Electronic Supplementary Material (ESI) for Chemical Communications.

Photocatalyst-Free Visible-Light Triggered Amination of Benzo[c][1,2,5]thiadiazole: Direct C–N Bond Formation from C(sp^2)–H bond

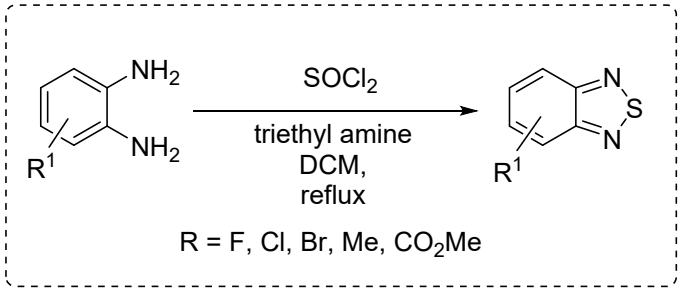
Contents:

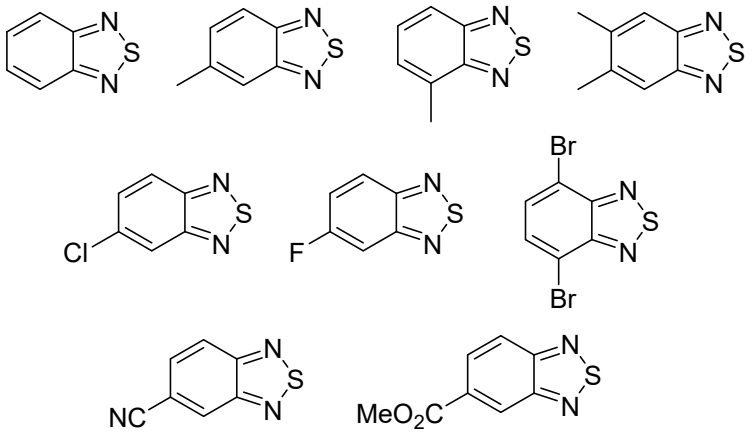
1. General

All the reactions were performed using oven-dried standard glassware or screw-caped vials. The reactions are stirred magnetically and monitored by analytical thin layer chromatography (TLC). TLC was made by silica gel 60 F254, and UV lamp was used as visualizing agent. Iodine, 5% aqueous potassium permanganate solutions were used as a developing agents followed by heating. Purification of products was performed using column chromatography on silica gel (100−120 and 230−400, mesh) where it is required. hexane/ethyl acetate was used as eluents. The solvents were removed by rotary evaporator at 40−45 °C under reduced pressure. All the reagents and solvents were purchased from commercial suppliers. Melting points reported in this work are uncorrected. ^{1}H NMR spectra were recorded on 300, 400, and 500 MHz instruments. Chemical shifts (δ) are reported in parts per million (ppm) with the reference solvent and the internal standards (TMS = 0; CDCl3 = 7.26).[1] The following abbreviations were used to explain the multiplicity of the spectra (s = singlet, d = doublet, dd = doublet of doublet, t = triplet, q = quartet, sep = septet, and m = multiplet). ^{13}C NMR spectra were recorded on 75, 100, and 125 MHz spectrometers. Infrared spectroscopy was performed neat on a BRUKER FT-IR spectrophotometer in chloroform; IR[KBr] spectra were recorded on a Thermo Nicolet-NEXUS 670 FT-IR instrument. Mass spectrometric analyses were performed using ESI techniques, mass spectra obtained on a SHIMADZU LCMS-2020 mass spectrometer. High Resolution Mass Spectra data were obtained on a Thermo scientific Exactive^{TM}Orbitrap mass spectrometer or Q STAR XL Hybrid MS/MS.

2. Synthesis of Benzo[*c*][1,2,5]thiadiazole derivatives

In a clean round bottom flask, 1, 2-diaminobenzene derivative (30.05 mmol) were taken and dissolved in CH_2Cl_2 (20 mL) followed by the addition of triethylamine (130.0 mmol). In an addition funnel, 96.0 mmol of $SOCl_2$ was dissolved in CH_2Cl_2 (10 mL) and added drop wise to the reaction mixture, stir the reaction mixture at reflux temperature. Reaction was monitored by TLC. After completion of reaction, removed the solvent under vacuum, the combined organic layer was washed with water and concentrated under vacuum. The benzo[*c*][1,2,5]thiadiazole derivatives were isolated by column chromatography. The synthesized benzothidiazole derivatives are good agreement with literature reports.[2]





3. Optimization survey

In a clean, oven dried reaction vial, chlorine source (1equiv.) and benzo[*c*][1,2,5]thiadiazole (1 mmol) was taken and closes the vial with a rubber septa and apply degassing with nitrogen gas. Under nitrogen solvent was added followed by the addition of piperidine (0.5 mmol). Stir the reaction mixture at ambient temperatures for 30 mints and then add 2 equivalents of acidic source, stir the reaction mixture under blue LED at ambient temperatures until the indicated reaction time. Reaction was monitoring by TLC. After reaction completion, the reaction mixture was diluted with ethyl acetate (3 x 10 mL) and 1 N of KOH solution (10 mL). The organic layer was taken and dried over anhydrous Na_2SO_4 then concentration under vacuum. The 4-(piperidin-1-yl)benzo[*c*][1,2,5]thiadiazole was collected by column chromatography.

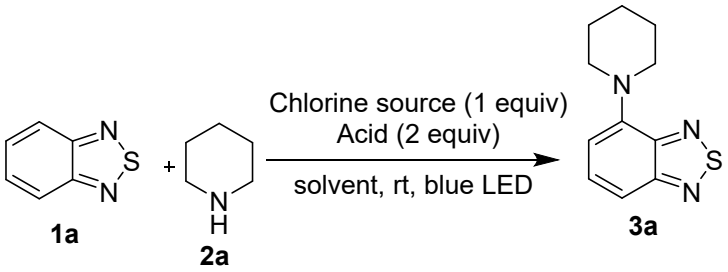


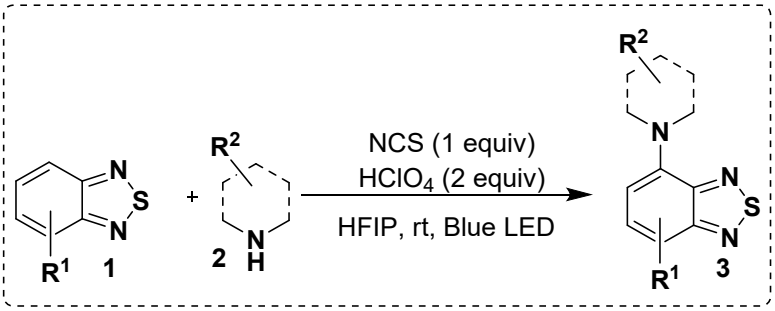
Table 1: Optimization survey

S. No	Chlorine source	Acid	Solvent	T (h)	Yield of 3[b]
1	NCS	$HClO_4$	CH_3CN	1	-
2	NCS	$HClO_4$	CH_3CN	2	-
3	NCS	$HClO_4$	CH_3CN	4	-
4	NCS	$HClO_4$	CH_3CN	6	8
5	NCS	$HClO_4$	CH_3CN	12	22
6	NCS	$HClO_4$	CH_3CN	24	62
7	**Cyanuric chloride**	$HClO_4$	CH_3CN	24	-
8	**Trichloroisocyanuric acid**	$HClO_4$	CH_3CN	24	-
9	NCS	**HCl**	CH_3CN	24	-
10	NCS	**H_2SO_4**	CH_3CN	24	-
11	NCS	**HNO_3**	CH_3CN	24	-
12	NCS	**MSA**	CH_3CN	24	19
13	NCS	**Pivalic acid**	CH_3CN	**24**	-
14	NCS	$HClO_4$	**HFIP**	24	78
15	NCS	$HClO_4$	**C_2H_5OH**	24	-
16	NCS	$HClO_4$	**DMSO**	**24**	-
17	NCS	$HClO_4$	**DMF**	**24**	-
18	NCS	$HClO_4$	**Toluene**	24	-
19	NCS	$HClO_4$	**DCE**	24	-
20	-	$HClO_4$	HFIP	24	-
21	NCS	-	HFIP	24	-
22[c]	NCS	$HClO_4$	HFIP	24	-

[a]Reaction conditions: **1** (1 mmol), **2a** (0.5 mmol), chlorine source (1 equiv.), Acid (2 equiv.), solvent (2 mL), at ambient temperature; [b]Yields are of isolated products; [c]Reaction carried in the absence of light; CC = Cyanuric chloride; TIC = Trichloroisocyanuric acid.

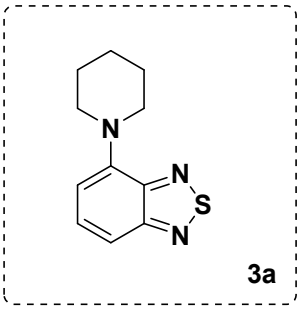
4. Experimental procedure for the synthesis of 3a-3v

In a clean, oven dried reaction vial, chlorine source (1 equiv., 0.5 mmol) and benzothiadiazole derivatives (2 equiv., 1 mmol) was taken and closes the vial with a rubber septa and apply degassing with nitrogen gas. Under nitrogen HFIP (2 mL) was added followed by the addition of piperidine (1 equiv., 0.5 mmol). Stir the reaction mixture at ambient temperatures for 30 mints and then add 2 equivalents of $HClO_4$, stir the reaction mixture under blue LED at ambient temperatures until the indicated reaction time. Reaction was monitoring by TLC. After reaction completion, the reaction mixture was diluted with ethyl acetate (3 x 10 mL) and 1 N of KOH solution (10 mL). The organic layer was taken and dried over anhydrous Na_2SO_4 then concentration under vacuum. The aminatedbenzothidiazoles**3a-3v** was collected by column chromatography.



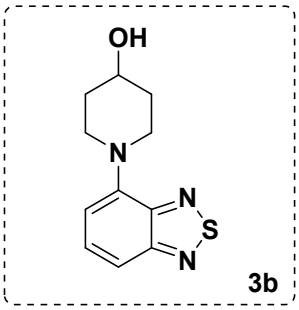
5. Spectroscopic data of 3a-3v

4-(piperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3a)



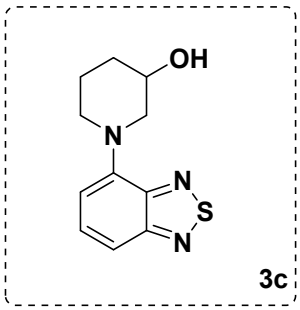
Yellow solid, 85 mg,78%, $\mathbf{R_f}$ = 0.45 (EtOAC/Hexane, 05:95);**MP** 148-150^{o}C; IR (KBr) 666, 1464, 1518, 1639, 1689, 2860, 2927, 2860,2927 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 1.55–1.62 (m, 2H), 1.76 (dt, *J* = 11.3, 5.8 Hz, 4H), 3.35–3.41 (m, 4H), 6.63 (d, *J* = 7.1 Hz, 1H), 7.32–7.44 (m, 2H);**^{13}C NMR** (101 MHz, $CDCl_3$) δ 24.6, 25.9, 51.7, 111.4, 112.9, 130.6, 145.3, 150.0, 156.7;**MS** (ESI) m/z 220 [M+H]+,**HRMS** (ESI, m/z): calcd for $C_{11}H_{14}N_3S$ [M+H]$^{+}$220.10287, found 220.10172.

1-(benzo[*c*][1,2,5]thiadiazol-4-yl)piperidin-4-ol (3b)



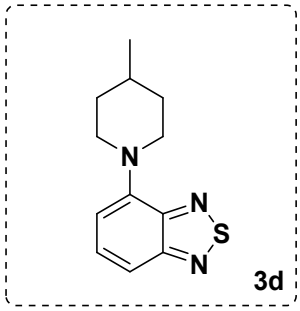
Yellow solid, 96 mg, 82%, $\mathbf{R_f}$= 0.48(EtOAC/Hexane, 1:1); **MP** 154-156^{o}C; **IR** (KBr) 627, 900, 1133, 1298, 1573, 2870, 2943 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 1.79 (m, 2H), 2.07 (d, *J* = 9.6 Hz, 2H),3.13 (m, *J* = 12.4Hz, 2H),3.87–3.94 (m, 3H),6.69 (d, *J* = 6.5 Hz, 1H),7.39 (dd, *J* = 8.7, 7.3 Hz, 1H),7.46 (d, *J* = 8.6 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ34.4, 40.5,48.0,67.8,111.7,113.4,130.5,144.4,149.8,156.7; **MS** (ESI) m/z 236 [M+H]+**HRMS** (ESI, m/z): calcd for $C_{11}H_{14}N_3OS$[M+H]+236.08576, found 236.08500.

1-(benzo[*c*][1,2,5]thiadiazol-4-yl)piperidin-3-ol (3c)



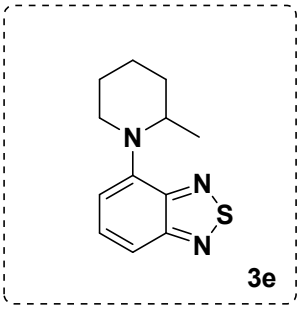
Yellow solid, 94 mg, 80%, $\mathbf{R_f}$ = 0.52 (EtOAC/Hexane, 1:1); **MP** 151-153°C; **IR** (KBr) 658, 1094, 1260, 1382, 1460, 1541, 2862, 2928 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 1.78 (dt, *J* = 13.2, 6.4 Hz, 2H), 1.87–1.93 (m, 1H), 2.07 (d, *J* = 4.9 Hz, 1H), 3.33 (d, *J* = 5.5 Hz, 1H), 3.40–3.47 (m, 1H), 3.53 (s, 1H), 3.60 (dd, *J* = 11.8, 2.7 Hz, 1H), 4.10 (s, 1H), 6.75 (d, *J* = 7.2 Hz, 1H), 7.45 (t, *J* = 8.0 Hz, 1H), 7.53 (d, *J* = 8.7 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 22.0, 32.1, 50.7, 57.7, 66.4, 112.2, 113.6, 130.5, 144.8, 149.9, 156.6; **MS** (ESI) m/z 236 $[M+H]^+$ **HRMS** (ESI, m/z): calcd for $C_{11}H_{14}N_3OS$ $[M+H]^+$236.08576, found 236.08479.

4-(4-methylpiperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3d)



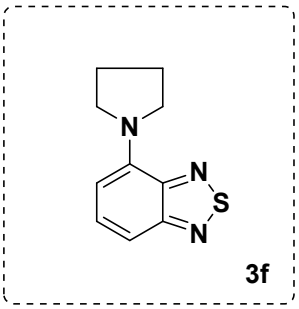
Yellow solid, 85 mg, 73%, $\mathbf{R_f}$ = 0.45(EtOAC/Hexane, 05:95); **MP** 144-146°C; **IR** (KBr) 810, 1101, 1264, 1460, 2850, 2928 cm^{-1}; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 1.04 (d, *J* = 6.2 Hz, 3H), 1.47–1.61 (m, 3H), 1.83 (dd, *J* = 12.7, 1.6 Hz, 2H), 2.84 (dd, *J* = 17.2, 7.0 Hz, 2H), 4.17 (d, *J* = 12.3 Hz, 2H), 6.73 (d, *J* = 7.3 Hz, 1H), 7.47 (dt, *J* = 8.7, 8.1 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 21.9, 31.0, 34.3, 51.0, 111.5, 112.9, 130.5, 145.2, 150.0, 156.7; **MS** (ESI) m/z 234 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{12}H_{16}N_3S$ $[M+H]^+$234.10649, found 234. 234.10624.

4-(2-methylpiperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3e)



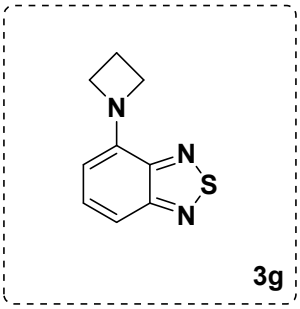
Yellow solid, 77 mg, 66%, $\mathbf{R_f}$= 0.46 (EtOAC/Hexane, 05:95); **MP** 162-164°C; **IR** (KBr) 2928, 2860, 1564, 1420, 1223, 1084, 629 cm^{-1};**^{1}H NMR** (400 MHz, $CDCl_3$) δ0.97 (d, *J* = 6.8 Hz, 3H), 1.71 (m ,4H),1.97–2.07 (m, 1H),3.19–3.26 (m, 1H),3.30–3.36 (m, 1H),4.83–4.91 (m, 1H),6.64 (d, *J* = 6.5 Hz, 1H),7.40 (d, *J* = 8.7, 4.1 Hz, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 13.8, 19.3, 26.1, 31.2, 45.1, 51.7, 112.7, 113.0, 130.6, 144.6, 150.2, 156.8; **MS** (ESI) m/z 234 $[M+H]^+$ **HRMS** (ESI, m/z): calcd for $C_{12}H_{16}N_3S$ $[M+H]^+$ 234.11852, found 234.11747.

4-(pyrrolidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3f)



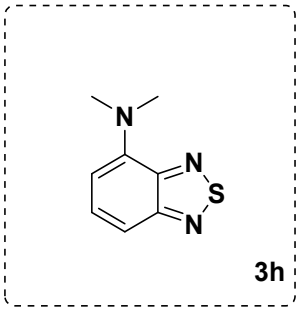
Yellow solid, 83 mg, 81%, $\mathbf{R_f}$ = 0.42 (EtOAC/Hexane, 05:95); **MP** 145-147°C; **IR** (KBr) 1100, 1223, 1261, 1714, 2866, 2944 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 2.06 (dd, *J* = 6.3, 3.3 Hz, 4H), 3.84 (dd, *J* = 7.9, 5.4 Hz, 4H), 6.24 (d, *J* = 7.6 Hz, 1H), 7.21 (d, *J* = 8.5 Hz, 1H), 7.42 (dd, *J* = 8.6, 7.7 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 35.2, 51.8, 117.2, 127.4, 133.2, 141.9, 158.9, 160.9. **MS** (ESI) m/z 206 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{10}H_{12}N_3S$ $[M+H]^+$206.07519, found 206.07491.

4-(azetidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3g)



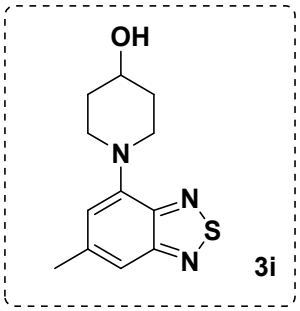
Yellow solid, 82 mg, 86%, $\mathbf{R_f}$ = 0.44 (EtOAC/Hexane, 05:95); **MP** 138-140^{o}C; **IR** (KBr) 740, 1306, 1493, 1547, 2865, 2927 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 2.39–2.52 (m, 2H), 4.33 (t, *J* = 7.3 Hz, 4H), 6.14 (d, *J* = 7.4 Hz, 1H), 7.26 (t, *J* = 4.1 Hz, 1H), 7.41 (dd, *J* = 8.7, 7.4 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 17.6, 54.1, 103.6, 108.9, 130.7, 143.4, 147.7, 156.7; **MS** (ESI) m/z 192 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_9H_{10}N_3S$ $[M+H]^+$192.05954, found 192.05864.

***N*,*N*-dimethylbenzo[*c*][1,2,5]thiadiazol-4-amine (3h)**



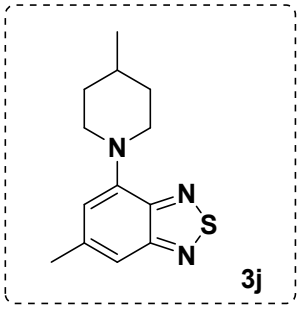
Yellow liquid, 71 mg, 75%, $\mathbf{R_f}$ = 0.6 (EtOAC/Hexane, 05:95); **IR** (KBr) 662, 1223, 1420, 1537, 2958, 2868 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 3.20 (s, 6H), 6.48 (dd, *J* = 6.8, 1.6 Hz, 1H), 7.33–7.41 (m, 2H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 42.6, 108.9, 111.1, 130.8, 144.5, 149.3, 156.9; **MS** (ESI) m/z 180 $[M+H]^+$

1-(6-methylbenzo[*c*][1,2,5]thiadiazol-4-yl)piperidin-4-ol (3i)



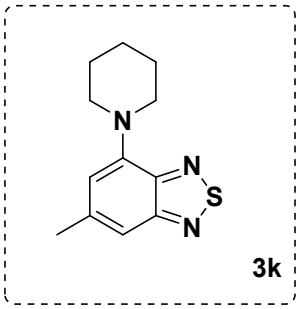
Yellow solid, 98 mg, 79%, $\mathbf{R_f}$ = 0.47 (EtOAC/Hexane, 1:1); **MP**168-170^{o}C; **IR** (KBr) 625, 1074, 1292, 1375, 1462, 2859, 2927 cm^{-1}; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 1.75–1.85 (m, 3H), 2.05 (t, *J* = 12.6 Hz, 3H), 2.39 (d, *J* = 1.0 Hz, 4H), 3.05–3.14 (m, 3H), 3.89 (dd, *J* = 8.5, 4.2 Hz, 4H), 6.52 (s, 1H), 7.24 (s, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 22.5, 34.4, 47.9, 67.8, 112.2, 114.8, 141.1, 143.5, 148.8, 157.1; **MS** (ESI) m/z 250 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{12}H_{16}N_3OS$ $[M+H]^+$250.10141, found 250.10078.

6-methyl-4-(4-methylpiperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3j)



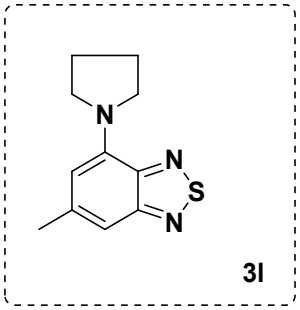
Yellow solid, 91 mg, 74%, $\mathbf{R_f}$ = 0.44 (EtOAC/Hexane, 05:95); **MP** 165-167^{o}C; **IR** (KBr) 685, 1093, 1200, 1275, 1533, 1658, 2884, 2979 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 0.95 (d, *J* = 6.1 Hz, 3H), 1.41–1.53 (m, 3H), 1.70–1.76 (m, 2H), 2.37 (d, *J* = 1.1 Hz, 3H), 2.72 (dd, *J* = 16.8, 7.1 Hz, 2H), 4.03–4.09 (m, 2H), 6.48 (d, *J* = 1.1 Hz, 1H), 7.18–7.20 (m, 1H);**^{13}C NMR** (101 MHz, $CDCl_3$) δ 22.0, 22.5, 31.0, 34.3, 51.0, 111.9, 114.6, 141.2, 144.2, 148.9, 157.1; **MS** (ESI) m/z 248 $[M+H]^+$ **HRMS** (ESI, m/z): calcd for $C_{13}H_{18}N_3S$ $[M+H]^+$ 248.12214, found 248.12199.

