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Supporting Information

Redox-Tunable Ring Expansion Enabled By A Single-Component Electrophilic Nitrogen Atom Synthon

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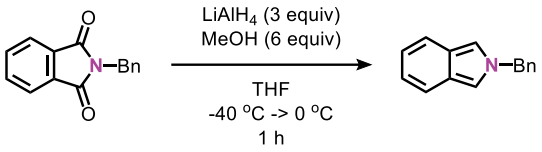
1. General Considerations

Unless noted otherwise, reactions were performed without precaution to exclude air and water. Unless otherwise noted, all reagents were used as received. Dibenzoazanorbornadiene (dbabh) was synthesized according to published procedures, which are reproduced here with slight modification.[1] Solvents were degassed and dried using a PPT Solvent Purification System. Reaction temperatures are reported as the temperature of the bath surrounding the flasks or vials.

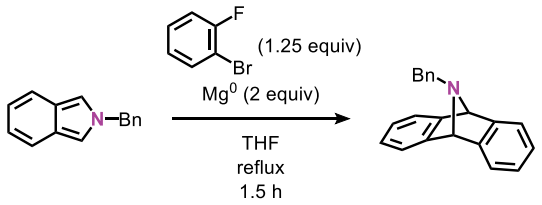
High resolution mass spectra were recorded on an Agilent 6224 TOF High Resolution Accurate MS with electrospray ionization. All mass spectra were processed with an Agilent MassHunter Operating System. Nuclear magnetic resonance spectra (1H-NMR, 13C-NMR and 19F-NMR) were recorded with Bruker spectrometers operating at 400 or 500 MHz for 1H. Chemical shifts are reported in parts per million (ppm, δ), downfield from tetramethylsilane (TMS, δ=0.00 ppm) and are referenced to residual solvent.[2] Coupling constants were reported in Hertz (Hz). Data for 1H-NMR spectra were reported as follows: chemical shift (ppm, s = singlet, d = doublet, t = triplet, q = quartet, quin = quintet, dd = doublet of doublets, td = triplet of doublets, ddd = doublet of doublet of doublets, m = multiplet, coupling constant (Hz), and integration).

2. Synthesis of DNIBX



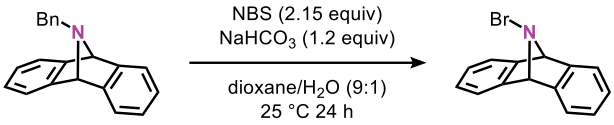
A 2 L three neck flask was charged with $LiAlH_4$ (17.9 g; 472 mmol) and fitted with a 350 mL addition funnel. The flask was evacuated and backfilled with N_2 three times before being fit with a balloon of N_2. THF (325 mL) was added and the mixture cooled to 0 °C. Methanol (38.0 mL; 939 mmol) in THF (325 mL) was added dropwise over a period of 30 min through the addition funnel, with periodic venting of the formed H_2 gas. The mixture was cooled to -40 °C, and N-benzylphthalimide (37.2 g; 157 mmol) was added as a solid in portions with vigorous stirring. The mixture was vigorously stirred at -40 °C for 30 minutes, and then warmed to 0 °C for an additional 30 minutes. The reaction was quenched by addition of Na_2SO_4 (2.5 g) in H_2O (23 mL) at 0 °C, and warmed to room temperature. The aluminum salts were filtered and washed with acetone (3 x 100 mL). The filtrate was dried over Na_2SO_4, and the solvent removed. The residue was washed with EtOH, leaving N-benzylisoindole (17.5 g; 84.5 mmol; 54%) as a yellow solid in sufficient purity to carry forward.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.51 (dt, *J* = 5.7, 2.9 Hz, 2H), 7.36 – 7.28 (m, 3H), 7.19 – 7.10 (m, 4H), 6.96 – 6.88 (m, 2H), 5.36 (s, 2H).



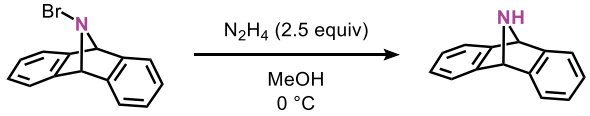
A 1L three neck flask was charged with Mg (4.6 g; 188.8 mmol) and fitted with a reflux condenser and pressure-equalizing addition funnel. The flask was evacuated and backfilled with N_2 three times. THF (55 mL) was added to the flask, and 1,2-dibromoethane (0.5 mL) was added with stirring. After initiation (evidenced by bubbling of the mixture), a solution of N-benzylisoindole (18.6 g; 89.9 mmol) in THF (200 mL) was added quickly via the addition funnel, and the mixture was heated to reflux. Through the addition funnel, ~ ¼ of a solution containing *o*-fluorobromobenzene (20.0 g; 114.5 mmol) in THF (55 mL) was added to the reaction. The remaining benzyne-precursor solution was added dropwise to the reaction over a period of 20 minutes while refluxing. After complete addition, the solution was refluxed for 1.5 h and cooled to room temperature. The reaction was quenched by the addition of saturated aqueous NH_4Cl () and stirring was maintained until excess Mg had been dissolved. The organic layer was separated and the aqueous layer extracted with Et_2O (2 x 100 mL). The combined organics were dried over Na_2SO_4, and the solvent was removed. The residue was dissolved in 40 mL of a 1:1 acetone:hexanes mixture, and cooled to 0 °C. The solid was filtered and washed with EtOH, giving 7-benzyl-2,3:5,6-dibenzo-7-azabicyclo[2.2.1]hepta-2,5-diene (13.2 g; 46.6mmol; 52%) as a nearly white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.22 (m, 8H), 6.99 (s, 4H), 4.95 (s, 2H), 3.51 (s, 2H).



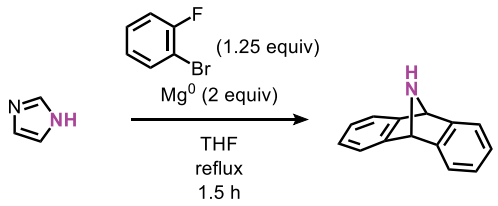
A mixture of 7-benzyl-2,3:5,6-dibenzo-7-azabicyclo[2.2.1]hepta-2,5-diene (13.2 g; 46.6 mmol) and $NaHCO_3$ (4.7 g; 55.9 mmol) and 167 mL of dioxane/H_2O (9:1, 150 mL:17 mL) was stirred at room temperature under air. N-bromosuccinimide (17.8 g; 100 mmol) was added as a solid and the mixture stirred for 24 h. A heavy white precipitate separated from the mixture during this time. The solvent was removed by rotary evaporation at 45 °C, and the residue partitioned between 1 M NaOH and CH_2Cl_2 (200 mL each). The organic layer was separated and the aqueous layer extracted with CH_2Cl_2 (2 x 100 mL). The combined organics were dried over Na_2SO_4 and evaporated to give a yellow solid. The solid was suspended in 1:1 EtOAc:EtOH and cooled to 0 °C. Filtration gave 7-bromo-2,3:5,6-dibenzo-7-azabicyclo[2.2.1]hepta-2,5-diene (10.6 g; 38.9 mmol; 83%) as a yellow solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.33 (dd, *J* = 5.1, 3.1 Hz, 2H), 7.26 (dd, *J* = 5.2, 3.1 Hz, 2H), 7.01 (ddd, *J* = 8.3, 5.3, 3.1 Hz, 4H), 5.35 (s, 2H).



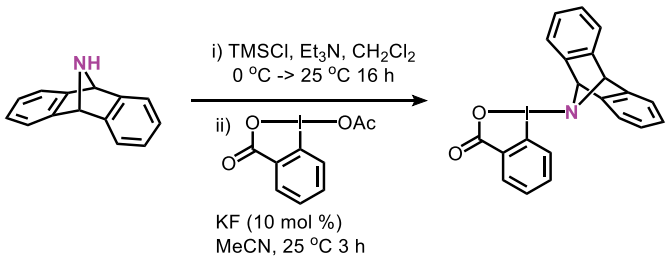
A suspension of 7-bromo-2,3:5,6-dibenzo-7-azabicyclo[2.2.1]hepta-2,5-diene (10.6 g; 38.9 mmol) in MeOH (120 mL) was stirred at 0 °C. A solution of hydrazine hydrate (4.8 g; 4.7 mL; 96 mmol) in MeOH (100 mL) was added dropwise over a 30 minute period. After stirring an additional 5 min at 0 °C, the solution was warmed to room temperature and the methanol was removed by rotary evaporation. The residue was taken up in 1 M HCl, and the solution filtered to remove a trace of solid (anthraquinone by ^{1}H NMR analysis). The solid was rinsed with H_2O, and the combined filtrates were cooled to 0 °C. NaOH pellets were added until the solution was made strongly basic and a white precipitate was observed. The solid was filtered, washed with H_2O, and dried under vacuum to give a dbabh (6.6 g; 34.2 mmol; 88%) as a white solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (dd, *J* = 5.2, 3.1 Hz, 4H), 6.95 (dd, *J* = 5.2, 3.0 Hz, 4H), 5.32 (s, 2H).



Alternatively, dbabh could be synthesized by the single-step reaction of imidazole and benzyne, as detailed below. However, due to the low yield and difficulty separating $Mg(OH)_2$ from the desired amine, large scale synthesis was typically conducted by the reported route as detailed in the preceding paragraphs.

A 1L two neck flask was charged with Mg (5.14 g; 214 mmol) and fitted with a reflux condenser and pressure-equalizing addition funnel. The flask was evacuated and backfilled with N_2 three times. THF (50 mL) was added to the flask, and 1,2-dibromoethane (0.5 mL) was added with stirring. After initiation (evidenced by bubbling of the mixture), a solution of imidazole (3.23 g; 47.6 mmol) in THF (250 mL) was added quickly via the addition funnel, and the mixture was heated to reflux. Typically, a white precipitate was noted at this stage. Through the addition funnel, ~ ¼ of a solution containing *o*-fluorobromobenzene (25 g; 143 mmol) in THF (200 mL) was added to the reaction. The remaining benzyne-precursor solution was added dropwise to the reaction over a period of 20 minutes while refluxing. After complete addition, the solution was refluxed for 2 h and cooled to room temperature. The reaction was quenched by the addition of sat. $NaHCO_3$ (250 mL) and diluted with H_2O (250 mL). The mixture was filtered, and the organic layer separated. The aqueous layer was extracted with Et_2O (3 x 100 mL). The combined organics were extracted with 1 M HCl (4 x 100 mL). The solution was made strongly basic by addition of NaOH pellets at 0 °C, and the basic solution extracted with Et_2O. The organic solvent was removed, giving 7-benzyl-2,3:5,6-dibenzo-7-azabicyclo[2.2.1]hepta-2,5-diene (1.36 g; 15%) as a brown oil in > 90% purity by NMR.



1-(9,10-dihydro-9,10-epiminoanthracen-11-yl)-1λ^3-benzo[*d*][1,2]iodaoxol-3(1*H*)-one (DNIBX) A flame-dried 250 mL round bottom flask was charged with dbabh (6.60 g; 34.2 mmol), then evacuated and backfilled with N_2 three times. CH_2Cl_2 (70 mL) was added and the solution was cooled to 0 °C. Et_3N (9.50 mL; 68.5 mmol), followed by TMSCl (5.20 mL; 41.1 mmol) were added slowly, and the solution was allowed to warm to room temperature overnight (16 h). The white precipitate (Et_3NHCl) was filtered off, and the filtrate was dried *in vacuo*. The resulting residue was stirred in hexanes (100 mL) at room temperature for 30 min, and the remaining white solid (Et_3NHCl) was filtered off. The filtrate was dried *in vacuo*, leaving a white solid (TMS-dbabh). 3-oxo-1λ^3-benzo[*d*][1,2]iodaoxol-1(3*H*)-yl acetate (10.3 g; 34.2 mmol; 1 equiv), and potassium fluoride (10 mol %) were added to the round bottom flask, which was then placed under an N_2 atmosphere. MeCN (100 mL) was added, and the mixture was stirred at room temperature overnight. The resulting suspension was filtered and washed with MeCN (2 x 4 mL) and Et_2O (2 x 8 mL). The white solid was dissolved in CH_2Cl_2 and filtered to remove hydrolyzed 1-hydroxy-1l3-benzo[d][1,2]iodaoxol-3(1H)-one. The CH_2Cl_2 solution was concentrated to near dryness, and Et_2O was added to precipitate the title compound as a white solid, which was filtered and further dried *in vacuo* (12.47 g; 83% from dbabh).

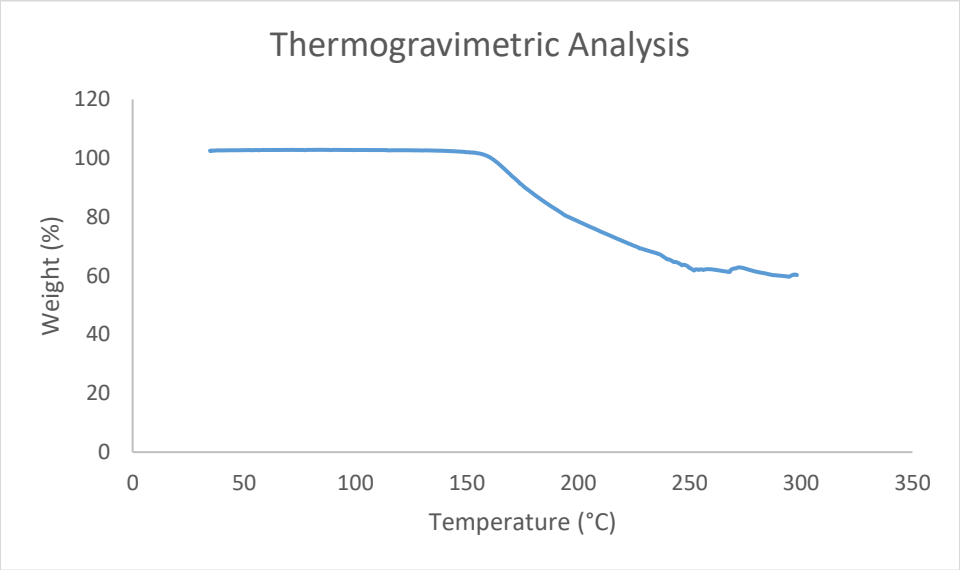
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.31 (dd, *J* = 7.4, 1.8 Hz, 1H), 8.11 (dd, *J* = 8.3, 1.0 Hz, 1H), 7.67 (ddd, *J* = 8.4, 7.2, 1.8 Hz, 1H), 7.59 (td, *J* = 7.3, 1.1 Hz, 1H), 7.43 (dd, *J* = 5.2, 3.1 Hz, 4H), 7.11 (dd, *J* = 5.3, 3.0 Hz, 4H), 5.75 (s, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.53, 134.06, 132.60, 132.29, 130.61, 127.17, 126.85, 121.74, 116.34, 74.94.

HRMS (ESI-TOF) calcd for $C_{21}H_{14}INO_2$ $[M+H]^+$ 440.0142, observed 440.0143

Crystals suitable for x-ray diffraction were grown by vapor diffusion of pentane into a saturated dichloroethane solution at room temperature (20-25 °C).

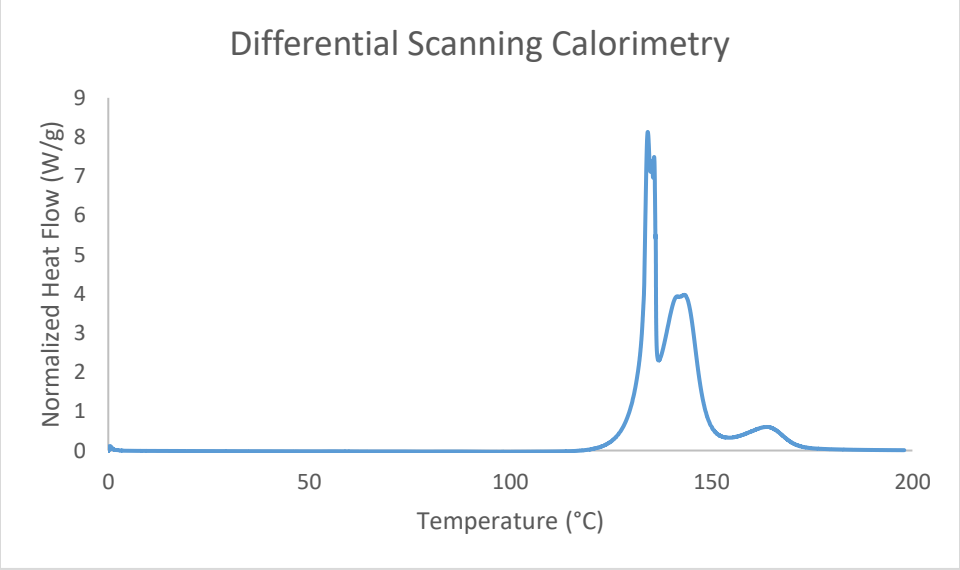
3. Safety Information of 1

Thermogravimetric Analysis



Supplemental Figure 1: TGA indicates that approximately 39% of mass is lost between 160 °C and 300 °C, which corresponds to ~ 170 amu. We hypothesize that this may result from the loss of anthracene (178 amu) at high temperature.

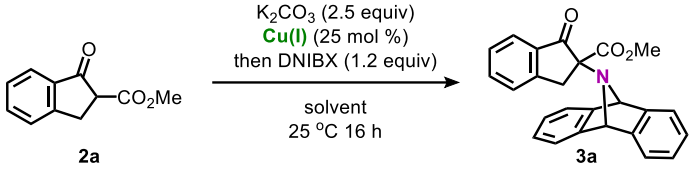
Differential Scanning Calorimetry



Supplemental Figure 2: DSC indicates a multifaceted exotherm that onsets at temperature of 132.58 °C, peaks at 134.20 and releases 436.57 J/g.

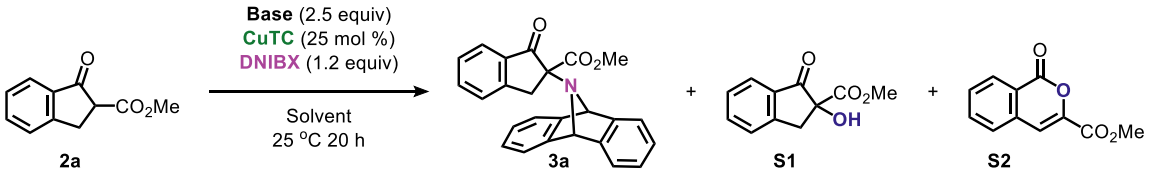
4. Copper-catalyzed Amination of Indanones

Reaction Optimization



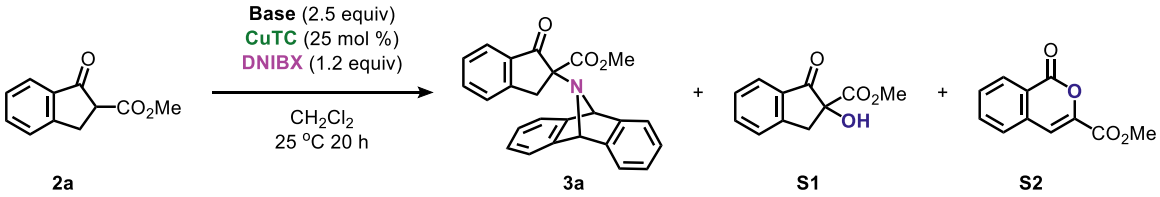
Copper source	solvent	atmosphere	Yield
CuBr	MeCN	N_2	25 +/- 3
$Cu(MeCN)_4PF_6$	MeCN	N_2	42 +/- 3
CuTC	MeCN	N_2	45 +/- 2
CuOTf	MeCN	N_2	42 +/- 2
CuBr	MeCN	air	0
$Cu(MeCN)_4PF_6$	MeCN	air	0
CuTC	MeCN	air	40 +/- 3
CuOTf	MeCN	air	0
CuBr	CH_2Cl_2	N_2	33 +/- 4
$Cu(MeCN)_4PF_6$	CH_2Cl_2	N_2	0
CuTC	CH_2Cl_2	N_2	51 +/- 3
CuOTf	CH_2Cl_2	N_2	0

Supplemental Table 1: Screen of copper catalysts



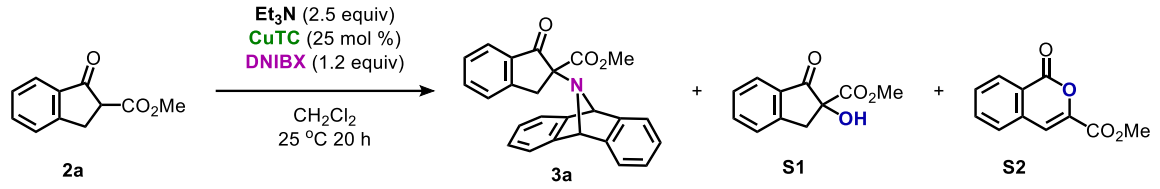
Base	Solvent	Yield (3a)	Alcohol (S1)	Coumarin (S2)	S.M. (2a)
K_2CO_3	CH_2Cl_2	63 +/- 4	11	6	0
K_2CO_3	THF	38 +/- 2	15	6	0
K_2CO_3	MeCN	45 +/- 2	19	3	0
K_2CO_3	Toluene	25 +/- 5	9	6	18 +/- 2
K_2CO_3	DMF	35 +/- 3	9	1	0
K_2CO_3	Et_2O	10 +/- 1	8	2	15 +/- 3
K_2CO_3	EtOAc	45 +/- 4	11	6	2

Supplemental Table 2: Solvent Screen



Base	Yield (3a)	Alcohol (S1)	Coumarin (S2)	S.M. (2a)
K_2CO_3	68 +/- 2	11 +/- 3	5	0
KOtBu	26 +/- 4	< 5	2	0
K_3PO_4	59 +/- 1	14 +/- 3	5	0
Et_3N	75 +/- 4	11 +/- 1	< 1	0
DMAP	27 +/- 3	19 +/- 5	7	0
DBU	2 +/- 1	12 +/- 5	5	0
NaOAc	28 +/- 3	20 +/- 3	17 +/- 1	0
none	19 +/- 3	19 +/- 1	21 +/- 2	10 +/- 5

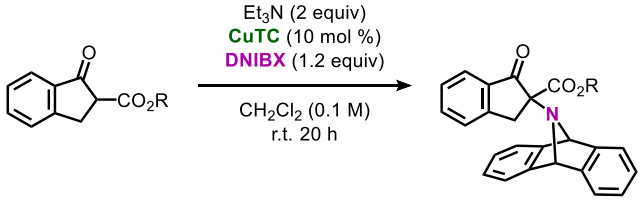
Supplemental Table 3: Base Screen



Conditions	atmosphere	Yield (3a)	Alcohol (S1)	Coumarin (S2)
ambient vial, all reagents at once	air	66 +/- 3	15	6
ambient vial, all reagents at once	N_2	73 +/- 3	4	1
oven dry vial, all reagents at once	N_2	68 +/- 3	4	1
ambient vial, 20 min pre-stir without DNIBX	N_2	71 +/- 4	12	5

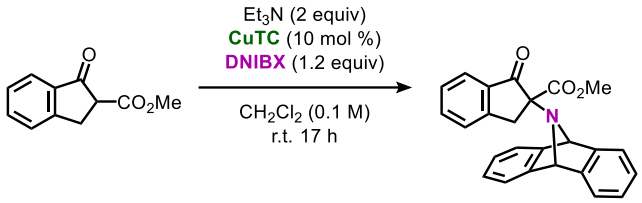
Supplemental Table 4: Screen of air and water sensitivity of amination.

General Procedure A for amination of indanones



A 1 dram vial was charged with indanone (0.3 mmol), CuTC (5.7 mg; 0.03 mmol), and DNIBX (158 mg; 0.36 mmol). The vial was evacuated and backfilled three times with N_2. CH_2Cl_2 (3 mL) and Et_3N (83 µL; 0.6 mmol) were added, and the reaction stirred at room temperature for 16-24 h (monitored by TLC). The reaction mixture was diluted up to 10 mL with CH_2Cl_2 and washed with saturated $NaHCO_3$ (3 x 10 mL). The organic layer was dried over Na_2SO_4 and purified by column chromatography.

Procedure for Model Substrate Amination Scale Up

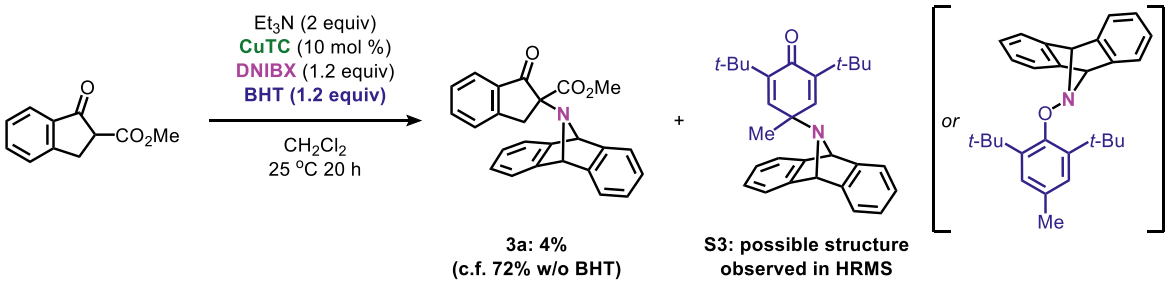


Scale up was performed with minor adjustments to General Procedure A. To a 4 dram septum capped vial, indanone (797 mg, 4.2 mmol), DNIBX (2.21 g, 5.0 mmol), and CuTC (80 mg, 0.42 mmol) were added. The vial was evacuated and backfilled three times with N_2. Dichloromethane (50 mL) and Et_3N (1.2 mL, 8.4 mmol) were added, and the reaction was stirred for 17 hours at room temperature. Once complete by TLC (17 hr), the mixture was diluted to 80 mL with CH_2Cl_2 and the organic layer was washed three times with 50 mL saturated $NaHCO_3$. Organic layer was dried with Na_2SO_4, concentrated via rotary evaporation, and purified by flash column chromatography. The subsequent product containing fractions were then concentrated and recrystallized from hot 15% EtOAc/Hexanes to yield 953 mg (60%) of **3a**.

Note: many of the aminated products were partially unstable on silica gel as evidenced by 2D TLC. As such, on larger scale (1 mmol), purification of many substrates can be accomplished by washing the crude residue with a minimal amount of MeOH, leaving behind **3** as a solid. This method of purification worked for substrates lacking an H-bond donor or acceptor moiety (**3a, 3h, 3k**) but was not as effective for polar substrates (**3g, 3l, 3o**)

Mechanistic Experiments

Radical Trap Experiment with 2,6-di-tert-butyl-4-methylphenol (BHT):



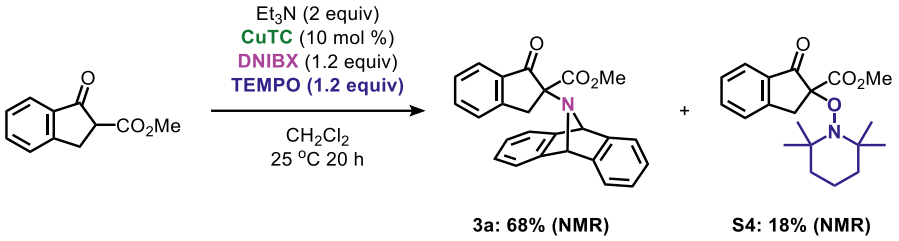
Following general procedure A (with the addition of 1.2 equiv. of BHT), only a trace amount of aminated product was observed. In addition, the dbabh-adduct was isolated and observed in the crude NMR and by HRMS.

When 1.2 equiv. of BHT was allowed to stir with DNIBX in CH_2Cl_2 overnight, this adduct was not observed. Instead, the DNIBX remained mostly intact (< 30% coversion) with the only observed decomposition coming from hydrolysis and release of dbabh and iodosylarene.

The presence of this adduct indicates the formation of N-centered radicals by the copper catalyst, which have been trapped by BHT.

S3: **HRMS** (ESI-TOF) calcd for $C_{29}H_{33}NO$ $[M+H]^+$ 412.2635, observed 412.2642

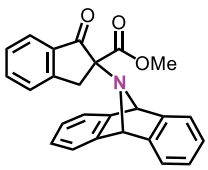
Radical trap experiment with TEMPO



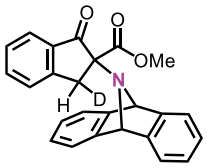
Following general procedure A (with the addition of 1.2 equiv. of TEMPO), a TEMPO-indanone adduct was observed in 18% yield. This observation is consistent with the radical character previously observed for copper(I) enolates.[3]

S4: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, *J* = 7.7 Hz, 1H), 7.63 (td, *J* = 7.5, 1.2 Hz, 1H), 7.50 (d, *J* = 7.7 Hz, 1H), 7.37 (t, *J* = 7.4 Hz, 1H), 4.61 (d, *J* = 17.7 Hz, 1H), 3.75 (s, 3H), 3.47 (d, *J* = 17.7 Hz, 1H), 1.69 – 1.35 (m, 6H), 1.33 (s, 4H), 1.31 – 1.25 (m, 1H), 1.20 (s, 3H), 1.06 (s, 3H), 0.58 (s, 3H).
The NMR are in alignment with reported data.[4]

<u>Characterization Data of Aminated Products</u>

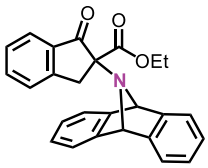


3a: White solid, 75% (60% on 4.2 mmol scale). R_f = 0.43 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 (td, *J* = 7.4, 1.3 Hz, 1H), 7.46 (dt, *J* = 7.5, 1.0 Hz, 1H), 7.40 (dt, *J* = 7.7, 0.9 Hz, 1H), 7.29 (td, *J* = 7.4, 1.0 Hz, 1H), 7.23 (dt, *J* = 7.1, 0.9 Hz, 2H), 7.09 (dt, *J* = 6.9, 1.0 Hz, 2H), 6.92 (td, *J* = 7.4, 1.3 Hz, 2H), 6.90 – 6.83 (m, 2H), 5.72 (s, 2H), 3.83 (d, *J* = 16.7 Hz, 1H), 3.37 (s, 3H), 3.28 (d, *J* = 16.7 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 200.52, 170.26, 150.06, 148.74, 148.64, 135.48, 135.20, 127.86, 126.09, 125.68, 125.48, 124.46, 121.55, 121.06, 73.18, 68.68, 52.66, 38.52.
HRMS (ESI-TOF) calcd for $C_{25}H_{19}NO_3$ $[M+H]^+$ 382.1438, observed 382.1453
Crystals suitable for X-ray diffraction were obtained from a supersaturated column fraction containing ~15% ethyl acetate in hexanes at room temperature (20-25 °C).

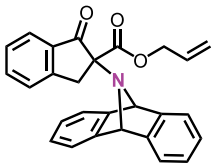


3a-D: White solid, 68%. R_f = 0.43 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (td, *J* = 7.5, 1.3 Hz, 1H), 7.45 (dt, *J* = 6.6, 0.9 Hz, 1H), 7.40 (dq, *J* = 7.7, 1.0 Hz, 1H), 7.29 (tt, *J* = 7.4, 0.9 Hz, 1H), 7.25 – 7.20 (m, 2H), 7.09 (dq, *J* = 6.9, 1.0 Hz, 2H), 6.92 (td, *J* = 7.4, 1.2 Hz, 2H), 6.89 – 6.83 (m, 2H), 5.71 (d, *J* = 2.2 Hz, 2H), 3.81 (s, 0.52H), 3.37 (d, *J* = 2.4 Hz, 3H), 3.26 (s, 0.51H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 200.55, 170.28, 150.02, 148.76, 148.66, 135.49, 135.25, 127.89, 126.12, 125.69, 125.49, 124.48, 121.56, 121.08, 73.14, 68.70, 52.66.

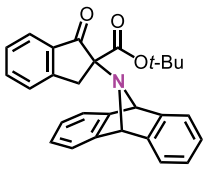
HRMS (ESI-TOF) calcd for $C_{25}H_{18}DNO_3$ $[M]^+$ 382.1428, observed 382.1438



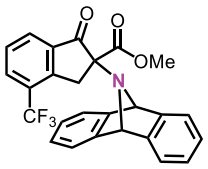
3b: Yellow solid, 78%. R_f = 0.43 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (td, *J* = 7.4, 1.3 Hz, 1H), 7.44 – 7.35 (m, 2H), 7.27 (t, *J* = 6.2 Hz, 1H), 7.21 (dt, *J* = 7.1, 0.9 Hz, 2H), 7.03 (d, *J* = 7.2 Hz, 2H), 6.91 (td, *J* = 7.4, 1.2 Hz, 2H), 6.84 (td, *J* = 7.4, 1.1 Hz, 2H), 5.67 (s, 2H), 3.89 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.84 – 3.73 (m, 2H), 3.27 (d, *J* = 16.8 Hz, 1H), 1.13 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 200.75, 169.98, 149.97, 148.91, 148.66, 135.36, 135.32, 127.78, 126.03, 125.63, 125.43, 124.28, 121.53, 120.98, 73.28, 68.66, 61.79, 38.44, 13.96.
HRMS (ESI-TOF) calcd for $C_{26}H_{21}NO_3$ $[M+H]^+$ 396.1594, observed 396.1599



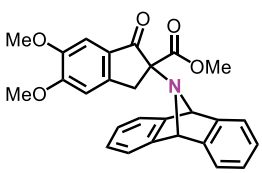
3c: Tan solid, 78%. R_f = 0.51 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (td, *J* = 7.4, 1.1 Hz, 1H), 7.45 – 7.36 (m, 2H), 7.33 – 7.25 (m, 1H), 7.22 (d, *J* = 7.1 Hz, 2H), 7.05 (d, *J* = 7.0 Hz, 2H), 6.92 (td, *J* = 7.4, 1.2 Hz, 2H), 6.85 (td, *J* = 7.4, 1.2 Hz, 2H), 5.77 (ddt, *J* = 11.8, 10.5, 5.3 Hz, 1H), 5.71 (s, 2H), 5.26 – 5.10 (m, 2H), 4.29 (ddt, *J* = 13.6, 5.4, 1.5 Hz, 1H), 4.21 – 4.07 (m, 1H), 3.83 (d, *J* = 16.8 Hz, 1H), 3.30 (d, *J* = 16.8 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 200.49, 169.54, 149.94, 148.82, 148.65, 135.43, 135.28, 131.56, 127.85, 126.07, 125.65, 125.45, 124.38, 121.55, 121.04, 118.18, 73.22, 68.67, 66.07, 38.45.
HRMS (ESI-TOF) calcd for $C_{27}H_{21}NO_3$ $[M+H]^+$ 408.1594, observed 408.1606



3d: White solid, 47%. R_f = 0.42 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (td, *J* = 7.4, 1.3 Hz, 1H), 7.42 (d, *J* = 7.7 Hz, 1H), 7.25 (t, *J* = 8.7 Hz, 1H), 7.17 (dd, *J* = 6.8, 1.5 Hz, 3H), 6.88 (dd, *J* = 7.9, 6.7 Hz, 4H), 6.77 (td, *J* = 7.3, 1.0 Hz, 2H), 5.53 (s, 2H), 3.63 (d, *J* = 17.2 Hz, 1H), 3.25 (d, *J* = 17.2 Hz, 1H), 1.36 (s, 9H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 201.97, 169.75, 149.91, 149.33, 148.75, 135.58, 135.07, 127.53, 125.83, 125.48, 125.31, 123.76, 121.51, 120.72, 82.45, 73.91, 68.52, 38.26, 28.00.
HRMS (ESI-TOF) calcd for $C_{28}H_{25}NO_3$ $[M+H]^+$ 424.1907, observed 424.1916

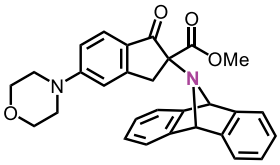


3e: Off-white solid, 67%. R_f = 0.53 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.6 Hz, 1H), 7.60 (d, *J* = 7.7 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 1H), 7.28 – 7.21 (m, 2H), 7.08 (d, *J* = 7.0 Hz, 2H), 6.93 (t, *J* = 7.2 Hz, 2H), 6.86 (t, *J* = 7.5 Hz, 2H), 5.71 (s, 2H), 4.02 (d, *J* = 17.6 Hz, 1H), 3.49 (d, *J* = 17.6 Hz, 1H), 3.38 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.46, 169.67, 148.55, 148.44, 147.45, 136.57, 131.91, 131.86, 128.31, 127.93, 127.76, 125.79, 125.60, 125.08, 122.36, 121.68, 121.05, 72.54, 68.67, 52.85, 37.35.
^{19}F NMR (376 MHz, $CDCl_3$) δ -62.15.
HRMS (ESI-TOF) calcd for $C_{26}H_{18}F_3NO_3$ $[M+H]^+$ 450.1312, observed 450.1319

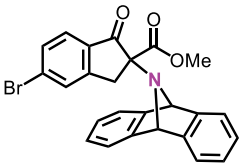


3f: Yellow solid, 81%. R_f = 0.09 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.24 (d, *J* = 1.3 Hz, 2H), 7.15 – 7.07 (m, 2H), 6.95 – 6.83 (m, 5H), 6.79 (s, 1H), 5.69 (s, 2H), 3.96 (s, 3H), 3.84 (s, 3H), 3.70 (d, *J* = 16.5 Hz, 1H), 3.39 (s, 3H), 3.14 (d, *J* = 16.5 Hz, 1H).

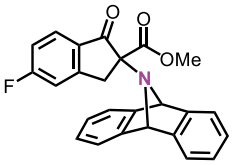
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.68, 170.52, 156.14, 149.75, 148.75, 145.66, 127.96, 125.66, 125.42, 121.53, 121.03, 106.98, 104.94, 73.56, 68.69, 56.44, 56.24, 52.65, 37.99.
HRMS (ESI-TOF) calcd for $C_{27}H_{23}NO_5$ $[M+H]^+$ 442.1649, observed 442.1665



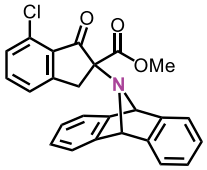
3g: Yellow solid, 50%. R_f = 0.19 (50% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, *J* = 8.7 Hz, 1H), 7.16 – 7.05 (m, 3H), 7.05 – 6.98 (m, 2H), 6.86 – 6.71 (m, 4H), 6.65 (dd, *J* = 8.8, 2.3 Hz, 1H), 6.56 (d, *J* = 2.2 Hz, 1H), 5.59 (s, 2H), 3.76 – 3.69 (m, 4H), 3.57 (d, *J* = 16.5 Hz, 1H), 3.25 – 3.18 (m, 7H), 2.99 (d, *J* = 16.6 Hz, 1H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 197.55, 170.60, 156.37, 152.88, 148.81 (2 overlapping peaks), 126.08, 126.01, 125.52, 125.34, 121.41, 120.98, 114.23, 108.86, 77.42, 77.16, 76.91, 73.36, 68.60, 66.55, 52.49, 47.57, 38.38.
HRMS (ESI-TOF) calcd for $C_{29}H_{26}N_2O_4$ $[M]^+$ 466.1893, observed 466.1898



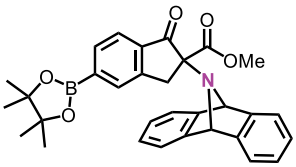
3h: White solid, 75%. R_f = 0.50 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.56 (m, 1H), 7.47 – 7.40 (m, 1H), 7.31 (d, *J* = 8.2 Hz, 1H), 7.23 (dt, *J* = 7.0, 1.0 Hz, 2H), 7.10 (dt, *J* = 6.8, 1.0 Hz, 2H), 6.93 (td, *J* = 7.4, 1.3 Hz, 2H), 6.88 (ddd, *J* = 7.8, 6.9, 1.3 Hz, 2H), 5.69 (s, 2H), 3.80 (d, *J* = 16.9 Hz, 1H), 3.37 (s, 3H), 3.25 (d, *J* = 16.9 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.31, 169.86, 151.60, 148.62, 148.49, 134.00, 131.57, 130.80, 129.43, 125.77, 125.61, 125.57, 121.59, 121.12, 73.26, 68.66, 52.79, 38.10, 31.07.
HRMS (ESI-TOF) calcd for $C_{25}H_{18}BrNO_3$ $[M+H]^+$ 460.0543, observed 460.0542



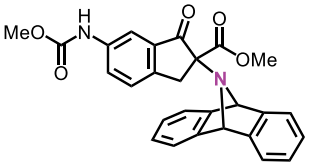
3i: White solid, 64%. R_f = 0.35 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (dd, *J* = 8.5, 5.3 Hz, 1H), 7.23 (dt, *J* = 7.1, 1.0 Hz, 2H), 7.11 (dt, *J* = 6.8, 0.9 Hz, 2H), 7.06 (dd, *J* = 8.4, 2.2 Hz, 1H), 6.99 (td, *J* = 8.7, 2.3 Hz, 1H), 6.93 (td, *J* = 7.5, 1.3 Hz, 2H), 6.88 (ddd, *J* = 7.7, 6.9, 1.3 Hz, 2H), 5.70 (s, 2H), 3.86 – 3.77 (m, 1H), 3.37 (s, 3H), 3.25 (d, *J* = 16.9 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.52, 169.97, 168.87, 166.31, 153.10, 152.99, 148.62, 148.55, 131.54, 126.92, 126.82, 125.74, 125.55, 121.58, 121.07, 116.32, 116.08, 113.03, 112.80, 73.36, 68.67, 52.75, 38.31, 31.06, 29.42.
^{19}F NMR (376 MHz, $CDCl_3$) δ -101.16.
HRMS (ESI-TOF) calcd for $C_{25}H_{18}NO_3F$ $[M+H]^+$ 400.1343, observed 400.1358



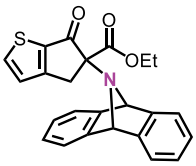
3j: White solid, 67%. R_f = 0.28 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (t, *J* = 7.7 Hz, 1H), 7.30 (dq, *J* = 7.6, 0.9 Hz, 1H), 7.24 (ddd, *J* = 7.1, 1.6, 0.9 Hz, 3H), 7.14 – 7.04 (m, 2H), 6.96 – 6.85 (m, 4H), 5.72 (s, 2H), 3.82 (d, *J* = 16.8 Hz, 1H), 3.38 (s, 3H), 3.27 (dt, *J* = 16.7, 1.0 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 197.36, 169.96, 152.19, 148.58, 148.45, 135.67, 132.65, 131.43, 129.65, 125.85, 125.65, 124.42, 121.59, 120.96, 73.51, 68.67, 52.78, 38.02.
HRMS (ESI-TOF) calcd for $C_{25}H_{18}NO_3Cl$ $[M+H]^+$ 416.1048, observed 416.1062



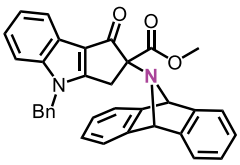
3k: Yellow solid, 52%. R_f = 0.45 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 – 7.81 (m, 1H), 7.71 (dd, *J* = 7.6, 0.9 Hz, 1H), 7.40 (dd, *J* = 7.6, 0.8 Hz, 1H), 7.22 (dt, *J* = 7.2, 0.9 Hz, 2H), 7.06 (dt, *J* = 7.0, 1.0 Hz, 2H), 6.92 (td, *J* = 7.5, 1.2 Hz, 2H), 6.86 (ddd, *J* = 7.7, 7.0, 1.2 Hz, 2H), 5.70 (s, 2H), 3.86 – 3.73 (m, 1H), 3.38 (s, 3H), 3.26 (d, *J* = 16.6 Hz, 1H), 1.37 (s, 9H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 201.04, 170.28, 148.86, 148.82, 148.60, 137.20, 133.89, 132.41, 125.69, 125.46, 123.37, 121.54, 121.14, 84.53, 73.46, 68.64, 52.66, 38.49, 25.07, 25.00. (C(*ipso*)-B not detected)
^{11}B NMR (128 MHz, $CDCl_3$) δ 30.86.
HRMS (ESI-TOF) calcd for $C_{31}H_{30}NO_3B$ $[M+H]^+$ 508.2290, observed 508.2303



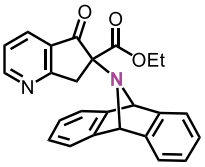
3l: White solid, 42%. R_f = 0.80 (70% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.77 (s, 1H), 7.35 – 7.29 (m, 2H), 7.25 – 7.21 (m, 2H), 7.10 (dd, *J* = 6.4, 1.3 Hz, 2H), 6.95 – 6.82 (m, 5H), 5.72 (s, 2H), 3.83 – 3.74 (m, 4H), 3.34 (s, 3H), 3.22 (d, *J* = 16.5 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 200.19, 170.11, 154.02, 148.69, 148.61, 144.89, 138.00, 135.83, 126.65, 126.50, 125.69, 125.46, 121.55, 121.07, 113.55, 77.36, 73.72, 68.68, 52.66, 37.95.
HRMS (ESI-TOF) calcd for $C_{27}H_{22}N_2O_5$ $[M+H]^+$ 455.1601, observed 455.1605



3m: Yellow solid, 71%. R_f = 0.18 (20% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 4.8 Hz, 1H), 7.25 – 7.20 (m, 2H), 7.16 – 7.09 (m, 2H), 6.99 (d, *J* = 4.8 Hz, 1H), 6.96 – 6.86 (m, 4H), 5.68 (s, 2H), 3.92 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.80 (dq, *J* = 10.8, 7.1 Hz, 1H), 3.65 (d, *J* = 16.8 Hz, 1H), 3.13 (d, *J* = 16.9 Hz, 1H), 1.16 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 190.98, 169.67, 163.70, 148.80, 148.67, 141.24, 139.16, 125.74, 125.54, 123.60, 121.52, 120.97, 78.01, 68.63, 61.89, 36.41, 14.00.
HRMS (ESI-TOF) calcd for $C_{24}H_{19}NO_3S$ $[M+H]^+$ 402.1158, observed 402.1159

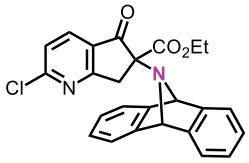


3n: Yellow oil, 67%. R_f = 0.20 (30% EtOAc/Hexanes)
^{1}H NMR (600 MHz, $CDCl_3$) δ 7.90 – 7.84 (m, 1H), 7.37 – 7.31 (m, 3H), 7.25 – 7.22 (m, 3H), 7.20 (dt, *J* = 5.8, 2.3 Hz, 4H), 7.09 (dd, *J* = 7.8, 1.8 Hz, 2H), 6.94 – 6.87 (m, 4H), 5.67 (s, 2H), 5.21 – 5.12 (m, 2H), 3.53 (d, *J* = 16.9 Hz, 1H), 3.40 (s, 3H), 2.83 (d, *J* = 16.9 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 187.96, 170.67, 164.27, 148.93, 148.61, 142.65, 135.30, 129.20, 128.34, 126.93, 125.61, 125.54, 124.02, 122.82, 122.10, 121.57, 121.33, 121.12, 117.78, 110.79, 78.57, 68.71, 52.76, 48.36, 31.89.
HRMS (ESI-TOF) calcd for $C_{34}H_{26}N_2O_3$ $[M+H]^+$ 511.2016, observed 511.2028

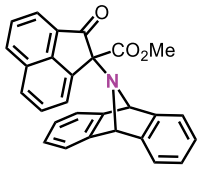


3o: Green solid, 23%. R_f = 0.26 (50% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.78 (dd, *J* = 4.8, 1.7 Hz, 1H), 7.59 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.30 (dd, *J* = 5.2, 3.1 Hz, 4H), 7.22 (t, *J* = 5.9 Hz, 3H), 7.02 (d, *J* = 7.1 Hz, 2H), 6.98 – 6.89 (m, 6H), 6.88 – 6.79 (m, 2H), 5.68 (s, 2H), 4.00 – 3.81 (m, 3H), 3.48 (d, *J* = 17.7 Hz, 1H), 1.16 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.78, 169.60, 169.54, 156.25, 148.85, 148.45, 131.93, 128.81, 125.73, 125.49, 122.91, 121.69, 120.91, 77.48, 77.16, 76.84, 73.11, 68.68, 62.05, 41.11, 13.97.

HRMS (ESI-TOF) calcd for $C_{25}H_{20}N_2O_3$ $[M+H]^+$ 397.1547, observed 397.1555

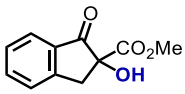


3p: Yellow solid, 60%. R_f = 0.26 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (d, *J* = 8.1 Hz, 1H), 7.19 – 7.14 (m, 3H), 6.98 (d, *J* = 7.1 Hz, 2H), 6.93 – 6.74 (m, 4H), 5.59 (s, 2H), 3.94 – 3.74 (m, 3H), 3.40 – 3.32 (m, 1H), 1.09 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.31, 170.70, 169.18, 158.34, 148.78, 148.32, 134.04, 127.70, 125.83, 125.58, 123.91, 121.75, 120.98, 73.32, 68.67, 62.21, 40.79, 13.97.
HRMS (ESI-TOF) calcd for $C_{25}H_{19}ClN_2O_3$ $[M+H]^+$ 431.1157, observed 431.1152

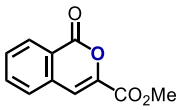


3q: Yellow solid, 42%. R_f = 0.58 (40%EtOAc/hexanes)
^{1}H NMR (500 MHz, $CDCl_3$) δ 8.06 (d, *J* = 8.1 Hz, 1H), 7.93 (d, *J* = 8.3 Hz, 1H), 7.68 (t, *J* = 7.6 Hz, 1H), 7.64 – 7.56 (m, 2H), 7.49 (d, *J* = 7.0 Hz, 1H), 7.13 (d, *J* = 7.2 Hz, 2H), 6.90 – 6.80 (m, 4H), 6.74 (t, *J* = 7.4 Hz, 2H), 5.38 (s, 2H), 3.58 (s, 3H).
13C NMR (126 MHz, $CDCl_3$) δ 199.86, 170.06, 149.54, 148.47, 141.38, 136.74, 132.31, 131.47, 130.88, 128.57, 128.20, 125.82, 125.68, 125.34, 122.22, 121.84, 121.27, 120.92, 75.29, 69.19, 52.89, 31.73.
HRMS (ESI-TOF) calcd for $C_{28}H_{19}NO_3$ $[M+H]^+$ 418.1438, observed 418.1447

<u>Characterization Data of Side Products</u>

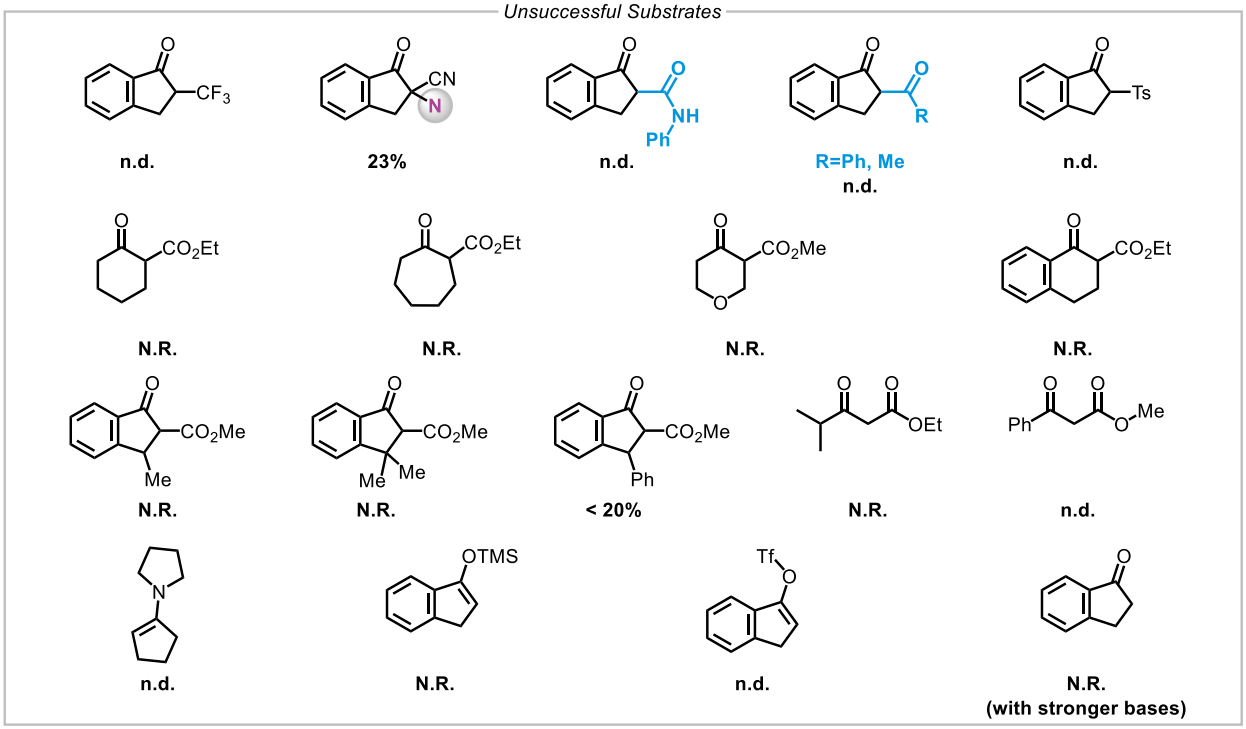


S1: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.80 (dd, *J* = 7.3, 4.3 Hz, 2H), 7.71 – 7.65 (m, 1H), 7.50 (dd, *J* = 7.7, 0.9 Hz, 2H), 7.44 (t, *J* = 7.6 Hz, 2H), 3.97 (d, *J* = 0.7 Hz, 1H), 3.76 – 3.71 (m, 4H), 3.26 (d, *J* = 17.2 Hz, 1H).
The NMR is in agreement with the literature.[5]



S2: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.37 (d, *J* = 7.9 Hz, 1H), 7.81 (td, *J* = 7.6, 1.3 Hz, 1H), 7.67 (td, *J* = 7.7, 1.2 Hz, 1H), 7.61 (d, *J* = 7.8 Hz, 1H), 7.51 (s, 1H), 3.97 (s, 3H).
The NMR is in agreement with the literature.[6]

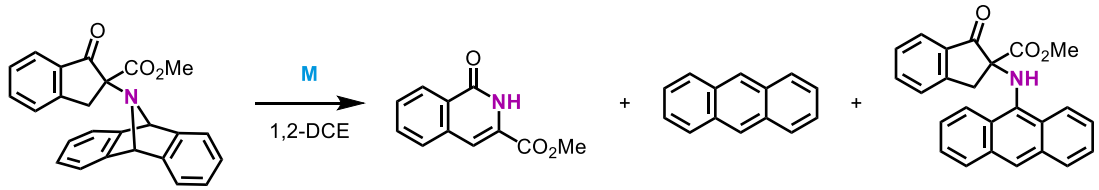
Unsuccessful Substrates



Supplemental Figure 3: Unsuccessful substrates in the amination procedure. N.d. = not detected (>50% conversion, no aminated product observed). N.R = no reaction (<15% conversion).

5. Thermal Conversion of Aminated Products to Isoquinolones

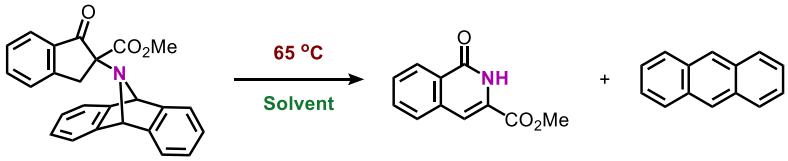
Reaction Optimization



3a 4a 5 S5

M	temp	Conversion	Yield 4a	Yield 5	Yield S5	temp	Conversion	Yield 4a	Yield 5	Yield S5
CuTC	60 °C	0	0	0	0	80 °C	0	0	0	0
$[CpFe(CO)_2]_2$	60 °C	0	0	0	0	80 °C	100	0	10*	10*
$[(cymene)RuCl_2]_2$	60 °C	0	0	0	0	80 °C	20	0	0	20
$Rh(OAc)_4$	60 °C	0	0	0	0	80 °C	0	0	0	0
$W_2(CO)_9$	60 °C	0	0	0	0	80 °C	0	0	0	0
$Pd(PPh_3)_4$	60 °C	0	0	0	0	80 °C	100	0	0	80
$Zn(OTf)_2$	60 °C	100	0	15	30	80 °C	100	0	15	30
none	60 °C	0	0	0	0	80 °C	0	0	0	0

Supplemental Table 5: Screening of metal catalysts

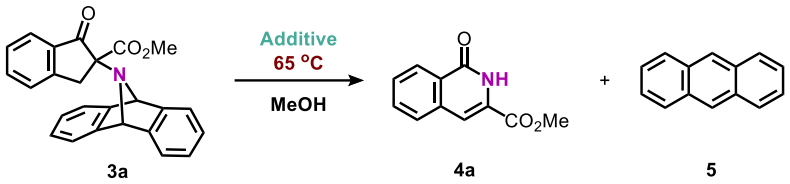


3a 4a 5

solvent	Conversion	Yield 4a	Yield 5	Efficiency
MeOH	67	20	25	**30**
EtOH	23	4	5	**17**
iPrOH	21	0	> 1	**0**
tBuOH	51	0	0	**0**
HFIP	100	0	31	**0**

*Efficiency = (yield A/conversion) * 100*

Supplemental Table 6: Alcohol solvent screen



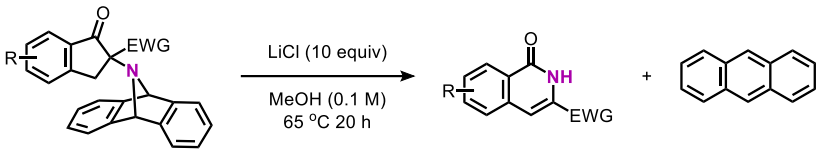
3a 4a 5

Additive	Conversion	Yield 4a	Yield 5	Efficiency
HFIP	50	17	18	**34**
K_2CO_3	100	0	17	**0**
LiCl	100	37	45	**37**
$PhI(OAc)_2$	74	3	5	**4**
$NaBH_4$	100	0	28	**0**
LiCl (10 eq)	97	66	80	**68**

*Efficiency = (yield A/conversion) * 100*

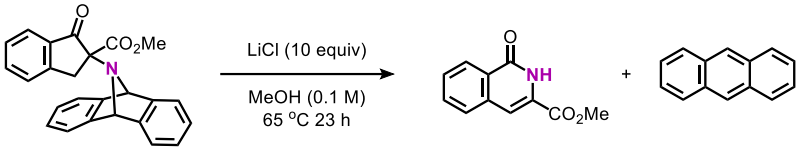
Supplemental Table 7: Additive screen

General Procedure B for synthesis of isoquinolones



A 1 dram vial was charged with amine (0.1 mmol) and LiCl (42 mg; 1 mmol). The vial was evacuated and backfilled three times with N_2, and MeOH (1 mL) was added. The solution was stirred at 65 °C for 24-48 h (monitored by TLC). The reaction was diluted with EtOAc (10 mL) and sat. $NaHCO_3$ (10 mL). The organic layer was separated and the aqueous layer was extracted with EtOAc (10 mL). The combined organic layers were dried over Na_2SO_4 and purified by column chromatography.

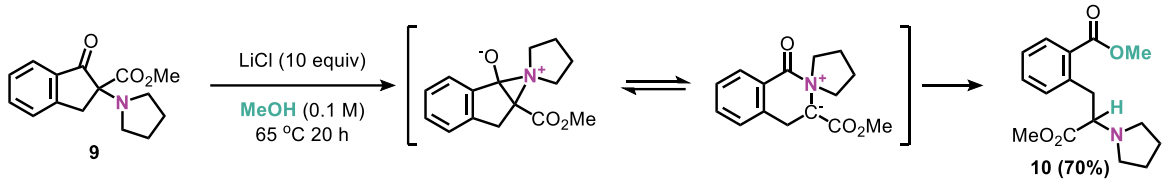
Procedure for Thermal Ring Expansion Scale Up



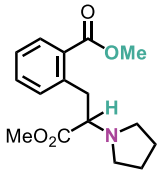
Scale up was performed with minor adjustments to General Procedure B. To a 4 dram septum capped vial, amine (474 mg, 1.2 mmol) and LiCl (520 mg, 12 mmol) were added. The vial containing the solids was exacuated and backfilled with N_2 three times, and MeOH (12 mL) was added. The reaction was stirred at 65 °C until completion by TLC (23 hr). The reaction was diluted with EtOAc (50 mL) and saturated $NaHCO_3$ (50 mL). The organic layer was separated and the aqueous layer was extracted three times with EtOAc (3 x 50 mL). The organic layer was dried with Na_2SO_4 and purified by column chromatography. Product containing fractions were then concentrated, and the product was recrystallized from DCM/hexanes prodviding 106 mg of **4a** (42)%.

Mechanistic Experiments

Reaction of pyrrolidine-substituted indanone

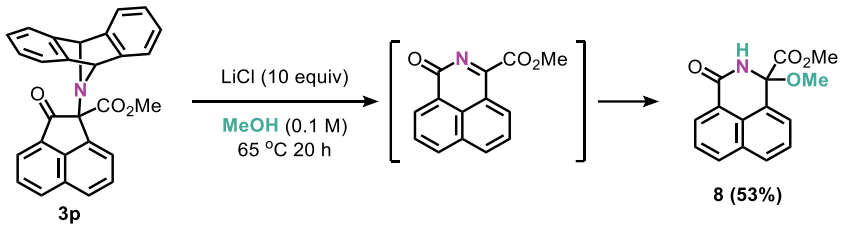


A 1 dram vial was charged with pyrrolidine **9** and LiCl (10 equiv). The vial was evacuated and backfilled with N_2 three times, and MeOH (1 mL) was added. The solution was heated to 65 °C and allowed to stir overnight. Trimethoxybenzene was added as a standard, the solution was diluted with CH_2Cl_2 (10 mL) and washed with sat. $NaHCO_3$ (10 mL). The organic layer was dried over Na_2SO_4, the solvent removed in vacuo, and the residue taken up in $CDCl_3$. The ring opened product **10** was observed in 70% NMR yield.

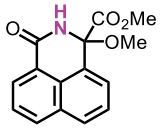


10: Yellow oil. R_f = 0.40 (60% EtOAc/hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.39 (td, *J* = 7.5, 1.5 Hz, 1H), 7.31 – 7.23 (m, 1H), 7.23 – 7.17 (m, 1H), 3.89 (s, 3H), 3.78 (dd, *J* = 12.5, 5.2 Hz, 1H), 3.49 (s, 4H), 3.14 (dd, *J* = 12.5, 10.1 Hz, 1H), 2.84 – 2.63 (m, 4H), 1.88 – 1.74 (m, 4H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.76, 139.63, 132.12, 132.06, 131.13, 129.71, 126.89, 77.48, 77.16, 76.84, 68.49, 52.14, 51.30, 51.16, 36.48, 23.58.
HRMS (ESI-TOF) calcd for $C_{16}H_{21}NO_4$ $[M+H]^+$ 292.1543, observed 292.1537

Trapping of 4H-isoquinolone tautomer

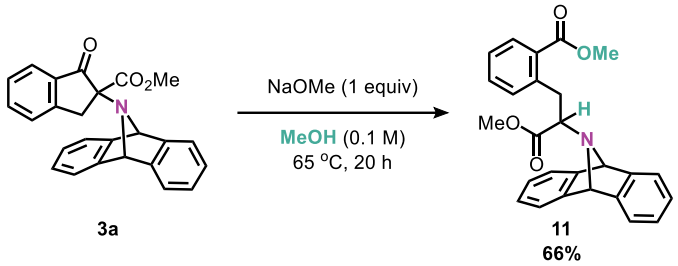


Amine **3p** was subjected to general procedure B. Lactam **8** was isolated in 53% yield.

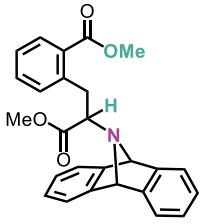


8: Pale pink solid, 53%. R_f = 0.42 (60% EtOAc/hexanes)
^{1}H NMR (600 MHz, $CDCl_3$) δ 8.52 (d, *J* = 7.1 Hz, 1H), 8.15 (d, *J* = 8.2 Hz, 1H), 8.04 (d, *J* = 8.2 Hz, 1H), 7.95 (d, *J* = 7.3 Hz, 1H), 7.70 (dtd, *J* = 9.7, 7.8, 1.6 Hz, 2H), 6.55 (s, 1H), 3.78 (d, *J* = 1.6 Hz, 3H), 3.16 (d, *J* = 1.6 Hz, 3H).
^{13}C NMR (151 MHz, $CDCl_3$) δ 169.27, 164.23, 133.30, 132.38, 129.91, 128.59, 128.26, 127.13, 126.62, 126.47, 125.62, 122.53, 88.58, 77.37, 77.16, 76.95, 53.84, 50.55.
HRMS (ESI-TOF) calcd for $C_{10}H_8N_2O_3$ $[M+H]^+$ 272.0917, observed 272.0912

Isolation of Retro-Dieckmann product

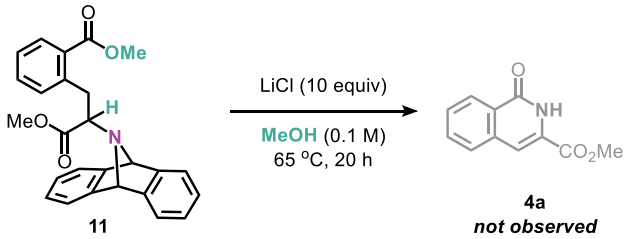


A 2 dram vial was charged with **3a** (38 mg, 0.1 mmol) and evacuated and refilled with N_2 three times. A solution of NaOMe in MeOH (0.1 M, 1mL) was added, and the reaction stirred at 65 °C overnight. After cooling to room temperature, the reaction was quenched with saturated NH_4Cl (4 mL), diluted with water (6 mL), and extracted with CH_2Cl_2 (3 x 5 mL). The organic layers were collected, dried over Na_2SO_4, and purified by column chromatography (0-30% EtOAc/hexanes).



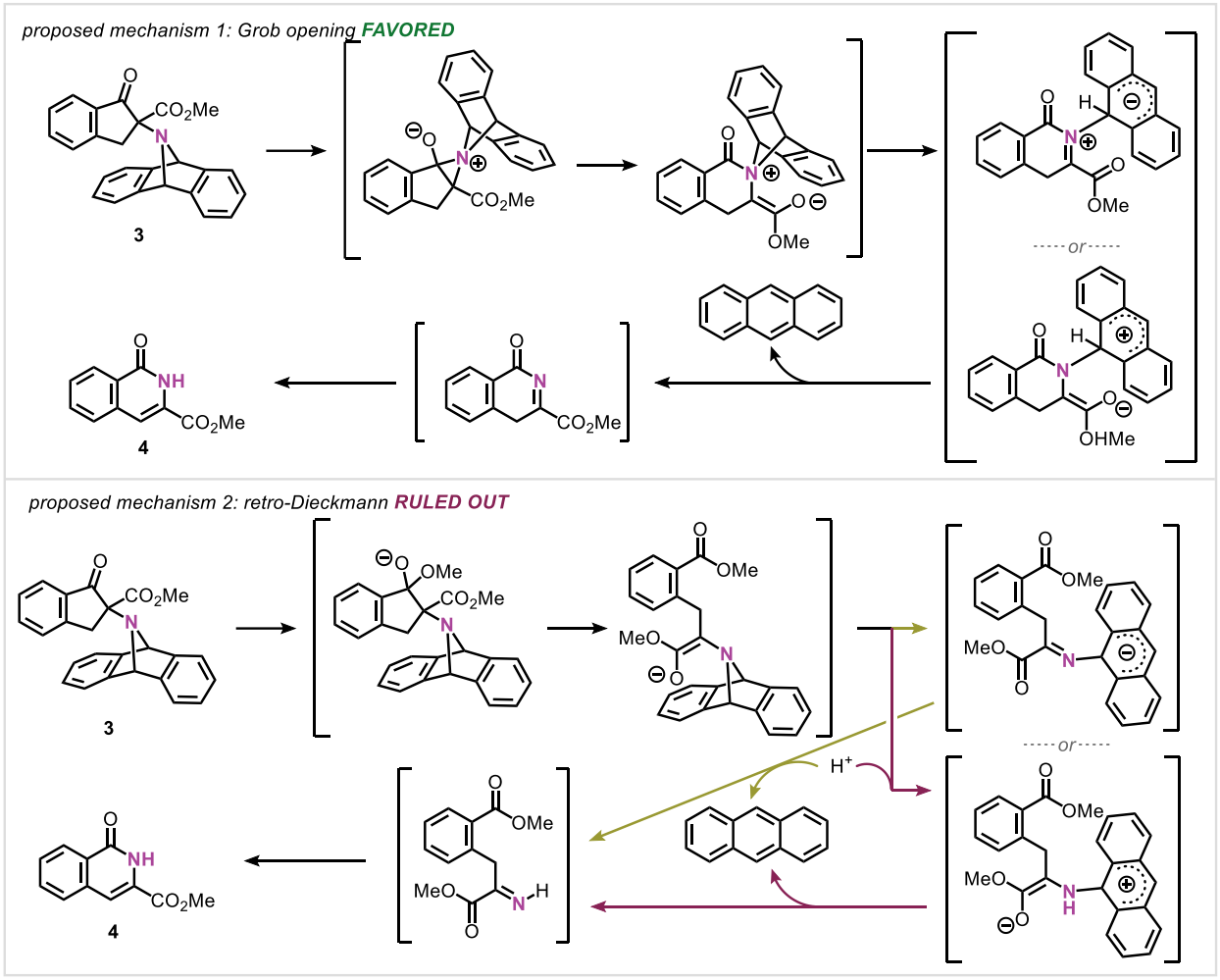
11: white solid, 66%. R_f = 0.50 (30% EtOAc/hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.39 – 7.31 (m, 3H), 7.31 – 7.19 (m, 4H), 7.11 (dd, *J* = 7.6, 1.3 Hz, 1H), 7.03 – 6.92 (m, 4H), 5.22 (s, 2H), 3.91 (t, *J* = 9.4 Hz, 1H), 3.79 (s, 3H), 3.50 (s, 3H), 3.16 (d, *J* = 8.6 Hz, 2H).
^{13}C NMR (151 MHz, $CDCl_3$) δ 172.40, 167.31, 147.65, 147.30, 139.19, 132.09, 131.91, 131.04, 129.47, 126.98, 125.90, 125.70, 122.48, 121.99, 70.14, 63.82, 52.00, 51.55, 36.83.
HRMS (ESI-TOF) calcd for $C_{26}H_{23}NO_4$ $[M+H]^+$ 414.1700, observed 414.1722

*Subjecting Retro-Dieckmann product **11** to Thermal Ring Expansion conditions*



Following general procedure B with **11** in place of **3a**, no isoquinolone (**4a**) was observed. 55% of **11** remained unreacted.

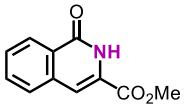
Mechanistic Proposal



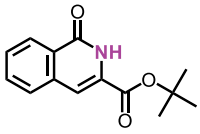
Supplemental Figure 4: Mechanistic possibilities investigated for thermal ring expansion.

Resubjection of **11** to the thermal reaction conditions allow us to rule out a mechanism in which a retro-Dieckmann reaction is followed by ring closing to generate **4** (Figure S4, bottom). Instead, we favor a mechanism similar to that proposed by Christoffers (Figure S4, top).[7] Intramolecular aziridination and Grob-type ring expansion give a zwitterionic species that is primed to extrude anthracene by an enolate-assisted C-N bond cleavage event.

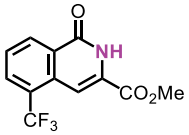
Characterization Data of Isoquinolones



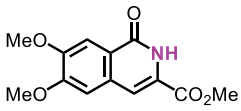
4a: White solid, 70% (from 3a/3b), 55% (from 3c), 42% (on 1.2 mmol scale from 3a). R_f = 0.10 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.10 (s, 1H), 8.46 (ddt, *J* = 8.0, 1.4, 0.7 Hz, 1H), 7.78 – 7.57 (m, 3H), 7.38 (d, *J* = 0.8 Hz, 1H), 3.99 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 162.33, 161.94, 136.06, 133.12, 129.46, 128.41, 128.24, 128.00, 127.89, 111.42, 53.27.
The NMR are in alignment with reported data.[8]



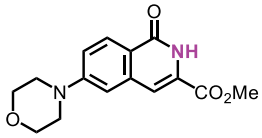
4d: Tan solid, 68%. R_f = 0.35 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.13 (s, 1H), 8.44 (ddt, *J* = 8.0, 1.5, 0.7 Hz, 1H), 7.75 – 7.63 (m, 2H), 7.60 (ddd, *J* = 8.3, 6.9, 1.5 Hz, 1H), 7.28 (s, 1H), 1.62 (s, 9H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 161.91, 160.73, 136.34, 133.07, 129.24, 129.18, 128.23, 128.14, 128.00, 110.72, 84.02, 28.22.
The NMR are in alignment with reported data.[9]



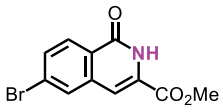
4e:White solid, 47%. Rf = 0.16 (30% EtOAc/hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.48 (s, 1H), 8.69 (ddt, *J* = 8.1, 1.4, 0.7 Hz, 1H), 8.07 (ddt, *J* = 7.6, 1.4, 0.8 Hz, 1H), 7.69 (tt, *J* = 7.6, 0.8 Hz, 1H), 7.62 (qd, *J* = 1.8, 0.7 Hz, 1H), 4.03 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 161.95, 160.80, 133.31, 132.05, 130.74 (q, J=5.39 Hz), 129.65, 129.26, 128.29, 127.06 (q, J=196.2 Hz), 106.38 (q, J= 2.89 Hz), 53.57. (*C*F_3 not detected)
^{19}F NMR (376 MHz, $CDCl_3$) δ -59.24.
HRMS (ESI-TOF) calcd for $C_{12}H_8F_3NO_3$ $[M+H]^+$ 272.0529, observed 272.0534



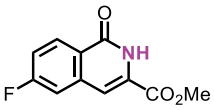
4f: Yellow solid, 44%. R_f = 0.09 (70% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.12 (s, 1H), 7.82 (s, 1H), 7.32 (s, 1H), 7.01 (s, 1H), 4.03 (s, 3H), 4.00 (s, 3H), 3.97 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 162.40, 161.18, 153.91, 151.36, 131.29, 126.43, 122.89, 111.28, 108.16, 107.98, 56.52, 56.36, 53.18.
HRMS (ESI-TOF) calcd for $C_{13}H_{13}NO_5$ $[M+H]^+$ 264.0866, observed 264.0870



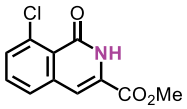
4g: R_f = 0.27 (70% EtOAc/2% MeOH/28% hexanes)
HRMS (ESI-TOF) calcd for $C_{15}H_{16}N_2O_4$ $[M+H]^+$ 289.1183, observed 289.1176



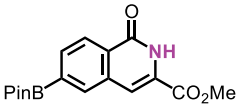
4h: Tan solid, 50%. R_f = 0.43 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.06 (s, 1H), 8.30 (d, *J* = 8.5 Hz, 1H), 7.84 (d, *J* = 1.9 Hz, 1H), 7.72 (dd, *J* = 8.5, 1.9 Hz, 1H), 4.00 (s, 3H).
Poor solubility in all attempted solvents ($CDCl_3$, THF, Toluene, DMSO, pyridine) prevented the acquisition of a suitable ^{13}C NMR.
HRMS (ESI-TOF) calcd for $C_{11}H_8BrNO_3$ $[M+H]^+$ 330.1507, observed 330.1513



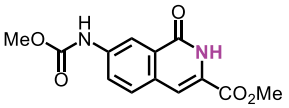
4i: Tan solid, 62%. R_f = 0.16 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.19 (s, 1H), 8.47 (dd, *J* = 9.4, 5.7 Hz, 1H), 7.37 – 7.28 (m, 3H), 4.00 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.84, 164.31, 162.09, 161.13, 138.53, 138.43, 131.32, 131.22, 129.12, 125.03, 118.12, 117.88, 113.41, 113.19, 110.47, 110.44, 53.50, 29.84.
^{19}F NMR (376 MHz, $CDCl_3$) δ -104.86.
The NMR are in alignment with reported data.[9]



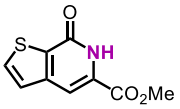
4j: Tan solid, 52%. R_f = 0.16 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.11 (s, 1H), 7.62 – 7.51 (m, 3H), 3.99 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 161.84, 160.19, 139.27, 136.20, 132.87, 132.58, 128.54, 127.52, 124.89, 110.82, 53.43.
The NMR are in alignment with reported data.[10]



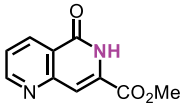
4k: This compound was prepared by a slight modification of general procedure B. After refluxing overnight in MeOH with 10 equivalents of LiCl, the solvent was removed and replaced with dichloromethane (1 mL). Et_3N (83 µL; 6 equiv) and pinacol (28 mg; 2.4 equiv) were added and the reaction stirred at room temperature for 2 hours. The solvent was removed by rotary evaporation, and the crude mixture purified by column chromatography.
White solid, 26%. R_f = 0.37 (70% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.12 (s, 1H), 8.43 (d, *J* = 8.0 Hz, 1H), 8.14 (s, 1H), 8.02 (dd, *J* = 8.0, 1.1 Hz, 1H), 7.39 (s, 1H), 3.99 (s, 3H), 1.38 (s, 12H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 162.39, 161.84, 135.38, 135.24, 135.13, 130.17, 127.65, 127.01, 111.70, 84.65, 53.35, 25.06. (C(*ipso*)-B not detected)
^{11}B NMR (128 MHz, $CDCl_3$) δ 30.72
HRMS (ESI-TOF) calcd for $C_{17}H_{20}BNO_5$ $[M+H]^+$ 330.1507, observed 330.1513



4l: Tan solid, 21%. R_f = 0.22 (70% EtOAc/hexanes)
^{1}H NMR (400 MHz, Pyr) δ 12.97 (s, 1H), 11.32 (s, 1H), 9.13 (d, *J* = 2.3 Hz, 1H), 8.36 (d, *J* = 8.7 Hz, 1H), 7.73 (d, *J* = 8.6 Hz, 1H), 7.40 (s, 1H), 3.84 (s, 3H), 3.75 (s, 4H).
Poor solubility in all attempted solvents ($CDCl_3$, THF, Toluene, DMSO, pyridine) prevented the acquisition of a suitable ^{13}C NMR.
HRMS (ESI-TOF) calcd for $C_{13}H_{12}N_2O_5$ $[M+H]^+$ 277.0819, observed 277.0825



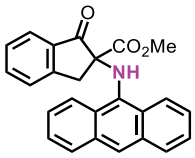
4m: Orange solid, 27%. R_f = 0.23 (70% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.34 (br, 1H), 7.80 (d, *J* = 5.2 Hz, 1H), 7.50 (s, 1H), 7.35 (d, *J* = 5.1 Hz, 1H), 3.99 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 162.25, 157.93, 144.69, 134.98, 134.52, 129.45, 125.62, 107.51, 53.42.
The NMR are in alignment with reported data.[8]



4o: White solid, 25%. R_f = 0.27 (70% EtOAc/2% MeOH/28% hexanes)
^{1}H NMR (500 MHz, $CDCl_3$) δ 9.32 (s, 1H), 9.01 (dd, *J* = 4.5, 1.8 Hz, 1H), 8.73 – 8.67 (m, 1H), 7.56 (s, 1H), 7.52 (dd, *J* = 8.1, 4.6 Hz, 1H), 4.03 (s, 3H).

