Supplementary Information

Photoredox/Copper Synergistic Catalysis: One-Step Modular Assembly of Sulfonimidamides from Aryl Diazonium Salts, Tr-NSO, and Amines

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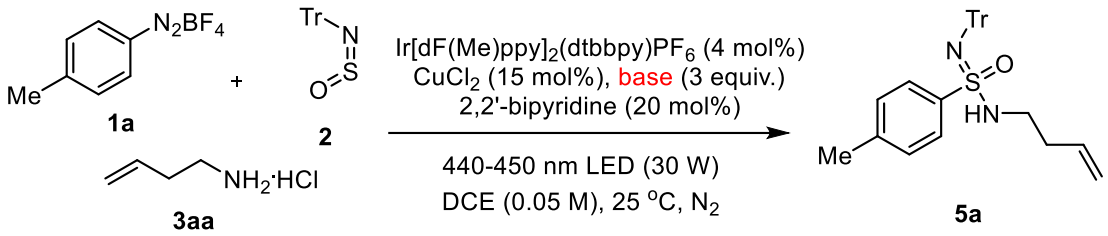
1 General Information

Chemicals were purchased from commercial suppliers and used without further purification unless otherwise stated. Analytical thin-layer chromatography (TLC) was performed on pre-coated silica gel 60 GF254 plates. Flash column chromatography was performed using Qingdao silica gel (60, particle size 0.040–0.063 mm). Visualization on TLC was achieved by UV light (254 nm). ^{1}H and ^{13}C NMR spectra were recorded on Bruker 400 MHz spectrometer in $CDCl_3$ or DMSO-d6 with tetramethylsilane (TMS) as internal standard. Chemical shifts are reported in ppm, and coupling constants (J) are given in Hz. ^{1}H NMR data are recorded as follows: chemical shift (δ, ppm), multiplicity (s = singlet; d = doublet; t = triplet; q = quartet; p = pentet; m = multiplet; brs = broad), coupling constant (Hz), and integration. ^{13}C NMR and ^{19}F NMR data are reported in terms of chemical shift (δ, ppm). High-resolution mass spectrometry (HRMS) analyses were performed on a Q-Exactive mass spectrometer (Thermo Scientific) equipped with a HESI ion source. XRD data were collected on a Rigaku Smartlab diffractometer. Visible light luminescence intensities were recorded using a SHIMADZU RF-6000 spectrofluorophotometer. A Low-temperature Stirring Reaction Bath (HC-0540A) was purchased from Hangzhou Huichuang Instrument and Equipment Co., Ltd.

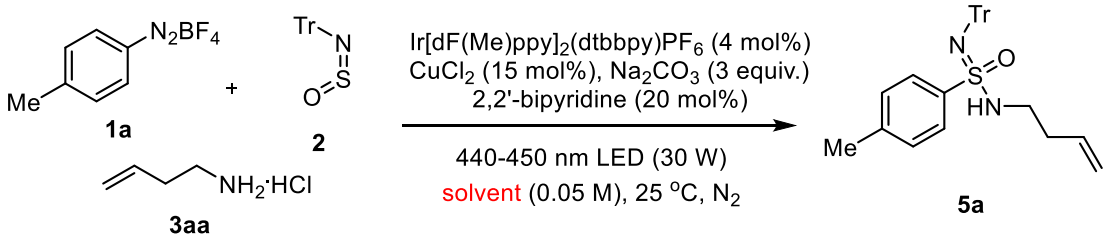
2 Supplementary Methods

2.1 Condition Optimization for the Reactions of Primary Amines



entry	base	yield (%)
1	pyridine	15
2	Et_3N	trace
4	K_3PO_4	28
5	Na_2CO_3	40

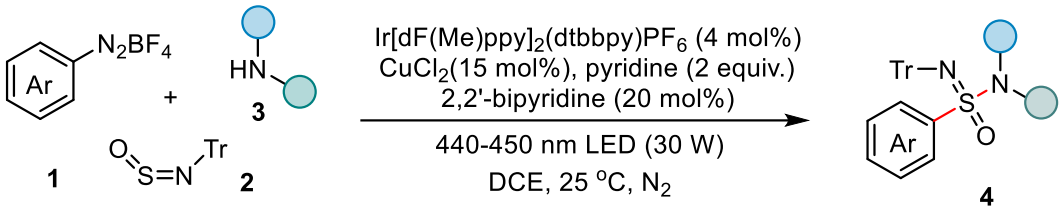
Reaction conditions: the reaction of **1a** (0.1 mmol, 1 equiv), **2** (0.15 mmol), **3aa** (0.2 mmol), Ir[dF(Me)ppy]$_2$(dtbbpy)PF_6 (4 mol%), $CuCl_2$ (15 mol%), 2,2'-bipyridine (20 mol%), and base (3 equiv) was performed in 2.0 mL of DCE at room temperature under N_2 with 30 W blue LED irradiation for 3 h. Isolated yield.



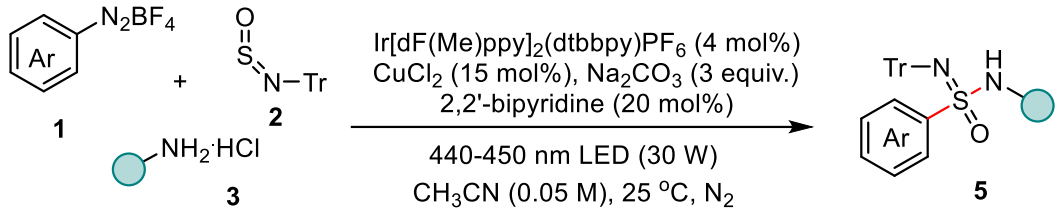
entry	solvent	yield (%)
1	EA	trace
3	THF	trace
4	DMF	20
7	MeCN	85

Reaction conditions: the reaction of **1a** (0.1 mmol, 1 equiv), **2** (0.15 mmol), **3aa** (0.2 mmol), Ir[dF(Me)ppy]$_2$(dtbbpy)PF_6 (4 mol%), $CuCl_2$ (15 mol%), 2,2'-bipyridine (20 mol%), and Na_2CO_3 (3 equiv) was performed in 2.0 mL of solvent at room temperature under N_2 with 30 W blue LED irradiation for 3 h. Isolated yield.

2.2 General Procedure for the Products



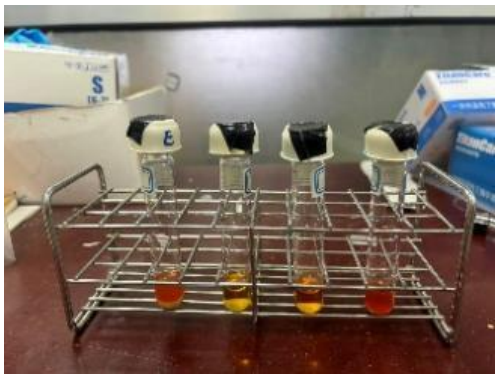
Procedure A (*secondary amines*): Unless otherwise specified, aryl diazonium salt **1** (0.1 mmol, 1.0 equiv), *N*-sulfinyltritylamine **2** (0.15 mmol, 1.5 equiv), $Ir[dF(Me)ppy]_2(dtbbpy)PF_6$ (4 mol%), $CuCl_2$ (15 mol%), and 2,2'-dipyridyl (20 mol%) were added to a 10 mL oven-dried reaction tube equipped with a magnetic stir bar. The tube was sealed with a rubber septum, evacuated and backfilled with N_2 (three cycles). A solution of amine **3** (0.2 mmol, 2.0 equiv) and pyridine (0.2 mmol, 2.0 equiv) in DCE (2.0 mL) was then added via syringe. The reaction mixture was stirred under irradiation with blue LEDs (440-450 nm, 30 W) at 25 °C for 3 h. Upon completion (monitored by TLC), the solvent was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel to afford the products **4**. For the N-methoxymethylamine hydrochloride substrate, 3 equivalents of pyridine were used.



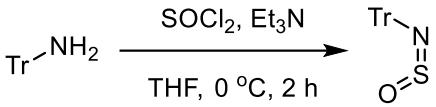
Procedure B (*primary amines*): Unless otherwise specified, aryl diazonium salt **1** (0.1 mmol, 1.0 equiv.), *N*-sulfinyltritylamine **2** (0.15 mmol, 1.5 equiv.), amine hydrochloride **3** (0.2 mmol, 2.0 equiv.), $Ir[dF(Me)ppy]_2(dtbbpy)PF_6$ (4 mol%), Na_2CO_3 (0.3 mmol, 3.0 equiv.), $CuCl_2$ (15 mol%), and 2,2'-dipyridyl (20 mol%) were added to a 10 mL oven-dried reaction tube equipped with a magnetic stir bar. The tube was sealed with a rubber septum, evacuated and backfilled with N_2 (three cycles). Then, CH_3CN (2.0 mL) was added via syringe. The reaction mixture was stirred under irradiation with blue LEDs (440-450 nm, 30 W) at 25 °C for 3 h. Upon completion (monitored by TLC),

the solvent was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel to afford the products **5**. For the free amines, 2 equivalents of Na_2CO_3 were used.

Reaction apparatus:



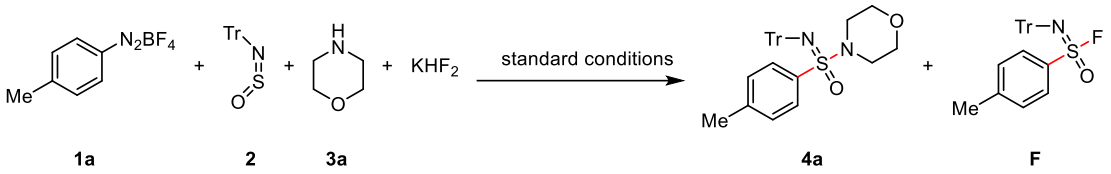

2.3 Synthetic Procedures for *N*-Sulfinyltritylamine[1]



Tritylamine (10.0 g, 38.56 mmol, 1.0 equiv) was dissolved in anhydrous tetrahydrofuran (145 mL) in an oven-dried 250 mL three-necked round bottom flask. Triethylamine (10.8 mL, 77.12 mmol, 2.0 equiv.) was added, and the reaction was cooled to 0 °C. Thionyl chloride (2.80 mL, 38.56 mmol, 1.0 equiv) was added dropwise. The reaction was stirred at 0 °C for 2 hours. The resulting mixture was filtered through Celite, and the filter cake was washed with diethyl ether to afford Tr-NSO as a white solid (10.72 g, 91% yield).

2.4 Mechanism Investigation

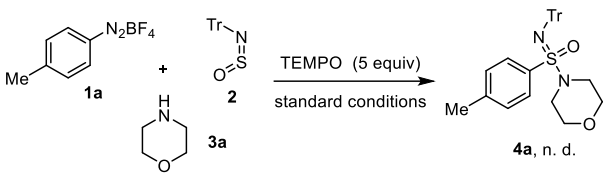
2.4.1 Control Experiment

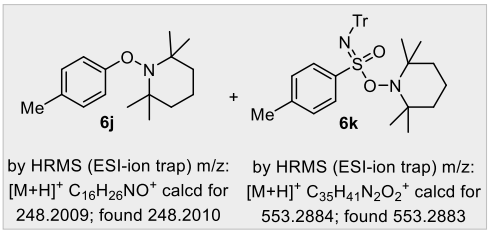


1a 2 3a 4a F

entry	**3a**	KHF_2 (2 equiv)	photo/PC	**4a**/yield (%)	**F**/yield (%)
1	√	√	√	75	/
2	/	√	√	/	< 10
3	/	√	/	/	35
4	√	√	/	/	/

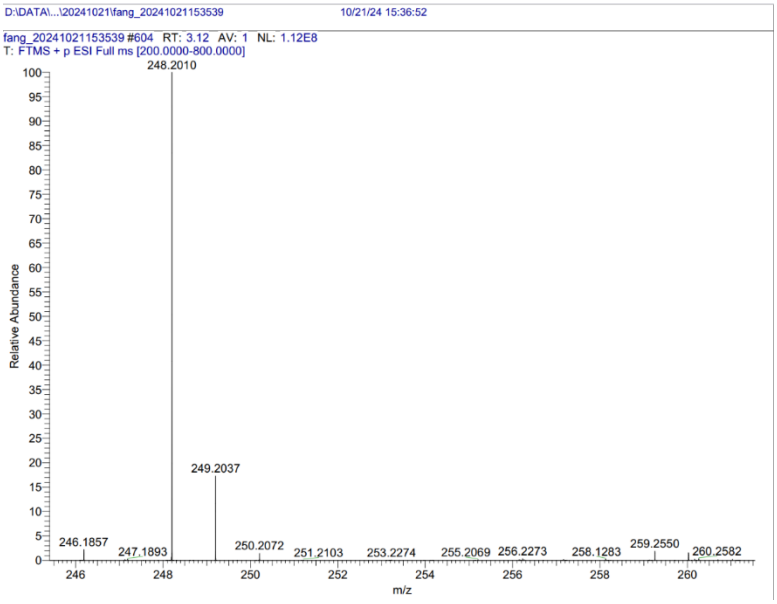
2.4.2 Radical Trapping Experiment

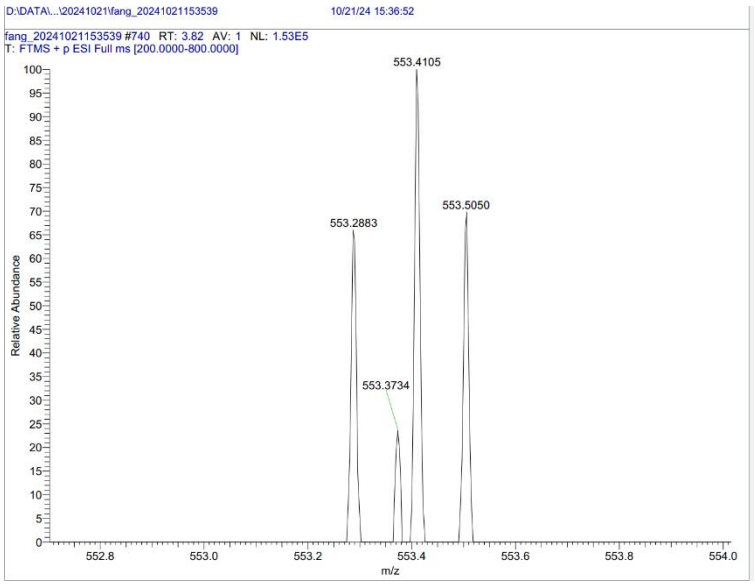




by HRMS (ESI-ion trap) m/z: $[M+H]^+$ $C_{16}H_{26}NO^+$ calcd for 248.2009; found 248.2010

by HRMS (ESI-ion trap) m/z: $[M+H]^+$ $C_{35}H_{41}N_2O_2^+$ calcd for 553.2884; found 553.2883





2.4.3 Stern-Volmer Luminescence Quenching Studies

The luminescence spectra were measured using a PerkinElmer LS 55 spectrofluorometer equipped with a quartz cuvette. Stock solutions of the photocatalyst $Ir[dF(Me)ppy]_2(dtbbpy)PF_6$ and the potential quenchers (**1a, 2**, **3a**, **pyridine, $CuCl_2$** and **$CuCl_2$+2,2'-bipyridine**) were prepared separately in DCE. For a typical quenching experiment, appropriate aliquots of the $Ir[dF(Me)ppy]_2(dtbbpy)PF_6$ stock solution and a quencher (**1a, 2**, **3a**, **pyridine, $CuCl_2$** and **$CuCl_2$+2,2'-bipyridine**) were added to the quartz cuvette and diluted with DCE to a final volume of 3.0 mL. The solution was excited at 400 nm, and the emission spectrum was recorded from 450 to 650 nm. Quenching data were analyzed by plotting I_0/I according to the Stern-Volmer relationship:

$$I_0/I = kq\tau_0[Q]+1$$

In the Stern-Volmer equation:

- **I_0** is the integrated luminescence intensity from 450 to 650 nm in the absence of the quencher.
- **I** is the integrated luminescence intensity from 450 to 650 nm in the presence of the quencher.
- **kq** is the bimolecular quenching rate constant.
- **[Q]** is the concentration of the quencher.
- **τ_0** is the excited-state lifetime of the photocatalyst in the absence of the quencher

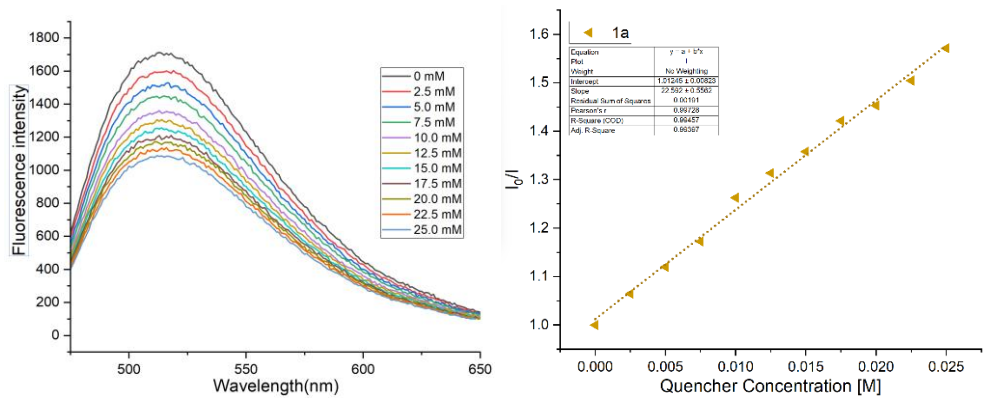


Figure S1 Emission spectra for Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ luminescence quenching by **1a** as additive (left) and Stern-Volmer plot (right)

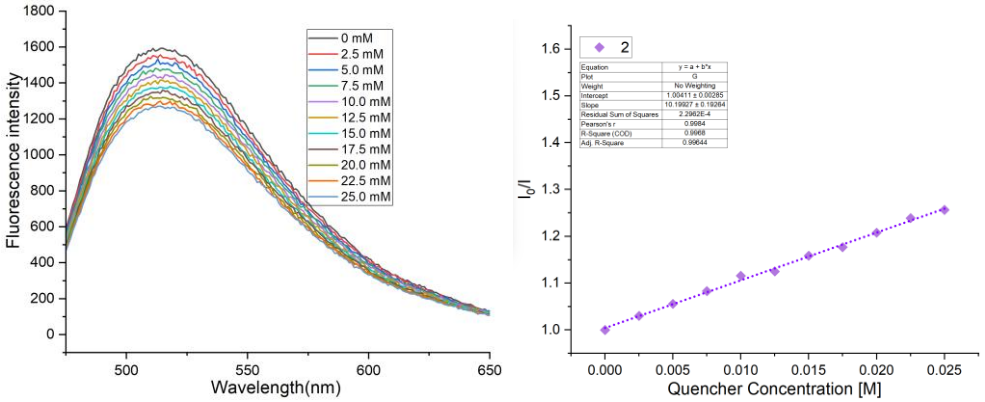


Figure S2 Emission spectra for Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ luminescence quenching by **2** as additive (left) and Stern-Volmer plot (right)

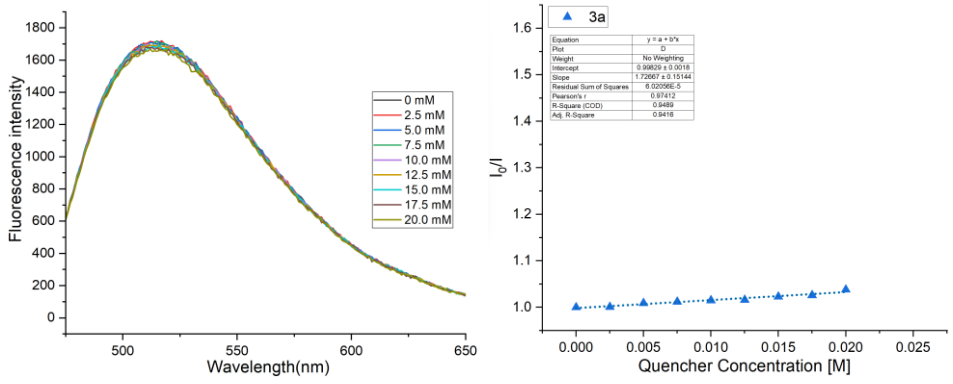


Figure S3 Emission spectra for Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ luminescence quenching by **3a** as additive (left) and Stern-Volmer plot (right)

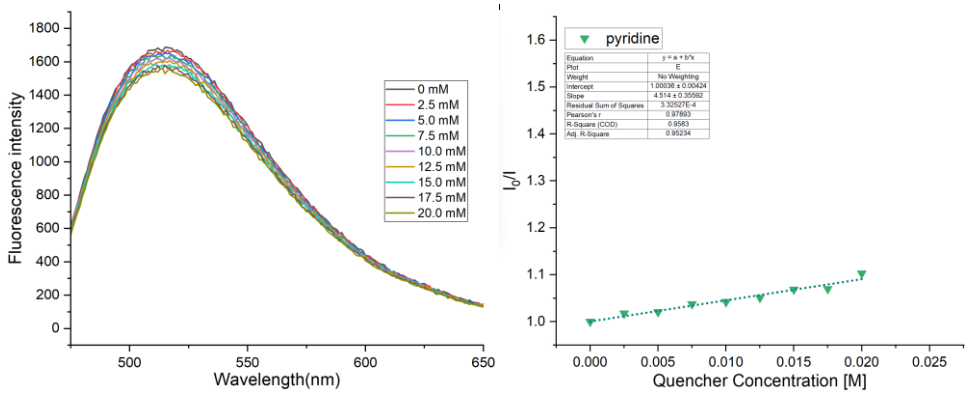


Figure S4 Emission spectra for Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ luminescence quenching by **pyridine** as additive (left) and Stern-Volmer plot (right)

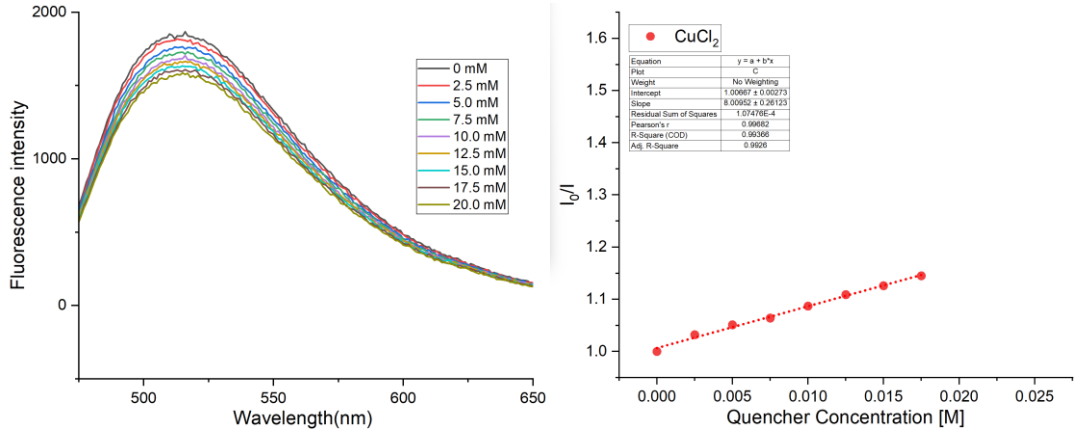


Figure S5 Emission spectra for Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ luminescence quenching by **CuCl$_2$** as additive (left) and Stern-Volmer plot (right)

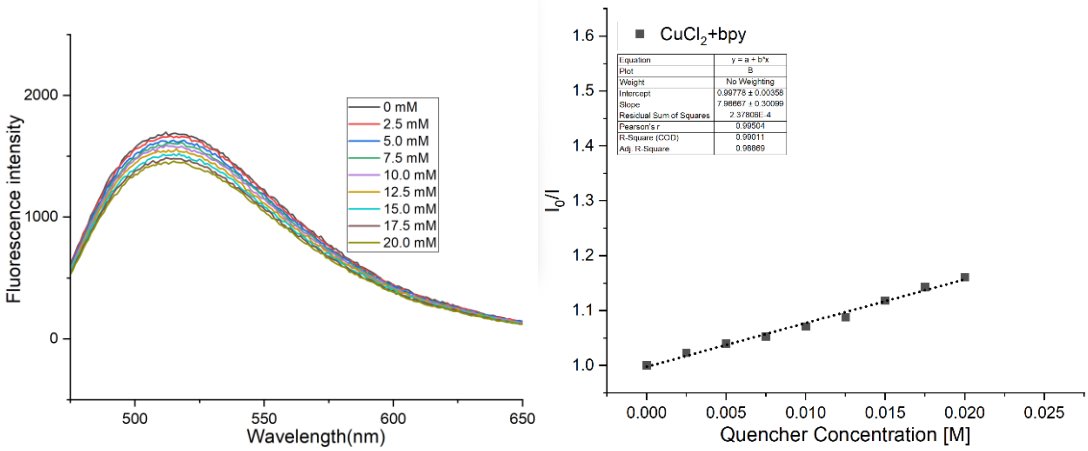


Figure S6 Emission spectra for Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ luminescence quenching by **CuCl$_2$+bpy** as additive (left) and Stern-Volmer plot (right)

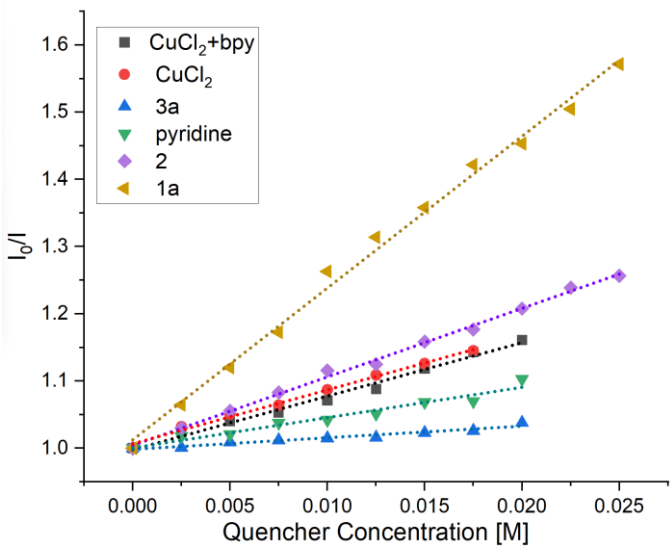
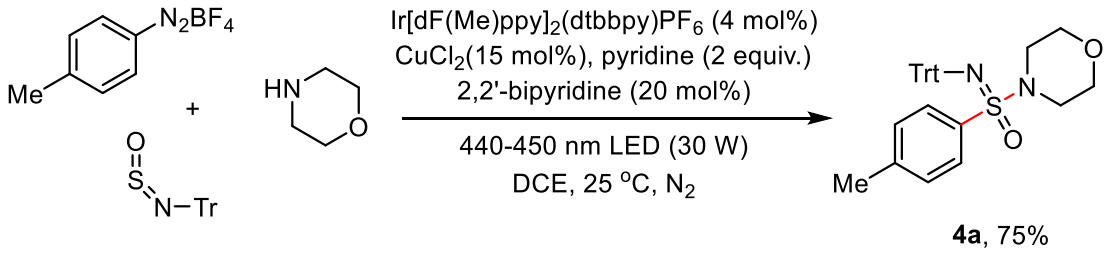


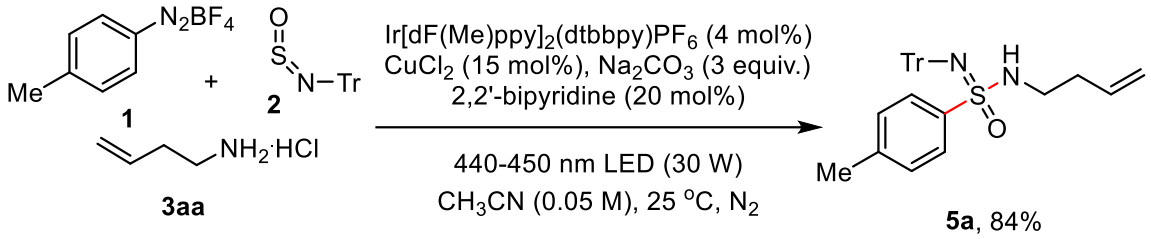
Figure S7 Stern-Volmer quenching experiments

2.5 Gram-Scale Reaction and Synthetic Transformations

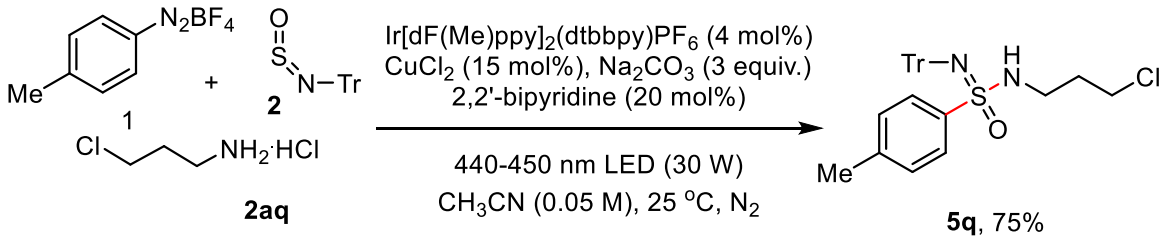


4a, 75%

Aryl diazonium salt **1a** (3.0 mmol, 1.0 equiv), *N*-sulfinyltritylamine **2** (4.5 mmol, 1.5 equiv), Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ (4 mol%), $CuCl_2$ (15 mol%), and 2,2'-dipyridyl (20 mol%) were added to a 100 mL oven-dried reaction tube equipped with a magnetic stir bar. The tube was sealed with a rubber septum, evacuated and backfilled with N_2 (three cycles). A solution of morpholine **3a** (6.0 mmol, 2.0 equiv) and pyridine (6.0 mmol, 2.0 equiv) in DCE (60 mL) was then added via syringe. The reaction mixture was stirred under irradiation with blue LEDs (440-450 nm, 30 W) at 25 °C for 24 h. Upon completion (monitored by TLC), the solvent was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (eluent: PE/EA = 1:10) to afford the product **4a** (1.1 g, 75% yield).

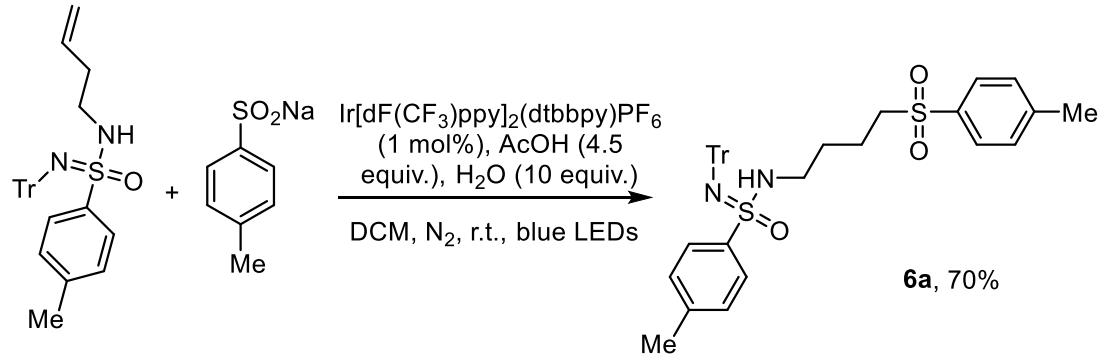


Aryl diazonium salt **1a** (3 mmol, 1.0 equiv.), *N*-sulfinyltritylamine **2** (4.5 mmol, 1.5 equiv.), amine **3aa** (6.0 mmol, 2.0 equiv.), Ir[dF(Me)ppy]$_2$(dtbbpy)PF$_6$ (4 mol%), Na_2CO_3 (9.0 mmol, 3.0 equiv.), $CuCl_2$ (15 mol%), and 2,2'-dipyridyl (20 mol%) were added to a 100 mL oven-dried reaction tube equipped with a magnetic stir bar. The tube was sealed with a rubber septum, evacuated and backfilled with N_2 (three cycles). Then, CH_3CN (60 mL) was added via syringe. The reaction mixture was stirred under irradiation with blue LEDs (440-450 nm, 30 W) at 25 °C for 12 h. Upon completion (monitored by TLC), the solvent was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel to afford the product **5a**. (eluent: PE/EA = 1:10) to afford the pure product (1.18 g, 84% yield).



Following the procedure described above, compound **5q** was synthesized on the same scale to afford the pure product (1.1 g, 75% yield).

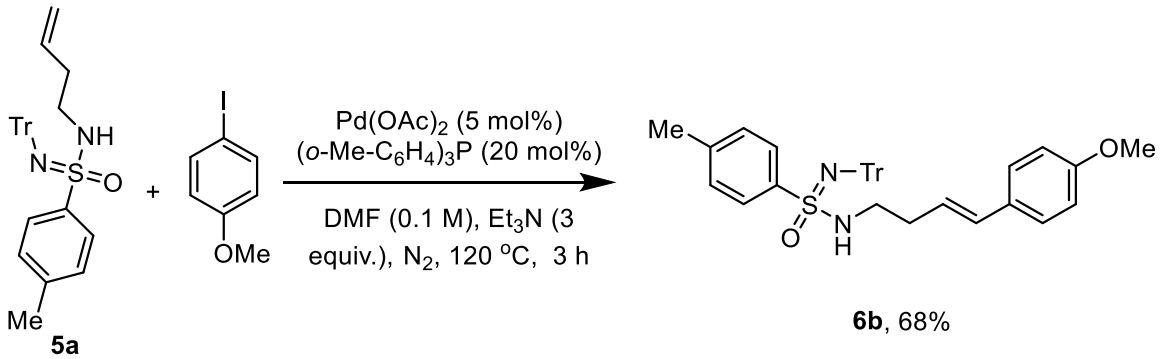
Synthesis of 6a[2]



A flame-dried 10 mL reaction tube equipped with a magnetic stir bar and sealed with a rubber septum was charged with **5a** (0.1 mmol), sodium *p*-toluenesulfinate (0.165

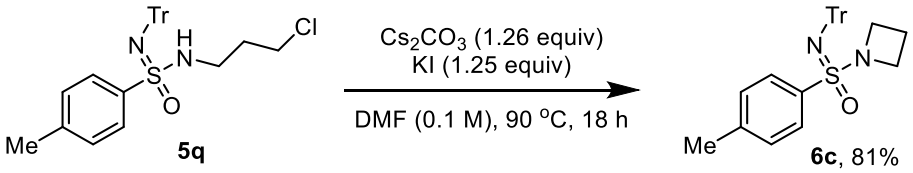
mmol), and [Ir(dF(CF_3)ppy)$_2$(dtbbpy)]PF_6 (1.1 mg, 0.001 mmol, 1 mol %). The tube was evacuated and backfilled with N_2 (three cycles). Dichloromethane (1.0 mL) and H_2O (18 μL) were added, followed by AcOH (25.7 μL, 0.45 mmol). The reaction vessel was placed 2 cm away from 30 W blue LED lamps (equipped with a cooling fan) and irradiated for 4 h, with the reaction progress monitored periodically by TLC. Upon completion, the reaction was quenched with saturated aqueous $NaHCO_3$ (3 mL). The aqueous phase was extracted with CH_2Cl_2 (3 × 5 mL). The combined organic extracts were dried over anhydrous Na_2SO_4 and concentrated under reduced pressure using a rotary evaporator. Purification of the residue by flash column chromatography on silica gel (eluent: PE/EA = 1:4) afforded the product **6a** (43.6 mg, 70% yield).

Synthesis of 6b[3]



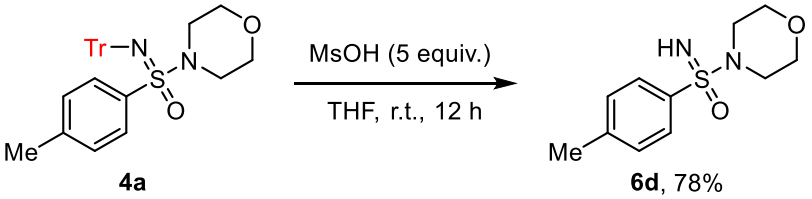
$Pd(OAc)_2$ (5 mol %), (*o*-Me-C_6H_4)$_3$P (20 mol %), Et_3N (91.1 mg, 0.9 mmol, 3.0 equiv), 4-Iodotoluene (65.4 mg, 0.3 mmol, 1.0 equiv), and *N*-(but-3-en-1-yl)-4-methyl-*N*′-tritylbenzenesulfonimidamide (139.9 mg, 1.1 mmol, 1.1 equiv) were added to a 10 mL oven-dried Schlenk tube equipped with a magnetic stir bar. The tube was sealed with a rubber septum, evacuated and backfilled with N_2 (three cycles). Then, DMF (3.0 mL) was added via syringe. The reaction mixture was stirred under 120 °C for 3 h. Upon completion, (monitored by TLC), the solvent was concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel to afford the pure product. (eluent: PE/EA = 3:1) to afford the pure product (38.9 mg, 68% yield).

Synthesis of 6c[4]



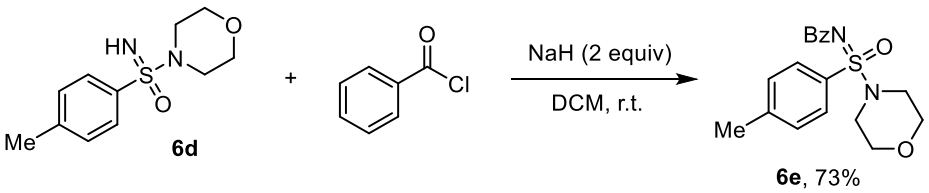
To *N*-(3-chloropropyl)-4-methyl-*N*′-tritylbenzenesulfonimidamide (48.9 mg, 0.1 mmol) in DMF (1 mL) was added Cs_2CO_3 (42.3 mg, 0.126 mmol) and KI (20.8 mg, 0.125 mmol). The mixture was heated to 90 °C in open air for 18 h. Upon cooling to room temperature, brine (10 mL) was added and the solution was extracted with DCM (3 x 15 mL). The combined organic layers were washed with water (20 mL), dried over $MgSO_4$ and condensed to afford a brown solid. flash column chromatography on silica gel (eluent: PE/EtOAc = 6/1 R_f=0.5) to afford the pure product (36.7 mg, 81%).

Synthesis of 6d[5]



According to a literature procedure, *N*-substituted sulfonimidamide **4a** (48.3 mg, 0.1 mmol, 1.0 equiv.) was placed in an oven-dried 10 mL reaction tube. The tube was sealed, evacuated, and backfilled with N_2 (three cycles). THF (1.0 mL) was added, followed by the addition of MsOH (5.0 equiv.). The reaction mixture was stirred at room temperature for 12 hours. Upon completion, the mixture was quenched with a saturated aqueous sodium bicarbonate solution and extracted with EtOAc (10 mL). The combined organic phases were dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by flash column chromatography (PE/EA = 1:2) afforded the product **6d** (18.7 mg, 78% yield).

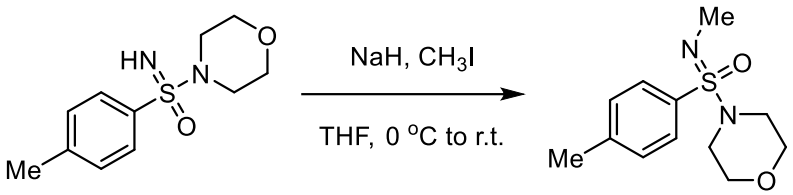
Synthesis of 6e[6]



4-(4-methylphenylsulfonimidoyl)morpholine **6d** (24.0 mg, 0.1 mmol, 1.0 equiv.) and

NaH (60% mineral oil) (8 mg, 0.2 mmol, 2.0 equiv.) were stirred in DCM (1.0 mL) under argon at room temperature. Benzoyl chloride (14.1 mg, 0.1 mmol, 1.0 equiv.) was then added and the reaction mixture was stirred for overnight at 30°C. Water (10.0 mL) was added and the resulting mixture was extracted with DCM three times. The combined organic layers were dried over $MgSO_4$ and concentrated. Purification by silica gel chromatography (PE/EA = 2/1, White solid, R_f=0.5) afforded the product **6e** (25.1 mg, 73% yield).

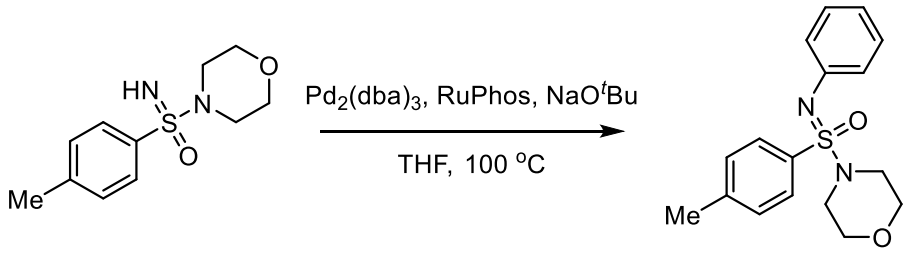
Synthesis of 6f[1]



6d **6f**, 93%

4-(4-methylphenylsulfonimidoyl)morpholine **6d** (24.0 mg, 0.1 mmol, 1.0 equiv.) was dissolved in THF (1.0 mL) and the reaction mixture was cooled to 0 °C. Sodium hydride (60% mineral oil) (12 mg, 0.3 mmol, 3.0 equiv.) was added and the reaction mixture stirred for 1 hours. Methyl iodide (142 mg, 1.0 mmol, 10.0 equiv.) was added. The reaction mixture was stirred for 22 hours before dilution with CH_2Cl_2. The solution was washed with water, then the layers were separated and the aqueous phase was extracted with DCM three time. The combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo. The combined organic layers were dried over $MgSO_4$ and concentrated. Purification by silica gel chromatography (PE/EA = 5/1, White oil, R_f=0.4) afforded the product **6f** (23.7 mg, 93% yield).

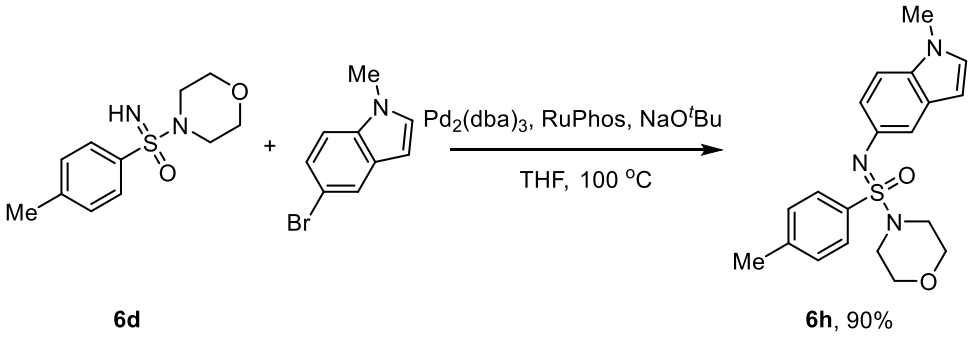
Synthesis of 6g[1]



6d **6g**, 95%

4-(4-methylphenylsulfonimidoyl)morpholine (24.0 mg, 0.1 mmol, 1.0 equiv.), sodium *tert*-butoxide (9.8 mg, 0.12 mmol, 1.2 equiv.), $Pd_2(dba)_3$ (4.5 mg, 0.005 mmol, 0.05 equiv.) and RuPhos (5.4 mg, 0.006 mmol, 0.012 equiv.) were added to an oven-dried reaction tube. The tube was sealed with a crimp cap. THF (1.5 mL) and bromobenzene (15.8 μL, 0.15 mmol, 1.5 equiv.) were added through the septum. The reaction mixture was placed in a pre-heated oil bath at 100 °C and stirred for 3 hours. The solution was diluted with water and extracted with ethyl acetate three time. The combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo. Purification by silica gel chromatography (PE/EA = 2/1, White soild, R_f=0.7) afforded the product (30.1 mg, 95% yield).

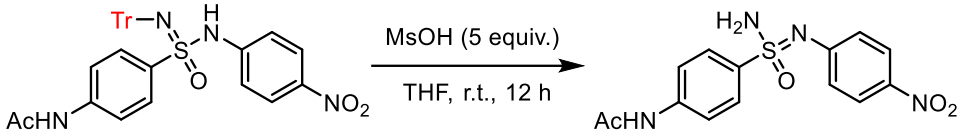
Synthesis of 6h[1]



6d **6h**, 90%

According to a literature procedure, 4-(4-methylphenylsulfonimidoyl)morpholine **6d** (24.0 mg, 0.1 mmol, 1.0 equiv.), sodium tert-butoxide (9.8 mg, 0.12 mmol, 1.2 equiv.), $Pd_2(dba)_3$ (4.5 mg, 0.005 mmol, 0.05 equiv.) and RuPhos (5.4 mg, 0.006 mmol, 0.012 equiv.) were added to an oven-dried reaction tube. The tube was sealed with a crimp cap. THF (1.5 mL) and 5-bromo-1-methyl-1*H*-indole (31.5 mg, 0.15 mmol, 1.5 equiv.) were added through the septum. The reaction mixture was placed in a pre-heated oil bath at 100 °C and stirred for 3 h. The solution was diluted with water and extracted with ethyl acetate × 3. The combined organic layers were dried over sodium sulfate, filtered and concentrated in vacuo. Purification by silica gel chromatography (petroleum ether/EtOAc = 2/1, yellow soild, R_f=0.4) afforded the product (33.3 mg, 90% yield).

Synthesis of 6i[5]

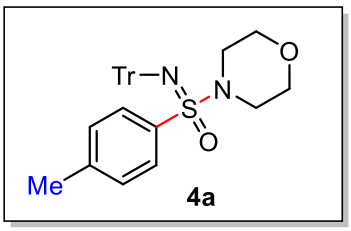


5ab **6i**, 76%

According to a literature procedure, *N*-substituted sulfonimidamide **5ab** (57.6 mg, 0.1 mmol, 1.0 equiv.) was placed in an oven-dried 10 mL reaction tube. The tube was sealed, evacuated, and backfilled with N_2 (three cycles). THF (1.0 mL) was added, followed by the addition of MsOH (5.0 equiv.). The reaction mixture was stirred at room temperature for 12 hours. Upon completion, the mixture was quenched with a saturated aqueous sodium bicarbonate solution and extracted with EtOAc (10 mL). The combined organic phases were dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Purification by flash column chromatography (PE/EA = 1:2) afforded the product **6i** (25.4 mg, 76% yield)

2.6 Characterization Data of Products 4, 5, and 6

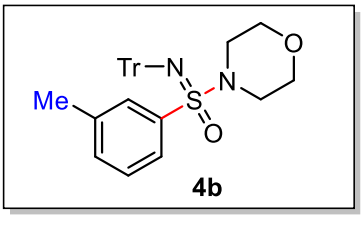
4-(4-methyl-*N*-tritylphenylsulfonimidoyl)morpholine (4a)



4a

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 78% yield as white solid (36.2 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.82 (d, *J* = 8.2 Hz, 2H), 7.62 - 7.49 (m, 6H), 7.33 (d, *J* = 8.2 Hz, 2H), 7.29 - 7.23 (m, 6H), 7.22 - 7.14 (m, 3H), 3.12 (dtd, *J* = 15.9, 11.1, 4.7 Hz, 4H), 2.61 (t, *J* = 4.6 Hz, 4H), 2.45 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.0, 142.1, 135.1, 129.3, 129.2, 127.3, 127.2, 126.3, 71.9, 65.8, 46.3, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaO_2S^+$ calcd for 505.1921; found 505.1916.

4-(3-methyl-*N*-tritylphenylsulfonimidoyl)morpholine (4b)

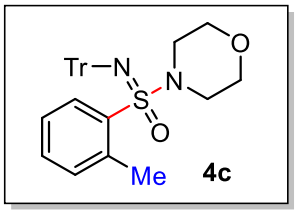


4b

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 82% yield as white solid (39.5 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.77 (d, *J* = 7.7 Hz,

1H), 7.68 (s, 1H), 7.57-7.55 (m, 6H), 7.42 (t, *J* = 7.7 Hz, 1H), 7.35 (d, *J* = 7.5 Hz, 1H), 7.27-7.23 (m, 6H), 7.21-7.17 (m, 3H), 3.12 (dtd, *J* = 15.8, 11.0, 4.6 Hz, 4H), 2.62 (t, *J* = 4.6 Hz, 4H), 2.45 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.9, 138.6, 137.7, 132.4, 129.2, 128.5, 127.3, 127.3, 126.3, 124.5, 71.9, 65.8, 46.2, 21.6. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaO_2S^+$ calcd for 505.1921; found 505.1916.

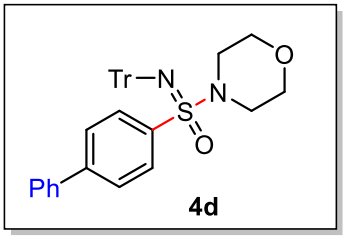
4-(2-methyl-*N*-tritylphenylsulfonimidoyl)morpholine (4c)



4c

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc= 8/1 R_f=0.5). was obtained in 75% yield as white solid (36.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.88 (m, 1H), 7.5-7.48 (m, 6H), 7.29 (td, *J* = 7.5, 1.1 Hz, 1H), 7.20 - 7.10 (m, 11H), 3.46 - 3.38 (m, 4H), 2.95 – 2.86 (m, 4H), 2.59 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.9, 137.9, 137.3, 132.7, 131.3, 131.0, 129.0, 127.2, 126.2, 125.6, 72.3, 66.3, 45.0, 21.1. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaO_2S^+$ calcd for 505.1921; found 505.1920.

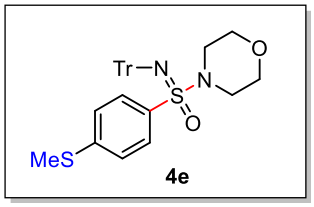
4-(*N*-trityl-[1,1'-biphenyl]-4-sulfonimidoyl)morpholine (4d)



4d

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 84% yield as white solid (45.6 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.99 (d, *J* = 8.4 Hz, 2H), 7.74 (d, *J* = 8.4 Hz, 2H), 7.63 (d, *J* = 7.4 Hz, 2H), 7.59 - 7.57 (m, 6H), 7.49 (t, *J* = 7.5 Hz, 2H), 7.42 (t, *J* = 7.3 Hz, 1H), 7.28 - 7.25 (m, 6H), 7.22 - 7.18 (m, 3H), 3.15 (dtd, *J* = 15.8, 11.1, 4.6 Hz, 4H), 2.68 (t, *J* = 4.5 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.9, 144.5, 139.6, 136.6, 129.2, 129.0, 128.2, 127.7, 127.4, 127.3, 126.3, 72.0, 65.8, 46.3. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{35}H_{32}N_2NaO_2S^+$ calcd for 567.2077; found 567.2079.

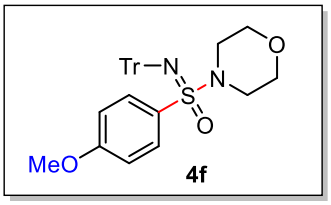
4-(4-(methylthio)-*N*-tritylphenylsulfonimidoyl)morpholine (4e)



4e

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 80% yield as white solid (41.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.82 (d, *J* = 8.5 Hz, 2H), 7.56 - 7.54 (m, 6H), 7.32 (d, *J* = 8.5 Hz, 2H), 7.26 - 7.22 (m, 6H), 7.20 - 7.16 (m, 3H), 3.12 (dtd, *J* = 15.7, 11.0, 4.5 Hz, 4H), 2.61 (t, *J* = 4.3 Hz, 4H), 2.50 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.8, 144.0, 133.9, 129.1, 127.4, 127.3, 126.3, 125.1, 71.9, 65.7, 46.2, 14.9. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaO_2S_2^+$ calcd for 537.1641; found 537.1639.

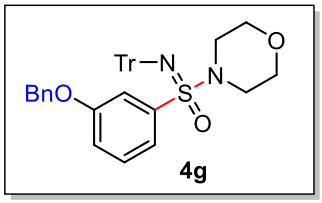
4-(4-methoxy-*N*-tritylphenylsulfonimidoyl)morpholine (4f)



4f

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 78% yield as white solid (38.8 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.87 (d, *J* = 8.9 Hz, 2H), 7.56 - 7.54 (m, 6H), 7.27 - 7.23 (m, 6H), 7.20 - 7.17 (m, 3H), 7.00 (d, *J* = 8.9 Hz, 2H), 3.87 (s, 3H), 3.13 (dtd, *J* = 15.8, 11.1, 4.6 Hz, 4H), 2.61 (t, *J* = 4.5 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 162.1, 148.0, 130.0, 129.2, 129.1, 127.3, 126.3, 113.7, 71.9, 65.8, 55.5, 46.3. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaO_3S^+$ calcd for 521.1870; found 521.1868.

4-(3-(benzyloxy)-*N*-tritylphenylsulfonimidoyl)morpholine (4g)

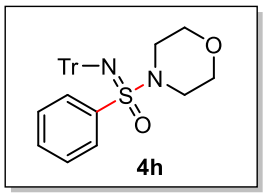


4g

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 78% yield as white solid (44.7 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.55 - 7.52 (m, 6H), 7.51 (s, 1H), 7.45 - 7.41 (m, 4H), 7.36 (t, *J* = 7.3 Hz, 2H), 7.31 (d, *J* = 7.1 Hz, 1H), 7.29 - 7.23 (m, 6H), 7.21 - 7.15 (m, 4H), 5.20 – 5.13 (m, 2H), 3.08 (dtd, *J* = 15.7, 11.0, 4.5 Hz, 4H), 2.51 (t, *J* = 4.4 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 158.5, 147.8, 138.9, 136.3, 129.7, 129.1, 128.7, 128.1, 127.4, 127.3, 126.3, 119.6, 118.9, 113.1, 72.0, 70.2, 65.8,

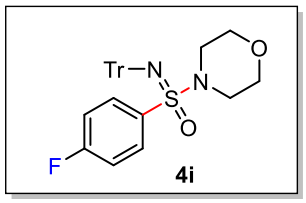
46.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{36}H_{34}N_2NaO_3S^+$ calcd for 597.2183; found 597.2174.

4-(*N*-tritylphenylsulfonimidoyl)morpholine (4h)



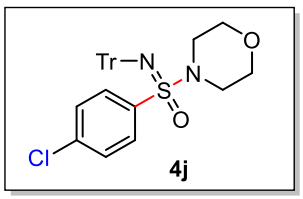
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 75% yield as white solid (35.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.94 (dd, *J* = 7.2, 2.3 Hz, 2H), 7.57 - 7.52 (m, 9H), 7.27 - 7.23 (m, 6H), 7.20 - 7.17 (m, 3H), 3.19 - 3.06 (m, 4H), 2.62 (t, *J* = 4.5 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.8, 137.8, 131.6, 129.1, 128.6, 127.3, 127.1, 126.3, 71.9, 65.8, 46.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{28}N_2NaO_2S^+$ calcd for 491.1764; found 491.1761.

4-(4-fluoro-*N*-tritylphenylsulfonimidoyl)morpholine (4i)



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 59% yield as white solid (28.7 mg). **^{1}H NMR (400 MHz, CDCl3)** δ 7.94 - 7.91 (m, 2H), 7.54 - 7.52 (m, 6H), 7.28 - 7.22 (m, 7H), 7.22 - 7.18 (m, 4H), 3.15 (dtd, *J* = 15.9, 11.2, 4.6 Hz, 4H), 2.63 (t, *J* = 4.6 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.5 (d, *J* = 253.3 Hz), 147.7, 134.0 (d, *J* = 2.8 Hz), 129.7 (d, *J* = 9.0 Hz), 129.1, 127.4, 126.4, 115.7 (d, *J* = 22.3 Hz), 72.1, 65.8, 46.2. **^{19}F NMR (377 MHz, $CDCl_3$)** δ -107.51. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{27}FN_2NaO_2S^+$ calcd for 509.1670; found 509.1666.

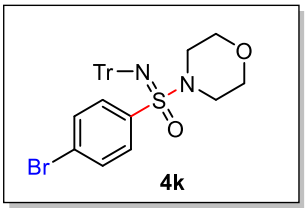
4-(4-chloro-*N*-tritylphenylsulfonimidoyl)morpholine (4j)



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 60% yield as white solid (30.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.85 (d, *J* = 8.6 Hz, 2H), 7.53 - 7.49 (m, 8H), 7.27 - 7.24 (m, 6H), 7.22 - 7.18 (m, 3H), 3.15 (dtd, *J* = 15.9, 11.1, 4.6 Hz, 4H), 2.64 (t, *J* = 4.5 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.7, 138.1, 136.5, 129.1, 128.9, 128.6, 127.4, 126.4, 72.1, 65.8, 46.2. **HRMS (ESI-ion trap)** m/z:

$[M+Na]^+$ $C_{29}H_{27}ClN_2NaO_2S^+$ calcd for 525.1374; found 525.1370.

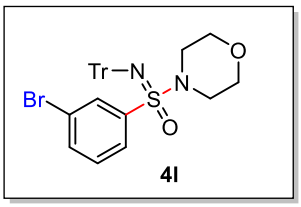
4-(4-bromo-*N*-tritylphenylsulfonimidoyl)morpholine (4k)



4k

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 65% yield as white solid (35.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.78 (d, *J* = 8.5 Hz, 2H), 7.67 (d, *J* = 8.4 Hz, 2H), 7.53 - 7.51 (m, 6H), 7.27 - 7.18 (m, 9H), 3.15 (dtd, *J* = 15.5, 10.9, 4.3 Hz, 4H), 2.64 (t, *J* = 4.4 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.7, 137.0, 131.9, 129.1, 128.7, 127.4, 126.5, 126.4, 72.1, 65.8, 46.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{27}BrN_2NaO_2S^+$ calcd for 569.0869; found 569.0867.

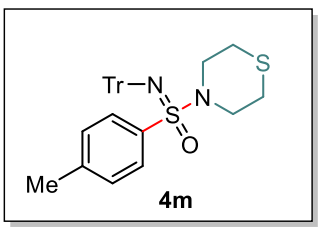
4-(3-bromo-*N*-tritylphenylsulfonimidoyl)morpholine (4l)



4l

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 65% yield as white solid (35.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.01 (s, 1H), 7.85 (d, *J* = 7.9 Hz, 1H), 7.67 (dd, *J* = 8.0, 0.7 Hz, 1H), 7.53 - 7.52 (m, 6H), 7.40 (t, *J* = 7.9 Hz, 1H), 7.28 - 7.24 (m, 6H), 7.22-7.18 (m, 3H), 3.16 (dtd, *J* = 15.8, 11.1, 4.6 Hz, 4H), 2.66 (t, *J* = 4.5 Hz, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.6, 139.7, 134.6, 130.2, 129.9, 129.1, 127.4, 126.4, 125.8, 122.8, 72.2, 65.7, 46.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{27}BrN_2NaO_2S^+$ calcd for 569.0869; found 569.0865.

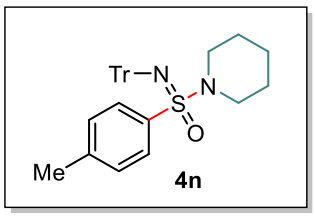
4-(4-methyl-*N*-tritylphenylsulfonimidoyl)thiomorpholine (4m)



4m

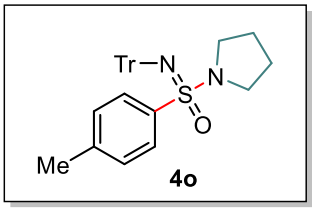
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 73% yield as white solid (36.3 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.81 (d, *J* = 8.3 Hz, 2H), 7.55 - 7.53 (m, 6H), 7.31 (d, *J* = 8.0 Hz, 2H), 7.30 - 7.24 (m, 6H), 7.21 - 7.17 (m, 3H), 2.97 -2.88 (m, 4H), 2.43 (s, 3H), 2.14 - 19.8 (m, 4H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.9, 142.0, 136.7, 129.3, 129.2, 127.3, 126.7, 126.3, 71.8, 47.9, 26.7, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaOS_2^+$ calcd for 521.1692; found 521.1692.

1-(4-methyl-*N*-tritylphenylsulfonimidoyl)piperidine (4n)



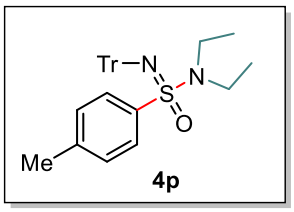
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 65% yield as white solid (31.2 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.81 (d, *J* = 8.2 Hz, 2H), 7.56 - 7.54 (m, 6H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.25 - 7.22 (m, 6H), 7.18 - 7.15 (m, 3H), 2.60 (t, *J* = 9.0 Hz, 4H), 2.42 (s, 3H), 1.08 - 1.01 (m, 6H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 148.2, 141.5, 136.3, 129.3, 129.0, 127.2, 127.1, 126.1, 71.8, 47.0, 24.7, 23.4, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{31}H_{32}N_2NaOS^+$ calcd for 503.2128; found 503.2121.

1-(4-methyl-*N*-tritylphenylsulfonimidoyl)pyrrolidine (4o)



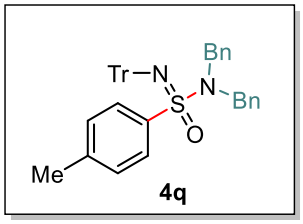
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 64% yield as white solid (29.8 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.88 (d, *J* = 8.1 Hz, 2H), 7.58 - 7.56 (m, 6H), 7.28 - 7.21 (m, 8H), 7.18 - 7.14 (m, 3H), 2.72 - 2.70 (m, 4H), 2.41 (s, 3H), 1.33 - 1.30 (m, 4H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 148.1, 141.4, 138.2, 129.2, 129.1, 127.1, 126.8, 126.1, 71.7, 47.6, 25.0, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaOS^+$ calcd for 489.1972; found 489.1972.

***N*,*N*-diethyl-4-methyl-*N′*-tritylbenzenesulfonimidamide (4p)**



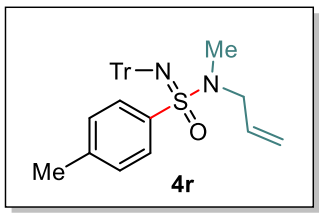
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 62% yield as white solid (29.1 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.86 (d, *J* = 8.3 Hz, 2H), 7.54 - 7.52 (m, 6H), 7.27 - 7.21 (m, 8H), 7.18 - 7.14 (m, 3H), 2.97 - 2.72 (m, 4H), 2.41 (s, 3H), 0.62 (t, *J* = 7.2 Hz, 6H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 148.2, 141.1, 129.3, 129.1, 127.2, 126.5, 126.1, 71.8, 41.5, 21.3, 13.1. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{32}N_2NaOS^+$ calcd for 491.2128; found 491.2125.

***N*,*N*-dibenzyl-4-methyl-*N*′-tritylbenzenesulfonimidamide (4q)**



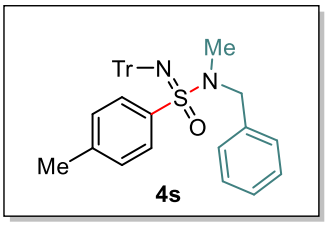
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 60% yield as white solid (35.5 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.71 (d, *J* = 8.1 Hz, 2H), 7.51 - 7.49 (m, 6H), 7.23 - 7.13 (m, 11H), 7.11 - 7.05 (m, 6H), 6.74 (d, *J* = 7.2 Hz, 4H), 4.14 (d, *J* = 14.9 Hz, 2H), 3.93 (d, *J* = 14.9 Hz, 2H), 2.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.1, 141.3, 140.9, 136.8, 129.2, 128.9, 127.9, 127.3, 127.2, 127.0, 126.2, 72.5, 51.3, 21.3. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{40}H_{36}N_2NaOS^+$ calcd for 615.2441; found 615.2441.

***N*-allyl-*N*,4-dimethyl-*N*′-tritylbenzenesulfonimidamide (4r)**



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 55% yield as white solid (25.6 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.84 (d, *J* = 8.3 Hz, 2H), 7.57 - 7.55 (m, 6H), 7.29 (d, *J* = 8.0 Hz, 2H), 7.26 - 7.22 (m, 6H), 7.19 - 7.15 (m, 3H), 5.07 (ddt, *J* = 16.8, 10.1, 6.6 Hz, 1H), 4.90 - 4.88 (m, 1H), 4.83 (dd, *J* = 17.0, 1.4 Hz, 1H), 3.31 (dd, *J* = 14.2, 6.1 Hz, 1H), 3.15 (dd, *J* = 14.2, 7.0 Hz, 1H), 2.42 (s, 3H), 2.19 (s, 3 H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.0, 141.5, 138.2, 133.9, 129.2, 127.9, 127.2, 126.8, 126.2, 117.8, 71.8, 53.3, 34.1, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaOS^+$ calcd for 489.1972; found 489.1967.

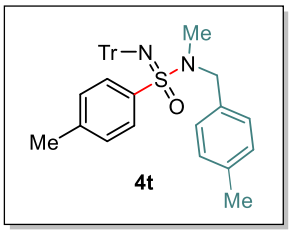
***N*-benzyl-*N*,4-dimethyl-*N*′-tritylbenzenesulfonimidamide (4s)**



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 10/1 R_f=0.6). was obtained in 55% yield as white solid (28.3 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 8.2 Hz, 2H), 7.56 - 7.54 (m, 6H), 7.29 (d, *J* = 8.1 Hz, 2H), 7.23 - 7.19 (m, 6H), 7.19 - 7.15 (m, 6H), 6.80 (dd, *J* = 6.5, 2.8 Hz, 2H), 3.99 (d, *J* = 13.8 Hz, 1H), 3.54 (d, *J* = 13.8 Hz, 1H), 2.43 (s, 3H), 2.20 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.1, 141.6, 137.8, 136.6, 129.2,

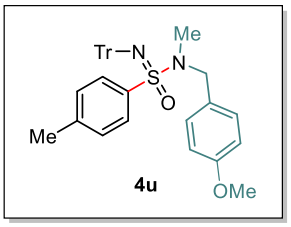
128.6, 128.1, 127.3, 127.2, 127.0, 126.2, 72.0, 54.5, 34.5, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{34}H_{32}N_2NaOS^+$ calcd for 539.2128; found 539.2123.

***N*,4-dimethyl-*N*-(4-methylbenzyl)-*N′*-tritylbenzenesulfonimidamide (4t)**



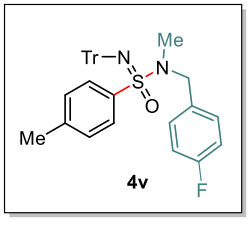
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 10/1 R_f=0.6). was obtained in 60% yield as white solid (31.8 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 7.7 Hz, 2H), 7.56 - 7.54 (m, 6H), 7.29 - 7.15 (m, 11H), 6.97 (d, *J* = 7.4 Hz, 2H), 6.68 (d, *J* = 7.4 Hz, 2H), 3.94 (d, *J* = 13.6 Hz, 1H), 3.51 (d, *J* = 13.6 Hz, 1H), 2.42 (s, 3H), 2.27 (s, 3H), 2.18 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.1, 141.5, 137.8, 136.8, 133.5, 129.2, 129.1, 128.8, 128.6, 127.3, 127.1, 126.2, 72.0, 54.2, 34.4, 21.4, 21.0. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{35}H_{34}N_2NaOS^+$ calcd for 553.2285; found 553.2282.

***N*-(4-methoxybenzyl)-*N*,4-dimethyl-*N′*-tritylbenzenesulfonimidamide (4u)**



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 10/1 R_f=0.6). was obtained in 62% yield as white solid (33.9 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.82 (d, *J* = 8.1 Hz, 2H), 7.56 - 7.54 (m, 6H), 7.30 – 7.28 (m, 2H), 7.25 - 7.21 (m, 6H), 7.19 - 7.16 (m, 3H), 6.73 - 6.68 (m, 4H), 3.92 (d, *J* = 13.5 Hz, 1H), 3.76 (s, 3H), 3.48 (d, *J* = 13.5 Hz, 1H), 2.44 (s, 3H), 2.17 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 158.8, 148.1, 141.5, 137.8, 129.9, 129.2, 129.2, 128.6, 127.3, 127.1, 126.2, 113.4, 72.0, 55.2, 53.9, 34.3, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{35}H_{34}N_2NaO_2S^+$ calcd for 569.2234; found 569.2225.

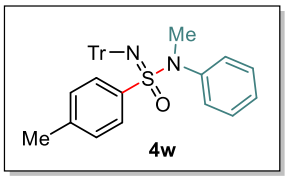
***N*-(4-fluorobenzyl)-*N*,4-dimethyl-*N′*-tritylbenzenesulfonimidamide (4v)**



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 10/1 R_f=0.6). was obtained in 57% yield as white solid (30.5 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 8.3 Hz, 2H), 7.56 - 7.53 (m, 6H), 7.30 (d, *J* = 8.0 Hz, 2H), 7.25 - 7.21 (m, 6H), 7.19 - 7.15 (m, 3H), 6.84 (t, *J* = 8.7 Hz, 2H), 6.75 - 6.71 (m, 2H), 3.96 (d, *J* = 13.8 Hz, 1H), 3.47 (d, *J* = 13.8 Hz, 1H), 2.44 (s, 3H), 2.19 (s, 3H).

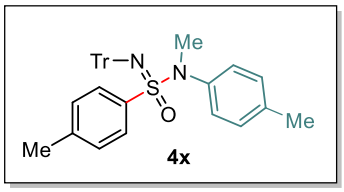
^{13}C NMR (101 MHz, $CDCl_3$) δ 162.0 (d, *J* = 245.5 Hz), 148.0, 141.7, 137.6, 132.3 (d, *J* = 3.0 Hz), 130.2 (d, *J* = 8.0 Hz), 129.2, 129.2, 127.3, 127.0, 126.2, 114.9 (d, *J* = 21.4 Hz), 72.0, 53.8, 34.5, 21.4. **^{19}F NMR (377 MHz, $CDCl_3$)** δ -115.38. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{35}H_{31}FN_2NaOS^+$ calcd for 557.2034; found 557.2031.

***N*,4-dimethyl-*N*-phenyl-*N'*-tritylbenzenesulfonimidamide (4w)**



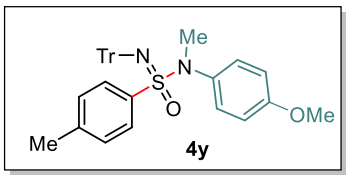
Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 60% yield as white solid (30.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.61 (d, *J* = 8.2 Hz, 2H), 7.59 - 7.57 (m, 6H), 7.27 - 7.21 (m, 8H), 7.19 - 7.16 (m, 3H), 7.10 - 7.04 (m, 3H), 6.59 (d, *J* = 7.2 Hz, 2H), 2.74 (s, 3H), 2.41 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.7, 143.6, 141.8, 137.2, 129.2, 128.9, 127.9, 127.3, 126.3, 125.8, 125.5, 72.2, 37.6, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{33}H_{30}N_2NaOS^+$ calcd for 525.1972; found 525.1970.

