Electronic Supplementary Material (ESI) for Green Chemistry.

Supporting Information

Photoinduced Remote Heteroaryl Migration Accompanied by the Cyanoalkylacylation in Continuous Flow

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Table of Contents

1. General information details

All components as well as reagents and solvents were used as received without further purification, unless stated otherwise. Reagents and solvents were bought from J&K and Energy Chemical. ^{1}H NMR (400 Hz), ^{13}C NMR (100 Hz) and ^{19}F NMR (376 Hz) were measured on 400 M spectrometer. The chemical shifts are given in parts per million (ppm) on the delta (δ) scale. The solvent peak was used as a reference value, for ^{1}H NMR: $CDCl_3$ = 7.26 ppm, for ^{13}C NMR: $CDCl_3$ = 77.16 ppm. The following abbreviations were used to explain multiplicities: s = singlet, d = doublet, dd = doublet of doublet, t = triplet, q = quartet and m = multiple. High-resolution mass spectra (HRMS) were obtained on an Agilent mass spectrometer using ESI – TOF (electrospray ionization-time of flight). X – Ray crystallographic analysis was performed with a Siemens SMART CCD and a Siemens P4 diffractometer. Analytical TLC was performed on precoated silica gel plates using 254 nm UV light. Syringe pump and microreactor of flow system were manufactured by Baoding Leifu Fluid Technology Co. Ltd, (TYD01 – 01 – CE type). Coil was used commercially available PFA (perfluoroalkoxyalkane) tube with an inner diameter of 0.6 mm (2.8 mL). Light source was used 20 W blue LEDs (455 nm).

2. Reaction optimization

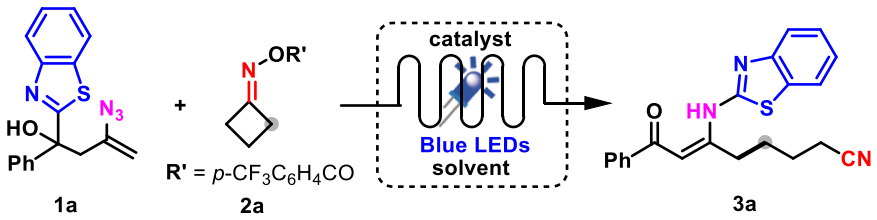


Table S1. The screening of solvents [a].

Entry	Solvent	Yield(%) [b]
1	CH_3CN	64
2	DCM	22
3	THF	16
4	DMF	55
5	DMA	60
6	1,4-dioxane	30
7	DCE	43
8	NMP	57
9	CH_3OH	14

10	EA	36
11	$CHCl_3$	*N.R.*
12	Acetone	52

[a] Standard conditions: **1a** (0.2 mmol, 1.0 eq.), **2a** (0.4 mmol, 2.0 eq.), *fac*-Ir(ppy)$_3$ (2.0 mol%), Et_3N (0.4 mmol, 2.0 eq.), solvent 2.0 mL, flow rate (300 μL/min), residence time: 9.3 min, single pump injection. [b] Isolated yield based on **1a**.

Table S2. The screening of bases [a].

Entry	Base	Yield(%) [b]
1	Pyridine	23
2	DIPEA	3
3	DBU	*Trace*
4	TMEDA	26
5	2,6-Dimethylpyridine	6
6	2,4,6-Trimethylpyridine	6
7	DMAP	14
8	DABCO	12
9	Et_2NH	55

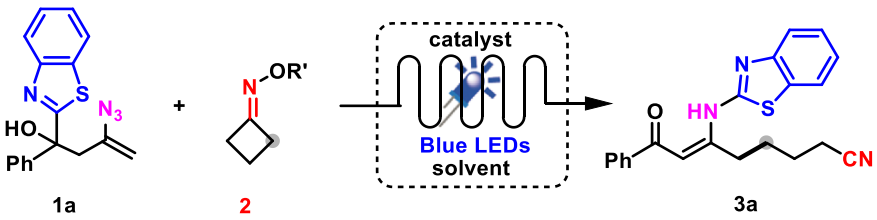
[a] Standard conditions: **1a** (0.2 mmol, 1.0 eq.), **2a** (0.4 mmol, 2.0 eq.), *fac*-Ir(ppy)$_3$ (2.0 mol%), base (0.4 mmol, 2.0 eq.), solvent of CH_3CN 2.0 mL, flow rate (300 μL/min), residence time: 9.3 min, single pump injection. [b] Isolated yield based on **1a**.

Table S3. The screening of catalysts [a].

Entry	Catalyst	Yield(%) [b]
1	4CzIPN	9
2	$Ir[dF(CF_3)ppy]_2(dtbbpy)PF_6$	*N.R.*
3	$Ir[dFCF_3ppy]_2(bpy)PF_6$	*N.R.*
4	$[Ir(ppy)_2(bpy)]PF_6$	*N.R.*
5	10-Methyl-9-phenylacridin-10-ium	*N.R.*
6	10-Methyl-9-(2,4,6-trimethylphenyl)acridin-10-ium	*Trace*
7	Eosin Y	*Trace*
8	$Ir(dFppy)_3$	*N.R.*

[a] Standard conditions: **1a** (0.2 mmol, 1.0 eq.), **2a** (0.4 mmol, 2.0 eq.), catalyst (2.0 mol%), Et_3N (0.4 mmol, 2.0 eq.), solvent of CH_3CN 2.0 mL, flow rate (300 μL/min), residence time: 9.3 min, single pump injection. [b] Isolated yield based on **1a**

Table S4. The screening of protecting group [a].



Entry	Protecting group	Yield(%) [b]
1	R' = PhCO	7
2	R' = *p*-NO_2PhCO	Trace
3	R' = *p*-OMePhCO	*N.R.*
4	R' = C_6F_5CO	42

[a] Standard conditions: **1a** (0.2 mmol, 1.0 eq.), **2** (0.4 mmol, 2.0 eq.), *fac*-Ir(ppy)$_3$ (2.0 mol%), Et_3N (0.4 mmol, 2.0 eq.), solvent of CH_3CN 2.0 mL, flow rate (300 μL/min), residence time: 9.3 min, single pump injection. [b] Isolated yield based on **1a**.

Table S5. The screening of mixed solvent [a].

Entry	Condition	Yield(%) [b]
1	CH_3CN : DMSO (v/v = 1 : 1)	60
2	CH_3CN : DMA (v/v = 1 : 1)	68
3	CH_3CN : DMF (v/v = 1 : 1)	69
4	CH_3CN : DMF (v/v = 3 : 1)	70
5	CH_3CN : DMF (v/v = 7 : 1)	85
6	CH_3CN : DMF (v/v = 9 : 1)	78
7	CH_3CN : DMA (v/v = 7 : 1)	80

[a] Standard conditions: **1a** (0.2 mmol, 1.0 eq.), **2** (0.4 mmol, 2.0 eq.), *fac*-Ir(ppy)$_3$ (2.0 mol%), Et_3N (0.4 mmol, 2.0 eq.), solvent 2.0 mL, flow rate (300 μL/min), residence time: 9.3 min, single pump injection. [b] Isolated yield based on **1a**.

Table S6. The screening of other conditions [a].

Entry	Condition	Yield(%) [b]
1 [c]	double pump injection	61
2	without base	20
3	without light	*N.R.*
4	without catalyst	*N.R.*
5	flow rate (200 μL/min)	70
6	flow rate (500 μL/min)	75

[a] Standard conditions: **1a** (0.2 mmol, 1.0 eq.), **2a** (0.4 mmol, 2.0 eq.), *fac*-Ir(ppy)$_3$ (2.0 mol%), Et_3N (0.4 mmol, 2.0 eq.), solvent 2.0 mL, flow rate (300 μL/min), residence time: 9.3 min, single pump injection. [b] Isolated yield based on **1a**. [c]Two pump system: pump 1 (**1a** and catalyst in 1.0 mL CH_3CN), flow rate (150 μL/min); pump 2 (**2a** and base in 1.0 mL CH_3CN), flow rate (150 μL/min), residence time: 9.3 min.

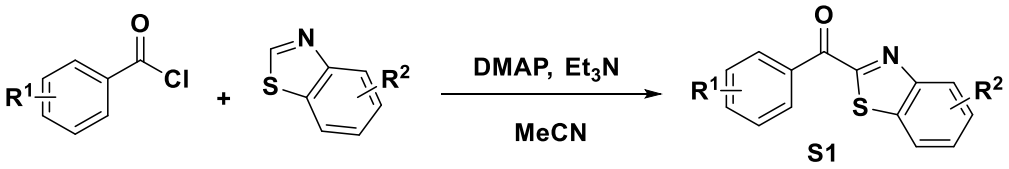
Table S7. The screening of other conditions for **1x** [a].

Entry	Condition	Yield(%) [b]
1	flow rate (100 μL/min)	*N.R.*
2	4.0 eq. of Et_3N	*N.D.*
3	NMP, DCM instead of mixed solvent	*N.D.*
4	4CzIPN, Eosin Y, $Ir[dFCF_3ppy]_2(bpy)PF_6$ instead of *fac*-$Ir(ppy)_3$	*N.D.*
5	DBU instead of Et_3N	*N.R.*

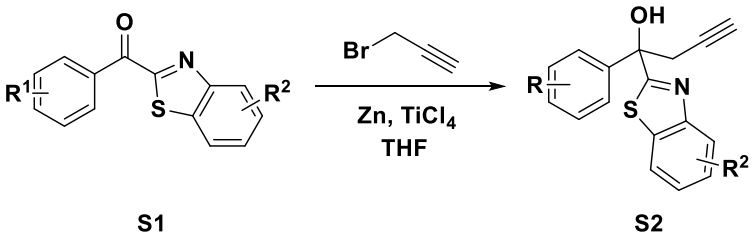
[a] Standard conditions: **1x** (0.2 mmol, 1.0 eq.), **2a** (0.4 mmol, 2.0 eq.), *fac*-$Ir(ppy)_3$ (2.0 mol%), Et_3N (0.4 mmol, 2.0 eq.), solvent 2.0 mL, flow rate (300 μL/min), residence time: 9.3 min, single pump injection. [b] Isolated yield based on **1x**.

3. Preparation of substrates

3.1 Synthesis of vinyl azide 1.

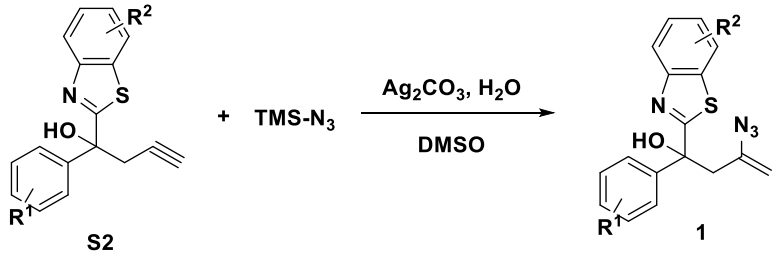


Step 1: [1] DMAP (740.0 mg, 30.0 mol%), aroyl chloride (if solid; 40.0 mmol, 2.0 equiv) and azole (if solid; 20.0 mmol, 1.0 equiv) were weighed in a sealable tube. The tube was sealed and flushed with a stream of dry N_2. CH_3CN (50.0 mL) was added, followed by Et_3N (8.4 mL, 3.0 equiv). Azole (20.0 mmol, 1.0 equiv) and aroyl chloride (40.0 mmol, 2.0 equiv) were added dropwise to the reaction mixture, and stirred for 24 h at 80 ℃. The mixture was then cooled to room temperature, diluted with EtOAc and sat. aq $NaHCO_3$, and extracted with EtOAc (3 × 40.0 mL). Combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated in vacuo. Purification by flash column chromatography afforded the desired product **S1**.



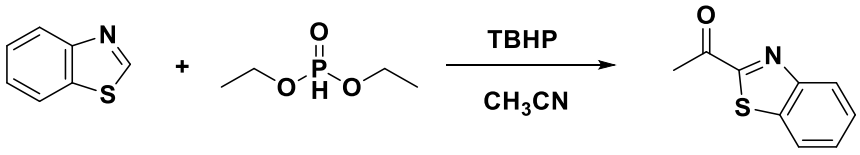
Step 2: [2] Under N_2 atmosphere, activated zinc (1.97 g, 15.0 mmol) was suspended in dry THF (30.0

mL) and was cooled to 0 ℃. Propargyl bromide (1.8 mL, 20.0 mmol) was added, followed by $TiCl_4$ (1.0 M in CH_2Cl_2, 0.5 mL, 0.5 mmol). The reaction mixture was stirred for 5 min before a solution of **S1** (10.0 mmol) in dry THF (20.0 mL) was added. The mixture was stirred for 1 h before quenched with saturated aqueous NH_4Cl (20.0 mL). The mixture was then extracted with EtOAc (20.0 mL) for three times. The combined organic phase was continuously washed with 20.0 mL brine, dried over $MgSO_4$, filtered, and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography to give the desired **S2**.



Step 3: [3] TMS-N_3 (2.64 mL, 20.0 mmol) and H_2O (0.36 mL, 20.0 mmol) successively Add to the dimethyl sulfoxide solution of **S2**. Then, the Ag_2CO_3 (0.28 g, 1.0 mmol) was added at 80 ℃ and stirred for 3 hours. The mixture was then cooled to room temperature, quenched with water. The mixture was then extracted with EtOAc (20.0 mL) for three times. The combined organic phase was continuously washed with 20.0 mL brine, dried over $MgSO_4$, filtered, and concentrated under reduced pressure. The resulting residue was purified by flash column chromatography to give the desired **1**.

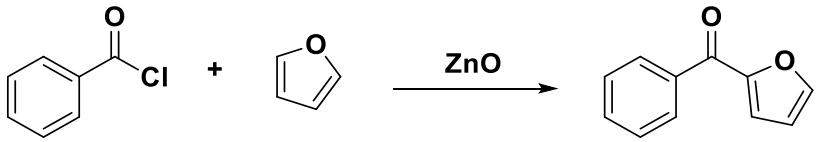
Synthesis of 1-(benzo[d]thiazol-2-yl)ethan-1-one [4]



A mixture of benzothiazole (135.0 mg, 1.0 mmol), phosphonate (5.0 mmol), and TBHP (10.0 mmol) in CH_3CN (2.0 mL) was stirred at 80 ℃ for 24 h. The reaction mixture was quenched with water (5.0 mL) and extracted with ethyl acetate (3 × 5.0 mL). The combined organic layers were washed with brine (15.0 mL) and dried over anhydrous $MgSO_4$. After filtration, the solvent was evaporated in vacuo. The crude product was purified by silica gel chromatography (petroleum ether/ethyl acetate 20/1) to give the

desired product.

Synthesis of furan-2-yl(phenyl)methanone [5]



The furan (5.0 mmol) was added to a mixture of ZnO (powder, 0.2 g, 2.5 mmol) and Benzoyl chloride (5.0 mmol) at room temperature and stirred with a magnetic stirrer. Color developed immediately and darkened with progress of the reaction. The reaction mixture was kept at room temperature with occasional stirring for a certain period of time as required to complete the reaction (monitored by TLC). The solid mass was then eluted with dichloromethane (CH_2Cl_2) (20.0 mL), and the dichloromethane extract was then washed with an aqueous solution of sodium bicarbonate and dried over anhydrous sodium sulfate. Evaporation of solvent furnished practically pure the corresponding product.

3.2 Synthesis of cyclobutanone *O*-acyl oximes 2

All Cyclobutanone oxime esters were prepared in accordance with methods described in the ref erences. [6-8]

4. The reaction equipment

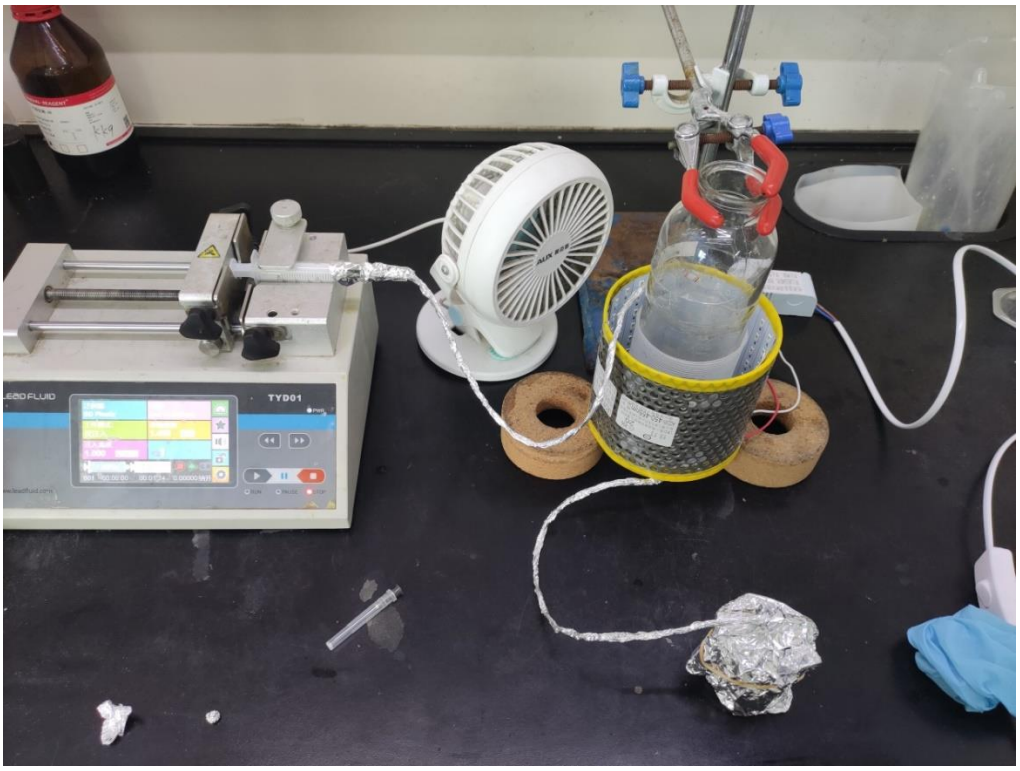


Figure S1. The reaction equipment without light

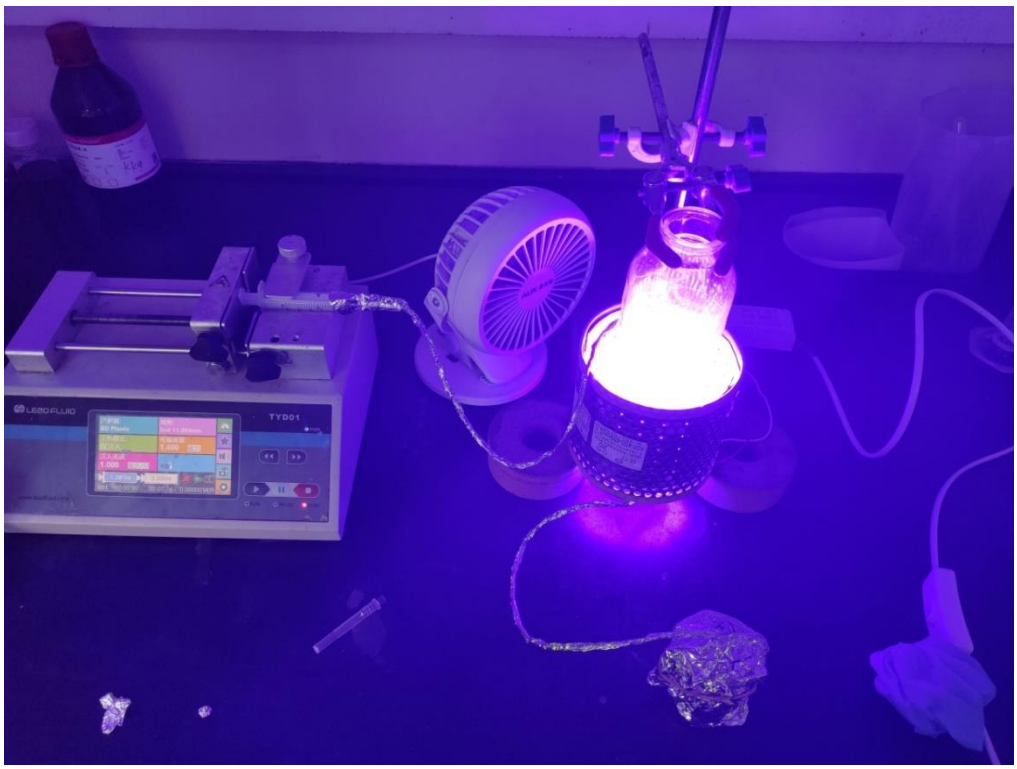
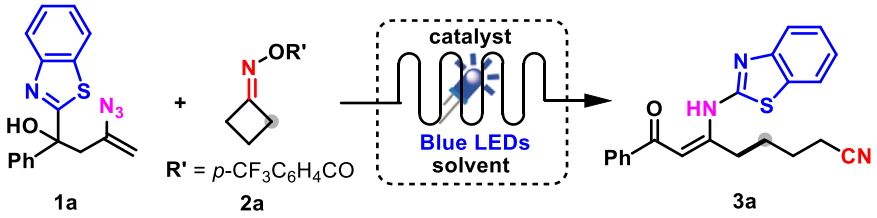


Figure S2. The reaction equipment

5. General produced of 3 and 4

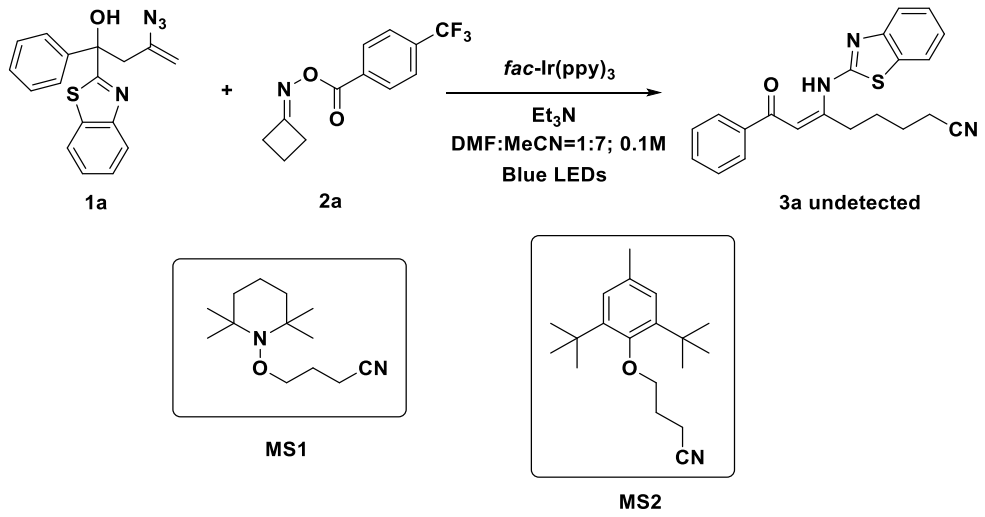
1a (0.2 mmol, 1.0 eq.), **2a** (0.4 mmol, 2.0 eq.), catalyst (2.0 mol%) and Et_3N (0.4 mmol, 2.0 eq.) was dissolved in 2.0 mL solvent (CH_3CN : DMF, v/v = 7 : 1), the solution was then injected to the micro – reactor (PFA tube, ID = 600 μm, volume = 2.8 mL) by a pump, flow rate (300 μL/min). After the reaction completed, diluted with EtOAc and water, and extracted with EtOAc (10.0 mL) for three times, combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated in vacuo. Purification by flash column chromatography afforded the desired product **3** and **4**.

6. Scale – Up Experiment



1a (10.0 mmol, 1.0 eq.), **2a** (20.0 mmol, 2.0 eq.), catalyst (2.0 mol%) and Et_3N (20.0 mmol, 2.0 eq.) was dissolved in 100.0 mL solvent (CH_3CN : DMF, v/v = 7 : 1), the solution was then injected to the micro – reactor (PFA tube, ID = 600 μm, volume = 2.8 mL) by a pump, flow rate (300 μL/min). After the reaction completed, diluted with EtOAc and water, and extracted with EtOAc (60.0 mL) for three times. Combined organic layers were washed with brine, dried over $MgSO_4$ and concentrated in vacuo. The crude product was purified by silica gel flash chromatography. Obtained 2.85 g of the desired product **3a** in 79% yield.

7. Radical – Capturing Experiments



Detected by HRMS

1a (0.2 mmol, 1.0 eq.), **2a** (0.4 mmol, 2.0 eq.), catalyst (2.0 mol%), Et_3N (0.4 mmol, 2.0 eq.) and 2,2,6,6-tetramethylpiperidine-1-oxyl (TEMPO, 0.6 mmol) or butylated hydroxytoluene (BHT, 0.6 mmol) was dissolved in 2.0 mL solvent (CH_3CN : DMF, v/v = 7 : 1), the solution was then injected to the micro – reactor (PFA tube, ID = 600 μm, volume = 2.8 mL) by a pump, flow rate (300 μL/min). After completing reaction, the reaction solution was detected by HRMS. MS1: HRMS [ESI] calcd for $C_{13}H_{25}N_2O^+$ $[M+H]^+$ 225.1961, found: 225.1962. MS2: HRMS [ESI] calcd for $C_{19}H_{30}NO^+$ $[M+H]^+$ 288.2322, found: 288.2336.

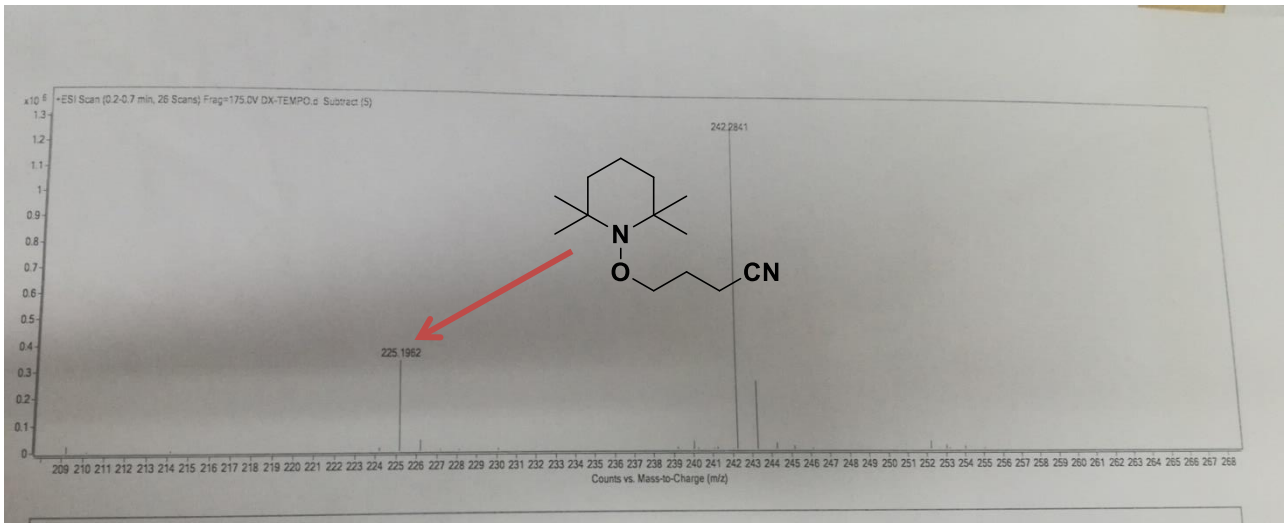


Figure S3. Radical trapped by TEMPO

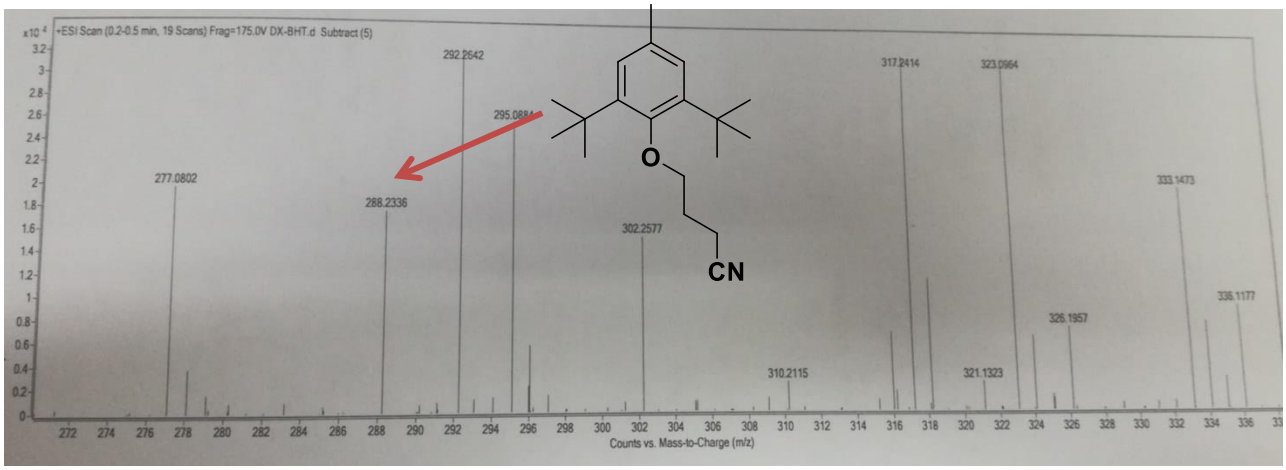


Figure S4. Radical trapped by BHT

8. Cyclic Voltammograms

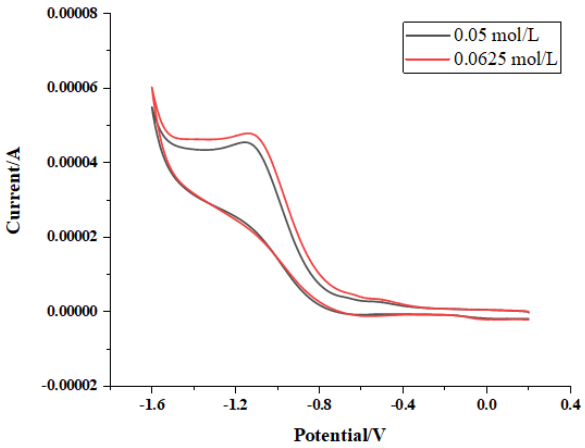


Figure S5. Cyclic voltammograms of **2a**

Cyclic voltammograms were recorded on a CHI660E Electrochemical Analyzer using a three-electrode cell at room temperature. The reference electrode was the saturated Ag/AgCl. A glassy carbon electrode was used as the working electrode and a platinum wire as the auxiliary electrode. Tetrabutylammonium hexafluorophosphate (0.1 M in CH_2Cl_2) was used as the supporting electrolyte. Voltammograms were taken in a solution of cyclobutanone O-(*p*-CF_3-benzoyl) oxime **2a** in CH_2Cl_2 (0.05 mol/L and 0.0625 mol/L), which were purged with Ar. The peak potentials for the irreversible reduction of **2a** were measured as –1.11 V vs. Ag/AgCl (–0.991 V vs. SCE) respectively.

9. X – ray Crystallography Structure of Compound 3a (Ellipsoids: 50% probability)

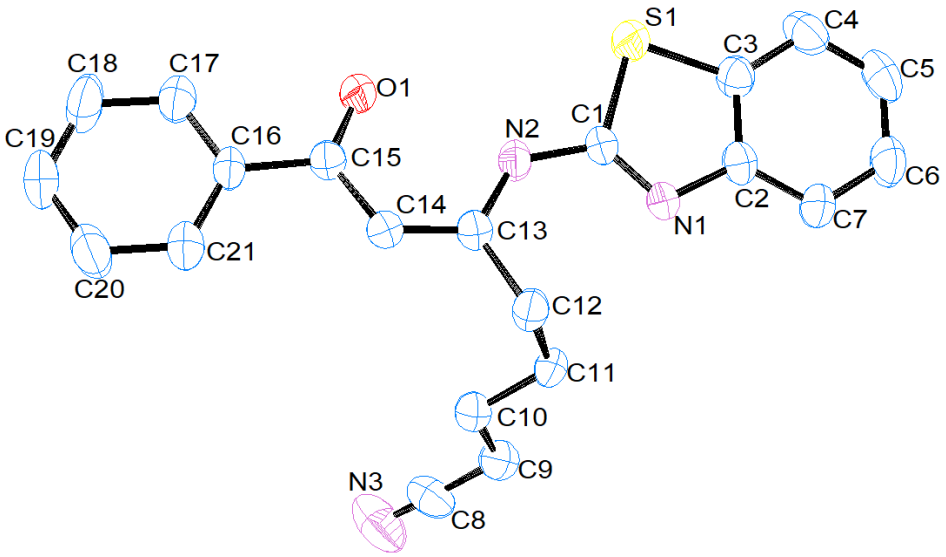


Figure S6. X – ray Crystallography Structure of Compounds **3a**

The X – ray crystallographic coordinates for structures reported in this article have been deposited at the Cambridge Crystallographic Data Centre (CCDC), under deposition number CCDC 2088908 (**3a**).

10. Fluorescence Quenching Experiment

Emission intensities were recorded using a F – 7000 FL Spectrophotometer (serial number: 2574 – 001). All quenching data was recorded using a 1.00 cm slit cuvette, PMT voltage 500 v, scan speed 1200 nm/min. In a typical experiment, the CH_3CN solution of *fac*-Ir(ppy)$_3$ (0.5 mM) was added the appropriate amount of quencher. After degassing with nitrogen for 10 min, the emission spectrum of the sample was collected.

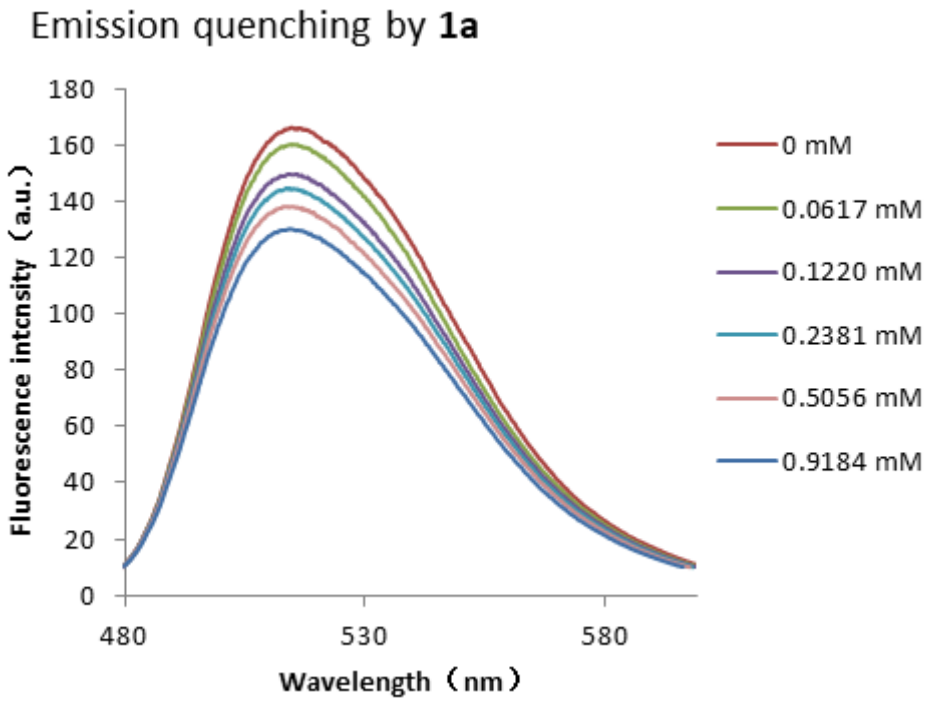


Figure S7. Fluorescence titration of 0.5 mM *fac*-Ir(ppy)$_3$ (CH_3CN) with increasing concentration of **1a** (0 – 0.9184 mM) excited at 370.8 nm.

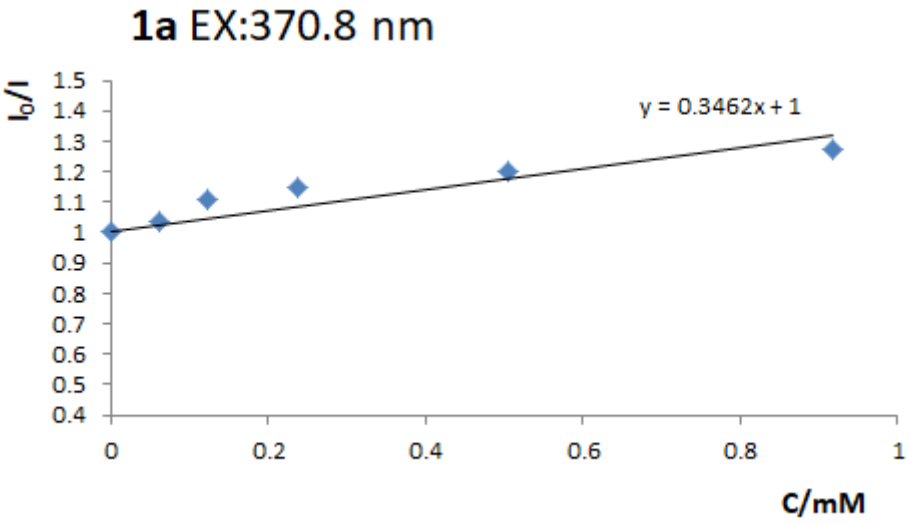


Figure S8. Fluorescence titration of 0.5 mM *fac*-Ir(ppy)$_3$ (CH_3CN) with increasing concentration of **1a** (0 – 0.9184 mM) excited at 370.8 nm.

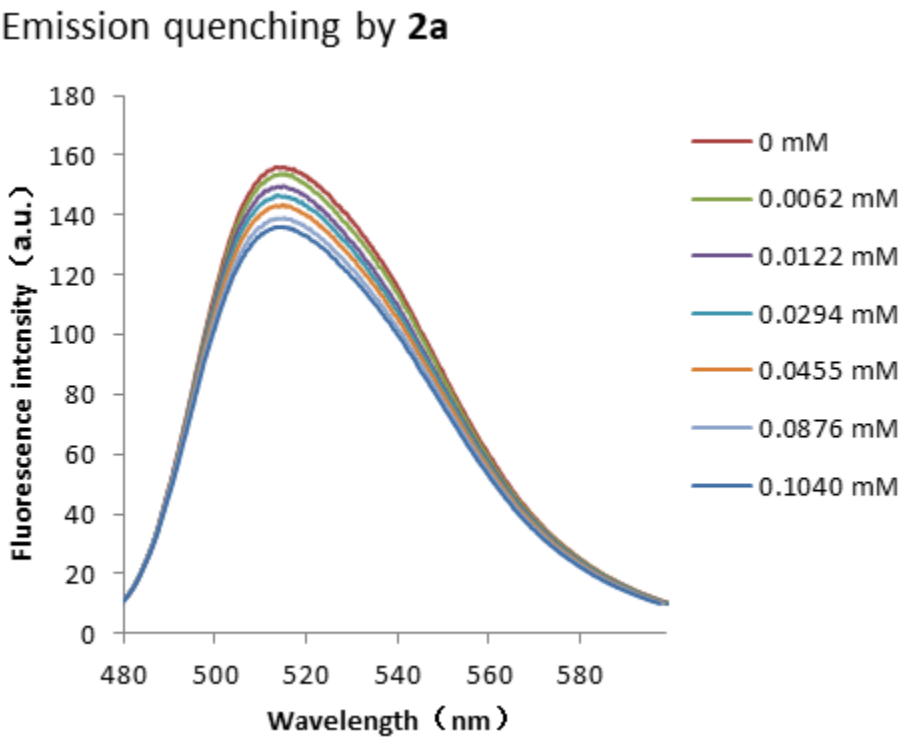


Figure S9. Fluorescence titration of 0.5 mM *fac*-Ir(ppy)$_3$ (CH_3CN) with increasing concentration of **2a** (0 – 0.1040 mM) excited at 371.8 nm.

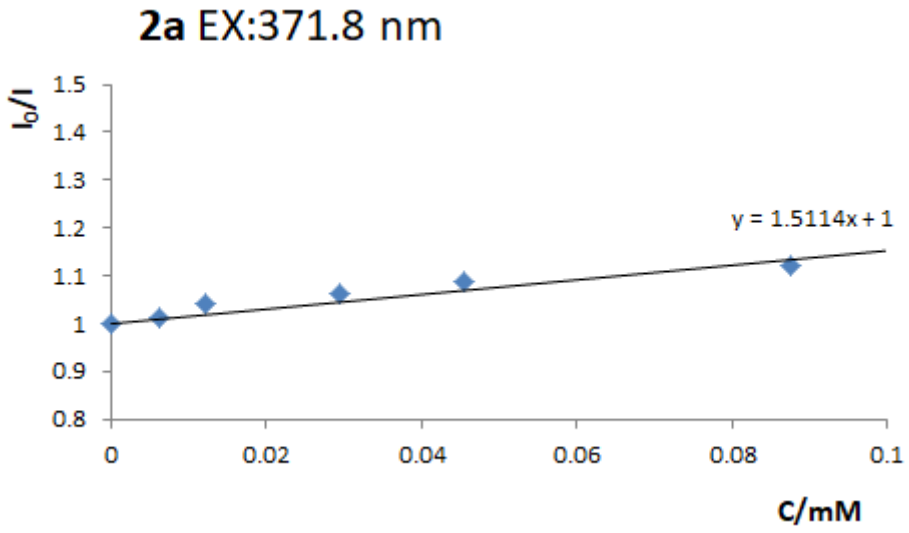
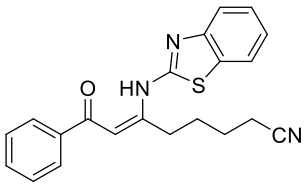


Figure S10. Fluorescence titration of 0.5 mM *fac*-Ir(ppy)$_3$ (CH_3CN) with increasing concentration of **2a** (0 – 0.1040 mM) excited at 371.8 nm.

11. Characterization data

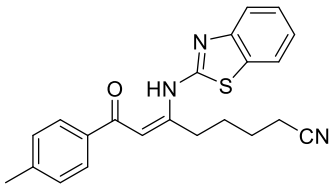
11.1 Characterization Data of Products 3

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-8-phenyloct-6-enenitrile (**3a**)



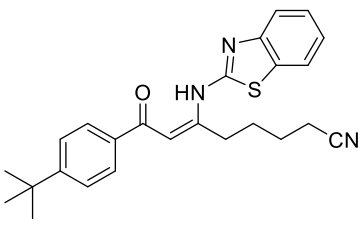
61.4 mg (85%); Yellow solid, Mp: 100.5 – 101.1°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.87 (s, 1H), 7.94 (d, *J* = 7.4 Hz, 2H), 7.72 (t, *J* = 6.9 Hz, 2H), 7.54 – 7.38 (m, 4H), 7.29 – 7.24 (m, 1H), 6.11 (s, 1H), 3.17 – 3.09 (m, 2H), 2.43 (t, *J* = 6.6 Hz, 2H), 1.94 – 1.83 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.0 , 161.6 , 159.6 , 152.0 , 138.7 , 132.3 , 131.8 , 128.6 , 127.5 , 126.4 , 124.1 , 121.40 , 121.1 ,119.6 , 98.4 , 33.7 , 27.5 , 25.2 , 16.9 . **HRMS** [ESI] calcd for $C_{21}H_{20}N_3OS^+$ $[M+H]^+$ 362.1322, found: 362.1322.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-8-(p-tolyl)oct-6-enenitrile (**3b**)



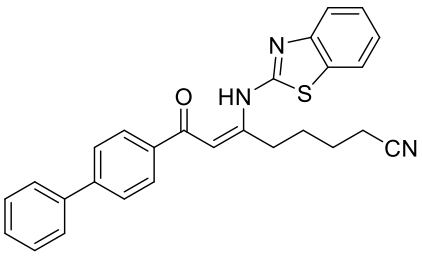
48.8 mg (65%); Yellow solid, Mp: 126.4 – 129.3°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.88 (s, 1H), 7.86 (d, *J* = 8.1 Hz, 2H), 7.73 (d, *J* = 8.4 Hz, 2H), 7.41 (t, *J* = 7.9 Hz, 1H), 7.28 (d, *J* = 7.9 Hz, 3H), 6.11 (s, 1H), 3.18 – 3.11 (m, 2H), 2.45 (t, *J* = 6.8 Hz, 2H), 2.42 (s, 3H), 1.95 – 1.85 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 190.9 , 161.3 , 159.6 , 152.1 , 143.1 , 136.2 , 131.9 , 129.5 , 127.8 , 126.4 , 124.2 , 121.4 , 121.2 , 119.7 , 98.5 , 33.9 , 27.7 , 25.3 , 21.7 , 17.1 . **HRMS** [ESI] calcd for $C_{22}H_{22}N_3OS^+$ $[M+H]^+$ 376.1478, found: 376.1476.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(4-(tert-butyl)phenyl)-8-oxooct-6-enenitrile (**3c**)



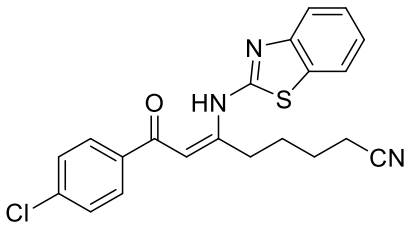
41.8 mg (50%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-d) δ 13.89 (s, 1H), 7.89 (d, *J* = 8.4 Hz, 2H), 7.71 (t, *J* = 7.2 Hz, 2H), 7.48 (d, *J* = 8.4 Hz, 2H), 7.39 (t, *J* = 7.7 Hz, 1H), 7.25 (t, *J* = 7.6 Hz, 1H), 6.11 (s, 1H), 3.16 – 3.09 (m, 2H), 2.43 (t, *J* = 6.7 Hz, 2H), 1.83 – 1.94 (m, 4H), 1.35 (s, 9H). **^{13}C NMR** (100 MHz, Chloroform-d) δ 190.8 , 161.2 , 159.5 , 156.0 , 152.0 , 136.0 , 131.8 , 127.5 , 126.3 , 125.6 , 124.1 , 121.3 , 121.2 , 119.7 , 98.5 , 35.1 , 33.7 , 31.2 , 27.6 , 25.2 , 17.0 . **HRMS** [ESI] calcd for $C_{25}H_{28}N_3OS^+$ $[M+H]^+$ 418.1948, found: 418.1949.