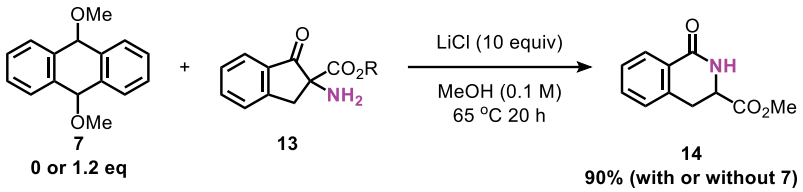
^{13}C NMR (101 MHz, $CDCl_3$) δ 162.17, 161.75, 155.43, 153.50, 136.12, 131.15, 124.87, 123.77, 112.61, 53.71.
HRMS (ESI-TOF) calcd for $C_{10}H_8N_2O_3$ $[M+H]^+$ 205.0608, observed 205.0616

Characterization Data of Side Products

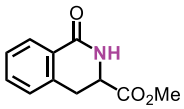


S5: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (ddt, *J* = 7.6, 4.7, 1.9 Hz, 2H), 8.14 (s, 1H), 7.90 – 7.83 (m, 2H), 7.74 (dt, *J* = 7.7, 1.0 Hz, 1H), 7.39 – 7.30 (m, 5H), 7.28 – 7.22 (m, 1H), 6.99 (dt, *J* = 7.6, 0.9 Hz, 1H), 5.61 (s, 1H), 3.75 (s, 3H), 3.34 (d, *J* = 17.3 Hz, 1H), 2.62 (d, *J* = 17.3 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 203.40, 172.35, 152.88, 136.31, 135.87, 133.81, 132.06, 129.17, 128.75, 128.01, 126.22, 125.73, 125.43, 125.14, 124.02, 73.77, 53.76, 51.02, 35.24.
HRMS (ESI-TOF) calcd for $C_{25}H_{19}NO_3$ $[M+H]^+$ 382.1438, observed 382.1445

Primary amine reaction under thermal conditions



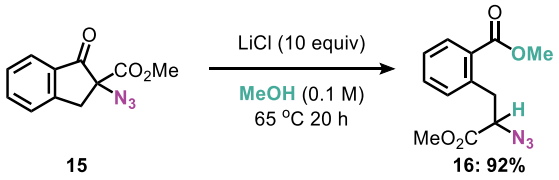
A 1 dram vial was charged with primary amine **13** and LiCl (10 equiv). The vial was evacuated and backfilled with N_2 three times, and MeOH (1 mL) was added. The solution was heated to 65 °C and allowed to stir overnight. Trimethoxybenzene was added as a standard, the solution was diluted with CH_2Cl_2 (10 mL) and washed with sat. $NaHCO_3$ (10 mL). The organic layer was dried over Na_2SO_4, the solvent removed in vacuo, and the residue taken up in $CDCl_3$. 3,4-dihydroisoquinolone **14** was observed in 90% NMR yield. This result is expected based off previous precedent,[7] though notably, neither adventitious O_2 nor dimethoxydihydroanthracene (**7**) was insufficient to oxidize **14** to **4a**.



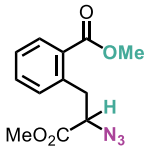
14: ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.46 (td, *J* = 7.5, 1.5 Hz, 1H), 7.40 – 7.33 (m, 1H), 7.25 – 7.21 (m, 1H), 6.61 (s, 1H), 4.41 (ddd, *J* = 9.7, 5.2, 2.0 Hz, 1H), 3.78 (s, 3H), 3.32 (dd, *J* = 15.7, 5.2 Hz, 1H), 3.21 (dd, *J* = 15.7, 9.8 Hz, 1H).

The NMR are in agreement with the literature.[7]

Azide reaction under thermal conditions



Following general procedure B, methyl 2-(2-azido-3-methoxy-3-oxopropyl)benzoate **16** was observed in 92% NMR yield and isolated in 85% yield.



16: pale yellow oil. R_f = 0.63 (33% EtOAc/hexanes)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.41 (td, *J* = 7.5, 1.5 Hz, 1H), 7.29 (td, *J* = 7.6, 1.4 Hz, 1H), 7.25 – 7.20 (m, 1H), 4.25 (dd, *J* = 9.1, 5.5 Hz, 1H), 3.84 (s, 3H), 3.69 (s, 3H), 3.57 (dd, *J* = 13.3, 5.5 Hz, 1H), 3.17 (dd, *J* = 13.3, 9.0 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 170.79, 167.61, 138.16, 132.66, 132.51, 131.42, 129.55, 127.62, 62.97, 52.73, 52.32, 36.76.

HRMS (ESI-TOF) calcd for $C_{12}H_{13}N_3O_4$ $[M+H]^+$ 264.0979, observed 264.0982

IR (ATR) 2106 cm^{-1} (N_3), 1742 cm^{-1} (C=O), 1715 cm^{-1} (C=O)

6. Photochemical conversion of aminated products to isoquinolines

Photochemical Reactor Setup for HTE Screening

The Lumidox® II Controller manufactured by Analytical Sales and Services, was connected to either a 96-Position Discovery LED Array 1, 96-Position Discovery LED Array 2, or 96-Position 420 nm Single Wavelength LED Array. Reactions were run with the intensity setting run of 1/5 (watt/amp details below). The LED array plates were cooled in a tumblestirrer connected with a liquid chiller set at 5°C, which maintained an internal temerpature of 20-25 °C for the reaction plate. The reactions were run in 1mL 8x30mm glass inserts inside a standard Para-dox® 96 position block for Photoredox Catalysis. The vials were equipped with a stir bar that was stirred via a tumblestirrer set at approximately 650-750 rpm.

96-Position Discovery LED Array 1

- LED Arrangement: 375 nm wells A1:H4, 385 nm wells A5:H8, 395 nm wells A9:H12
- Intensity setting 1/5 delivers 62.5 mA per well

96-Position Discovery LED Array 2

- LED Arrangement: 405 nm wells A1:H3, 445 nm wells A4:H6, 470 nm wells A7:H9, 590 nm wells A10:H12
- Intensity setting 1/5 delivers 62.5 mA per well

96-Position 420 nm Single Wavelength LED Array:

- LED Arrangement: 420 nm wells A1:H12
- Intensity setting 1/5 delivers 75.0 mW per well

Product Page: Lumidox® II LED Arrays & Lamps - Analytical Sales and Services, Inc. (analytical-sales.com)

Reaction Setup for HTE Screens

In a nitrogen filled glovebox, separate stock solutions containing substrate, photocatalyst, and additive were prepared in MeOH. These prepared stock solutions were dosed using pipettes across the reaction blocks to arrive at a total of 100 µL of MeOH with a reaction concentration of 0.02 M. The reaction blocks were then sealed with a PFA lined silicone mat, removed from the glovebox, and irradiated for 18 hours using the equipment setup described above. The reactions were then quenched with a 70:30 MeCN:DMSO quench solution (**QS-1** or **QS-2**) that contained *N,N*-dibenzylaniline as internal standard and acetic acid. A 125 µL aliquot was taken from each reaction well and diluted with 650 µL of acetonitrile to afford a sample that was analyzed using UPLC-MS. All data is reported as a ratio between the desired product and the internal standard. Analysis was completed using PyParse (an automated, accurate and accessible program for data extraction from HTE).[11]

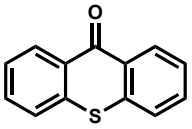
Quench Solutions

- **QS-1:** containing *N,N*-dibenzylaniline at 0.0001 M and AcOH at 0.01 M in DMSO
- **QS-2:** containing *N,N*-dibenzylaniline at 0.001 M and AcOH at 0.1 M in DMSO

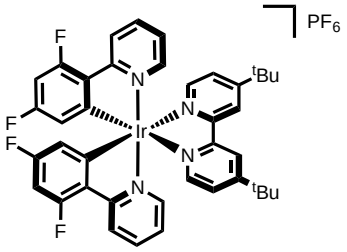
LCMS Conditions

- **Formic acid:** Acquity UPLC CSH C18 column (30mm x 2.1mm i.d., 1.7µm packing diameter) at 45 °C, 1 - 100% 0.1% v/v solution of Formic Acid in Acetonitrile in 0.1% v/v solution of Formic Acid in Water over 2 min at 1.3 ml/min. Inject: 0.5 ul. UV detection was an averaged signal from wavelength of 210 nm to 350 nm.
- **HPH:** Acquity UPLC CSH C18 column (30mm x 2.1mm i.d., 1.7µm packing diameter) at 45 °C, 1 - 100% Acetonitrile in 10 mM Ammonium Bicarbonate in H2O adjusted to pH 10 with Ammonia over 2 min at 1.3 ml/min. Inject: 0.5 ul. UV detection was an averaged signal from wavelength of 210 nm to 350 nm.

Photocatalysts Used for HTE



CAS 492-22-8
PC-1



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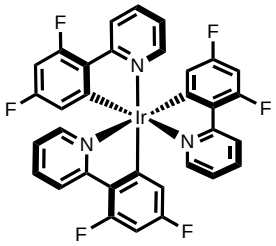
PC-2



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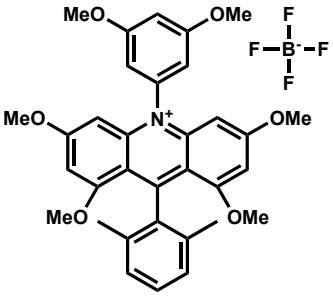
PC-3



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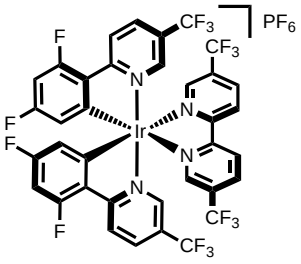
PC-4



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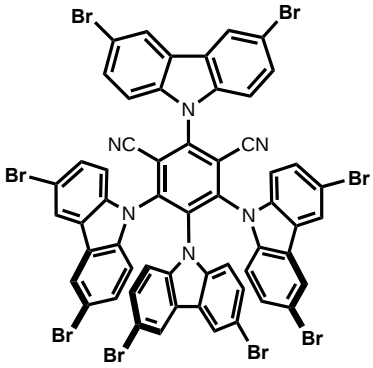
PC-5



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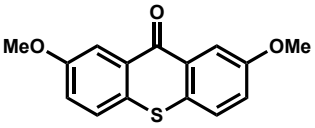

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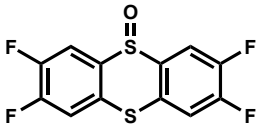

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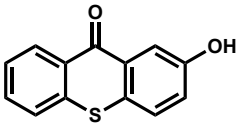
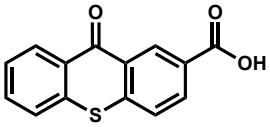


CAS 31696-67-0
PC-9



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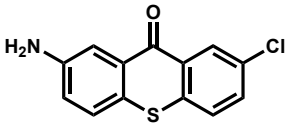
PC-10



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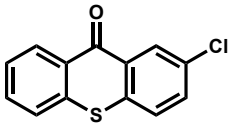
PC-11



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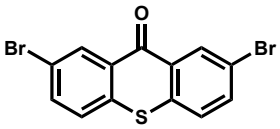
PC-12



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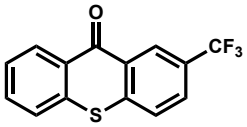

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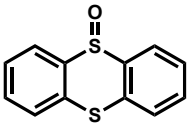

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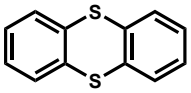
PC-15



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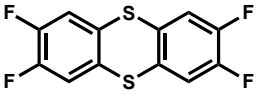
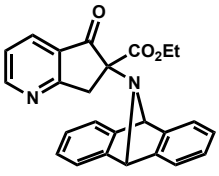
PC-16

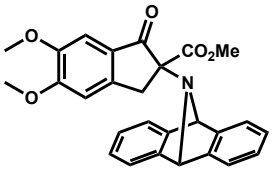


CAS 1225203-47-3
PC-17

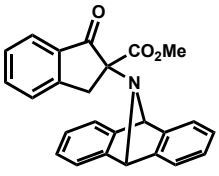
Substrates used for HTE



Sub-1



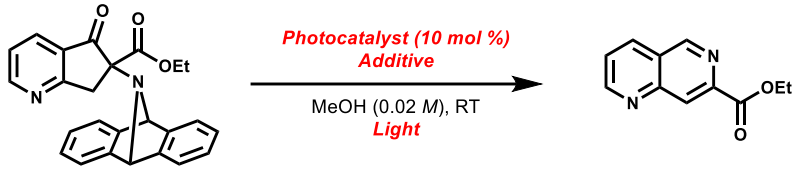
Sub-2



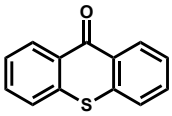
Sub-3

HTE Results

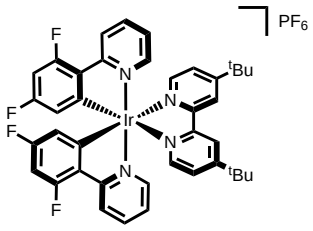
Wavelength screening across three photocatalysts and acetic or benzoic acid additive. Quenched using 600uL of **QS-1** per reaction to arrive at 6 mol % of internal standard relative to **Sub-1.**



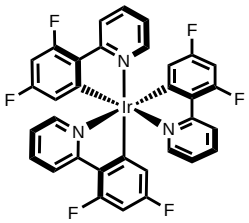
Sub-1	Pdt/IS	Wavelength						
Photocatalyst	Additive	375 nm	385 nm	395 nm	405 nm	445 nm	470 nm	590 nm
None	None	0.04	0.61	0.29	0.1	0.05	0.09	0.02
PC-1	None	0.07	0.06	0.56	0.51	0.12	0.04	0
PC-2	None	0.11	0.19	0.53	0.33	0.3	0.18	0.07
PC-3	None	0	0.1	0.11	0	0	0	0
PC-1	BzOH	0.22	0.18	0.38	0.5	0.67	0.29	0.08
PC-2	BzOH	0.16	0.28	0.5	0.43	0.36	0.39	0.56
PC-3	BzOH	0	0	0.05	0.09	0.04	0	0
PC-1	AcOH	0.12	0.17	0.36	0.55	0.67	0.33	0.11



CAS 492-22-8
PC-1

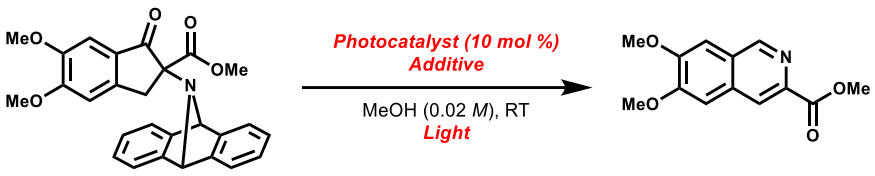


CAS 1072067-44-7
PC-2

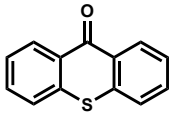


CAS 387859-70-3
PC-3

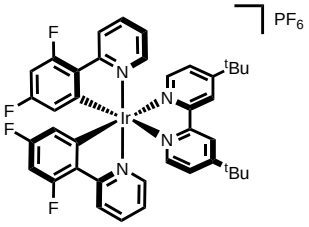
Wavelength screening across three photocatalysts and acetic or benzoic acid additive. Quenched using 600uL of **QS-1** per reaction to arrive at 6 mol % of internal standard relative to **Sub-2.**



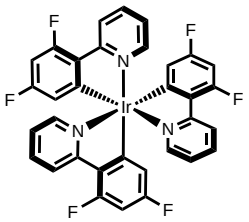
Sub-2	Pdt/IS	Wavelength						
Photocatalyst	Additive	375 nm	385 nm	395 nm	405 nm	445 nm	470 nm	590 nm
None	None	1	0.76	3.45	0.97	0.24	0.03	0
PC-1	None	0.57	0.59	1.43	1.05	0.72	0.28	0.17
PC-2	None	1.05	0.69	0.94	0.97	0.75	0.63	0.91
PC-3	None	0.86	1.8	1.34	0.7	0.7	0.97	0.4
PC-1	BzOH	1.4	1.27	1.4	1.06	1.11	1.05	0.75
PC-2	BzOH	0	1.84	0.08	1.18	1.06	1.12	1.2
PC-3	BzOH	1.24	1.49	1.24	1.32	1.05	0.99	0.84
PC-1	AcOH	0.03	1.3	0.05	1.04	1.07	1	0.86



CAS 492-22-8
PC-1

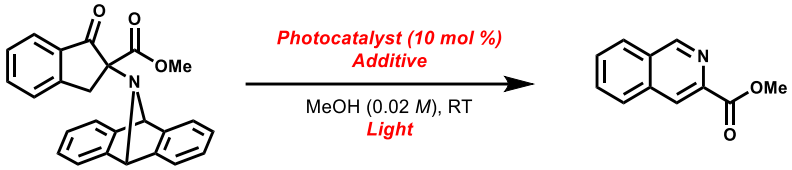


CAS 1072067-44-7
PC-2

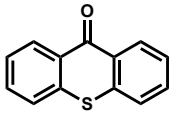


CAS 387859-70-3
PC-3

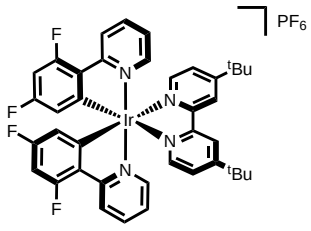
Wavelength screening across three photocatalysts and acetic or benzoic acid additive. Quenched using 600uL of **QS-1** per reaction to arrive at 6 mol % of internal standard relative to **Sub-3.**



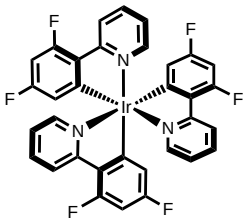
Sub-3	Pdt/IS	Wavelength						
Photocatalyst	Additive	375 nm	385 nm	395 nm	405 nm	445 nm	470 nm	590 nm
None	None	1.34	1.34	1.62	0.73	0.27	0.05	0.02
PC-1	None	0.9	0.94	1.13	1.07	0.77	0.24	0.15
PC-2	None	0.91	1.74	0.99	0.84	0.91	0.43	0.51
PC-3	None	0.52	0.44	0	0.21	0.13	0.08	0.02
PC-1	BzOH	0.03	0.76	0.92	0.85	0.37	0.27	0.1
PC-2	BzOH	0.04	1.02	0.99	0.78	0.88	0.88	0.52
PC-3	BzOH	0.05	0.26	0.11	0.23	0.17	0.09	0.04
PC-1	AcOH	0	0.84	0.97	0.84	0.68	0.29	0.11



CAS 492-22-8
PC-1

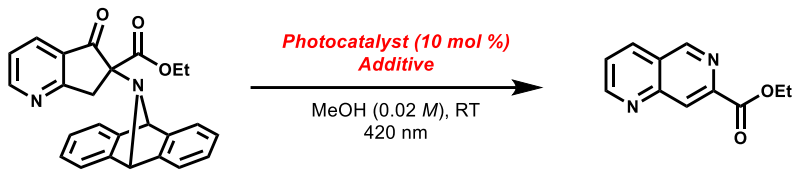


CAS 1072067-44-7
PC-2

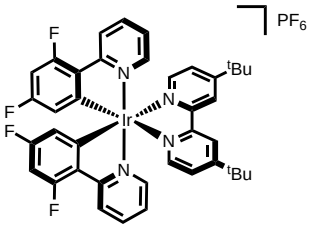


CAS 387859-70-3
PC-3

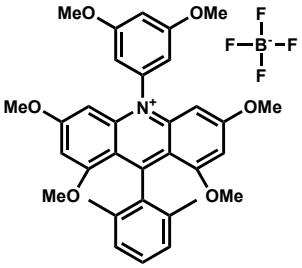
Expanded photocatalyst and additive screen for pyridine substrate, **Sub-1.** Quenched using 120uL of **QS-2** per well to arrive at 12 mol % of internal standard relative to **Sub-1**.



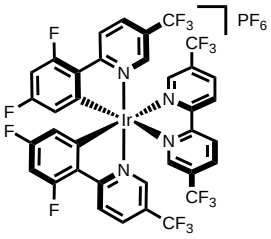
Pdt/IS	Photocatalyst					
Additive	PC-2	PC-4	PC-5	PC-6	PC-7	PC-8
None	0.42	0.16	0.42	0	0.21	0.33
Schreiner's Urea	0.48	0.16	2.56	0	0.28	0.55
Schreiner's thiourea	0.52	0	1.29	0.86	0	1.1
AcOH	0.56	0	1.73	0.25	0.78	3.96



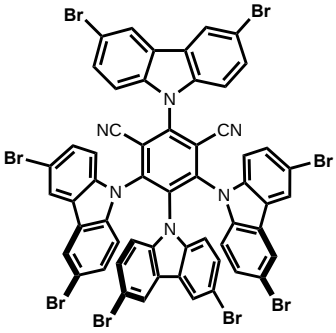
CAS 1072067-44-7
PC-2



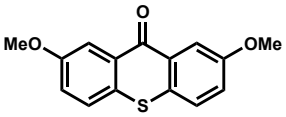
CAS 1965330-59-9
PC-4



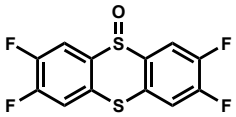
CAS 1973375-72-2
PC-5



CAS 1802772-69-5
PC-6

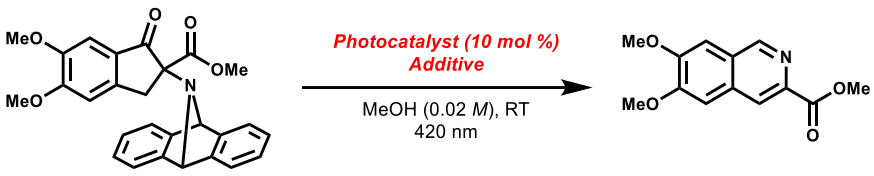


CAS 435344-88-0
PC-7

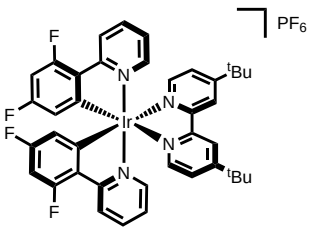


CAS 2320491-72-1
PC-8

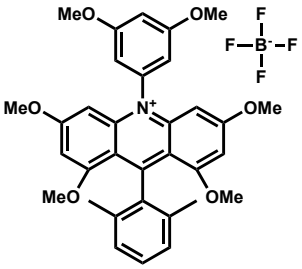
Expanded photocatalyst and additive screen for dimethoxy substrate, **Sub-2.** Quenched using 120uL of **QS-2** per well to arrive at 12 mol % of internal standard relative to **Sub-2**.



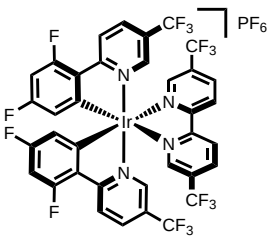
Pdt/IS	Photocatalyst					
Additive	PC-2	PC-4	PC-5	PC-6	PC-7	PC-8
None	0.97	0.27	4.07	3.79	2.17	0.24
Schreiner's Urea	0.92	0.41	4.2	3.59	2.21	4.65
Schreiner's thiourea	2.66	0	3.27	1.93	1.24	5.21
AcOH	4.59	0.6	3.79	5.61	3.35	7.54



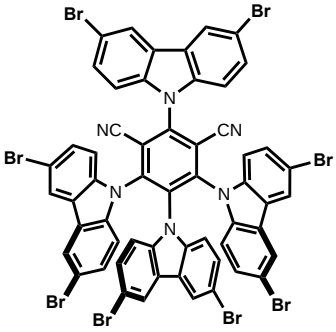
CAS 1072067-44-7
PC-2



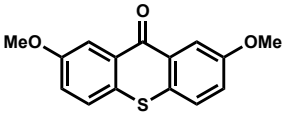
CAS 1965330-59-9
PC-4



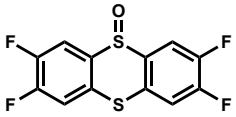
CAS 1973375-72-2
PC-5



CAS 1802772-69-5
PC-6

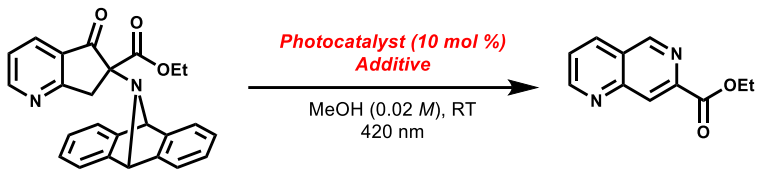


CAS 435344-88-0
PC-7



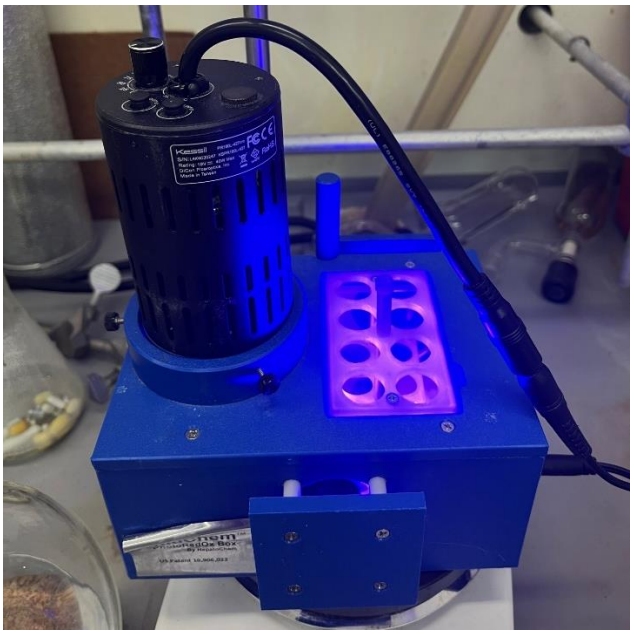
CAS 2320491-72-1
PC-8

Expanded photocatalyst and acidic additive screen for **Sub-1**. Quenched using 120uL of **QS-2** per well to arrive at 12 mol % of internal standard relative to **Sub-1**.



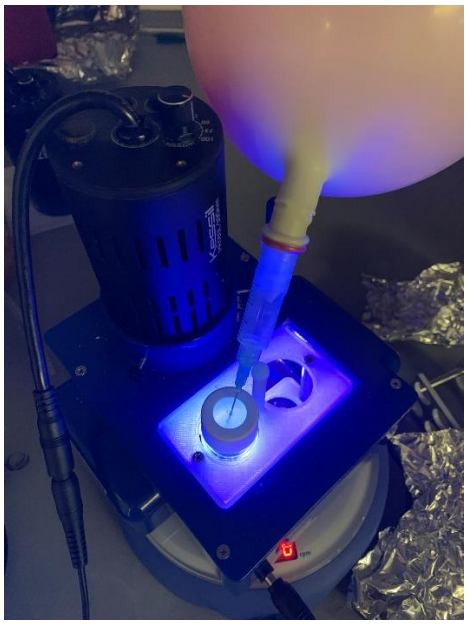
Pdt/IS	Additive		
Photocatalyst	AcOH	Chloroacetic acid	Trichloroactic acid
PC-1	5.4	0	0.33
PC-7	0	0	0.13
PC-9	0	0	0.32
PC-10	0.64	1.17	2.63
PC-11	0.44	2.06	0.23
PC-12	4.63	4.92	0
PC-13	0	4.92	0.26
PC-14	5.85	0	0
PC-15	0.25	4.12	0.4
PC-8	0	0	0
PC-17	0.25	3.74	0.74
PC-18	3.78	4.18	0.44

Photochemical Reactor Setup for Scope Exploration



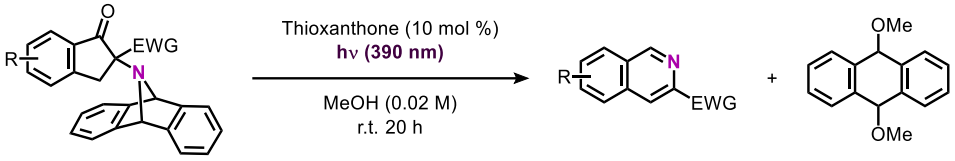
Supplemental Figure 5a: Kessil PR 160L-390 nm LED placed in an EvoluChem Photoredox box. A small fan maintains reaction temperature near room temperature. When necessary, the Kessil lamp could be exchanged for a different wavelength.

Photochemical Reactor Setup for Scale Up Reaction



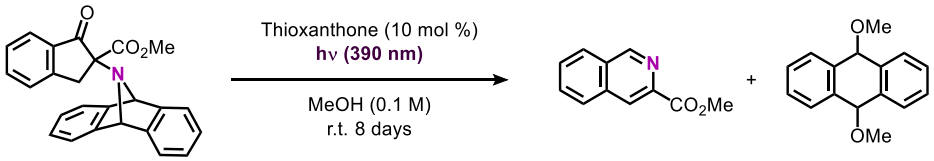
Supplemental Figure 6b: Kessil PR 160L-390 nm LED placed in an EvoluChem Photoredox box. A small fan maintains reaction temperature near room temperature. Vial was covered with foil for the duration of the reaction.

General Procedure C for the synthesis of Isoquinolines



A 2 dram vial was charged with amine (0.1 mmol) and thioxanthone (2.1 mg; 0.01 mmol). The vial was evacuated and backfilled three times with N_2, and MeOH (5 mL) was added. The solution was irradiated with one 390 nm purple LED lamp (Kessil PR 160L-390 nm LED) and kept at room temperature using an EvoluChem Photoredox box for 24-96 h (monitored by TLC). The solvent was removed by rotary evaporation, and the product purified by column chromatography.

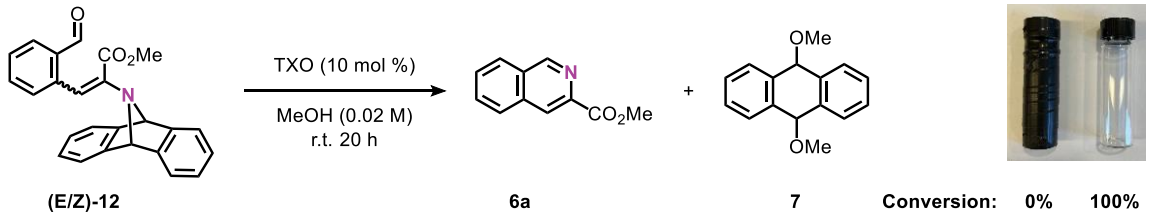
Procedure for Scale up synthesis of Isoquinolines



To a 4 dram septum capped vial, amine (1.25 mmol) and thioxanthone (27 mg, 0.125 mmol) were added and the vial was evacuated and refilled with N_2 three times. Methanol (12.5 mL, 0.1 M) was added, and the solution was irradiated with one 390 nm purple LED lamp (Kessil PR 160L-390 nm LED) and kept at room temperature using an EvoluChem Photoredox box for 8 days (monitored by TLC). The solvent was removed by rotary evaporation, and the product purified by column chromatography providing **6a** in 61% (141 mg).

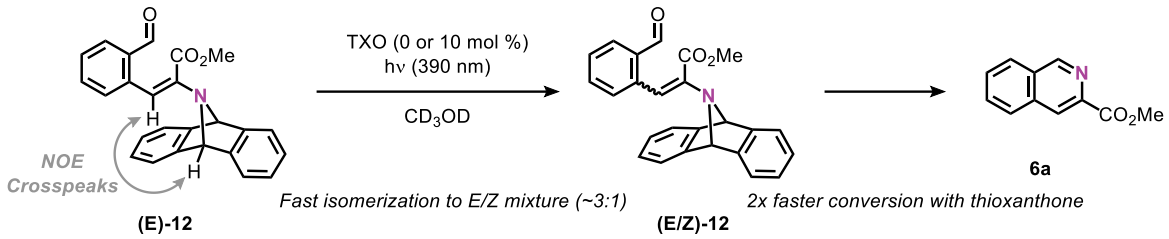
Mechanistic experiments

Aldehyde Light/Dark Conversion Experiment

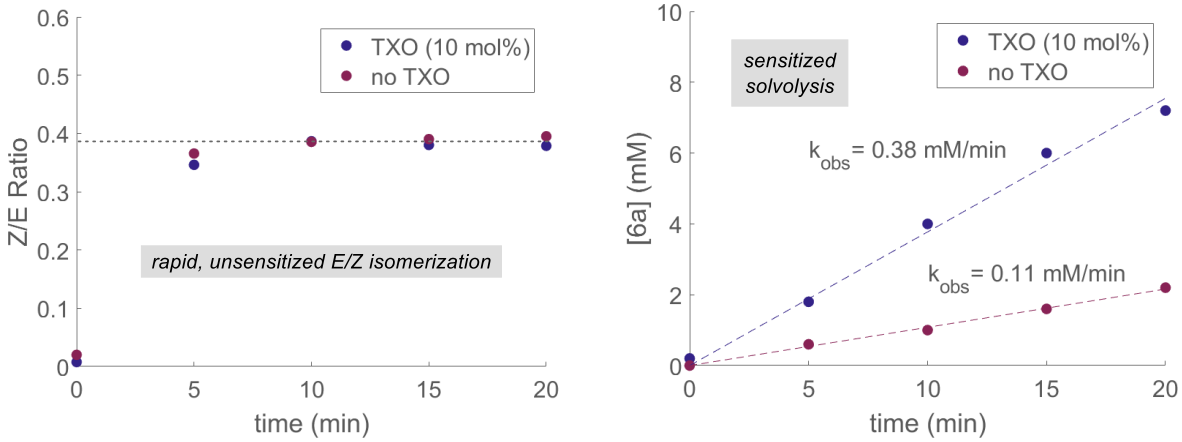


Following general procedure C, a mixture of **E/Z-12** with thioxanthone (10 mol %) in MeOH was split between two 2-dram vials. One vial was wrapped tightly with electrical tape, such that light permeation was prohibited (see image above). The vials were placed side by side in an EvoluChem Photoredox box and irradiated for 20 h at room temperature with a Kessil PR 160L-390nm lamp with constant stirring. Only the vial that was exposed to irradiation showed any conversion, indicating that fragmentation of **12** only occurs upon photoexcitation under our reaction conditions. Thermal fragmentation (hypothetically from the heat generated by the lamp) is not observed.

Aldehyde to isoquinoline photokinetics



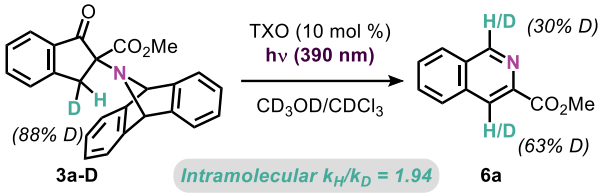
A solution of E-aldehyde **12** in CD_3OD with (or without) thioxanthone (10 mol %) was placed in an NMR tube under an atmosphere of N_2. The NMR tube was irradiated using a 390 nm Kessil lamp in 5 minute increments to obtain initial rate kinetics. Temperature was controlled using an electronically powered fan to circulate air. After 5 minutes, E/Z isomerization occurred to give an ~3:1 mixture of E:Z aldehydes, regardless of the presence of photosensitizer. The ratio remained constant throughout the remainder of the measurements.



Supplemental Figure 7: E/Z Ratio in **12** and concentration of **6a** as a function of time under sensitized (blue) and unsensitized (red) conditions.

Despite the similar isomerization behavior in the presence/absence of sensitization, the product formation showed a remarkable difference. **4a** was formed 2x faster in the presence of a sensitizer, supporting the necessity of a triplet excited state in the conversion from **12** to **4a**.
Based on the proximity of the amine and aldehyde, isomerization to the Z olefin is necessary at some point of the reaction, and based on the above isomerization results, likely occurs prior to decomposition of the dbabh functional group.

Kinetic Isotope Experiment

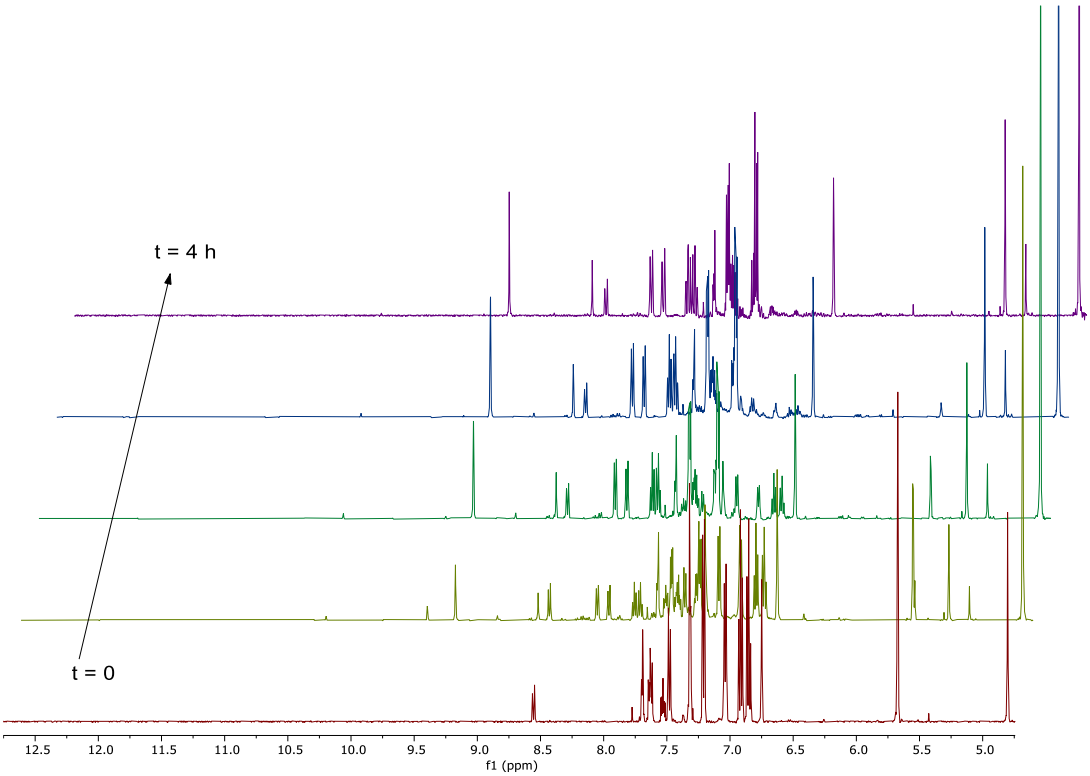


A flame dried NMR tube was charged with a solution of **3a** (0.02 mmol), thioxanthone (0.002 mmol) and mesitylene (0.01 mmol; internal standard) in $CD_3OD/CDCl_3$ (0.8 mL/0.2 mL; 1 mL total). The $CDCl_3$ was added to solubilize **3a** and enable accurate conversion measurements. An NMR was taken prior to photolysis to serve as t=0. The NMR tube was placed in the photoreactor (Supplemental Figure 5) and irradiated at room temperature. NMR was taken every hour until full conversion was reached. The kinetic isotope effect was calculated based on the ratio of deuterium incorporation at the 1- and 4-position of **6a-D**. Actual deuterium incorporation at each position was not calculated *in situ* due to overlap with suitable reference peaks in **6a-D** and thioxanthone. The *in situ* measured ratios were compared to **6a-D** isolated by preparative TLC after the completion of the reaction and found to be nearly identical. However, due to a small overlap between the 4-H peak in **6a** and an intermediate species observed during the reaction, the ratio of isolated material was used for the final KIE calculation. The reaction was performed in triplicate, and the results are reproduced below:

Trial 1					
Time (hr)	Conversion **3a-D**	Yield **6a-D**	1D incorporation	4D incorporation	Ratio (1H:4H)
0	0	0	-	-	-
1	54%	33%	-	-	1.84
2	74%	62%	-	-	2.18
3	90%	77%	-	-	2.16
4	100%	73%	-	-	2.12
Isolated	-	-	29%	63%	1.91

Trial 2					
Time (hr)	Conversion **3a-D**	Yield **6a-D**	1D incorporation	4D incorporation	Ratio (1H:4H)
0	0	0	-	-	-
1	42%	30%	-	-	1.91
2	73%	53%	-	-	1.92
3	86%	63%	-	-	1.97
4	93%	70%	-	-	2.00
Isolated	-	-	30%	64%	1.94

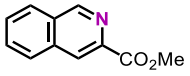
Trial 3					
Time (hr)	Conversion **3a-D**	Yield **6a-D**	1D incorporation	4D incorporation	Ratio (1H:4H)
0	0	0	-	-	-
1	27%	25%	-	-	1.89
2	69%	53%	-	-	1.89
3	87%	68%	-	-	2.06
4	96%	76%	-	-	2.07
Isolated	-	-	31%	63%	1.86



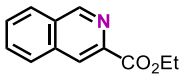
Supplemental Figure 8: Representative ^{1}H NMR spectra from KIE experiments.

In a separate experiment, **3a** was subjected to the same conditions in CD_3OD and no deuterium incorporation was found.

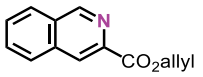
Characterization Data of Isoquinolines



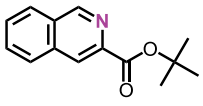
6a: Yellow oil, 59%, (61% on 1.2 mmol scale). R_f = 0.06 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.33 (t, *J* = 0.9 Hz, 1H), 8.60 (d, *J* = 1.0 Hz, 1H), 8.09 – 8.02 (m, 1H), 7.98 (dq, *J* = 8.4, 1.0 Hz, 1H), 7.83 – 7.68 (m, 2H), 4.06 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.44, 152.82, 141.65, 135.61, 131.32, 130.09, 129.76, 128.16, 127.84, 124.19, 53.00.
The NMR are in alignment with reported data.[8]



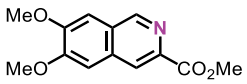
6b: Yellow oil, 64%. R_f = 0.14 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.34 (s, 1H), 8.59 (s, 1H), 8.05 (d, *J* = 7.9 Hz, 1H), 7.97 (d, *J* = 8.0 Hz, 1H), 7.82 – 7.69 (m, 2H), 4.53 (q, *J* = 7.1 Hz, 2H), 1.48 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 165.97, 152.84, 141.99, 135.62, 131.25, 130.03, 129.66, 128.11, 127.83, 124.06, 61.98, 14.58.
The NMR are in alignment with reported data.[12]



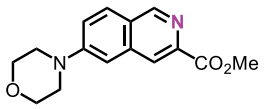
6c: Yellow oil, 64%. R_f = 0.20 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.34 (s, 1H), 8.60 (s, 1H), 8.05 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.97 (dd, *J* = 8.1, 1.5 Hz, 1H), 7.77 (dqd, *J* = 8.2, 7.0, 1.4 Hz, 2H), 6.12 (ddt, *J* = 17.4, 10.4, 5.9 Hz, 1H), 5.46 (dq, *J* = 17.2, 1.5 Hz, 1H), 5.33 (dq, *J* = 10.4, 1.2 Hz, 1H), 4.97 (dt, *J* = 5.9, 1.3 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 165.59, 152.91, 141.72, 135.59, 132.17, 131.29, 130.09, 129.76, 128.13, 127.84, 124.23, 119.24, 66.59.
The NMR are in alignment with reported data.[13]



6d: Orange oil, 55%. R_f = 0.23 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.33 (d, *J* = 1.0 Hz, 1H), 8.49 (d, *J* = 1.0 Hz, 1H), 8.03 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.98 – 7.92 (m, 1H), 7.81 – 7.67 (m, 2H), 1.69 (s, 9H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 164.95, 152.80, 143.27, 135.67, 131.08, 129.85, 129.38, 128.01, 127.79, 123.45, 82.15, 28.37.
HRMS (ESI-TOF) calcd for $C_{14}H_{15}NO_2$ $[M+H]^+$ 230.1176, observed 230.1180

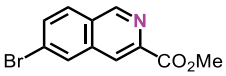


6f: Orange solid, 45%. R_f = 0.09 (70% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.11 (s, 1H), 8.45 (s, 1H), 7.28 (s, 1H), 7.19 (s, 1H), 4.05 (s, 3H), 4.05 (s, 3H), 4.04 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.71, 153.66, 152.31, 150.05, 140.61, 132.29, 126.58, 122.81, 105.98, 105.56, 56.39, 56.36, 52.85.
The NMR are in alignment with reported data.[14]

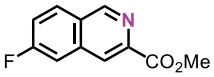


6g: [Ir(dF-CF_3ppy)$_2$(dtbpy)]PF_6 (1 mol %) and 420 nm irradiation used in place of thioxanthone (10 mol %) and 390 nm irradiation to avoid morpholine oxidation.
Yellow solid, 32%. R_f = 0.09 (70% EtOAc/Hexanes)
^{1}H NMR (500 MHz, $CDCl_3$) δ 9.11 (s, 1H), 8.40 (s, 1H), 7.91 (d, *J* = 9.0 Hz, 1H), 7.47 – 7.41 (m, 1H), 7.10 (d, *J* = 2.5 Hz, 1H), 4.04 (s, 3H), 3.94 – 3.84 (m, 4H), 3.38 (t, *J* = 4.9 Hz, 4H).

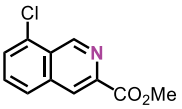
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.76, 152.70, 151.70, 142.06, 137.55, 128.93, 124.87, 123.15, 120.88, 108.16, 66.74, 52.91, 48.35.
HRMS (ESI-TOF) calcd for $C_{15}H_{16}N_2O_3$ $[M+H]^+$ 273.1234, observed 273.1241



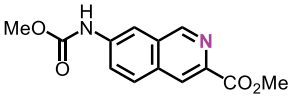
6h: Yellow solid, 52%. R_f = 0.40 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.32 – 9.26 (m, 1H), 8.50 (d, *J* = 0.9 Hz, 1H), 8.17 – 8.12 (m, 1H), 7.92 (dt, *J* = 8.8, 0.7 Hz, 1H), 7.82 (dd, *J* = 8.7, 1.9 Hz, 1H), 4.06 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.04, 152.67, 142.62, 136.71, 133.36, 130.29, 129.34, 128.38, 126.26, 122.92, 53.14.
HRMS (ESI-TOF) calcd for $C_{11}H_8ClNO_2$ $[M+H]^+$ 265.9811, observed 265.9811



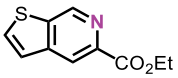
6i: Yellow solid, 68%. Rf = 0.15 (30% EtOAc/hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.32 – 9.27 (m, 1H), 8.54 (s, 1H), 8.08 (dd, *J* = 9.0, 5.3 Hz, 1H), 7.58 (dd, *J* = 9.0, 2.5 Hz, 1H), 7.50 (td, *J* = 8.7, 2.5 Hz, 1H), 4.05 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.16, 164.99, 162.46, 152.42, 142.48, 137.28, 137.17, 130.91, 130.82, 127.21, 123.57, 123.51, 120.40, 120.14, 111.75, 111.54, 53.10.
^{19}F NMR (376 MHz, $CDCl_3$) δ -105.08.
HRMS (ESI-TOF) calcd for $C_{11}H_8FNO_2$ $[M+H]^+$ 206.0612, observed 206.0615



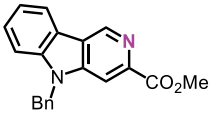
6j: Yellow solid, 60%. R_f = 0.35 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.73 (s, 1H), 8.58 (s, 1H), 7.90 (d, *J* = 8.1 Hz, 1H), 7.77 (dd, *J* = 7.5, 1.2 Hz, 1H), 7.71 (d, *J* = 7.8 Hz, 1H), 4.07 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.06, 149.97, 142.54, 137.14, 133.03, 131.40, 130.02, 127.27, 127.20, 123.70, 53.15.
HRMS (ESI-TOF) calcd for $C_{11}H_8ClNO_2$ $[M+H]^+$ 221.0316, observed 221.0321



6l: Orange solid, 56%. R_f = 0.20 (50% EtOAc/2% MeOH/48% hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.25 (s, 1H), 8.52 (s, 1H), 8.26 (s, 1H), 7.91 (d, *J* = 8.8 Hz, 1H), 7.67 (dd, *J* = 8.8, 2.2 Hz, 1H), 7.11 (s, 1H), 4.05 (s, 3H), 3.84 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.54, 153.88, 152.16, 140.53, 139.04, 131.95, 131.02, 129.29, 124.02, 123.86, 113.92, 77.48, 77.16, 76.84, 52.96, 52.92.
HRMS (ESI-TOF) calcd for $C_{13}H_{12}N_2O_4$ $[M+H]^+$ 261.0870, observed 261.0876

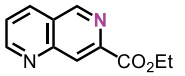


6m: White solid, 19%. R_f = 0.17 (30% EtOAc/Hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.27 (t, *J* = 0.9 Hz, 1H), 8.60 (d, *J* = 1.0 Hz, 1H), 7.83 (d, *J* = 5.4 Hz, 1H), 7.51 (dd, *J* = 5.4, 0.8 Hz, 1H), 4.53 (q, *J* = 7.1 Hz, 2H), 1.48 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.01, 145.33, 144.66, 142.50, 139.54, 133.40, 123.93, 120.36, 62.04, 14.59.
HRMS (ESI-TOF) calcd for $C_{10}H_9NO_2S$ $[M+H]^+$ 208.0427, observed 208.0425
The NMR are in alignment with reported data.[15]

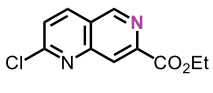


6n: white solid, 32%. R_f = 0.17 (70% EtOAc/Hexanes)

^{1}H NMR (500 MHz, $CDCl_3$) δ 9.28 (s, 1H), 8.52 (dd, *J* = 7.4, 1.9 Hz, 1H), 7.49 – 7.37 (m, 3H), 7.32 (dd, *J* = 9.9, 2.5 Hz, 4H), 7.13 – 7.08 (m, 2H), 5.57 (s, 2H), 4.00 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 161.94, 159.05, 143.63, 139.64, 135.95, 130.43, 129.21, 128.18, 127.18, 126.30, 126.02, 125.63, 124.12, 122.82, 122.46, 111.80, 109.85, 98.01, 53.40, 47.30
HRMS (ESI-TOF) calcd for $C_{20}H_{16}N_2O_2$ $[M+H]^+$ 317.1285, observed 317.1283

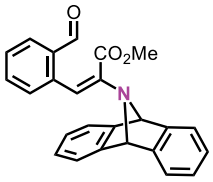


6o: Yellow solid, 63%. R_f = 0.18 (70% EtOAc/Hexanes)
^{1}H NMR (500 MHz, $CDCl_3$) δ 9.37 (s, 1H), 9.19 (dd, *J* = 4.2, 1.8 Hz, 1H), 8.79 (s, 1H), 8.37 (d, *J* = 8.3 Hz, 1H), 7.65 (dd, *J* = 8.3, 4.2 Hz, 1H), 4.54 (q, *J* = 7.1 Hz, 2H), 1.48 (t, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 165.32, 155.72, 153.20, 150.77, 145.77, 135.67, 125.42, 125.27, 124.33, 62.24, 14.50.
HRMS (ESI-TOF) calcd for $C_{20}H_{16}N_2O_2$ $[M+H]^+$ 203.0815, observed 203.0824



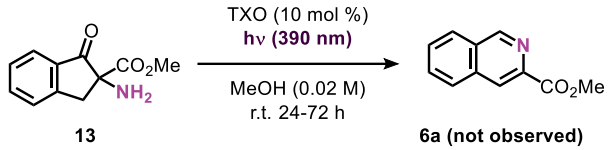
6p: Greenish solid, 57%. Rf = 0.12 (50% EtOAc/Hexanes)
^{1}H NMR (600 MHz, $CDCl_3$) δ 9.37 (s, 1H), 8.72 (s, 1H), 8.32 (d, *J* = 8.5 Hz, 1H), 7.64 (d, *J* = 8.5 Hz, 1H), 4.55 (q, *J* = 7.2 Hz, 2H), 1.49 (t, *J* = 7.2 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 164.92, 156.71, 152.61, 150.83, 146.96, 138.19, 126.05, 124.15, 123.95, 62.43, 14.47.
HRMS (ESI-TOF) calcd for $C_{11}H_9ClN_2O_2$ $[M+H]^+$ 237.0425, observed 237.0424

Characterization of side products



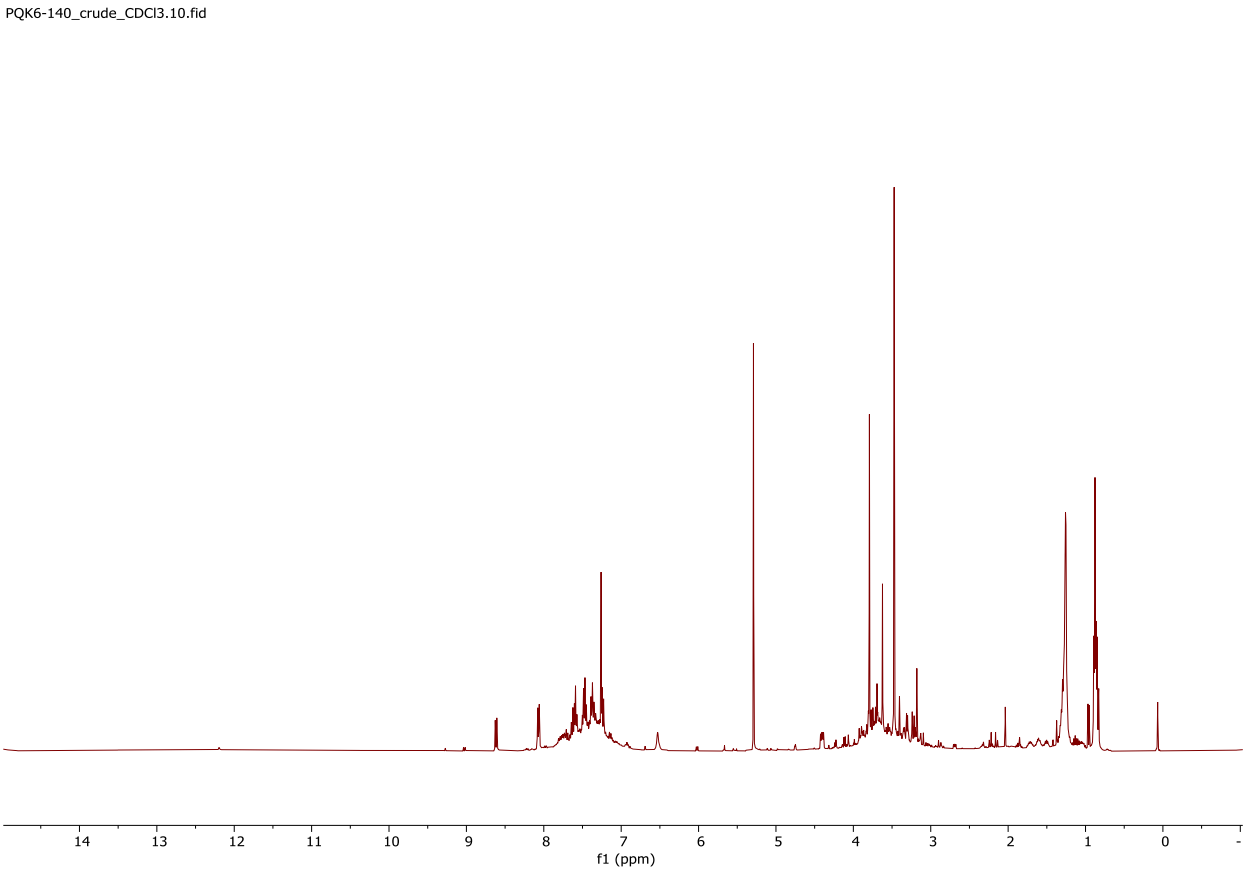
(E)-12: This compound was synthesized by general procedure C, substituting THF for MeOH. The reaction was performed with 0.5 mmol of **3a**.
Yellow solid (53.7 mg, 28%)
^{1}H NMR (500 MHz, $CDCl_3$) δ 9.62 (d, *J* = 1.1 Hz, 1H), 7.77 (dt, *J* = 7.8, 1.4 Hz, 1H), 7.45 – 7.34 (m, 5H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.26 (d, *J* = 1.2 Hz, 1H), 7.09 – 7.02 (m, 5H), 6.42 (s, 1H), 5.60 (d, *J* = 1.2 Hz, 2H), 3.54 (d, *J* = 1.2 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 192.05, 165.72, 146.80, 139.65, 139.55, 133.49, 133.44, 129.47, 128.91, 127.38, 126.21, 121.90, 113.46, 69.61, 52.15.
1D NOE of δ 5.60 (bridgehead C-H) showed crosspeaks with δ 6.42 (olefin C-H) and 7.38 (dbabh-aryl C-H). No crosspeaks were observed with the aldehyde, allowing assignment of E-olefin.
HRMS (ESI-TOF) calcd for $C_{25}H_{19}NO_3$ $[M]^+$ 381.1365, observed 381.1355

Primary amine photochemistry



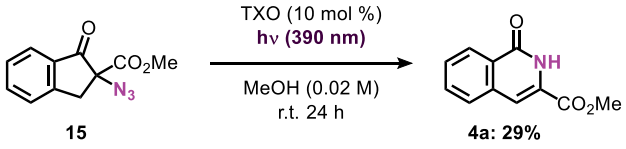
13 **6a (not observed)**

Following general procedure C using primary amine **13** in place of **3a**, no isoquinoline (**6a**) was observed. Significant photodecomposition was observed as shown by the crude NMR below:



Supplemental Figure 9: Crude ^{1}H NMR spectrum of the photochemical reaction of primary amine **13**.

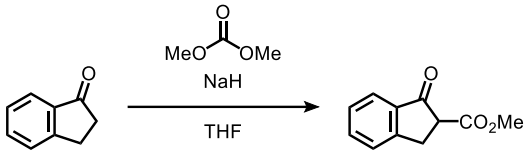
Azide Comparison Experiments



15 **4a: 29%**

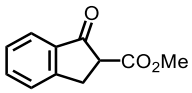
Following general procedure C, **4a** was observed in 29% yield starting from azide **15**.

7. General Procedure D for the preparation of indanone-esters

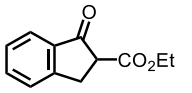


To a stirred solution of NaH (excess) in THF, dimethyl carbonate (5-10 equiv; or the appropriate dialkyl carbonate) and the indanone starting material in THF were added sequentially. The mixture was allowed to stir until consumption of the starting material by TLC. Often, the mixture solidified into a foam-like material upon completion. The reaction was quenched with a saturated aqueous NH_4Cl solution and extracted with EtOAc (3x). The organic layers were dried with Na_2SO_4, the solvent removed by rotary evaporation, and the residue purified by column chromatography.

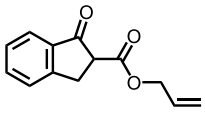
Characterization Data of Starting Materials



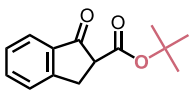
2a: Brown solid (2.2 g; 49%).
^{1}H NMR (400 MHz, $CDCl_3$) keto-tautomer δ 7.76 (dq, *J* = 7.7, 0.7 Hz, 1H), 7.61 (td, *J* = 7.4, 1.2 Hz, 1H), 7.49 (dt, *J* = 7.7, 0.9 Hz, 1H), 7.41 – 7.36 (td, *J* = 7.7, 0.9 Hz, 1H), 3.78 (d, *J* = 0.6 Hz, 3H), 3.73 (dd, *J* = 8.3, 4.1 Hz, 1H), 3.56 (dd, *J* = 17.3, 4.1 Hz, 1H), 3.37 (dd, *J* = 17.3, 8.3 Hz, 1H); enol-tautomer δ 10.35 (s, 1H), 7.63 (dq, 1H), 7.45 (td, 1H), 3.84 (s, 3H), 3.50 (s, 2H).
The NMR is in alignment with the literature.[16]



2b: Orange oil
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.43 (s, 0H), 7.75 (t, *J* = 7.3 Hz, 1H), 7.71 – 7.56 (m, 1H), 7.54 – 7.32 (m, 3H), 4.36 – 4.11 (m, 3H), 3.70 (dtd, *J* = 8.4, 4.2, 1.6 Hz, 1H), 3.60 – 3.46 (m, 2H), 3.36 (dt, *J* = 17.4, 6.7 Hz, 1H), 1.40 – 1.22 (m, 5H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.69, 169.24, 153.74, 135.50, 135.39, 129.42, 127.89, 127.88, 126.90, 126.66, 124.82, 124.77, 120.79, 77.47, 77.16, 76.84, 63.88, 61.85, 61.82, 60.20, 53.43, 32.66, 30.40, 14.58, 14.38, 14.31.
The NMR is in alignment with the literature.[16]

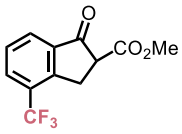


2c: Yellow oil
^{1}H NMR (400 MHz, $CDCl_3$) δ 10.36 (s, 0H), 7.88 – 7.72 (m, 1H), 7.69 – 7.31 (m, 3H), 6.08 – 5.86 (m, 1H), 5.37 (ddq, *J* = 17.2, 8.5, 1.5 Hz, 1H), 5.32 – 5.21 (m, 1H), 4.80 – 4.59 (m, 2H), 3.75 (dd, *J* = 8.3, 4.1 Hz, 1H), 3.61 – 3.51 (m, 1H), 3.38 (dd, *J* = 17.2, 8.3 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 199.40, 168.90, 153.65, 143.37, 136.95, 135.54, 135.35, 132.42, 131.78, 129.56, 127.93, 126.94, 126.65, 125.92, 124.85, 124.80, 120.87, 118.73, 118.26, 102.27, 77.48, 77.16, 76.84, 66.28, 64.74, 53.36, 32.63, 31.02, 30.40.
The NMR is in alignment with the literature.[17]

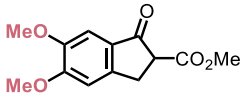


2d: To a mixture of **2a** (950 mg; 5 mmol) and zinc oxide (162 mg; 2 mmol) in toluene (30 mL) was added *tert*-butanol (956 µL; 10 mmol). The reaction was refluxed until consumption of **2a** by TLC. Additional zinc oxide was added as

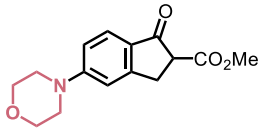
necessary. Once complete, the mixture was filtered through celite and purified by column chromatography to give **3d** as a brown oil (704 mg; 60%).
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (dt, *J* = 7.7, 1.0 Hz, 1H), 7.63 (d, *J* = 1.3 Hz, 0H), 7.49 (dp, *J* = 7.7, 1.0 Hz, 1H), 7.46 – 7.41 (m, 0H), 7.40 (s, 1H), 3.62 (dd, *J* = 8.2, 4.0 Hz, 1H), 3.55 – 3.45 (m, 1H), 3.39 – 3.28 (m, 1H), 1.57 (s, 1H), 1.49 (s, 9H).
The NMR is in alignment with the literature.[16]



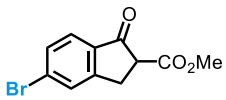
2e: yellow solid
^{1}H NMR (400 MHz, $CDCl_3$) (both tautomers) δ 10.26 (s, 1H), 7.99 – 7.92 (m, 1H), 7.89 (dt, *J* = 7.6, 1.0 Hz, 1H), 7.80 (dt, *J* = 7.6, 0.9 Hz, 1H), 7.66 (dt, *J* = 7.7, 0.9 Hz, 1H), 7.52 (dtq, *J* = 15.7, 7.8, 0.9 Hz, 2H), 3.87 (s, 3H), 3.81 (s, 3H), 3.80 – 3.77 (m, 1H), 3.77 – 3.71 (m, 1H), 3.71 – 3.68 (m, 2H), 3.62 – 3.52 (m, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.17, 169.40, 168.95, 168.08, 150.85, 140.47, 138.70, 136.86, 132.21, 132.16, 128.49, 128.30, 127.61, 127.24, 126.08, 126.03, 125.56, 124.19, 103.26, 77.48, 77.16, 76.84, 53.11, 52.85, 51.57, 32.06, 29.32.
^{19}F NMR (376 MHz, $CDCl_3$) δ -62.09, -62.32.
HRMS (ESI-TOF) calcd for $C_{13}H_{12}N_2O_4$ $[M+H]^+$ 259.0577, observed 259.0592



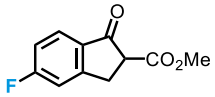
2f: Yellow solid
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer: δ 7.17 (s, 1H), 6.90 (s, 1H), 3.97 (s, 3H), 3.89 (s, 3H), 3.78 (s, 3H), 3.72 (dd, *J* = 7.9, 3.5 Hz, 1H), 3.50 – 3.40 (m, 1H), 3.27 (dd, *J* = 17.0, 7.9 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) keto tautomer: δ 198.03, 170.02, 156.26, 149.94, 149.36, 128.07, 107.39, 104.99, 56.46, 56.28, 53.54, 52.86, 30.16.
The NMR is in agreement with the literature.[16]



2g: Orange solid
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer: δ 7.59 (d, *J* = 8.7 Hz, 1H), 6.81 (dd, *J* = 8.8, 2.3 Hz, 1H), 6.74 (d, *J* = 2.3 Hz, 1H), 3.80 (s, 4H), 3.71 (s, 3H), 3.63 (dd, *J* = 8.2, 3.9 Hz, 1H), 3.39 (dd, *J* = 17.1, 3.9 Hz, 1H), 3.33 – 3.26 (m, 4H), 3.18 (dd, *J* = 17.1, 8.2 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) keto tautomer: δ 197.07, 170.31, 156.46 (2 overlapping peaks), 126.29, 126.13, 114.50, 109.37, 66.58, 53.46, 52.75, 47.64, 30.43.
HRMS (ESI-TOF) calcd for $C_{15}H_{17}NO_4$ $[M+H]^+$ 276.1230, observed 276.1243

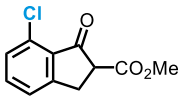


2h: Tan solid
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer: δ 7.71 – 7.67 (m, 1H), 7.62 (d, *J* = 8.1 Hz, 1H), 7.57 – 7.46 (m, 1H), 3.79 (s, 3H), 3.74 (dd, *J* = 8.3, 4.0 Hz, 1H), 3.55 (dd, *J* = 17.5, 4.0 Hz, 1H), 3.35 (dd, *J* = 17.5, 8.3 Hz, 1H). enol tautomer: δ 10.31 (s, 1H), 7.62 (m, 1H), 7.52 – 7.46 (m, 2H), 3.85 (s, 3H), 3.49 (s, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 198.21, 169.20, 155.22, 134.20, 131.70, 131.12, 130.34, 130.01, 128.26, 125.98, 53.24, 53.04, 51.48, 32.54, 30.05.
The NMR is in agreement with the literature.[16]

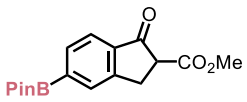


2i: Brown solid
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer: δ 7.76 (dd, *J* = 8.5, 5.3 Hz, 1H), 7.15 (dddd, *J* = 8.4, 2.3, 1.5, 0.9 Hz, 1H), 7.12 – 7.03 (m, 1H), 3.78 (d, *J* = 0.8 Hz,

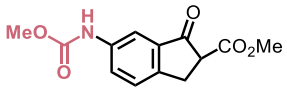
3H), 3.75 (dd, *J* = 8.3, 4.0 Hz, 1H), 3.55 (dddt, *J* = 17.5, 4.1, 1.8, 1.0 Hz, 1H), 3.35 (ddq, *J* = 17.5, 8.3, 0.8 Hz, 1H). enol tautomer: δ 10.34 (s, 1H), 7.57 (ddd, *J* = 7.7, 5.6, 2.1 Hz, 1H), 7.15 (m, 1H), 7.12 – 7.03 (m, 1H), 3.84 (d, *J* = 1.3 Hz, 3H), 3.50 – 3.47 (m, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) (both tautomers) δ 197.51, 169.33, 168.95, 166.39, 156.70, 156.59, 131.70, 127.20, 127.09, 116.50, 116.26, 114.64, 113.47, 113.24, 112.55, 112.32, 53.43, 52.96, 51.35, 32.65, 30.23, 30.21.
^{19}F NMR (376 MHz, $CDCl_3$) δ -101.32, -110.88.
The NMR is in agreement with the literature.[17]



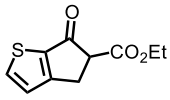
2j: Tan solid
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer: δ 7.52 (t, *J* = 7.7 Hz, 1H), 7.39 (dq, *J* = 7.7, 1.0 Hz, 1H), 7.37 – 7.28 (m, 1H, overlaps with enol tautomer), 3.79 (s, 3H), 3.76 (dd, *J* = 8.5, 4.2 Hz, 1H), 3.57 – 3.48 (ddt, *J* = 17.3, 4.2, 0.8 Hz, 1H), 3.33 (ddt, *J* = 17.3, 8.4, 0.8 Hz, 1H). enol tautomer: δ 10.74 (s, 1H), 7.37 – 7.29 (m, 3H), 3.86 (s, 3H), 3.50 (s, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 196.31, 169.31, 155.97, 145.80, 135.84, 132.99, 131.38, 130.31, 129.65, 128.72, 125.05, 123.34, 103.23, 53.83, 53.00, 51.53, 32.46, 29.63.
The NMR of the enol tautomer is in agreement with the literature.[18]



2k: White solid
^{1}H NMR (400 MHz, $CDCl_3$) (both tautomers) δ 10.32 (s, 0H), 7.93 (dt, *J* = 16.5, 0.9 Hz, 1H), 7.85 – 7.80 (m, 1H), 7.75 (dd, *J* = 7.7, 0.8 Hz, 1H), 7.65 (dd, *J* = 7.6, 0.8 Hz, 0H), 3.86 (s, 1H), 3.78 (s, 3H), 3.74 (dd, *J* = 8.3, 4.1 Hz, 1H), 3.56 (dd, *J* = 17.2, 4.1 Hz, 1H), 3.52 (s, 1H), 3.37 (dd, *J* = 17.2, 8.3 Hz, 1H), 1.36 (s, 17H).
^{13}C NMR (101 MHz, $CDCl_3$) (both tautomers) δ 199.90, 169.64, 152.65, 137.30, 133.93, 133.43, 133.06, 130.94, 123.79, 120.18, 103.58, 84.54, 84.14, 53.44, 52.90, 51.41, 32.56, 30.33, 25.16, 25.02, 22.50.
^{11}B NMR (128 MHz, $CDCl_3$) δ 30.66.
HRMS (ESI-TOF) calcd for $C_{17}H_{21}BO_5$ $[M+H]^+$ 317.1555, observed 317.1559

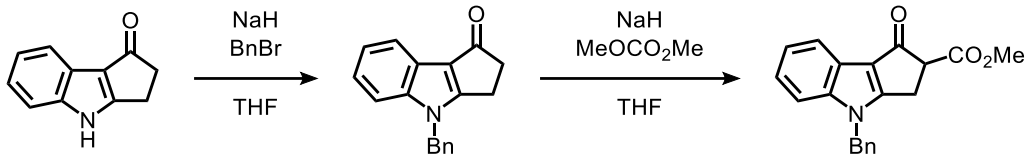


2l: Starting from 6-amino-indanone (345.1 mg; 2.37 mmol) and an excess of NaH and dimethylcarbonate. Tan solid (251.0 mg; 40%).
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer: δ 7.79 (s,1H), 7.66 (d, *J* = 2.2 Hz, 1H), 7.45 (d, *J* = 8.3, 1H), 6.68 (s, 1H), 3.79 (overlapping singlets, 6H), 3.75 (m, 1H), 3.51 (dd, *J* = 4.04, 17.19 Hz, 1H), 3.33 (dd, *J* = 8.22, 17.13 Hz, 1H). enol tautomer: δ 10.29 (s, 1H), 7.64 (s, 1H), 7.39 (d, *J* = 8.11, 1H), 6.68 (s, 1H), 3.86 (s, 3H), 3.79 (s, 3H), 3.48 (s, 2H)
^{13}C NMR (101 MHz, $CDCl_3$) (both tautomers) δ 199.08, 169.57, 154.02, 148.43, 138.10, 135.90, 127.00, 126.64, 125.10, 123.77, 113.72, 103.21, 53.77, 53.66, 52.80, 52.70, 52.56, 51.27, 32.06, 29.77, 29.57.
HRMS (ESI-TOF) calcd for $C_{13}H_{13}NO_5$ $[M+H]^+$ 264.0866, observed 264.0872



2m: This compound was prepared by literature procedures.[19]
Yellow oil
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 4.8 Hz, 1H), 7.11 – 7.04 (m, 1H), 4.31 – 4.18 (m, 2H), 3.99 (dd, *J* = 7.3, 3.1 Hz, 1H), 3.42 (dd, *J* = 17.2, 3.1 Hz, 1H), 3.30 – 3.20 (m, 1H), 1.30 (d, *J* = 7.1 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 189.98, 169.03, 167.93, 141.95, 139.50, 123.98, 61.91, 58.20, 28.43, 14.31.

HRMS (ESI-TOF) calcd for $C_{10}H_{10}SO_3$ $[M+H]^+$ 211.0423, observed 211.0429

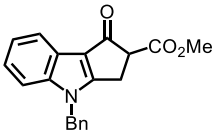


S6 **S7** **2n**

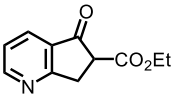
Compound **S6** was synthesized via literature methods.[20,21]

S7: To a mixure of NaH (80 mg; 60% in mineral oil, 2 mmol) in THF (6 mL) was added a solution of **S1** (270 mg; 1.6 mmol) in THF (6 mL) at 0 °C. The reaction was stirred at 0 °C for 5 minutes, at which point benzyl bromide (240 µL; 2 mmol) was added to the reaction mixture. The mixture was allowed to warm to room temperature overnight and quenched with H_2O. The reaction was extracted with EtOAc, the combined organic layers dried over Na_2SO_4, and the residue purified by column chromatography to give S2 as a white solid (300 mg; 72%).