6-methyl-4-(piperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3k)



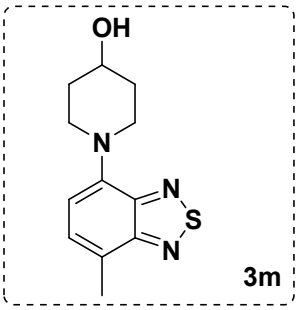
Yellow solid, 80 mg, 68%, $\mathbf{R_f}$ = 0.47 (EtOAC/Hexane, 05:95); **MP** 142-144^{o}C; IR (KBr) 2933, 2860, 1632, 1533, 1454, 1266, 1102, 817 cm^{-1}; **^{1}H NMR** (300 MHz, $CDCl_3$) δ 1.60 (dt, *J* = 10.7, 5.5 Hz, 2H), 1.77 (dd, *J* = 10.5, 5.2 Hz, 4H), 2.38 (s, 3H), 3.35–3.40 (m, 4H), 6.49 (s, 1H), 7.20 (dd, *J* = 5.1, 0.9 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 22.5, 24.6, 26.0, 51.7, 111.9, 114.5, 141.2, 144.4, 148.9, 157.1;**MS** (ESI) m/z 234 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{12}H_{16}N_3S$ $[M+H]^+$234.11852, found 234.11747.

6-methyl-4-(pyrrolidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3l)



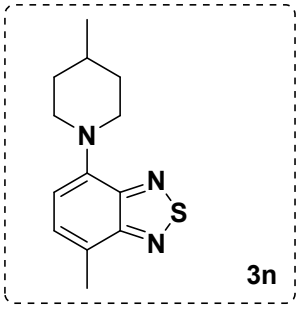
Yellow solid, 80 mg, 73%, $\mathbf{R_f}$ = 0.62 (EtOAC/Hexane, 05:95); **MP** 137-139^{o}C; IR (KBr) 809, 1103, 1264, 1458, 1507, 1634, 2929, 2964 cm^{-1}; **^{1}H NMR** (300 MHz, $CDCl_3$) δ 1.99–2.10 (m, 4H), 2.43 (s, 3H), 3.77–3.86 (t, *J* = 6.5 Hz, 4H), 6.07 (s, 1H), 7.00 (s, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 22.4, 25.6, 50.1, 106.6, 140.3, 142.1, 147.5, 157.6; **MS** (ESI) m/z 220 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{11}H_{14}N_3S$ $[M+H]^+$220.10287, found 220.10172.

1-(7-methylbenzo[*c*][1,2,5]thiadiazol-4-yl)piperidin-4-ol (3m)



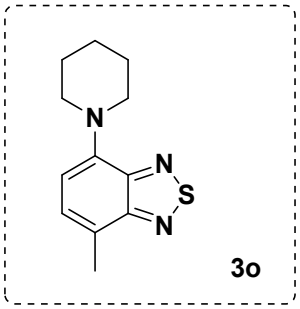
Yellow solid, 93 mg, 75%, $\mathbf{R_f}$ = 0.45(EtOAC/Hexane, 1:1); **MP** 166-168^{o}C; **IR** (KBr) 716, 1047, 1261, 1380, 1463, 2857, 2926 cm^{-1}; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 1.76–1.84 (m, 2H), 2.02–2.11 (m, 2H), 2.56 (d, *J* = 1.0 Hz, 3H), 3.06–3.16 (m, 2H), 3.77–3.91 (m, 3H), 6.63 (d, *J* = 7.5 Hz, 1H), 7.15 (dd, *J* = 7.5, 1.1 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 17.4, 34.4, 48.3, 67.9, 112.5, 123.4, 128.9, 142.6, 150.0, 156.8; **MS** (ESI) m/z 250 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{12}H_{16}N_3OS$ $[M+H]^+$250.10141, found 250.10074.

4-methyl-7-(4-methylpiperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3n)



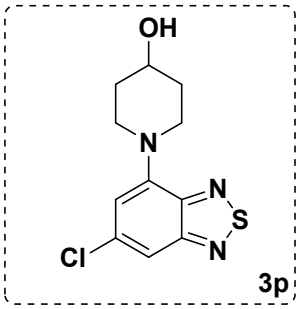
Yellow solid, 89 mg, 72%, $\mathbf{R_f}$ =0.5 (EtOAC/Hexane, 05:95); **MP**158-160^{o}C; IR (KBr) 816, 1097, 1264, 1494, 1561, 1629, 2814, 2968 cm^{-1}; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 0.94 (d, *J* = 5.2 Hz, 3H), 1.44–1.55 (m, 3H), 1.73 (d, *J* = 10.8 Hz, 2H), 2.54 (s, 3H), 2.67 (t, *J* = 11.4 Hz, 2H), 3.97 (d, *J* = 11.8 Hz, 2H), 6.58 (d, *J* = 7.4 Hz, 1H), 7.11 (d, *J* = 7.4 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 16.3, 20.9, 29.9, 33.3, 50.2, 111.1, 121.6, 127.9, 142.2, 149.1, 155.8; **MS** (ESI) m/z 248 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{13}H_{18}N_3S$ $[M+H]^+$248.13417, found 248.13300.

4-methyl-7-(piperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3o)



Yellow solid, 82 mg, 70%, $\mathbf{R_f}$ = 0.49 (EtOAC/Hexane, 05:95); **MP** 152-154°C; **IR** (KBr) 814, 1101, 1267, 1447, 1564, 2924, 2972 cm^{-1}; **^{1}H NMR** (300 MHz, $CDCl_3$) δ 1.52–1.65 (m, 2H), 1.72–1.82 (m, 4H), 2.55 (s, 3H), 3.23–3.37 (m, 4H), 6.60 (d, *J* = 7.5 Hz, 1H), 7.13 (d, *J* = 7.4 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 16.3, 23.6, 25.0, 50.9, 111.2, 121.9, 127.9, 142.5, 149.1, 155.8; **MS** (ESI) m/z 234 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{12}H_{16}N_3S$ $[M+H]^+$234.10649,found 234.10624.

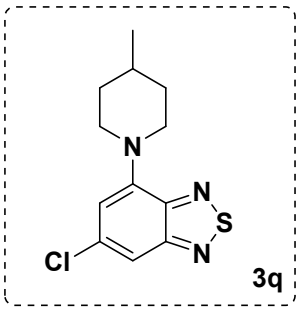
1-(6-chlorobenzo[*c*][1,2,5]thiadiazol-4-yl)piperidin-4-ol (3p)



Yellow solid, 93 mg, 69%, $\mathbf{R_f}$ = 0.46 (EtOAC/Hexane, 1:1); **MP** 157-159°C; **IR** (KBr) 664, 935, 1389, 1465, 1536, 1574, 2862, 2935 cm^{-1}; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 1.77–1.88 (m, 2H), 2.06–2.18 (m, 2H), 3.20–3.34 (m, 2H), 3.94–4.07 (m, 3H), 6.67 (d, *J* = 1.7 Hz, 1H), 7.50 (d, *J* = 1.7 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 34.1, 47.6, 67.5, 111.6, 112.6, 137.7, 144.0, 148.4, 156.4;

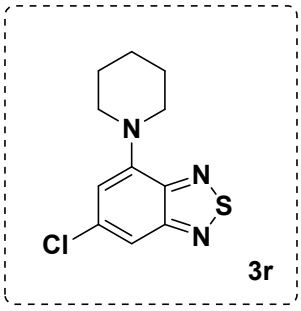
MS (ESI) m/z 270 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{11}H_{13}ClN_3OS$ $[M+H]^+$270.04679, found 270.04591

6-chloro-4-(4-methylpiperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3q)



Yellow solid, 81 mg, 61%, $\mathbf{R_f}$ = 0.42(EtOAC/Hexane, 05:95); **MP** 150-152°C; **IR** (KBr) 627, 851, 1133, 1298, 1573, 2870, 2901 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 0.96 (d, *J* = 6.3 Hz, 3H), 1.32–1.48 (m, 3H), 1.6–1.74 (m, 2H), 3.31–3.51 (m, 13H), 7.27–7.41 (m, 1H), 7.57–7.81 (m, 4H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 22.3, 30.9, 35.2, 51.9, 114.9, 126.9, 132.9, 141.3, 152.8, 155.4; **MS** (ESI) m/z 268 $[M+H]^+$

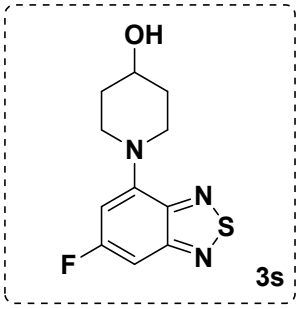
6-chloro-4-(piperidin-1-yl)benzo[*c*][1,2,5]thiadiazole (3r)



Yellow solid, 82 mg, 65%, $\mathbf{R_f}$ = 0.48(EtOAC/Hexane, 05:95); **MP** 155-157°C; IR (KBr) 706, 935, 1275, 1534, 1582, 2815, 2968 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 1.64–1.73 (m, 2H), 1.77–1.89 (m, 4H), 3.49–3.60 (m, 4H), 6.64 (s, 1H), 7.48 (s, 1H); **^{13}C NMR** (101 MHz, CDCl3) δ 24.5, 25.8,

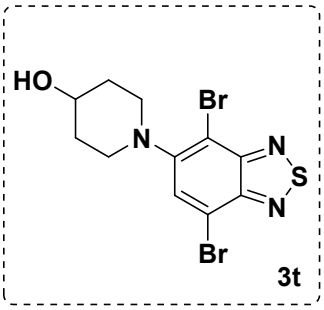
51.3, 111.2, 112.4, 137.8, 144.8, 148.5, 156.5; **MS** (ESI) m/z 253 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{11}H_{12}ClN_3S$ $[M+H]^+$253.06390, found 254.06279.

1-(6-fluorobenzo[*c*][1,2,5]thiadiazol-4-yl)piperidin-4-ol (3s)



Yellow solid, 88 mg, 70%, $\mathbf{R_f}$ = 0.52(EtOAC/Hexane, 1:1); **MP** 163-165°C; **IR** (KBr) 697, 848, 1072, 1371, 1497, 1539, 2668, 2941 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 1.75–1.85 (m, 2H), 2.04–2.13 (m, 2H), 3.31–3.44 (m, 2H), 3.75–3.85 (m, 2H), 3.89–3.99 (m, 1H), 7.37 (d, *J* = 12.5, 9.4 Hz, 1H), 7.53 (d, *J* = 9.4, 4.3 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 35.5, 48.9, 68.1, 114.0, 122.8 (d, *J* = 10.1 Hz), 129.1 (d, *J* = 11.4 Hz), 152.4 (d, *J* = 26.0 Hz), 153.38, 154.9; **MS** (ESI) m/z 253 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{11}H_{12}FN_3OS$ $[M+H]^+$253.07634, found 253.07546.

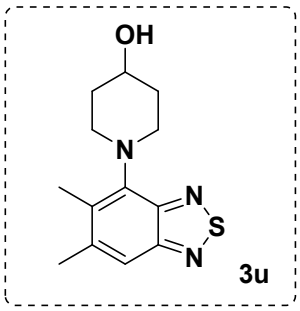
1-(4,7-dibromobenzo[*c*][1,2,5]thiadiazol-5-yl)piperidin-4-ol (3t)



Yellow solid, 69 mg, 35%, $\mathbf{R_f}$ = 0.46 (EtOAC/Hexane, 1:1); **MP** 162-164°C; **IR** (KBr) 706, 896, 1069, 1476, 1524, 2869, 2945 cm^{-1}; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 1.73–1.88 (m, 2H), 2.02–2.11 (m, 2H), 3.38–3.49 (m, 2H), 3.60–3.68 (m, 2H), 3.90–3.99 (m, 1H), 7.81 (s, 1H); **^{13}C NMR** (101

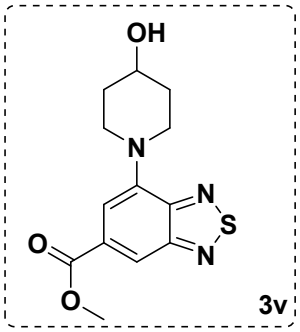
MHz, $CDCl_3$) δ 23.5, 25.7, 51.6, 114.0, 125.9, 131.9, 140.4, 151.8, 154.3; **MS** (ESI) m/z 393 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{11}H_{11}Br_2N_3OS$ $[M+H]^+$394.07774, found 394.07765.

1-(5,6-dimethylbenzo[*c*][1,2,5]thiadiazol-4-yl)piperidin-4-ol (3u)



Yellow solid, 72 mg, 55%, $\mathbf{R_f}$ = 0.42 (EtOAC/Hexane, 1:1); **MP**170-172°C; **IR** (KBr) 663, 1069, 1378, 1467, 2870, 2943 cm^{-1}; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 1.70–1.83 (m, 3H), 1.98–2.10 (m, 2H), 2.43 (s, 3H), 2.44 (s, 3H), 3.37 (d, *J* = 136.9 Hz, 3H), 3.94 (s, 1H), 7.57 (s, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 14.8, 22.1, 35.7, 49.5, 116.6, 135.3, 141.2, 141.8, 152.1, 155.1; **MS** (ESI) m/z 263 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{13}H_{17}N_3OS$ $[M+H]^+$263.11706, found 263.11574.

methyl 7-(4-hydroxypiperidin-1-yl)benzo[*c*][1,2,5]thiadiazole-5-carboxylate (3v)



Yellow solid, 72 mg, 49%, $\mathbf{R_f}$ = 0.44 (EtOAC/Hexane, 1:1); **MP** 169-171°C; **IR** (KBr) 1070, 1253, 1289, 1461, 1723, 2860, 2926 cm^{-1}; **^{1}H NMR** (500 MHz, $CDCl_3$) δ 1.83–1.89 (m, 2H), 2.15 (dd, *J* = 13.3, 3.8 Hz, 2H), 3.20–3.30 (m, 2H), 3.98 (s, 3H), 3.99–4.07 (m, *J* = 14.0, 8.6, 3.4 Hz, 3H), 7.36 (s, 1H), 8.25 (d, *J* = 0.6 Hz, 1H); **^{13}C NMR** (101 MHz, $CDCl_3$) δ 34.3, 47.9, 52.7, 67.7, 110.8,

115.7, 132.2, 144.1, 151.3, 156.2, 166.9; **MS** (ESI) m/z 294 $[M+H]^+$**HRMS** (ESI, m/z): calcd for $C_{13}H_{16}N_3O_3S$ $[M+H]^+$294.09124, found 294.09020.

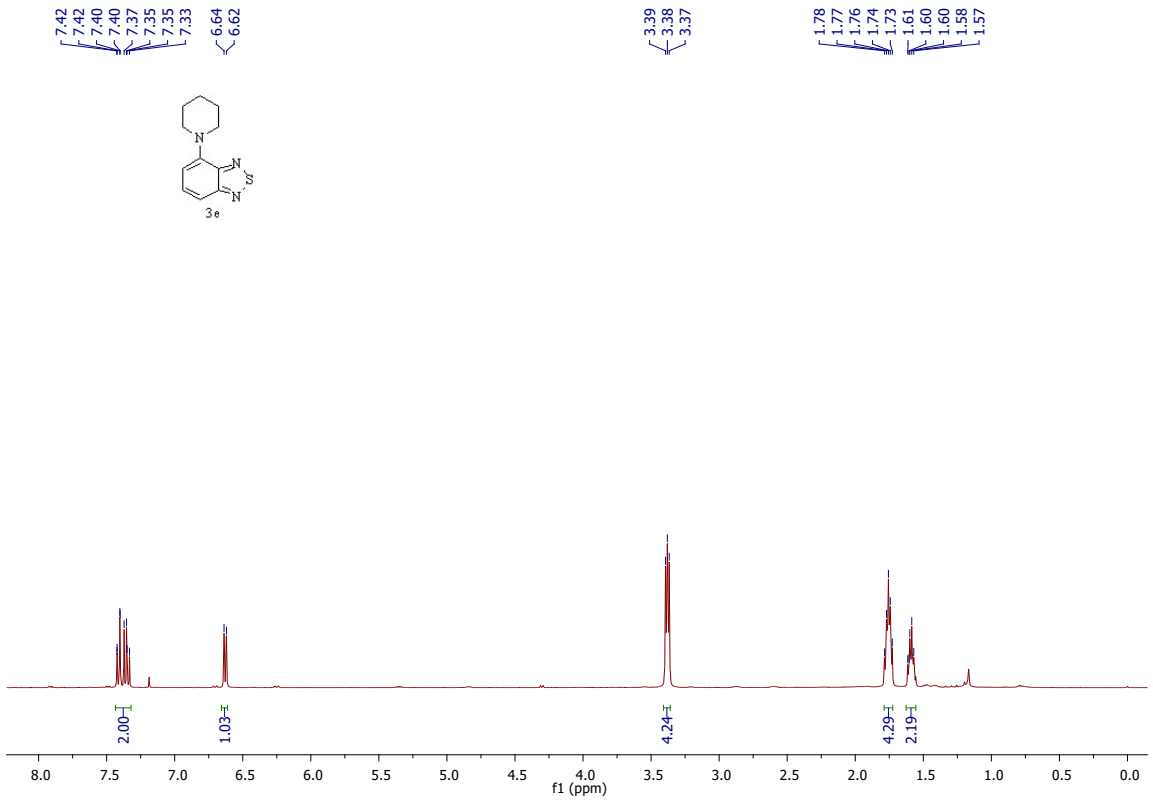
5. References

[1] H. E. Gottlieb, V. Kotlyar and A. Nudelman, *J. Org. Chem.,* 1997, **62**, 7512–7515.

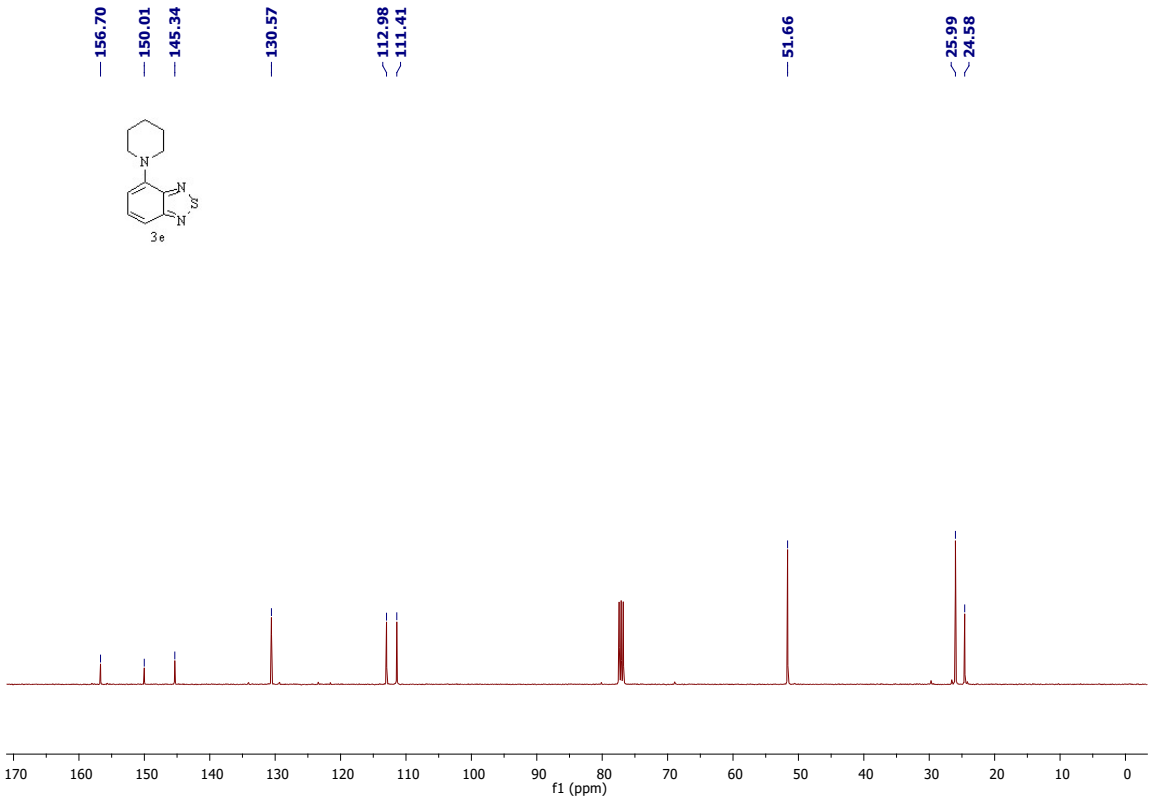
[2] (a) J. Wu, G. Lai, Z. Li, Y. Lu, T. Leng, Y. Shen andC. Wang, *Dyes and Pigments*, 2016, **124**, 268–276.(b) R. Agneeswari, V. Tamilavan, M. Song and M. H. Hyun, *J. Mater. Chem. C*, 2014, 2, 8515–8524. (c) Q. Zhang, J. Zhang, H. Zuo, C. Wang andY. Shen, *Tetrahedron*, 2016**,** **72**, 1244–1248. (d) Y. H. Nguyen, B. J. Lampkin, A. Venkatesh, A. Ellern, A. J. Rossini and B. VanVeller, *J. Org. Chem.,* 2018, **83**, *17*, 9850–9857. (e) I. Jeong, S. Chae, A. Yi, J. Kim, H. H. Chun, J. H. Cho, H. J. Kim andH. Suh, *Polymer,* 2017**, 109**, 27, 115–125. (f) Y. Macé, E. Bony, D. Delvaux, A. Pinto, V. Mathieu, R. Kiss, O. Feron, J. Q.-Leclercq and O. Riant, *Med. Chem. Research,*2015, **24**, *8*, 3143–3156.