***N*,4-dimethyl-*N*-(*p*-tolyl)-*N'*-tritylbenzenesulfonimidamide (4x)**



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 67% yield as white solid (34.6 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.62 (d, *J* = 8.2 Hz, 2H), 7.60 - 7.57 (m, 6H), 7.27 - 7.21 (m, 6H), 7.19 - 7.15 (m, 3H), 6.89 (d, *J* = 8.2 Hz, 2H), 6.46 (d, *J* = 8.3 Hz, 2H), 2.71 (s, 3H), 2.41 (s, 3H), 2.23 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.8, 141.7, 141.0, 137.2, 135.3, 129.3, 128.9, 128.6, 127.3, 127.2, 126.3, 125.8, 72.2, 37.7, 21.4, 20.9. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{34}H_{32}N_2NaOS^+$ calcd for 539.2128; found 539.2125.

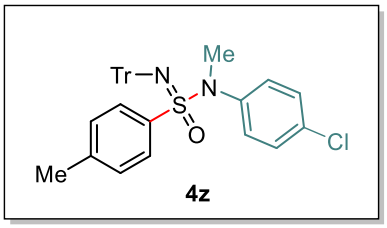
***N*-(4-methoxyphenyl)-*N*,4-dimethyl-*N'*-tritylbenzenesulfonimidamide (4y)**



Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 65% yield as white solid (34.5 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.61 - 7.57 (m, 8H), 7.27 - 7.22 (m, 8H), 7.20 - 7.16 (m, 3H), 6.62 (d, *J* = 9.0 Hz, 2H), 6.47 (d, *J* = 9.0 Hz,

2H), 3.72 (s, 3H), 2.72 (s, 3H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 157.5, 147.8, 141.7, 137.0, 136.4, 129.3, 128.9, 127.5, 127.4, 127.2, 126.3, 113.2, 72.2, 55.3, 38.0, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{34}H_{32}N_2NaO_2S^+$ calcd for 555.2077; found 555.2068.

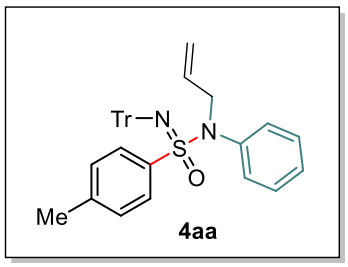
***N*-(4-chlorophenyl)-*N*,4-dimethyl-*N′*-tritylbenzenesulfonimidamide (4z)**



4z

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 58% yield as white solid (31.1 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.62 (d, *J* = 8.3 Hz, 2H), 7.59 - 7.56 (m, 6H), 7.28 - 7.24 (m, 8H), 7.20 - 7.17 (m, 3H), 7.04 (d, *J* = 8.8 Hz, 2H), 6.50 (d, *J* = 8.8 Hz, 2H), 2.70 (s, 3H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 147.5, 142.1, 142.1, 136.8, 130.9, 129.2, 129.1, 128.0, 127.3, 127.2, 126.8, 126.4, 72.3, 37.4, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{33}H_{29}ClN_2NaOS^+$ calcd for 559.1582; found 559.1581.

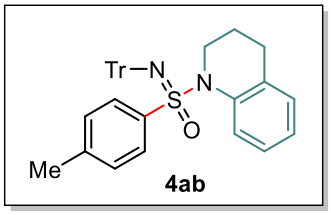
***N*-allyl-4-methyl-*N*-phenyl-*N′*-tritylbenzenesulfonimidamide (4aa)**



4aa

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.6). was obtained in 62% yield as white solid (32.7 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.61 (d, *J* = 7.8 Hz, 2H), 7.55 – 7.53 (m, 6H), 7.24 – 7.17 (m, 11H), 7.11 - 7.04 (m, 3H), 6.53 – 6.52 (m, 2H), 4.98 (dd, *J* = 15.4, 7.0 Hz, 1H), 4.71 (t, *J* = 15.2 Hz, 2H), 4.29 - 4.26 (m, 1H), 3.56 (dd, *J* = 14.1, 7.6 Hz, 1H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 147.8, 141.8, 140.6, 137.9, 133.5, 129.3, 128.9, 128.1, 127.9, 127.3, 126.3, 126.1, 117.8, 72.4, 52.3, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{35}H_{32}N_2NaOS^+$ calcd for 551.2128; found 551.2128.

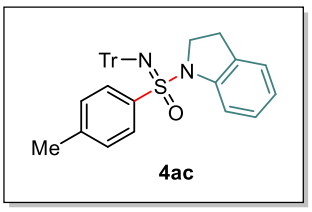
1-(4-methyl-*N*-tritylphenylsulfonimidoyl)-1,2,3,4-tetrahydroquinoline (4ab)



4ab

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 58% yield as white solid (30.6 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.74 (d, *J* = 8.2 Hz, 2H), 7.58 – 7.56 (m, 6H), 7.34 (d, *J* = 8.2 Hz, 1H), 7.26 – 7.20 (m, 8H), 7.17 (dd, *J* = 14.3, 7.2 Hz, 3H), 6.90 (dd, *J* = 10.2, 4.3 Hz, 1H), 6.86 – 6.83 (m, 2H), 3.53 – 3.47 (m, 1H), 2.86 (ddd, *J* = 13.0, 8.8, 3.9 Hz, 1H), 2.39(s, 3H), 2.33 (dd, *J* = 15.7, 7.8 Hz, 1H), 2.12 (dt, *J* = 16.3, 6.1 Hz, 1H), 1.33 (ddd, *J* = 14.6, 9.4, 6.2 Hz, 1H), 1.23 – 1.16 (m, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.6, 141.9, 140.8, 138.7, 129.3, 129.2, 128.3, 127.3, 126.7, 126.3, 125.6, 124.4, 122.8, 72.1, 46.1, 26.9, 21.4, 21.3. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{35}H_{32}N_2NaOS^+$ calcd for 551.2128; found 551.2125.

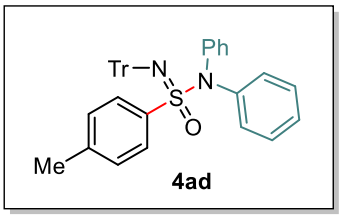
1-(4-methyl-*N*-tritylphenylsulfonimidoyl)indoline (4ac)



4ac

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 57% yield as white solid (29.2 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.93 (d, *J* = 8.2 Hz, 2H), 7.57 – 7.55 (m, 6H), 7.31 – 7.23 (m, 4H), 7.20 – 7.12 (m, 8H), 6.90 (t, *J* = 7.7 Hz, 1H), 6.85 (d, *J* = 7.2 Hz, 1H), 6.72 (t, *J* = 7.3 Hz, 1H), 3.37 – 7.21 (m, 2H), 2.44 (dd, *J* = 11.3, 6.2 Hz, 2H), 2.37 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.5, 143.2, 142.3, 139.0, 130.8, 129.4, 129.0, 126.8, 126.6, 126.2, 124.3, 121.4, 113.9, 72.1, 50.0, 27.4, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{34}H_{30}N_2NaOS^+$ calcd for 537.1972; found 537.1968.

4-methyl-*N*,*N*-diphenyl-*N′*-tritylbenzenesulfonimidamide (4ad)

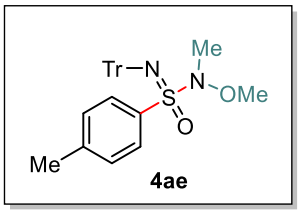


4ad

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 50% yield as white solid (28.2 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.72 (d, *J* = 8.2 Hz, 2H), 7.28 – 7.22 (m, 8H), 7.20 – 7.16 (m, 9H), 7.11 – 7.05 (m, 6H), 6.78 (d, *J* = 7.0 Hz, 4H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.6, 143.7, 142.6, 141.8, 129.4,

129.2, 128.3, 128.0, 127.4, 127.2, 126.3, 125.7, 72.9, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{38}H_{32}N_2NaOS^+$ calcd for 587.2128; found 587.2128.

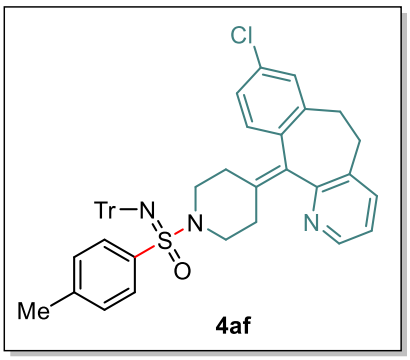
***N*-methoxy-*N*,4-dimethyl-*N'*-tritylbenzenesulfonimidamide (4ae)**



4ae

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 50% yield as white solid (22.8 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.91 (d, *J* = 8.2 Hz, 2H), 7.55 – 7.53 (m, 6H), 7.32 (d, *J* = 8.1 Hz, 2H), 7.26 – 7.23 (m, 6H), 7.20 – 7.16 (m, 3H), 3.31 (s, 3H), 2.43 (s, 3H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.7, 142.8, 132.6, 129.2, 129.0, 128.9, 127.3, 126.3, 72.4, 62.9, 39.2, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{28}H_{28}N_2NaO_2S^+$ calcd for 479.1764; found 479.1758.

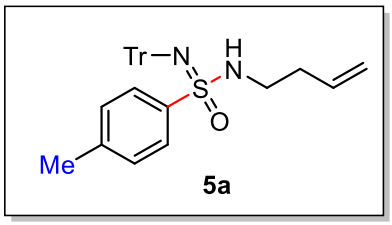
8-chloro-11-(1-(4-methyl-*N*-tritylphenylsulfonimidoyl)piperidin-4-ylidene)-6,11-dihydro-5*H*-benzo[5,6]cyclohepta[1,2-b]pyridine (4af)



4af

Prepared according to procedure A, flash column chromatography on silica gel (eluent: PE/EtOAc = 2/1 R_f=0.3). was obtained in 56% yield as yellow solid (E/Z = 1.05:1) (39.5 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.31 – 8.29 (m, 1H), 7.81 (d, *J* = 8.1 Hz, 2H), 7.55 – 7.53 (m, 2H), 7.25 – 7.21 (m, 6H), 7.18 – 7.14 (m, 3H), 7.04 (d, *J* = 11.7 Hz, 2H), 7.01 (dd, *J* = 7.7, 4.9 Hz, 1H), 6.91 (dd, *J* = 8.0, 3.7 Hz, 1H), 3.15 (td, *J* = 13.9, 7.2 Hz, 2H), 3.01 – 2.93 (m, 2H), 2.72 – 2.64 (m, 2H), 2.48 – 2.37 (m, 5H), 2.05 – 1.98 (m, 1H), 1.83 (ddd, *J* = 17.9, 15.1, 11.0 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 157.0, 148.0, 146.5, 141.7, 141.7, 139.3, 137.3, 137.3, 137.3, 137.2, 136.5, 136.5, 136.4, 136.4, 133.3, 133.3, 133.2, 133.2, 132.7, 130.5, 129.2, 128.9, 128.8, 127.2, 127.0, 126.9, 126.2, 125.9, 122.1, 71.8, 47.5, 47.5, 47.4, 31.6, 31.2, 29.9, 29.8, 29.5, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{45}H_{40}ClN_3NaOS^+$ calcd for 728.2473; found 728.2470.

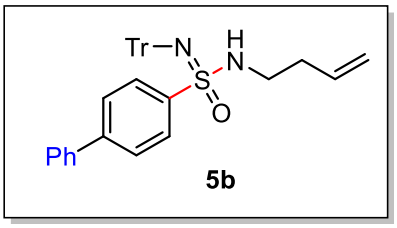
***N*-(but-3-en-1-yl)-4-methyl-*N′*-tritylbenzenesulfonimidamide (5a)**



5a

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.5). was obtained in 85% yield as white solid (39.6 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.90 (d, *J* = 8.2 Hz, 2H), 7.59 – 7.57 (m, 6H), 7.27 – 7.23 (m, 8H), 7.20 – 7.16 (m, 3H), 5.34 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 4.86 (d, *J* = 10.2 Hz, 1H), 4.76 (d, *J* = 17.1 Hz, 1H), 3.44 (s, 1H), 2.77 – 2.42 (m, 2H), 2.41 (s, 3H), 1.72 (dd, *J* = 13.4, 6.7 Hz, 2H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 148.1, 141.9, 140.8, 134.8, 129.3, 129.1, 127.5, 126.9, 126.4, 117.3, 71.9, 42.3, 33.3, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaOS^+$ calcd for 489.1972; found 489.1971.

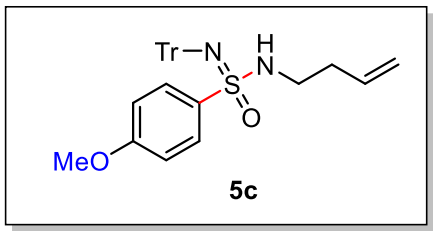
***N*-(but-3-en-1-yl)-*N′*-trityl-[1,1'-biphenyl]-4-sulfonimidamide (5b)**



5b

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, v/v, R_f=0.5). was obtained in 86% yield as white solid (45.4 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 8.07 (dd, *J* = 10.2, 3.2 Hz, 2H), 7.67 (dd, *J* = 8.2, 3.5 Hz, 2H), 7.62 – 7.61 (m, 8H), 7.47 (dd, *J* = 10.8, 4.1 Hz, 2H), 7.40 – 7.37 (m, 1H), 7.28 – 7.25 (m, 6H), 7.21 – 7.19 (m, 3H), 5.37 (ddd, *J* = 16.8, 10.2, 4.3 Hz, 1H), 4.89 (d, *J* = 10.1 Hz, 1H), 4.80 (d, *J* = 17.1 Hz, 1H), 3.57 (s, 1H), 2.63 (m, 2H), 1.77 (d, *J* = 4.5 Hz, 2H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 147.9, 144.1, 142.2, 139.6, 134.6, 129.0, 128.9, 128.1, 127.4, 127.3, 127.3, 127.2, 126.3, 117.2, 71.9, 42.2, 33.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{35}H_{32}N_2NaOS^+$ calcd for 551.2128; found 551.2128.

***N*-(but-3-en-1-yl)-4-methoxy-*N′*-tritylbenzenesulfonimidamide (5c)**

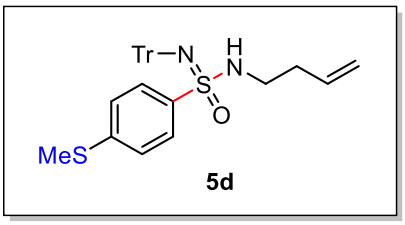


5c

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, v/v, R_f=0.5). was obtained in 88% yield as white solid (42.4 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.95 (d, *J* = 8.8 Hz, 2H), 7.59 -7.57 (m, 6H), 7.26

– 7.23 (m, 6H), 7.20 – 7.16 (m, 3H), 6.94 (d, *J* = 8.8 Hz, 2H), 5.35 (ddt, *J* = 17.0, 10.2, 6.9 Hz, 1H), 4.87 (d, *J* = 9.8 Hz, 1H), 4.77 (dd, *J* = 17.1, 1.1 Hz, 1H), 3.84 (s, 3H), 3.42 (s, 1H), 2.63 – 2.44 (m, 2H), 1.73 (dd, *J* = 13.5, 6.8 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 161.8, 148.0, 135.4, 134.7, 129.0, 128.9, 127.4, 126.3, 117.2, 113.7, 71.7, 55.5, 42.1, 33.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaO_2S^+$ calcd for 505.1921; found 505.1917.

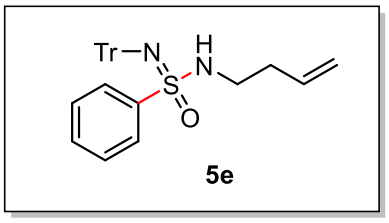
***N*-(but-3-en-1-yl)-4-(methylthio)-*N′*-tritylbenzenesulfonimidamide (5d)**



5d

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, v/v, R_f=0.5). was obtained in 87% yield as white solid (43.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.90 (d, *J* = 8.5 Hz, 2H), 7.57 – 7.55 (m, 6H), 7.28 – 7.23 (m, 8H), 7.20 – 7.17 (m, 3H), 5.35 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 4.88 (d, *J* = 10.2 Hz, 1H), 4.78 (dd, *J* = 17.1, 1.4 Hz, 1H), 3.47 (s, 1H), 2.60 (dd, *J* = 12.2, 6.1 Hz, 1H), 2.51 (s, 3H), 2.47 – 2.46 (m, 1H), 1.75 (q, *J* = 6.7 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.9, 143.5, 139.6, 134.6, 129.0, 127.4, 127.2, 126.3, 125.3,117.3,71.8,42.1,33.2,15.0. **HRMS(ESI-iontrap)**m/z:$[M+Na]^+C_{30}H_{30}N_2NaOS_2$+calcd for 521.1692; found 521.1691.

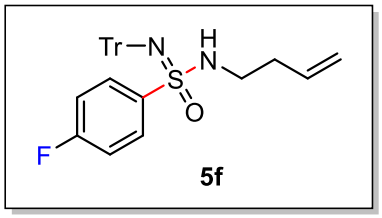
***N*-(but-3-en-1-yl)-*N′*-tritylbenzenesulfonimidamide (5e)**



5e

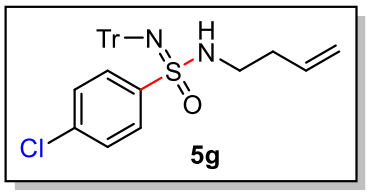
Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.6). was obtained in 80% yield as white solid (36.2 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.02 – 8.00 (m, 2H), 7.59 – 7.57 (m, 6H), 7.49 – 7.44 (m, 3H), 7.27 – 7.23 (m, 6H), 7.20 7.16 (m, 3H), 5.34 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 4.86 (d, *J* = 10.1 Hz, 1H), 4.76 (dd, *J* = 17.1, 1.3 Hz, 1H), 3.49 (s, 1H), 2.61 (dd, *J* = 11.9, 6.0 Hz, 1H), 2.53 – 2.47 (m, 1H), 1.73 (dd, *J* = 13.5, 6.7 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.9, 143.5, 134.6, 131.3, 129.0, 128.6, 127.4, 126.8, 126.3, 117.3, 71.8, 42.2, 33.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{28}N_2NaOS^+$ calcd for 475.1815; found 475.1808.

***N*-(but-3-en-1-yl)-4-fluoro-*N′*-tritylbenzenesulfonimidamide (5f)**



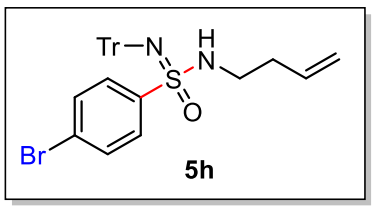
Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.6). was obtained in 70% yield as white solid (32.9 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.01 – 7.97 (m, 2H), 7.56 – 7.54 (m, 6H), 7.27 – 7.24 (m, 6H), 7.19 – 7.17 (m, 3H), 7.15 – 7.10 (m, 2H), 5.36 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 4.89 (d, *J* = 10.1 Hz, 1H), 4.79 (dd, *J* = 17.1, 1.5 Hz, 1H), 3.51 (s, 1H), 2.67 – 2.50 (m, 2H), 1.77 (q, *J* = 7.0 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 164.3 (d, *J* = 252.5 Hz), 147.8, 139.6 (d, *J* = 3.0 Hz), 134.5, 129.4 (d, *J* = 9.1 Hz), 129.0, 127.5, 126.4, 117.4, 115.6 (d, *J* = 22.4 Hz), 72.0, 42.1, 33.2. **^{19}F NMR (377 MHz, $CDCl_3$)** δ -108.17. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{27}FN_2NaOS^+$ calcd for 493.1721; found 493.1718.

***N*-(but-3-en-1-yl)-4-chloro-*N′*-tritylbenzenesulfonimidamide (5g)**



Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.6). was obtained in 69% yield as white solid (33.5 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.91 (d, *J* = 8.6 Hz, 2H), 7.55 – 7.53 (m, 6H), 7.41 (d, *J* = 8.6 Hz, 2H), 7.26 – 7.23 (m, 6H), 7.20 - 7.16 (m, 3H), 5.35 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 4.89 (d, *J* = 10.1 Hz, 1H), 4.79 (dd, *J* = 17.1, 1.3 Hz, 1H), 3.56 (s, 1H), 2.66 – 2.59 (m, 1H), 2.54 – 2.48 (m, 1H), 1.76 (q, *J* = 6.6 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.7, 142.1, 137.5, 134.5, 128.9, 128.8, 128.3, 127.5, 126.4, 117.4, 72.0, 42.1, 33.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{27}ClN_2NaOS^+$ calcd for 509.1425; found 509.1424.

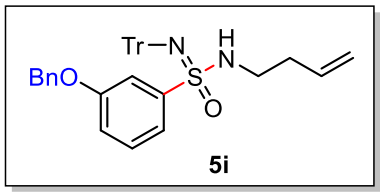
4-bromo-*N*-(but-3-en-1-yl)-*N′*-tritylbenzenesulfonimidamide (5h)



Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.6). was obtained in 75% yield as white solid (39.7 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.84 (d, *J* = 8.6 Hz, 2H), 7.59 (d, *J* = 8.6 Hz, 2H), 7.54 – 7.52 (m, 6H), 7.27 – 7.23 (m, 6H), 7.21 – 7.17 (m,

3H), 5.36 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 4.89 (d, *J* = 10.2 Hz, 1H), 4.79 (dd, *J* = 17.1, 1.4 Hz, 1H), 3.53 (s, 1H), 2.65 – 2.50 (m, 2H), 1.77 (q, *J* = 6.8 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.7, 142.7, 134.5, 131.8, 128.9, 128.5, 127.5, 126.4, 126.0, 117.5, 72.0, 42.2, 33.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{27}BrN_2NaOS^+$ calcd for 553.0920; found 553.0922.

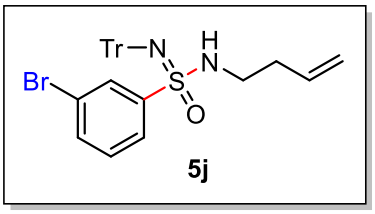
3-(benzyloxy)-*N*-(but-3-en-1-yl)-*N*'-tritylbenzenesulfonimidamide (5i)



5i

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 83% yield as white solid (46.3 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.60 – 7.54 (m, 8H), 7.42 – 7.32 (m, 6H), 7.28 – 7.23 (m, 6H), 7.20 – 7.17 (m, 3H), 7.10 (dd, *J* = 8.1, 1.9 Hz, 1H), 5.39 – 5.29 (m, 1H), 5.10 (s, 1H), 4.87 (d, *J* = 9.6 Hz, 1H), 4.77 (dd, *J* = 17.1, 1.3 Hz, 1H), 3.47 (t, *J* = 5.7 Hz, 1H), 2.64 – 2.44 (m, 1H), 1.73 (q, *J* = 6.6 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 158.6, 147.9, 144.7, 136.3, 134.7, 129.7, 129.0, 128.7, 128.1, 127.9, 127.4, 126.3, 119.3, 118.4, 117.3, 112.7, 71.9, 70.2, 42.2, 33.2. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{36}H_{34}N_2NaO_2S^+$ calcd for 581.2234; found 581.2230.

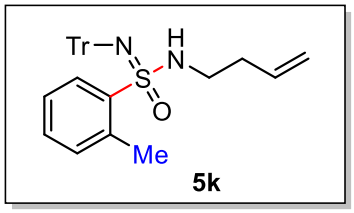
3-bromo-*N*-(but-3-en-1-yl)-*N*′-tritylbenzenesulfonimidamide (5j)



5j

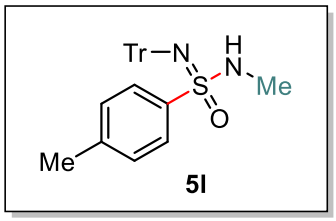
Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.5). was obtained in 76% yield as white solid (40.3 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.04 (t, *J* = 1.7 Hz, 1H), 7.90 - 7.88 (m, 1H), 7.60 (ddd, *J* = 7.9, 1.8, 0.9 Hz, 1H), 7.55 – 7.53 (m, 6H), 7.32 (t, *J* = 7.9 Hz, 1H), 7.27 – 7.23 (m, 6H), 7.21 – 7.17 (m, 3H), 5.38 (ddt, *J* = 17.1, 10.2, 6.9 Hz, 1H), 4.93 – 4.90 (m, 1H), 4.82 (dd, *J* = 17.1, 1.6 Hz, 1H), 3.61 (s, 1H), 2.70 – 2.51 (m, 2H), 1.83 – 1.78 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.7, 145.4, 134.5, 134.2, 130.1, 129.8, 128.9, 127.5, 126.4, 125.4, 122.5, 117.5, 72.1, 42.1, 33.3. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{27}BrN_2NaOS^+$calcd for553.0920; found 553.0919.

***N*-(but-3-en-1-yl)-2-methyl-*N′*-tritylbenzenesulfonimidamide (5k)**



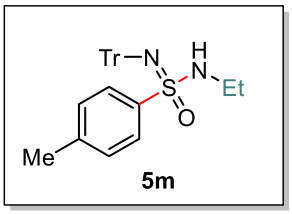
Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.5). was obtained in 70% yield as white solid (32.6 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.05 (d, *J* = 7.9 Hz, 1H), 7.56 – 7.54 (m, 6H), 7.33 (td, *J* = 7.4, 1.2 Hz, 1H), 7.23 – 7.19 (m, 8H), 7.17 – 7.13 (m, 3H), 5.39 (ddt, *J* = 17.1, 10.2, 6.8 Hz, 1H), 4.92 – 4.89 (m, 1H), 4.83 (dd, *J* = 17.1, 1.6 Hz, 1H), 3.53 (s, 1H), 2.64 (s, 3H), 2.57 – 2.47 (m, 2H), 1.82 – 1.76 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.0, 140.8, 136.7, 134.9, 132.4, 131.3, 129.1, 128.9, 127.4, 126.2, 125.7, 117.2, 72.2, 41.8, 33.4, 20.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaOS^+$calcd for 489.1972; found 489.1964.

***N*,4-dimethyl-*N′*-tritylbenzenesulfonimidamide (5l)**



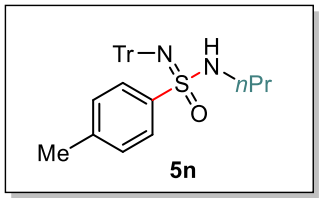
Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.6). was obtained in 80% yield as white solid (34 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (d, *J* = 8.2 Hz, 2H), 7.60 – 7.58 (m, 6H), 7.27 – 7.23 (m, 8H), 7.20 – 7.16 (m, 3H), 3.32 (s, 1H), 2.41 (s, 3H), 2.13 (s, 3H).**^{13}C NMR (101 MHz, $CDCl_3$)** δ 148, 141.8, 139.8, 129.2, 129.0, 127.4, 127.0, 126.3, 71.8, 29.6, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{30}H_{30}N_2NaOS^+$calcd for 449.1659; found 449.1653.

***N*-ethyl-4-methyl-*N′*-tritylbenzenesulfonimidamide (5m)**



Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.5). was obtained in 81% yield as white solid (35.7 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 8.2 Hz, 2H), 7.52 – 7.50 (m, 6H), 7.18 – 7.14 (m, 8H), 7.09 (t, *J* = 7.1 Hz, 3H), 3.14 (s, 1H), 2.48 – 2.35 (m, 2H), 2.32 (s, 3H), 0.53 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.0, 141.7, 140.7, 129.2, 129.0, 127.4, 126.8, 126.2, 71.8, 38.1, 21.3, 14.3. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{28}H_{28}N_2NaOS^+$ calcd for 463.1815; found 463.1815.

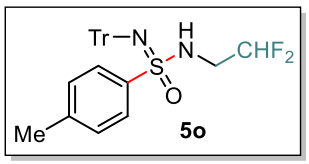
4-methyl-*N*-propyl-*N′*-tritylbenzenesulfonimidamide (5n)



5n

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.5). was obtained in 71% yield as white solid (32.3 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.91 (d, *J* = 8.2 Hz, 2H), 7.59 – 7.59 (m, 6H), 7.26 – 7.22 (m, 8H), 7.18 (q, *J* = 7.1 Hz, 3H), 3.33 (s, 1H), 2.47 (dd, *J* = 12.8, 6.0 Hz, 1H), 2.40 (s, 3H), 2.37 – 2.34 (m, 1H), 0.98 (dt, *J* = 14.1, 7.0 Hz, 2H), 0.56 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 148.0, 141.7, 140.7, 129.2, 129.0, 127.4, 126.8, 126.2, 71.8, 45.0, 22.3, 21.3, 11.1. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{30}N_2NaOS^+$calcd for 477.1972; found 477.1971.

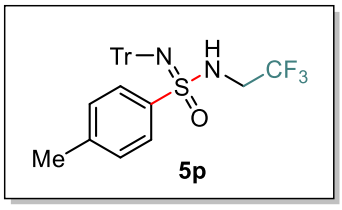
***N*-(2, 2-difluoroethyl)-4-methyl-*N′*-tritylbenzenesulfonimidamide (5o)**



5o

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.6). was obtained in 82% yield as white solid (39.1 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.90 (d, *J* = 8.2 Hz, 2H), 7.57 – 7.55 (m, 6H), 7.30 – 7.24 (dd, *J* = 14.5, 7.6 Hz, 8H), 7.22 – 7.20 (m, 3H), 5.10 (tt, *J* = 56.2, 4.4 Hz, 1H), 3.75 (s, 1H), 2.90 – 2.69 (m, 2H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 147.5, 142.4, 140.6, 129.5, 128.9, 127.6, 126.6, 126.5, 114.0 (t, *J* = 241.6 Hz), 72.1, 45.5 (t, *J* = 27.4 Hz), 21.4. **^{19}F NMR (377 MHz, CDCl$_3$)** δ -122.23, -122.27. **HRMS (ESI-ion trap)** m/z: [M+Na]+ $C_{28}H_{26}F_2N_2NaOS^+$ calcd for 499.1627; found 499.1625.

4-methyl-*N*-(2,2,2-trifluoroethyl)-*N′*-tritylbenzenesulfonimidamide (5p)

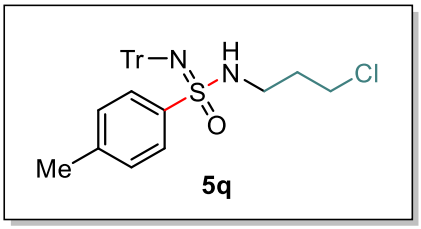


5p

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.6). was obtained in 79% yield as white solid (39.1 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.91 (d, *J* = 7.9 Hz, 2H), 7.57 – 7.56 (m, 6H), 7.28 – 7.24 (m, 8H), 7.21 – 7.18 (m, 3H), 3.78 (s, 1H), 2.94 (dd, *J* = 17.9, 8.8 Hz, 2H), 2.40 (s, 3H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 147.3, 142.4, 140.6, 129.3, 128.8, 127.7, 126.7, 126.6, 123.7 (q, *J* = 278.5 Hz), 72.2, 44.7 (q, *J* = 34.2 Hz), 21.4. **^{19}F NMR (377 MHz, CDCl$_3$)** δ -72.18. **HRMS (ESI-ion trap)** m/z:

[M+Na]$^+$ $C_{28}H_{25}F_3N_2NaOS^+$ calcd for 517.1532; found 517.1532.

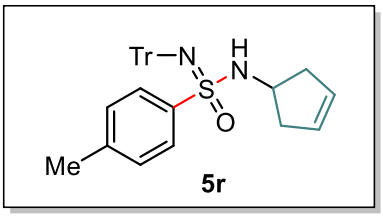
_N_-(3-chloropropyl)-4-methyl-_N′_-tritylbenzenesulfonimidamide (5q)



5q

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1, R_f=0.6). was obtained in 77% yield as white solid (37.5 mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.90 (d, *J* = 8.2 Hz, 2H), 7.58 – 7.56 (m, 6H), 7.28 – 7.23 (m, 8H), 7.20 – 7.17 (m, 3H), 3.42 (s, 1H), 3.16 (t, *J* = 6.4 Hz, 2H), 2.67 (dt, *J* = 13.1, 6.6 Hz, 1H), 2.57 (dt, *J* = 12.9, 6.5 Hz, 1H), 2.41 (s, 3H), 1.45 – 1.38 (m, 2H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 147.9, 142.0, 140.6, 129.3, 129.0, 127.4, 126.8, 126.4, 71.9, 42.0, 40.6, 31.9, 21.4. **HRMS (ESI-ion trap)** m/z: [M+Na]$^+$ $C_{29}H_{29}ClN_2NaOS^+$calcd for 511.1582; found 511.1583.

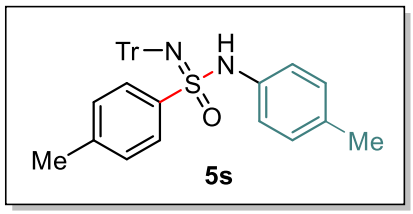
_N_-(cyclopent-3-en-1-yl)-4-methyl-_N′_-tritylbenzenesulfonimidamide (5r)



5r

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.6). was obtained in 77% yield as white solid (36.8mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.89 (d, *J* = 8.2 Hz, 2H), 7.57 – 7.55 (m, 6H), 7.26 – 7.21 (m, 8H), 7.18 – 7.15 (m, 3H), 5.39 (dddd, *J* = 10.1, 6.0, 4.1, 2.1 Hz, 2H), 3.68 – 3.58 (m, 2H), 2.40 (s, 3H),2.21 (dd, *J* = 16.6, 5.6 Hz, 1H), 2.05 (dd, *J* = 16.3, 5.6 Hz, 1H), 1.53 (dd, *J* = 41.8, 16.8 Hz, 2H). **^{13}C NMR (101 MHz, CDCl$_3$)** δ 148.1, 142.1, 141.6, 129.2, 129.0, 128.7, 128.1, 127.4, 126.7, 126.2, 72.0, 53.0, 39.9, 39.4, 21.4. **HRMS (ESI-ion trap)** m/z: [M+Na]$^+$ $C_{31}H_{30}N_2NaOS^+$ calcd for 501.1972; found 501.1969.

4-methyl-_N_-(_p_-tolyl)-_N′_-tritylbenzenesulfonimidamide (5s)

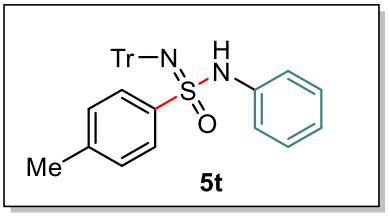


5s

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.5). was obtained in 54% yield as white solid (27.1mg). **^{1}H NMR (400 MHz, CDCl$_3$)** δ 7.77 (d, *J* = 5.9 Hz, 2H), 7.52 – 7.51 (m, 6H), 7.29 – 7.15 (m, 11H), 6.85 (d, *J* = 8.0 Hz, 2H), 6.53 (d, *J* = 5.9 Hz, 2H), 5.47 (s, 1H), 2.37 (s, 3H), 2.18 (s, 3H). **^{13}C NMR (101 MHz,**

$CDCl_3$) δ 146.9, 142.1, 140.4, 132.8, 129.3, 129.2, 129.1, 127.5, 127.0, 126.5, 120.9, 72.3, 21.4, 20.7. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{33}H_{30}N_2NaOS^+$calcd for 525.1972; found 525.1971.

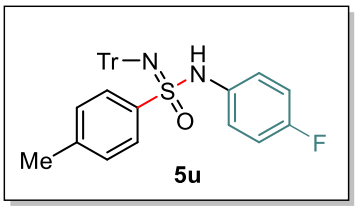
4-methyl-*N*-phenyl-*N*'-tritylbenzenesulfonimidamide (5t)



5t

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.5). was obtained in 52% yield as white solid (25.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.72 (s, 2H), 7.51 – 7.49 (m, 6H), 7.25 – 7.16 (m, 13H), 6.97 (t, *J* = 7.4 Hz, 2H), 6.84 (t, *J* = 7.2 Hz, 1H), 5.50 (s, 1H), 2.36 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.0, 142.3, 140.2, 130.2, 129.3, 129.0, 127.6, 126.9, 126.6, 126.5, 123.1, 72.1, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{32}H_{28}N_2NaOS^+$calcd for 511.1815; found 511.1811.

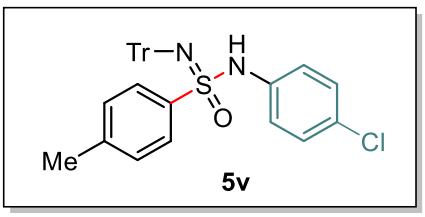
***N*-(4-fluorophenyl)-4-methyl-*N*′-tritylbenzenesulfonimidamide (5u)**



5u

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.5). was obtained in 66% yield as white solid (33.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.69 (d, *J* = 6.2 Hz, 2H), 7.49 – 7.49 (m, 6H), 7.21 – 7.15 (m, 11H), 6.76 (t, *J* = 8.5 Hz, 2H), 6.62 (s, 2H), 5.54 (s, 1H), 2.37 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 159.3 (d, *J* = 242.1 Hz), 146.7, 142.4, 139.8, 129.4, 129.1, 128.1 (d, *J* = 21.9 Hz), 127.6, 127.0, 126.7, 123.1, 115.36 (d, *J* = 22.6 Hz), 72.4, 21.5. **^{19}F NMR (377 MHz, $CDCl_3$)** δ -119.83. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{32}H_{27}FN_2NaOS^+$calcd for 529.1721; found 529.1720.

***N*-(4-chlorophenyl)-4-methyl-*N*′-tritylbenzenesulfonimidamide (5v)**

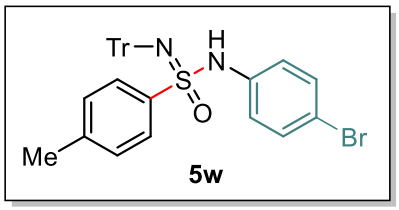


5v

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.5). was obtained in 62% yield as white solid (32.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.70 (s, 2H), 7.47 – 7.46 (m, 6H), 7.24 – 7.15 (m, 11H), 7.01 (d, *J* = 8.4 Hz, 2H), 6.62 (s, 2H), 5.60 (s, 1H), 2.37 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 146.4, 142.5, 139.7,

129.4, 129.0, 128.7, 128.0, 127.6, 127.0, 126.7, 121.9, 72.4, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{32}H_{27}ClN_2NaOS^+$calcd for 545.1425; found 545.1424.

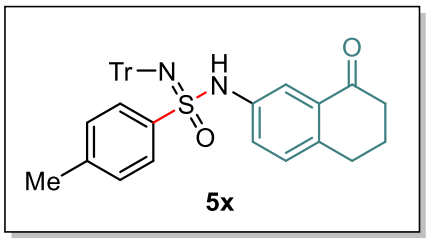
***N*-(4-bromophenyl)-4-methyl-*N′*-tritylbenzenesulfonimidamide (5w)**



5w

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =8/1, R_f=0.5). was obtained in 59% yield as white solid (33.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.70 (s, 2H), 7.47 – 7.45 (m, 6H), 7.24 – 7.14 (m, 13H), 6.57 (d, *J* = 3.8 Hz, 2H), 5.60 (s, 1H), 2.37 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 146.9, 142.5, 139.6, 131.6, 129.5, 129.0, 128.0, 127.6, 127.0, 126.7, 115.5, 72.4, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{32}H_{27}BrN_2NaOS^+$calcd for 589.0920; found 589.0920.

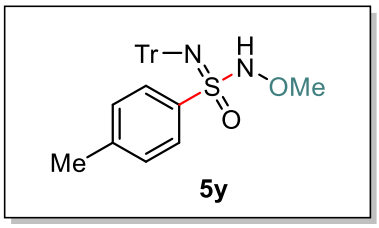
4-methyl-*N*-(8-oxo-5,6,7,8-tetrahydronaphthalen-2-yl)-*N′*-tritylbenzenesulfonimidamide (5x)



5x

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc =2/1, R_f=0.3). was obtained in 74% yield as yellow solid (41.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.80 (s, 2H), 7.71 (d, *J* = 8.5 Hz, 1H), 7.46 – 7.44 (m, 6H), 7.24 – 7.12 (m, 11H), 6.59 (s, 1H), 6.52 (d, *J* = 7.0 Hz, 1H), 2.74 – 2.61 (m, 2H), 2.50 – 2.47 (m, 2H), 2.36 (s, 3H), 1.97 – 1.94 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 197.5, 146.2, 145.7, 142.8, 139.9, 129.6, 129.1, 128.4, 128.2, 128.0, 127.6, 127.1, 126.9, 126.8, 117.4, 72.5, 38.9, 29.9, 23.3, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{36}H_{32}N_2NaO_2S^+$calcd for 579.2077; found 579.2073.

***N*-methoxy-4-methyl-*N′*-tritylbenzenesulfonimidamide (5y)**

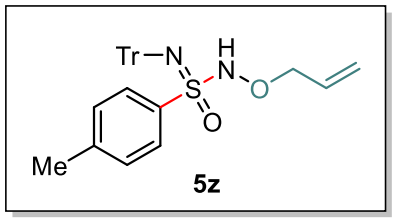


5y

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.4). was obtained in 50% yield as white solid (22.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.00 (d, *J* = 8.3 Hz, 2H), 7.58 – 7.56 (m, 6H), 7.32 (d, *J* = 8.0 Hz, 2H), 7.29 – 7.24 (m, 6H), 7.23 – 7.19

(m, 3H), 5.85 (s, 1H), 3.17 (s, 3H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.5, 143.1, 137.4, 129.3, 129.1, 128.1, 127.5, 126.5, 72.2, 63.5, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{27}H_{26}N_2NaO_2S^+$calcd for 465.1608; found 465.1604.

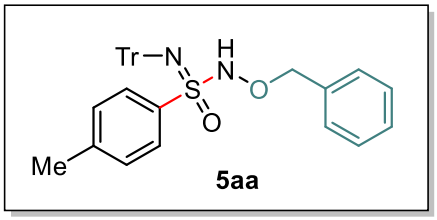
***N*-(allyloxy)-4-methyl-*N′*-tritylbenzenesulfonimidamide (5z)**



5z

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.4). was obtained in 68% yield as white solid (31.8 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.99 (d, *J* = 8.2 Hz, 2H), 7.58 – 7.56 (m, 6H), 7.32 – 7.19 (m, 11H), 5.79 (s, 1H), 5.57 (qd, *J* = 11.2, 5.9 Hz, 1H), 5.00 (dd, *J* = 23.2, 5.9 Hz, 2H), 3.79 (qd, *J* = 12.5, 5.9 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.5, 143.1, 137.4, 132.8, 129.3, 129.1, 128.2, 127.5, 126.5, 118.3, 76.4, 72.2, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{29}H_{28}N_2NaO_2S^+$ calcd for 491.1764; found 491.1758.

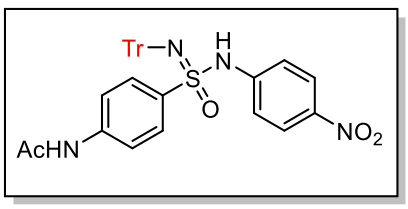
***N*-(benzyloxy)-4-methyl-*N′*-tritylbenzenesulfonimidamide (5aa)**



5aa

Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc = 8/1 R_f=0.5). was obtained in 49% yield as white solid (25.4 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.01 (d, *J* = 8.3 Hz, 2H), 7.58 – 7.55 (m, 6H), 7.30 (d, *J* = 8.1 Hz, 2H), 7.25 – 7.18 (m, 12H), 7.03 (dd, *J* = 6.5, 2.9 Hz, 2H), 5.78 (s, 1H), 4.31 (dd, *J* = 39.1, 11.4 Hz, 2H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.2, 143.1, 137.5, 136.1, 129.3, 129.1, 128.5, 128.2, 128.2, 128.0, 127.5, 126.5, 77.5, 72.3, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{33}H_{30}N_2NaO_2S^+$ calcd for 541.1921; found 541.1917.

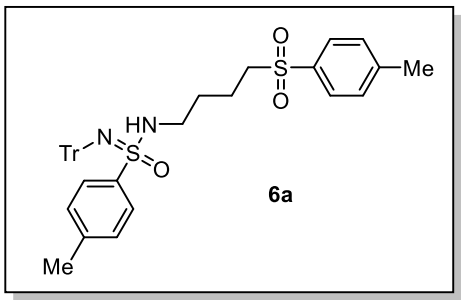
***N*-(4-(*N*-(4-nitrophenyl)-*N′*-tritylsulfamidimidoyl)phenyl)acetamide (5ab)**



Prepared according to procedure B, flash column chromatography on silica gel (eluent: PE/EtOAc=1/1, R_f=0.3). **5ab** was obtained in 50% yield as light yellow solid (28.8 mg). **^{1}H NMR (400 MHz, DMSO-*d6*)** δ 10.33 (s, 1H), 9.81 (s, 1H), 8.01 (d, *J* = 7.6 Hz, 2H), 7.84 (d, *J* = 8.1 Hz, 2H), 7.77

(d, *J* = 7.6 Hz, 2H), 7.43 – 7.41 (m, 6H), 7.20 – 7.15 (m, 9H), 6.91 (d, *J* = 8.1 Hz, 2H), 2.07 (s, 2H). **^{13}C NMR (101 MHz, DMSO-*d6*)** δ 169.5, 147.4, 146.6, 143.2, 141.1, 137.0, 129.1, 128.1, 127.8, 126.9, 125.0, 119.4, 116.6, 72.1, 24.6. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{33}H_{28}N_4NaO_4S^+$ calcd for 599.1724; found 599.1719.

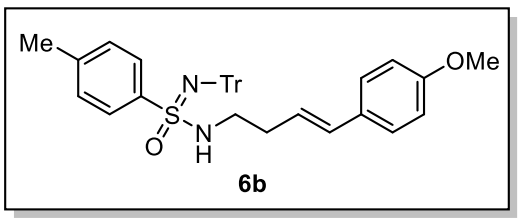
4-methyl-*N*-(4-tosylbutyl)-*N′*-tritylbenzenesulfonimidamide (6a)



6a

Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 4/1 R_f=0.5). was obtained in 70% yield as white solid (43.6 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.85 (d, *J* = 8.1 Hz, 2H), 7.69 (d, *J* = 8.1 Hz, 2H), 7.55 – 7.53 (m, 6H), 7.31 (d, *J* = 8.1 Hz, 2H), 7.26 – 7.14 (m, 13H), 3.39 (s, 1H), 2.80 - 2.76 (m, 1H), 2.42 (s, 3H), 2.40 (s, 3H), 2.47 – 2.31 (m, 2H), 1.35 (dt, *J* = 15.7, 7.8 Hz, 2H), 1.05 – 0.98 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 147.9, 144.6, 141.9, 140.4, 135.9, 129.8, 129.2, 128.9, 127.9, 127.4, 126.8, 126.3, 71.9, 55.5, 42.4, 27.7, 21.5, 21.3, 19.8. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{37}H_{38}N_2NaO_3S_2^+$ calcd for 645.2217; found 645.2211.

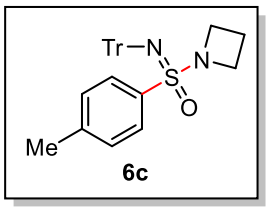
(*E*)-*N*-(4-(4-methoxyphenyl)but-3-en-1-yl)-4-methyl-*N*'-tritylbenzenesulfonimidamide (6b)



6b

Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 3/1 R_f=0.5). was obtained in 68% yield as white solid (38.9 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.93 (dd, *J* = 16.6, 7.9 Hz, 4H), 7.58 – 7.56 (m, 6H), 7.25 – 7.17 (m, 13H), 6.14 (d, *J* = 15.8 Hz, 1H), 5.88 – 5.81 (m, 1H), 3.91 (s, 3H), 3.44 (s, 1H), 2.75 – 2.54 (m, 2H), 2.42 (s, 3H), 1.93 (d, *J* = 6.5 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 166.9, 148.0, 142.0, 141.5, 140.7, 131.4, 129.9, 129.4, 129.1, 128.0, 127.5, 126.9, 126.4, 125.9, 71.9, 52.1, 42.6, 32.8, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+Na]^+$ $C_{37}H_{36}N_2NaOS^+$ calcd for 579.2441; found 579.2439.

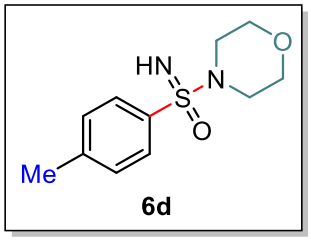
1-(4-methyl-*N*-tritylphenylsulfonimidoyl)azetidine (6c)



6c

Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 6/1 R_f=0.5). was obtained in 81% yield as white solid (36.7 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.74 (d, *J* = 8.2 Hz, 2H), 7.56 – 7.55 (m, 6H), 7.25 – 7.21 (m, 8H), 7.19 – 7.14 (m, 3H), 3.38 (q, *J* = 7.5 Hz, 2H), 3.25 (q, *J* = 7.5 Hz, 2H), 2.40 (s, 3H), 1.64 (p, *J* = 7.5 Hz, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 148.1, 141.9, 134.9, 129.3, 129.2, 128.1, 127.2, 126.2, 71.6, 50.8, 21.5, 14.5. **HRMS (ESI-ion trap)** m/z: [M+Na]+ $C_{29}H_{28}N_2NaOS^+$ calcd for 475.1815; found 475.1811.

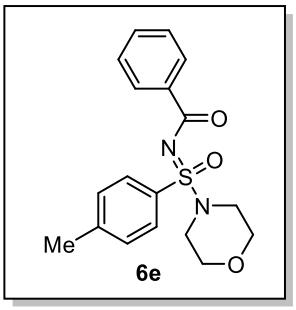
4-(4-methylphenylsulfonimidoyl)morpholine (6d)



6d

Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 5/1 R_f=0.3). was obtained in 78% yield as white solid (18.7 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.75 (d, *J* = 8.3 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 3.72 – 3.70 (m, 4H), 2.98 – 2.96 (m, 4H), 2.44 (s, 3H), 2.32 (s, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 143.4, 131.9, 129.4, 128.1, 66.4, 47.0, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+H]^+$ $C_{11}H_{16}N_2NaO_2S^+$ calcd for 241.1005; found 241.1004.

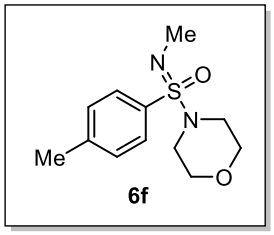
***N*-(morpholino(oxo)(*p*-tolyl)-λ^6-sulfaneylidene)benzamide (6e)**



6e

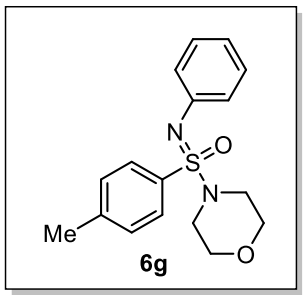
Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 2/1 R_f=0.5). was obtained in 73% yield as white solid (25.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 8.16 (d, *J* = 7.6 Hz, 2H), 7.81 (d, *J* = 8.1 Hz, 2H), 7.51 (t, *J* = 7.2 Hz, 1H), 7.41 (t, *J* = 7.6 Hz, 2H), 7.37 (d, *J* = 8.0 Hz, 2H), 3.80 – 3.77 (m, 4H), 3.20 – 3.19 (m, 4H), 2.44 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 172.6, 144.5, 135.7, 132.2, 131.9, 130.0, 129.4, 128.0, 127.9, 66.1, 45.5, 21.6. **HRMS (ESI-ion trap)** m/z: $[M+H]^+$ $C_{18}H_{21}N_2O_3S^+$ calcd for 345.1268; found 345.1264.

4-(*N*,4-dimethylphenylsulfonimidoyl)morpholine (6f)



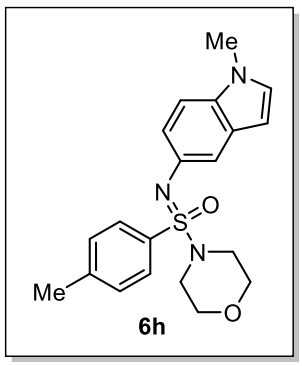
Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 5/1 R_f=0.4). was obtained in 93% yield as white solid (23.7 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.72 (d, *J* = 8.0 Hz, 2H), 7.31 (d, *J* = 7.9 Hz, 2H), 3.73 – 3.71 (m, 4H), 2.96 – 2.85 (m, 7H), 2.42 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 143.1, 131.6, 129.4, 127.9, 66.3, 46.7, 27.9, 21.4. **HRMS (ESI-ion trap)** m/z: $[M+H]^+$ $C_{12}H_{19}N_2O_2S^+$ calcd for 255.1162; found 255.1159.

4-(4-methyl-*N*-phenylphenylsulfonimidoyl)morpholine (6g)



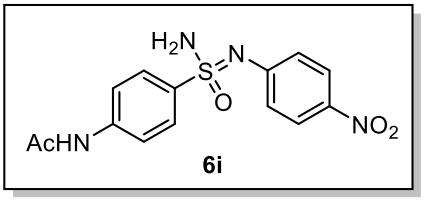
Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 2/1 R_f=0.7). was obtained in 95% yield as white solid (30.1 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.84 (d, *J* = 8.2 Hz, 2H), 7.34 (d, *J* = 8.1 Hz, 2H), 7.24 (d, *J* = 4.1 Hz, 4H), 6.97 (dt, *J* = 8.5, 4.2 Hz, 1H), 3.68 – 3.58 (m, 4H), 2.99 – 2.94 (m, 4H), 2.44 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 143.4, 143.4, 131.9, 129.6, 129.0, 128.1, 123.6, 121.9, 66.2, 46.6, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+H]^+$ $C_{17}H_{21}N_2O_2S^+$ calcd for 317.1319; found 317.1317.

4-(4-methyl-*N*-(1-methyl-1*H*-indol-5-yl)phenylsulfonimidoyl)morpholine (6h)



Prepared according to the procedure, flash column chromatography on silica gel (eluent: PE/EtOAc = 2/1 R_f=0.4). was obtained in 90% yield as white solid (33.3 mg). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.88 (d, *J* = 8.1 Hz, 2H), 7.48 (s, 1H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.21 – 7.15 (m, 2H), 6.99 (d, *J* = 2.9 Hz, 1H), 6.38 (d, *J* = 2.9 Hz, 1H), 3.75 (s, 3H), 3.65 – 3.54 (m, 4H), 3.06 – 2.99 (m, 4H), 2.43 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 143.1, 135.4, 133.2, 132.3, 129.5, 129.0, 128.9, 128.2, 119.3, 114.5, 109.3, 100.3, 66.2, 46.7, 32.9, 21.5. **HRMS (ESI-ion trap)** m/z: $[M+H]^+$ $C_{20}H_{24}N_3O_2S^+$ calcd for 370.1584; found. 370.1581.

***N*-(4-(*N'*-(4-nitrophenyl)sulfamidimidoyl)phenyl)acetamide (6i)**



6i

Prepared according to the procedure, flash column chromatography on silica gel (eluent:PE/EtOAc=1/2, R_f=0.3). was obtained in 76% yield as light yellow solid (25.4 mg). **^{1}H NMR (400 MHz, DMSO-*d6*)** δ 10.34 (s, 1H), 8.04 (d, *J* = 9.0 Hz, 2H), 7.89 (d, *J* = 8.7 Hz, 2H), 7.75 (m, 2H), 7.63 (s, 2H), 7.08 (d, *J* = 8.9 Hz, 2H), 2.08 (s, 3H). **^{13}C NMR (101 MHz, DMSO-*d6*)** δ 169.5, 143.3, 140.4, 136.9, 128.2, 125.6, 122.4, 119.1, 24.7. **HRMS (ESI-ion trap)** m/z: $[M+H]^+$ $C_{14}H_{15}N_4O_4S^+$ calcd for 335.0809; found335.0805.

2.7 Crystal Data and Structure Refinement for Compounds 4a and 5s

Experimental 4-(4-methyl-*N*-tritylphenylsulfonimidoyl)morpholine **4a** (CCDC: 2394079) was crystallized from petroleum ether/dichloromethane (1:1), under the condition of room temperature. Experimental 4-methyl-*N*-(*p*-tolyl)-*N'*-tritylbenzenesulfonimidamide **5s** (CCDC: 2498236) was crystallized from petroleum ether/ dichloromethane (1:1), under the condition of room temperature.

Datablock lsy2024072403_0m - ellipsoid plot

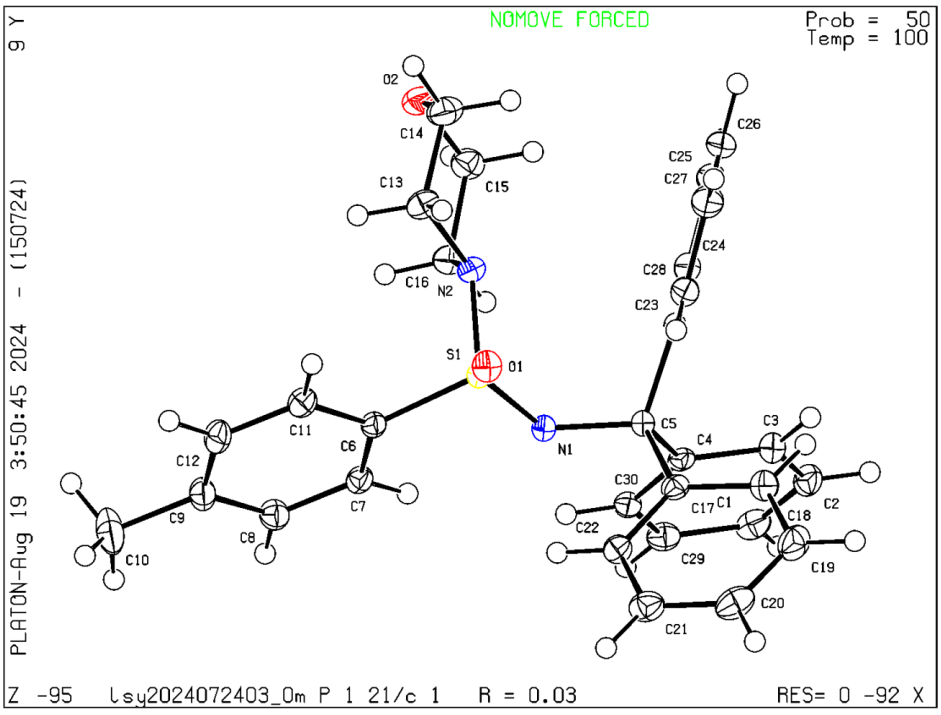


Table 1 Crystal data and structure refinement for 4a.

Identification code	**4a**
Empirical formula	$C_{30}H_{30}N_2O_2S$
Formula weight	482.62
Temperature/K	100.0(2)
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	8.5994(2)
b/Å	11.1072(3)
c/Å	26.0801(8)
α/°	90
β/°	96.6200(10)
γ/°	90
Volume/Å^3	2474.44(12)
Z	4
ρ_{calc}g/cm^3	1.295
μ/mm^{-1}	1.397
F(000)	1024.0
Crystal size/mm^3	0.43 × 0.4 × 0.39
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	6.824 to 136.844
Index ranges	$-10 \le h \le 10$, $-13 \le k \le 13$, $-31 \le l \le 31$
Reflections collected	87014
Independent reflections	4544 [R_{int} = 0.0380, R_{sigma} = 0.0120]
Data/restraints/parameters	4544/0/317
Goodness-of-fit on F^2	1.039
Final R indexes [I>=2σ (I)]	R_1 = 0.0310, wR_2 = 0.0784
Final R indexes [all data]	R_1 = 0.0329, wR_2 = 0.0795
Largest diff. peak/hole / e Å^{-3}	0.32/-0.41

Table 2 Fractional Atomic Coordinates (×10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for 4a. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor.

Atom	*x*	*y*	*z*	U(eq)
S1	5374.3(3)	3024.6(3)	2826.1(2)	14.54(9)
O1	5793.4(11)	4282.5(8)	2860.7(4)	19.9(2)
O2	9765.8(11)	997.2(10)	2650.9(4)	25.5(2)
N1	4334.4(12)	2423.3(10)	3177.0(4)	16.1(2)
N2	7079.8(12)	2313.1(10)	2846.6(4)	16.5(2)
C1	2100.1(16)	-467.8(13)	4363.4(6)	22.8(3)
C2	3053.8(17)	279.7(13)	4688.8(5)	23.2(3)
C3	3813.8(16)	1243.5(13)	4490.1(5)	20.6(3)
C4	3633.1(14)	1491.1(12)	3960.4(5)	15.8(3)
C5	4483.2(15)	2575.7(12)	3745.2(5)	15.5(3)
C6	4405.3(15)	2747.2(12)	2199.5(5)	15.7(3)
C7	3252.2(15)	1882.4(12)	2101.0(5)	17.3(3)
C8	2571.3(16)	1705.0(13)	1597.2(5)	21.1(3)
C9	3049.1(17)	2361.0(13)	1187.8(5)	22.4(3)
C10	2317(2)	2150.7(17)	640.8(6)	36.9(4)

Table 2 Fractional Atomic Coordinates ($\times 10^4$) and Equivalent Isotropic Displacement Parameters ($Å^2 \times 10^3$) for 4a. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor.

Atom	*x*	*y*	*z*	U(eq)
C11	4913.9(16)	3408.6(12)	1795.1(5)	19.4(3)
C12	4241.5(17)	3205.4(13)	1294.3(5)	21.9(3)
C13	8336.7(16)	2889.8(13)	2595.9(6)	22.6(3)
C14	9852.2(17)	2248.4(14)	2778.3(6)	26.5(3)
C15	8556.6(16)	448.7(13)	2903.5(6)	23.6(3)
C16	6975.7(16)	1014.7(12)	2738.7(5)	20.3(3)
C17	3609.6(15)	3732.1(12)	3883.5(5)	16.4(3)
C18	3758.3(16)	4169.0(13)	4388.6(5)	22.4(3)
C19	2971.0(17)	5197.9(14)	4515.6(6)	27.4(3)
C20	2021.2(18)	5817.5(13)	4138.5(6)	27.7(3)
C21	1842.4(17)	5387.4(13)	3636.8(6)	24.9(3)
C22	2625.2(15)	4350.7(12)	3512.8(5)	19.4(3)
C23	6222.1(15)	2600.4(13)	3978.2(5)	17.8(3)
C24	7027.6(16)	1529.0(14)	4094.0(5)	22.0(3)
C25	8613.1(17)	1533.2(16)	4276.7(6)	28.5(3)
C26	9425.4(17)	2608.7(16)	4338.7(6)	30.7(4)
C27	8641.7(17)	3678.8(16)	4217.7(6)	29.5(3)
C28	7047.9(16)	3678.1(14)	4040.6(5)	22.5(3)
C29	1905.8(16)	-234.4(12)	3838.4(6)	21.4(3)
C30	2661.0(15)	741.5(12)	3638.7(5)	17.7(3)

Table 3 Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for 4a. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\cdots]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
S1	15.09(16)	14.86(16)	13.80(16)	-0.12(11)	2.18(11)	0.02(11)
O1	23.1(5)	16.2(5)	20.3(5)	-0.9(4)	2.4(4)	-0.3(4)
O2	19.2(5)	30.3(6)	27.2(5)	-6.4(4)	4.1(4)	4.5(4)
N1	15.7(5)	19.6(6)	13.2(5)	-0.3(4)	2.0(4)	-0.2(4)
N2	15.1(5)	16.5(5)	18.4(6)	-1.0(4)	3.5(4)	-0.2(4)
C1	22.1(7)	18.9(7)	28.9(8)	5.7(6)	8.6(6)	2.4(6)
C2	25.0(7)	26.2(7)	19.1(7)	5.8(6)	5.7(5)	4.7(6)
C3	21.4(7)	24.3(7)	16.3(7)	0.2(5)	2.7(5)	0.2(6)
C4	13.5(6)	16.9(6)	17.3(6)	1.2(5)	3.3(5)	4.6(5)
C5	15.4(6)	18.6(6)	12.5(6)	-0.3(5)	1.6(5)	0.6(5)
C6	16.7(6)	16.1(6)	14.5(6)	0.3(5)	2.5(5)	3.4(5)
C7	18.2(6)	17.4(6)	16.9(6)	2.1(5)	4.6(5)	1.7(5)
C8	20.8(7)	22.2(7)	20.2(7)	0.0(5)	1.8(5)	-3.0(6)
C9	26.1(7)	25.5(7)	15.6(7)	0.7(5)	2.2(5)	0.7(6)
C10	46.0(10)	46.6(10)	17.0(7)	2.5(7)	-0.7(7)	-15.8(8)
C11	20.5(7)	18.3(7)	20.1(7)	1.7(5)	5.2(5)	-1.1(5)
C12	26.8(7)	22.5(7)	17.1(7)	4.5(5)	5.5(5)	-0.3(6)
C13	19.5(7)	24.0(7)	25.4(7)	1.5(6)	7.2(6)	-2.4(6)
C14	18.5(7)	29.8(8)	31.9(8)	-4.1(6)	5.6(6)	-0.9(6)
C15	22.9(7)	21.3(7)	26.3(7)	-3.2(6)	1.1(6)	3.7(6)

Table 3 Anisotropic Displacement Parameters ($Å^2 \times 10^3$) for 4a. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\cdots]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
C16	19.2(7)	17.1(7)	24.6(7)	-2.9(5)	1.8(5)	0.2(5)
C17	14.0(6)	17.2(6)	18.6(7)	-0.1(5)	3.9(5)	-2.6(5)
C18	21.5(7)	26.4(7)	19.1(7)	-3.1(6)	2.0(5)	0.5(6)
C19	27.8(8)	29.7(8)	25.6(8)	-10.7(6)	6.8(6)	-3.1(6)
C20	26.9(8)	20.7(7)	37.4(9)	-5.0(6)	11.3(6)	2.4(6)
C21	22.9(7)	22.9(7)	29.6(8)	4.3(6)	5.6(6)	4.2(6)
C22	18.5(6)	20.9(7)	19.0(7)	0.8(5)	3.5(5)	-1.2(5)
C23	15.0(6)	27.3(7)	11.5(6)	-0.1(5)	2.7(5)	1.1(5)
C24	20.4(7)	29.8(8)	16.2(7)	2.2(6)	3.3(5)	3.2(6)
C25	21.2(7)	45.1(9)	19.4(7)	5.9(6)	3.4(6)	10.7(7)
C26	14.9(7)	57.0(11)	19.8(7)	-0.1(7)	0.7(5)	0.8(7)
C27	20.5(7)	44.0(9)	23.9(8)	-4.7(7)	2.9(6)	-9.1(7)
C28	19.1(7)	30.2(8)	18.5(7)	-2.0(6)	2.9(5)	-2.1(6)
C29	19.0(7)	18.7(7)	26.4(7)	-1.2(6)	2.8(5)	0.7(5)
C30	16.4(6)	19.3(7)	17.3(6)	1.1(5)	1.8(5)	3.7(5)

Table 4 Bond Lengths for 4a.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
S1	O1	1.4431(10)	C8	C9	1.393(2)
S1	N1	1.5073(11)	C9	C10	1.510(2)
S1	N2	1.6614(11)	C9	C12	1.394(2)
S1	C6	1.7737(13)	C11	C12	1.385(2)
O2	C14	1.4289(18)	C13	C14	1.513(2)
O2	C15	1.4298(18)	C15	C16	1.5145(19)
N1	C5	1.4822(16)	C17	C18	1.3958(19)
N2	C13	1.4727(17)	C17	C22	1.3909(19)
N2	C16	1.4701(17)	C18	C19	1.388(2)
C1	C2	1.386(2)	C19	C20	1.387(2)
C1	C29	1.384(2)	C20	C21	1.385(2)
C2	C3	1.386(2)	C21	C22	1.391(2)
C3	C4	1.3996(19)	C23	C24	1.392(2)
C4	C5	1.5476(18)	C23	C28	1.392(2)
C4	C30	1.3908(19)	C24	C25	1.392(2)
C5	C17	1.5514(18)	C25	C26	1.384(2)
C5	C23	1.5481(17)	C26	C27	1.385(2)
C6	C7	1.3832(19)	C27	C28	1.395(2)
C6	C11	1.3964(19)	C29	C30	1.3950(19)
C7	C8	1.3896(19)			

Table 5 Bond Angles for 4a.

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°
O1	S1	N1	123.53(6)	C8	C9	C10	121.04(13)
O1	S1	N2	104.20(6)	C8	C9	C12	118.33(13)
O1	S1	C6	108.25(6)	C12	C9	C10	120.62(13)
N1	S1	N2	110.67(6)	C12	C11	C6	119.58(13)
N1	S1	C6	103.52(6)	C11	C12	C9	121.01(13)
N2	S1	C6	105.44(6)	N2	C13	C14	107.78(11)
C14	O2	C15	109.17(10)	O2	C14	C13	111.41(12)
C5	N1	S1	124.58(9)	O2	C15	C16	111.66(12)
C13	N2	S1	117.98(9)	N2	C16	C15	108.66(11)
C16	N2	S1	115.24(9)	C18	C17	C5	120.87(12)
C16	N2	C13	111.92(11)	C22	C17	C5	121.31(12)
C29	C1	C2	119.25(13)	C22	C17	C18	117.80(13)
C3	C2	C1	120.33(13)	C19	C18	C17	121.16(13)
C2	C3	C4	121.16(13)	C20	C19	C18	120.21(14)
C3	C4	C5	120.50(12)	C21	C20	C19	119.41(14)
C30	C4	C3	117.94(12)	C20	C21	C22	120.09(14)
C30	C4	C5	121.56(11)	C21	C22	C17	121.30(13)
N1	C5	C4	106.48(10)	C24	C23	C5	120.25(12)
N1	C5	C17	109.80(10)	C28	C23	C5	121.19(12)
N1	C5	C23	111.26(10)	C28	C23	C24	118.38(12)
C4	C5	C17	107.37(10)	C25	C24	C23	120.97(14)
C4	C5	C23	110.29(10)	C26	C25	C24	120.29(15)
C23	C5	C17	111.45(11)	C25	C26	C27	119.24(13)
C7	C6	S1	122.84(10)	C26	C27	C28	120.58(15)
C7	C6	C11	120.35(12)	C23	C28	C27	120.52(14)
C11	C6	S1	116.73(10)	C1	C29	C30	120.43(13)
C6	C7	C8	119.27(12)	C4	C30	C29	120.88(12)
C7	C8	C9	121.41(13)				

Table 6 Torsion Angles for 4a.