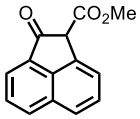
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 – 7.87 (m, 1H), 7.32 – 7.14 (m, 7H), 7.13 – 7.04 (m, 2H), 5.25 (s, 2H), 2.96 – 2.85 (m, 4H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 195.39, 168.09, 142.83, 135.66, 129.20, 128.28, 126.84, 123.68, 122.54, 121.77, 121.23, 120.23, 110.71, 48.28, 40.98, 21.05.
The NMR align with the literature values.[22]



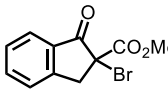
Synthesized from S2 using general procedure D.
2n: Brown oil, 64%. R_f = 0.15 (30% EtOAc/hexanes)
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer: δ 7.98 – 7.89 (m, 1H), 7.40 – 7.22 (m, 7H), 7.21 – 7.14 (m, 2H), 5.40 – 5.25 (m, 2H), 4.02 (dd, *J* = 7.1, 2.7 Hz, 1H), 3.81 (s, 3H), 3.42 (dd, *J* = 17.3, 2.7 Hz, 1H), 3.11 (dd, *J* = 17.3, 7.1 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) keto tautomer: δ 187.45, 170.17, 167.15, 143.13, 135.24, 129.30, 128.45, 126.96, 124.16, 122.94, 121.91, 121.41, 118.55, 110.91, 57.89, 52.90, 48.56, 25.34.
HRMS (ESI-TOF) calcd for $C_{20}H_{17}NO_3$ $[M+H]^+$ 320.1281, observed 320.1303



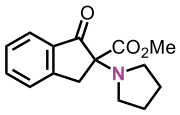
This compound was synthesized by literature procedures.[23]
2o: Tan solid
^{1}H NMR (400 MHz, $CDCl_3$) keto tautomer δ 8.85 (dd, *J* = 4.8, 1.7 Hz, 1H), 8.05 (dd, *J* = 7.8, 1.7 Hz, 1H), 7.36 (ddt, *J* = 7.8, 4.8, 0.8 Hz, 1H), 4.26 (qd, *J* = 7.2, 0.9 Hz, 2H), 3.81 (dd, *J* = 8.4, 4.1 Hz, 1H), 3.73 – 3.65 (m, 1H), 3.57 – 3.46 (m, 1H), 1.32 (t, *J* = 7.1 Hz, 3H). enol tautomer: δ 10.50 (s, 1H), 8.61 (dd, *J* = 5.0, 1.6 Hz, 1H), 7.89 (dd, *J* = 7.7, 1.6 Hz, 1H), 7.29 (dd, *J* = 7.7, 5.0 Hz, 1H), 4.35 (q, *J* = 7.1 Hz, 2H), 3.64 (s, 2H), 1.38 (t, *J* = 7.1 Hz, 4H).
^{13}C NMR (101 MHz, $CDCl_3$) (both tautomers) δ 197.91, 173.01, 169.29, 168.56, 167.26, 163.73, 156.47, 149.94, 132.88, 130.82, 128.73, 128.26, 122.97, 121.83, 102.51, 62.01, 60.52, 53.08, 35.00, 33.18, 14.47, 14.21.
HRMS (ESI-TOF) calcd for $C_{11}H_{11}NO_3$ $[M+H]^+$ 206.0812, observed 206.0825



2q: **^{1}H NMR** (400 MHz, $CDCl_3$) (both tautomers) δ 10.92 (s, 1H), 8.04 (d, *J* = 8.1 Hz, 1H), 7.92 (h, *J* = 7.9 Hz, 3H), 7.81 (d, *J* = 8.4 Hz, 1H), 7.71 – 7.36 (m, 8H), 4.68 (s, 1H), 3.92 (s, 3H), 3.70 (s, 3H).
The NMR is in agreement with the literature.[24]

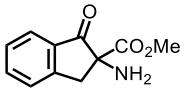


S8: This compound is synthesized according to literature procedures.[25]
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (ddd, *J* = 7.8, 1.3, 0.6 Hz, 1H), 7.69 (td, *J* = 7.5, 1.2 Hz, 1H), 7.46 (dddd, *J* = 8.0, 4.7, 1.9, 0.9 Hz, 2H), 4.26 – 4.16 (m, 1H), 3.82 (s, 3H), 3.72 – 3.63 (m, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 195.12, 167.67, 150.24, 136.48, 132.27, 128.71, 126.42, 126.06, 58.25, 54.35, 43.96.
The NMR is in agreement with the literature.[26]

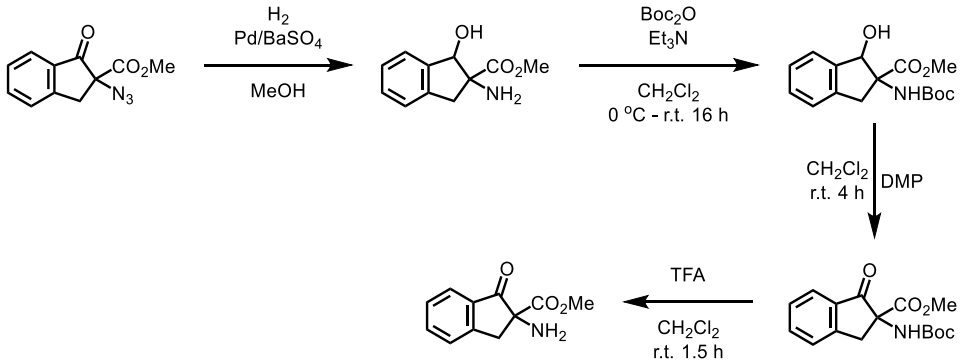


9: This compound was synthesized by a modified literature procedure.[27] To a solution of methyl 2-bromo-1-oxo-2,3-dihydro-1H-indene-2-carboxylate (**S8**, 200 mg; 0.8 mmol) in 1,4-dioxane (11 mL) was added pyrrolidine (72 µL; 0.88 mmol) and triethylamine (133 µL; 0.96 mmol). The reaction was stirred at room temperature overnight. Water (20 mL) was added, and the mixture extracted with CH_2Cl_2 (3 x 10 mL). The combined organic layers were dried over $MgSO_4$, filtered and purified via column chromatography.

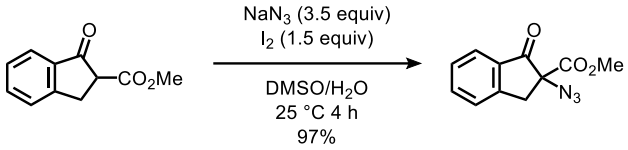
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (dt, *J* = 7.7, 1.1 Hz, 1H), 7.63 (td, *J* = 7.5, 1.2 Hz, 1H), 7.48 (dt, *J* = 7.7, 1.0 Hz, 1H), 7.42 – 7.36 (m, 1H), 3.73 (s, 3H), 3.66 (d, *J* = 17.1 Hz, 1H), 3.33 (d, *J* = 17.1 Hz, 1H), 2.82 (td, *J* = 6.9, 4.3 Hz, 4H), 1.87 – 1.77 (m, 4H).
^{13}C NMR (126 MHz, $CDCl_3$) δ 199.97, 170.67, 152.50, 135.75, 134.92, 128.01, 126.53, 125.14, 76.03, 52.89, 48.38, 34.03, 24.16.
HRMS (ESI-TOF) calcd for $C_{15}H_{17}NO_3$ $[M+H]^+$ 260.1281, observed 1260.1291

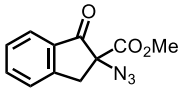


13: This compound can be synthesized by reduction of the alpha-azido indanone as reported in the literature.[28] However, in our hands, over-reduction of the alpha-azido indanone to the amino-alcohol was a consistent major product. Reoxidation of the alcohol could be achieved by the following route:

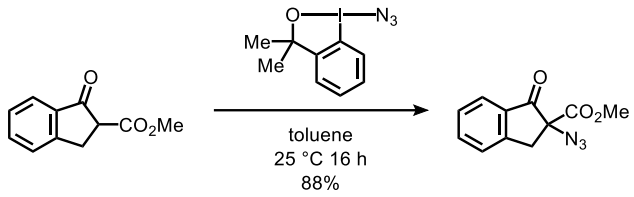


Clear oil
^{1}H NMR (400 MHz, CDCl3) δ 7.84 – 7.77 (m, 1H), 7.65 (td, J = 7.5, 1.3 Hz, 1H), 7.48 (dt, J = 7.7, 1.0 Hz, 1H), 7.46 – 7.38 (m, 1H), 3.69 (s, 4H), 3.09 (d, J = 17.1 Hz, 1H), 2.28 – 2.04 (m, 2H).
The NMR is in agreement with the literature.[28]





15: This compound was synthesized according to two different literature procedures. Our preferred method was the iodine mediated azidation using sodium azide.[10] Briefly, **2a** (570 mg; 3.0 mmol) was dissolved in DMSO (21 mL). A solution of sodium azide (682.5 mg; 10.5 mmol) in water (11 mL) was added. Iodine (1.14 g; 4.5 mmol) was added and the solution stirred at room temperature for 4 hours. The solution was quenched with sat. $Na_2S_2O_3$ (10 mL), and extracted with EtOAc (3 x 30 mL). The combined organics were washed with brine (3 x 100 mL), dried over Na_2SO_4, and purified by column chromatography (0-10% EtOAc/hexanes). **15** was obtained as a brown oil that solidified upon cooling (669.0 mg; 97%).



Alternatively, **15** could be synthesized by the method of Waser.[29] Briefly, **2a** (95 mg; 0.5 mmol) was dissolved in toluene (2.5 mL). 1-azido-1,2-benziodoxole-3-(1*H*)-one (198 mg; 0.65 mmol), was added, and the solution stirred at room temperature for 16 h. The solvent was removed under a stream of N_2, and the residue purified by column chromatography. **15** was obtained as a brown oil that solidified upon cooling (100 mg; 88%).

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.84 (d, *J* = 7.7 Hz, 1H), 7.69 (td, *J* = 7.5, 1.3 Hz, 1H), 7.50 – 7.43 (m, 2H), 3.81 (d, *J* = 1.4 Hz, 3H), 3.68 (d, *J* = 17.4 Hz, 1H), 3.05 (d, *J* = 17.3 Hz, 1H).
The NMR is in agreement with the literature.[10]

8. Crystallographic Data

The diffraction data for **1** and **3a** were measured at 100 K on a Bruker D8 VENTURE diffractometer equipped with a microfocus Mo-target X-ray tube (λ = 0.71073 Å) and PHOTON 100 CMOS detector. Data were collected using ϕ scans. The data reduction and integration were performed with the Bruker APEX4 software package (Bruker AXS, version 2017.3-0, 2018). Data were scaled and corrected for absorption effects using the multi-scan procedure as implemented in SADABS. The structures were solved by SHELXT and refined by a full-matrix least-squares procedure using SHELXL. Crystallographic data and details of the data collection and structure refinement are listed in table S1.

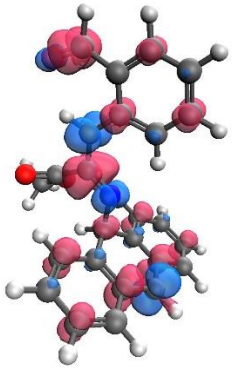
Table S1. Crystallographic and refinement data for complexes

Compound	**1 (DNIBX)**	**3a**
CCDC Number	2344471	2344470
Empirical formula	$C_{21}H_{14}INO_2$	$C_{25}H_{19}NO_3$
Formula weight	439.23	381.41
Temperature/K	100(2)	100(2)
Crystal system	monoclinic	monoclinic
Space group	$P2_1/c$	C2/c
a/Å	8.2543(4)	34.3469(17)
b/Å	31.3103(15)	7.9550(4)
c/Å	7.0230(3)	15.3192(7)
α/°	90	90
β/°	114.3000(10)	96.697(2)
γ/°	90	90
Volume/Å^3	1654.25(13)	4157.1(3)
Z	4	8
ρ_{calc}g/cm^3	1.764	1.357
μ/mm^{-1}	1.950	0.088
F(000)	864.0	1800.0
Crystal size/mm^3	0.174 × 0.092 × 0.056	0.392 × 0.245 × 0.152
Radiation	MoKα (λ = 0.71073)	MoKα (λ = 0.71073)
2Θ range for data collection/°	5.204 to 55.762	4.776 to 64.192
Index ranges	-10 ≤ h ≤ 10, -40 ≤ k ≤ 41, -9 ≤ l ≤ 9	-51 ≤ h ≤ 51, -11 ≤ k ≤ 11, -22 ≤ l ≤ 22
Reflections collected	56966	72927
Independent reflections	3923 [R_{int} = 0.0443, R_{sigma} = 0.0275]	7243 [R_{int} = 0.0372, R_{sigma} = 0.0178]
Data/restraints/parameters	3923/0/226	7243/0/293
Goodness-of-fit on F^2	1.122	1.039
Final R indexes [I>=2σ (I)]	R_1 = 0.0271, wR_2 = 0.0557	R_1 = 0.0457, wR_2 = 0.1164
Final R indexes [all data]	R_1 = 0.0360, wR_2 = 0.0570	R_1 = 0.0550, wR_2 = 0.1223
Largest diff. peak/hole / e Å^{-3}	1.10/-1.88	0.47/-0.22

9. Computational Details

Ground and transition state geometries were optimized with frequency calculations using density functional theory (DFT) in Gaussian16 (Revision A.03)[30] using the polarizable continuum solvation model (PCM)[31] in methanol (MeOH) at the M062X/6-31g(d) level of theory with the D3 version of Grimme's dispersion corrections.[32,33] This basis set/functional combo was chosen because it most accurately reproduced the crystal structure of **3a**. Single point energy calculations for all structures were conducted using PCM(MeOH) at the M062X/def2tzvp level. All of the optimized geometries were verified by frequency calculations as ground states (zero imaginary frequencies) or transition states (one imaginary frequency). Transition states were verified by intrinsic reaction coordinate (IRC) calculations to connect to the corresponding ground states. Quasi-harmonic corrected free energies (Gtz) for each independently optimized structure were computed using Grimme entropic corrections[34] and Head-Gordon enthalpic corrections[35] as implemented in Paton's GoodVibes python package.[36] Due to the lack of thermochemical data in bond scans, the intermediate geometries were analyzed using only electronic energies.

10. Supplemental Computational Figures



Supplemental Figure 10: Spin density of triplet C-N bond cleavage product demonstrating highly delocalized radical character.

11. References

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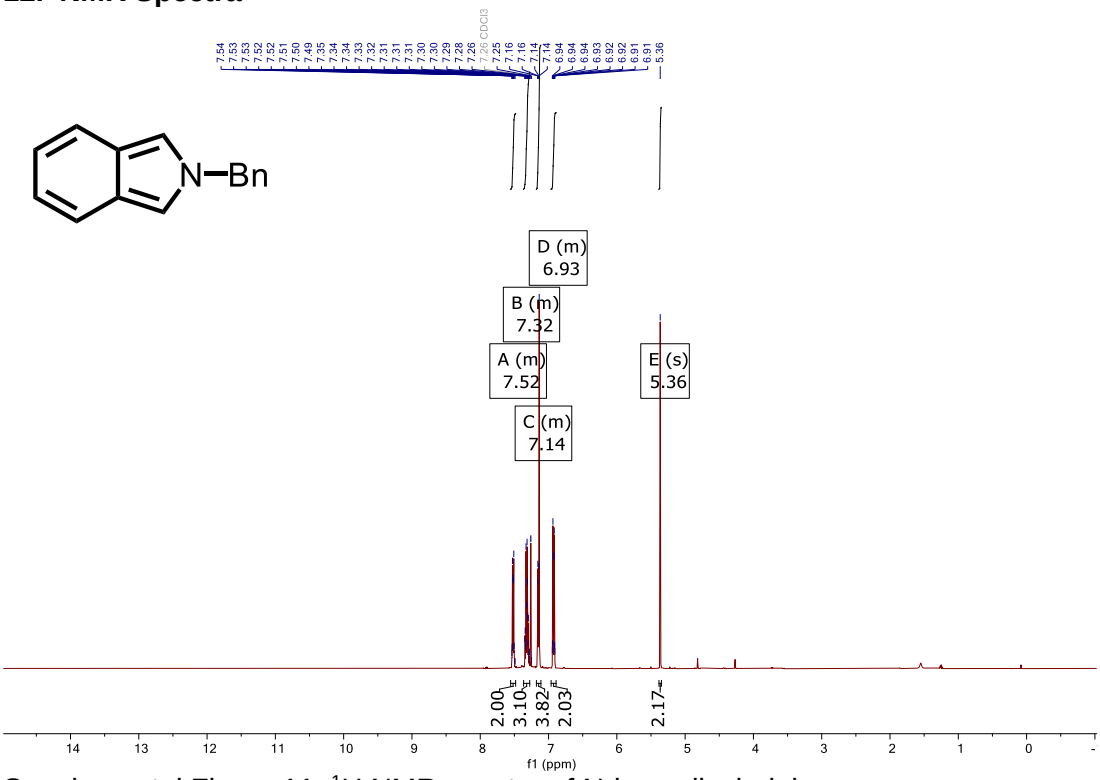
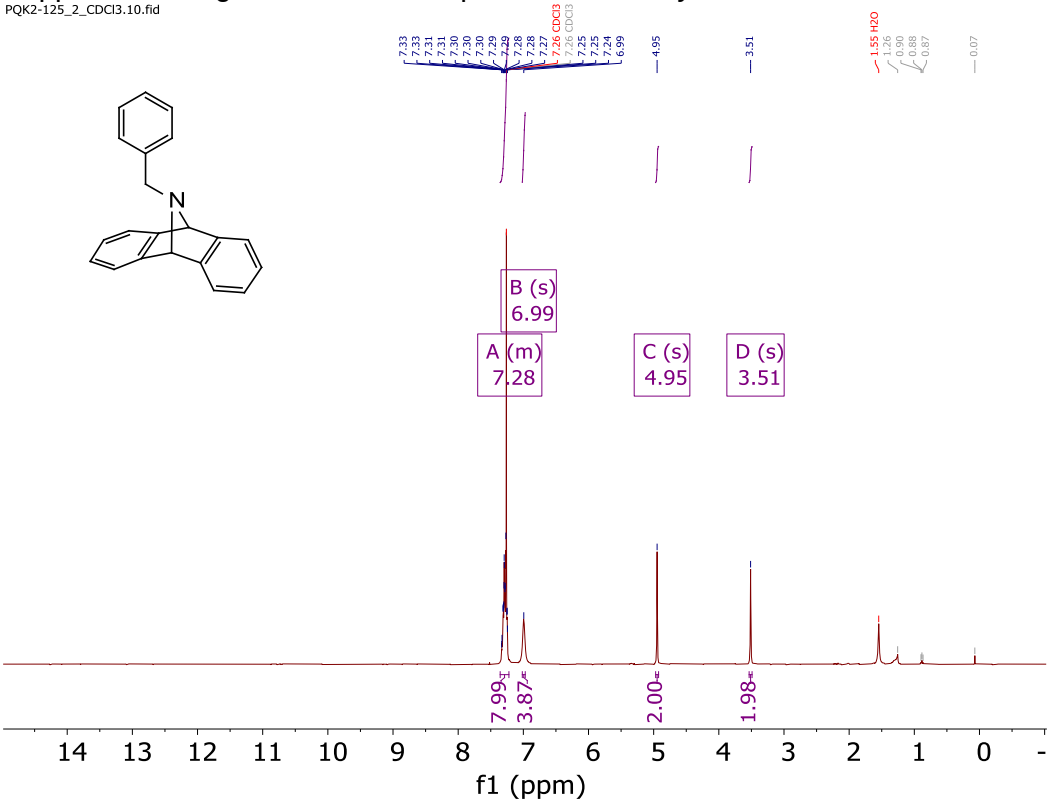
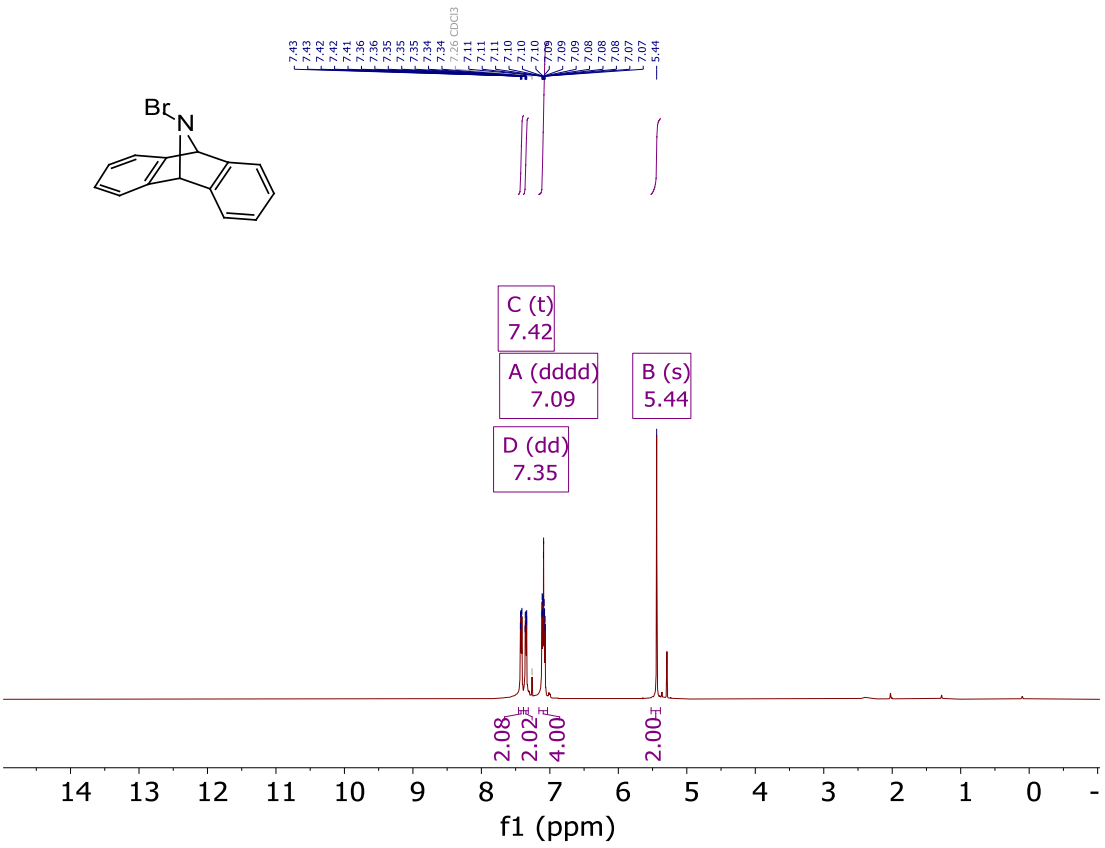
12. NMR Spectra



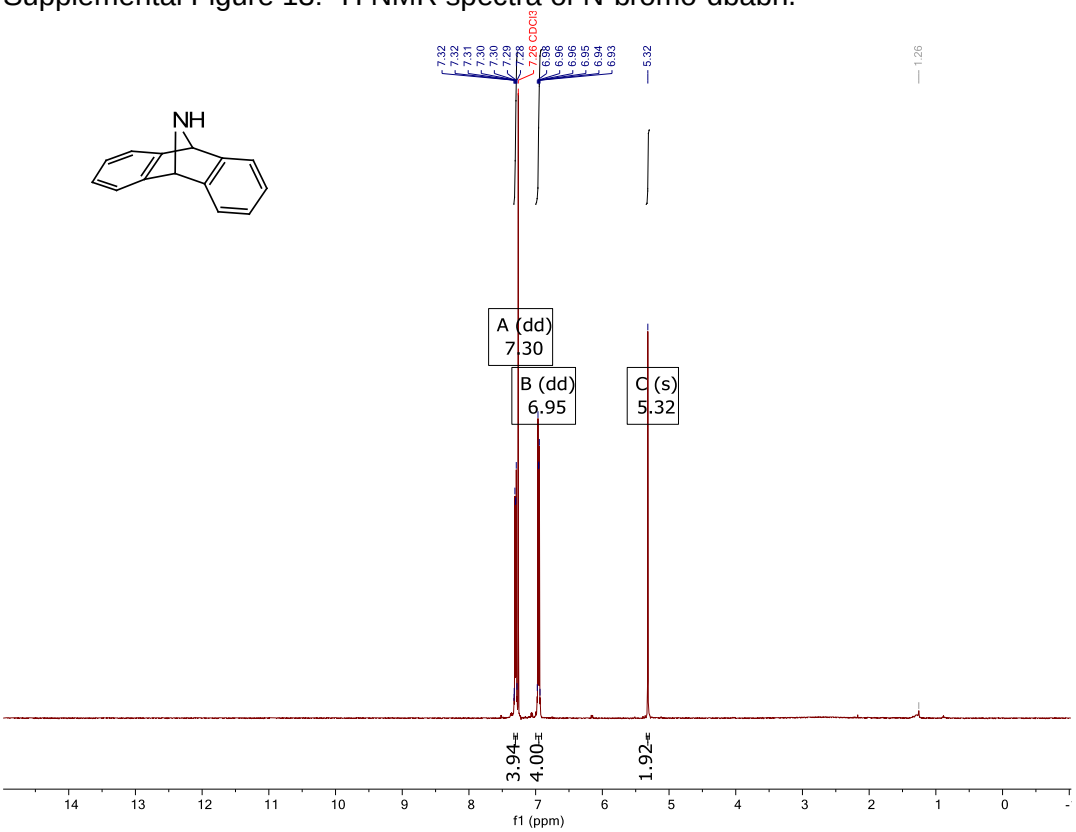
Supplemental Figure 11: ^{1}H NMR spectra of N-benzylisoindole.



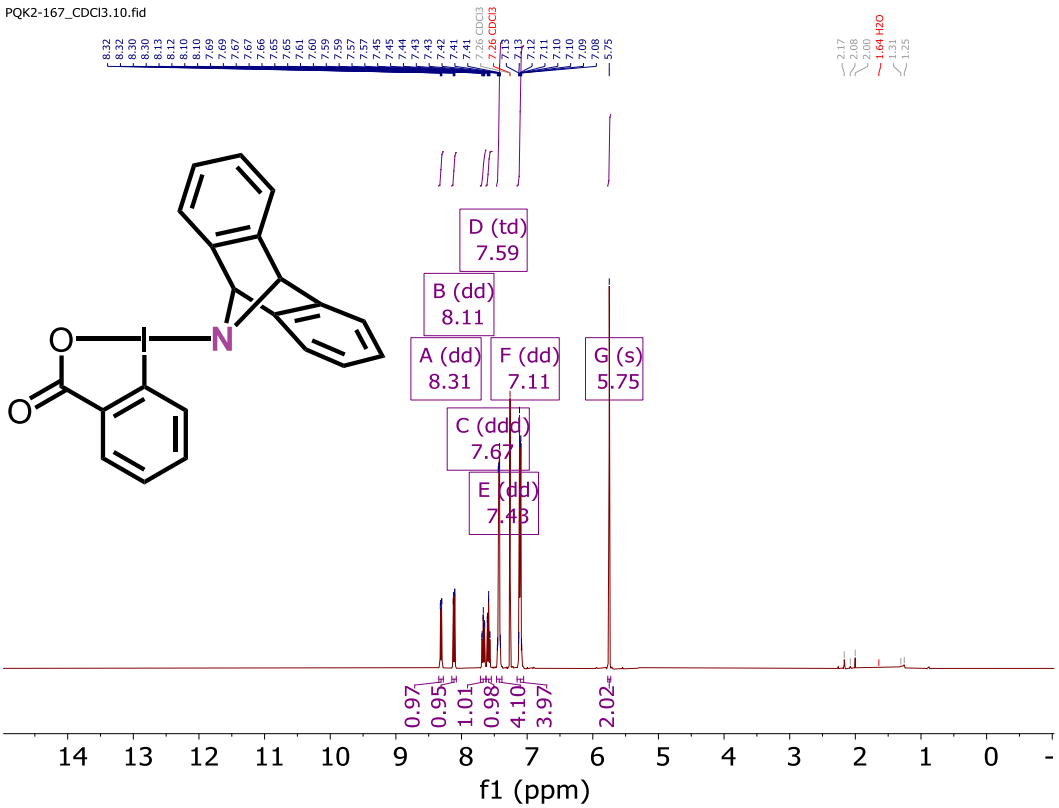
Supplemental Figure 12: ^{1}H NMR spectra of N-benzyl-dbabh.



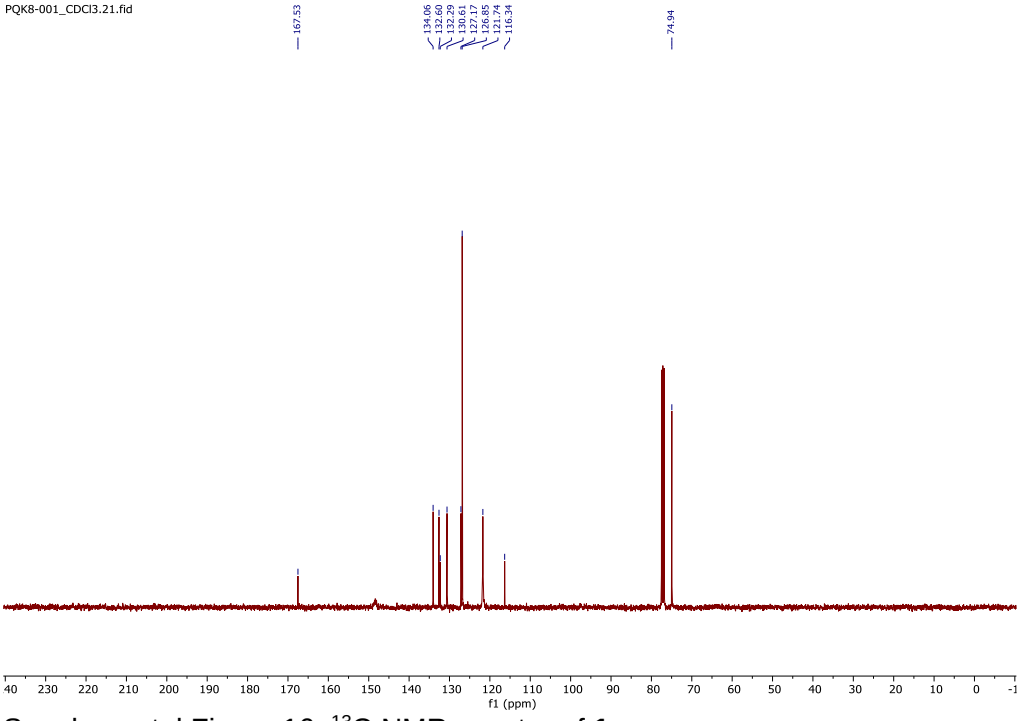
Supplemental Figure 13: ^{1}H NMR spectra of N-bromo-dbabh.



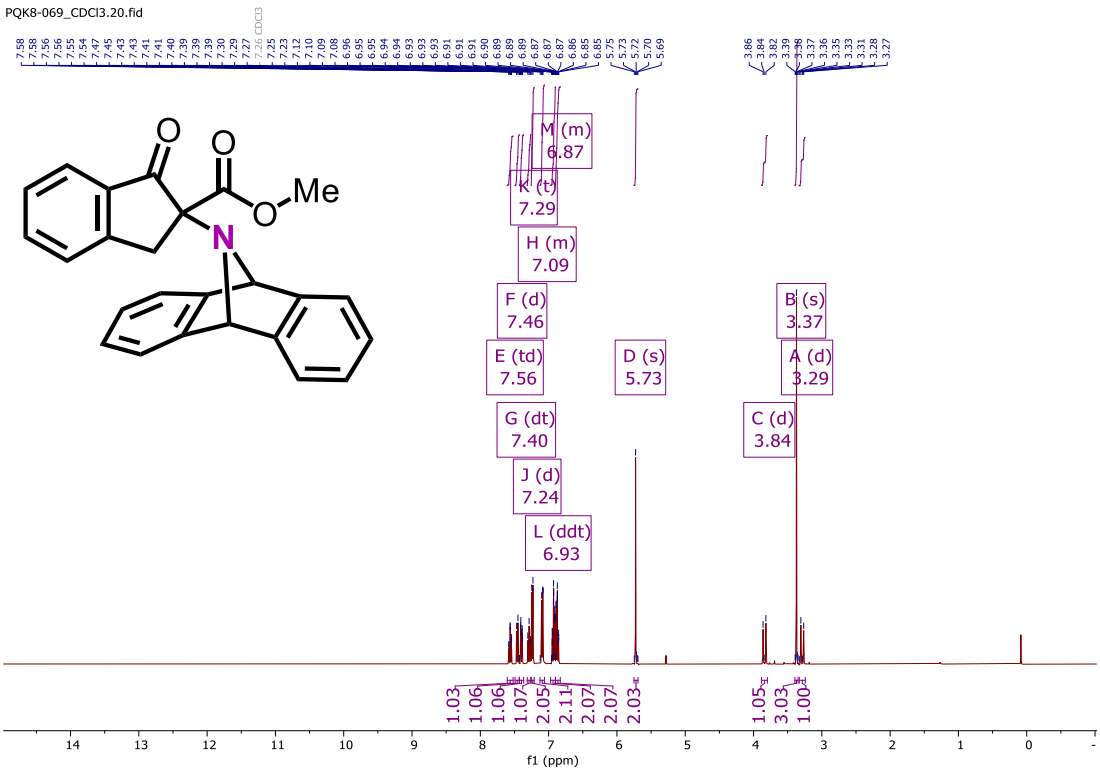
Supplemental Figure 14: ^{1}H NMR spectra of NH-dbabh.



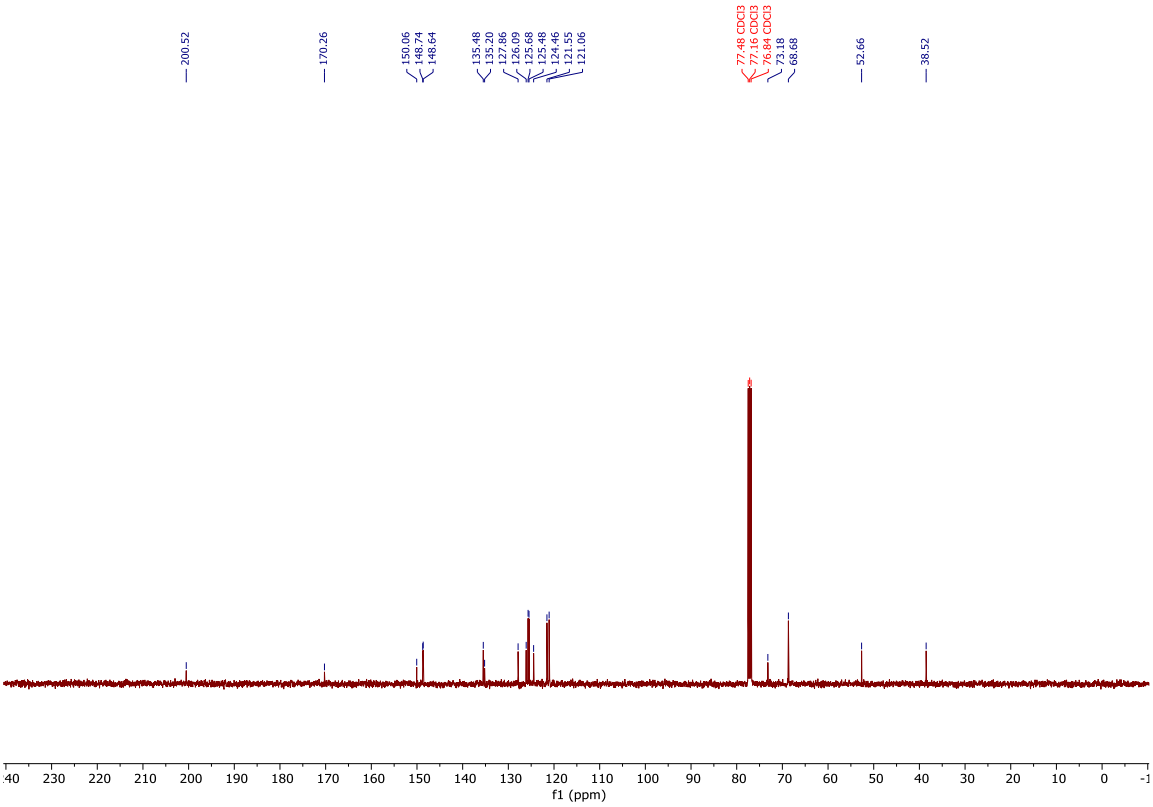
Supplemental Figure 15: ^{1}H NMR spectra of **1**.



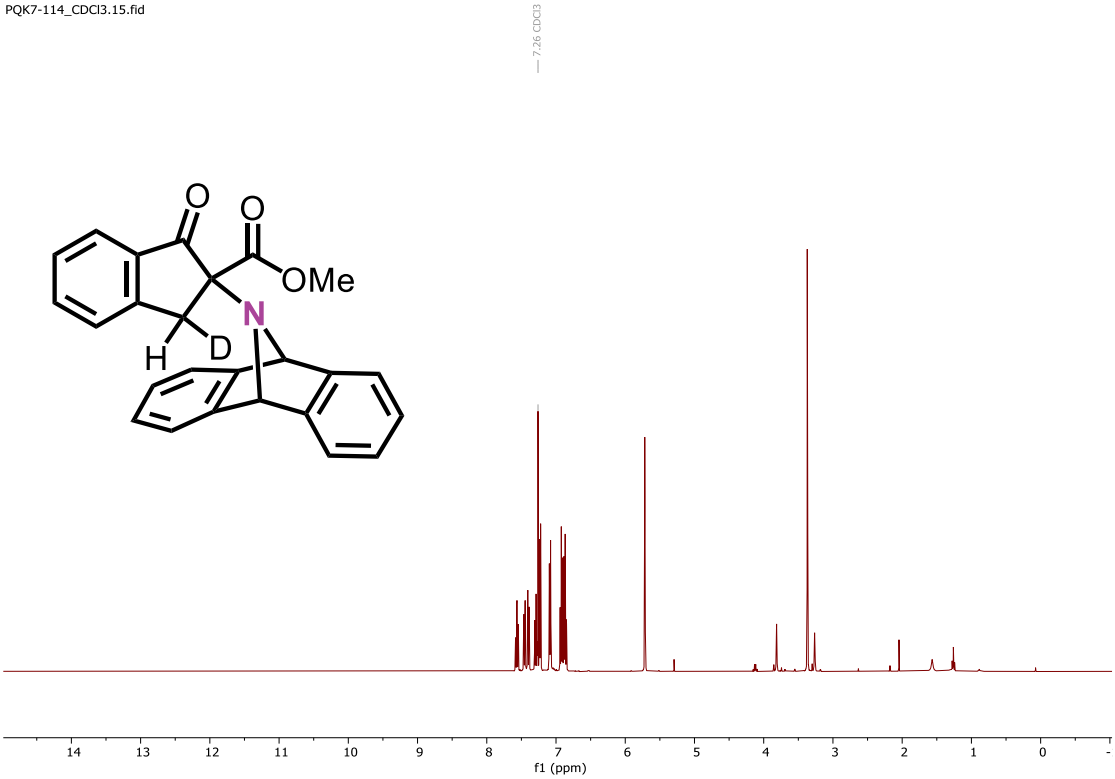
Supplemental Figure 16: ^{13}C NMR spectra of **1**.



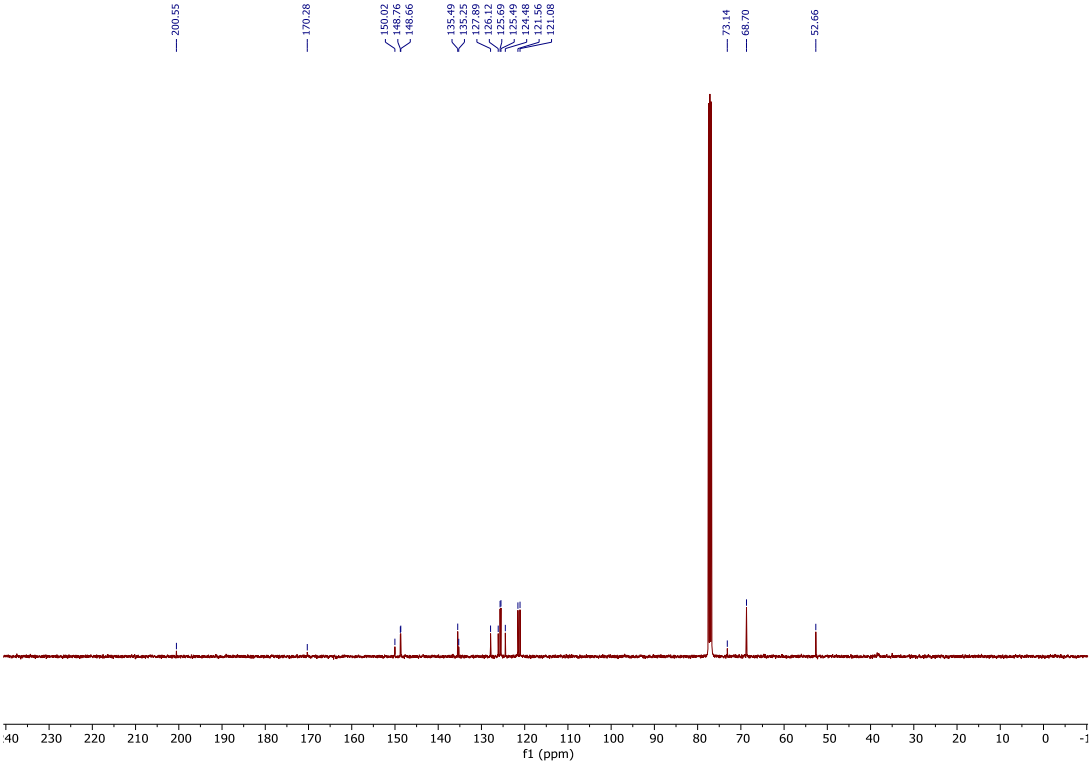
Supplemental Figure 17: ^{1}H NMR spectra of **3a**.



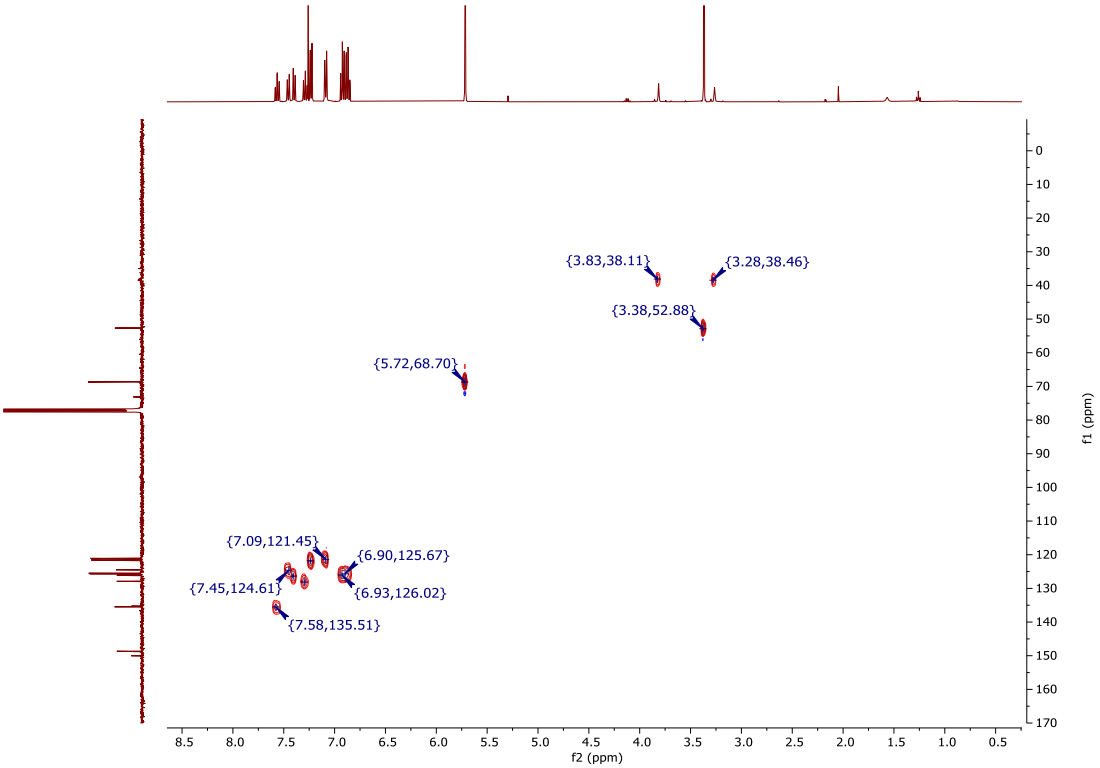
Supplemental Figure 18: ^{13}C NMR spectra of **3a**.



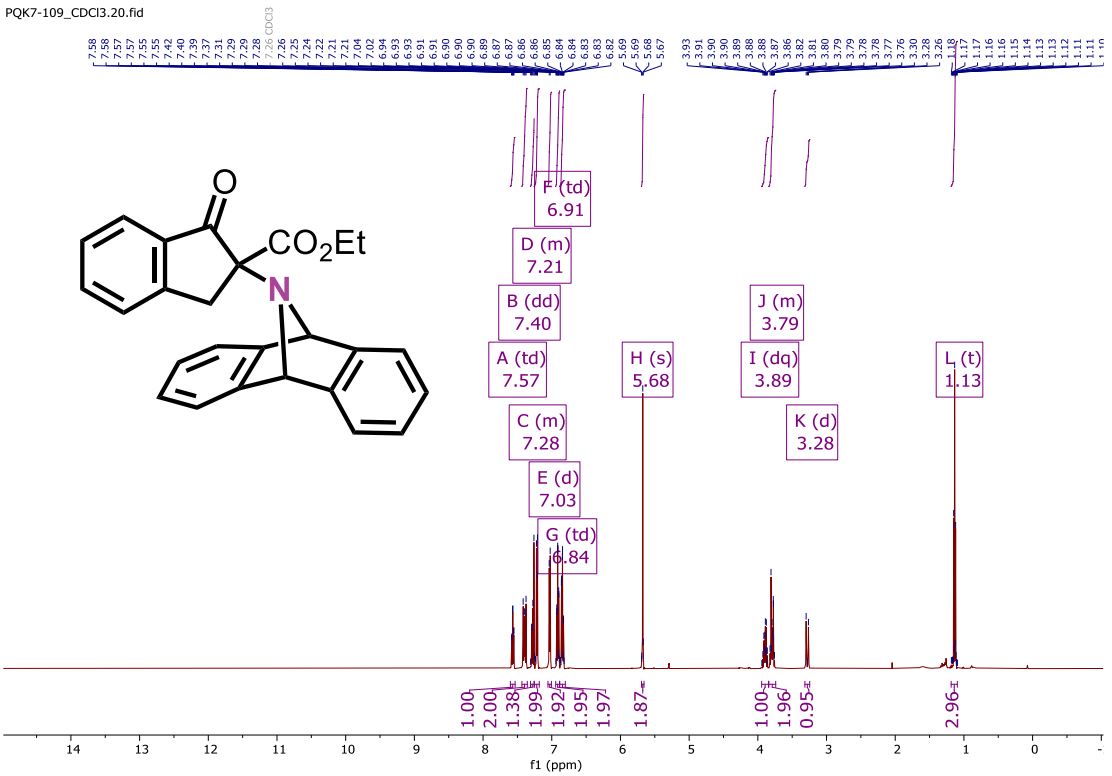
Supplemental Figure 19: ^{1}H NMR spectra of **3a-D**.



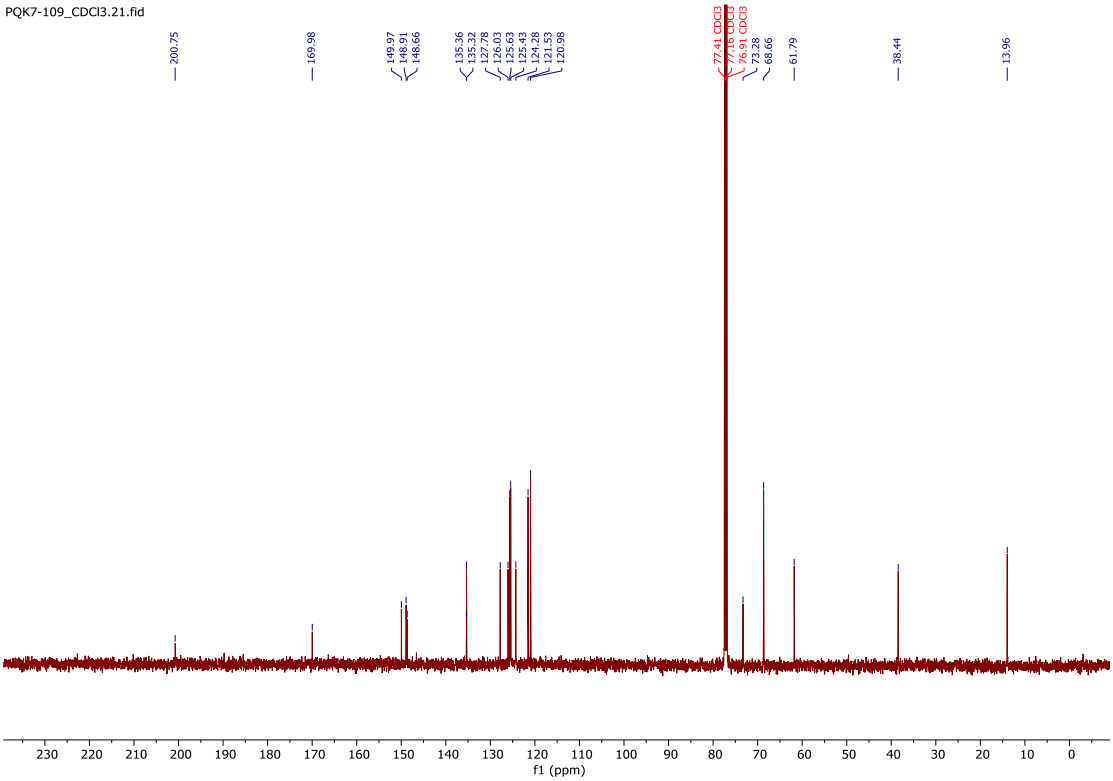
Supplemental Figure 20: ^{13}C NMR spectra of **3a-D**.



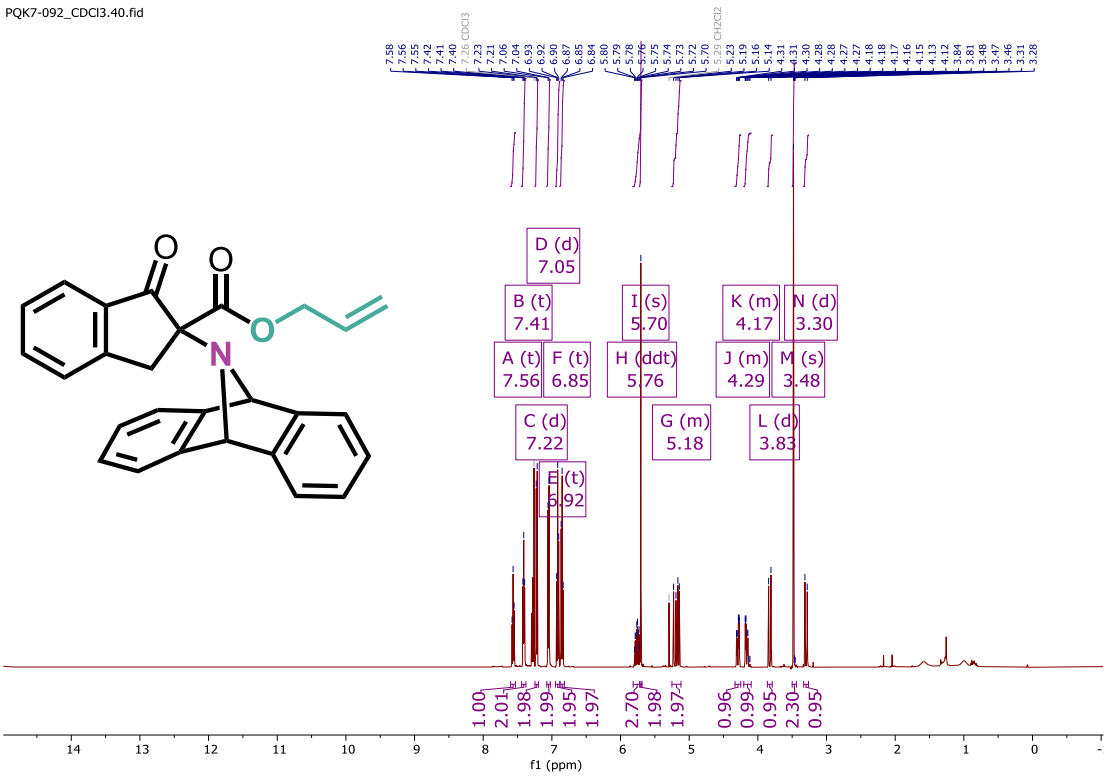
Supplemental Figure 21: ^{1}H-^{13}C HSQC spectrum of **3a-D**.



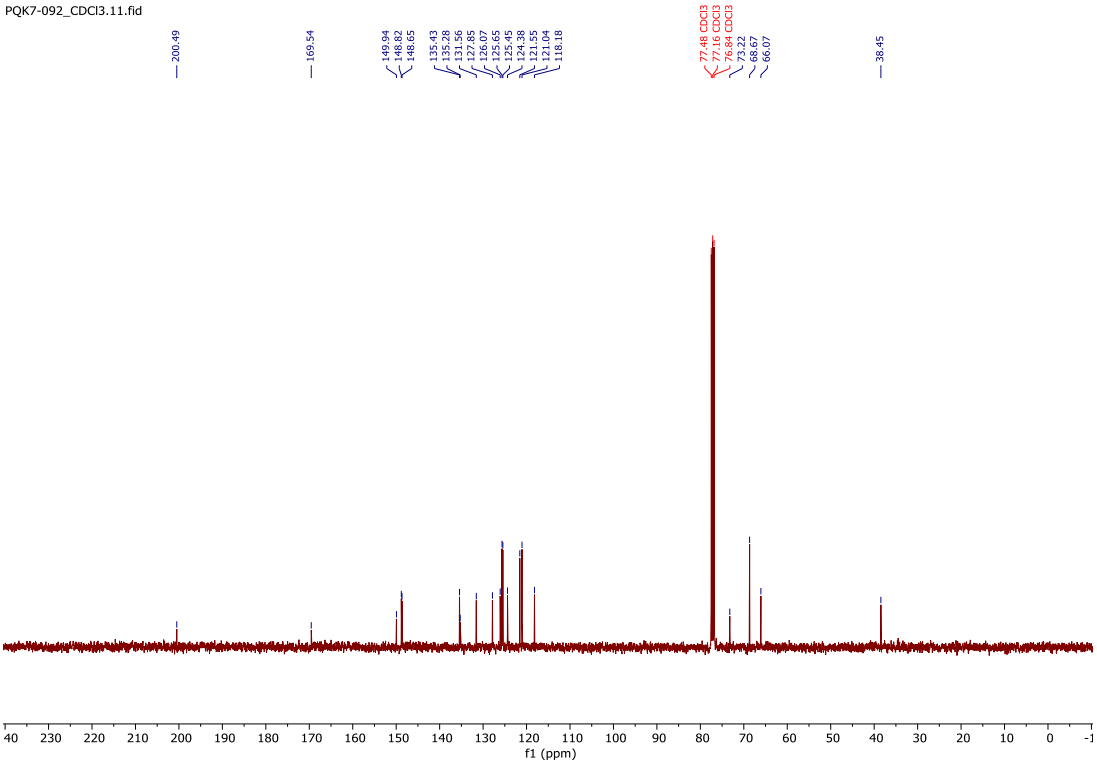
Supplemental Figure 22: ^{1}H NMR spectra of **3b**.



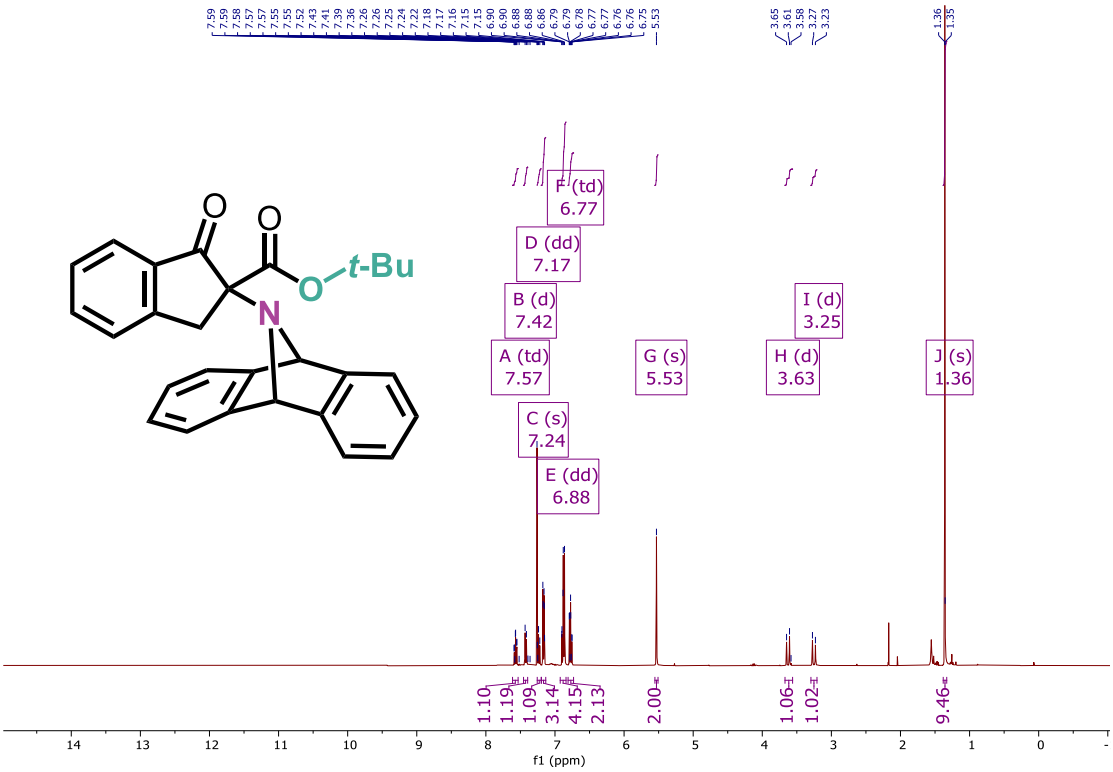
Supplemental Figure 23: ^{13}C NMR spectra of **3b**.



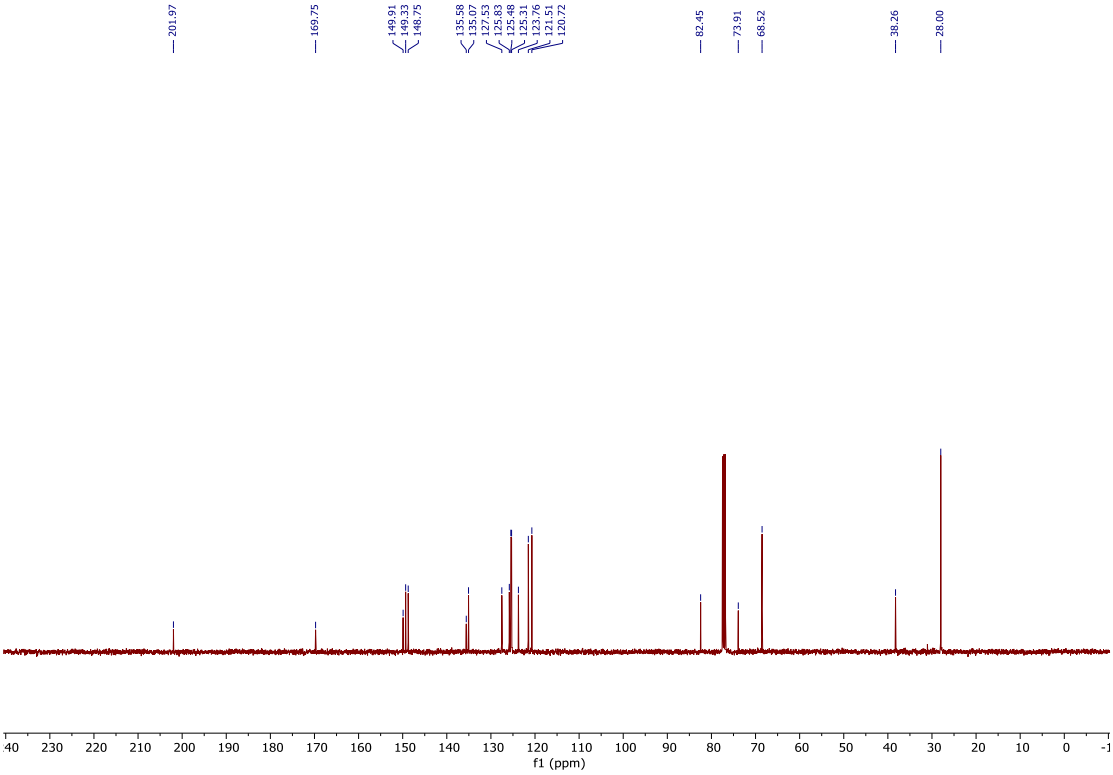
Supplemental Figure 24: ^{1}H NMR spectra of **3c**.



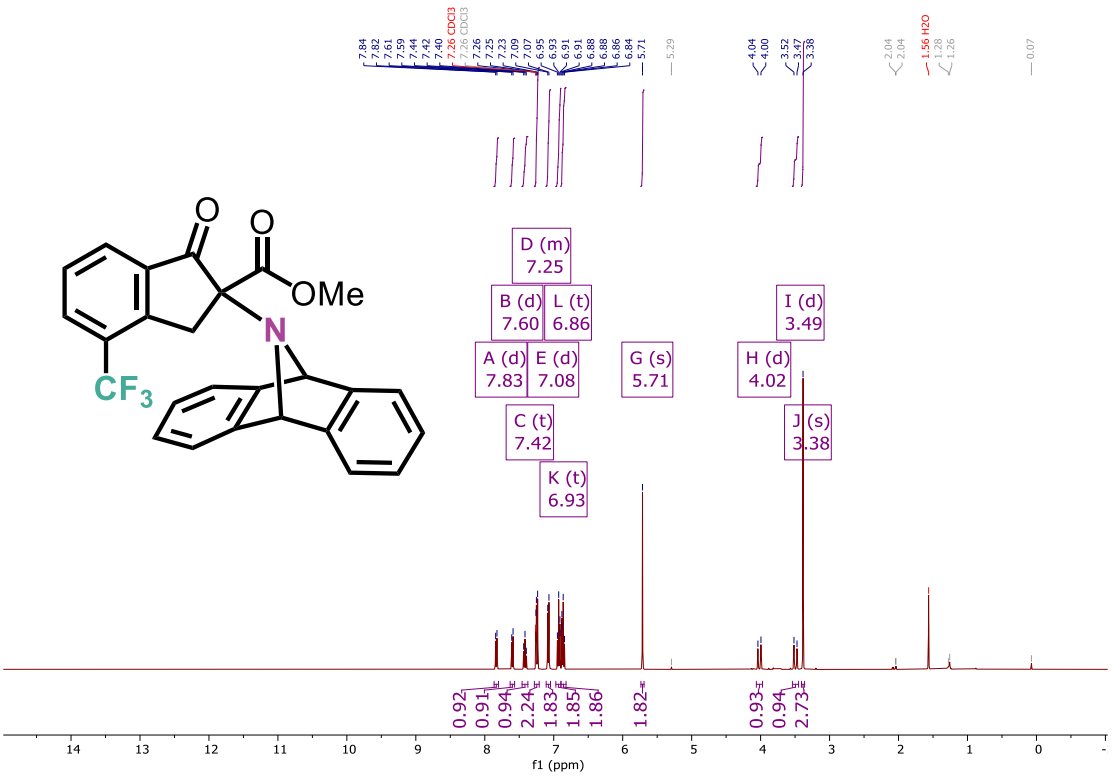
Supplemental Figure 25: ^{13}C NMR spectra of **3c**.



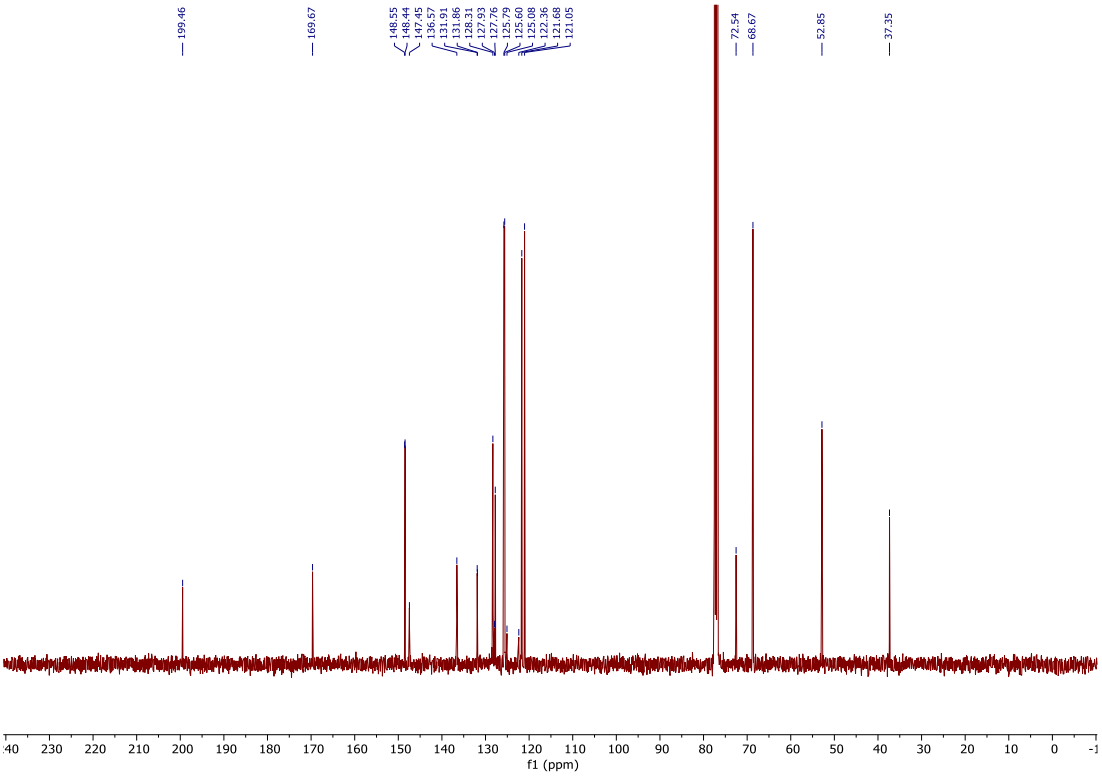
Supplemental Figure 26: ^{1}H NMR spectra of **3d**.



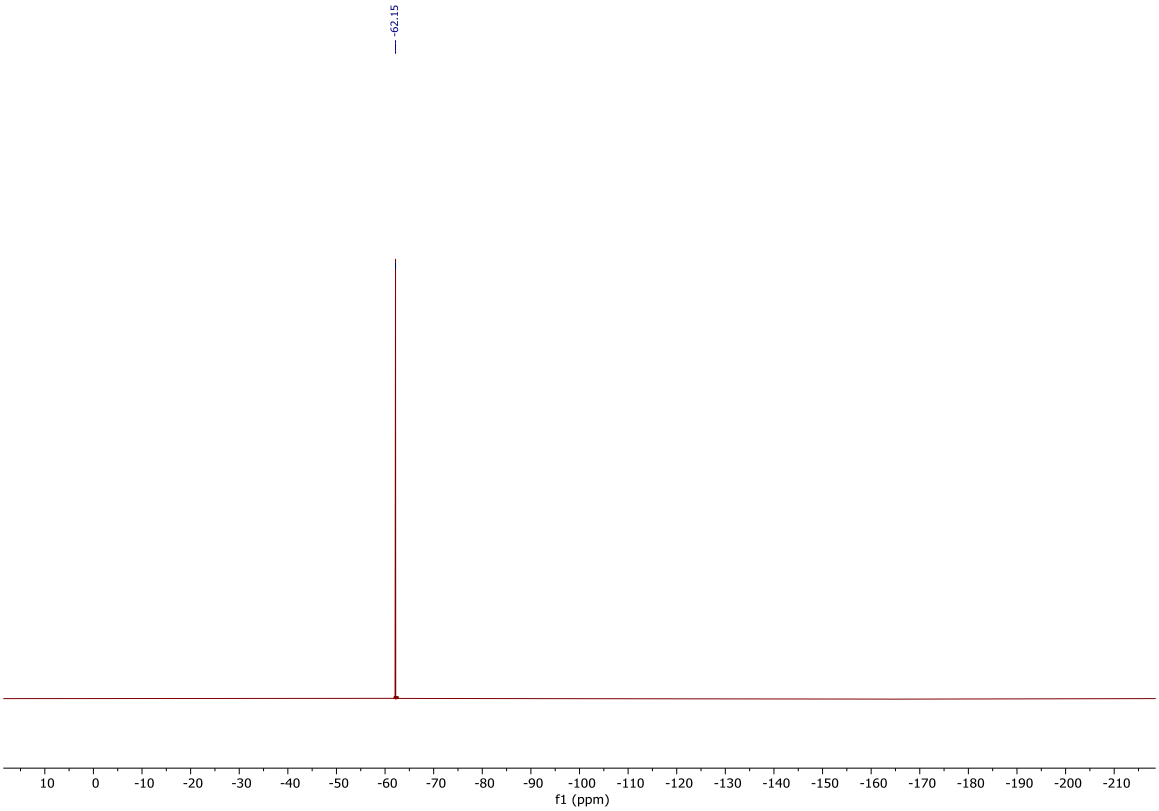
Supplemental Figure 27: ^{13}C NMR spectra of **3d**.



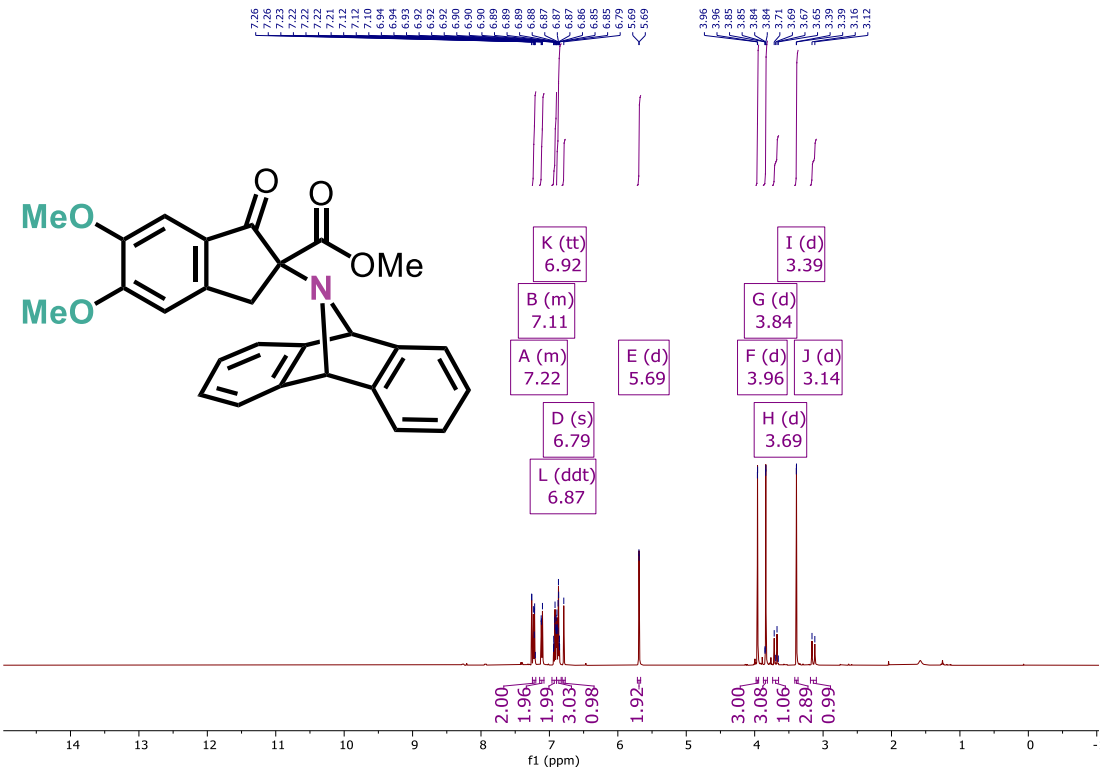
Supplemental Figure 28: ^{1}H NMR spectra of **3e**.



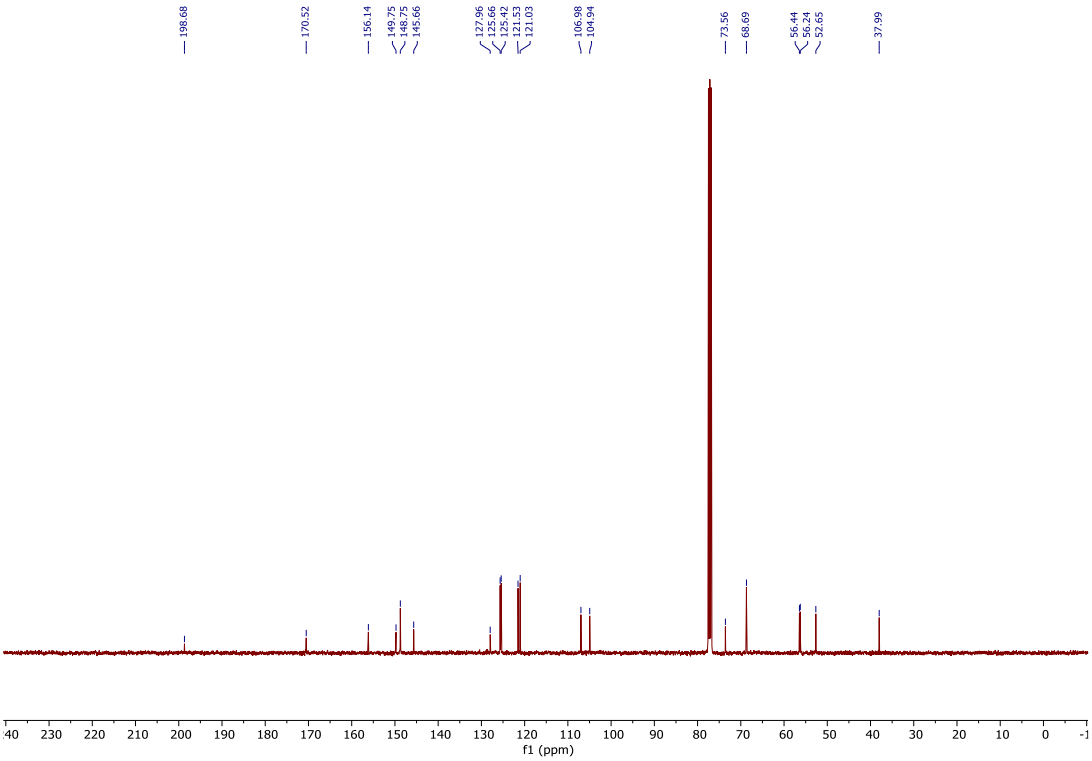
Supplemental Figure 29: ^{13}C NMR spectra of **3e**.



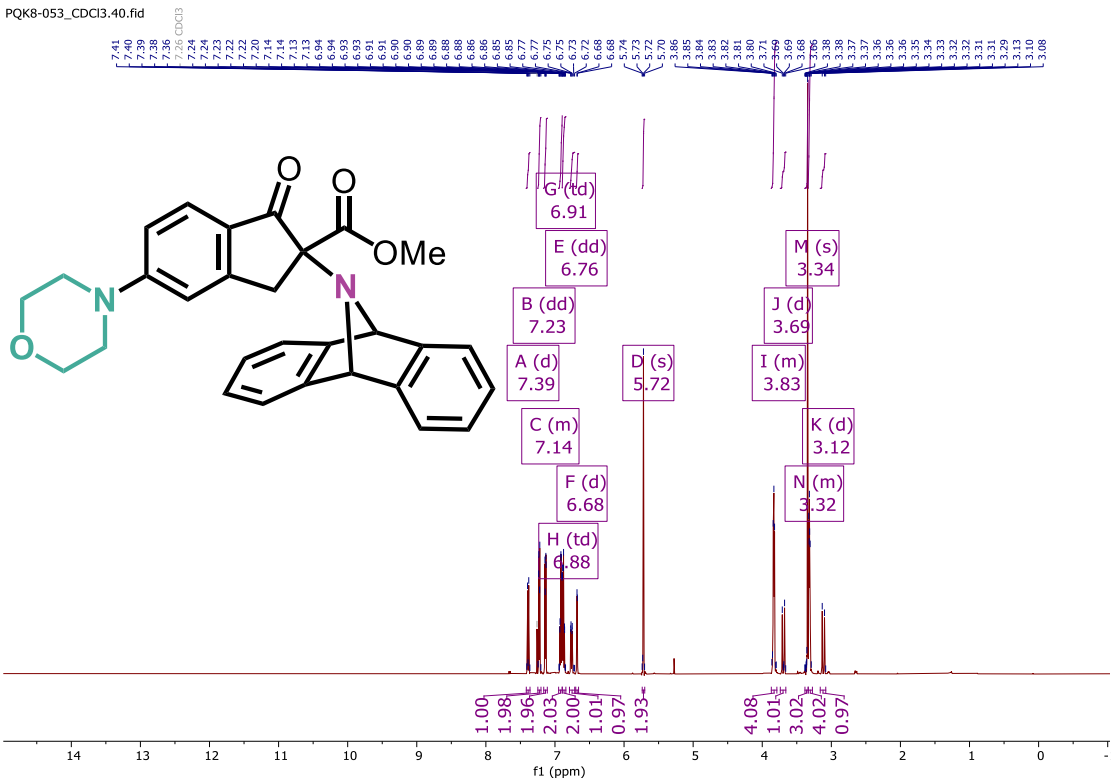
Supplemental Figure 30: ^{19}F NMR spectra of **3e**.



