Supporting Information For

Silver-Catalyzed Tandem C≡C bond Hydroazidation/Radical Addition/Cyclization of Biphenyl Acetylene: One-pot Synthesis of 6-Methyl Sulfonylated Phenanthridines

Jiawei Tang,[a] Paramasivam Sivaguru,[a] Yongquan Ning,[a] Giuseppe Zanoni[c] and Xihe Bi*[a,b]

[a] Jilin Province Key Laboratory of Organic Functional Molecular Design & Synthesis, Department of Chemistry, Northeast Normal University, Changchun 130024, China. [b] State Key Laboratory of Elemento-Organic Chemistry, Nankai University, Tianjin 300071, China. [c] University of Pavia, Department of Chemistry, Viale Taramelli 12, 27100 – Pavia, Italy.

*Corresponding Author E-Mail: bixh507@nenu.edu.cn

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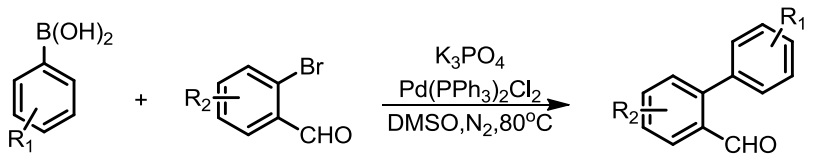
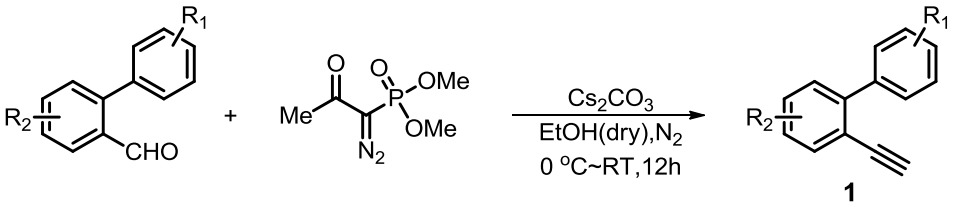
1. General Information

All the reagents were purchased from commercial sources and used without purification unless otherwise indicated. The products were purified by column chromatography over silica gel (300-400 size). NMR spectra were measured on a Varian I NOVA 500 or Bruker AV-600 spectrometer and reported in parts per million. The ^{1}H NMR (600 MHz) chemical shifts were measured relative to TMS, DMSO or $CDCl_3$ as the internal reference. The ^{13}C NMR (125 MHz or 150 MHz) chemical shifts were given using $CDCl_3$ and DMSO as the internal standard. High resolution mass spectra (HRMS) were recorded on the Exactive Mass Spectrometer (Agilent 1200HPLC/MicrOTOF II) equipped with ESI ionization source. Melting points were determined with XRC-1 and are uncorrected.

2. Preparation of the Substrates[1,2]

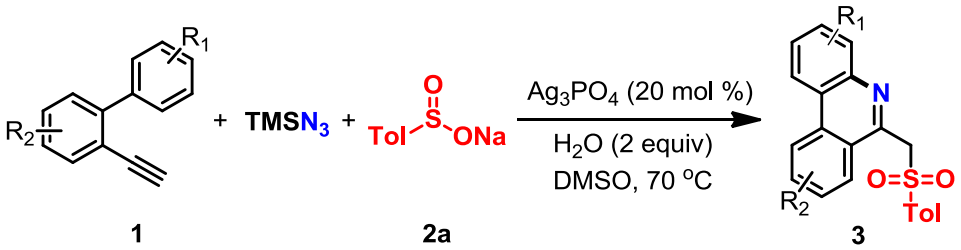


Typical synthetic procedure (with [1,1'-biphenyl]-2-carbaldehyde as an example): To a stirred solution of phenyboronic (731.6 mg, 6.0 mmol), potassium phosphate (2.1 g, 10.0 mmol) and bis(triphenylphosphine)palladium(II) chloride (175.5 mg, 0.25 mmol) in DMSO was added 2-bromobenzaldehyde (925 mg, 5.0 mmol) under nitrogen at 80 ^{o}C for 10 h. After completion, the resulting mixture was concentrated and extract with dichloromethane (3 x 15 mL), washed with brine (3 x 40 mL). The combined organic layer was dried over $MgSO_4$ and evaporated. Finally, the crude product was further purified by flash column chromatography (silica gel) using petroleum ether/ethyl acetate as an eluent.



Typical synthetic procedure (with 1a as an example): To a stirred solution of aldehyde (182.2 mg, 1.0 mmol) and BOR (Bestman-Ohira Reagent) (384 mg, 2.0 mmol) in dry EtOH (10 mL) was added Cs_2CO_3 (977 mg, 3.0 mmol) at 0 °C and the resulting mixture was stirred until complete consumption of aldehyde (monitored by TLC). After complete conversion of aldehyde, solvent was evaporated under reduced pressure and the mixture was extracted with 10 mL of ethyl acetate thrice and washed with 5 mL brine. Then the combined organic phase was collected by passing through anhydrous Na_2SO_4. Organic portion was evaporated and directly used for purification using silica gel (300-400 mesh) column chromatography with petroleum ether and ethyl acetate as the eluent.

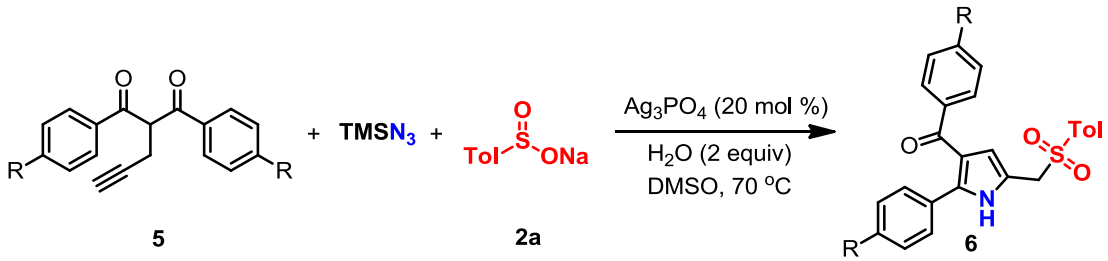
3. General Experimental Procedure for the Synthesis of Products



Typical synthetic procedure (with 3a as an example): To a stirred suspension of 2-ethynyl-1,1'-biphenyl (**1a**) (89 mg, 0.5 mmol), $TMSN_3$ (99 μL, 0.75 mmol) and H_2O (18 μL) in DMSO (2 mL) at 70 °C, TsNa (134mg, 0.75 mmol), Ag_3PO_4 (41.8 mg, 0.10 mmol) was added. Then the mixture was stirred at 70 °C for 6.0 h until the complete conversion of substrate **1a**. After completion, the resulting mixture was concentrated and extract with dichloromethane (3 x 15 mL), washed with brine (3 x 40 mL). The combined organic layer was dried over $MgSO_4$ and concentrated. Finally, the crude product was further purified by flash column chromatography (silica gel) using petroleum ether/ethyl acetate (3:1) as an eluent to gave pure product **3a** as a light yellow solid in 63% yield.

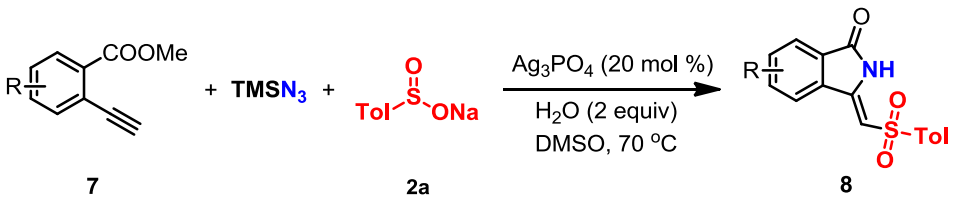
Typical synthetic procedure (with 3b as an example): To a stirred suspension of 2-ethynyl-4'-methyl-1,1'-biphenyl (**1b**) (192 mg, 1 mmol), $TMSN_3$ (198 μL, 1.5 mmol) and H_2O (36 μL) in DMSO (5 mL) at 70 °C, TsNa (268 mg, 1.5 mmol), Ag_3PO_4 (83.6 mg, 0.20 mmol) was added. Then the mixture was stirred at 70 °C for

6.0 h until the complete conversion of substrate **1b**. After completion, the resulting mixture was concentrated and extract with dichloromethane (3 x 20 mL), washed with brine (3 x 40 mL). The combined organic layer was dried over $MgSO_4$ and concentrated. Finally, the crude product was further purified by flash column chromatography (silica gel) using petroleum ether/ethyl acetate (3:1) as an eluent to gave pure product **3b** as a yellow solid in 52% yield (0.52 mmol, 188.3 mg).



5 2a 6

Typical synthetic procedure (with 6a as an example): To a solution of 1,3-diphenyl-2-(prop-2-yn-1-yl)propane-1,3-dione (**5a**) (131 mg, 0.5 mmol), $TMSN_3$ (99 μL, 0.75 mmol) and H_2O (18 μL) in DMSO (2 mL) at 70 °C, TsNa (134mg, 0.75 mmol), Ag_3PO_4 (41.8 mg, 0.10 mmol) was added. The mixture was then stirred for 6.0 h until substrate **5a** disappeared. The resulting mixture was concentrated and taken up by dichloromethane (3 x 15 mL). The organic layer was washed with brine (3 x 40 mL), dried over $MgSO_4$ and concentrated. Purification of the crude product with flash column chromatography (silica gel; petroleum ether: ethyl acetate = 4:1) gave **6a** in 57% yield as a yellow solid.



7 2a 8

Typical synthetic procedure (with 8a as an example): To a solution of methyl 2-ethynylbenzoate (**7a**) (80 mg, 0.5 mmol), $TMSN_3$ (99 μL, 0.75 mmol) and H_2O (18 μL) in DMSO (2 mL) at 70 °C, TsNa (134mg, 0.75 mmol), Ag_3PO_4 (41.8 mg, 0.10 mmol) was added. The mixture was then stirred for 6.0 h until substrate **7a** disappeared. The resulting mixture was concentrated and taken up by dichloromethane (3 x 15 mL). The organic layer was washed with brine (3 x 40 mL), dried over $MgSO_4$ and concentrated. Purification of the crude product with flash

column chromatography (silica gel; petroleum ether: ethyl acetate = 3:1) gave **8a** in 72% yield as a white solid.

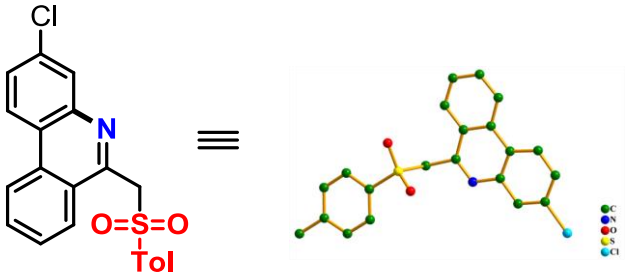
4. Reference

[1] Kumar, R.; Verma, D.; Mobin, S. M.; Namboothiri, I. N. N. *Org. Lett*. **2012**, *14*, 4070- 4073.

[2] Dutta, U.; Lupton, D. W.; Maiti, D. *Org. Lett*. **2016**, *18*, 860-863.

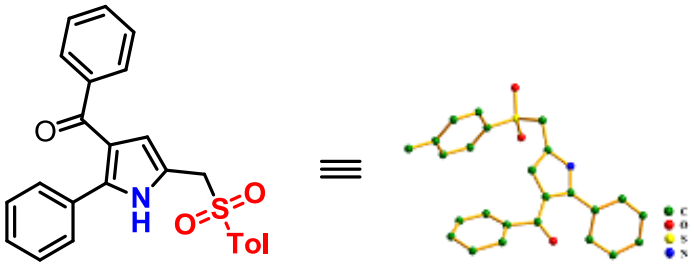
5. X-Ray Crystallographic Information

Table S1. Crystallography data and structure refinement for **3e (**CCDC 1545378**)**



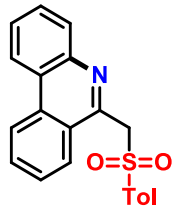
Empirical formula	C_{21} H_{16} Cl N O_2 S
Temperature	298(2)K
Wavelength	0.71073 Å
Unit cell dimensions	a = 22.262(3) A alpha = 90 deg. b = 5.2166(7) A beta = 100.464(2) deg. c = 15.694(2) A gamma = 90 deg.
Volume	1792.2(4) A^3
Z	4
Calculated density	1.415 Mg/m^3
Absorption coefficient	0.345 mm^{-1}
F(000)	792
Crystal size	0.1 x 0.1x 0.1 m
Theta range for data collection	1.860 to 26.419 deg.
Reflections collected / unique	9687 / 3667 [R(int) = 0.0399]
Data / restraints / parameters	3667 / 0 / 235
Goodness-of-fit on F^2	1.045
Final R indices [I>2sigma(I)]	R1 = 0.0550, wR2 = 0.1282
R indices (all data)	R1 = 0.0735, wR2 = 0.1393

Table S2. Crystallography data and structure refinement for **6a (**CCDC 1547932**)**

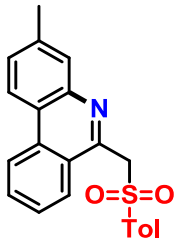


Empirical formula	C_{25} H_{21} N O_3 S
Temperature	298(2)K
Wavelength	0.71073 Å
Unit cell dimensions	a = 14.339(3) A alpha = 90 deg. b = 15.396(3) A beta = 90 deg. c = 18.846(3) A gamma = 90 deg.
Volume	4160.4(14) A^3
Z	1
Calculated density	1.618 Mg/m^3
Absorption coefficient	0.774 mm^{-1}
F(000)	2052
Crystal size	0.1 x 0.1x 0.1 m
Theta range for data collection	1.323 to 26.436 deg.
Reflections collected / unique	24164 / 19853 [R(int) = 0.0765]
Data / restraints / parameters	19853 / 3 / 962
Goodness-of-fit on F^2	1.017
Final R indices [I>2sigma(I)]	R1 = 0.1415, wR2 = 0.3187
R indices (all data)	R1 = 0.2529, wR2 = 0.4030

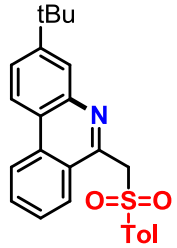
6. Spectral Data of All the Synthesized Products



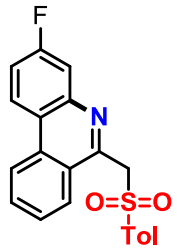
(3a) Light yellow solid (109.7 mg, 0.32 mmol, 63% yield), m.p: 195-196 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.63 (d, *J* = 8.4 Hz, 1H), 8.56-8.52 (m, 1H), 8.34 (d, *J* = 8.4 Hz, 1H), 7.87-7.83 (m, 2H), 7.72 (t, *J* = 7.8 Hz, 1H), 7.69-7.64 (m, 2H), 7.56 (d, *J* = 8.4 Hz, 2H), 7.17 (d, *J* = 7.8 Hz, 2H), 5.15 (s, 2H), 2.37 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 149.8, 144.7, 143.2, 135.5, 133.1, 130.9, 129.8, 129.4, 128.7, 127.63, 127.61, 127.0, 125.6, 124.0, 122.3, 122.0, 62.6, 21.5; **HRMS** (ESI) m/z calcd. for $C_{21}H_{18}NO_2S$ $[M+H]^+$ 348.1053, found 348.1062.



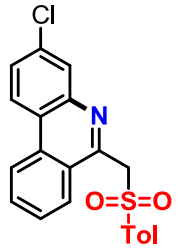
(3b) Yellow solid (108.6 mg, 0.30 mmol, 60% yield), m.p: 198-199 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.57 (d, *J* = 8.4 Hz, 1H), 8.41 (d, *J* = 8.4 Hz, 1H), 8.30 (d, *J* = 8.4 Hz, 1H), 7.82 (t, *J* = 7.8 Hz, 1H), 7.67 (t, *J* = 7.8 Hz, 1H), 7.63 (s, 1H), 7.56 (d, *J* = 7.8 Hz, 2H), 7.48 (d, *J* = 8.4 Hz, 1H), 7.18 (d, *J* = 8.4 Hz, 2H), 5.12 (s, 2H), 2.54 (s, 3H), 2.38 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 149.7, 144.6, 143.5, 138.8, 135.6, 133.2, 130.8, 129.44, 129.39, 128.6, 127.1, 126.9, 125.3, 122.1, 121.71, 121.67, 62.7, 21.5, 21.4; **HRMS** (ESI) m/z calcd. for $C_{22}H_{20}NO_2S$ $[M+H]^+$ 362.1209, found 362.1218.



(3c) Light yellow solid (125.3 mg, 0.31 mmol, 62% yield), m.p: 185-186 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.60 (d, *J* = 7.8 Hz, 1H), 8.47 (d, *J* = 8.4 Hz, 1H), 8.29 (d, *J* = 8.4 Hz, 1H), 7.85-7.82 (m, 1H), 7.80 (d, *J* = 1.8 Hz, 1H), 7.76-7.74 (m, 1H), 7.69-7.66 (m, 1H), 7.56 (d, *J* = 7.8 Hz, 2H), 7.18 (d, *J* = 7.8 Hz, 2H), 5.13 (s, 2H), 2.38 (s, 3H), 1.43 (s, 9H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 152.1, 149.5, 144.6, 143.3, 135.5, 133.1, 130.8, 129.4, 128.7, 127.2, 126.9, 125.9, 125.7, 125.4, 122.1, 121.6, 62.6, 34.9, 31.3, 21.5; **HRMS** (ESI) m/z calcd. for $C_{25}H_{26}NO_2S$ $[M+H]^+$ 404.1679, found 404.1687.

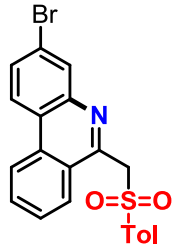


(3d) White solid (135.5 mg, 0.37 mmol, 74% yield), m.p: 191-192 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.53 (d, *J* = 8.4 Hz, 1H), 8.49 (dd, *J* = 6.0 Hz, *J* = 9.0 Hz, 1H), 8.34 (d, *J* = 8.4 Hz, 1H), 7.87-7.84 (m, 1H), 7.72-7.70 (m, 1H), 7.56 (d, *J* = 8.4 Hz, 2H), 7.46 (dd, *J* = 3.0 Hz, *J* = 9.0 Hz, 1H), 7.42-7.38 (m, 1H), 7.19 (d, *J* = 8.4 Hz, 2H), 5.12 (s, 2H), 2.39 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 162.5 (d, *J* = 247.5 Hz), 151.2, 144.8, 144.4 (d, *J* = 12.0 Hz), 135.5, 132.9, 131.3, 129.5, 128.6, 127.5, 127.2, 125.2, 124.0 (d, *J* = 9.0 Hz), 122.1, 120.7 (d, *J* = 1.5 Hz), 116.7 (d, *J* = 24.0 Hz), 114.2 (d, *J* = 19.5 Hz), 62.6, 21.6; **HRMS** (ESI) m/z calcd. for $C_{21}H_{17}FNO_2S$ $[M+H]^+$ 366.0959, found 366.0958.

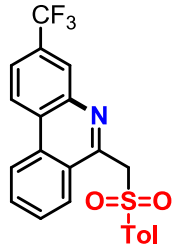


(3e) Light yellow solid (101.2 mg, 0.27 mmol, 53% yield), m.p: 208-209 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.58 (d, *J* = 8.4 Hz, 1H), 8.47 (d, *J* = 8.4 Hz, 1H), 8.37 (d, *J* = 8.4 Hz, 1H), 7.89 (t, *J* = 7.8 Hz, 1H), 7.82 (d, *J* = 2.4 Hz, 1H), 7.76 (t, *J* = 7.8 Hz,

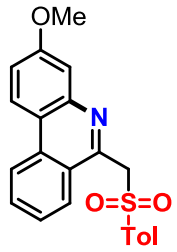
1H), 7.63-7.61 (m, 1H), 7.56 (d, *J* = 8.4 Hz, 2H), 7.21 (d, *J* = 7.8 Hz, 2H), 5.13 (s, 2H), 2.41 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 151.2, 144.9, 143.9, 135.4, 134.4, 132.8, 131.4, 129.5, 129.1, 128.7, 128.2, 128.0, 127.3, 125.6, 123.4, 122.5, 122.2, 62.7, 21.6; **HRMS** (ESI) m/z calcd. for $C_{21}H_{17}ClNO_2S$ $[M+H]^+$ 382.0669, found 382.0663.



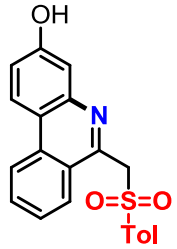
(3f) Yellow solid (114.2 mg, 0.26 mmol, 51% yield), m.p: 192-193 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.59 (d, *J* = 7.8 Hz, 1H), 8.40 (d, *J* = 9.0 Hz, 1H), 8.37 (d, *J* = 8.4 Hz, 1H), 7.99 (s, 1H), 7.89 (t, *J* = 7.8 Hz, 1H), 7.79-7.74 (m, 2H), 7.56 (d, *J* = 8.4 Hz, 2H), 7.21 (d, *J* = 8.4 Hz, 2H), 5.13 (s, 2H), 2.41 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 151.2, 144.9, 135.4, 132.8, 132.3, 131.4, 130.9, 129.6, 128.7, 128.1, 127.3, 125.6, 123.5, 122.9, 122.4, 122.2, 62.8, 21.7; **HRMS** (ESI) m/z calcd. for $C_{21}H_{16}BrNNaO_2S$ $[M+Na]^+$ 447.9983, found 447.9987.



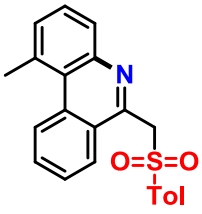
(3g) Yellow solid (143.6 mg, 0.35 mmol, 69% yield), m.p: 193-194 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.64 (t, *J* = 8.4 Hz, 2H), 8.41 (d, *J* = 8.4 Hz, 1H), 8.08 (s, 1H), 7.93 (t, *J* = 7.8 Hz, 1H), 7.85-7.81 (m, 2H), 7.56 (d, *J* = 7.8 Hz, 2H), 7.20 (d, *J* = 7.8 Hz, 2H), 5.15 (s, 2H), 2.39 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 151.6, 145.0, 142.5, 135.3, 132.4, 131.5, 130.5 (q, *J* = 33.0 Hz), 129.6, 128.9, 128.6, 127.4 (q, *J* = 4.5 Hz), 127.3, 126.22, 126.18, 123.9 (q, *J* = 271.5 Hz), 123.4 (q, *J* = 3.0 Hz), 123.1, 122.7, 62.7, 21.5; **HRMS** (ESI) m/z calcd. for $C_{22}H_{17}F_3NO_2S$ $[M+H]^+$ 416.0927, found 416.0933.



(3h) Yellow solid (86.0 mg, 0.22 mmol, 43% yield), m.p: 196-197 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.53 (d, *J* = 8.4 Hz, 1H), 8.43 (d, *J* = 9.0 Hz, 1H), 8.26 (d, *J* = 8.4 Hz, 1H), 7.83-7.79 (m, 1H), 7.63 (t, *J* = 7.8 Hz, 1H), 7.58 (d, *J* = 7.8 Hz, 2H), 7.32-7.28 (m, 2H), 7.20 (d, *J* = 7.8 Hz, 2H), 5.12 (s, 2H), 3.93 (s, 3H), 2.39 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 160.1, 150.1, 144.6, 135.6, 133.4, 131.0, 129.5, 128.7, 127.0, 126.6, 124.7, 123.2, 121.8, 118.9, 118.2, 114.6, 109.5, 62.7, 55.6, 21.6; **HRMS** (ESI) m/z calcd. for $C_{22}H_{19}NNaO_3S$ $[M+Na]^+$ 400.0978, found 400.0979.

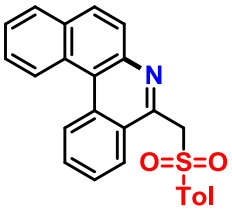


(3i) Light yellow solid (108.1 mg, 0.28 mmol, 56% yield), m.p: 225-226 °C; **^{1}H NMR** (600 MHz, DMSO) δ 10.12 (s, 1H), 8.69 (d, *J* = 7.8 Hz, 1H), 8.61 (d, *J* = 9.0 Hz, 1H), 8.37 (d, *J* = 8.4 Hz, 1H), 7.87 (t, *J* = 7.8 Hz, 1H), 7.67-7.60 (m, 3H), 7.37 (d, *J* = 7.8 Hz, 2H), 7.24 (d, *J* = 8.4 Hz, 1H), 7.13 (s, 1H), 5.38 (s, 2H), 2.40 (s, 3H); **^{13}C NMR** (125 MHz, DMSO) δ 158.6, 150.9, 145.1, 144.8, 136.8, 133.4, 131.5, 130.0, 128.7, 128.2, 126.5, 124.6, 124.5, 122.2, 118.9, 116.9, 112.5, 61.6, 21.6; **HRMS** (ESI) m/z calcd. for $C_{21}H_{17}NNaO_3S$ $[M+Na]^+$ 386.0827, found 386.0828.