(Z)-8-([1,1'-biphenyl]-4-yl)-6-(benzo[d]thiazol-2-ylamino)-8-oxooct-6-enenitrile (**3d**)



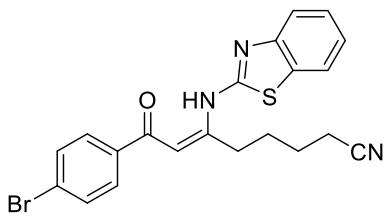
76.0 mg (87%); Yellow solid, Mp: 124.7 – 129.6°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.92 (s, 1H), 8.06 – 7.99 (m, 2H), 7.76 – 7.68 (m, 4H), 7.67 – 7.61 (m, 2H), 7.50 – 7.37 (m, 4H), 7.30 – 7.26 (m, 1H), 6.17 (s, 1H), 3.22 – 3.11 (m, 2H), 2.46 (t, *J* = 6.9 Hz, 2H), 2.00 – 1.83 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 190.5 , 161.7 ,159.5 , 152.1 , 145.1 , 140.1 , 137.5 , 131.9 , 129.1 , 128.2 , 127.4 , 126.5 , 124.2 , 121.5 , 121.3 , 119.2 , 98.5 , 33.9 , 27.7 , 25.3 , 17.1 . **HRMS** [ESI] calcd for $C_{27}H_{24}N_3OS^+$ $[M+H]^+$ 438.1635, found: 438.1643.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(4-chlorophenyl)-8-oxooct-6-enenitrile (**3e**)



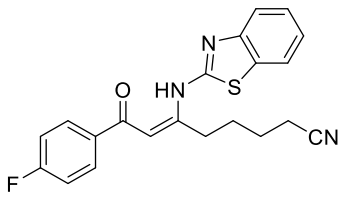
62.4 mg (79%); Yellow solid, Mp: 121.3 – 125.0°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.84 (s, 1H), 7.89 (d, *J* = 8.5 Hz, 2H), 7.74 (d, *J* = 8.2 Hz, 2H), 7.47 – 7.40 (m, 3H), 7.30 (d, *J* = 7.6 Hz, 1H), 6.07 (s, 1H), 3.18 – 3.12 (m, 2H), 2.46 (t, *J* = 6.7 Hz, 2H), 1.96 – 1.86 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 189.6 , 162.3 , 159.3 , 152.0 , 138.7 , 137.2 , 131.9 , 129.0(4) , 129.0(0) , 126.5 , 124.4 , 121.6 , 121.3 , 119.7 , 98.1 , 33.9 , 27.7 , 25.3 , 17.1 . **HRMS** [ESI] calcd for $C_{21}H_{19}N_3OS^+$ $[M+H]^+$ 396.0932, found: 396.0929.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(4-bromophenyl)-8-oxooct-6-enenitrile (**3f**)



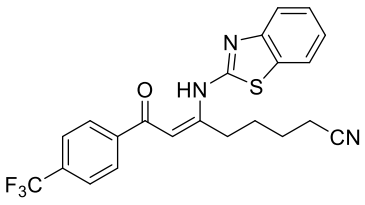
72.9 mg (83%); Yellow solid, Mp: 134.8 – 138.5°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.84 (s, 1H), 7.81 (d, *J* = 8.5 Hz, 2H), 7.76 – 7.71 (m, 2H), 7.60 (d, *J* = 8.5 Hz, 2H), 7.42 (t, *J* = 7.5 Hz, 1H), 7.29 (d, *J* = 7.6 Hz, 1H), 6.06 (s, 1H), 3.17 – 3.11 (m, 2H), 2.45 (t, *J* = 6.7 Hz, 2H), 1.96 – 1.84 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 189.7 , 162.3 , 159.3 , 152.0 , 137.6 , 132.0 ,130.1 , 129.2 ,127.3 , 126.5 , 124.4 , 121.5 , 121.3 , 119.7 , 98.0 , 33.9 , 27.6 , 25.3 , 17.1 . **HRMS** [ESI] calcd for $C_{21}H_{19}BrN_3OS^+$ $[M+H]^+$ 440.0427, found: 440.0423.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(4-fluorophenyl)-8-oxooct-6-enenitrile (**3g**)



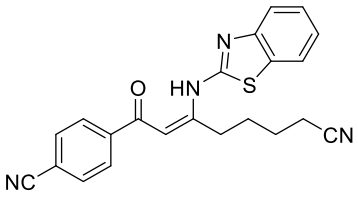
59.14 mg (78%); Yellow solid, Mp: 108.5 – 112.4°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.82 (s, 1H), 7.97 (dd, *J* = 8.7, 5.5 Hz, 2H), 7.74 (d, *J* = 8.8 Hz, 2H), 7.41 (t, *J* = 7.6 Hz, 1H), 7.29 (d, *J* = 7.7 Hz, 1H), 7.14 (t, *J* = 8.6 Hz, 2H), 6.07 (s, 1H), 3.18 – 3.12 (m, 2H), 2.45 (t, *J* = 6.8 Hz, 2H), 1.96 – 1.85 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 189.5 , 165.4 (d, *J* = 252.0 Hz, 1C), 161.9 , 159.4 , 152.0 , 135.1 (d, *J* = 3.0 Hz, 1C), 131.9 , 130.1 (d, *J* = 8.9 Hz, 2C), 126.5 , 124.3 , 121.5 , 121.3 , 119.7 , 115.8 (d, *J* = 21.6 Hz, 2C), 98.1 , 33.9 , 27.6 , 25.3 , 17.1 . **^{19}F NMR** (376 MHz, Chloroform-*d*) δ -106.79. **HRMS** [ESI] calcd for $C_{21}H_{19}FN_3OS^+$ $[M+H]^+$ 380.1227, found: 380.1229.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-8-(4-(trifluoromethyl)phenyl)oct-6-enenitrile (**3h**)



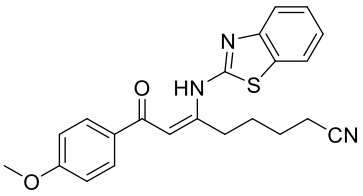
54.9 mg (64%); Yellow solid, Mp: 111.4 – 117.8°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.85 (s, 1H), 8.04 (d, *J* = 8.1 Hz, 2H), 7.78 – 7.71 (m, 4H), 7.43 (t, *J* = 7.7 Hz, 1H), 7.30 (t, *J* = 7.6 Hz, 1H), 6.11 (s, 1H), 3.20 – 3.14 (m, 2H), 2.46 (t, *J* = 6.8 Hz, 2H), 1.98 – 1.86 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 189.6 , 163.0 , 159.2 , 151.9 , 141.9 , 133.6 (q, *J* = 96.2 Hz, 1C), 132.0 , 127.9 , 126.6 , 125.7 (q, *J* = 10.6 Hz, 2C) , 124.5 , 123.8 (q, *J* = 805.7 Hz, 1C), 121.7 , 121.3 , 119.8 , 98.3 , 33.9 , 27.6 , 25.3 , 17.1 . **^{19}F NMR** (376 MHz, Chloroform-*d*) δ -62.91. **HRMS** [ESI] calcd for $C_{22}H_{19}F_3N_3OS^+$ $[M+H]^+$ 430.1195, found: 430.1191.

(Z)-4-(3-(benzo[d]thiazol-2-ylamino)-7-cyanohept-2-enoyl)benzonitrile (**3i**)



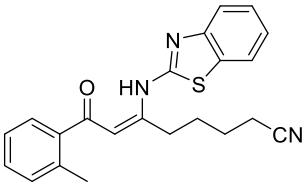
24.7 mg (32%); Yellow solid, Mp: 130.9 – 134.1°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.85 (s, 1H), 8.05 – 8.00 (m, 2H), 7.80 – 7.75 (m, 4H), 7.46 – 7.42 (m, 1H), 7.34 – 7.29 (m, 1H), 6.09 (s, 1H), 3.21 – 3.14 (m, 2H), 2.46 (t, *J* = 6.8 Hz, 2H), 1.98 – 1.87 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 188.8 , 163.6 , 159.0 , 151.9 , 142.4 , 132.6 , 132.0 , 128.1 , 126.7 , 124.6 , 121.8 , 121.4 , 119.6 , 118.4 , 115.4 , 98.1 , 33.9 , 27.6 , 25.3 , 17.1 . **HRMS** [ESI] calcd for $C_{22}H_{19}N_4OS^+$ $[M+H]^+$ 387.1274, found: 387.1272.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(4-methoxyphenyl)-8-oxooct-6-enenitrile (**3j**)



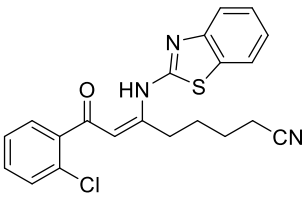
32.0 mg (41%); Yellow solid, Mp: 133.4 – 136.8°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.84 (s, 1H), 7.94 (d, *J* = 7.4 Hz, 2H), 7.63 (d, *J* = 8.9 Hz, 1H), 7.55 – 7.45 (m, 3H), 7.22 (d, *J* = 2.3 Hz, 1H), 7.03 – 6.97 (m, 1H), 6.10 (s, 1H), 3.85 (s, 3H), 3.14 – 3.07 (m, 2H), 2.44 (t, *J* = 6.7 Hz, 2H), 1.95 – 1.83 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 189.9 , 163.1 , 160.8 , 159.6 , 152.1 , 131.8 , 131.4 , 129.8 , 126.4 , 124.0 , 121.3 , 121.2 , 119.7 , 113.9 , 96.2 , 55.6 , 33.8 , 27.6 , 25.3 , 17.0 . **HRMS** [ESI] calcd for $C_{22}H_{22}N_3O_2S^+$ $[M+H]^+$ 392.1427, found: 392.1426.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-8-(o-tolyl)oct-6-enenitrile (**3k**)



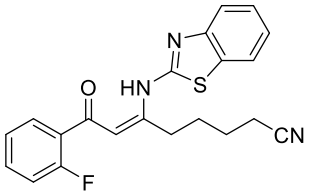
27.8 mg (37%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.65 (s, 1H), 7.74 (d, *J* = 8.1 Hz, 2H), 7.51 – 7.48 (m, 1H), 7.42 (t, *J* = 7.6 Hz, 1H), 7.34 (t, *J* = 7.3 Hz, 1H), 7.27 (d, *J* = 7.3 Hz, 3H), 5.78 (s, 1H), 3.14 – 3.08 (m, 2H), 2.52 (s, 3H), 2.44 (t, *J* = 6.7 Hz, 2H), 1.94 – 1.84 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 196.1 , 161.0 , 159.5 , 152.0 , 140.4 , 136.7 , 132.0 , 131.5 , 130.4 , 127.8 , 126.5 , 125.8 , 124.3 , 121.5 , 121.3 , 119.7 , 102.4 , 33.6 , 27.6 , 25.3 , 20.6 , 17.1 . **HRMS** [ESI] calcd for $C_{22}H_{22}N_3OS^+$ $[M+H]^+$ 376.1478, found: 376.1476.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(2-chlorophenyl)-8-oxooct-6-enenitrile (**3l**)



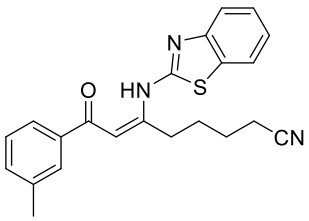
49.8 mg (63%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.49 (s, 1H), 7.78 – 7.73 (m, 2H), 7.55 – 7.52 (m, 1H), 7.45 – 7.41 (m, 2H), 7.40 – 7.34 (m, 2H), 7.32 – 7.28 (m, 1H), 5.85 (s, 1H), 3.15 – 3.10 (m, 2H), 2.44 (t, *J* = 6.9 Hz, 2H), 1.94 – 1.85 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 192.5 , 161.8 , 159.3 , 151.9 , 140.0 , 132.0 , 131.4 , 131.1 , 130.6 , 129.6 , 127.1 , 126.5 , 124.4 , 121.6 , 121.3 , 119.6 , 102.7 , 33.6 , 27.5 , 25.3 , 17.1 . **HRMS** [ESI] calcd for $C_{21}H_{19}ClN_3OS^+$ $[M+H]^+$ 396.0932, found: 396.0933.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(2-fluorophenyl)-8-oxooct-6-enenitrile (**3m**)



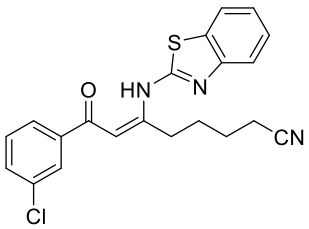
50.0 mg (66%); Yellow solid, Mp: 104.3 – 105.0°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.74 (s, 1H), 7.88 – 7.81 (m, 1H), 7.74 (t, *J* = 7.0 Hz, 2H), 7.51 – 7.45 (m, 1H), 7.42 (t, *J* = 7.7 Hz, 1H), 7.30 – 7.23 (m, 2H), 7.17 – 7.09 (m, 1H), 6.09 (s, 1H), 3.13 (t, *J* = 7.2 Hz, 2H), 2.44 (t, *J* = 6.7 Hz, 2H), 1.96 – 1.83 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 188.3 (d, *J* = 3.3 Hz, 1C), 161.9 , 160.9 (d, *J* = 251.54 Hz, 1C), 159.3 , 152.0 , 133.5 (d, *J* = 9.0 Hz, 1C), 132.0 , 130.7 (d, *J* = 2.4 Hz, 1C), 127.6 (d, *J* = 12.2 Hz, 1C), 126.5 , 124.6 (d, *J* = 3.3 Hz, 1C), 124.3 , 121.6 , 121.3 , 119.7 , 116.7 (d, *J* = 23.5 Hz, 1C), 102.7 (d, *J* = 9.9 Hz, 1C), 33.6 , 27.5 , 25.3 , 17.0 . **^{19}F NMR** (376 MHz, Chloroform-*d*) δ -111.15. **HRMS** [ESI] calcd for $C_{21}H_{19}FN_3OS^+$ $[M+H]^+$ 380.1227, found: 380.1228.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-8-(m-tolyl)oct-6-enenitrile (**3n**)



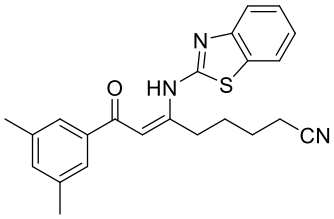
54 mg (72%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.89 (s, 1H), 7.77 – 7.70 (m, 4H), 7.42 – 7.34 (m, 3H), 7.29 – 7.25 (m, 1H), 6.11 (s, 1H), 3.17 – 3.11 (m, 2H), 2.46 – 2.41 (m, 5H), 1.95 – 1.85 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.4 , 161.5 , 159.6 , 152.1 , 138.9 , 138.5 , 133.2 , 131.9 , 128.6 , 128.3 , 126.5 , 124.8 , 124.2 , 121.4 , 121.3 , 119.7 , 98.7 , 33.9 , 27.7 , 25.4 , 21.6 , 17.1 . **HRMS** [ESI] calcd for $C_{22}H_{22}N_3OS^+$ $[M+H]^+$ 376.1478, found: 376.1475.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(3-chlorophenyl)-8-oxooct-6-enenitrile (**3o**)



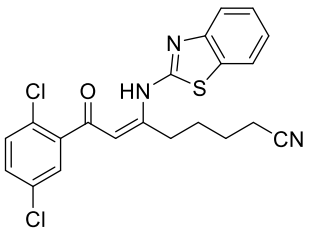
49.0 mg (62%); Yellow solid, Mp: 100.9 – 106.5°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.81 (s, 1H), 7.91 (s, 1H), 7.81 (d, *J* = 7.7 Hz, 1H), 7.76 – 7,72 (m, 2H), 7.50 (d, *J* = 7.9 Hz, 1H), 7.44 – 7.39 (m, 2H), 7.29 (t, *J* = 7.6 Hz, 1H), 6.06 (s, 1H), 3.18 – 3.13 (m, 2H), 2.45 (t, *J* = 6.7 Hz, 2H), 1.95 – 1.86 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 189.4 , 162.6 , 159.2 , 152.0 , 140.5 , 135.0 , 132.2 , 132.0 , 130.0 , 127.8 , 126.5 , 125.7 , 124.4 , 121.6 , 121.3 , 119.7 , 98.2 , 33.9 , 27.7 , 25.4 , 17.1 . **HRMS** [ESI] calcd for $C_{21}H_{19}ClN_3OS^+$ $[M+H]^+$ 396.0932, found: 396.0928.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(3,5-dimethylphenyl)-8-oxooct-6-enenitrile (**3p**)



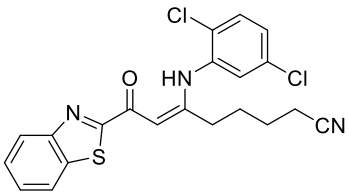
25.7 mg (34%); Yellow solid, Mp: 125.8 – 127.6°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.90 (s, 1H), 7.73 (d, *J* = 8.5 Hz, 2H), 7.55 (s, 2H), 7.41 (t, *J* = 7.9 Hz, 1H), 7.28 (d, *J* = 7.6 Hz, 1H), 7.18 (s, 1H), 6.11 (s, 1H), 3.19 – 3.12 (m, 2H), 2.46 (t, *J* = 6.8 Hz, 2H), 2.39 (s, 6H), 1.96 – 1.86 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.6 , 161.4 , 159.6 , 152.1 , 138.9 , 138.4 , 134.1 , 131.9 , 126.4 , 125.5 , 124.2 , 121.4 , 121.2 , 119.7 , 98.8 , 33.9 , 27.7 , 25.4 , 21.5 , 17.1 . **HRMS** [ESI] calcd for $C_{23}H_{24}N_3OS^+$ $[M+H]^+$ 390.1635, found: 390.1637.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(2,5-dichlorophenyl)-8-oxooct-6-enenitrile (**3q**)



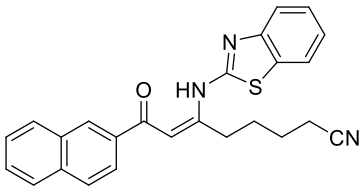
15.4 mg (18%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.44 (s, 1H), 7.76 (t, *J* = 8.1 Hz, 2H), 7.51 (d, *J* = 2.2 Hz, 1H), 7.45 – 7.41 (m, 1H), 7.37 – 7.29 (m, 3H), 5.80 (s, 1H), 3.15 – 3.09 (m, 2H), 2.44 (t, *J* = 6.8 Hz, 2H), 1.93 – 1.84 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 190.7 , 162.7 , 159.0 , 151.9 , 141.1 , 133.1 ,132.0 , 131.8 , 131.2 , 129.5 , 129.4 , 126.6 , 124.6 , 121.7 , 121.3 , 119.6 , 102.1 , 33.6 , 27.4 , 25.3 , 17.0 . **HRMS** [ESI] calcd for $C_{21}H_{18}Cl_2N_3OS^+$ $[M+H]^+$ 430.0542, found: 430.0537.

(Z)-8-(benzo[d]thiazol-2-yl)-6-((2,5-dichlorophenyl)amino)-8-oxooct-6-enenitrile (**3q'**)



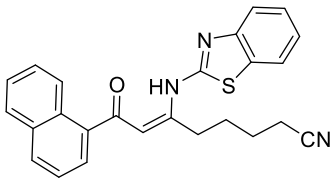
17.2 mg (20%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 12.59 (s, 1H), 8.15 (d, *J* = 8.0 Hz, 1H), 7.98 (d, *J* = 7.8 Hz, 1H), 7.57 – 7.53 (m, 1H), 7.51 – 7.45 (m, 2H), 7.30 – 7.27 (m, 2H), 6.62 (s, 1H), 2.49 (t, *J* = 7.2 Hz, 2H), 2.33 (t, *J* = 6.7 Hz, 2H), 1.76 – 1.68 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 166.7 , 137.3 , 136.5 , 133.2 , 131.4 , 129.3 , 128.4 , 127.6 , 126.8 , 126.7 , 124.9 , 122.5 , 119.1 , 93.8 , 31.7 , 26.9 , 24.9 , 17.1 . **HRMS** [ESI] calcd for $C_{21}H_{18}Cl_2N_3OS^+$ $[M+H]^+$ 430.0542, found: 430.0537.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(naphthalen-2-yl)-8-oxooct-6-enenitrile (**3r**)



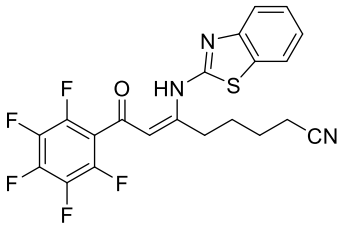
37.0 mg (45%); Yellow solid, Mp: 111.2 – 120.7°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.97 (s, 1H), 8.47 (s, 1H), 8.05 – 7.97 (m, 2H), 7.94 – 7.87 (m, 2H), 7.77 – 7.72 (m, 2H), 7.61 – 7.54 (m, 2H), 7.44 – 7.39 (m, 1H), 7.31 – 7.26 (m, 1H), 6.29 (s, 1H), 3.23 – 3.16 (m, 2H), 2.47 (t, *J* = 6.9 Hz, 2H), 2.00 – 1.89 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 190.9 , 161.7 , 159.5 , 152.1 , 136.1 , 135.4 , 132.8 , 132.0 , 129.6 , 128.7 , 128.6 , 128.2 , 127.9 , 126.8 , 126.5 , 124.3 , 123.9 , 121.5 , 121.3 , 119.7 , 98.7 , 33.9 , 27.7 , 25.4 , 17.1 . **HRMS** [ESI] calcd for $C_{25}H_{22}N_3OS^+$ $[M+H]^+$ 412.1478, found: 412.1473.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(naphthalen-1-yl)-8-oxooct-6-enenitrile (**3s**)



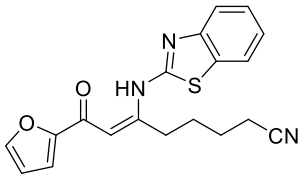
22.2 mg (27%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.05 (s, 1H), 8.16 (d, *J* = 8.2 Hz, 1H), 8.02 – 7.96 (m, 2H), 7.93 – 7.88 (m, 1H), 7.85 (d, *J* = 8.3 Hz, 1H), 7.59 – 7.43 (m, 5H), 7.39 – 7.34 (m, 1H), 6.63 (s, 1H), 2.43 – 2.35 (m, 2H), 2.11 (t, *J* = 7.0 Hz, 2H), 1.68 – 1.59 (m, 2H), 1.57 – 1.46 (m, 2H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 180.3 , 169.4 , 154.1 , 137.2 , 134.4 , 133.8 , 130.1 , 128.6 , 128.3 , 127.6 , 127.1 , 126.6 , 126.5 , 125.4 , 124.7 , 124.2 , 122.5 , 122.43 , 119.1 , 92.3 , 31.71 , 27.3 , 24.9 , 16.9 . **HRMS** [ESI] calcd for $C_{25}H_{22}N_3OS^+$ $[M+H]^+$ 412.1478, found: 412.1478.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-8-(perfluorophenyl)oct-6-enenitrile (**3t**)



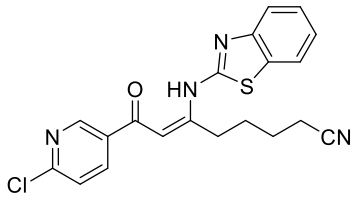
25.3 mg (28%); Yellow solid, Mp: 142.1 – 143.4°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.29 (s, 1H), 7.78 (t, *J* = 8.9 Hz, 2H), 7.48 – 7.43 (m, 1H), 7.36 – 7.31 (m, 1H), 5.65 (s, 1H), 3.16 – 3.10 (m, 2H), 2.45 (t, *J* = 6.8 Hz, 2H), 1.95 – 1.84 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 181.8 , 164.1 , 158.6 , 151.7 , 144.4 (m, 2C), 141.2 (m, 1C), 137.8 (m, 2C), 132.1 , 126.7 , 124.9 , 122.0 , 121.4 , 119.5 , 115.8 (m, 1C), 103.2 , 33.5 , 27.4 , 25.2 , 17.1 . **^{19}F NMR** (376 MHz, Chloroform-*d*) δ -140.99 – -141.07 (m), -150.89 – -151.02 (m), -160.39 – -160.54 (m). **HRMS** [ESI] calcd for $C_{21}H_{15}F_5N_3OS^+$ $[M+H]^+$ 452.0851, found: 452.0853.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(furan-2-yl)-8-oxooct-6-enenitrile (**3u**)



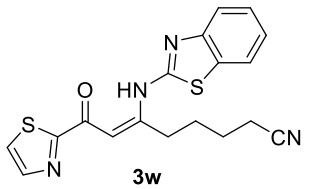
13.3 mg (19%); Red colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 12.64 (s, 1H), 8.14 (d, *J* = 8.1 Hz, 1H), 7.98 (d, *J* = 7.9 Hz, 1H), 7.51 (dt, *J* = 26.9, 7.5 Hz, 2H), 6.56 (s, 1H), 6.48 – 6.39 (m, 1H), 6.03 (d, *J* = 3.2 Hz, 1H), 2.55 (t, *J* = 7.4 Hz, 2H), 2.36 (t, *J* = 6.7 Hz, 2H), 1.84 – 1.72 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 181.1 , 170.1 , 166.3 , 154.0 , 145.3 , 139.2 , 137.3 , 126.8 , 126.7 , 124.9 , 122.5 , 119.3 , 111.7 , 100.5 , 93.9 , 32.5 , 26.9 , 25.2 , 17.1 . **HRMS** [ESI] calcd for $C_{19}H_{18}N_3O_2S^+$ $[M+H]^+$ 352.1114, found: 352.1109.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(6-chloropyridin-3-yl)-8-oxooct-6-enenitrile (**3v**)



31.7 mg (40%); Yellow solid, Mp: 149.8 – 155.9°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.79 (s, 1H), 8.92 (d, *J* = 2.0 Hz, 1H), 8.18 (dd, *J* = 8.3, 2.3 Hz, 1H), 7.76 (t, *J* = 7.1 Hz, 2H), 7.46 – 7.41 (m, 2H), 7.31 (t, *J* = 7.6 Hz, 1H), 6.03 (s, 1H), 3.19 – 3.13 (m, 2H), 2.46 (t, *J* = 6.7 Hz, 2H), 1.97 – 1.87 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 187.5 , 163.6 , 158.9 , 154.7 , 151.9 , 149.2 , 137.8 , 133.0 , 132.0 , 126.6 , 124.6 , 124.5 , 121.7 , 121.3 , 119.6 , 97.8 , 33.9 , 27.6 , 25.3 , 17.1 . **HRMS** [ESI] calcd for $C_{20}H_{17}ClN_4OSNa^+$ $[M+Na]^+$ 419.0704, found: 419.0701.

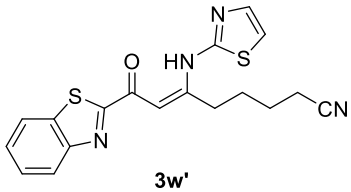
(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-8-(thiazol-2-yl)oct-6-enenitrile (**3w**)



3w

Major

and

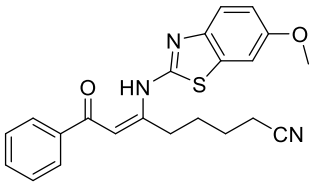


3w'

27.9 mg (Total yield of two isomers: 38%); Yellow colloid. major : minor = 1.0 : 0.16. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.55 (s, 1H, minor, 86%), 13.40 (s, 1H, major, 86%), 8.16 (d, *J* = 8.1 Hz, 1H, minor, 14%), 8.00 (d, *J* = 3.0 Hz, 1H, major, 86%), 7.98 (s, 1H, minor, 14%), 7.76 (t, *J* = 8.9 Hz, 2H, major, 86%), 7.65 (d, *J* = 3.0 Hz, 1H, major, 86%), 7.59 – 7.47 (m, 3H, minor, 14%), 7.40 – 7.45 (m, 1H, major, 86%), 7.32 – 7.28 (m, 1H, major, 86%), 7.00 (d, *J* = 3.6 Hz, 1H, minor, 14%), 6.65 (s, 1H, minor, 14%), 6.60 (s, 1H, major, 86%), 3.21 – 3.17 (m, 2H, major, 86%),

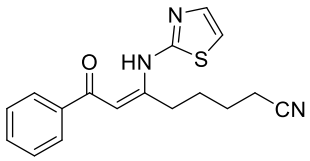
3.11 – 3.04 (m, 2H, minor, 14%), 2.51 – 2.43 (m, 2H, major, 86%), 2.43 – 2.39 (m, 2H, minor, 14%), 2.01 – 1.82(m, 8H, major + minor). ^{13}C NMR (100 MHz, Chloroform-*d*) δ 181.8 , 181.7 , 169.4 , 169.3 , 164.8 , 163.9 , 160.4 , 158.9 , 153.9 , 151.9 , 144.7 , 140.6 , 137.3 , 132.0 , 127.1 , 126.9 , 126.6 , 125.7 , 125.0 , 124.6 , 122.5 , 121.8 , 121.3 , 119.6 (0.62) , 119.6 (0.57) , 114.2 , 97.4 , 96.2 , 33.8 , 33.4 , 29.8 , 27.5 , 27.3 , 25.4 , 25.3 , 17.0 . **HRMS** [ESI] calcd for $C_{18}H_{16}N_4OS_2Na^+$ $[M+Na]^+$ 391.0658, found: 391.0644.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-(4-methoxyphenyl)-8-oxooct-6-enenitrile (**3y**)



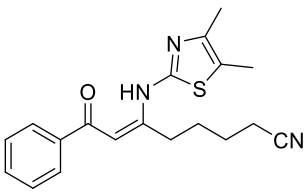
26.6 mg (34%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-d) δ 13.84 (s, 1H), 7.94 (d, J = 7.4 Hz, 2H), 7.63 (d, J = 8.9 Hz, 1H), 7.55 – 7.45 (m, 3H), 7.22 (d, J = 2.3 Hz, 1H), 7.03 – 6.97 (m, 1H), 6.10 (s, 1H), 3.85 (s, 3H), 3.14 – 3.07 (m, 2H), 2.44 (t, J = 6.7 Hz, 2H), 1.95 – 1.83 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-d) δ 190.9 , 161.9 , 157.3 , 157.0 , 146.2 , 138.9 , 133.2 , 132.2 , 128.7 , 127.6 , 122.0 , 119.7 , 115.0 , 104.6 , 98.0 , 56.0 , 33.7 , 27.6 , 25.3 , 17.0 . **HRMS** [ESI] calcd for $C_{22}H_{22}N_3O_2S^+$ $[M+H]^+$ 392.1427, found: 392.1426.

(Z)-8-oxo-8-phenyl-6-(thiazol-2-ylamino)oct-6-enenitrile (**3z**)



31.7 mg (51%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.90 (s, 1H), 7.97 – 7.89 (m, 2H), 7.54 – 7.43 (m, 3H), 7.39 (d, *J* = 3.6 Hz, 1H), 6.92 (d, *J* = 3.6 Hz, 1H), 6.03 (s, 1H), 3.04 – 2.95 (m, 2H), 2.41 (t, *J* = 6.8 Hz, 2H), 1.88 – 1.77 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 190.6 , 161.2 , 162.1 , 140.3 , 139.0 , 132.0 , 128.6 , 127.5 , 119.6 , 113.3 , 96.9 , 33.3 , 27.3 , 25.2 , 17.0 . **HRMS** [ESI] calcd for $C_{17}H_{18}N_3OS^+$ $[M+H]^+$ 312.1165, found: 312.1166.

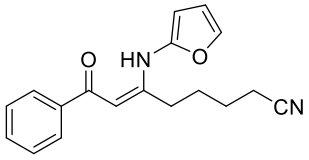
(Z)-6-((4,5-dimethylthiazol-2-yl)amino)-8-oxo-8-phenyloct-6-enenitrile (**3x'**)



27.1 mg (40%); Yellow solid, Mp: 102.0 – 104.2^{o}C. **^{1}H NMR** (400 MHz, Chloroform-d) δ 13.66 (s, 1H), 7.91 (d, J = 7.2 Hz, 2H), 7.52 – 7.42 (m, 3H), 5.97 (s, 1H), 2.93 (t, J = 7.1 Hz, 2H), 2.41 (t, J = 6.6 Hz, 2H), 2.28 (s, 3H),

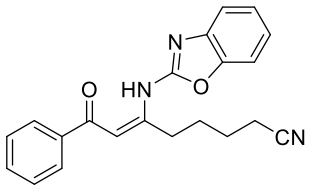
2.22 (s, 3H), 1.86 – 1.77 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-d) δ 190.2 , 162.3 , 156.1 , 145.3 , 139.3 , 131.8 , 128.6 , 127.4 , 120.8 ,119.7 , 96.5 , 33.2 , 27.5 , 25.2 , 17.0 , 14.9 , 11.2 . **HRMS** [ESI] calcd for $C_{19}H_{22}N_3OS^+$ $[M+H]^+$ 340.1478, found: 340.1451.

(Z)-8-oxo-8-phenyl-6-(thiophen-2-ylamino)oct-6-enenitrile (**3y'**)



37.2 mg (60%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 12.83 (s, 1H), 7.92 – 7.90 (m, 2H), 7.48 – 7.44 (m, 3H), 7.26 – 7.21 (m, 1H), 6.40 (dd, *J* = 3.2, 2.1 Hz, 1H), 5.97 (d, *J* = 3.3 Hz, 1H), 5.95 (s, 1H), 2.46 (s, 2H), 2.34 (s, 2H), 1.74 – 1.71 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 190.2 , 163.9 , 146.1 , 139.6 , 138.8 , 131.6 , 128.5 , 127.4 , 119.4 , 111.5 , 100.1 , 94.6 , 32.5 , 26.9 , 25.0 , 17.1 . **HRMS** [ESI] calcd for $C_{18}H_{19}N_2O_2^+$ $[M+H]^+$ 295.1441, found: 295.1449.

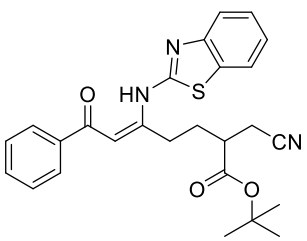
(Z)-6-(benzo[d]oxazol-2-ylamino)-8-oxo-8-phenyloct-6-enenitrile (**3z'**)



55.2 mg (80%); Yellow solid, Mp: 220.3 – 225.6°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.75 (s, 1H), 7.96 (d, *J* = 7.4 Hz, 2H), 7.56 – 7.46 (m, 4H), 7.41 (d, *J* = 7.9 Hz, 1H), 7.28 – 7.21 (m, 2H), 6.20 (s, 1H), 3.13 (t, *J* = 7.2 Hz, 2H), 2.48 (t, *J* = 6.6 Hz, 2H), 1.96 – 1.87 (m, 4H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.3 , 159.8 , 155.6 , 148.0 , 142.2 , 138.7 , 132.5 , 128.7 , 127.8 , 124.6 , 123.6 , 119.7 , 118.4 , 109.8 , 99.2 , 33.2 , 27.4 , 25.2 , 17.0 . **HRMS** [ESI] calcd for $C_{21}H_{20}N_3O_2S^+$ $[M+H]^+$ 346.1550, found: 346.1552.

11.2 Characterization Data of Products 4

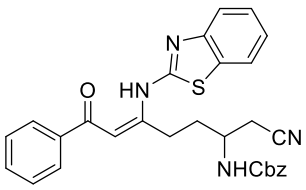
tert-butyl(Z)-5-(benzo[d]thiazol-2-ylamino)-2-(cyanomethyl)-7-oxo-7-phenylhept-5-enoate (**4a**)



73.8 mg (80%); Yellow solid, Mp: 117.9 – 120.5°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.86 (s, 1H), 7.97 – 7.93 (m, 2H), 7.74 (t, *J* = 7.5 Hz, 2H), 7.56 – 7.40 (m, 4H), 7.31 – 7.26 (m, 1H), 6.14 (s, 1H), 3.24 – 3.12 (m, 2H), 2.86 (p, *J* = 6.8 Hz, 1H), 2.76 – 2.65 (m, 2H), 2.26 – 2.18 (m, 1H), 2.15 –

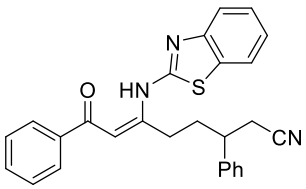
2.05 (m, 1H), 1.50 (s, 9H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.2 , 171.5 , 160.9 , 159.5 , 152.0 , 138.8 , 132.5 , 131.9 , 128.8 , 127.7 , 126.5 , 124.3 , 121.5 , 121.3 , 118.0 , 98.8 , 82.6 , 42.4 , 32.2 , 30.5 , 28.2 , 19.7 . **HRMS** [ESI] calcd for $C_{26}H_{28}N_3O_3S^+$ $[M+H]^+$ 462.1846, found: 462.1844.

benzyl(Z)-(5-(benzo[d]thiazol-2-ylamino)-1-cyano-7-oxo-7-phenylhept-5-en-2-yl)carbamate (**4b**)



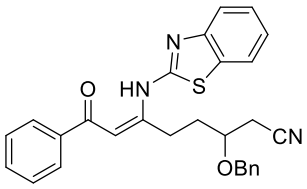
52.0 mg (51%); Yellow solid, Mp: 162.4 – 175.4°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.94 (s, 1H), 7.98 – 7.93 (m, 2H), 7.84 (d, *J* = 8.1 Hz, 1H), 7.68 (d, *J* = 7.8 Hz, 1H), 7.57 – 7.53 (m, 1H), 7.50 – 7.46 (m, 2H), 7.45 – 7.35 (m, 5H), 7.21 (t, *J* = 7.4 Hz, 1H), 7.04 (t, *J* = 7.3 Hz, 1H), 6.73 (s, 1H), 6.17 (s, 1H), 5.25 (d, *J* = 11.9 Hz, 1H), 5.14 (d, *J* = 11.9 Hz, 1H), 4.03 – 3.95 (m, 1H), 3.67 – 3.59 (m, 1H), 2.91 – 2.81 (m, 1H), 2.75 – 2.62 (m, 2H), 2.27 – 2.17 (m, 1H), 2.15 – 2.08 (m, 1H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.4 , 160.3 , 160.0 , 156.2 , 151.8 , 138.5 , 136.0 , 132.6 , 131.0 , 128.8 , 128.8 , 128.7 , 128.5 , 127.7 , 126.5 , 124.4 , 121.3 , 121.1 , 117.2 , 99.2 , 67.6 , 48.6 , 32.2 , 31.5 , 23.9 . **HRMS** [ESI] calcd for $C_{29}H_{27}N_4O_3S^+$ $[M+H]^+$ 511.1798, found: 511.1796.

(Z)-6-(benzo[d]thiazol-2-ylamino)-8-oxo-3,8-diphenyloct-6-enenitrile (**4c**)



30.6 mg (35%); Yellow solid, Mp:135.4 – 145.4°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.83 (s, 1H), 7.93 – 7.88 (m, 2H), 7.73 (d, *J* = 8.2 Hz, 2H), 7.53 (d, *J* = 7.3 Hz, 1H), 7.48 – 7.37 (m, 5H), 7.31 (t, *J* = 8.7 Hz, 4H), 6.00 (s, 1H), 3.21 – 3.14 (m, 1H), 3.05 – 2.96 (m, 2H), 2.76 – 2.65 (m, 2H), 2.36 – 2.29 (m, 1H), 2.27 – 2.19 (m, 1H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.1, 161.6, 159.5, 152.0, 141.0, 138.8, 132.4, 132.0, 129.2, 128.7, 127.9, 127.6, 127.5, 126.5, 124.3, 121.5, 121.3, 118.5, 98.7, 42.5, 33.7, 32.9, 25.3. **HRMS** [ESI] calcd for $C_{27}H_{23}N_3OSNa^+$ $[M+Na]^+$ 460.1454, found: 460.1452.

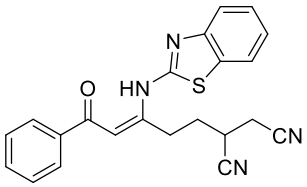
(Z)-6-(benzo[d]thiazol-2-ylamino)-3-(benzyloxy)-8-oxo-8-phenyloct-6-enenitrile (**4d**)



37.4 mg (40%); Yellow solid, Mp: 153.3 – 157.2°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.88 (s, 1H), 7.91 (d, *J* = 7.3 Hz, 2H), 7.73 (d, *J* = 7.9 Hz, 1H), 7.68 (d, *J* = 8.0 Hz, 1H), 7.54 (t, *J* = 7.2 Hz, 1H), 7.46 (t, *J* = 7.4 Hz, 2H),

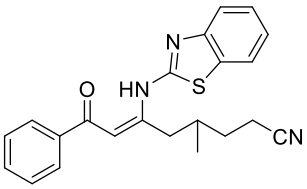
7.43 – 7.26 (m, 7H), 6.10 (s, 1H), 4.73 (d, *J* = 11.6 Hz, 1H), 4.62 (d, *J* = 11.6 Hz, 1H), 3.92 (p, *J* = 5.6 Hz, 1H), 3.32 – 3.24 (m, 1H), 3.18 – 3.08 (m, 1H), 2.70 (qd, *J* = 16.9, 5.5 Hz, 2H), 2.20 – 2.10 (m, 2H). **^{13}C NMR** (100 MHz, Chloroform-d) δ 191.1 , 161.5 , 159.5 , 152.0 , 138.8 , 137.5 , 132.4 , 131.9 , 128.8 , 128.2 , 128.0 , 127.7 , 126.5 , 124.3 , 121.4 , 121.3 , 117.6 , 98.6 , 74.3 , 72.1 , 33.0 , 30.4 , 23.1 . **HRMS** [ESI] calcd for $C_{28}H_{26}N_3O_2S^+$ $[M+H]^+$ 468.174, found: 468.1740.

(Z)-2-(3-(benzo[d]thiazol-2-ylamino)-5-oxo-5-phenylpent-3-en-1-yl)succinonitrile (**4e**)



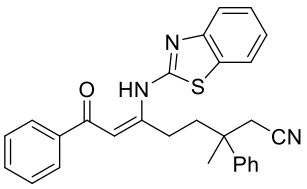
34.7 mg (45%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.83 (s, 1H), 7.98 – 7.93 (m, 2H), 7.77 – 7.71 (m, 2H), 7.55 (t, *J* = 7.3 Hz, 1H), 7.48 (t, *J* = 7.4 Hz, 2H), 7.43 – 7.39 (m, 1H), 7.31 – 7.26 (m, 1H), 6.19 (s, 1H), 3.51 – 3.44 (m, 1H), 3.21 – 3.12 (m, 2H), 2.82 (d, *J* = 6.6 Hz, 2H), 2.34 – 2.25 (m, 2H). **^{13}C NMR** (100 MHz, Chloroform-d) δ 191.3 , 159.4 , 158.8 , 151.9 , 138.4 , 132.7 , 131.7 , 128.8 , 127.7 , 126.6 , 124.4 , 121.5 , 121.3 , 118.6 , 115.6 , 99.3 , 32.2 , 30.5 , 28.4 , 21.1 . **HRMS** [ESI] calcd for $C_{22}H_{19}N_4OS^+$ $[M+H]^+$ 387.1274, found: 387.1268.

(Z)-6-(benzo[d]thiazol-2-ylamino)-4-methyl-8-oxo-8-phenyloct-6-enenitrile (**4f**)



22.5 mg (30%); Yellow colloid. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.86 (s, 1H), 7.97 – 7.92 (m, 2H), 7.73 (d, *J* = 8.4 Hz, 2H), 7.57 – 7.52 (m, 1H), 7.48 (t, *J* = 7.4 Hz, 2H), 7.44 – 7.39 (m, 1H), 7.31 – 7.26 (m, 1H), 6.08 (s, 1H), 3.48 – 3.41 (m, 1H), 2.68 – 2.61 (m, 1H), 2.48 (t, *J* = 7.7 Hz, 2H), 2.21 – 2.12 (m, 1H), 1.98 – 1.89 (m, 1H), 1.74 – 1.65 (m, 1H), 1.07 (d, *J* = 6.7 Hz, 3H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 190.9, 160.4, 159.7, 152.0, 138.8, 132.4, 131.9, 128.7, 127.7, 126.5, 124.3, 121.3, 121.3, 120.0, 100.2, 41.5, 32.7, 31.5, 18.9, 15.1. **HRMS** [ESI] calcd for $C_{22}H_{22}N_3OS^+$ $[M+H]^+$ 376.1478, found: 376.1475.

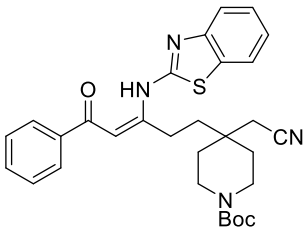
(Z)-6-(benzo[d]thiazol-2-ylamino)-3-methyl-8-oxo-3,8-diphenyloct-6-enenitrile (**4g**)



29.8 mg (33%); Yellow oil. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.83 (s, 1H), 7.89 (d, *J* = 7.4 Hz, 2H), 7.74 (d, *J* = 8.2 Hz, 2H), 7.51 – 7.40 (m, 8H), 7.32 – 7.28 (m, 2H), 5.94 (s, 1H), 3.05 – 2.99 (m, 1H), 2.83 – 2.71 (m, 3H),

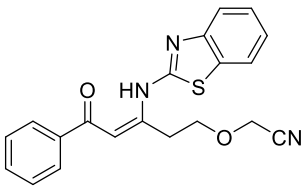
2.32 – 2.23 (m, 2H), 1.70 (s, 3H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.2 , 162.4 , 159.4 , 152.0 , 143.5 , 138.8 , 132.3 , 132.0 , 129.0 , 128.7, 127.6, 127.3, 126.5, 126.0, 124.3 , 121.4, 121.3, 118.1, 98.6, 41.0, 40.7, 31.6, 30.4, 25.0. **HRMS** [ESI] calcd for $C_{28}H_{26}N_3OS^+$ $[M+H]^+$ 452.1791, found: 452.1791.

tert-butyl(Z)-4-(3-(benzo[d]thiazol-2-ylamino)-5-oxo-5-phenylpent-3-en-1-yl)-4-(cyanomethyl)piperidine-1-carboxylate (**4h**)



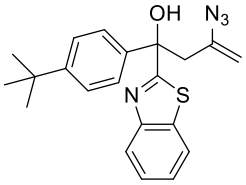
60.4 mg (57%); Yellow solid, Mp: 138.0 – 141.2°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.93 (s, 1H), 7.98 – 7.93 (m, 2H), 7.74 (d, *J* = 7.8 Hz, 1H), 7.69 (d, *J* = 8.0 Hz, 1H), 7.56 – 7.46 (m, 3H), 7.43 – 7.39 (m, 1H), 7.31 – 7.27 (m, 1H), 6.16 (s, 1H), 3.59 – 3.50 (m, 2H), 3.45 – 3.37 (m, 2H), 3.17 – 3.08 (m, 2H), 2.54 (s, 2H), 2.06 – 1.98 (m, 2H), 1.71 (d, *J* = 13.0 Hz, 2H), 1.65 – 1.61 (m, 2H), 1.46 (s, 9H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.3 , 162.0 , 159.5 , 154.9 , 152.0 , 138.7 , 132.4 , 131.8 , 128.7 , 127.7 , 126.6 , 124.3 , 121.3 , 121.1 , 117.6 , 98.9 , 79.9 , 39.4 , 35.6 , 34.7 , 34.3 , 29.1 , 28.5 , 26.9 . **HRMS** [ESI] calcd for $C_{30}H_{35}N_4O_3S^+$ $[M+H]^+$ 531.2424, found: 531.2424.

(Z)-2-((3-(benzo[d]thiazol-2-ylamino)-5-oxo-5-phenylpent-3-en-1-yl)oxy)acetonitrile (**4i**)



18.2 mg (25%); Yellow solid, Mp: 131.0 – 156.0°C. **^{1}H NMR** (400 MHz, Chloroform-*d*) δ 13.85 (s, 1H), 7.99 – 7.93 (m, 2H), 7.77 – 7.70 (m, 2H), 7.57 – 7.39 (m, 4H), 7.29 (d, *J* = 7.9 Hz, 1H), 6.19 (s, 1H), 4.33 (s, 2H), 4.05 (t, *J* = 6.4 Hz, 2H), 3.48 (t, *J* = 6.4 Hz, 2H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 191.1 , 159.7 , 157.9 , 152.0 , 138.7 , 132.5 , 131.9 , 128.8 , 127.7 , 126.5 , 124.3 , 121.5 , 121.3 , 116.1 , 99.9 , 69.7 , 56.4 , 34.8 . **HRMS** [ESI] calcd for $C_{20}H_{18}N_3O_2S^+$ $[M+H]^+$ 364.1114, found: 364.1116.

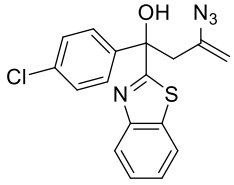
3-azido-1-(benzo[d]thiazol-2-yl)-1-(4-(tert-butyl)phenyl)but-3-en-1-ol (**1c**)



^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.02 – 7.99 (m, 1H), 7.86 – 7.82 (m, 1H), 7.64 – 7.60 (m, 2H), 7.47 – 7.33 (m, 1H), 7.38 – 7.33 (m, 3H), 4.84 (d, *J* = 1.8 Hz, 1H), 4.72 (d, *J* = 1.9 Hz, 1H), 4.43 (s, 1H), 3.40 (d, *J* = 14.6 Hz, 1H), 3.12 (d, *J* =

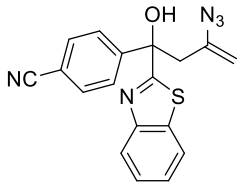
14.5 Hz, 1H), 1.28 (s, 9H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 177.7 , 153.5 , 150.8 , 141.7 , 140.1 , 135.7 , 126.0 , 125.4 , 125.2 , 125.0 , 123.2 , 121.9 , 103.2 , 78.5 , 45.8 , 34.6 , 31.4 . **HRMS** [ESI] calcd for $C_{21}H_{22}N_4OSNa^+$ $[M+Na]^+$ 401.1407, found: 401.1403.