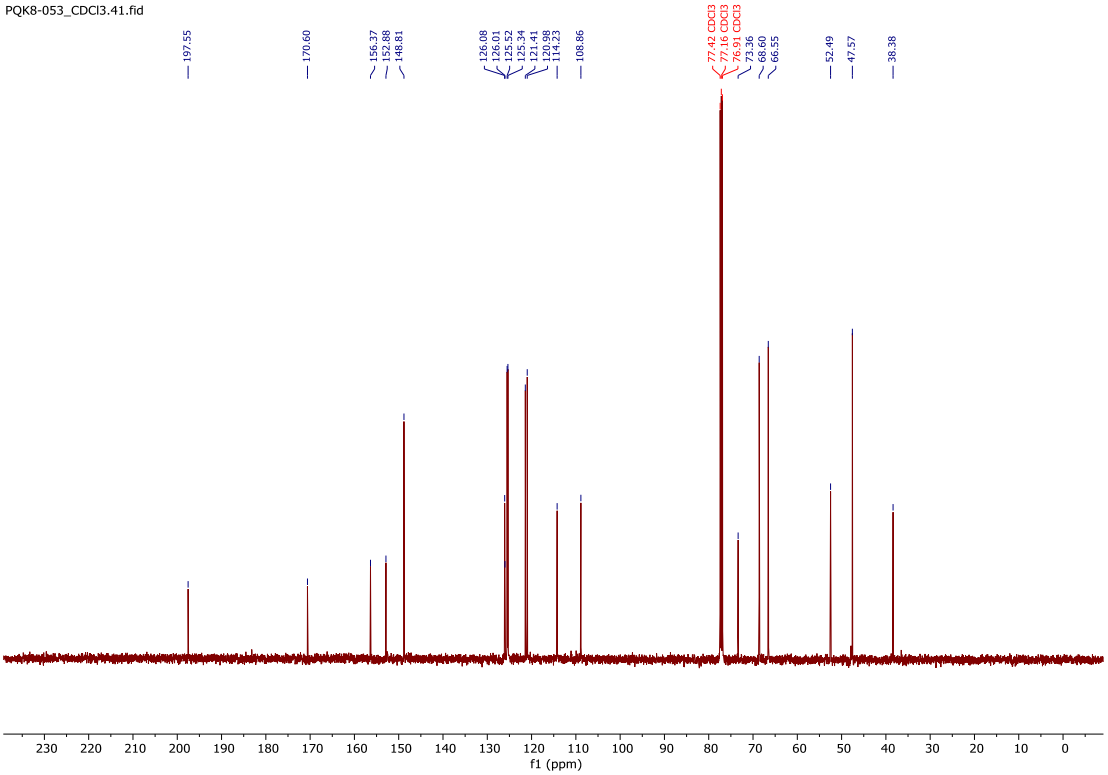
Supplemental Figure 31: ^{1}H NMR spectra of **3f**.



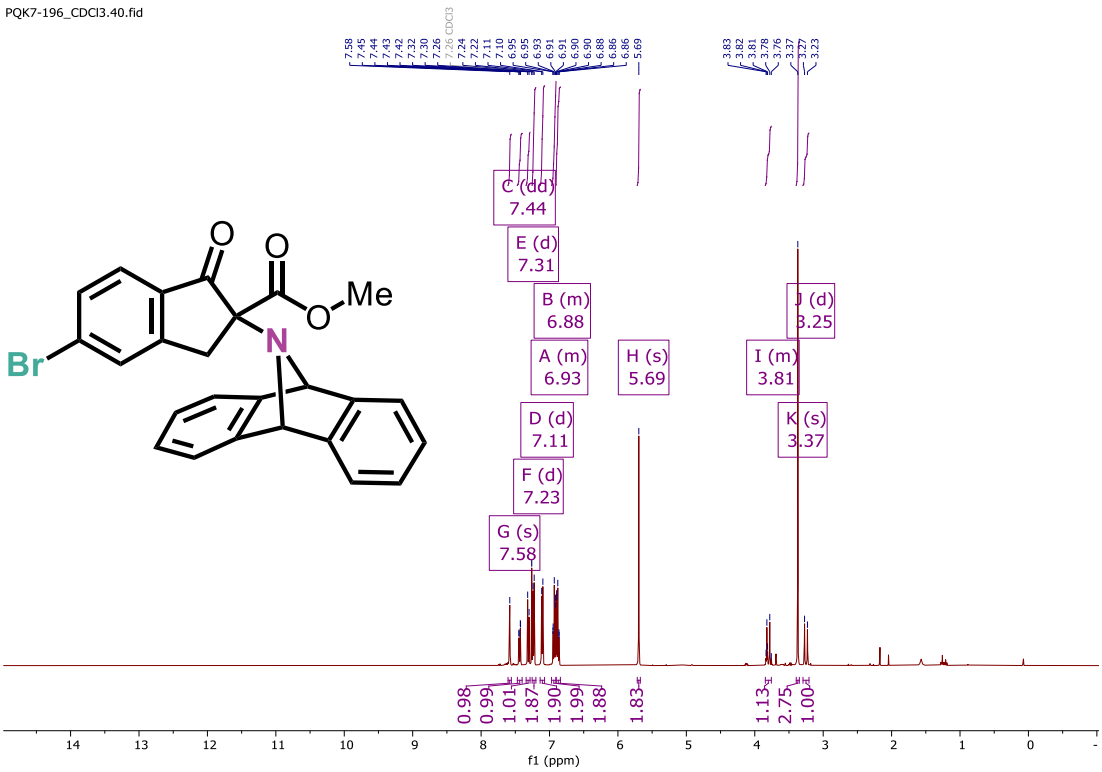
Supplemental Figure 32: ^{13}C NMR spectra of **3f**.



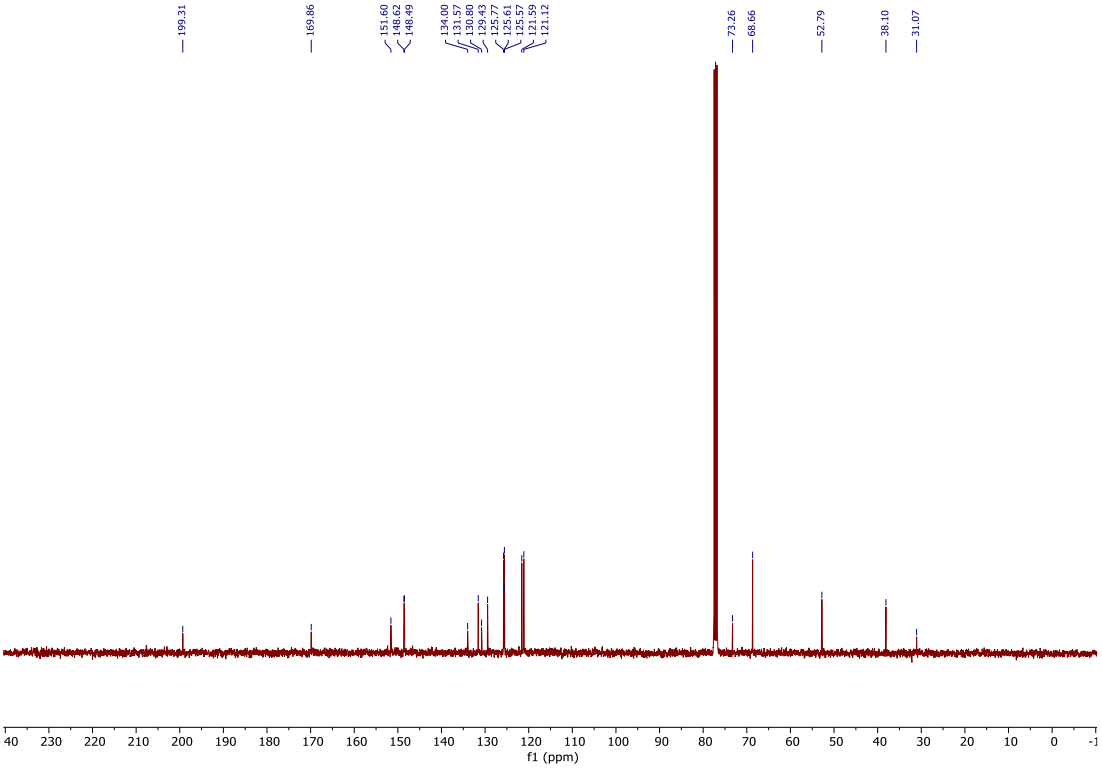
Supplemental Figure 33: ^{1}H NMR spectra of **3g**.



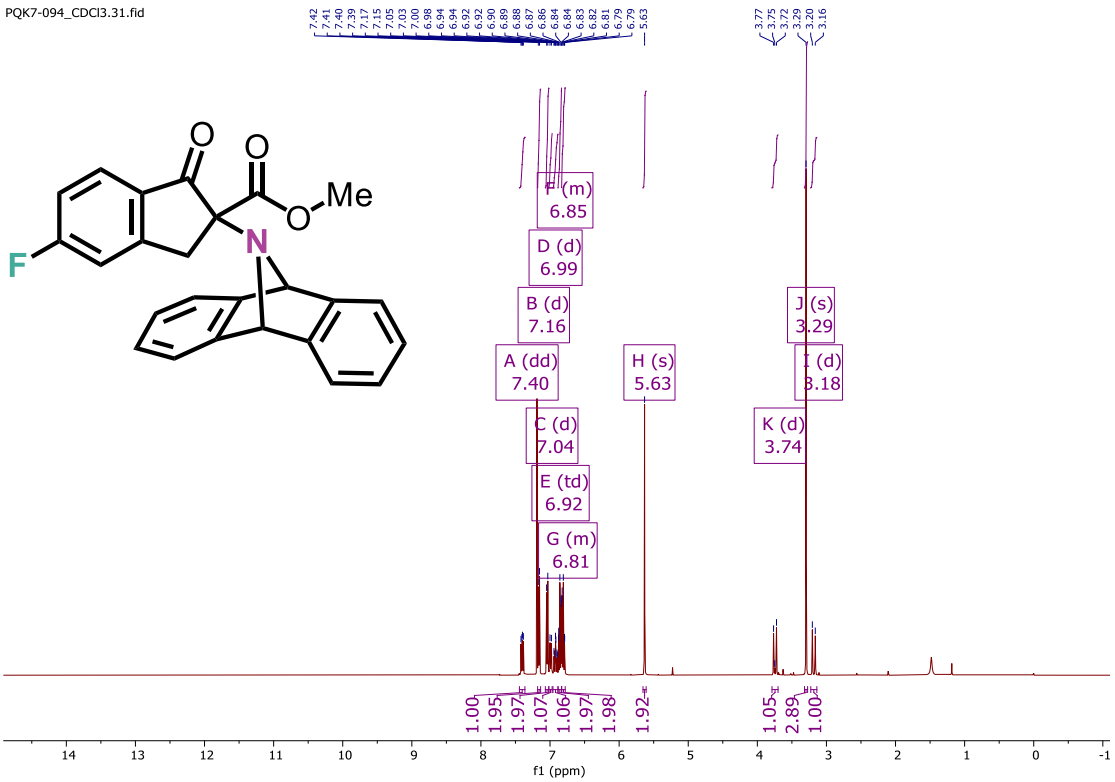
Supplemental Figure 34: ^{13}C NMR spectra of **3g**.



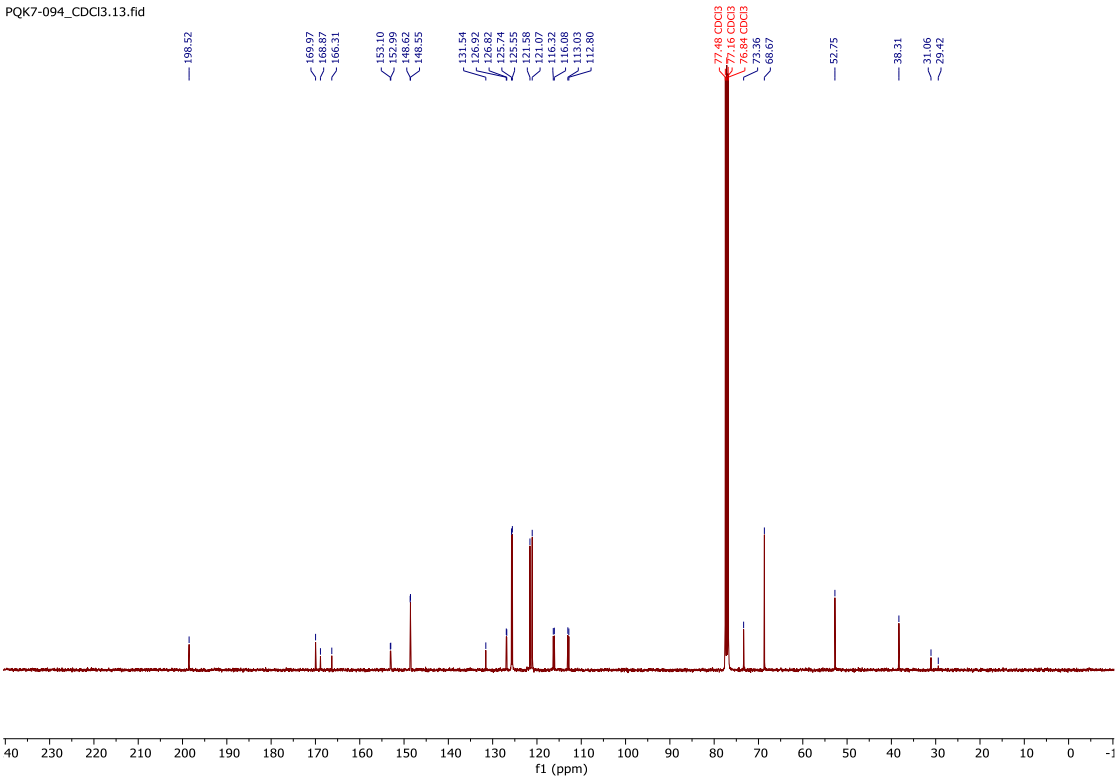
Supplemental Figure 35: ^{1}H NMR spectra of **3h**.



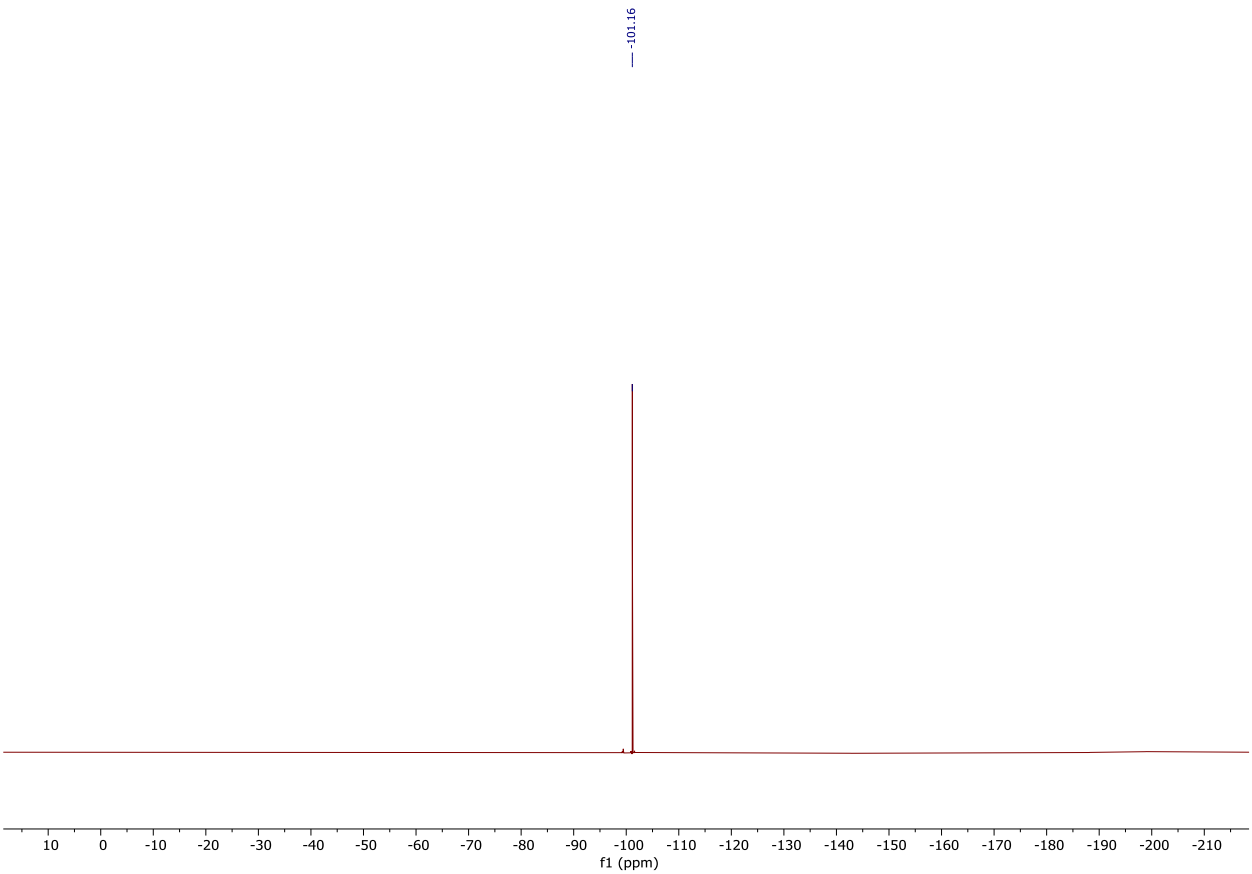
Supplemental Figure 36: ^{13}C NMR spectra of **3h**.



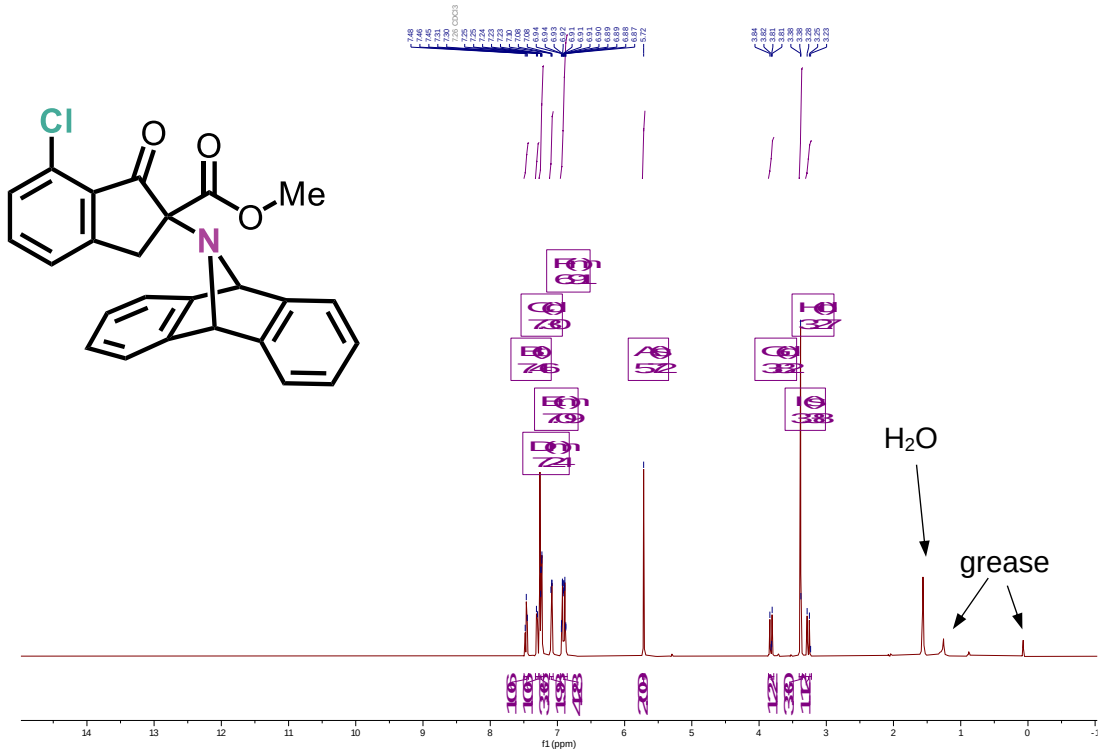
Supplemental Figure 37: ^{1}H NMR spectra of **3i**.



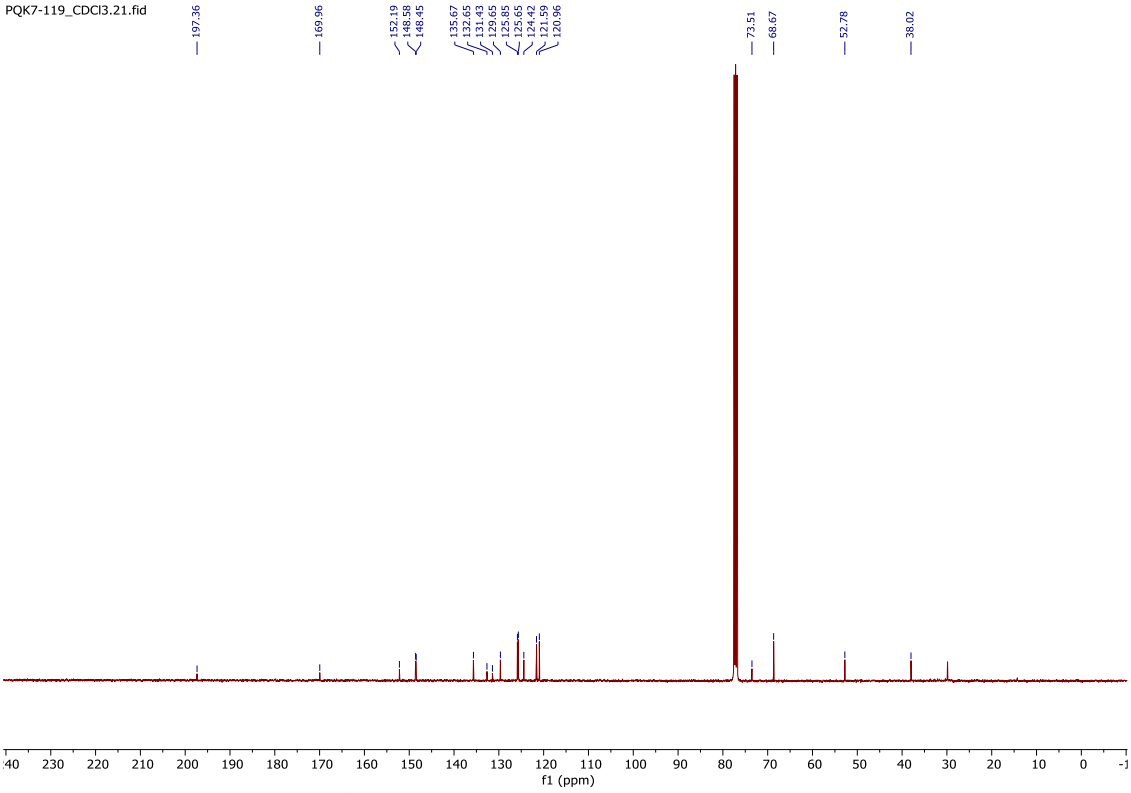
Supplemental Figure 38: ^{13}C NMR spectra of **3i**.



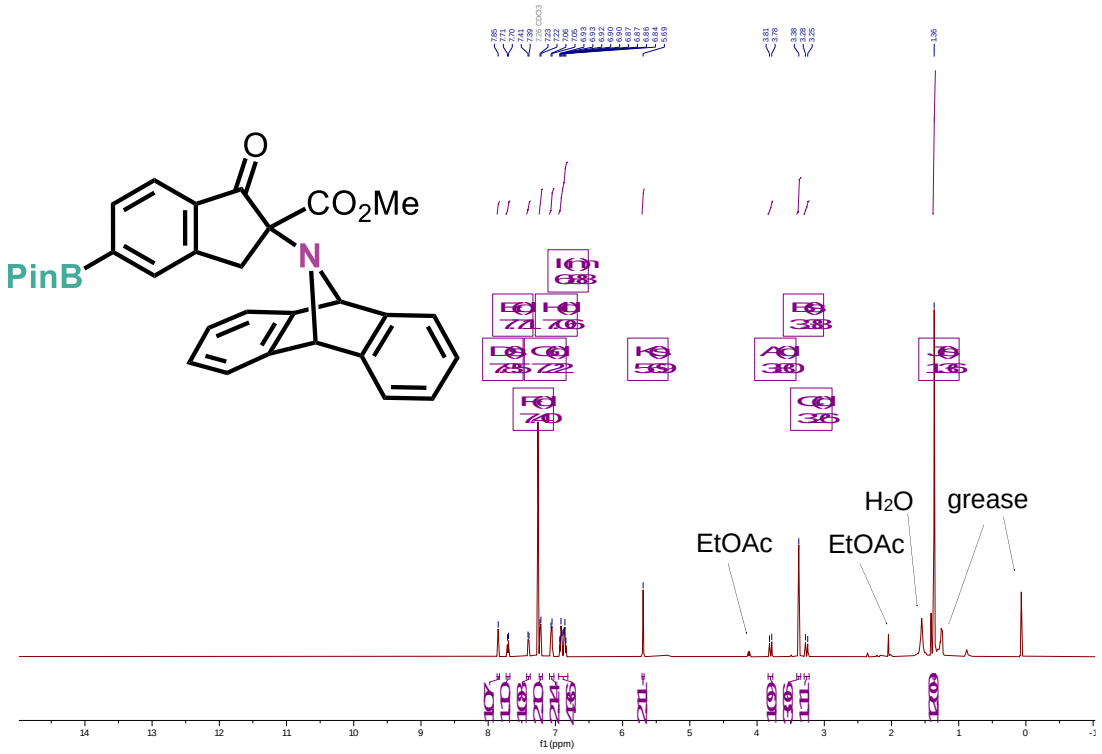
Supplemental Figure 39: ^{19}F NMR spectra of **3i**.



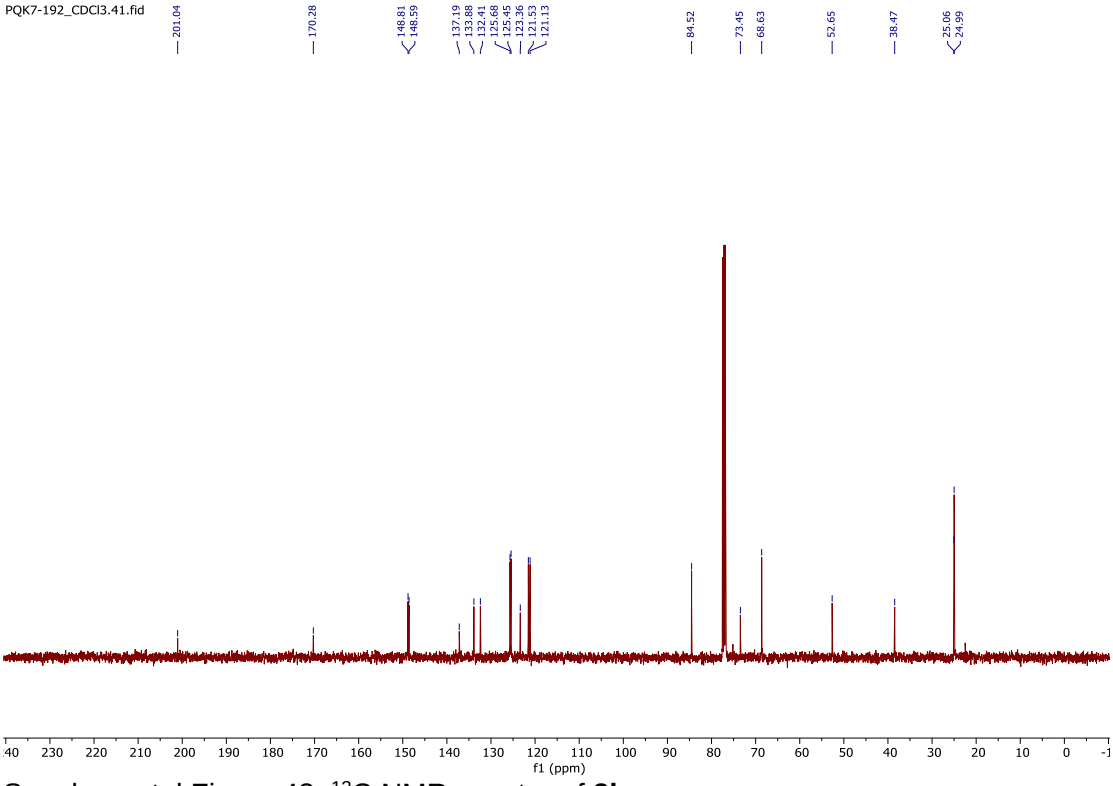
Supplemental Figure 40: ^{1}H NMR spectra of **3j**.



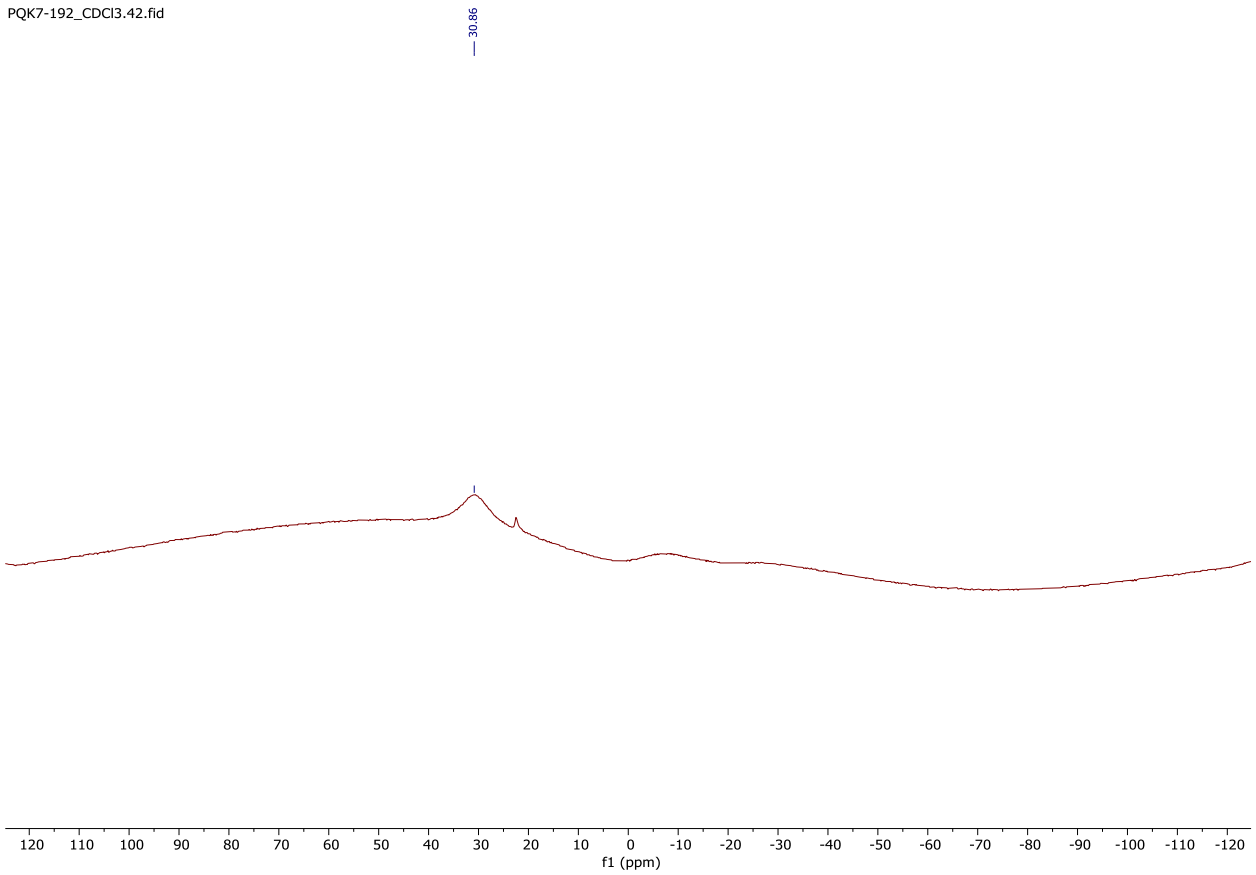
Supplemental Figure 41: ^{13}C NMR spectra of **3j**.



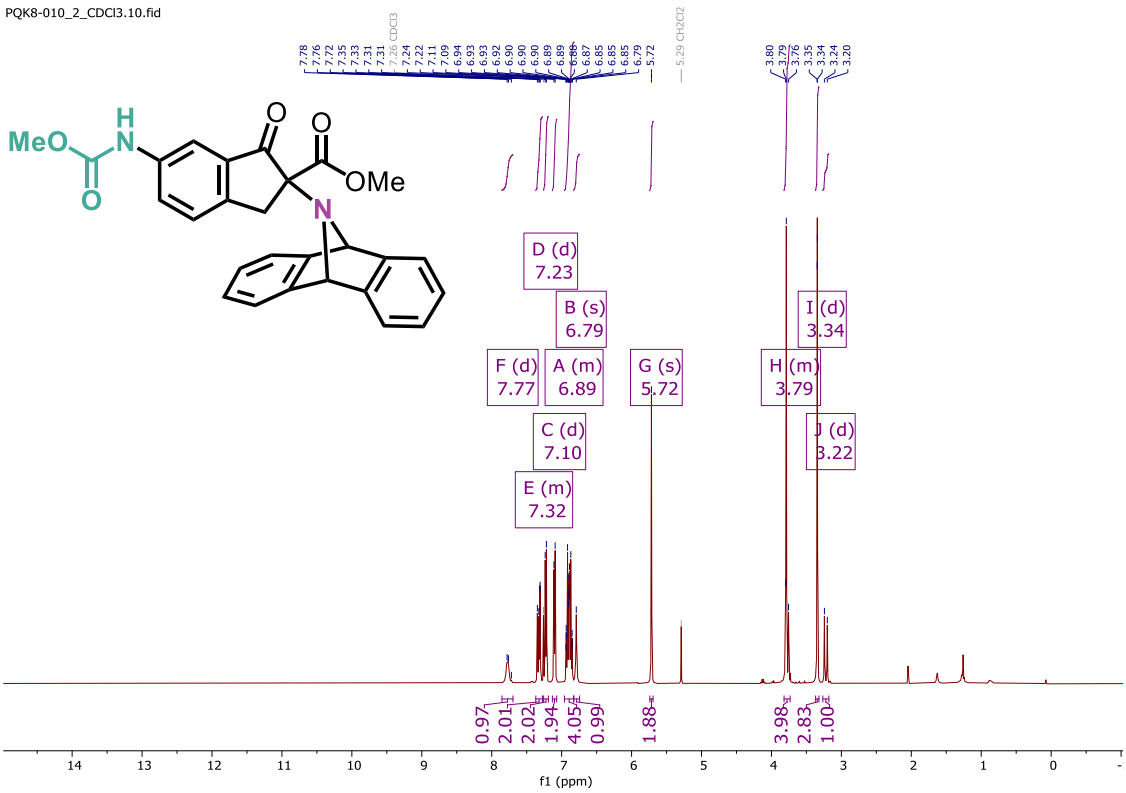
Supplemental Figure 42: ^{1}H NMR spectra of **3k**.



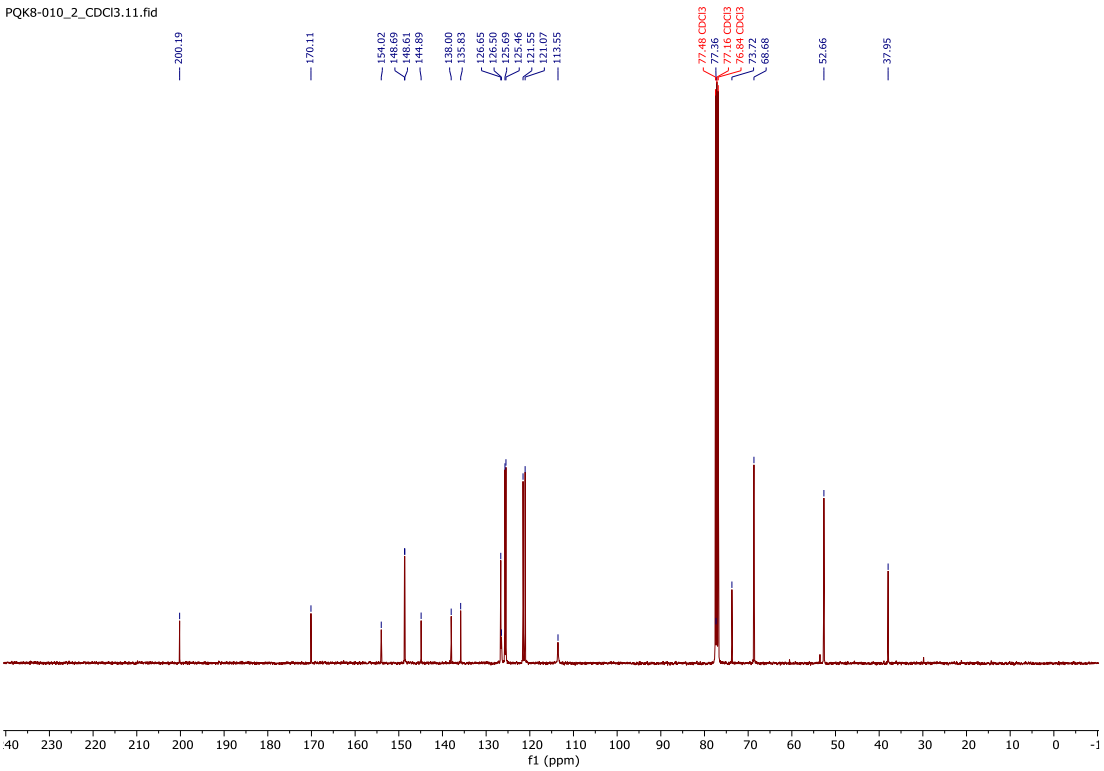
Supplemental Figure 43: ^{13}C NMR spectra of **3k**.



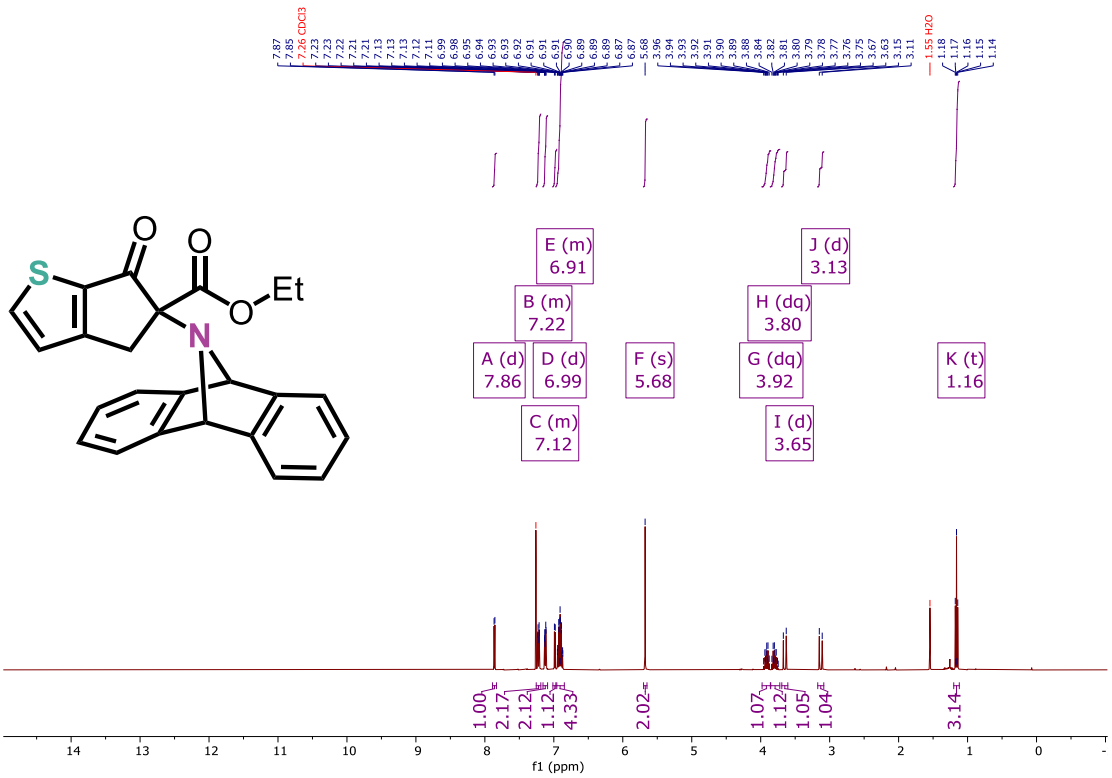
Supplemental Figure 44: ^{11}B NMR spectra of **3k**.



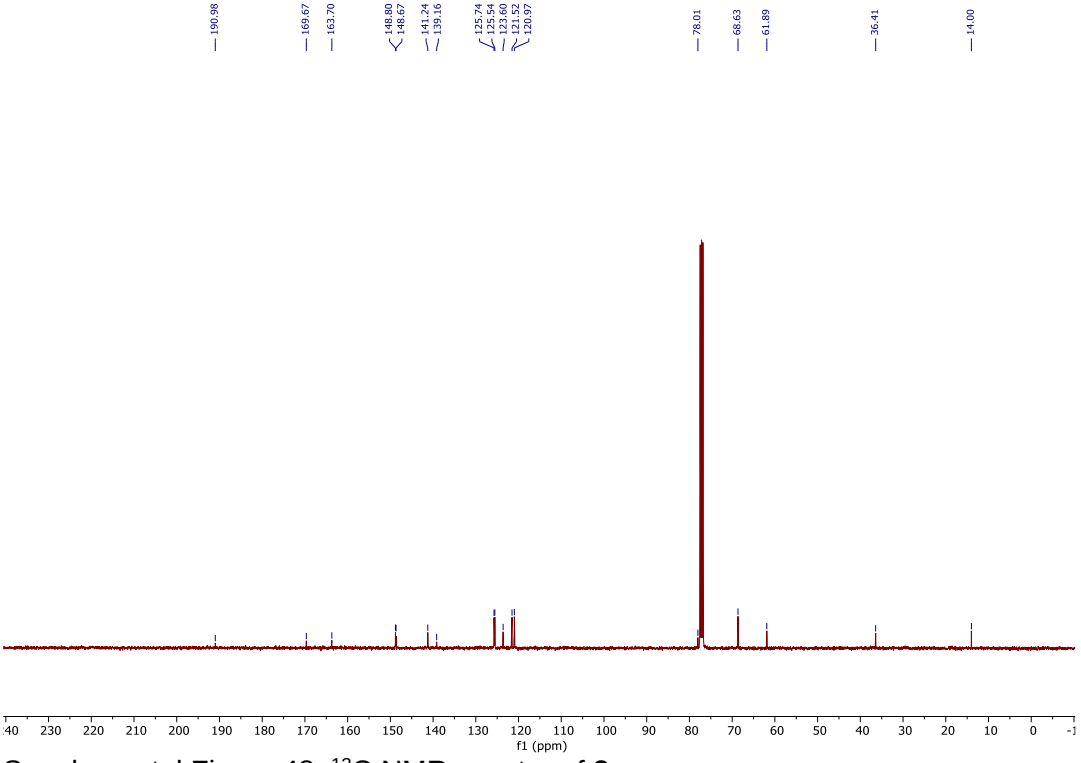
Supplemental Figure 45: ^{1}H NMR spectra of **3l**.



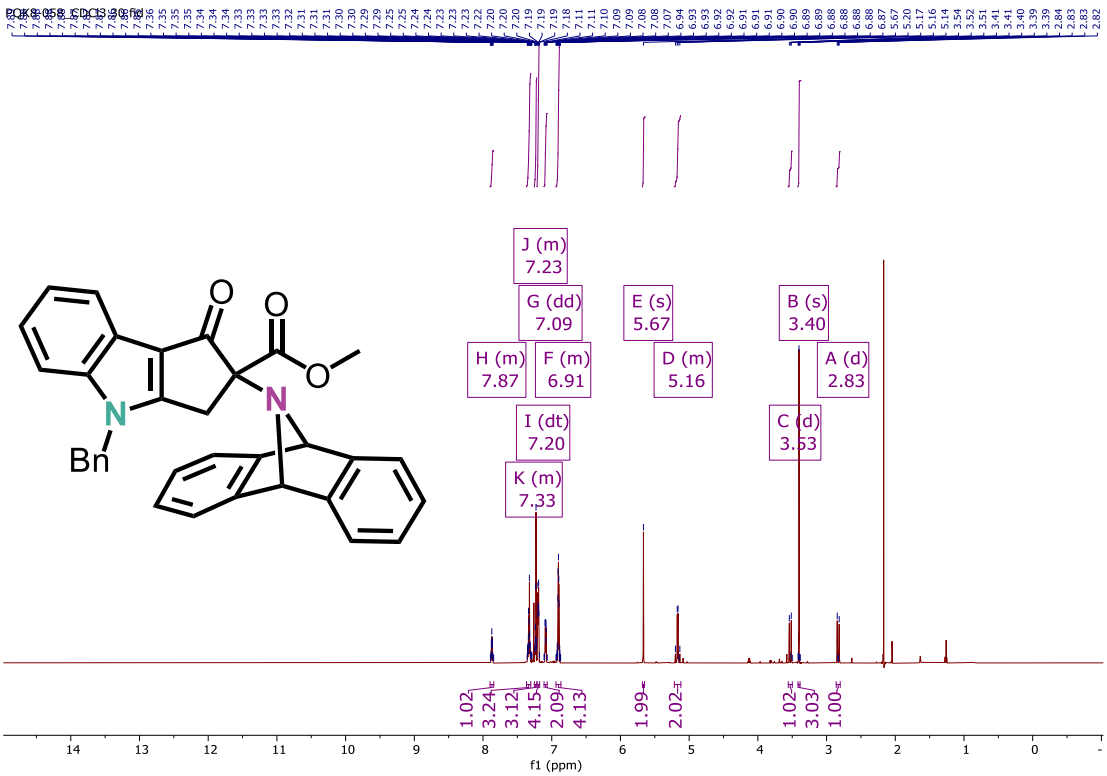
Supplemental Figure 46: ^{13}C NMR spectra of **3l**.



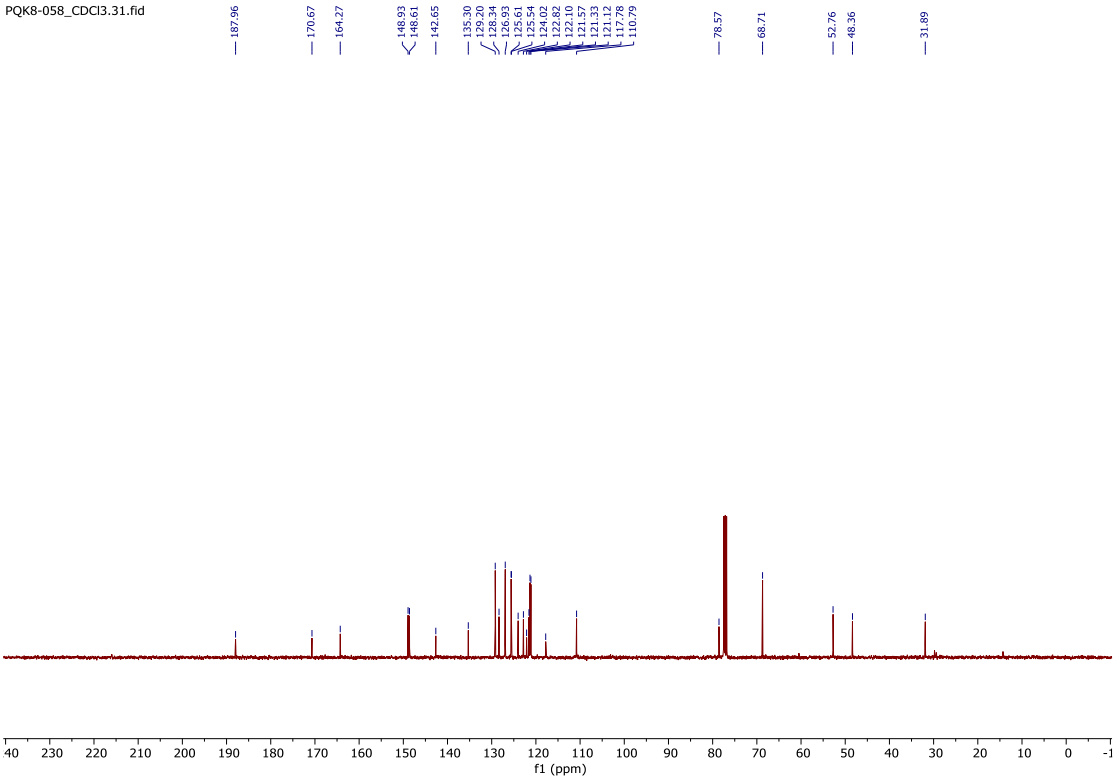
Supplemental Figure 47: ^{1}H NMR spectra of **3m**.



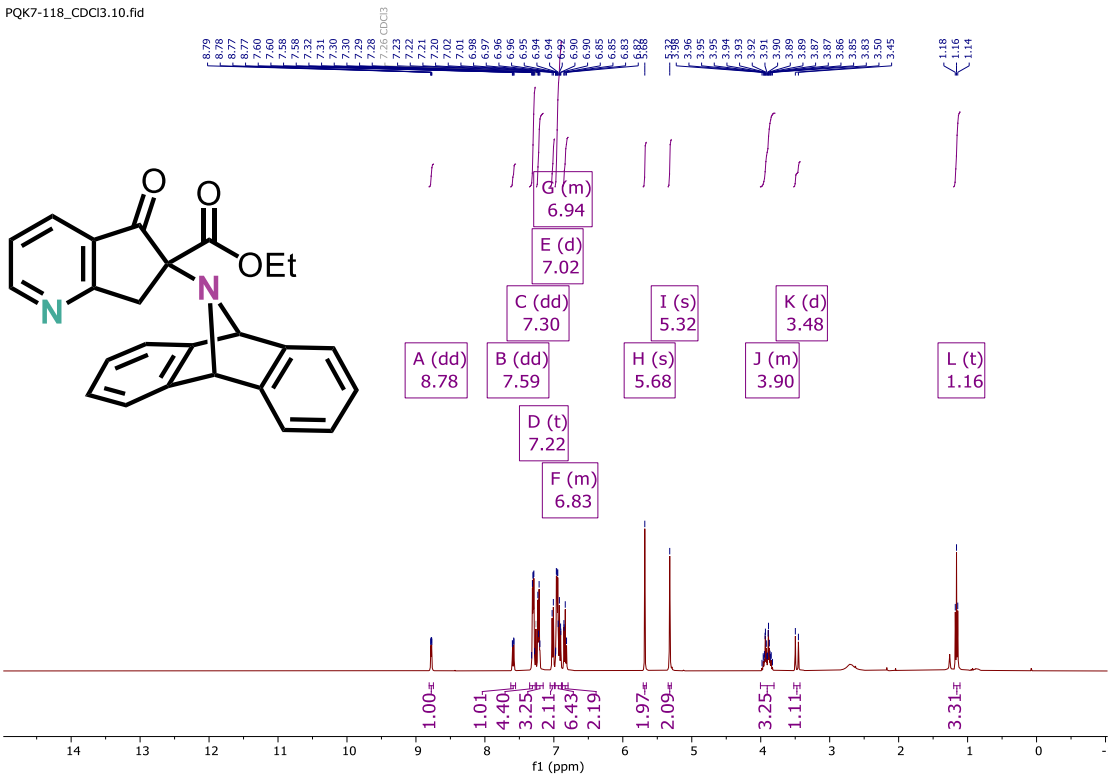
Supplemental Figure 48: ^{13}C NMR spectra of **3m**.



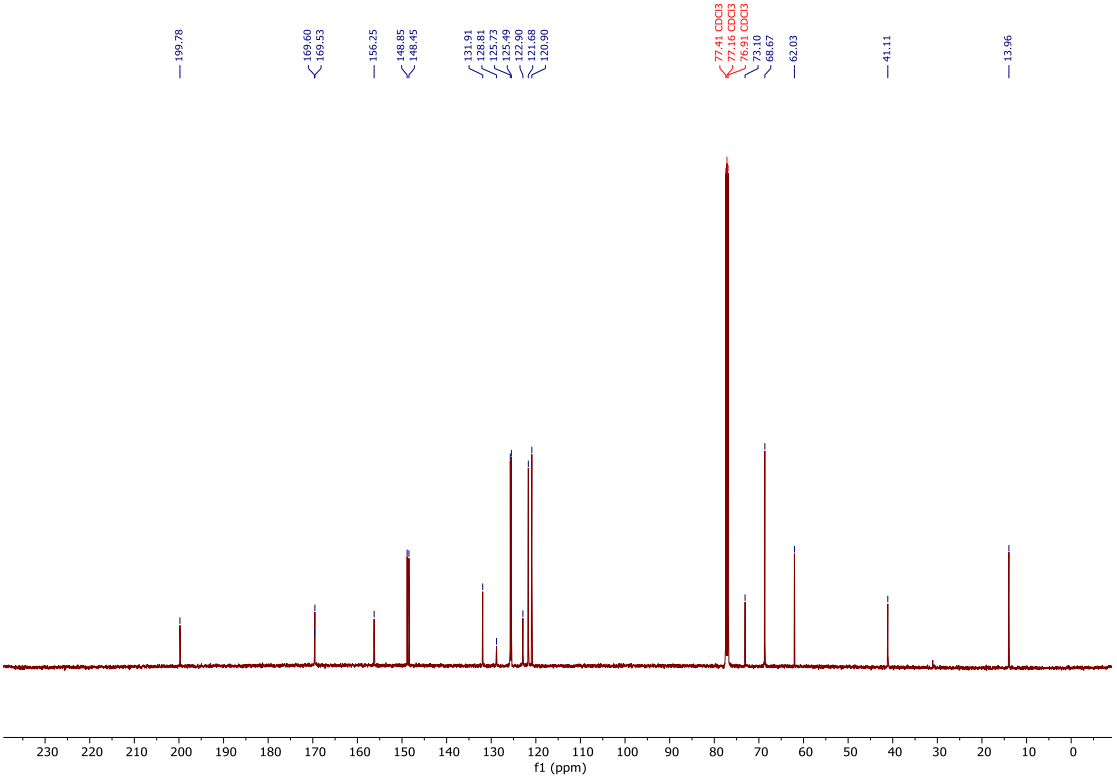
Supplemental Figure 49: ^{1}H NMR spectra of **3n**.



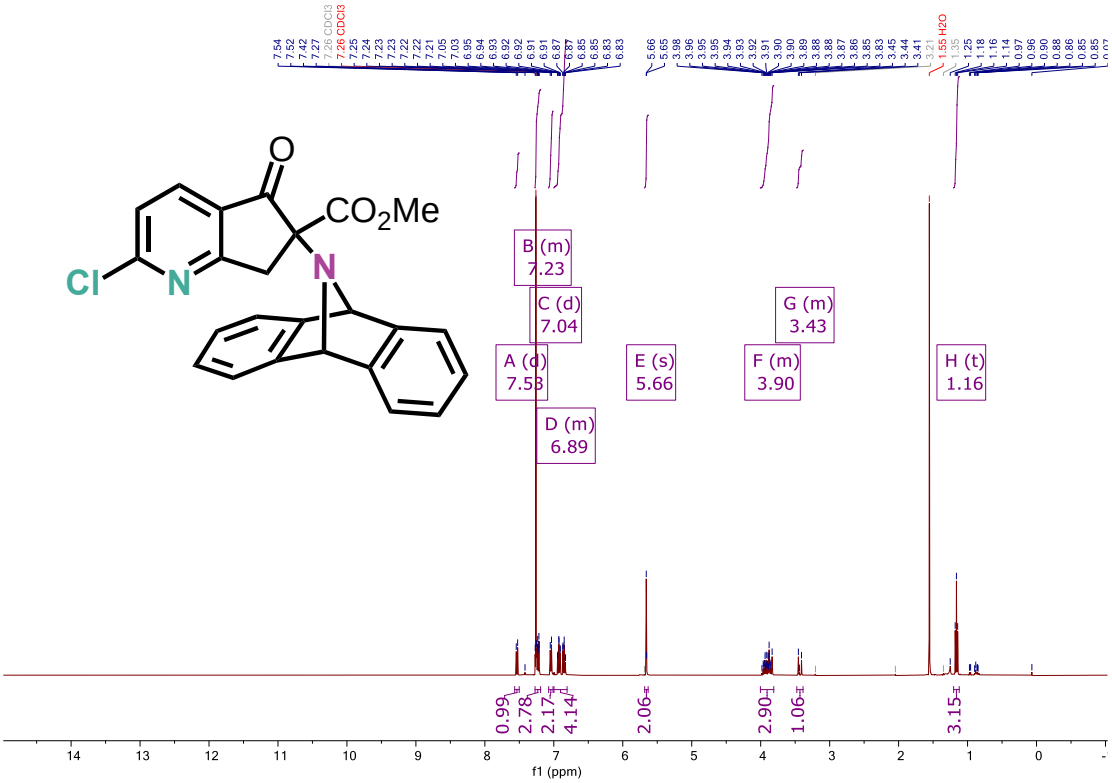
Supplemental Figure 50: ^{13}C NMR spectra of **3n**.



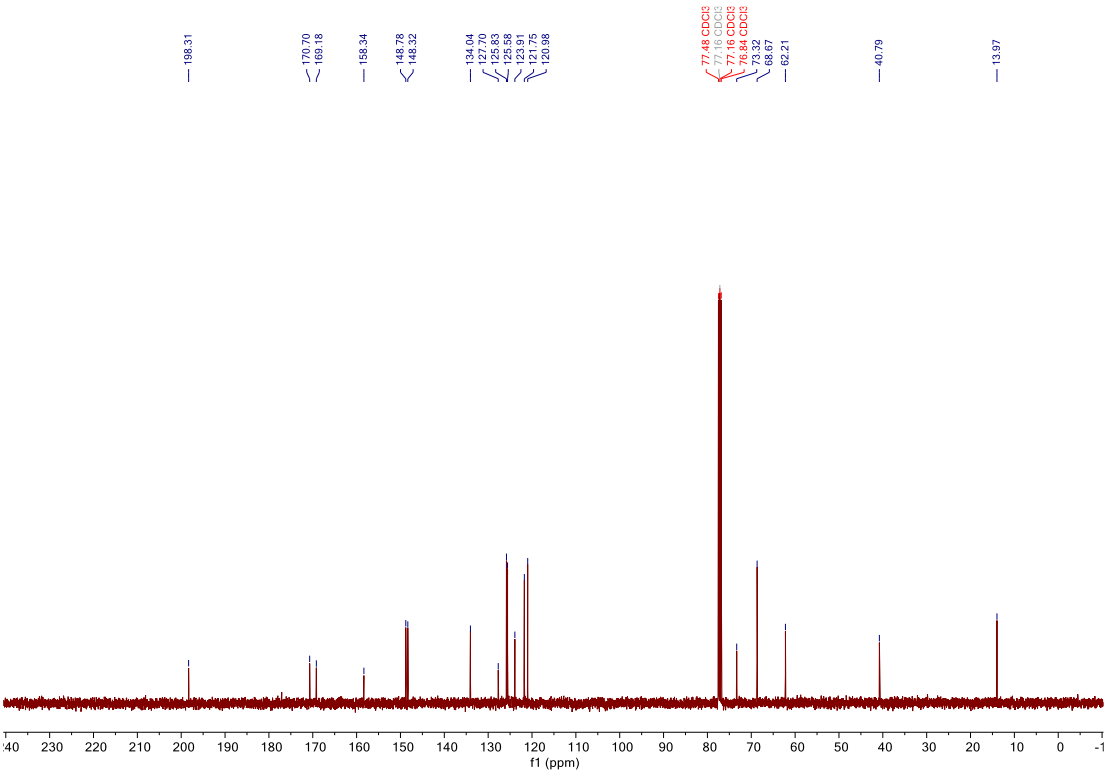
Supplemental Figure 51: ^{1}H NMR spectra of **3o**.



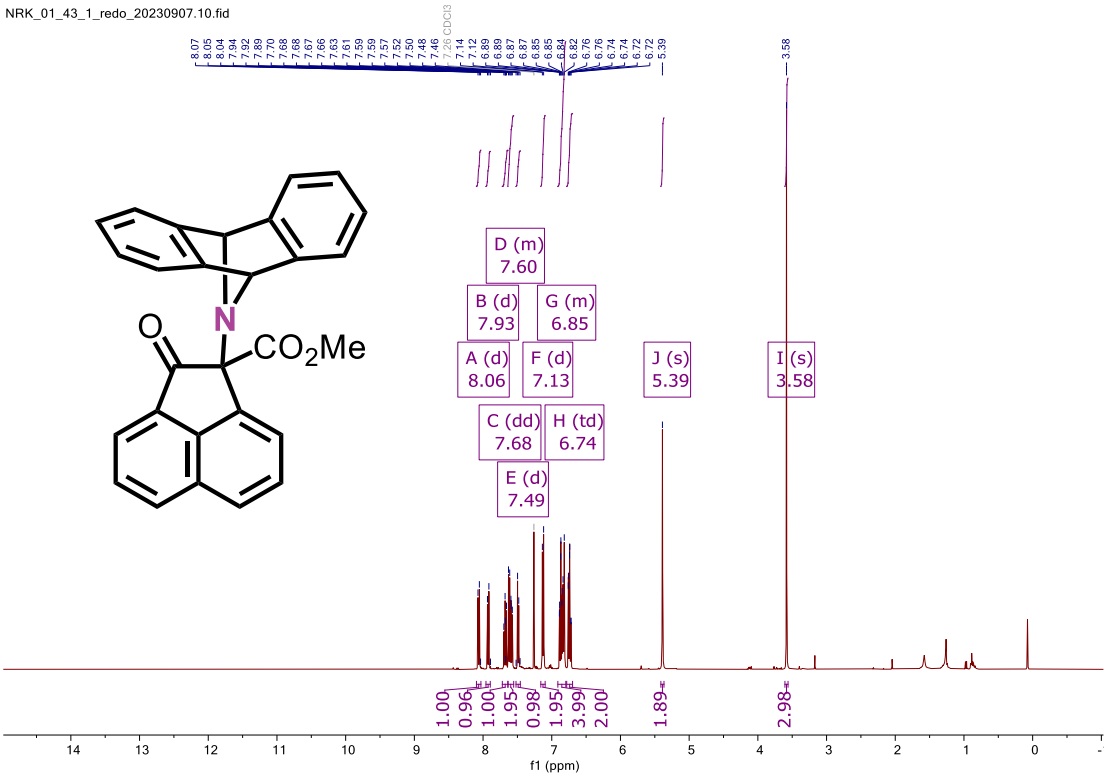
Supplemental Figure 52: ^{13}C NMR spectra of **3o**.



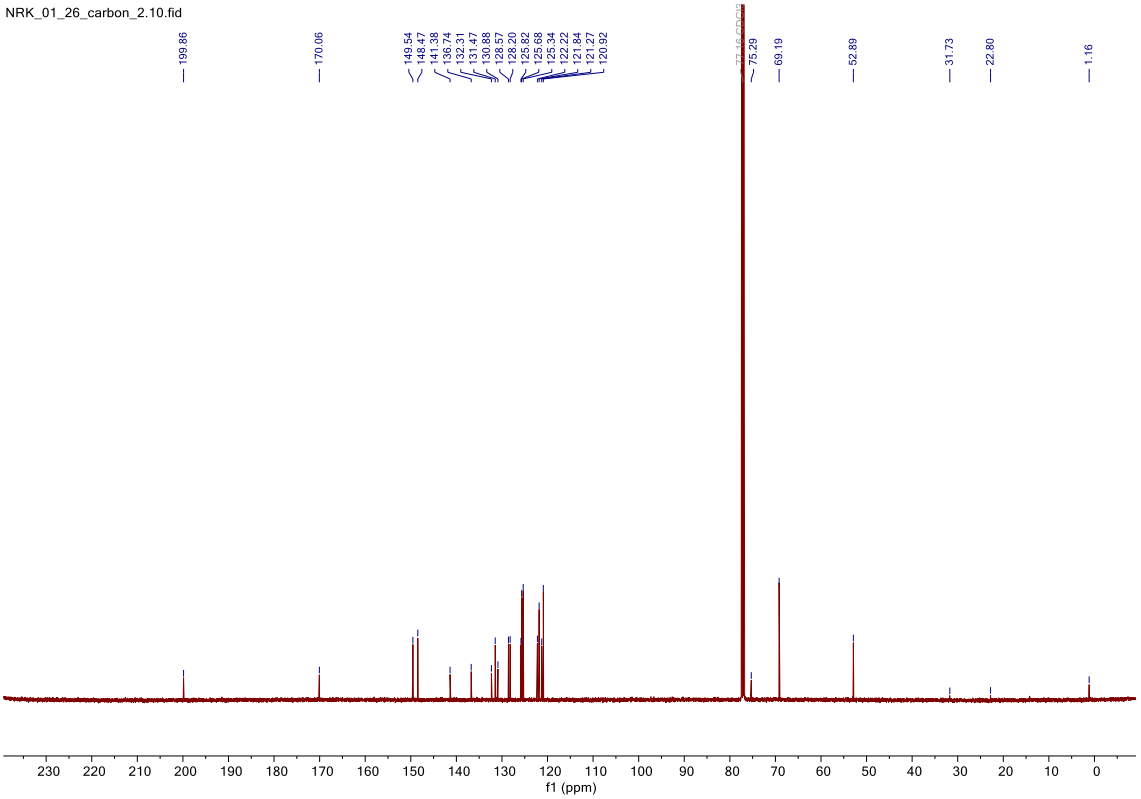
Supplemental Figure 53: ^{1}H NMR spectra of **3p**.



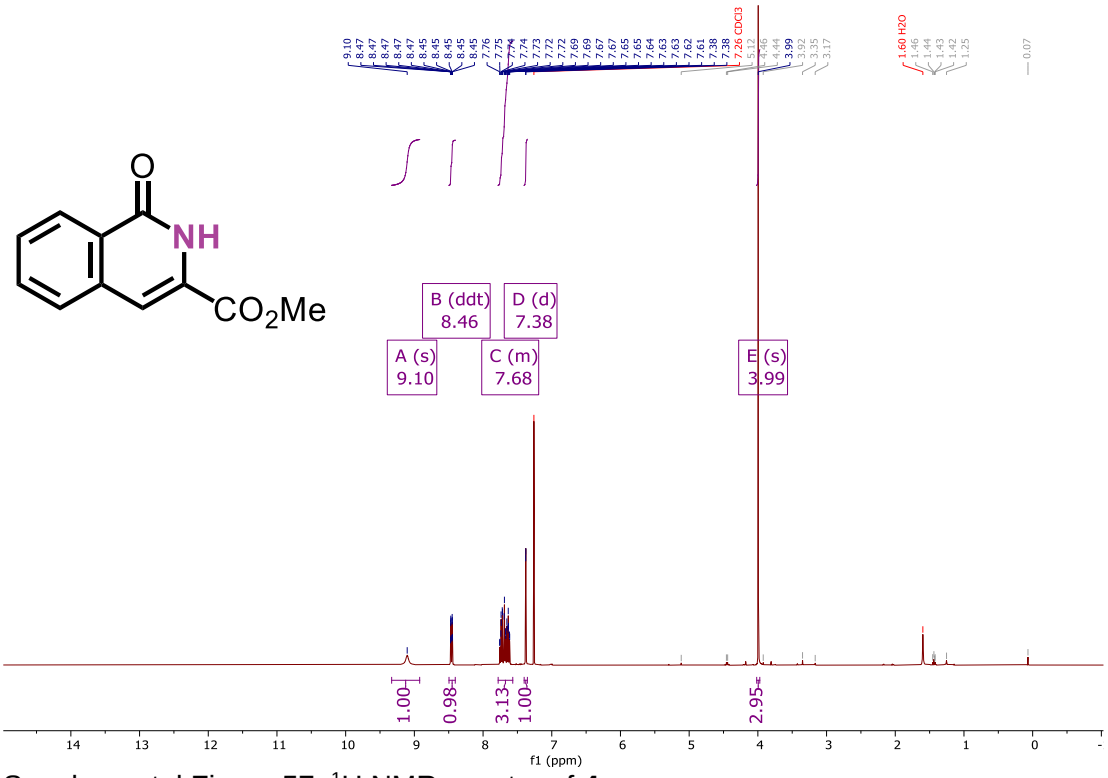
Supplemental Figure 54: ^{13}C NMR spectra of **3p**.



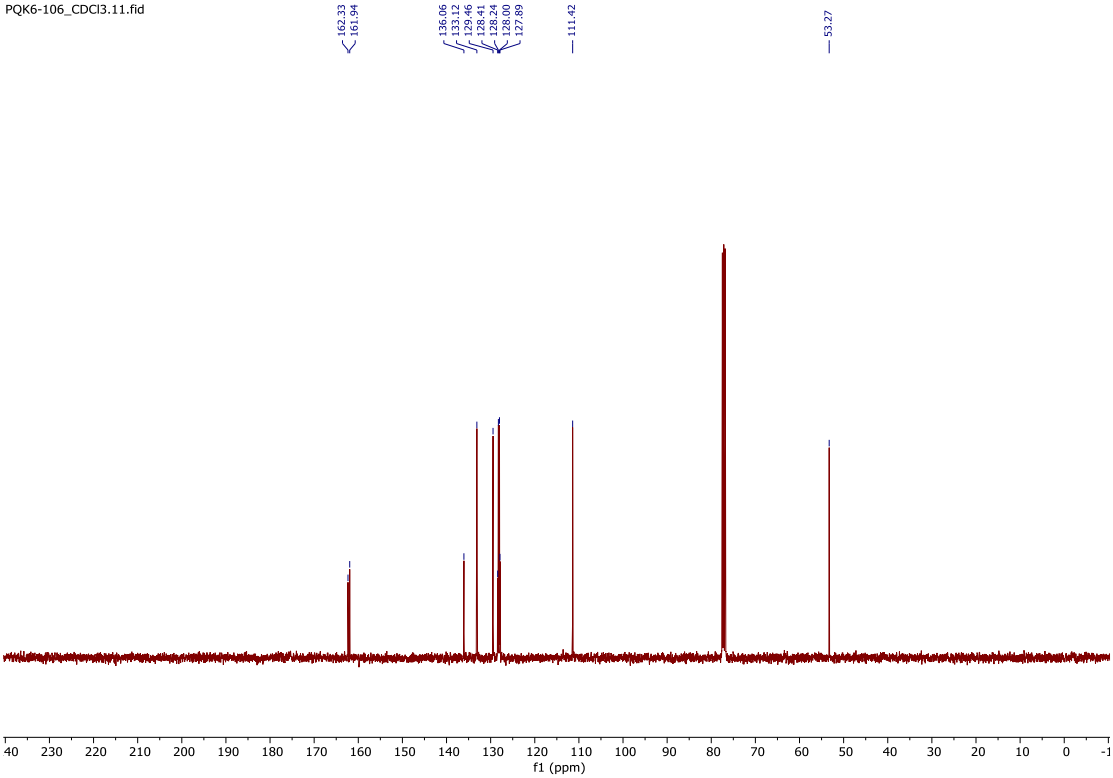
Supplemental Figure 55: ^{1}H NMR spectra of **3q**.



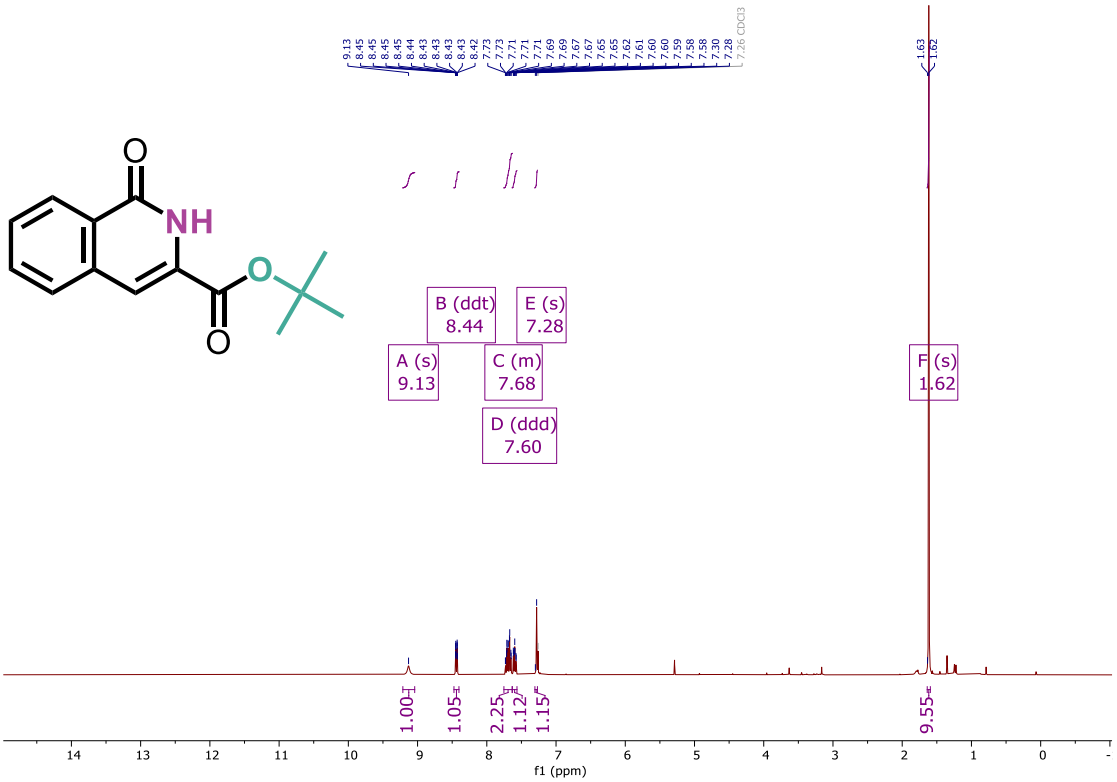
Supplemental Figure 56: ^{13}C NMR spectra of **3q**.



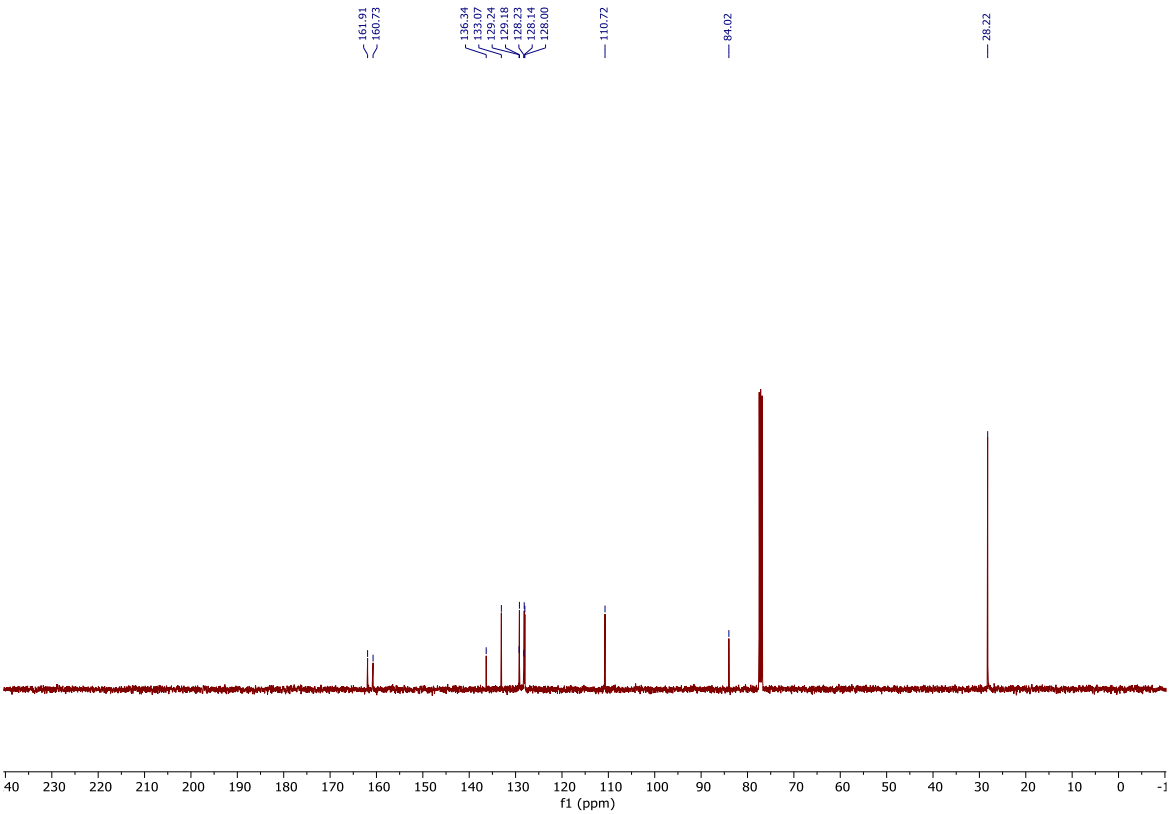
Supplemental Figure 57: ^{1}H NMR spectra of **4a**.



