Supporting Information

Cobalt catalyzed oxidative annulation of benzothiophene-[*b*]-1,1-dioxide through diasteroselective double C-H activation

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1. General Information:

Reactions were run using standard glassware and techniques.

The C-H activation was carried out in a sealed Pyrex pressure tube purchased from SciLabware.com. Unless otherwise stated, all reactions and manipulations were performed under an atmosphere of ambient air unless. Yields refer to isolated compounds, estimated to be ≥ 95% pure as determined by ^{1}H-NMR. All the solvents were used as received. THF was distilled from sodium benzopheneone ketyl. All the chemicals were purchased from Aldrich and Chemtronica, Sweden. For column chromatography silica gel (60 Å) from Chemtronica was used. A series of petroleum ether (40-65 °C) – ethylacetate compositions were used to identify optimal detection for use with Aldrich TLC sheets (silica gel on aluminium foils with fluorescence indicator 254 nm).

Analytical information: The melting points recorded are uncorrected. ^{1}H NMR, ^{13}C and ^{19}F NMR spectroscopy, and IR spectroscopy were used to characterize all isolated compounds. In addition, all the compounds are further characterized by HRMS. Nuclear magnetic resonance spectra were recorded on a Varian 500 & Bruker 400 MHz instrument. All ^{1}H NMR experiments are reported in units, parts per million (ppm), and were measured relative to the signals for residual chloroform (7.26 ppm) in the deuterated solvent, unless otherwise stated. All ^{13}C NMR spectra were reported in ppm relative to deuterated chloroform (77.23 ppm), unless otherwise stated, and all were obtained with H decoupling.

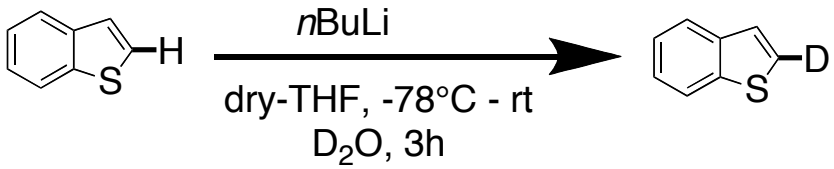
2. General procedure for the preparation of 8-aminoquinolinyl amides (1)

The amides were prepared according to the reported procedure.[S1]

3. Synthesis of benzothiophene-[*b*]-1,1-dioxide (2)

The benzothiophene [*b*]-1,1-dioxide was prepared according to the reported procedure. [S2]

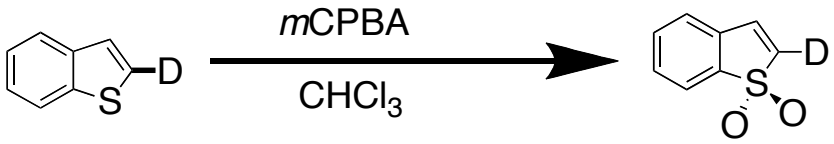
4. Synthesis of benzothiophene-2-*d*



The benzothiophene-2-d was synthesized according to the procedure reported by Glorius *et al.*[S3]

n-BuLi (1.6 M solution in hexane, 6 mL, 1.5 equiv) was added dropwise to a solution of benzothiophene (0.8 g, 1 equiv) in dry THF (20 mL) at -78 °C. The resulting mixture was stirred at the same temperature for further 2h and D_2O (6 mL) was added. The white suspension was warmed to room temperature and stirred for another 1h. H_2O (15 mL) was added and the product was extracted with diethylether (3 × 15 mL). The combined organic phases were washed with brine, dried over anhydrous Na_2SO_4 and the solvent was removed under reduced pressure. Spectroscopic data were in accordance with the literature.

5. Synthesis of benzothiophene-[*b*]-1,1-dioxide-d



To a stirred solution of benzothiophene-d (0.3 g, 2.2 mmol, 1 equiv), in $CHCl_3$ (20 mL) was added *m*CPBA (0.95 g, 5.5 mmol, 2.5 equiv) slowly at room temperature with vigorous stirring. After overnight stirring, saturated $NaHCO_3$ was added and the organic layer was extracted three times with DCM (10 mL). The solvent was dried with Na_2SO_4 and evaporated to dryness. The crude product was continued for the C-H activation without further purification resulted in 70 % isolated yield as a colorless solid.

6. Synthesis of [Cp*Co(CO)I_2]

The [Cp*Co(CO)I_2] catalyst was prepared according to the reported procedure. [S4]

7. Optimization of reaction conditions

7.1. Optimization of general conditions

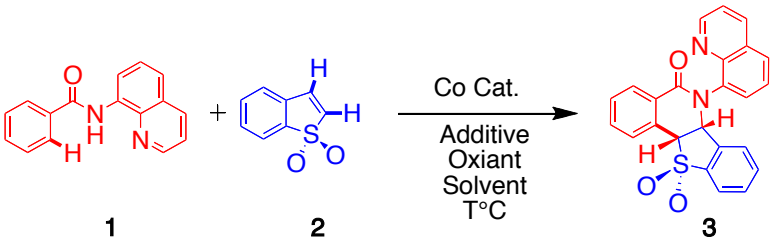


Table S1. Screening of additive. [a]

Entry	Additive	Yield (%)
1	NaOAc	15
2	KOAc	85
3	NaOPiv	50
4	KOPiv	40
5	$NaHCO_3$	30
6	Na_2HPO_4	25
7	K_2CO_3	10

[a]Reaction conditions: Amide **1** (0.2 mmol), benzothiophene-[*b*]-1,1-dioxide **2** (0.3 mmol), $Co(acac)_2$ (0.04 mmol), additive (0.8 mmol), Ag_2O (0.4 mmol), [TFE+ *t*AmylOH (1:1)] (2 mL) reaction run in a sealed tube at 110 °C under air for 24 h.

Table S2. Screening of oxidant. [a]

Entry	Oxidant	Yield (%)
1	Ag_2O	85
2	Ag_2CO_3	15
3	AgF	NR
4	AgOPiv	10
5	AgOTf	NR
6	$Mn(OAc)_2$	NR
7	$Mn(OAc)_3$	NR
8	$AgNO_3$	NR

[a]Reaction conditions: Amide **1** (0.2 mmol), benzothiophene-[*b*]-1,1-dioxide **2** (0.3 mmol), $Co(acac)_2$ (0.04 mmol), KOAc (0.8 mmol), oxidant (0.4 mmol), [TFE+ *t*AmylOH (1:1)] (2 mL) reaction run in a sealed tube at 110 °C under air for 24 h.

Table S3. Screening of catalyst. [a]

Entry	Catalyst	Yield (%)
1	$Co(acac)_2$	85
2	$Co(OH)_2$	NR
3	$Co(OAc)_2 \bullet H_2O$	35
4	$CoCl_2$	10
5	$[Cp^*Co(CO)I_2]$	NR
6	$Ni(OAc)_2$	NR
7	$Ni(acac)_2$	NR
8	$Cu(OAc)_2$	NR

[a]Reaction conditions: Amide **1** (0.2 mmol), benzothiophene-[*b*]-1,1-dioxide **2** (0.3 mmol), catalyst (0.04 mmol), KOAc (0.8 mmol), Ag_2O (0.4 mmol), [TFE+ *t*AmylOH (1:1)] (2 mL) reaction run in a sealed tube at 110°C under air for 24 h.

Table S4. Screening of Solvent. [a]

Entry	Solvent	Yield (%)
1	TFE+*t*AmylOH (1:1)	85
2	TFE	60
3	*t*AmylOH	30
4	TFE+1-BuOH (1:1)	14
5	TFE+Ethyleneglycol (1:1)	NR
6	TFE+MeOH (1:1)	NR
7	TFE+EtOH (1:1)	NR
8	TFE+Toluene (1:1)	NR

[a]Reaction conditions: Amide **1** (0.2 mmol), benzothiophene-[*b*]-1,1-dioxide **2** (0.3 mmol), catalyst (0.04 mmol), KOAc (0.8 mmol), Ag_2O (0.4 mmol), solvent (2 mL) reaction run in a sealed tube at 110°C under air for 24 h.

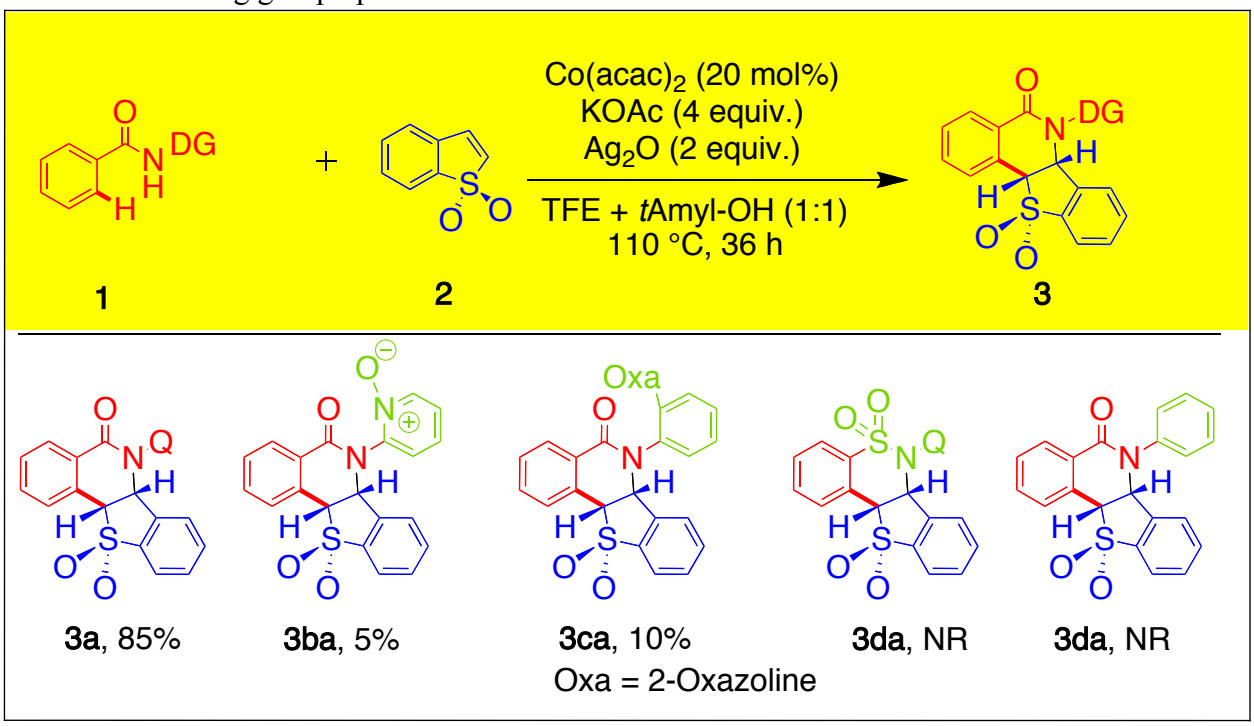
Table S5. Screening of Temperature. [a]

Entry	Temperature (°C)	Yield (%)
1	110	85
2	80	60
3	60	30
4	RT	14

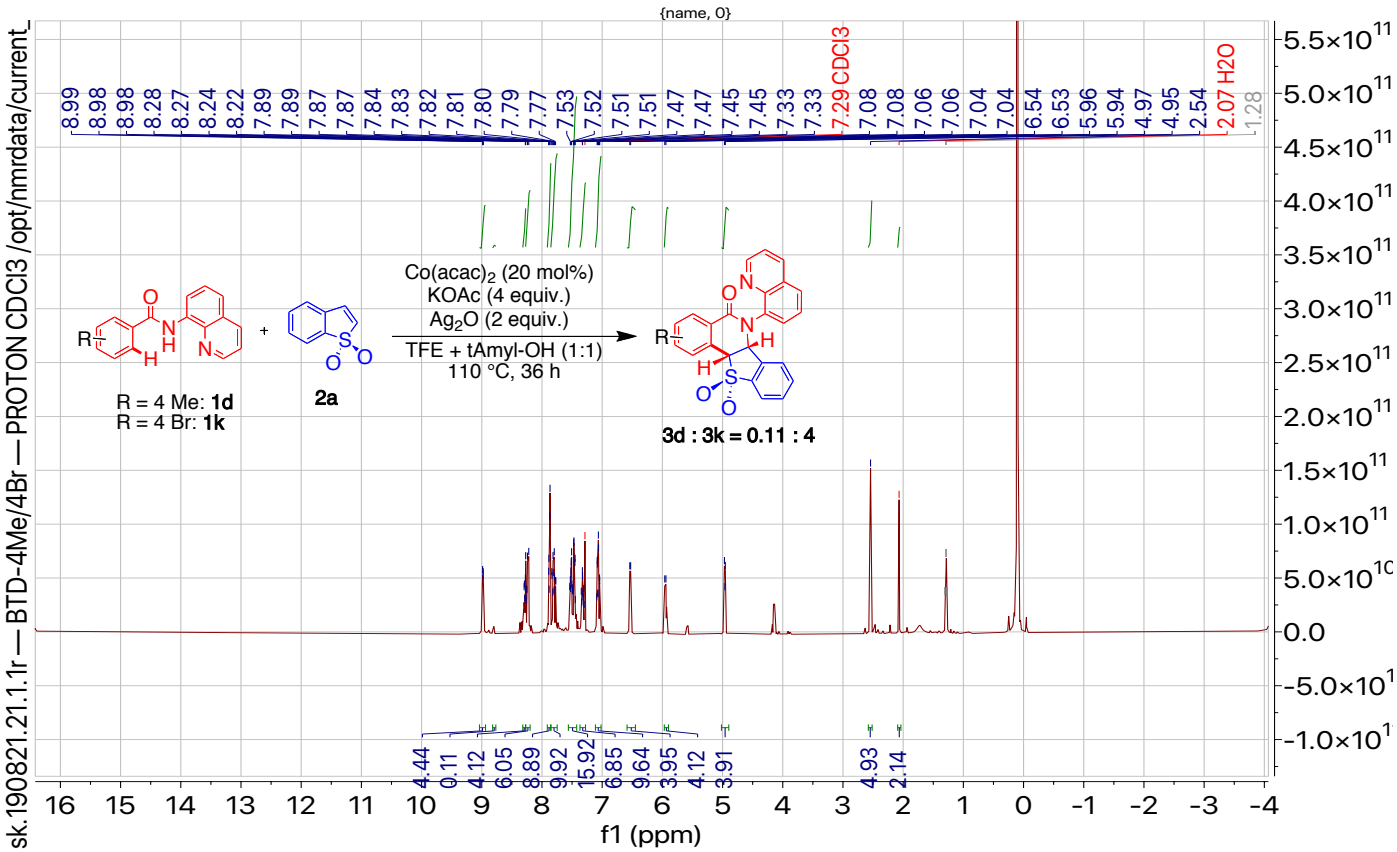
[a]Reaction conditions: Amide **1** (0.2 mmol), benzothiophene-[*b*]-1,1-dioxide **2** (0.3 mmol), catalyst (0.04 mmol), KOAc (0.8 mmol), Ag_2O (0.4 mmol), [TFE+ *t*AmylOH (1:1)] (2 mL) reaction run in a sealed tube at (temperature) under air for 24 h.

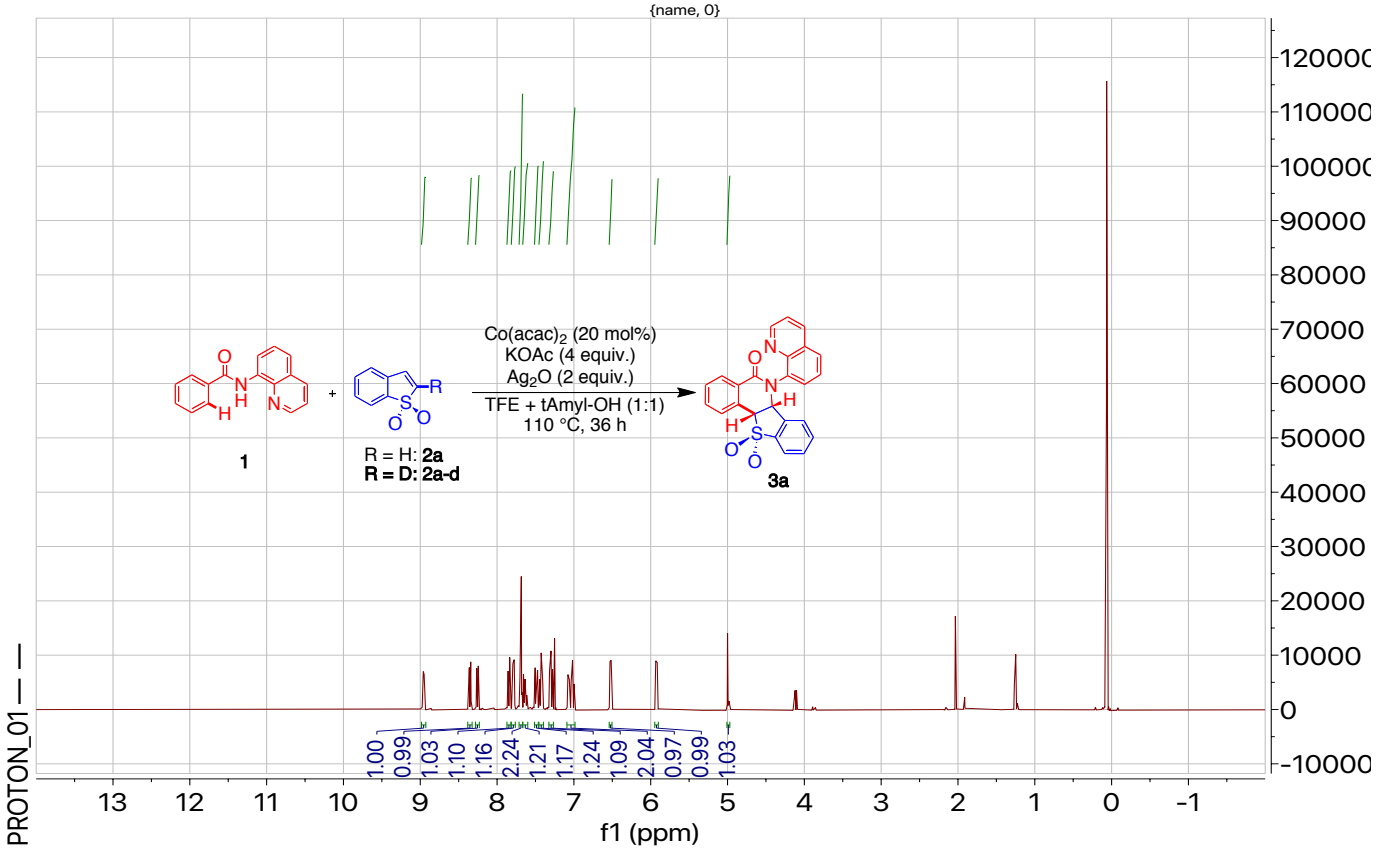
8. Optimization of directing group

Table S6. Directing group optimization



9. Control experiments

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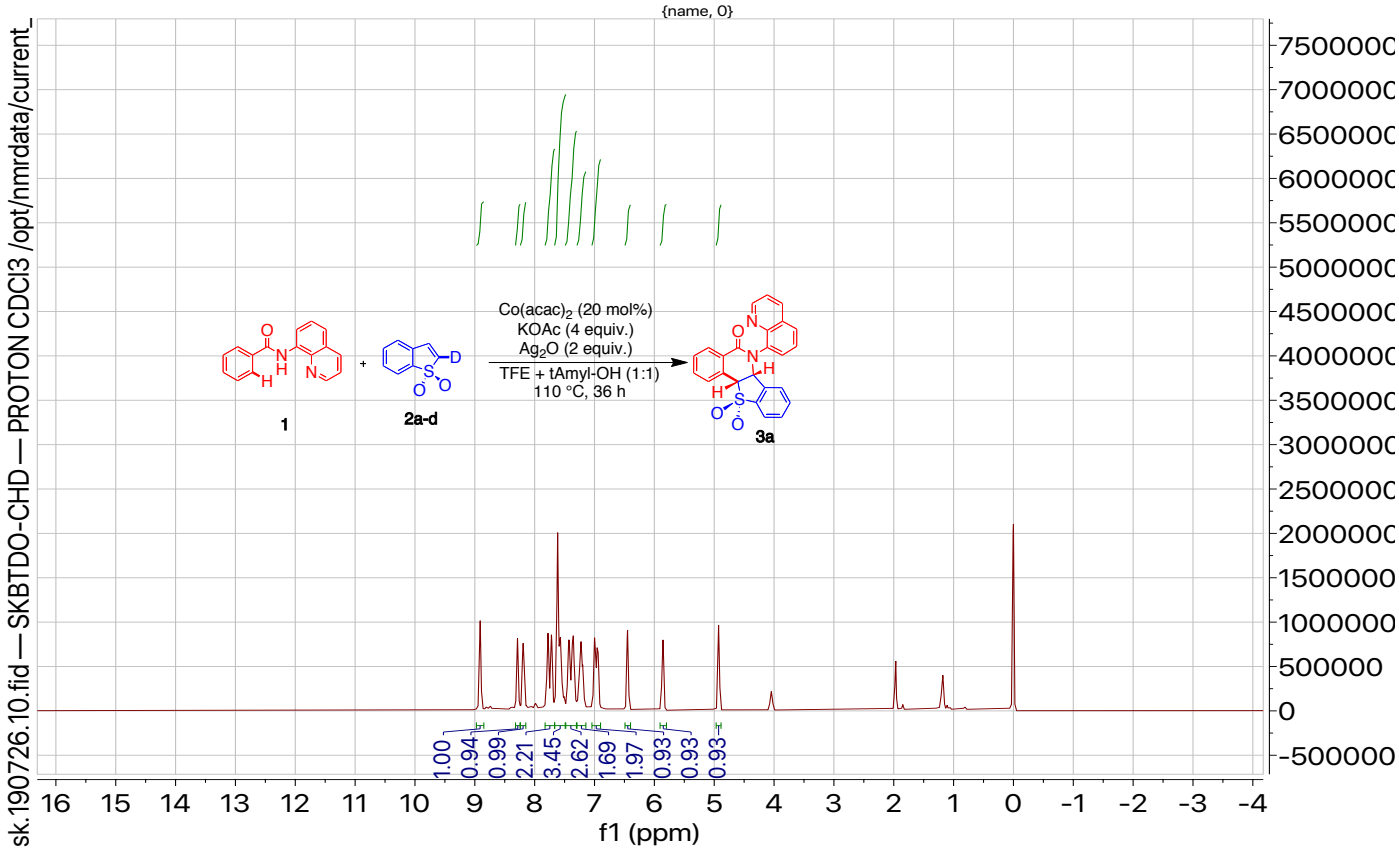
Co(acac)$_2$ (20 mol%)
KOAc (4 equiv.)
Ag$_2$O (2 equiv.)
TFE + tAmyl-OH (1:1)
110 °C, 36 h
1
R = H: 2a
R = D: 2a-d
3a
1.00 0.99 1.03 1.10 1.16 2.24 1.21 1.17 1.24 1.09 2.04 0.97 0.99 1.03
f1 (ppm)
PROTON_01 — —


{name, 0}
Co(acac)$_2$ (20 mol%)
KOAc (4 equiv.)
Ag$_2$O (2 equiv.)
TFE + tAmyl-OH (1:1)
110 °C, 36 h
1
2a-d
3a
1.00 0.94 0.99 2.21 3.45 2.62 1.69 1.97 0.93 0.93 0.93
f1 (ppm)
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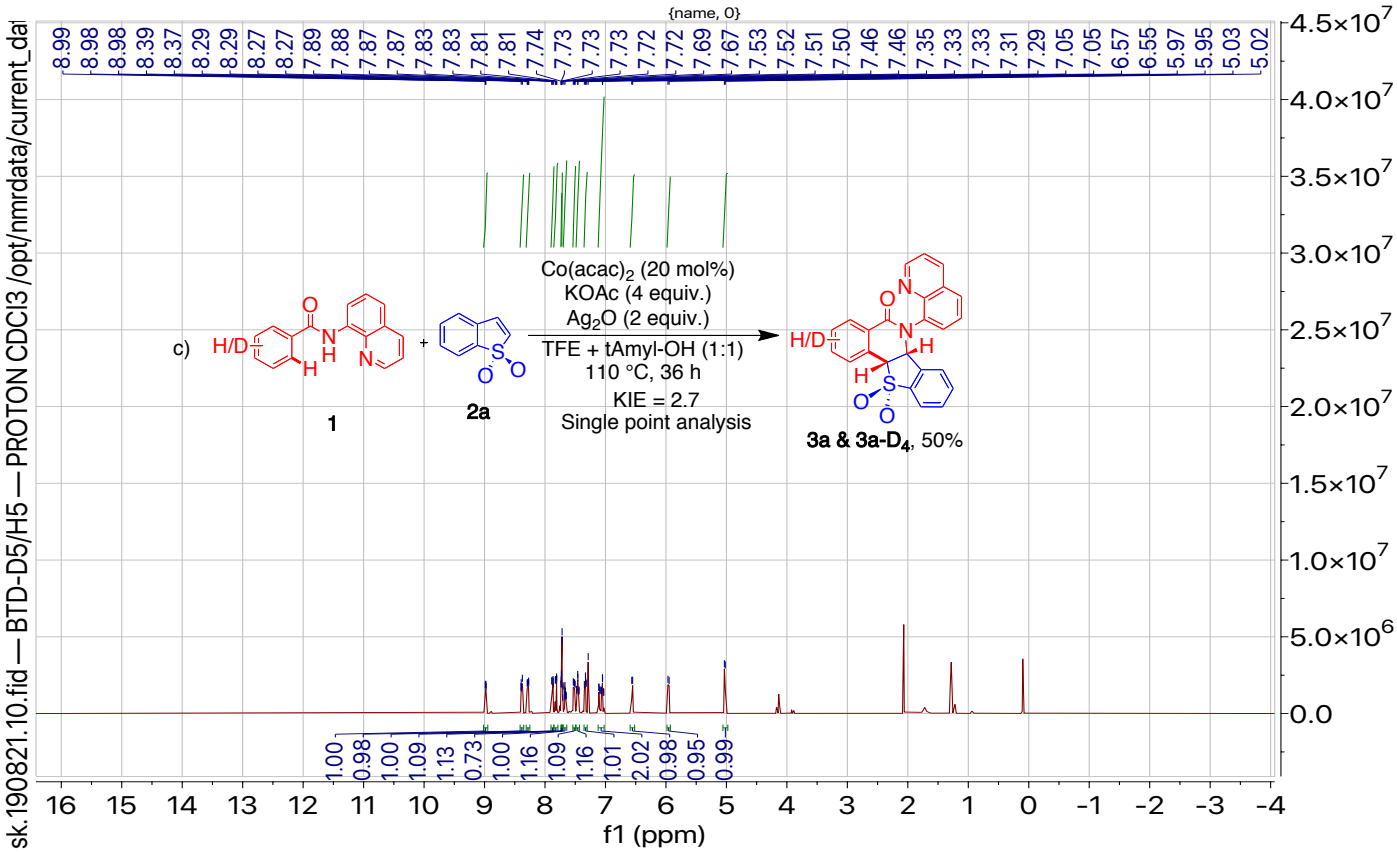
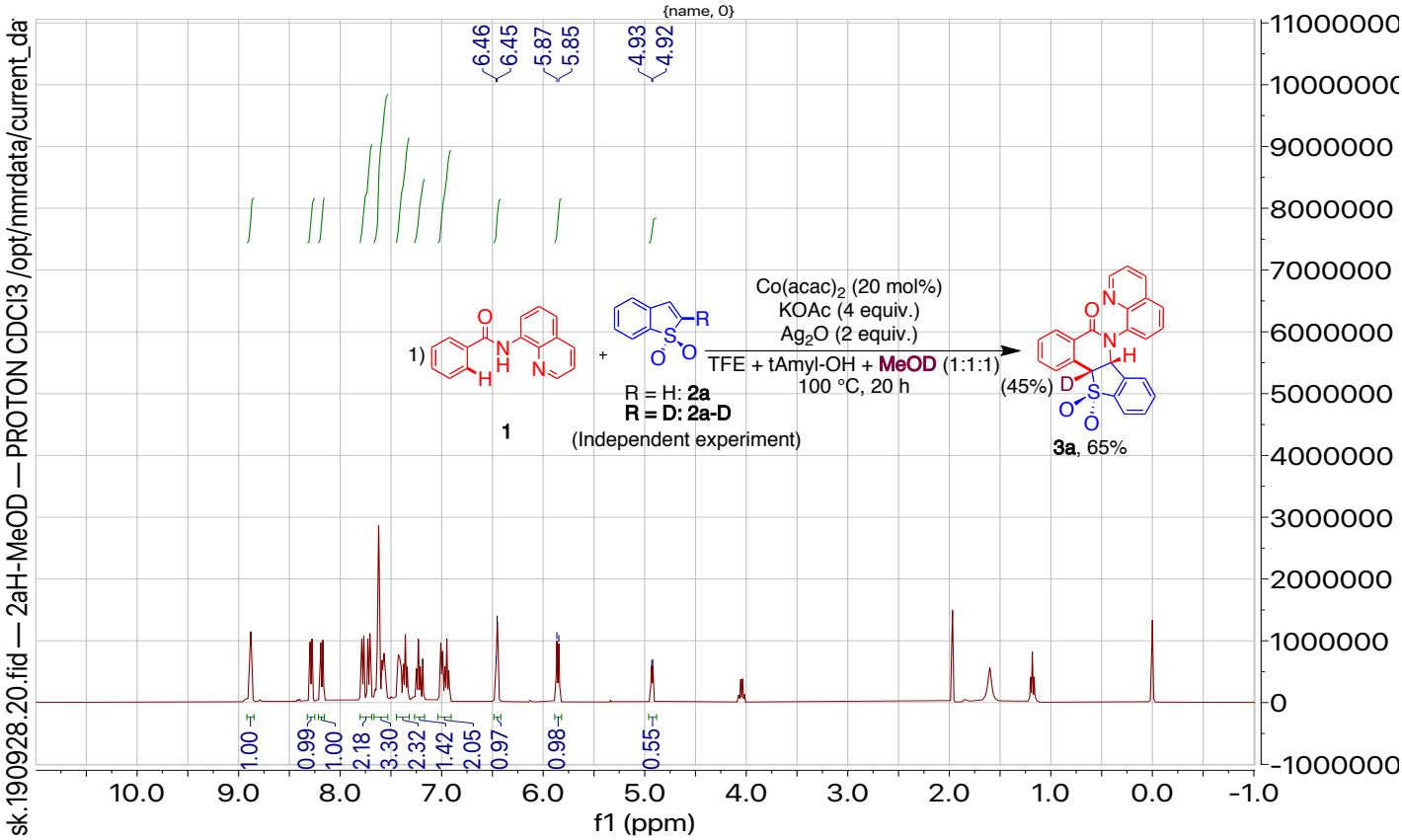

sk.190821.10.fid — BTD-D5/H5 — PROTON CDCl3 /opt/nmrdata/current_dat
{name, 0}
c)
H/D
1
2a
Co(acac)2 (20 mol%)
KOAc (4 equiv.)
Ag2O (2 equiv.)
TFE + tAmyl-OH (1:1)
110 °C, 36 h
KIE = 2.7
Single point analysis
3a & 3a-D4, 50%
f1 (ppm)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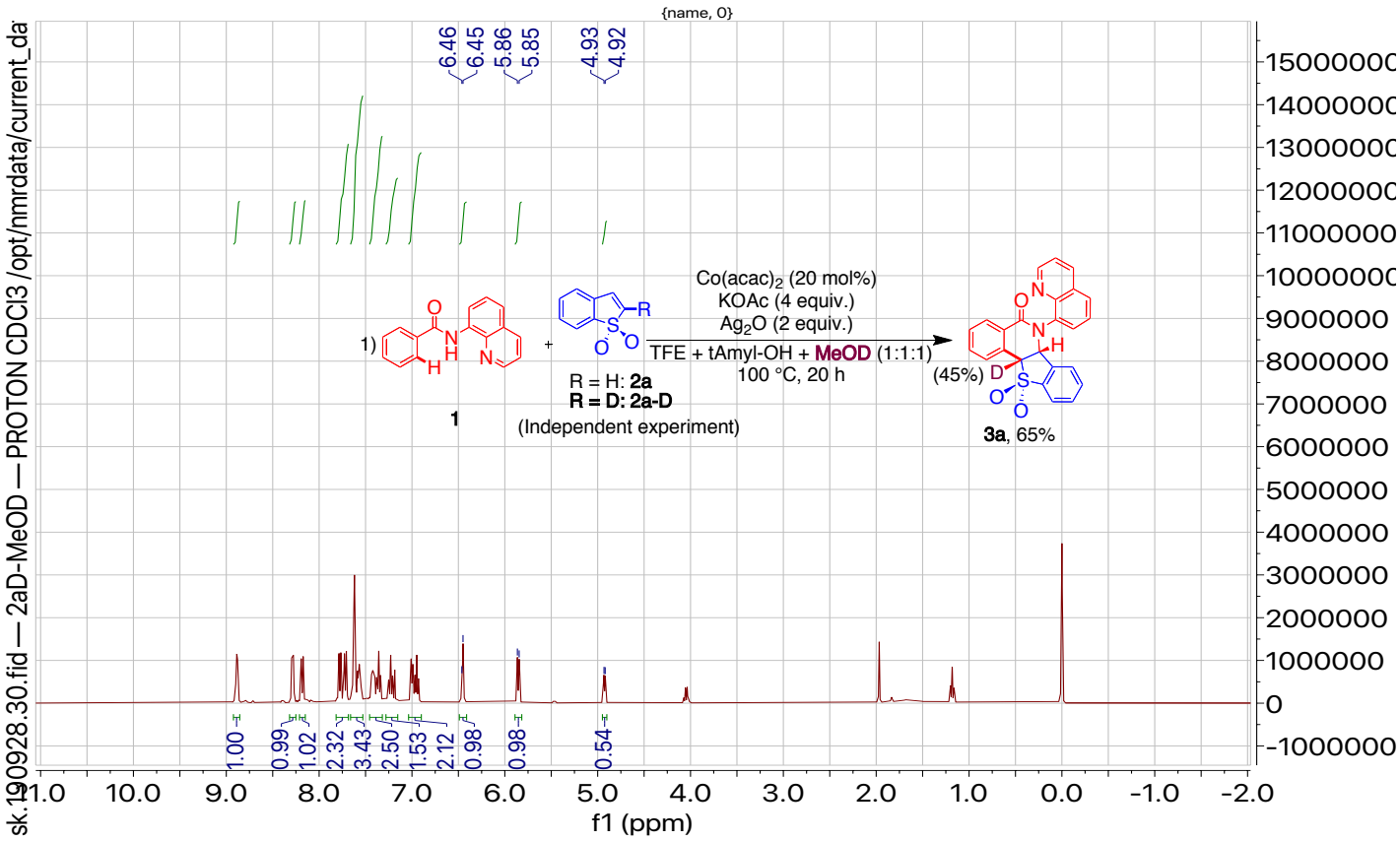
{name, 0}
1)
1
R = H: 2a
R = D: 2a-D
(Independent experiment)
Co(acac)2 (20 mol%)
KOAc (4 equiv.)
Ag2O (2 equiv.)
TFE + tAmyl-OH + MeOD (1:1:1)
100 °C, 20 h
(45%)
3a, 65%
f1 (ppm)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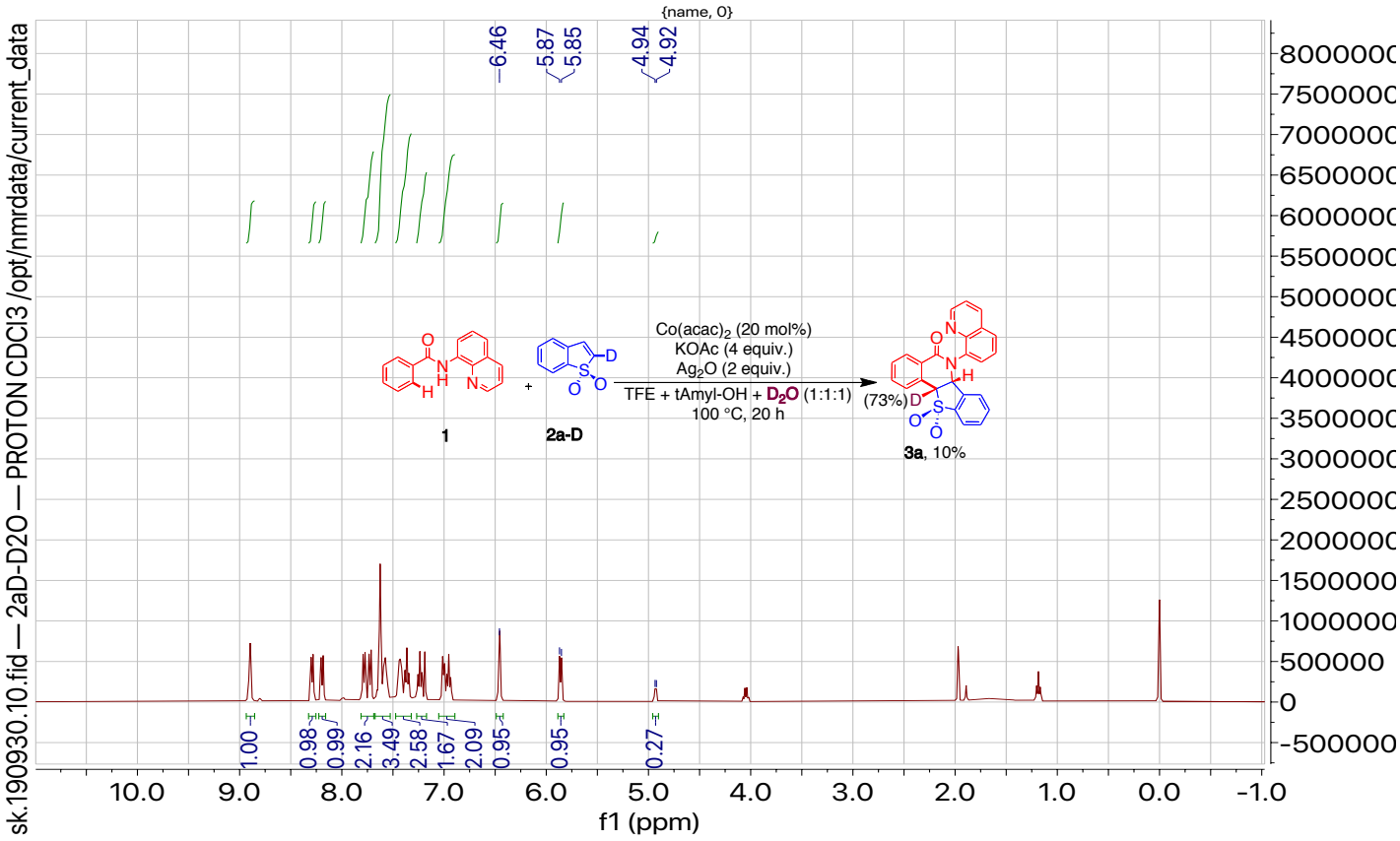
6.46
6.45
5.86
5.85
4.93
4.92
1.00
0.99
1.02
2.32
3.43
2.50
1.53
2.12
0.98
0.98
0.54
1)
1
R = H: 2a
R = D: 2a-D
(Independent experiment)
Co(acac)2 (20 mol%)
KOAc (4 equiv.)
Ag2O (2 equiv.)
TFE + tAmyl-OH + MeOD (1:1:1)
100 °C, 20 h
(45%)
3a, 65%
f1 (ppm)


{name, 0}
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6.46
5.87
5.85
4.94
4.92
1.00
0.98
0.99
2.16
3.49
2.58
1.67
2.09
0.95
0.95
0.27
1
2a-D
Co(acac)2 (20 mol%)
KOAc (4 equiv.)
Ag2O (2 equiv.)
TFE + tAmyl-OH + D2O (1:1:1)
100 °C, 20 h
(73%)
3a, 10%
f1 (ppm)

10. General procedure for cobalt catalyzed C-H activation

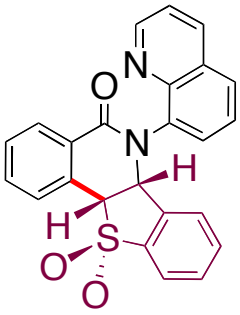
8-aminoquinolinamide **1** (1 equiv.), benzothiophene [*b*]-1,1-dioxide **2** (1.5 equiv), $Co(acac)_2$ (20 mol%), KOAc (4 equiv), Ag_2O (2 equiv), were placed in a 10 mL vial are dissolved in 1 mL of TFE+^{t}Amyl-OH (1:1). The vial was placed in a preheated hot block and stirred at 110 °C for 36 h. TLC was used to monitor reaction progress. The solvent was evaporated and the products were separated by column chromatography using a step gradient moving from petroleum ether (40-65 °C) to pure ethyl acetate as eluent. In most cases the compounds were eluted with ethyl acetate.

11. 1 mmol scale experiment

8-aminoquinolinamide **1a** (1.22 mmol), benzothiophene [*b*]-1,1-dioxide **2a** (1.02 mmol), $Co(acac)_2$ (0.2 mmol), KOAc (4.8 mmol) and Ag_2O (2.4 mmol) were placed in a 50 mL vial and dissolved in 5 mL of TFE+^{t}Amyl-OH (1:1). The vial was placed in a preheated hot block and stirred at 110 °C for 36 h. TLC was used to monitor reaction progress. The solvent was evaporated and the product (**3a**) was separated by column chromatography using a step gradient moving from petroleum ether (40-65 °C) to pure ethyl acetate as eluent as brown solid (0.29g, 67%).

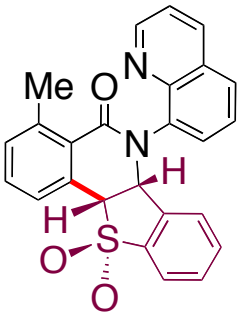
12. Spectroscopic and Analytical Data

(6a*R*)-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3a):



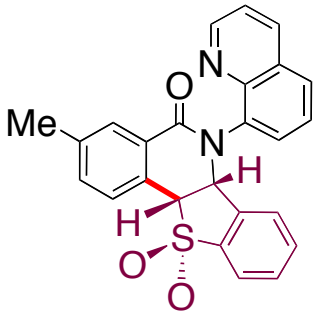
The general procedure was followed using benzamide **1a** (107 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [*b*]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3a** in 85% (126 mg) isolated yield. Brown solid, m.pt – 248 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.97 (s, 1H), 8.37 (t, *J* = 6.4 Hz, 1H), 8.27 (t, *J* = 6.5 Hz, 1H), 7.86 (t, *J* = 6.4 Hz, 1H), 7.80 (t, *J* = 6.7 Hz, 1H), 7.70 (d, *J* = 5.0 Hz, 2H), 7.65 (d, *J* = 5.4 Hz, 1H), 7.54 – 7.48 (m, 2H), 7.44 (q, *J* = 6.9 Hz, 1H), 7.31 (q, *J* = 7.1 Hz, 1H), 7.07 (q, *J* = 6.8, 6.3 Hz, 1H), 7.06 – 6.99 (m, 1H), 6.53 (d, *J* = 5.6 Hz, 1H), 5.93 (d, *J* = 6.7 Hz, 1H), 5.01 (d, *J* = 5.6 Hz, 1H), 2.17 (s, 1H). **^{13}C NMR (500 MHz, Chloroform-*d*)** δ 162.83, 150.86, 144.74, 138.65, 136.80, 136.23, 135.47, 132.98, 132.27, 132.24, 130.71, 130.36, 130.01, 129.49, 129.33, 128.86, 128.58, 128.45, 126.46, 126.19, 122.49, 121.70, 64.64, 57.69. **IR (neat)**: 1665, 1519, 1483, 1321, 1258. **HRMS (ESI)** M/Z calculated for $C_{24}H_{16}N_2O_3S$ $[M+H]^+$: 413.0954, found: 413.0910.