3-azido-1-(benzo[d]thiazol-2-yl)-1-(4-chlorophenyl)but-3-en-1-ol (**1e**)



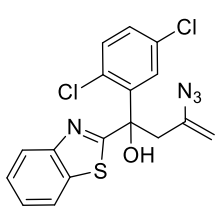
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.91 (d, *J* = 8.1 Hz, 1H), 7.74 (d, *J* = 7.9 Hz, 1H), 7.59 (d, *J* = 8.6 Hz, 2H), 7.38 – 7.33 (m, 1H), 7.27 – 7.18 (dd, *J* = 19.0, 8.3 Hz, 3H), 4.74 (s, 1H), 4.62 (s, 1H), 4.47 (s, 1H), 3.22 (d, *J* = 14.6 Hz, 1H), 3.05 (d, *J* = 14.6 Hz, 1H). **^{13}C NMR** (100 MHz, Chloroform-d) δ 177.0 , 153.4 , 141.4 , 141.3 , 135.5 , 133.8 , 128.5 , 127.2 , 126.1 , 125.1 , 123.3 , 121.9 , 103.3 , 78.3 , 45.9 . **HRMS** [ESI] calcd for $C_{17}H_{13}ClN_4OSNa^+$ $[M+Na]^+$ 379.0391, found: 379.0387.

4-(3-azido-1-(benzo[d]thiazol-2-yl)-1-hydroxybut-3-en-1-yl)benzonitrile (**1i**)



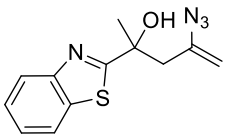
^{1}H NMR (400 MHz, Chloroform-*d*) δ 8.01 (d, *J* = 8.1 Hz, 1H), 7.90 (d, *J* = 8.4 Hz, 2H), 7.84 (d, *J* = 7.9 Hz, 1H), 7.62 (d, *J* = 8.4 Hz, 2H), 7.47 (t, *J* = 7.5 Hz, 1H), 7.36 (t, *J* = 7.5 Hz, 1H), 4.85 (s, 1H), 4.74 – 4.63 (m, 2H), 3.32 (d, *J* = 14.6 Hz, 1H), 3.15 (d, *J* = 14.6 Hz, 1H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 176.2 , 153.5 , 147.9 , 141.0 , 135.5 , 132.2 , 126.6 , 126.2 , 125.3 , 123.3 , 121.9 , 118.8 , 111.7 , 103.4 , 78.3 , 45.9 . **HRMS** [ESI] calcd for $C_{18}H_{13}N_5OSNa^+$ $[M+Na]^+$ 370.0733, found: 370.0731.

3-azido-1-(benzo[d]thiazol-2-yl)-1-(2,5-dichlorophenyl)but-3-en-1-ol (**1q**)



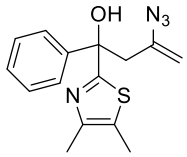
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 8.2 Hz, 1H), 7.88 – 7.82 (m, 1H), 7.73 (d, *J* = 7.9 Hz, 1H), 7.40 – 7.35 (m, 1H), 7.28 (t, *J* = 7.4 Hz, 1H), 7.18 (d, *J* = 1.8 Hz, 2H), 4.64 (s, 1H), 4.60 (d, *J* = 1.5 Hz, 1H), 4.16 (s, 1H), 3.68 (d, *J* = 14.6 Hz, 1H), 3.32 (d, *J* = 14.6 Hz, 1H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 174.3 , 152.3 , 141.6 , 141.4 , 135.8 , 133.2 , 132.3 , 130.8 , 129.8 , 128.9 , 126.2 , 125.6 , 123.7 , 121.9 , 103.2 , 77.7 , 41.9 . **HRMS** [ESI] calcd for $C_{17}H_{12}Cl_2N_4OSNa^+$ $[M+Na]^+$ 413.0001, found: 412.9995.

4-azido-2-(benzo[d]thiazol-2-yl)pent-4-en-2-ol (**1x**)



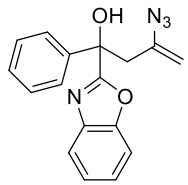
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.98 (d, *J* = 8.1 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 1H), 7.49 – 7.45 (m, 1H), 7.39 – 7.35 (m, 1H), 4.80 (d, *J* = 1.6 Hz, 1H), 4.75 (d, *J* = 1.8 Hz, 1H), 3.89 (s, 1H), 2.88 (d, *J* = 14.3 Hz, 1H), 2.72 (d, *J* = 14.3 Hz, 1H), 1.73 (s, 3H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 179.0 , 153.6 , 141.9 , 135.4 , 126.1 , 125.0 , 123.0 , 121.9 , 102.7 , 75.5 , 46.2 , 29.2 . **HRMS** [ESI] calcd for $C_{12}H_{12}N_4OSNa^+$ $[M+Na]^+$ 283.0624, found: 283.0622.

3-azido-1-(4,5-dimethylthiazol-2-yl)-1-phenylbut-3-en-1-ol (**1x'**)



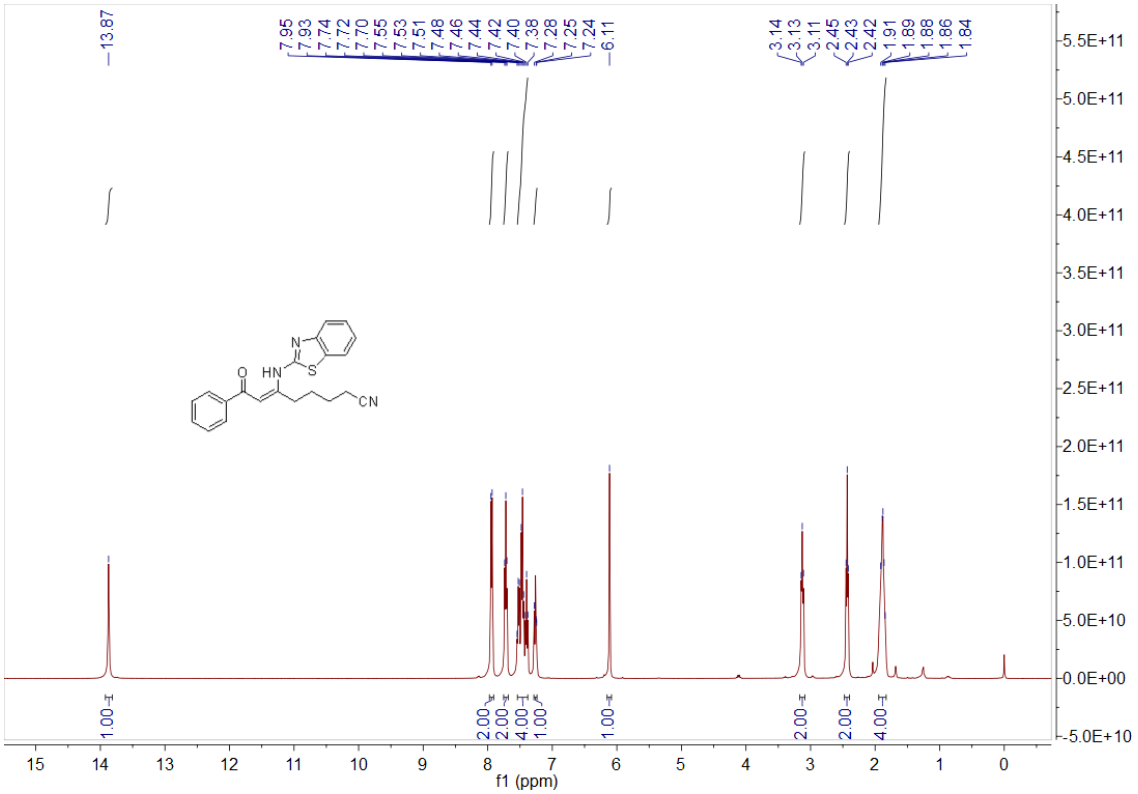
^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.54 (s, 2H), 7.19 (d, *J* = 31.3 Hz, 3H), 4.63 (d, *J* = 13.5 Hz, 2H), 4.23 (s, 1H), 3.09 (d, *J* = 13.3 Hz, 1H), 2.96 (d, *J* = 13.3 Hz, 1H), 2.25 – 2.11 (m, 6H). **^{13}C NMR** (100 MHz, Chloroform-d) δ 171.1 , 147.7 , 143.8 , 141.8 , 128.2 , 127.5 , 127.0 , 125.5 , 103.0 , 77.8 , 46.0 , 14.9 , 11.3 . **HRMS** [ESI] calcd for $C_{15}H_{16}N_4OSNa^+$ $[M+Na]^+$ 323.0937, found: 323.0938.

3-azido-1-(benzo[d]oxazol-2-yl)-1-phenylbut-3-en-1-ol (**1z'**)

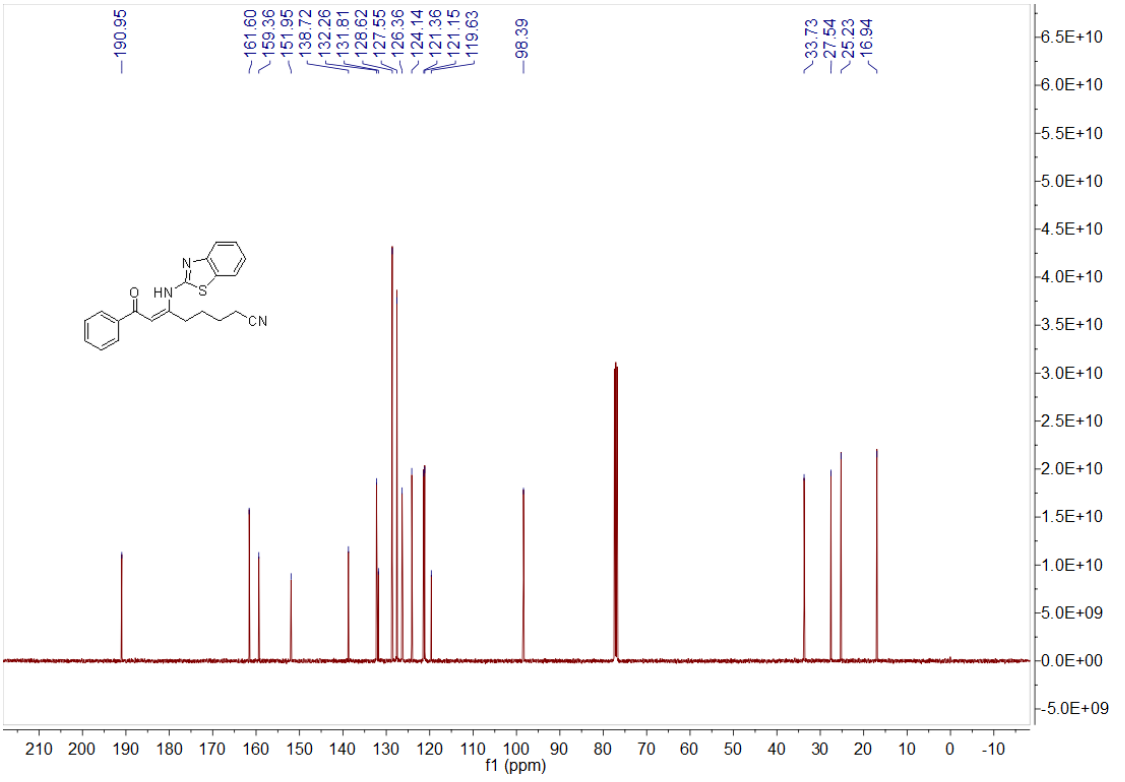


^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.77 – 7.69 (m, 1H), 7.65 (d, *J* = 7.5 Hz, 2H), 7.54 – 7.47 (m, 1H), 7.41 – 7.26 (m, 5H), 4.74 (d, *J* = 17.1 Hz, 2H), 4.28 (s, 1H), 3.34 (d, *J* = 14.5 Hz, 1H), 3.04 (d, *J* = 14.5 Hz, 1H). **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 167.6 , 151.3 , 141.6 , 141.3 , 140.4 , 128.6 , 128.3 , 125.4 , 125.4 , 124.7 , 120.4 , 111.1 , 103.1 , 75.3 , 44.9 . **HRMS** [ESI] calcd for $C_{17}H_{14}N_4O_2Na^+$ $[M+Na]^+$ 329.1009, found: 329.1011.

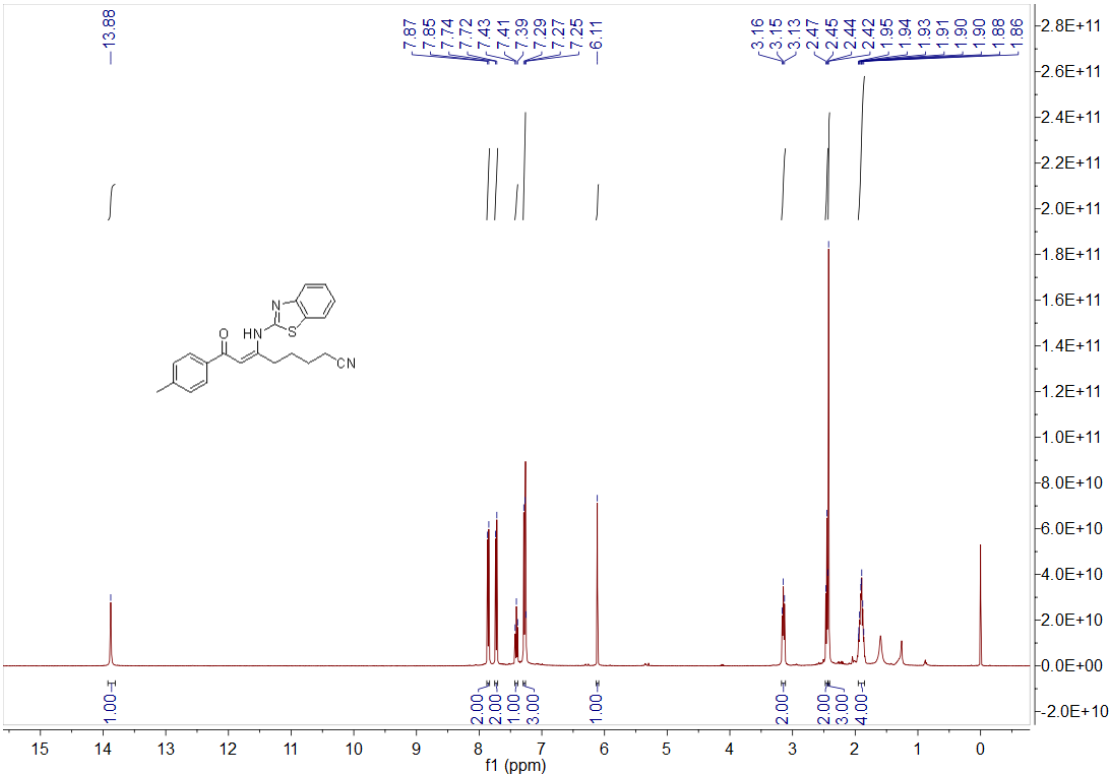
12. Copies of ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra for the products.



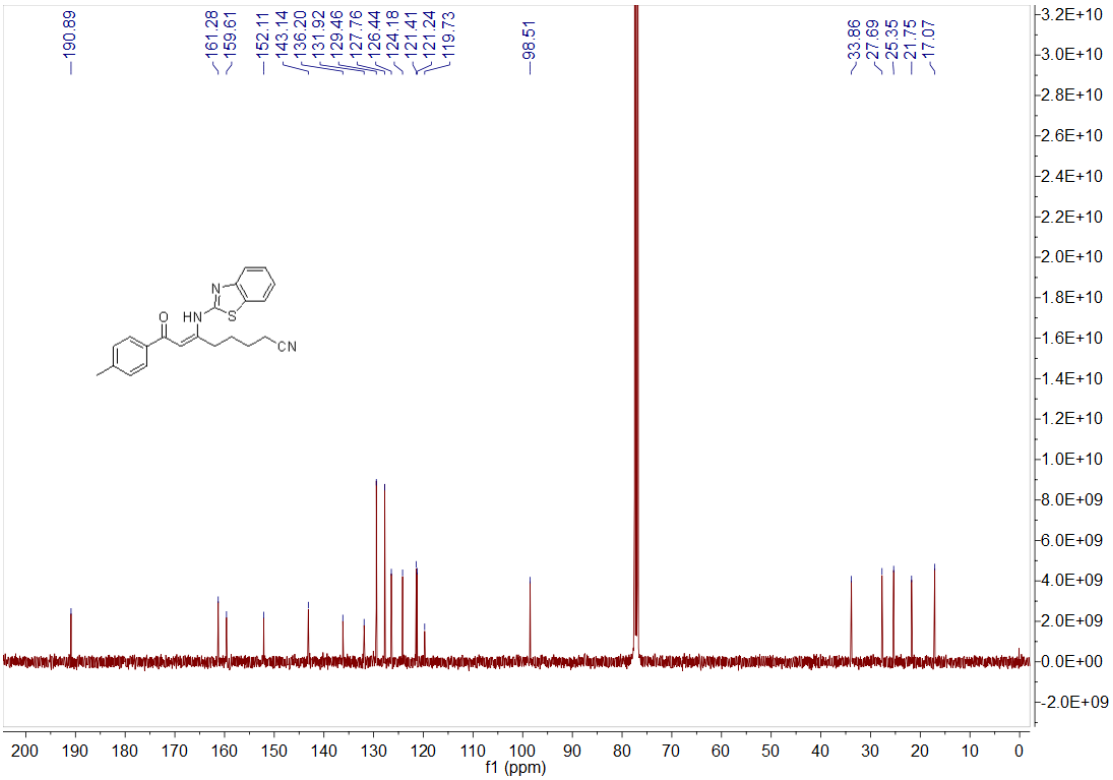
^{1}H NMR Spectrum of Compound **3a** (400 Hz, $CDCl_3$)



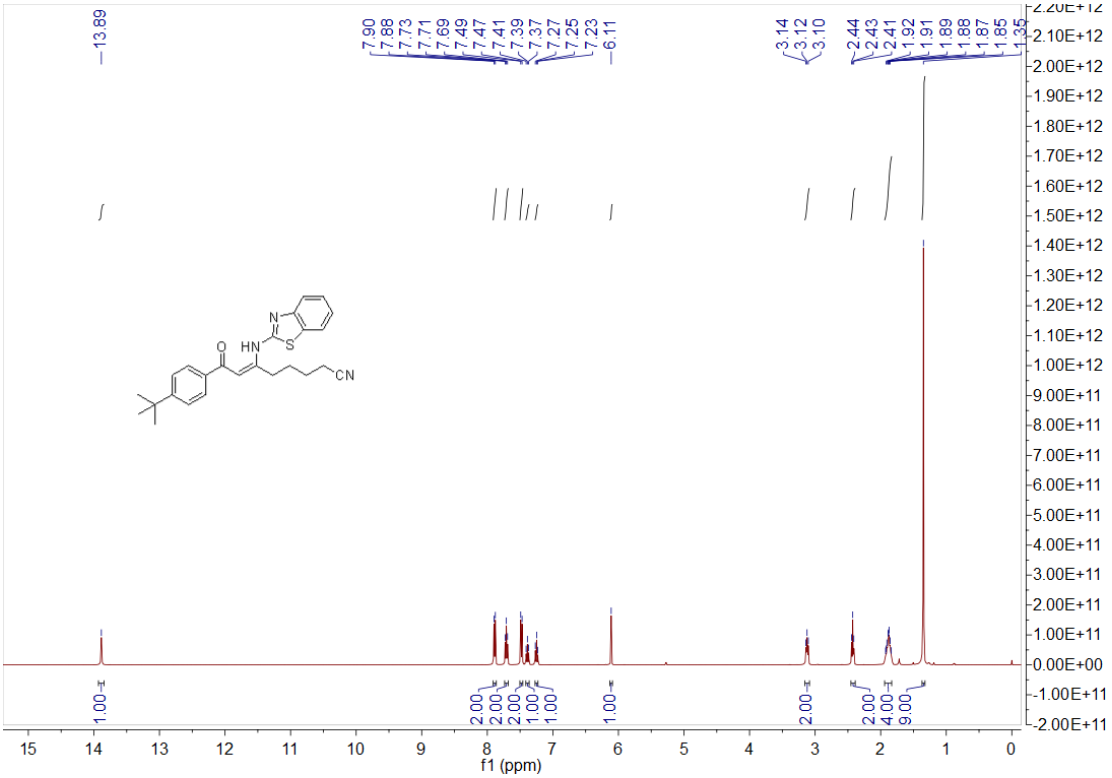
^{13}C NMR Spectrum of Compound **3a** (100 Hz, $CDCl_3$)



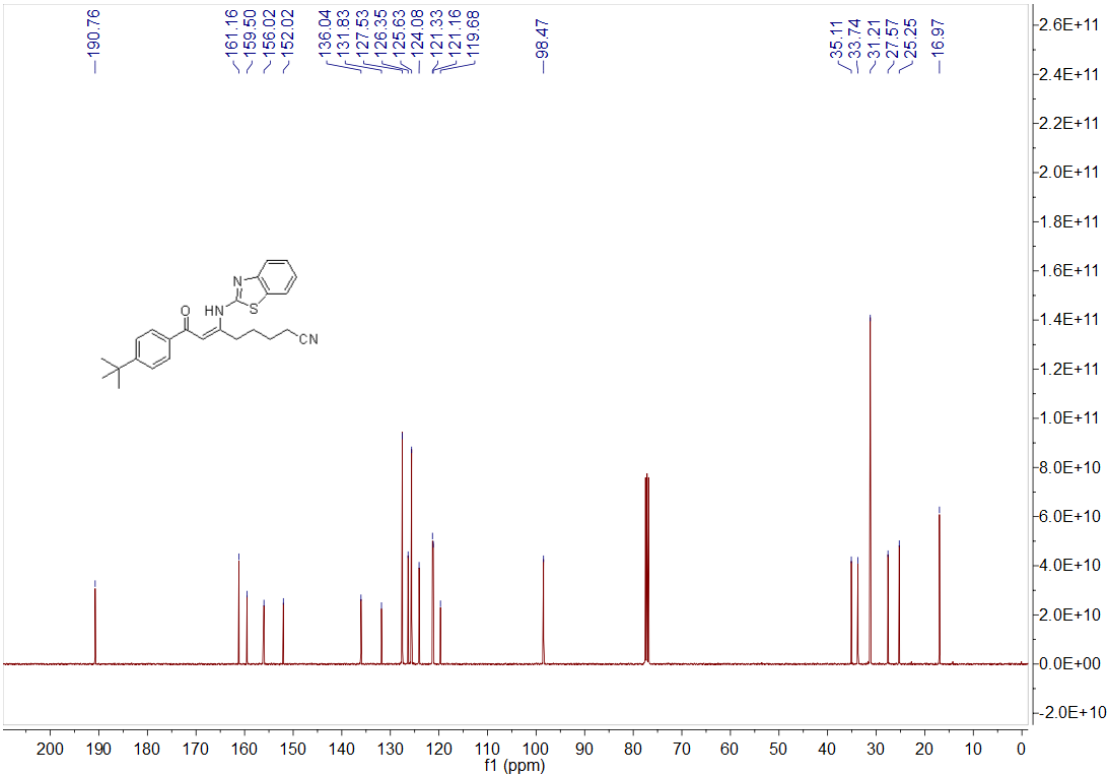
^{1}H NMR Spectrum of Compound **3b** (400 Hz, $CDCl_3$)



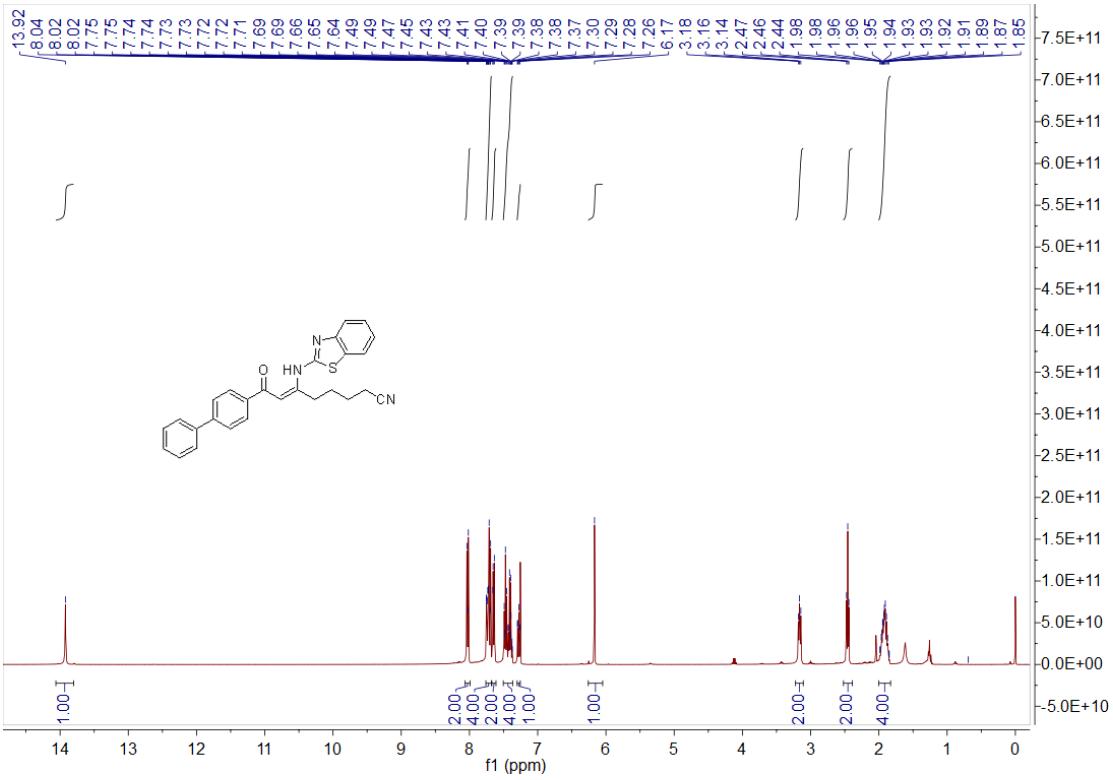
^{13}C NMR Spectrum of Compound **3b** (100 Hz, $CDCl_3$)



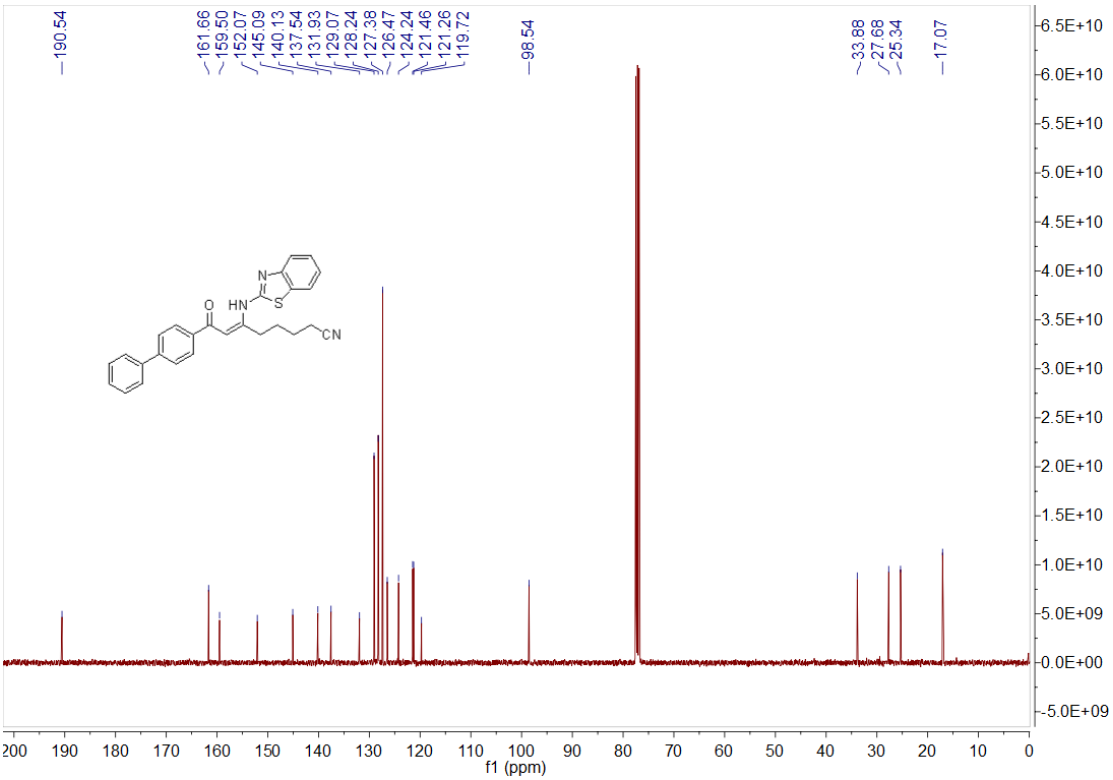
^{1}H NMR Spectrum of Compound **3c** (400 Hz, $CDCl_3$)



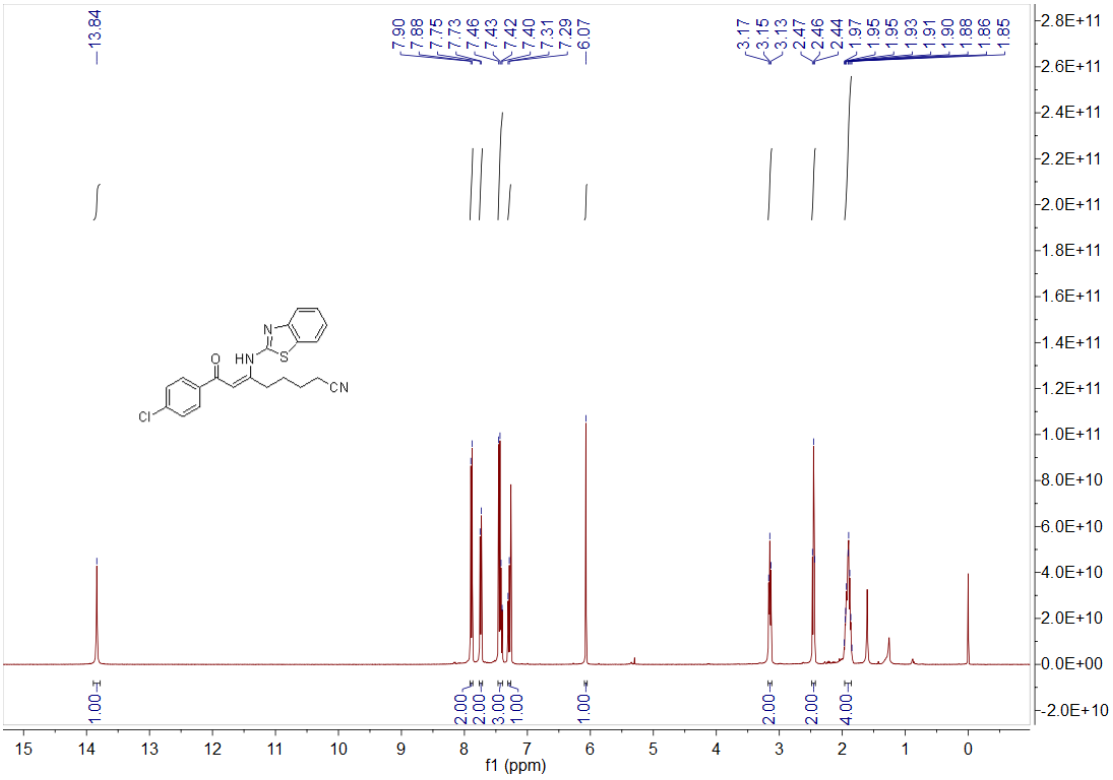
^{13}C NMR Spectrum of Compound **3c** (100 Hz, $CDCl_3$)



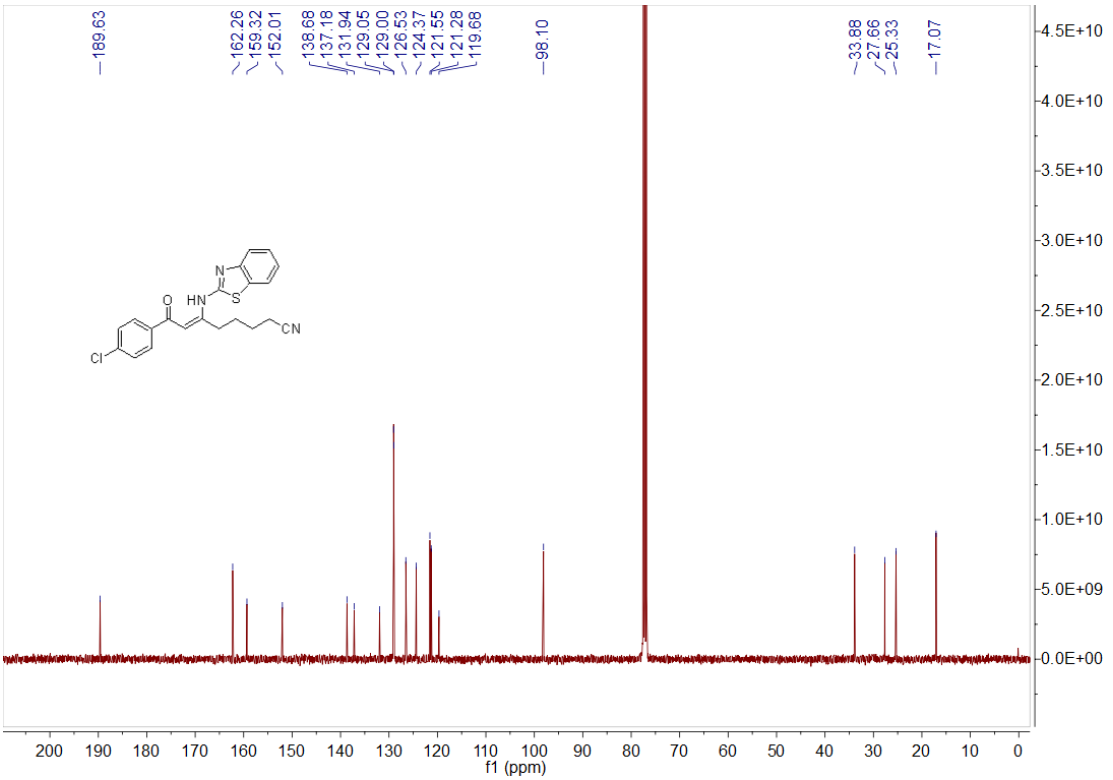
^{1}H NMR Spectrum of Compound **3d** (400 Hz, $CDCl_3$)



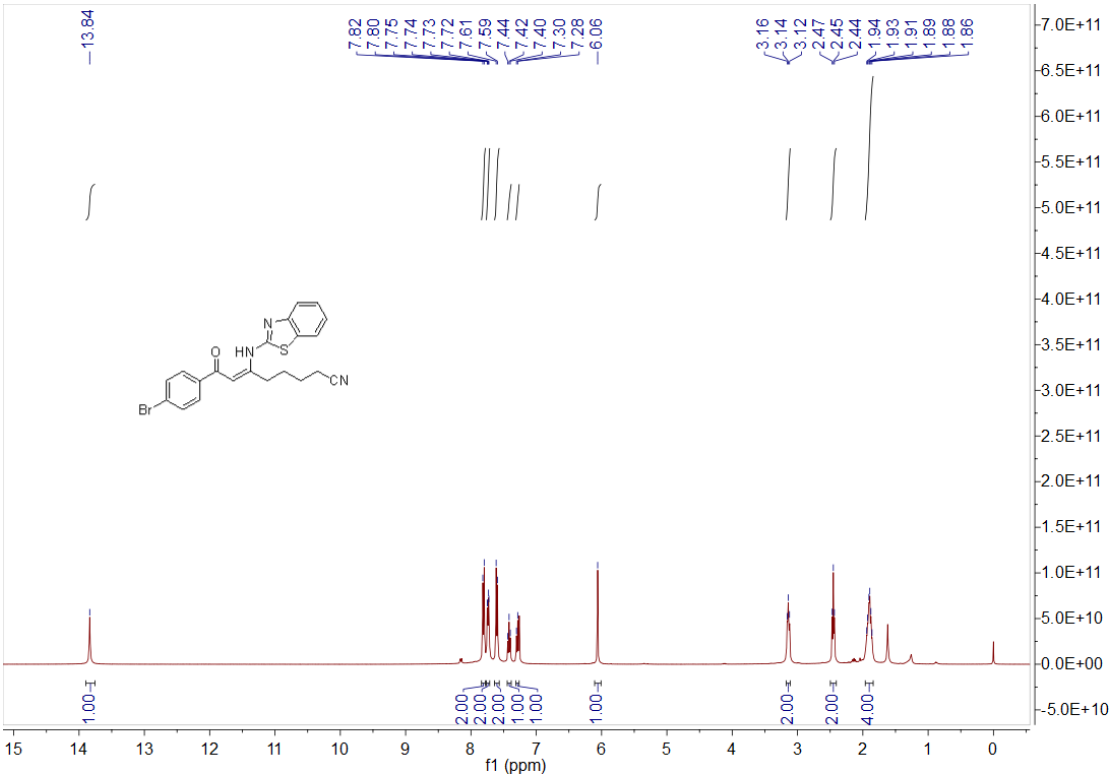
^{13}C NMR Spectrum of Compound **3d** (100 Hz, $CDCl_3$)



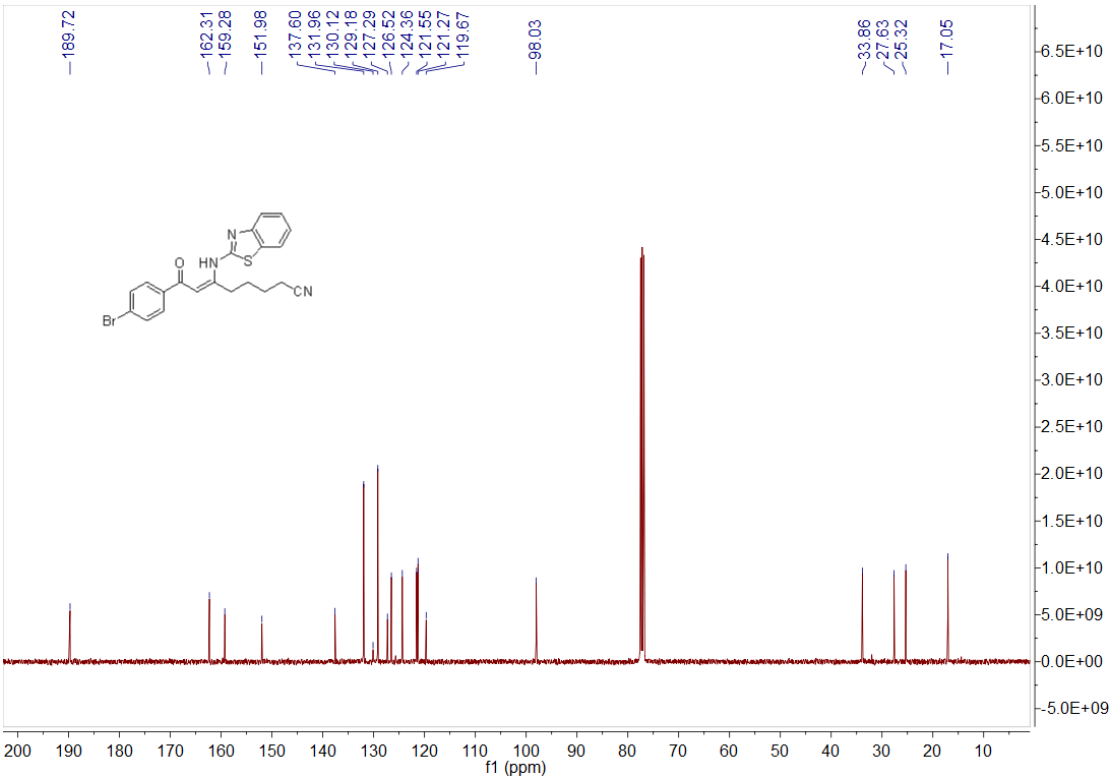
^{1}H NMR Spectrum of Compound **3e** (400 Hz, $CDCl_3$)



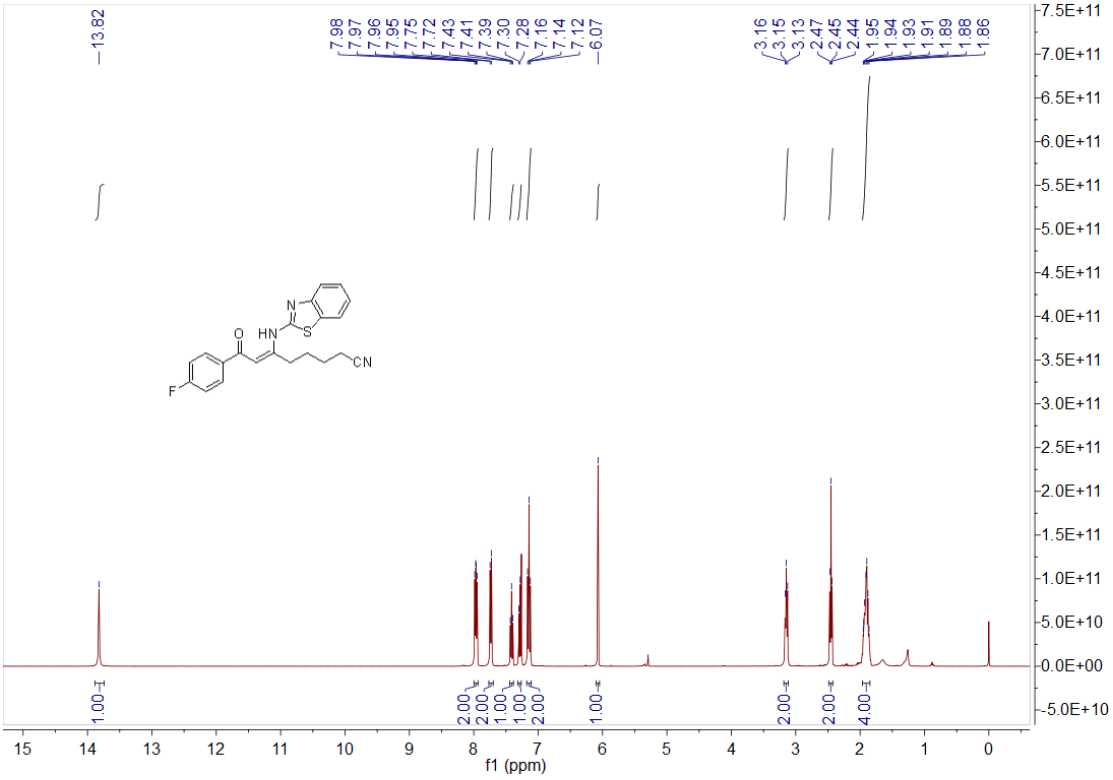
^{13}C NMR Spectrum of Compound **3e** (100 Hz, $CDCl_3$)



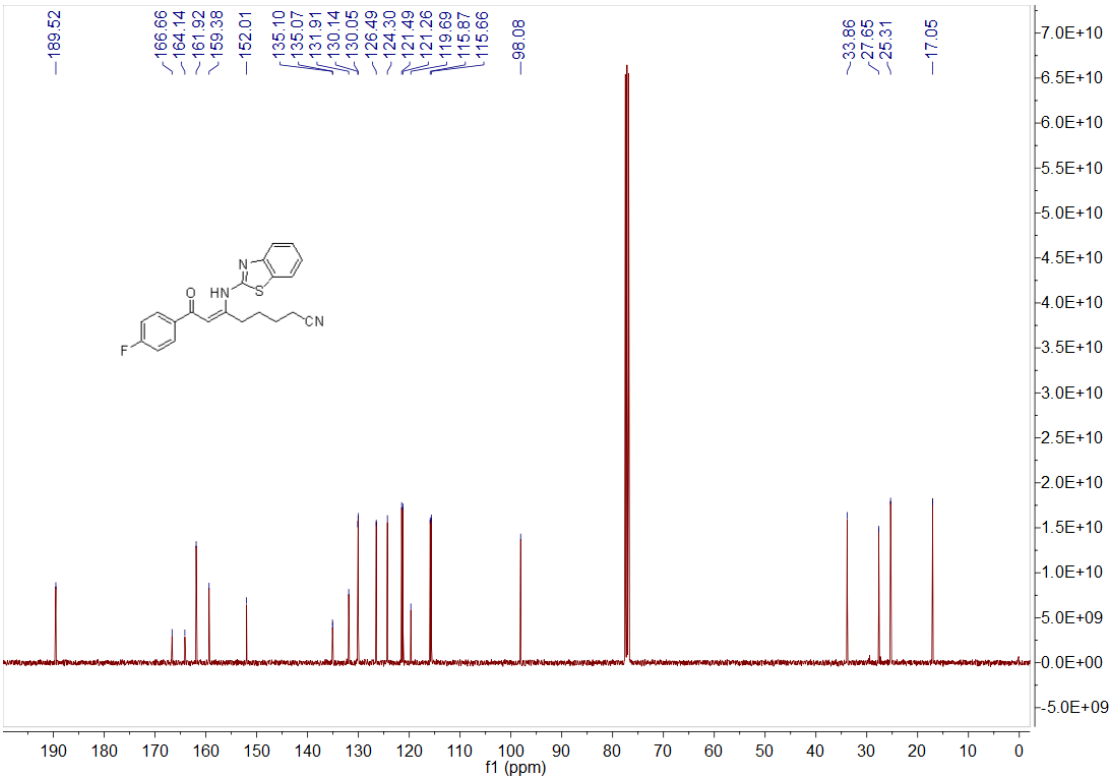
^{1}H NMR Spectrum of Compound **3f** (400 Hz, $CDCl_3$)



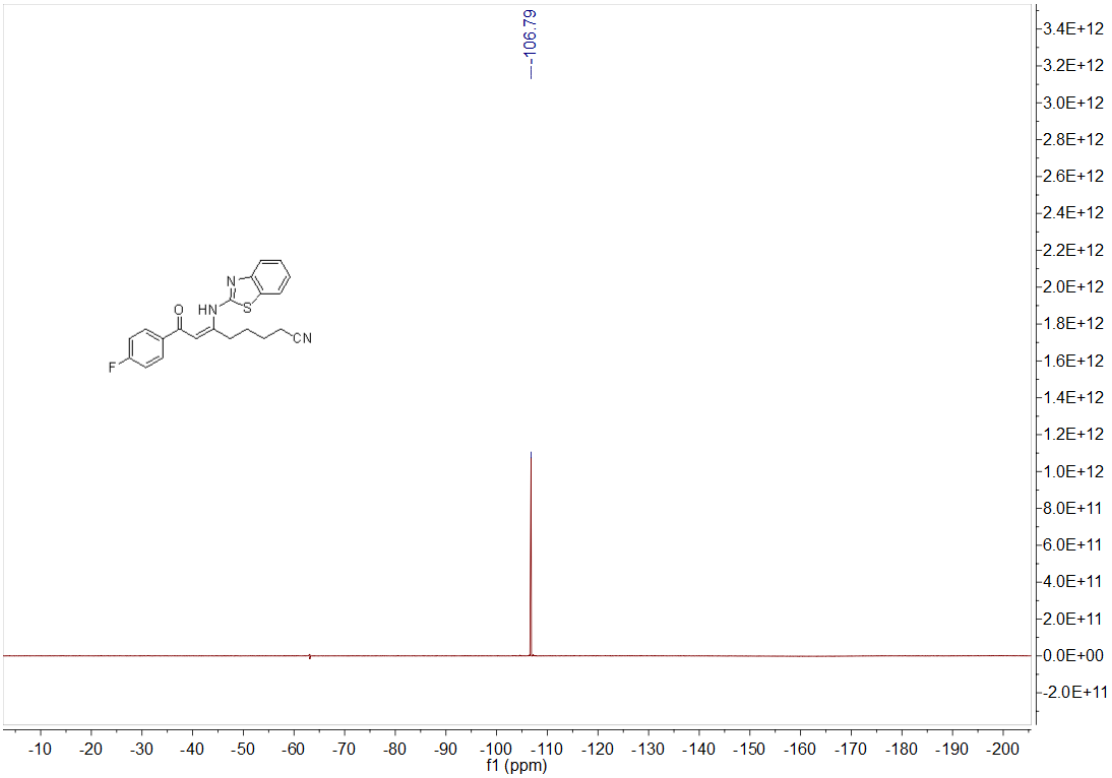
^{13}C NMR Spectrum of Compound **3f** (100 Hz, $CDCl_3$)