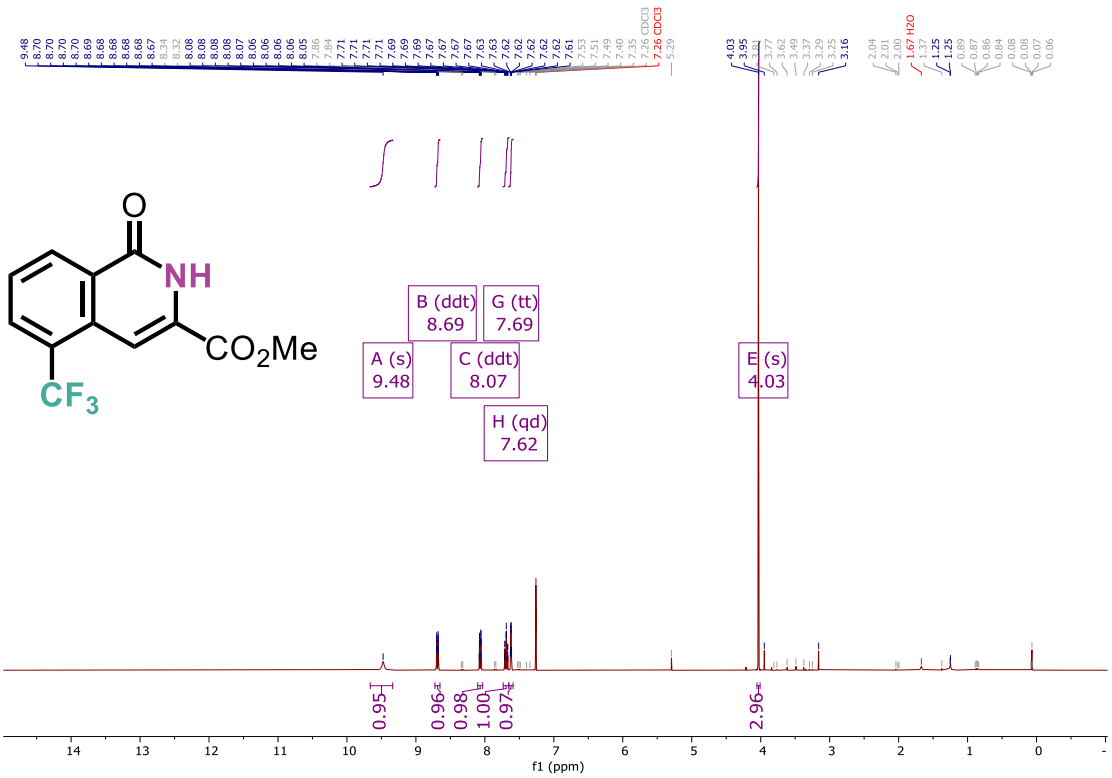
Supplemental Figure 58: ^{1}H NMR spectra of **4a**.



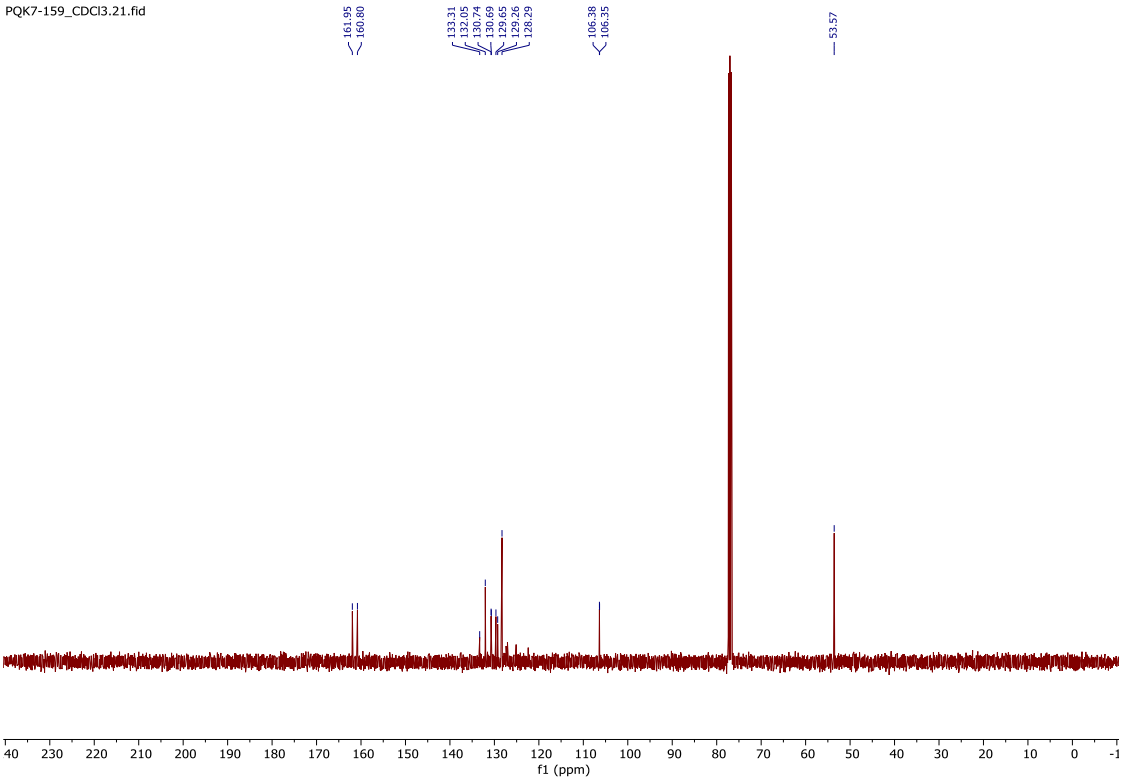
Supplemental Figure 59: ^{1}H NMR spectra of **4d**.



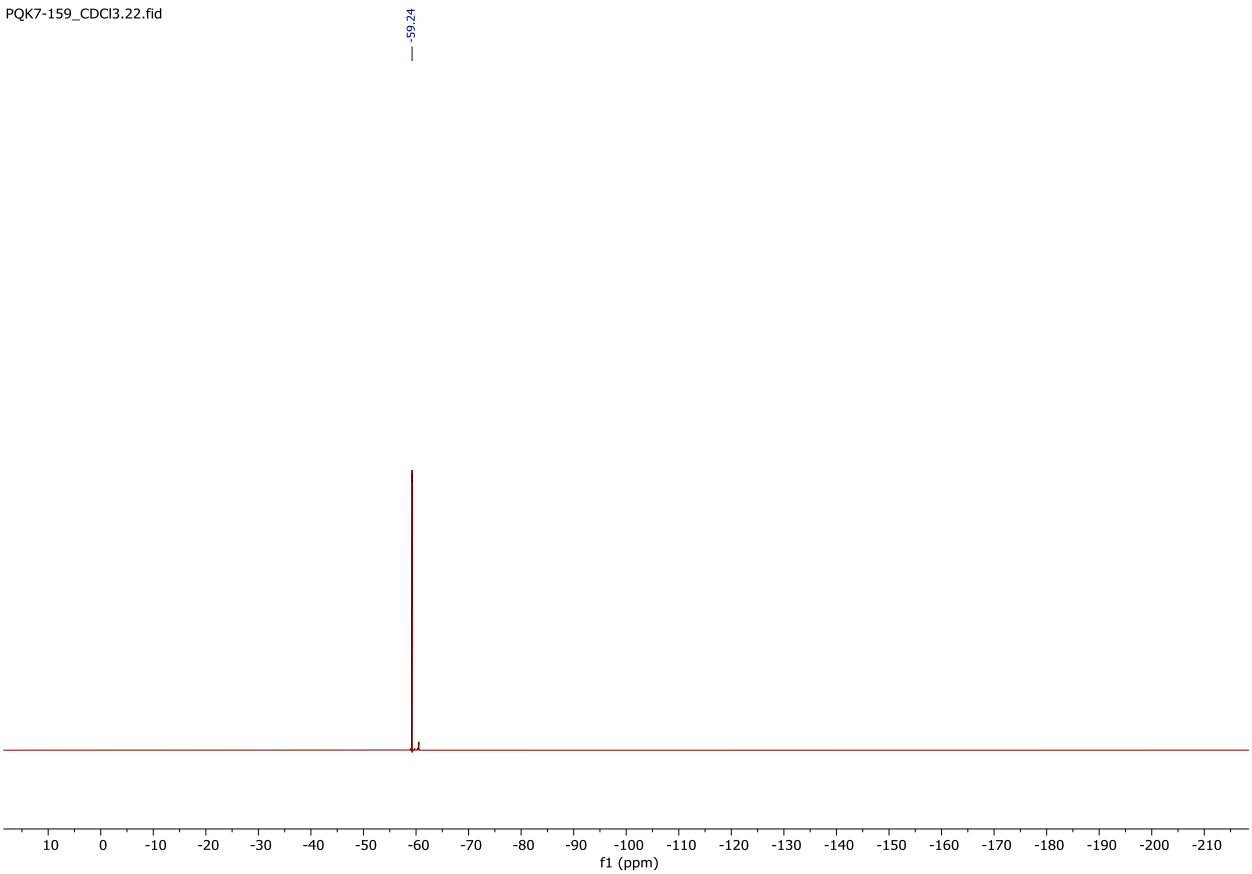
Supplemental Figure 60: ^{13}C NMR spectra of **4d**.



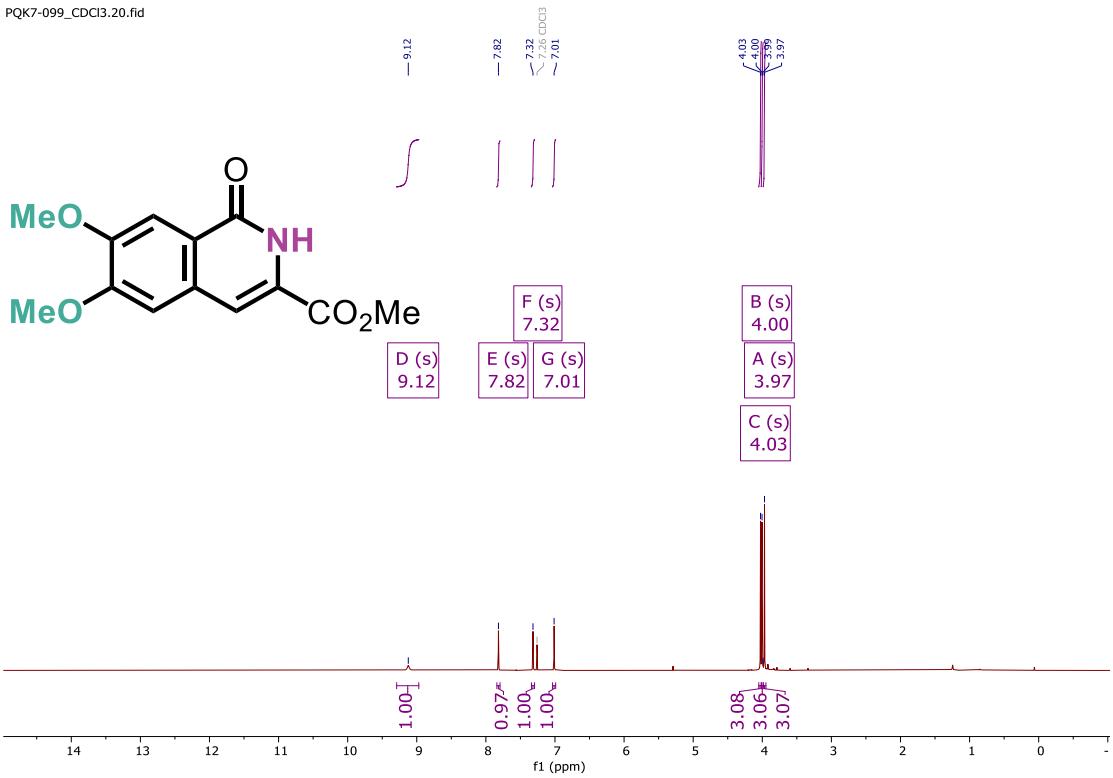
Supplemental Figure 61: ^{1}H NMR spectra of **4e**.



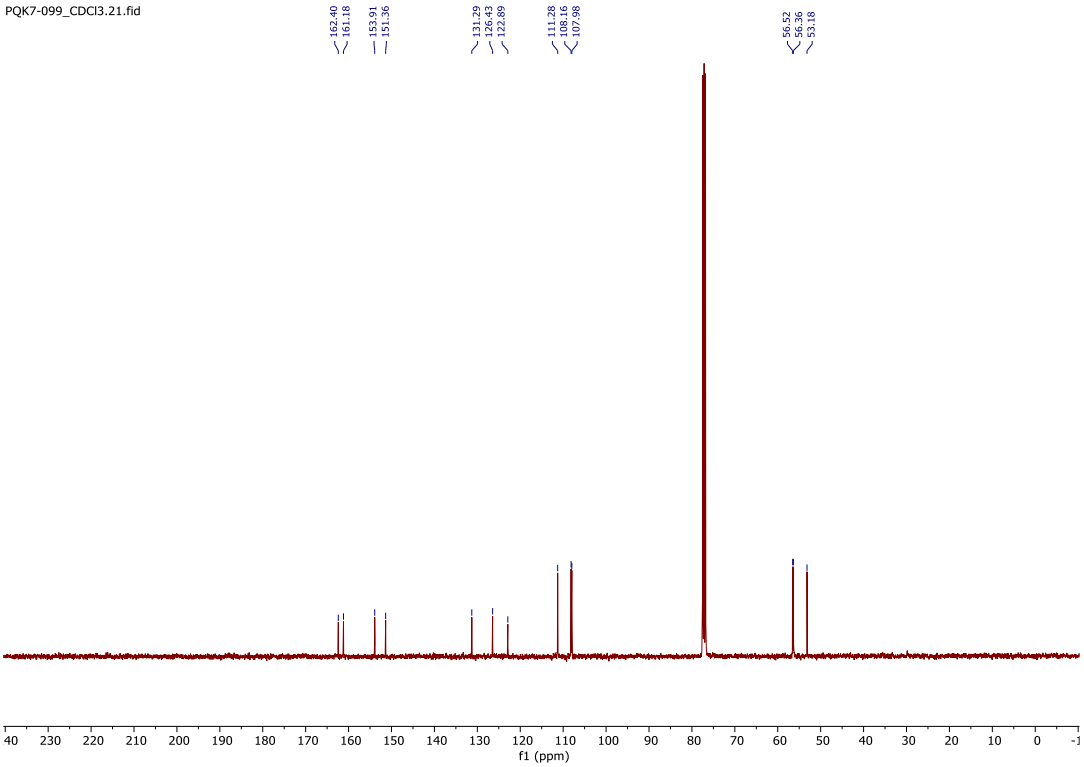
Supplemental Figure 62: ^{13}C NMR spectra of **4e**.



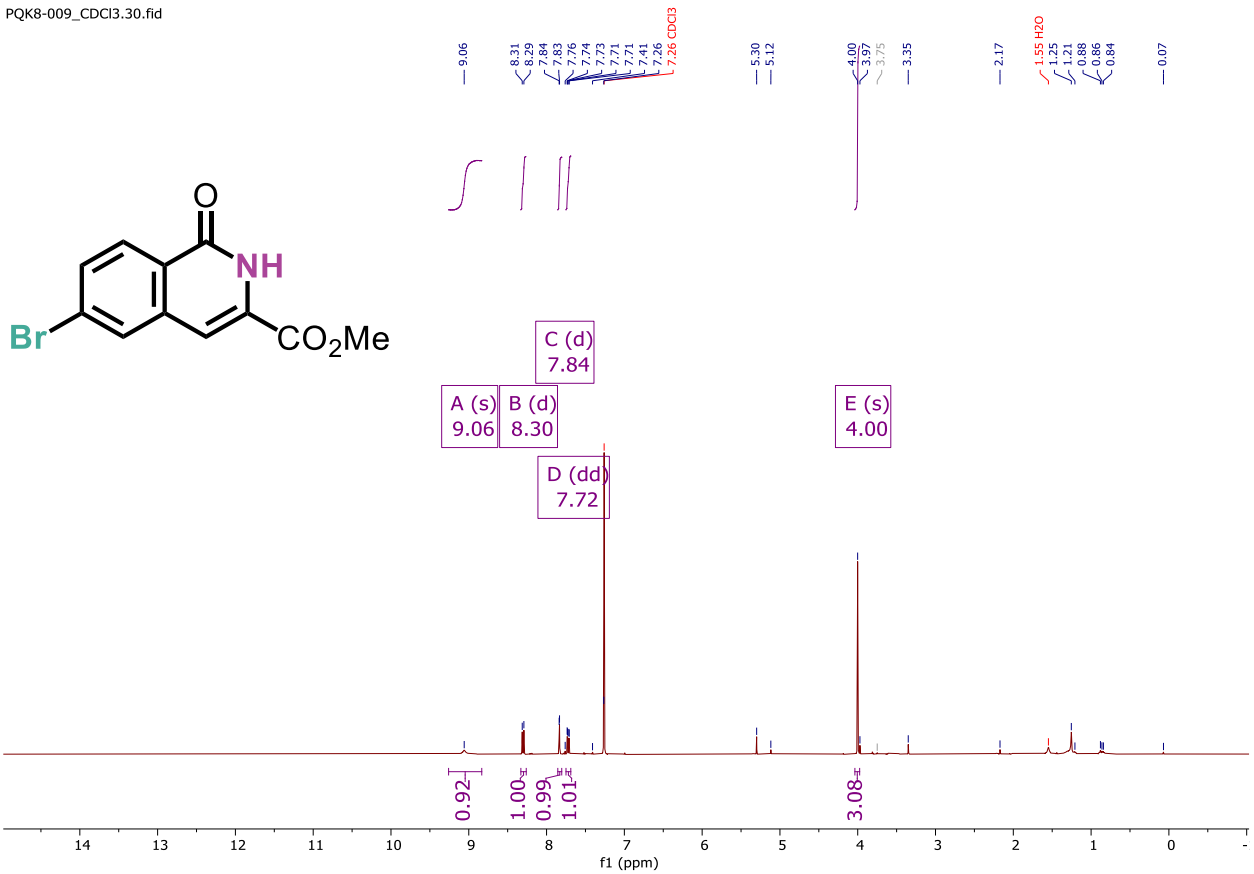
Supplemental Figure 63: ^{19}F NMR spectra of **4e**.



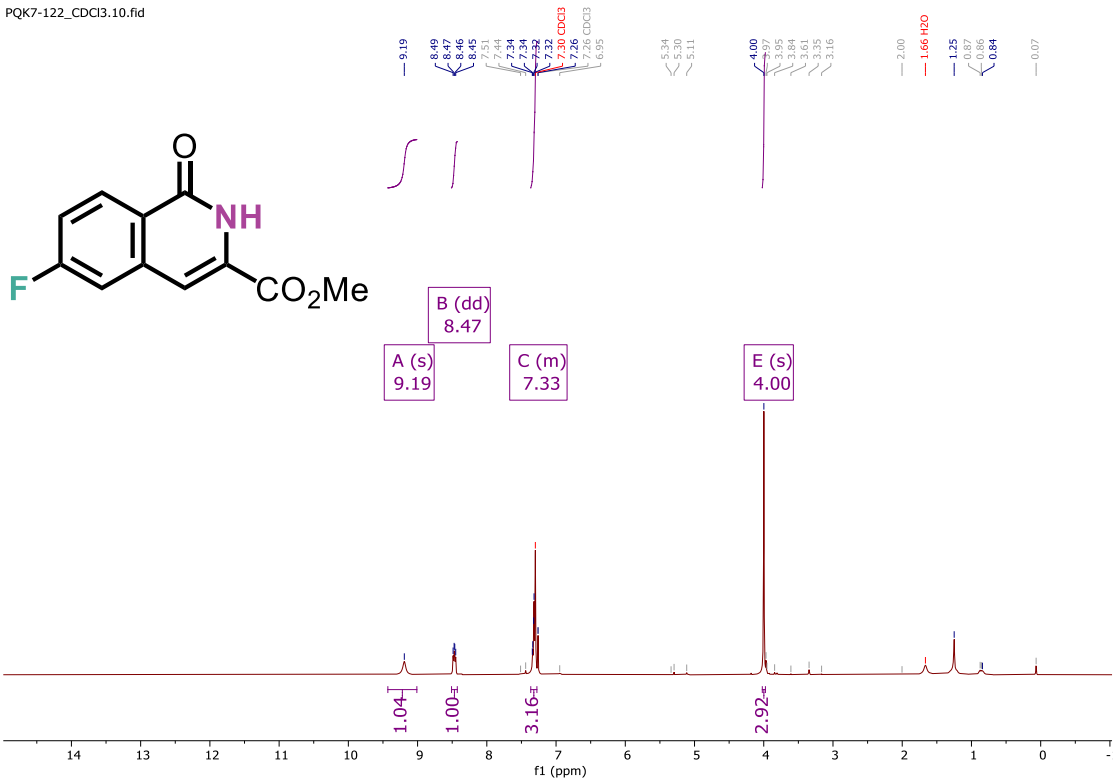
Supplemental Figure 64: ^{1}H NMR spectra of **4f**.



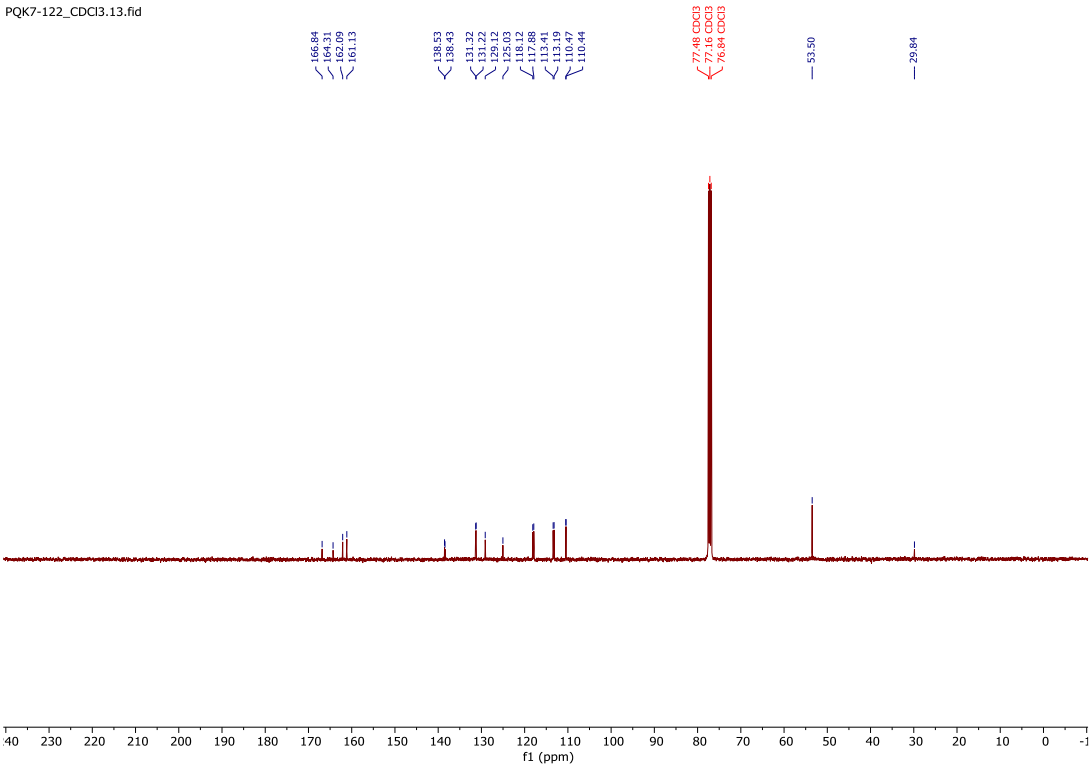
Supplemental Figure 65: ^{13}C NMR spectra of **4f**.



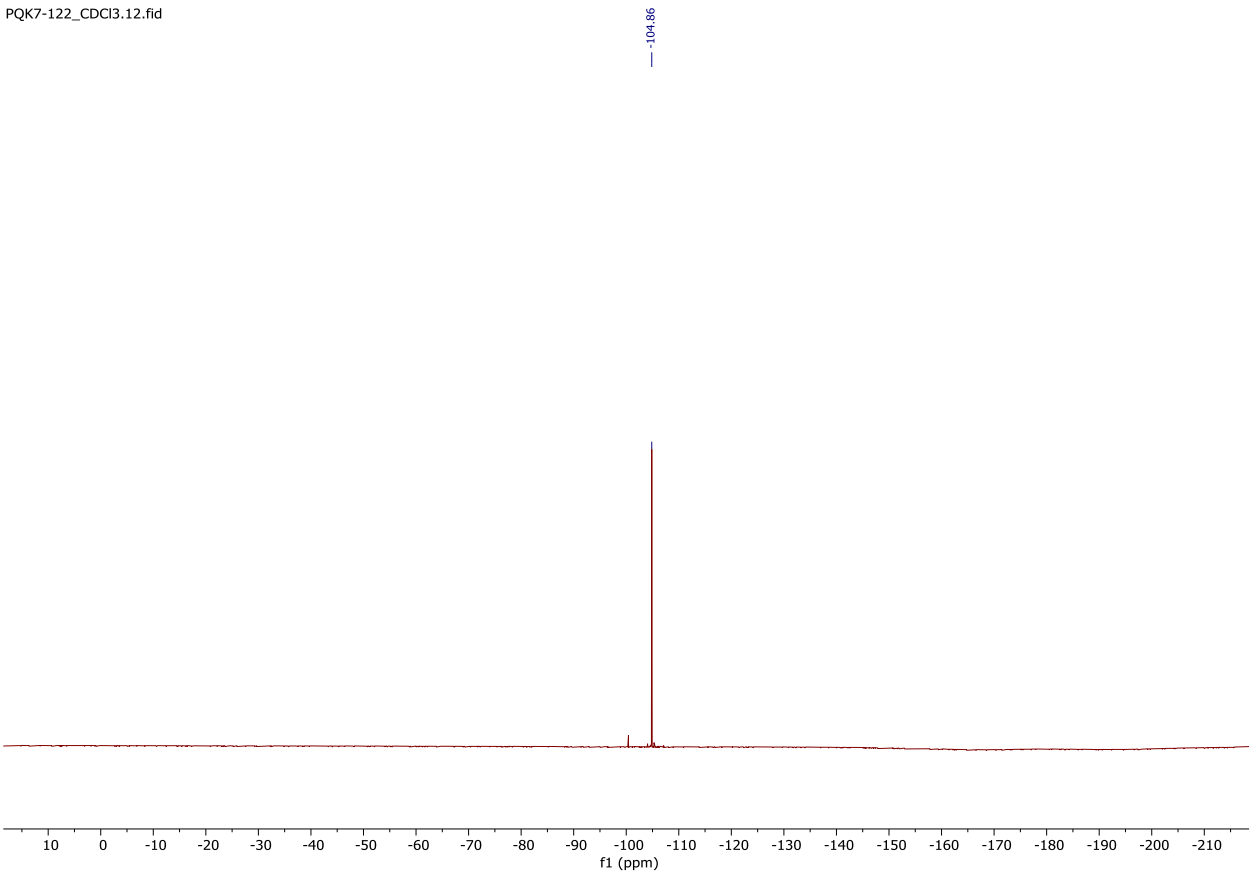
Supplemental Figure 66: ^{1}H NMR spectra of **4h**.



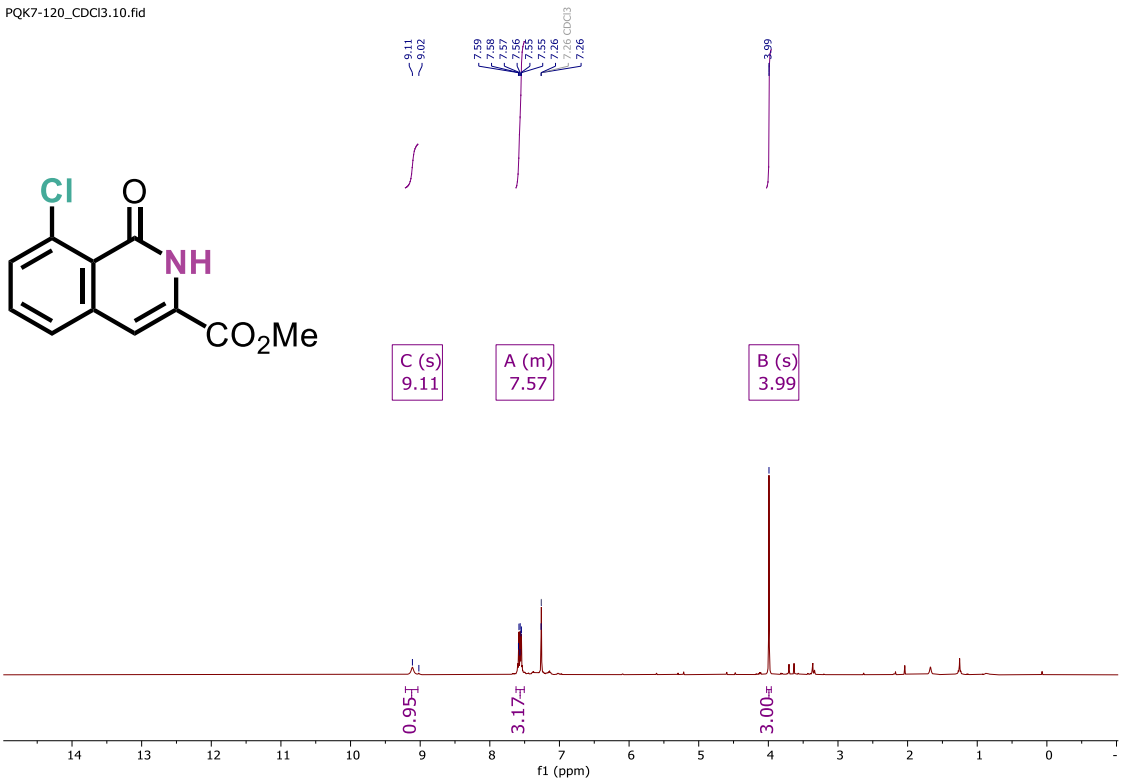
Supplemental Figure 67: ^{1}H NMR spectra of **4i**.



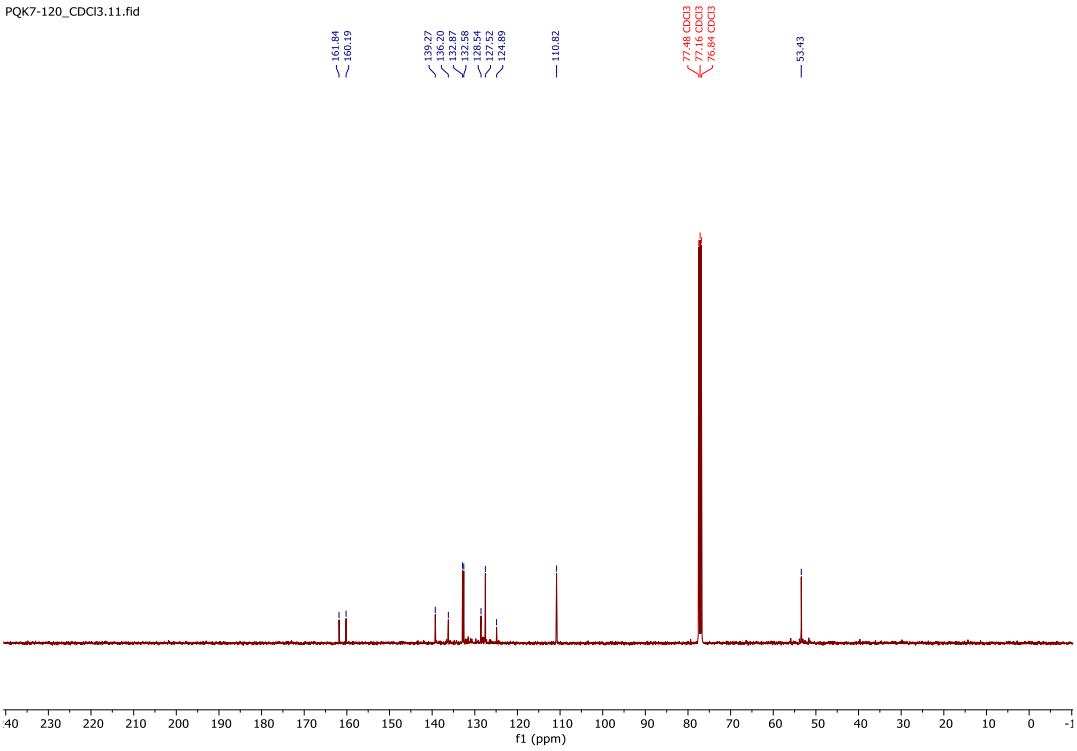
Supplemental Figure 68: ^{13}C NMR spectra of **4i**.



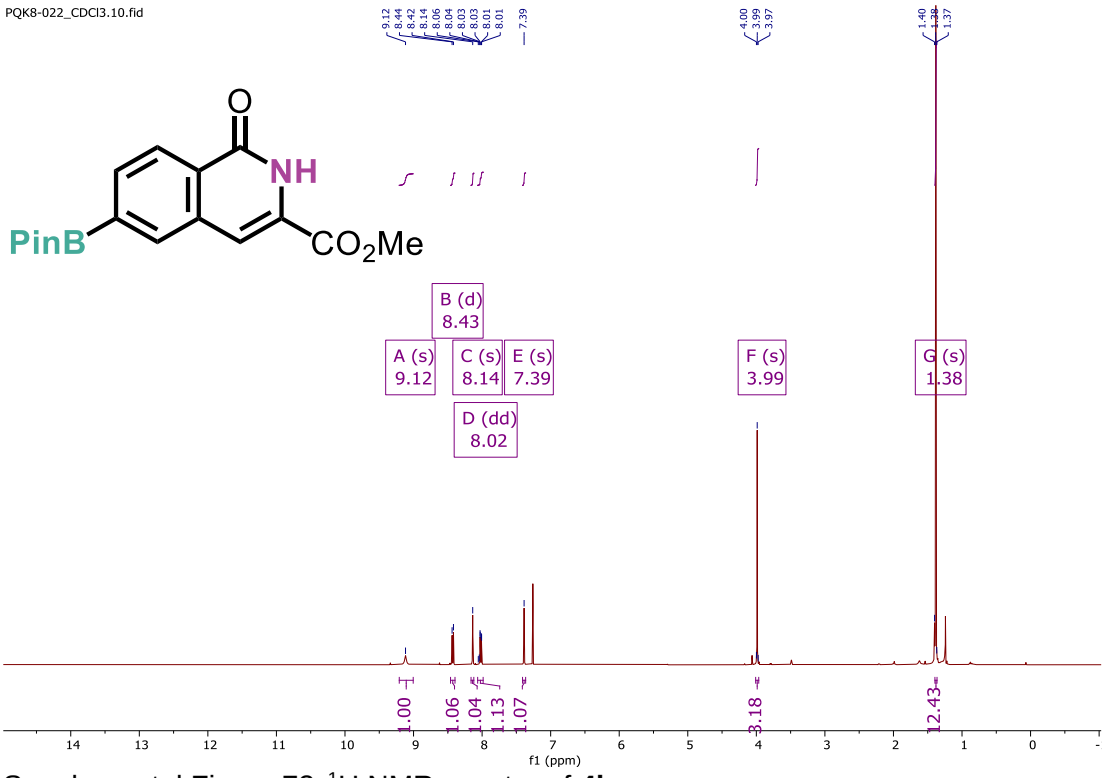
Supplemental Figure 69: ^{19}F NMR spectra of **4i**.



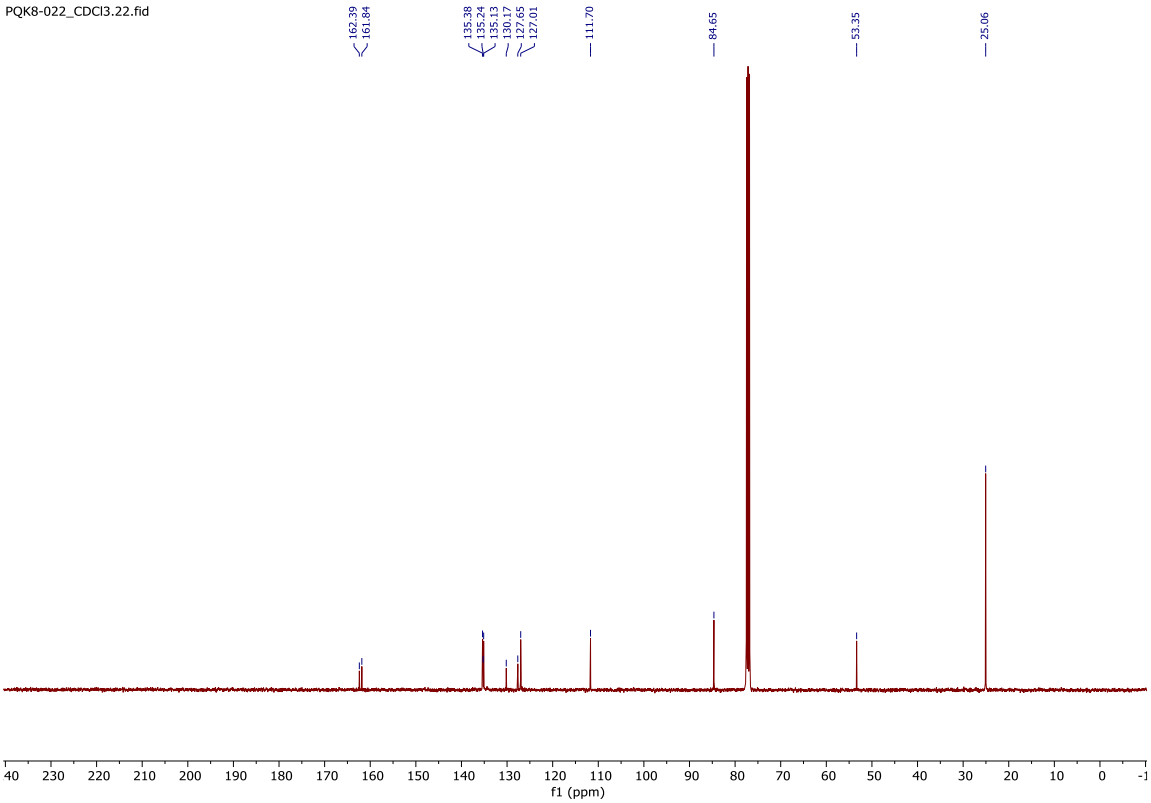
Supplemental Figure 70: ^{1}H NMR spectra of **4j**.



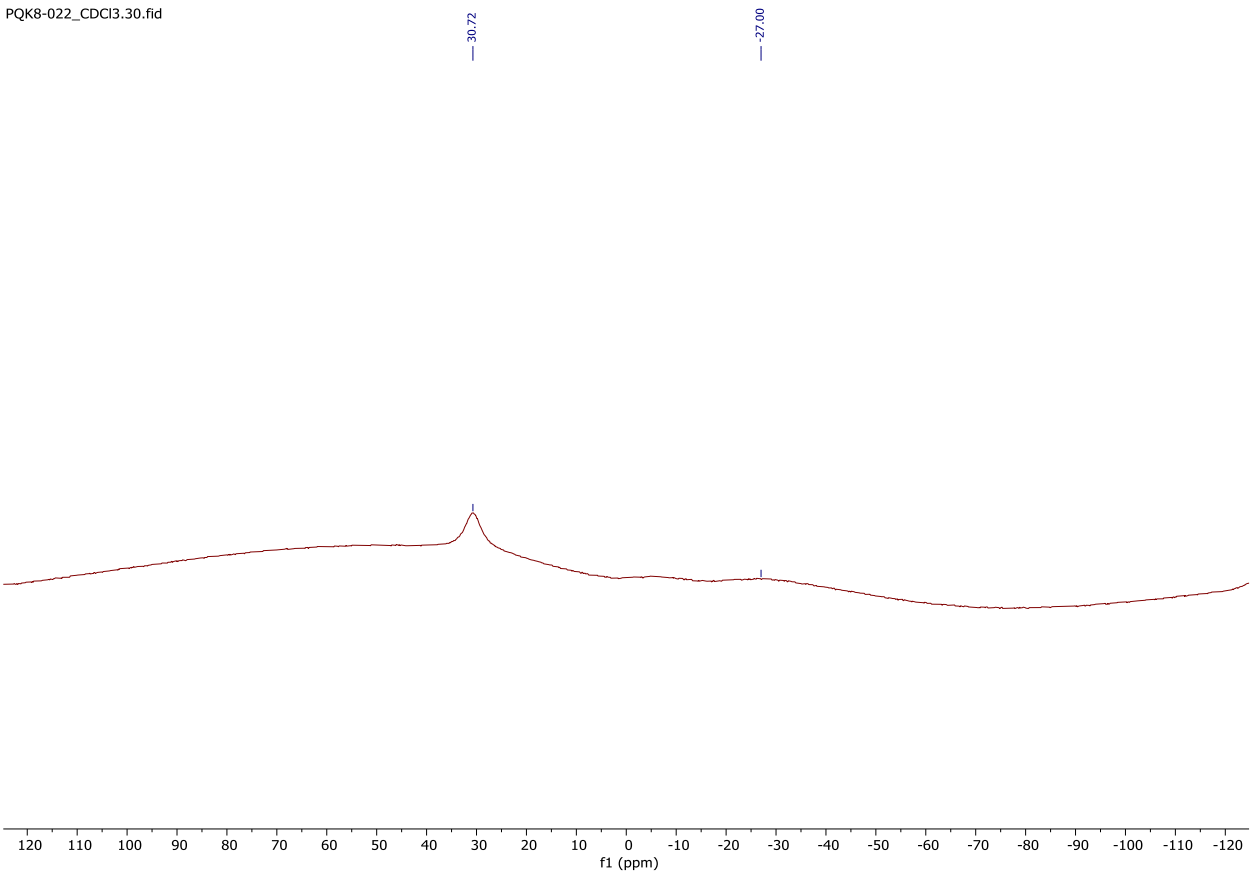
Supplemental Figure 71: ^{13}C NMR spectra of **4j**.



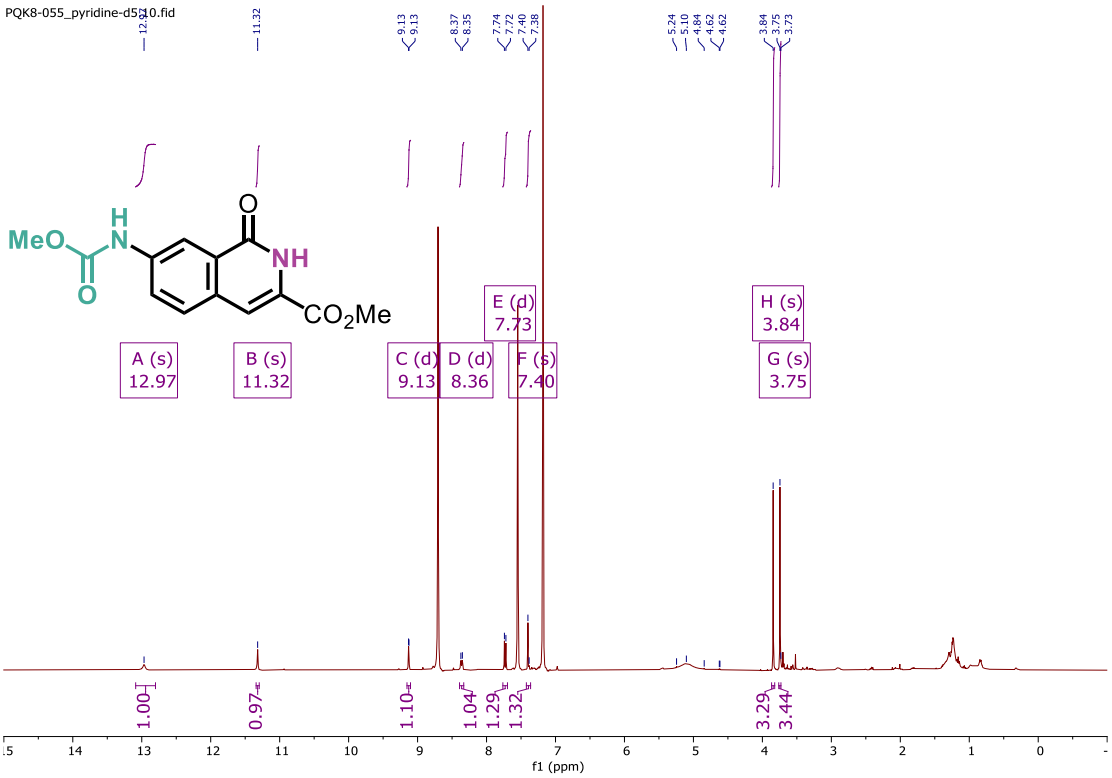
Supplemental Figure 72: ^{1}H NMR spectra of **4k**.



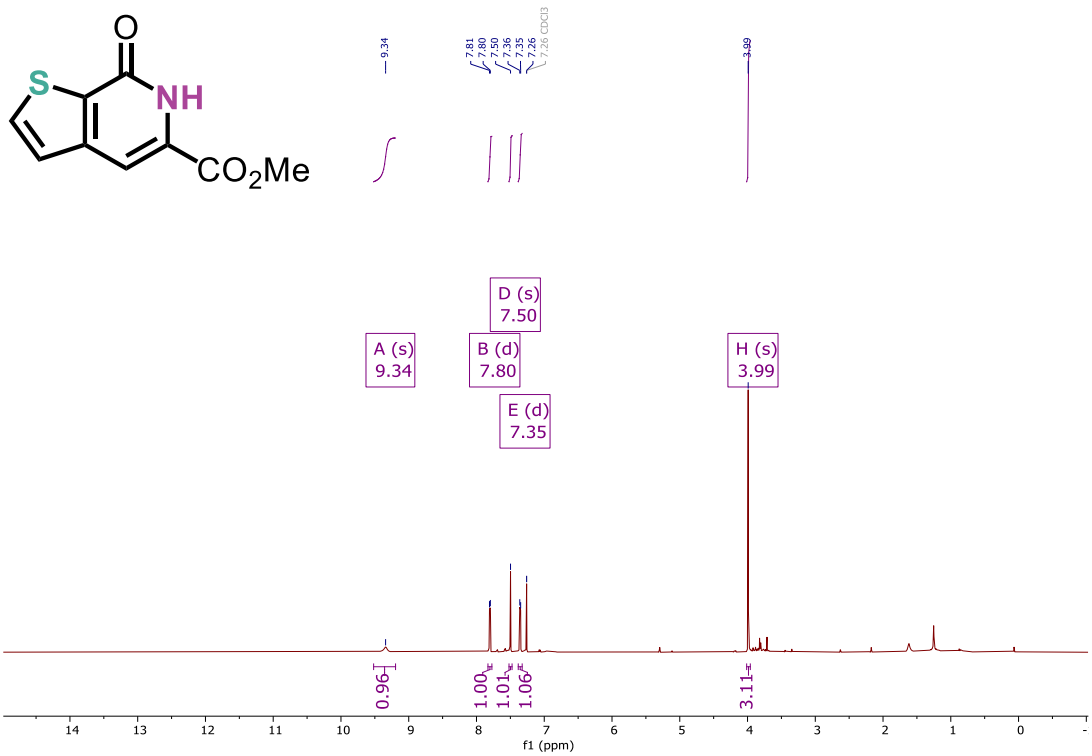
Supplemental Figure 73: ^{13}C NMR spectra of **4k**.



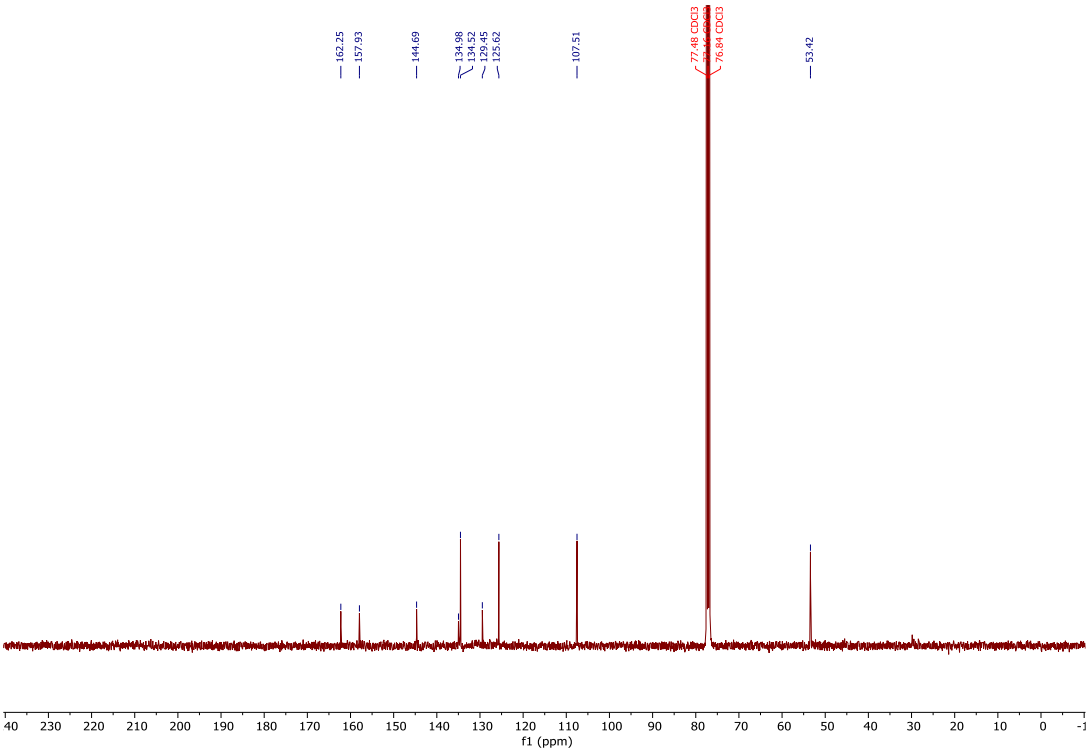
Supplemental Figure 74: ^{11}B NMR spectra of **4k**.



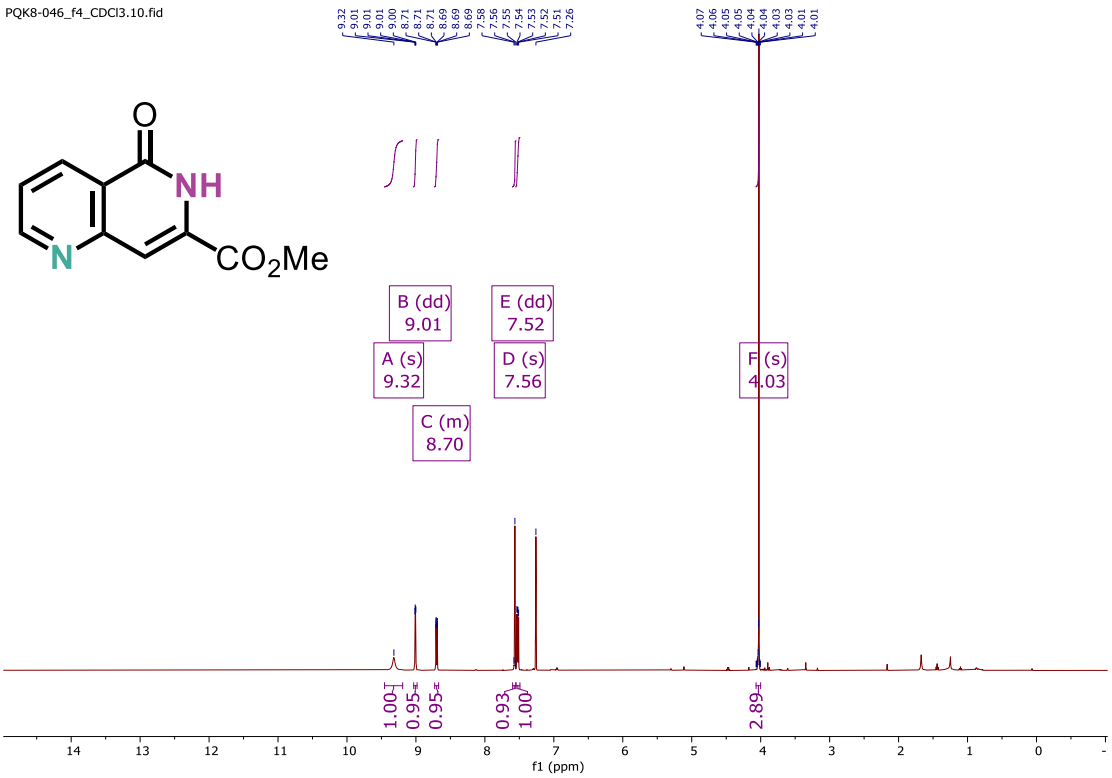
Supplemental Figure 75: ^{1}H NMR spectra of **4l** in pyridine-d6.



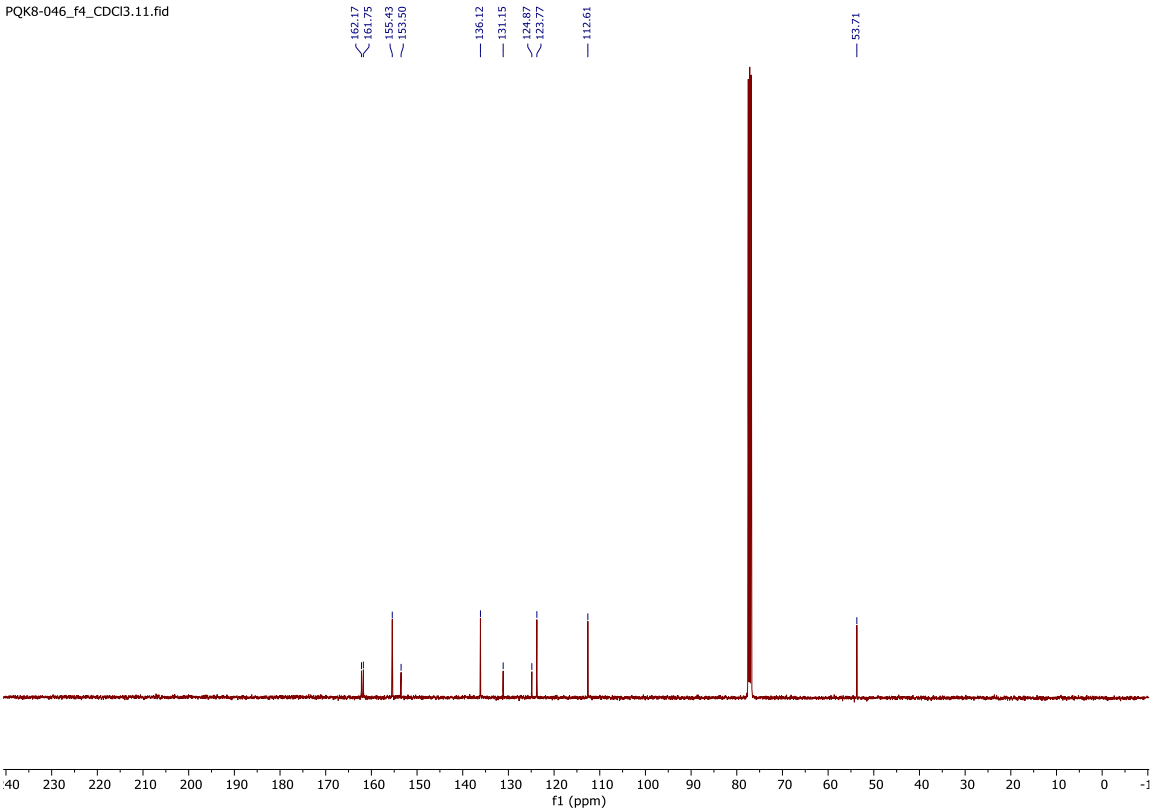
Supplemental Figure 76: ^{1}H NMR spectra of **4m**.



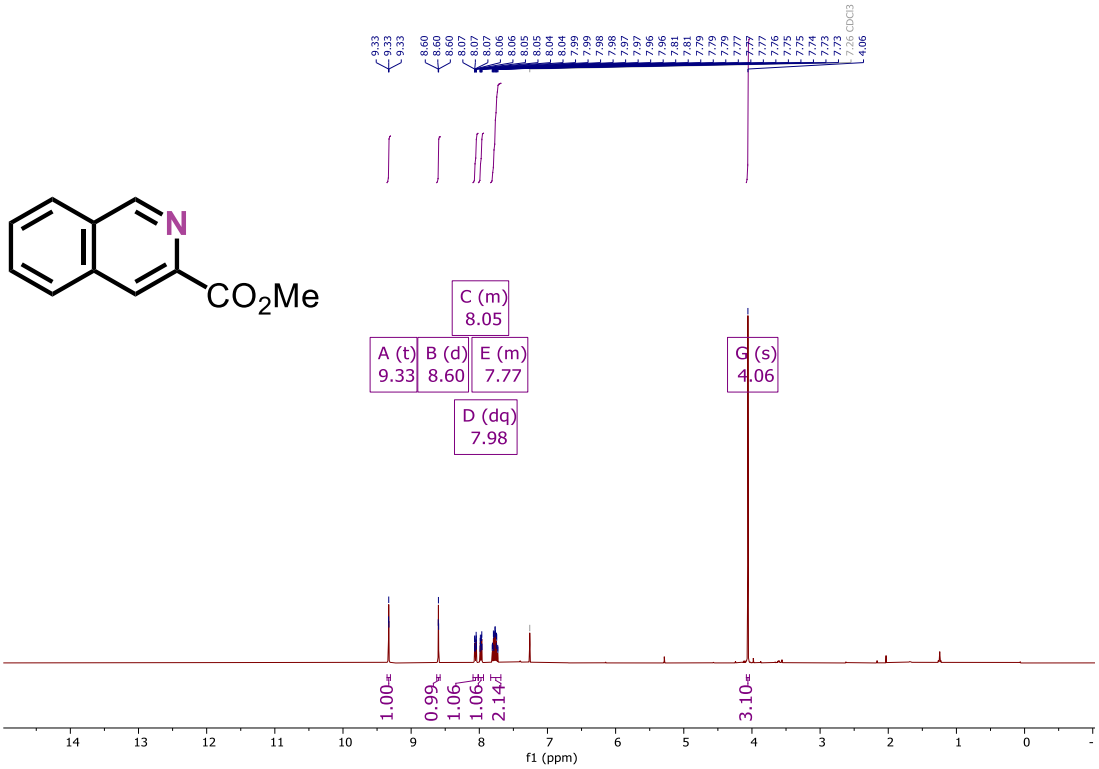
Supplemental Figure 77: ^{13}C NMR spectra of **4m**.



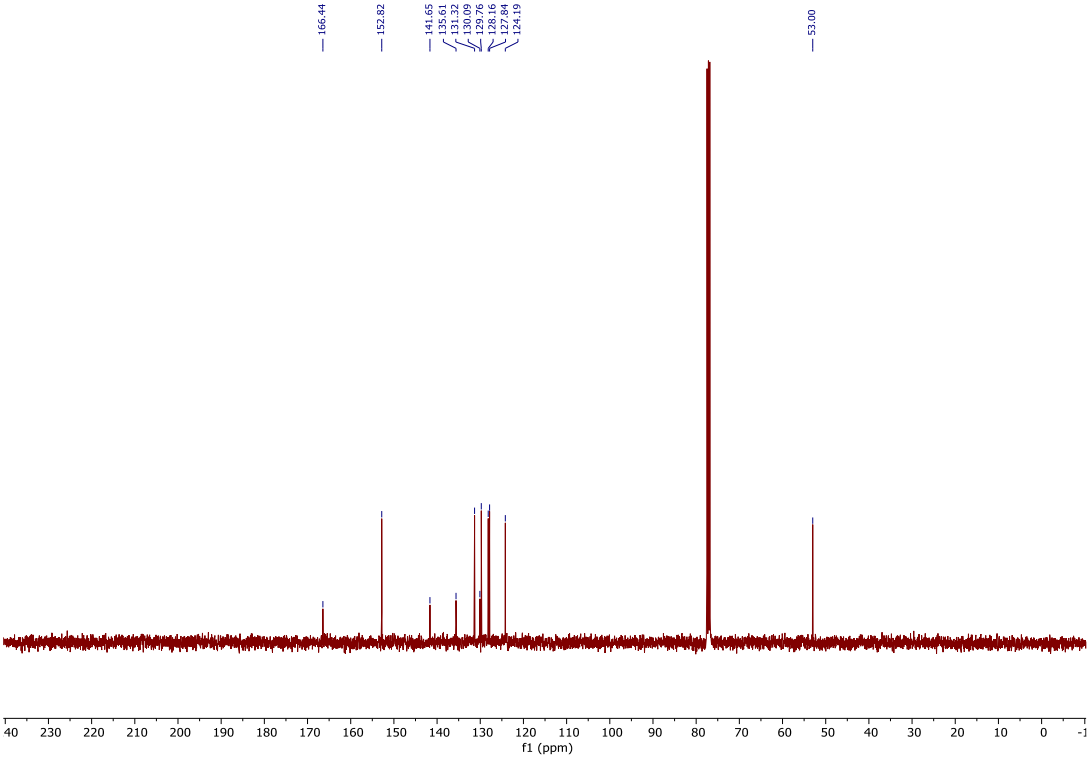
Supplemental Figure 78: ^{1}H NMR spectra of **4o**.



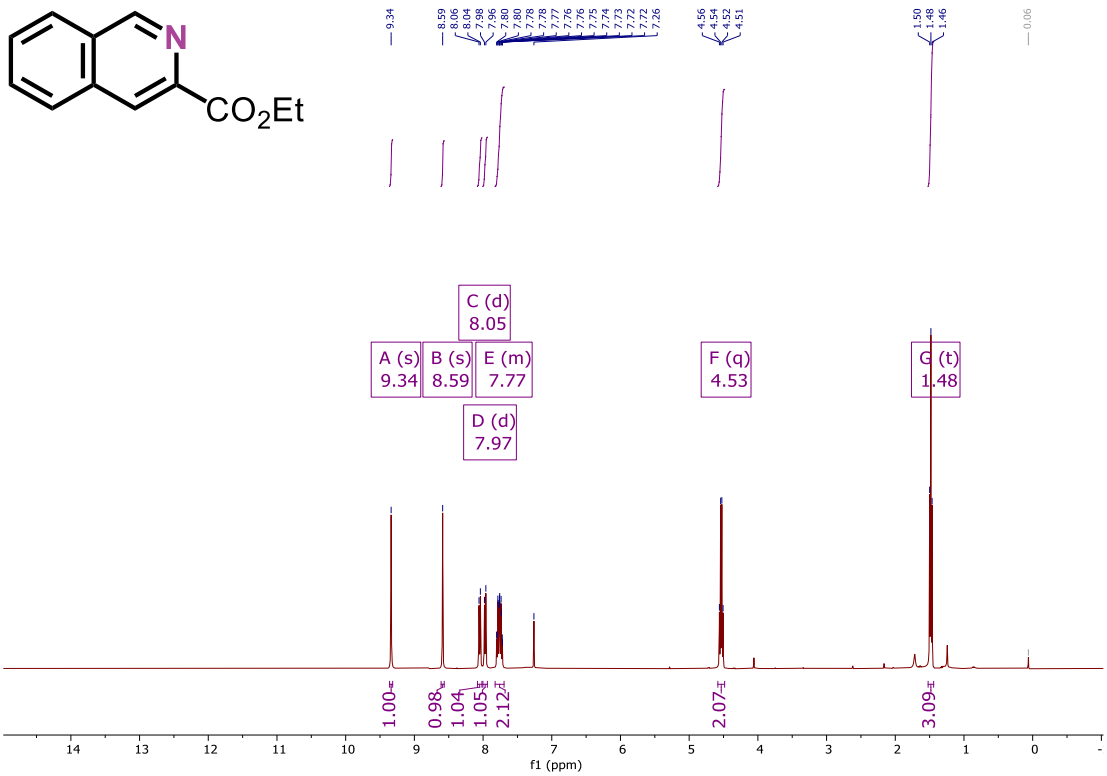
Supplemental Figure 79: ^{1}H NMR spectra of **4o**.



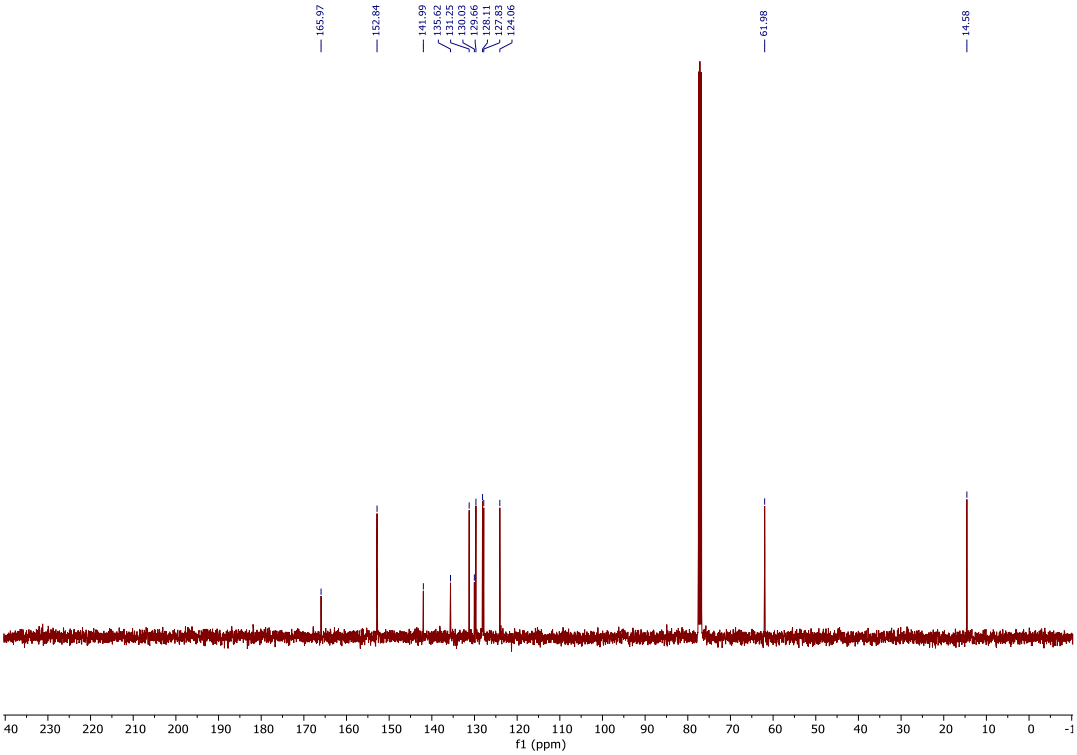
Supplemental Figure 80: ^{1}H NMR spectra of **6a**.



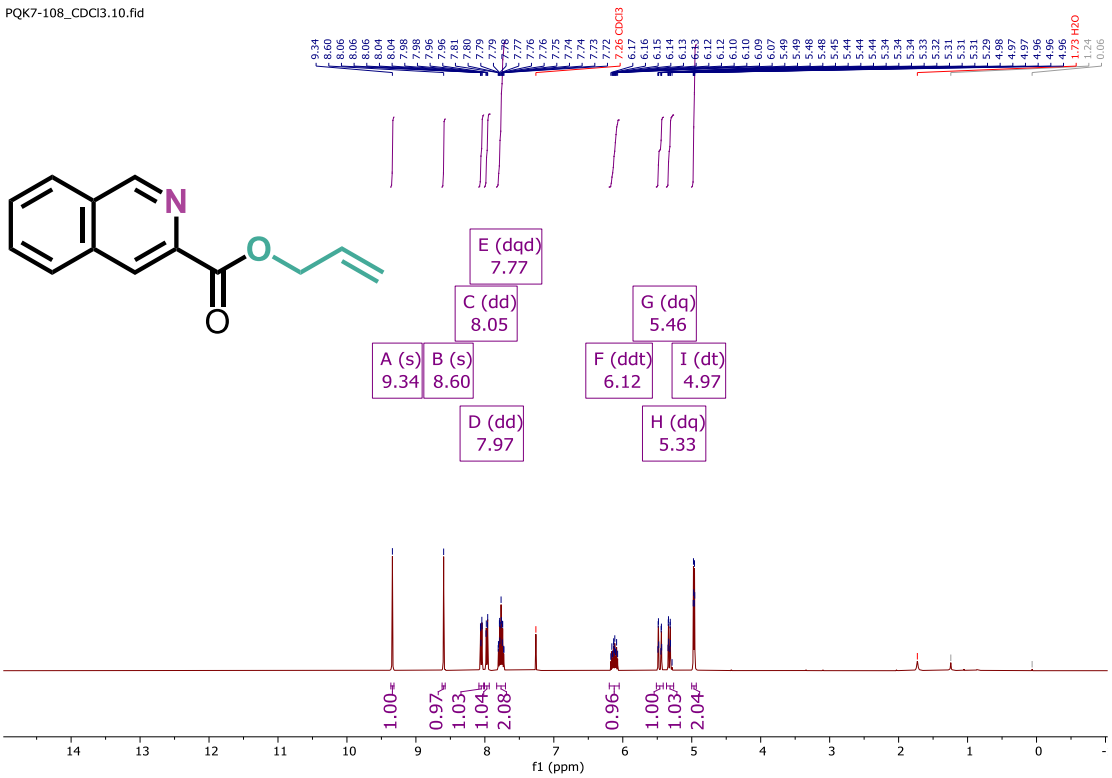
Supplemental Figure 81: ^{13}C NMR spectra of **6a**.



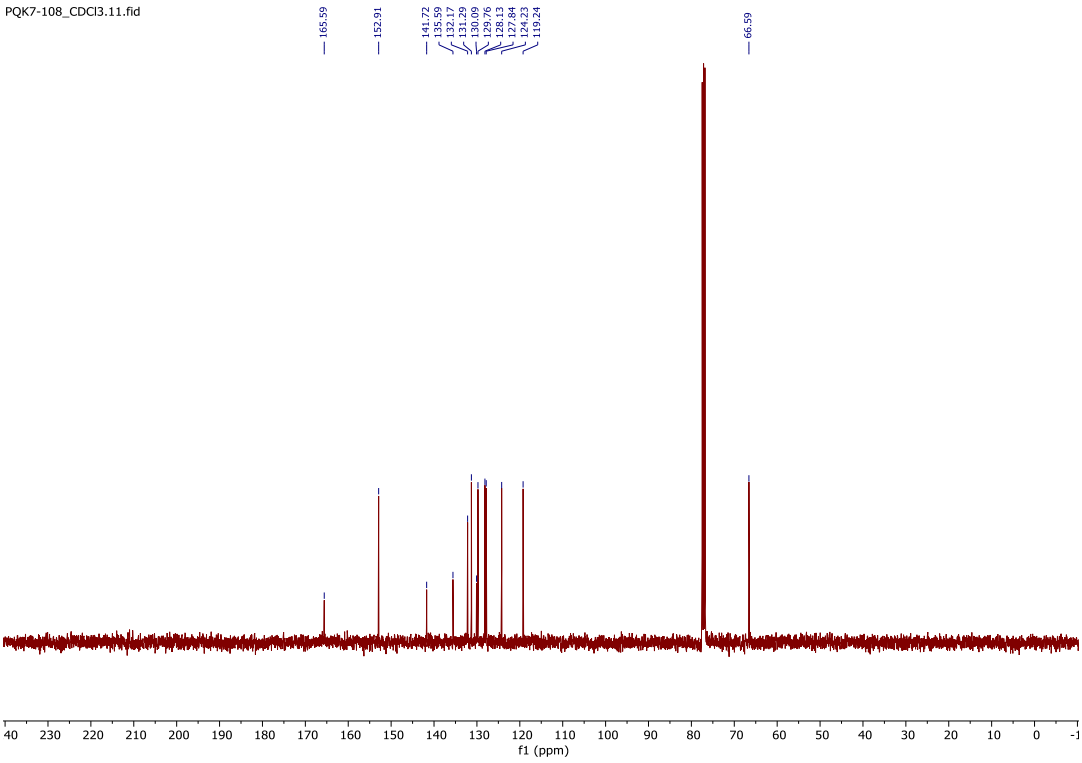
Supplemental Figure 82: ^{1}H NMR spectra of **6b**.



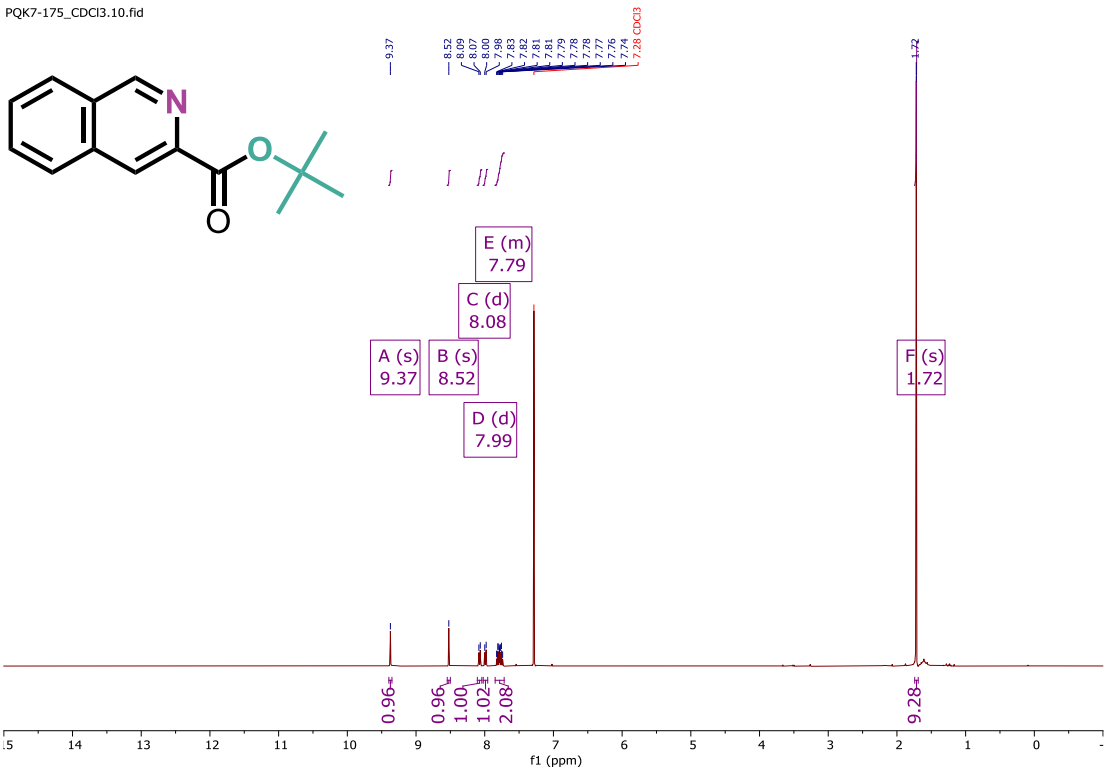
Supplemental Figure 83: ^{13}C NMR spectra of **6b**.



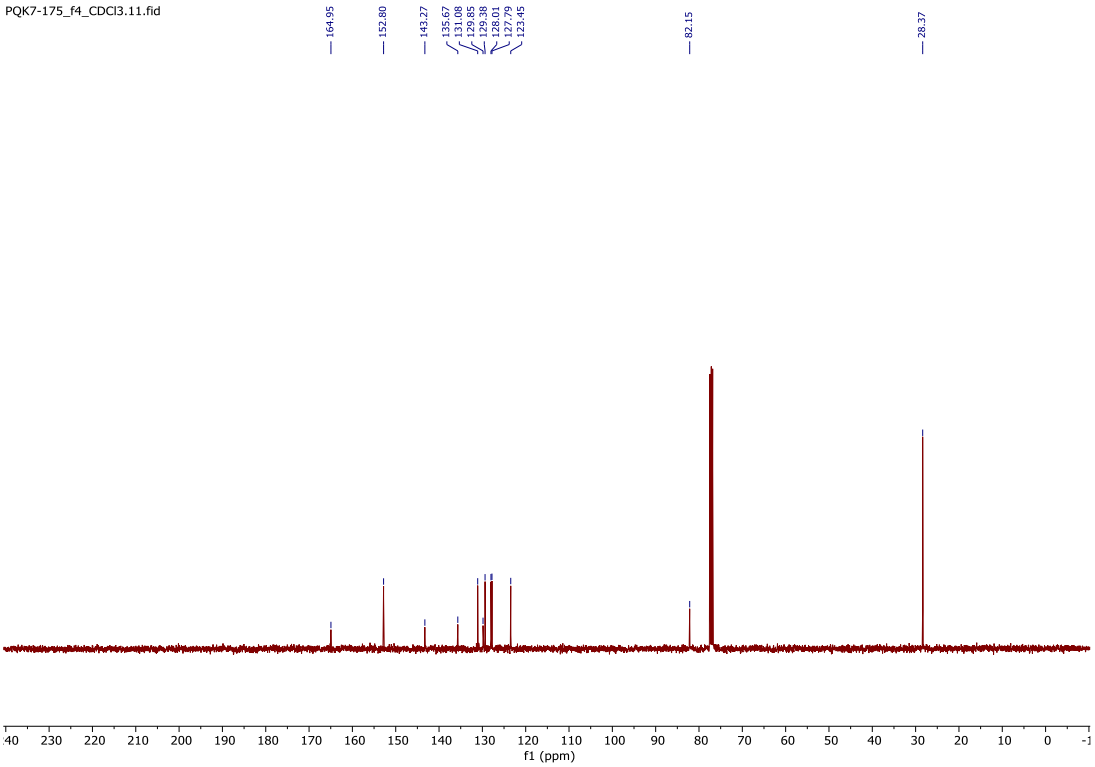
Supplemental Figure 84: ^{1}H NMR spectra of **6c**.