(6a)-4-methyl-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3b):



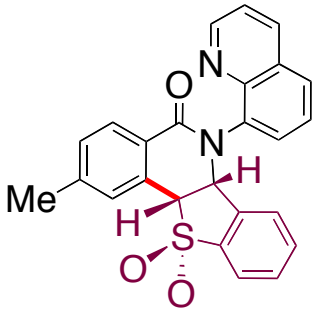
The general procedure was followed using benzamide **1b** (113 mg, 0.43 mmol, 1 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3b** in 69% (106 mg) isolated yield. Brown solid, m.pt – 113 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** 8.99 (s, 1H), 8.26 (d, *J* = 8.2 Hz, 1H), 7.85 (d, *J* = 7.8 Hz, 1H), 7.77 (d, *J* = 8.2 Hz, 1H), 7.54 (q, *J* = 8.7 Hz, 3H), 7.48 – 7.38 (m, 2H), 7.33 – 7.26 (m, 2H), 7.12 (d, *J* = 7.2 Hz, 1H), 7.00 (t, *J* = 7.6 Hz, 1H), 6.48 (s, 1H), 5.95 (d, *J* = 7.6 Hz, 1H), 4.97 (d, *J* = 5.6 Hz, 1H), 2.77 (s, 3H). **^{13}C NMR (500 MHz, Chloroform-*d*)** δ 163.56, 150.67, 143.66, 138.52, 136.85, 136.60, 135.77, 134.71, 132.47, 132.22, 132.05, 130.60, 129.33, 128.30, 128.10, 127.43, 127.28, 126.50, 122.53, 121.62, 65.73, 57.07, 23.45. **IR (neat)**: 1639, 1467, 1368, 1301, 1255, 1149, 1123. **HRMS (ESI)** M/Z calculated for $C_{25}H_{17}N_2O_3S$ $[M+H]^+$: 427.1111, found: 427.1110.

(6a)-3-methyl-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3c):



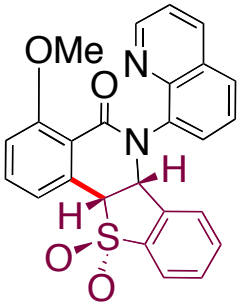
The general procedure was followed using benzamide **1c** (113 mg, 0.43 mmol, 1 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3c** in 69% (106 mg) isolated yield. Yellow solid, m.pt – 220 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** 8.97 (s, 1H), 8.27 (s, 1H), 8.18 (s, 1H), 7.83 (dd, *J* = 27.9, 8.5 Hz, 2H), 7.60 (d, *J* = 7.6 Hz, 1H), 7.52 (d, *J* = 8.5 Hz, 2H), 7.44 (t, *J* = 8.0 Hz, 2H), 7.32 (t, *J* = 8.2 Hz, 1H), 7.11 – 6.98 (m, 2H), 6.50 (s, 1H), 5.93 (d, *J* = 7.6 Hz, 1H), 4.98 (d, *J* = 5.9 Hz, 1H), 2.49 (s, 3H). **^{13}C NMR (500 MHz, Chloroform-*d*)** δ 163.03, 150.75, 140.69, 138.71, 137.76, 136.80, 136.34, 135.62, 133.80, 132.18, 130.64, 130.46, 129.79, 129.33, 129.25, 129.16, 128.78, 128.38, 125.17, 122.53, 121.64, 64.51, 57.75, 21.51. **IR (neat)**: 1646, 1498, 1426, 1366, 1303, 1279, 1150. **HRMS (ESI)** M/Z calculated for $C_{25}H_{17}N_2O_3S$ $[M+H]^+$: 427.1111, found: 427.1110.

(6a)-4-methyl-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3d):



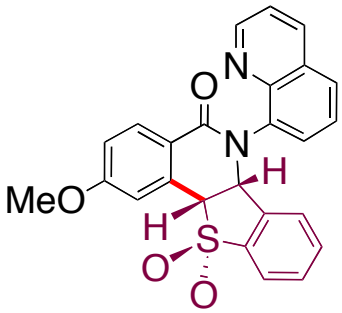
The general procedure was followed using benzamide **1d** (113 mg, 0.43 mmol, 1 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3d** in 62% (95 mg) isolated yield. Yellow solid, m.pt – 113 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.97 (s, 1H), 8.25 (t, *J* = 7.7 Hz, 2H), 7.86 (d, *J* = 7.7 Hz, 1H), 7.79 (d, *J* = 8.2 Hz, 1H), 7.52 – 7.40 (m, 4H), 7.34 – 7.25 (m, 1H), 7.10 – 7.00 (m, 2H), 6.52 (d, *J* = 5.8 Hz, 1H), 5.92 (d, *J* = 7.7 Hz, 1H), 4.95 (d, *J* = 5.8 Hz, 1H), 2.53 (s, 3H). **^{13}C NMR (500 MHz, Chloroform-*d*)** δ 163.02, 150.80, 144.80, 143.84, 138.68, 136.76, 136.36, 135.57, 132.28, 132.22, 131.27, 130.65, 130.05, 129.32, 129.28, 128.59, 128.38, 126.87, 126.46, 126.08, 122.49, 121.65, 64.68, 57.73, 21.69. **IR (neat)**: 1722, 1659, 1611, 1369, 1300, 1275, 1262, 1151, 1125. **HRMS (ESI)** M/Z calculated for $C_{25}H_{17}N_2O_3S$ $[M+H]^+$: 427.1111, found: 427.1110.

(6a)-4-methoxy-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3e):



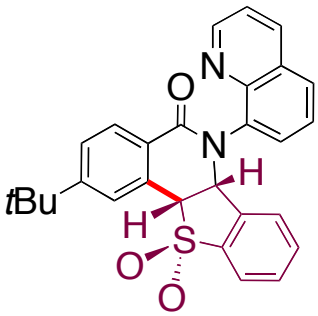
The general procedure was followed using benzamide **1e** (120 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3e** in 59% (84 mg) isolated yield. Yellow solid, m.pt – 204 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.89 (s, 1H), 8.25 – 8.11 (m, 2H), 7.83 – 7.66 (m, 2H), 7.39 (d, *J* = 21.8 Hz, 5H), 7.30 – 7.15 (m, 2H), 6.97 (dd, *J* = 14.8, 5.9 Hz, 2H), 6.44 (s, 1H), 5.84 (d, *J* = 6.3 Hz, 1H), 4.87 (s, 1H), 2.44 (s, 3H). **^{13}C NMR (500 MHz, Chloroform-*d*)** 162.02, 149.74, 142.83, 137.71, 135.80, 135.33, 134.57, 131.33, 131.18, 130.26, 129.63, 129.04, 128.31, 128.26, 127.58, 127.35, 125.87, 125.47, 125.07, 121.49, 120.62, 63.69, 56.71, 20.64. **IR (neat)**: 2247, 2122, 1659, 1622. **HRMS (ESI)** M/Z calculated for $C_{25}H_{18}N_2O_4S$ $[M+H]^+$: 443.1060, found: 443.1060.

(6a)-2-methoxy-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3f):



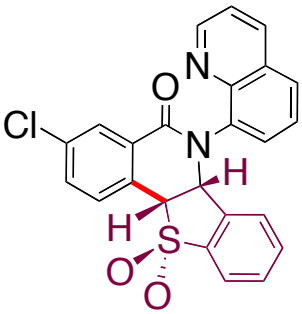
The general procedure was followed using benzamide **1f** (120 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3f** in 60% (95 mg) isolated yield. Colorless solid, m.pt – >250 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.98 (s, 1H), 8.29 (t, *J* = 10.7 Hz, 2H), 7.86 (d, *J* = 7.7 Hz, 1H), 7.80 (d, *J* = 8.2 Hz, 1H), 7.55 – 7.48 (m, 1H), 7.45 (t, *J* = 7.7 Hz, 1H), 7.37 – 7.29 (m, 1H), 7.15 (d, *J* = 12.0 Hz, 2H), 7.12 – 7.00 (m, 2H), 6.53 (d, *J* = 5.8 Hz, 1H), 5.95 (d, *J* = 7.7 Hz, 1H), 4.96 (d, *J* = 5.8 Hz, 1H), 3.97 (s, 3H). **^{13}C NMR (500 MHz, Chloroform-*d*)** δ 163.15, 162.89, 150.75, 138.63, 136.41, 135.58, 132.39, 132.24, 132.14, 130.64, 129.33, 128.54, 128.34, 128.03, 126.49, 122.49, 122.17, 121.62, 116.25, 113.36, 64.85, 57.76, 55.78. **IR (neat)**: 1645, 1607, 1500, 1372, 1306, 1263, 1152, 1030. **HRMS (ESI)** M/Z calculated for $C_{25}H_{18}N_2O_4S$ $[M+H]^+$: 443.1060, found: 443.1059.

(6a)-2-*tert*-butyl-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3g):



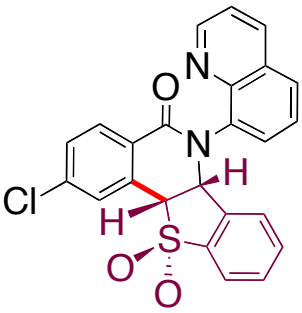
The general procedure was followed using benzamide **1g** (131 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3g** in 79% (131 mg) isolated yield. Colorless solid, m.pt – 210 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.94 (s, 1H), 8.27 (dd, *J* = 9.7, 5.7 Hz, 2H), 7.85 (dd, *J* = 7.8, 3.8 Hz, 1H), 7.81 – 7.75 (m, 1H), 7.67 (d, *J* = 4.0 Hz, 2H), 7.52 – 7.39 (m, 2H), 7.32 – 7.26 (m, 1H), 7.10 – 6.99 (m, 2H), 6.52 (s, 1H), 5.92 (dd, *J* = 8.0, 3.8 Hz, 1H), 4.99 (t, *J* = 4.9 Hz, 1H), 1.43 (s, 9H). **^{13}C NMR (500 MHz, Chloroform-*d*)** δ 162.99, 156.76, 150.81, 144.79, 138.73, 136.77, 136.32, 135.57, 132.27, 132.23, 130.64, 129.81, 129.31, 128.55, 128.38, 127.66, 126.92, 126.42, 125.93, 125.73, 122.46, 121.67, 77.35, 77.10, 76.85, 65.03, 57.83, 35.28, 31.21. **IR (neat)**: 1700, 1651, 1609, 1500, 1423, 1387, 1309, 1152, 1123. **HRMS (ESI)** M/Z calculated for $C_{28}H_{23}N_2O_3S$ $[M+H]^+$: 469.1580, found: 469.1579.

(6a)-3-chloro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3h):



The general procedure was followed using benzamide **1h** (121 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3h** in 55% (89 mg) isolated yield. Colorless solid, m.pt – 180 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 9.01 – 8.93 (m, 1H), 8.33 (d, *J* = 2.2 Hz, 1H), 8.31 – 8.25 (m, 1H), 7.89 – 7.79 (m, 2H), 7.70 – 7.62 (m, 2H), 7.52 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 1H), 7.32 (t, *J* = 7.8 Hz, 1H), 7.05 (t, *J* = 7.7 Hz, 2H), 6.52 (d, *J* = 5.9 Hz, 1H), 5.95 (d, *J* = 7.7 Hz, 1H), 4.98 (d, *J* = 5.8 Hz, 1H). **^{13}C NMR (500 MHz, Chloroform-*d*)** δ 161.68, 150.87, 144.51, 138.44, 136.90, 135.88, 135.22, 133.04, 132.40, 132.16, 131.01, 130.86, 130.23, 130.09, 129.36, 128.63, 126.49, 124.59, 122.56, 121.79, 64.04, 57.67. **IR (neat)**: 1658, 1592, 1571, 1498, 1391, 1374, 1309, 1151, 1123. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}ClN_2O_3S$ $[M+H]^+$: 447.0565, found: 447.0563.

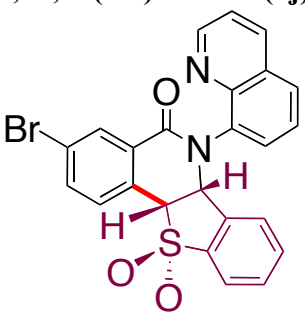
(6a)-2-chloro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3i):



The general procedure was followed using benzamide **1i** (121 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3i** in 60% (95 mg) isolated yield.

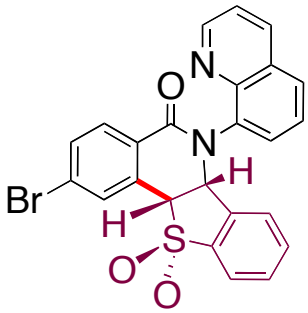
Colorless solid, m.pt – >250 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.98 (s, 1H), 8.29 (t, *J* = 9.0 Hz, 2H), 7.85 (dd, *J* = 25.9, 8.0 Hz, 2H), 7.70 (s, 1H), 7.61 (d, *J* = 8.2 Hz, 1H), 7.49 (dt, *J* = 29.0, 7.2 Hz, 2H), 7.38 – 7.23 (m, 2H), 7.07 (d, *J* = 7.8 Hz, 2H), 6.53 (d, *J* = 5.9 Hz, 1H), 5.95 (d, *J* = 7.8 Hz, 1H), 4.95 (d, *J* = 5.7 Hz, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 162.13, 150.88, 139.31, 138.51, 136.89, 135.99, 135.23, 132.42, 132.25, 131.63, 130.87, 130.75, 129.38, 128.74, 128.64, 128.59, 127.99, 127.94, 126.52, 122.60, 121.78, 64.19, 57.74. **IR (neat)**: 1656, 1594, 1423, 1315, 1280, 1154. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}ClN_2O_3S$ $[M+H]^+$: 447.0565, found: 447.0565.

(6a)-3-bromo-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3j):



The general procedure was followed using benzamide **1j** (140 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3j** in 64% (114 mg) isolated yield. Brown solid, m.pt – 230 °C, **^{1}H NMR (500 MHz, DMSO-d_6)** δ 9.05 – 8.98 (m, 1H), 8.59 – 8.51 (m, 1H), 8.20 (d, *J* = 1.9 Hz, 1H), 8.10 – 7.96 (m, 4H), 7.68 (d, *J* = 7.9 Hz, 2H), 7.58 (t, *J* = 7.9 Hz, 1H), 7.39 (t, *J* = 7.8 Hz, 1H), 7.22 (d, *J* = 8.7 Hz, 1H), 6.74 (d, *J* = 7.2 Hz, 1H), 6.32 (d, *J* = 5.9 Hz, 1H), 5.87 (d, *J* = 7.8 Hz, 1H), 5.71 (d, *J* = 6.0 Hz, 1H). **^{13}C NMR (126 MHz, DMSO-d_6)** δ 161.12, 151.77, 144.30, 138.40, 137.53, 136.44, 136.01, 135.55, 133.29, 132.03, 131.86, 131.68, 131.57, 131.41, 129.54, 129.33, 129.22, 126.59, 124.12, 122.70, 122.65, 63.02, 57.99, 31.17. **IR (neat)**: 1644, 1303, 1275, 1149, 762. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}BrN_2O_3S$ $[M+H]^+$: 491.0060, found: 491.0059.

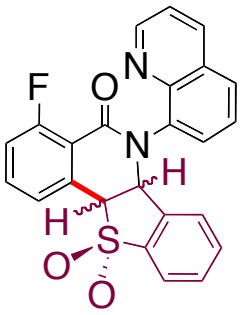
(6a)-2-bromo-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3k):



The general procedure was followed using benzamide **1k** (140 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3k** in 62% (110 mg) isolated yield. Yellow solid, m.pt – >250 °C, **^{1}H NMR (500 MHz, DMSO-d_6)** δ 9.01 (s, 1H), 8.54 (s, 1H), 8.08 – 7.98 (m, 3H), 7.98 – 7.88 (m, 2H), 7.69 (s, 1H), 7.57 (d, *J* = 7.7 Hz, 1H), 7.38 (d, *J* = 7.7 Hz, 1H), 7.21 (d, *J* = 7.7 Hz, 1H), 6.75 (s, 1H), 6.34 (s, 1H), 5.88 (s, 1H), 5.68 (t, *J* = 4.4 Hz, 1H). **^{13}C NMR (126 MHz, DMSO-d_6)** δ 161.73, 151.73, 144.39, 138.35, 137.51, 136.12, 135.57, 133.87, 133.32, 132.11, 131.86, 131.69, 131.35, 129.52, 129.48, 129.26, 129.19, 128.81, 127.08, 126.58, 122.73, 122.62, 63.01, 58.03. **IR (neat)**: 1651, 1310,

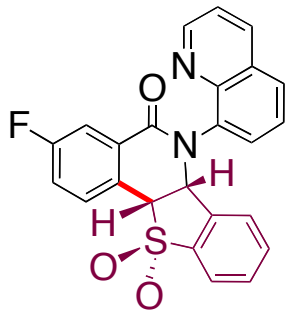
1275, 1152, 1124, 762. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}BrN_2O_3S$ $[M+H]^+$: 491.0060, found: 491.0060.

(6a)-4-fluoro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3l):



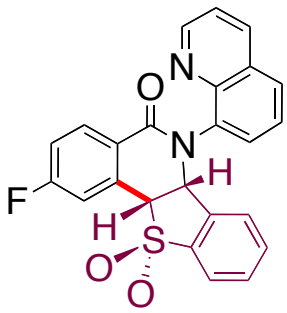
The general procedure was followed using benzamide **1l** (114 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3l** in 50% (78 mg) isolated yield. Yellow solid, m.pt – >250 °C, **^{1}H NMR (400 MHz, Chloroform-*d*)** δ 8.90 (s, 1H), 8.72 (s, 1H), 8.27 – 8.04 (m, 2H), 7.74 (dd, *J* = 27.1, 9.0 Hz, 4H), 7.59 (s, 1H), 7.52 – 7.13 (m, 7H), 7.13 – 6.79 (m, 2H), 6.44 (s, 1H), 6.01 – 5.84 (m, 1H), 4.93 (s, 1H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 163.56, 160.91, 158.90, 150.99, 149.76, 143.73, 143.36, 138.85, 138.66, 137.29, 135.82, 135.66, 135.26, 134.78, 134.74, 134.64, 134.36, 133.75, 133.30, 133.20, 132.14, 131.43, 131.40, 130.37, 129.95, 129.79, 129.76, 129.32, 128.36, 128.29, 127.88, 127.47, 127.36, 125.97, 125.48, 125.41, 124.01, 123.97, 122.75, 121.59, 121.52, 120.76, 120.66, 118.60, 118.37, 117.77, 117.72, 116.68, 116.64, 114.92, 114.71, 63.73, 56.40, 45.00. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -107.37, -107.86. **IR (neat)**: 1655, 1610, 1468, 1388, 1305, 1255, 1153, 1125, 906. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}FN_2O_3S$ $[M+H]^+$: 431.0860, found: 431.0859.

(6a)-3-fluoro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3m):



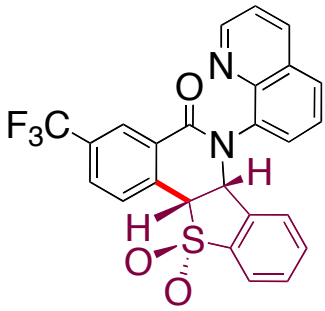
The general procedure was followed using benzamide **1m** (114 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3m** in 62% (96 mg) isolated yield. Yellow solid, m.pt – >250 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.98 (d, *J* = 4.7 Hz, 1H), 8.31 – 8.26 (m, 1H), 8.04 (dd, *J* = 9.0, 2.9 Hz, 1H), 7.90 – 7.79 (m, 2H), 7.73 – 7.67 (m, 1H), 7.52 (dd, *J* = 8.3, 4.3 Hz, 1H), 7.49 – 7.37 (m, 3H), 7.36 – 7.29 (m, 1H), 7.27 (d, *J* = 5.5 Hz, 1H), 7.06 (dd, *J* = 10.1, 4.0 Hz, 2H), 6.52 (d, *J* = 5.8 Hz, 1H), 5.94 (d, *J* = 7.3 Hz, 1H), 4.99 (d, *J* = 5.7 Hz, 1H). ^{13}C NMR (126 MHz, **Chloroform-*d***) δ 165.01, 163.02, 161.78, 150.86, 138.48, 136.94, 135.87, 135.24, 132.35, 132.22, 131.92, 131.86, 130.84, 129.35, 128.61, 126.53, 122.58, 122.08, 122.05, 121.78, 120.45, 120.26, 117.05, 116.86, 64.00, 63.93, 60.42, 57.74. **^{19}F NMR (376 MHz, DMSO)** δ -108.70, -109.85. **IR (neat)**: 1648, 1022, 990. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}FN_2O_3S$ $[M+H]^+$: 431.0860, found: 431.0860.

(6a)-2-fluoro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3n):



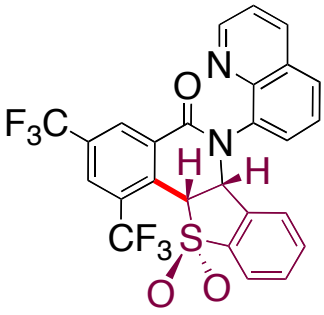
The general procedure was followed using benzamide **1n** (114 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3n** in 67% (104 mg) isolated yield. Brown solid, m.pt – >250 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.98 (s, 1H), 8.43 – 8.34 (m, 1H), 8.28 (d, *J* = 8.2 Hz, 1H), 7.84 (dd, *J* = 24.6, 7.8 Hz, 2H), 7.56 – 7.50 (m, 1H), 7.46 (s, 1H), 7.41 (d, *J* = 8.0 Hz, 1H), 7.33 (s, 2H), 7.07 (d, *J* = 7.2 Hz, 2H), 6.55 (d, *J* = 5.9 Hz, 1H), 5.96 (d, *J* = 7.7 Hz, 1H), 4.97 (d, *J* = 5.8 Hz, 1H). **^{13}C NMR (126 MHz, Chloroform-*d*)** δ 166.22, 164.19, 162.06, 150.86, 138.44, 136.85, 135.26, 133.02, 132.94, 132.42, 132.21, 130.83, 129.36, 128.79, 128.71, 128.55, 126.49, 122.54, 121.75, 117.80, 117.63, 115.81, 115.63, 64.37, 57.72. **^{19}F NMR (376 MHz, $CDCl_3$)** δ -105.02. **IR (neat)**: 1648, 1606, 1497, 1388, 1312, 1279, 1149, 1128. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}FN_2O_3S$ $[M+H]^+$: 431.0860, found: 431.0858.

(6a)-6-(quinolin-8-yl)-3-(trifluoromethyl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3o):



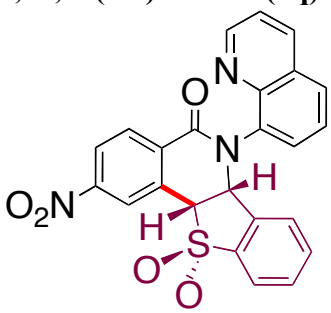
The general procedure was followed using benzamide **1o** (136 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3o** in 64% (110 mg) isolated yield. Yellow solid, m.pt – 146 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 9.00 – 8.95 (m, 1H), 8.63 (d, *J* = 2.0 Hz, 1H), 8.31 – 8.27 (m, 1H), 7.95 (dd, *J* = 8.1, 2.0 Hz, 1H), 7.90 – 7.80 (m, 3H), 7.52 (dd, *J* = 8.3, 4.0 Hz, 1H), 7.47 (t, *J* = 7.6 Hz, 1H), 7.32 (t, *J* = 7.8 Hz, 1H), 7.07 (ddd, *J* = 7.8, 5.7, 2.0 Hz, 2H), 6.55 (d, *J* = 5.7 Hz, 1H), 5.95 (d, *J* = 7.8 Hz, 1H), 5.06 (d, *J* = 5.6 Hz, 1H). **^{13}C NMR (126 MHz, Chloroform-*d*)** δ 161.53, 150.94, 144.44, 138.35, 136.94, 135.72, 135.03, 132.83, 132.56, 132.53, 132.12, 130.97, 130.33, 129.97, 129.59, 129.43, 129.40, 129.37, 129.34, 128.74, 128.69, 127.23, 127.20, 127.17, 127.14, 126.48, 124.57, 122.55, 122.40, 121.84, 64.13, 57.64. **^{19}F NMR (470 MHz, Chloroform-*d*)** δ -62.97. **IR (neat)**: 1658, 1310, 1152, 1124. **HRMS (ESI)** M/Z calculated for $C_{25}H_{15}F_3N_2O_3S$ $[M+H]^+$: 481.0828, found: 481.0827.

(6a)-6-(quinolin-8-yl)-1,3-bis(trifluoromethyl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3p):



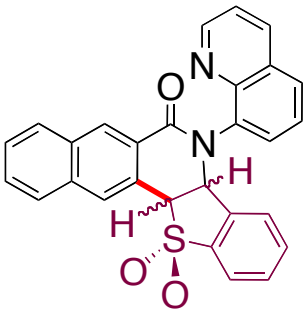
The general procedure was followed using benzamide **1p** (165 mg, 0.43 mmol, 1 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3p** in 70% (116 mg) isolated yield. Brown solid, m.pt – 106 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.97 (d, *J* = 4.4 Hz, 1H), 8.89 (d, *J* = 3.9 Hz, 1H), 8.28 (d, *J* = 4.7 Hz, 2H), 7.91 – 7.86 (m, 1H), 7.80 (dt, *J* = 8.4, 2.2 Hz, 1H), 7.53 (dt, *J* = 8.1, 3.9 Hz, 1H), 7.48 (dt, *J* = 11.0, 5.5 Hz, 1H), 7.35 – 7.28 (m, 1H), 7.06 (dt, *J* = 18.6, 5.6 Hz, 2H), 6.53 (s, 1H), 5.99 (d, *J* = 7.7 Hz, 1H), 5.44 (d, *J* = 4.7 Hz, 1H). **^{13}C NMR (126 MHz, Chloroform-*d*)** δ 159.94, 150.97, 144.22, 138.08, 136.98, 134.82, 133.87, 132.81, 132.67, 132.54, 132.07, 131.10, 130.89, 130.51, 129.24, 128.72, 128.38, 128.17, 127.05, 126.50, 123.85, 123.81, 122.99, 121.89, 61.91, 57.96. **^{19}F NMR (470 MHz, Chloroform-*d*)** δ -57.25, -63.24, -63.25. **IR (neat)**: 1667, 1623, 1449, 1467, 1272. **HRMS (ESI)** M/Z calculated for $C_{26}H_{14}F_6N_2O_3S$ $[M+H]^+$: 549.0702, found: 549.0701.

(6a)-2-nitro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (3q):



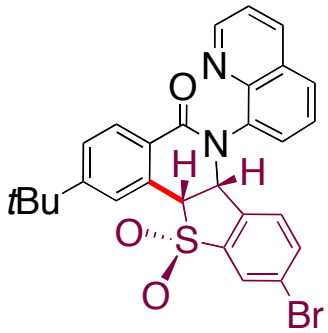
The general procedure was followed using benzamide **1q** (126 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3q** in 75% (95 mg) isolated yield. Colorless solid, m.pt – >250 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.97 (d, *J* = 4.1 Hz, 1H), 8.55 (d, *J* = 9.8 Hz, 2H), 8.45 (d, *J* = 8.4 Hz, 1H), 8.30 (d, *J* = 8.3 Hz, 1H), 7.86 (dd, *J* = 21.8, 8.0 Hz, 2H), 7.57 – 7.46 (m, 2H), 7.34 (t, *J* = 7.9 Hz, 1H), 7.08 (q, *J* = 7.8 Hz, 2H), 6.57 (d, *J* = 5.8 Hz, 1H), 5.97 (d, *J* = 7.7 Hz, 1H), 5.11 (d, *J* = 5.6 Hz, 1H). **^{13}C NMR (126 MHz, Chloroform-*d*)** δ 160.93, 151.05, 150.21, 144.32, 138.16, 136.91, 135.46, 134.78, 134.51, 132.66, 131.96, 131.65, 131.13, 129.37, 128.88, 128.71, 128.09, 126.46, 124.98, 124.08, 122.67, 121.94, 63.95, 57.73. **IR (neat)**: 1658, 1522, 1335, 1314, 1152. **HRMS (ESI)** M/Z calculated for $C_{24}H_{15}N_3O_5S$ $[M+H]^+$: 458.0805, found: 458.0804.

(12b)-5-(quinolin-8-yl)-4b,12b-dihydro-13*H*-13λ^6-benzo[*g*][1]benzothieno[3,2-*c*]isoquinoline-6,13,13(5*H*)-trione (3r):



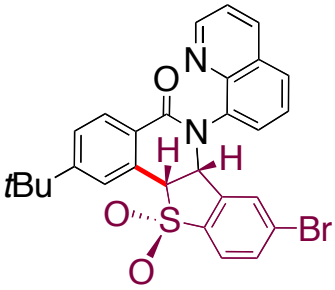
The general procedure was followed using benzamide **1r** (128 mg, 0.43 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **2a** (60 mg, 0.36 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **3r** in 49% (81 mg) isolated yield. Brown solid, m.pt –208 °C, **^{1}H NMR (400 MHz, DMSO-*d*$_6$)** δ 9.11 – 9.03 (m, 1H), 8.83 (s, 1H), 8.62 (dd, *J* = 8.4, 1.7 Hz, 1H), 8.37 – 8.23 (m, 3H), 8.12 – 8.03 (m, 2H), 7.91 – 7.71 (m, 4H), 7.64 (q, *J* = 7.5 Hz, 2H), 7.46 (t, *J* = 7.9 Hz, 1H), 7.28 (q, *J* = 7.3 Hz, 1H), 6.91 – 6.81 (m, 1H), 6.47 (dd, *J* = 12.1, 5.7 Hz, 1H), 6.05 – 5.83 (m, 2H). **^{13}C NMR (101 MHz, DMSO-*d*$_6$)** δ 170.82, 162.75, 162.62, 151.73, 151.69, 144.61, 144.55, 139.02, 138.60, 137.53, 136.67, 136.43, 136.13, 136.09, 135.54, 134.96, 133.42, 133.24, 133.14, 132.00, 131.57, 131.17, 130.59, 130.50, 129.96, 129.56, 129.49, 129.46, 129.33, 129.20, 129.14, 129.10, 129.01, 128.45, 128.28, 128.23, 128.11, 126.65, 126.61, 126.49, 126.23, 125.73, 124.60, 123.25, 122.80, 122.68, 122.61, 64.04, 60.82, 60.23, 58.50, 58.05, 21.24, 14.56. **IR (neat)**: 2247, 2122, 1659, 1622. **HRMS (ESI)** M/Z calculated for $C_{28}H_{18}N_2O_3S$ $[M+H]^+$: 463.1111, found: 463.1110.

(6a)-9-bromo-2-*tert*-butyl-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6- [1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (4a):



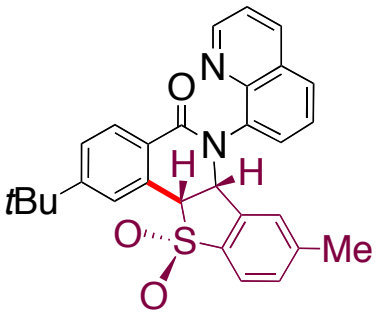
The general procedure was followed using benzamide **1g** (74 mg, 0.29 mmol, 1.2 equiv.) and 6-bromobenzothiophene [b]-1,1-dioxide **4a** (60 mg, 0.24 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **4a** in 65% (86 mg) isolated yield. Brown solid, m.pt –154 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 8.95 (d, *J* = 2.4 Hz, 1H), 8.27 (d, *J* = 8.3 Hz, 2H), 7.99 (d, *J* = 1.9 Hz, 1H), 7.86 – 7.80 (m, 1H), 7.72 – 7.66 (m, 1H), 7.65 (d, *J* = 1.9 Hz, 1H), 7.50 (dd, *J* = 8.3, 4.2 Hz, 1H), 7.38 (t, *J* = 7.8 Hz, 1H), 7.17 – 7.10 (m, 2H), 6.51 (d, *J* = 5.8 Hz, 1H), 5.80 (d, *J* = 8.2 Hz, 1H), 5.00 (d, *J* = 5.8 Hz, 1H), 1.44 (s, 9H). **^{13}C NMR (126 MHz, Chloroform-*d*)** δ 162.89, 156.96, 150.83, 144.66, 140.44, 136.87, 136.04, 135.29, 134.44, 132.45, 129.92, 129.87, 129.35, 128.52, 127.86, 126.79, 126.65, 125.67, 125.62, 125.40, 124.53, 121.73, 65.36, 57.36, 35.30, 31.18. **IR (neat)**: 1662, 1608, 1462, 1421, 1362, 1318, 1151, 1136. **HRMS (ESI)** M/Z calculated for $C_{28}H_{23}N_2O_3S$ $[M+H]^+$: 547.0686, found: 547.0685.

2-*tert*-butyl-8-bromo-6-(quinolin-8-yl)-6a-11a-dihydro-11H-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (4b):



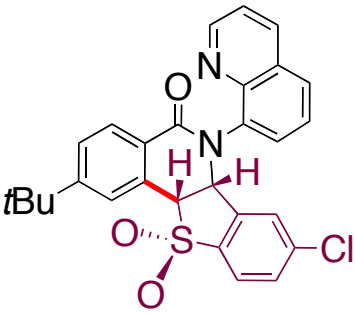
The general procedure was followed using benzamide **1g** (74 mg, 0.29 mmol, 1.2 equiv.) and 5-bromobenzothiophene [b]-1,1-dioxide **4b** (60 mg, 0.24 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **4b** in 62% (81 mg) isolated yield. Brown solid, m.pt –116 °C, **^{1}H NMR (500 MHz, Chloroform-*d*)** δ 9.00 – 8.95 (m, 1H), 8.30 (dd, *J* = 14.2, 8.3 Hz, 2H), 7.86 (d, *J* = 8.3 Hz, 1H), 7.76 – 7.63 (m, 3H), 7.60 – 7.50 (m, 2H), 7.39 (t, *J* = 7.8 Hz, 1H), 7.27 (d, *J* = 1.5 Hz, 1H), 7.13 (d, *J* = 7.3 Hz, 1H), 6.46 (d, *J* = 5.8 Hz, 1H), 6.03 (s, 1H), 5.00 (d, *J* = 5.8 Hz, 1H), 1.44 (s, 9H). **^{13}C NMR (126 MHz, Chloroform-*d*)** δ 162.87, 156.95, 150.93, 144.53, 137.65, 137.54, 136.94, 133.82, 132.29, 131.81, 129.92, 129.41, 128.64, 127.85, 126.80, 126.78, 126.51, 125.70, 125.49, 123.76, 121.80, 77.29, 77.03, 76.78, 65.10, 57.48, 35.30, 31.18, 27.01. **IR (neat)**: 1655, 1609, 1256, 1013. **HRMS (ESI)** M/Z calculated for $C_{28}H_{23}N_2O_3S$ $[M+H]^+$: 547.0686, found: 547.0684.

2-*tert*-butyl-8-methyl-6-(quinolin-8-yl)-6a-11a-dihydro-11H-11λ^6 [1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (4c):



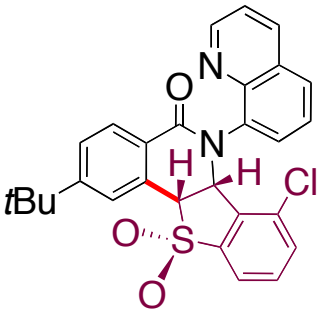
The general procedure was followed using benzamide **1g** (121 mg, 0.39 mmol, 1.2 equiv.) and 5-methylbenzothiophene [b]-1,1-dioxide **4c** (60 mg, 0.33 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **4c** in 69% (110 mg) isolated yield. Brown solid, m.pt – >250 °C, **^{1}H NMR (400 MHz, Chloroform-*d*)** δ 8.87 (s, 1H), 8.18 (d, *J* = 4.2 Hz, 2H), 7.75 – 7.69 (m, 1H), 7.64 (d, *J* = 8.2 Hz, 1H), 7.62 – 7.56 (m, 2H), 7.40 (dd, *J* = 8.3, 4.1 Hz, 1H), 7.22 (ddd, *J* = 17.3, 8.6, 3.1 Hz, 1H), 7.17 – 7.10 (m, 1H), 7.00 (d, *J* = 4.5 Hz, 1H), 6.33 (s, 1H), 5.59 (s, 1H), 4.89 (d, *J* = 3.1 Hz, 1H), 1.83 (s, 3H), 1.35 (s, 9H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 161.96, 155.68, 149.77, 143.81, 142.16, 135.61, 135.53, 135.00, 134.80, 131.26, 130.28, 128.77, 128.25, 128.01, 127.15, 126.56, 125.90, 125.34, 125.11, 124.68, 121.13, 120.59, 64.17, 56.80, 34.23, 30.17. **IR (neat)**: 1656, 1520, 1302, 1166, 1131, 1021, 993. **HRMS (ESI)** M/Z calculated for $C_{29}H_{26}N_2O_3S$ $[M+H]^+$: 483.1737, found: 483.1736.

(6a)-2-*tert*-butyl-8-chloro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (4d):



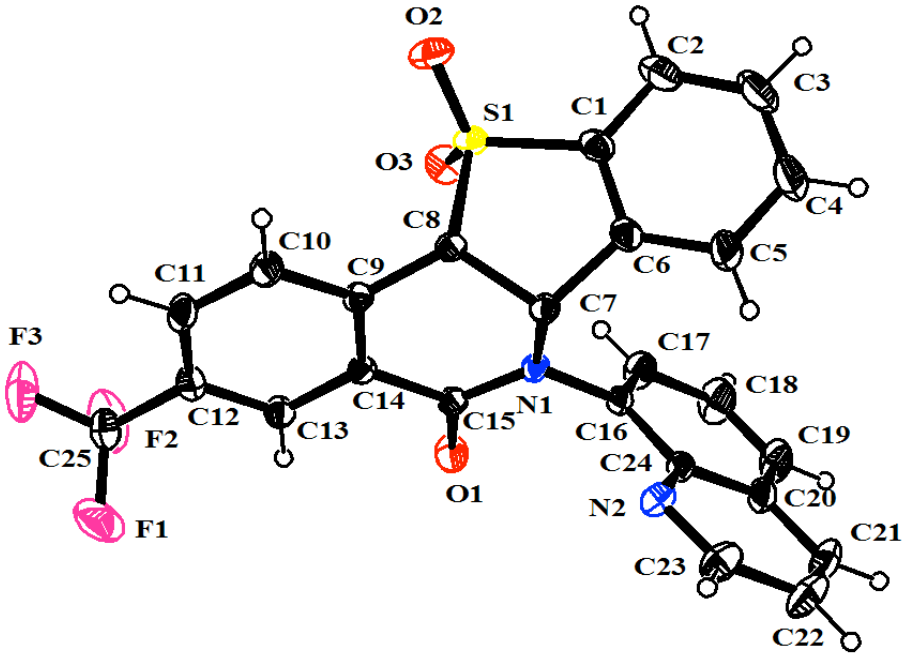
The general procedure was followed using benzamide **1g** (109 mg, 0.36 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **4d** (60 mg, 0.30 mmol, 1 equiv.). Purification by column chromatography on silica gel (100% PE → 80% PE → 50% PE → 100% EA) yielded **4d** in 79% (119 mg) isolated yield. Brown solid, m.pt – >250 °C, **^{1}H NMR (400 MHz, Chloroform-*d*)** δ 8.87 (s, 1H), 8.26 – 8.16 (m, 2H), 7.80 – 7.74 (m, 1H), 7.70 (dd, *J* = 8.4, 2.9 Hz, 1H), 7.65 – 7.54 (m, 2H), 7.46 – 7.39 (m, 1H), 7.30 (td, *J* = 9.5, 4.8 Hz, 2H), 7.09 – 7.02 (m, 1H), 6.39 (s, 1H), 5.80 (s, 1H), 4.92 (d, *J* = 4.6 Hz, 1H), 1.35 (s, 9H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 161.85, 155.92, 149.88, 143.59, 137.56, 136.58, 136.18, 135.85, 135.05, 131.21, 129.93, 128.89, 128.38, 127.72, 127.60, 126.79, 125.78, 125.45, 124.68, 124.56, 122.65, 120.76, 64.16, 56.48, 34.26, 30.15. **IR (neat)**: 1651, 1315, 1052, 1022, 1005. **HRMS (ESI)** M/Z calculated for $C_{28}H_{23}ClN_2O_3S$ $[M+H]^+$: 503.1191, found: 503.1190.

(6a)-2-*tert*-butyl-7-chloro-6-(quinolin-8-yl)-6a,11a-dihydro-11*H*-11λ^6-[1]benzothieno[3,2-*c*]isoquinoline-5,11,11(6*H*)-trione (4e):



The general procedure was followed using benzamide **1g** (109 mg, 0.36 mmol, 1.2 equiv.) and benzothiophene [b]-1,1-dioxide **4e** (60 mg, 0.30 mmol, 1 equiv.). Purification by column chromatography on silica gel using petroleum ether and isopropanol (100% PE → 95% PE → 90% PE → 80% PE) yielded **4e** in 60% (96 mg) isolated yield. R_f = 0.5 Brown solid, m.pt – >250 °C, **^{1}H NMR (400 MHz, Chloroform-*d*)** δ 8.83 (s, 1H), 8.22 (dd, *J* = 8.3, 2.8 Hz, 1H), 8.11 (d, *J* = 8.3 Hz, 1H), 7.80 (dd, *J* = 7.5, 2.7 Hz, 1H), 7.73 (d, *J* = 8.3 Hz, 1H), 7.63 (d, *J* = 8.0 Hz, 1H), 7.53 (s, 1H), 7.43 (td, *J* = 7.8, 2.7 Hz, 1H), 7.35 (dd, *J* = 8.3, 4.0 Hz, 1H), 7.16 (dt, *J* = 19.7, 5.3 Hz, 3H), 6.75 (d, *J* = 7.2 Hz, 1H), 6.31 (s, 1H), 4.86 (d, *J* = 2.9 Hz, 1H), 1.36 (s, 9H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 162.36, 155.77, 149.65, 140.41, 134.45, 133.11, 132.32, 131.06, 130.16, 128.89, 128.37, 127.85, 126.95, 126.11, 124.84, 124.58, 124.40, 120.55, 120.41, 65.30, 55.95, 34.26, 30.17. **IR (neat)**: 2247, 2123, 1662, 1616, 1376, 1315. **HRMS (ESI)** M/Z calculated for $C_{28}H_{23}ClN_2O_3S$ $[M+H]^+$: 503.1191, found: 503.1190.

13. X-ray crystallography data



CCDC - 1952987

Figure S1. The X-ray crystal data and structure refinement for **3o**

Table S7. Crystal data and structure refinement for 3o

Identification code	Nivedha_SK3CF3	
Chemical formula	$C_{25}H_{15}F_3N_2O_3S$	
Formula weight	480.45 g/mol	
Temperature	296(2) K	
Wavelength	0.71073 Å	
Crystal size	0.170 x 0.220 x 0.250 mm	
Crystal habit	clear light brown BLock	
Crystal system	monoclinic	
Space group	C 1 2/c 1	
Unit cell dimensions	a = 14.3324(4) Å	α = 90°
	b = 10.8827(3) Å	β = 99.6348(13)°
	c = 28.1221(7) Å	γ = 90°
Volume	4324.5(2) $Å^3$	
Z	8	
Density (calculated)	1.476 g/cm^3	
Absorption coefficient	0.207 mm^{-1}	
F(000)	1968	
Theta range for data collection	2.36 to 25.00°	
Index ranges	-16<=h<=16, -12<=k<=12, -33<=l<=33	
Reflections collected	15994	
Independent reflections	3790 [R(int) = 0.0220]	
Coverage of independent reflections	99.6%	
Absorption correction	multi-scan	
Max. and min. transmission	0.9660 and 0.9500	
Refinement method	Full-matrix least-squares on F^2	
Refinement program	SHELXL-2014/7 (Sheldrick, 2014)	

Function minimized	$\Sigma\ w(F_o^2 - F_c^2)^2$
Data / restraints / parameters	3790 / 0 / 307
Goodness-of-fit on F^2	1.049
Final R indices	3255 data; I>2σ(I) R1 = 0.0426, wR2 = 0.1035
	all data R1 = 0.0508, wR2 = 0.1088
Weighting scheme	$w=1/[\sigma^2(F_o^2)+(0.0426P)^2+7.4366P]$ where $P=(F_o^2+2F_c^2)/3$
Largest diff. peak and hole	0.643 and -0.372 eÅ^{-3}
R.M.S. deviation from mean	0.044 eÅ^{-3}

Table S8. Atomic coordinates and equivalent isotropic atomic displacement parameters (Å^2) for 3o.

