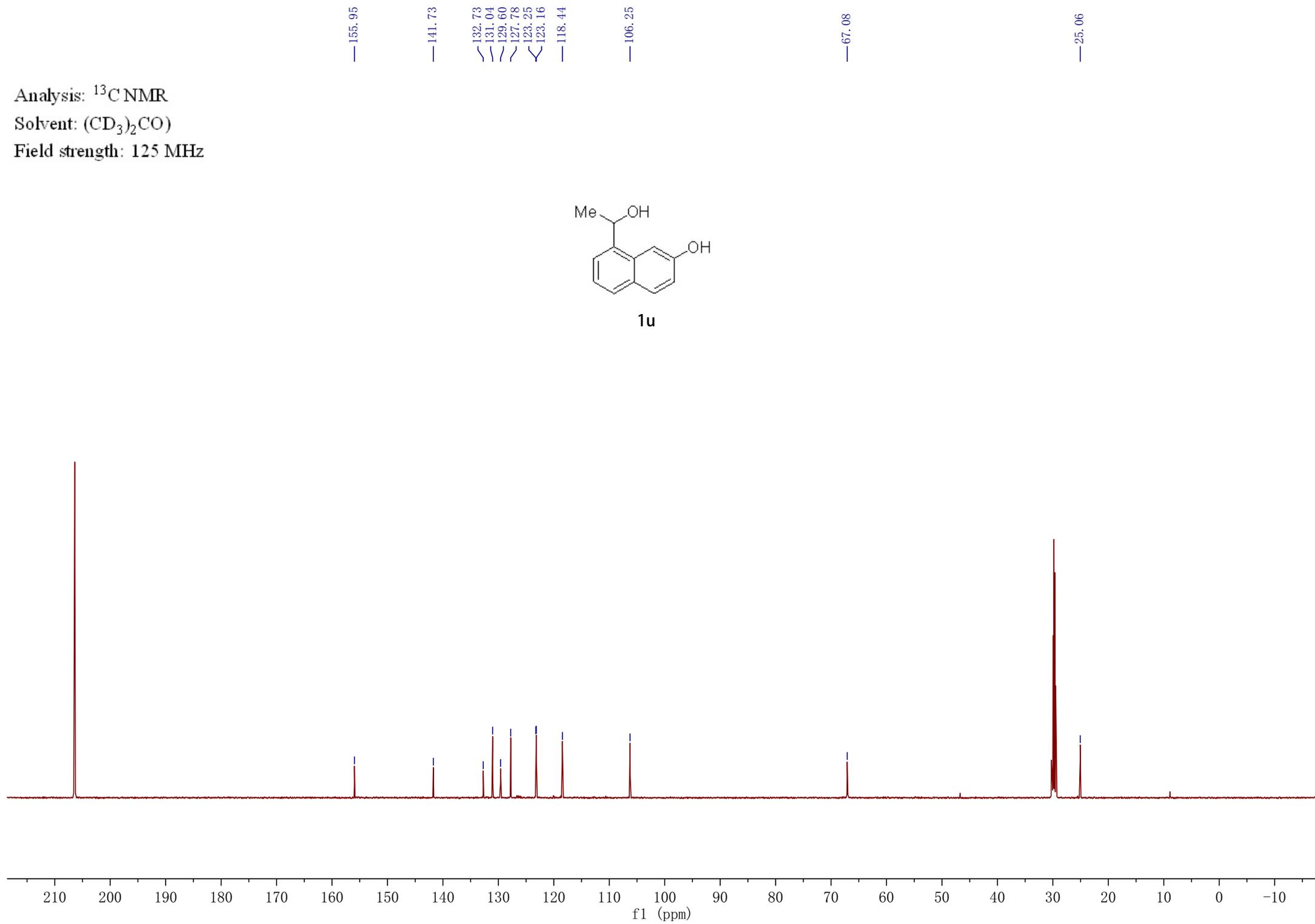
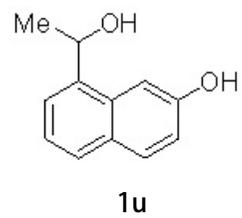
1.547



1u

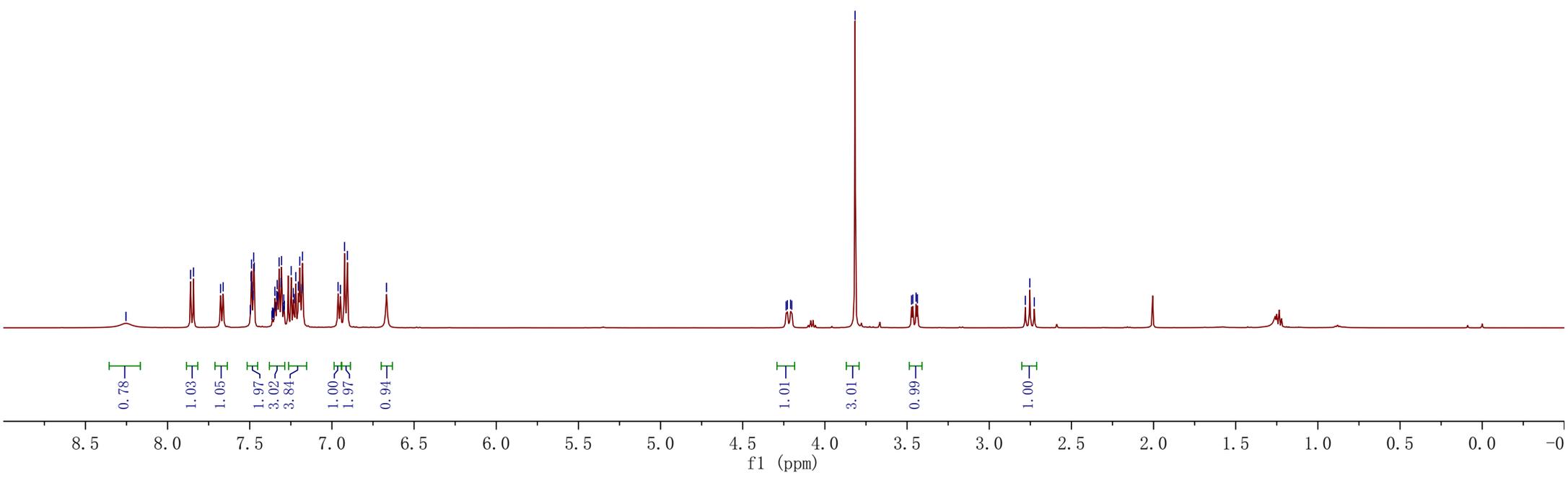
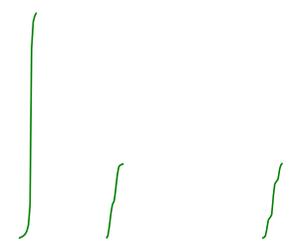
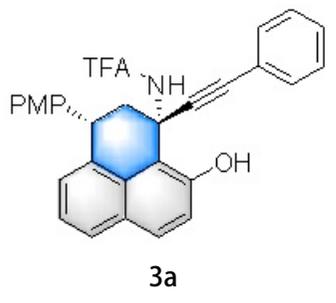
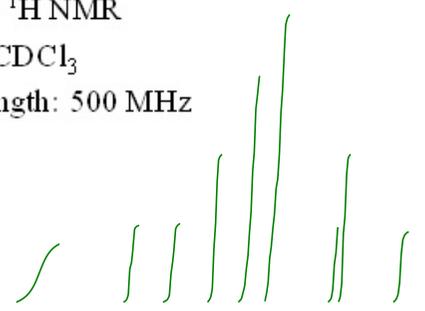


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $(\text{CD}_3)_2\text{CO}$   
Field strength: 125 MHz



Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 500 MHz

8.253, 7.860, 7.842, 7.678, 7.662, 7.497, 7.492, 7.489, 7.486, 7.481, 7.476, 7.473, 7.365, 7.362, 7.359, 7.354, 7.347, 7.342, 7.336, 7.333, 7.330, 7.321, 7.310, 7.306, 7.296, 7.293, 7.289, 7.248, 7.235, 7.230, 7.220, 7.205, 7.196, 7.183, 7.179, 6.963, 6.948, 6.923, 6.906, 6.668, 4.236, 4.228, 4.209, 4.201, 3.817, 3.473, 3.465, 3.445, 3.437, 2.780, 2.753, 2.726



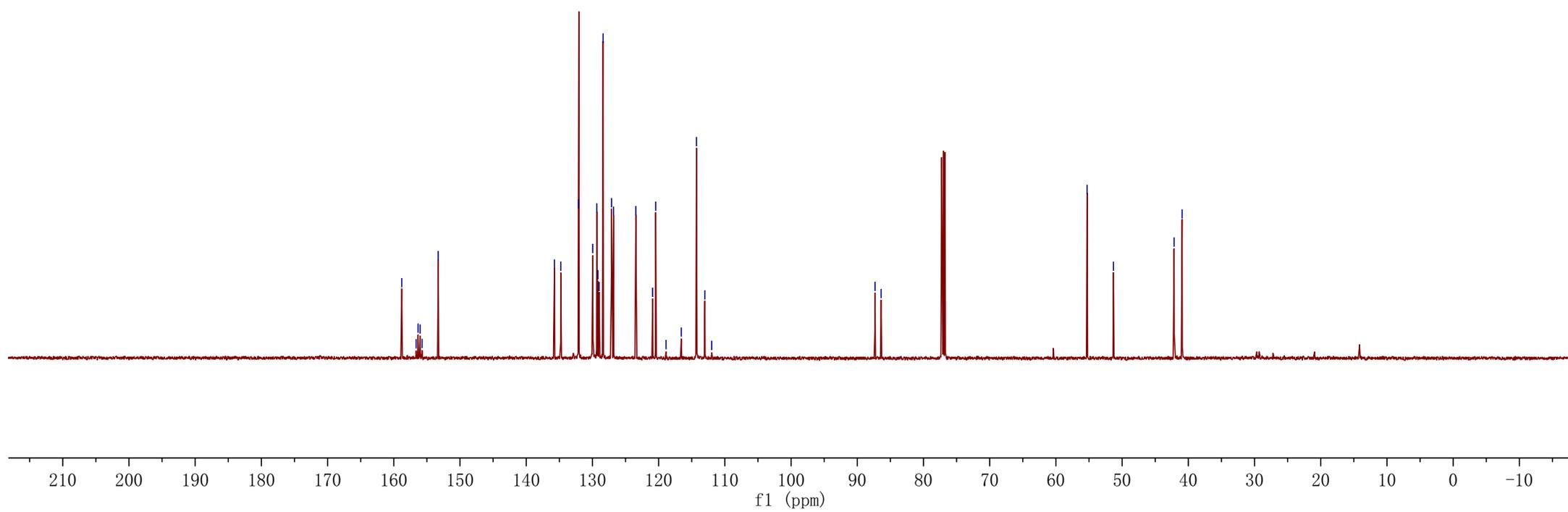
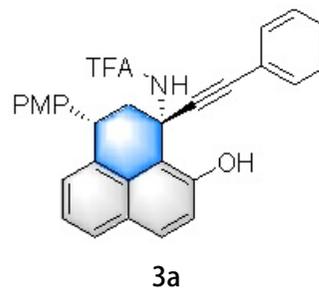
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.80  
156.62  
156.32  
156.03  
155.73  
153.29  
135.74  
134.78  
132.09  
129.96  
129.34  
129.18  
128.99  
128.39  
127.11  
126.82  
123.45  
120.91  
120.44  
118.88  
116.58  
114.29  
113.02  
111.99

87.32  
86.40

55.29  
51.31

42.15  
40.94



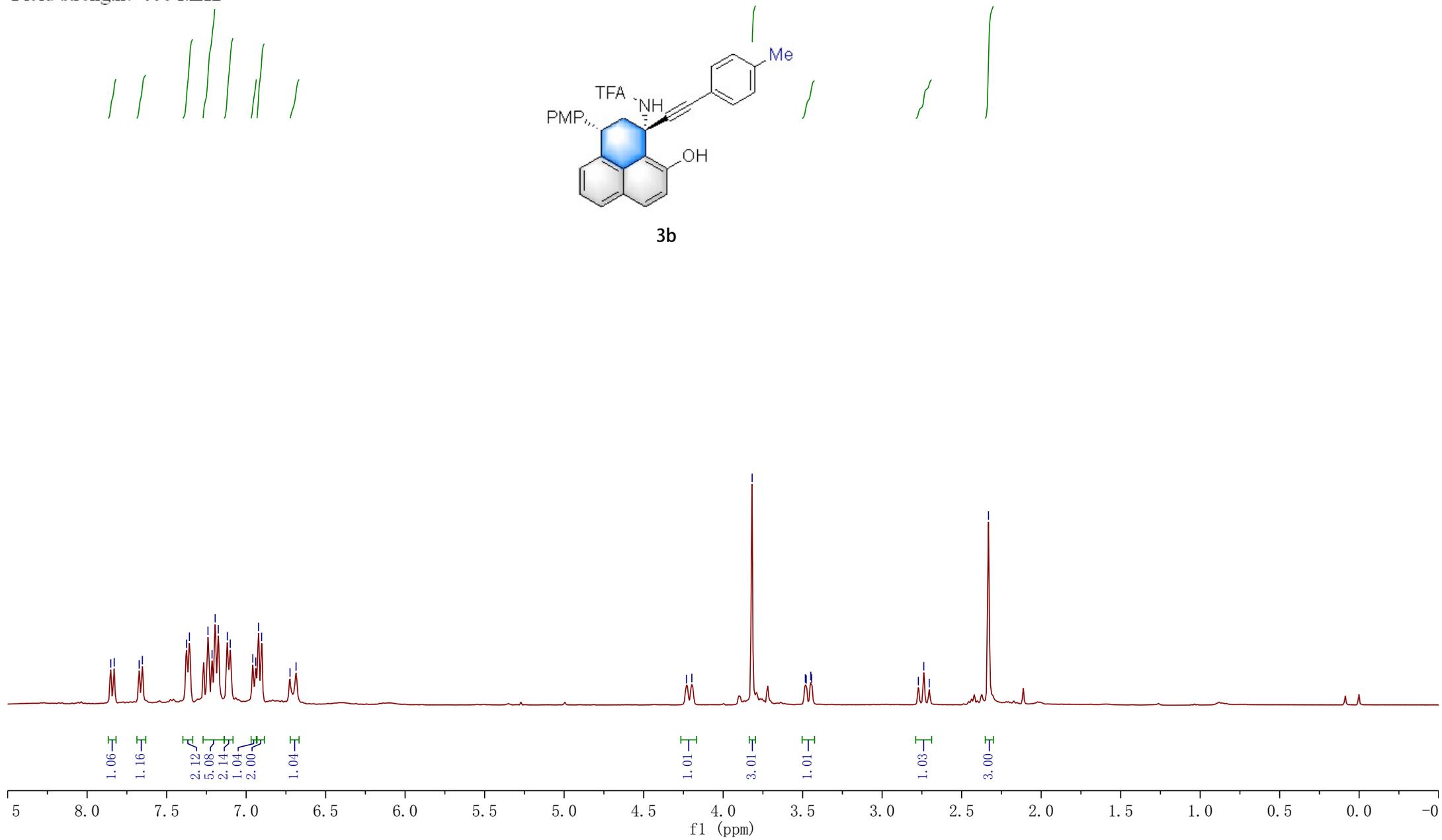
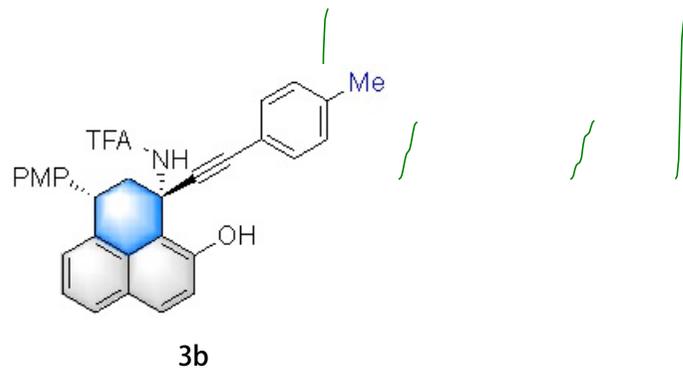
7.851  
7.829  
7.673  
7.653  
7.375  
7.356  
7.240  
7.214  
7.195  
7.175  
7.118  
7.100  
6.958  
6.940  
6.922  
6.903  
6.724  
6.686

4.231  
4.197  
3.818  
3.483  
3.478  
3.449  
3.443  
2.772  
2.738  
2.704  
2.331

Analysis:  $^1\text{H}$  NMR

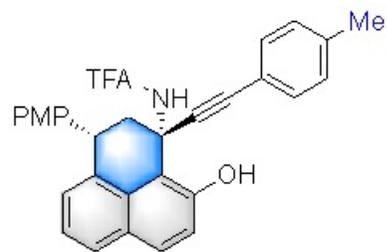
Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz

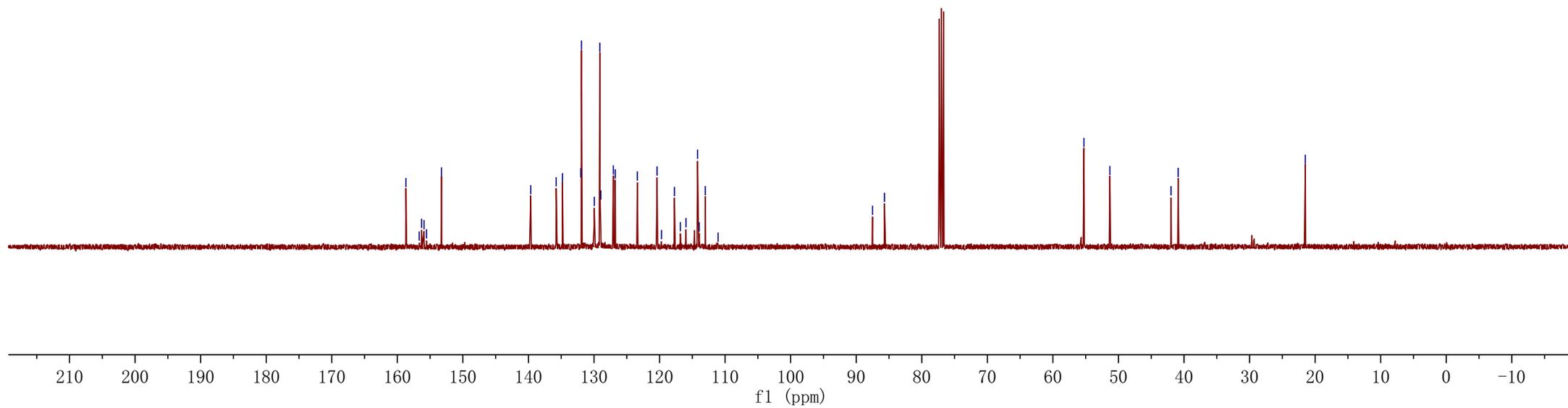


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

158.68  
156.66  
156.29  
155.92  
155.55  
153.26  
139.64  
135.77  
134.81  
132.02  
131.91  
129.95  
129.11  
128.96  
127.05  
126.76  
123.39  
120.38  
119.70  
117.72  
116.82  
115.96  
114.19  
113.95  
113.02  
111.07  
87.52  
85.69  
55.27  
51.31  
41.98  
40.90  
21.50



3b

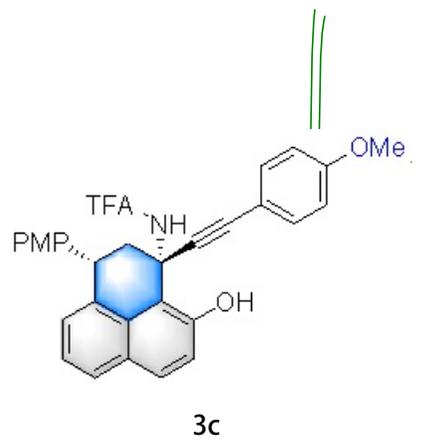
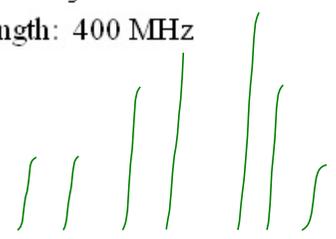


7.858  
7.836  
7.676  
7.656  
7.421  
7.400  
7.245  
7.216  
7.197  
7.176  
6.956  
6.937  
6.924  
6.903  
6.881  
6.810  
6.652

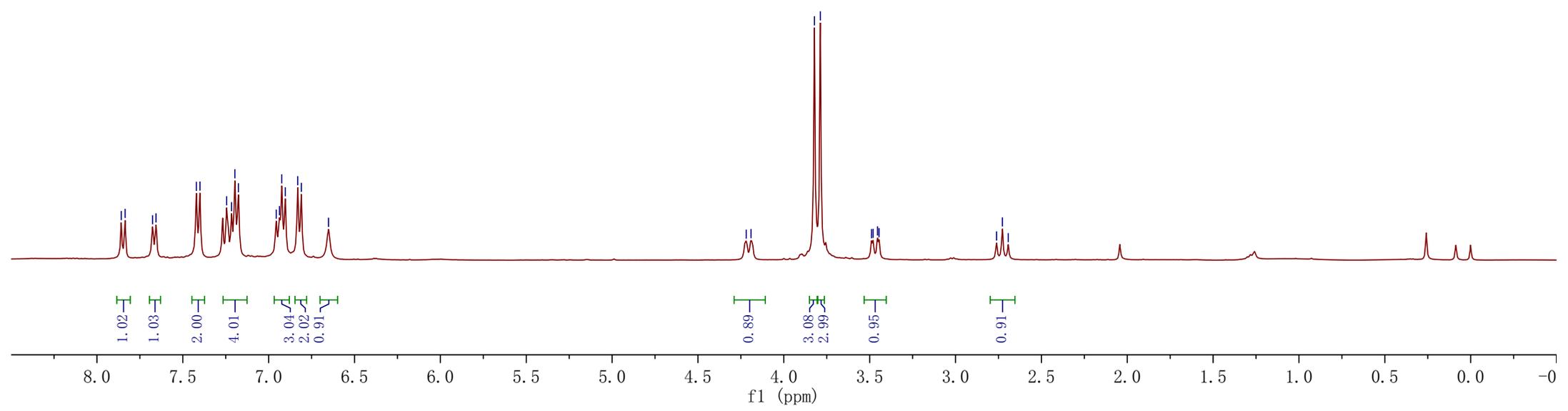
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



4.219  
4.191  
3.822  
3.787  
3.489  
3.480  
3.455  
3.446  
2.761  
2.727  
2.693



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

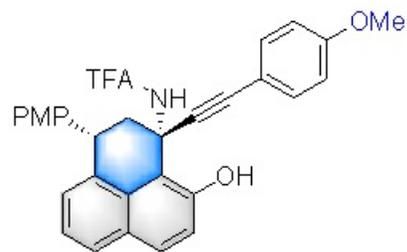
160.38  
158.68  
156.63  
156.26  
155.89  
155.52  
153.27  
135.80  
134.83  
133.59  
132.02  
129.97  
129.09  
128.95  
127.06  
126.77  
123.40  
120.36  
119.70  
116.83  
114.19  
114.01  
113.95  
113.07  
112.77  
111.09

87.52  
85.04

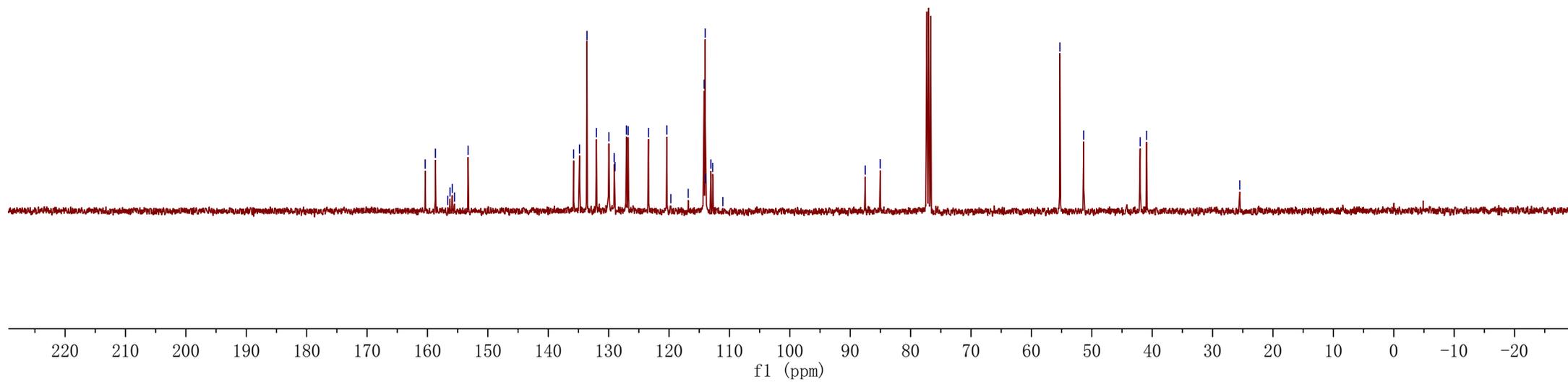
55.28  
51.35

41.99  
40.92

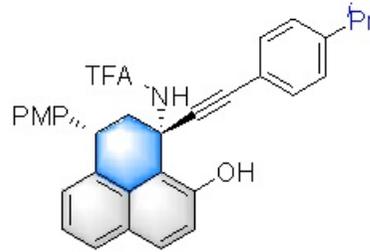
25.50



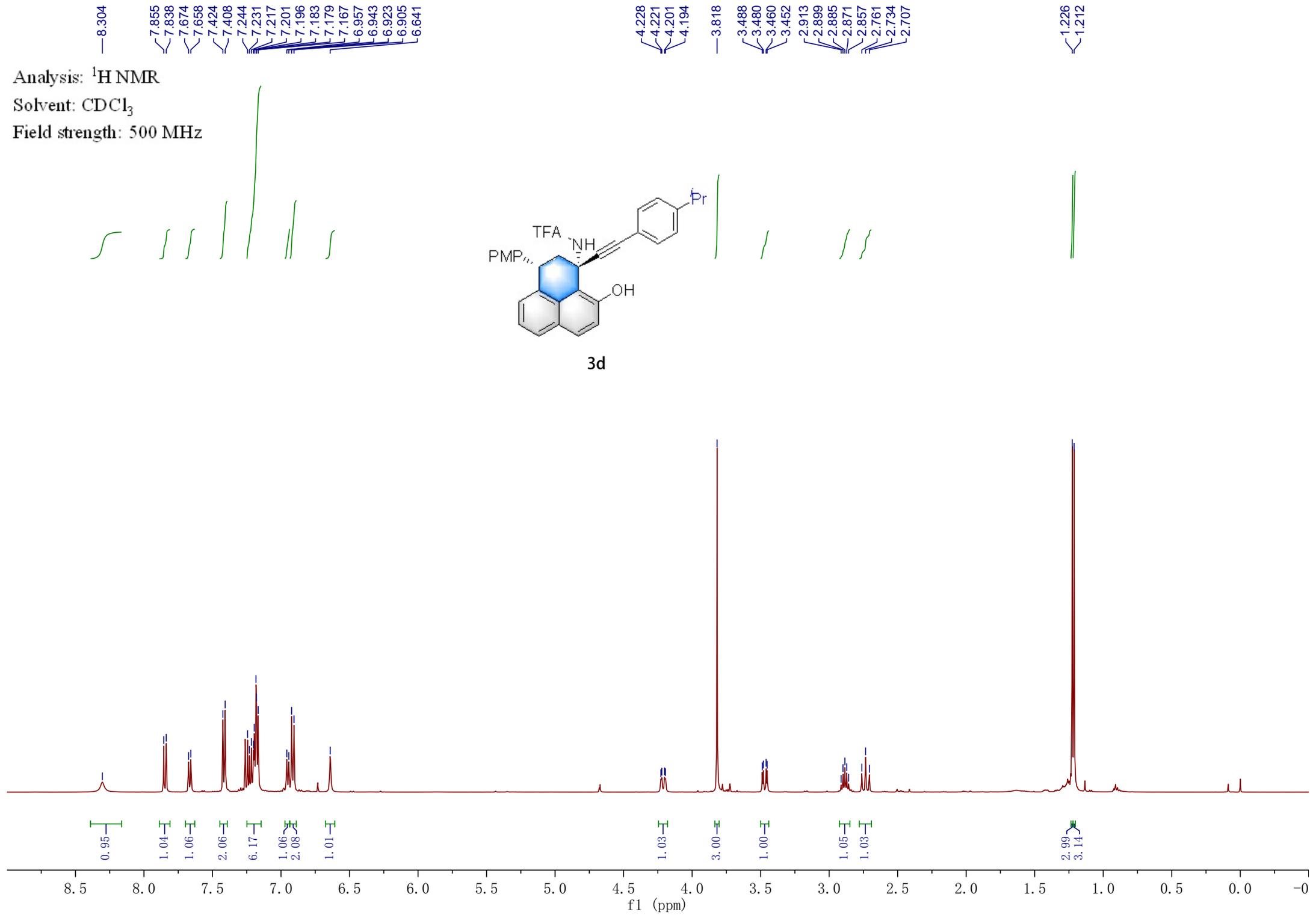
3c



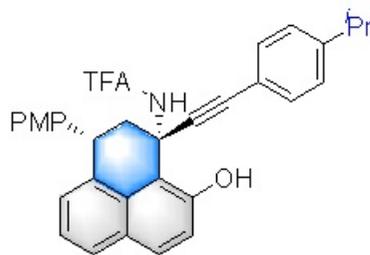
Analysis:  $^1\text{H}$  NMR  
 Solvent:  $\text{CDCl}_3$   
 Field strength: 500 MHz



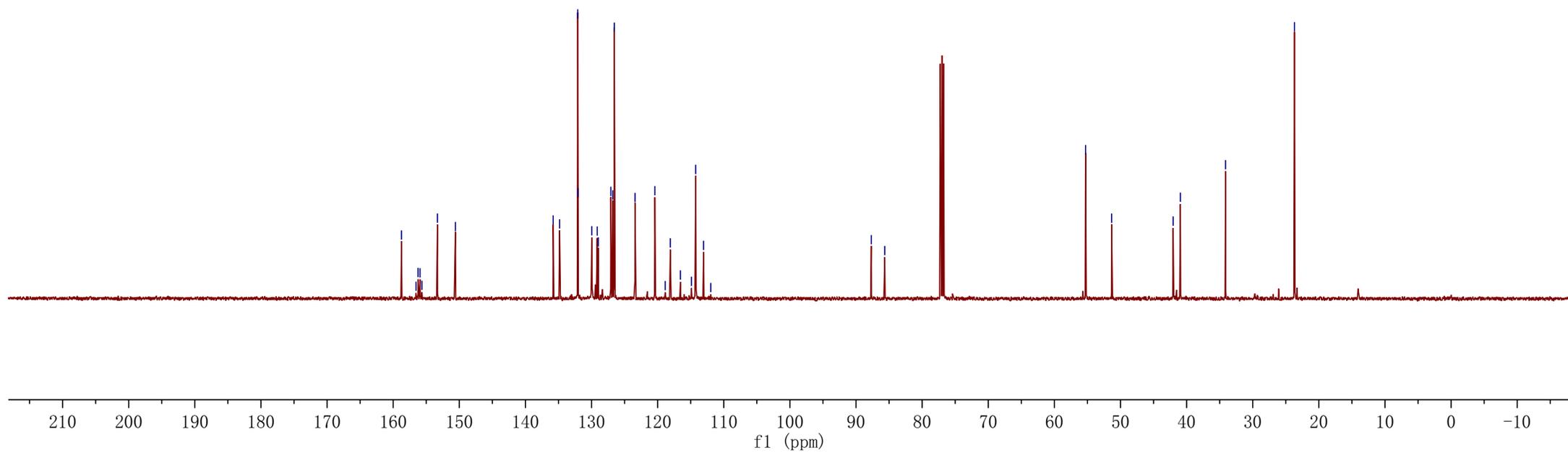
3d



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



**3d**

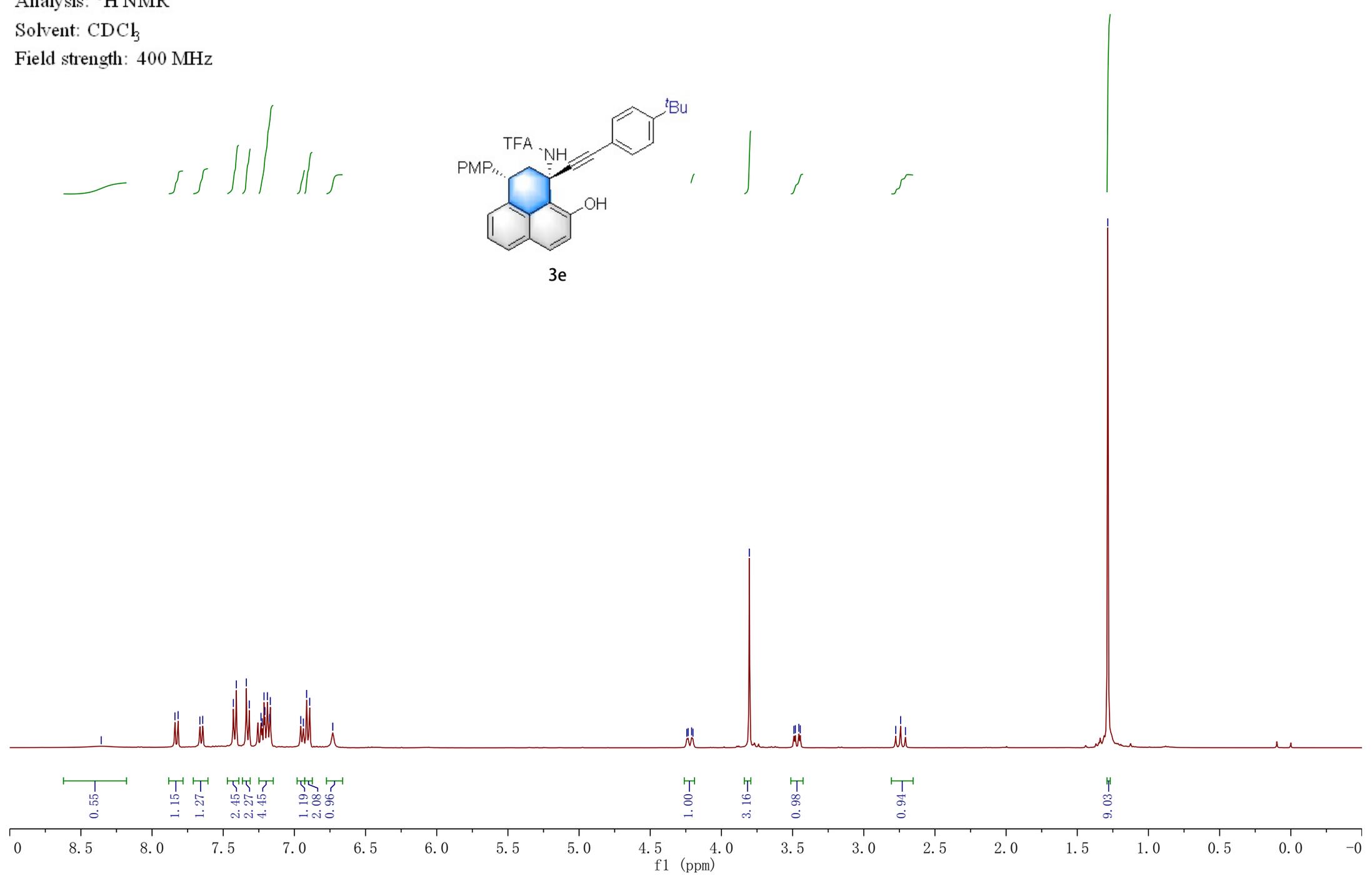
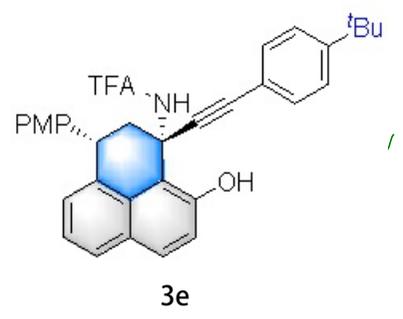
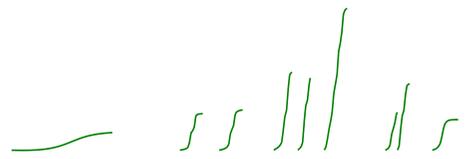


8.357  
7.839  
7.817  
7.664  
7.644  
7.429  
7.408  
7.338  
7.317  
7.235  
7.226  
7.214  
7.207  
7.190  
7.174  
7.169  
6.955  
6.937  
6.914  
6.893  
6.730

Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 400 MHz

4.243  
4.234  
4.210  
4.200  
3.804  
3.491  
3.481  
3.456  
3.447  
2.775  
2.741  
2.707

1.286



158.65  
156.67  
156.30  
155.93  
155.55  
153.26  
152.77

135.77  
134.81  
132.01  
131.78  
129.94  
129.07  
128.96  
127.05  
126.76  
125.39  
123.39  
120.37  
119.70  
117.76  
116.82  
114.18  
113.95  
113.01  
111.07

87.48  
85.75

55.24  
51.31

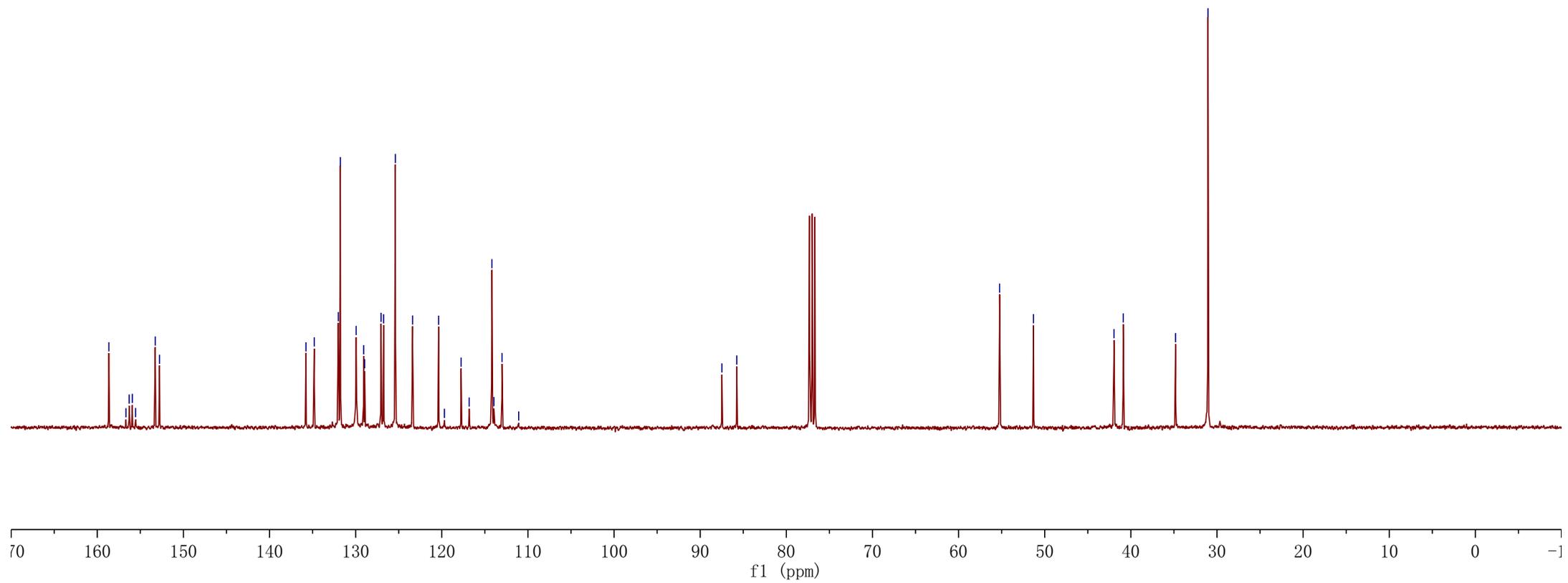
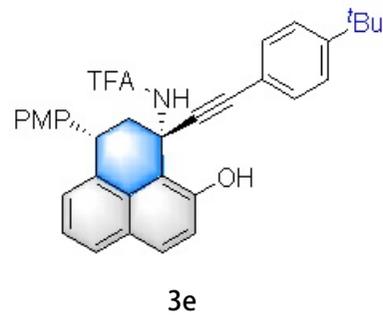
41.96  
40.89

34.81  
31.04

Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 100 MHz



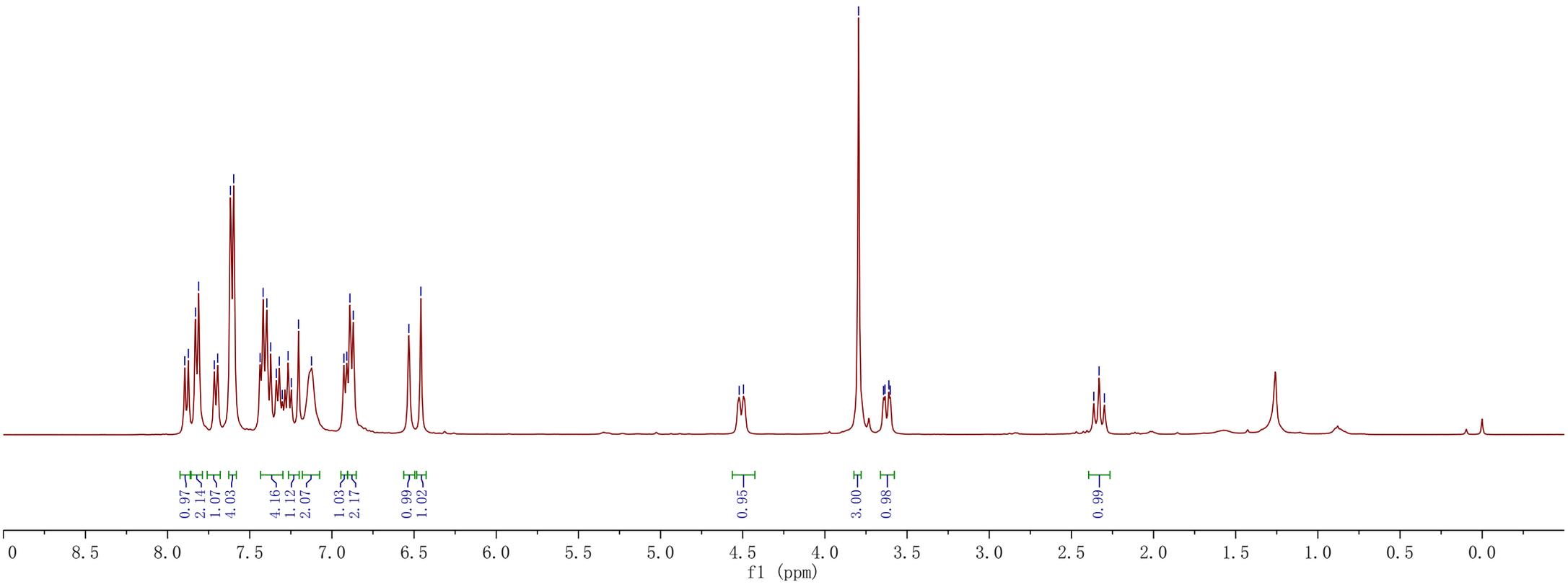
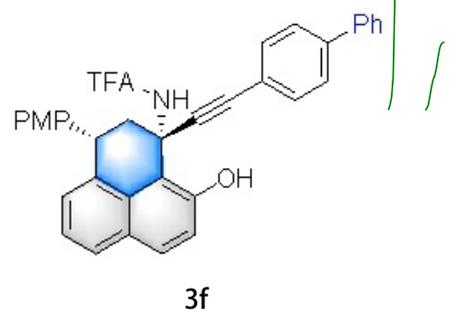
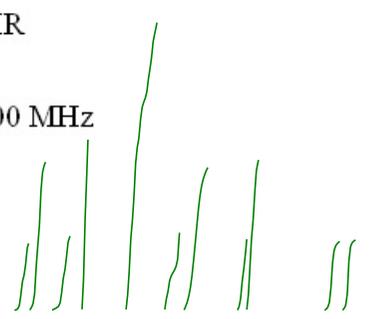
7.896  
7.873  
7.831  
7.811  
7.716  
7.695  
7.617  
7.598  
7.437  
7.419  
7.396  
7.372  
7.338  
7.320  
7.267  
7.247  
7.203  
7.124  
6.927  
6.909  
6.890  
6.879  
6.832  
6.459

4.521  
4.495

3.795  
3.643  
3.635  
3.611  
3.602

2.364  
2.332  
2.299

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

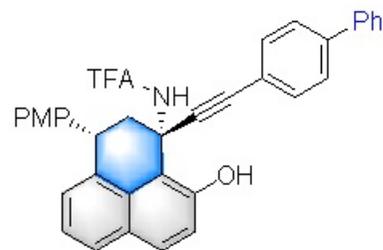
158.64  
156.96  
156.07  
155.70  
155.33  
154.97  
154.34  
140.62  
139.93  
135.51  
134.48  
132.81  
131.27  
130.01  
129.75  
128.74  
127.29  
127.03  
126.91  
126.49  
125.77  
125.01  
119.65  
117.67  
116.77  
114.12  
113.90  
111.83  
111.02  
108.96

60.55

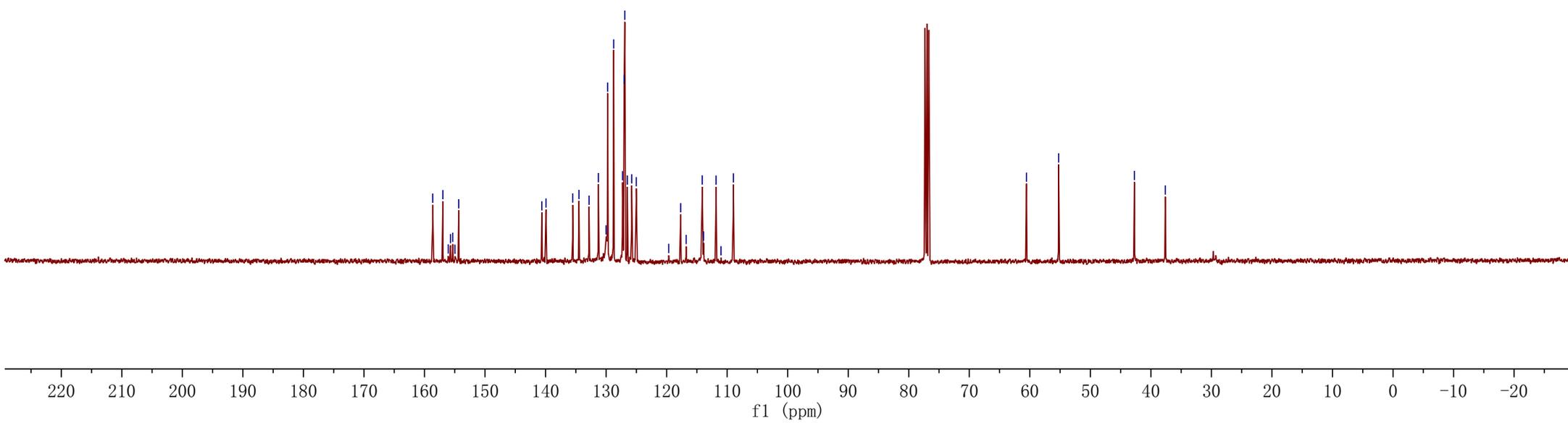
55.24

42.73

37.62

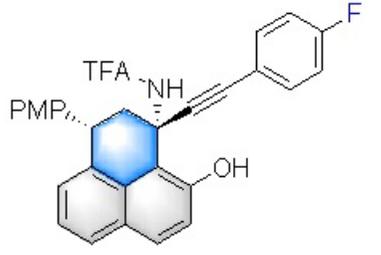
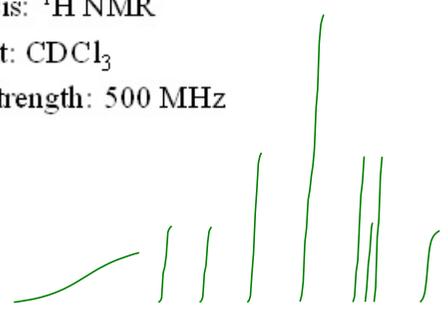


**3f**



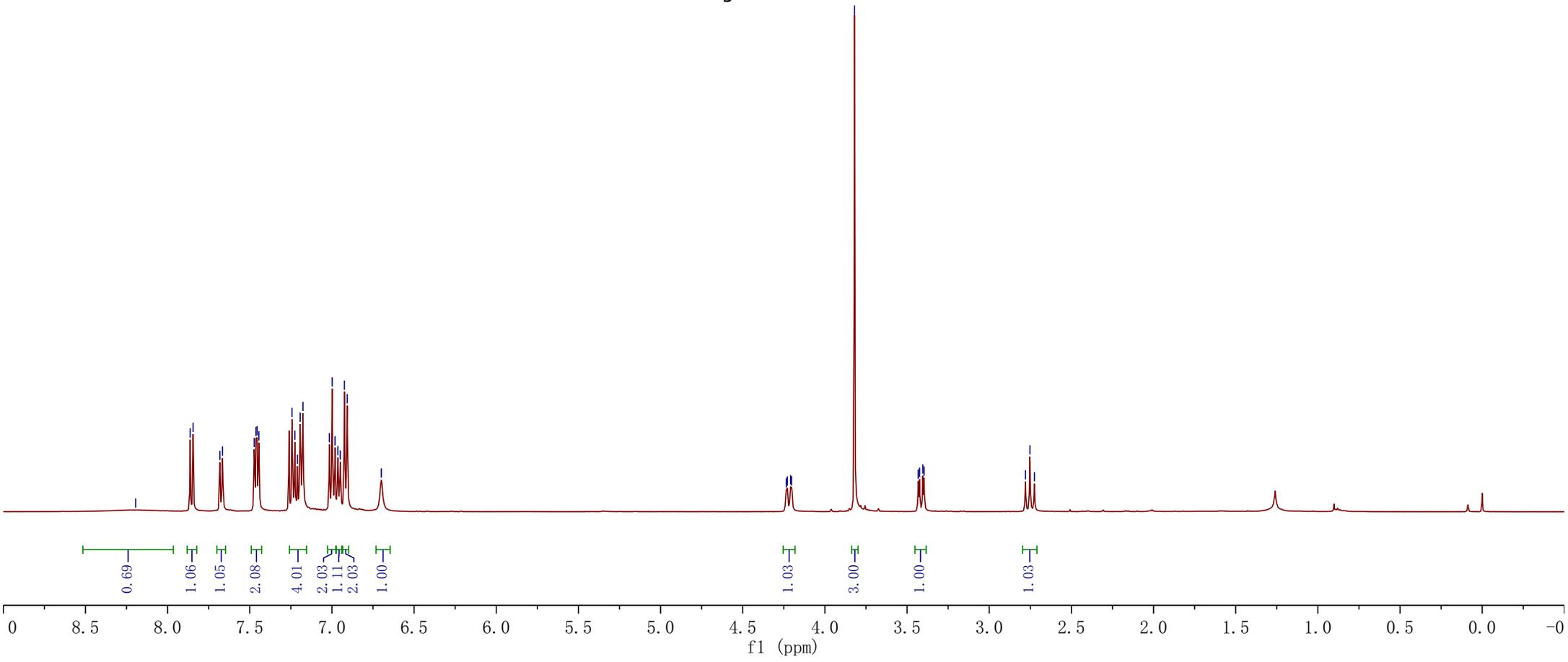
8.194  
7.863  
7.845  
7.682  
7.666  
7.473  
7.462  
7.455  
7.445  
7.243  
7.225  
7.210  
7.193  
7.176  
7.016  
6.999  
6.981  
6.964  
6.949  
6.924  
6.907  
6.699

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



3g

4.235  
4.229  
4.209  
4.202  
3.820  
3.432  
3.424  
3.404  
3.396  
2.779  
2.752  
2.725



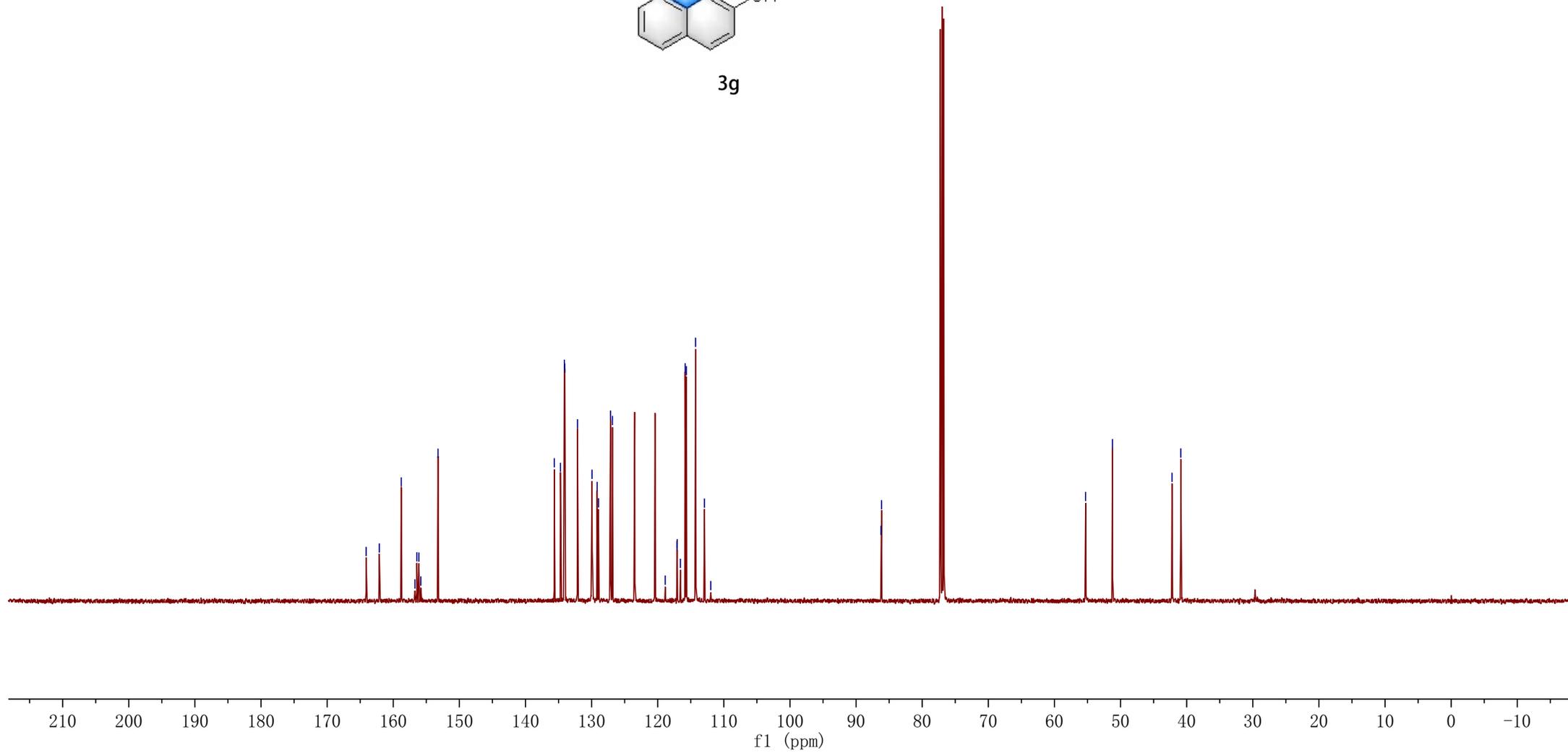
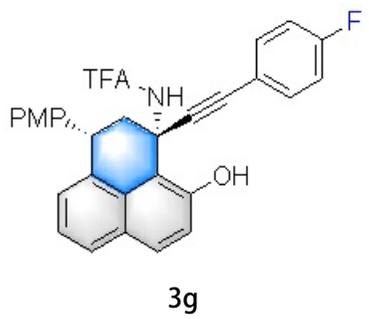
164.10  
162.10  
158.79  
156.72  
156.42  
156.13  
155.83  
153.23  
135.65  
134.71  
134.12  
134.06  
132.13  
129.94  
129.16  
128.96  
127.14  
126.85  
118.87  
117.08  
117.05  
116.57  
115.85  
115.67  
114.28  
112.94  
111.98

86.23  
86.15

55.29  
51.23

42.22  
40.89

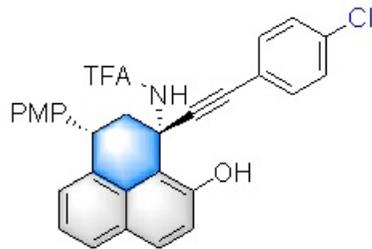
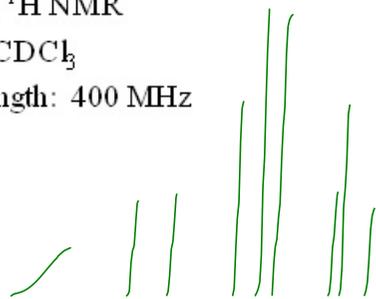
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



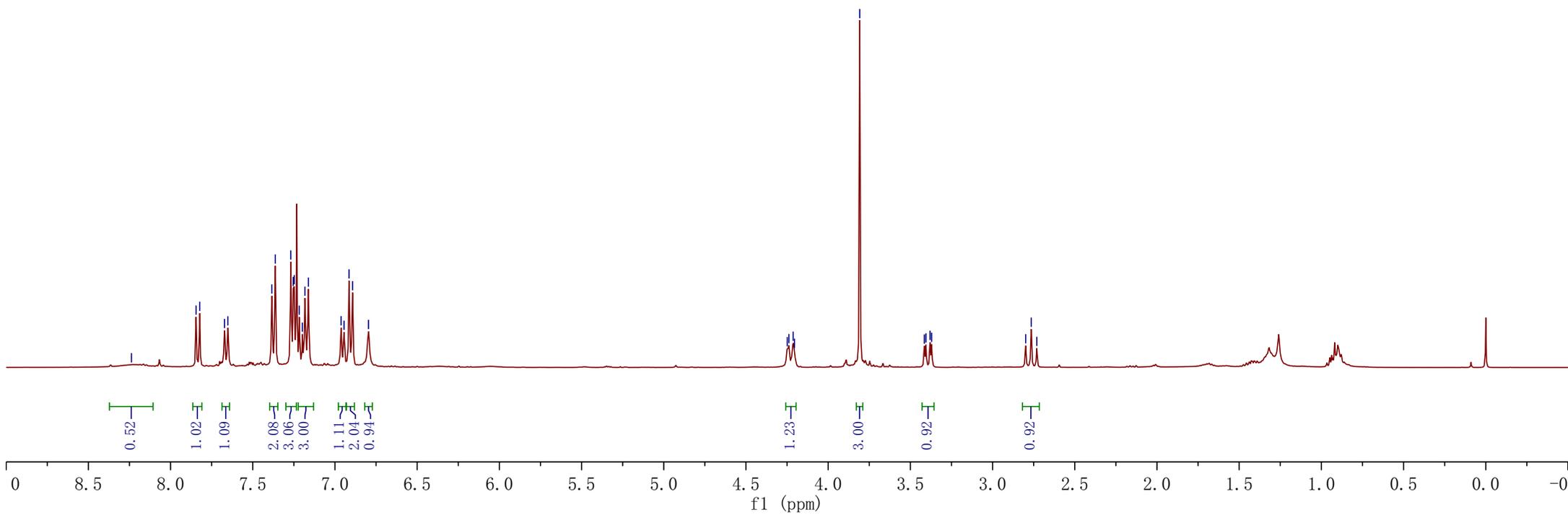
Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

8.238  
7.845  
7.822  
7.672  
7.651  
7.384  
7.363  
7.269  
7.254  
7.248  
7.218  
7.198  
7.183  
7.162  
6.963  
6.945  
6.915  
6.893  
6.796

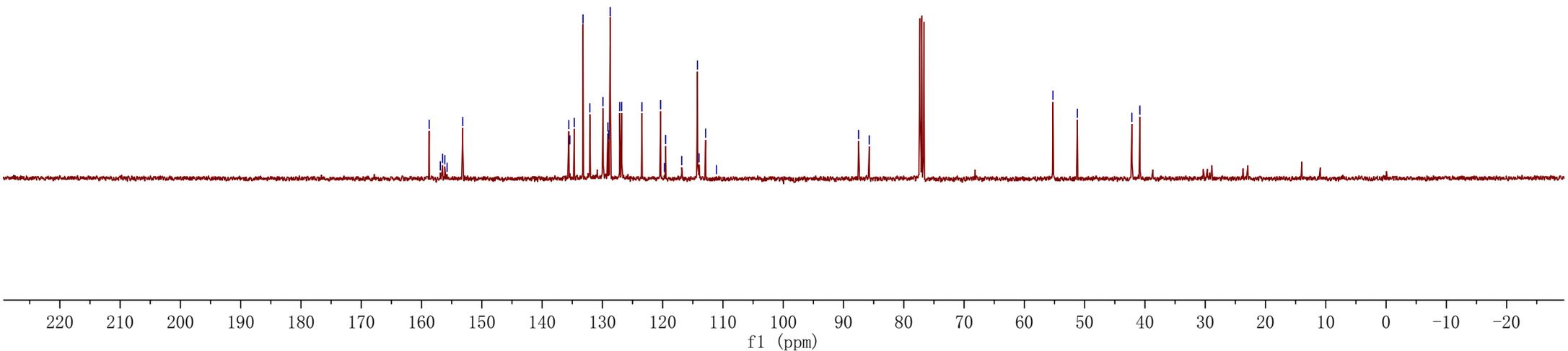
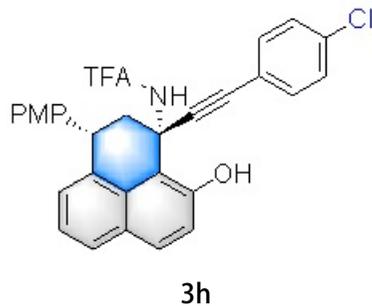
4.249  
4.239  
4.213  
4.205  
3.808  
3.415  
3.405  
3.380  
3.371  
2.799  
2.765  
2.731



3h



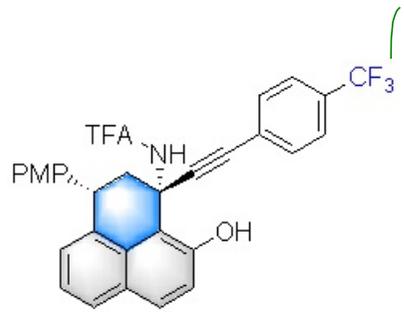
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



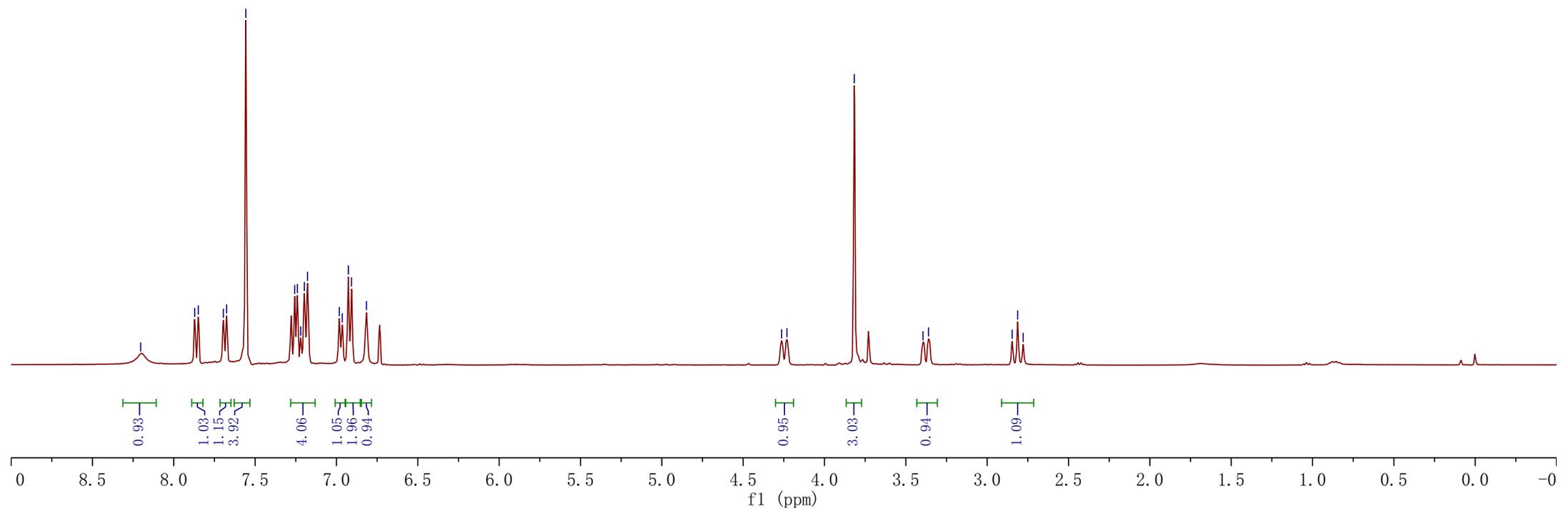
Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 400 MHz

8.204  
7.871  
7.849  
7.695  
7.675  
7.557  
7.257  
7.240  
7.220  
7.197  
7.178  
6.982  
6.964  
6.927  
6.907  
6.815

