

## *Supporting Information*

**Visible-light-induced C(sp<sup>3</sup>)-H thiocyanation of pyrazolin-5-ones:**

**A practical synthesis of 4-thiocyanated 5-hydroxy-1*H*-pyrazoles**

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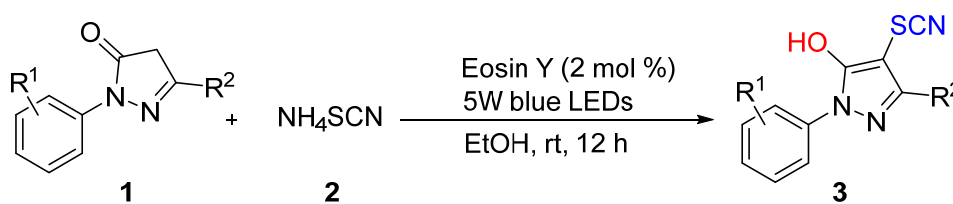
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## 1. General information

All reactions were carried out at room temperature under air unless otherwise stated.  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR and  $^{19}\text{F}$  NMR spectra were recorded on 400 MHz NMR spectrometer using DMSO or Methanol- $\text{D}_4$  as the solvent. Chemical shifts are given as  $\delta$  value (ppm) with reference to tetramethylsilane (TMS) as an internal standard. The peak patterns are indicated as follows: s, singlet; d, doublet; t, triplet; m, multiplet; q, quartet. Unless otherwise obtained, all reagents were obtained from commercial suppliers and used without further purification. Products were purified by flash chromatography on 200–300 mesh silica gels. Infrared spectra were recorded with a Nicolet 5700 spectrometer and are reported in reciprocal centimeter ( $\text{cm}^{-1}$ ). HRMS data were measured on a Synapt G2-Si instrument.

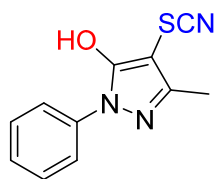
## 2. Experimental section

### 2.1 Representative procedure for the model reaction

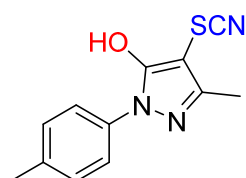


Pyrazolone (**1**, 0.5 mmol, 1.0 eq.) was added to a 10 mL Schlenk bottle with a high vacuum PTFE valve-glass sea.  $\text{NH}_4\text{SCN}$  (**2**, 1.5 mmol, 3.0 eq.), Eosin Y (2 mol%) and EtOH (2 mL) were then added. The reaction was stirred under blue LEDs irradiation for 12 h. At the end of the reaction, the solvent was removed in vacuum and the product was purified by silica gel chromatography using DCM/methanol (6:1 ~ 12:1, v/v) as eluent to give the pure product **3**.

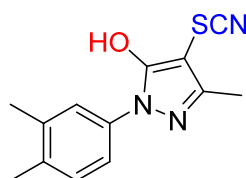
### 3. Characterization data of products



**3-methyl-1-phenyl-4-thiocyanato-1H-pyrazol-5-ol (3a).** Yellow solid, Yield: 84%.  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  7.77–7.62 (m, 2H), 7.55–7.45 (m, 2H), 7.38–7.26 (m, 1H), 2.29 (s, 3H);  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  157.03, 151.42, 137.87, 129.55, 126.87, 121.68, 112.64, 79.58, 12.69; IR (KBr)  $\nu$ : 3433, 2123, 1655, 1496, 1361, 1015, 823, 761  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{11}\text{H}_8\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 230.0388; found: 230.0391.

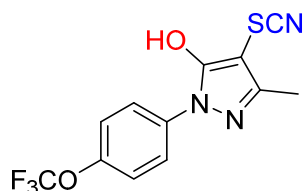


**3-methyl-4-thiocyanato-1-(p-tolyl)-1H-pyrazol-5-ol (3b).** Yellow solid, Yield: 77%;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  7.55 (d,  $J = 8.2$  Hz, 2H), 7.29 (d,  $J = 8.2$  Hz, 2H), 2.34 (s, 3H), 2.27 (s, 3H);  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  156.83, 151.04, 136.28, 135.53, 129.93, 121.73, 112.68, 79.19, 21.00, 12.68; IR (KBr)  $\nu$ : 3441, 2121, 1653, 1516, 1363, 1022, 821, 762  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{12}\text{H}_{10}\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 244.0545; found: 244.0547.



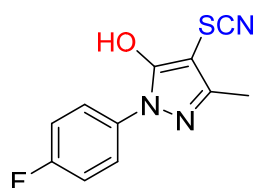
**1-(3,4-dimethylphenyl)-3-methyl-4-thiocyanato-1H-pyrazol-5-ol (3c).** Yellow solid, Yield: 85%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.35 (s, 1H), 7.28 (d,  $J = 8.2$  Hz, 1H), 7.22 (d,  $J = 8.2$  Hz, 1H), 2.37 (s, 3H), 2.29 (d,  $J = 6.6$  Hz, 6H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  158.57, 150.94, 137.53, 136.05, 133.98, 129.82, 123.28,

119.72, 110.86, 80.68, 18.55, 18.07, 10.43; IR (KBr)  $\nu$ : 3447, 2156, 1625, 1502, 1445, 1211, 974, 797  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{13}\text{H}_{12}\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 258.0701; found: 258.0705.

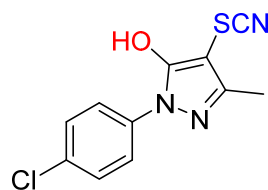


**3-methyl-4-thiocyanato-1-(4-(trifluoromethoxy)phenyl)-1H-pyrazol-5-ol (3d)**

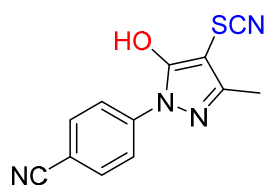
Yellow solid, Yield: 81%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.76 (d,  $J = 8.7$  Hz, 2H), 7.41 (d,  $J = 8.7$  Hz, 2H), 2.38 (s, 3H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  158.03, 152.11, 147.36, 135.64, 123.30, 121.57, 120.49 (q,  $J_{\text{CF}} = 128.3$  Hz), 120.49 (q,  $J_{\text{CF}} = 384.8$  Hz), 110.80, 80.49, 10.74;  $^{19}\text{F}$  NMR (377 MHz, methanol- $d_4$ )  $\delta$  -59.63 (s, 3F); IR (KBr)  $\nu$ : 3429, 2160, 1631, 1510, 1267, 1215, 1167, 841  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{12}\text{H}_7\text{F}_3\text{N}_3\text{O}_2\text{S}$  ( $[\text{M}-\text{H}]^-$ ): 314.0211; found: 314.0208.



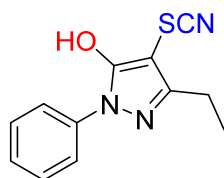
**1-(4-fluorophenyl)-3-methyl-4-thiocyanato-1H-pyrazol-5-ol (3e).** Yellow solid, Yield: 71%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.80–7.66 (m, 2H), 7.17–7.06 (m, 2H), 2.23 (s, 3H) ppm.  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  163.83, 159.95(d,  $J_{\text{CF}} = 121.2$  Hz), 150.97, 136.16 (d,  $J_{\text{CF}} = 3.0$  Hz), 122.89 (d,  $J_{\text{CF}} = 8.1$  Hz), 114.67 (d,  $J_{\text{CF}} = 11.6$  Hz), 113.30, 72.62, 11.71;  $^{19}\text{F}$  NMR (377 MHz, methanol- $d_4$ )  $\delta$  -120.29 (s, 1F); IR (KBr)  $\nu$ : 3375, 2158, 1616, 1493, 1410, 1323, 833, 741  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{11}\text{H}_7\text{FN}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 248.0654; found: 248.0651.



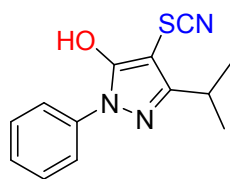
**1-(4-chlorophenyl)-3-methyl-4-thiocyanato-1H-pyrazol-5-ol (3f).** Yellow solid, Yield: 72%;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  7.74 (d,  $J$  = 8.6 Hz, 2H), 7.55 (d,  $J$  = 8.5 Hz, 2H), 2.28 (s, 3H);  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  157.14, 151.84, 136.80, 130.83, 129.53, 122.94, 112.55, 79.78, 12.73; IR (KBr)  $\nu$ : 3442, 2155, 1626, 1491, 1328, 834, 740  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{11}\text{H}_7\text{ClN}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 263.9999; found: 263.9995.



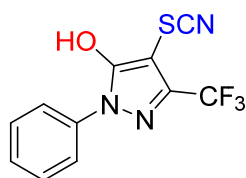
**1-(4-cyanophenyl)-3-methyl-4-thiocyanato-1H-pyrazol-5-ol (3g).** Yellow solid, Yield: 66%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  8.14 (d,  $J$  = 8.7 Hz, 2H), 7.69 (d,  $J$  = 8.7 Hz, 2H), 2.25 (s, 3H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  165.23, 152.96, 143.94, 132.49, 119.05, 118.75, 113.08, 105.72, 73.09, 11.92; IR (KBr)  $\nu$ : 3445, 2233, 2142, 1606, 1513, 976, 829  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{12}\text{H}_7\text{N}_4\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 255.0341; found: 255.0338.



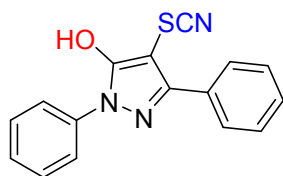
**3-ethyl-1-phenyl-4-thiocyanato-1H-pyrazol-5-ol (3h).** Yellow solid, Yield: 61%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.62–7.61 (m, 2H), 7.51–7.45 (m, 2H), 7.39–7.32 (m, 1H), 2.81–2.74 (m, 2H), 1.37–1.31 (m, 3H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  158.52, 156.45, 136.63, 128.87, 127.07, 122.28, 111.21, 79.46, 19.73, 11.72; IR (KBr)  $\nu$ : 2980, 2156, 1626, 1496, 1305, 824, 723  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{12}\text{H}_{10}\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 244.0545; found: 244.0542.



**3-(iso-propyl)-1-phenyl-4-thiocyanato-1H-pyrazol-5-ol (3i).** Yellow solid, Yield: 68%;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  8.08–8.06 (m, 2H), 7.29–7.23 (m, 2H), 6.96–6.90 (m, 1H), 2.96–2.87 (m, 1H), 1.27–1.23 (m, 6H);  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  165.93, 157.87, 142.26, 128.54, 121.88, 117.67, 115.32, 65.31, 28.08, 21.83; IR (KBr)  $\nu$ : 3448, 2928, 2155, 1603, 1503, 1365, 1105, 756  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{13}\text{H}_{12}\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 258.0701; found: 258.0698.

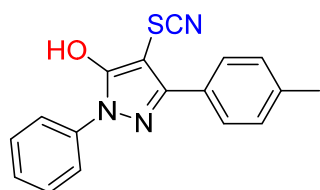


**1-phenyl-4-thiocyanato-3-(trifluoromethyl)-1H-pyrazol-5-ol(3j)** Yellow solid, Yield: 83%;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  8.04 (d,  $J = 7.8$  Hz, 2H), 7.41–7.33 (m, 2H), 7.15–7.08 (m, 1H);  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  164.76, 141.00, 140.72, 128.93, 124.17, 121.96 (q,  $J_{\text{CF}} = 270.7$  Hz), 121.96 (q,  $J_{\text{CF}} = 406.0$  Hz), 118.97, 113.91, 66.33;  $^{19}\text{F}$  NMR (377 MHz, DMSO- $d_6$ )  $\delta$  –62.23 (s, 3F); IR (KBr)  $\nu$ : 3443, 2123, 1636, 1475, 1175, 1120, 1022, 762  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{11}\text{H}_5\text{F}_3\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 284.0106; found: 284.0102.

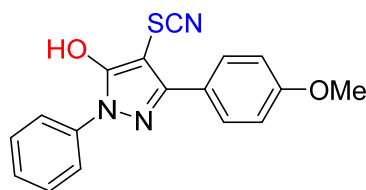


**1,3-diphenyl-4-thiocyanato-1H-pyrazol-5-ol (3k).** Yellow solid, Yield: 73%;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  8.21–8.10 (m, 2H), 7.93–7.84 (m, 2H), 7.51–7.42 (m, 2H), 7.39–7.30 (m, 3H), 7.07–6.97 (m, 1H);  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  166.02, 150.28, 141.82, 134.88, 128.72, 128.65, 128.05, 127.47, 122.84, 118.30,

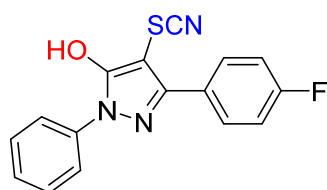
115.32, 66.66; IR (KBr)  $\nu$ : 3454, 2153, 1638, 1495, 1251, 1121, 1020  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{16}\text{H}_{10}\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 292.0545; found: 292.0540.



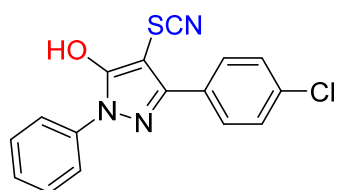
**1-phenyl-4-thiocyanato-3-(*p*-tolyl)-1*H*-pyrazol-5-ol (3l).** Yellow solid, Yield: 87%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.82–7.76 (m, 2H), 7.76–7.70 (m, 2H), 7.47–7.41 (m, 2H), 7.34–7.24 (m, 3H), 2.40 (s, 3H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  159.26, 150.85, 137.27, 136.93, 127.39, 127.20, 126.94, 126.17, 124.42, 120.49, 111.12, 73.71, 18.43; IR (KBr)  $\nu$ : 3381, 2930, 2152, 1611, 1497, 1310, 823, 762  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{17}\text{H}_{12}\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 306.0701; found: 306.0703.



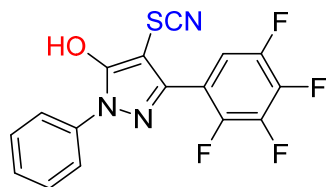
**3-(4-methoxyphenyl)-1-phenyl-4-thiocyanato-1*H*-pyrazol-5-ol (3m).** Yellow solid, Yield: 77%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.80 (d,  $J = 8.6$  Hz, 2H), 7.72 (d,  $J = 8.6$  Hz, 2H), 7.55–7.44 (m, 2H), 7.41–7.31 (m, 1H), 7.08–7.06 (m, 2H), 3.85 (s, 3H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  161.04, 158.63, 152.32, 137.20, 129.34, 128.81, 126.97, 122.30, 121.70, 113.82, 111.67, 78.25, 54.52; IR (KBr)  $\nu$ : 3435, 2155, 1612, 1501, 1402, 1253, 1028, 831  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{17}\text{H}_{12}\text{N}_3\text{O}_2\text{S}$  ( $[\text{M}-\text{H}]^-$ ): 322.0650; found: 322.0647.



**3-(4-fluorophenyl)-1-phenyl-4-thiocyanato-1H-pyrazol-5-ol (3n)** Yellow solid, Yield: 61%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.90–7.82 (m, 4H), 7.42–7.36 (m, 2H), 7.23–7.14 (m, 3H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  164.21, 162.87 (d,  $J_{\text{CF}} = 245.0$  Hz), 151.23, 139.85, 129.75 (d,  $J_{\text{CF}} = 3.0$  Hz), 129.64 (d,  $J_{\text{CF}} = 4.0$  Hz), 128.24, 124.85, 121.60, 114.71 (d,  $J_{\text{CF}} = 10.0$  Hz), 113.89, 71.81;  $^{19}\text{F}$  NMR (377 MHz, methanol- $d_4$ )  $\delta$  –115.76 (s, 1F); IR (KBr)  $\nu$ : 3441, 2158, 1562, 1512, 1219, 1089, 839  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{16}\text{H}_9\text{FN}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 310.0451; found: 310.0455.



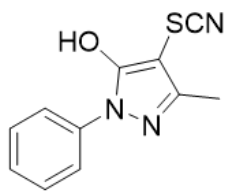
**3-(4-chlorophenyl)-1-phenyl-4-thiocyanato-1H-pyrazol-5-ol (3o)** Yellow solid, Yield: 69%;  $^1\text{H}$  NMR (400 MHz, DMSO- $d_6$ )  $\delta$  8.36–8.07 (m, 2H), 8.06–7.81 (m, 2H), 7.67–7.47 (m, 2H), 7.45–7.29 (m, 2H), 7.15–6.96 (m, 1H);  $^{13}\text{C}$  NMR (101 MHz, DMSO- $d_6$ )  $\delta$  165.71, 148.84, 145.47, 141.67, 133.69, 132.64, 128.97, 128.76, 123.07, 118.47, 115.11, 67.02; IR (KBr)  $\nu$ : 3439, 2124, 1654, 1020, 824, 762  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{16}\text{H}_9\text{ClN}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 326.0155; found: 326.0152.



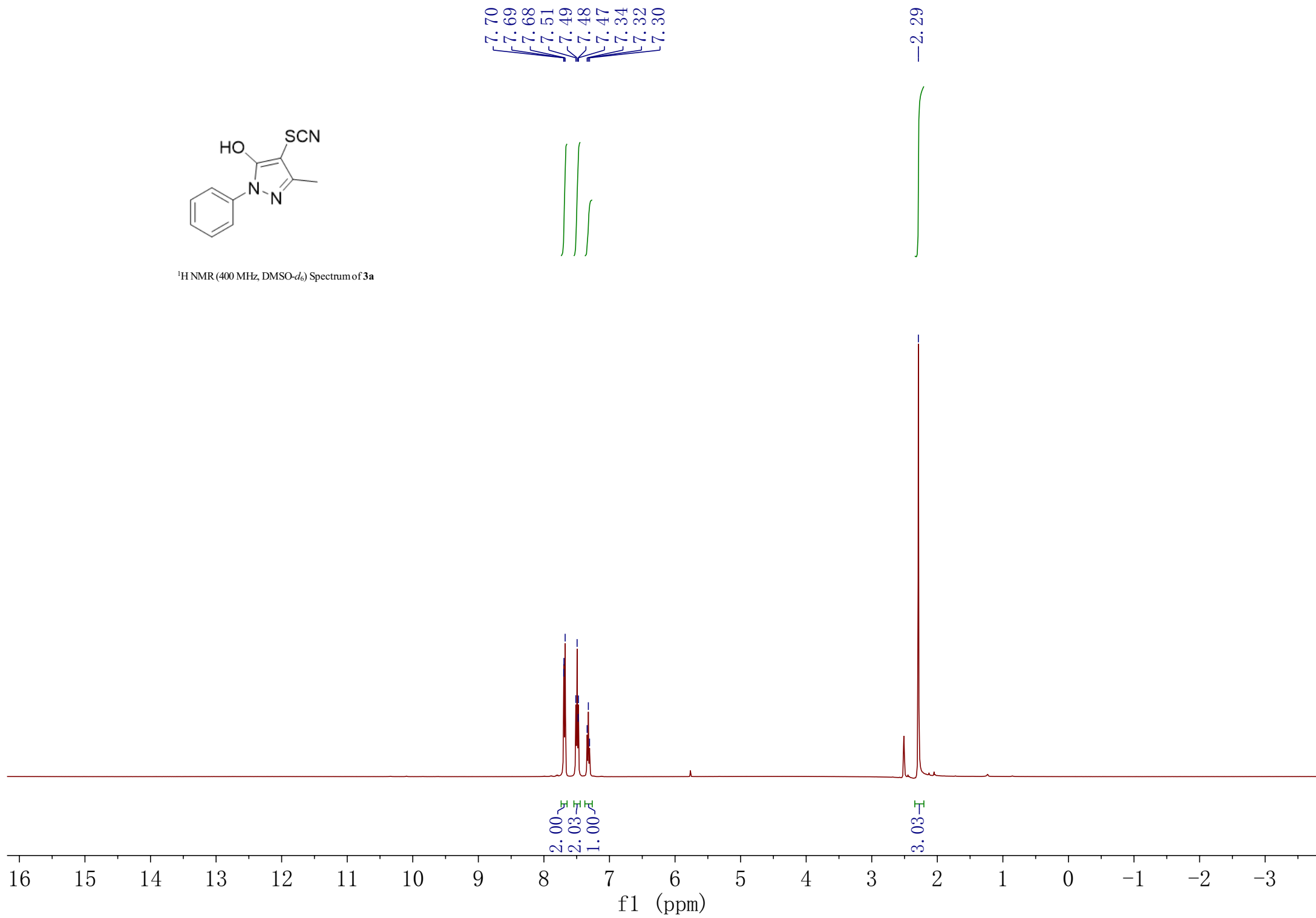
**1-phenyl-3-(2,3,4,5-tetrafluorophenyl)-4-thiocyanato-1H-pyrazol-5-ol (3p).** Yellow solid, Yield: 65%;  $^1\text{H}$  NMR (400 MHz, methanol- $d_4$ )  $\delta$  7.85–7.83 (m, 2H), 7.44–7.33 (m, 3H), 7.24–7.18 (m, 1H);  $^{13}\text{C}$  NMR (101 MHz, methanol- $d_4$ )  $\delta$  164.22, 145.65, 141.61, 139.76, 139.08, 128.25, 125.01, 121.39, 118.48, 118.26, 115.28, 113.03, 112.06, 73.52;  $^{19}\text{F}$  NMR (376 MHz, methanol- $d_4$ )  $\delta$  –140.33 ~ –140.43 (m, 1F), –142.03 ~ –142.14 (m, 1F), –158.61 ~ –158.81 (m, 2F); IR (KBr)  $\nu$ : 3406, 2155, 1541, 1490, 1057, 982, 865, 762  $\text{cm}^{-1}$ ; HRMS (ESI) calcd for  $\text{C}_{16}\text{H}_6\text{F}_4\text{N}_3\text{OS}$  ( $[\text{M}-\text{H}]^-$ ): 364.0168; found: 364.0165.

