

## Tandem Approach for the Synthesis of 3-Sulfenylimidazo[1,5-*a*]pyridines from Dithioesters

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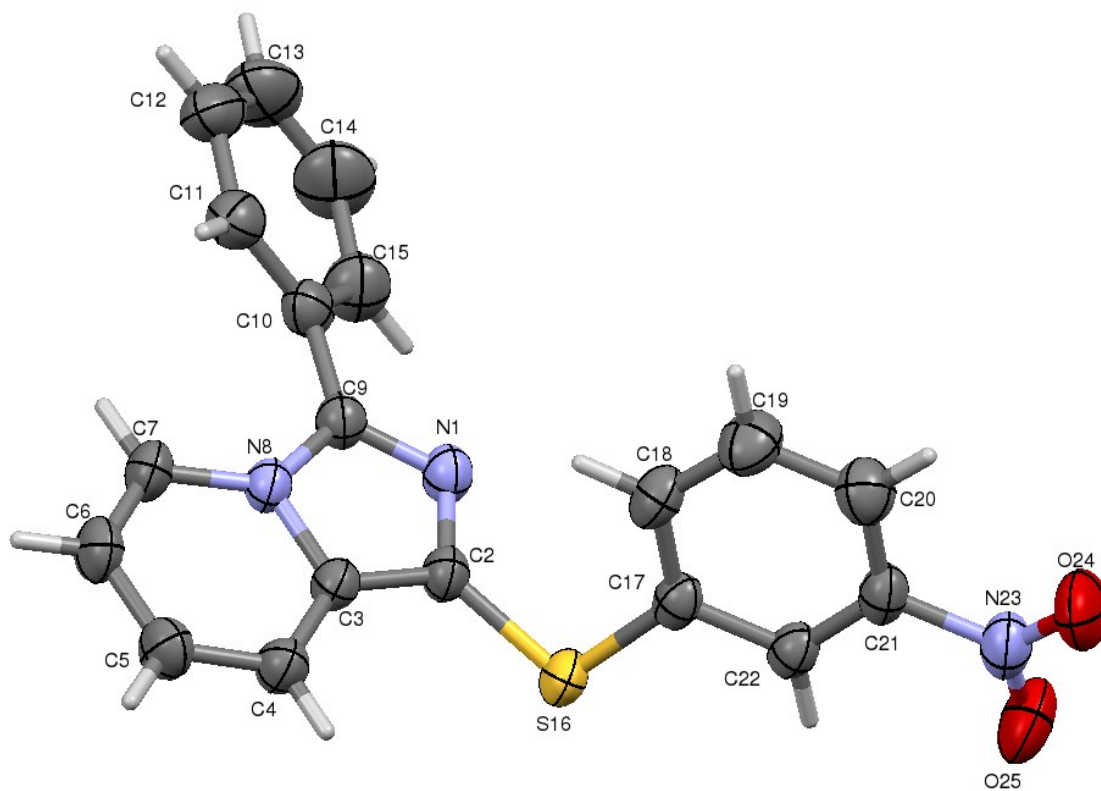
**General Information:** 2-methylaminopyridine, 2-hydrazinylpyridine, sulfonyl hydrazides and iodine were purchased from commercial sources and used as received. Reagent grade THF was purchased from Sigma-Aldrich and distilled over sodium. Purification of reaction products was carried out by flash column chromatography using Sorbent Technologies Standard Grade silica gel (60 Å, 230–400 mesh). Analytical thin layer chromatography was performed on EM Reagent 0.25 mm silica gel 60 F254 plates. Visualization was accomplished with UV light, potassium permanganate and DragendorffMunier stains followed by heating. Melting points were recorded on a Thomas Hoover capillary melting point apparatus and are uncorrected. Proton nuclear magnetic resonance spectra (<sup>1</sup>H-NMR) were recorded on Agilent-400 MHz and are reported in ppm using chloroform as the internal standard (7.24 ppm). Data are reported as app = apparent, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, comp = complex, br = broad; and coupling constant(s) in Hz. Proton-decoupled carbon nuclear magnetic resonance spectra (<sup>13</sup>C-NMR) were recorded on a Agilent-400 MHz, Bruker-400 MHz and are reported in ppm using chloroform as the internal standard (77.0 ppm). Mass spectra were recorded on Agilent mass spectrum

**General Procedure for the oxidative desulfurative cyclization of dithioesters :**

To a solution of dithioester (1.0 eq, 1.0 mmol) in ethanol (5 mL) was added amine or hydrazine (1.1 eq, 1.1 mmol) at room temperature, the resulting mixture was stirred for 45 min. monitored the dithioester could no longer be detected. To the above mixture was added I<sub>2</sub> (2.2 equiv, 2.2 mmol). The mixture was stirred at room temperature for 2h and progress was monitored by TLC. The reaction mixture was heated to 80 °C for 12-24 hrs. Once the reaction was completed, the reaction mixture was cooled to room temperature and ethanol was removed using rotary evaporator. The reaction mixture was quenched with 10 mL of water and; the aqueous layer was extracted with EtOAc (15 mL X 3). The combined organic layers were washed with water, dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>. The solvent was removed under reduced pressure; the residue was purified by silica gel chromatography.

**General Procedure for the oxidative desulfurative cyclization of dithioesters :** To a solution of dithioester (1.0 eq, 1.0 mmol) in THF (2 mL) was added amine or hydrazine (1.1 eq, 1.1 mmol) at room temperature, the resulting mixture was stirred for 45 min. monitored the dithioester could no longer be detected. To the above mixture was added I<sub>2</sub> (2.0 equiv. The mixture was stirred at room temperature for 1.5 h and progress was monitored by TLC. The reaction mixture was diluted with EtOAc neutralized with saturated sodium bicarbonate solution, separated organic layer; the aqueous layer was extracted with EtOAc (25 mL X 3). The combined organic layers were washed with water, dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>. The solvent was removed under reduced pressure; the residue was purified by silica gel chromatography.

### Ortep of Compound - 4h



### ORTEP of 4h

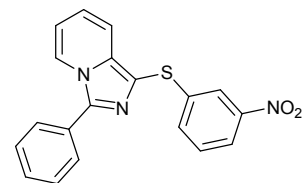


Table 1: Crystal data and structure refinement details.

Empirical formula	C <sub>19</sub> H <sub>13</sub> N <sub>3</sub> O <sub>2</sub> S		
Formula weight	347.38		
Temperature	296(2) K		
Wavelength	1.54178 Å		
Reflns. for cell determination	2729		
θ range for above	4.65° to 64.53°		
Crystal system	Monoclinic		
Space group	P 21/c		
Cell dimensions			
a = 9.6224(12) Å	b = 14.7044(19) Å	c = 11.8502(16)	
α = 90.00°	β = 98.565(4)°	γ = 90.00°	
Volume	1658.0(4) Å <sup>3</sup>		
Z	4		
Density(calculated)	1.392 Mg m <sup>-3</sup>		
Absorption coefficient	1.885 mm <sup>-1</sup>		
F <sub>000</sub>	720		
Crystal size	0.27 × 0.25 × 0.22 mm		
θ range for data collection	4.65° to 64.53°		
Index ranges	-11 ≤ h ≤ 11		
	-16 ≤ k ≤ 17		
	-13 ≤ l ≤ 13		
Reflections collected	16278		
Independent reflections	2729 [R <sub>int</sub> = 0.0399]		
Absorption correction	multi-scan		
Refinement method	Full matrix least-squares on F <sup>2</sup>		
Data / restraints / parameters	2729 / 0 / 226		
Goodness-of-fit on F <sup>2</sup>	1.052		
Final [I > 2σ(I)]	R1 = 0.0355, wR2 = 0.0938		
R indices (all data)	R1 = 0.0368, wR2 = 0.0949		
Largest diff. peak and hole	0.210 and -0.212 e Å <sup>-3</sup>		

Table 2: Bond lengths (Å).

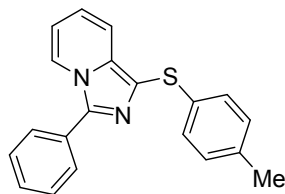
Atoms	Length	Atoms	Length
N1-C9	1.324(2)	C11-C12	1.390(3)
N1-C2	1.364(2)	C12-C13	1.362(4)
C2-C3	1.388(2)	C13-C14	1.378(4)
C2-S16	1.7412(15)	C14-C15	1.377(3)
C3-N8	1.3969(19)	S16-C17	1.7715(16)
C3-C4	1.409(2)	C17-C18	1.385(2)
C4-C5	1.360(2)	C17-C22	1.398(2)
C5-C6	1.418(3)	C18-C19	1.384(3)
C6-C7	1.341(2)	C19-C20	1.382(3)
C7-N8	1.3851(19)	C20-C21	1.377(2)
N8-C9	1.380(2)	C21-C22	1.379(2)
C9-C10	1.466(2)	C21-N23	1.473(2)
C10-C11	1.391(3)	N23-O25	1.211(2)
C10-C15	1.395(3)	N23-O24	1.220(2)

Table 3: Bond angles (°).

Atoms	Angle	Atoms	Angle
C9-N1-C2	106.75(12)	C12-C11-C10	120.08(19)
N1-C2-C3	110.66(12)	C13-C12-C11	120.4(2)
N1-C2-S16	122.71(11)	C12-C13-C14	120.1(2)
C3-C2-S16	126.42(12)	C15-C14-C13	120.4(2)
C2-C3-N8	104.66(12)	C14-C15-C10	120.2(2)
C2-C3-C4	136.07(14)	C2-S16-C17	103.58(7)
N8-C3-C4	119.26(13)	C18-C17-C22	119.38(15)
C5-C4-C3	119.17(15)	C18-C17-S16	123.72(12)
C4-C5-C6	120.25(15)	C22-C17-S16	116.90(12)
C7-C6-C5	120.94(15)	C19-C18-C17	120.46(15)
C6-C7-N8	119.61(15)	C20-C19-C18	121.07(16)
C9-N8-C7	132.00(13)	C21-C20-C19	117.41(16)
C9-N8-C3	107.21(12)	C20-C21-C22	123.39(15)
C7-N8-C3	120.68(13)	C20-C21-N23	118.90(15)
N1-C9-N8	110.70(13)	C22-C21-N23	117.69(15)
N1-C9-C10	123.62(14)	C21-C22-C17	118.27(14)
N8-C9-C10	125.67(13)	O25-N23-O24	123.22(15)
C11-C10-C15	118.76(16)	O25-N23-C21	118.59(15)
C11-C10-C9	123.33(16)	O24-N23-C21	118.19(16)
C15-C10-C9	117.82(16)		

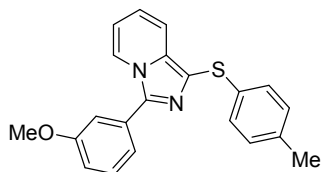
## Experimental section: Characterization for compounds 4a-3q and 5a-5e

### 3-phenyl-1-(p-tolylthio)imidazo[1,5-a]pyridine (4a):



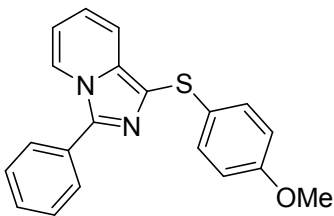
Pale yellow solid (160mg, 80%); M.p. 85–87 °C; <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 8.49 (s, 1H), 7.85 (s, 2H), 7.59-7.53 (m, 3H), 7.47 (s, 1H), 7.06-7.0 (m, 5H), 6.81 (d, *J* = 5.6 Hz, 1H), 2.16 (s, 3H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 139.0, 135.4, 134.7, 129.6, 129.5, 128.99, 128.93, 128.2, 127.8, 121.9, 120.7, 118.5, 113.7, 20.8; HRMS (ESI-MS) *m/z*: Calcd for C<sub>14</sub>H<sub>12</sub>N<sub>2</sub> [M + H]<sup>+</sup> 317.1034 found: 317.1049.

### 3-(3-methoxyphenyl)-1-(p-tolylthio)imidazo[1,5-a]pyridine (4b):



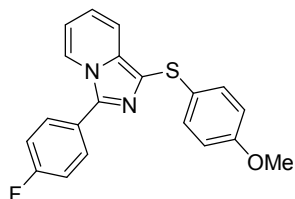
Brown solid (136mg, 82%); mp. 122–124 °C; <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 8.53 (br s, 1H), 7.59 (br s, 1H), 7.47-7.38 (m, 3H), 7.04 (br s, 6H), 6.82 (d, *J* = 5.2 Hz, 1H), 3.83 (s, 3H), 2.18 (s, 3H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 160.1, 138.9, 135.4, 134.8, 134.5, 130.8, 129.9, 129.5, 127.7, 122.1, 120.8, 120.1, 118.4, 115.2, 113.7, 113.6, 55.4, 20.8; HRMS (ESI-MS) *m/z*: Calcd for C<sub>14</sub>H<sub>12</sub>N<sub>2</sub>O [M + H]<sup>+</sup> 347.1140 found: 347.1129.

### 1-((4-methoxyphenyl)thio)-3-phenylimidazo[1,5-a]pyridine (4c):



Oily compound (168mg, 84%); <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 8.48 (d, *J* = 6.4 Hz, 1H), 7.85 (d, *J* = 6.8 Hz, 2H), 7.64 (t, *J* = 5.2 Hz, 1H), 7.54 (d, *J* = 7.2 Hz, 2H), 7.47 (t, *J* = 6.4 Hz, 1H), 7.24-7.22 (m, 2H), 7.01-6.96 (m, 1H), 6.85-6.78 (m, 3H), 3.66 (s, 3H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>) δ 158.5, 138.7, 134.6, 130.2, 129.7, 129.5, 129.4, 128.3, 123.3, 122.4, 120.8, 117.8, 115.2, 114.7, 113.1, 55.6 ppm. HRMS (ESI-MS) *m/z*: Calcd for C<sub>14</sub>H<sub>11</sub>FN<sub>2</sub> [M + H]<sup>+</sup> 333.0983 found: 333.0912.

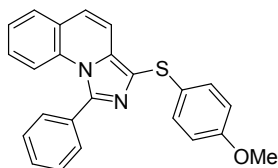
### 3-(4-fluorophenyl)-1-((4-methoxyphenyl)thio)imidazo[1,5-a]pyridine (4d):



Pale yellow solid (172mg, 86%); mp. 105–107 °C; <sup>1</sup>H NMR (400MHz DMSO-d<sub>6</sub>): δ 8.44 (s, 1H), 7.89 (d, *J* = 5.2 Hz, 2H), 7.63 (d, *J* = 6.4 Hz, 1H), 7.37 (d, *J* = 6.4 Hz, 2H), 7.21 (d, *J* = 4.4 Hz, 2H), 7.98 (t, *J* = 6 Hz, 1H), 6.82 (d, *J* = 6.4 Hz, 3H), 3.66 (s, 3H); <sup>13</sup>C NMR (100 MHz,

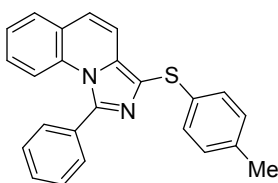
DMSO- $d_6$ )  $\delta$  163.9, 161.5, 158.5, 137.9, 134.5, 130.79, 130.70, 130.2, 128.3, 127.5, 126.3, 126.2, 123.2, 120.7, 117.8, 116.6, 116.3, 115.2, 114.7, 113.1, 55.6 ppm. HRMS (ESI-MS)  $m/z$ : Calcd for  $C_{13}H_9ClN_2$   $[M + H]^+$  351.0889 found: 351.0881.

### 3-((4-methoxyphenyl)thio)-1-phenylimidazo[1,5-a]quinoline (4e):



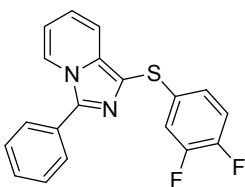
Pale brown solid (160mg, 80%); mp. 106–108 °C;  $^1H$  NMR (400 MHz DMSO- $d_6$ ):  $\delta$  7.87 (br s, 1H), 7.6 (s, 2H), 7.59 (d,  $J$  = 15.2 Hz, 4H), 7.42–7.34 (m, 4H), 7.26 (t,  $J$  = 4.4 Hz, 2H), 6.88–6.86 (m, 2H), 3.69 (s, 3H);  $^{13}C$  NMR (100 MHz, DMSO- $d_6$ ):  $\delta$  158.6, 142.7, 133.4, 133.3, 132.1, 130.5, 130.2, 130.0, 129.6, 129.3, 128.5, 127.7, 126.2, 125.5, 124.2, 123.4, 117.0, 116.3, 115.3, 55.6 ppm. HRMS (ESI-MS)  $m/z$ : Calcd for  $C_{11}H_8N_2S$   $[M + H]^+$  383.1140 found: 383.1139.

### 1-phenyl-3-(p-tolylthio)imidazo[1,5-a]quinoline (4f):



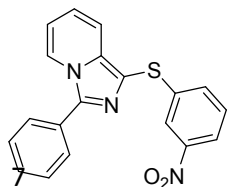
Pale green solid (138mg, 85%). mp. 90–92 °C;  $^1H$  NMR (400MHz DMSO- $d_6$ ):  $\delta$  7.88 (br s, 1H), 7.68–7.61 (m, 5H), 7.54 (d,  $J$  = 6.8 Hz, 1H), 7.41 (d,  $J$  = 11.6 Hz, 3H), 7.35 (s, 1H), 7.10 (d,  $J$  = 10.4 Hz, 2.22 (s, 3H);  $^{13}C$  NMR (100 MHz, DMSO- $d_6$ ):  $\delta$  142.9, 135.7, 134.2, 133.8, 133.4, 132.2, 130.9, 130.2, 130.0, 129.7, 129.4, 128.6, 128.3, 127.7, 126.3, 125.5, 124.4, 122.1, 117.0, 116.2, 20.9 ppm. HRMS (ESI-MS)  $m/z$ : Calcd for  $C_{14}H_{12}N_2$   $[M + H]^+$  367.1191 found: 367.1199.

### 1-((3,4-difluorophenyl)thio)-3-phenylimidazo[1,5-a]pyridine (4g):



Pale yellow solid (164mg, 82%); mp. 101–103 °C;  $^1H$  NMR (400 MHz DMSO- $d_6$ ):  $\delta$  8.54 (s, 1H), 7.87 (s, 2H), 7.63–7.50 (m, 4H), 7.30 (d,  $J$  = Hz, 1H), 7.19 (br s, 1H), 7.06 (br s, 1H), 6.95 (br s, 1H), 6.86 (d,  $J$  = 4.4 Hz, 1H);  $^{13}C$  NMR (100 MHz, DMSO- $d_6$ ):  $\delta$  151.7, 151.5, 150.0, 149.8, 149.2, 149.0, 147.5, 147.4, 139.6, 135.1, 134.8, 129.3, 129.2, 129.0, 128.2, 123.17, 123.12, 123.0, 122.1, 121.5, 119.3, 118.0, 117.5, 117.3, 116.3, 116.1, 113.9; HRMS (ESI-MS):  $m/z$   $[M+H]^+$  Calcd for  $C_{13}H_{10}N_2$ : 339.0689 found: 339.0631.

### 1-((3-nitrophenyl)thio)-3-phenylimidazo[1,5-a]pyridine (4h):

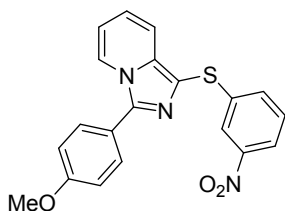


Yellow solid (178mg, 89%); mp. 132–134 °C;  $^1H$  NMR (400 MHz DMSO- $d_6$ ):  $\delta$  8.52 (d,  $J$  = 6 Hz, 1H), 7.88 (t,  $J$  = 7.2 Hz, 4H), 7.61–7.47 (m, 6H), 7.03

(t,  $J = 7.6$  Hz, 1H), 6.85 (d,  $J = 6.4$ Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ ):  $\delta$  148.6, 141.5, 139.8, 135.7, 132.6, 130.9, 129.7, 129.5, 129.4, 128.4, 123.6, 123.5, 120.8, 120.4, 117.4, 116.5, 115.0 ppm. HRMS (ESI-MS)  $m/z$ : Calcd for  $\text{C}_{12}\text{H}_8\text{FN}_3$   $[\text{M} + \text{H}]^+$  348.0728 found: 348.0773.

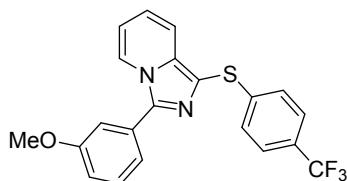
### 3-(4-methoxyphenyl)-1-((3-nitrophenyl)thio)imidazo[1,5-a]pyridine (4i):

Yellow solid (162mg, 81%); mp. 102–104 °C;  $^1\text{H}$  NMR (400 MHz DMSO- $d_6$ ):  $\delta$  8.62 (s, 1H), 7.98-7.94 (m, 2H), 7.68 (t,  $J = 5.2$  Hz, 1H), 7.56-7.51 (m, 3H), 7.46 (s, 1H), 7.42 (s, 1H), 7.11 (br s, 2H), 6.92 (d,  $J = 5.6$  Hz, 1H), 3.86 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ ):  $\delta$  160.1, 148.6, 141.6, 139.9, 135.5, 132.1, 130.4, 130.0, 129.3, 122.4, 121.9, 121.1, 120.2, 120.1, 117.8, 115.5, 114.0, 113.7, 55.4; HRMS (ESI-MS)  $m/z$ : Calcd for  $\text{C}_{17}\text{H}_{12}\text{N}_2$   $[\text{M} + \text{H}]^+$  378.0834 found: 378.0862.



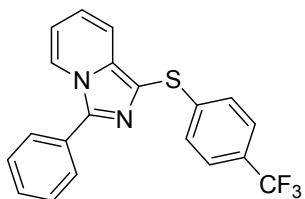
### 3-(3-methoxyphenyl)-1-((4-(trifluoromethyl)phenyl)thio)imidazo[1,5-a]pyridine (4j)

Pale yellow solid (140mg, 78%); mp. 90–92 °C;  $^1\text{H}$  NMR (400M Hz DMSO- $d_6$ ):  $\delta$  8.60 (d,  $J = 6$  Hz, 1H), 7.60 (d,  $J = 9.2$  Hz, 1H), 7.55 (d,  $J = 8.4$  Hz, 2H), 7.47 (d,  $J = 10$  Hz, 2H), 7.41 (s, 1H), 7.26 (d,  $J = 6.8$  Hz, 2H), 7.07 (d,  $J = 7.2$  Hz, 2H), 6.89 (d,  $J = 6$ Hz, 1H), 3.84 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ )  $\delta$  164.8, 162.8, 160.1, 149.2, 148.8, 144.7, 139.5, 139.0, 135.8, 135.1, 130.8, 130.6, 128.7, 128.5, 126.36, 126.30, 126.2, 126.1, 123.8, 123.3, 123.2, 120.6, 120.1, 119.3, 117.4, 116.5, 115.6, 114.9, 113.6, 55.7 ppm. HRMS (ESI-MS):  $m/z$   $[\text{M} + \text{H}]^+$  Calcd for  $\text{C}_{15}\text{H}_{14}\text{N}_2$ : 401.0908 found: 401.0919.



### 3-phenyl-1-((4-(trifluoromethyl)phenyl)thio)imidazo[1,5-a]pyridine (4k):

Oily compound (152mg, 76%);  $^1\text{H}$  NMR (400 MHz DMSO- $d_6$ ):  $\delta$  8.60 (d,  $J = 8$  Hz, 1H), 7.89 (d,  $J = 3.2$  Hz, 2H), 7.60-7.54 (m, 5H), 7.53 (br s, 1H) 7.27 (d,  $J = 7.6$  Hz, 2H), 7.09 (d,  $J = 8.4$  Hz, 1H), 6.92 (d,  $J = 3.6$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz, DMSO- $d_6$ ):  $\delta$  144.8, 139.7, 135.7, 129.64, 129.60, 128.5, 126.39, 126.32, 126.1, 126.0, 123.7, 123.4, 117.4, 116.5, 114.9; HRMS (ESI-MS)  $m/z$ : Calcd for  $\text{C}_{19}\text{H}_{17}\text{FN}_2\text{S}$   $[\text{M} + \text{H}]^+$  371.0752 found: 371.0767.





### 1-phenyl-3-((4-(trifluoromethyl)phenyl)thio)imidazo[1,5-a]quinoline (4l):

Oily Compound (176mg, 84%); <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 7.93 (br s, 1H), 7.22 (s, 2H), 6.22 (t, *J* = 8 Hz, 5H), 7.55 (d, *J* = 8 Hz, 1H), 7.49 (d, *J* = 5.2 Hz, 2H), 7.40 (d, *J* = 6.4, 2H), 7.33 (d, *J* = 6.4 Hz, 2H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>) δ 144.3, 143.6, 134.6, 133.4, 132.2, 130.4, 130.1, 129.8, 129.4, 128.8, 126.6, 126.4, 126.37, 123.33, 125.5, 125.1, 119.2, 117.0, 115.9 ppm.

HRMS (ESI-MS) *m/z*: Calcd for C<sub>17</sub>H<sub>11</sub>FN<sub>2</sub> [M + H]<sup>+</sup> 421.0908 found: 421.0967.

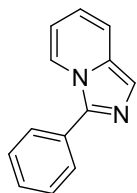
### 1-(cyclopropylthio)-3-phenylimidazo[1,5-a]pyridine (4m)

Oily compound (152mg, 72%); <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 8.24 (d, *J* = 7.6 Hz, 1H), 7.81 (d, *J* = 6.8 Hz, 2H), 7.64 (d, *J* = 9.2 Hz, 1H), 7.51 (t, *J* = 8.2 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 1H), 6.83-6.79 (m, 1H), 6.60 (t, *J* = 6.4 Hz, 1H), 2.36-2.30 (m, 1H), 0.83-0.78 (m, 2H), 0.77-0.73 (m, 2H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 138.4, 133.8, 129.8, 128.9, 128.8, 128.1, 123.9, 121.7, 120.0, 118.6, 113.4, 29.6, 16.7, 8.4 HRMS (ESI-MS) *m/z*: Calcd for C<sub>19</sub>H<sub>17</sub>FN<sub>2</sub>S [M + H]<sup>+</sup> 267.0878 found: 267.0866.

### 1-(phenethylthio)-3-phenylimidazo[1,5-a]pyridine(4n)

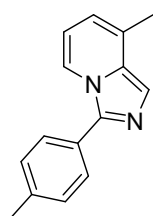
Oily compound (152mg, 76%); <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 8.23 (d, *J* = 7.6 Hz, 1H), 7.81 (d, *J* = 7.2 Hz, 2H), 7.60 (d, *J* = 8.8 Hz, 1H), 7.52 (t, *J* = 7.6 Hz, 2H), 7.44 (t, *J* = 7.6 Hz, 1H), 7.22 (t, *J* = 3.6 Hz, 2H), 7.17 (t, *J* = 6.8 Hz, 3H), 6.81-6.78 (m, 1H), 6.60 (t, *J* = 6.8 Hz, 1H), 3.18-3.12 (m, 2H), 2.93 (t, *J* = 7.2 Hz, 2H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 148.2, 138.0, 137.5, 133.7, 130.5, 130.4, 130.1, 130.0, 127.7, 125.9, 123.9, 123.3, 121.4, 120.0, 118.6, 116.1, 115.9, 113.6, 38.2, 35.8; HRMS (ESI-MS) *m/z*: Calcd for C<sub>19</sub>H<sub>17</sub>FN<sub>2</sub>S [M + H]<sup>+</sup> 331.1191 found: 331.1186.