4.263  
4.231  
3.817  
3.394  
3.360  
2.846  
2.813  
2.779



3i

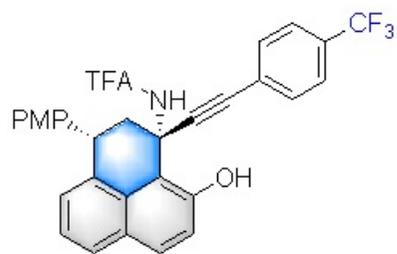


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

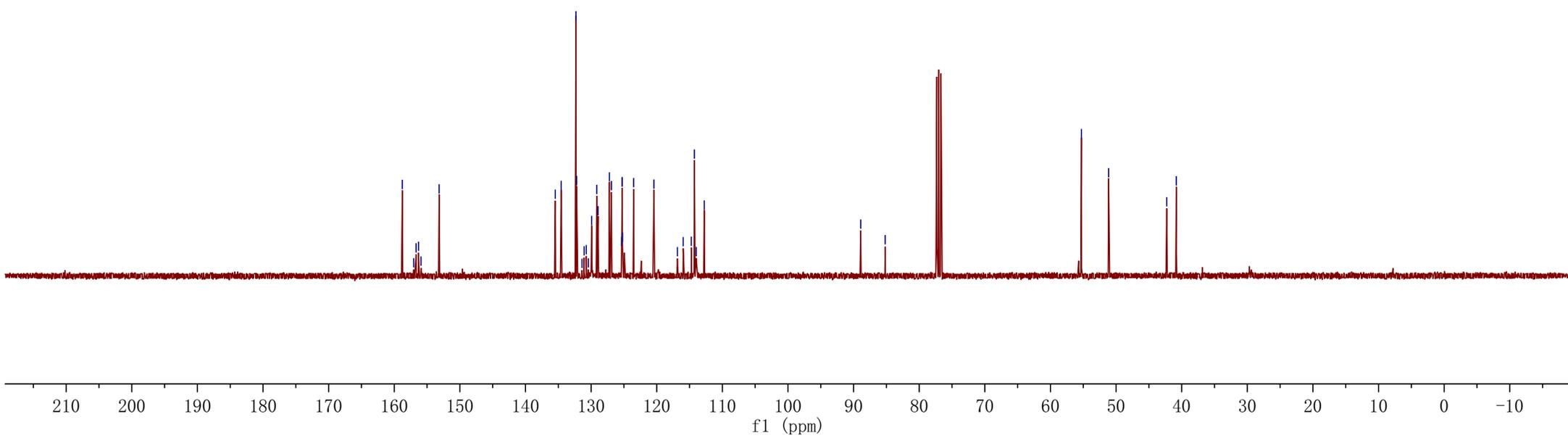
158.78  
157.04  
156.67  
156.30  
155.92  
153.16  
135.46  
134.57  
132.32  
132.21  
131.39  
131.07  
130.74  
130.41  
129.92  
129.14  
128.94  
127.21  
126.90  
125.33  
125.30  
125.26  
125.22  
123.52  
120.43  
116.85  
115.97  
114.74  
114.26  
113.98  
112.76  
88.92  
85.19

55.28  
51.14

42.28  
40.82



**3i**



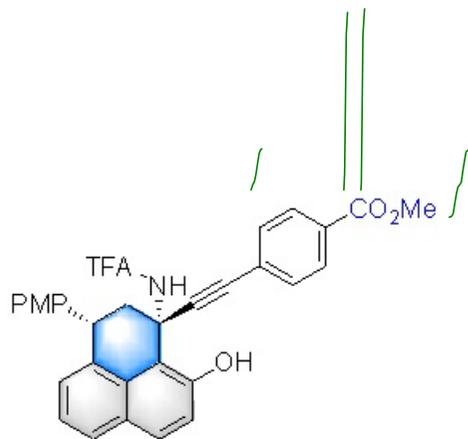
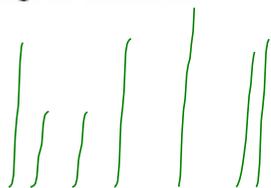
7.934  
7.913  
7.839  
7.816  
7.670  
7.650  
7.496  
7.476  
7.240  
7.220  
7.201  
7.186  
7.165  
6.965  
6.947  
6.913  
6.892

4.279  
4.269  
4.246  
4.236  
3.875  
3.805  
3.422  
3.413  
3.388  
3.378  
2.841  
2.807  
2.773

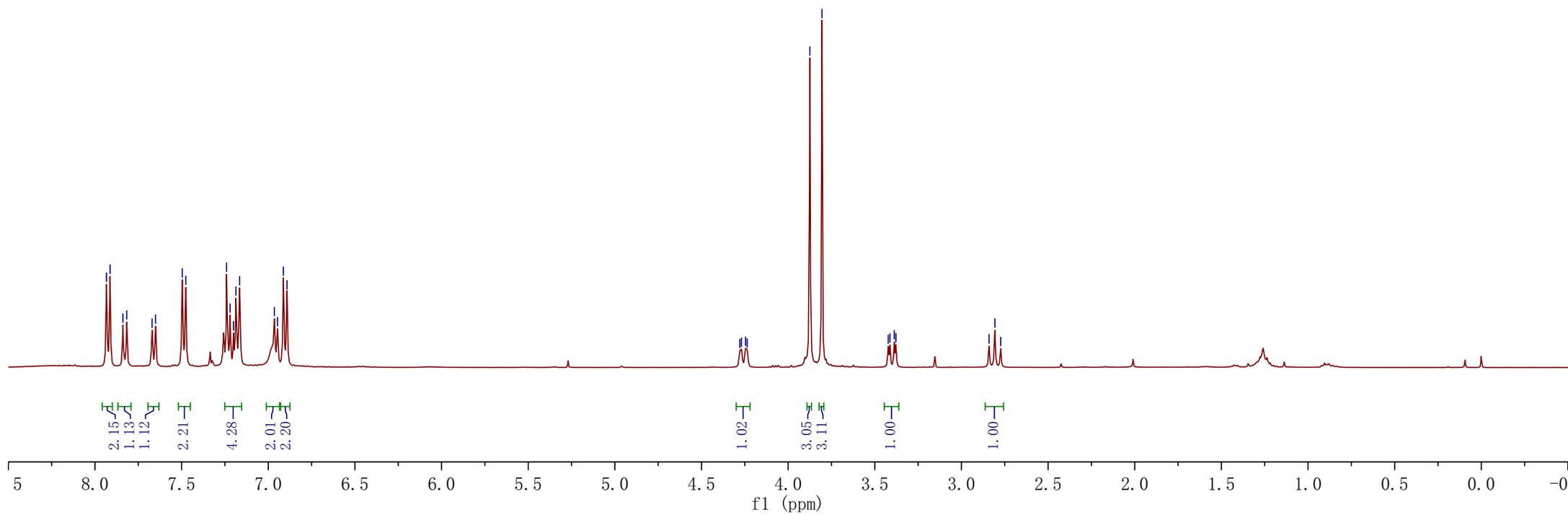
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz

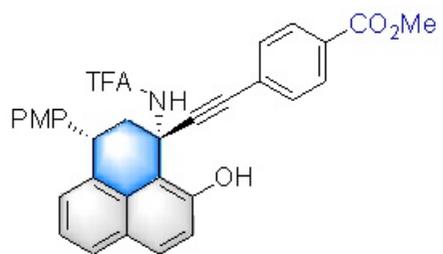


3j

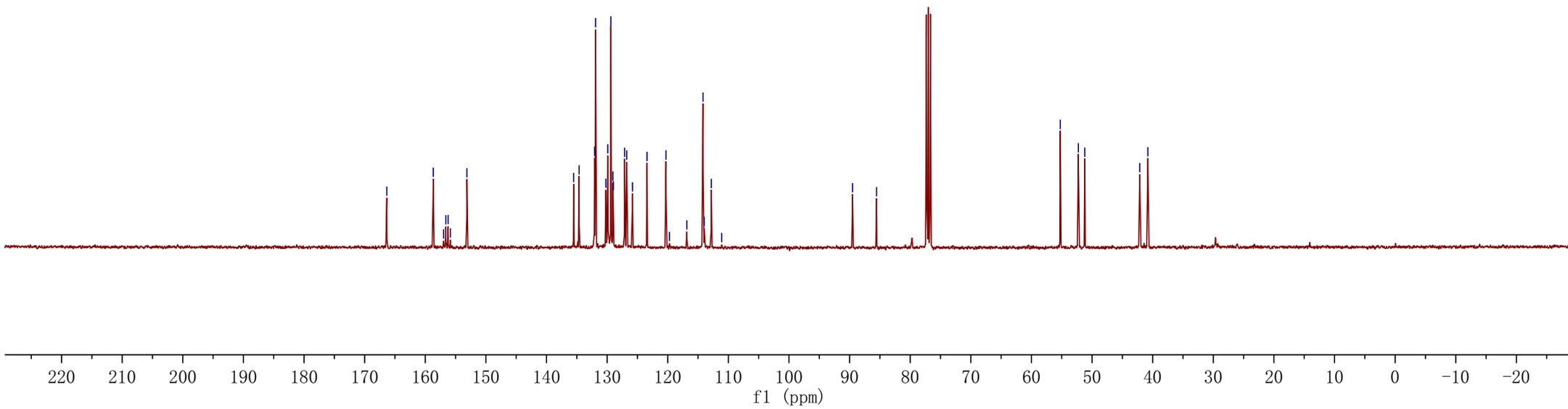


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

166.35  
158.68  
156.97  
156.60  
156.23  
155.85  
153.13  
135.53  
134.62  
132.07  
131.91  
130.21  
129.90  
129.38  
129.05  
128.97  
127.11  
126.77  
125.82  
123.42  
120.29  
119.72  
116.85  
114.18  
113.97  
112.81  
111.10  
89.51  
85.55  
55.24  
52.26  
51.20  
42.14  
40.79



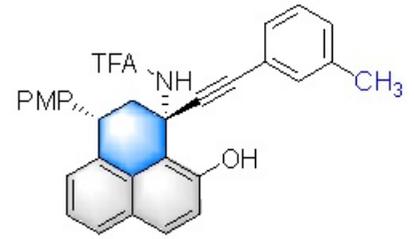
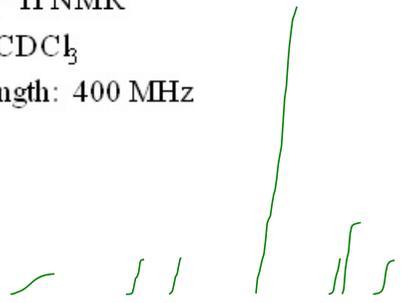
**3j**



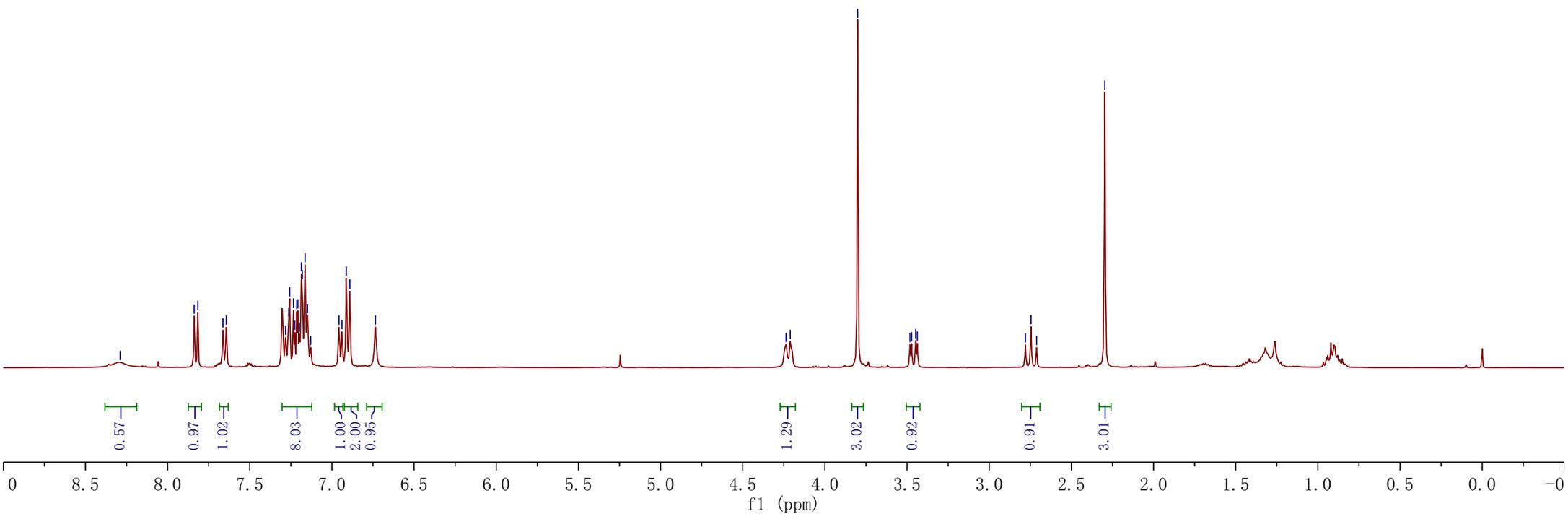
8.288  
7.838  
7.816  
7.663  
7.643  
7.282  
7.263  
7.257  
7.234  
7.226  
7.214  
7.207  
7.199  
7.186  
7.180  
7.163  
7.149  
7.129  
6.957  
6.939  
6.913  
6.891  
6.735

4.236  
4.211  
3.801  
3.482  
3.472  
3.448  
3.438  
2.780  
2.746  
2.712  
2.297

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



3k

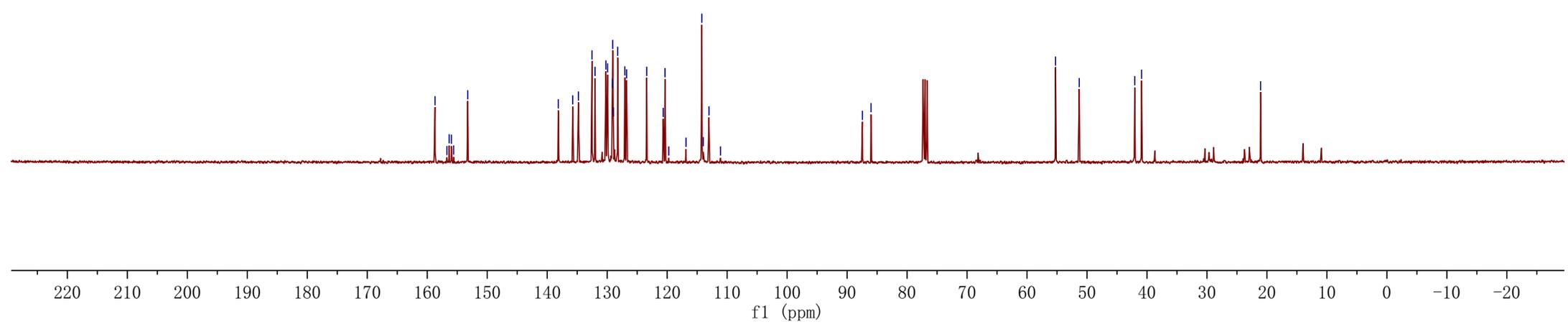
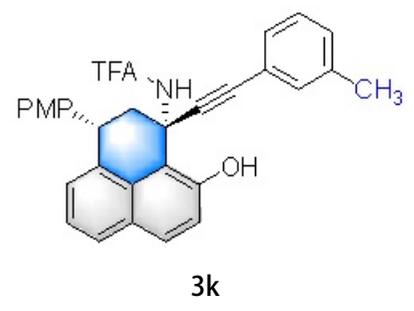


158.70  
156.71  
156.34  
155.97  
155.60  
153.24  
138.16  
135.75  
134.80  
132.54  
132.03  
130.21  
129.93  
129.11  
129.08  
128.97  
128.25  
127.06  
126.76  
123.40  
120.65  
120.36  
119.73  
116.85  
114.21  
113.98  
113.02  
111.10  
87.45  
86.01

55.24  
51.30  
42.04  
40.90

21.06

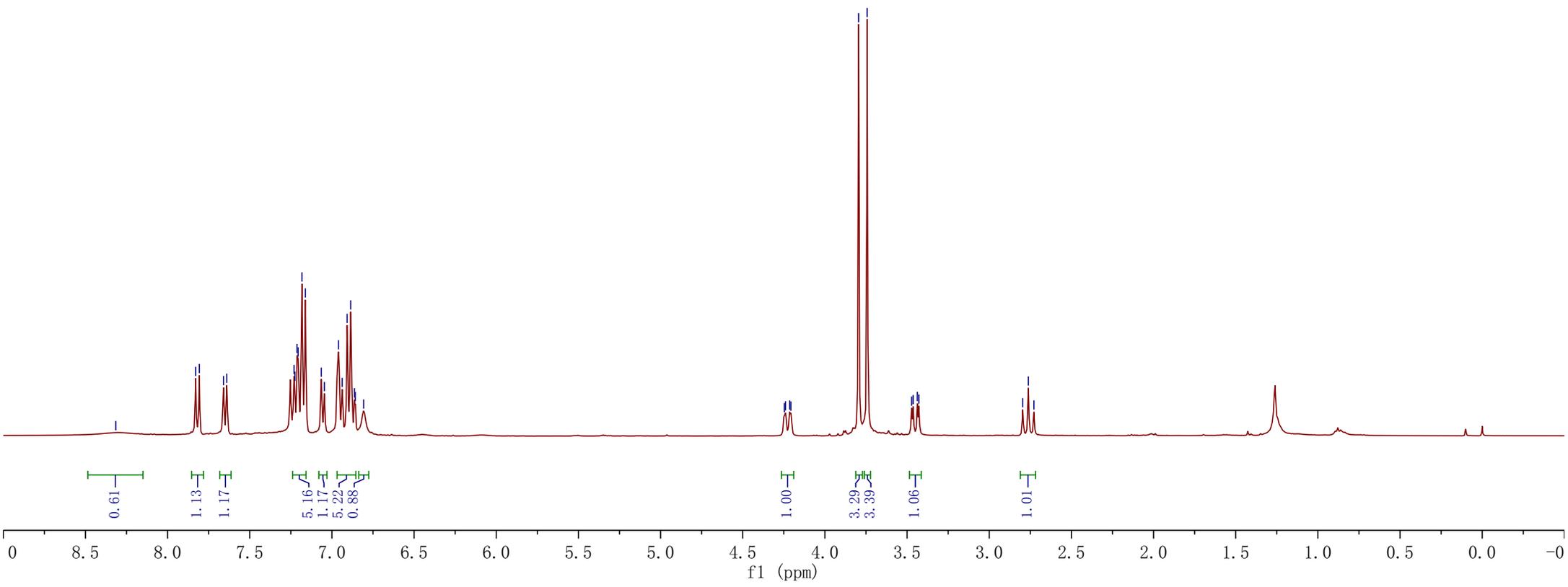
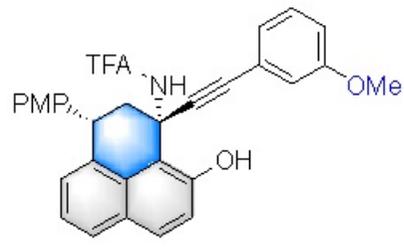
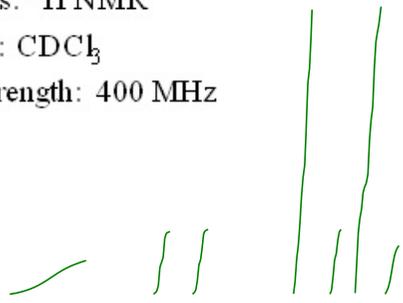
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



8.315  
 7.829  
 7.807  
 7.660  
 7.640  
 7.231  
 7.226  
 7.213  
 7.206  
 7.182  
 7.162  
 7.065  
 7.046  
 6.960  
 6.938  
 6.908  
 6.886  
 6.863  
 6.858  
 6.807

4.247  
 4.240  
 4.214  
 4.207  
 3.795  
 3.743  
 3.472  
 3.463  
 3.438  
 3.428  
 2.796  
 2.762  
 2.728

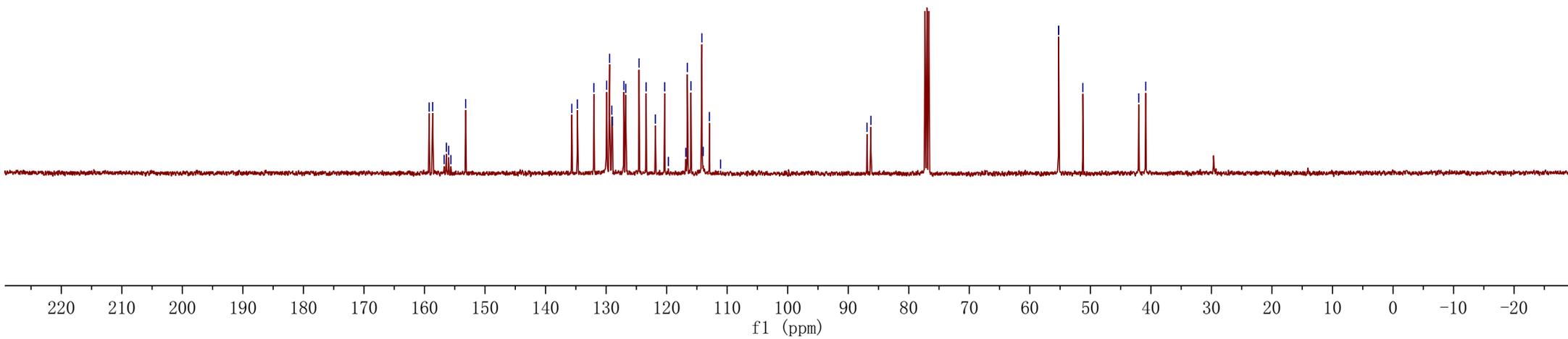
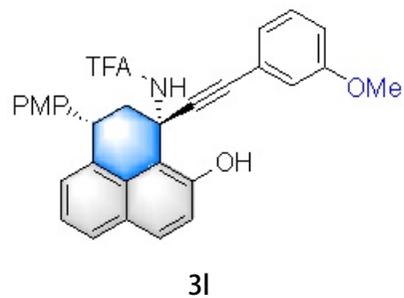
Analysis:  $^1\text{H}$  NMR  
 Solvent:  $\text{CDCl}_3$   
 Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

159.23 158.65 156.75 156.38 156.01 155.64 153.20  
135.66 134.75 132.02 129.91 129.43 129.06 128.95 127.06 126.75 124.56 123.39 121.86 120.32 119.71 116.83 116.58 115.98 114.17 113.96 112.94 111.08 86.90 86.25

55.24 55.22 51.24  
42.01 40.86



7.853  
7.831  
7.678  
7.657  
7.438  
7.345  
7.326  
7.314  
7.292  
7.237  
7.233  
7.220  
7.217  
7.202  
7.197  
7.184  
7.163  
6.966  
6.948  
6.919  
6.897  
6.797

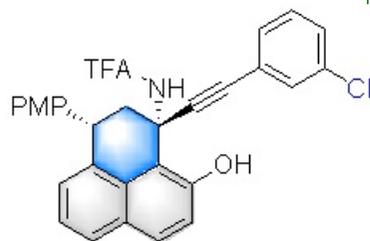
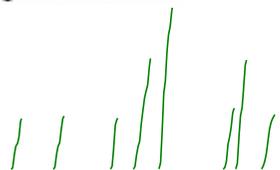
4.252  
4.243  
4.219  
4.211  
3.812  
3.403  
3.393  
3.368  
3.358

2.816  
2.782  
2.748

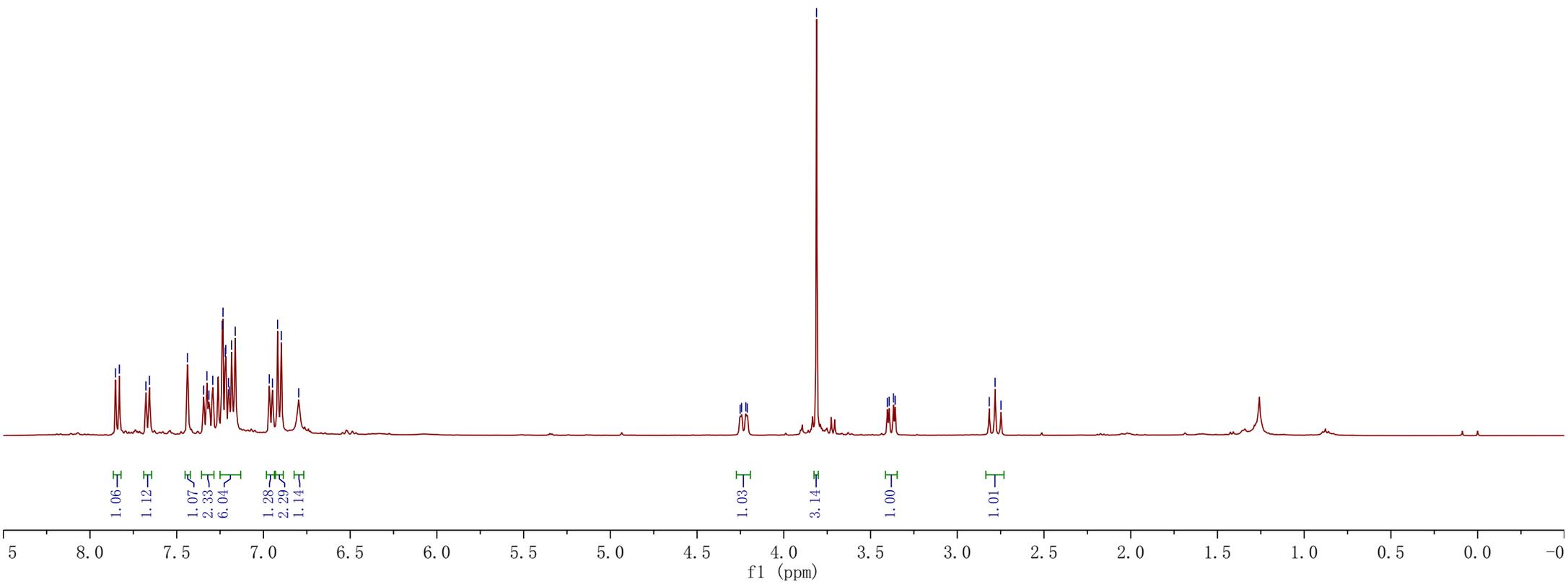
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



3m

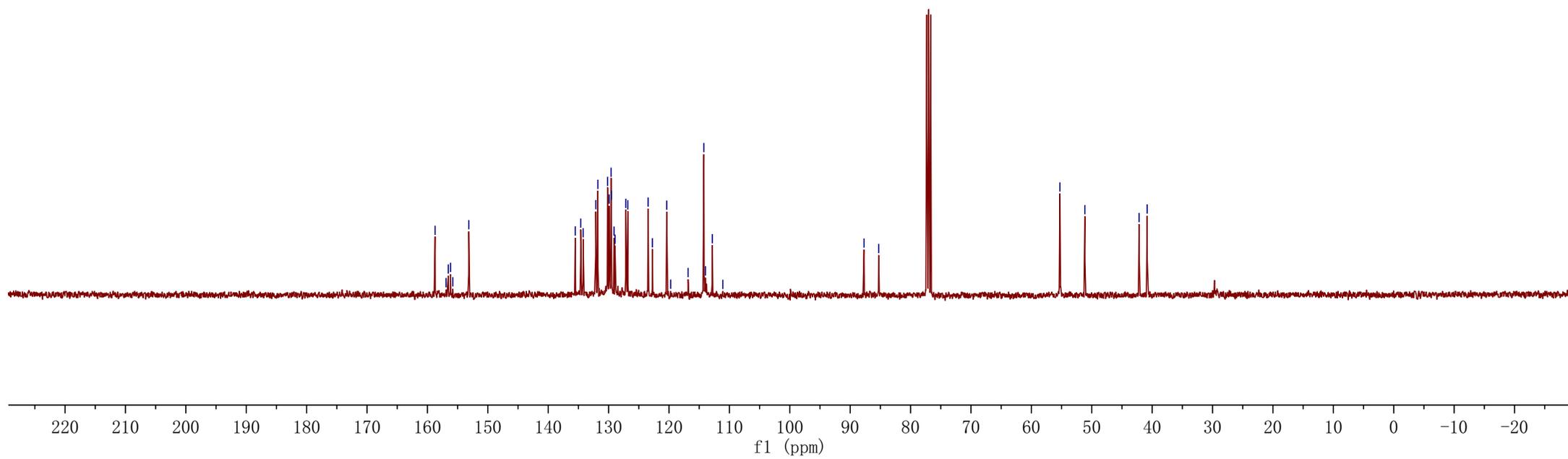
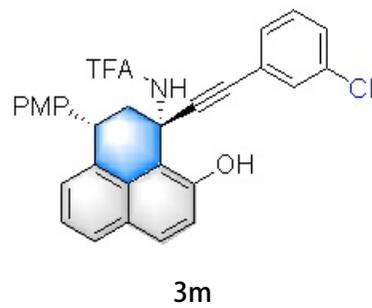


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.73  
156.91  
156.54  
156.17  
155.79  
153.14  
135.53  
134.62  
134.22  
132.12  
131.78  
130.18  
129.91  
129.59  
129.52  
129.10  
128.94  
127.15  
126.83  
123.46  
122.75  
120.38  
119.72  
116.84  
114.23  
113.96  
112.82  
111.09  
87.71  
85.28

55.27  
51.14

42.17  
40.83

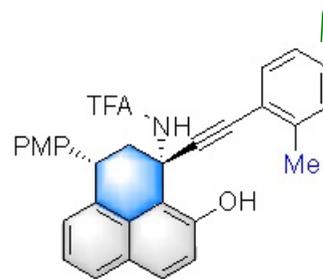


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

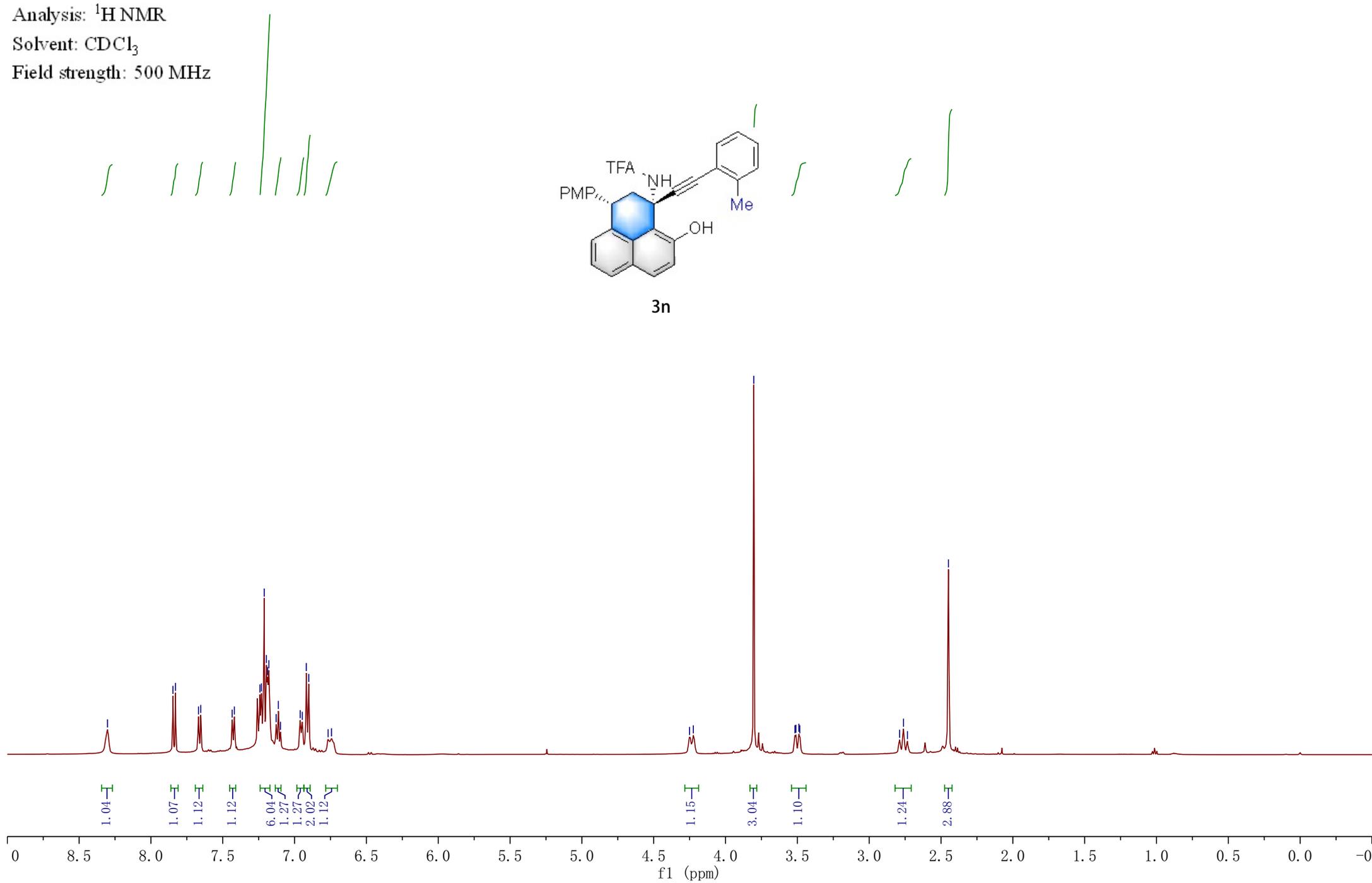
8.302  
7.847  
7.829  
7.669  
7.653  
7.435  
7.419  
7.241  
7.231  
7.211  
7.196  
7.187  
7.179  
7.128  
7.113  
7.098  
6.961  
6.946  
6.919  
6.901  
6.767  
6.743

4.250  
4.224  
3.804  
3.517  
3.510  
3.490  
3.483

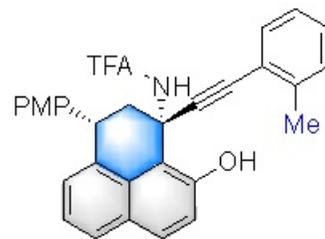
2.788  
2.761  
2.734  
2.449



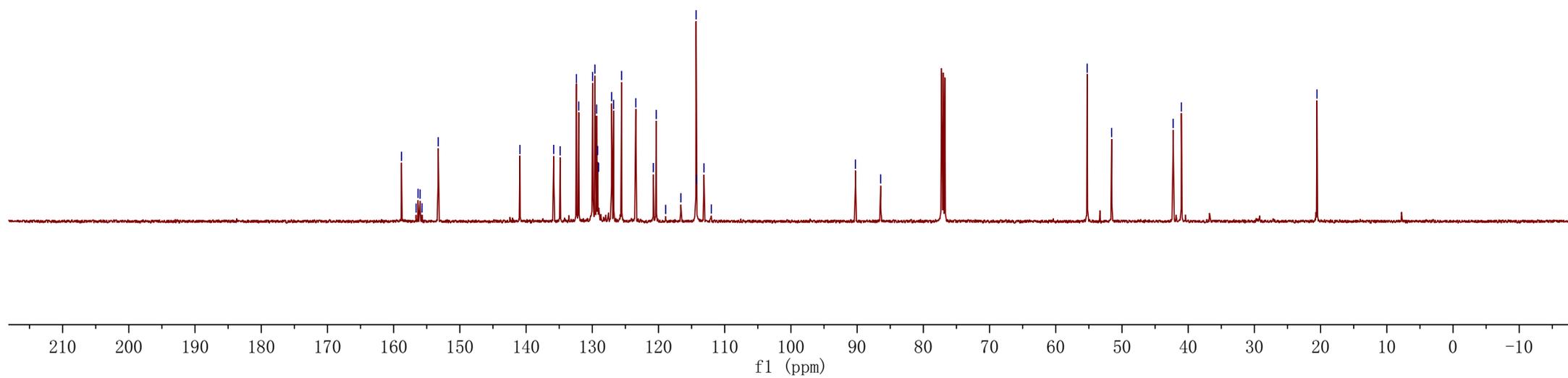
3n



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



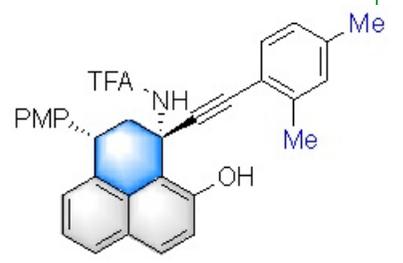
**3n**



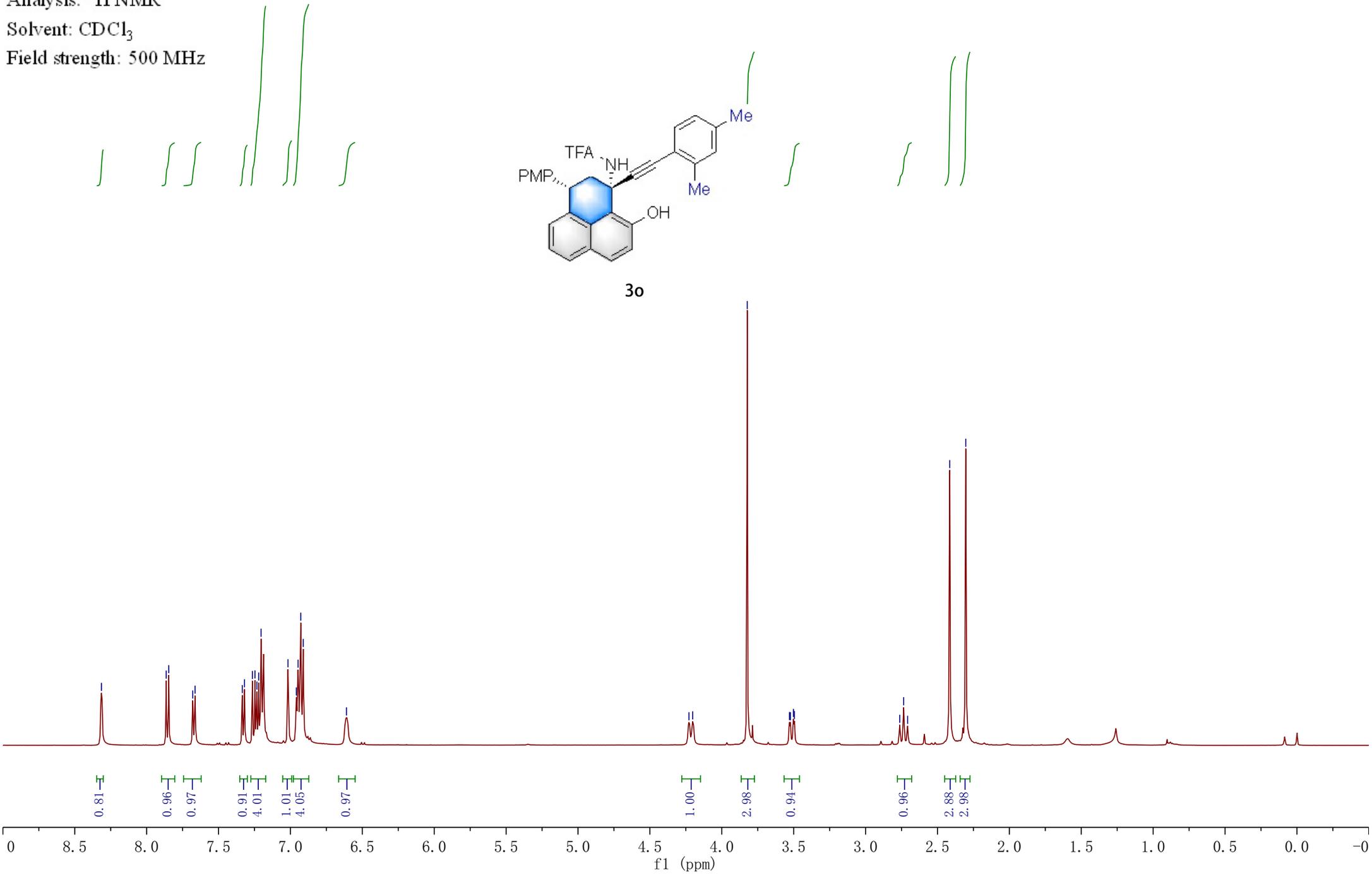
8.314  
 7.864  
 7.846  
 7.679  
 7.663  
 7.335  
 7.319  
 7.265  
 7.247  
 7.233  
 7.221  
 7.204  
 7.017  
 6.959  
 6.947  
 6.928  
 6.911  
 6.610

4.228  
 4.202  
 3.823  
 3.529  
 3.523  
 3.502  
 3.495  
 2.762  
 2.735  
 2.708  
 2.415  
 2.303

Analysis: <sup>1</sup>H NMR  
 Solvent: CDCl<sub>3</sub>  
 Field strength: 500 MHz

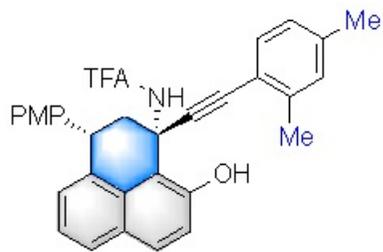


3o

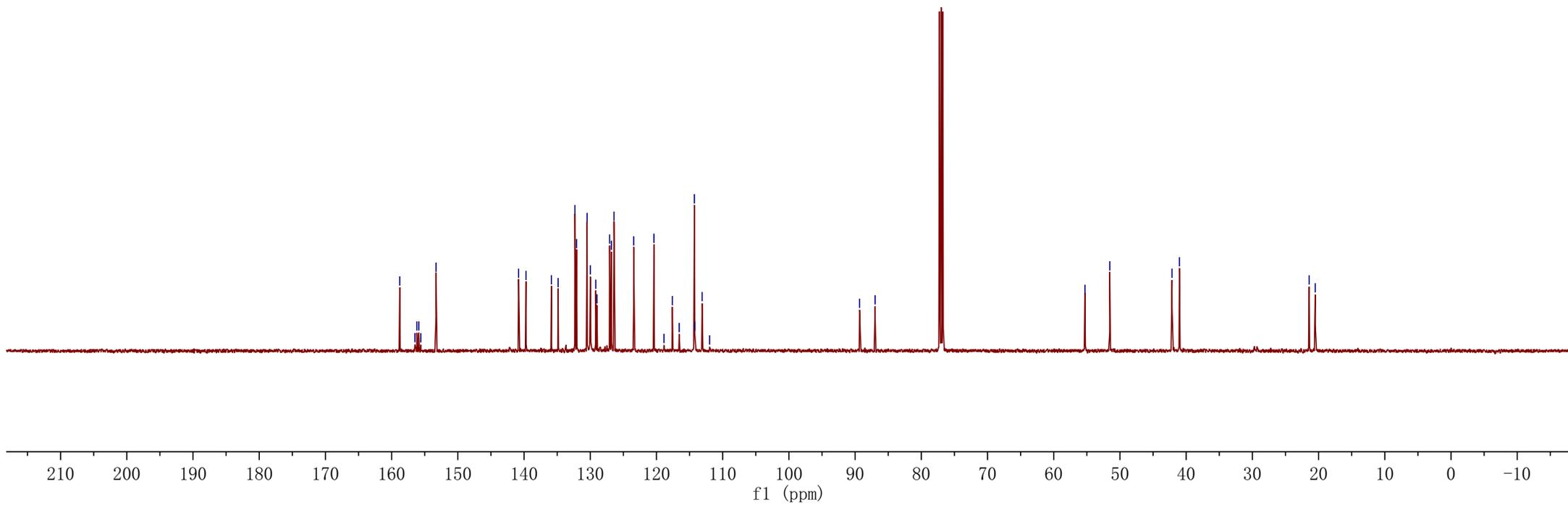


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.78  
156.48  
156.19  
155.89  
155.60  
153.29  
140.83  
139.71  
135.88  
134.86  
132.32  
132.07  
130.48  
129.99  
129.17  
128.99  
127.08  
126.81  
126.42  
123.44  
120.38  
118.87  
117.60  
116.57  
114.28  
114.21  
113.11  
111.97  
89.33  
86.98  
55.28  
51.54  
42.14  
41.02  
21.42  
20.51



3o

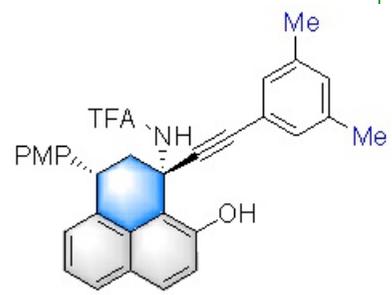


8.278  
7.851  
7.833  
7.671  
7.655  
7.263  
7.245  
7.199  
7.191  
7.174  
7.118  
6.980  
6.959  
6.944  
6.920  
6.903  
6.625

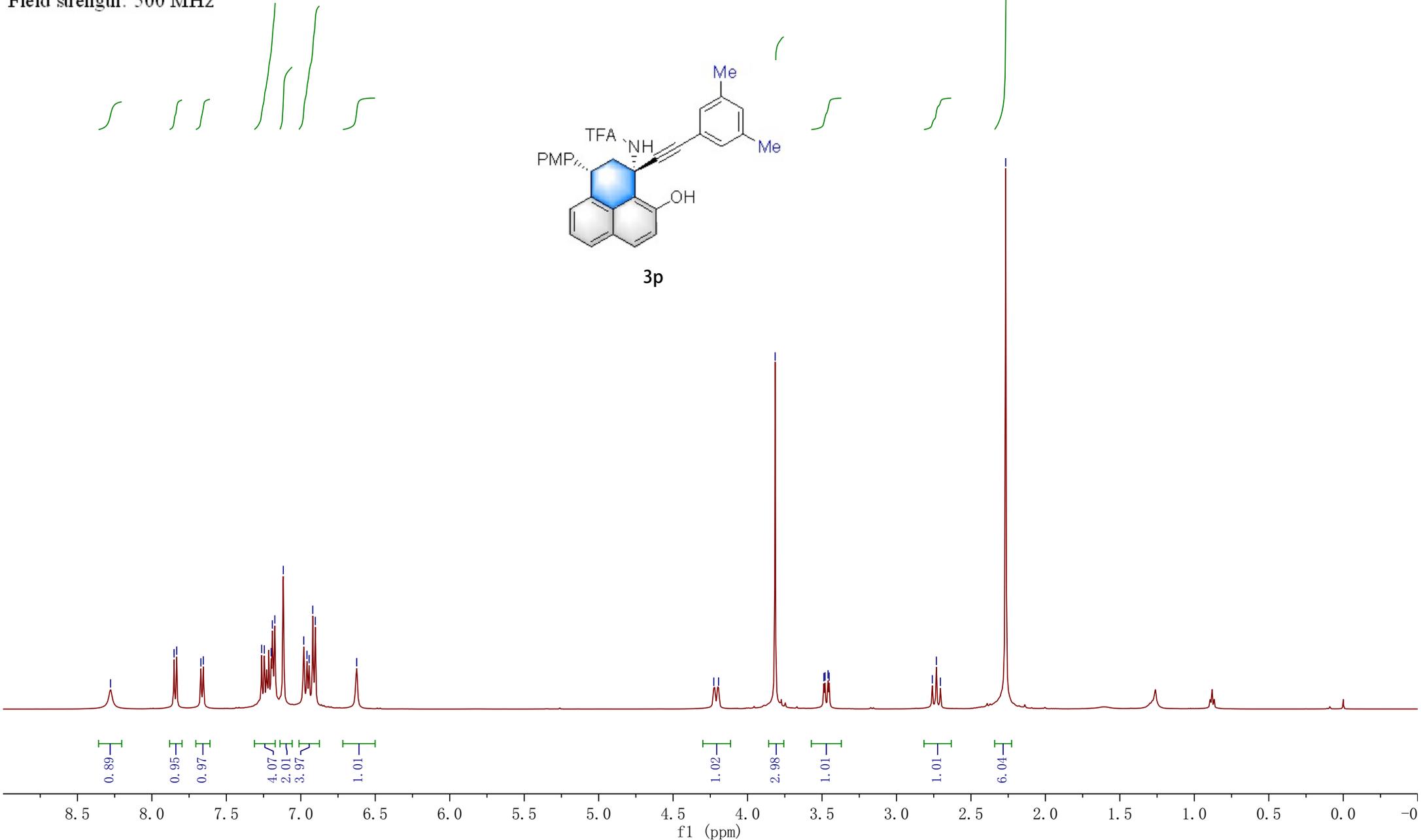
Analysis: <sup>1</sup>H NMR

Solvent: CDCl<sub>3</sub>

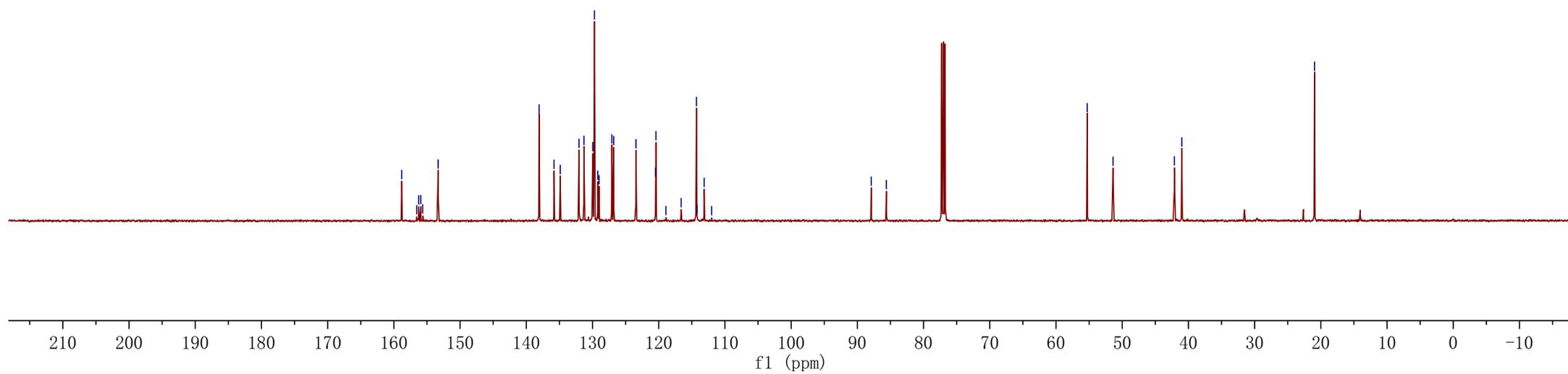
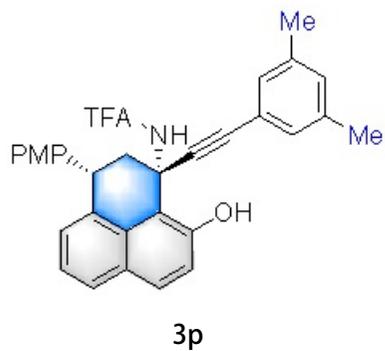
Field strength: 500 MHz



4.227  
4.195  
3.815  
3.487  
3.480  
3.460  
3.452  
2.759  
2.732  
2.705  
2.267



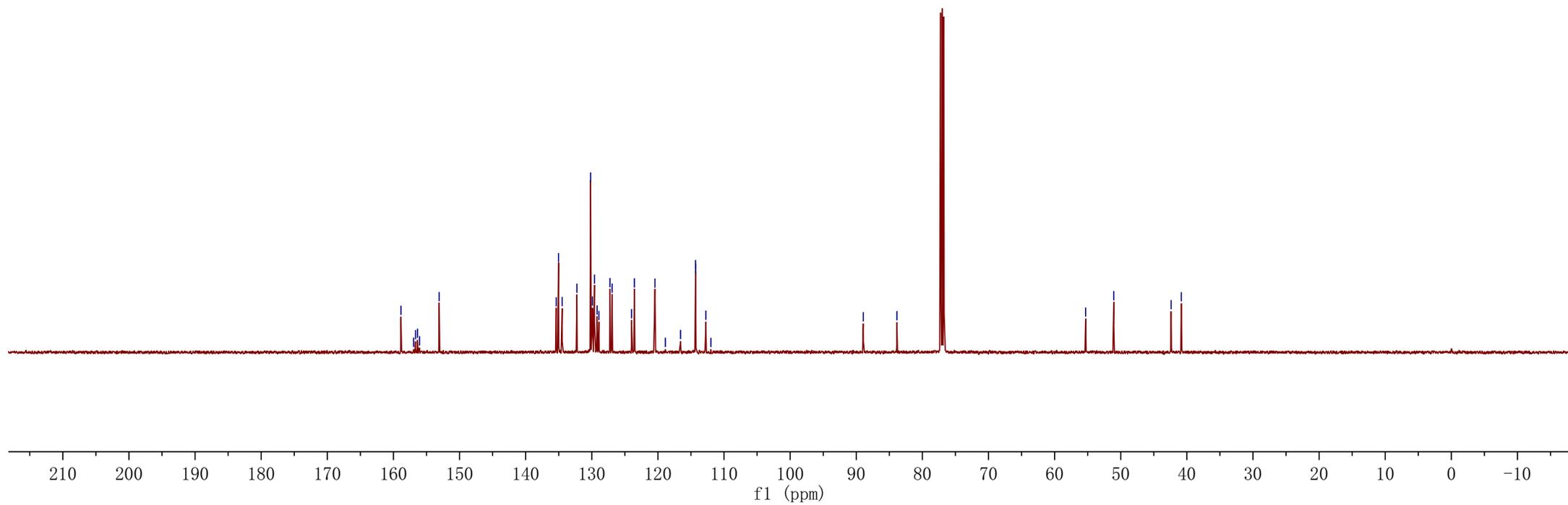
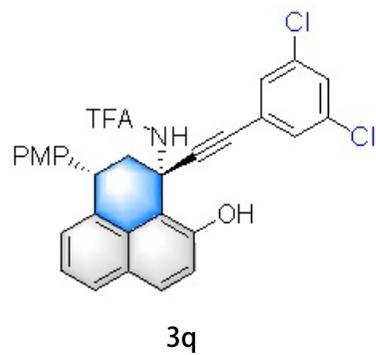
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz





Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

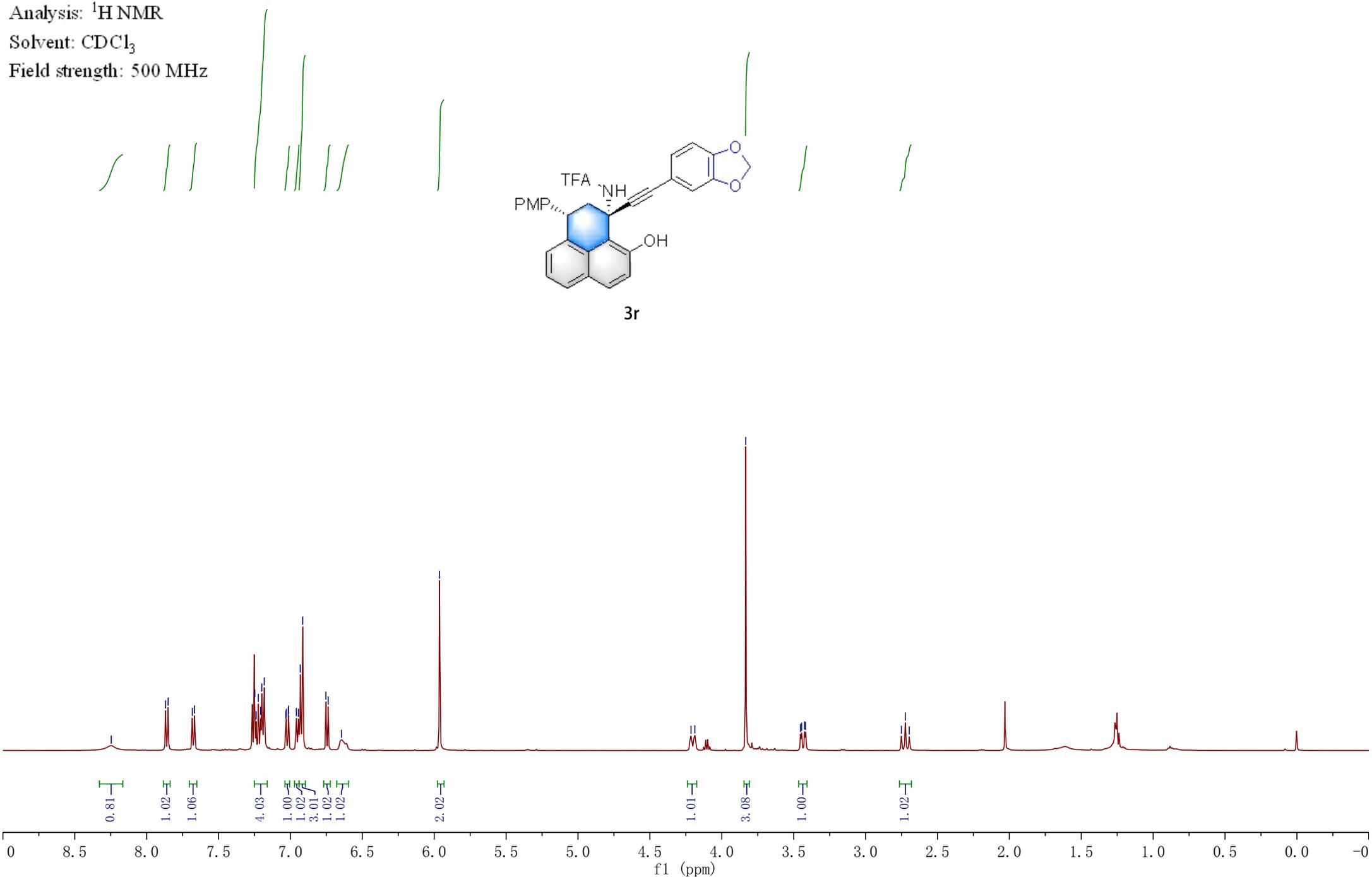
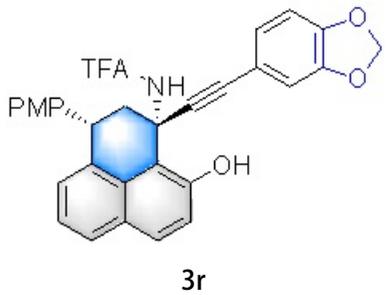
158.86  
156.95  
156.65  
156.35  
156.05  
153.08  
135.38  
135.03  
134.49  
132.25  
130.18  
129.91  
129.59  
129.20  
128.93  
127.25  
126.93  
123.99  
123.56  
120.45  
118.87  
116.57  
114.31  
114.31  
112.74  
111.98  
— 88.94  
— 83.85  
— 55.31  
— 51.06  
— 42.38  
— 40.84



Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

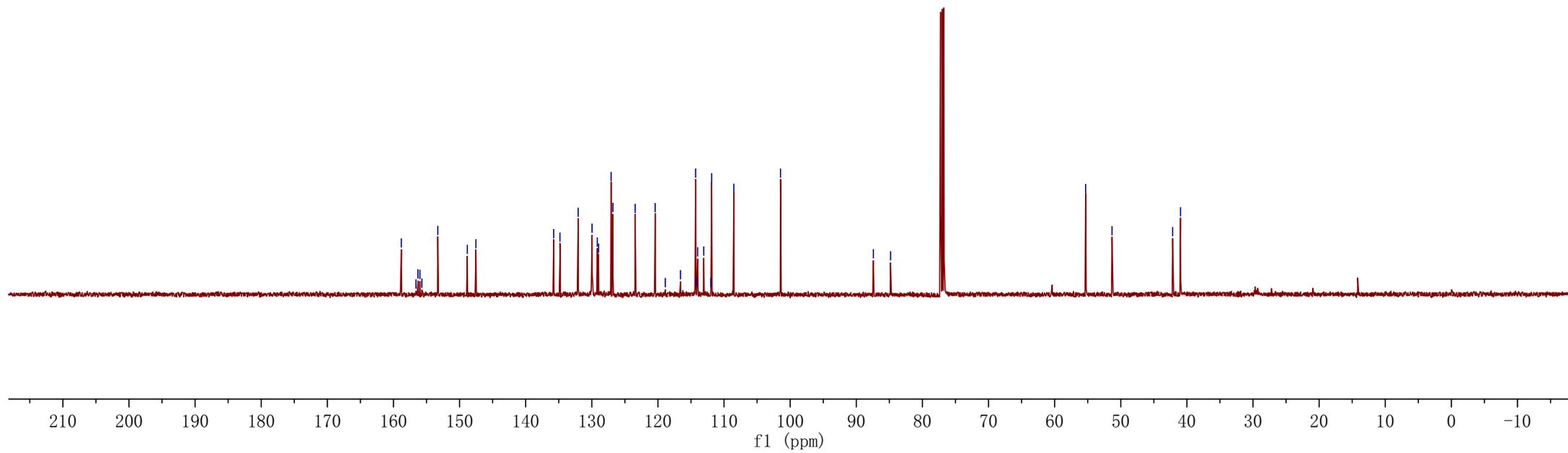
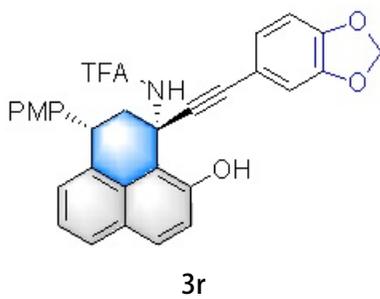
8.246  
7.869  
7.851  
7.683  
7.667  
7.248  
7.238  
7.223  
7.208  
7.199  
7.182  
7.032  
7.029  
7.015  
7.013  
6.959  
6.944  
6.932  
6.915  
6.753  
6.737  
6.645  
5.963

4.214  
4.187  
3.833  
3.453  
3.445  
3.425  
3.417  
2.751  
2.724  
2.696



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

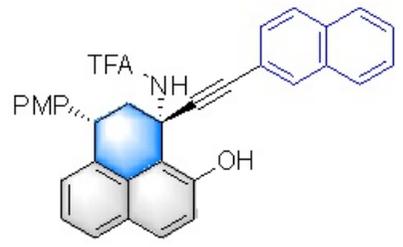
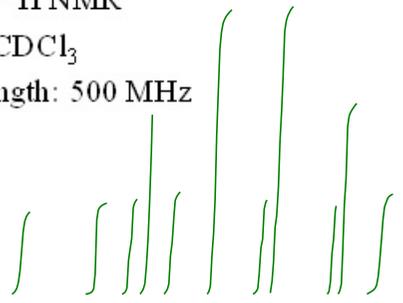
158.81  
156.59  
156.29  
156.00  
155.70  
153.29  
148.83  
147.52  
135.77  
134.82  
132.06  
129.97  
129.17  
128.99  
127.08  
126.81  
123.44  
120.42  
118.89  
116.59  
114.30  
114.23  
114.00  
113.07  
111.99  
111.87  
108.52  
101.46  
87.42  
84.81  
55.31  
51.32  
42.16  
40.96



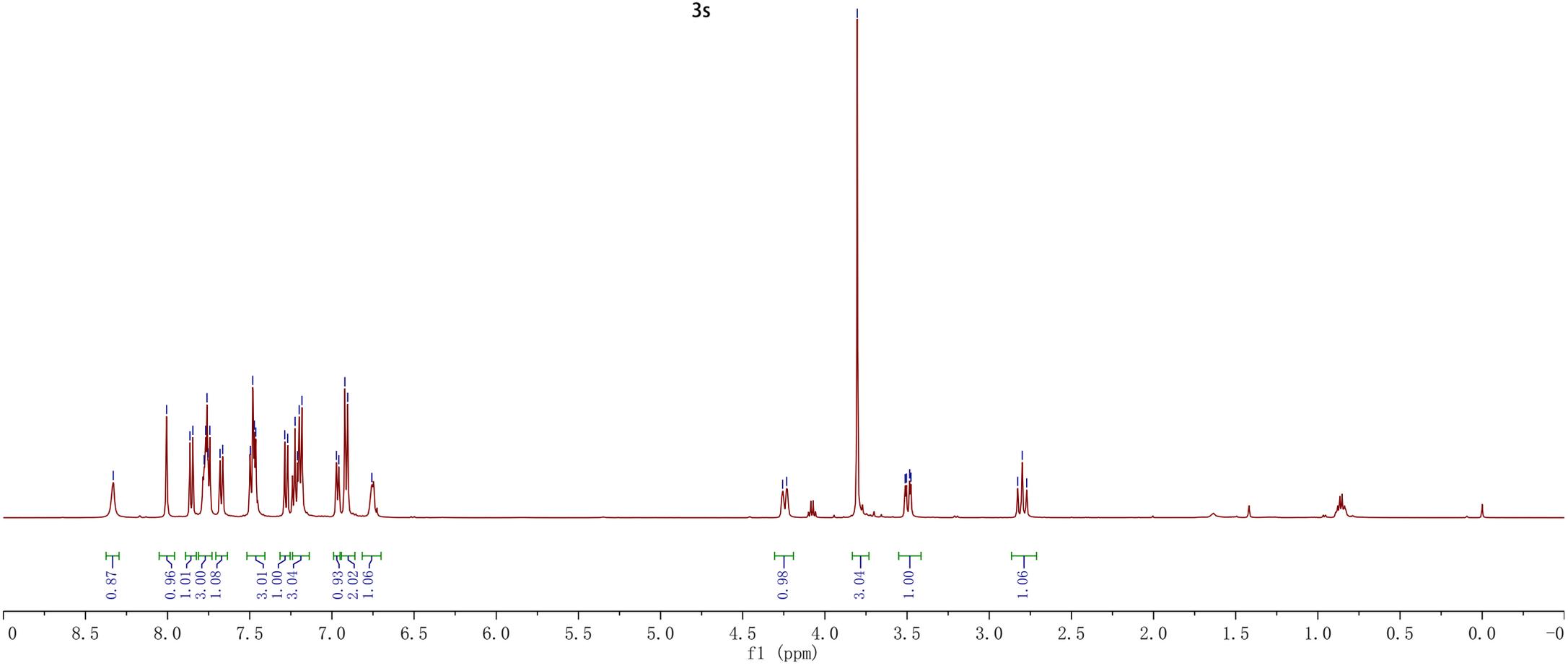
8.331  
8.006  
7.864  
7.846  
7.777  
7.768  
7.760  
7.754  
7.743  
7.681  
7.665  
7.496  
7.482  
7.472  
7.463  
7.287  
7.269  
7.224  
7.209  
7.199  
7.183  
6.973  
6.958  
6.921  
6.904  
6.757

4.257  
4.232  
3.803  
3.512  
3.504  
3.484  
3.477  
2.826  
2.799  
2.772

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



3s

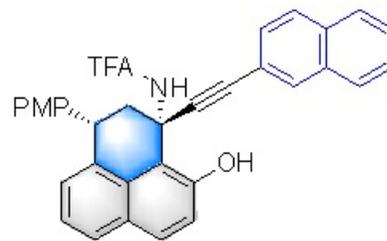


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

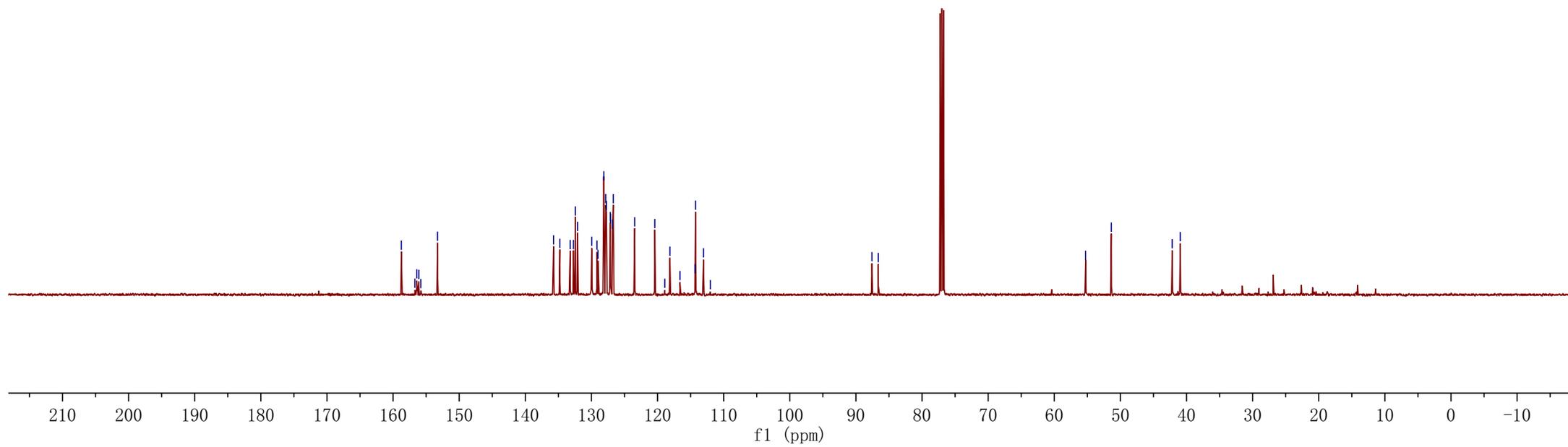
158.75  
156.70  
156.40  
156.11  
155.81  
153.28  
135.73  
134.78  
133.22  
132.72  
132.44  
132.10  
129.96  
129.17  
129.01  
128.13  
127.85  
127.74  
127.15  
127.12  
126.83  
126.70  
123.46  
120.41  
118.90  
118.13  
116.61  
114.31  
114.26  
113.05  
112.01  
87.58  
86.62