A	B	C	D	Angle/°	A	B	C	D	Angle/°
S1	N1	C5	C4	-160.05(9)	C5	C17	C18	C19	-179.52(13)
S1	N1	C5	C17	84.01(12)	C5	C17	C22	C21	-179.99(12)
S1	N1	C5	C23	-39.85(15)	C5	C23	C24	C25	176.41(12)
S1	N2	C13	C14	166.01(9)	C5	C23	C28	C27	-175.55(12)
S1	N2	C16	C15	-165.68(9)	C6	S1	N1	C5	-168.86(10)
S1	C6	C7	C8	-178.76(10)	C6	S1	N2	C13	78.65(11)
S1	C6	C11	C12	177.83(10)	C6	S1	N2	C16	-57.21(11)
O1	S1	N1	C5	-45.78(13)	C6	C7	C8	C9	1.4(2)
O1	S1	N2	C13	-35.24(11)	C6	C11	C12	C9	0.8(2)
O1	S1	N2	C16	-171.11(9)	C7	C6	C11	C12	0.9(2)
O1	S1	C6	C7	-148.82(11)	C7	C8	C9	C10	179.19(14)
O1	S1	C6	C11	34.30(12)	C7	C8	C9	C12	0.2(2)
O2	C15	C16	N2	-57.02(15)	C8	C9	C12	C11	-1.4(2)
N1	S1	N2	C13	-170.03(10)	C10	C9	C12	C11	179.66(14)
N1	S1	N2	C16	54.10(11)	C11	C6	C7	C8	-2.0(2)
N1	S1	C6	C7	-16.17(13)	C13	N2	C16	C15	55.83(14)
N1	S1	C6	C11	166.95(10)	C14	O2	C15	C16	60.06(14)
N1	C5	C17	C18	-170.87(12)	C15	O2	C14	C13	-61.45(15)
N1	C5	C17	C22	10.72(16)	C16	N2	C13	C14	-56.75(15)
N1	C5	C23	C24	-84.29(15)	C17	C5	C23	C24	152.80(12)
N1	C5	C23	C28	90.81(15)	C17	C5	C23	C28	-32.10(17)
N2	S1	N1	C5	78.60(11)	C17	C18	C19	C20	-0.3(2)
N2	S1	C6	C7	100.14(12)	C18	C17	C22	C21	1.5(2)
N2	S1	C6	C11	-76.75(11)	C18	C19	C20	C21	1.2(2)
N2	C13	C14	O2	59.31(15)	C19	C20	C21	C22	-0.7(2)
C1	C2	C3	C4	0.4(2)	C20	C21	C22	C17	-0.7(2)
C1	C29	C30	C4	0.6(2)	C22	C17	C18	C19	-1.0(2)
C2	C1	C29	C30	0.0(2)	C23	C5	C17	C18	-47.12(16)
C2	C3	C4	C5	179.65(12)	C23	C5	C17	C22	134.46(12)
C2	C3	C4	C30	0.23(19)	C23	C24	C25	C26	-1.1(2)
C3	C4	C5	N1	167.73(11)	C24	C23	C28	C27	-0.4(2)
C3	C4	C5	C17	-74.72(14)	C24	C25	C26	C27	0.1(2)
C3	C4	C5	C23	46.90(16)	C25	C26	C27	C28	0.7(2)
C3	C4	C30	C29	-0.74(19)	C26	C27	C28	C23	-0.6(2)
C4	C5	C17	C18	73.76(15)	C28	C23	C24	C25	1.2(2)
C4	C5	C17	C22	-104.66(13)	C29	C1	C2	C3	-0.5(2)
C4	C5	C23	C24	33.64(16)	C30	C4	C5	N1	-12.87(16)
C4	C5	C23	C28	-151.26(12)	C30	C4	C5	C17	104.69(13)
C5	C4	C30	C29	179.85(12)	C30	C4	C5	C23	-133.70(12)

Table 7 Hydrogen Atom Coordinates (Å×10^4) and Isotropic Displacement Parameters (Å^2×10^3) for 4a.

Atom	*x*	*y*	*z*	U(eq)
H1	1585.66	-1132.77	4499.04	27
H2	3186.94	130.36	5049.86	28
H3	4469.03	1745.22	4717.43	25
H7	2929.31	1414.73	2374.81	21
H8	1762.64	1124.01	1530.42	25
H10A	2043.58	2926.23	475.17	55
H10B	1369.75	1661.98	644.28	55
H10C	3063.32	1727.58	447.77	55
H11	5716.15	3994.39	1863.11	23
H12	4598.45	3648.23	1018.98	26
H13A	8417.39	3752.64	2690.42	27
H13B	8110.55	2827.69	2215.98	27
H14A	10718.75	2623.25	2616.11	32
H14B	10082.84	2340.32	3156.97	32
H15A	8809.83	533.86	3281.78	28
H15B	8508.84	-421.59	2821.22	28
H16A	6673.21	878.72	2365.32	24
H16B	6170.27	644.4	2930.83	24
H18	4409.96	3754.69	4650.01	27
H19	3083.1	5478.61	4861.94	33
H20	1497.75	6530.71	4223.63	33
H21	1184.03	5801.14	3376.97	30
H22	2484.8	4059.25	3168.12	23
H24	6486.67	784.18	4047.49	26
H25	9140.21	794.57	4359.24	34
H26	10508.27	2612.77	4462.79	37
H27	9194.29	4419.96	4255.62	35
H28	6522.02	4419.04	3961.88	27
H29	1253.98	-742.07	3612.76	26
H30	2509.28	896.08	3278.1	21

Datablock lsy1128_1 - ellipsoid plot

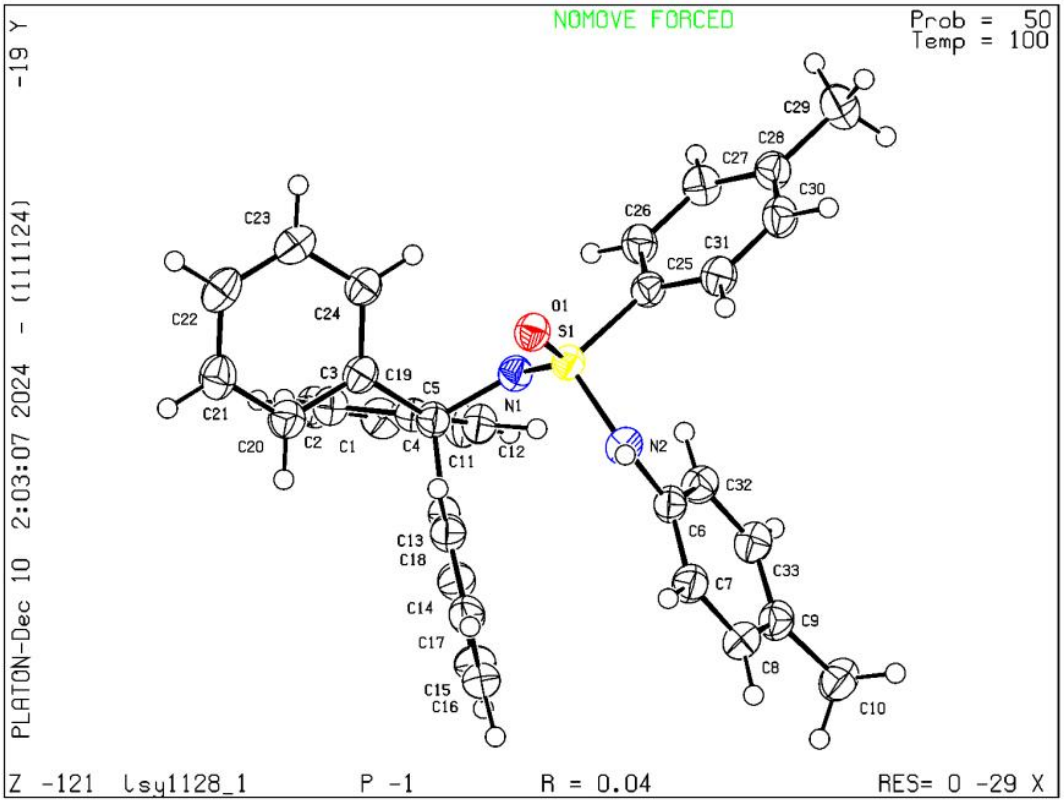


Table 1 Crystal data and structure refinement for 5s.

Identification code	5s
Empirical formula	$C_{33}H_{30}N_2OS$
Formula weight	502.65
Temperature/K	100.0(2)
Crystal system	triclinic
Space group	P-1
a/Å	9.4679(7)
b/Å	12.0255(9)
c/Å	13.0782(10)
α/°	108.106(3)
β/°	109.861(3)
γ/°	92.837(3)
Volume/Å^3	1310.94(17)
Z	2

ρ_{calc}g/cm^3	1.273
μ/mm^{-1}	1.313
F(000)	532.0
Crystal size/mm^3	0.32 × 0.3 × 0.27
Radiation	CuKα (λ = 1.54178)
2Θ range for data collection/°	7.668 to 136.62
Index ranges	-11 ≤ h ≤ 11, -14 ≤ k ≤ 14, -15 ≤ l ≤ 13
Reflections collected	20935
Independent reflections	4728 [R_{int} = 0.0337, R_{sigma} = 0.0240]
Data/restraints/parameters	4728/0/336
Goodness-of-fit on F^2	1.049
Final R indexes [I>=2σ (I)]	R_1 = 0.0359, wR_2 = 0.0971
Final R indexes [all data]	R_1 = 0.0373, wR_2 = 0.0984
Largest diff. peak/hole / e Å^{-3}	0.32/-0.37

Table 2 Fractional Atomic Coordinates (× 10^4) and Equivalent Isotropic Displacement Parameters (Å^2×10^3) for 5s. U_{eq} is defined as 1/3 of of the trace of the orthogonalised U_{IJ} tensor.

Atom	*x*	*y*	*z*	U(eq)
S1	5750.6(4)	3349.8(3)	8809.1(3)	29.78(11)
O1	6545.9(11)	4439.0(9)	9785.8(9)	33.7(2)
N1	5895.1(13)	3080.7(10)	7653.6(10)	31.6(3)
N2	4018.9(14)	3295.2(11)	8829.6(11)	33.2(3)
C1	5923.9(19)	1605.1(14)	3676.9(14)	39.4(3)
C2	6606.9(19)	2790.5(14)	4155.5(14)	40.1(4)
C3	6566.4(17)	3511.4(14)	5205.0(14)	36.4(3)
C4	5863.6(16)	3057.1(13)	5803.6(12)	31.6(3)
C5	5704.5(16)	3845.0(12)	6932.5(12)	31.2(3)
C6	2712.0(16)	2448.8(13)	8032.7(12)	32.4(3)
C7	1296.6(17)	2759.4(14)	7981.3(14)	37.1(3)
C8	-24.0(18)	1932.8(15)	7295.5(15)	40.0(3)

C9	19.0(18)	774.1(14)	6663.7(13)	37.4(3)
C10	-1410.3(19)	-147.6(16)	6009.7(15)	44.6(4)
C11	5238.4(19)	1141.1(14)	4267.5(14)	39.3(3)
C12	5216.3(17)	1854.8(13)	5322.5(13)	35.6(3)
C13	4099.1(16)	4191.4(12)	6669.1(13)	31.9(3)
C14	2885.2(18)	3616.6(14)	5619.4(14)	37.2(3)
C15	1423.4(18)	3873.5(15)	5461.4(15)	42.4(4)
C16	1150.1(18)	4708.9(15)	6345.1(15)	40.8(4)
C17	2356.9(18)	5308.8(14)	7381.7(14)	37.5(3)
C18	3816.0(17)	5055.6(13)	7538.2(13)	34.7(3)
C19	6977.7(16)	4943.6(13)	7522.7(12)	32.3(3)
C20	6771.7(18)	5950.5(13)	7213.3(14)	37.1(3)
C21	7968(2)	6899.5(14)	7657.9(15)	42.4(4)
C22	9376.0(19)	6863.8(14)	8427.4(15)	43.0(4)
C23	9589.7(18)	5870.9(14)	8748.0(14)	39.6(3)
C24	8406.4(17)	4917.5(13)	8291.5(13)	35.0(3)
C25	6369.8(16)	2117.0(12)	9199.5(12)	31.4(3)
C26	7127.0(17)	1362.3(13)	8615.3(13)	35.1(3)
C27	7637.4(18)	434.3(14)	8971.2(13)	37.5(3)
C28	7417.6(18)	244.6(13)	9902.6(13)	36.8(3)
C29	7974(2)	-772.0(16)	10275.1(16)	47.1(4)
C30	6652.6(18)	1014.8(14)	10475.0(14)	38.3(3)
C31	6125.3(17)	1943.2(13)	10130.5(13)	35.5(3)
C32	2776.2(17)	1318.0(13)	7354.8(13)	35.4(3)
C33	1434.7(18)	495.1(14)	6689.4(13)	37.1(3)

Table 3 Anisotropic Displacement Parameters ($Å^2×10^3$) for 5s. The Anisotropic displacement factor exponent takes the form: $-2\pi^2[h^2a^{*2}U_{11}+2hka^*b^*U_{12}+\cdots]$.

Atom	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
S1	29.24(18)	29.22(18)	29.88(19)	9.83(14)	10.68(14)	2.39(13)
O1	33.9(5)	31.6(5)	32.9(5)	9.1(4)	11.7(4)	1.9(4)

N1	31.1(6)	30.8(6)	32.2(6)	11.3(5)	11.0(5)	3.0(5)
N2	32.2(6)	32.4(6)	33.1(6)	7.8(5)	13.5(5)	3.6(5)
C1	44.7(9)	40.7(8)	33.9(8)	11.7(6)	16.8(7)	10.7(7)
C2	43.7(9)	44.5(9)	40.1(8)	19.8(7)	20.8(7)	8.7(7)
C3	36.5(8)	34.9(7)	39.4(8)	15.2(6)	14.3(6)	3.9(6)
C4	28.8(7)	34.0(7)	30.9(7)	12.5(6)	8.8(6)	5.2(5)
C5	31.7(7)	30.3(7)	31.0(7)	11.5(6)	10.8(6)	2.4(6)
C6	32.9(7)	33.5(7)	31.3(7)	13.2(6)	11.5(6)	1.2(6)
C7	36.1(8)	34.2(7)	43.2(8)	14.6(6)	16.6(7)	5.0(6)
C8	32.3(8)	43.9(8)	47.0(9)	19.0(7)	15.9(7)	5.4(6)
C9	37.2(8)	41.5(8)	32.9(8)	14.5(6)	11.8(6)	-0.3(6)
C10	38.7(8)	49.3(9)	41.5(9)	13.3(7)	13.7(7)	-3.1(7)
C11	42.6(8)	33.1(7)	39.1(8)	9.3(6)	15.1(7)	3.2(6)
C12	37.1(8)	35.3(8)	35.8(8)	13.1(6)	15.0(6)	2.3(6)
C13	32.3(7)	31.2(7)	34.3(7)	14.9(6)	12.4(6)	2.8(6)
C14	36.6(8)	36.9(8)	36.4(8)	13.2(6)	11.4(6)	4.4(6)
C15	33.8(8)	46.1(9)	41.5(9)	16.5(7)	6.5(7)	3.7(7)
C16	32.2(8)	45.6(9)	50.8(9)	24.7(7)	15.6(7)	9.7(6)
C17	39.4(8)	38.5(8)	41.6(8)	18.5(7)	19.1(7)	9.4(6)
C18	34.8(7)	35.4(7)	34.6(8)	13.7(6)	12.7(6)	4.0(6)
C19	32.4(7)	32.3(7)	31.5(7)	8.2(6)	14.1(6)	2.6(6)
C20	35.8(8)	34.8(8)	39.7(8)	12.8(6)	13.4(6)	4.3(6)
C21	47.4(9)	31.2(8)	48.5(9)	11.8(7)	20.5(8)	2.1(7)
C22	38.6(8)	36.5(8)	47.0(9)	4.2(7)	18.7(7)	-4.4(6)
C23	31.5(7)	44.7(9)	37.3(8)	8.2(7)	13.0(6)	1.3(6)
C24	34.1(7)	36.6(8)	35.0(8)	11.2(6)	15.3(6)	4.7(6)
C25	30.2(7)	29.7(7)	30.7(7)	9.4(6)	8.8(6)	0.7(5)
C26	38.8(8)	36.2(8)	32.0(8)	12.6(6)	15.0(6)	4.7(6)
C27	41.0(8)	36.2(8)	36.7(8)	11.6(6)	17.3(7)	7.8(6)
C28	36.6(8)	35.3(8)	36.6(8)	13.9(6)	10.8(6)	2.2(6)
C29	57.0(10)	46.2(9)	48.1(10)	24.7(8)	23.5(8)	14.5(8)

C30	42.0(8)	40.7(8)	35.4(8)	16.0(7)	16.6(7)	3.0(6)
C31	37.5(8)	35.3(7)	34.7(8)	11.1(6)	16.0(6)	4.4(6)
C32	33.7(7)	38.2(8)	33.7(8)	11.1(6)	13.5(6)	3.8(6)
C33	39.4(8)	36.1(8)	32.7(8)	8.3(6)	13.6(6)	0.9(6)

Table 4 Bond Lengths for 5s.

Atom	Atom	Length/Å	Atom	Atom	Length/Å
S1	O1	1.4572(10)	C13	C14	1.394(2)
S1	N1	1.4993(12)	C13	C18	1.394(2)
S1	N2	1.6473(12)	C14	C15	1.393(2)
S1	C25	1.7762(15)	C15	C16	1.385(2)
N1	C5	1.4854(18)	C16	C17	1.386(2)
N2	C6	1.4117(19)	C17	C18	1.390(2)
C1	C2	1.386(2)	C19	C20	1.394(2)
C1	C11	1.379(2)	C19	C24	1.393(2)
C2	C3	1.392(2)	C20	C21	1.391(2)
C3	C4	1.392(2)	C21	C22	1.383(2)
C4	C5	1.548(2)	C22	C23	1.386(2)
C4	C12	1.395(2)	C23	C24	1.385(2)
C5	C13	1.549(2)	C25	C26	1.388(2)
C5	C19	1.5397(19)	C25	C31	1.387(2)
C6	C7	1.394(2)	C26	C27	1.385(2)
C6	C32	1.391(2)	C27	C28	1.385(2)
C7	C8	1.384(2)	C28	C29	1.506(2)
C8	C9	1.392(2)	C28	C30	1.395(2)
C9	C10	1.506(2)	C30	C31	1.383(2)
C9	C33	1.390(2)	C32	C33	1.393(2)
C11	C12	1.388(2)			

Table 5 Bond Angles for 5s.

Atom	Atom	Atom	Angle/°	Atom	Atom	Atom	Angle/°

O1	S1	N1	122.60(6)	C11	C12	C4	121.14(14)
O1	S1	N2	100.99(6)	C14	C13	C5	122.63(13)
O1	S1	C25	108.83(6)	C14	C13	C18	118.07(14)
N1	S1	N2	117.50(7)	C18	C13	C5	119.16(13)
N1	S1	C25	102.13(7)	C15	C14	C13	120.72(15)
N2	S1	C25	103.17(7)	C16	C15	C14	120.56(15)
C5	N1	S1	128.36(10)	C15	C16	C17	119.18(15)
C6	N2	S1	126.98(10)	C16	C17	C18	120.26(15)
C11	C1	C2	119.23(15)	C17	C18	C13	121.15(14)
C1	C2	C3	120.35(15)	C20	C19	C5	120.38(13)
C2	C3	C4	120.97(14)	C24	C19	C5	121.06(13)
C3	C4	C5	122.55(13)	C24	C19	C20	118.28(14)
C3	C4	C12	117.82(14)	C21	C20	C19	120.62(15)
C12	C4	C5	119.54(13)	C22	C21	C20	120.40(15)
N1	C5	C4	104.63(11)	C21	C22	C23	119.45(14)
N1	C5	C13	109.48(11)	C24	C23	C22	120.21(15)
N1	C5	C19	111.17(11)	C23	C24	C19	121.03(15)
C4	C5	C13	110.63(11)	C26	C25	S1	121.12(11)
C19	C5	C4	108.71(11)	C31	C25	S1	118.52(11)
C19	C5	C13	111.97(11)	C31	C25	C26	120.32(14)
C7	C6	N2	117.23(13)	C27	C26	C25	119.38(14)
C32	C6	N2	123.39(14)	C26	C27	C28	121.52(14)
C32	C6	C7	119.29(14)	C27	C28	C29	120.85(14)
C8	C7	C6	120.11(14)	C27	C28	C30	118.01(14)
C7	C8	C9	121.55(15)	C30	C28	C29	121.14(14)
C8	C9	C10	121.07(15)	C31	C30	C28	121.46(14)
C33	C9	C8	117.44(14)	C30	C31	C25	119.31(14)
C33	C9	C10	121.46(15)	C6	C32	C33	119.46(14)
C1	C11	C12	120.46(15)	C9	C33	C32	121.97(15)

Table 6 Torsion Angles for 5s.

A	B	C	D	Angle/°	A	B	C	D	Angle/°
S1	N1	C5	C4	-175.66(10)	C5	C19	C24	C23	174.60(13)
S1	N1	C5	C13	-57.07(16)	C6	C7	C8	C9	1.4(2)
S1	N1	C5	C19	67.17(16)	C6	C32	C33	C9	1.2(2)
S1	N2	C6	C7	-160.21(12)	C7	C6	C32	C33	-3.7(2)
S1	N2	C6	C32	23.2(2)	C7	C8	C9	C10	174.26(15)
S1	C25	C26	C27	177.82(11)	C7	C8	C9	C33	-3.9(2)
S1	C25	C31	C30	-177.51(12)	C8	C9	C33	C32	2.6(2)
O1	S1	N1	C5	-50.83(15)	C10	C9	C33	C32	-175.53(14)
O1	S1	N2	C6	176.55(12)	C11	C1	C2	C3	-1.7(2)
O1	S1	C25	C26	-117.02(12)	C12	C4	C5	N1	39.46(17)
O1	S1	C25	C31	60.89(13)	C12	C4	C5	C13	-78.35(16)
N1	S1	N2	C6	40.50(15)	C12	C4	C5	C19	158.31(13)
N1	S1	C25	C26	13.95(14)	C13	C5	C19	C20	-36.17(18)
N1	S1	C25	C31	-168.15(12)	C13	C5	C19	C24	150.04(13)
N1	C5	C13	C14	-99.73(16)	C13	C14	C15	C16	0.2(2)
N1	C5	C13	C18	75.75(16)	C14	C13	C18	C17	2.3(2)
N1	C5	C19	C20	-158.99(13)	C14	C15	C16	C17	1.5(2)
N1	C5	C19	C24	27.23(18)	C15	C16	C17	C18	-1.3(2)
N2	S1	N1	C5	75.20(13)	C16	C17	C18	C13	-0.6(2)
N2	S1	C25	C26	136.32(12)	C18	C13	C14	C15	-2.1(2)
N2	S1	C25	C31	-45.77(13)	C19	C5	C13	C14	136.50(14)
N2	C6	C7	C8	-174.22(14)	C19	C5	C13	C18	-48.02(17)
N2	C6	C32	C33	172.77(14)	C19	C20	C21	C22	-0.9(2)
C1	C2	C3	C4	1.0(2)	C20	C19	C24	C23	0.7(2)
C1	C11	C12	C4	0.9(2)	C20	C21	C22	C23	0.4(2)
C2	C1	C11	C12	0.7(2)	C21	C22	C23	C24	0.7(2)
C2	C3	C4	C5	-176.05(14)	C22	C23	C24	C19	-1.2(2)
C2	C3	C4	C12	0.6(2)	C24	C19	C20	C21	0.4(2)
C3	C4	C5	N1	-143.92(13)	C25	S1	N1	C5	-172.80(12)

C3	C4	C5	C13	98.27(16)	C25	S1	N2	C6	-70.92(13)
C3	C4	C5	C19	-25.07(18)	C25	C26	C27	C28	-0.4(2)
C3	C4	C12	C11	-1.6(2)	C26	C25	C31	C30	0.4(2)
C4	C5	C13	C14	15.07(19)	C26	C27	C28	C29	179.73(15)
C4	C5	C13	C18	-169.45(12)	C26	C27	C28	C30	0.4(2)
C4	C5	C19	C20	86.36(16)	C27	C28	C30	C31	0.0(2)
C4	C5	C19	C24	-87.43(16)	C28	C30	C31	C25	-0.4(2)
C5	C4	C12	C11	175.21(14)	C29	C28	C30	C31	-179.35(15)
C5	C13	C14	C15	173.44(14)	C31	C25	C26	C27	0.0(2)
C5	C13	C18	C17	-173.37(13)	C32	C6	C7	C8	2.5(2)
C5	C19	C20	C21	-173.59(14)					

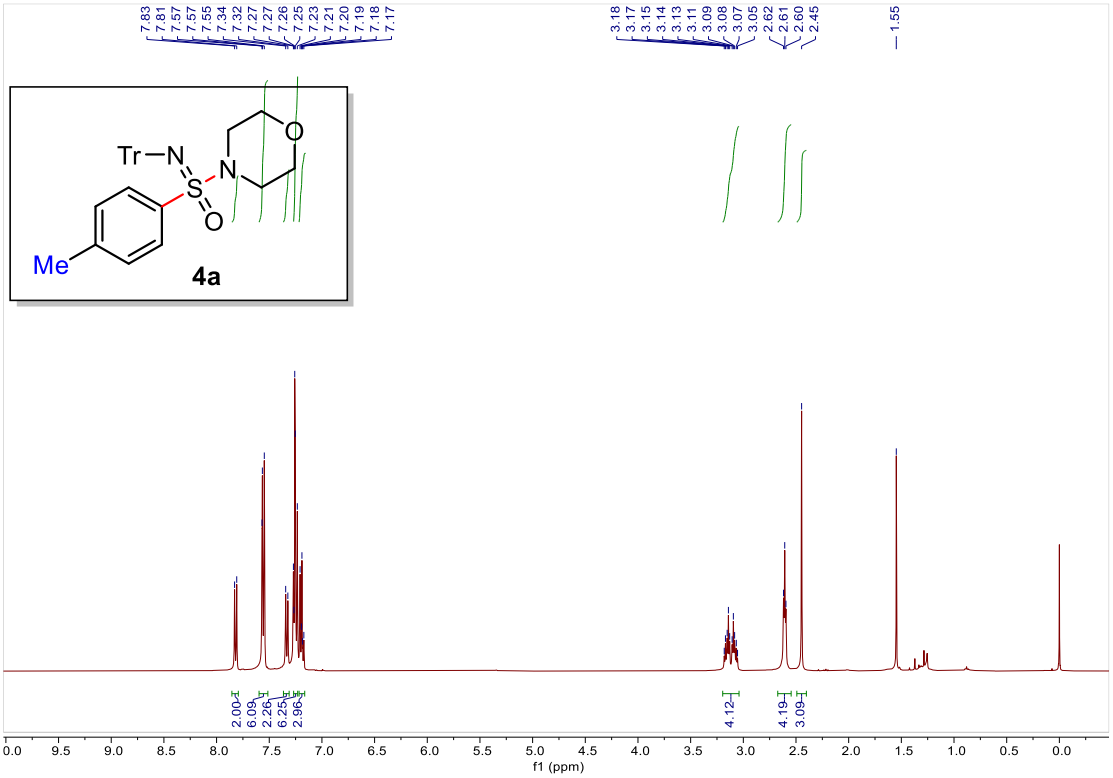
Table 7 Hydrogen Atom Coordinates (Å × 10^4) and Isotropic Displacement Parameters (Å^2×10^3) for 5s.

Atom	*x*	*y*	*z*	U(eq)
H2	3895.24	3853.56	9398.35	40
H1	5927.89	1117.85	2950.54	47
H2A	7105.42	3112.64	3764.84	48
H3	7025.08	4325.38	5517.61	44
H7	1238.19	3539.48	8417.64	45
H8	-982.16	2161.56	7254.95	48
H10A	-1683.43	-434.46	6553.54	67
H10B	-1234.26	-813.69	5433.68	67
H10C	-2243.37	205.52	5616.27	67
H11	4778.1	327.23	3950.04	47
H12	4752.48	1519.02	5723.94	43
H14	3056.36	3043.38	5004.89	45
H15	607.19	3472.37	4741.68	51
H16	147.97	4868.7	6242.02	49
H17	2185.73	5895.23	7987.51	45
H18	4634.99	5478.76	8249.81	42

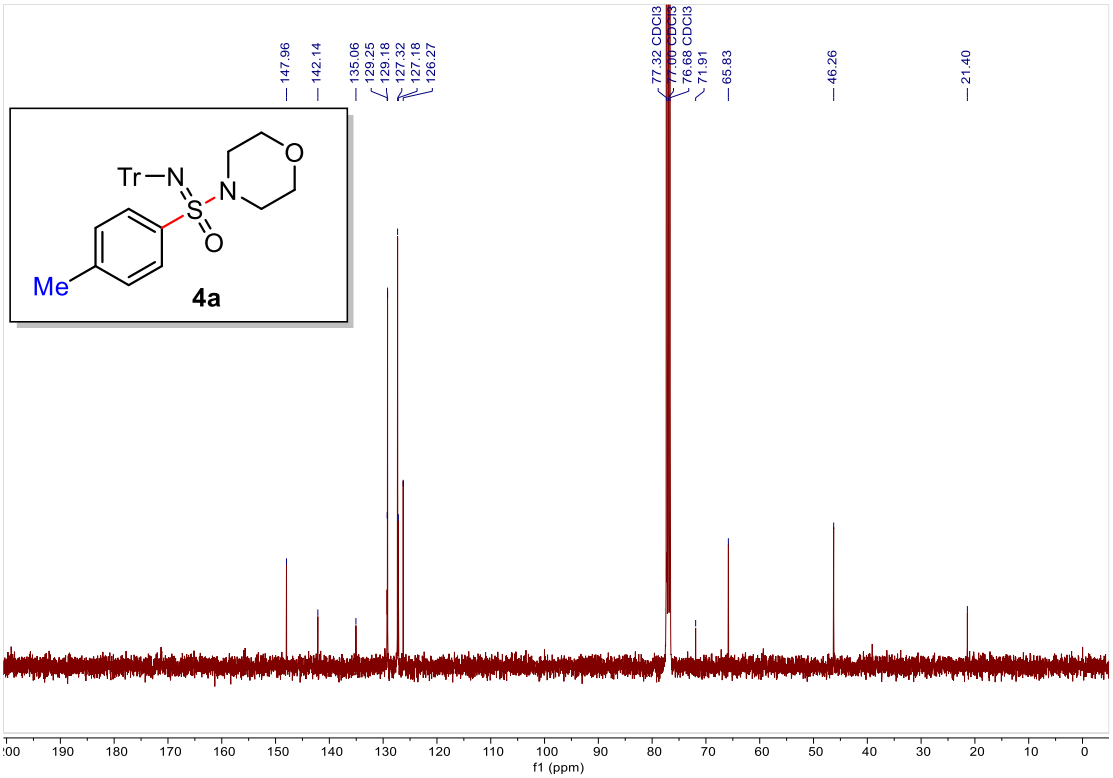
H20	5805.2	5989.23	6693.8	45
H21	7816.92	7576.08	7431.59	51
H22	10189.93	7514.58	8733.52	52
H23	10550.69	5843.96	9282.65	47
H24	8571.69	4235.07	8506.02	42
H26	7293.65	1481.15	7977.45	42
H27	8149.95	-83.96	8567.29	45
H29A	7150.34	-1462.5	9895.29	71
H29B	8289.02	-538.54	11118.64	71
H29C	8843.62	-976.38	10053.73	71
H30	6490.24	899.1	11115.5	46
H31	5601.27	2456.4	10527.28	43
H32	3727.52	1108.74	7345.73	43
H33	1488.9	-280.32	6239.57	45

3 Copies of NMR Spectra

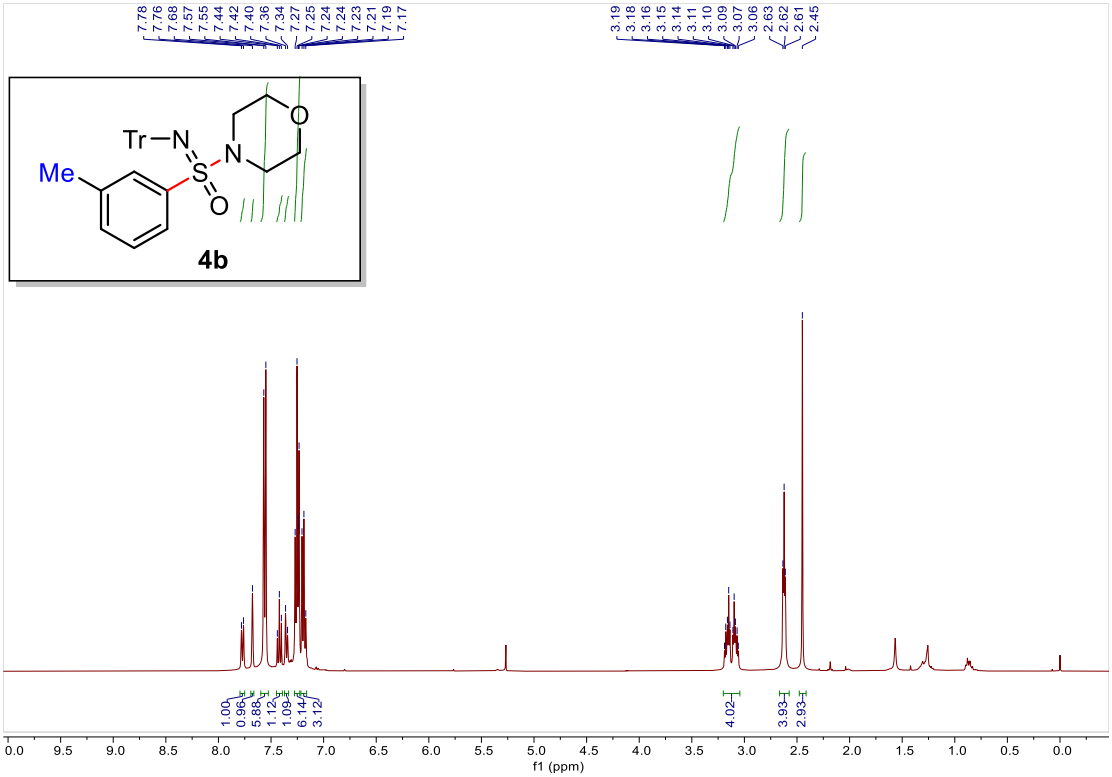
^{1}H NMR (400 MHz, $CDCl_3$) of 4a



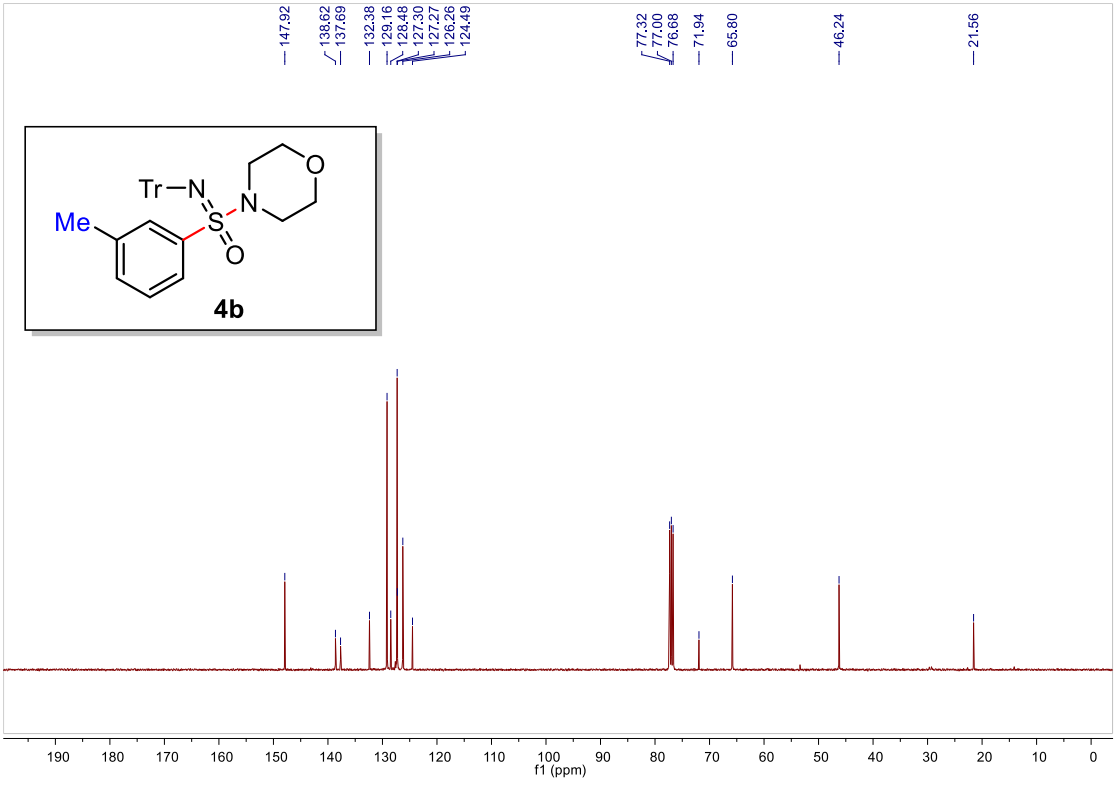
^{13}C NMR (101 MHz, $CDCl_3$) of 4a



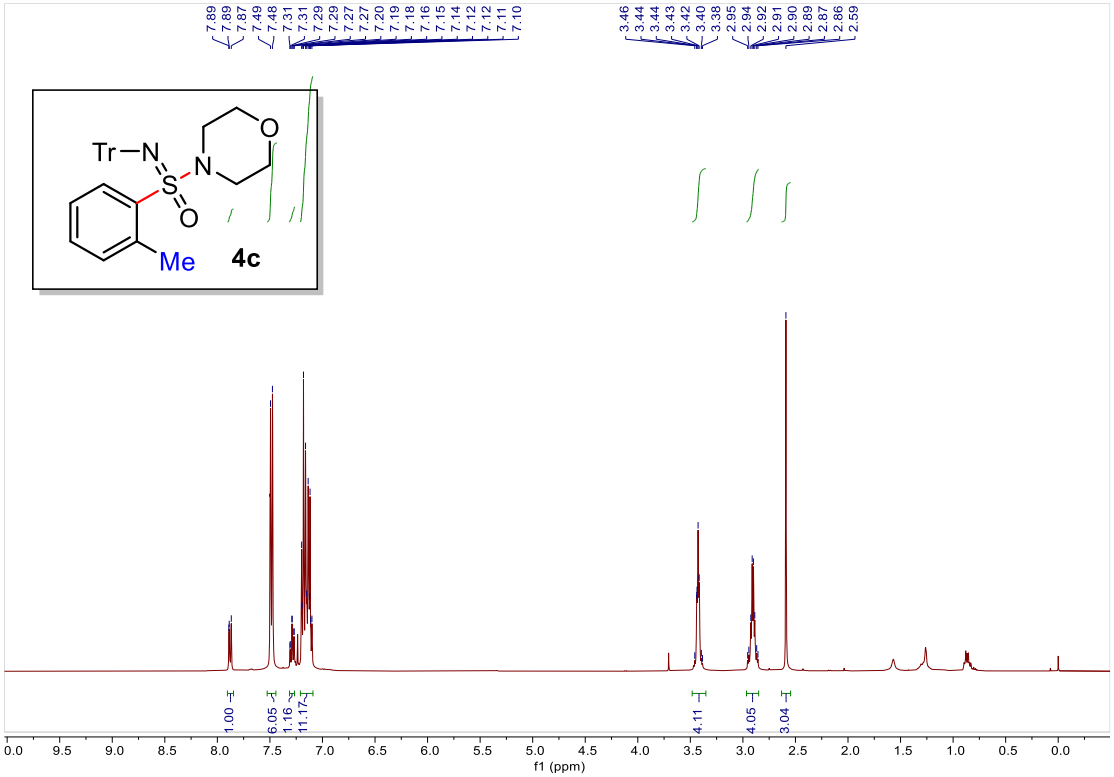
^{1}H NMR (400 MHz, $CDCl_3$) of **4b**



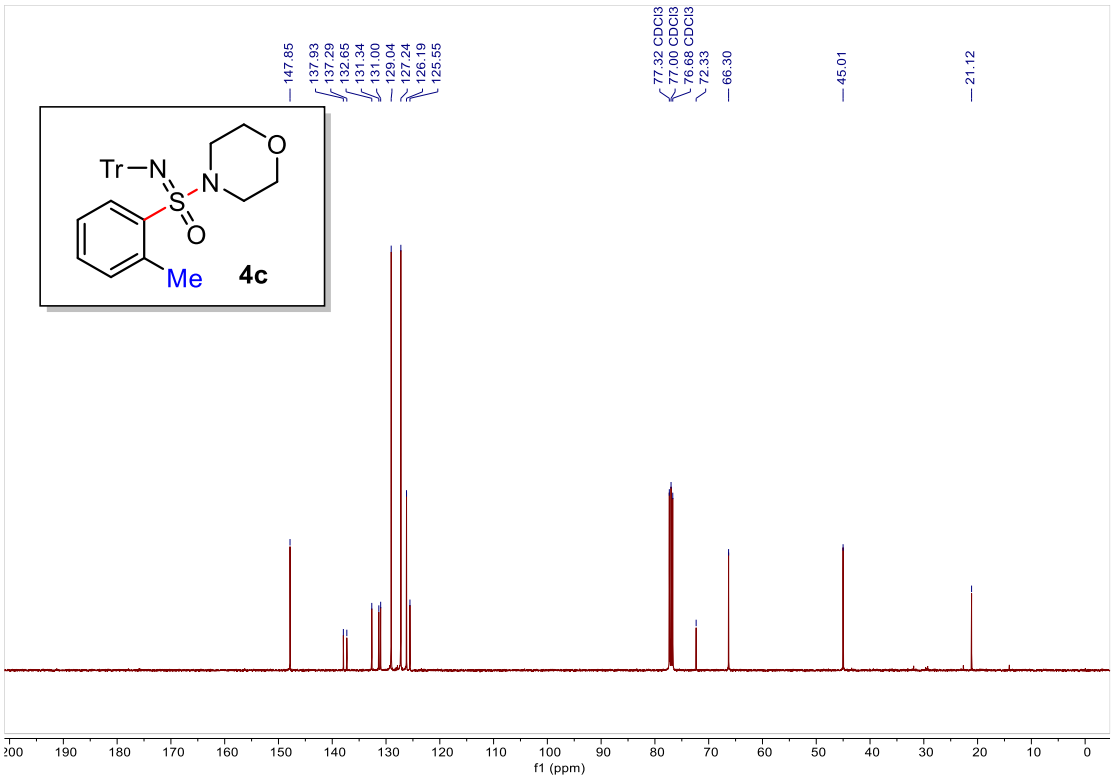
^{13}C NMR (101 MHz, $CDCl_3$) of **4b**



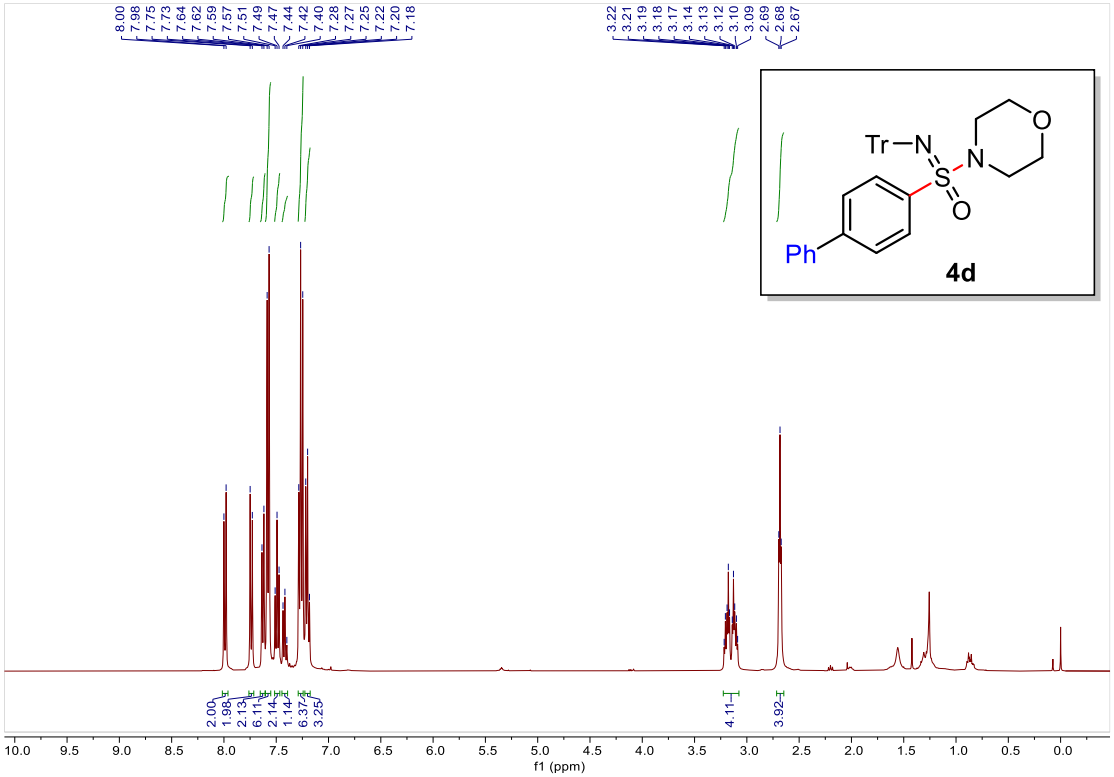
^{1}H NMR (400 MHz, $CDCl_3$) of **4c**



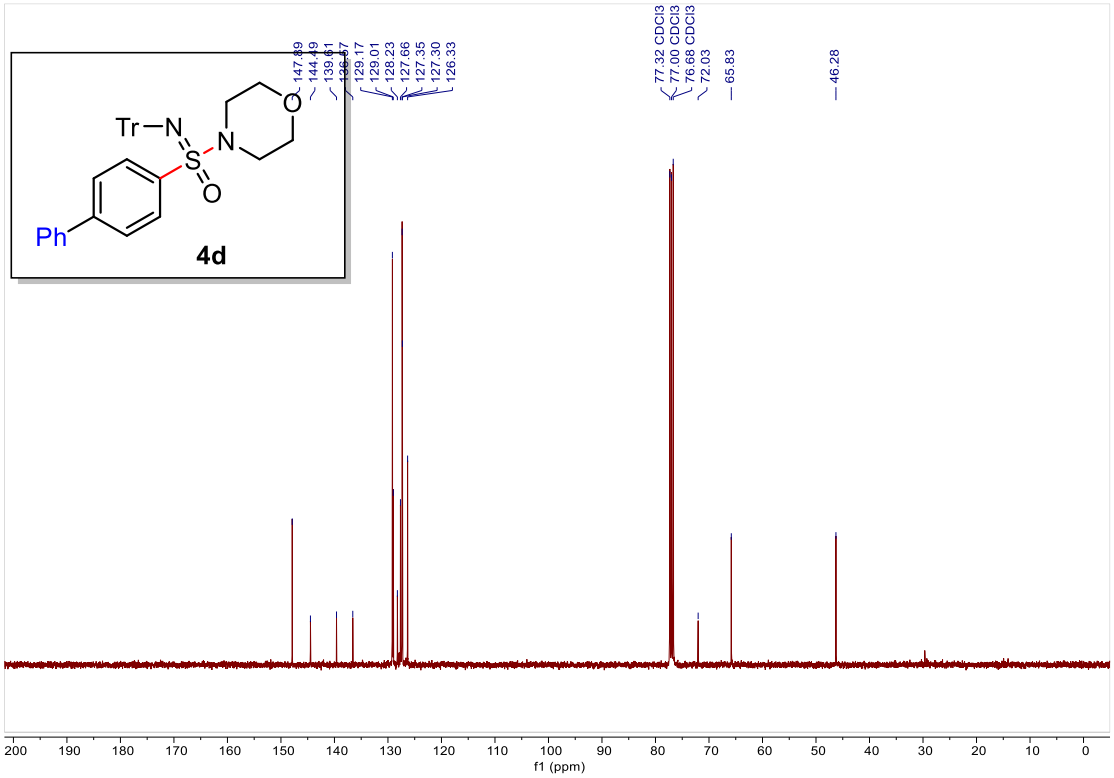
^{13}C NMR (101 MHz, $CDCl_3$) of **4c**



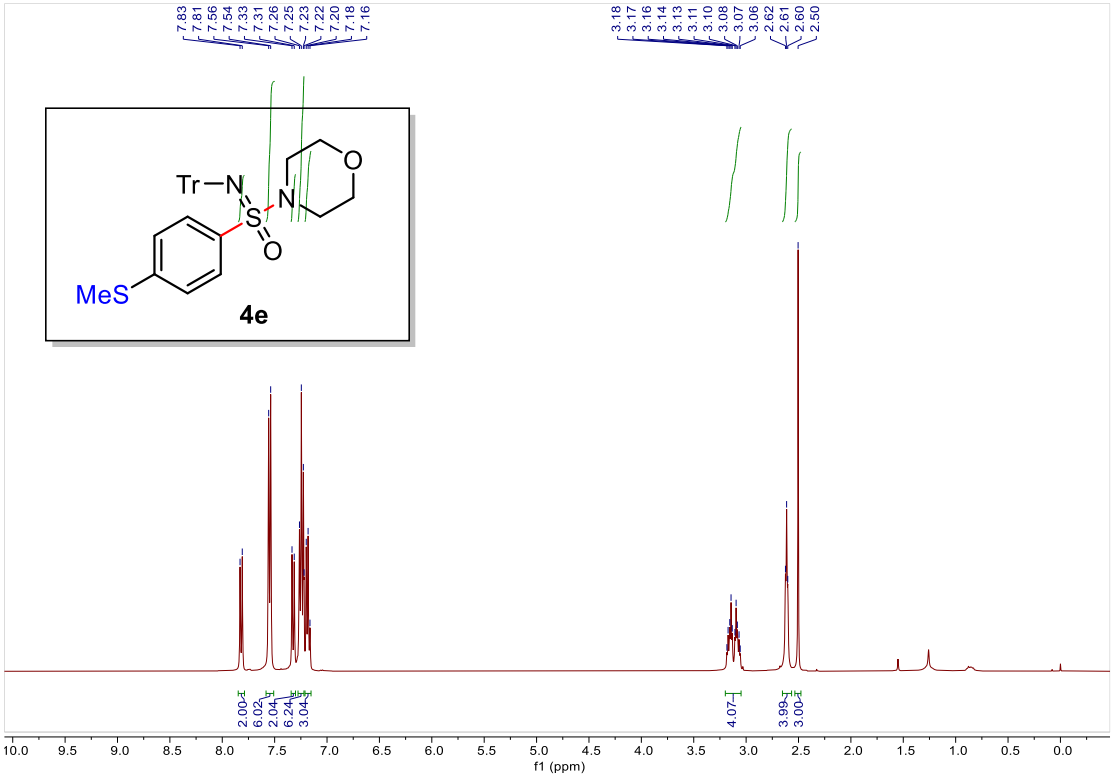
^{1}H NMR (400 MHz, $CDCl_3$) of **4d**



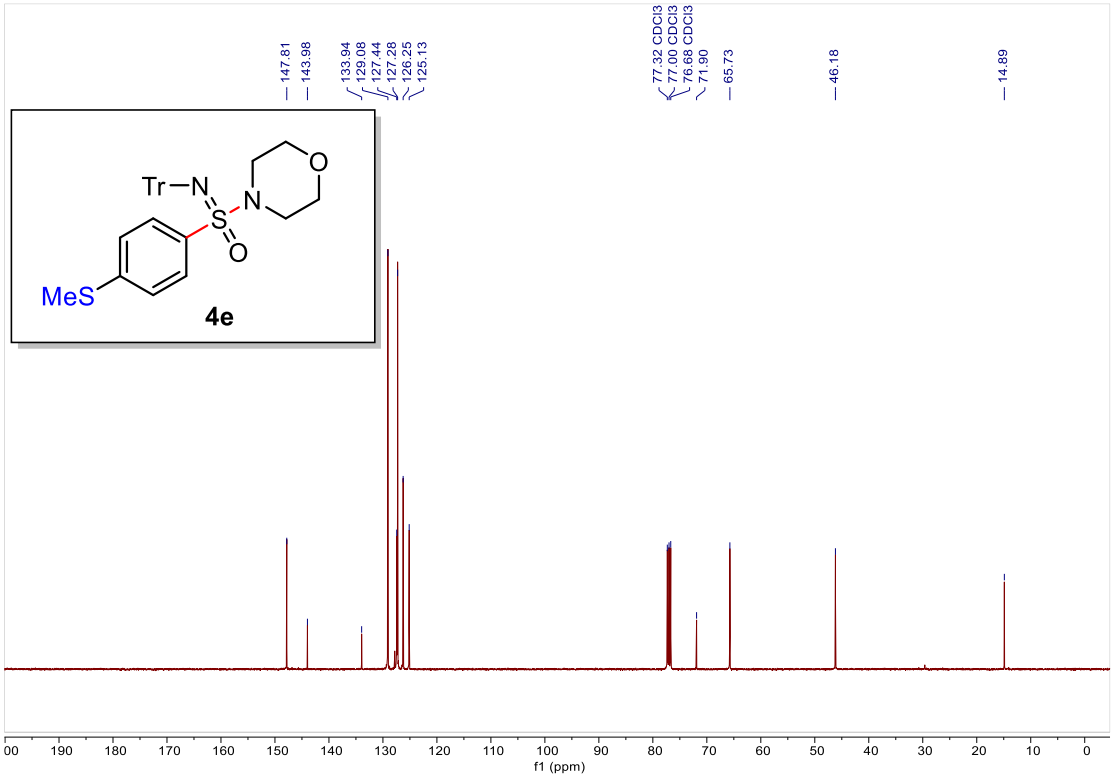
^{13}C NMR (101 MHz, $CDCl_3$) of **4d**



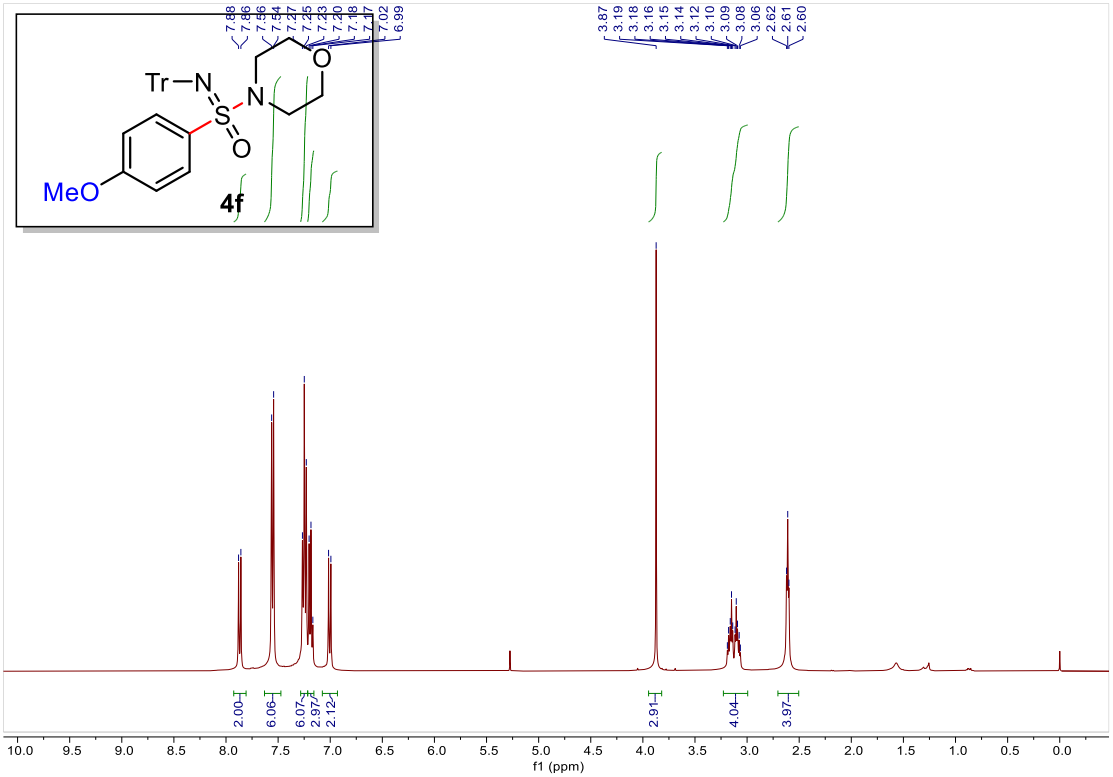
^{1}H NMR (400 MHz, $CDCl_3$) of 4e



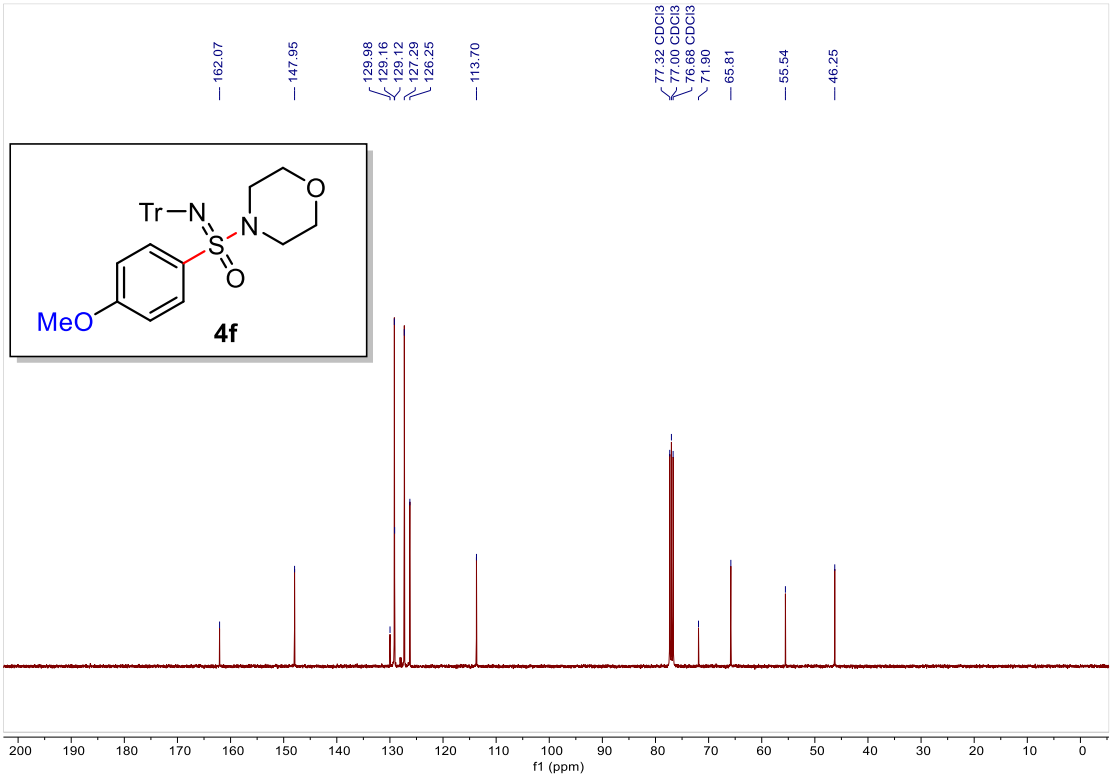
^{13}C NMR (101 MHz, $CDCl_3$) of 4e



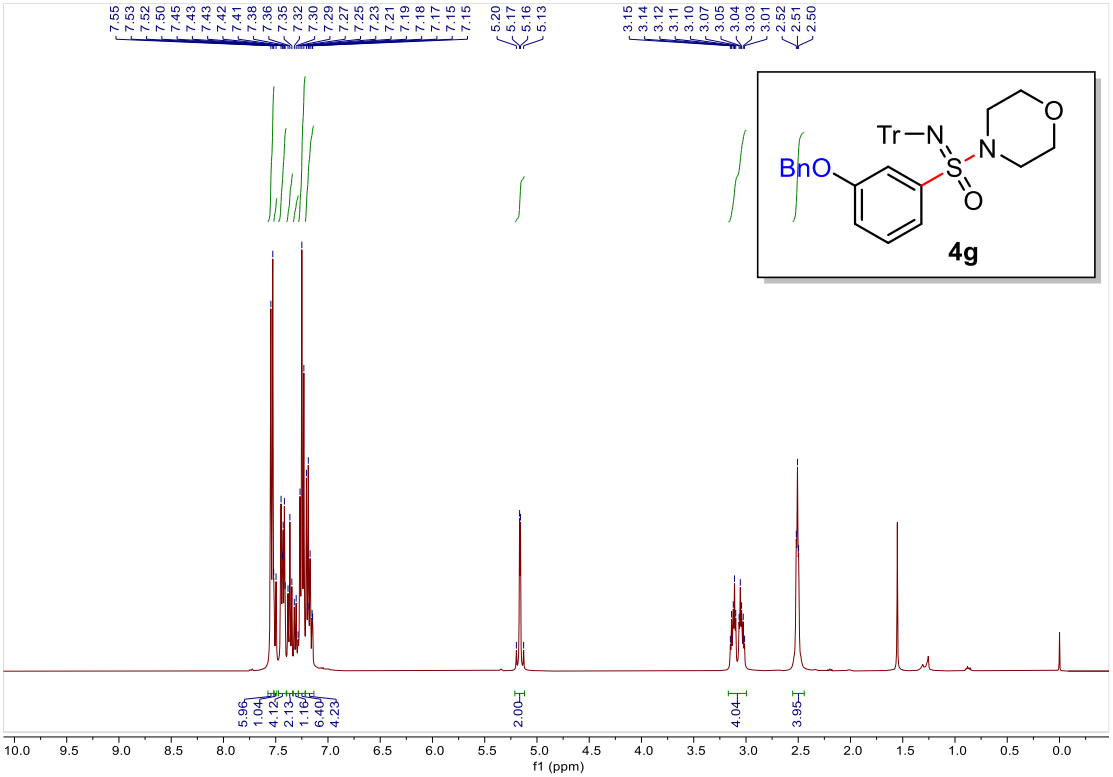
^{1}H NMR (400 MHz, $CDCl_3$) of **4f**



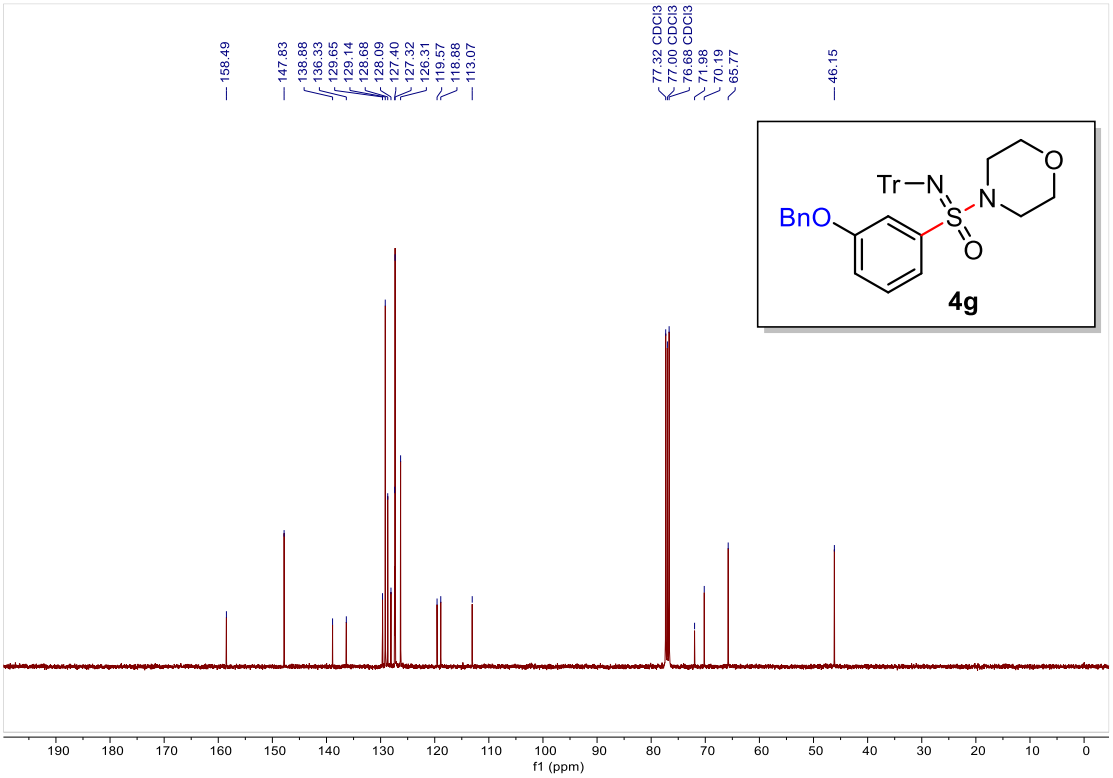
^{13}C NMR (101 MHz, $CDCl_3$) of **4f**



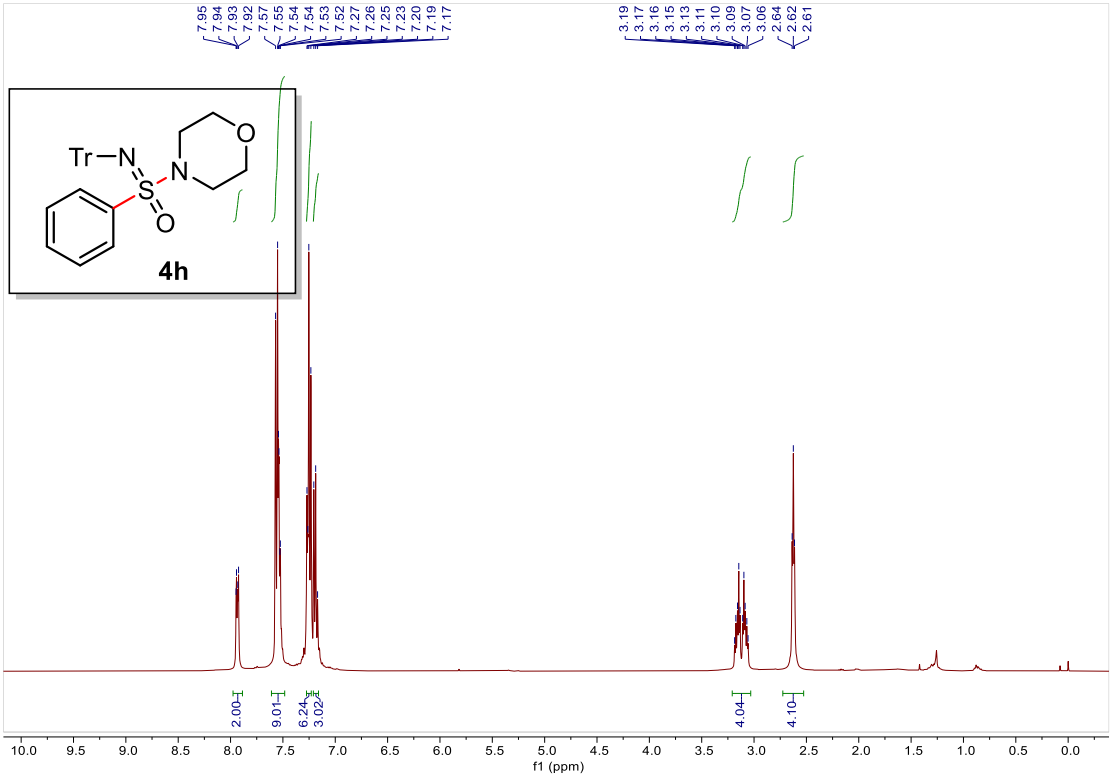
^{1}H NMR (400 MHz, $CDCl_3$) of 4g



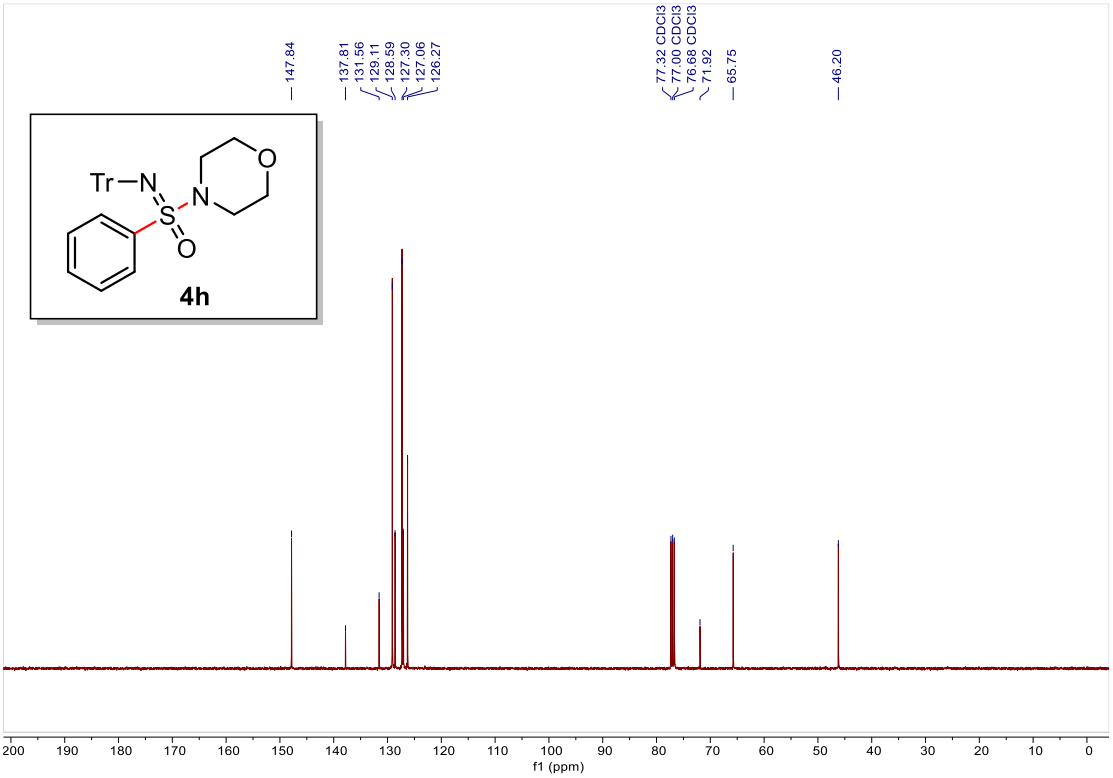
^{13}C NMR (101 MHz, $CDCl_3$) of 4g



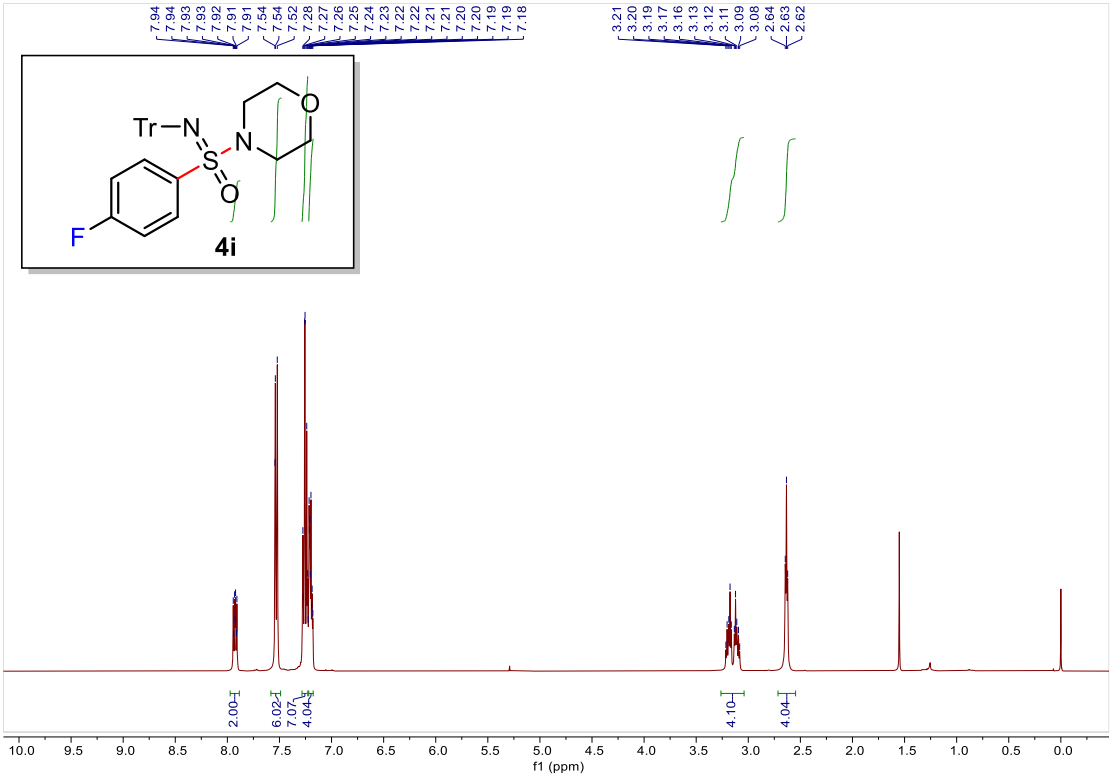
^{1}H NMR (400 MHz, $CDCl_3$) of **4h**



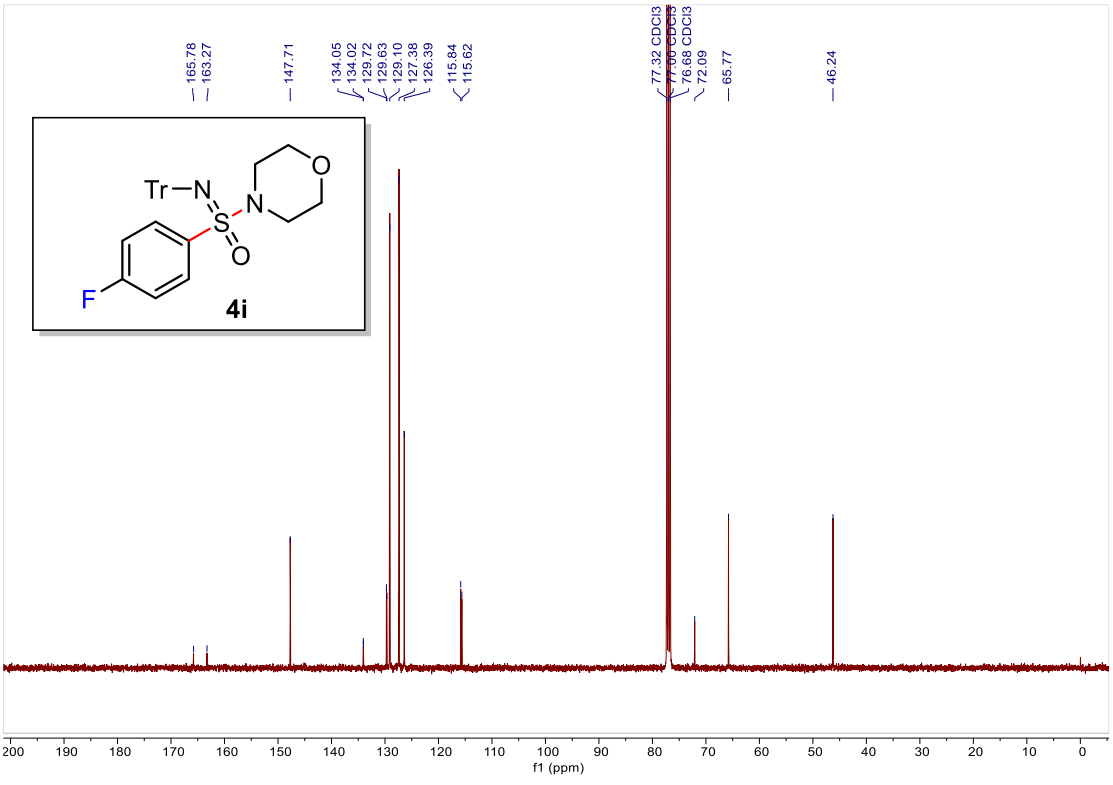
^{13}C NMR (101 MHz, $CDCl_3$) of **4h**