### 3-phenylimidazo[1,5-a]pyridine (5a):



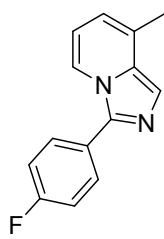
Pale yellow solid (164mg, 82%); mp. 101–103 °C; <sup>1</sup>H NMR (400 MHz DMSO-*d*<sub>6</sub>): δ 6.70–6.66 (m, 1H), 6.82–6.79 (m, 1H), 7.45 (t, *J* = 7.2 Hz, 1H), 7.54–7.50 (m, 3H), 7.62 (d, *J* = 8.8 Hz, 1H), 7.81–7.79 (m, 2H), 8.42 (d, *J* = 6.8 Hz, 1H); <sup>13</sup>C NMR (100 MHz, DMSO-*d*<sub>6</sub>): δ 137.7, 131.8, 130.6, 128.5, 128.1, 127.8, 122.4, 122.1, 121.4, 119.1, 118.9, 113.9, 113.8; HRMS (ESI-MS): *m/z* [M+H]<sup>+</sup> Calcd for C<sub>13</sub>H<sub>10</sub>N<sub>2</sub>: 195.2319 found: 195.2321.

### (3g):8-methyl-3-(p-tolyl)imidazo[1,5-a]pyridine (5b):



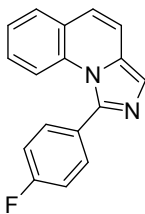
Pale yellow solid (140mg, 70%); mp. 90–92 °C; <sup>1</sup>H NMR (400M Hz DMSO-*d*<sub>6</sub>): δ 2.30 (s, 3H), 2.32 (s, 3H), 6.38–6.37 (m, 2H), 7.21 (d, *J* = 7.6 Hz, 2H), 7.41 (d, *J* = 0.8 Hz, 1H), 7.57 (d, *J* = 7.6 Hz, 2H), 8.00–7.98 (m, 1H); <sup>13</sup>C NMR (100 MHz, DMSO-*d*<sub>6</sub>): δ 138.7, 138.6, 132.6, 129.7, 129.5, 128.6, 128.0, 127.8, 127.4, 119.3, 119.2, 118.9, 118.7, 117.7, 117.6, 117.5, 113.3, 113.2, 113.1, 21.4, 17.8; HRMS (ESI-MS): *m/z* [M+H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>14</sub>N<sub>2</sub>: 222.2851 found: 222.2864.

### 3-(4-Fluorophenyl)-8-methylimidazo[1,5-a]pyridine (5c):



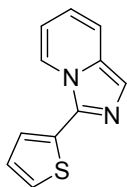
Oily compound (168mg, 84%); <sup>1</sup>H NMR (400 MHz DMSO-*d*<sub>6</sub>): δ 2.37 (s, 3H), 6.61–6.60 (m, 2H), 7.36–7.31 (m, 2H), 7.51 (s, 1H), 7.84–7.80 (m, 2H), 7.51 (s, 1H), 7.84–7.80 (m, 2H), 8.23–8.21 (m, 1H); <sup>13</sup>C NMR (100 MHz, DMSO-*d*<sub>6</sub>): δ 164.2, 161.8, 141.0, 132.3, 132.2, 132.0, 130.63, 130.60, 129.4, 128.1, 125.8, 125.6, 122.7, 122.6, 121.8, 117.6, 116.8, 116.4, 116.2; HRMS (ESI-MS) *m/z*: Calcd for C<sub>14</sub>H<sub>11</sub>FN<sub>2</sub> [M + H]<sup>+</sup> 227.2489 found: 227.2488.

### 1-(4-fluorophenyl)imidazo[1,5-a]quinoline (5d):



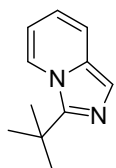
Oily Compound (176mg, 88%); <sup>1</sup>H NMR (400 MHz DMSO-*d*<sub>6</sub>): δ 7.19 (d, *J* = 9.6 Hz, 1H), 7.41 (m, 5H), 7.50 (d, *J* = 9.6 Hz, 1H), 7.53 (s, 1H), 7.66–7.62 (m, 2H), 7.78 (d, *J* = 7.6 Hz, 1H); <sup>13</sup>C NMR (100 MHz, DMSO-*d*<sub>6</sub>): δ 164.0, 161.6, 146.9, 143.7, 143.6, 143.5, 138.0, 130.7, 130.6, 130.5, 129.4, 127.6, 126.6, 126.0, 125.6, 116.6, 116.4; HRMS (ESI-MS) *m/z*: Calcd for C<sub>17</sub>H<sub>11</sub>FN<sub>2</sub> [M + H]<sup>+</sup> 263.2810 found: 263.2818.

### 3-(thiophen-3-yl)imidazo[1,5-a]pyridine (5e):



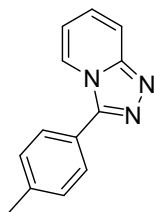
Pale brown solid (160mg, 80%); mp. 106–108 °C; <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 6.82–6.74 (m, 2H), 7.19–7.17 (m, 1H), 7.50 (s, 1H), 7.66–7.58 (m, 3H), 8.49 (d, *J* = 6.4 Hz, 1H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 133.1, 132.7, 131.9, 128.5, 126.7, 126.6, 124.28, 124.23, 122.6, 121.08, 121.03, 119.6, 118.9, 114.5; HRMS (ESI-MS) *m/z*: Calcd for C<sub>11</sub>H<sub>8</sub>N<sub>2</sub>S [M + H]<sup>+</sup> 201.2596 found: 201.2593.

### 3-(tert-butyl)imidazo[1,5-a]pyridine (5f):



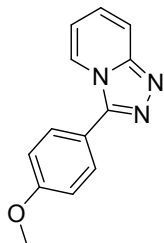
Oily Compound; yield: 138mg (69%); <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ = 1.45 (s, 9H), 6.58 (t, *J* = 6.8 Hz, 1H), 6.70–6.65 (m, 1H), 7.22 (s, 1H), 7.50 (d, *J* = 9.6 Hz, 1H), 8.34 (d, *J* = 7.6 Hz, 1H), <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ = 27.4, 28.2, 112.0, 117.83, 117.89, 118.9, 123.8, 131.6, 145.0; HRMS (ESI-MS) *m/z*: Calcd for C<sub>11</sub>H<sub>14</sub>N<sub>2</sub> [M + H]<sup>+</sup> 174.2423 found: 174.2427.

### 3-(p-tolyl)-[1,2,4]triazolo[4,3-a]pyridine (5g):



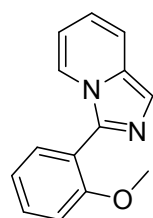
Pale yellow solid; yield: 170mg (85%); MP 118–120 °C; <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 8.19 (t, *J* = 6.8 Hz, 1H), 7.70 (t, *J* = 9.2 Hz, 1H), 7.64–7.60 (m, 2H), 7.30 (d, *J* = 7.6 Hz, 2H), 7.20–7.18 (m, 1H), 6.78 (t, *J* = 6.4 Hz, 1H), 2.37 (s, 3H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 150.3, 146.7, 140.3, 129.9, 28.0, 126.6, 122.6, 116.6, 116.5, 114.0, 21.4; HRMS (ESI-MS) *m/z*: Calcd for C<sub>13</sub>H<sub>11</sub>N<sub>3</sub> [M + H]<sup>+</sup> 209.2465 found: 209.2462.

### 3-(4-methoxyphenyl)-[1,2,4]triazolo[4,3-a]pyridine (5h):



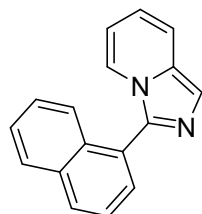
Pale yellow solid; yield: 168mg (84%); MP 121–123 °C; <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 8.20 (d, *J* = 6.8 Hz, 1H), 7.77–7.71 (m, 3H), 7.22 (t, *J* = 7.2 Hz, 1H), 7.06 (d, *J* = 8 Hz, 2H), 6.81 (t, *J* = 6.4 Hz, 1H), 3.86 (s, 3H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>) δ 161.0, 129.7, 126.6, 122.5, 118.9, 116.7, 113.9, 55.4; HRMS (ESI-MS) *m/z*: Calcd for C<sub>13</sub>H<sub>11</sub>N<sub>3</sub>O [M + H]<sup>+</sup> 225.2459 found: 225.2458.

### 3-(2-methoxyphenyl)imidazo[1,5-a]pyridine (5i):



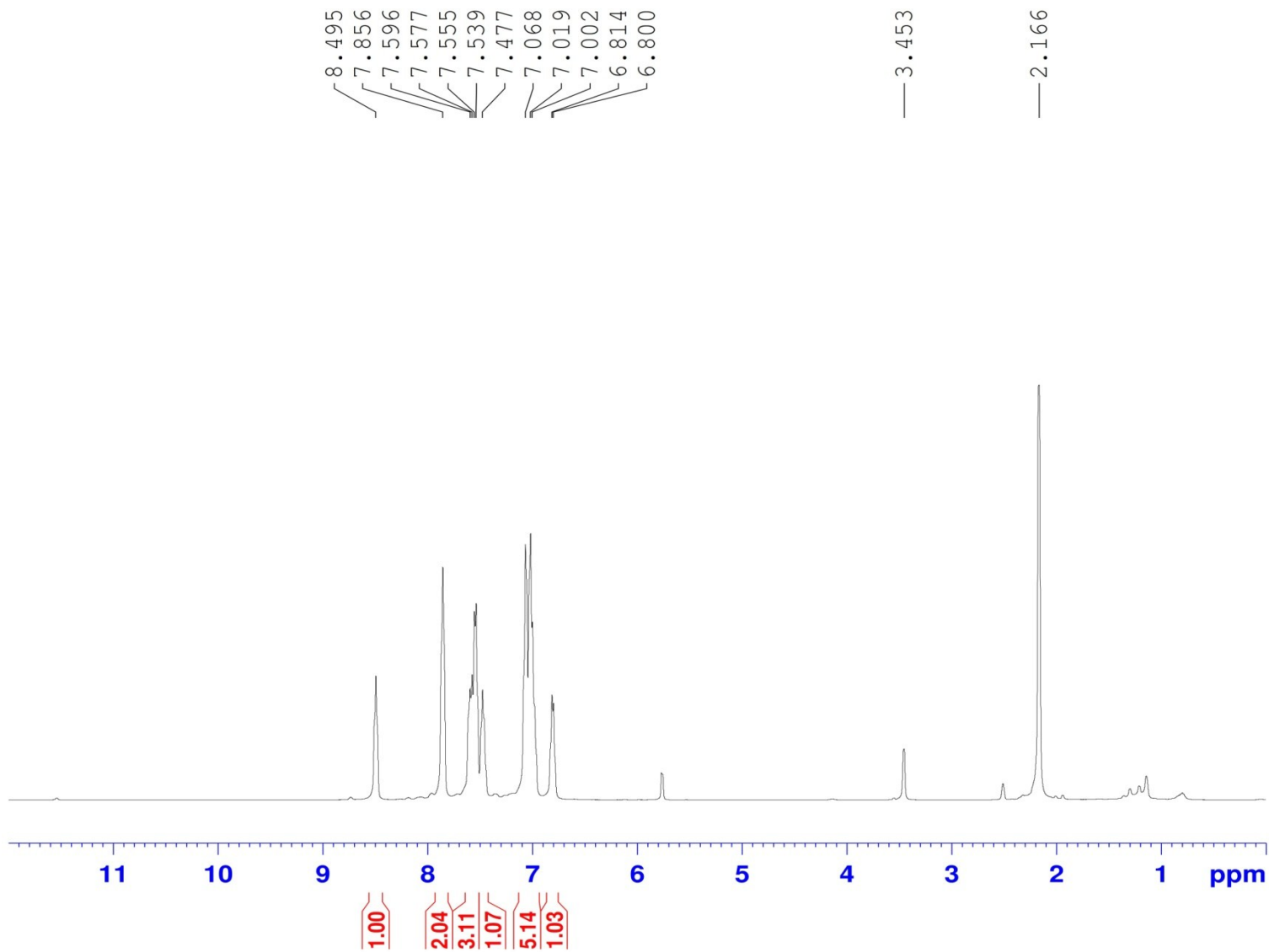
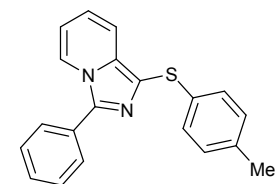
Pale brown solid (143mg, 76%); mp. 119–121 °C; <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): 7.61-7.56 (m, 3H), 7.47-7.42 (m, 2H), 7.09 (t, *J* = 7.2 Hz, 1H), 7.03 (d, *J* = 8.8 Hz, 1H), 6.73-6.69 (m, 1H), 6.49 (t, *J* = 6.8 Hz, 1H), 3.79 (s, 3H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 157.3, 136.1, 132.4, 131.2, 130.5, 123.0, 121.1, 120.0, 119.4, 118.4, 118.1, 111.7, 111.2, 55.5; HRMS (ESI-MS) *m/z*: Calcd for C<sub>14</sub>H<sub>12</sub>N<sub>2</sub>O [M + H]<sup>+</sup> 225.2579 found: 225.2566.

### 3-(naphthalen-1-yl)imidazo[1,5-a]pyridine (5j):

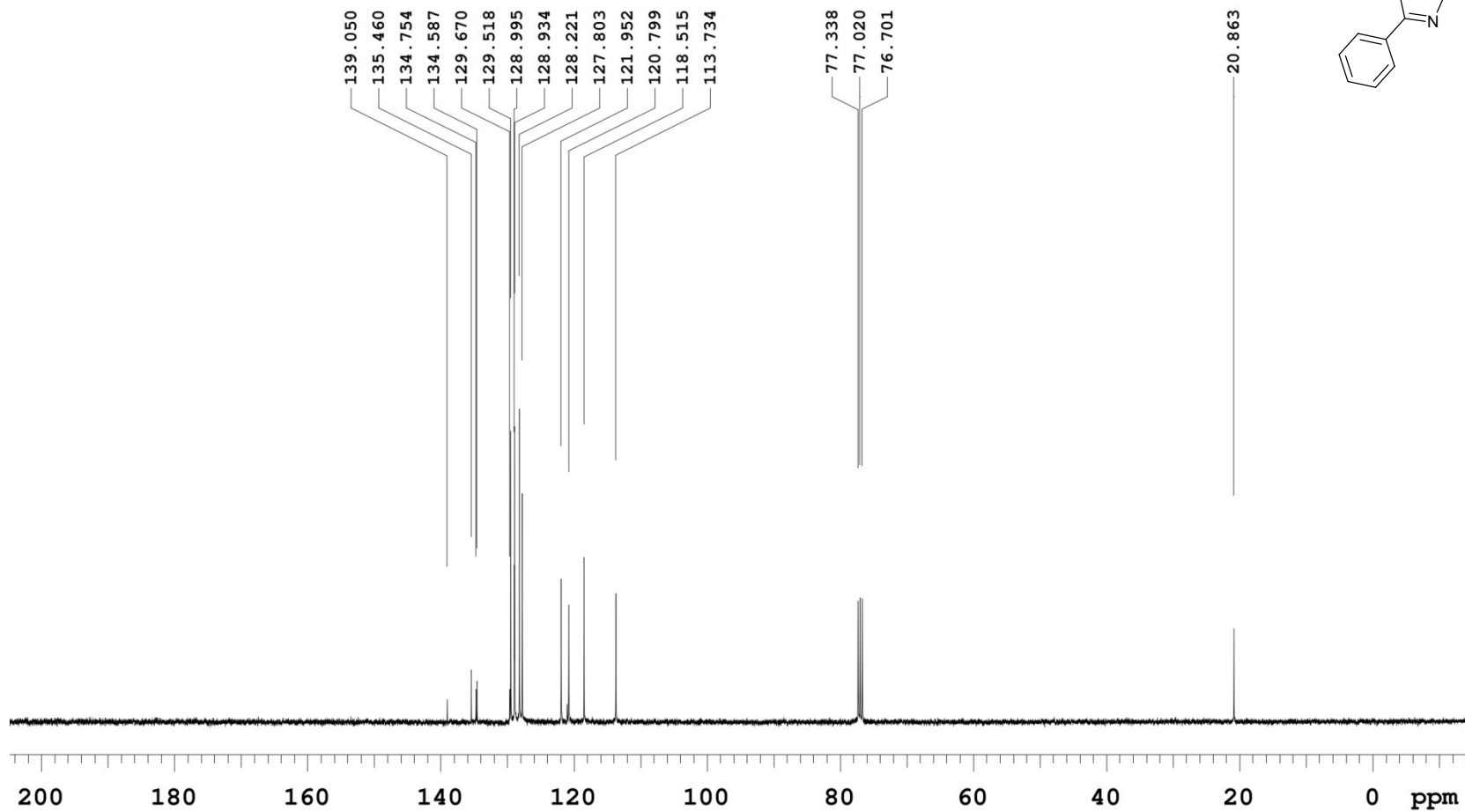
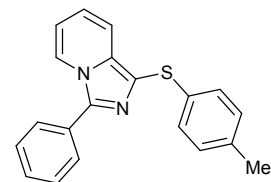


Pale brown solid (154mg, 73%); mp. 104–106°C; <sup>1</sup>H NMR (400 MHz DMSO-d<sub>6</sub>): δ 7.98-7.91 (m, 2H), 7.73-7.71 (m, 2H), 7.66-7.64 (m, 2H), 7.60-7.53 (m, 1H), 7.51-7.49 (m, 2H), 7.46-7.42 (m, 2H), 6.74-6.70 (m, 1H), 6.54-6.41 (m, 1H); <sup>13</sup>C NMR (100 MHz, DMSO-d<sub>6</sub>): δ 136.9, 133.9, 131.9, 131.0, 129.7, 128.5, 127.4, 126.9, 125.5, 125.3, 121.7, 120.2, 118.8, 118.5, 112.5; HRMS (ESI-MS) *m/z*: Calcd for C<sub>17</sub>H<sub>12</sub>N<sub>2</sub> [M + H]<sup>+</sup> 225.2906 found: 225.2911.

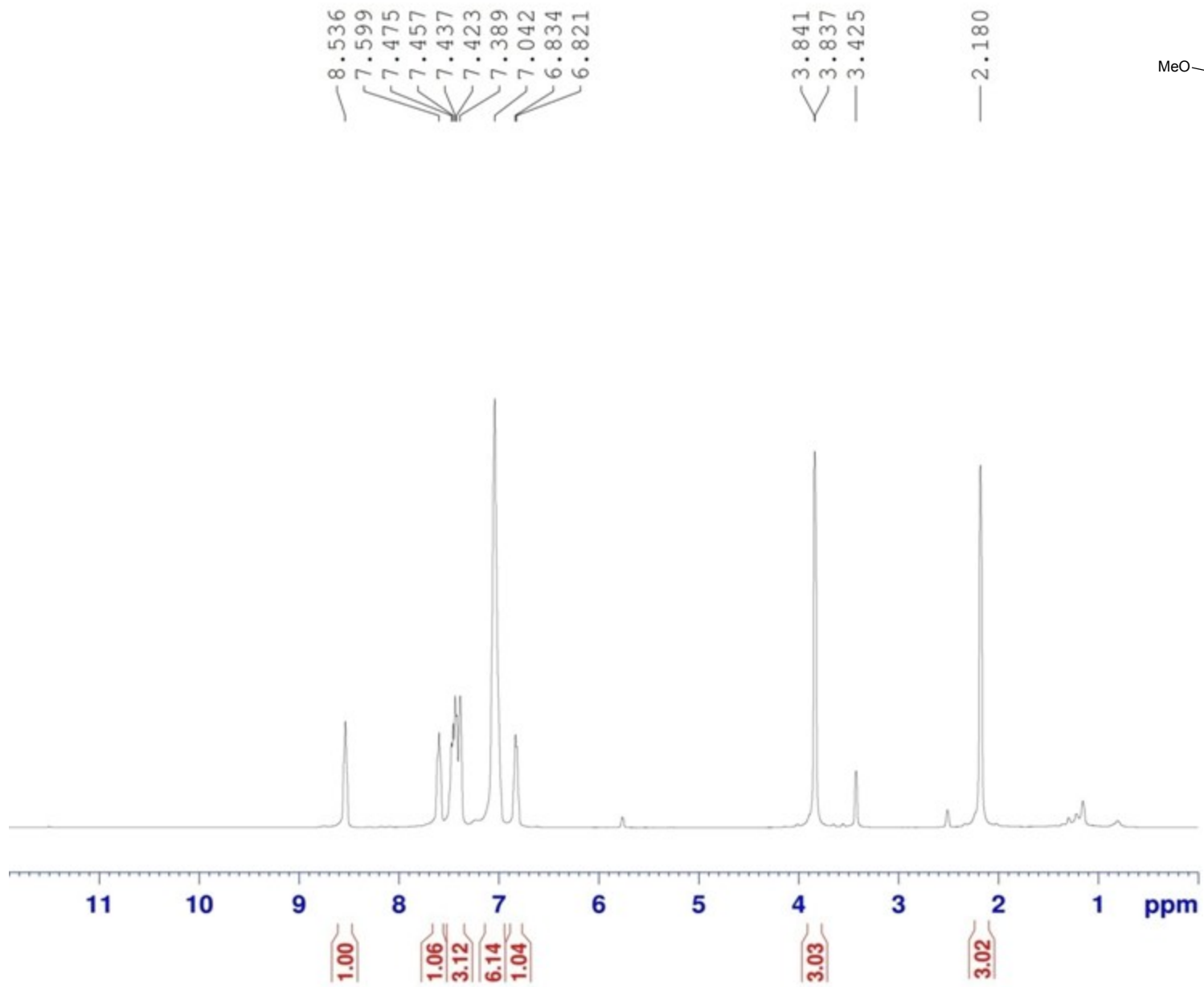
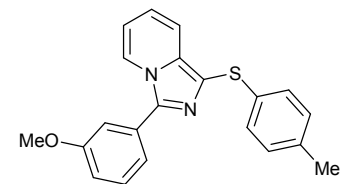
<sup>1</sup>H NMR of 4a



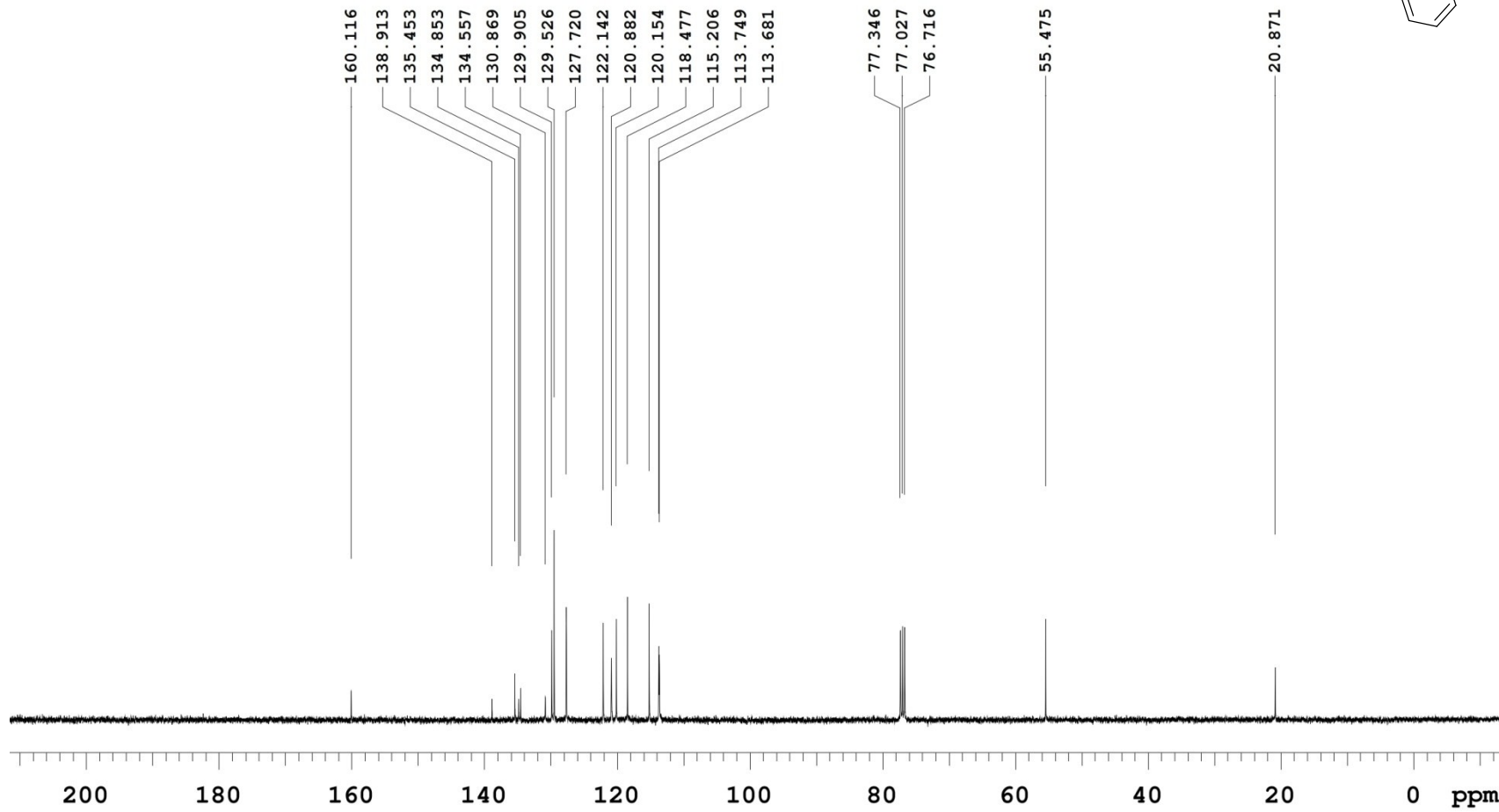
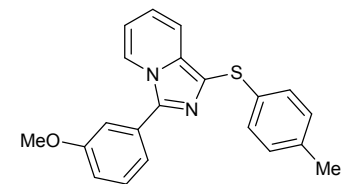
<sup>13</sup>C Spectra of 4a