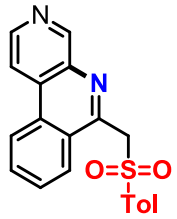


(3j) Light yellow solid (103.2 mg, 0.29 mmol, 57% yield), m.p: 205-206 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.87 (d, *J* = 8.4 Hz, 1H), 8.39 (d, *J* = 8.4 Hz, 1H),

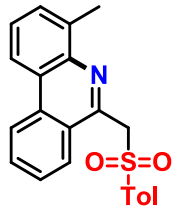
7.86-7.83 (m, 1H), 7.74-7.72 (m, 1H), 7.69 (d, *J* = 8.4 Hz, 1H), 7.57-7.53 (m, 3H), 7.49 (d, *J* = 7.2 Hz, 1H), 7.16 (d, *J* = 7.8 Hz, 2H), 5.14 (s, 2H), 3.09 (s, 3H), 2.37 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 149.4, 144.7, 144.6, 135.5, 134.9, 134.4, 131.8, 130.0, 129.4, 128.8, 128.7, 127.7, 127.0, 126.8, 126.7, 126.4, 123.7, 62.6, 26.7, 21.5; **HRMS** (ESI) m/z calcd. for $C_{22}H_{20}NO_2S$ $[M+H]^+$ 362.1209, found 362.1215.



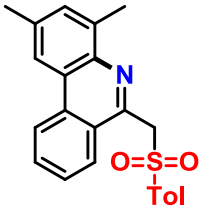
(3k) Yellow solid (125.4 mg, 0.32 mmol, 63% yield), m.p: 254-255 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.11 (d, *J* = 8.4 Hz, 1H), 9.05 (d, *J* = 8.4 Hz, 1H), 8.48 (d, *J* = 7.8 Hz, 1H), 8.03 (d, *J* = 7.8 Hz, 1H), 7.96 (d, *J* = 9.0 Hz, 1H), 7.91 (t, *J* = 7.8 Hz, 1H), 7.78 (t, *J* = 7.8 Hz, 1H), 7.75-7.71 (m, 2H), 7.68 (t, *J* = 7.2 Hz, 1H), 7.54 (d, *J* = 7.8 Hz, 2H), 7.15 (d, *J* = 7.8 Hz, 2H), 5.24 (s, 2H), 2.35 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 148.8, 144.7, 143.0, 135.5, 133.5, 133.3, 130.5, 129.6, 129.4, 129.3, 128.73, 128.69, 127.9, 127.8, 127.1, 127.0, 126.8, 126.74, 126.72, 126.68, 120.9, 62.6, 21.6; **HRMS** (ESI) m/z calcd. for $C_{25}H_{20}NO_2S$ $[M+H]^+$ 398.1209, found 398.1202.



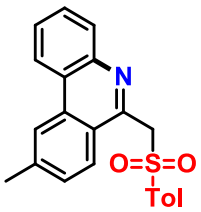
(3l) Yellow solid (129.9 mg, 0.35 mmol, 70% yield), m.p: 198-199 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.15 (s, 1H), 8.77 (d, *J* = 6.0 Hz, 1H), 8.66 (d, *J* = 8.4 Hz, 1H), 8.48 (d, *J* = 7.8 Hz, 1H), 8.31 (d, *J* = 5.4 Hz, 1H), 7.99-7.97 (m, 1H), 7.93-7.90 (m, 1H), 7.56 (d, *J* = 7.8 Hz, 2H), 7.22 (d, *J* = 8.4 Hz, 2H), 5.18 (s, 2H), 2.41 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 153.2, 151.9, 146.1, 145.1, 138.3, 135.2, 131.7, 131.3, 130.0, 129.6, 128.9, 128.7, 127.5, 127.2, 122.9, 115.1, 62.6, 21.6; **HRMS** (ESI) m/z calcd. for $C_{20}H_{16}N_2NaO_2S$ $[M+Na]^+$ 371.0830, found 371.0835.



(3m) Light yellow solid (110.4 mg, 0.31 mmol, 61% yield), m.p: 225-226 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.64 (d, *J* = 7.8 Hz, 1H), 8.41-8.38 (m, 2H), 7.86 (t, *J* = 7.8 Hz, 1H), 7.75 (t, *J* = 7.8 Hz, 1H), 7.53 (t, *J* = 7.8 Hz, 1H), 7.51-7.46 (m, 3H), 7.14 (d, *J* = 8.4 Hz, 2H), 5.16 (s, 2H), 2.36 (s, 3H), 2.31 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 148.2, 144.4, 141.8, 137.9, 135.4, 133.5, 130.7, 129.2, 128.8, 127.5, 127.2, 126.9, 125.3, 123.8, 122.5, 119.7, 62.6, 21.5, 17.4; **HRMS** (ESI) m/z calcd. for $C_{22}H_{20}NO_2S$ $[M+H]^+$ 362.1209, found 362.1213.

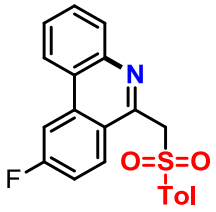


(3n) Yellow solid (122.2 mg, 0.33 mmol, 65% yield), m.p: 201-202 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.62 (d, *J* = 8.4 Hz, 1H), 8.39 (d, *J* = 7.8 Hz, 1H), 8.17 (s, 1H), 7.85-7.82 (m, 1H), 7.75-7.72 (m, 1H), 7.48 (d, *J* = 7.8 Hz, 2H), 7.32 (s, 1H), 7.15 (d, *J* = 8.4 Hz, 2H), 5.15 (s, 2H), 2.56 (s, 3H), 2.37 (s, 3H), 2.27 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 147.1, 144.4, 140.2, 137.6, 137.1, 135.4, 133.2, 131.1, 130.4, 129.2, 128.9, 127.4, 126.8, 125.5, 123.7, 122.5, 119.3, 62.5, 22.0, 21.5, 17.3; **HRMS** (ESI) m/z calcd. for $C_{23}H_{22}NO_2S$ $[M+H]^+$ 376.1366, found 376.1374.

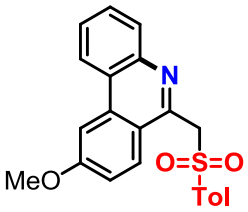


(3o) White solid (108.6 mg, 0.30 mmol, 60% yield), m.p: 188-189 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.54-8.51 (m, 1H), 8.41 (s, 1H), 8.24 (d, *J* = 8.4 Hz, 1H), 7.80-7.78 (m, 1H), 7.66-7.62 (m, 2H), 7.57-7.52 (m, 3H), 7.17 (d, *J* = 8.4 Hz, 2H), 5.11 (s, 2H), 2.64 (s, 3H), 2.37 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 149.6, 144.6, 143.5, 141.5,

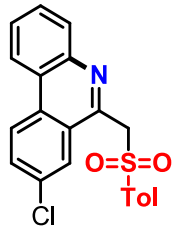
135.5, 133.3, 129.8, 129.4, 128.7, 128.5, 127.3, 126.9, 123.9, 123.8, 121.94, 121.89, 62.7, 22.3, 21.5; **HRMS** (ESI) m/z calcd. for $C_{22}H_{20}NO_2S$ $[M+H]^+$ 362.1209, found 362.1211.



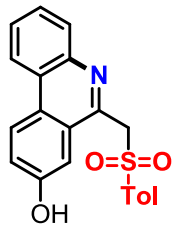
(3p) White solid (89.3 mg, 0.23 mmol, 46% yield), m.p: 184-185 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.44-8.40 (m, 2H), 8.25-8.22 (m, 1H), 7.84-7.82 (m, 1H), 7.72-7.67 (m, 2H), 7.56 (d, *J* = 7.8 Hz, 2H), 7.50-7.46 (m, 1H), 7.20 (d, *J* = 7.8 Hz, 2H), 5.12 (s, 2H), 2.40 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 163.9 (d, *J* = 252.0 Hz), 149.3, 144.8, 143.6, 135.7 (d, *J* = 10.5 Hz), 135.4, 130.2 (d, *J* = 9.0 Hz), 130.0, 129.5, 129.4, 128.7, 127.7, 123.6 (d, *J* = 4.5 Hz), 122.7, 122.2, 116.9 (d, *J* = 24.0 Hz), 107.5 (d, *J* = 22.5 Hz), 62.9, 21.6; **HRMS** (ESI) m/z calcd. for $C_{21}H_{16}FNNaO_2S$ $[M+Na]^+$ 388.0778, found 388.0771.



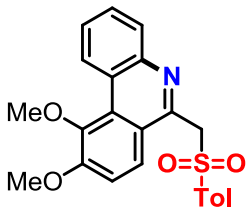
(3q) White solid (116.0 mg, 0.29 mmol, 58% yield), m.p: 175-176 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.45 (d, *J* = 7.8 Hz, 1H), 8.26 (d, *J* = 9.0 Hz, 1H), 7.91 (s, 1H), 7.79 (d, *J* = 7.8 Hz, 1H), 7.66-7.60 (m, 2H), 7.55 (d, *J* = 8.4 Hz, 2H), 7.32-7.30 (m, 1H), 7.17 (d, *J* = 7.8 Hz, 2H), 5.08 (s, 2H), 4.03 (s, 3H), 2.37 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 161.5, 149.2, 144.6, 143.7, 135.5, 135.4, 129.8, 129.4, 129.0, 128.8, 128.7, 127.1, 123.8, 122.0, 120.6, 117.7, 103.0, 62.8, 55.6, 21.5; **HRMS** (ESI) m/z calcd. for $C_{22}H_{19}NNaO_3S$ $[M+Na]^+$ 400.0978, found 400.0979.



(3r) Yellow solid (105.1 mg, 0.28 mmol, 55% yield), m.p: 212-213 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.52 (d, *J* = 8.4 Hz, 1H), 8.47-8.46 (m, 1H), 8.15 (d, *J* = 1.2 Hz, 1H), 7.91 (d, *J* = 7.2 Hz, 1H), 7.77-7.76 (m, 1H), 7.71-7.67 (m, 2H), 7.58 (d, *J* = 8.0 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 5.10 (s, 2H), 2.39 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 148.7, 145.0, 135.4, 133.7, 131.61, 131.56, 129.9, 129.6, 129.2, 128.7, 128.2, 126.3, 126.2, 124.0, 123.4, 121.9, 62.4, 21.6; **HRMS** (ESI) m/z calcd. for $C_{21}H_{17}ClNO_2S$ $[M+H]^+$ 382.0669, found 382.0665.

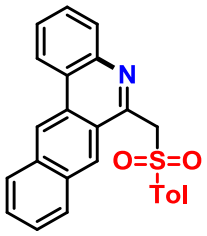


(3s) Yellow solid (125.6 mg, 0.35 mmol, 69% yield), m.p: 247-248 °C; **^{1}H NMR** (600 MHz, DMSO) δ 10.25 (s, 1H), 8.70 (d, *J* = 9.0 Hz, 1H), 8.64 (d, *J* = 8.4 Hz, 1H), 7.77-7.75 (m, 1H), 7.68-7.67 (m, 2H), 7.65-7.63 (m, 3H), 7.47 (dd, *J* = 2.5 Hz, *J* = 9.0 Hz, 1H), 7.37 (d, *J* = 7.8 Hz, 2H), 5.28 (s, 2H), 2.39 (s, 3H); **^{13}C NMR** (150MHz, DMSO) δ 157.4, 149.7, 144.8, 142.1, 136.8, 130.0, 129.7, 128.6, 128.1, 127.9, 127.6, 126.0, 124.8, 124.4, 122.4, 122.3, 111.0, 61.9, 21.6; **HRMS** (ESI) m/z calcd. for $C_{21}H_{18}NO_3S$ $[M+H]^+$ 364.1007, found 364.1005.

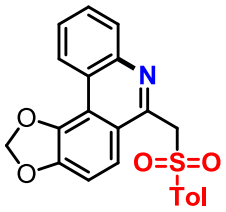


(3t) Yellow solid (146.9 mg, 0.36 mmol, 72% yield), m.p: 193-194 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.36-8.35 (m, 1H), 7.82 (s, 1H), 7.77-7.76 (m, 1H), 7.62 (s, 1H), 7.60-7.57 (m, 2H), 7.51 (d, *J* = 7.8 Hz, 2H), 7.14 (d, *J* = 7.8 Hz, 2H), 5.07 (s, 2H), 4.11 (s, 3H), 4.08 (s, 3H), 2.34 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 152.6, 149.6,

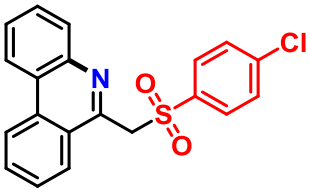
148.0, 144.6, 142.9, 135.4, 129.8, 129.3, 129.0, 128.5, 127.7, 127.0, 123.6, 121.4, 120.9, 106.7, 101.8, 63.3, 56.1, 56.0, 21.5; **HRMS** (ESI) m/z calcd. for $C_{23}H_{22}NO_4S$ $[M+H]^+$ 408.1264, found 408.1270.



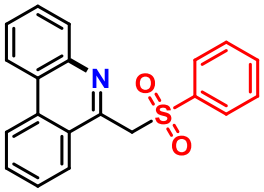
(3u) White solid (135.4 mg, 0.34 mmol, 68% yield), m.p: 187-188 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.09-9.05 (m, 1H), 8.98-8.95 (m, 1H), 8.23 (d, *J* = 8.8 Hz, 1H), 8.07-8.04 (m, 1H), 8.00 (d, *J* = 8.8 Hz, 1H), 7.92-7.89 (m, 1H), 7.76-7.72 (m, 2H), 7.72-7.68 (m, 2H), 7.52 (d, *J* = 8.2 Hz, 2H), 7.13 (d, *J* = 8.0 Hz, 2H), 5.21 (s, 2H), 2.35 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 148.8, 145.2, 144.6, 135.4, 134.7, 132.6, 129.7, 129.4, 128.8, 128.70, 128.65, 128.6, 128.5, 128.3, 128.1, 127.2, 127.1, 126.9, 124.5, 124.2, 122.9, 62.9, 21.5; **HRMS** (ESI) m/z calcd. for $C_{25}H_{20}NO_2S$ $[M+H]^+$ 398.1209, found 398.1205.



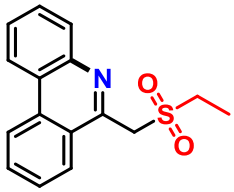
(3v) Yellow solid (123.5 mg, 0.32 mmol, 63% yield), m.p: 217-218 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.36-8.34 (m, 1H), 7.94 (s, 1H), 7.77-7.75 (m, 1H), 7.69 (s, 1H), 7.62-7.60 (m, 2H), 7.56 (d, *J* = 7.8 Hz, 2H), 7.20 (d, *J* = 7.8 Hz, 2H), 6.19 (s, 2H), 5.05 (s, 2H), 2.39 (s, 3H); **^{13}C NMR** (125 MHz, DMSO) δ 151.7, 149.2, 148.5, 144.8, 143.1, 136.7, 131.1, 130.0, 129.6, 128.7, 127.7, 124.3, 123.3, 122.7, 105.3, 102.9, 100.8, 62.0, 21.6; **HRMS** (ESI) m/z calcd. for $C_{22}H_{18}NO_4S$ $[M+H]^+$ 392.0957, found 392.0958.



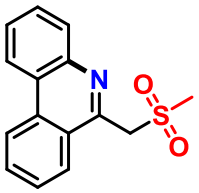
(3w) White solid (117.0 mg, 0.30 mmol, 60% yield), m.p: 182-183 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.67 (d, *J* = 8.4 Hz, 1H), 8.58-8.56 (m, 1H), 8.36 (d, *J* = 8.4 Hz, 1H), 7.92-7.89 (m, 1H), 7.80-7.76 (m, 2H), 7.70-7.69 (m, 2H), 7.59-7.57 (m, 2H), 7.37-7.35 (m, 2H), 5.17 (s, 2H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 149.4, 143.2, 140.5, 136.7, 133.2, 131.1, 130.3, 129.8, 129.1, 128.9, 127.9, 127.8, 126.9, 125.5, 124.0, 122.4, 122.0, 62.4; **HRMS** (ESI) m/z calcd. for $C_{20}H_{14}ClNNaO_2S$ $[M+Na]^+$ 390.0326, found 390.0331.



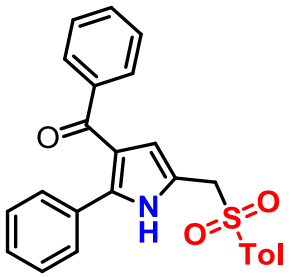
(3x) White solid (103.6 mg, 0.31 mmol, 62% yield), m.p: 188-189 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.62 (d, *J* = 7.8 Hz, 1H), 8.53 (t, *J* = 5.4 Hz, 1H), 8.34 (d, *J* = 7.8 Hz, 1H), 7.86 (t, *J* = 7.8 Hz, 1H), 7.79-7.78 (m, 1H), 7.72 (t, *J* = 7.8 Hz, 1H), 7.68-7.64 (m, 4H), 7.55 (t, *J* = 7.2 Hz, 1H), 7.38 (t, *J* = 7.8 Hz, 2H), 5.17 (s, 2H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 149.6, 143.2, 138.3, 133.6, 133.1, 130.9, 129.9, 128.8, 128.70, 128.66, 127.66, 127.65, 126.9, 125.5, 123.9, 122.3, 121.9, 62.5; **HRMS** (ESI) m/z calcd. for $C_{20}H_{16}NO_2S$ $[M+H]^+$ 334.0896, found 334.0899.



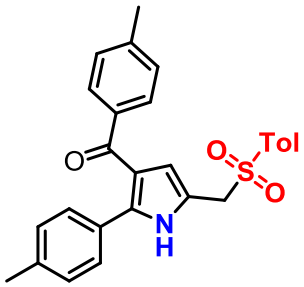
(3y) White solid (84.4 mg, 0.30 mmol, 59% yield), m.p: 190-191 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.66 (d, *J* = 7.8 Hz, 1H), 8.59 (d, *J* =7.8 Hz, 1H), 8.39 (d, *J* = 8.4 Hz, 1H), 8.12 (d, *J* = 8.4 Hz, 1H), 7.89 (t, *J* = 7.2 Hz, 1H), 7.78-7.75 (m, 2H), 7.72 (t, *J* =7.8 Hz, 1H), 5.02 (s, 2H), 3.21 (q, *J* =7.2 Hz, 2H), 1.48 (t, *J* =7.2 Hz, 3H); **^{13}C NMR** (150MHz, $CDCl_3$) δ 150.4, 143.3, 133.3, 131.2, 129.9, 128.9, 127.9, 127.8, 127.1, 125.6, 124.3, 122.4, 122.1, 58.2, 46.6, 6.5; **HRMS** (ESI) m/z calcd. for $C_{16}H_{16}NO_2S$ $[M+H]^+$ 286.0896, found 286.0897.



(3z) White solid (88.4 mg, 0.33 mmol, 65% yield), m.p: 183-184 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.67 (d, *J* = 7.8 Hz, 1H), 8.60 (d, *J* =7.8 Hz, 1H), 8.35 (d, *J* = 8.4 Hz, 1H), 8.15-8.13 (m, 1H), 7.91-7.88 (m, 1H), 7.78-7.76 (m, 2H), 7.74-7.71 (m, 1H), 5.04 (s, 2H), 3.09 (s, 3H); **^{13}C NMR** (150MHz, $CDCl_3$) δ 150.3, 143.3, 133.4, 131.2, 129.9, 129.0, 127.9, 126.9, 125.5, 124.3, 122.4, 122.2, 60.6, 40.4; **HRMS** (ESI) m/z calcd. for $C_{15}H_{14}NO_2S$ $[M+H]^+$ 272.0740, found 272.0746.

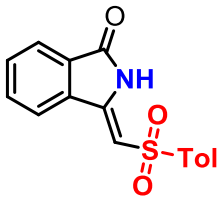


(5a) Yellow solid (118.6 mg, 0.29 mmol, 57% yield), m.p: 221-222 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.13 (s, 1H), 7.62-7.59 (m, 4H), 7.47-7.46 (m, 2H), 7.42 (t, *J* = 7.2 Hz, 1H), 7.33-7.30 (m, 5H), 7.28 (d, *J* = 7.8 Hz, 2H), 6.16 (d, *J* = 2.4 Hz, 1H), 4.38 (s, 2H), 2.46 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 191.7, 145.3, 139.2, 138.9, 134.4, 131.8, 131.2, 129.8, 129.5, 128.5, 128.43, 128.39, 127.8, 120.5, 118.2, 116.1, 55.5, 21.7; **HRMS** (ESI) m/z calcd. for $C_{25}H_{22}NO_3S$ $[M+H]^+$ 416.1320, found 416.1323.

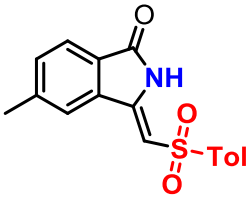


(5b) White solid (135.5 mg, 0.31 mmol, 61% yield), m.p: 235-236 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.19 (s, 1H), 7.57 (d, *J* = 8.4 Hz, 2H), 7.53 (d, *J* = 7.8 Hz, 2H), 7.36 (d, *J* = 8.4 Hz, 2H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.11 (d, *J* = 8.4 Hz, 2H), 7.08 (d, *J* = 7.8 Hz, 2H), 6.09 (d, *J* = 2.4 Hz, 1H), 4.36 (s, 2H), 2.45 (s, 3H), 2.36 (s, 3H), 2.33 (s,

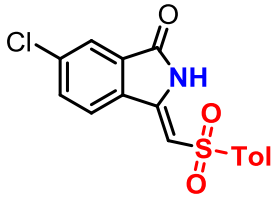
3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 191.5, 145.2, 142.4, 138.9, 138.4, 136.7, 134.4, 129.80, 129.79, 129.2, 128.6, 128.5, 128.2, 120.3, 117.7, 116.1, 55.6, 21.7, 21.6, 21.3; **HRMS** (ESI) m/z calcd. for $C_{27}H_{26}NO_3S$ $[M+H]^+$ 444.1633, found 444.1628.



(7a) White solid (108.0 mg, 0.36 mmol, 72% yield), m.p: 163-164 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.36 (s, 1H), 7.83-7.81 (m, 1H), 7.78 (d, *J* = 8.4 Hz, 2H), 7.57-7.56 (m, 2H), 7.51-7.49 (m, 1H), 7.29 (d, *J* = 8.4 Hz, 2H), 6.00 (s, 1H), 2.37 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 167.3, 144.9, 143.4, 138.7, 135.9, 133.1, 132.3, 130.1, 129.0, 127.2, 124.3, 121.3, 100.7, 21.6; **HRMS** (ESI) m/z calcd. for $C_{16}H_{14}NO_3S$ $[M+H]^+$ 300.0694, found 300.0692.



(7b) White solid (102.1 mg, 0.33 mmol, 65% yield), m.p: 171-172 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.35 (s, 1H), 7.84 (d, *J* = 8.4 Hz, 2H), 7.75 (d, *J* = 7.8 Hz, 1H), 7.43 (d, *J* = 7.8 Hz, 1H), 7.36 (t, *J* = 8.4 Hz, 3H), 6.05 (s, 1H), 2.46 (s, 3H), 2.44 (s, 3H); **^{13}C NMR** (150 MHz, $CDCl_3$) δ 167.5, 144.8, 144.2, 143.6, 138.7, 136.2, 133.1, 130.1, 127.1, 126.4, 124.0, 121.7, 100.2, 21.9, 21.6; **HRMS** (ESI) m/z calcd. for $C_{17}H_{16}NO_3S$ $[M+H]^+$ 314.0851, found 314.0853.