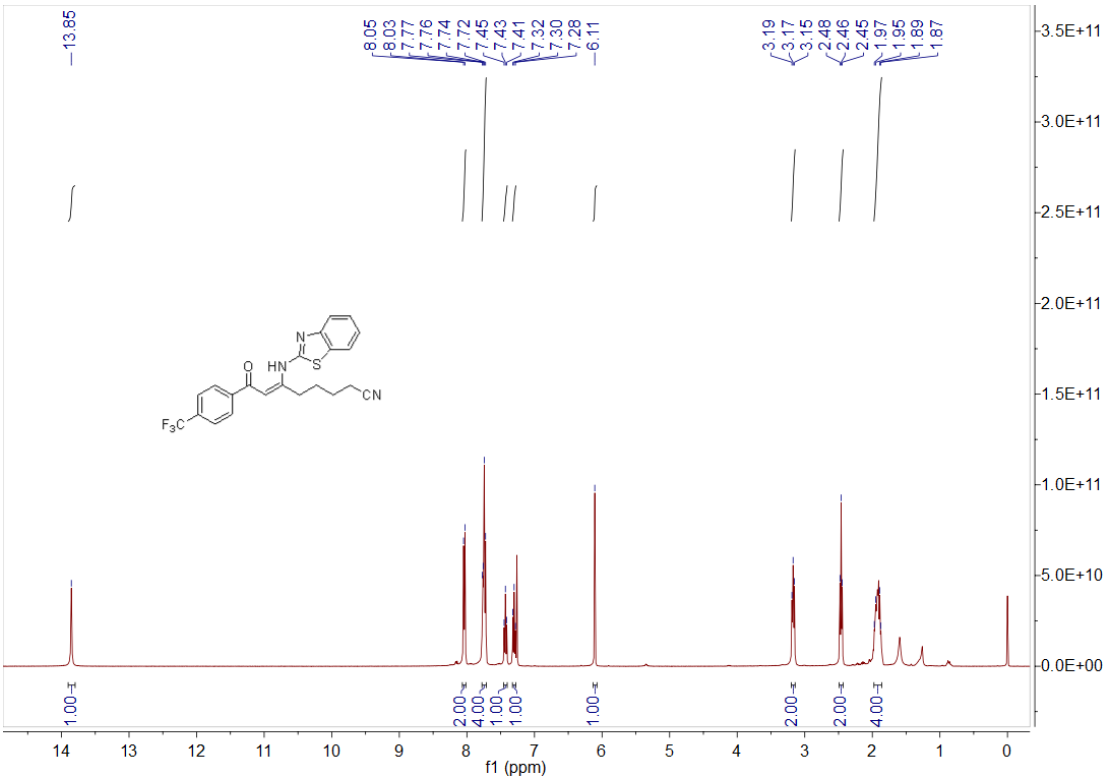
^{1}H NMR Spectrum of Compound **3g** (400 Hz, $CDCl_3$)



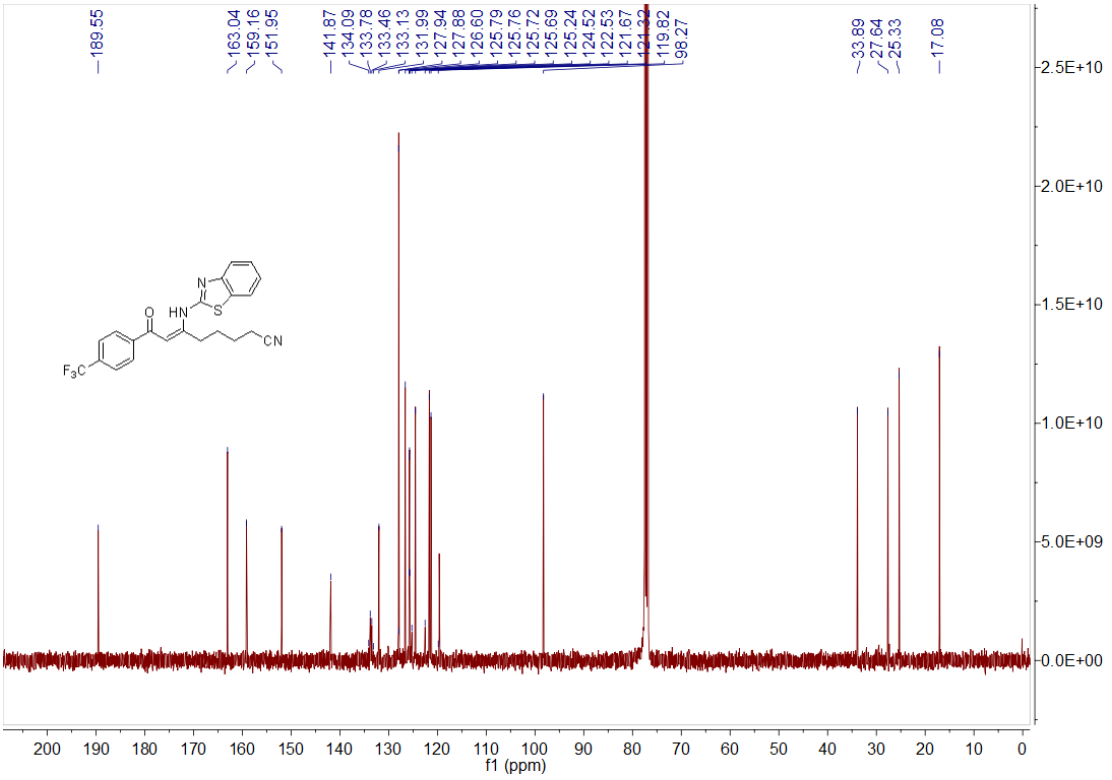
^{13}C NMR Spectrum of Compound **3g** (100 Hz, $CDCl_3$)



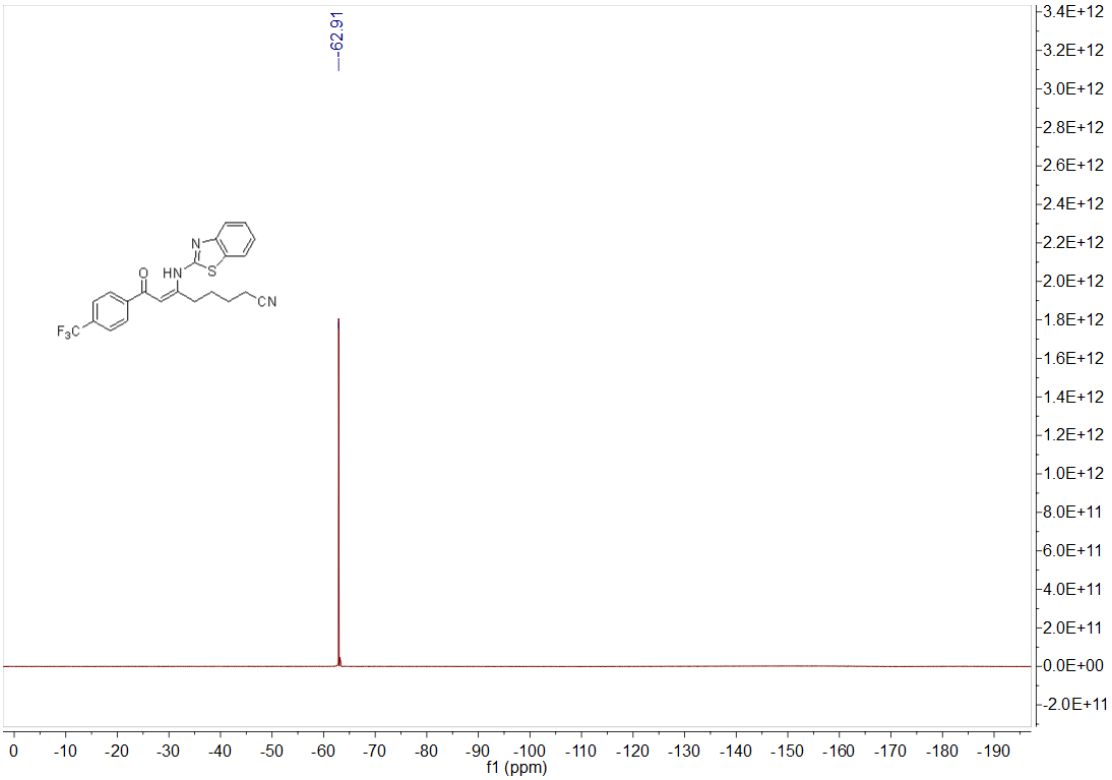
^{19}F NMR Spectrum of Compound **3g** (376 Hz, $CDCl_3$)



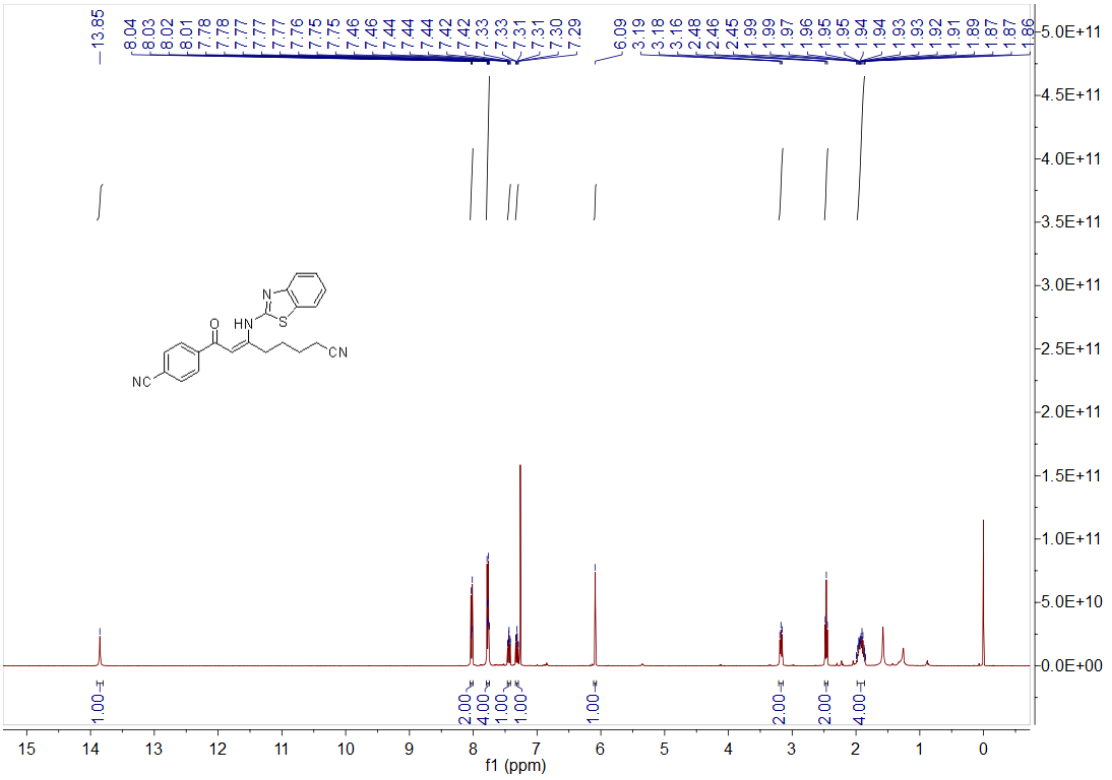
^{1}H NMR Spectrum of Compound **3h** (400 Hz, $CDCl_3$)



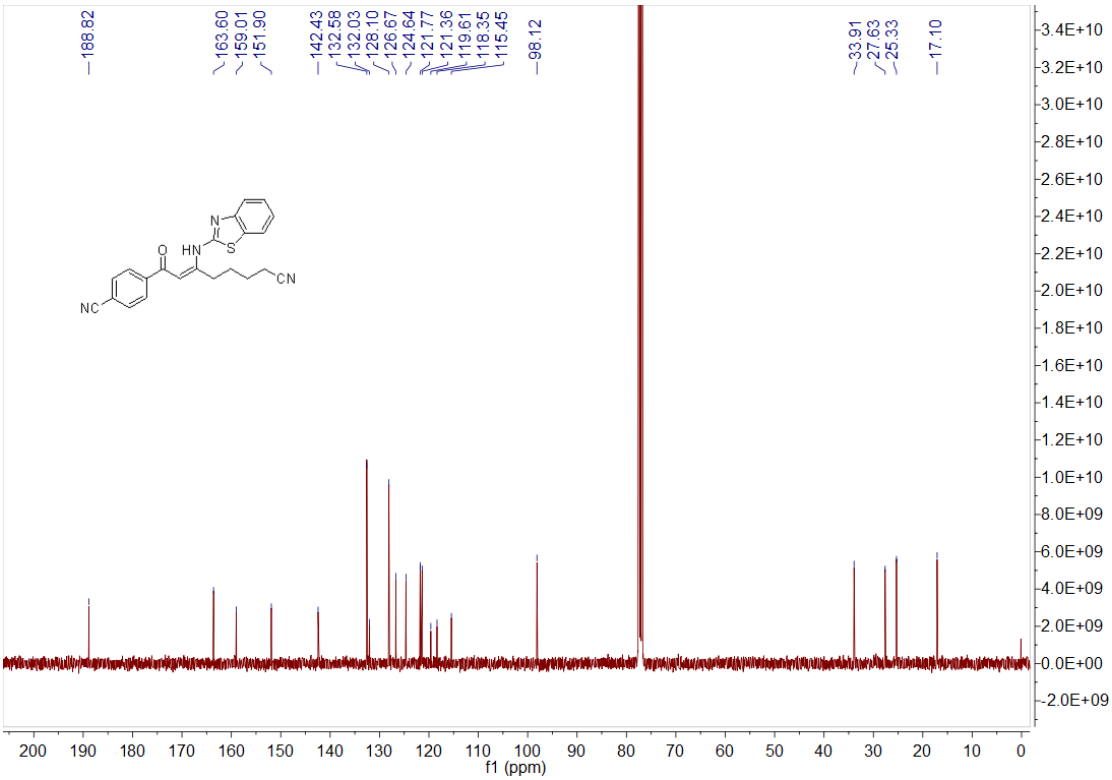
^{13}C NMR Spectrum of Compound **3h** (100 Hz, $CDCl_3$)



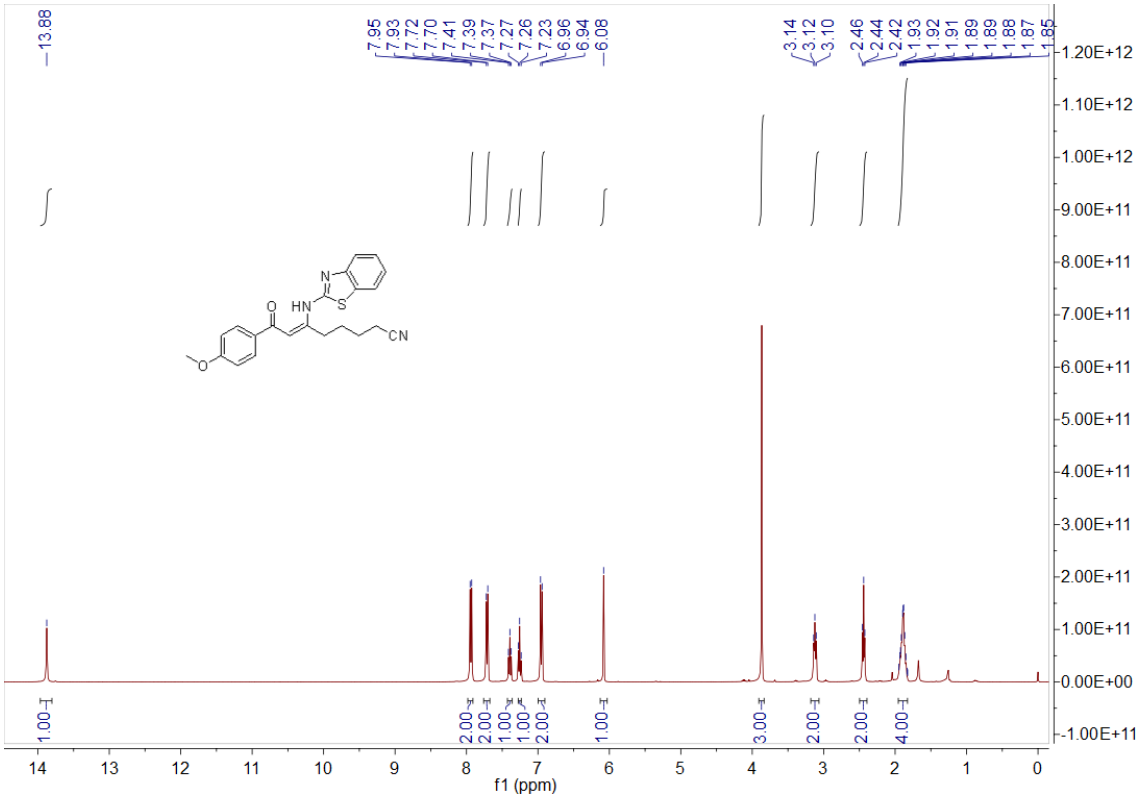
^{19}F NMR Spectrum of Compound **3h** (376 Hz, $CDCl_3$)



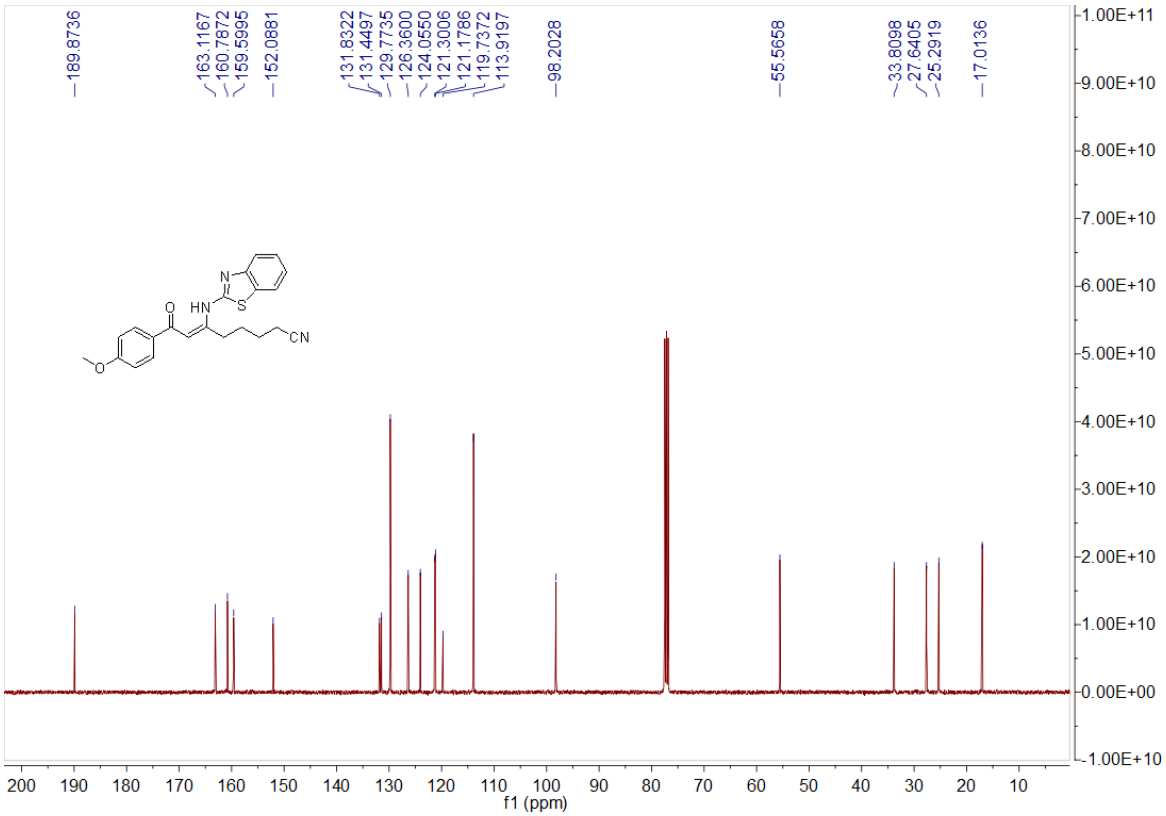
^{1}H NMR Spectrum of Compound **3i** (400 Hz, $CDCl_3$)



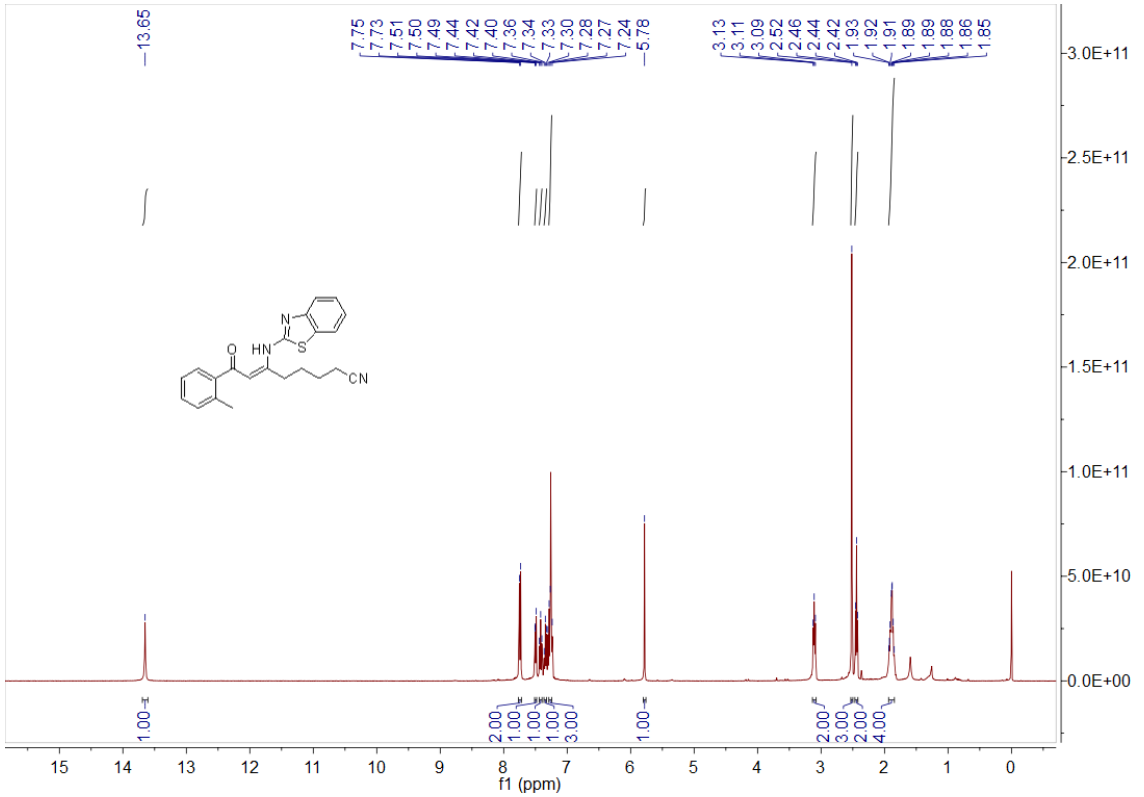
^{13}C NMR Spectrum of Compound **3i** (100 Hz, $CDCl_3$)



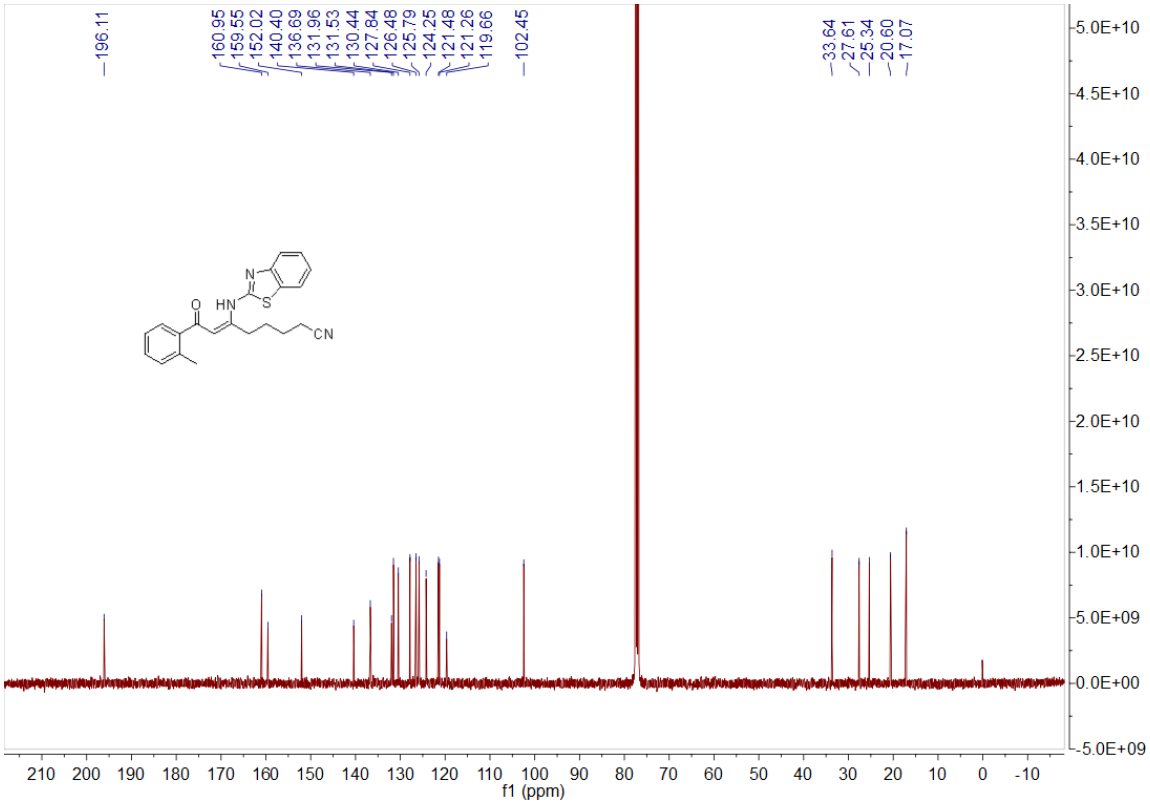
^{1}H NMR Spectrum of Compound **3j** (400 Hz, $CDCl_3$)



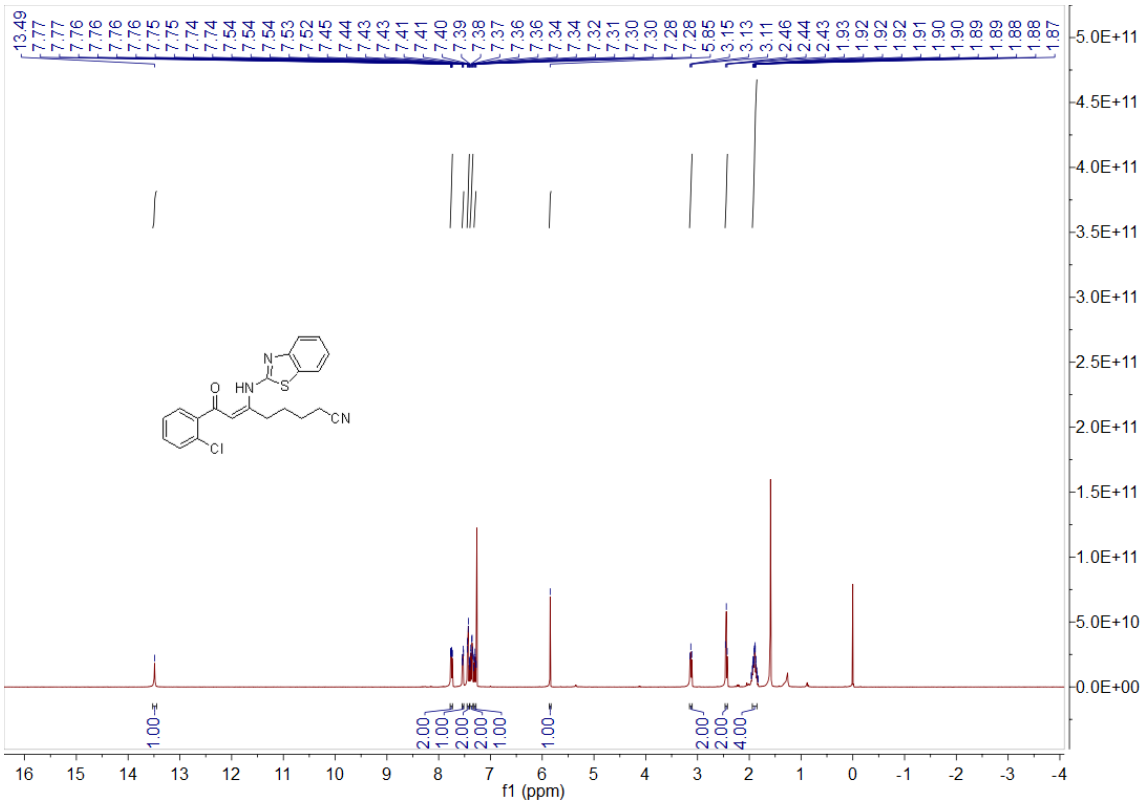
^{13}C NMR Spectrum of Compound **3j** (100 Hz, $CDCl_3$)



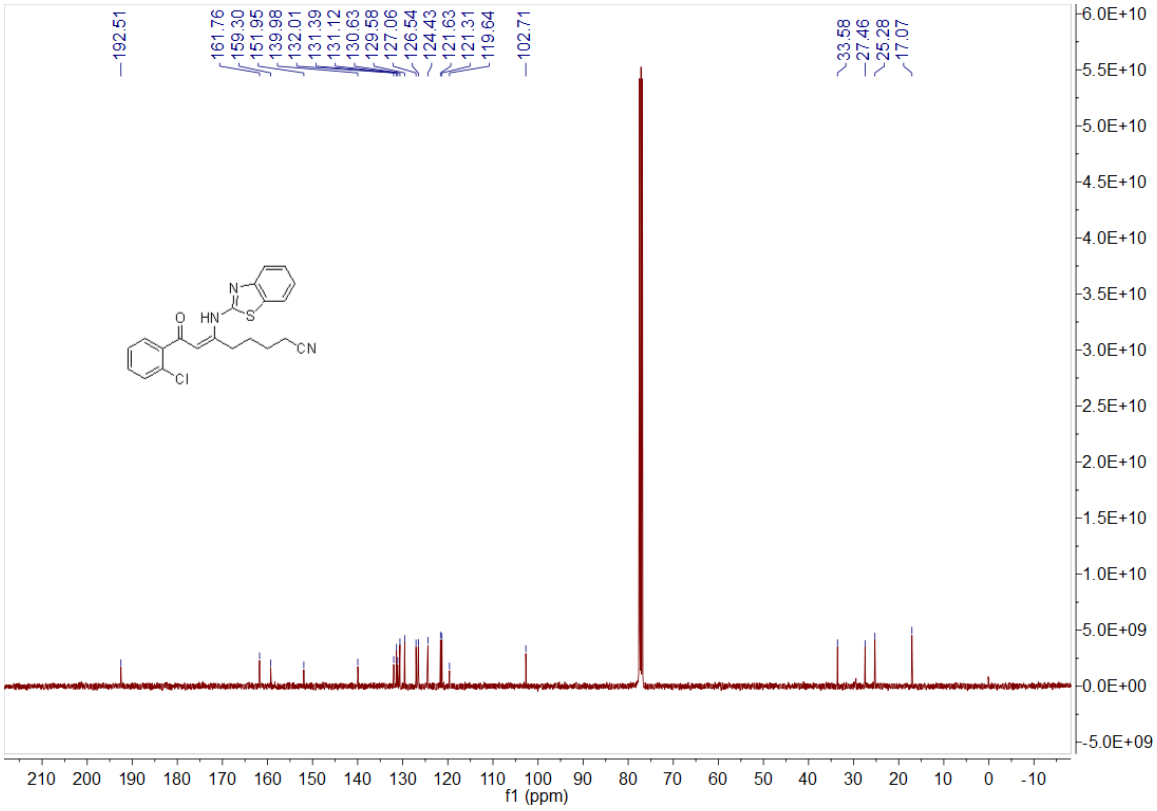
^{1}H NMR Spectrum of Compound **3k** (400 Hz, $CDCl_3$)



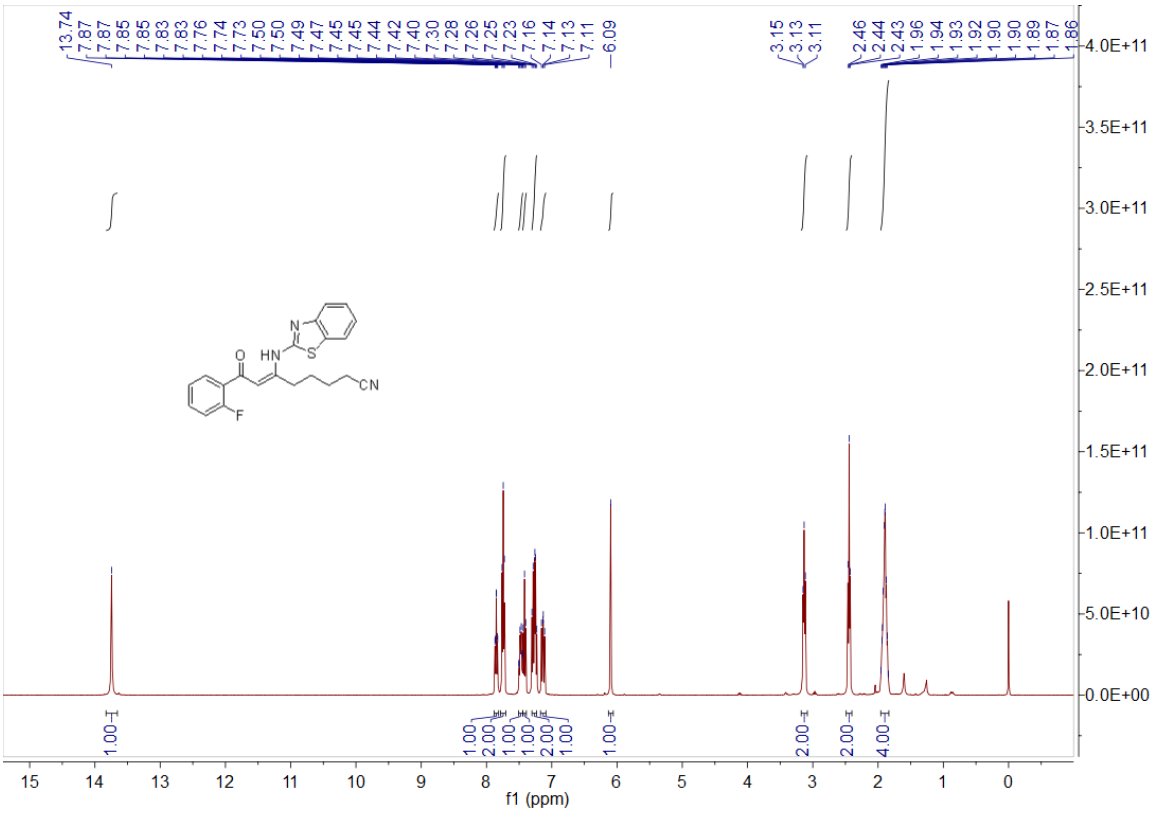
^{13}C NMR Spectrum of Compound **3k** (100 Hz, $CDCl_3$)



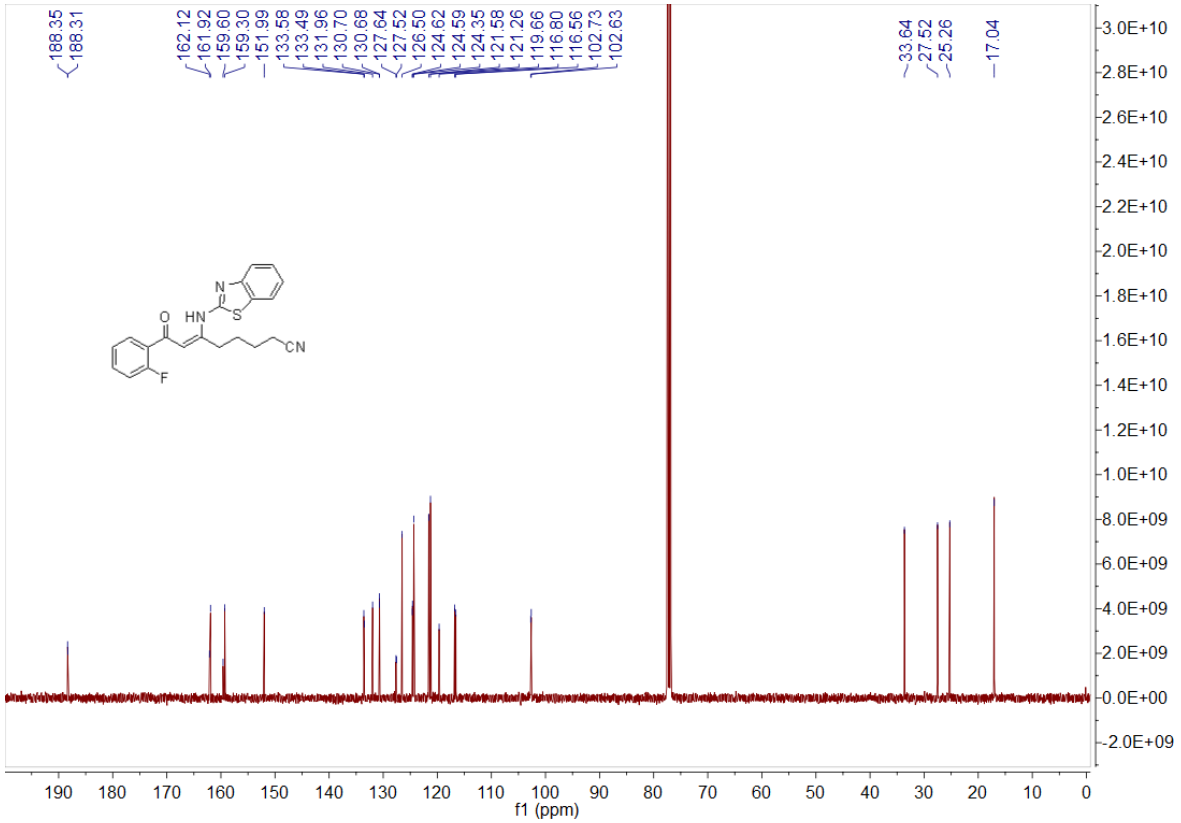
^{1}H NMR Spectrum of Compound **3l** (400 Hz, $CDCl_3$)



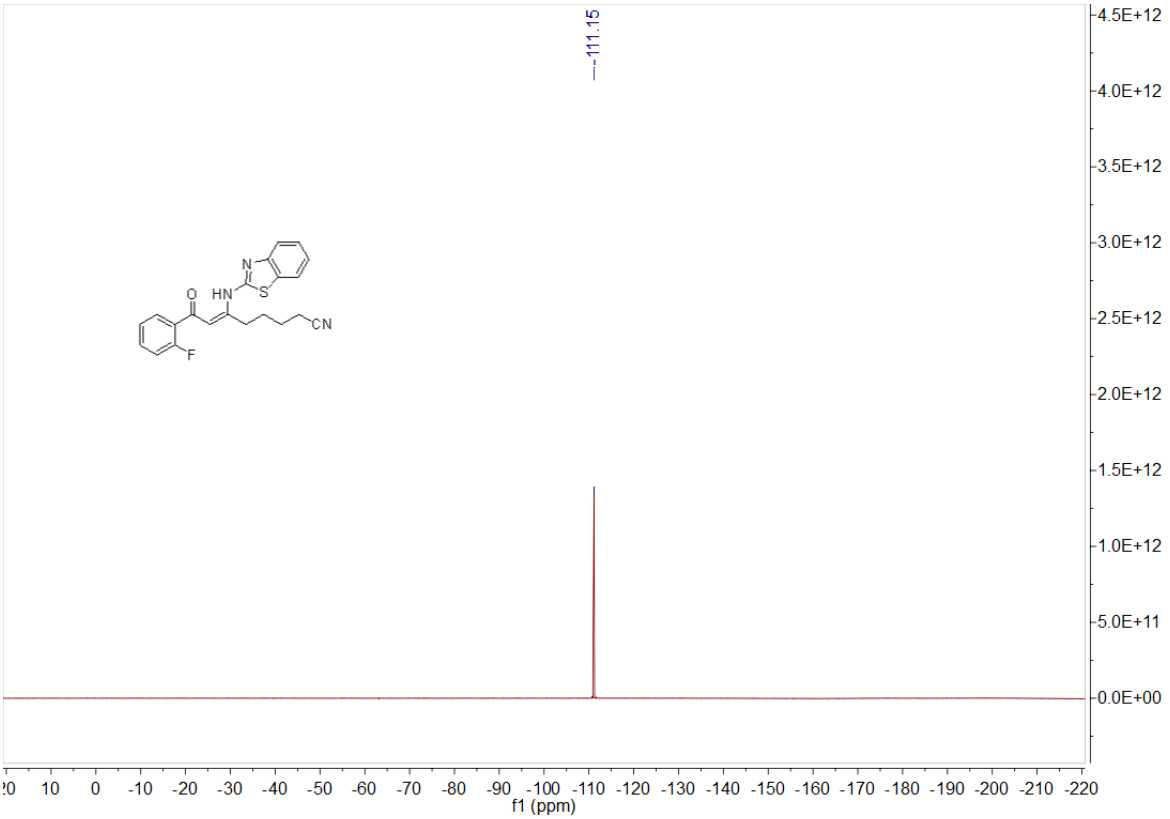
^{13}C NMR Spectrum of Compound **3l** (100 Hz, $CDCl_3$)



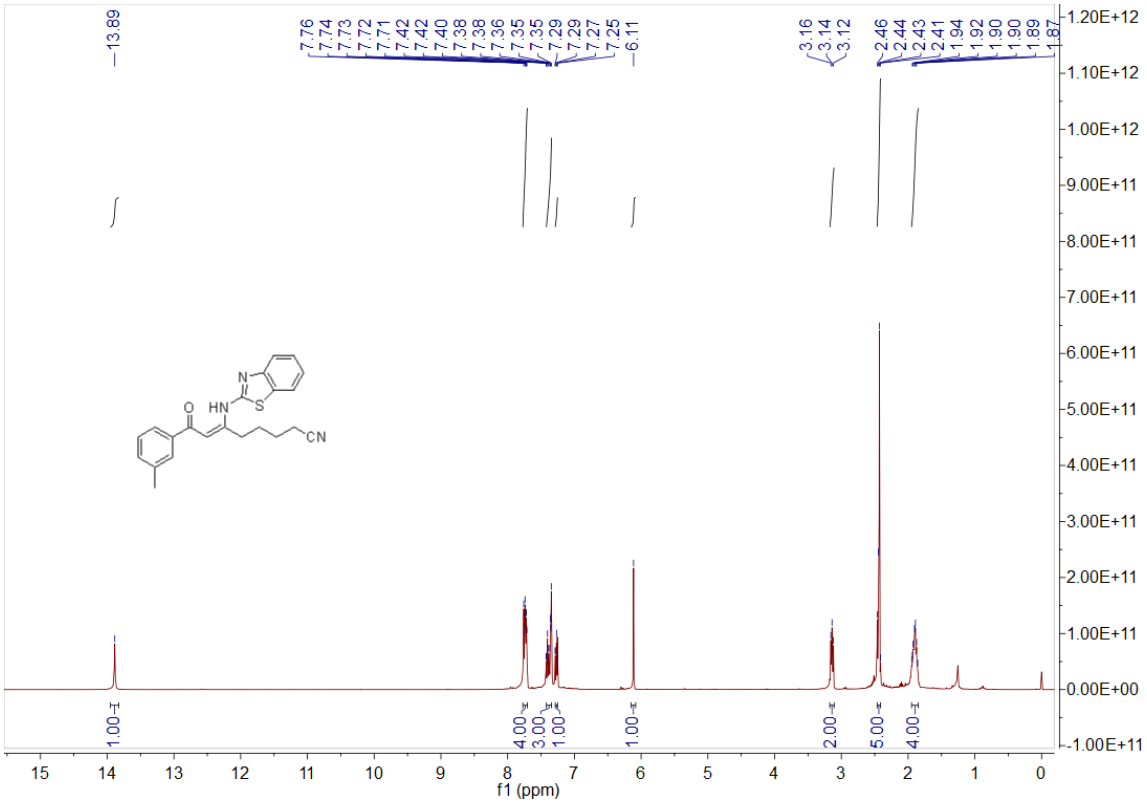
^{1}H NMR Spectrum of Compound **3m** (400 Hz, $CDCl_3$)



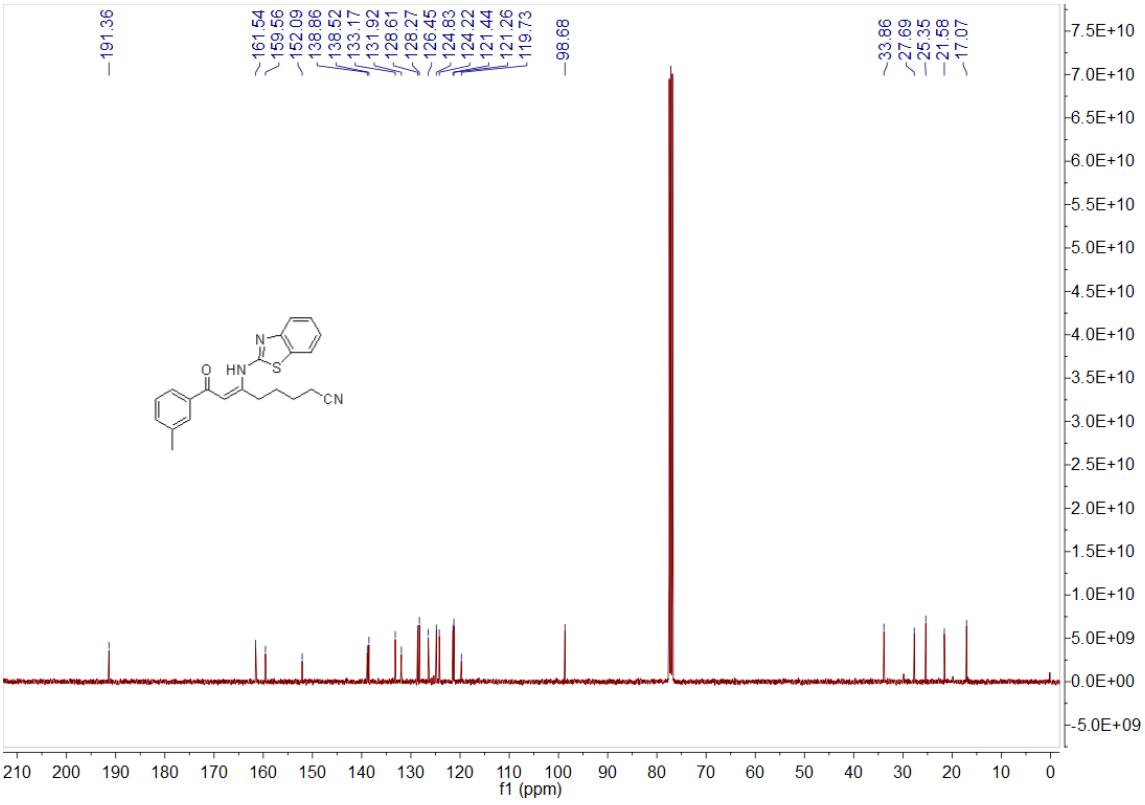
^{13}C NMR Spectrum of Compound **3m** (100 Hz, $CDCl_3$)