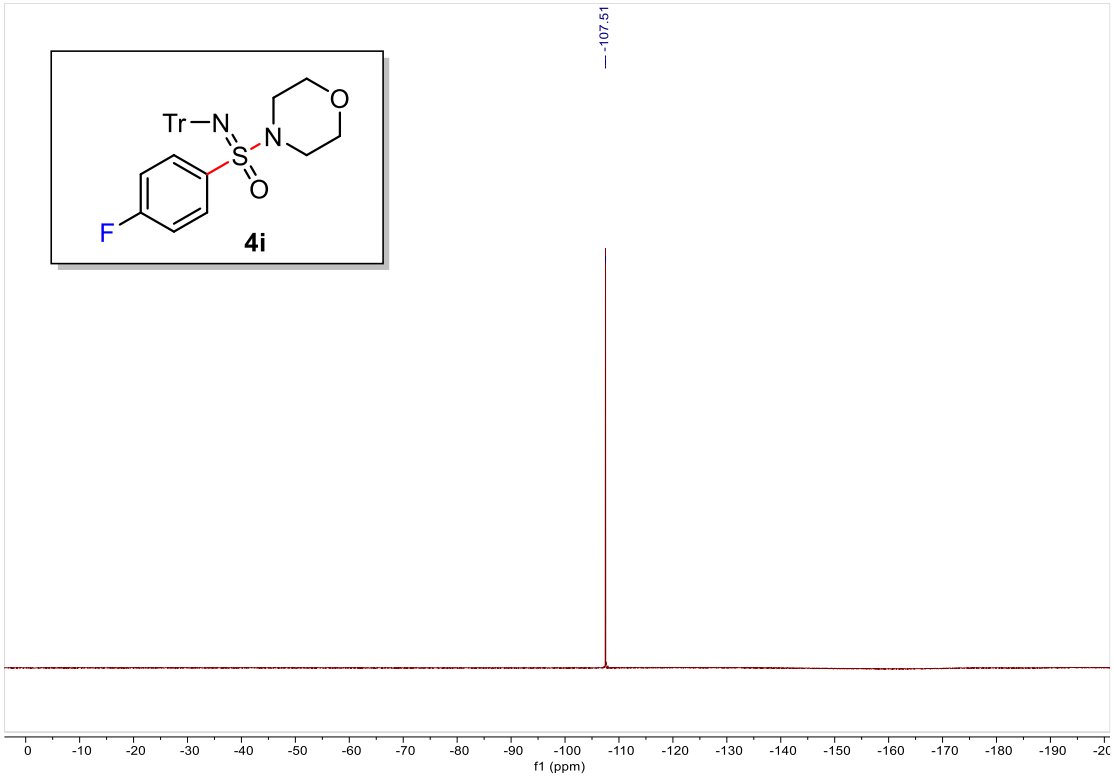
^{1}H NMR (400 MHz, $CDCl_3$) of 4i



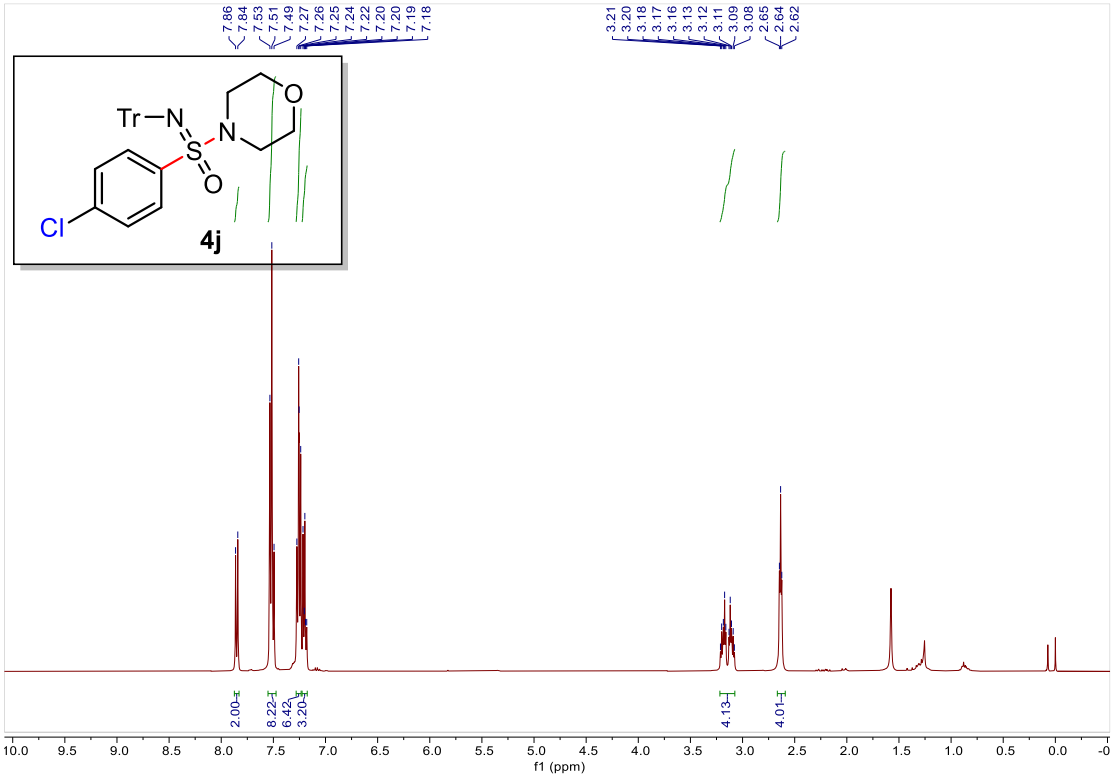
^{13}C NMR (101 MHz, $CDCl_3$) of 4i



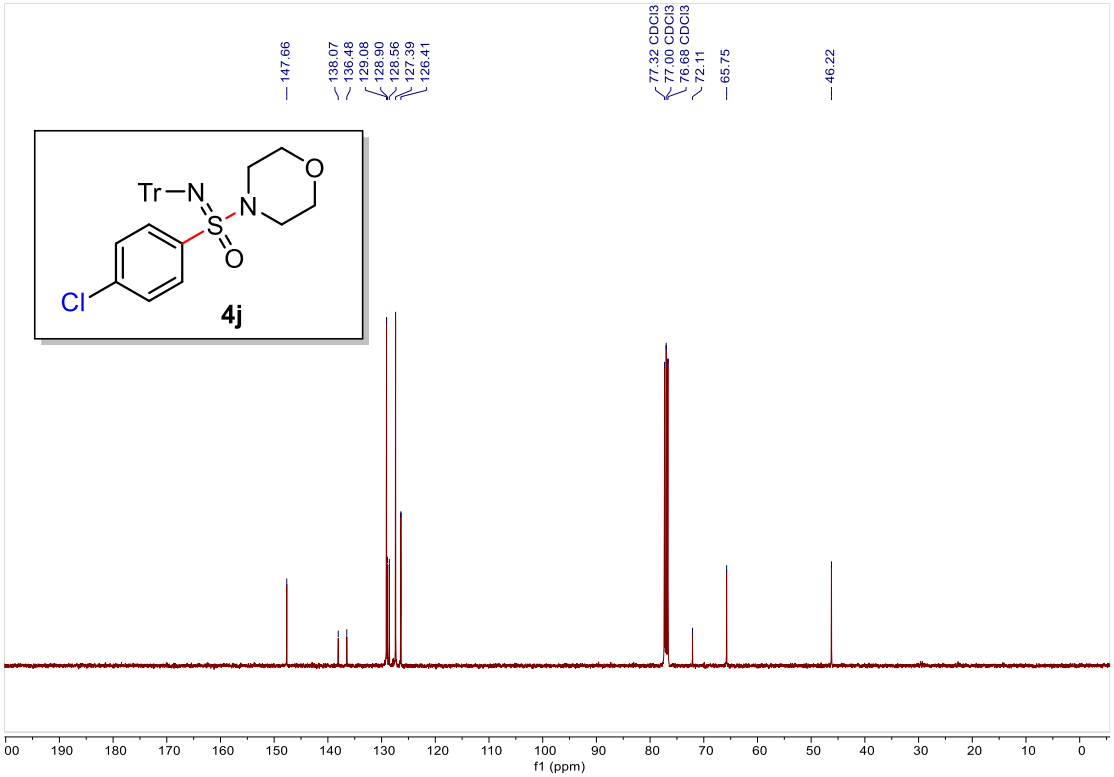
^{19}F NMR (377 MHz, $CDCl_3$) of 4i



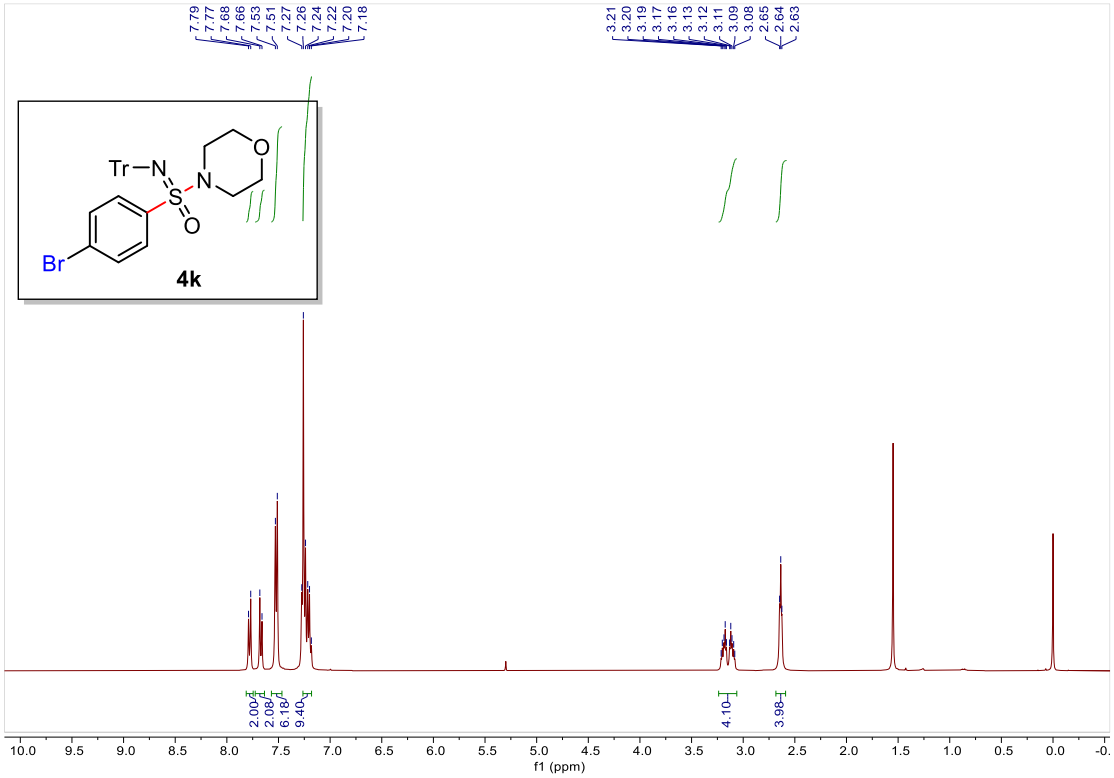
^{1}H NMR (400 MHz, $CDCl_3$) of 4j



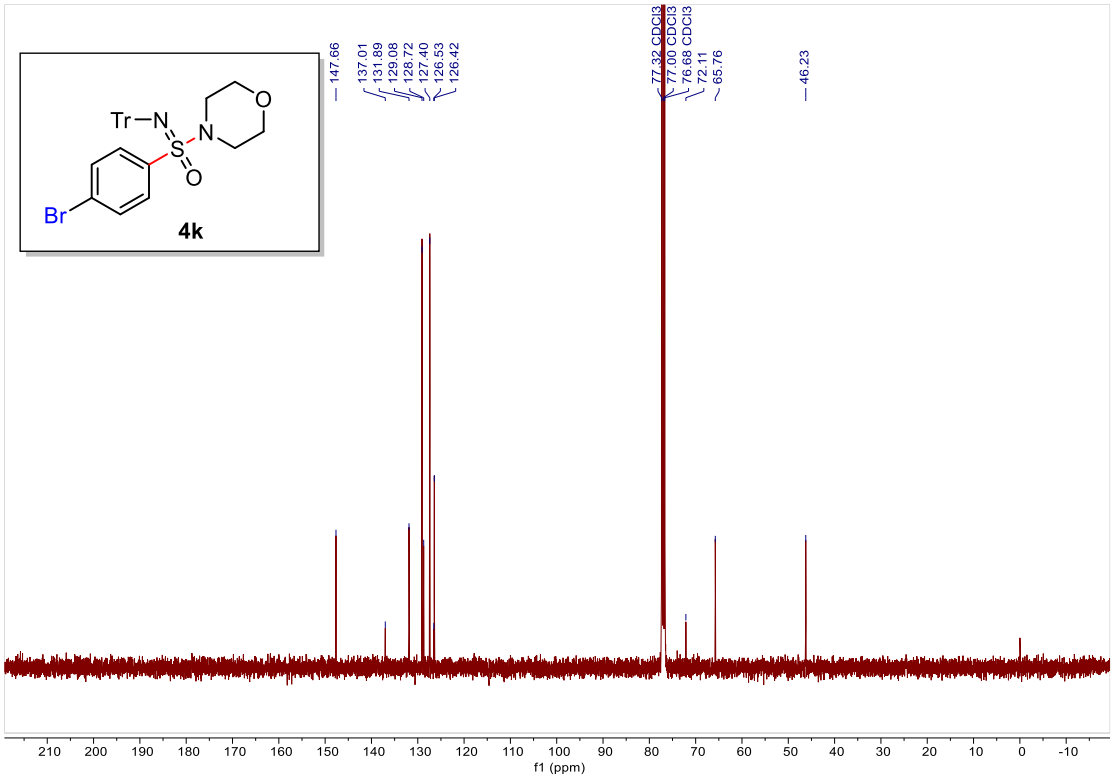
^{13}C NMR (101 MHz, $CDCl_3$) of 4j



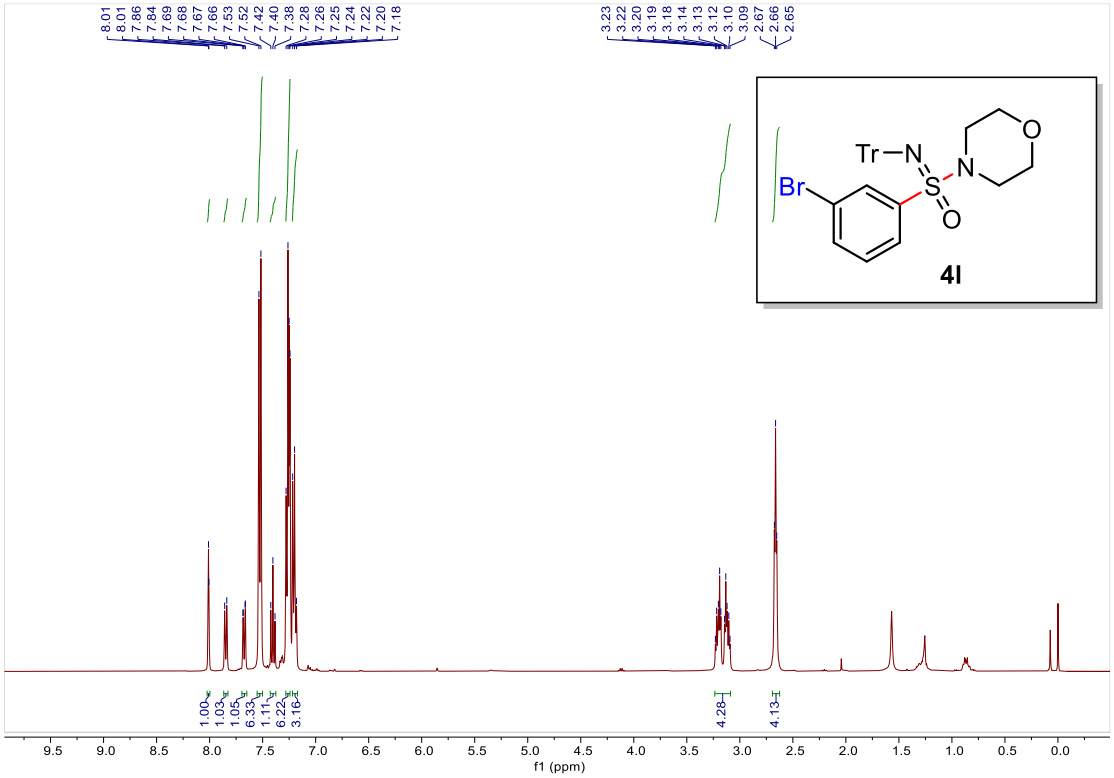
^{1}H NMR (400 MHz, $CDCl_3$) of 4k



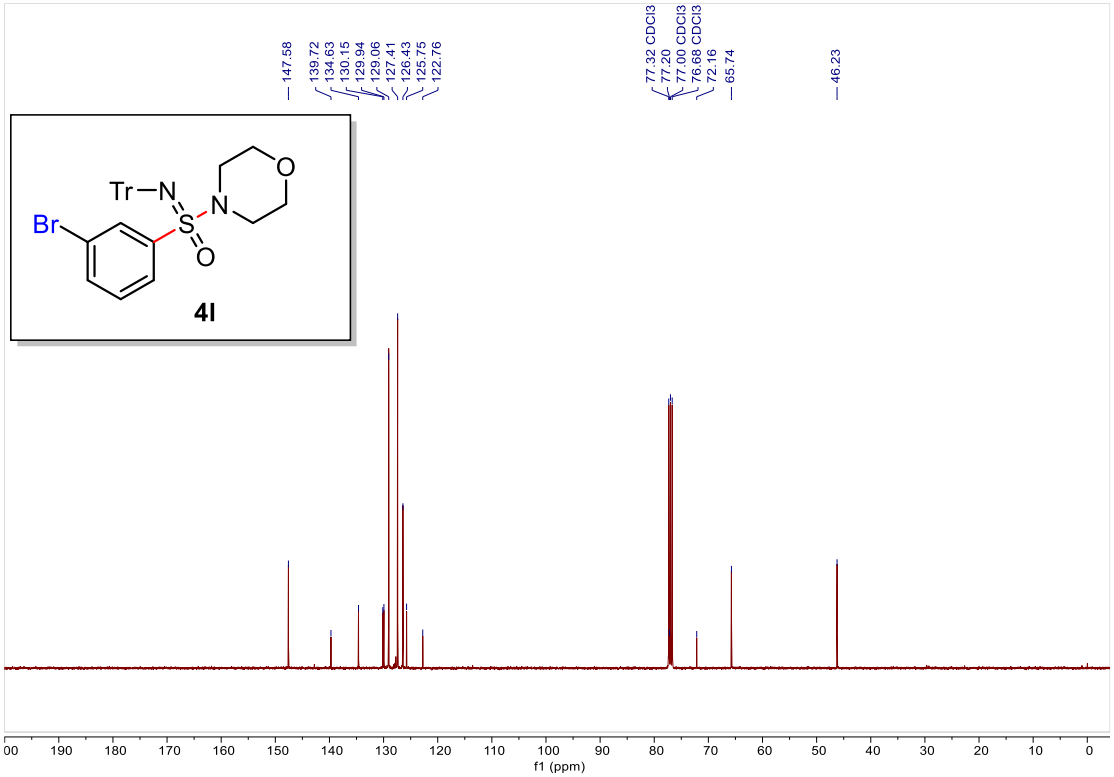
^{13}C NMR (101 MHz, $CDCl_3$) of 4k



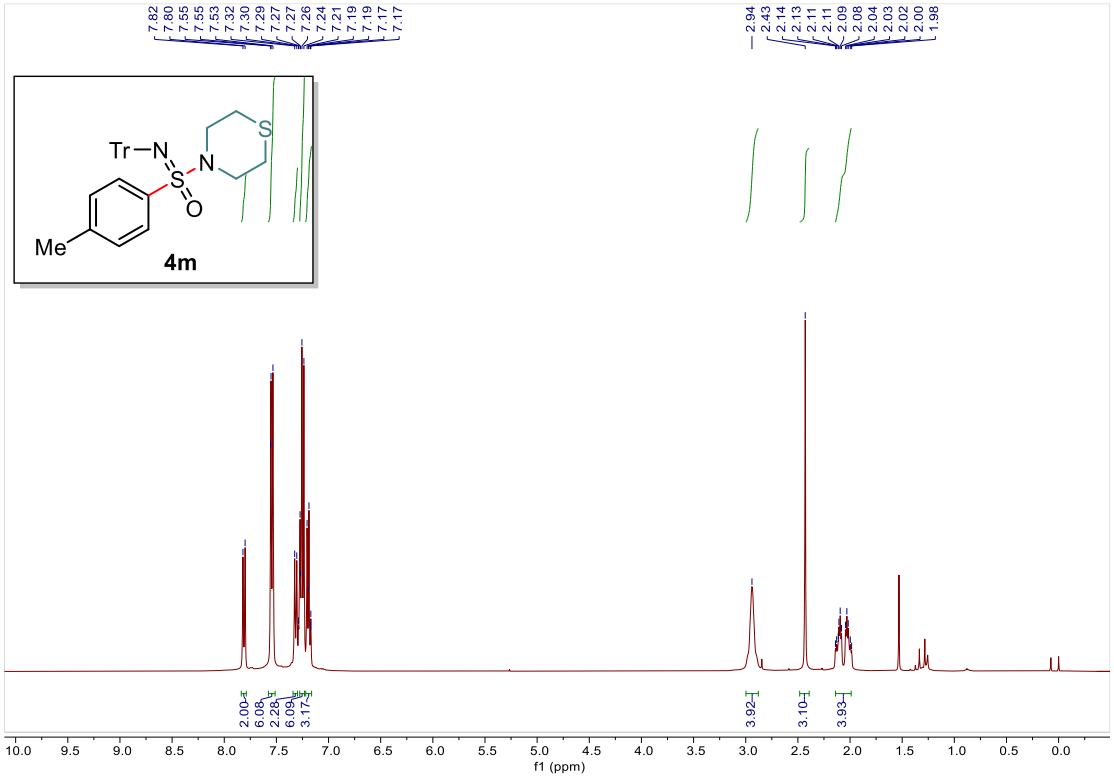
^{1}H NMR (400 MHz, $CDCl_3$) of 4l



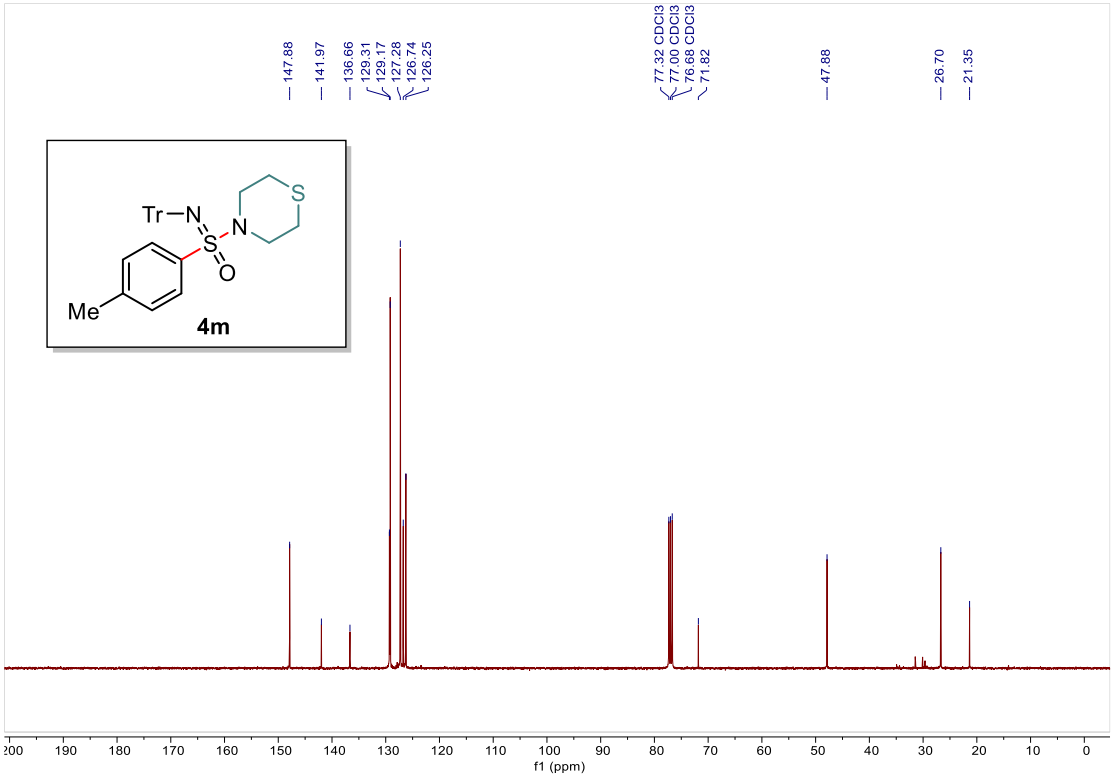
^{13}C NMR (101 MHz, $CDCl_3$) of **4l**



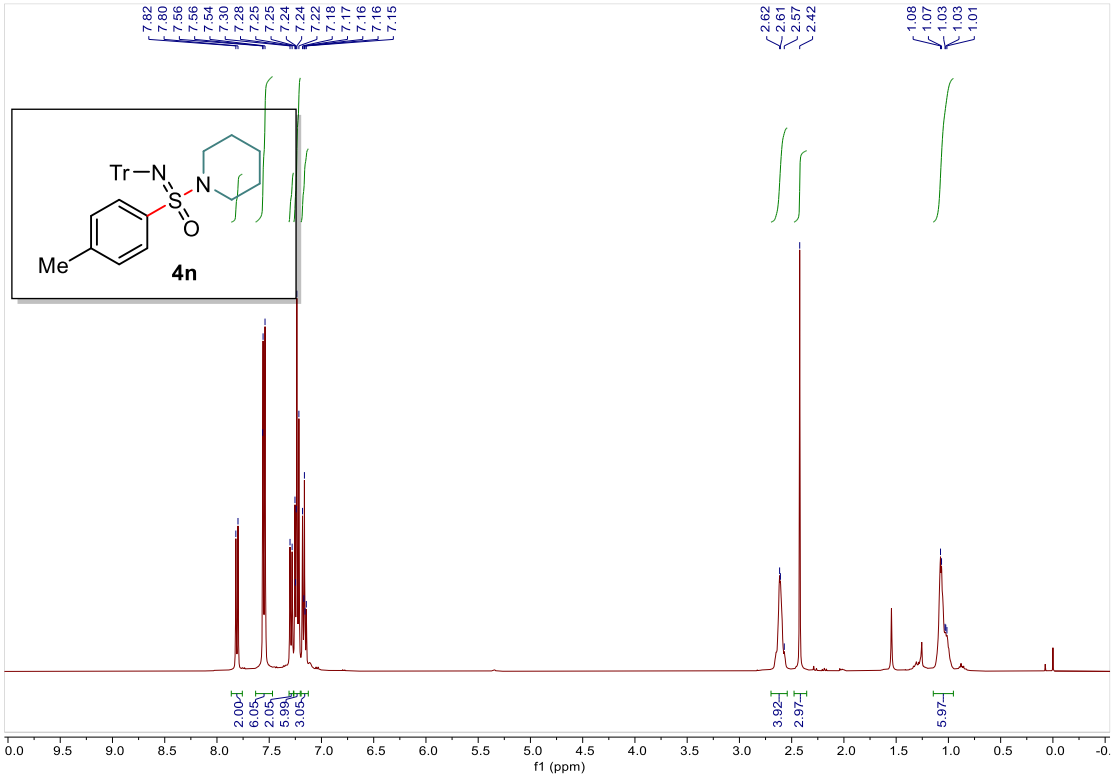
^{1}H NMR (400 MHz, $CDCl_3$) of **4m**



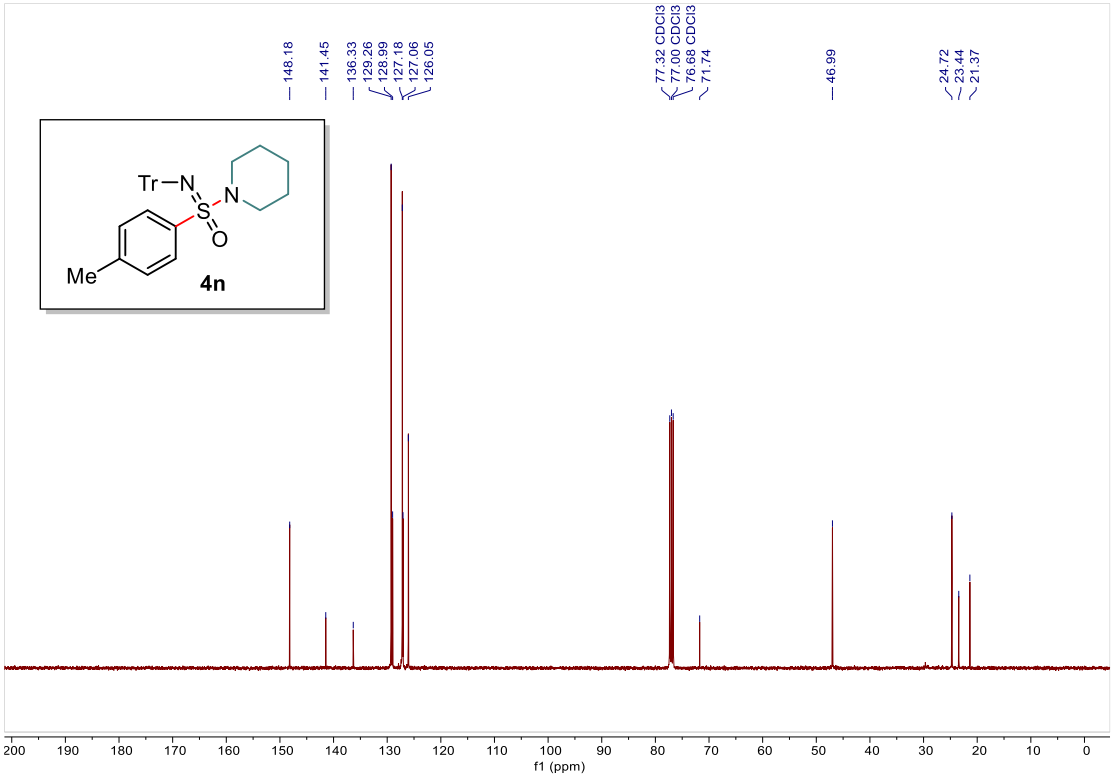
^{13}C NMR (101 MHz, $CDCl_3$) of **4m**



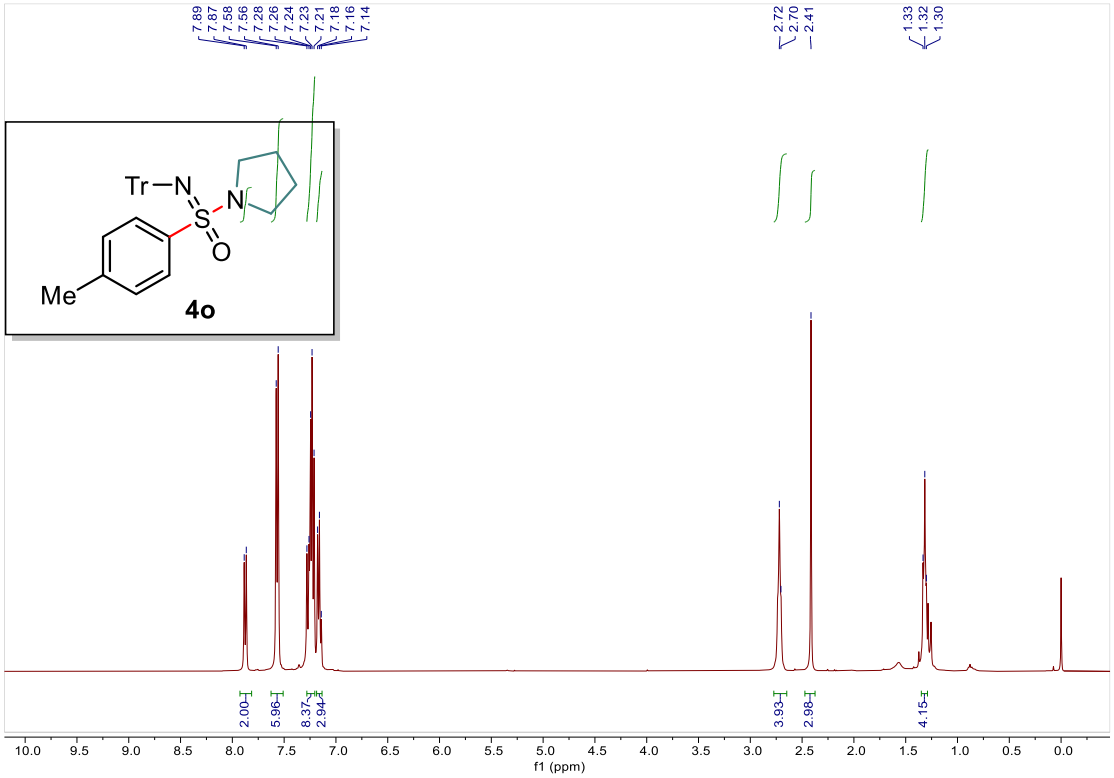
^{1}H NMR (400 MHz, $CDCl_3$) of **4n**



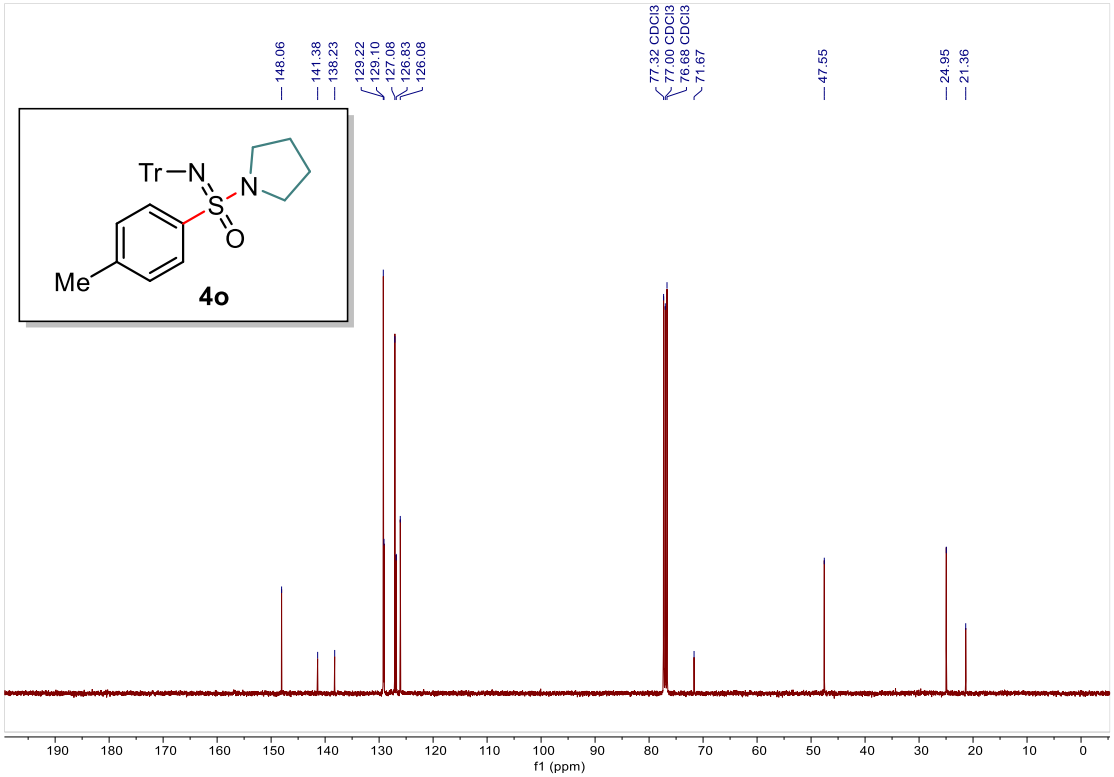
^{13}C NMR (101 MHz, $CDCl_3$) of **4n**



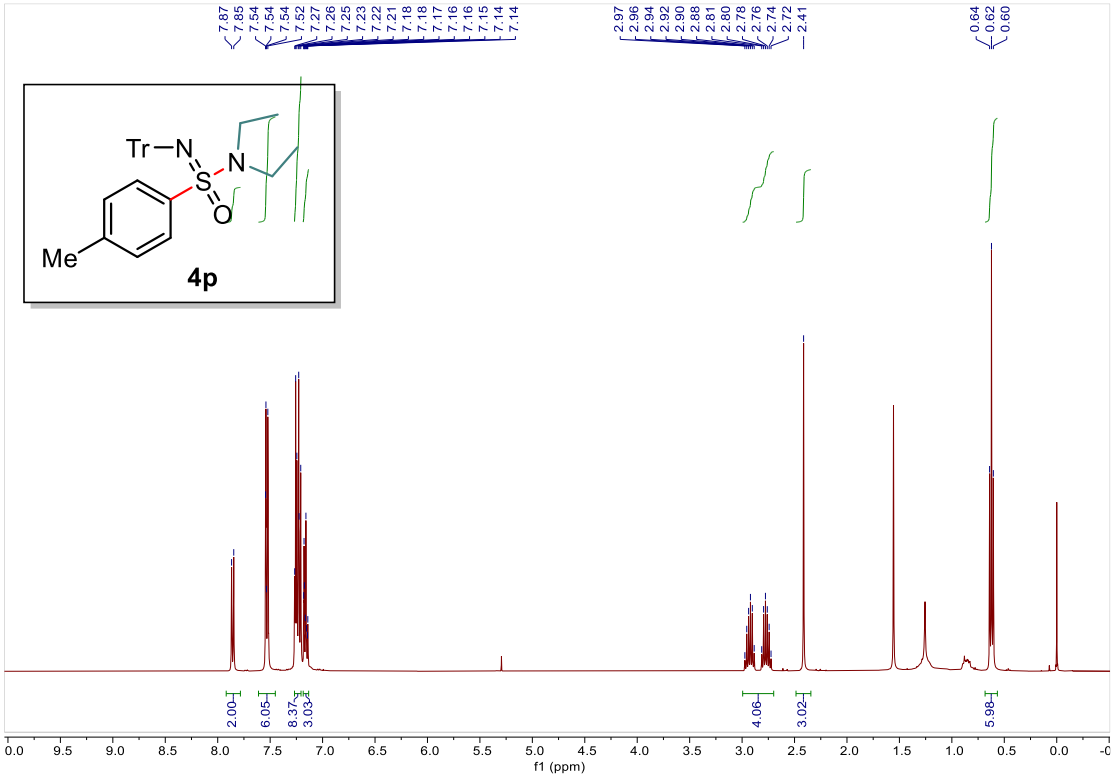
^{1}H NMR (400 MHz, $CDCl_3$) of **4o**



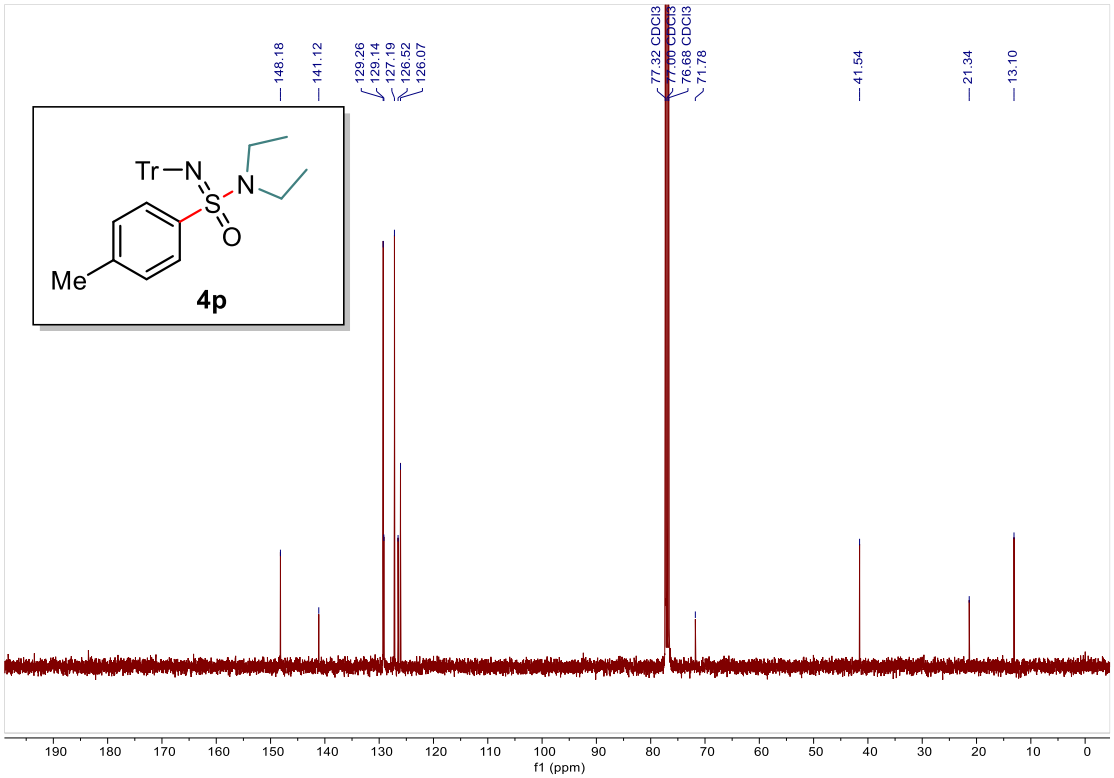
^{1}H NMR (400 MHz, $CDCl_3$) of **4o**



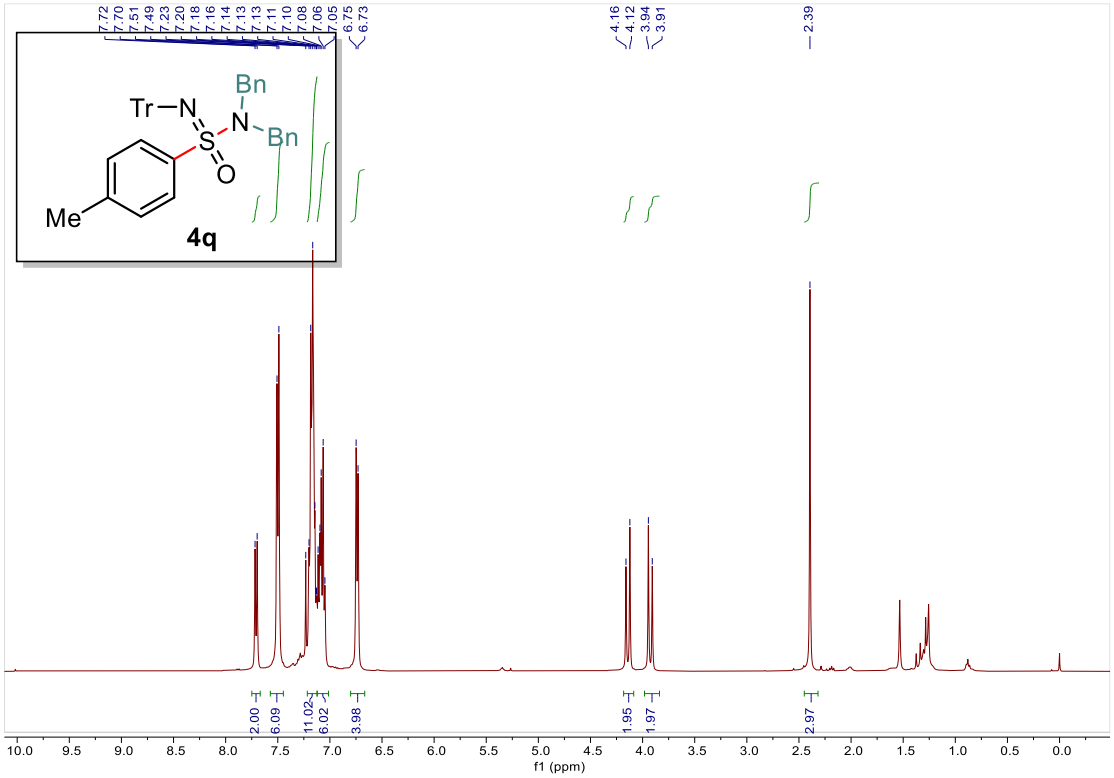
^{1}H NMR (400 MHz, $CDCl_3$) of **4p**



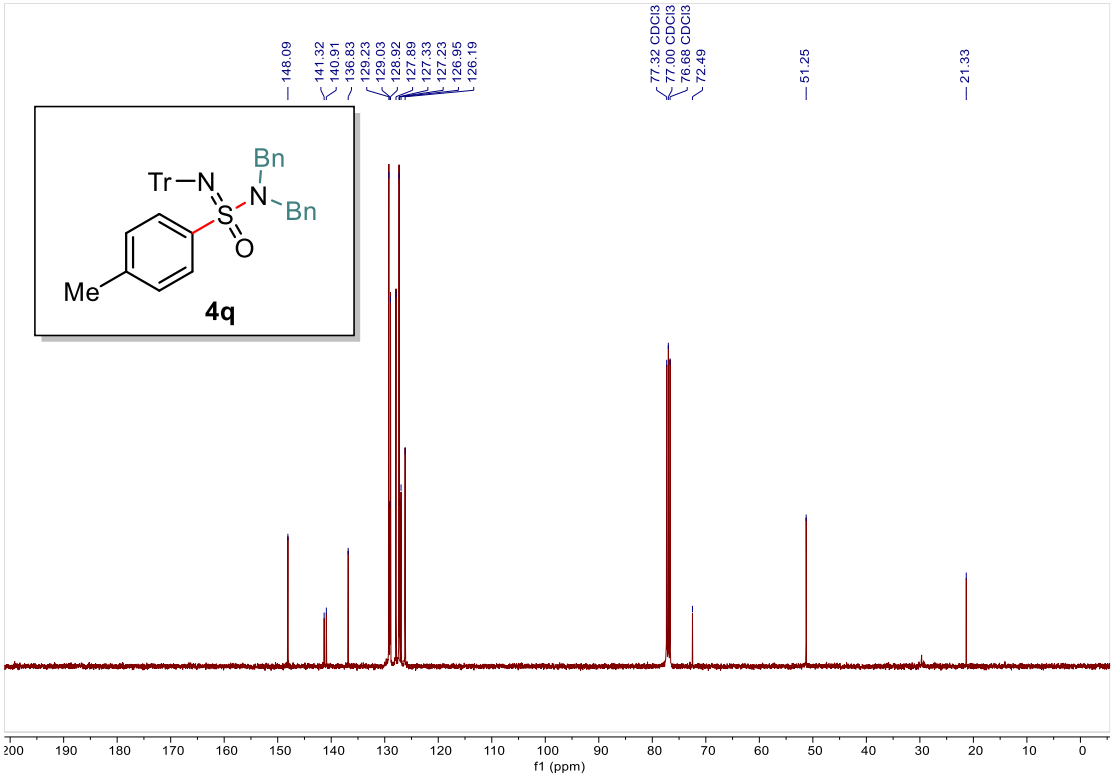
^{1}H NMR (400 MHz, $CDCl_3$) of **4p**



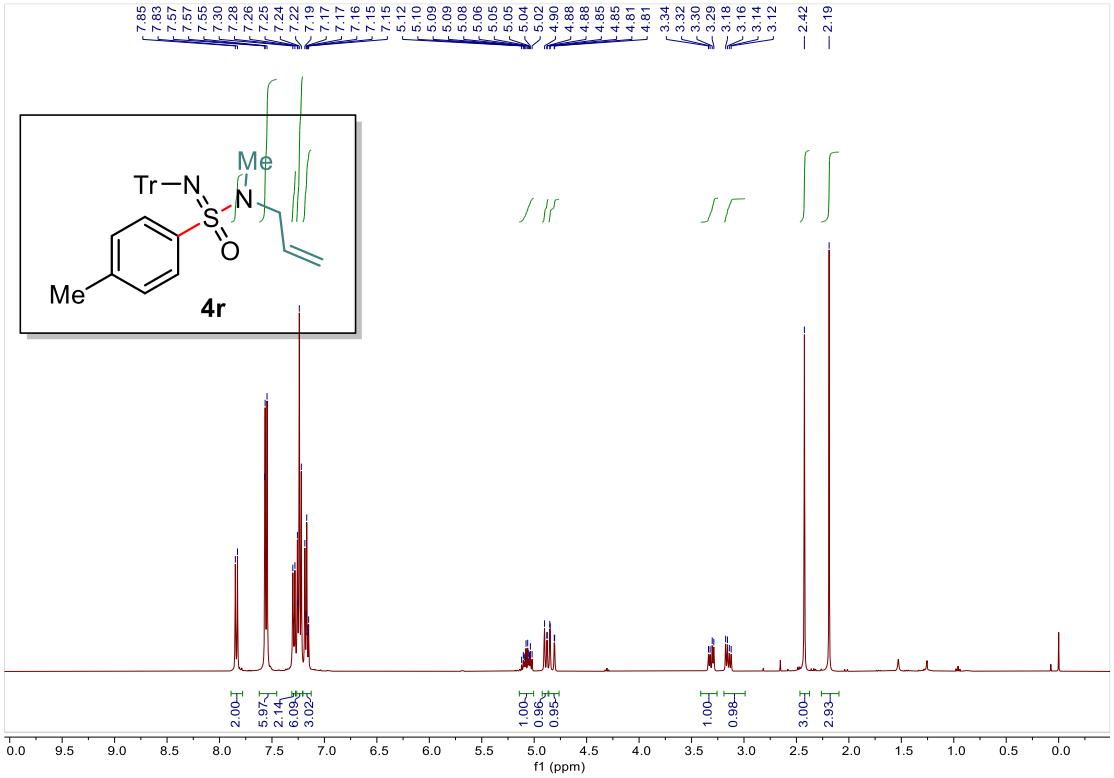
^{1}H NMR (400 MHz, $CDCl_3$) of **4q**



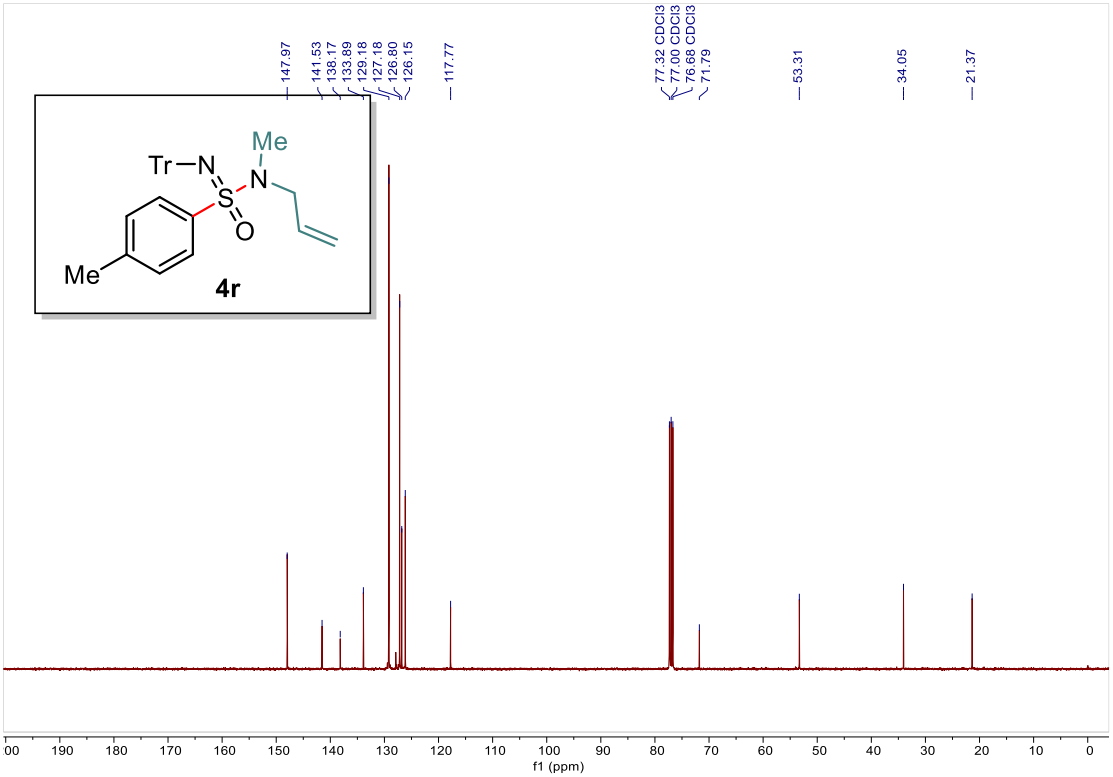
^{13}C NMR (101 MHz, $CDCl_3$) of **4q**



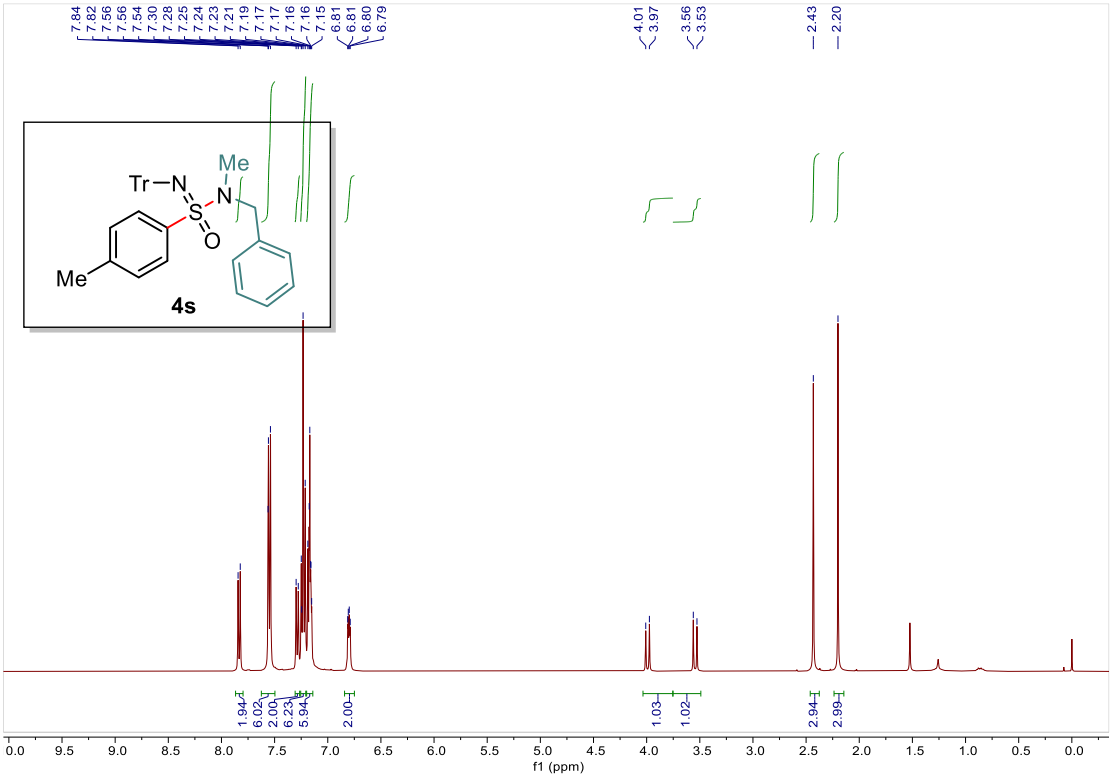
^{1}H NMR (400 MHz, $CDCl_3$) of **4r**



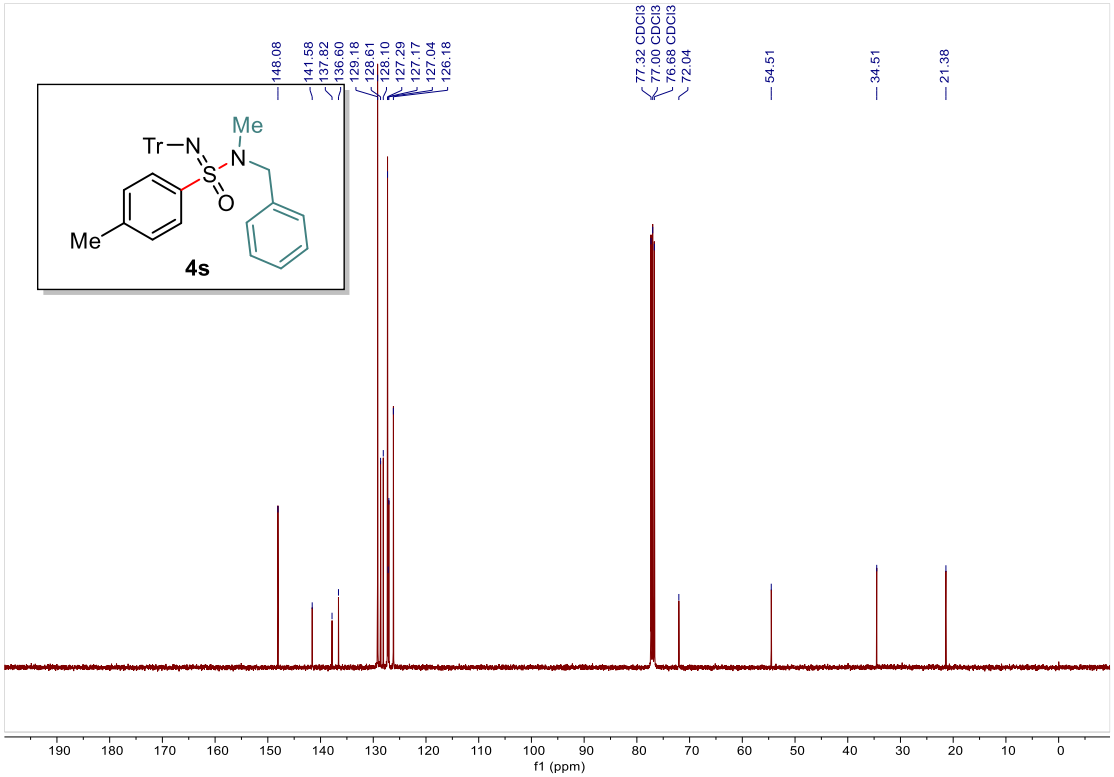
^{13}C NMR (101 MHz, $CDCl_3$) of **4r**



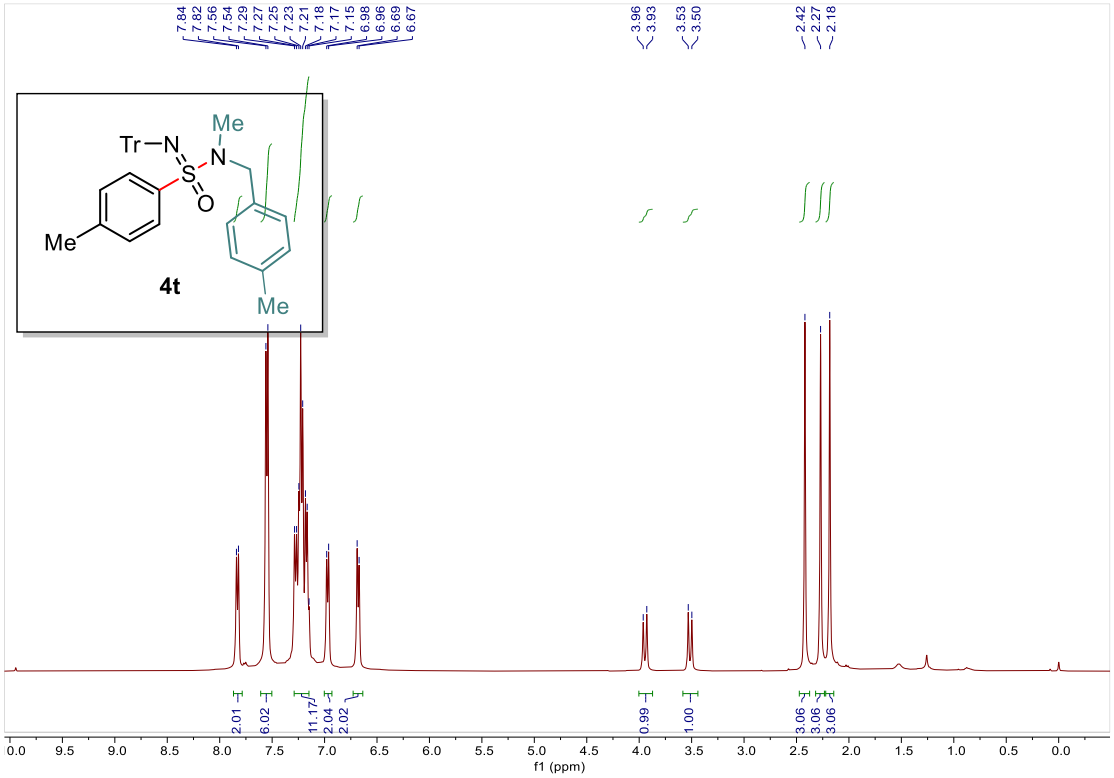
^{1}H NMR (400 MHz, $CDCl_3$) of **4s**



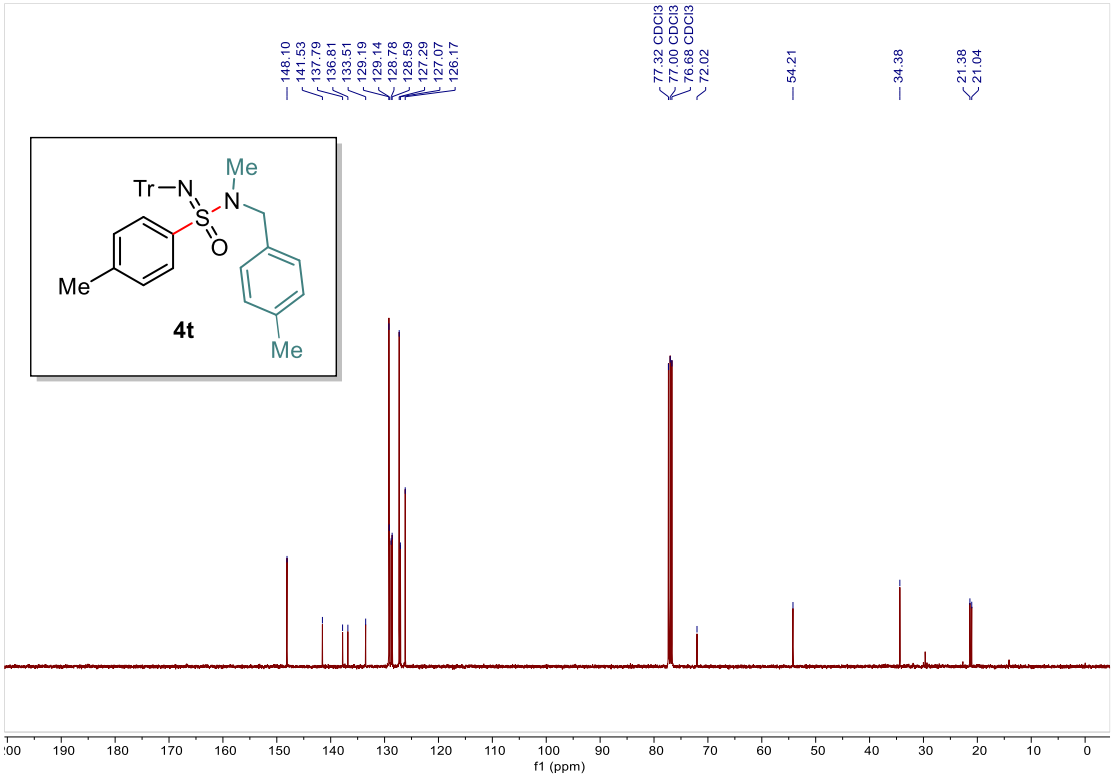
^{13}C NMR (101 MHz, $CDCl_3$) of **4s**