Supplemental Figure 85: ^{13}C NMR spectra of **6c**.

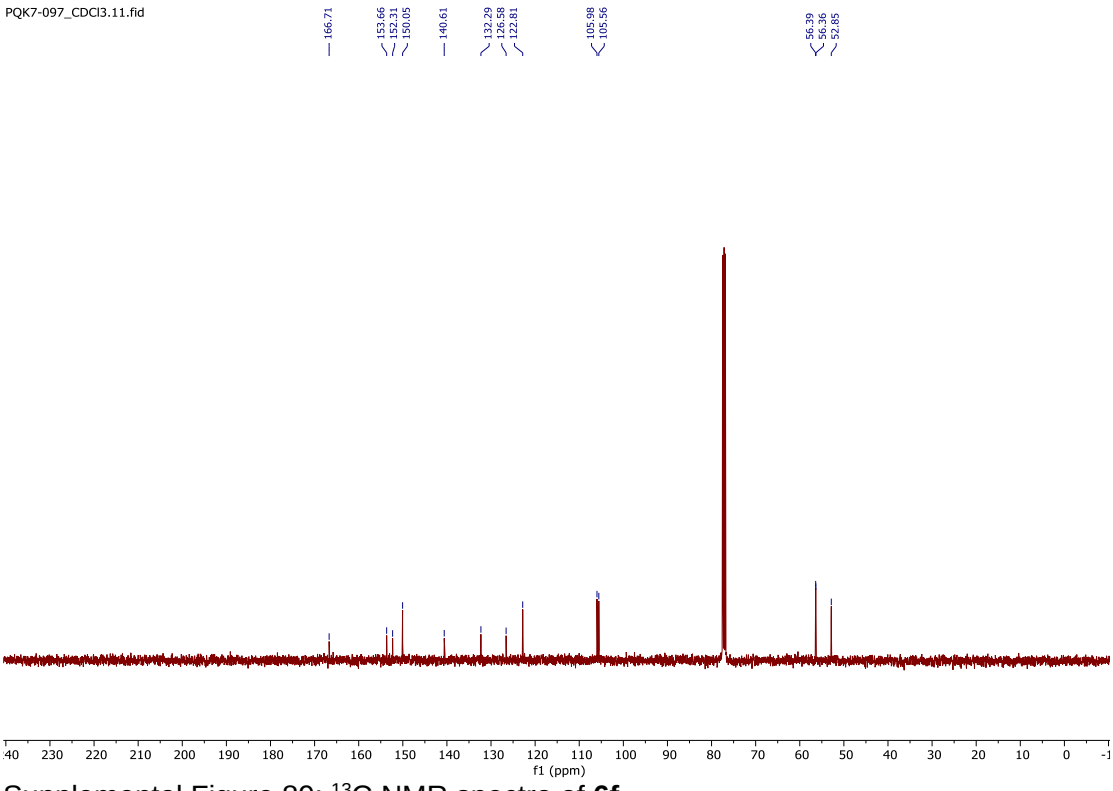


Supplemental Figure 86: ^{1}H NMR spectra of **6d**.

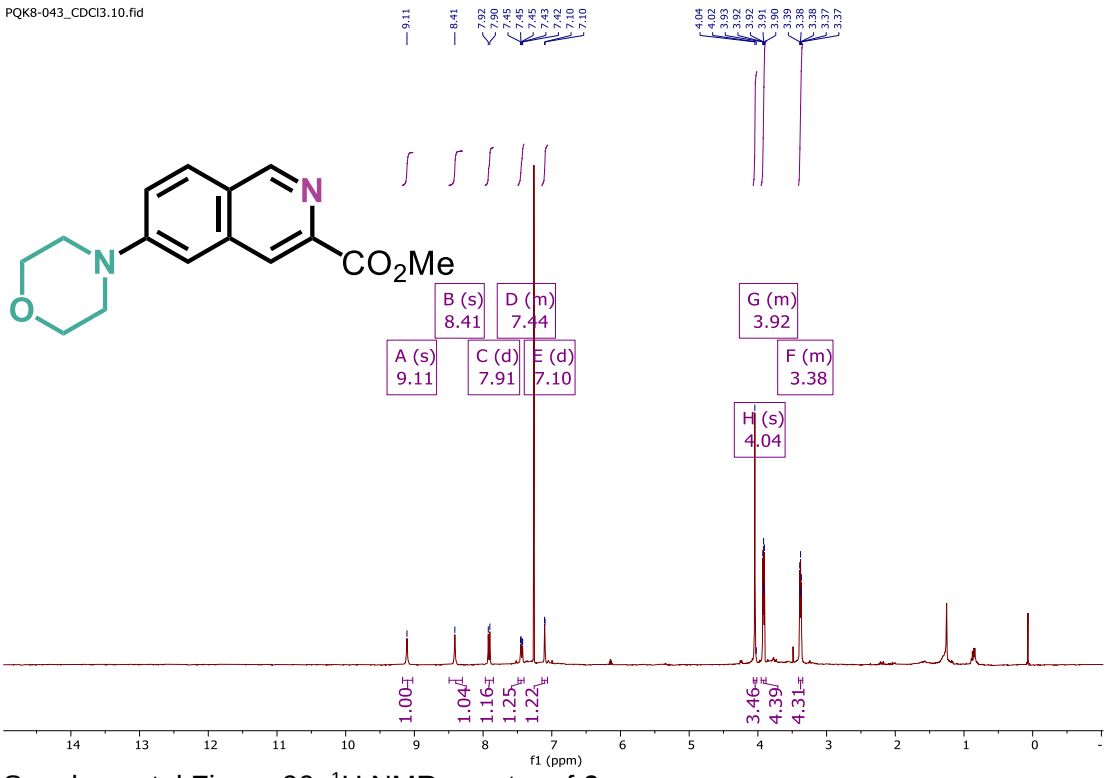


Supplemental Figure 87: ^{13}C NMR spectra of **6d**.

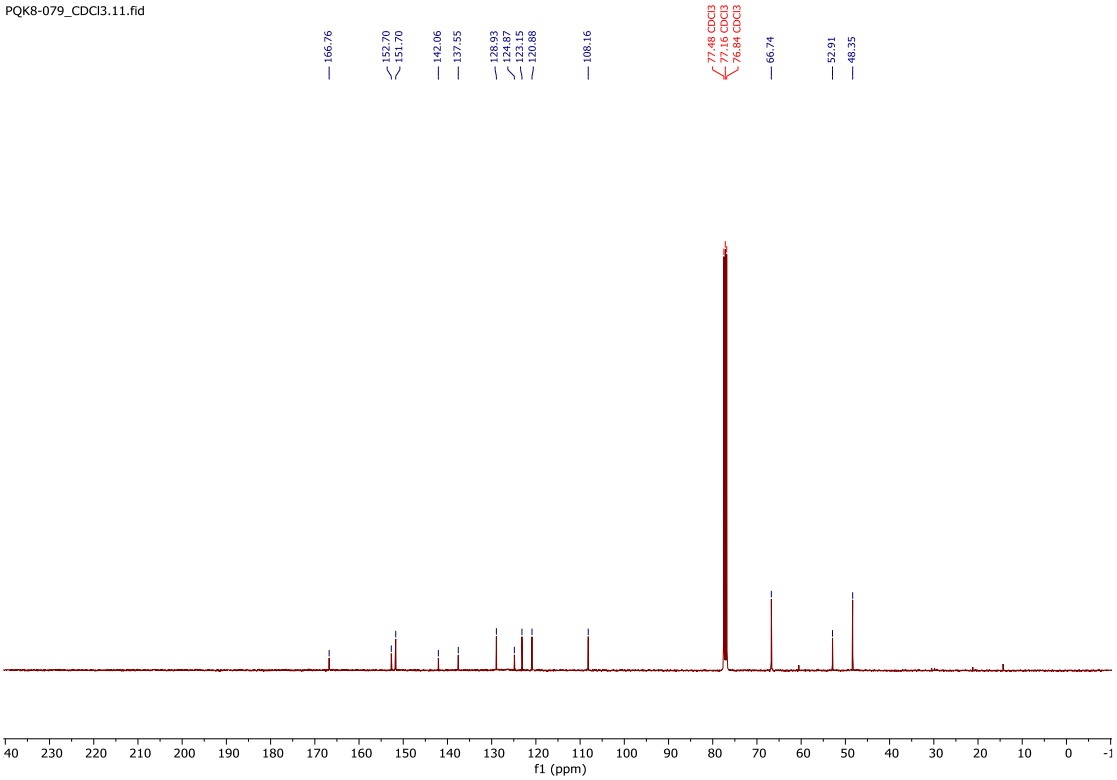
Supplemental Figure 88: ^{1}H NMR spectra of **6f**.



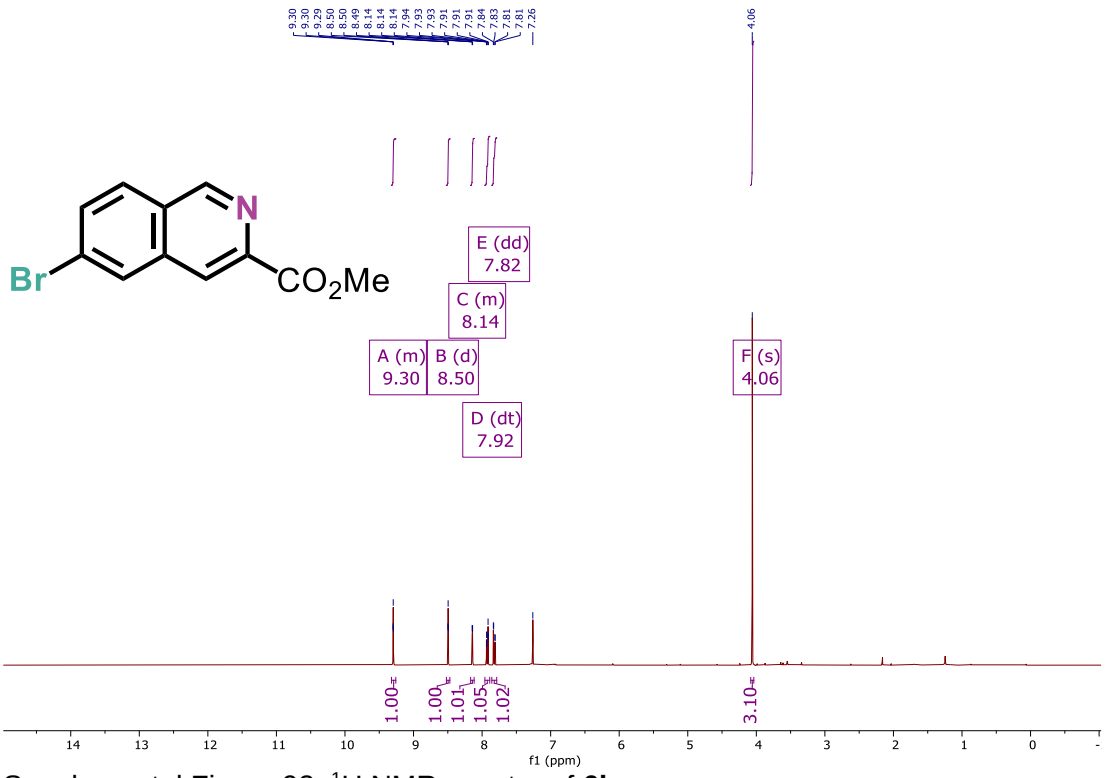
Supplemental Figure 89: ^{13}C NMR spectra of **6f**.



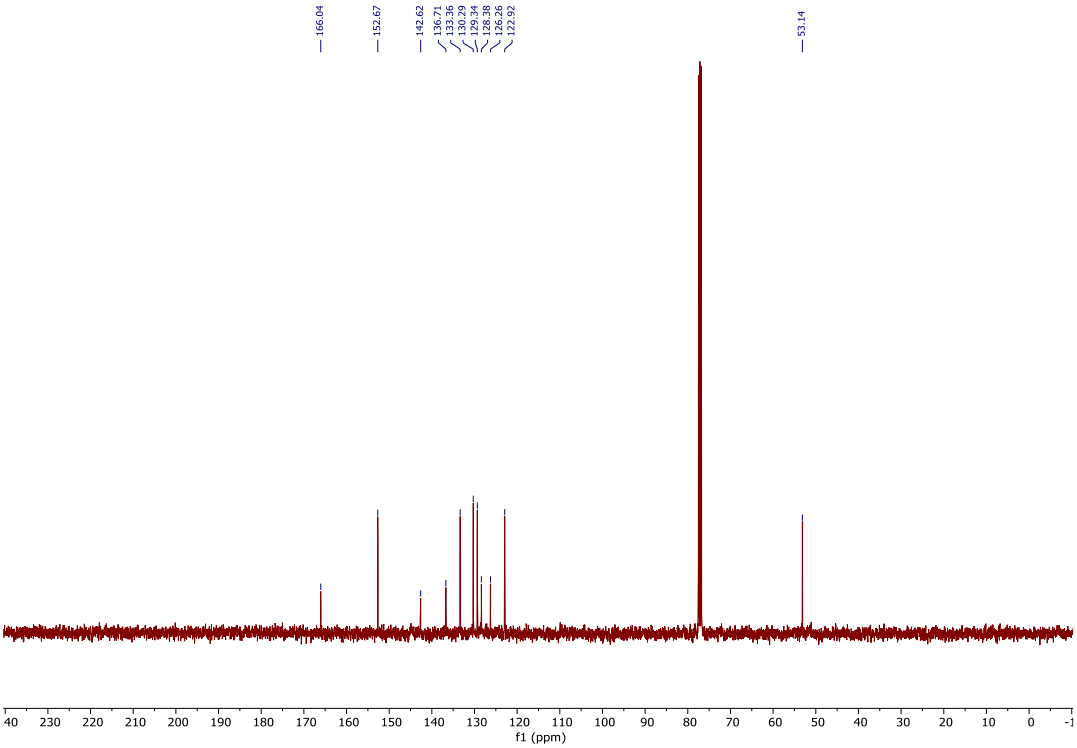
Supplemental Figure 90: ^{1}H NMR spectra of **6g**.



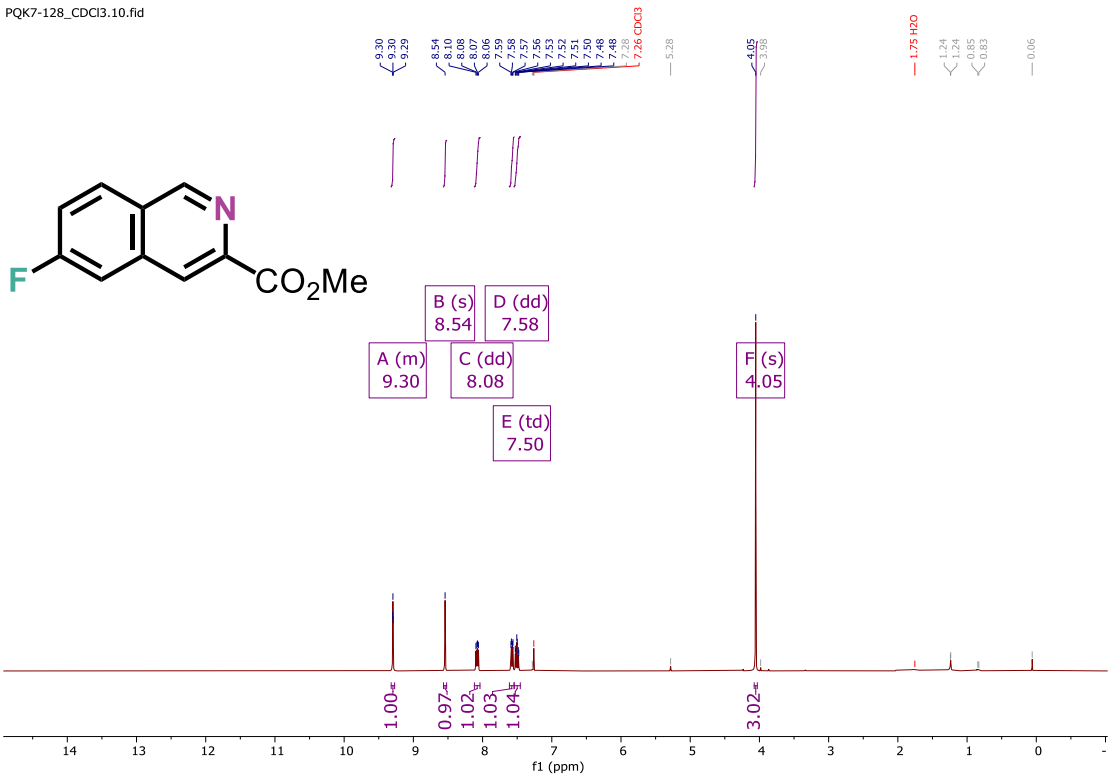
Supplemental Figure 91: ^{13}C NMR spectra of **6g**.



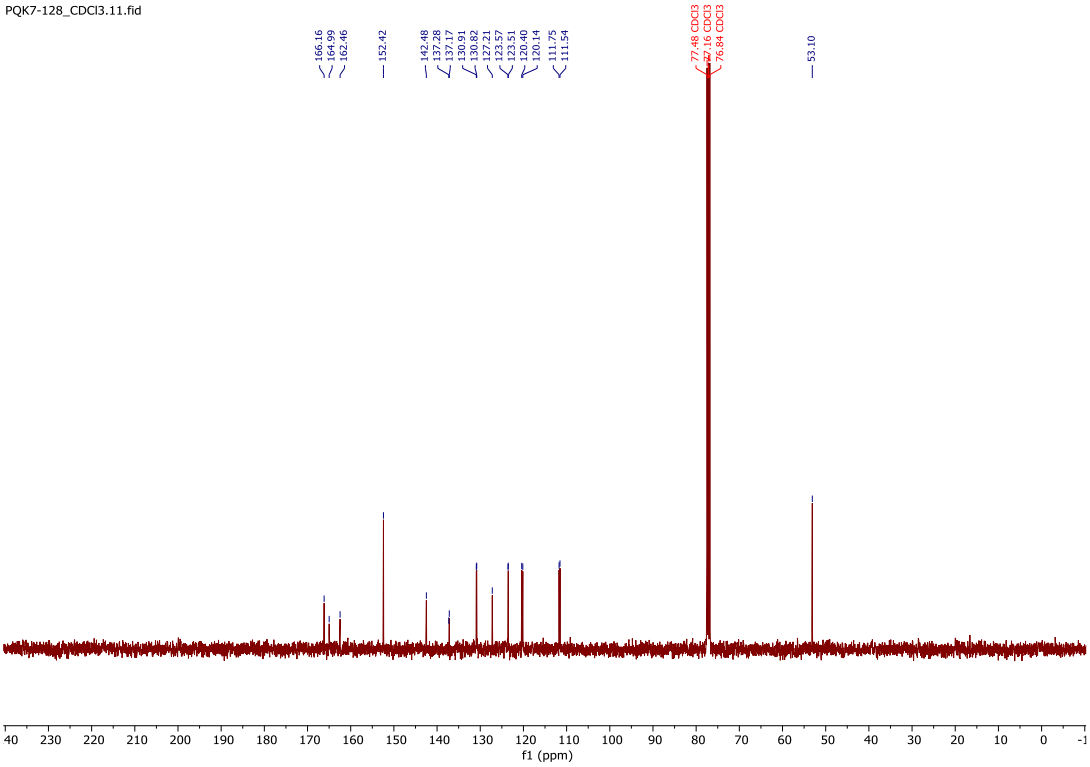
Supplemental Figure 92: ^{1}H NMR spectra of **6h**.



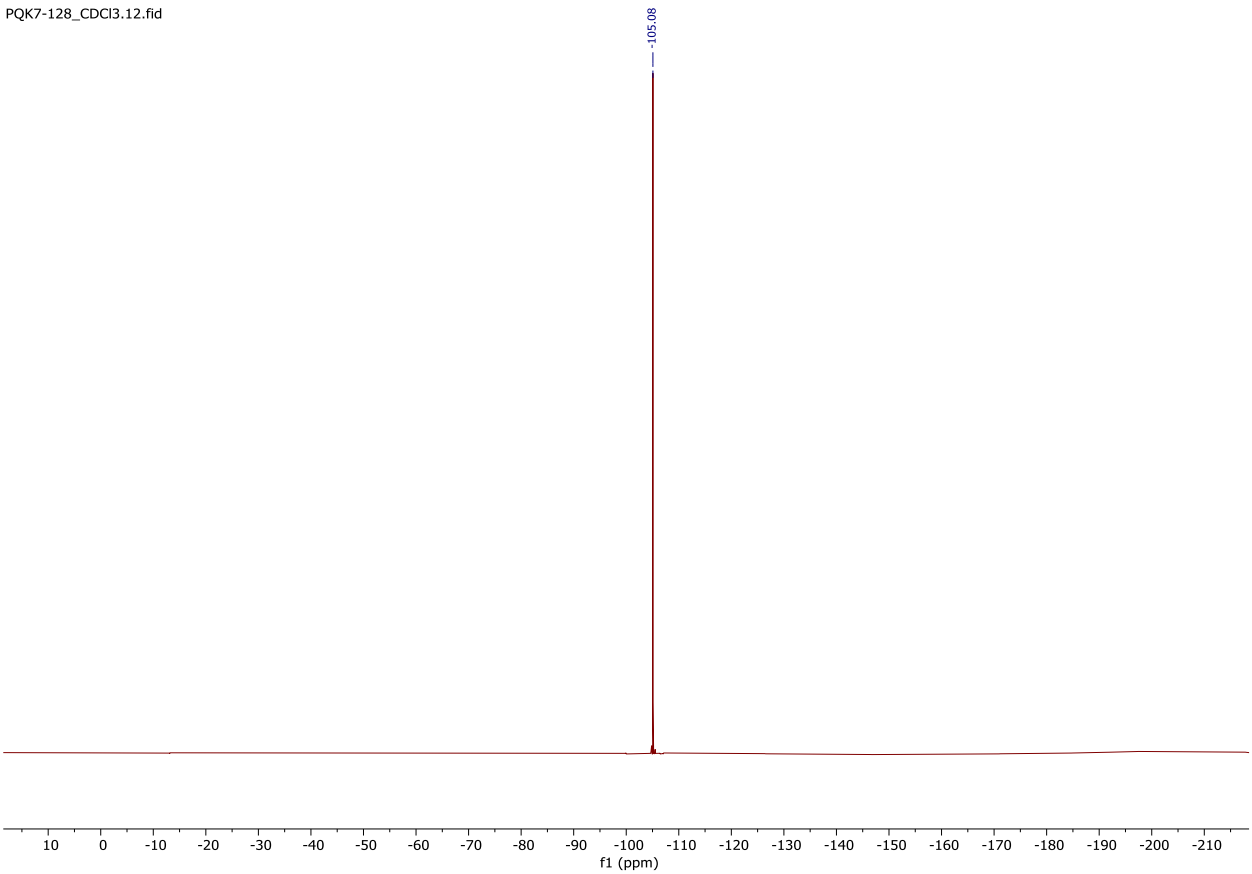
Supplemental Figure 93: ^{13}C NMR spectra of **6h**.



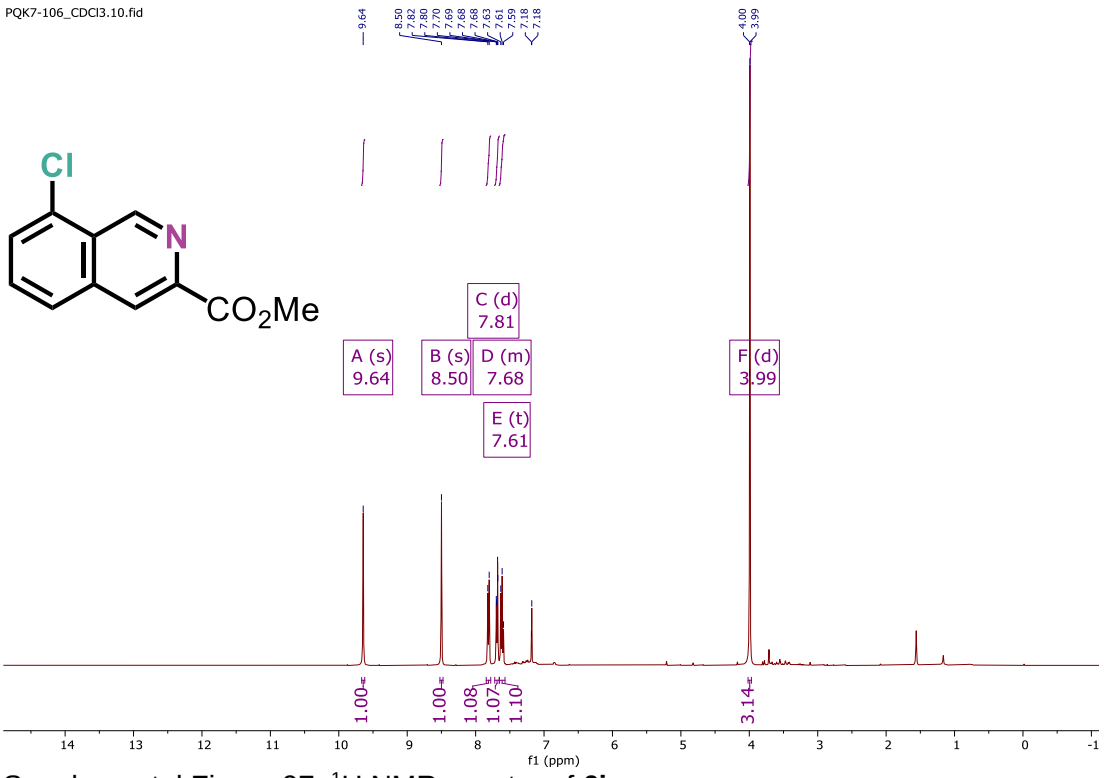
Supplemental Figure 94: ^{1}H NMR spectra of **6i**.



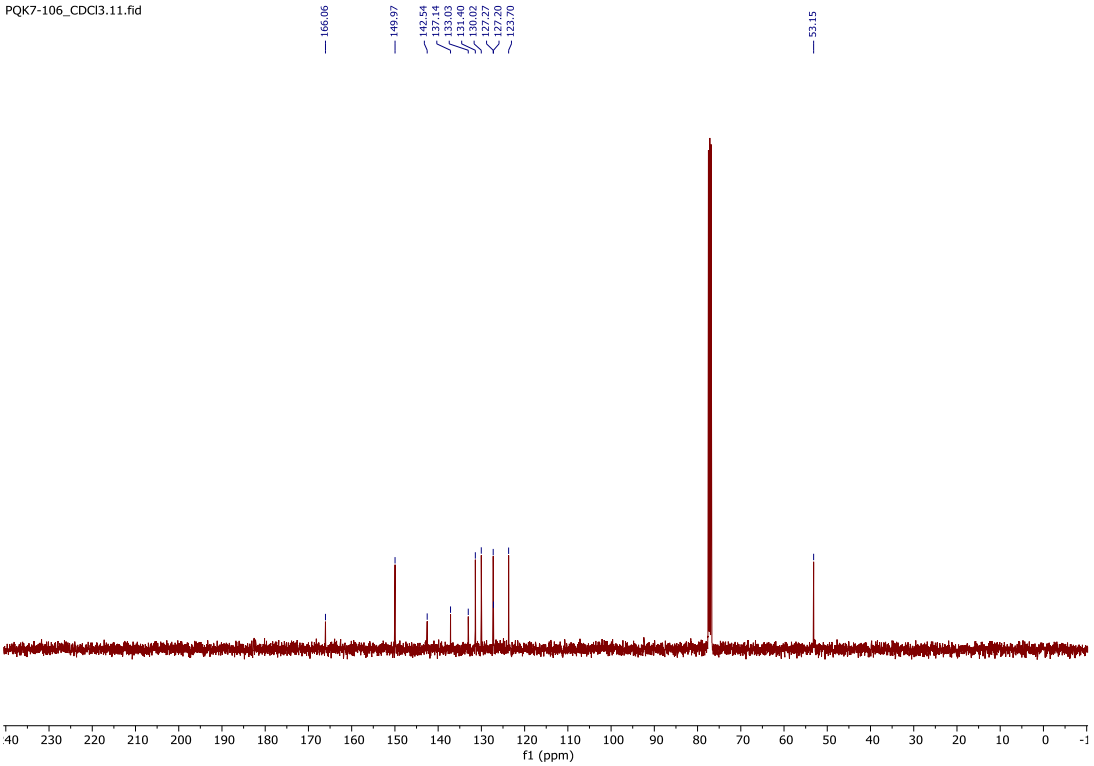
Supplemental Figure 95: ^{13}C NMR spectra of **6i**.



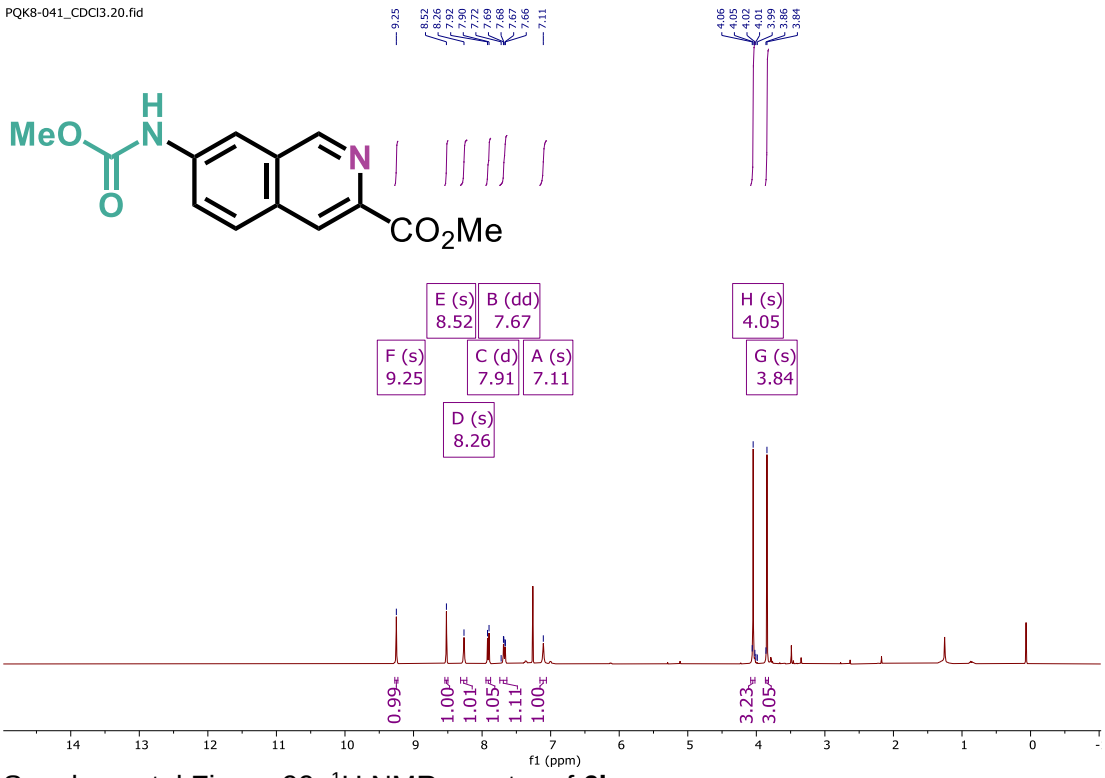
Supplemental Figure 96: ^{19}F NMR spectra of **6i**.



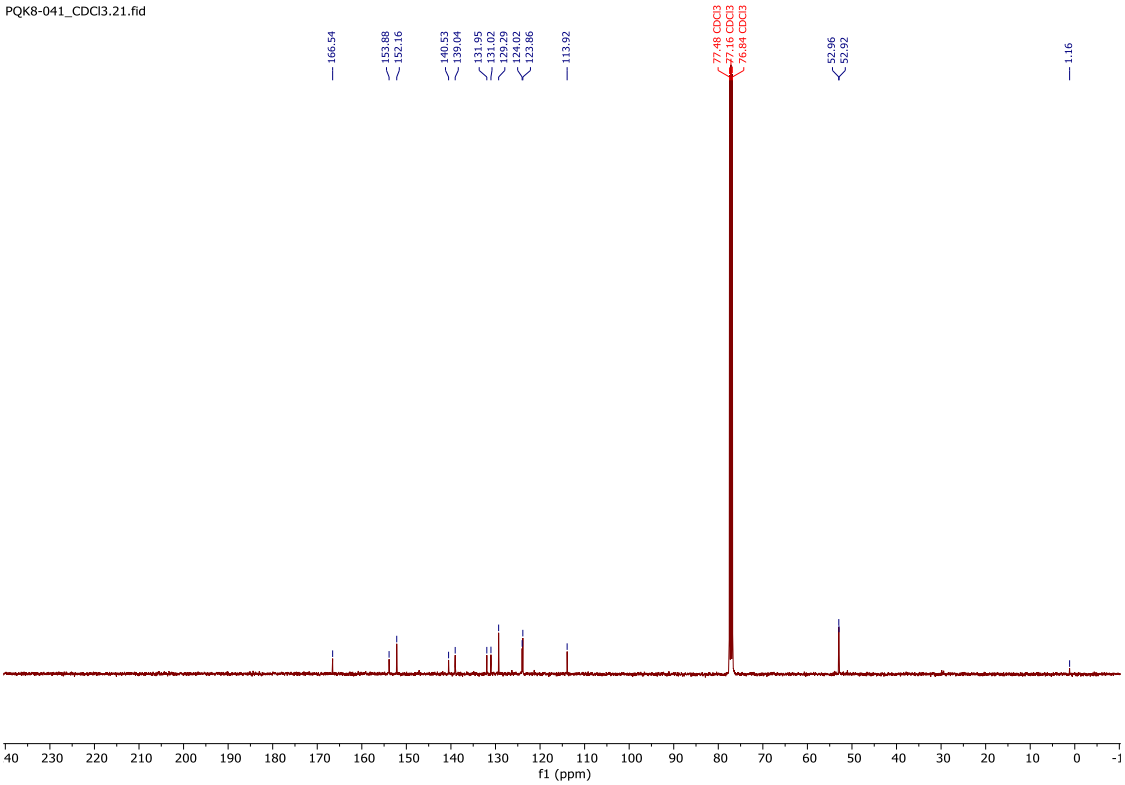
Supplemental Figure 97: ^{1}H NMR spectra of **6j**.



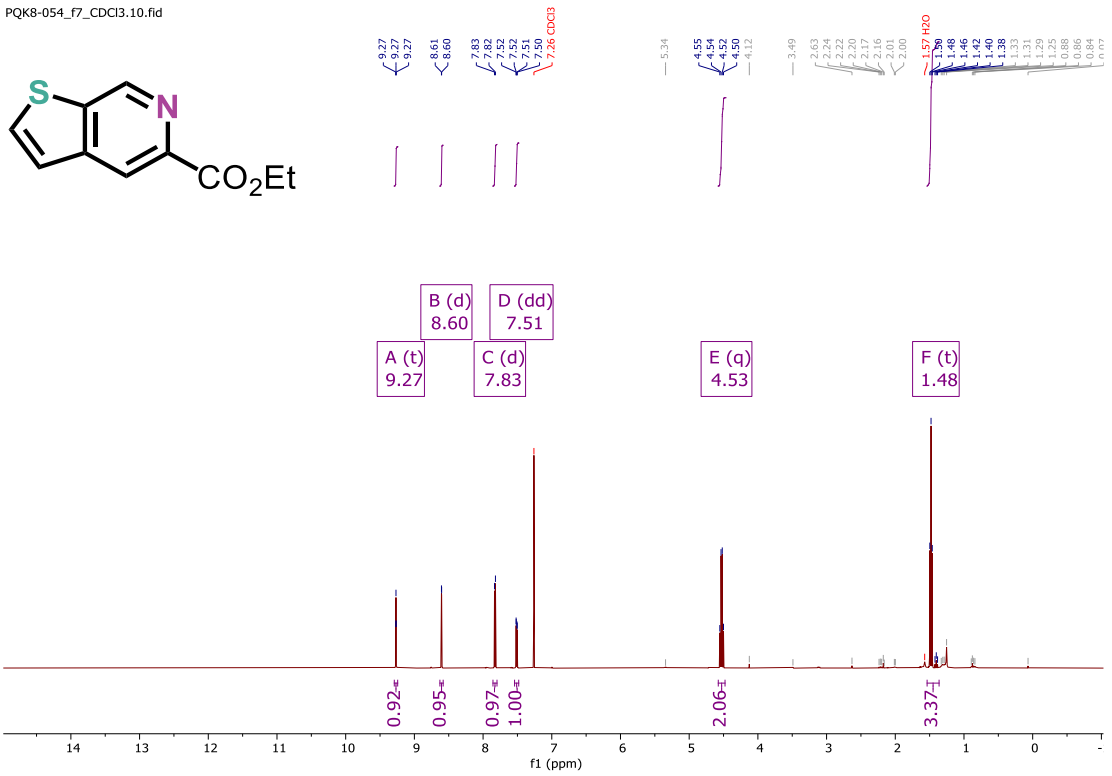
Supplemental Figure 98: ^{13}C NMR spectra of **6j**.



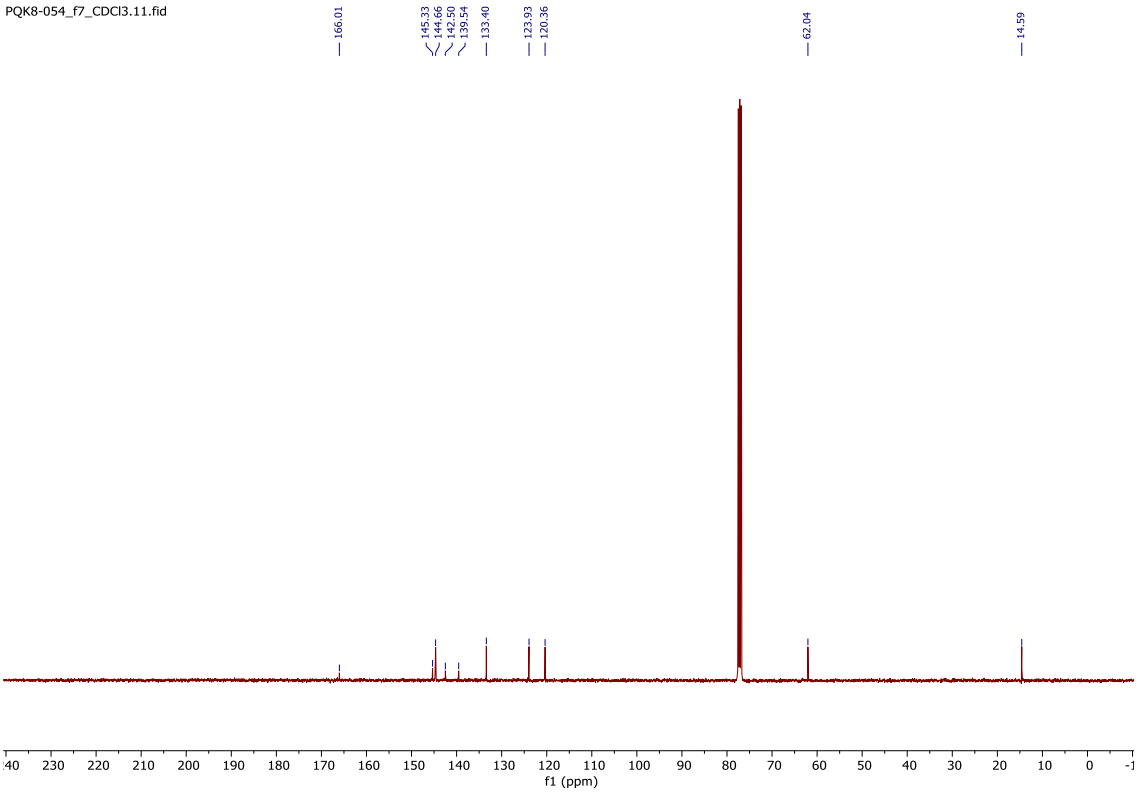
Supplemental Figure 99: ^{1}H NMR spectra of **6l**.



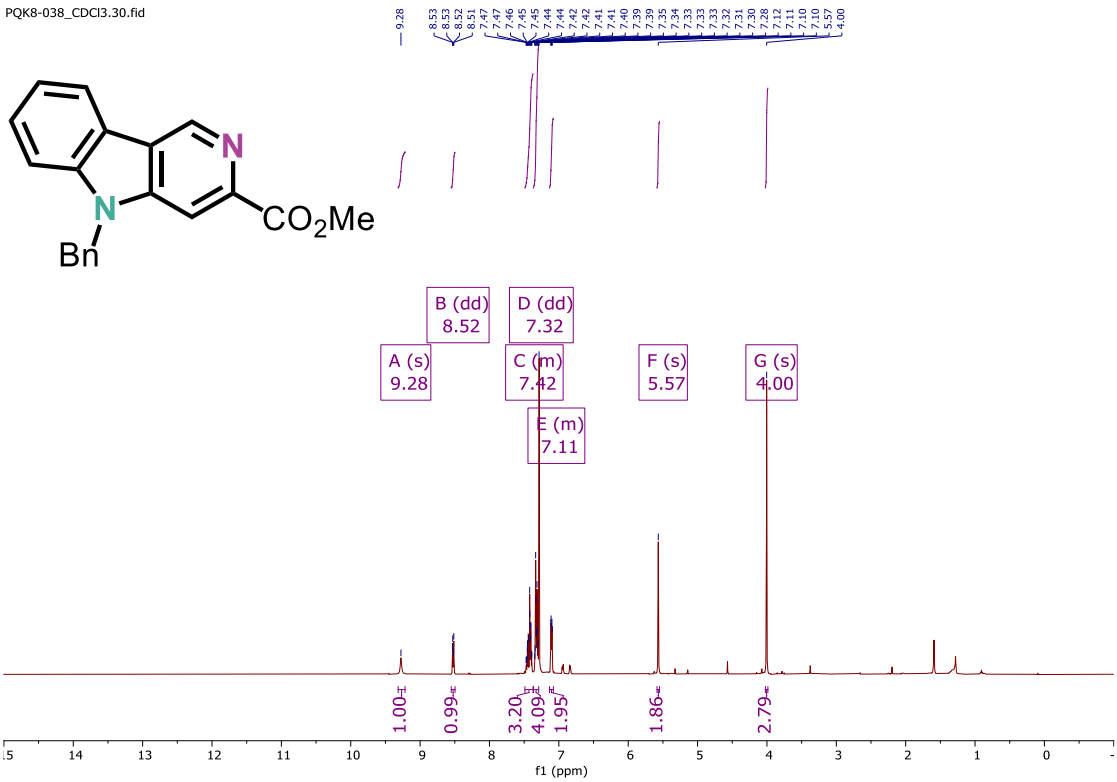
Supplemental Figure 100: ^{13}C NMR spectra of **6l**.



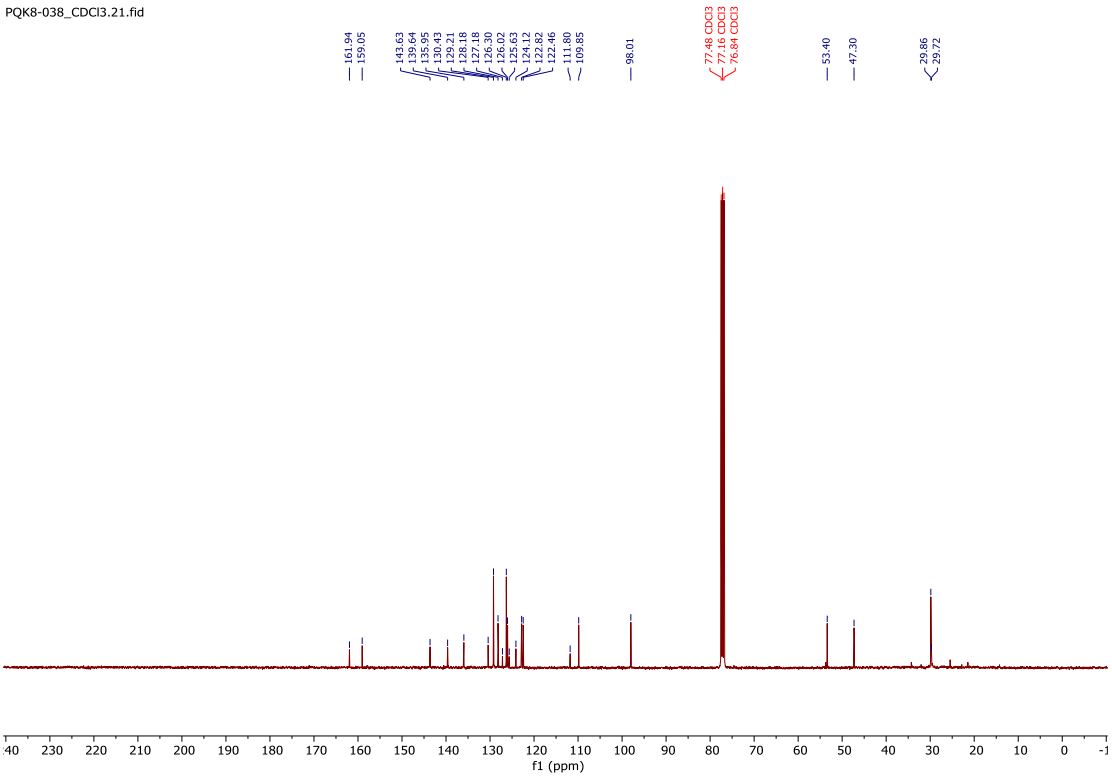
Supplemental Figure 101: ^{1}H NMR spectra of **6m**.



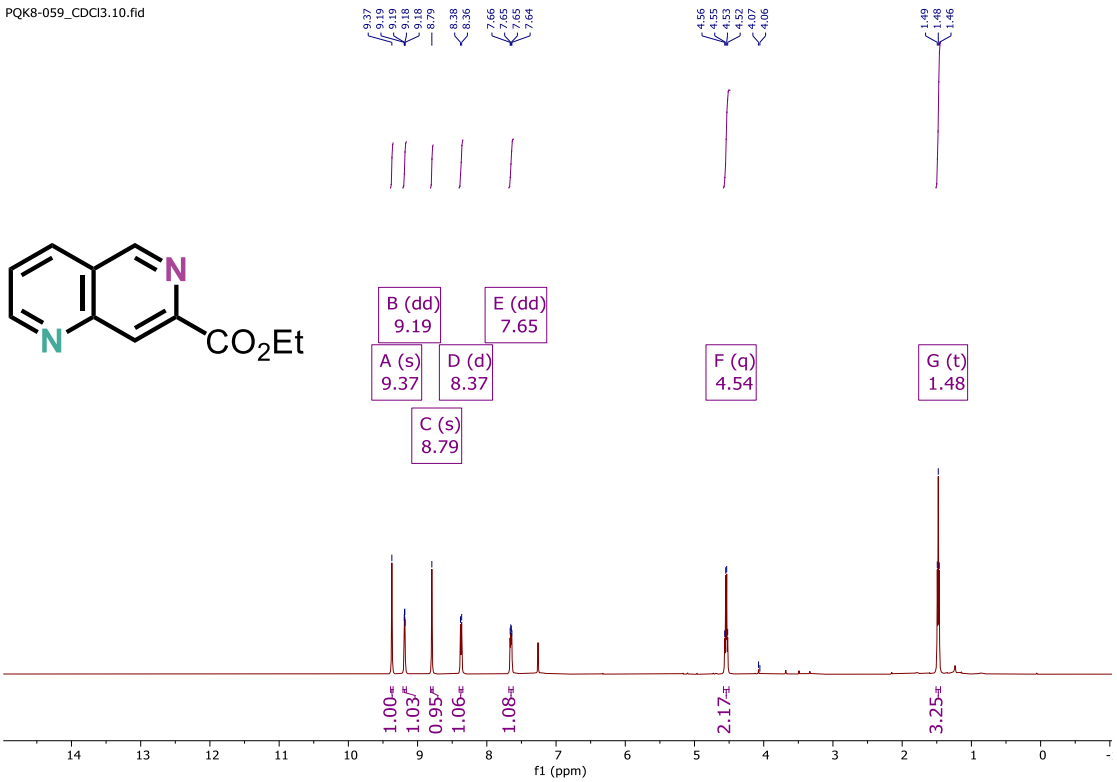
Supplemental Figure 102: ^{13}C NMR spectra of **6m**.



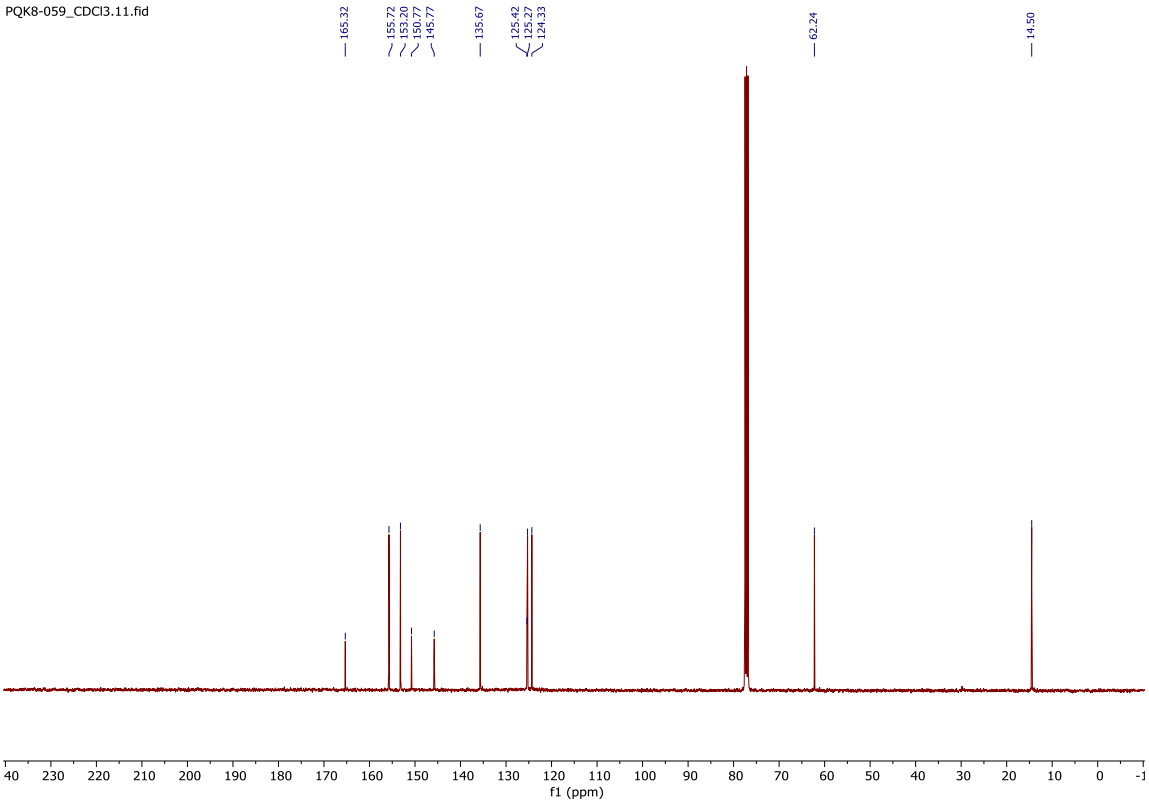
Supplemental Figure 103: ^{1}H NMR spectra of **6n**.



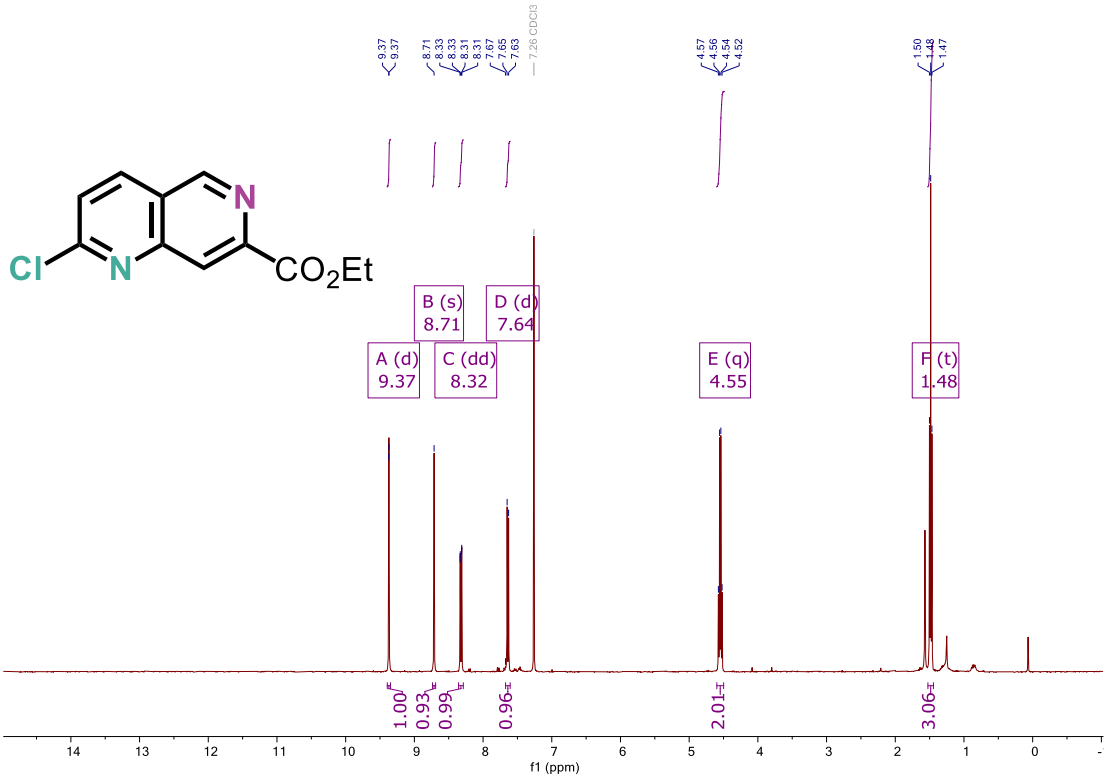
Supplemental Figure 104: ^{13}C NMR spectra of **6n**.



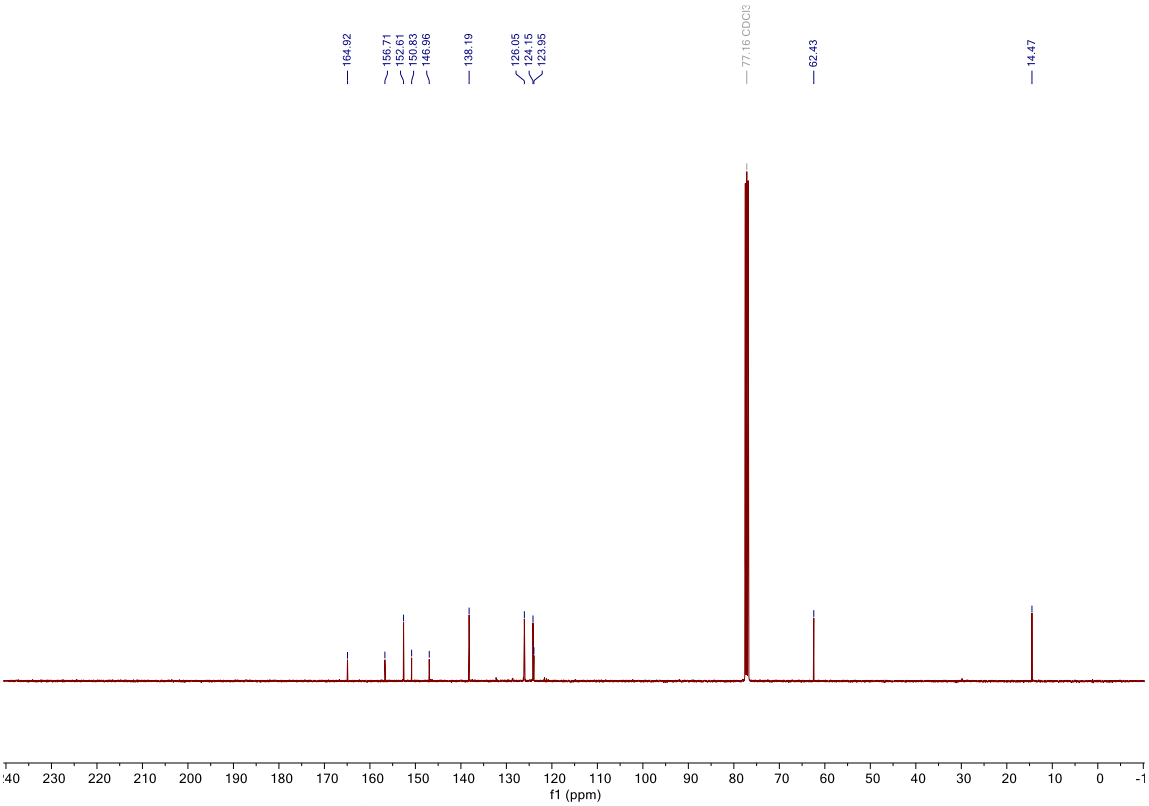
Supplemental Figure 105: ^{1}H NMR spectra of **6o**.



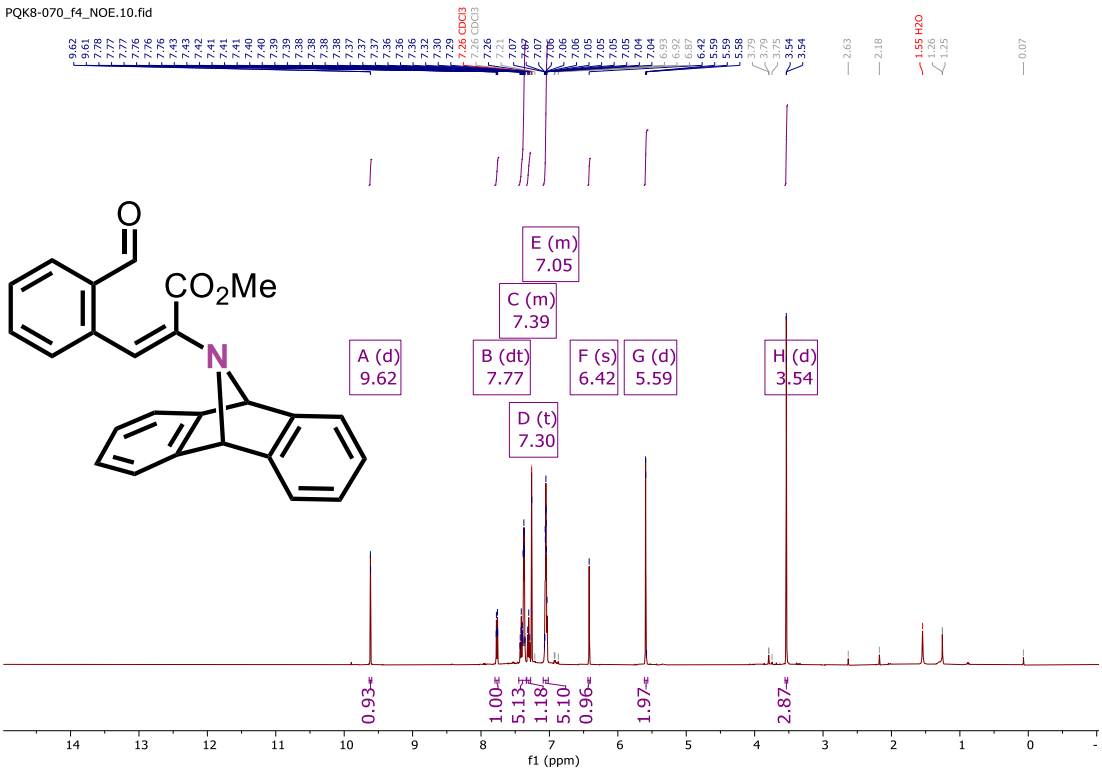
Supplemental Figure 106: ^{13}C NMR spectra of **6o**.



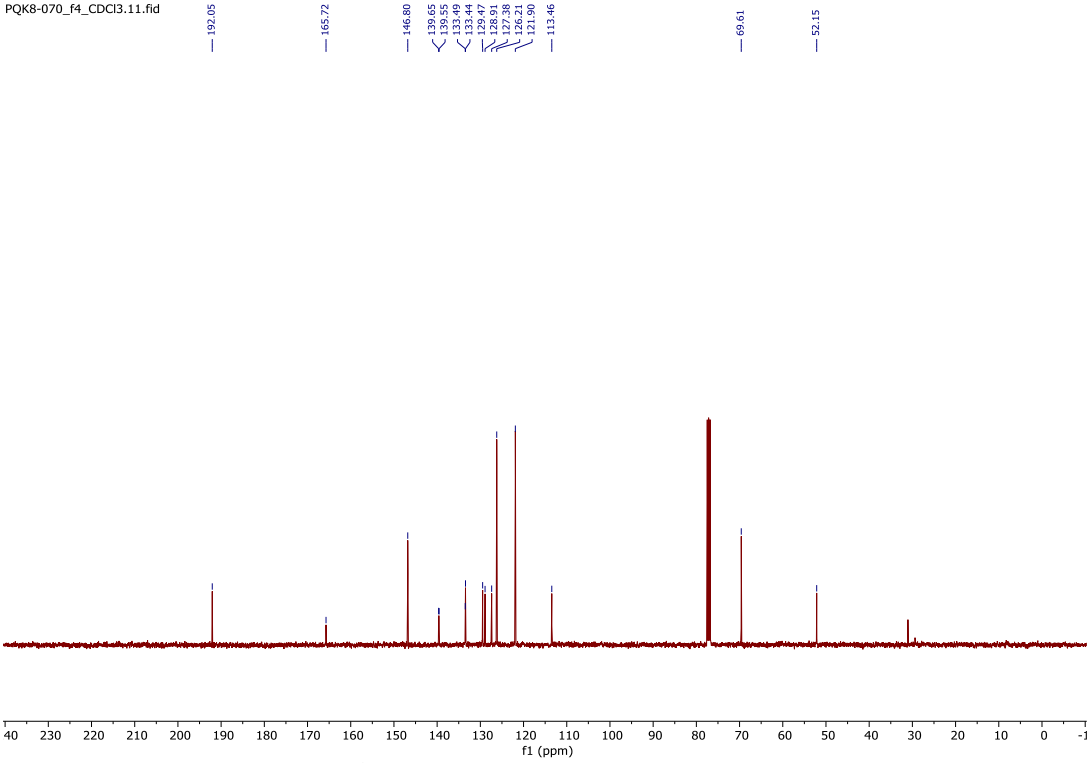
Supplemental Figure 107: ^{1}H NMR spectra of **6p**.



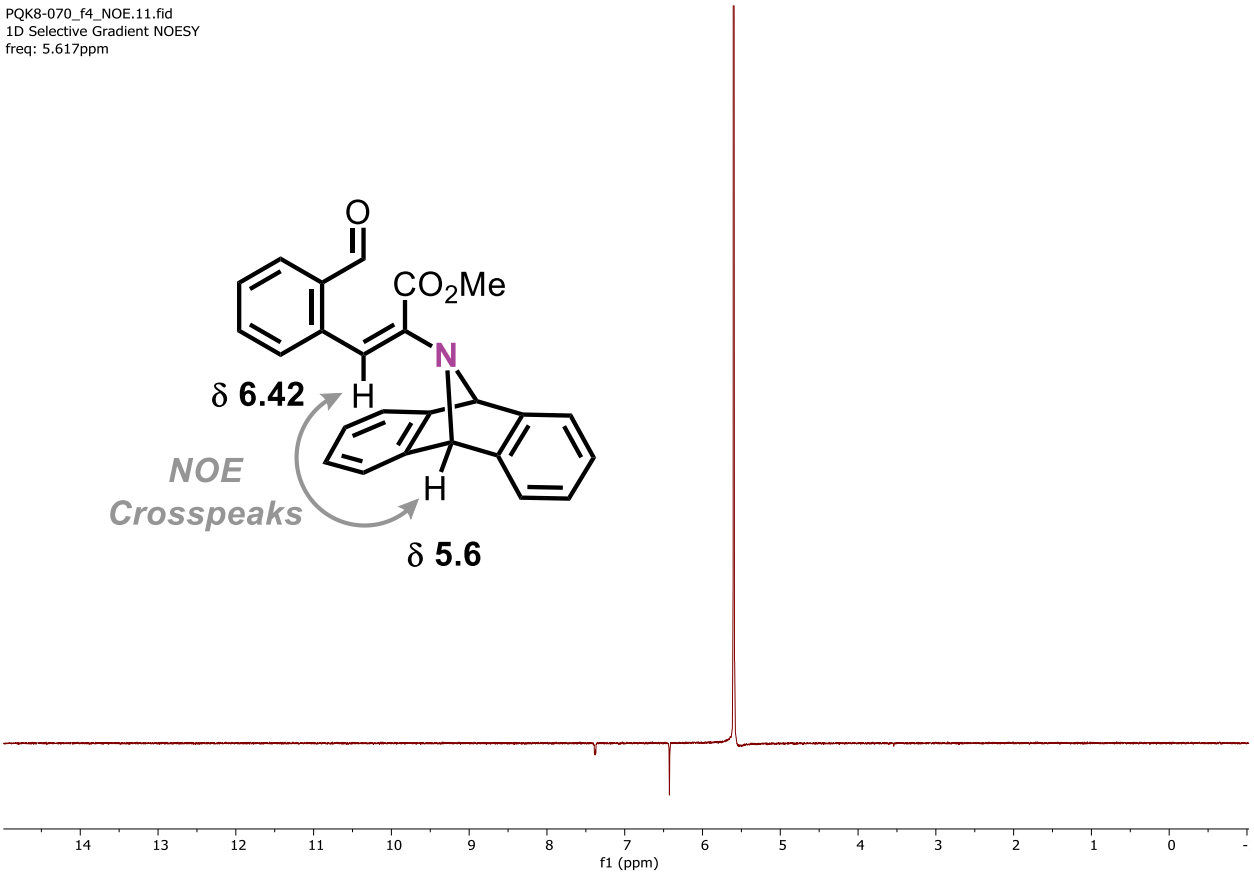
Supplemental Figure 108: ^{13}C NMR spectra of **6p**.



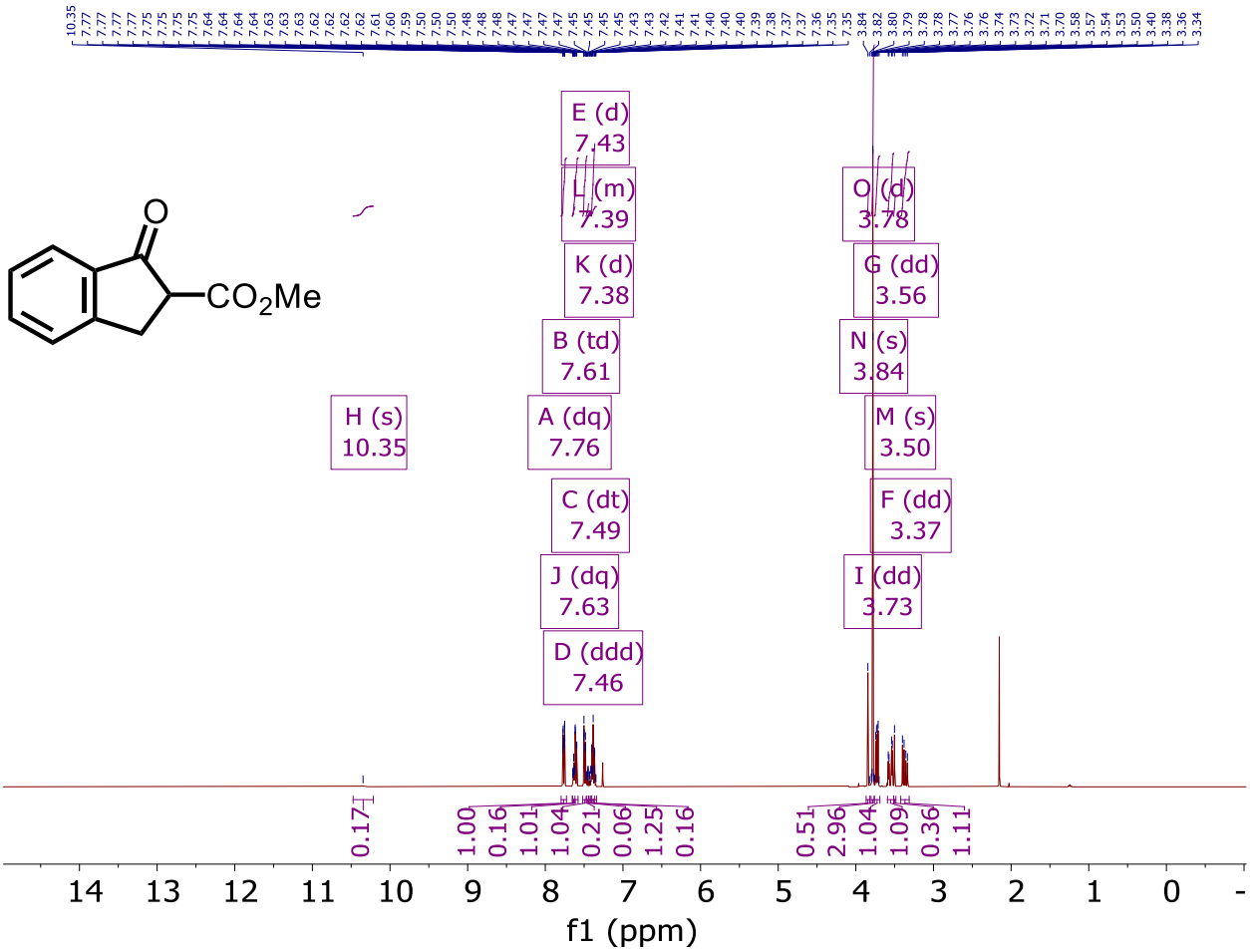
Supplemental Figure 109: ^{1}H NMR spectra of **(E)-12**.



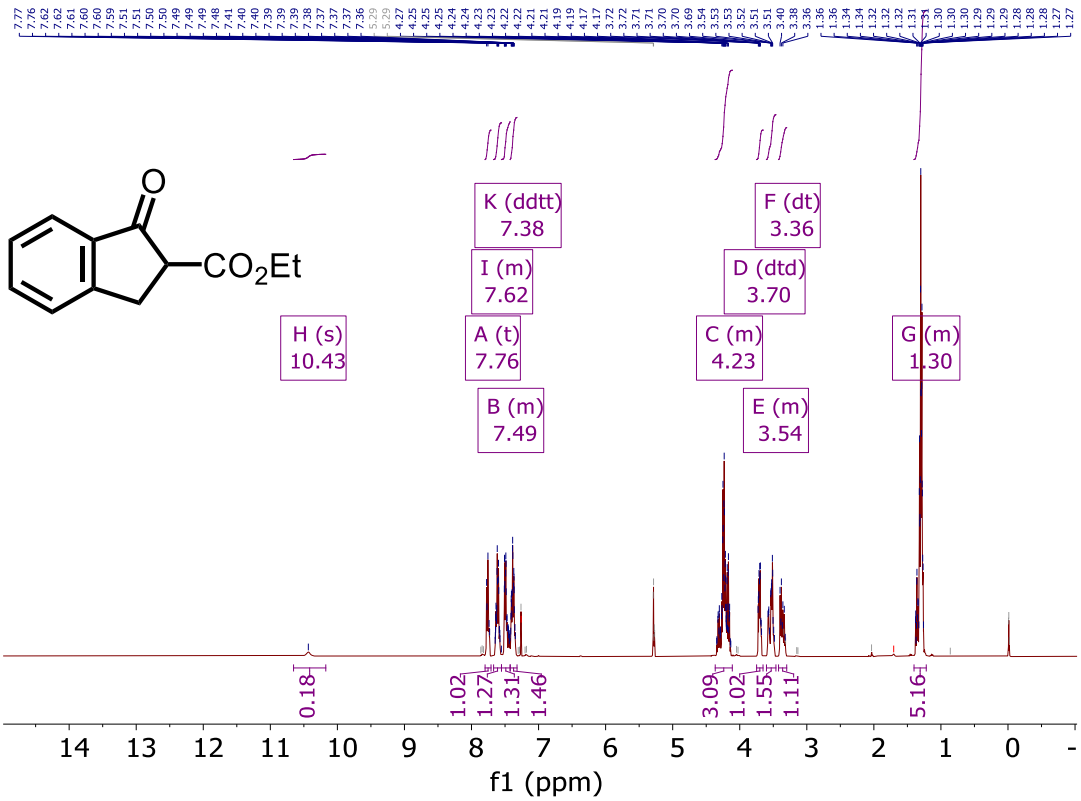
Supplemental Figure 110: ^{13}C NMR spectra of **(E)-12**.



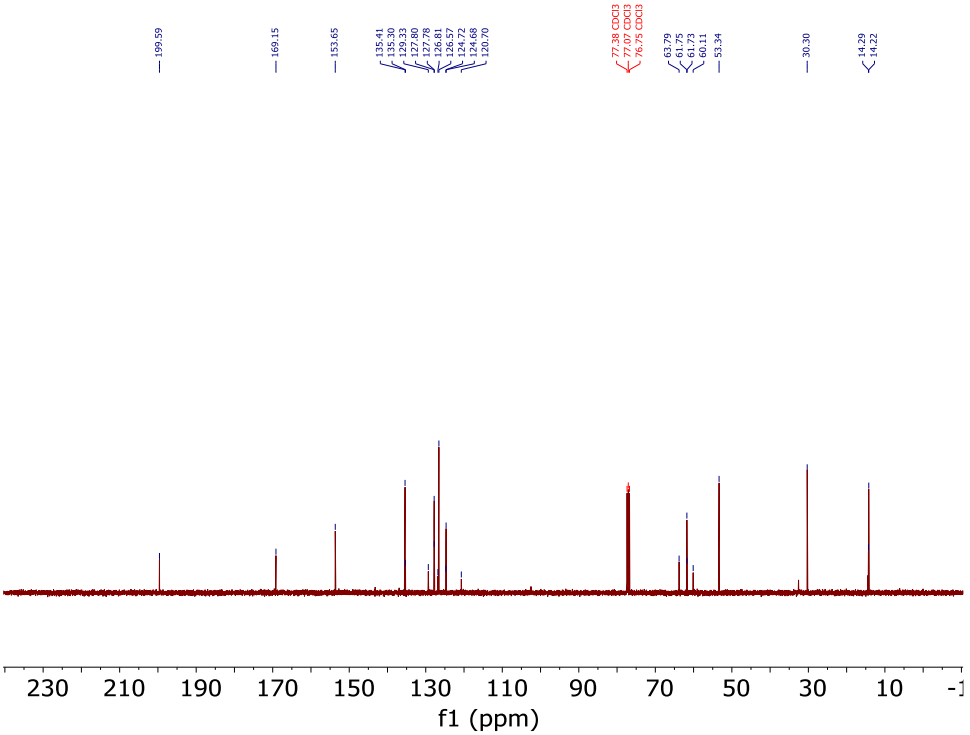
Supplemental Figure 111: 1D-NOE spectra of **(E)-12**. NOE crosspeaks between bridgehead C-H and olefin C-H. No correlation with aldehyde C-H. This spectrum allows assignment of E-olefin.