55.27  
51.38

42.17  
40.94



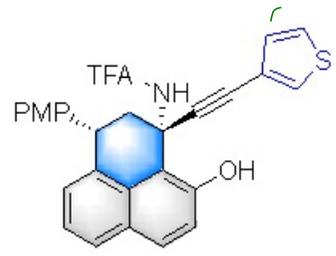
3s



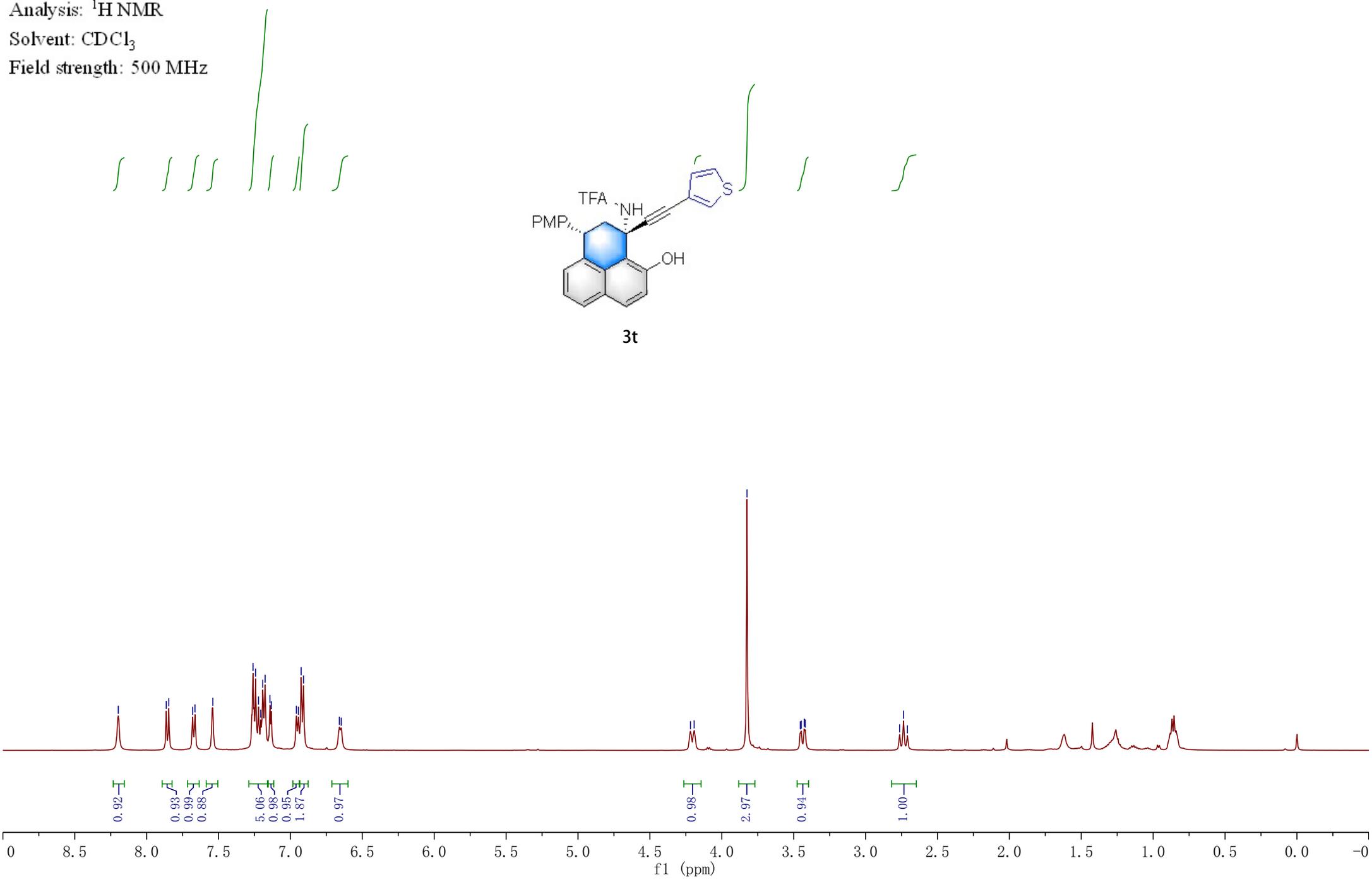
Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

8.197  
7.864  
7.846  
7.680  
7.664  
7.540  
7.260  
7.242  
7.222  
7.206  
7.193  
7.176  
7.143  
7.133  
6.959  
6.945  
6.925  
6.909  
6.660  
6.647

4.218  
4.192  
3.825  
3.453  
3.447  
3.426  
3.420  
2.764  
2.736  
2.709

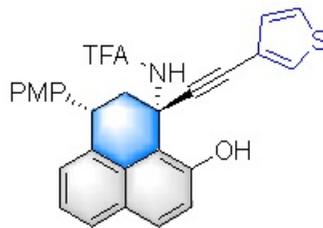


3t

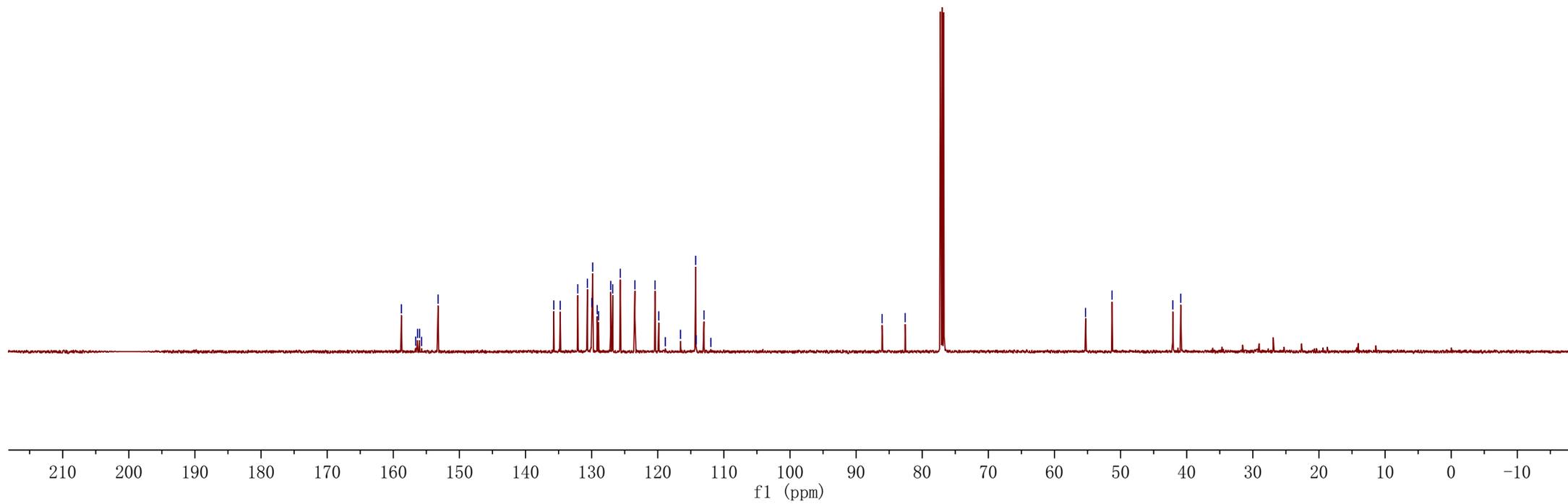


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.77 156.61 156.32 156.02 155.73 153.22 135.73 134.76 132.10 130.65 129.95 129.84 129.16 128.96 127.11 126.82 125.66 123.46 120.42 119.85 118.86 116.56 114.26 114.20 113.01 111.97 86.07 82.58 55.31 51.30 42.10 40.91



3t



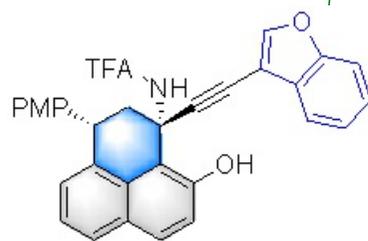
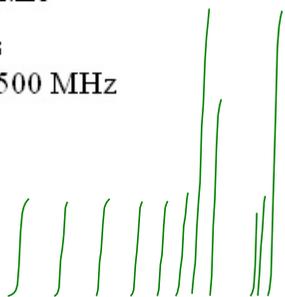
Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

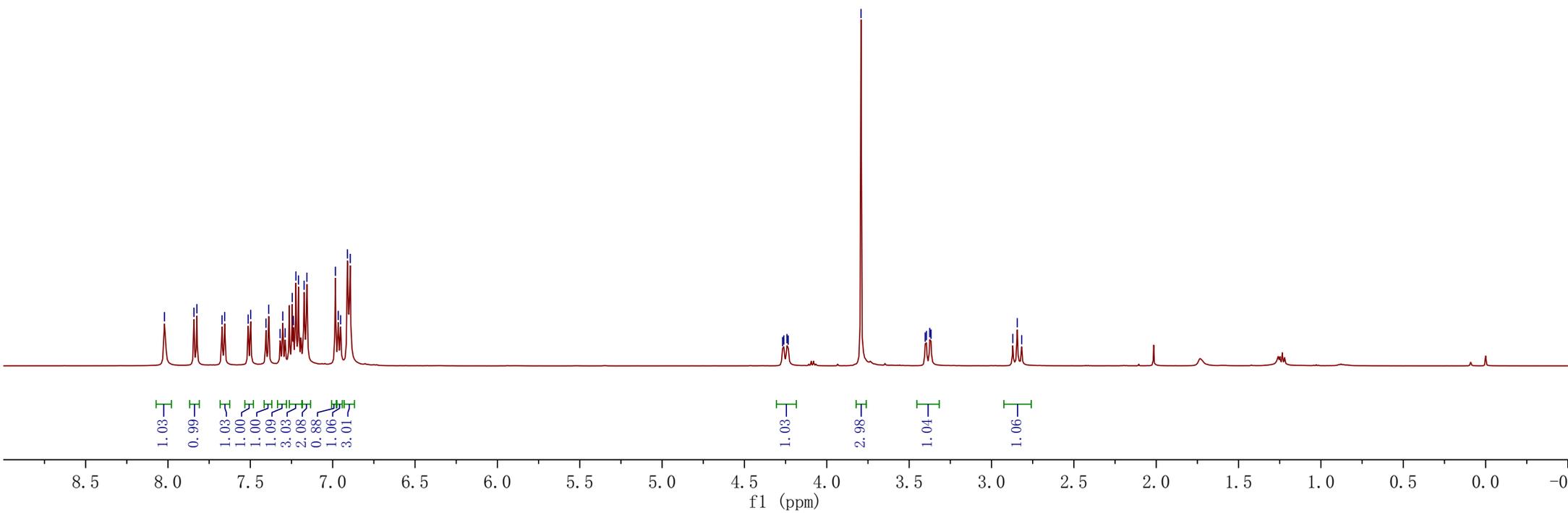
Field strength: 500 MHz

8.021  
7.842  
7.824  
7.672  
7.656  
7.513  
7.498  
7.405  
7.389  
7.320  
7.303  
7.289  
7.246  
7.239  
7.223  
7.208  
7.174  
7.157  
6.983  
6.966  
6.952  
6.911  
6.893

4.268  
4.261  
4.242  
4.234  
3.792  
3.403  
3.395  
3.375  
3.367  
2.870  
2.844  
2.817



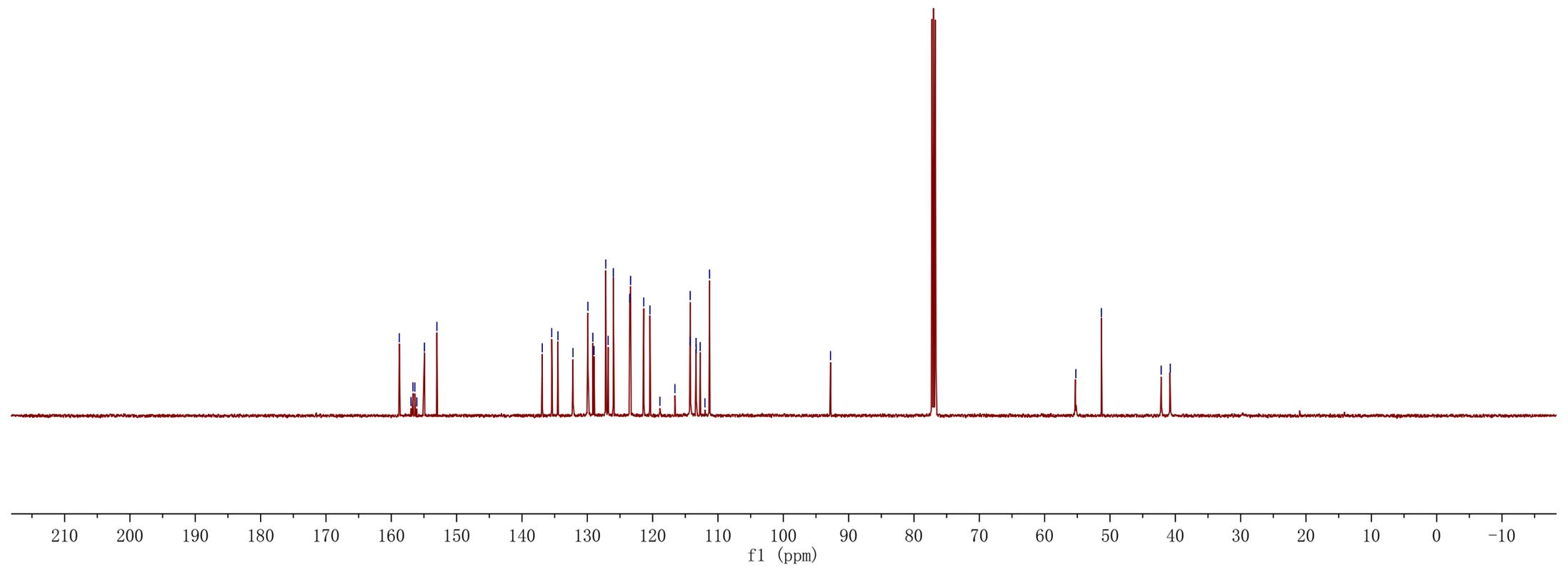
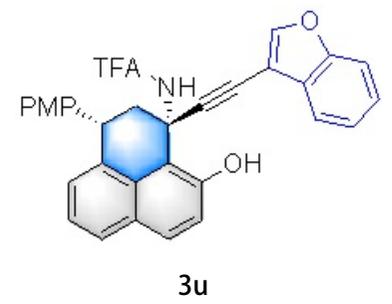
3u



158.77  
156.98  
156.69  
156.39  
156.09  
154.93  
153.01  
136.90  
135.45  
134.49  
132.19  
129.91  
129.16  
128.97  
127.17  
126.82  
126.02  
123.50  
123.37  
121.37  
120.41  
118.88  
116.58  
114.27  
114.25  
113.35  
113.32  
112.72  
111.99  
111.29  
92.78

55.23  
51.32  
42.17  
40.77

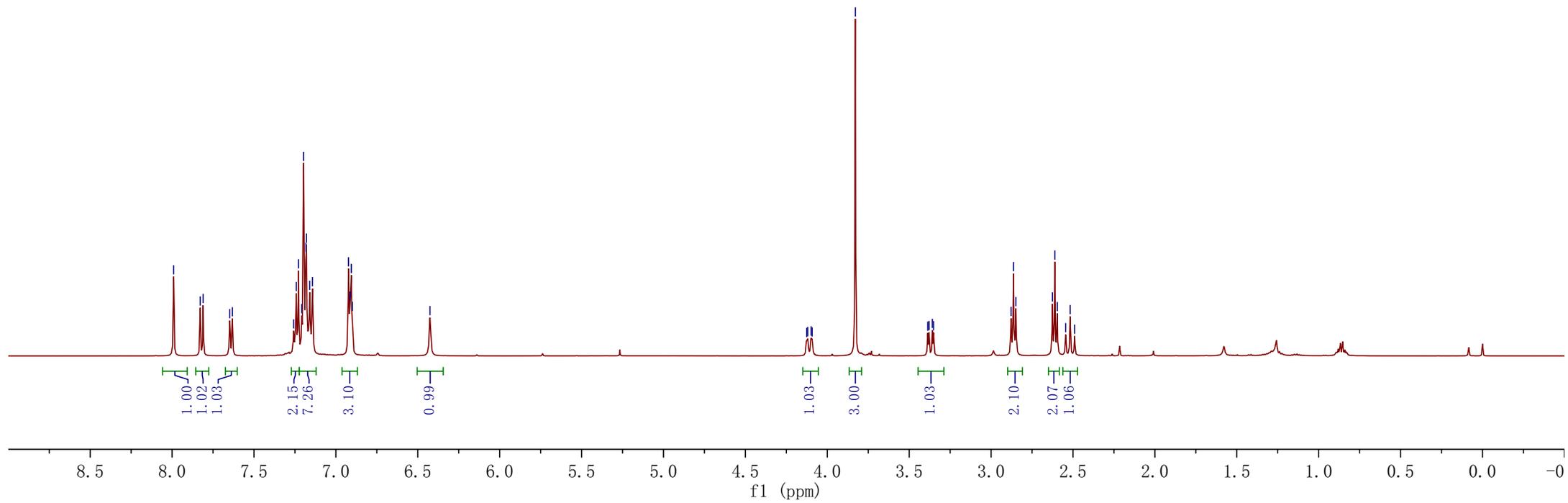
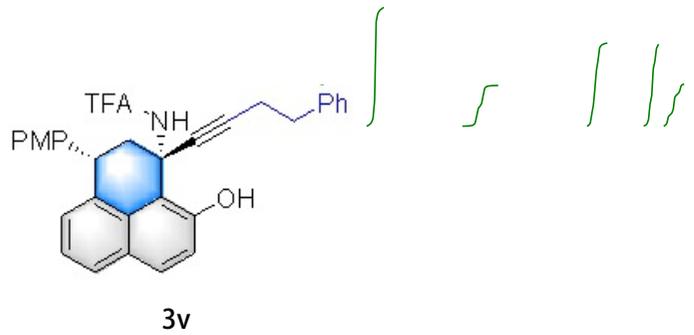
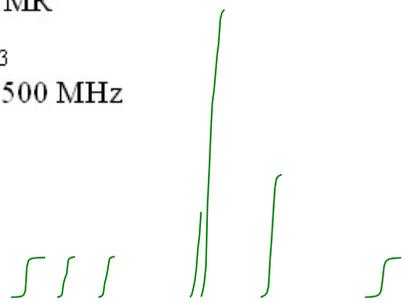
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



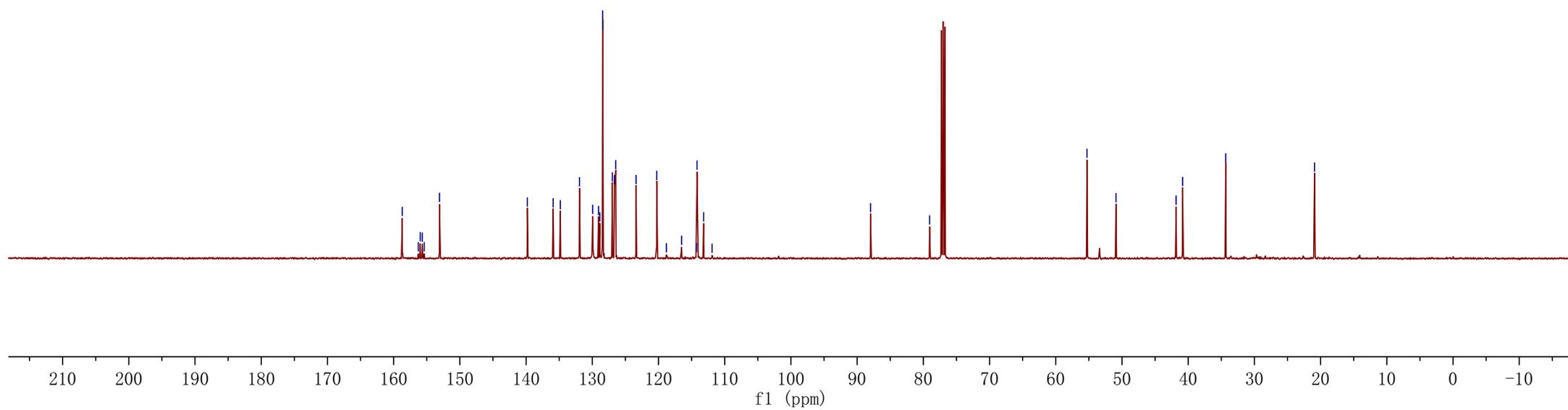
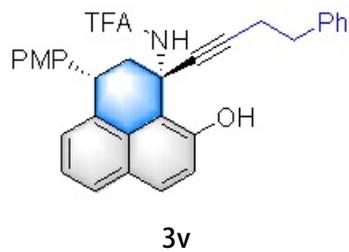
Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

7.990  
7.828  
7.810  
7.648  
7.632  
7.258  
7.242  
7.228  
7.209  
7.198  
7.183  
7.180  
7.160  
7.143  
6.923  
6.913  
6.906  
6.900  
— 6.425

4.126  
4.119  
4.099  
4.093  
— 3.829  
3.387  
3.379  
3.359  
3.351  
2.878  
2.863  
2.848  
2.625  
2.611  
2.596  
2.545  
2.517  
2.490



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

7.828  
7.806  
7.654  
7.634  
7.265  
7.246  
7.236  
7.218  
7.198  
7.176  
7.148  
7.127  
6.990  
6.972  
6.955  
6.935  
6.916  
6.895  
6.602

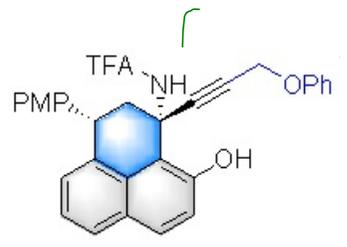
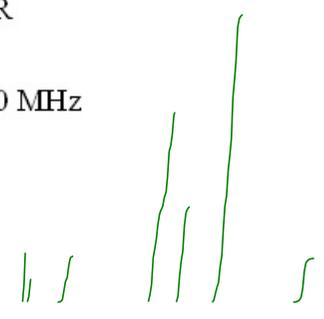
4.775

4.160  
4.153  
4.127  
4.120

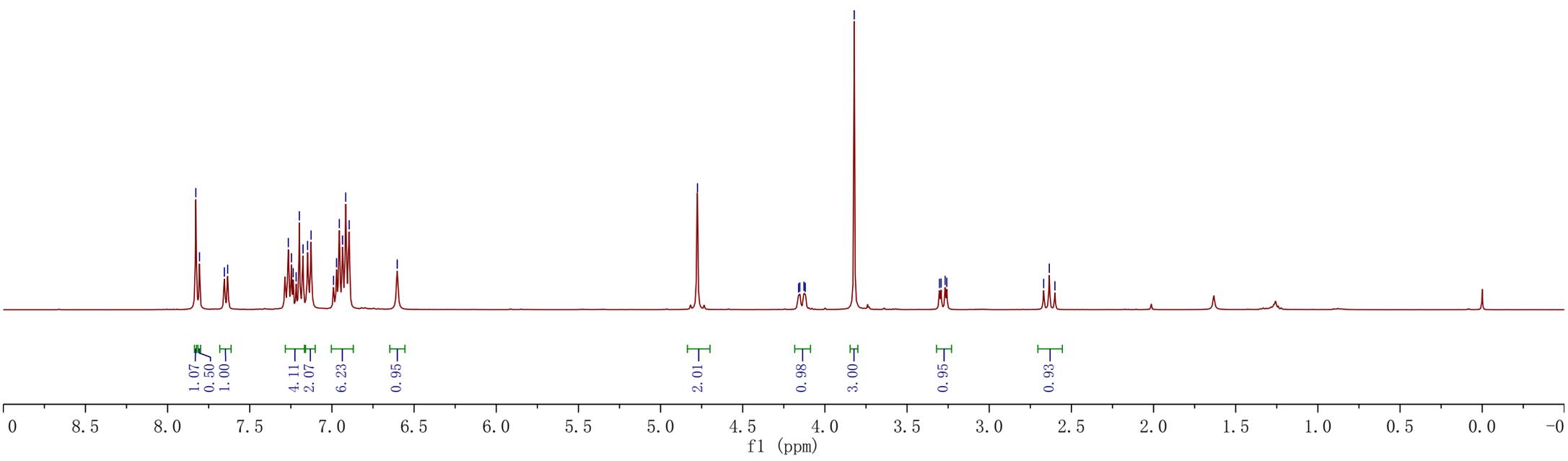
3.821

3.303  
3.293  
3.268  
3.258

2.669  
2.634  
2.600



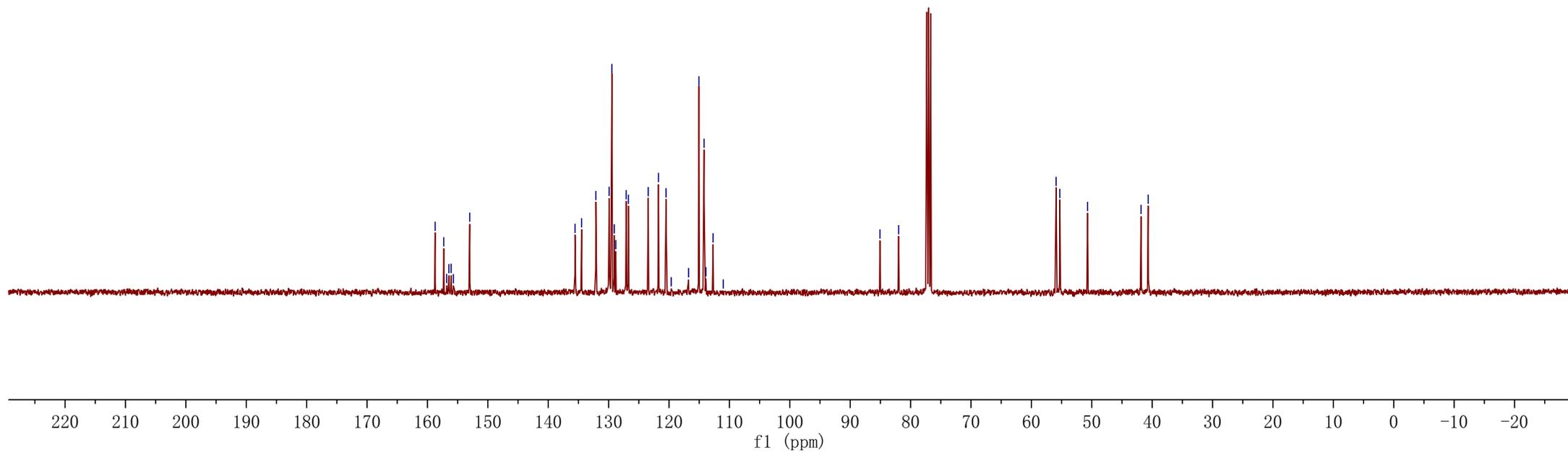
3w



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



**3w**



7.850  
7.833  
7.716  
7.700  
7.340  
7.327  
7.312  
7.295  
7.281  
7.255  
7.236  
7.168  
7.151  
7.104  
7.086  
6.974  
6.960  
6.871  
6.854

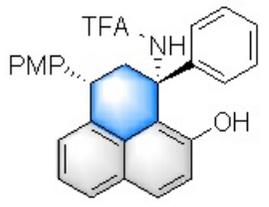
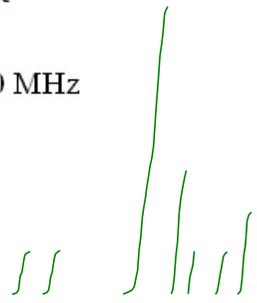
4.326  
4.300

3.788

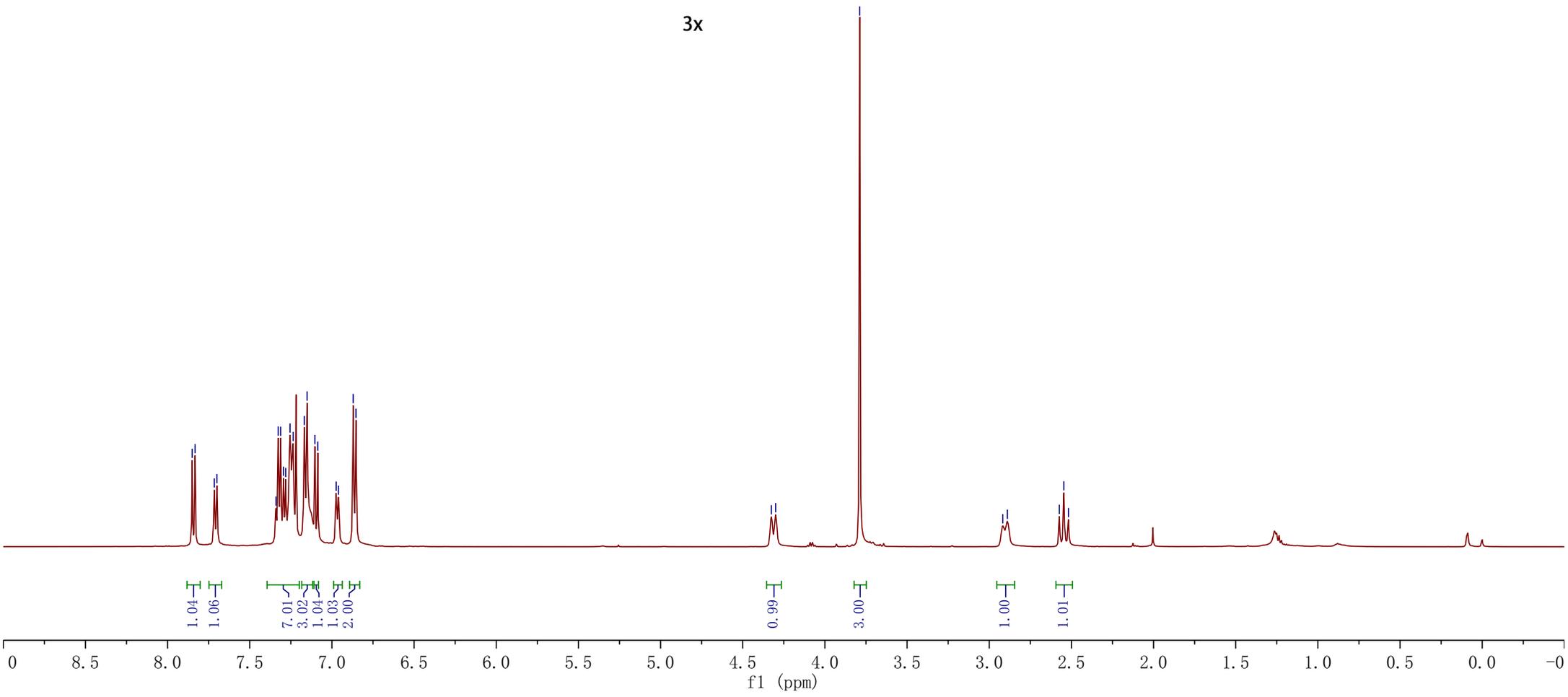
2.917  
2.890

2.573  
2.546  
2.518

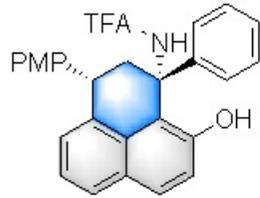
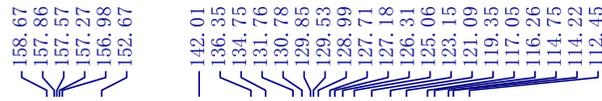
Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



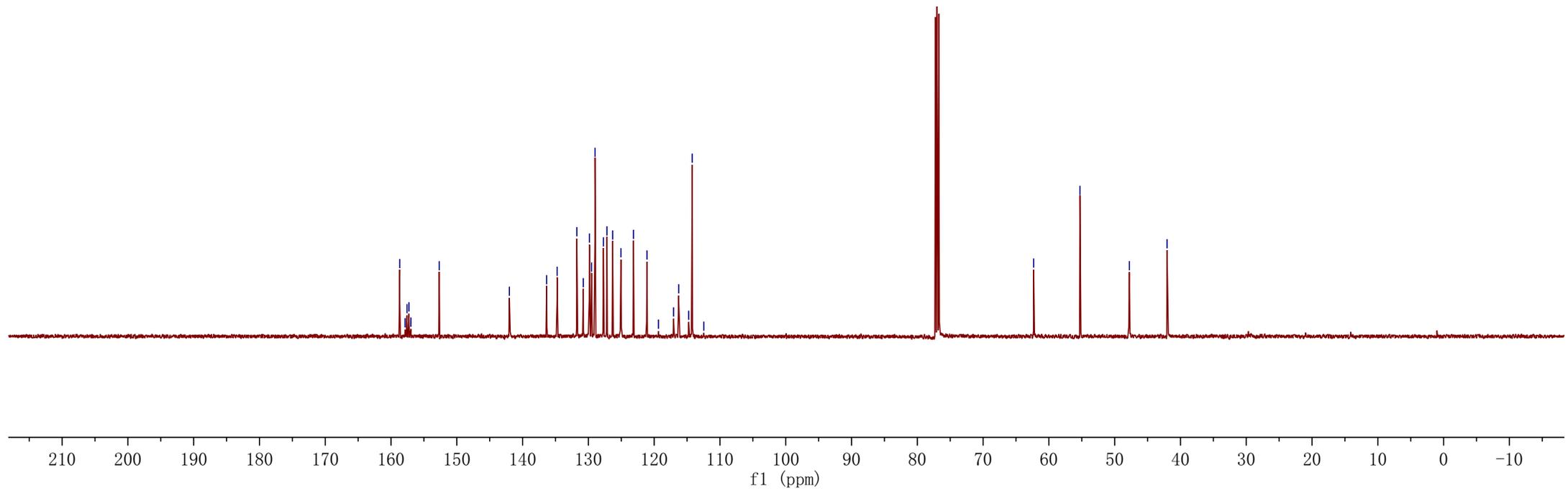
3x



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



**3x**



7.848  
7.830  
7.711  
7.695  
7.246  
7.230  
7.215  
7.169  
7.146  
7.116  
7.099  
7.071  
6.971  
6.957  
6.873  
6.856

4.313  
4.287

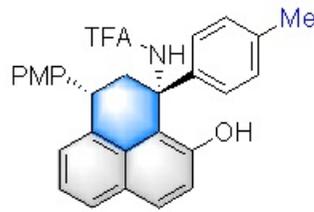
3.793

2.901  
2.868

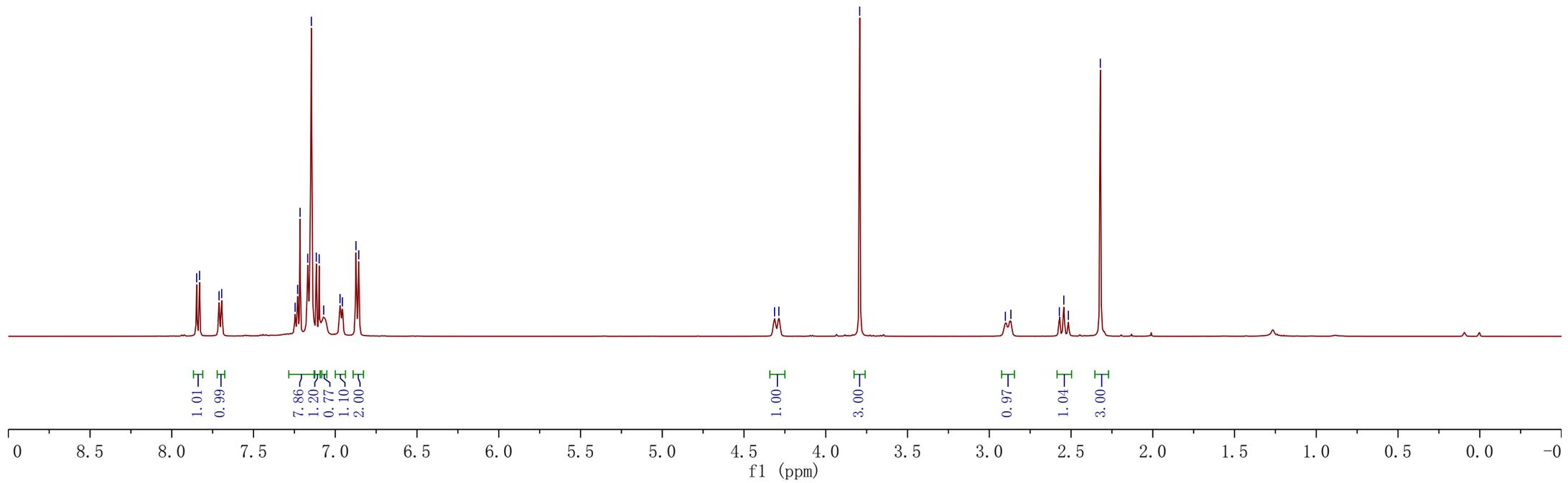
2.571  
2.544  
2.516

2.321

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



3y



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.675  
157.828  
157.536  
157.243  
156.952  
152.773  
138.675  
137.645  
136.371  
134.783  
131.738  
130.758  
129.775  
129.527  
127.178  
126.323  
125.045  
123.104  
121.176  
119.337  
117.036  
116.292  
114.740  
114.192  
112.438

62.091

55.266

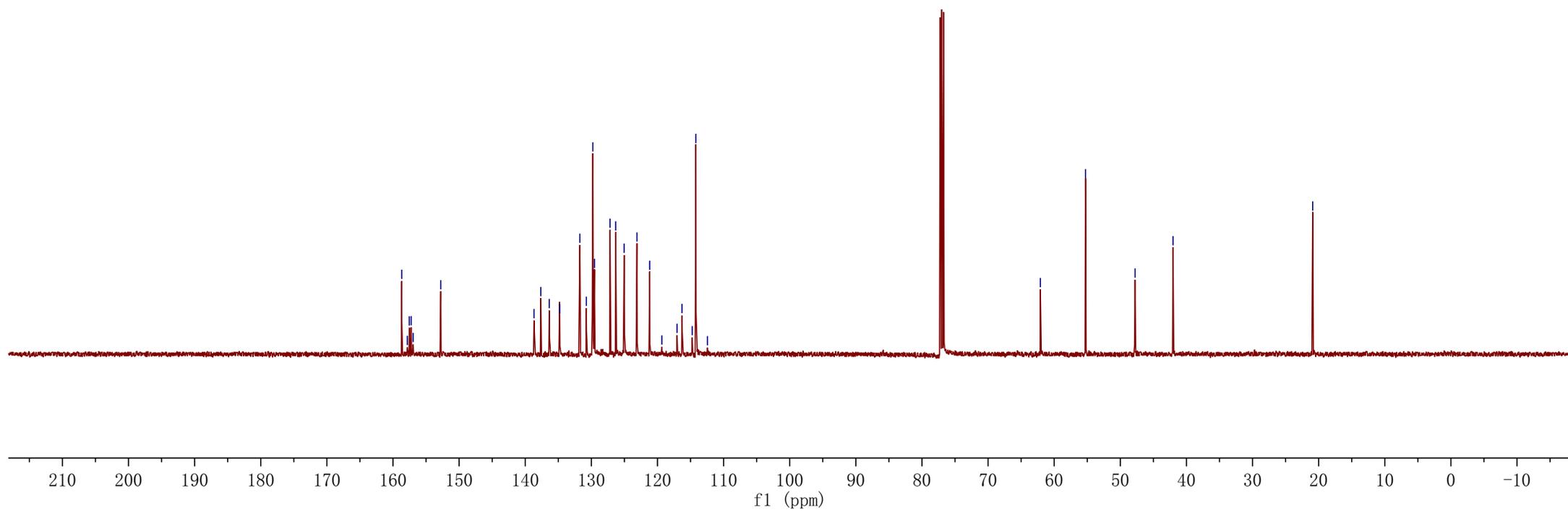
47.765

42.027

20.901



3y



7.859  
7.841  
7.724  
7.708  
7.260  
7.245  
7.226  
7.134  
7.121  
7.083  
7.065  
6.978  
6.963  
6.861  
6.844

4.331  
4.305

3.792

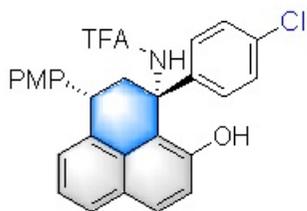
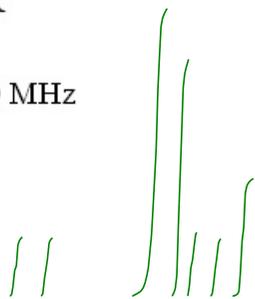
2.888  
2.860

2.541  
2.514  
2.486

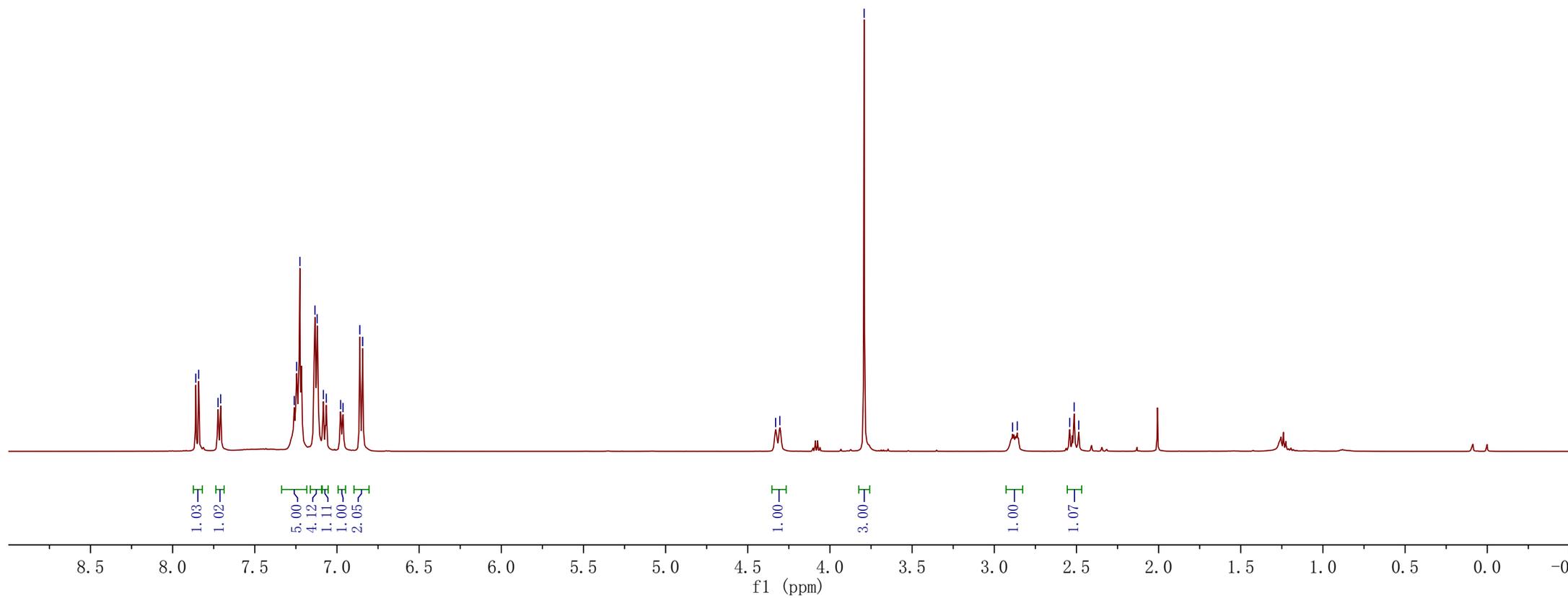
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



3z



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.679  
157.923  
157.629  
157.336  
157.043  
152.376

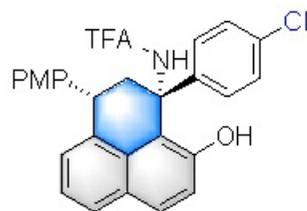
141.180  
136.191  
134.560  
133.256  
131.880  
130.685  
129.799  
129.526  
128.874  
127.223  
126.582  
126.413  
123.283  
120.828  
119.300  
117.004  
115.983  
114.709  
114.222  
112.404

62.084

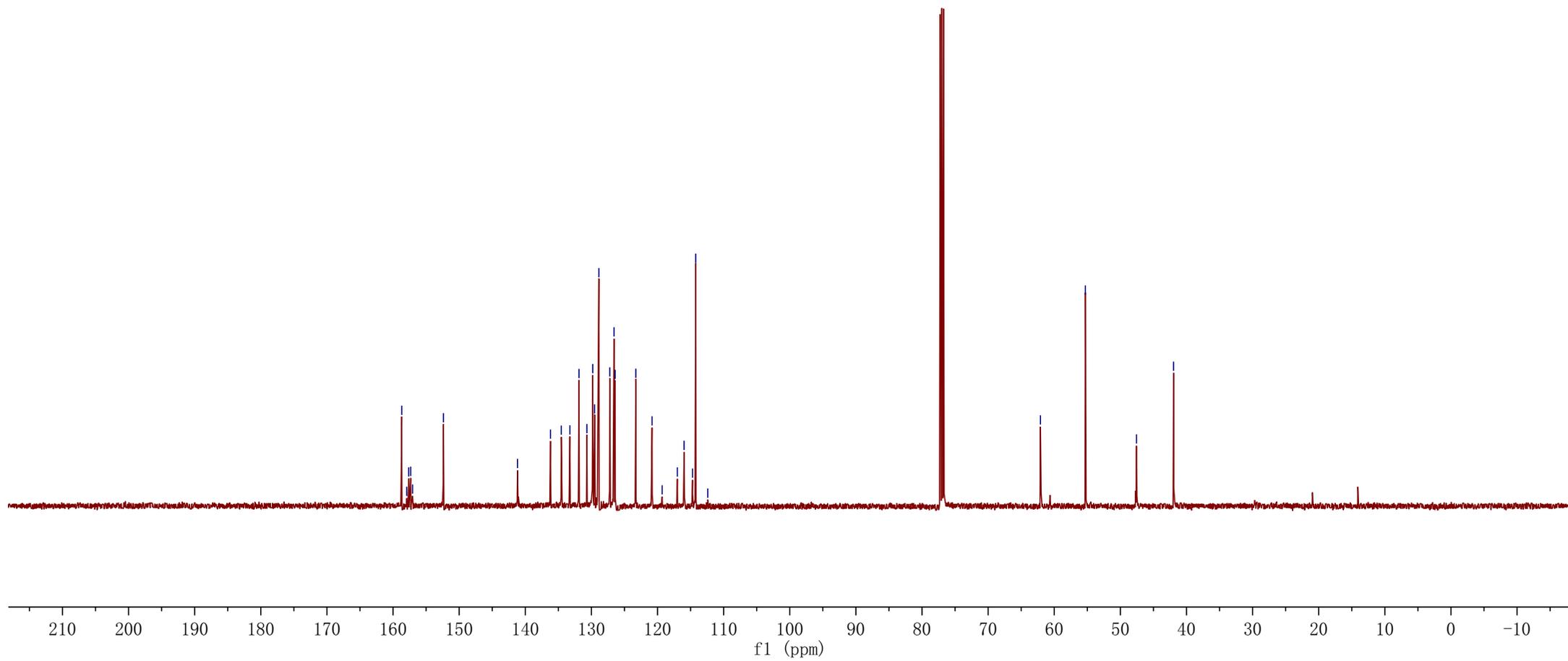
55.296

47.557

41.958



3z

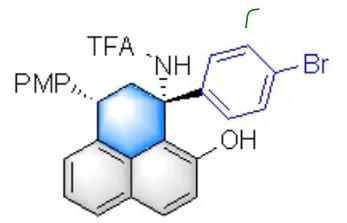
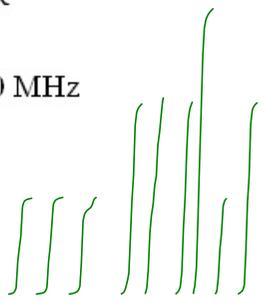


7.859  
7.842  
7.724  
7.708  
7.576  
7.363  
7.346  
7.281  
7.260  
7.244  
7.229  
7.222  
7.133  
7.117  
7.071  
7.063  
7.053  
7.046  
6.975  
6.960  
6.855  
6.838

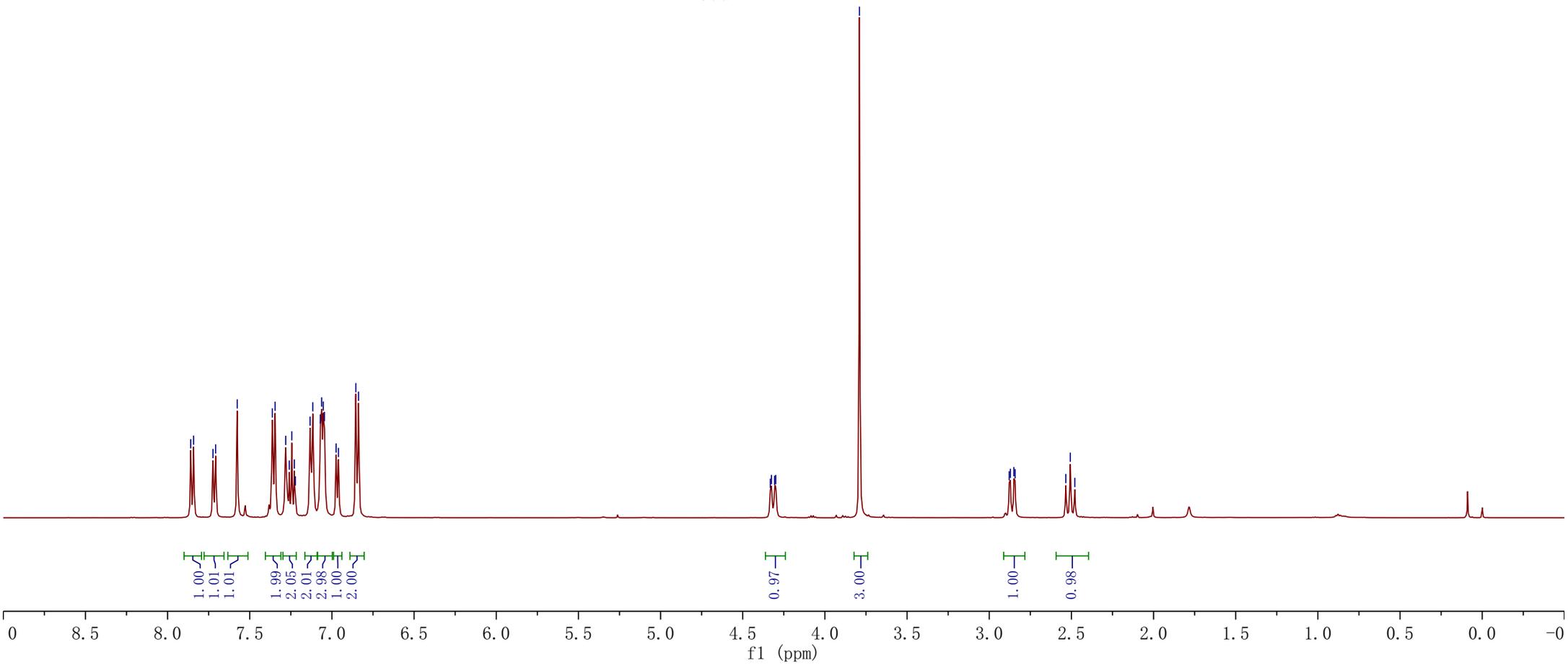
4.332  
4.325  
4.306  
4.299  
3.790

2.878  
2.871  
2.850  
2.843  
2.534  
2.507  
2.479

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



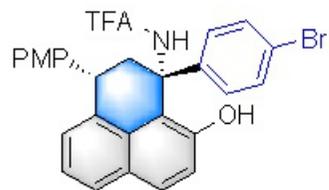
3aa



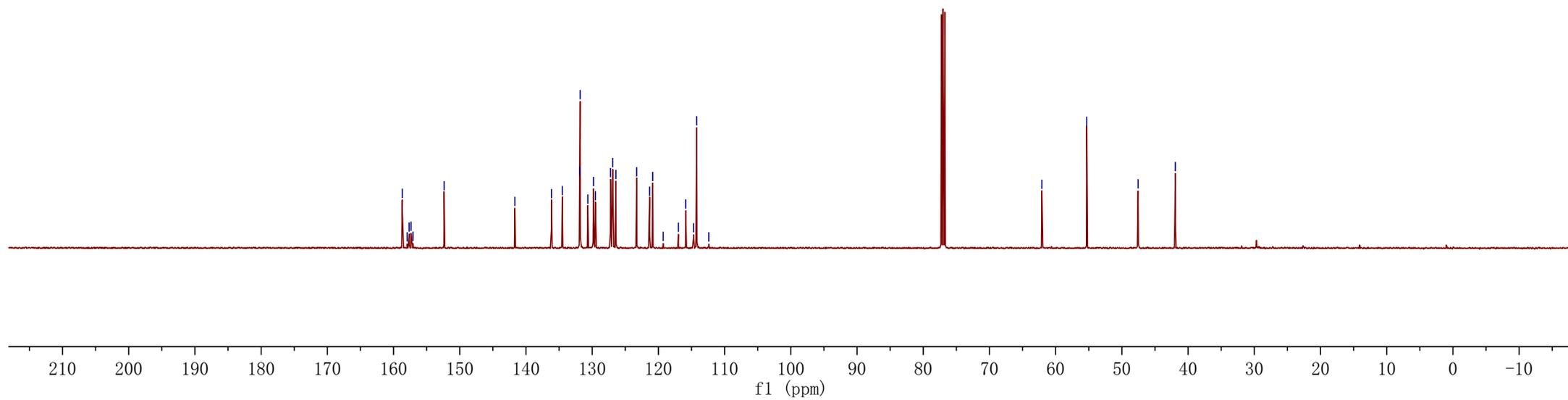
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.67  
157.94  
157.65  
157.35  
157.06  
152.36  
141.67  
136.15  
134.52  
131.91  
131.82  
130.66  
129.80  
129.52  
127.24  
126.91  
126.42  
123.28  
121.33  
120.86  
119.28  
116.98  
115.88  
114.69  
114.22  
112.39

62.08  
55.31  
47.55  
41.93



3aa



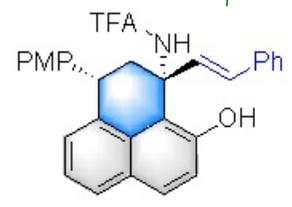
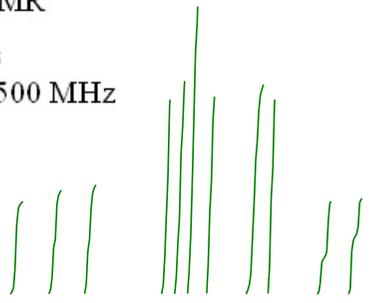
8.016  
7.854  
7.836  
7.702  
7.686  
7.361  
7.358  
7.344  
7.308  
7.293  
7.278  
7.255  
7.252  
7.250  
7.243  
7.238  
7.234  
7.229  
7.223  
7.216  
7.168  
7.152  
6.976  
6.964  
6.949  
6.899  
6.882  
6.676  
6.643  
6.542  
6.509

4.321  
4.313  
4.295  
4.287

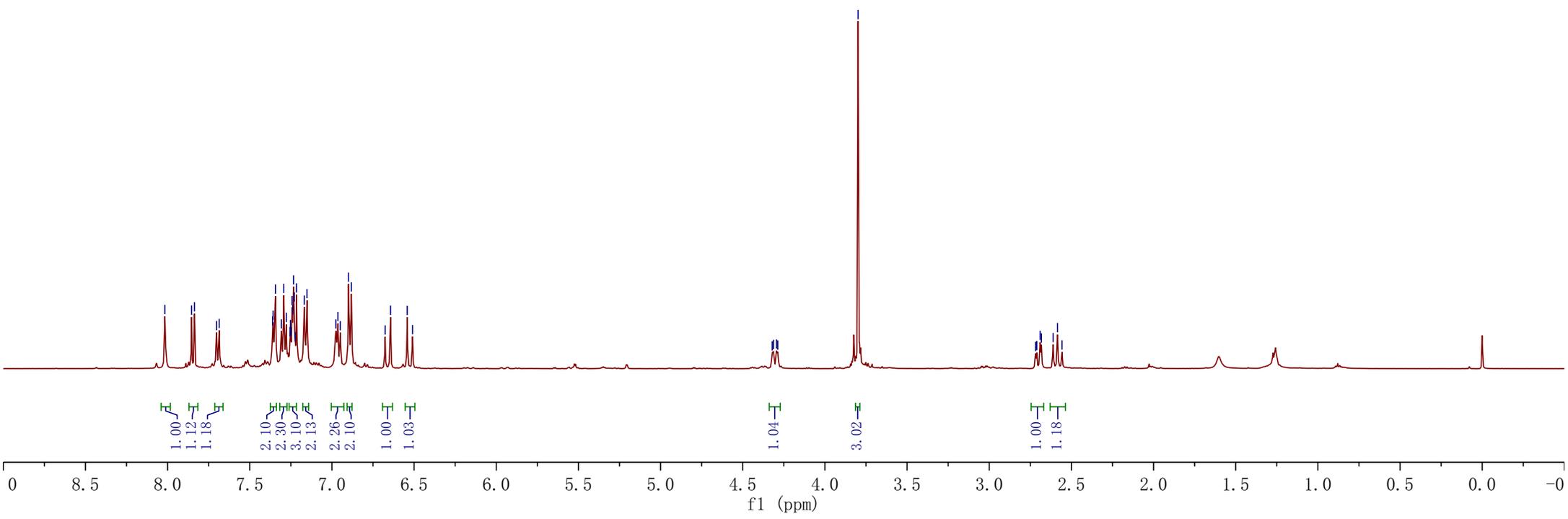
3.798

2.718  
2.711  
2.690  
2.682  
2.611  
2.585  
2.557

Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 500 MHz



3ab

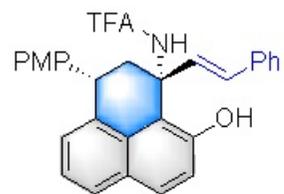


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

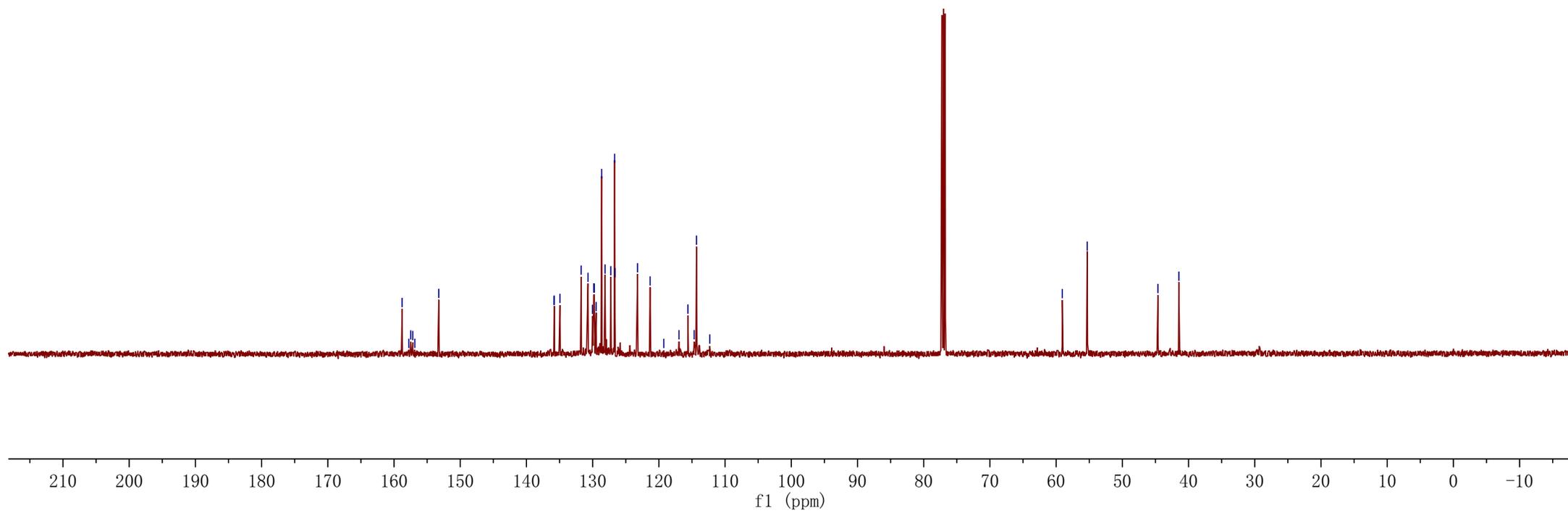
158.78  
157.76  
157.47  
157.18  
156.86  
153.24  
135.84  
135.81  
134.94  
131.74  
130.70  
130.04  
129.84  
129.75  
129.48  
128.64  
128.13  
127.26  
126.68  
126.63  
123.22  
121.32  
119.26  
116.96  
115.61  
114.67  
114.32  
112.31

— 59.07  
— 55.31

— 44.63  
— 41.46



3ab



Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz

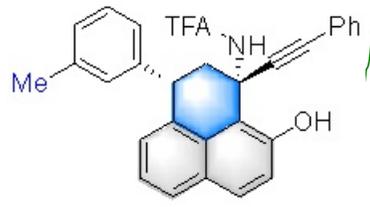
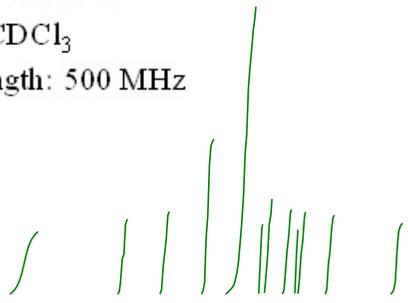
8.294  
7.870  
7.852  
7.686  
7.669  
7.500  
7.498  
7.484  
7.481  
7.367  
7.352  
7.341  
7.338  
7.326  
7.312  
7.298  
7.290  
7.256  
7.238  
7.231  
7.223  
7.216  
7.208  
7.147  
7.131  
7.100  
7.084  
7.068  
6.961  
6.946  
6.659

4.237  
4.229  
4.210  
4.202

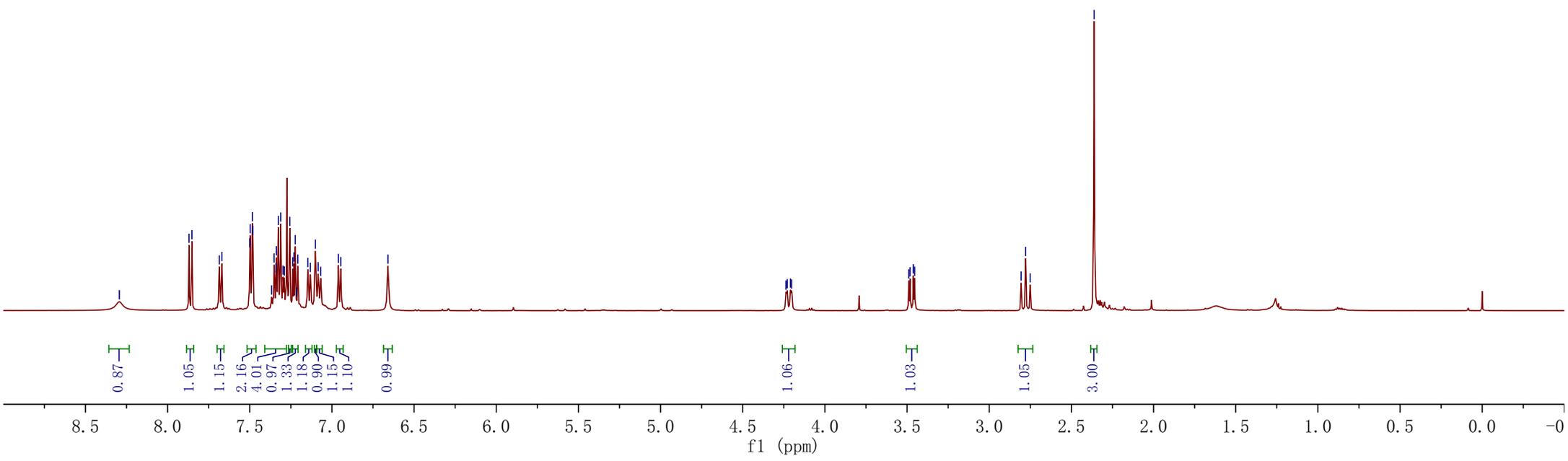
3.490  
3.482  
3.462  
3.454

2.806  
2.778  
2.751

2.362



3ac



156.65  
156.35  
156.05  
155.75  
153.34

142.69  
138.52  
135.49  
132.13  
132.07  
129.75  
129.37  
129.18  
128.97  
128.74  
128.41  
128.02  
127.12  
126.93  
126.11  
123.47  
120.90  
120.47  
118.89  
116.59  
114.29  
112.99  
112.00