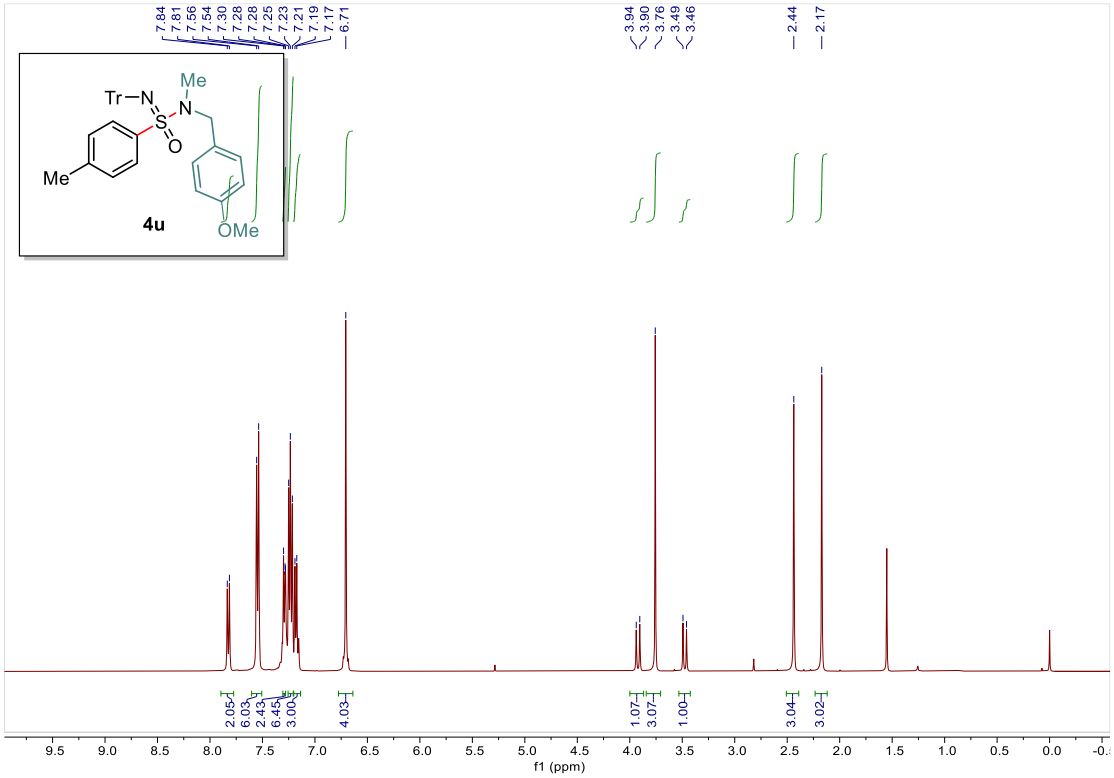
^{1}H NMR (400 MHz, $CDCl_3$) of **4t**



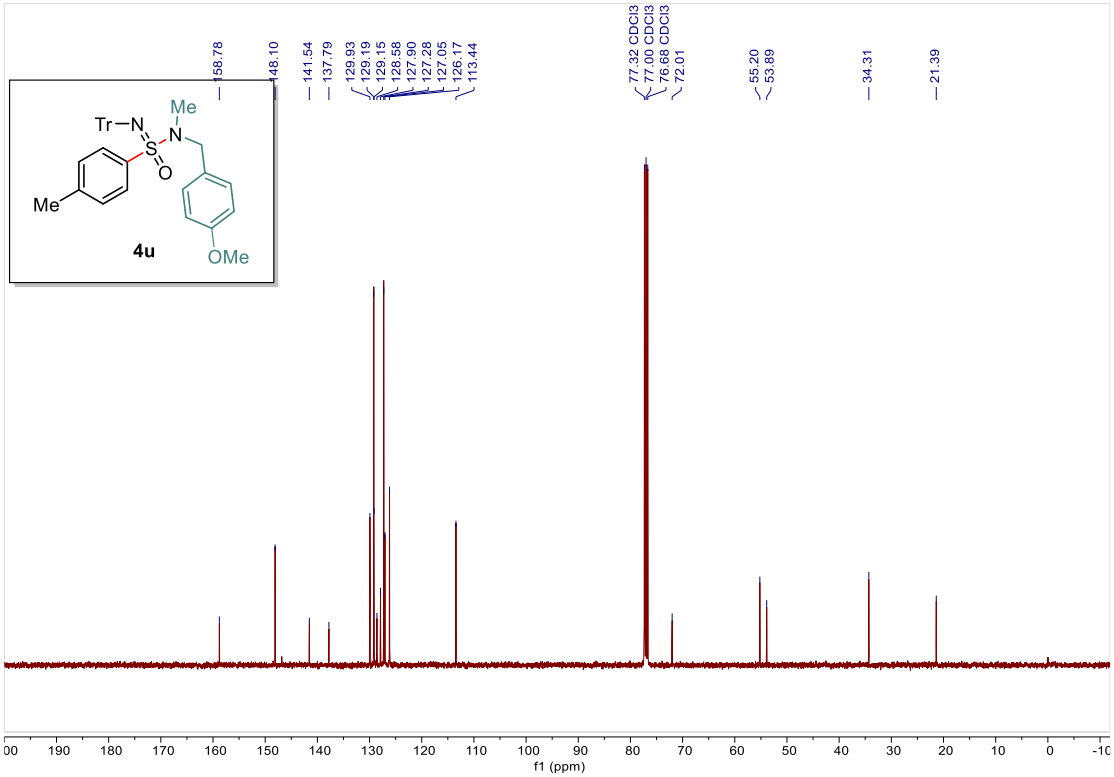
^{13}C NMR (101 MHz, $CDCl_3$) of **4t**



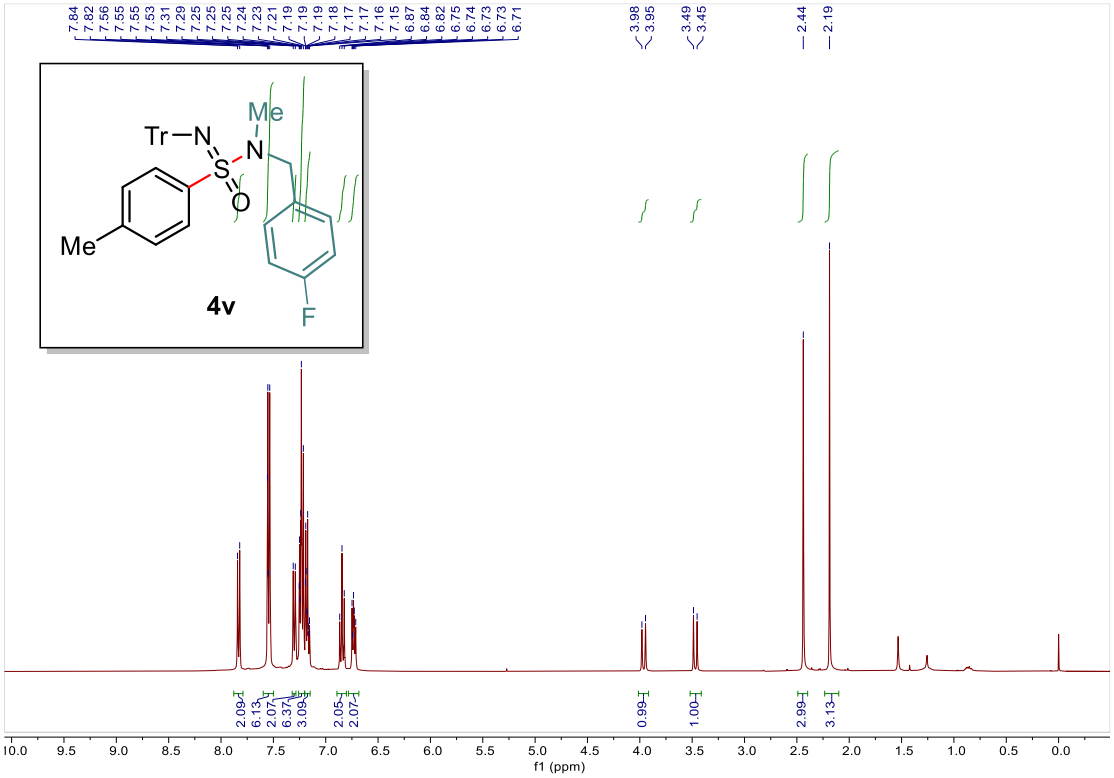
^{1}H NMR (400 MHz, $CDCl_3$) of **4u**



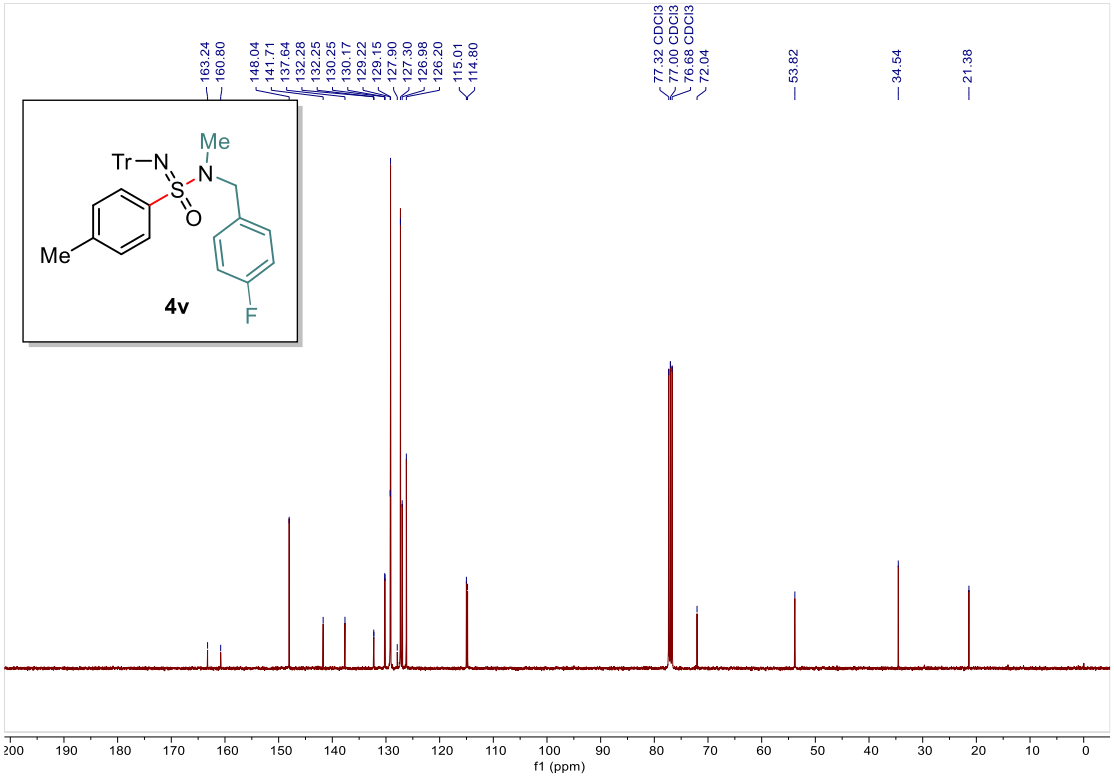
^{13}C NMR (101 MHz, $CDCl_3$) of **4u**



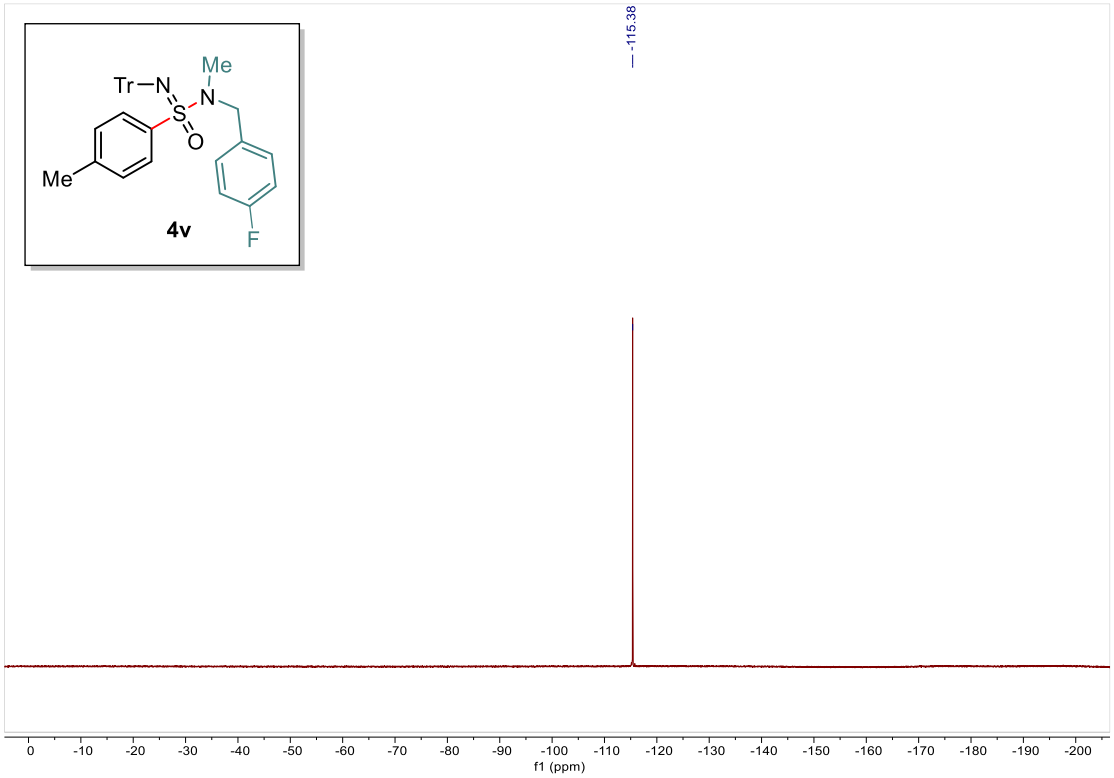
^{1}H NMR (400 MHz, $CDCl_3$) of **4v**



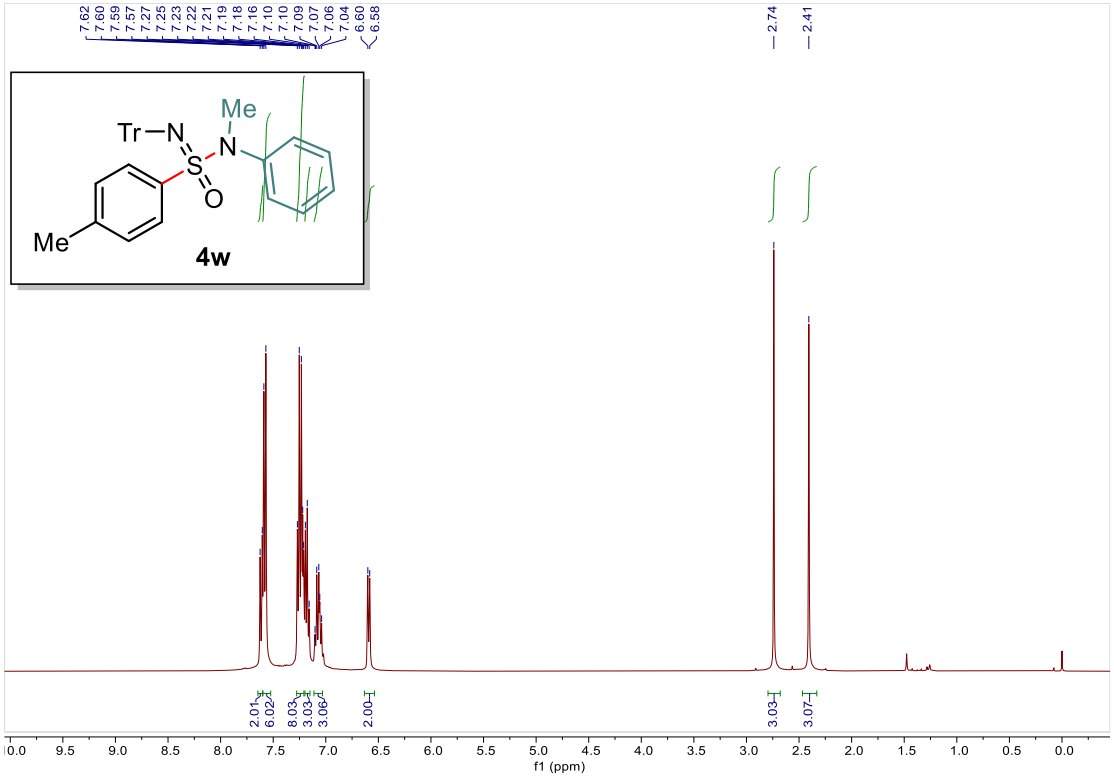
^{1}H NMR (400 MHz, $CDCl_3$) of **4v**



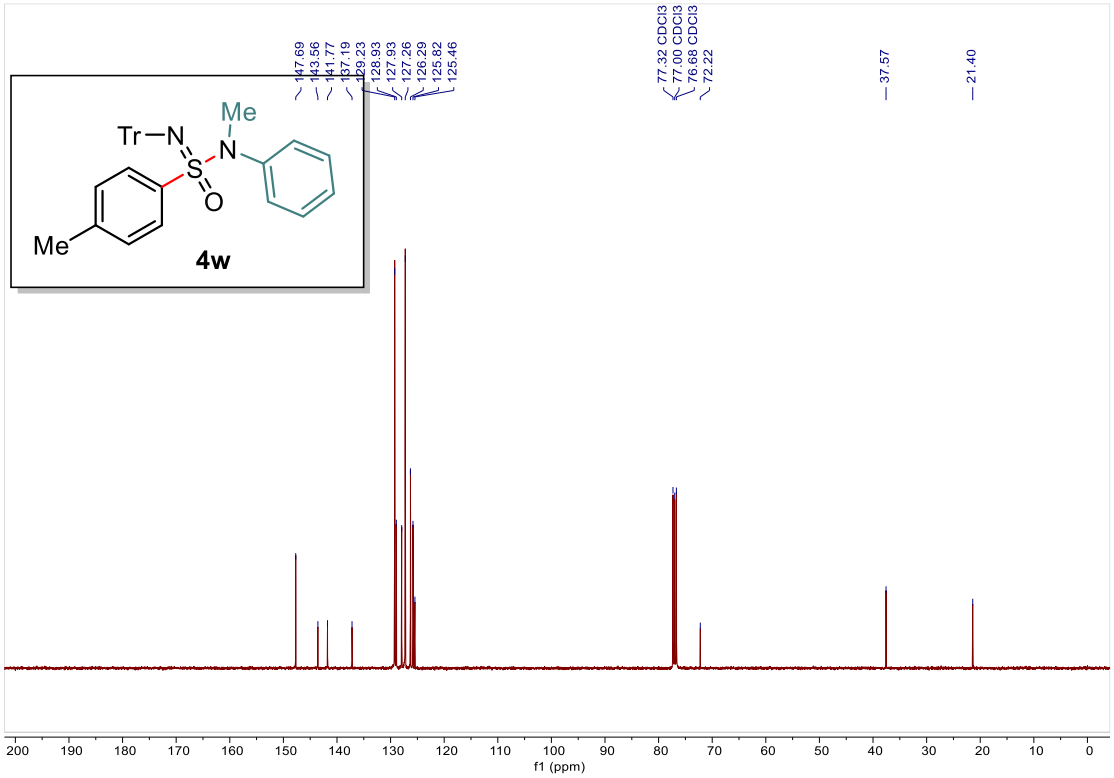
^{19}F NMR (377 MHz, $CDCl_3$) of **4v**



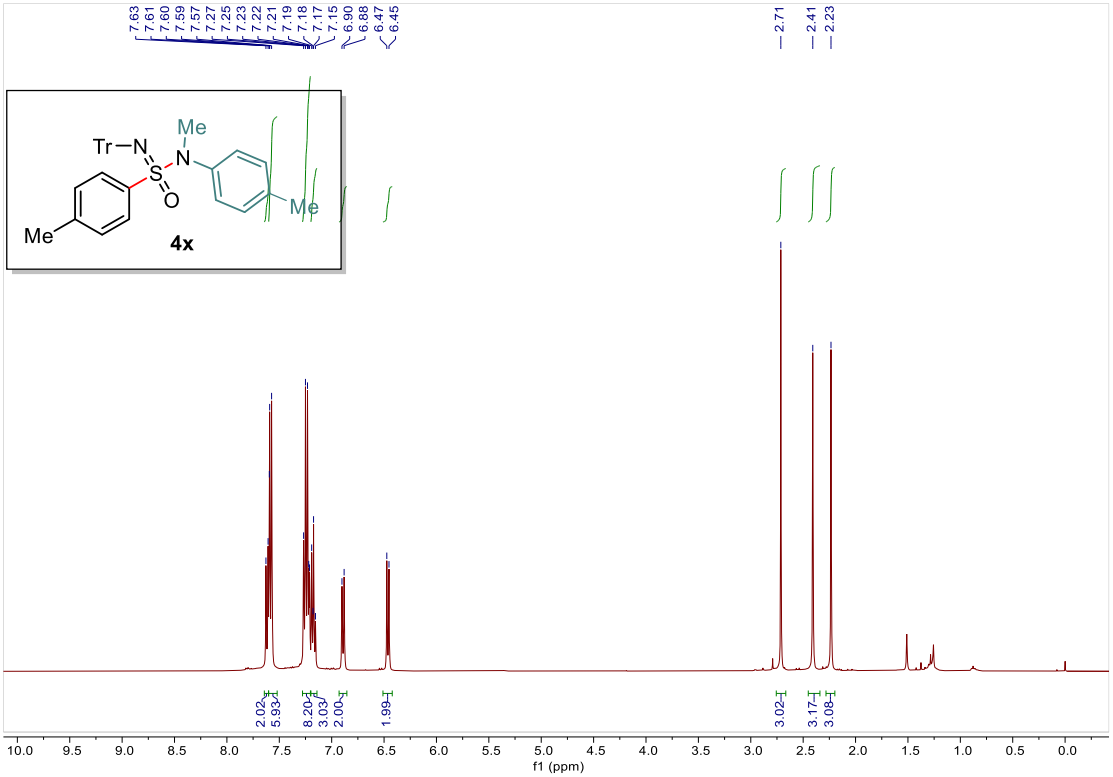
^{1}H NMR (400 MHz, $CDCl_3$) of 4w



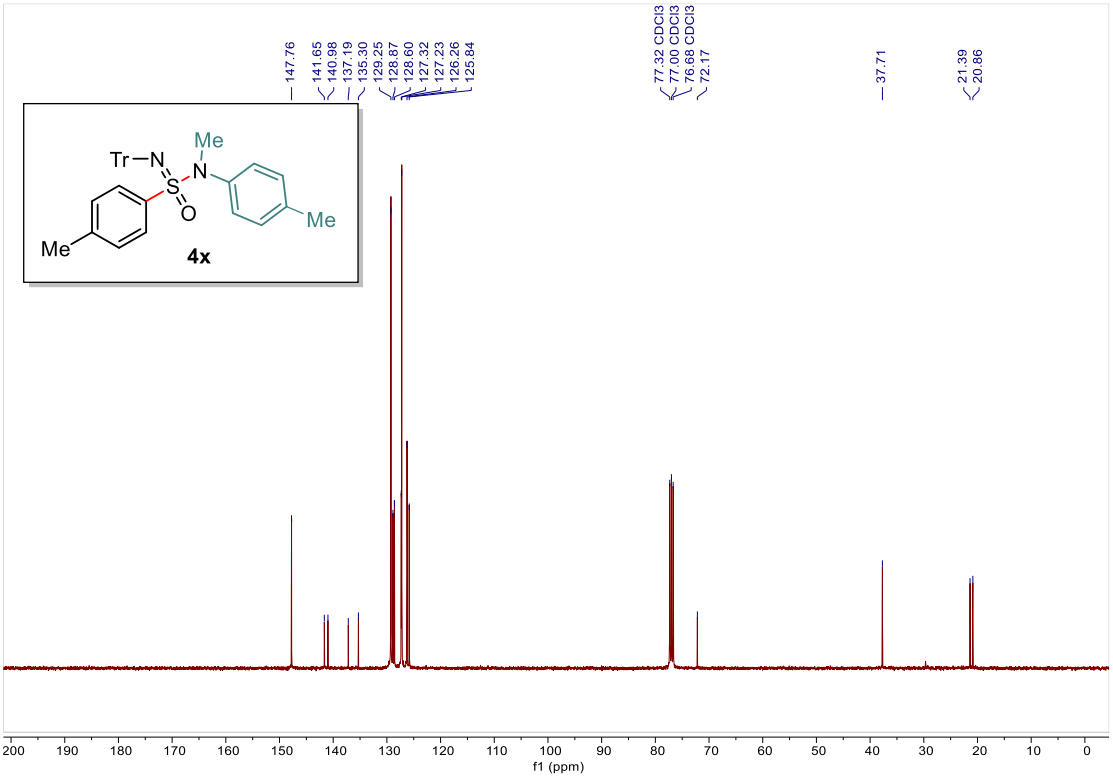
^{13}C NMR (101 MHz, $CDCl_3$) of 4w



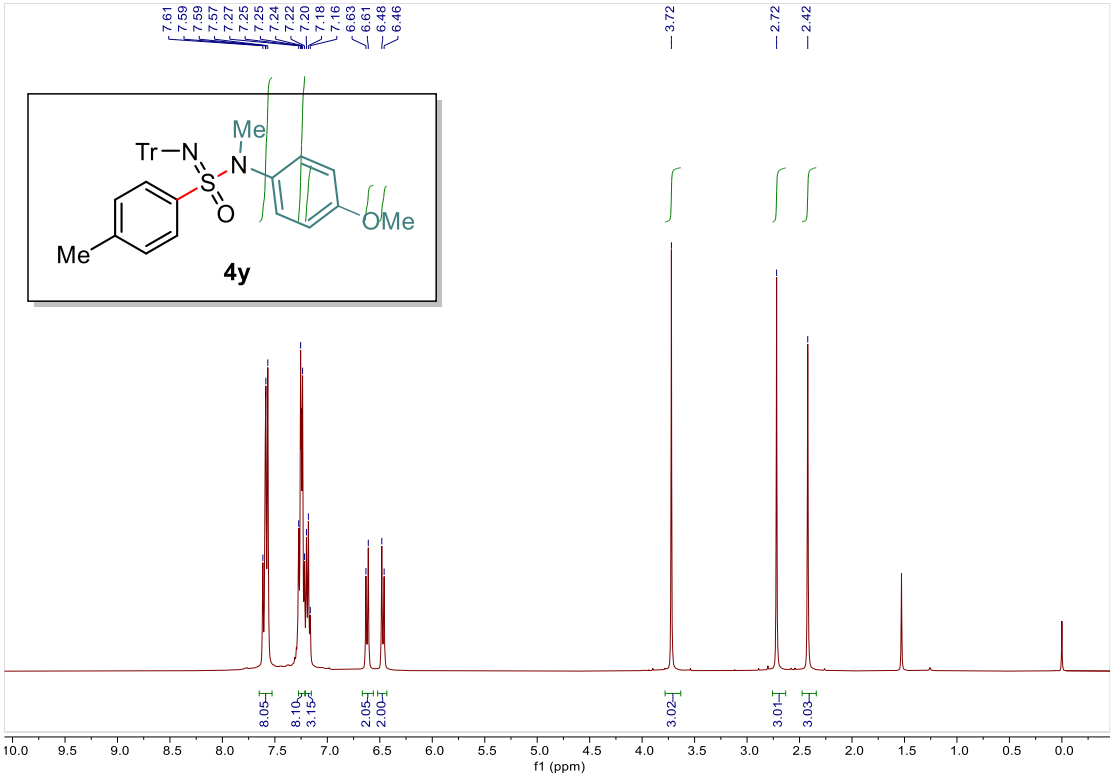
^{1}H NMR (400 MHz, $CDCl_3$) of 4x



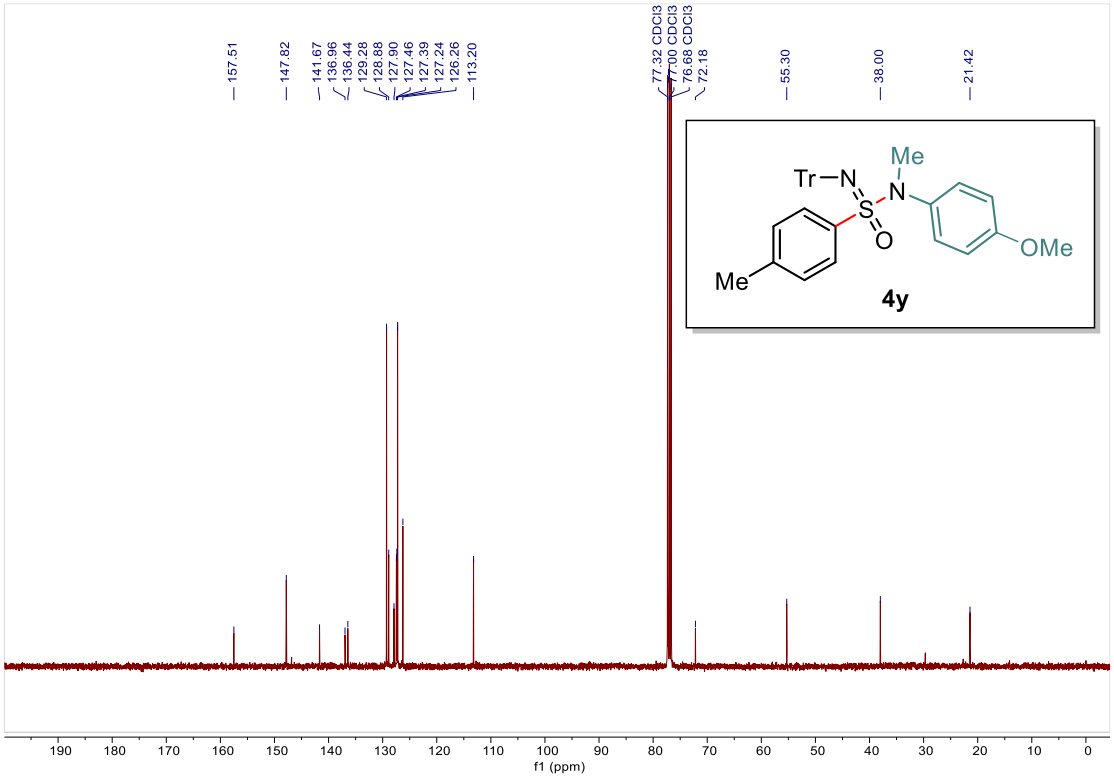
^{13}C NMR (101 MHz, $CDCl_3$) of 4x



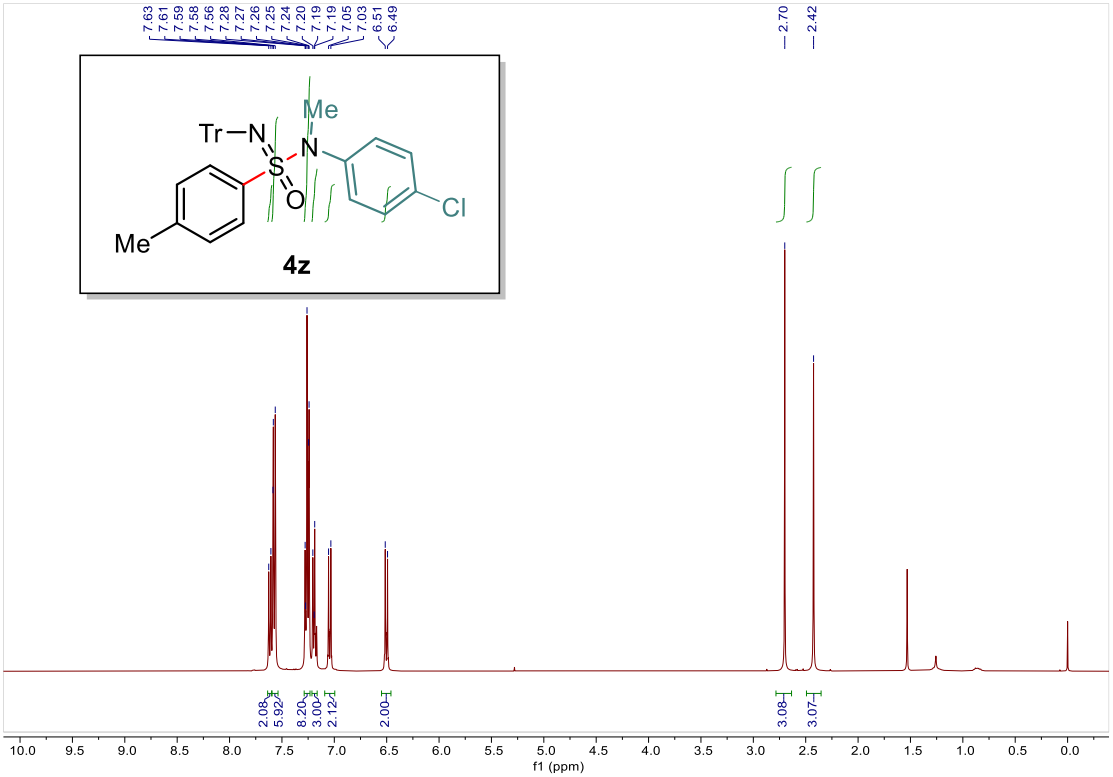
^{1}H NMR (400 MHz, $CDCl_3$) of 4y



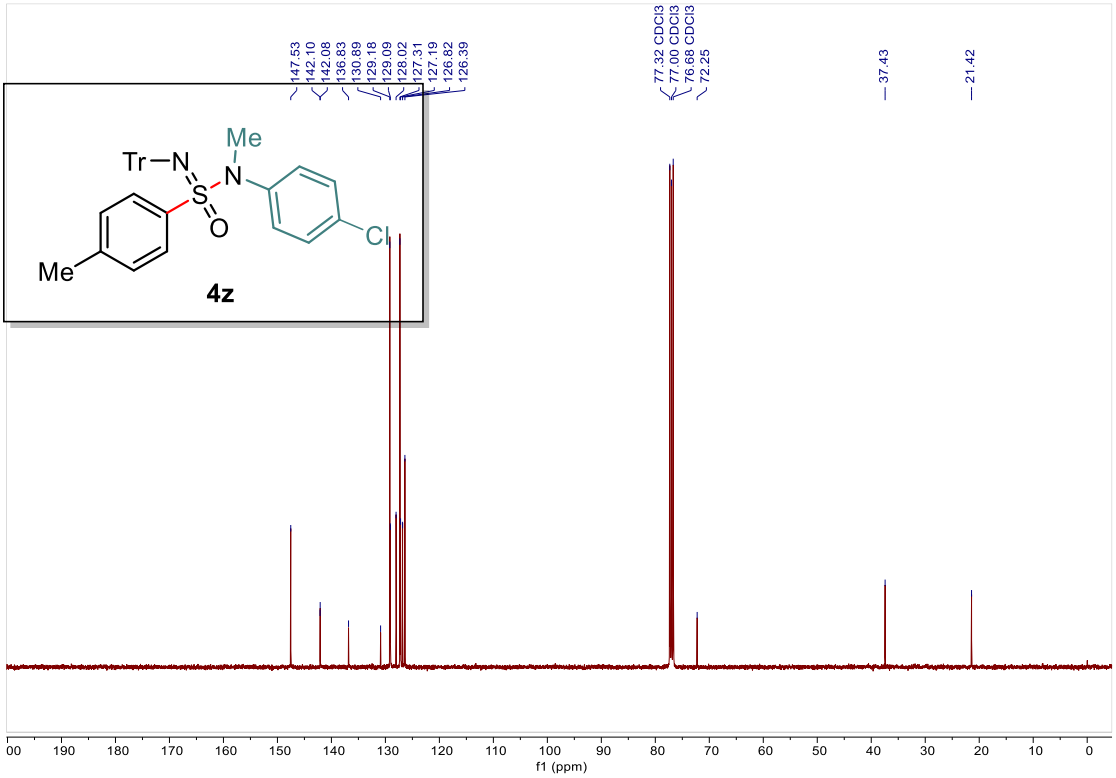
^{13}C NMR (101 MHz, $CDCl_3$) of 4y



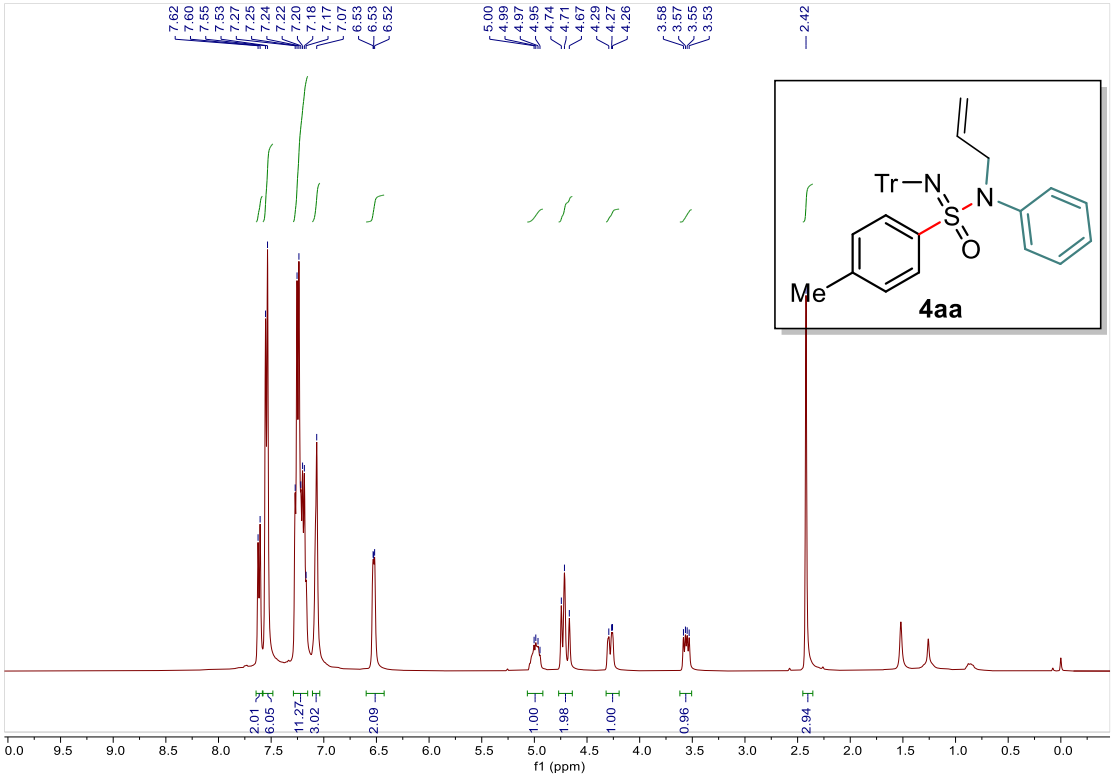
^{1}H NMR (400 MHz, $CDCl_3$) of 4z



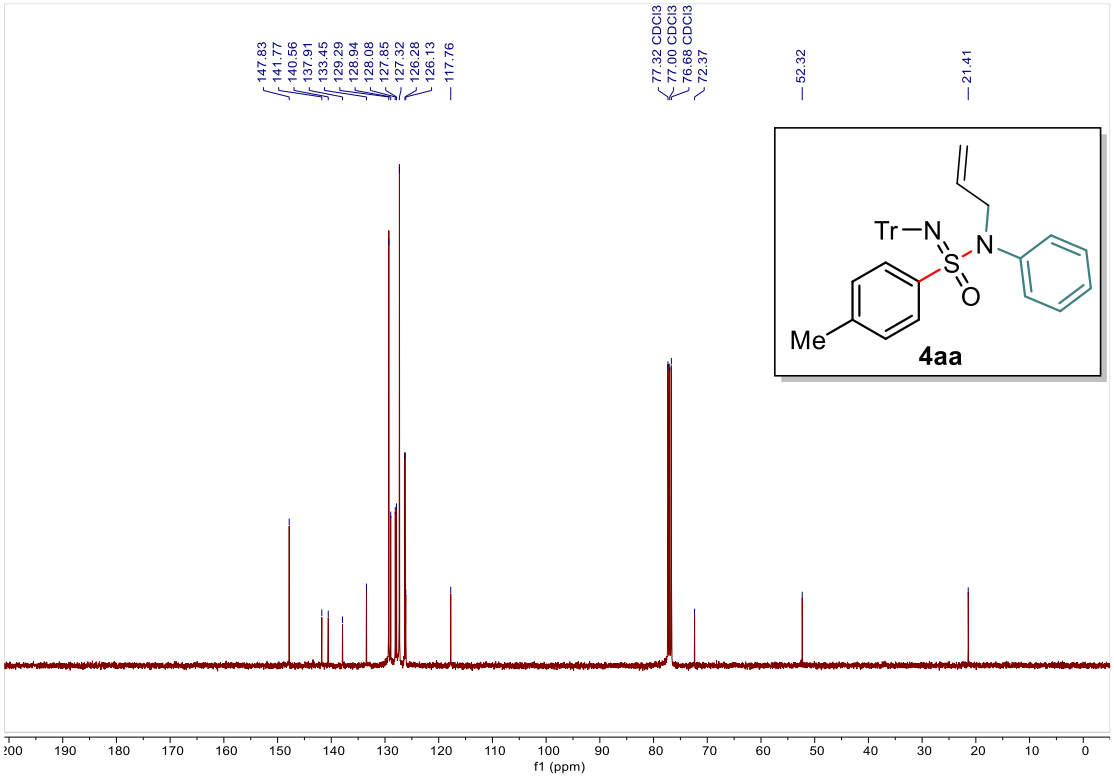
^{13}C NMR (101 MHz, $CDCl_3$) of 4z



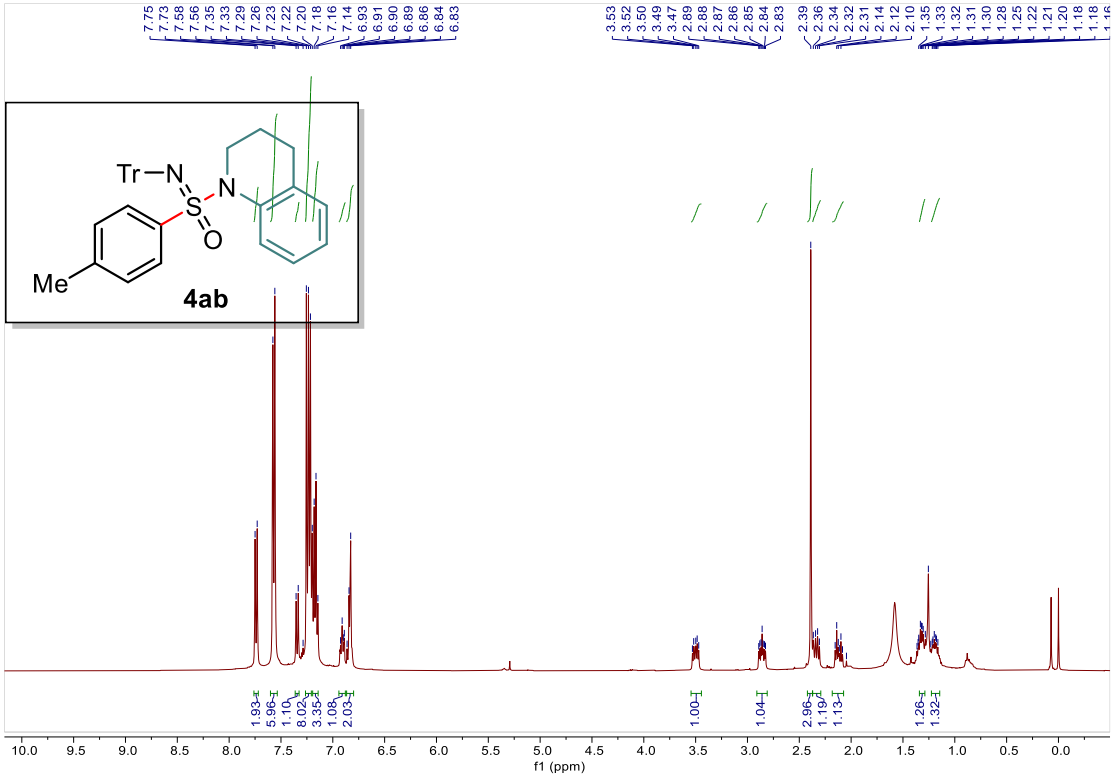
^{1}H NMR (400 MHz, $CDCl_3$) of **4aa**



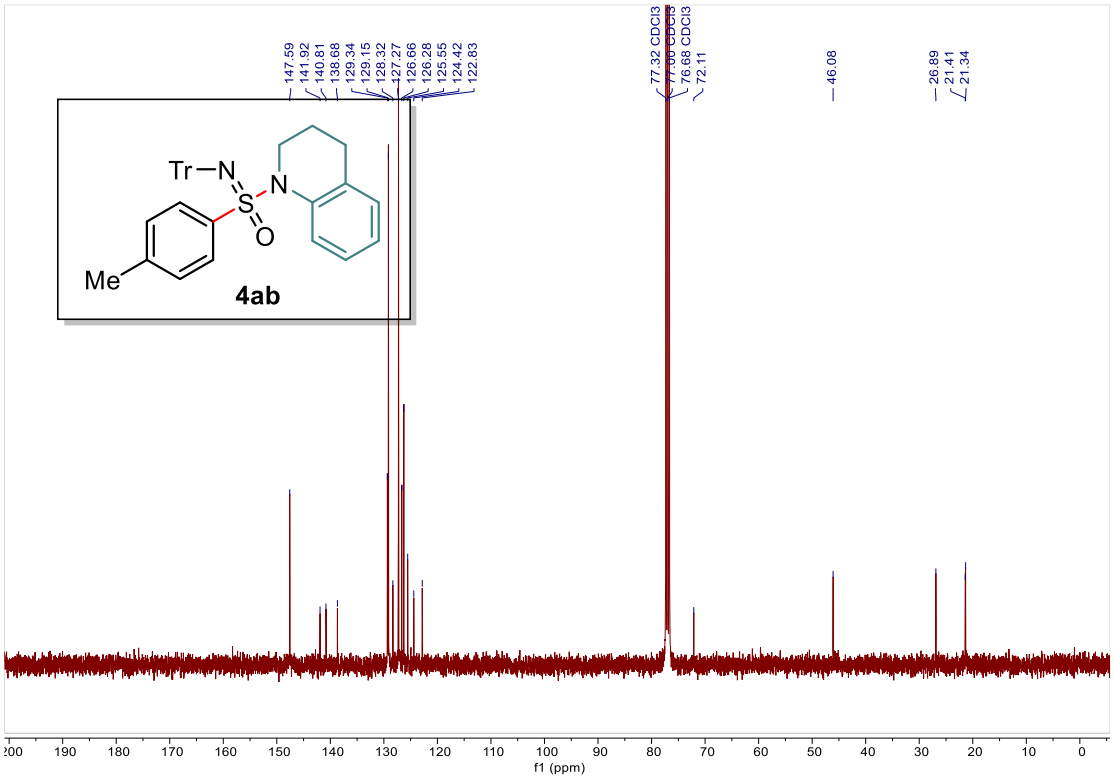
^{13}C NMR (101 MHz, $CDCl_3$) of **4aa**



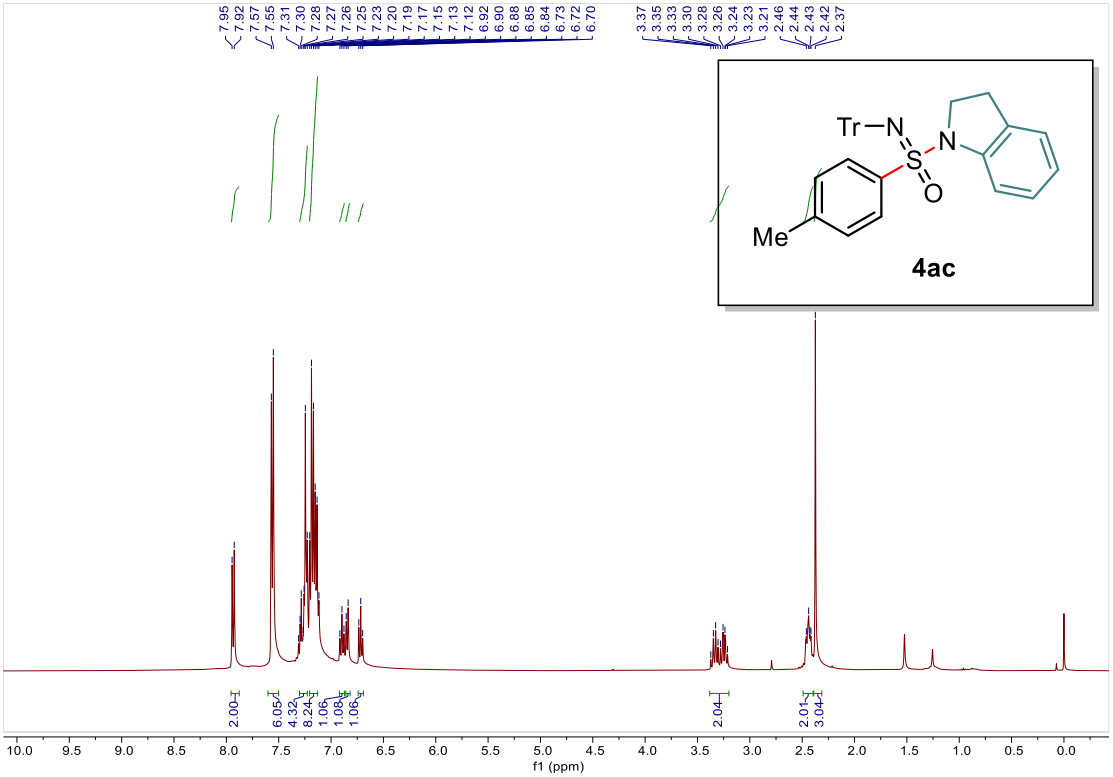
^{1}H NMR (400 MHz, $CDCl_3$) of **4ab**



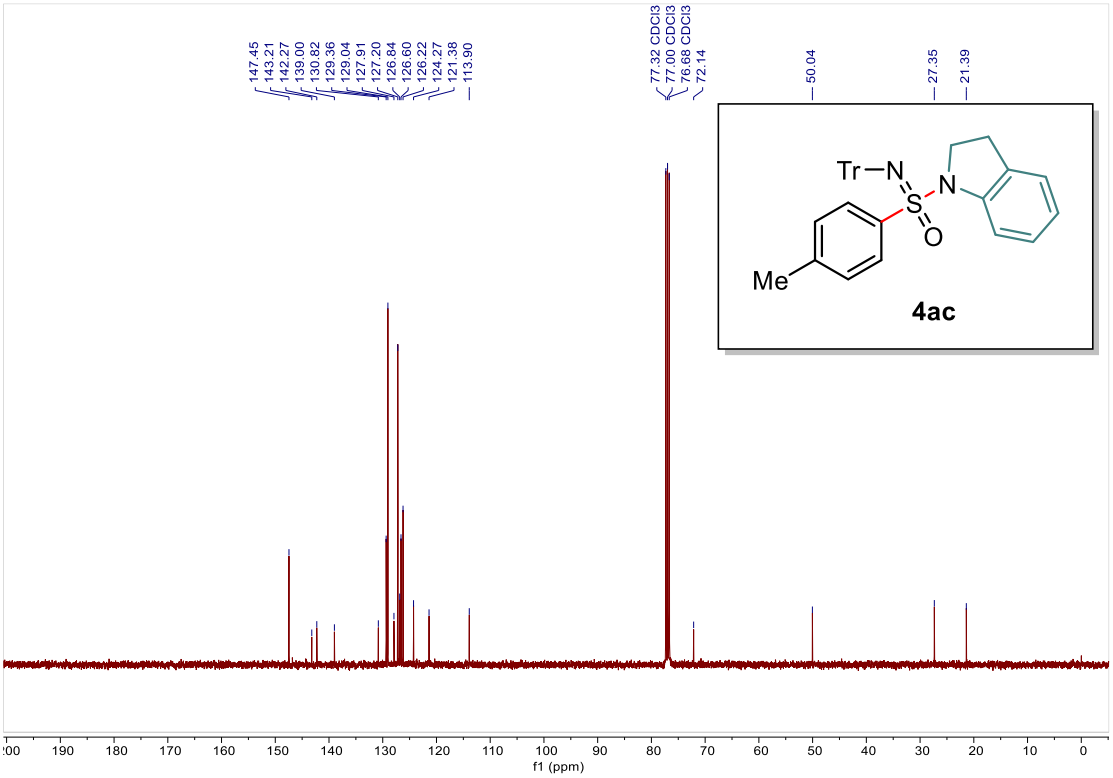
^{13}C NMR (101 MHz, $CDCl_3$) of **4ab**



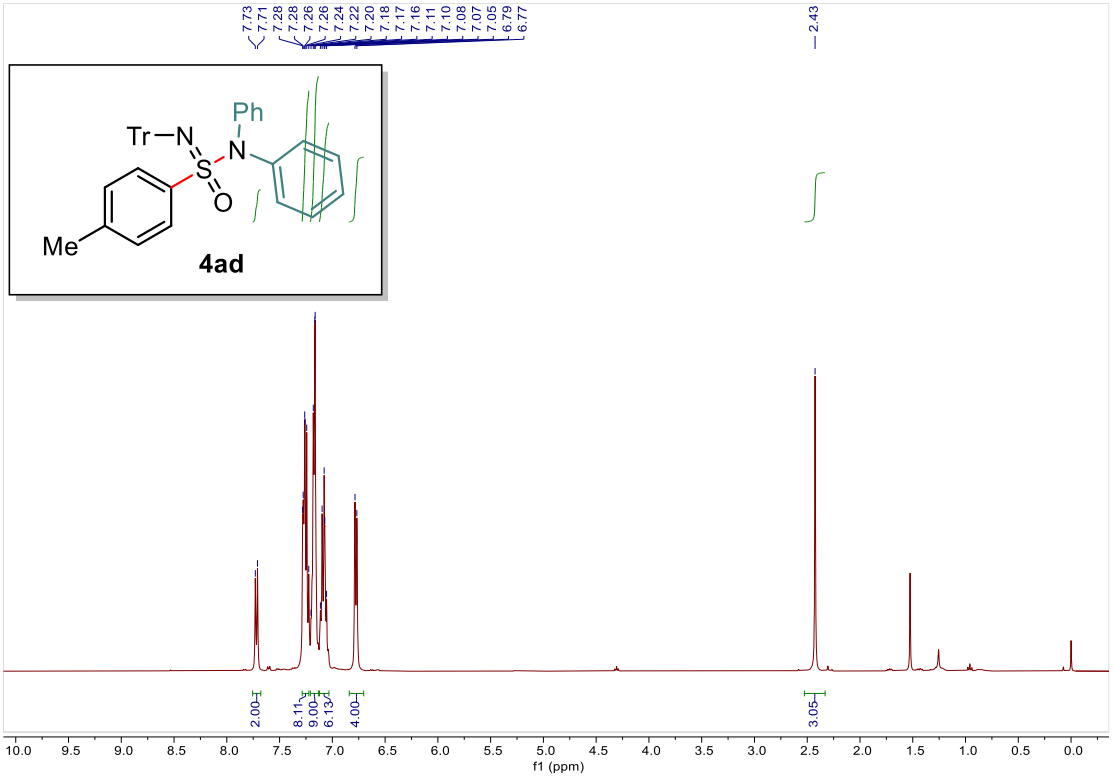
^{1}H NMR (400 MHz, $CDCl_3$) of **4ac**



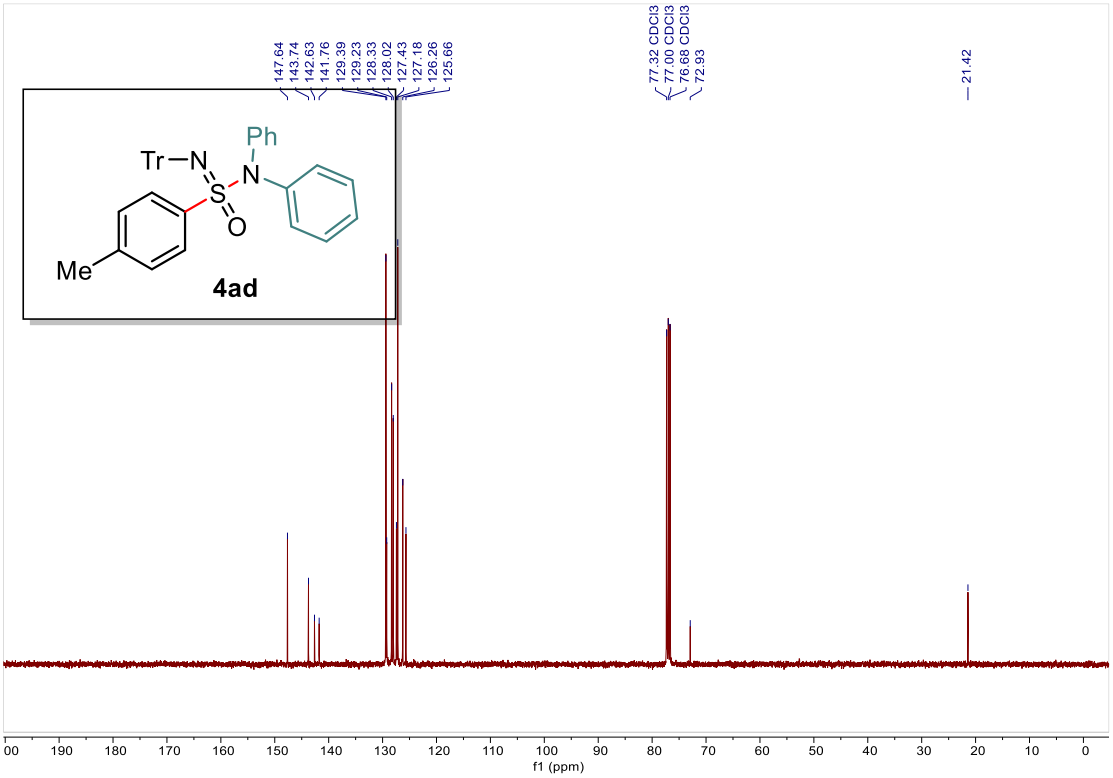
^{13}C NMR (101 MHz, $CDCl_3$) of **4ac**



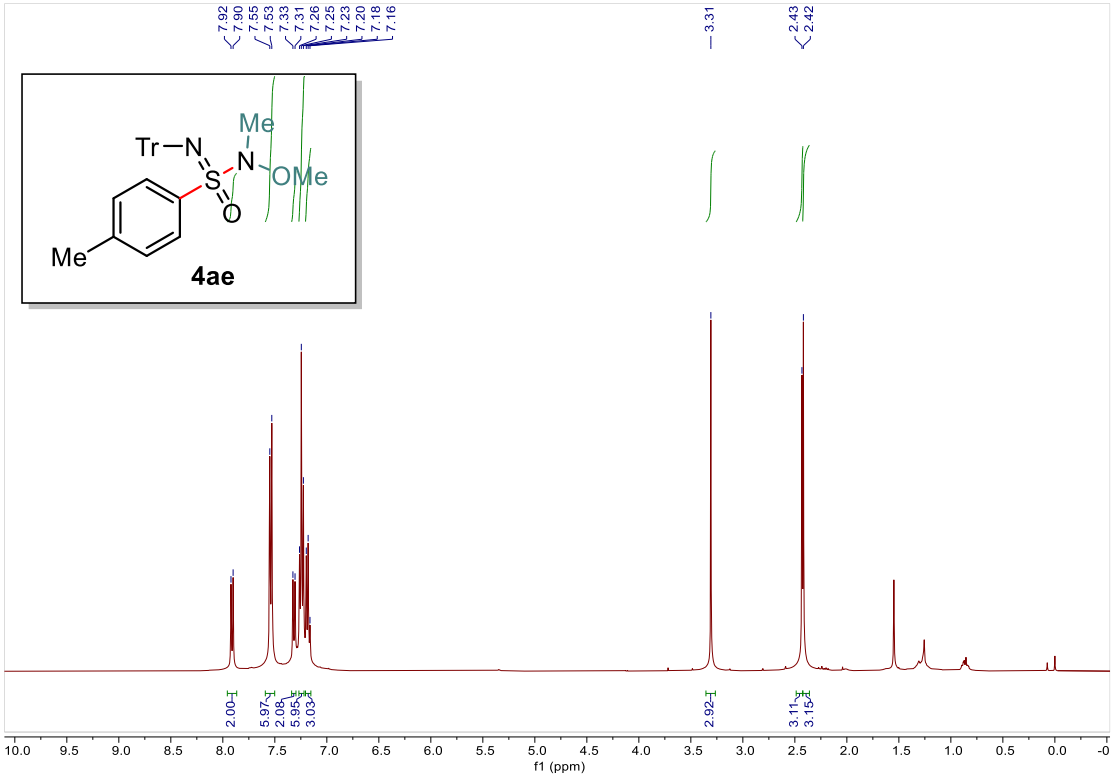
^{1}H NMR (400 MHz, $CDCl_3$) of 4ad



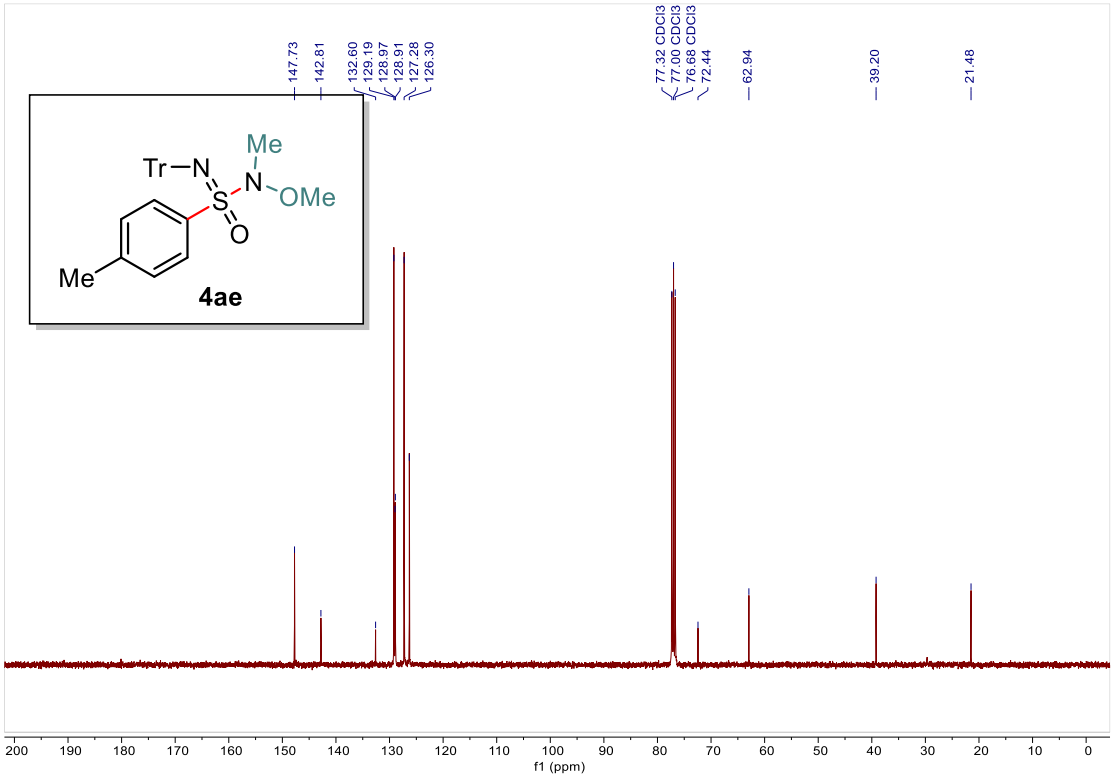
^{13}C NMR (101 MHz, $CDCl_3$) of 4ad



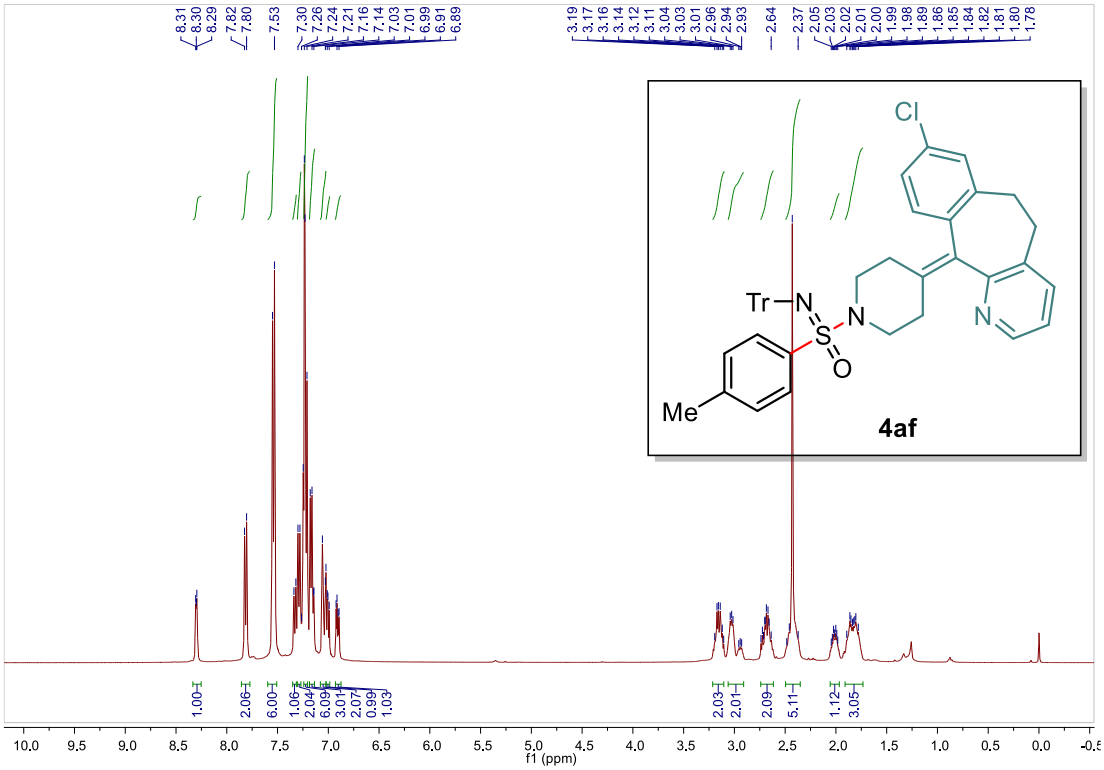
^{1}H NMR (400 MHz, $CDCl_3$) of 4ae



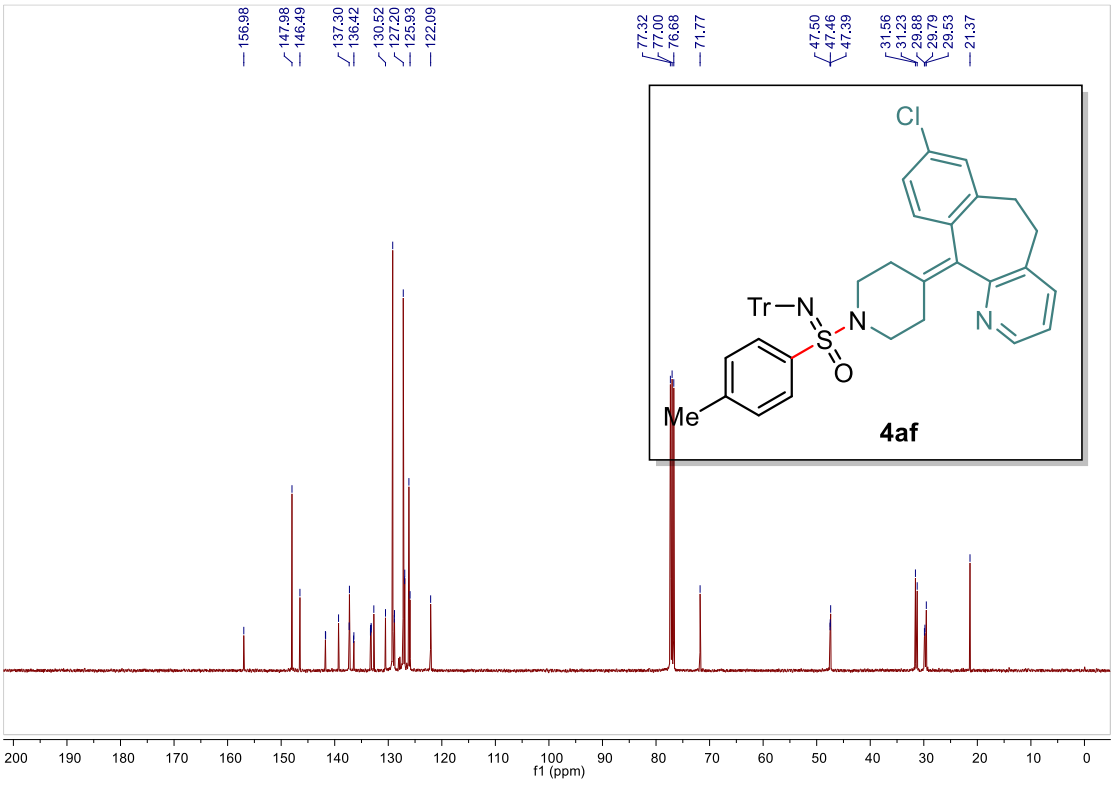
^{13}C NMR (101 MHz, $CDCl_3$) of 4ae



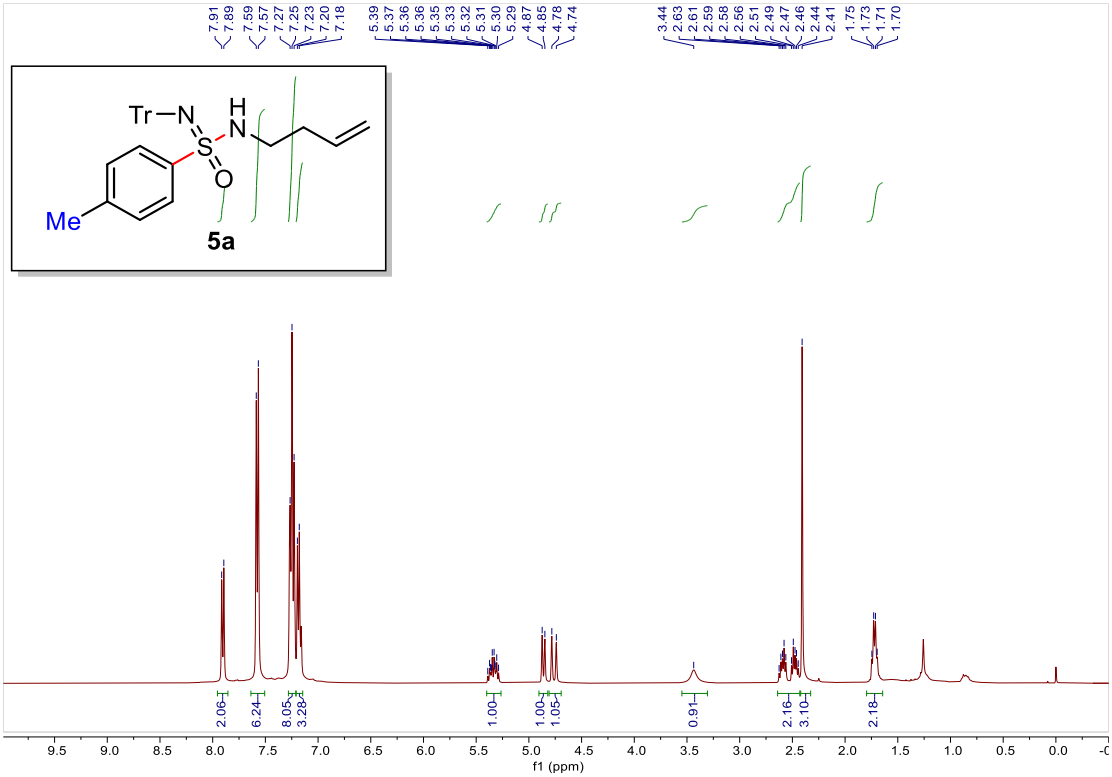
^{1}H NMR (400 MHz, $CDCl_3$) of **4af**



