Electronic Supplementary Material (ESI) for Green Chemistry.

Supporting Information for

Aliphatic C–H arylation with heteroarenes without photocatalyst

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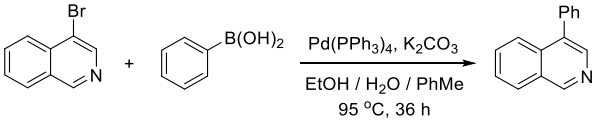
1. General information

^{1}H NMR spectra were recorded using a Bruker Avance DPX 400 MHz or 600 MHz instrument with tetramethylsilane (TMS) as an internal standard. ^{13}C NMR spectra were obtained at 101 MHz or 151 MHz and referenced to the internal solvent signals. HRMS (ESI) spectra were recorded on Fourier Transform Ion Cyclotron Resonance Mass Spectrometer by Technical Institute of Physics and Chemistry. EPR spectra were recorded by X Band on a Brucker ESR 300E spectrometer. UV-vis absorption spectra were recorded with a U-3900 UV-vis spectrophotometer. Blue LEDs (3 W, λ=415 ± 10 nm, 145lm @ 700 mA) were used as the irradiation light. All reagents were purchased from commercial suppliers and used without further purification. Flash chromatography was carried out with silica gel (200-300 mesh). Analytical TLC was performed with silica gel GF254 plates, and the products visualized by UV detection.

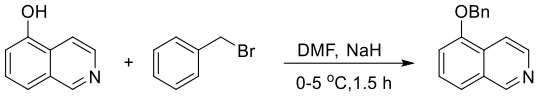
2. Substrates preparation

2.1 General procedure for the synthesis of 4-Phenylisoquinoline and 5-Phenylisoquinoline.



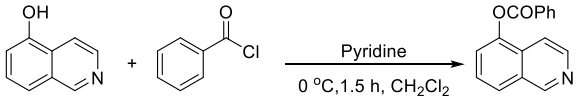
Prepared according to literature methods[1]. In an oven-dried round-bottom flask, 4-bromoisoquinoline (500 mg, 2.403 mmol, 1.0 equiv.) was taken in a mixture of 2.5 mL of EtOH, 5 mL of water, and 10 mL of toluene and degassed for 20 min. To the resulting mixture were successively added phenylboronic acid (440 mg, 3.605 mmol, 1.5 equiv.), K_2CO_3 (1.328 g, 9.612 mmol, 4.0 equiv.), and $Pd(PPh_3)_4$ (139 mg, 0.120 mmol, 0.05 equiv.) at room temperature. The resulting mixture was stirred at 95 °C (oil bath) under positive argon pressure for 36 h. The reaction mixture was cooled to room temperature, quenched with saturated NH_4Cl solution, and extracted with CH_2Cl_2. The combined organic layer was dried over Na_2SO_4 and concentrated in vacuo to obtain a black oil which was purified by column chromatography on silica gel (petroleum ether/ ethyl acetate = 5:1–2:1) to obtain 4-phenylisoquinoline as a yellow oil. 5-Phenylisoquinoline was prepared according to the aforementioned procedures and obtained as a yellow oil.

2.2 General procedure for the synthesis of 5-Benzyloxyisoquinoline.



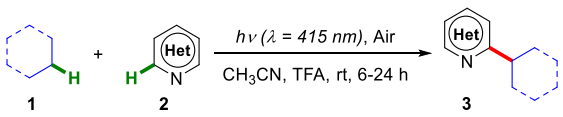
Prepared according to the literature methods[2]. A solution of 5-hydroxyisoquinoline (10 g, 69 mmol) in 150 mL of *N,N*-dimethylformamide (DMF) was cooled to 0−5 °C and treated with 60% sodium hydride (2.60 g) over 5 min. After 30 min, benzyl bromide (10.1 g, 59 mmol) was added dropwise over 5 min. After a further 1.5 h, the reaction was quenched with brine and extracted with AcOEt. The combined organic layers were washed with 1 N sodium hydroxide solution and brine, dried over magnesium sulfate, and evaporated under reduced pressure. The resulting brown oil was purfied by column chromatography on silica gel (petroleum ether/ethyl acetate = 1:1) to give the desired product as a purple colored solid.

2.3 General procedure for the synthesis of Isoquinolin-5-yl benzoate.



Prepared according to the literature methods[3]. To a solution of isoquinolin-5-ol (10 mmol) in pyridine (10 mL) cooled in an ice bath was added benzoyl chloride (12 mmol) dropwise over 10 min with stirring. Subsequently, the reaction mixture was kept under stirring for 60 min. After total consumption of the starting material was confirmed by TLC, the reaction mixture was extracted with dichloromethane (10 mL) and washed with a solution of diluted HCl (10 mL). The organic phase was then washed with water, dried on Na_2SO_4, filtrated, and evaporated under pressure. The phenyl benzoates were purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 5:1) to give the desired product as white solid.

3. General experimental procedure.



A 10 mL Pyrex tube equipped with a magnetic stir bar was charged with heteroarenes (0.1 mmol, 1 equiv.), alkanes (5.0 mmol, 50.0 equiv.), TFA (0.12 mmol, 1.2 equiv.), and 2.5 mL of CH_3CN. The mixture was irradiated by blue LEDs (λ = 415 nm) for 6-24 h in the air at room temperature. After reaction, the mixture was diluted with 1.0 mL of aqueous 1 M NaOH solution

and extracted with ethyl acetate. Then the organic phase was combined together and washed with brine and dried over anhydrous sodium sulfate. Upon removal of solvent under vacuum, the residue was purified by chromatography on silica gel (petroleum ether/ethyl acetate = 10:1–5:1) to give the desired product.

4. Mechanism study

4.1 UV-vis absorption and luminescence quenching experiments.

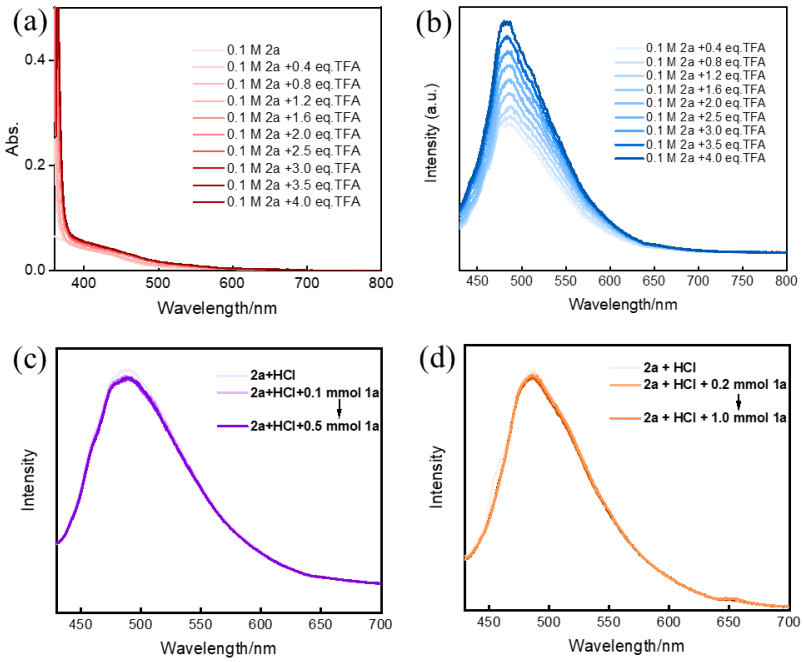


Figure S1. UV-vis absorption and Luminescence quenching experiments. (a) UV-vis absorption spectrum of isoquinoline **2a** (0.1 M) by TFA in CH_3CN. (b) Fluorescence quenching of isoquinoline **2a** (0.1 M) by TFA in CH_3CN. (c) Fluorescence quenching of isoquinoline **2a** (0.1 M) by cyclohexane **1a** in CH_3CN under acidic condition (0.1 M). (d) Fluorescence quenching of isoquinoline **2a** (0.1 M) by cyclohexane **1a** in CH_3COCH_3 under acidic condition (0.1 M).

4.2 Electron paramagnetic resonance (EPR) spectroscopy experiments.

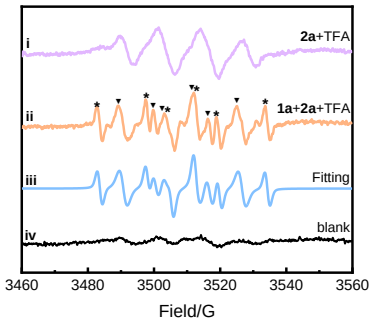


Figure S2. Electron paramagnetic resonance (EPR) spectroscopy experiments: **i**: the CH_3CN

solution of DMPO, **2a** and TFA in air atmosphere with blue light irradiation; **ii**: the CH_3CN solution of DMPO, **1a**, **2a** and TFA in air atmosphere with blue light irradiation; **iii**: standard $O_2^{\bullet-}$ and carbon radical signal peak; **iv**: the CH_3CN solution of DMPO in air atmosphere with blue light irradiation.

4.3 UV–vis absorption experiments.

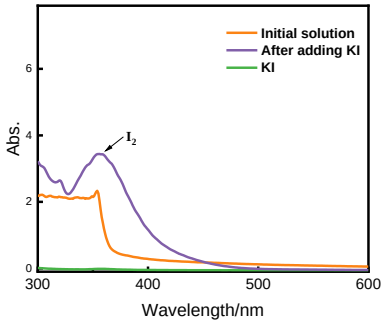
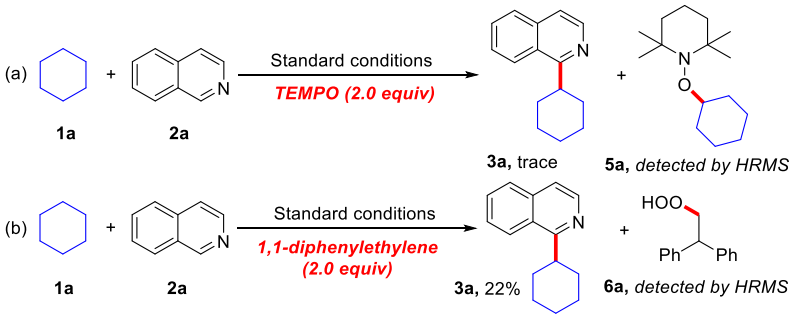


Figure S3. UV–vis absorption spectra: (a) a CH_3CN solution of KI (labeled by green line); standard reaction solution (labeled by orange line); a standard reaction solution containing I_2 (labeled by purple line).

4.4 Radical-trapping experiments.



Scheme S1. Radical-trapping experiments

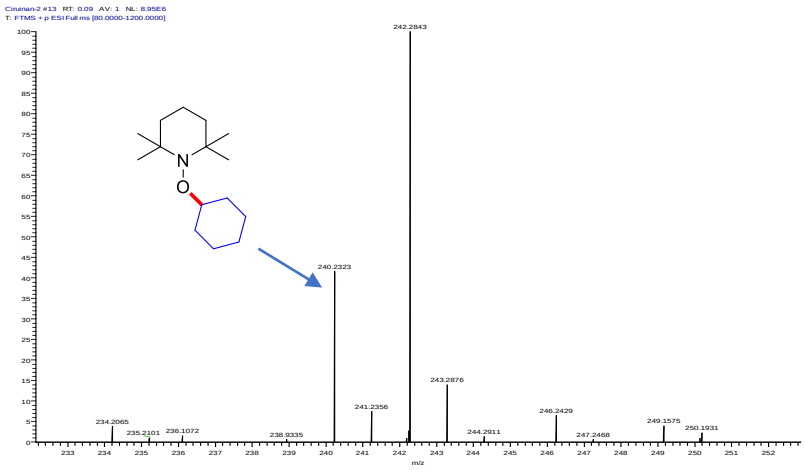


Figure S4. HRMS of **5a**.

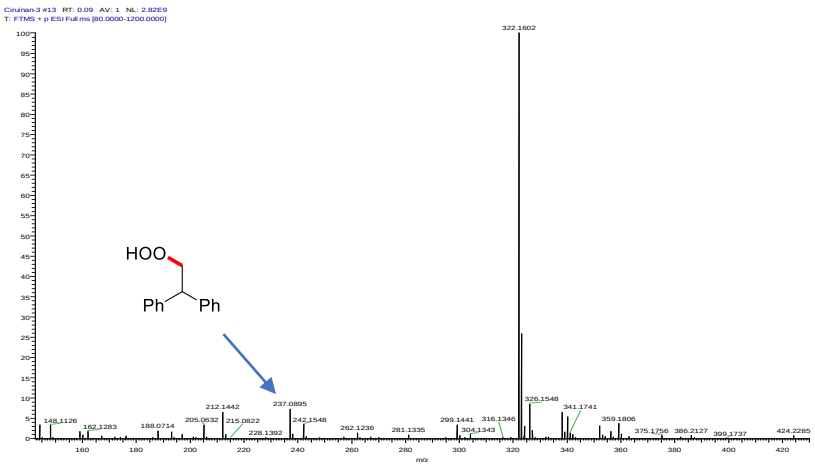


Figure S5. HRMS of **6a**.

5. Electrochemical and optical spectroscopic data

The cross-over point of isoquinoline was 341 nm, and E_{00} = 3.82 eV. According to the reduction potential of isoquinoline/isoquinoline$^{\bullet-}$ ($E_{1/2}$ = -1.23 V *vs.* SCE) and the E_{00} transition energy, the photoexcited protonated isoquinoline (**I***) is estimated to display an oxidation potential of +2.59 V *vs*. SCE. CF_3COO^- (+2.40 V vs SCE) enable electron transfer to **I*** (+2.59 V vs SCE).

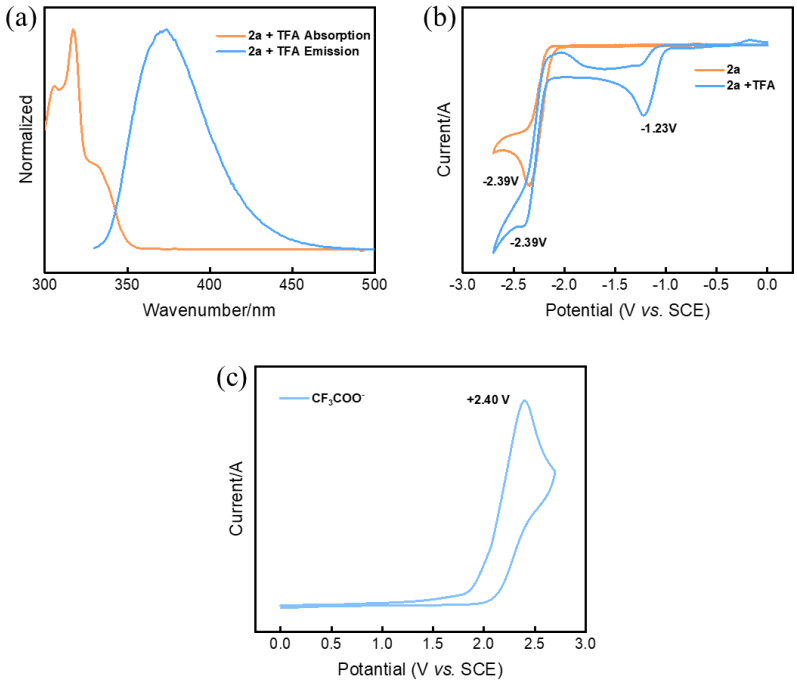
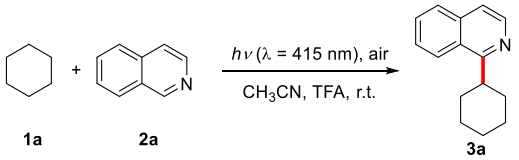


Figure S6 (a) The UV-Vis absorption spectrum (organe line) and fluorescence spectrum (blue line) of protonated isoquinoline by TFA (2.0×10^{-5} M) in CH_3CN. (b) The cyclic voltammetry experiment of isoquinoline (10 mM) and protonated isoquinoline by TFA (10 mM) in CH_3CN under argon atmosphere. 0.1 M n-Bu_4NPF_6 as electrolyte. (c) The cyclic voltammetry experiment of

CF_3COONH_4 (0.1 M) in CH_3CN.

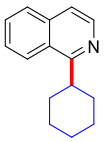
6. Scale-up experiment



A 150 mL reaction tube (inner diameter: 5.0 cm, length: 18 cm) equipped with a magnetic stir bar was charged with isoquinoline (900 µL, 7.5 mmol), cyclohexane (20 mL, 25 equiv.), TFA (900 µL, 1.2 equiv.) in CH_3CN (70 mL). The mixture was irradiated by blue LEDs (λ = 415 nm) for 26 h at room temperature. After reaction, the mixture was diluted with aqueous 1 M NaOH solution and extracted with ethyl acetate. Then the organic phase was combined together and washed with brine and dried over anhydrous sodium sulfate. Upon removal of solvent under vacuum, the residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate = 10:1) to give the desired product **3a** in 60% yield (0.95 g).

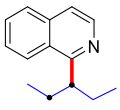
7. Characterization data for compounds

1-Cyclohexylisoquinoline (3a)



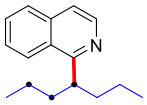
The compound was prepared according to the General Experimental Procedure. Yellow oil; 20.1 mg, yield 95%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (d, *J* = 5.8 Hz, 1H), 8.21 (d, *J* = 8.3 Hz, 1H), 7.78 (d, *J* = 7.9 Hz, 1H), 7.63 (t, *J* = 7.5 Hz, 1H), 7.56 (t, *J* = 7.7 Hz, 1H), 7.46 (d, *J* = 5.7 Hz, 1H), 3.56 (t, *J* = 11.8 Hz, 1H), 1.96 (t, *J* = 17.7 Hz, 4H), 1.84 (q, *J* = 11.7, 10.2 Hz, 3H), 1.53 (q, *J* = 13.2 Hz, 2H), 1.40 (t, *J* = 12.1 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 141.9, 136.4, 129.5, 127.6, 126.8, 126.3, 124.7, 118.9, 41.6, 32.6, 26.9, 26.3. HRMS (ESI) Calcd. for $C_{15}H_{18}N$ $[M+H]^+$: 212.1434. Found: 212.1439.

1-(Pentan-2-yl)isoquinoline and 1-(Pentan-3-yl)isoquinoline (3b)



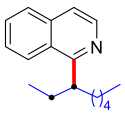
The compound was prepared according to the General Experimental Procedure. Yellow oil; 10.1 mg, yield 51%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (dd, *J* = 11.8, 5.7 Hz, 1H), 8.24 (t, *J* = 8.2 Hz, 1H), 7.87 – 7.54 (m, 3H), 7.48 (dd, *J* = 5.7, 1.1 Hz, 1H), 3.88 – 3.48 (m, 1H), 2.11 – 1.91 (m, 1H), 1.90 – 1.64 (m, 1H), 1.43 – 1.17 (m, 4H), 0.85 (dt, *J* = 44.0, 7.4 Hz, 4H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.1, 142.1, 142.0, 136.4, 129.5(4), 129.5(1), 127.6, 127.5, 126.8(3), 126.8(9), 126.8(6), 124.9, 124.7, 118.8, 118.6, 39.0, 35.8, 28.2, 21.0, 20.5, 14.3, 12.3. HRMS (ESI) Calcd. for $C_{14}H_{18}N$ $[M+H]^+$: 200.1434. Found: 200.1437.

1-(Heptan-2-yl)isoquinoline, 1-(Heptan-3-yl)isoquinoline and 1-(Heptan-4-yl)isoquinoline (3c)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 12.7 mg, yield 56%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.52 (dd, *J* = 17.1, 5.6 Hz, 1H), 8.23 (dd, *J* = 13.4, 8.6 Hz, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.65 (t, *J* = 7.7 Hz, 1H), 7.58 (d, *J* = 8.1 Hz, 1H), 7.48 (d, *J* = 5.6 Hz, 1H), 3.86 – 3.47 (m, 1H), 1.98 (dp, *J* = 15.5, 7.4 Hz, 1H), 1.89 – 1.66 (m, 2H), 1.41 (d, *J* = 6.8 Hz, 1H), 1.25 (p, *J* = 10.4, 9.2 Hz, 5H), 0.81 (dt, *J* = 28.2, 6.7 Hz, 5H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 166.1, 165.5, 165.3, 142.1, 142.0, 136.4, 136.3, 129.6, 128.0, 127.9, 127.6, 127.5, 126.8(4), 126.8(9), 124.9, 124.8, 124.8, 118.8, 118.6(3), 118.6(0), 38.1, 36.8, 36.1, 35.2, 32.1, 30.1, 29.7, 28.6, 27.6, 23.0, 22.6, 21.0, 20.5, 14.3, 14.1, 14.0, 12.3. HRMS (ESI) Calcd. for $C_{16}H_{22}N$ $[M+H]^+$: 228.1747. Found: 228.1753.

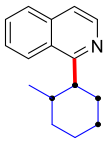
1-(Octan-2-yl)isoquinoline, 1-(octan-3-yl)isoquinoline and 1-(octan-4-yl)isoquinoline (3d)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 13.0 mg, yield 54%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.52 (dd, *J* = 16.3, 5.7 Hz, 1H), 8.31 – 8.16 (m, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.65 (t, *J* = 7.9 Hz, 1H), 7.58 (d, *J* = 8.1 Hz, 1H), 7.48 (d, *J* = 5.5 Hz, 1H), 3.84 – 3.43 (m, 1H), 1.97 (tt, *J* = 16.1, 8.6 Hz, 1H), 1.88 – 1.68 (m, 2H), 1.41 (d, *J* = 6.8 Hz, 1H), 1.36

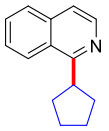
– 1.15 (m, 6H), 1.14 – 1.04 (m, 1H), 0.82 (dt, *J* = 27.3, 7.6 Hz, 5H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 166.2, 165.6, 165.3, 142.1(0), 142.1(6), 142.0, 136.4, 136.3, 129.6(6), 129.6(5), 128.0, 127.9, 127.5(5), 127.5(1), 126.8(4), 126.8(0), 126.8(8), 124.9(1), 124.9(5), 124.8, 118.8, 118.6(4), 118.6(1), 38.1, 36.8, 36.1, 35.5, 35.4, 32.1, 31.8, 30.1, 29.5, 28.6, 27.9, 27.5, 23.0, 22.6, 22.5, 21.0, 20.5, 14.6, 14.1, 14.0, 12.4. HRMS (ESI) Calcd. for $C_{17}H_{24}N$ $[M+H]^+$: 242.1903. Found: 242.1906.

1-((1S)-2-Methylcyclohexyl)isoquinoline, 1-(1-Methylcyclohexyl)isoquinoline, 1-((1S)-3-Methylcyclohexyl)isoquinoline and 1-(4-Methylcyclohexyl)isoquinoline (3e)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 20.0 mg, yield 89%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.56 – 8.45 (m, 1H), 8.25 (dd, *J* = 16.3, 8.1 Hz, 1H), 7.82 (d, *J* = 7.9 Hz, 1H), 7.66 (t, *J* = 6.9 Hz, 1H), 7.60 (d, *J* = 7.6 Hz, 1H), 7.49 (d, *J* = 4.3 Hz, 1H), 4.09 – 2.96 (m, 1H), 2.30 – 1.47 (m, 8H), 1.46 – 0.90 (m, 3H), 0.67 (d, *J* = 6.2 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 165.6, 142.2, 142.1(0), 142.1(5), 142.0, 136.6(3), 136.6(7), 129.7, 129.6, 127.7(0), 127.7(5), 127.6, 126.9(2), 126.9(8), 126.6, 126.5, 124.9(4), 124.9(6), 119.0, 118.7, 41.6, 41.5, 41.1, 38.7, 36.6, 35.9, 35.8, 35.4, 35.1, 34.1, 33.3, 32.6, 32.4, 32.3, 32.1, 29.8, 28.2, 27.9, 27.3, 27.0, 26.8, 26.6, 22.9(4), 22.9(0), 21.3, 20.9, 18.9, 18.5. HRMS (ESI) Calcd. for $C_{16}H_{20}N$ $[M+H]^+$: 226.1590. Found: 226.1593.

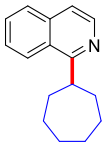
1-Cyclopentylisoquinoline (3f)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 12.0 mg, yield 61%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (d, *J* = 5.6 Hz, 1H), 8.29 (d, *J* = 8.4 Hz, 1H), 7.84 (d, *J* = 7.9 Hz, 1H), 7.69 (t, *J* = 7.6 Hz, 1H), 7.62 (t, *J* = 7.8 Hz, 1H), 7.52 (d, *J* = 5.7 Hz, 1H),

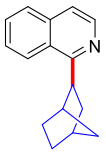
4.06 (p, *J* = 8.4 Hz, 1H), 2.25 – 2.07 (m, 4H), 2.03 – 1.89 (m, 2H), 1.86 – 1.74 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.8, 141.7, 136.3, 129.6, 127.4, 127.2, 126.8, 125.3, 119.0, 43.0, 32.8, 26.1. HRMS (ESI) Calcd. for $C_{14}H_{16}N$ $[M+H]^+$: 198.1277. Found: 198.1281.

1-Cycloheptylisoquinoline (3g)



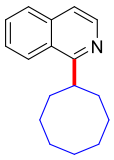
The compound was prepared according to the General Experimental Procedure. Yellow oil; 22.1 mg, yield 98%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.3). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 (d, *J* = 5.8 Hz, 1H), 8.20 (d, *J* = 8.4 Hz, 1H), 7.80 (d, *J* = 8.0 Hz, 1H), 7.61 (dt, *J* = 26.0, 7.4 Hz, 2H), 7.46 (d, *J* = 5.8 Hz, 1H), 3.73 (td, *J* = 9.7, 4.5 Hz, 1H), 2.12 – 1.85 (m, 6H), 1.83 – 1.58 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 141.8, 136.5, 129.5, 127.6, 126.8, 126.0, 124.8, 118.8, 43.3, 34.6, 28.1, 27.6. HRMS (ESI) Calcd. for $C_{16}H_{20}N$ $[M+H]^+$: 226.1590. Found: 226.1590.

1-((1*R*,2*S*,4*S*)-Bicyclo[2.2.1]heptan-2-yl)isoquinoline (3h)



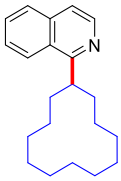
The compound was prepared according to the General Experimental Procedure. Yellow oil; 10.9 mg, yield 49%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.43 (d, *J* = 5.7 Hz, 1H), 8.18 (d, *J* = 8.4 Hz, 1H), 7.76 (d, *J* = 8.0 Hz, 1H), 7.58 (dt, *J* = 24.8, 7.3 Hz, 2H), 7.43 (d, *J* = 5.7 Hz, 1H), 3.56 (dd, *J* = 9.1, 4.9 Hz, 1H), 2.58 (d, *J* = 3.6 Hz, 1H), 2.40 (dd, *J* = 15.7, 3.7 Hz, 2H), 1.68 (tt, *J* = 13.4, 7.3 Hz, 4H), 1.56 (t, *J* = 9.7 Hz, 1H), 1.40 (t, *J* = 9.7 Hz, 1H), 1.18 (d, *J* = 9.6 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.2, 141.3, 136.3, 129.4, 127.4, 127.0, 126.7, 125.4, 118.8, 45.5, 43.0, 36.8, 36.1, 35.9, 30.3, 29.6. HRMS (ESI) Calcd. for $C_{16}H_{18}N$ $[M+H]^+$: 224.1434. Found: 224.1433.