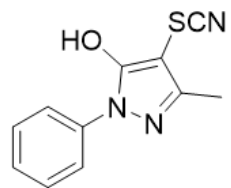
#### 4. $^1\text{H}$ , $^{13}\text{C}$ and $^{19}\text{F}$ NMR spectra of the products





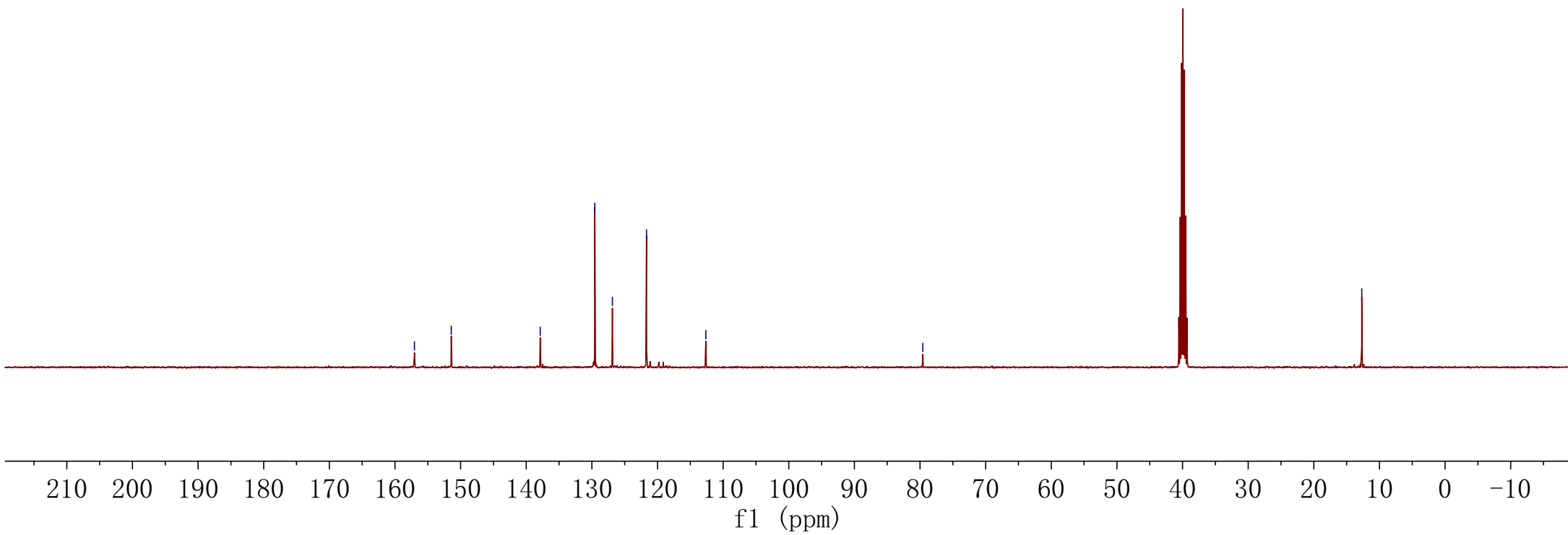
<sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) Spectrum of 3a

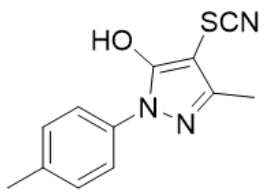




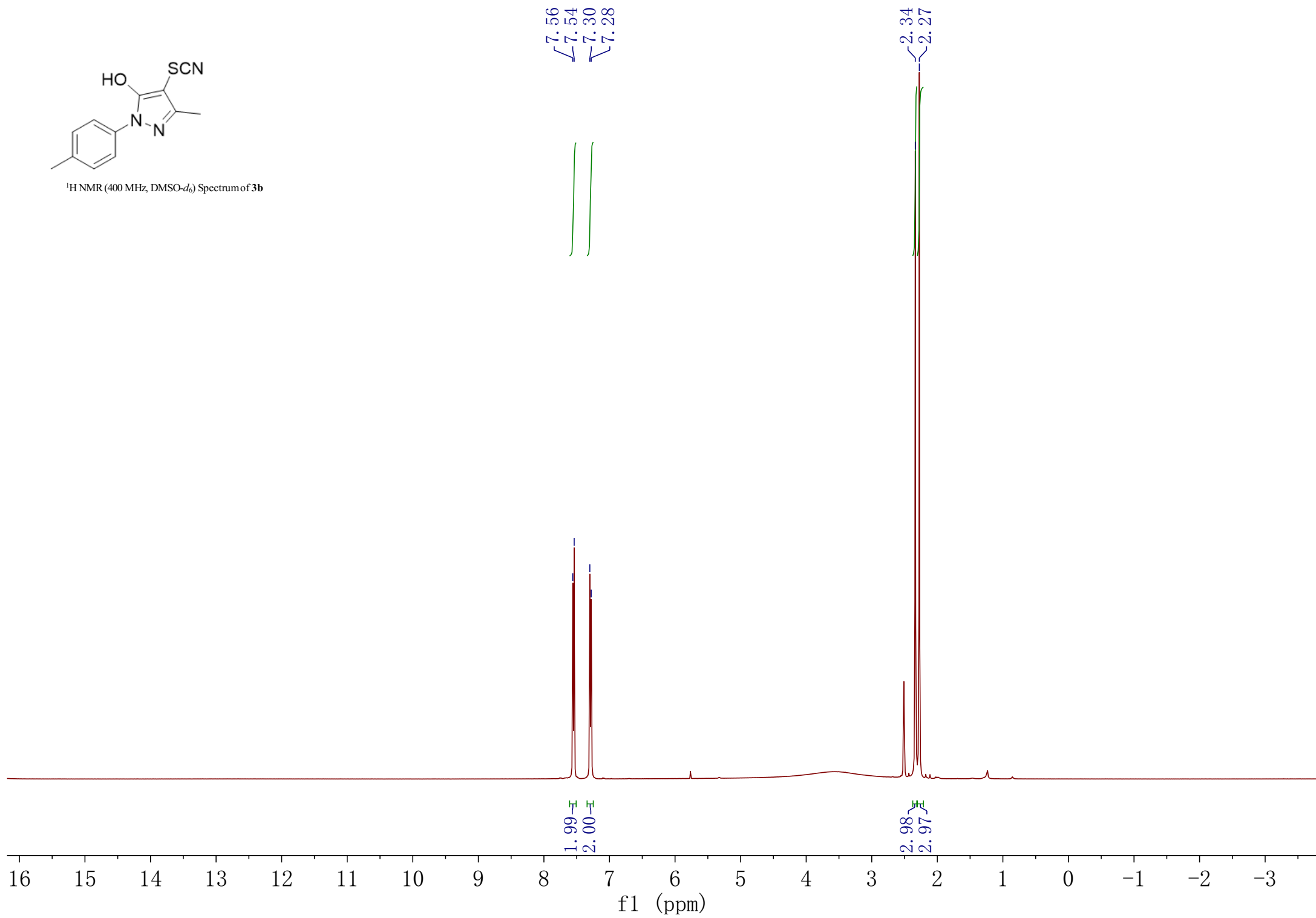
<sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) Spectrum of **3a**

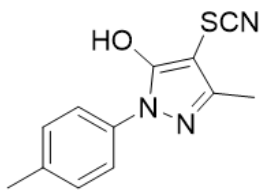
—157.03  
—151.42  
—137.87  
~129.55  
~126.87  
~121.68  
—112.64  
  
—79.58  
  
—12.69



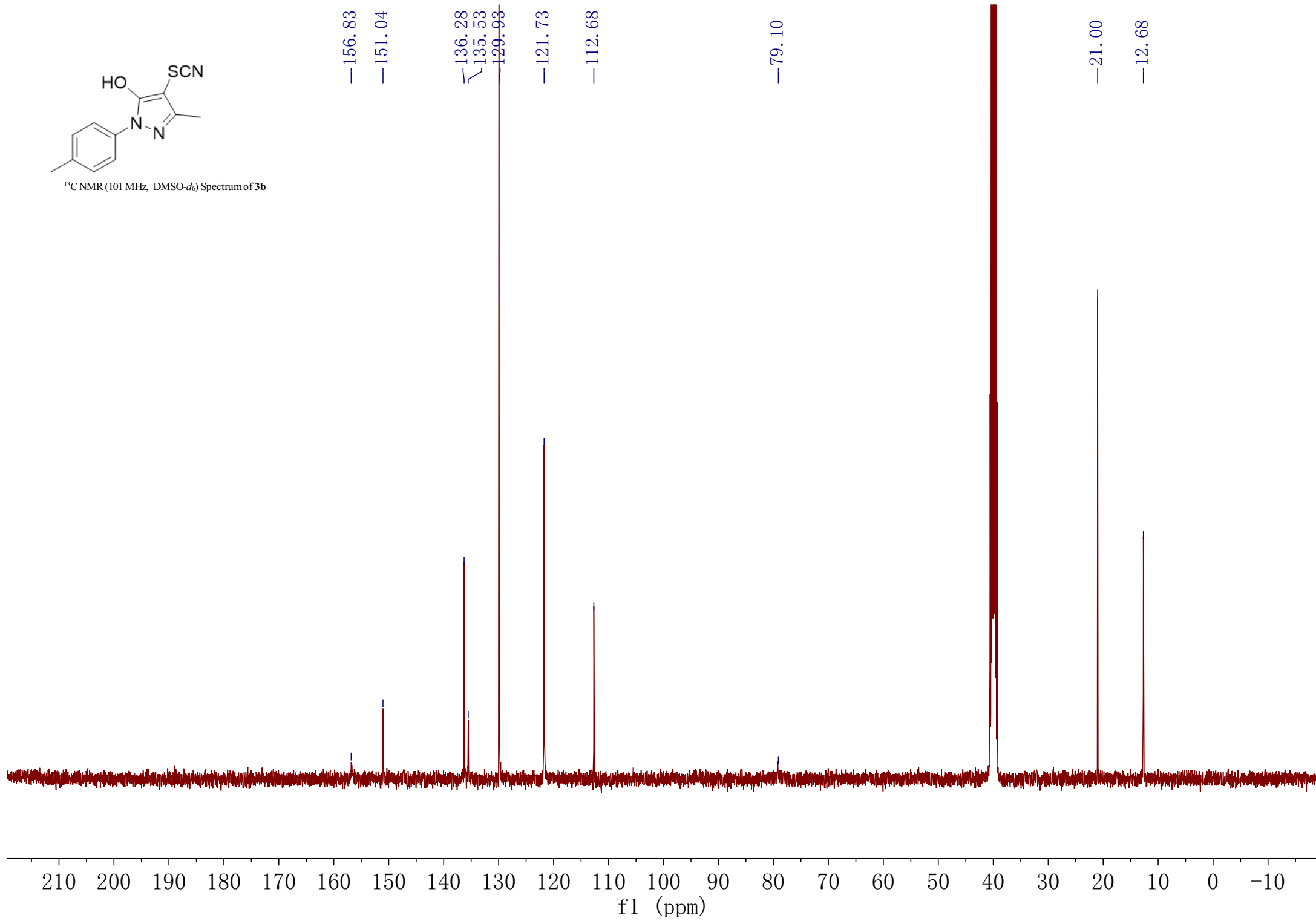


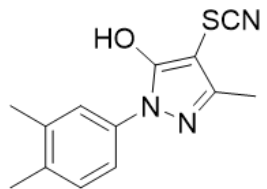
<sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) Spectrum of **3b**



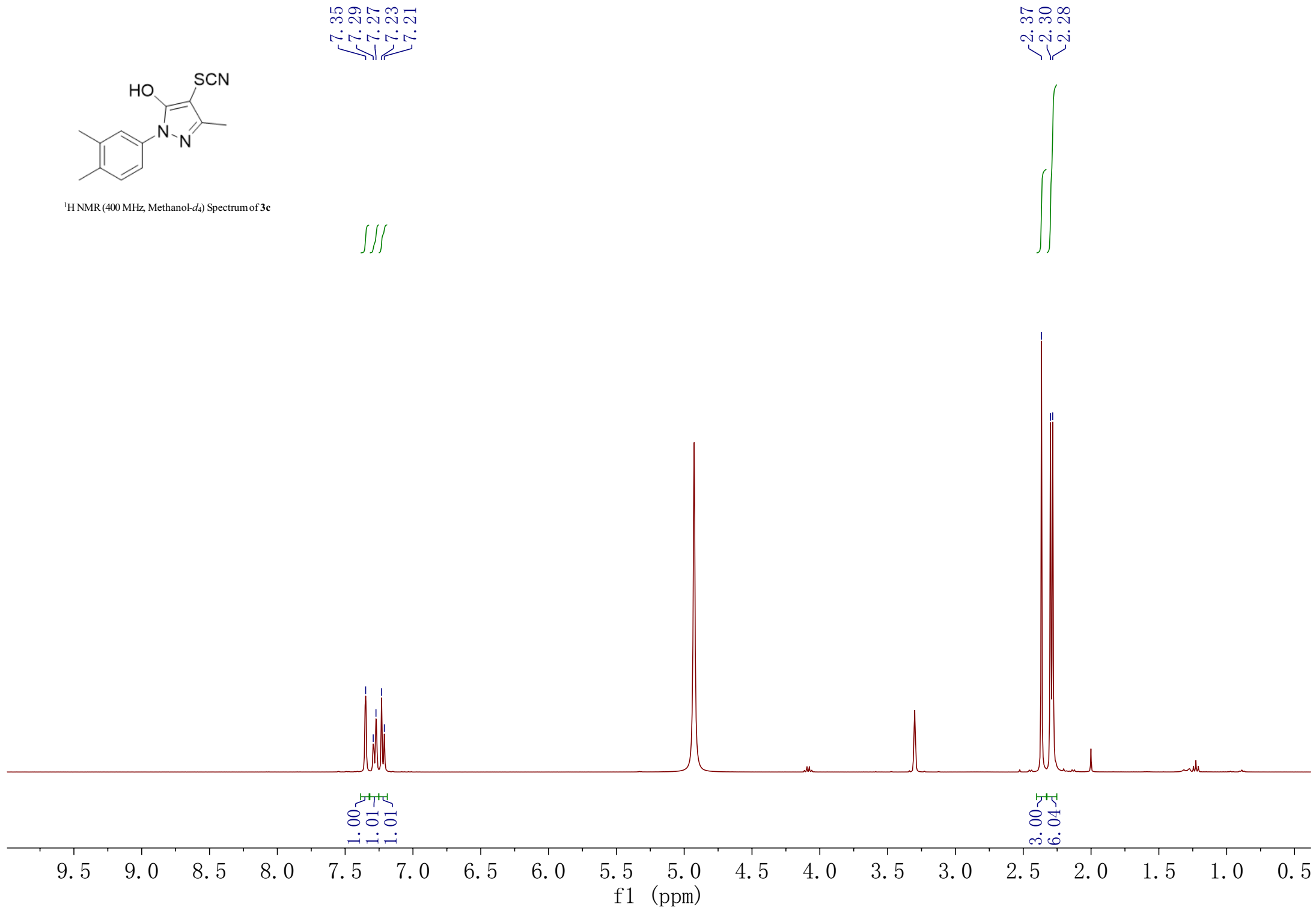


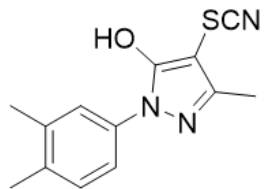
<sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) Spectrum of **3b**



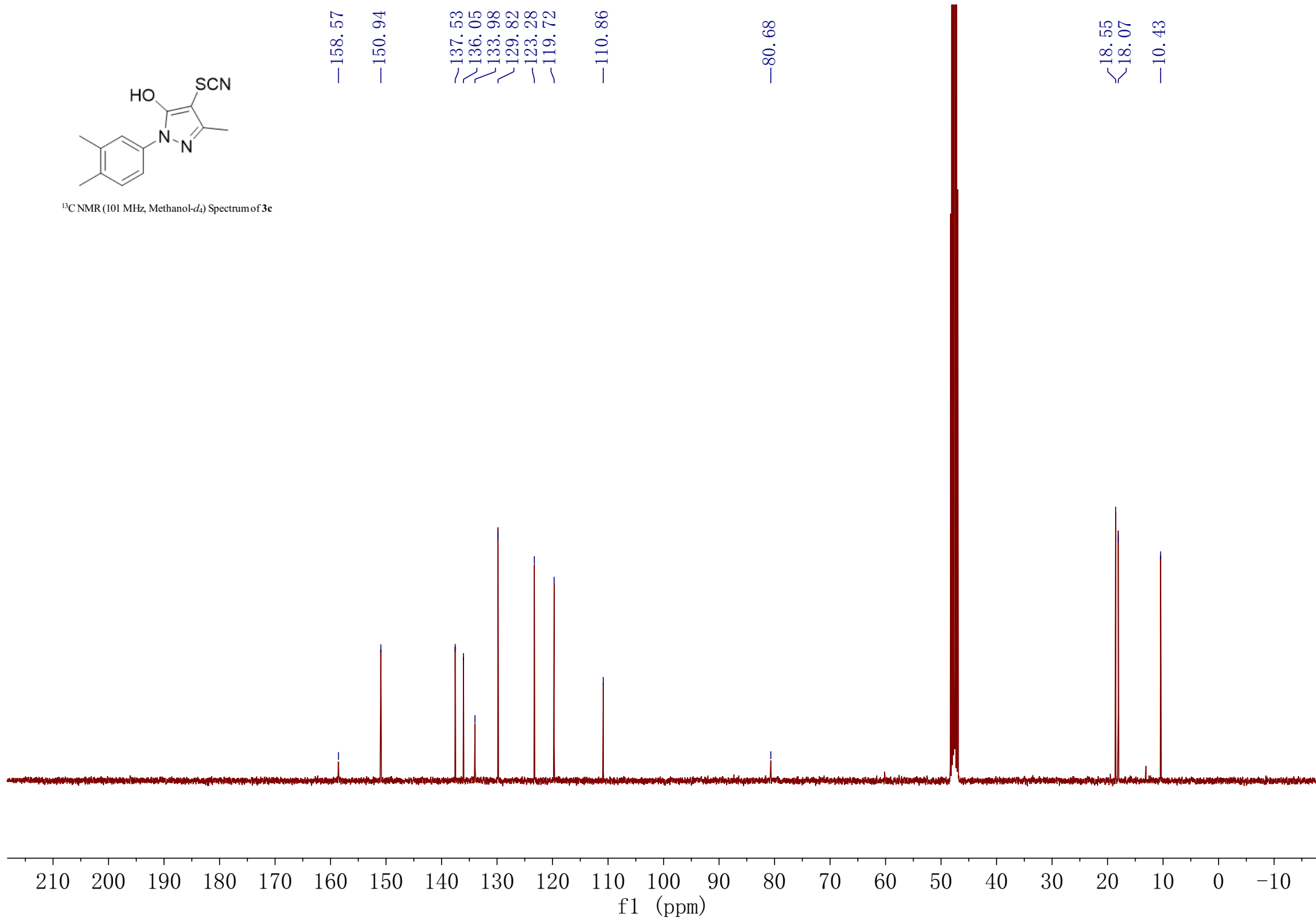


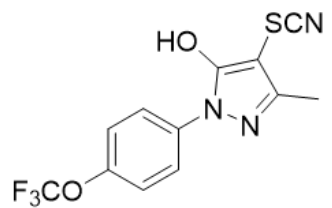
<sup>1</sup>H NMR (400 MHz, Methanol-d<sub>4</sub>) Spectrum of 3c