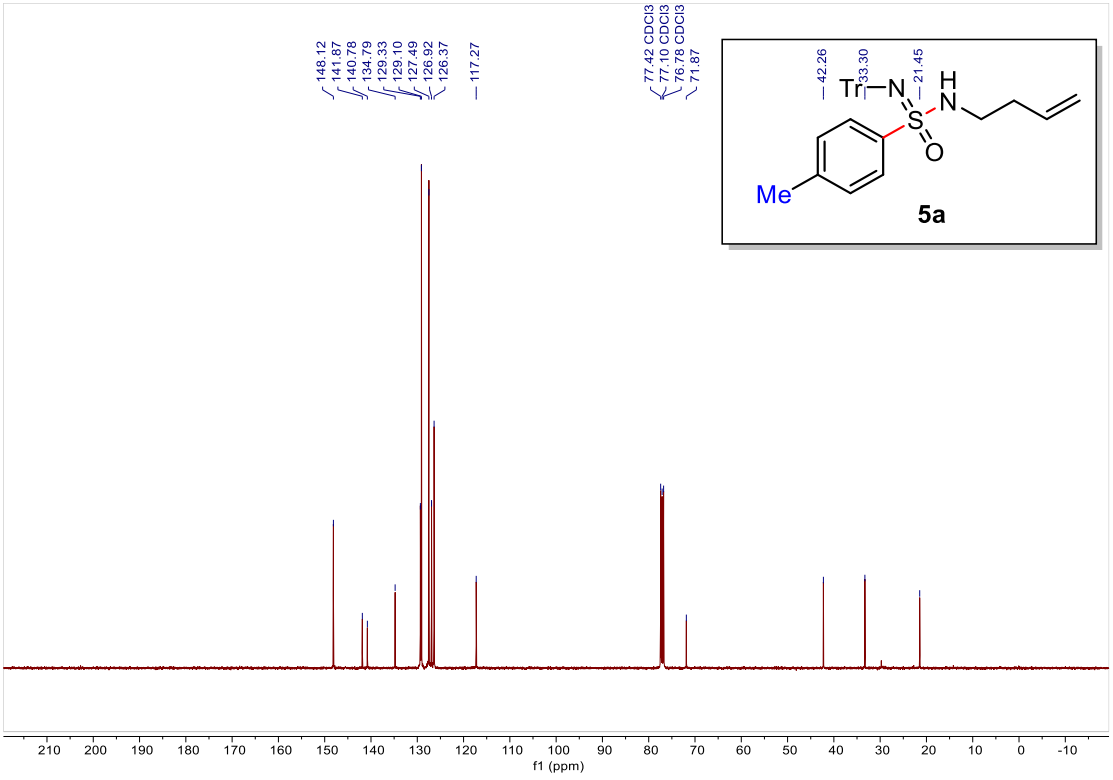
^{13}C NMR (101 MHz, $CDCl_3$) of **4af**



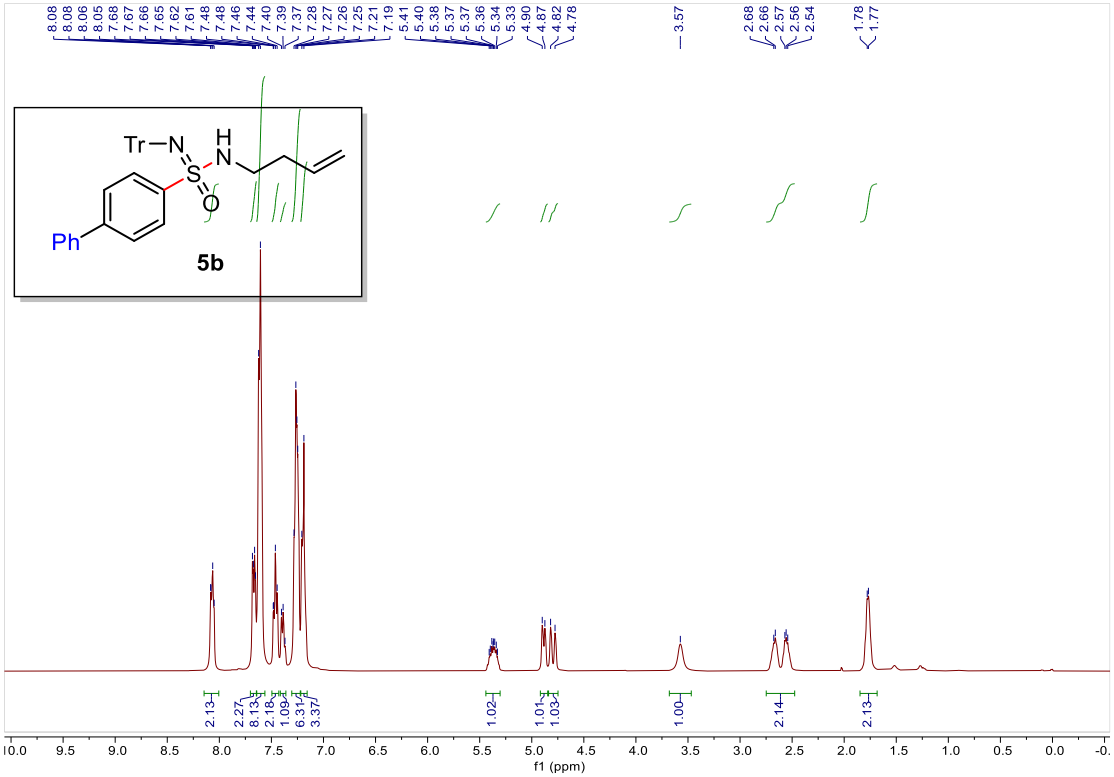
^{1}H NMR (400 MHz, $CDCl_3$) of **5a**



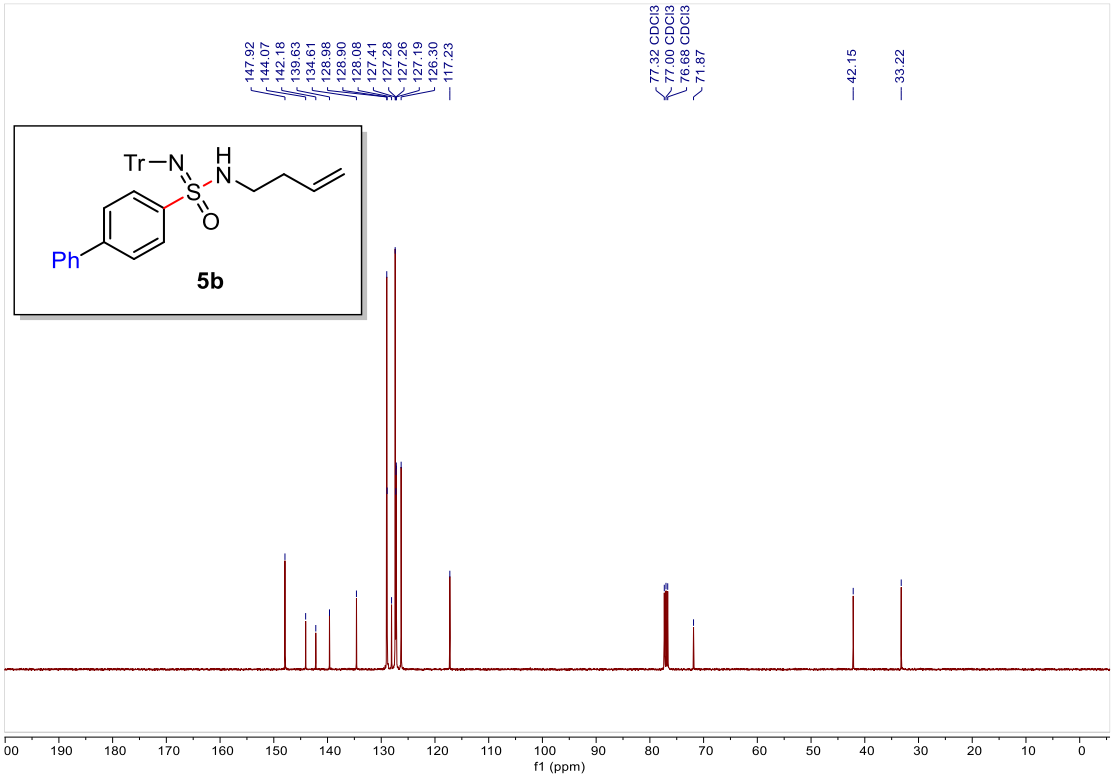
^{13}C NMR (101 MHz, $CDCl_3$) of **5a**



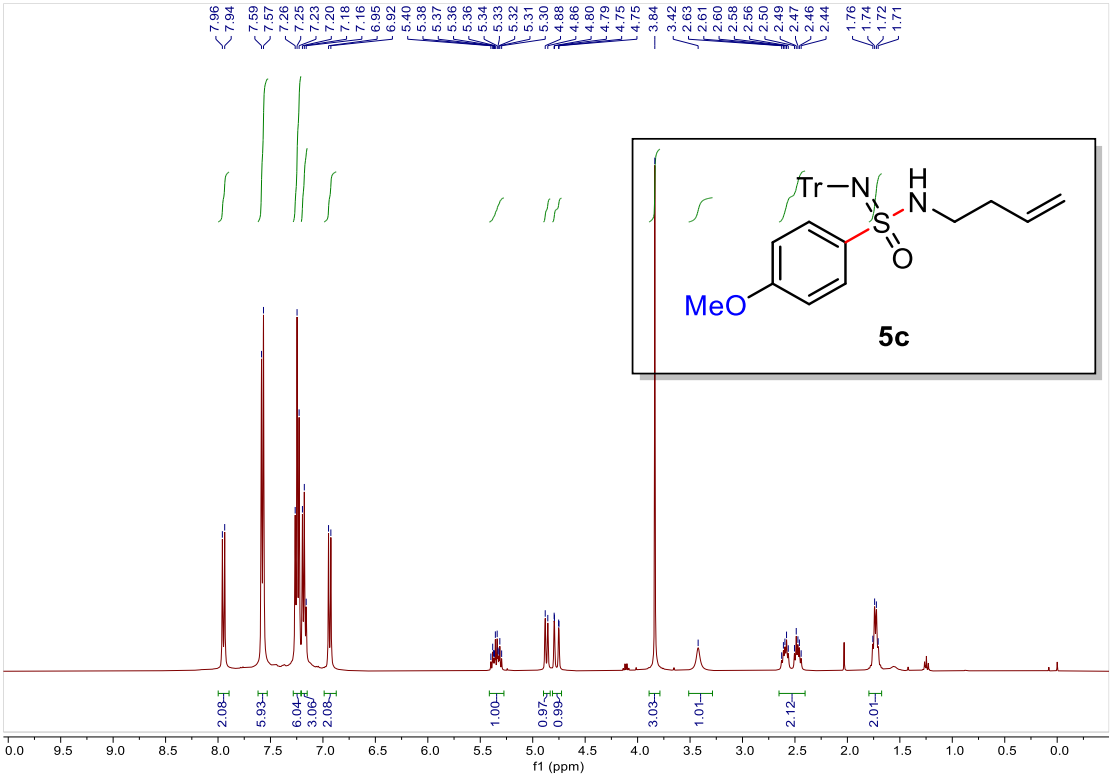
^{1}H NMR (400 MHz, $CDCl_3$) of **5b**



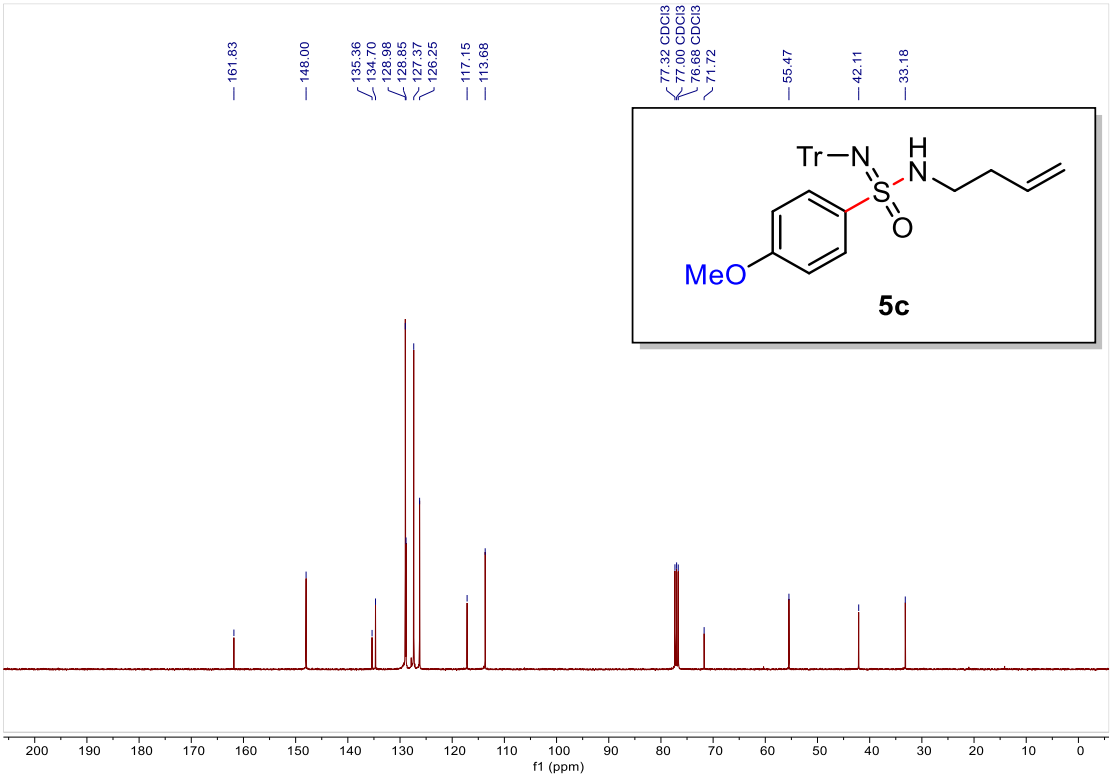
^{13}C NMR (101 MHz, $CDCl_3$) of **5b**



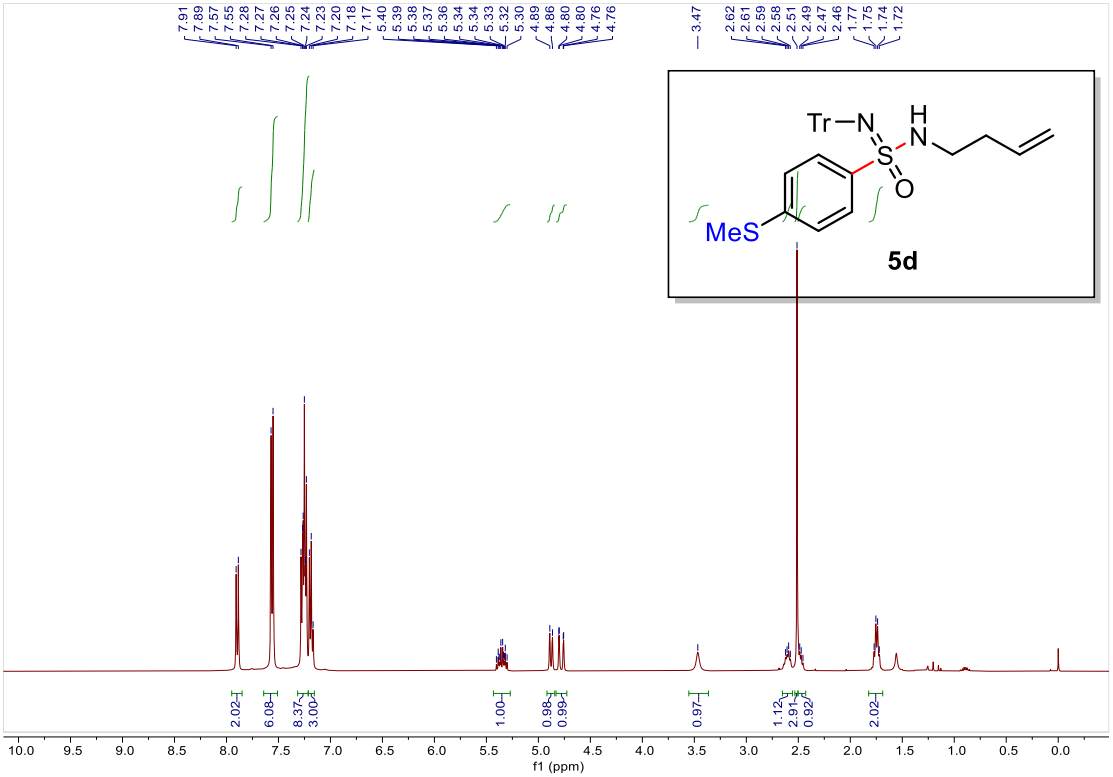
^{1}H NMR (400 MHz, $CDCl_3$) of **5c**



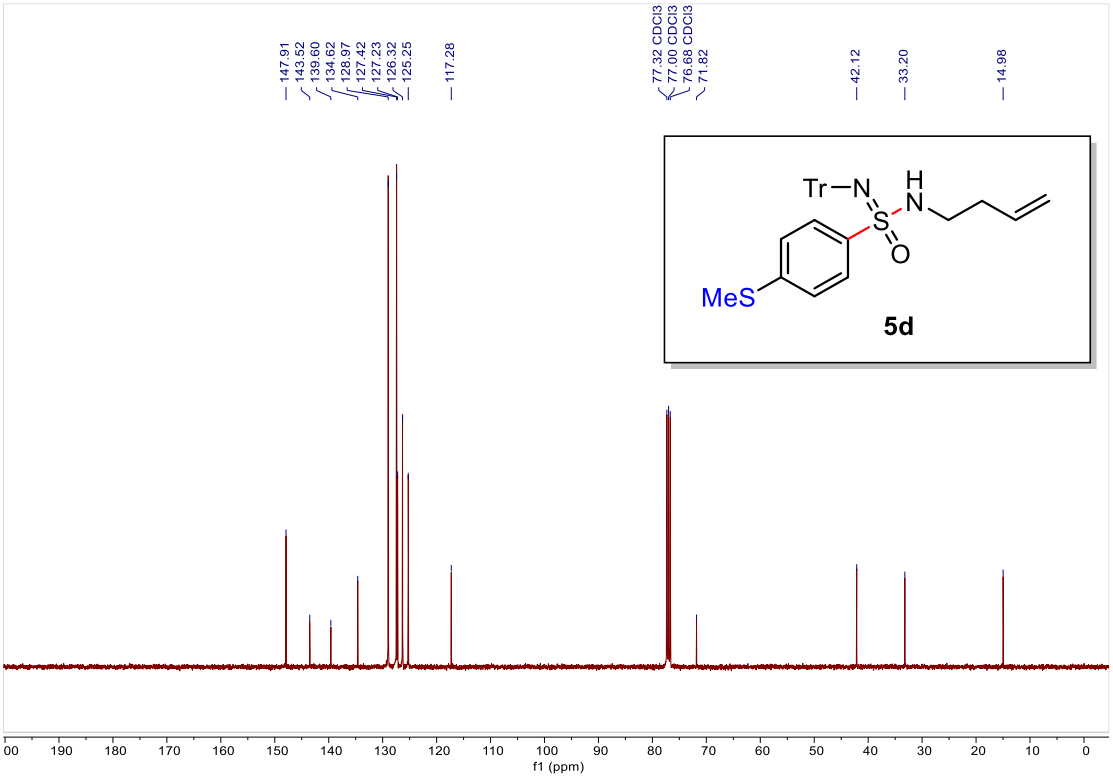
^{13}C NMR (101 MHz, $CDCl_3$) of **5c**



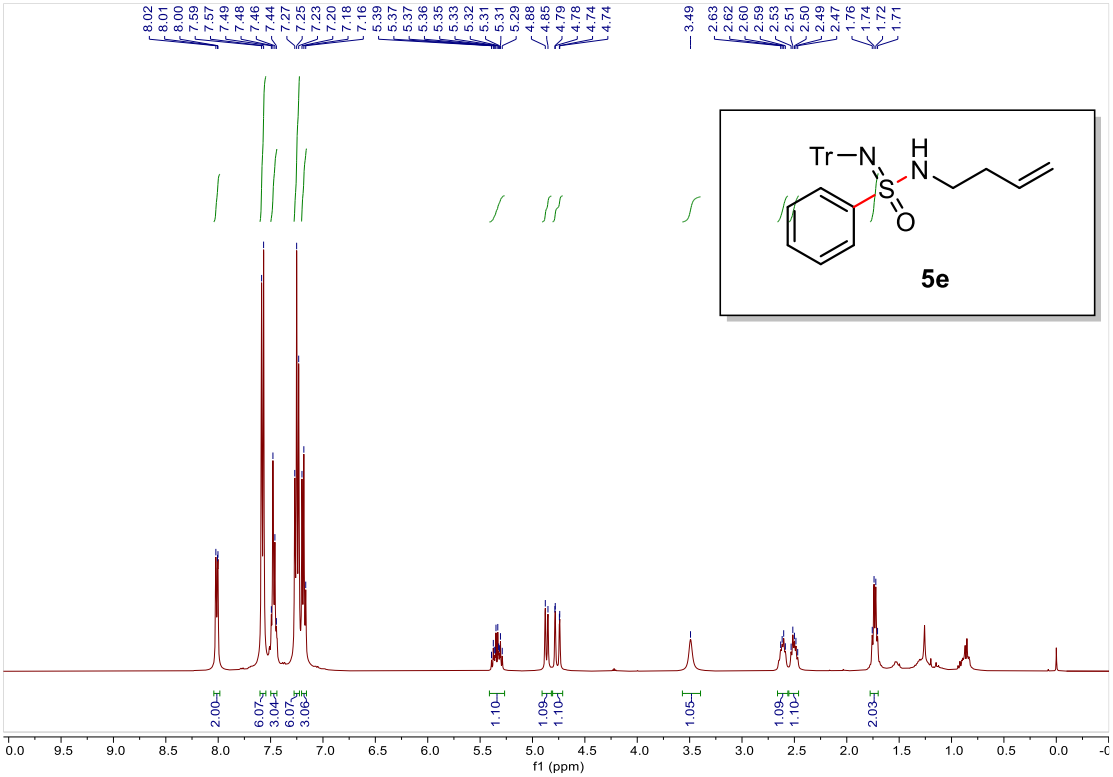
^{1}H NMR (400 MHz, $CDCl_3$) of **5d**



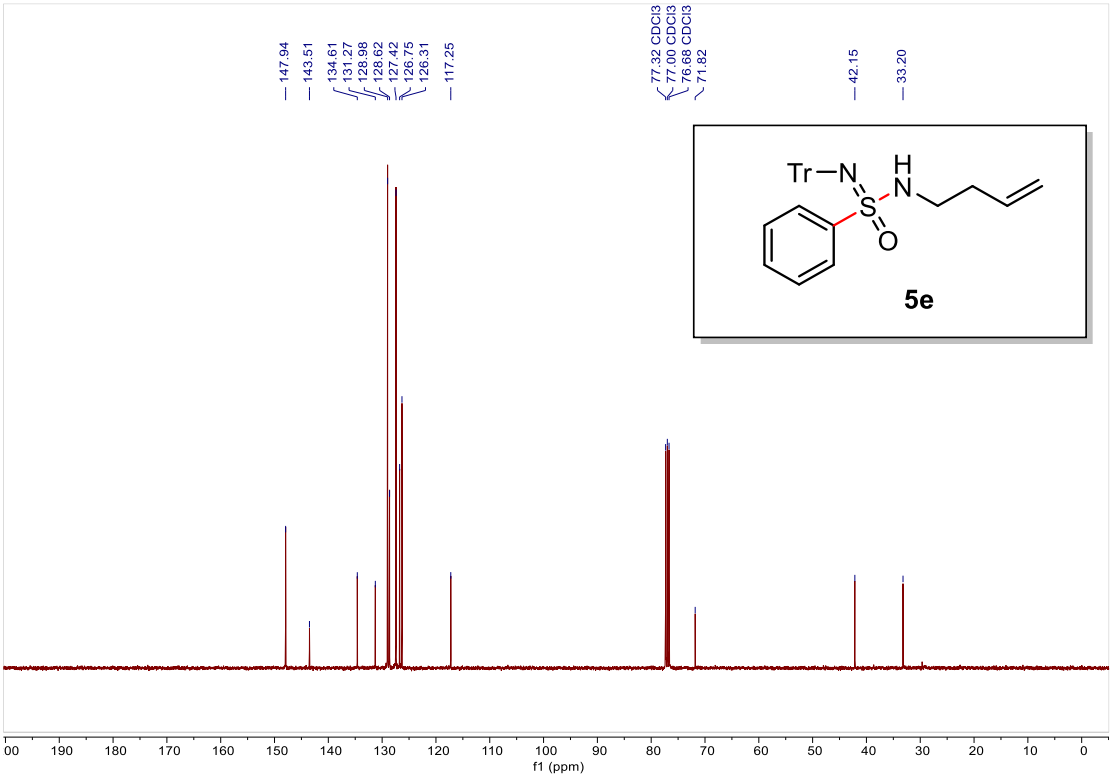
^{13}C NMR (101 MHz, $CDCl_3$) of **5d**



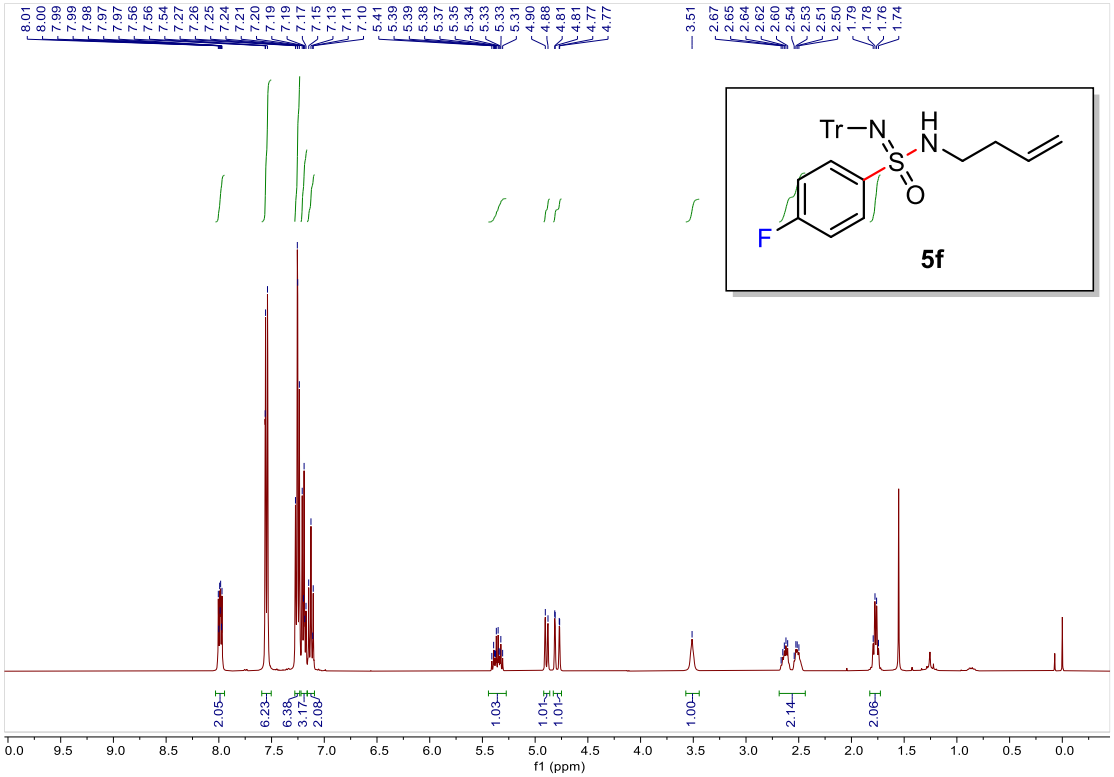
^{1}H NMR (400 MHz, $CDCl_3$) of **5e**



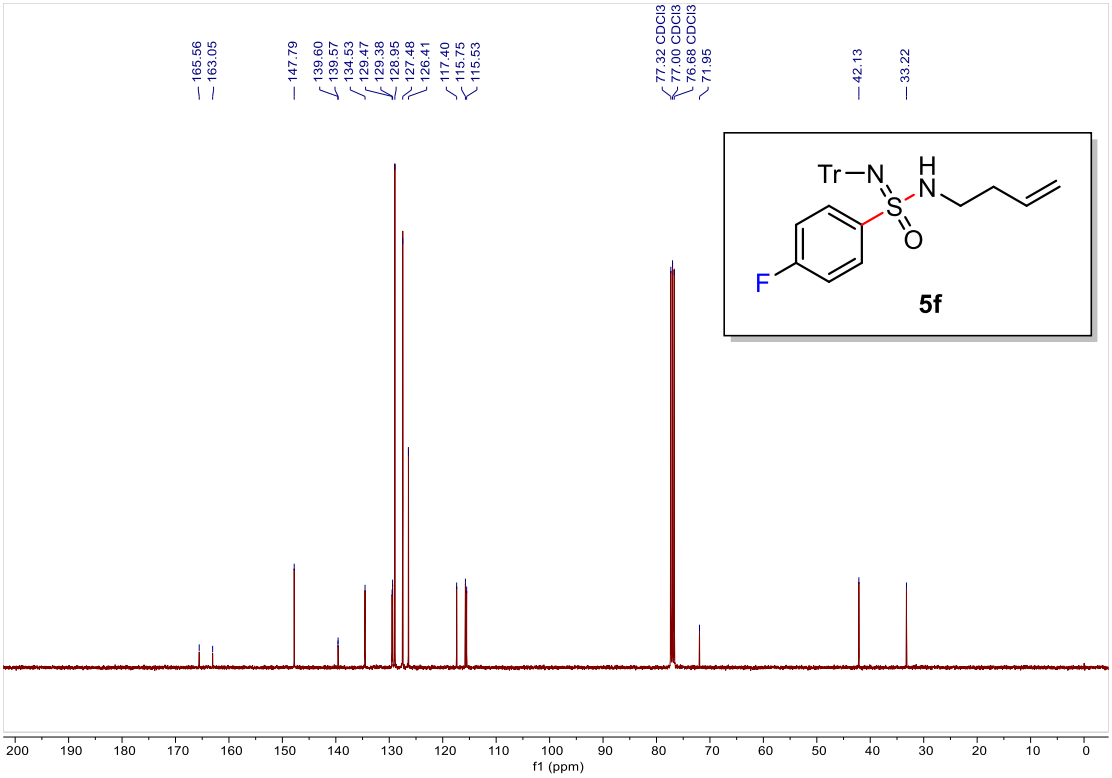
^{13}C NMR (101 MHz, $CDCl_3$) of **5e**



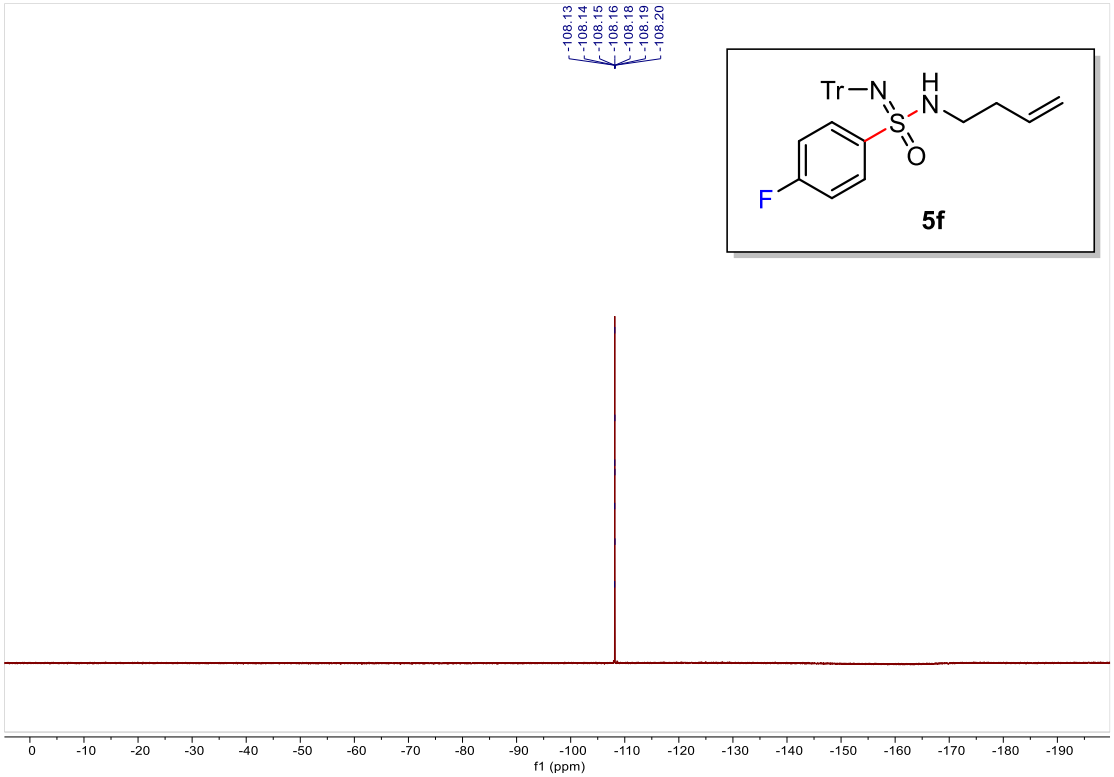
^{1}H NMR (400 MHz, $CDCl_3$) of **5f**



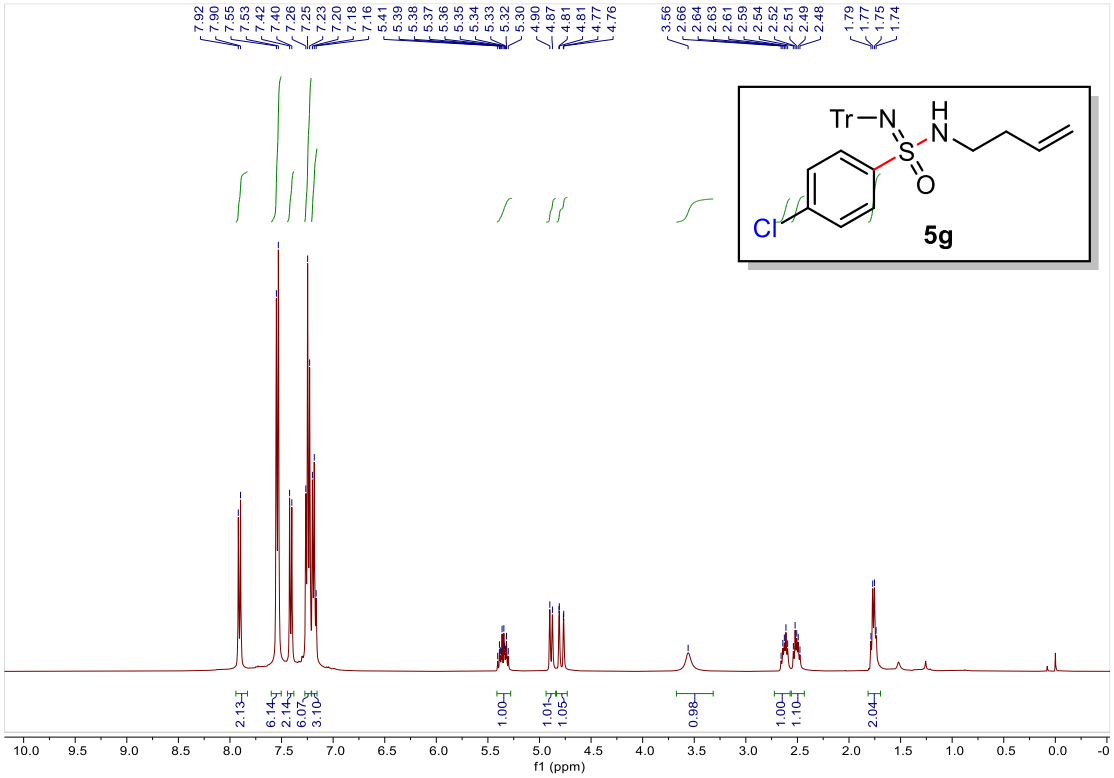
^{13}C NMR (101 MHz, $CDCl_3$) of **5f**



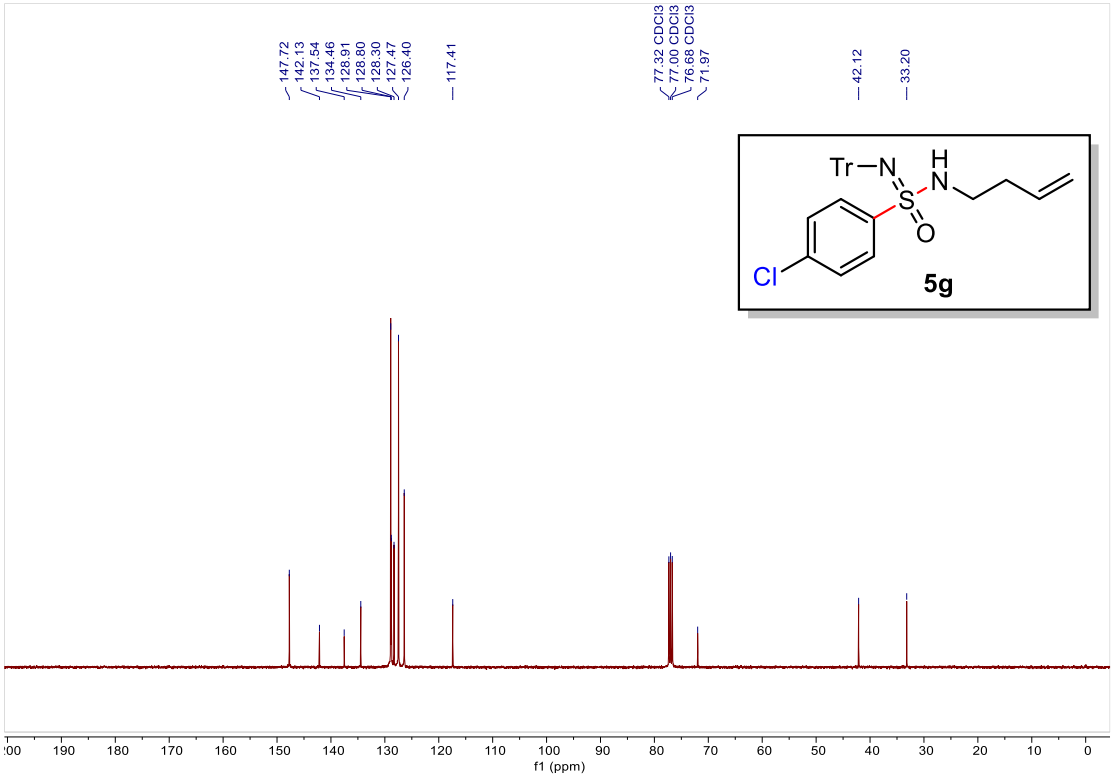
^{19}F NMR (377 MHz, $CDCl_3$) of 5f



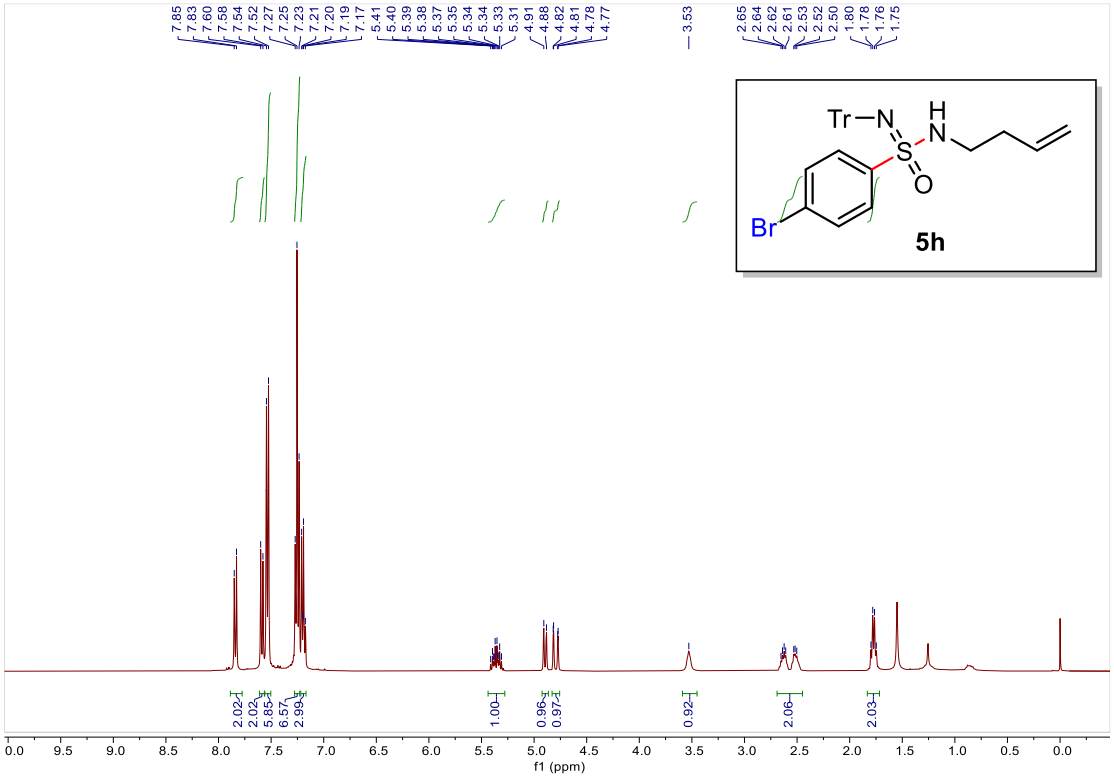
^{1}H NMR (400 MHz, $CDCl_3$) of 5g



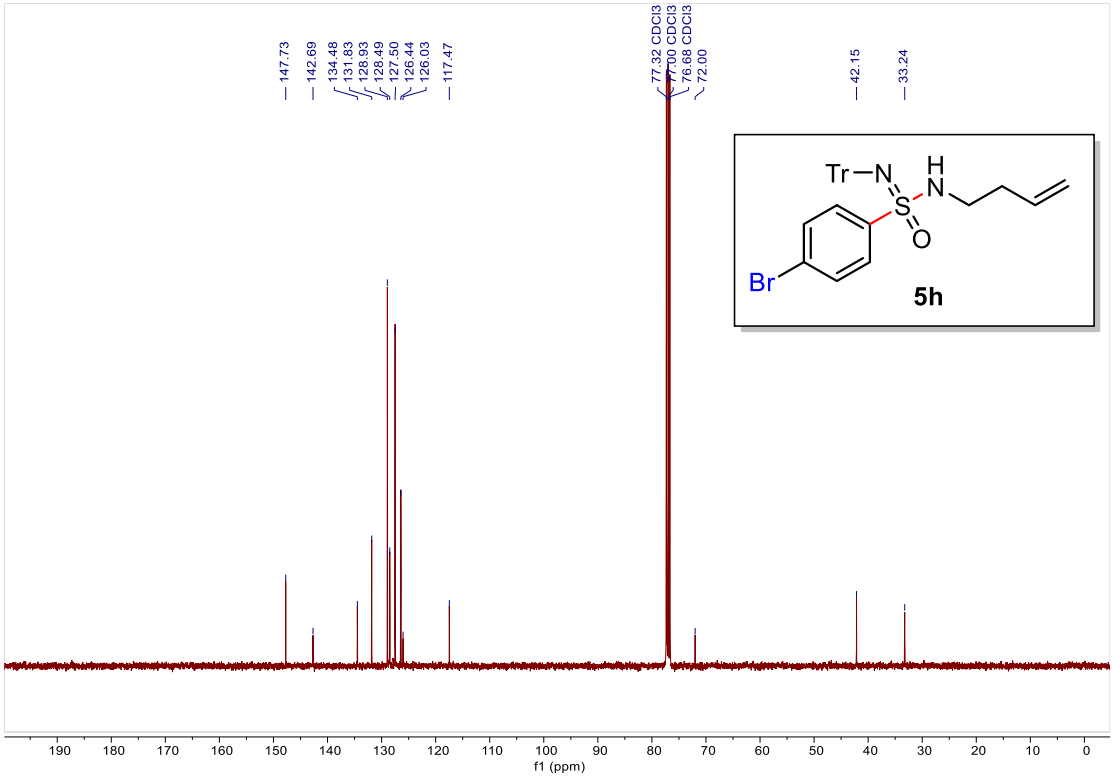
^{13}C NMR (101 MHz, $CDCl_3$) of **5g**



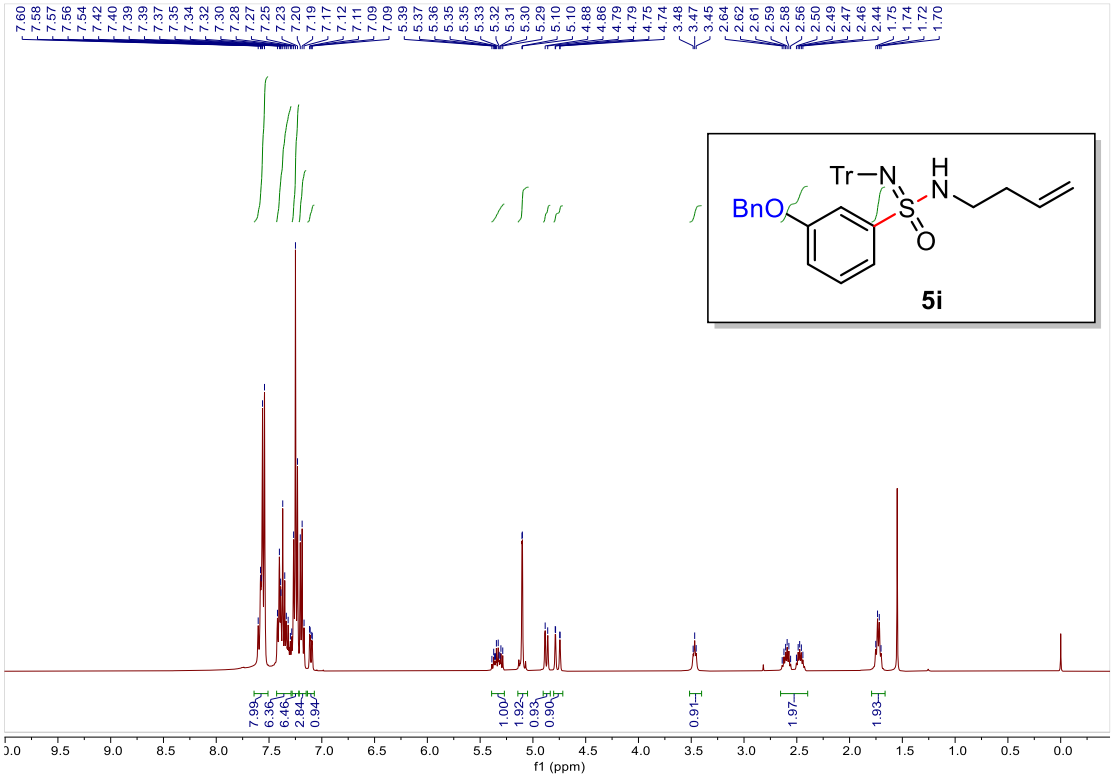
^{1}H NMR (400 MHz, $CDCl_3$) of **5h**



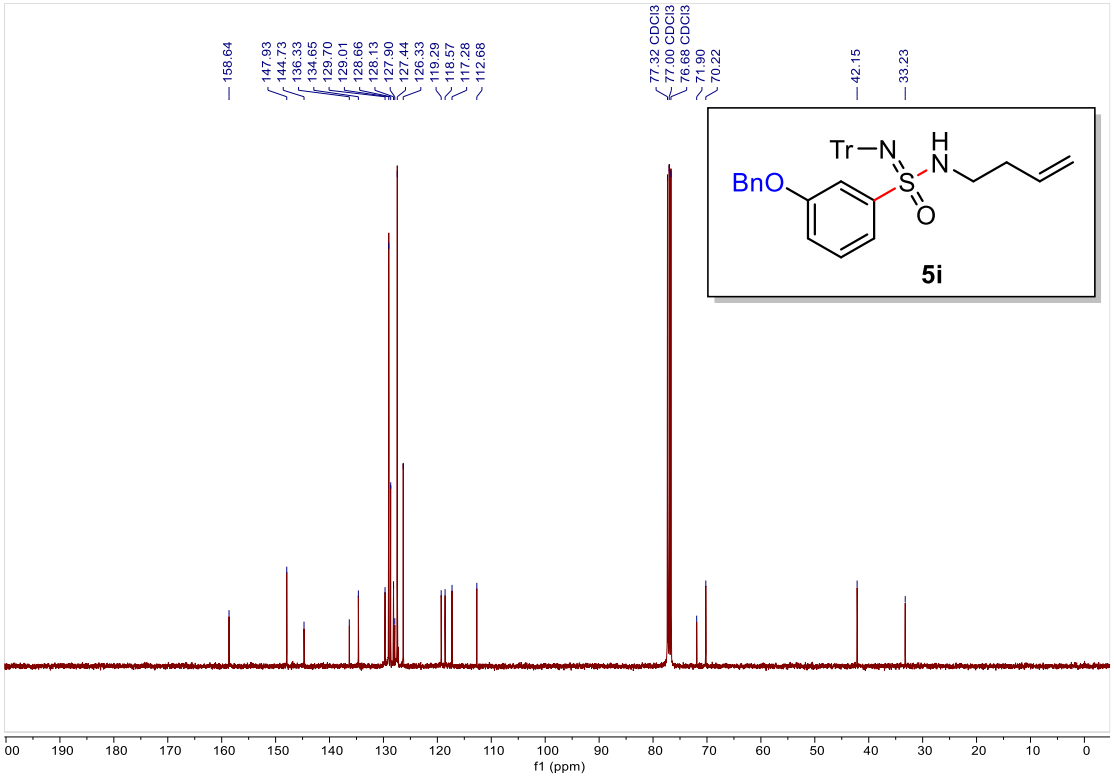
^{13}C NMR (101 MHz, $CDCl_3$) of 5h



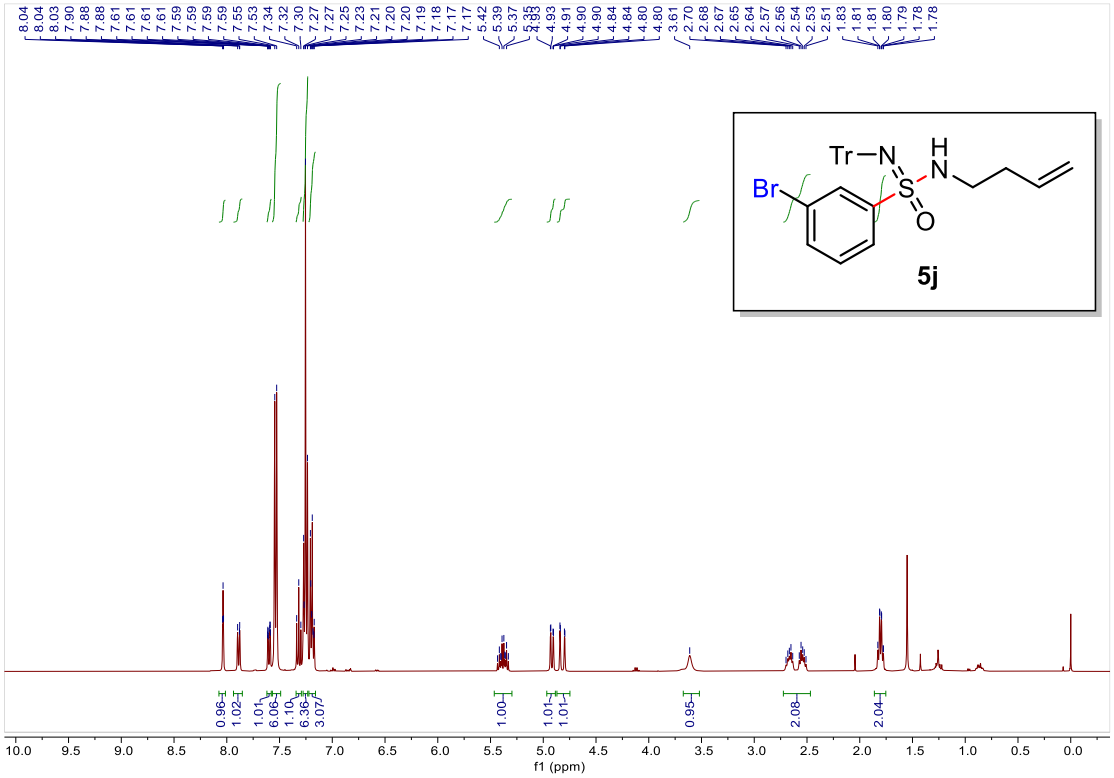
^{13}C NMR (101 MHz, $CDCl_3$) of 5i



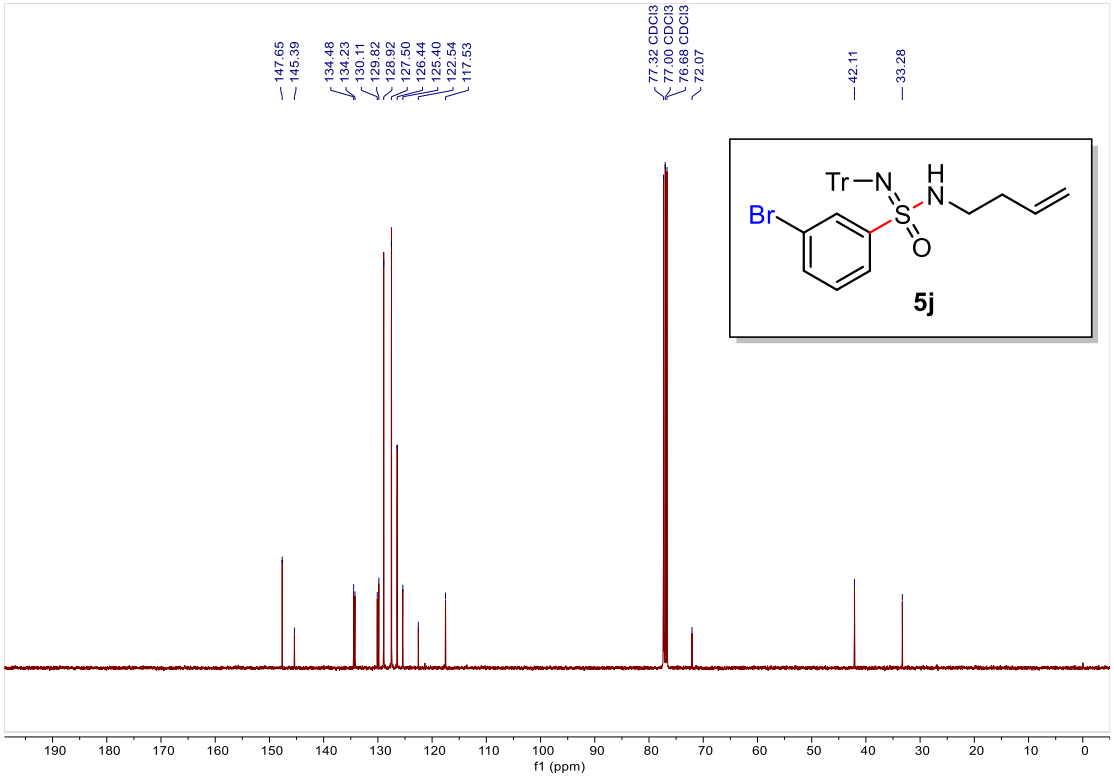
^{13}C NMR (101 MHz, $CDCl_3$) of **5i**



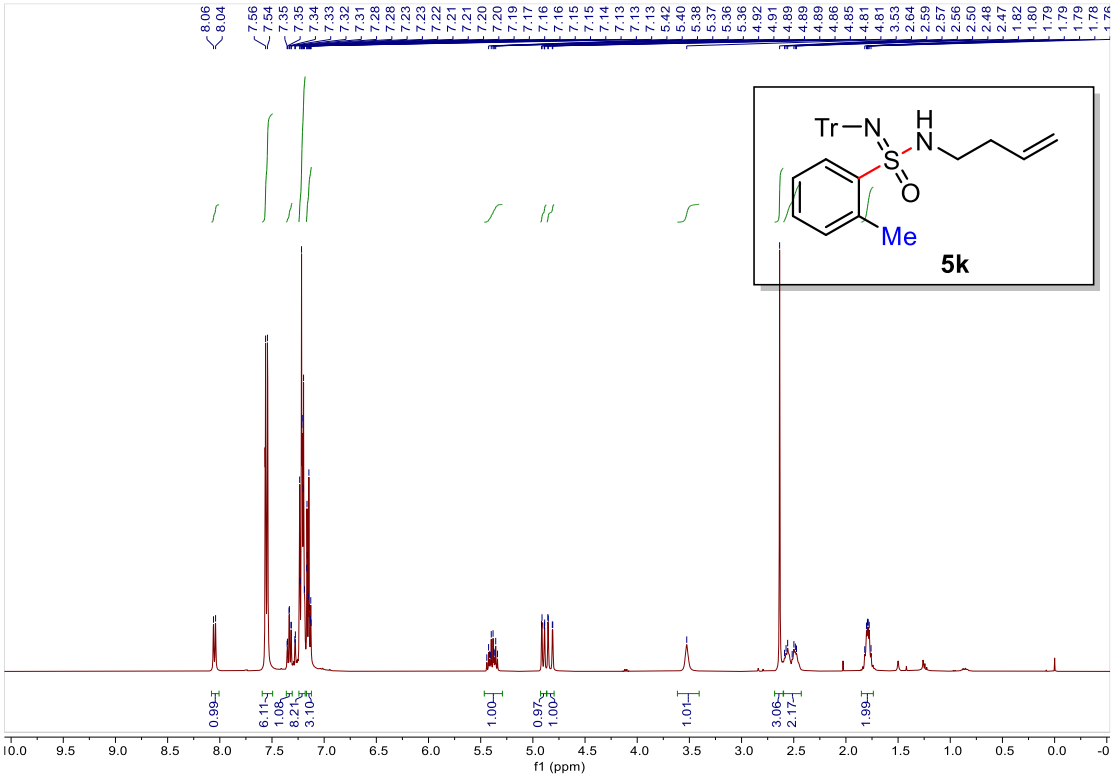
^{1}H NMR (400 MHz, $CDCl_3$) of **5j**



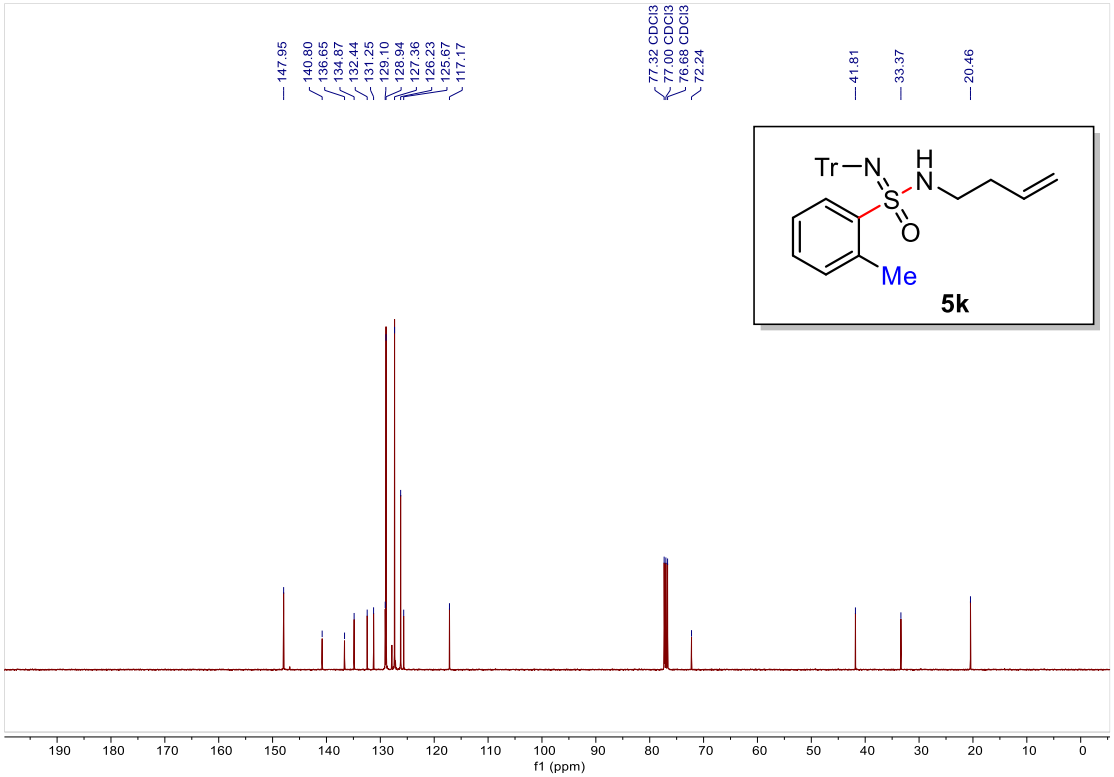
^{13}C NMR (101 MHz, $CDCl_3$) of **5j**



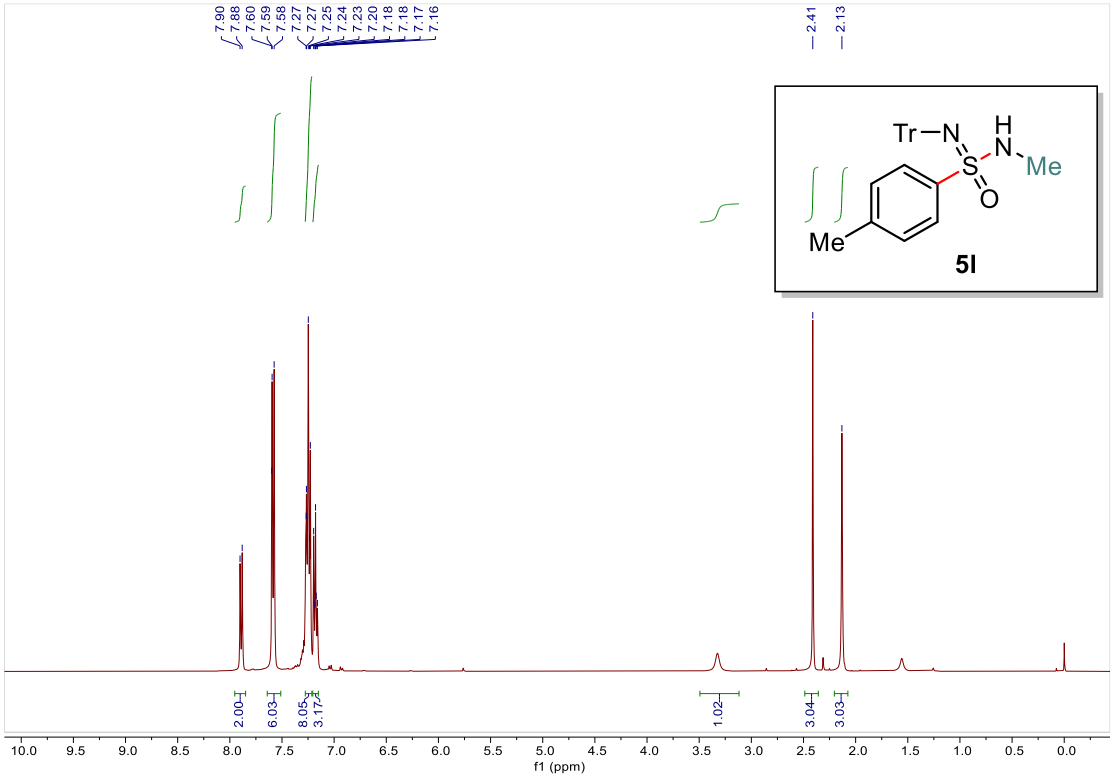
^{1}H NMR (400 MHz, $CDCl_3$) of **5k**



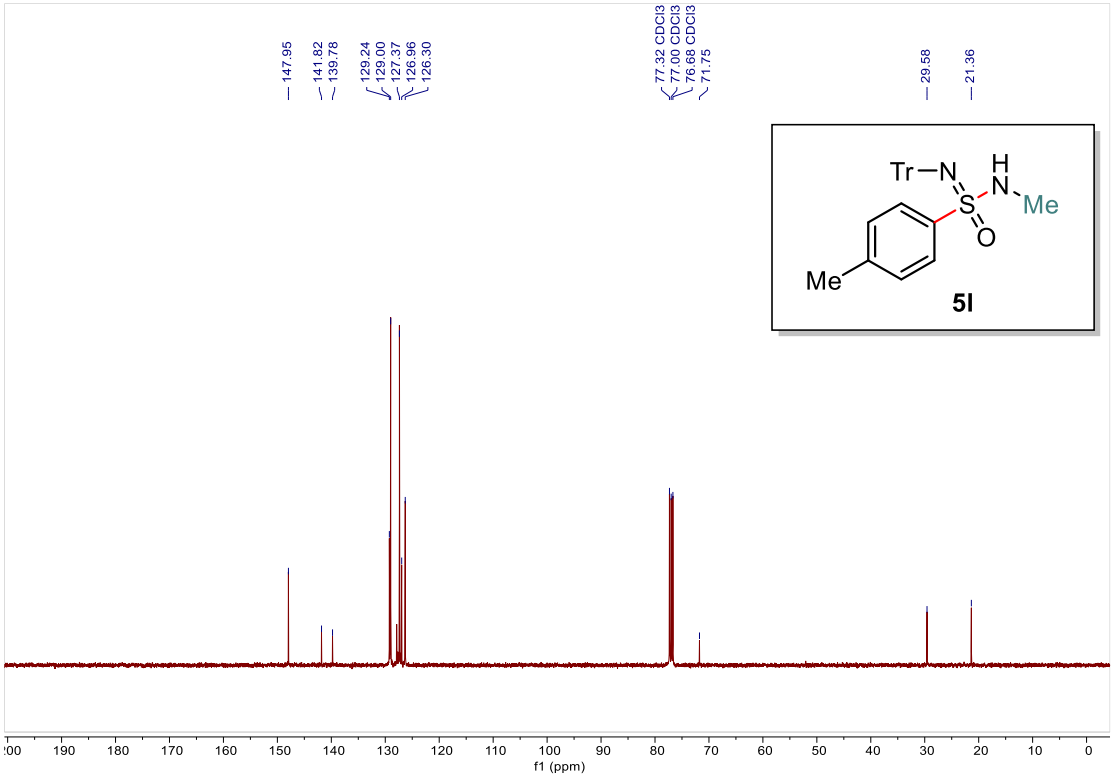
^{13}C NMR (101 MHz, $CDCl_3$) of 5k



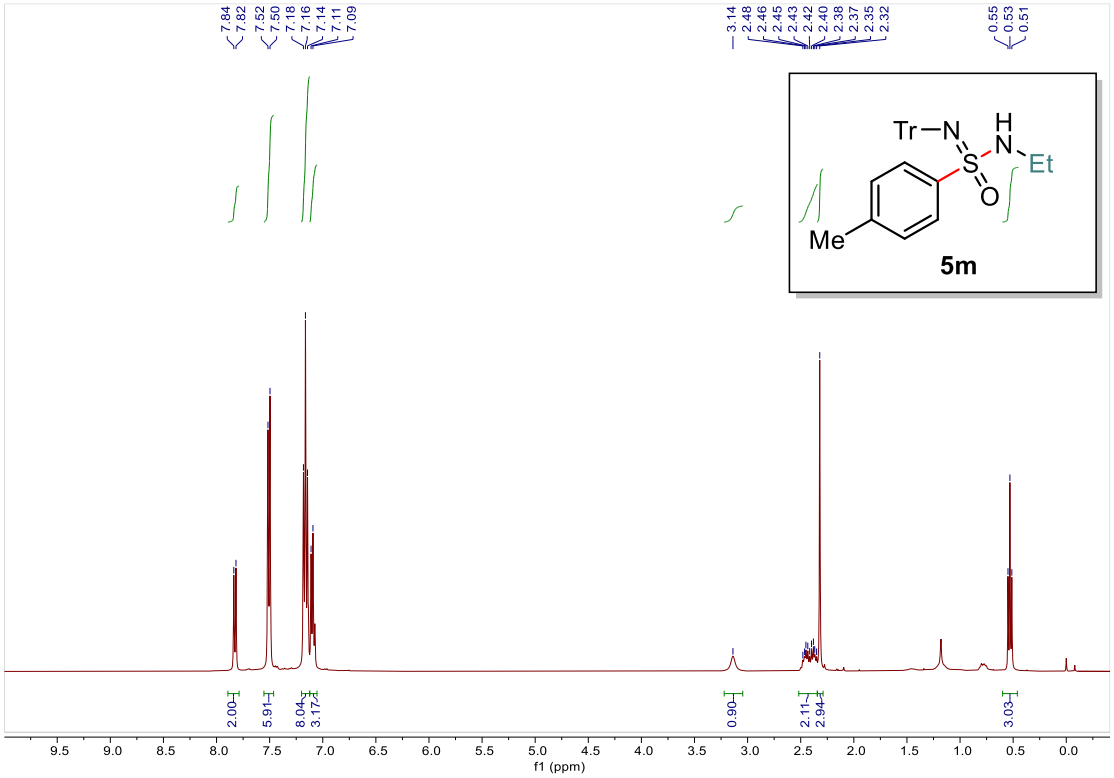
^{1}H NMR (400 MHz, $CDCl_3$) of 5l



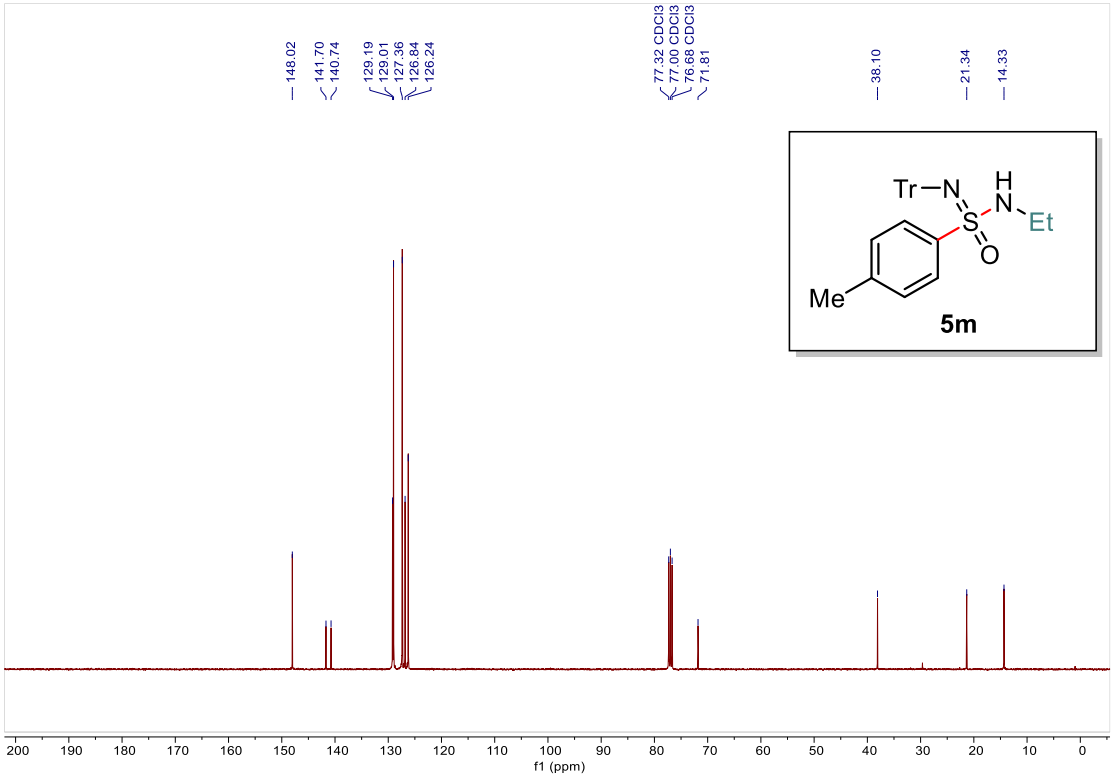
^{13}C NMR (101 MHz, $CDCl_3$) of **5l**