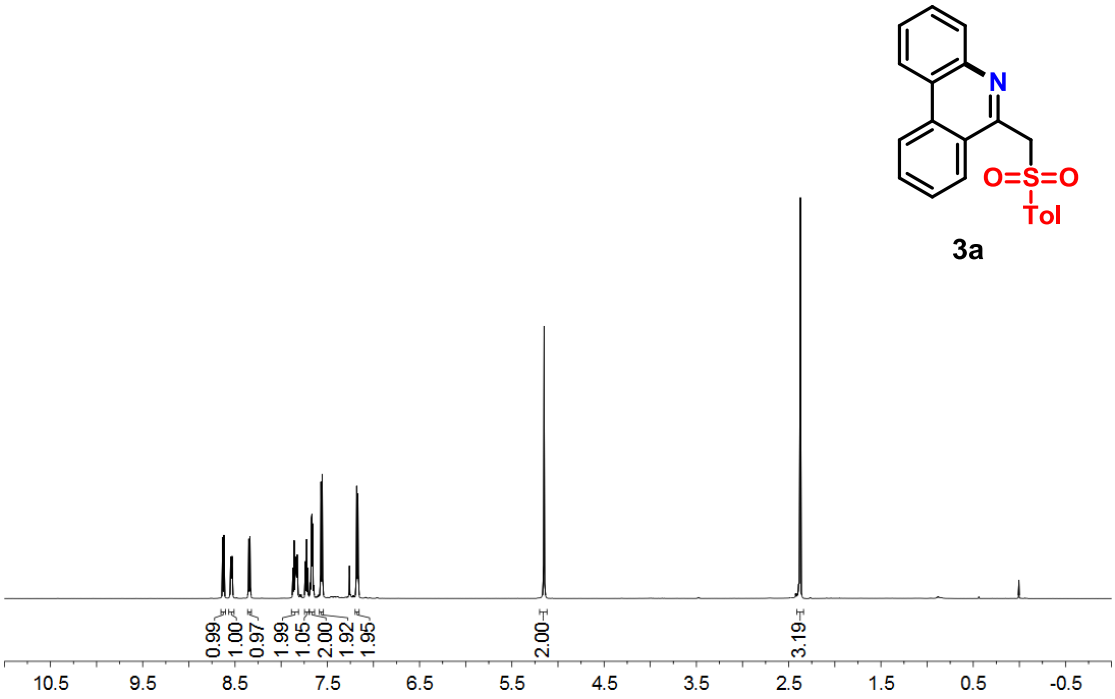


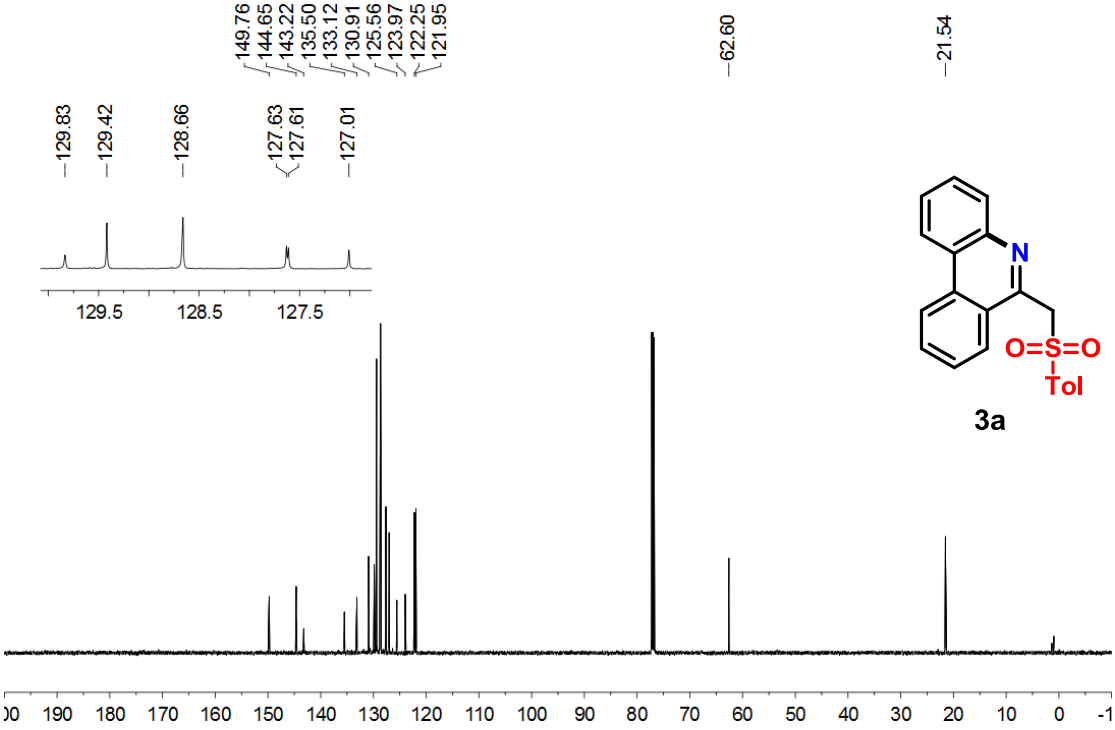
(7c) White solid (71.8 mg, 0.22 mmol, 43% yield), m.p: 185-186 °C; **^{1}H NMR** (600 MHz, $CDCl_3$) δ 9.49 (s, 1H), 7.85 (t, *J* = 8.4 Hz, 3H), 7.60 (d, *J* = 8.4 Hz, 1H), 7.50 (d, *J* = 8.4 Hz, 1H), 7.37 (d, *J* = 8.4 Hz, 2H), 6.06 (s, 1H), 2.45 (s, 3H); **^{13}C NMR** (125 MHz, $CDCl_3$) δ 165.9, 145.1, 142.3, 138.8, 138.3, 133.9, 133.2, 130.6, 130.2, 127.2,

124.6, 122.5, 101.4, 21.7; **HRMS** (ESI) m/z calcd. for $C_{16}H_{13}ClNO_3S$ $[M+H]^+$ 334.0305, found 334.0312.

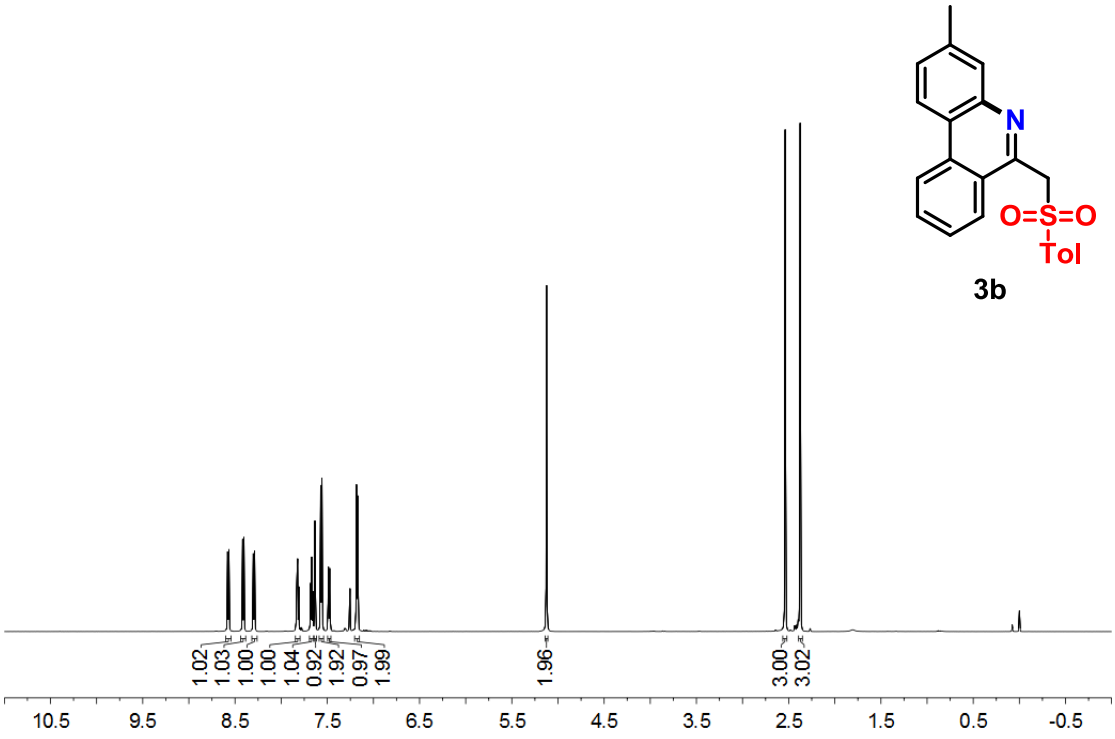
7. NMR Spectra Copies of All the Products

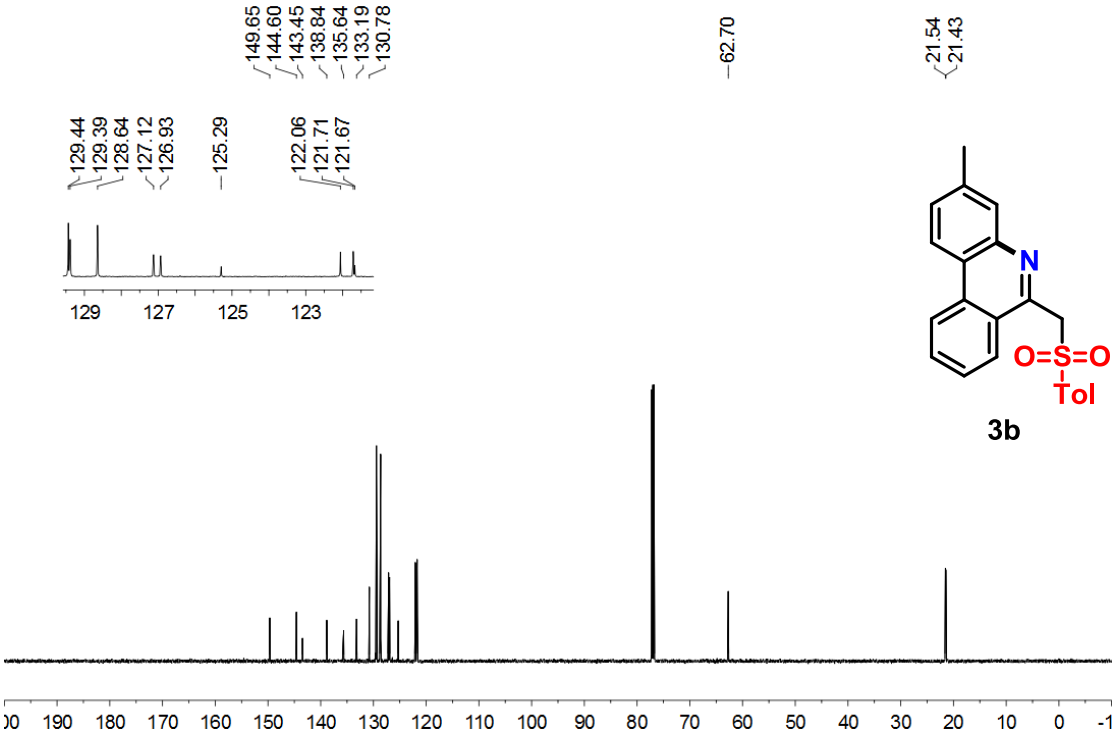
3a ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



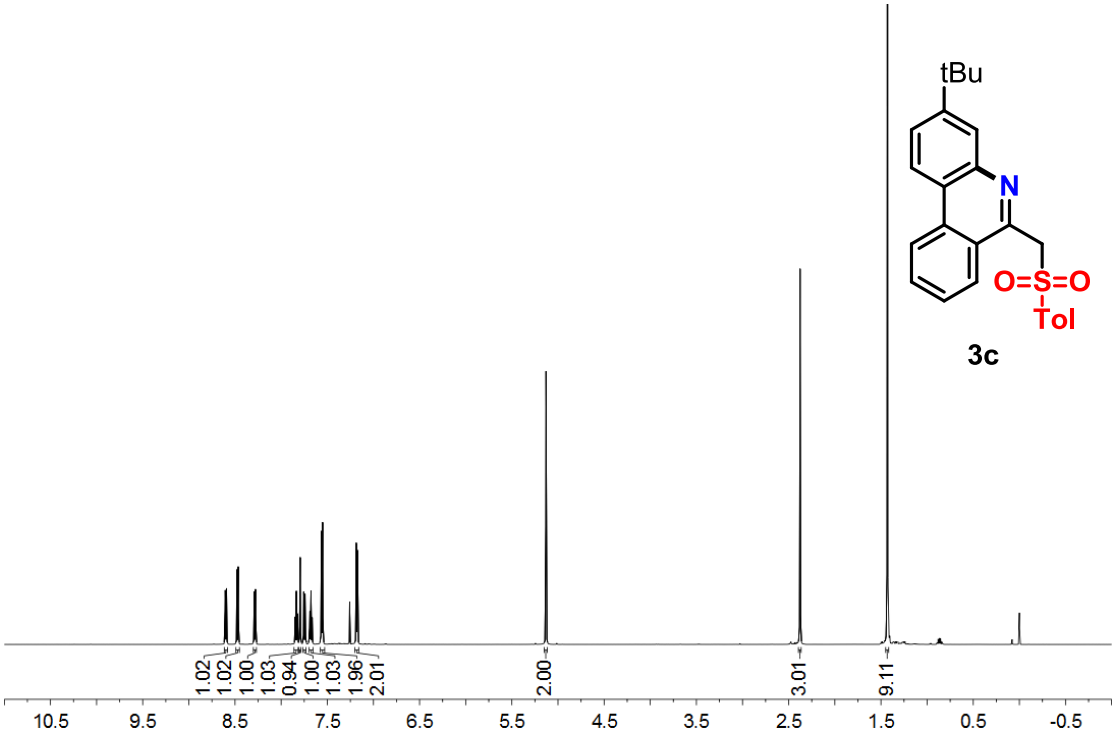


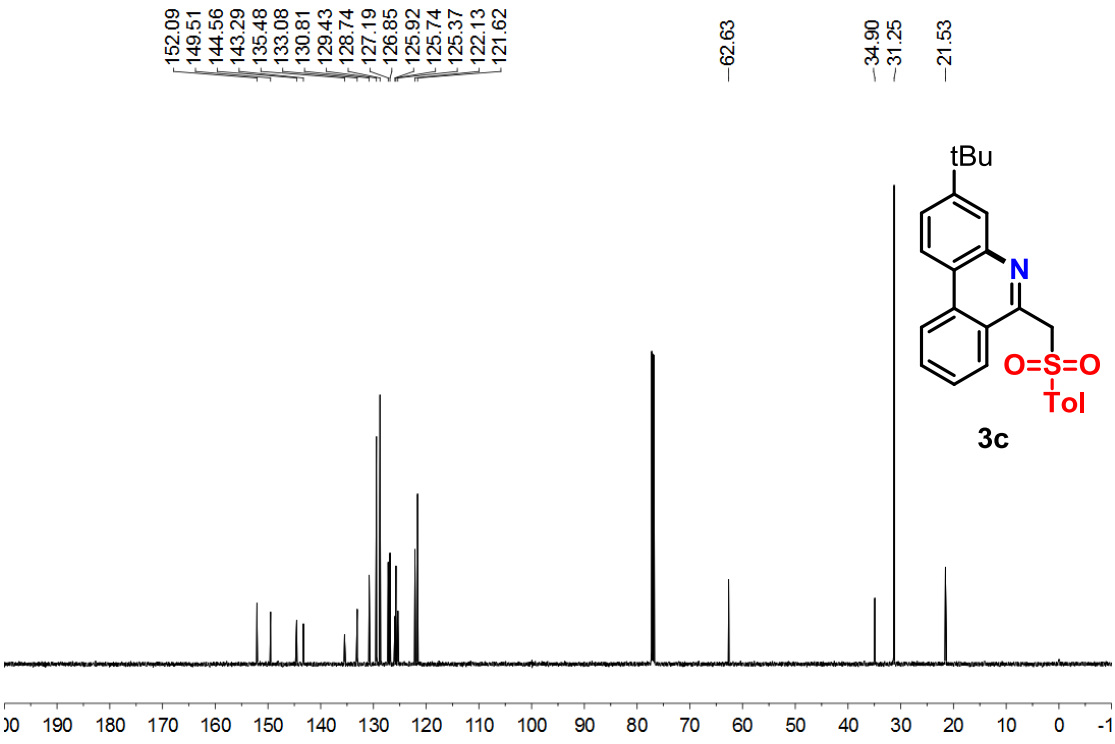
3b ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



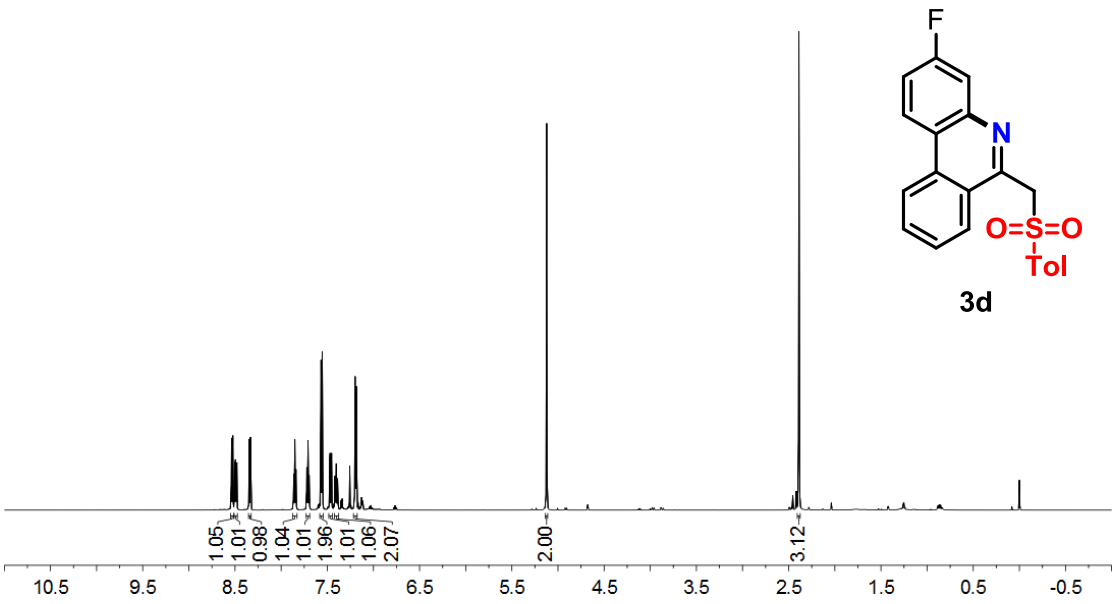


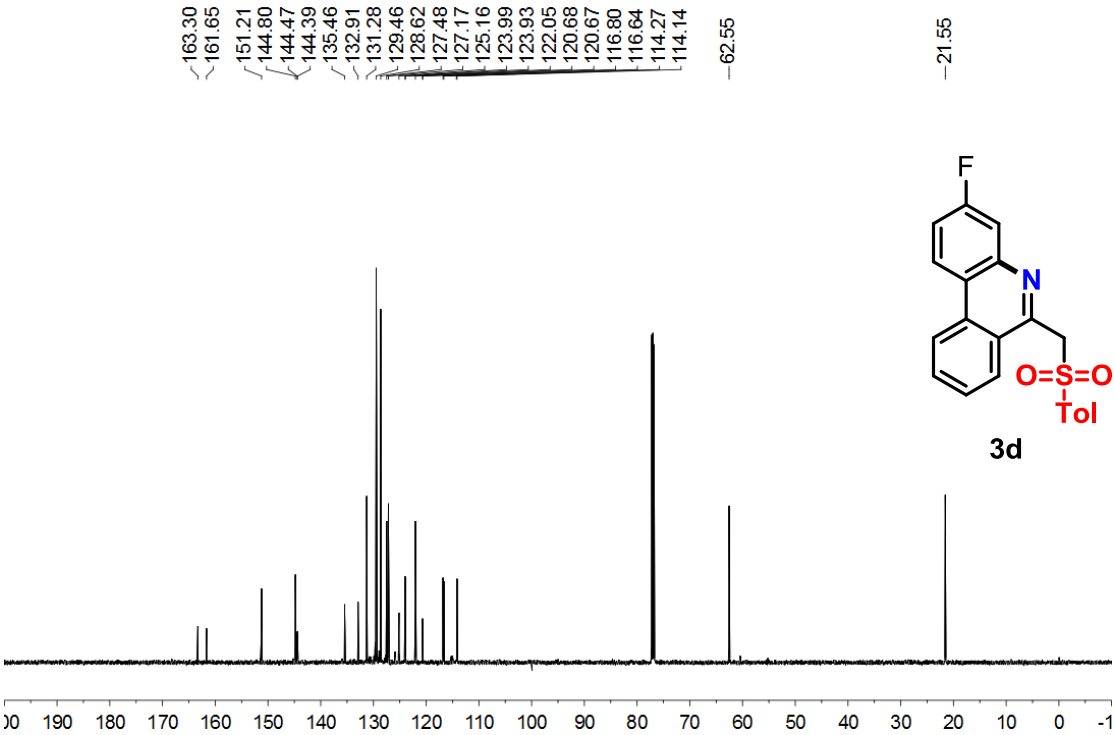
3c ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



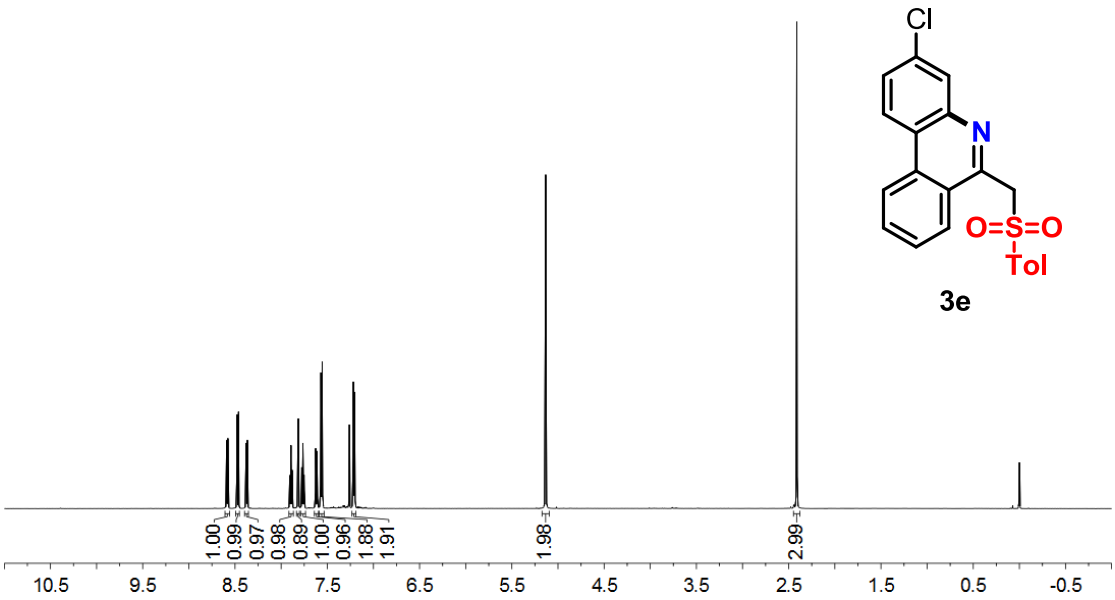


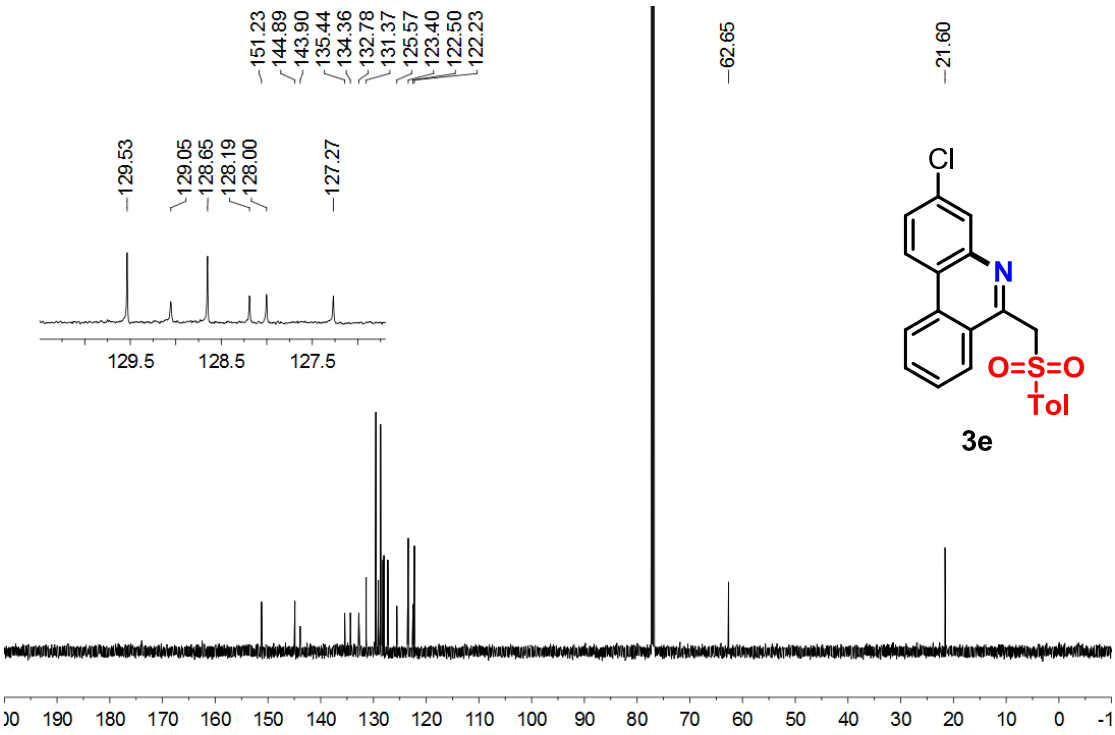
3d ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