1-Cyclooctylisoquinoline (3i)



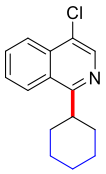
The compound was prepared according to the General Experimental Procedure. Yellow oil; 23.4 mg, yield 98%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.4). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.47 (d, *J* = 5.7 Hz, 1H), 8.21 (d, *J* = 8.3 Hz, 1H), 7.80 (d, *J* = 7.9 Hz, 1H), 7.62 (dt, *J* = 25.1, 7.4 Hz, 2H), 7.46 (d, *J* = 5.8 Hz, 1H), 3.84 (td, *J* = 9.0, 4.2 Hz, 1H), 2.13 – 1.95 (m, 4H), 1.94 – 1.82 (m, 2H), 1.82 – 1.60 (m, 8H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 167.9, 141.7, 136.6, 129.6, 127.6, 126.9, 126.0, 124.9, 118.8, 41.1, 33.1, 26.8, 26.8, 26.3. HRMS (ESI) Calcd. for $C_{17}H_{22}N$ $[M+H]^+$: 240.1747. Found: 240.1744.

1-Cyclododecylisoquinoline (3j)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 14.9 mg, yield 51%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 (d, *J* = 5.7 Hz, 1H), 8.25 (d, *J* = 8.4 Hz, 1H), 7.82 (dd, *J* = 8.1, 1.4 Hz, 1H), 7.67 (t, *J* = 7.5 Hz, 1H), 7.61 (ddd, *J* = 8.3, 6.8, 1.4 Hz, 1H), 7.50 (d, *J* = 5.7 Hz, 1H), 3.89 (t, *J* = 6.3 Hz, 1H), 1.94 (dp, *J* = 27.6, 7.0 Hz, 4H), 1.64 – 1.46 (m, 9H), 1.45 – 1.33 (m, 7H), 1.30 – 1.19 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 141.6, 136.5, 129.7, 127.6, 127.1, 127.0, 124.8, 119.0, 36.7, 29.8, 23.9(3), 23.9(7), 23.8, 23.6, 23.0. HRMS (ESI) Calcd. for $C_{21}H_{30}N$ $[M+H]^+$: 296.2373. Found: 296.2394.

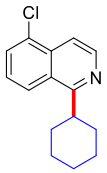
4-Chloro-1-cyclohexylisoquinoline (3k)



The compound was prepared according to the General Experimental Procedure. White solid; 9.6 mg, yield 39%. Purified by column chromatography on silica gel (eluting with hexane/ethyl

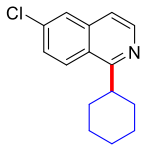
acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.44 (s, 1H), 8.15 (t, *J* = 6.5 Hz, 2H), 7.69 (t, *J* = 7.8 Hz, 1H), 7.57 (t, *J* = 7.9 Hz, 1H), 3.44 (t, *J* = 11.9 Hz, 1H), 1.85 (d, *J* = 12.6 Hz, 4H), 1.74 (t, *J* = 11.5 Hz, 3H), 1.45 (td, *J* = 15.4, 7.8 Hz, 2H), 1.31 (t, *J* = 12.4 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 164.7, 140.7, 133.8, 130.6, 127.6, 127.2, 126.2, 125.1, 124.2, 41.5, 32.6, 26.8, 26.2. HRMS (ESI) Calcd. for $C_{15}H_{17}ClN$ $[M+H]^+$: 246.1044. Found: 246.1045.

5-Chloro-1-cyclohexylisoquinoline (3l)



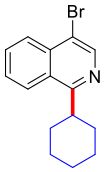
The compound was prepared according to the General Experimental Procedure. Yellow oil; 11.3 mg, yield 46%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.58 (d, *J* = 6.0 Hz, 1H), 8.15 (d, *J* = 8.7 Hz, 1H), 7.88 (d, *J* = 6.0 Hz, 1H), 7.72 (d, *J* = 7.4 Hz, 1H), 7.47 (t, *J* = 8.0 Hz, 1H), 3.54 (t, *J* = 11.9 Hz, 1H), 2.01 – 1.89 (m, 4H), 1.83 (q, *J* = 12.5, 11.0 Hz, 3H), 1.52 (q, *J* = 12.3 Hz, 2H), 1.40 (t, *J* = 13.0 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.0, 143.0, 134.3, 131.9, 129.6, 127.3, 126.5, 123.8, 115.1, 41.8, 32.7, 26.8, 26.2. HRMS (ESI) Calcd. for $C_{15}H_{17}ClN$ $[M+H]^+$: 246.1044. Found: 246.1042.

6-Chloro-1-cyclohexylisoquinoline (3m)



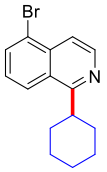
The compound was prepared according to the General Experimental Procedure. Yellow oil; 15.5 mg, yield 63%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 5.8 Hz, 1H), 8.14 (d, *J* = 9.0 Hz, 1H), 7.76 (s, 1H), 7.49 (d, *J* = 9.0 Hz, 1H), 7.37 (d, *J* = 5.7 Hz, 1H), 3.49 (t, *J* = 11.7 Hz, 1H), 1.96 (d, *J* = 11.4 Hz, 4H), 1.83 (q, *J* = 12.4 Hz, 3H), 1.60 – 1.46 (m, 2H), 1.41 (t, *J* = 13.1 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 143.0, 137.2, 135.7, 127.7, 126.6, 126.2, 124.4, 118.0, 41.7, 32.6, 26.8, 26.2. HRMS (ESI) Calcd. for $C_{15}H_{17}ClN$ $[M+H]^+$: 246.1044. Found: 246.1043.

4-Bromo-1-cyclohexylisoquinoline (3n)



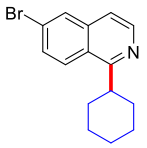
The compound was prepared according to the General Experimental Procedure. White solid; 19.3 mg, yield 67%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.65 (s, 1H), 8.16 (dd, *J* = 16.3, 8.5 Hz, 2H), 7.72 (t, *J* = 7.6 Hz, 1H), 7.60 (t, *J* = 7.7 Hz, 1H), 3.50 (t, *J* = 12.0 Hz, 1H), 2.00 – 1.88 (m, 4H), 1.81 (t, *J* = 11.8 Hz, 3H), 1.58 – 1.45 (m, 2H), 1.43 – 1.33 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.3, 143.6, 134.9, 130.8, 127.7, 127.6, 126.8, 125.1, 117.6, 41.5, 32.6, 26.8, 26.2. HRMS (ESI) Calcd. for $C_{15}H_{17}BrN$ $[M+H]^+$: 290.0539. Found: 290.0547.

5-Bromo-1-cyclohexylisoquinoline (3o)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 13.0 mg, yield 45%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.6). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.62 (d, *J* = 6.0 Hz, 1H), 8.24 (d, *J* = 8.5 Hz, 1H), 7.97 (d, *J* = 7.4 Hz, 1H), 7.90 (d, *J* = 6.1 Hz, 1H), 7.46 (t, *J* = 7.9 Hz, 1H), 3.58 (t, *J* = 12.0 Hz, 1H), 1.97 (d, *J* = 14.0 Hz, 4H), 1.86 (d, *J* = 12.8 Hz, 3H), 1.56 (td, *J* = 15.0, 7.6 Hz, 2H), 1.48 – 1.37 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.1, 143.2, 135.5, 133.5, 127.4, 127.1, 124.5, 122.6, 117.8, 41.8, 32.7, 26.8, 26.2. HRMS (ESI) Calcd. for $C_{15}H_{17}BrN$ $[M+H]^+$: 290.0539. Found: 290.0547.

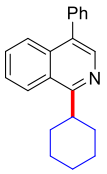
6-Bromo-1-cyclohexylisoquinoline (3p)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 17.0 mg, yield 59%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (d, *J* = 5.8 Hz, 1H), 8.05 (d, *J* = 9.1 Hz,

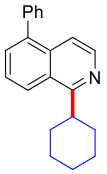
1H), 7.94 (s, 1H), 7.62 (d, *J* = 9.1 Hz, 1H), 7.36 (t, *J* = 4.2 Hz, 1H), 3.48 (dt, *J* = 15.0, 7.5 Hz, 1H), 2.00 – 1.89 (m, 4H), 1.81 (q, *J* = 12.4 Hz, 3H), 1.51 (tt, *J* = 12.6, 6.3 Hz, 2H), 1.39 (td, *J* = 12.7, 3.2 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.9, 143.0, 137.6, 130.3, 129.6, 126.6, 124.7, 124.3, 117.9, 41.6, 32.6, 26.8, 26.2. HRMS (ESI) Calcd. for $C_{15}H_{17}BrN$ $[M+H]^+$: 290.0539. Found: 290.0547.

1-Cyclohexyl-4-phenylisoquinoline (3q)



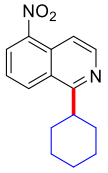
The compound was prepared according to the General Experimental Procedure. Yellow oil; 8.3 mg, yield 29%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (s, 1H), 8.30 (d, *J* = 7.5 Hz, 1H), 7.91 (d, *J* = 7.8 Hz, 1H), 7.66 – 7.56 (m, 2H), 7.54 – 7.42 (m, 5H), 3.76 – 3.41 (m, 1H), 2.1 – 1.79 (m, 7H), 1.64 – 1.49 (m, 2H), 1.48 – 1.38 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.1, 141.6, 137.5, 134.8, 131.5, 130.3, 129.7, 128.5, 127.7, 126.7, 125.9, 125.8, 124.9, 41.6, 32.7, 26.9, 26.3. HRMS (ESI) Calcd. for $C_{21}H_{22}N$ $[M+H]^+$: 288.1747. Found: 288.1750.

1-Cyclohexyl-5-phenylisoquinoline (3r)



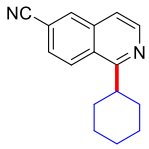
The compound was prepared according to the General Experimental Procedure. Yellow oil; 13.9 mg, yield 48%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (d, *J* = 6.0 Hz, 1H), 8.26 (d, *J* = 7.7 Hz, 1H), 7.62 (d, *J* = 7.2 Hz, 1H), 7.55 (d, *J* = 6.0 Hz, 2H), 7.46 (h, *J* = 7.5, 7.0 Hz, 5H), 3.63 (t, *J* = 11.8 Hz, 1H), 1.94 (ddd, *J* = 46.9, 29.1, 13.3 Hz, 7H), 1.56 (q, *J* = 13.3 Hz, 2H), 1.48 – 1.36 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.8, 141.9, 140.2, 139.6, 134.9, 130.4, 130.0, 128.5, 127.7, 126.5, 126.3, 124.2, 117.0, 41.8, 32.7, 26.9, 26.3. HRMS (ESI) Calcd. for $C_{21}H_{22}N$ $[M+H]^+$: 288.1747. Found: 288.1754.

1-Cyclohexyl-5-nitroisoquinoline (3s)



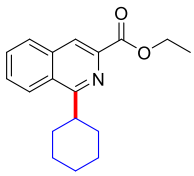
The compound was prepared according to the General Experimental Procedure. Yellow oil; 7.5 mg, yield 29%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 5:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.69 (d, *J* = 6.1 Hz, 1H), 8.59 (d, *J* = 8.4 Hz, 1H), 8.43 (d, *J* = 7.7 Hz, 1H), 8.22 (d, *J* = 6.3 Hz, 1H), 7.70 (td, *J* = 8.2, 2.8 Hz, 1H), 3.59 (dt, *J* = 13.7, 6.8 Hz, 1H), 1.97 (q, *J* = 9.0, 7.8 Hz, 4H), 1.86 (q, *J* = 11.8, 10.8 Hz, 3H), 1.55 (qd, *J* = 13.1, 12.6, 3.5 Hz, 2H), 1.41 (td, *J* = 12.7, 3.3 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.4, 146.0, 145.2, 131.4, 128.8, 127.2, 126.8, 125.1, 113.4, 42.2, 32.7, 26.7, 26.1. HRMS (ESI) Calcd. for $C_{15}H_{17}N_2O_2$ $[M+H]^+$: 257.1285. Found: 257.1284.

1-Cyclohexylisoquinoline-6-carbonitrile (3t)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 10.8 mg, yield 46%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.2). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.61 (d, *J* = 5.8 Hz, 1H), 8.32 (d, *J* = 8.7 Hz, 1H), 8.20 (s, 1H), 7.72 (d, *J* = 8.7 Hz, 1H), 7.53 (d, *J* = 5.7 Hz, 1H), 3.53 (t, *J* = 11.8 Hz, 1H), 1.99 – 1.89 (m, 4H), 1.82 (d, *J* = 12.6 Hz, 3H), 1.53 (q, *J* = 13.2 Hz, 2H), 1.39 (t, *J* = 13.0 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.3, 143.7, 135.5, 133.6, 127.5, 126.9, 126.3, 118.6, 118.3, 113.4, 41.8, 32.6, 26.7, 26.1. HRMS (ESI) Calcd. for $C_{16}H_{17}N_2$ $[M+H]^+$: 237.1386. Found: 237.1386.

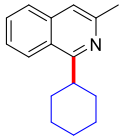
Ethyl 1-cyclohexylisoquinoline-3-carboxylate (3u)



The compound was prepared according to the General Experimental Procedure. White solid; 3.8

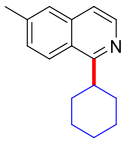
mg, yield 14%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.40 (s, 1H), 8.30 (d, *J* = 7.4 Hz, 1H), 7.96 (d, *J* = 7.1 Hz, 1H), 7.74 (d, *J* = 5.3 Hz, 2H), 4.52 (q, *J* = 7.2 Hz, 2H), 3.60 (s, 1H), 2.11 – 1.92 (m, 6H), 1.84 (d, *J* = 12.7 Hz, 1H), 1.64– 1.38 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.3, 166.1, 140.9, 136.0, 130.0, 129.0, 128.9, 127.7, 124.9, 122.1, 61.4, 42.0, 32.2, 26.8, 26.1, 14.4. HRMS (ESI) Calcd. for $C_{18}H_{22}NO_2$ $[M+H]^+$: 284.1645. Found: 284.1659.

1-Cyclohexyl-3-methylisoquinoline (3v)



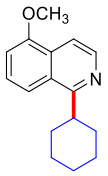
The compound was prepared according to the General Experimental Procedure. Colorless oil; 8.6 mg, yield 38%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.6). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 8.5 Hz, 1H), 7.69 (d, *J* = 7.9 Hz, 1H), 7.57 (t, *J* = 7.5 Hz, 1H), 7.47 (t, *J* = 7.8 Hz, 1H), 7.29 (s, 1H), 3.53 (t, *J* = 11.4 Hz, 1H), 2.66 (s, 3H), 2.08 – 1.72 (m, 7H), 1.63 – 1.35 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.0, 150.4, 137.2, 129.4, 127.0, 125.7, 124.7, 124.3, 116.8, 41.7, 32.5, 26.9, 26.2, 24.5. HRMS (ESI) Calcd. for $C_{16}H_{20}N$ $[M+H]^+$: 226.1590. Found: 226.1591.

1-Cyclohexyl-6-methylisoquinoline (3w)



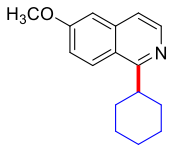
The compound was prepared according to the General Experimental Procedure. Yellow oil; 12.3 mg, yield 55%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 – 8.39 (m, 1H), 8.09 (d, *J* = 8.7 Hz, 1H), 7.54 (s, 1H), 7.38 (d, *J* = 7.8 Hz, 2H), 3.51 (dt, *J* = 11.5, 7.1 Hz, 1H), 2.51 (d, *J* = 2.8 Hz, 3H), 2.03 – 1.88 (m, 4H), 1.83 (q, *J* = 11.2, 9.6 Hz, 3H), 1.52 (qd, *J* = 13.2, 12.5, 3.6 Hz, 2H), 1.45 – 1.33 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.4, 142.0, 139.7, 136.7, 129.0, 126.5, 124.7, 124.6, 118.5, 41.5, 32.6, 26.9, 26.3, 21.8. HRMS (ESI) Calcd. for $C_{16}H_{20}N$ $[M+H]^+$: 226.1590. Found: 226.1590.

1-Cyclohexyl-5-methoxyisoquinoline (3x)



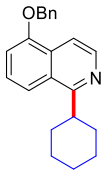
The compound was prepared according to the General Experimental Procedure. Yellow oil; 5.0 mg, yield 21%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.6). ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.28 – 9.06 (m, 1H), 8.57 (d, *J* = 5.9 Hz, 1H), 8.45 (d, *J* = 8.6 Hz, 1H), 8.15 (t, *J* = 8.2 Hz, 1H), 7.64 (d, *J* = 7.7 Hz, 1H), 4.65 (d, *J* = 2.5 Hz, 3H), 4.19 (t, *J* = 11.6 Hz, 1H), 2.67 – 2.40 (m, 7H), 2.30 – 1.98 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.0, 155.1, 141.4, 129.1, 127.1, 126.8, 116.6, 113.1, 107.0, 55.7, 41.8, 32.6, 26.9, 26.3. HRMS (ESI) Calcd. for $C_{16}H_{20}NO$ $[M+H]^+$: 242.1539. Found: 242.1540.

1-Cyclohexyl-6-methoxyisoquinoline (3y)



The compound was prepared according to the General Experimental Procedure. White solid; 3.8 mg, yield 16%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.3). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.45 (d, *J* = 5.7 Hz, 1H), 8.15 (d, *J* = 9.2 Hz, 1H), 7.42 (d, *J* = 5.7 Hz, 1H), 7.26 – 7.19 (m, 1H), 7.09 (s, 1H), 3.97 (d, *J* = 2.7 Hz, 3H), 3.52 (q, *J* = 8.7 Hz, 1H), 2.04 – 1.92 (m, 4H), 1.85 (t, *J* = 11.5 Hz, 3H), 1.61 – 1.48 (m, 2H), 1.48 – 1.38 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.1, 160.3, 142.4, 138.5, 126.7, 121.9, 119.6, 118.4, 105.1, 55.4, 41.6, 32.6, 26.9, 26.2. HRMS (ESI) Calcd. for $C_{16}H_{20}NO$ $[M+H]^+$: 242.1539. Found: 242.1539.

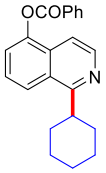
5-(Benzyloxy)-1-cyclohexylisoquinoline (3z)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 7.1 mg, yield 22%. Purified by column chromatography on silica gel (eluting with hexane/ethyl

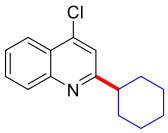
acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 (d, *J* = 6.0 Hz, 1H), 8.01 (d, *J* = 5.9 Hz, 1H), 7.81 (d, *J* = 8.6 Hz, 1H), 7.54 – 7.32 (m, 6H), 7.06 (d, *J* = 7.7 Hz, 1H), 5.25 (s, 2H), 3.54 (t, *J* = 11.8 Hz, 1H), 2.03– 1.89 (m, 4H), 1.83 (t, *J* = 13.0 Hz, 3H), 1.53 (q, *J* = 12.9 Hz, 2H), 1.41 (t, *J* = 12.8 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.0, 154.2, 141.1, 136.6, 129.4, 128.7, 128.2, 127.4, 127.2, 126.9, 117.0, 113.5, 108.7, 70.4, 41.8, 32.5, 26.9, 26.2. HRMS (ESI) Calcd. for $C_{22}H_{24}NO$ $[M+H]^+$: 318.1852. Found: 318.1861.

1-Cyclohexylisoquinolin-5-yl benzoate (3aa)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 18.8 mg, yield 56%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 4:1, R_f = 0.6). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.50 (d, *J* = 5.9 Hz, 1H), 8.38 – 8.29 (m, 2H), 8.18 (d, *J* = 8.6 Hz, 1H), 7.70 (t, *J* = 7.4 Hz, 1H), 7.63 (t, *J* = 8.0 Hz, 1H), 7.61 – 7.55 (m, 4H), 3.58 (tt, *J* = 11.9, 3.5 Hz, 1H), 2.03 – 1.98 (m, 2H), 1.88 – 1.79 (m, 2H), 1.84 (qd, *J* = 12.7, 3.5 Hz, 3H), 1.54 (qt, *J* = 13.0, 3.5 Hz, 2H), 1.44 – 1.37 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.9, 165.0, 146.5, 142.3, 134.1, 130.5, 130.4, 129.0, 128.9, 127.4, 126.5, 122.9, 122.1, 112.4, 41.9, 32.6, 26.9, 26.2. HRMS (ESI) Calcd. for $C_{22}H_{22}NO_2$ $[M+H]^+$: 332.1645. Found: 332.1655.

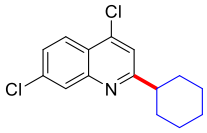
4-Chloro-2-cyclohexylquinoline (3ab)



The compound was prepared according to the General Experimental Procedure. Yellow oil; 11.3 mg, yield 46%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 8.4 Hz, 1H), 8.06 (d, *J* = 8.4 Hz, 1H), 7.71 (t, *J* = 7.9 Hz, 1H), 7.57 – 7.52 (m, 1H), 7.42 (s, 1H), 2.89 (td, *J* = 11.8, 3.2 Hz, 1H), 2.02 (d, *J* = 12.9 Hz, 2H), 1.93 – 1.84 (m, 2H), 1.82 – 1.74 (m, 1H), 1.60 (q, *J* = 12.7 Hz, 2H), 1.52 – 1.40 (m, 2H), 1.38 – 1.28 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.8, 148.6, 142.7, 130.2, 129.3, 126.6,

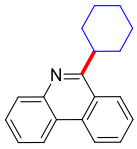
125.2, 123.9, 119.8, 47.4, 32.7, 26.5, 26.0. HRMS (ESI) Calcd. for $C_{15}H_{17}ClN$ $[M+H]^+$: 246.1044. Found: 246.1044.

4,7-Dichloro-2-cyclohexylquinoline (3ac)



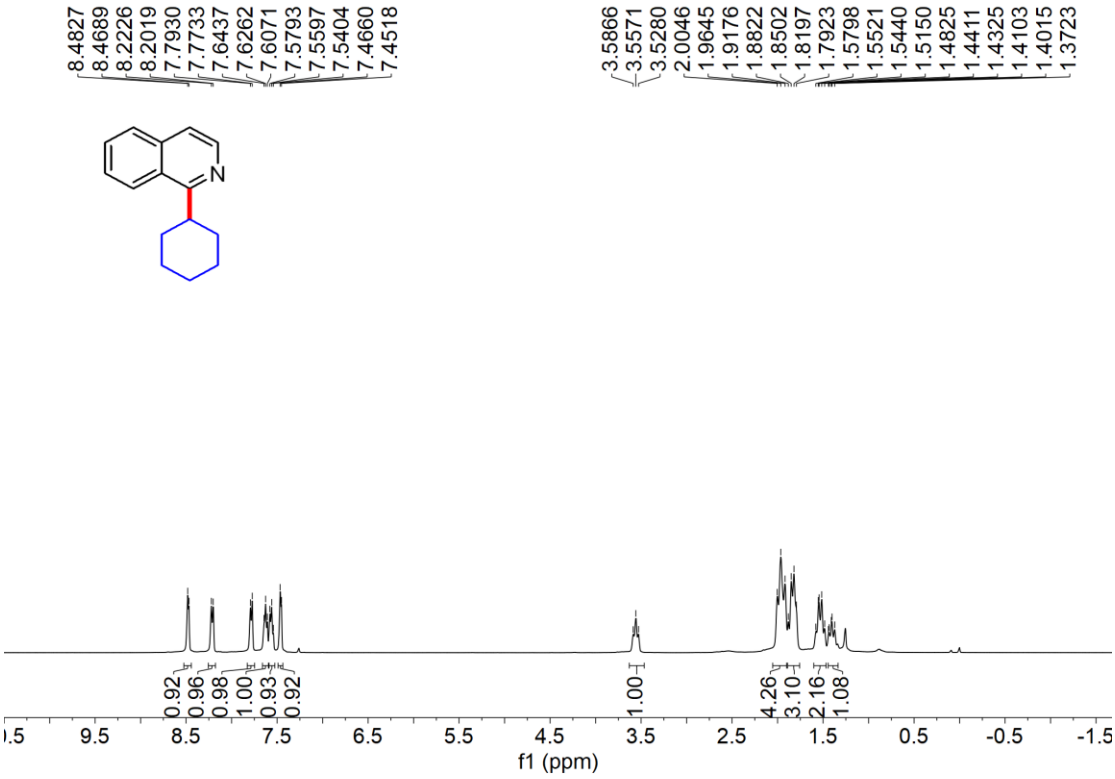
The compound was prepared according to the General Experimental Procedure. Yellow oil; 16.9 mg, yield 60%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 10:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 – 8.59 (m, 2H), 8.05 (d, *J* = 8.9 Hz, 1H), 7.98 (s, 1H), 3.46 (t, *J* = 11.5 Hz, 1H), 2.62 (d, *J* = 12.9 Hz, 2H), 2.51 (d, *J* = 13.0 Hz, 2H), 2.40 (d, *J* = 13.1 Hz, 1H), 2.21 (qd, *J* = 12.4, 3.0 Hz, 2H), 2.07 (q, *J* = 13.0 Hz, 2H), 1.94 (t, *J* = 12.6 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 168.2, 149.3, 142.6, 136.3, 128.6, 127.6, 125.3, 123.7, 120.3, 47.4, 32.7, 26.6, 26.2. HRMS (ESI) Calcd. for $C_{15}H_{16}Cl_2N$ $[M+H]^+$: 280.0654. Found: 280.0659.