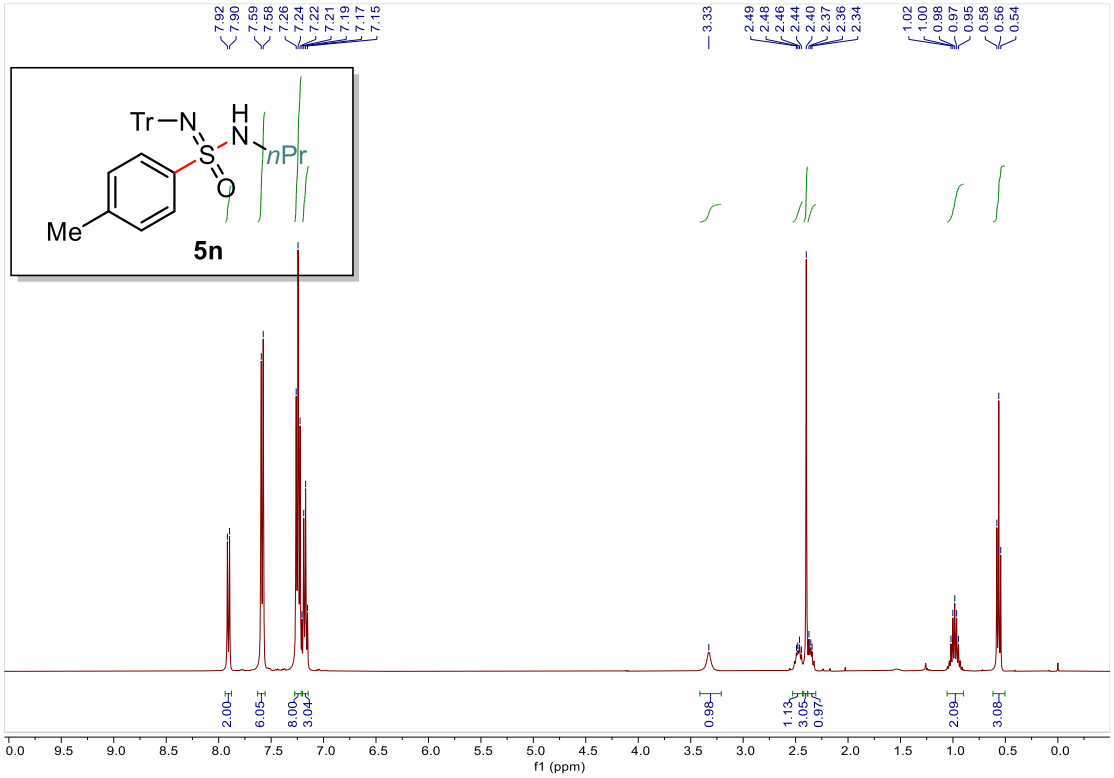
^{1}H NMR (400 MHz, $CDCl_3$) of **5m**



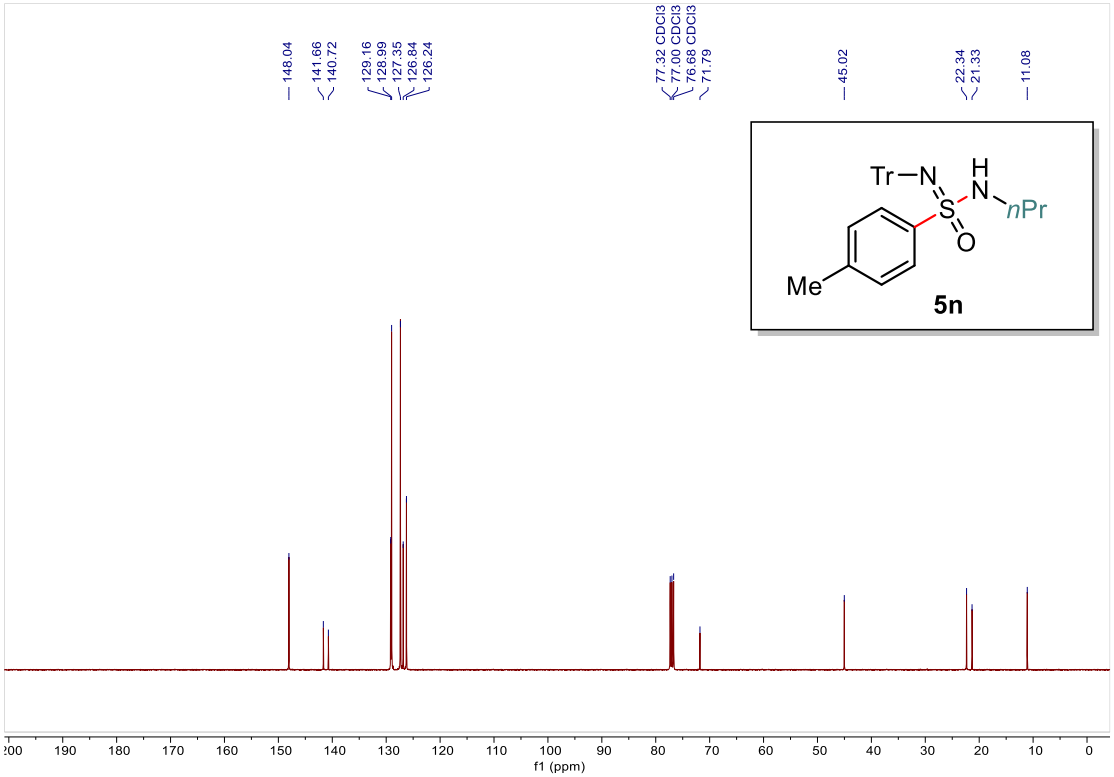
^{13}C NMR (101 MHz, $CDCl_3$) of **5m**



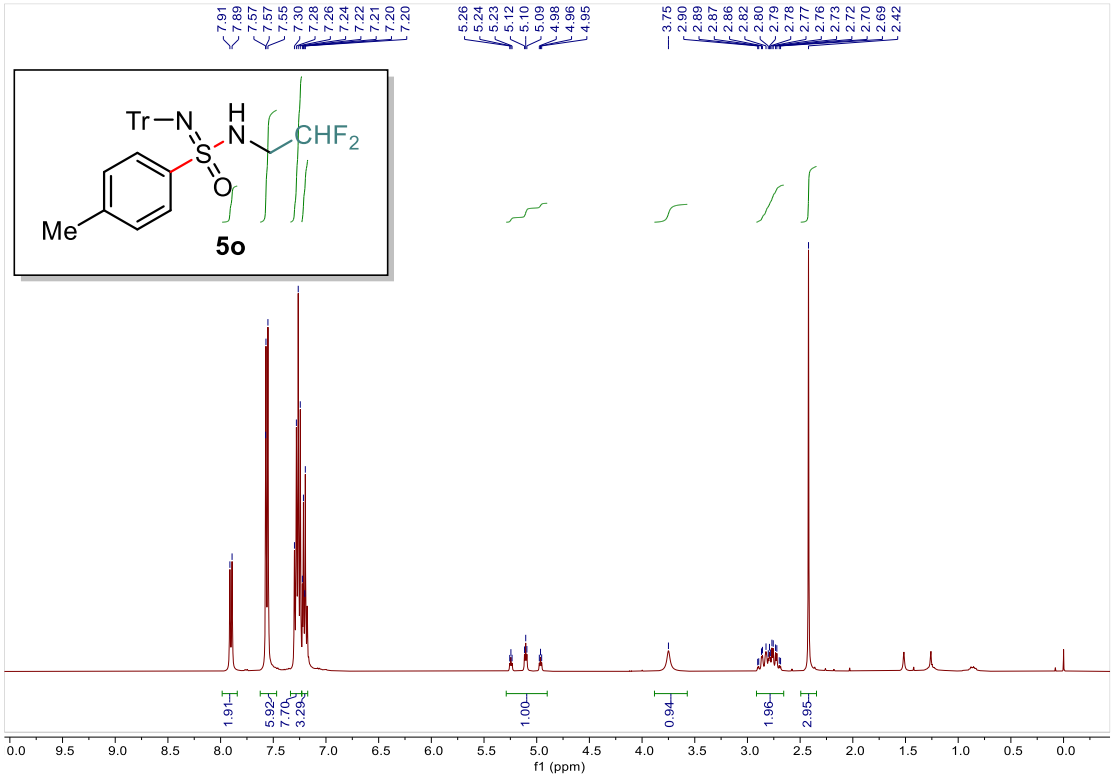
^{1}H NMR (400 MHz, $CDCl_3$) of **5n**



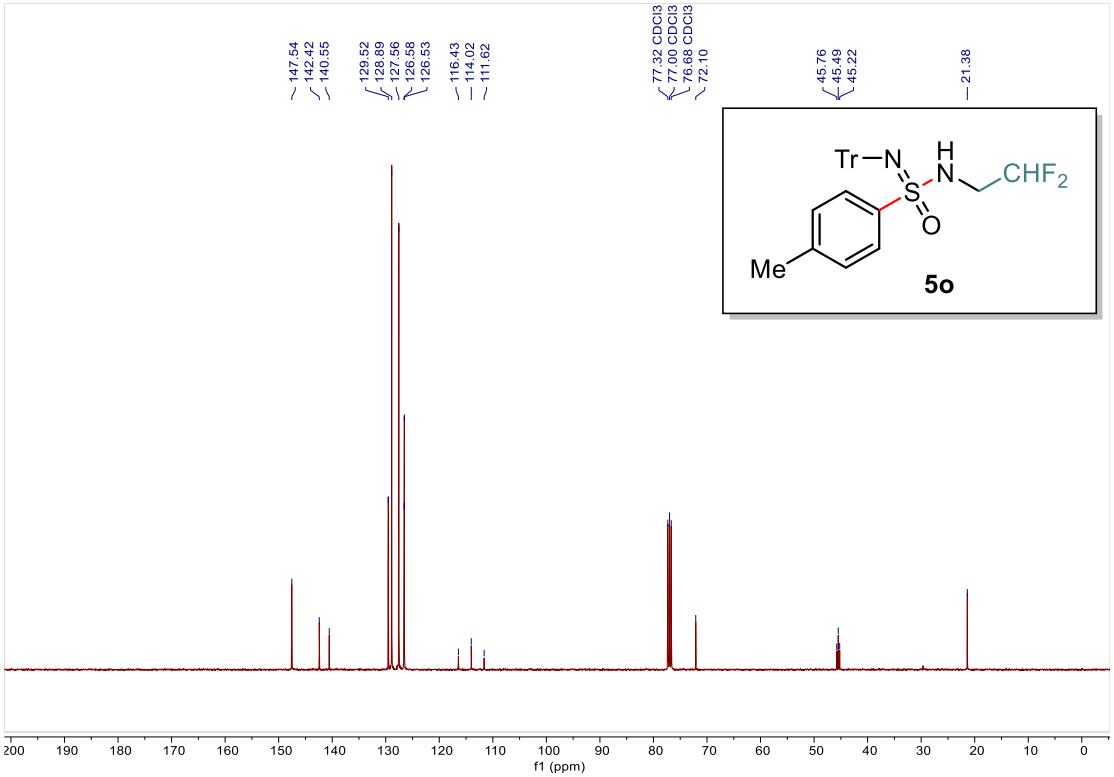
^{13}C NMR (101 MHz, $CDCl_3$) of **5n**



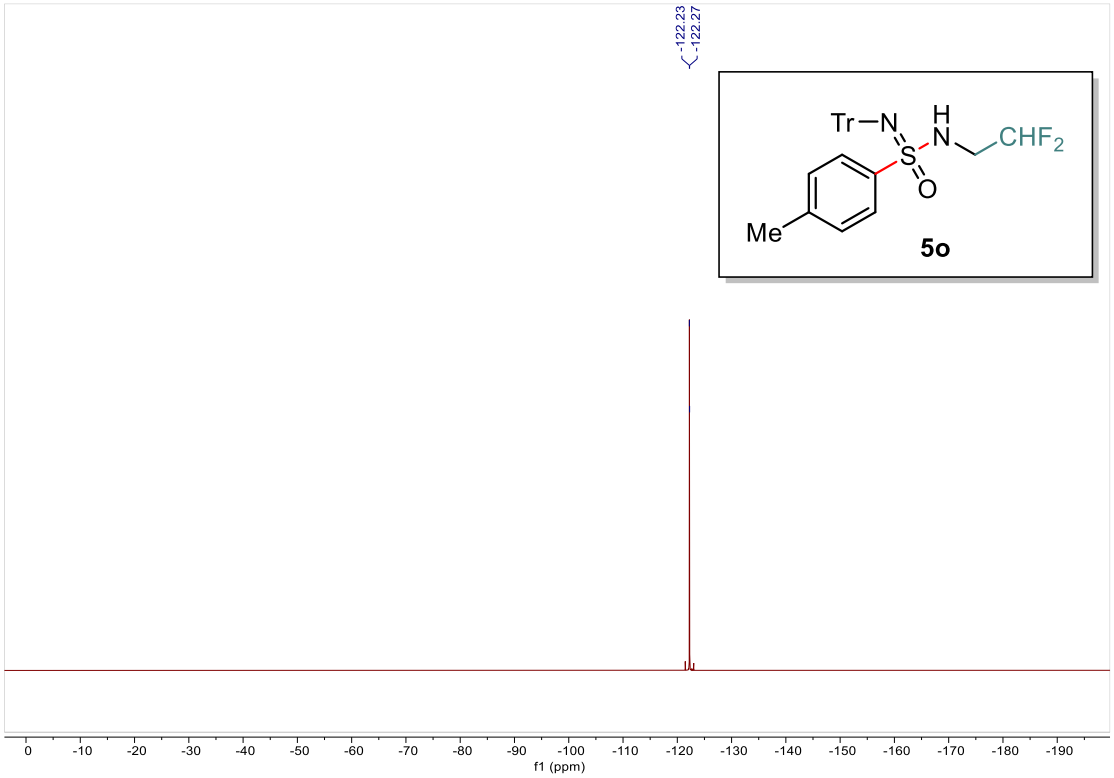
^{1}H NMR (400 MHz, $CDCl_3$) of **5o**



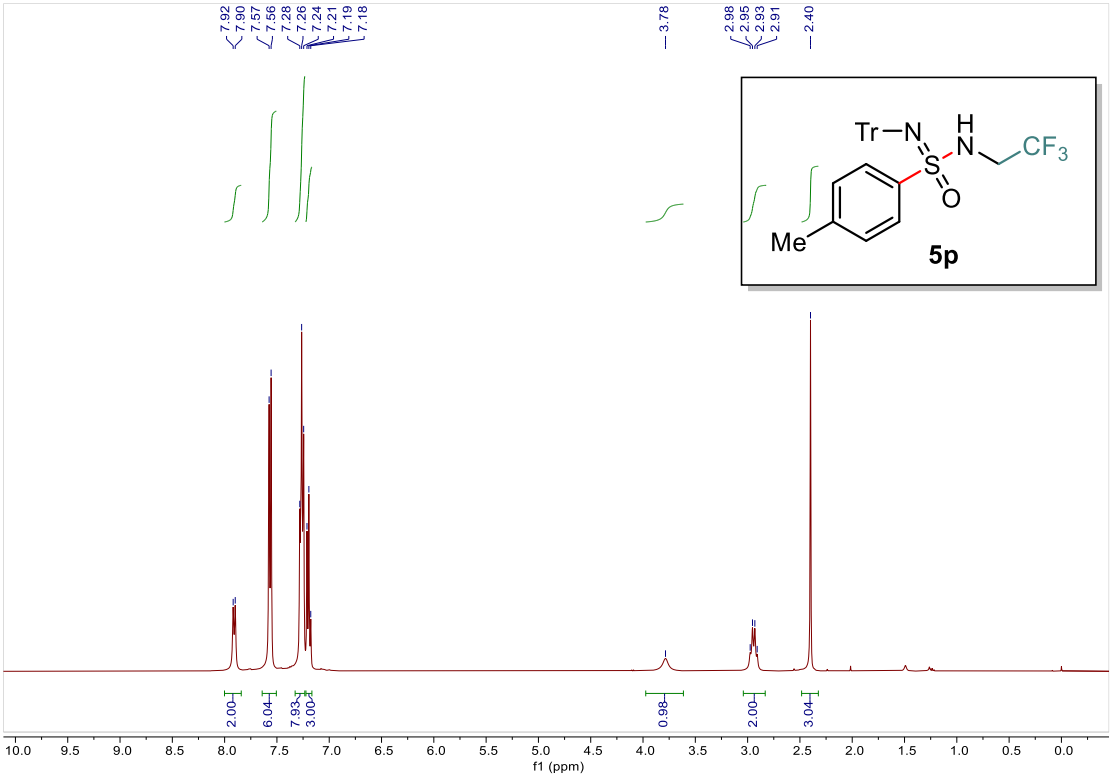
^{13}C NMR (101 MHz, $CDCl_3$) of **5o**



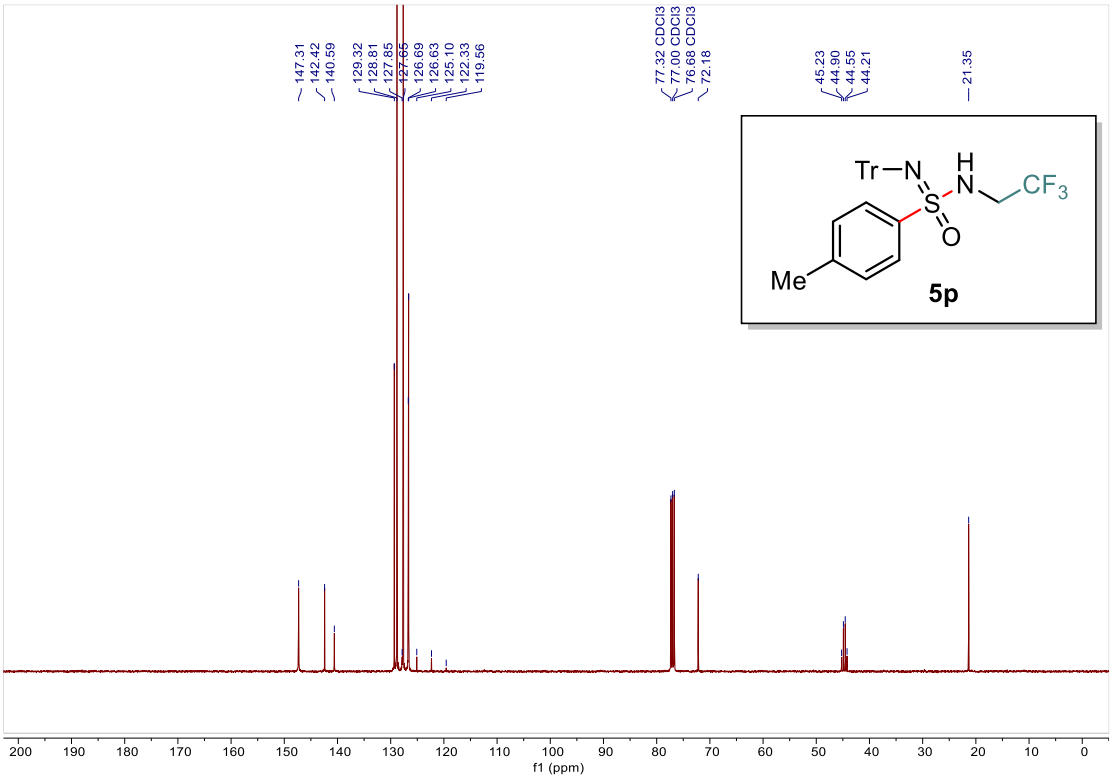
^{19}F NMR (377 MHz, $CDCl_3$) of **5o**



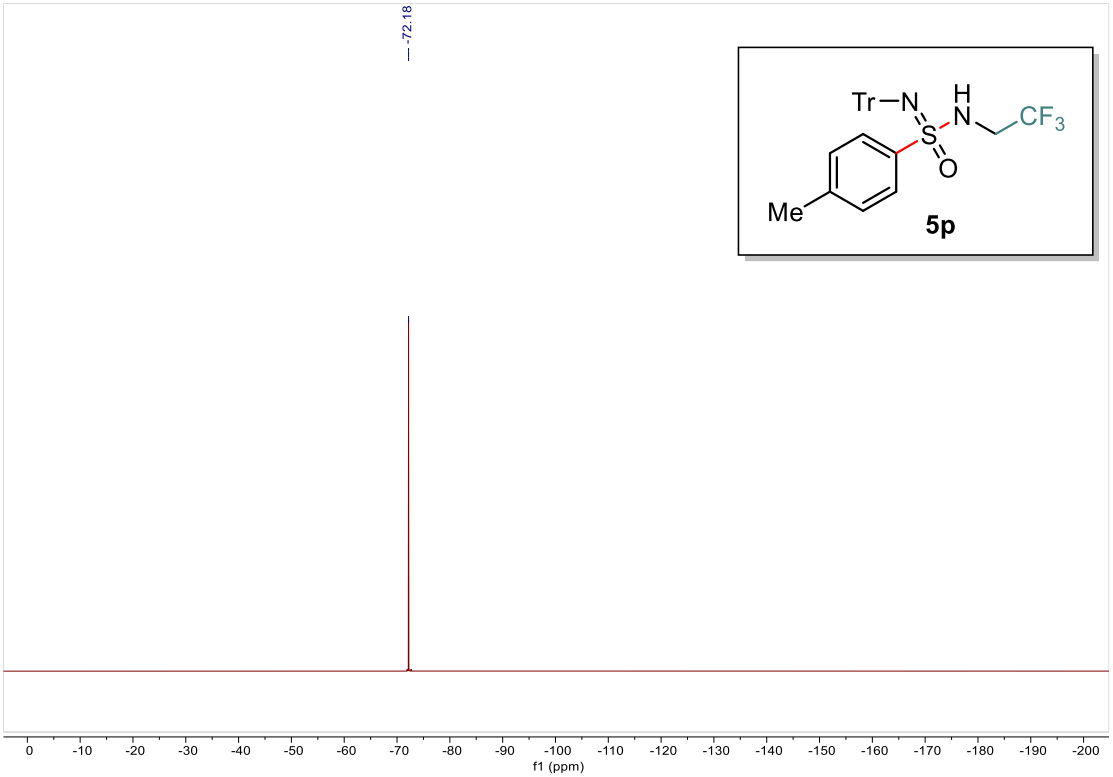
^{1}H NMR (400 MHz, $CDCl_3$) of **5p**



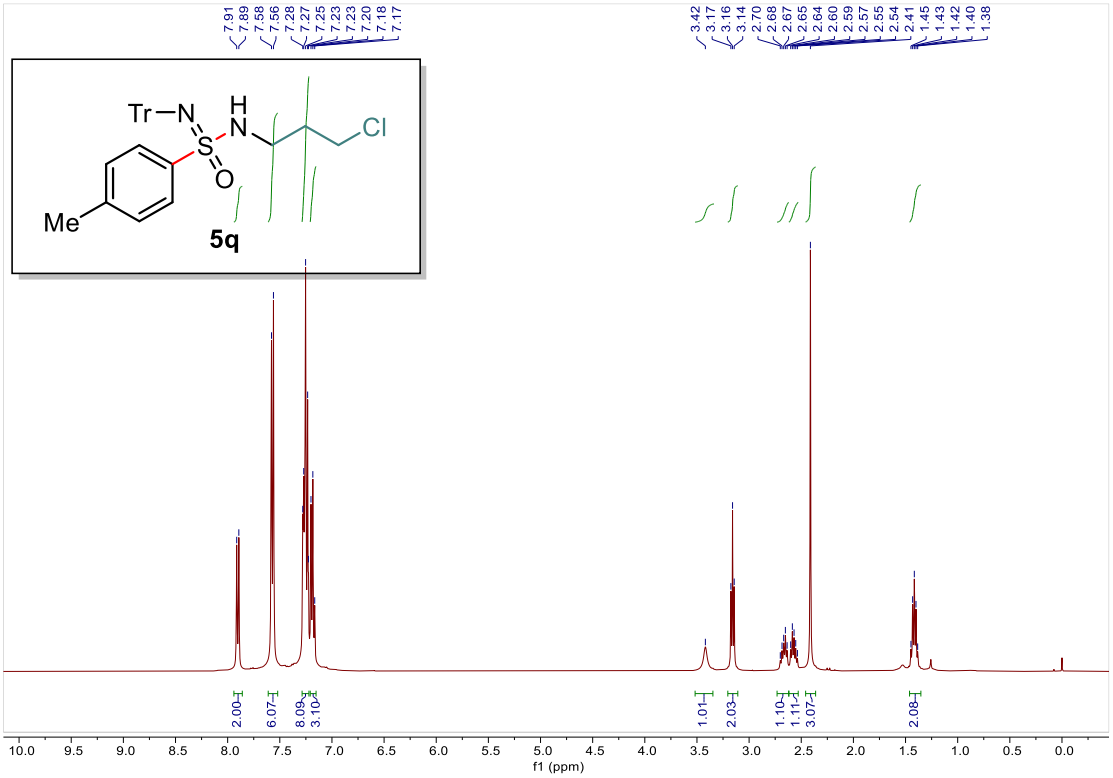
^{13}C NMR (101 MHz, $CDCl_3$) of **5p**



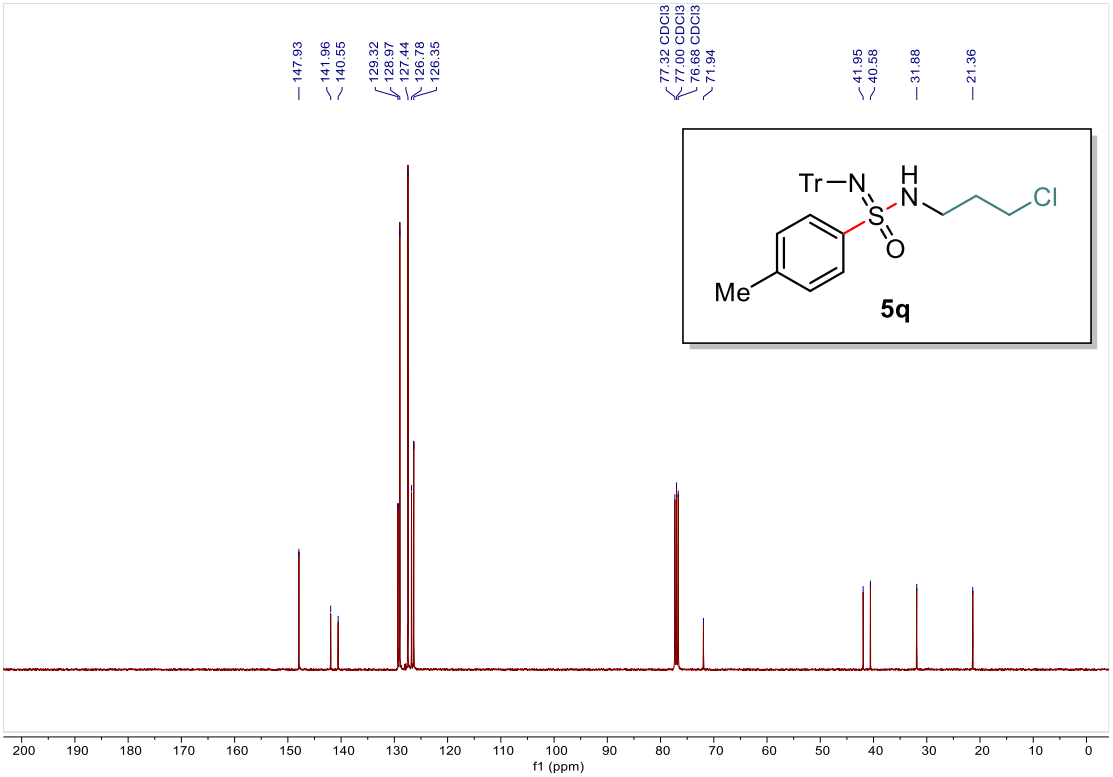
^{19}F NMR (377 MHz, $CDCl_3$) of **5p**



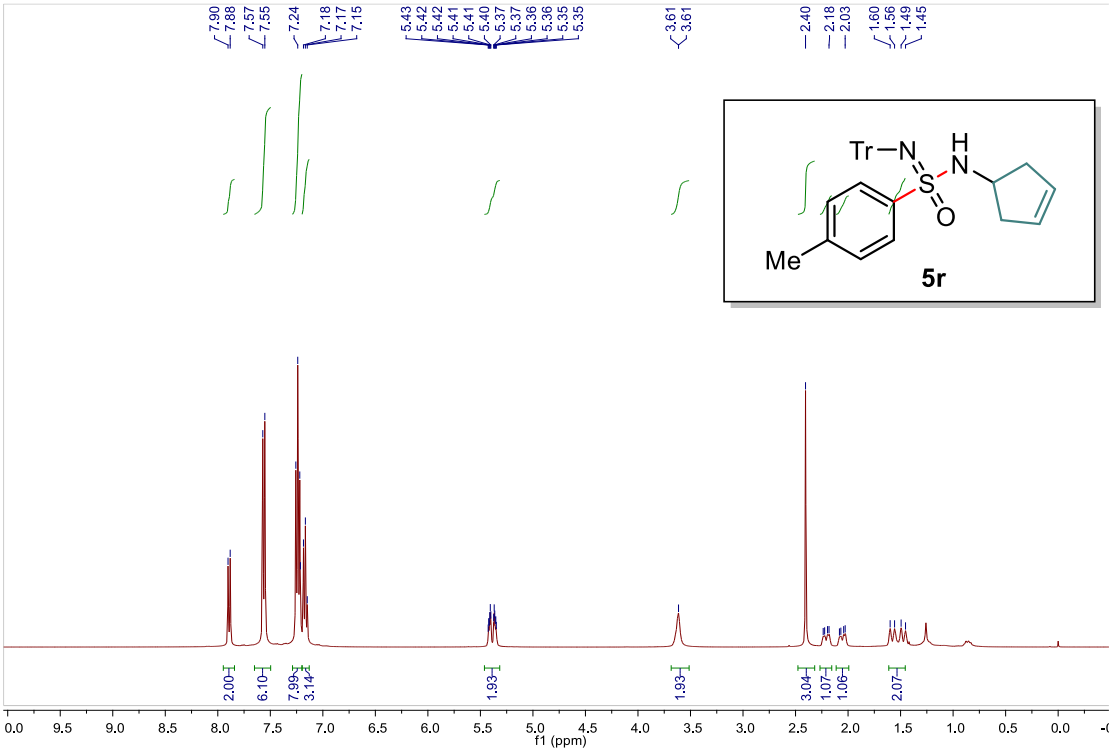
^{1}H NMR (400 MHz, $CDCl_3$) of **5q**



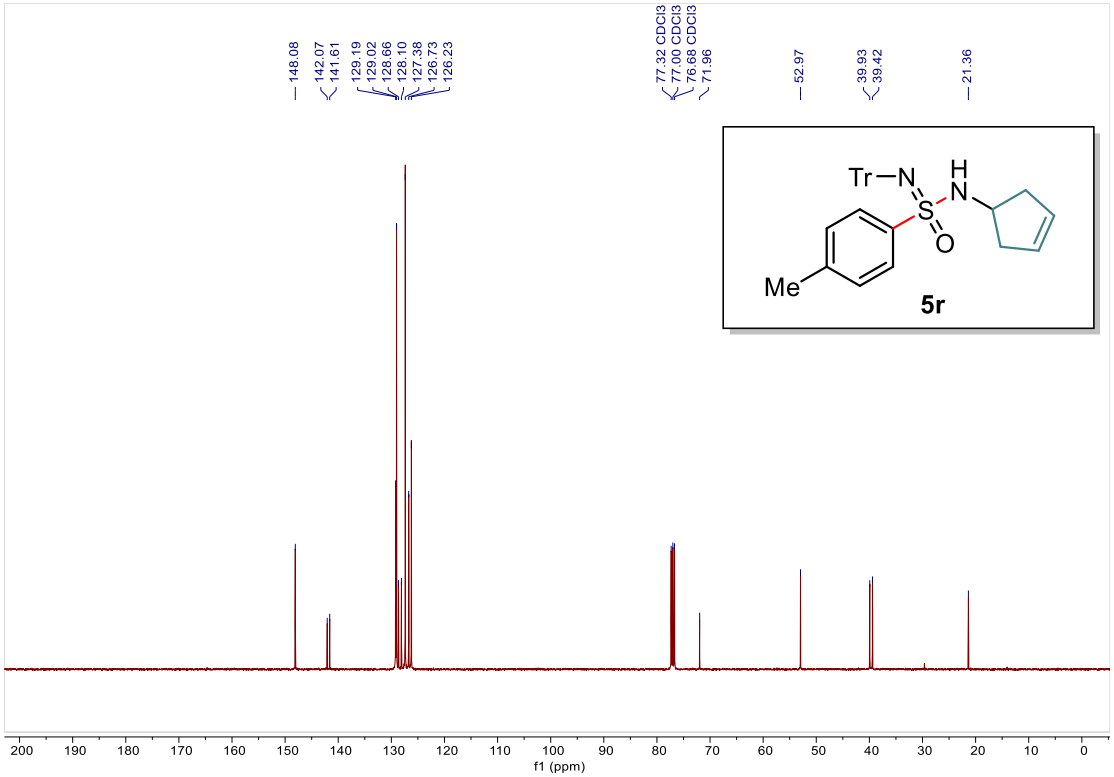
^{13}C NMR (101 MHz, $CDCl_3$) of **5q**



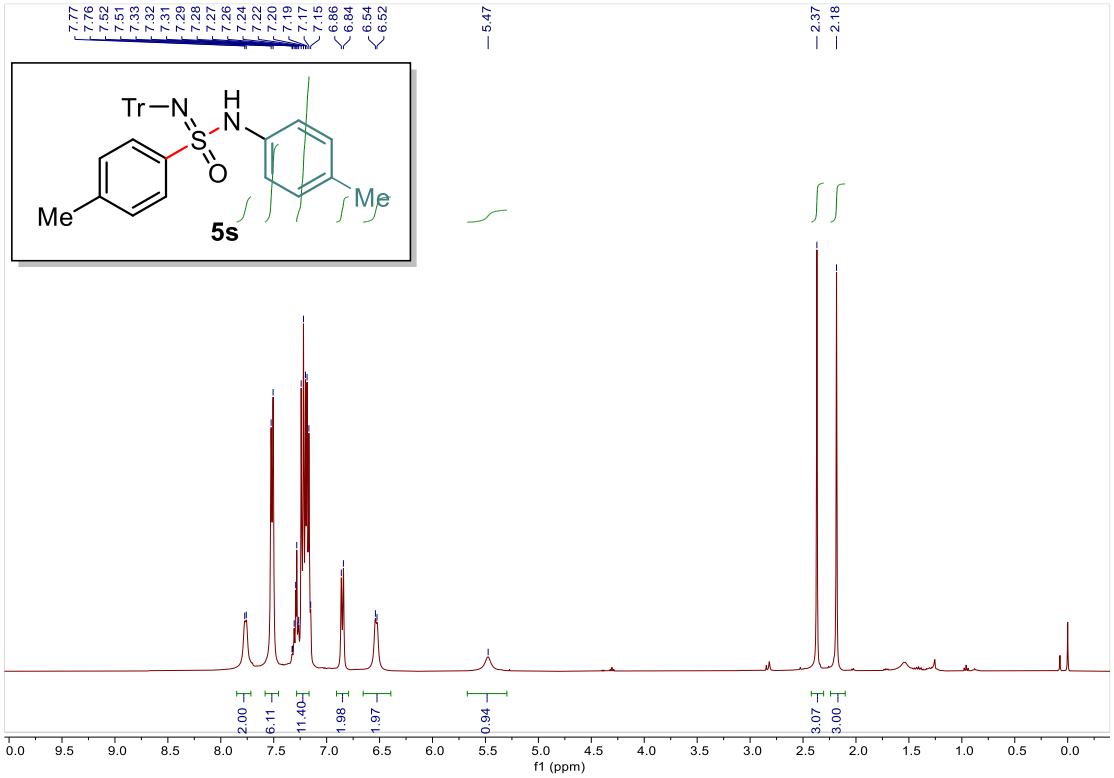
^{1}H NMR (400 MHz, $CDCl_3$) of **5r**



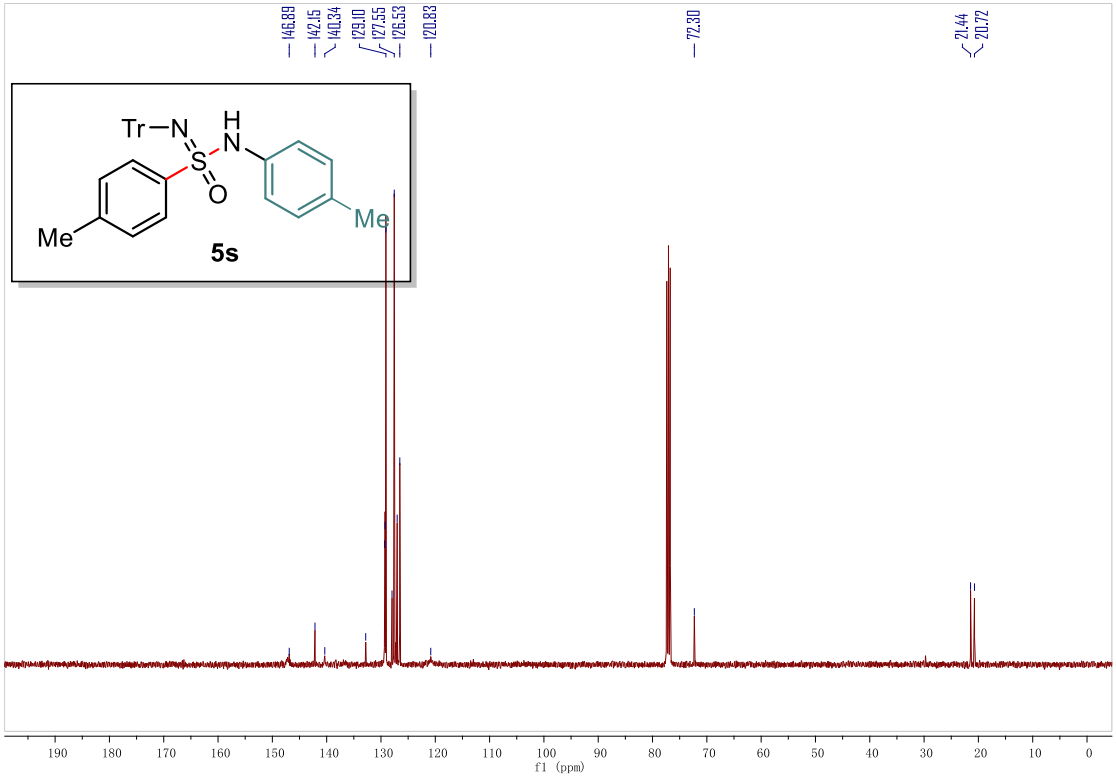
^{13}C NMR (101 MHz, $CDCl_3$) of 5r



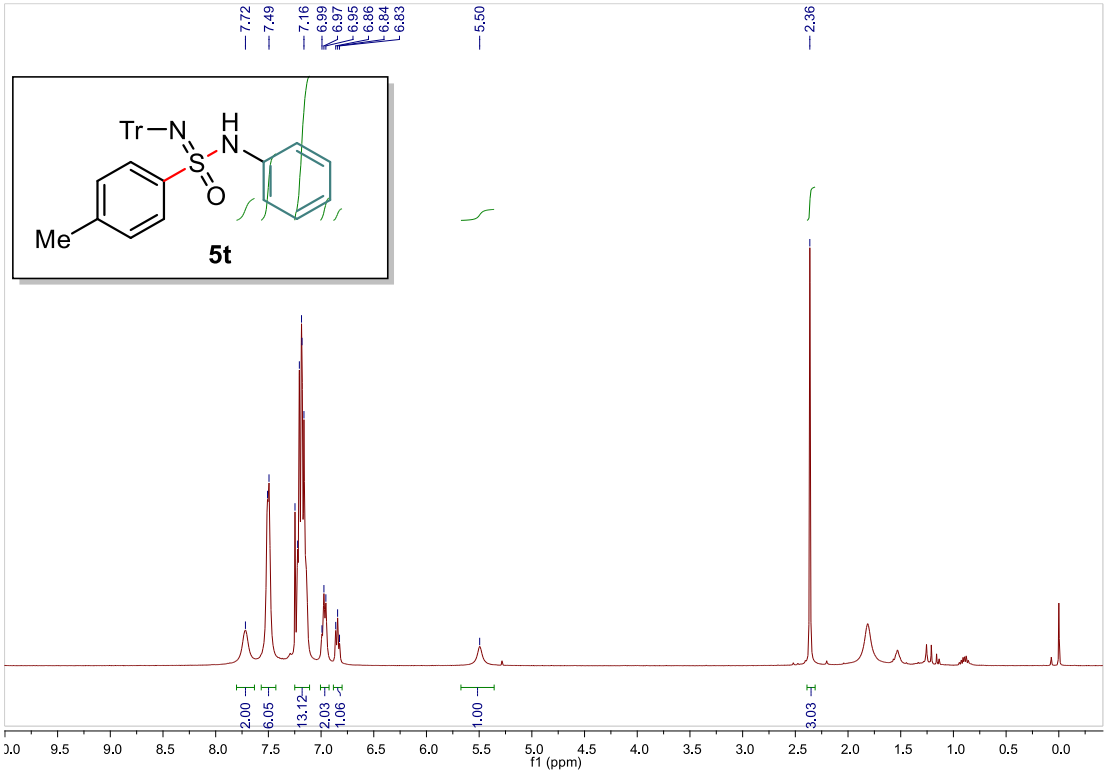
^{1}H NMR (400 MHz, $CDCl_3$) of 5s



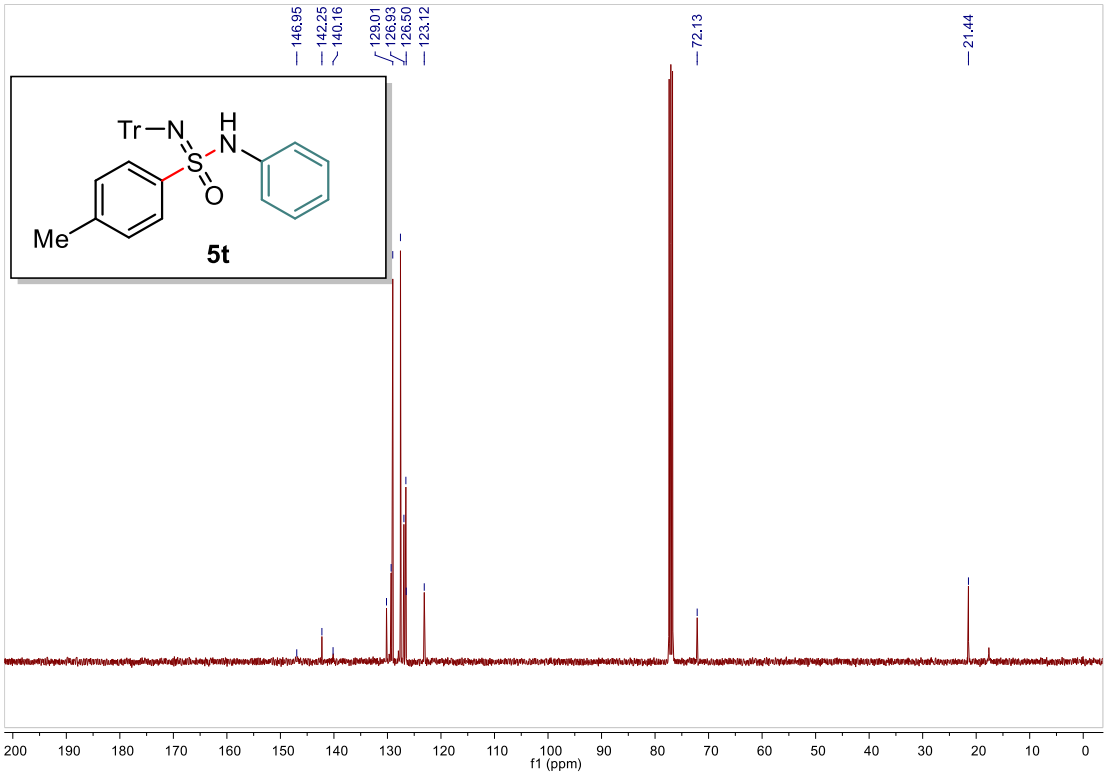
^{13}C NMR (101 MHz, $CDCl_3$) of 5s



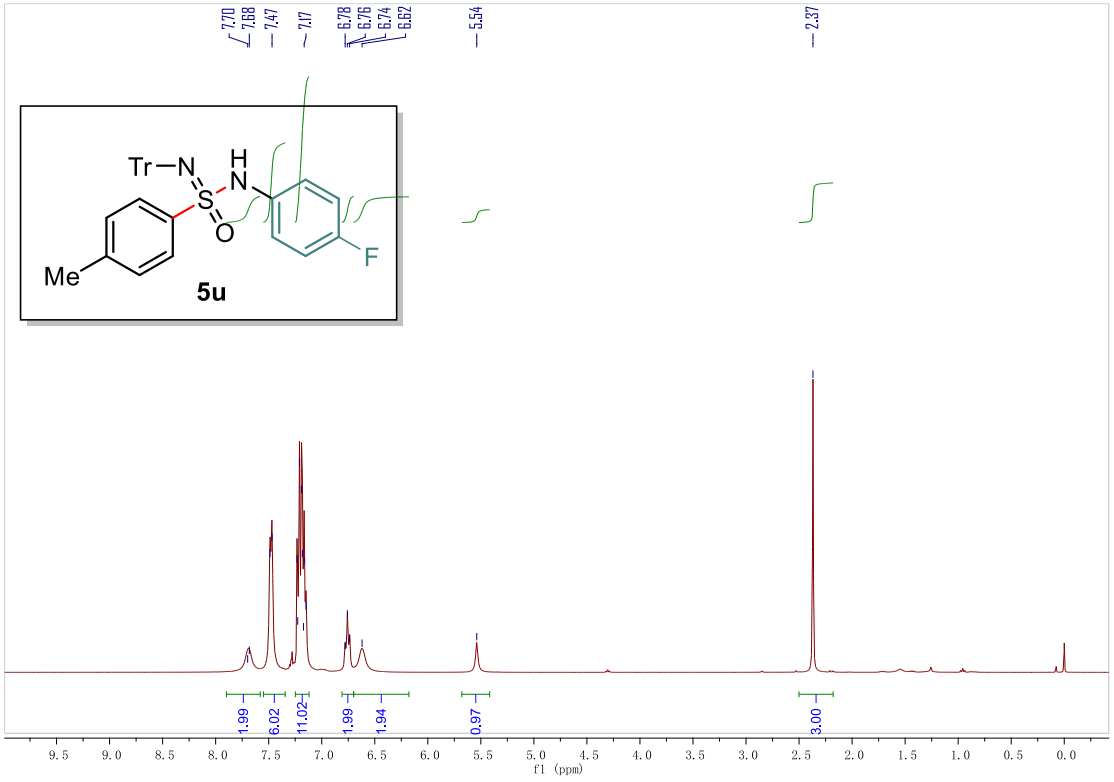
^{1}H NMR (400 MHz, $CDCl_3$) of 5t



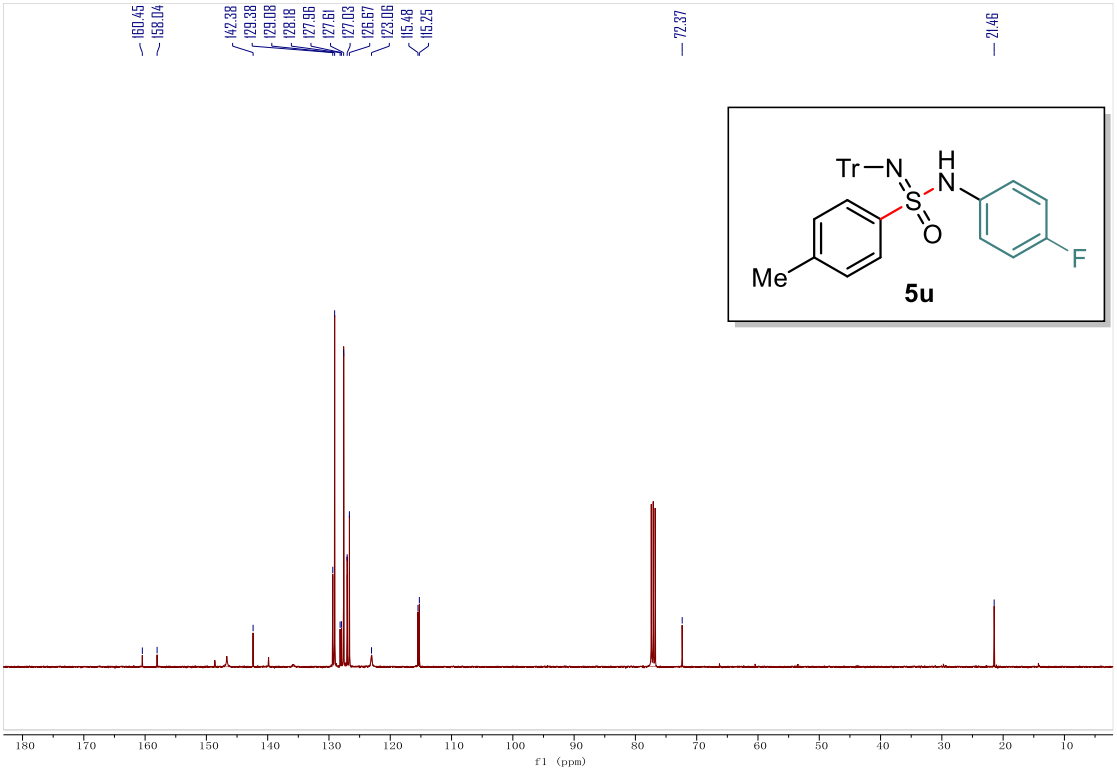
^{13}C NMR (101 MHz, $CDCl_3$) of 5t



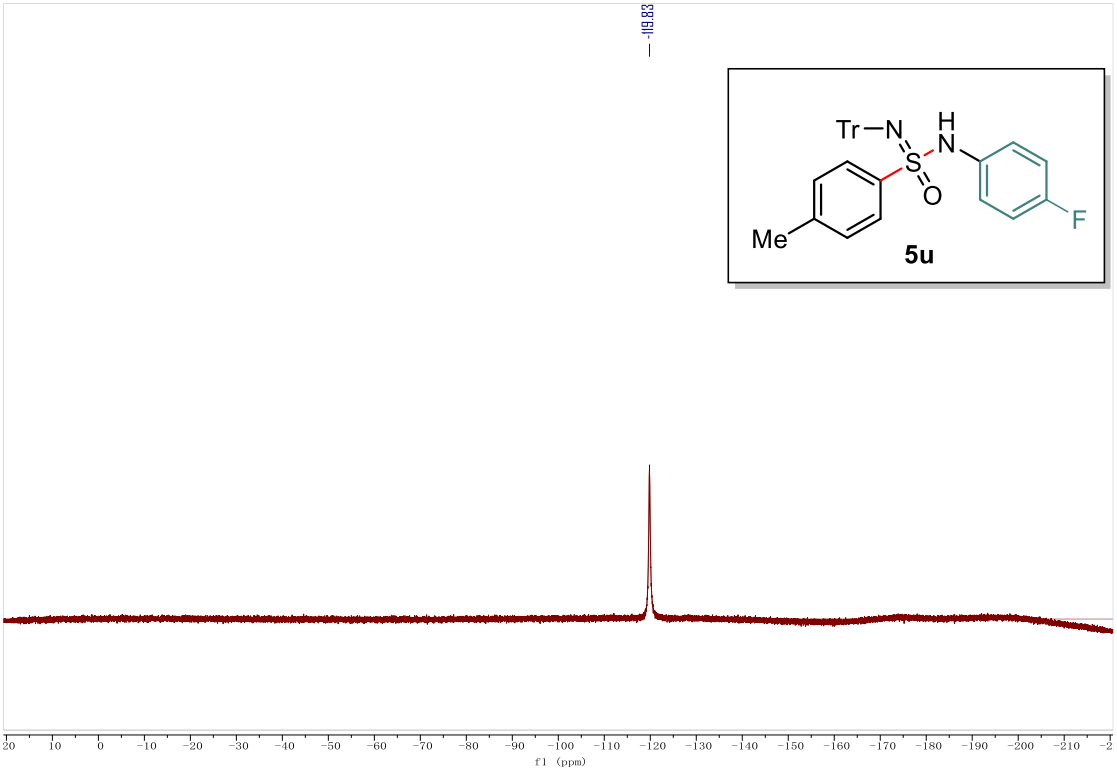
^{1}H NMR (400 MHz, $CDCl_3$) of 5u



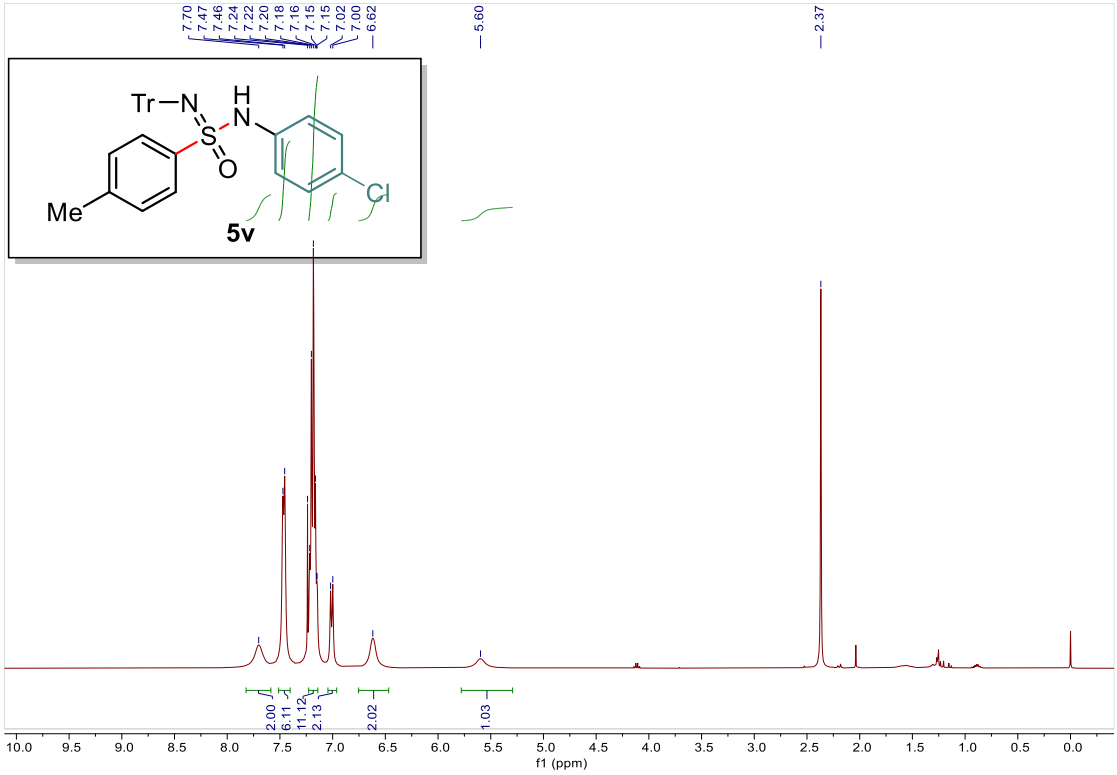
^{13}C NMR (101 MHz, $CDCl_3$) of **5u**



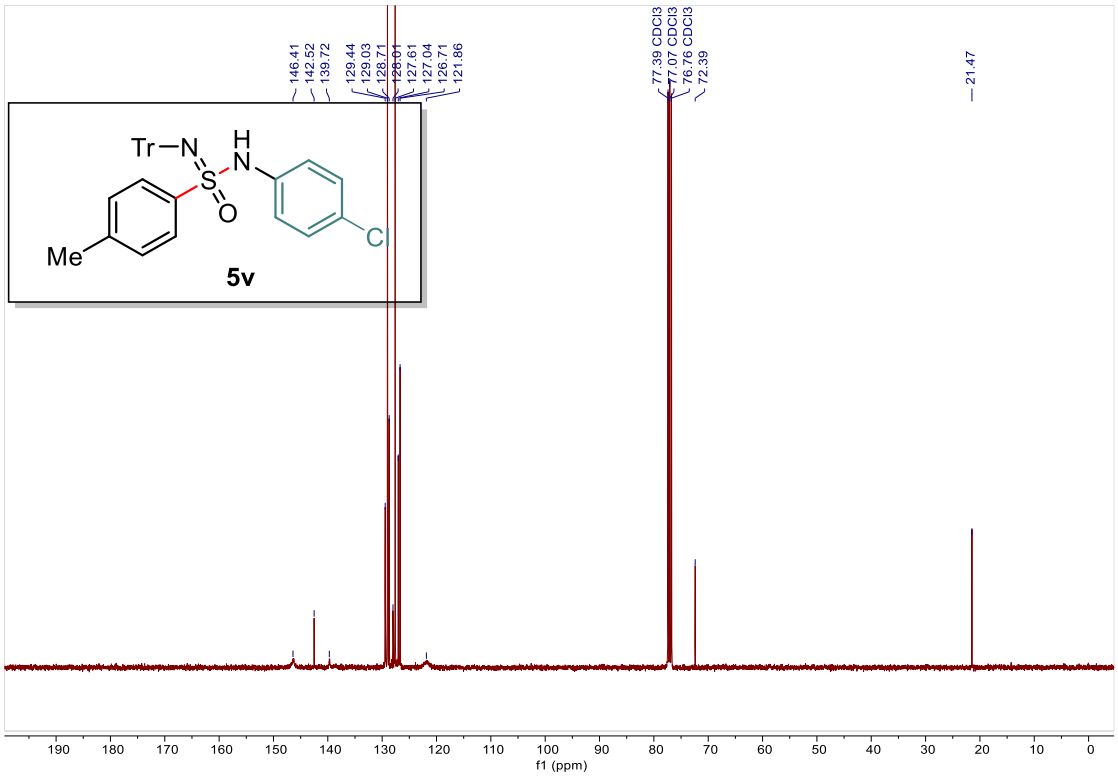
^{19}F NMR (377 MHz, $CDCl_3$) of **5u**