<sup>1</sup>H NMR of 4b

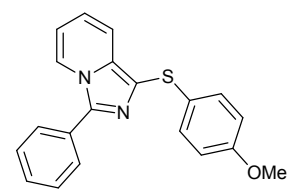


<sup>13</sup>C Spectra of **4b**

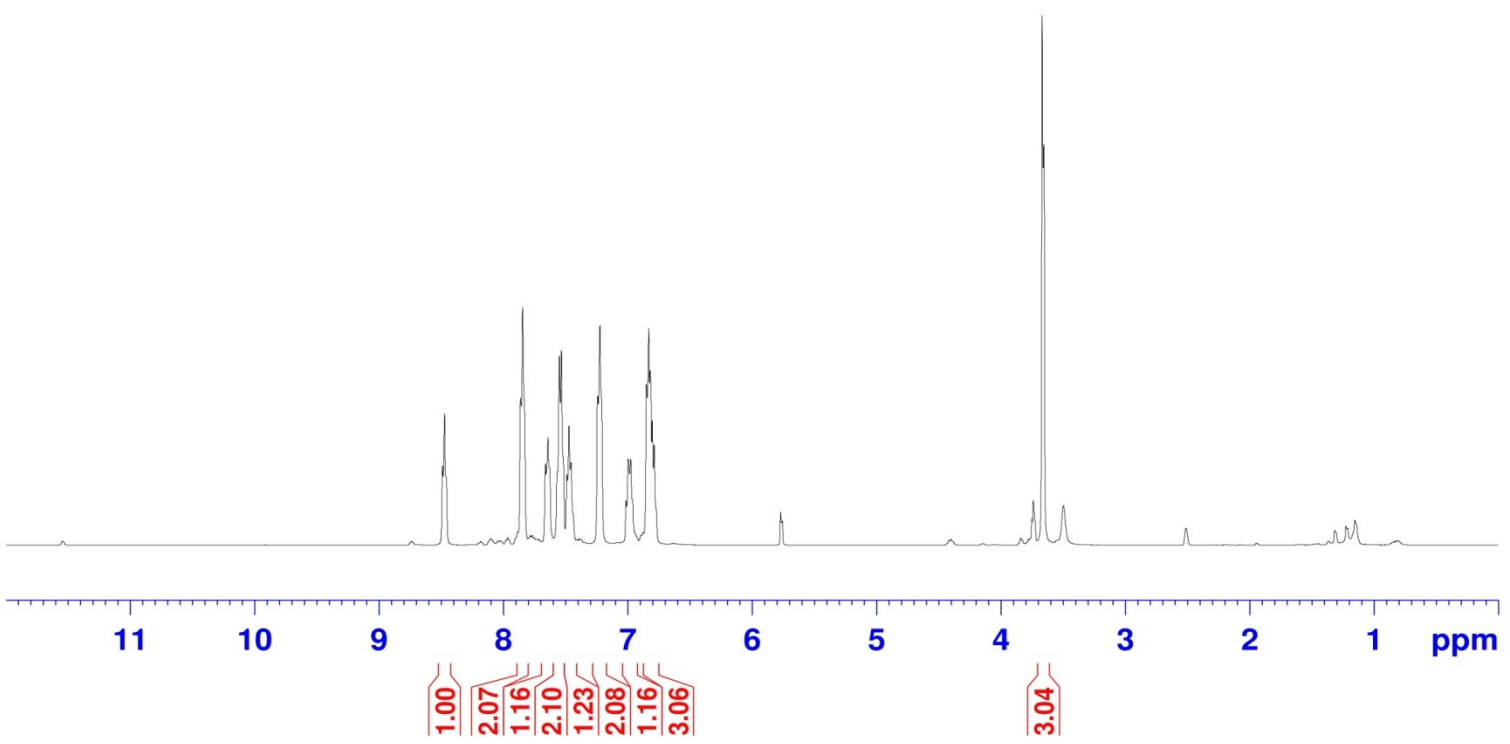


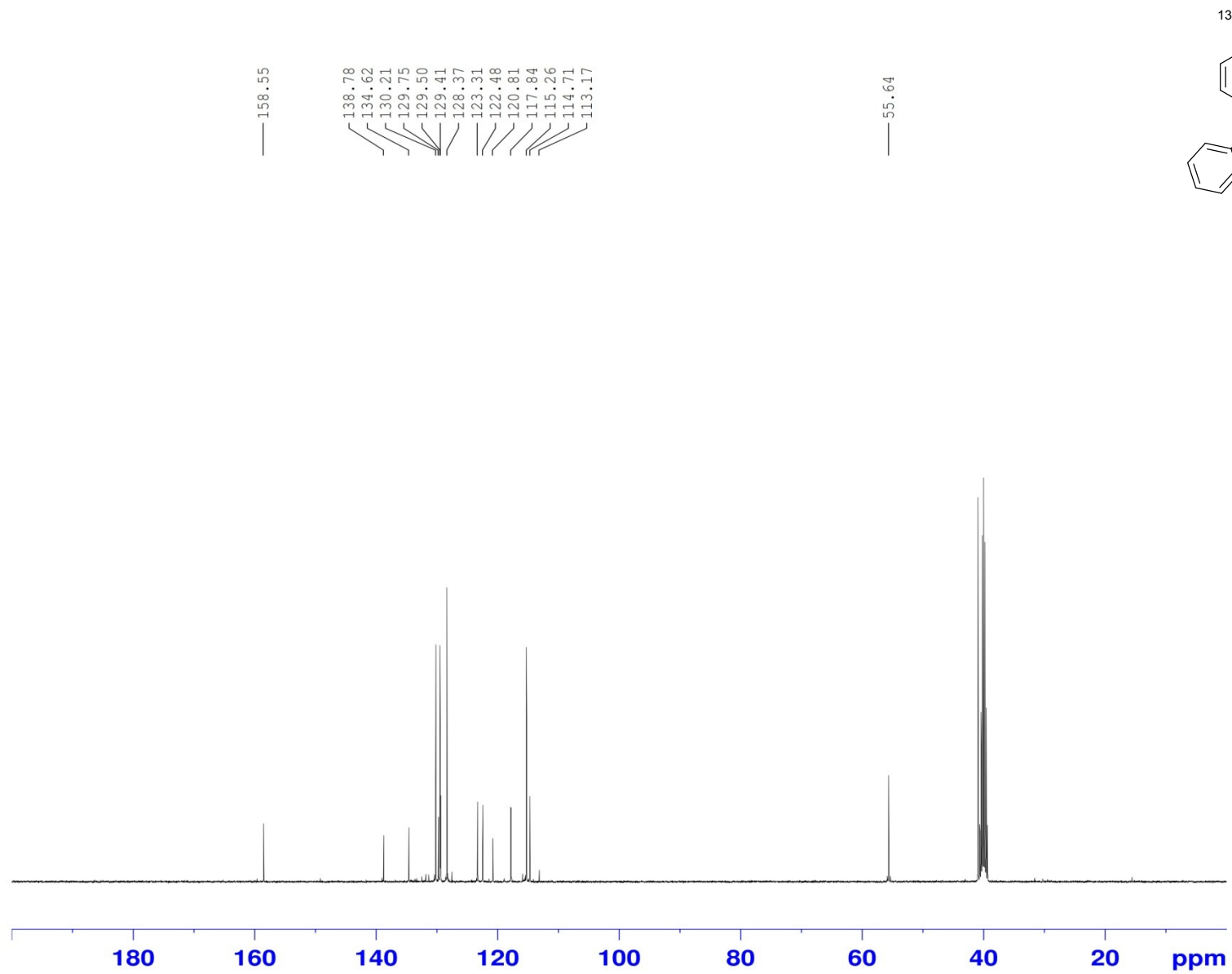


<sup>1</sup>H NMR of 4c

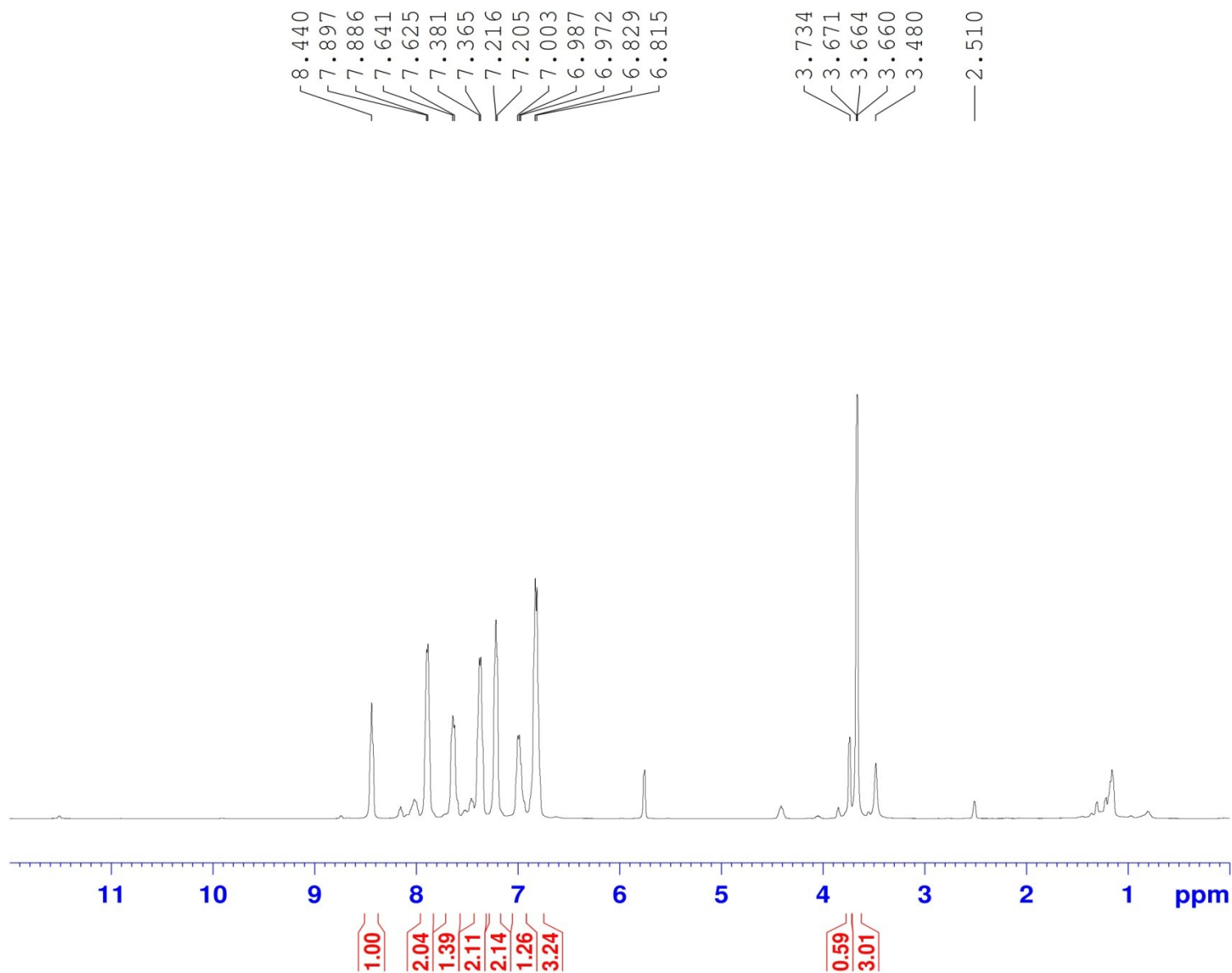
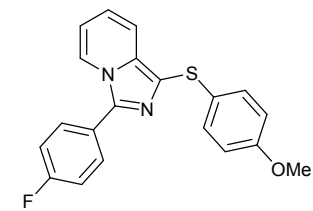


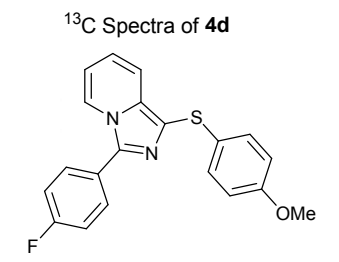
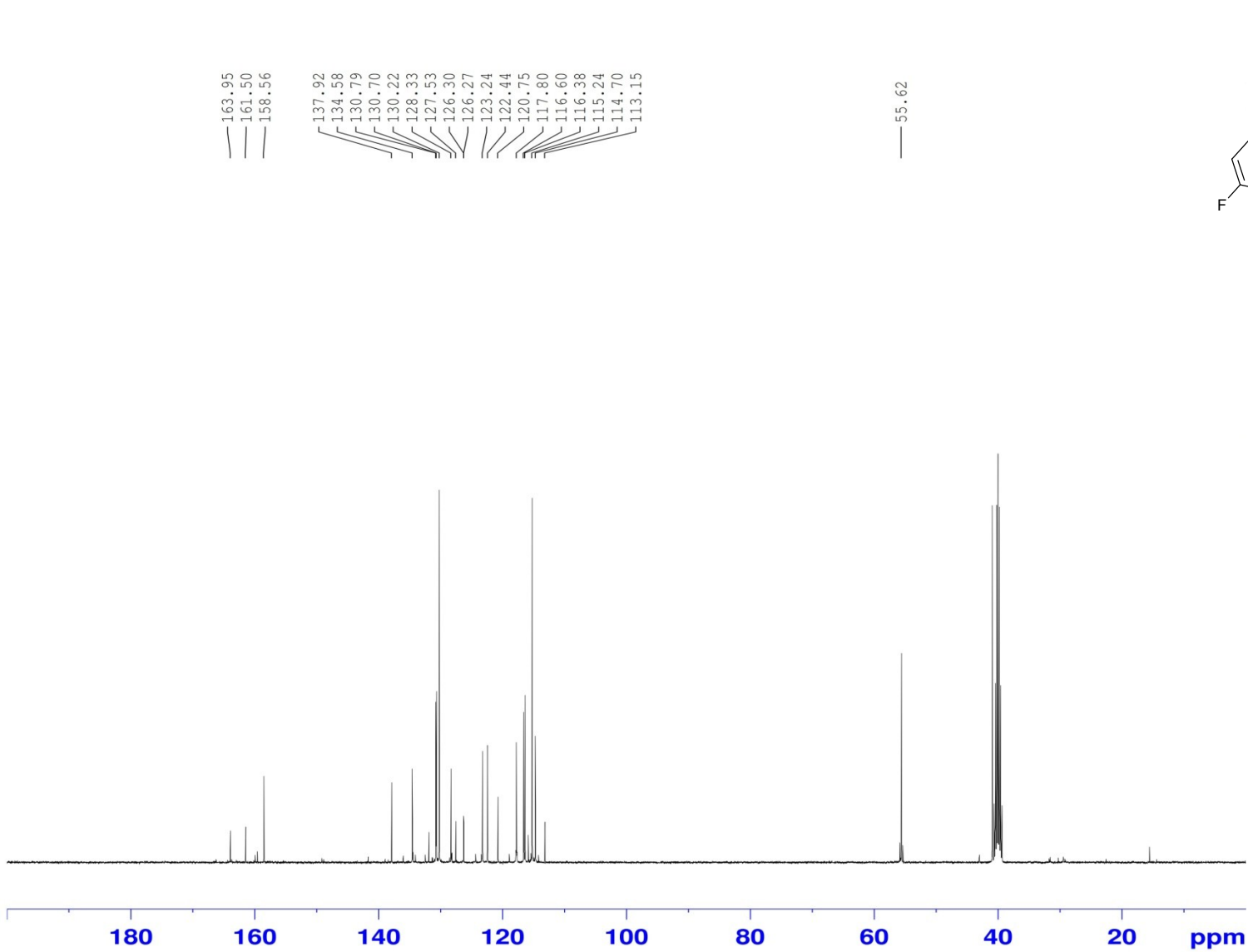
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8.475  
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7.846  
7.664  
7.643  
7.630  
7.552  
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7.474  
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7.244  
7.241  
7.224  
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6.998  
6.977  
6.963  
6.851  
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6.820  
6.804  
6.787  
3.669  
3.654  
3.497  
— 2.512

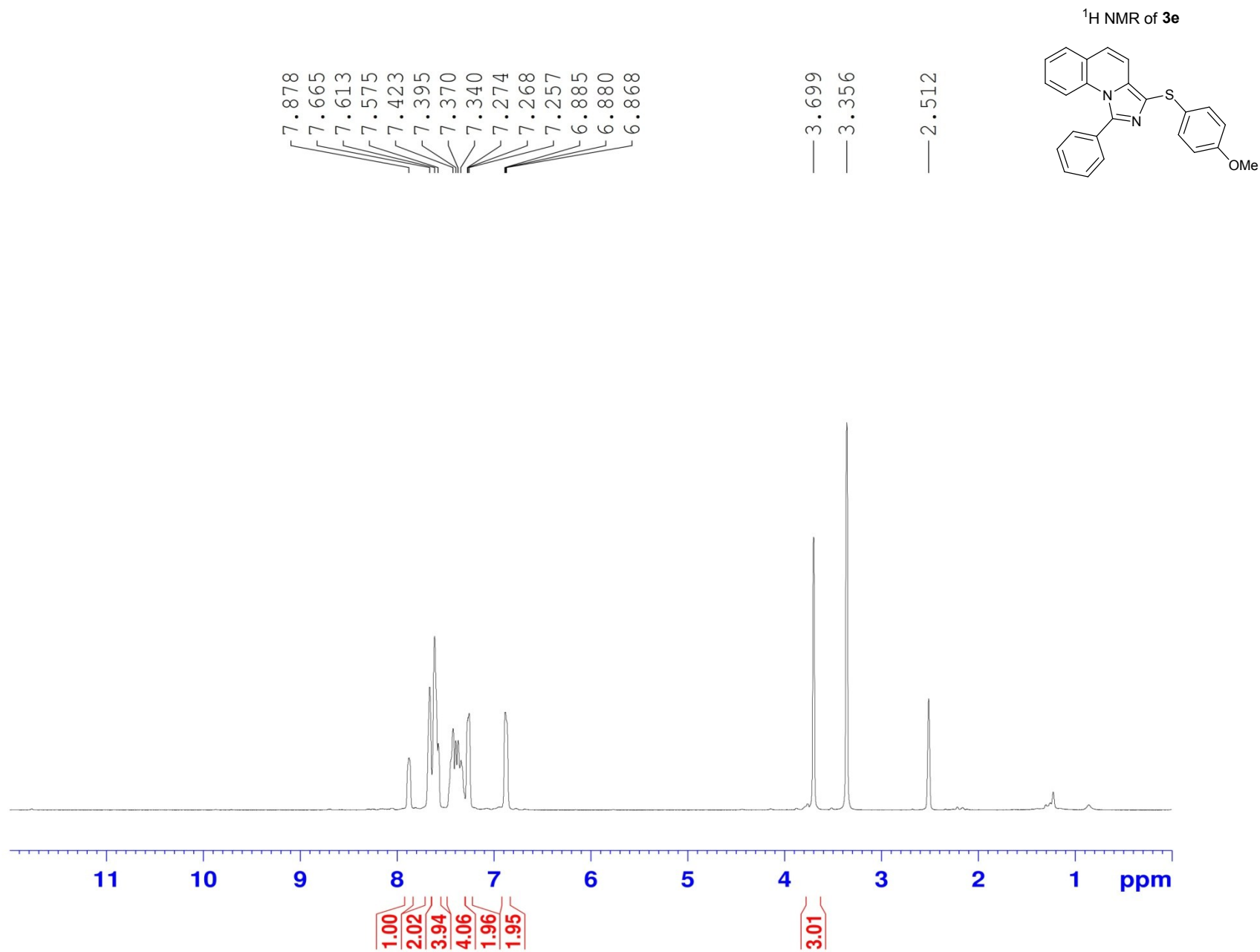




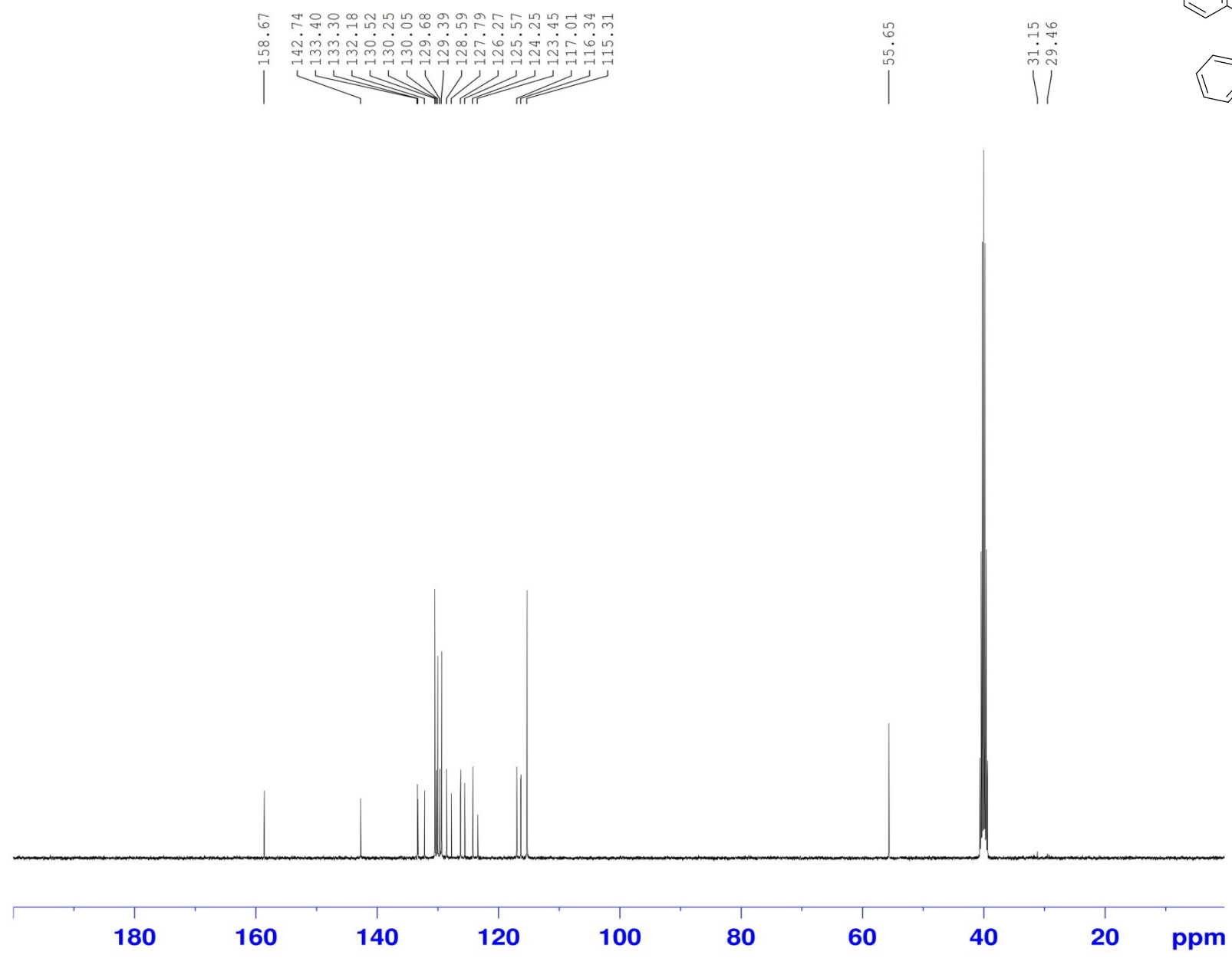
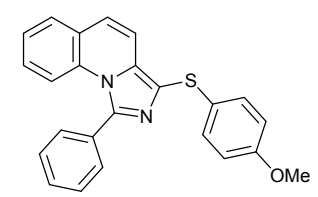
1H NMR of 4d



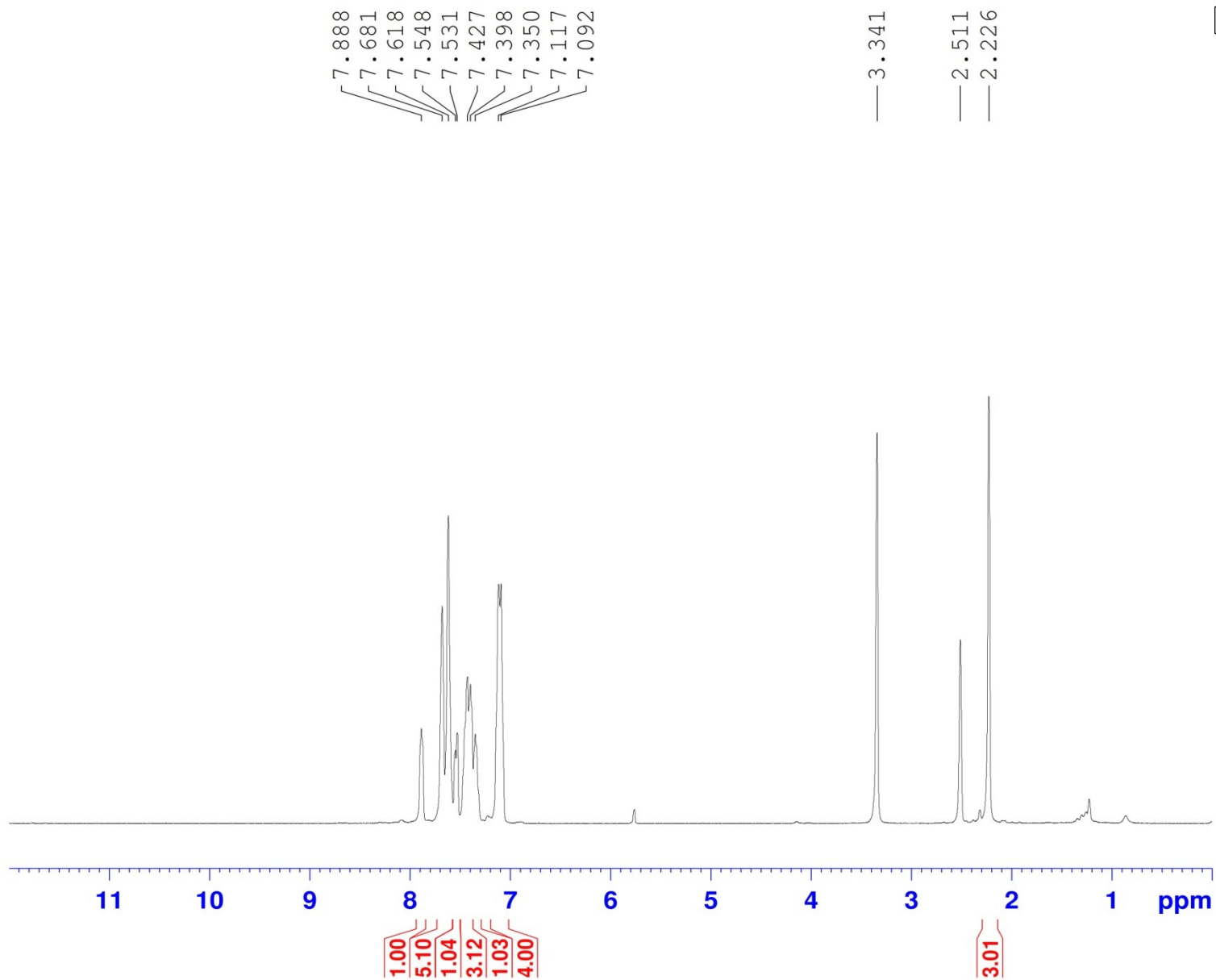
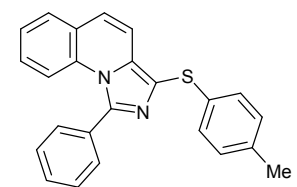