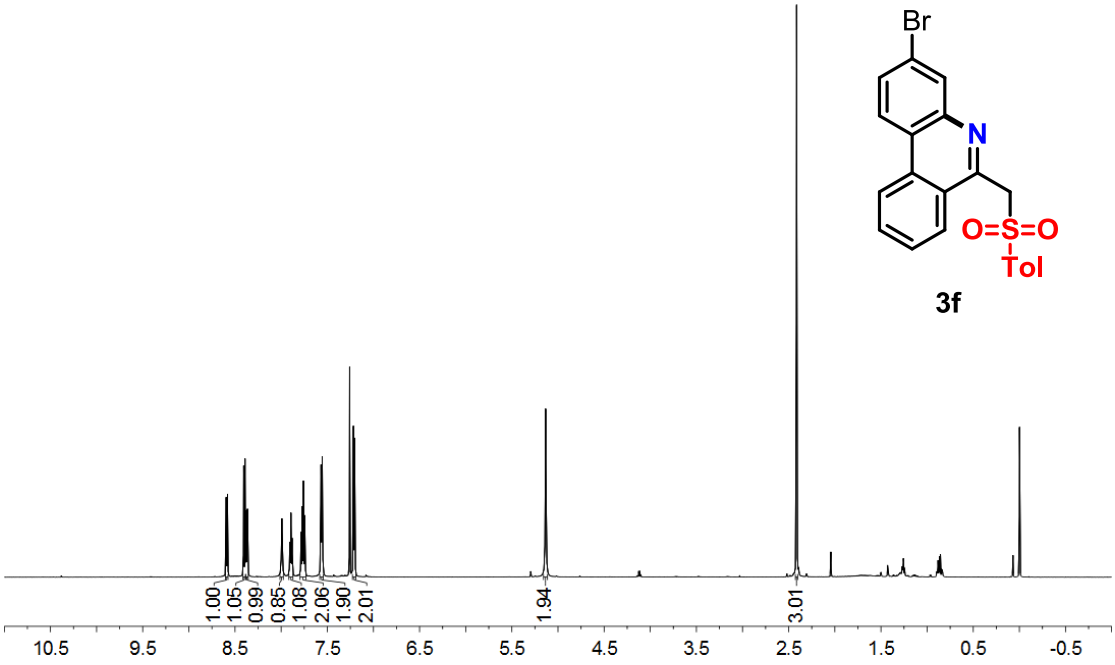


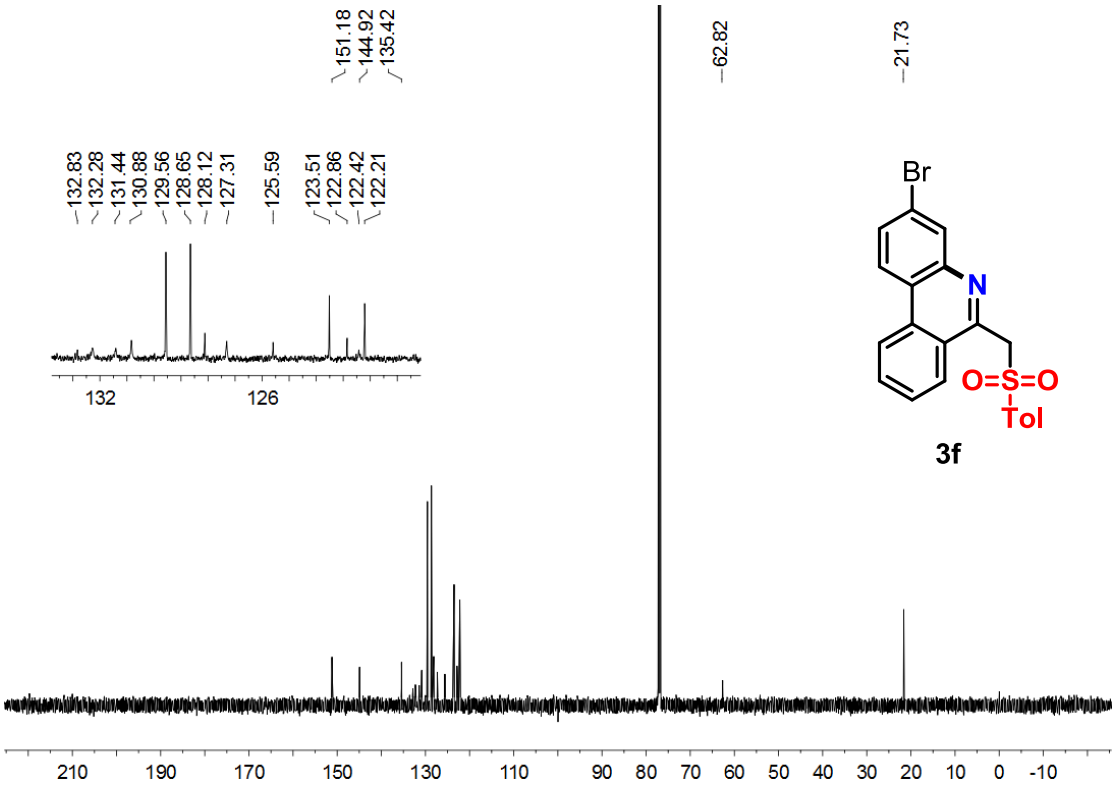
3e ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



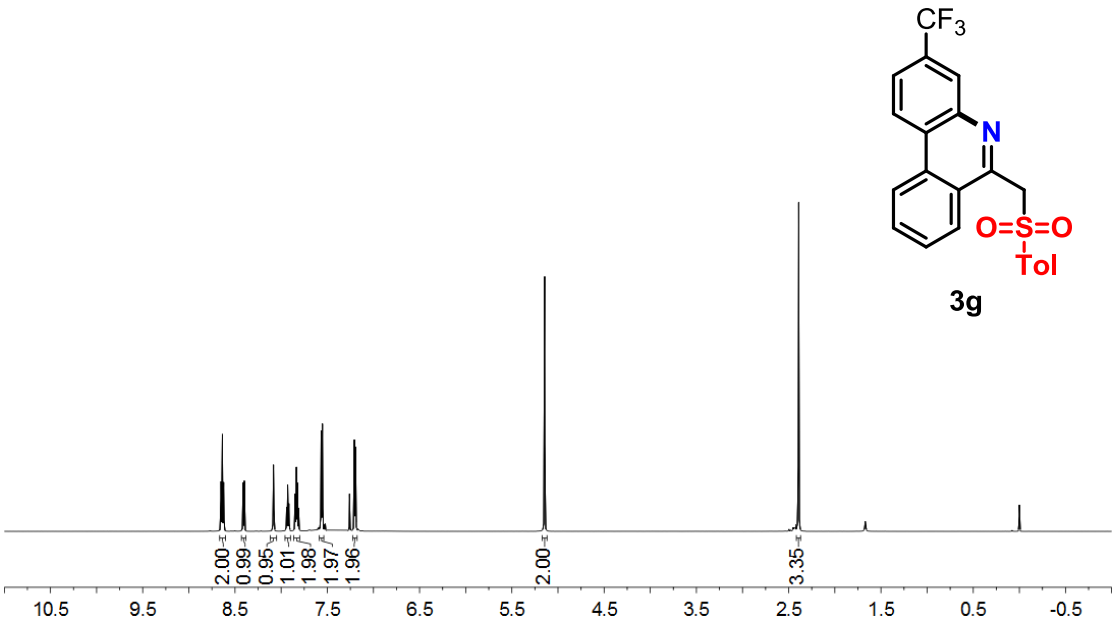


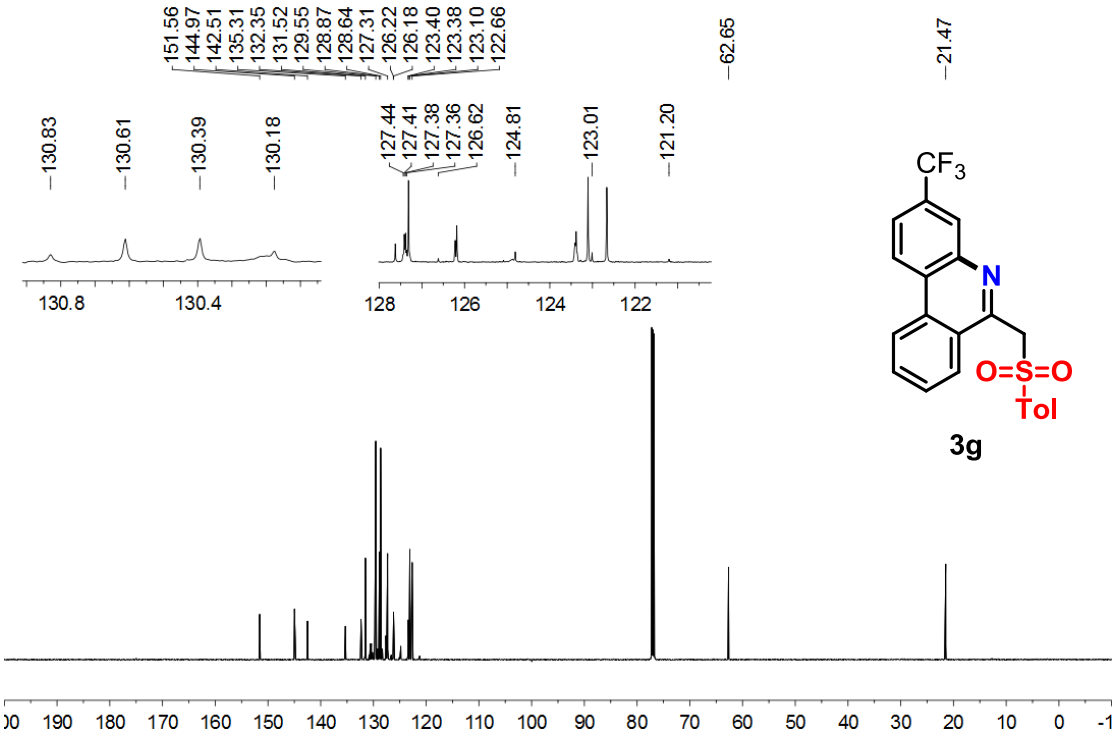
3f ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



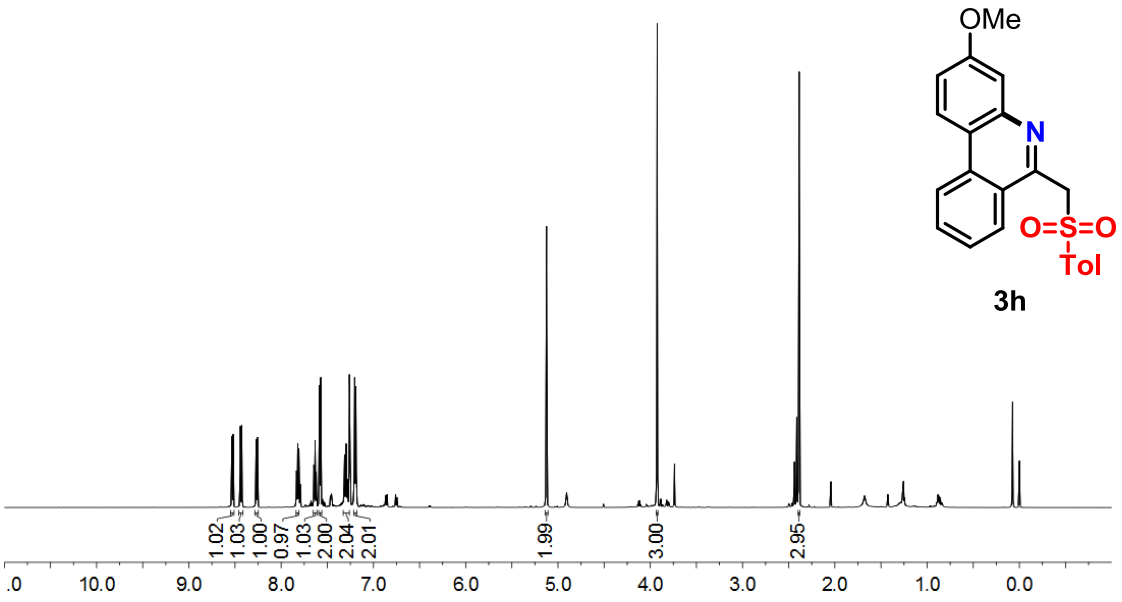


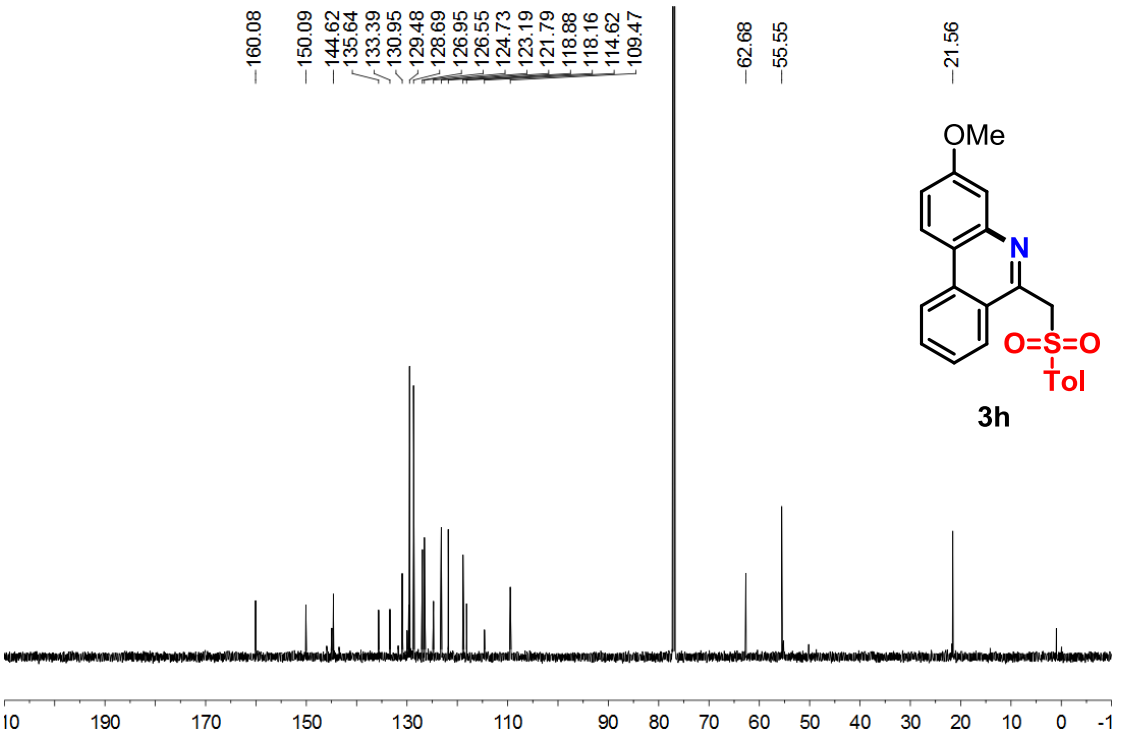
3g ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



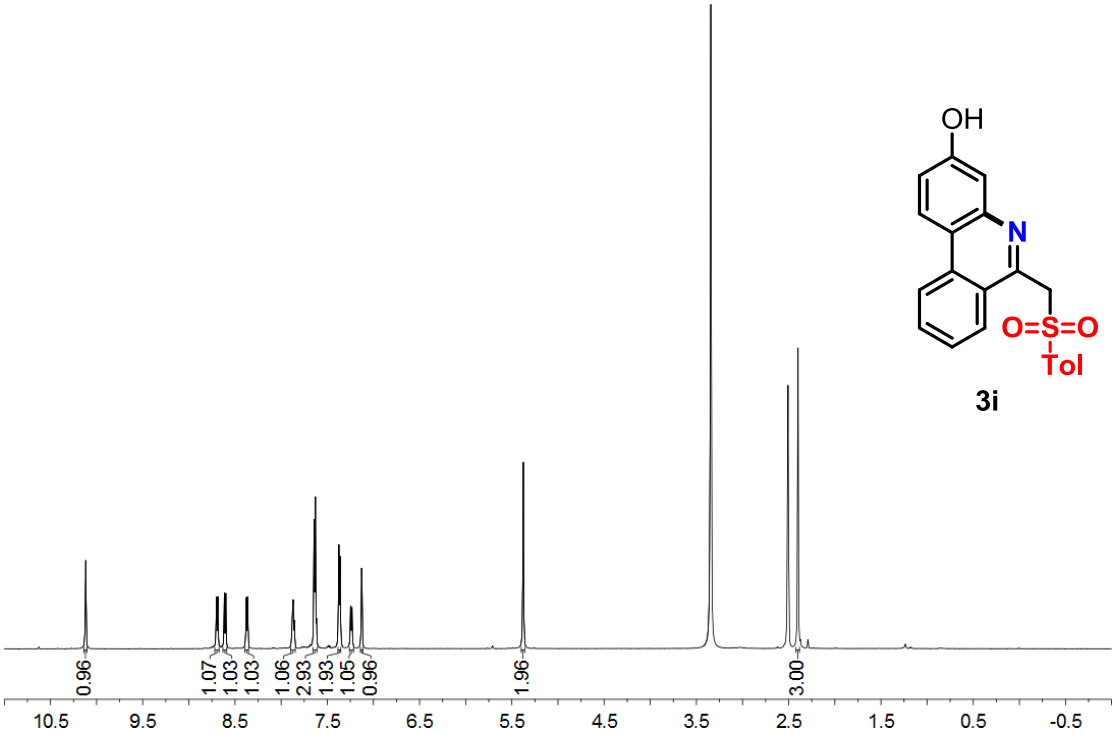


3h ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)

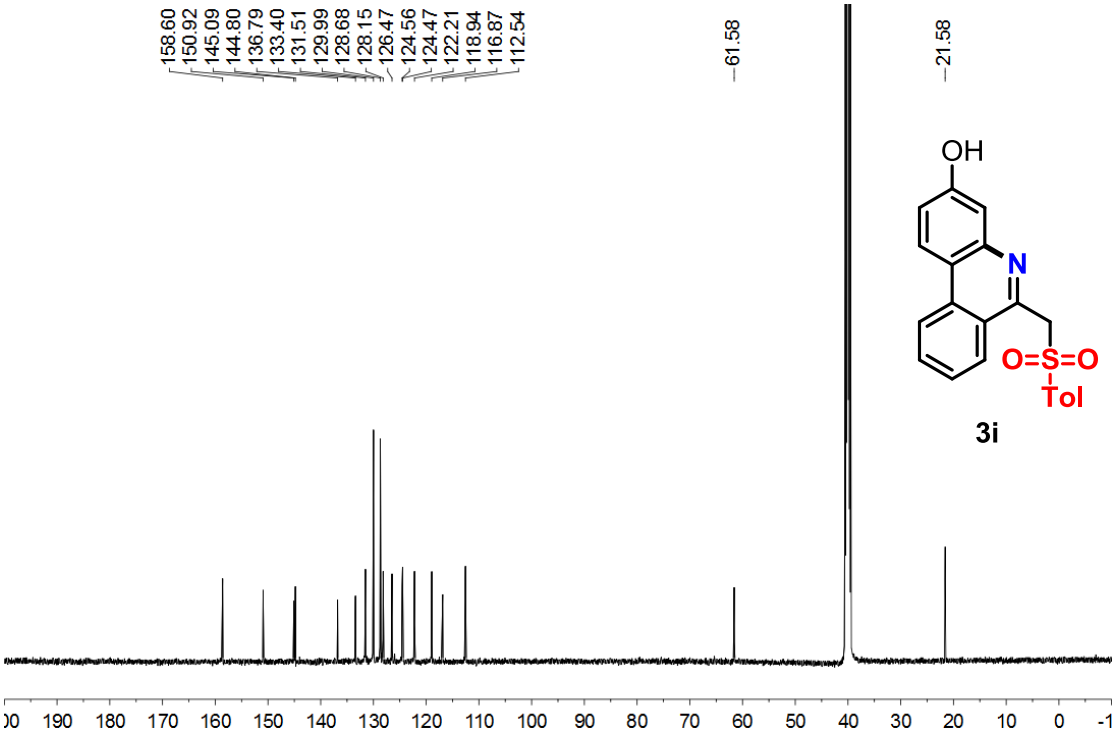




3i ^{1}H NMR (600 MHz, DMSO) & ^{13}C NMR (125 MHz, DMSO)