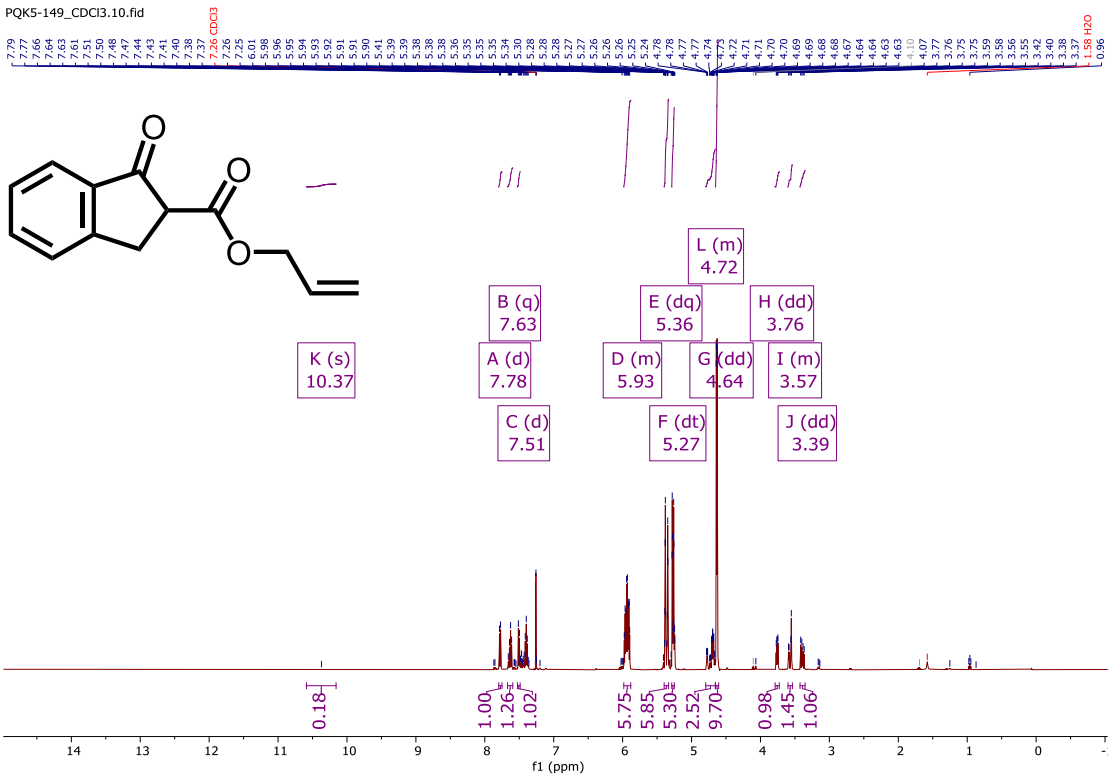
Supplemental Figure 112: ^{1}H NMR spectra of **2a**.



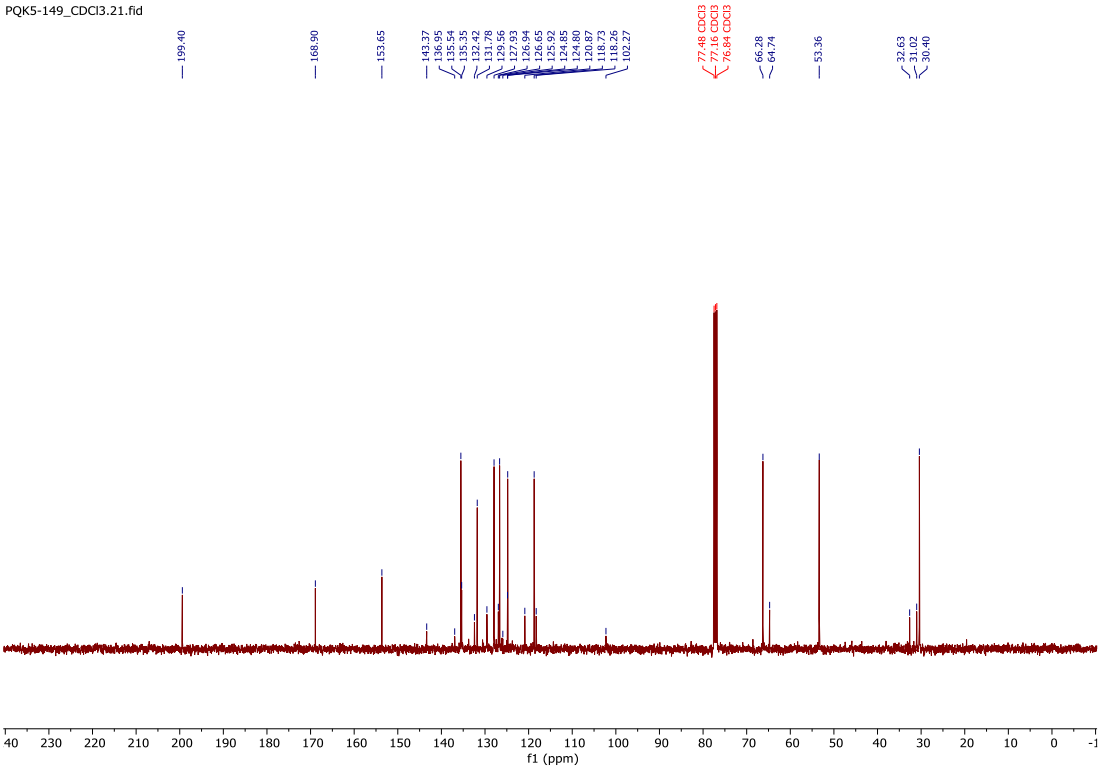
Supplemental Figure 113: ^{1}H NMR spectra of **2b**.



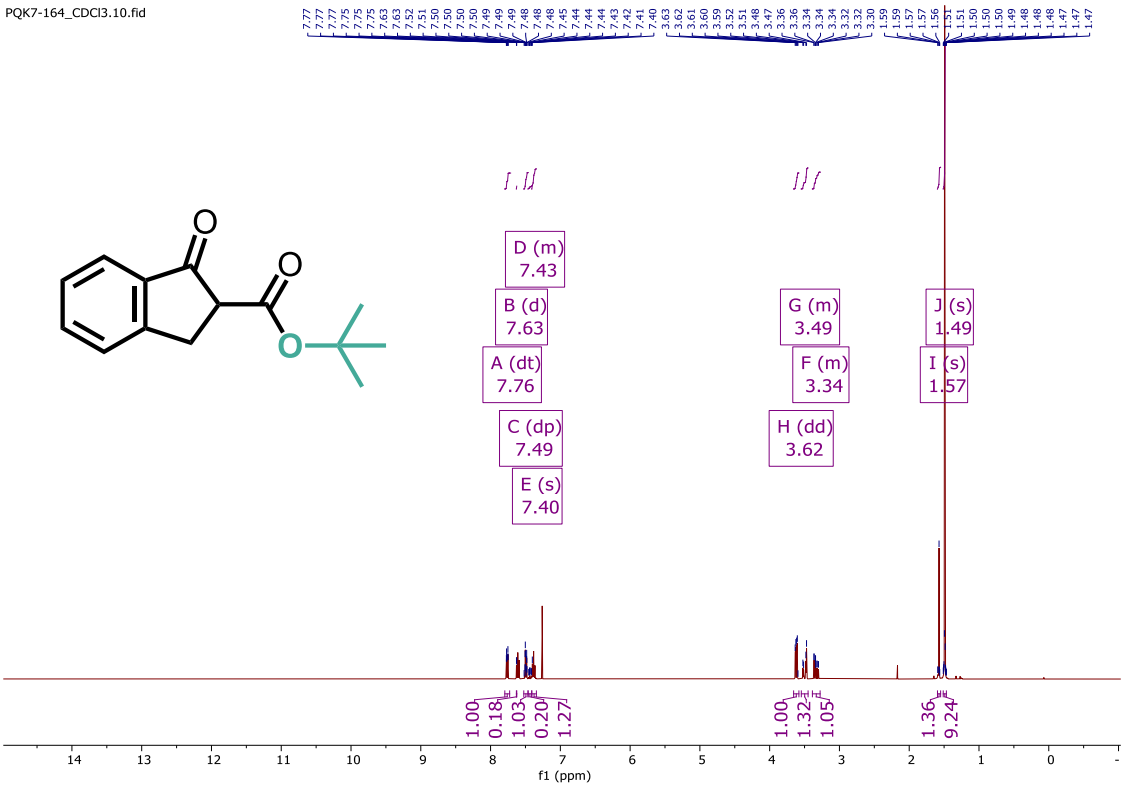
Supplemental Figure 114: ^{13}C NMR spectra of **2b**.



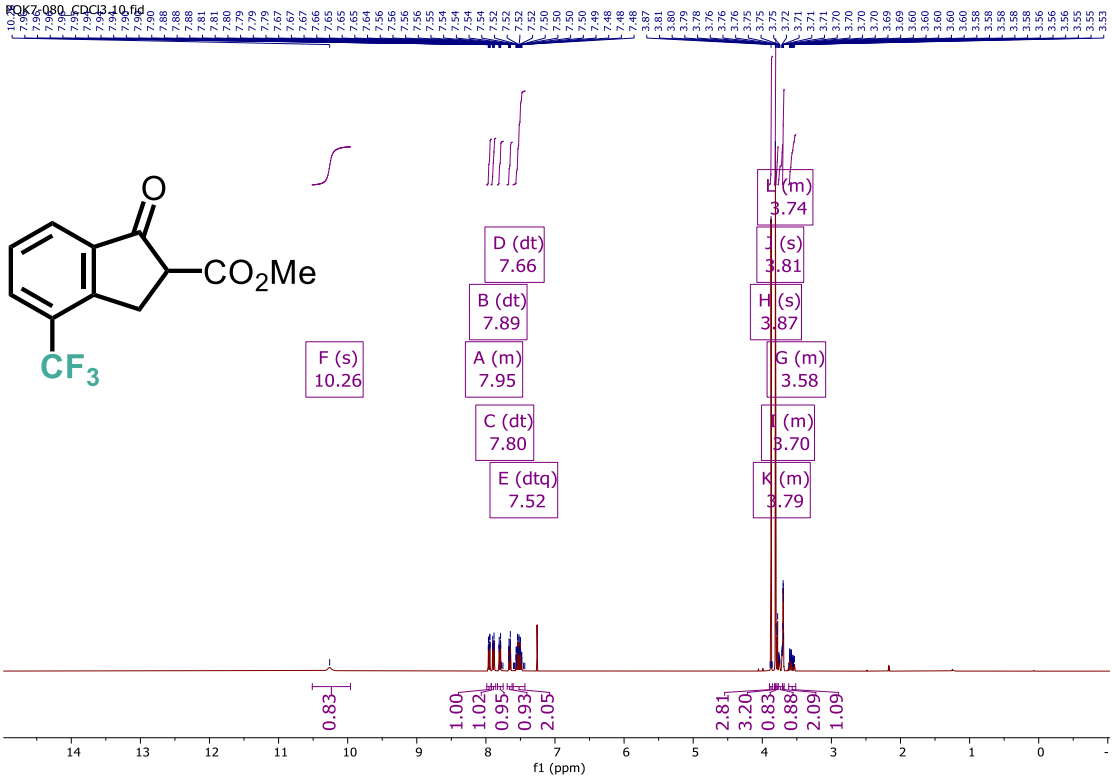
Supplemental Figure 115: ^{1}H NMR spectra of **2c**.



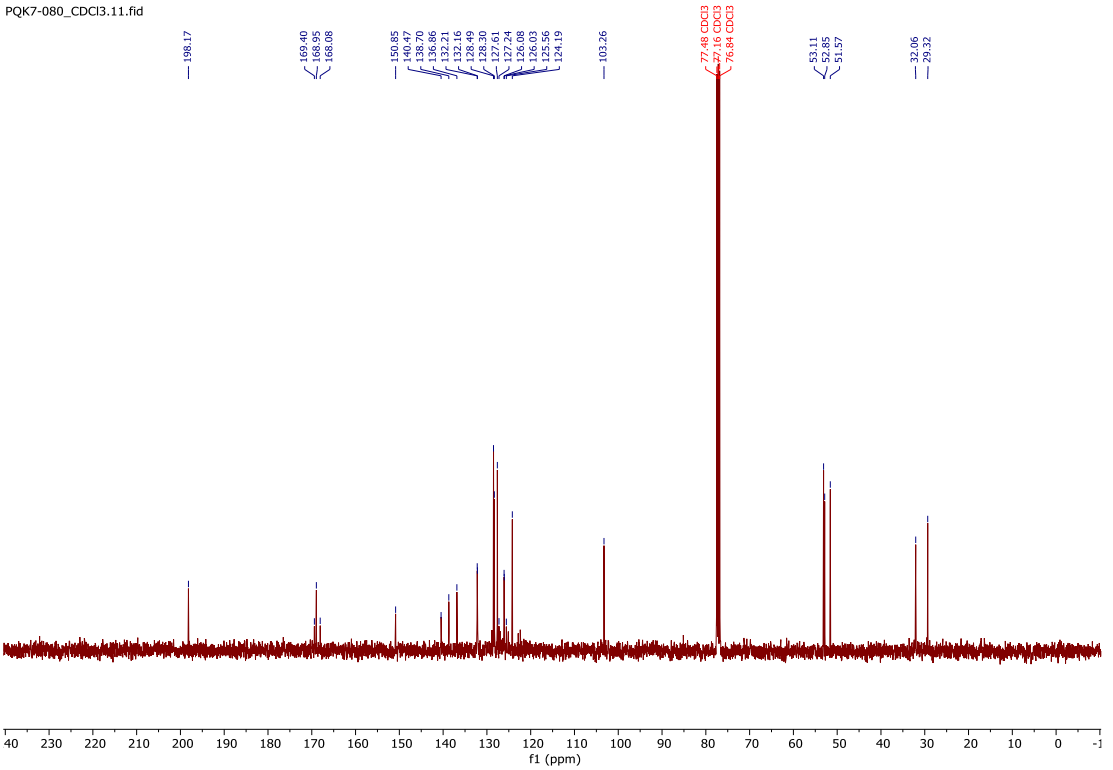
Supplemental Figure 116: ^{13}C NMR spectra of **2c**.



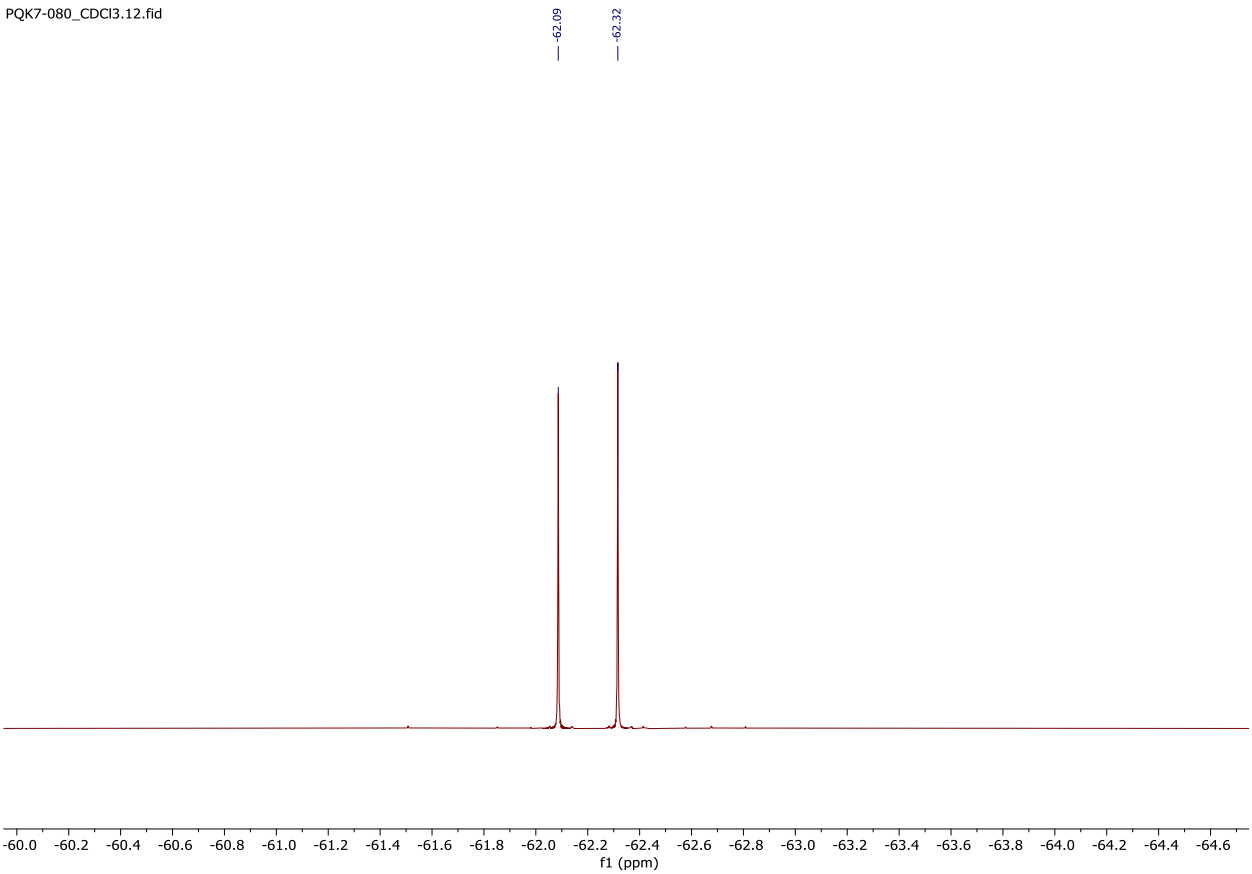
Supplemental Figure 117: ^{1}H NMR spectra of **2d**.



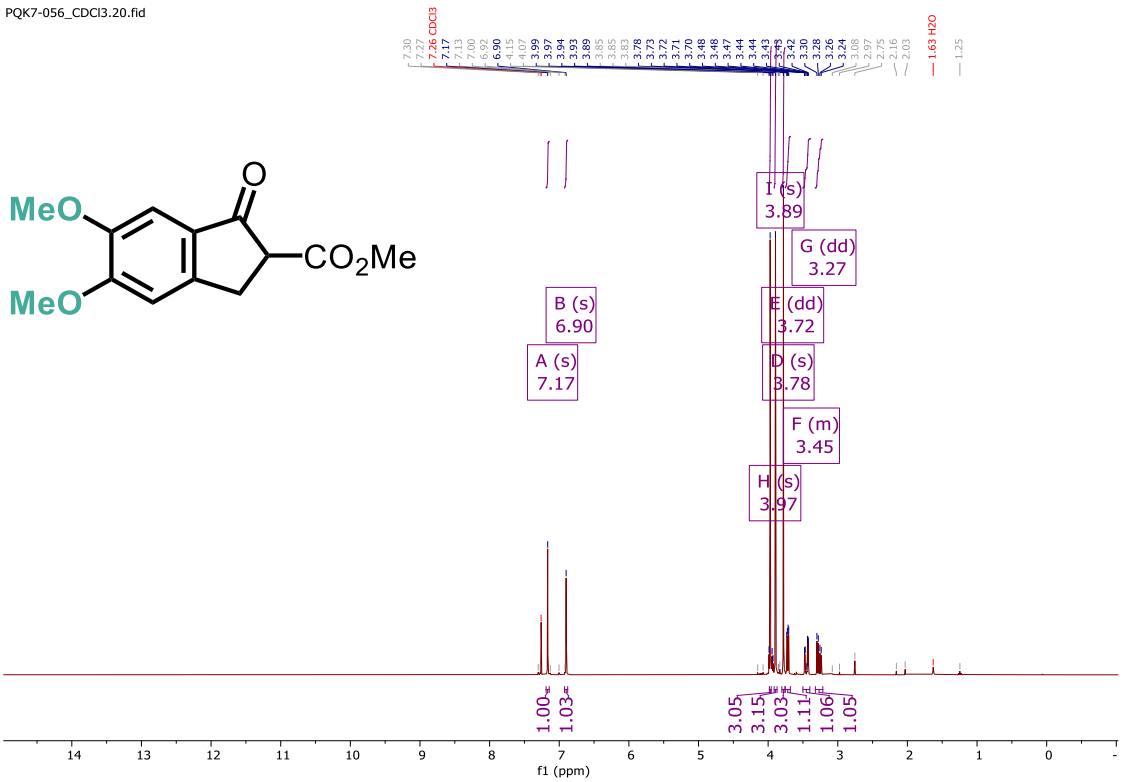
Supplemental Figure 118: ^{1}H NMR spectra of **2e**.



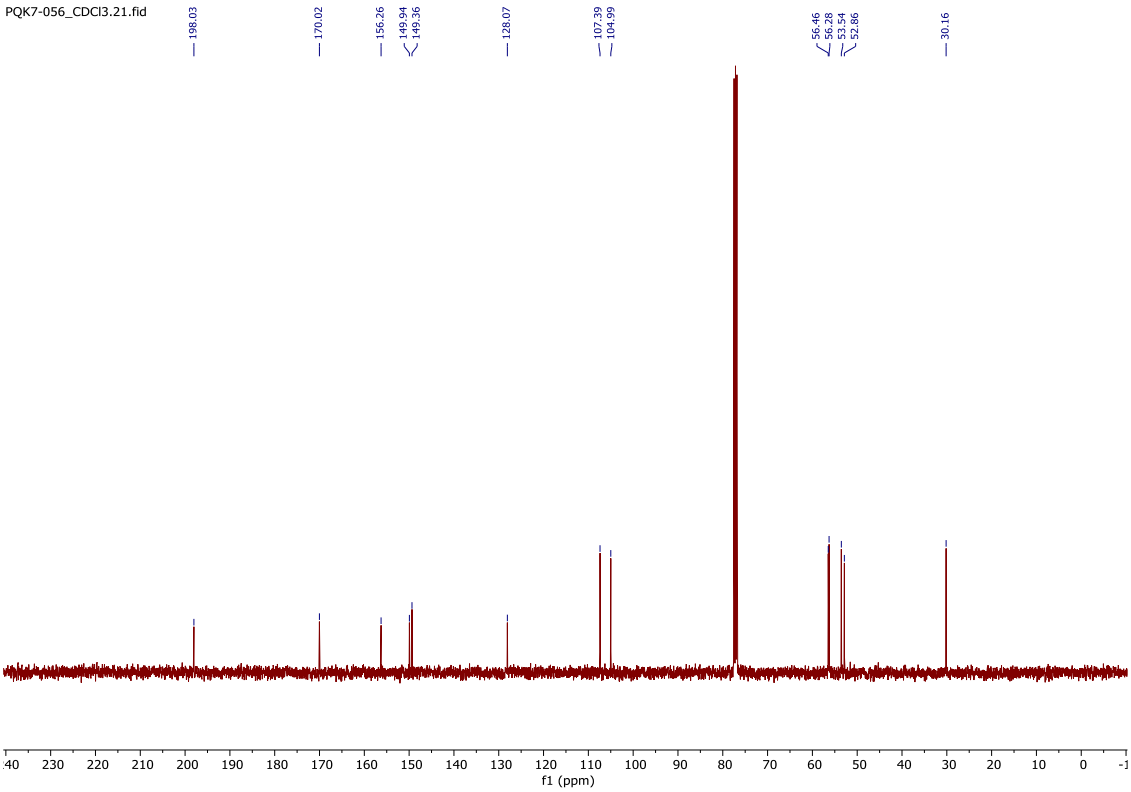
Supplemental Figure 119: ^{13}C NMR spectra of **2e**.



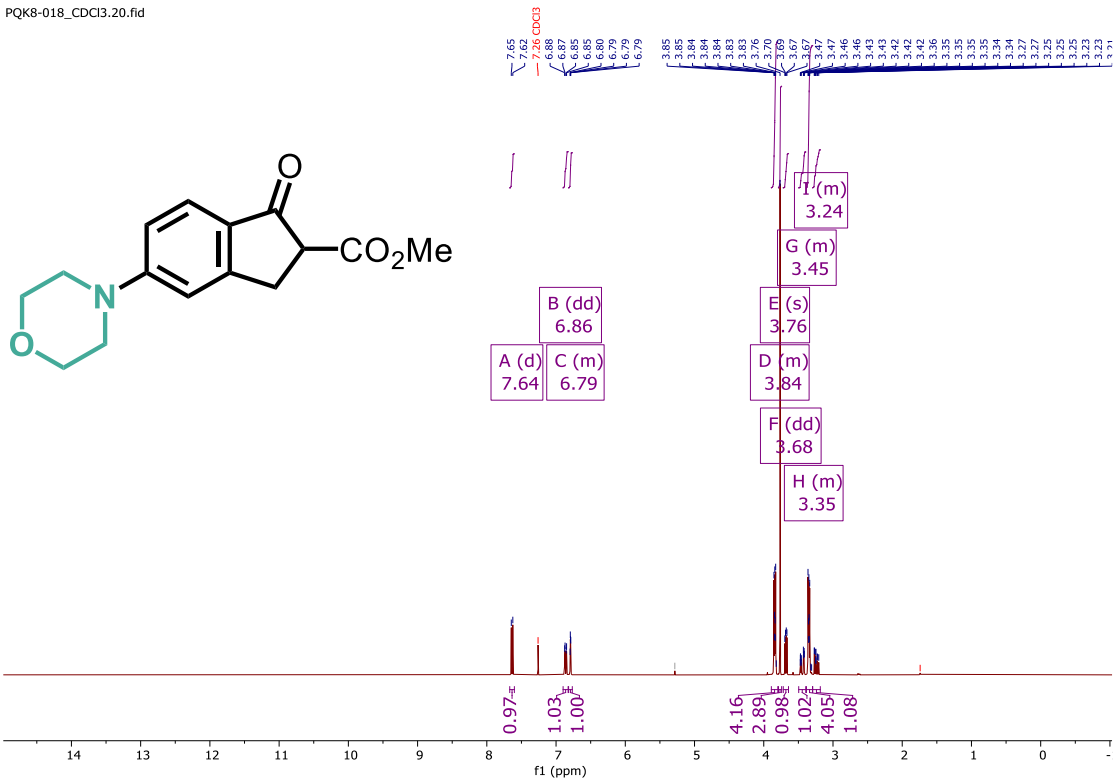
Supplemental Figure 120: ^{19}F NMR spectra of **2e**.



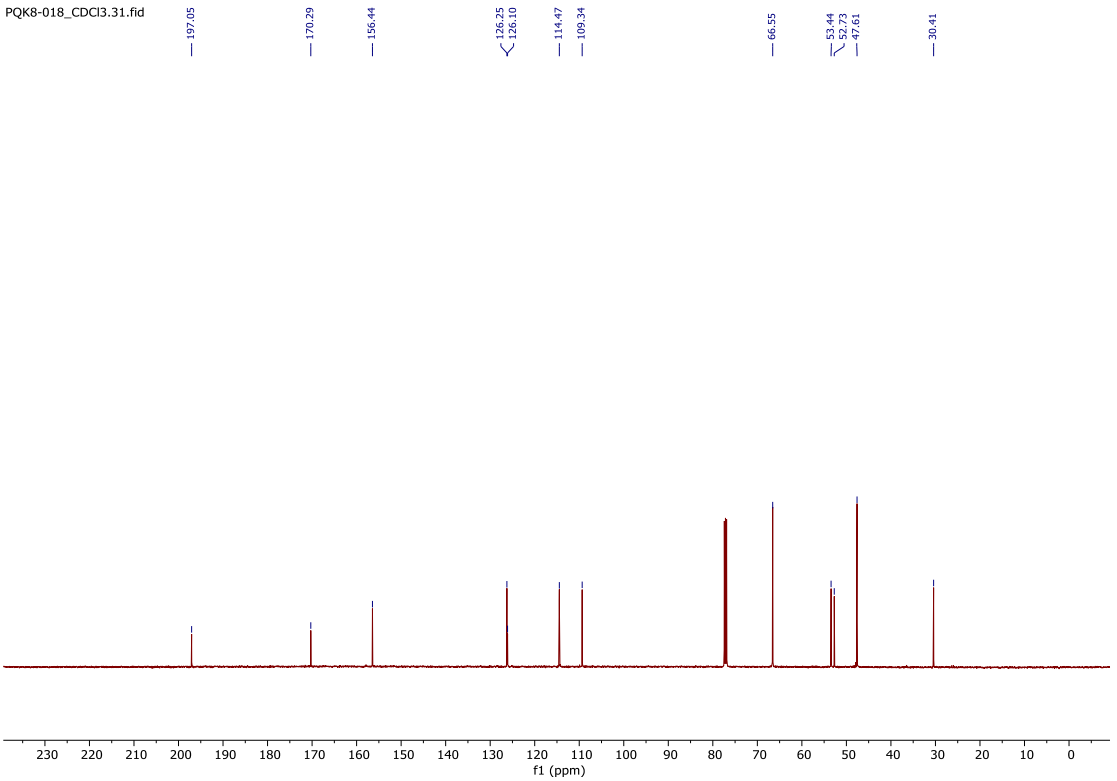
Supplemental Figure 121: ^{1}H NMR spectra of **2f**.



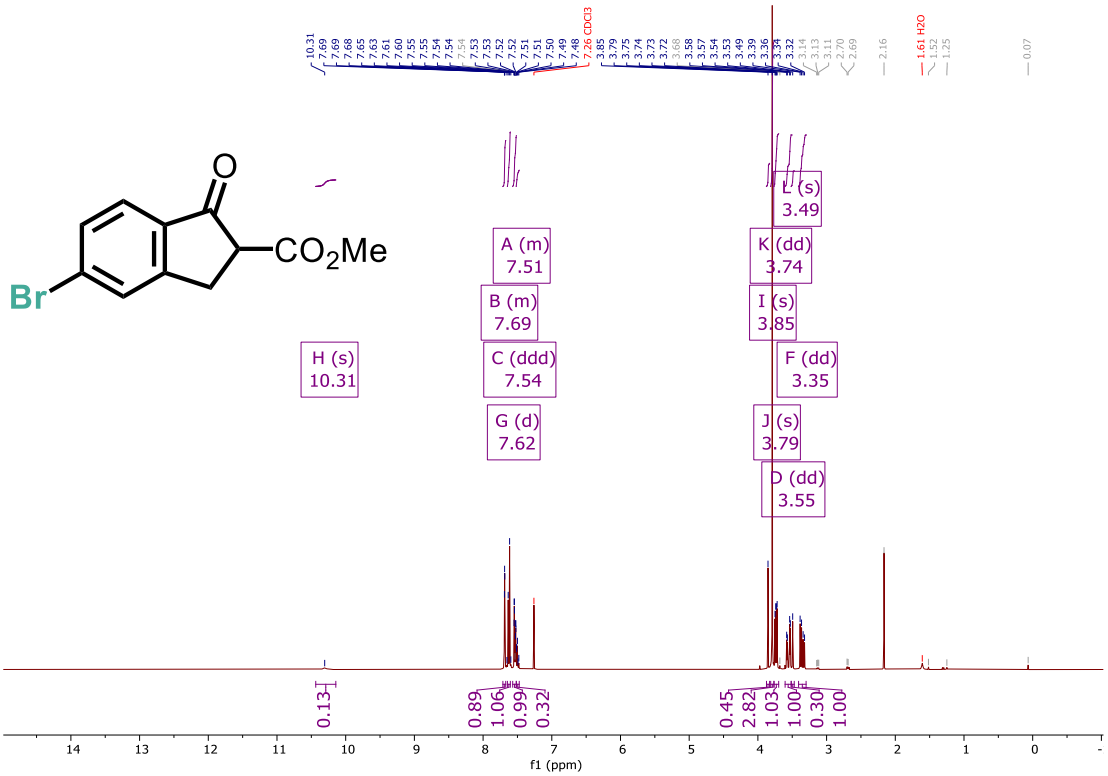
Supplemental Figure 122: ^{13}C NMR spectra of **2f**.



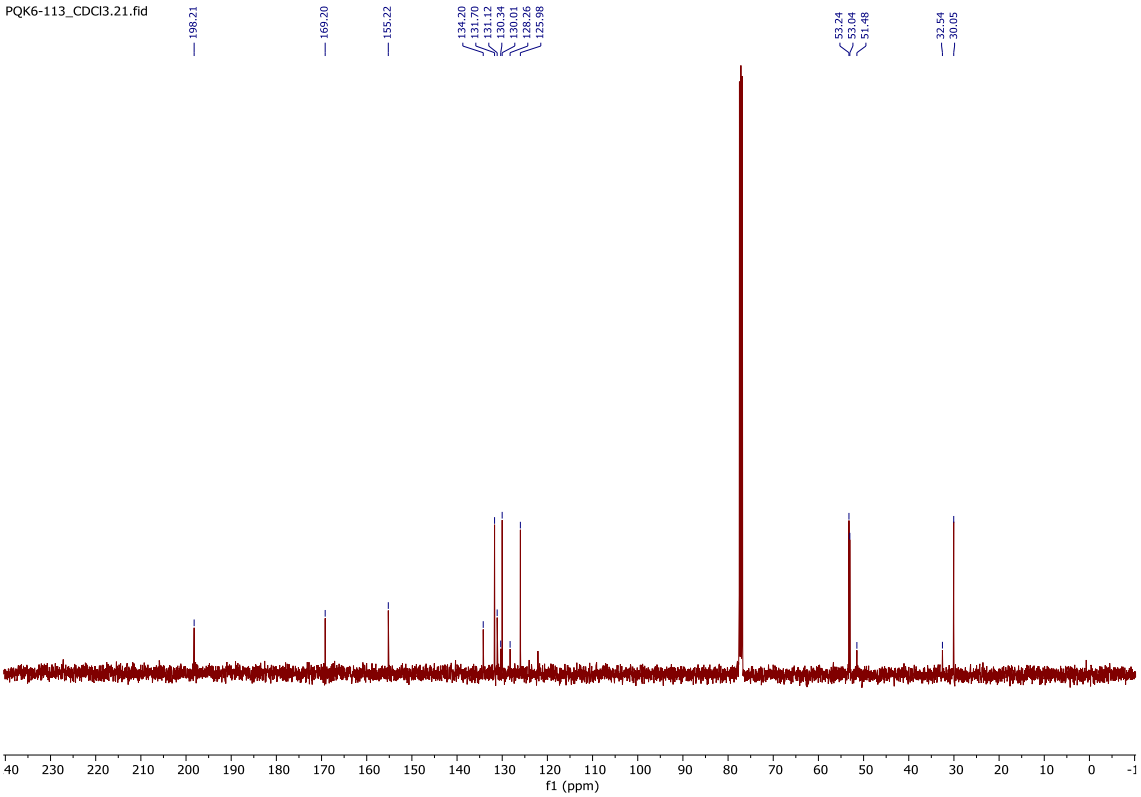
Supplemental Figure 123: ^{1}H NMR spectra of **2g**.



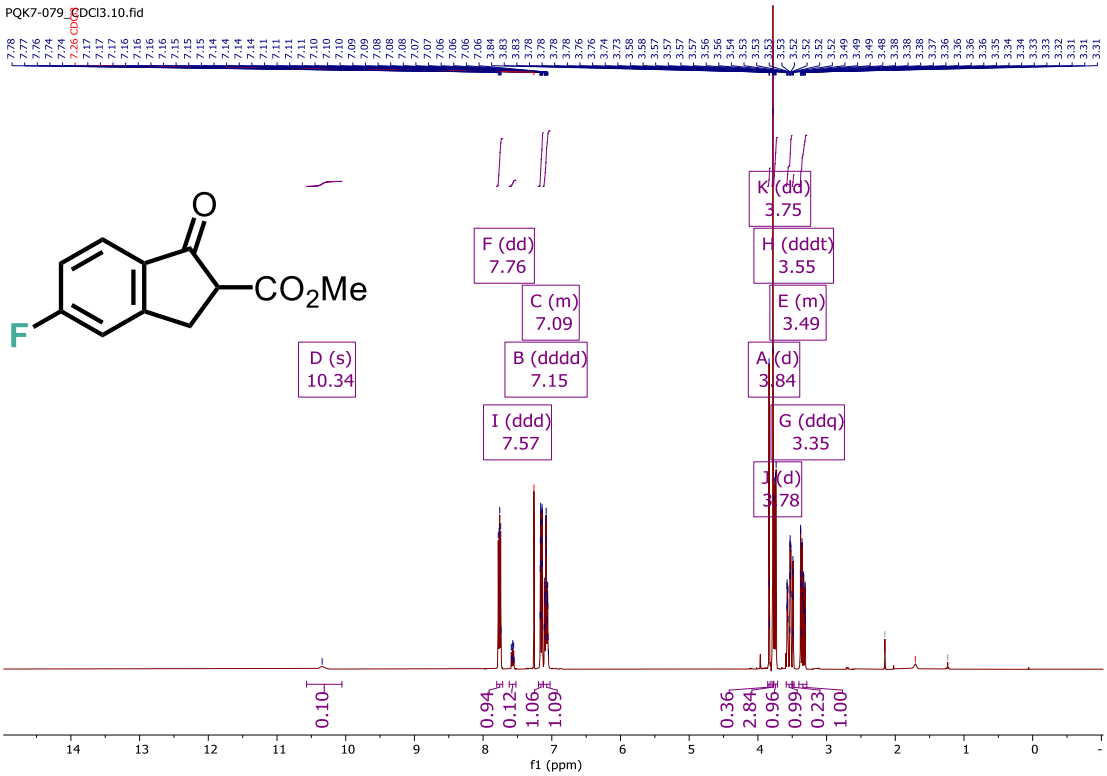
Supplemental Figure 124: ^{13}C NMR spectra of **2g**.



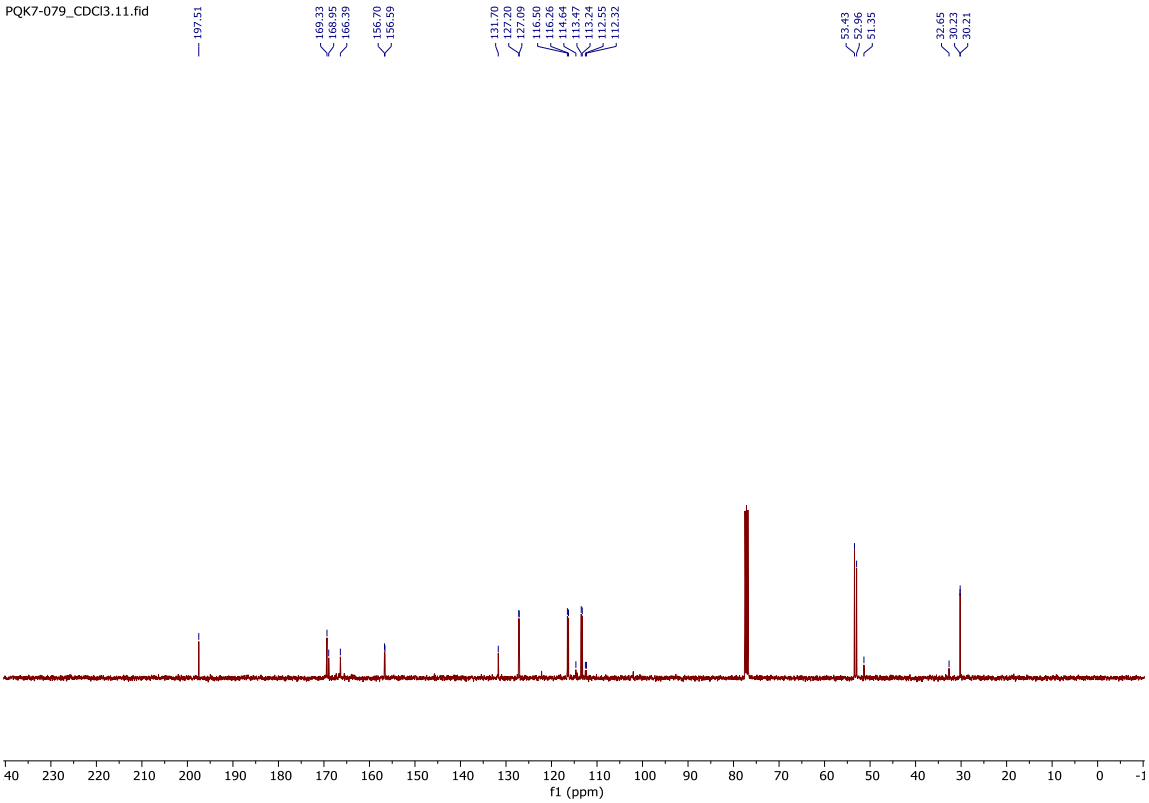
Supplemental Figure 125: ^{1}H NMR spectra of **2h**.



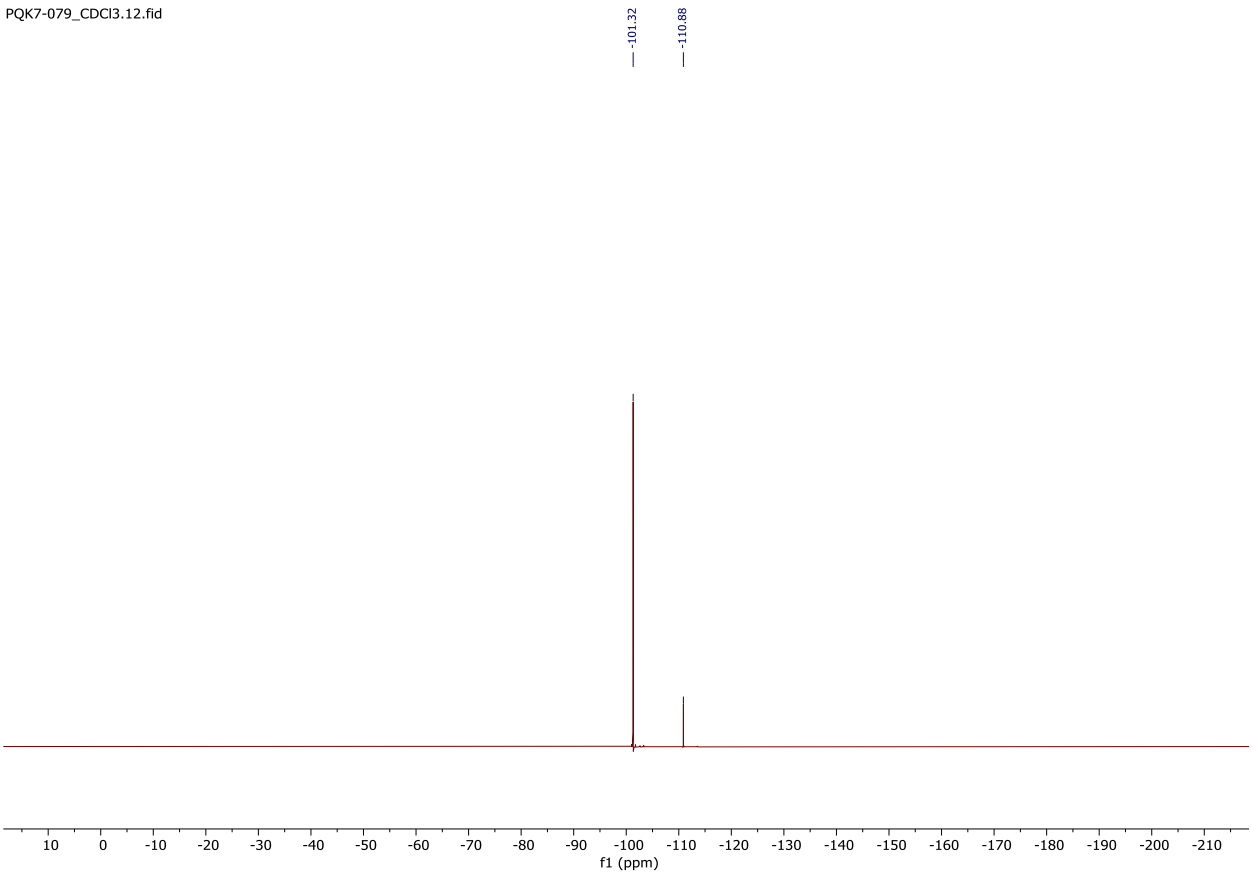
Supplemental Figure 126: ^{13}C NMR spectra of **2h**.



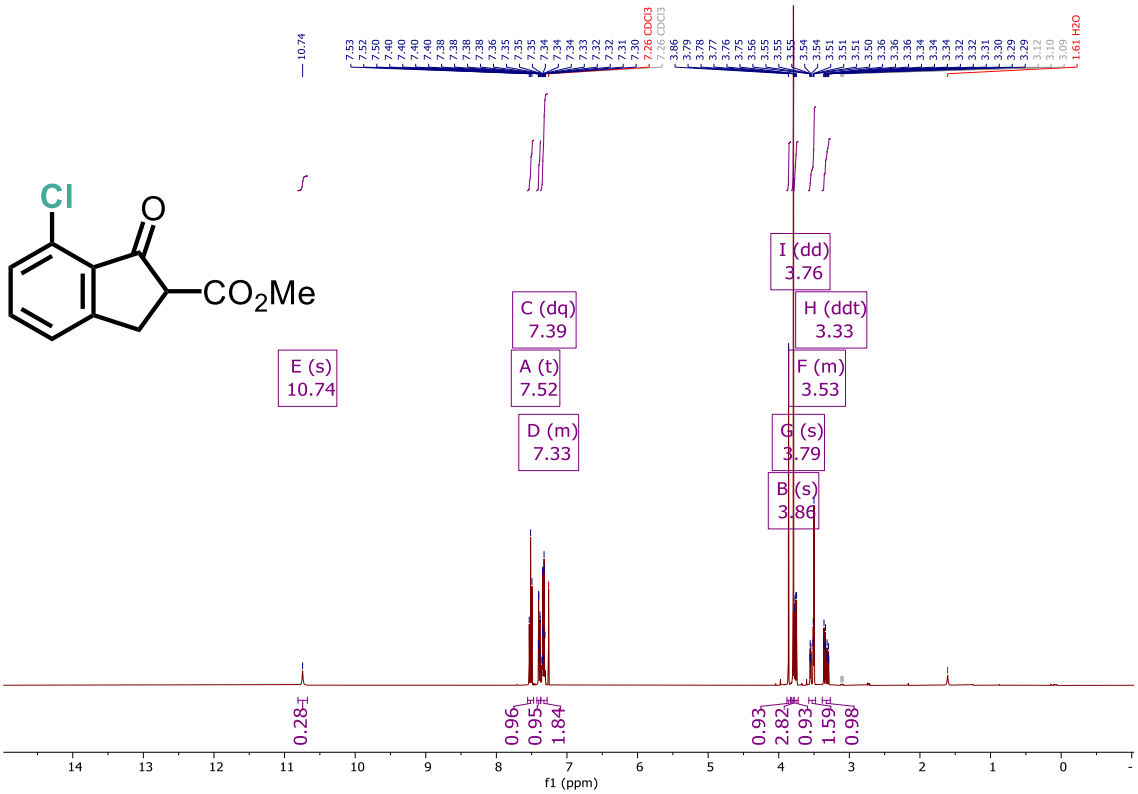
Supplemental Figure 127: ^{1}H NMR spectra of **2i**.



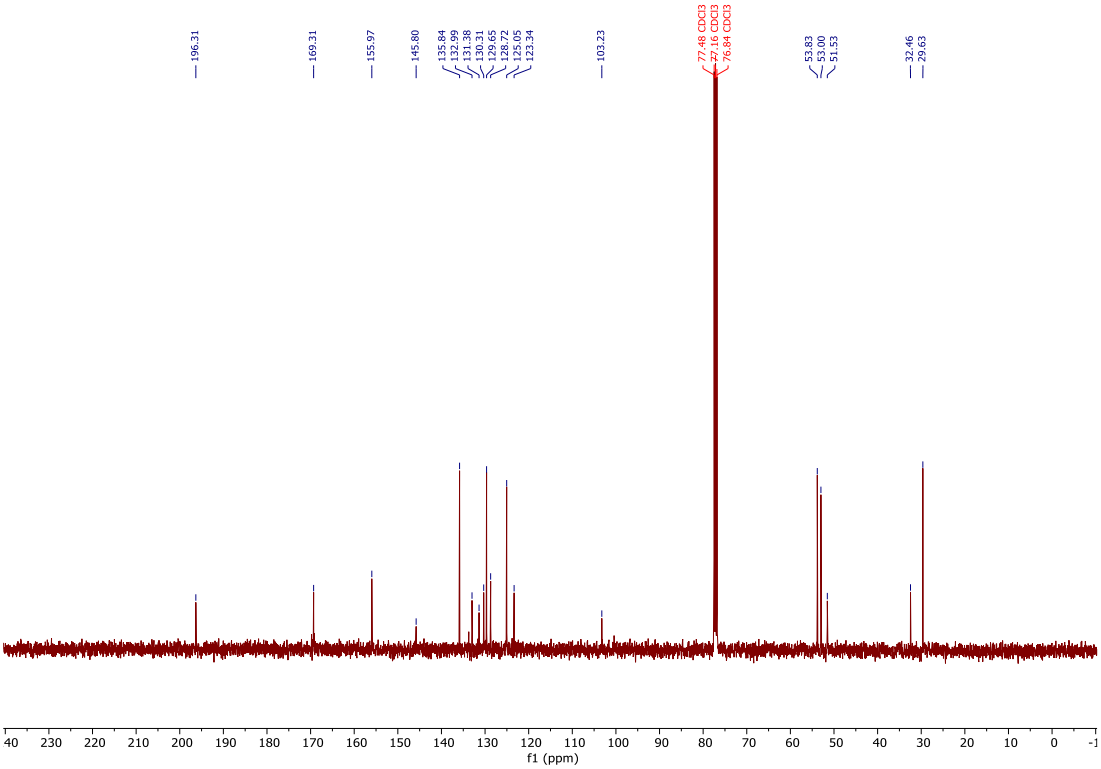
Supplemental Figure 128: ^{13}C NMR spectra of **2i**.



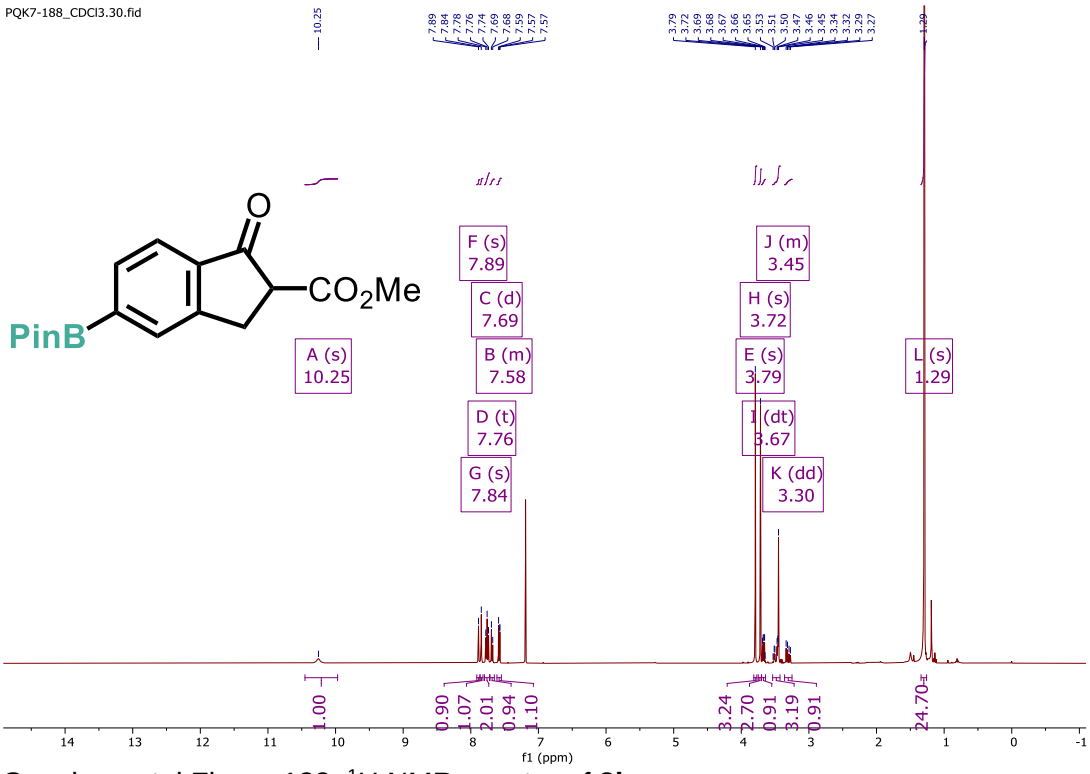
Supplemental Figure 129: ^{19}F NMR spectra of **2i**.



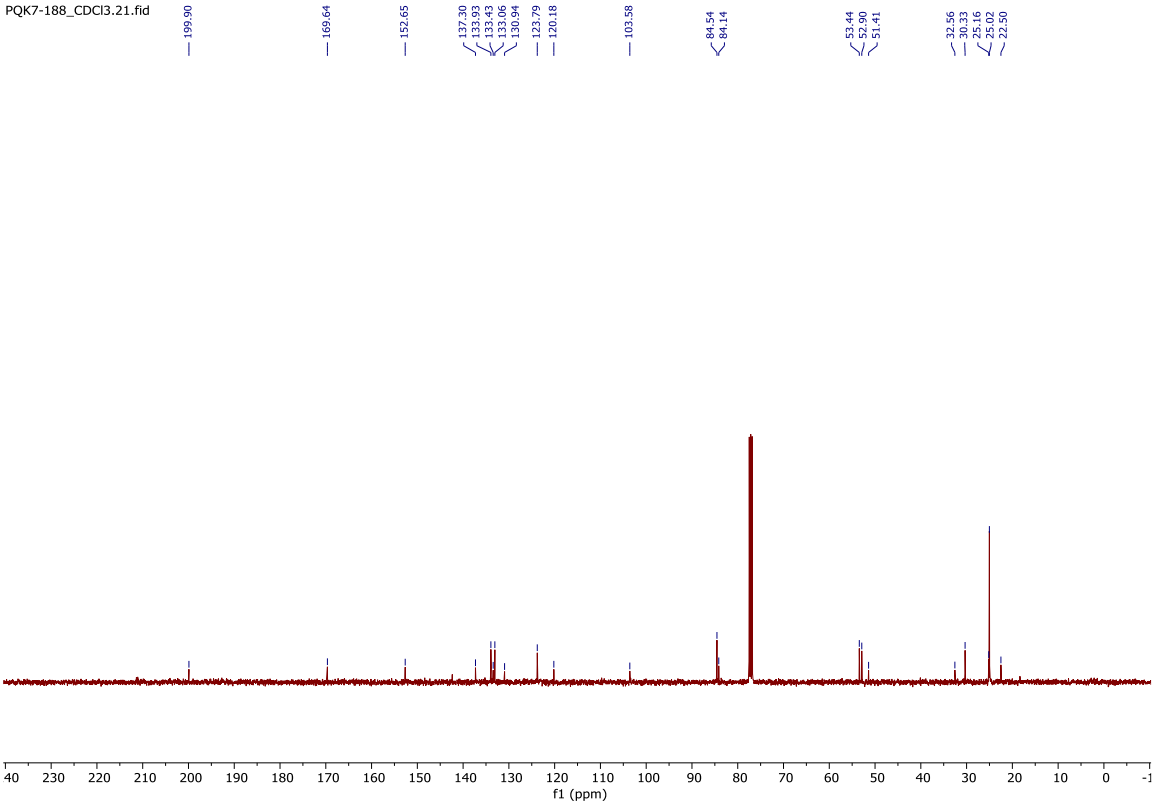
Supplemental Figure 130: ^{1}H NMR spectra of **2j**.



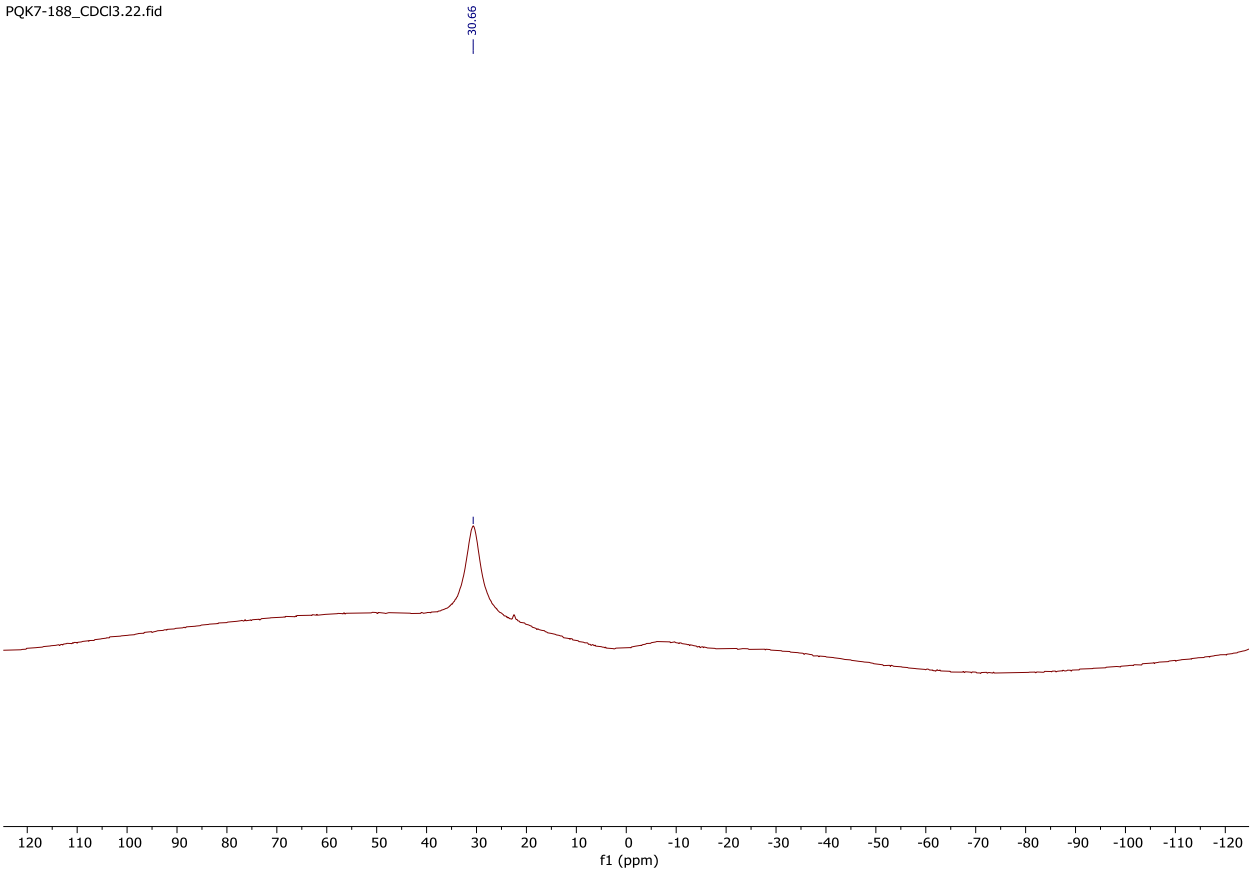
Supplemental Figure 131: ^{13}C NMR spectra of **2j**.



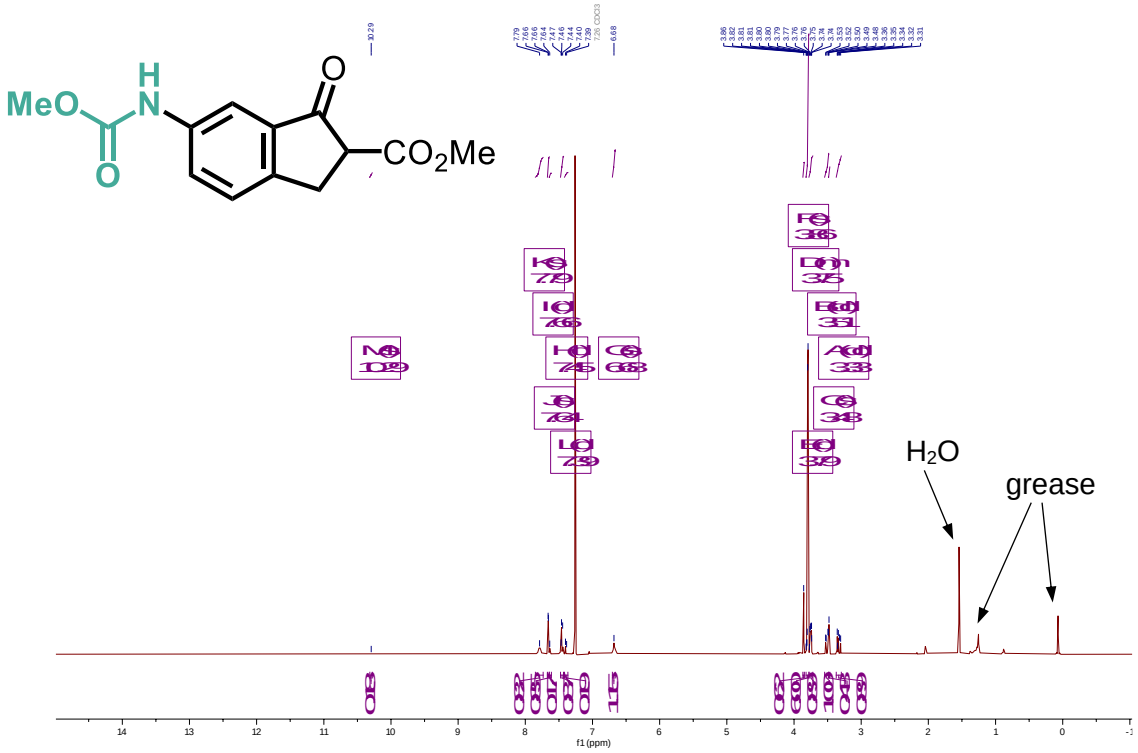
Supplemental Figure 132: ^{1}H NMR spectra of **2k**.



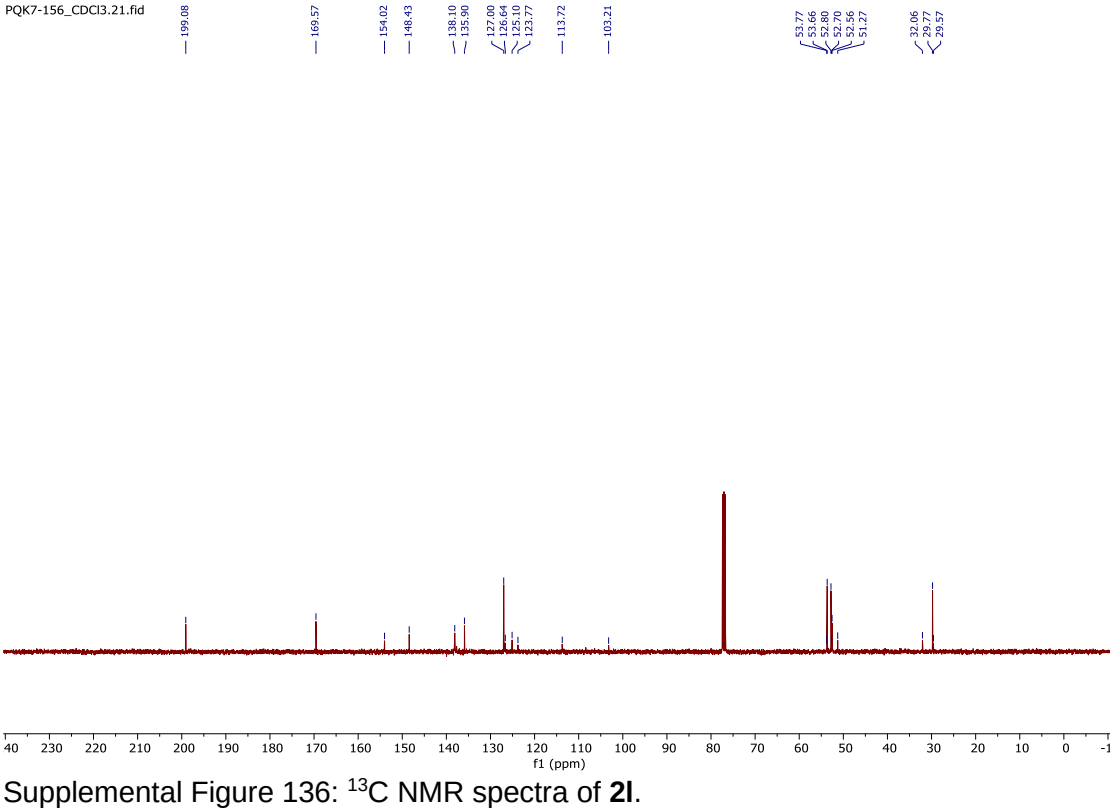
Supplemental Figure 133: ^{1}H NMR spectra of **2k**.



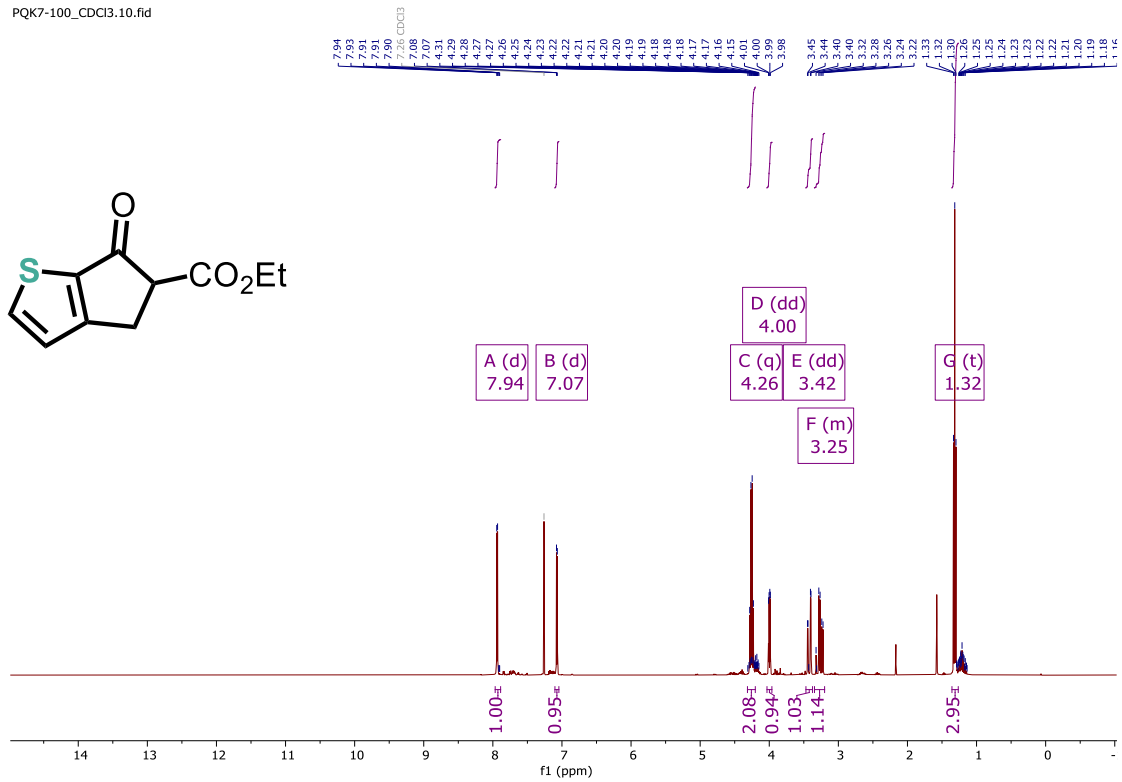
Supplemental Figure 134: ^{11}B NMR spectra of **2k**.



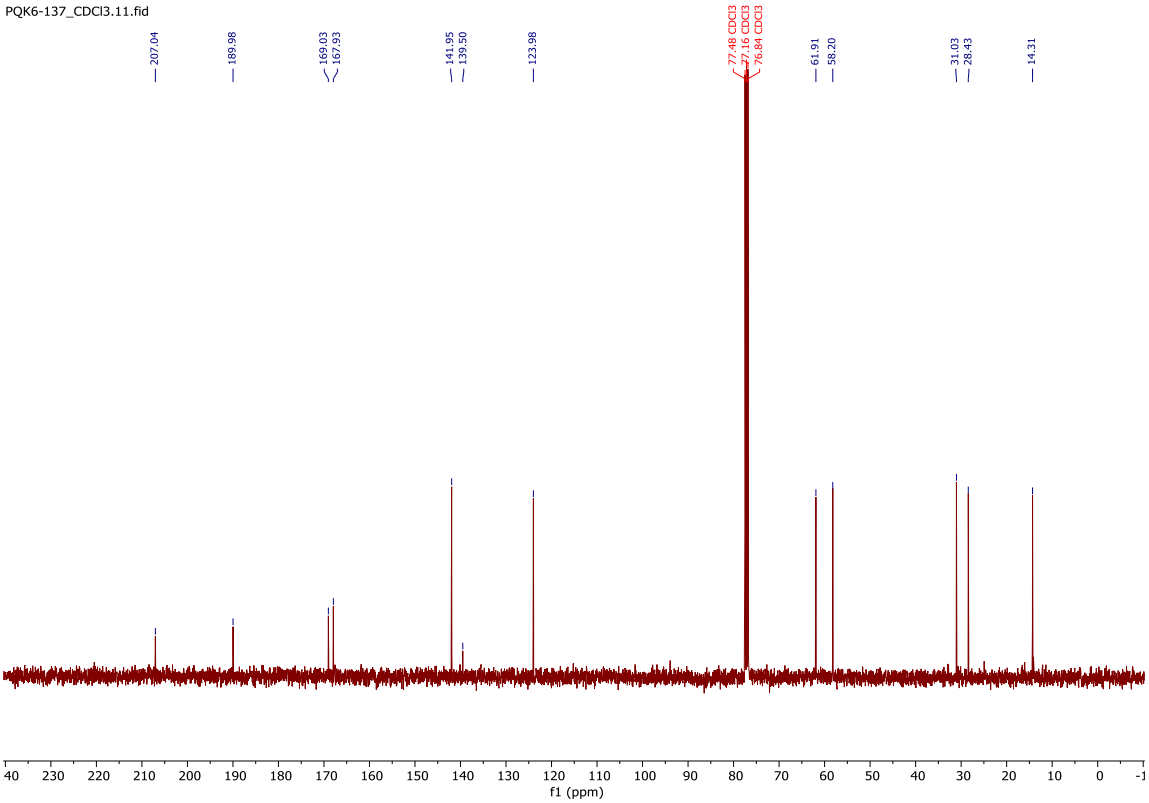
jjSupplemental Figure 135 : ^{1}H NMR spectra of **2l**.



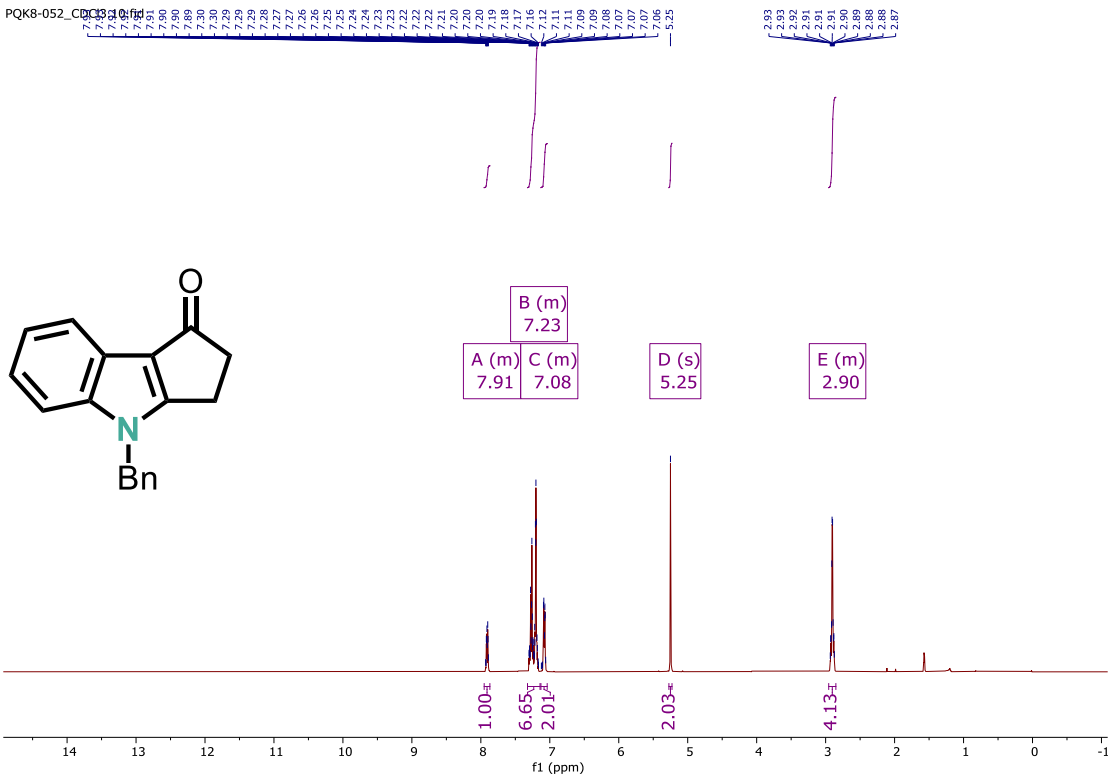
Supplemental Figure 136: ^{13}C NMR spectra of **2l**.



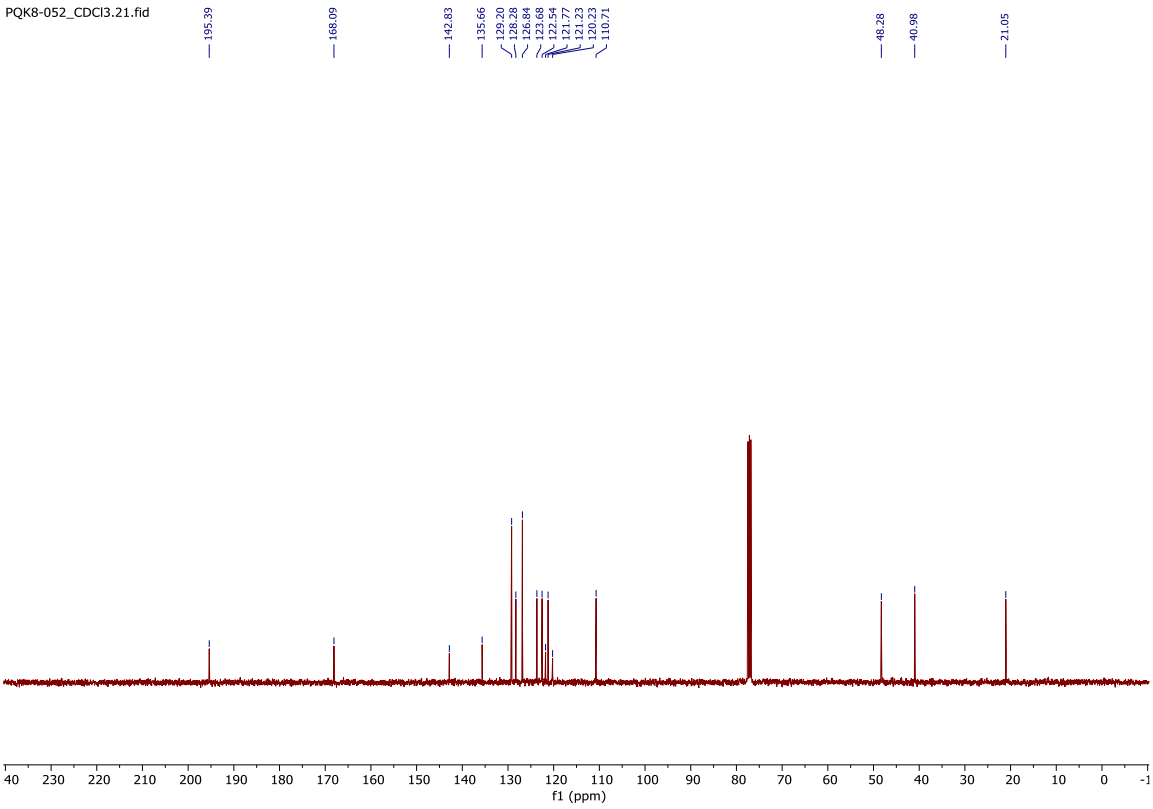
Supplemental Figure 137: ^{1}H NMR spectra of **2m**.



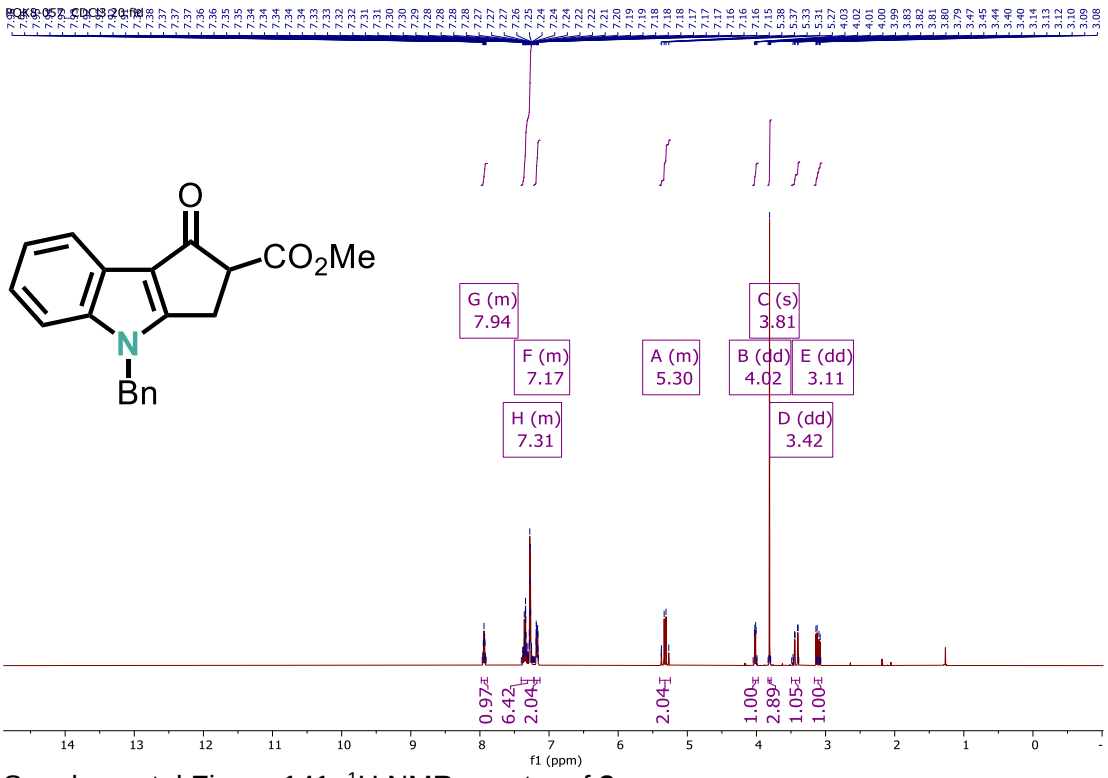
Supplemental Figure 138: ^{13}C NMR spectra of **2m**.