6. Copies of ^{1}H and ^{13}C NMR spectra of 3a to 3y

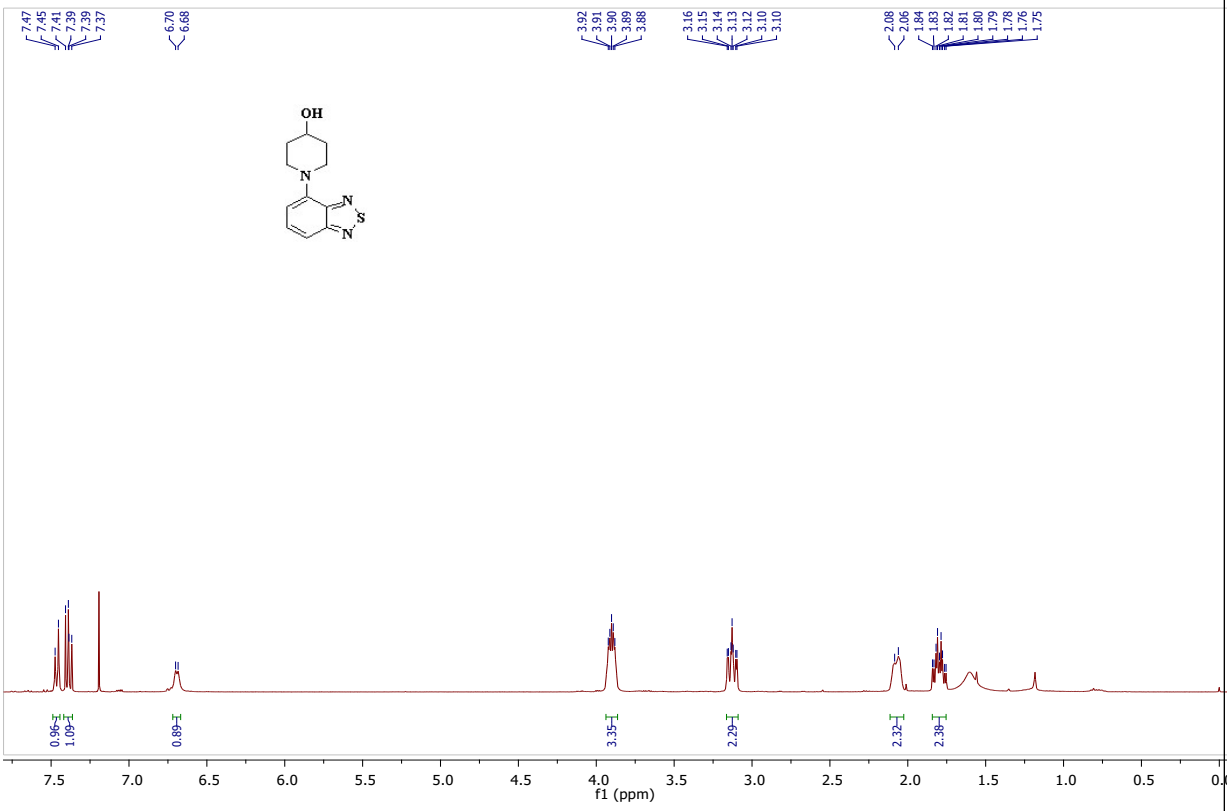
^{1}H NMR of **3a** (400 MHz, $CDCl_3$)



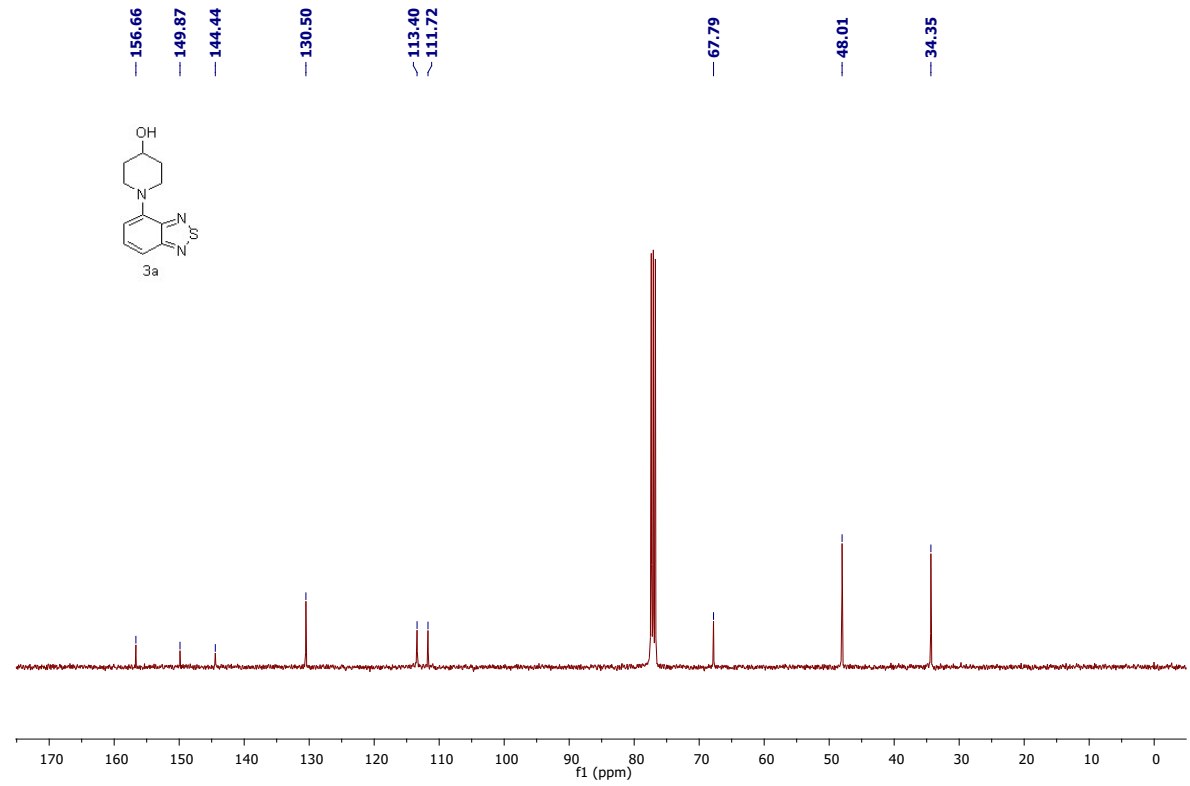
^{13}C NMR of **3a** (101 MHz, $CDCl_3$)



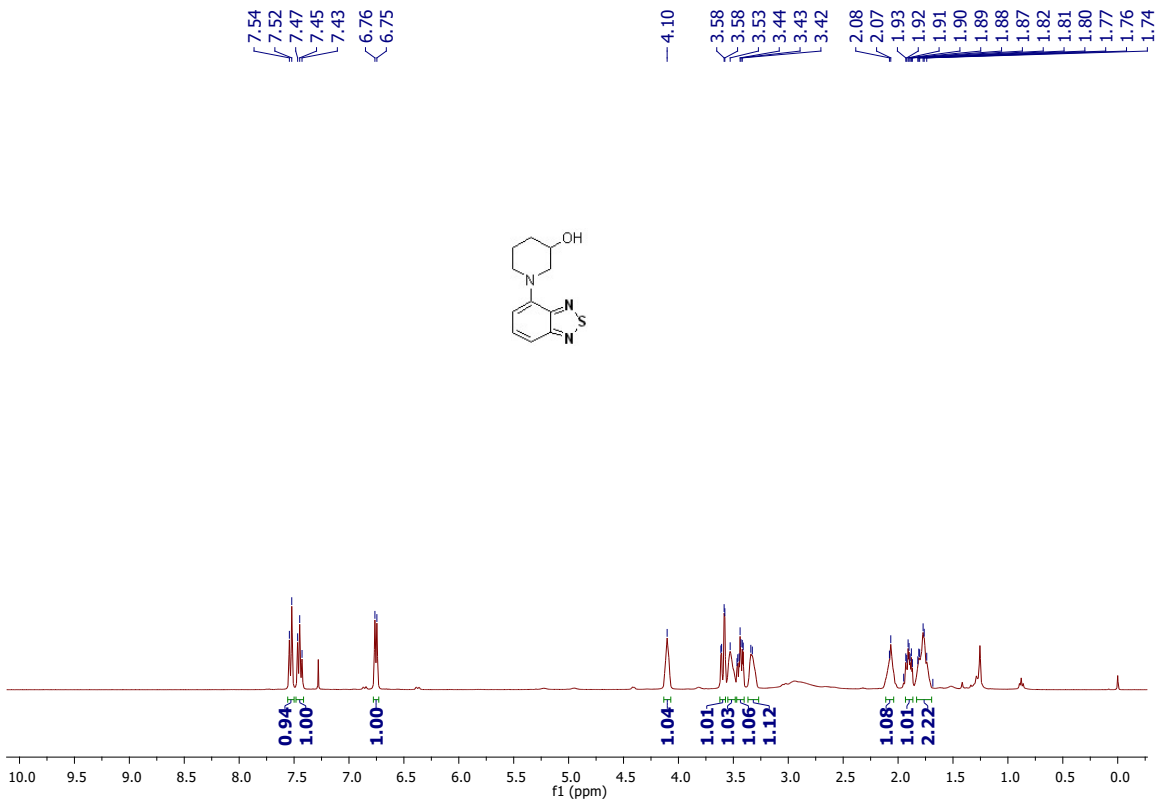
^{1}H NMR of **3b** (500 MHz, $CDCl_3$)



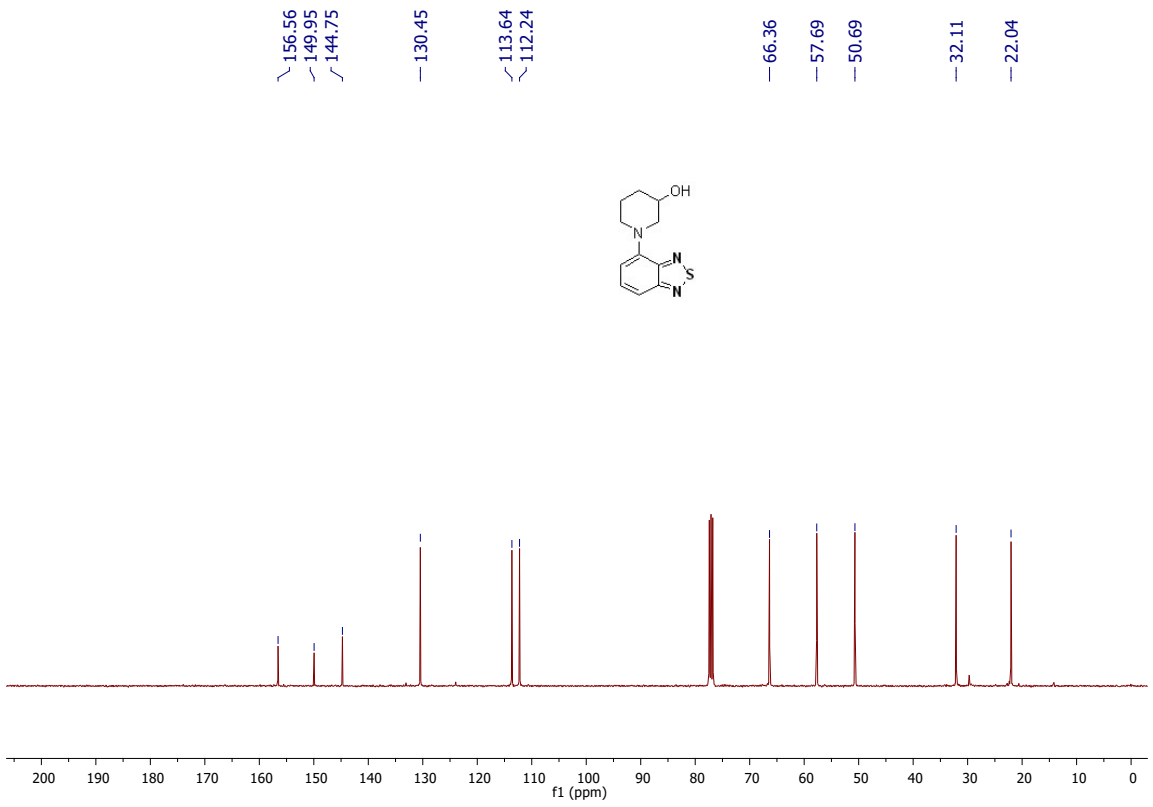
^{13}C NMR of **3b** (101 MHz, $CDCl_3$)



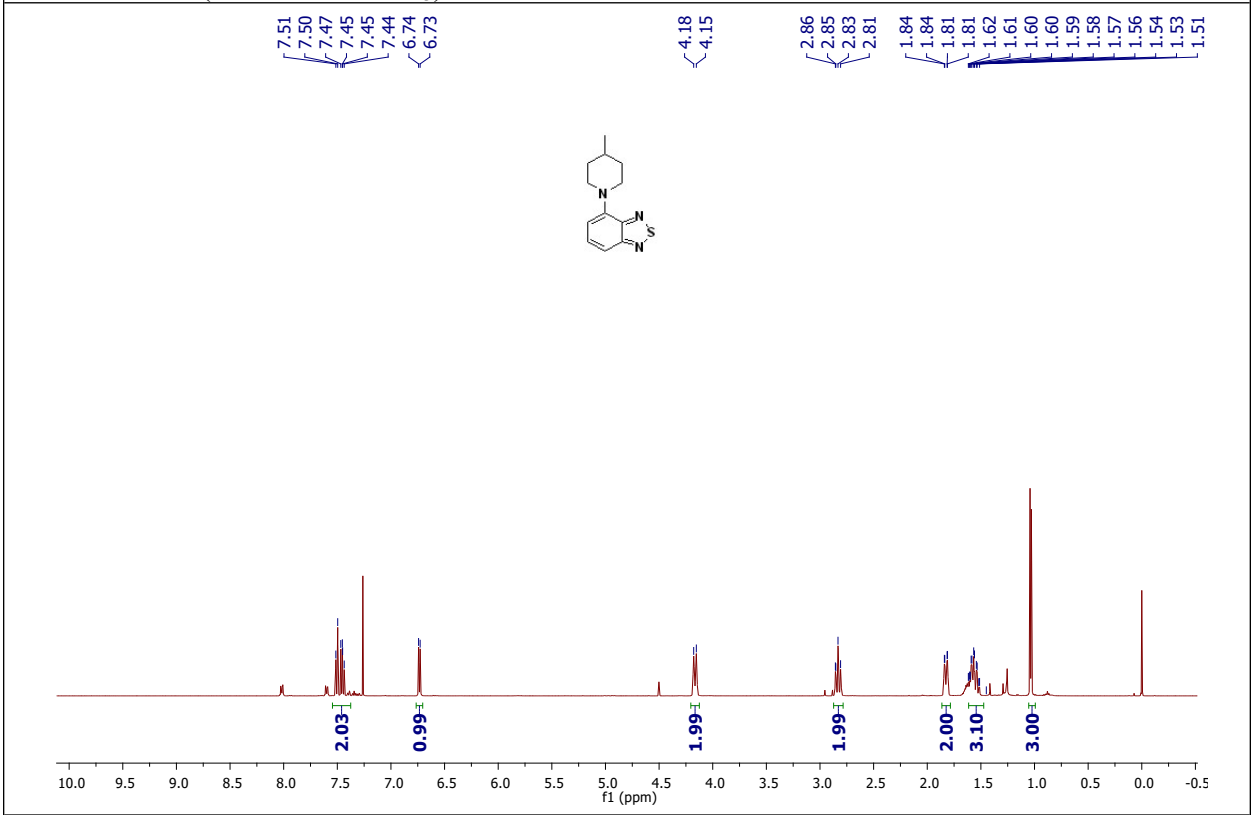
^{1}H NMR of **3c** (400 MHz, $CDCl_3$)



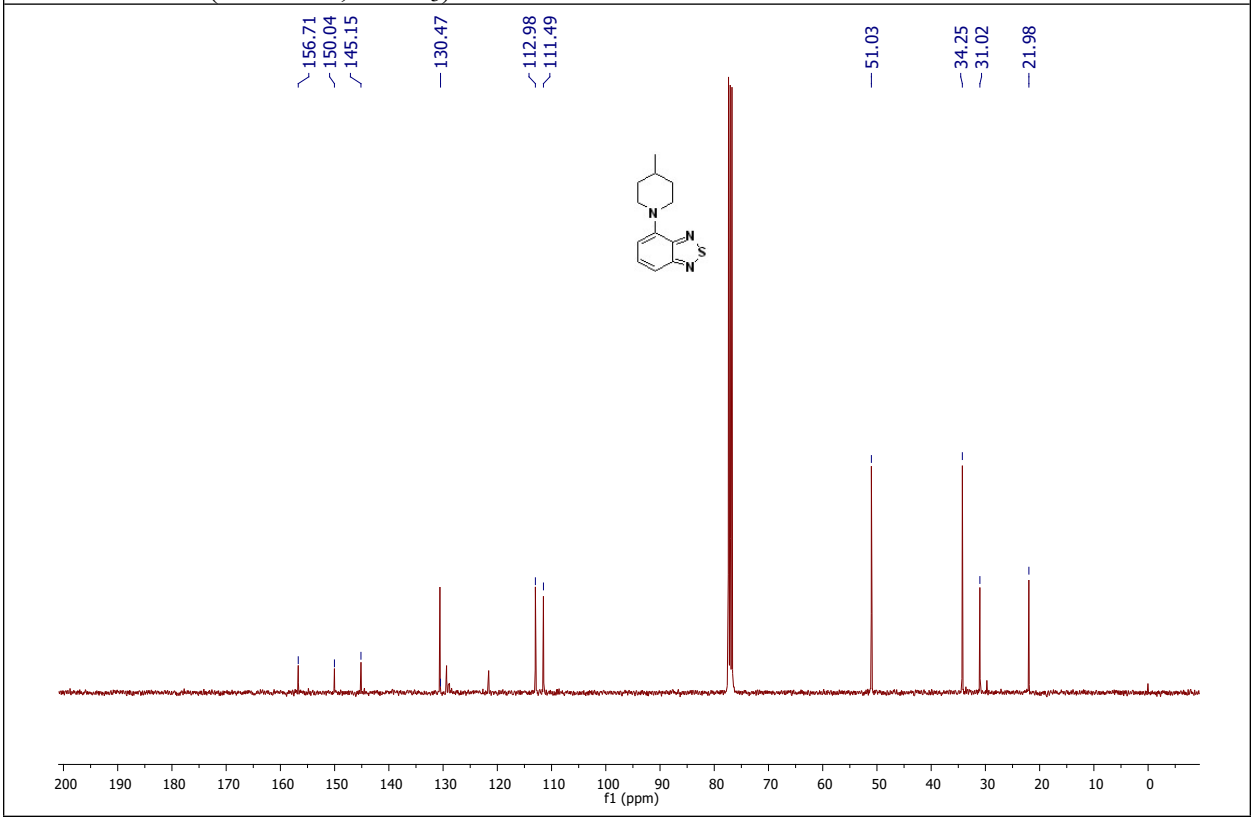
^{13}C NMR of **3c** (101 MHz, $CDCl_3$)



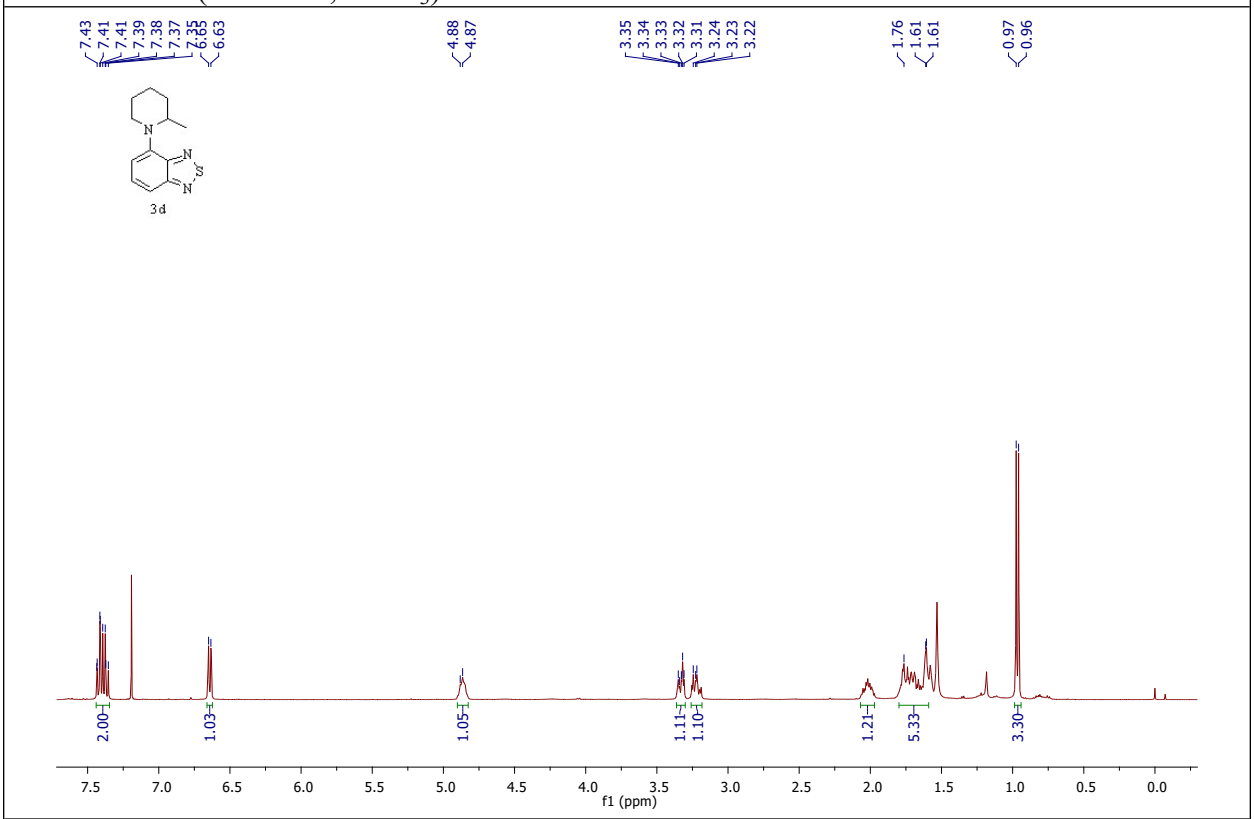
^{1}H NMR of **3d** (500 MHz, $CDCl_3$)