U(eq) is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x/a	y/b	z/c	U(eq)
C1	0.90090(17)	0.5700(2)	0.12128(8)	0.0367(5)
C2	0.8661(2)	0.6680(2)	0.14448(11)	0.0555(7)
C3	0.9291(3)	0.7528(3)	0.16799(13)	0.0753(10)
C4	0.0246(3)	0.7425(3)	0.16816(12)	0.0717(10)
C5	0.0606(2)	0.6497(3)	0.14346(10)	0.0539(7)
C6	0.99685(17)	0.5641(2)	0.12048(8)	0.0372(5)
C7	0.90051(14)	0.41516(19)	0.05871(7)	0.0281(5)
C8	0.88083(14)	0.28556(19)	0.04319(7)	0.0285(5)
C9	0.89816(17)	0.2428(2)	0.99897(8)	0.0384(5)
C10	0.88482(18)	0.1203(2)	0.98703(8)	0.0414(6)
C11	0.85402(16)	0.0397(2)	0.01903(8)	0.0348(5)
C12	0.83395(16)	0.0818(2)	0.06265(8)	0.0332(5)
C13	0.84791(14)	0.20443(19)	0.07479(7)	0.0273(4)
C14	0.82740(14)	0.24479(19)	0.12265(7)	0.0283(5)
C15	0.84372(15)	0.46363(19)	0.09641(7)	0.0294(5)
C16	0.80846(15)	0.40549(19)	0.17780(7)	0.0285(5)
C17	0.72148(15)	0.46566(19)	0.17915(7)	0.0295(5)
C18	0.58296(18)	0.5460(2)	0.13966(10)	0.0486(6)
C19	0.5568(2)	0.5880(3)	0.18274(11)	0.0587(8)
C20	0.6153(2)	0.5672(3)	0.22445(10)	0.0537(7)
C21	0.70144(17)	0.5041(2)	0.22450(8)	0.0392(5)
C22	0.7660(2)	0.4777(3)	0.26651(9)	0.0545(7)
C23	0.8482(2)	0.4183(3)	0.26404(9)	0.0597(8)
C24	0.86991(18)	0.3831(2)	0.21904(8)	0.0437(6)
C25	0.83996(19)	0.9064(2)	0.00779(9)	0.0432(6)
F1	0.74959(13)	0.87636(16)	0.00171(9)	0.0890(7)
F2	0.88631(16)	0.83585(15)	0.04170(6)	0.0809(6)
F3	0.86840(16)	0.87295(15)	0.96745(6)	0.0802(6)
N1	0.83157(12)	0.36701(15)	0.13223(6)	0.0266(4)
N2	0.66127(13)	0.48637(18)	0.13693(7)	0.0359(4)
O1	0.05377(12)	0.33527(16)	0.11790(6)	0.0457(4)
O2	0.08074(12)	0.47181(18)	0.05185(6)	0.0511(5)
O3	0.80843(13)	0.16943(15)	0.15195(6)	0.0454(4)
S1	0.02359(4)	0.43687(5)	0.08679(2)	0.03295(16)

Table S9. Bond lengths (Å) for 3o.

C1-C6	1.381(3)	C1-C2	1.386(3)
C1-C15	1.519(3)	C2-C3	1.380(4)
C2-H2	0.93	C3-C4	1.372(5)
C3-H3	0.93	C4-C5	1.375(4)
C4-H4	0.93	C5-C6	1.387(3)
C5-H5	0.93	C6-S1	1.756(2)
C7-C8	1.489(3)	C7-C15	1.534(3)
C7-S1	1.824(2)	C7-H7	0.98
C8-C9	1.389(3)	C8-C13	1.390(3)
C9-C10	1.379(3)	C9-H9	0.93
C10-C11	1.381(3)	C10-H10	0.93
C11-C12	1.384(3)	C11-C25	1.492(3)
C12-C13	1.383(3)	C12-H12	0.93
C13-C14	1.491(3)	C14-O3	1.225(2)
C14-N1	1.356(3)	C15-N1	1.486(3)
C15-H15	0.98	C16-C24	1.356(3)
C16-C17	1.414(3)	C16-N1	1.439(3)
C17-N2	1.365(3)	C17-C21	1.417(3)
C18-N2	1.310(3)	C18-C19	1.403(4)
C18-H18	0.93	C19-C20	1.342(4)
C19-H19	0.93	C20-C21	1.413(4)
C20-H20	0.93	C21-C22	1.403(4)
C22-C23	1.356(4)	C22-H22	0.93
C23-C24	1.406(3)	C23-H23	0.93
C24-H24	0.93	C25-F2	1.314(3)
C25-F1	1.319(3)	C25-F3	1.319(3)
O1-S1	1.4312(17)	O2-S1	1.4320(17)

Table S10. Bond angles (°) for 3o.

C6-C1-C2	118.7(2)	C6-C1-C15	114.8(2)
C2-C1-C15	126.5(2)	C3-C2-C1	118.8(3)
C3-C2-H2	120.6	C1-C2-H2	120.6
C4-C3-C2	121.3(3)	C4-C3-H3	119.4
C2-C3-H3	119.4	C3-C4-C5	121.1(3)
C3-C4-H4	119.4	C5-C4-H4	119.4
C4-C5-C6	117.1(3)	C4-C5-H5	121.5
C6-C5-H5	121.5	C1-C6-C5	122.8(2)
C1-C6-S1	110.70(17)	C5-C6-S1	126.5(2)
C8-C7-C15	115.58(17)	C8-C7-S1	111.82(14)
C15-C7-S1	104.05(14)	C8-C7-H7	108.4
C15-C7-H7	108.4	S1-C7-H7	108.4
C9-C8-C13	119.4(2)	C9-C8-C7	121.76(19)
C13-C8-C7	118.83(18)	C10-C9-C8	120.2(2)

C10-C9-H9	119.9	C8-C9-H9	119.9
C9-C10-C11	120.1(2)	C9-C10-H10	120.0
C11-C10-H10	120.0	C10-C11-C12	120.3(2)
C10-C11-C25	121.8(2)	C12-C11-C25	118.0(2)
C13-C12-C11	119.7(2)	C13-C12-H12	120.2
C11-C12-H12	120.2	C12-C13-C8	120.35(19)
C12-C13-C14	117.69(19)	C8-C13-C14	121.95(19)
O3-C14-N1	122.03(19)	O3-C14-C13	120.63(19)
N1-C14-C13	117.34(17)	N1-C15-C1	110.01(17)
N1-C15-C7	111.16(16)	C1-C15-C7	105.81(17)
N1-C15-H15	109.9	C1-C15-H15	109.9
C7-C15-H15	109.9	C24-C16-C17	120.6(2)
C24-C16-N1	119.75(19)	C17-C16-N1	119.60(18)
N2-C17-C16	119.02(18)	N2-C17-C21	122.7(2)
C16-C17-C21	118.2(2)	N2-C18-C19	124.5(2)
N2-C18-H18	117.7	C19-C18-H18	117.7
C20-C19-C18	118.8(2)	C20-C19-H19	120.6
C18-C19-H19	120.6	C19-C20-C21	120.0(2)
C19-C20-H20	120.0	C21-C20-H20	120.0
C22-C21-C20	123.6(2)	C22-C21-C17	119.5(2)
C20-C21-C17	116.8(2)	C23-C22-C21	120.7(2)
C23-C22-H22	119.6	C21-C22-H22	119.6
C22-C23-C24	120.1(2)	C22-C23-H23	120.0
C24-C23-H23	120.0	C16-C24-C23	120.7(2)
C16-C24-H24	119.6	C23-C24-H24	119.6
F2-C25-F1	108.4(2)	F2-C25-F3	105.8(2)
F1-C25-F3	105.0(2)	F2-C25-C11	112.3(2)
F1-C25-C11	111.3(2)	F3-C25-C11	113.6(2)
C14-N1-C16	116.95(16)	C14-N1-C15	124.43(16)
C16-N1-C15	117.93(16)	C18-N2-C17	117.0(2)
O1-S1-O2	118.40(11)	O1-S1-C6	110.50(11)
O2-S1-C6	111.25(11)	O1-S1-C7	109.65(10)
O2-S1-C7	111.11(10)	C6-S1-C7	93.05(10)

Table S11. Torsion angles (°) for 3o.

C6-C1-C2-C3	-3.2(4)	C15-C1-C2-C3	175.8(3)
C1-C2-C3-C4	0.9(5)	C2-C3-C4-C5	2.3(5)
C3-C4-C5-C6	-3.1(5)	C2-C1-C6-C5	2.5(4)
C15-C1-C6-C5	-176.6(2)	C2-C1-C6-S1	-177.1(2)
C15-C1-C6-S1	3.7(2)	C4-C5-C6-C1	0.6(4)
C4-C5-C6-S1	-179.8(2)	C15-C7-C8-C9	156.3(2)
S1-C7-C8-C9	-85.0(2)	C15-C7-C8-C13	-26.4(3)
S1-C7-C8-C13	92.4(2)	C13-C8-C9-C10	-1.4(3)
C7-C8-C9-C10	175.9(2)	C8-C9-C10-C11	0.1(4)
C9-C10-C11-C12	1.7(4)	C9-C10-C11-C25	-179.2(2)
C10-C11-C12-C13	-2.2(3)	C25-C11-C12-C13	178.7(2)
C11-C12-C13-C8	0.8(3)	C11-C12-C13-C14	-178.61(19)
C9-C8-C13-C12	1.0(3)	C7-C8-C13-C12	-176.37(19)
C9-C8-C13-C14	-179.62(19)	C7-C8-C13-C14	3.0(3)

C12-C13-C14-O3	7.4(3)	C8-C13-C14-O3	-172.0(2)
C12-C13-C14-N1	-173.20(19)	C8-C13-C14-N1	7.4(3)
C6-C1-C15-N1	94.4(2)	C2-C1-C15-N1	-84.7(3)
C6-C1-C15-C7	-25.8(2)	C2-C1-C15-C7	155.2(2)
C8-C7-C15-N1	37.7(2)	S1-C7-C15-N1	-85.25(17)
C8-C7-C15-C1	157.14(18)	S1-C7-C15-C1	34.15(18)
C24-C16-C17-N2	-179.8(2)	N1-C16-C17-N2	-0.2(3)
C24-C16-C17-C21	1.4(3)	N1-C16-C17-C21	-179.04(19)
N2-C18-C19-C20	0.5(5)	C18-C19-C20-C21	-0.1(4)
C19-C20-C21-C22	-179.3(3)	C19-C20-C21-C17	0.1(4)
N2-C17-C21-C22	178.9(2)	C16-C17-C21-C22	-2.4(3)
N2-C17-C21-C20	-0.6(3)	C16-C17-C21-C20	178.1(2)
C20-C21-C22-C23	-179.0(3)	C17-C21-C22-C23	1.5(4)
C21-C22-C23-C24	0.4(5)	C17-C16-C24-C23	0.5(4)
N1-C16-C24-C23	-179.1(2)	C22-C23-C24-C16	-1.4(5)
C10-C11-C25-F2	126.3(3)	C12-C11-C25-F2	-54.6(3)
C10-C11-C25-F1	-111.9(3)	C12-C11-C25-F1	67.2(3)
C10-C11-C25-F3	6.3(3)	C12-C11-C25-F3	-174.6(2)
O3-C14-N1-C16	-2.7(3)	C13-C14-N1-C16	177.89(17)
O3-C14-N1-C15	-173.0(2)	C13-C14-N1-C15	7.6(3)
C24-C16-N1-C14	72.6(3)	C17-C16-N1-C14	-106.9(2)
C24-C16-N1-C15	-116.4(2)	C17-C16-N1-C15	64.0(2)
C1-C15-N1-C14	-146.6(2)	C7-C15-N1-C14	-29.8(3)
C1-C15-N1-C16	43.2(2)	C7-C15-N1-C16	160.05(17)
C19-C18-N2-C17	-0.9(4)	C16-C17-N2-C18	-177.8(2)
C21-C17-N2-C18	1.0(3)	C1-C6-S1-O1	-96.69(18)
C5-C6-S1-O1	83.7(2)	C1-C6-S1-O2	129.67(17)
C5-C6-S1-O2	-49.9(2)	C1-C6-S1-C7	15.60(17)
C5-C6-S1-C7	-164.0(2)	C8-C7-S1-O1	-41.54(17)
C15-C7-S1-O1	83.88(15)	C8-C7-S1-O2	91.23(16)
C15-C7-S1-O2	-143.34(14)	C8-C7-S1-C6	-154.58(15)
C15-C7-S1-C6	-29.16(15)		

Table S12. Anisotropic atomic displacement parameters (Å^2) for 3o. The anisotropic atomic displacement factor exponent takes the form: $-2\pi^2[\, h^2 a^{*2} U_{11} + ... + 2\, h\, k\, a^* b^* U_{12} \,]$

	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
C1	0.0492(14)	0.0288(11)	0.0347(12)	0.0023(9)	0.0142(10)	-0.0067(10)
C2	0.0735(19)	0.0304(13)	0.0707(19)	-0.0085(13)	0.0354(16)	-0.0081(13)
C3	0.108(3)	0.0392(16)	0.089(2)	-0.0248(16)	0.047(2)	-0.0241(17)
C4	0.096(3)	0.0476(18)	0.073(2)	-0.0188(16)	0.0206(19)	-0.0379(17)
C5	0.0583(17)	0.0504(16)	0.0526(16)	0.0004(13)	0.0080(13)	-0.0232(13)
C6	0.0451(13)	0.0337(12)	0.0332(12)	0.0044(10)	0.0081(10)	-0.0103(10)
C7	0.0321(11)	0.0303(11)	0.0228(10)	0.0048(8)	0.0073(8)	-0.0020(9)
C8	0.0280(11)	0.0323(11)	0.0251(10)	0.0011(9)	0.0046(8)	-0.0009(9)
C9	0.0482(14)	0.0425(13)	0.0271(11)	-0.0006(10)	0.0134(10)	-0.0053(11)
C10	0.0523(15)	0.0454(14)	0.0285(12)	-0.0080(10)	0.0124(10)	-0.0004(11)
C11	0.0365(12)	0.0334(12)	0.0332(12)	-0.0054(10)	0.0014(9)	0.0019(9)
C12	0.0379(12)	0.0297(11)	0.0326(11)	0.0019(9)	0.0078(9)	-0.0016(9)

	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
C13	0.0271(11)	0.0295(11)	0.0257(10)	-0.0007(9)	0.0054(8)	0.0002(8)
C14	0.0292(11)	0.0307(11)	0.0260(10)	0.0008(9)	0.0073(8)	-0.0029(9)
C15	0.0321(11)	0.0275(11)	0.0300(11)	0.0031(9)	0.0094(9)	-0.0003(9)
C16	0.0324(11)	0.0287(11)	0.0258(10)	-0.0037(9)	0.0090(9)	-0.0030(9)
C17	0.0352(11)	0.0262(11)	0.0289(11)	-0.0011(9)	0.0105(9)	-0.0035(9)
C18	0.0417(14)	0.0557(16)	0.0498(15)	0.0106(13)	0.0119(12)	0.0139(12)
C19	0.0537(17)	0.0604(18)	0.0688(19)	0.0081(15)	0.0303(15)	0.0259(14)
C20	0.0642(18)	0.0533(16)	0.0511(16)	-0.0065(13)	0.0310(14)	0.0139(14)
C21	0.0472(14)	0.0376(13)	0.0362(13)	-0.0077(10)	0.0168(11)	-0.0011(10)
C22	0.0680(19)	0.0678(18)	0.0292(13)	-0.0172(12)	0.0126(12)	0.0032(15)
C23	0.0635(18)	0.083(2)	0.0289(13)	-0.0127(13)	-0.0039(12)	0.0109(16)
C24	0.0407(13)	0.0542(15)	0.0344(13)	-0.0074(11)	0.0012(10)	0.0074(11)
C25	0.0522(15)	0.0364(13)	0.0401(14)	-0.0048(11)	0.0052(11)	0.0066(11)
F1	0.0643(12)	0.0401(9)	0.161(2)	-0.0242(11)	0.0153(12)	-0.0113(8)
F2	0.1322(17)	0.0420(9)	0.0588(11)	0.0042(8)	-0.0122(11)	0.0174(10)
F3	0.1384(18)	0.0474(10)	0.0605(11)	-0.0180(8)	0.0337(11)	0.0060(10)
N1	0.0314(9)	0.0270(9)	0.0231(9)	-0.0001(7)	0.0097(7)	-0.0006(7)
N2	0.0334(10)	0.0418(11)	0.0341(10)	0.0036(8)	0.0096(8)	0.0047(8)
O1	0.0460(10)	0.0445(10)	0.0437(10)	0.0083(8)	-0.0009(8)	0.0043(8)
O2	0.0423(10)	0.0646(12)	0.0516(10)	0.0064(9)	0.0228(8)	-0.0090(8)
O3	0.0722(12)	0.0341(9)	0.0351(9)	0.0044(7)	0.0242(8)	-0.0094(8)
S1	0.0314(3)	0.0363(3)	0.0320(3)	0.0047(2)	0.0079(2)	-0.0036(2)

Table S13. Hydrogen atomic coordinates and isotropic atomic displacement parameters (Å^2) for 3o.

	x/a	y/b	z/c	U(eq)
H2	0.8015	0.6765	0.1442	0.067
H3	0.9064	0.8182	0.1840	0.09
H4	1.0656	0.7993	0.1853	0.086
H5	1.1249	0.6445	0.1422	0.065
H7	0.8876	0.4680	0.0301	0.034
H9	0.9188	0.2968	-0.0227	0.046
H10	0.8966	0.0920	-0.0426	0.05
H12	0.8112	0.0280	0.0837	0.04
H15	0.7817	0.4930	0.0804	0.035
H18	0.5418	0.5617	0.1111	0.058
H19	0.4999	0.6294	0.1824	0.07
H20	0.5991	0.5944	0.2533	0.064
H22	0.7523	0.5011	0.2964	0.065
H23	0.8903	0.4008	0.2921	0.072
H24	0.9270	0.3440	0.2175	0.052

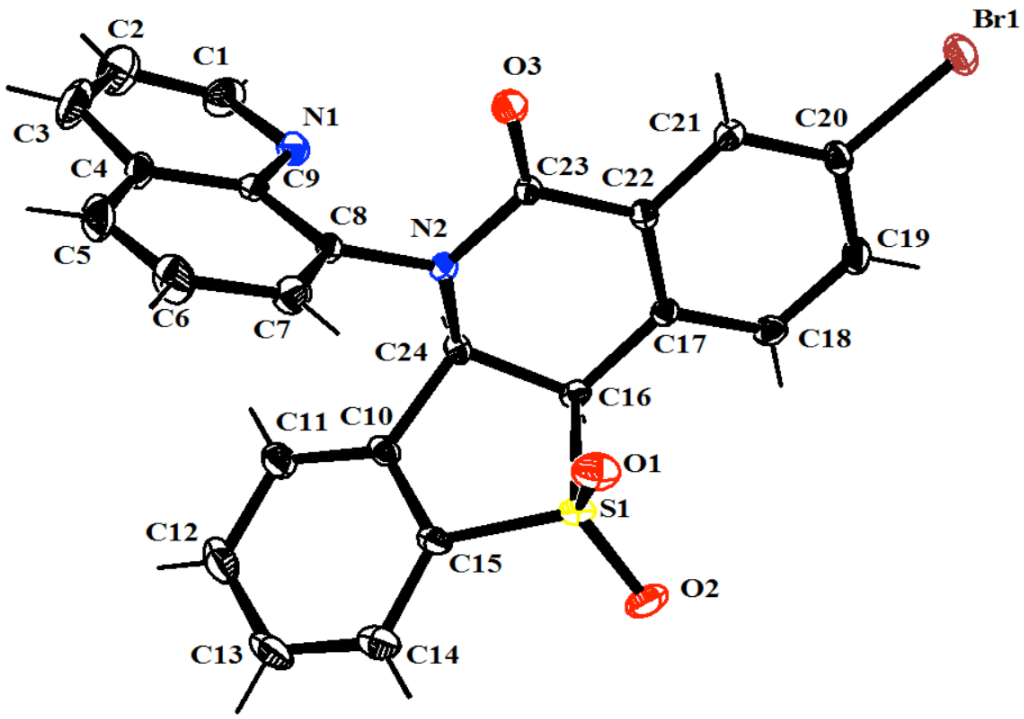


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Figure S2. The X-ray crystal data and structure refinement for **3j**

Table S14. Crystal data and structure refinement for 3j

Identification code	Nivedha_SK2Br	
Chemical formula	$C_{24}H_{15}BrN_2O_3S$	
Formula weight	491.35 g/mol	
Temperature	296(2) K	
Wavelength	0.71073 Å	
Crystal size	0.100 x 0.220 x 0.250 mm	
Crystal habit	clear light yellow Block	
Crystal system	triclinic	
Space group	P -1	
Unit cell dimensions	a = 8.4236(2) Å	α = 91.2210(10)°
	b = 9.3593(2) Å	β = 102.8590(10)°
	c = 14.8260(4) Å	γ = 101.6750(10)°
Volume	1113.28(5) $Å^3$	
Z	2	
Density (calculated)	1.466 g/cm^3	
Absorption coefficient	1.968 mm^{-1}	
F(000)	496	
Theta range for data collection	2.23 to 25.00°	
Index ranges	-10<=h<=9, -11<=k<=11, -14<=l<=17	
Reflections collected	14735	
Independent reflections	3912 [R(int) = 0.0273]	
Coverage of independent	100.0%	

reflections		
Absorption correction	multi-scan	
Max. and min. transmission	0.8280 and 0.6390	
Refinement method	Full-matrix least-squares on F2	
Refinement program	SHELXL-2014/7 (Sheldrick, 2014)	
Function minimized	Σ w(Fo2 - Fc2)2	
Data / restraints / parameters	3912 / 0 / 282	
Goodness-of-fit on F2	1.073	
Δ/σmax	0.001	
Final R indices	3161 data; I>2σ(I)	R1 = 0.0346, wR2 = 0.0896
	all data	R1 = 0.0452, wR2 = 0.0929
Weighting scheme	$w=1/[\sigma^2(F_o^2)+(0.0493P)^2+0.2557P]$ where $P=(F_o^2+2F_c^2)/3$	
Largest diff. peak and hole	0.504 and -0.338 eÅ^{-3}	
R.M.S. deviation from mean	0.060 eÅ^{-3}	

Table S15. Atomic coordinates and equivalent isotropic atomic displacement parameters (Å^2) for 3j.

U(eq) is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x/a	y/b	z/c	U(eq)
Br1	0.47050(4)	0.30318(3)	0.01342(2)	0.05061(14)
C1	0.6089(4)	0.9616(4)	0.2852(3)	0.0587(9)
C2	0.5617(5)	0.9530(4)	0.3703(3)	0.0714(12)
C3	0.6575(5)	0.9043(4)	0.4414(3)	0.0698(12)
C4	0.8051(4)	0.8622(3)	0.4321(2)	0.0457(8)
C5	0.9125(5)	0.8081(4)	0.5032(2)	0.0621(10)
C6	0.0519(5)	0.7707(4)	0.4884(2)	0.0608(9)
C7	0.0929(4)	0.7870(3)	0.4018(2)	0.0454(7)
C8	0.9928(3)	0.8406(3)	0.33205(17)	0.0307(6)
C9	0.8441(3)	0.8780(3)	0.34379(19)	0.0333(6)
C10	0.9049(4)	0.5928(3)	0.20343(18)	0.0362(7)
C11	0.7687(4)	0.5309(3)	0.2375(2)	0.0499(8)
C12	0.7584(5)	0.3893(4)	0.2672(2)	0.0650(11)
C13	0.8776(5)	0.3116(4)	0.2613(2)	0.0643(11)
C14	0.0122(5)	0.3706(3)	0.2260(2)	0.0545(9)
C15	0.0214(4)	0.5107(3)	0.19679(19)	0.0386(7)
C16	0.0390(3)	0.7310(3)	0.09493(17)	0.0307(6)
C17	0.1369(3)	0.8715(3)	0.07277(17)	0.0299(6)
C18	0.1867(4)	0.8846(3)	0.98945(18)	0.0385(7)
C19	0.2839(4)	0.0125(3)	0.97164(19)	0.0402(7)
C20	0.3317(3)	0.1295(3)	0.03760(19)	0.0351(6)
C21	0.2815(3)	0.1203(3)	0.11997(19)	0.0341(6)

	x/a	y/b	z/c	U(eq)
C22	0.1843(3)	0.9898(3)	0.13790(17)	0.0288(6)
C23	0.1372(3)	0.9798(3)	0.22936(18)	0.0316(6)
C24	0.9383(3)	0.7436(3)	0.16751(17)	0.0303(6)
N1	0.7455(3)	0.9272(2)	0.27080(18)	0.0416(6)
N2	0.0351(3)	0.8543(2)	0.24347(14)	0.0286(5)
O1	0.3154(3)	0.6819(2)	0.20856(15)	0.0513(5)
O2	0.1956(3)	0.5150(2)	0.06918(16)	0.0552(6)
O3	0.1940(3)	0.0800(2)	0.29018(13)	0.0476(5)
S1	0.17081(9)	0.60560(7)	0.14174(5)	0.03832(19)

Table S16. Bond lengths (Å) for 3j.

Br1-C20	1.892(3)	C1-N1	1.315(4)
C1-C2	1.403(5)	C1-H1	0.93
C2-C3	1.327(5)	C2-H2	0.93
C3-C4	1.411(5)	C3-H3	0.93
C4-C5	1.404(5)	C4-C9	1.422(4)
C5-C6	1.351(5)	C5-H5	0.93
C6-C7	1.407(4)	C6-H6	0.93
C7-C8	1.355(4)	C7-H7	0.93
C8-C9	1.412(4)	C8-N2	1.437(3)
C9-N1	1.360(4)	C10-C15	1.381(4)
C10-C11	1.382(4)	C10-C24	1.514(4)
C11-C12	1.398(5)	C11-H11	0.93
C12-C13	1.370(5)	C12-H12	0.93
C13-C14	1.374(5)	C13-H13	0.93
C14-C15	1.383(4)	C14-H14	0.93
C15-S1	1.754(3)	C16-C17	1.489(3)
C16-C24	1.527(3)	C16-S1	1.820(3)
C16-H16	0.98	C17-C22	1.386(3)
C17-C18	1.391(4)	C18-C19	1.374(4)
C18-H18	0.93	C19-C20	1.385(4)
C19-H19	0.93	C20-C21	1.377(4)
C21-C22	1.392(4)	C21-H21	0.93
C22-C23	1.495(3)	C23-O3	1.230(3)
C23-N2	1.359(3)	C24-N2	1.485(3)
C24-H24	0.98	O1-S1	1.434(2)
O2-S1	1.433(2)		

Table S17. Bond angles (°) for 3j.

N1-C1-C2	124.4(4)	N1-C1-H1	117.8
C2-C1-H1	117.8	C3-C2-C1	119.0(3)
C3-C2-H2	120.5	C1-C2-H2	120.5
C2-C3-C4	120.8(3)	C2-C3-H3	119.6
C4-C3-H3	119.6	C5-C4-C3	124.5(3)
C5-C4-C9	119.4(3)	C3-C4-C9	116.0(3)
C6-C5-C4	120.7(3)	C6-C5-H5	119.7

C4-C5-H5	119.7	C5-C6-C7	120.5(3)
C5-C6-H6	119.7	C7-C6-H6	119.7
C8-C7-C6	120.2(3)	C8-C7-H7	119.9
C6-C7-H7	119.9	C7-C8-C9	121.1(2)
C7-C8-N2	119.5(2)	C9-C8-N2	119.3(2)
N1-C9-C8	118.8(2)	N1-C9-C4	123.2(3)
C8-C9-C4	118.0(3)	C15-C10-C11	118.9(3)
C15-C10-C24	114.7(2)	C11-C10-C24	126.3(3)
C10-C11-C12	118.2(3)	C10-C11-H11	120.9
C12-C11-H11	120.9	C13-C12-C11	121.4(3)
C13-C12-H12	119.3	C11-C12-H12	119.3
C12-C13-C14	121.0(3)	C12-C13-H13	119.5
C14-C13-H13	119.5	C13-C14-C15	117.1(3)
C13-C14-H14	121.4	C15-C14-H14	121.4
C10-C15-C14	123.2(3)	C10-C15-S1	110.5(2)
C14-C15-S1	126.2(3)	C17-C16-C24	115.5(2)
C17-C16-S1	112.32(19)	C24-C16-S1	103.96(17)
C17-C16-H16	108.2	C24-C16-H16	108.2
S1-C16-H16	108.2	C22-C17-C18	119.4(2)
C22-C17-C16	119.3(2)	C18-C17-C16	121.2(2)
C19-C18-C17	120.7(2)	C19-C18-H18	119.6
C17-C18-H18	119.6	C18-C19-C20	119.3(2)
C18-C19-H19	120.4	C20-C19-H19	120.4
C21-C20-C19	121.2(2)	C21-C20-Br1	120.1(2)
C19-C20-Br1	118.7(2)	C20-C21-C22	119.3(2)
C20-C21-H21	120.4	C22-C21-H21	120.4
C17-C22-C21	120.2(2)	C17-C22-C23	121.3(2)
C21-C22-C23	118.5(2)	O3-C23-N2	121.8(2)
O3-C23-C22	120.7(2)	N2-C23-C22	117.5(2)
N2-C24-C10	110.9(2)	N2-C24-C16	110.4(2)
C10-C24-C16	105.3(2)	N2-C24-H24	110.0
C10-C24-H24	110.0	C16-C24-H24	110.0
C1-N1-C9	116.6(3)	C23-N2-C8	118.3(2)
C23-N2-C24	123.3(2)	C8-N2-C24	117.24(19)
O2-S1-O1	117.81(13)	O2-S1-C15	111.26(13)
O1-S1-C15	110.87(13)	O2-S1-C16	111.12(13)
O1-S1-C16	110.47(12)	C15-S1-C16	92.46(13)

Table S18. Torsion angles (°) for 3j.

N1-C1-C2-C3	-1.6(6)	C1-C2-C3-C4	0.3(6)
C2-C3-C4-C5	-179.3(3)	C2-C3-C4-C9	1.1(5)
C3-C4-C5-C6	-179.8(3)	C9-C4-C5-C6	-0.1(5)
C4-C5-C6-C7	0.8(5)	C5-C6-C7-C8	0.0(5)
C6-C7-C8-C9	-1.4(4)	C6-C7-C8-N2	-178.9(3)
C7-C8-C9-N1	-178.1(2)	N2-C8-C9-N1	-0.6(3)
C7-C8-C9-C4	2.0(4)	N2-C8-C9-C4	179.5(2)
C5-C4-C9-N1	178.9(3)	C3-C4-C9-N1	-1.4(4)
C5-C4-C9-C8	-1.2(4)	C3-C4-C9-C8	178.5(3)
C15-C10-C11-C12	2.5(4)	C24-C10-C11-C12	179.6(3)

C10-C11-C12-C13	-1.3(5)	C11-C12-C13-C14	0.1(5)
C12-C13-C14-C15	-0.1(5)	C11-C10-C15-C14	-2.6(4)
C24-C10-C15-C14	180.0(3)	C11-C10-C15-S1	174.4(2)
C24-C10-C15-S1	-3.1(3)	C13-C14-C15-C10	1.4(5)
C13-C14-C15-S1	-175.1(2)	C24-C16-C17-C22	24.4(4)
S1-C16-C17-C22	-94.6(3)	C24-C16-C17-C18	-158.0(3)
S1-C16-C17-C18	83.0(3)	C22-C17-C18-C19	0.8(4)
C16-C17-C18-C19	-176.8(3)	C17-C18-C19-C20	-0.3(4)
C18-C19-C20-C21	-0.9(4)	C18-C19-C20-Br1	178.3(2)
C19-C20-C21-C22	1.6(4)	Br1-C20-C21-C22	-177.70(19)
C18-C17-C22-C21	-0.2(4)	C16-C17-C22-C21	177.4(2)
C18-C17-C22-C23	-178.5(2)	C16-C17-C22-C23	-0.9(4)
C20-C21-C22-C17	-1.0(4)	C20-C21-C22-C23	177.4(2)
C17-C22-C23-O3	172.5(3)	C21-C22-C23-O3	-5.8(4)
C17-C22-C23-N2	-5.0(4)	C21-C22-C23-N2	176.6(2)
C15-C10-C24-N2	-92.8(3)	C11-C10-C24-N2	89.9(3)
C15-C10-C24-C16	26.6(3)	C11-C10-C24-C16	-150.6(3)
C17-C16-C24-N2	-39.8(3)	S1-C16-C24-N2	83.7(2)
C17-C16-C24-C10	-159.6(2)	S1-C16-C24-C10	-36.1(2)
C2-C1-N1-C9	1.2(5)	C8-C9-N1-C1	-179.6(2)
C4-C9-N1-C1	0.3(4)	O3-C23-N2-C8	0.5(4)
C22-C23-N2-C8	178.0(2)	O3-C23-N2-C24	167.8(2)
C22-C23-N2-C24	-14.7(4)	C7-C8-N2-C23	-88.0(3)
C9-C8-N2-C23	94.4(3)	C7-C8-N2-C24	103.9(3)
C9-C8-N2-C24	-73.6(3)	C10-C24-N2-C23	153.0(2)
C16-C24-N2-C23	36.7(3)	C10-C24-N2-C8	-39.6(3)
C16-C24-N2-C8	-155.9(2)	C10-C15-S1-O2	-130.9(2)
C14-C15-S1-O2	45.9(3)	C10-C15-S1-O1	95.9(2)
C14-C15-S1-O1	-87.3(3)	C10-C15-S1-C16	-17.1(2)
C14-C15-S1-C16	159.7(3)	C17-C16-S1-O2	-89.22(19)
C24-C16-S1-O2	145.16(17)	C17-C16-S1-O1	43.5(2)
C24-C16-S1-O1	-82.15(19)	C17-C16-S1-C15	156.84(18)
C24-C16-S1-C15	31.22(18)		

Table S19. Anisotropic atomic displacement parameters (Å^2) for 3j.

The anisotropic atomic displacement factor exponent takes the form: $-2\pi^2[\, h^2\, a^{*2}\, U_{11} + ... + 2\, h\, k\, a^*\, b^*\, U_{12}\,]$

	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
Br1	0.0475(2)	0.0449(2)	0.0628(2)	0.01755(15)	0.02275(17)	0.00497(14)
C1	0.0387(19)	0.057(2)	0.081(3)	-0.0008(18)	0.0154(18)	0.0118(16)
C2	0.041(2)	0.080(3)	0.099(3)	-0.016(2)	0.034(2)	0.0097(19)
C3	0.067(3)	0.077(3)	0.071(3)	-0.018(2)	0.047(2)	-0.003(2)
C4	0.053(2)	0.0411(16)	0.0447(18)	-0.0063(13)	0.0271(16)	-0.0016(14)
C5	0.088(3)	0.067(2)	0.0337(19)	0.0039(16)	0.0292(19)	0.005(2)
C6	0.081(3)	0.068(2)	0.0318(18)	0.0131(15)	0.0083(18)	0.017(2)
C7	0.0505(19)	0.0482(17)	0.0391(17)	0.0056(14)	0.0086(15)	0.0161(15)

	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
C8	0.0395(16)	0.0265(13)	0.0273(14)	0.0005(10)	0.0119(12)	0.0057(12)
C9	0.0391(16)	0.0253(13)	0.0362(16)	-0.0004(11)	0.0152(13)	0.0015(12)
C10	0.0452(17)	0.0294(14)	0.0293(15)	-0.0011(11)	0.0068(13)	-0.0007(13)
C11	0.058(2)	0.0419(17)	0.0479(19)	-0.0009(14)	0.0234(16)	-0.0057(15)
C12	0.086(3)	0.050(2)	0.050(2)	0.0049(16)	0.028(2)	-0.019(2)
C13	0.103(3)	0.0322(17)	0.052(2)	0.0118(14)	0.016(2)	0.002(2)
C14	0.076(2)	0.0314(15)	0.052(2)	0.0049(14)	0.0058(18)	0.0122(16)
C15	0.0514(19)	0.0279(14)	0.0342(15)	0.0018(11)	0.0077(14)	0.0059(13)
C16	0.0361(15)	0.0298(13)	0.0252(14)	0.0003(10)	0.0043(12)	0.0082(11)
C17	0.0307(15)	0.0318(13)	0.0299(14)	0.0042(11)	0.0077(12)	0.0120(11)
C18	0.0504(18)	0.0381(15)	0.0293(15)	0.0004(12)	0.0109(13)	0.0131(14)
C19	0.0475(18)	0.0474(17)	0.0341(16)	0.0128(13)	0.0202(14)	0.0164(14)
C20	0.0293(15)	0.0370(15)	0.0436(16)	0.0145(12)	0.0123(13)	0.0121(12)
C21	0.0329(15)	0.0337(14)	0.0381(16)	0.0021(11)	0.0109(13)	0.0097(12)
C22	0.0298(14)	0.0288(13)	0.0290(14)	0.0049(10)	0.0060(12)	0.0094(11)
C23	0.0342(15)	0.0292(14)	0.0346(15)	0.0030(11)	0.0110(12)	0.0110(12)
C24	0.0319(15)	0.0313(13)	0.0276(14)	0.0029(11)	0.0055(12)	0.0079(11)
N1	0.0361(14)	0.0380(13)	0.0547(16)	0.0045(11)	0.0170(12)	0.0097(11)
N2	0.0328(12)	0.0277(11)	0.0263(11)	0.0004(8)	0.0098(10)	0.0059(9)
O1	0.0426(12)	0.0429(11)	0.0629(14)	0.0006(10)	-0.0009(11)	0.0112(10)
O2	0.0583(15)	0.0454(12)	0.0681(15)	-0.0107(11)	0.0221(12)	0.0187(11)
O3	0.0663(14)	0.0357(11)	0.0382(11)	-0.0079(9)	0.0193(10)	-0.0019(10)
S1	0.0423(4)	0.0287(4)	0.0449(4)	-0.0011(3)	0.0087(3)	0.0114(3)

Table S20. Hydrogen atomic coordinates and isotropic atomic displacement parameters (Å^2) for 3j.

	x/a	y/b	z/c	U(eq)
H1	0.5389	0.9936	0.2357	0.07
H2	0.4648	0.9811	0.3767	0.086
H3	0.6270	0.8978	0.4979	0.084
H5	0.8875	0.7979	0.5610	0.075
H6	1.1212	0.7338	0.5359	0.073
H7	1.1891	0.7610	0.3923	0.054
H11	0.6860	0.5822	0.2406	0.06
H12	0.6687	0.3469	0.2915	0.078
H13	0.8672	0.2176	0.2816	0.077
H14	1.0936	0.3184	0.2219	0.065
H16	0.9618	0.6842	0.0376	0.037
H18	1.1539	0.8058	-0.0547	0.046
H19	1.3173	1.0205	-0.0841	0.048
H21	1.3121	1.2003	0.1631	0.041
H24	0.8329	0.7703	0.1386	0.036

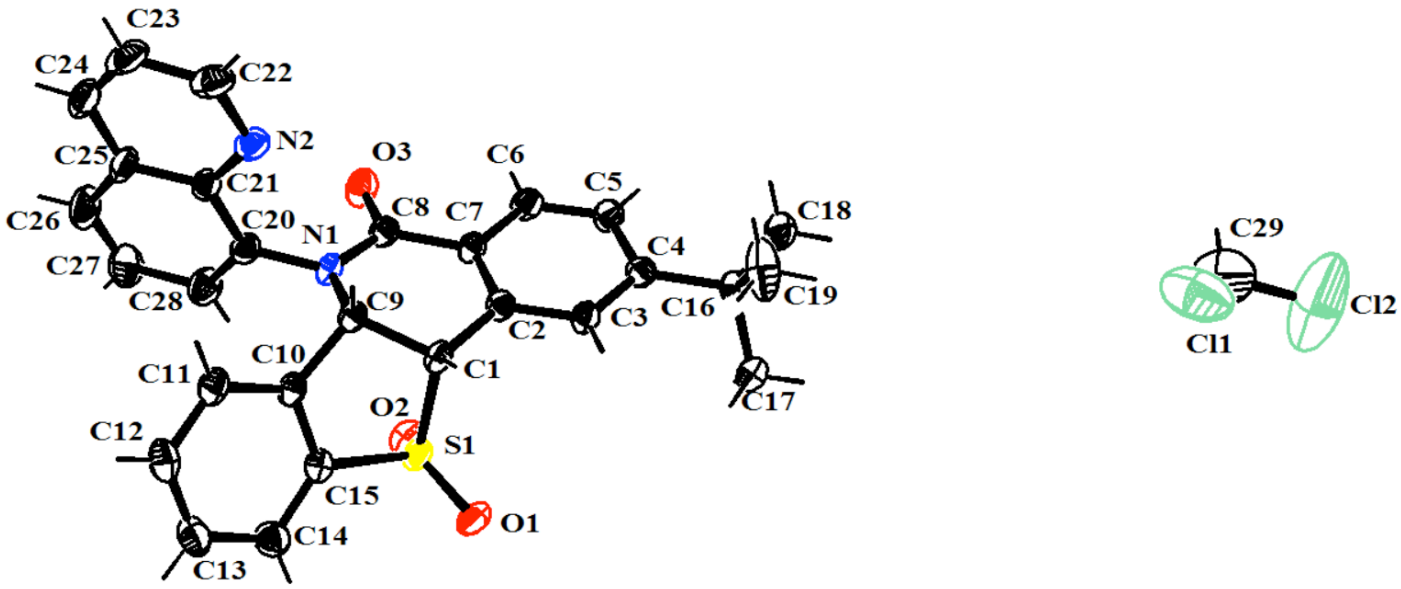

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Figure S3. The X-ray crystal data and structure refinement for **3g**

Table S21. Crystal data and structure refinement for 3g.

Identification code	Nivedha_4Tbu	
Chemical formula	$C_{29}H_{26}Cl_2N_2O_3S$	
Formula weight	553.48 g/mol	
Temperature	296(2) K	
Wavelength	0.71073 Å	
Crystal size	0.100 x 0.220 x 0.250 mm	
Crystal habit	clear light brown Rectangular	
Crystal system	monoclinic	
Space group	P 1 21/c 1	
Unit cell dimensions	a = 9.1009(3) Å	α = 90°
	b = 23.1368(8) Å	β = 109.4998(16)°
	c = 13.2040(4) Å	γ = 90°
Volume	2620.84(15) $Å^3$	
Z	4	
Density (calculated)	1.403 g/cm^3	
Absorption coefficient	0.362 mm^{-1}	
F(000)	1152	

Theta range for data collection	1.86 to 25.00°
Index ranges	-10<=h<=10, -24<=k<=27, -15<=l<=14
Reflections collected	16006
Independent reflections	4611 [R(int) = 0.0363]
Coverage of independent reflections	100.0%
Absorption correction	multi-scan
Max. and min. transmission	0.9650 and 0.9150
Refinement method	Full-matrix least-squares on F^2
Refinement program	SHELXL-2014/7 (Sheldrick, 2014)
Function minimized	$\Sigma\, w(F_o^2 - F_c^2)^2$
Data / restraints / parameters	4611 / 2 / 338
Goodness-of-fit on F^2	1.040
Δ/σ_{max}	0.001

Final R indices	3030 data; I>2σ(I) R1 = 0.0880, wR2 = 0.2629
	all data R1 = 0.1251, wR2 = 0.3036
Weighting scheme	$w=1/[\sigma^2(F_o^2)+(0.1740P)^2+4.9492P]$ where $P=(F_o^2+2F_c^2)/3$
Extinction coefficient	0.0030(20)
Largest diff. peak and hole	0.924 and -1.207 eÅ^{-3}
R.M.S. deviation from mean	0.100 eÅ^{-3}

Table S22. Atomic coordinates and equivalent isotropic atomic displacement parameters (Å^2) for 3g.