6-Cyclohexylphenanthridine (3ad)

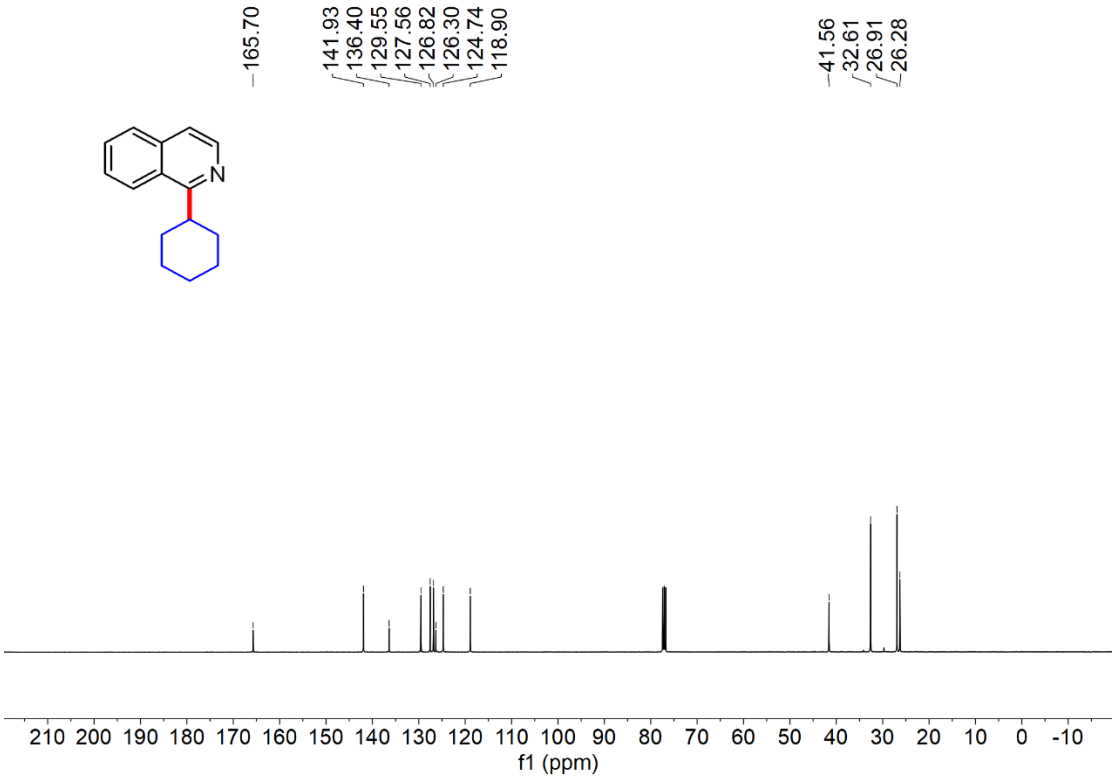


The compound was prepared according to the General Experimental Procedure. Yellow oil; 11.3 mg, yield 43%. Purified by column chromatography on silica gel (eluting with hexane/ethyl acteate = 20:1, R_f = 0.5). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.68 (d, *J* = 8.3 Hz, 1H), 8.57 (d, *J* = 8.1 Hz, 1H), 8.36 (d, *J* = 8.2 Hz, 1H), 8.21 (d, *J* = 8.0 Hz, 1H), 7.84 (t, *J* = 7.6 Hz, 1H), 7.78 – 7.69 (m, 2H), 7.64 (t, *J* = 7.6 Hz, 1H), 3.67 (dt, *J* = 13.7, 6.9 Hz, 1H), 2.14 (d, *J* = 13.2 Hz, 2H), 2.01 (q, *J* = 13.1, 12.5 Hz, 4H), 1.90 (d, *J* = 12.7 Hz, 1H), 1.70 – 1.56 (m, 2H), 1.51 (td, *J* = 12.6, 3.2 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.3, 143.9, 133.0, 130.0, 128.4, 127.1, 126.2, 125.6, 124.7, 123.4, 122.6, 121.8, 42.0, 32.3, 26.9, 26.4. HRMS (ESI) Calcd. for $C_{19}H_{20}N$ $[M+H]^+$: 262.1590. Found: 262.1591.

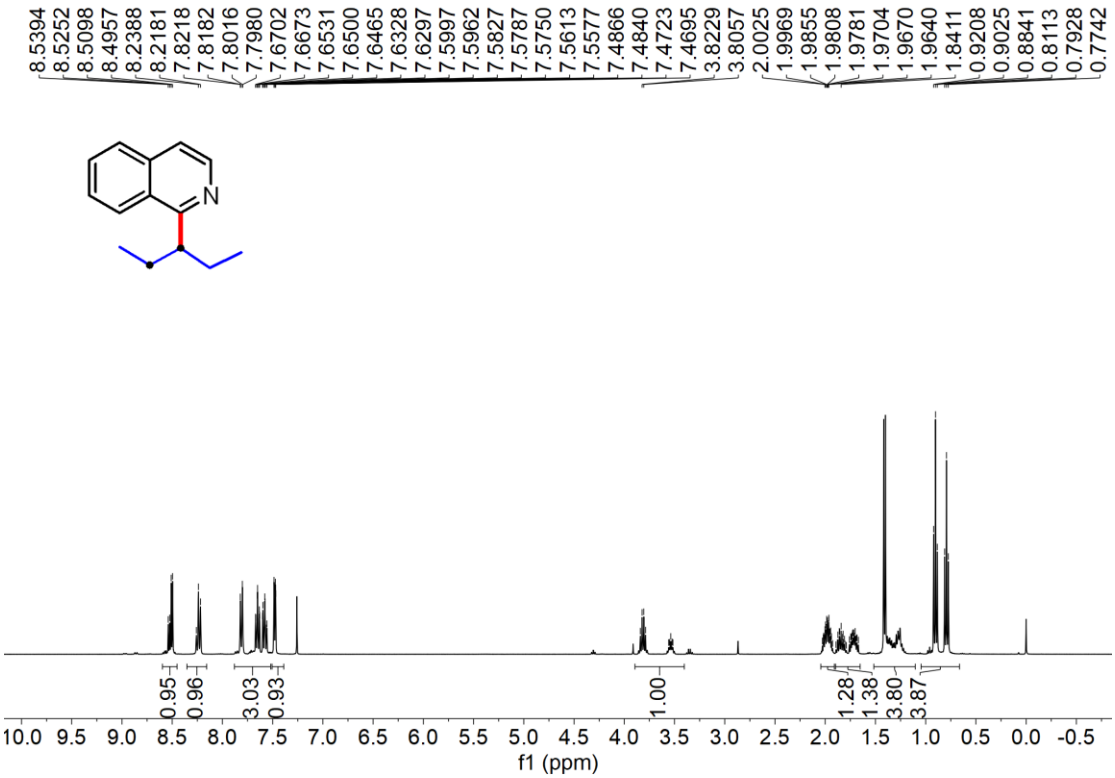
8. ^{1}H NMR and ^{13}C NMR spectra of all products



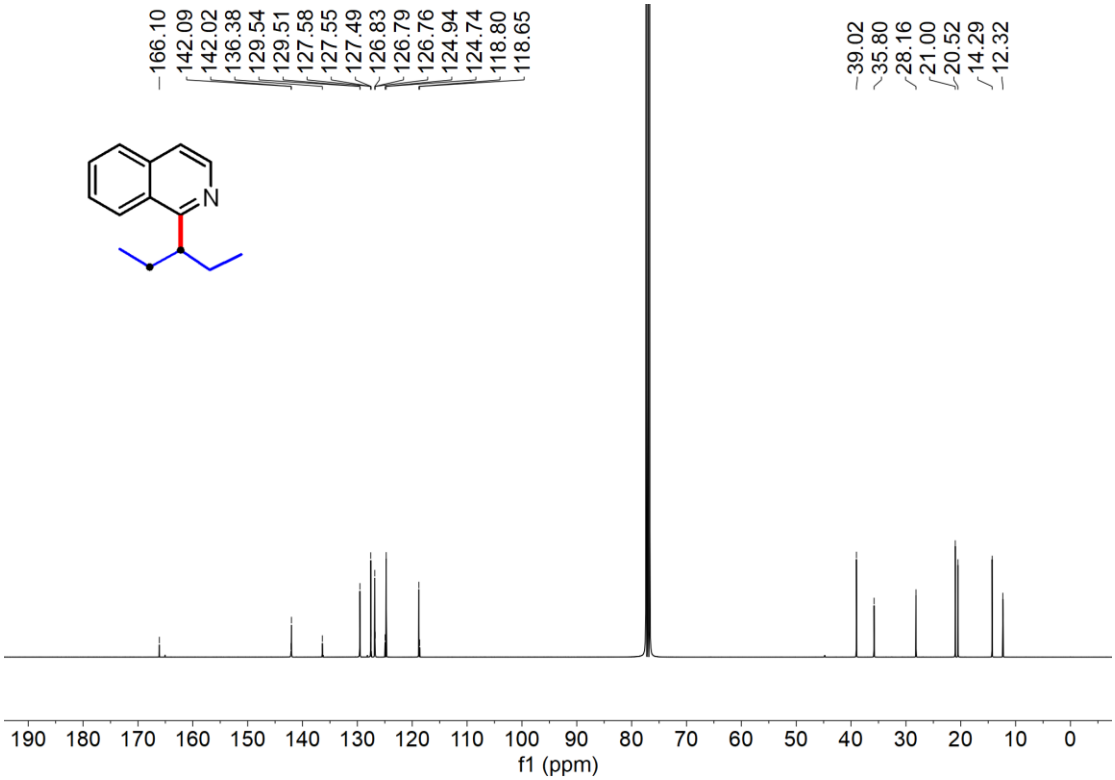
^{1}H NMR (400 MHz, $CDCl_3$) of **3a**



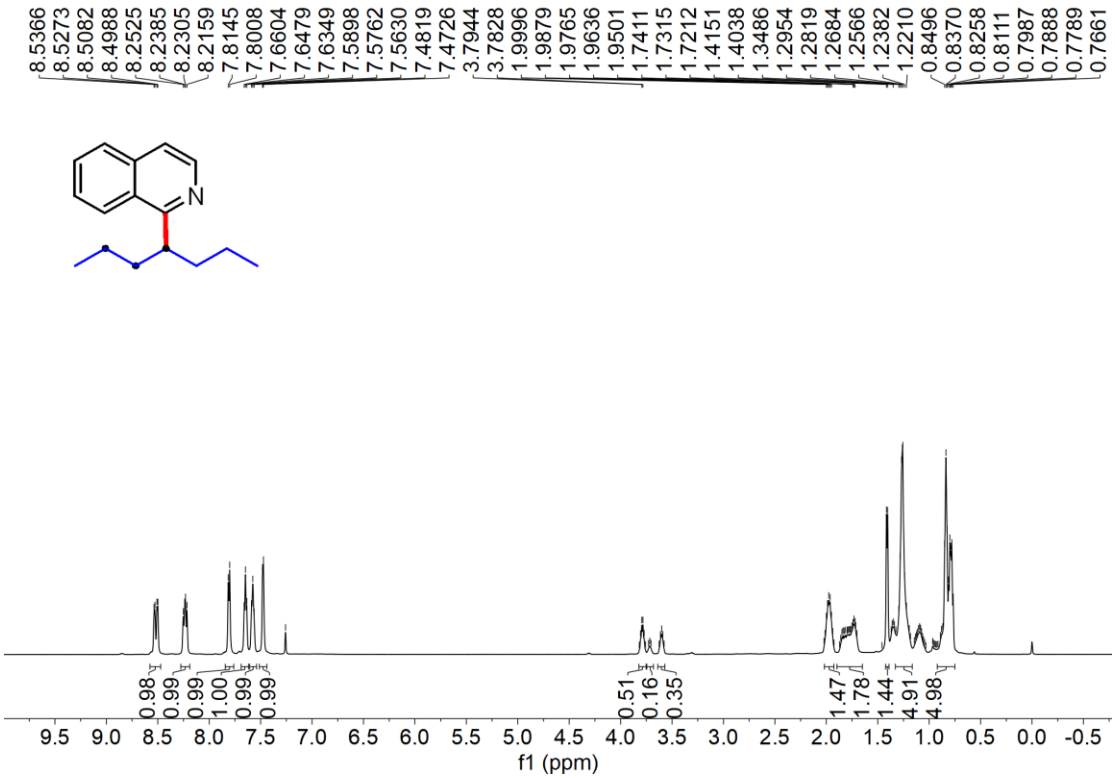
^{13}C NMR (101 MHz, $CDCl_3$) of **3a**



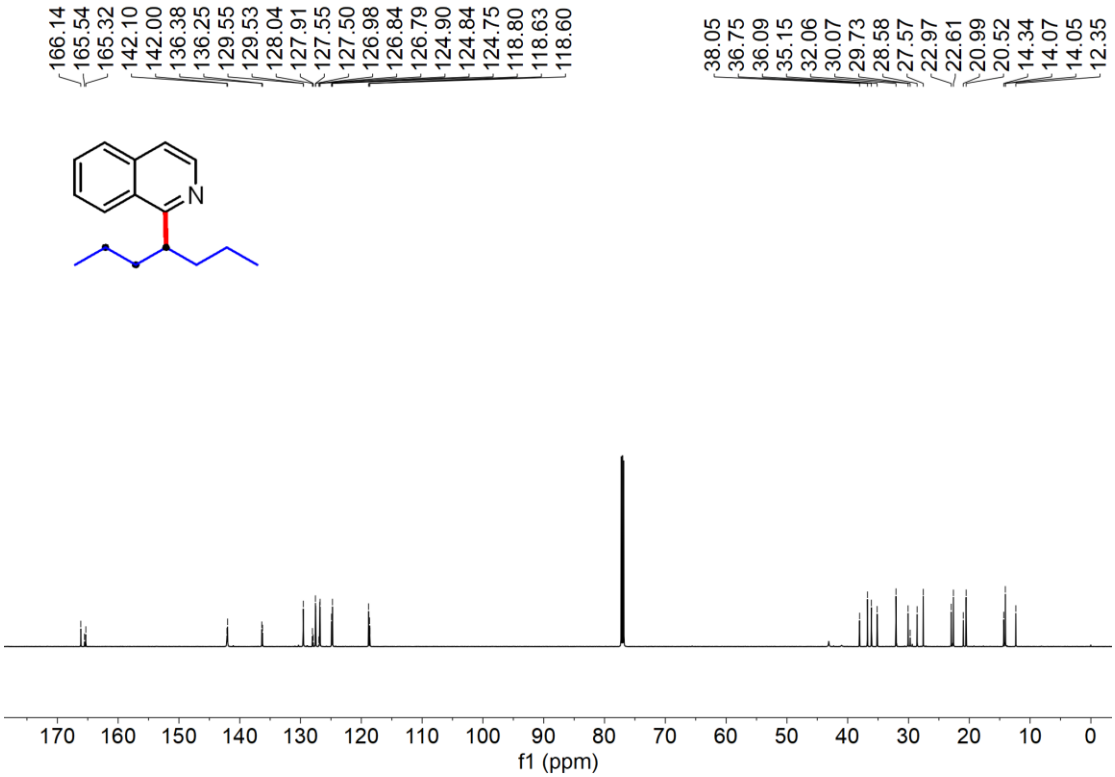
^{1}H NMR (400 MHz, $CDCl_3$) of **3b**



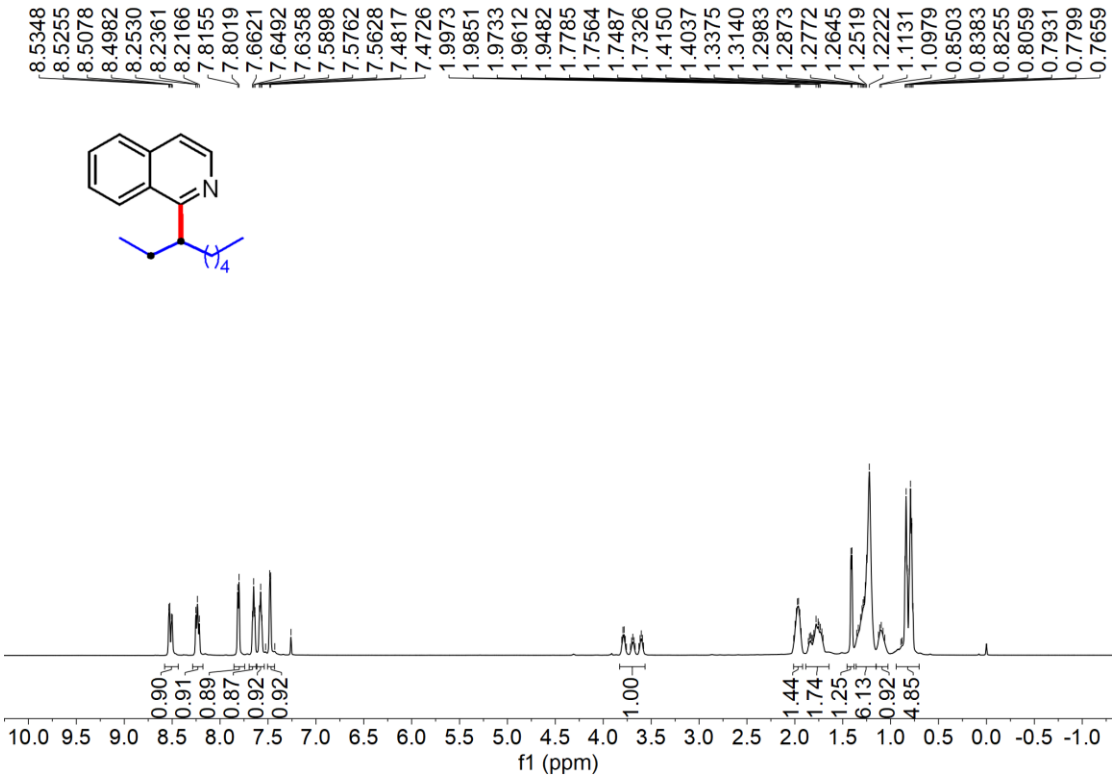
^{13}C NMR (101 MHz, $CDCl_3$) of **3b**



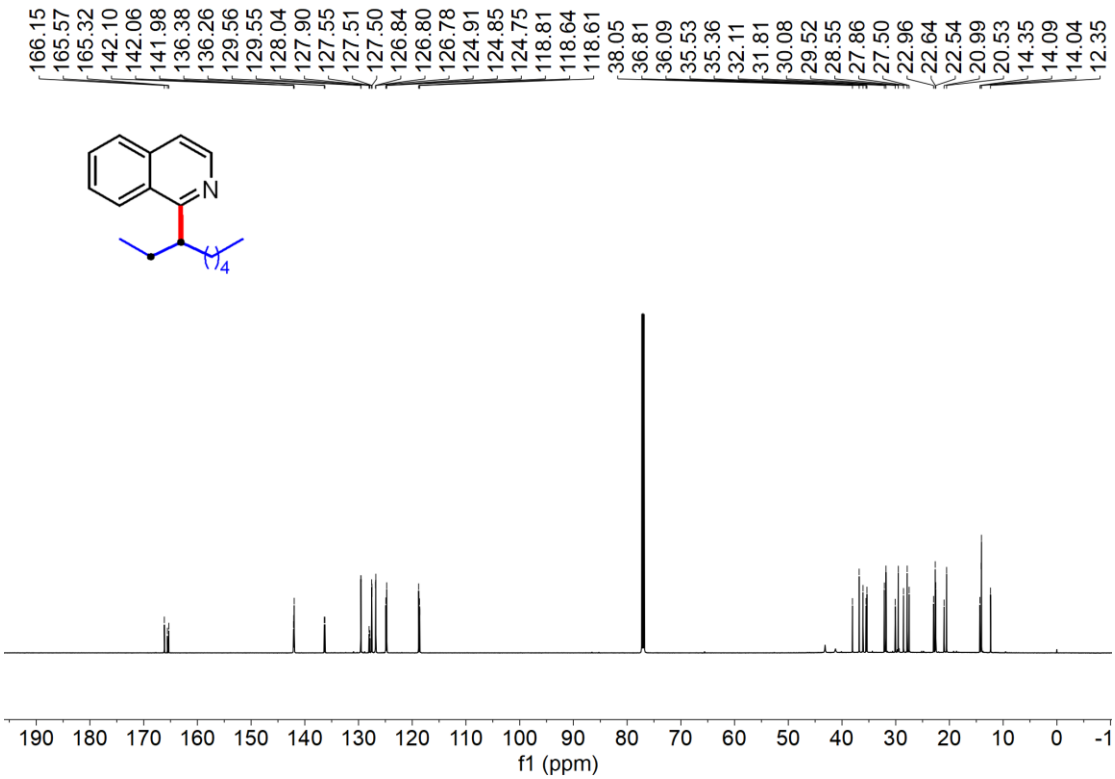
^{1}H NMR (600 MHz, $CDCl_3$) of **3c**



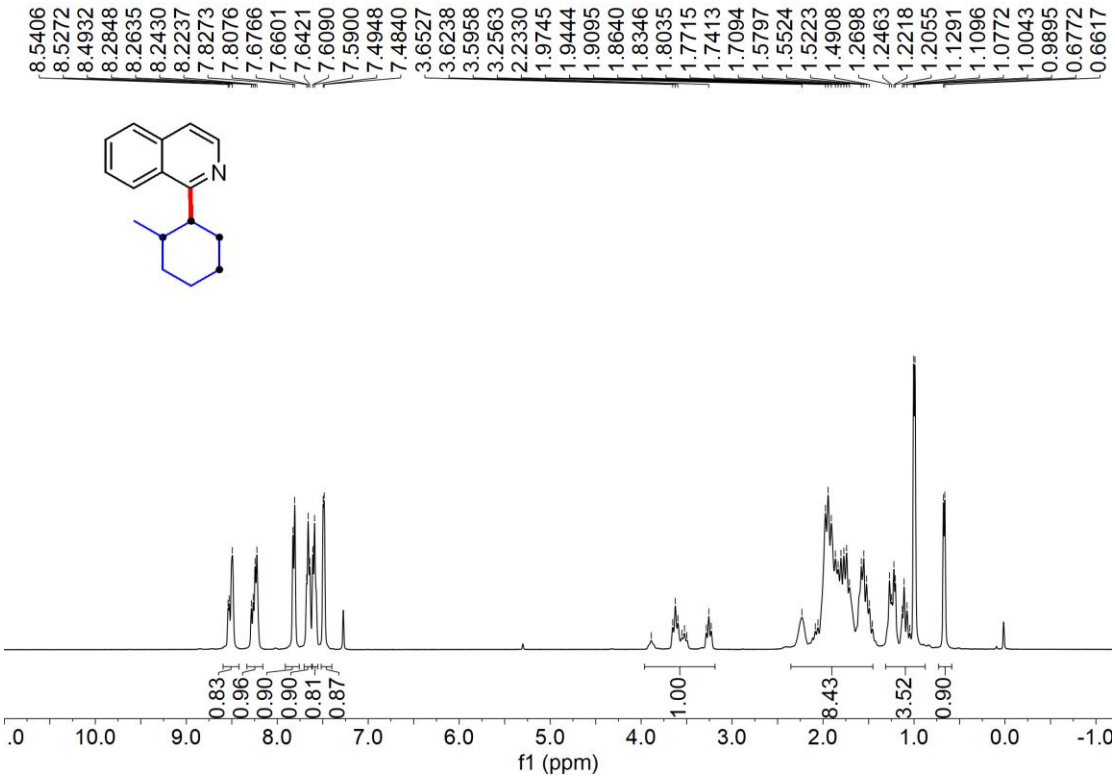
^{13}C NMR (151 MHz, $CDCl_3$) of **3c**



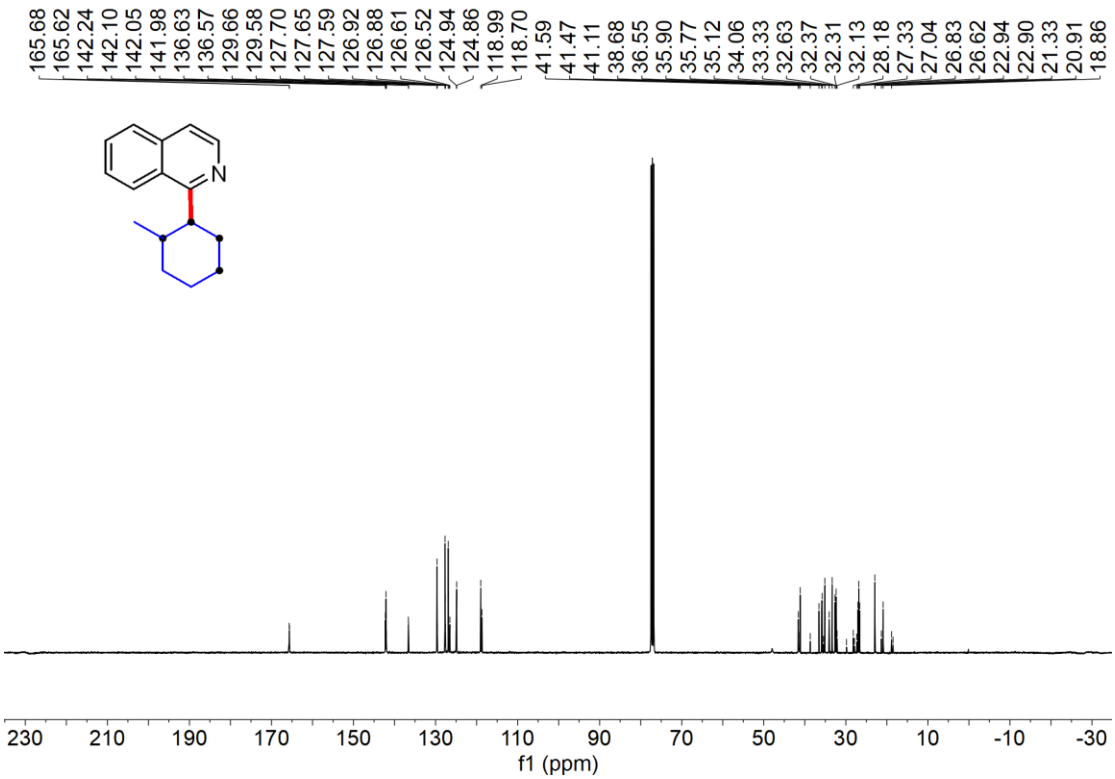
^{1}H NMR (600 MHz, $CDCl_3$) of **3d**



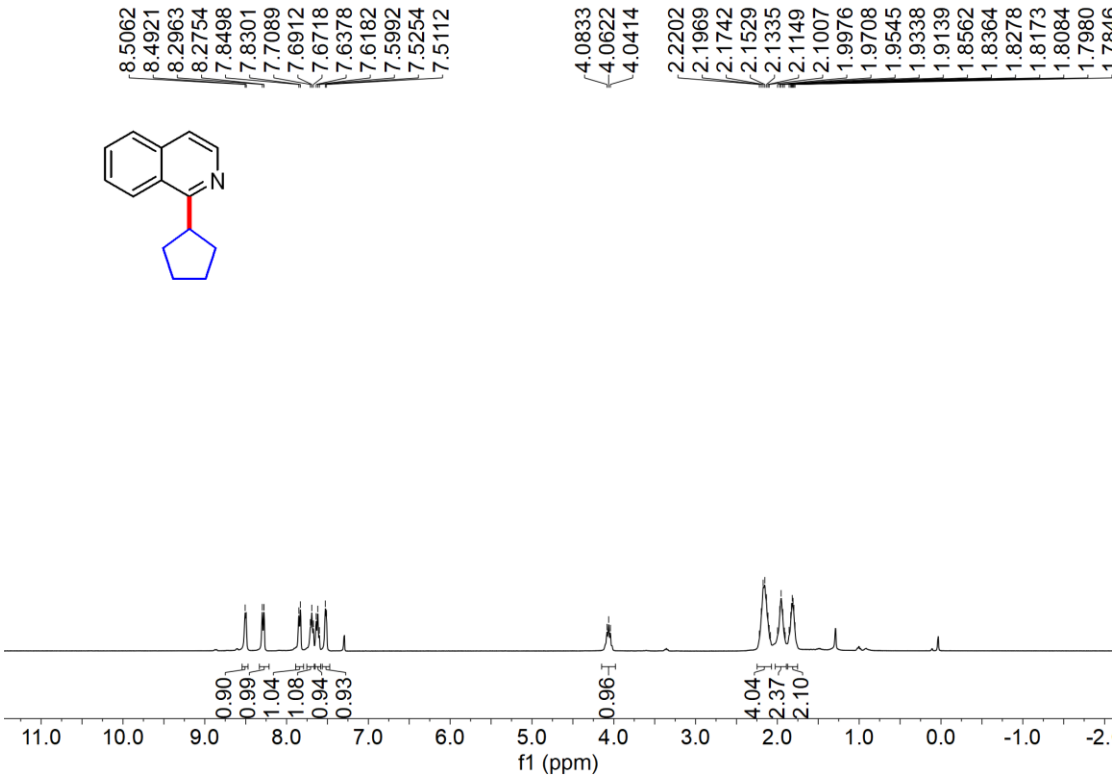
^{13}C NMR (151 MHz, $CDCl_3$) of **3d**