87.39  
86.38

51.27

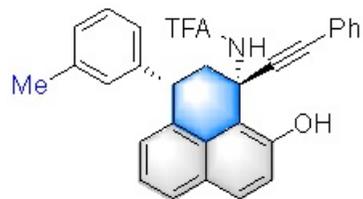
42.04  
41.71

21.43

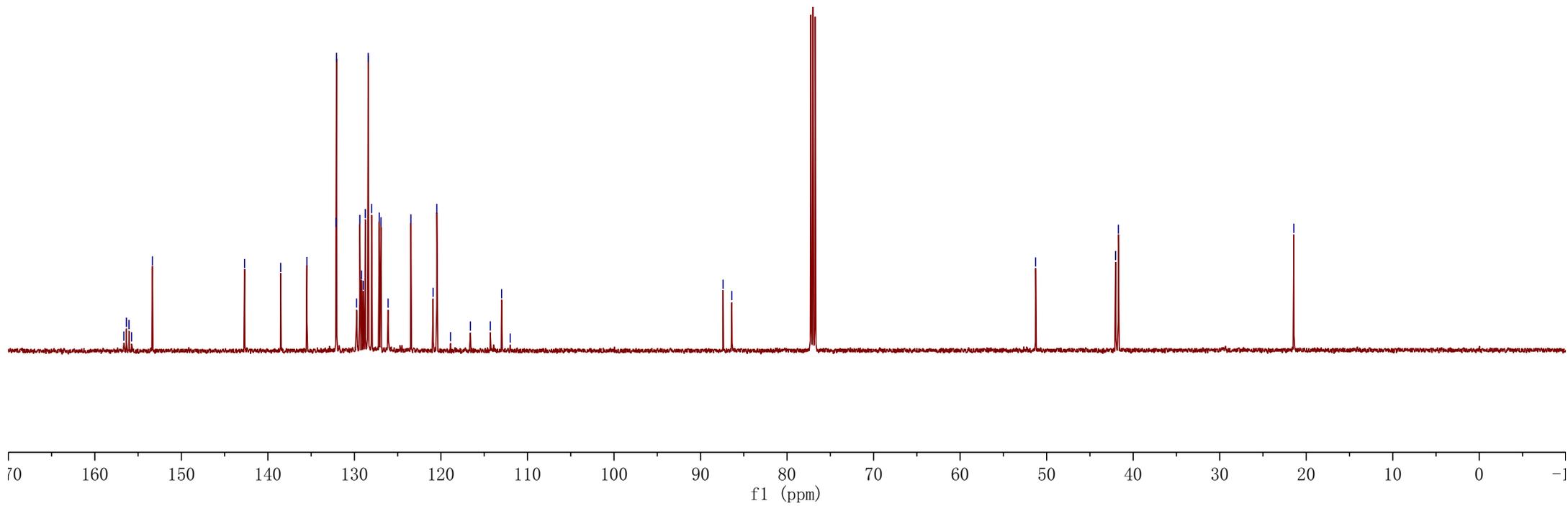
Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 125 MHz



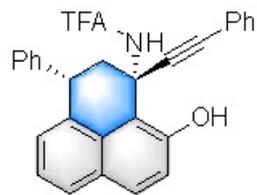
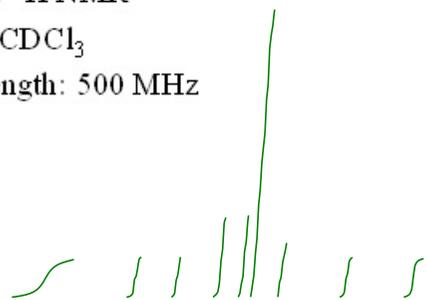
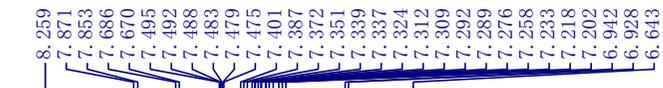
3ac



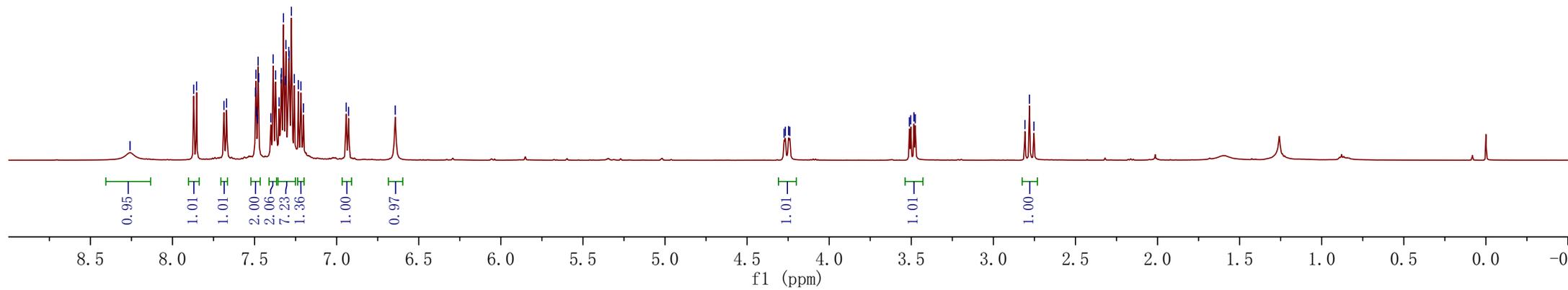
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

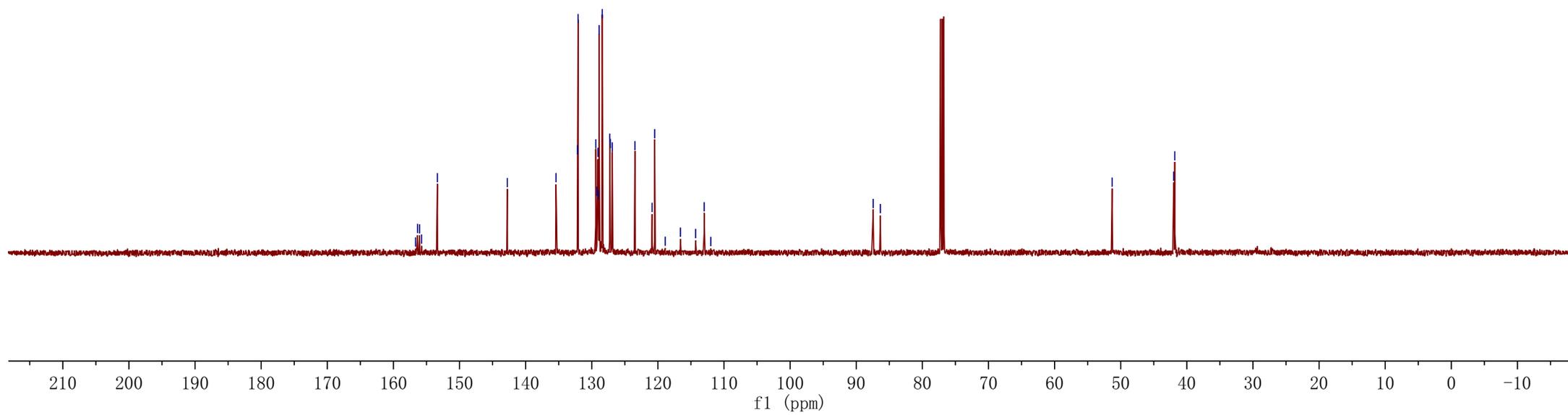
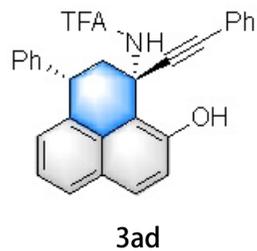
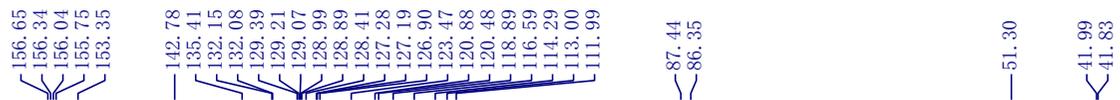
Field strength: 500 MHz



3ad



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

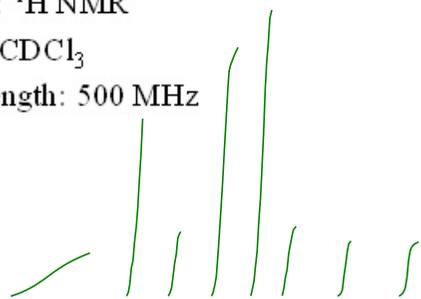


8.237  
7.886  
7.868  
7.848  
7.832  
7.817  
7.804  
7.697  
7.681  
7.505  
7.501  
7.494  
7.473  
7.459  
7.339  
7.324  
7.308  
7.295  
7.278  
7.207  
7.192  
7.176  
6.934  
6.667

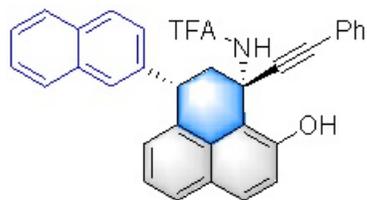
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

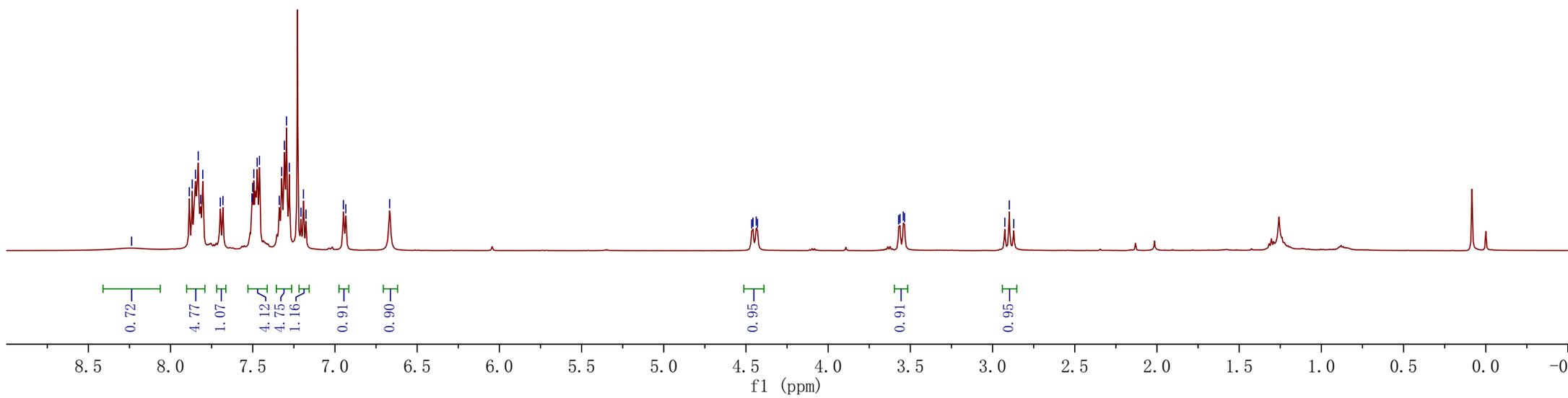
Field strength: 500 MHz



4.465  
4.457  
4.438  
4.430  
3.571  
3.563  
3.543  
3.535  
2.925  
2.898  
2.871



3ae

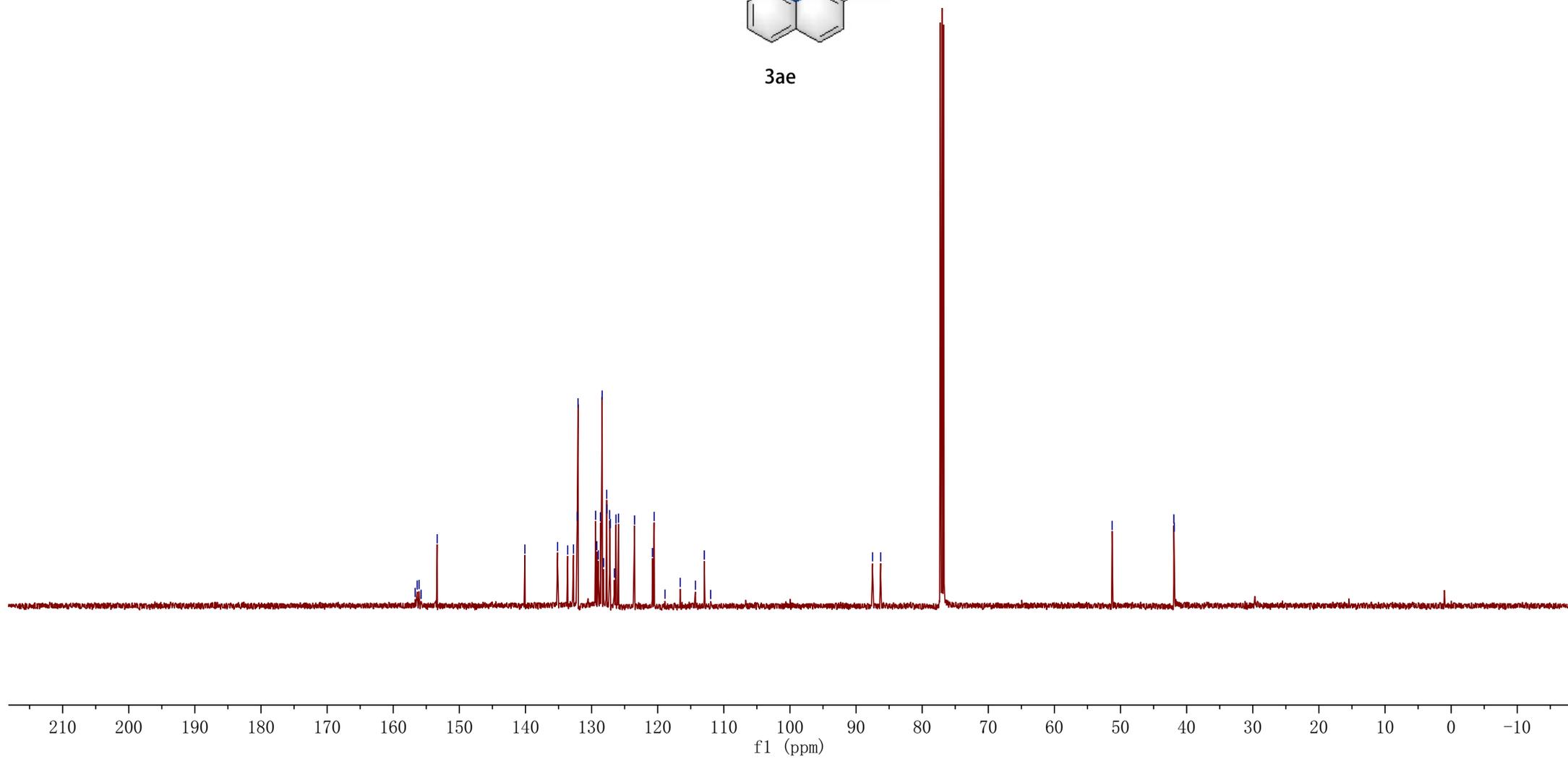
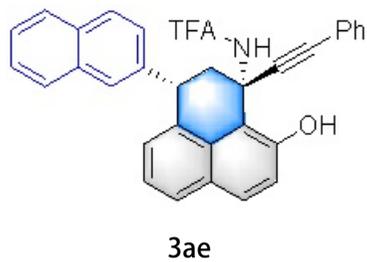


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

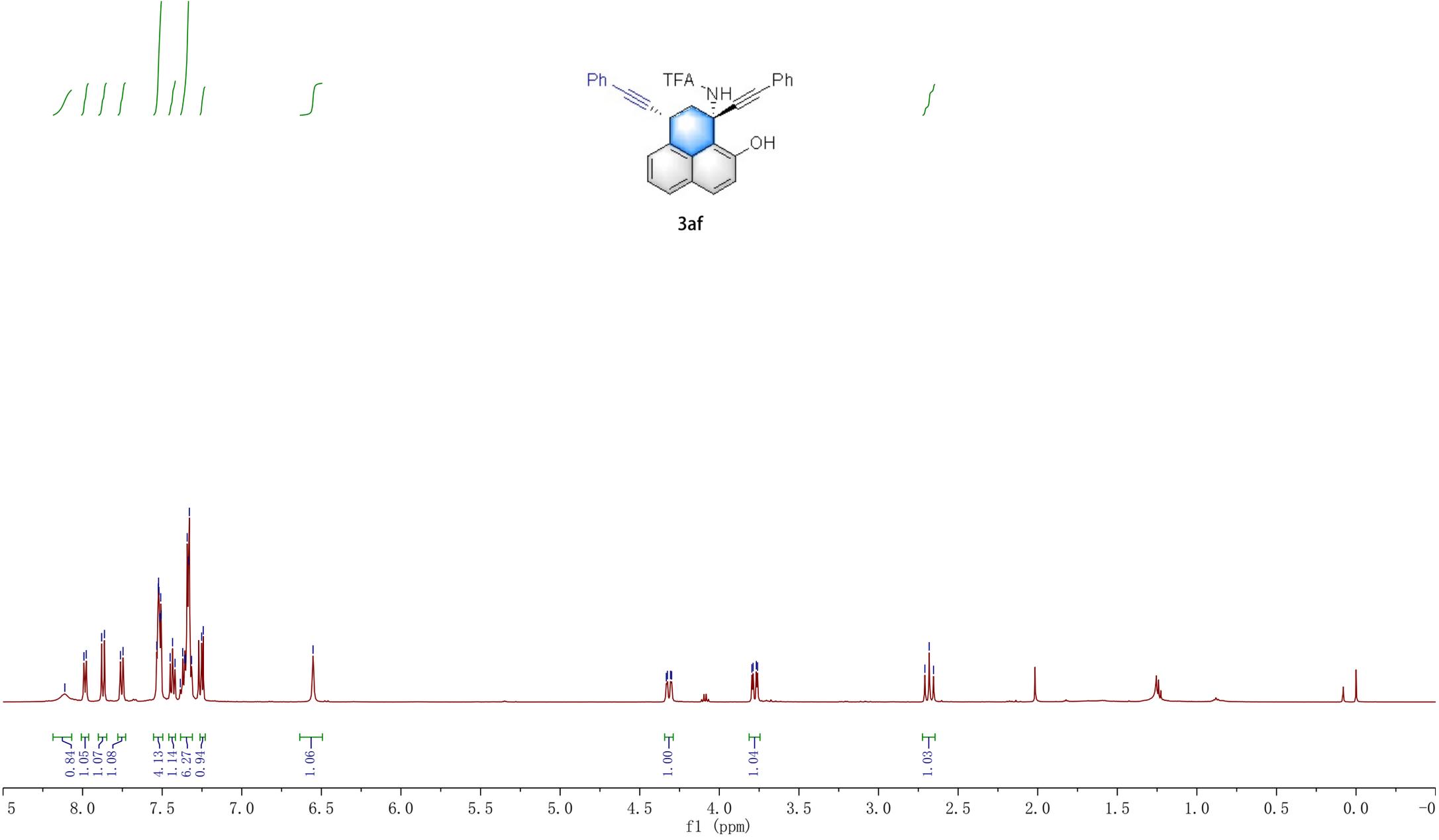
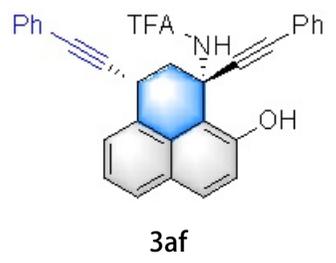
156.68  
156.38  
156.08  
155.79  
153.35  
140.09  
135.14  
133.62  
132.74  
132.18  
132.05  
129.39  
129.22  
128.98  
128.67  
128.40  
128.19  
127.72  
127.70  
127.27  
127.16  
126.55  
126.32  
125.93  
123.50  
120.80  
120.53  
118.89  
116.59  
114.30  
112.95  
111.99  
87.50  
86.28

51.28

41.93  
41.88

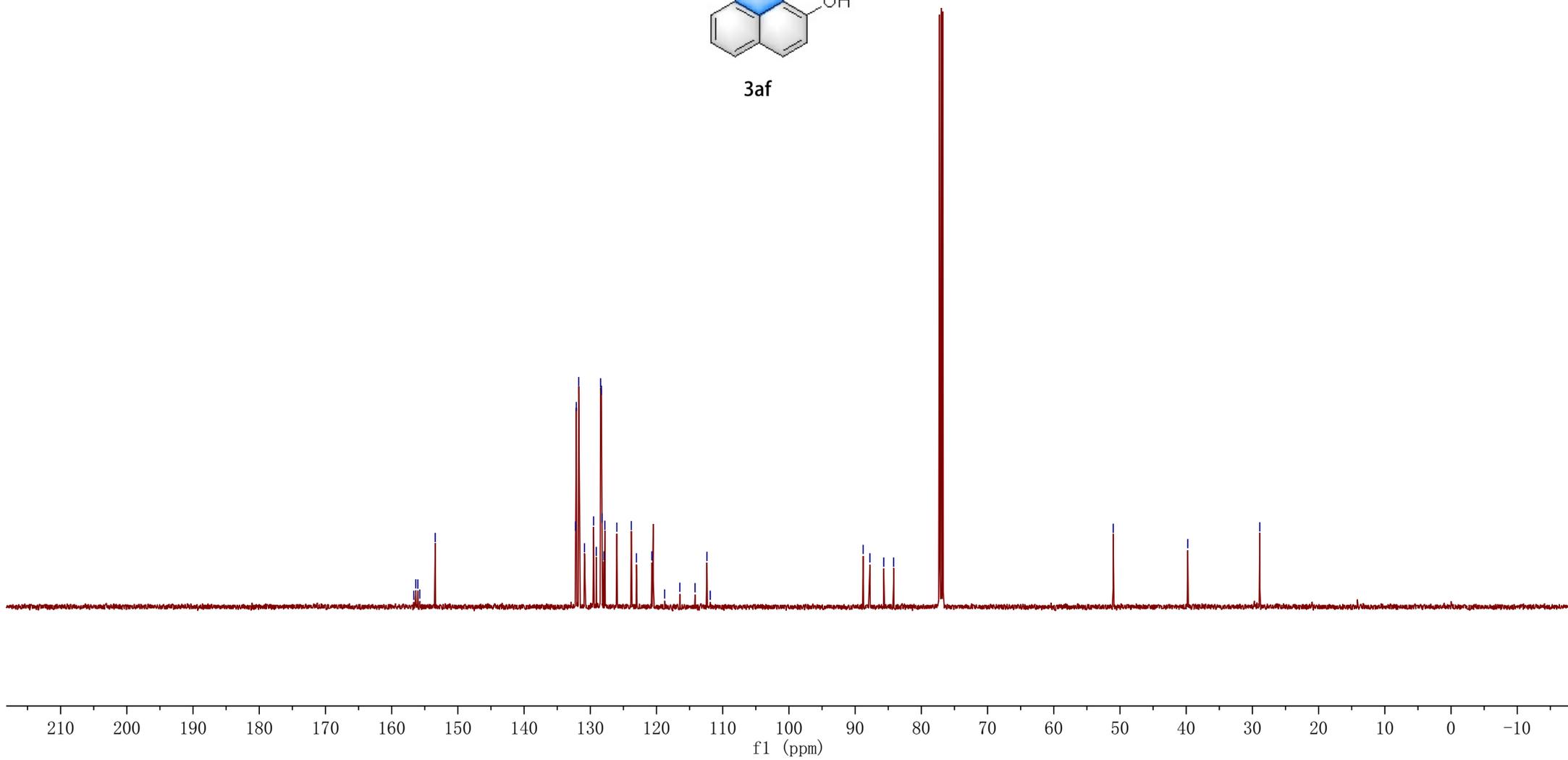
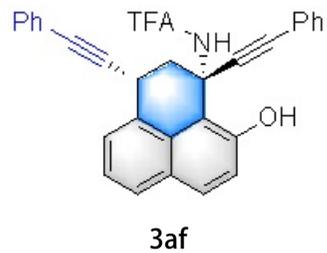


Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

156.65  
156.35  
156.05  
155.75  
153.42  
132.22  
132.11  
131.75  
130.88  
129.50  
129.10  
128.44  
128.33  
128.25  
127.96  
127.80  
125.99  
123.81  
123.03  
120.70  
118.78  
116.48  
114.18  
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111.88  
88.79  
87.77  
85.68  
84.19  
51.02  
39.76  
28.88

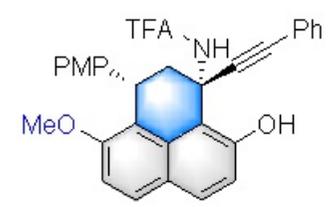


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz

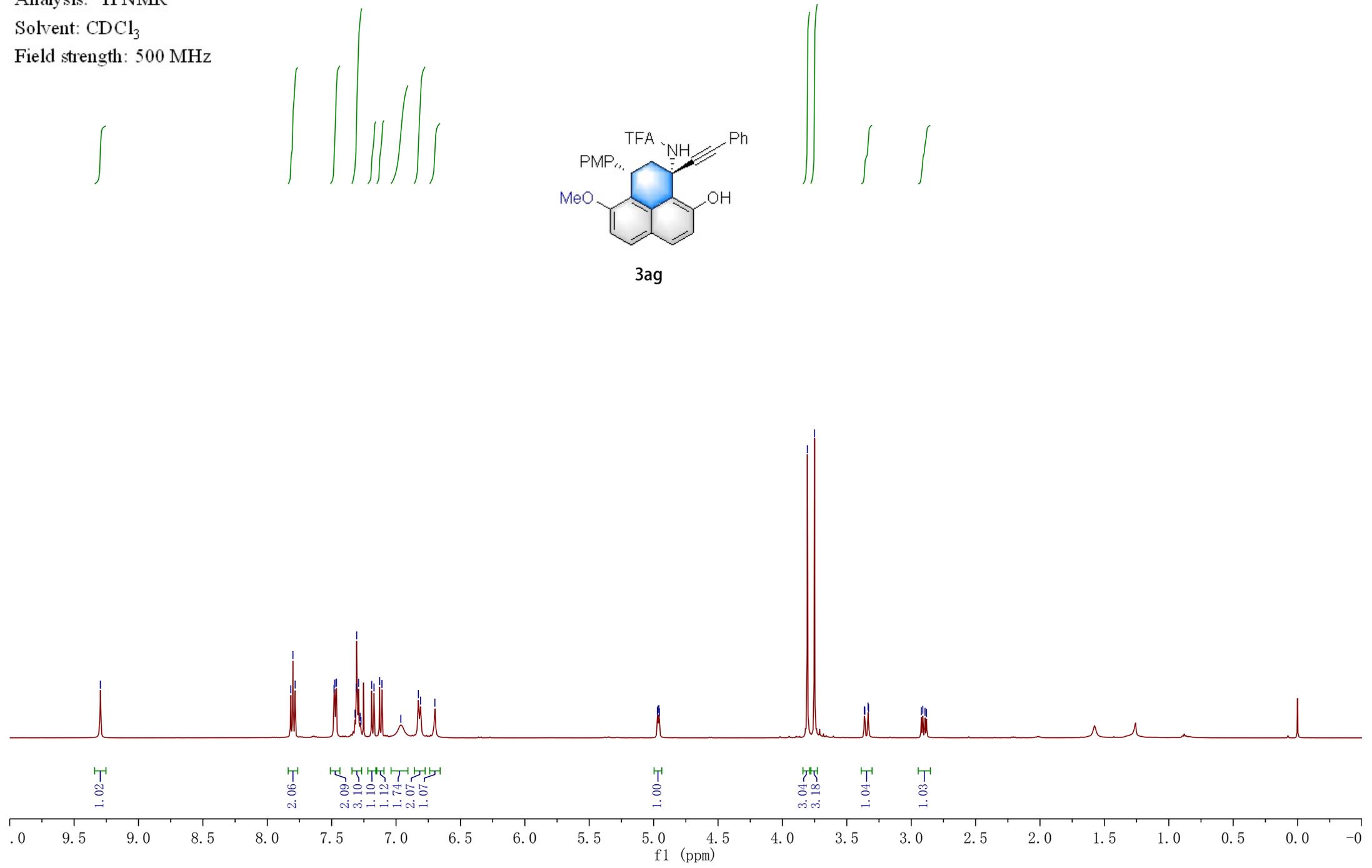
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7.784  
7.482  
7.479  
7.467  
7.463  
7.319  
7.309  
7.305  
7.291  
7.279  
7.273  
7.189  
7.171  
7.127  
7.109  
6.963  
6.827  
6.810  
6.699

4.971  
4.967  
4.959  
4.955

3.806  
3.751  
3.364  
3.360  
3.335  
3.331  
2.922  
2.910  
2.893  
2.881



3ag



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.88  
157.14  
156.84  
156.54  
156.24  
154.97  
154.63

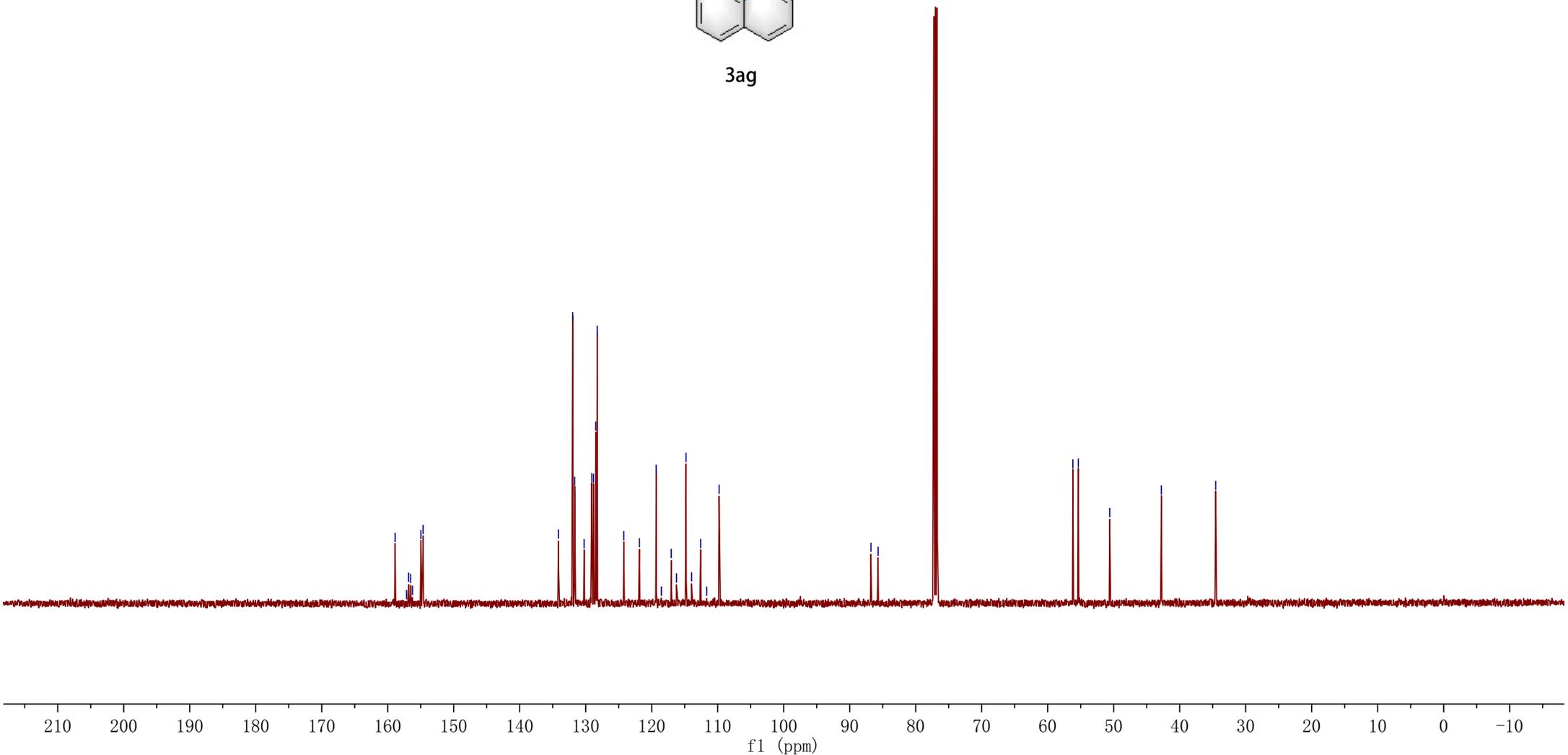
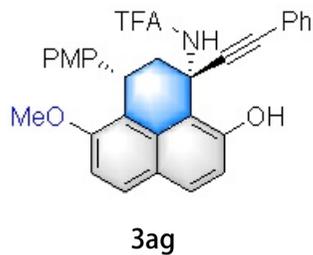
134.14  
131.98  
131.67  
130.25  
129.08  
128.82  
128.48  
128.26  
124.23  
121.86  
119.32  
118.53  
117.04  
116.24  
114.79  
113.95  
112.59  
111.66  
109.78

86.78  
85.70

56.18  
55.36  
50.60

42.78

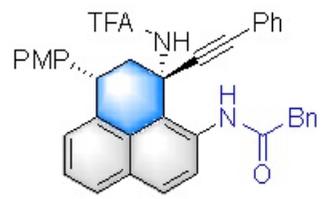
34.54



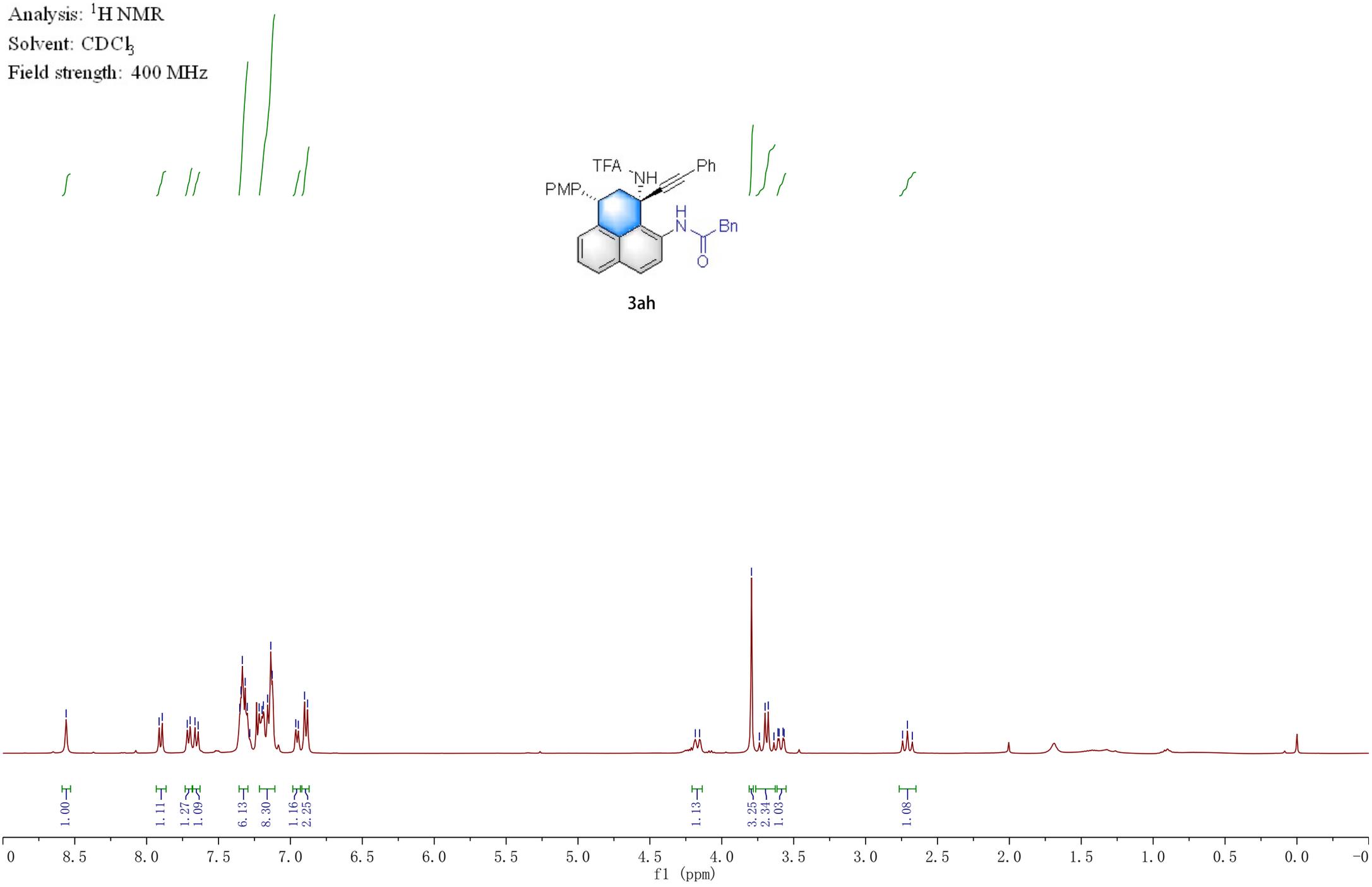
8.560  
7.913  
7.891  
7.718  
7.697  
7.664  
7.642  
7.352  
7.344  
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7.314  
7.300  
7.283  
7.218  
7.197  
7.188  
7.159  
7.137  
7.126  
6.963  
6.945  
6.902  
6.881

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

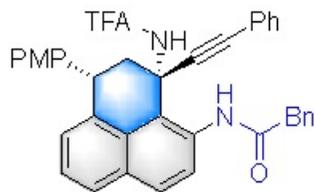
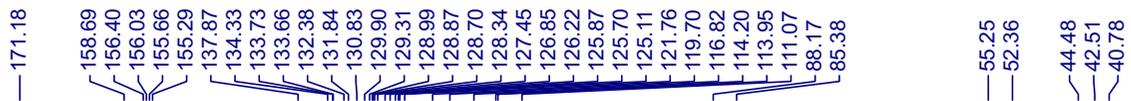
4.184  
4.154  
3.793  
3.738  
3.699  
3.677  
3.637  
3.609  
3.601  
3.574  
3.566  
2.742  
2.709  
2.675



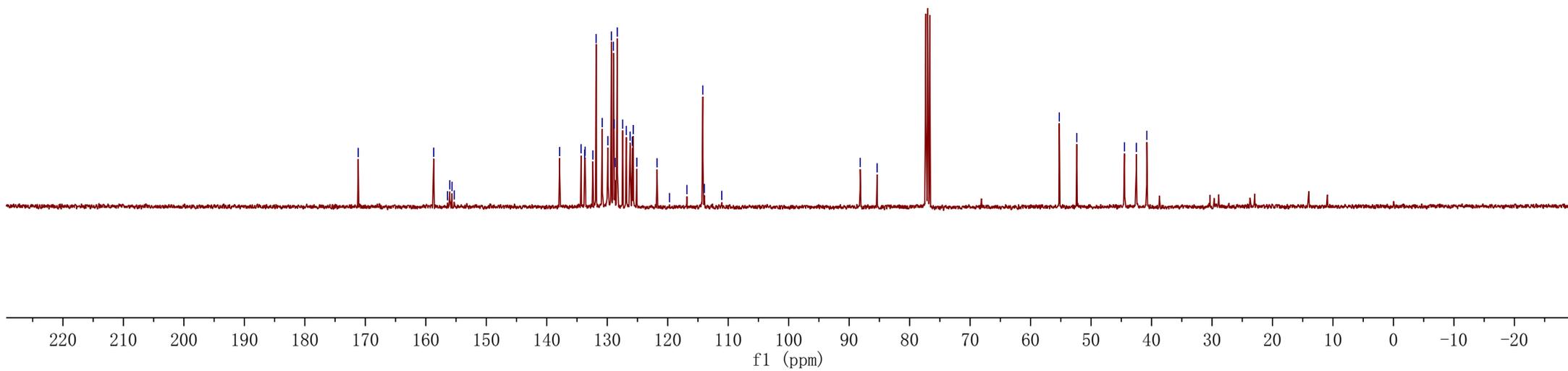
3ah



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



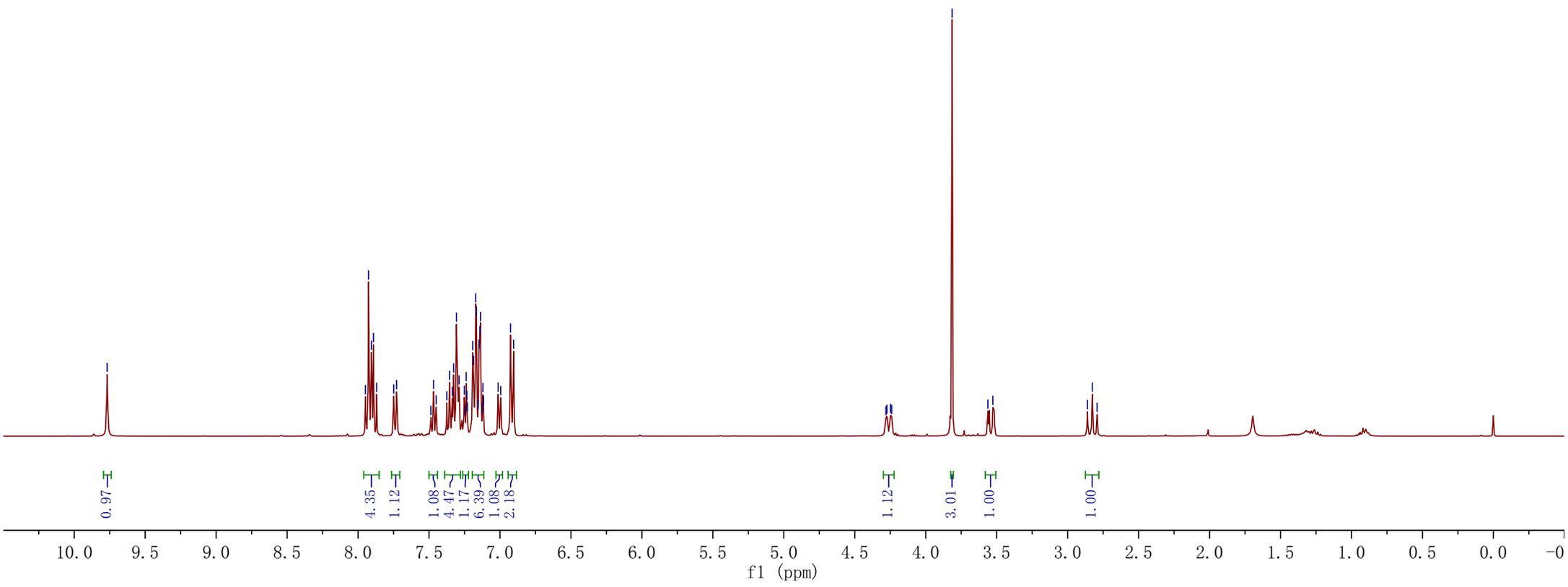
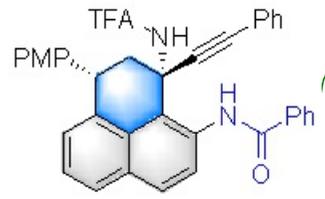
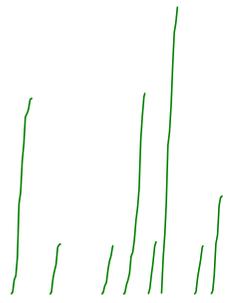
3ah



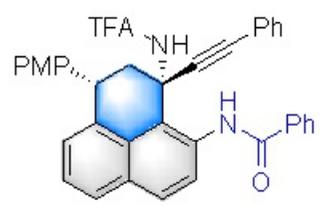
9.768  
 7.948  
 7.926  
 7.906  
 7.891  
 7.869  
 7.749  
 7.728  
 7.487  
 7.468  
 7.449  
 7.374  
 7.356  
 7.336  
 7.327  
 7.307  
 7.288  
 7.251  
 7.245  
 7.238  
 7.234  
 7.230  
 7.192  
 7.186  
 7.171  
 7.166  
 7.154  
 7.148  
 7.141  
 7.137  
 7.125  
 7.120  
 7.116  
 7.013  
 6.995  
 6.926  
 6.904

4.281  
 4.273  
 4.248  
 4.240  
 3.814  
 3.562  
 3.527  
 2.861  
 2.827  
 2.793

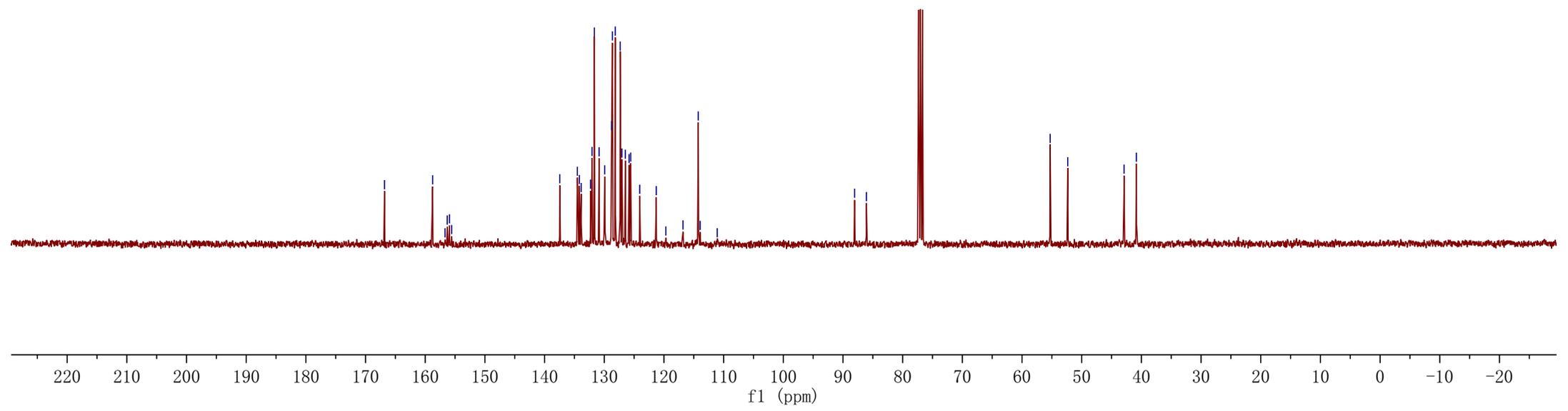
Analysis: <sup>1</sup>H NMR  
 Solvent: CDCl<sub>3</sub>  
 Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



3ai

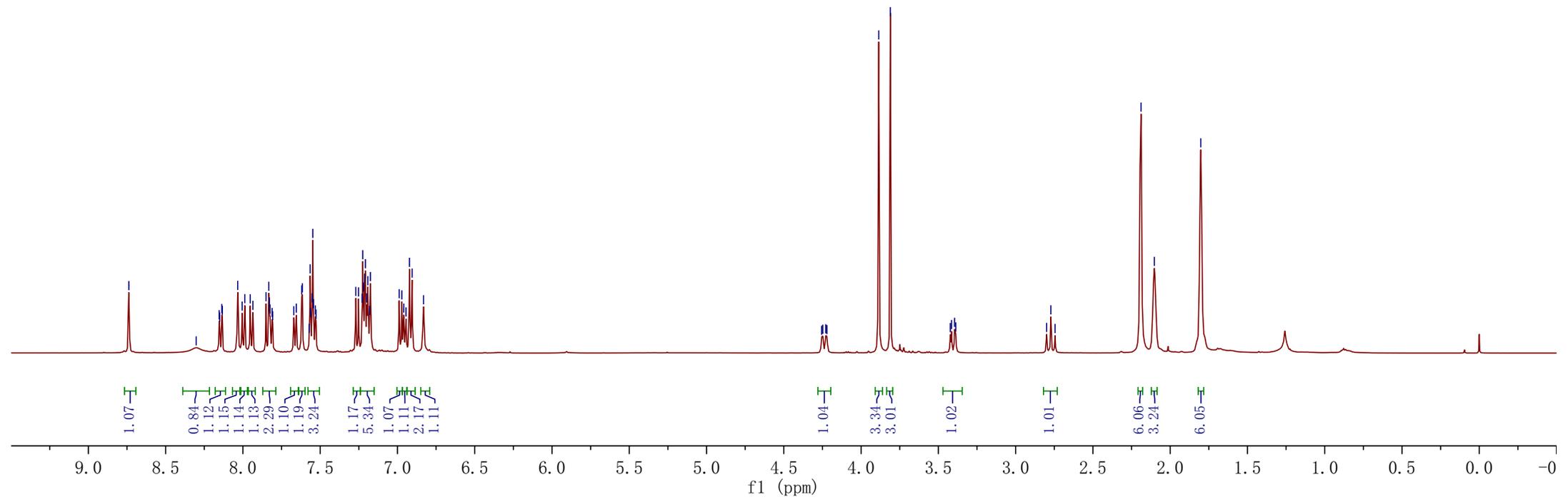
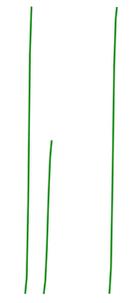
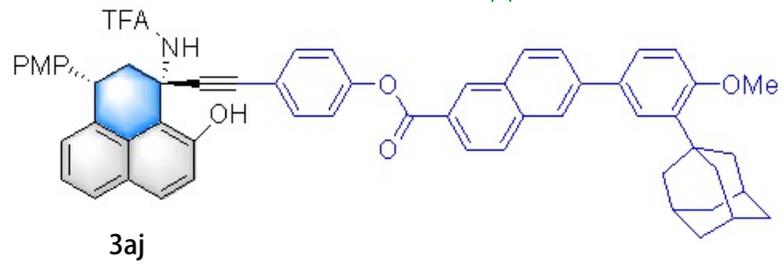
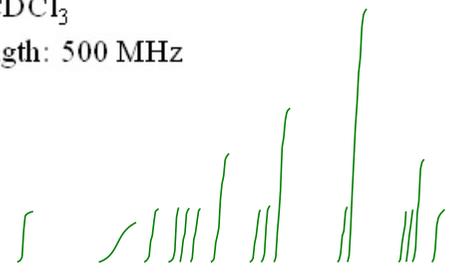


8.738  
8.302  
8.154  
8.150  
8.137  
8.133  
8.034  
8.005  
7.988  
7.953  
7.935  
7.850  
7.833  
7.828  
7.825  
7.811  
7.807  
7.671  
7.655  
7.620  
7.615  
7.571  
7.565  
7.561  
7.552  
7.548  
7.543  
7.532  
7.527  
7.270  
7.252  
7.229  
7.225  
7.220  
7.213  
7.207  
7.198  
7.192  
7.179  
7.175  
6.989  
6.972  
6.959  
6.945  
6.905  
6.831  
4.255  
4.248  
4.229  
4.221  
3.886  
3.811  
3.423  
3.415  
3.395  
3.387  
2.799  
2.772  
2.745  
2.189  
2.102  
1.802

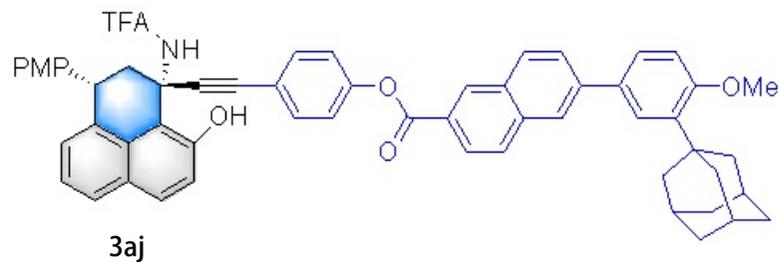
Analysis: <sup>1</sup>H NMR

Solvent: CDCl<sub>3</sub>

Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

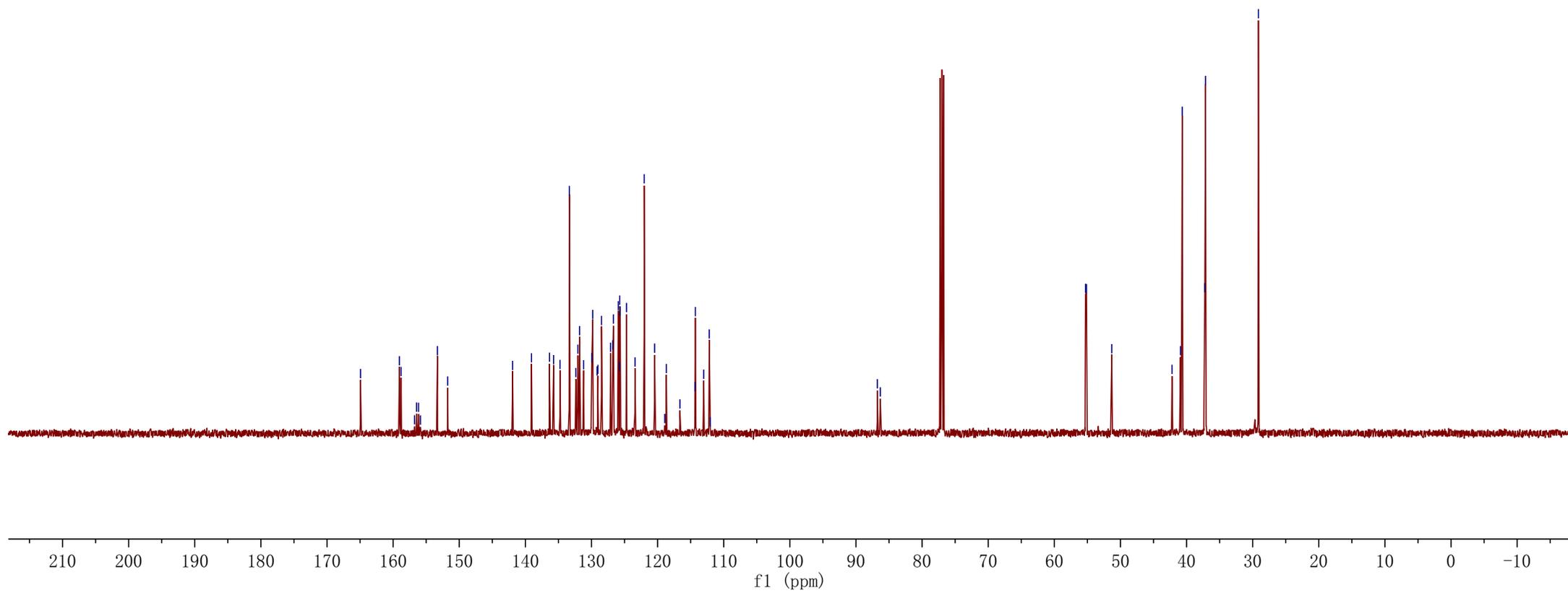


164.93  
159.05  
158.80  
156.75  
156.45  
156.16  
155.86  
153.30  
151.75  
141.93  
139.07  
136.35  
135.73  
134.77  
133.35  
132.37  
132.06  
131.80  
131.19  
129.96  
129.82  
129.16  
129.02  
128.48  
127.11  
126.77  
126.69  
125.95  
125.77  
125.74  
125.66  
124.70  
123.41  
122.03  
120.45  
118.92  
118.67  
116.62  
114.32  
114.29  
113.03  
112.19  
112.03  
86.77  
86.32

55.29  
55.14  
51.31

42.20  
40.92  
40.65  
37.24  
37.13

29.13



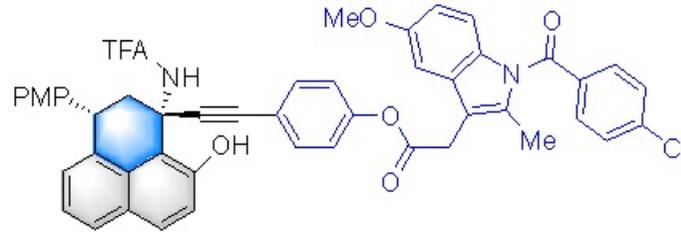
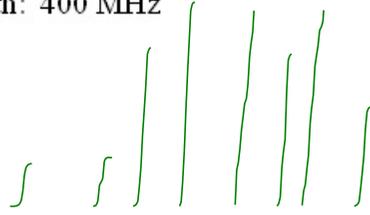
8.179  
7.849  
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7.480  
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7.458  
7.448  
7.247  
7.233  
7.226  
7.214  
7.194  
7.189  
7.168  
7.046  
7.025  
6.954  
6.936  
6.923  
6.901  
6.884  
6.861  
6.701  
6.695  
6.680  
6.673

4.224  
4.217  
4.191  
4.184  
3.886  
3.821  
3.419  
3.409  
3.384  
3.375  
2.772  
2.737  
2.703  
2.435

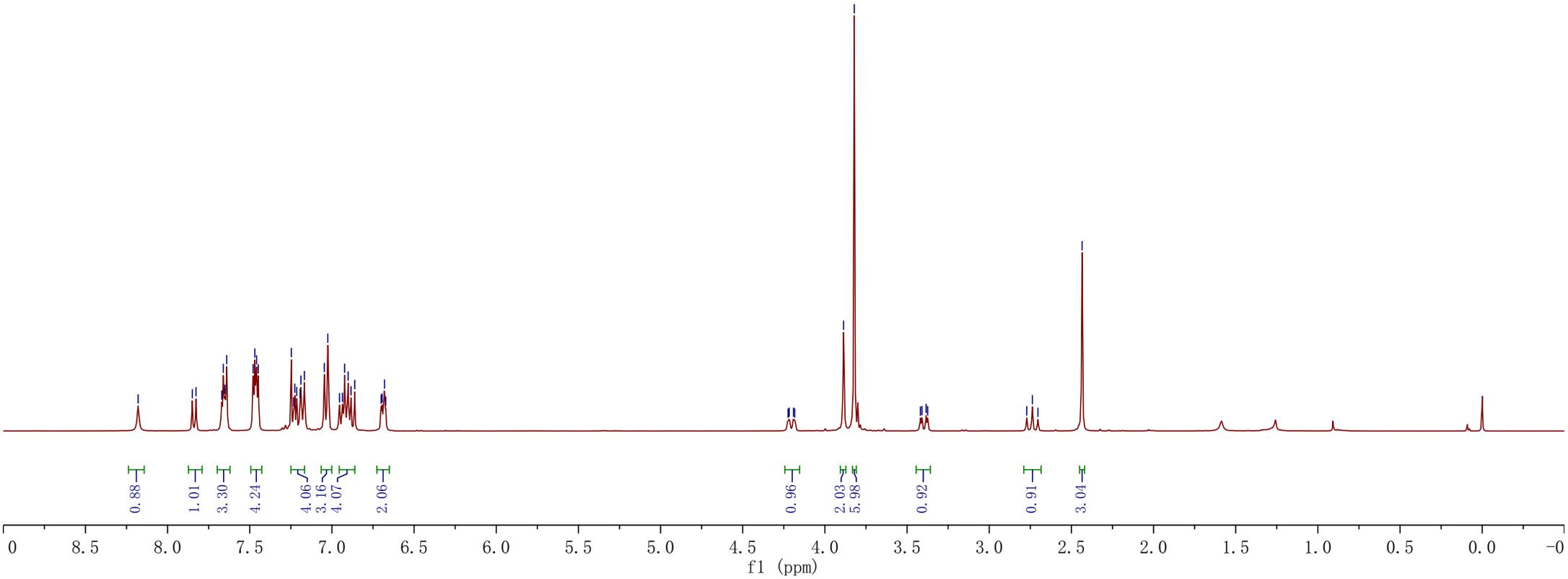
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



3ak



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

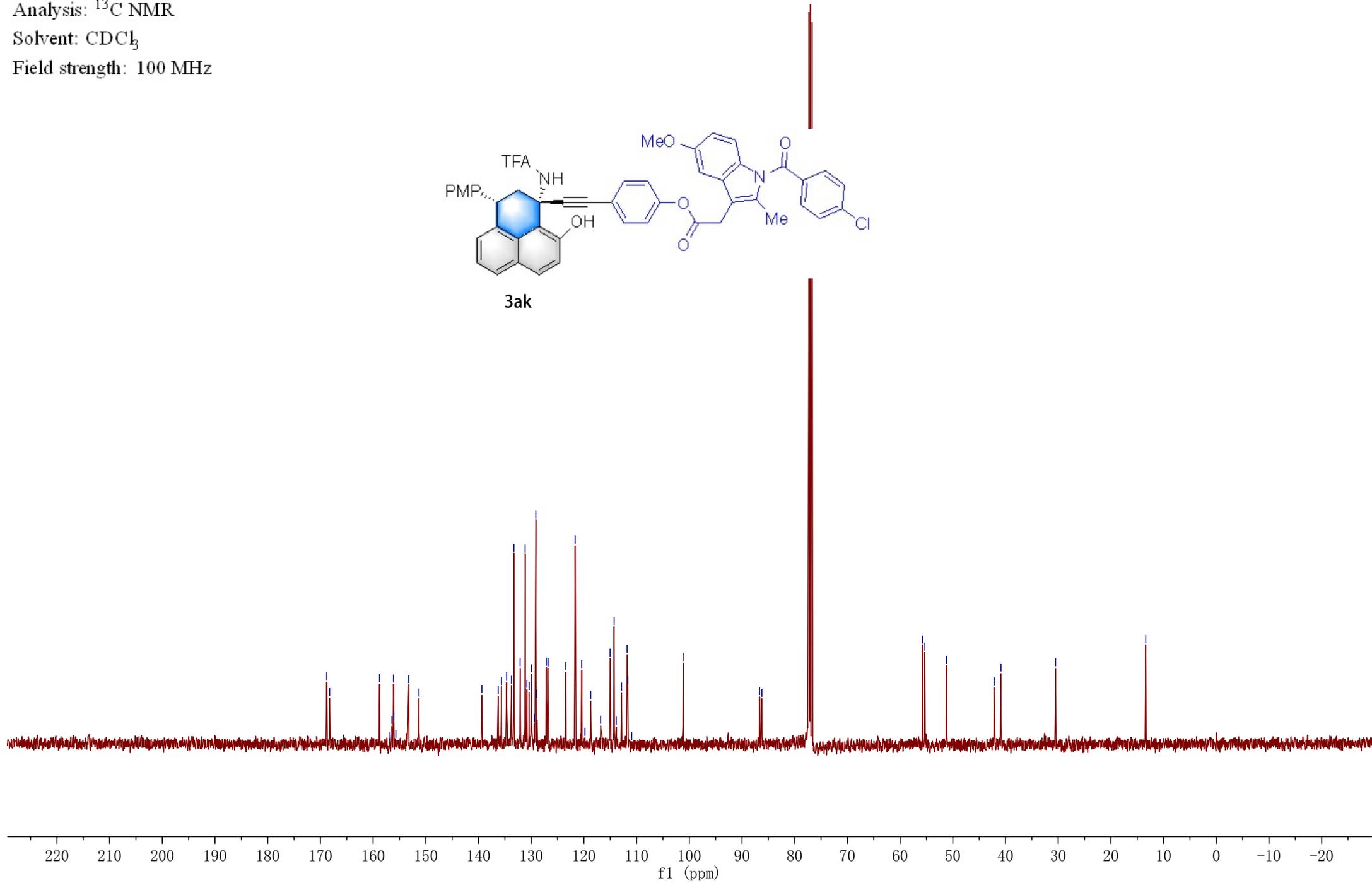
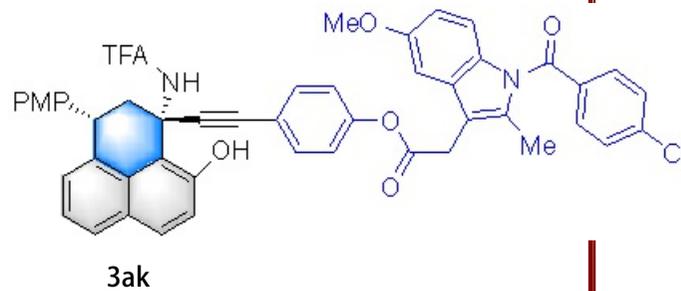
168.80  
168.25  
158.77  
156.79  
156.42  
156.13  
156.05  
155.68  
153.24  
151.29  
139.36  
136.27  
135.64  
134.66  
133.74  
133.29  
132.11  
131.16  
130.83  
130.39  
129.95  
129.40  
129.13  
128.93  
127.13  
126.81  
123.44  
121.66  
120.43  
119.81  
118.72  
116.83  
115.03  
114.26  
112.86  
111.80  
111.67  
110.93  
101.18  
86.66  
86.23

55.72  
55.30  
51.18

42.14  
40.86

30.50

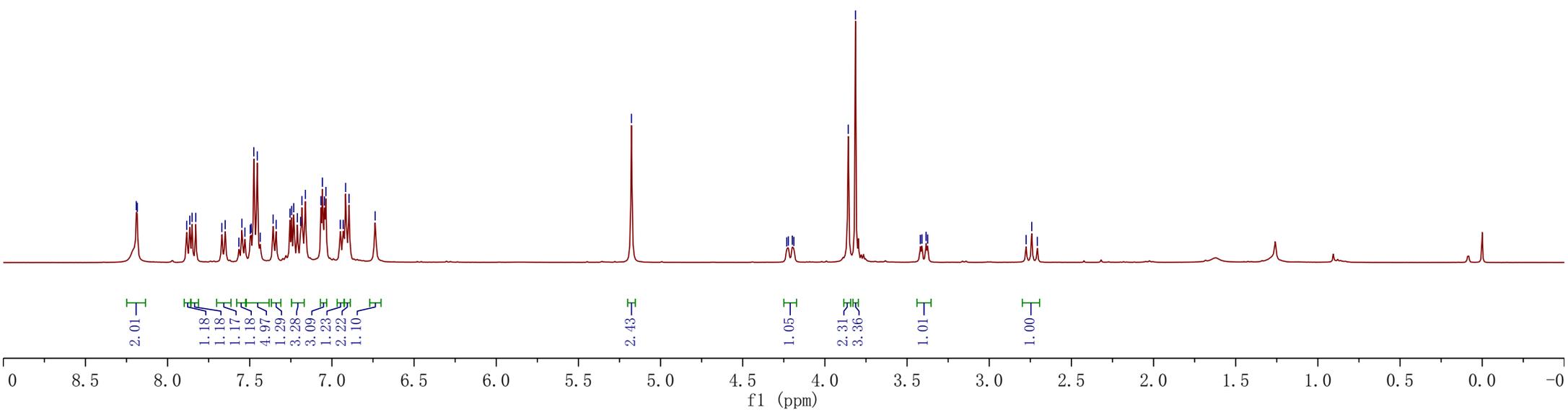
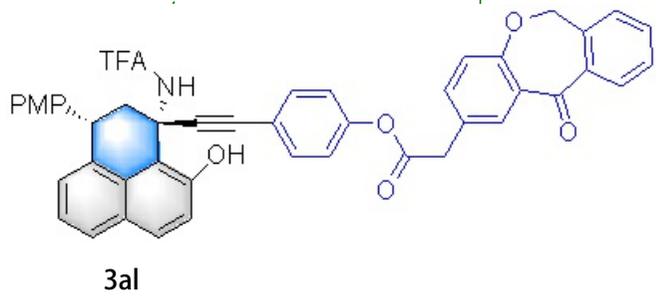
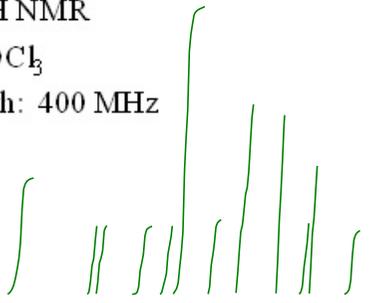
13.38