U(eq) is defined as one third of the trace of the orthogonalized U_{ij} tensor.

	x/a	y/b	z/c	U(eq)
C1	0.0487(6)	0.6718(2)	0.3023(4)	0.0376(11)
C2	0.9440(6)	0.6458(2)	0.3568(4)	0.0383(11)
C3	0.8803(6)	0.5907(2)	0.3305(4)	0.0403(11)
C4	0.7857(5)	0.5662(2)	0.3821(4)	0.0410(12)
C5	0.7571(6)	0.5983(2)	0.4624(4)	0.0464(12)
C6	0.8203(6)	0.6528(2)	0.4903(4)	0.0470(13)
C7	0.9132(6)	0.6770(2)	0.4371(4)	0.0373(11)
C8	0.9753(6)	0.7365(2)	0.4664(4)	0.0393(11)
C9	0.0555(5)	0.7373(2)	0.3018(3)	0.0359(11)
C10	0.2077(6)	0.7521(2)	0.2850(3)	0.0374(11)
C11	0.2400(7)	0.8025(2)	0.2398(4)	0.0498(13)
C12	0.3845(7)	0.8096(3)	0.2275(5)	0.0603(16)
C13	0.4961(7)	0.7664(3)	0.2601(5)	0.0620(16)
C14	0.4657(6)	0.7156(3)	0.3026(5)	0.0550(14)
C15	0.3206(6)	0.7095(2)	0.3143(4)	0.0412(12)
C16	0.7179(6)	0.5053(2)	0.3503(4)	0.0429(12)
C17	0.8496(7)	0.4621(3)	0.3724(6)	0.0714(19)
C18	0.6152(8)	0.4869(3)	0.4161(6)	0.0665(17)
C19	0.6183(10)	0.5055(4)	0.2327(5)	0.094(3)
C20	0.1006(6)	0.8201(2)	0.4312(4)	0.0421(12)
C21	0.0055(6)	0.8666(2)	0.3758(4)	0.0422(12)
C22	0.7828(7)	0.8980(3)	0.2477(5)	0.0641(17)
C23	0.8254(10)	0.9558(3)	0.2715(7)	0.074(2)
C24	0.9567(10)	0.9685(3)	0.3484(7)	0.073(2)
C25	0.0568(7)	0.9231(2)	0.4065(5)	0.0542(15)
C26	0.1990(9)	0.9324(3)	0.4906(6)	0.075(2)
C27	0.2859(9)	0.8866(3)	0.5434(6)	0.078(2)
C28	0.2371(7)	0.8304(3)	0.5137(5)	0.0588(15)
Cl1	0.3490(4)	0.19536(19)	0.3962(3)	0.1749(17)
N1	0.0511(5)	0.76182(16)	0.4053(3)	0.0365(9)
N2	0.8682(5)	0.85366(19)	0.2963(4)	0.0499(11)
O1	0.2781(5)	0.59668(16)	0.3140(4)	0.0621(11)
O2	0.2952(5)	0.65064(17)	0.4769(3)	0.0591(11)
O3	0.9586(5)	0.76167(17)	0.5441(3)	0.0573(11)
S1	0.24982(15)	0.64880(5)	0.36264(10)	0.0435(4)
Cl2	0.2835(11)	0.0939(2)	0.4854(5)	0.317(5)
C30	0.3331(16)	0.1638(2)	0.5065(5)	0.155(5)

Table S23. Bond lengths (Å) for 3g.

C1-C2	1.499(7)	C1-C9	1.518(7)
C1-S1	1.815(5)	C1-H1	0.98
C2-C7	1.386(7)	C2-C3	1.395(7)
C3-C4	1.385(7)	C3-H3	0.93
C4-C5	1.389(7)	C4-C16	1.539(7)
C5-C6	1.384(7)	C5-H5	0.93
C6-C7	1.384(7)	C6-H6	0.93
C7-C8	1.491(7)	C8-O3	1.232(6)
C8-N1	1.357(6)	C9-N1	1.493(6)
C9-C10	1.513(7)	C9-H9	0.98
C10-C15	1.382(7)	C10-C11	1.385(7)
C11-C12	1.388(8)	C11-H11	0.93
C12-C13	1.388(9)	C12-H12	0.93
C13-C14	1.369(8)	C13-H13	0.93
C14-C15	1.387(8)	C14-H14	0.93
C15-S1	1.753(5)	C16-C17	1.512(8)
C16-C19	1.515(8)	C16-C18	1.533(8)
C17-H17A	0.96	C17-H17B	0.96
C17-H17C	0.96	C18-H18A	0.96
C18-H18B	0.96	C18-H18C	0.96
C19-H19A	0.96	C19-H19B	0.96
C19-H19C	0.96	C20-C28	1.372(8)
C20-C21	1.422(7)	C20-N1	1.426(6)
C21-N2	1.369(7)	C21-C25	1.401(7)
C22-N2	1.317(7)	C22-C23	1.400(10)
C22-H22	0.93	C23-C24	1.316(10)
C23-H23	0.93	C24-C25	1.434(9)
C24-H24	0.93	C25-C26	1.412(10)
C26-C27	1.366(10)	C26-H26	0.93
C27-C28	1.389(9)	C27-H27	0.93
C28-H28	0.93	Cl1-C30	1.678(2)
O1-S1	1.429(4)	O2-S1	1.425(4)
Cl2-C30	1.677(2)	C30-H30A	0.97
C30-H30B	0.97		

Table S24. Bond angles (°) for 3g.

C2-C1-C9	115.9(4)	C2-C1-S1	112.4(3)
C9-C1-S1	105.0(3)	C2-C1-H1	107.7
C9-C1-H1	107.7	S1-C1-H1	107.7
C7-C2-C3	119.6(4)	C7-C2-C1	118.8(4)
C3-C2-C1	121.7(4)	C4-C3-C2	121.7(5)
C4-C3-H3	119.1	C2-C3-H3	119.1
C3-C4-C5	117.6(5)	C3-C4-C16	119.9(4)
C5-C4-C16	122.5(4)	C6-C5-C4	121.5(5)
C6-C5-H5	119.2	C4-C5-H5	119.2
C5-C6-C7	120.2(5)	C5-C6-H6	119.9

C7-C6-H6	119.9	C6-C7-C2	119.4(5)
C6-C7-C8	119.0(4)	C2-C7-C8	121.6(4)
O3-C8-N1	121.4(5)	O3-C8-C7	120.7(4)
N1-C8-C7	117.9(4)	N1-C9-C10	110.7(4)
N1-C9-C1	111.2(4)	C10-C9-C1	105.5(4)
N1-C9-H9	109.8	C10-C9-H9	109.8
C1-C9-H9	109.8	C15-C10-C11	118.3(5)
C15-C10-C9	115.4(4)	C11-C10-C9	126.1(4)
C10-C11-C12	119.8(5)	C10-C11-H11	120.1
C12-C11-H11	120.1	C13-C12-C11	120.1(5)
C13-C12-H12	119.9	C11-C12-H12	119.9
C14-C13-C12	121.2(5)	C14-C13-H13	119.4
C12-C13-H13	119.4	C13-C14-C15	117.6(5)
C13-C14-H14	121.2	C15-C14-H14	121.2
C10-C15-C14	122.9(5)	C10-C15-S1	110.1(4)
C14-C15-S1	127.0(4)	C17-C16-C19	111.4(6)
C17-C16-C18	107.5(5)	C19-C16-C18	108.2(5)
C17-C16-C4	109.5(4)	C19-C16-C4	109.0(4)
C18-C16-C4	111.3(4)	C16-C17-H17A	109.5
C16-C17-H17B	109.5	H17A-C17-H17B	109.5
C16-C17-H17C	109.5	H17A-C17-H17C	109.5
H17B-C17-H17C	109.5	C16-C18-H18A	109.5
C16-C18-H18B	109.5	H18A-C18-H18B	109.5
C16-C18-H18C	109.5	H18A-C18-H18C	109.5
H18B-C18-H18C	109.5	C16-C19-H19A	109.5
C16-C19-H19B	109.5	H19A-C19-H19B	109.5
C16-C19-H19C	109.5	H19A-C19-H19C	109.5
H19B-C19-H19C	109.5	C28-C20-C21	120.7(5)
C28-C20-N1	119.0(5)	C21-C20-N1	120.2(4)
N2-C21-C25	123.8(5)	N2-C21-C20	118.1(5)
C25-C21-C20	118.0(5)	N2-C22-C23	124.1(7)
N2-C22-H22	117.9	C23-C22-H22	117.9
C24-C23-C22	119.8(6)	C24-C23-H23	120.1
C22-C23-H23	120.1	C23-C24-C25	120.1(6)
C23-C24-H24	120.0	C25-C24-H24	120.0
C21-C25-C26	120.0(6)	C21-C25-C24	115.9(6)
C26-C25-C24	124.1(6)	C27-C26-C25	120.3(6)
C27-C26-H26	119.8	C25-C26-H26	119.8
C26-C27-C28	120.4(6)	C26-C27-H27	119.8
C28-C27-H27	119.8	C20-C28-C27	120.5(6)
C20-C28-H28	119.8	C27-C28-H28	119.8
C8-N1-C20	116.6(4)	C8-N1-C9	123.7(4)
C20-N1-C9	118.4(4)	C22-N2-C21	116.2(5)
O2-S1-O1	117.9(2)	O2-S1-C15	110.5(2)
O1-S1-C15	111.7(2)	O2-S1-C1	110.4(2)
O1-S1-C1	110.9(2)	C15-S1-C1	92.5(2)
Cl2-C30-Cl1	111.8(4)	Cl2-C30-H30A	109.3
Cl1-C30-H30A	109.3	Cl2-C30-H30B	109.3
Cl1-C30-H30B	109.3	H30A-C30-H30B	107.9

Table S25. Torsion angles (°) for 3g.

C9-C1-C2-C7	-26.1(6)	S1-C1-C2-C7	94.6(5)
C9-C1-C2-C3	155.4(4)	S1-C1-C2-C3	-83.9(5)
C7-C2-C3-C4	0.4(7)	C1-C2-C3-C4	178.9(4)
C2-C3-C4-C5	-0.5(7)	C2-C3-C4-C16	180.0(4)
C3-C4-C5-C6	0.0(7)	C16-C4-C5-C6	179.5(5)
C4-C5-C6-C7	0.7(8)	C5-C6-C7-C2	-0.9(8)
C5-C6-C7-C8	178.0(4)	C3-C2-C7-C6	0.4(7)
C1-C2-C7-C6	-178.2(4)	C3-C2-C7-C8	-178.5(4)
C1-C2-C7-C8	3.0(7)	C6-C7-C8-O3	7.7(7)
C2-C7-C8-O3	-173.5(5)	C6-C7-C8-N1	-172.7(4)
C2-C7-C8-N1	6.1(7)	C2-C1-C9-N1	38.0(6)
S1-C1-C9-N1	-86.6(4)	C2-C1-C9-C10	158.1(4)
S1-C1-C9-C10	33.4(4)	N1-C9-C10-C15	97.3(5)
C1-C9-C10-C15	-23.1(5)	N1-C9-C10-C11	-85.6(5)
C1-C9-C10-C11	154.1(5)	C15-C10-C11-C12	-1.6(7)
C9-C10-C11-C12	-178.6(5)	C10-C11-C12-C13	0.1(9)
C11-C12-C13-C14	1.5(10)	C12-C13-C14-C15	-1.6(9)
C11-C10-C15-C14	1.6(7)	C9-C10-C15-C14	178.9(5)
C11-C10-C15-S1	-176.8(4)	C9-C10-C15-S1	0.5(5)
C13-C14-C15-C10	0.0(8)	C13-C14-C15-S1	178.1(4)
C3-C4-C16-C17	62.0(6)	C5-C4-C16-C17	-117.4(6)
C3-C4-C16-C19	-60.0(7)	C5-C4-C16-C19	120.6(6)
C3-C4-C16-C18	-179.2(5)	C5-C4-C16-C18	1.3(7)
C28-C20-C21-N2	-178.1(5)	N1-C20-C21-N2	-1.3(7)
C28-C20-C21-C25	1.3(7)	N1-C20-C21-C25	178.0(4)
N2-C22-C23-C24	-1.4(10)	C22-C23-C24-C25	0.8(10)
N2-C21-C25-C26	179.0(5)	C20-C21-C25-C26	-0.3(8)
N2-C21-C25-C24	-0.6(8)	C20-C21-C25-C24	-179.9(5)
C23-C24-C25-C21	0.1(8)	C23-C24-C25-C26	-179.4(6)
C21-C25-C26-C27	-0.9(9)	C24-C25-C26-C27	178.6(6)
C25-C26-C27-C28	1.3(11)	C21-C20-C28-C27	-1.0(9)
N1-C20-C28-C27	-177.7(5)	C26-C27-C28-C20	-0.3(10)
O3-C8-N1-C20	-4.2(7)	C7-C8-N1-C20	176.2(4)
O3-C8-N1-C9	-171.0(4)	C7-C8-N1-C9	9.4(6)
C28-C20-N1-C8	82.0(6)	C21-C20-N1-C8	-94.8(5)
C28-C20-N1-C9	-110.4(5)	C21-C20-N1-C9	72.8(6)
C10-C9-N1-C8	-148.1(4)	C1-C9-N1-C8	-31.1(6)
C10-C9-N1-C20	45.4(5)	C1-C9-N1-C20	162.3(4)
C23-C22-N2-C21	0.9(8)	C25-C21-N2-C22	0.1(7)
C20-C21-N2-C22	179.4(5)	C10-C15-S1-O2	-95.2(4)
C14-C15-S1-O2	86.5(5)	C10-C15-S1-O1	131.4(4)
C14-C15-S1-O1	-46.9(5)	C10-C15-S1-C1	17.7(4)
C14-C15-S1-C1	-160.6(5)	C2-C1-S1-O2	-44.0(4)
C9-C1-S1-O2	82.8(3)	C2-C1-S1-O1	88.6(4)
C9-C1-S1-O1	-144.5(3)	C2-C1-S1-C15	-157.0(4)
C9-C1-S1-C15	-30.1(3)		

Table S26. Anisotropic atomic displacement parameters (Å^2) for 3g.

The anisotropic atomic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}\ U_{11} + ... + 2\ h\ k$

$a^* b^* U_{12}$]

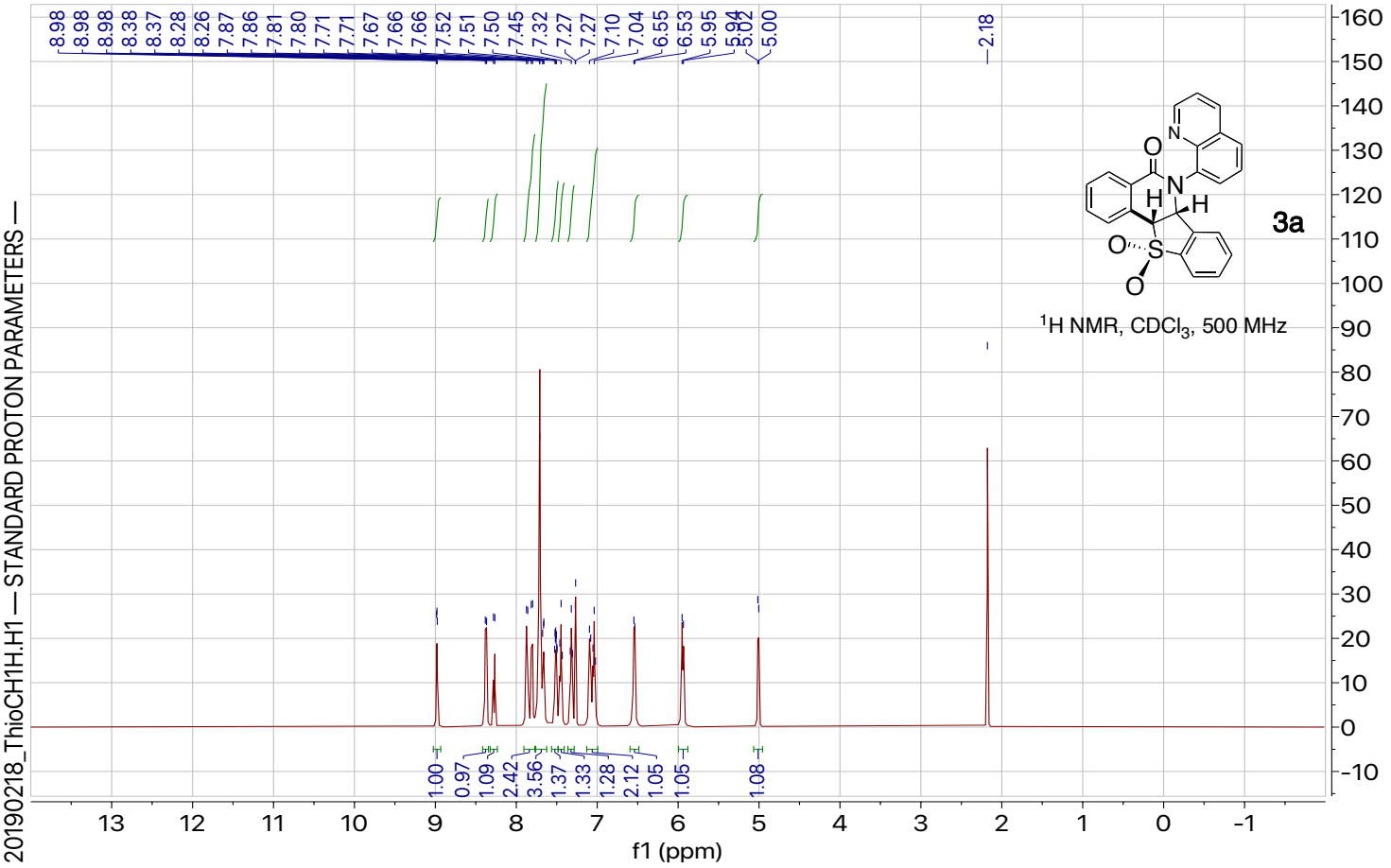
	U_{11}	U_{22}	U_{33}	U_{23}	U_{13}	U_{12}
C1	0.052(3)	0.029(3)	0.033(2)	-0.0014(19)	0.016(2)	0.000(2)
C2	0.045(3)	0.035(3)	0.036(2)	0.005(2)	0.015(2)	0.001(2)
C3	0.051(3)	0.032(3)	0.041(3)	0.000(2)	0.020(2)	-0.003(2)
C4	0.041(2)	0.037(3)	0.043(3)	0.008(2)	0.012(2)	0.002(2)
C5	0.054(3)	0.040(3)	0.050(3)	0.006(2)	0.025(2)	-0.001(2)
C6	0.059(3)	0.043(3)	0.047(3)	0.001(2)	0.028(3)	0.004(2)
C7	0.047(3)	0.031(3)	0.034(2)	0.0031(19)	0.013(2)	0.001(2)
C8	0.046(3)	0.036(3)	0.036(2)	0.002(2)	0.014(2)	0.002(2)
C9	0.045(3)	0.030(3)	0.031(2)	0.0067(19)	0.0114(19)	0.003(2)
C10	0.048(3)	0.031(3)	0.031(2)	0.0008(19)	0.010(2)	-0.002(2)
C11	0.064(3)	0.036(3)	0.051(3)	0.009(2)	0.021(3)	0.000(2)
C12	0.067(4)	0.053(4)	0.065(4)	0.009(3)	0.028(3)	-0.015(3)
C13	0.054(3)	0.061(4)	0.073(4)	0.005(3)	0.025(3)	-0.015(3)
C14	0.048(3)	0.056(4)	0.059(3)	0.004(3)	0.015(3)	0.001(3)
C15	0.047(3)	0.036(3)	0.039(2)	0.000(2)	0.012(2)	-0.004(2)
C16	0.047(3)	0.033(3)	0.050(3)	0.003(2)	0.018(2)	-0.004(2)
C17	0.065(4)	0.040(4)	0.114(6)	-0.012(3)	0.038(4)	-0.003(3)
C18	0.076(4)	0.041(3)	0.096(5)	0.006(3)	0.047(4)	-0.008(3)
C19	0.114(6)	0.085(6)	0.060(4)	0.010(4)	-0.002(4)	-0.048(5)
C20	0.050(3)	0.036(3)	0.043(3)	-0.005(2)	0.019(2)	0.000(2)
C21	0.053(3)	0.033(3)	0.048(3)	0.001(2)	0.027(2)	-0.001(2)
C22	0.066(4)	0.063(4)	0.070(4)	0.023(3)	0.032(3)	0.026(3)
C23	0.095(5)	0.046(4)	0.103(5)	0.032(4)	0.062(5)	0.032(4)
C24	0.107(6)	0.032(3)	0.109(6)	0.007(3)	0.075(5)	0.005(3)
C25	0.082(4)	0.026(3)	0.073(4)	-0.004(3)	0.050(3)	-0.002(3)
C26	0.097(5)	0.047(4)	0.091(5)	-0.028(4)	0.045(4)	-0.023(4)
C27	0.072(4)	0.068(5)	0.086(5)	-0.029(4)	0.016(4)	-0.021(4)
C28	0.062(3)	0.050(4)	0.056(3)	-0.010(3)	0.009(3)	-0.004(3)
Cl1	0.127(3)	0.213(4)	0.199(4)	0.076(3)	0.074(2)	0.025(2)
N1	0.049(2)	0.025(2)	0.0349(19)	0.0011(16)	0.0128(17)	0.0011(17)
N2	0.057(3)	0.043(3)	0.053(3)	0.009(2)	0.024(2)	0.010(2)
O1	0.075(3)	0.034(2)	0.090(3)	0.000(2)	0.044(2)	0.0089(19)
O2	0.070(3)	0.056(3)	0.047(2)	0.0178(18)	0.0131(19)	0.0094(19)
O3	0.085(3)	0.046(2)	0.051(2)	-0.0122(18)	0.035(2)	-0.008(2)
S1	0.0536(8)	0.0297(7)	0.0493(8)	0.0080(5)	0.0200(6)	0.0054(5)
Cl2	0.623(14)	0.173(4)	0.296(6)	-0.092(4)	0.344(9)	-0.160(6)
C30	0.173(12)	0.159(12)	0.138(10)	0.052(9)	0.061(9)	0.028(10)

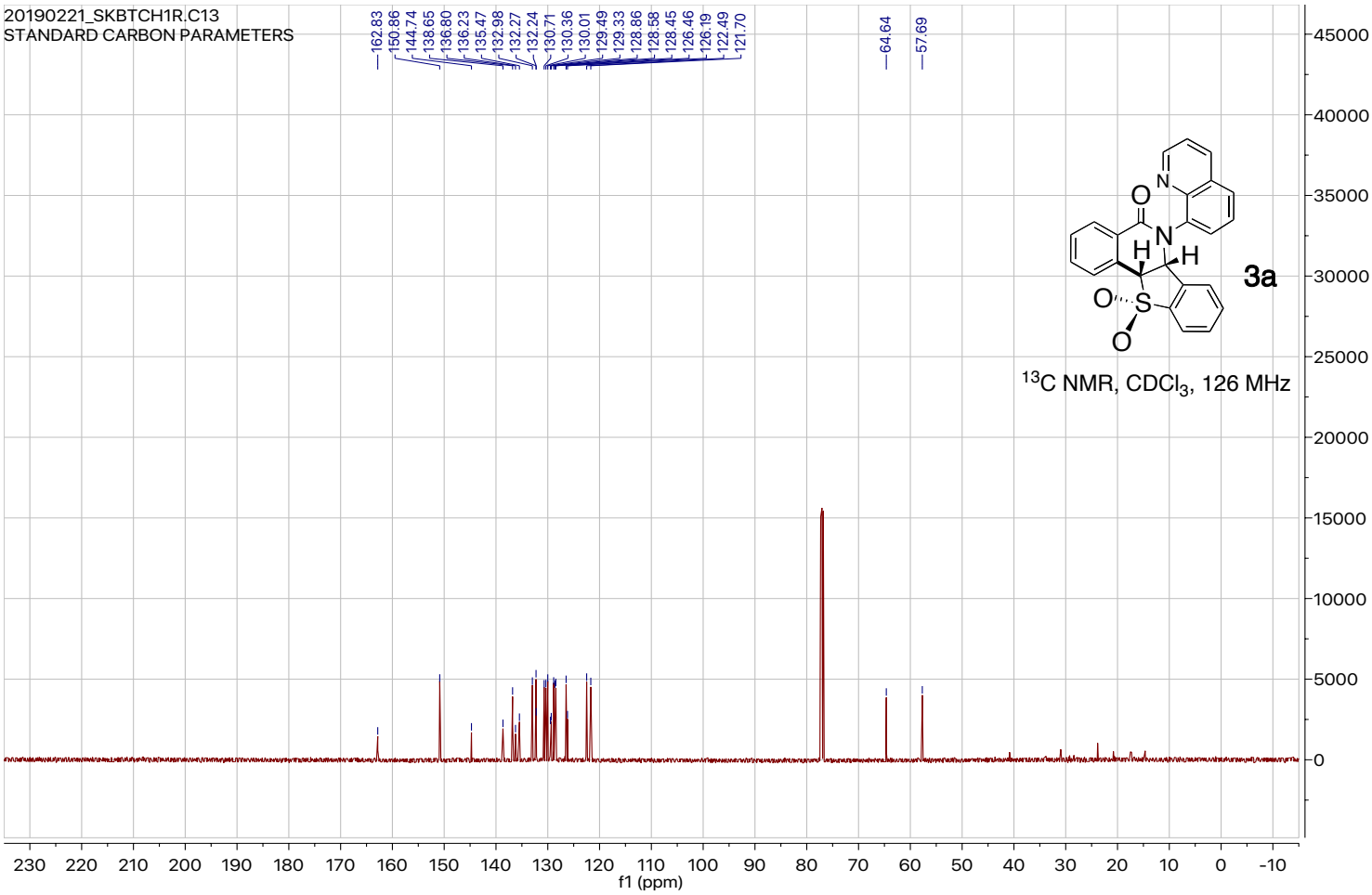
Table S27. Hydrogen atomic coordinates and isotropic atomic displacement parameters (Å^2) for 3g.

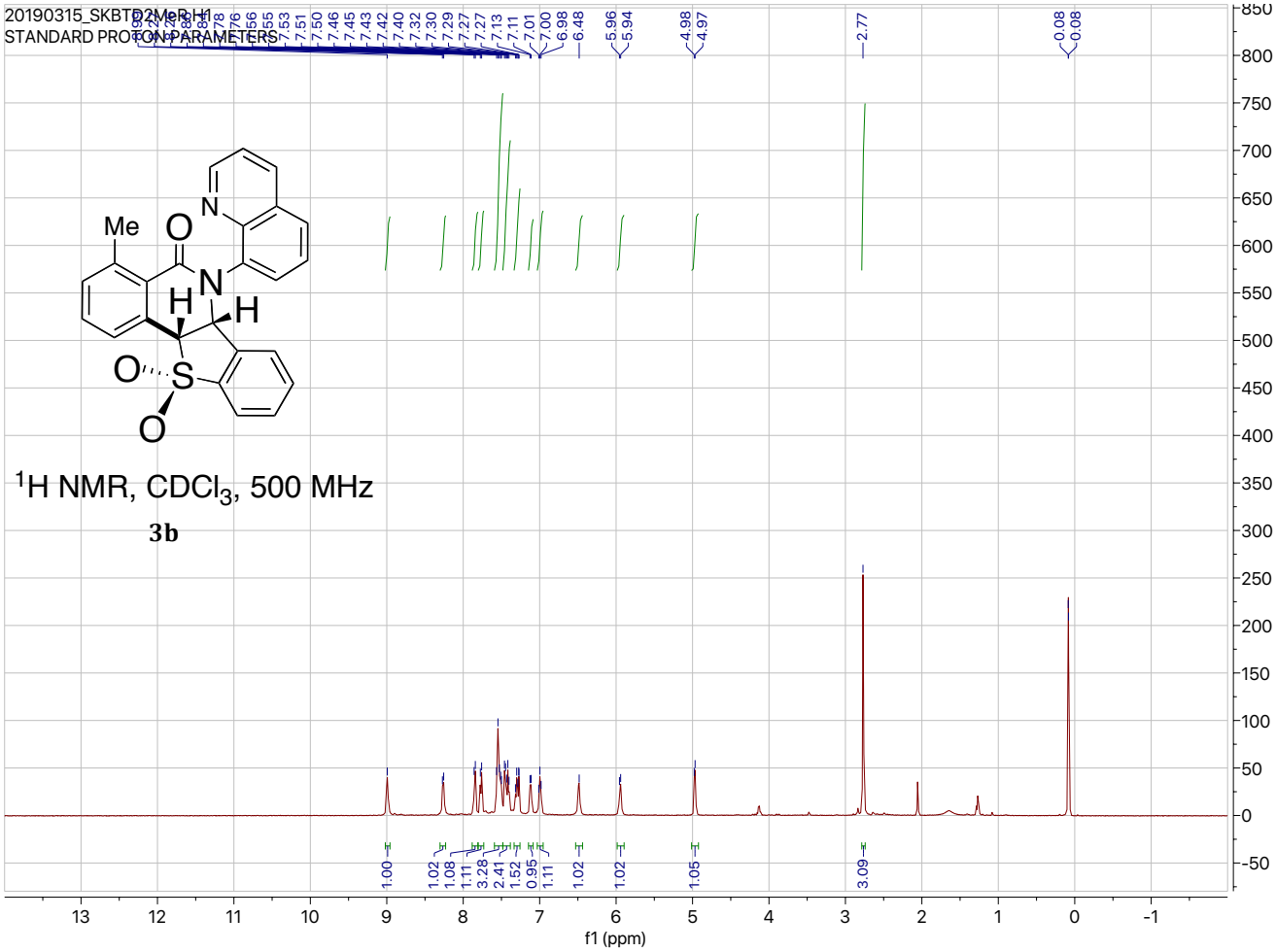
	x/a	y/b	z/c	U(eq)
H1	1.0122	0.6587	0.2274	0.045
H3	0.9018	0.5699	0.2768	0.048
H5	0.6940	0.5828	0.4983	0.056
H6	0.8003	0.6733	0.5449	0.056
H9	0.9680	0.7525	0.2420	0.043
H11	1.1651	0.8314	0.2177	0.06
H12	1.4065	0.8434	0.1972	0.072

	x/a	y/b	z/c	U(eq)
H13	1.5934	0.7720	0.2530	0.074
H14	1.5396	0.6863	0.3229	0.066
H17A	0.8072	0.4239	0.3561	0.107
H17B	0.9131	0.4641	0.4467	0.107
H17C	0.9119	0.4709	0.3283	0.107
H18A	0.5727	0.4493	0.3934	0.1
H18B	0.5319	0.5142	0.4052	0.1
H18C	0.6769	0.4858	0.4909	0.1
H19A	0.6814	0.5157	0.1899	0.142
H19B	0.5358	0.5332	0.2212	0.142
H19C	0.5745	0.4678	0.2124	0.142
H22	0.6884	0.8903	0.1941	0.077
H23	0.7611	0.9853	0.2332	0.089
H24	0.9845	1.0069	0.3650	0.087
H26	1.2335	0.9699	0.5102	0.09
H27	1.3783	0.8932	0.5997	0.093
H28	1.2973	0.7995	0.5499	0.071
H30A	0.4318	0.1669	0.5647	0.186
H30B	0.2549	0.1840	0.5281	0.186

14. NMR Spectra of Products



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H
H
O
S
O
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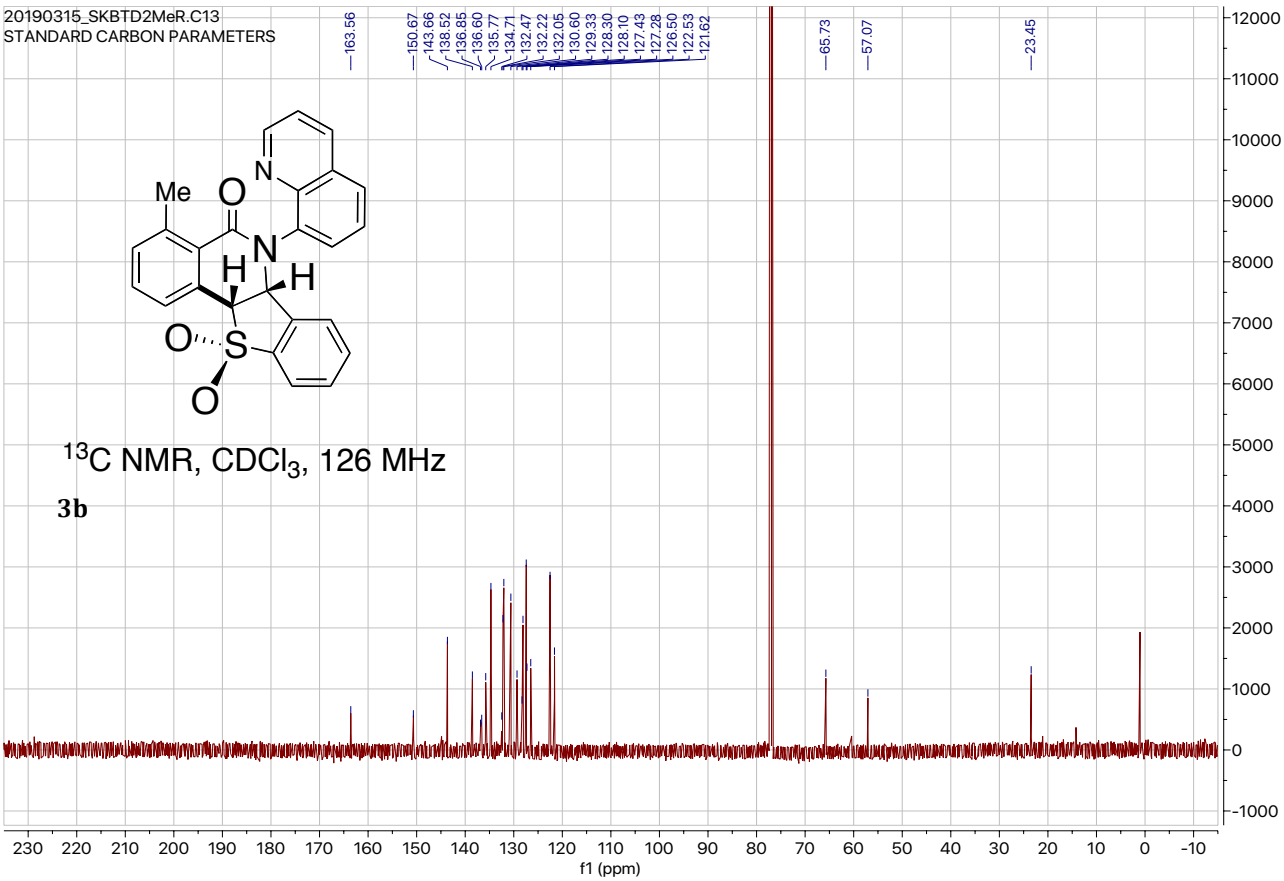
3b
f1 (ppm)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H
H
O
S
O
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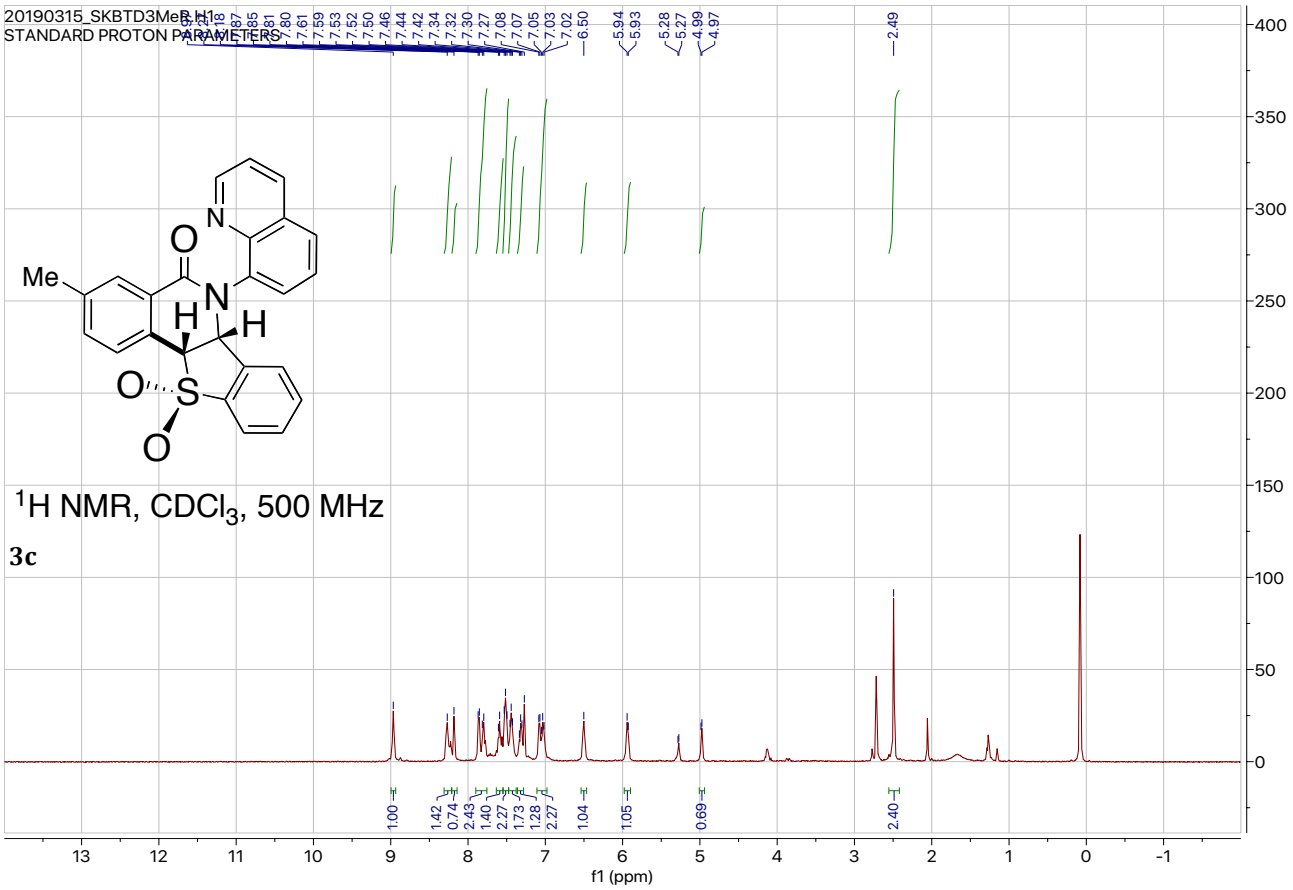
f1 (ppm)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S
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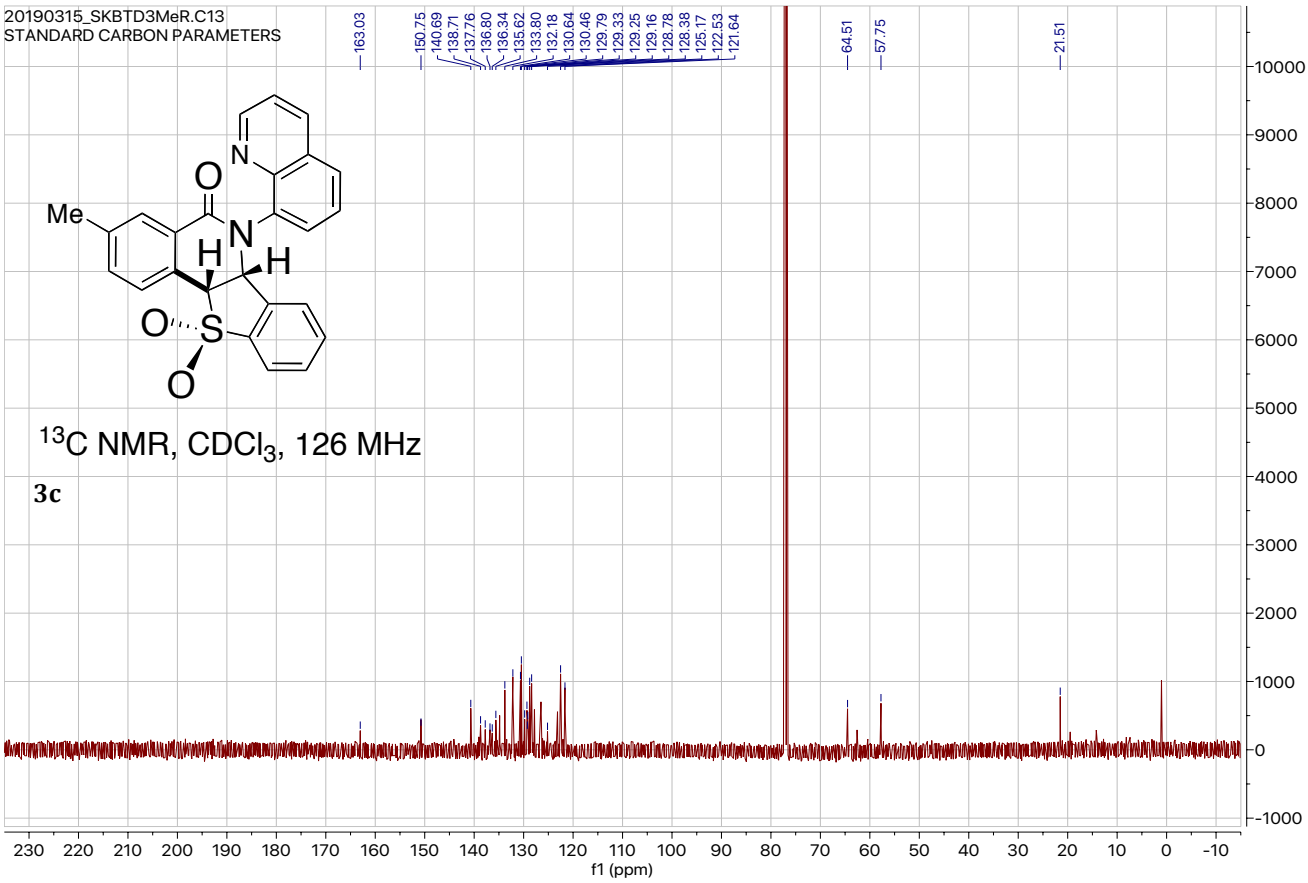
3c
f1 (ppm)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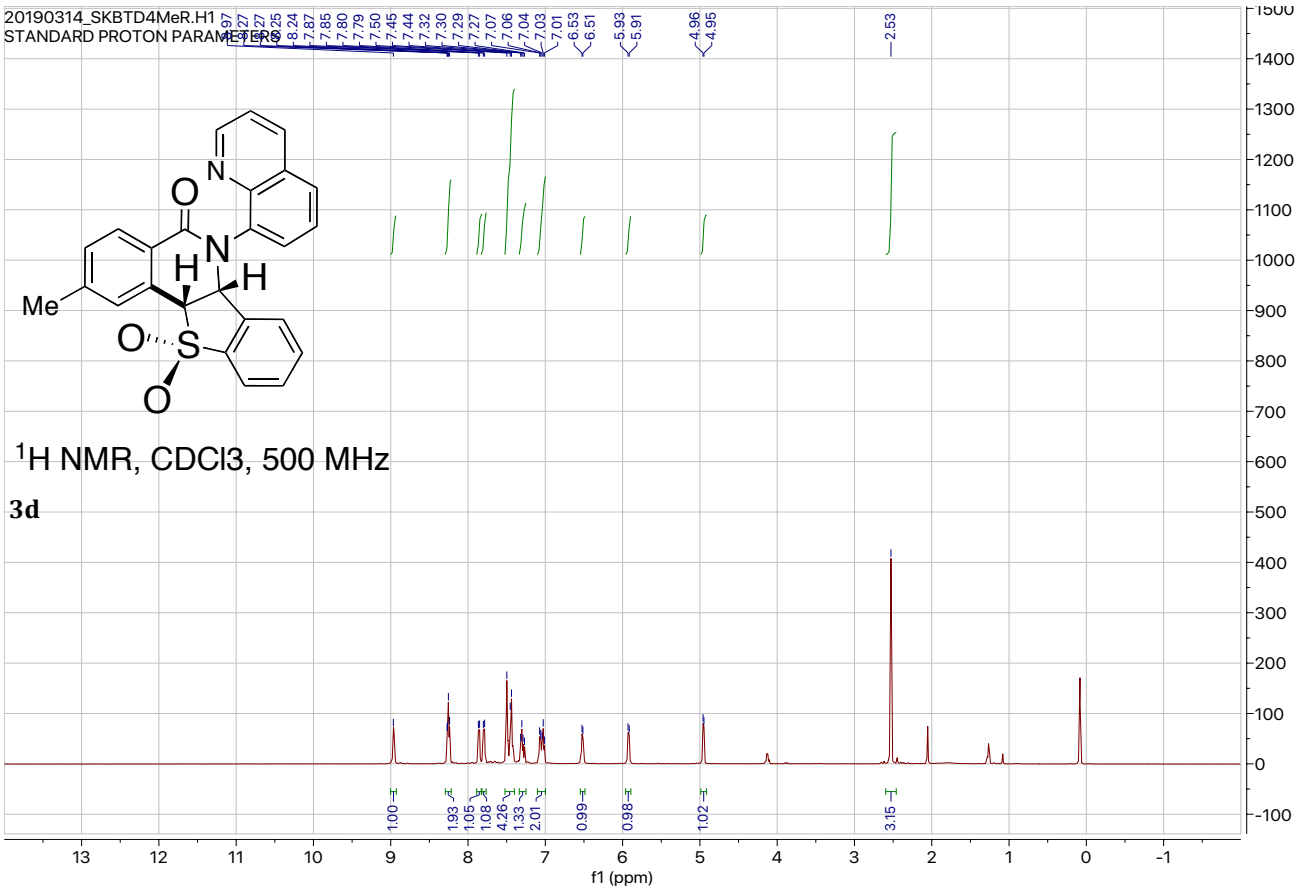
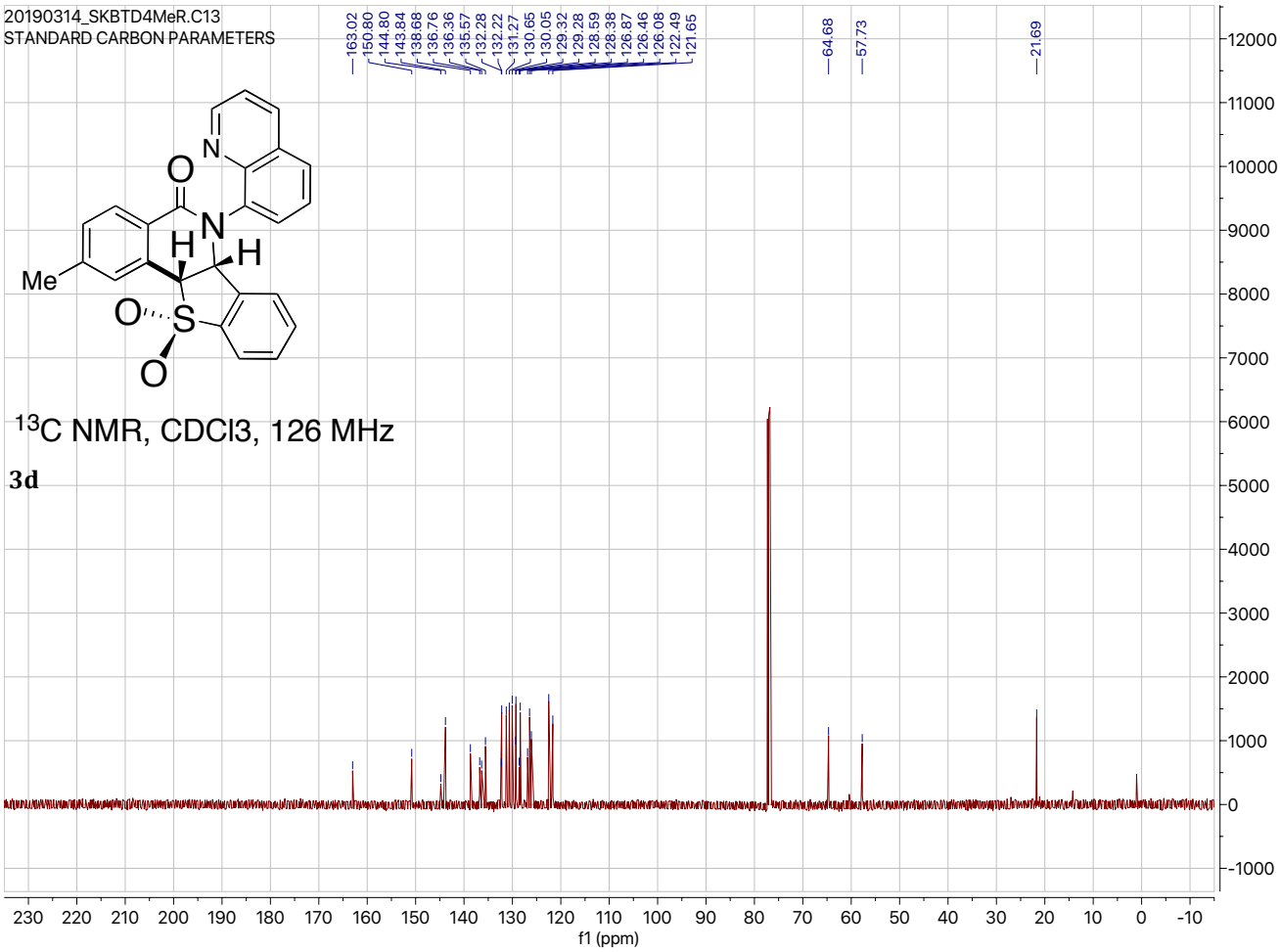
H
H
O
S
O
^{13}C NMR, $CDCl_3$, 126 MHz
3c
f1 (ppm)