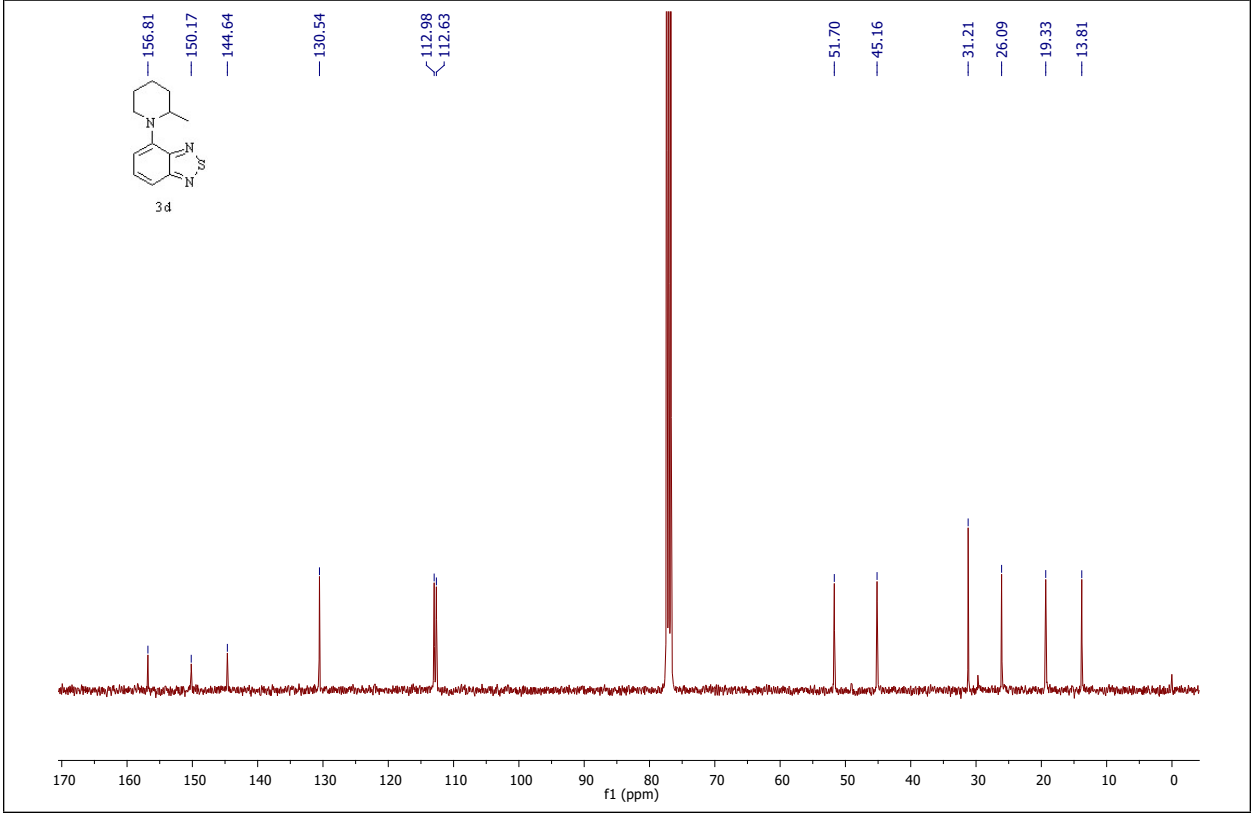
^{13}C NMR of **3d** (101 MHz, $CDCl_3$)



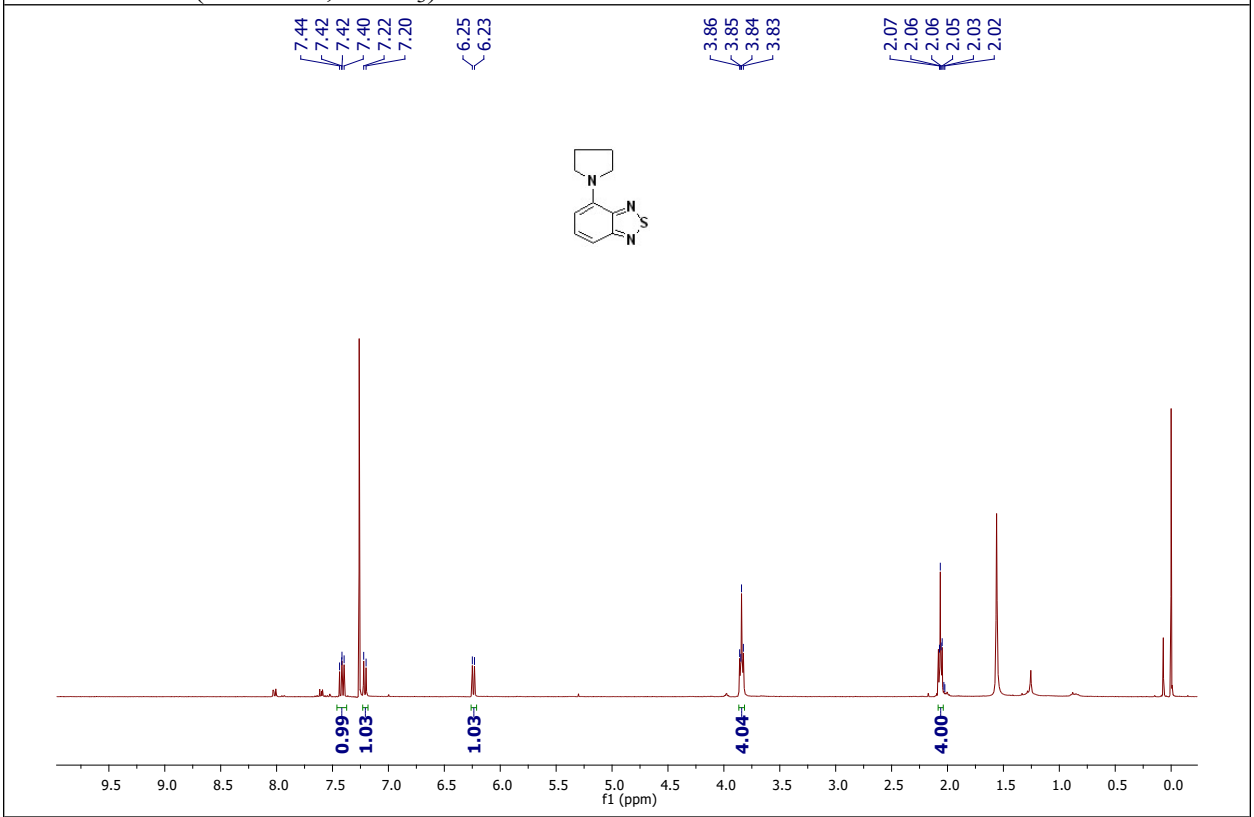
^{1}H NMR of **3e** (400 MHz, $CDCl_3$)



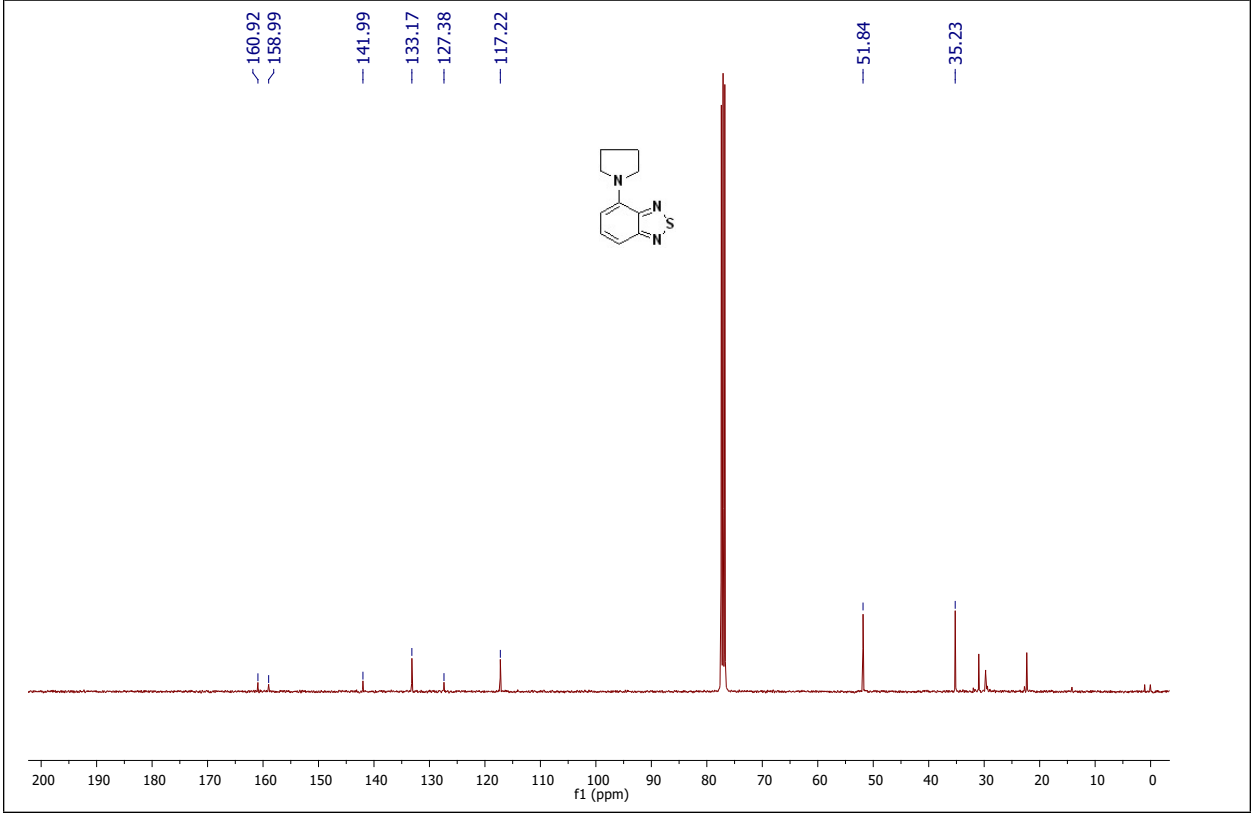
^{13}C NMR of **3e** (101 MHz, $CDCl_3$)



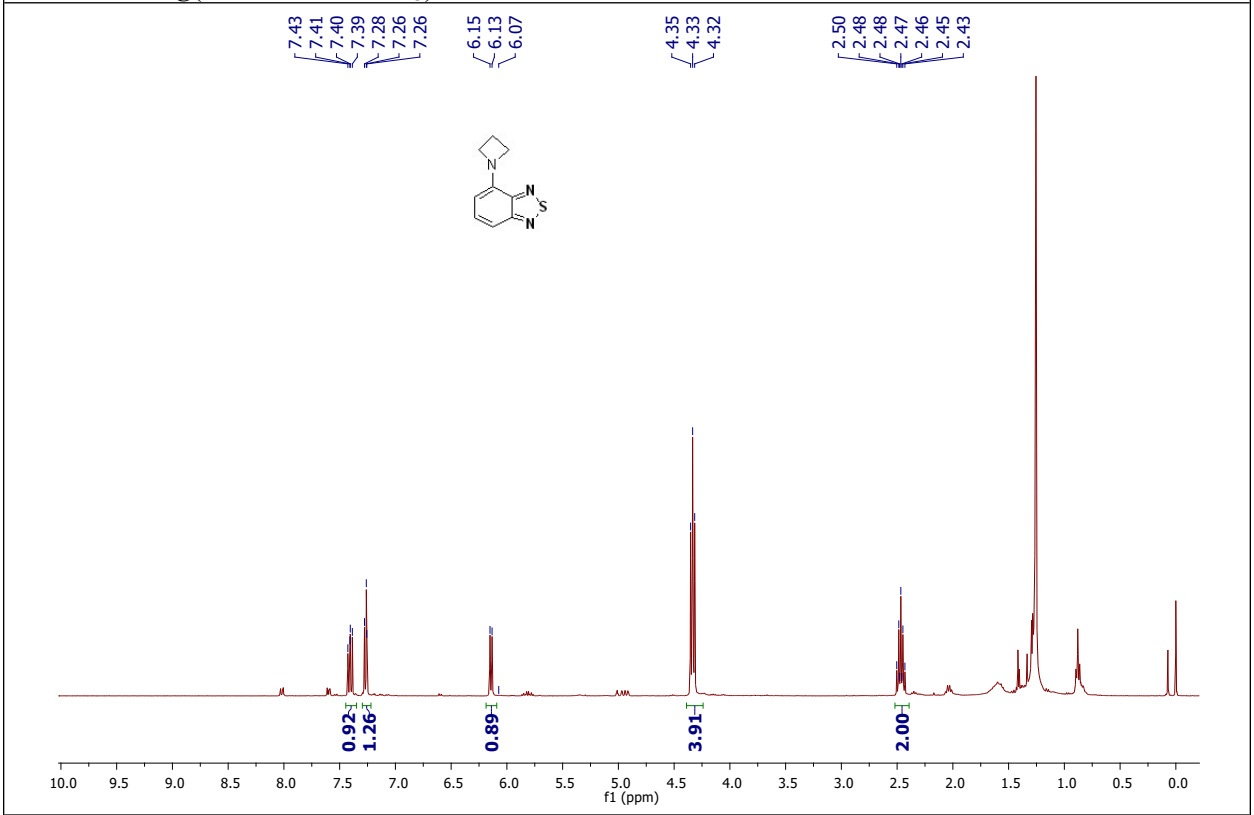
^{1}H NMR of **3f** (400 MHz, $CDCl_3$)



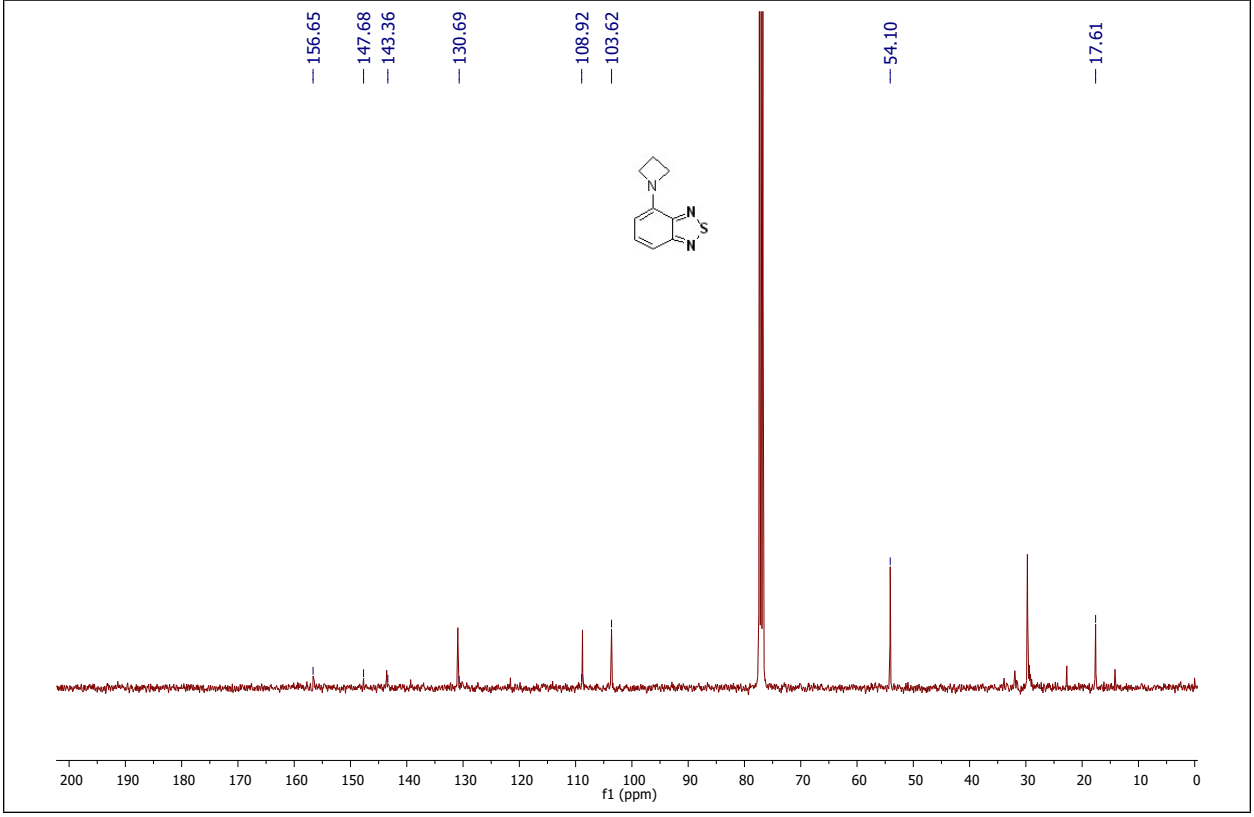
^{13}C NMR of **3f** (101 MHz, $CDCl_3$)



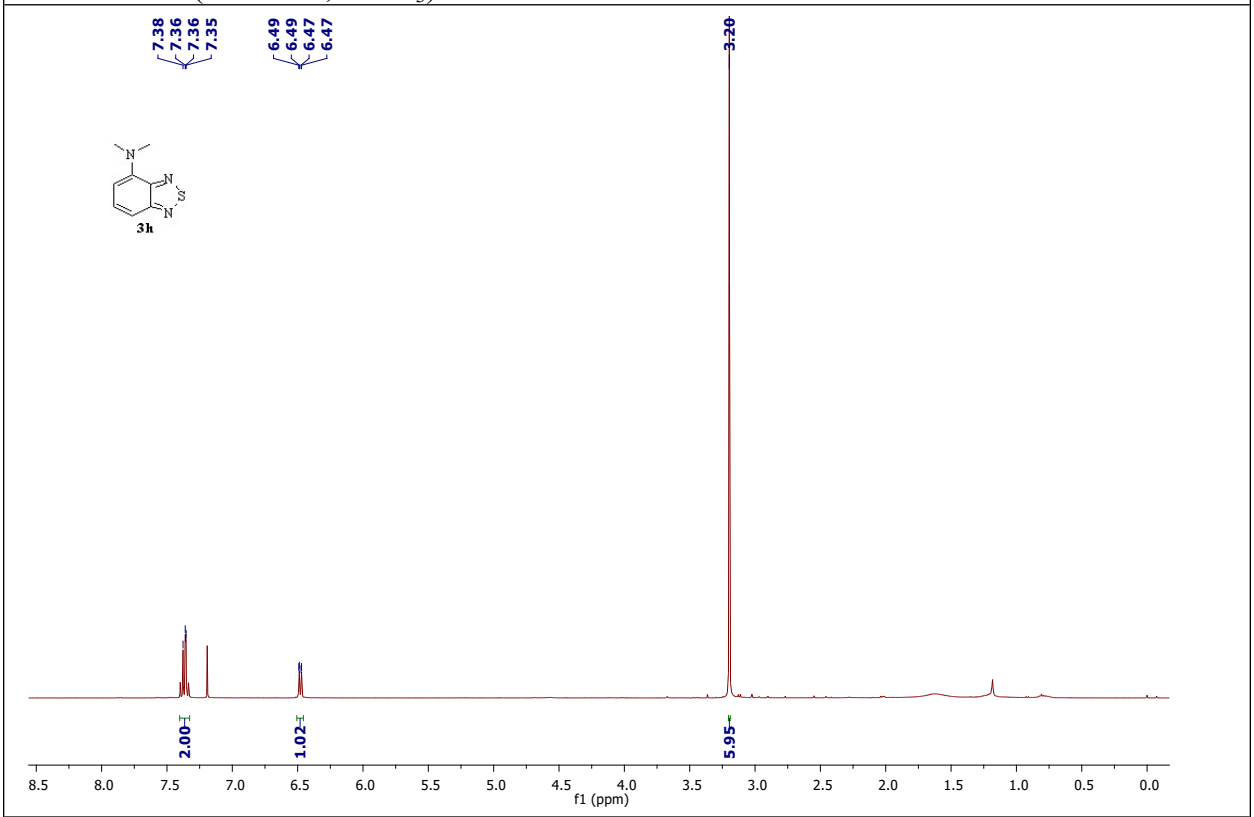
^{1}H NMR of **3g**(400 MHz, $CDCl_3$)



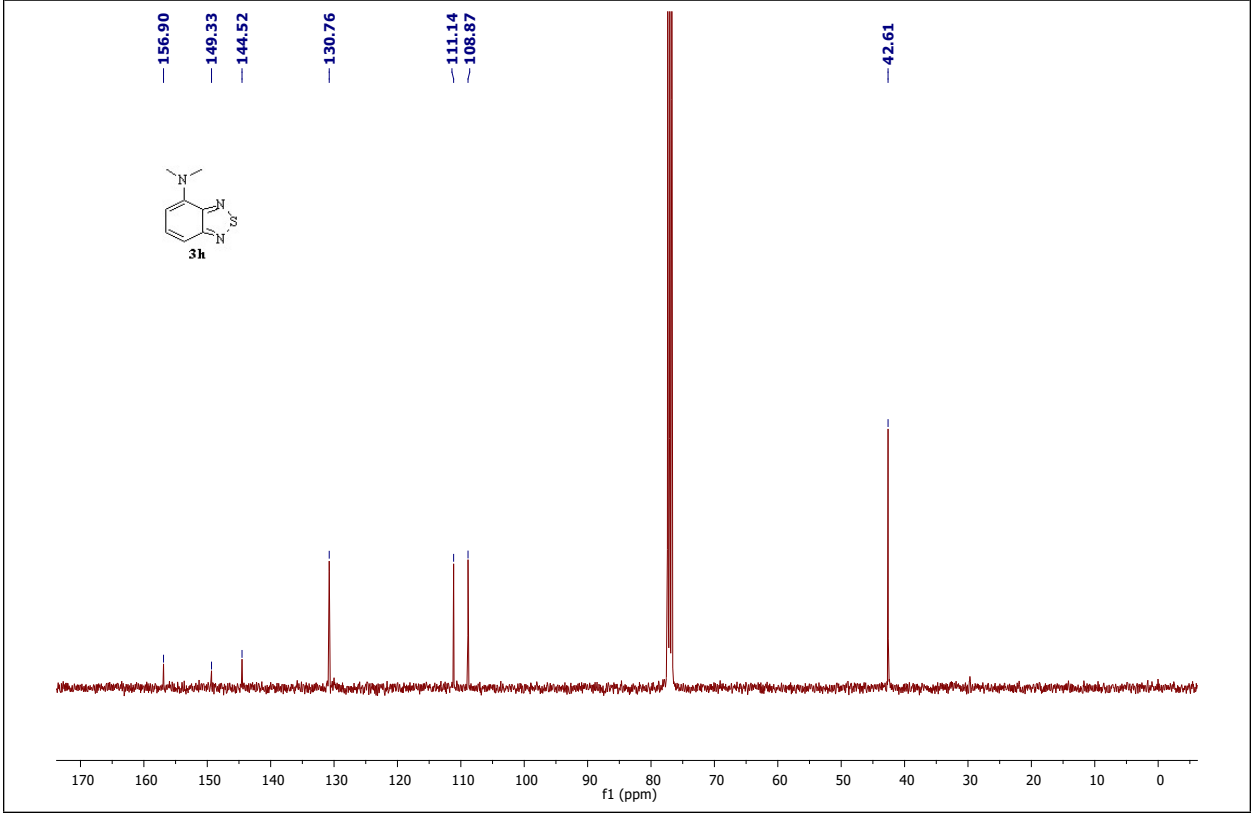
^{13}C NMR of **3g**(101 MHz, $CDCl_3$)