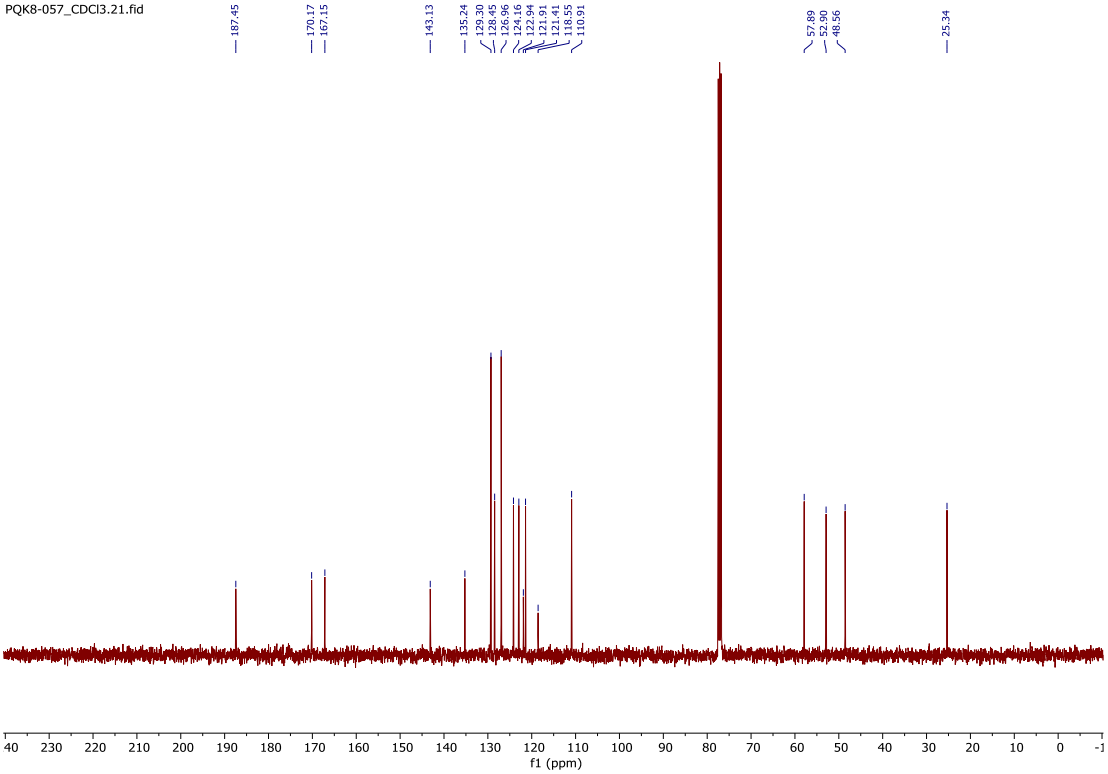
Supplemental Figure 139: ^{1}H NMR spectra of **S2**.



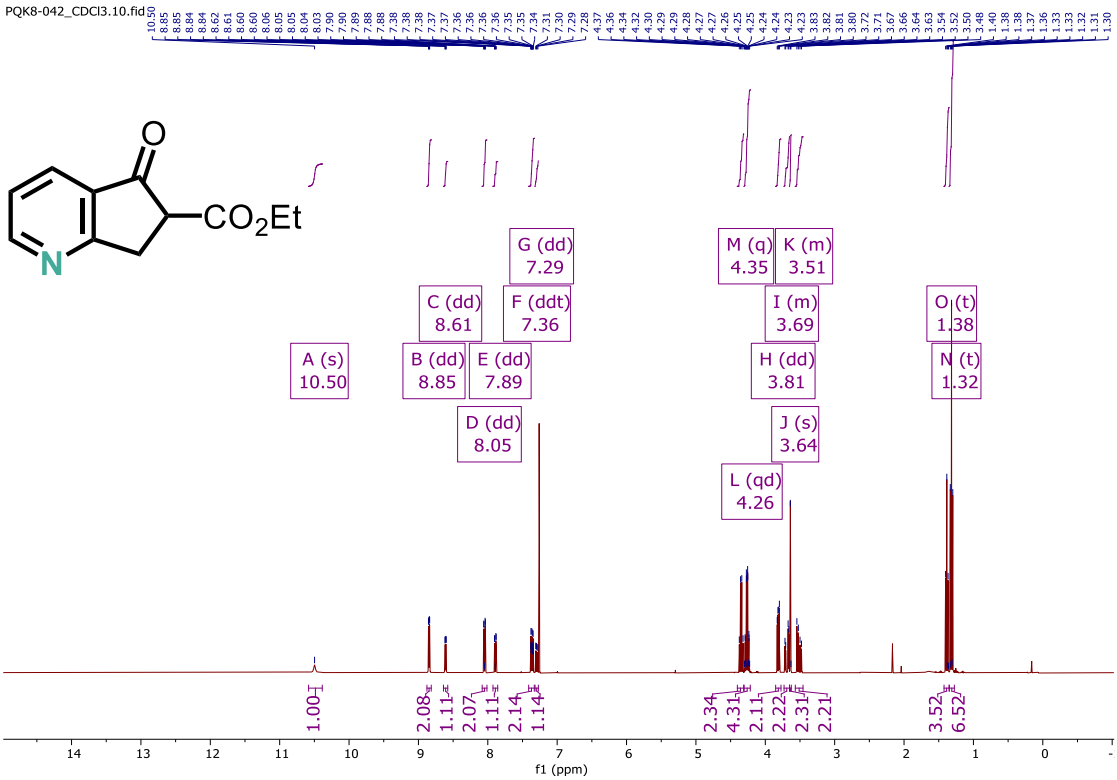
Supplemental Figure 140: ^{13}C NMR spectra of **S2**.



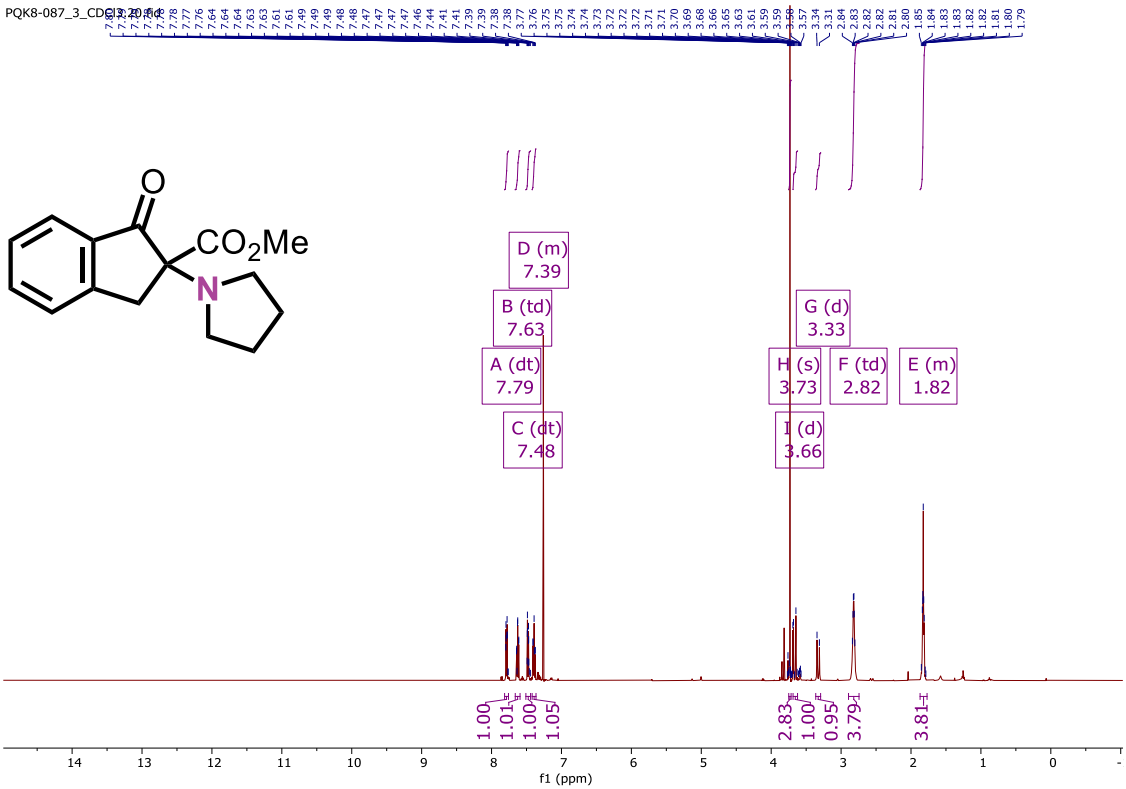
Supplemental Figure 141: ^{1}H NMR spectra of **2n**.



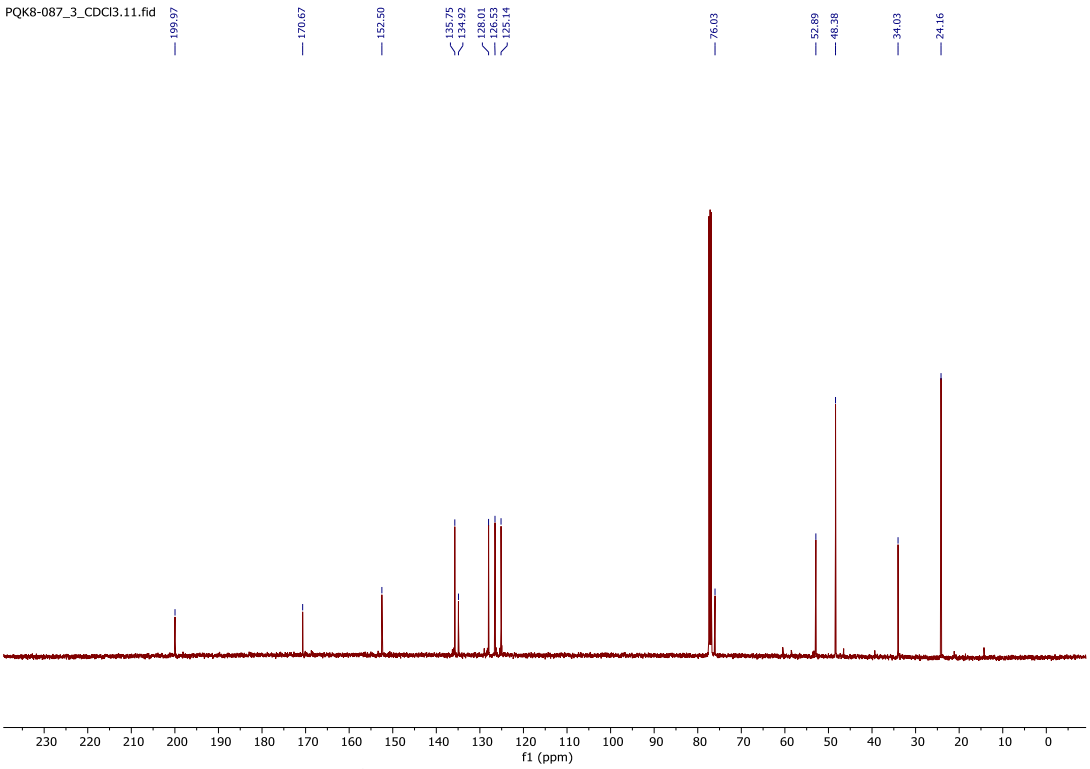
Supplemental Figure 142: ^{13}C NMR spectra of **2n**.



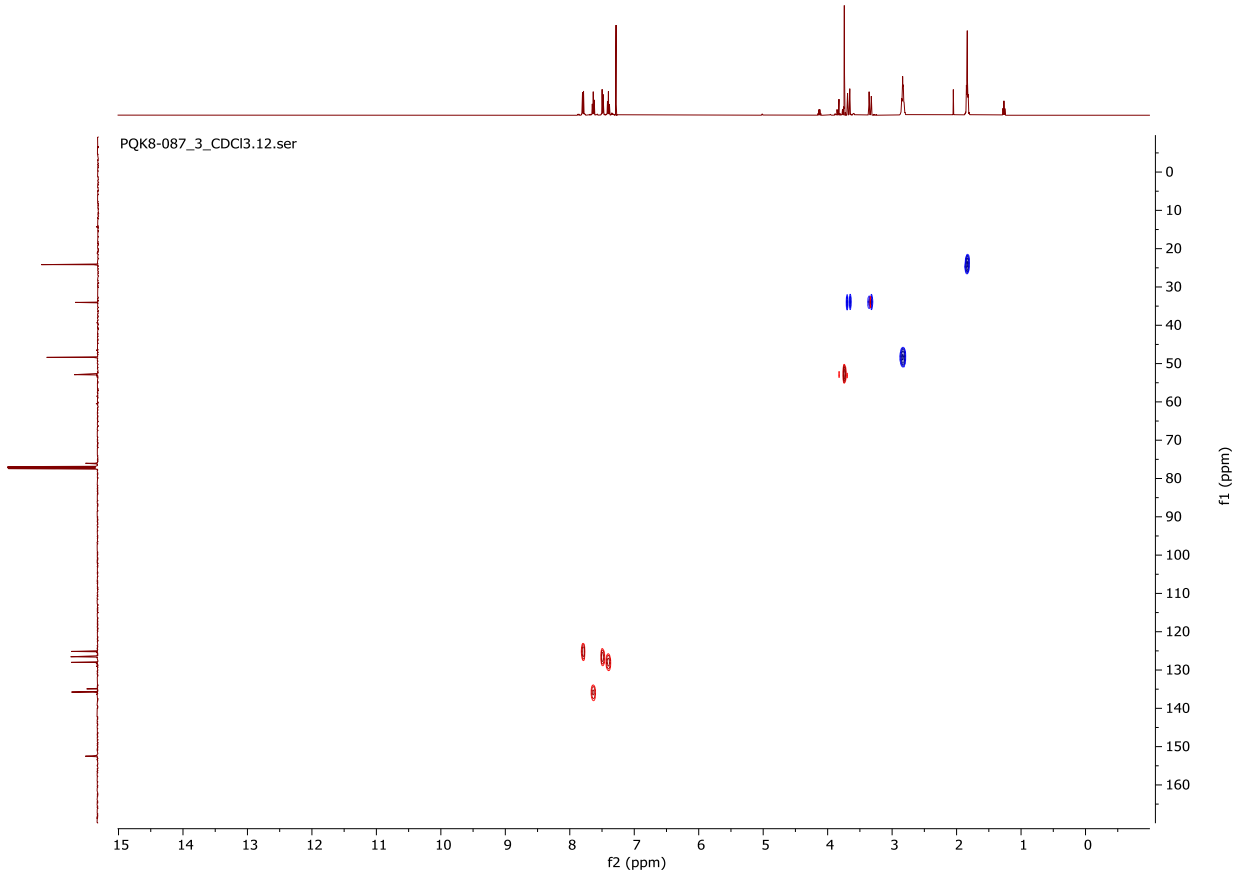
Supplemental Figure 143: ^{1}H NMR spectra of **2m**.



Supplemental Figure 144: ^{1}H NMR spectra of **9**.

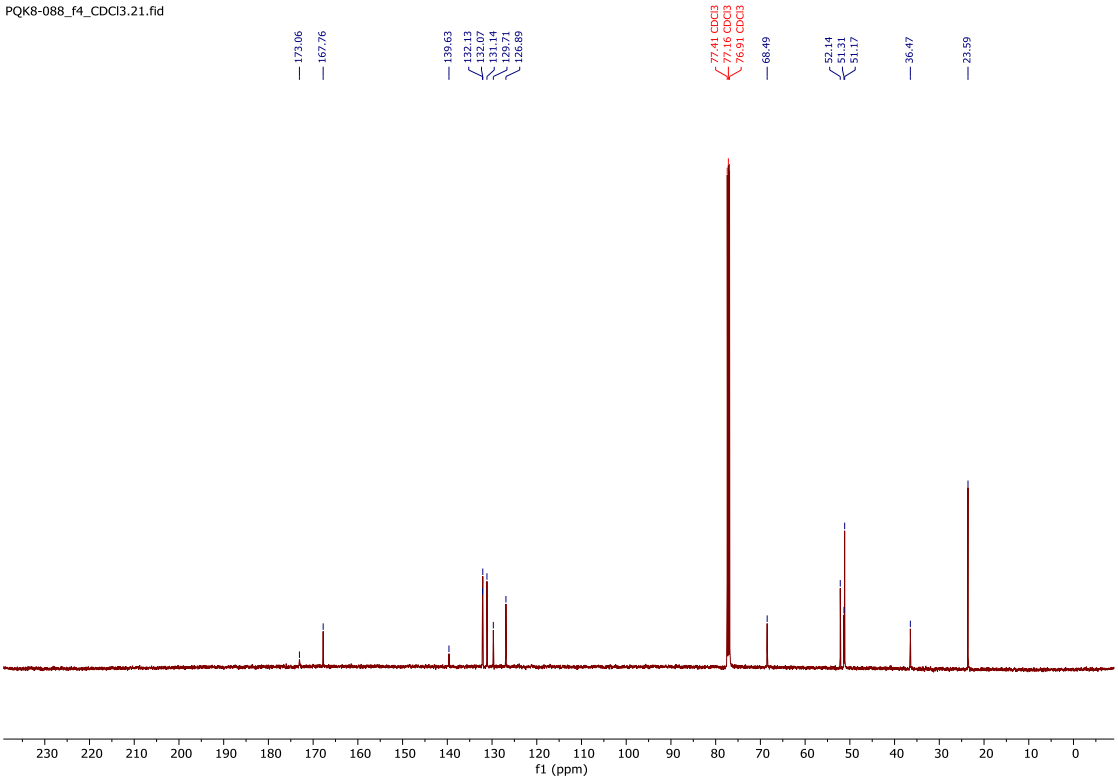


Supplemental Figure 145: ^{13}C NMR spectra of **9**.

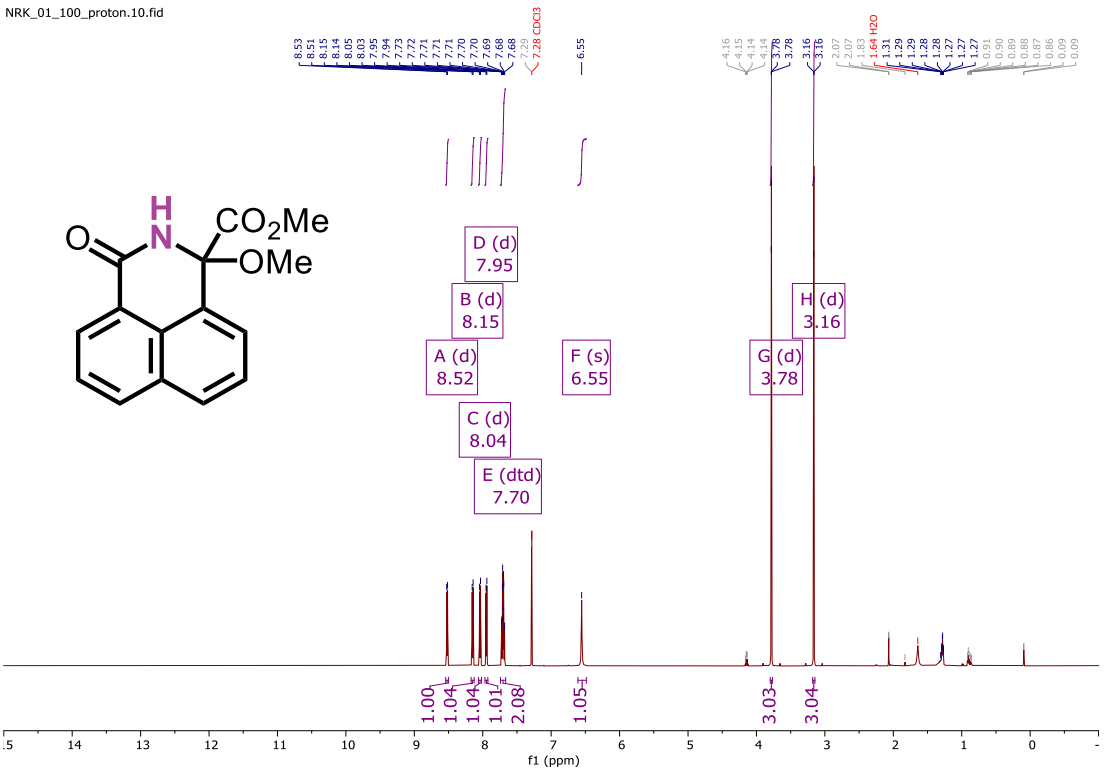


Supplemental Figure 146: ^{1}H-^{13}C HSQC NMR spectra of **9**.

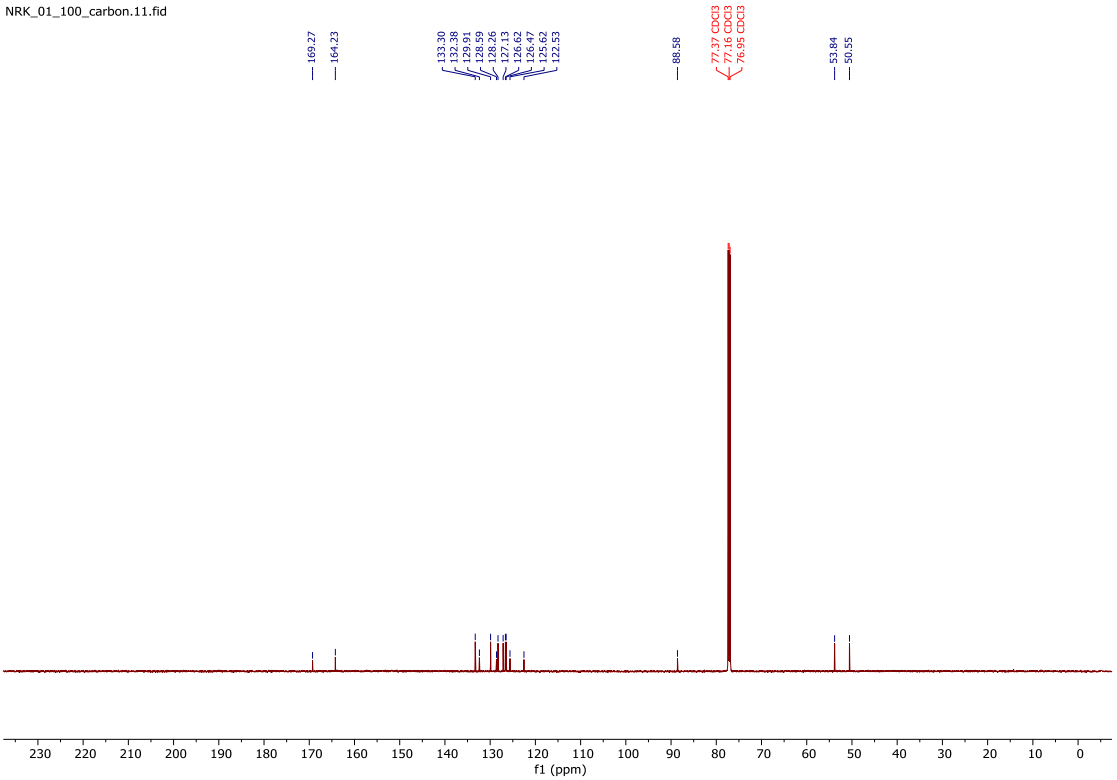
Supplemental Figure 147: ^{1}H NMR spectra of **10**.



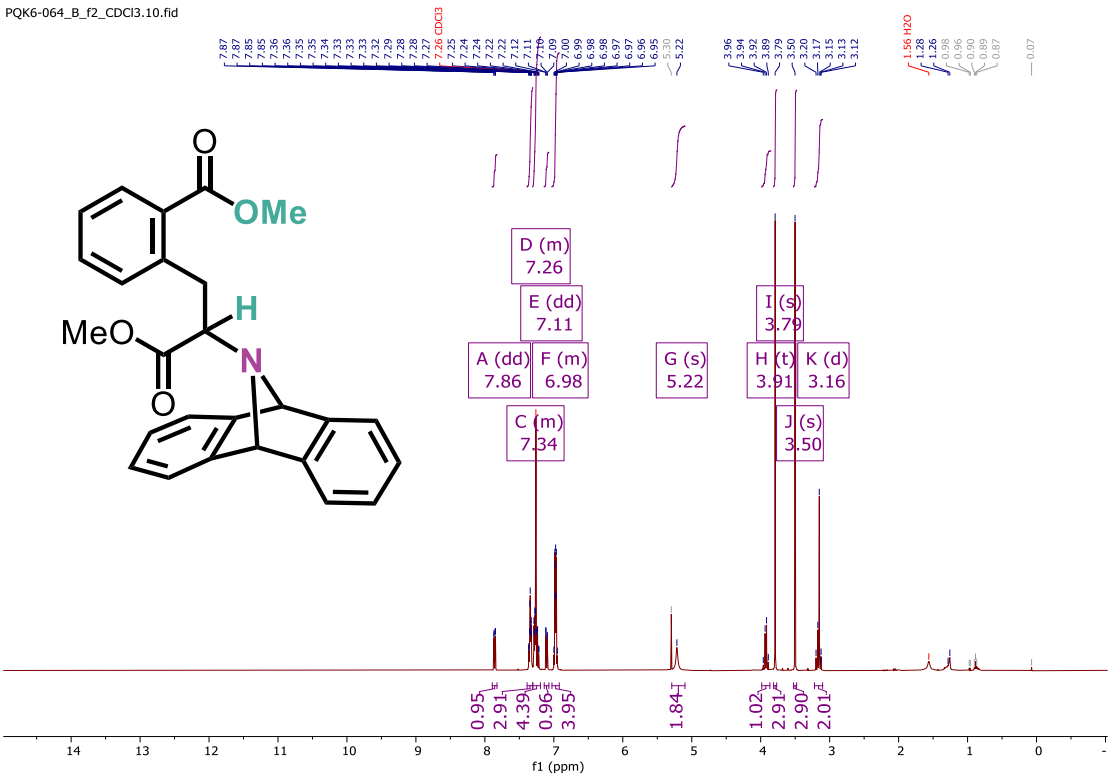
Supplemental Figure 148: ^{13}C NMR spectra of **10**.



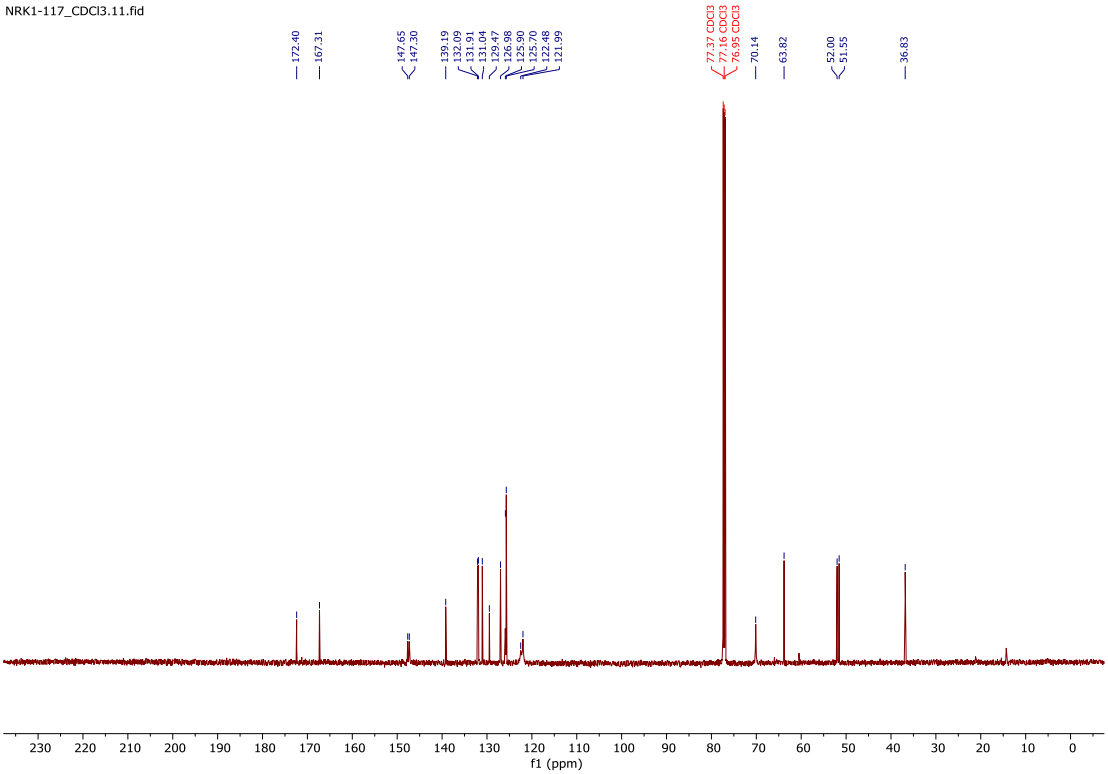
Supplemental Figure 149: ^{1}H NMR spectra of **8**.



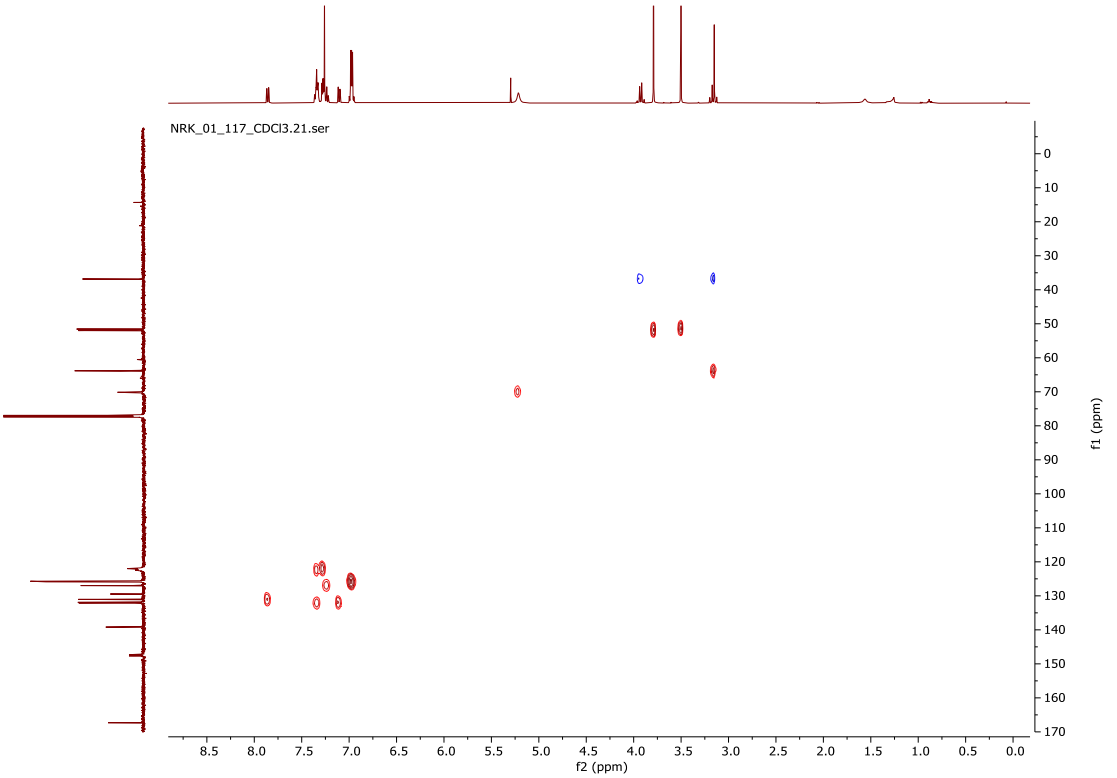
Supplemental Figure 150: ^{13}C NMR spectra of **8**.



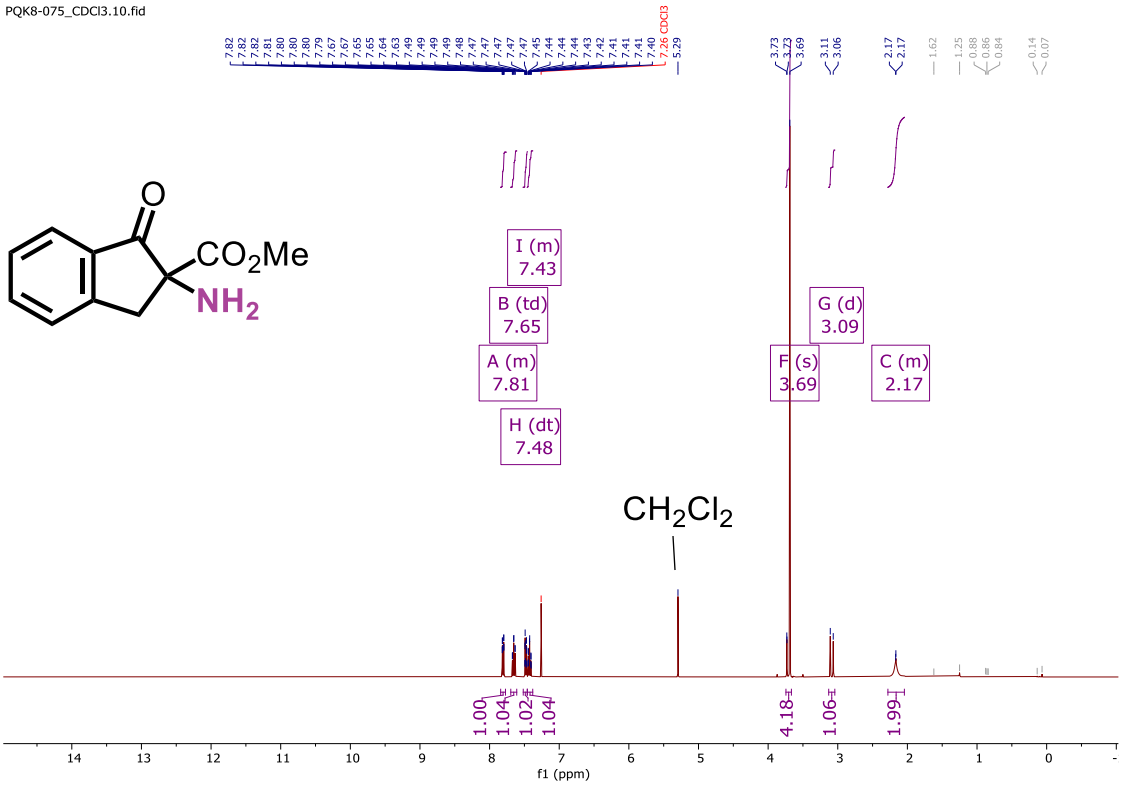
Supplemental Figure 151: ^{1}H NMR spectra of **11**.



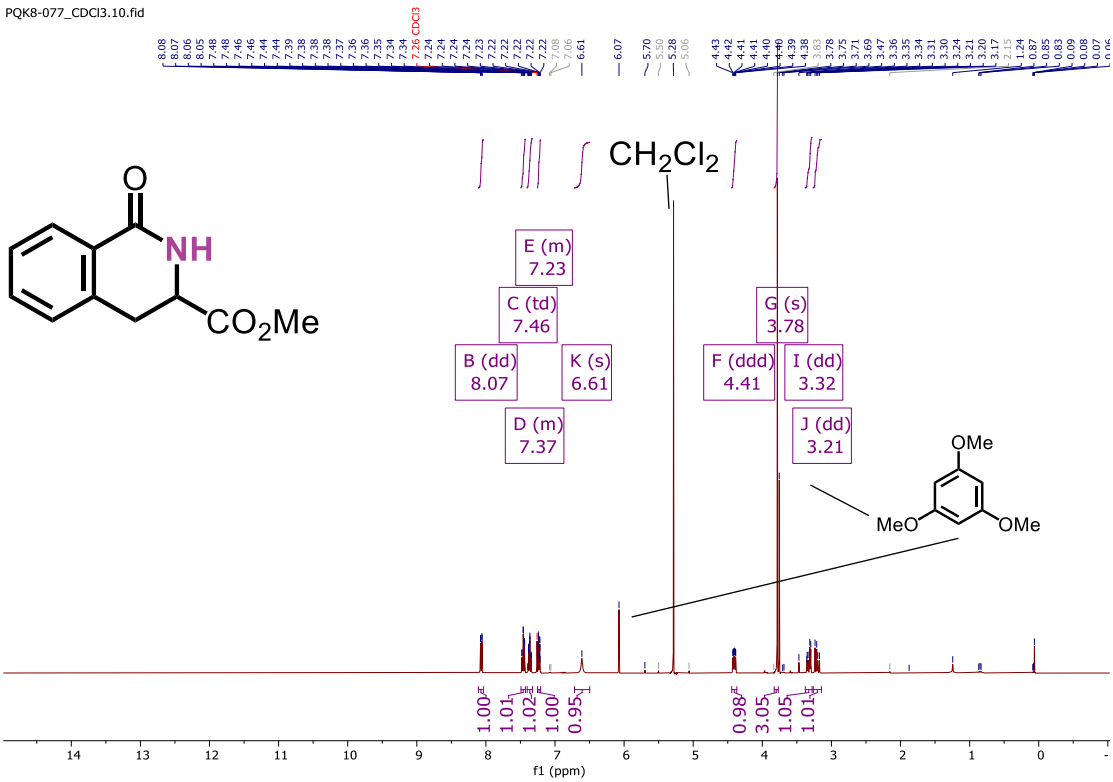
Supplemental Figure 152: ^{13}C NMR spectra of **11**.



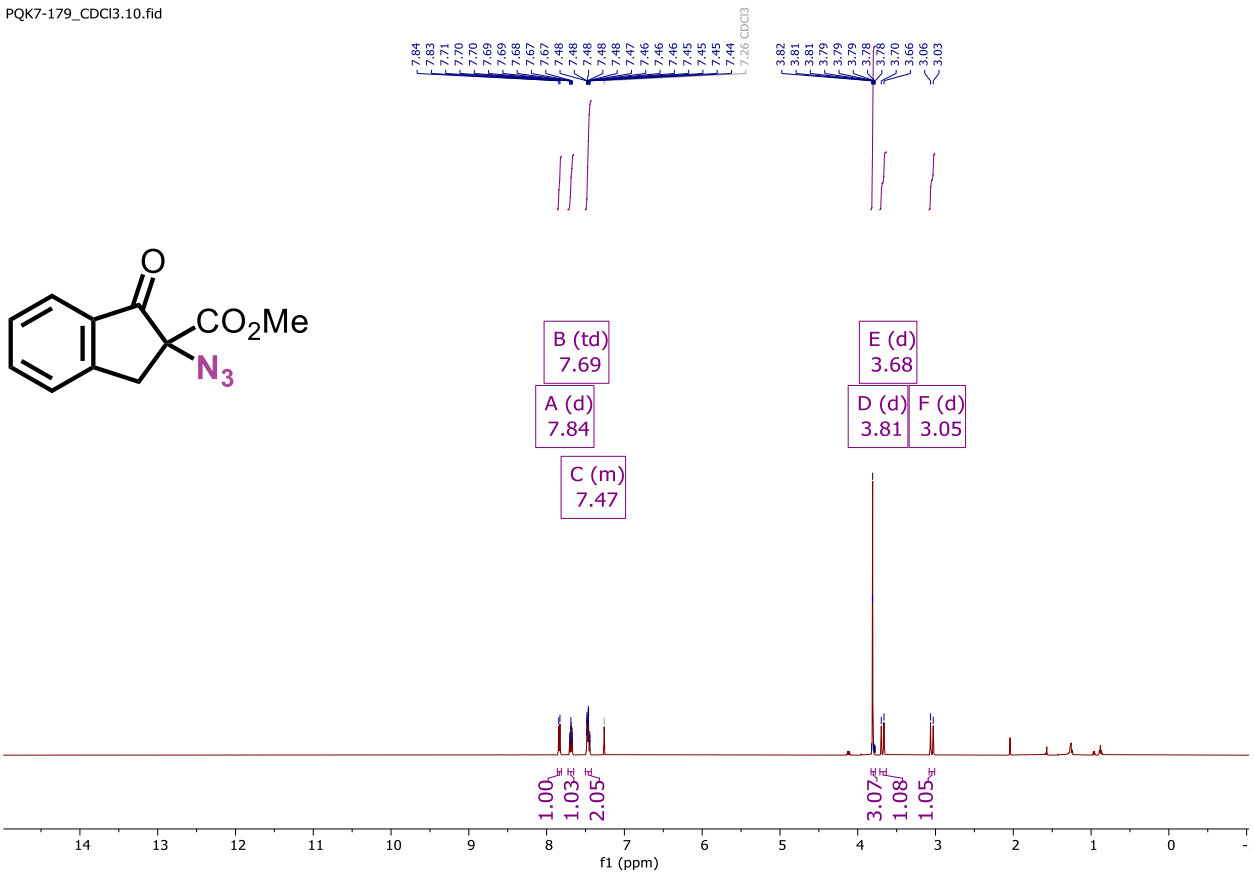
Supplemental Figure 153: ^{1}H-^{13}C HSQC NMR spectra of **11**.



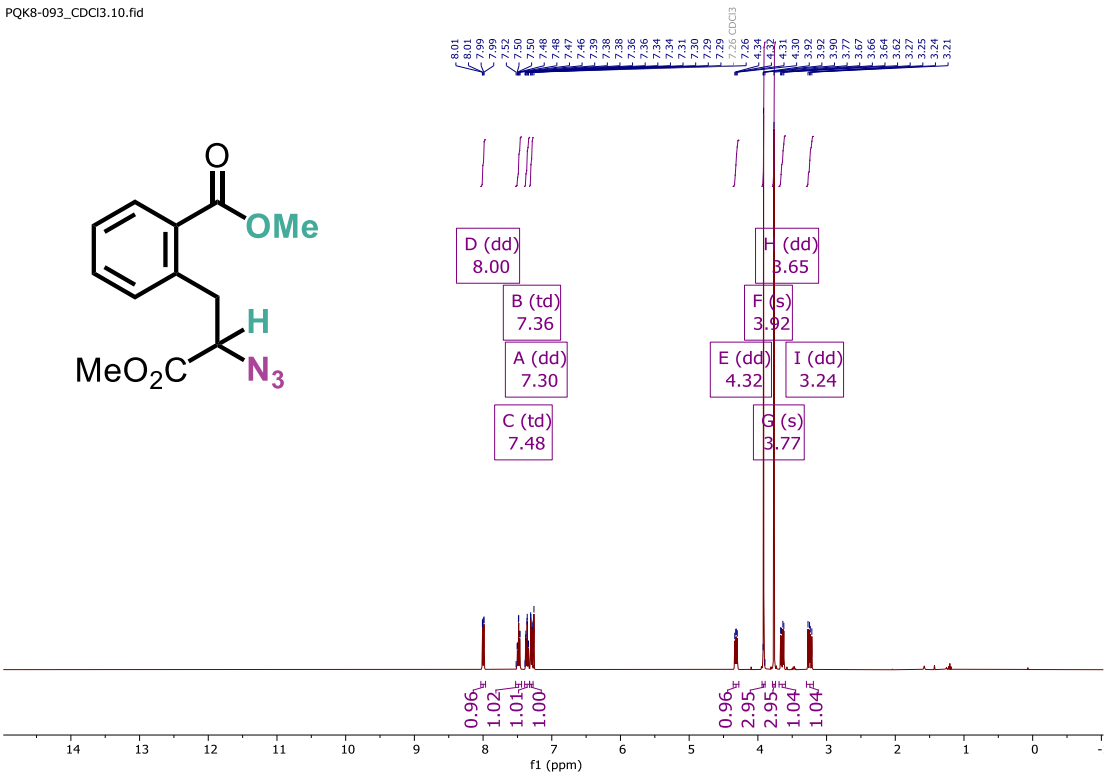
Supplemental Figure 154: ^{1}H NMR spectra of **13**.



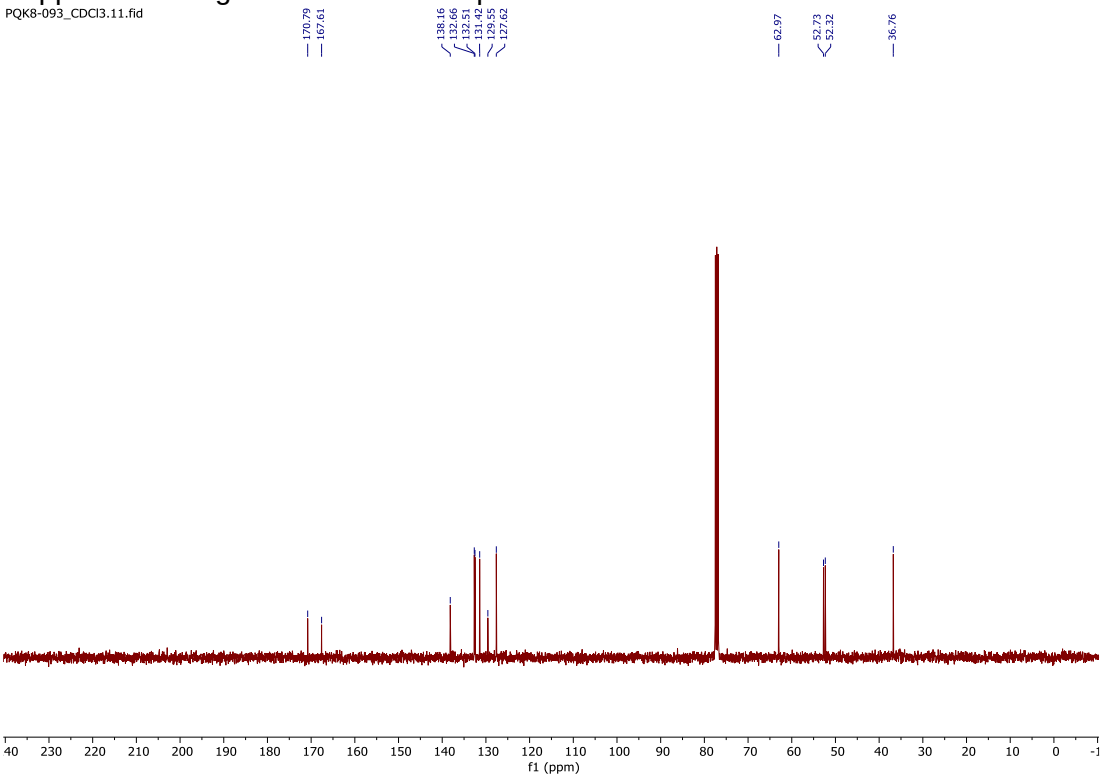
Supplemental Figure 155: ^{1}H NMR spectra of **14**.



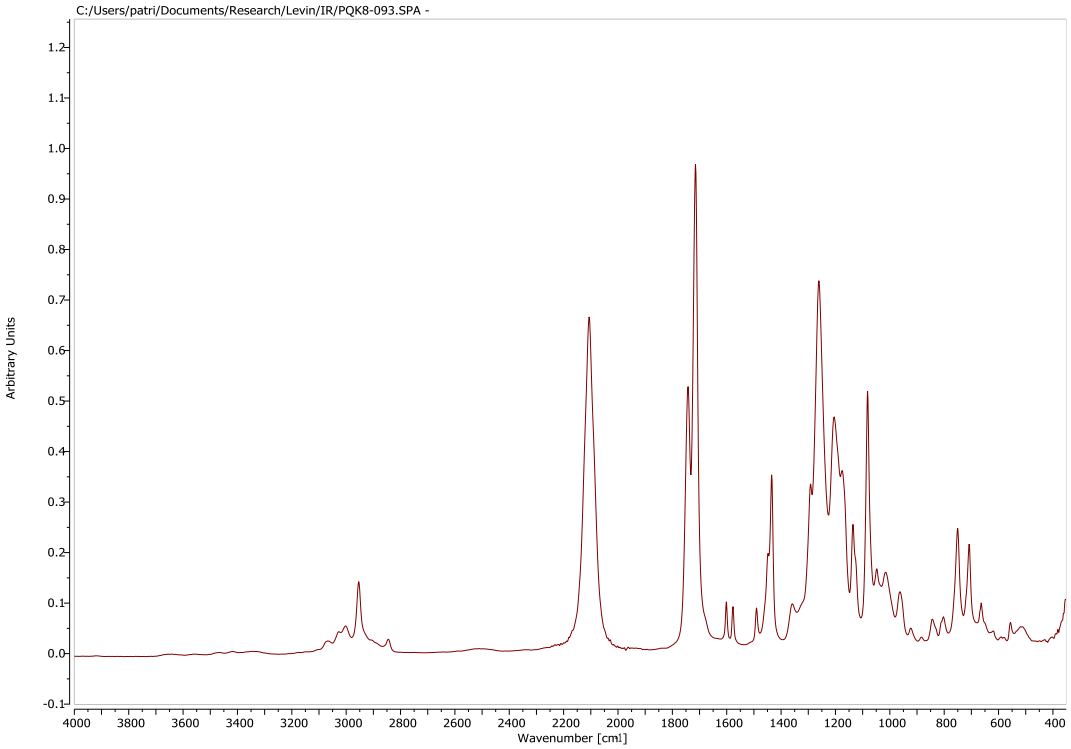
Supplemental Figure 156: ^{1}H NMR spectra of **15**.



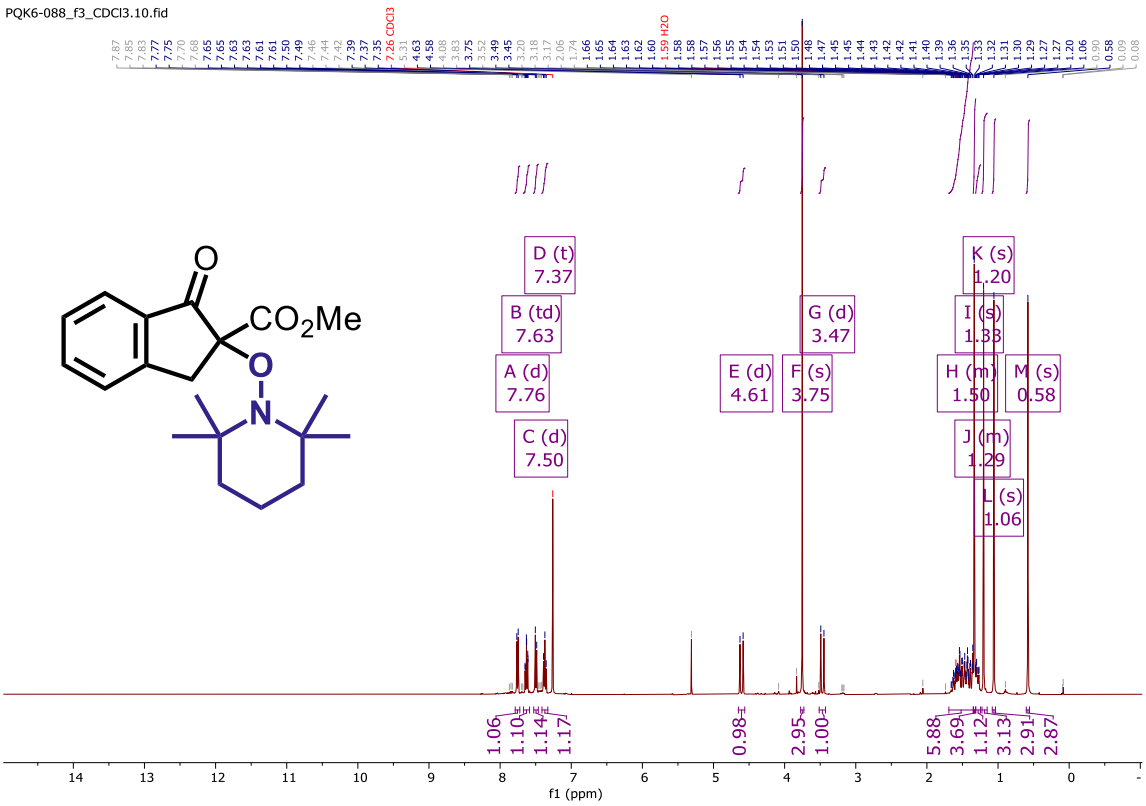
Supplemental Figure 157: ^{1}H NMR spectra of **16**.



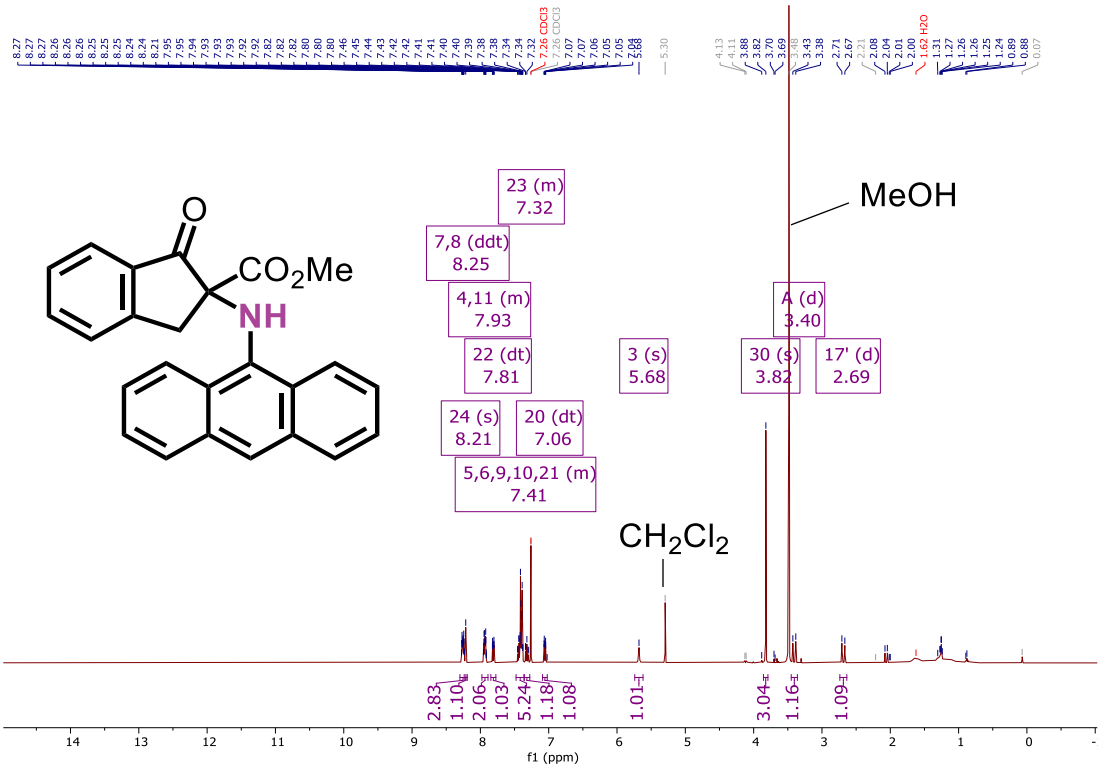
Supplemental Figure 158: ^{13}C NMR spectra of **16**.



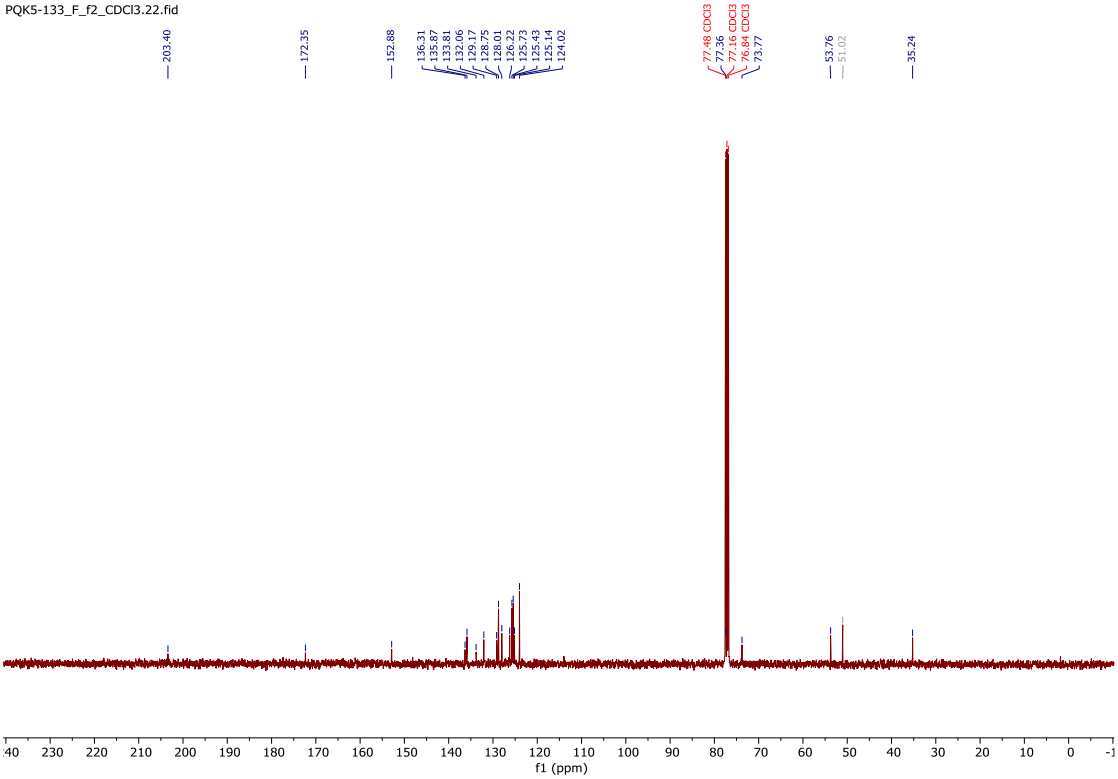
Supplemental Figure 159: IR spectrum of **16.**



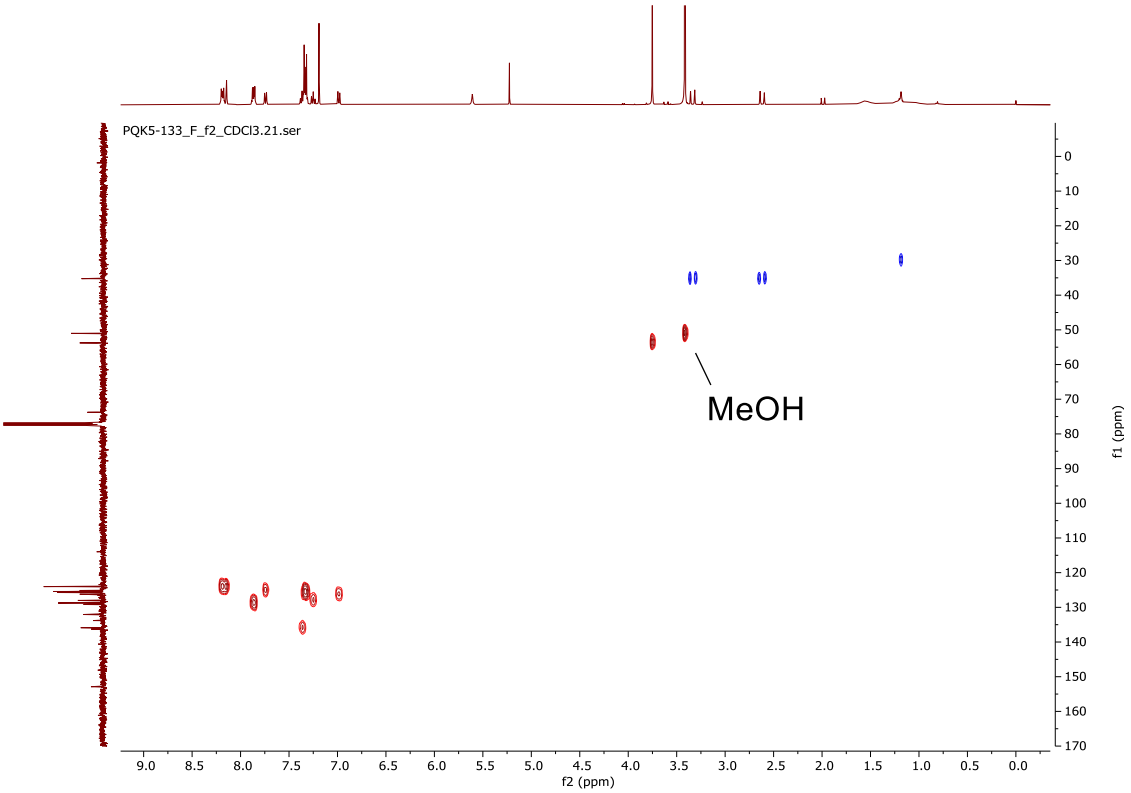
Supplemental Figure 160: ^{1}H NMR spectra of **S4**.



Supplemental Figure 161: ^{1}H NMR spectra of **S5**.



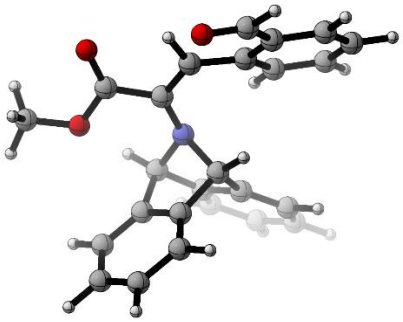
Supplemental Figure 162: ^{13}C NMR spectra of **S5**.



Supplemental Figure 163: ^{1}H-^{13}C HSQC NMR spectra of **S5**.

13. DFT Coordinates

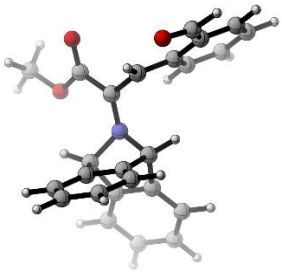
Optimized Geometries of **12** (and starting geometries of relaxed coordinate scans)



Cis_Aldehyde_singlet

C	1.46230	4.31530	-0.19350
C	0.71480	3.33750	0.48360
C	0.91590	2.01870	0.13230
C	1.83520	1.65940	-0.86500
C	2.58030	2.61390	-1.52630
C	2.37830	3.95980	-1.17810
C	0.32810	0.70250	0.62940
C	1.78490	0.13250	-0.94990
C	2.39190	-0.36960	0.36530
C	1.46610	-0.02050	1.35810
C	1.69890	-0.30860	2.68860
H	0.98450	-0.03740	3.46040
C	2.88970	-0.97570	3.01690
C	3.81030	-1.31890	2.03120
C	3.57260	-1.01020	0.68260
H	-0.63620	0.74390	1.13000
H	1.32030	5.36260	0.05390
H	0.00000	3.61710	1.25210
H	3.29490	2.34210	-2.29760
H	2.94270	4.73360	-1.68930
H	2.13450	-0.32080	-1.87260
H	3.09260	-1.22960	4.05270
H	4.72280	-1.83810	2.30790
H	4.29290	-1.28190	-0.08390
N	0.32870	-0.02810	-0.67630
C	-0.44710	-1.17580	-0.84160
C	-1.78130	-1.20310	-0.61260
H	-2.24800	-2.17600	-0.68090
C	0.13000	-2.49410	-1.29510
O	-0.54450	-3.43650	-1.64800
O	1.46160	-2.53140	-1.25570
C	-4.71440	0.83160	0.67330

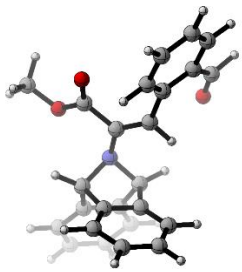
C	-3.84690	-0.24570	0.45970
C	-2.66230	-0.07120	-0.29620
C	-2.40420	1.20960	-0.81220
C	-3.27420	2.27090	-0.58940
C	-4.43700	2.09060	0.15930
H	-5.61580	0.67020	1.25960
H	-1.50430	1.36560	-1.39800
H	-3.04170	3.24580	-1.00680
H	-5.11390	2.91910	0.33750
C	-4.24820	-1.52130	1.09540
O	-3.61150	-2.55450	1.11650
H	-5.23370	-1.47050	1.60010
C	2.05910	-3.77170	-1.64580
H	3.13210	-3.62470	-1.54110
H	1.71430	-4.57480	-0.99250
H	1.79920	-4.00610	-2.67950



Cis_Aldehyde_triplet

C	3.33230	3.48740	-0.32790
C	2.15070	3.01270	0.26210
C	1.82800	1.68440	0.07200
C	2.65090	0.83330	-0.67740
C	3.81790	1.29130	-1.25510
C	4.15030	2.64260	-1.07220
C	0.67700	0.81880	0.56930
C	1.98890	-0.53830	-0.62720
C	2.10370	-1.01640	0.82510
C	1.27970	-0.16530	1.57800
C	1.15520	-0.31040	2.94440
H	0.51530	0.34420	3.52840
C	1.87830	-1.34500	3.56020
C	2.69730	-2.18700	2.81540
C	2.82390	-2.02870	1.42560
H	-0.24460	1.32620	0.84700
H	3.60970	4.52930	-0.20360
H	1.51440	3.67370	0.84270
H	4.45830	0.63520	-1.83650
H	5.05780	3.03430	-1.52080
H	2.22760	-1.24590	-1.41410

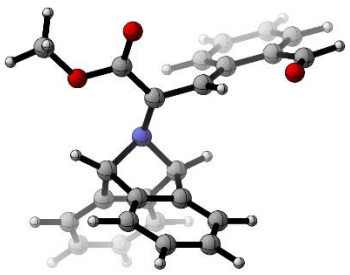
H	1.79150	-1.49200	4.63220
H	3.24210	-2.98280	3.31350
H	3.46210	-2.69010	0.84750
N	0.55450	-0.08220	-0.61800
C	-0.52070	-0.92940	-0.73840
C	-1.70980	-0.73750	0.11120
H	-1.88440	-1.44550	0.91220
C	-0.59590	-1.95470	-1.75090
O	-1.54330	-2.72500	-1.86010
O	0.47020	-1.99350	-2.58590
C	-4.65100	1.58210	0.48350
C	-3.78700	0.51580	0.73790
C	-2.63310	0.31770	-0.08960
C	-2.42640	1.24580	-1.14670
C	-3.29900	2.29420	-1.37400
C	-4.42370	2.47280	-0.56000
H	-5.52070	1.71230	1.12310
H	-1.55610	1.12080	-1.78380
H	-3.10780	2.98180	-2.19180
H	-5.10830	3.29460	-0.73840
C	-4.15290	-0.33990	1.88120
O	-3.55010	-1.31450	2.28940
H	-5.08280	-0.01780	2.39040
C	0.41440	-3.00830	-3.58750
H	1.33440	-2.90840	-4.16110
H	0.35650	-3.99780	-3.12910
H	-0.45410	-2.86130	-4.23290



Trans_Aldehyde_singlet

C	-5.02300	0.20470	-1.96450
C	-3.74300	-0.34100	-2.15240
C	-2.79940	-0.11920	-1.17020
C	-3.10700	0.61770	-0.01790
C	-4.36510	1.14940	0.17830
C	-5.32820	0.93610	-0.82090
C	-1.35020	-0.56410	-0.99970
C	-1.83620	0.60310	0.82220
C	-1.66770	-0.84440	1.29800
C	-1.36410	-1.58780	0.14690

C	-1.16710	-2.95260	0.20720
H	-0.93180	-3.53110	-0.68150
C	-1.26430	-3.57580	1.46220
C	-1.56030	-2.83890	2.60420
C	-1.77230	-1.45230	2.53280
H	-0.80490	-0.82170	-1.90750
H	-5.78400	0.05510	-2.72400
H	-3.50890	-0.91250	-3.04550
H	-4.60750	1.71950	1.07010
H	-6.32440	1.34980	-0.69920
H	-1.71460	1.39440	1.55920
H	-1.09920	-4.64580	1.54170
H	-1.62500	-3.34080	3.56460
H	-2.00530	-0.88150	3.42710
N	-0.83990	0.64790	-0.30270
C	0.52530	0.70240	0.04730
C	1.41830	-0.23400	-0.32650
H	1.02840	-1.08590	-0.87410
C	0.94170	1.98370	0.71190
O	2.00510	2.17530	1.25700
O	-0.00540	2.92600	0.62480
C	5.11390	-0.56280	-1.11040
C	3.73120	-0.43680	-1.28000
C	2.88770	-0.26390	-0.16140
C	3.47150	-0.25610	1.10790
C	4.84800	-0.39010	1.26730
C	5.67880	-0.53890	0.15780
H	5.74390	-0.68280	-1.98840
H	2.83140	-0.14330	1.97510
H	5.27300	-0.38090	2.26620
H	6.75150	-0.64050	0.28300
C	3.22770	-0.48800	-2.67030
O	2.06690	-0.39550	-3.01400
H	4.02200	-0.62860	-3.43030
C	0.32390	4.17390	1.24190
H	-0.54670	4.81060	1.09930
H	0.52600	4.02900	2.30480
H	1.20230	4.61080	0.76350

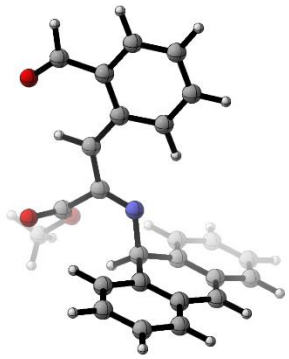


Trans_Aldehyde_triplet

C	3.34020	-3.48330	0.33200
C	2.15630	-3.01240	-0.25640
C	1.83130	-1.68430	-0.06850
C	2.65420	-0.83000	0.67710
C	3.82340	-1.28420	1.25310
C	4.15820	-2.63520	1.07250
C	0.67750	-0.82220	-0.56520
C	1.98950	0.54020	0.62530
C	2.10020	1.01510	-0.82850
C	1.27590	0.16090	-1.57760
C	1.14760	0.30310	-2.94390
H	0.50740	-0.35380	-3.52500
C	1.86720	1.33780	-3.56360
C	2.68660	2.18280	-2.82260
C	2.81700	2.02750	-1.43270
H	-0.24370	-1.33210	-0.83960
H	3.61950	-4.52500	0.20930
H	1.52010	-3.67600	-0.83410
H	4.46380	-0.62550	1.83160
H	5.06750	-3.02400	1.51990
H	2.22860	1.25010	1.40990
H	1.77730	1.48260	-4.63560
H	3.22880	2.97850	-3.32360
H	3.45540	2.69130	-0.85770
N	0.55580	0.08150	0.62020
C	-0.52000	0.92820	0.73890
C	-1.70850	0.73470	-0.11110
H	-1.88050	1.43950	-0.91550
C	-0.59460	1.95680	1.74820
O	-1.54140	2.72820	1.85470
O	0.47110	1.99690	2.58350
C	-4.65200	-1.58230	-0.47920
C	-3.78590	-0.51840	-0.73650
C	-2.63330	-0.31840	0.09230
C	-2.42970	-1.24250	1.15350
C	-3.30420	-2.28870	1.38360
C	-4.42780	-2.46900	0.56850
H	-5.52070	-1.71390	-1.11980
H	-1.55990	-1.11640	1.79130
H	-3.11530	-2.97340	2.20440
H	-5.11390	-3.28890	0.74910
C	-4.14810	0.33260	-1.88450
O	-3.54320	1.30470	-2.29550
H	-5.07710	0.00920	-2.39450
C	0.41560	3.01440	3.58230
H	1.33510	2.91530	4.15670

H	0.35880	4.00270	3.12130
H	-0.45340	2.86990	4.22760

Optimized Triplet C-N cleavage product (and geometry of singlet NBO calculation from Fig. 5D)

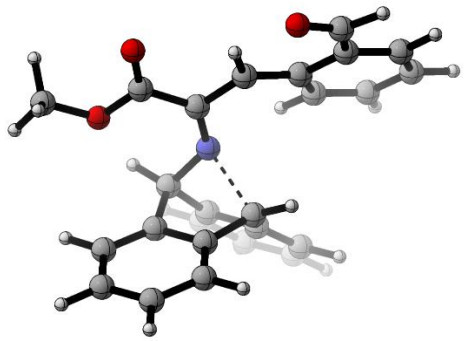


Trans_Aldehyde_triplet_CN_cleaved

C	3.41644	1.82911	-3.12900
C	3.74400	2.03898	-1.80074
C	3.15213	1.26642	-0.77565
C	2.21027	0.27378	-1.13630
C	1.89106	0.07411	-2.47570
C	2.48886	0.83980	-3.47461
C	3.51014	1.45558	0.59088
C	1.48782	-0.54056	-0.08069
C	2.05268	-0.38944	1.32059
C	2.99848	0.61746	1.62384
C	3.44010	0.74721	2.96036
H	4.16726	1.51927	3.19722
C	2.96421	-0.09343	3.95156
C	2.03437	-1.09154	3.63839
C	1.58453	-1.22789	2.32704
H	4.23038	2.22740	0.84588
H	3.88213	2.43147	-3.90270
H	4.46810	2.80189	-1.52750
H	1.16081	-0.68967	-2.73366
H	2.23236	0.67092	-4.51535
H	1.55307	-1.60171	-0.36024
H	3.31562	0.02047	4.97225
H	1.66202	-1.75455	4.41234
H	0.85210	-1.99465	2.08004
N	0.09648	-0.07301	-0.03563
C	-0.87358	-0.91336	-0.20503
C	-2.26333	-0.57974	-0.10026
H	-2.94233	-1.42145	-0.13280
C	-0.65012	-2.39650	-0.47163
O	-0.90446	-3.26567	0.32819

O	-0.16401	-2.61572	-1.69255
C	-4.85713	2.10379	0.33678
C	-4.27894	0.84085	0.21393
C	-2.86343	0.71517	0.04148
C	-2.10684	1.90886	-0.00403
C	-2.70956	3.15319	0.11968
C	-4.08849	3.26310	0.29308
H	-5.93348	2.17674	0.47001
H	-1.03623	1.83558	-0.13801
H	-2.09528	4.04702	0.07808
H	-4.55856	4.23561	0.39041
C	-5.24447	-0.28200	0.28588
O	-5.00677	-1.47097	0.21588
H	-6.29001	0.05746	0.42016
C	0.09191	-3.99201	-2.01709
H	0.48295	-3.98509	-3.03157
H	0.82357	-4.40746	-1.32218
H	-0.83464	-4.56493	-1.96177

Geometry of C-N bond cleavage transition state on triplet energy surface



Trans_Aldehyde_triplet_CN_cleavage_TS

C	0.95808	4.49486	-0.21057
C	0.46074	3.48665	0.62284
C	0.82107	2.17123	0.36290
C	1.62976	1.86219	-0.74550
C	2.12266	2.85595	-1.57074
C	1.78679	4.18626	-1.28726
C	0.44391	0.94359	1.09657
C	1.74198	0.35306	-0.86313
C	2.42054	-0.17712	0.39065
C	1.60638	0.12710	1.49842
C	1.93572	-0.35827	2.75984
H	1.30326	-0.14569	3.61664
C	3.10696	-1.10659	2.90598
C	3.92336	-1.37879	1.80842

C	3.57642	-0.92238	0.53108
H	-0.46899	0.92204	1.68651
H	0.69358	5.52934	-0.01511
H	-0.18172	3.72901	1.46446
H	2.73958	2.61145	-2.43070
H	2.16103	4.98147	-1.92416
H	2.14218	-0.01953	-1.80357
H	3.38269	-1.48242	3.88628
H	4.82513	-1.96801	1.94122
H	4.18717	-1.16724	-0.33309
N	0.32121	-0.02271	-0.61625
C	-0.25782	-1.18329	-0.79311
C	-1.66178	-1.33119	-0.41120
H	-1.98447	-2.34596	-0.23056
C	0.40217	-2.44071	-1.24038
O	-0.18203	-3.50416	-1.32078
O	1.68972	-2.29071	-1.57717
C	-4.78701	0.50841	0.54805
C	-3.87745	-0.53792	0.38049
C	-2.60398	-0.29443	-0.25162
C	-2.36755	1.03614	-0.71737
C	-3.28828	2.04740	-0.53020
C	-4.51007	1.79785	0.11143
H	-5.73484	0.29891	1.03827
H	-1.44658	1.24796	-1.24555
H	-3.06486	3.04340	-0.90039
H	-5.23290	2.59368	0.25281
C	-4.31989	-1.83408	0.91766
O	-3.70672	-2.88717	0.91558
H	-5.33310	-1.79564	1.36511
C	2.36162	-3.48817	-1.97553
H	3.38517	-3.19135	-2.19602
H	2.34044	-4.21918	-1.16505
H	1.88530	-3.91328	-2.86079