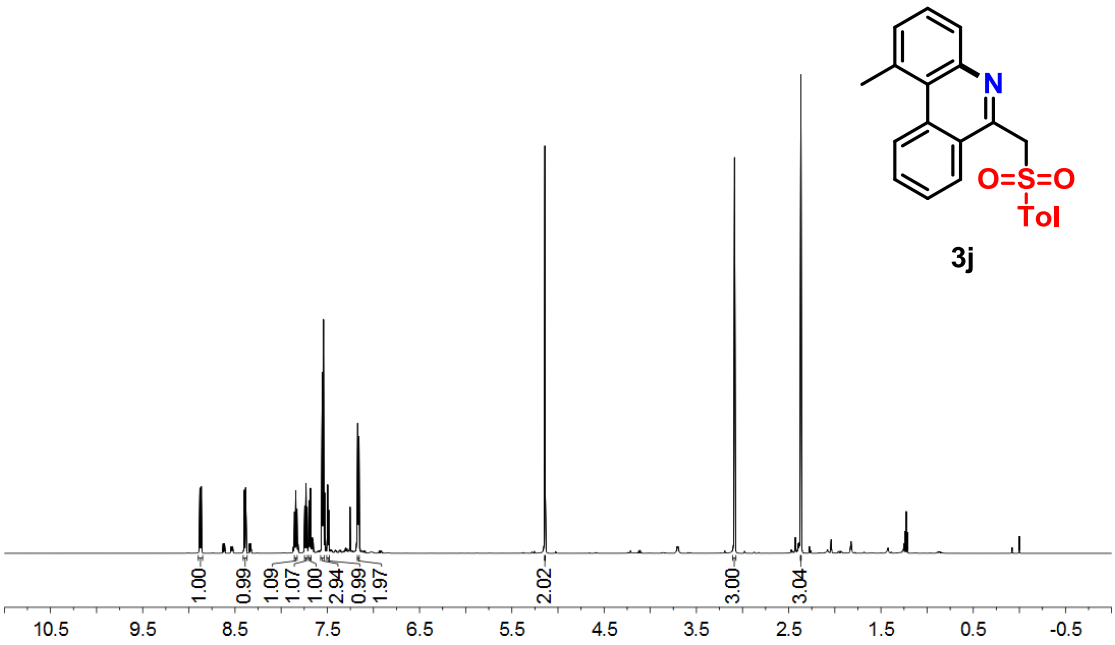


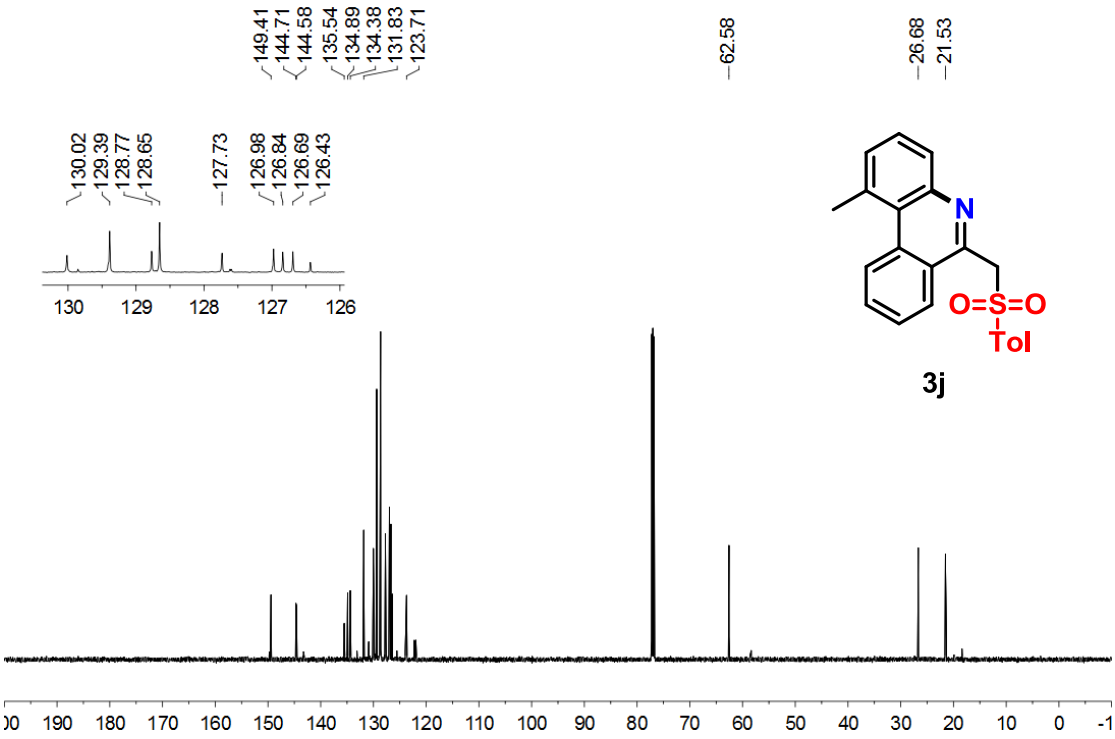
3i



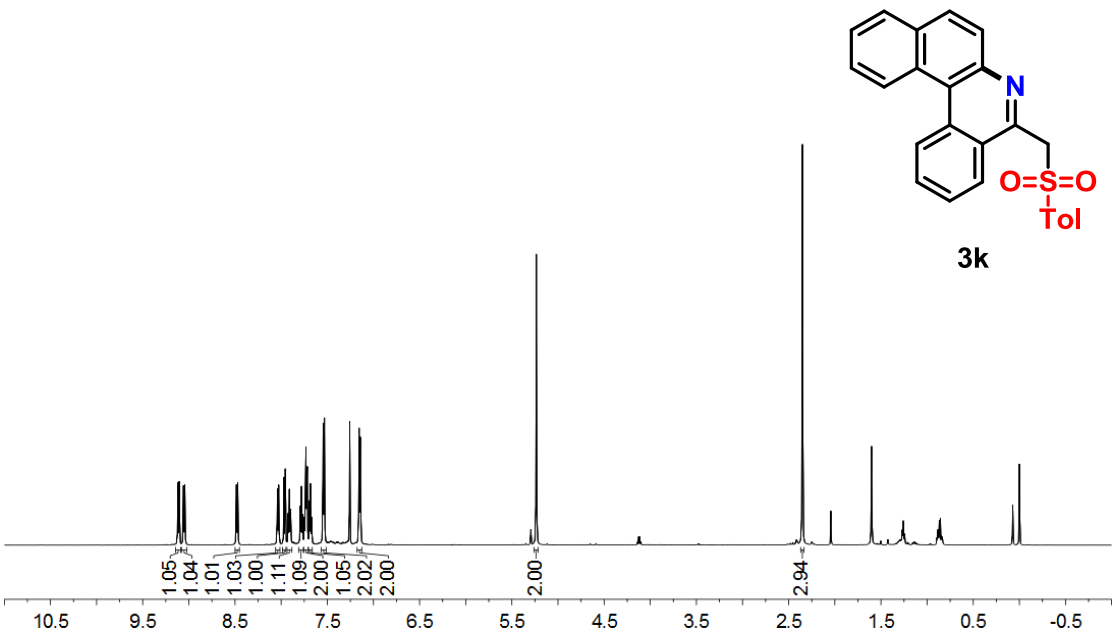
3i

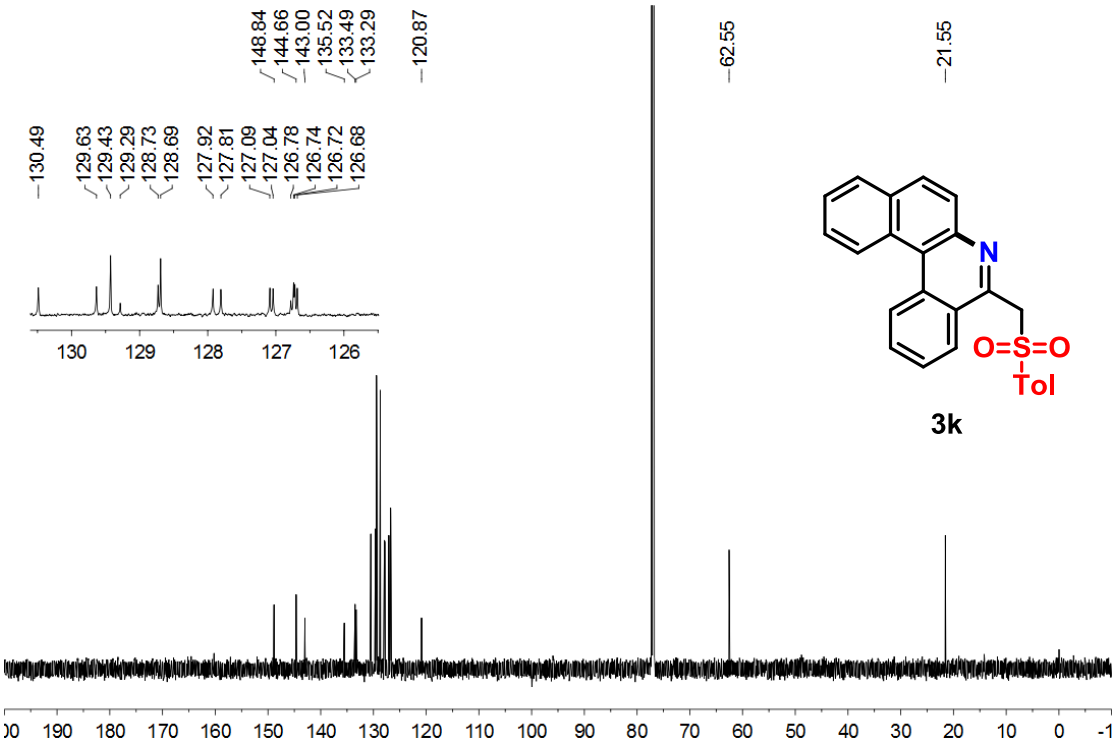
3j ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



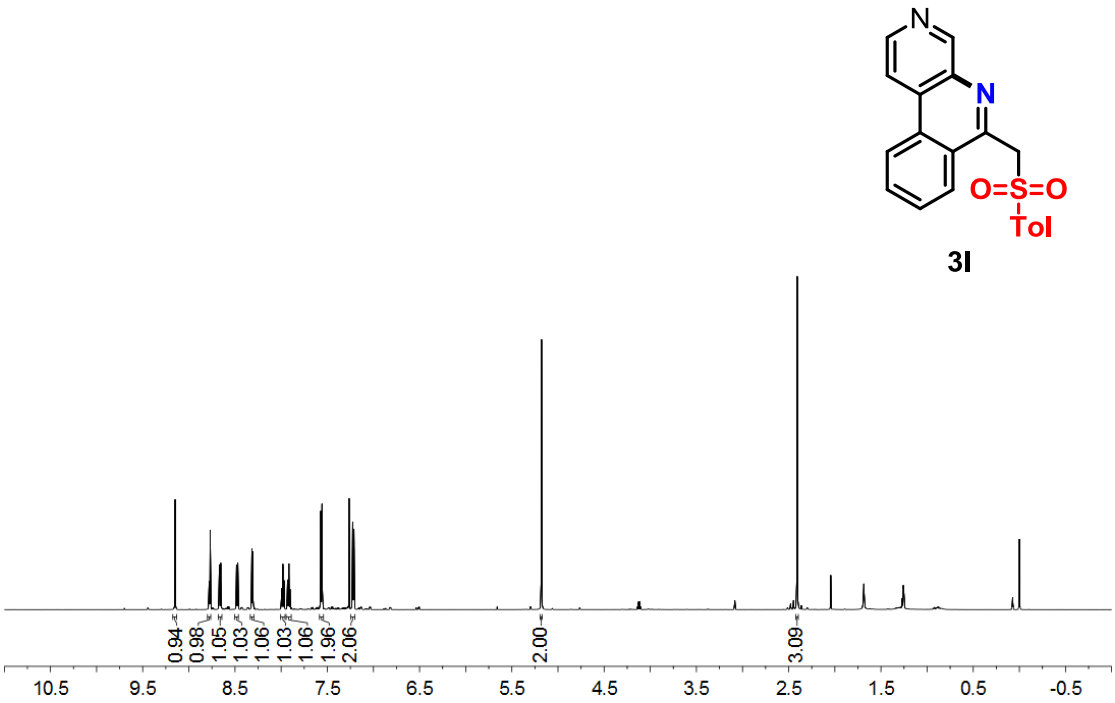


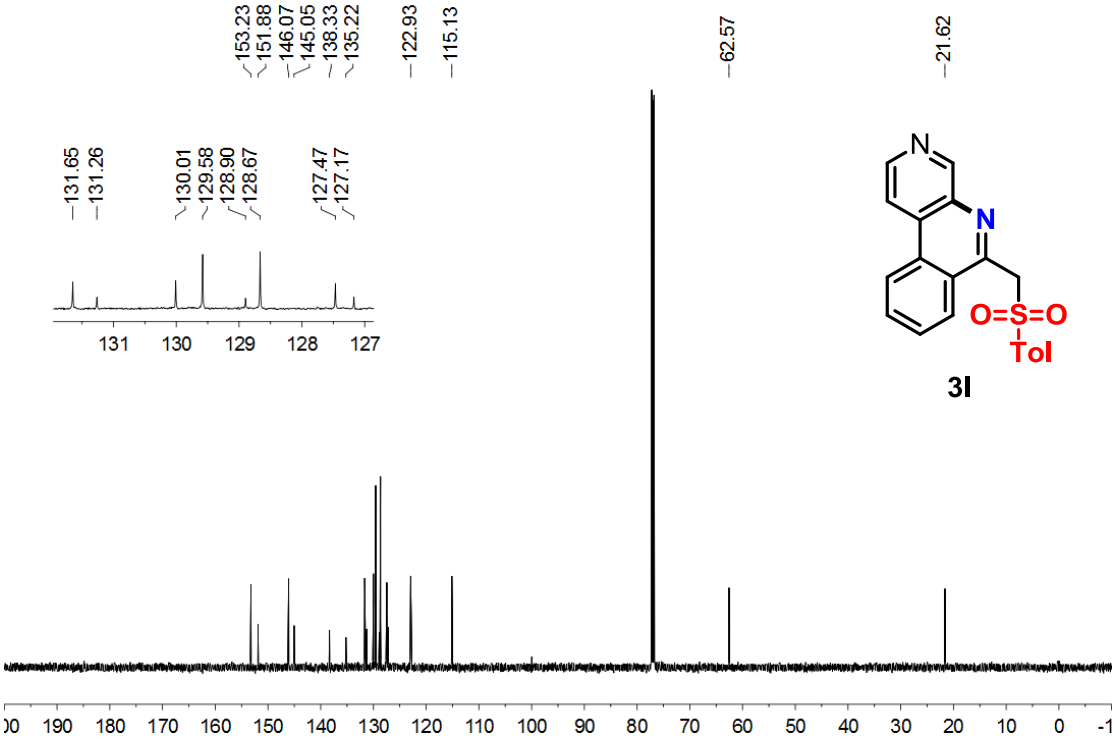
3k ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



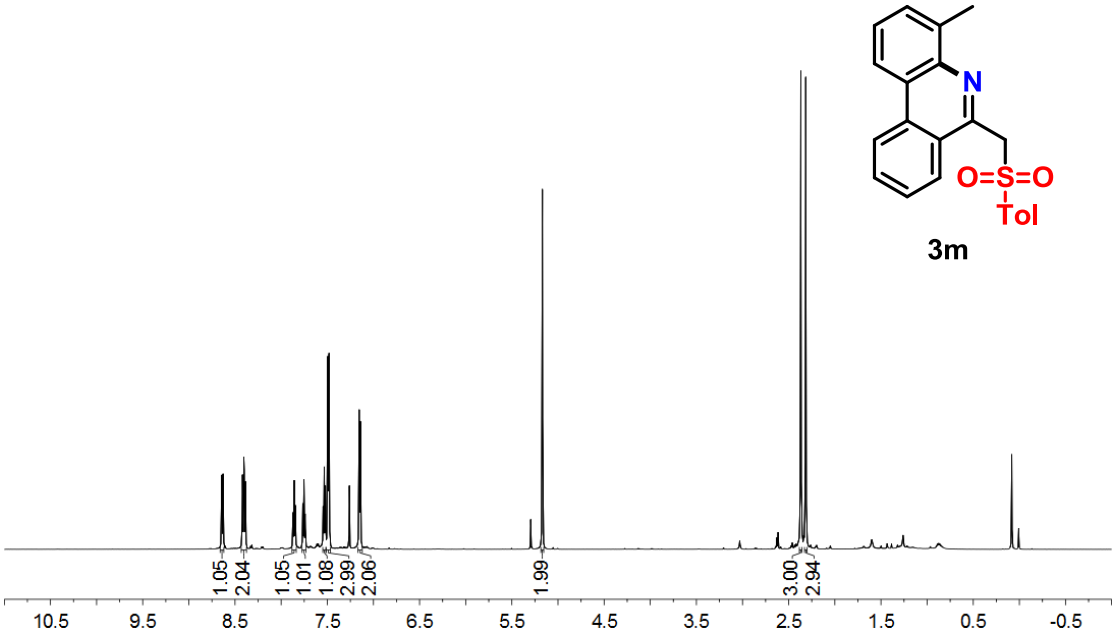


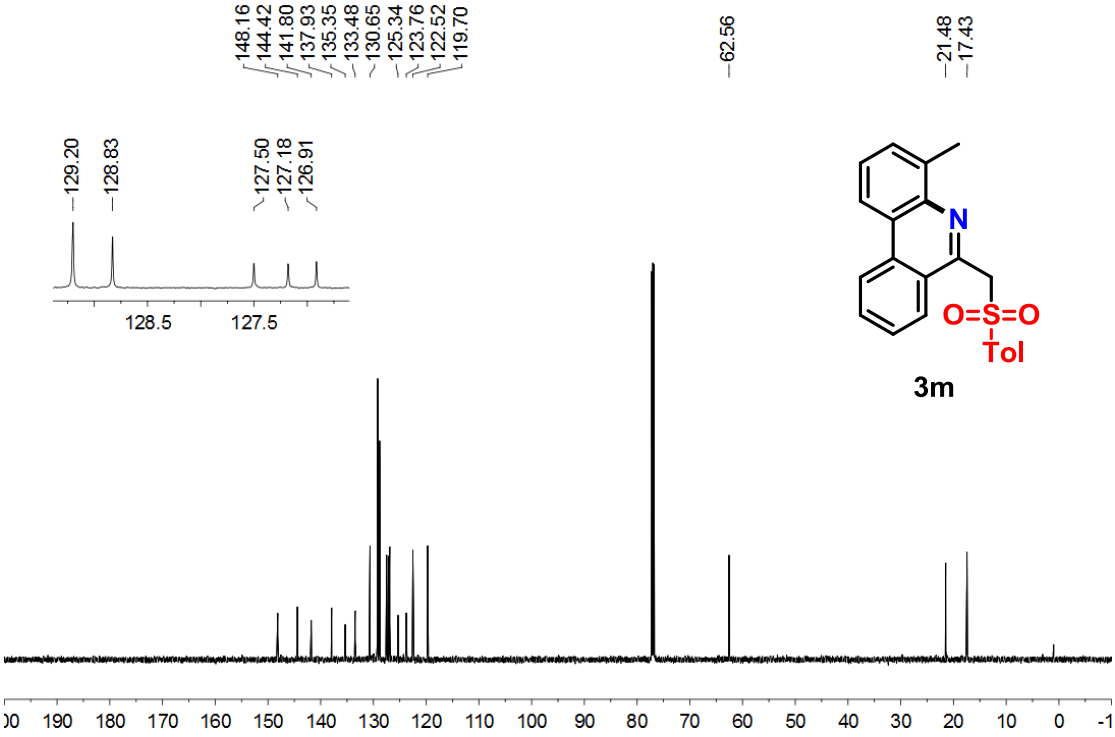
3l ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



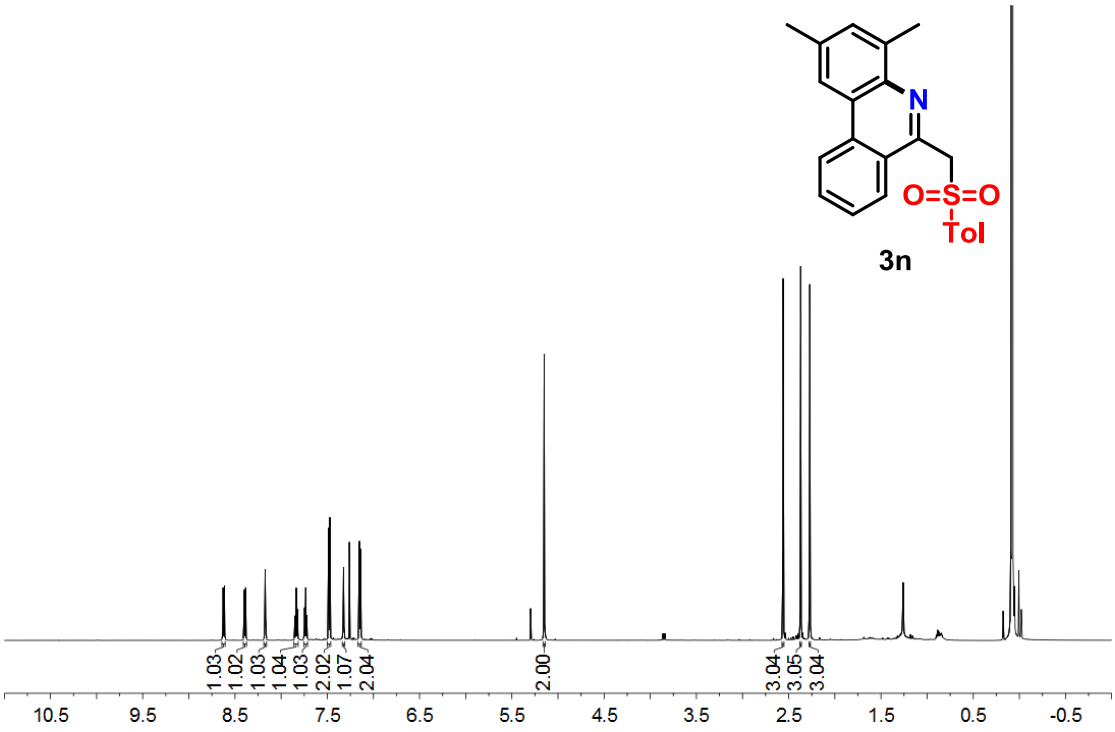


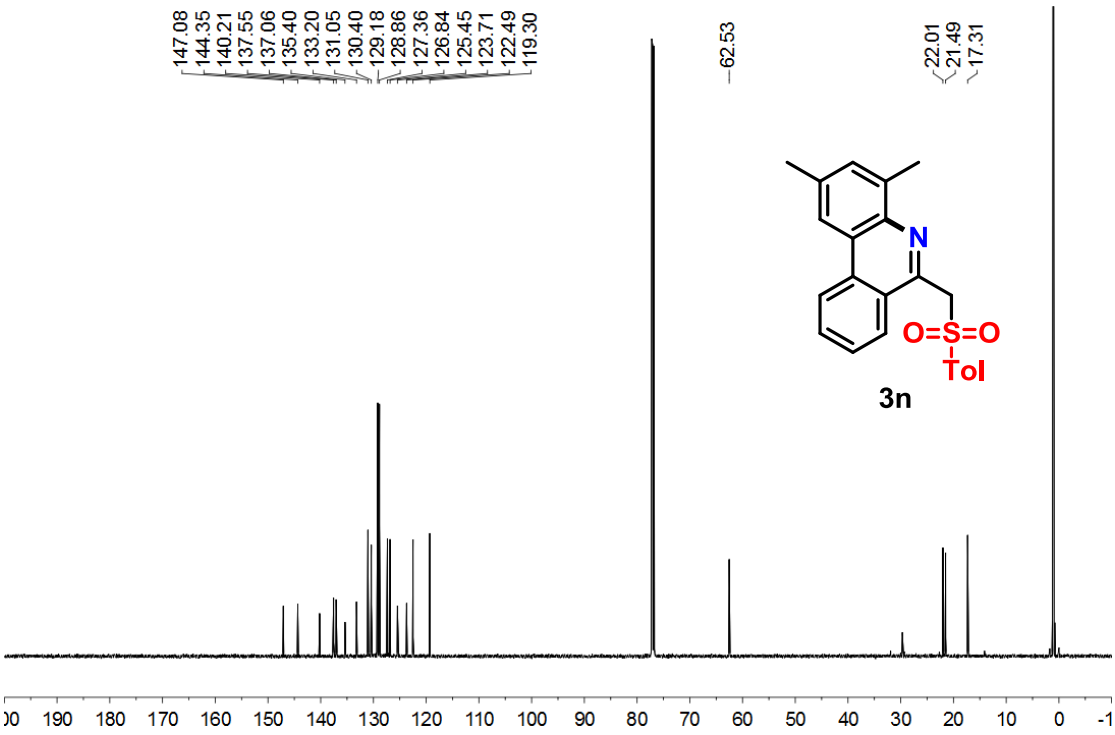
3m ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



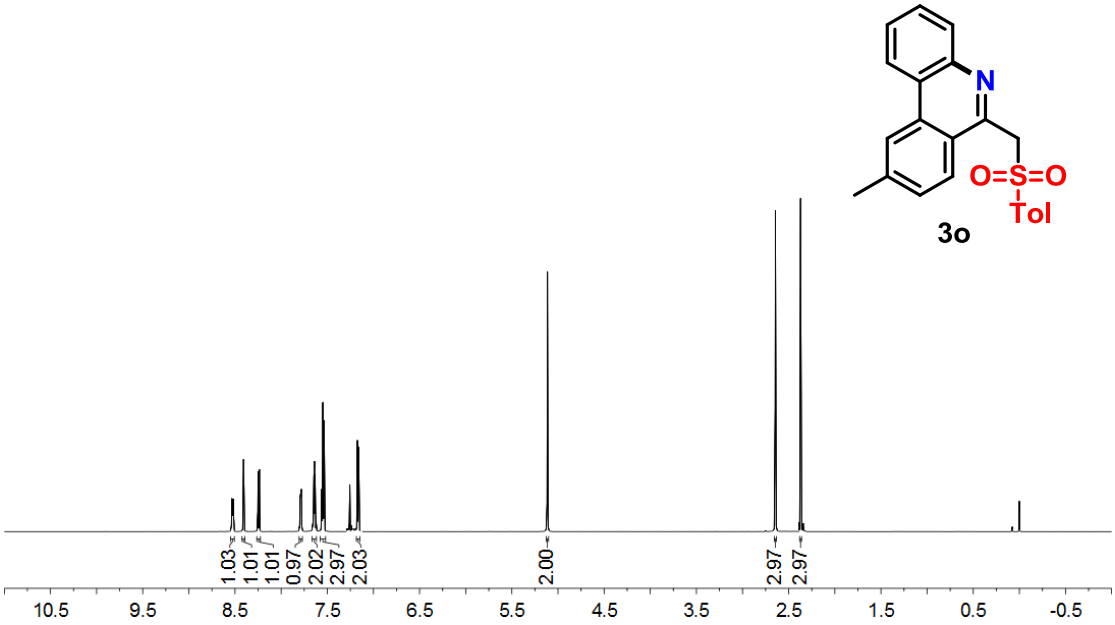


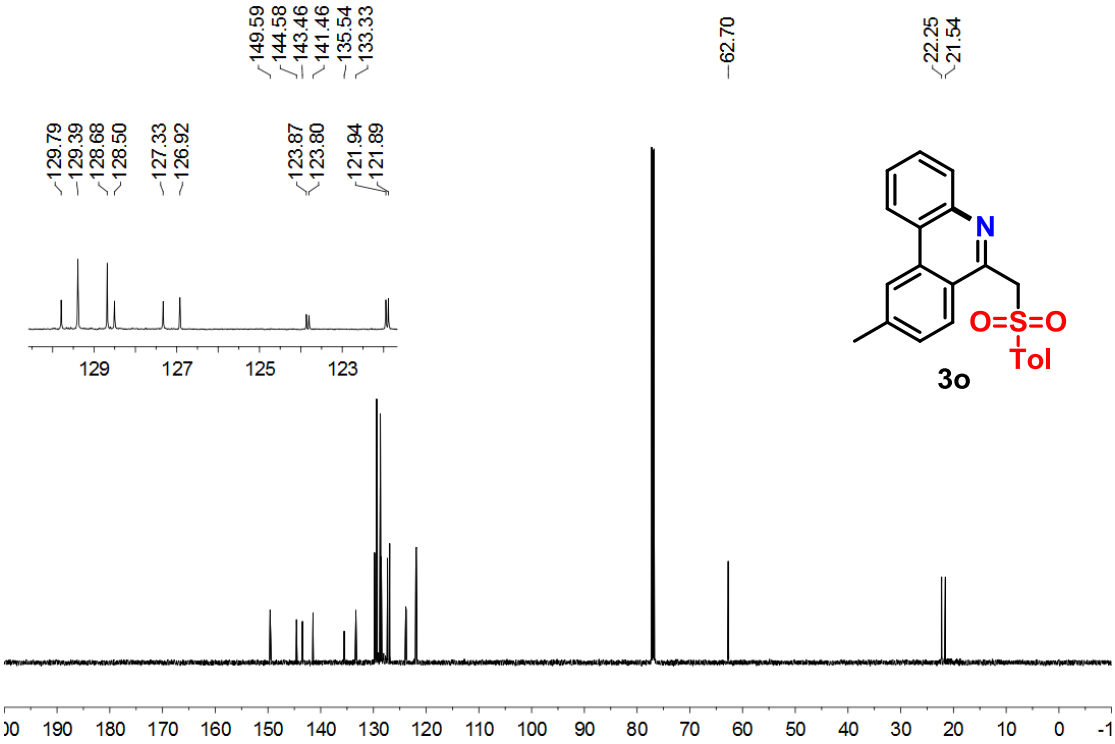
3n ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



