Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Metal-free transfer hydrogenation/cycloaddition cascade of activated quinolines and isoquinolines with tosyl azides

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1. General Information:

Unless otherwise noted, all the reactions were performed using oven-dried Schlenk tubes under nitrogen. The reactions were monitored by Merck silica gel 60 F_{254} precoated plates (0.25 mm) visualizing under UV light (254 nm) or I_2 staining. Temperature mentioned for any reaction is corresponding to the oil bath temperature. Column chromatography was performed using silica gel 60-120 Å or 100-200 Å mesh of Merck Company.

2. Analytical Methods:

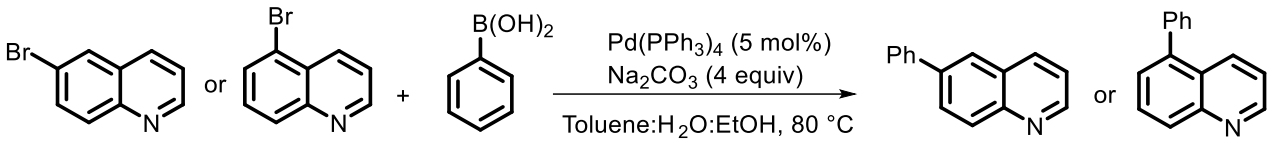
^{1}H, ^{13}C, and ^{19}F nuclear magnetic resonance spectra were recorded on Bruker Advance III 400 MHz spectrometer at 25 °C. NMRs of the products were measured in $CDCl_3$. The chemical shifts in ^{1}H NMR and $^{13}C\{1H\}$ NMR spectra are reported in parts per million (ppm) and are referenced to the residual solvent signal as the internal standard; ^{1}H NMR spectra ($CDCl_3$: δ 7.26 ppm) and ^{13}C ($CDCl_3$: δ 77.16). The coupling constant (J) was reported in Hertz (Hz). Splitting patterns are denoted as "s" for singlet; "d" for doublet; "t" for triplet; "q" for quartet; "sext" for sextet; "sept" for septet; "m" for multiplet, "br" for broad; "dt" for doublet of triplets; "td" for triplet of doublets. ESI-HRMS were recorded on AGILENT 6520 Q-TOF spectrometer.

3. Materials:

All commercially available chemicals were used as received unless otherwise indicated. The quinoline, isoquinoline, and azide substrates were purchased from GLR Innovations/TCI and used without further purification. 7-Methyl quinoline was purchased from TCI Chemicals, containing 25% 5-methyl quinoline at maximum. 6-phenyl quinoline and 5-phenyl quinoline are prepared in the lab according to literature procedures.[1] Pregnenolone and Isopulegol derived quinoline were prepared in the lab, and the detailed procedures are described here. Formic acid-d_2 was purchased from Sigma-Aldrich.

4. Preparation of Starting materials:

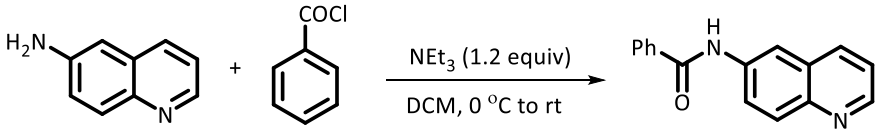
4.1. Preparation of 6-phenyl and 5-phenyl quinoline:[1]



a1 **a2** **a3** **a4** **a5**

A mixture of 6-Bromo-quinoline or 5-Bromo-quinoline (312 mg, 1.5 mmol, 1 equiv.), sodium carbonate (635 mg, 4 equiv.), phenylboronic acid (219 mg, 1.2 equiv.), water (2 mL), toluene (2 mL) and ethanol (1 mL) was degassed by nitrogen bubbling, then $Pd(PPh_3)_4$ (87 mg, 5 mol%) was added, and the mixture was heated to 80 °C for 12 hours. After the completion of the reaction, the mixture was filtered through a plug of Celite, and the filtrate was diluted with water (20 mL) and extracted with CH_2Cl_2 (3 x 10 mL). The combined organic extracts were washed with brine (20 mL) and dried over Na_2SO_4. The drying agent was filtered off, and the solvent was evaporated. The residue was purified by column chromatography (silica, Hexane:EtOAc 4:1). 6-Phenyl quinoline was obtained in 81% yield, and 5-Phenyl-quinoline was obtained in 92% yield.