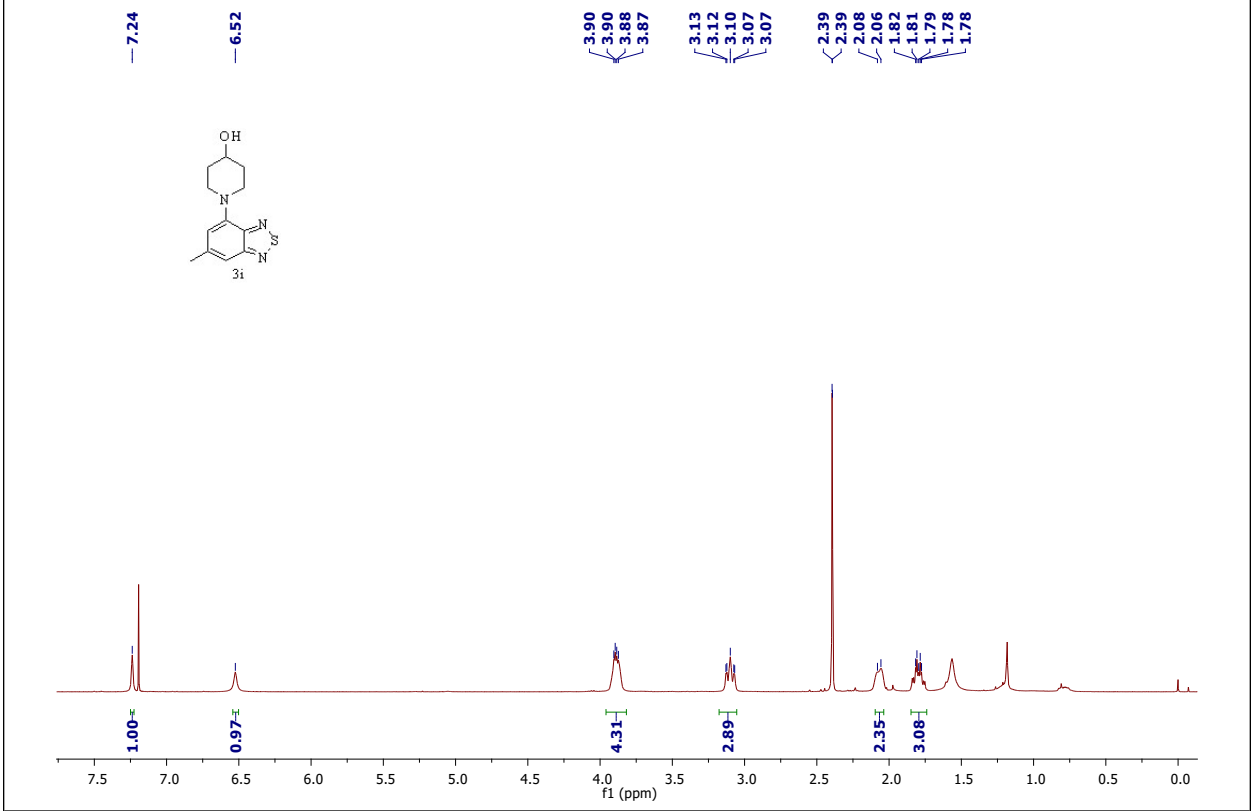
^{1}H NMR of **3h**(400 MHz, $CDCl_3$)



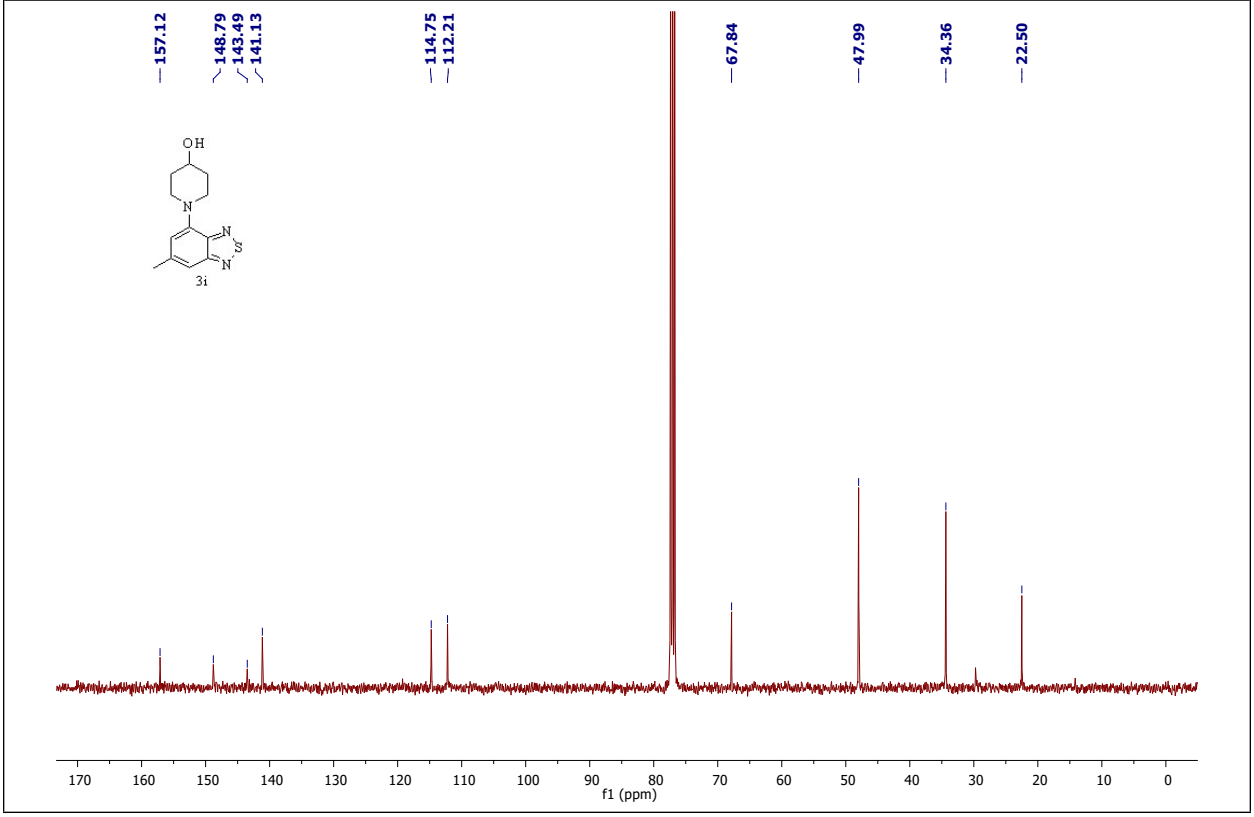
^{13}C NMR of **3h**(101 MHz, $CDCl_3$)



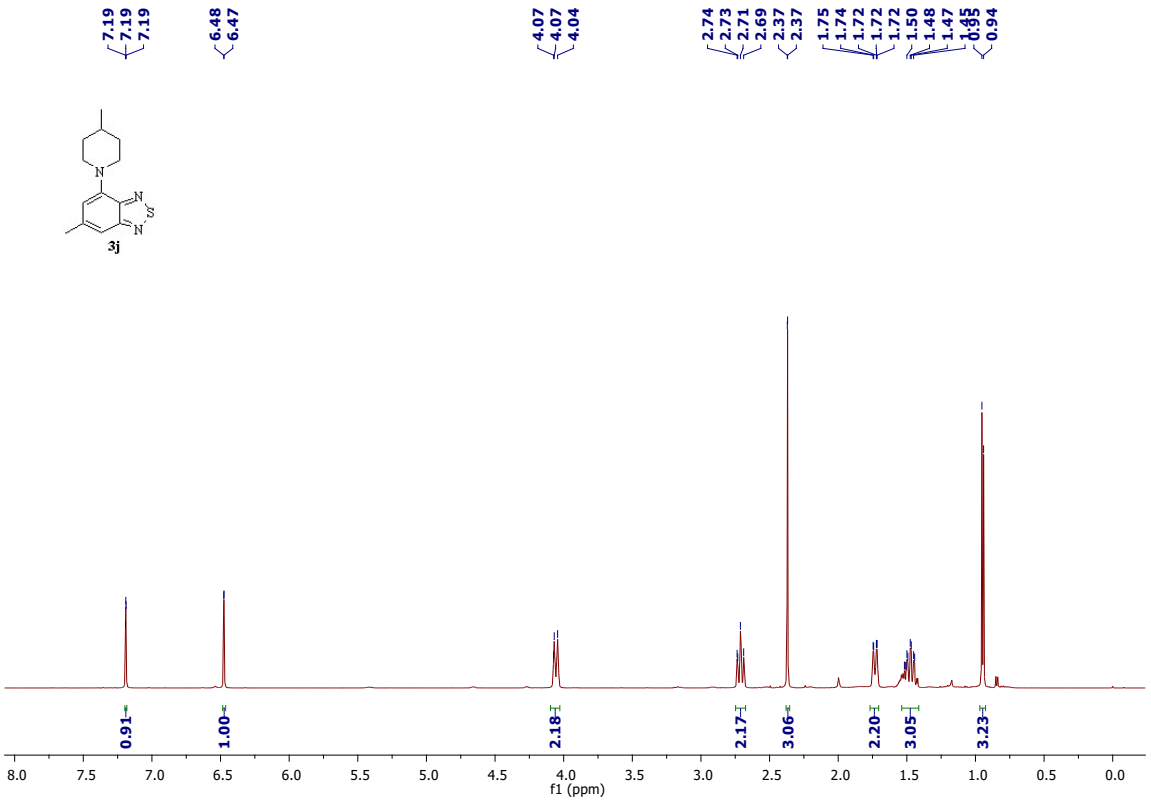
^{1}H NMR of **3i**(500 MHz, $CDCl_3$)



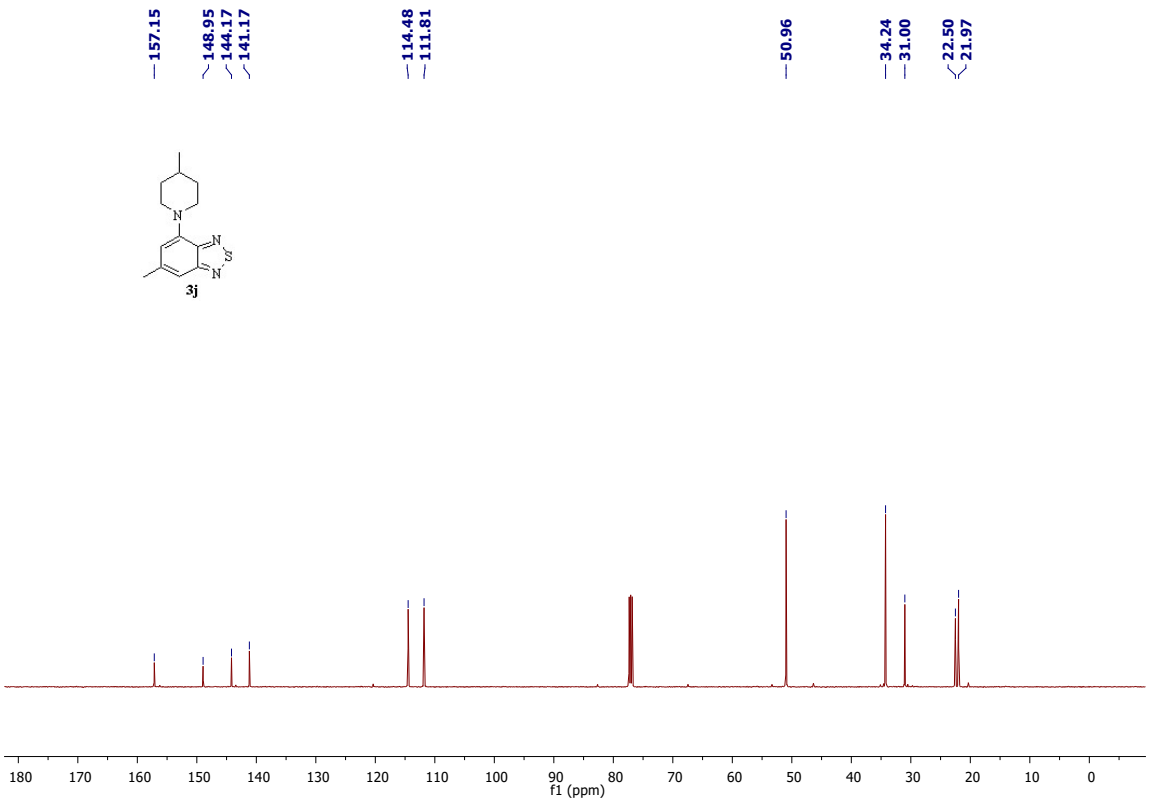
^{13}C NMR of **3i**(101 MHz, $CDCl_3$)



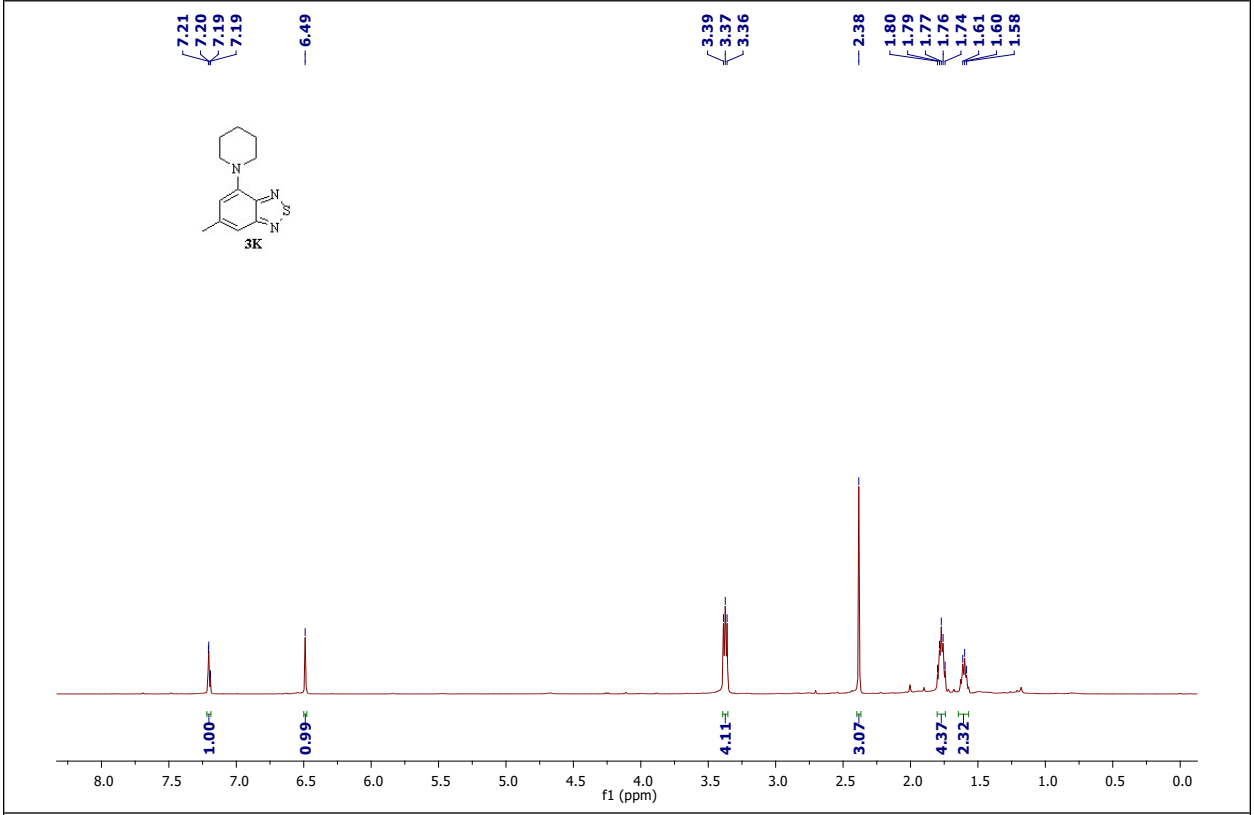
^{1}H NMR of **3j**(400 MHz, $CDCl_3$)



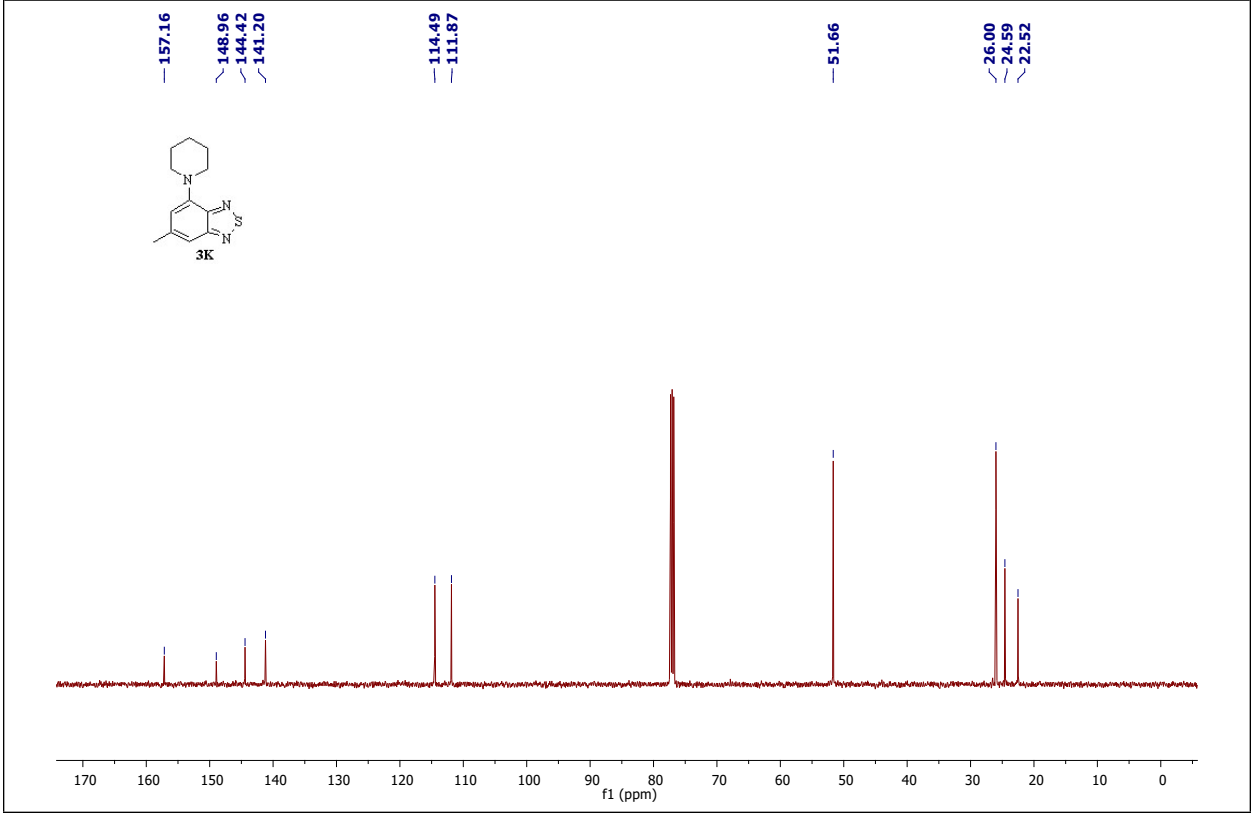
^{13}C NMR of **3j**(101 MHz, $CDCl_3$)



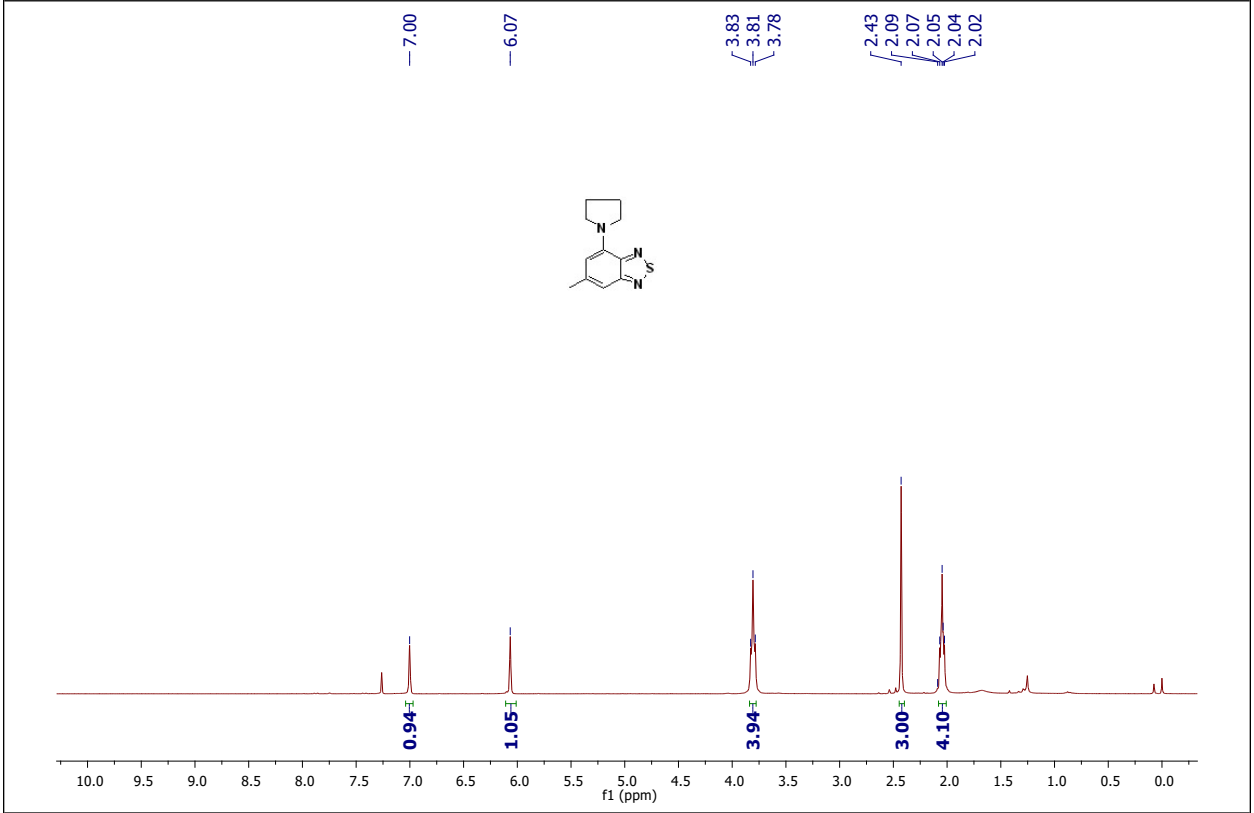
^{1}H NMR of **3k**(300 MHz, $CDCl_3$)