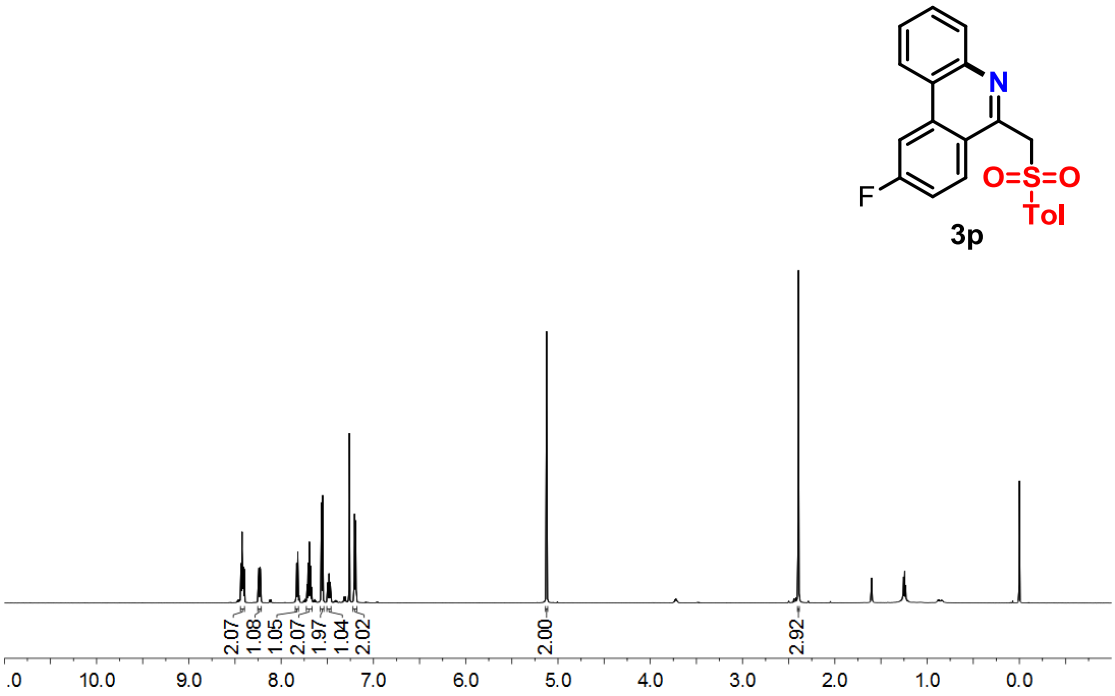


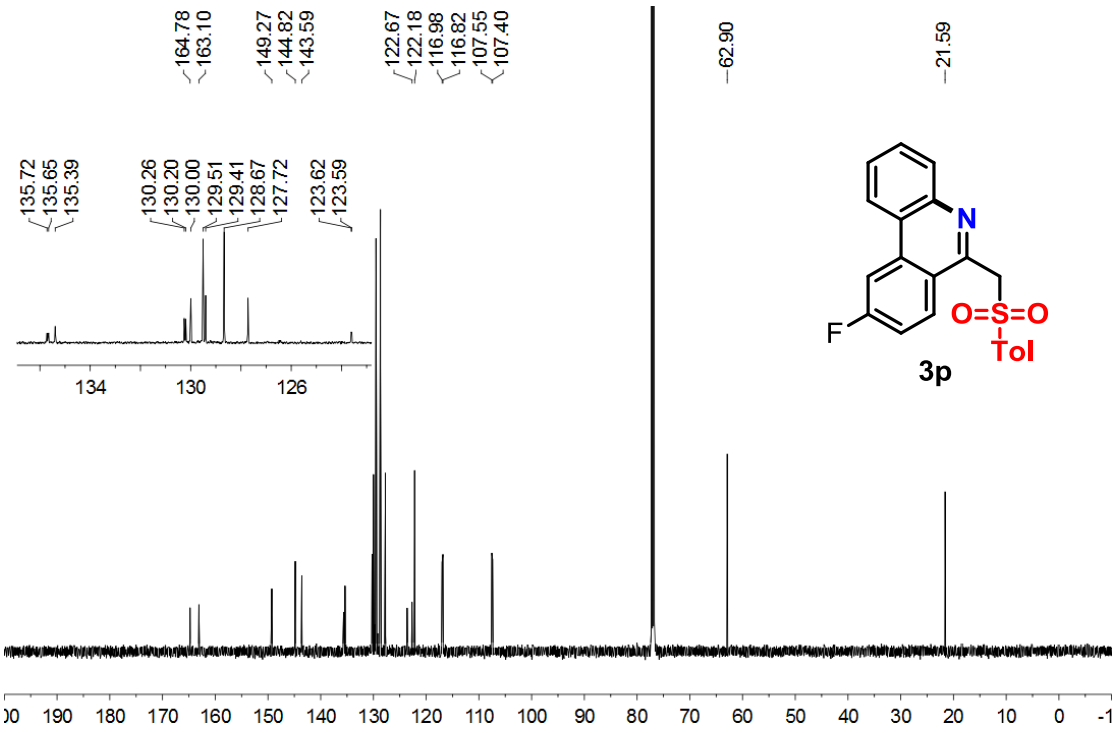
3o ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



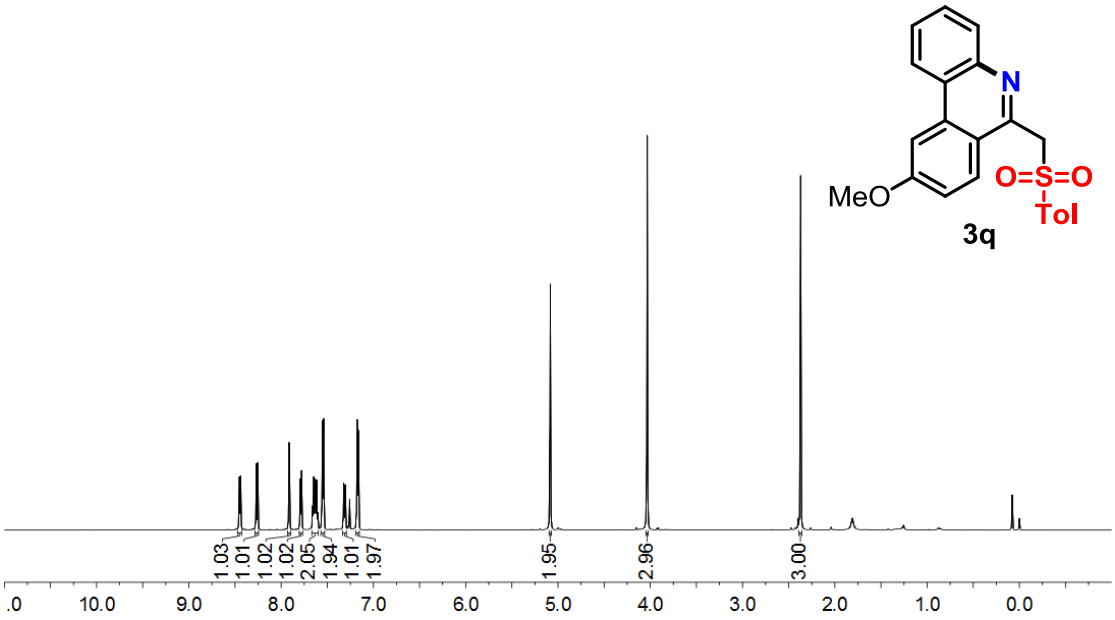


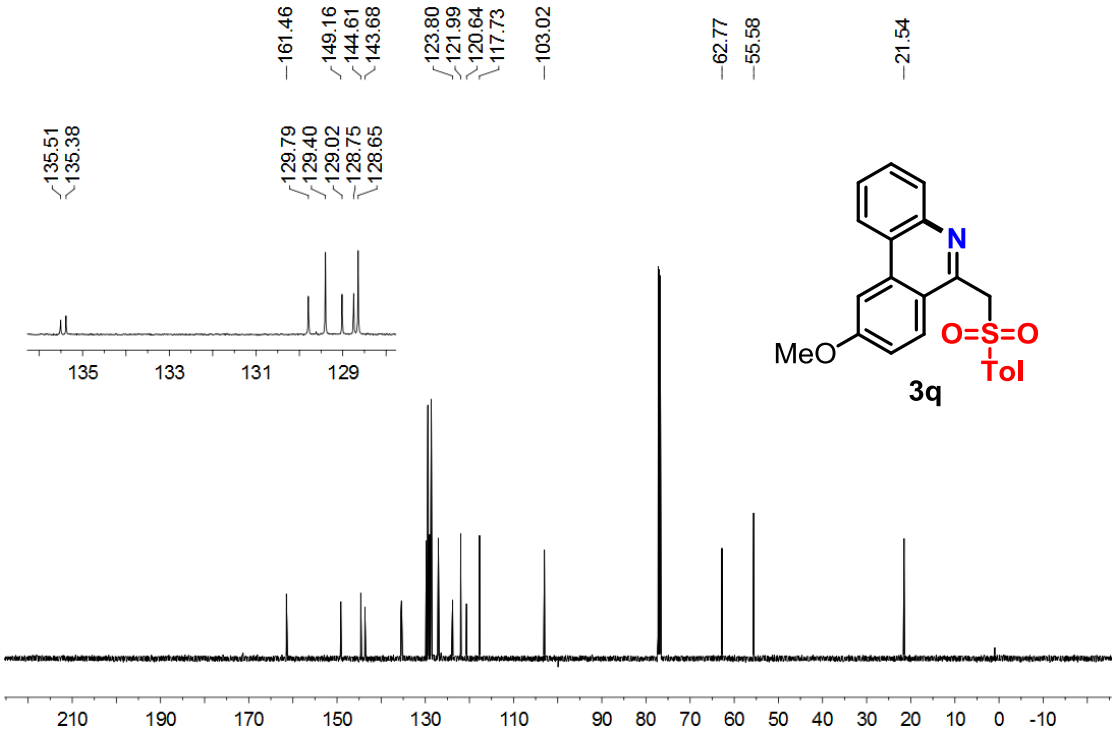
3p ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



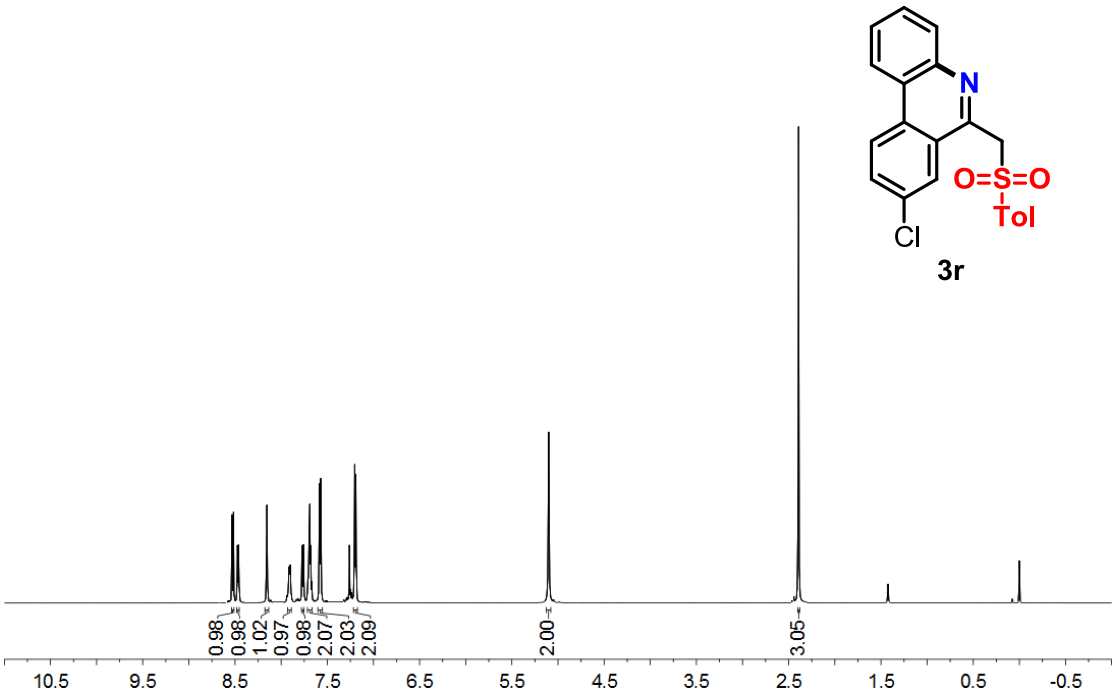


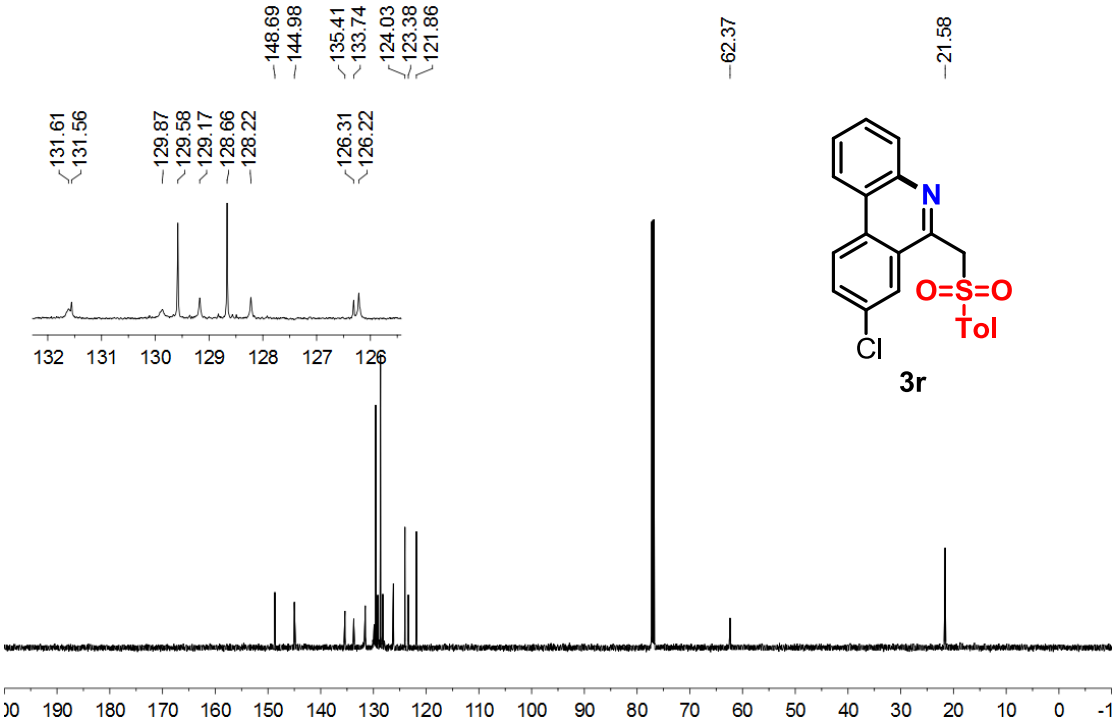
3q ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



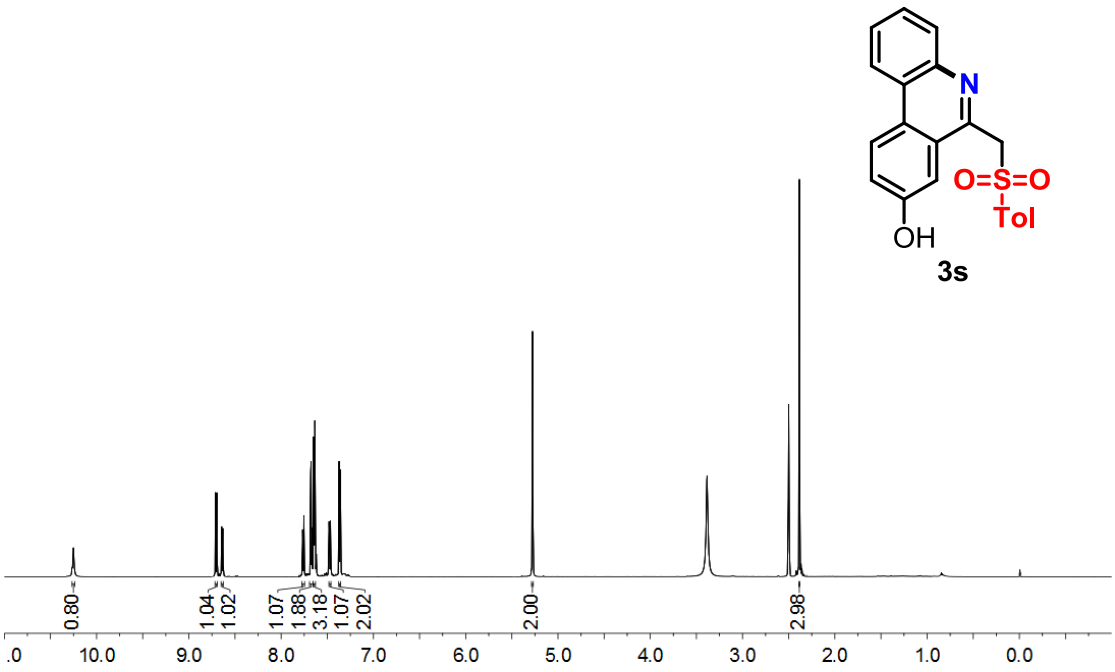


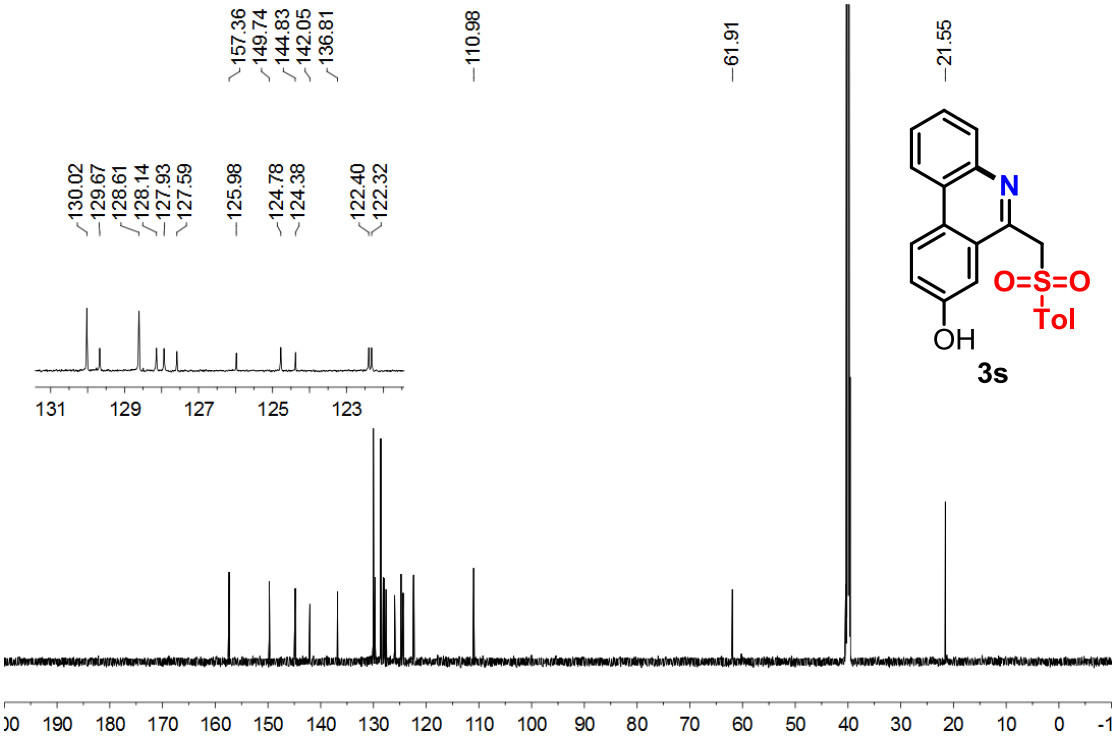
3r ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



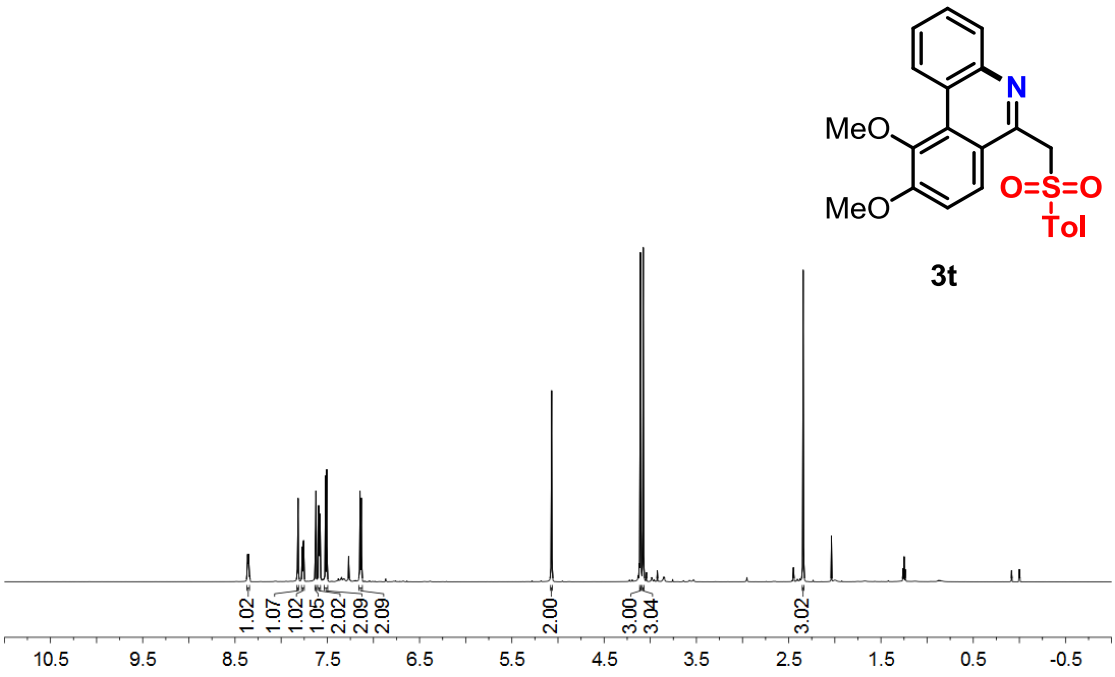


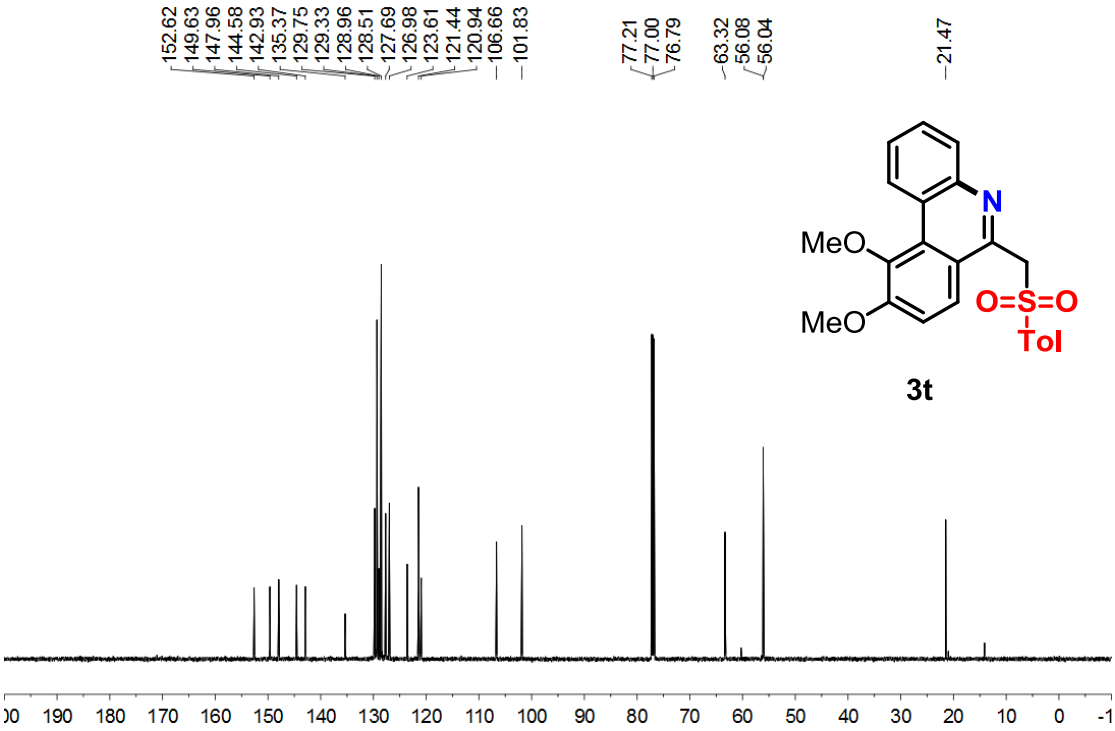
3s ^{1}H NMR (600 MHz, DMSO) & ^{13}C NMR (150 MHz, DMSO)