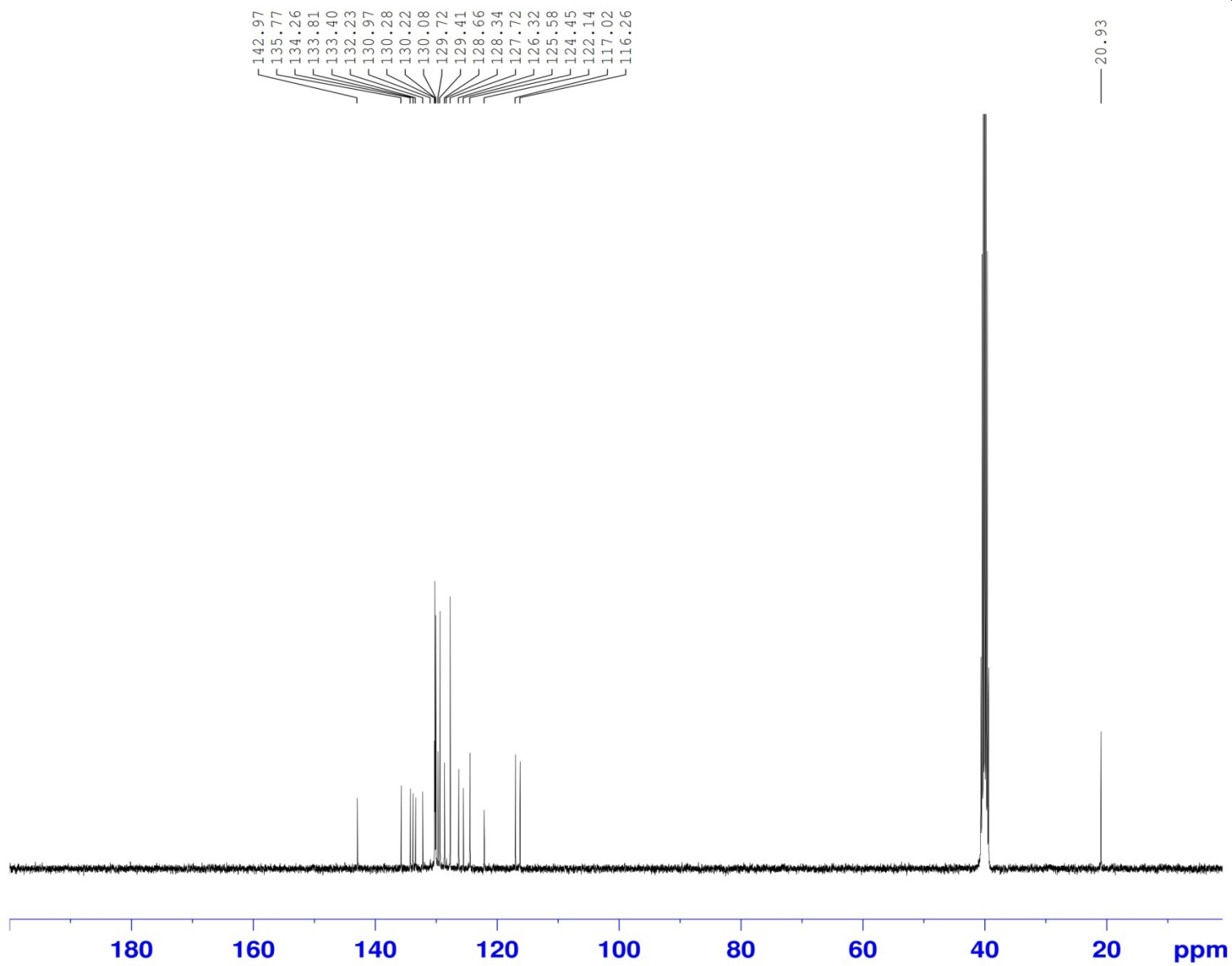
<sup>13</sup>C Spectra of 3e



<sup>1</sup>H NMR of 4f

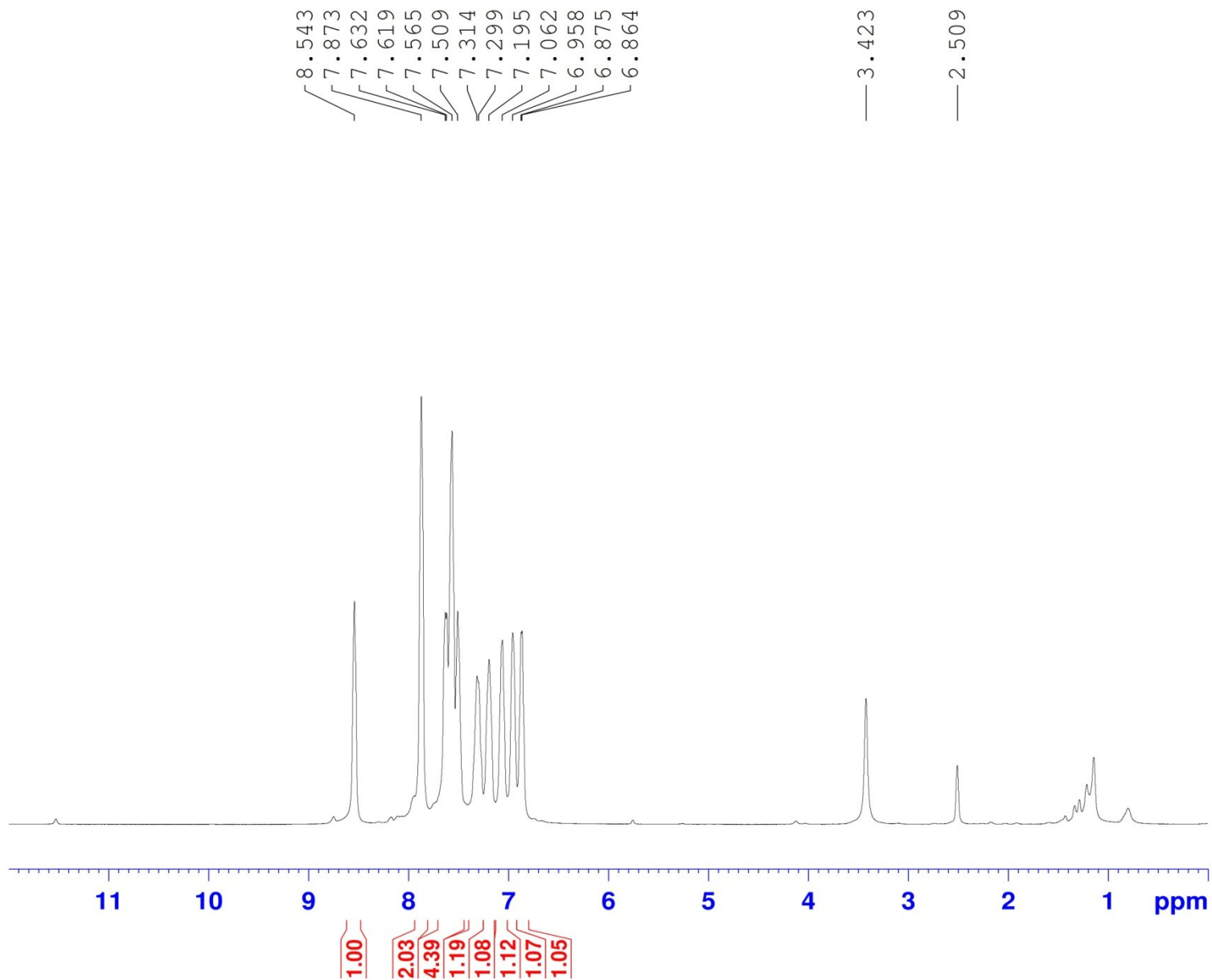
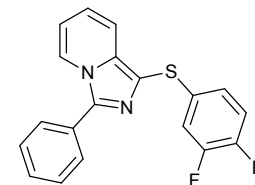


<sup>13</sup>C Spectra of 4f

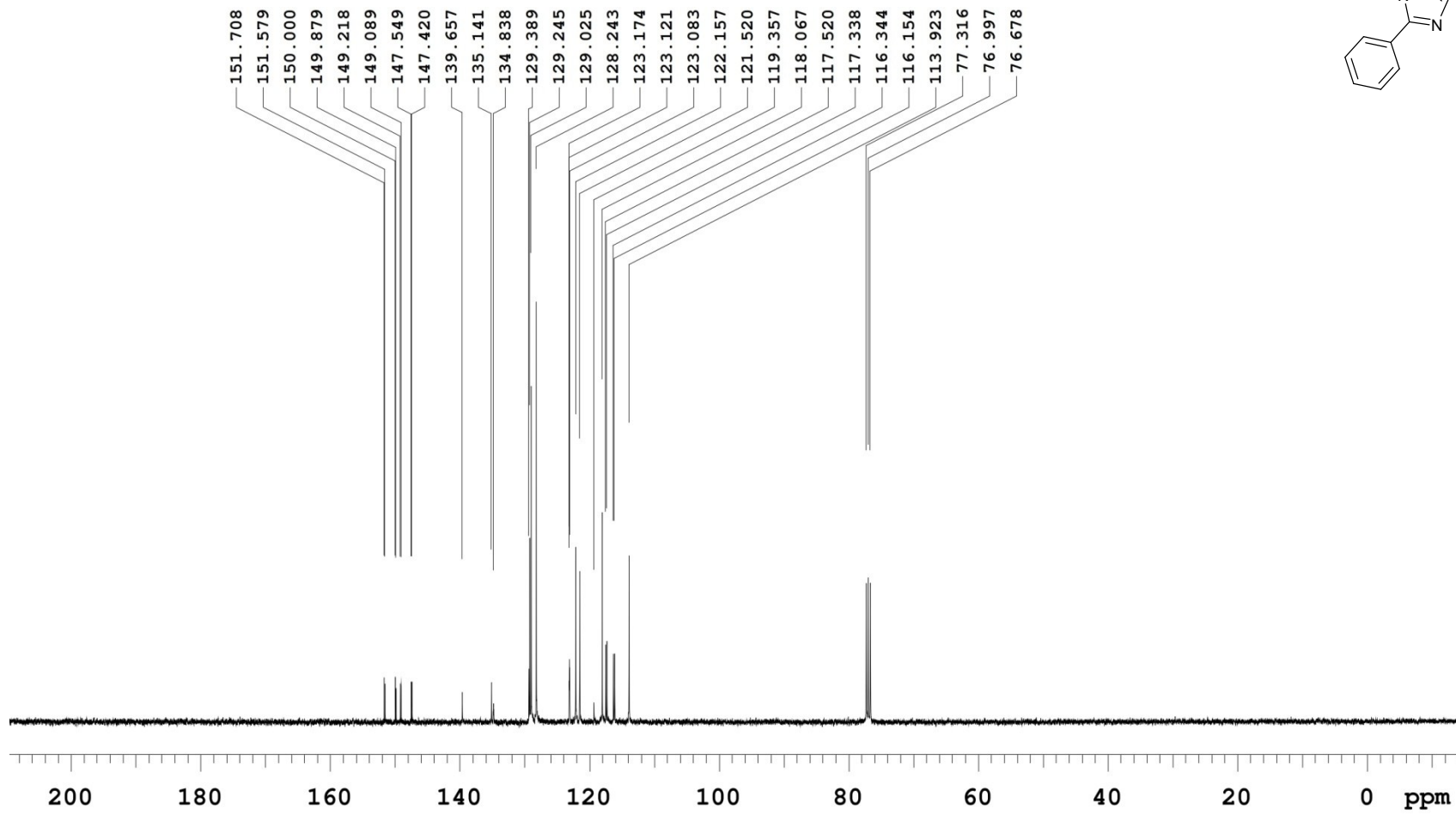
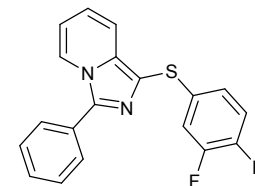


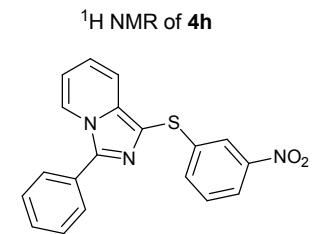
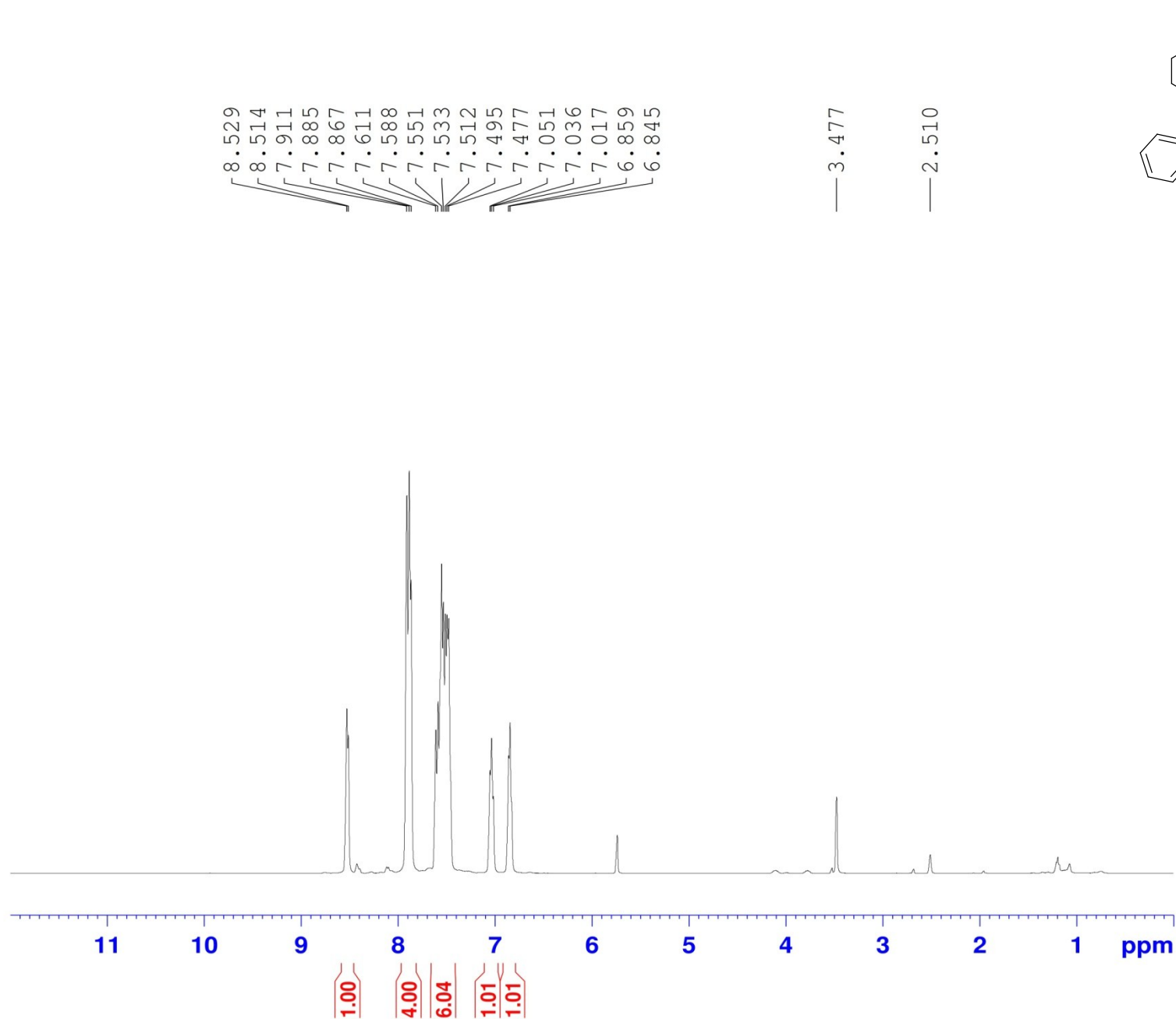


<sup>1</sup>H NMR of 4g

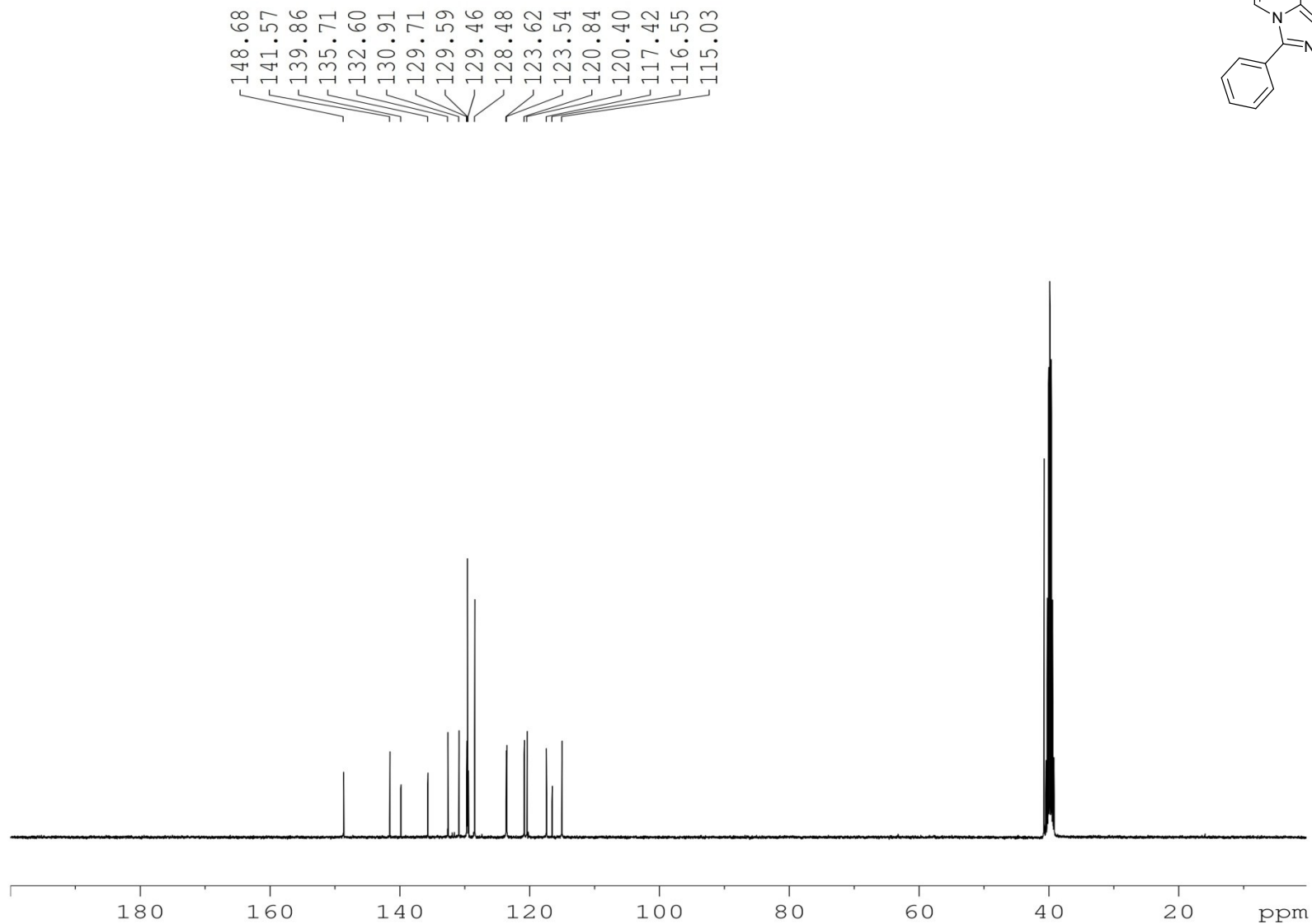
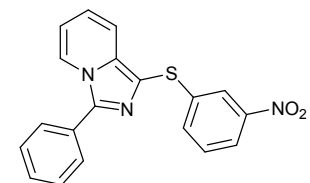


<sup>13</sup>C Spectra of 4g

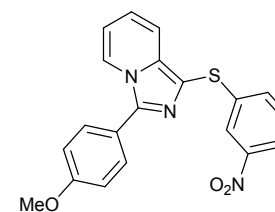




<sup>13</sup>C Spectra of 4h



1H NMR of 4i

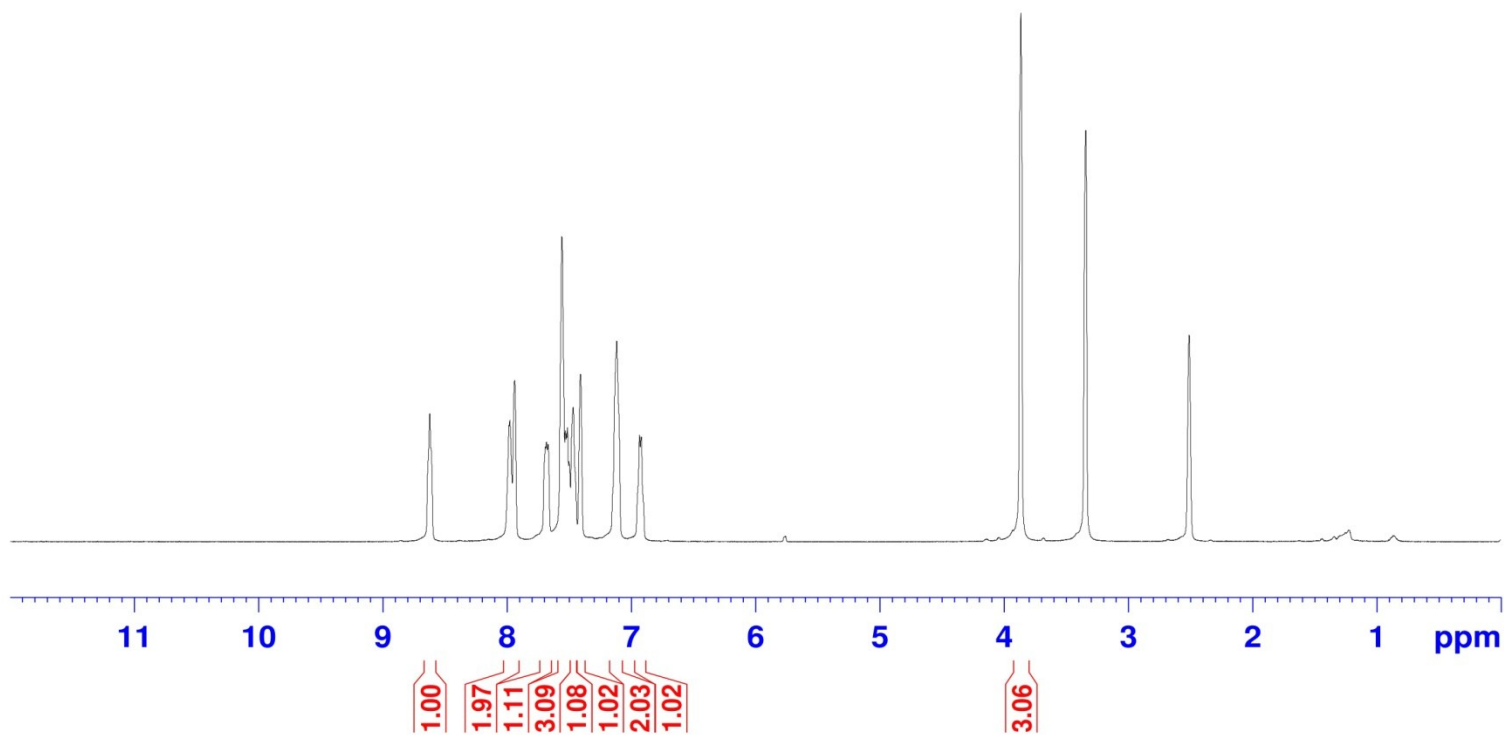


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7.984  
7.978  
7.940  
7.692  
7.684  
7.671  
7.560  
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7.522  
7.514  
7.468  
7.410  
7.118  
6.935  
6.921

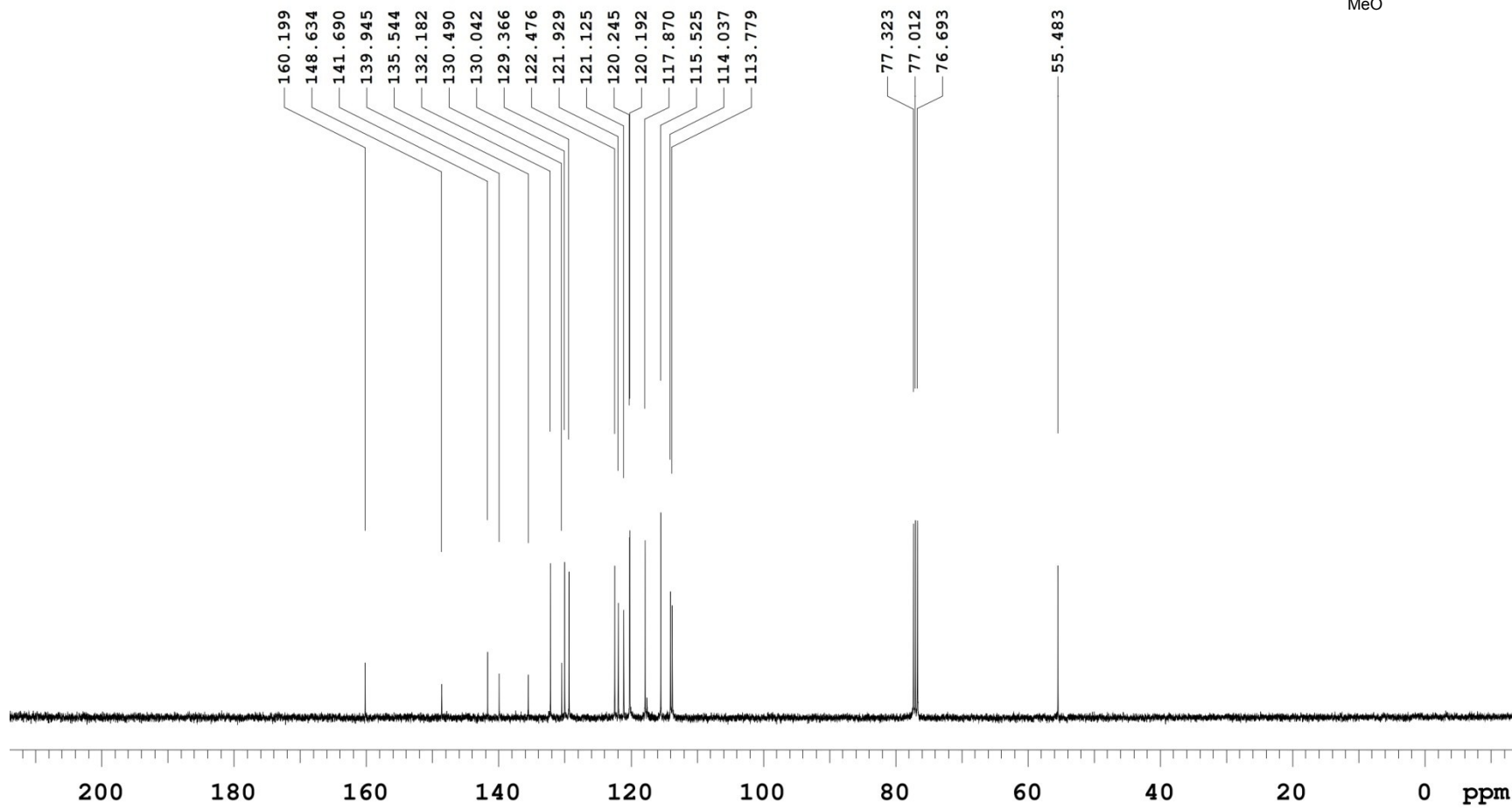
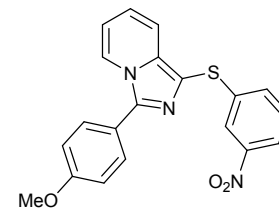
— 3.864