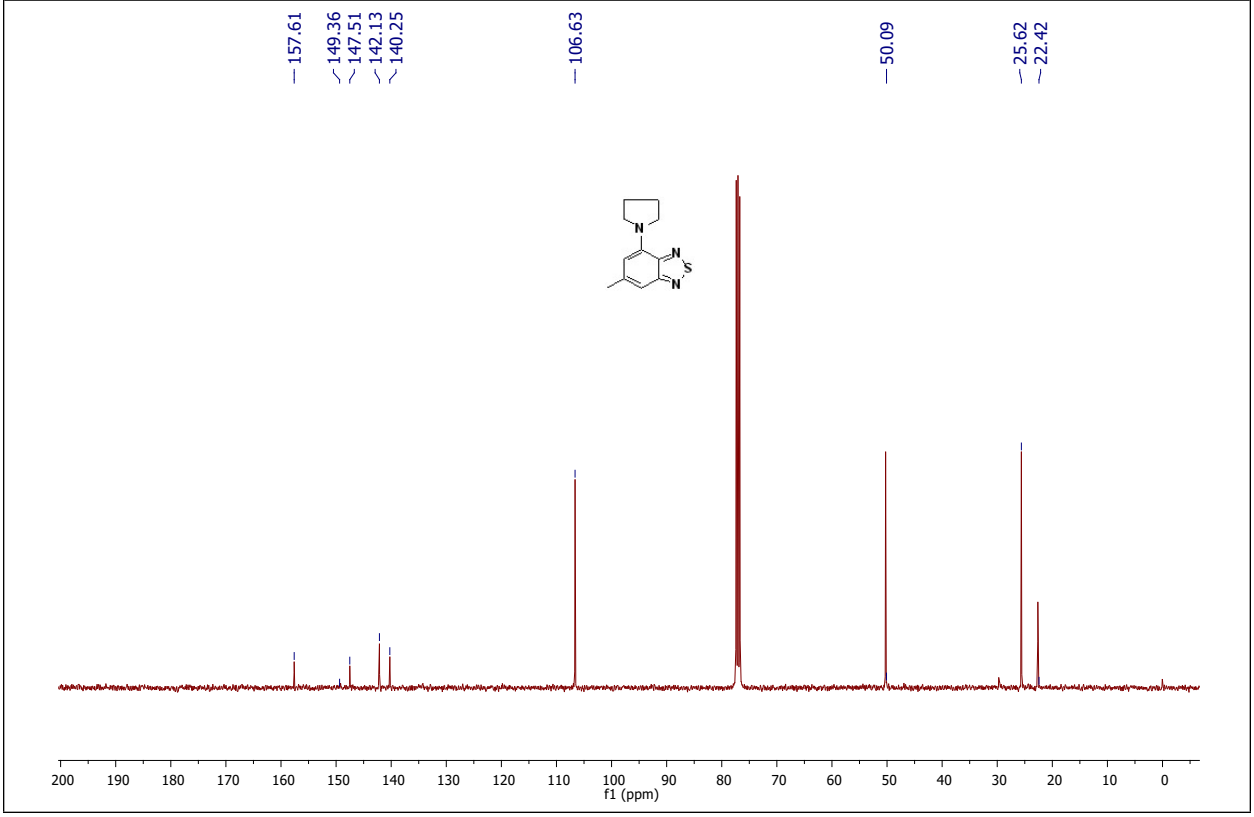
^{13}C NMR of **3k**(101 MHz, $CDCl_3$)



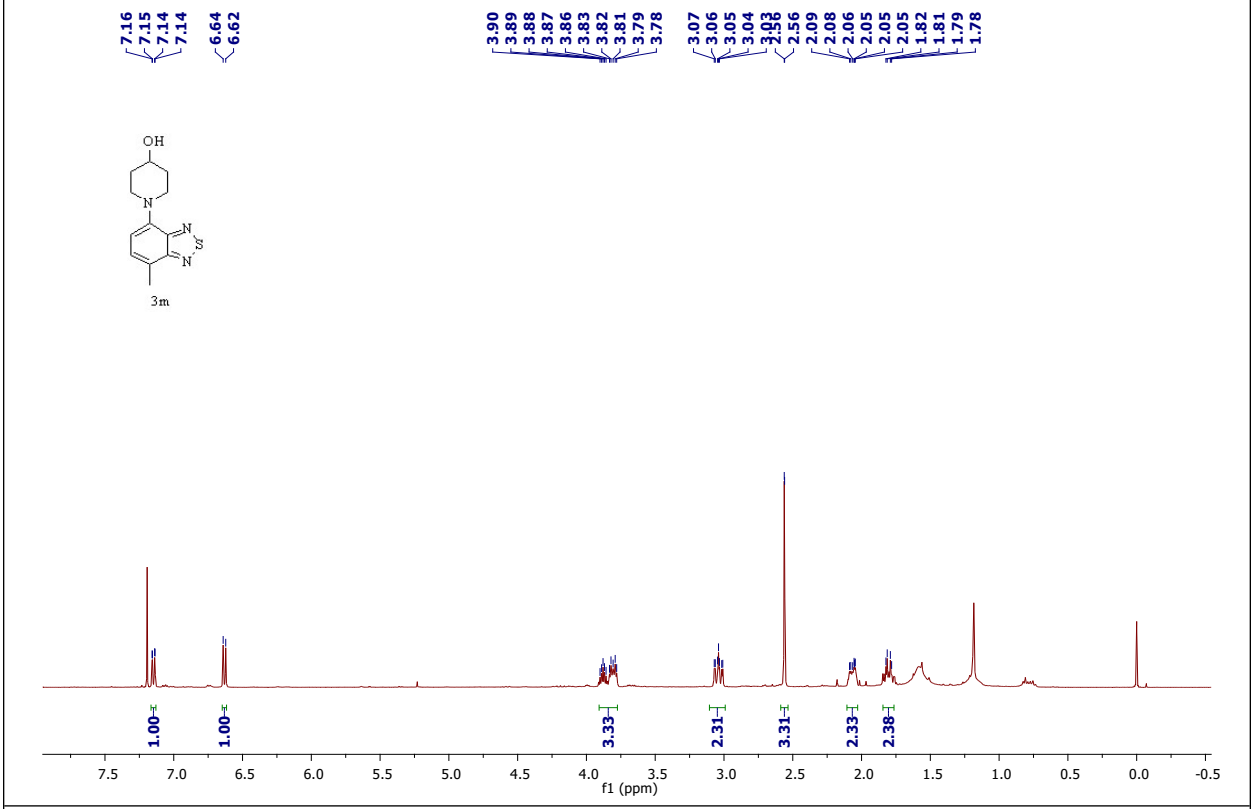
^{1}H NMR of **3l** (300 MHz, $CDCl_3$)



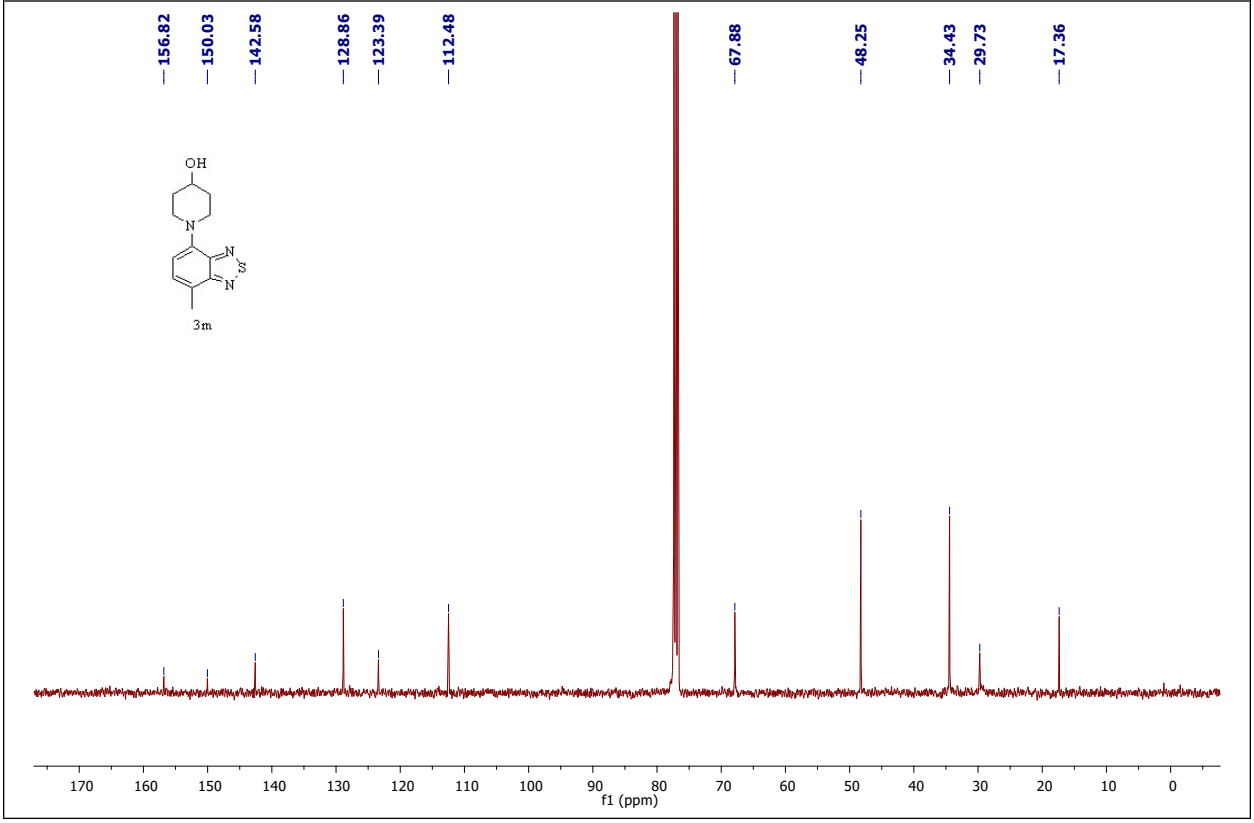
^{13}C NMR of **3l** (101 MHz, $CDCl_3$)



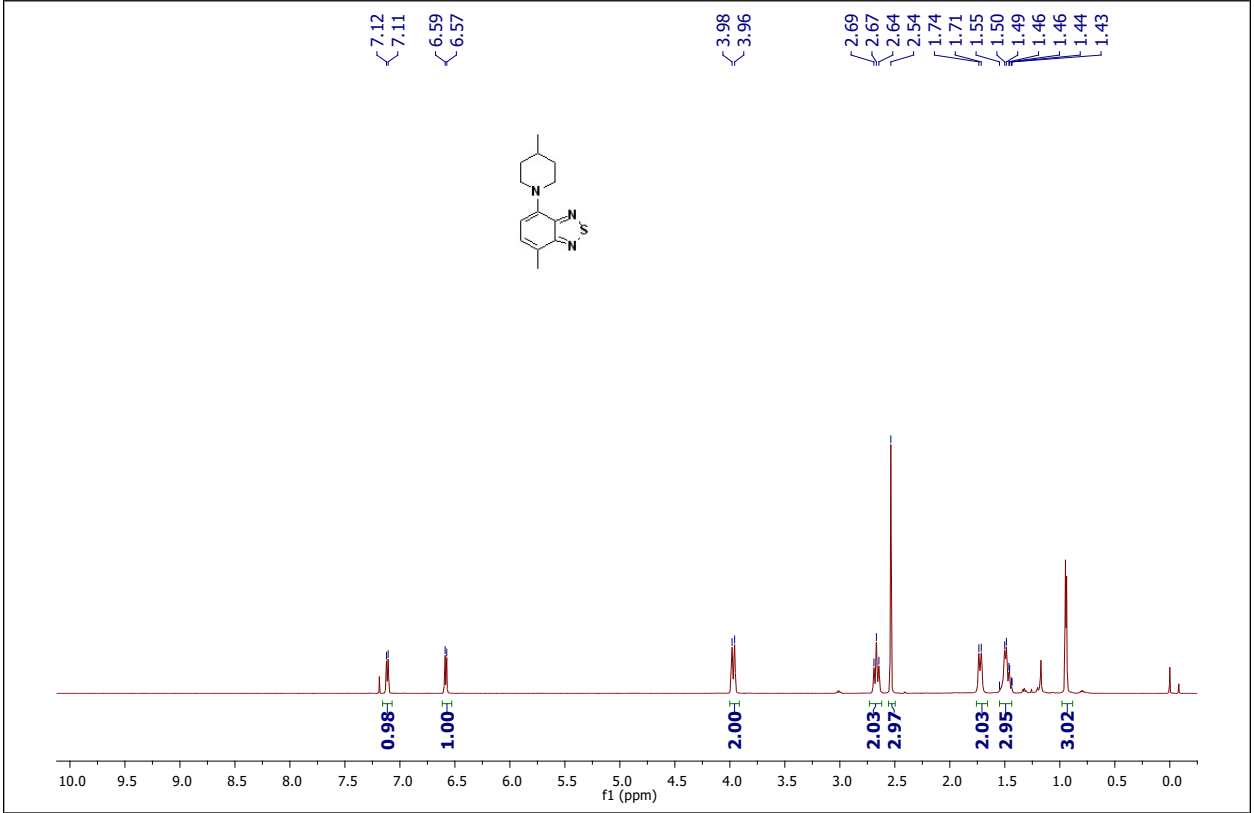
^{1}H NMR of **3m** (500 MHz, $CDCl_3$)



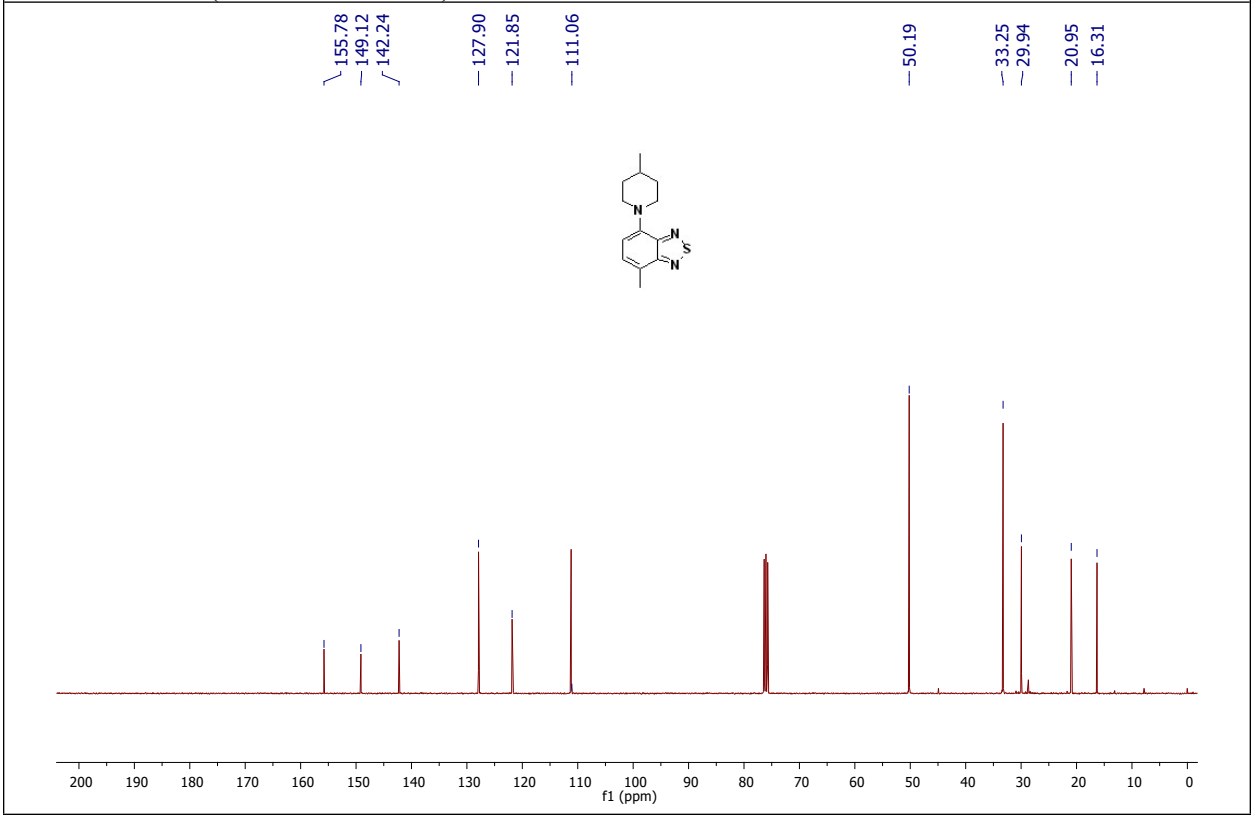
^{13}C NMR of **3m** (101 MHz, $CDCl_3$)



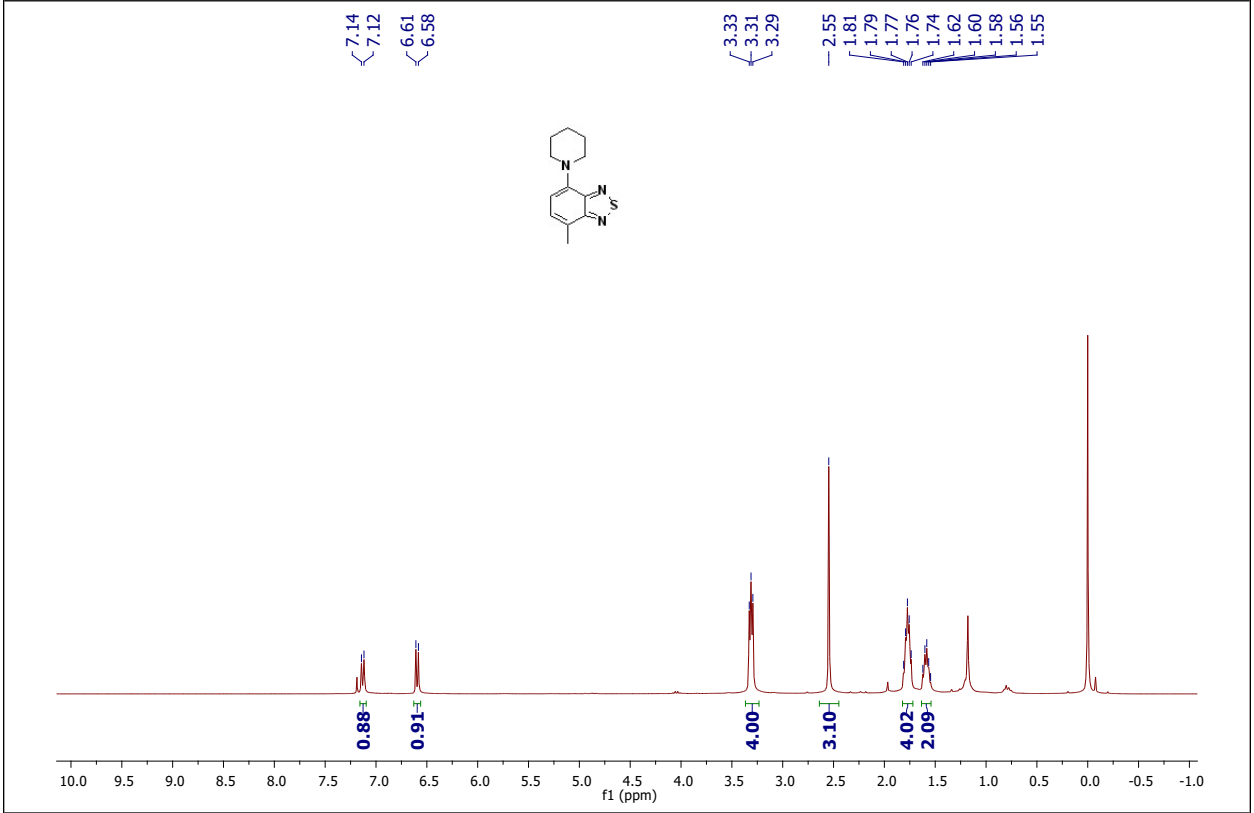
^{1}H NMR of **3n** (500 MHz, $CDCl_3$)



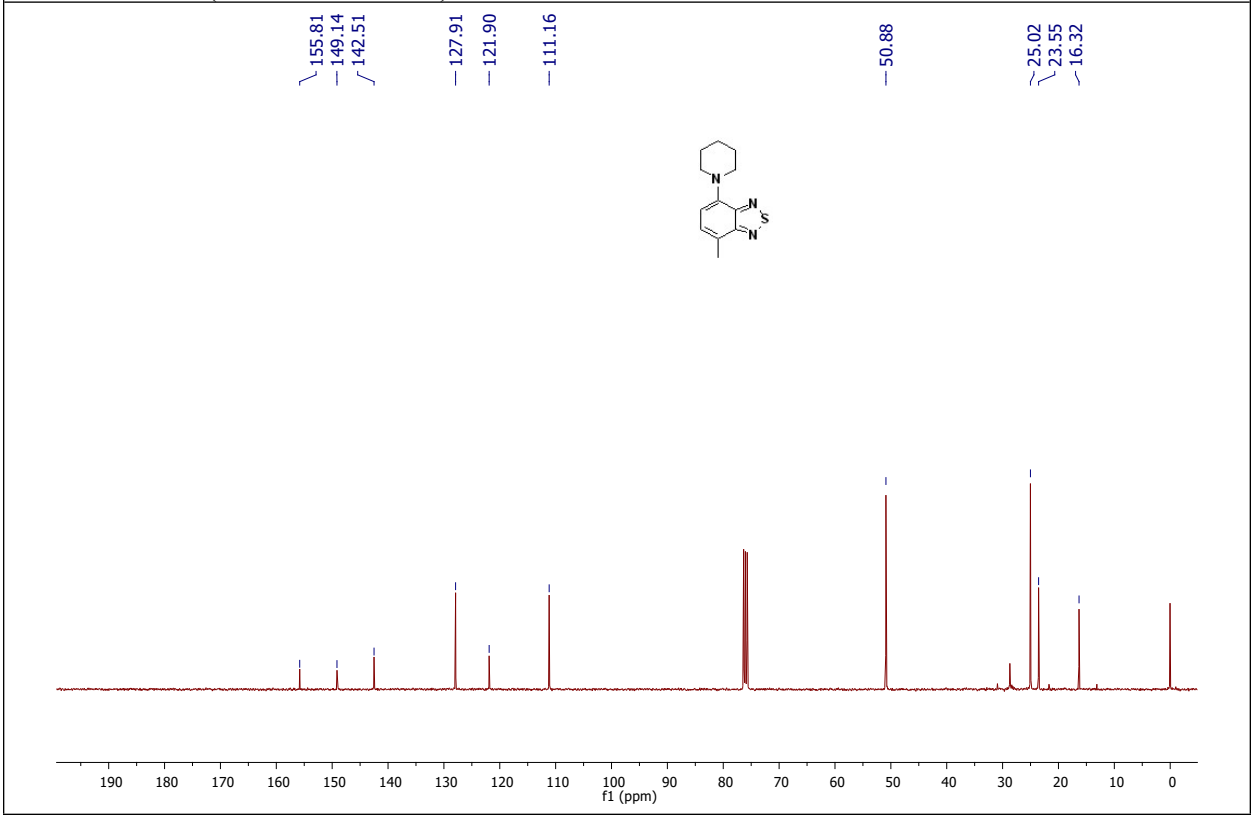
^{13}C NMR of **3n** (101 MHz, $CDCl_3$)