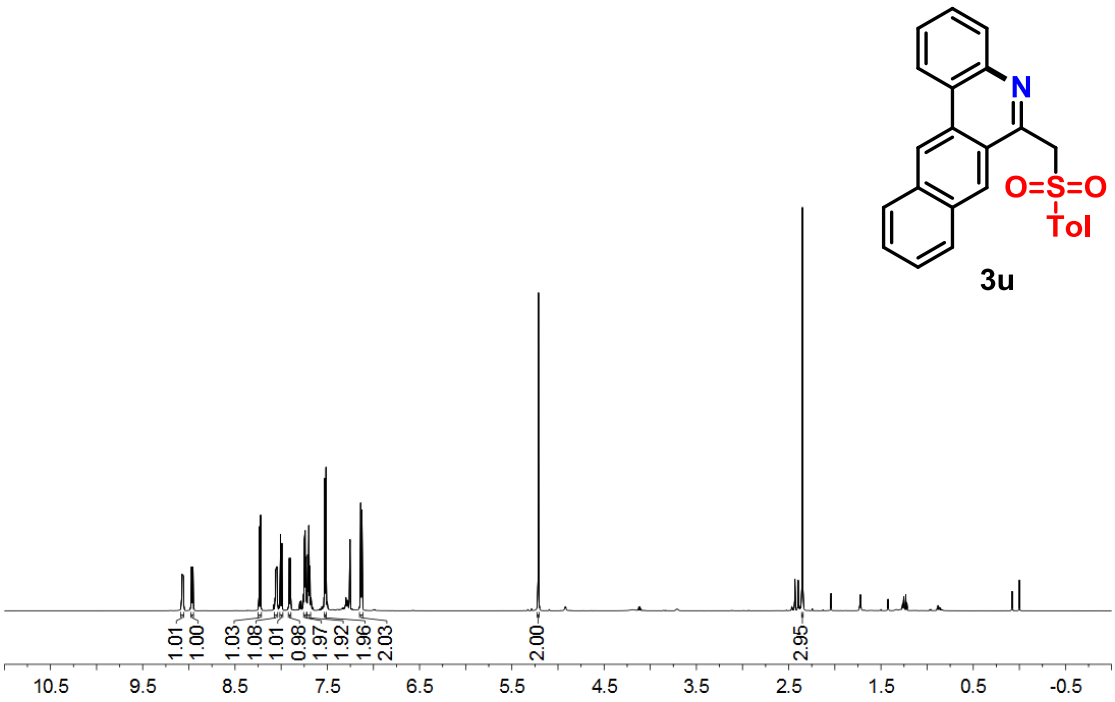


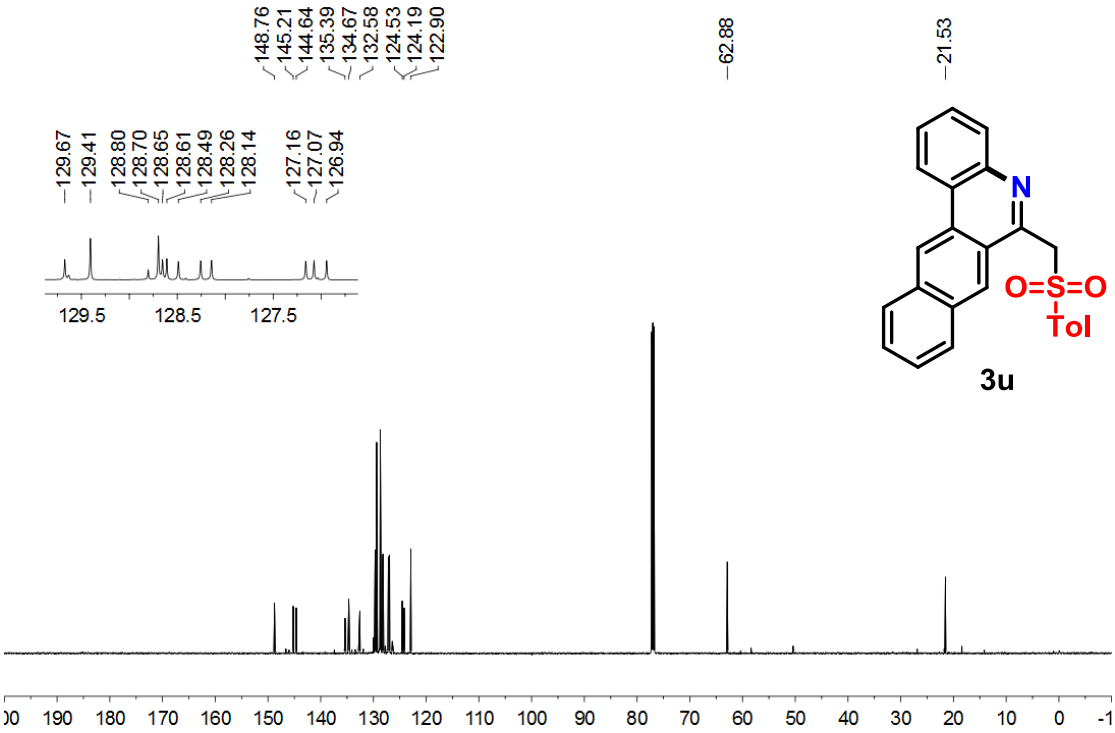
3t ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



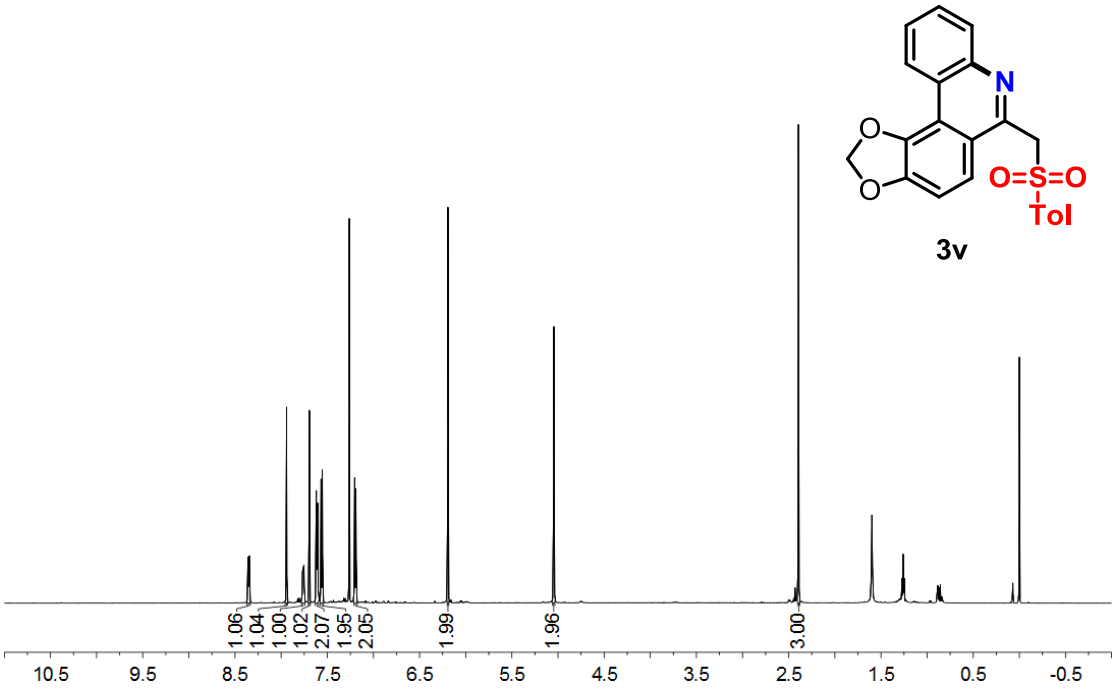


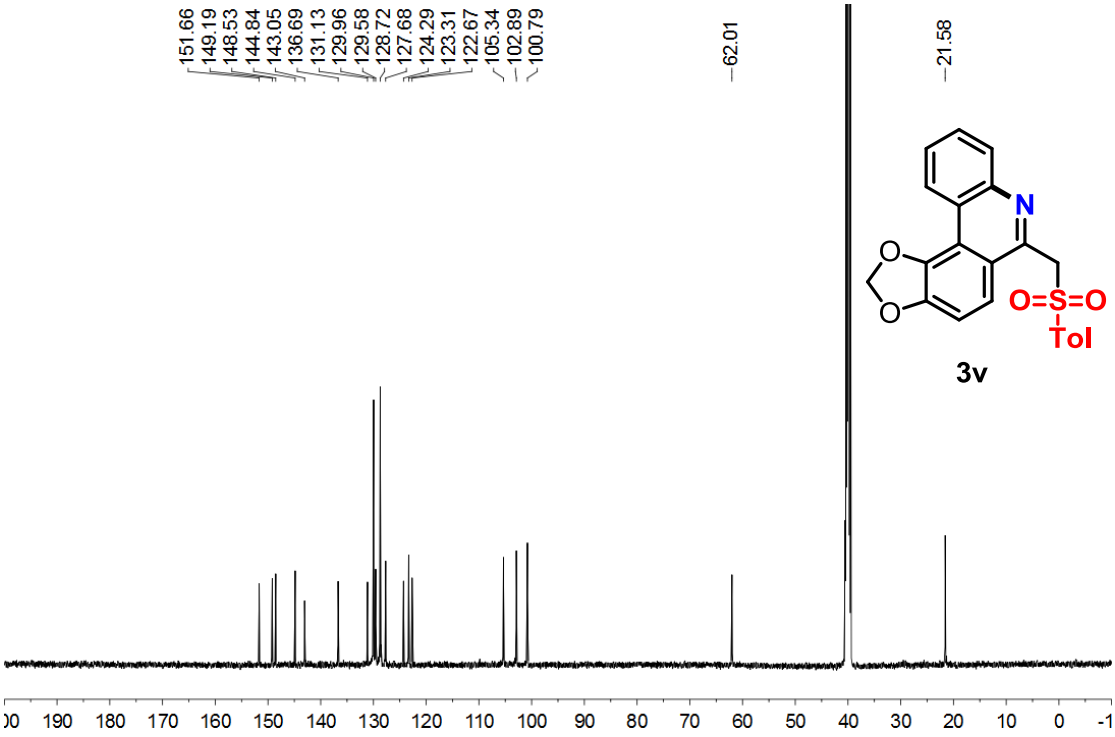
3u ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



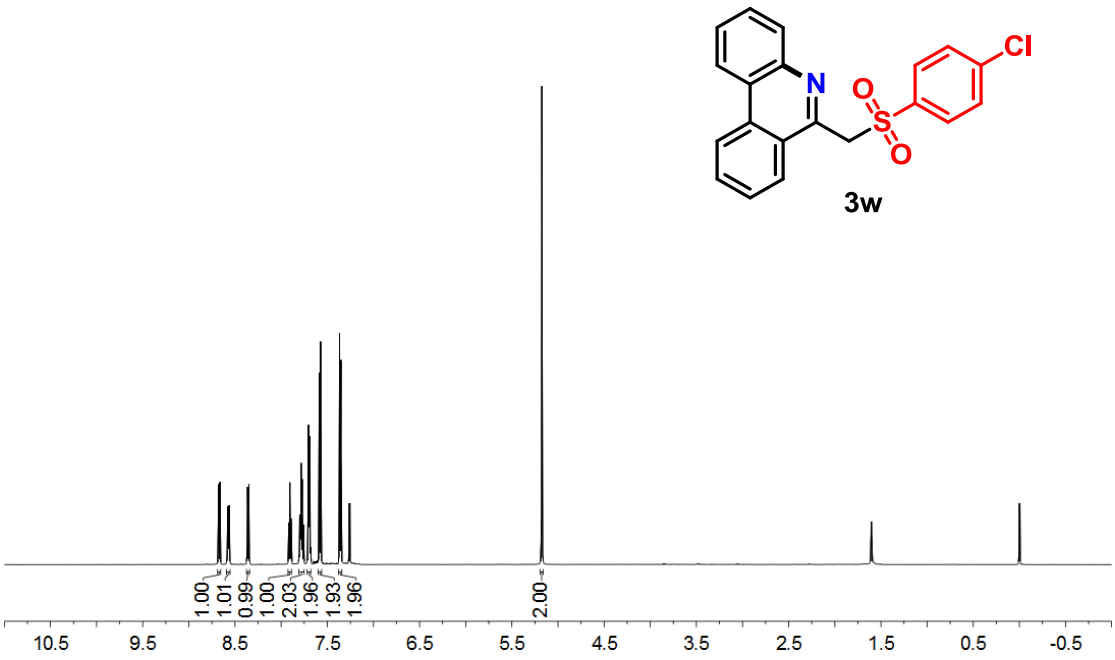


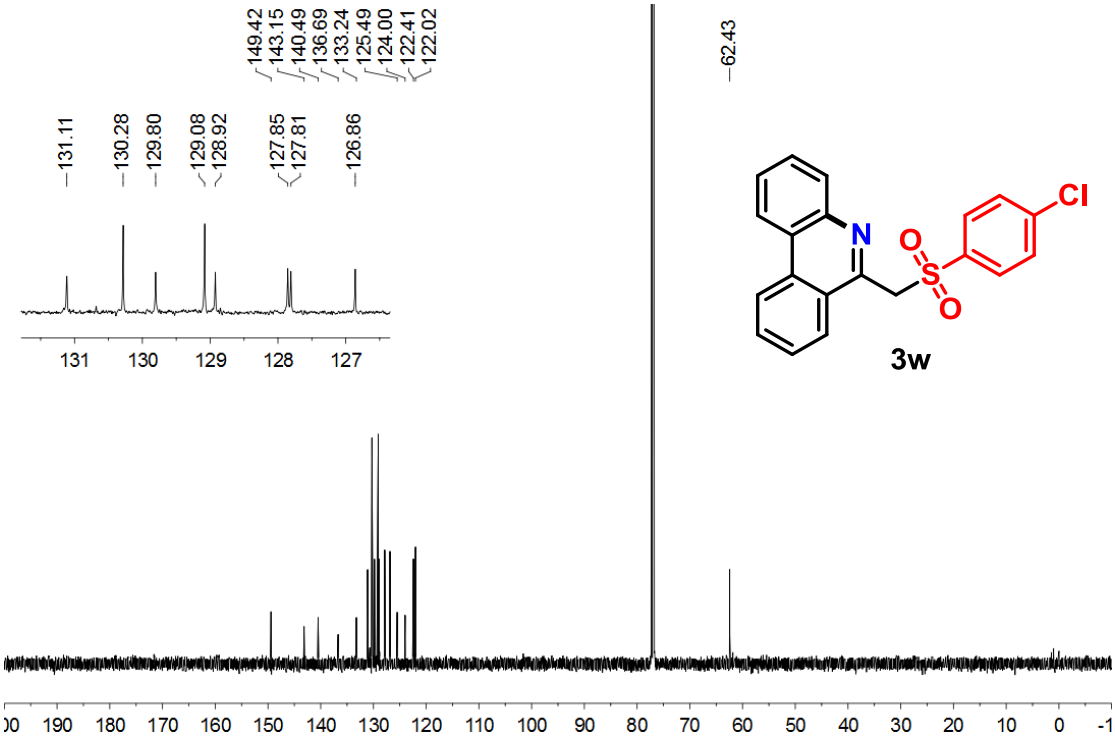
3v ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (125 MHz, DMSO)



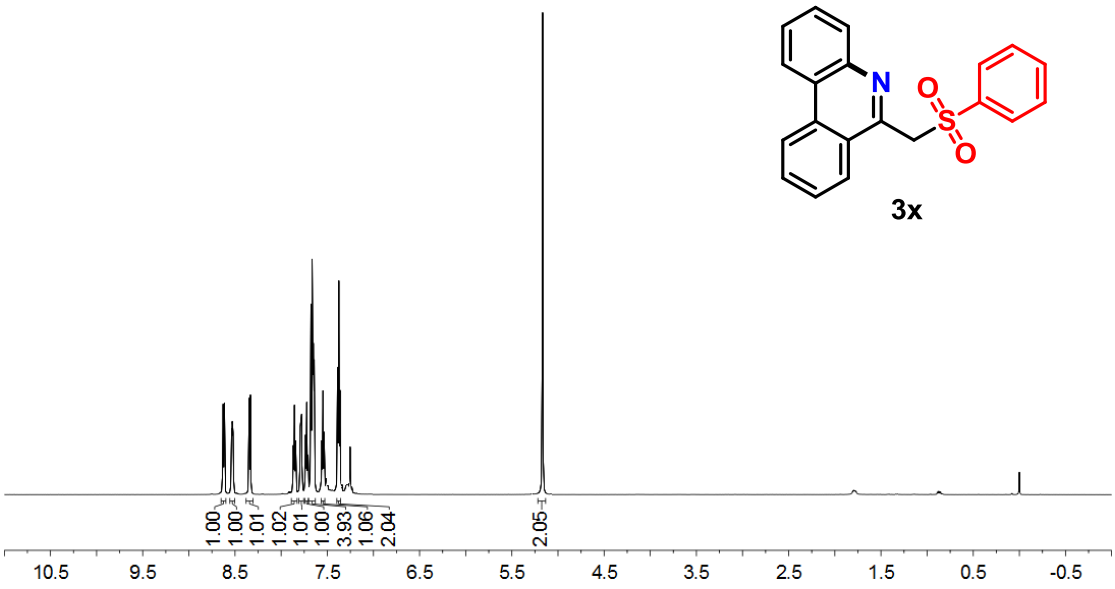


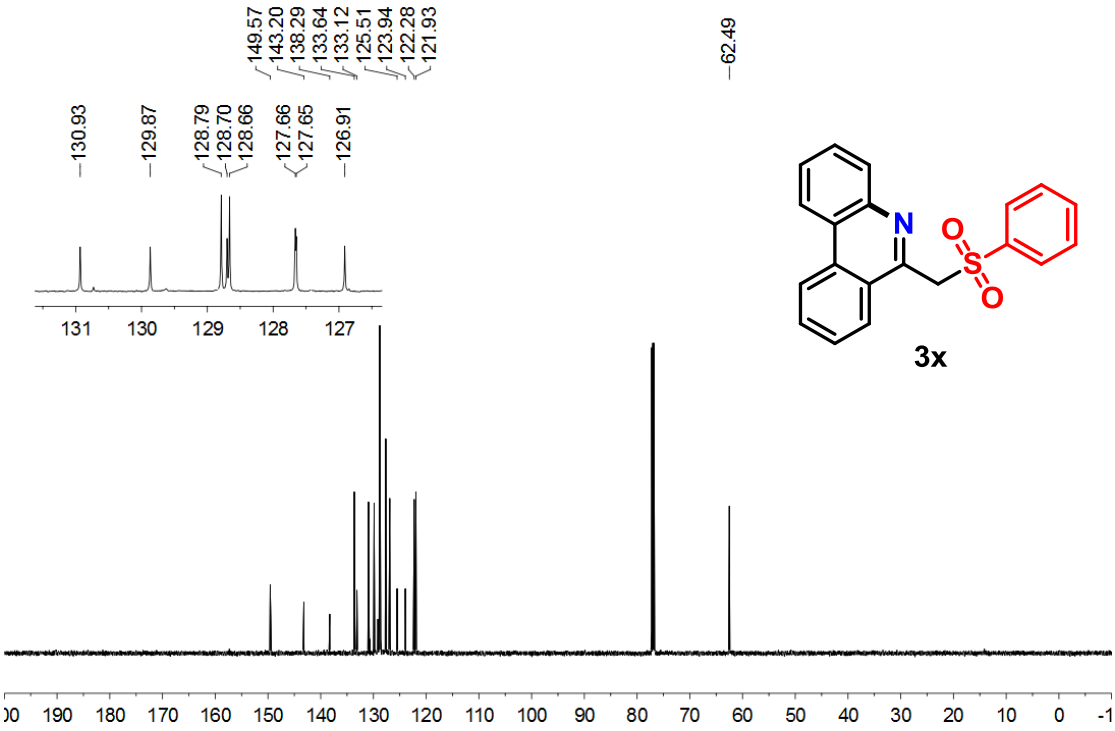
3w ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



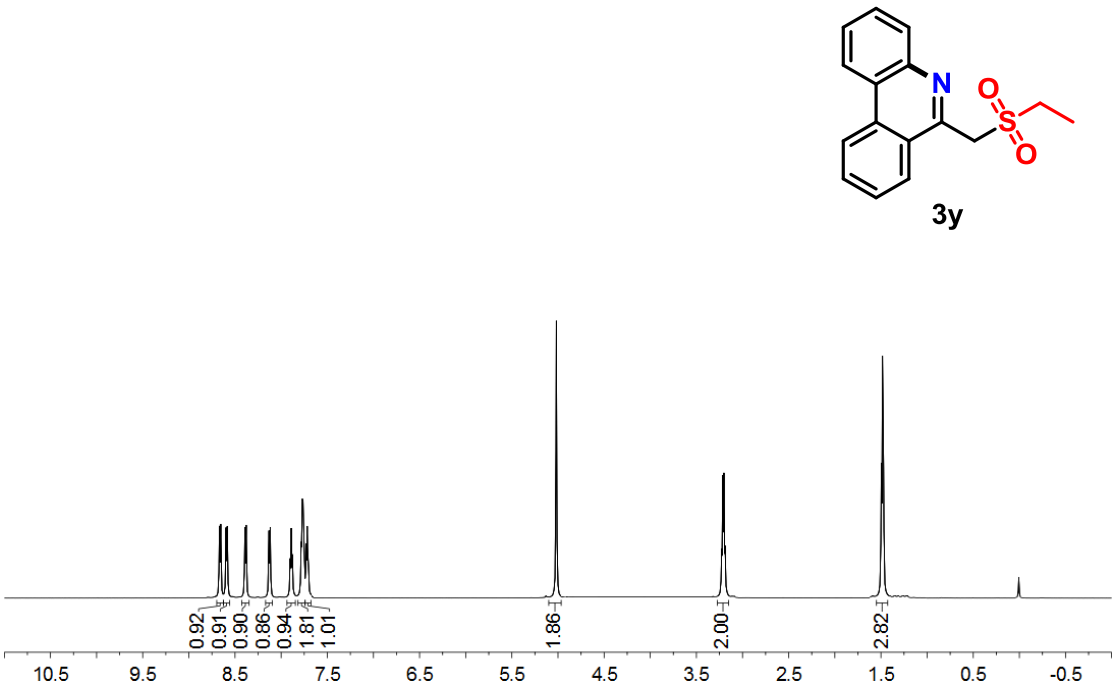


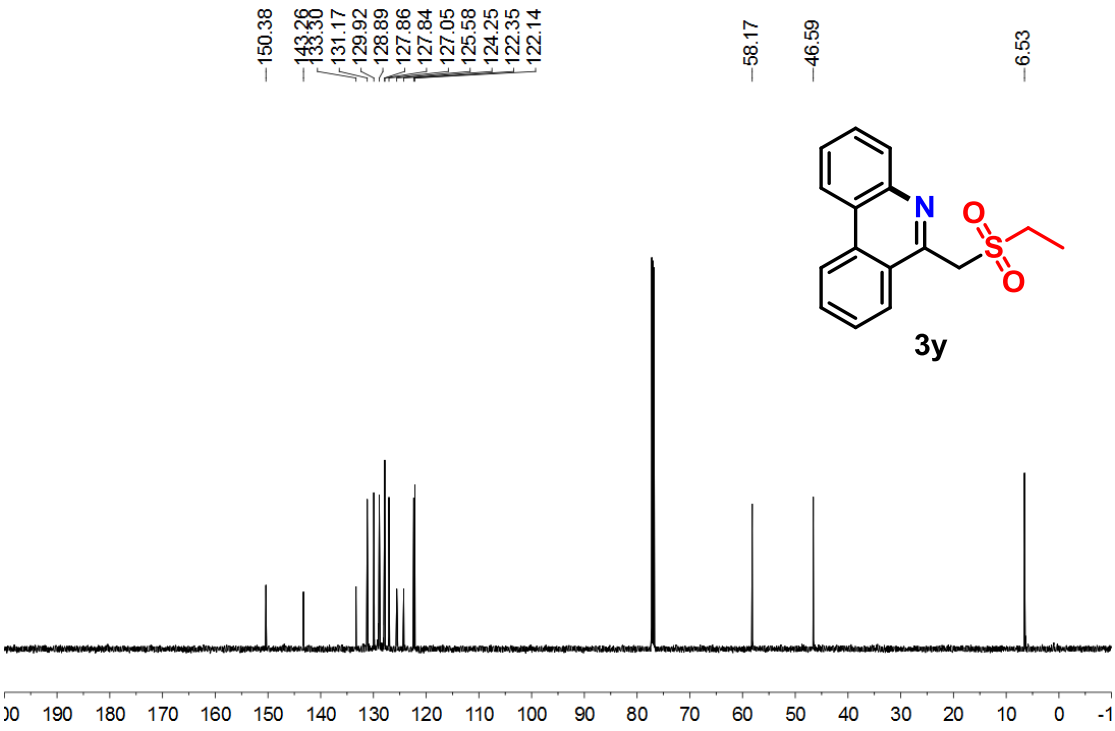
3x ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