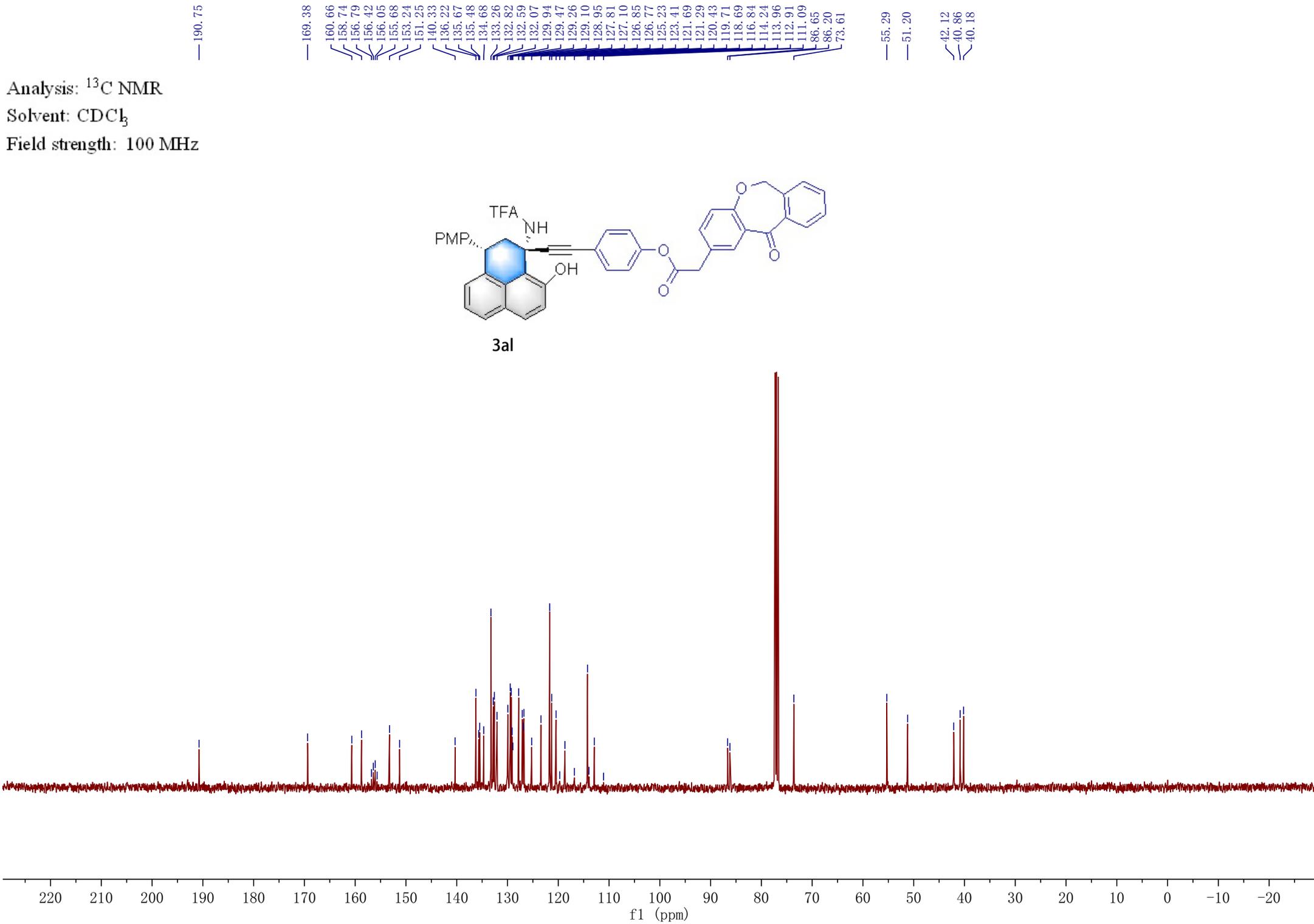
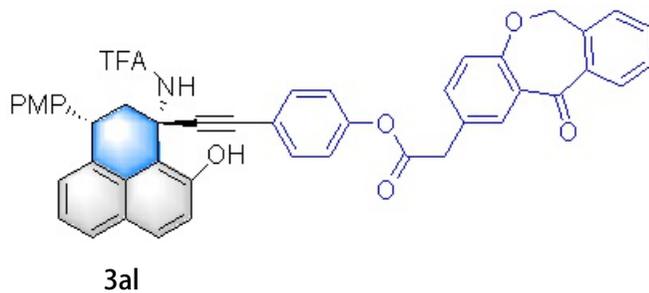
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7.828  
7.670  
7.649  
7.566  
7.548  
7.529  
7.497  
7.491  
7.475  
7.454  
7.436  
7.358  
7.340  
7.255  
7.245  
7.232  
7.210  
7.190  
7.183  
7.161  
7.067  
7.058  
7.046  
7.037  
6.949  
6.931  
6.916  
6.896  
6.737  
5.177

4.232  
4.222  
4.198  
4.189  
3.858  
3.814  
3.419  
3.409  
3.384  
3.375  
2.775  
2.741  
2.707

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

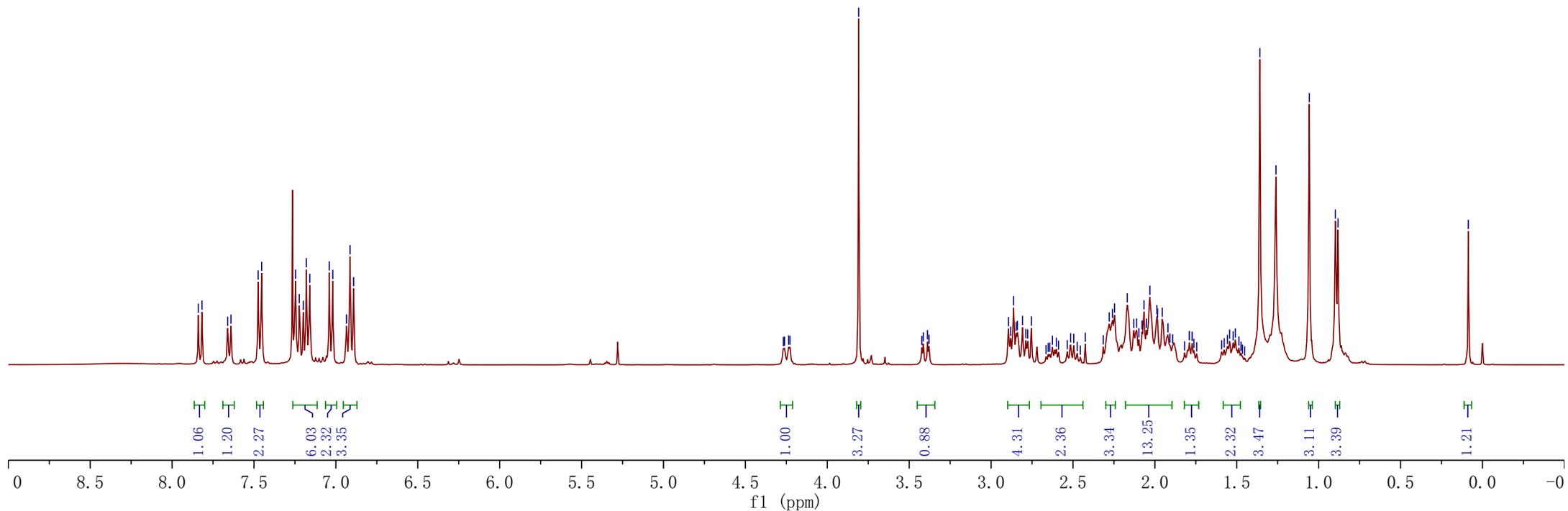
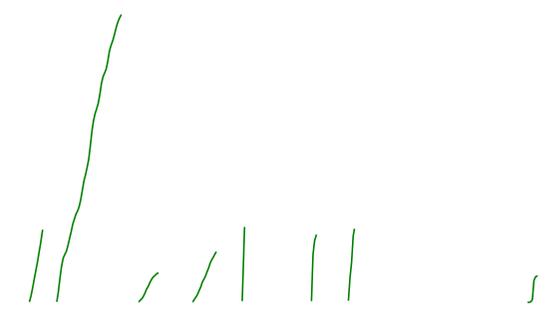
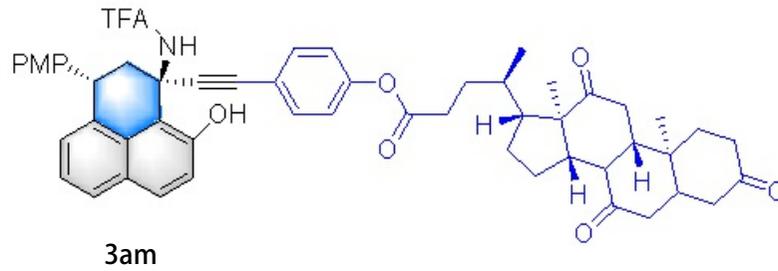


7.84  
7.82  
7.66  
7.64  
7.47  
7.45  
7.25  
7.22  
7.20  
7.18  
7.16  
7.04  
7.02  
6.94  
6.91  
6.89

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



4.27  
4.26  
4.24  
4.23  
3.81  
3.42  
3.41  
3.39  
3.38  
2.89  
2.88  
2.86  
2.85  
2.84  
2.81  
2.79  
2.78  
2.75  
2.66  
2.65  
2.64  
2.63  
2.60  
2.59  
2.54  
2.51  
2.50  
2.47  
2.46  
2.43  
2.32  
2.28  
2.26  
2.25  
2.17  
2.13  
2.11  
2.10  
2.08  
2.07  
2.05  
2.03  
1.99  
1.98  
1.95  
1.92  
1.91  
1.89  
1.82  
1.79  
1.77  
1.76  
1.74  
1.59  
1.58  
1.56  
1.54  
1.52  
1.51  
1.49  
1.47  
1.45  
1.36  
1.26  
1.06  
0.90  
0.88  
0.09



212.00  
209.22  
208.68

172.00

158.60  
156.81  
156.44  
156.06  
155.70  
153.17  
151.16  
135.76  
134.71  
133.14  
131.82  
129.87  
129.03  
128.92  
126.94  
126.55  
123.30  
121.69  
120.24  
119.71  
118.63  
116.83  
114.12  
113.96  
112.99  
111.09

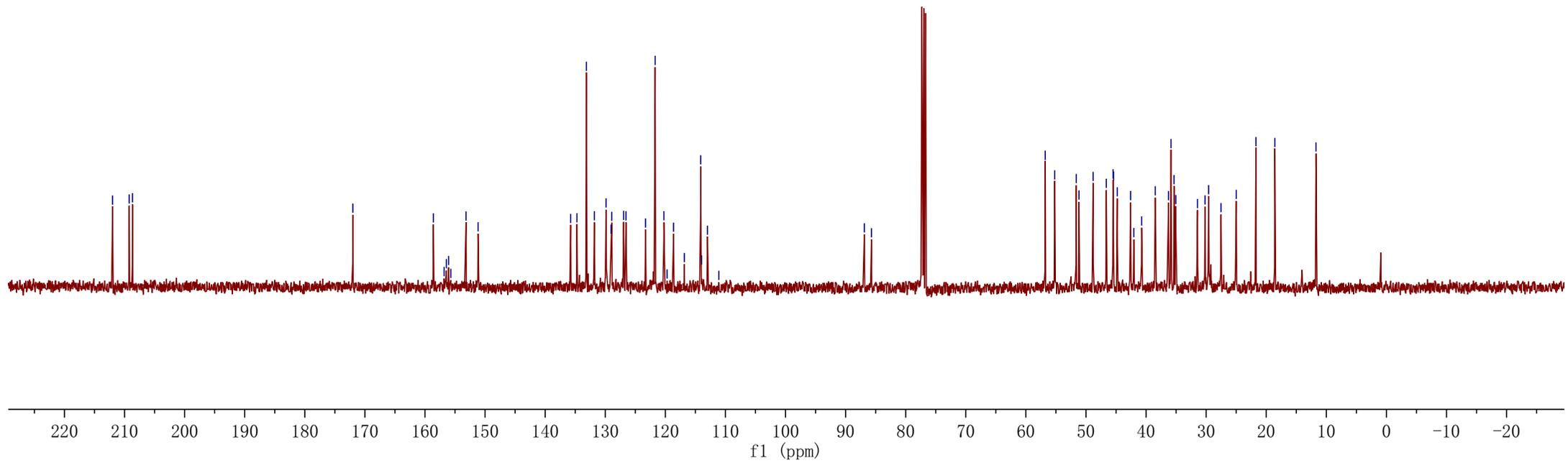
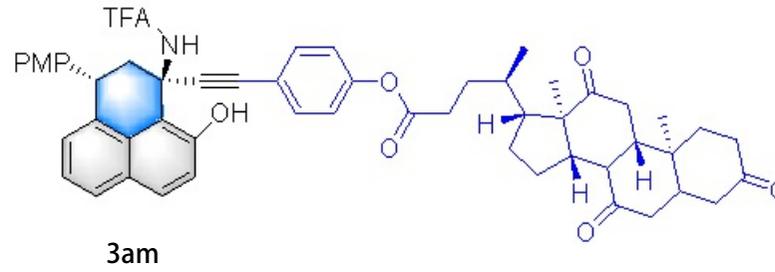
86.88  
85.70

56.78  
55.20  
51.62  
51.16  
48.82  
46.62  
45.50  
45.40  
44.79  
42.58  
42.04  
40.74  
38.47  
36.26  
35.85  
35.35  
35.05  
31.44  
30.18  
29.59  
27.52  
24.99  
21.71  
18.56  
11.72

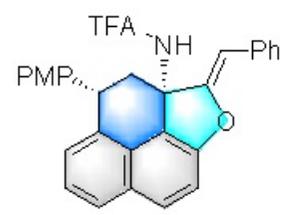
Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 100 MHz

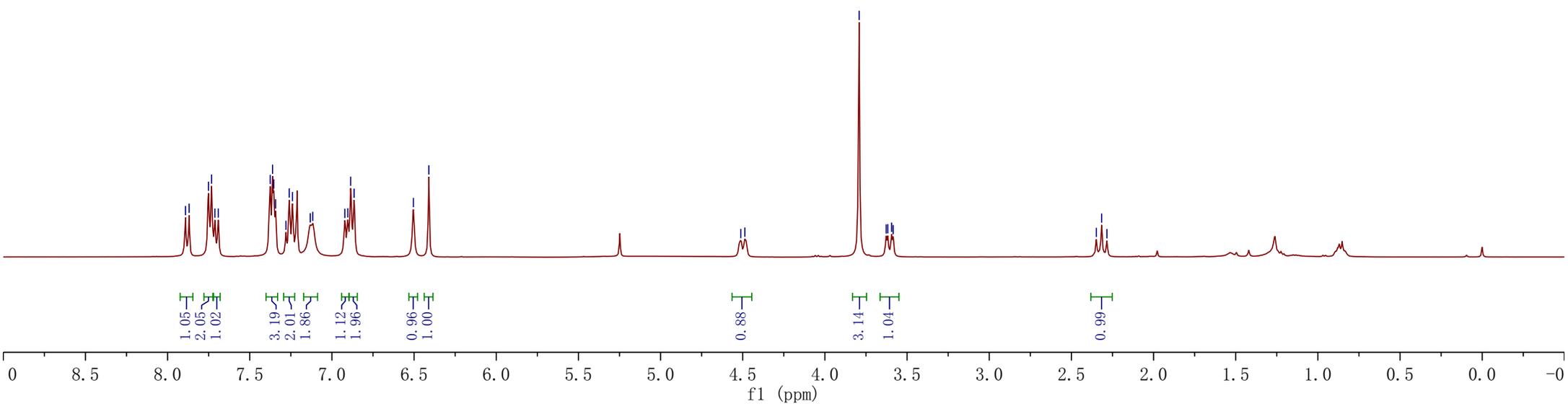


Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 400 MHz



4a

7.891  
7.869  
7.751  
7.732  
7.712  
7.691  
7.376  
7.361  
7.354  
7.343  
7.280  
7.260  
7.240  
7.132  
7.117  
6.921  
6.903  
6.886  
6.865  
4.512  
4.487  
3.792  
3.627  
3.618  
3.594  
3.585  
2.348  
2.316  
2.284



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

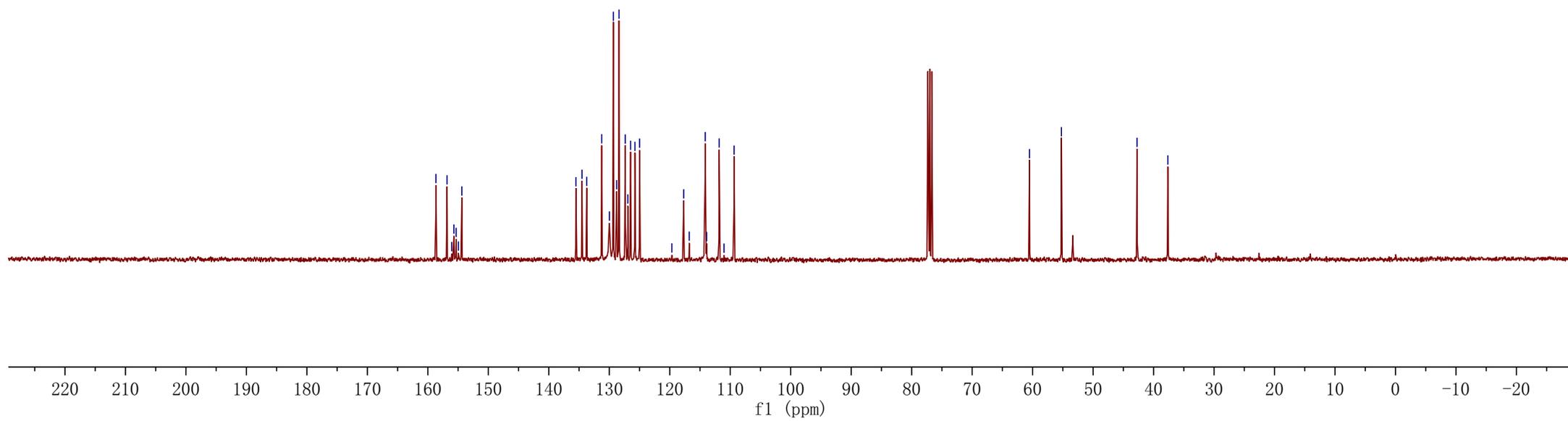
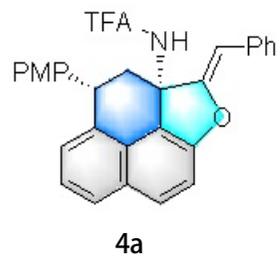
158.661  
156.822  
156.059  
155.689  
155.320  
154.949  
154.375  
135.520  
134.514  
133.734  
131.252  
129.975  
129.327  
128.771  
128.389  
127.359  
126.929  
126.475  
125.757  
124.993  
119.655  
117.691  
116.780  
114.133  
113.903  
111.824  
111.025  
109.360

60.515

55.238

42.738

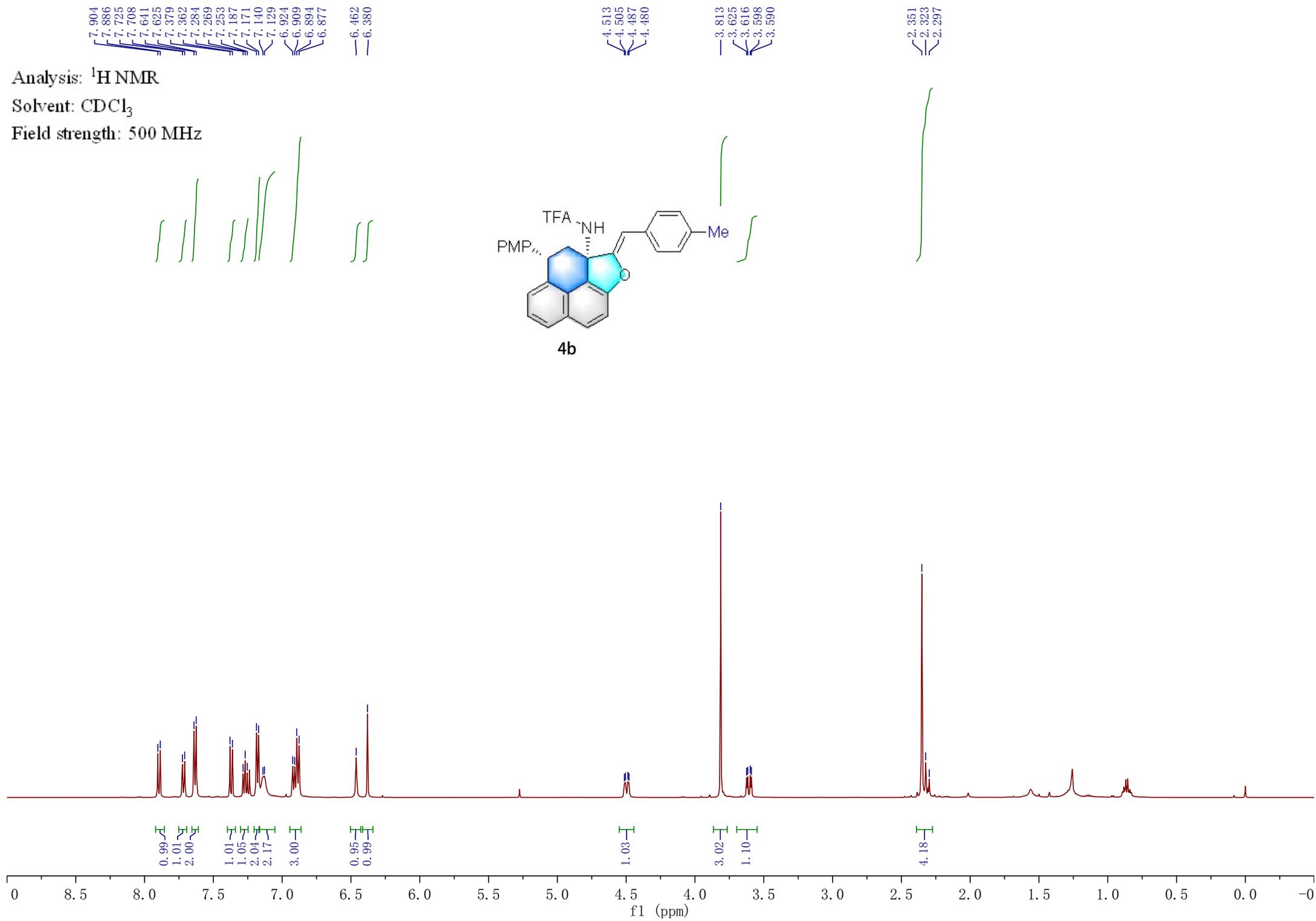
37.644



Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.75  
156.25  
155.94  
155.64  
155.35  
155.05  
154.48  
137.27  
135.58  
134.63  
131.20  
130.95  
130.00  
129.29  
129.13  
128.80  
127.00  
126.48  
125.77  
124.97  
118.85  
117.81  
116.55  
114.25  
114.20  
111.95  
111.89  
109.35

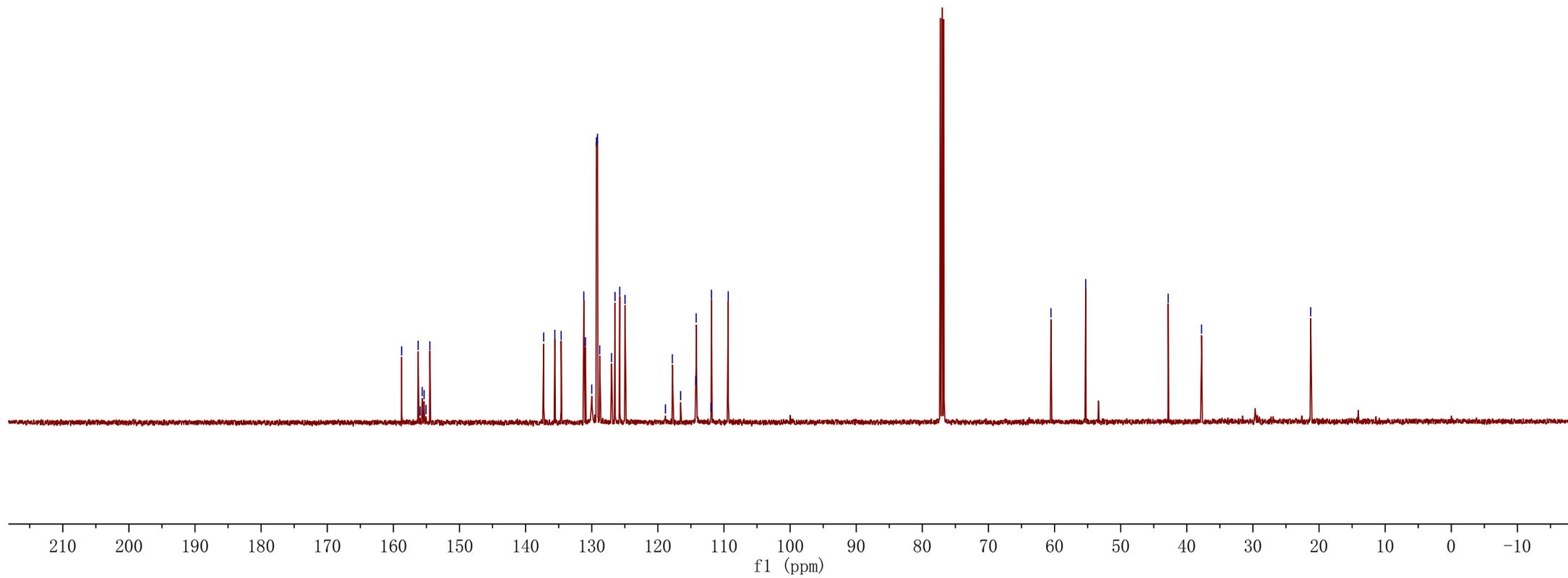
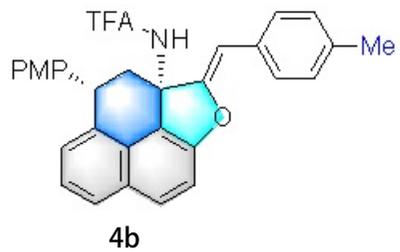
— 60.55

— 55.29

— 42.82

— 37.78

— 21.27



7.898  
7.876  
7.723  
7.700  
7.678  
7.373  
7.351  
7.285  
7.267  
7.142  
7.126  
6.915  
6.910  
6.893

4.512  
4.502  
4.480  
4.471

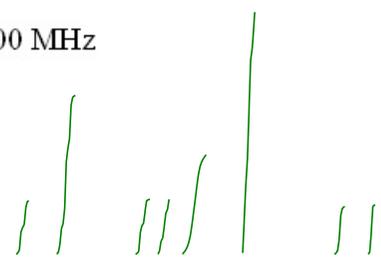
3.811  
3.622  
3.612  
3.589  
3.578

2.352  
2.320  
2.288

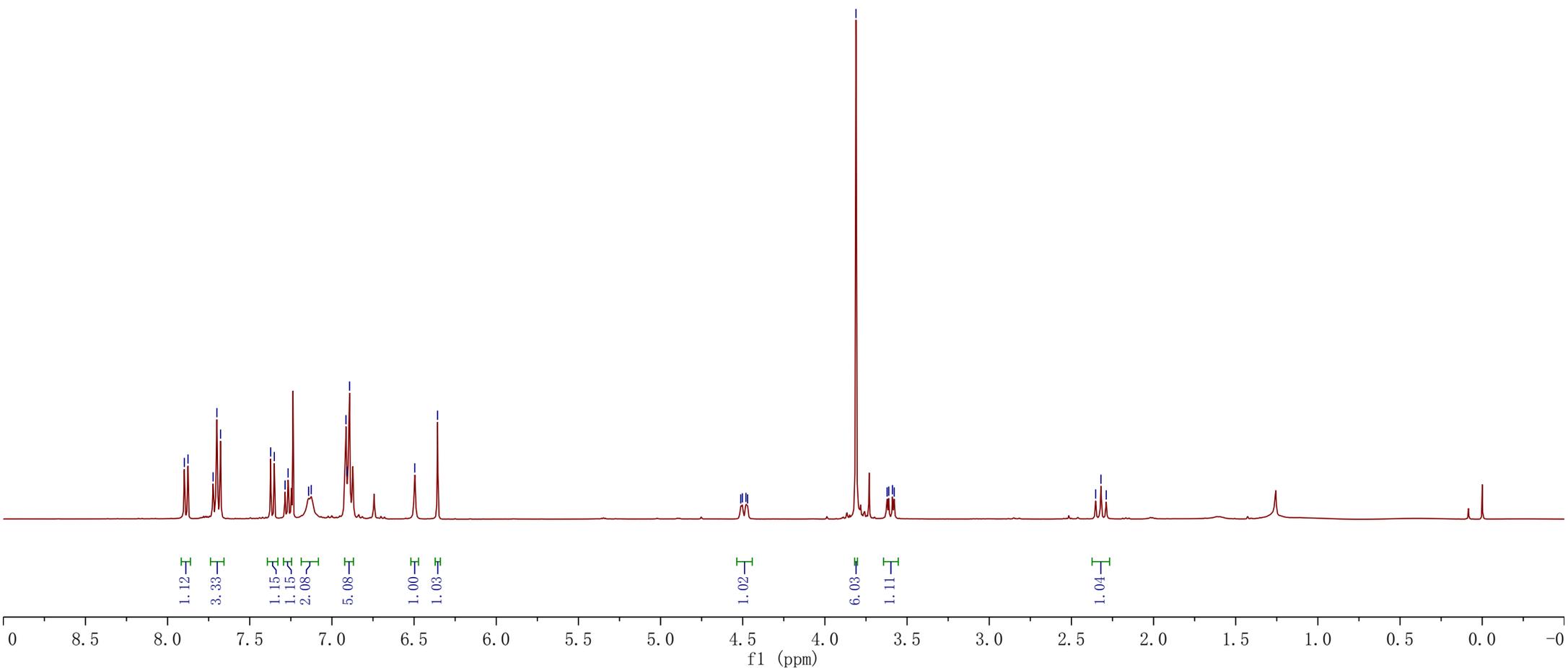
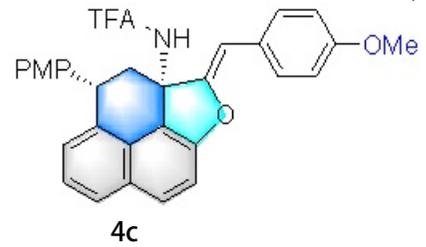
Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



6.496  
6.357

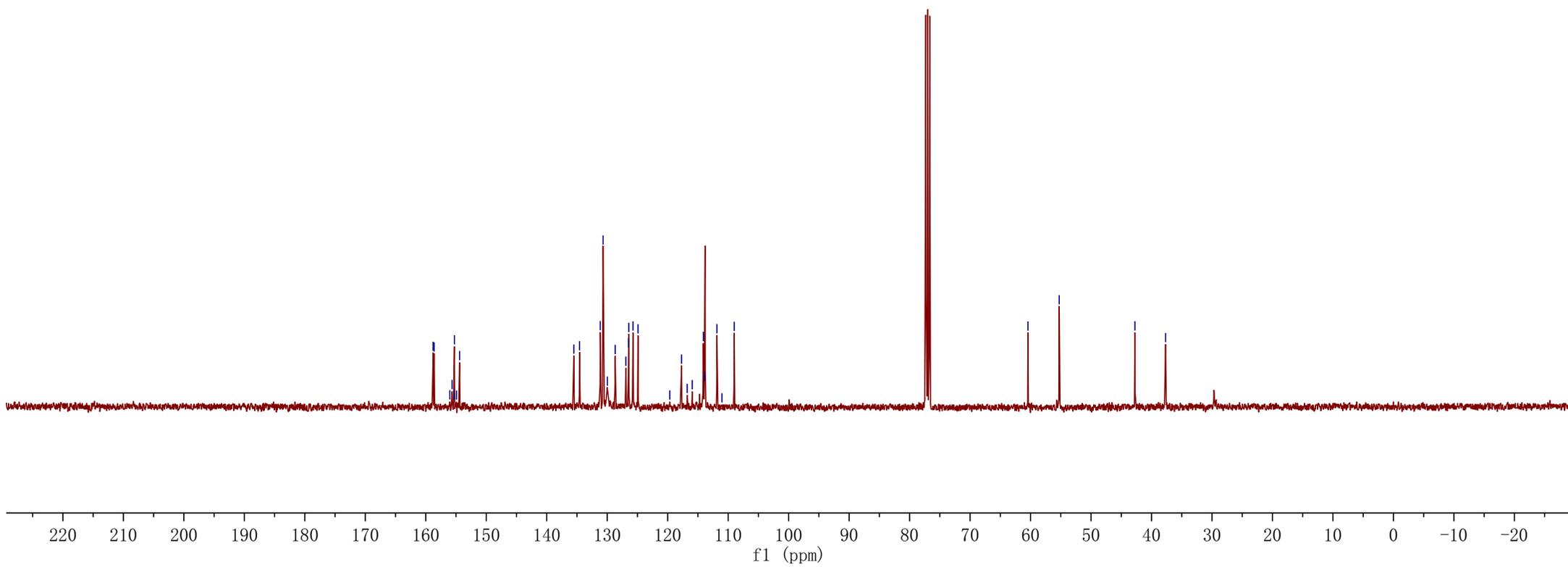
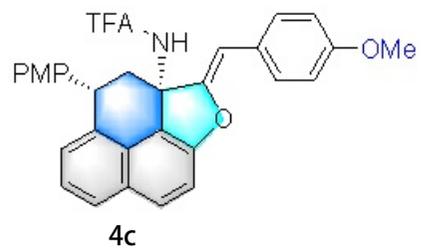


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

158.78  
158.61  
156.02  
155.65  
155.35  
155.26  
154.91  
154.41  
135.52  
134.59  
131.15  
130.68  
129.97  
128.68  
126.92  
126.49  
126.43  
125.74  
124.91  
119.66  
117.71  
116.78  
115.94  
114.10  
113.90  
111.85  
111.02  
108.99

60.43  
55.26

42.74  
37.67



Analysis:  $^1\text{H NMR}$   
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

7.908  
7.886  
7.729  
7.709  
7.689  
7.669  
7.380  
7.358  
7.290  
7.272  
7.254  
7.234  
7.148  
7.131  
6.927  
6.909  
6.897  
6.875  
6.460  
6.396

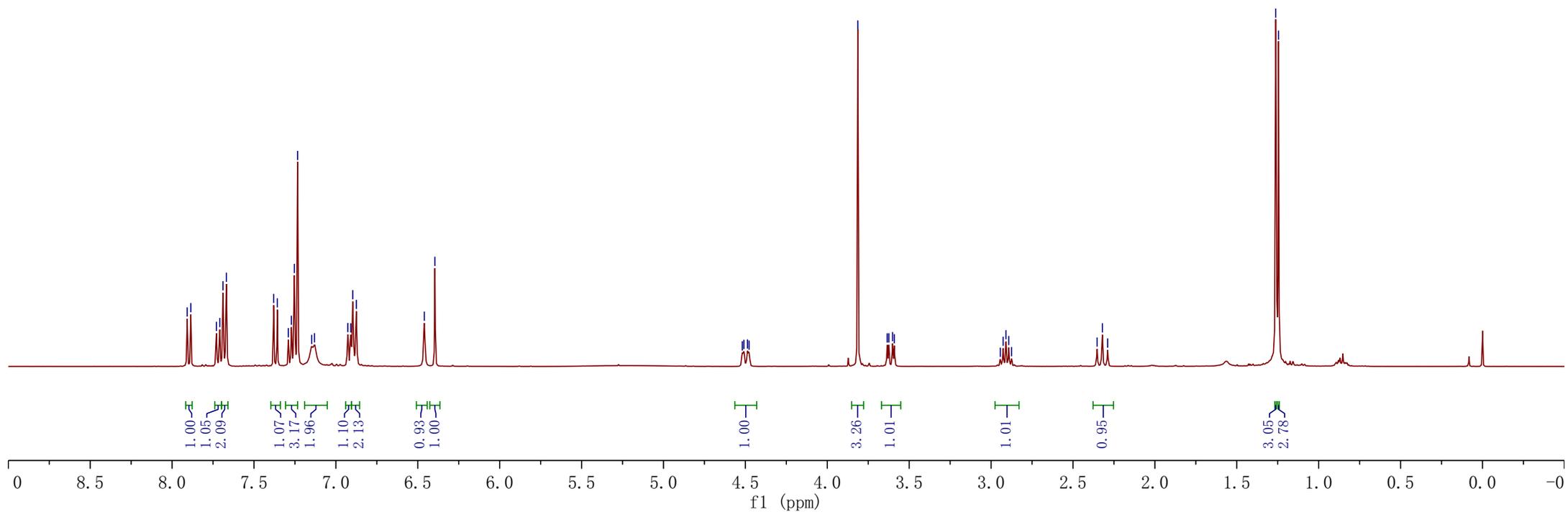
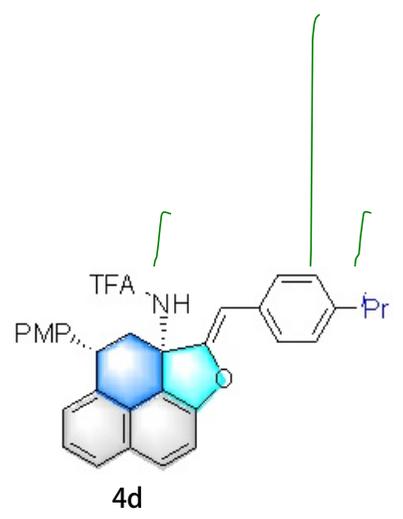
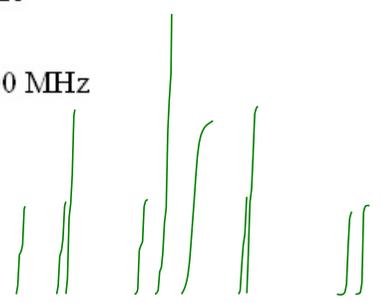
4.519  
4.509  
4.487  
4.477

3.814  
3.634  
3.624  
3.601  
3.591

2.944  
2.926  
2.909  
2.892  
2.875

2.353  
2.321  
2.288

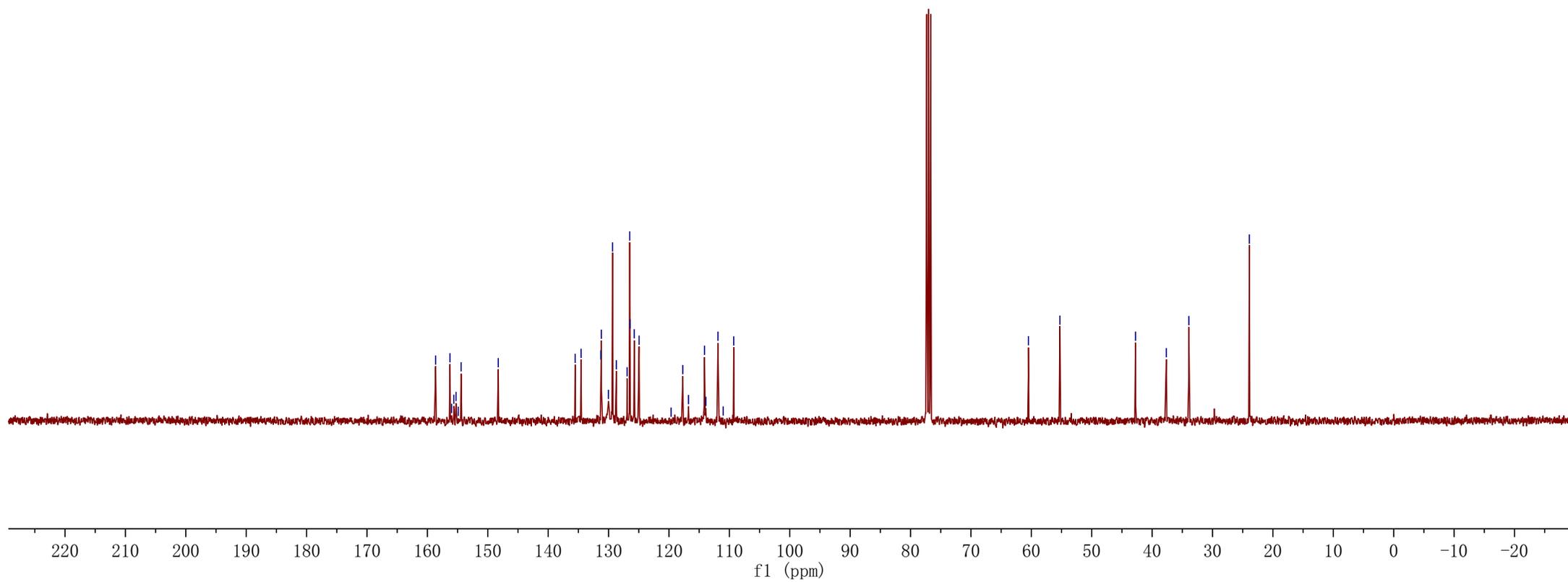
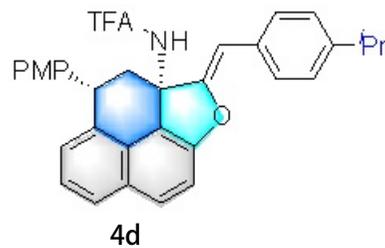
1.262  
1.245



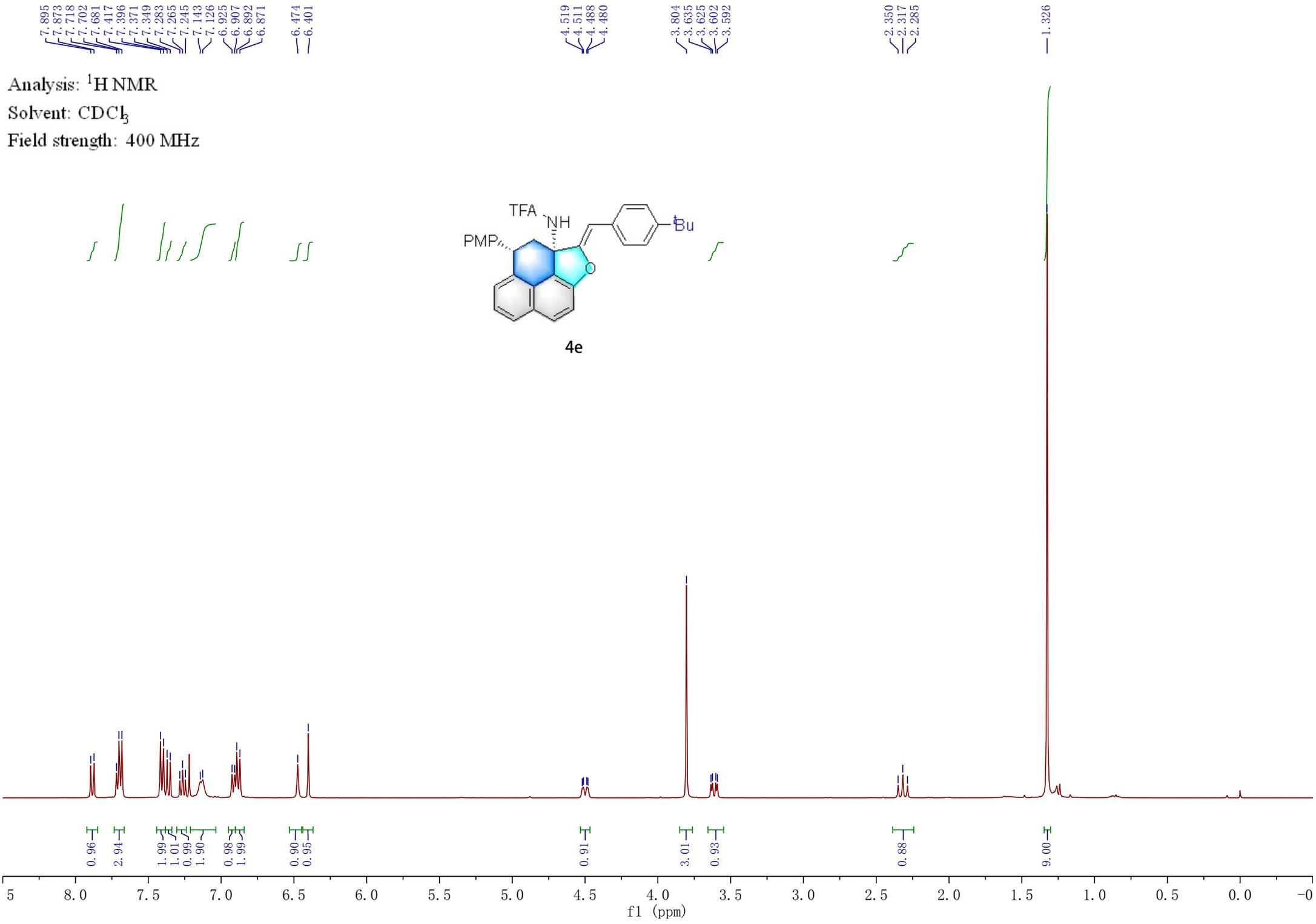
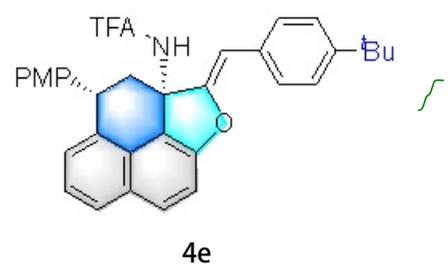
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

158.63  
156.26  
155.99  
155.62  
155.25  
154.89  
154.42  
148.27  
135.54  
134.56  
131.29  
131.20  
130.03  
129.35  
128.72  
126.93  
126.50  
126.45  
125.75  
124.95  
119.65  
117.71  
116.77  
114.11  
113.89  
111.88  
111.02  
109.28

60.48  
55.27  
42.75  
37.66  
33.92  
23.90



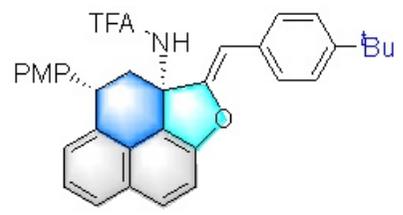
Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 400 MHz



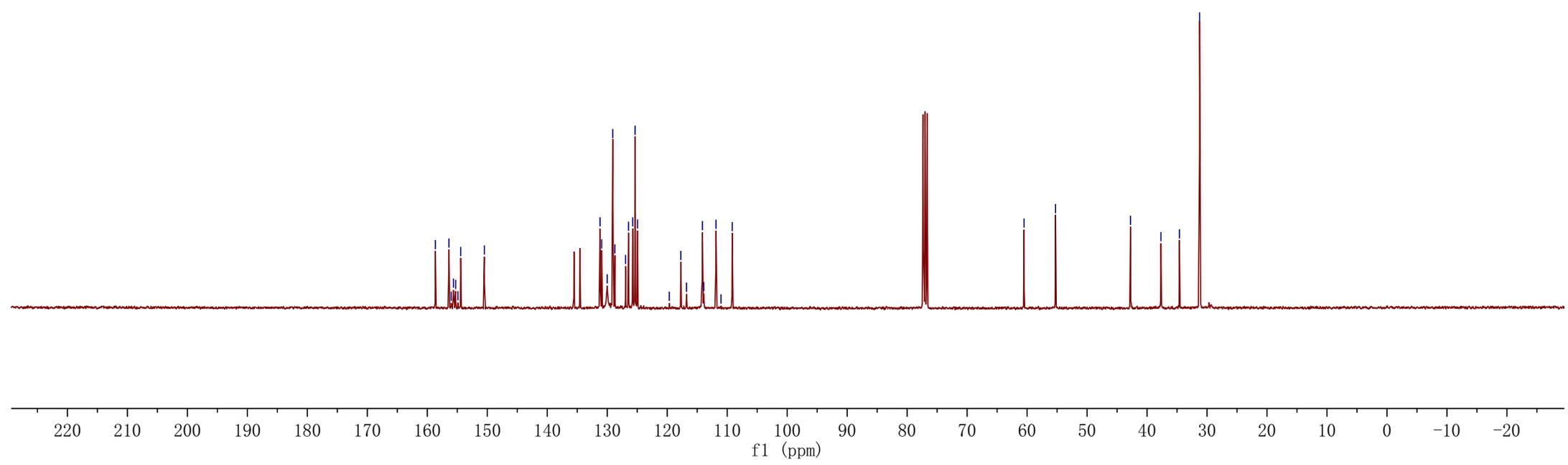
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

158.65  
156.39  
156.00  
155.63  
155.26  
154.89  
154.42  
150.48  
131.20  
130.93  
130.01  
129.08  
128.73  
126.95  
126.45  
125.76  
125.36  
124.95  
119.66  
117.73  
116.78  
114.13  
113.90  
111.86  
111.03  
109.16

60.50  
55.26  
42.76  
37.68  
34.60  
31.24



4e



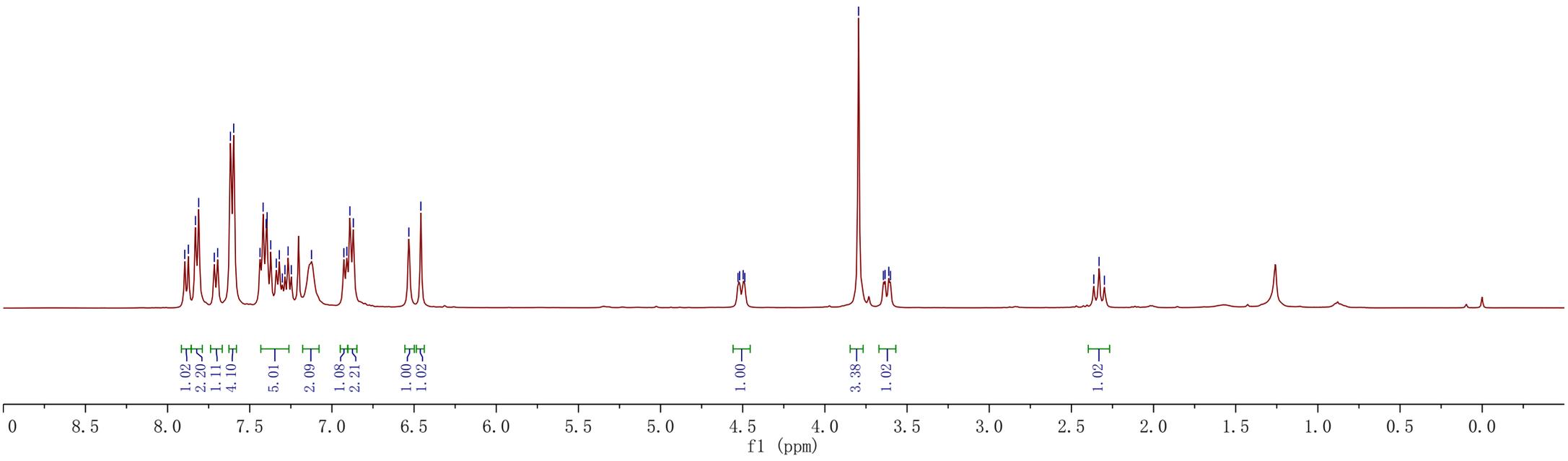
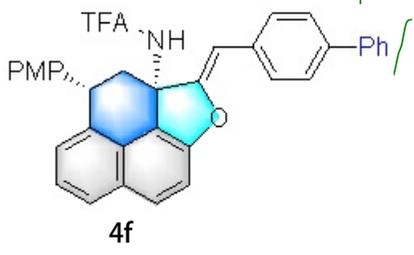
Analysis:  $^1\text{H NMR}$   
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

7.896  
7.873  
7.831  
7.811  
7.716  
7.695  
7.617  
7.598  
7.438  
7.419  
7.400  
7.395  
7.372  
7.338  
7.320  
7.302  
7.286  
7.247  
7.124  
6.927  
6.909  
6.891  
6.870  
6.532  
6.459

4.529  
4.519  
4.497  
4.487

3.795  
3.644  
3.634  
3.611  
3.601

2.364  
2.332  
2.299



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

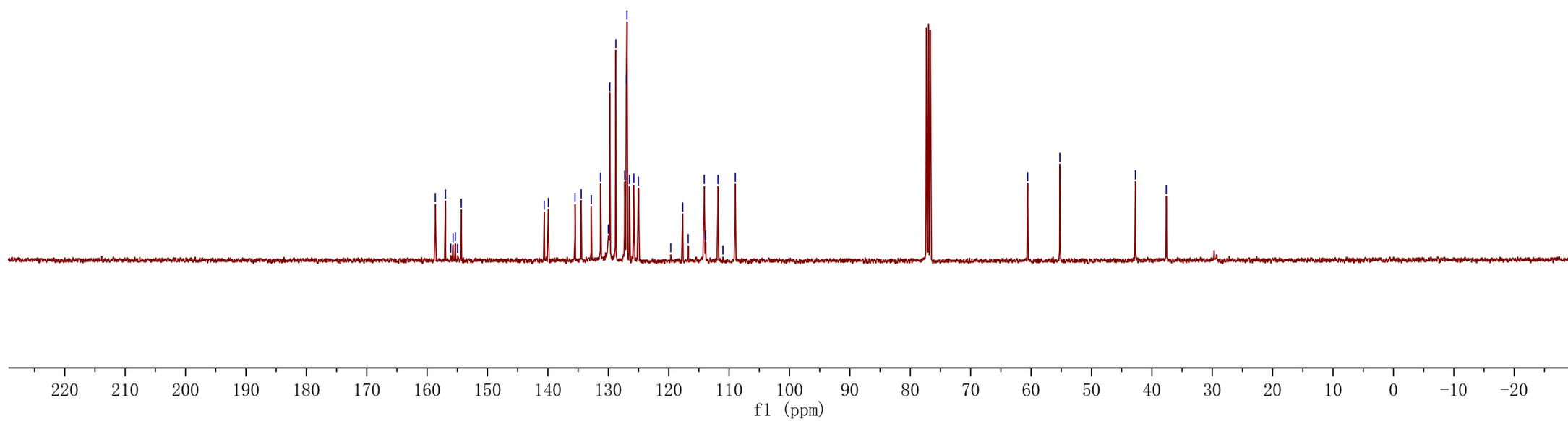
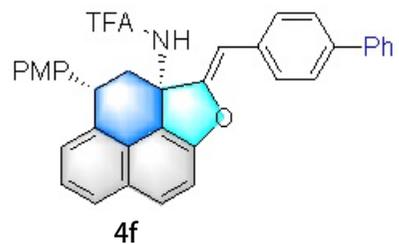
158.64  
156.96  
156.07  
155.70  
155.33  
154.97  
154.34  
140.62  
139.93  
135.51  
134.48  
132.81  
131.27  
130.01  
129.75  
128.74  
127.29  
127.03  
126.91  
126.49  
125.77  
125.01  
119.65  
117.67  
116.77  
114.12  
113.90  
111.83  
111.02  
108.96

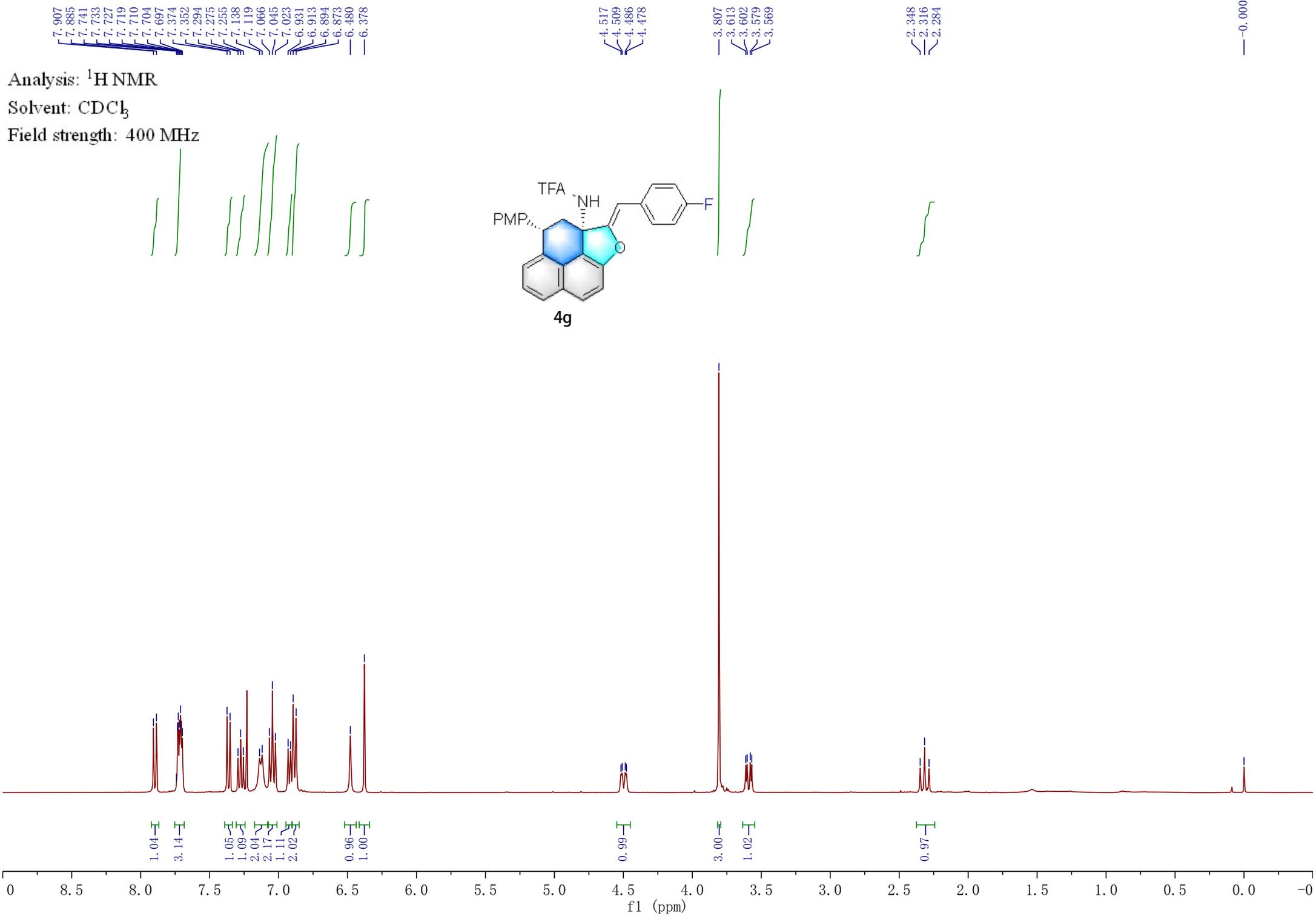
60.55

55.24

42.73

37.62

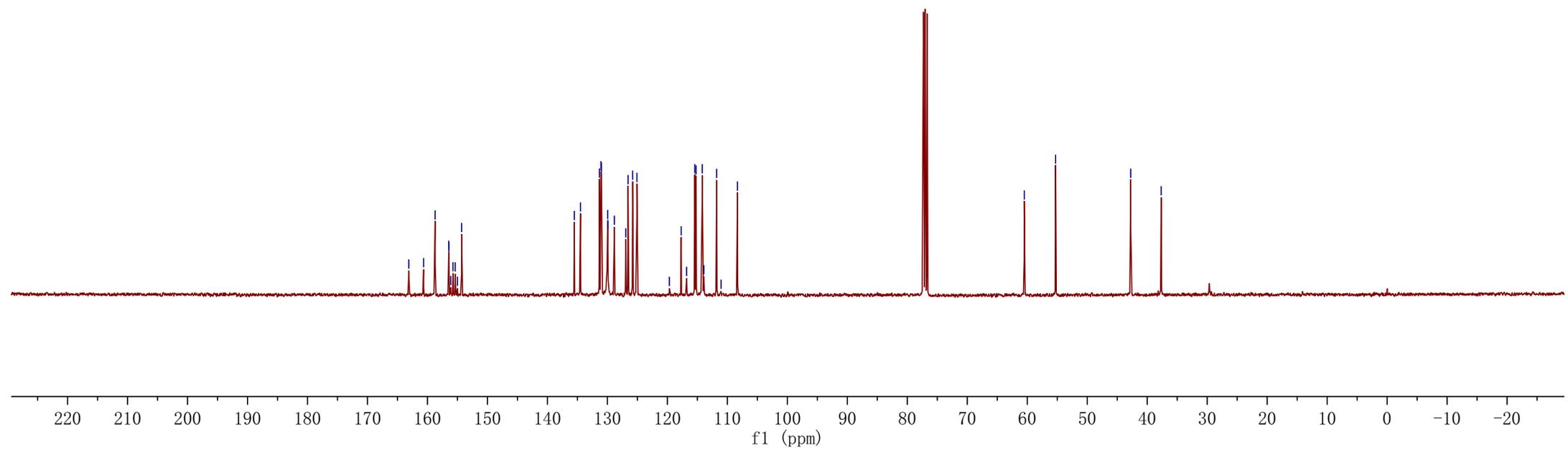
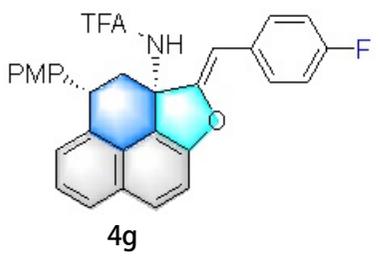




Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

163.11  
160.65  
158.73  
156.45  
156.43  
156.11  
155.75  
155.38  
155.01  
154.30  
135.52  
134.49  
131.32  
131.08  
131.00  
129.96  
129.93  
128.84  
126.93  
126.55  
125.80  
125.08  
119.67  
117.69  
116.79  
115.43  
115.22  
114.18  
113.92  
111.78  
111.04  
108.32

60.49  
55.27  
42.75  
37.68

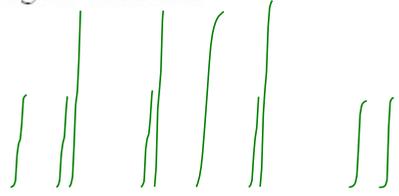


7.917  
7.895  
7.733  
7.713  
7.678  
7.656  
7.382  
7.360  
7.334  
7.313  
7.301  
7.282  
7.262  
7.136  
7.120  
6.933  
6.914  
6.895  
6.873  
6.494  
6.370

Analysis:  $^1\text{H}$  NMR

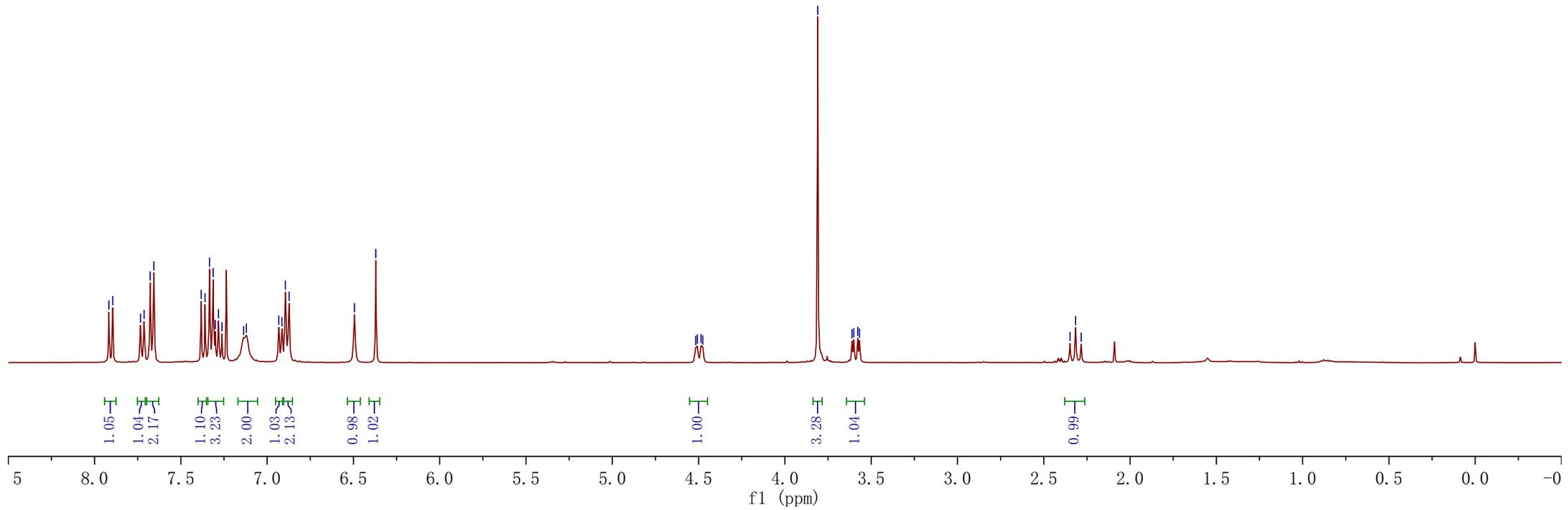
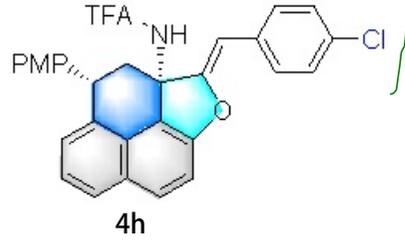
Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



4.517  
4.507  
4.486  
4.476  
3.810  
3.611  
3.601  
3.578  
3.568

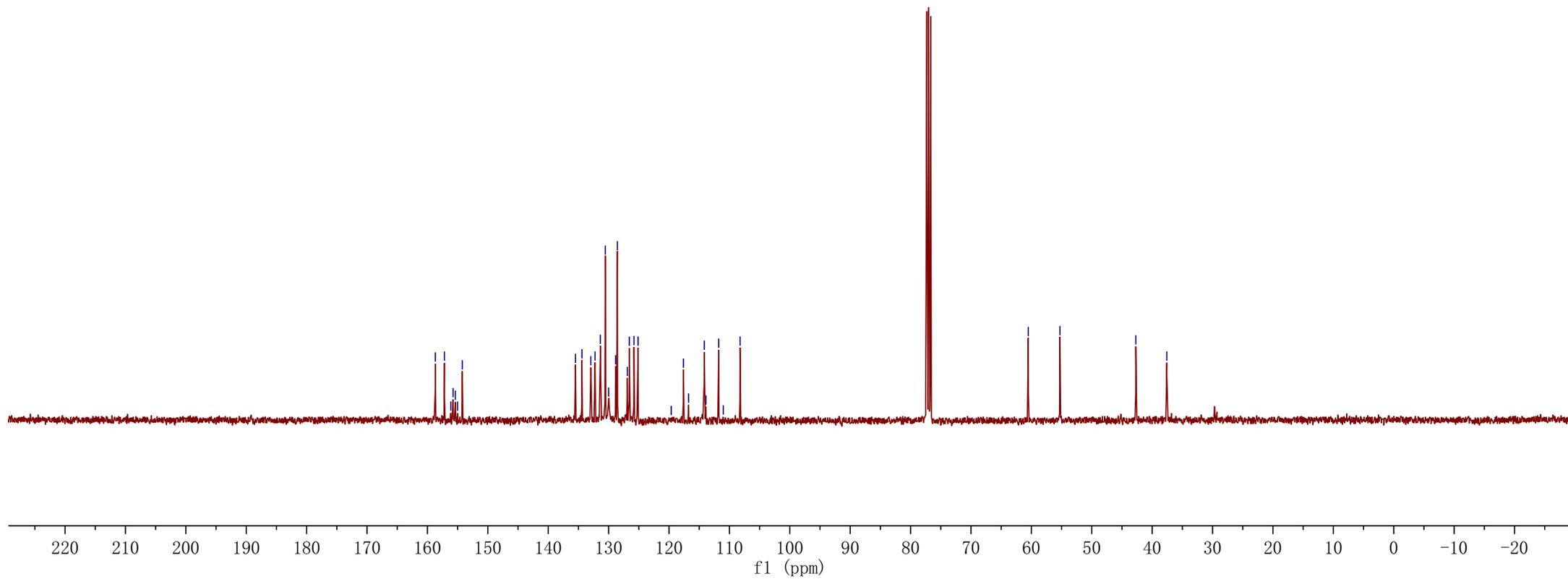
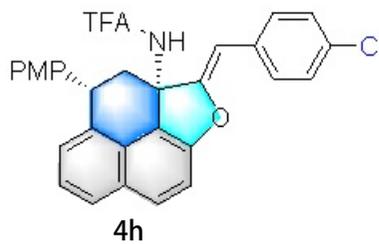
2.348  
2.316  
2.283



Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

158.69  
157.18  
156.12  
155.75  
155.38  
155.01  
154.22  
135.49  
134.41  
132.95  
132.25  
131.37  
130.55  
130.00  
128.84  
128.54  
126.89  
126.57  
125.80  
125.12  
119.63  
117.61  
116.76  
114.15  
113.88  
111.77  
111.01  
108.23

60.51  
55.27  
42.71  
37.58



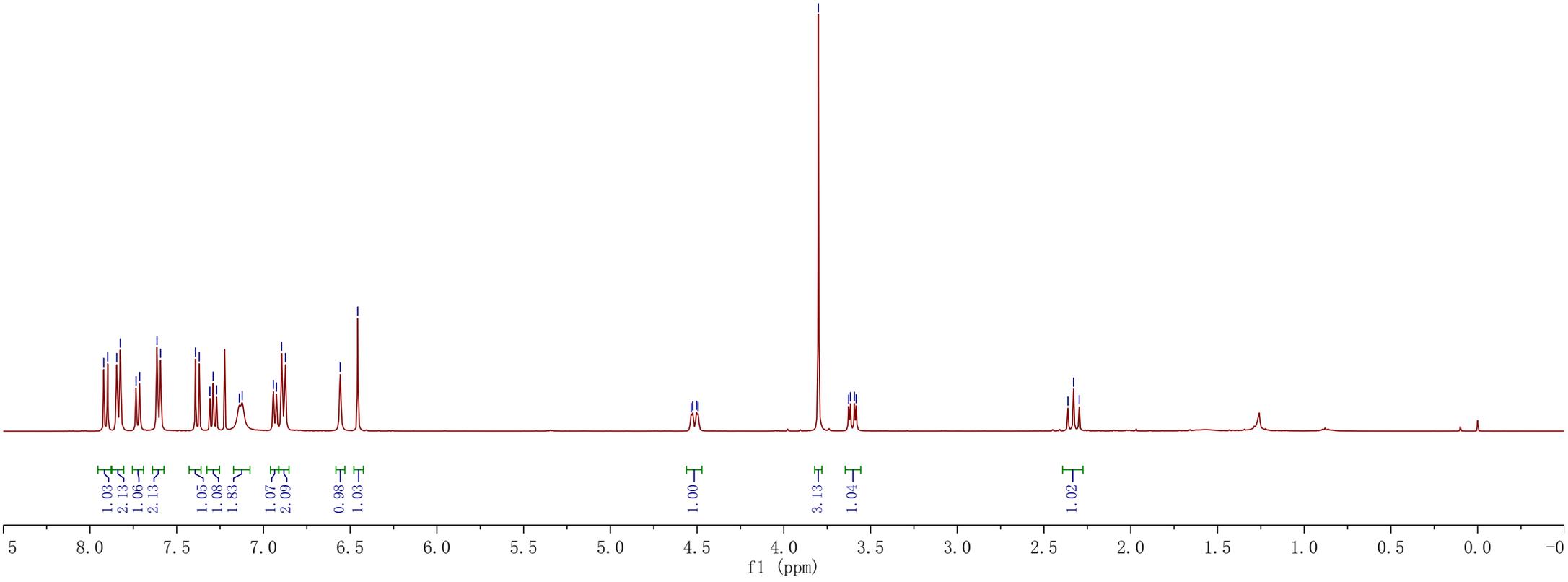
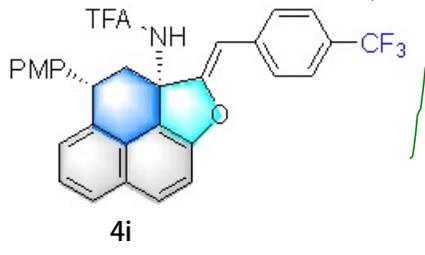
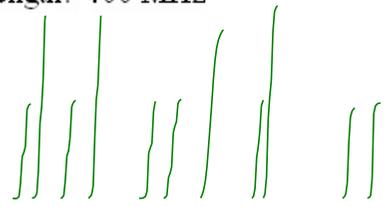
7.920  
7.898  
7.845  
7.825  
7.734  
7.713  
7.614  
7.593  
7.392  
7.370  
7.309  
7.290  
7.270  
7.139  
7.123  
6.943  
6.925  
6.895  
6.873  
6.557  
6.456

4.534  
4.525  
4.503  
4.494

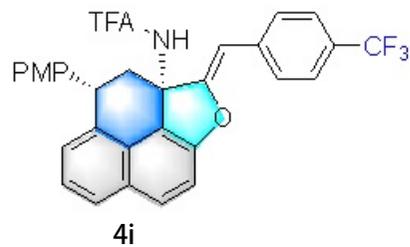
3.801  
3.626  
3.616  
3.593  
3.583

2.362  
2.330  
2.297

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



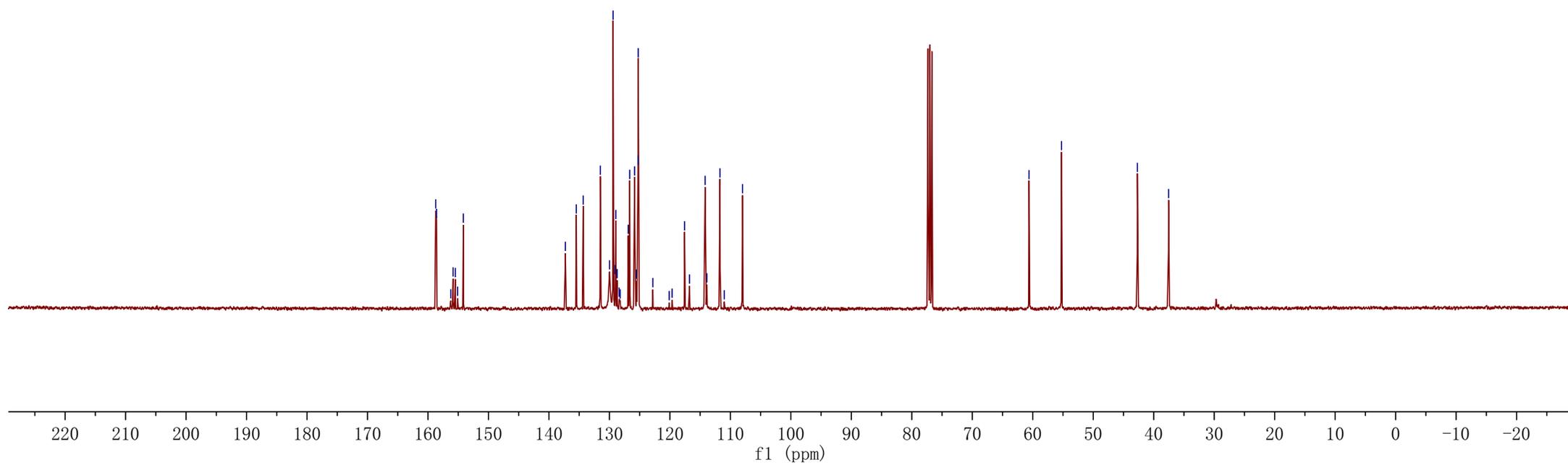
158.72  
158.58  
156.22  
155.85  
155.48  
155.11  
154.15  
137.29  
135.48  
134.34  
131.50  
129.98  
129.39  
129.05  
128.94  
128.73  
128.41  
128.23  
126.89  
126.64  
125.84  
125.52  
125.27  
125.24  
122.82  
120.11  
119.63  
117.57  
116.76  
114.18  
113.88  
111.72  
111.00  
107.99

60.62

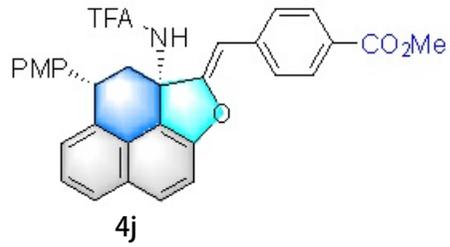
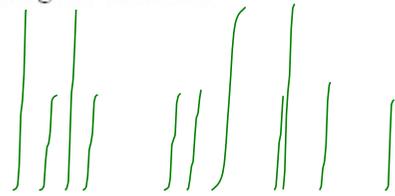
55.24

42.70

37.54



Analysis:  $^1\text{H NMR}$   
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

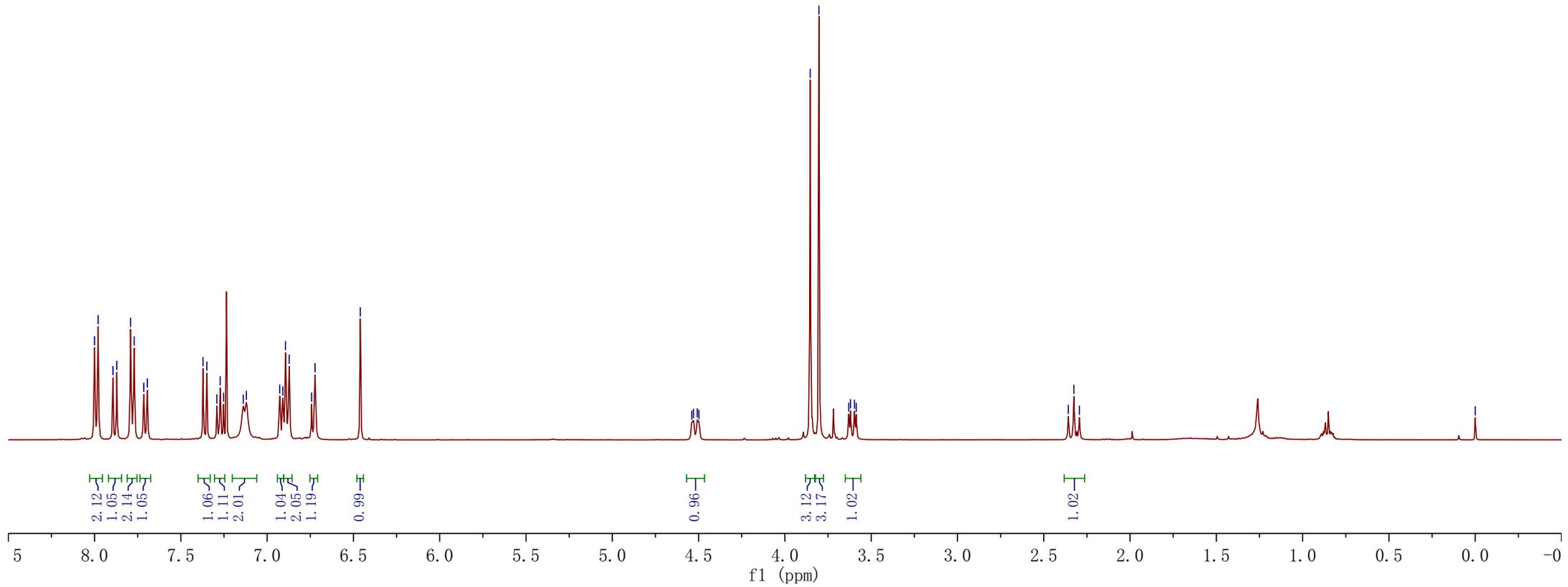


4.539  
4.529  
4.508  
4.498

3.853  
3.803  
3.630  
3.620  
3.597  
3.587

2.358  
2.326  
2.294

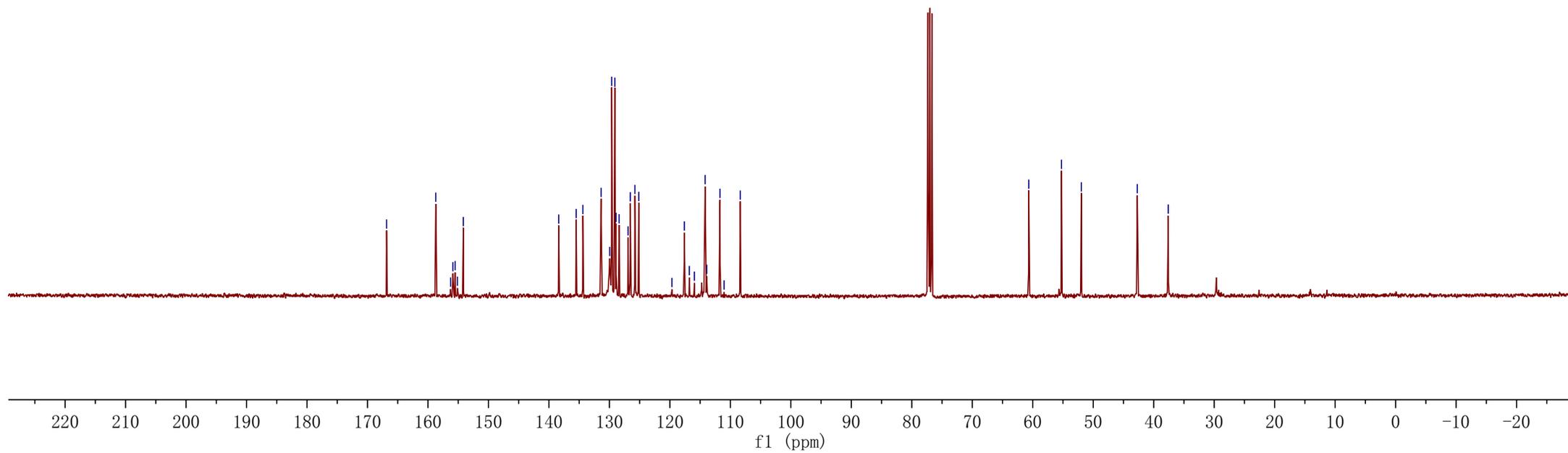
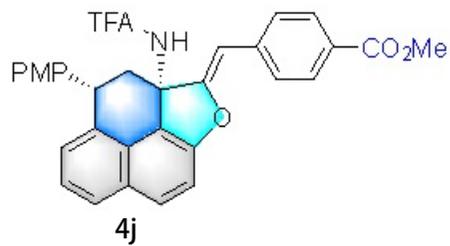
-0.000



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

166.84  
158.71  
156.24  
155.88  
155.51  
155.13  
154.16  
138.38  
135.50  
134.39  
131.37  
129.96  
129.62  
129.10  
128.90  
128.40  
126.91  
126.54  
125.78  
125.15  
119.66  
117.61  
116.79  
115.95  
114.17  
113.91  
111.71  
111.03  
108.36

60.66  
55.25  
51.97  
42.72  
37.60

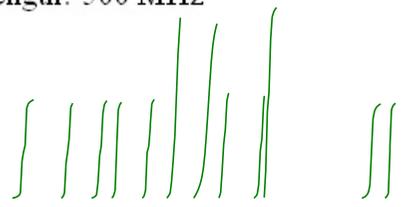


7.917  
7.899  
7.734  
7.718  
7.597  
7.582  
7.522  
7.399  
7.382  
7.293  
7.286  
7.279  
7.276  
7.271  
7.262  
7.255  
7.082  
7.067  
6.928  
6.914  
6.900  
6.883  
6.882  
6.385

Analysis: <sup>1</sup>H NMR

Solvent: CDCl<sub>3</sub>

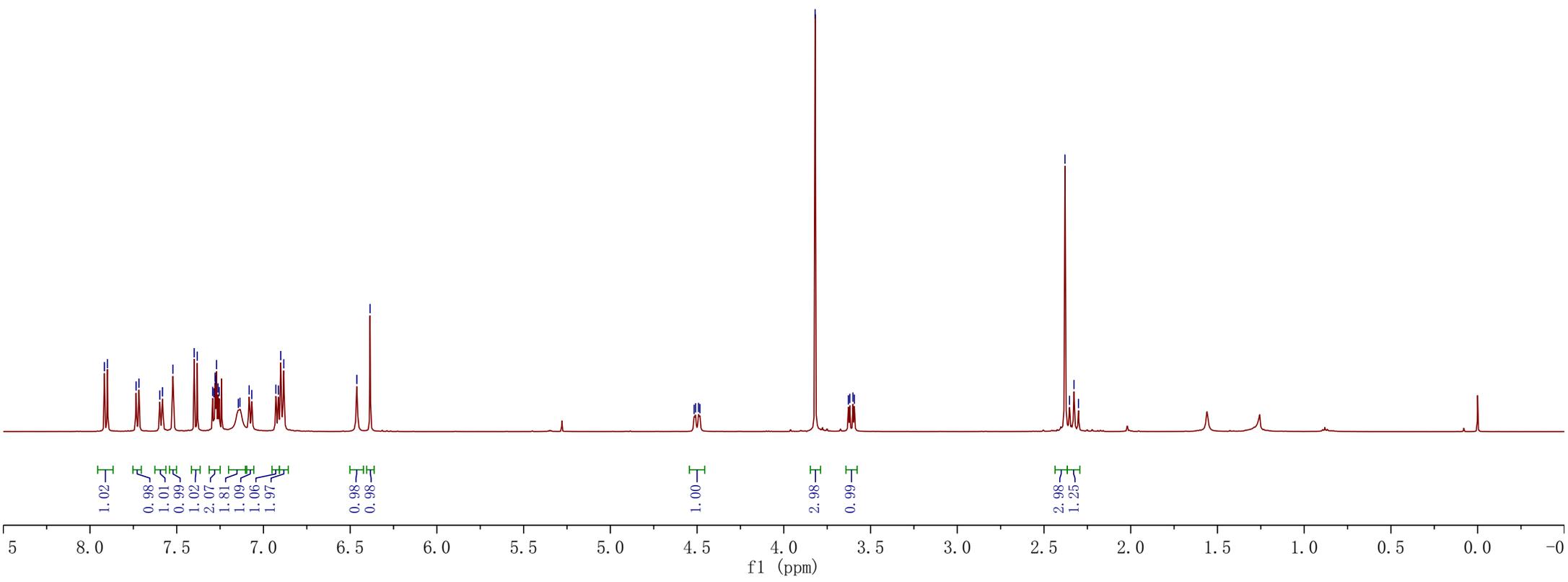
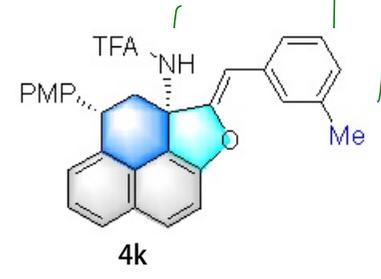
Field strength: 500 MHz



4.517  
4.509  
4.492  
4.484

3.820  
3.628  
3.620  
3.601  
3.593

2.379  
2.353  
2.327  
2.301



158.77  
156.75  
155.96  
155.67  
155.37  
155.08  
154.47  
137.95  
135.59  
134.60  
133.68  
131.24  
130.10  
130.00  
128.84  
128.33  
128.22  
126.99  
126.46  
125.79  
125.01  
118.86  
117.80  
116.56  
114.35  
114.23  
112.13  
111.93  
109.50

— 60.60

— 55.31

— 42.82

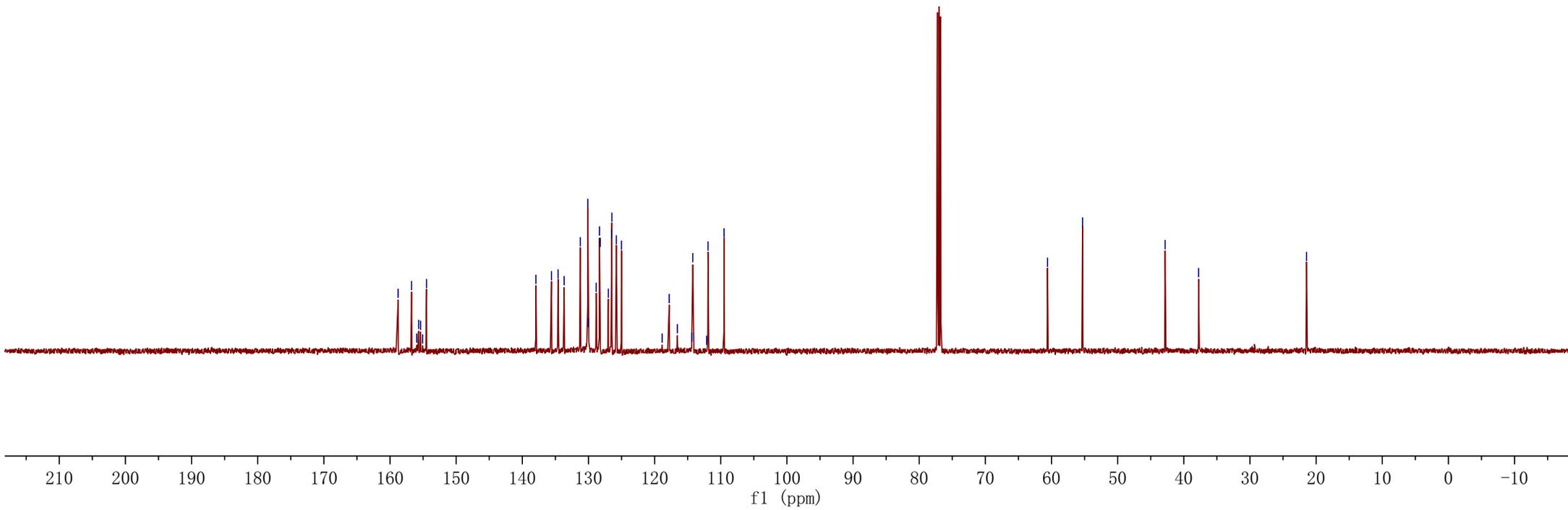
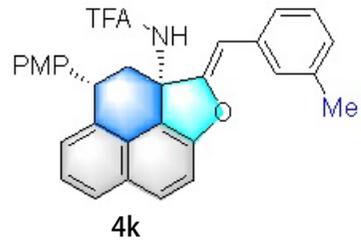
— 37.77

— 21.45

Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 125 MHz

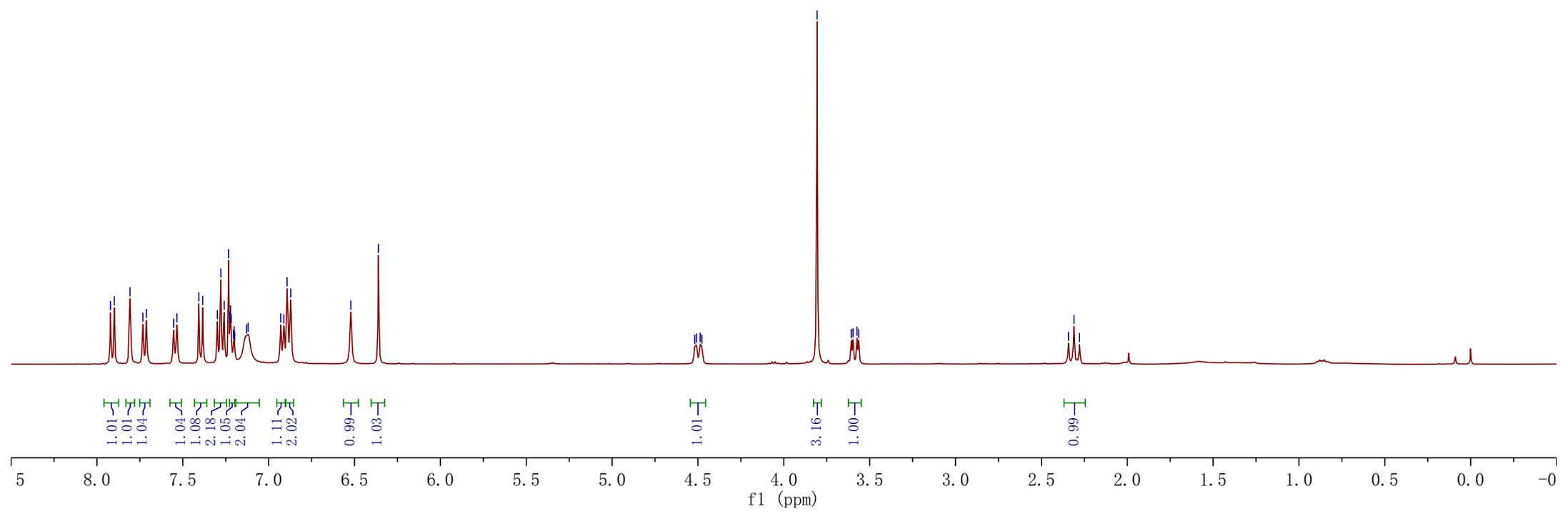
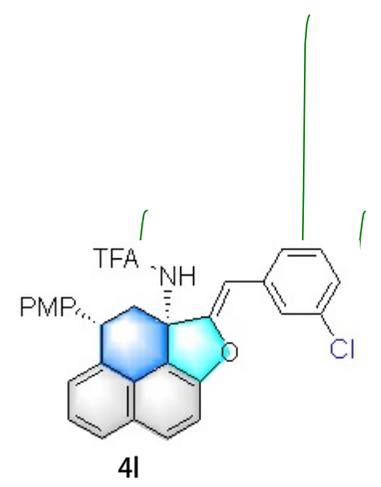
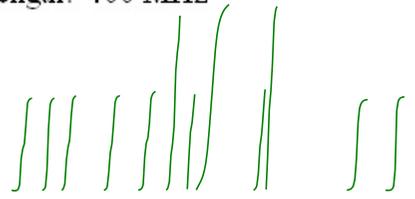


7.921  
7.899  
7.808  
7.733  
7.712  
7.553  
7.534  
7.406  
7.384  
7.299  
7.278  
7.259  
7.233  
7.226  
7.222  
6.958  
6.912  
6.893  
6.871  
— 6.522  
— 6.361

4.518  
4.509  
4.487  
4.477  
— 3.806  
— 3.607  
— 3.597  
— 3.574  
— 3.564

2.342  
— 2.310  
— 2.278

Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

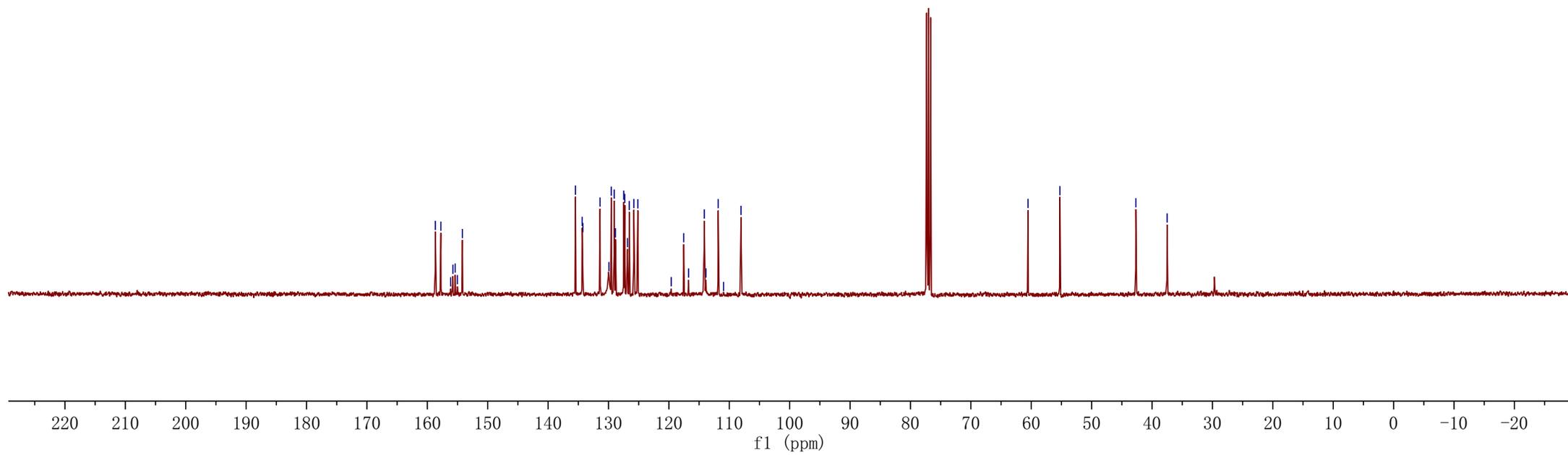
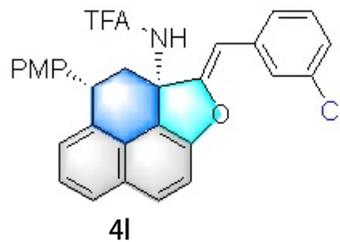
158.67  
157.75  
156.12  
155.75  
155.38  
155.02  
154.19  
135.47  
134.36  
134.24  
131.40  
129.93  
129.54  
129.05  
128.85  
127.48  
127.31  
126.85  
126.56  
125.80  
125.14  
119.61  
117.54  
116.73  
114.14  
113.86  
111.83  
110.95  
108.05

— 60.53

— 55.26

— 42.68

— 37.50

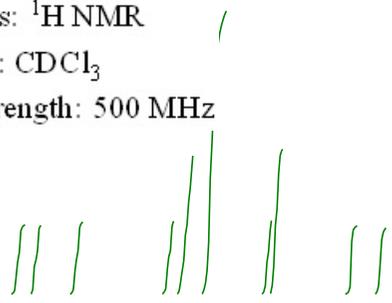


7.986  
7.970  
7.912  
7.895  
7.742  
7.725  
7.357  
7.340  
7.301  
7.286  
7.270  
7.255  
7.183  
7.169  
7.160  
7.155  
6.946  
6.931  
6.912  
6.895  
— 6.592  
— 6.471

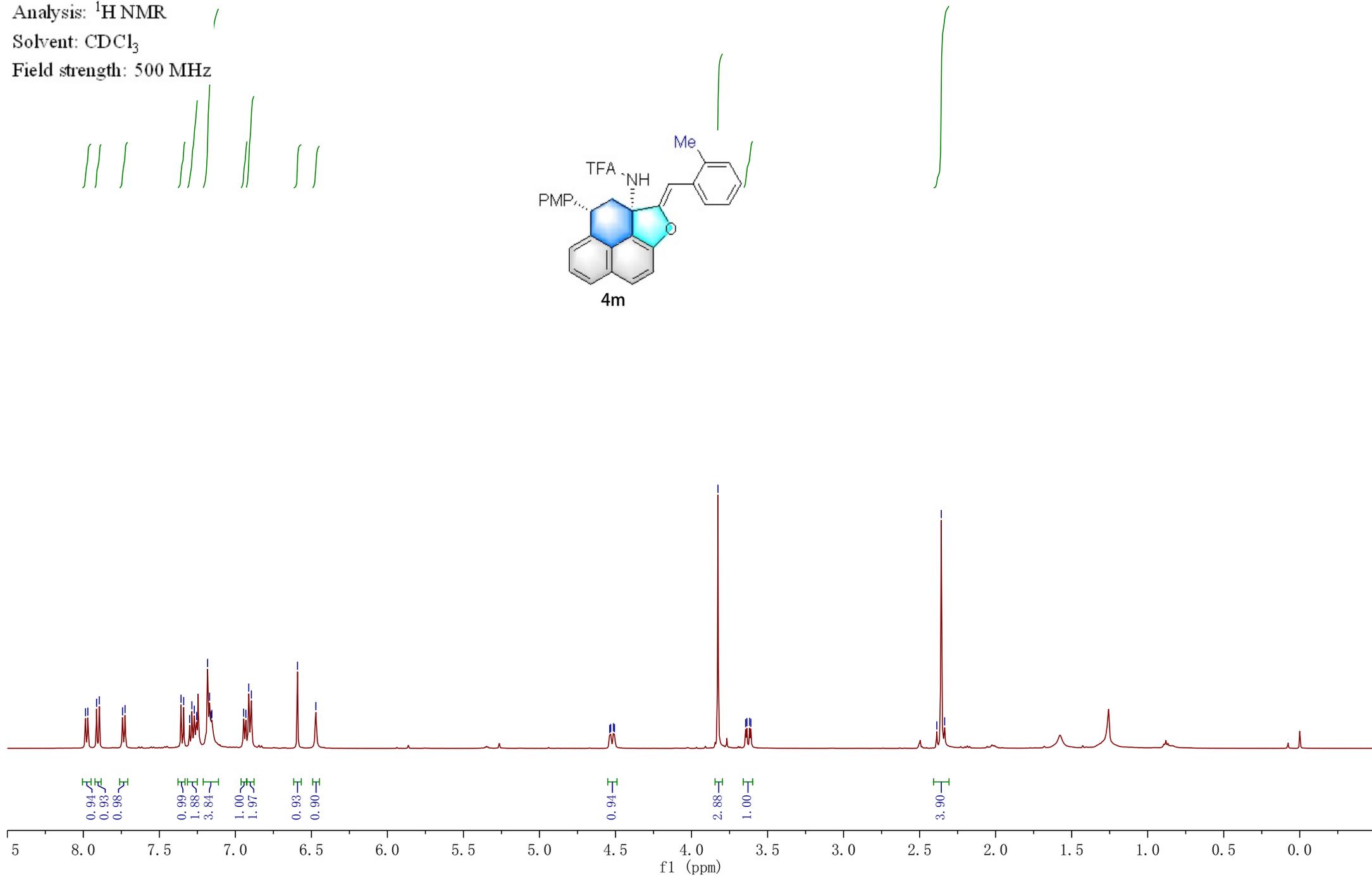
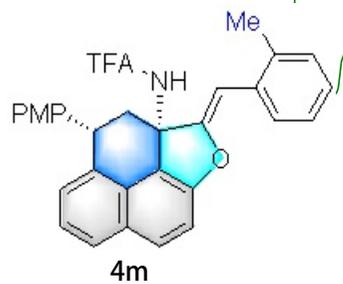
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 500 MHz



4.538  
4.532  
4.513  
4.507  
— 3.826  
— 3.644  
— 3.636  
— 3.618  
— 3.610  
2.387  
2.358  
2.335



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.80  
156.92  
155.91  
155.61  
155.32  
155.03  
154.49  
136.42  
135.54  
134.63  
132.32  
131.26  
130.13  
129.44  
128.82  
127.46  
127.03  
126.53  
125.81  
125.01  
118.86  
117.87  
116.56  
114.26  
111.96  
106.75

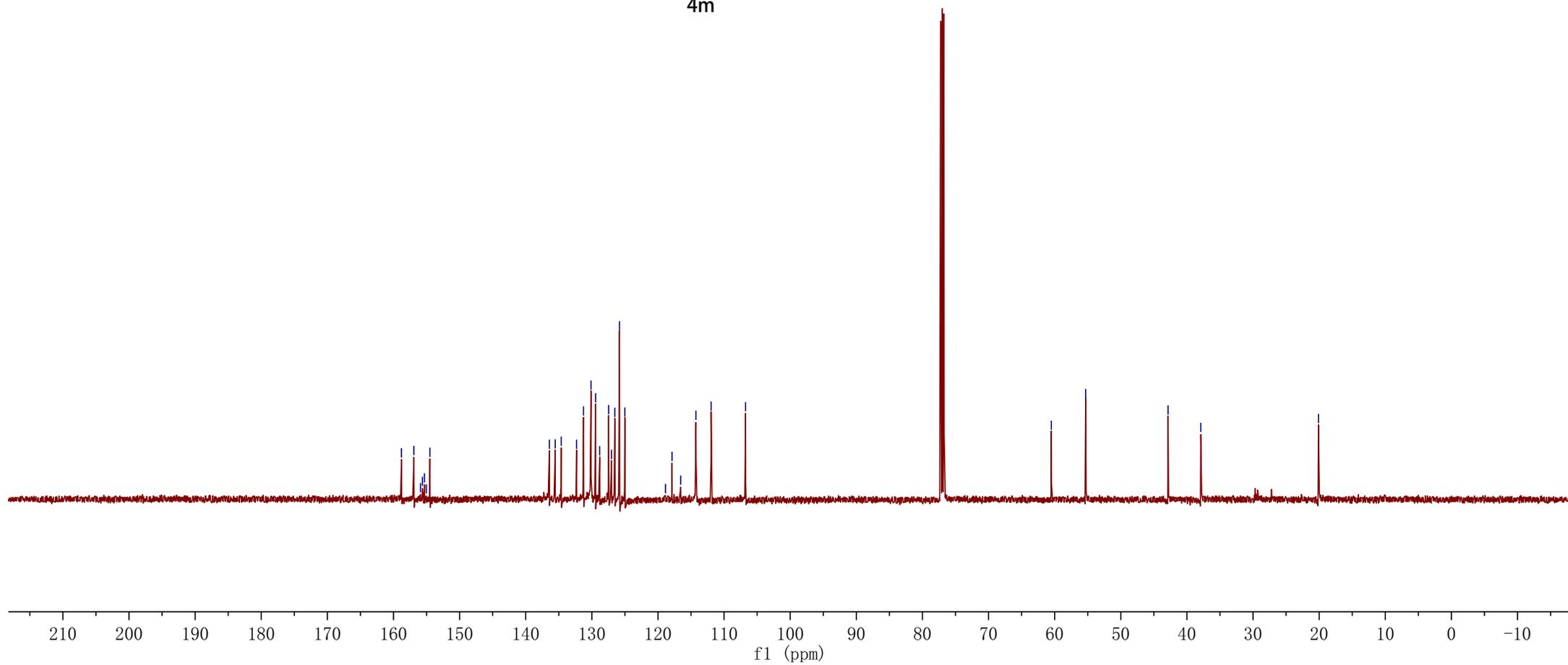
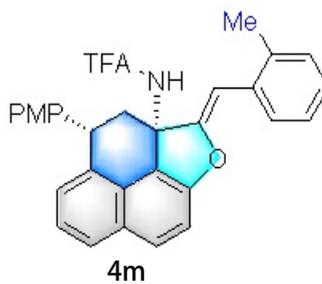
60.50

55.32

42.85

37.91

20.11



7.909  
7.887  
7.725  
7.704  
7.406  
7.384  
7.366  
7.286  
7.267  
7.248  
7.145  
7.125  
6.924  
6.920  
6.904  
6.896  
6.878  
6.874  
6.441  
6.352

4.518  
4.508  
4.487  
4.477

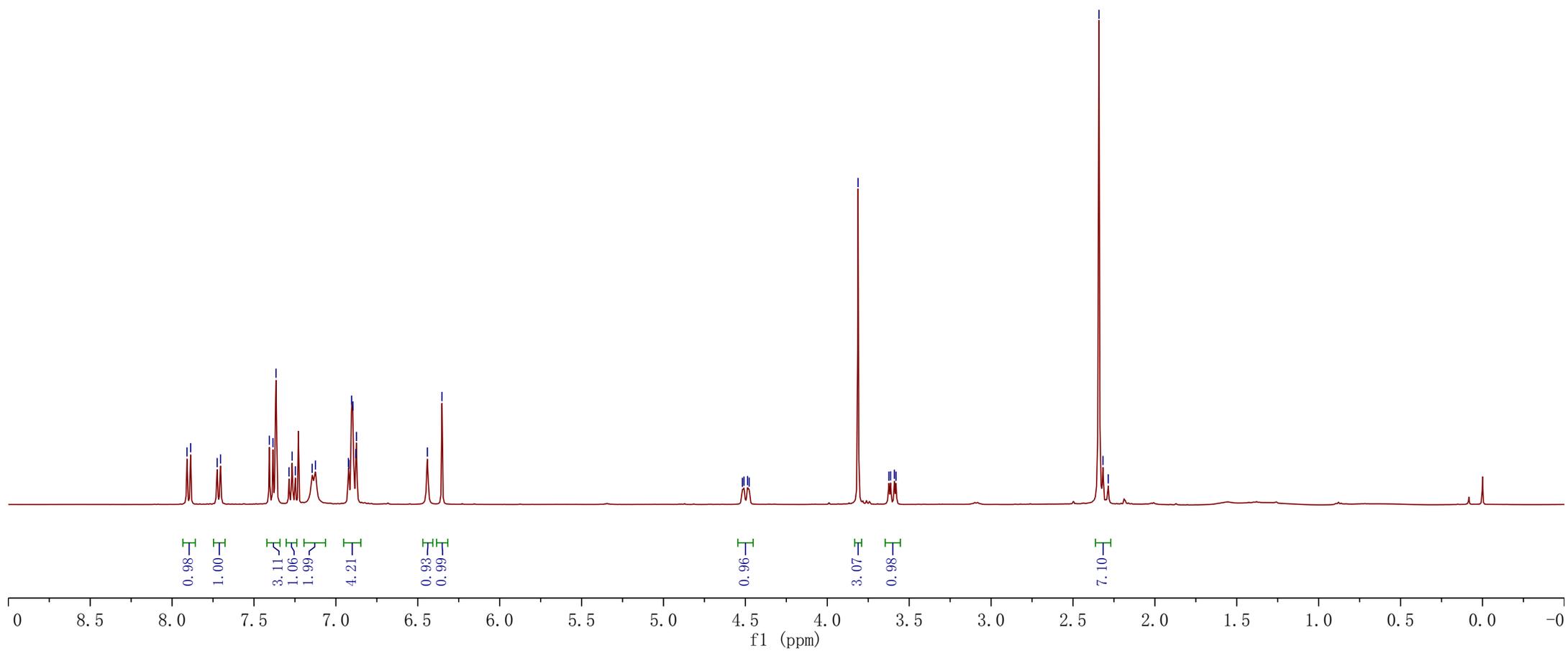
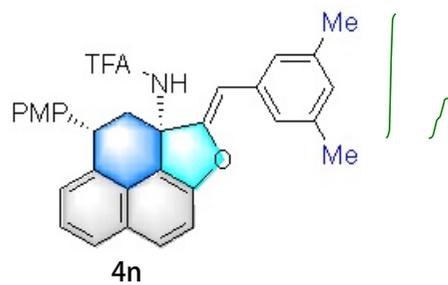
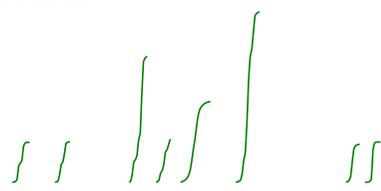
3.812  
3.624  
3.614  
3.591  
3.580

2.341  
2.317  
2.285

Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

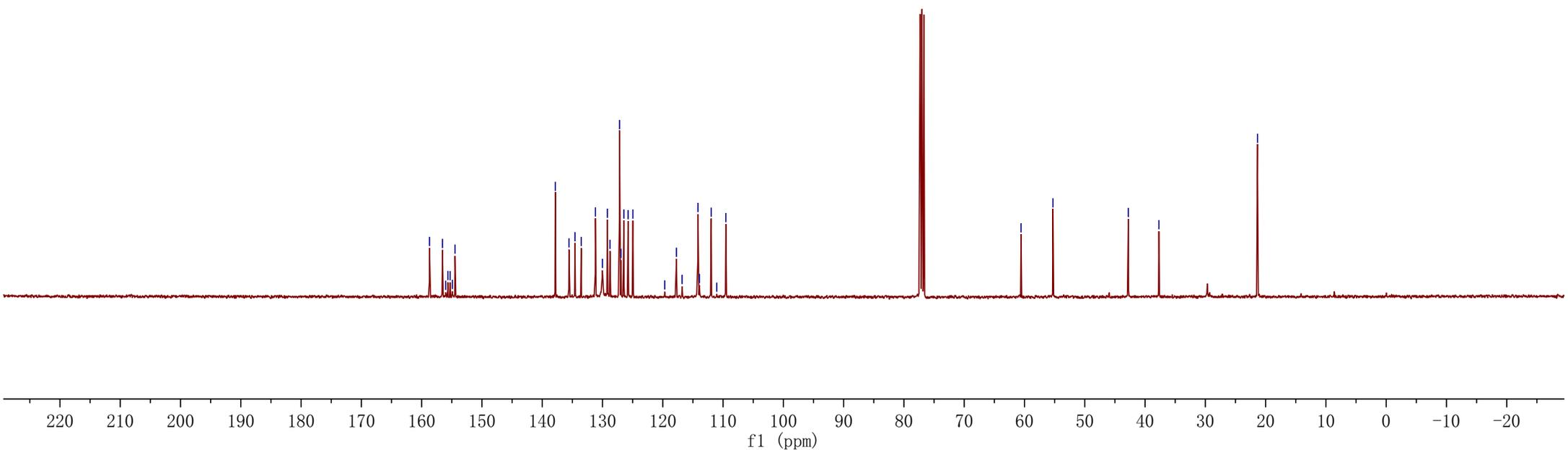
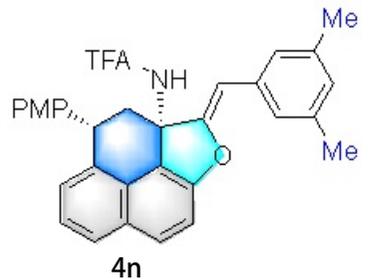
Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

158.70  
156.54  
156.01  
155.64  
155.28  
154.91  
154.46  
137.83  
135.57  
134.57  
133.53  
131.18  
130.01  
129.19  
128.76  
127.17  
126.94  
126.46  
125.75  
124.96  
119.68  
117.74  
116.80  
114.16  
113.93  
111.97  
111.05  
109.54

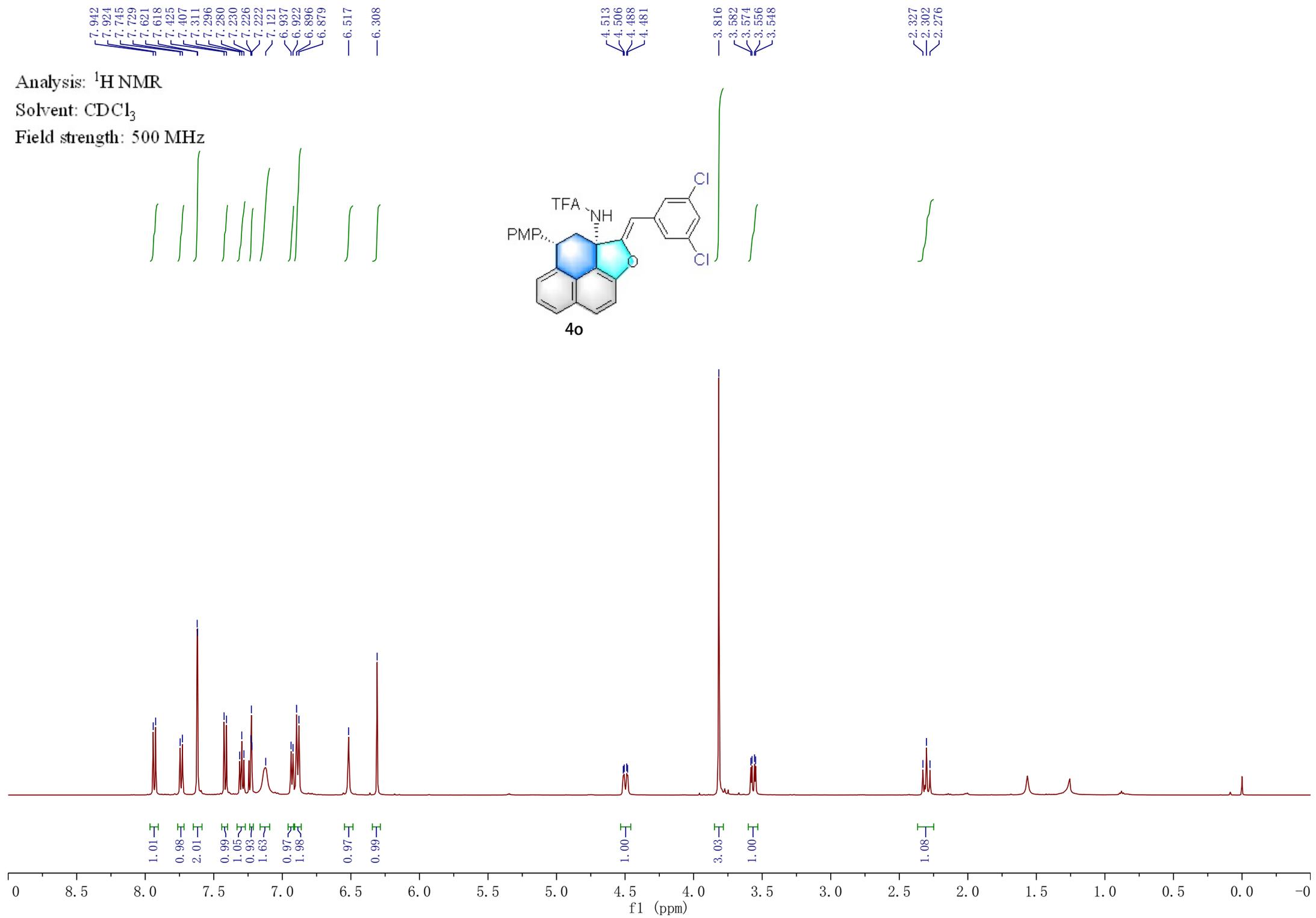
60.57  
55.28  
42.78  
37.70  
21.34



Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

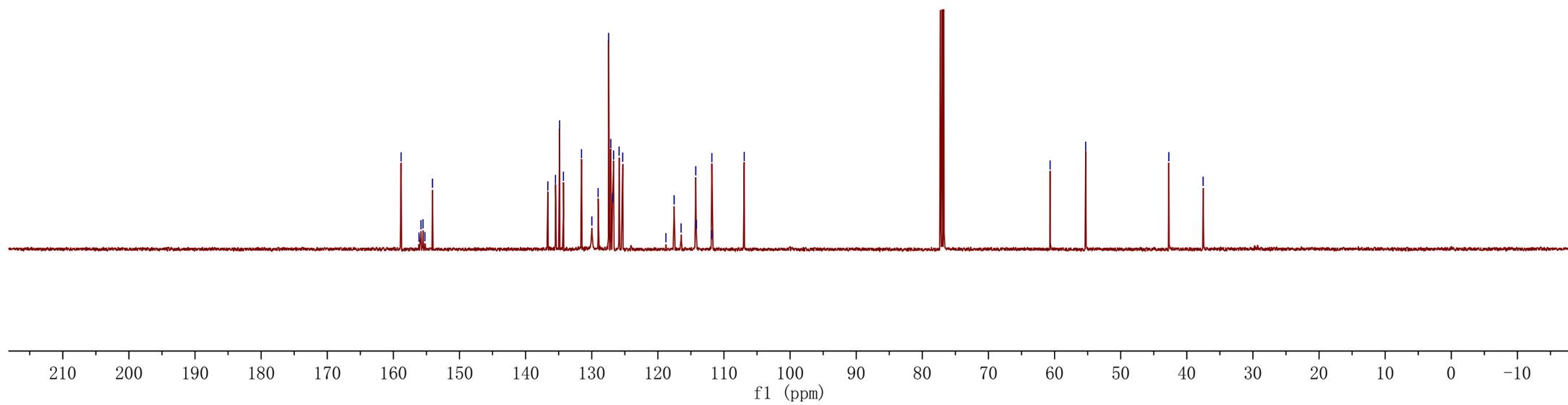
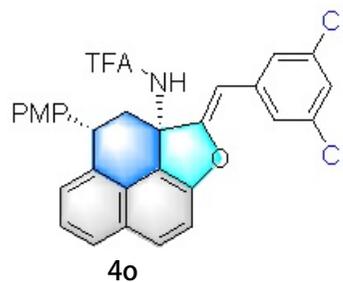
Field strength: 500 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

158.83  
156.12  
155.82  
155.52  
155.23  
154.08  
136.64  
135.49  
134.86  
134.29  
131.55  
129.98  
129.04  
127.44  
127.12  
126.87  
126.69  
125.87  
125.32  
118.79  
117.54  
116.49  
114.27  
114.19  
111.89  
111.83  
106.93

— 60.68  
— 55.30  
— 42.72  
— 37.54



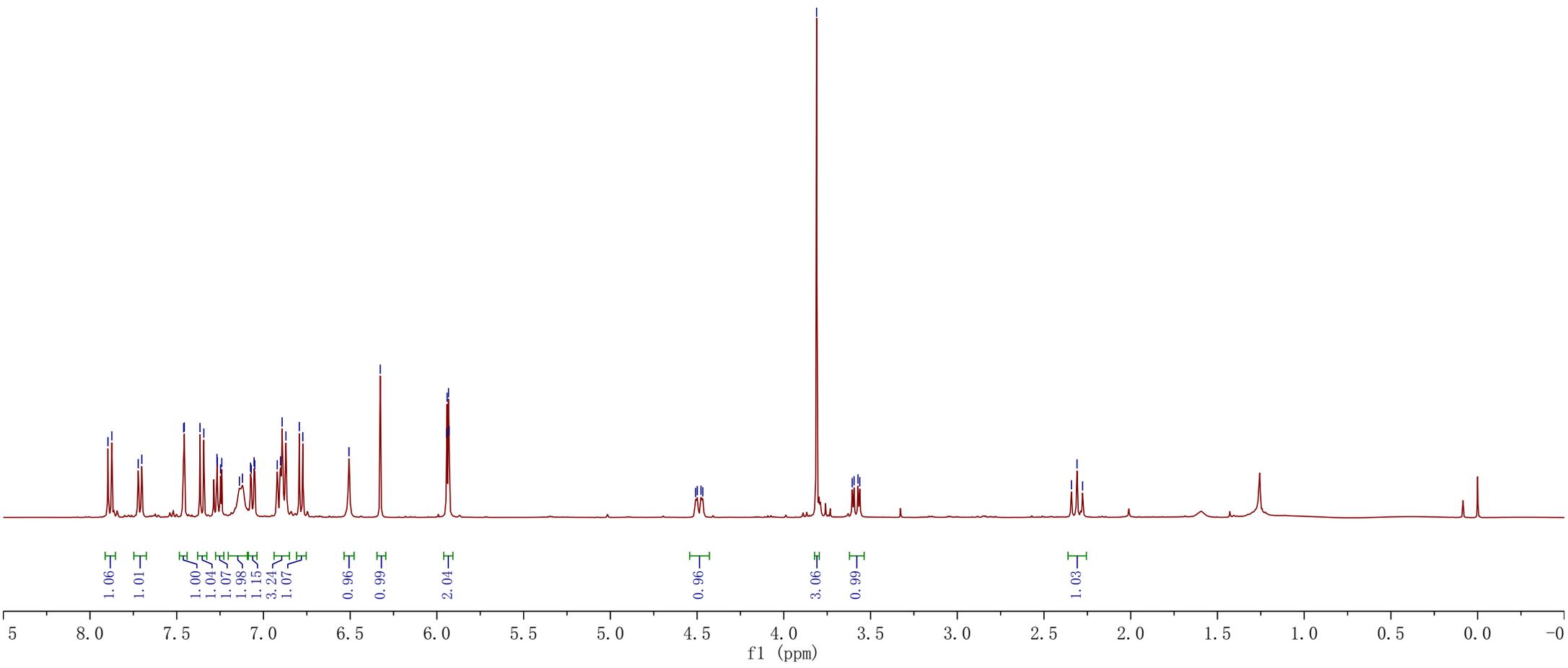
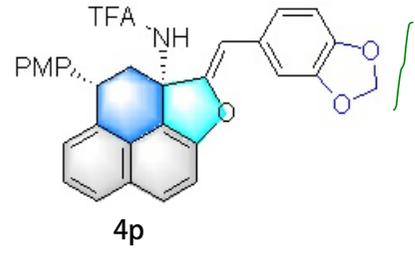
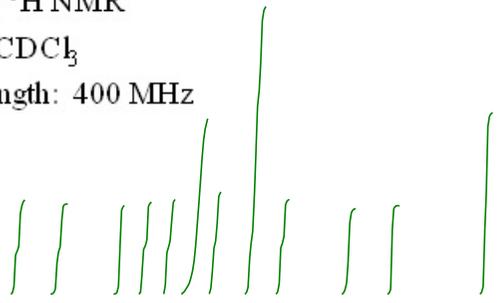
7.896  
7.874  
7.722  
7.701  
7.460  
7.456  
7.366  
7.344  
7.268  
7.265  
7.247  
7.240  
7.139  
7.121  
7.074  
7.070  
7.054  
7.050  
6.920  
6.892  
6.870  
6.793  
6.773  
6.507  
6.326  
5.945  
5.941  
5.933  
5.929

4.509  
4.499  
4.477  
4.467

3.811  
3.606  
3.595  
3.572  
3.562

2.342  
2.310  
2.278

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

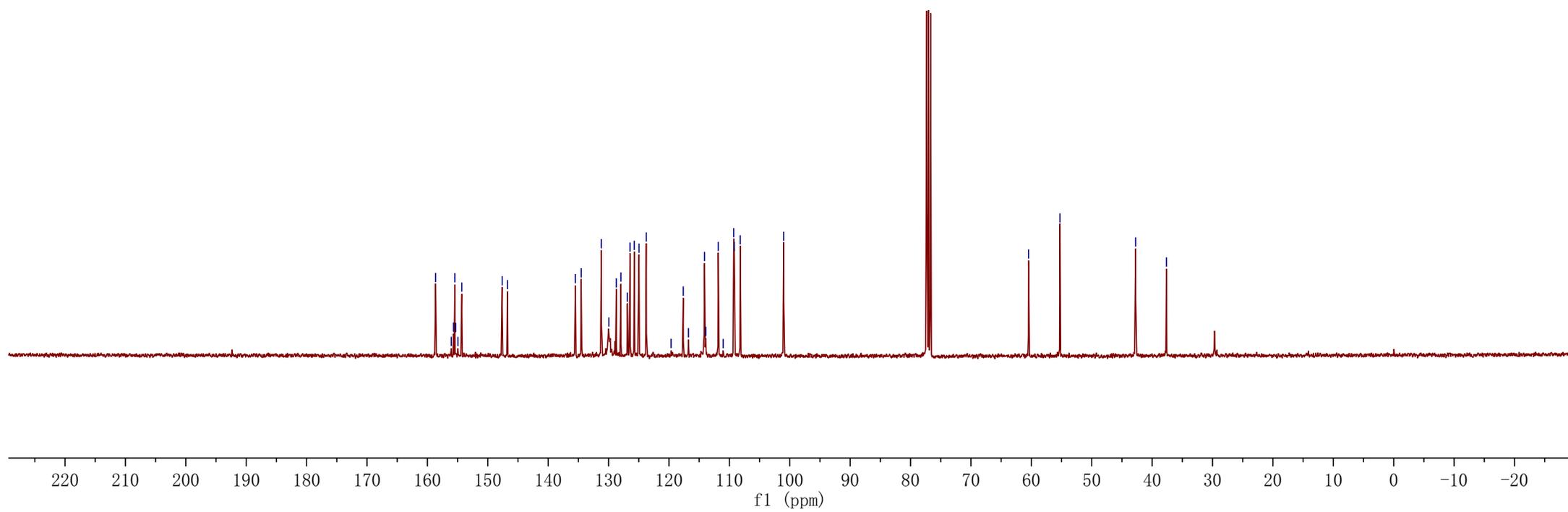
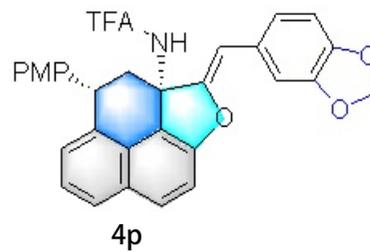
158.64  
156.04  
155.67  
155.46  
155.30  
154.94  
154.30  
147.62  
146.74  
135.50  
134.53  
131.20  
129.96  
128.72  
127.96  
126.89  
126.45  
125.75  
124.96  
123.76  
119.65  
117.64  
116.77  
114.11  
113.90  
111.84  
111.02  
109.28  
109.18  
108.20  
101.01

— 60.46

— 55.26

— 42.73

— 37.63



8.130  
7.956  
7.952  
7.935  
7.931  
7.903  
7.881  
7.847  
7.822  
7.800  
7.787  
7.770  
7.764  
7.715  
7.694  
7.456  
7.443  
7.437  
7.428  
7.421  
7.413  
7.399  
7.283  
7.264  
7.244  
7.137  
7.119  
6.928  
6.910  
6.890  
6.869  
6.575  
6.526

4.540  
4.531  
4.509  
4.500

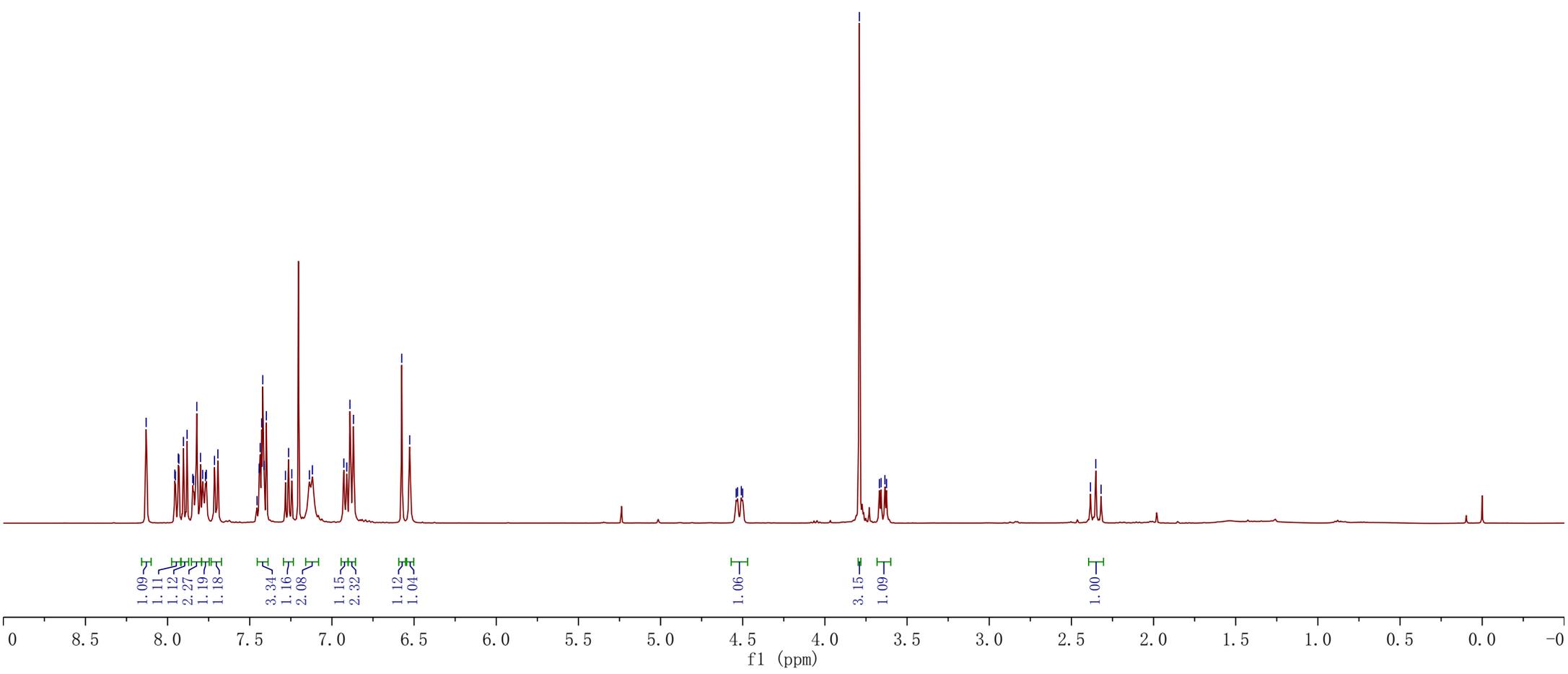
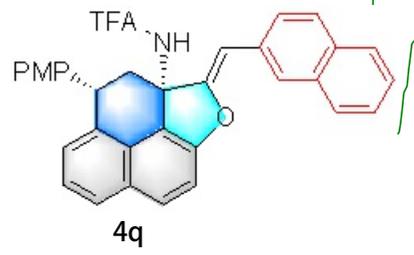
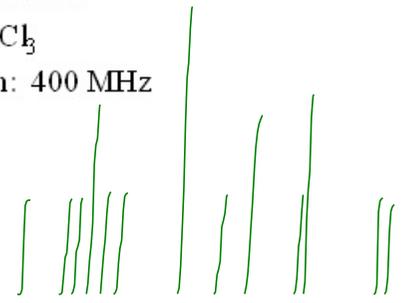
3.790  
3.668  
3.658  
3.635  
3.625

2.384  
2.352  
2.319

Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

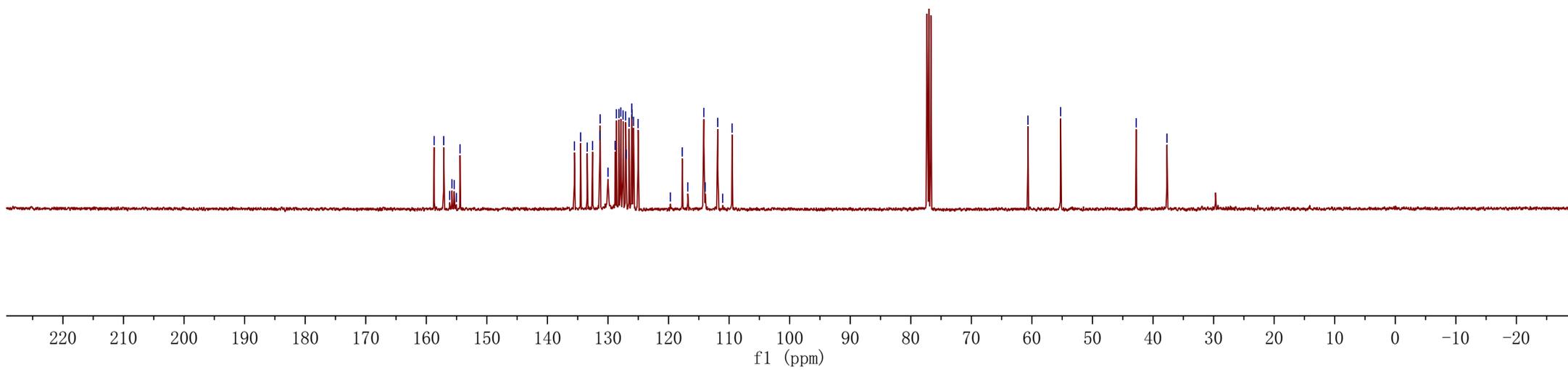
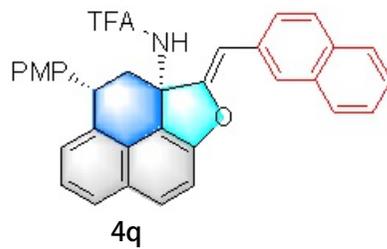
158.70  
157.12  
156.13  
155.76  
155.39  
155.02  
154.42  
135.55  
134.52  
133.43  
132.55  
131.35  
131.29  
130.00  
128.82  
128.62  
128.18  
127.89  
127.51  
127.09  
126.97  
126.51  
126.07  
126.02  
125.78  
125.04  
119.69  
117.74  
116.82  
114.17  
113.94  
111.88  
111.06  
109.51