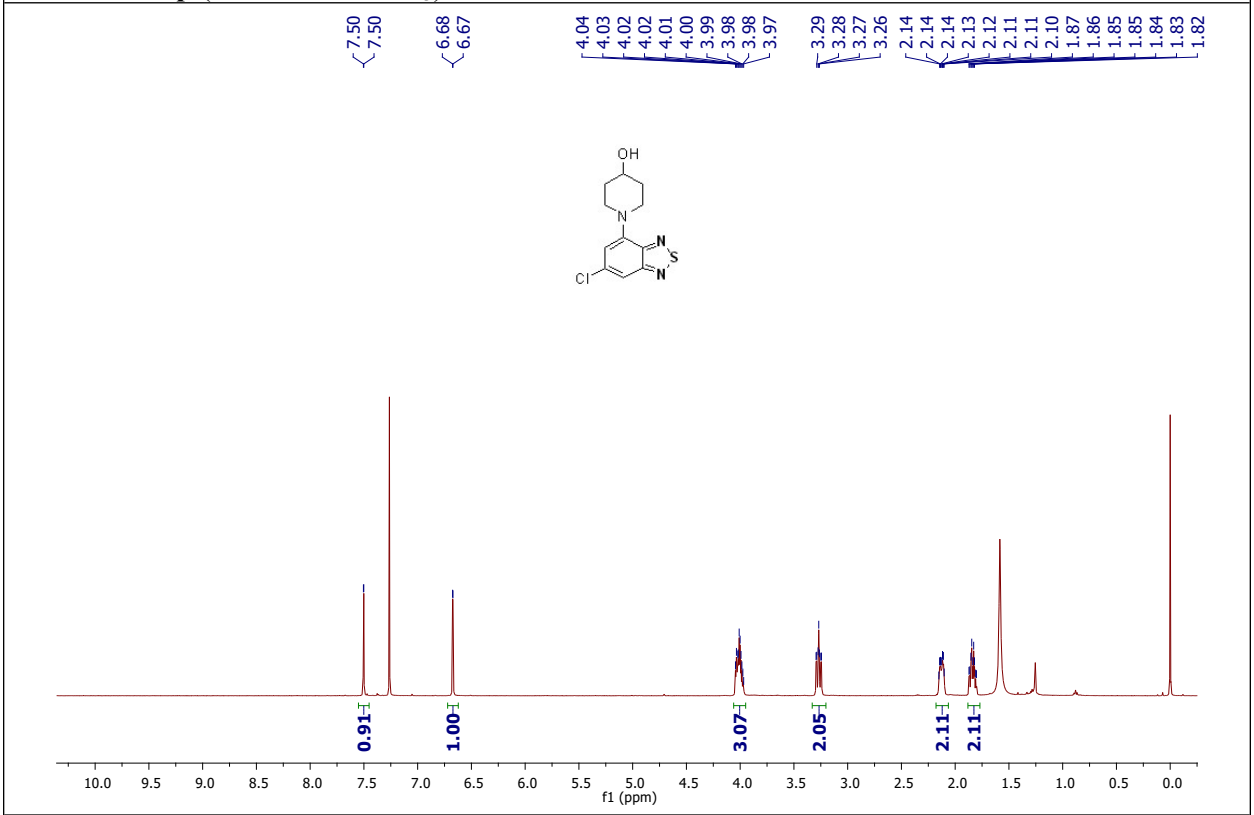
^{1}H NMR of **3o** (300 MHz, $CDCl_3$)



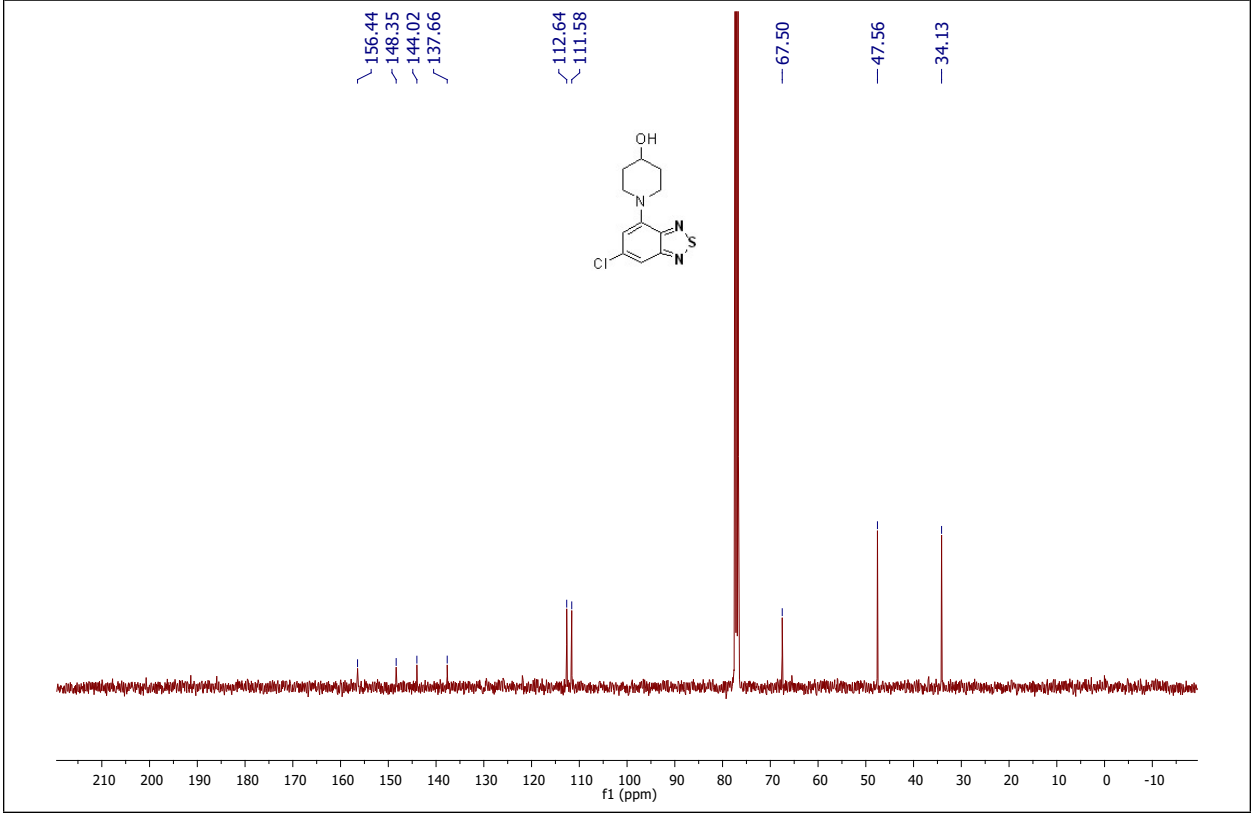
^{13}C NMR of **3o** (101 MHz, $CDCl_3$)



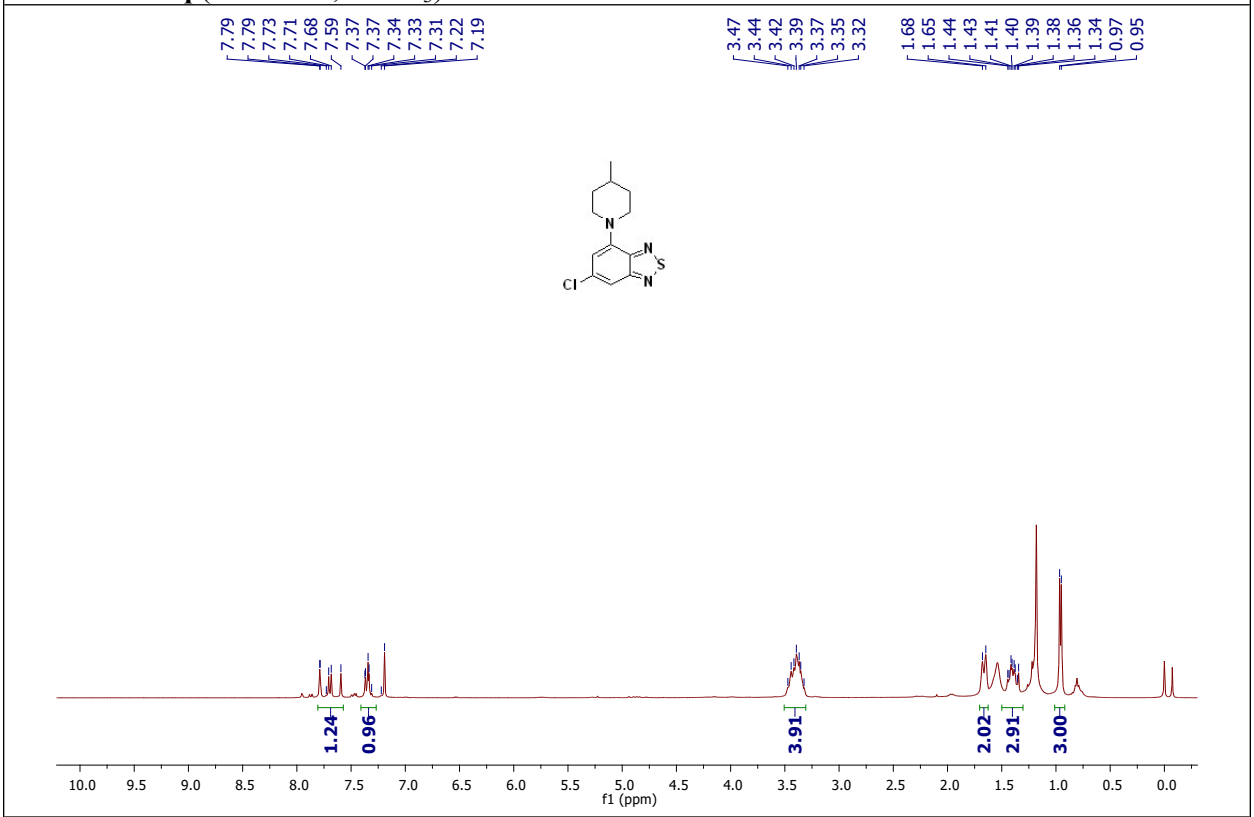
^{1}H NMR of **3p** (500 MHz, $CDCl_3$)



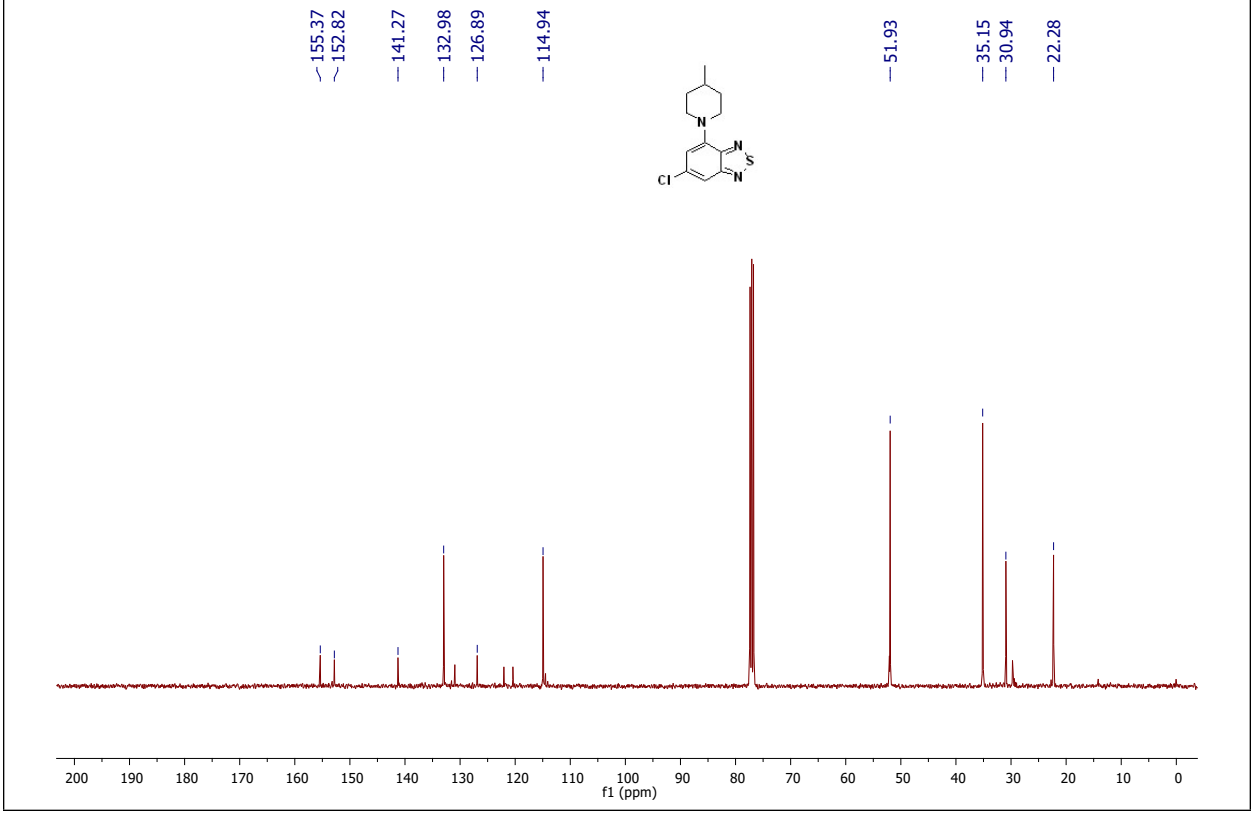
^{13}C NMR of **3p** (101 MHz, $CDCl_3$)



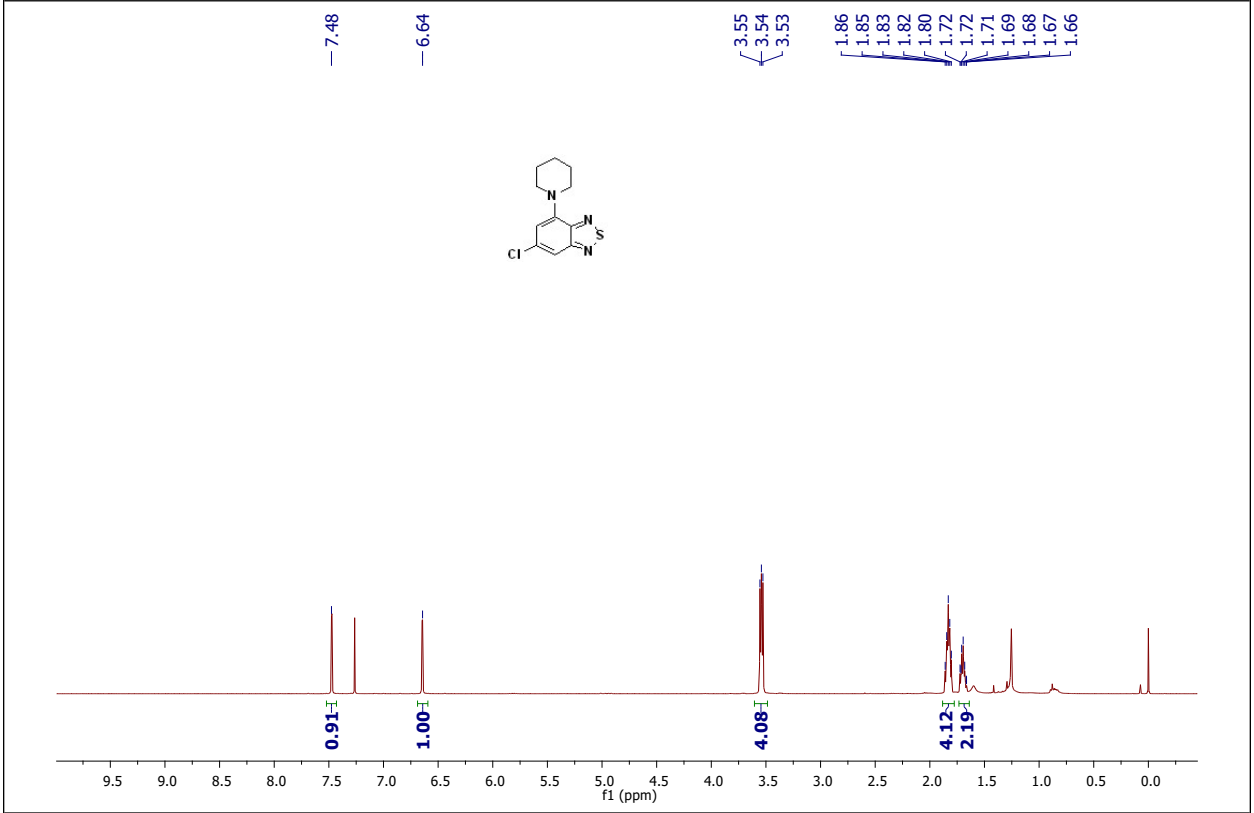
^{1}H NMR of **3q** (400 MHz, $CDCl_3$)



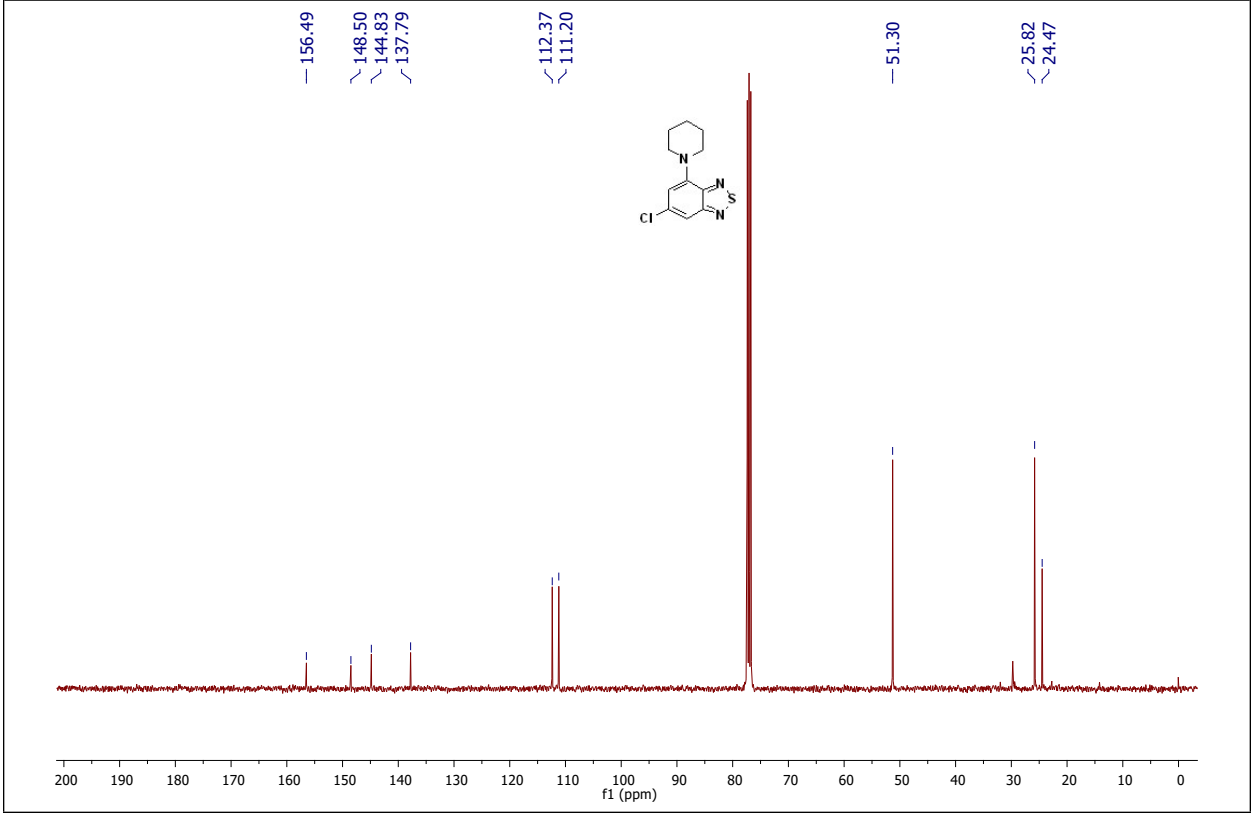
^{13}C NMR of **3q** (101 MHz, $CDCl_3$)