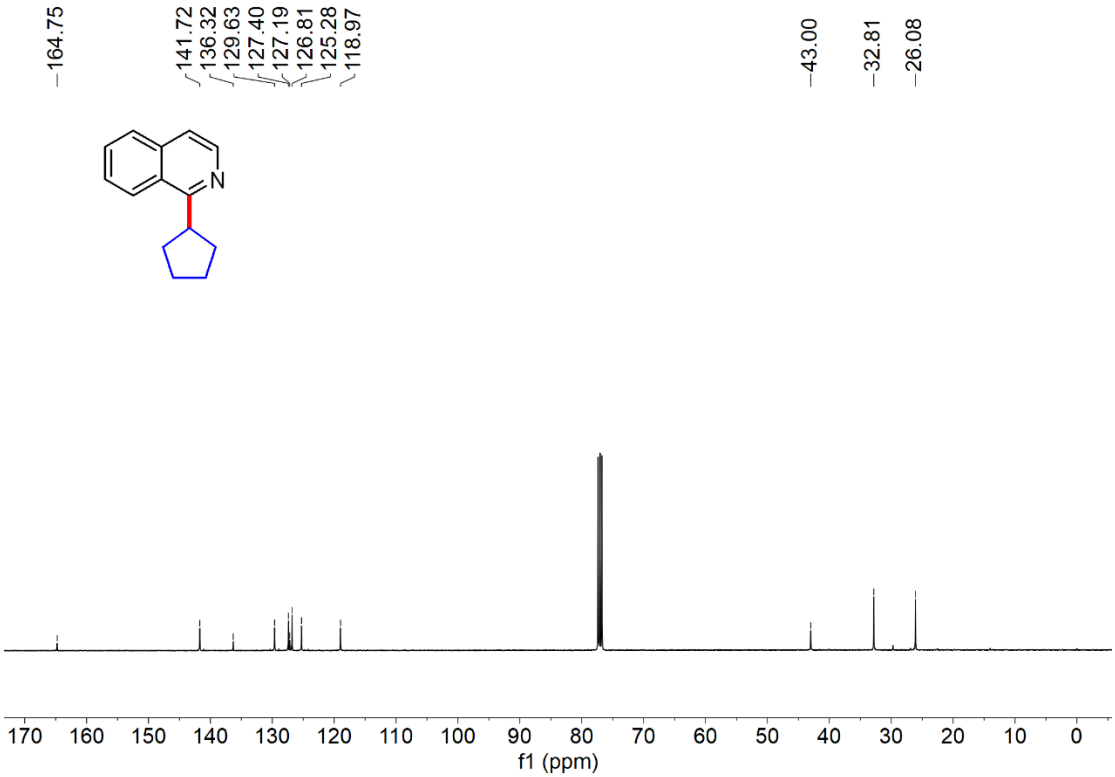
^{1}H NMR (400 MHz, $CDCl_3$) of **3e**



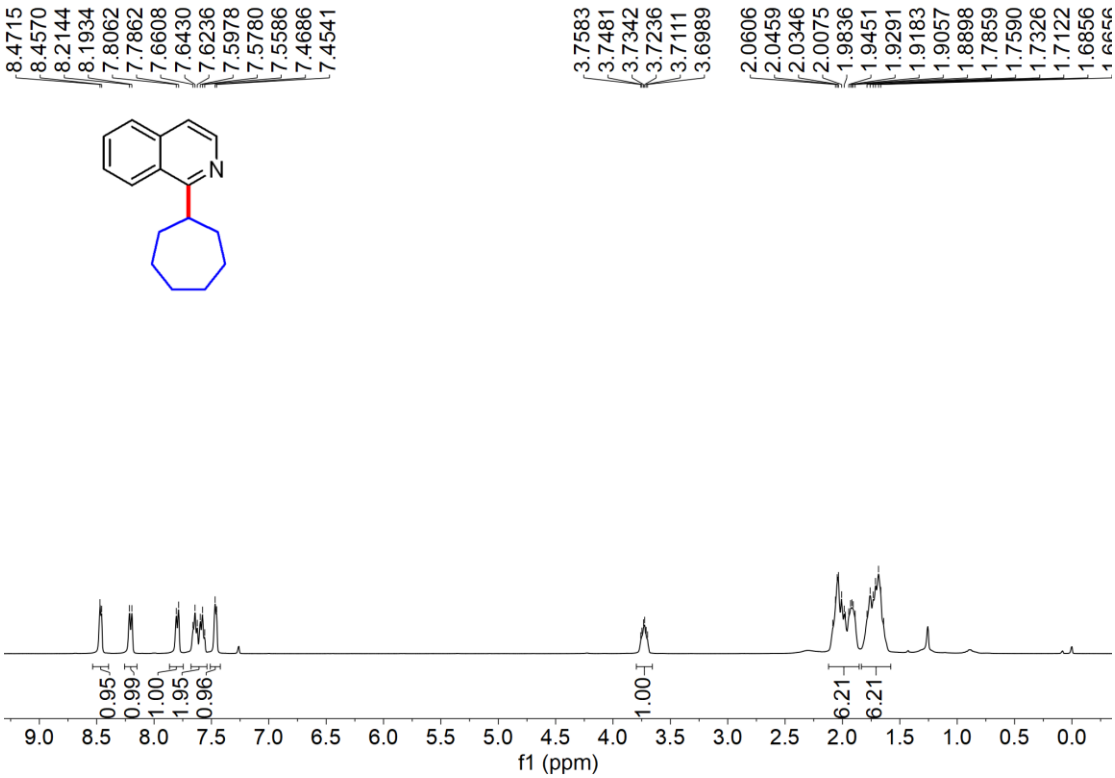
^{13}C NMR (101 MHz, $CDCl_3$) of **3e**



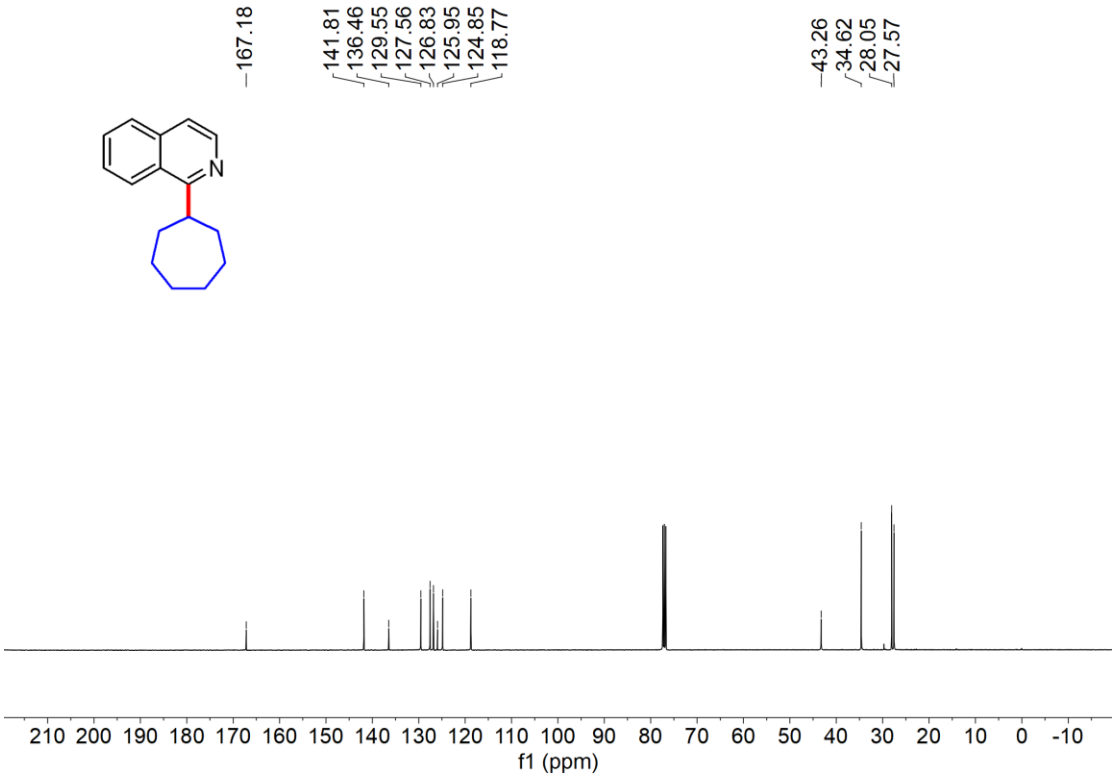
^{1}H NMR (400 MHz, $CDCl_3$) of **3f**



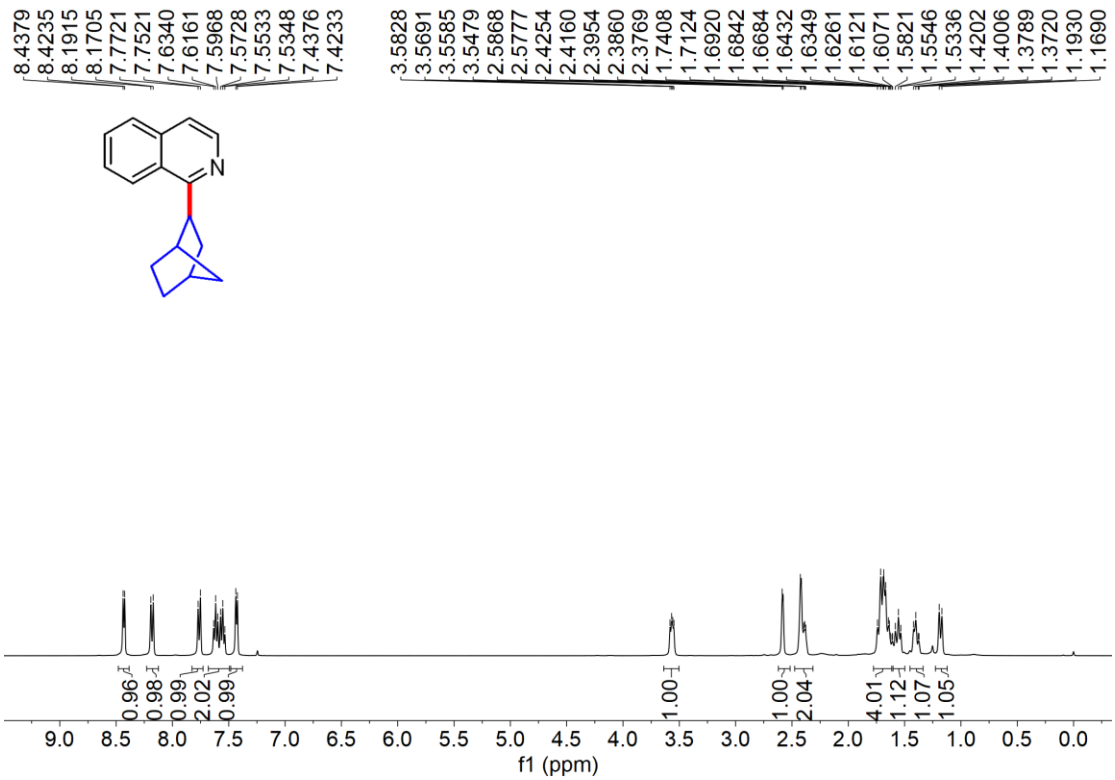
^{13}C NMR (101 MHz, $CDCl_3$) of **3f**



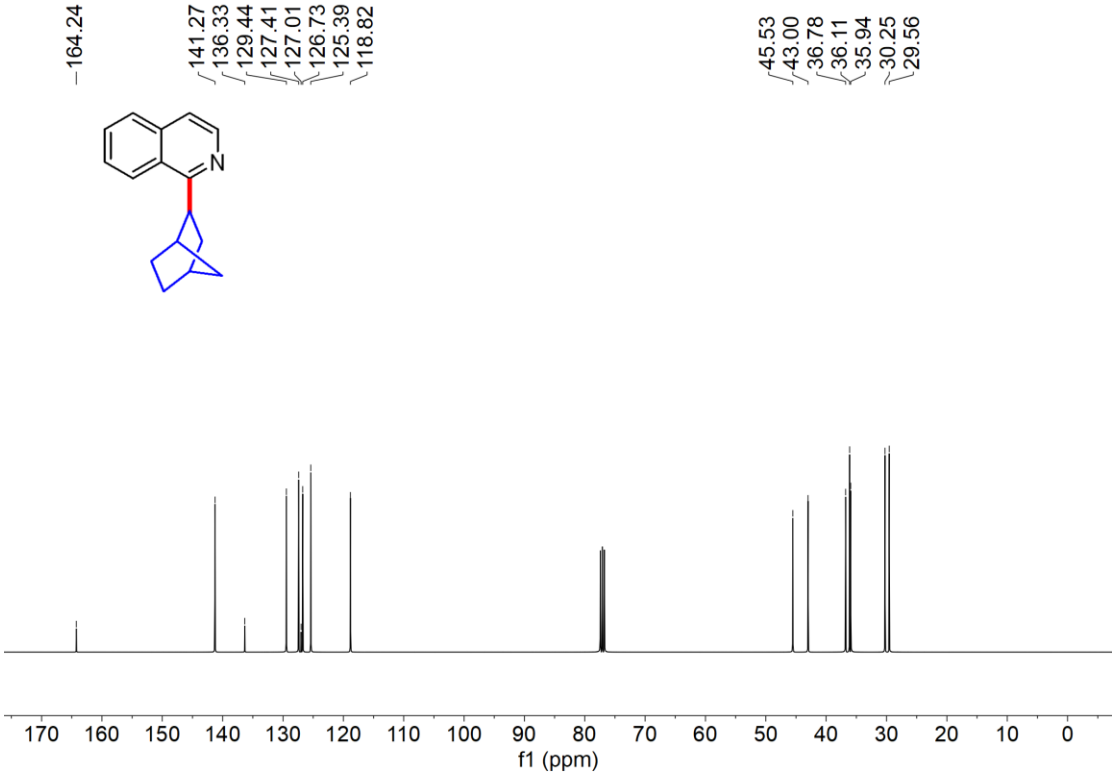
^{1}H NMR (400 MHz, $CDCl_3$) of **3g**



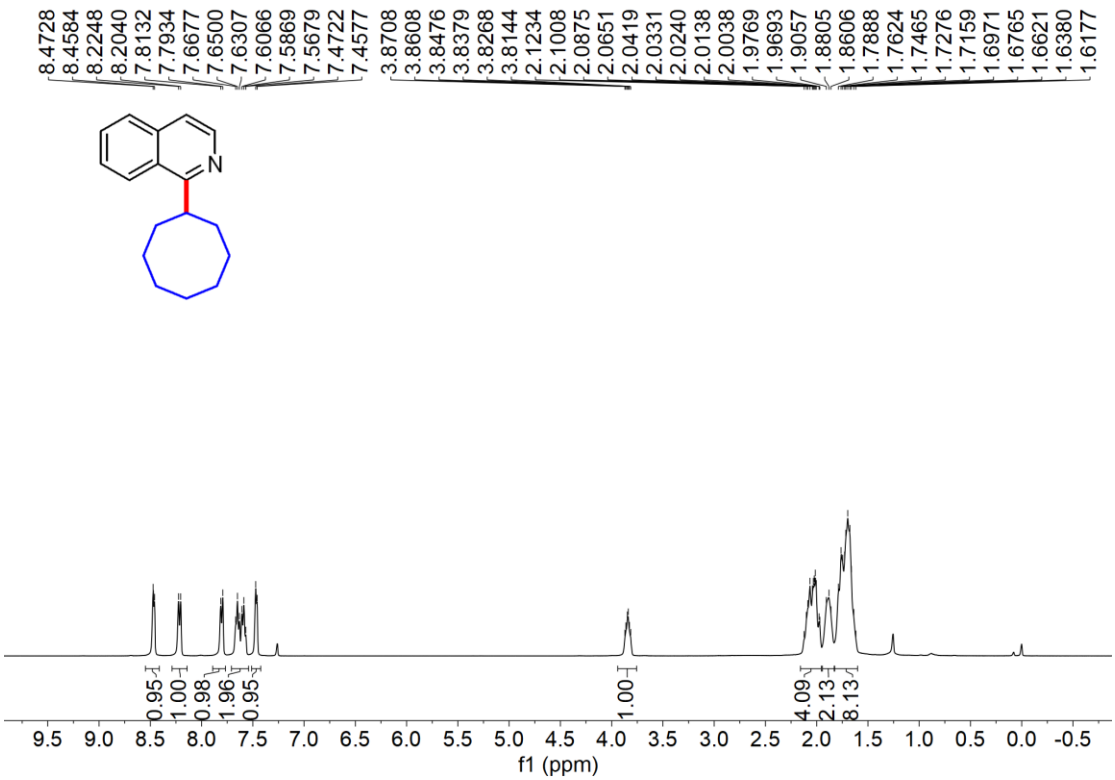
^{13}C NMR (101 MHz, $CDCl_3$) of **3g**



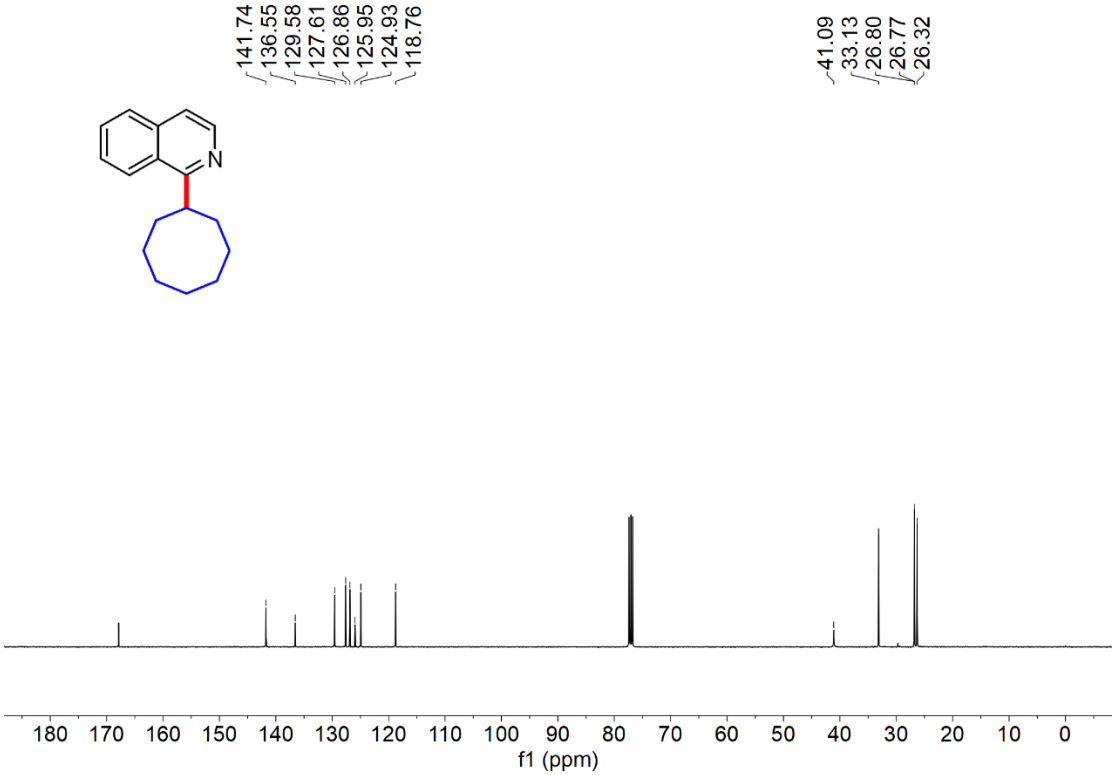
^{1}H NMR (400 MHz, $CDCl_3$) of **3h**



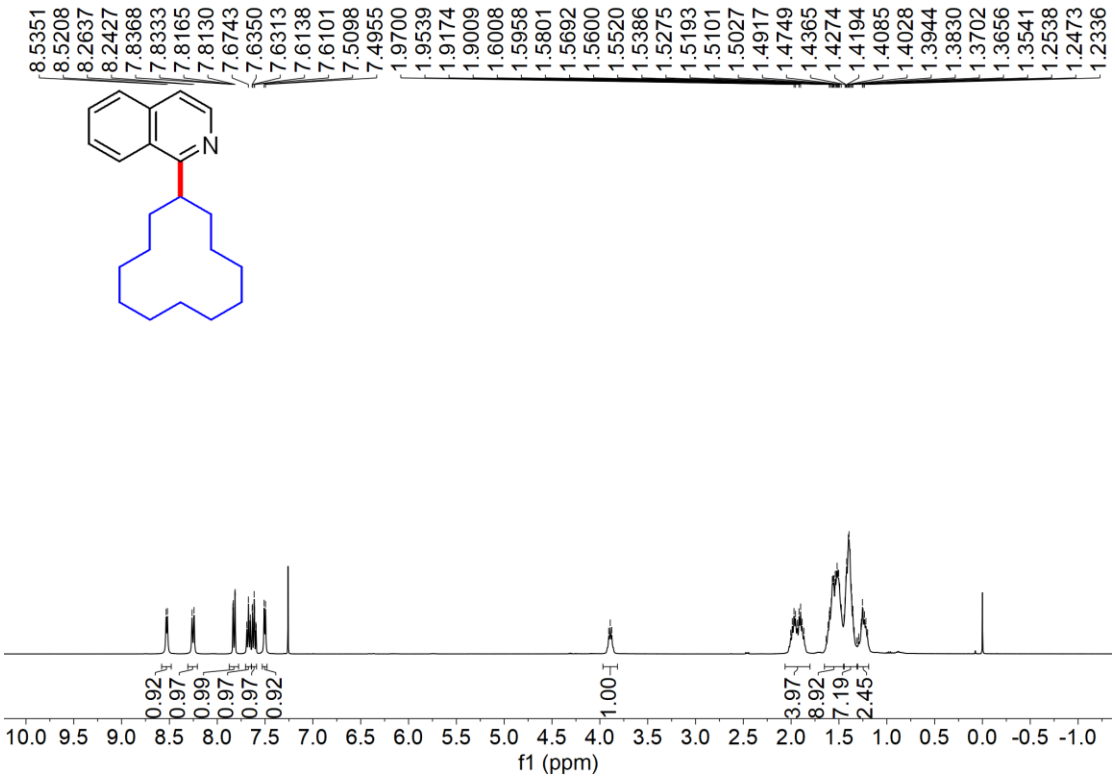
^{13}C NMR (101 MHz, $CDCl_3$) of **3h**



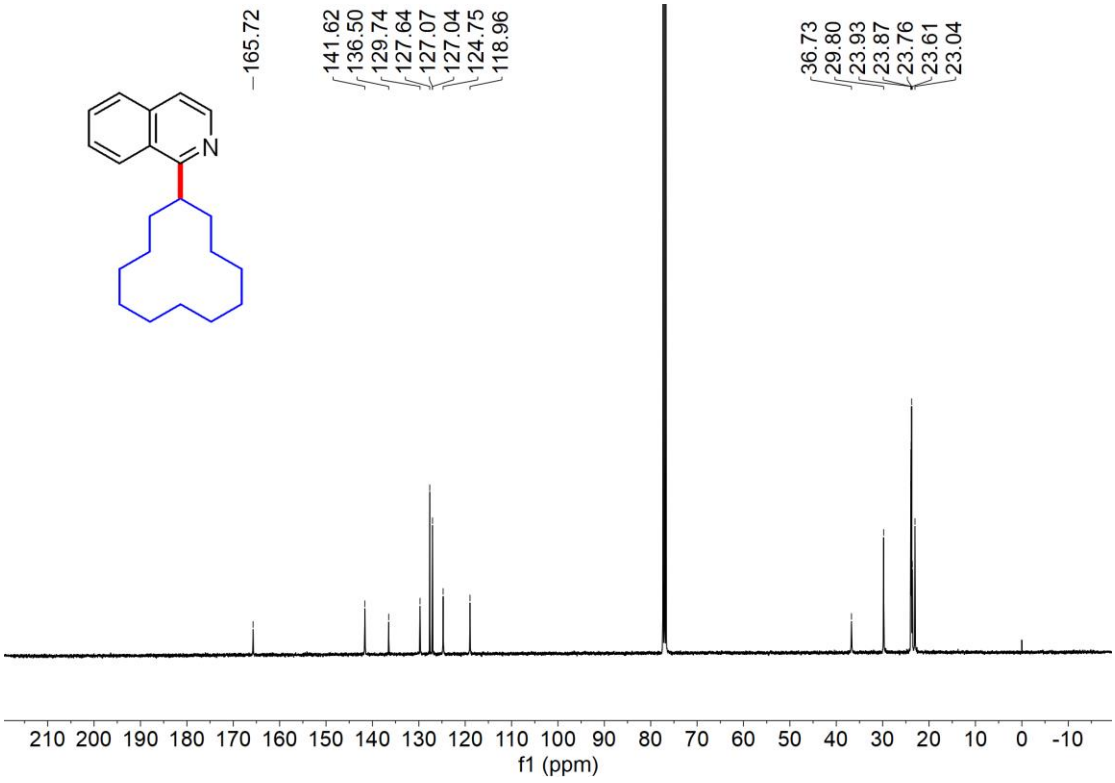
^{1}H NMR (400 MHz, $CDCl_3$) of **3i**



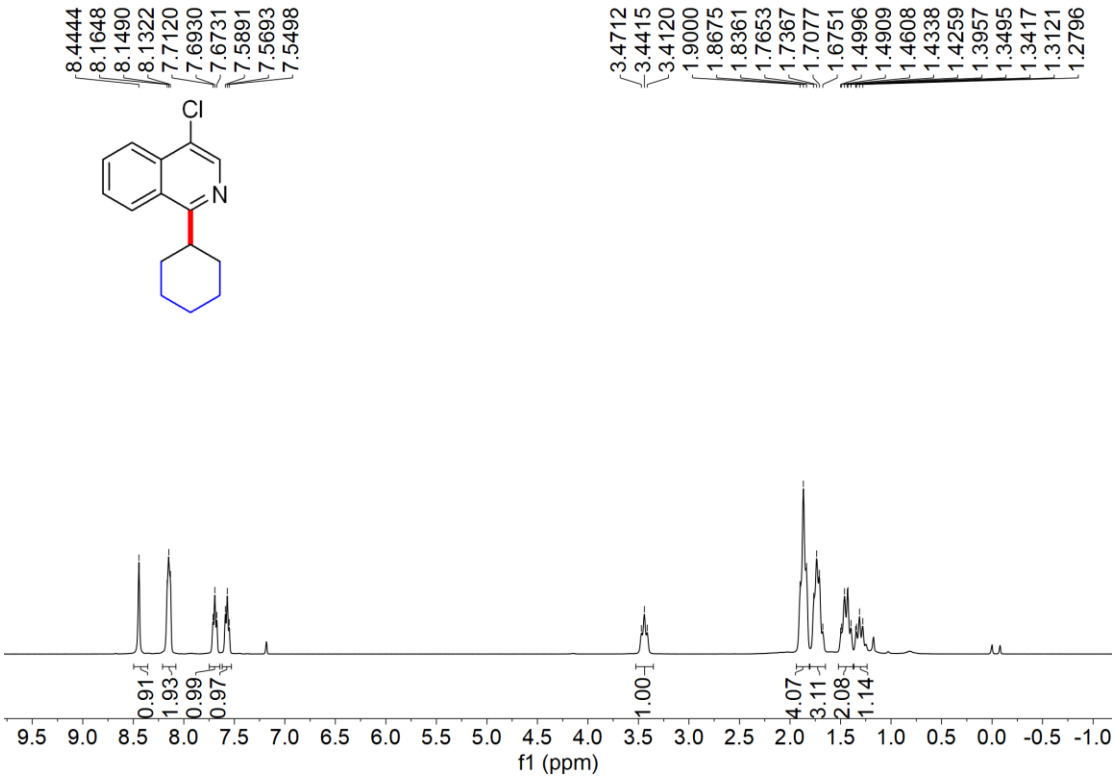
^{13}C NMR (101 MHz, $CDCl_3$) of **3i**