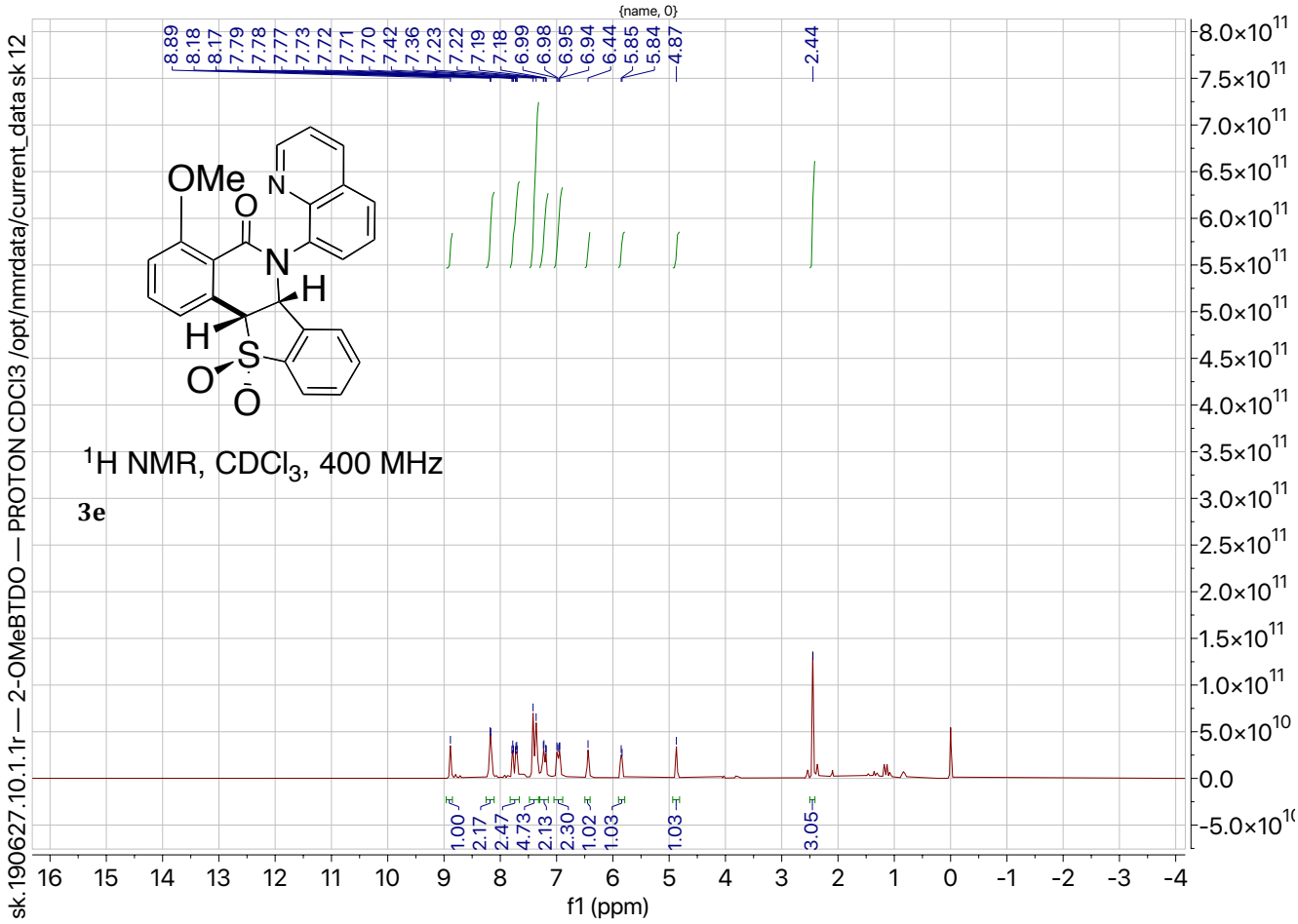
^{1}H NMR, CDCl3, 500 MHz

3d



^{13}C NMR, CDCl3, 126 MHz

3d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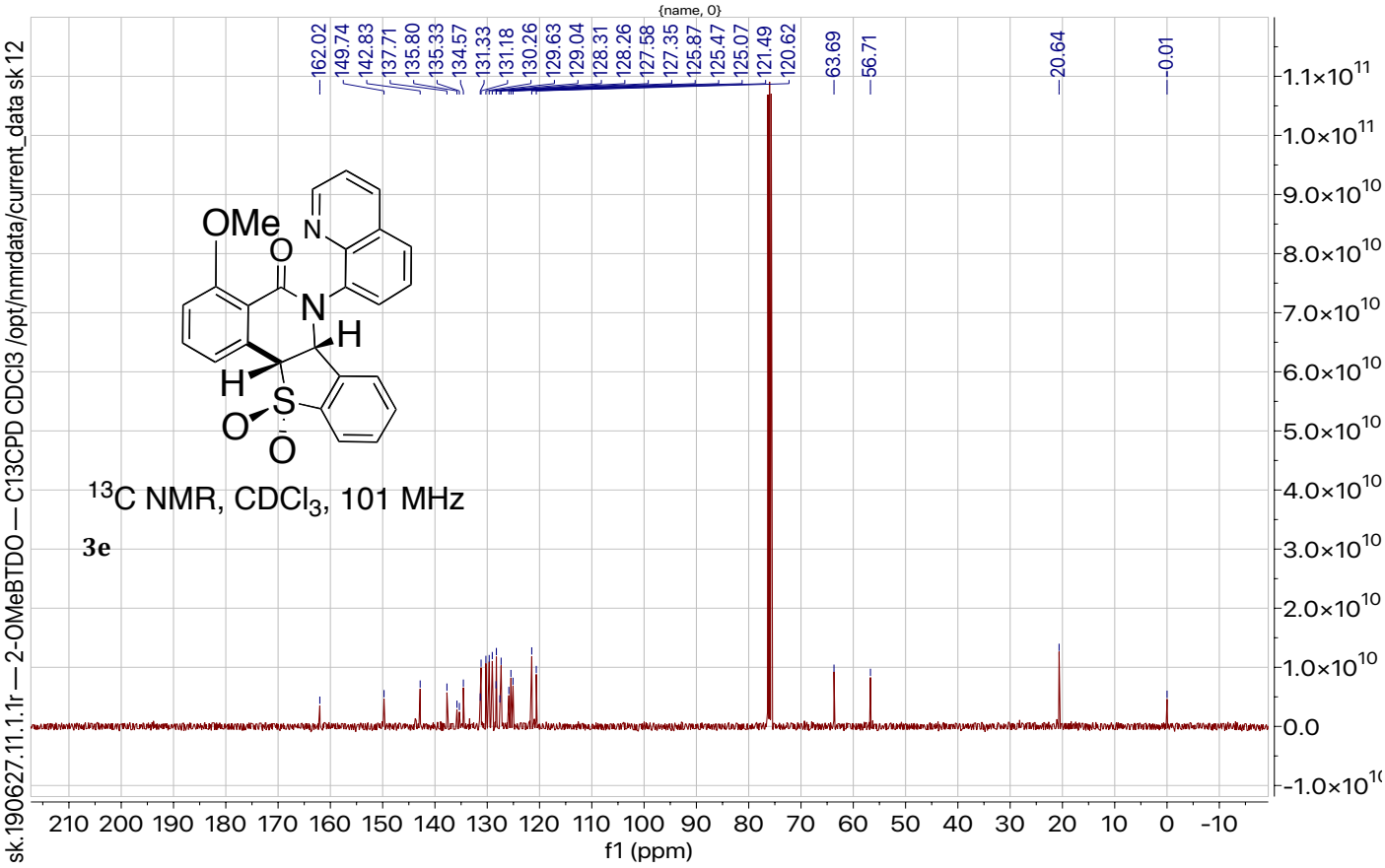
8.18
8.17
7.79
7.78
7.77
7.73
7.72
7.71
7.70
7.42
7.36
7.23
7.22
7.19
7.18
6.99
6.98
6.95
6.94
6.44
5.85
5.84
4.87
2.44
OMe
N
O
N
H
H
S
O
O
^{1}H NMR, $CDCl_3$, 400 MHz
3e
1.00
2.17
2.47
4.73
2.13
2.30
1.02
1.03
1.03
3.05
f1 (ppm)
sk.190627.10.1.1r — 2-OMeBTDO — PROTON CDCl3 /opt/nmrdata/current_data sk 12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135.33
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130.26
129.63
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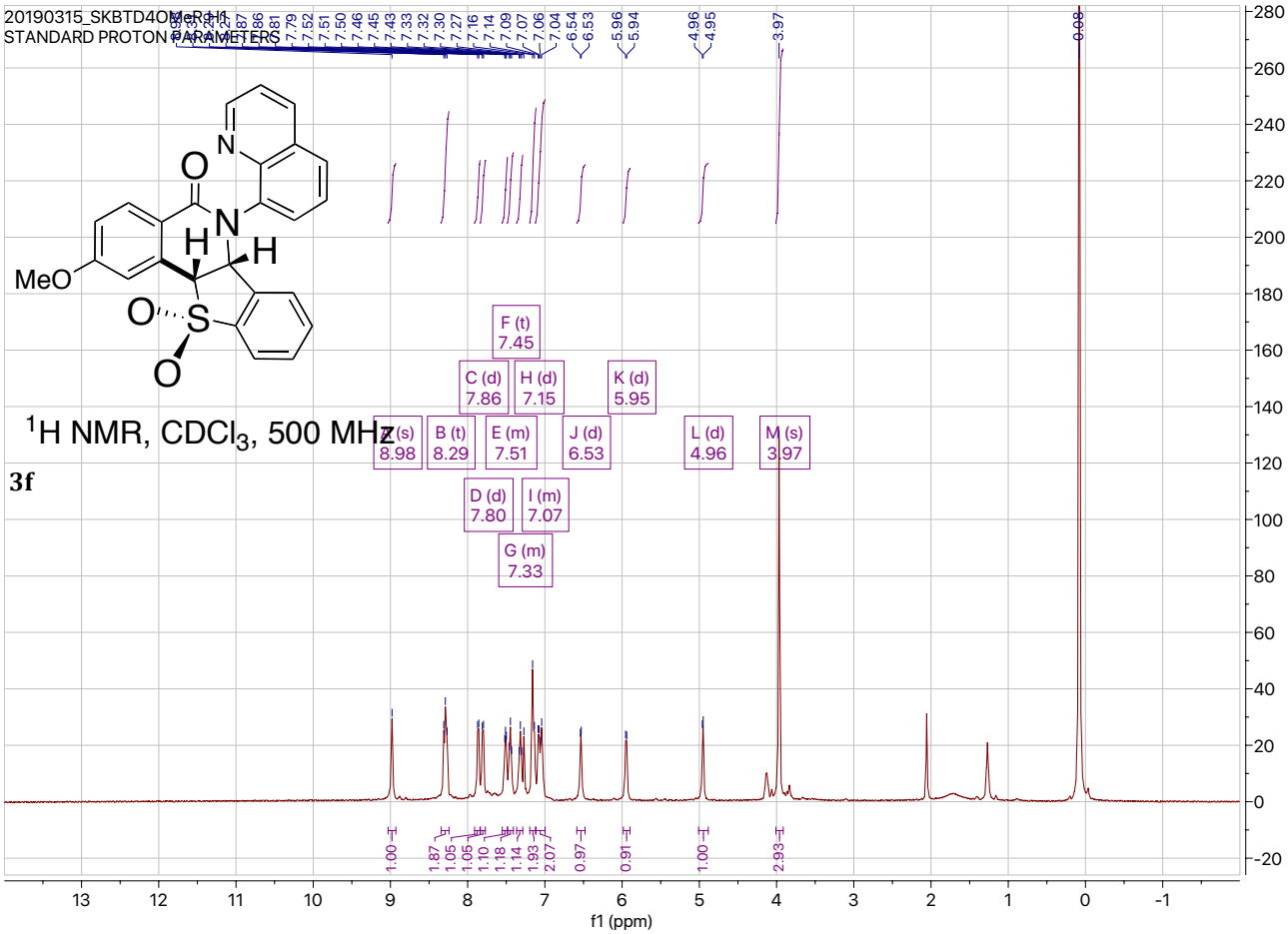
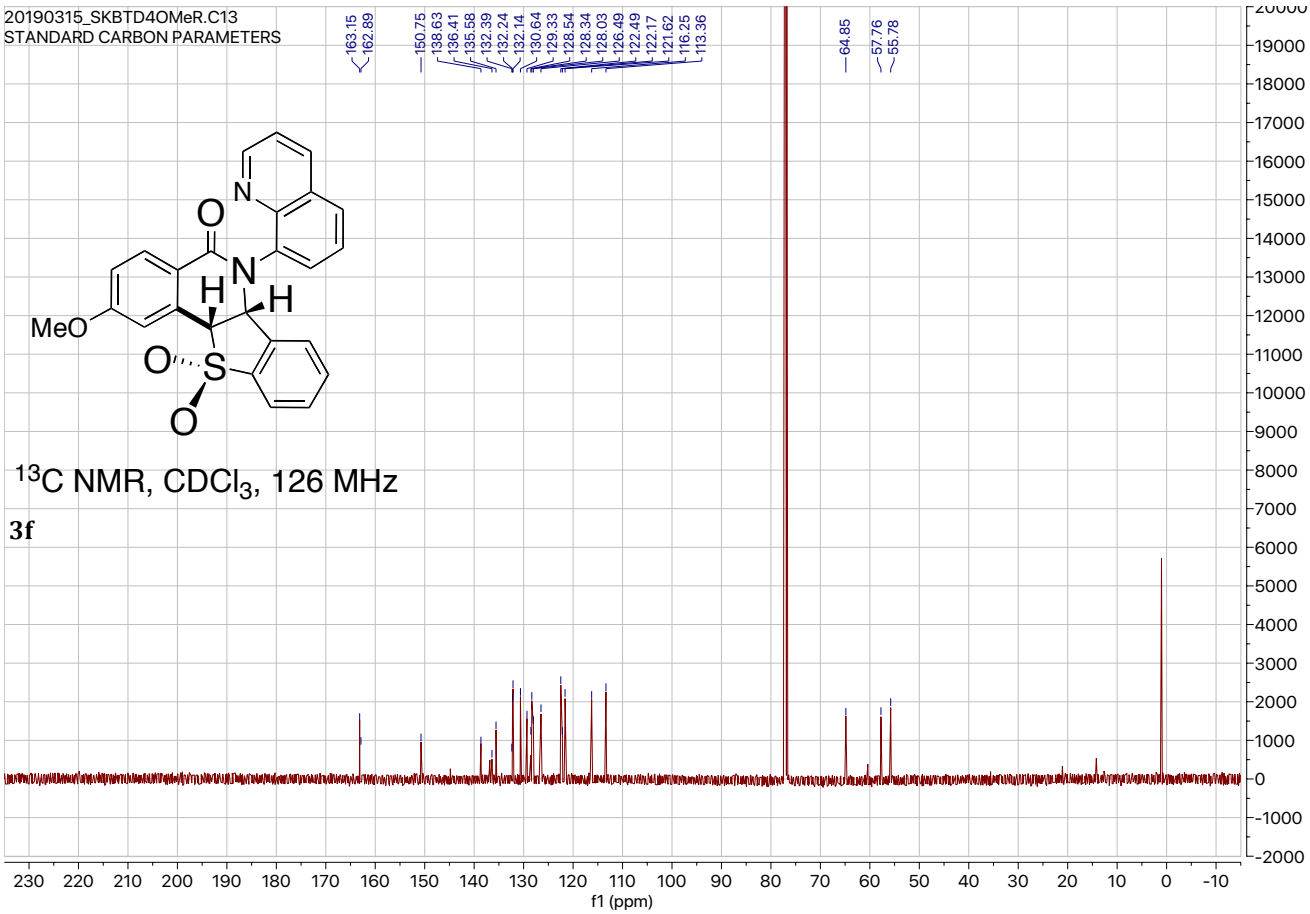
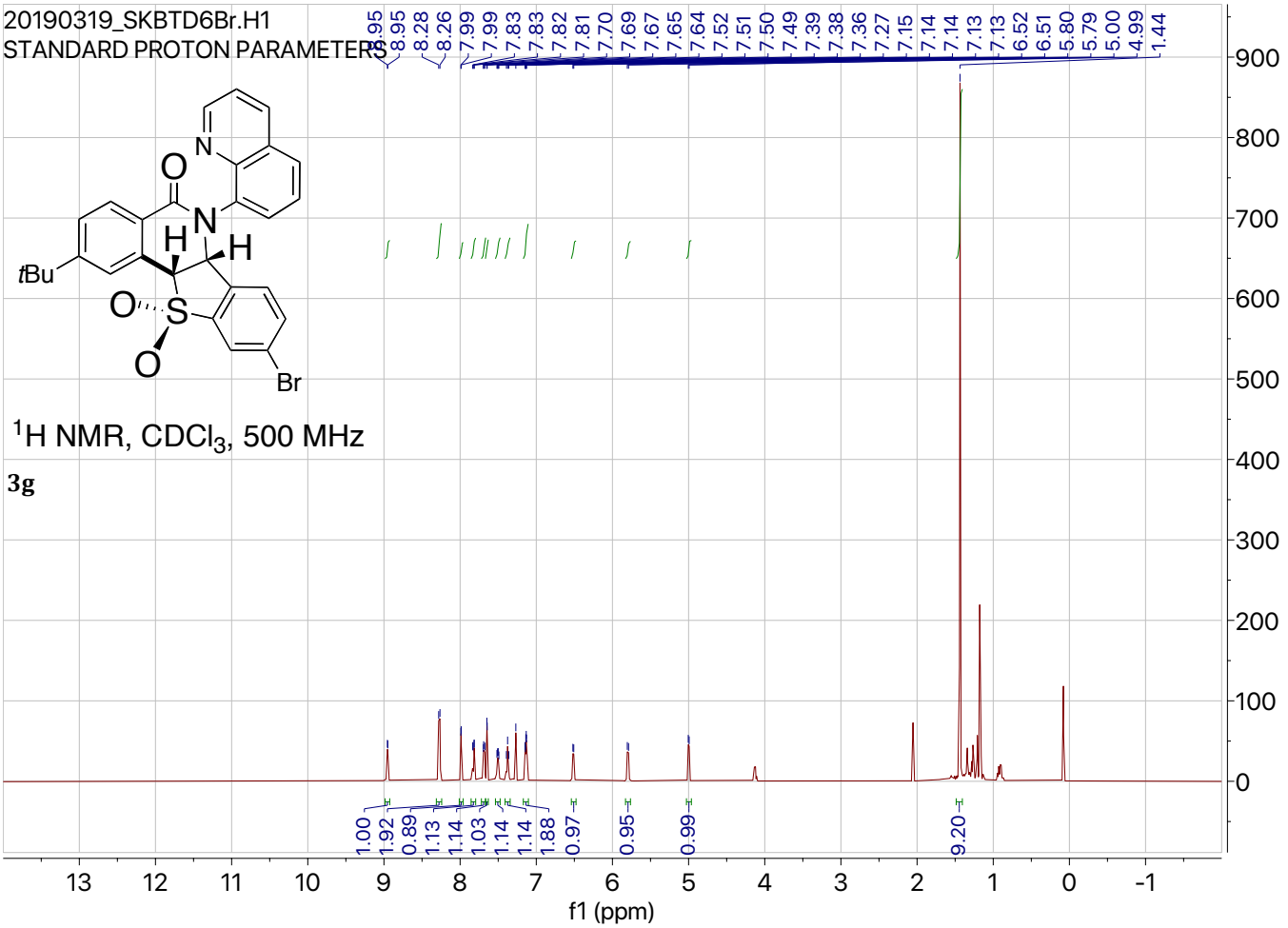
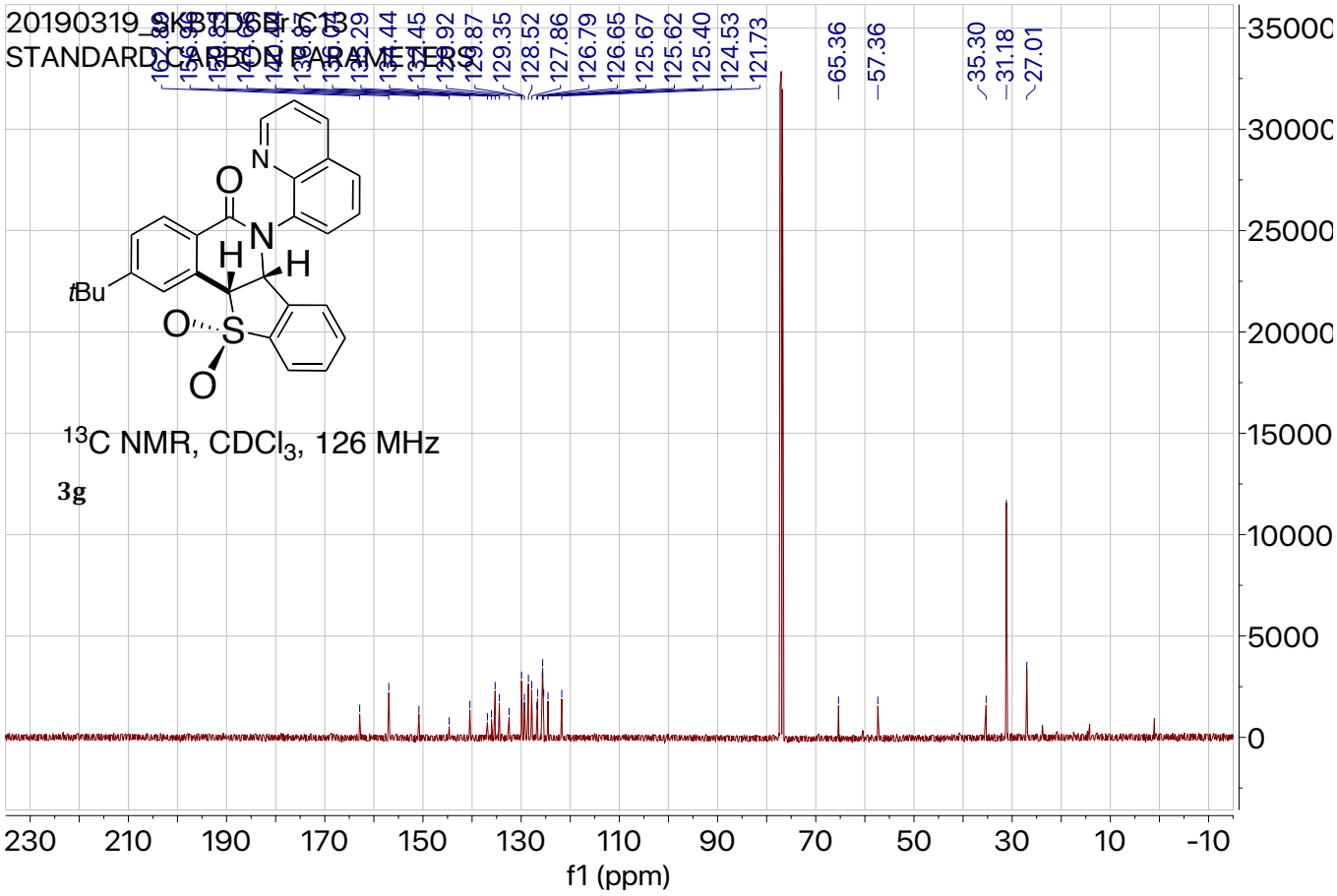
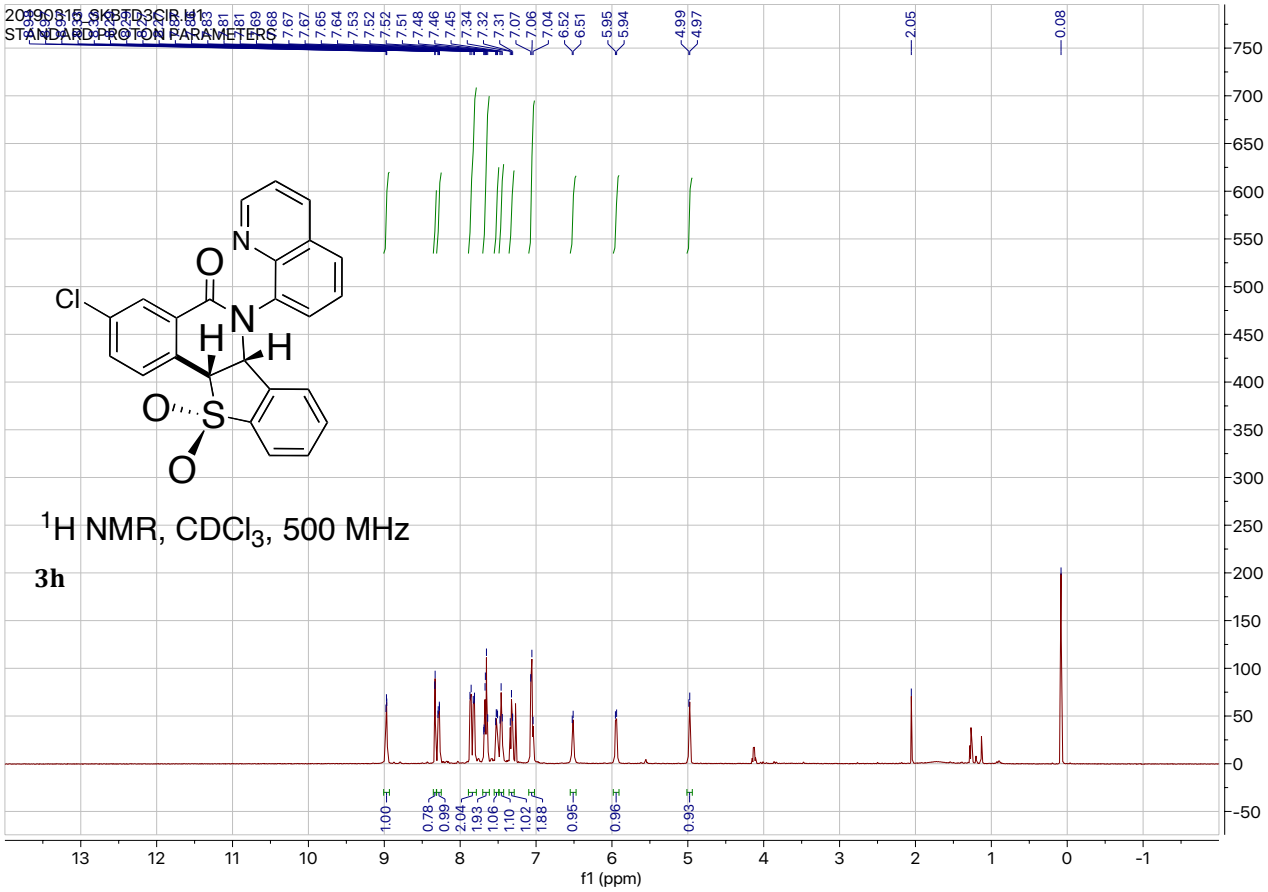
128.31
128.26
127.58
127.35
125.87
125.47
125.07
121.49
120.62
63.69
56.71
20.64
0.01
OMe
N
O
N
H
H
S
O
O
^{13}C NMR, $CDCl_3$, 101 MHz
3e
f1 (ppm)
sk.190627.11.1.1r — 2-OMeBTDO — C13CPD CDCl3 /opt/nmrdata/current_data sk 12

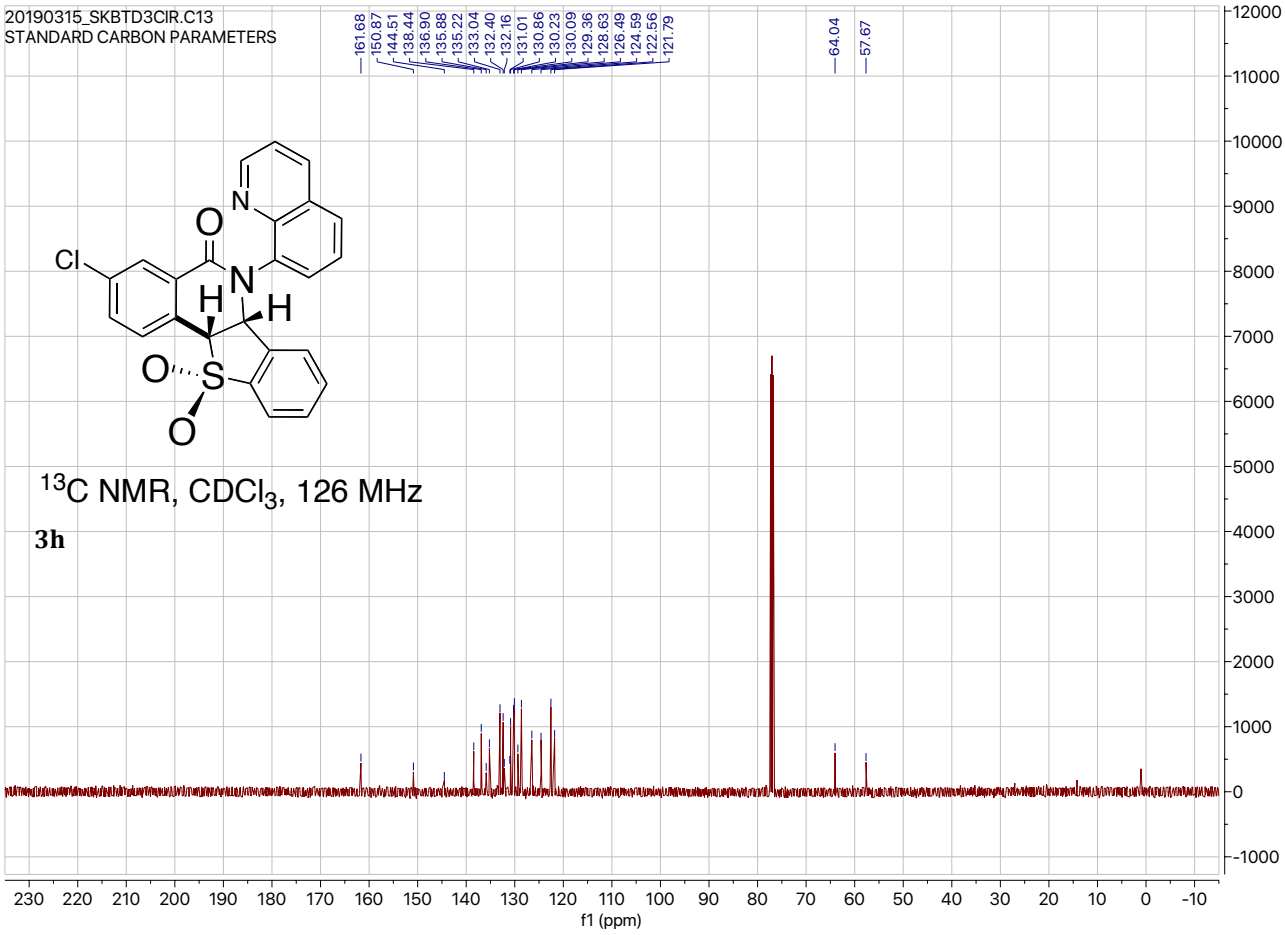

20190315_SKBTD4OMeR.H1
STANDARD PROTON PARAMETERS
MeO
N
O
H
S
^{1}H NMR, CDCl$_3$, 500 MHz
3f
A (s) 8.98
B (t) 8.29
C (d) 7.86
D (d) 7.80
E (m) 7.51
F (t) 7.45
G (m) 7.33
H (d) 7.15
I (m) 7.07
J (d) 6.53
K (d) 5.95
L (d) 4.96
M (s) 3.97
f1 (ppm)

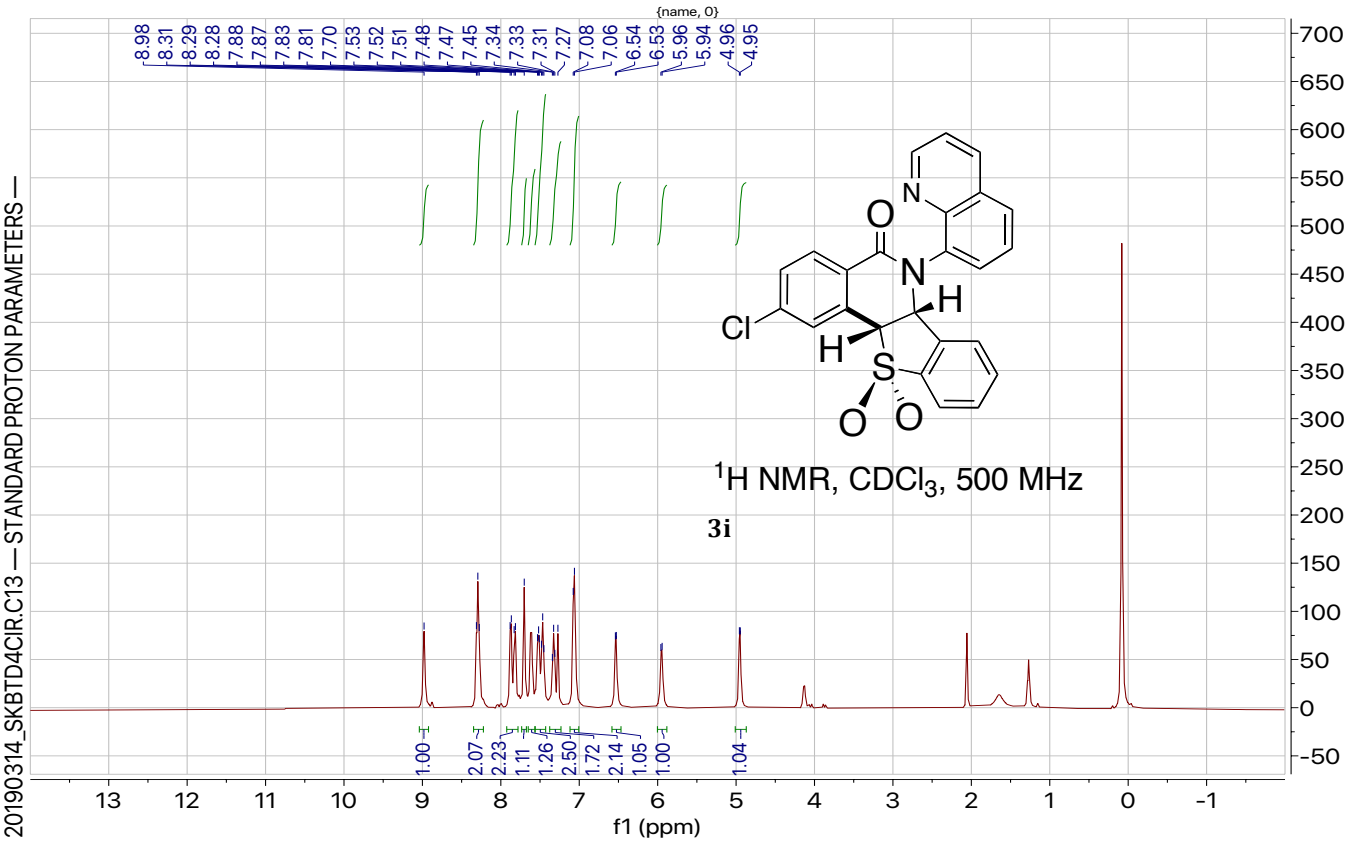

20190315_SKBTD4OMeR.C13
STANDARD CARBON PARAMETERS
MeO
N
O
H
S
^{13}C NMR, CDCl$_3$, 126 MHz
3f
163.15
162.89
150.75
138.63
136.41
135.58
132.39
132.24
132.14
130.64
129.33
128.54
128.34
128.03
126.49
122.49
122.17
121.62
116.25
113.36
64.85
57.76
55.78
f1 (ppm)


20190319_SKBTD6Br.H1
STANDARD PROTON PARAMETERS
^{1}H NMR, $CDCl_3$, 500 MHz
3g
f1 (ppm)


20190319_SKBTD6Br.C13
STANDARD CARBON PARAMETERS
^{13}C NMR, $CDCl_3$, 126 MHz
3g
f1 (ppm)


20190315_SKBTD3CIR.H1
STANDARD PROTON PARAMETERS
^{1}H NMR, $CDCl_3$, 500 MHz
3h
f1 (ppm)