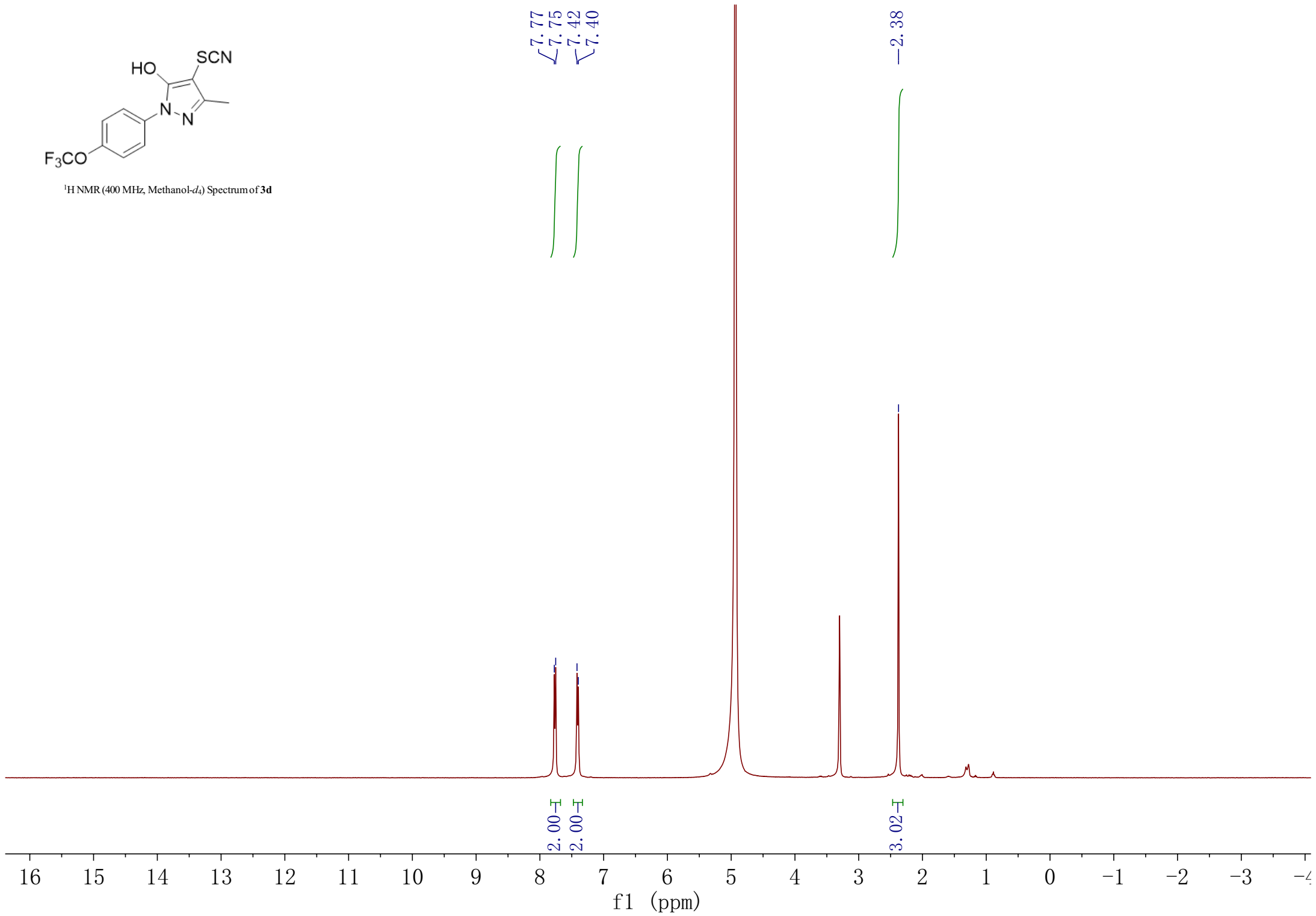


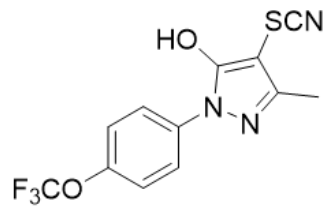
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3c



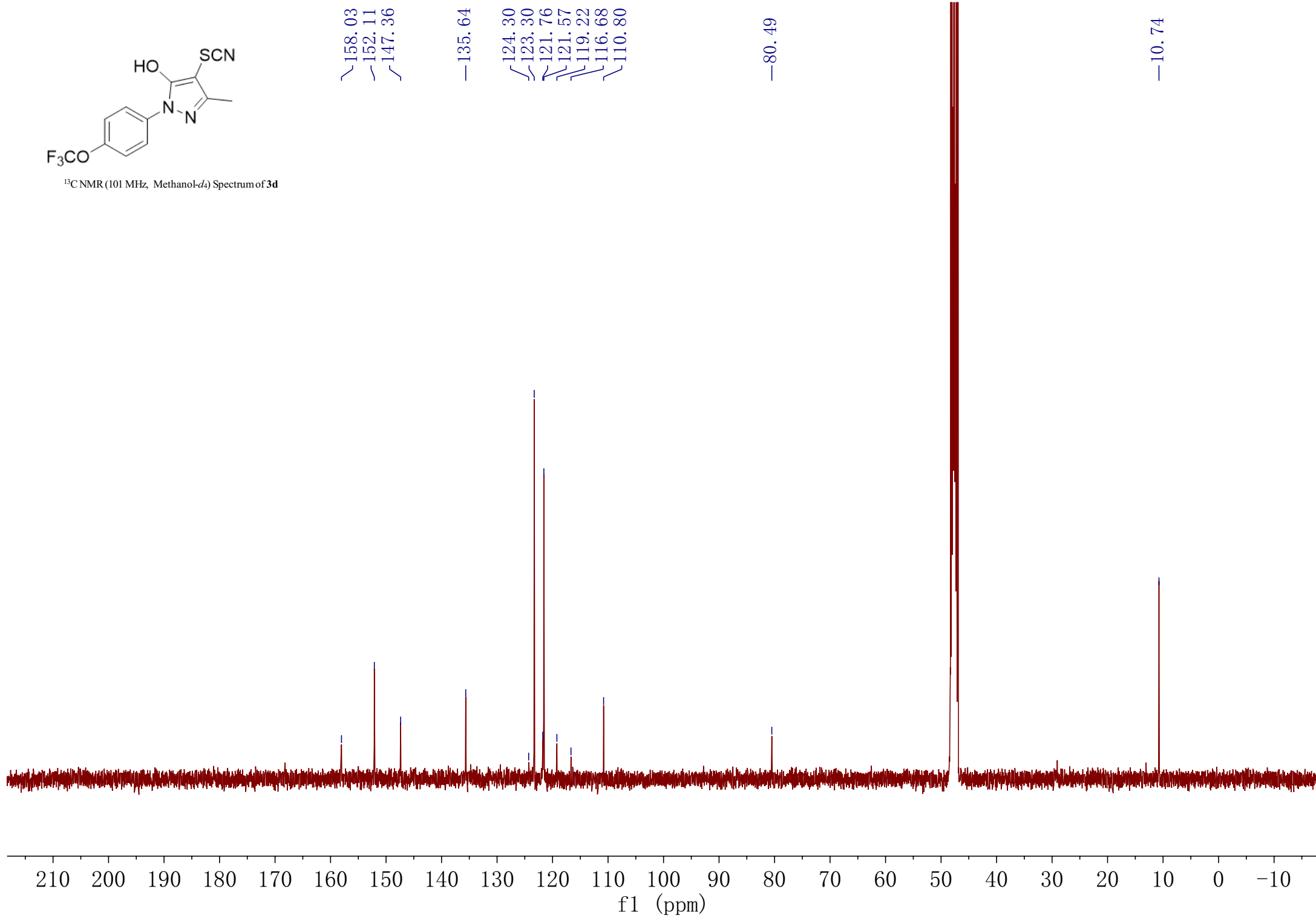


<sup>1</sup>H NMR (400 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3d

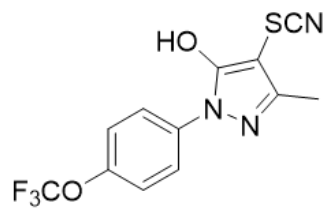




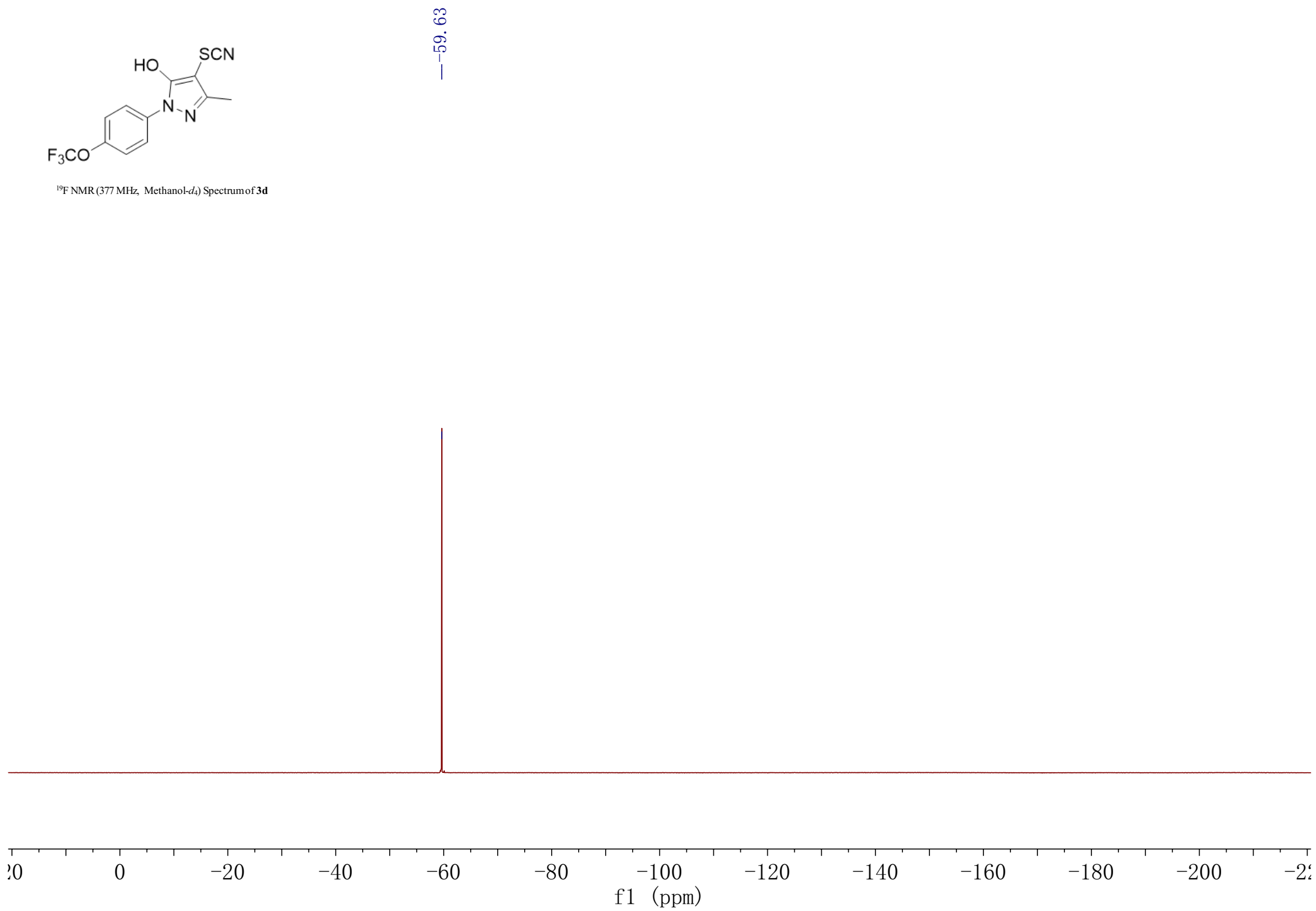
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3d

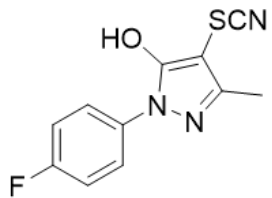




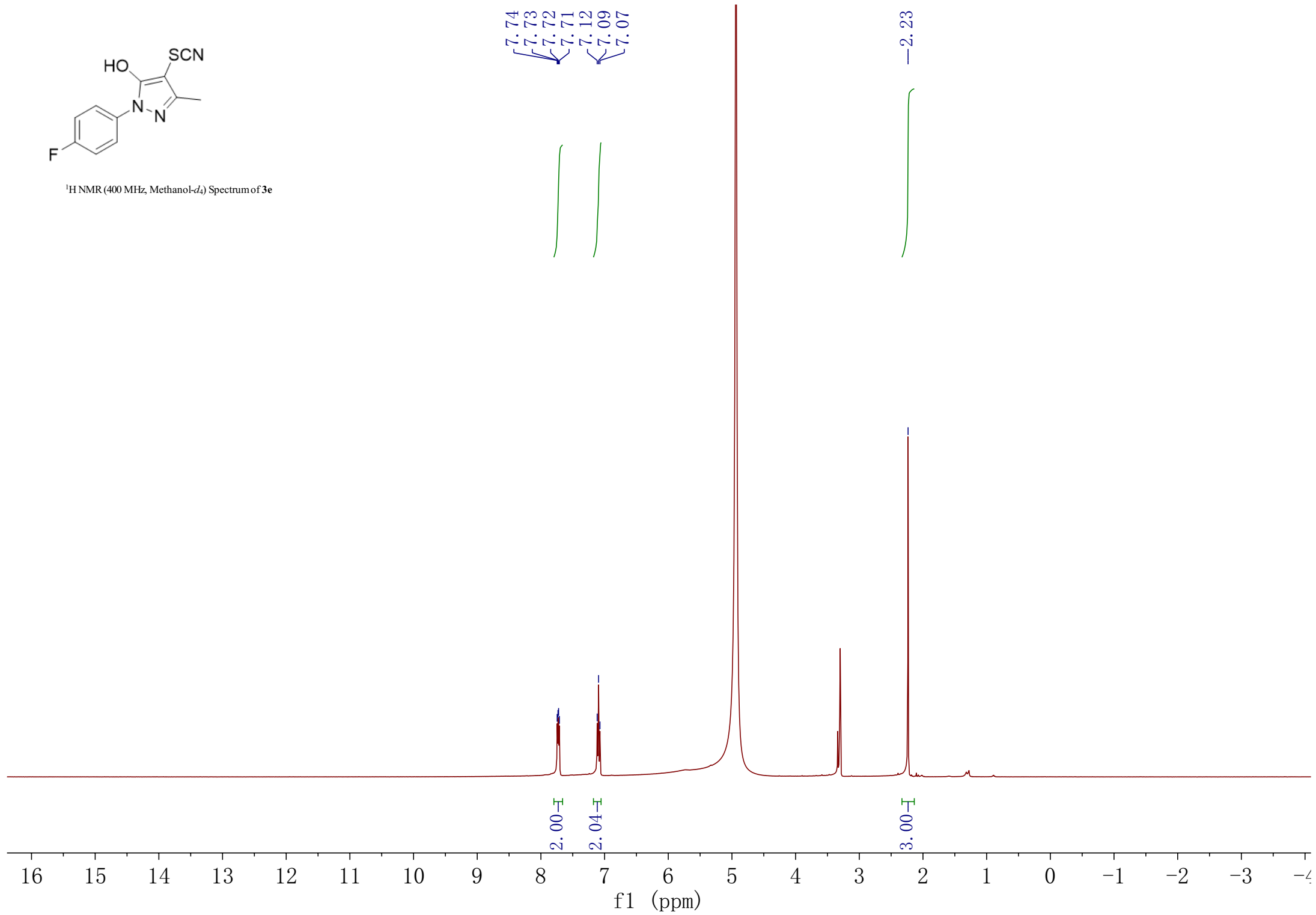


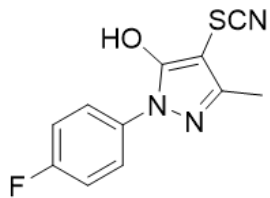
<sup>19</sup>F NMR (377 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3d



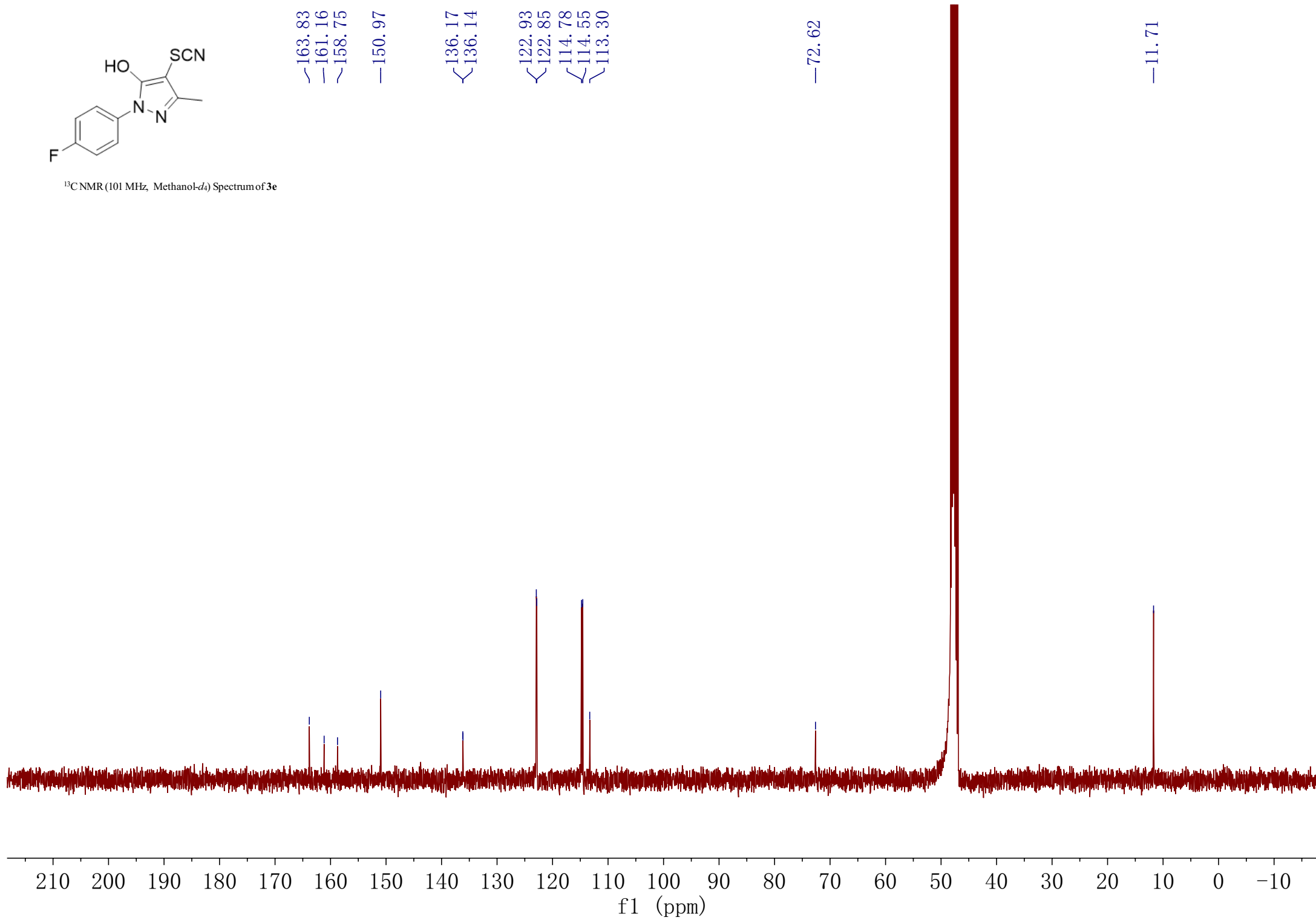


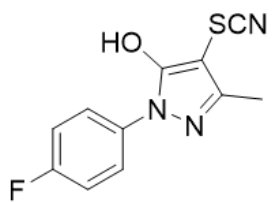
<sup>1</sup>H NMR (400 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3e