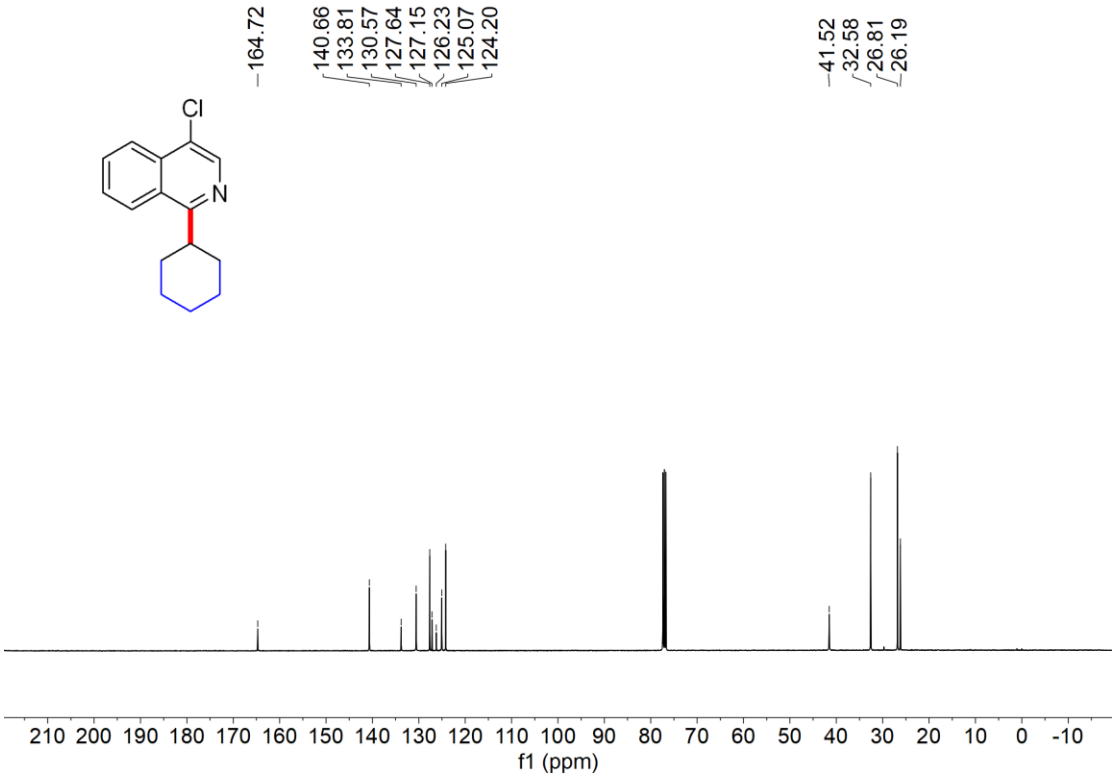
^{1}H NMR (400 MHz, $CDCl_3$) of **3j**



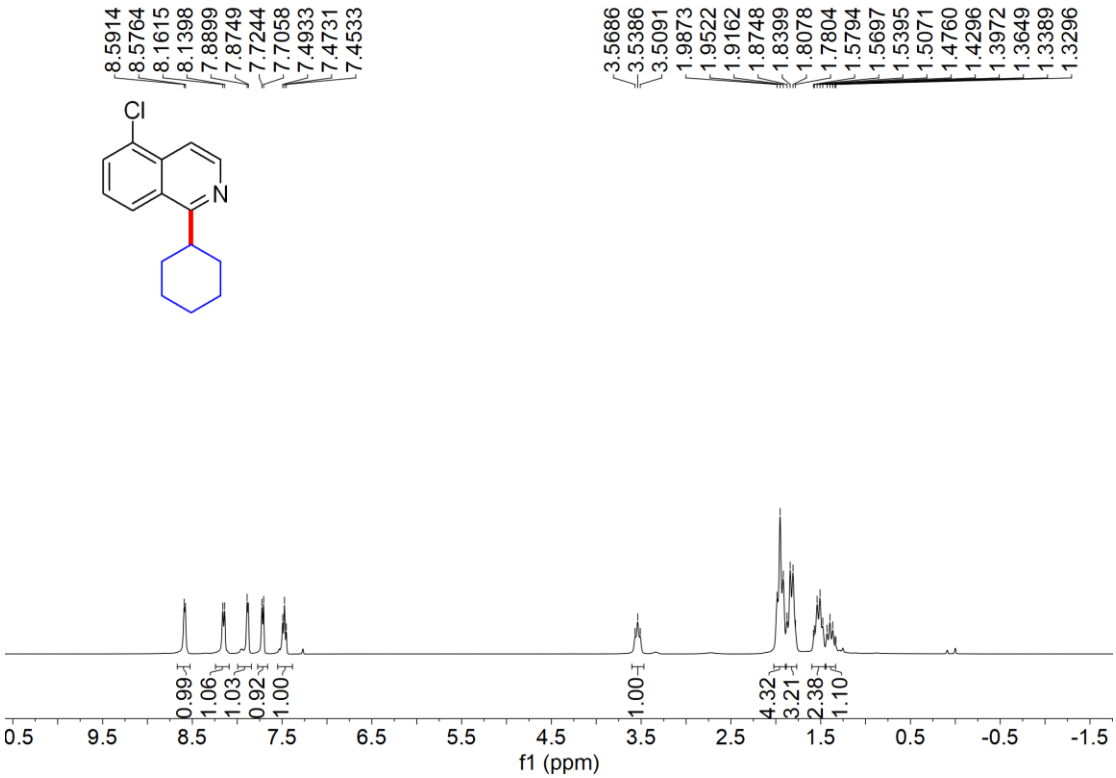
^{13}C NMR (101 MHz, $CDCl_3$) of **3j**



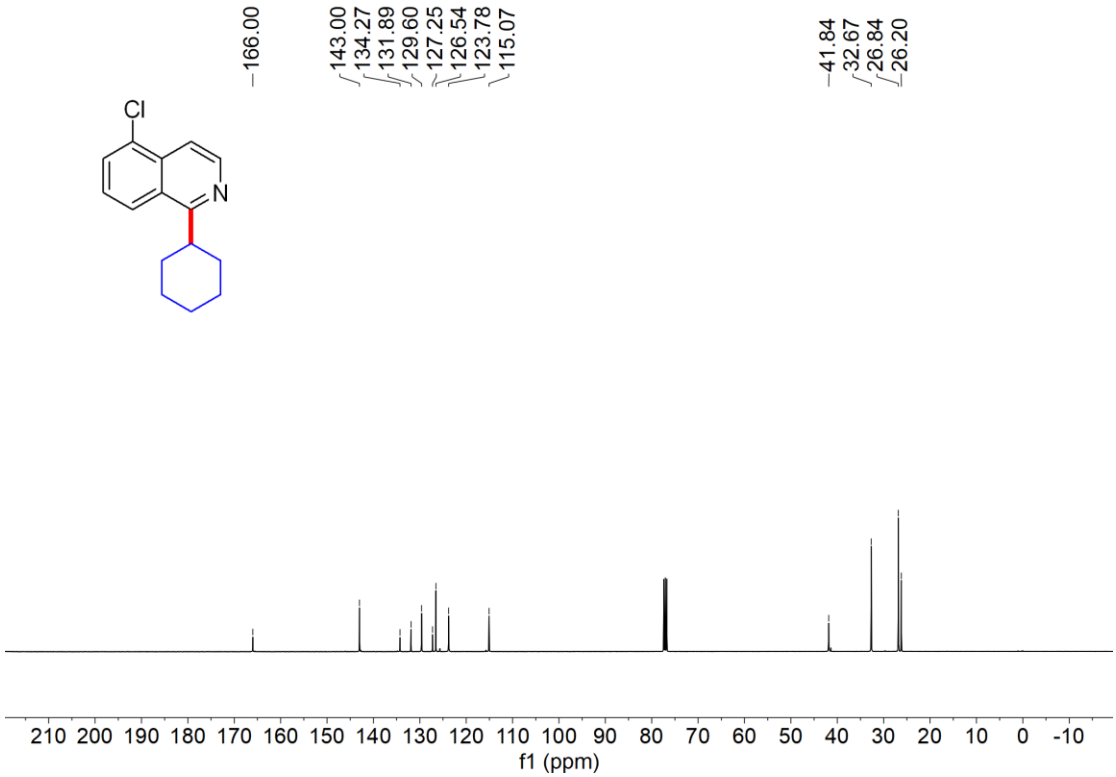
^{1}H NMR (400 MHz, $CDCl_3$) of **3k**



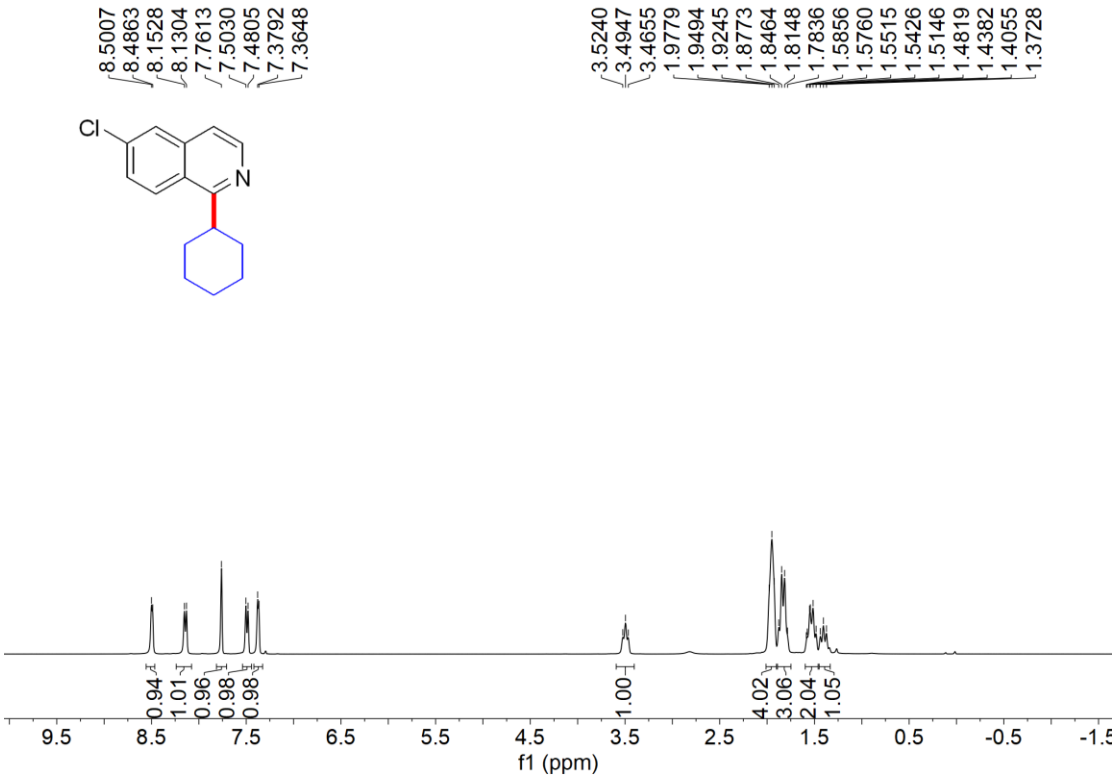
^{13}C NMR (101 MHz, $CDCl_3$) of **3k**



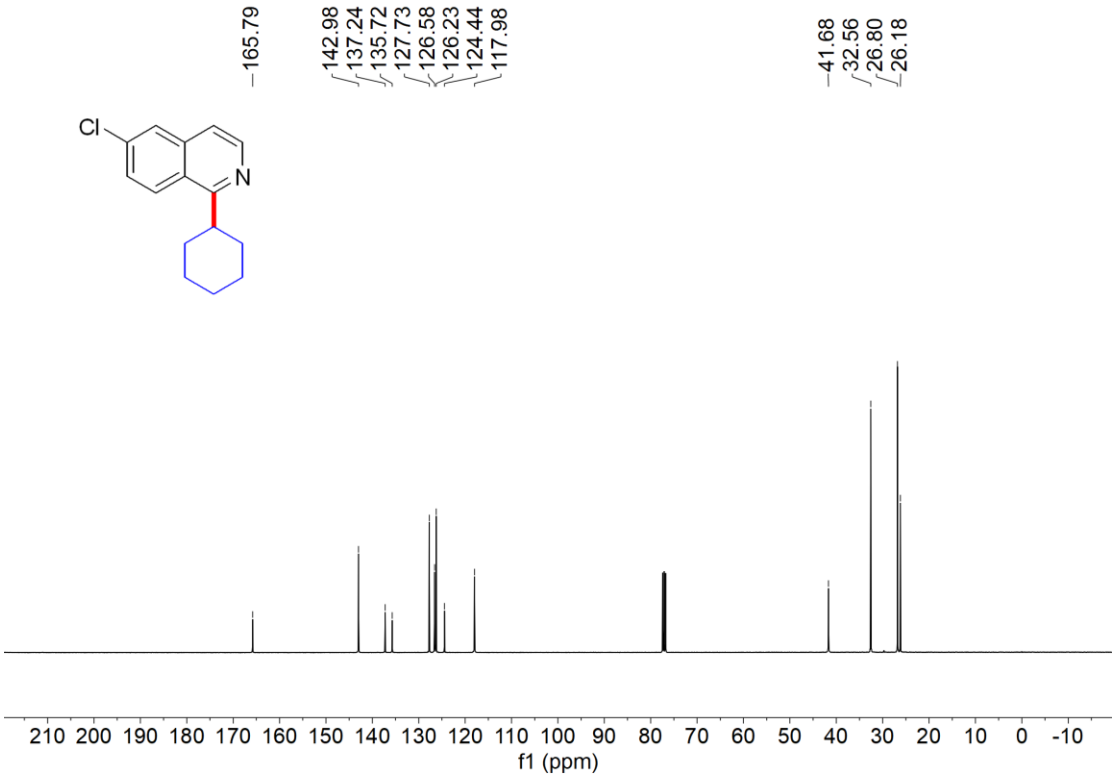
^{1}H NMR (400 MHz, $CDCl_3$) of **3l**



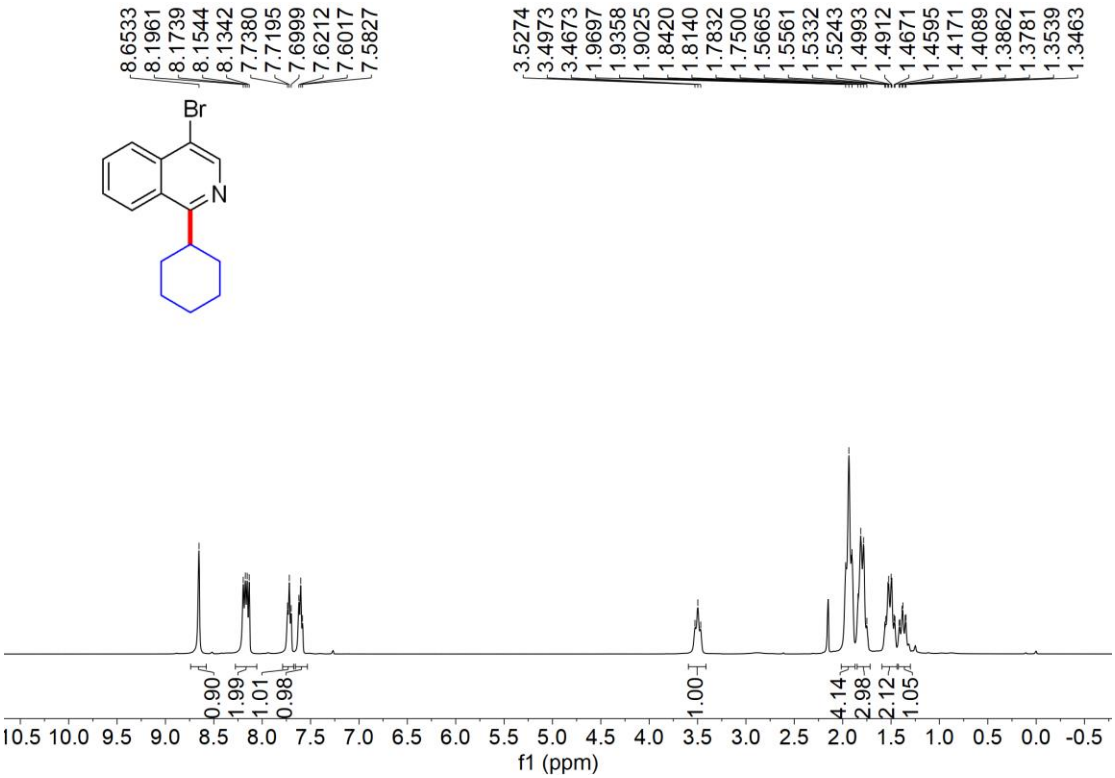
^{13}C NMR (101 MHz, $CDCl_3$) of **3l**



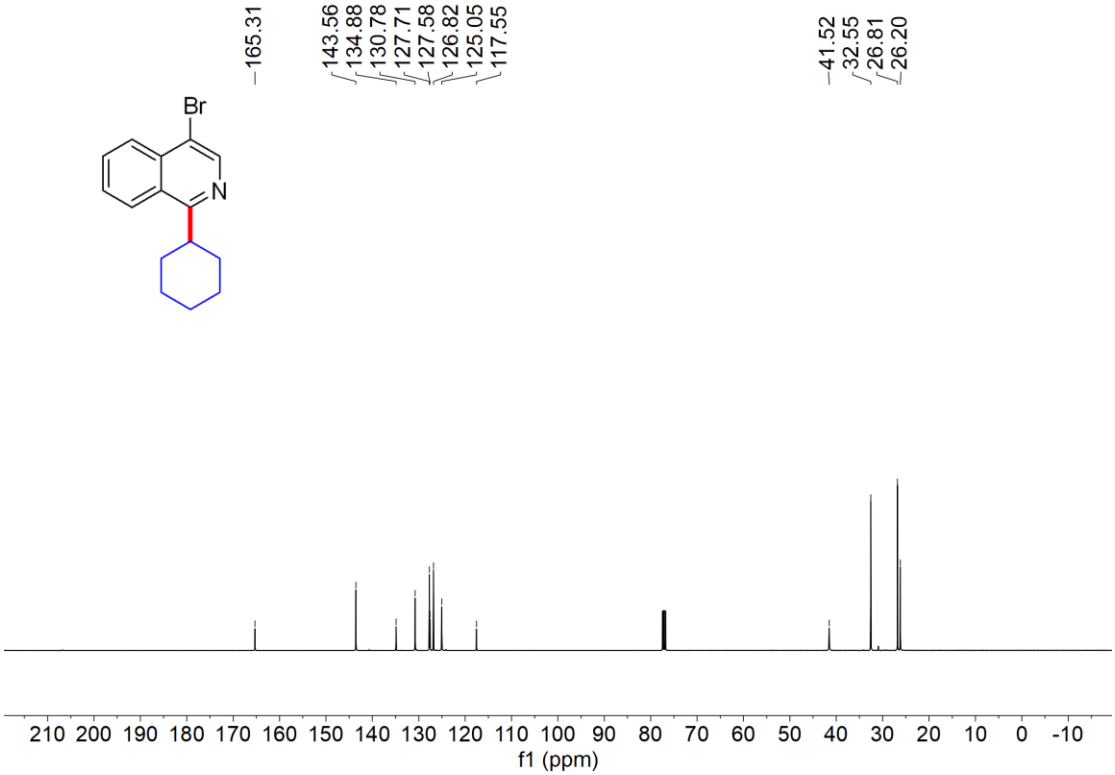
^{1}H NMR (400 MHz, $CDCl_3$) of **3m**



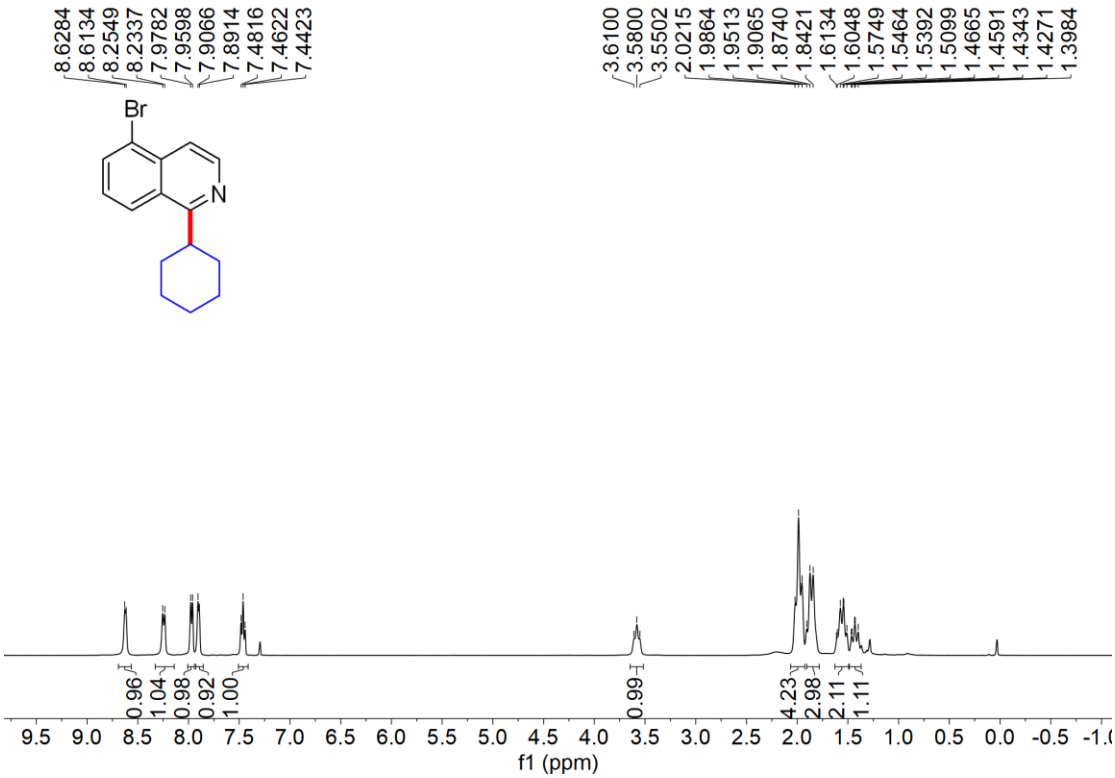
^{13}C NMR (101 MHz, $CDCl_3$) of **3m**



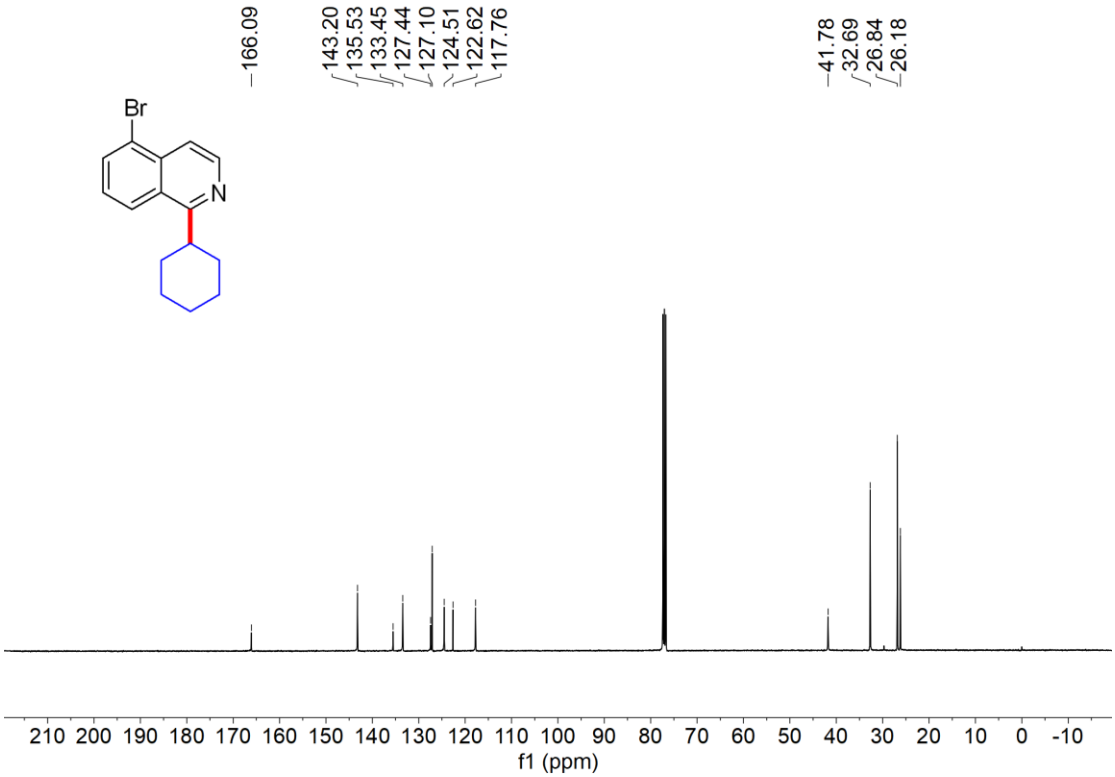
^{1}H NMR (400 MHz, $CDCl_3$) of **3n**



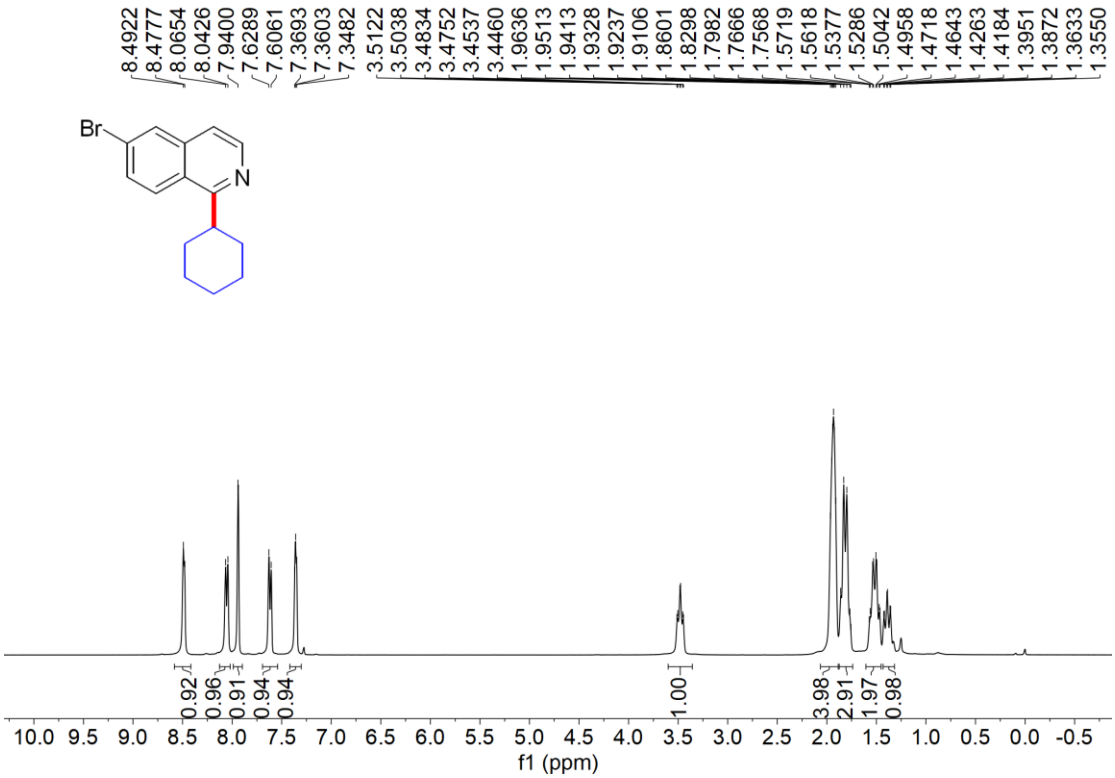
^{13}C NMR (101 MHz, $CDCl_3$) of **3n**