20190315_SKBTD3CIR.C13
STANDARD CARBON PARAMETERS
^{13}C NMR, $CDCl_3$, 126 MHz
3h
f1 (ppm)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7.81
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7.53
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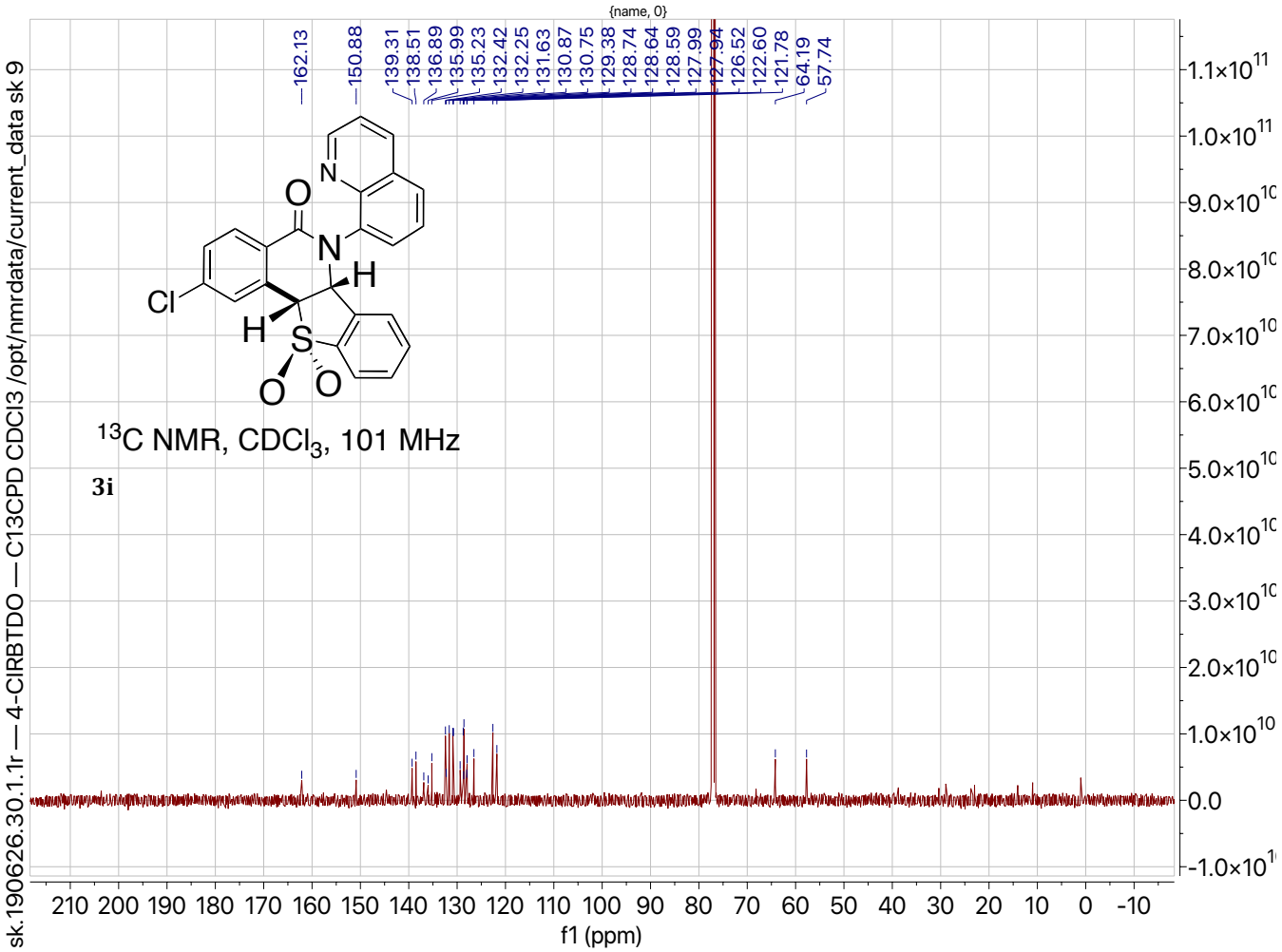
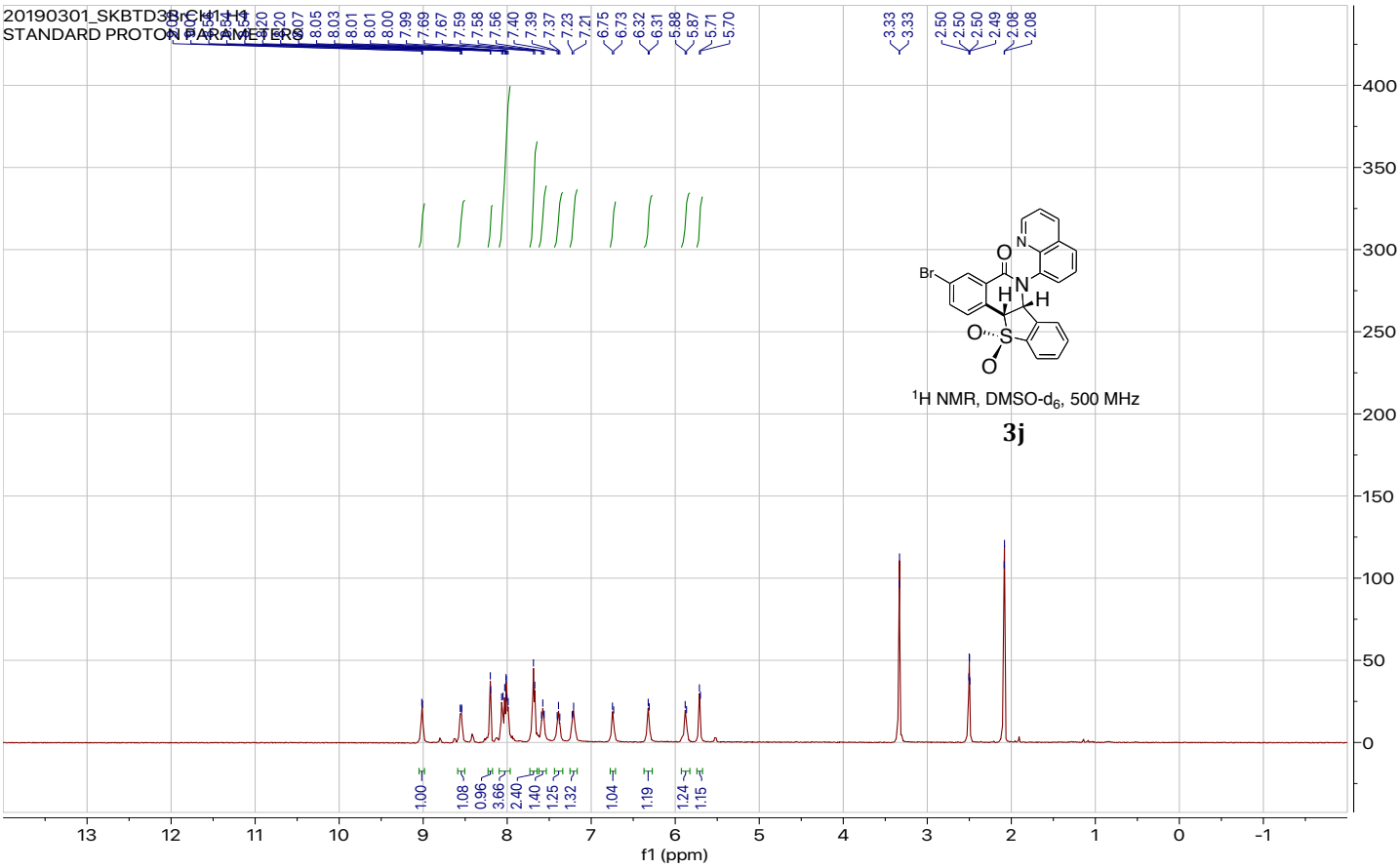
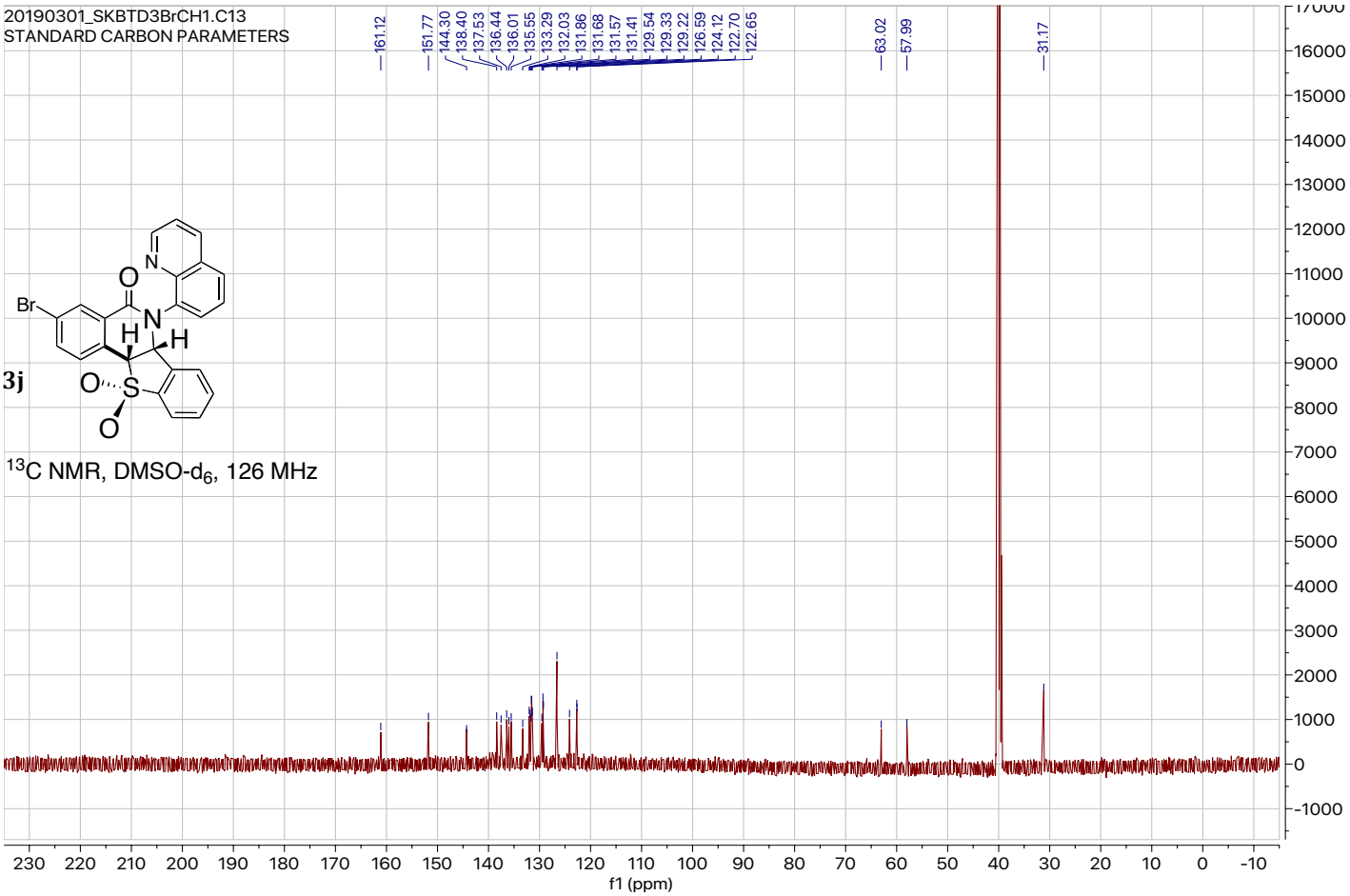
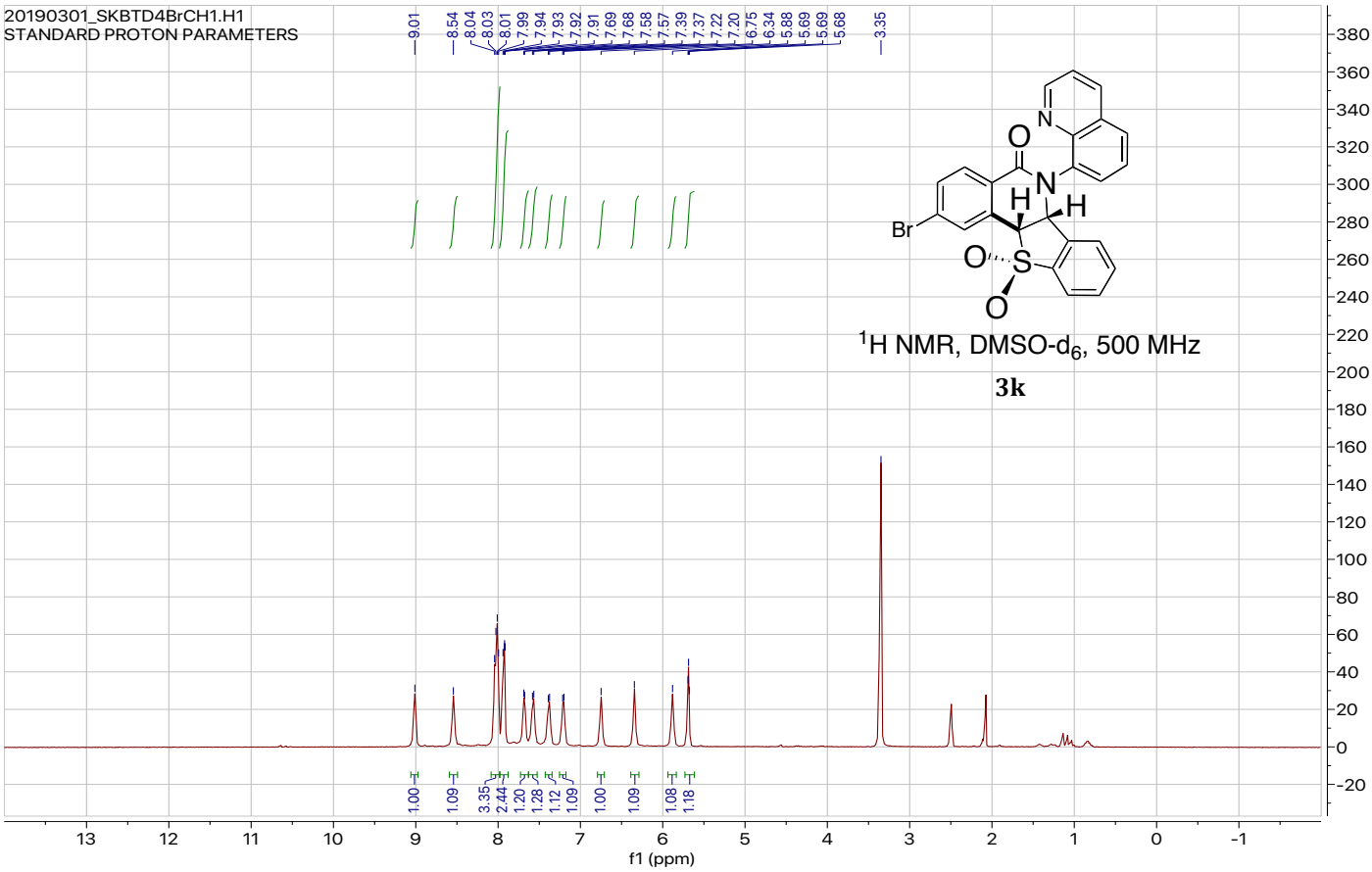
7.47
7.45
7.34
7.33
7.31
7.27
7.08
7.06
6.54
6.53
5.96
5.94
4.96
4.95
1.00
2.07
2.23
1.11
1.26
2.50
1.72
2.14
1.05
1.00
1.04
20190314_SKBTD4CIR.C13 — STANDARD PROTON PARAMETERS —
f1 (ppm)
^{1}H NMR, $CDCl_3$, 500 MHz
3i


{name, 0}
162.13
150.88
139.31
138.51
136.89
135.99
135.23
132.42
132.25
131.63
130.87
130.75
129.38
128.74
128.64
128.59
127.99
127.94
126.52
122.60
121.78
64.19
57.74
sk.190626.30.1.1r — 4-CIRBTDO — C13CPD CDCl3 /opt/nmrdata/current_data sk 9
f1 (ppm)
^{13}C NMR, $CDCl_3$, 101 MHz
3i

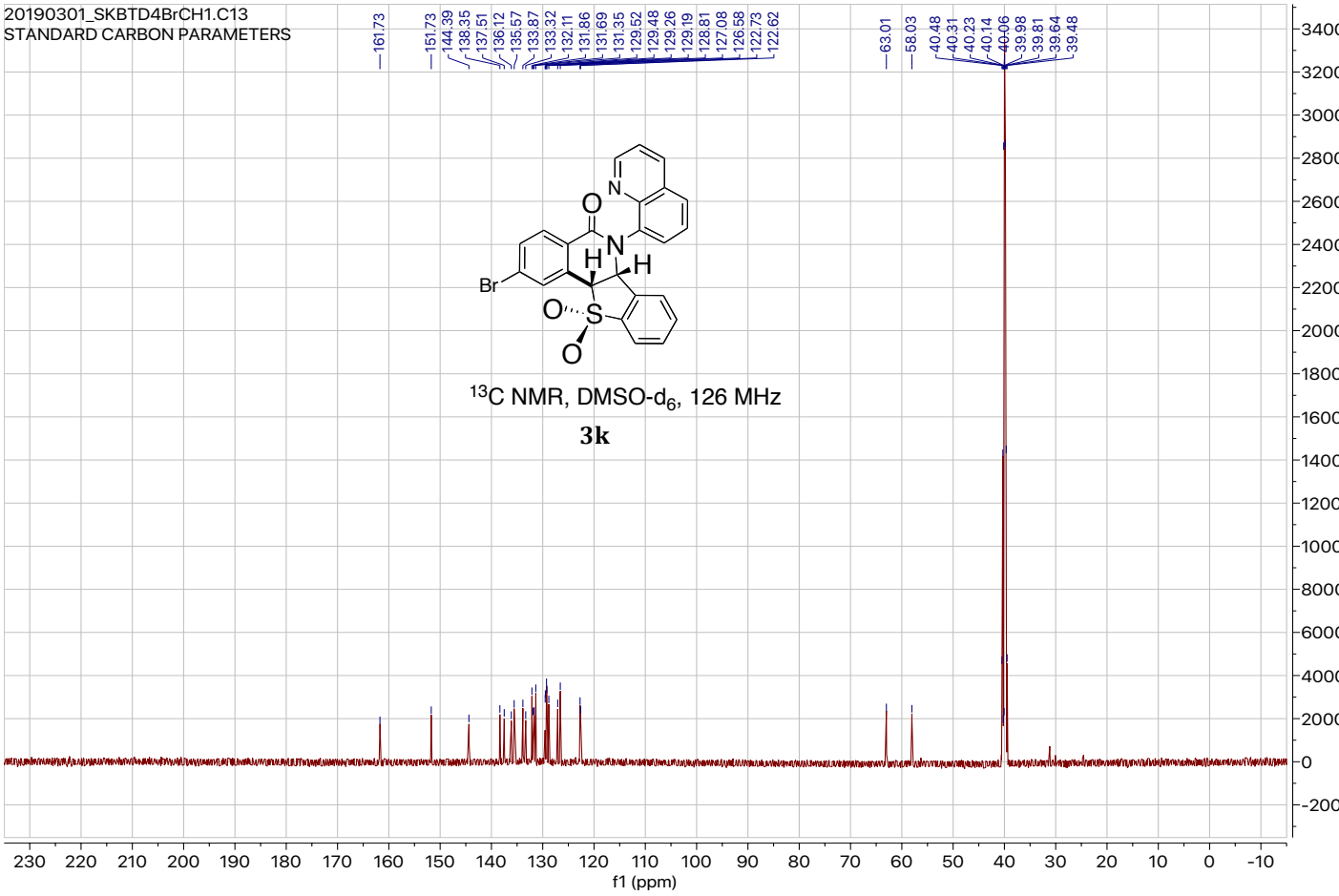

20190301_SKBTD3BrCH1.H1
STANDARD PROTON PARAMETERS
^{1}H NMR, DMSO-d$_6$, 500 MHz
3j
f1 (ppm)


20190301_SKBTD3BrCH1.C13
STANDARD CARBON PARAMETERS
3j
^{13}C NMR, DMSO-d$_6$, 126 MHz
f1 (ppm)



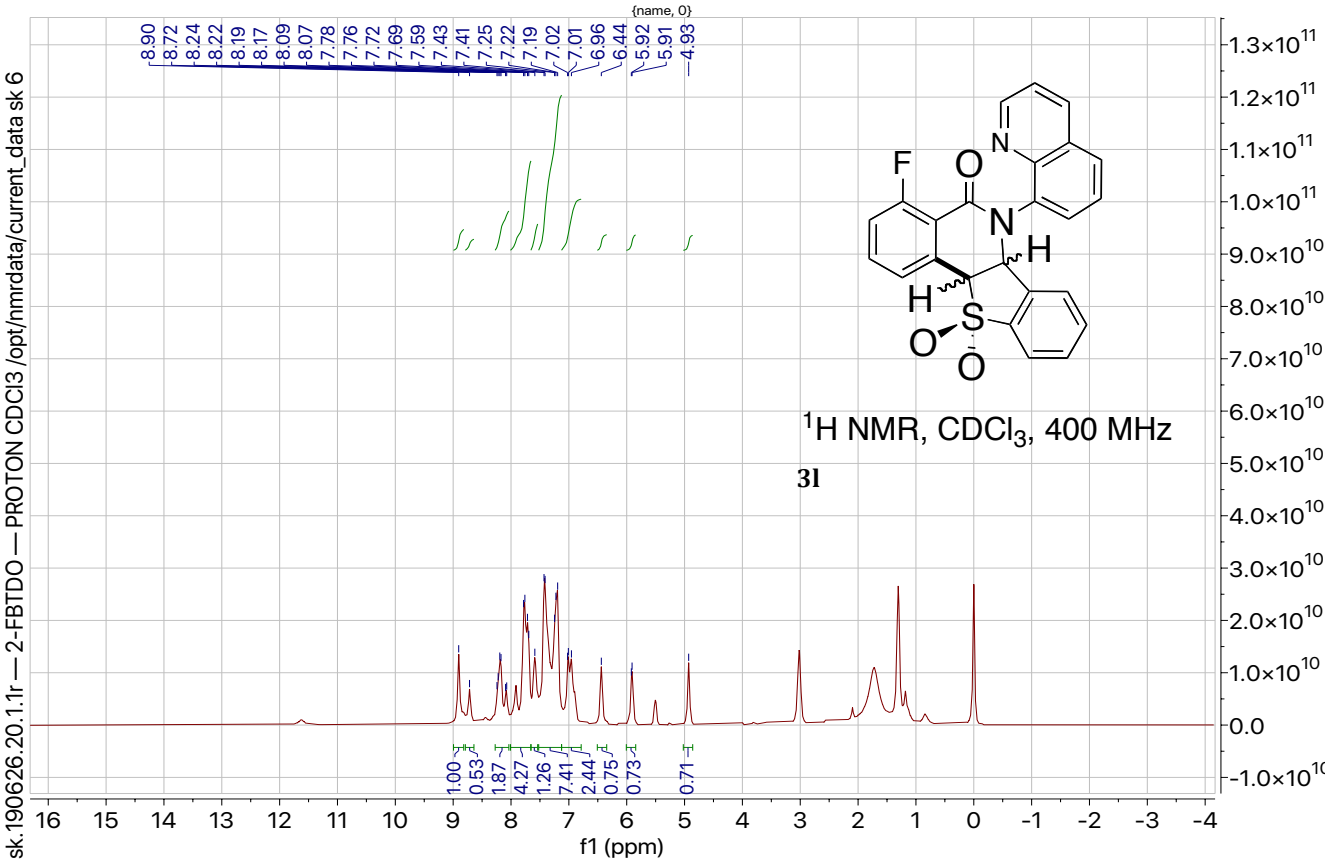
^{1}H NMR, DMSO-d$_6$, 500 MHz

3k



^{13}C NMR, DMSO-d$_6$, 126 MHz

3k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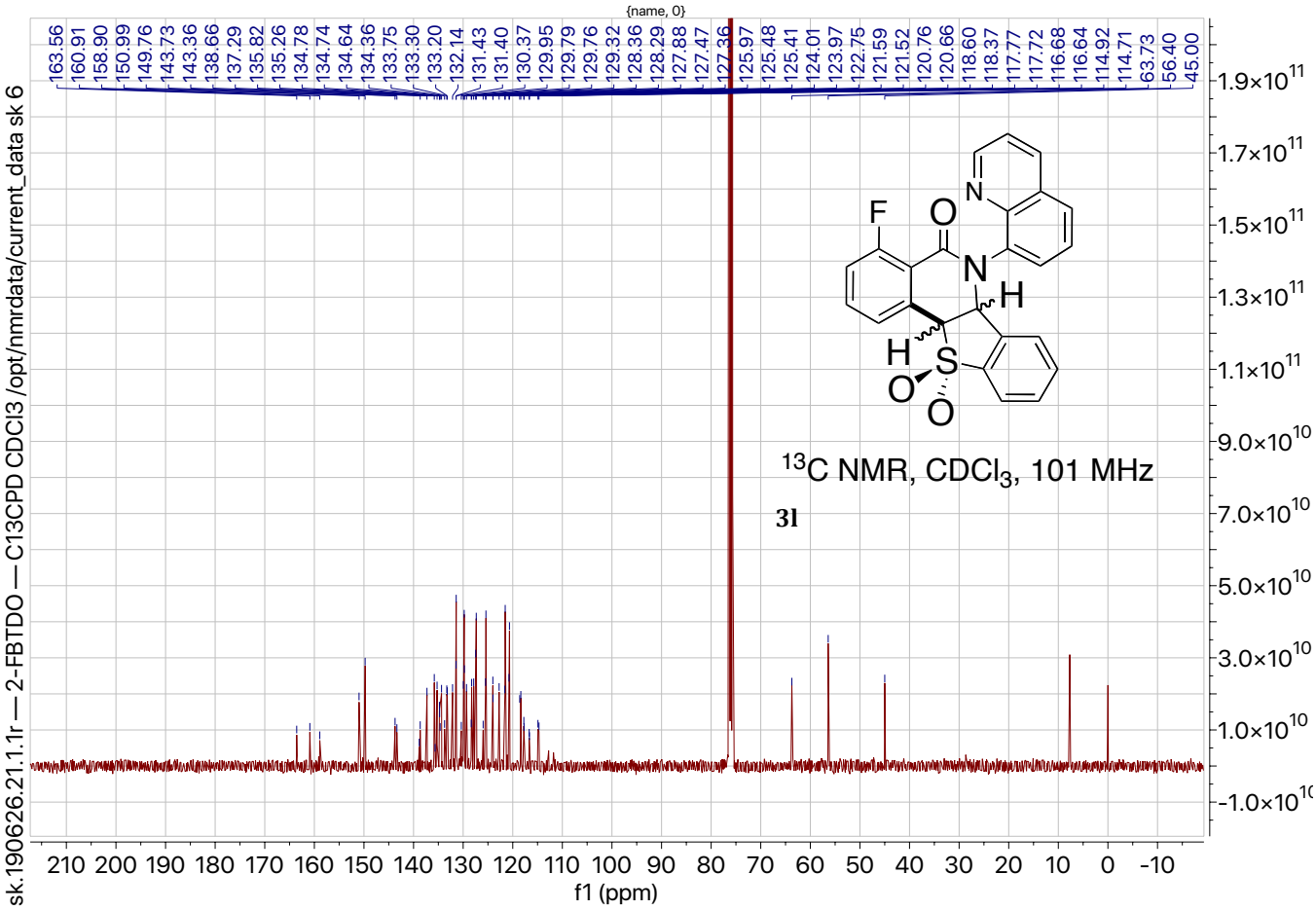
1.00 0.53 1.87 4.27 1.26 7.41 2.44 0.75 0.73 0.71
F
O
N
N
H
H
S
O
O
^{1}H NMR, $CDCl_3$, 400 MHz
3l
f1 (ppm)
sk.190626.20.1.1r — 2-FBTDO — PROTON CDCl3 /opt/nmrdata/current_data sk 6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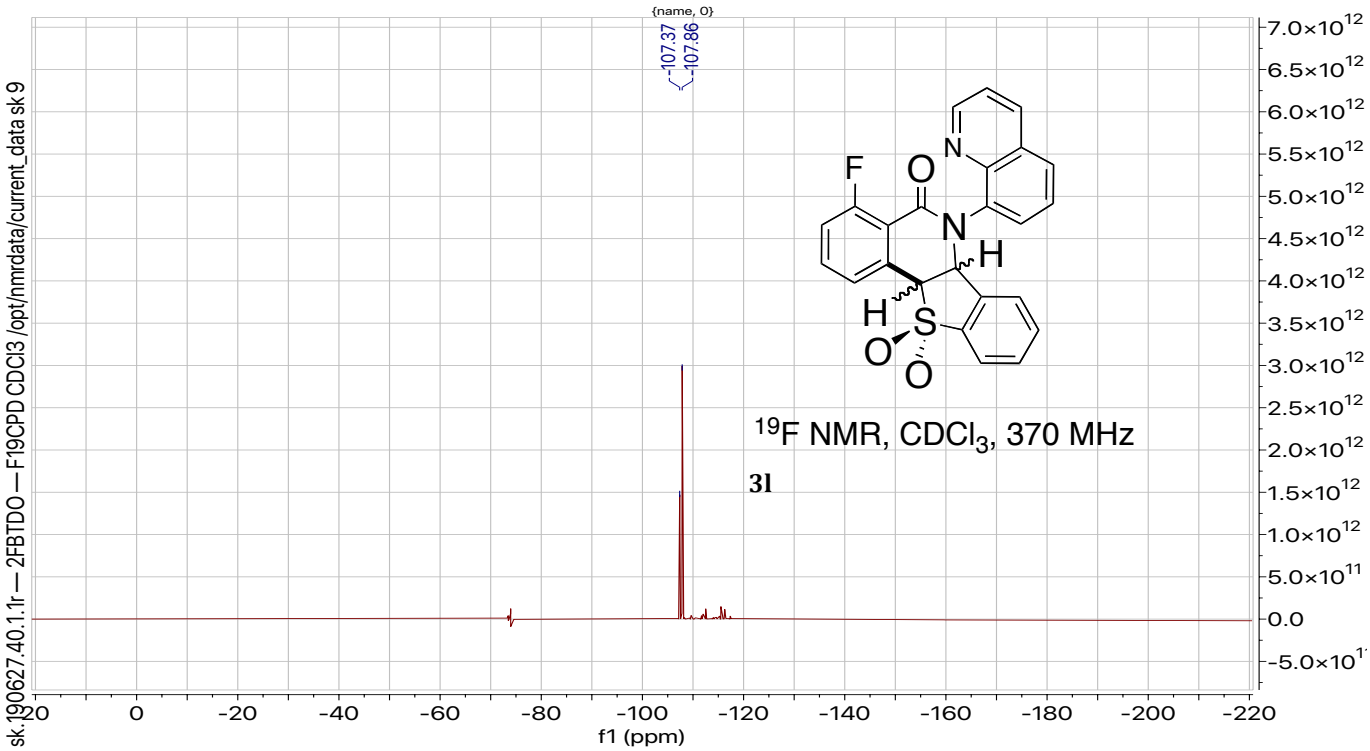
163.56 160.91 158.90 150.99 149.76 143.73 143.36 138.66 137.29 135.82 135.26 134.78 134.74 134.64 134.36 133.75 133.30 133.20 132.14 131.43 131.40 130.37 129.95 129.79 129.76 129.32 128.36 128.29 127.88 127.47 127.36 125.97 125.48 125.41 124.01 123.97 122.75 121.59 121.52 120.76 120.66 118.60 118.37 117.77 117.72 116.68 116.64 114.92 114.71 63.73 56.40 45.00
F
O
N
N
H
H
S
O
O
^{13}C NMR, $CDCl_3$, 101 MHz
3l
f1 (ppm)
sk.190626.21.1.1r — 2-FBTDO — C13CPD CDCl3 /opt/nmrdata/current_data sk 6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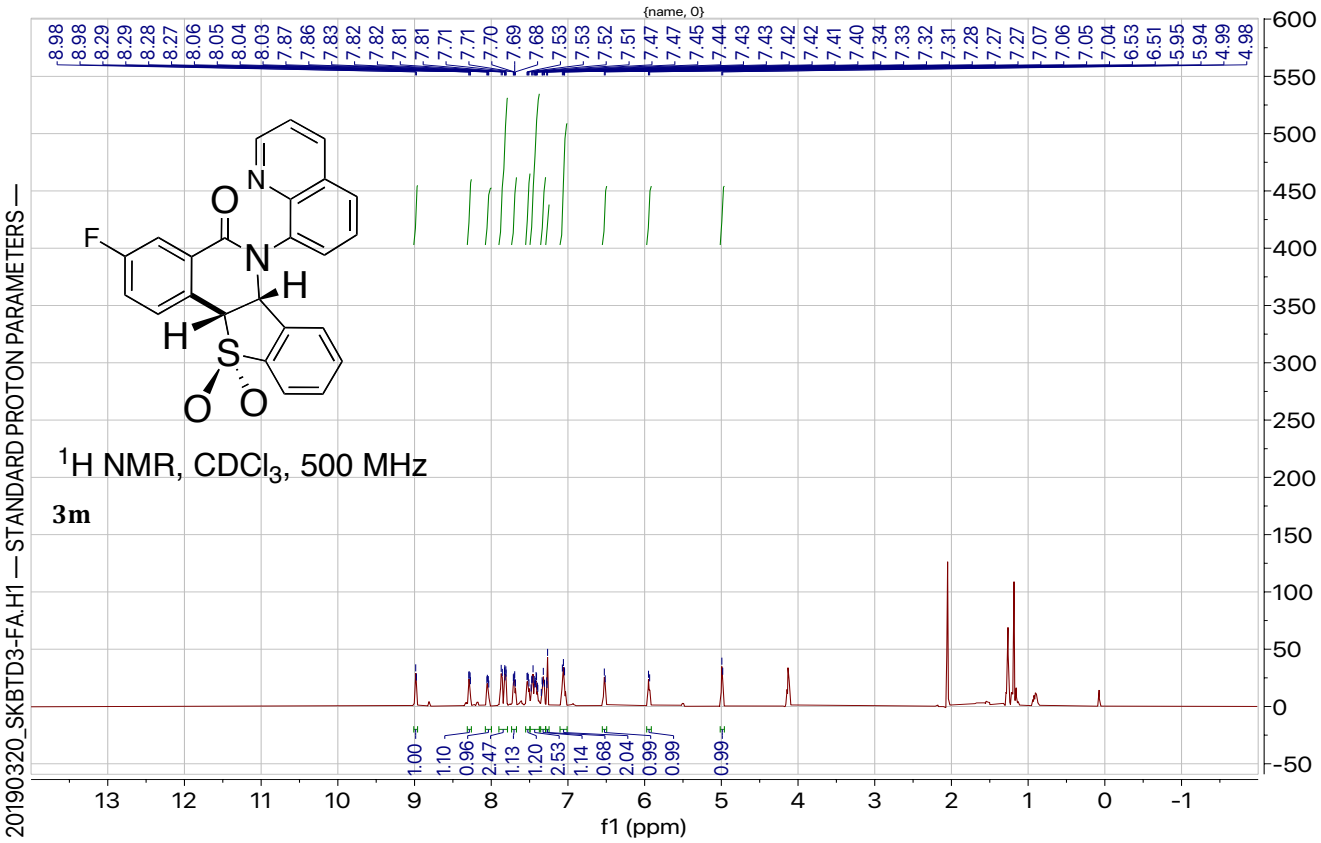
-107.86
F
O
N
N
H
H
S
O
O
^{19}F NMR, $CDCl_3$, 370 MHz
3l
sk.190627.40.1.1r — 2FBTDO — F19CPD CDCl3 /opt/nmrdata/current_data sk 9
f1 (ppm)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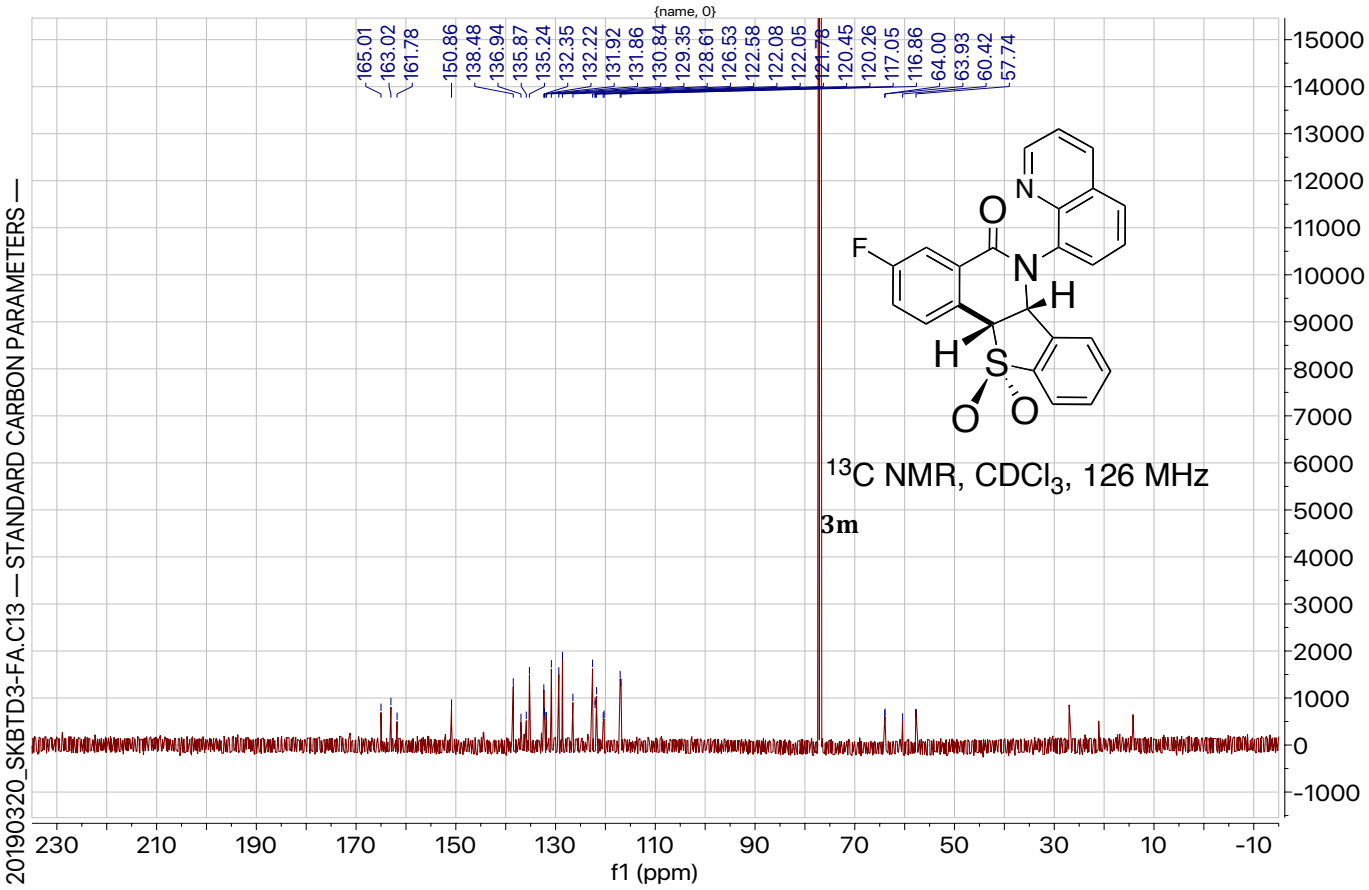
1.00 1.10 0.96 2.47 1.13 1.20 2.53 1.14 0.68 2.04 0.99 0.99 0.99
f1 (ppm)
20190320_SKBTD3-FA.H1 — STANDARD PROTON PARAMETERS —
^{1}H NMR, $CDCl_3$, 500 MHz
3m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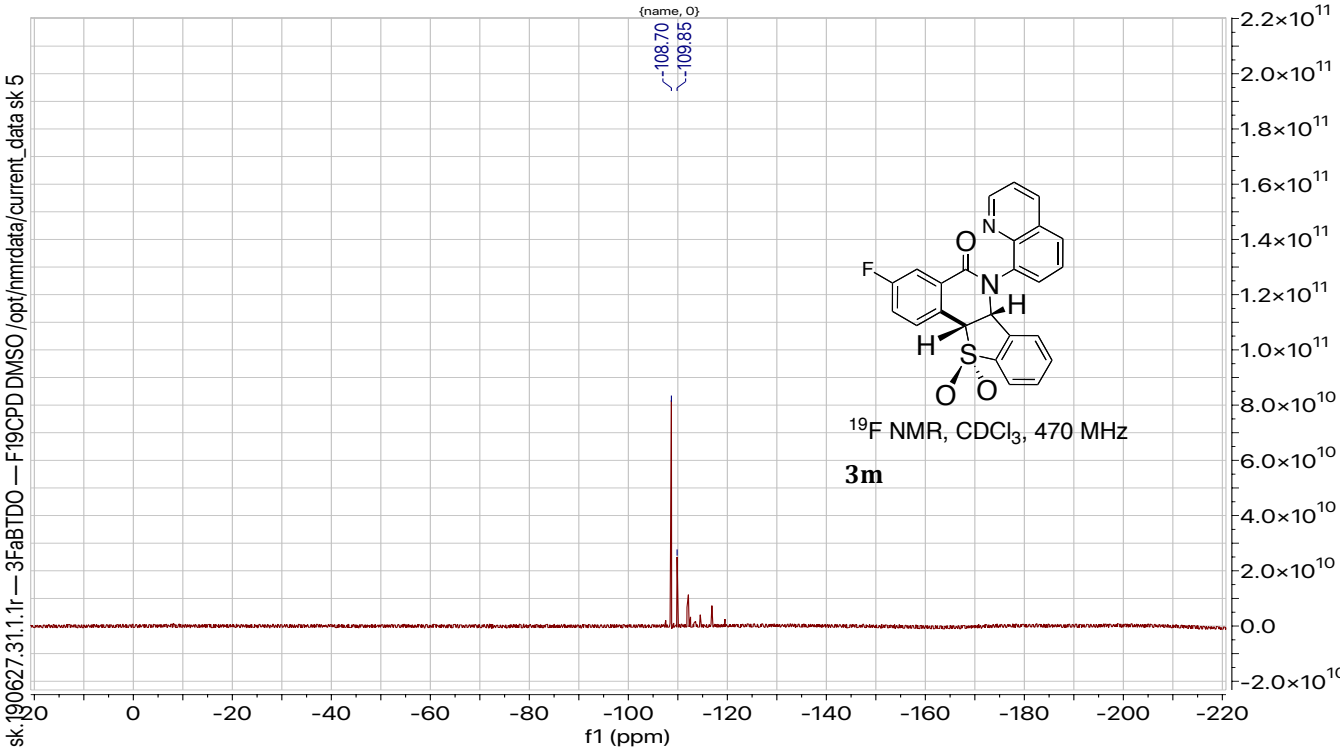
f1 (ppm)
20190320_SKBTD3-FA.C13 — STANDARD CARBON PARAMETERS —
^{13}C NMR, $CDCl_3$, 126 MHz
3m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-109.85
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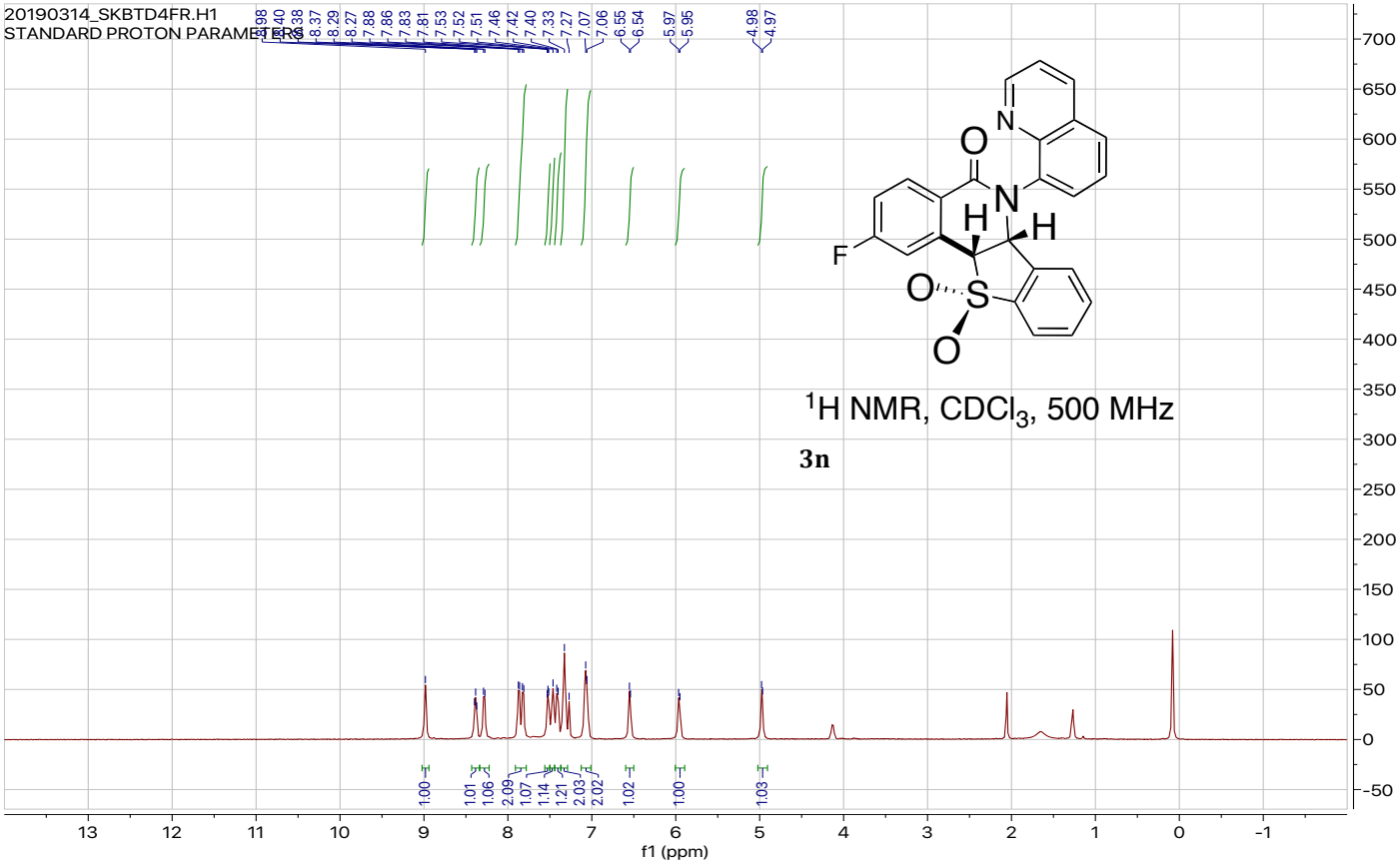
f1 (ppm)
F
O
N
H
H
S
O
O
N
^{19}F NMR, $CDCl_3$, 470 MHz
3m