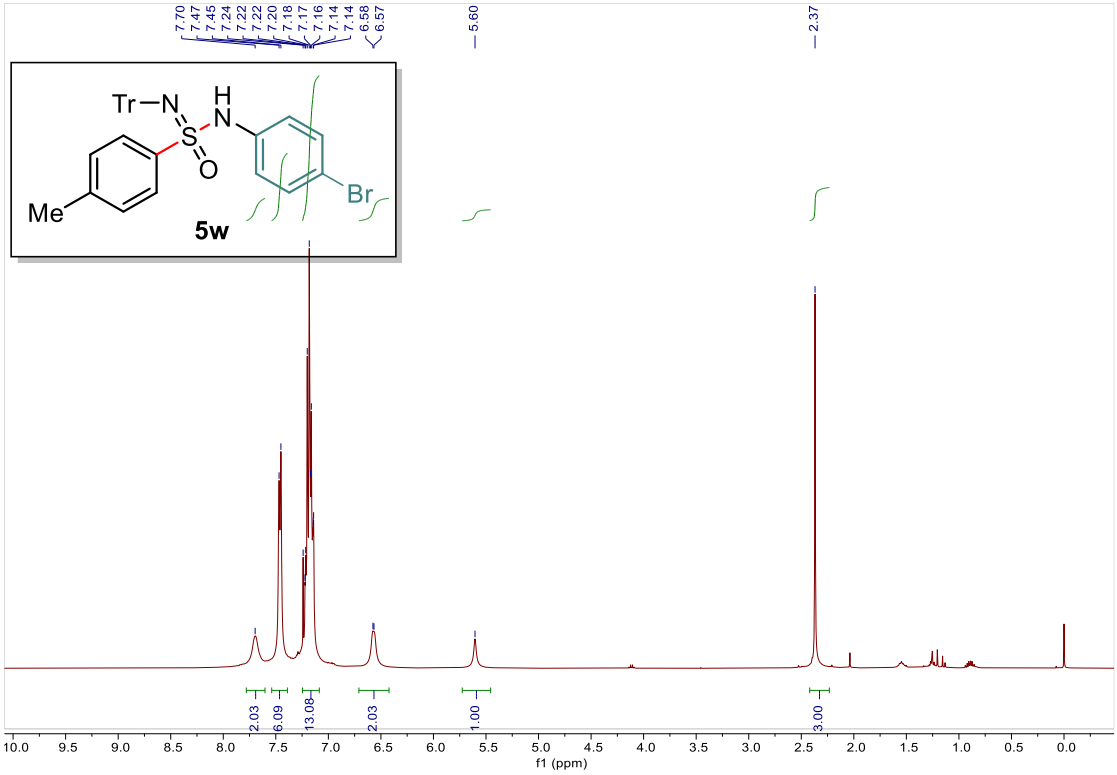
^{1}H NMR (400 MHz, $CDCl_3$) of 5v



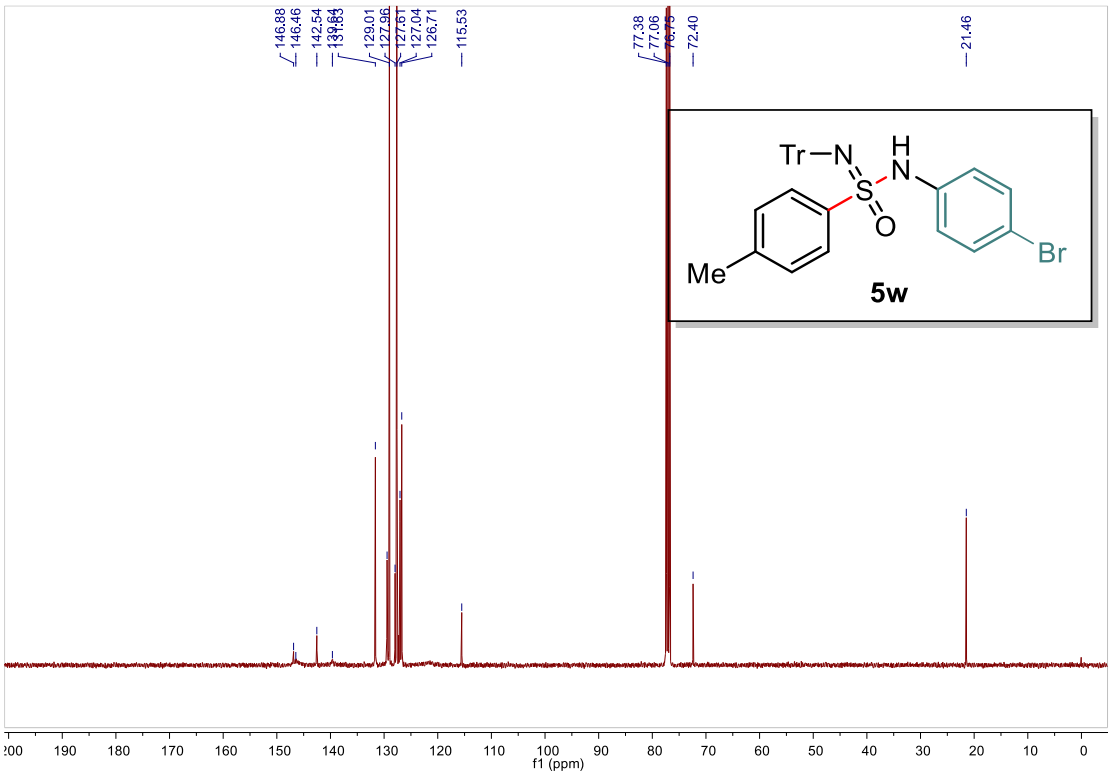
^{13}C NMR (101 MHz, $CDCl_3$) of 5v



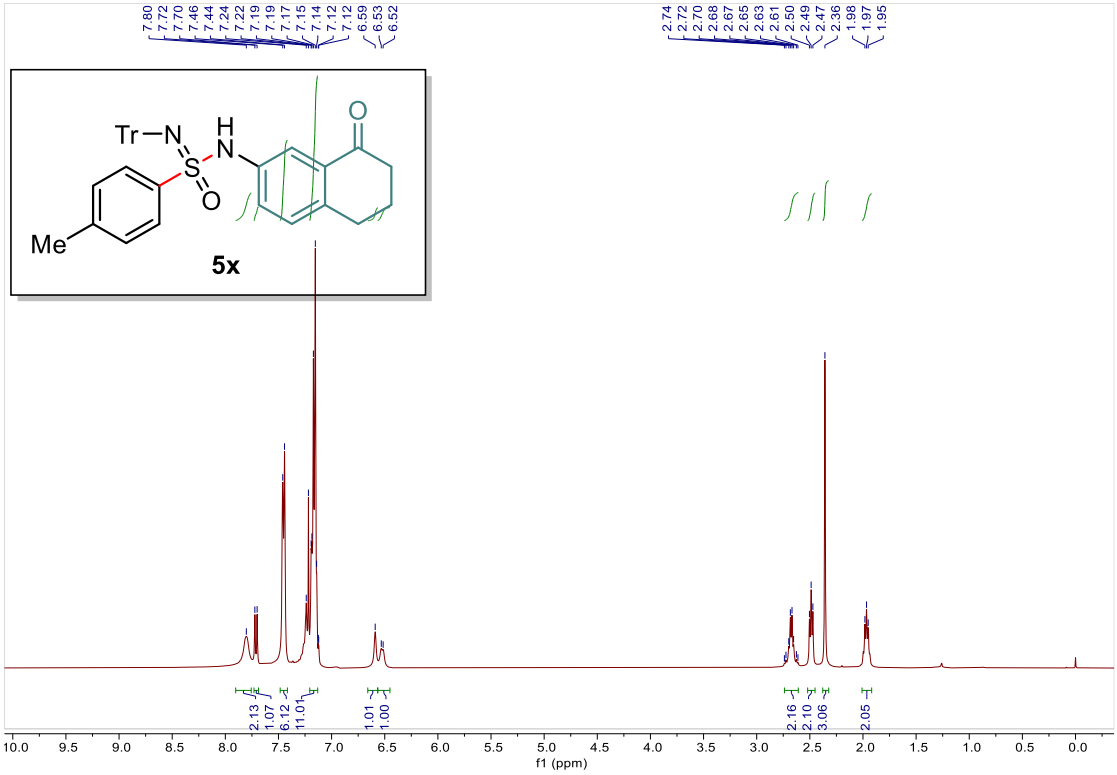
^{1}H NMR (400 MHz, $CDCl_3$) of 5w



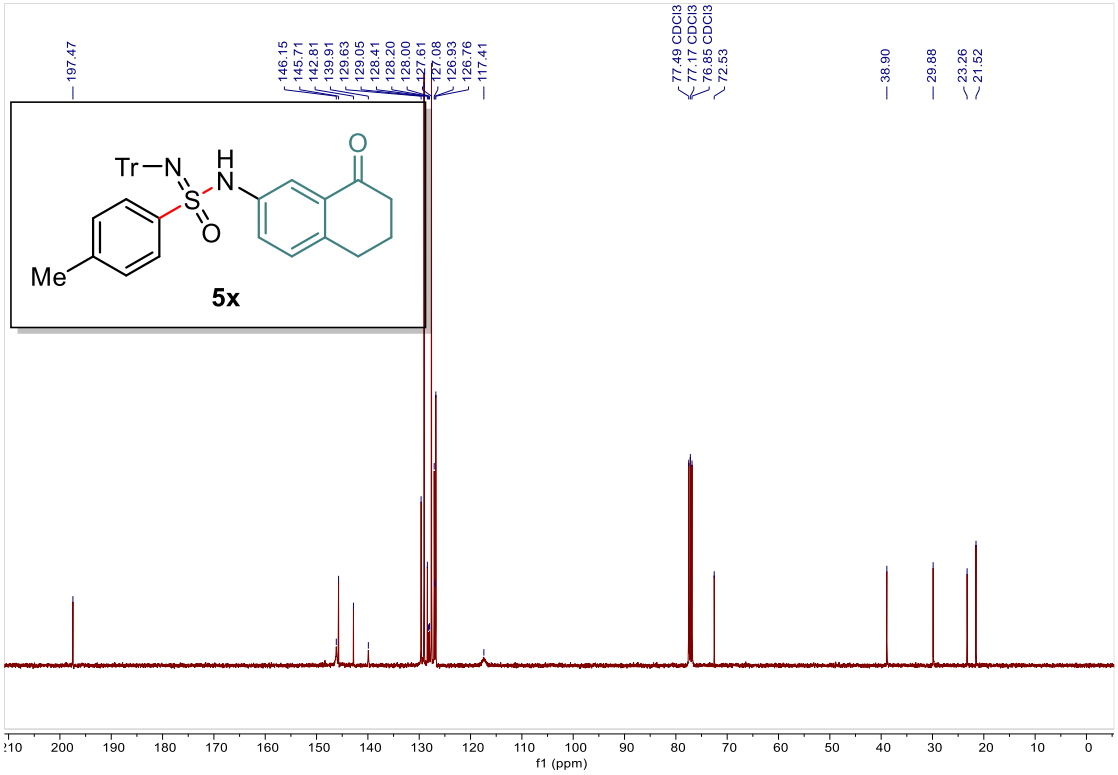
^{13}C NMR (101 MHz, $CDCl_3$) of 5w



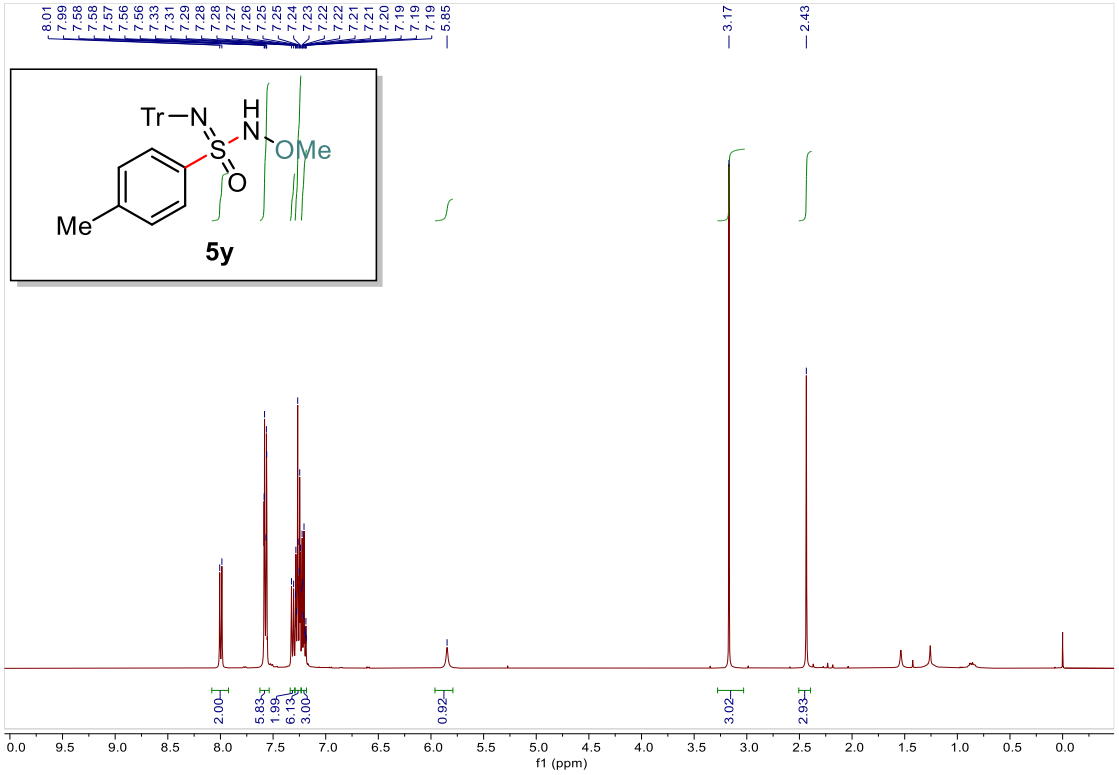
^{1}H NMR (400 MHz, $CDCl_3$) of 5x



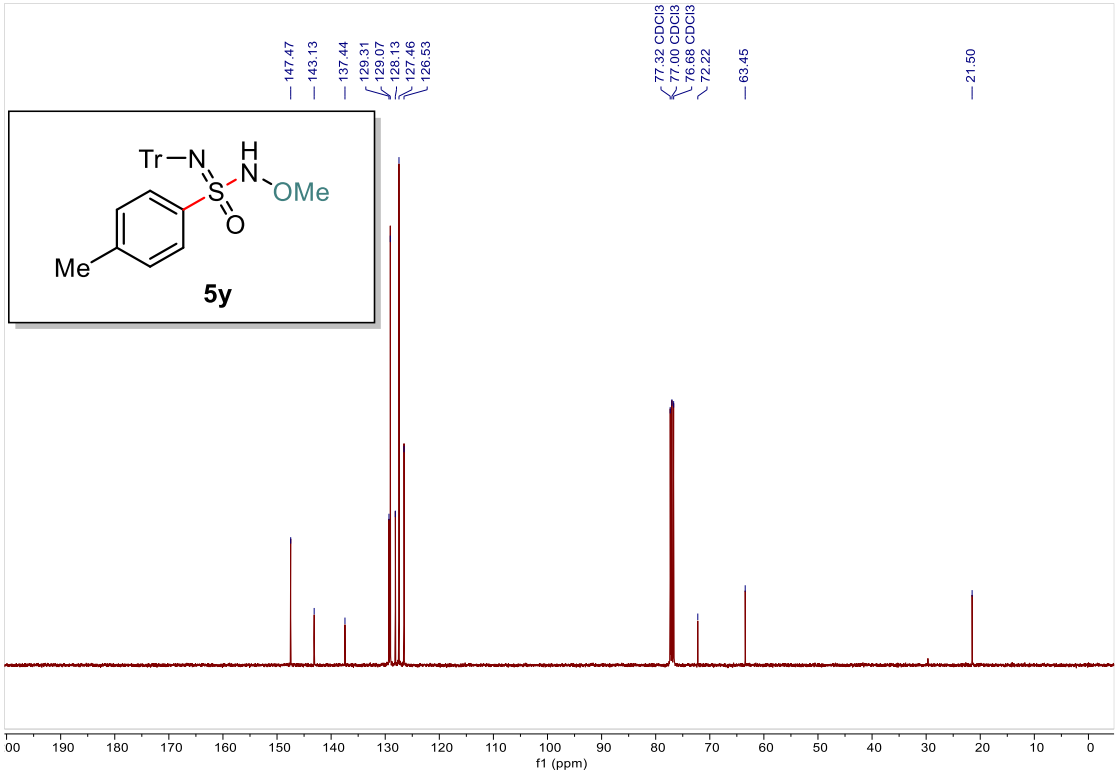
^{13}C NMR (101 MHz, $CDCl_3$) of 5x



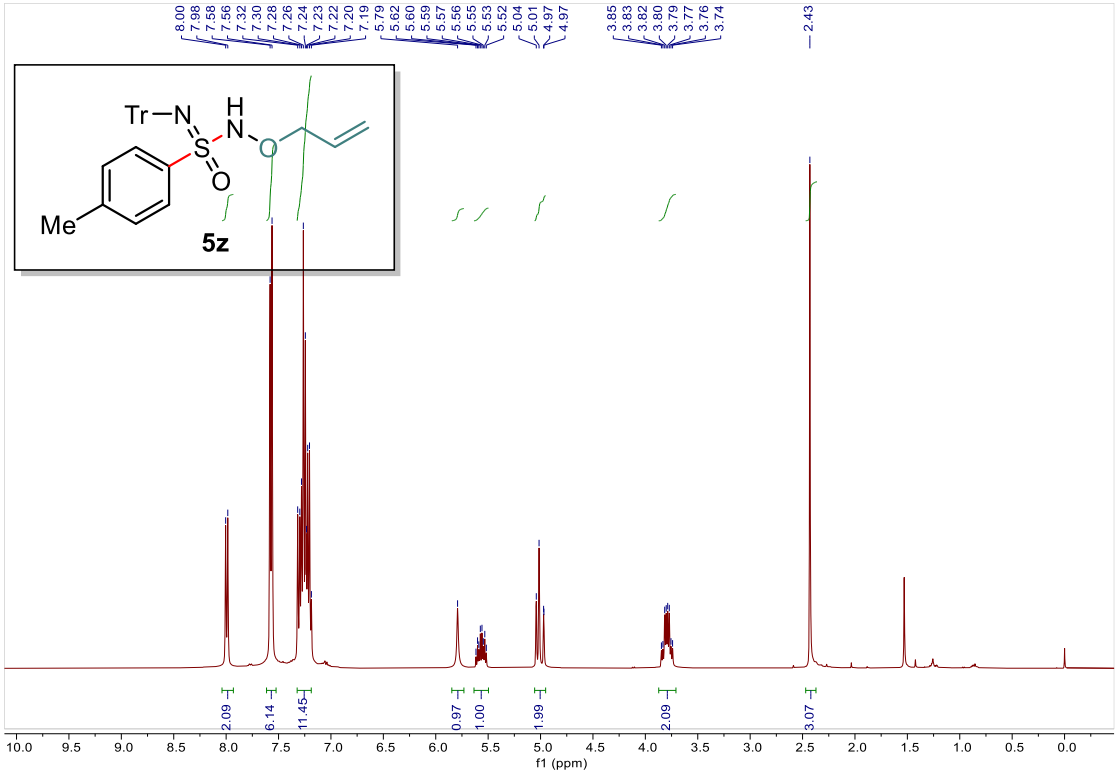
^{1}H NMR (400 MHz, $CDCl_3$) of 5y



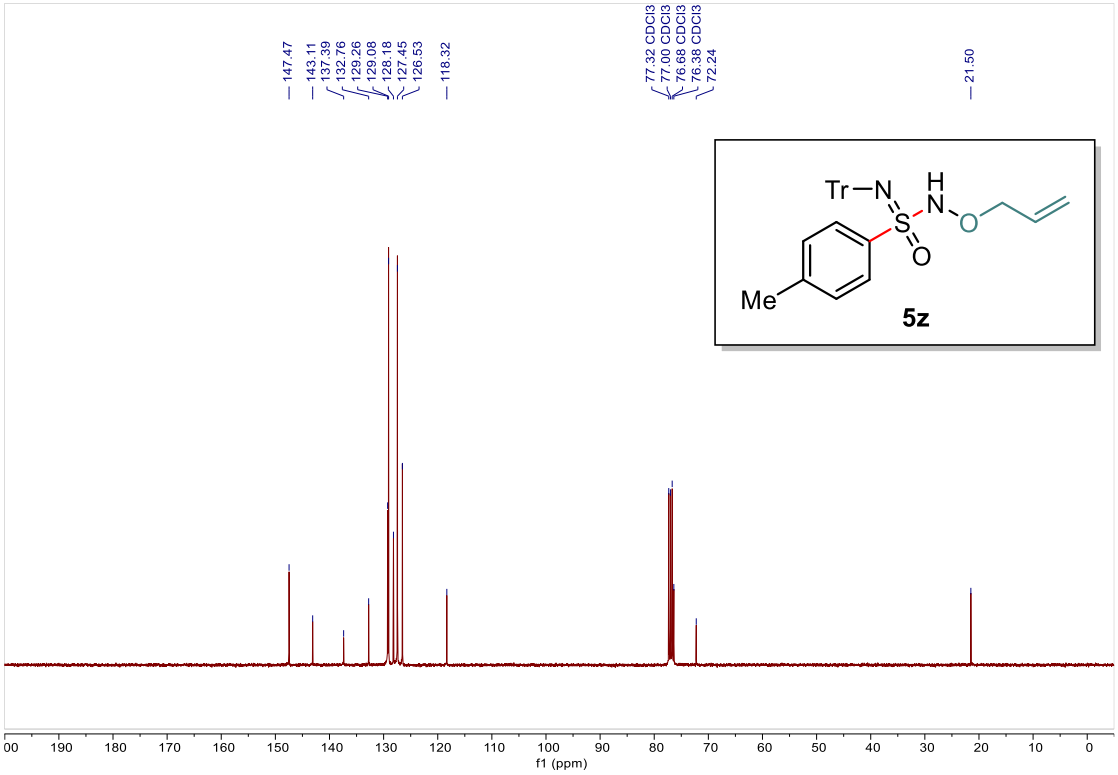
^{13}C NMR (101 MHz, $CDCl_3$) of 5y



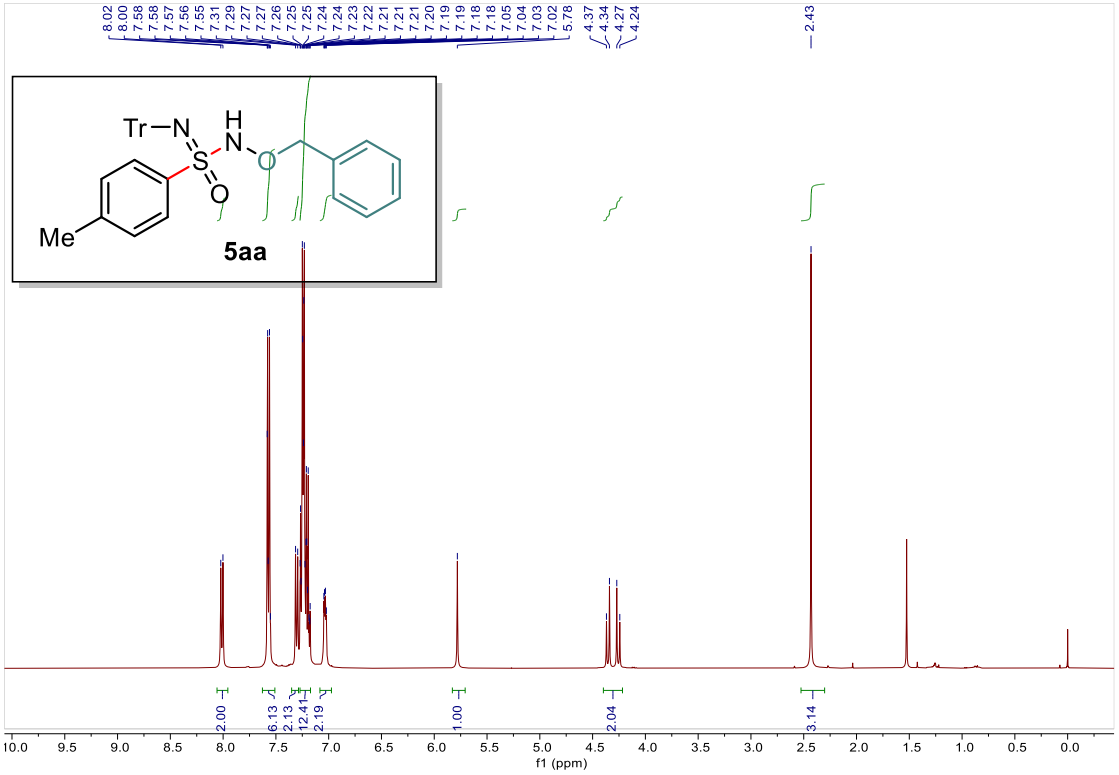
^{1}H NMR (400 MHz, $CDCl_3$) of 5z



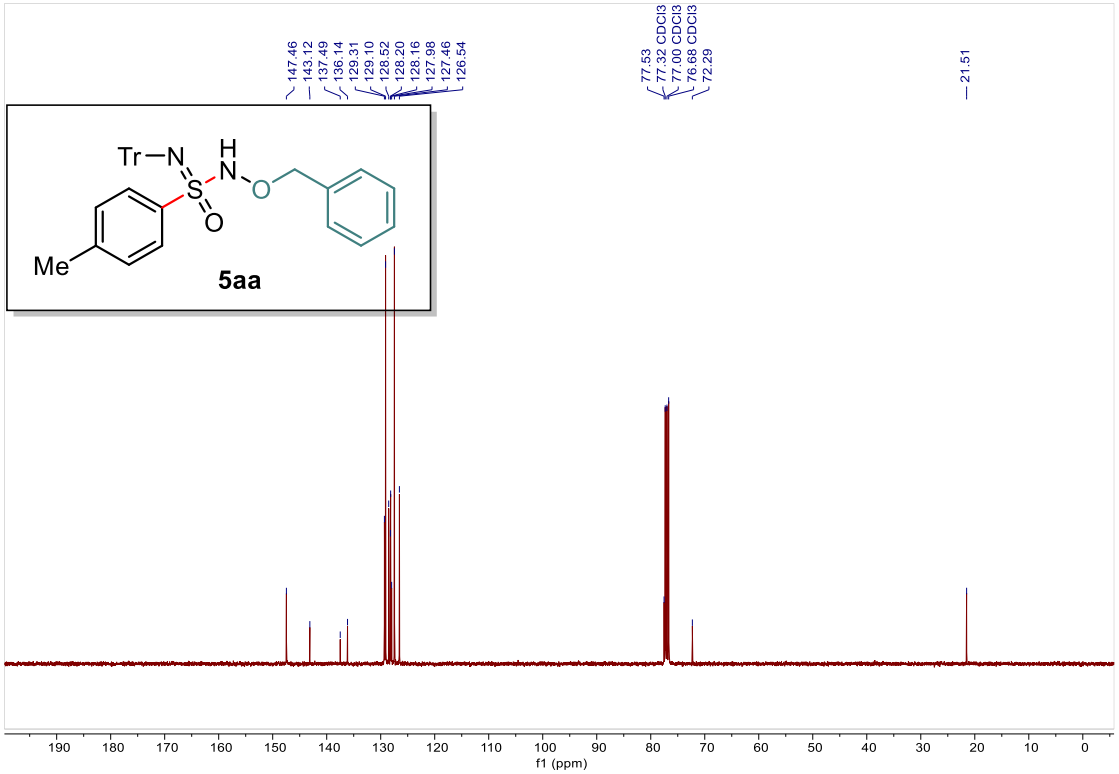
^{13}C NMR (101 MHz, $CDCl_3$) of 5z



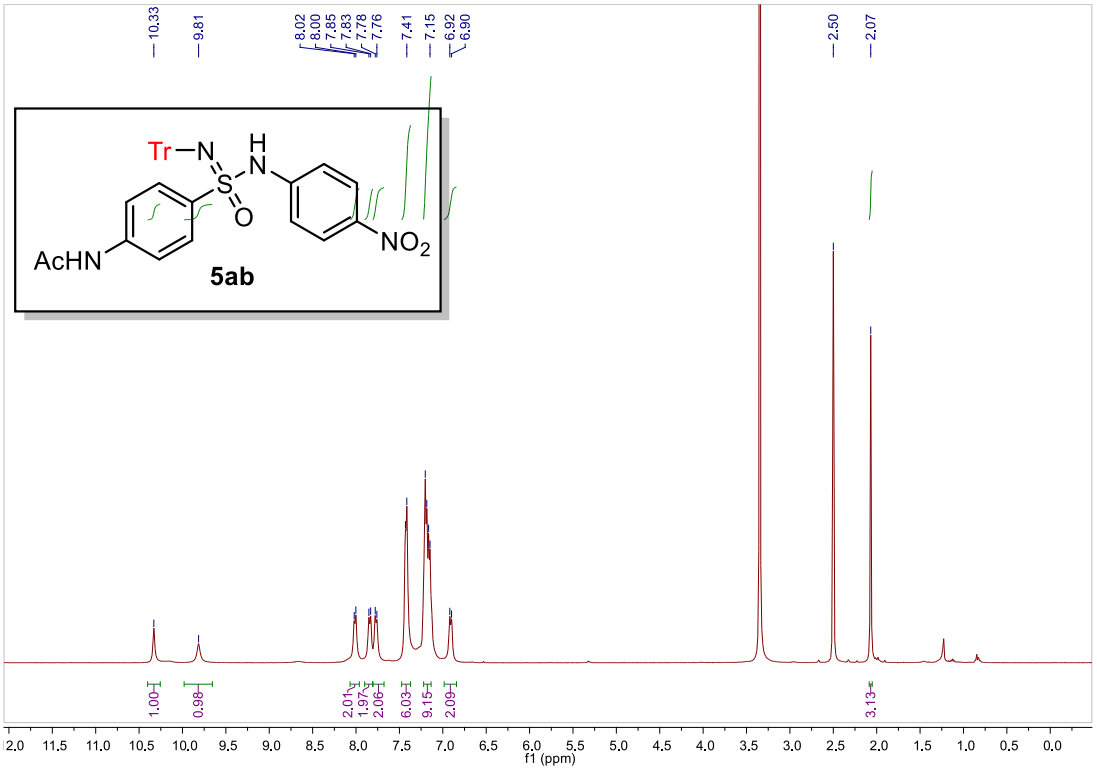
^{1}H NMR (400 MHz, $CDCl_3$) of **5aa**



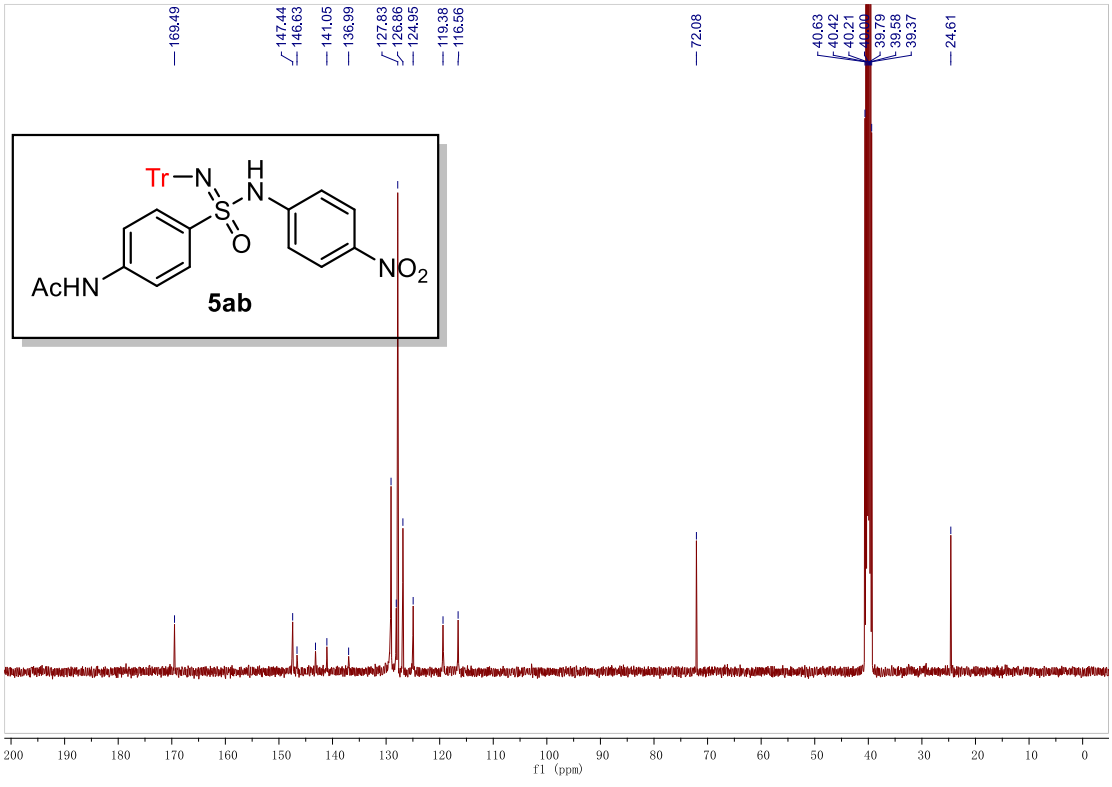
^{13}C NMR (101 MHz, $CDCl_3$) of **5aa**



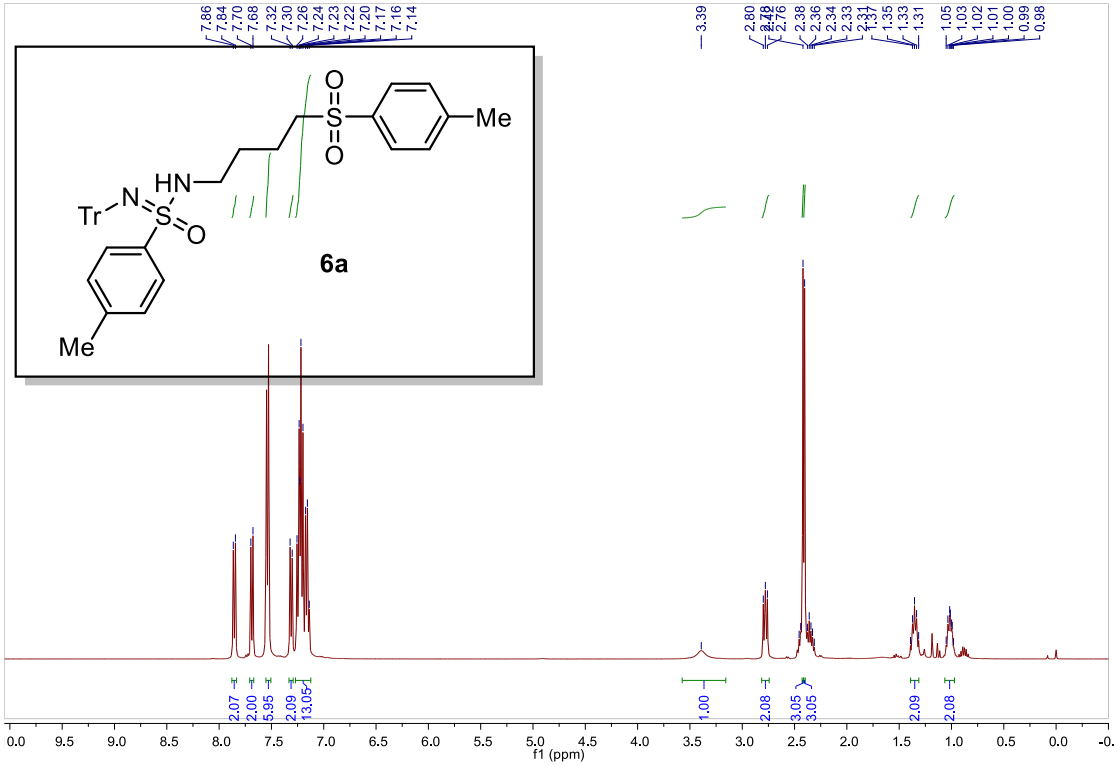
^{1}H NMR (400 MHz, DMSO-*d6*) of 5ab



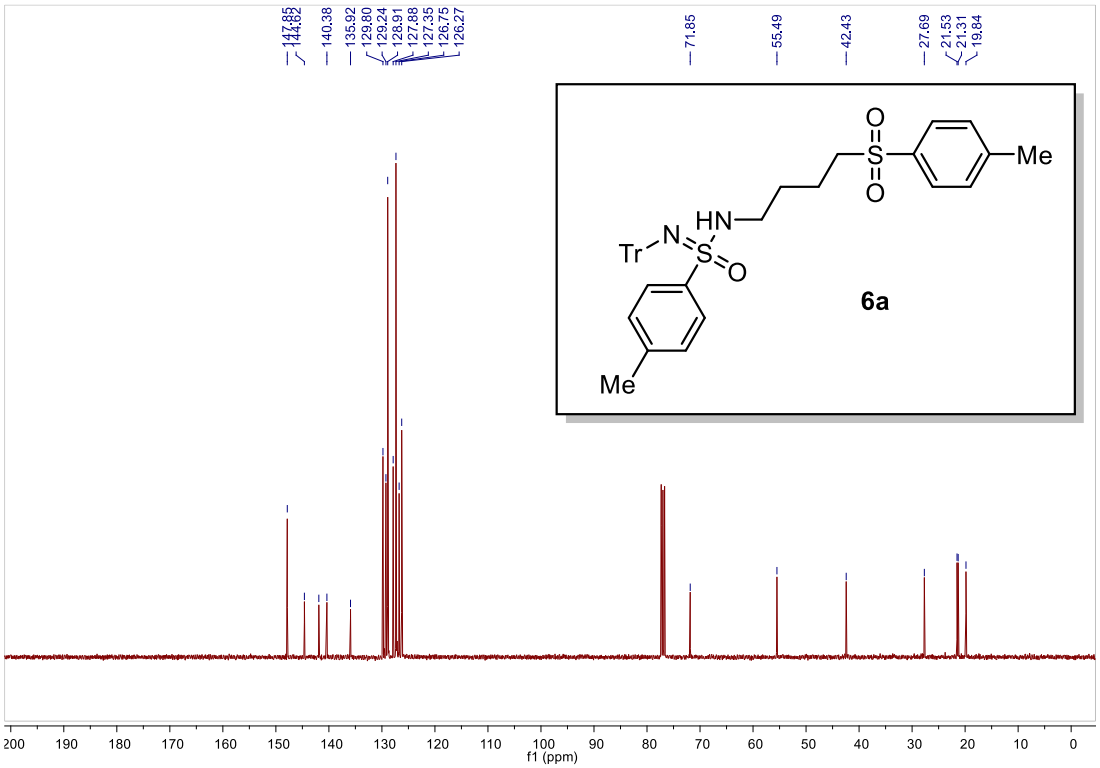
^{13}C NMR (101 MHz, DMSO-*d6*) of 5ab



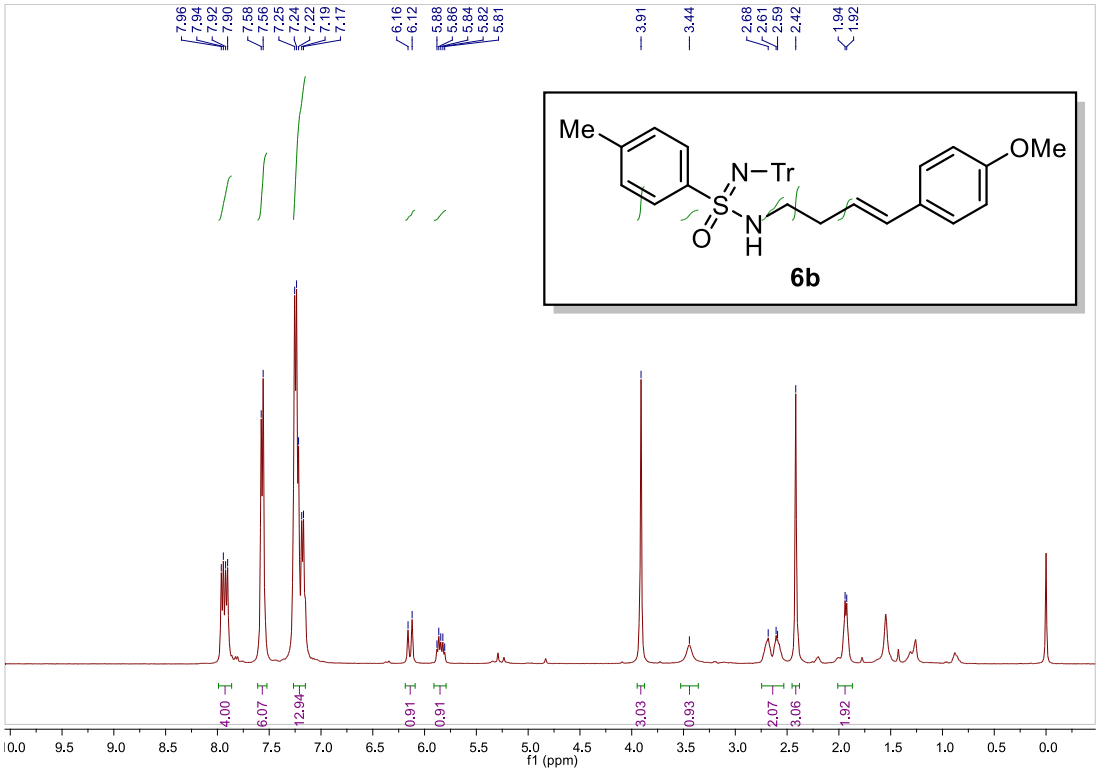
^{1}H NMR (400 MHz, $CDCl_3$) of **6a**



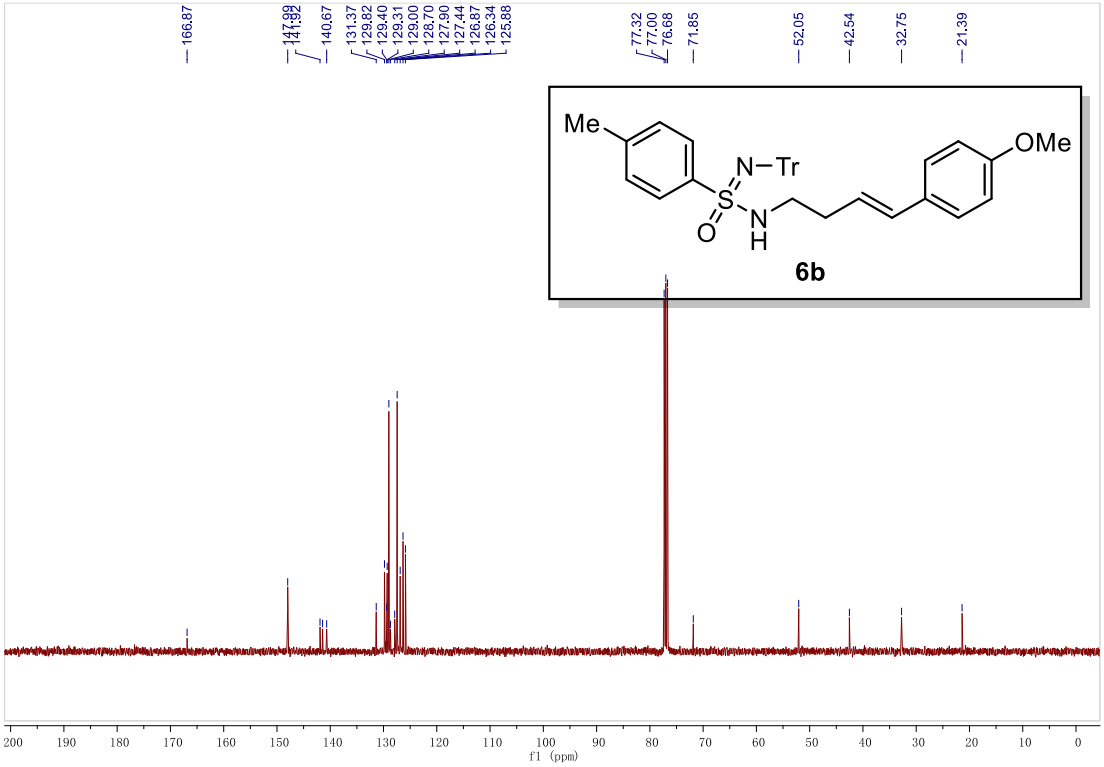
^{13}C NMR (101 MHz, $CDCl_3$) of **6a**



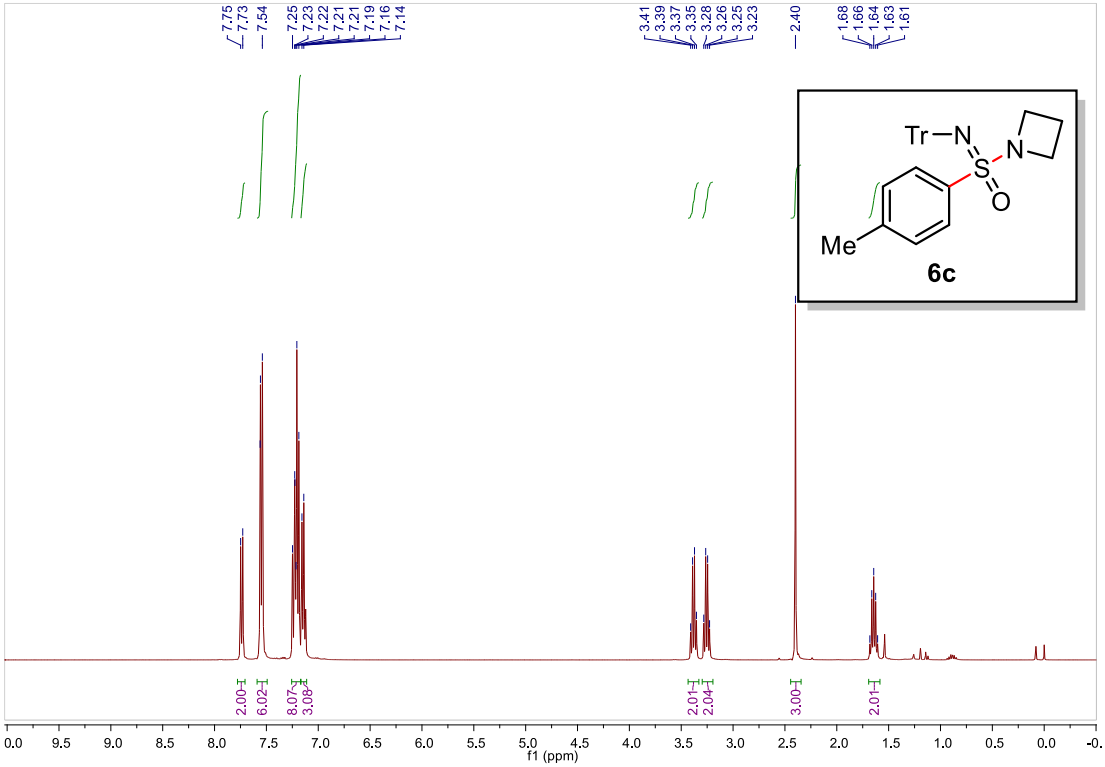
^{1}H NMR (400 MHz, $CDCl_3$) of **6b**



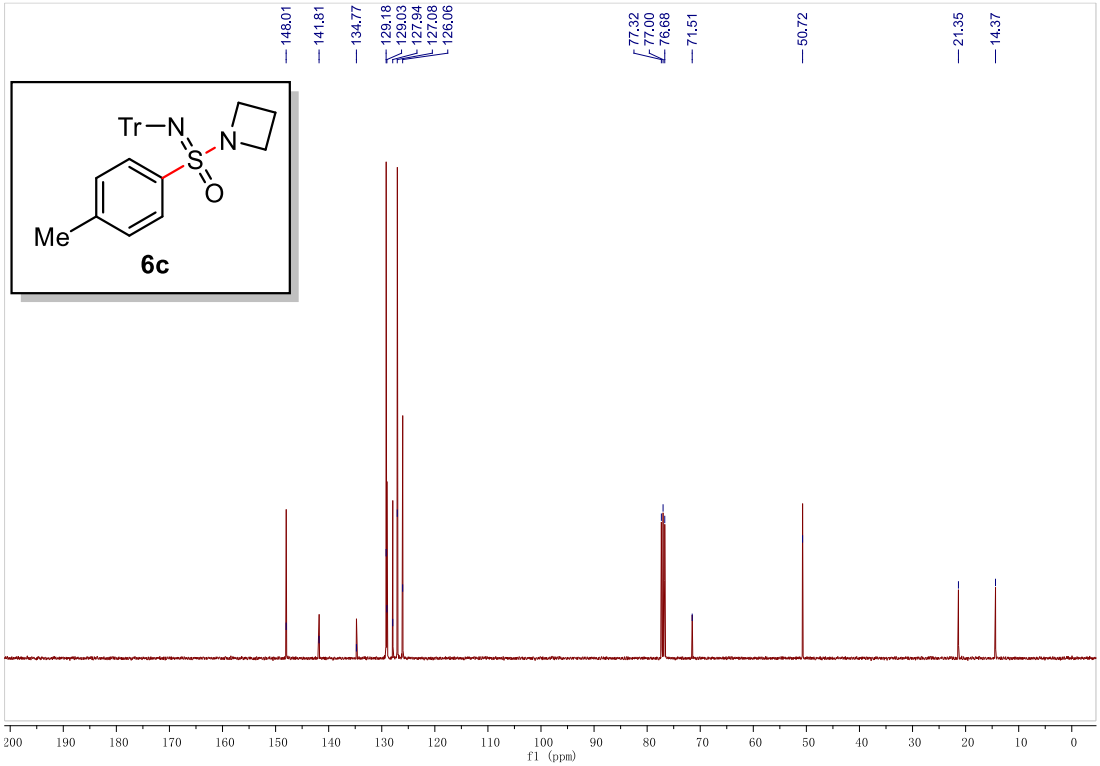
^{13}C NMR (101 MHz, $CDCl_3$) of **6b**



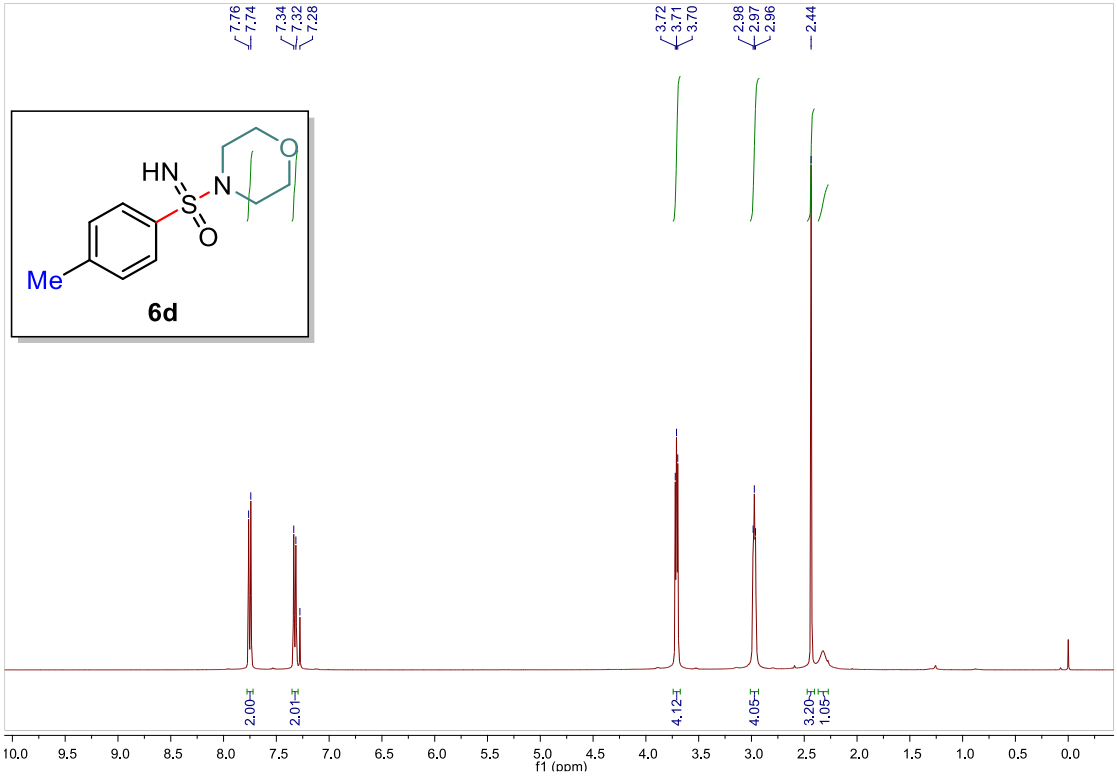
^{1}H NMR (400 MHz, $CDCl_3$) of 6c



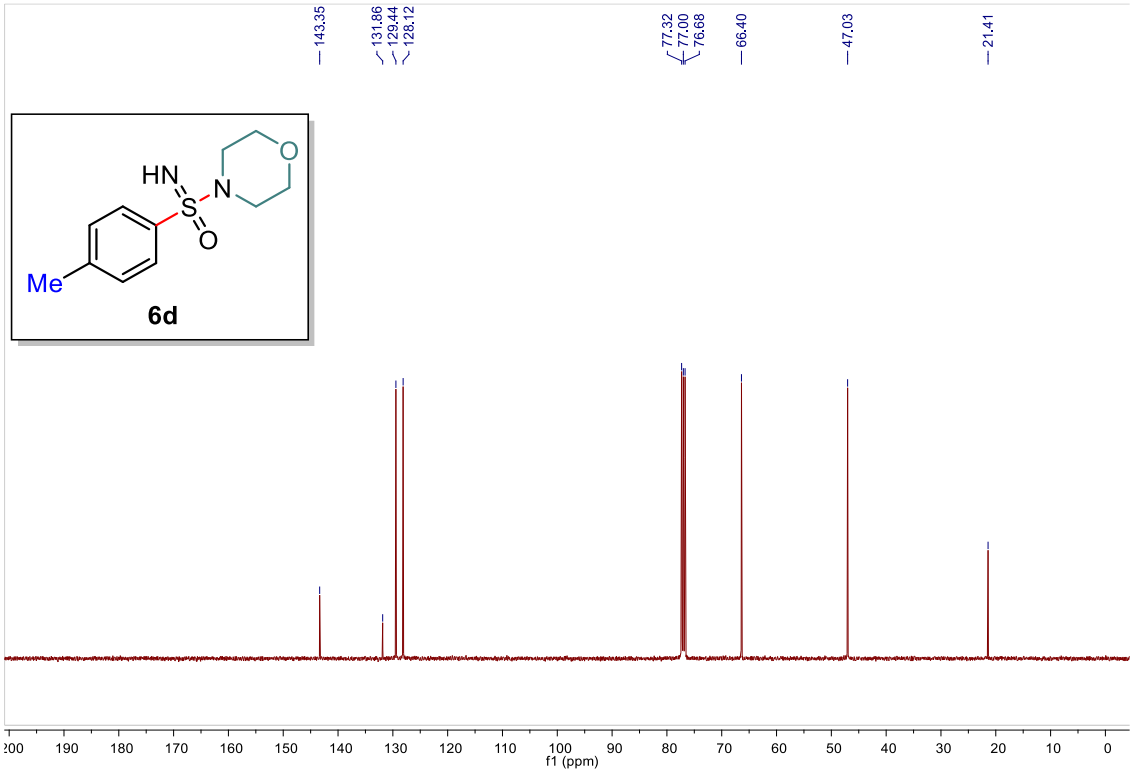
^{13}C NMR (101 MHz, $CDCl_3$) of 6c



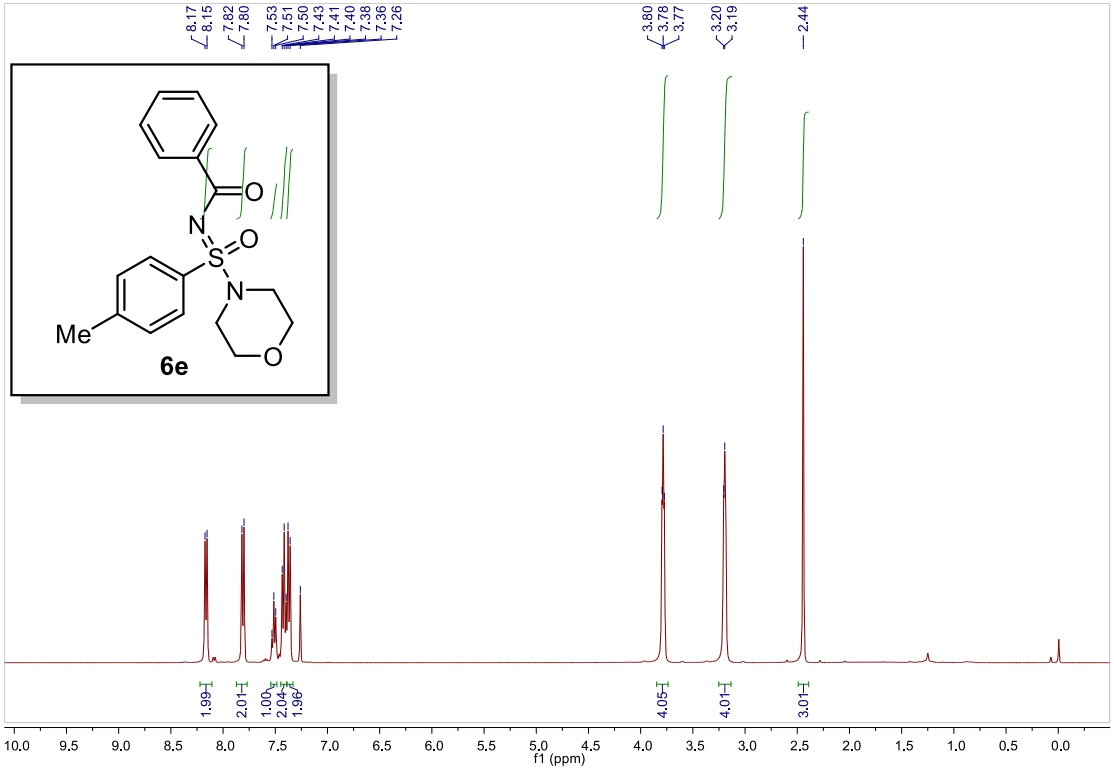
^{1}H NMR (400 MHz, $CDCl_3$) of 6d



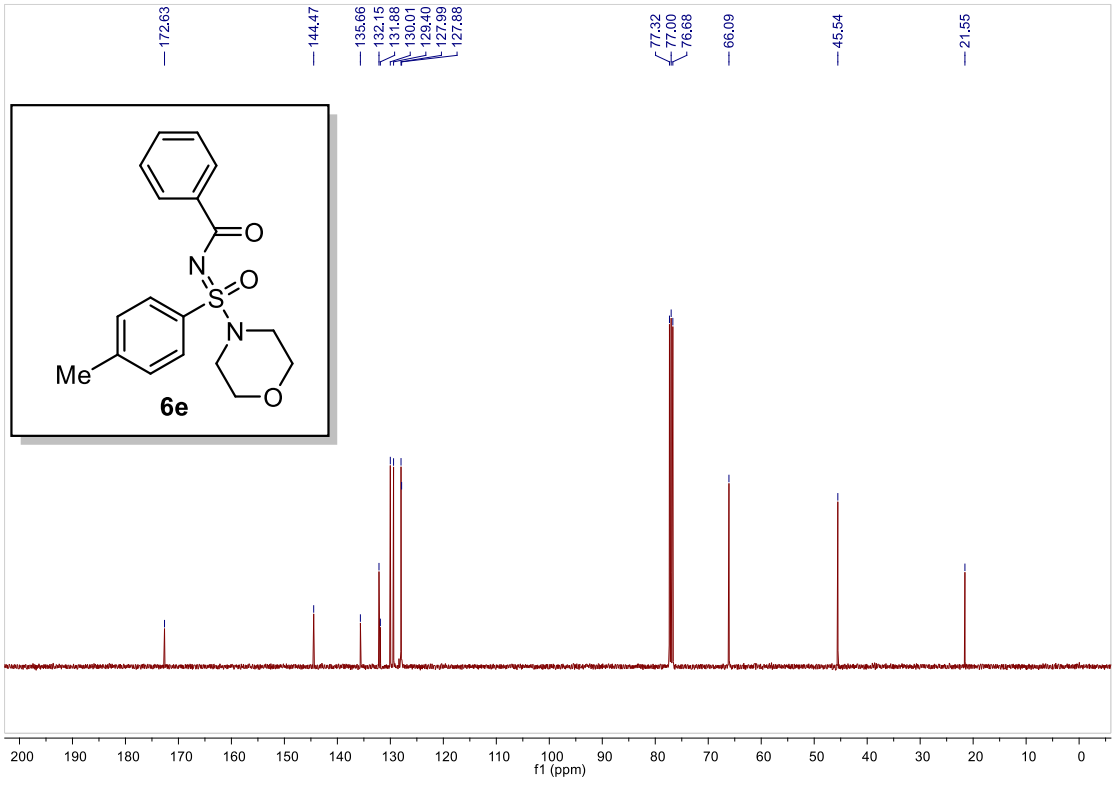
^{13}C NMR (101 MHz, $CDCl_3$) of 6d



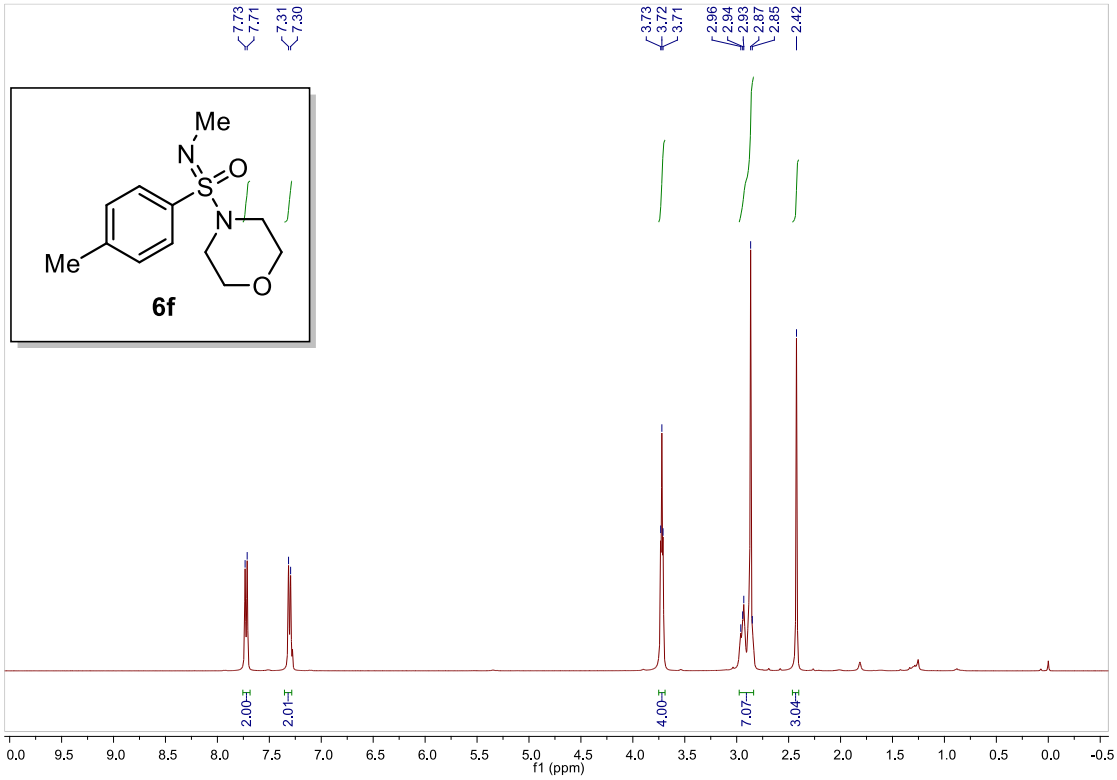
^{1}H NMR (400 MHz, $CDCl_3$) of 6e



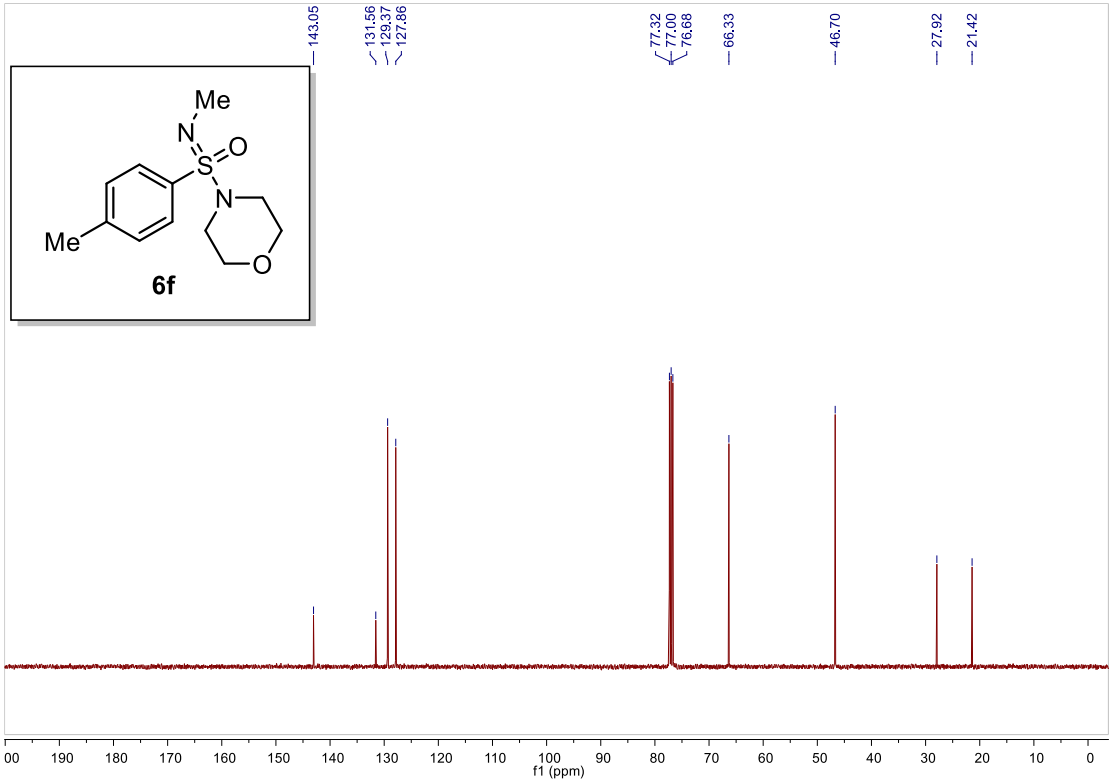
^{13}C NMR (101 MHz, $CDCl_3$) of 6e



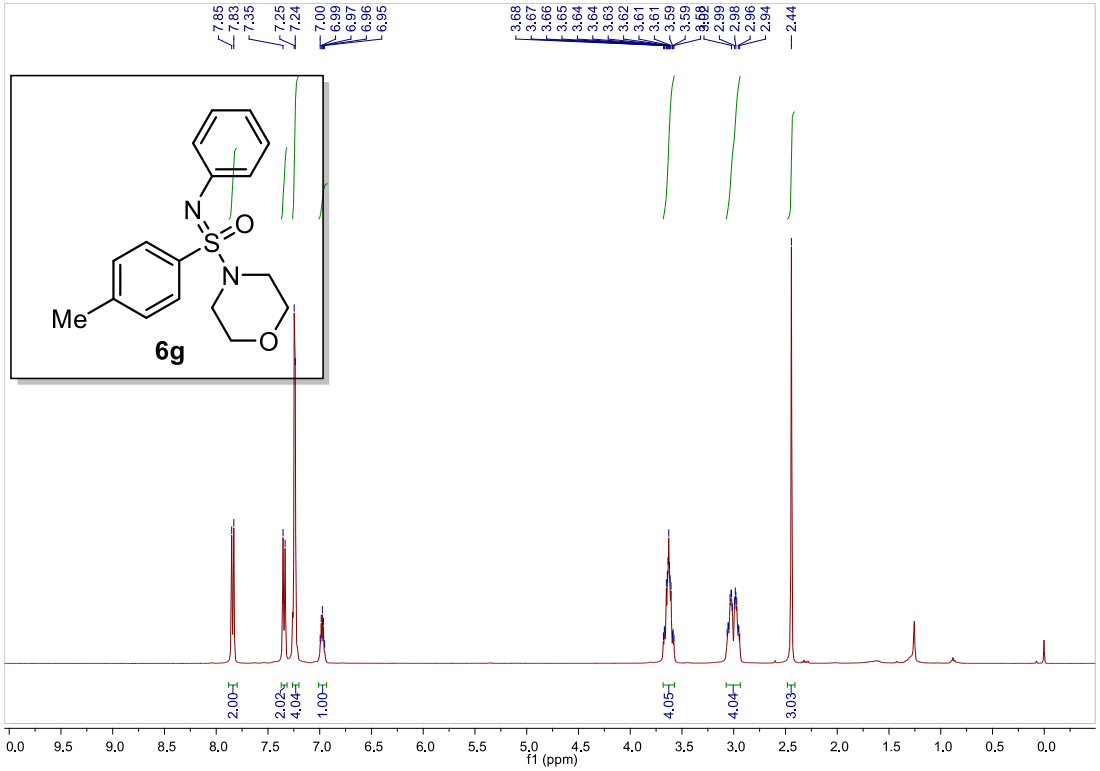
^{1}H NMR (400 MHz, $CDCl_3$) of **6f**



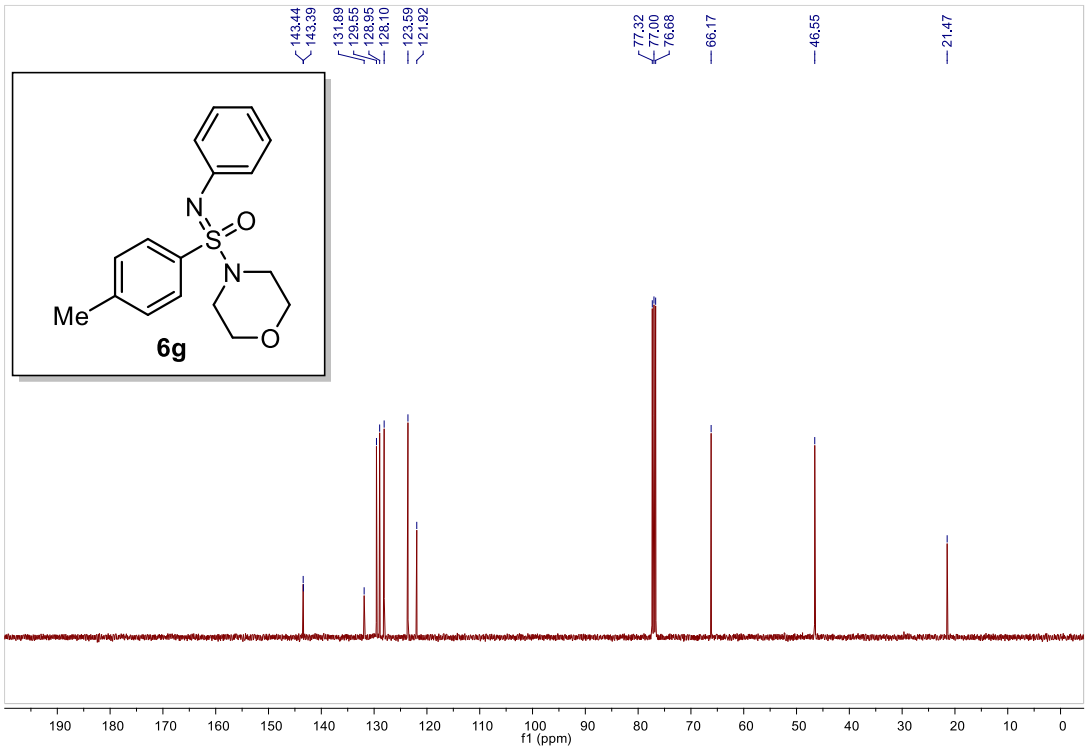
^{13}C NMR (101 MHz, $CDCl_3$) of **6f**



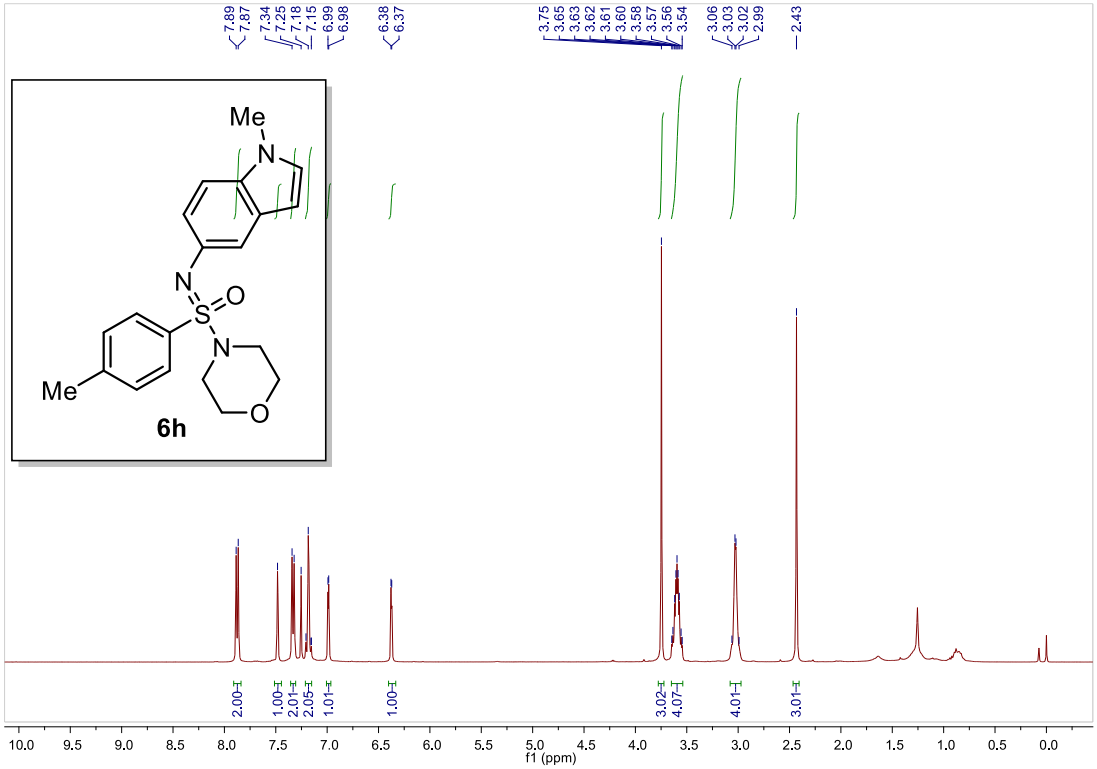
^{1}H NMR (400 MHz, $CDCl_3$) of 6g



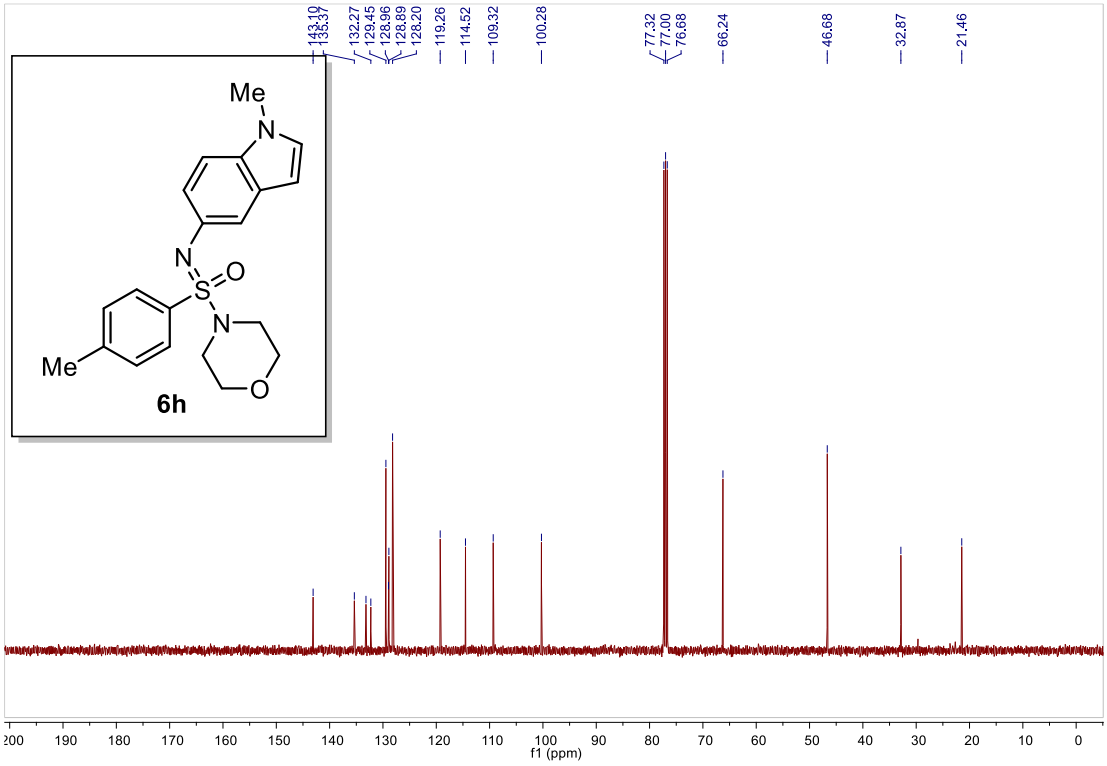
^{13}C NMR (101 MHz, $CDCl_3$) of 6g



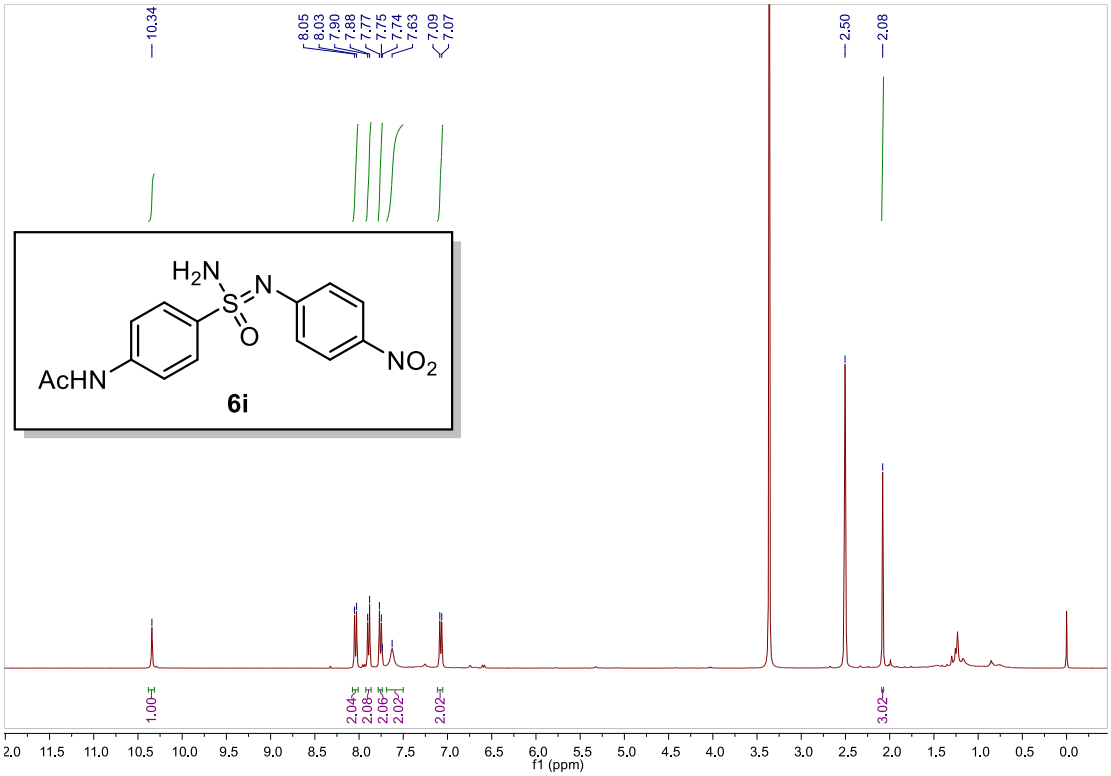
^{1}H NMR (400 MHz, $CDCl_3$) of **6h**



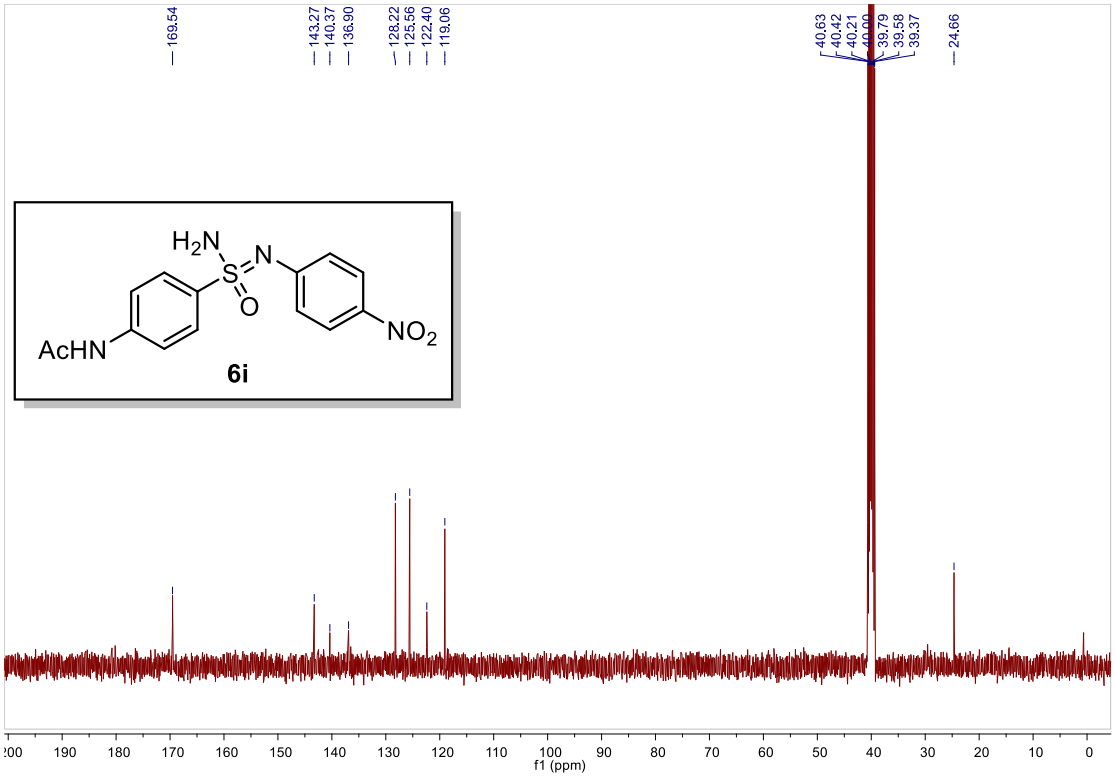
^{13}C NMR (101 MHz, $CDCl_3$) of **6h**



^{1}H NMR (400 MHz, DMSO-*d6*) of 6i



^{13}C NMR (101 MHz, DMSO-*d6*) of 6i



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