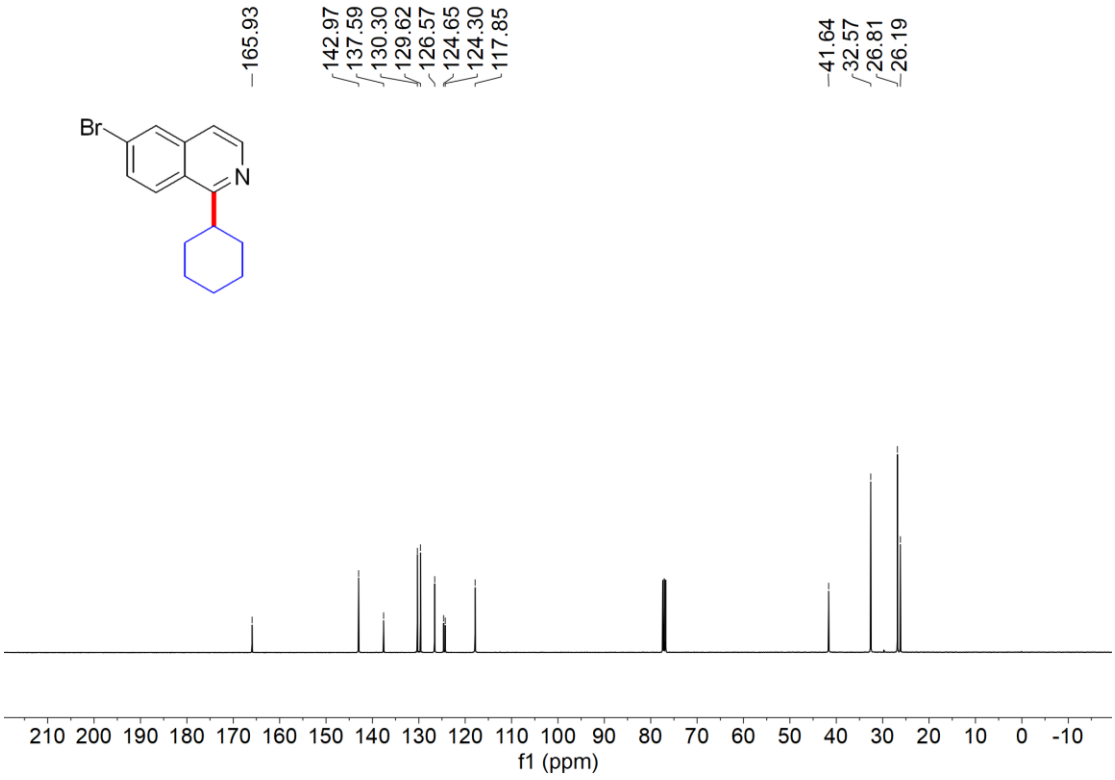
^{1}H NMR (400 MHz, $CDCl_3$) of **3o**



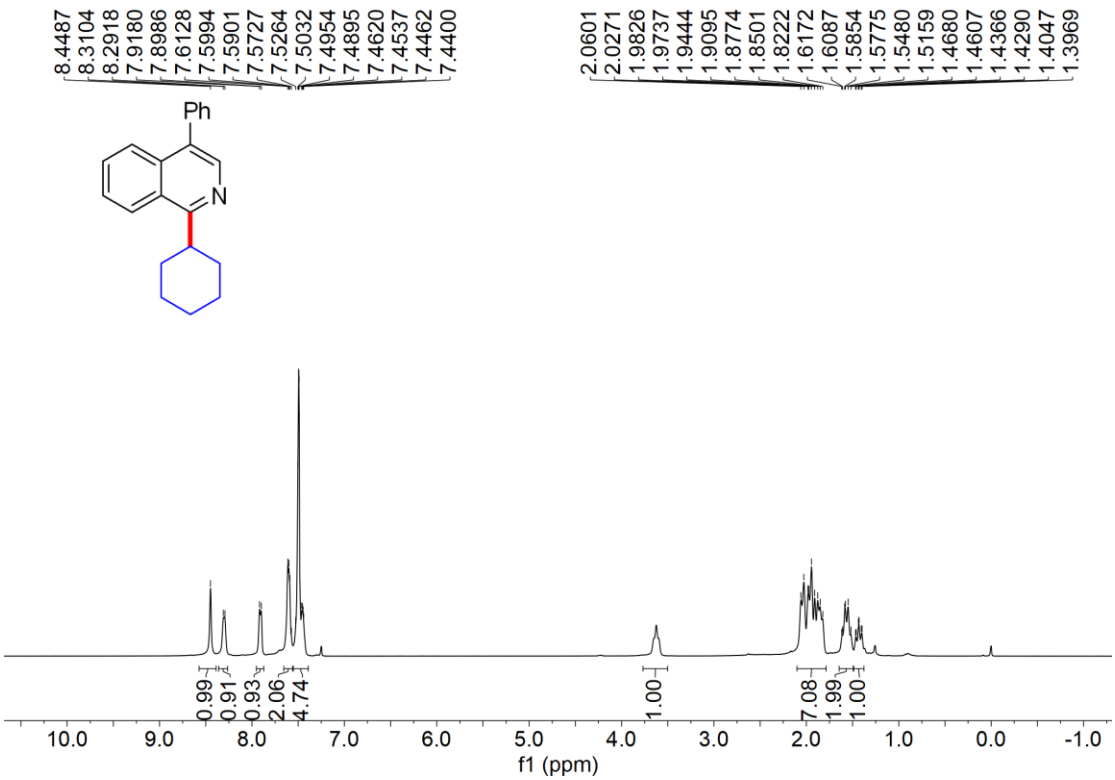
^{13}C NMR (101 MHz, $CDCl_3$) of **3o**



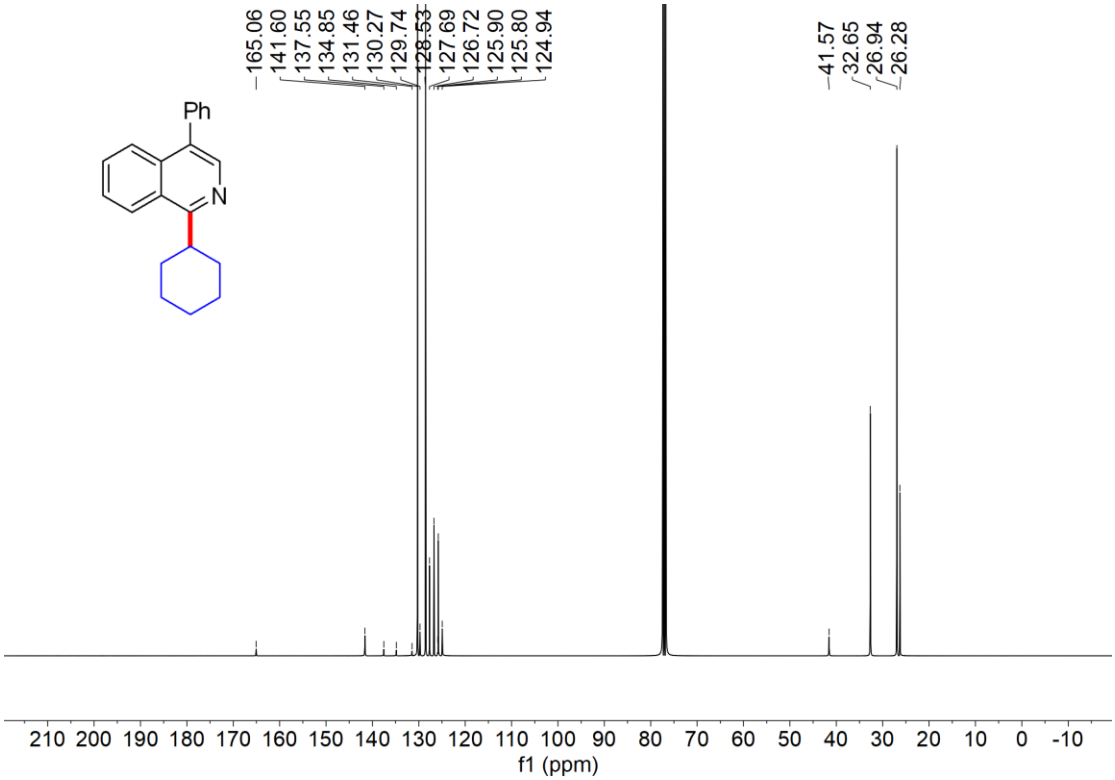
^{1}H NMR (400 MHz, $CDCl_3$) of **3p**



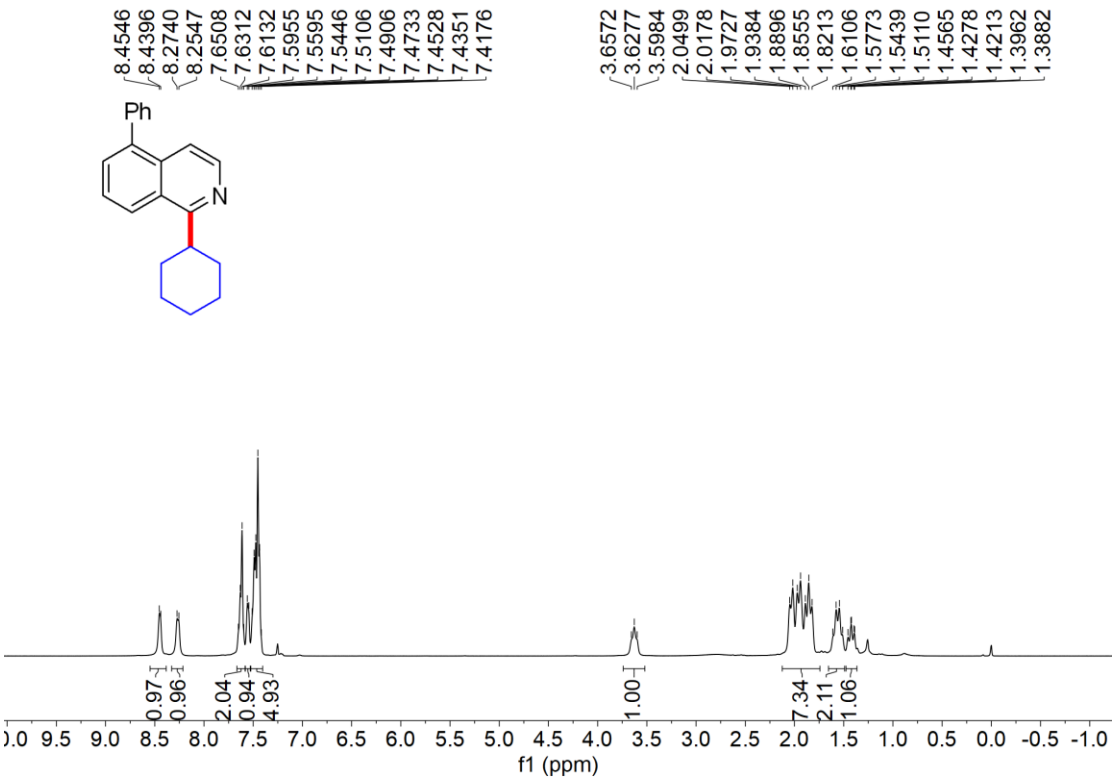
^{13}C NMR (101 MHz, $CDCl_3$) of **3p**



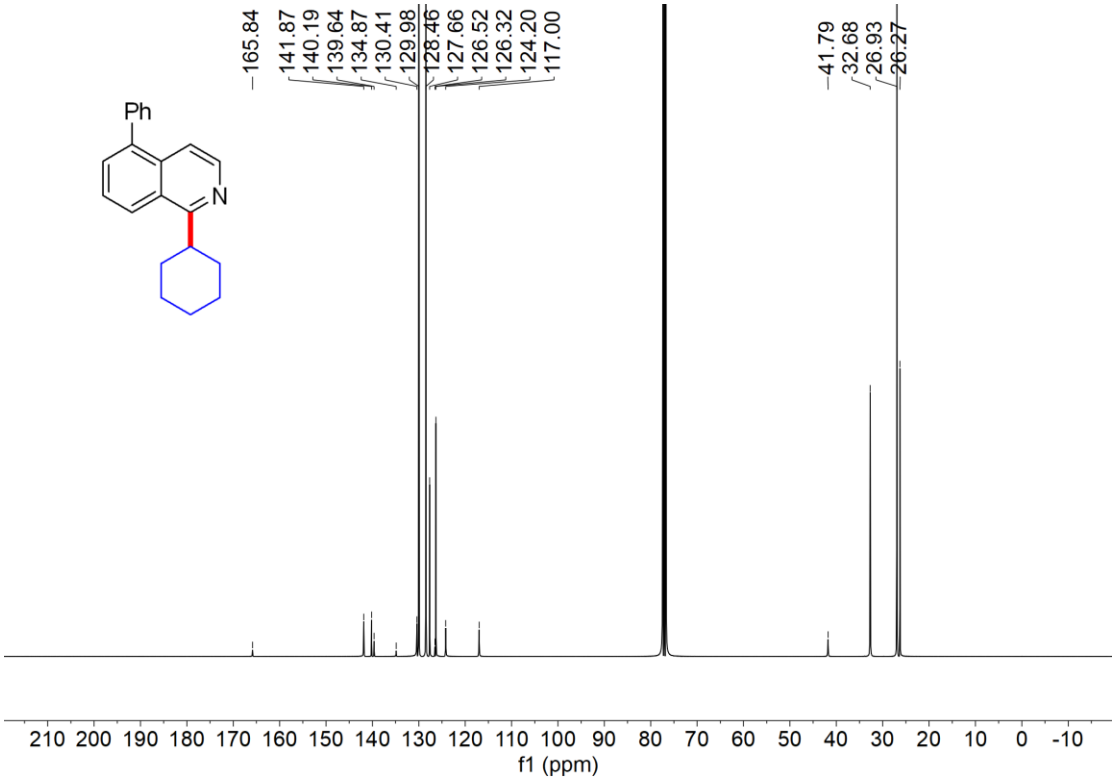
^{1}H NMR (400 MHz, $CDCl_3$) of **3q**



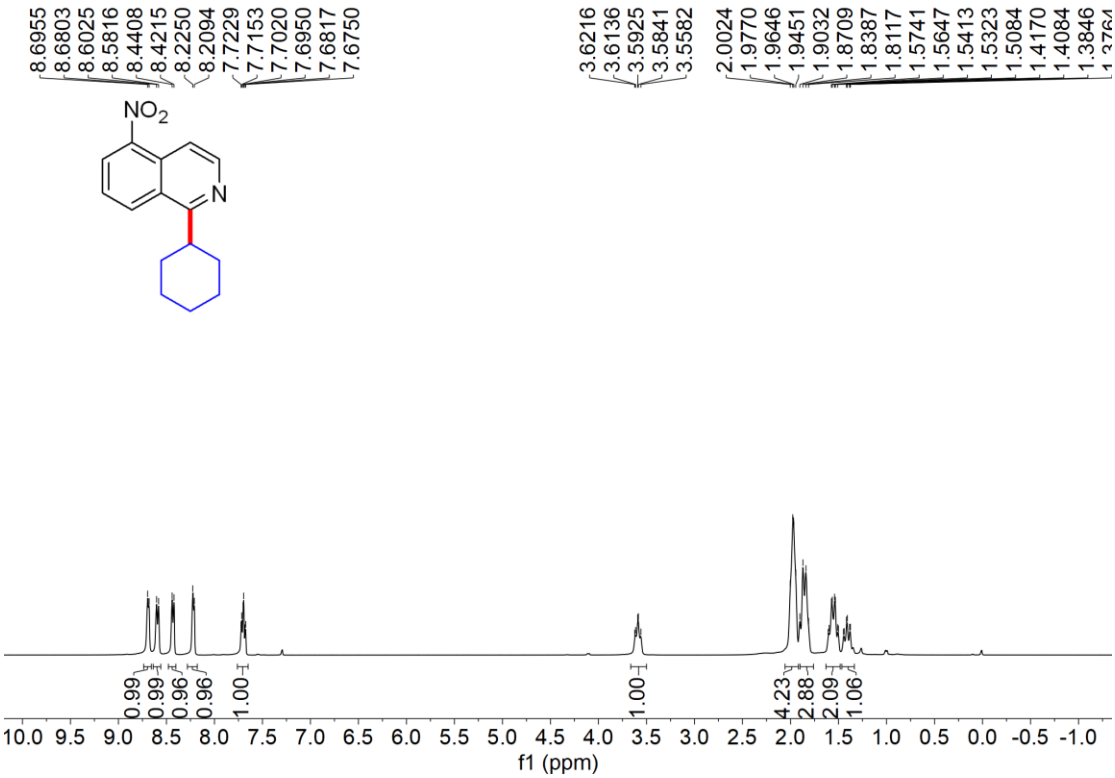
^{13}C NMR (101 MHz, $CDCl_3$) of **3q**



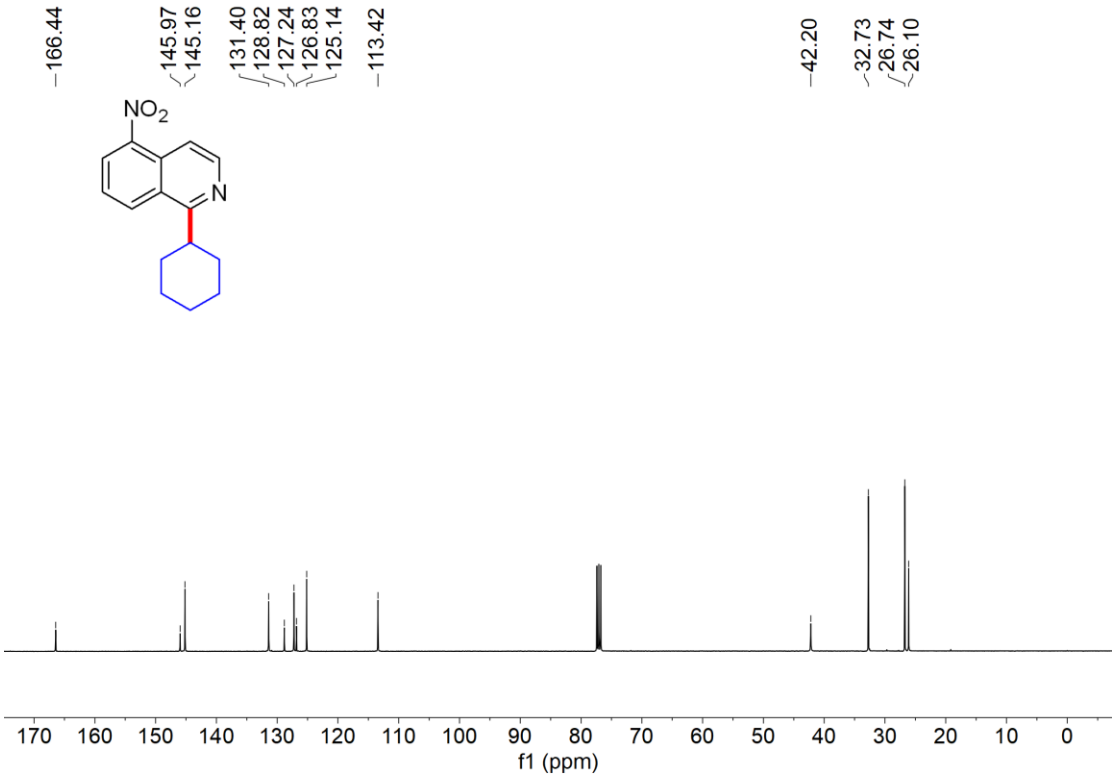
^{1}H NMR (400 MHz, $CDCl_3$) of **3r**



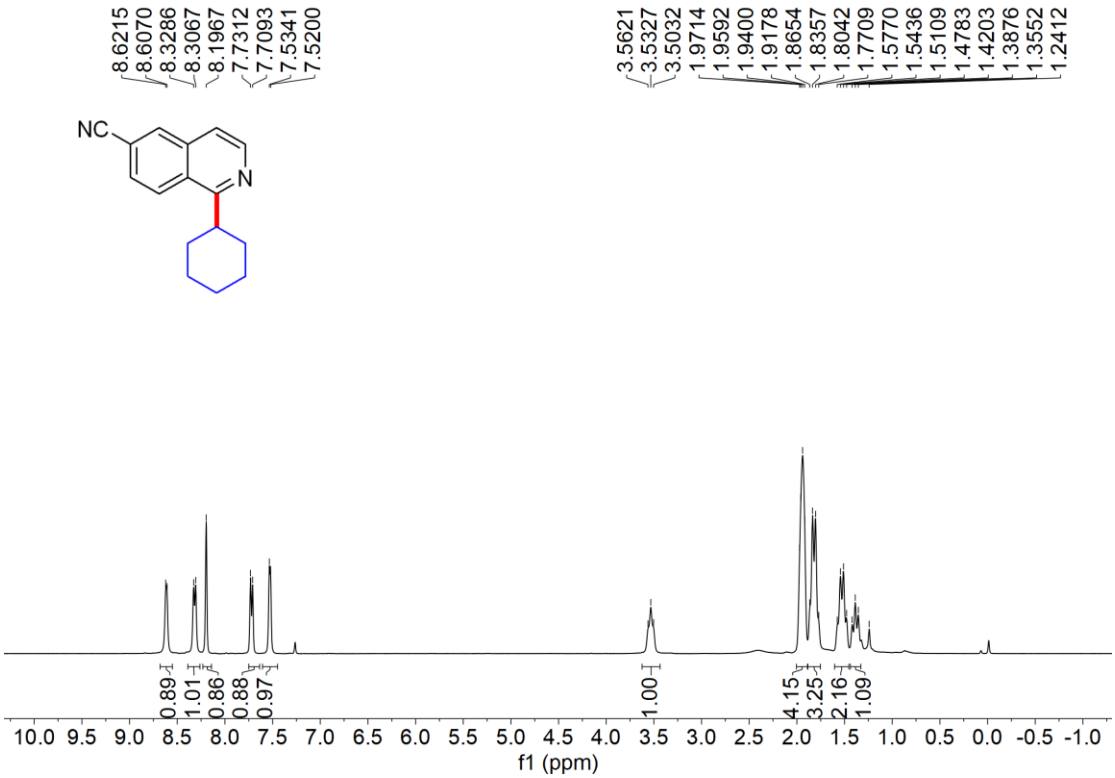
^{13}C NMR (101 MHz, $CDCl_3$) of **3r**



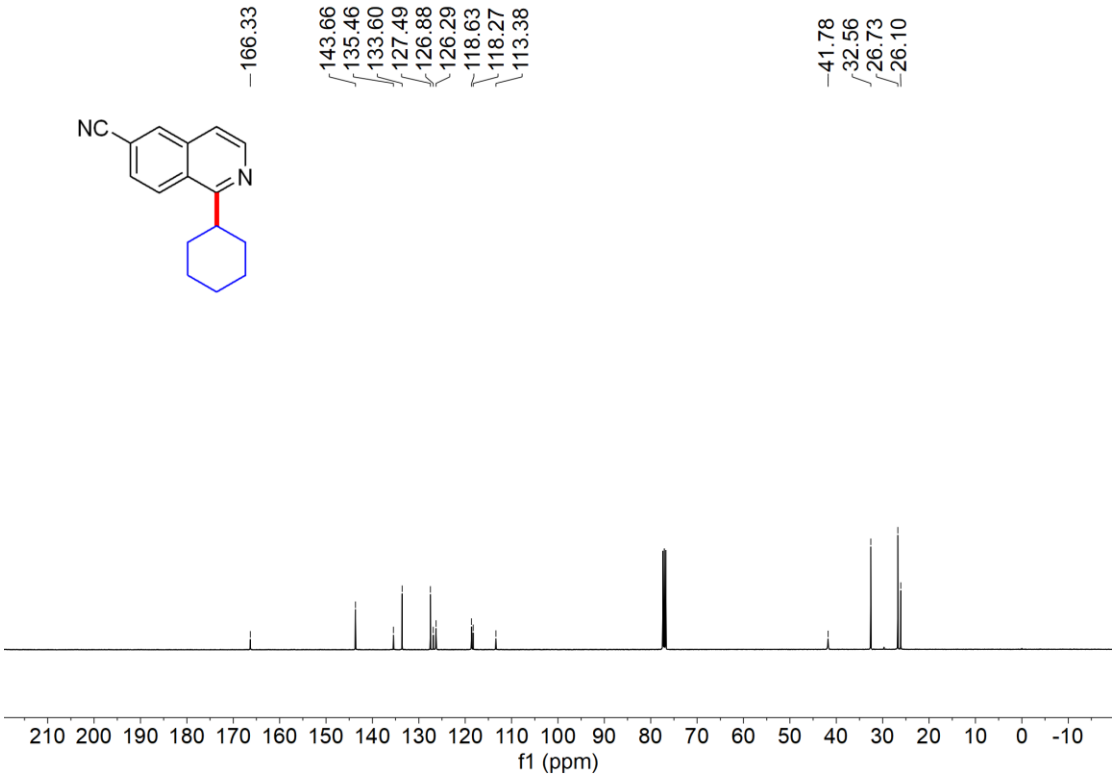
^{1}H NMR (400 MHz, $CDCl_3$) of **3s**



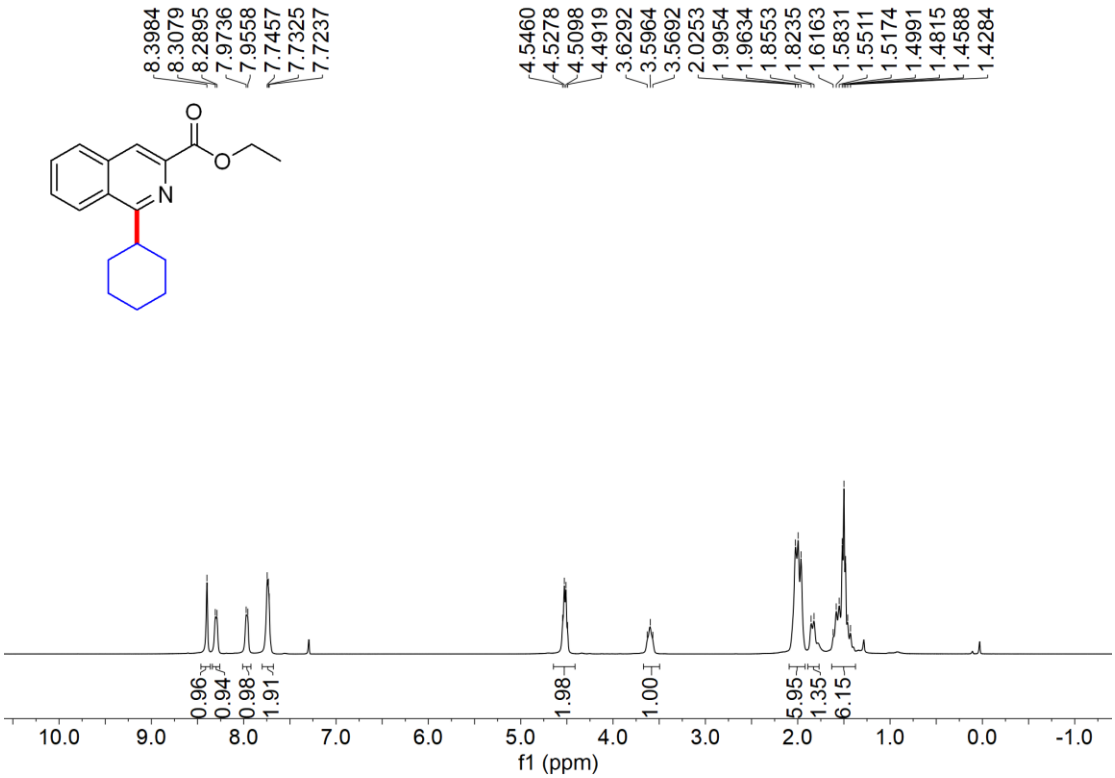
^{13}C NMR (101 MHz, $CDCl_3$) of **3s**