20190314_SKBTD4FR.H1
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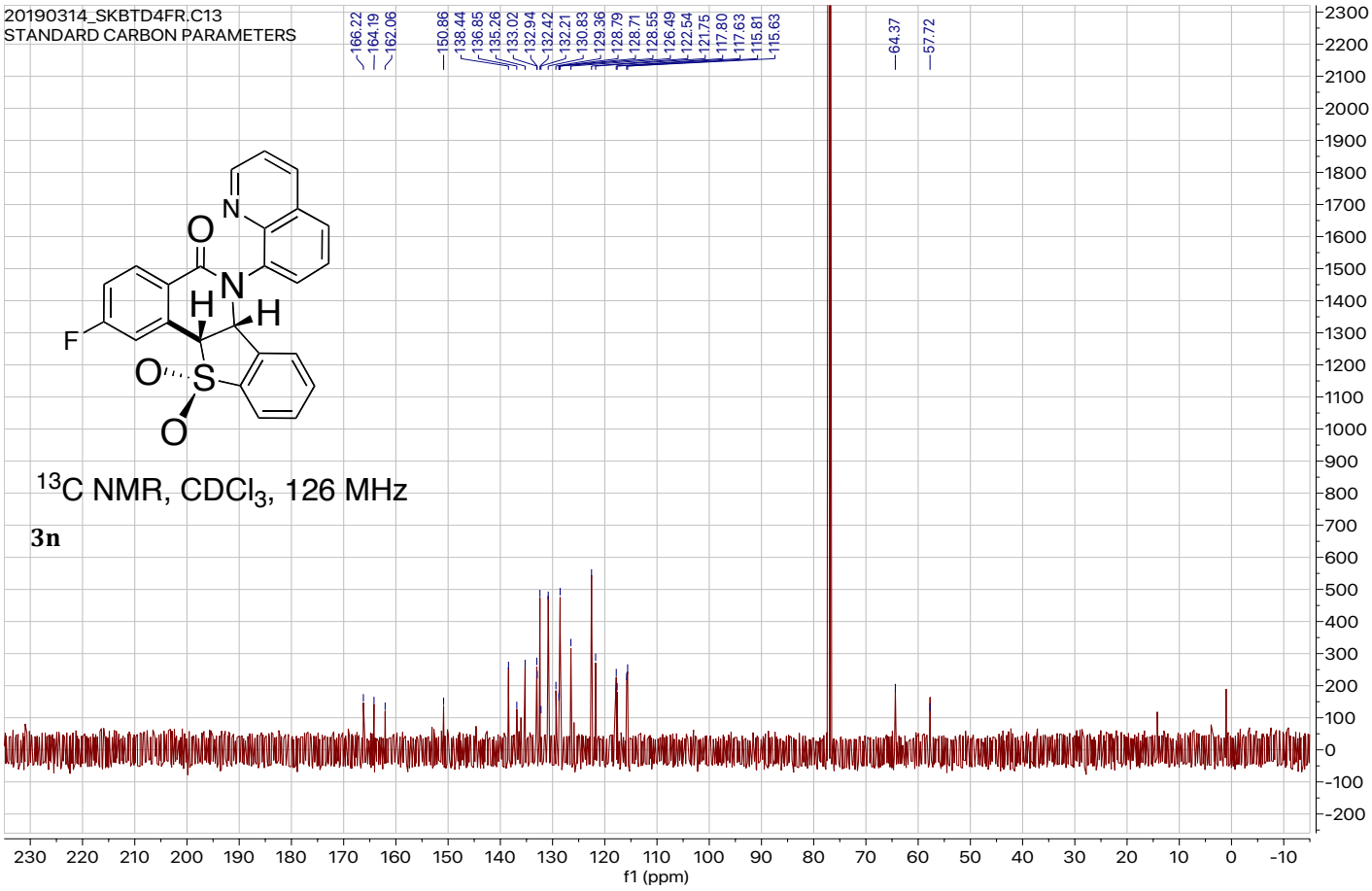
1.00 1.01 1.06 2.09 1.07 1.14 1.21 2.03 2.02 1.02 1.00 1.03
f1 (ppm)
^{1}H NMR, $CDCl_3$, 500 MHz
3n


20190314_SKBTD4FR.C13
STANDARD CARBON PARAMETERS
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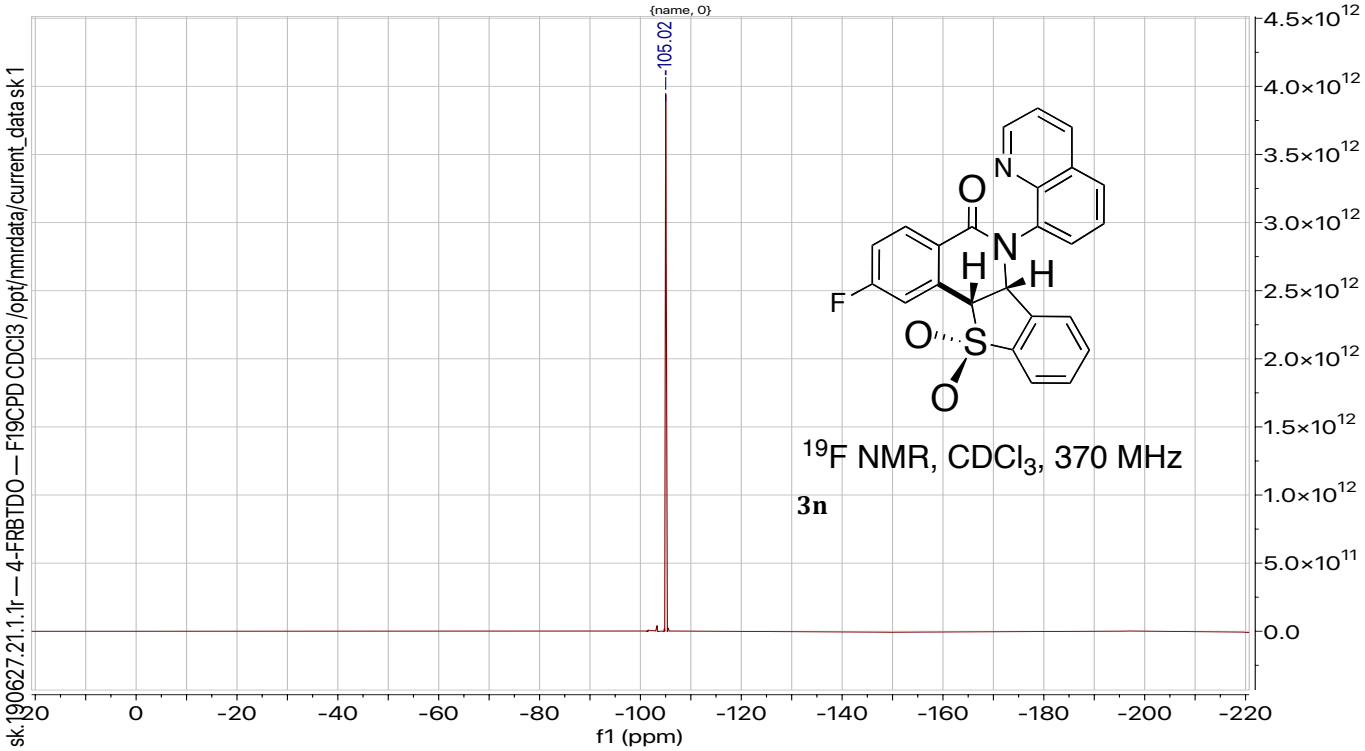
f1 (ppm)
^{13}C NMR, $CDCl_3$, 126 MHz
3n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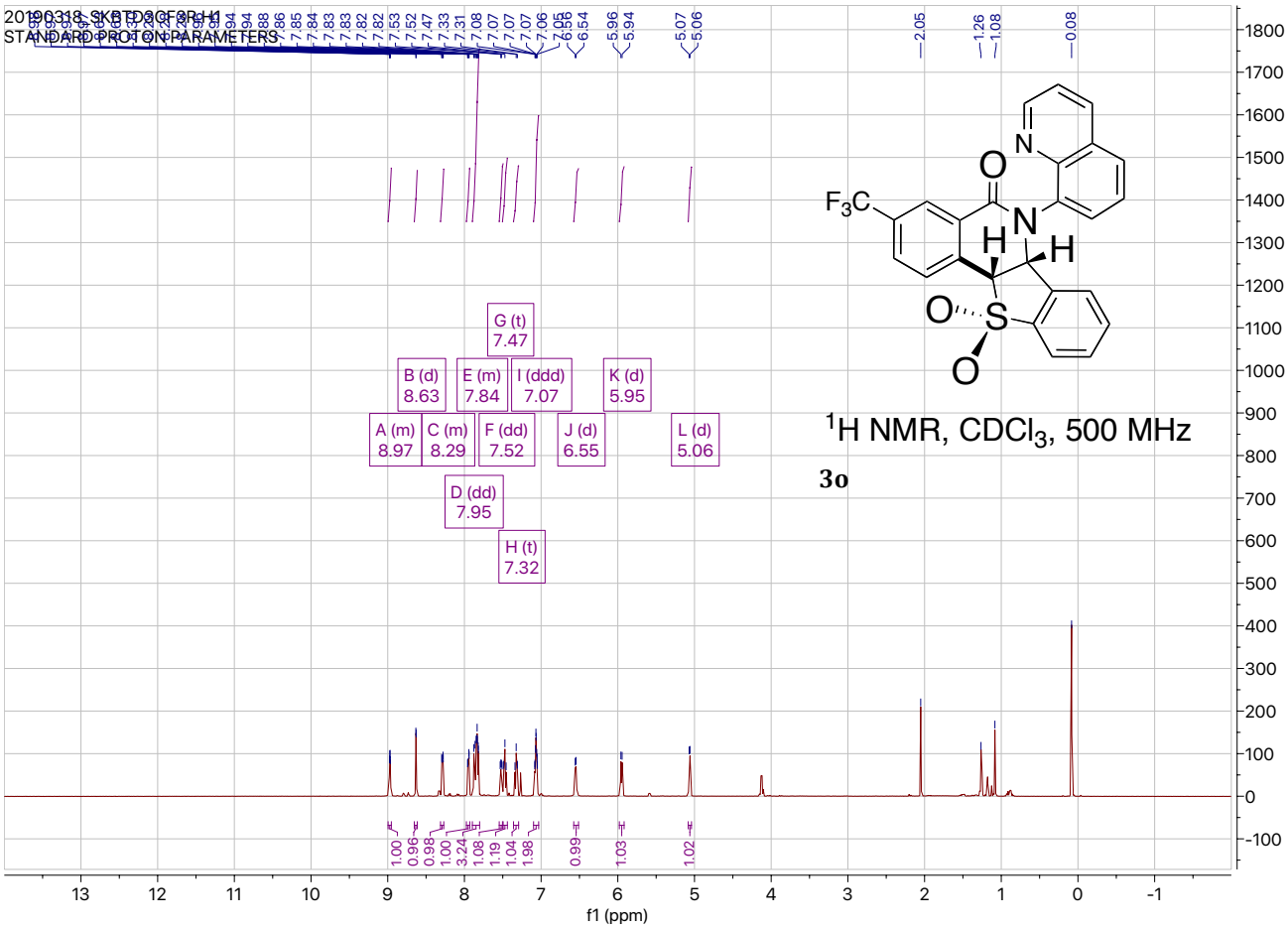
f1 (ppm)
^{19}F NMR, $CDCl_3$, 370 MHz
3n


20190318_SKBTD3CF3R.H1
STANDARD PROTON PARAMETERS
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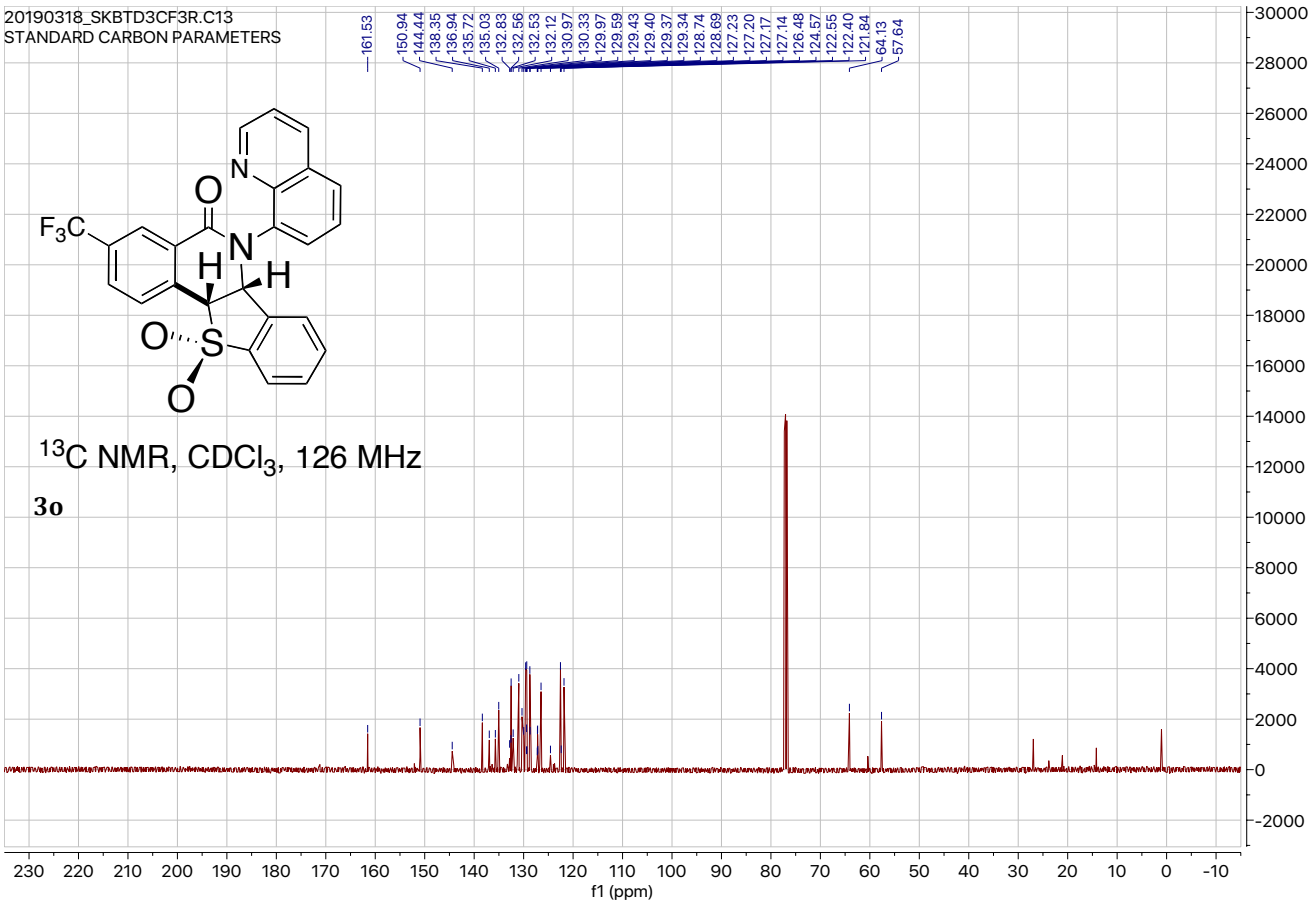
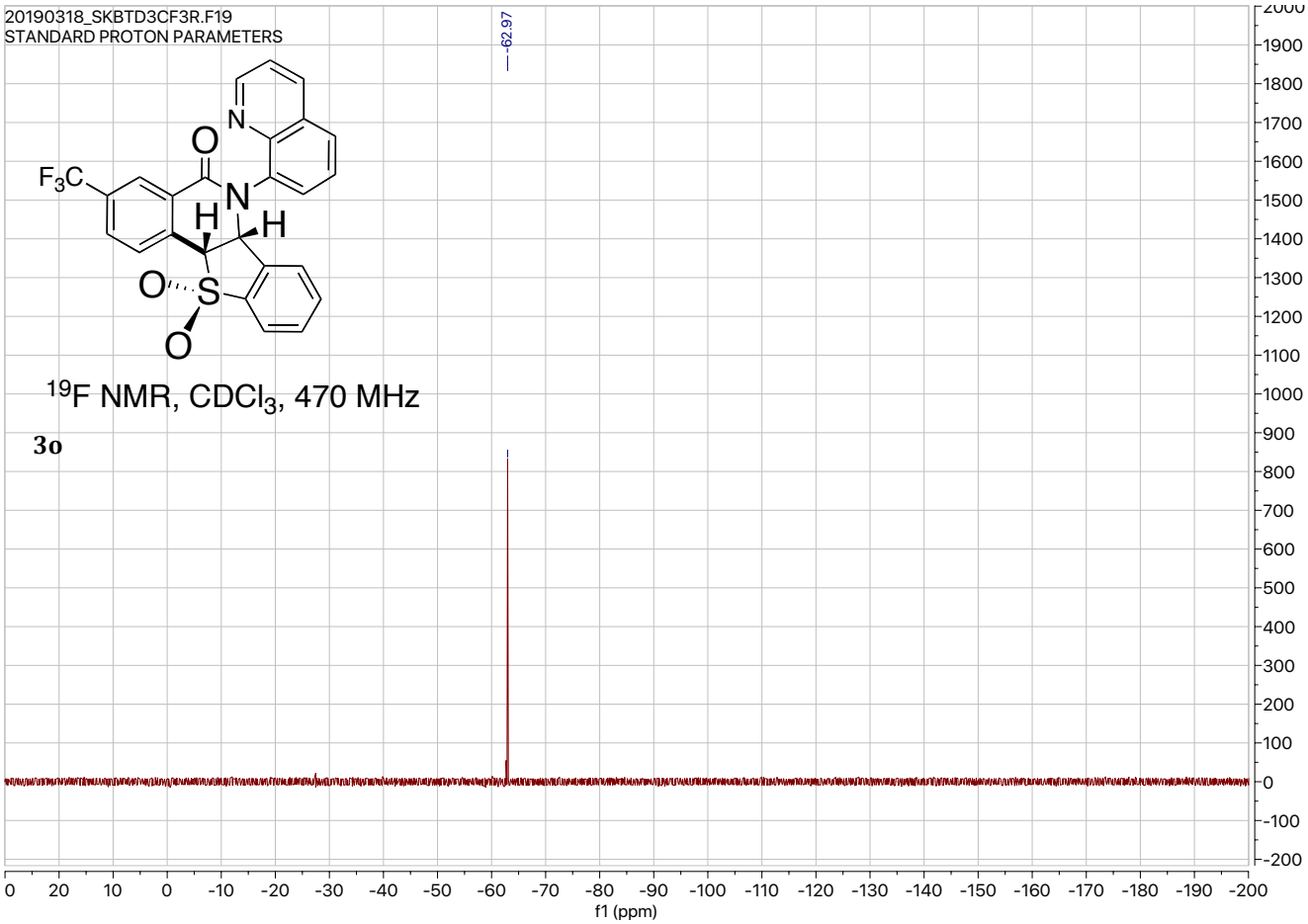
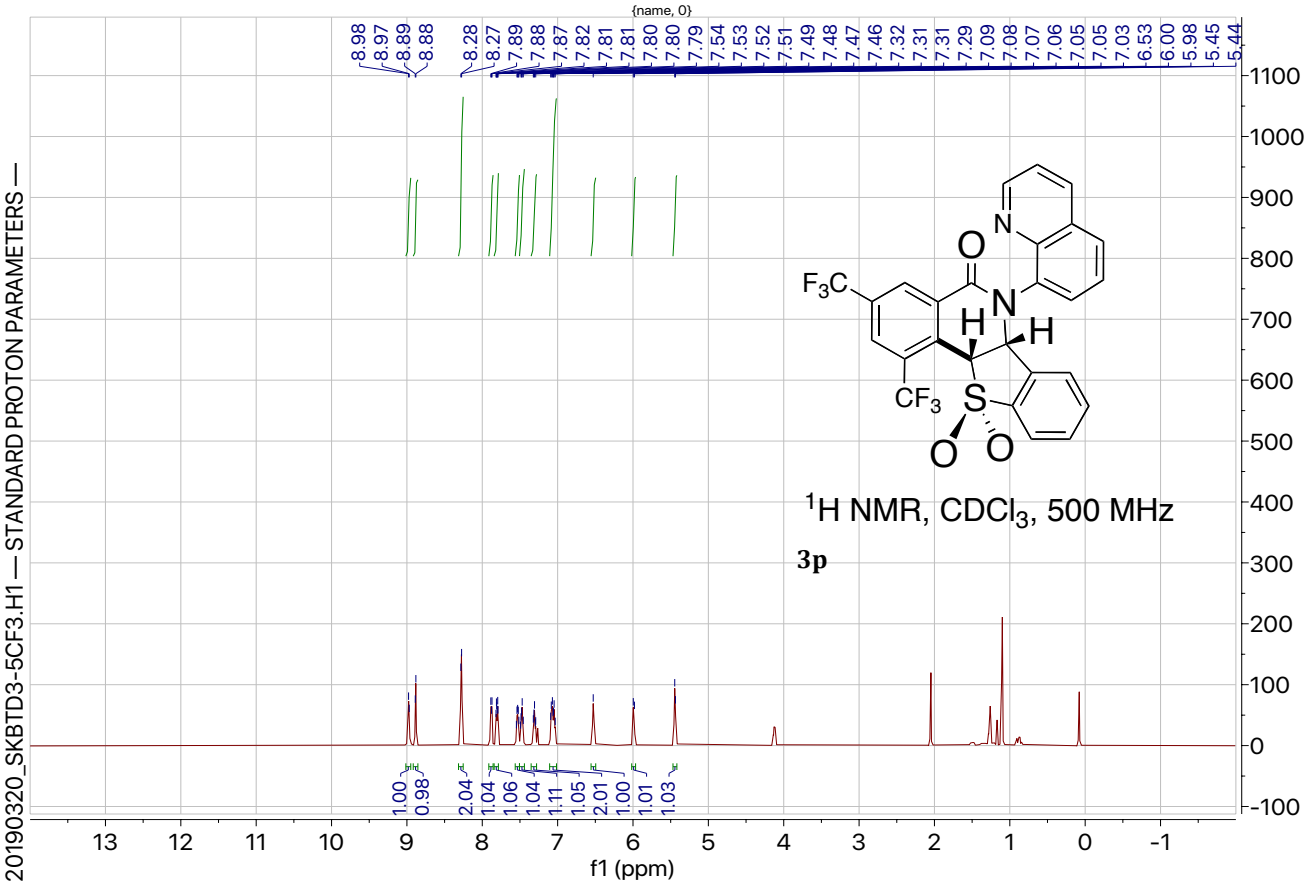
B (d) 8.63
C (m) 8.29
D (dd) 7.95
E (m) 7.84
F (dd) 7.52
G (t) 7.47
H (t) 7.32
I (ddd) 7.07
J (d) 6.55
K (d) 5.95
L (d) 5.06
^{1}H NMR, $CDCl_3$, 500 MHz
3o
f1 (ppm)


20190318_SKBTD3CF3R.C13
STANDARD CARBON PARAMETERS
^{13}C NMR, $CDCl_3$, 126 MHz
3o
f1 (ppm)


20190318_SKBTD3CF3R.F19
STANDARD PROTON PARAMETERS
-62.97
^{19}F NMR, $CDCl_3$, 470 MHz
3o
f1 (ppm)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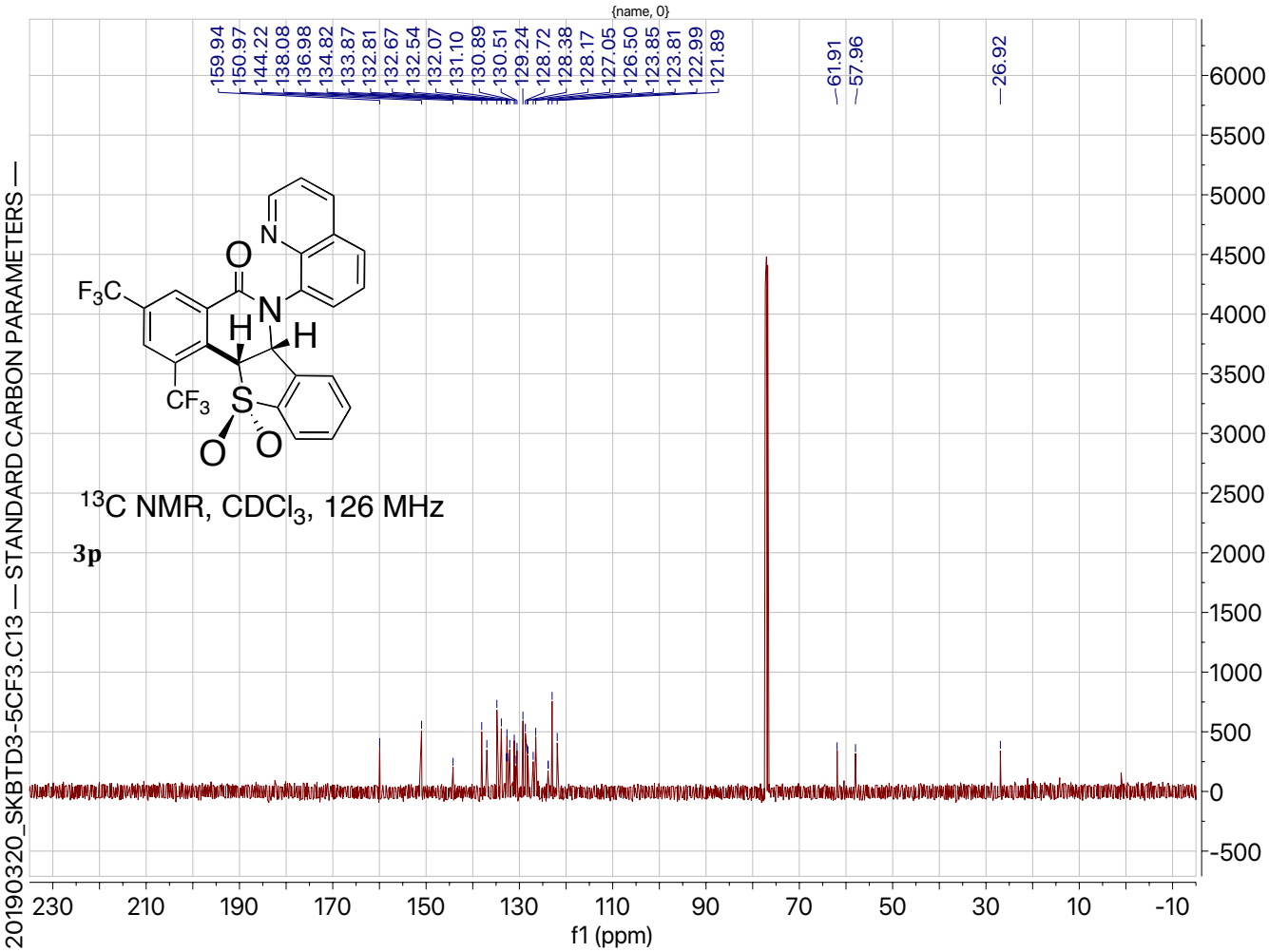
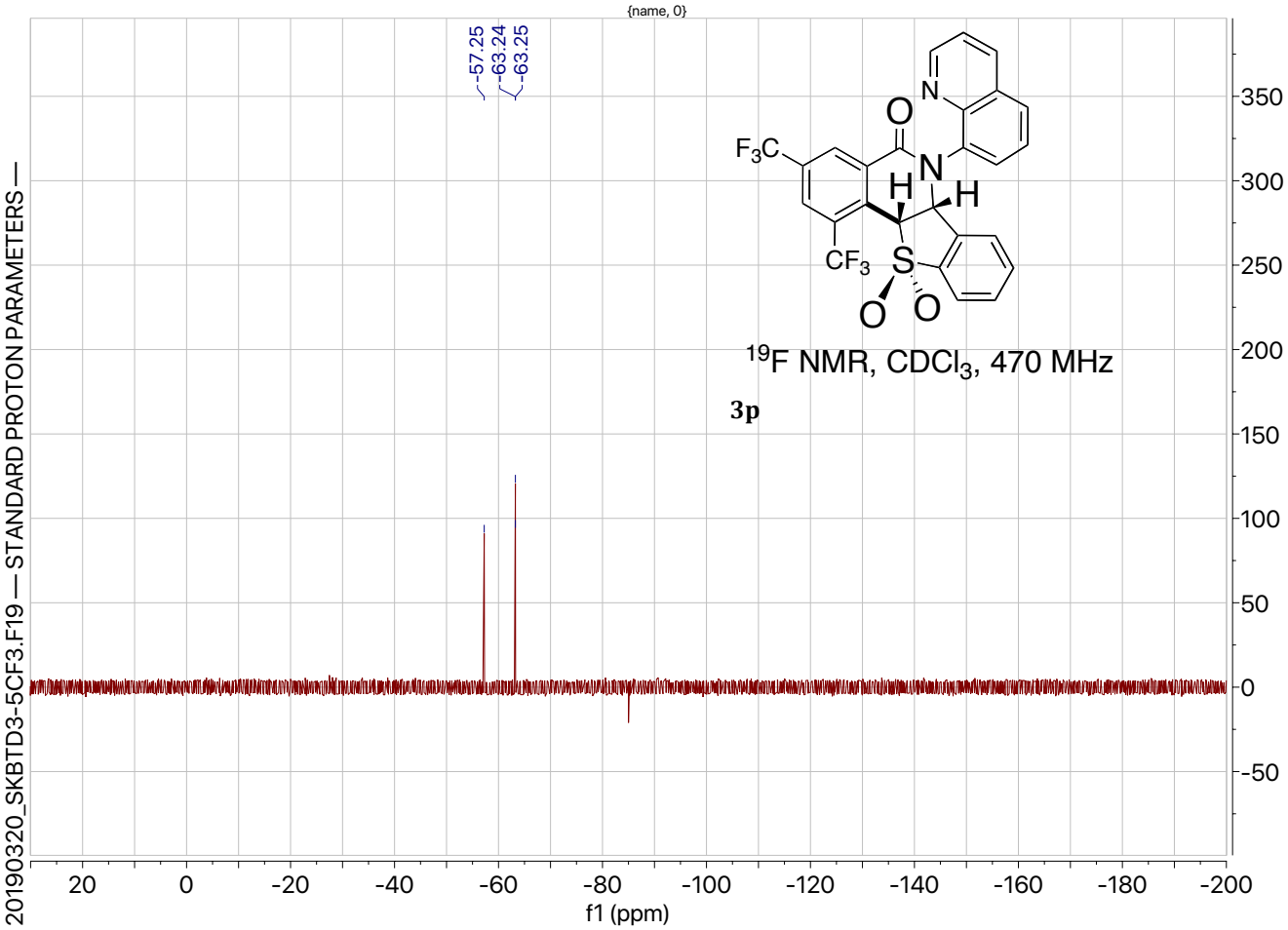
1.00 0.98 2.04 1.04 1.06 1.04 1.11 1.05 2.01 1.00 1.01 1.03
f1 (ppm)
20190320_SKBTD3-5CF3.H1 — STANDARD PROTON PARAMETERS —
^{1}H NMR, $CDCl_3$, 500 MHz
3p


{name, 0}
159.94 150.97 144.22 138.08 136.98 134.82 133.87 132.81 132.67 132.54 132.07 131.10 130.89 130.51 129.24 128.72 128.38 128.17 127.05 126.50 123.85 123.81 122.99 121.89
61.91 57.96
26.92
f1 (ppm)
20190320_SKBTD3-5CF3.C13 — STANDARD CARBON PARAMETERS —
^{13}C NMR, $CDCl_3$, 126 MHz
3p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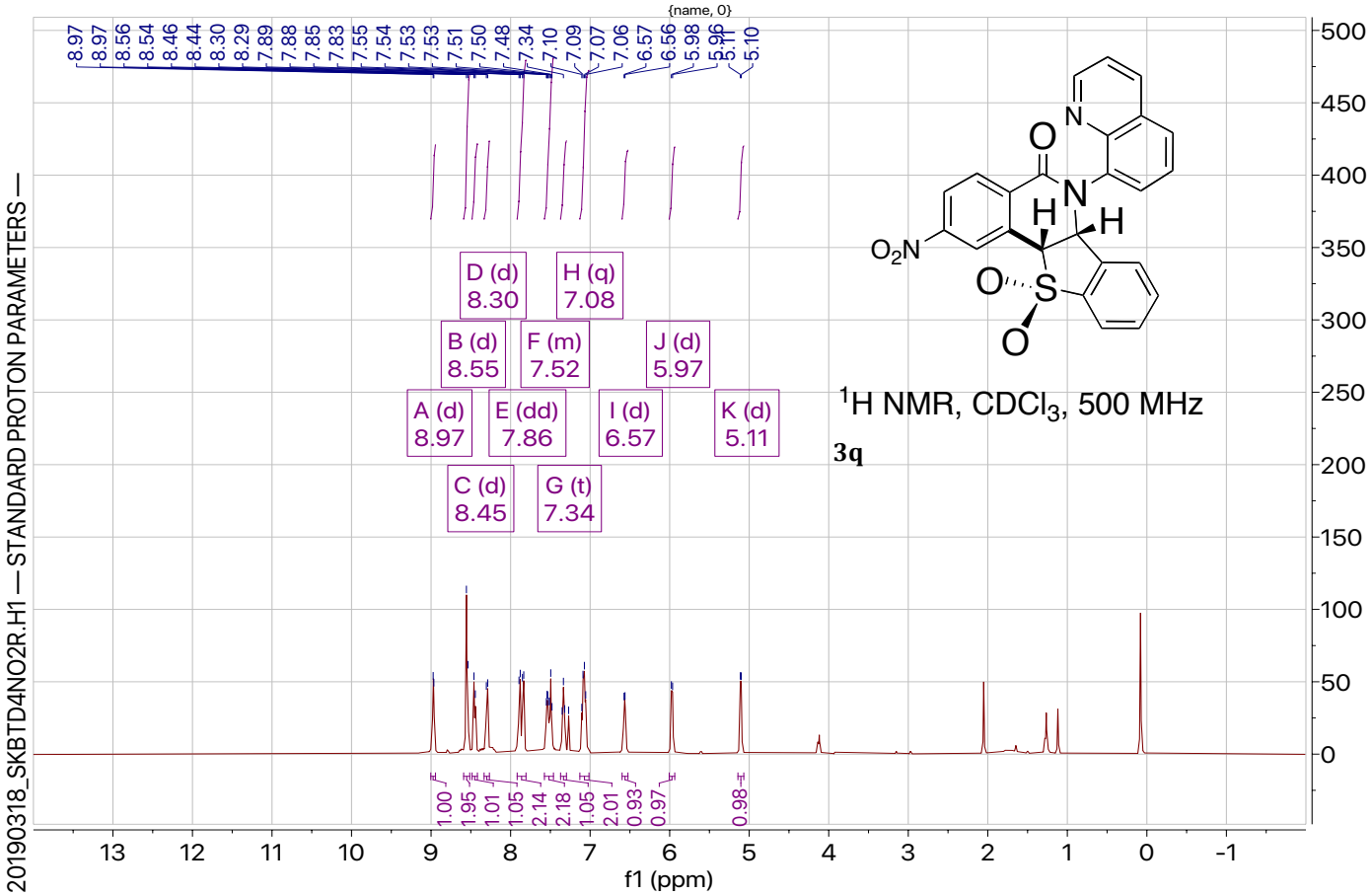
-63.24
-63.25
^{19}F NMR, $CDCl_3$, 470 MHz
3p
20190320_SKBTD3-5CF3.F19 — STANDARD PROTON PARAMETERS —
f1 (ppm)