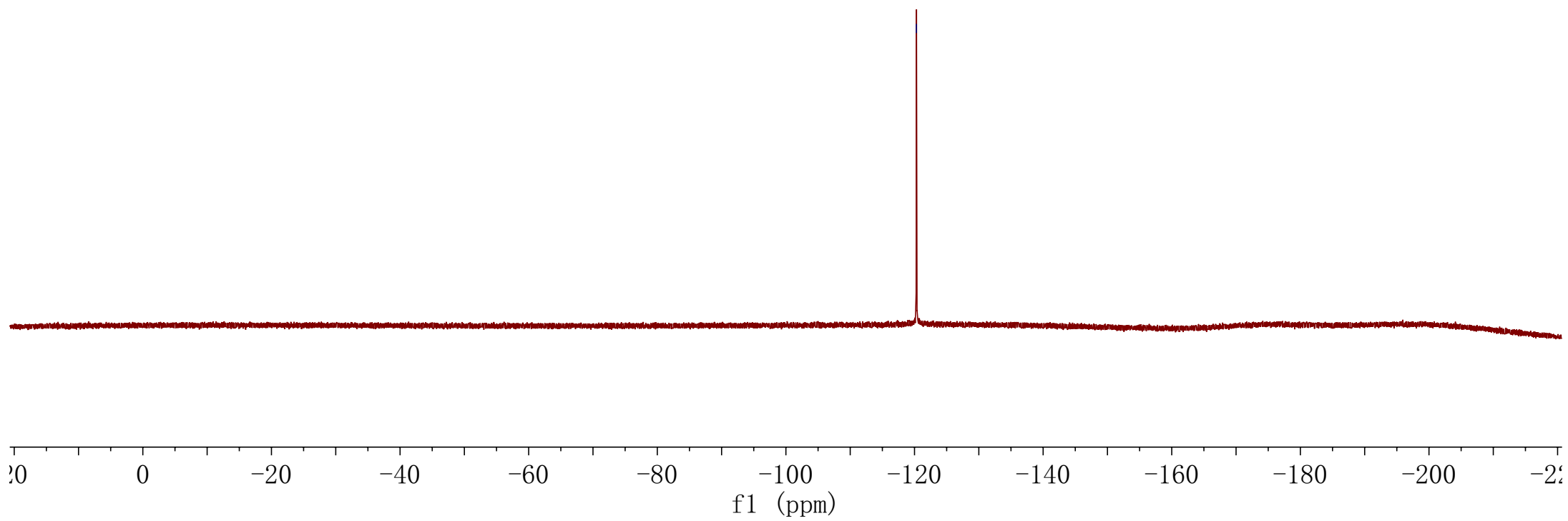


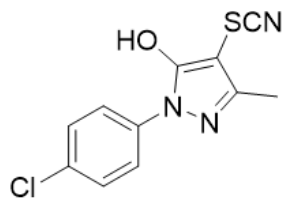
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3e



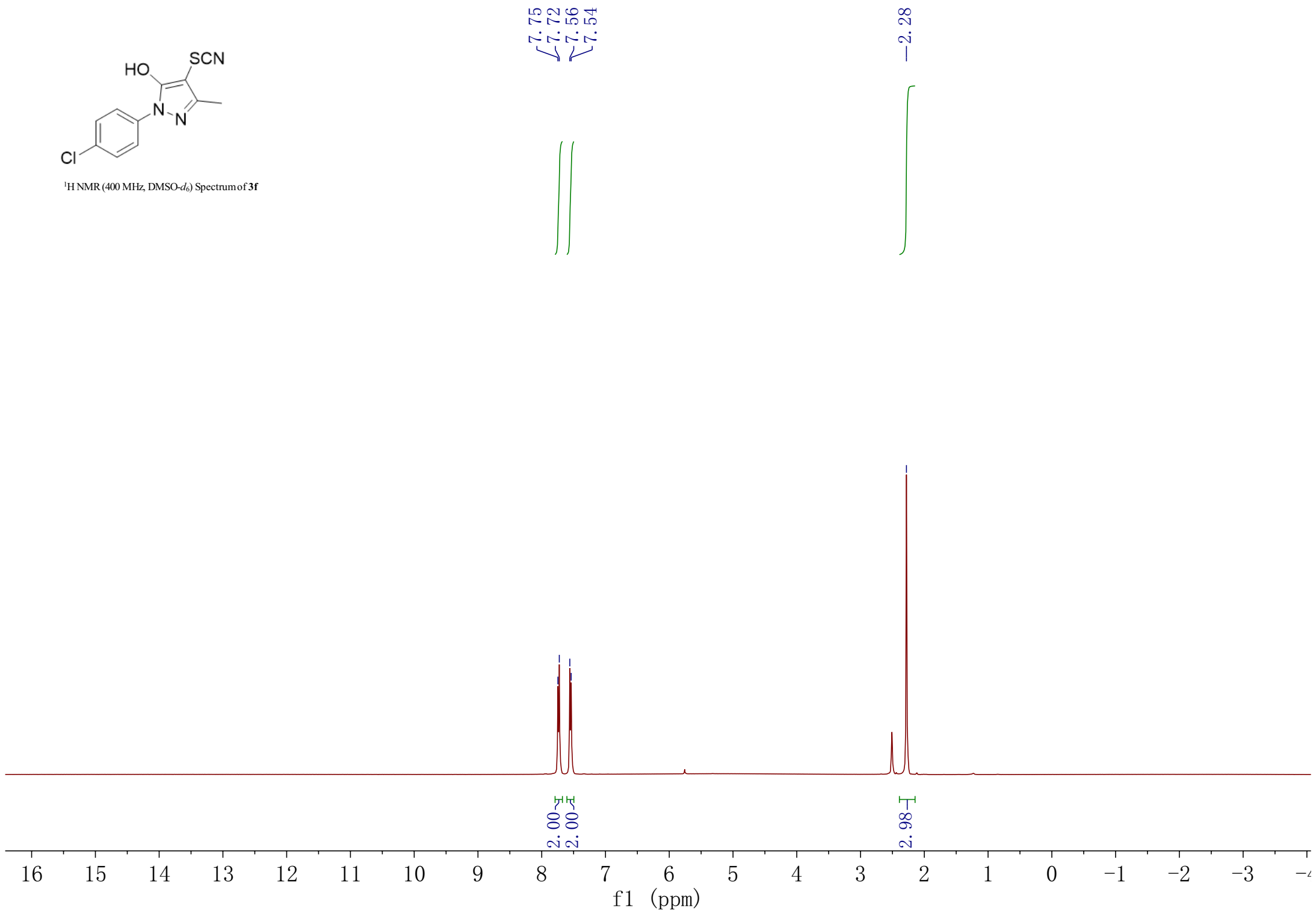


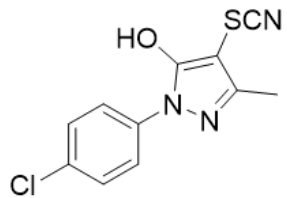
<sup>19</sup>F NMR (377 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3e



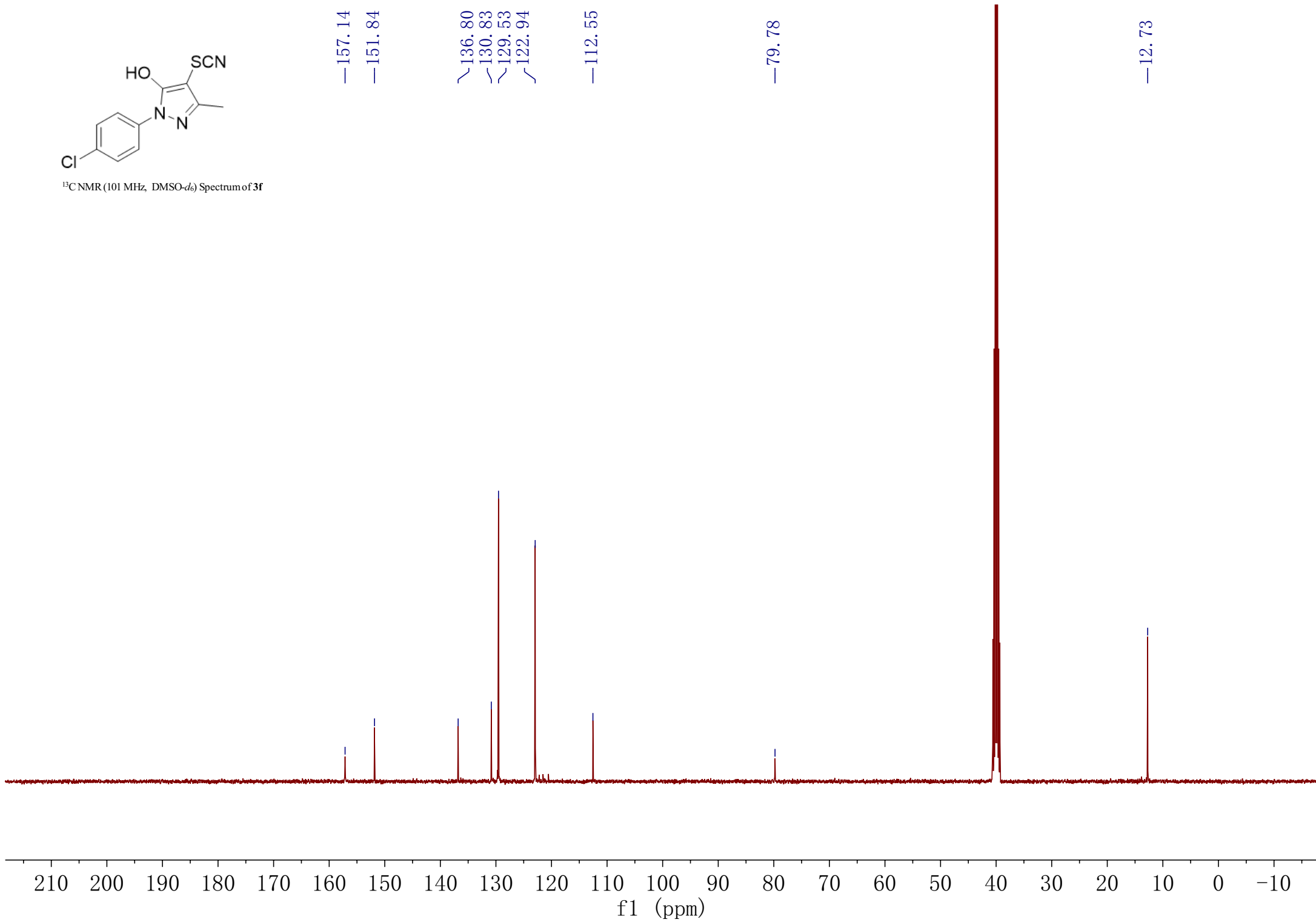


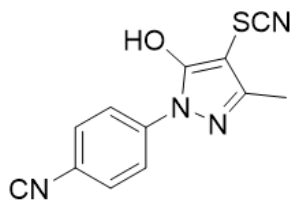
<sup>1</sup>H NMR (400 MHz, DMSO-d<sub>6</sub>) Spectrum of 3f



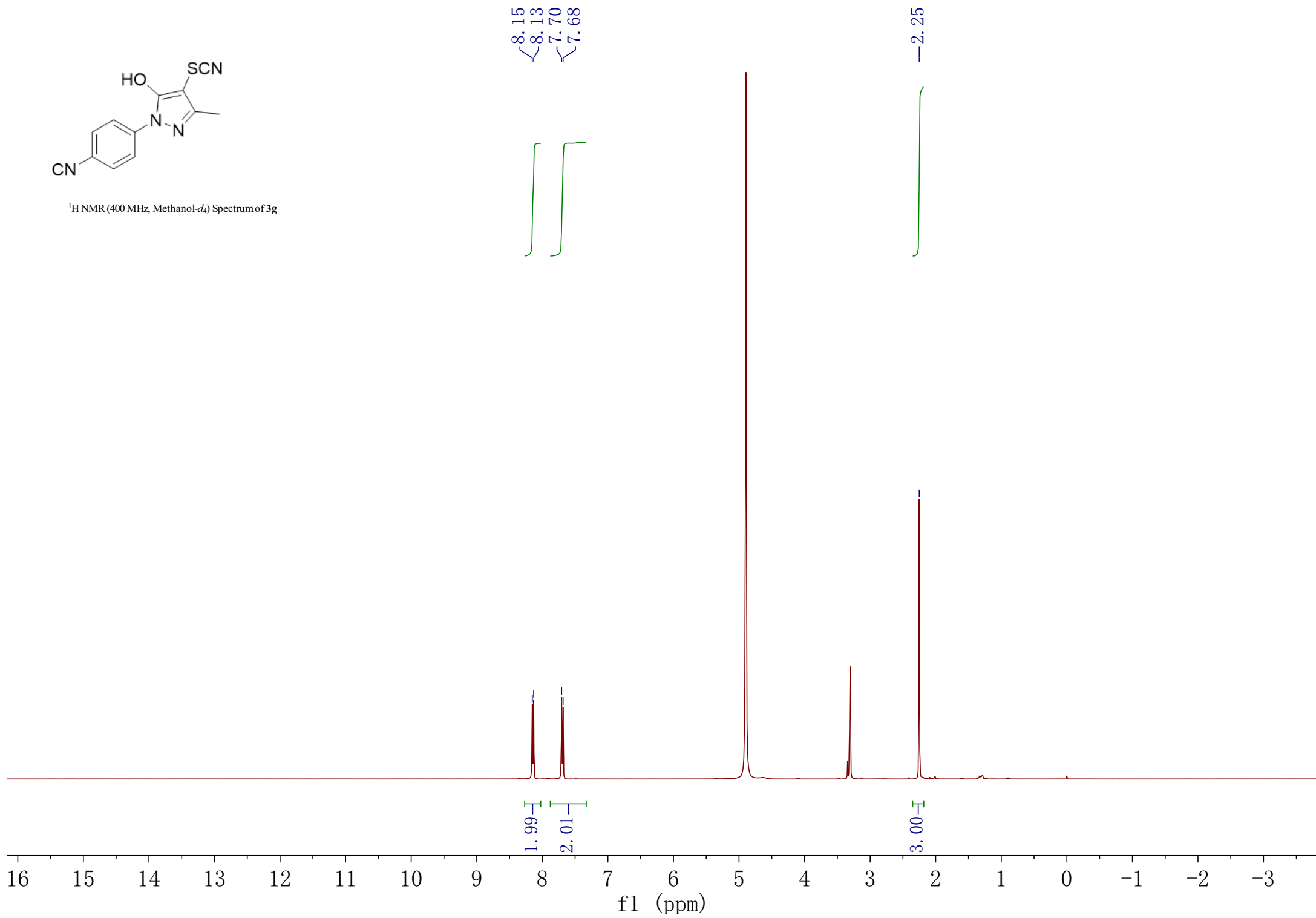


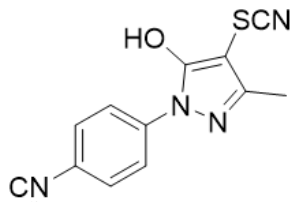
<sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) Spectrum of 3f