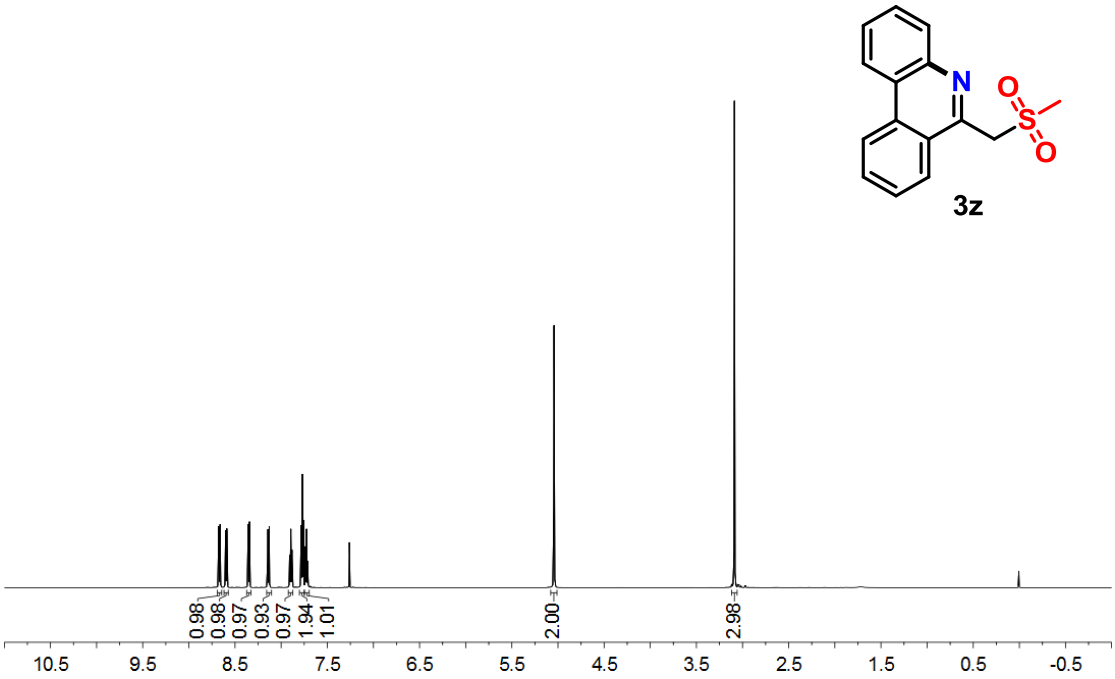


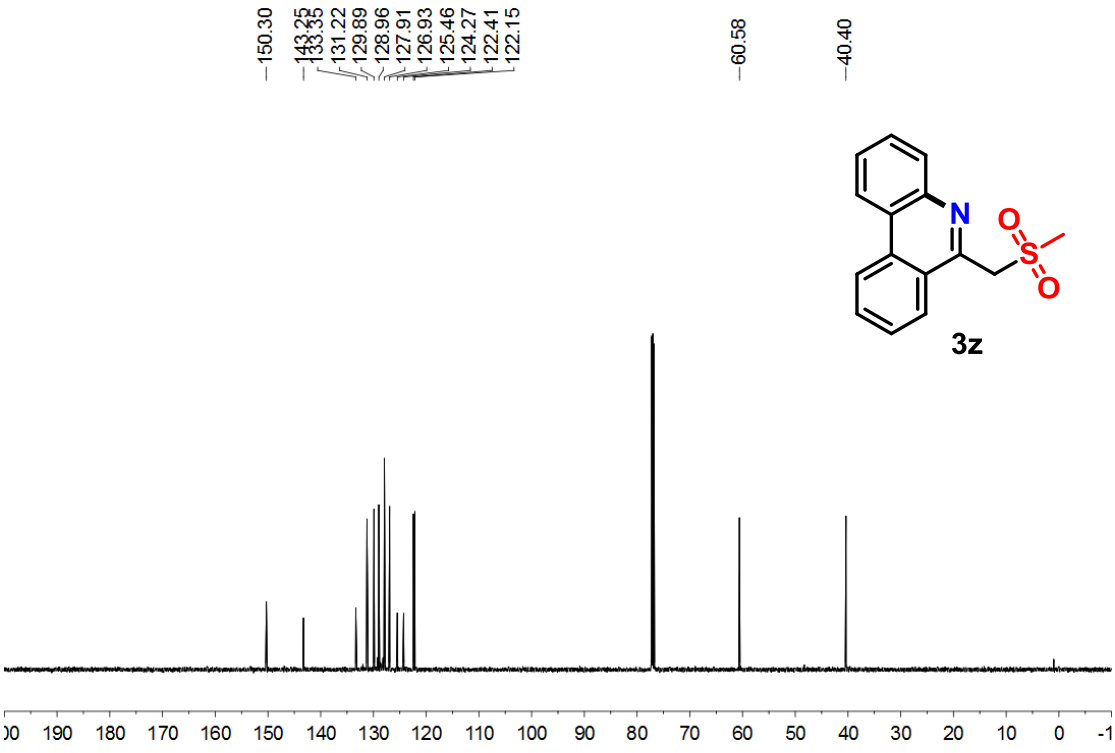
3y ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



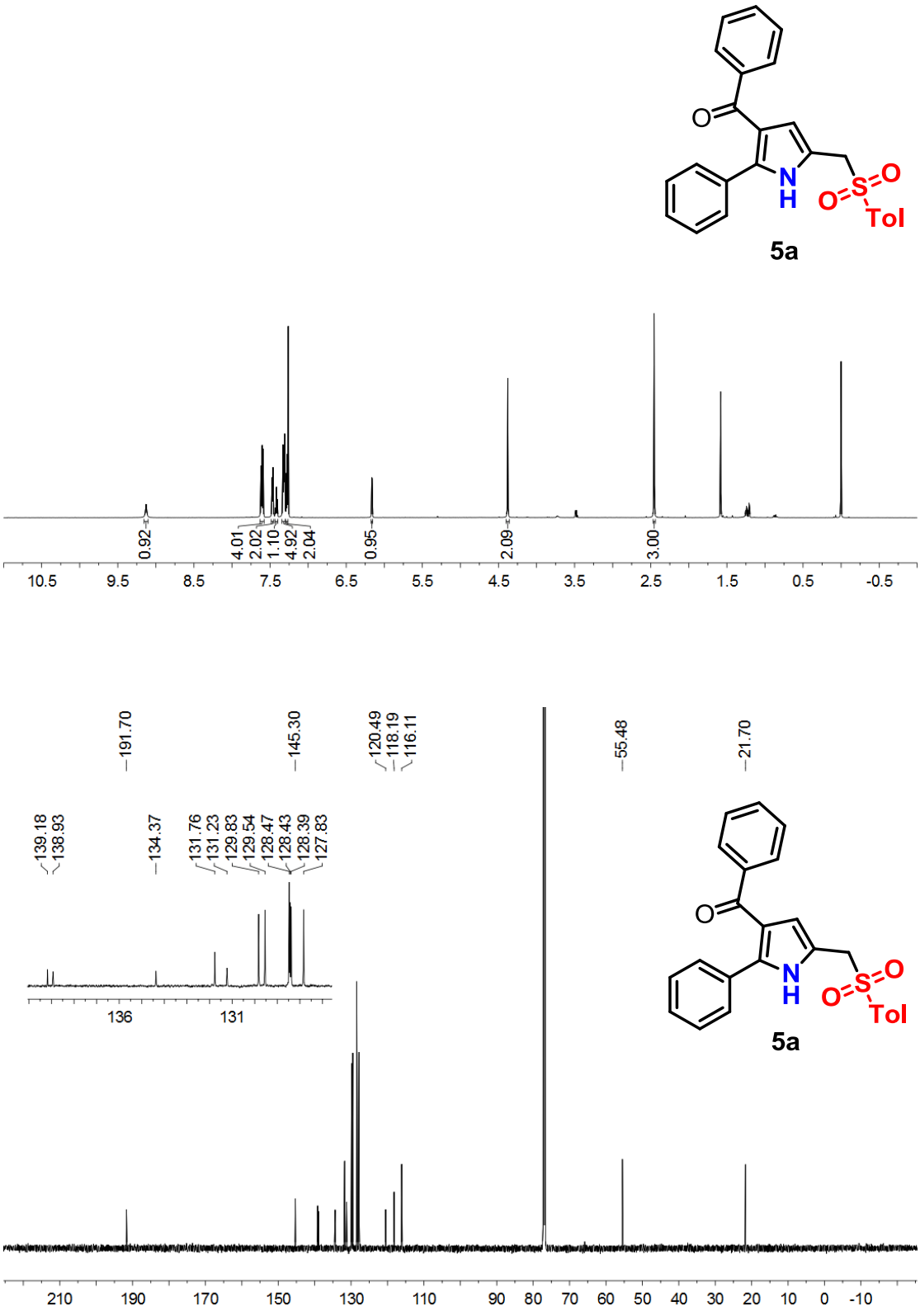


3z ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)

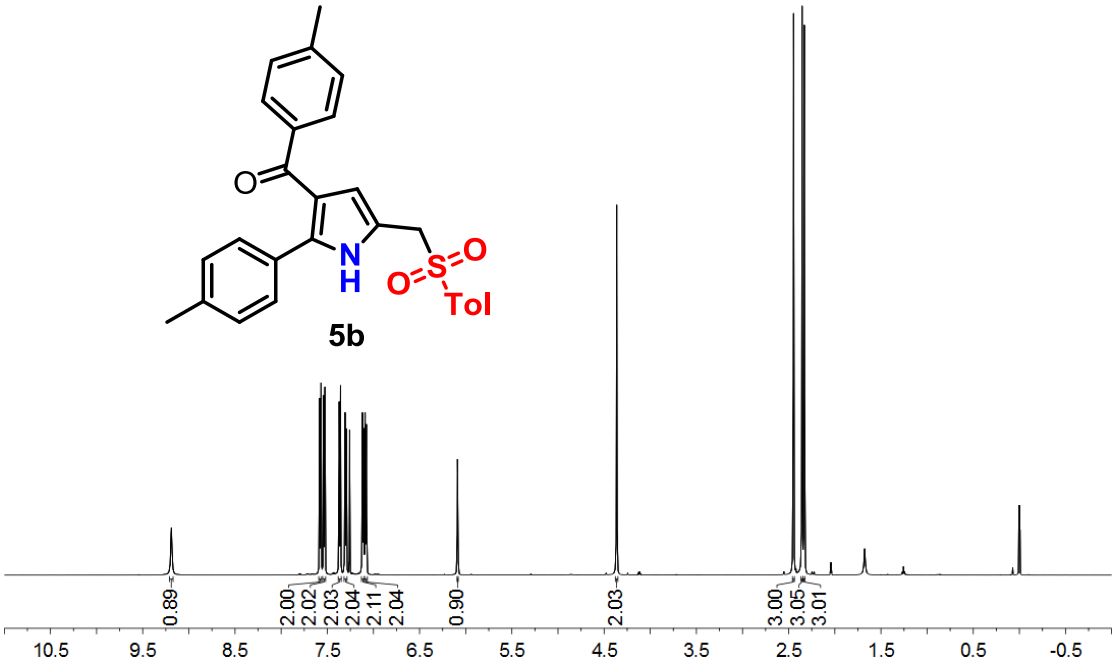


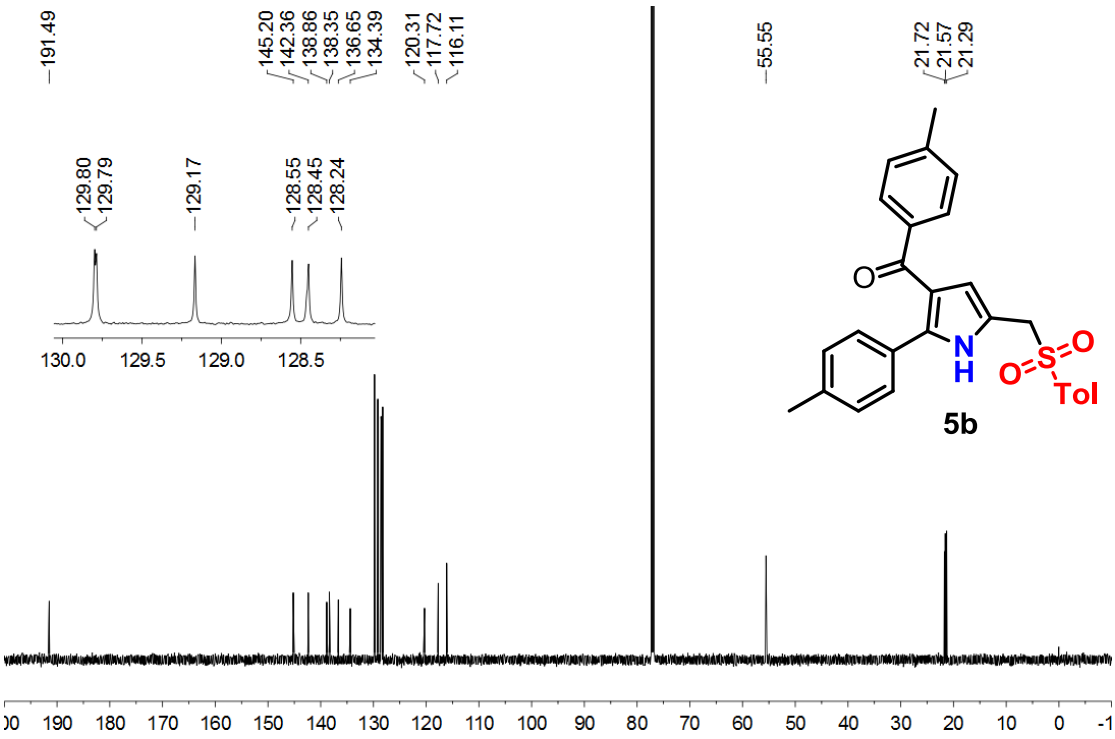


5a ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)

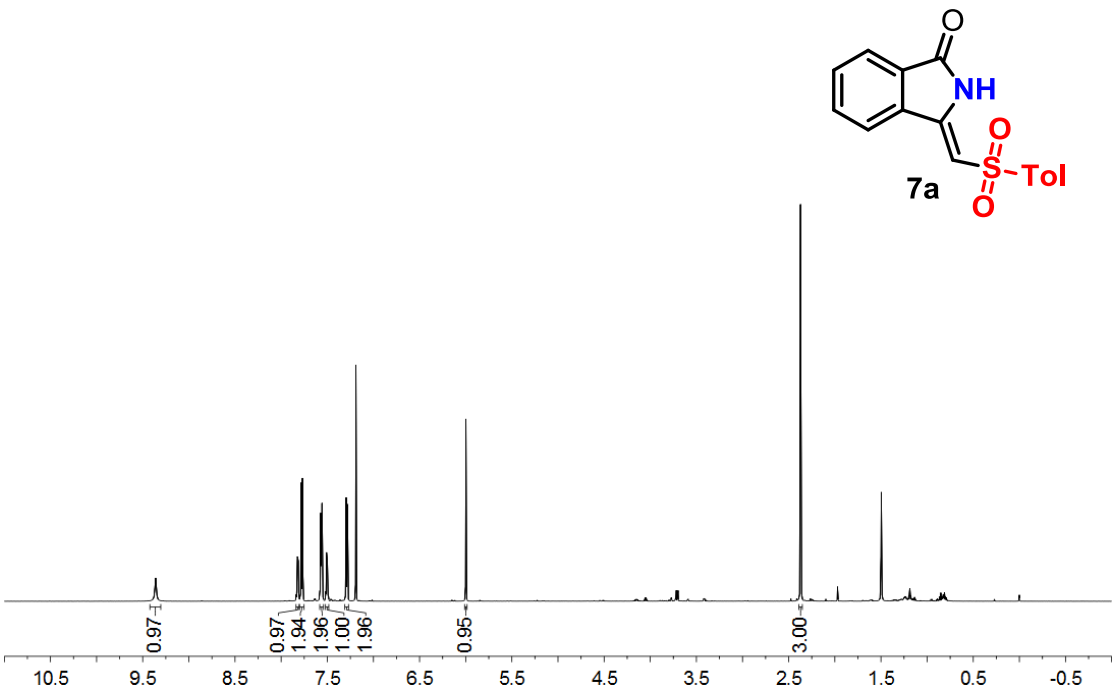


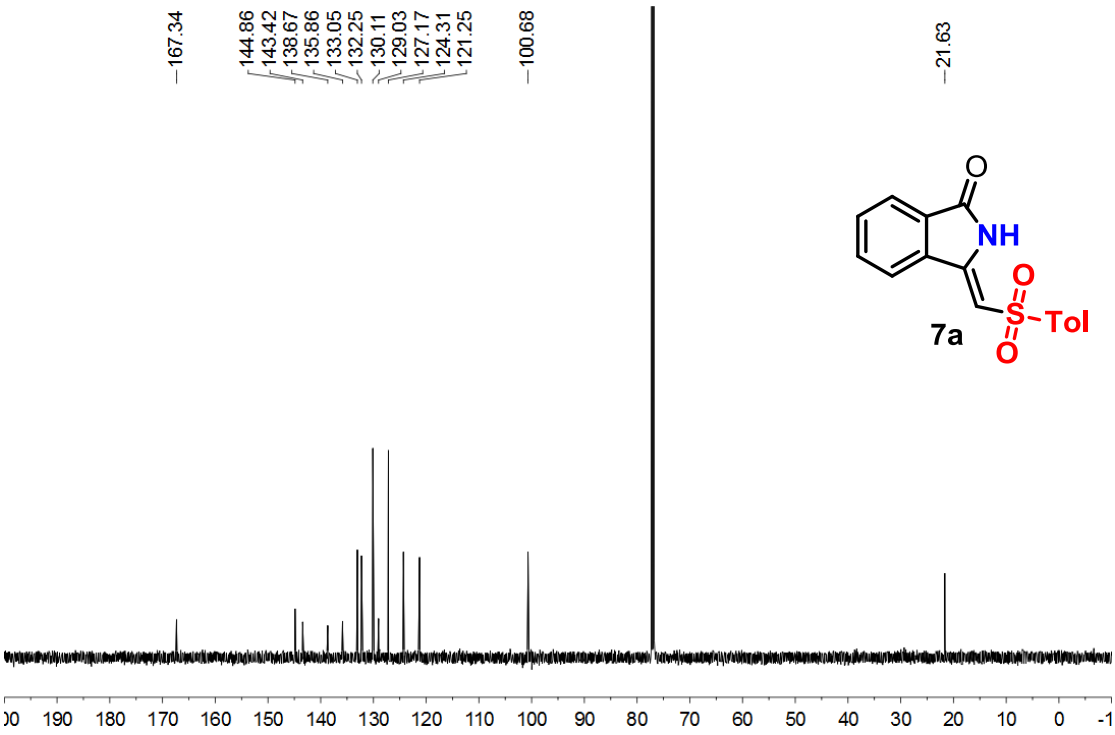
5b ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)



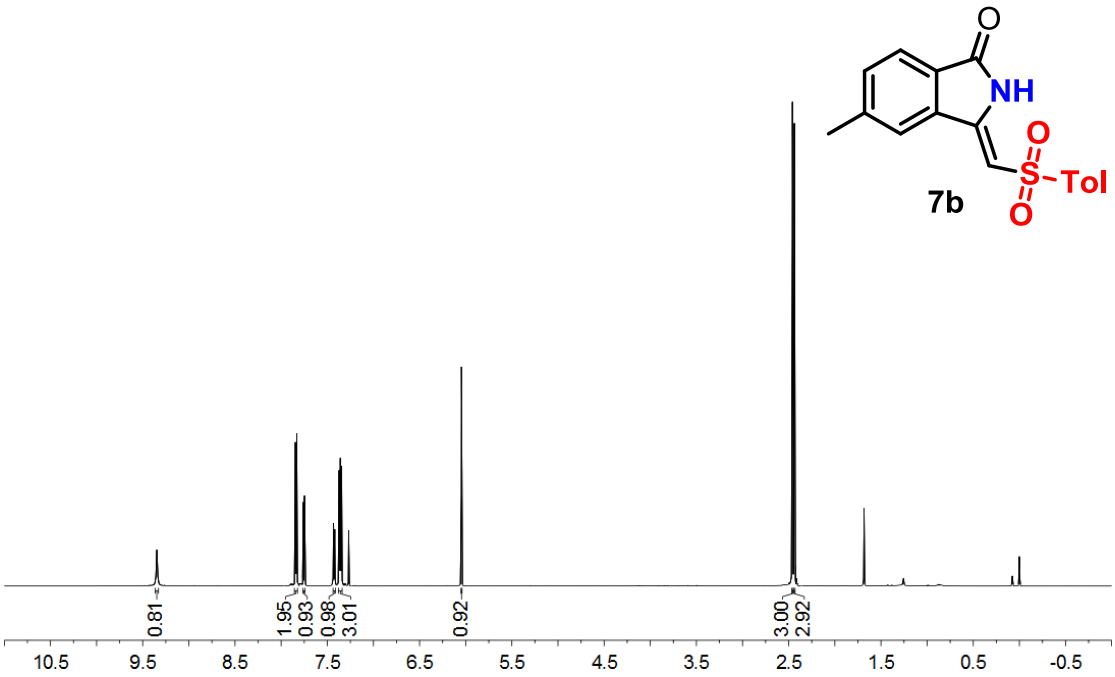


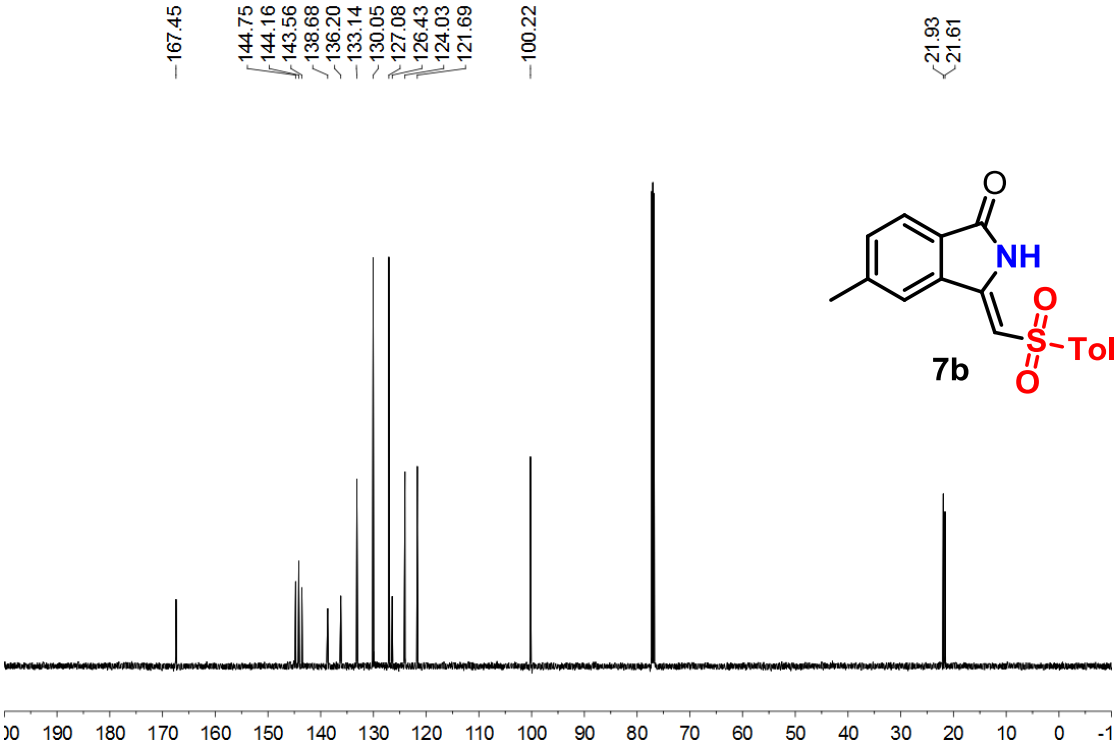
7a ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)





7b ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (150 MHz, $CDCl_3$)





7c ^{1}H NMR (600 MHz, $CDCl_3$) & ^{13}C NMR (125 MHz, $CDCl_3$)