{name, 0}
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D (d) 8.30
H (q) 7.08
B (d) 8.55
F (m) 7.52
J (d) 5.97
A (d) 8.97
E (dd) 7.86
I (d) 6.57
K (d) 5.11
C (d) 8.45
G (t) 7.34
1.00 1.95 1.01 1.05 2.14 2.18 1.05 2.01 0.93 0.97 0.98
^{1}H NMR, $CDCl_3$, 500 MHz
3q
f1 (ppm)
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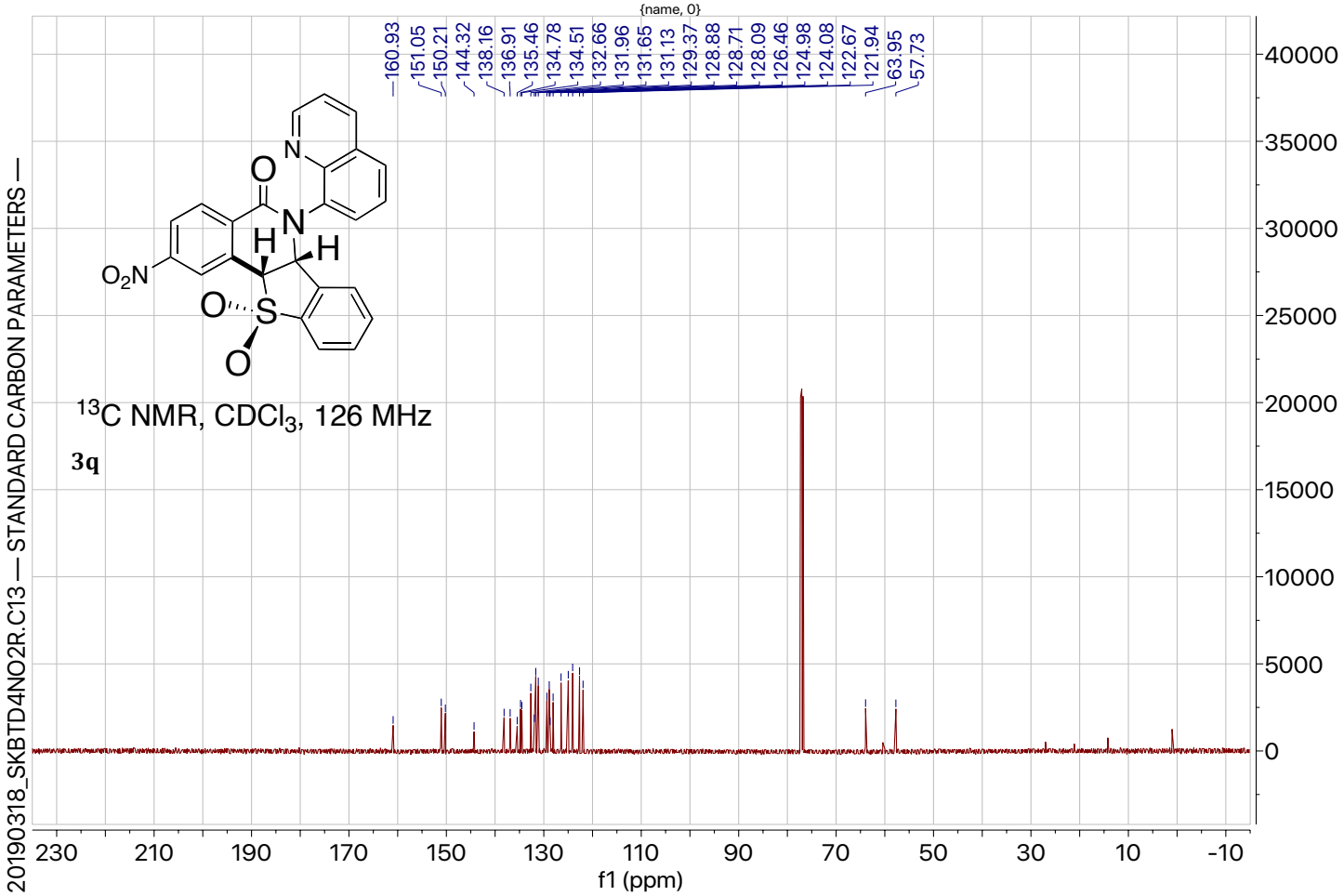
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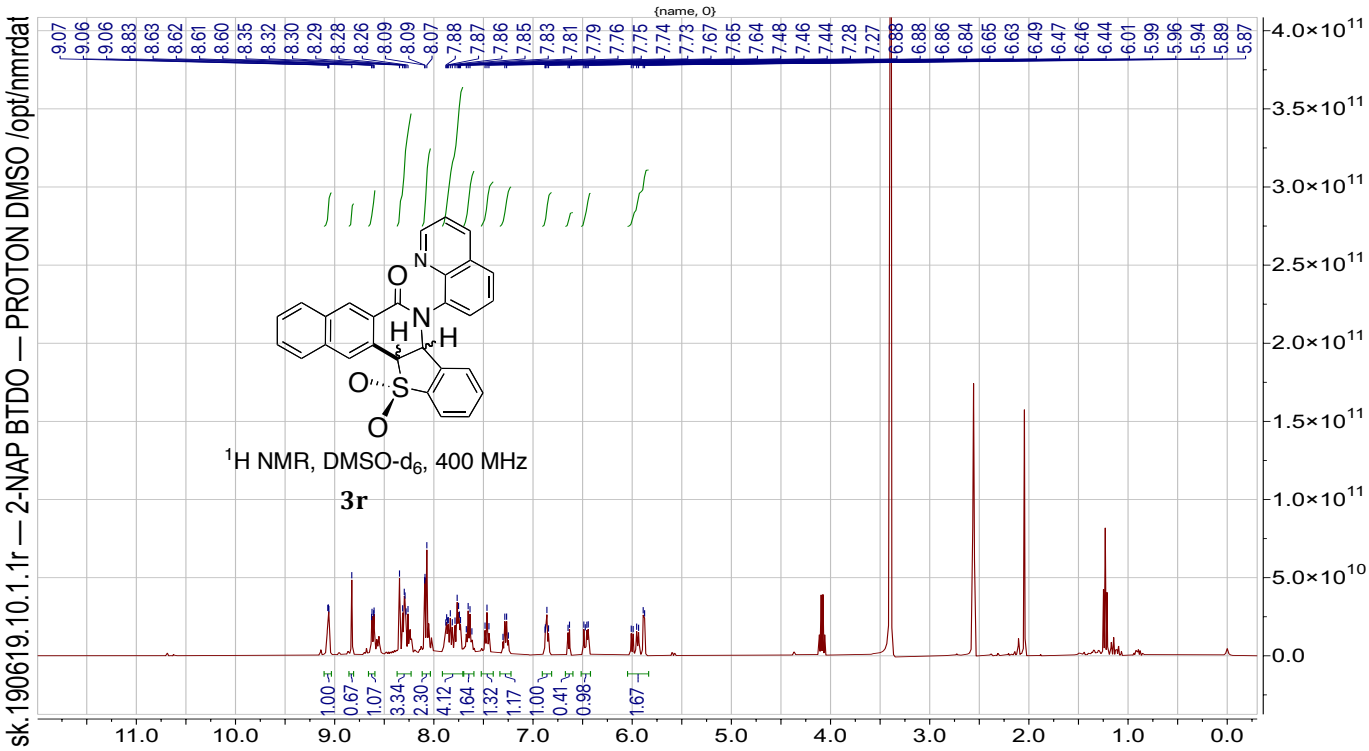
^{13}C NMR, $CDCl_3$, 126 MHz
3q
f1 (ppm)
20190318_SKBTD4NO2R.C13 — STANDARD CARBON PARAMETERS —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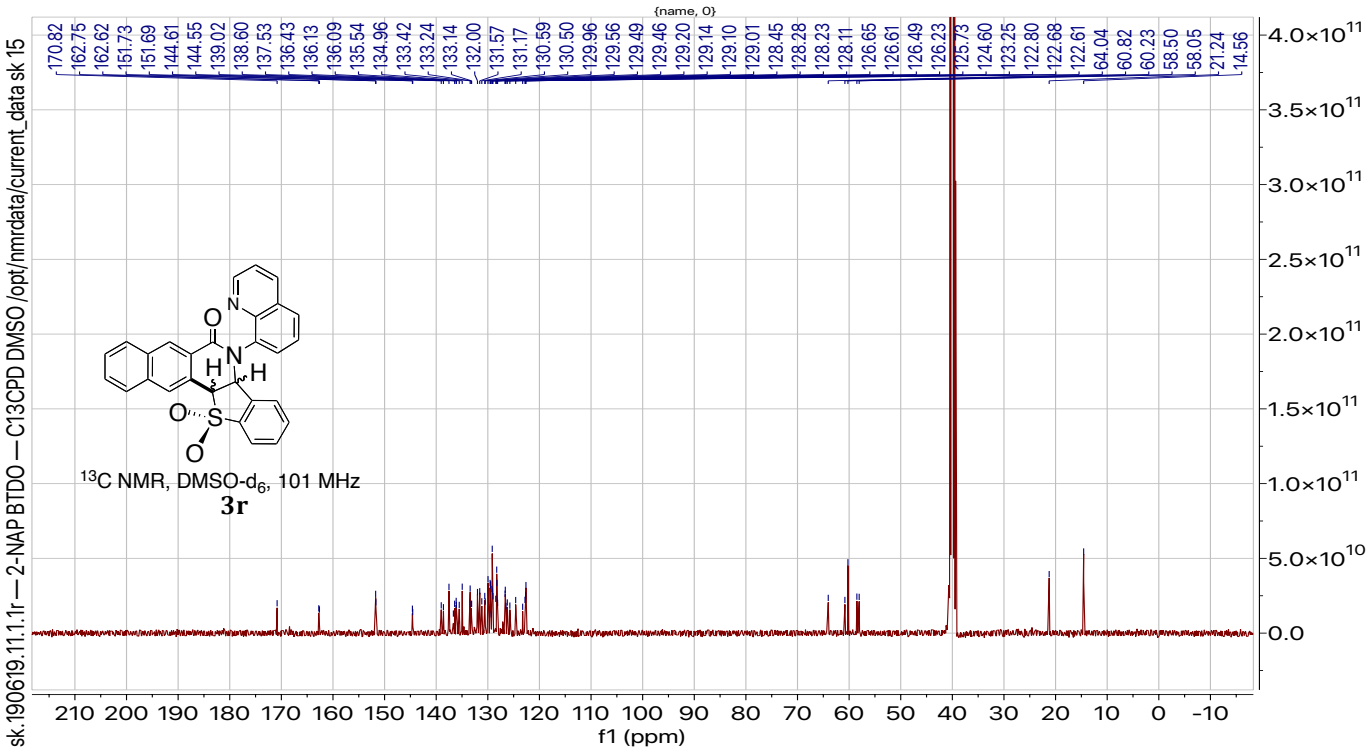
3r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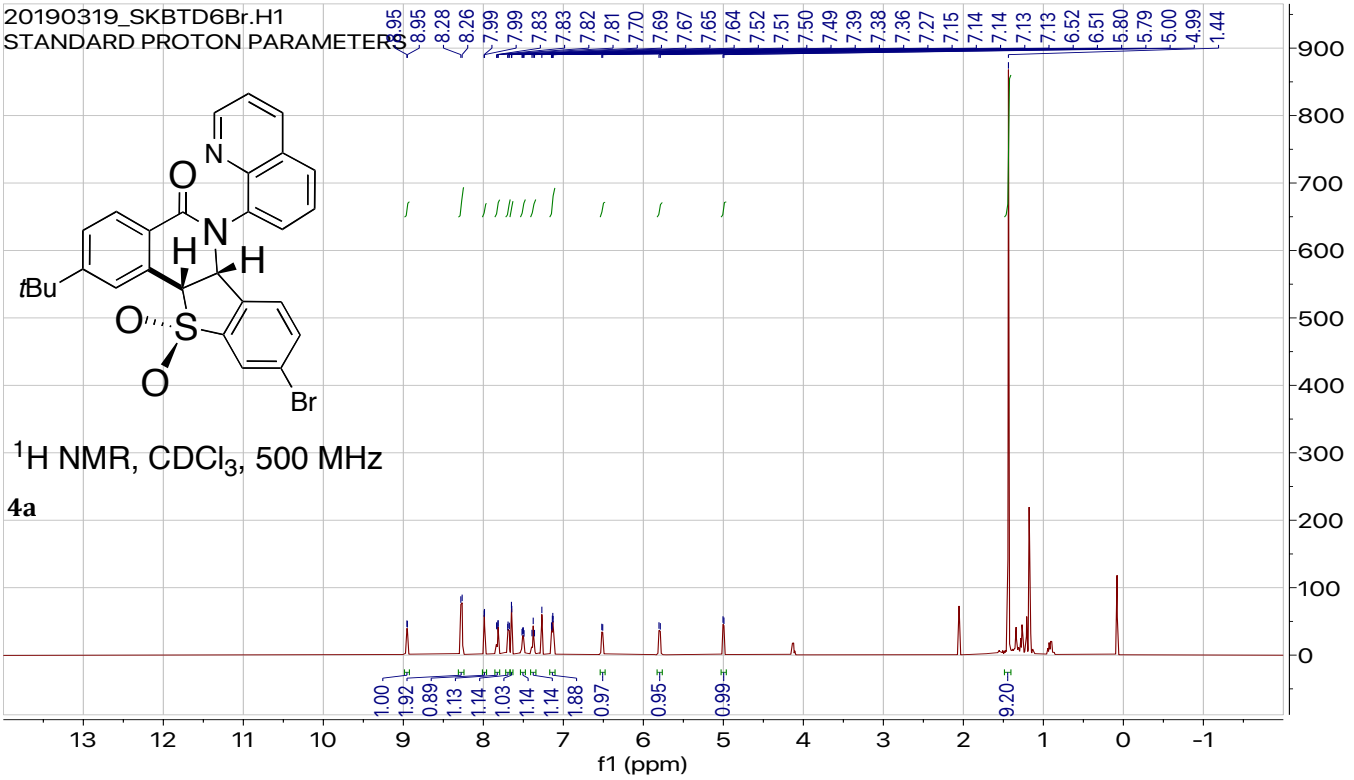
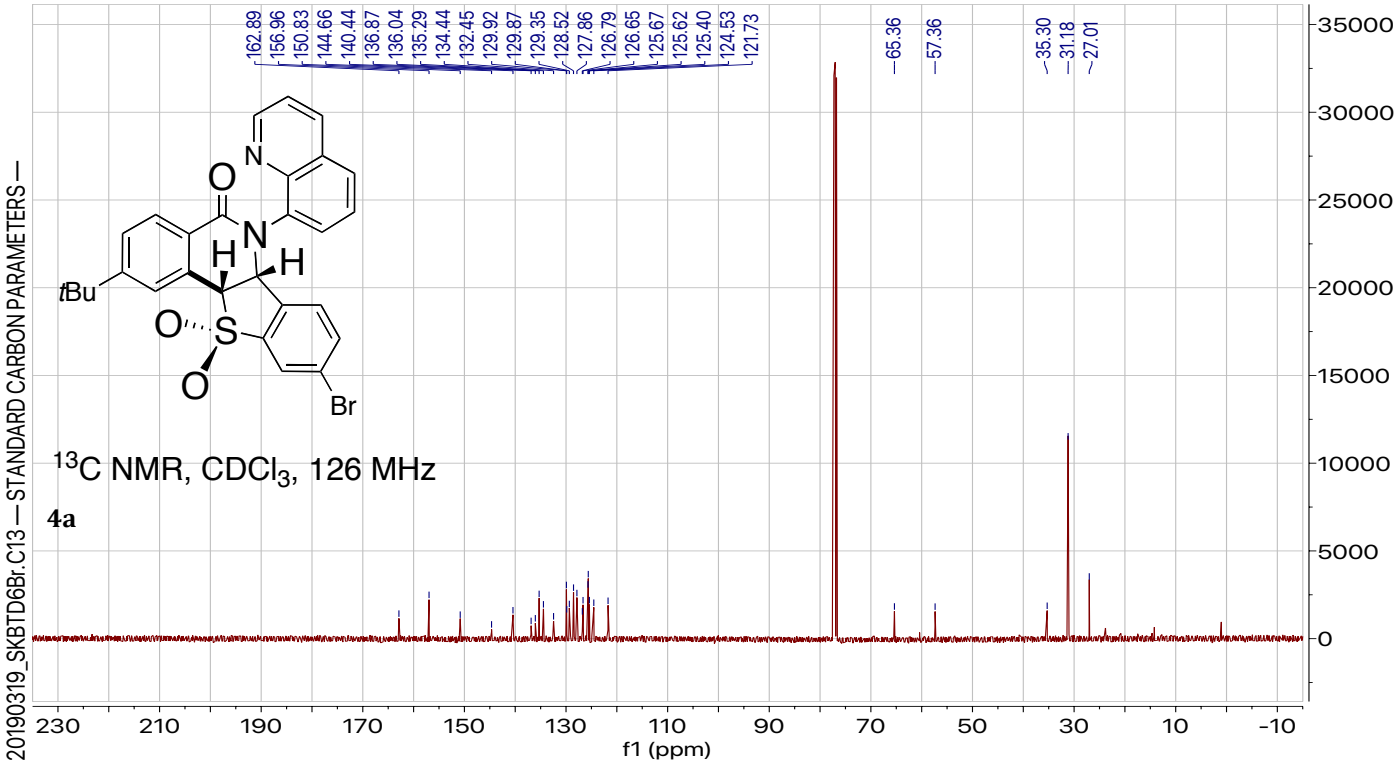
^{13}C NMR, DMSO-d$_6$, 101 MHz
3r
f1 (ppm)



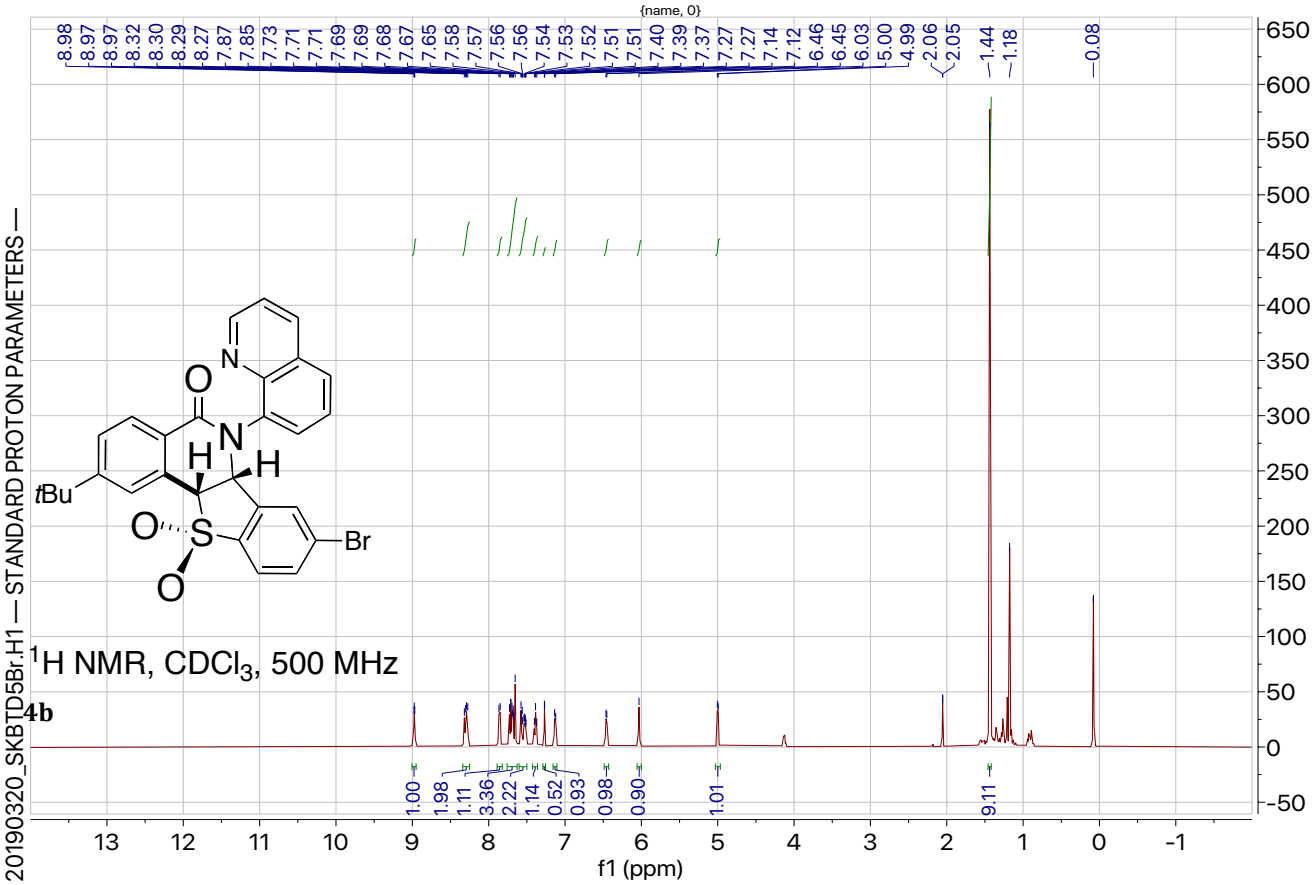
^{1}H NMR, $CDCl_3$, 500 MHz

4a



^{13}C NMR, $CDCl_3$, 126 MHz

4a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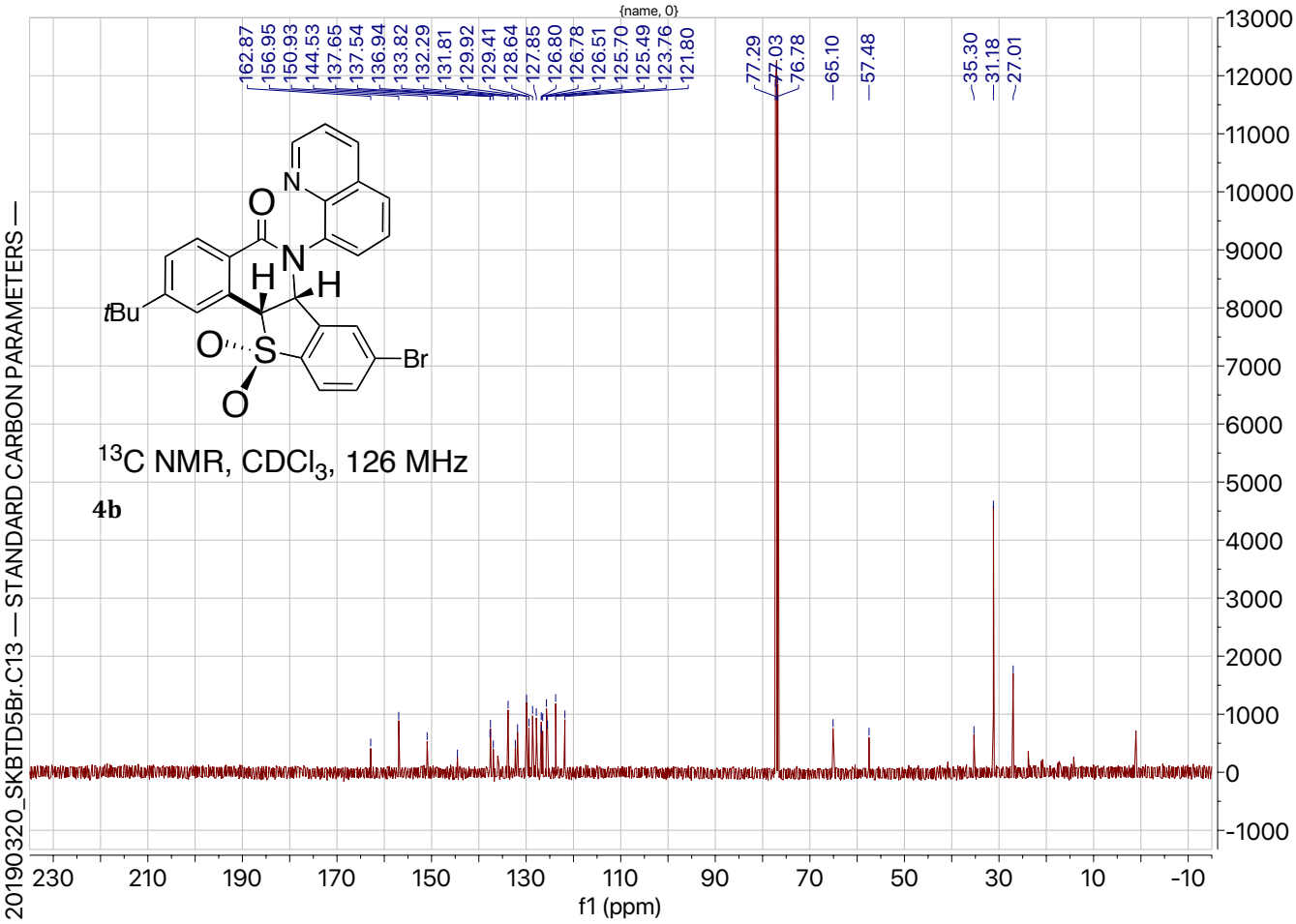
1.00 1.98 1.11 3.36 2.22 1.14 0.52 0.93 0.98 0.90 1.01 9.11
f1 (ppm)
20190320_SKBTD5Br.H1 — STANDARD PROTON PARAMETERS —
tBu
Br
^{1}H NMR, $CDCl_3$, 500 MHz
4b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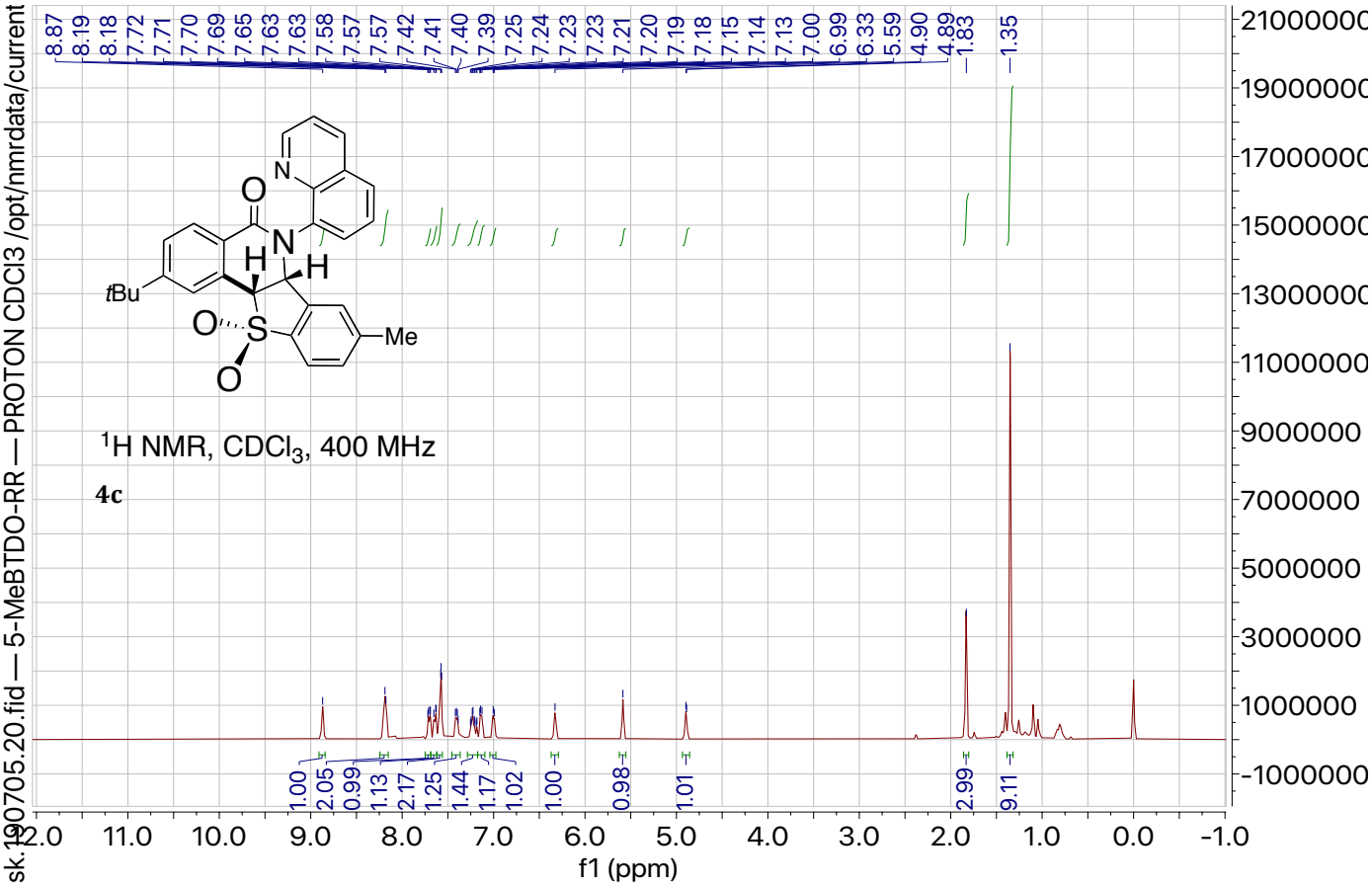
77.29 77.03 76.78 65.10 57.48 35.30 31.18 27.01
f1 (ppm)
20190320_SKBTD5Br.C13 — STANDARD CARBON PARAMETERS —
tBu
Br
^{13}C NMR, $CDCl_3$, 126 MHz
4b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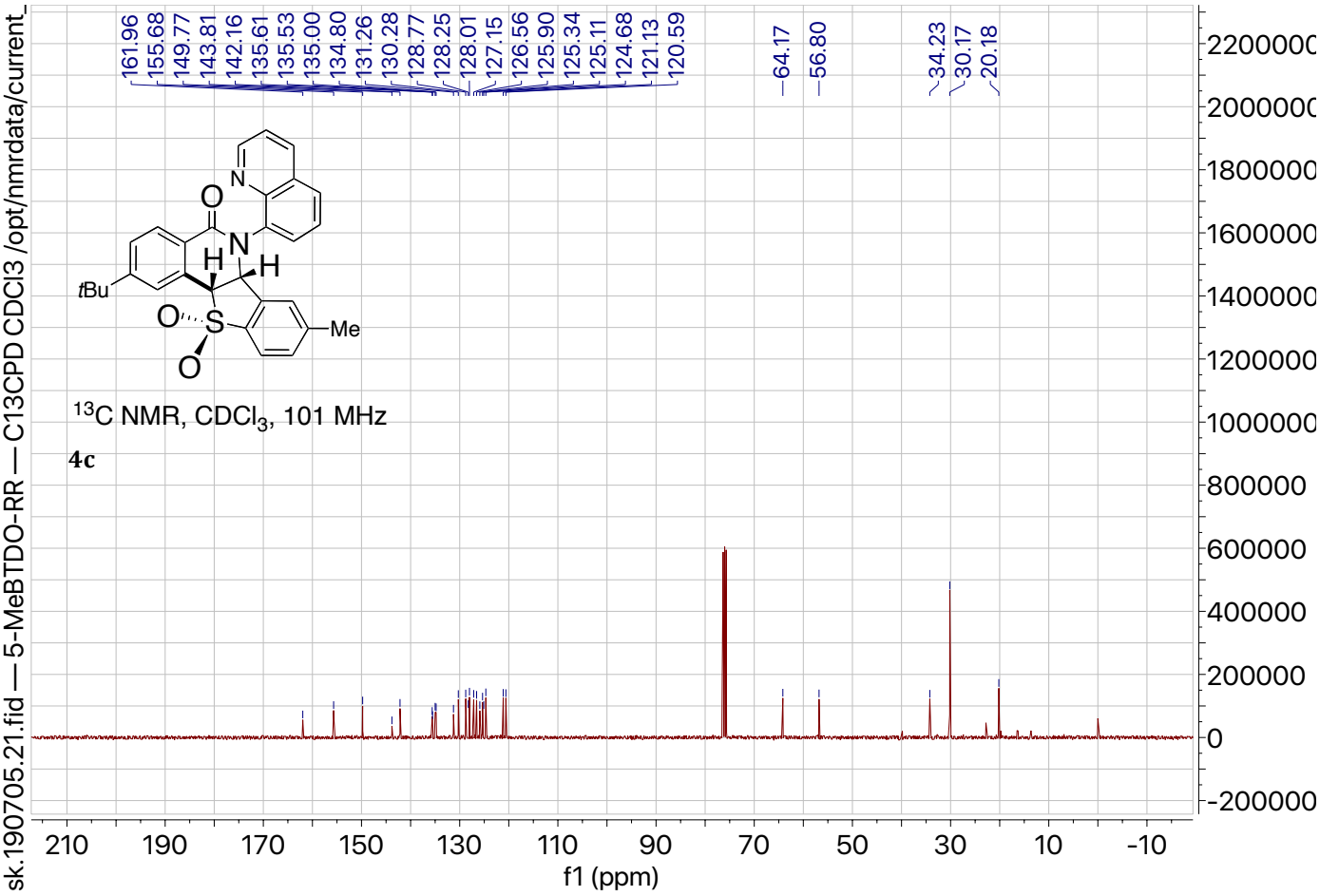
1.00 2.05 0.99 1.13 2.17 1.25 1.44 1.17 1.02 1.00 0.98 1.01 2.99 9.11
N
O
N
H
H
tBu
O
S
Me
O
^{1}H NMR, $CDCl_3$, 400 MHz
4c
f1 (ppm)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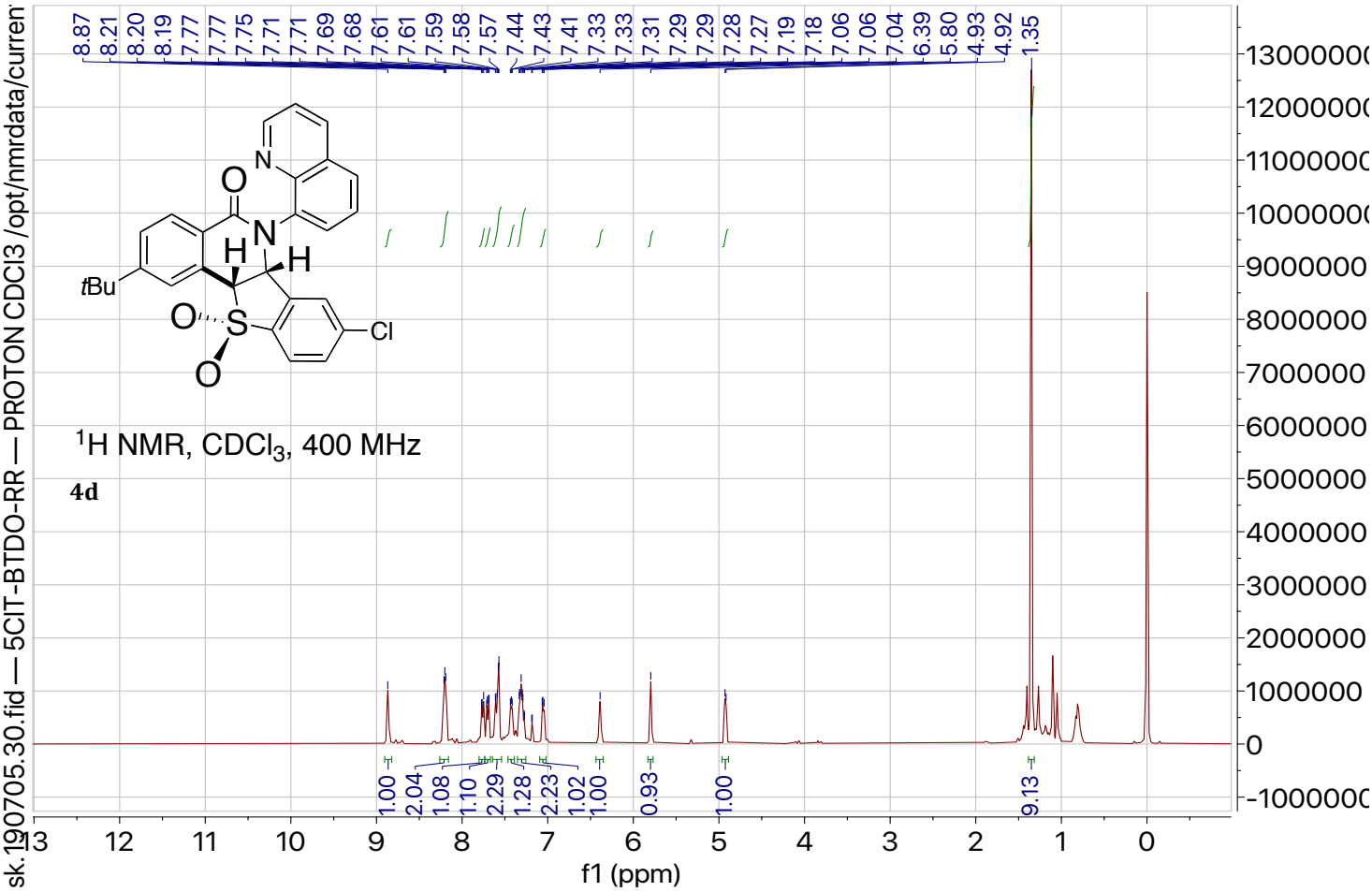
64.17
56.80
34.23
30.17
20.18
N
O
N
H
H
tBu
O
S
Me
O
^{13}C NMR, $CDCl_3$, 101 MHz
4c
f1 (ppm)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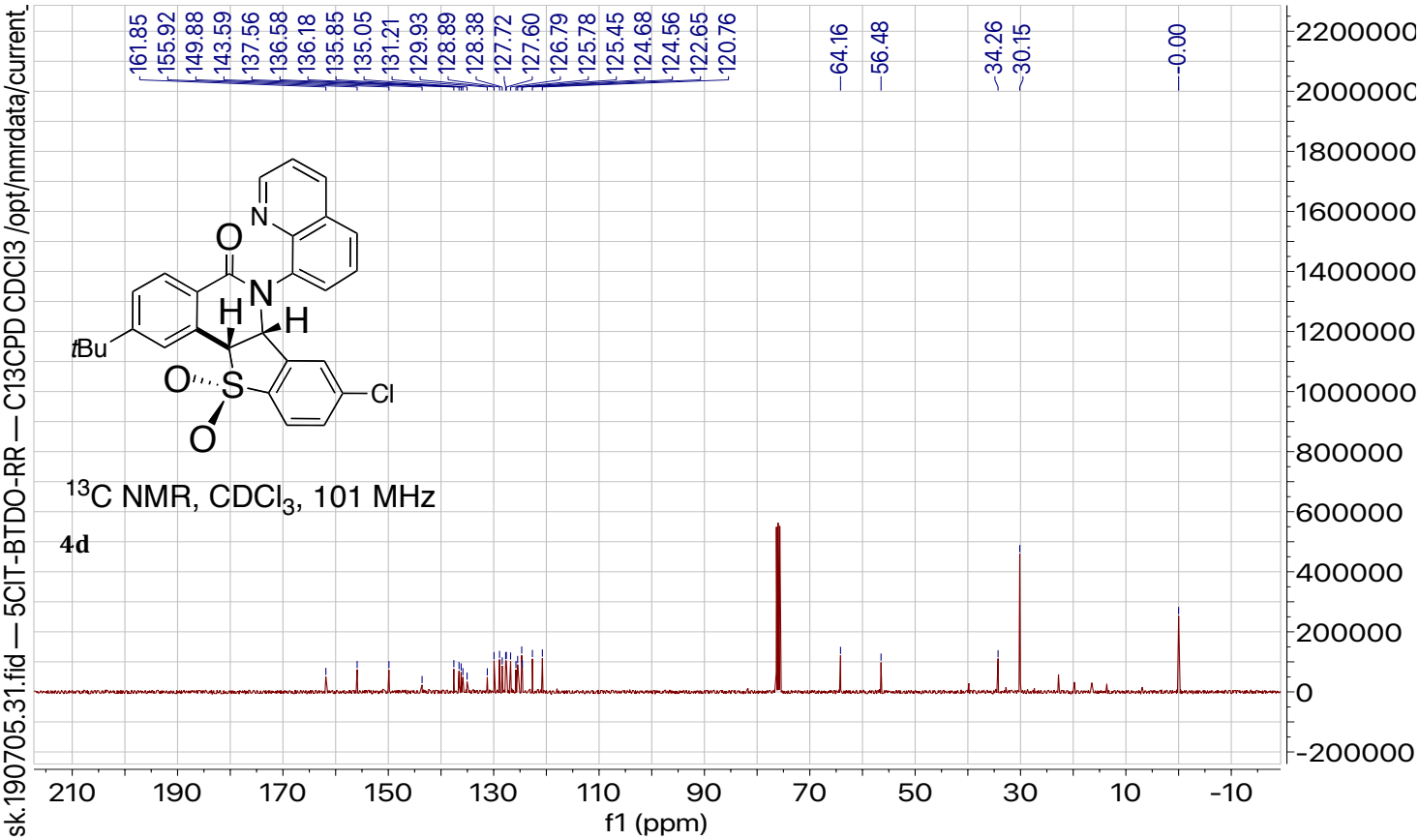
1.00 2.04 1.08 1.10 2.29 1.28 2.23 1.02 1.00 0.93 1.00 9.13
^{1}H NMR, $CDCl_3$, 400 MHz
4d
f1 (ppm)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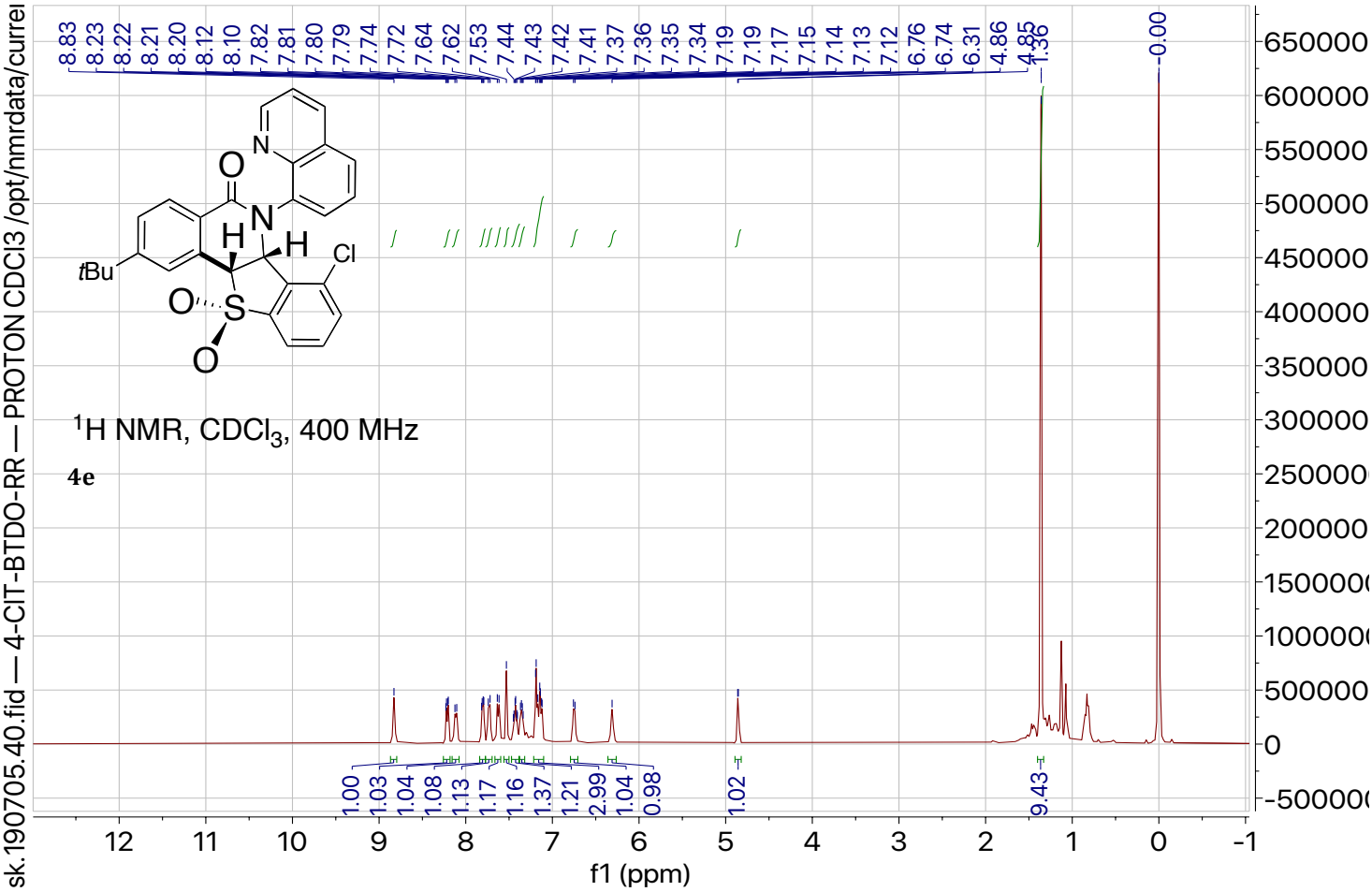
^{13}C NMR, $CDCl_3$, 101 MHz
4d
f1 (ppm)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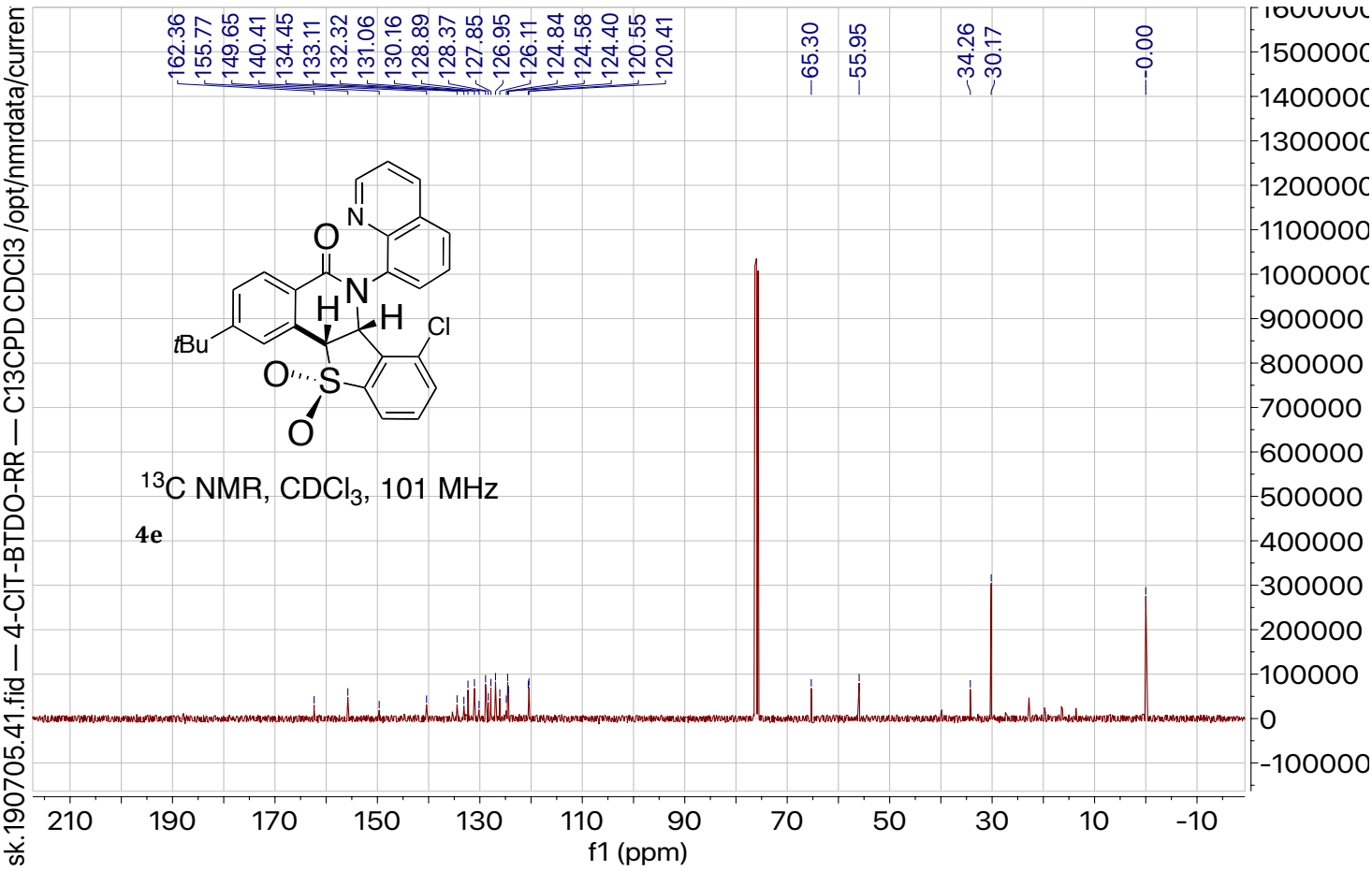
1.00 1.03 1.04 1.08 1.13 1.17 1.16 1.37 1.21 2.99 1.04 0.98 1.02 9.43
N
O
N
H
H
Cl
tBu
O
S
O
^{1}H NMR, $CDCl_3$, 400 MHz
4e
f1 (ppm)


sk.190705.41.fid — 4-CIT-BTDO-RR — C13CPD CDCl3 /opt/nmrdata/curren
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65.30 55.95 34.26 30.17 -0.00
N
O
N
H
H
Cl
tBu
O
S
O
^{13}C NMR, $CDCl_3$, 101 MHz
4e
f1 (ppm)

15. Gram scale experiment

The benzamide **1a** (1.79 g, 1.1 equiv), benzothiophene-(b)-1,1-dioxide (1 g, 1 equiv) (**2a**), $Co(acac)_2$ 460 mg, 20 mol%), Ag_2O (2.79 g, 2 equiv), and KOAc (2.37 g, 4 equiv) were weighed into the 100 mL Duran reagent bottle and the mixture of TFE+tAmylOH (1:1) (30 mL) was added and the bottle was inserted into the preheated oil bath. The reaction was continued for 36 h at 90 °C and the TLC was used to determine the completion of the reaction. Once the reaction was completed the solvent was removed and the product was purified by column chromatography with petroleum ether (40-65°C) and ethyl acetate as eluent. The product **3a** was isolated as brown solid (65%, 1.62 g).

Figure S4: Reaction flask

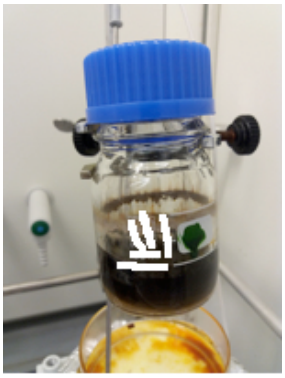

Figure S5: After column chromatography

16. References:

S1. Kathiravan, S.; Suriyanarayanan, S.; Nicholls, I. A. *Org. Lett*. **2019**, *21*, 1968-1972.

S2. Madec, D.; Mingoia, F.; Macovei, C.; Maitro, G.; Giambastiani, G.; Poli, G. *Eur. J. Org. Chem*. **2005**, 552-557.

S3. Kuhl, N.; Hopkinson, M. N.; Glorius, F. *Angew. Chem. Int. Ed*. **2012**, *51*, 8230.

S4. Sun, B.; Yoshino, T.; Matsunaga, S.; Kanai, M. *Adv. Synth. Catal*. **2014**, *356*, 1491-1495.