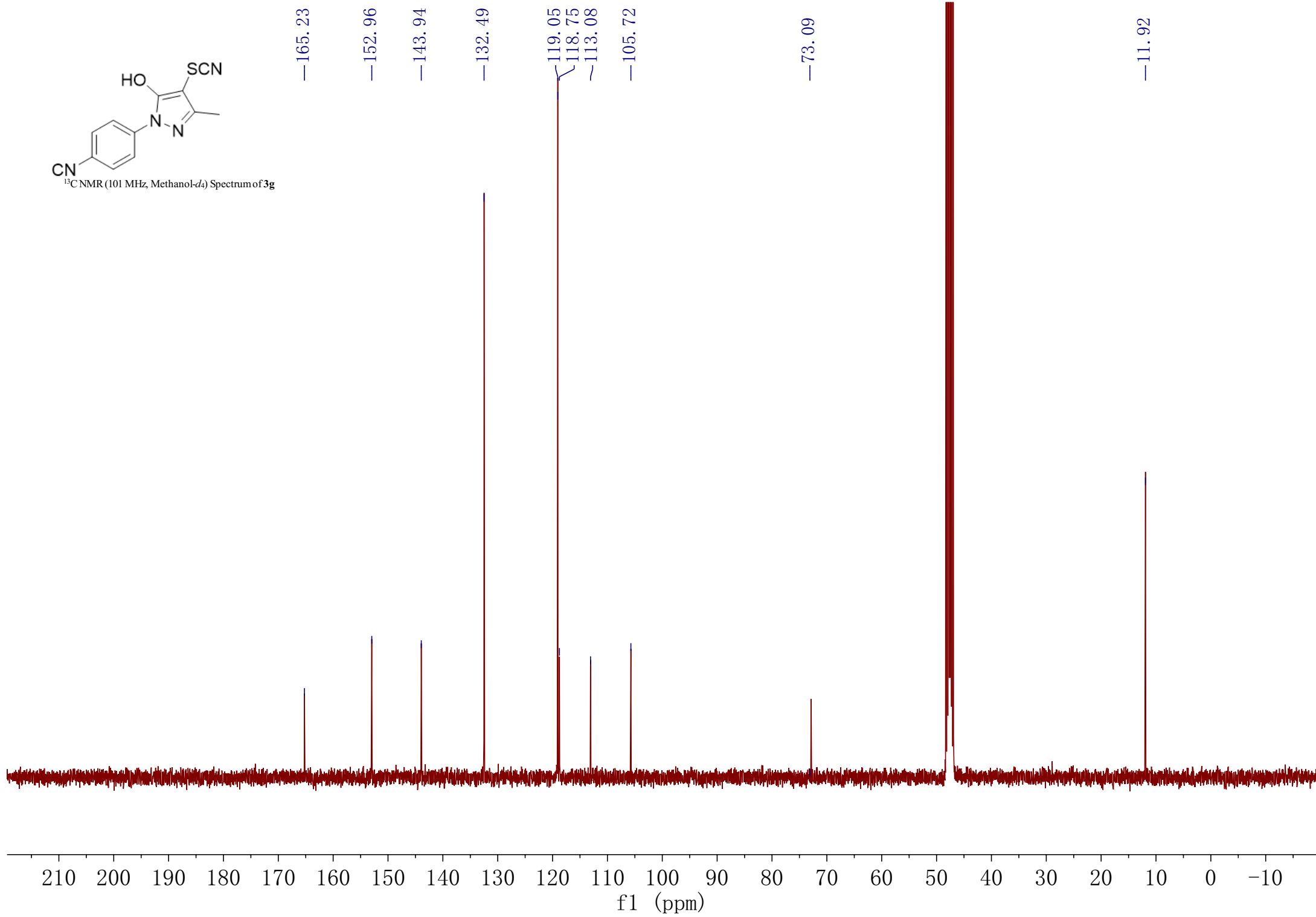


<sup>1</sup>H NMR (400 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3g

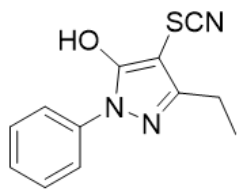




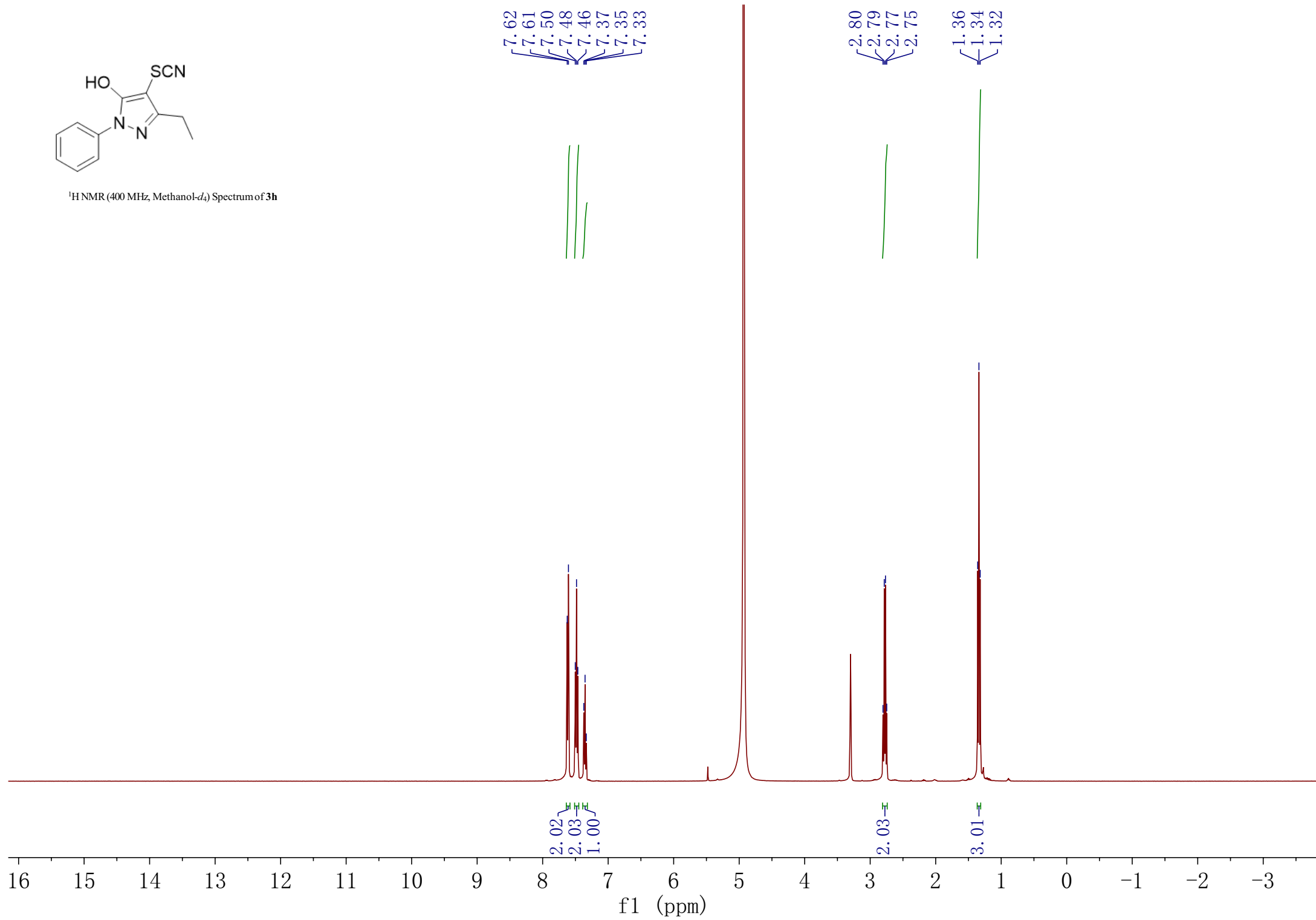
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3g

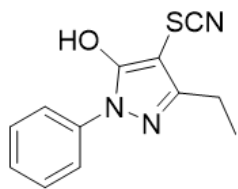




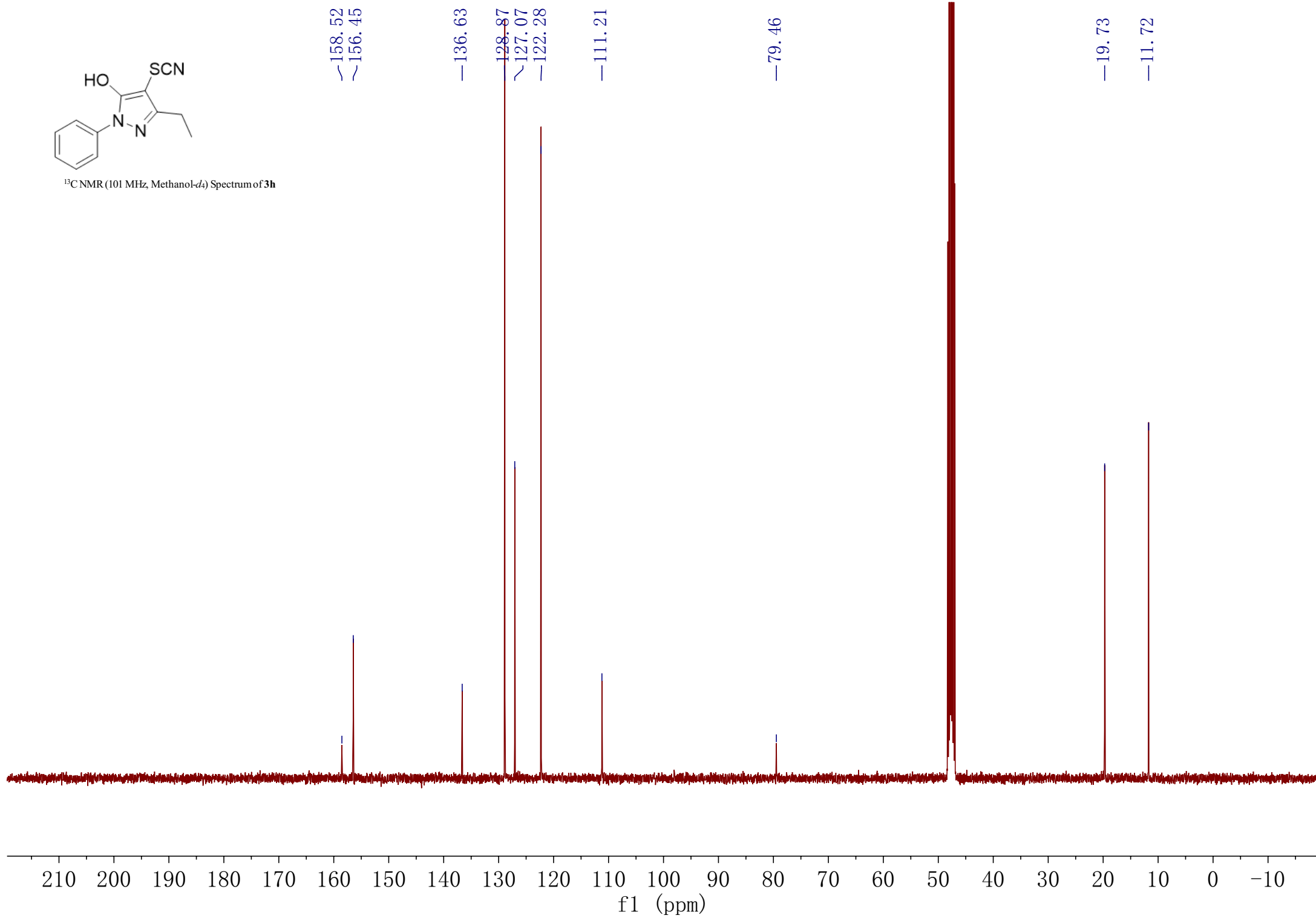


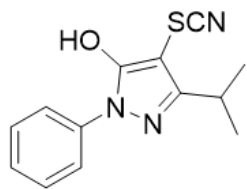
<sup>1</sup>H NMR (400 MHz, Methanol-*d*<sub>4</sub>) Spectrum of **3h**



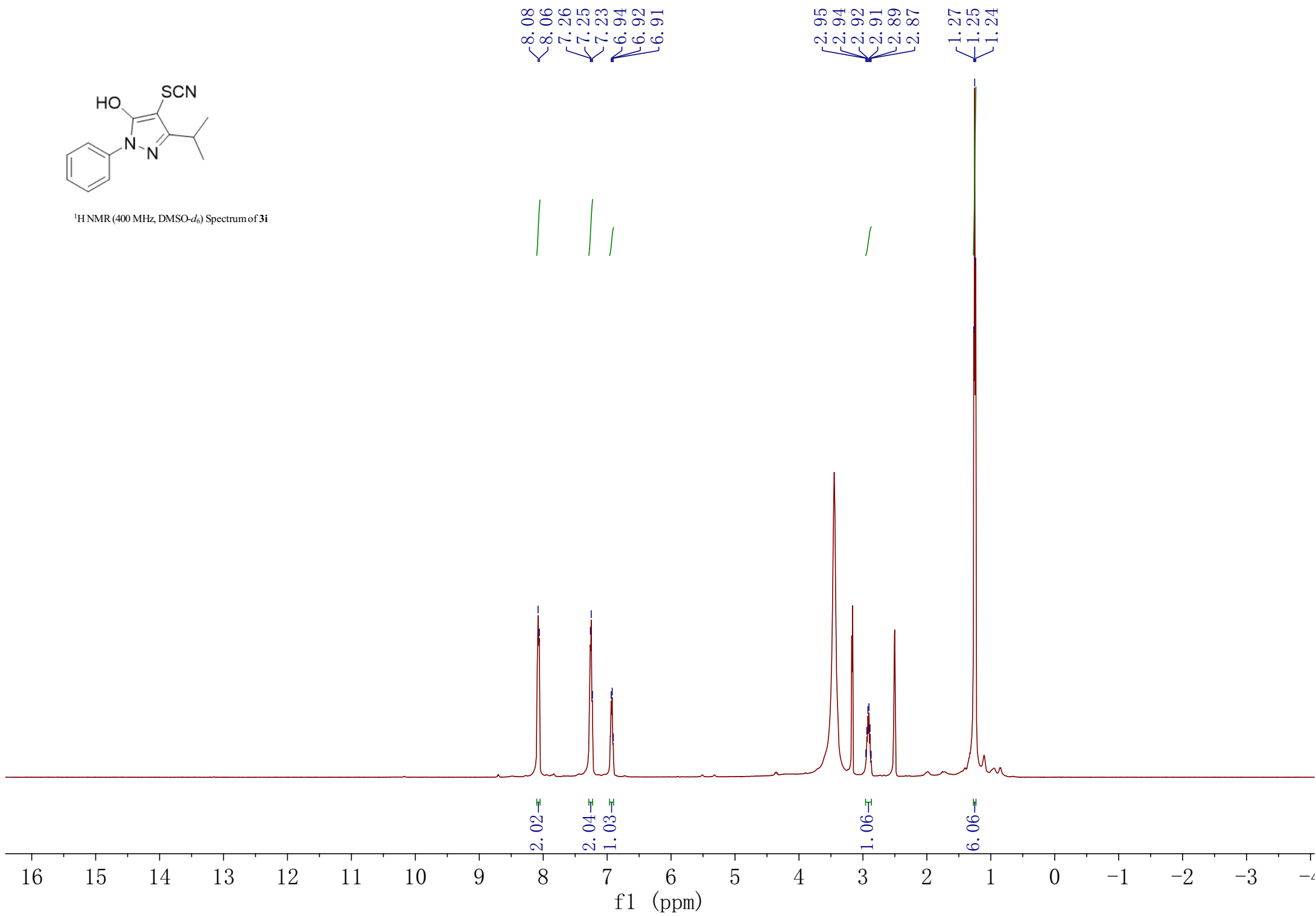


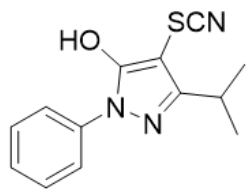
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of **3h**



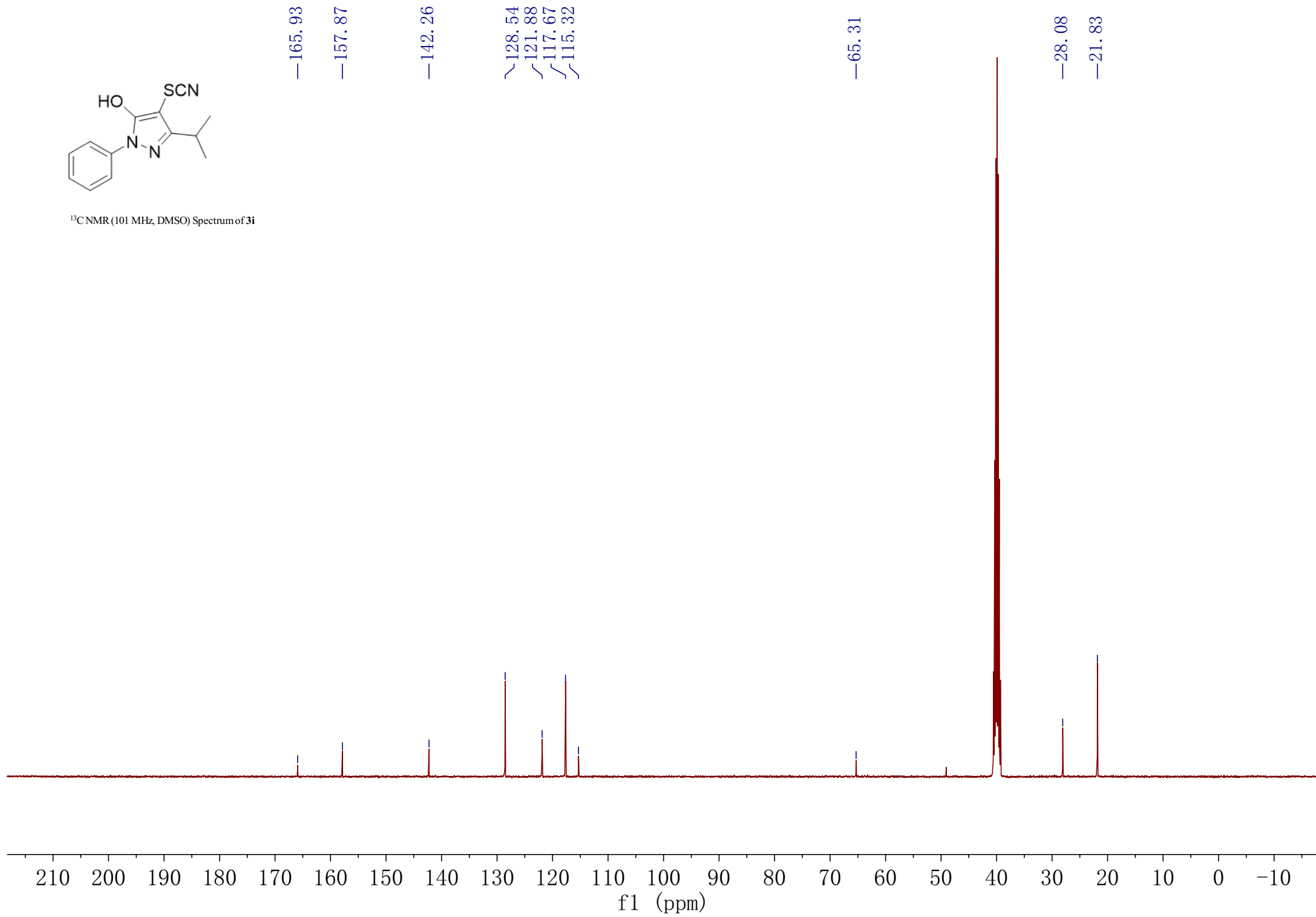


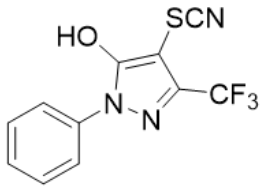
<sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) Spectrum of **3i**



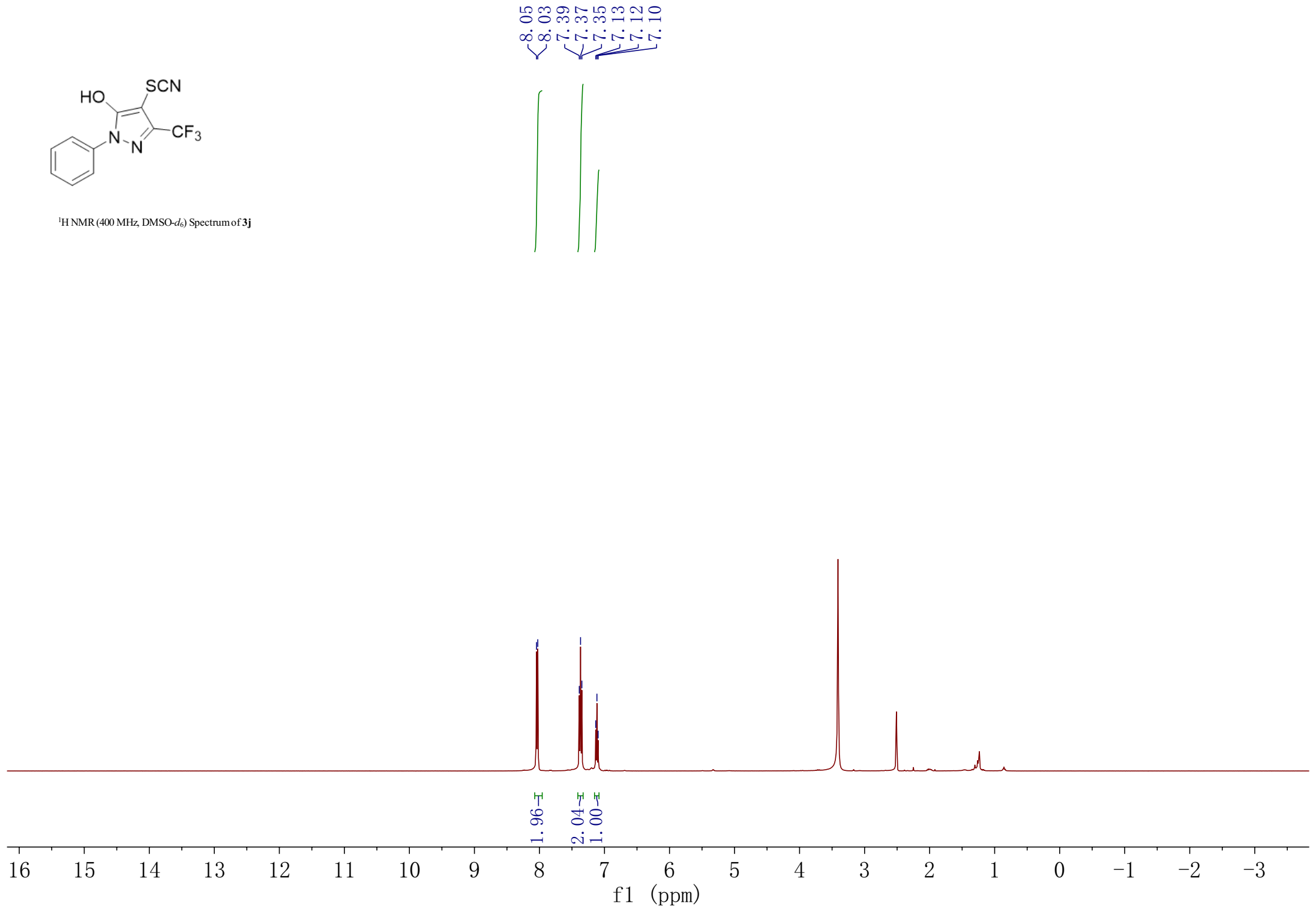


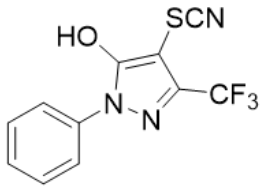
<sup>13</sup>C NMR (101 MHz, DMSO) Spectrum of **3i**