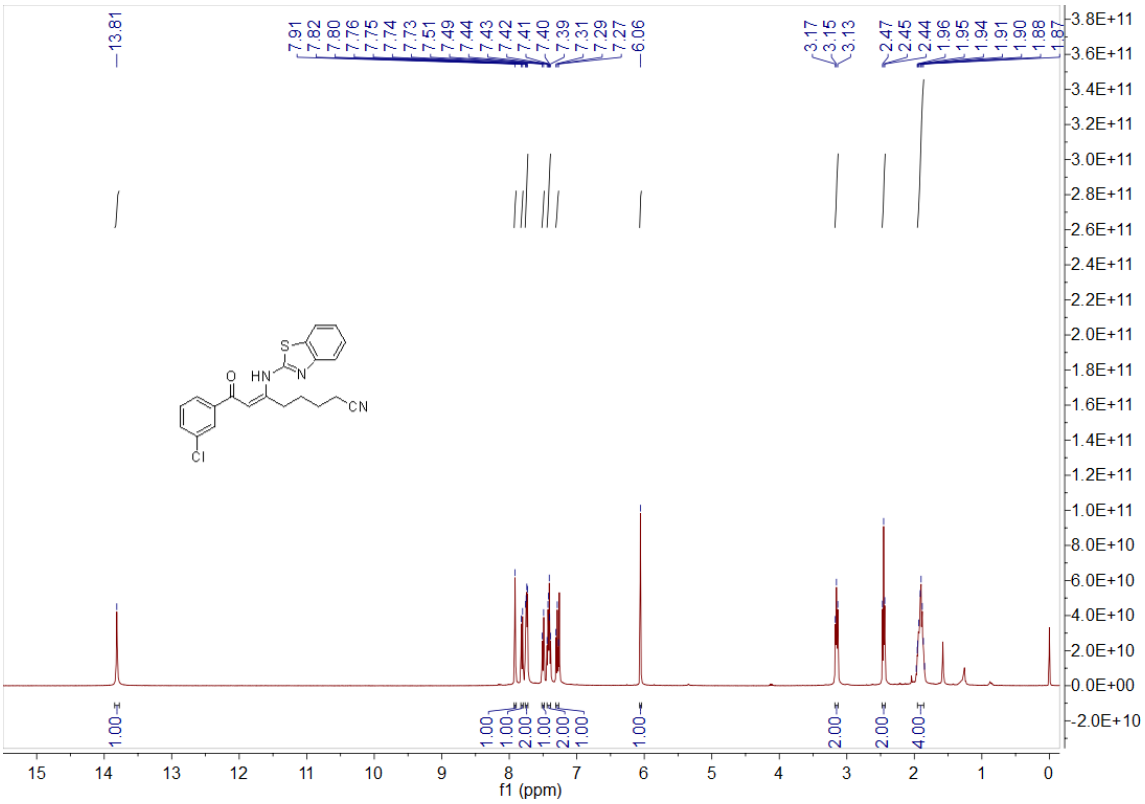
^{19}F NMR Spectrum of Compound **3m** (376 Hz, $CDCl_3$)



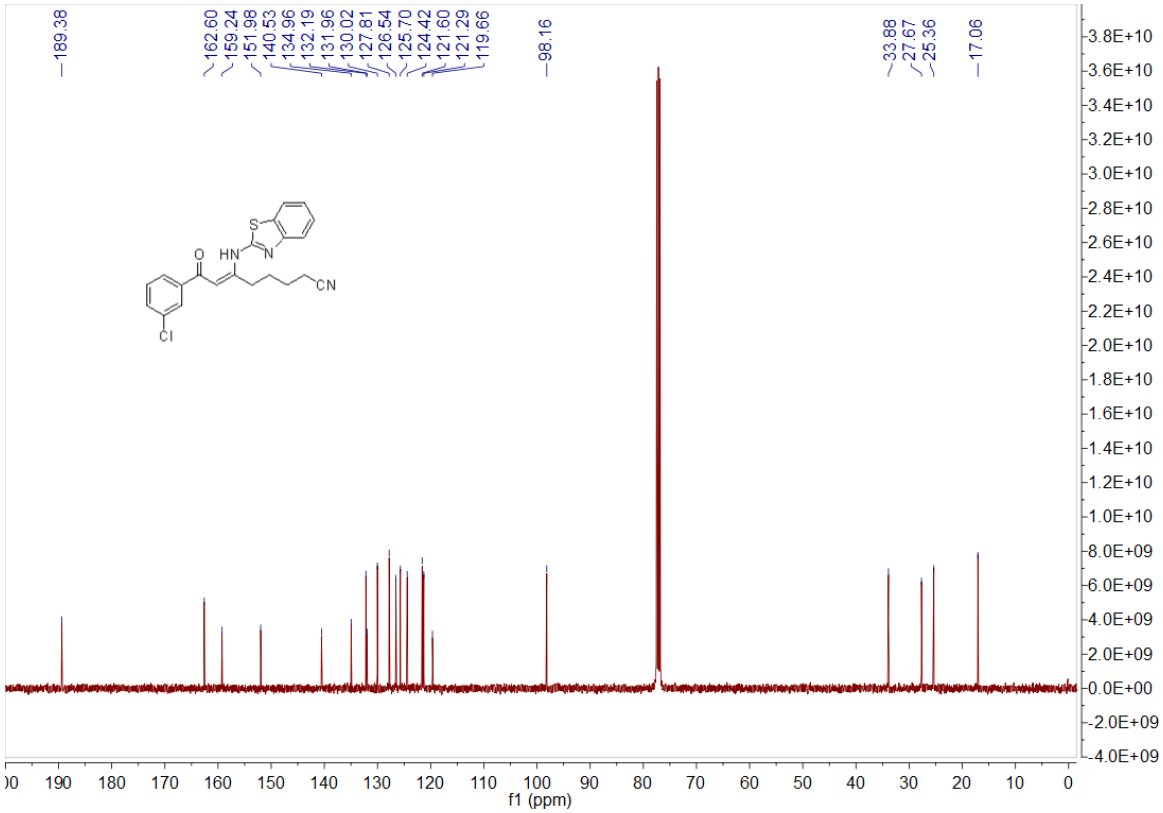
^{1}H NMR Spectrum of Compound **3n** (400 Hz, $CDCl_3$)



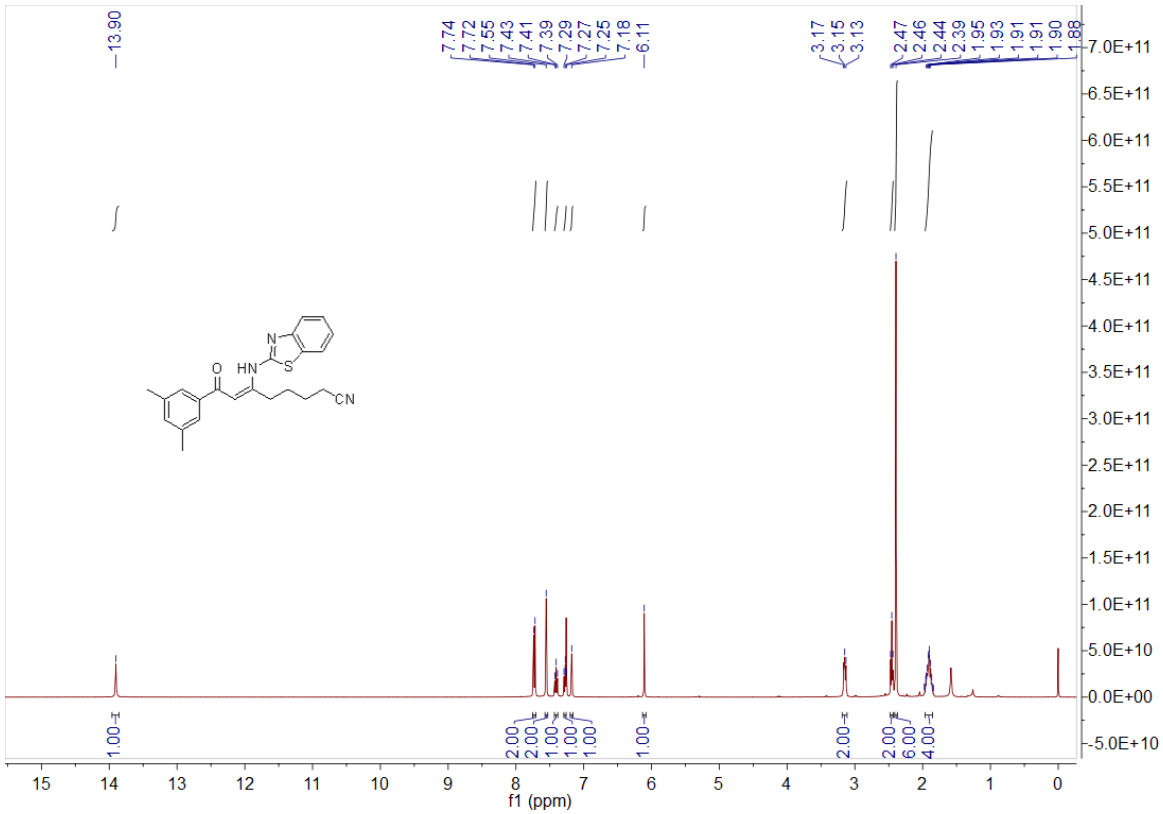
^{13}C NMR Spectrum of Compound **3n** (100 Hz, $CDCl_3$)



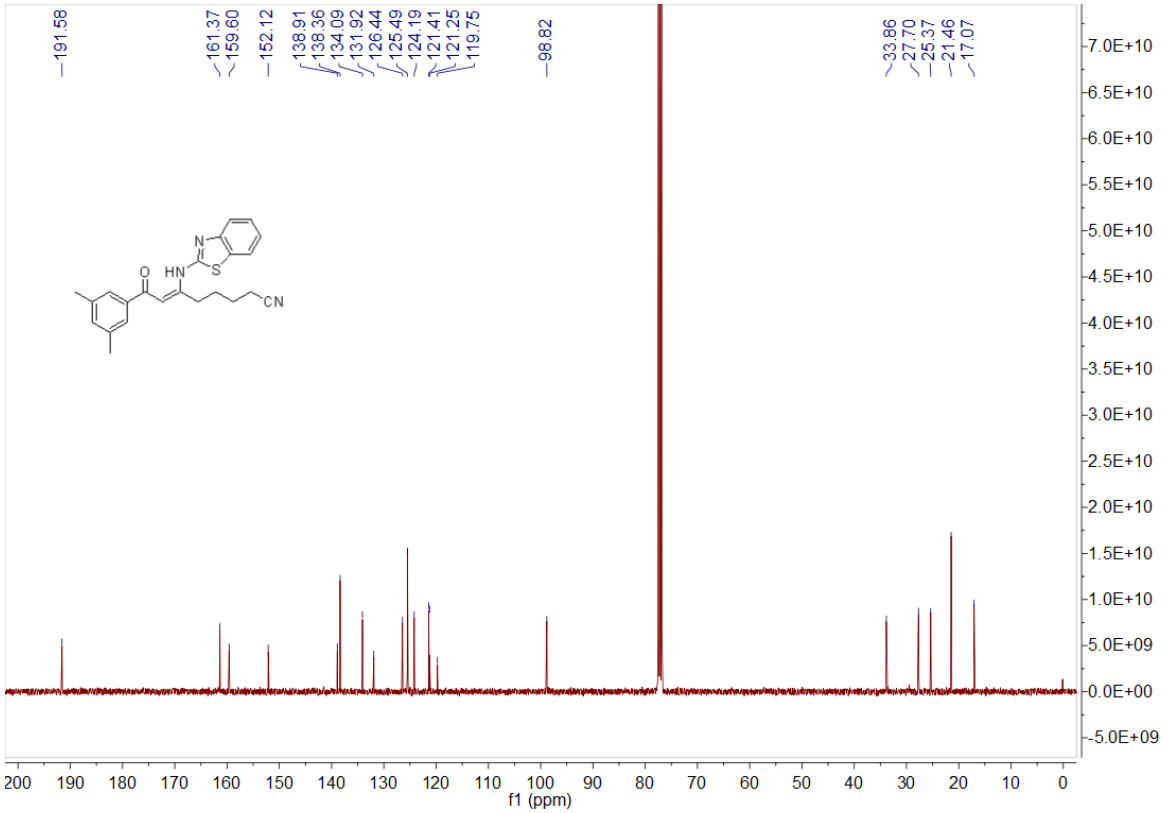
^{1}H NMR Spectrum of Compound **3o** (400 Hz, $CDCl_3$)



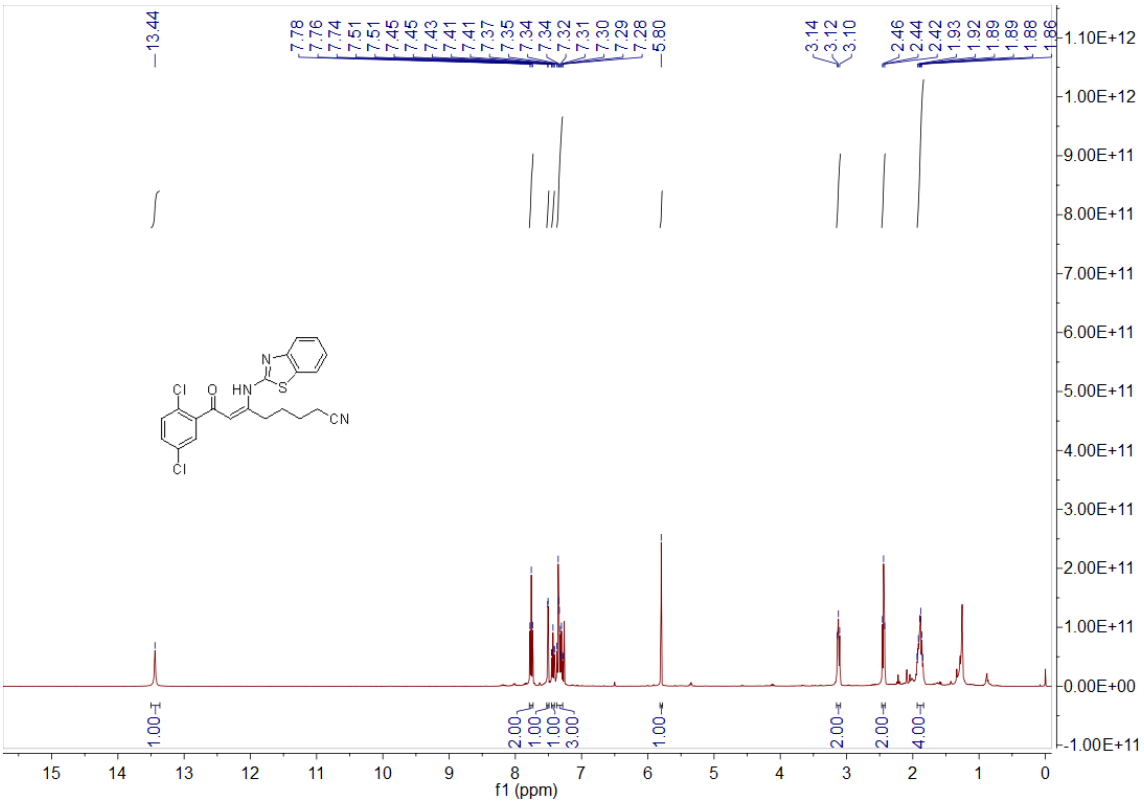
^{13}C NMR Spectrum of Compound **3o** (100 Hz, $CDCl_3$)



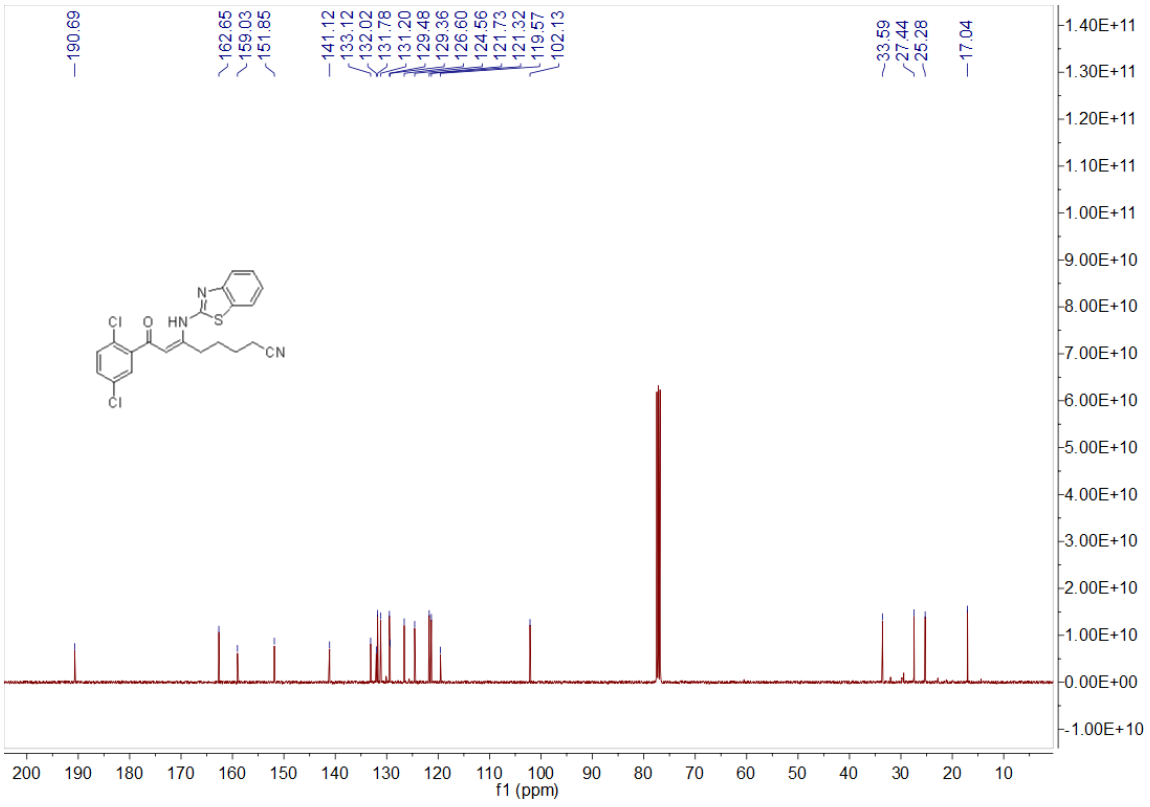
^{1}H NMR Spectrum of Compound **3p** (400 Hz, $CDCl_3$)



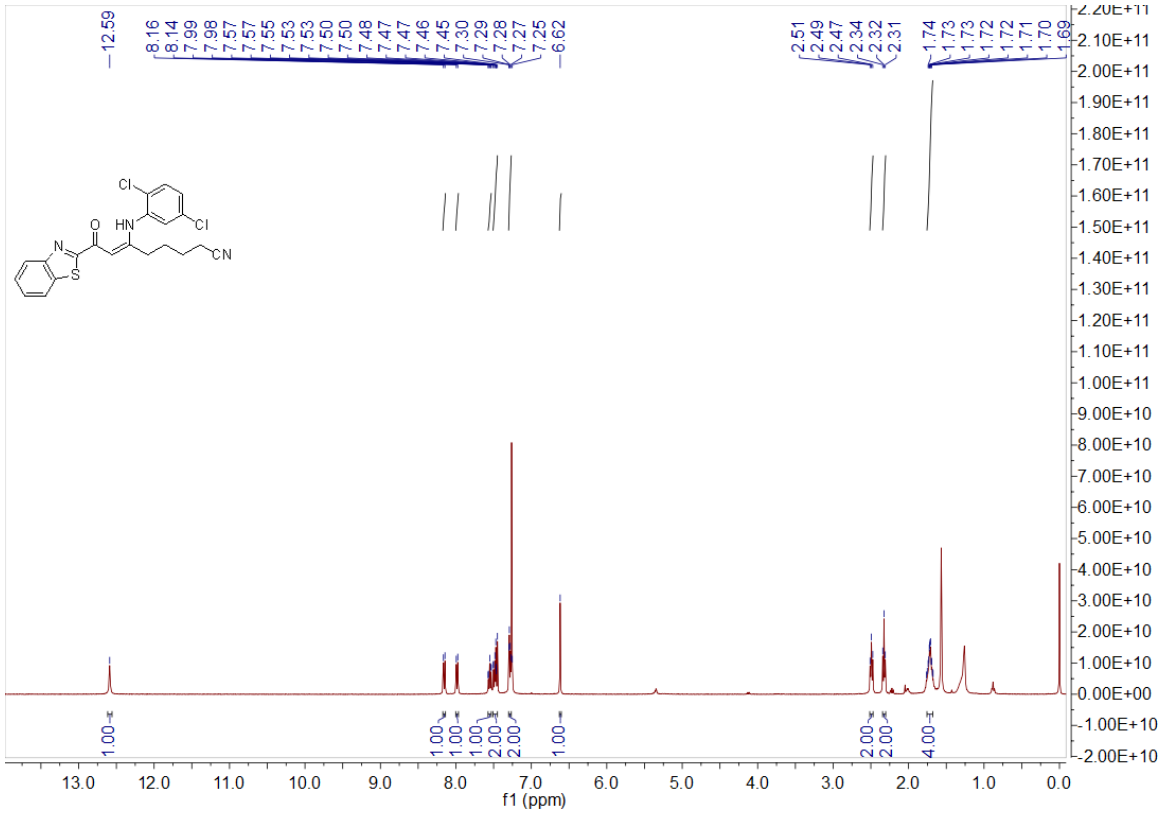
^{13}C NMR Spectrum of Compound **3p** (100 Hz, $CDCl_3$)



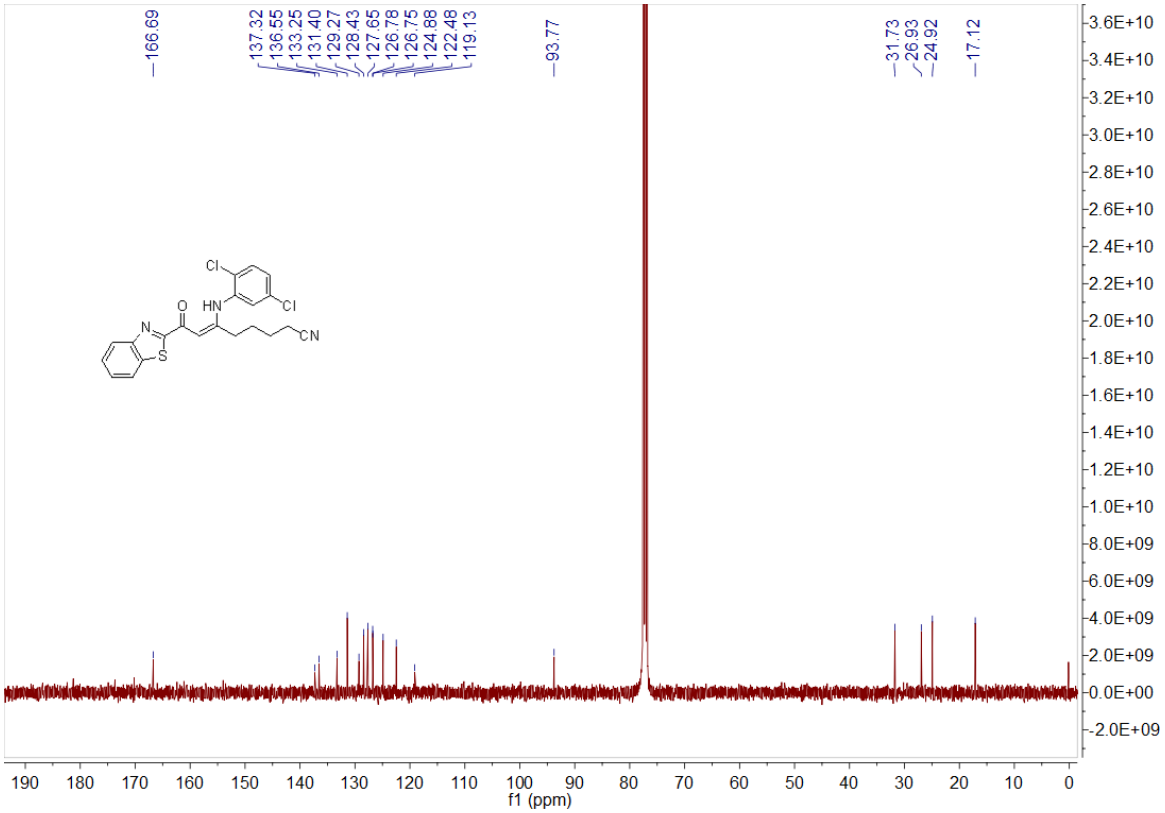
^{1}H NMR Spectrum of Compound **3q** (400 Hz, $CDCl_3$)



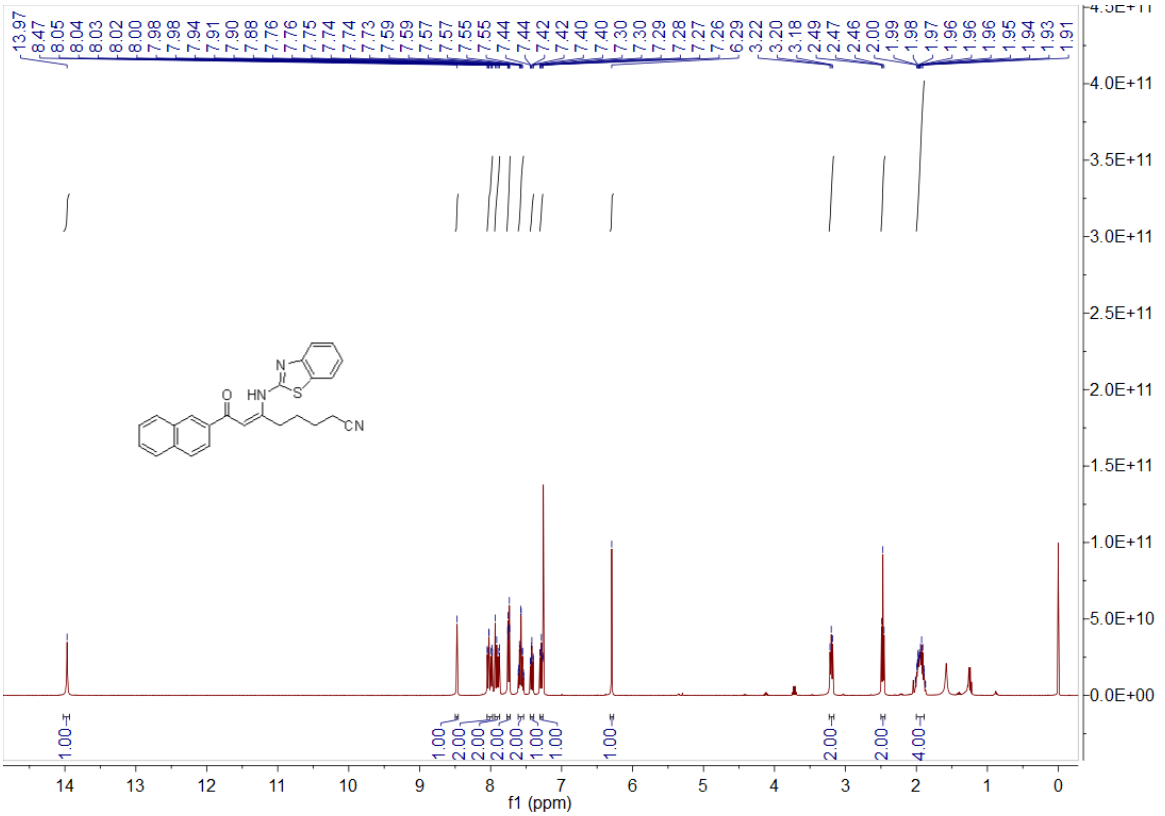
^{13}C NMR Spectrum of Compound **3q** (100 Hz, $CDCl_3$)



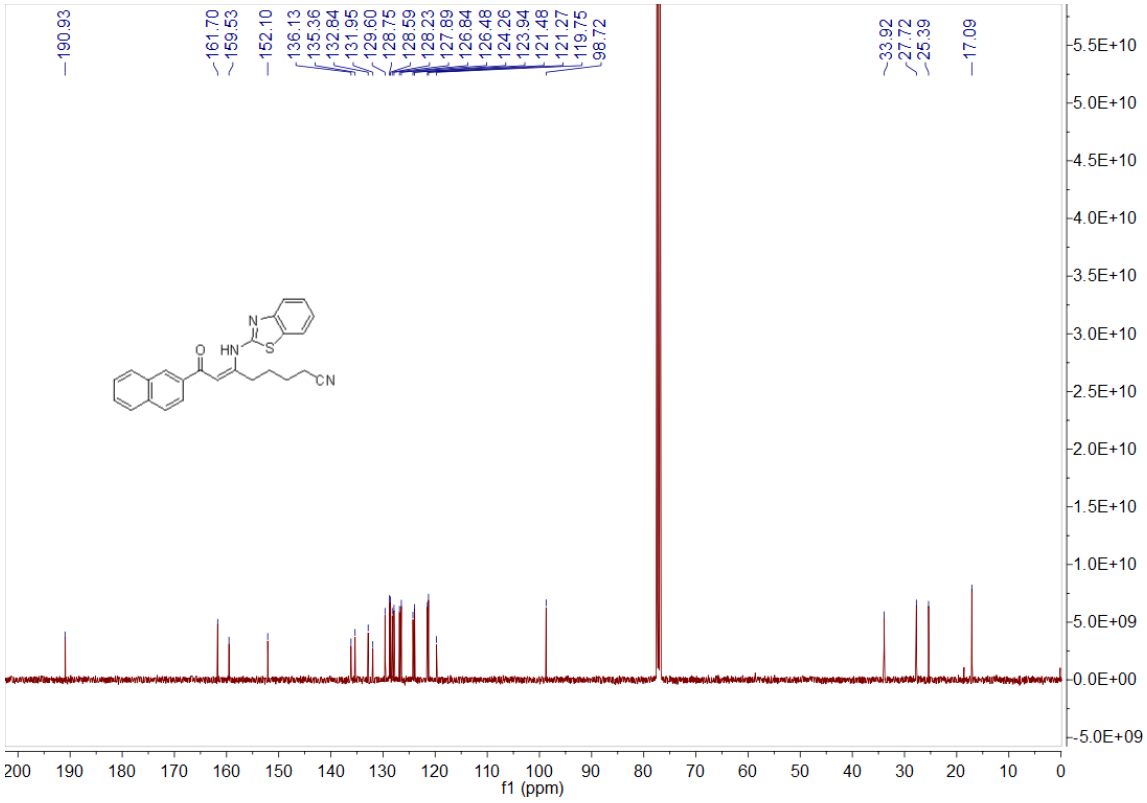
^{1}H NMR Spectrum of Compound **3q'** (400 Hz, $CDCl_3$)



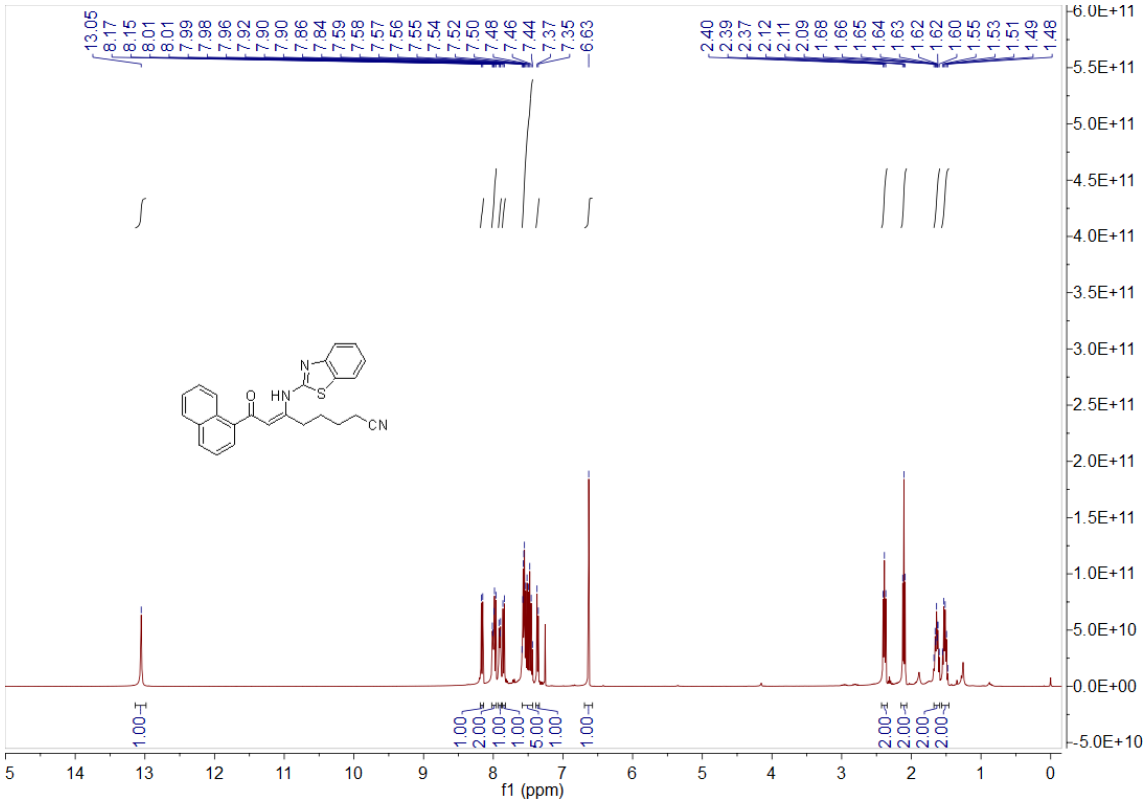
^{13}C NMR Spectrum of Compound **3q'** (100 Hz, $CDCl_3$)



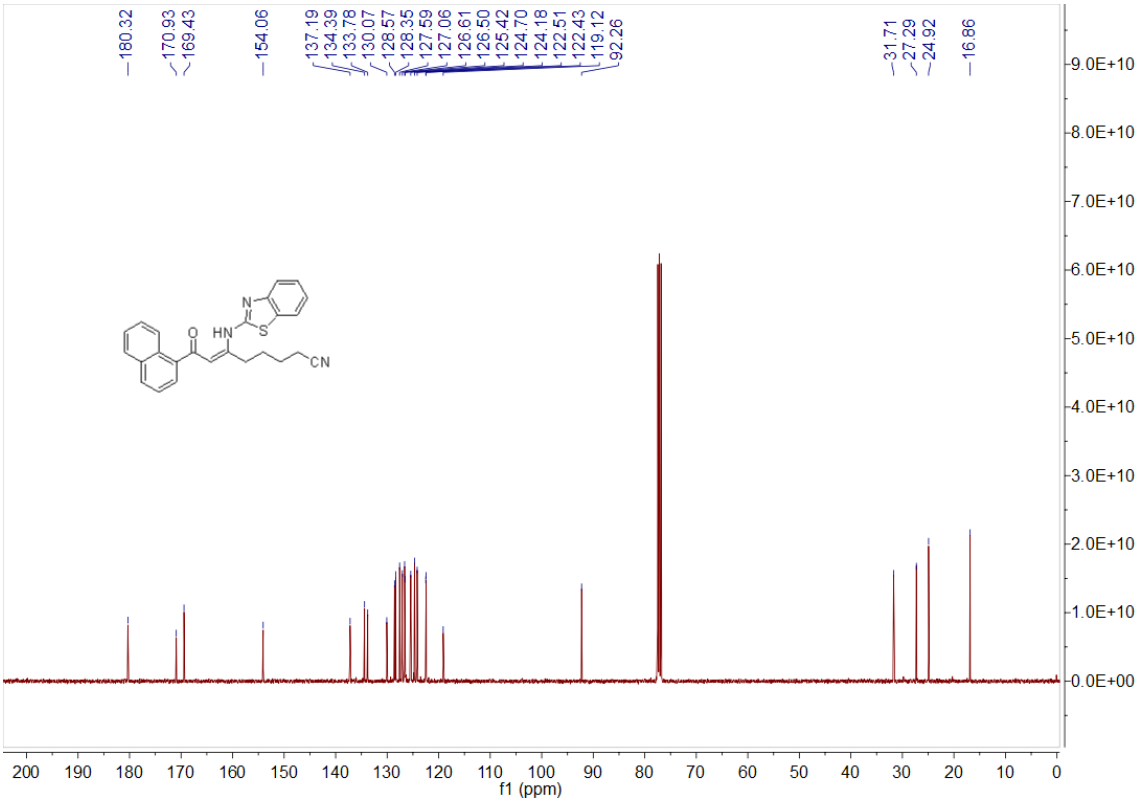
^{1}H NMR Spectrum of Compound **3r** (400 Hz, $CDCl_3$)



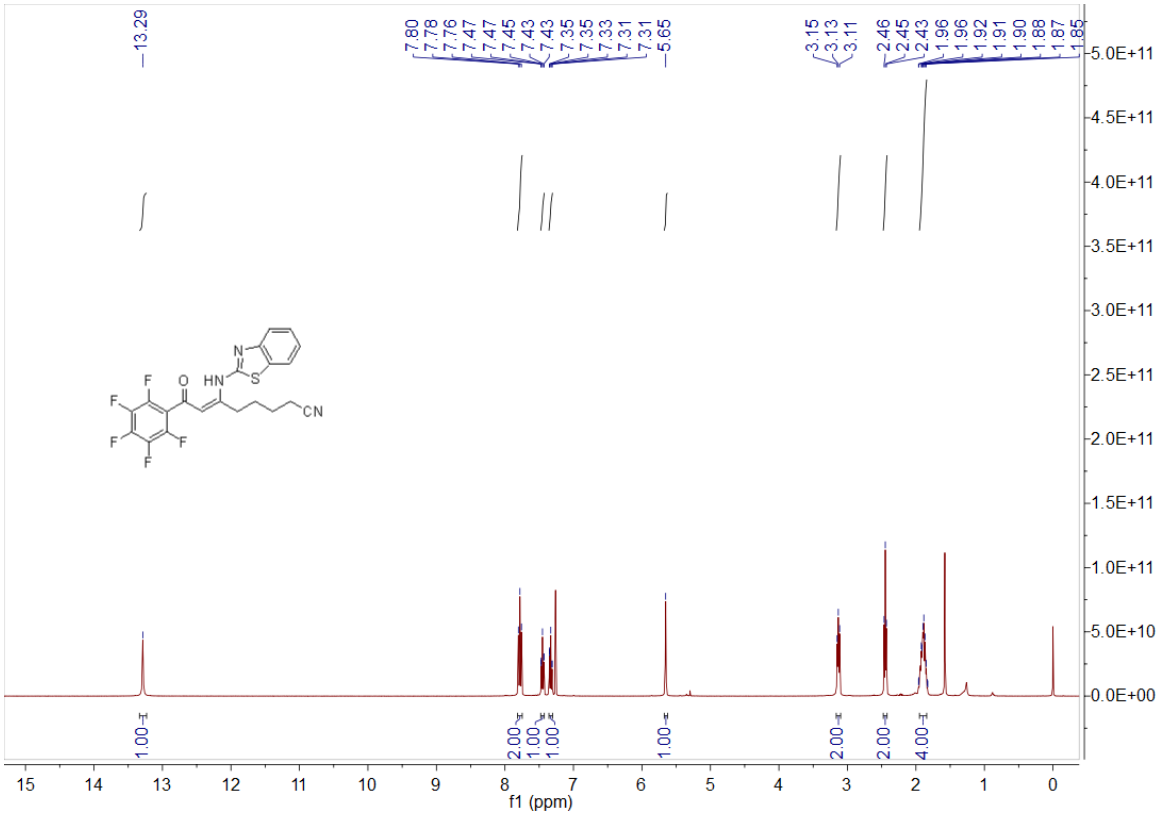
^{13}C NMR Spectrum of Compound **3r** (100 Hz, $CDCl_3$)



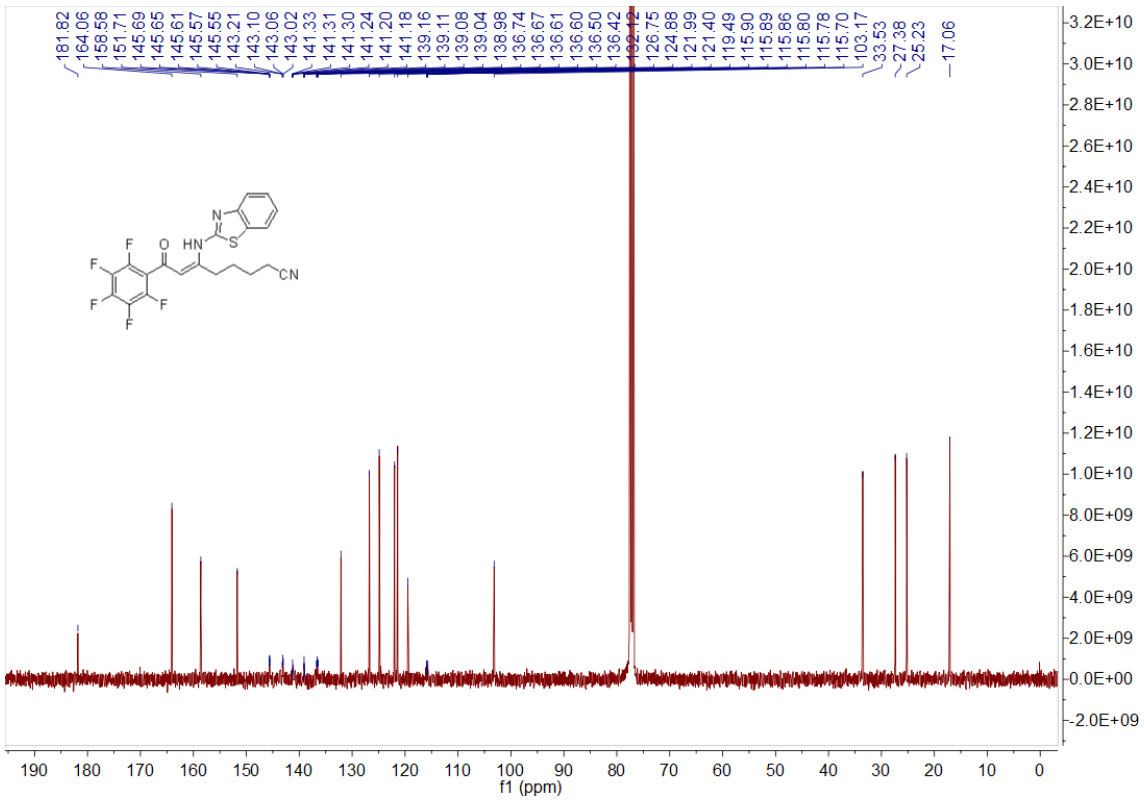
^{1}H NMR Spectrum of Compound **3s** (400 Hz, $CDCl_3$)



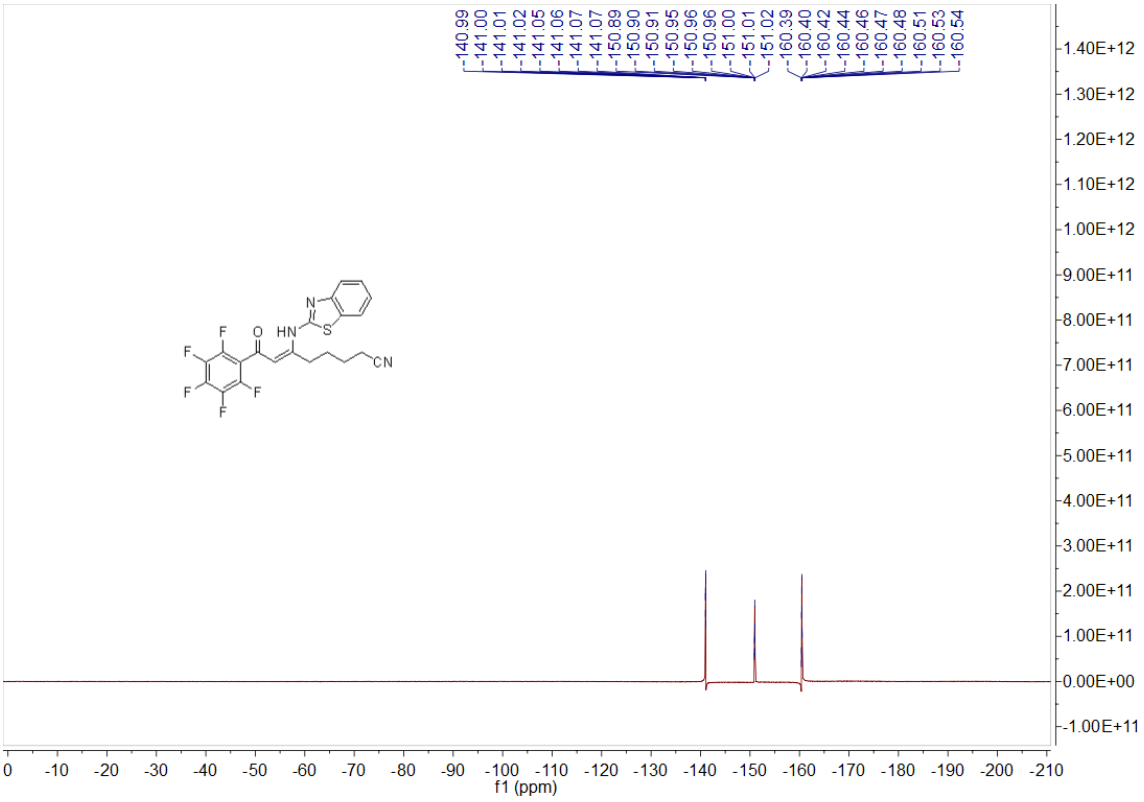
^{13}C NMR Spectrum of Compound **3s** (100 Hz, $CDCl_3$)



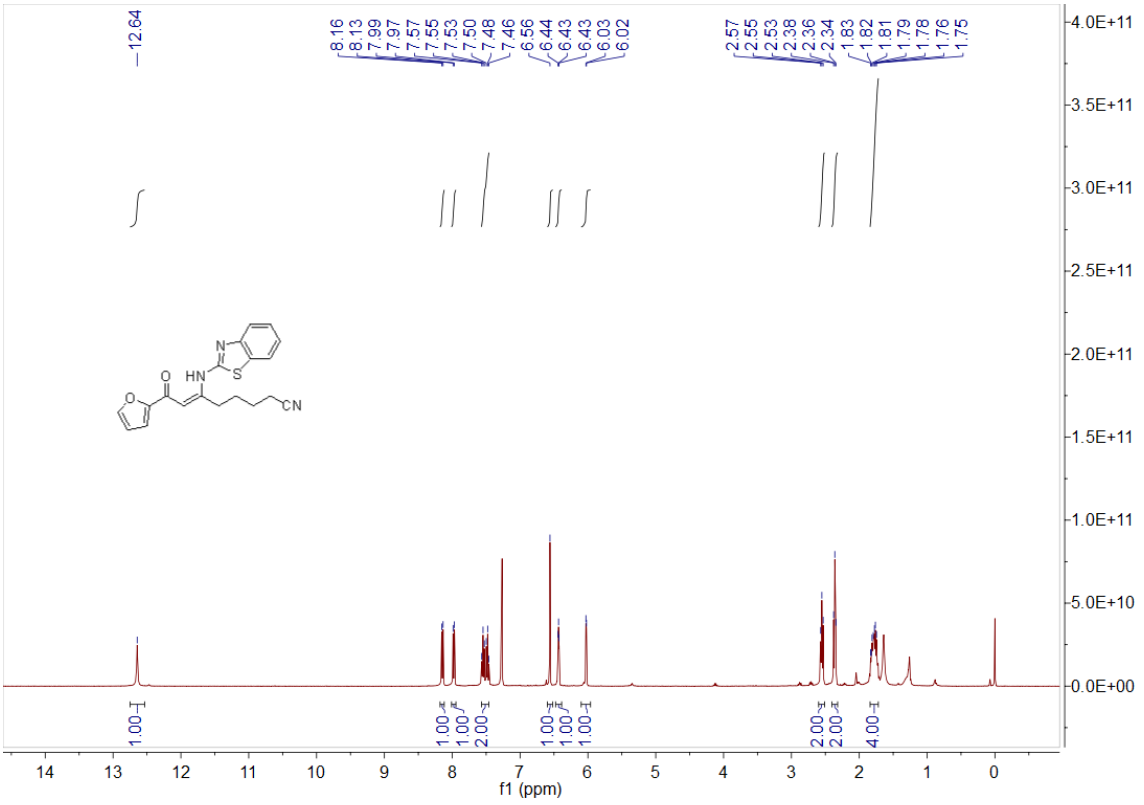
^{1}H NMR Spectrum of Compound **3t** (400 Hz, $CDCl_3$)