— 3.342

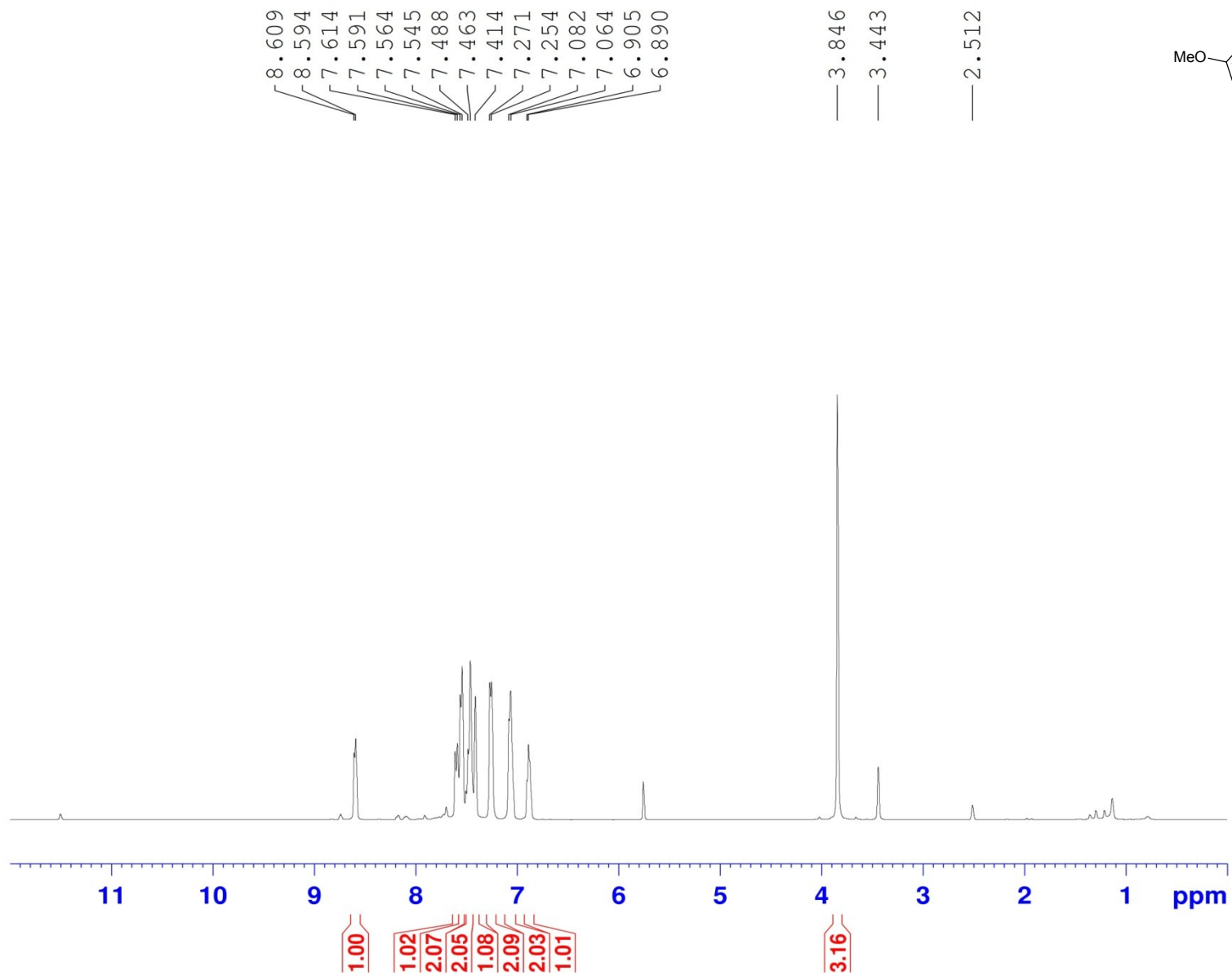
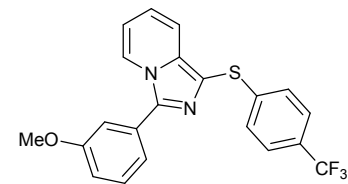
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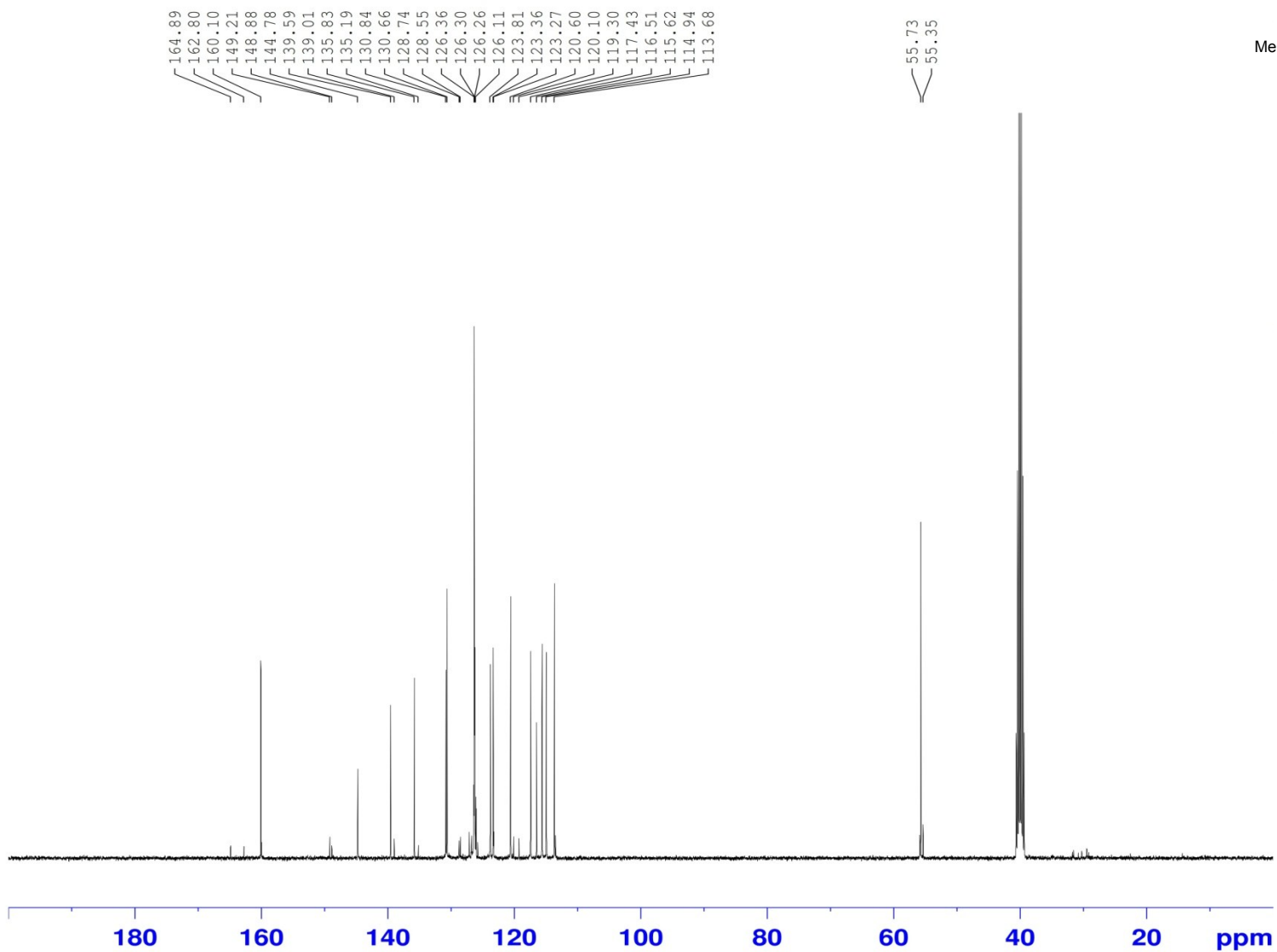
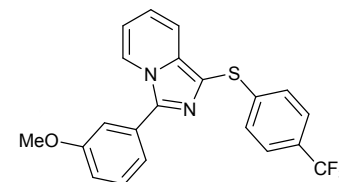
<sup>13</sup>C Spectra of 4i



<sup>1</sup>H NMR of 4j

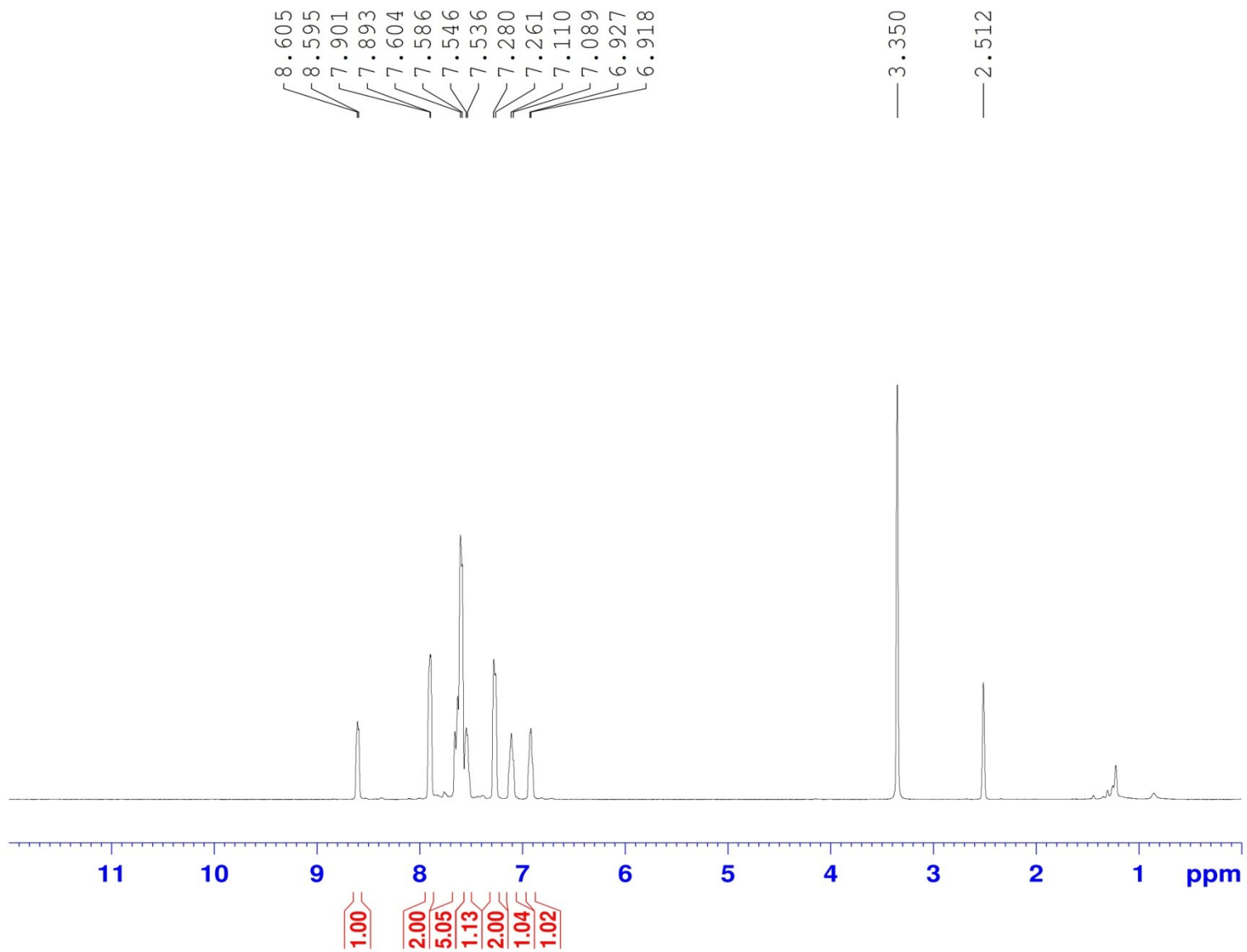
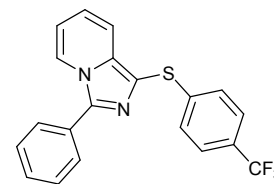


<sup>13</sup>C Spectra of 4j

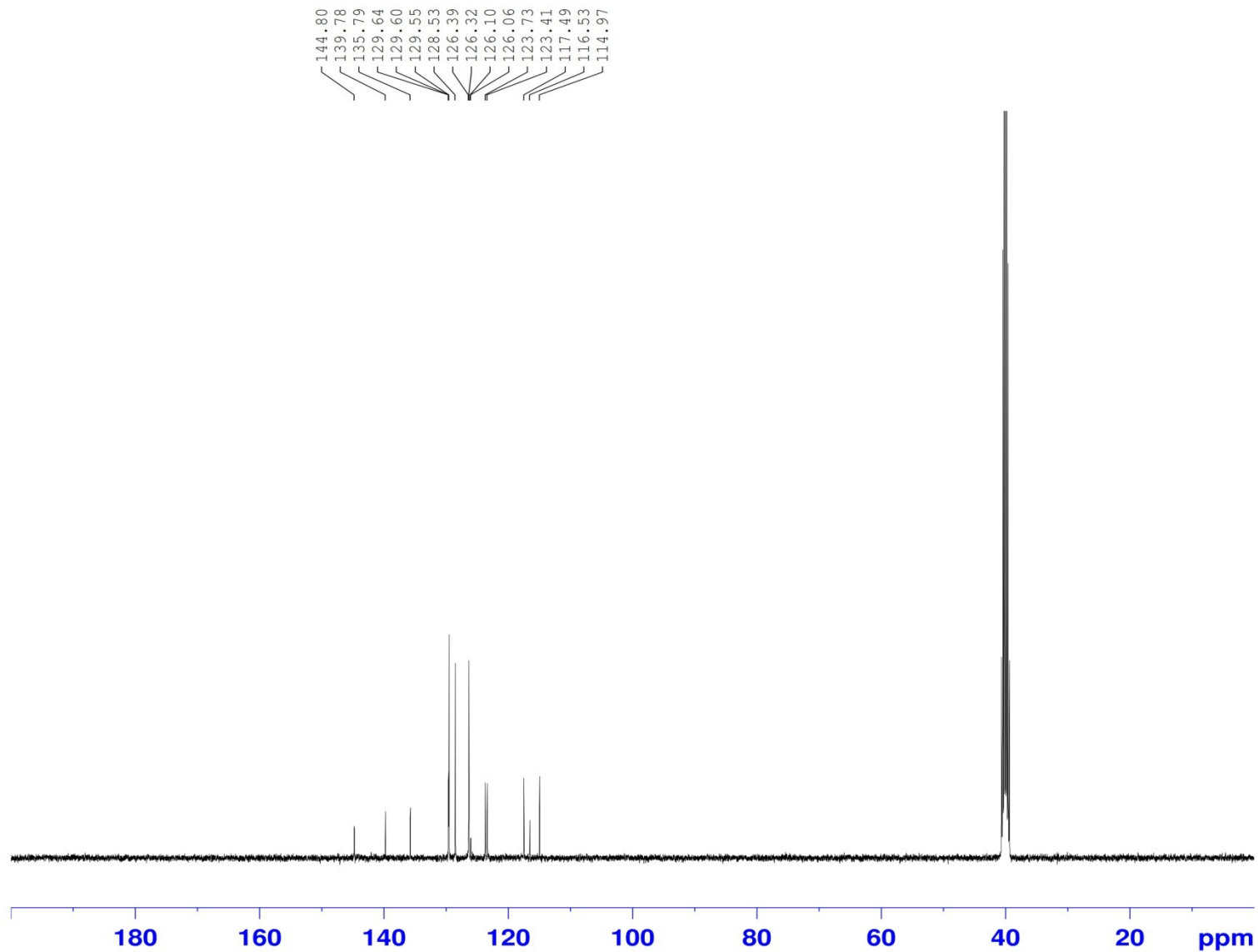
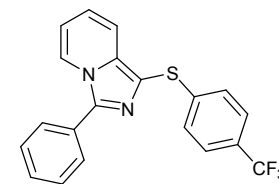




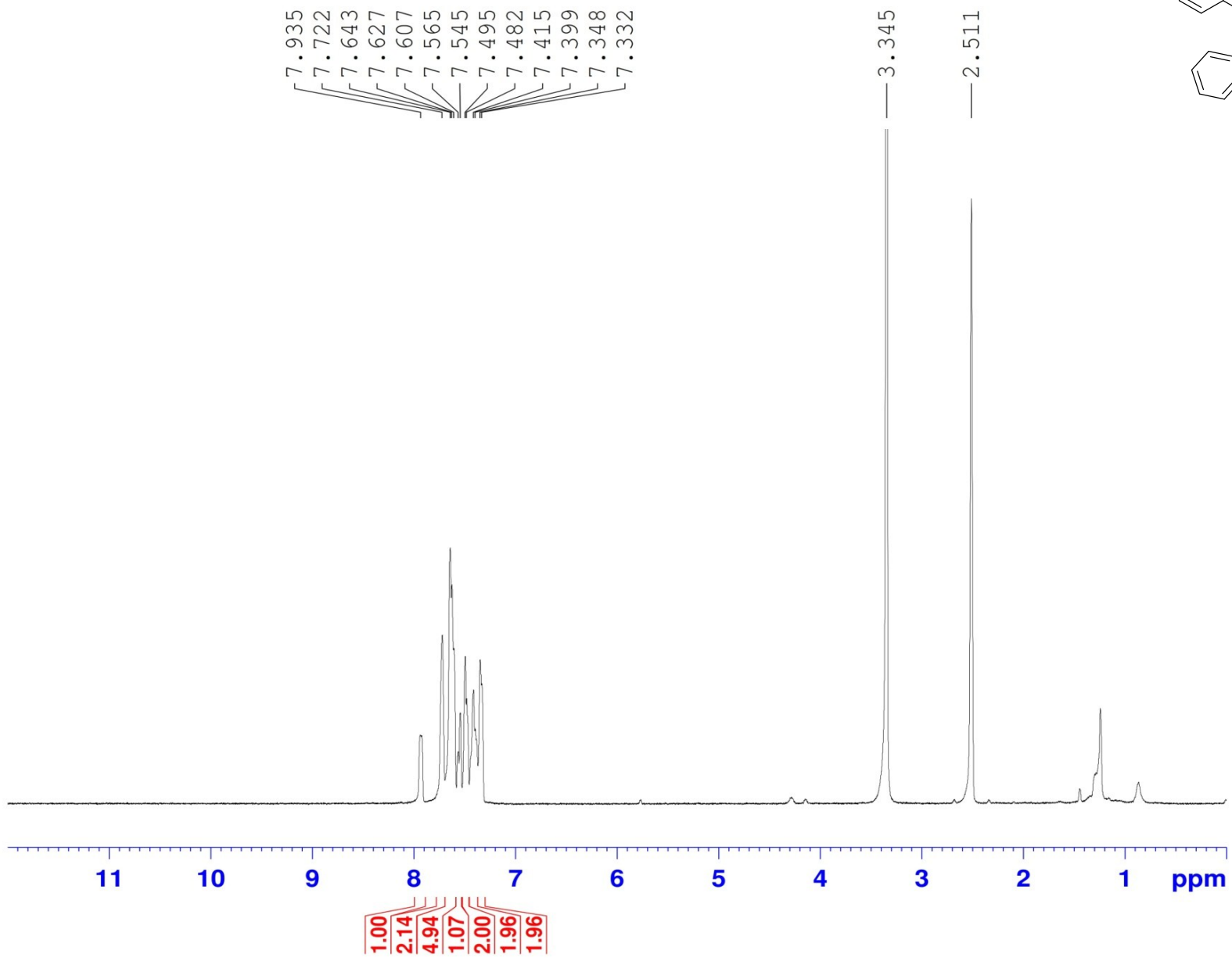
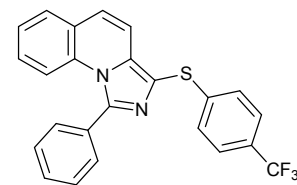
<sup>1</sup>H NMR of 4k



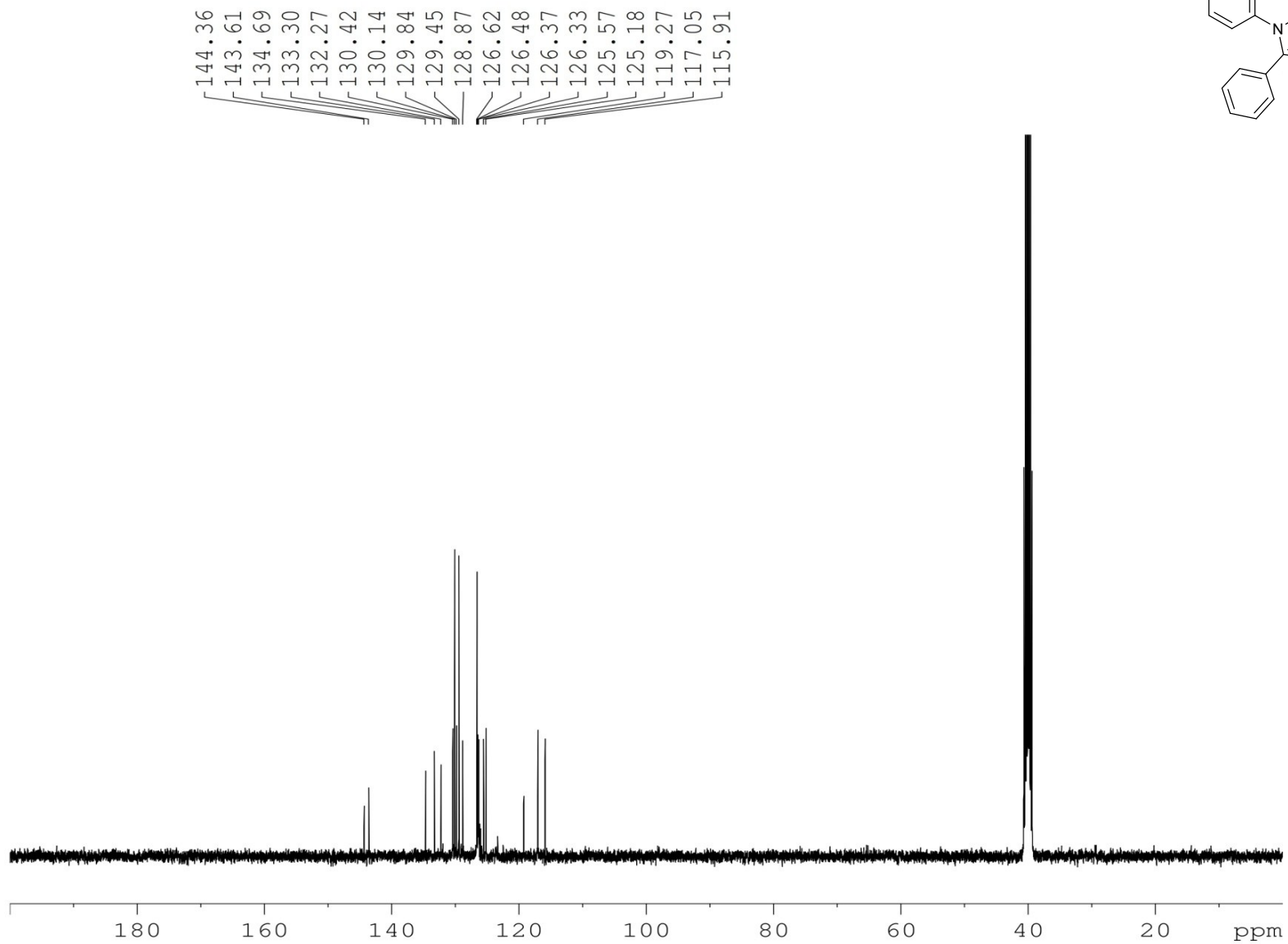
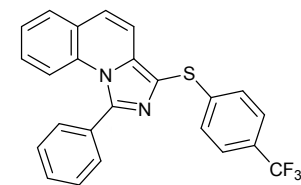
<sup>13</sup>C NMR of 4k



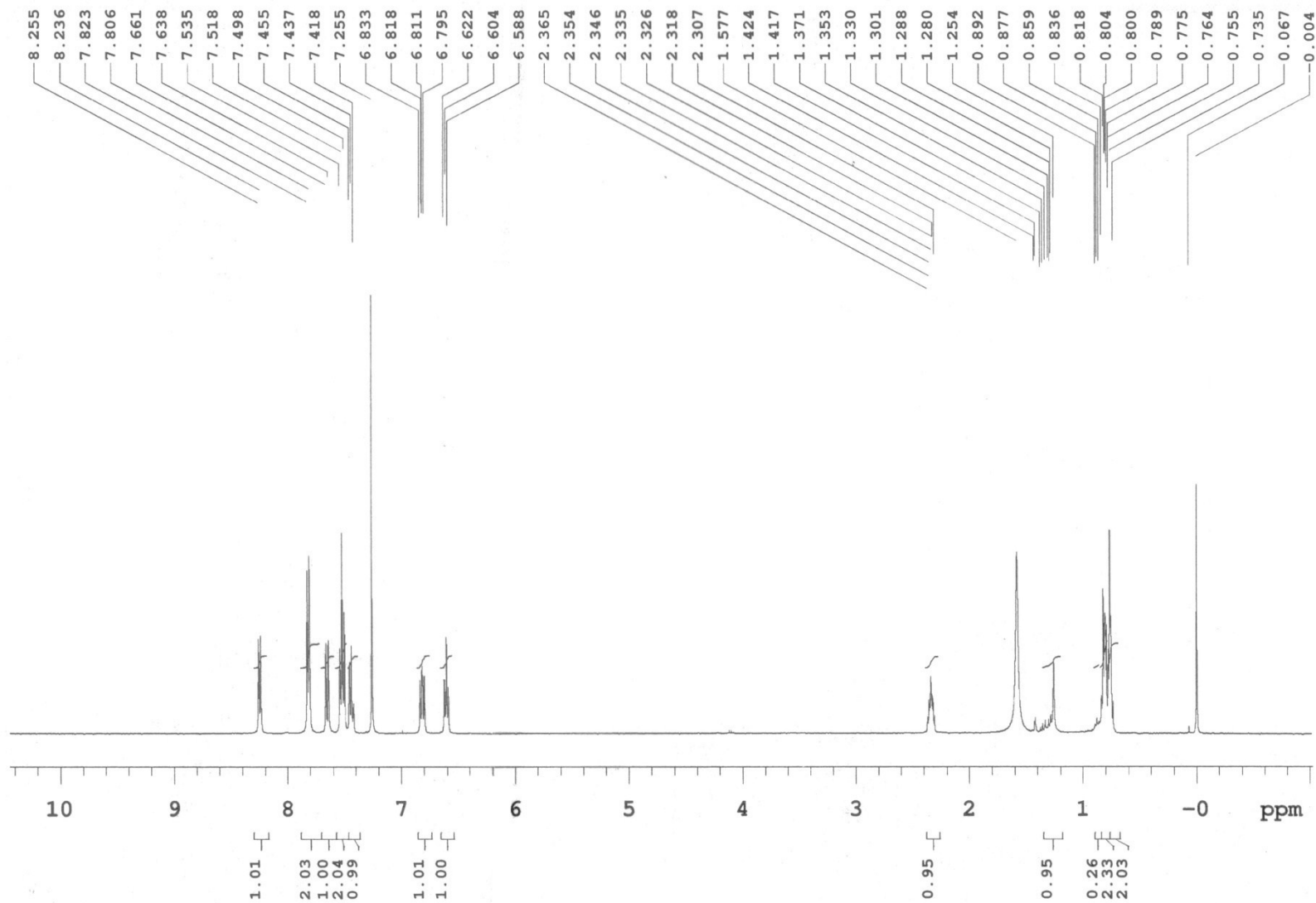
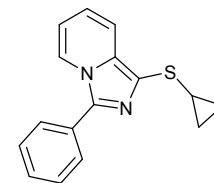
<sup>1</sup>H NMR of 4l



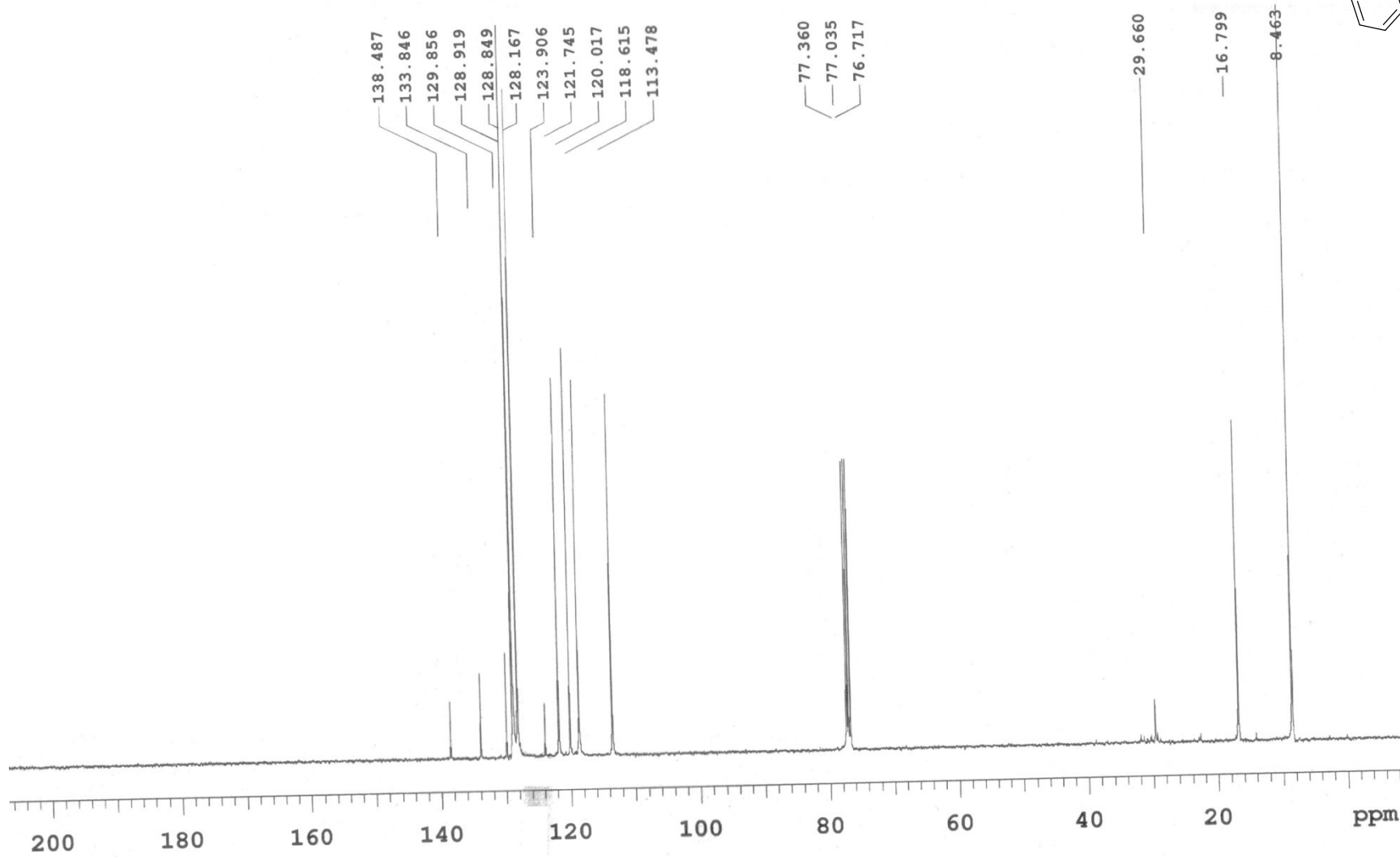
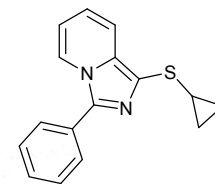
<sup>13</sup>C Spectra of 4I