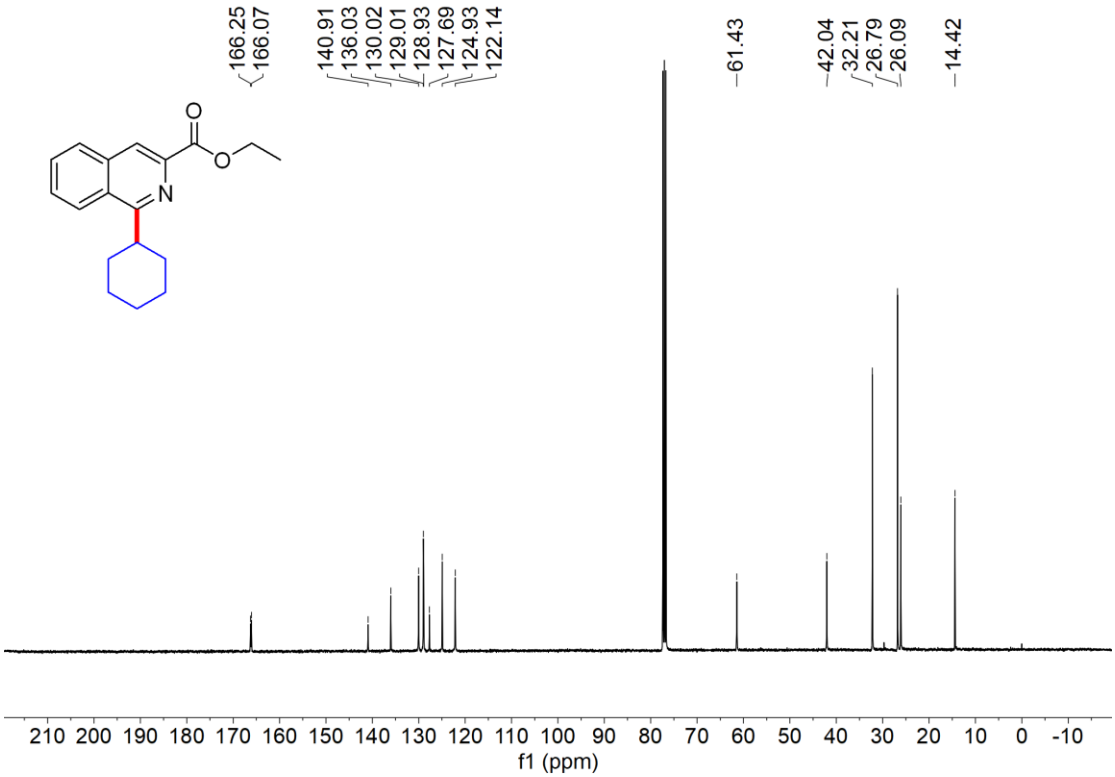
^{1}H NMR (400 MHz, $CDCl_3$) of **3t**



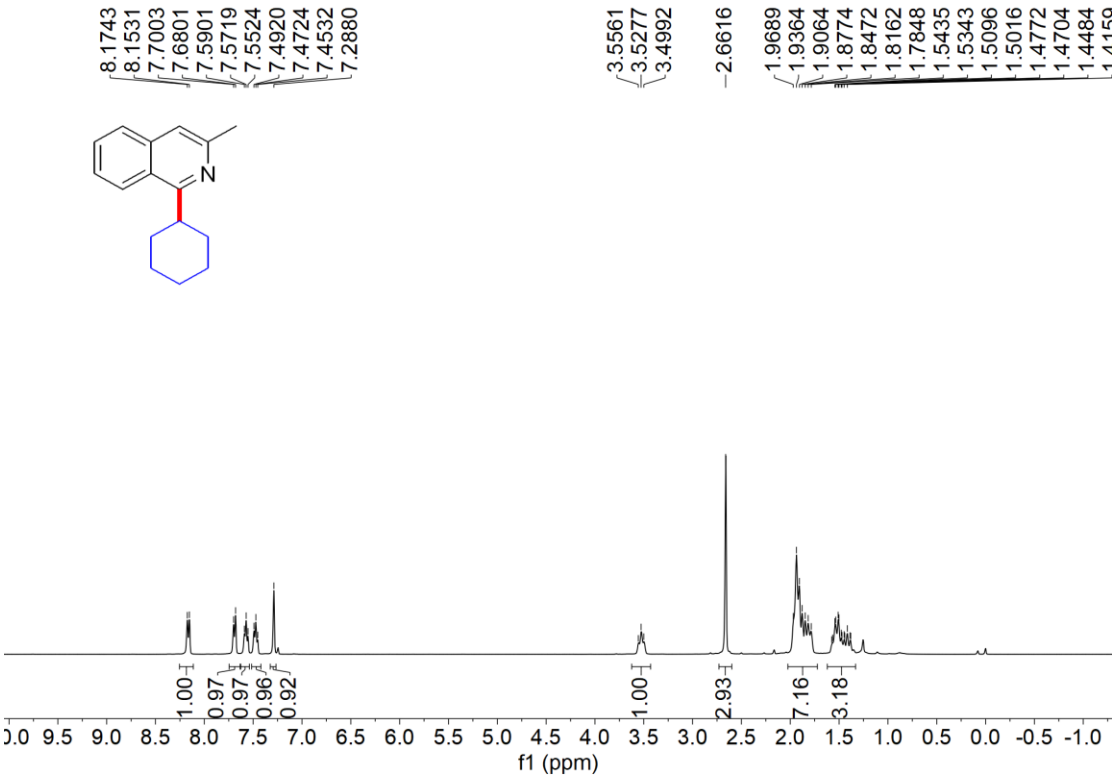
^{13}C NMR (101 MHz, $CDCl_3$) of **3t**



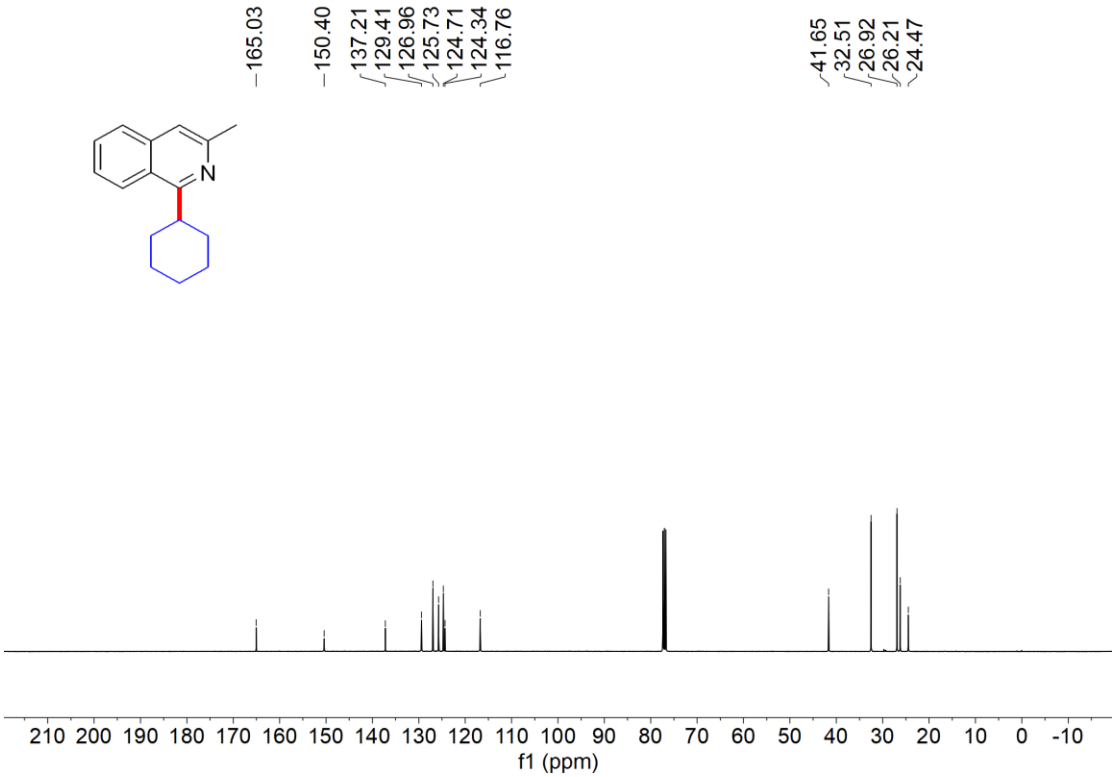
^{1}H NMR (400 MHz, $CDCl_3$) of **3u**



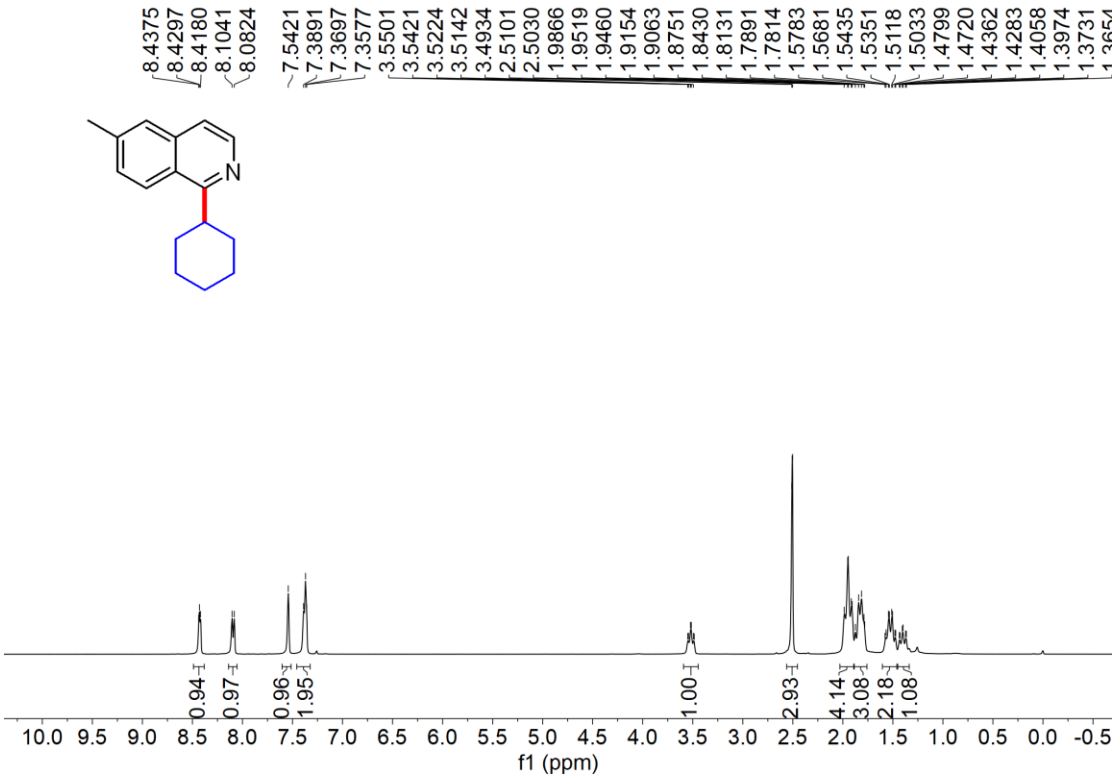
^{13}C NMR (101 MHz, $CDCl_3$) of **3u**



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



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



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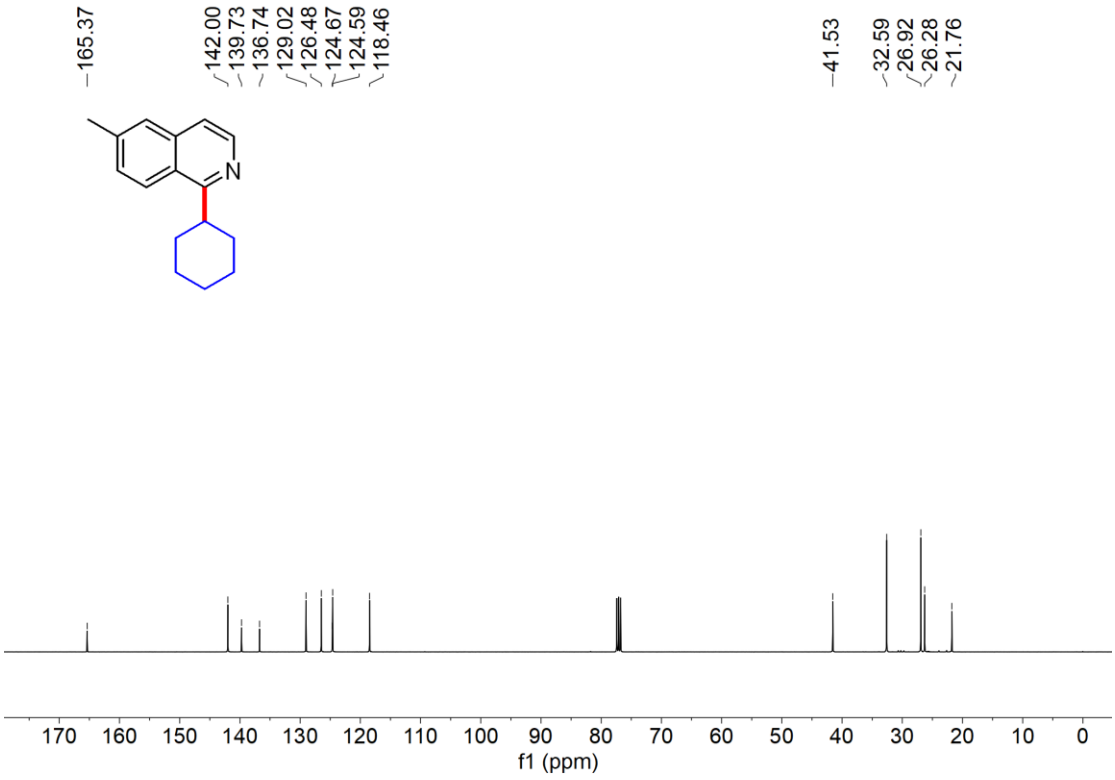
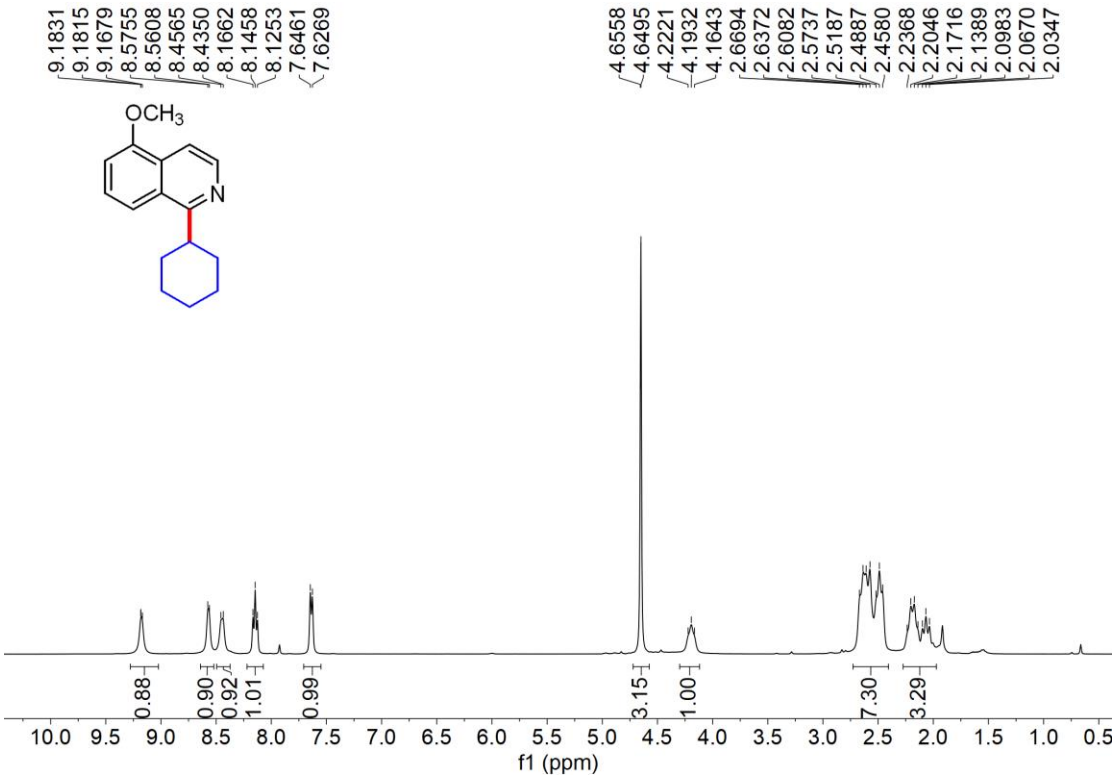
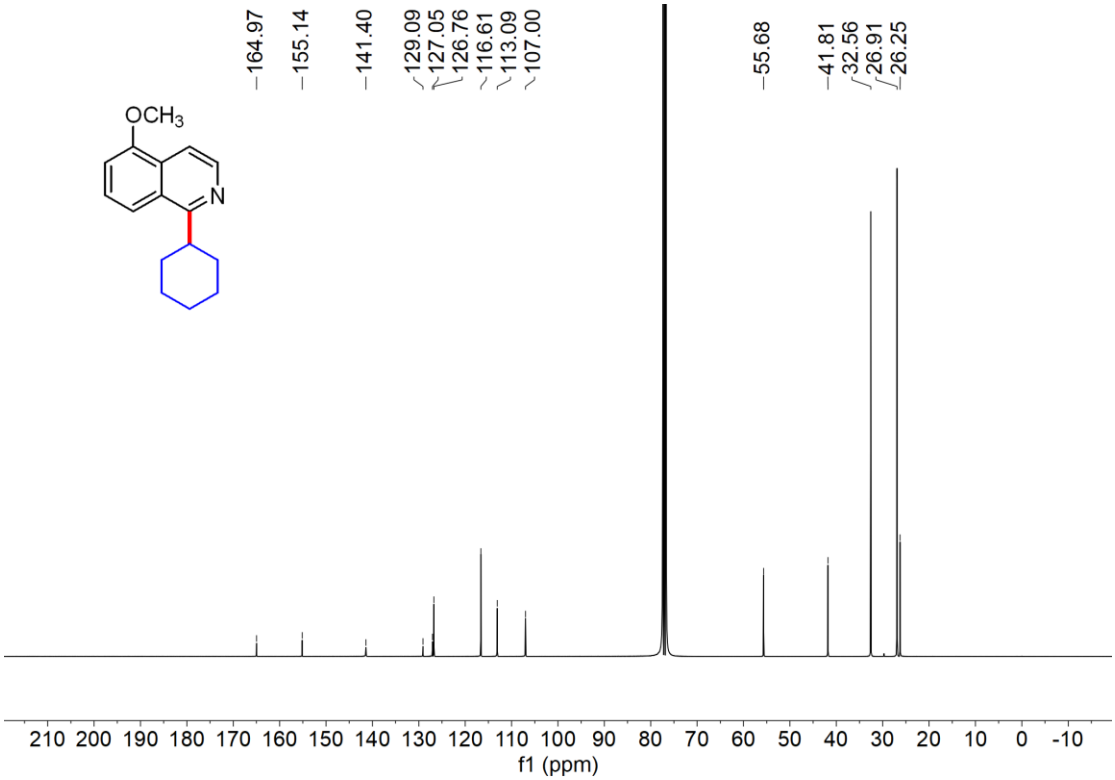


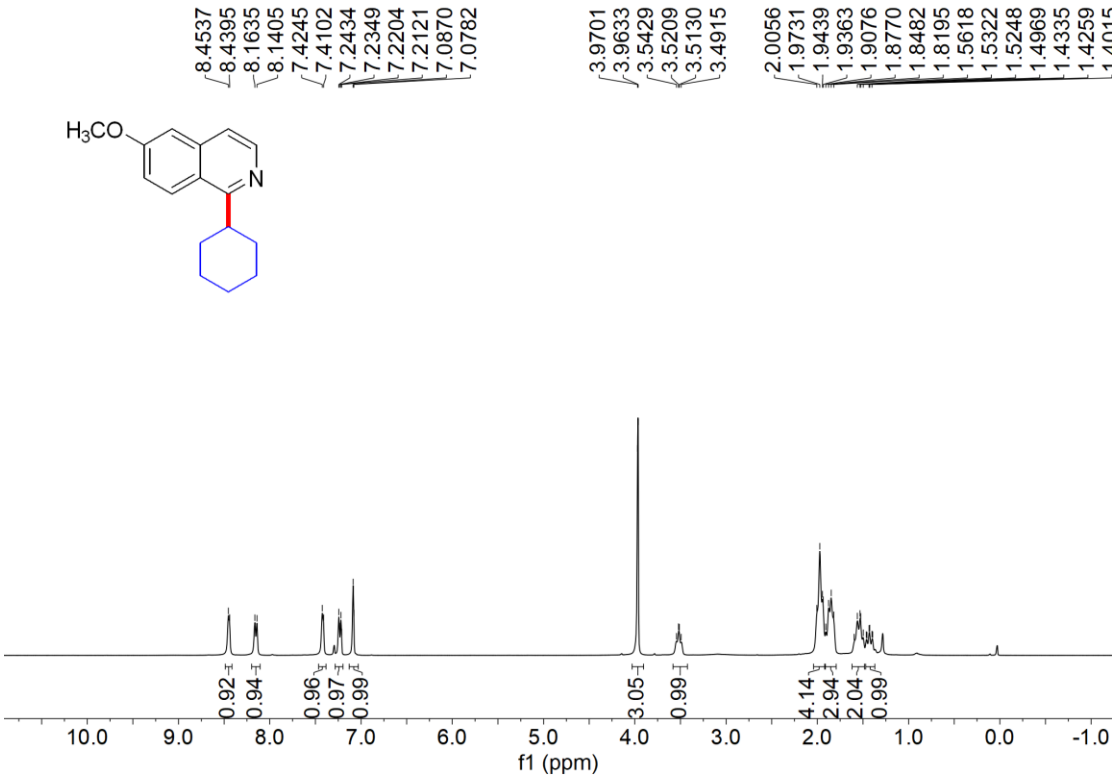
^{13}C NMR (101 MHz, $CDCl_3$) of **3w**



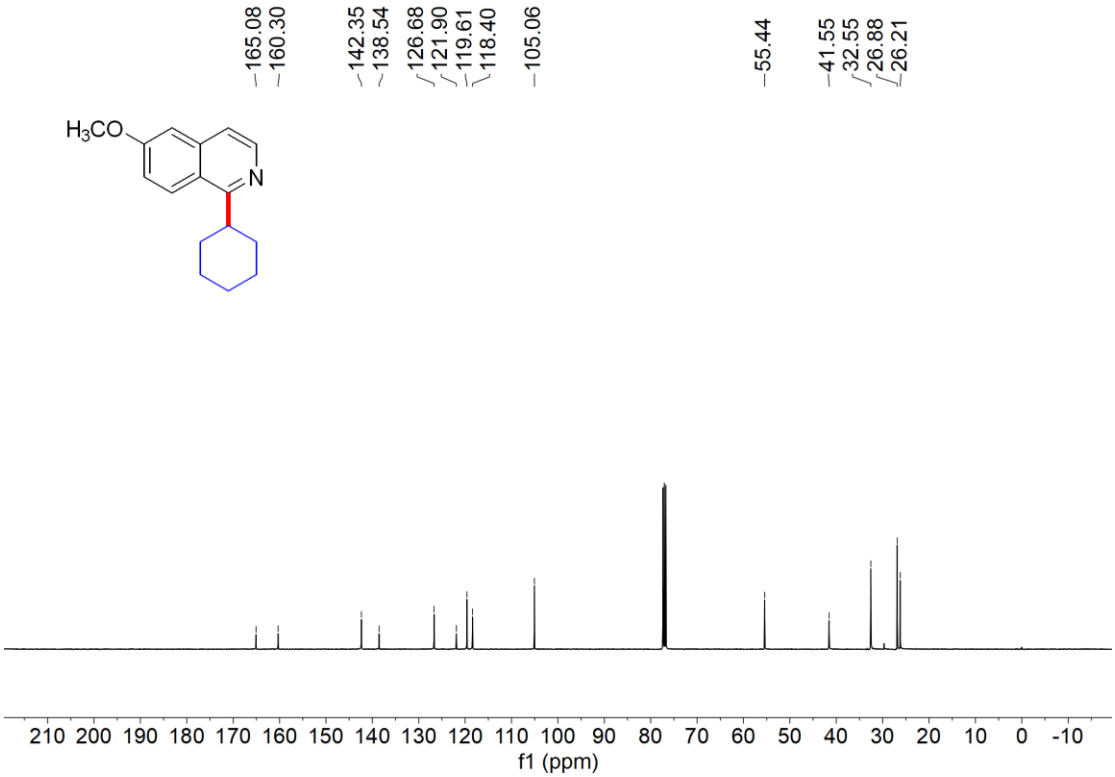
^{1}H NMR (400 MHz, $CDCl_3$) of **3x**



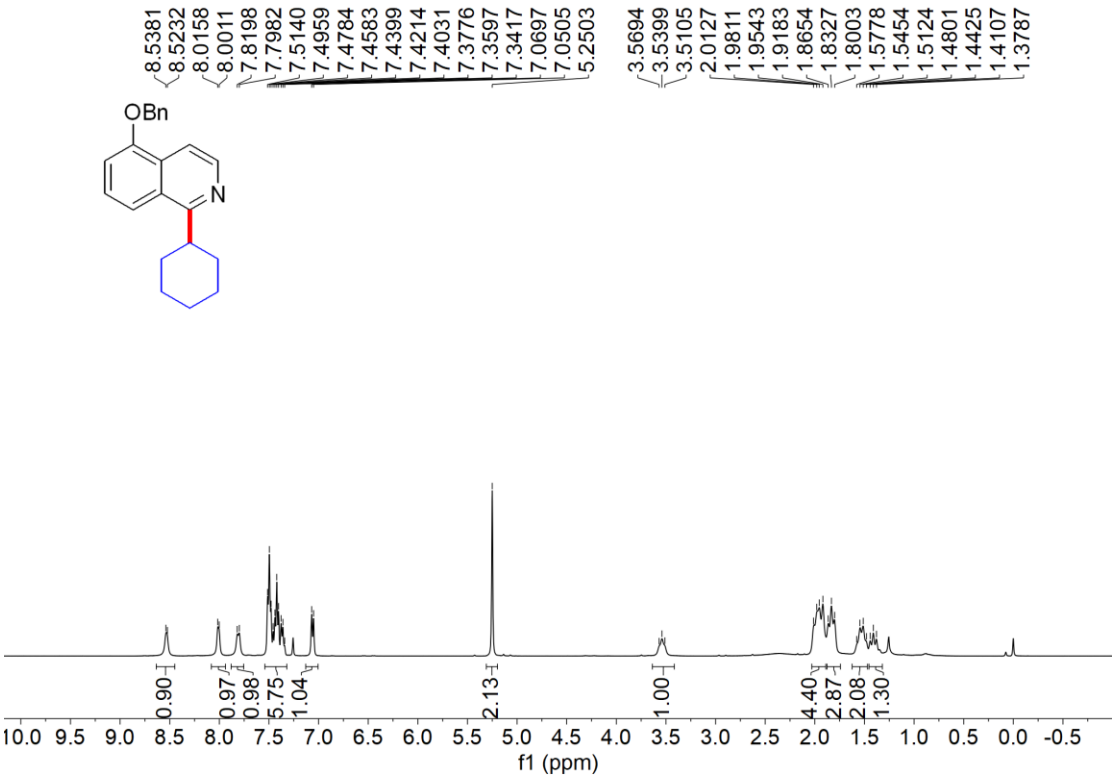
^{13}C NMR (101 MHz, $CDCl_3$) of **3x**