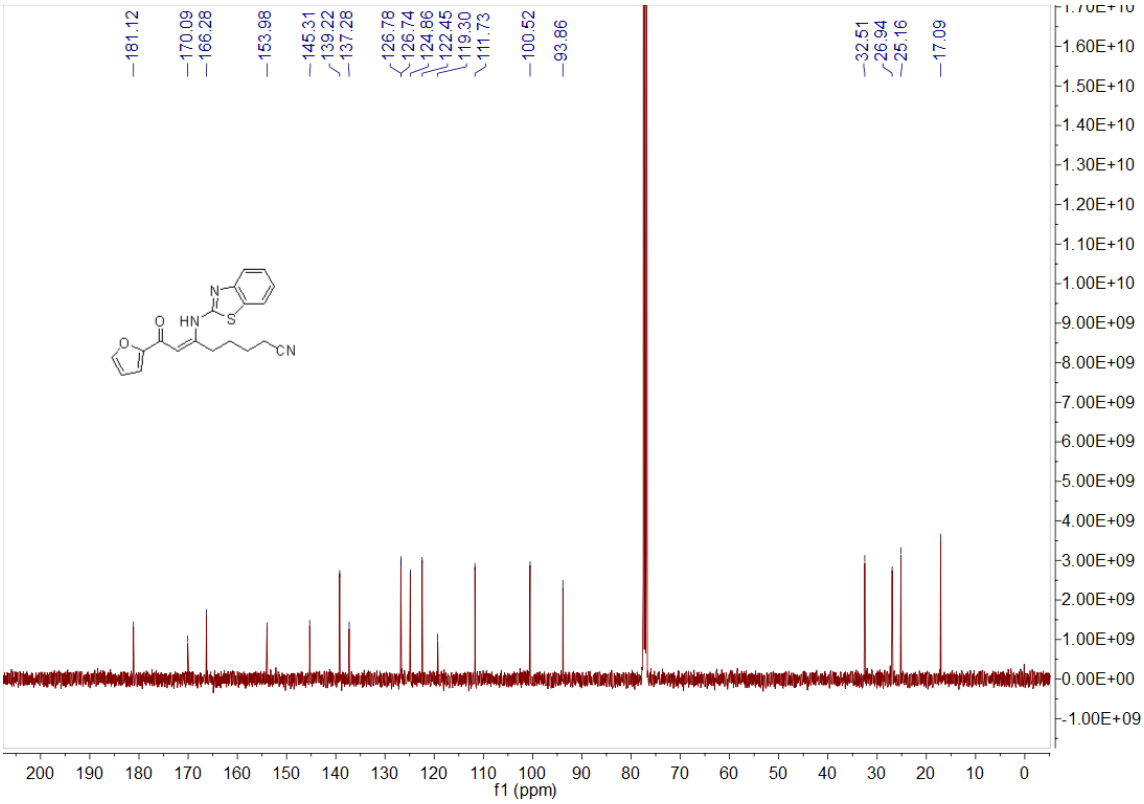
^{13}C NMR Spectrum of Compound **3t** (100 Hz, $CDCl_3$)



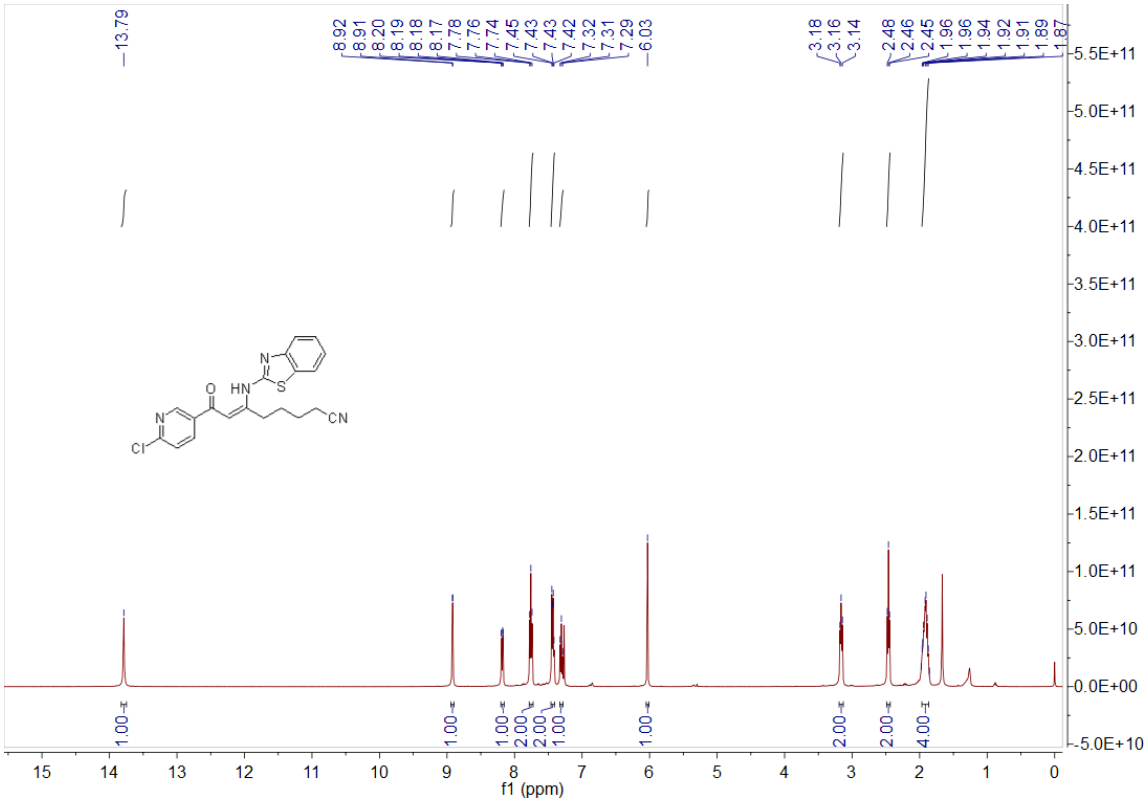
^{19}F NMR Spectrum of Compound **3t** (376 Hz, $CDCl_3$)



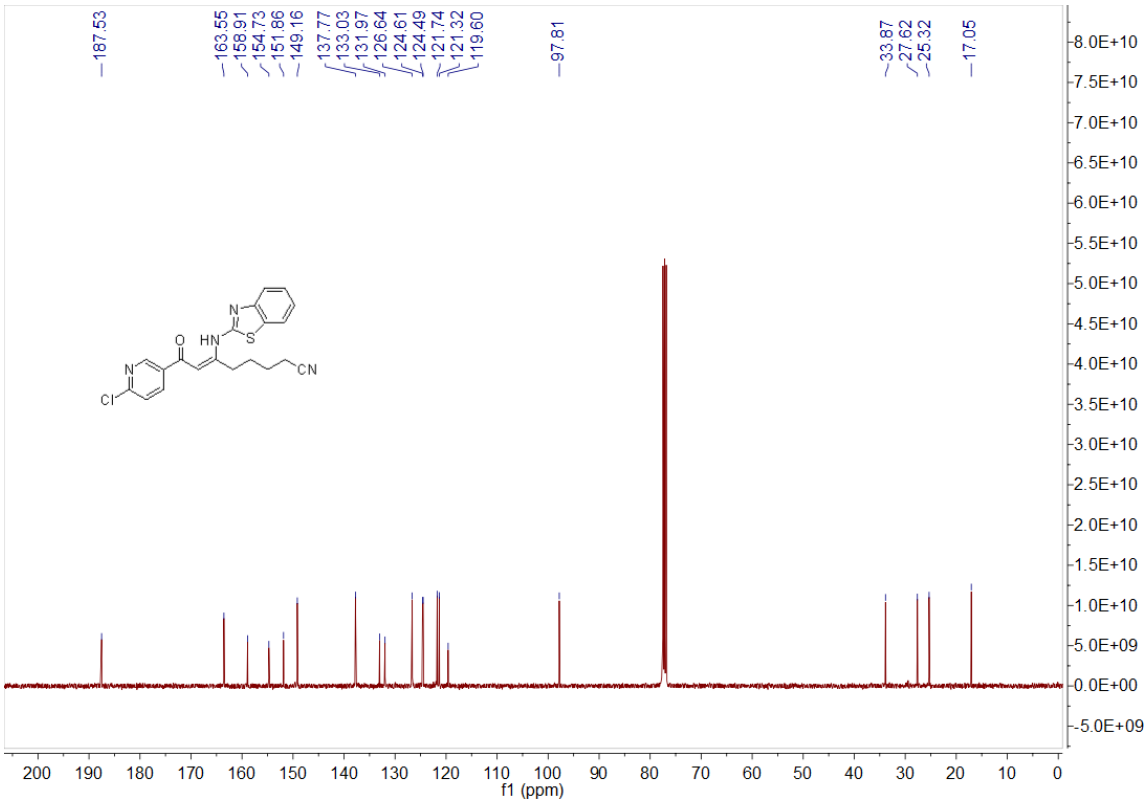
^{1}H NMR Spectrum of Compound **3u** (400 Hz, $CDCl_3$)



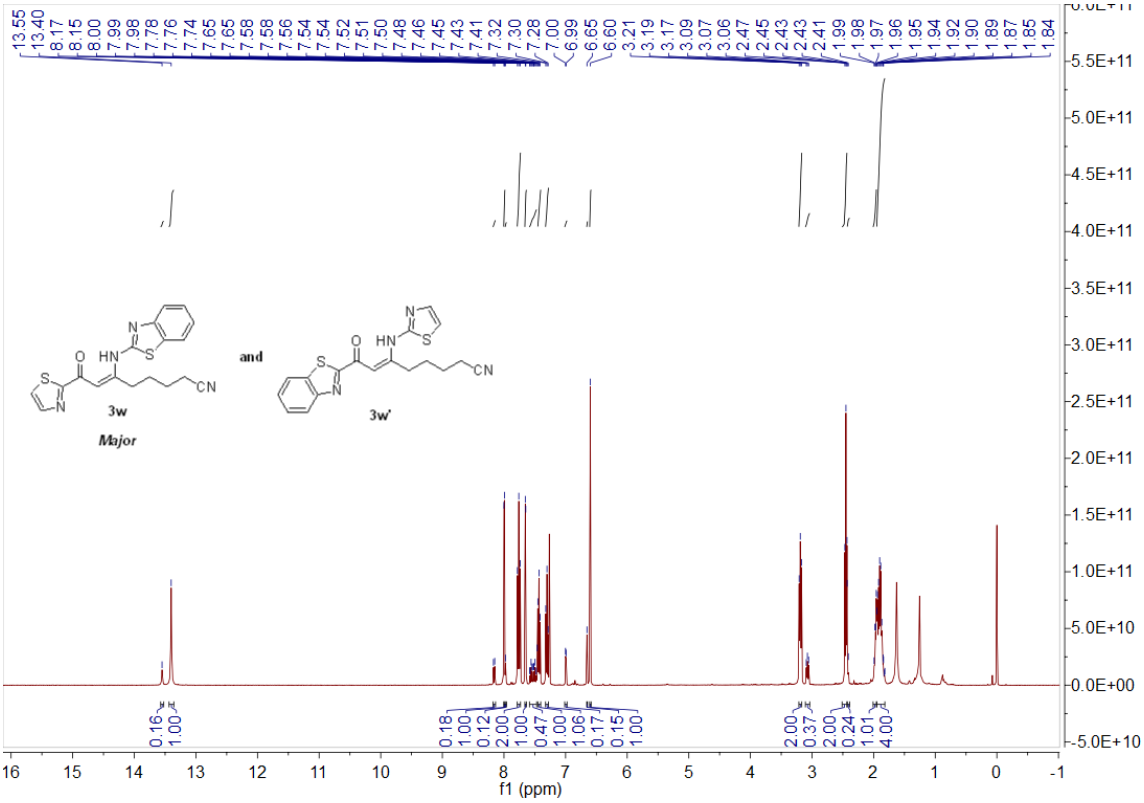
^{13}C NMR Spectrum of Compound **3u** (100 Hz, $CDCl_3$)



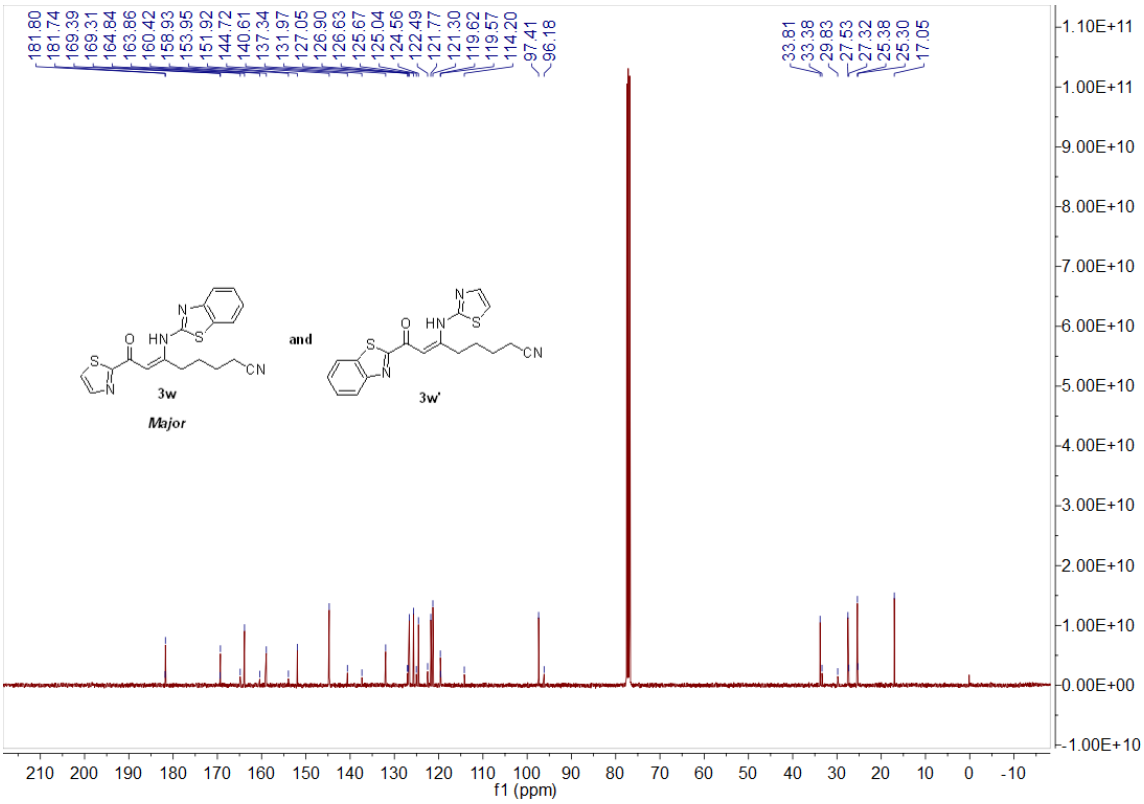
^{1}H NMR Spectrum of Compound **3v** (400 Hz, $CDCl_3$)



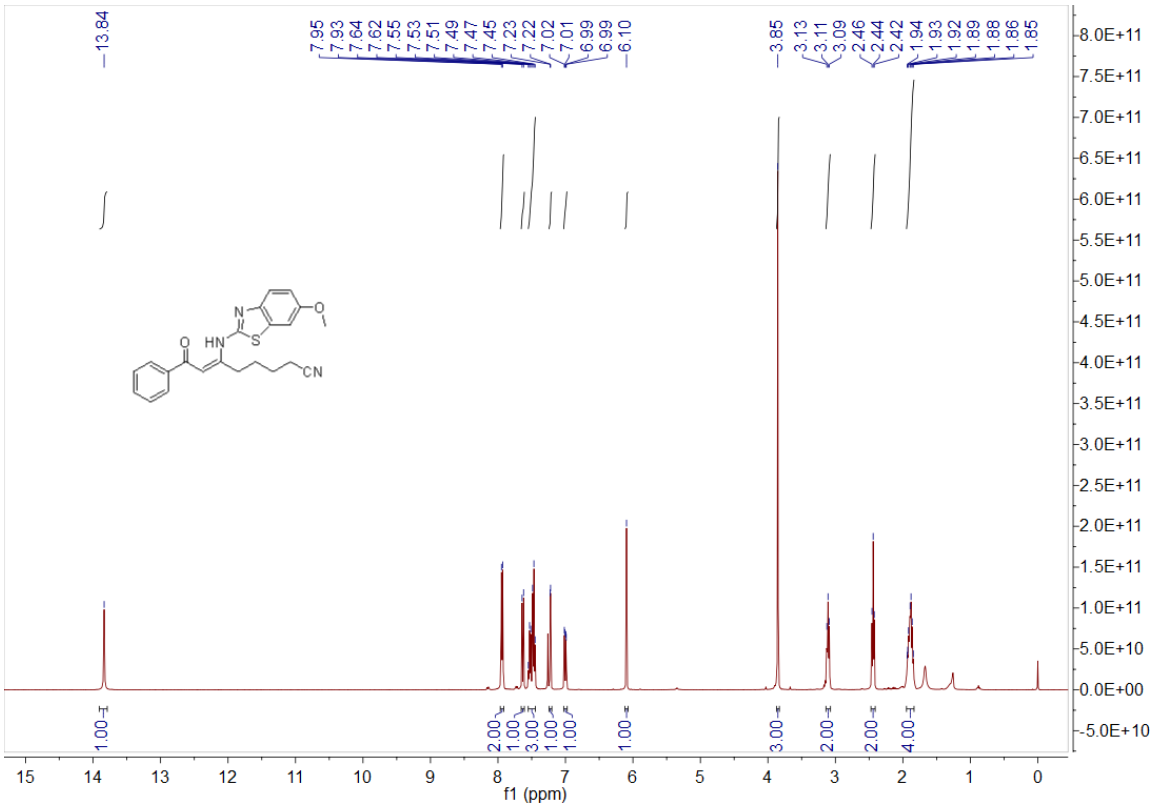
^{13}C NMR Spectrum of Compound **3v** (100 Hz, $CDCl_3$)



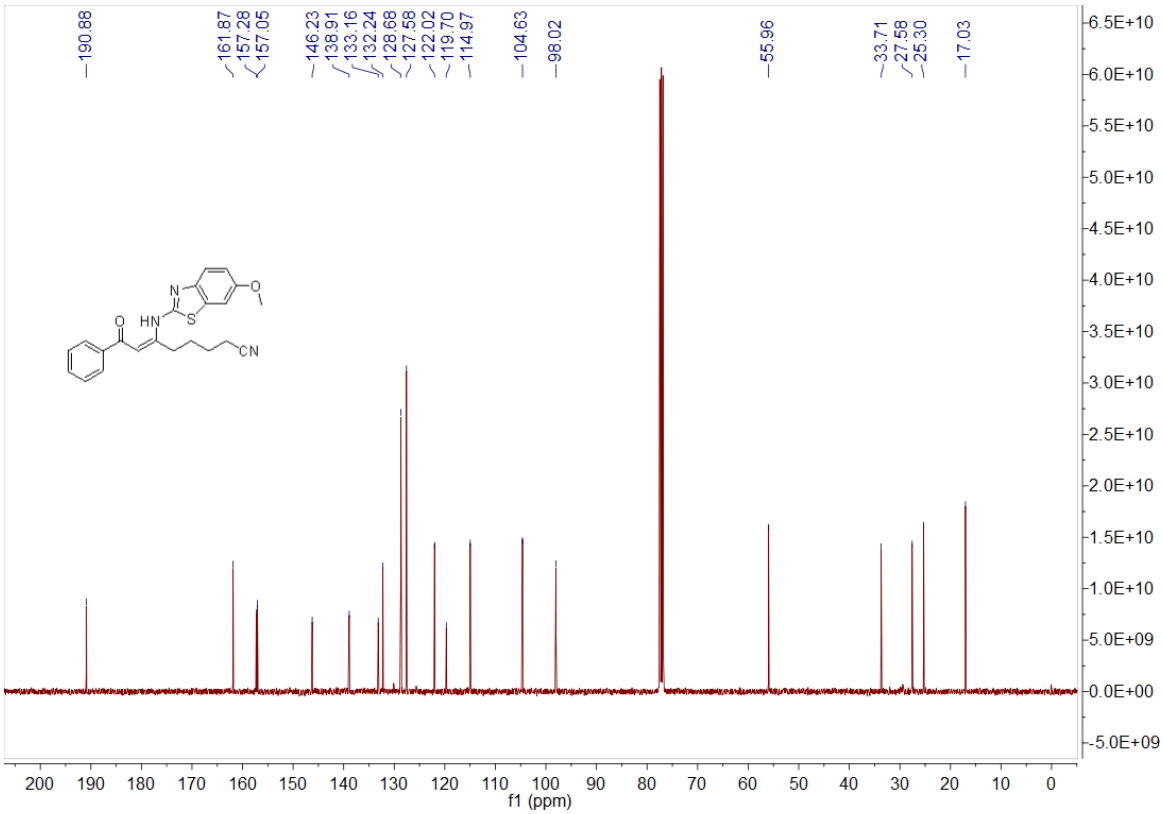
^{1}H NMR Spectrum of Compound **3w** and **3w'** (400 Hz, $CDCl_3$)



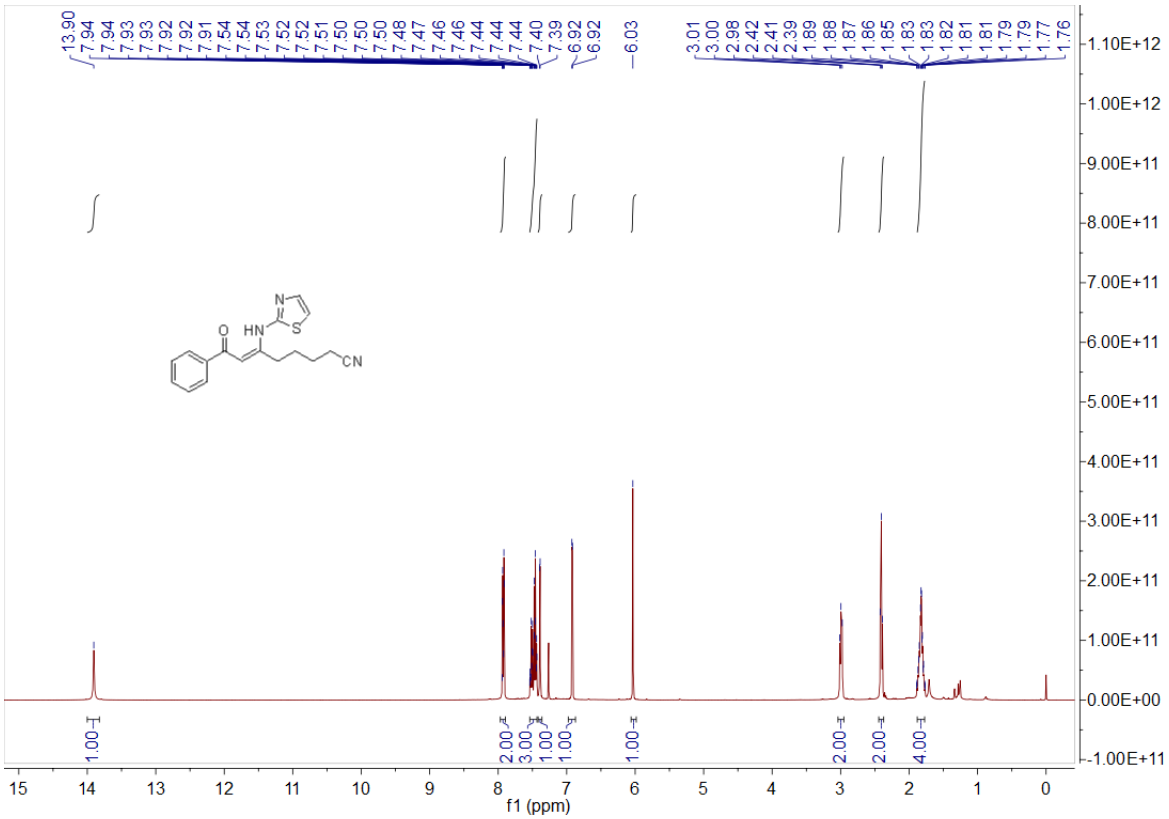
^{13}C NMR Spectrum of Compound **3w** and **3w'** (100 Hz, $CDCl_3$)



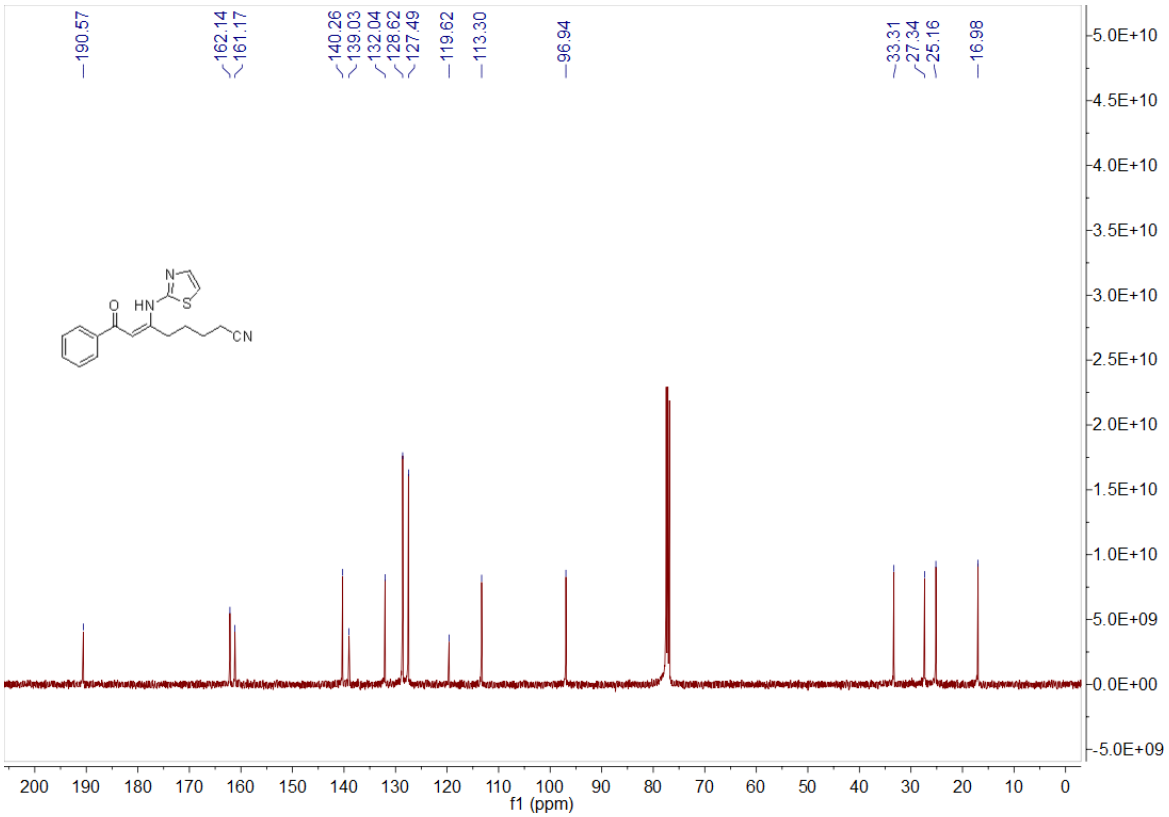
^{1}H NMR Spectrum of Compound **3y** (400 Hz, $CDCl_3$)



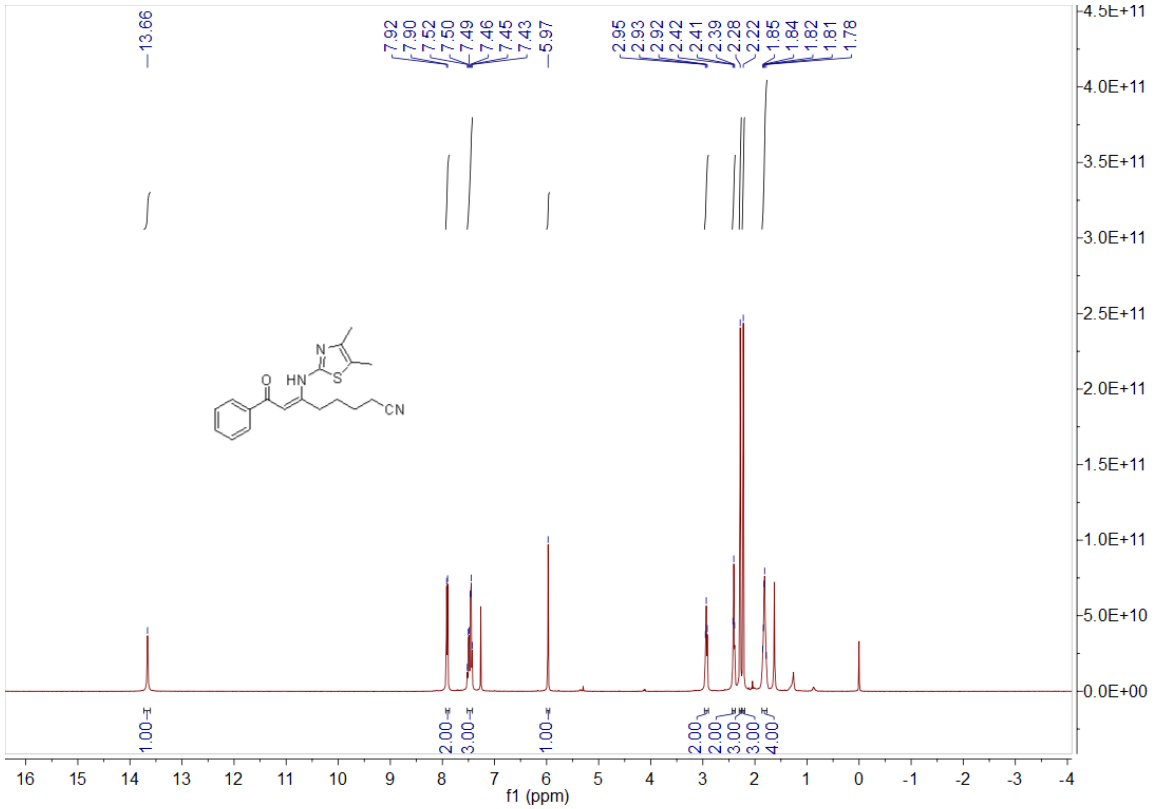
^{13}C NMR Spectrum of Compound **3y** (100 Hz, $CDCl_3$)



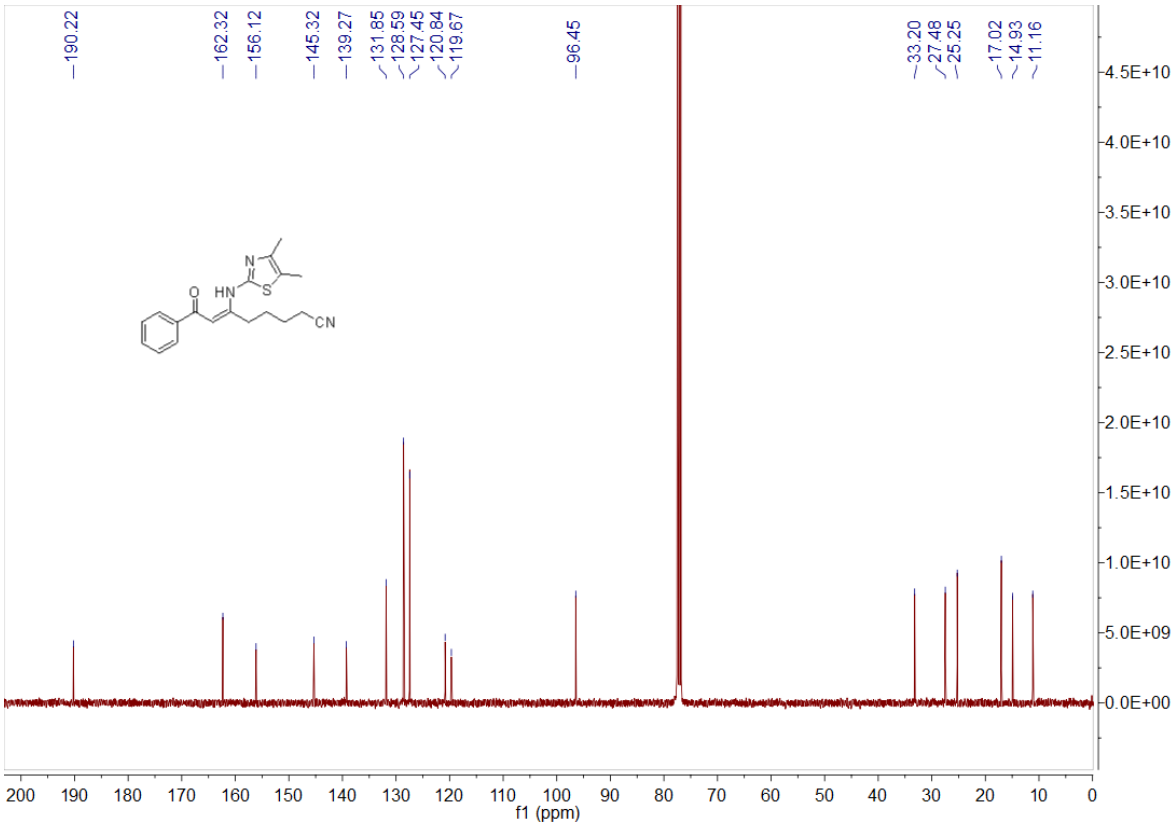
^{1}H NMR Spectrum of Compound **3z** (400 Hz, $CDCl_3$)



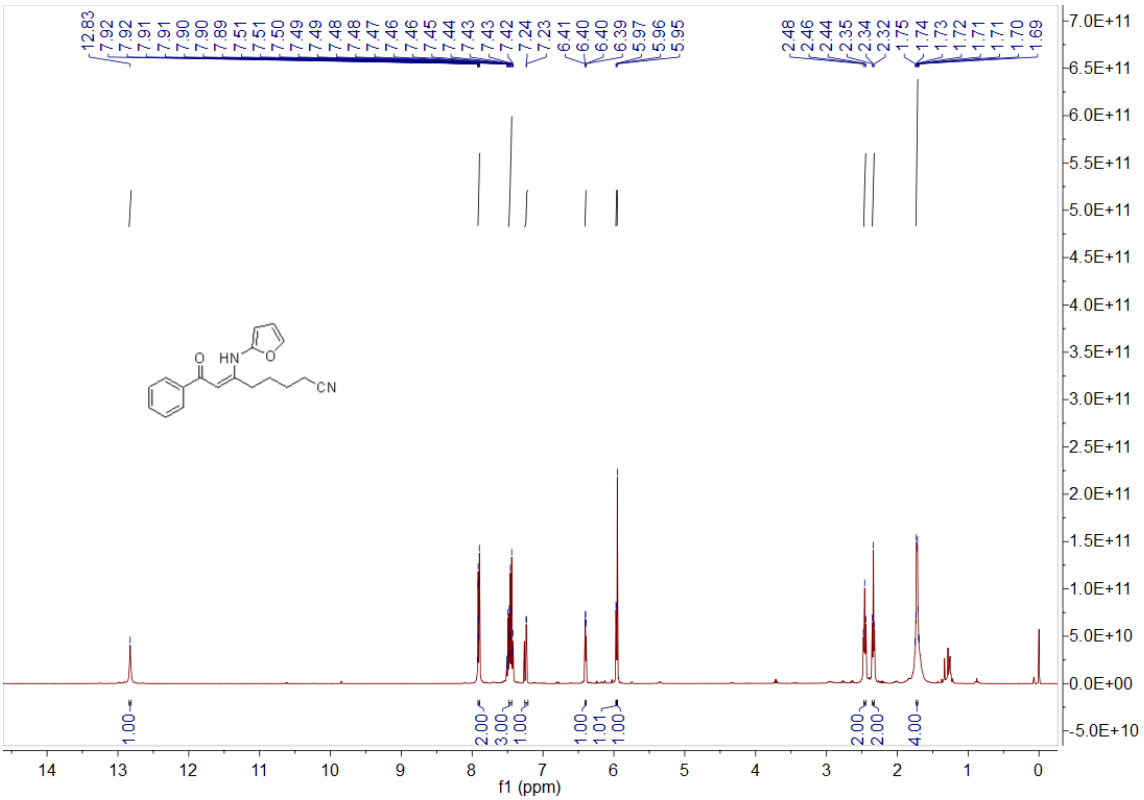
^{13}C NMR Spectrum of Compound **3z** (100 Hz, $CDCl_3$)



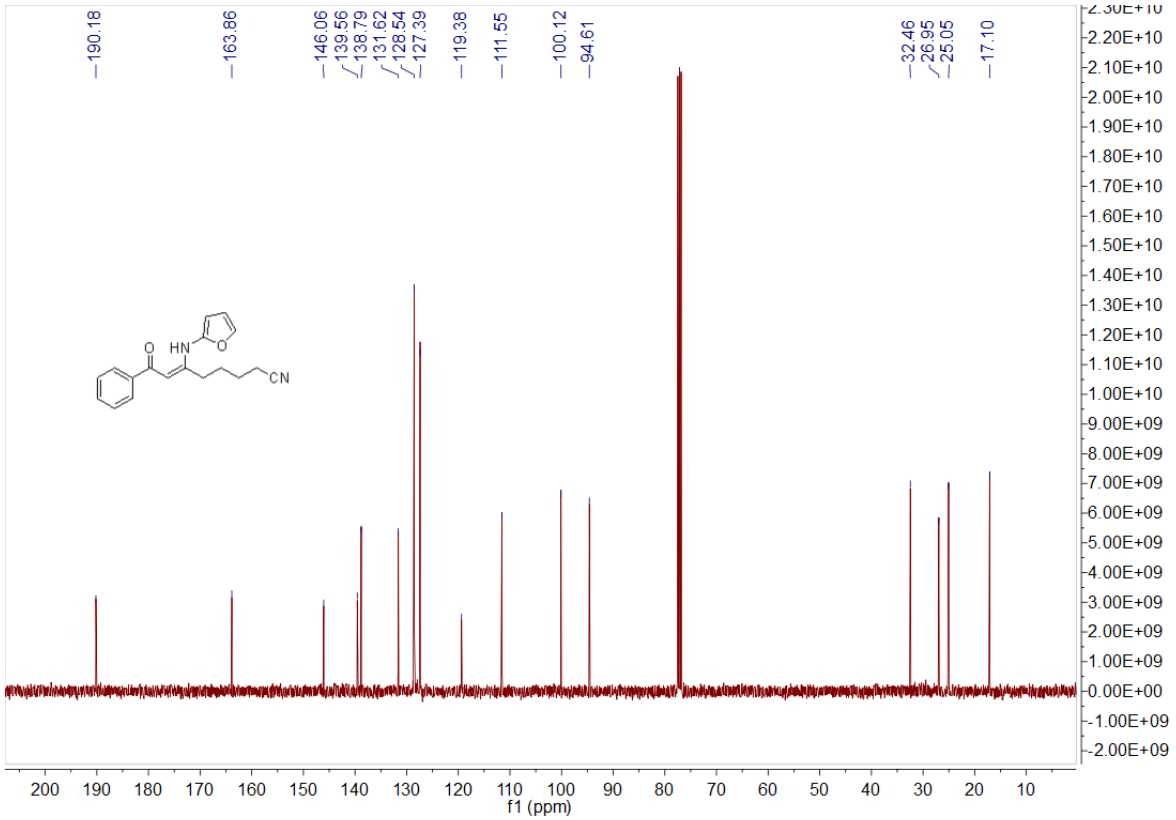
^{1}H NMR Spectrum of Compound **3x'** (400 Hz, $CDCl_3$)



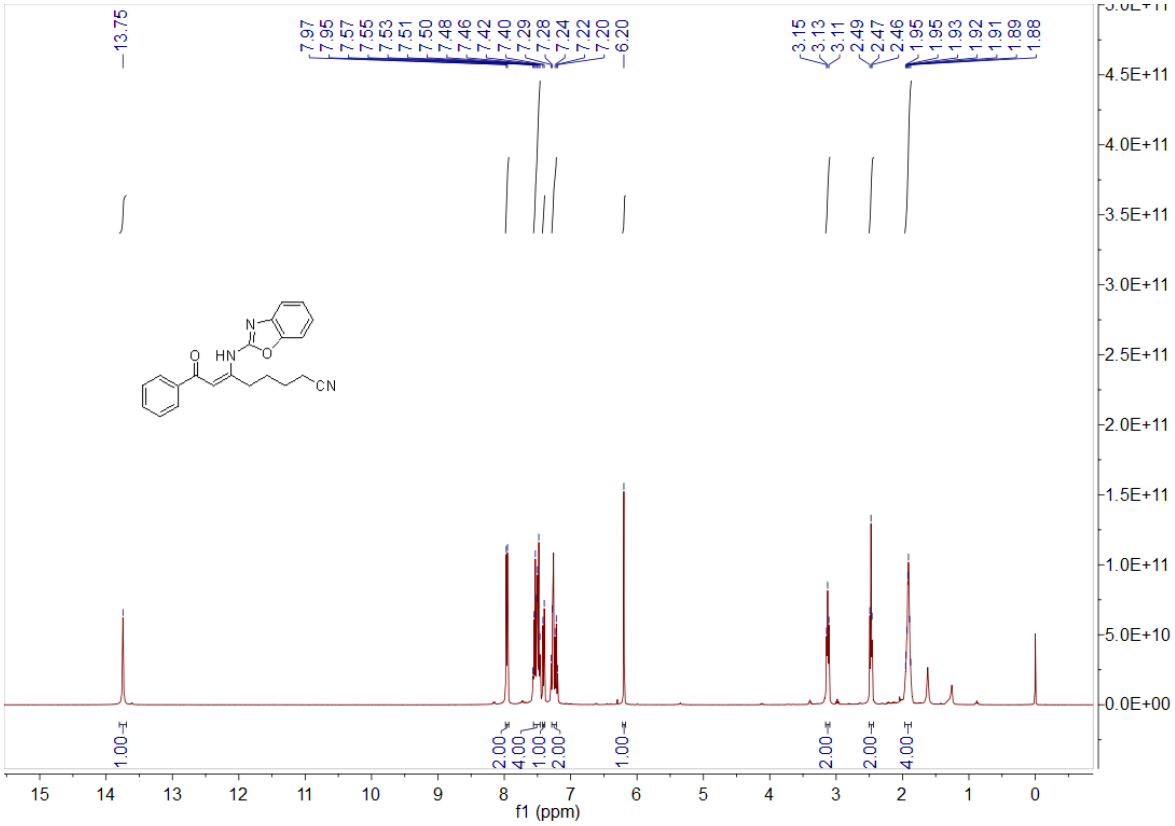
^{13}C NMR Spectrum of Compound **3x'** (100 Hz, $CDCl_3$)



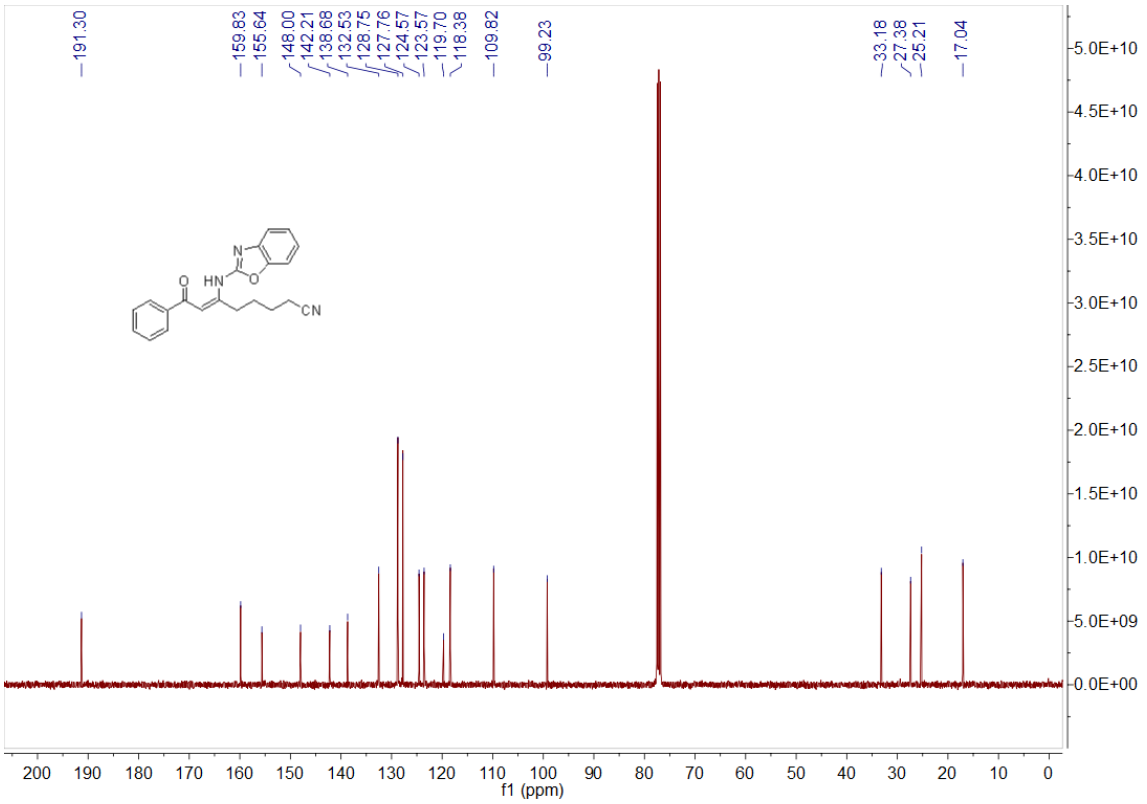
^{1}H NMR Spectrum of Compound **3y'** (400 Hz, $CDCl_3$)