— 60.65

— 55.25

— 42.78

— 37.70

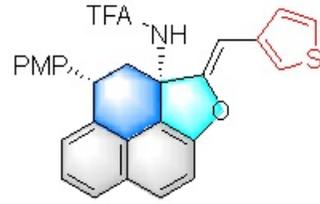
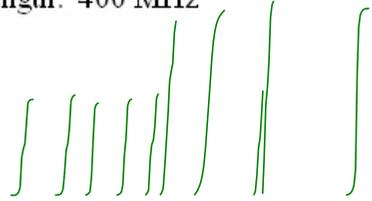


7.898  
7.876  
7.717  
7.696  
7.603  
7.598  
7.471  
7.459  
7.363  
7.341  
7.304  
7.296  
7.292  
7.283  
7.263  
7.244  
6.916  
6.897  
6.887  
6.865  
6.503

Analysis:  $^1\text{H}$  NMR

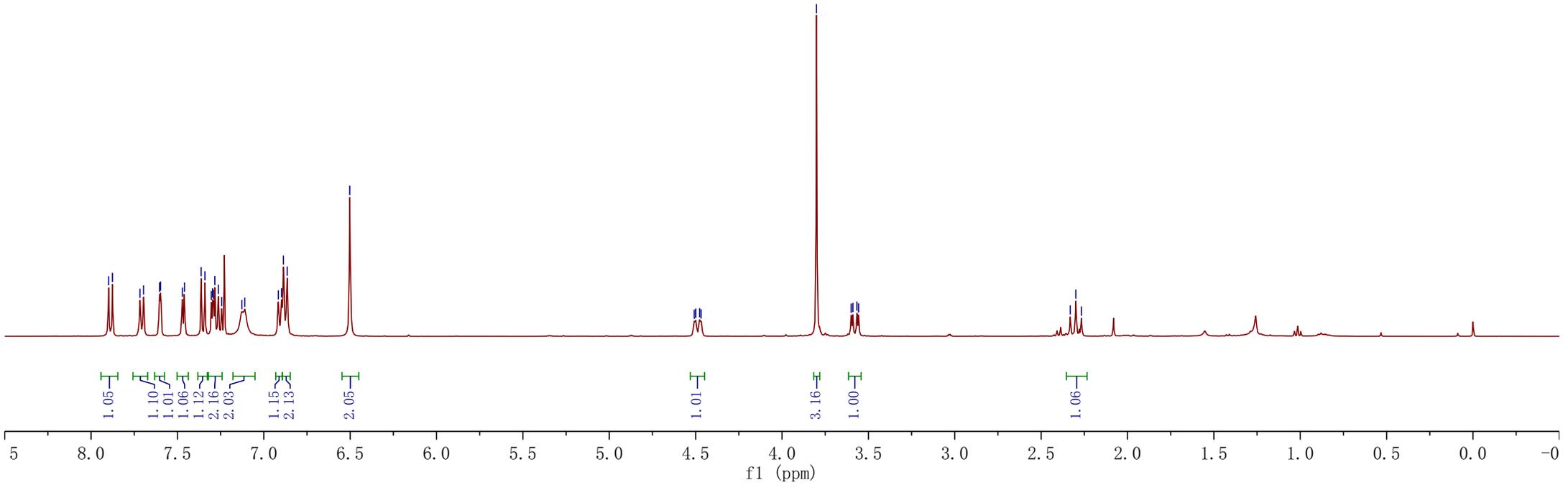
Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



4.508  
4.499  
4.477  
4.468  
3.800  
3.600  
3.590  
3.567  
3.557  
2.331  
2.299  
2.267

4r



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

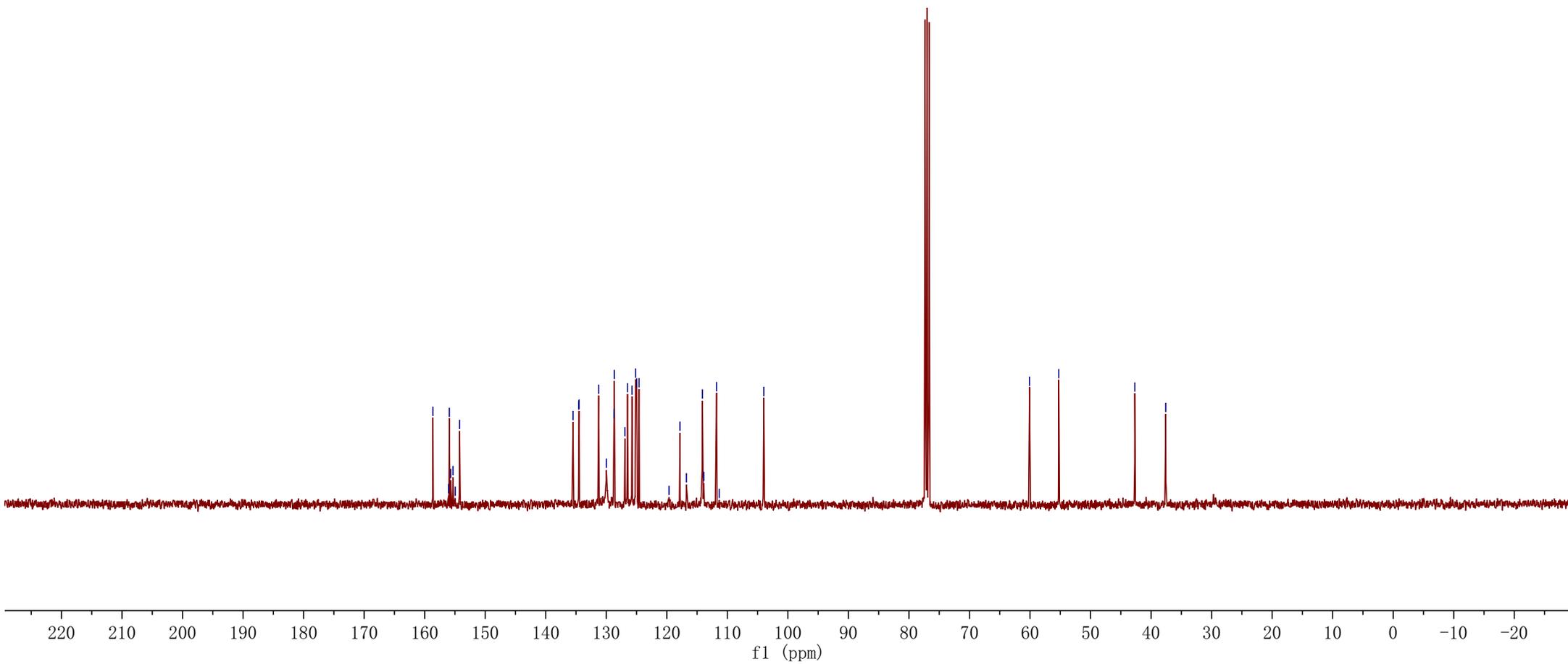
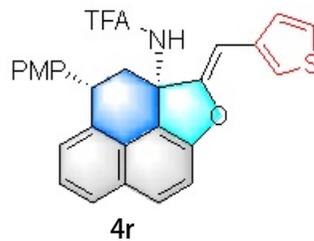
158.64  
156.05  
155.93  
155.69  
155.32  
154.95  
154.23  
135.49  
134.54  
134.49  
131.26  
129.98  
128.73  
128.67  
126.92  
126.49  
125.75  
125.16  
124.98  
124.58  
119.63  
117.83  
116.76  
114.12  
113.88  
111.79  
111.34  
103.97

60.09

55.25

42.69

37.58



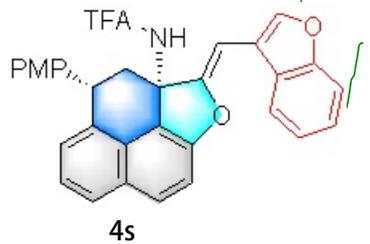
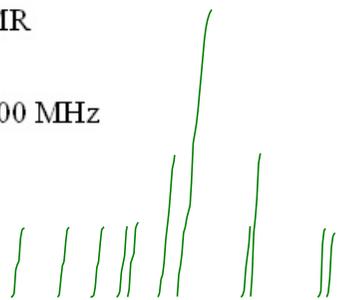
7.939  
7.917  
7.739  
7.718  
7.585  
7.567  
7.475  
7.455  
7.436  
7.414  
7.302  
7.283  
7.272  
7.263  
7.254  
7.222  
7.205  
7.187  
7.163  
7.132  
7.114  
6.928  
6.910  
6.896  
6.874  
6.591  
6.554

4.530  
4.522  
4.499  
4.491

3.810  
3.605  
3.595  
3.572  
3.562

2.355  
2.323  
2.291

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



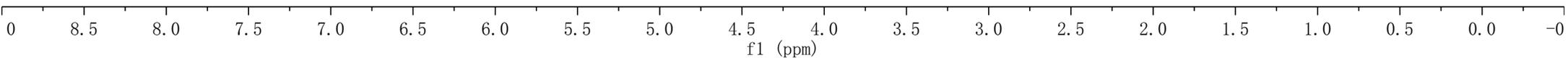
0.98  
0.99  
1.00  
1.01  
1.06  
2.02  
4.09  
1.01  
2.05  
0.98  
0.91

0.94

3.00

0.96

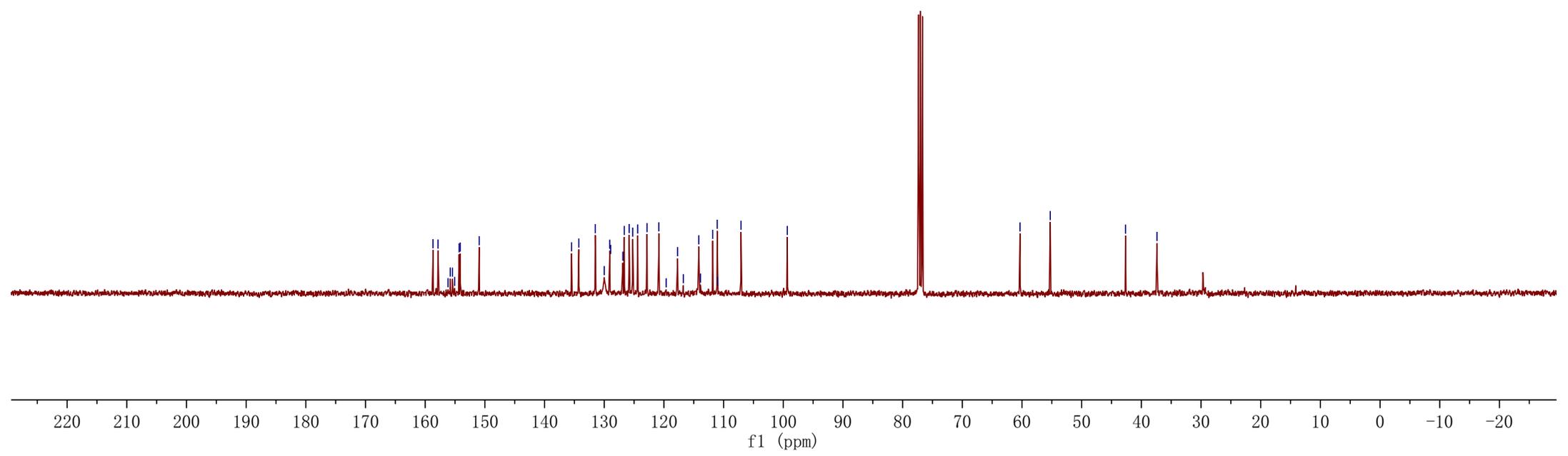
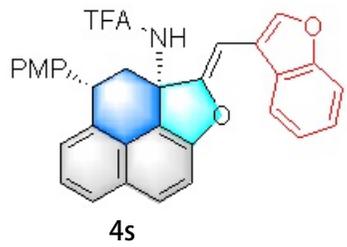
1.02



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

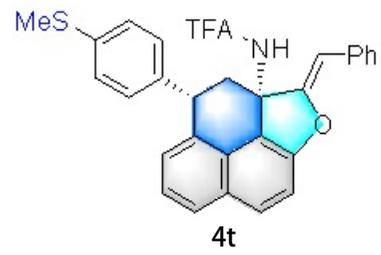
158.69  
157.85  
156.17  
155.80  
155.42  
155.05  
154.31  
154.13  
150.95  
135.47  
134.26  
131.51  
130.00  
129.08  
128.93  
126.88  
126.64  
125.82  
125.23  
124.39  
122.82  
120.86  
119.62  
117.71  
116.74  
114.16  
113.87  
111.82  
111.07  
111.00  
107.08  
99.33

60.33  
55.27  
42.65  
37.38

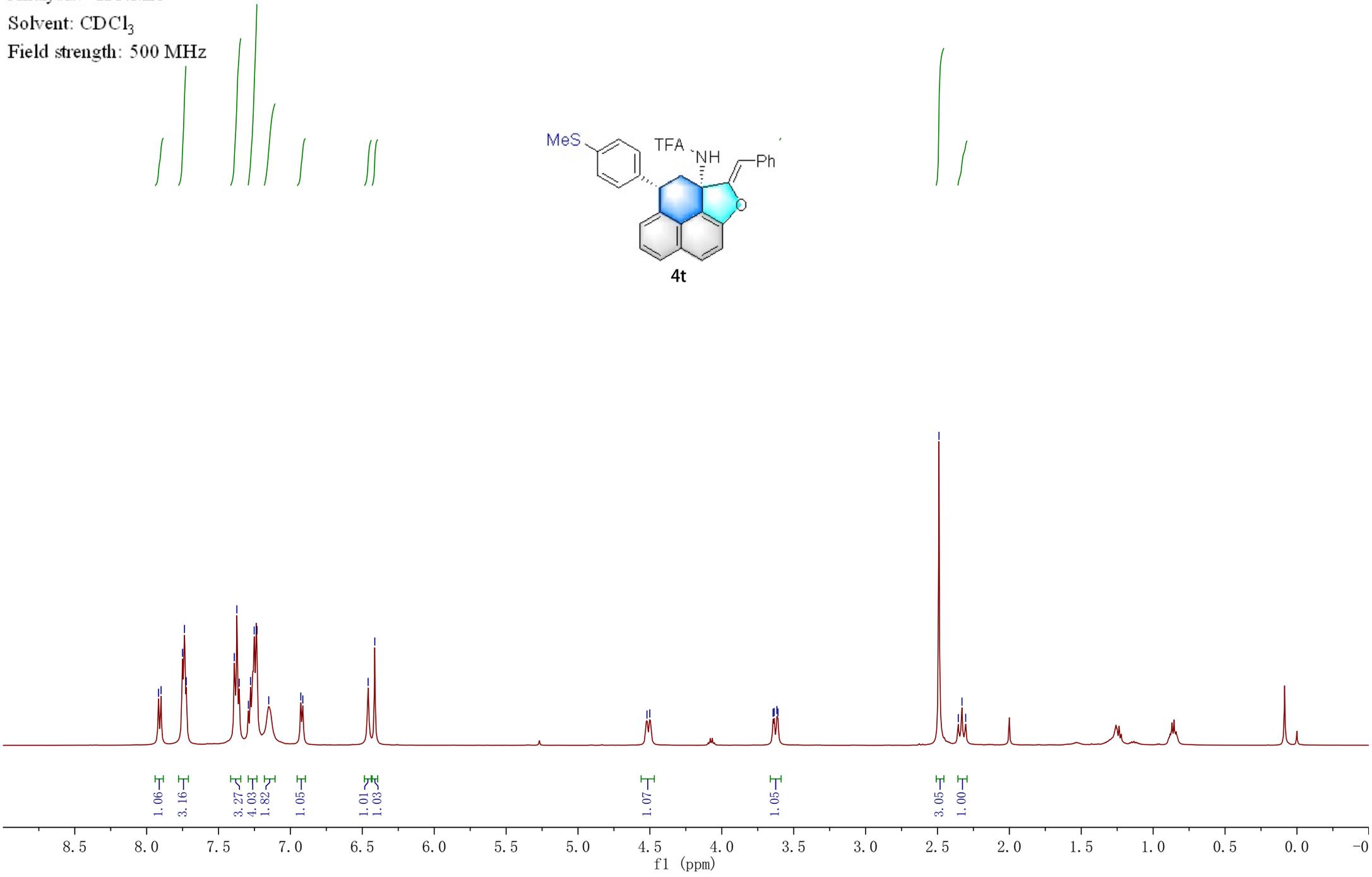


7.917  
7.899  
7.750  
7.737  
7.724  
7.391  
7.373  
7.356  
7.293  
7.277  
7.252  
7.232  
7.151  
6.928  
6.914  
  
6.460  
6.413

Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 500 MHz



4.520  
4.501  
  
3.643  
3.636  
3.617  
3.609  
  
2.489  
2.355  
2.330  
2.304



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

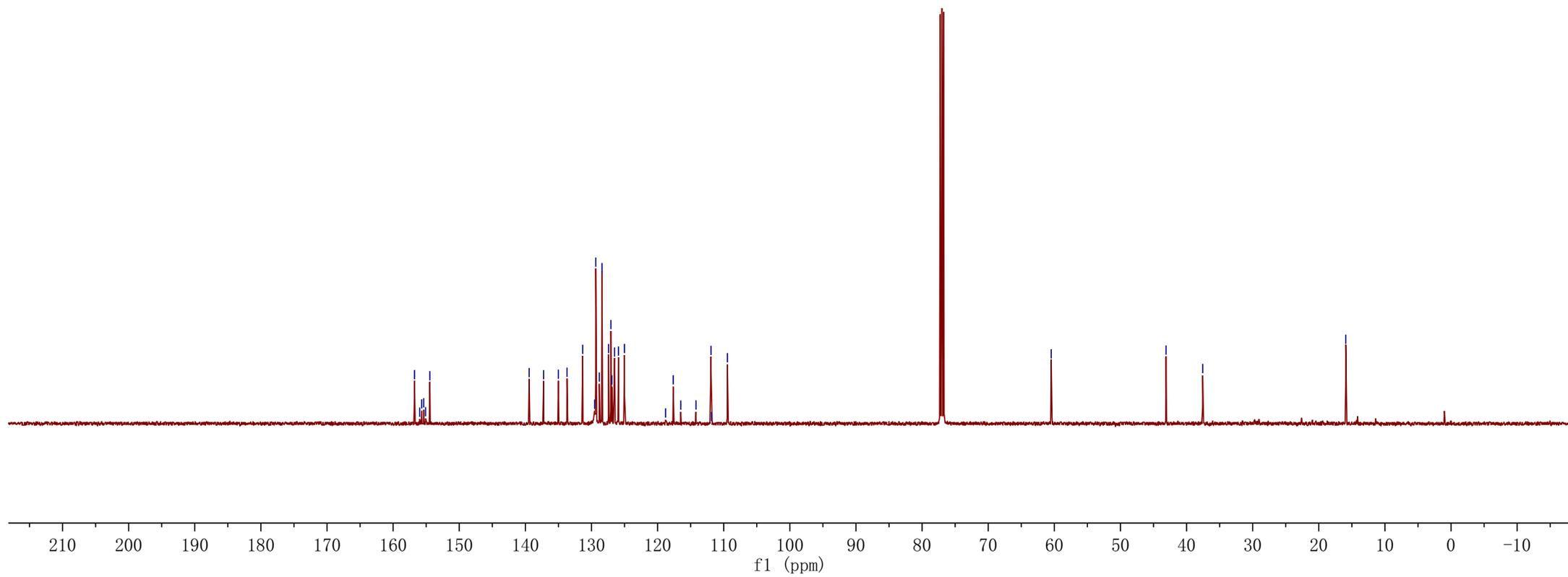
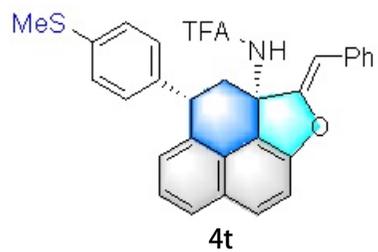
156.76  
155.97  
155.68  
155.38  
155.09  
154.44  
139.43  
137.25  
135.01  
133.70  
131.33  
129.53  
129.35  
128.81  
128.41  
127.41  
127.06  
126.91  
126.51  
125.92  
125.01  
118.79  
117.64  
116.49  
114.19  
111.92  
111.83  
109.44

— 60.47

— 43.10

— 37.55

— 15.92



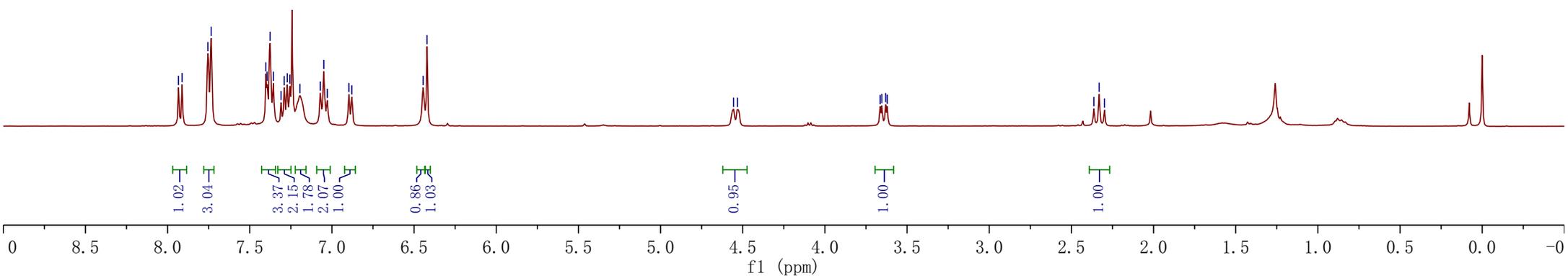
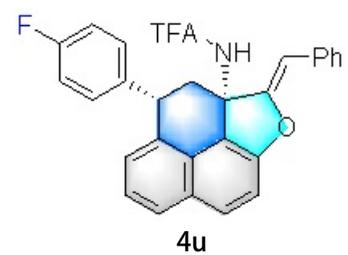
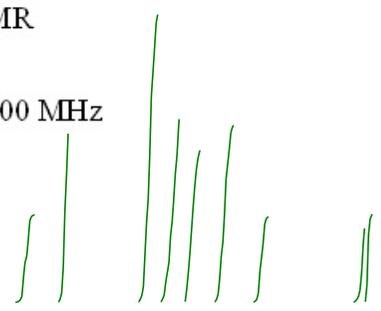
Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

7.934  
7.912  
7.755  
7.735  
7.402  
7.395  
7.376  
7.356  
7.310  
7.291  
7.272  
7.256  
7.195  
7.071  
7.049  
7.028  
6.897  
6.879  
6.445  
6.421

4.556  
4.532

3.664  
3.654  
3.631  
3.621

2.363  
2.331  
2.299



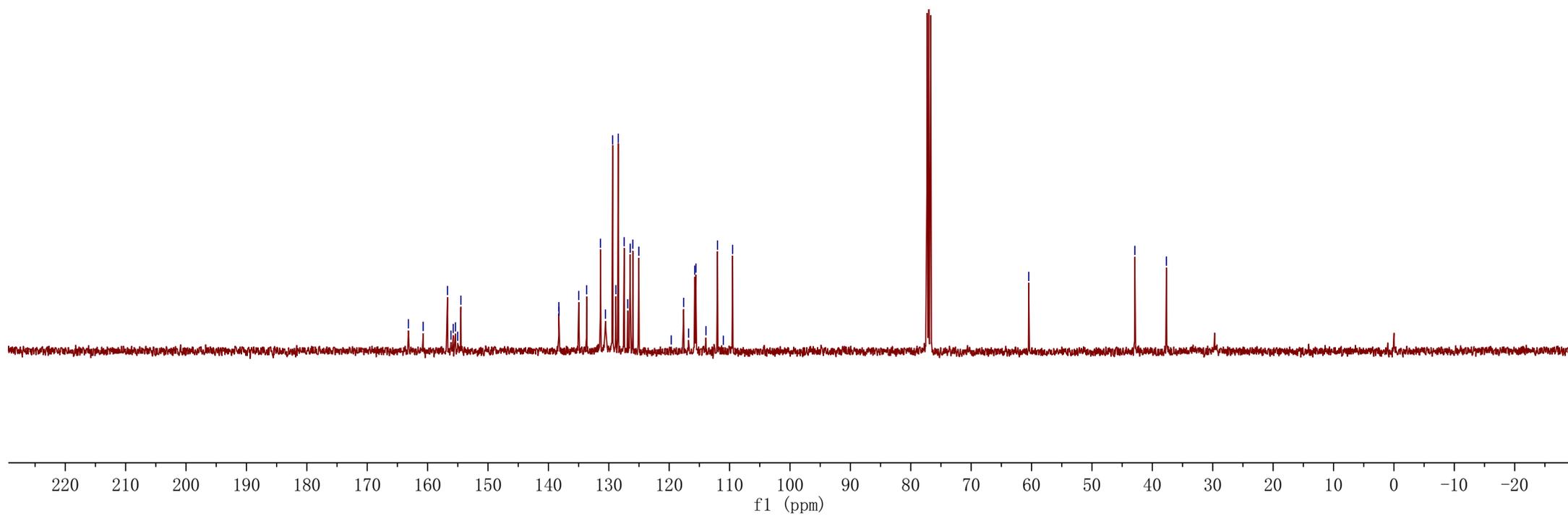
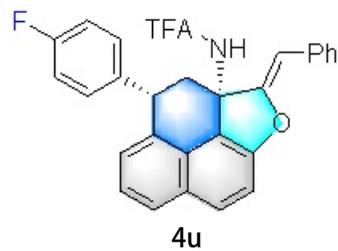
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

163.18  
160.74  
156.71  
156.13  
155.76  
155.39  
155.02  
154.48  
138.27  
138.24  
134.98  
133.67  
131.39  
130.56  
129.37  
128.83  
128.44  
127.46  
126.87  
126.45  
126.03  
125.03  
119.66  
117.60  
116.78  
115.78  
115.56  
113.91  
112.00  
111.03  
109.49

— 60.47

— 42.90

— 37.68



7.902  
7.878  
7.855  
7.729  
7.711  
7.371  
7.352  
7.333  
7.231  
7.225  
7.208  
7.203  
7.053  
6.802  
6.782

— 6.278

— 5.859

4.841  
4.827

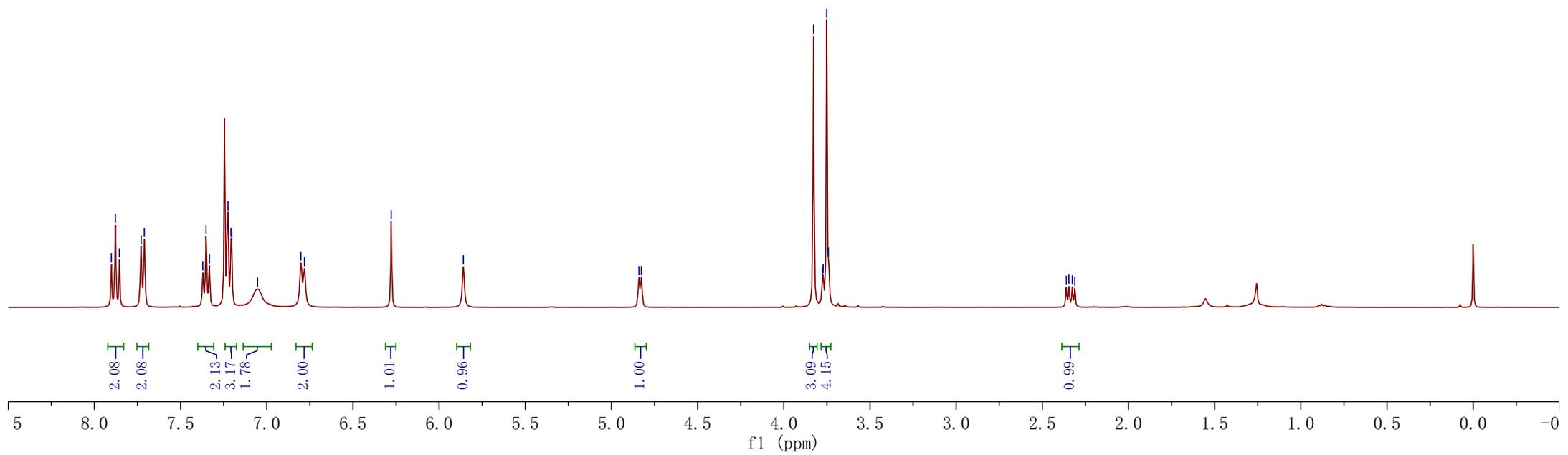
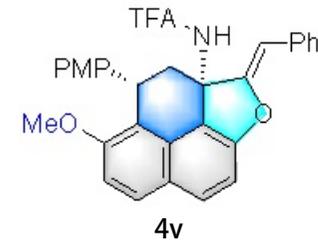
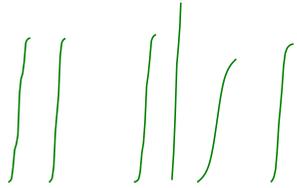
3.828  
3.776  
3.772  
3.751  
3.742

2.361  
2.346  
2.326  
2.312

Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz

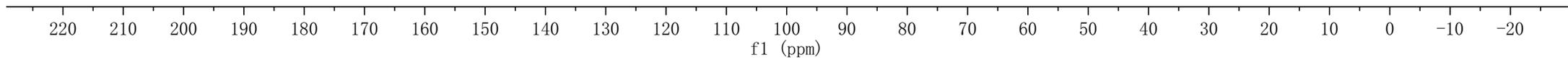
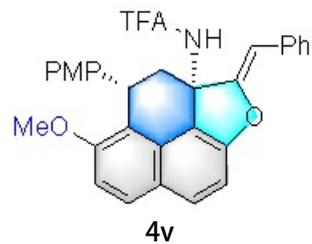


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

158.20  
157.81  
156.11  
155.43  
155.18  
154.81  
154.45  
154.08  
134.99  
133.95  
131.19  
129.25  
128.78  
128.56  
128.35  
128.16  
127.15  
124.42  
119.64  
116.78  
116.12  
114.03  
113.22  
111.81  
110.35  
109.62  
108.36

59.82  
56.13  
55.29

37.02  
35.71



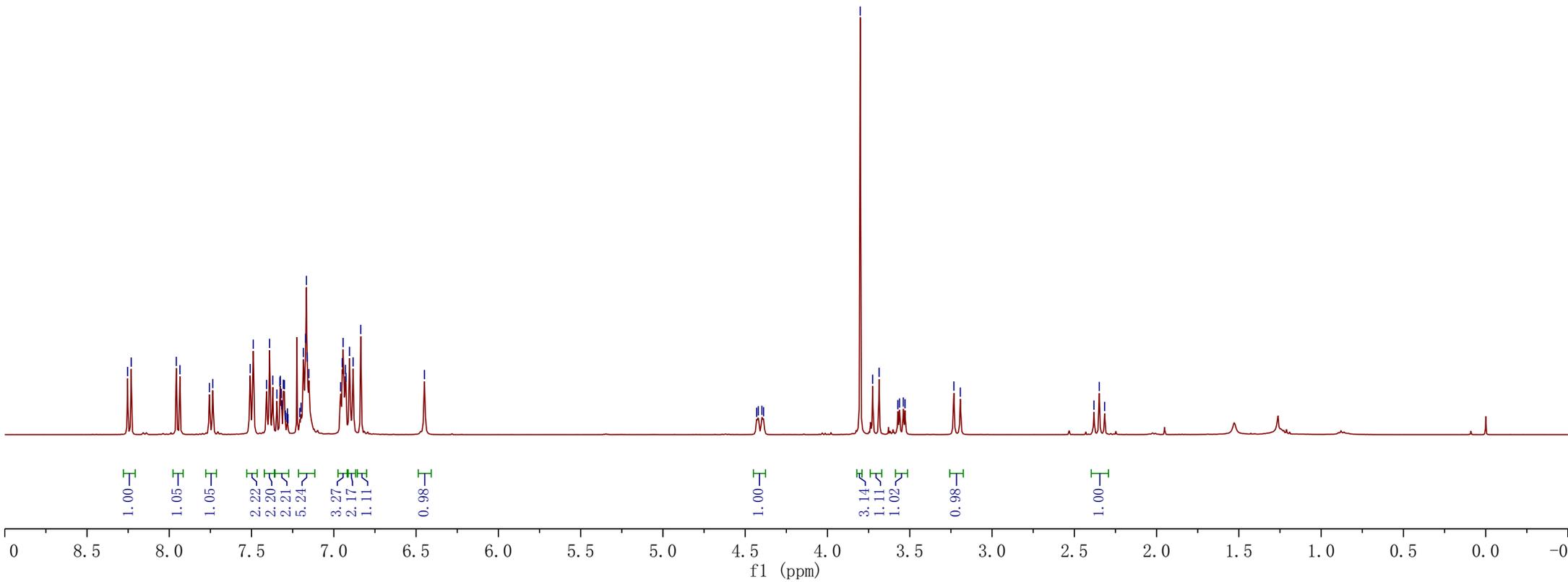
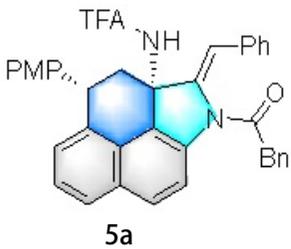
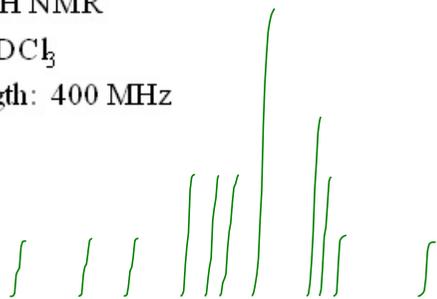
Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

8.253  
8.231  
7.957  
7.935  
7.756  
7.735  
7.508  
7.490  
7.409  
7.390  
7.371  
7.346  
7.328  
7.325  
7.319  
7.316  
7.307  
7.300  
7.295  
7.285  
7.282  
7.279  
7.207  
7.199  
7.185  
7.171  
7.166  
7.162  
7.152  
6.959  
6.949  
6.944  
6.929  
6.926  
6.905  
6.883  
6.837  
6.449

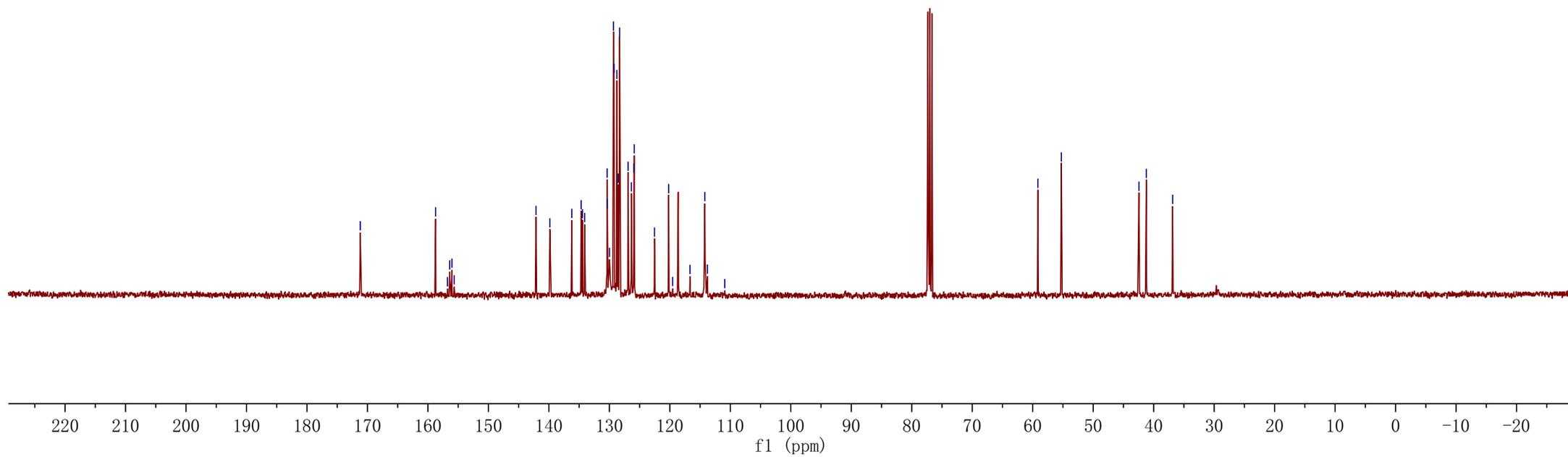
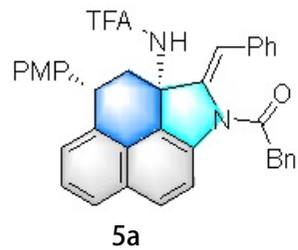
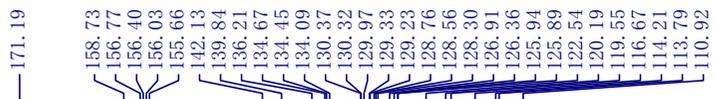
4.430  
4.420  
4.398  
4.388

3.801  
3.726  
3.686  
3.572  
3.562  
3.539  
3.529  
3.232  
3.193

2.381  
2.348  
2.316



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz



Analysis:  $^1\text{H NMR}$

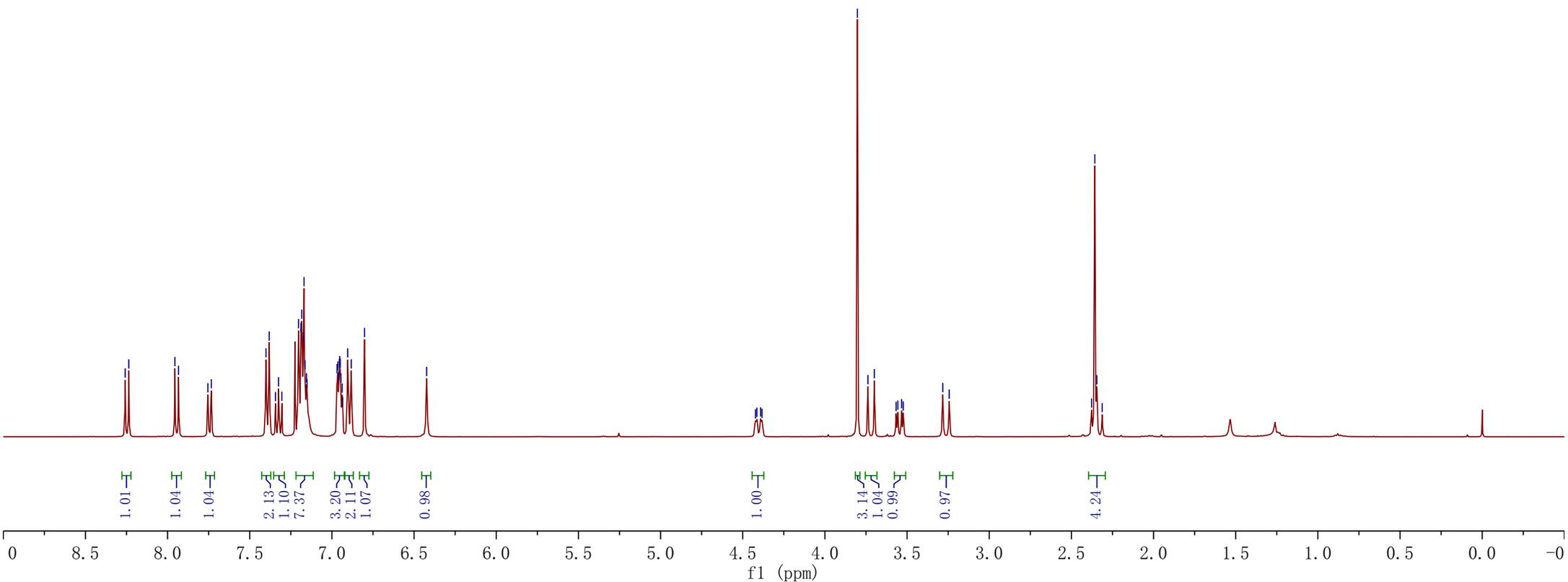
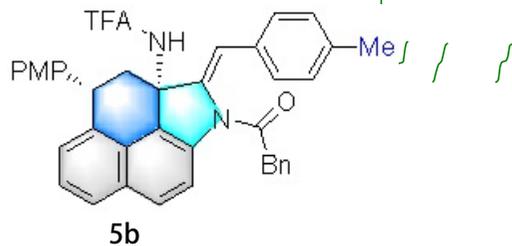
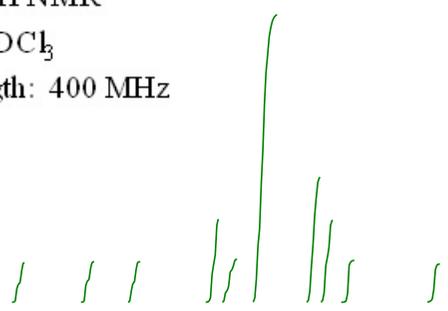
Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz

8.258  
8.236  
7.955  
7.933  
7.755  
7.734  
7.401  
7.382  
7.344  
7.325  
7.305  
7.203  
7.189  
7.184  
7.175  
7.170  
7.164  
7.155  
7.152  
6.969  
6.964  
6.958  
6.955  
6.953  
6.949  
6.945  
6.938  
6.934  
6.904  
6.882  
6.802  
6.423

4.423  
4.414  
4.391  
4.382  
3.802  
3.738  
3.699  
3.567  
3.556  
3.533  
3.523  
3.283  
3.243

2.378  
2.357  
2.345  
2.313



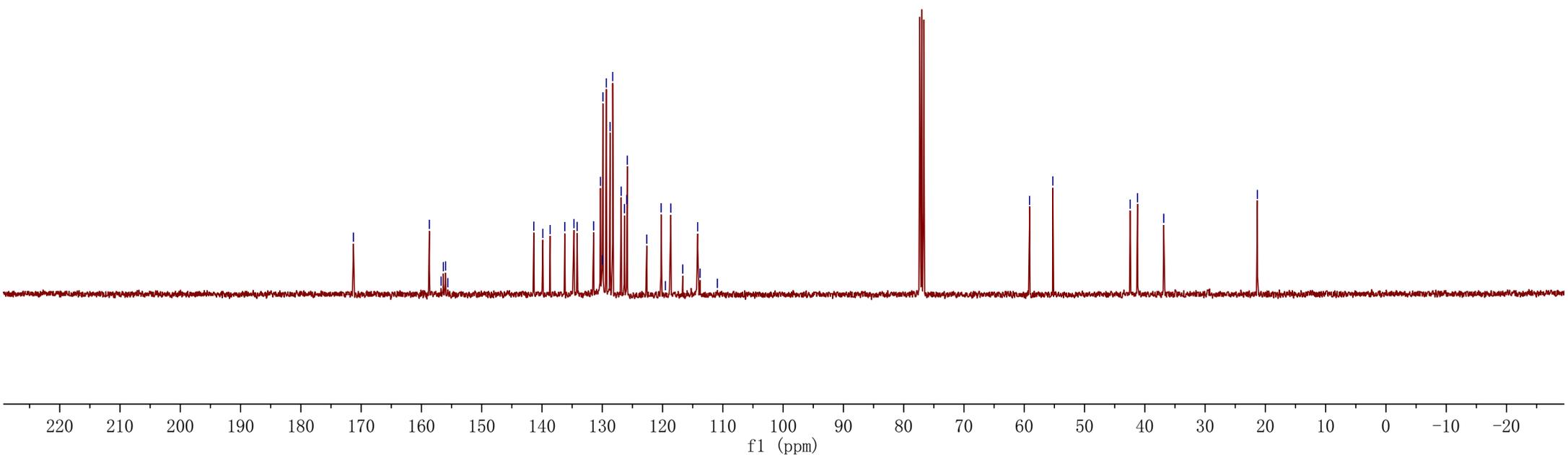
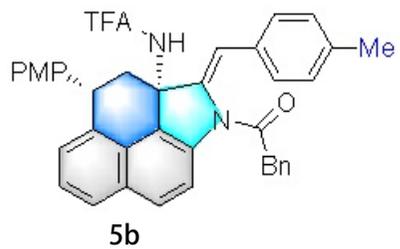
Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

171.28  
158.68  
156.73  
156.36  
155.99  
155.62  
141.36  
139.86  
138.65  
136.22  
134.70  
134.17  
131.43  
130.30  
129.98  
129.89  
129.33  
128.71  
128.27  
126.86  
126.32  
125.92  
125.85  
122.62  
120.24  
119.53  
118.63  
116.65  
114.18  
113.78  
110.91

59.12  
55.26

42.43  
41.22  
36.86

21.32

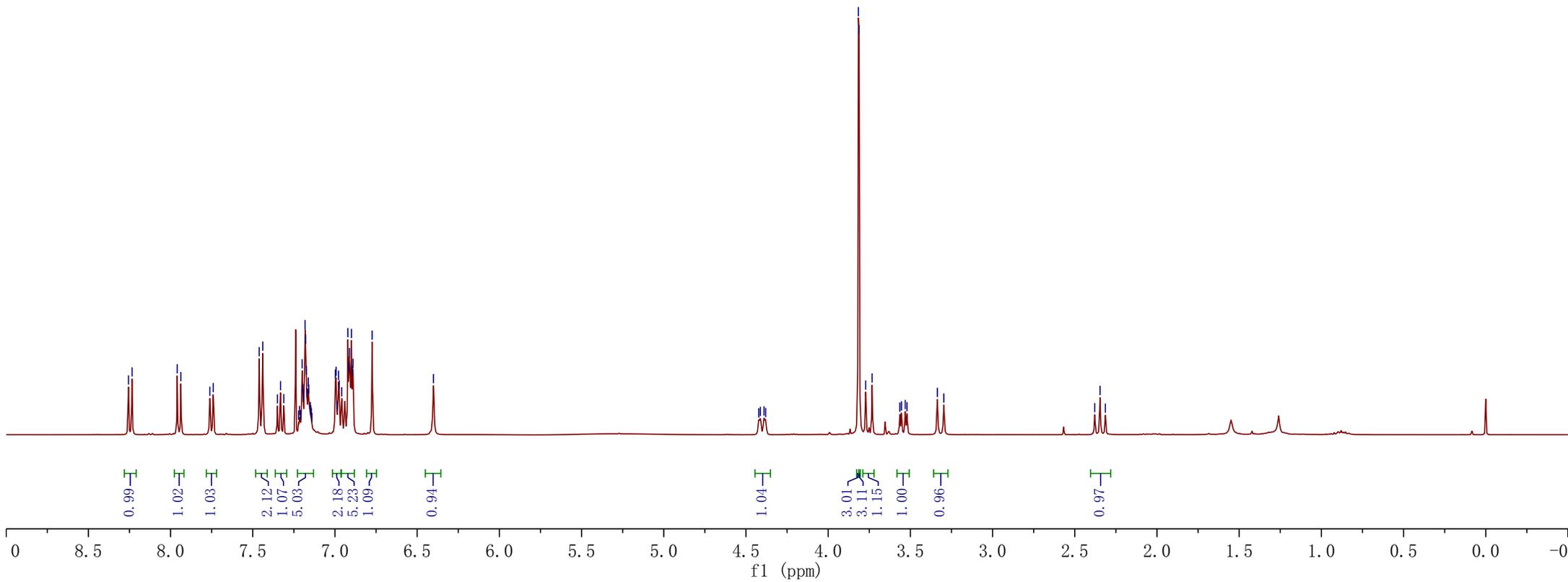
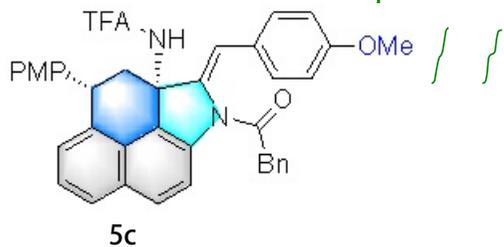
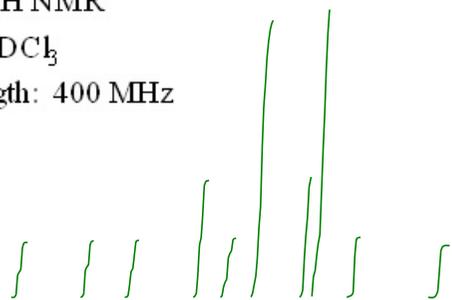


Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz

8.256  
8.234  
7.959  
7.937  
7.761  
7.740  
7.461  
7.439  
7.350  
7.331  
7.311  
7.222  
7.215  
7.210  
7.200  
7.195  
7.192  
7.182  
7.178  
7.174  
7.170  
7.163  
7.160  
7.150  
7.147  
7.143  
7.140  
6.998  
6.993  
6.988  
6.978  
6.974  
6.959  
6.922  
6.916  
6.912  
6.900  
6.893  
6.890  
6.774  
6.401  
4.422  
4.412  
4.390  
4.380  
3.816  
3.812  
3.772  
3.733  
3.564  
3.554  
3.531  
3.521  
3.336  
3.297  
2.379  
2.346  
2.314

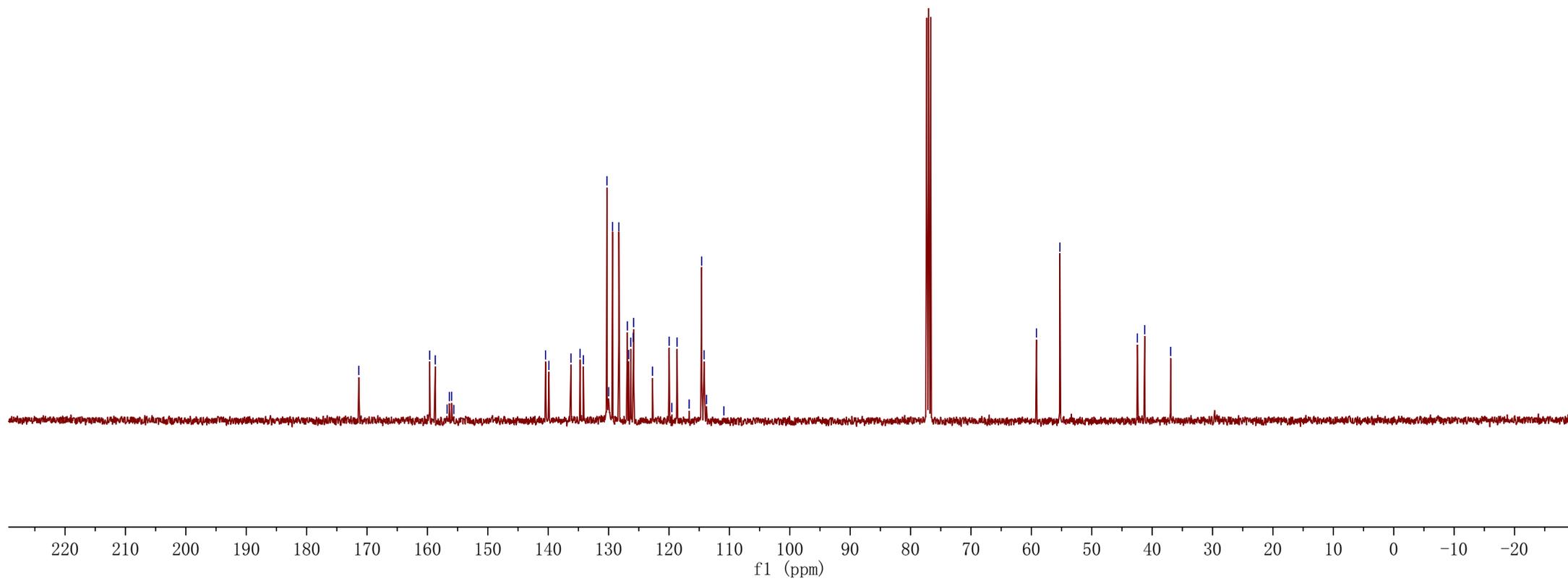
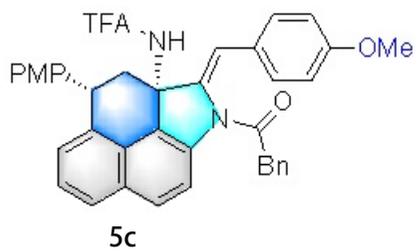


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

171.37  
159.63  
158.70  
156.74  
156.36  
155.99  
155.62  
140.44  
139.89  
136.23  
134.73  
134.18  
130.28  
129.99  
129.35  
128.31  
126.89  
126.67  
126.33  
125.93  
125.86  
122.73  
119.97  
119.54  
118.66  
116.66  
114.59  
114.19  
113.79  
110.91

59.16  
55.28

42.46  
41.24  
36.94

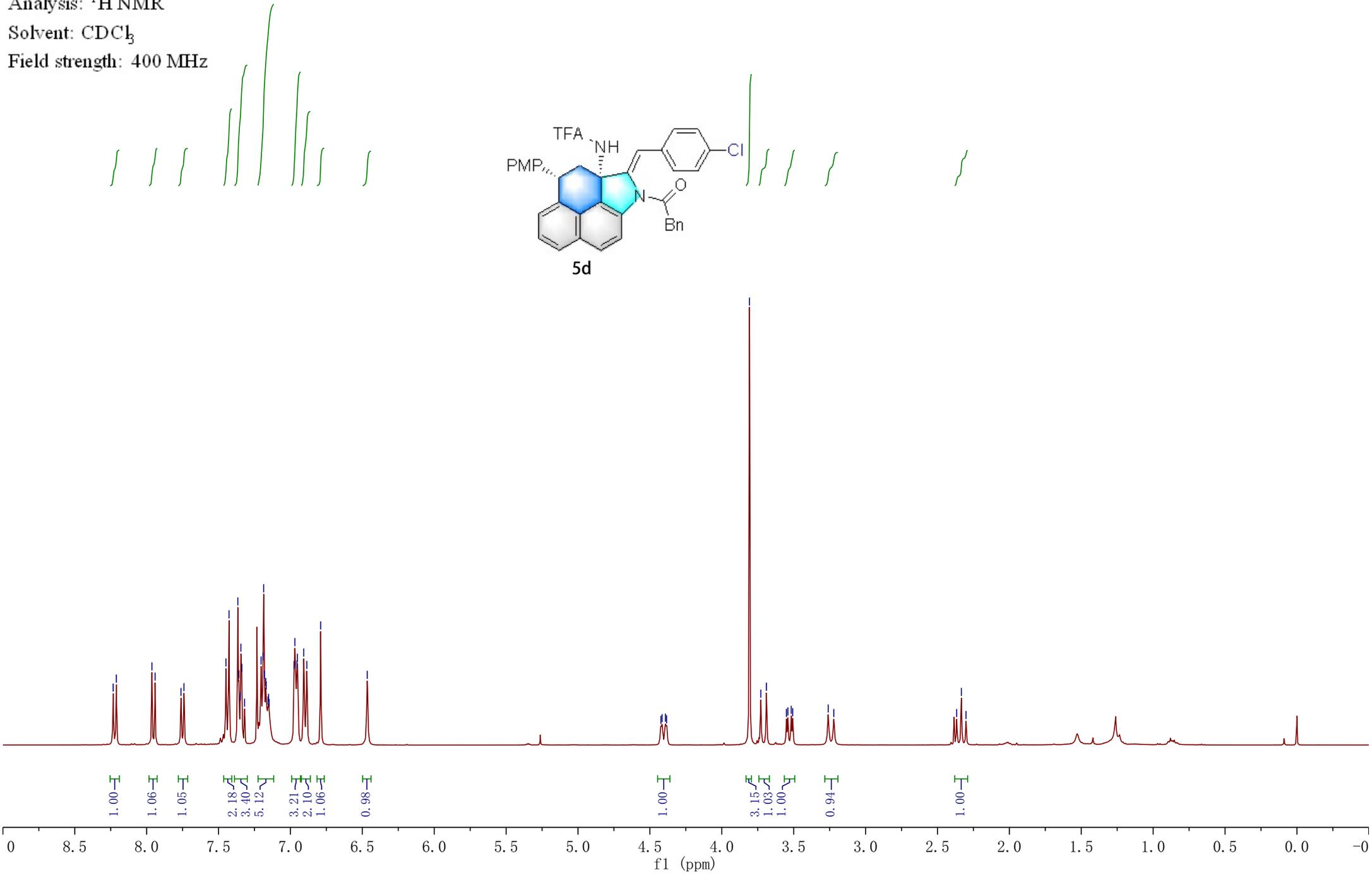
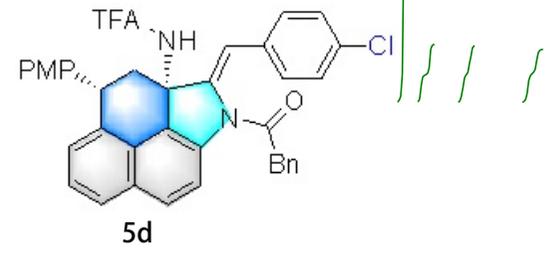


8.233  
8.211  
7.963  
7.941  
7.761  
7.740  
7.448  
7.427  
7.366  
7.358  
7.349  
7.345  
7.338  
7.319  
7.204  
7.191  
7.186  
7.180  
7.172  
7.169  
7.157  
7.152  
7.148  
6.974  
6.969  
6.955  
6.951  
6.908  
6.886  
6.790  
6.466

4.423  
4.415  
4.392  
4.384  
3.807  
3.729  
3.690  
3.550  
3.540  
3.517  
3.507  
3.260  
3.221

2.366  
2.334  
2.302

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

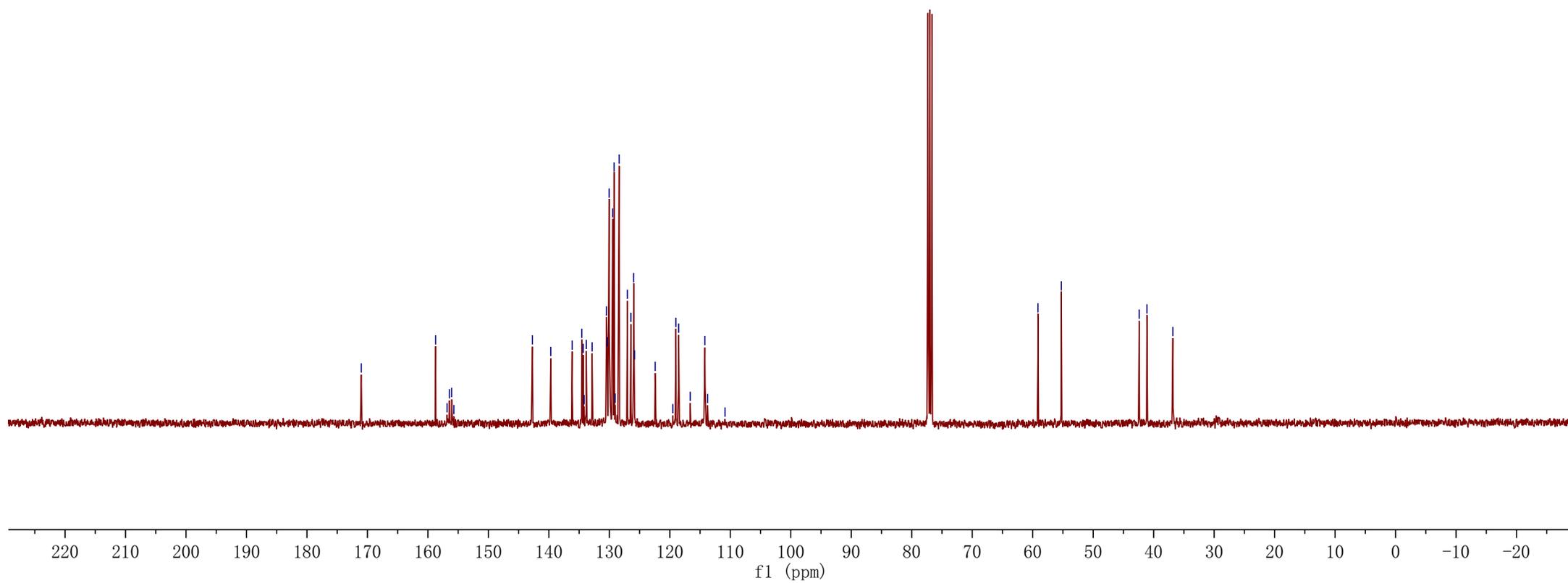
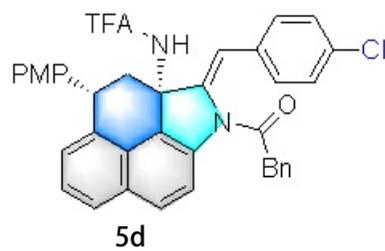


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

171.02  
158.72  
156.83  
156.45  
156.08  
155.71  
142.72  
139.68  
136.15  
134.56  
134.32  
134.17  
133.81  
132.85  
130.47  
130.35  
130.04  
129.45  
129.22  
129.05  
128.38  
127.02  
126.44  
125.99  
125.85  
122.42  
119.50  
119.00  
118.54  
116.62  
114.20  
113.75  
110.87

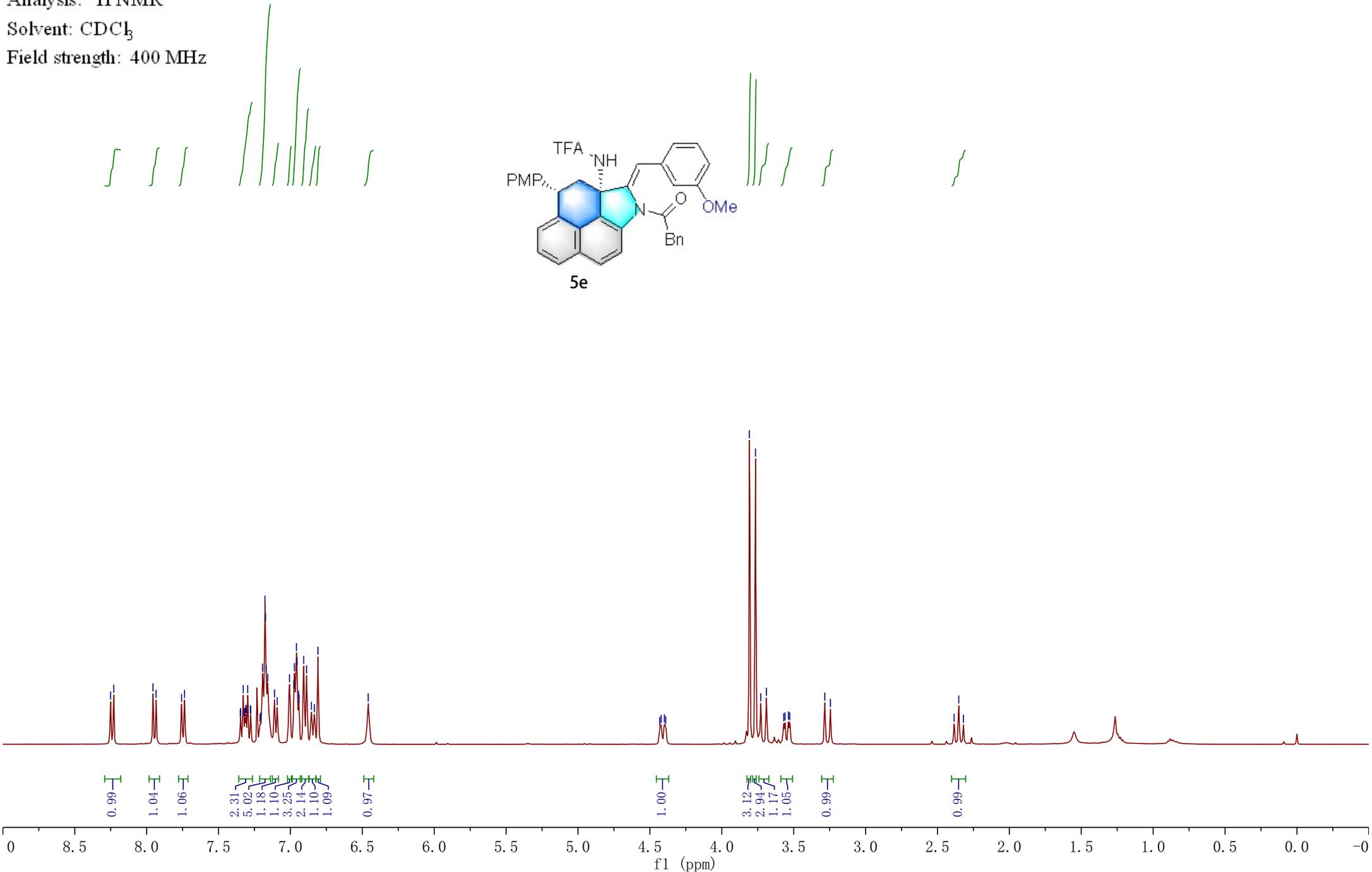
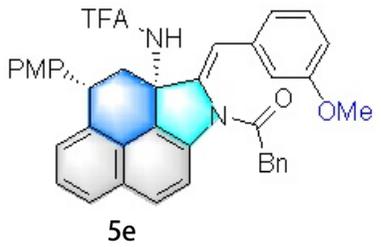
59.13  
55.27

42.39  
41.11  
36.83



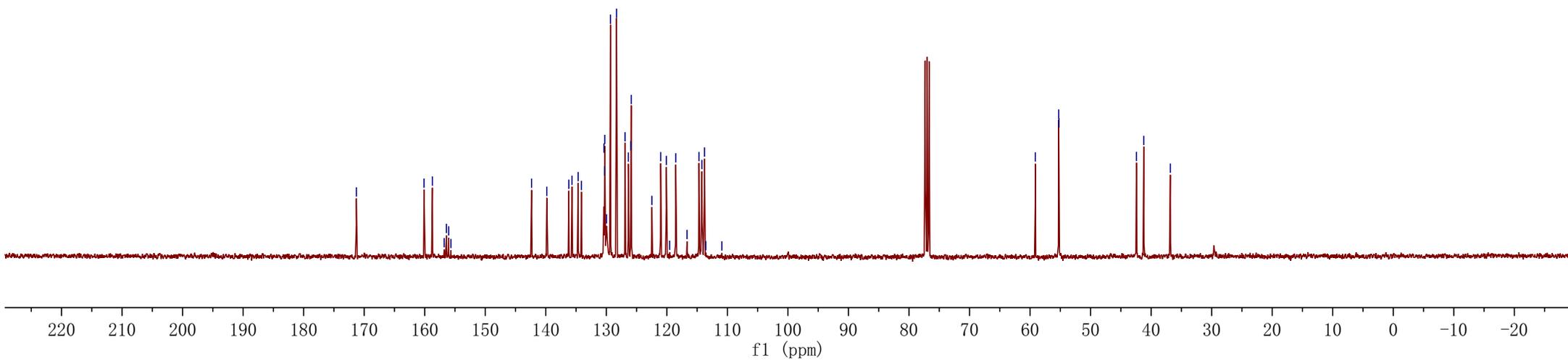
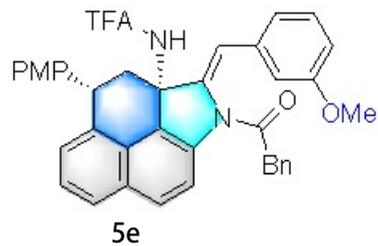
8.251 8.229 7.956 7.934 7.757 7.736 7.349 7.346 7.328 7.319 7.316 7.310 7.307 7.297 7.279 7.276 7.211 7.208 7.194 7.177 7.173 7.169 7.158 7.111 7.092 7.007 6.977 6.958 6.954 6.943 6.940 6.908 6.888 6.854 6.834 6.809 6.459 4.432 4.422 4.399 4.389 3.808 3.766 3.729 3.690 3.569 3.560 3.536 3.527 3.284 3.245 2.384 2.352 2.320