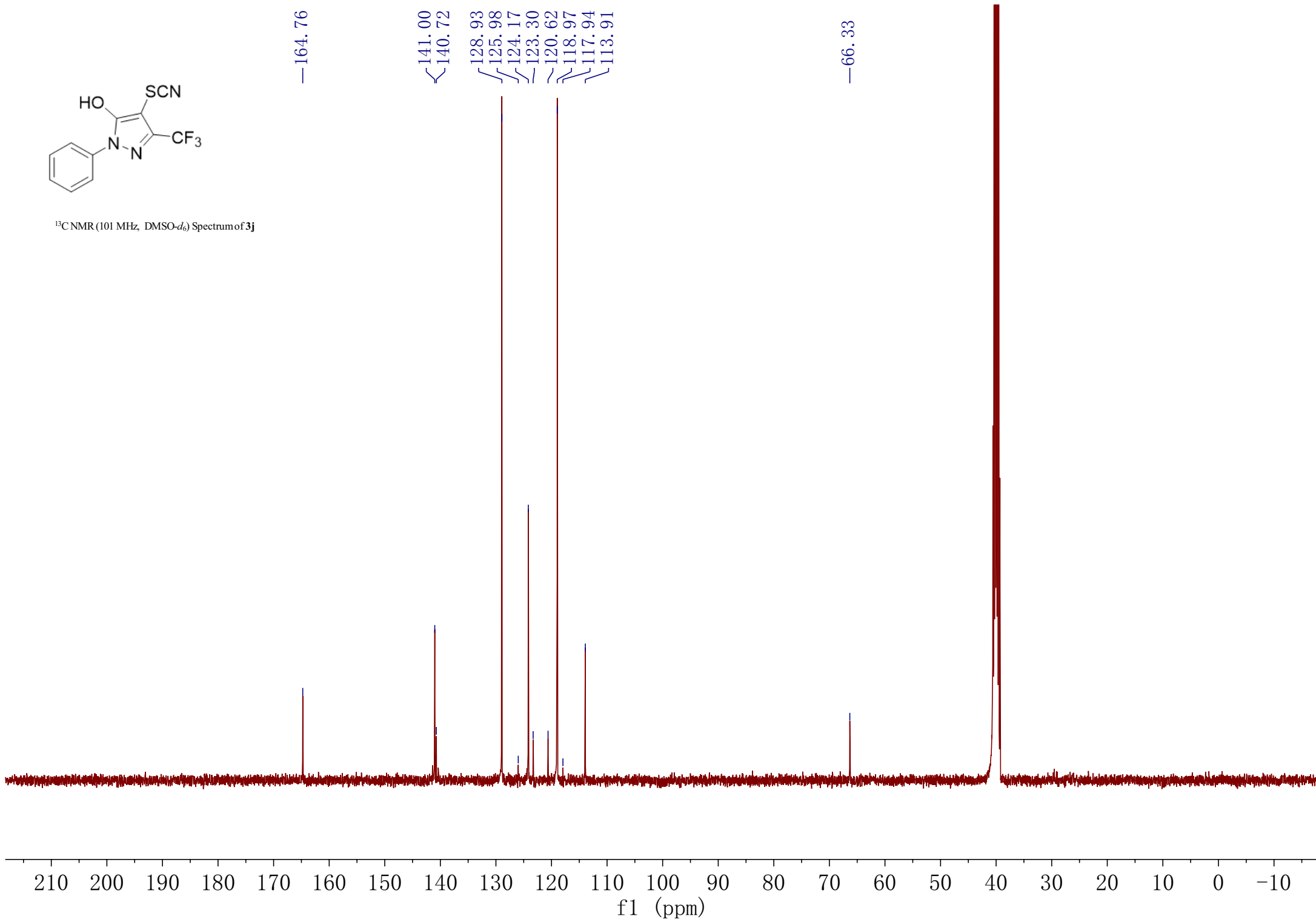


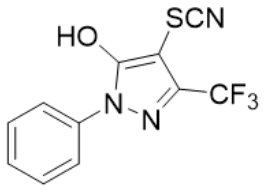
<sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) Spectrum of 3j



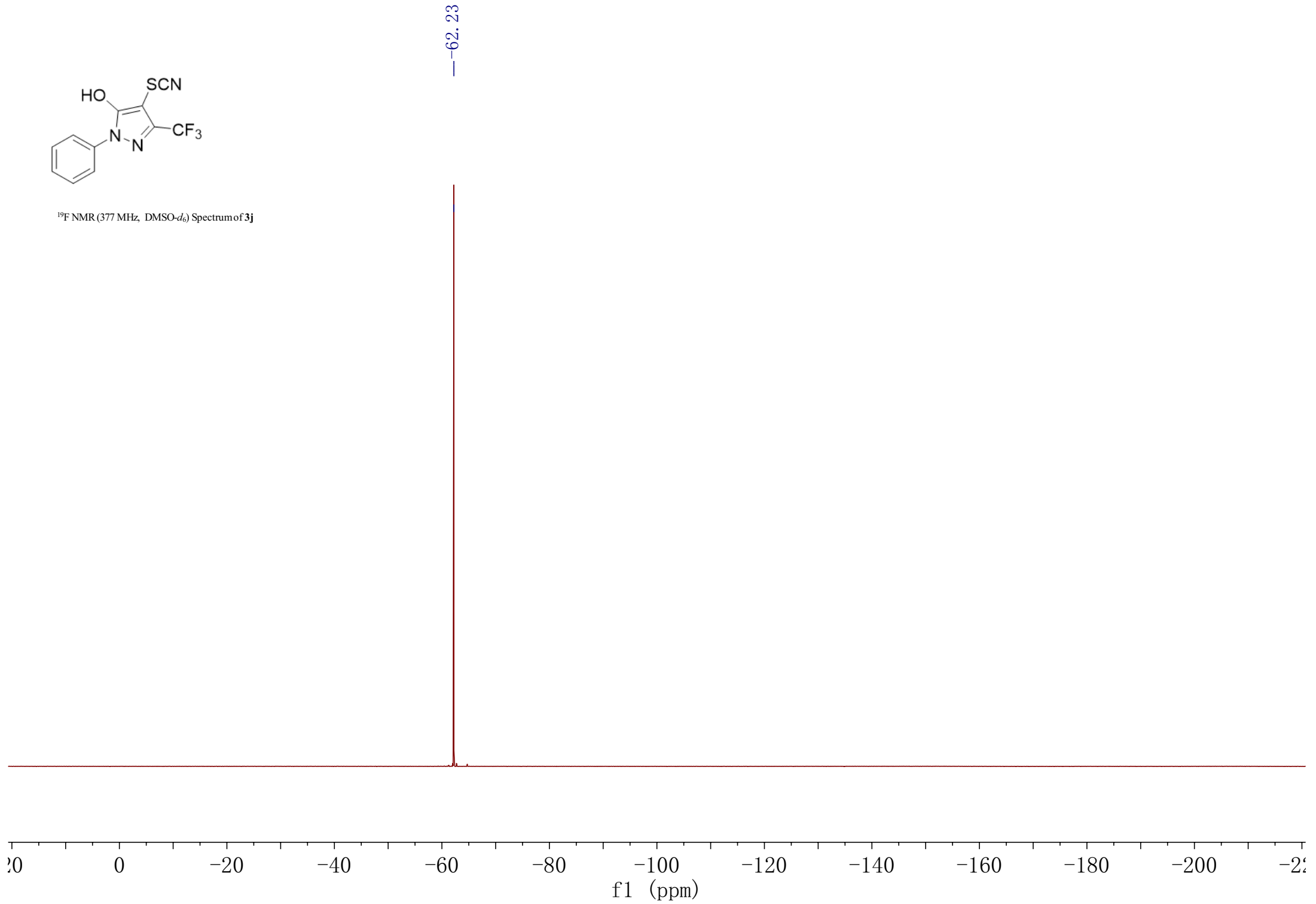


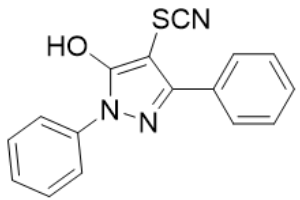
<sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) Spectrum of 3j



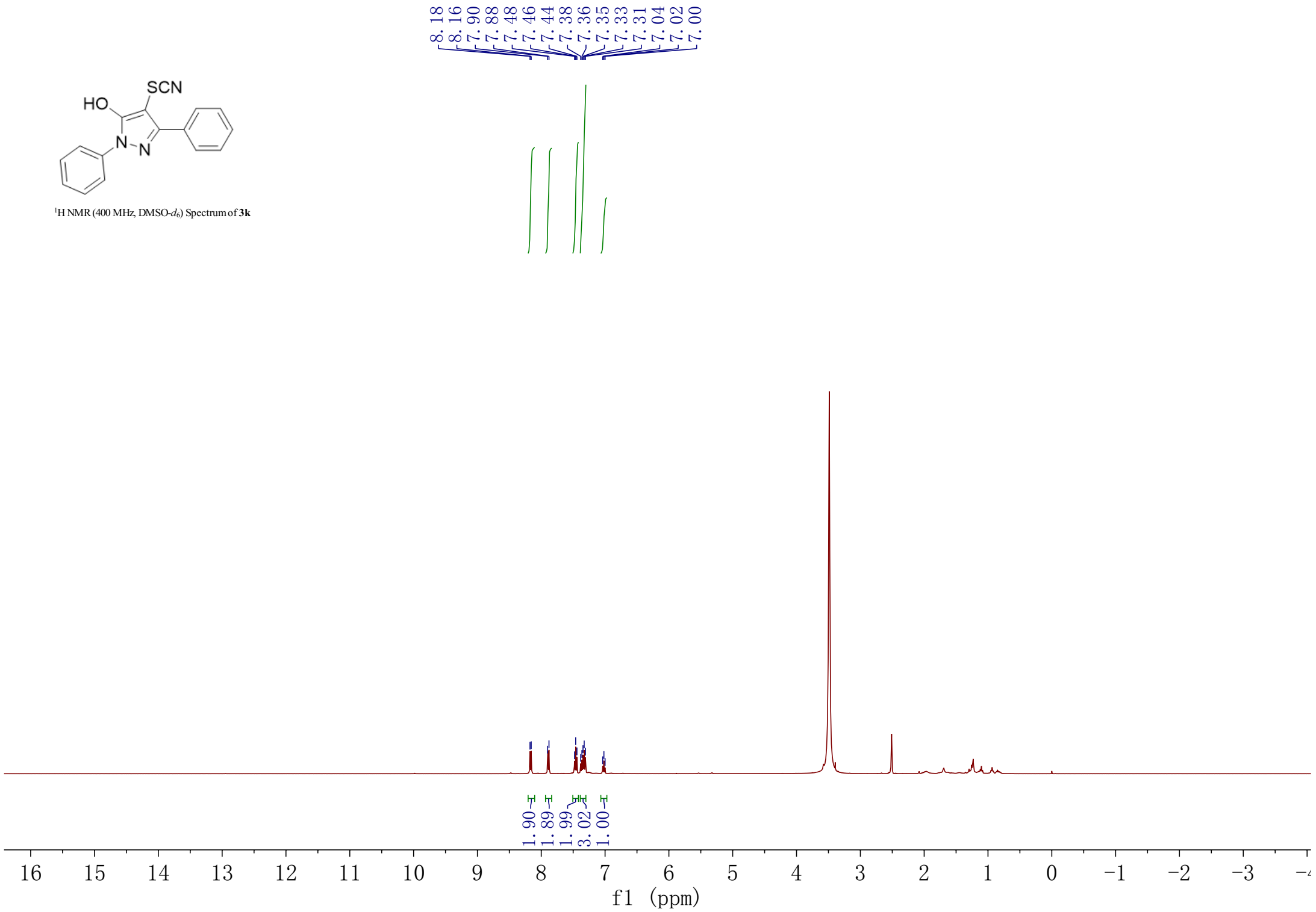


<sup>19</sup>F NMR (377 MHz, DMSO-*d*<sub>6</sub>) Spectrum of 3j

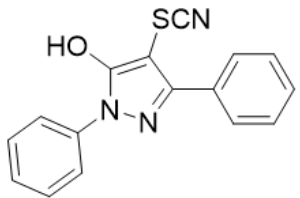




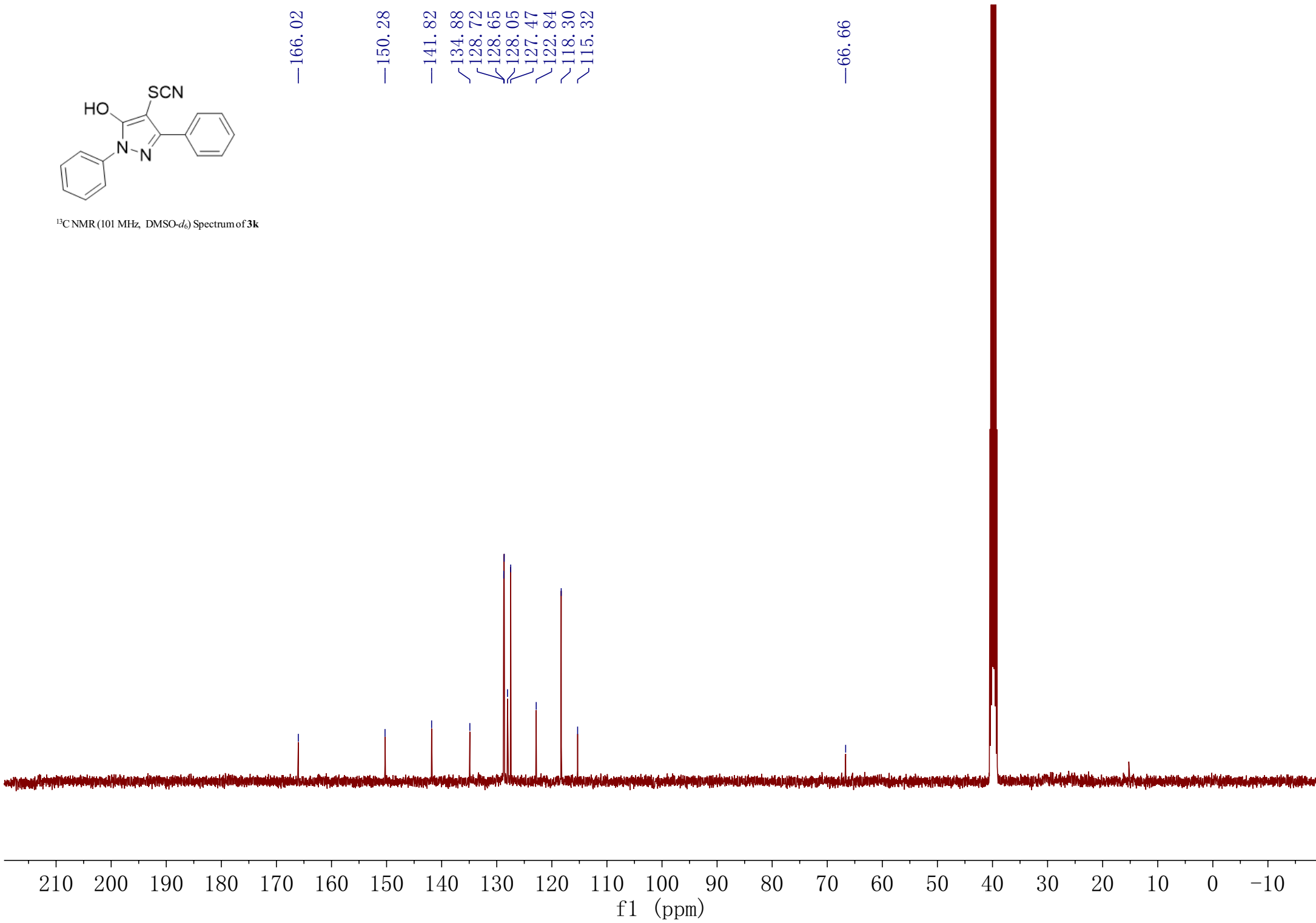
<sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) Spectrum of **3k**

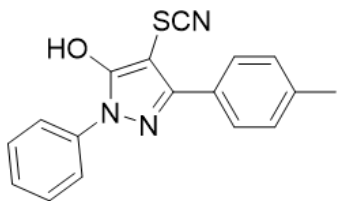




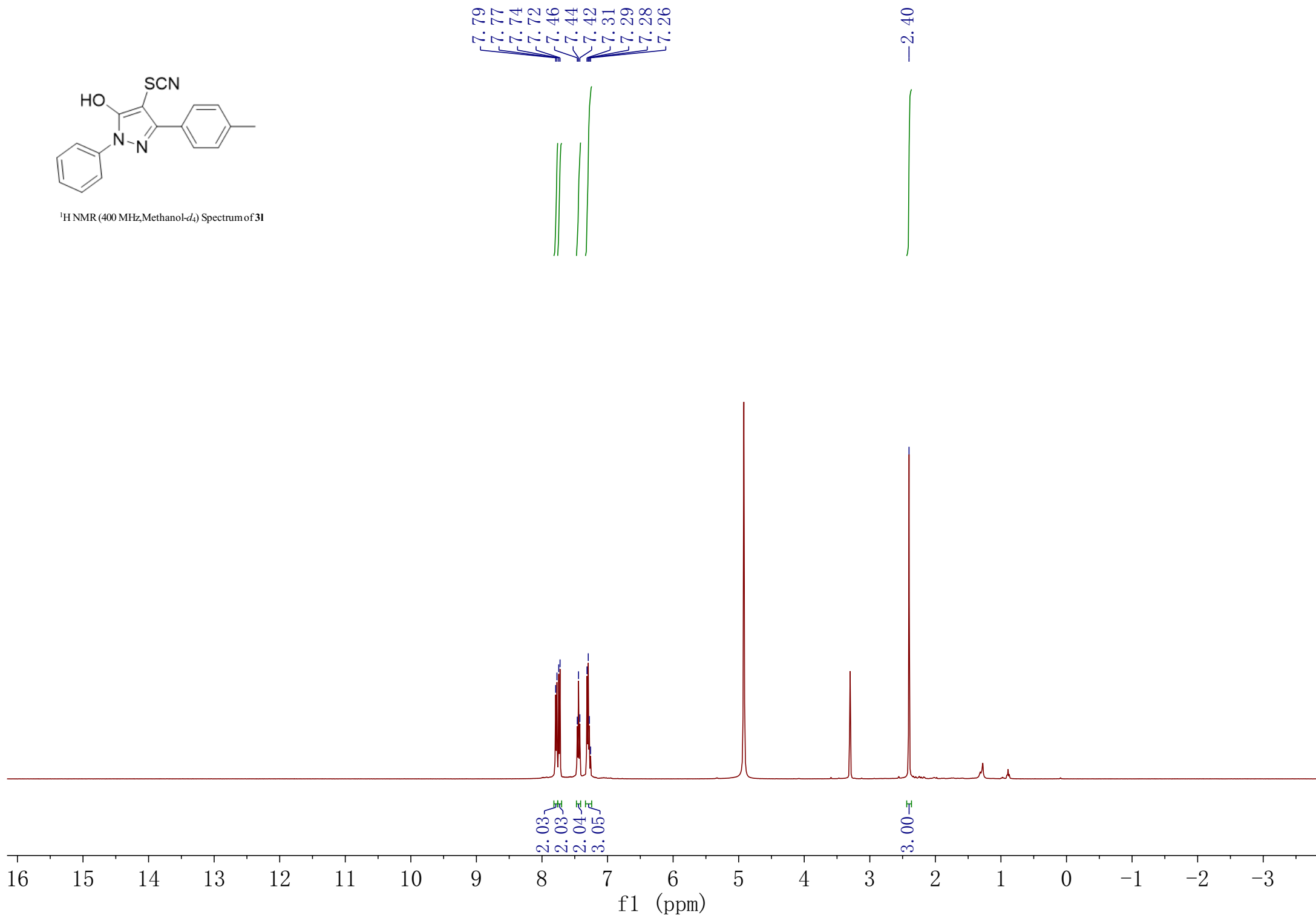


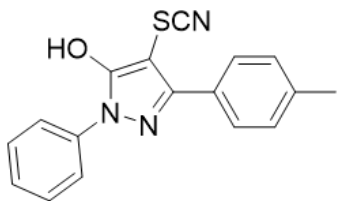
<sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) Spectrum of 3k