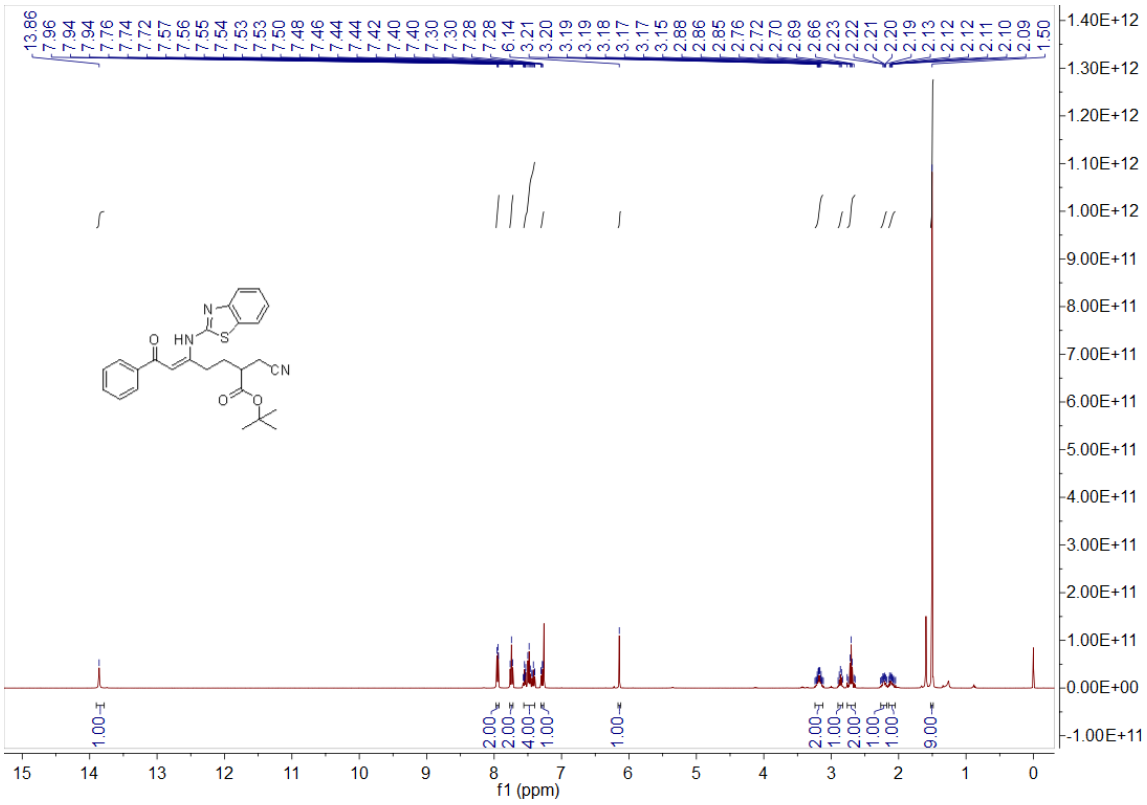
^{13}C NMR Spectrum of Compound **3y'** (100 Hz, $CDCl_3$)



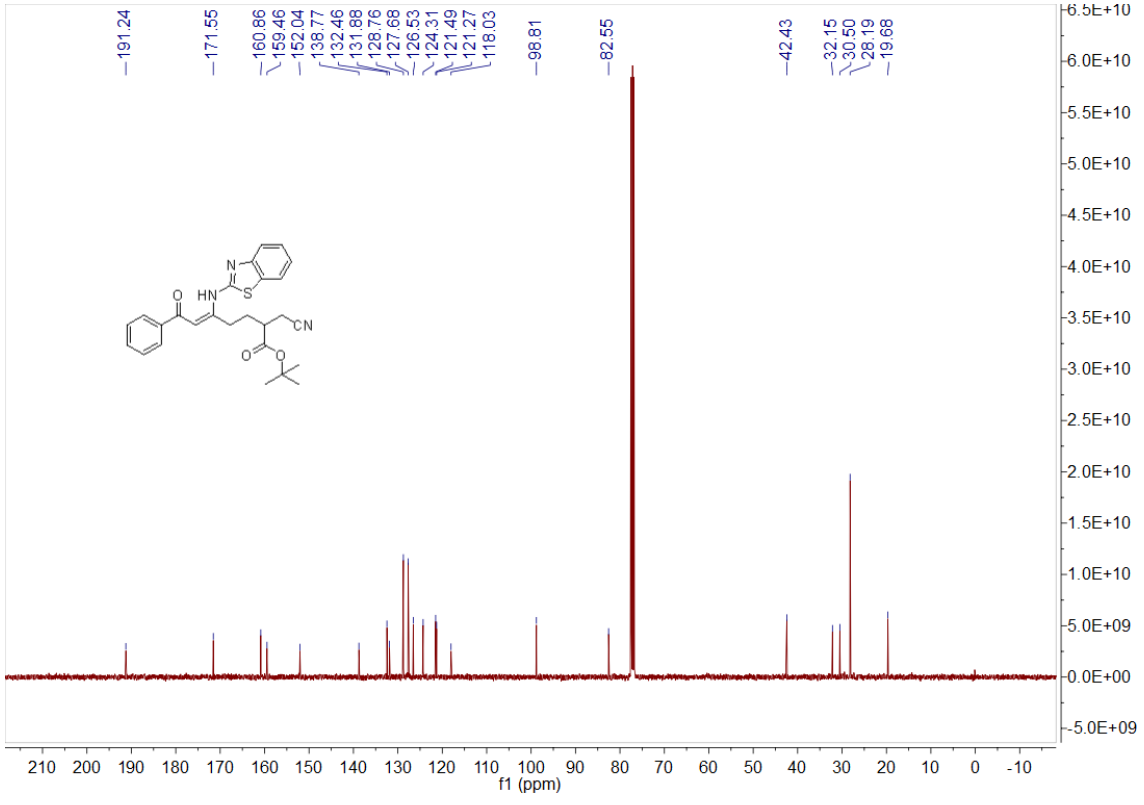
^{1}H NMR Spectrum of Compound **3z'** (400 Hz, $CDCl_3$)



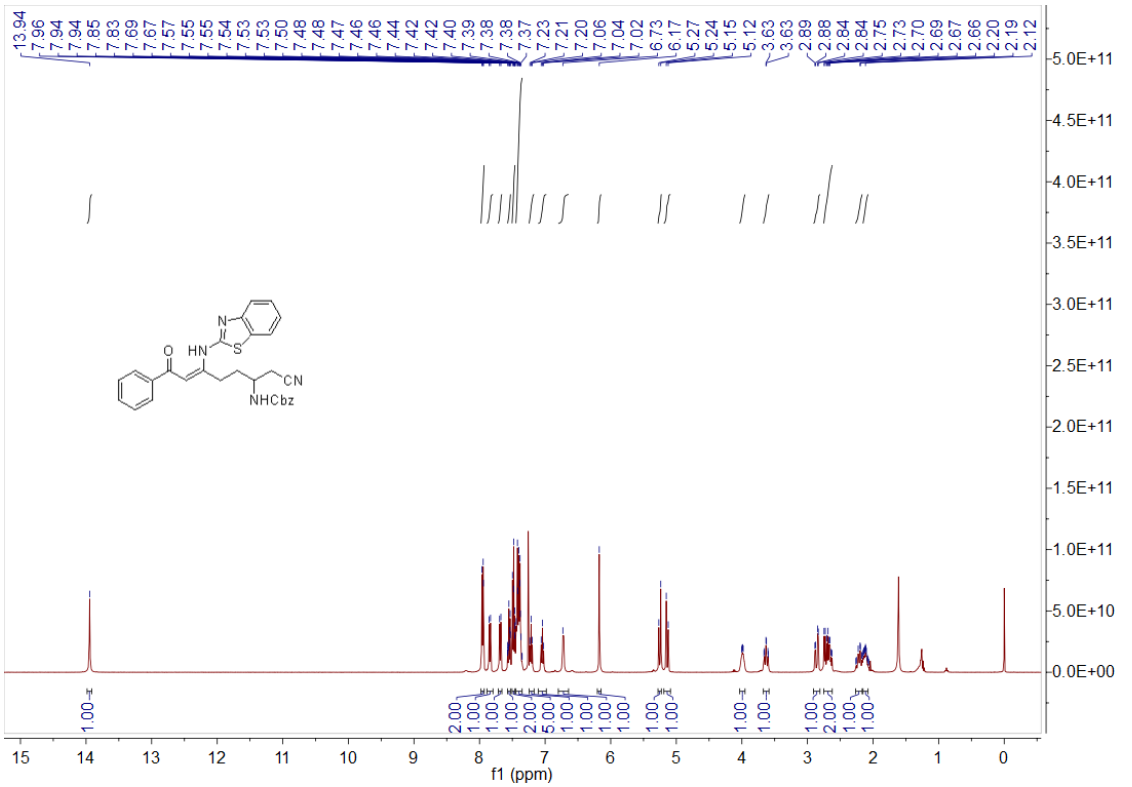
^{13}C NMR Spectrum of Compound **3z'** (100 Hz, $CDCl_3$)



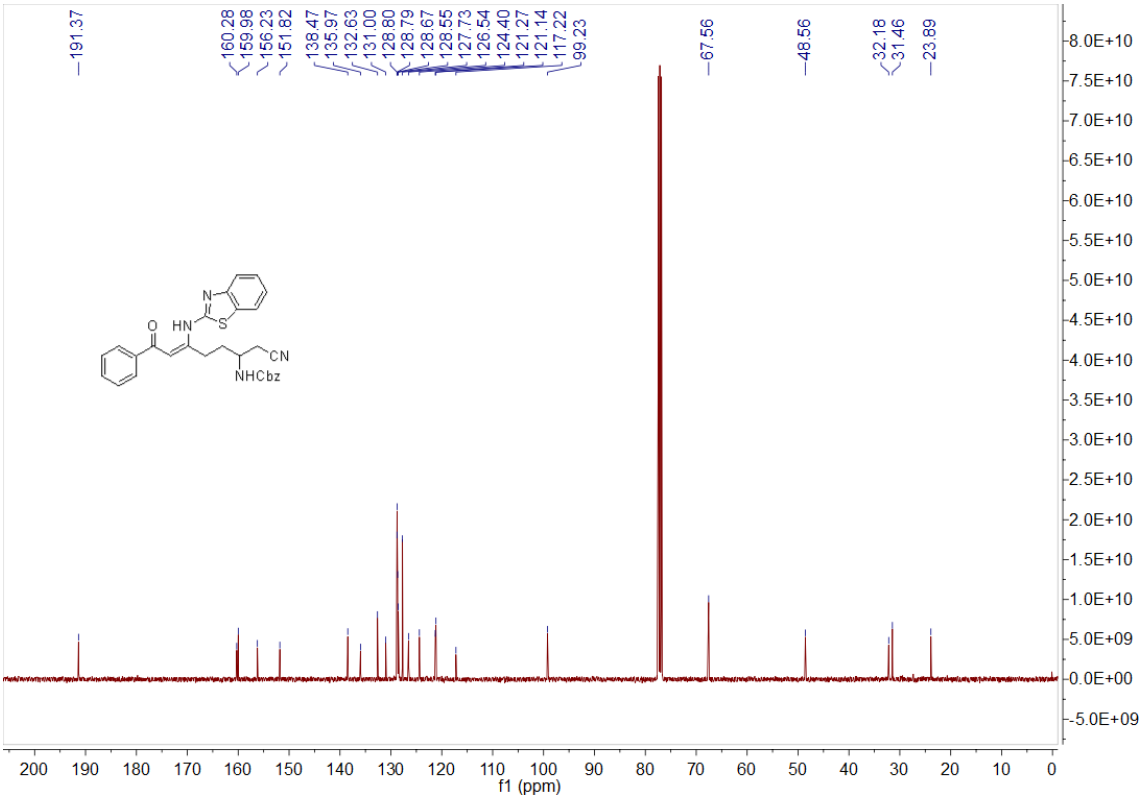
^{1}H NMR Spectrum of Compound **4a** (400 Hz, $CDCl_3$)



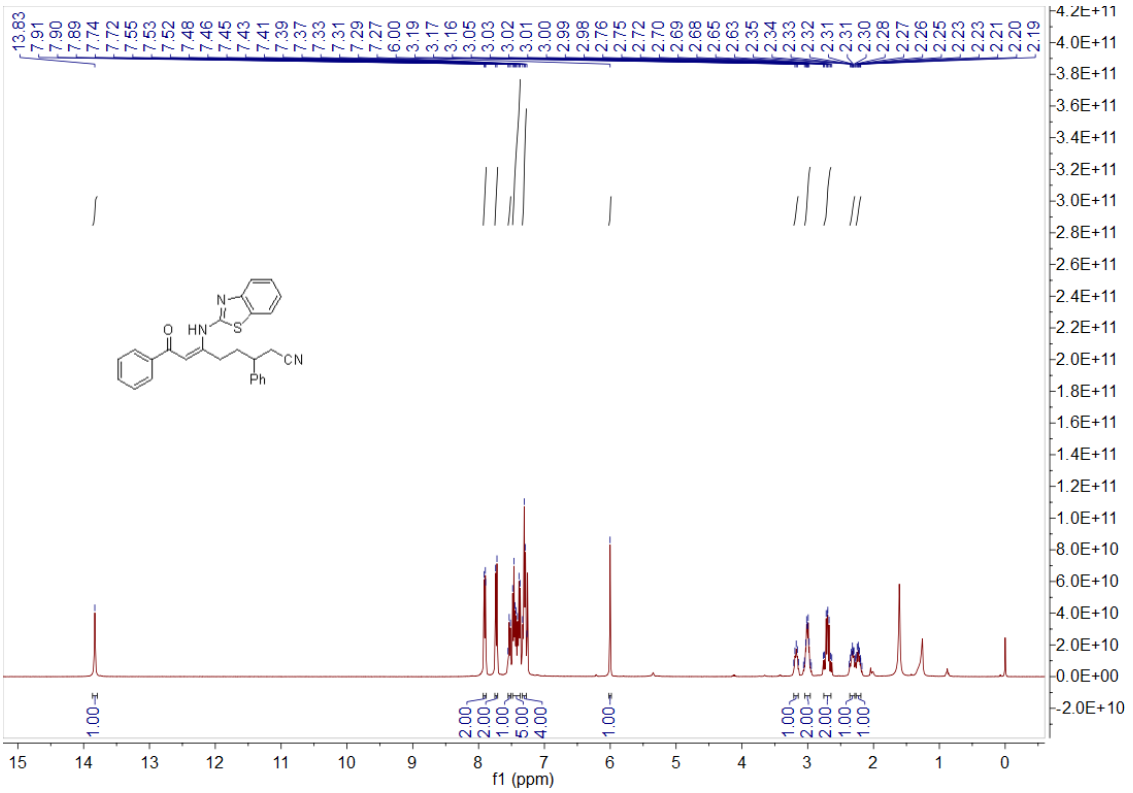
^{13}C NMR Spectrum of Compound **4a** (100 Hz, $CDCl_3$)



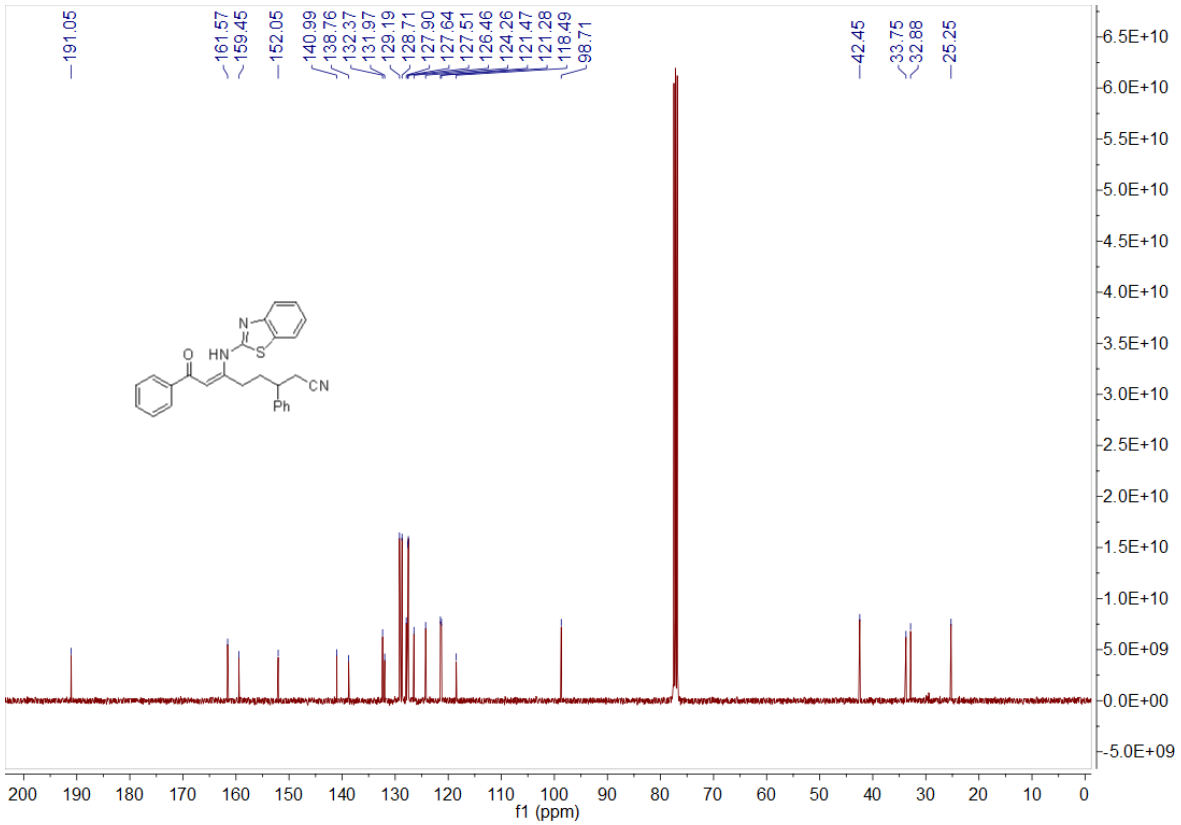
^{1}H NMR Spectrum of Compound **4b** (400 Hz, $CDCl_3$)



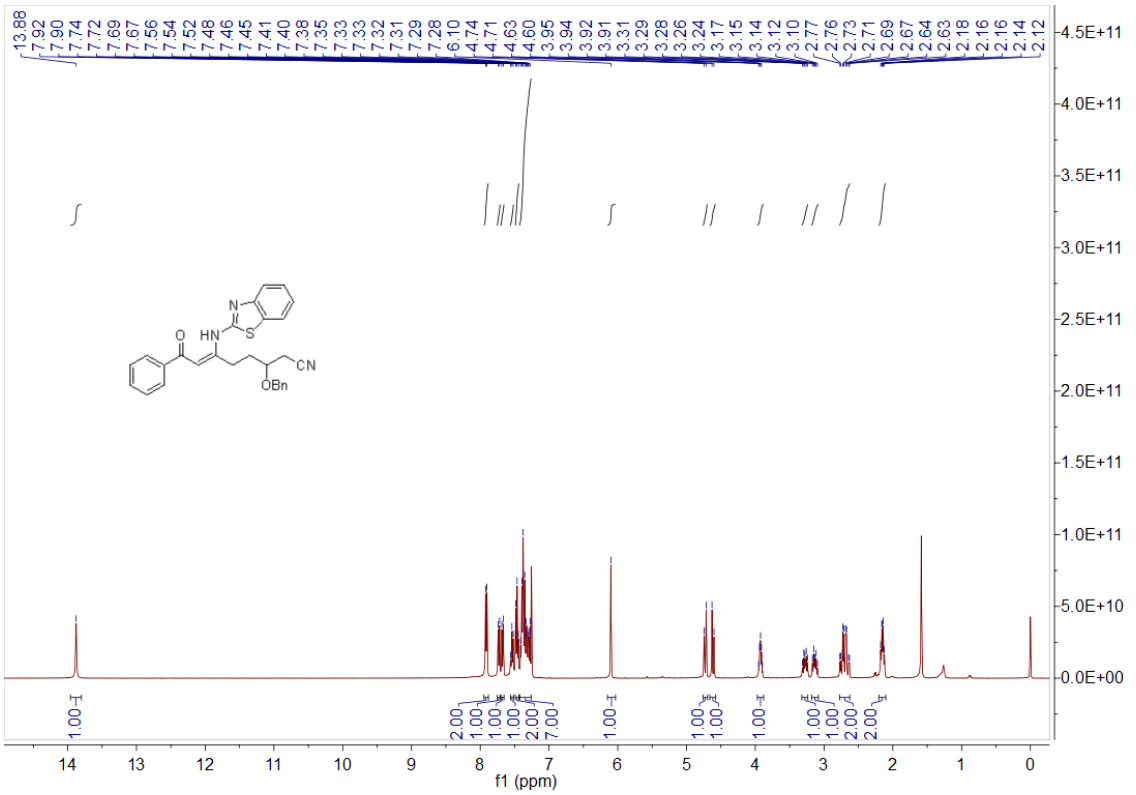
^{13}C NMR Spectrum of Compound **4b** (100 Hz, $CDCl_3$)



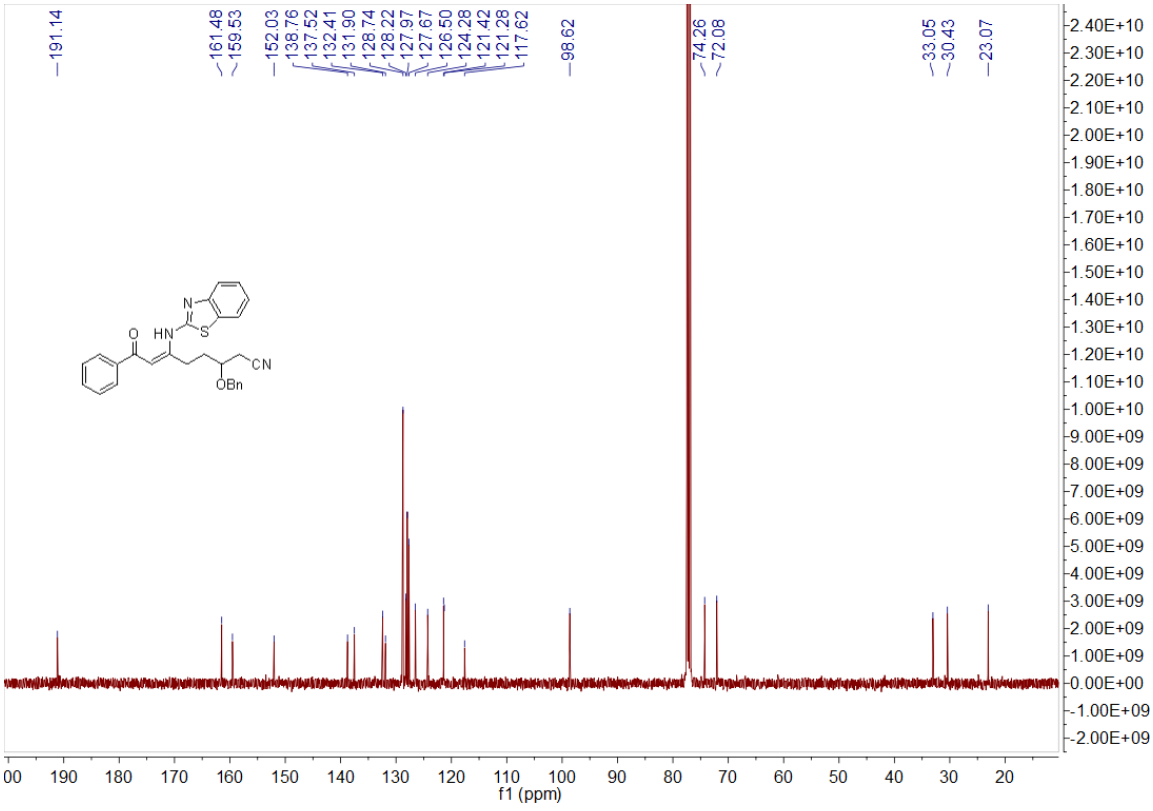
^{1}H NMR Spectrum of Compound **4c** (400 Hz, $CDCl_3$)



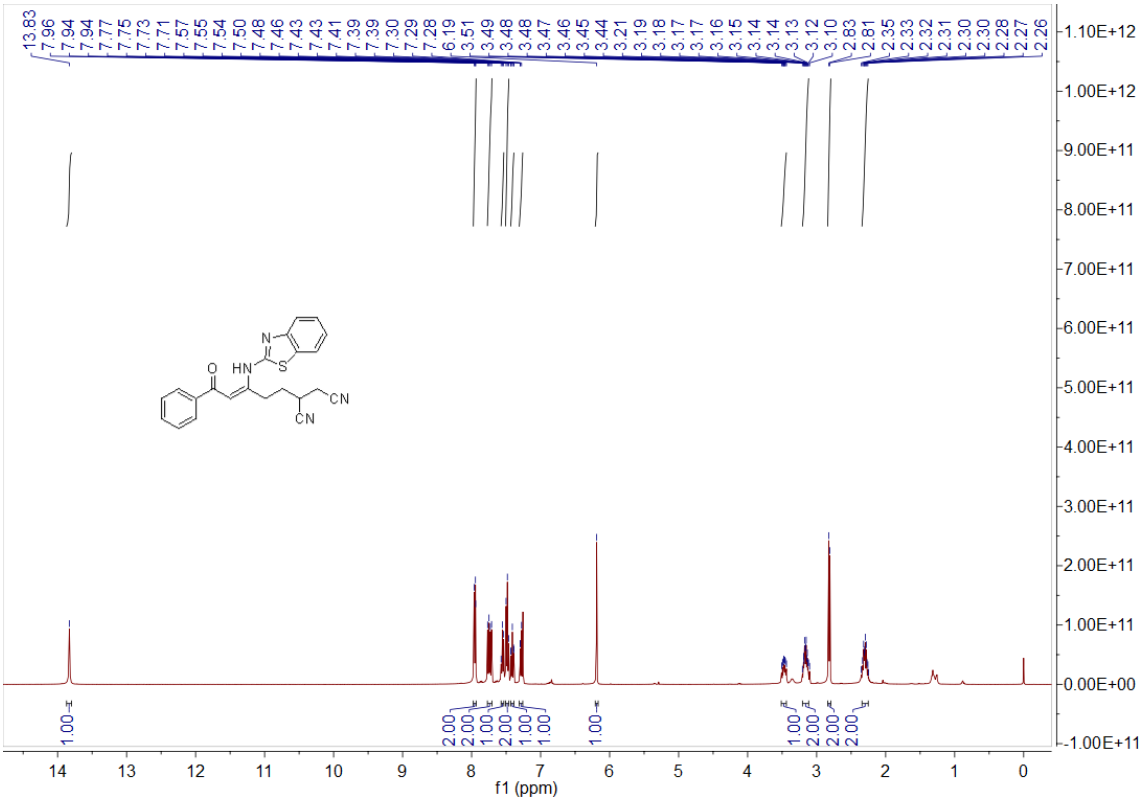
^{13}C NMR Spectrum of Compound **4c** (100 Hz, $CDCl_3$)



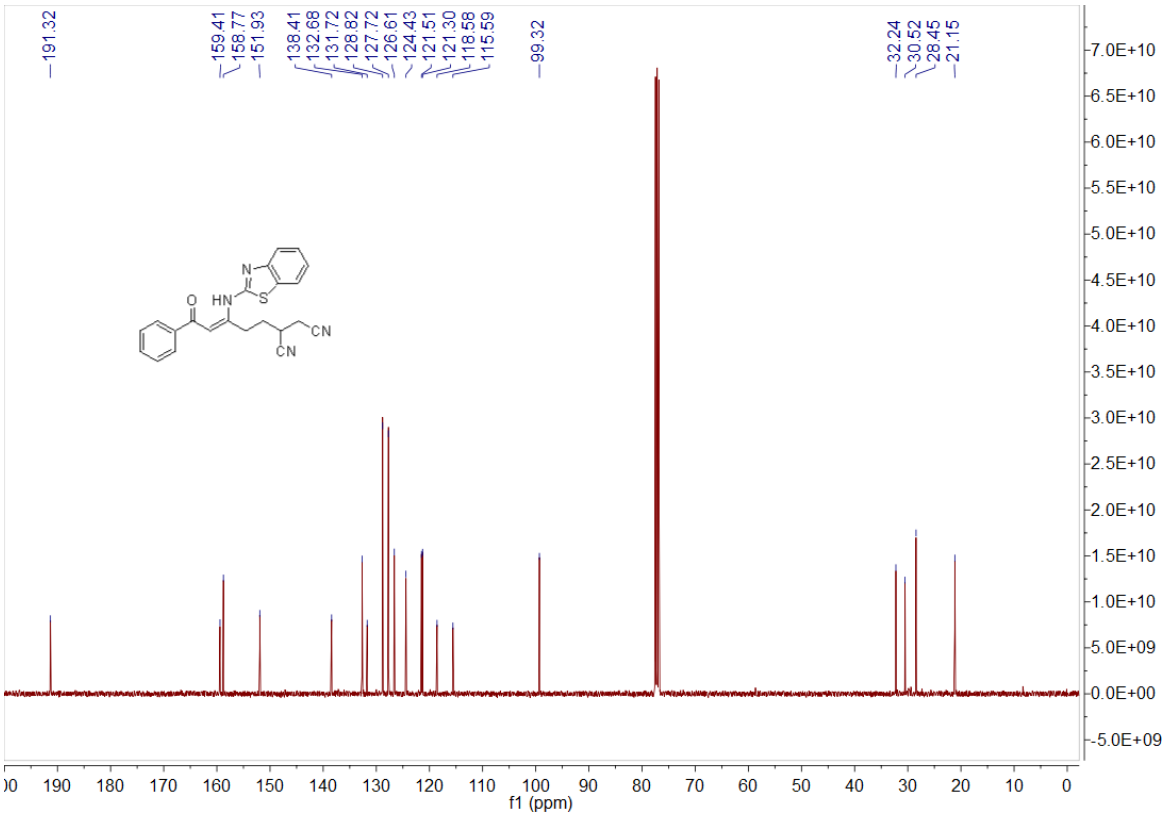
^{1}H NMR Spectrum of Compound **4d** (400 Hz, $CDCl_3$)



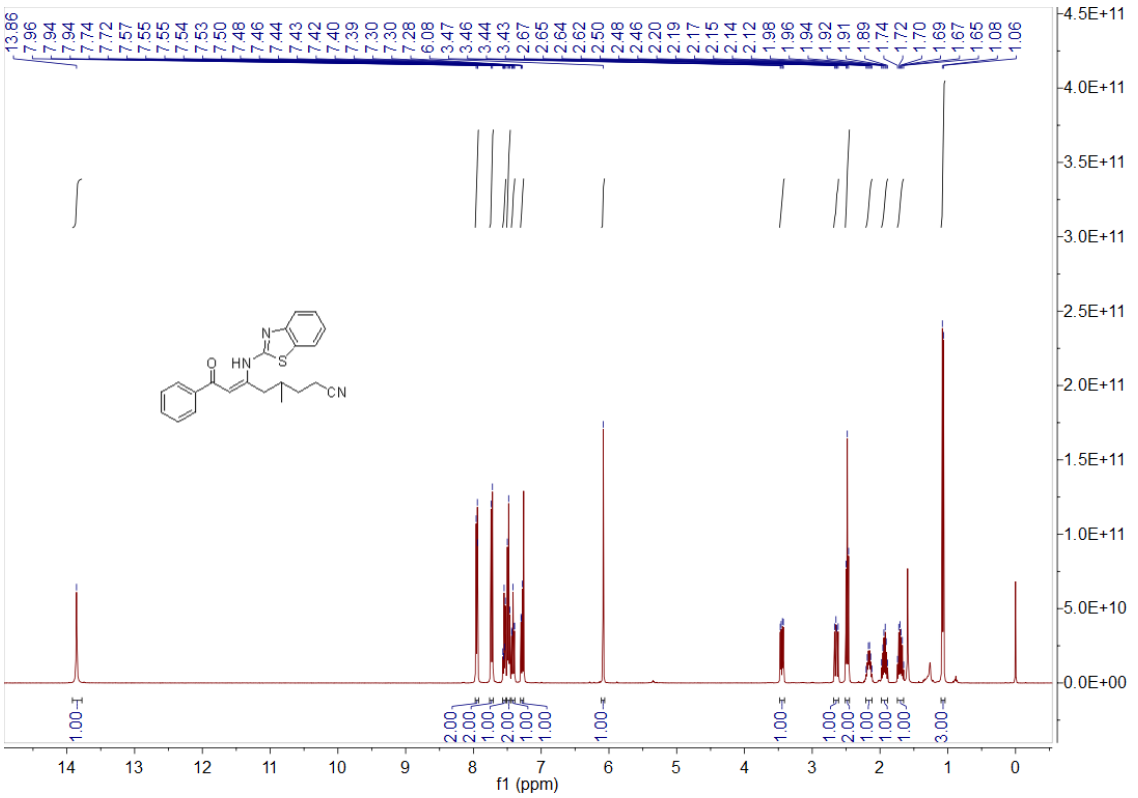
^{13}C NMR Spectrum of Compound **4d** (100 Hz, $CDCl_3$)



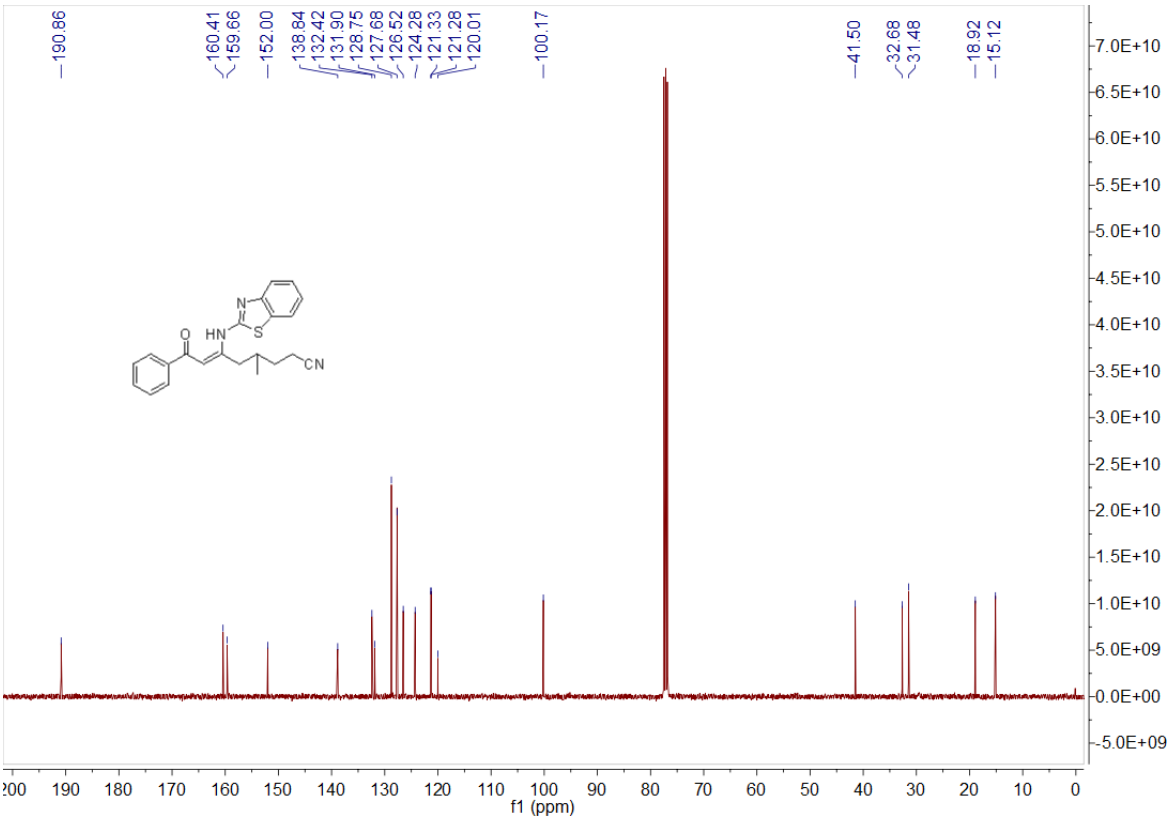
^{1}H NMR Spectrum of Compound **4e** (400 Hz, $CDCl_3$)



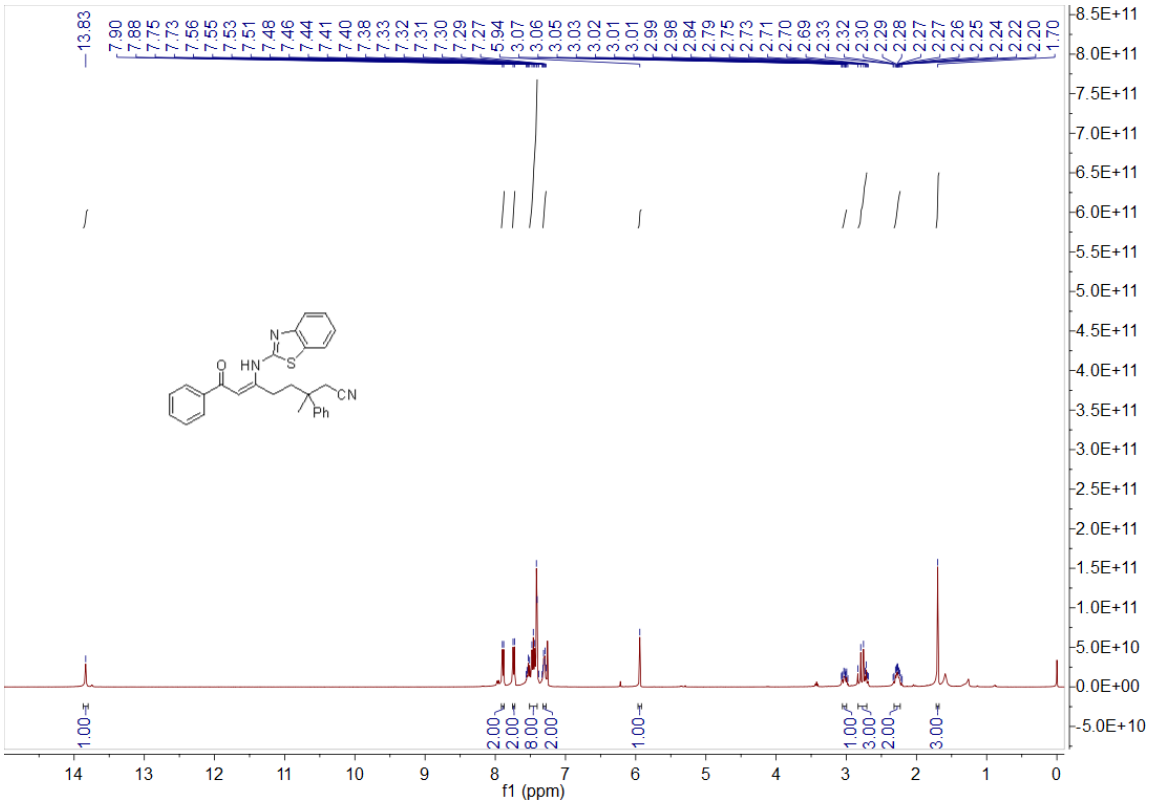
^{13}C NMR Spectrum of Compound **4e** (100 Hz, $CDCl_3$)



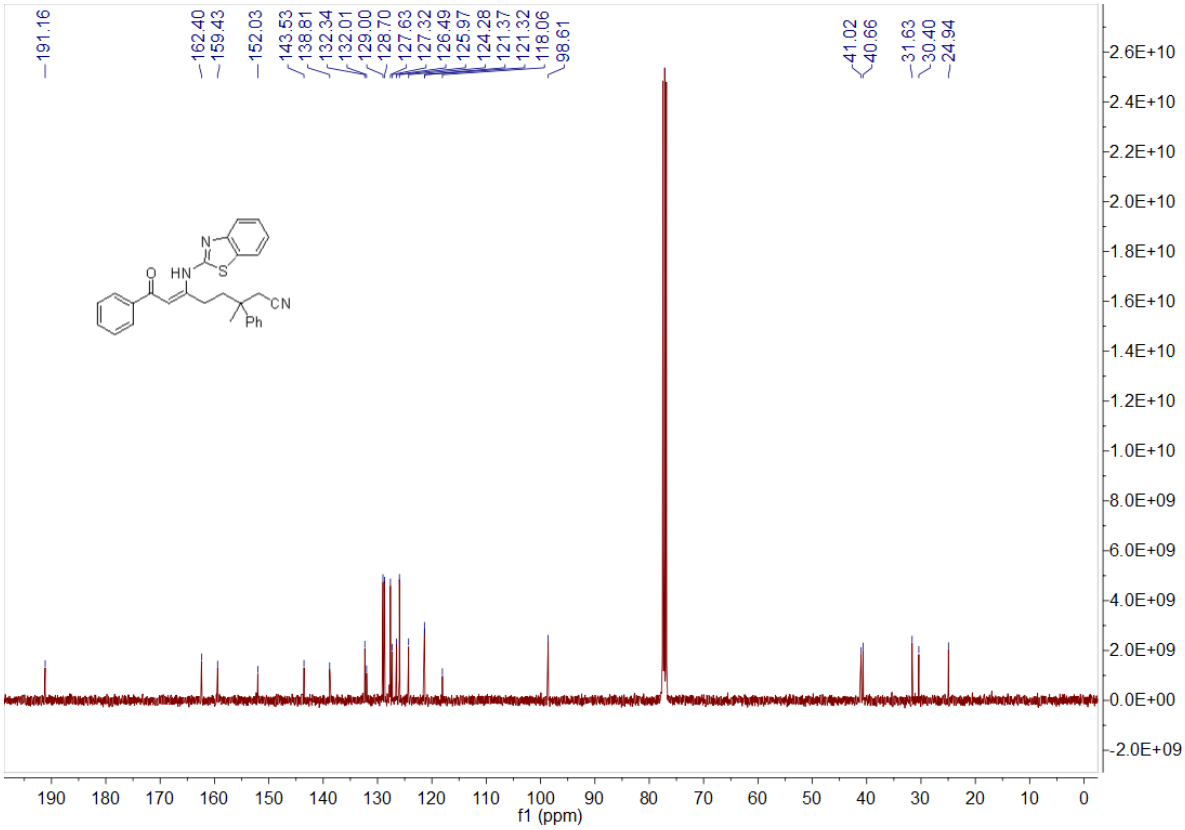
^{1}H NMR Spectrum of Compound **4f** (400 Hz, $CDCl_3$)



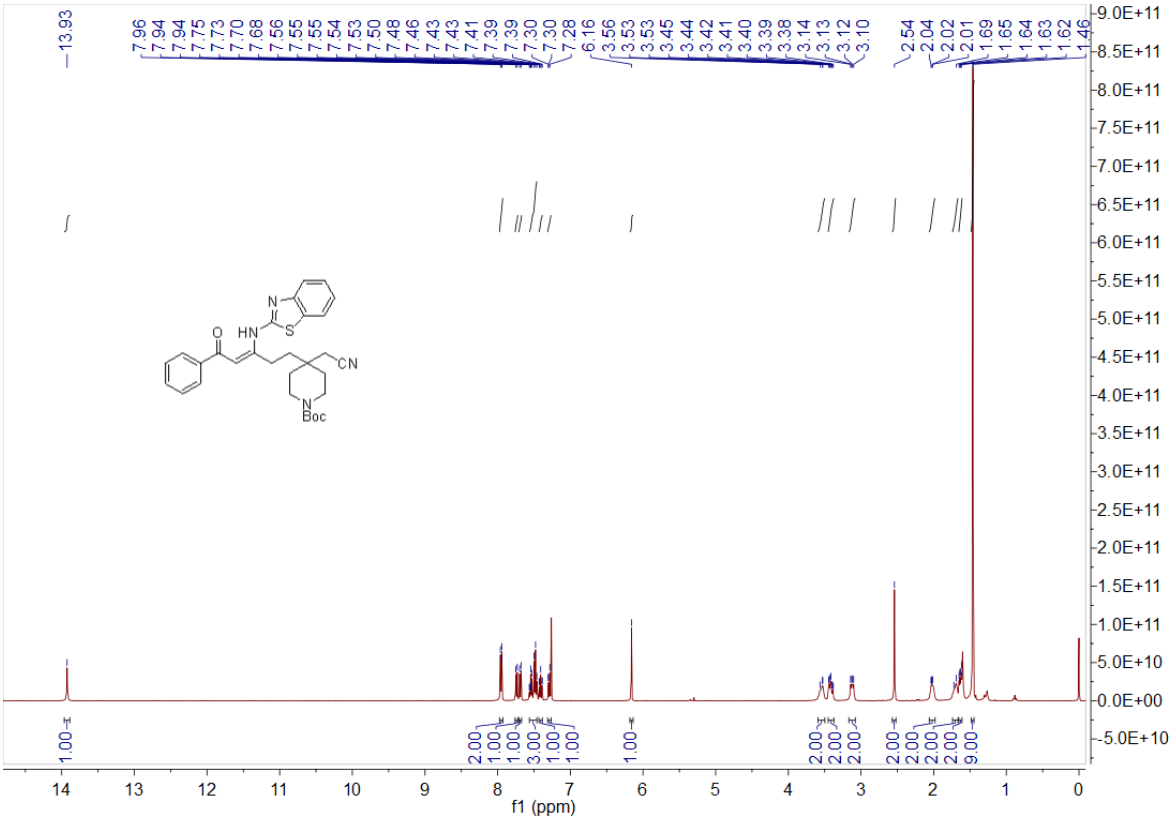
^{13}C NMR Spectrum of Compound **4f** (100 Hz, $CDCl_3$)



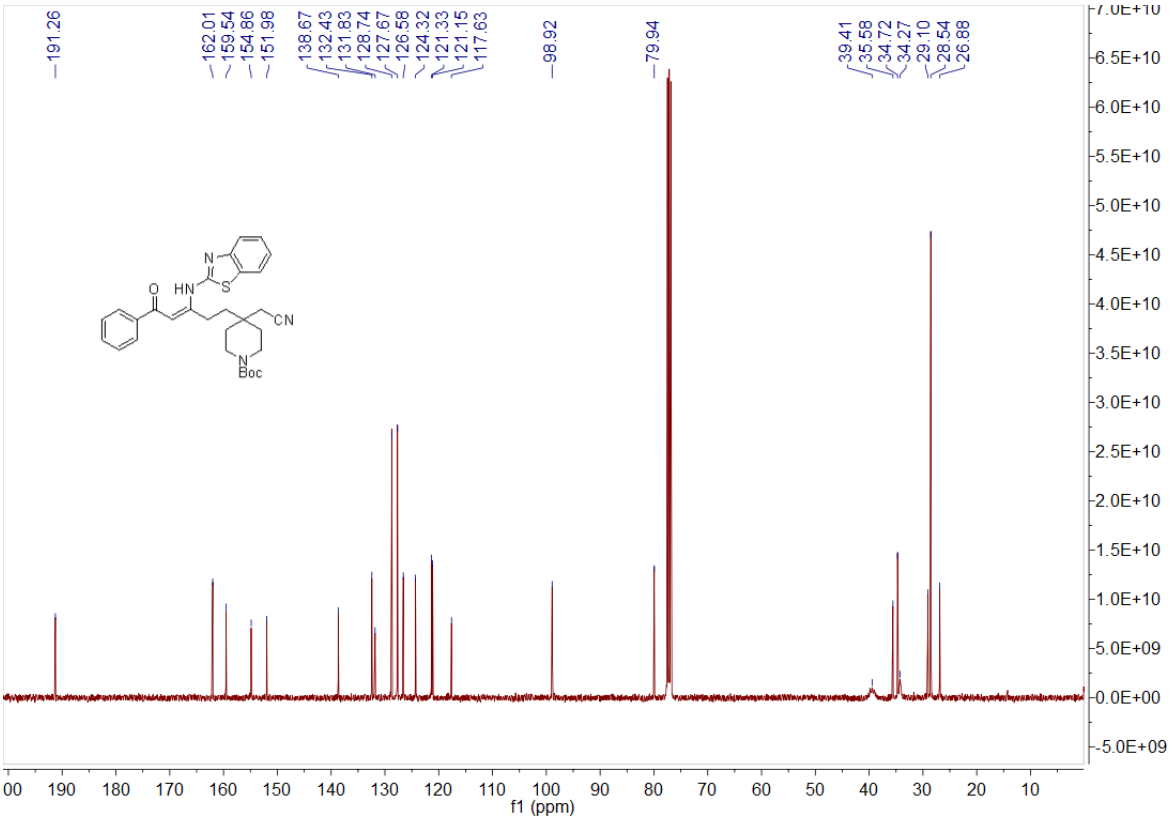
^{1}H NMR Spectrum of Compound **4g** (400 Hz, $CDCl_3$)