Analysis: <sup>1</sup>H NMR  
 Solvent: CDCl<sub>3</sub>  
 Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

171.28  
160.11  
158.73  
156.78  
156.41  
156.04  
155.67  
142.35  
139.83  
136.20  
135.68  
134.66  
134.12  
130.39  
130.30  
130.26  
129.96  
129.32  
128.31  
126.91  
126.36  
125.95  
125.88  
122.47  
121.01  
120.08  
119.54  
118.52  
116.67  
114.69  
114.21  
113.78  
113.56  
110.91  
59.13  
55.27  
55.22  
42.43  
41.22  
36.83



Analysis:  $^1\text{H NMR}$

Solvent:  $\text{CDCl}_3$

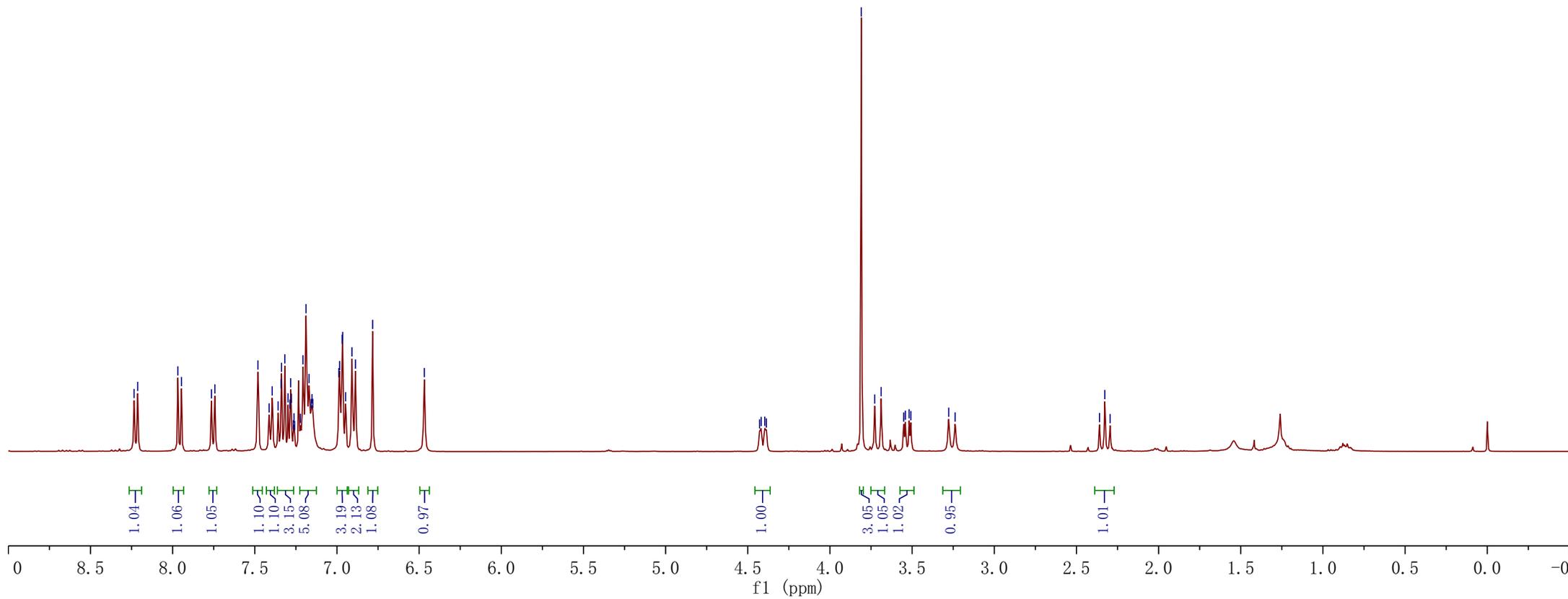
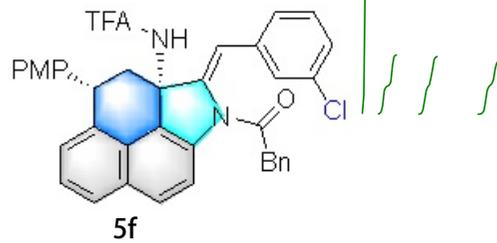
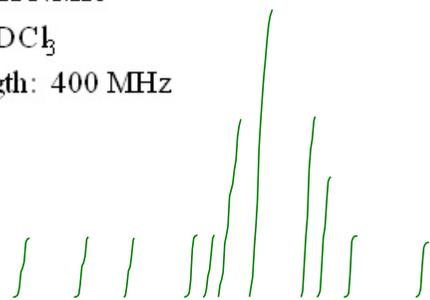
Field strength: 400 MHz

8.235  
8.213  
7.968  
7.946  
7.764  
7.743  
7.481  
7.413  
7.394  
7.358  
7.340  
7.337  
7.317  
7.298  
7.286  
7.282  
7.278  
7.266  
7.261  
7.257  
7.223  
7.207  
7.188  
7.170  
7.157  
7.152  
7.147  
7.147  
6.989  
6.984  
6.969  
6.965  
6.947  
6.909  
6.887  
6.783  
6.468

4.428  
4.419  
4.397  
4.387

3.810  
3.728  
3.689  
3.551  
3.541  
3.518  
3.508  
3.277  
3.238

2.360  
2.327  
2.295

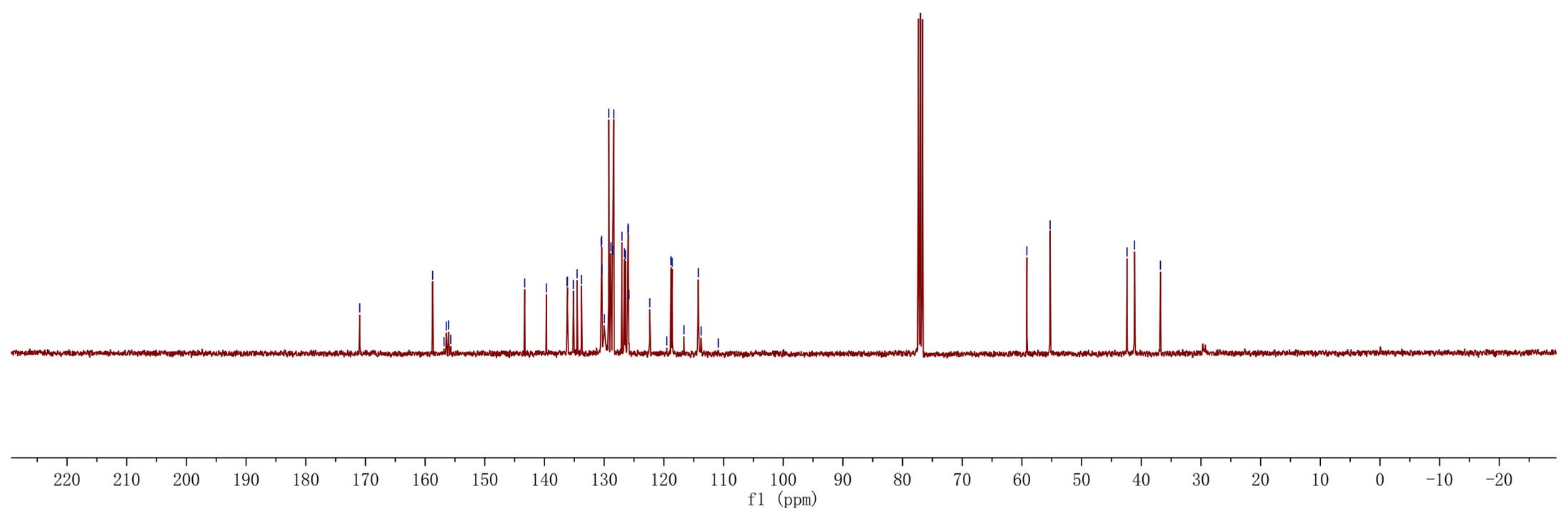
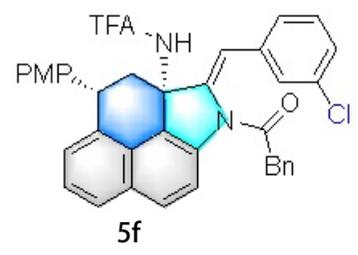


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

170.96  
158.73  
156.82  
156.45  
156.08  
155.71  
143.31  
139.69  
136.24  
136.15  
135.18  
134.53  
133.80  
130.51  
130.42  
130.36  
129.96  
129.23  
128.88  
128.60  
128.39  
127.02  
126.61  
126.45  
126.01  
125.98  
125.84  
122.36  
119.50  
118.81  
118.60  
116.63  
114.22  
113.75  
110.87

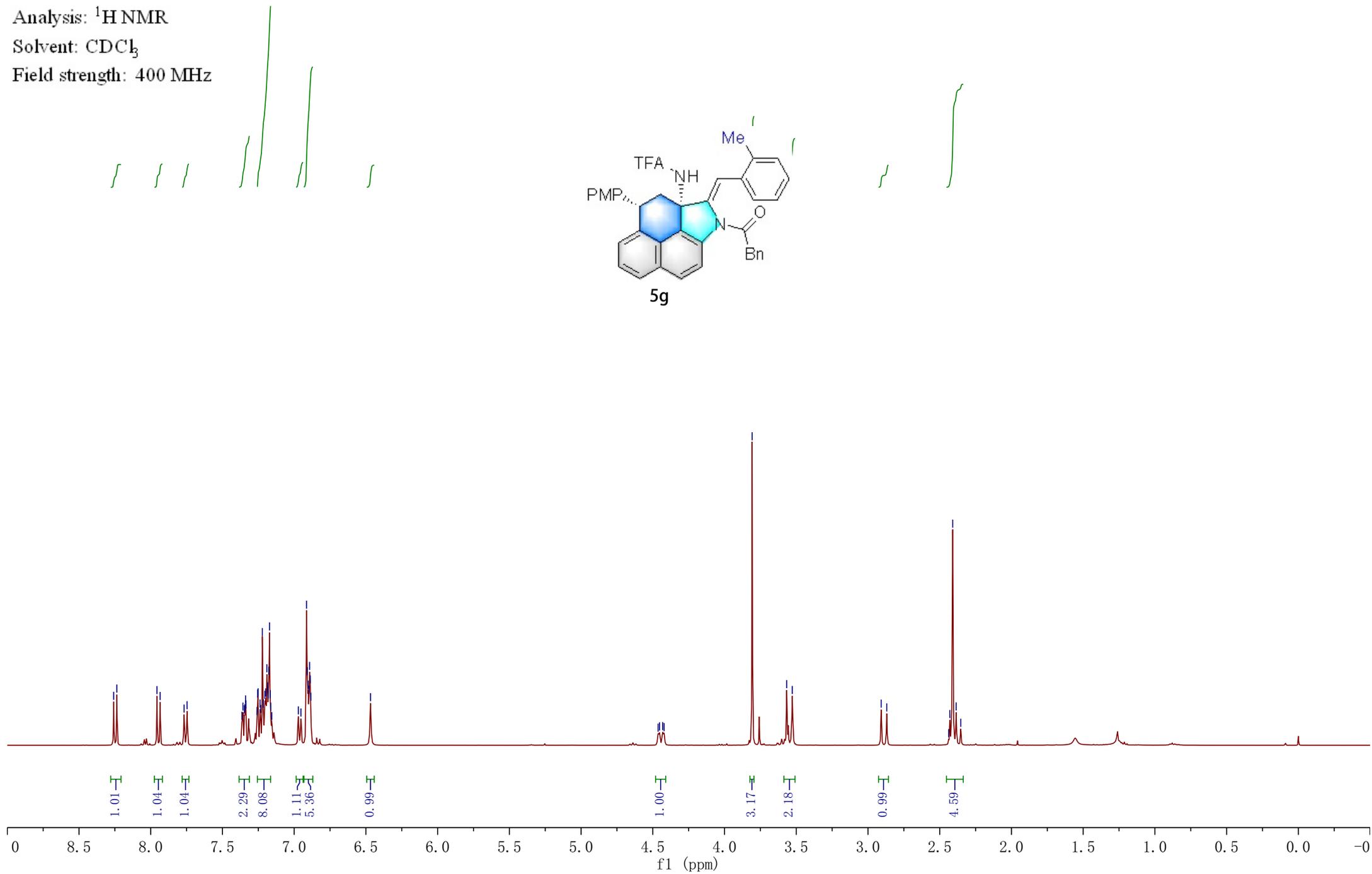
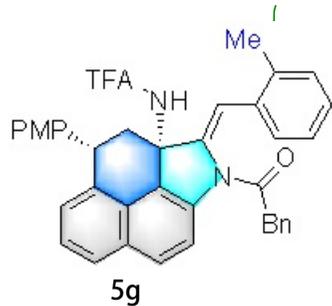
59.16  
55.27

42.39  
41.14  
36.79

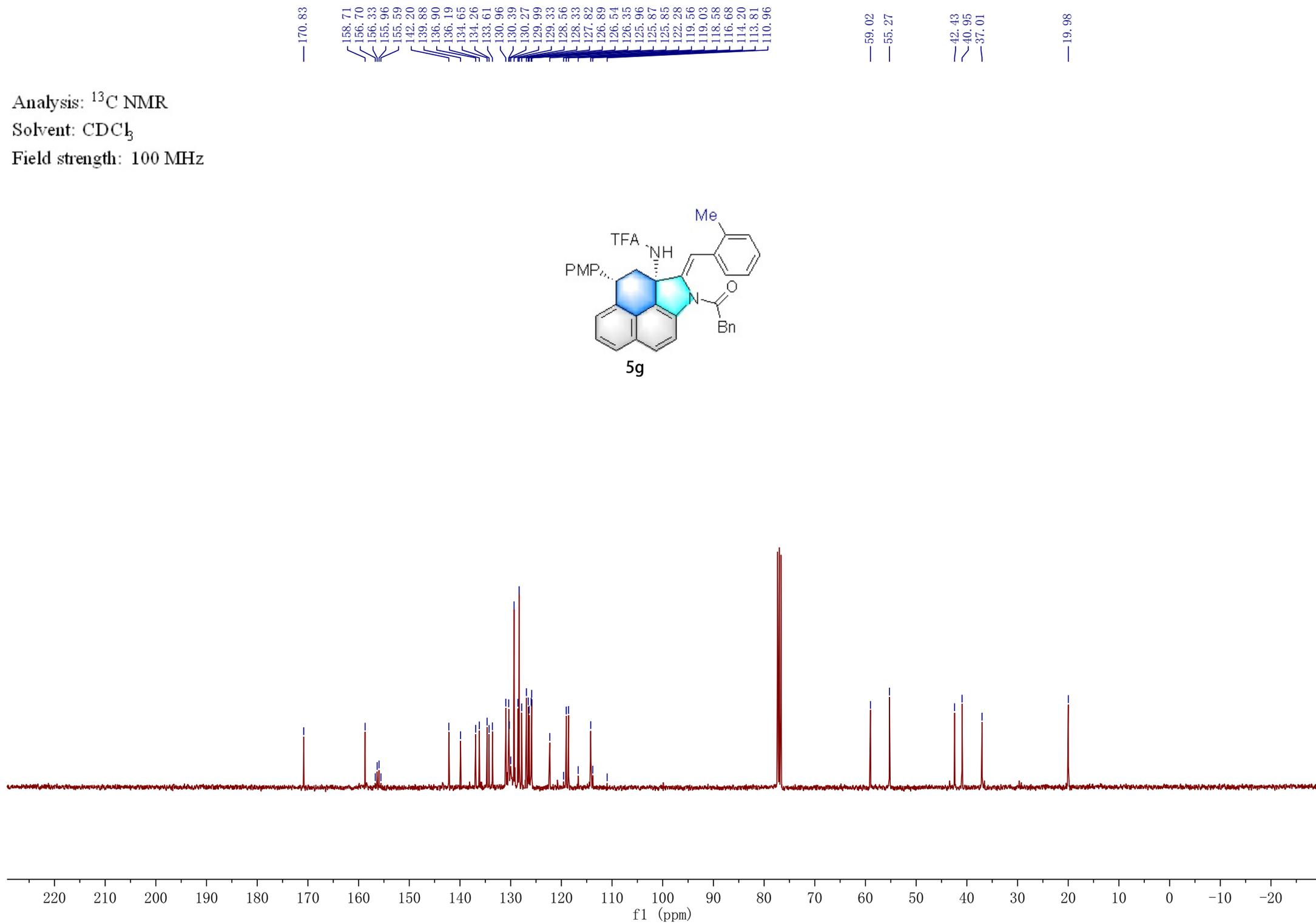
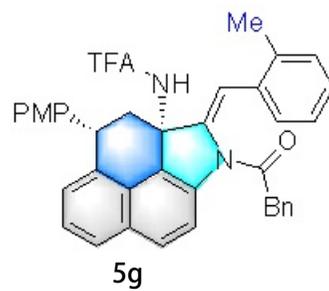


Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

8.258, 8.236, 7.956, 7.934, 7.767, 7.747, 7.364, 7.357, 7.347, 7.343, 7.339, 7.336, 7.259, 7.255, 7.251, 7.238, 7.233, 7.222, 7.215, 7.204, 7.199, 7.190, 7.186, 7.182, 7.177, 7.172, 7.166, 7.164, 7.156, 6.971, 6.953, 6.914, 6.908, 6.902, 6.897, 6.892, 6.888, 6.884, 6.468, 4.463, 4.453, 4.431, 4.421, 3.808, 3.567, 3.528, 2.908, 2.869, 2.437, 2.430, 2.409, 2.386, 2.353



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

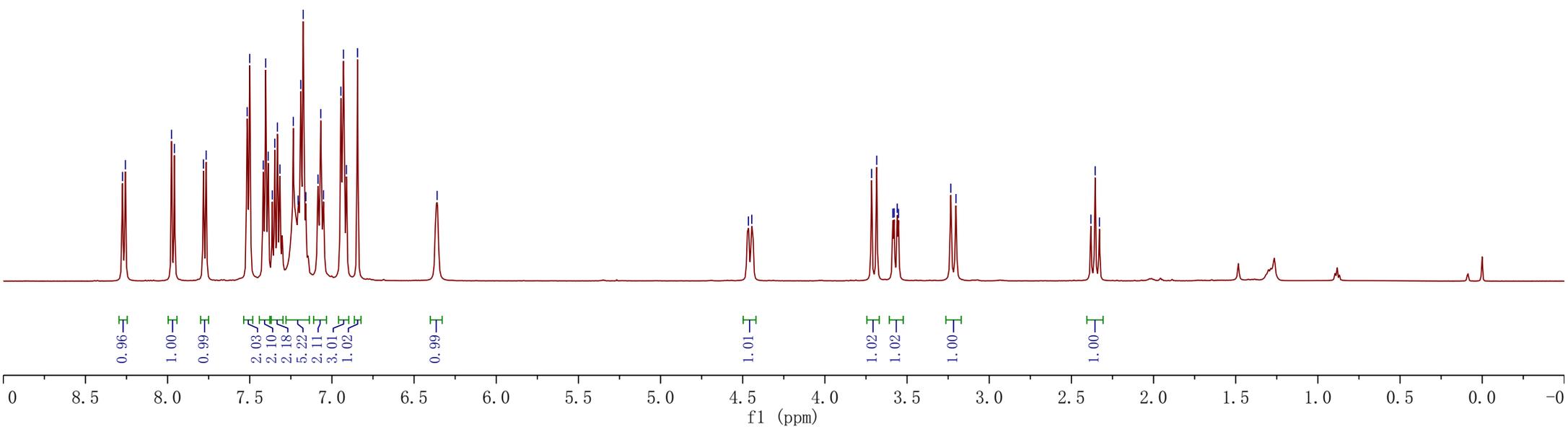
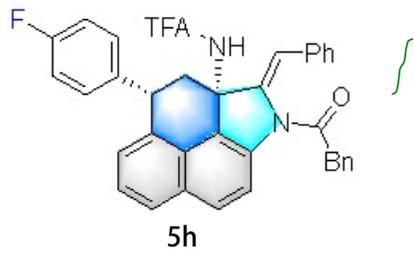
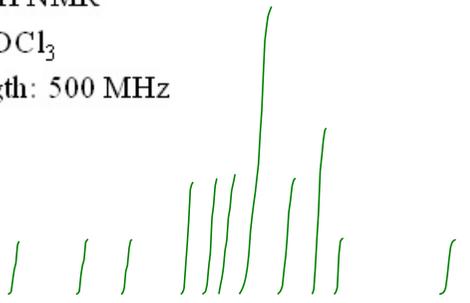


8.274  
8.257  
7.976  
7.958  
7.782  
7.765  
7.516  
7.500  
7.418  
7.403  
7.388  
7.363  
7.348  
7.332  
7.316  
7.235  
7.206  
7.189  
7.175  
7.159  
7.085  
7.068  
7.051  
6.945  
6.930  
6.912  
6.844  
6.360

4.465  
4.445  
3.716  
3.684  
3.586  
3.579  
3.560  
3.552  
3.234  
3.202

2.381  
2.355  
2.330

Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 500 MHz

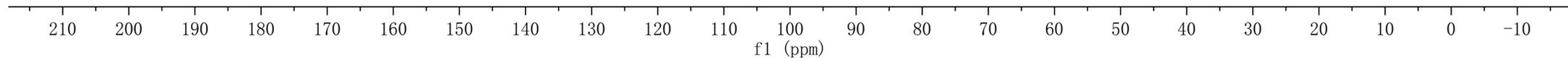
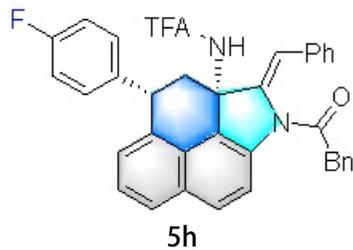


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

171.211  
162.971  
161.016  
156.702  
156.406  
156.110  
155.813  
142.004  
139.987  
138.402  
138.375  
135.641  
134.400  
134.051  
130.508  
130.358  
129.327  
129.287  
128.779  
128.650  
128.350  
126.965  
126.336  
126.210  
125.904  
125.802  
122.365  
120.250  
118.756  
118.670  
116.369  
115.825  
115.658  
114.071  
111.786

59.083

42.586  
41.274  
36.865



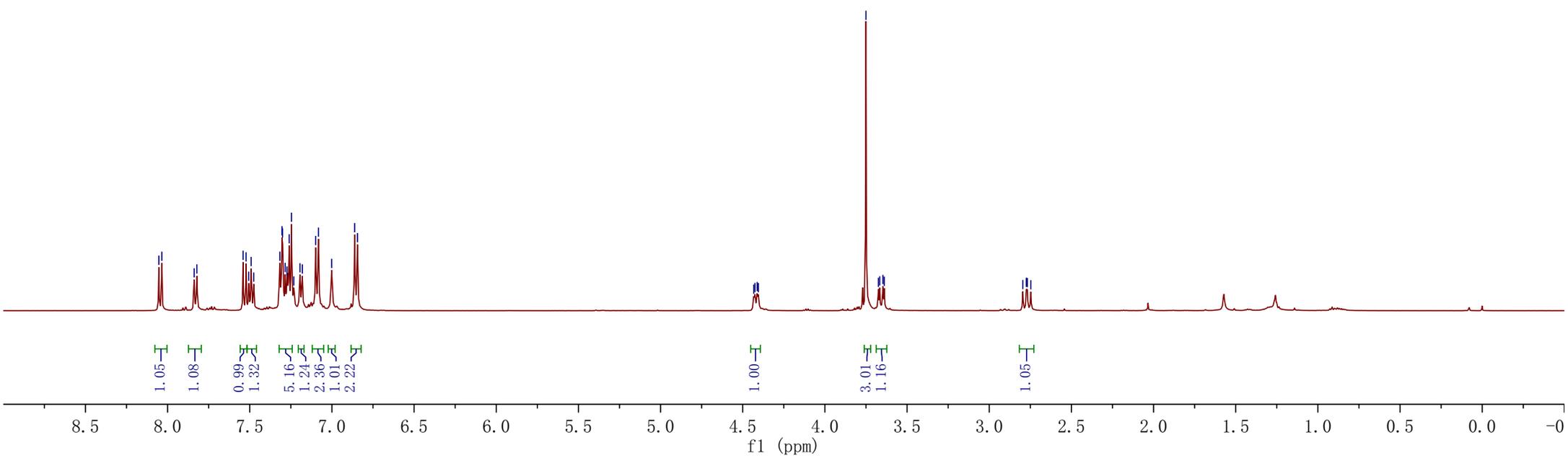
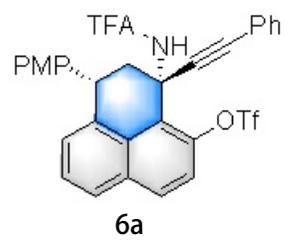
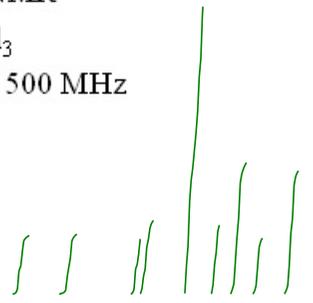
8.053  
8.035  
7.838  
7.822  
7.541  
7.522  
7.507  
7.492  
7.476  
7.317  
7.304  
7.301  
7.284  
7.274  
7.260  
7.246  
7.232  
7.194  
7.180  
7.099  
7.082  
7.002  
6.862  
6.844

4.433  
4.426  
4.412  
4.405

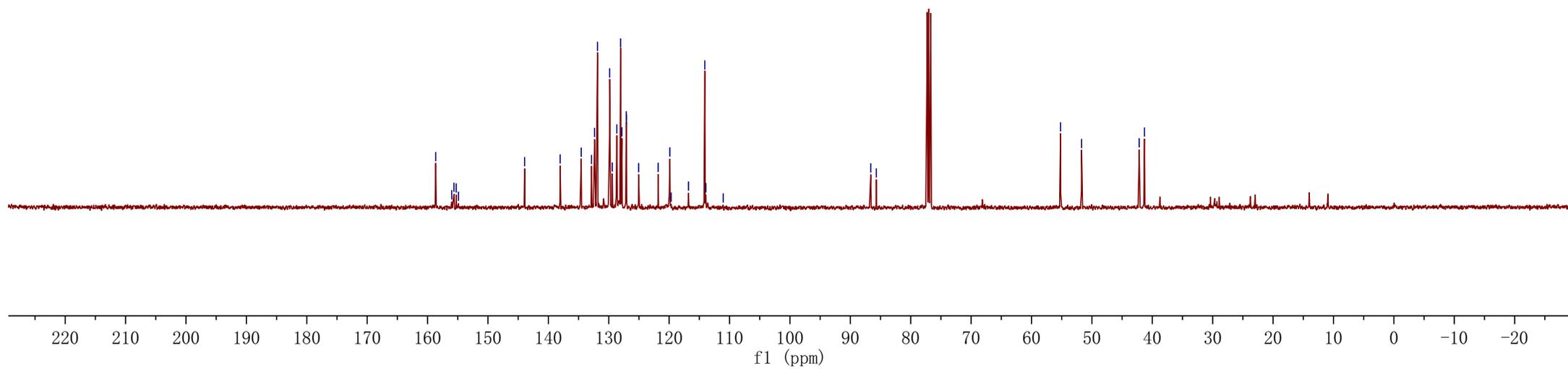
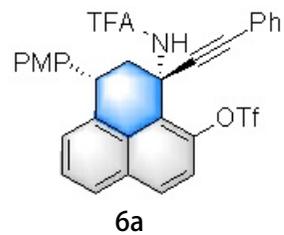
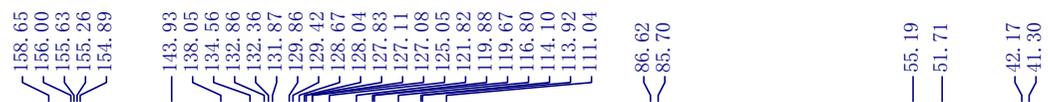
3.750  
3.675  
3.666  
3.647  
3.639

2.795  
2.774  
2.768  
2.747

Analysis: <sup>1</sup>H NMR  
Solvent: CDCl<sub>3</sub>  
Field strength: 500 MHz

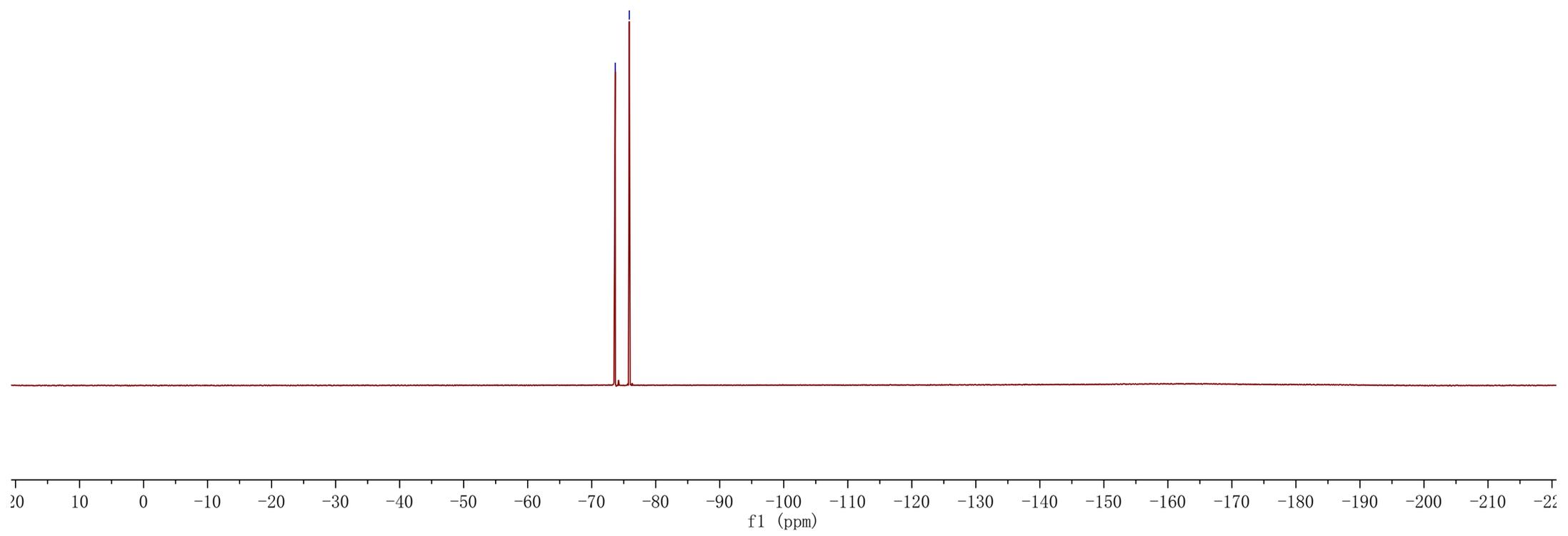
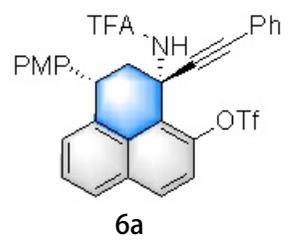


Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz



Analysis:  $^{19}\text{F}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 471 MHz

-73.676  
-75.877

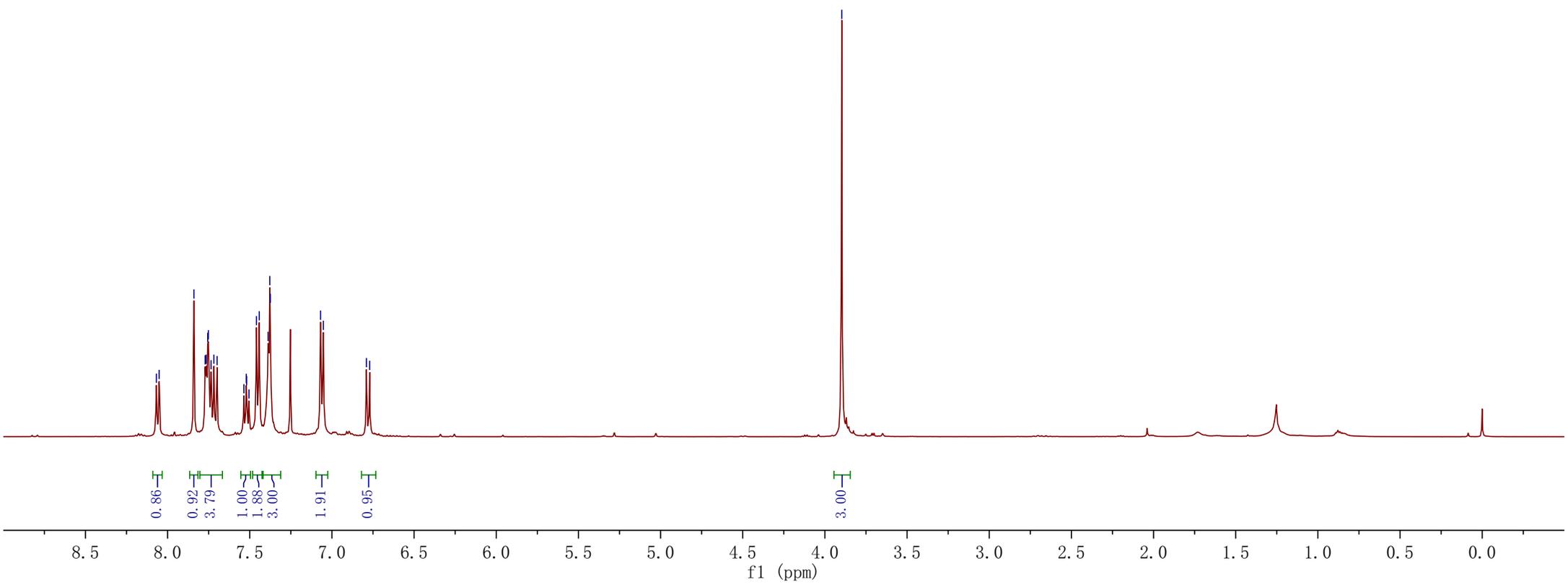
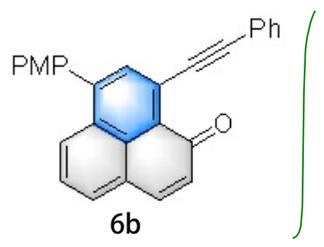
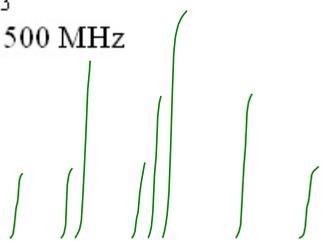


8.068  
8.051  
7.840  
7.771  
7.765  
7.756  
7.752  
7.735  
7.718  
7.699  
7.536  
7.521  
7.519  
7.505  
7.459  
7.442  
7.388  
7.378  
7.375  
7.069  
7.052  
6.790  
6.771

Analysis: <sup>1</sup>H NMR

Solvent: CDCl<sub>3</sub>

Field strength: 500 MHz



184.25

159.83

146.06

140.51

138.71

132.53

131.43

131.35

130.93

130.23

130.12

129.57

128.98

128.52

128.40

128.35

128.02

126.49

125.94

123.41

113.99

98.13

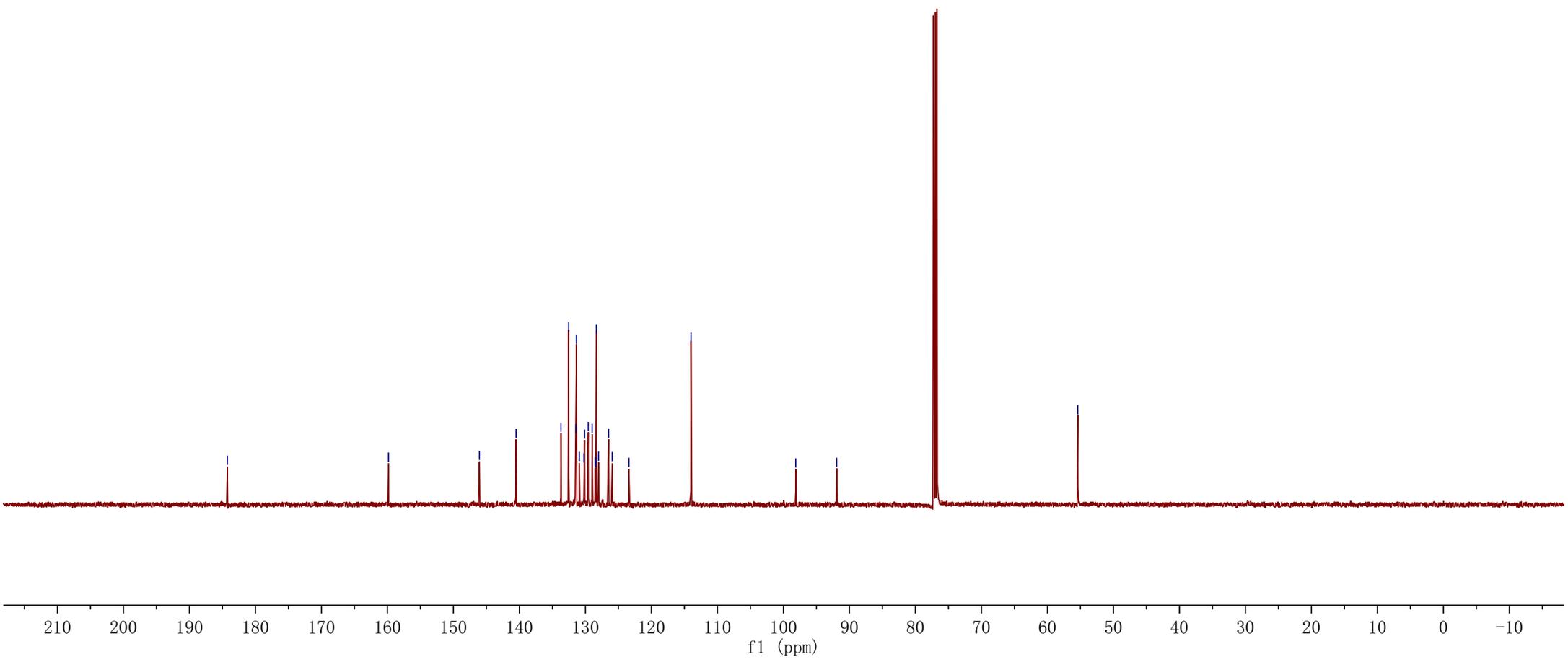
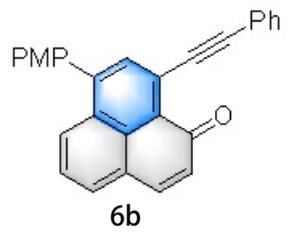
91.93

55.40

Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 125 MHz



Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz

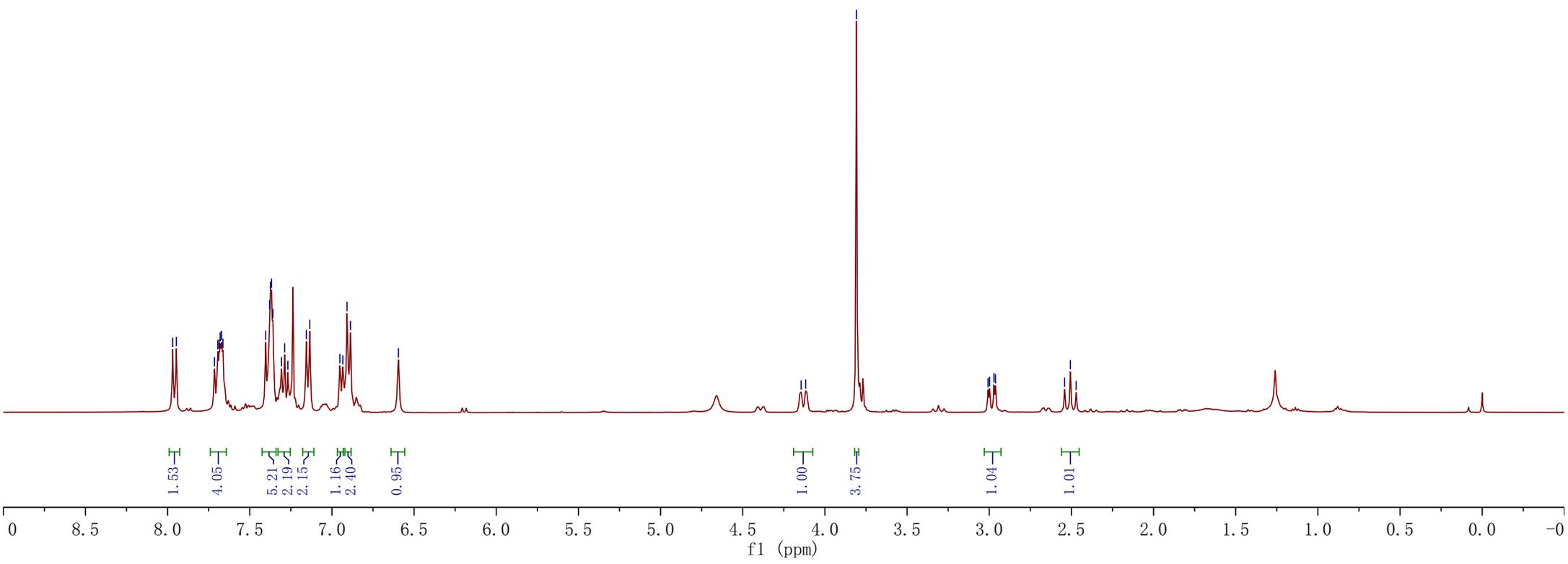
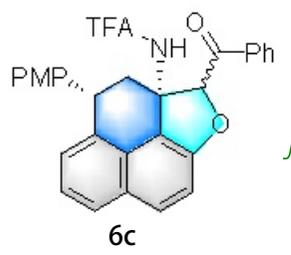
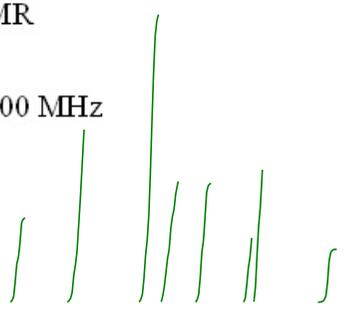
7.969  
7.947  
7.715  
7.694  
7.686  
7.680  
7.671  
7.663  
7.403  
7.379  
7.375  
7.367  
7.359  
7.307  
7.288  
7.268  
7.136  
7.135  
6.952  
6.934  
6.908  
6.887  
6.595

4.145  
4.117

3.808

3.007  
2.998  
2.971  
2.962

2.541  
2.506  
2.471



1.53  
4.05  
5.21  
2.19  
2.15  
1.16  
2.40  
0.95

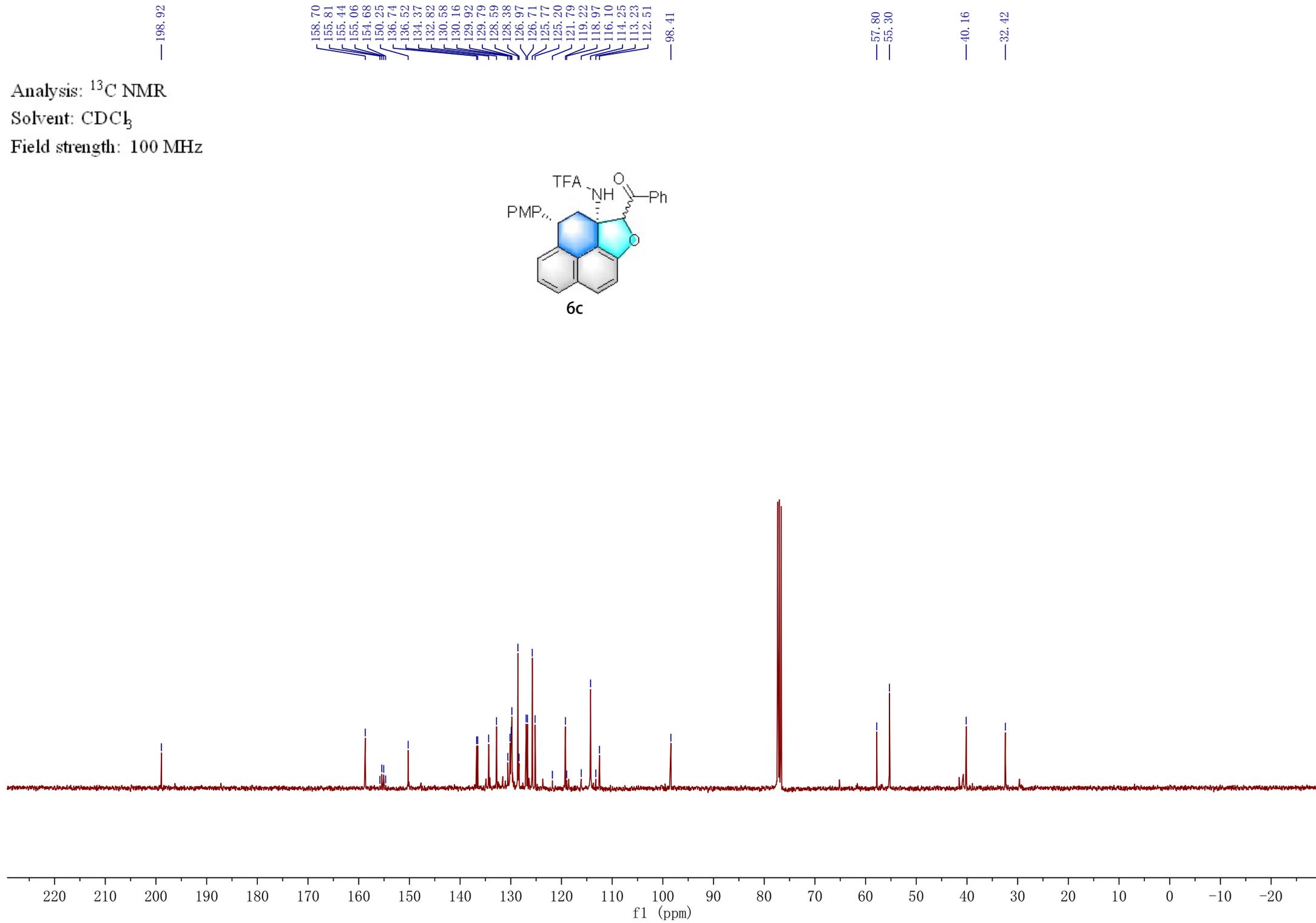
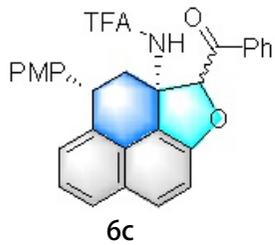
1.00

3.75

1.04

1.01

Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

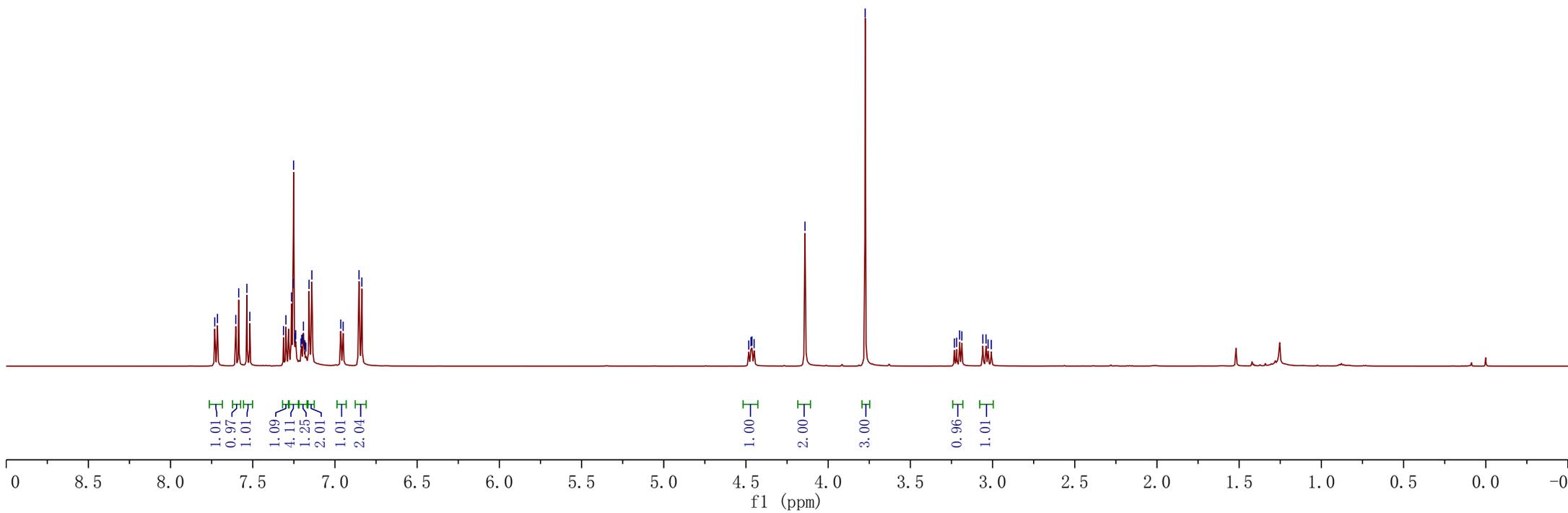
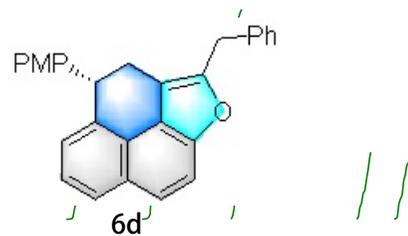


7.731  
7.715  
7.603  
7.585  
7.536  
7.518  
7.313  
7.298  
7.264  
7.256  
7.252  
7.242  
7.239  
7.207  
7.202  
7.195  
7.192  
7.183  
7.177  
7.158  
7.141  
6.965  
6.950  
6.854  
6.837

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 500 MHz



4.483  
4.469  
4.464  
4.450  
4.141  
3.775  
3.232  
3.219  
3.200  
3.187  
3.059  
3.040  
3.027  
3.008



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 125 MHz

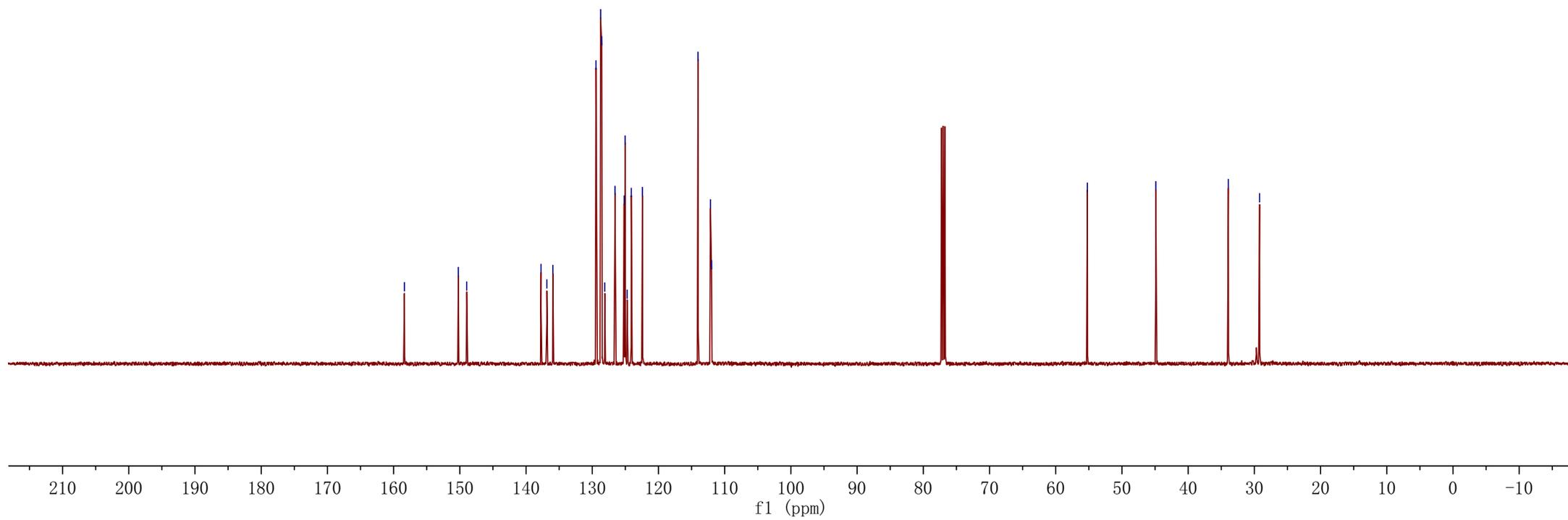
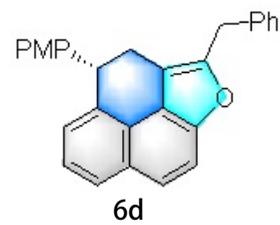
158.37  
150.23  
148.96  
137.74  
136.86  
135.95  
129.44  
128.73  
128.56  
128.12  
126.57  
125.18  
125.04  
124.74  
124.10  
122.43  
114.03  
112.14  
111.98

55.22

44.89

33.93

29.22



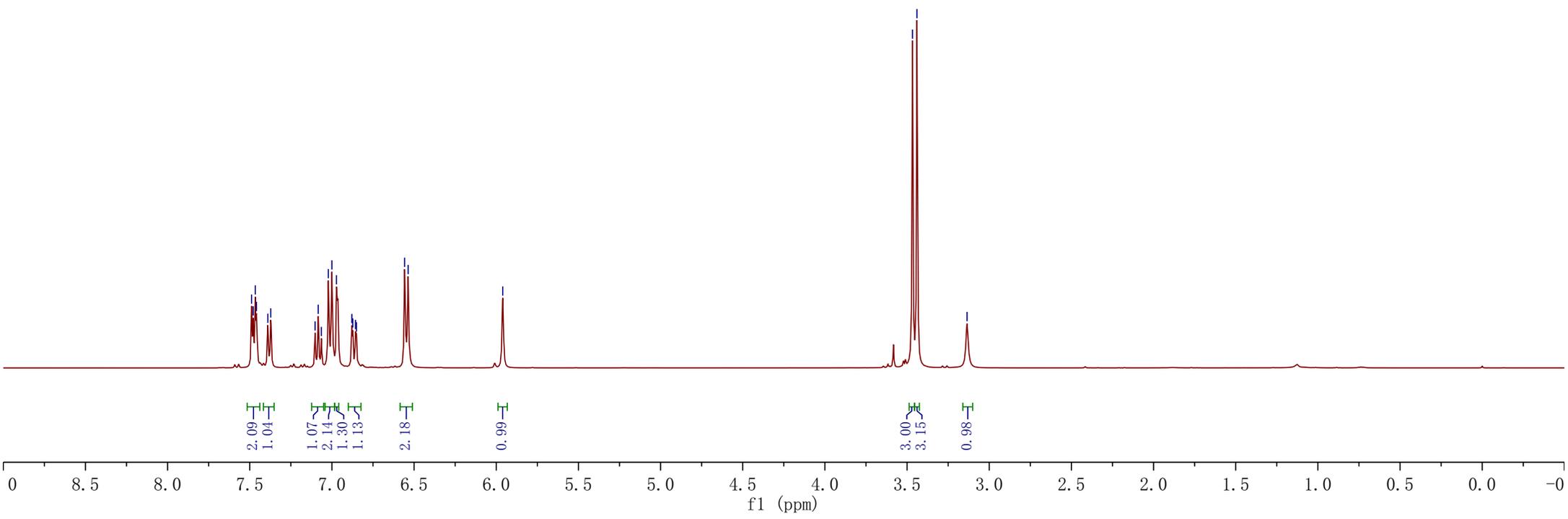
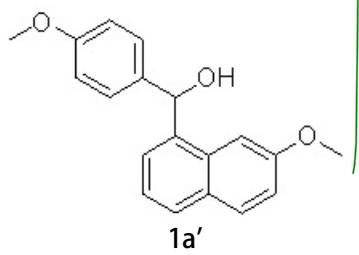
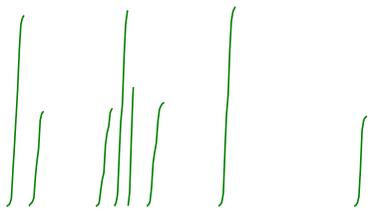
7.489  
7.479  
7.467  
7.459  
7.390  
7.372  
7.103  
7.083  
7.064  
7.022  
7.000  
6.973  
6.879  
6.873  
6.856  
6.851  
6.558  
6.536

5.960

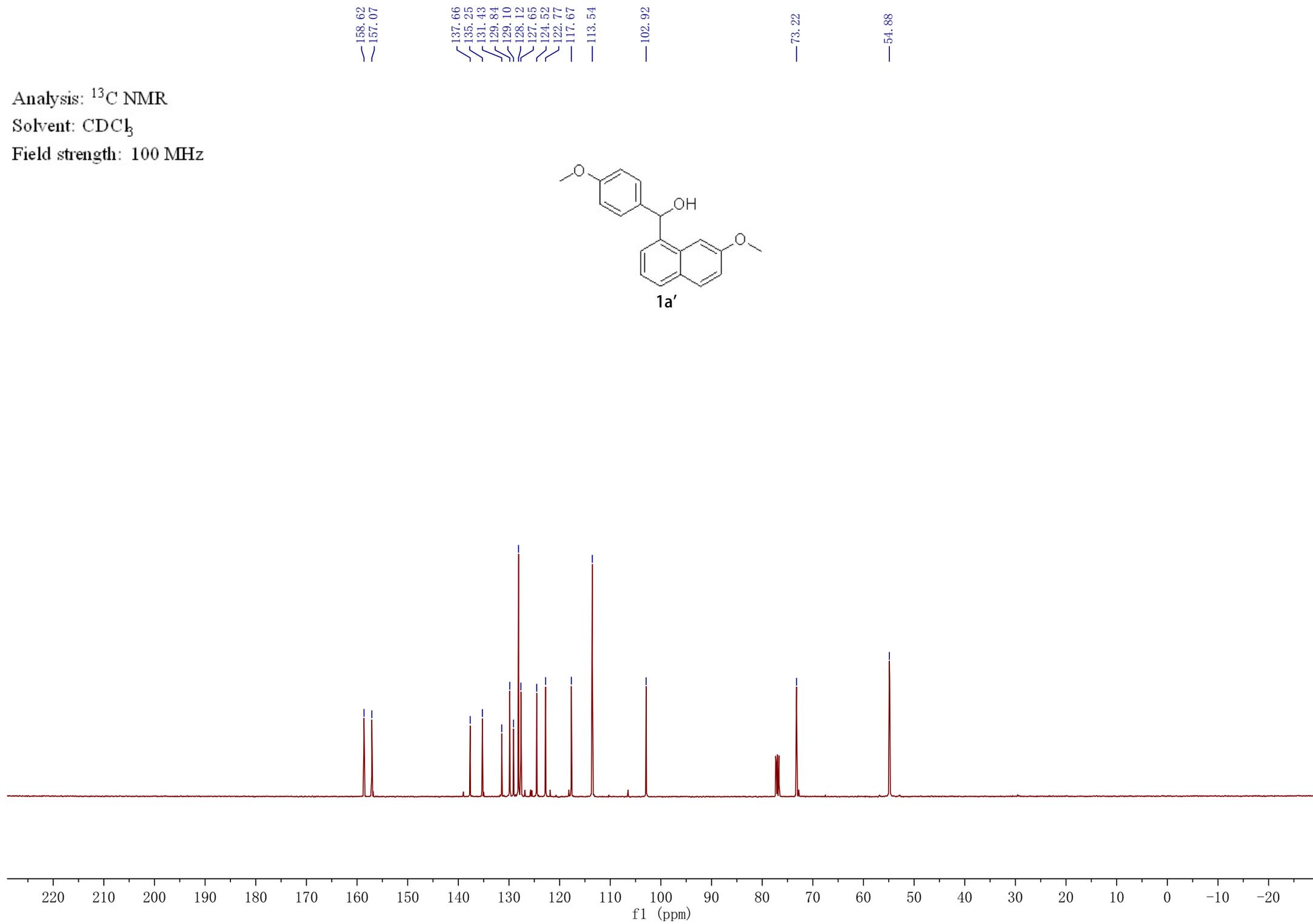
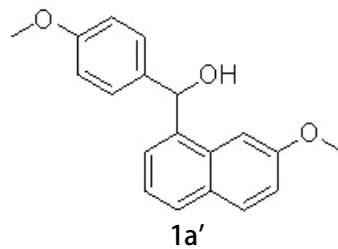
3.467  
3.440

3.135

Analysis:  $^1\text{H}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 400 MHz



Analysis:  $^{13}\text{C}$  NMR  
Solvent:  $\text{CDCl}_3$   
Field strength: 100 MHz

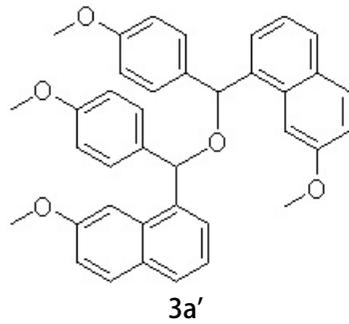
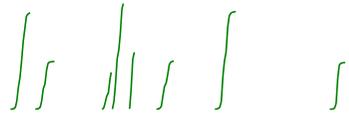


7.732  
7.718  
7.710  
7.698  
7.623  
7.605  
7.346  
7.326  
7.299  
7.278  
7.232  
7.094  
7.069  
6.830  
6.810  
6.326

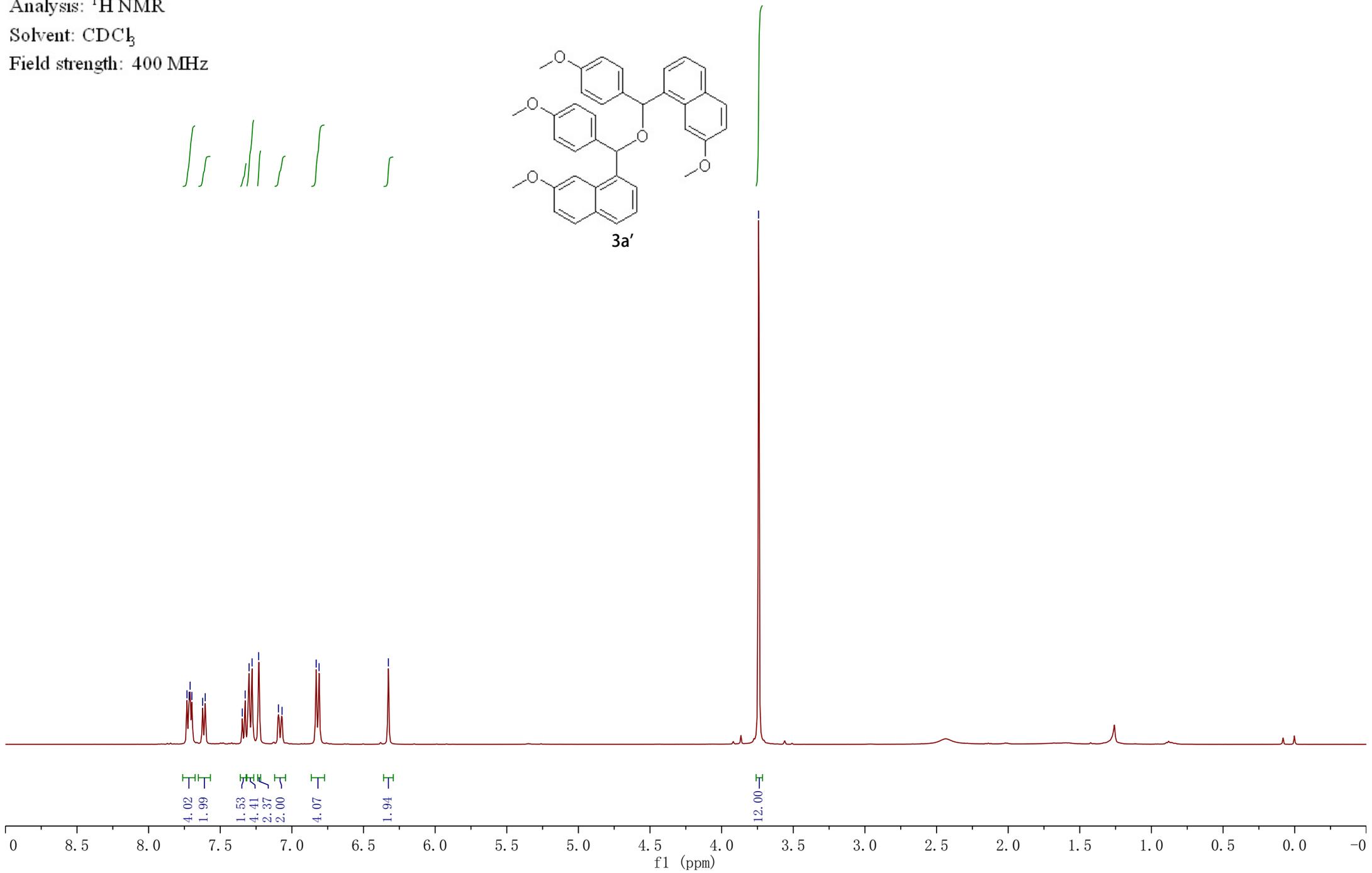
Analysis:  $^1\text{H}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 400 MHz



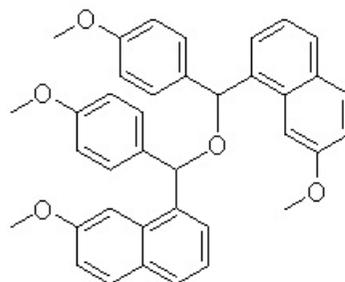
3.742



Analysis:  $^{13}\text{C}$  NMR

Solvent:  $\text{CDCl}_3$

Field strength: 100 MHz



3a'

158.99  
157.42  
137.68  
135.37  
131.64  
130.09  
129.36  
128.24  
128.00  
124.80  
122.94  
117.94  
113.85  
103.06  
73.69  
55.20  
55.10