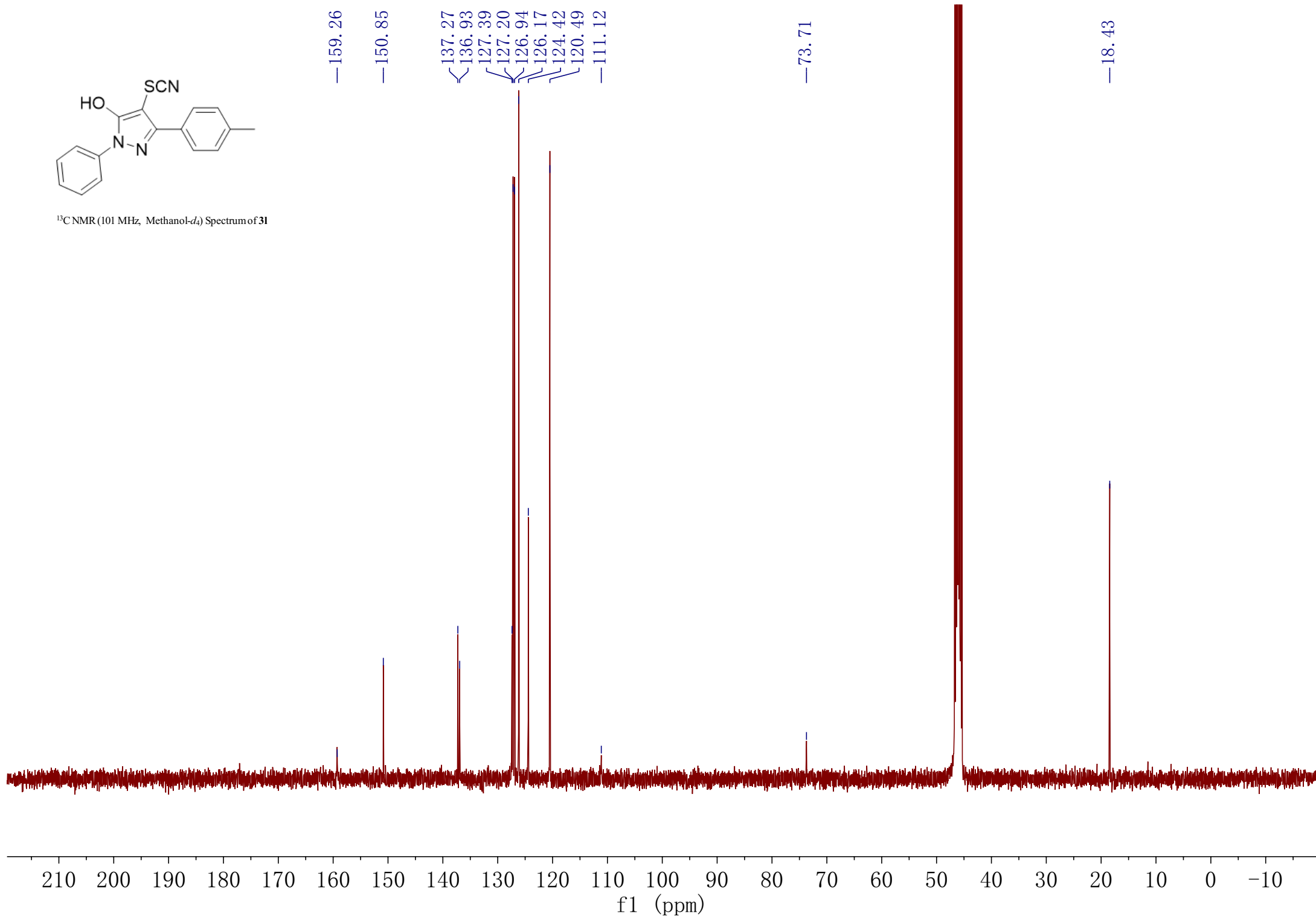


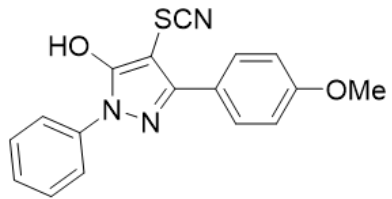
<sup>1</sup>H NMR (400 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 31



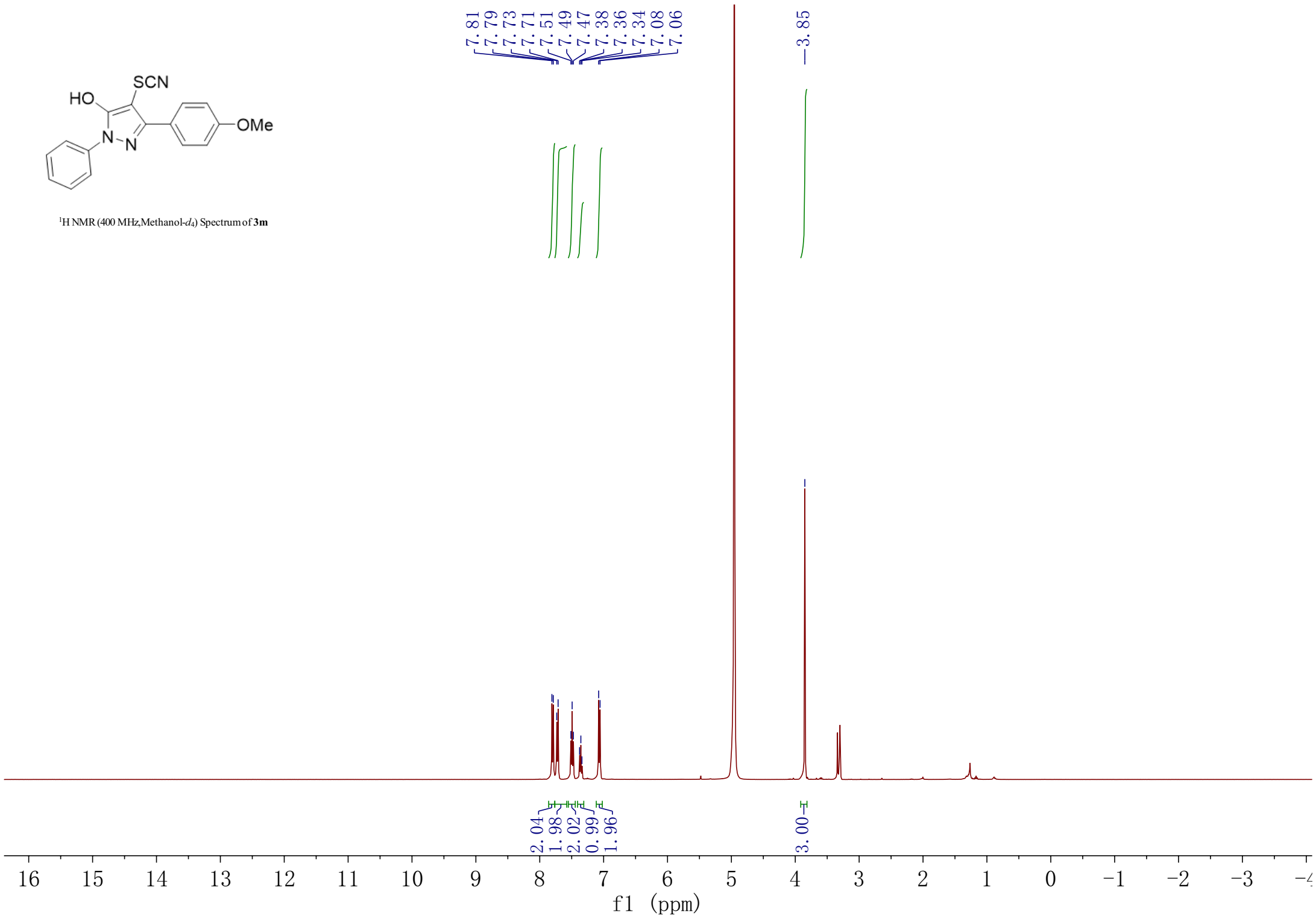


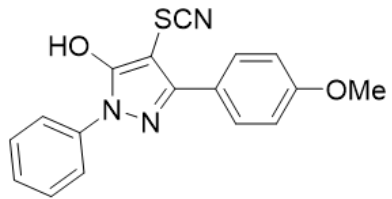
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of **31**



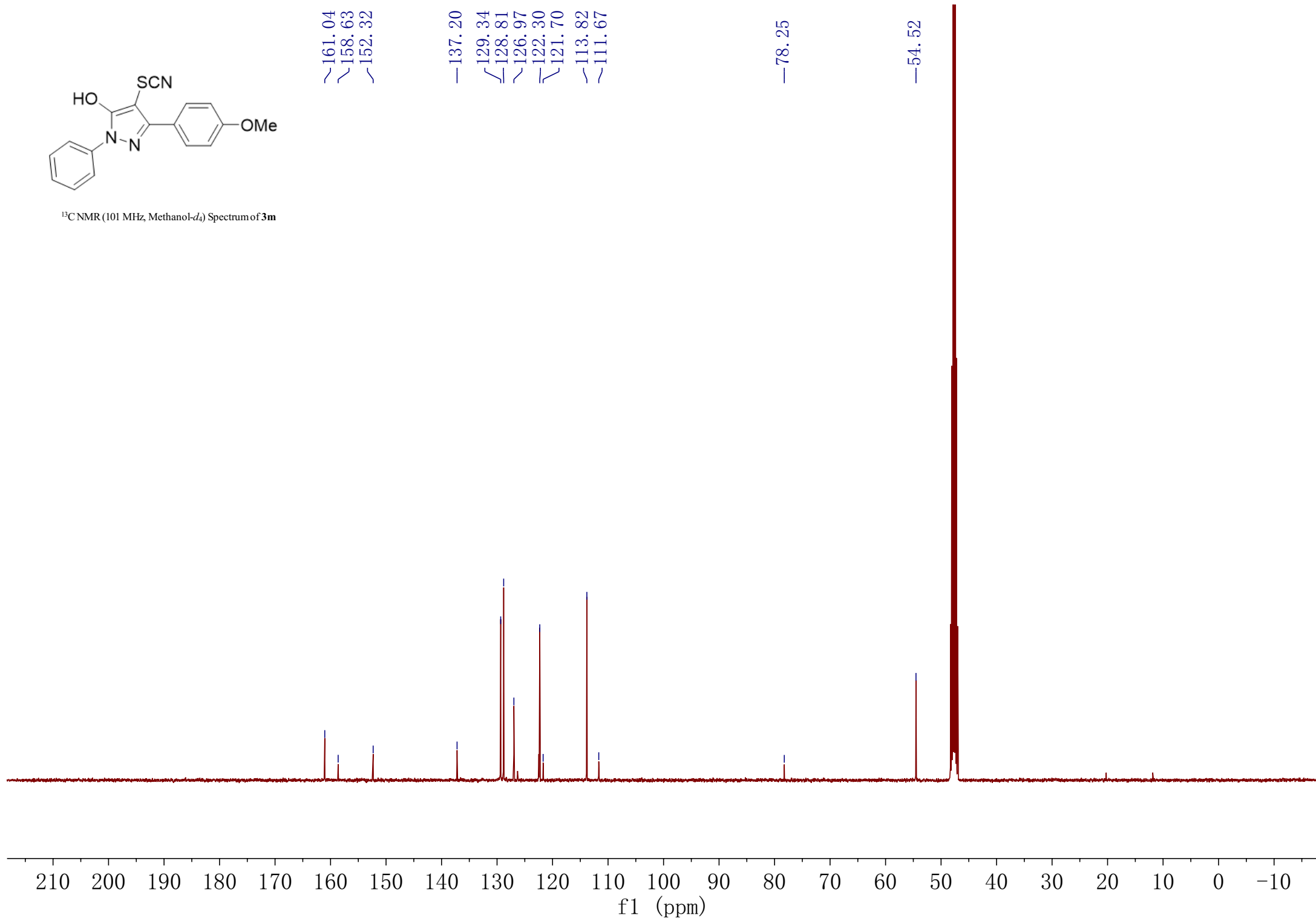


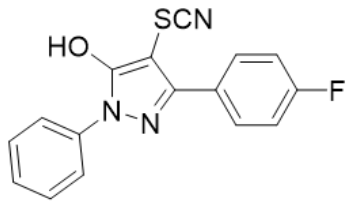
<sup>1</sup>H NMR (400 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3m



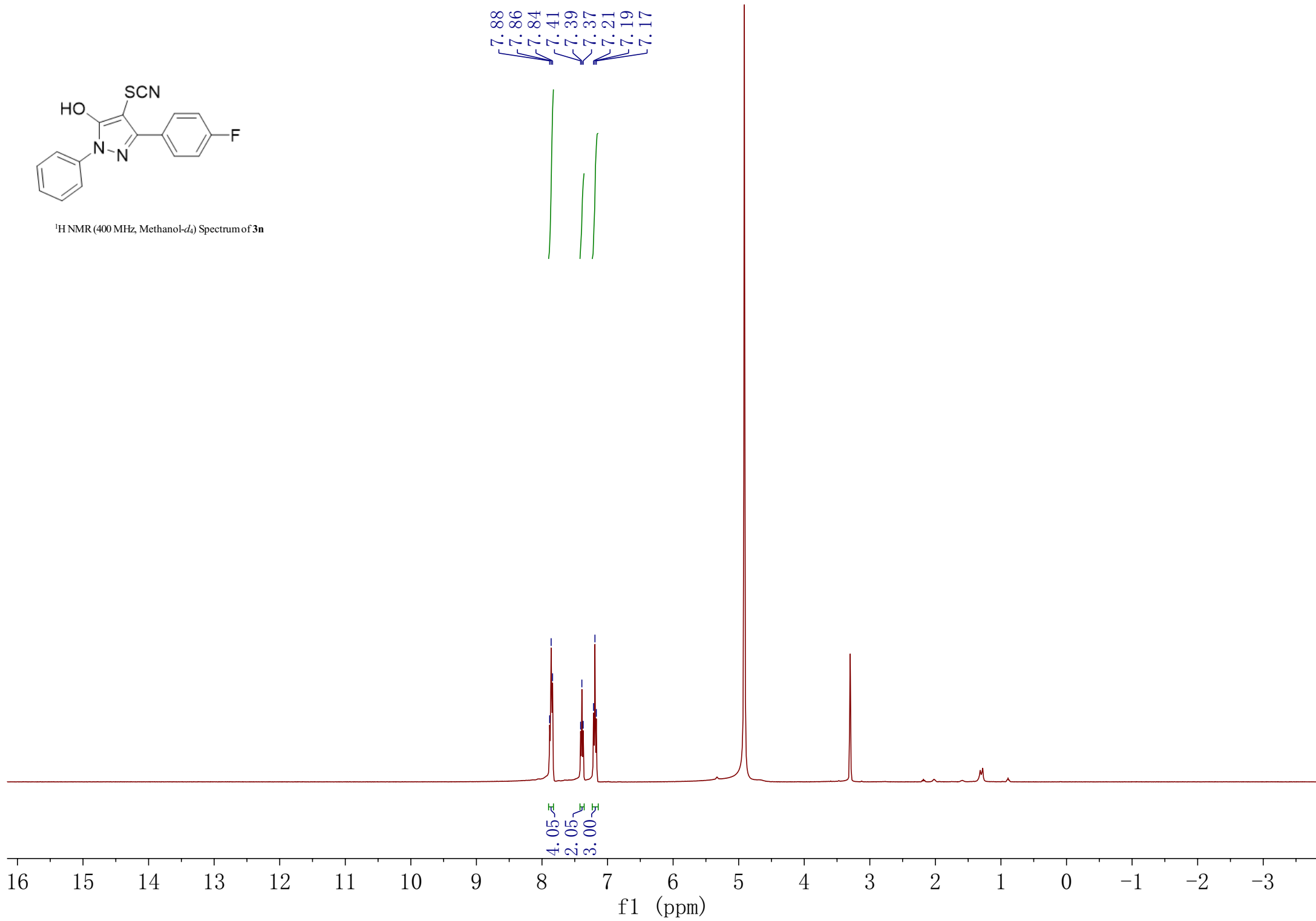


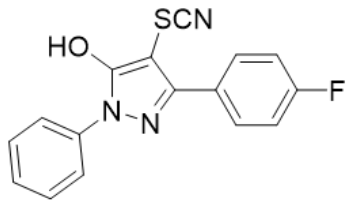
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of **3m**



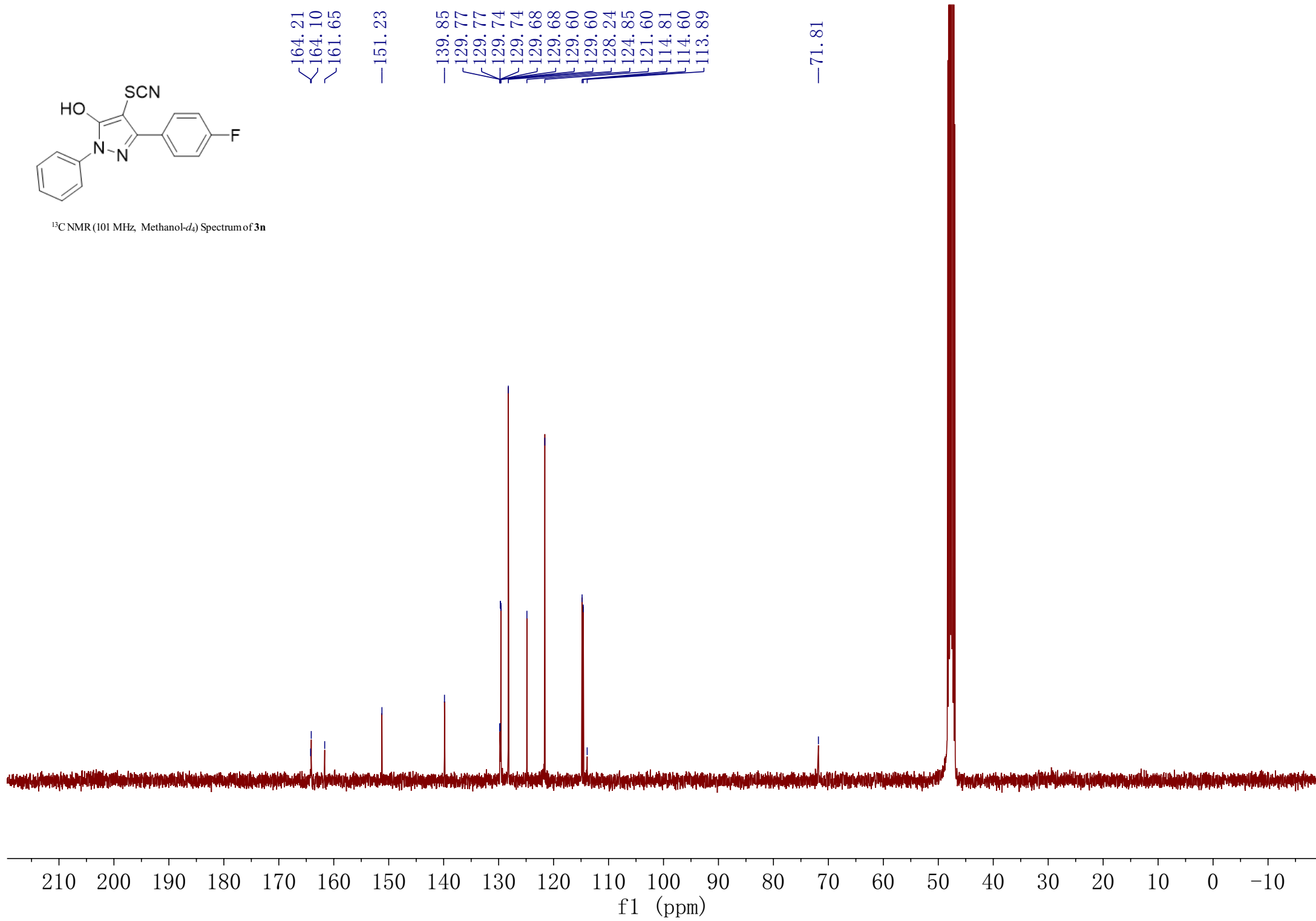


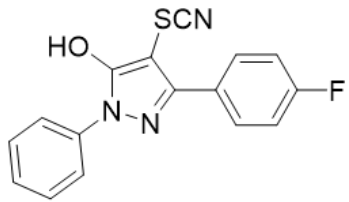
<sup>1</sup>H NMR (400 MHz, Methanol-d<sub>4</sub>) Spectrum of 3n