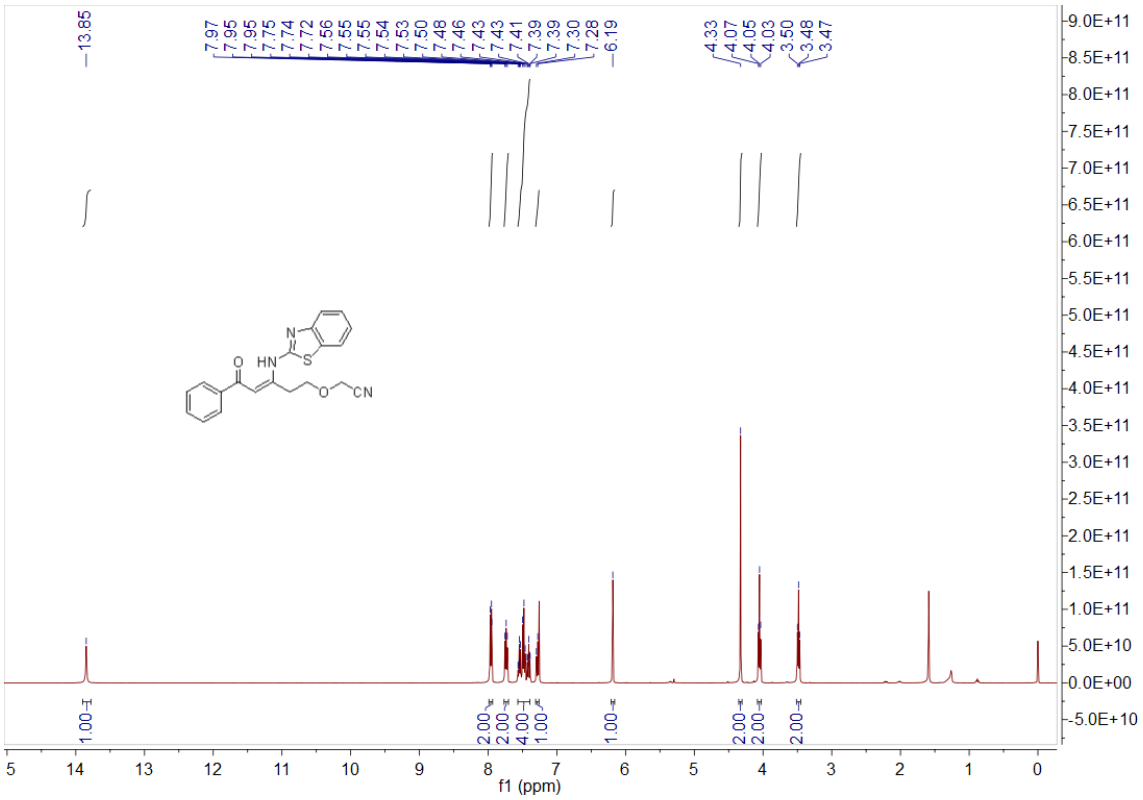
^{13}C NMR Spectrum of Compound **4g** (100 Hz, $CDCl_3$)



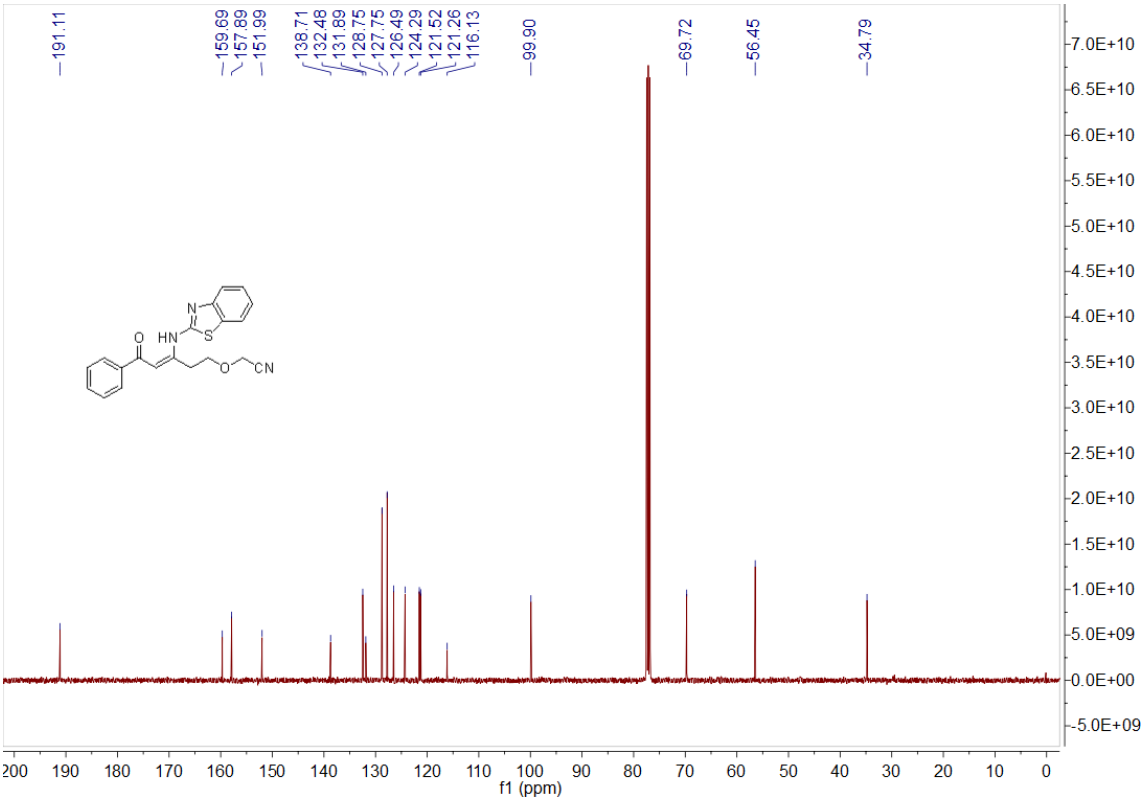
^{1}H NMR Spectrum of Compound **4h** (400 Hz, $CDCl_3$)



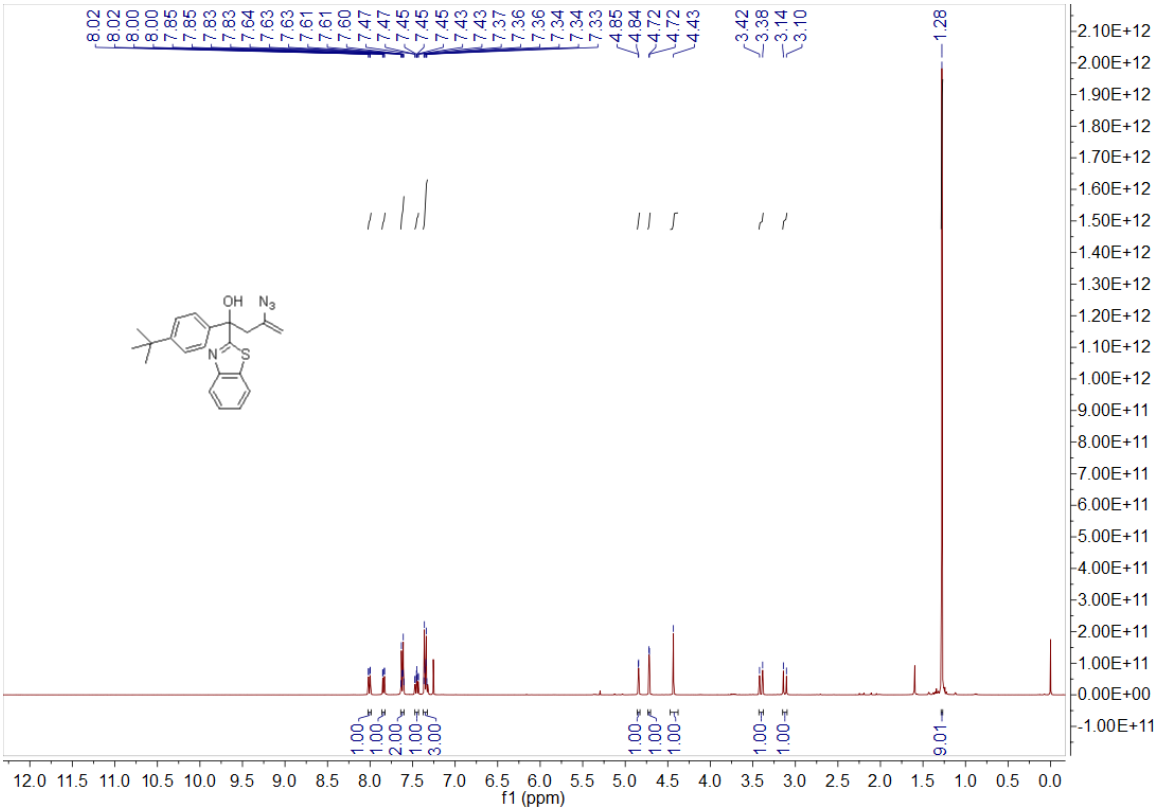
^{13}C NMR Spectrum of Compound **4h** (100 Hz, $CDCl_3$)



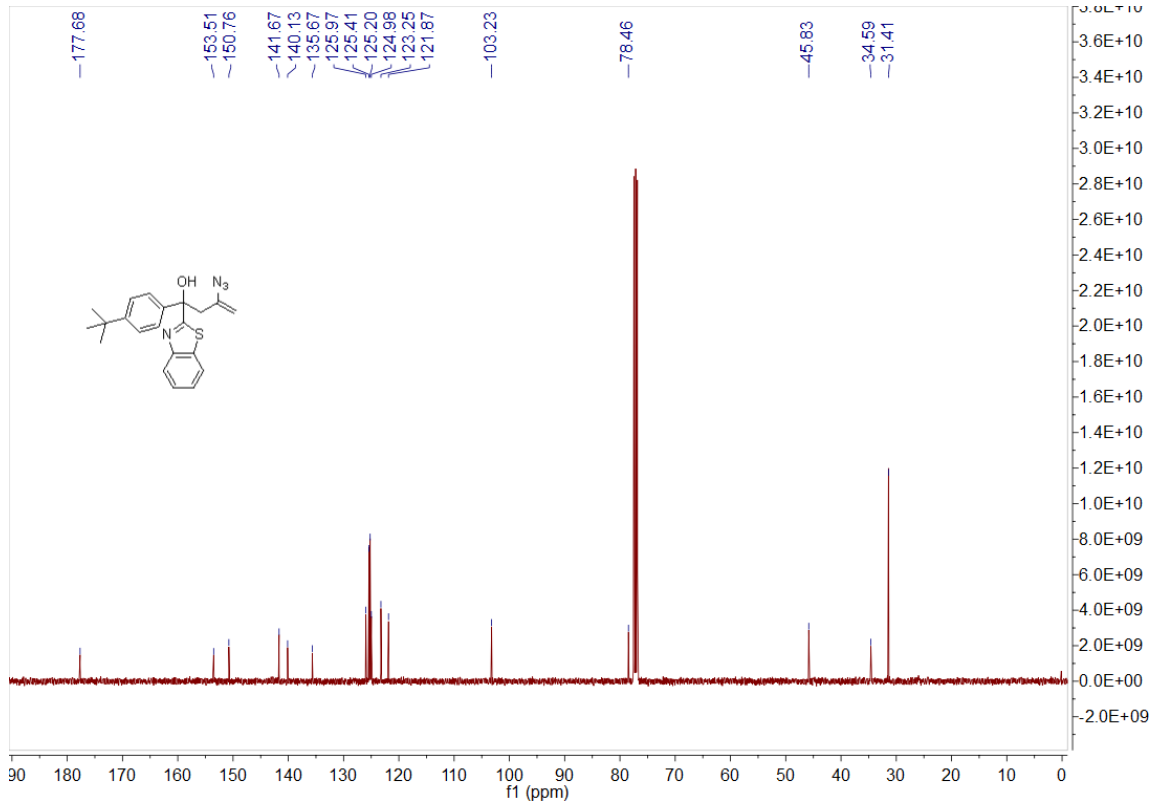
^{1}H NMR Spectrum of Compound **4i** (400 Hz, $CDCl_3$)



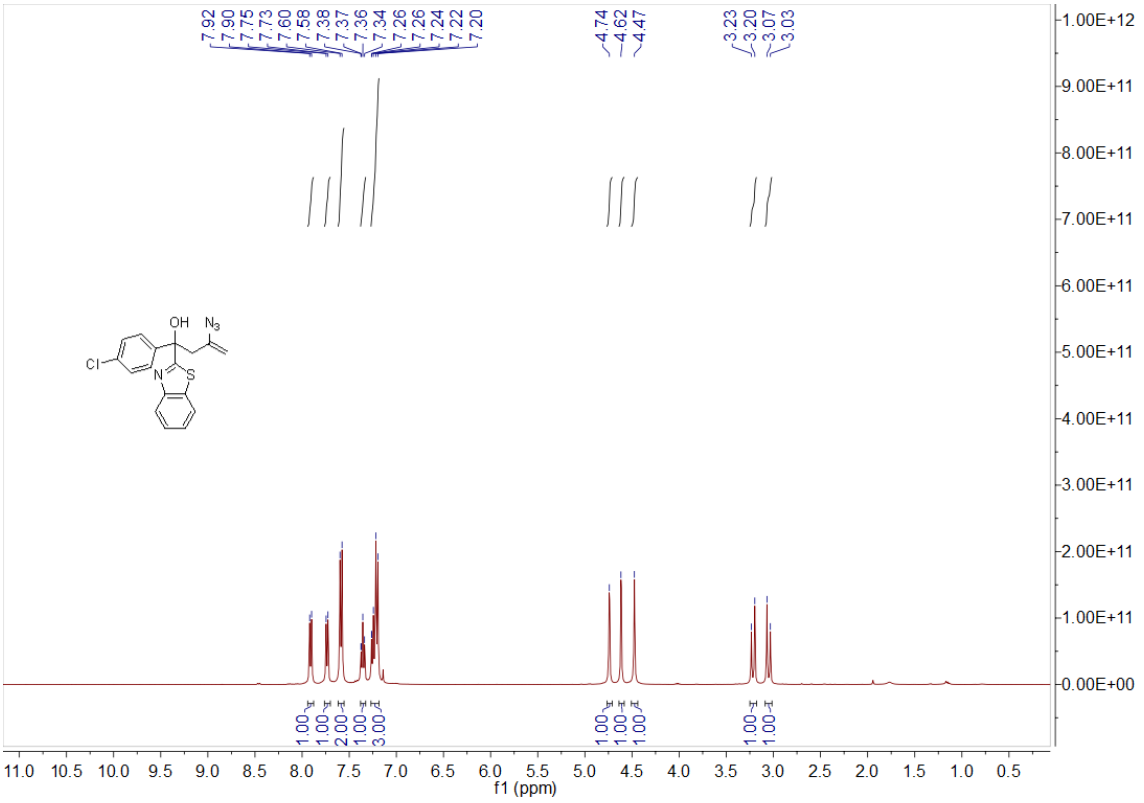
^{13}C NMR Spectrum of Compound **4i** (100 Hz, $CDCl_3$)



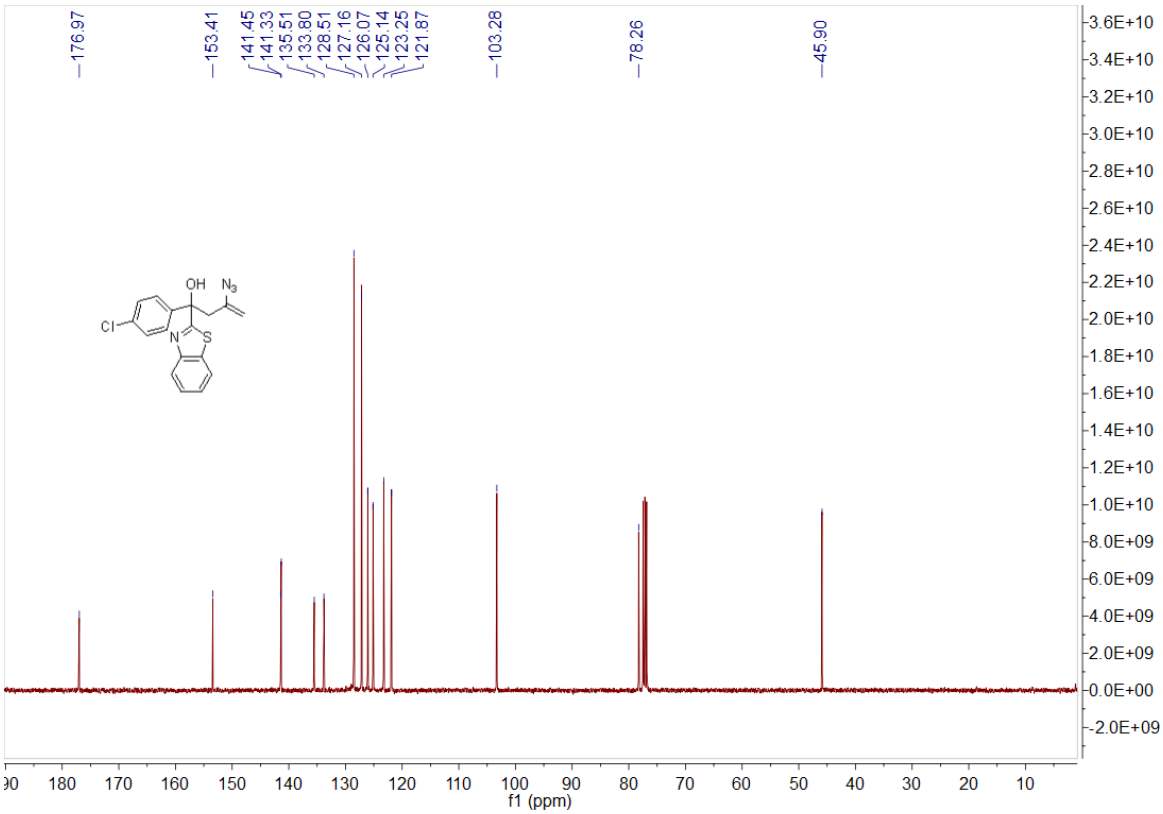
^{1}H NMR Spectrum of Compound **1c** (400 Hz, $CDCl_3$)



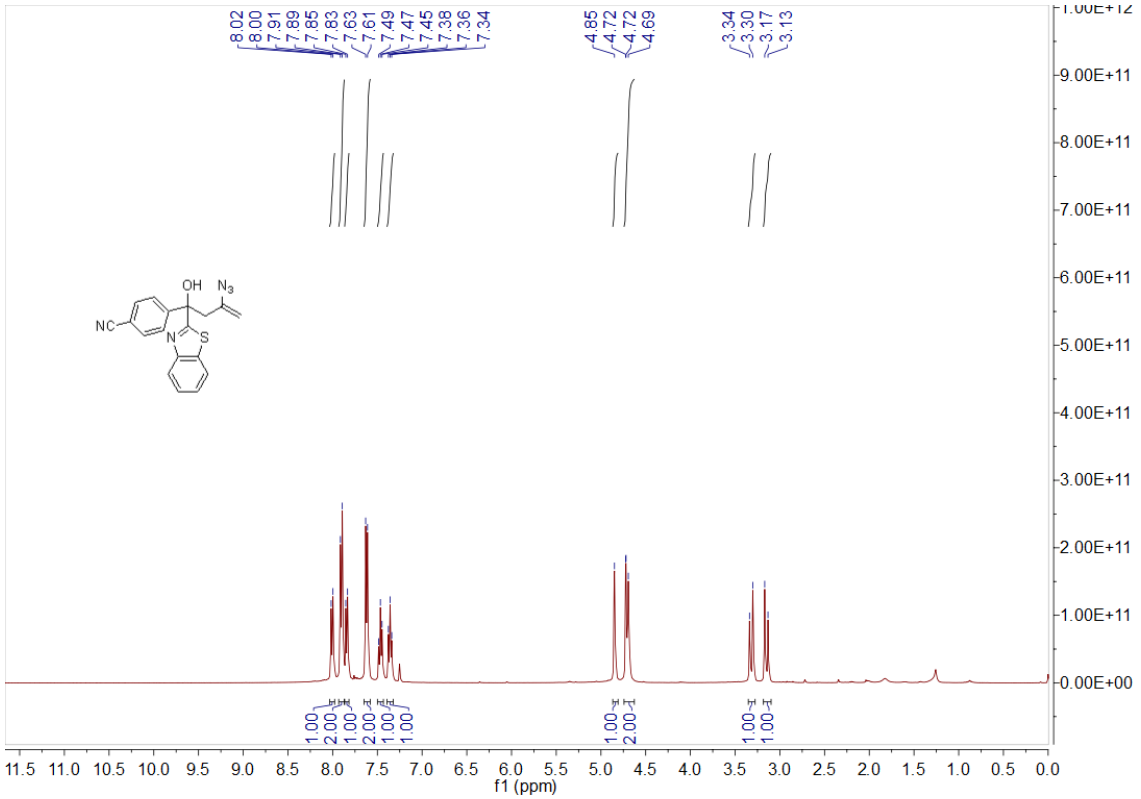
^{13}C NMR Spectrum of Compound **1c** (100 Hz, $CDCl_3$)



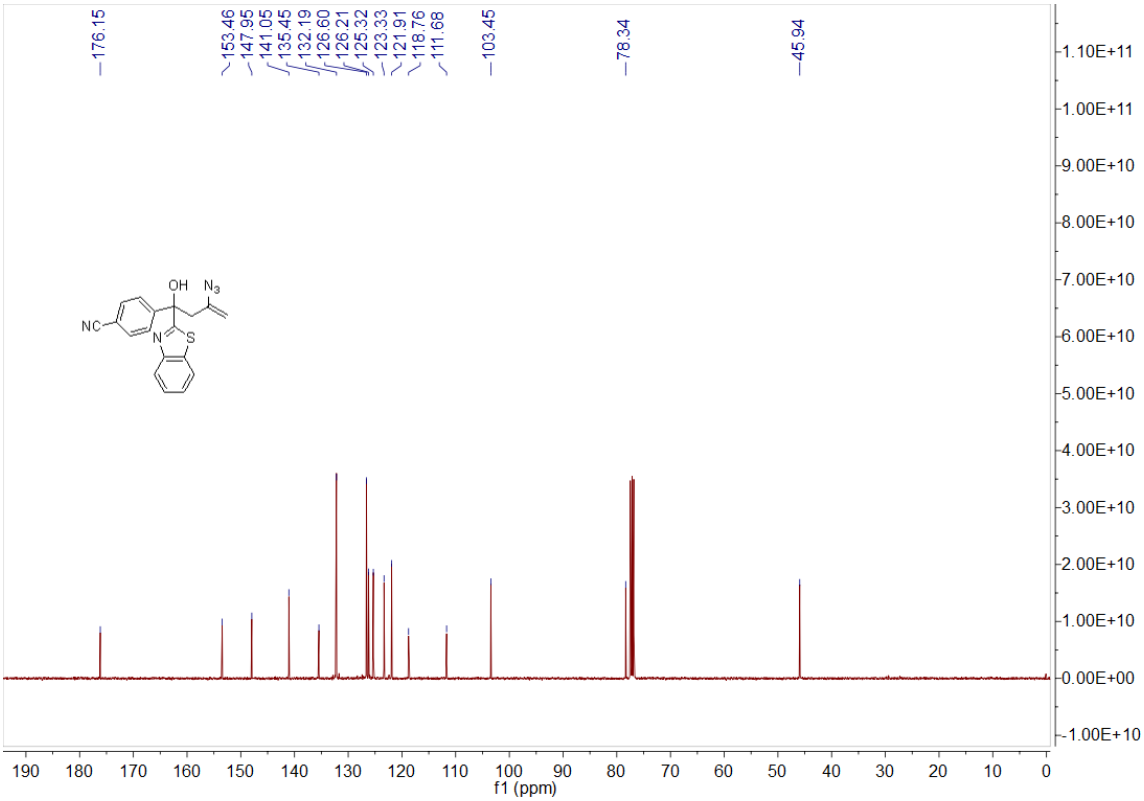
^{1}H NMR Spectrum of Compound **1e** (400 Hz, $CDCl_3$)



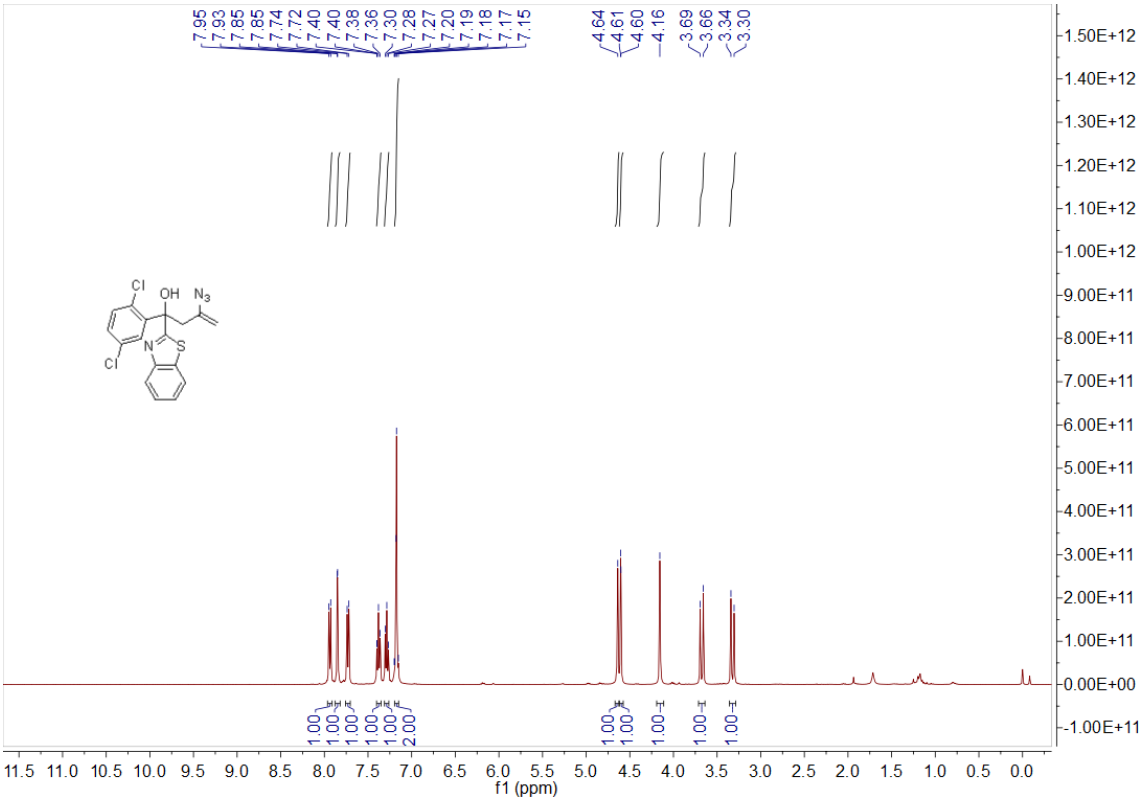
^{13}C NMR Spectrum of Compound **1e** (100 Hz, $CDCl_3$)



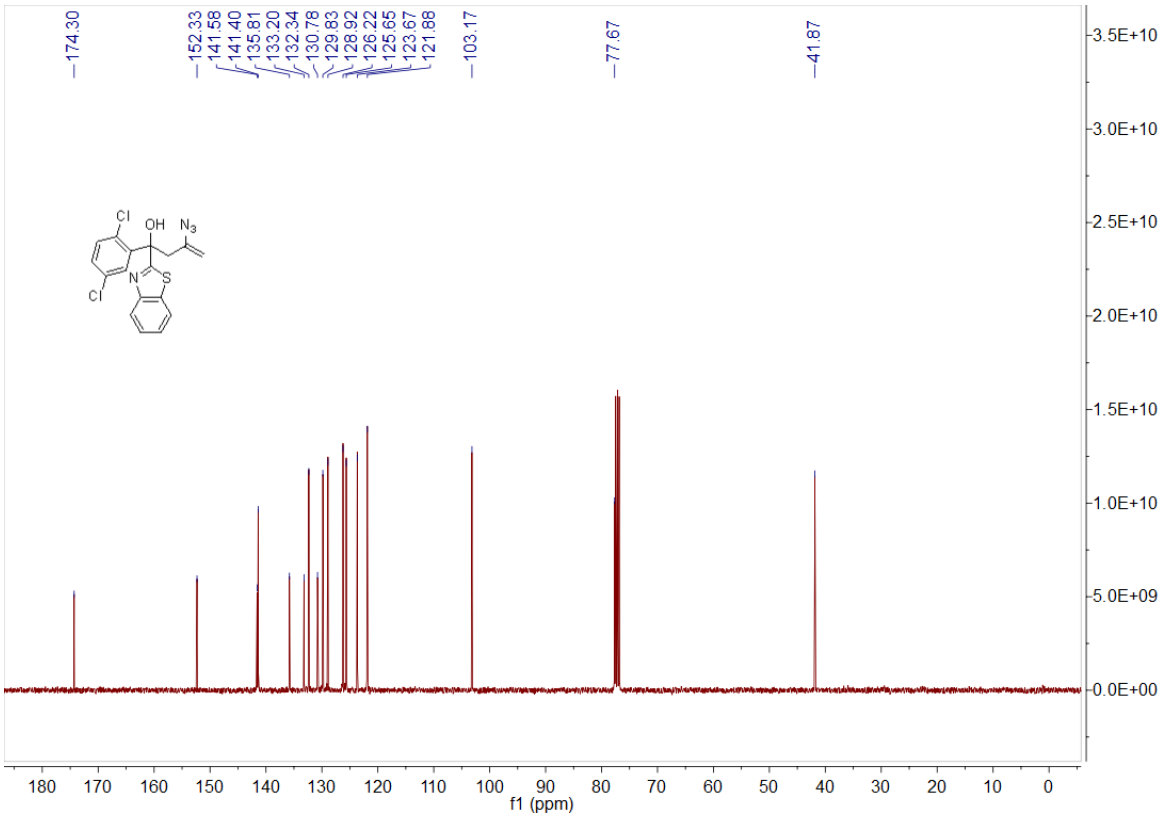
^{1}H NMR Spectrum of Compound **1i** (400 Hz, $CDCl_3$)



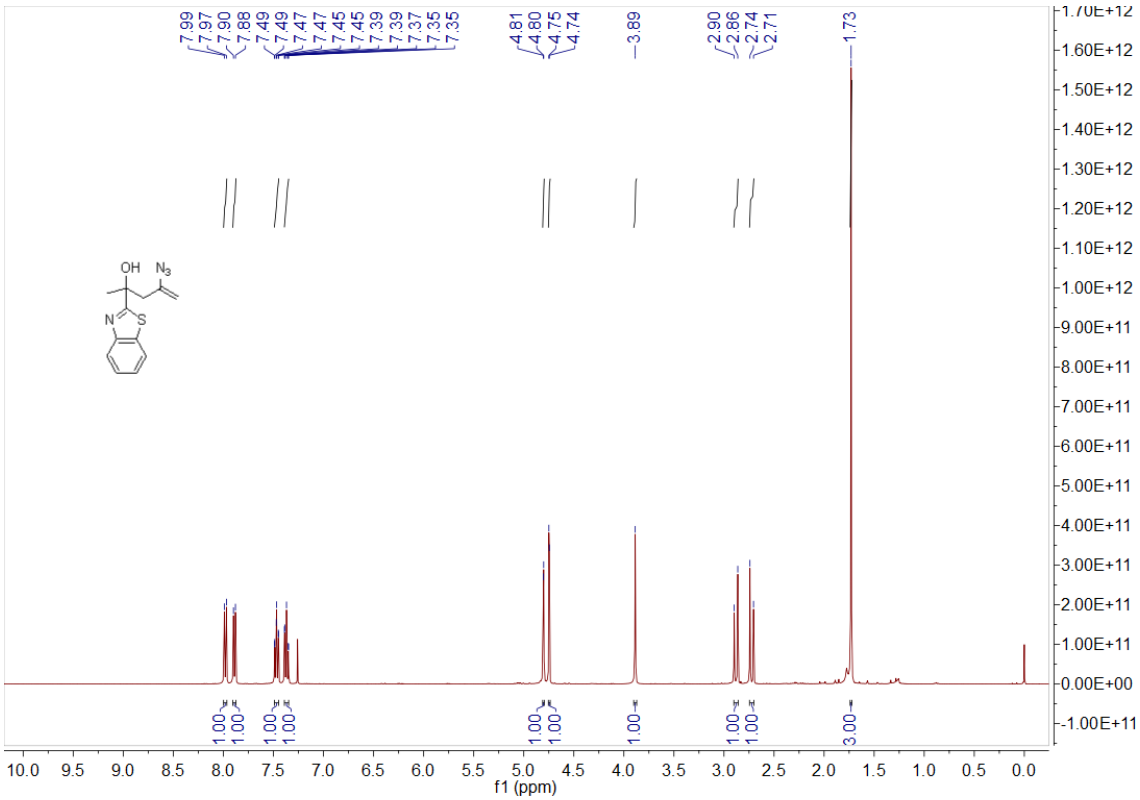
^{13}C NMR Spectrum of Compound **1i** (100 Hz, $CDCl_3$)



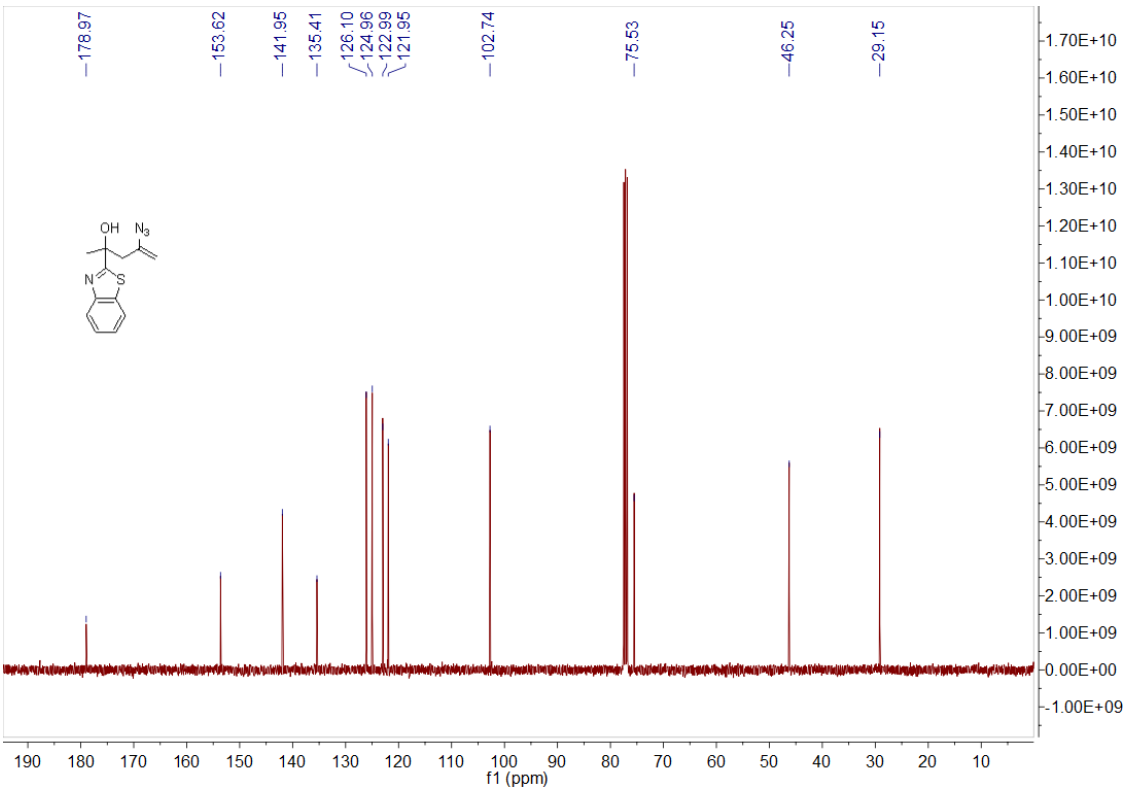
^{1}H NMR Spectrum of Compound **1q** (400 Hz, $CDCl_3$)



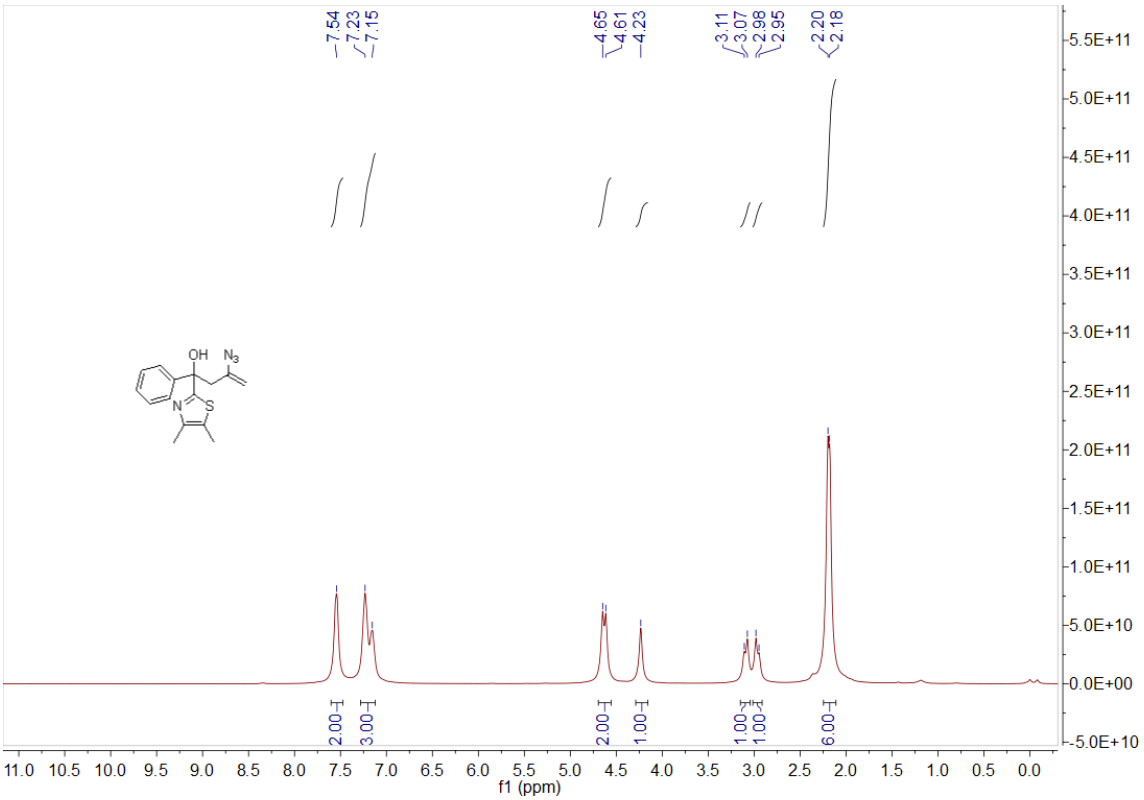
^{13}C NMR Spectrum of Compound **1q** (100 Hz, $CDCl_3$)



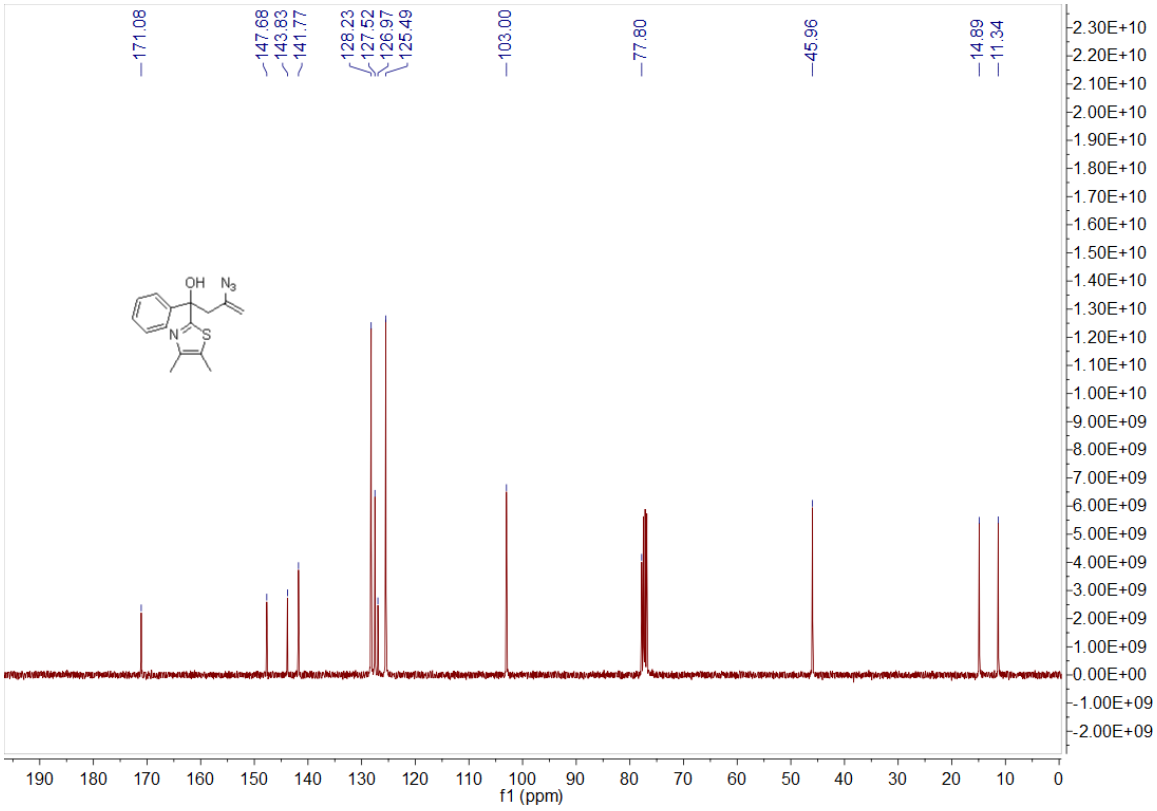
^{1}H NMR Spectrum of Compound **1z'** (400 Hz, $CDCl_3$)



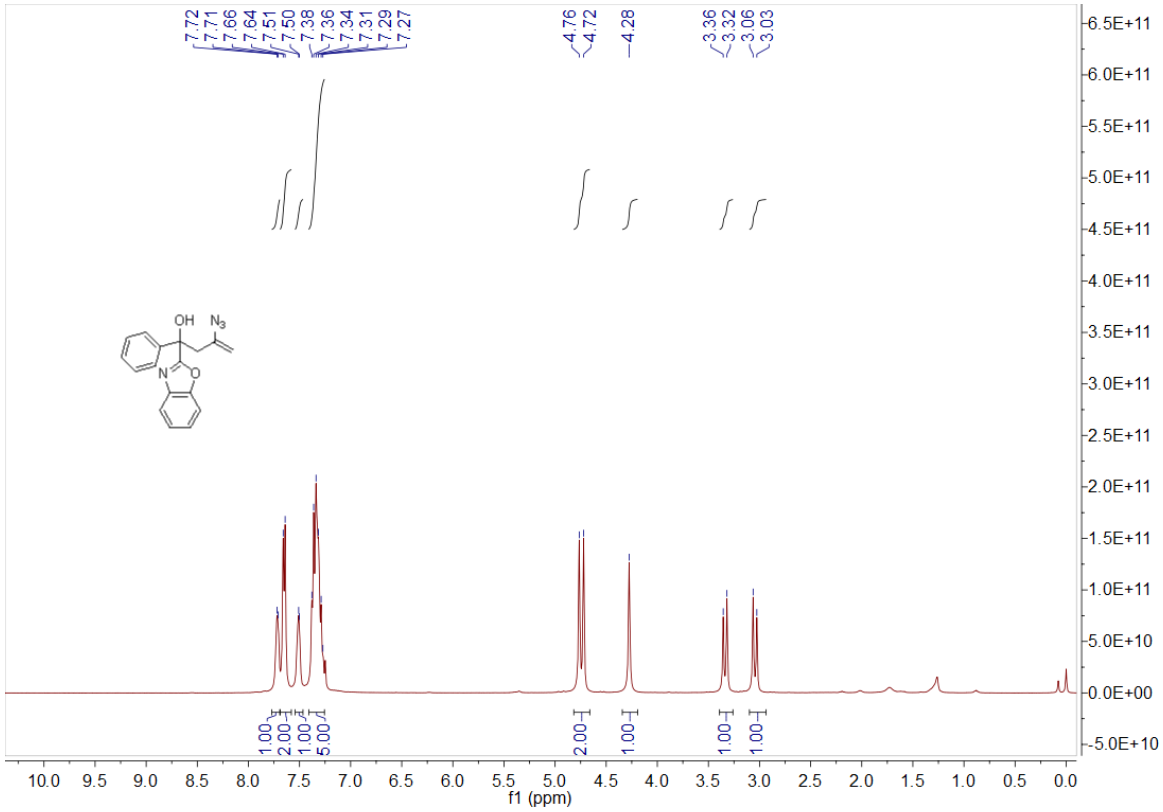
^{13}C NMR Spectrum of Compound **1z'** (100 Hz, $CDCl_3$)



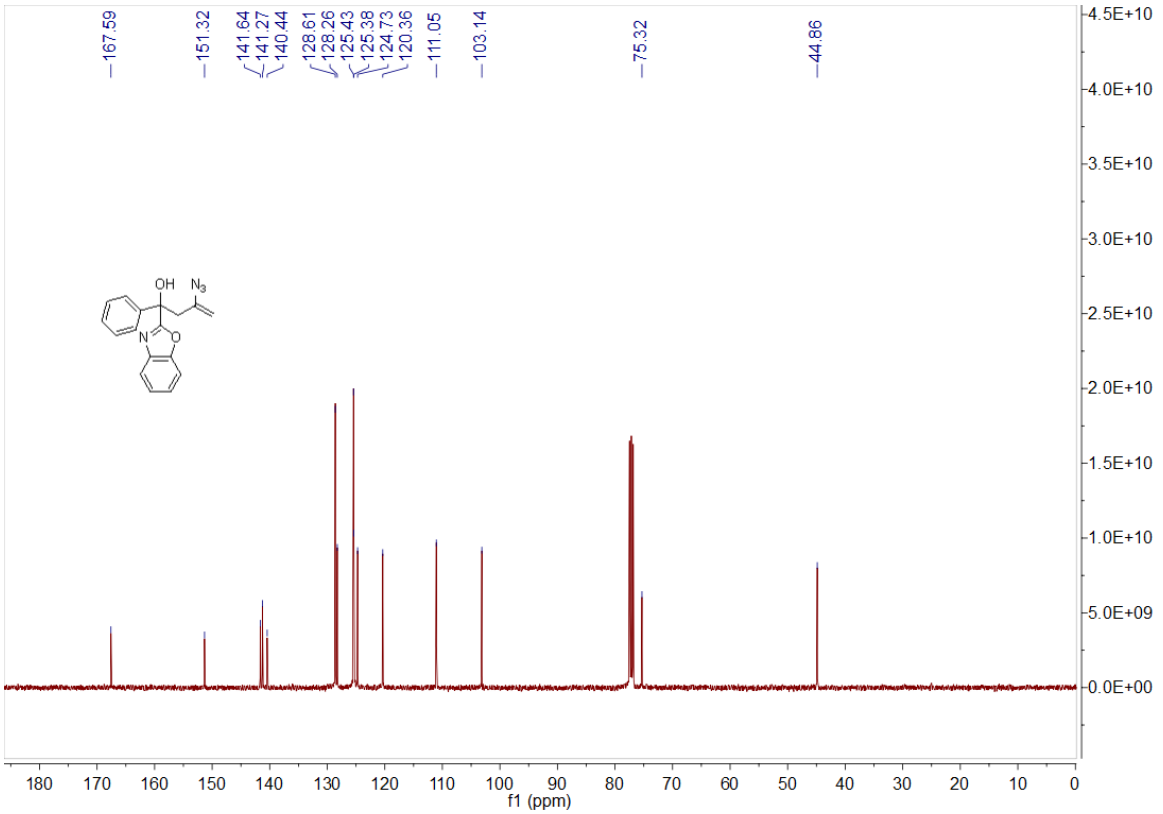
^{1}H NMR Spectrum of Compound **1x'** (400 Hz, $CDCl_3$)



^{13}C NMR Spectrum of Compound **1x'** (100 Hz, $CDCl_3$)



^{1}H NMR Spectrum of Compound **1z'** (400 Hz, $CDCl_3$)



^{13}C NMR Spectrum of Compound **1z'** (100 Hz, $CDCl_3$)

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