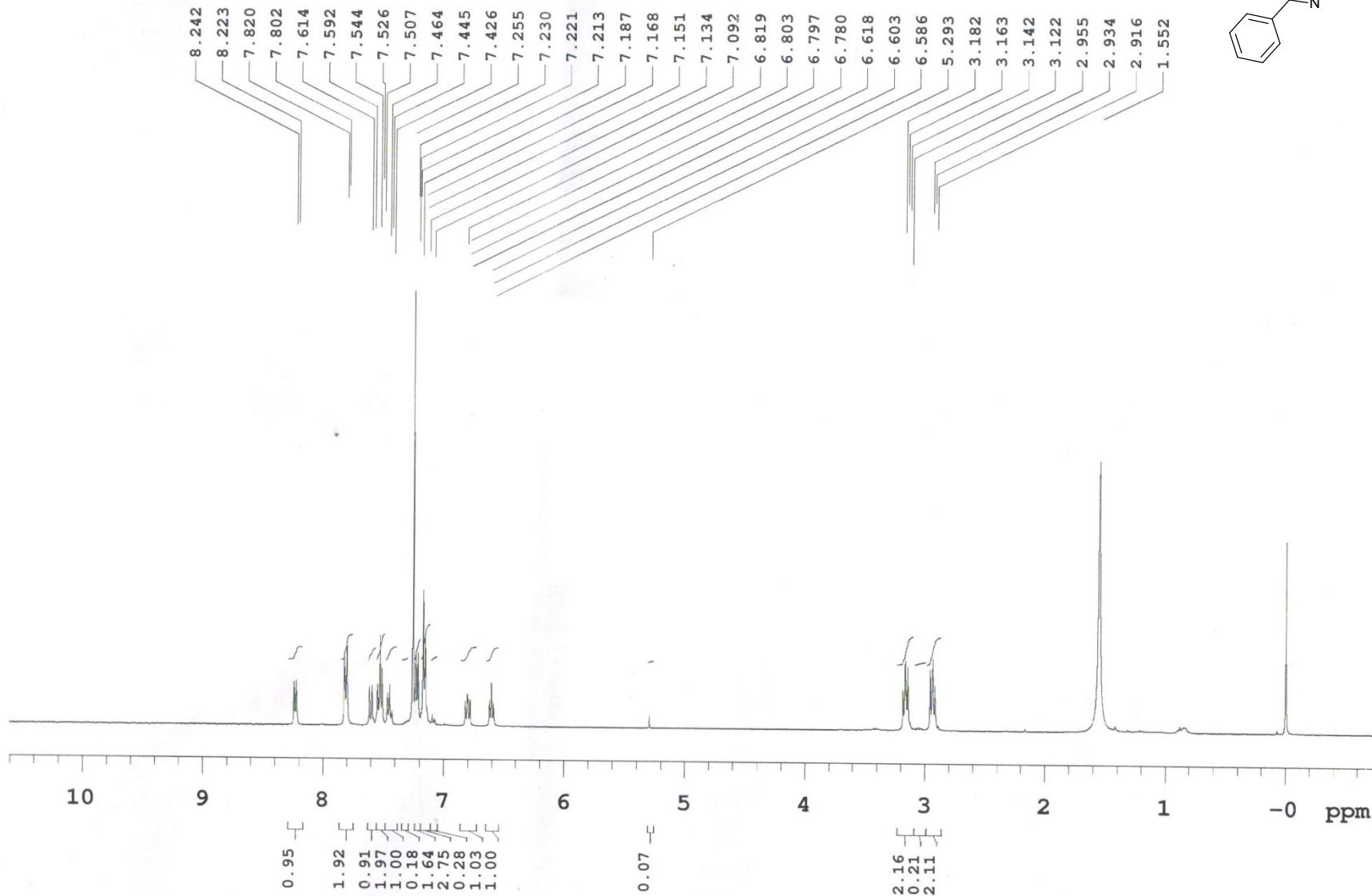
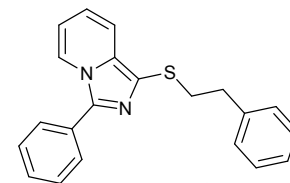
<sup>1</sup>H NMR of 4m

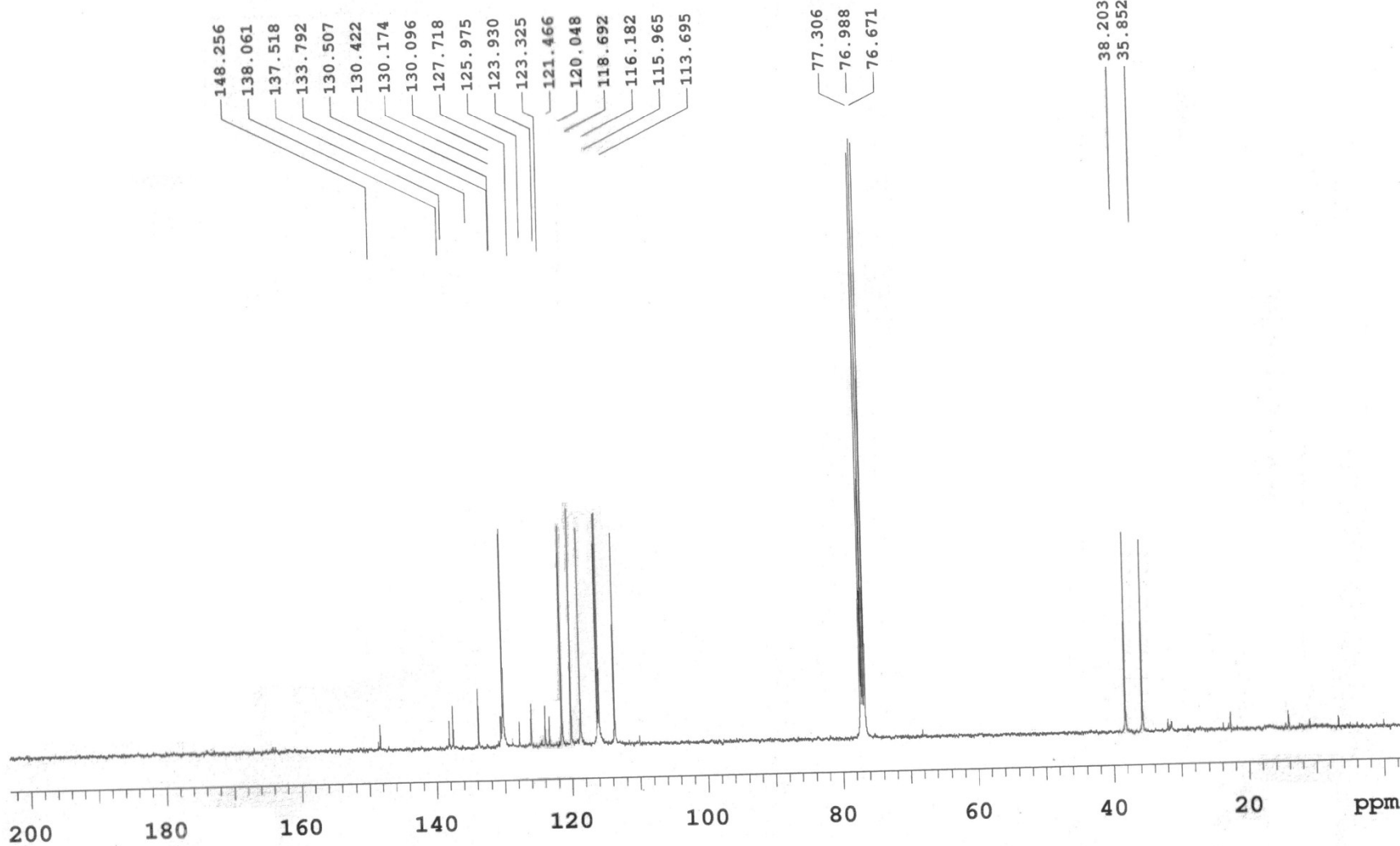
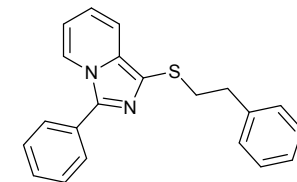


<sup>13</sup>C NMR of 4m



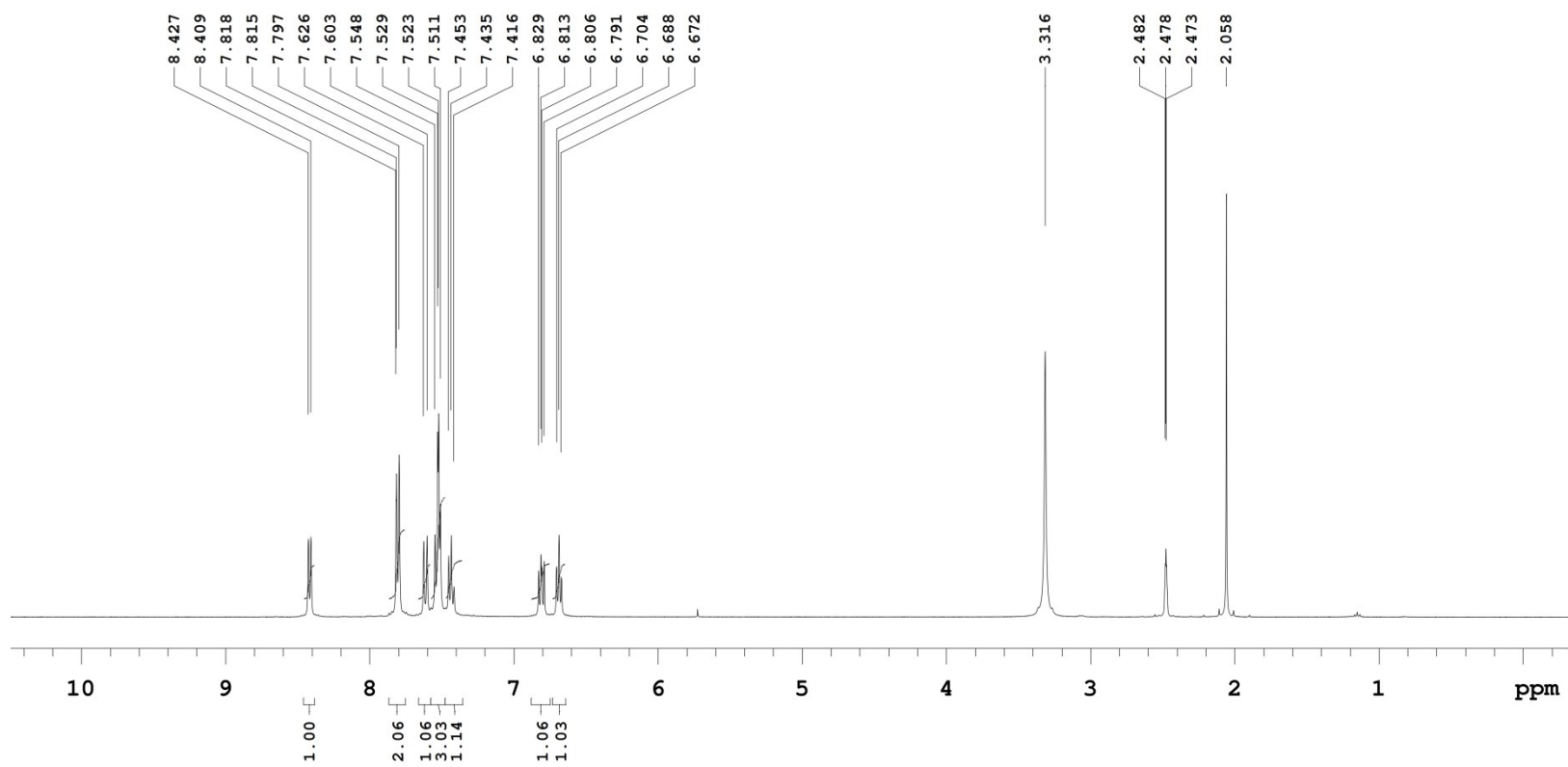
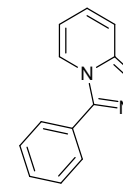
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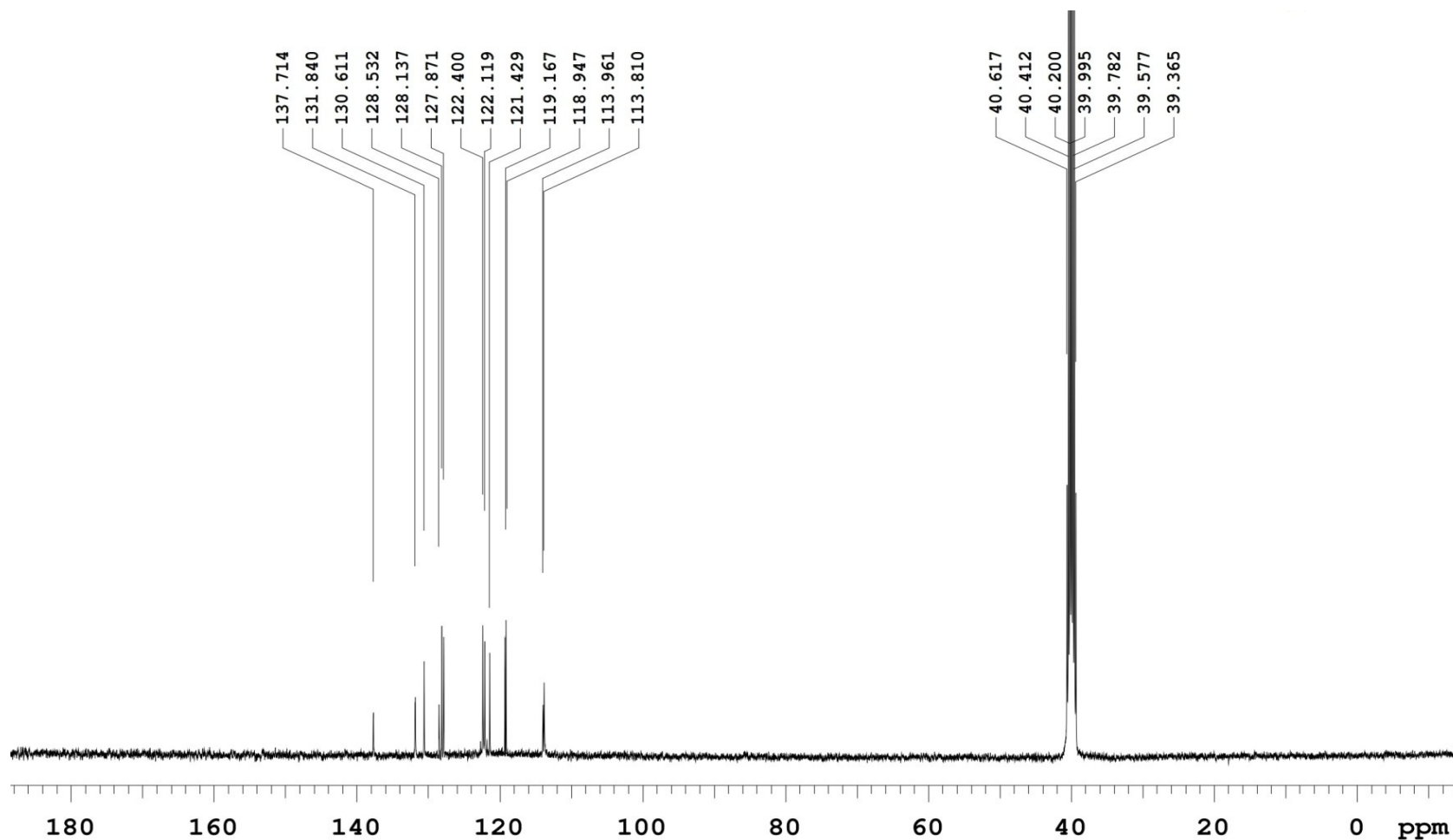
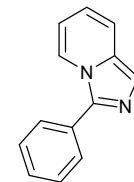




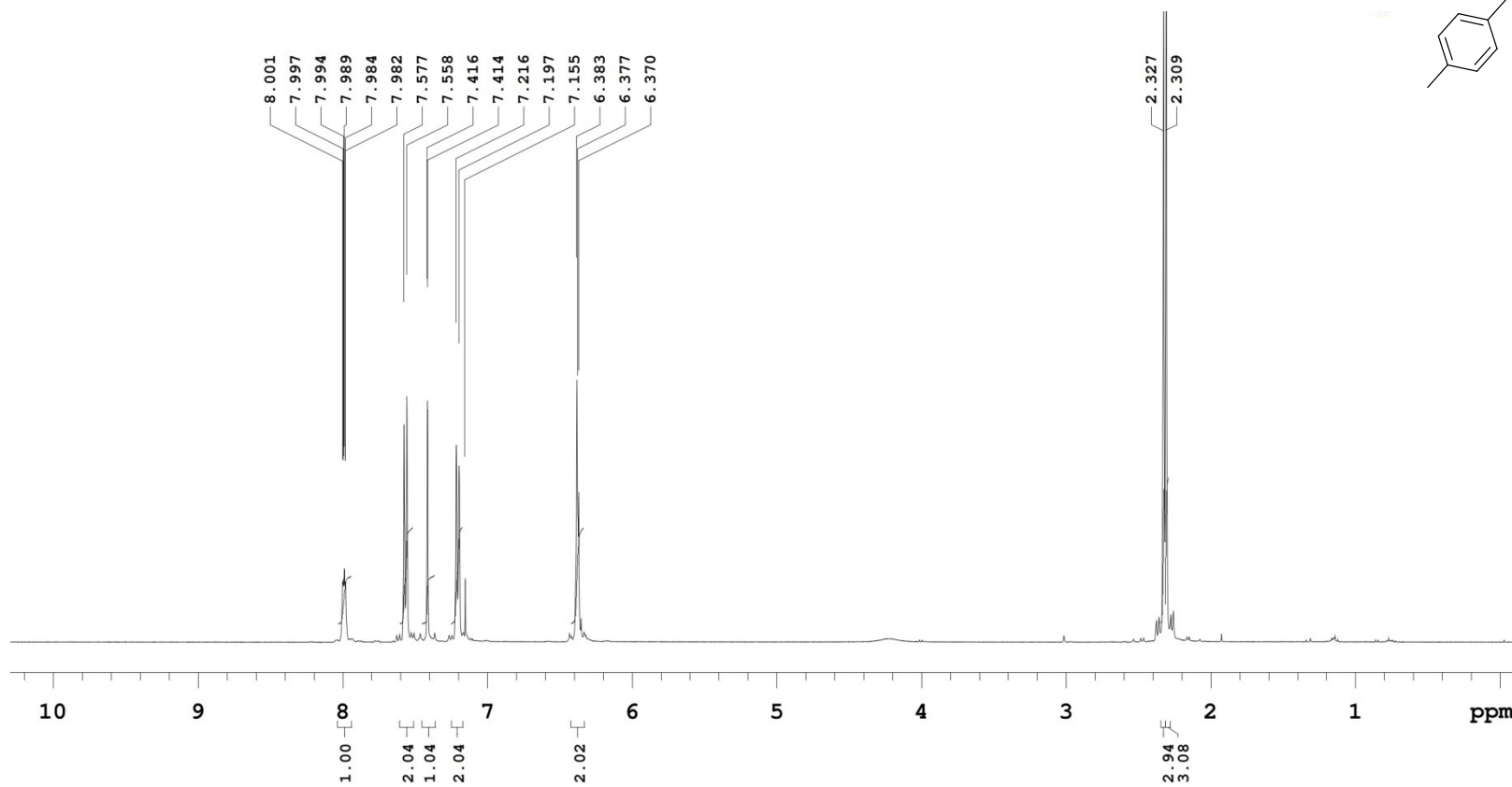
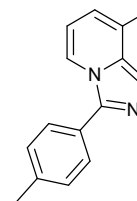


<sup>1</sup>H NMR of 5a

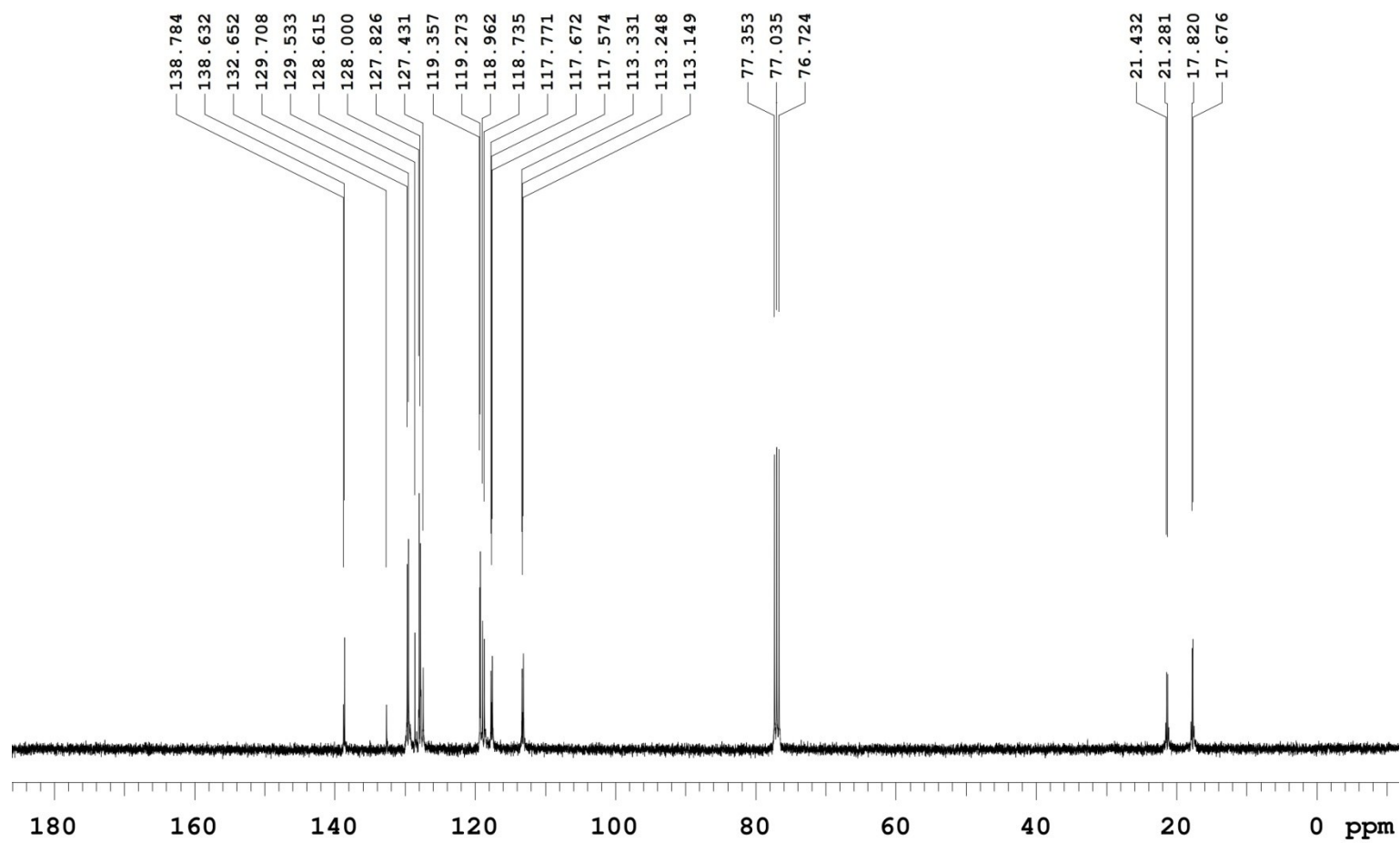
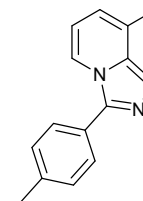




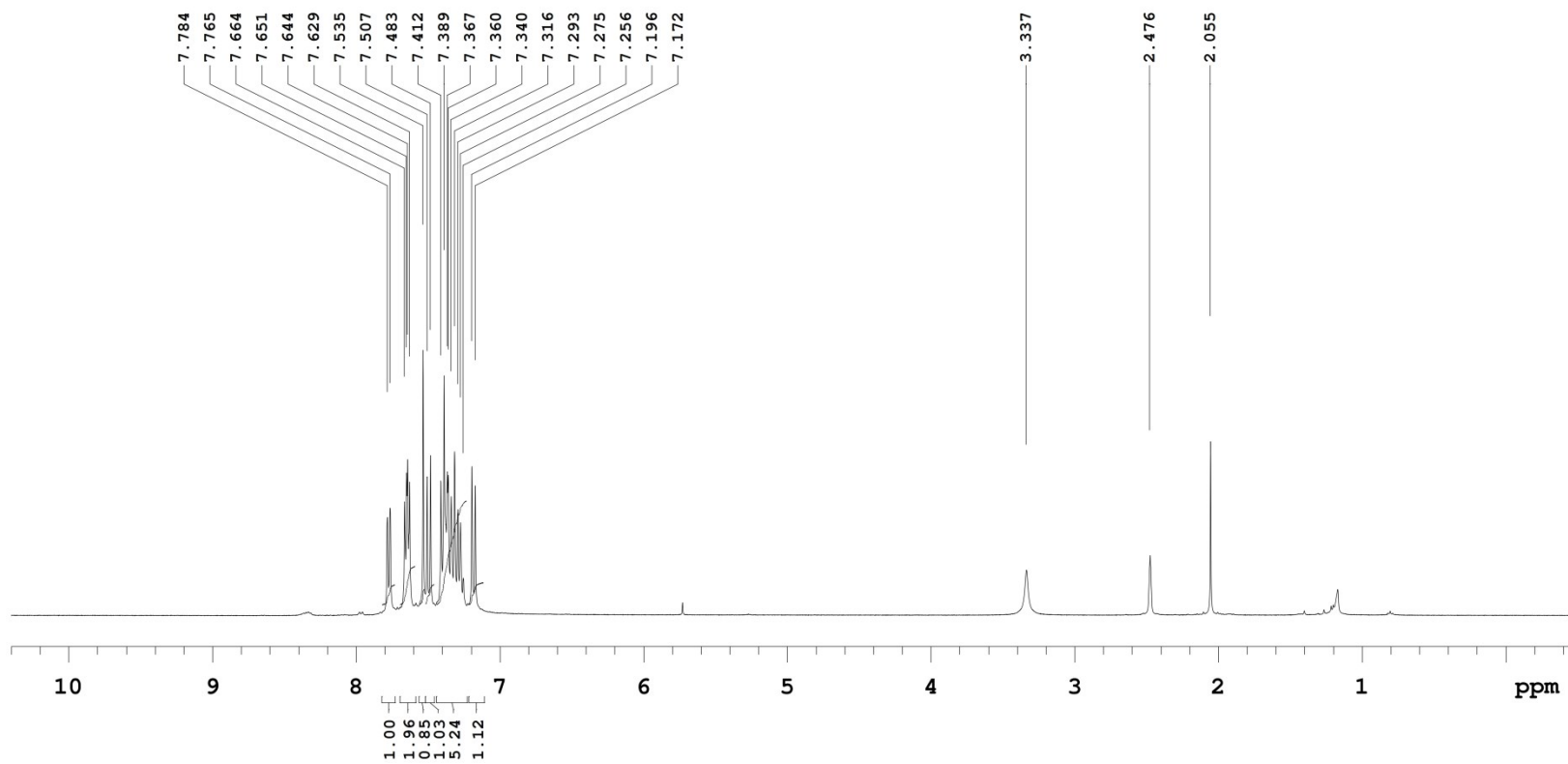
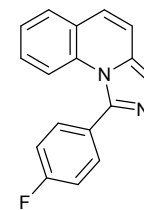
<sup>1</sup>H NMR of 5b