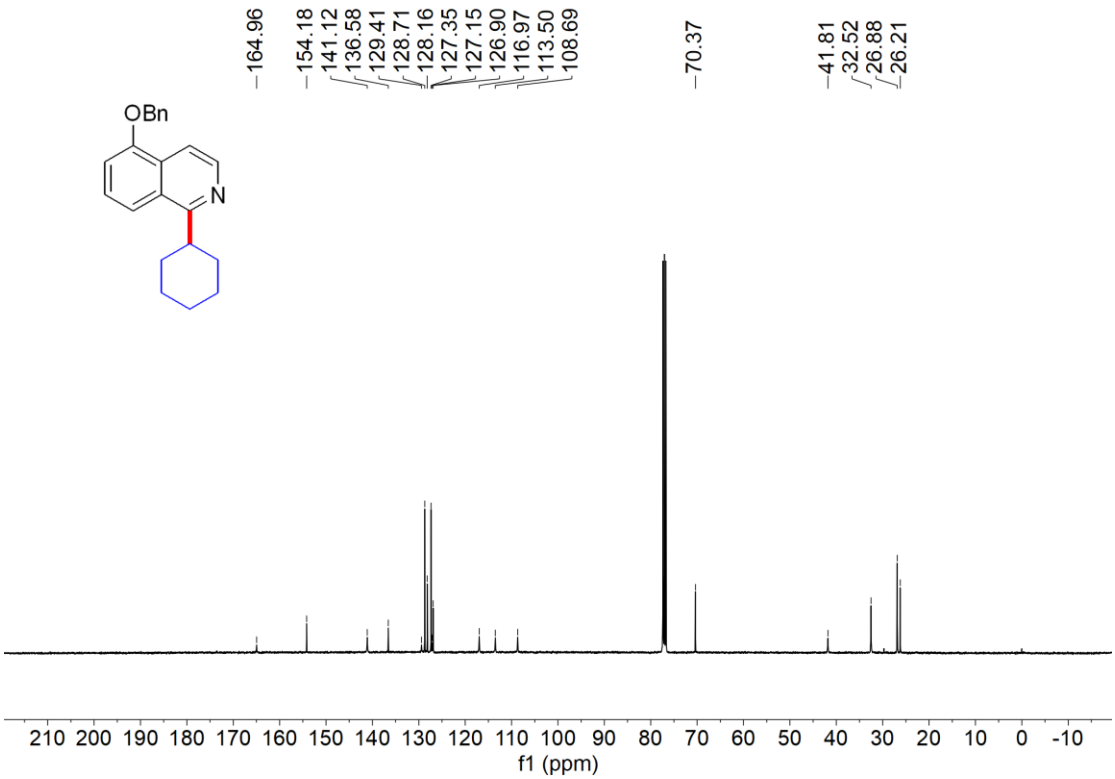
^{1}H NMR (400 MHz, $CDCl_3$) of **3y**



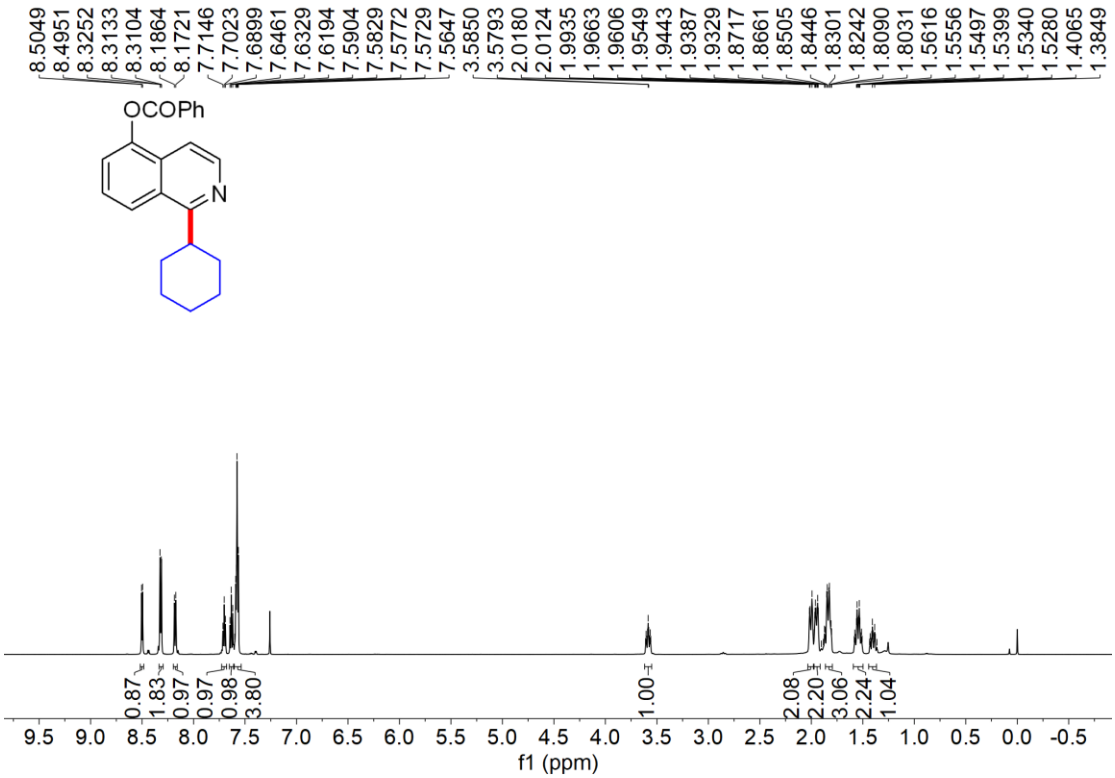
^{13}C NMR (101 MHz, $CDCl_3$) of **3y**



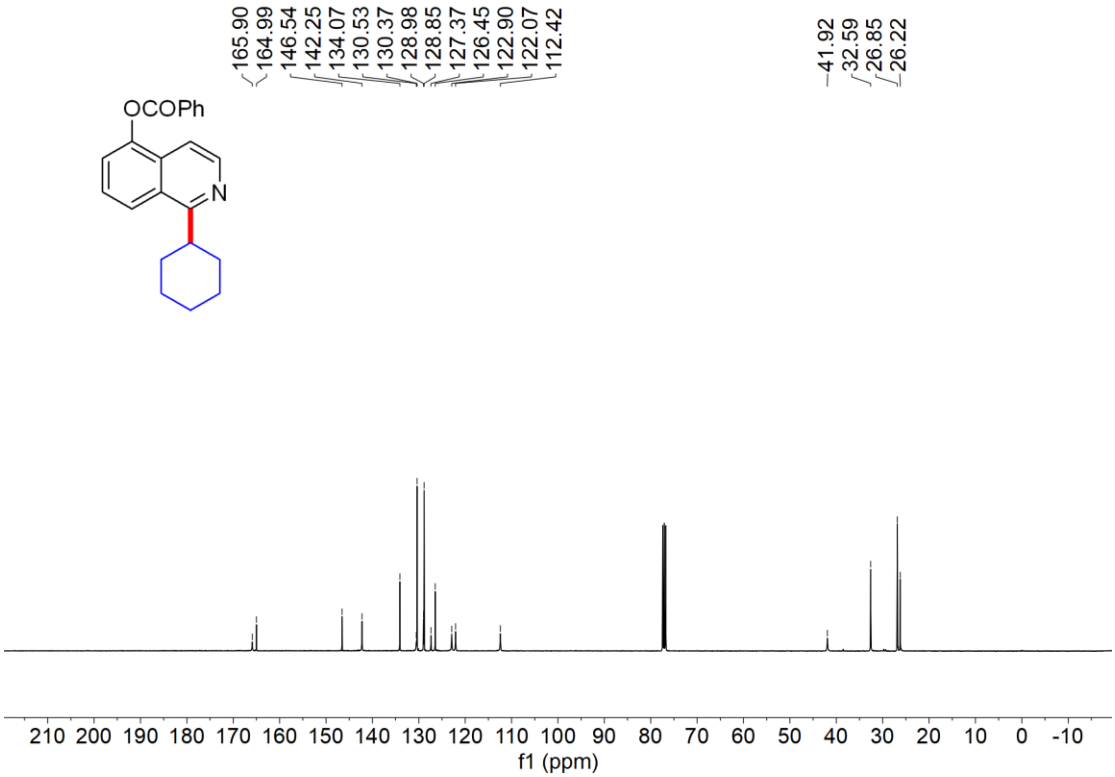
^{1}H NMR (400 MHz, $CDCl_3$) of **3z**



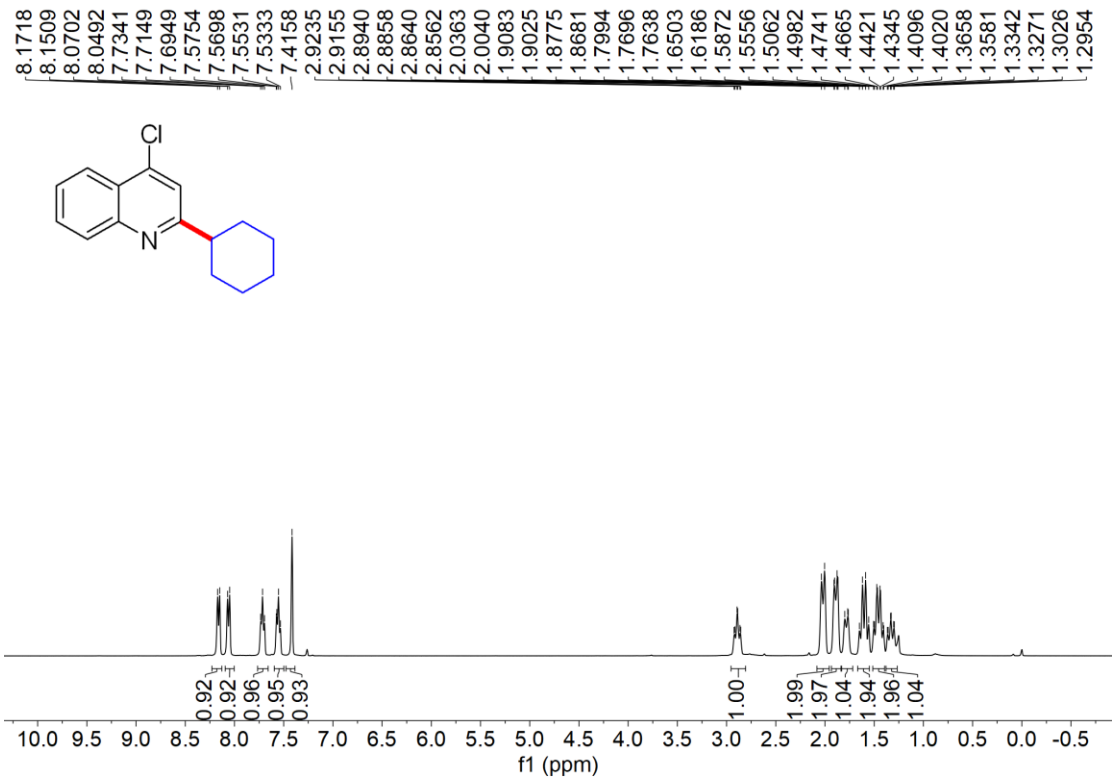
^{13}C NMR (101 MHz, $CDCl_3$) of **3z**



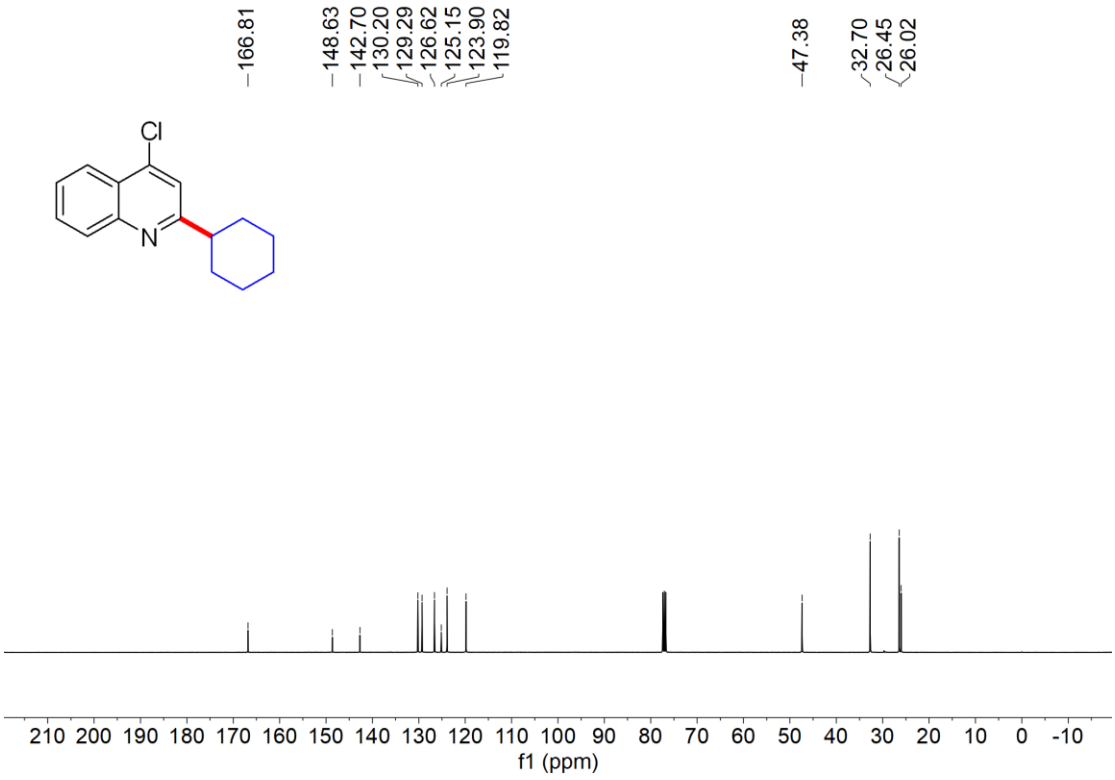
^{1}H NMR (600 MHz, $CDCl_3$) of **3aa**



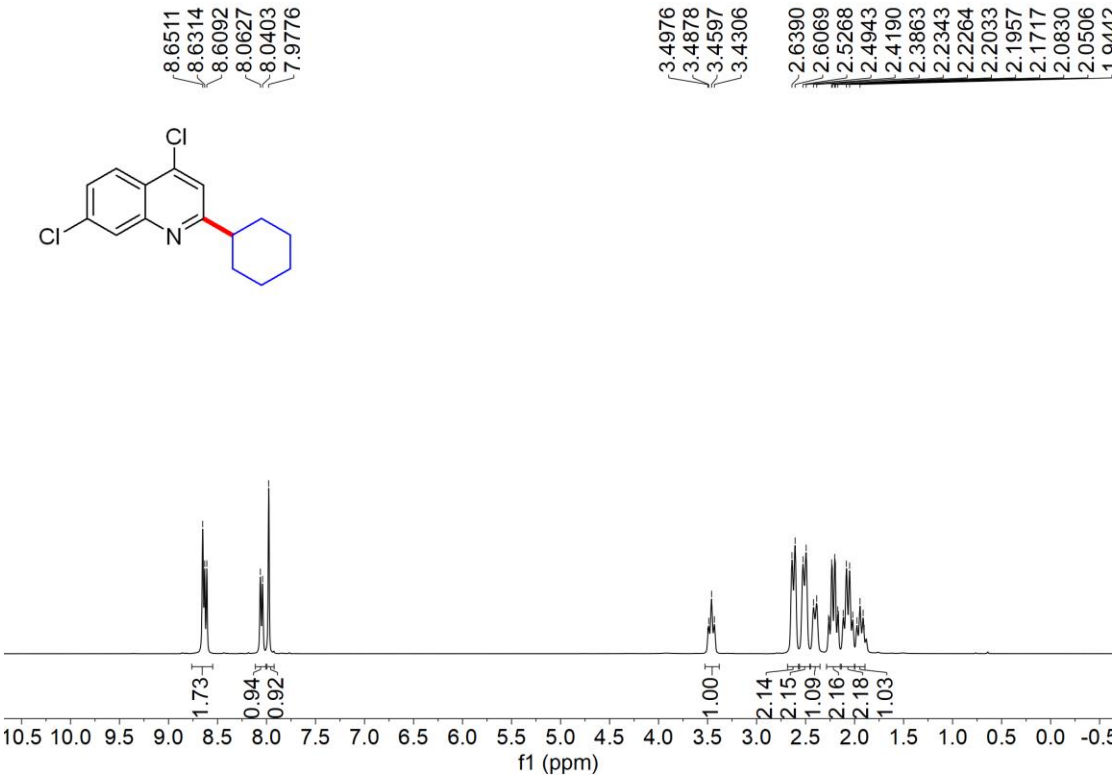
^{13}C NMR (101 MHz, $CDCl_3$) of **3aa**



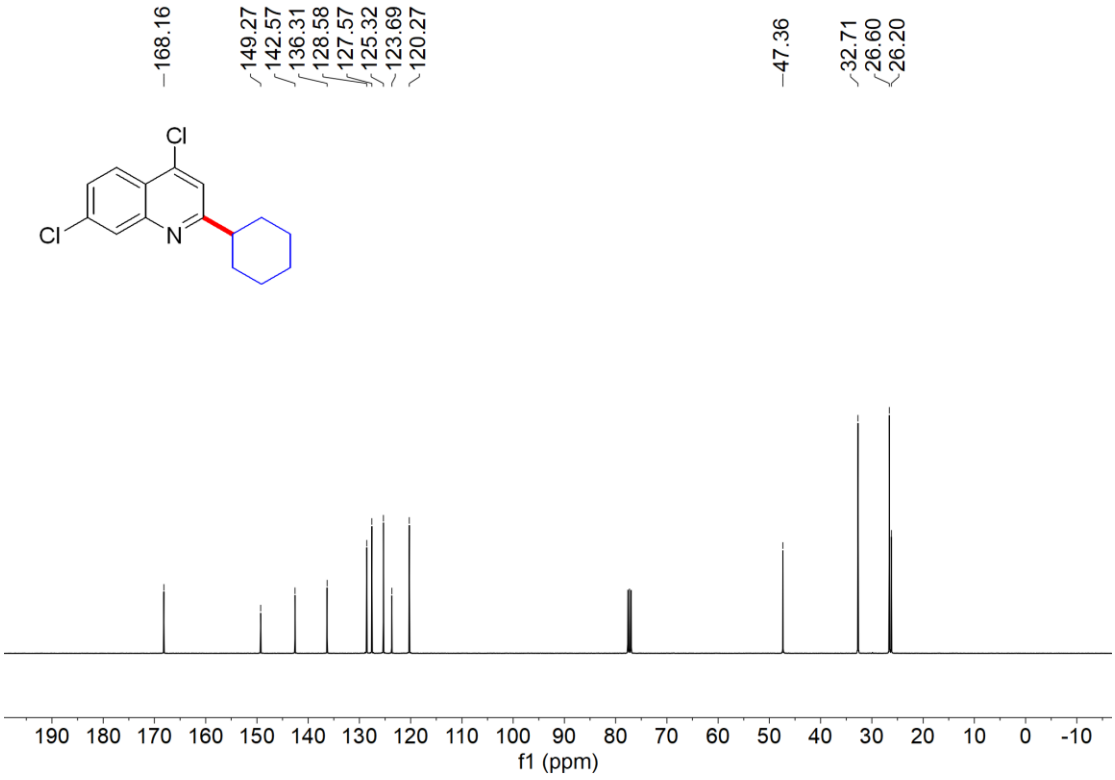
^{1}H NMR (400 MHz, $CDCl_3$) of **3ab**



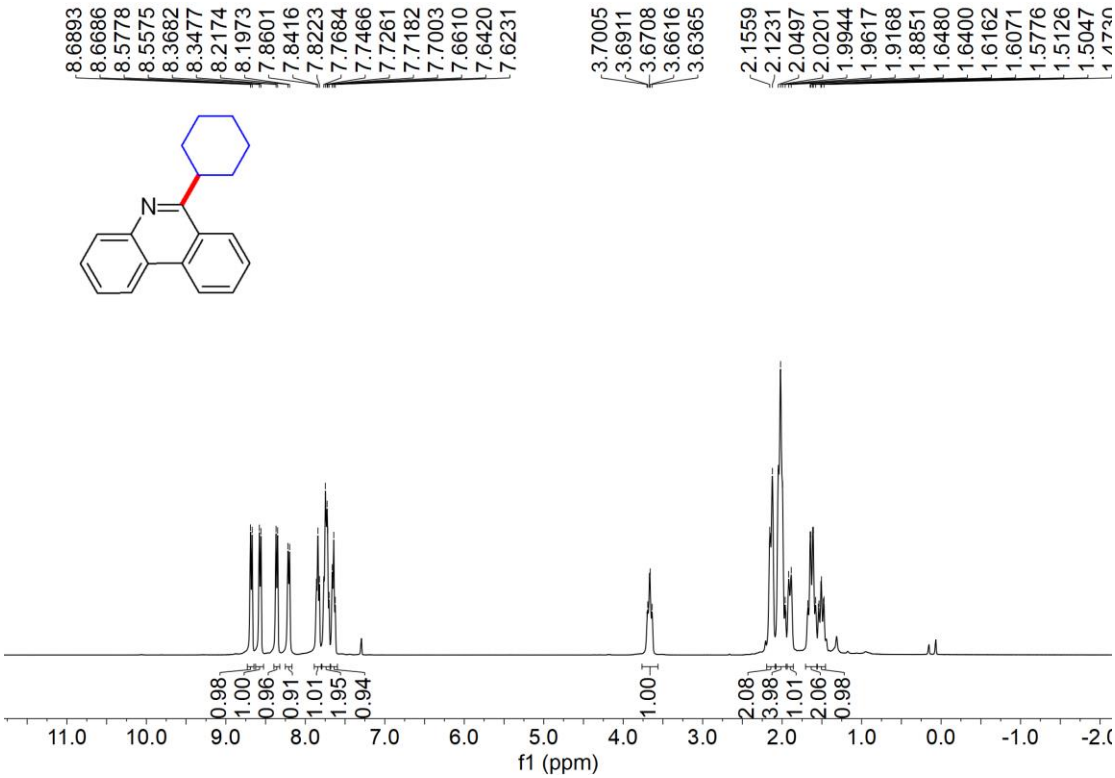
^{13}C NMR (101 MHz, $CDCl_3$) of **3ab**



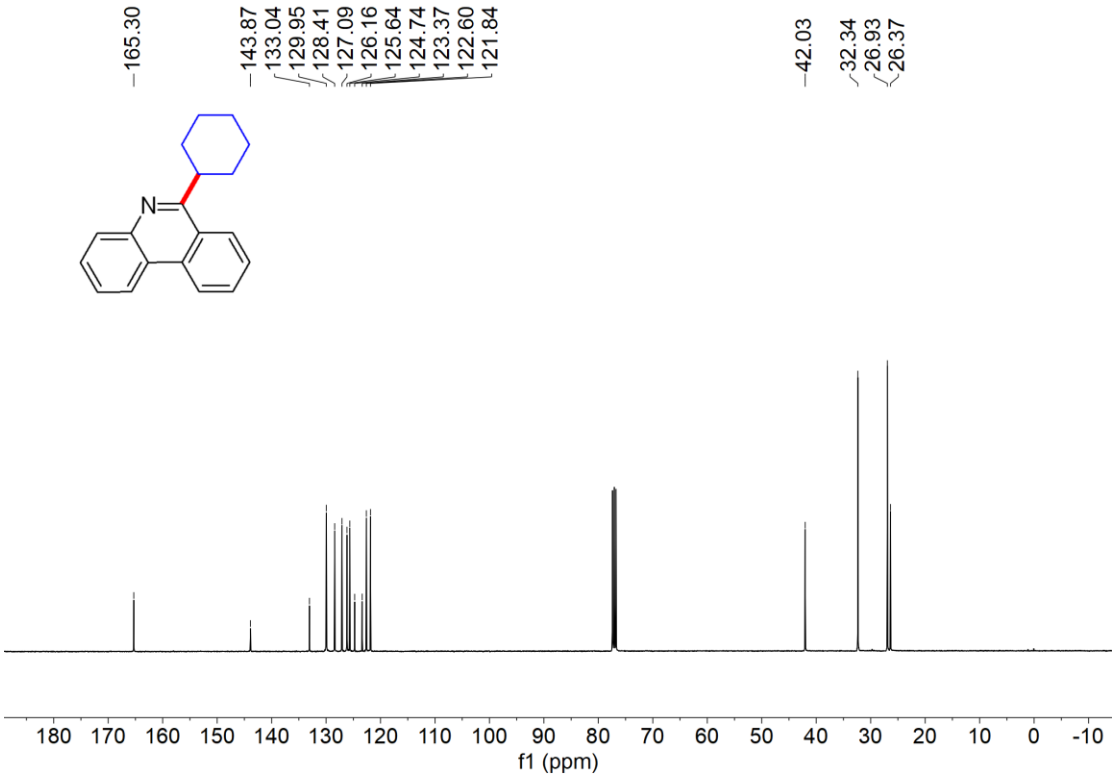
^{1}H NMR (400 MHz, $CDCl_3$) of **3ac**



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



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



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

9. References

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2. Y. Yoshida, D. Barrett, H. Azami, C. Morinaga, S. Matsumoto, Y. Matsumoto and H. Takasugi, *Bioorg. Med. Chem.*, 1999, **7**, 2647-2666.

3. G. Siano, S. Crespi, M. Mella and S. M. Bonesi, *J. Org. Chem.*, 2019, **84**, 4338-4352.