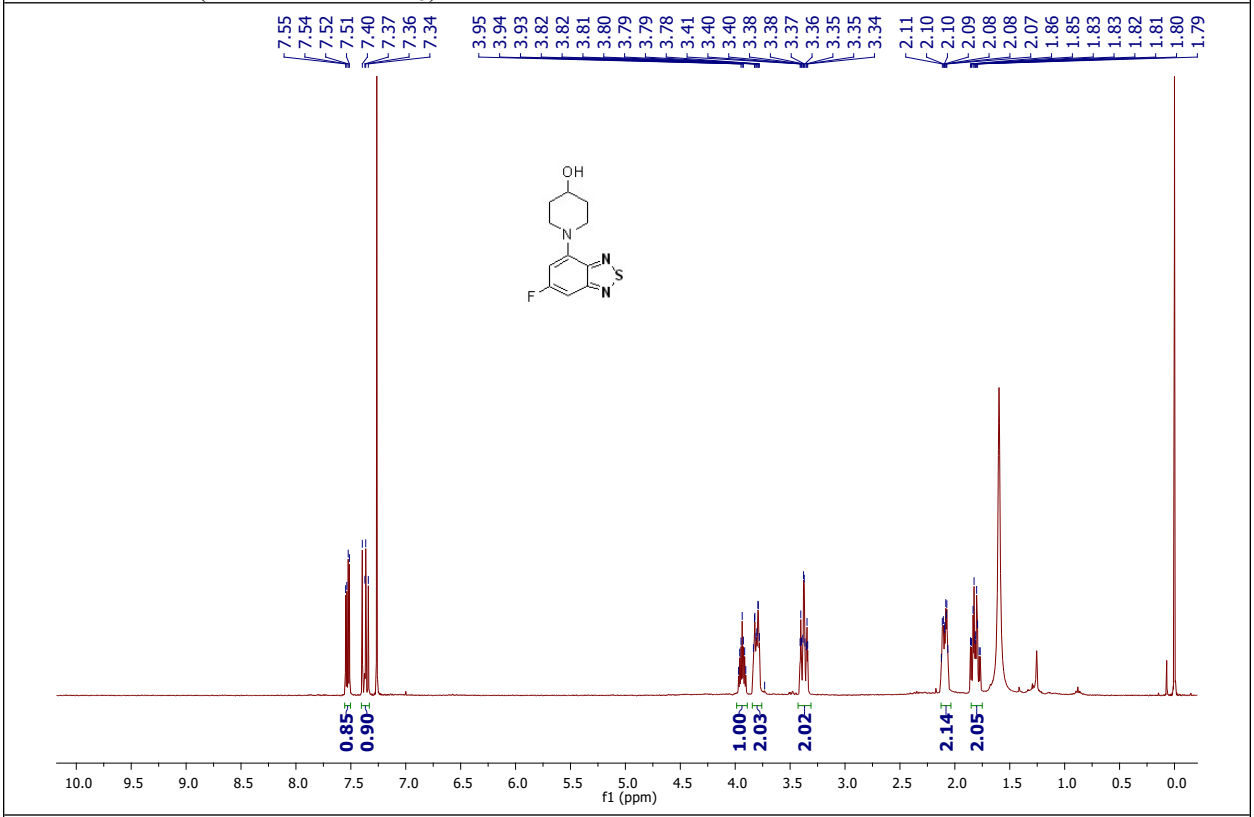
^{1}H NMR of **3r** (400 MHz, $CDCl_3$)



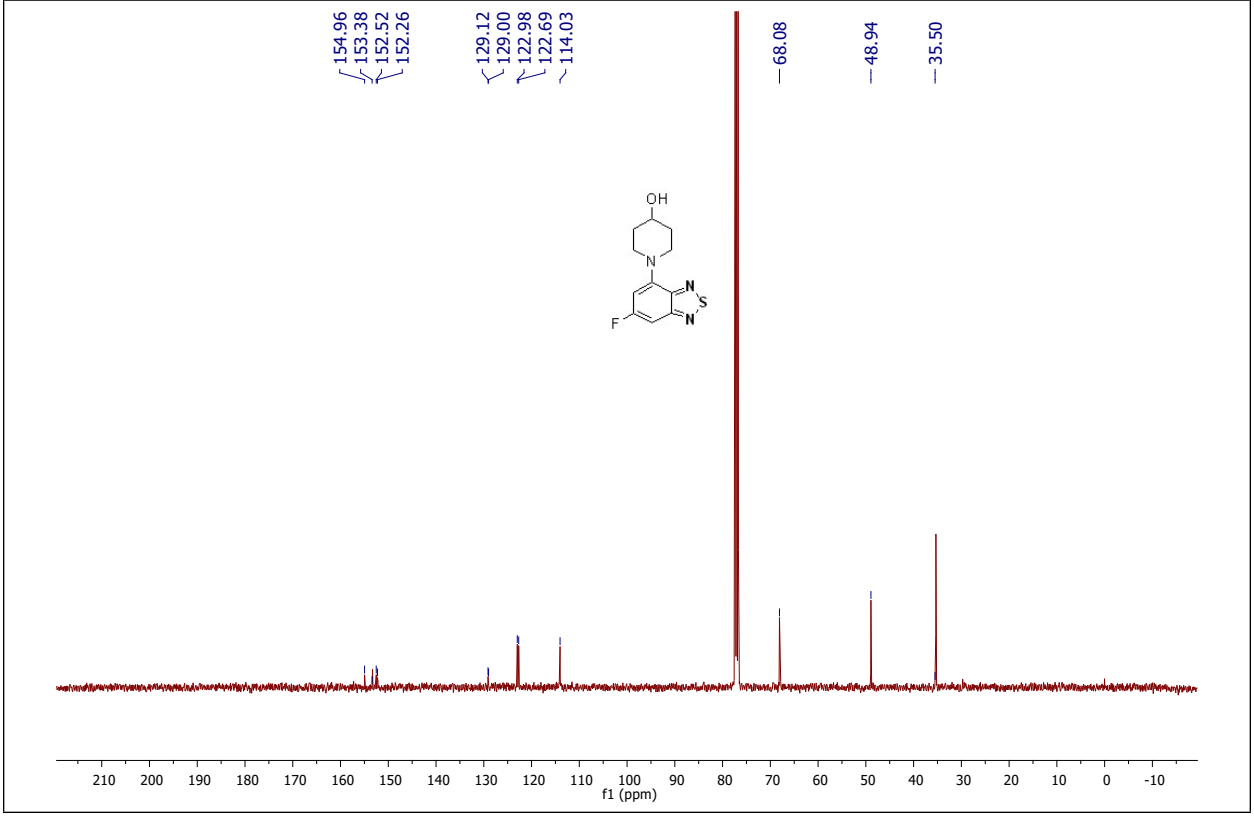
^{13}C NMR of **3r** (101 MHz, $CDCl_3$)



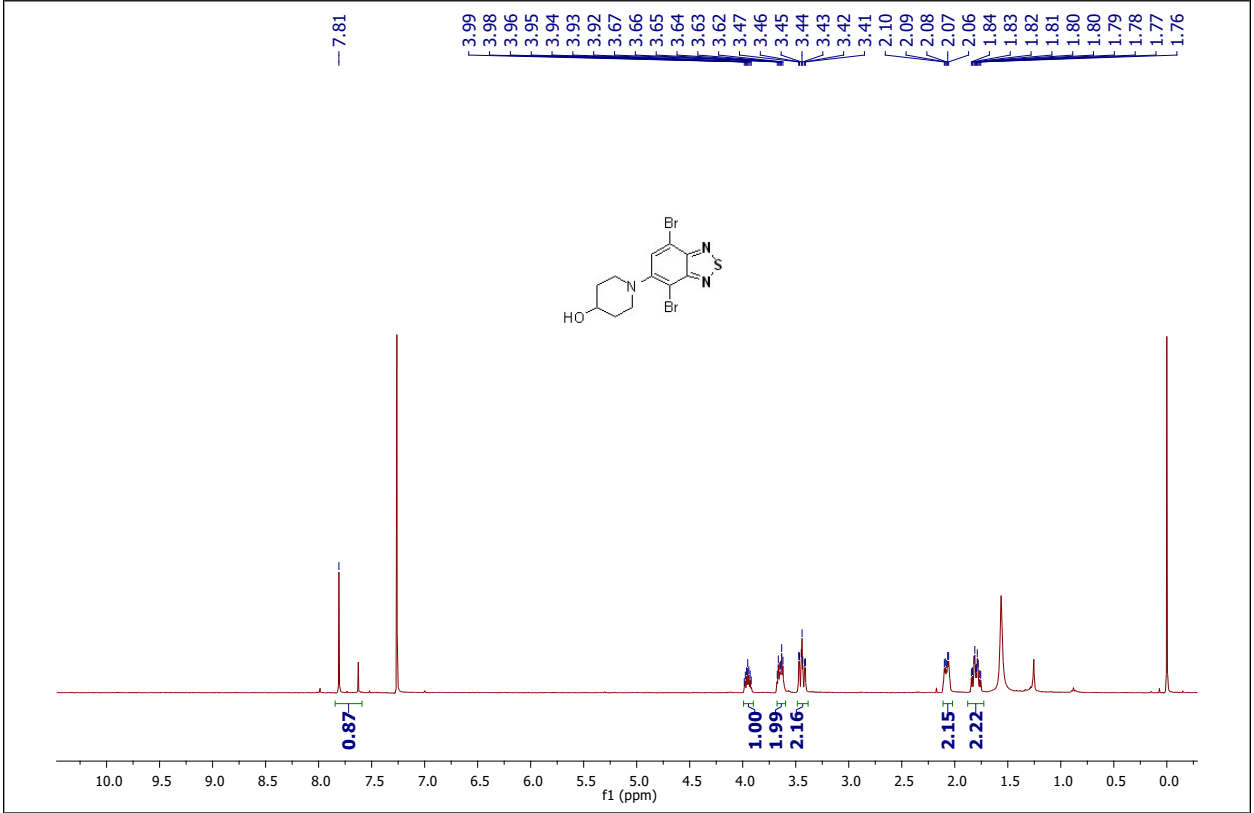
^{1}H NMR of **3s** (400 MHz, $CDCl_3$)



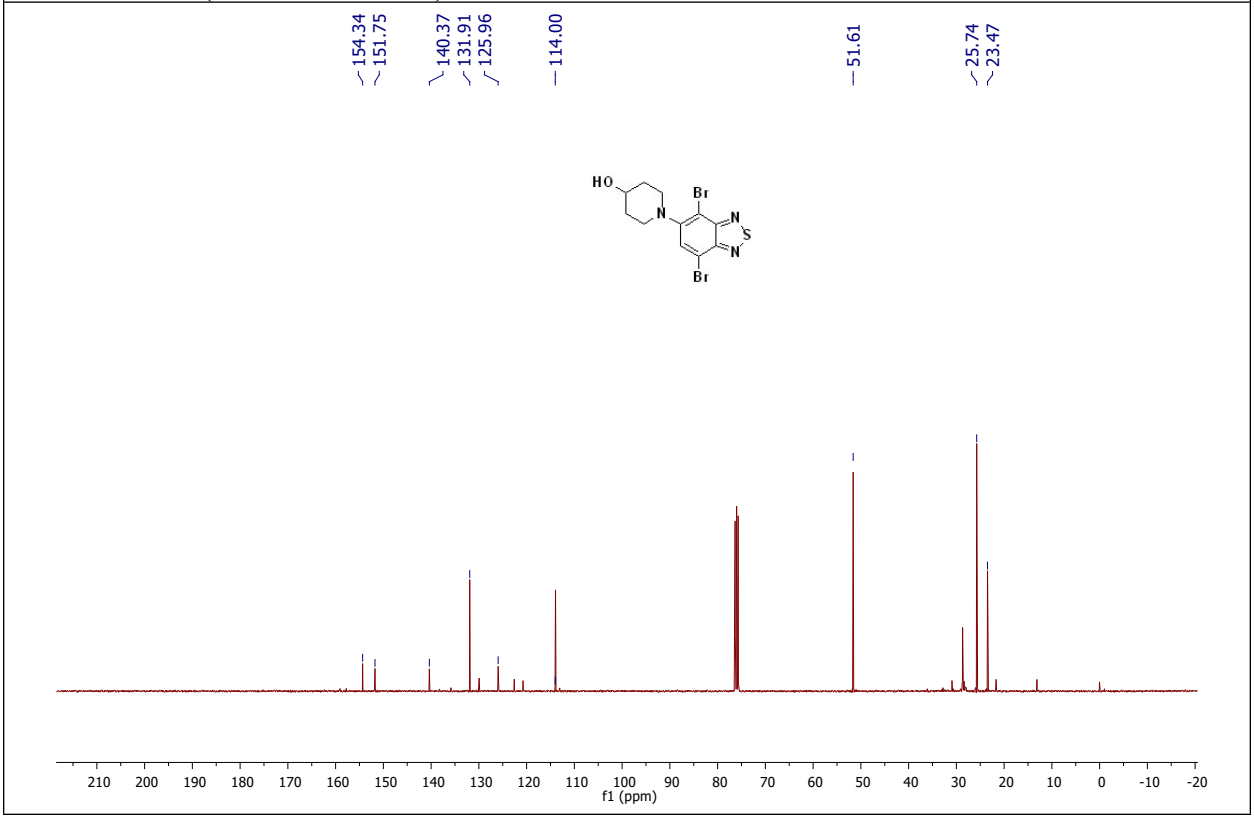
^{13}C NMR of **3s** (101 MHz, $CDCl_3$)



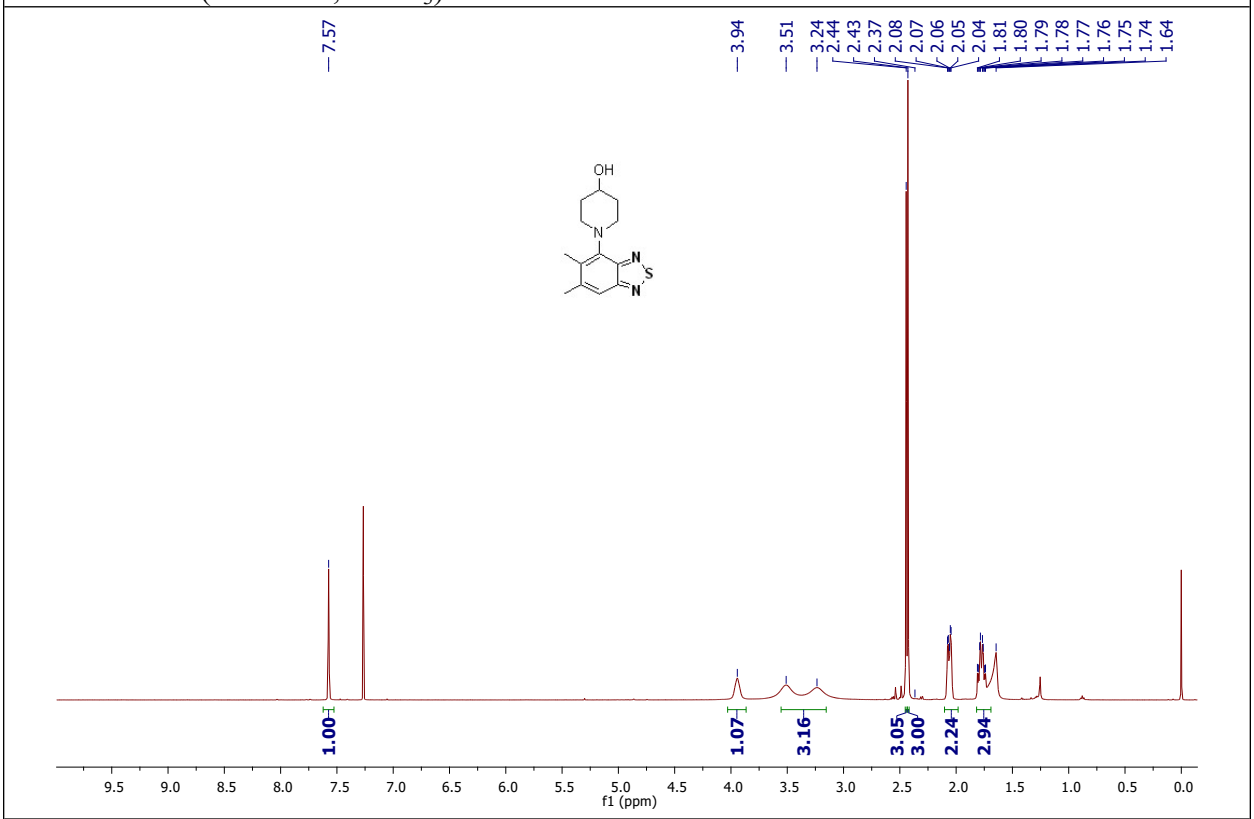
^{1}H NMR of **3t** (400 MHz, $CDCl_3$)



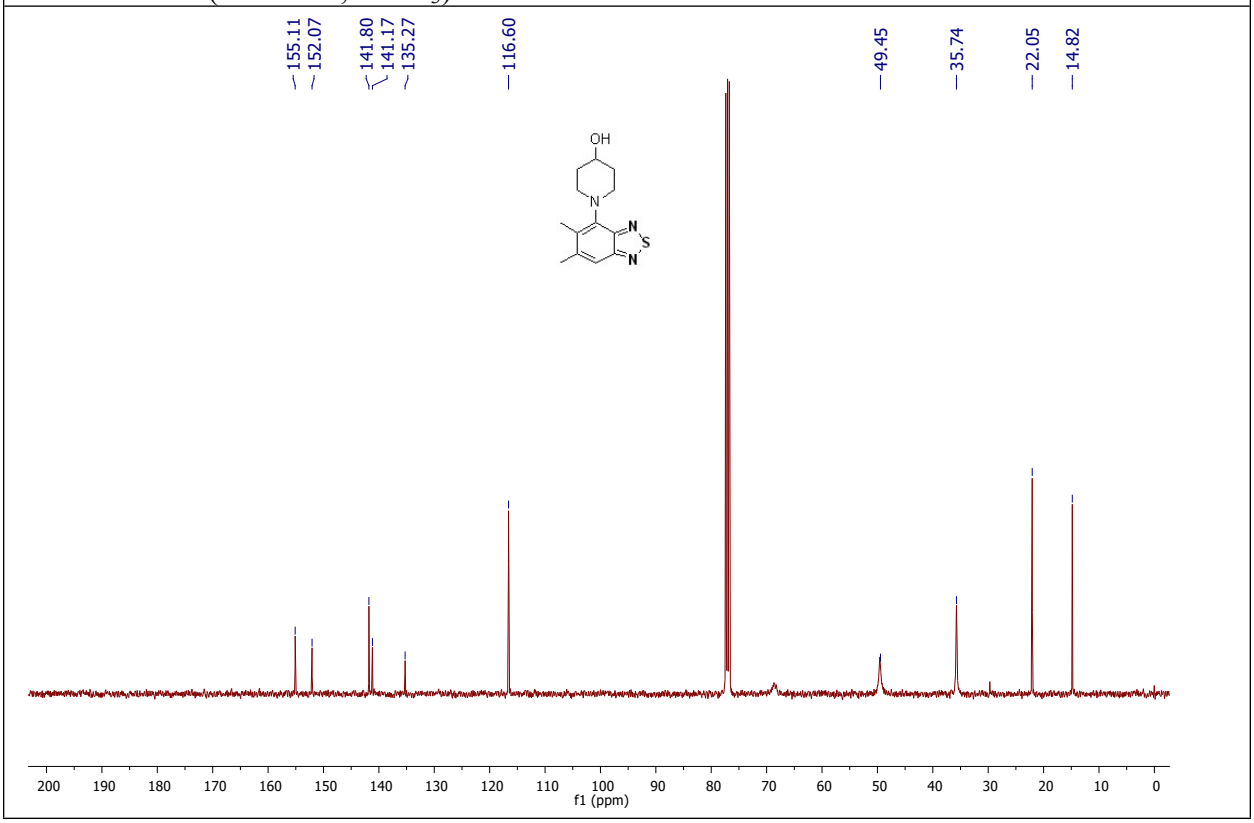
^{13}C NMR of **3t** (101 MHz, $CDCl_3$)



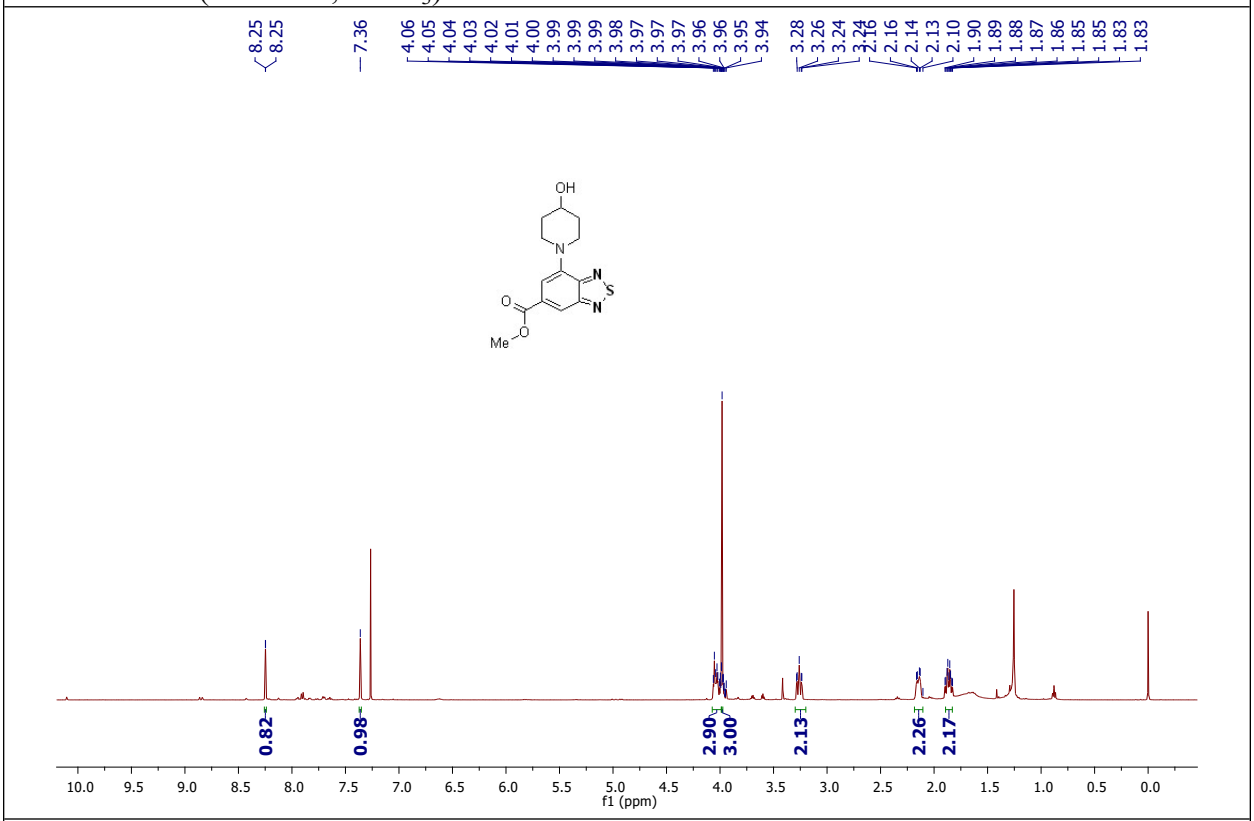
^{1}H NMR of **3u** (500 MHz, $CDCl_3$)



^{13}C NMR of **3u** (101 MHz, $CDCl_3$)



^{1}H NMR of **3v** (101 MHz, $CDCl_3$)



^{13}C NMR of **3v** (101 MHz, $CDCl_3$)