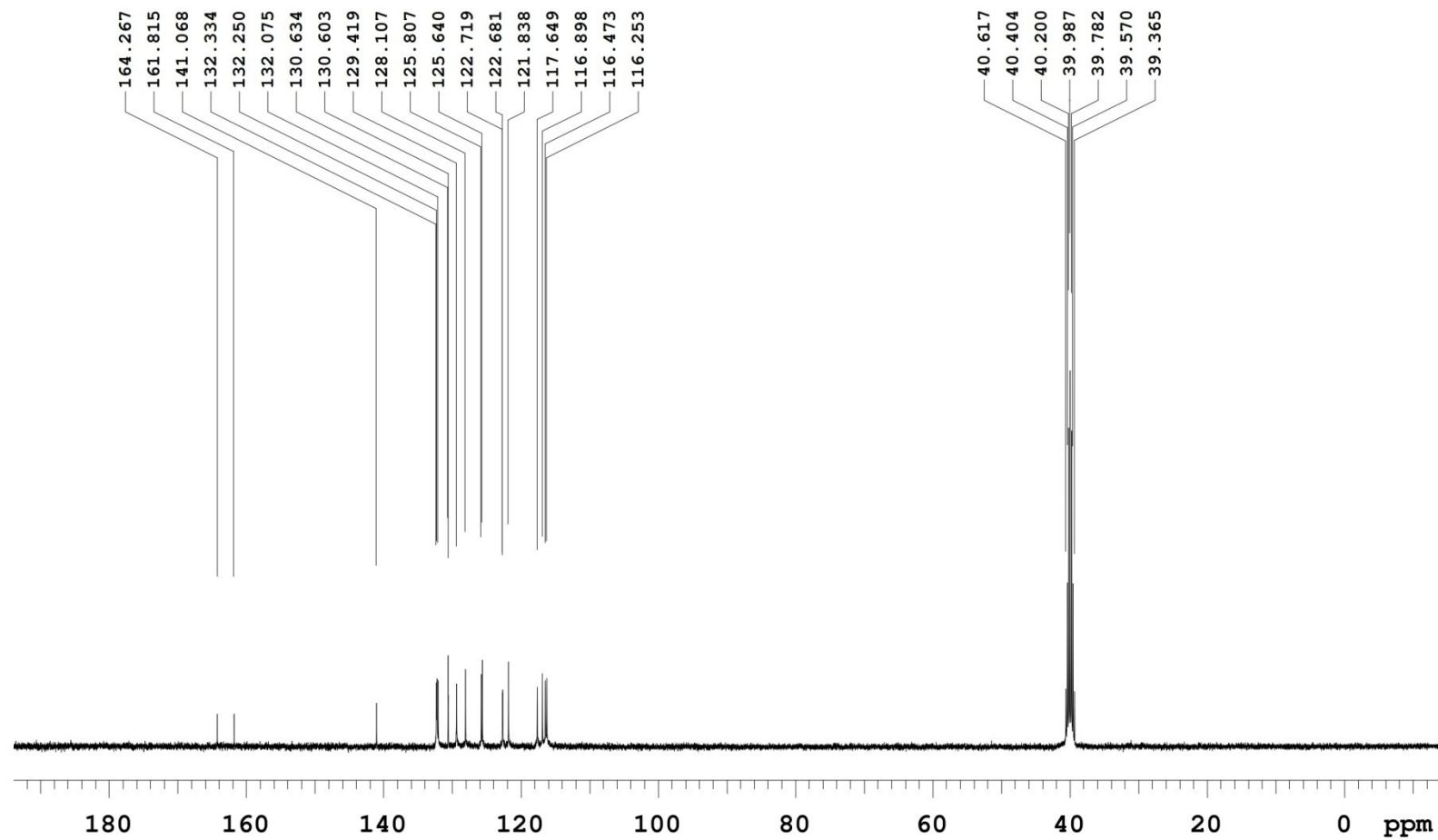
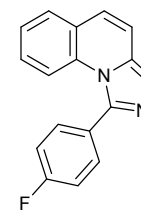
<sup>13</sup>C NMR of 5b



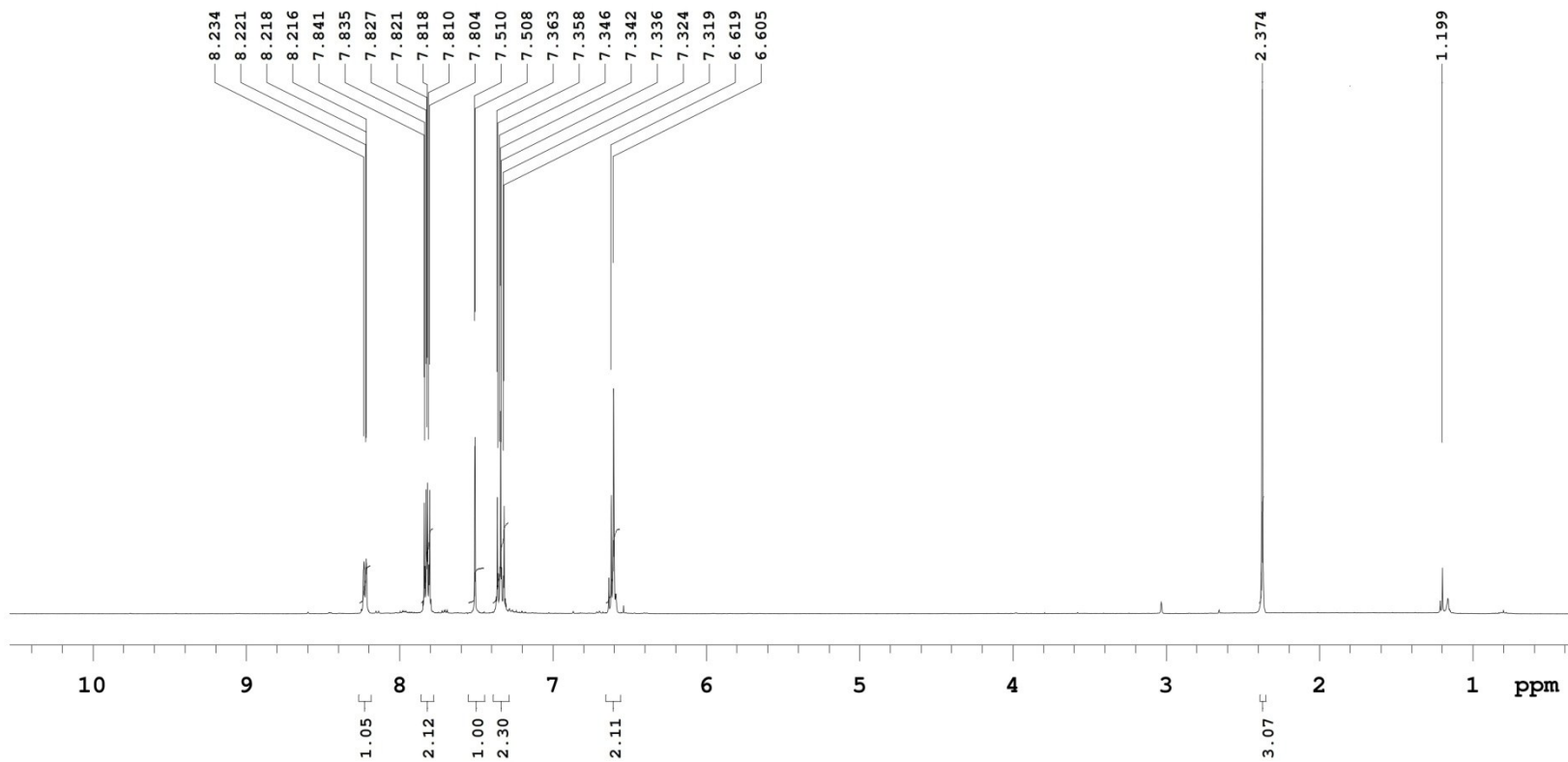
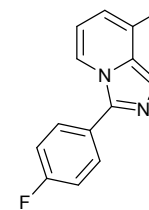
<sup>1</sup>H NMR of 5c

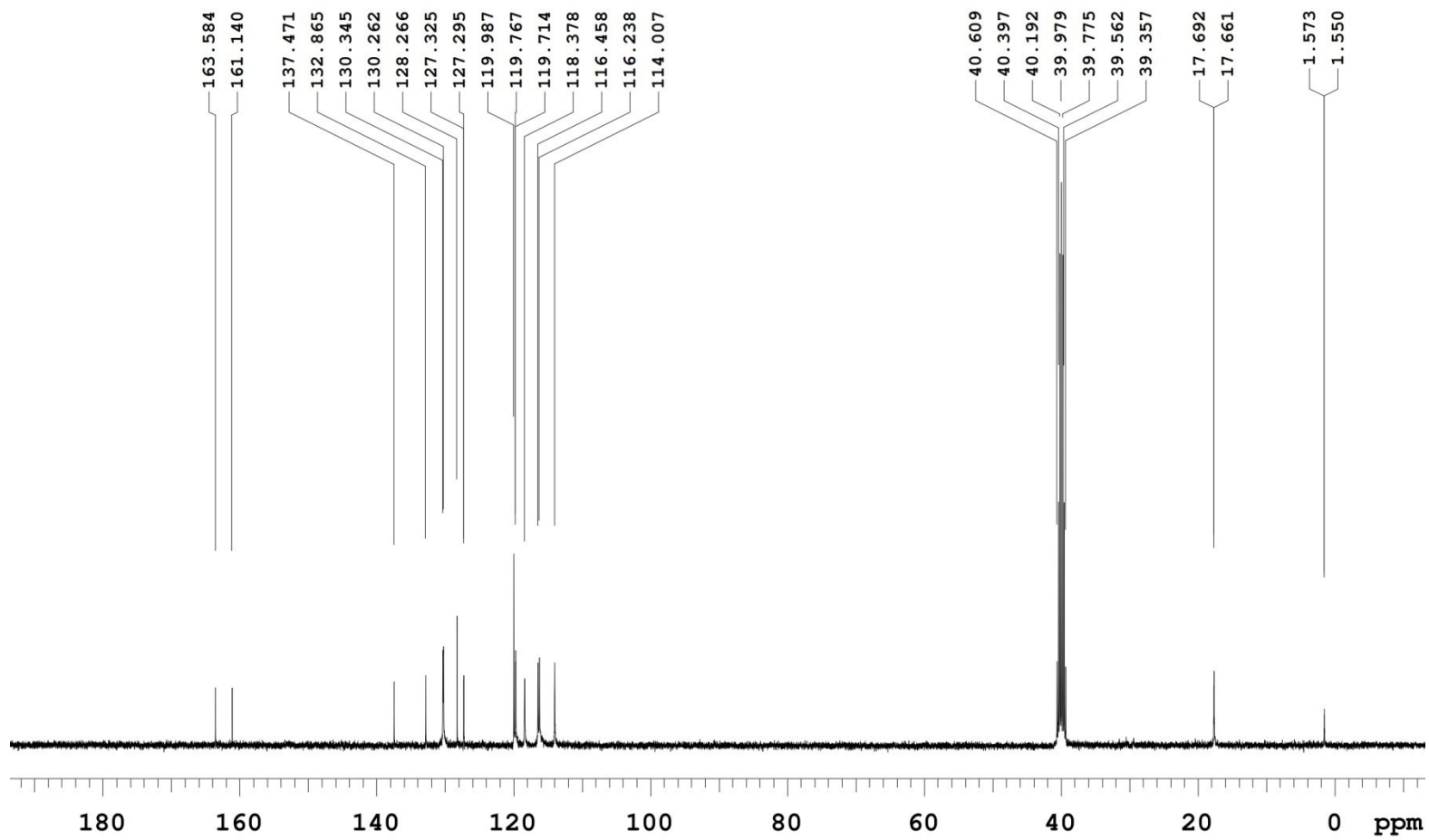
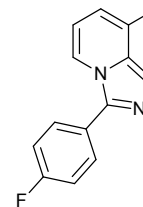


<sup>13</sup>C NMR of 5c



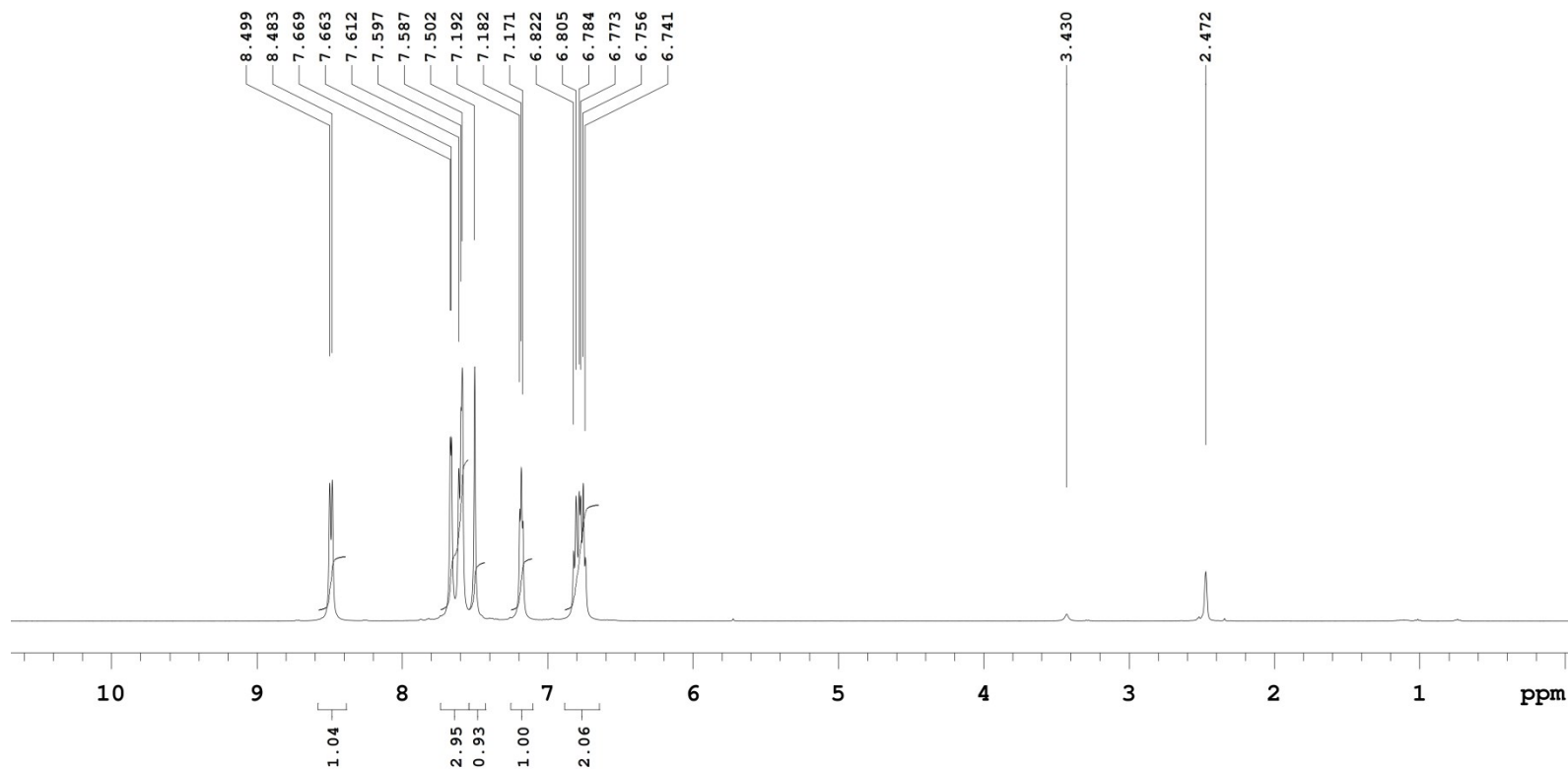
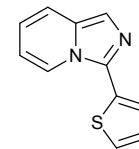
<sup>1</sup>H NMR of **5d**



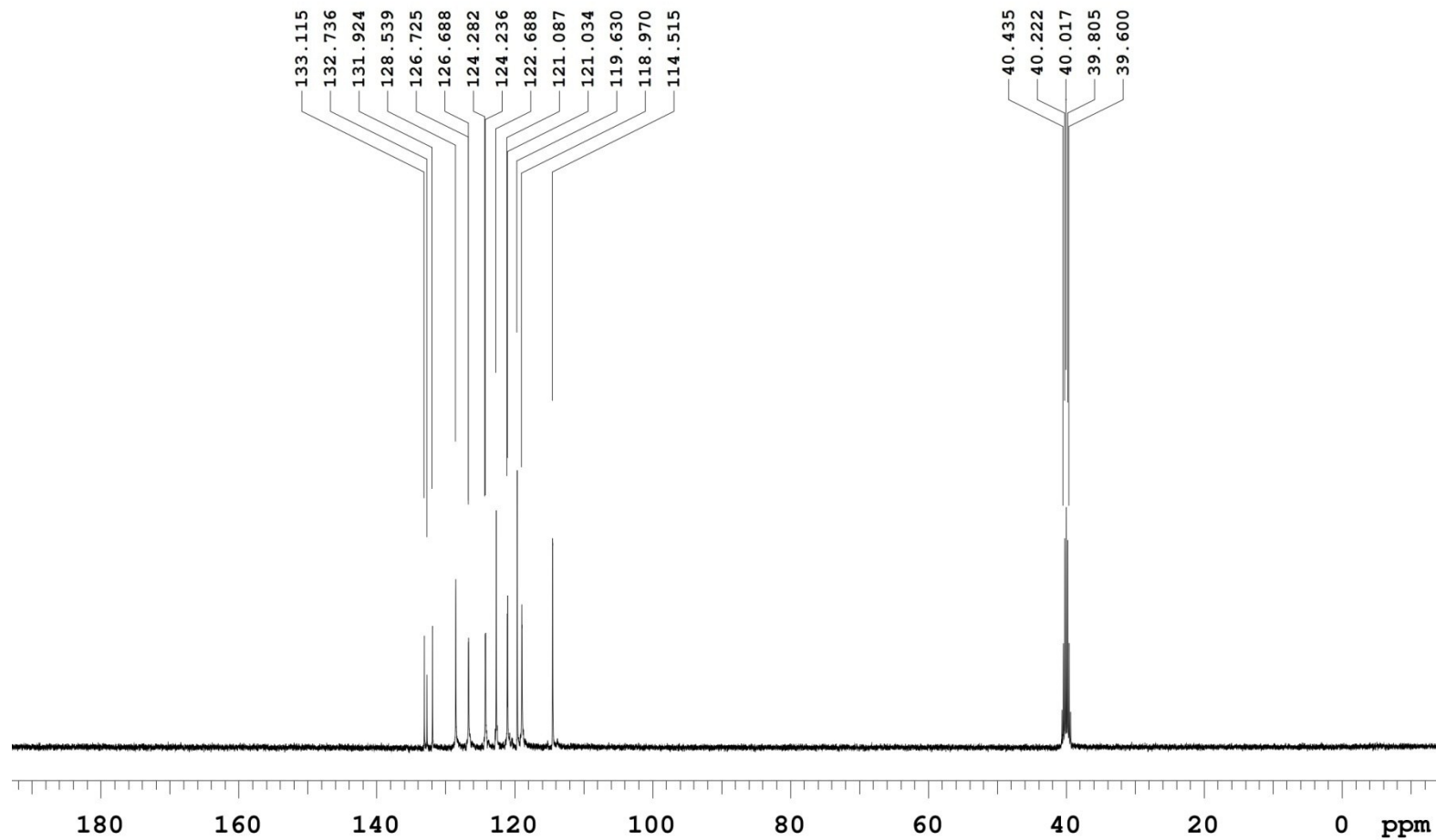
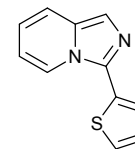




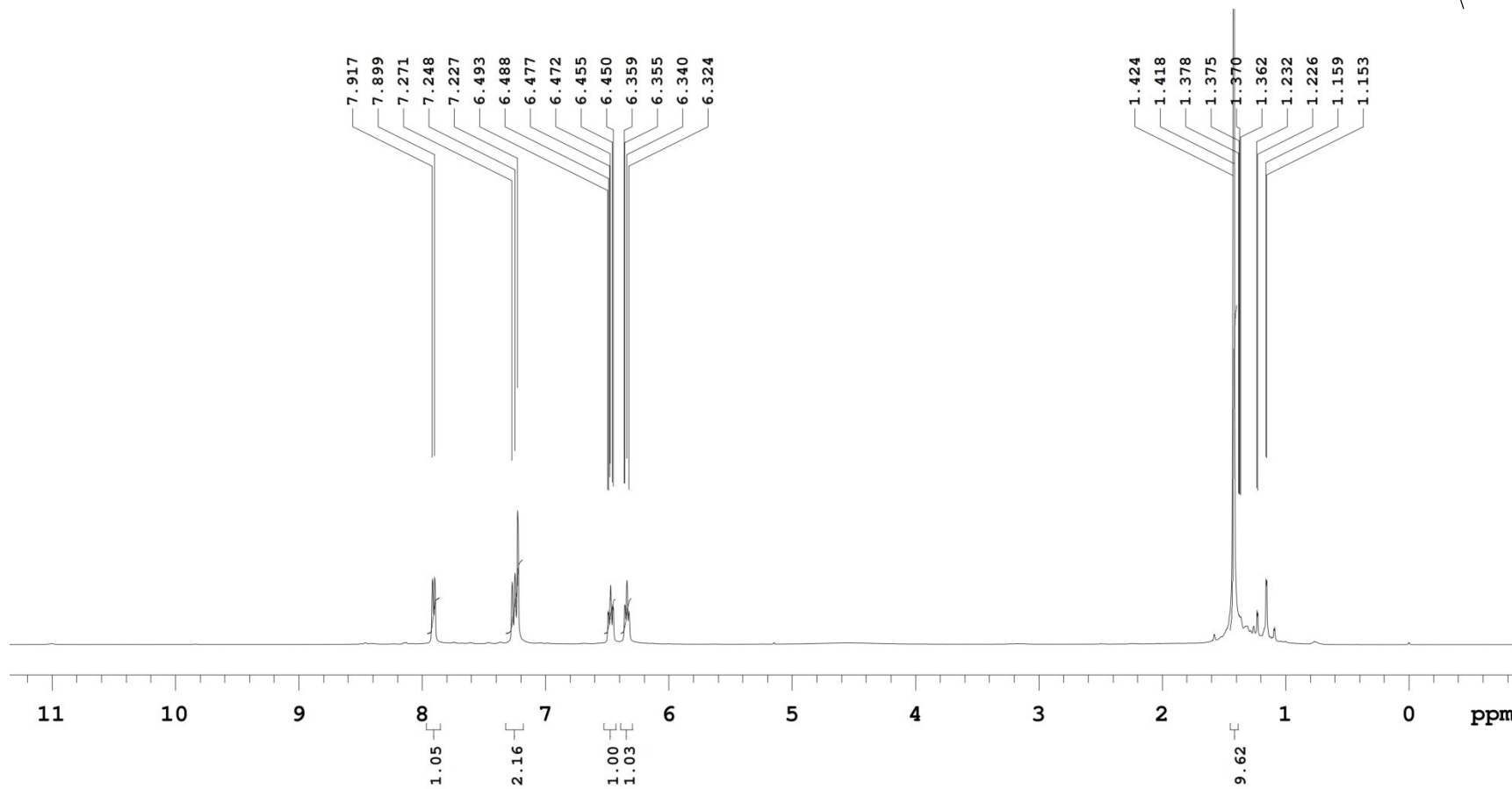
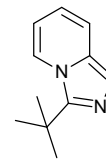
<sup>1</sup>H NMR of 5e