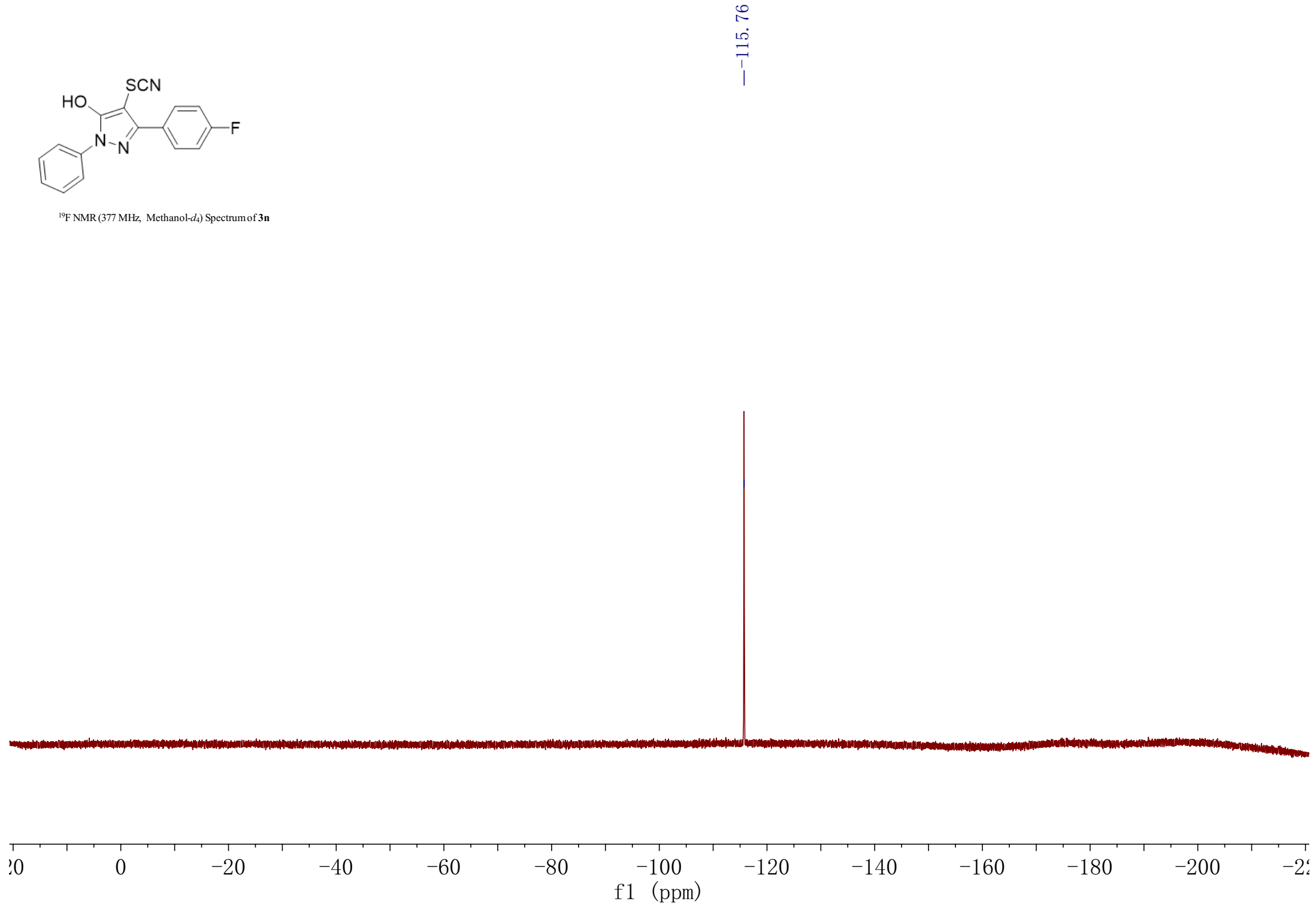


<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3n

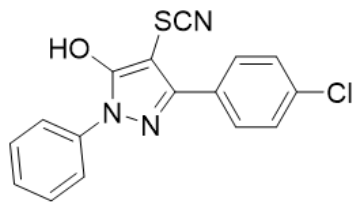




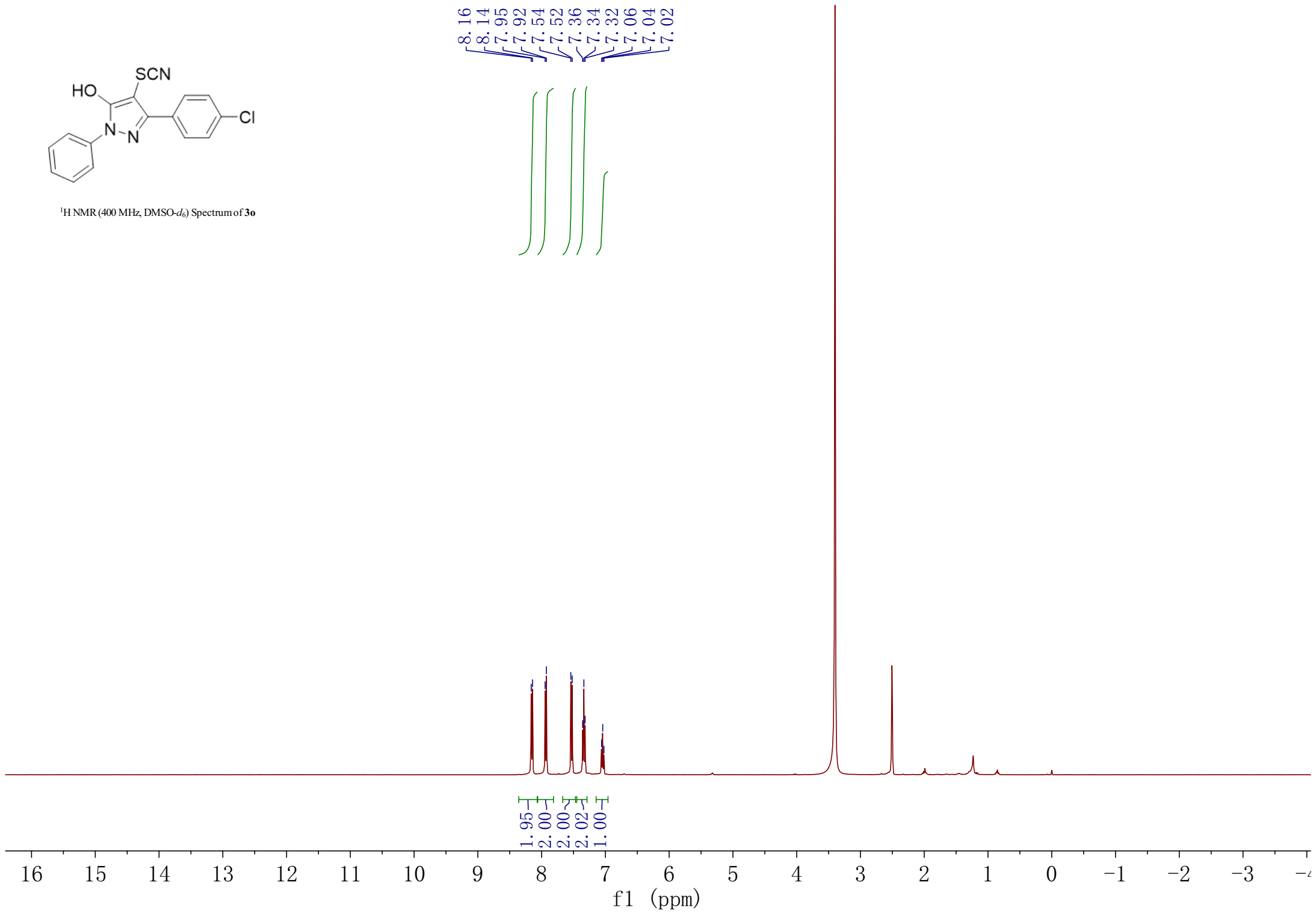
<sup>19</sup>F NMR (377 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3n

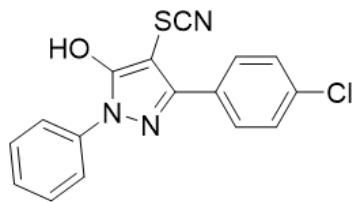




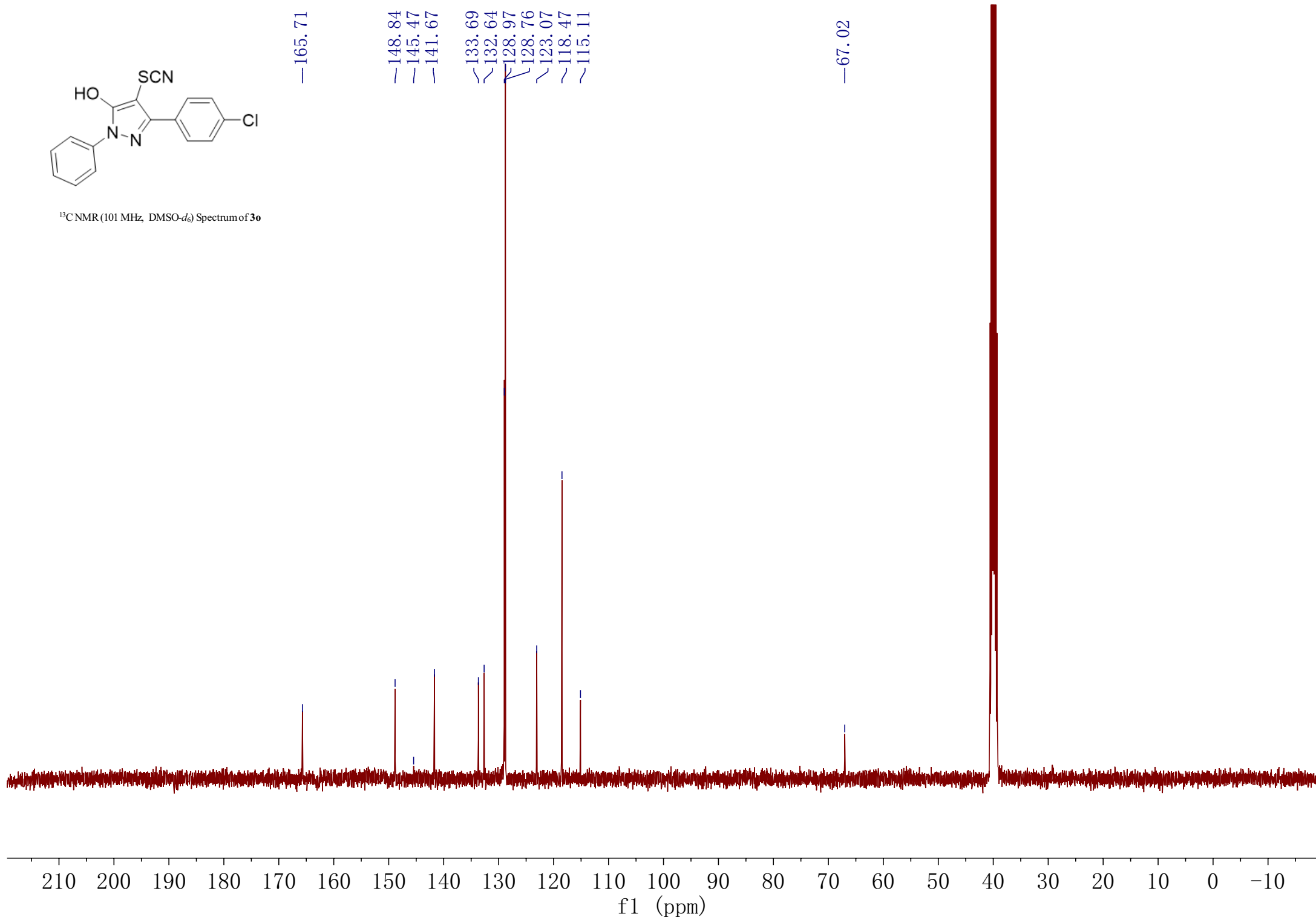


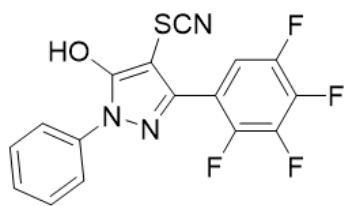
<sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) Spectrum of 30



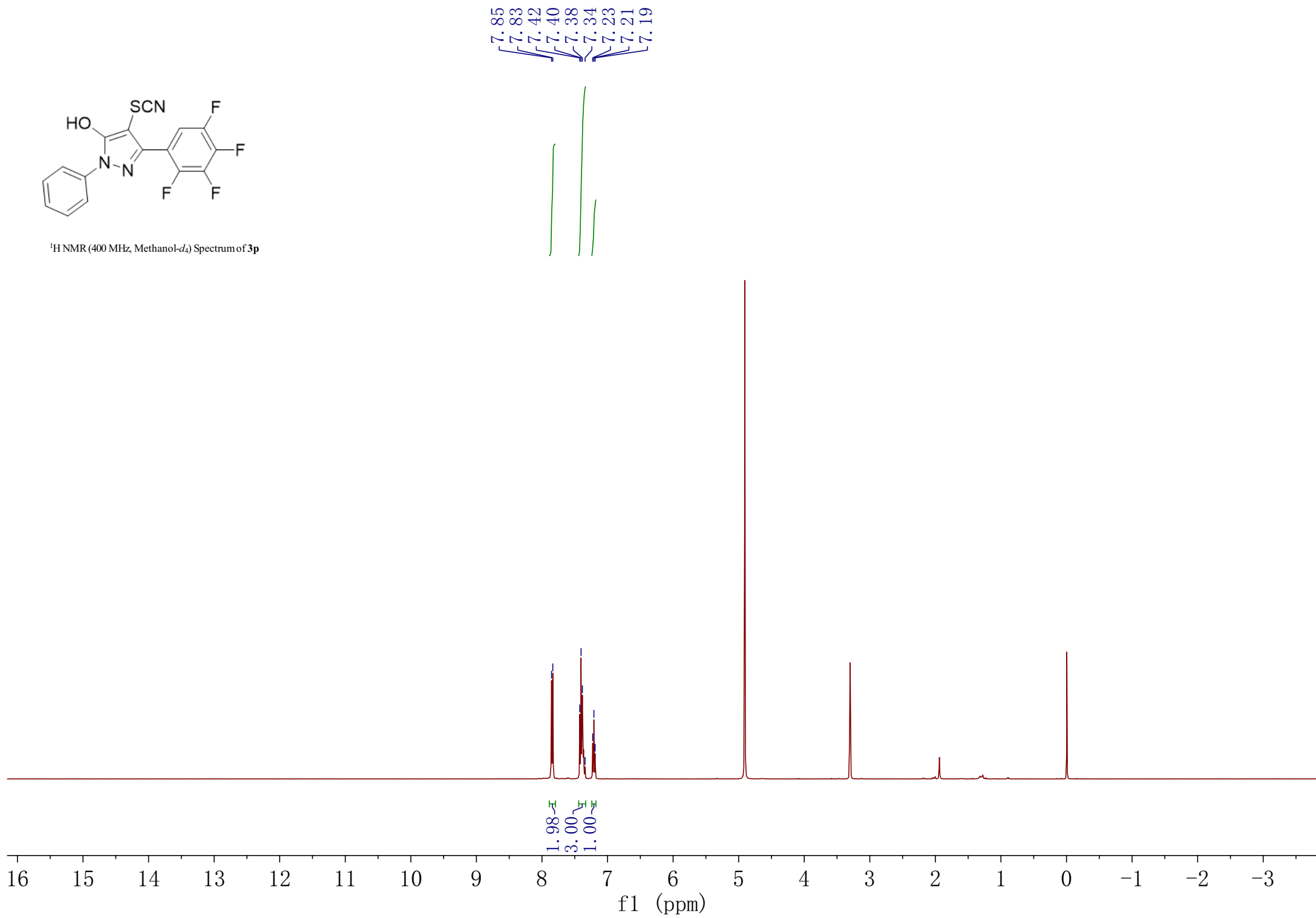


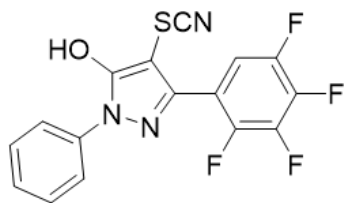
<sup>13</sup>C NMR (101 MHz, DMSO-*d*<sub>6</sub>) Spectrum of **3o**



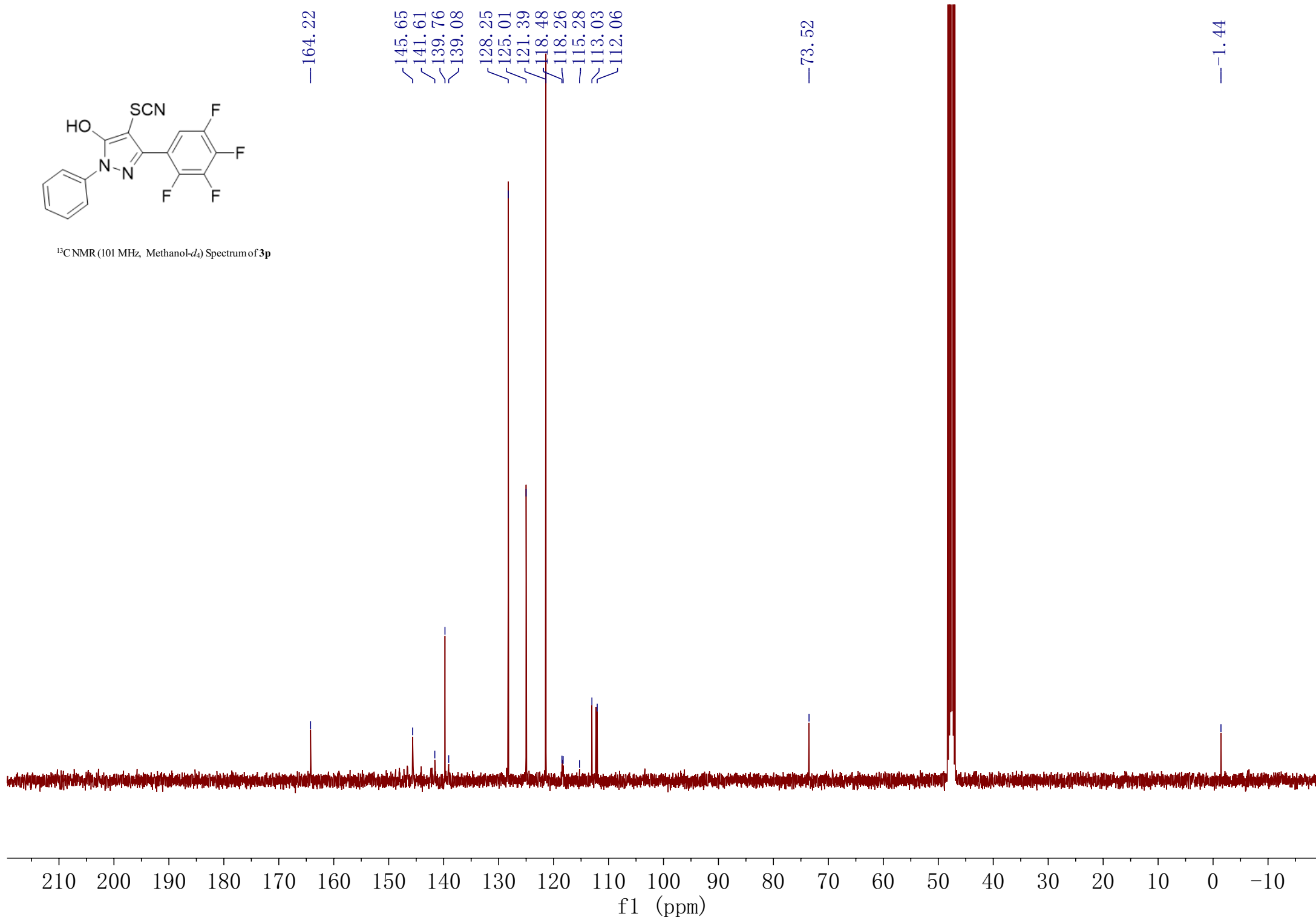


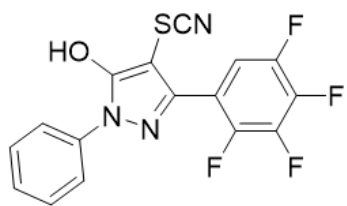
<sup>1</sup>H NMR (400 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3p





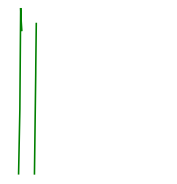
<sup>13</sup>C NMR (101 MHz, Methanol-*d*<sub>4</sub>) Spectrum of 3p





<sup>19</sup>F NMR (377 MHz, Methanol-*d*<sub>4</sub>) Spectrum of **3p**

-140.33  
-140.38  
-140.43  
-142.03  
-142.06  
-142.14  
-158.61  
-158.70  
-158.74  
-158.76  
-158.81



1.00  
0.96

1.95

10

-10

-30

-50

-70

-90

-110

-130

-150

-170

-190

-210

f1 (ppm)