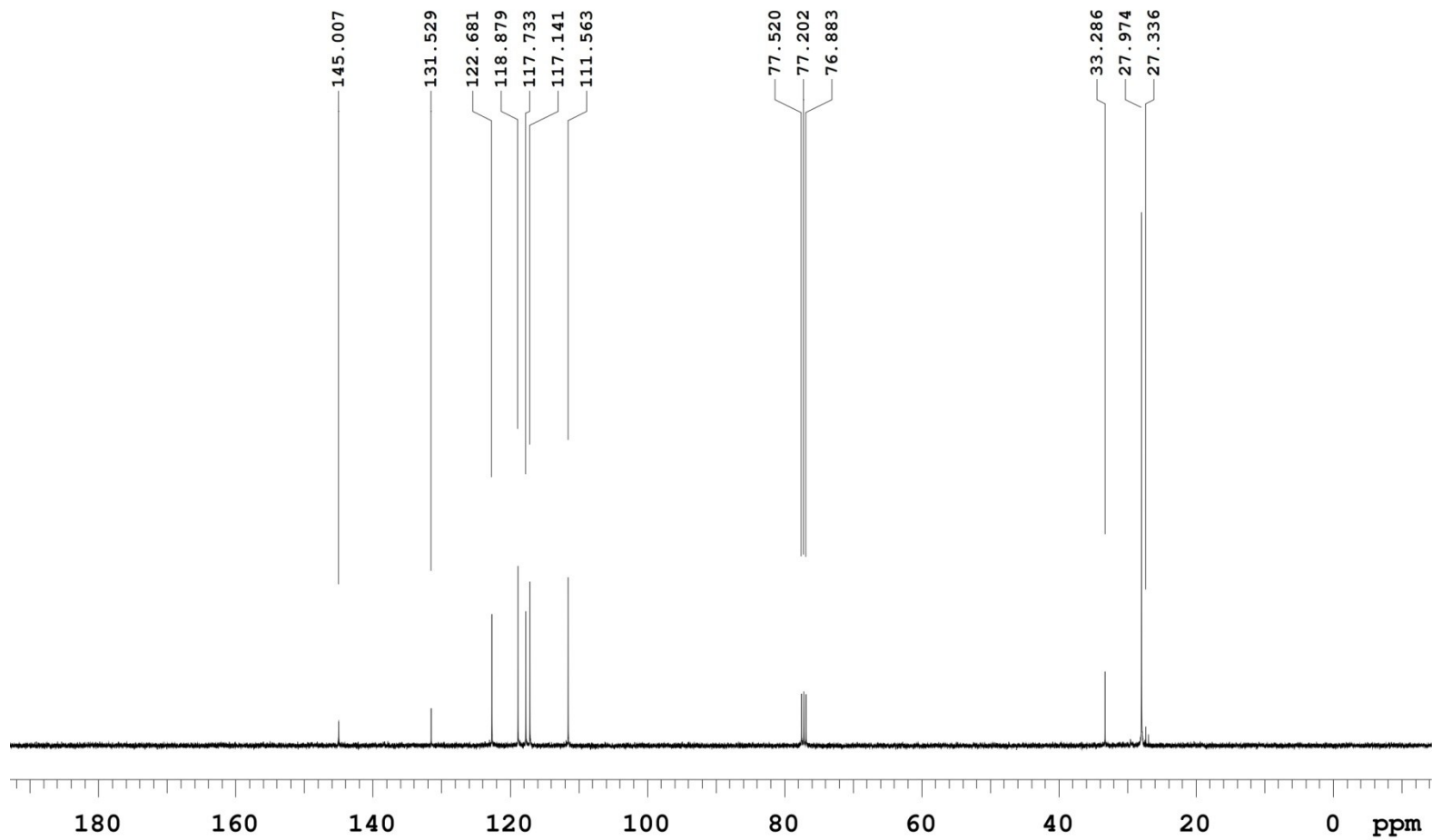
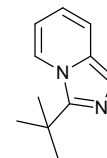
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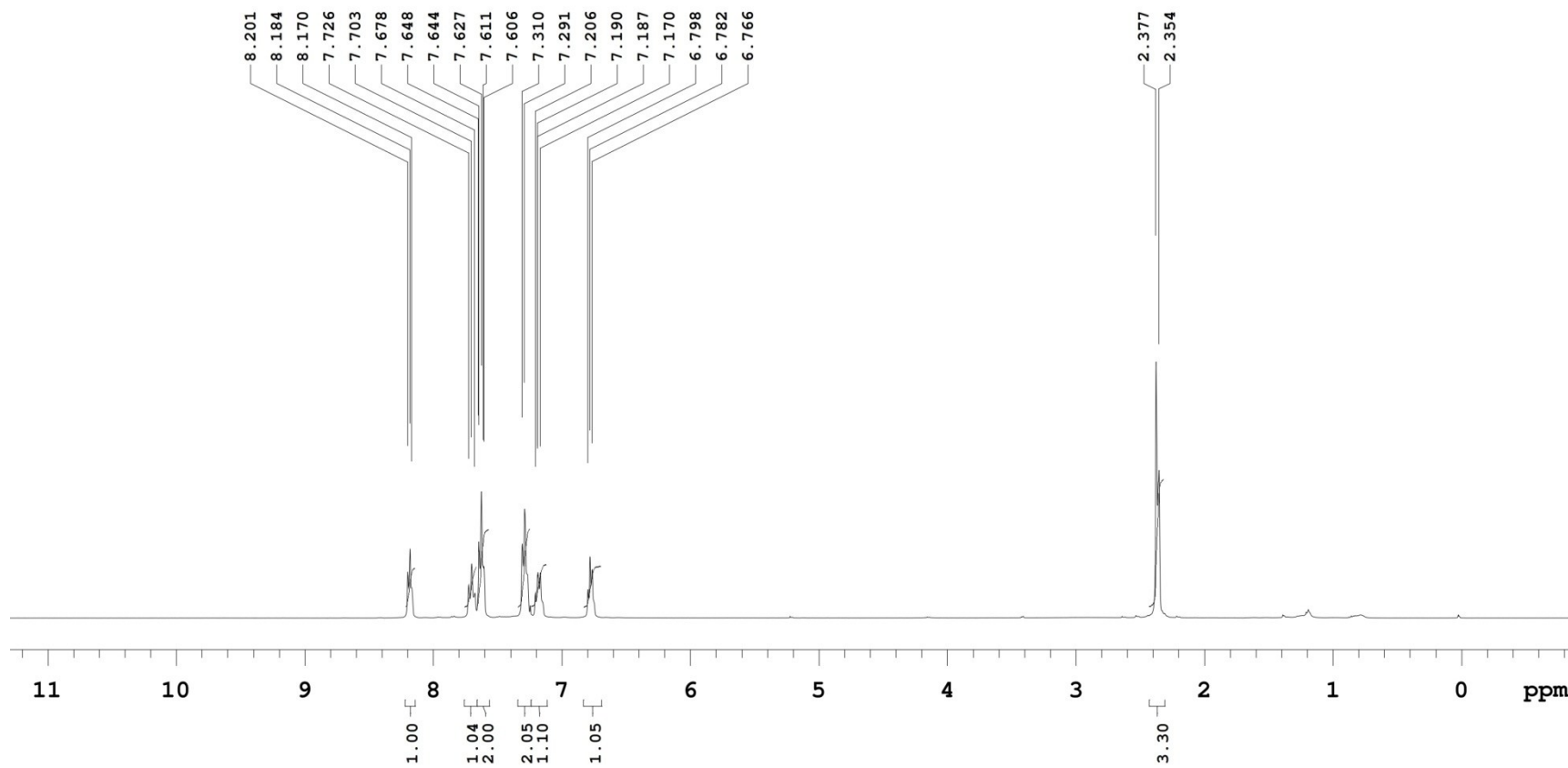
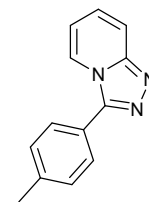


<sup>1</sup>H NMR of 5f

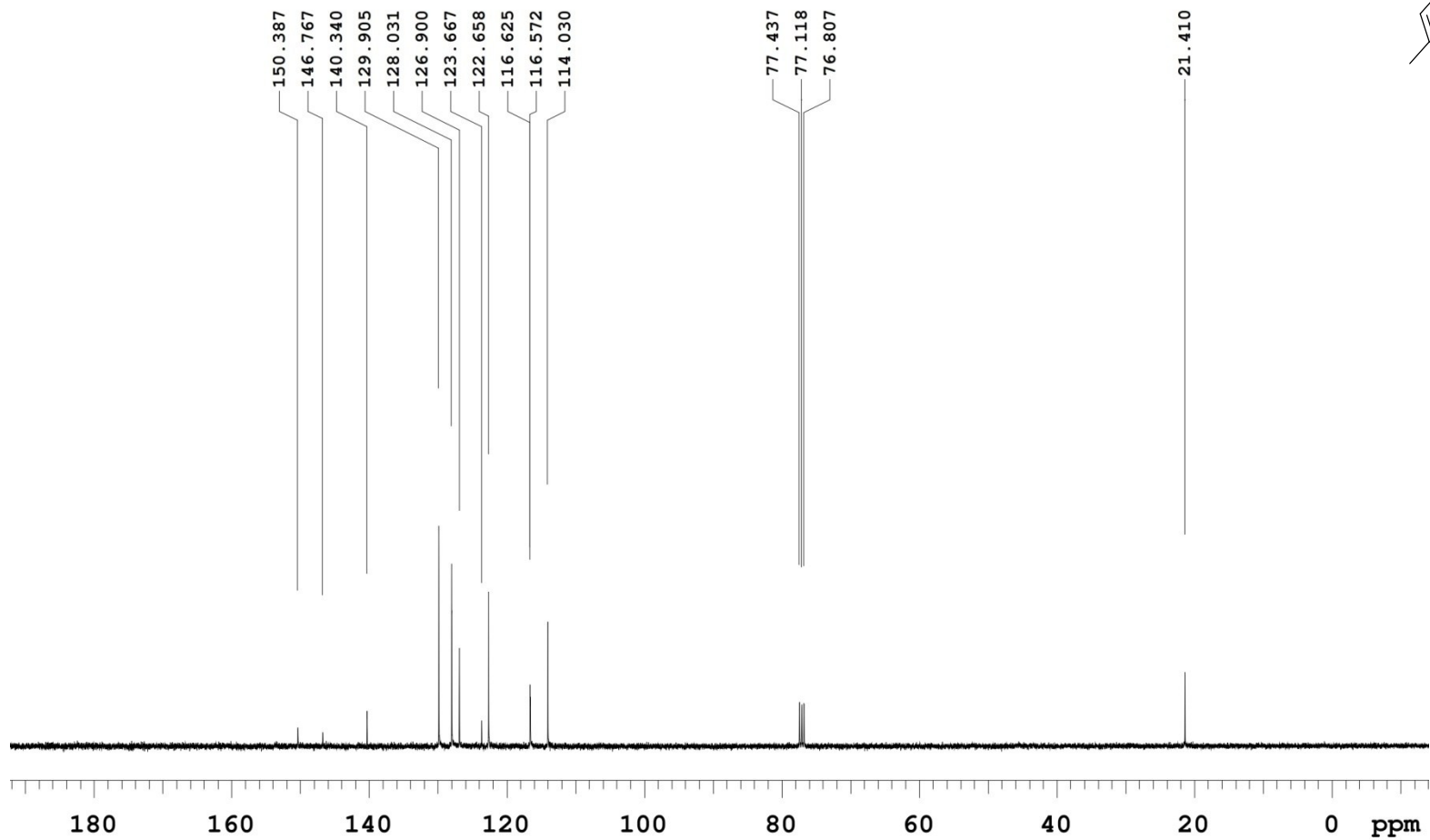
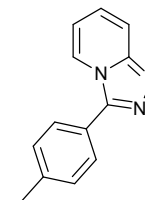


<sup>13</sup>C NMR of 5f

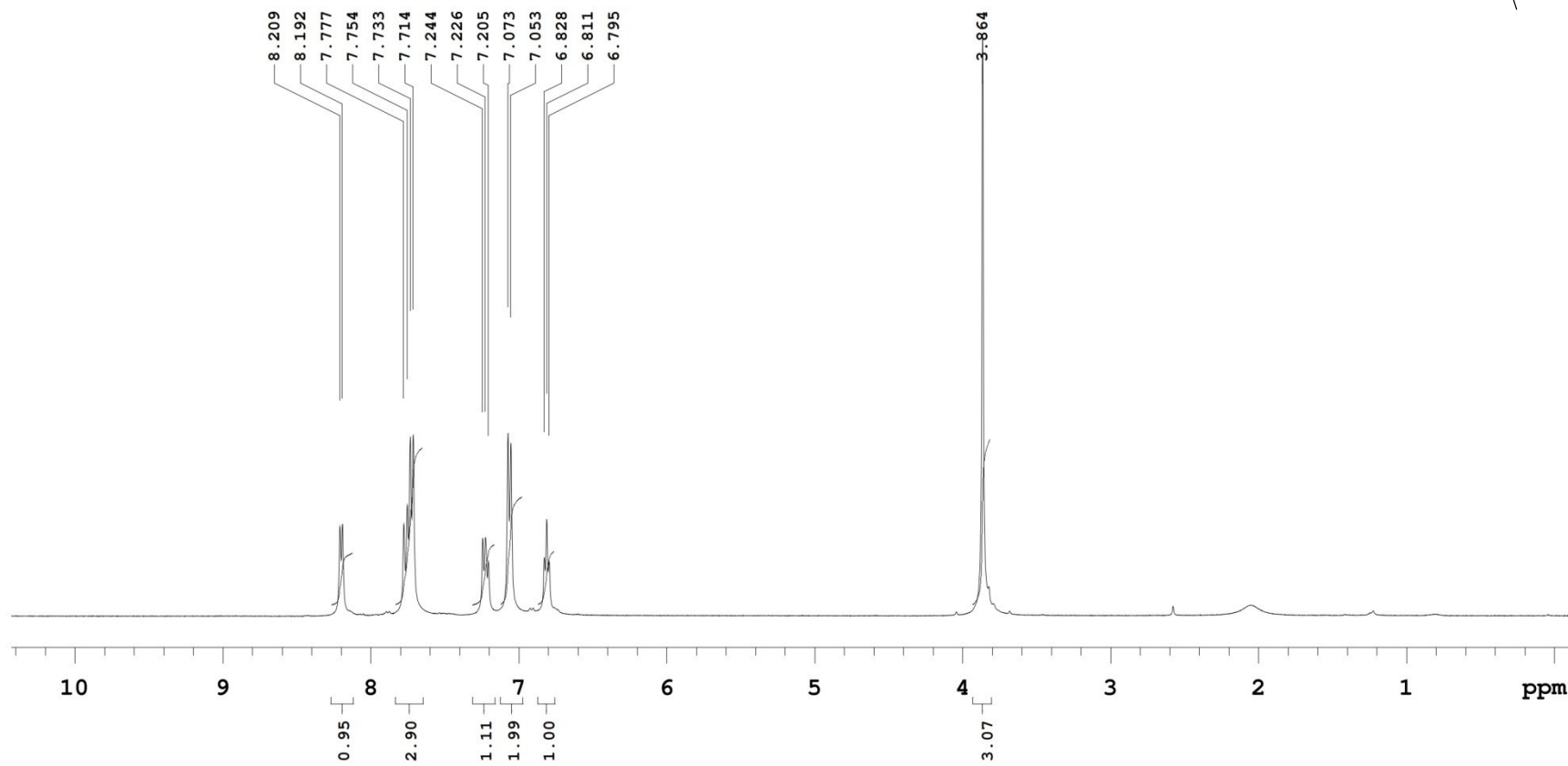
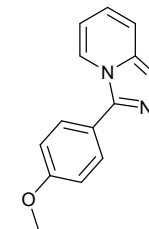


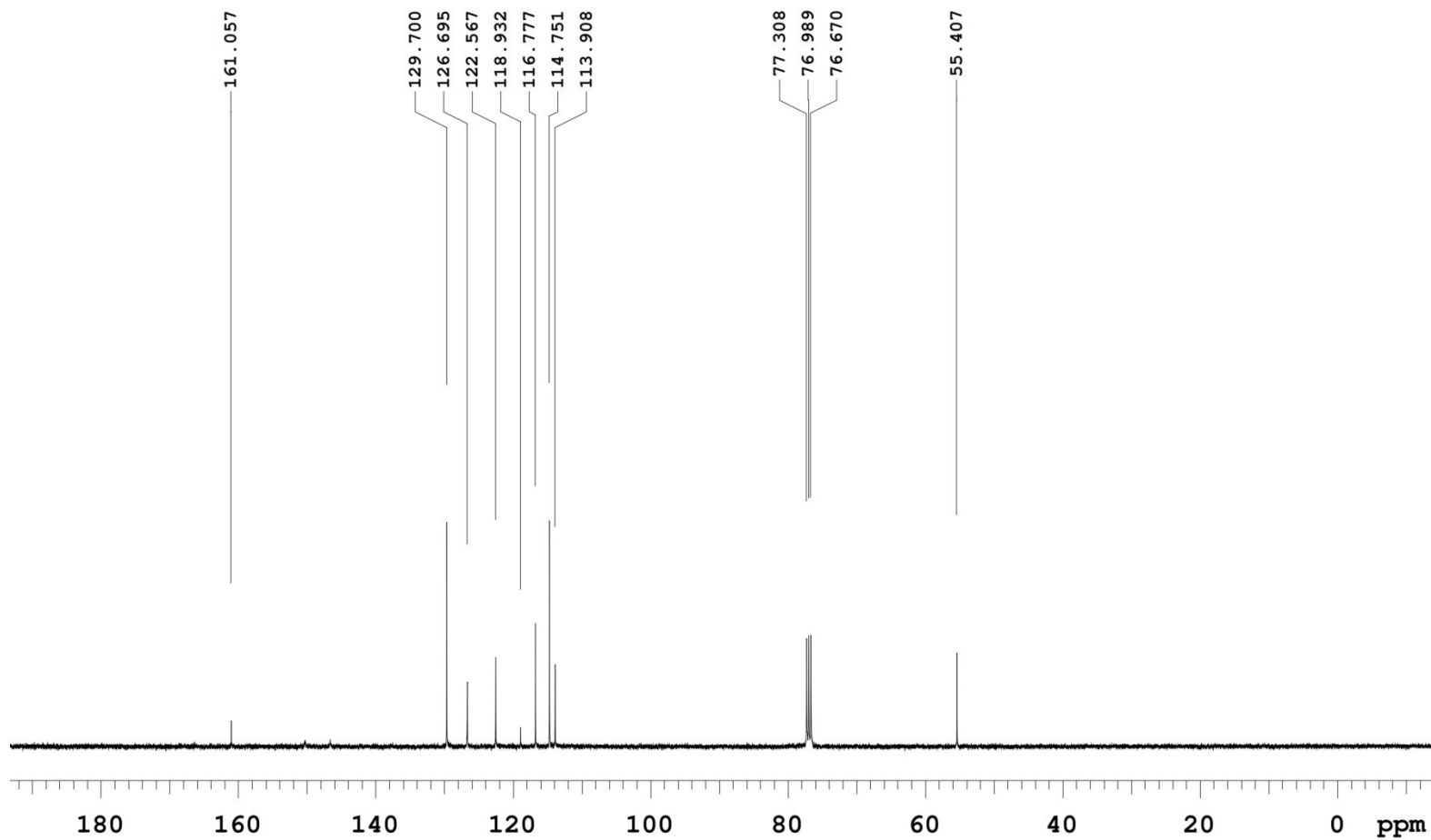
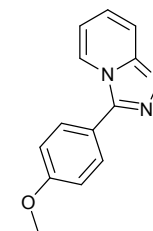


<sup>13</sup>C NMR of 5g

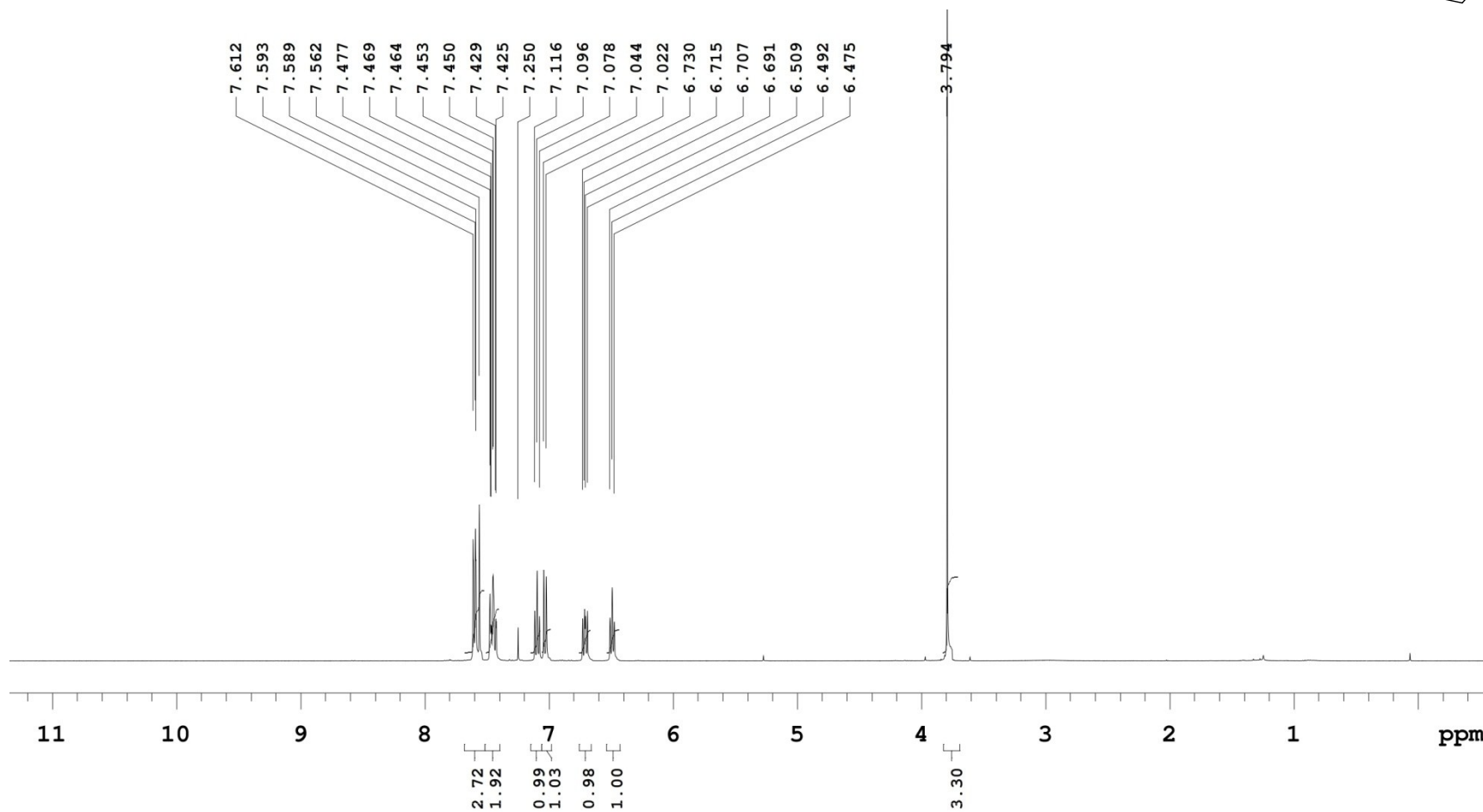
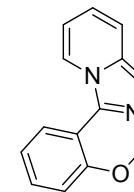


<sup>1</sup>H NMR of **5h**

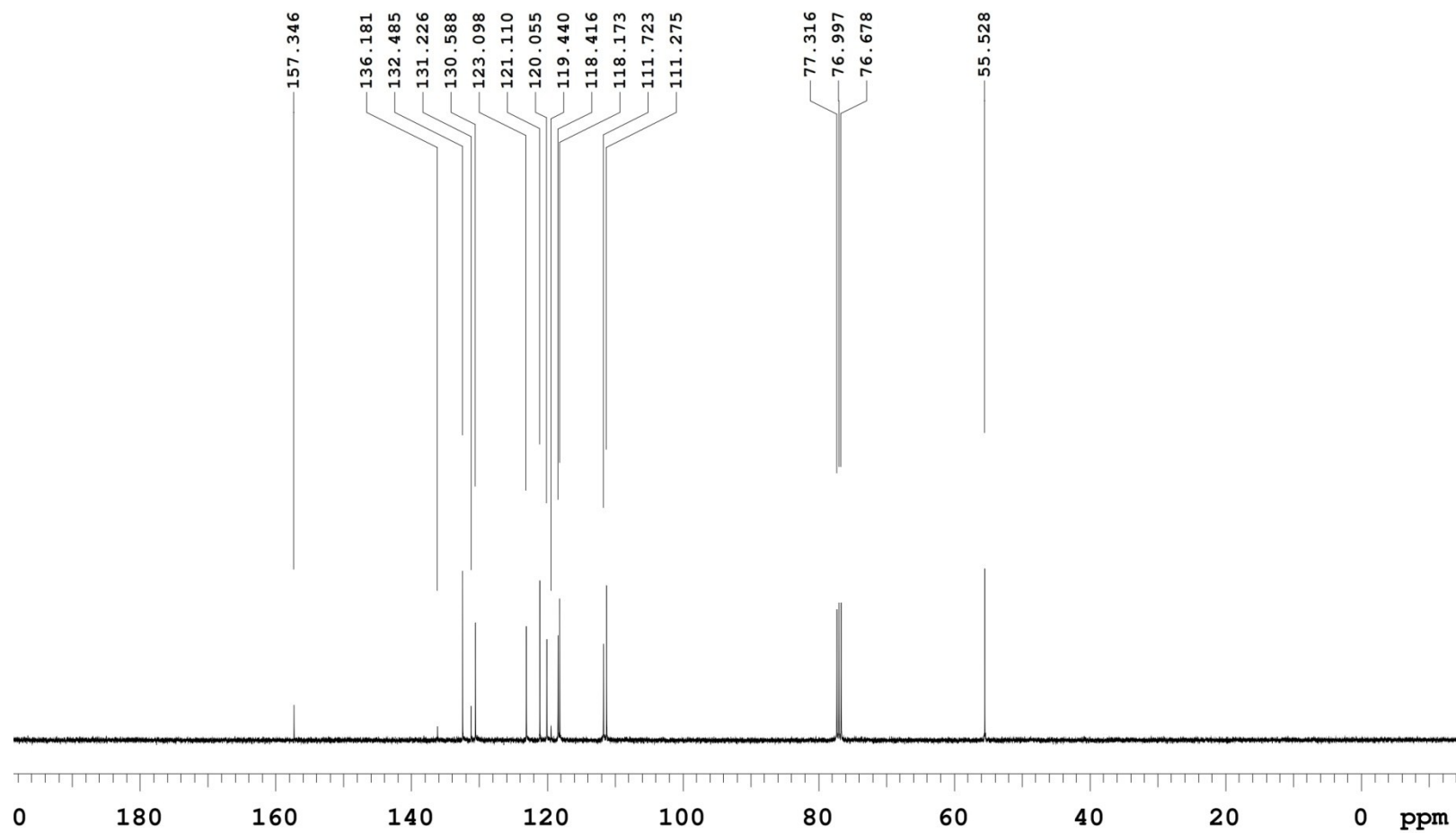
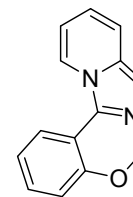




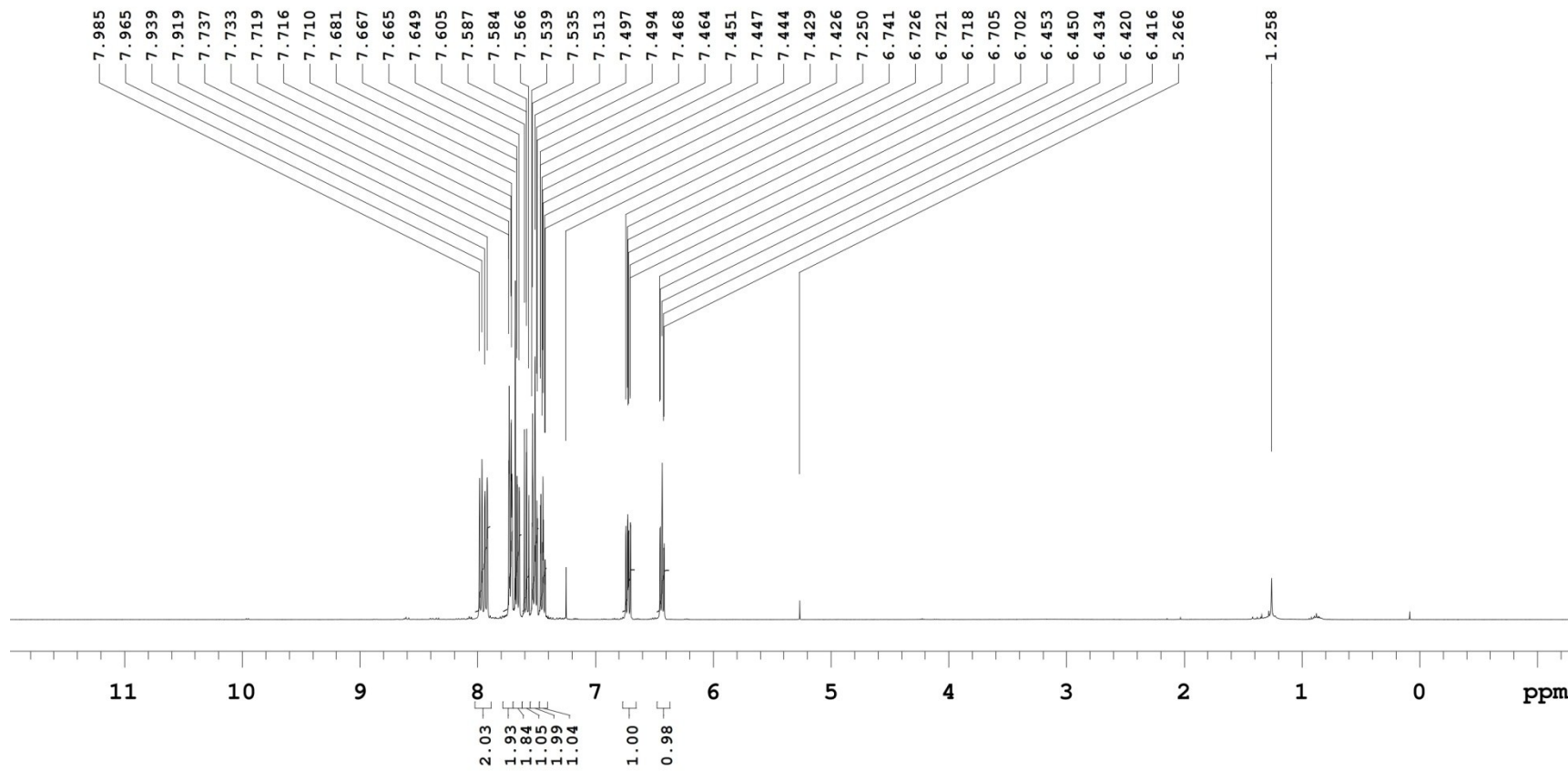
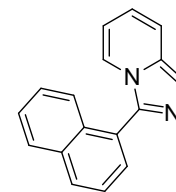




<sup>13</sup>C NMR of 5i



<sup>1</sup>H NMR of **5j**



<sup>13</sup>C NMR of **5j**