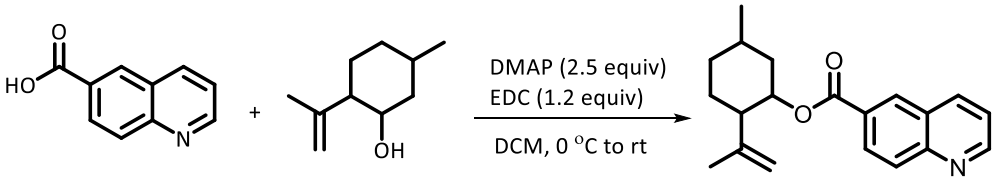
4.2. Preparation of N-(quinolin-6-yl)benzamide:[2]



a6 **a7** **a8**

In a round-bottom flask was taken 6-amino- quinoline (300 mg, 2.1 mmol, 1.0 equiv.) and Et_3N (1.2 equiv.) under a nitrogen atmosphere, and 4-5 mL DCM was added and cooled to 0 °C. To this, PhCOCl (1.2 equiv.) was added dropwise with stirring. The reaction mixture was allowed to warm to room temperature and stirred for 18 h. The reaction mixture was then diluted with DCM and quenched with a saturated solution of $NaHCO_3$, and the resulting mixture was extracted twice with CH_2Cl_2. The combined organic layer was washed with brine and dried over anhydrous Na_2SO_4, filtered, and concentrated under vacuum. The crude product was purified by silica gel column chromatography (silica, 2% MeOH/DCM) furnishing N-(quinolin-6-yl)benzamide (477 mg, 92% yield) as yellow solid.

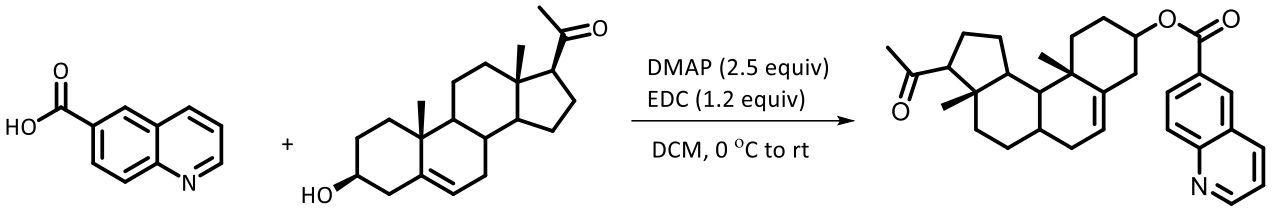
4.3. Preparation of Pregnenolone and Isopulegol-derived quinoline



a9 **a10** **a11**

To a suspension of **a9** (807 mg, 1.2 equiv) in CH_2Cl_2 was added 4-(dimethylamino)-pyridine (DMAP, 2.5 equiv.) in one portion at room temperature and the reaction mixture was stirred for 10 min. To this was added N-(3-(Dimethylamino)propyl)-N'-ethylcarbodiimide hydrochloride (EDC, 1.2 equiv) at 0 °C and the

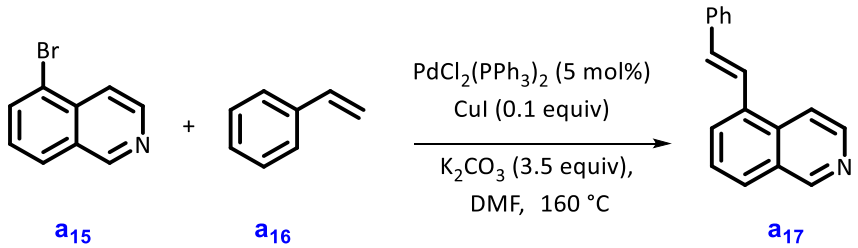
resultant suspension was stirred for 10 min. Then, a solution of **a_{10}** (600 mg, 3.88 mmol) in CH_2Cl_2 was added. The cooling bath was removed after the completion of the addition, and the reaction mixture was stirred at room temperature for 16 h. The solution was diluted by the addition of saturated aqueous NH_4Cl solution and CH_2Cl_2 at room temperature. The organic phase was dried with anhydrous Na_2SO_4, and then concentrated by removing the solvent under vacuum. Finally, the residue was purified by silica gel column chromatography (silica, 1:4 EtOAc/Hexane) to yield **a_{11}** (850 mg, 71%) as yellow oil. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.99 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.54 (d, *J* = 1.7 Hz, 1H), 8.28 – 8.24 (m, 2H), 8.13 (d, *J* = 8.8 Hz, 1H), 7.45 (dd, *J* = 8.3, 4.2 Hz, 1H), 5.10 (td, *J* = 10.9, 4.4 Hz, 1H), 4.83 (s, 1H), 4.73 – 4.72 (m, 1H), 2.39 – 2.32 (m, 1H), 2.23 – 2.18 (m, 1H), 1.83 – 1.77 (m, 2H), 1.72 (s, 3H), 1.69 – 1.61 (m, 1H), 1.55 – 1.47 (m, 1H), 1.25 – 1.17 (m, 1H), 1.06 – 1.02 (m, 1H), 0.98 (d, *J* = 6.5 Hz, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 165.6, 152.4, 150.1, 146.2, 137.4, 130.9, 129.7, 129.2, 128.9, 127.5, 121.8, 112.2, 74.9, 51.1, 40.6, 34.3, 31.6, 30.5, 22.2, 19.6. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{20}H_{24}NO_2$ 310.1807; found 310.1799.



a_{12} **a_{13}** **a_{14}**

To a suspension of **a_{12}** (1.2 mmol) in CH_2Cl_2 was added DMAP (4- (dimethylamino)-pyridine, 2.5 mmol) in one portion at room temperature and the reaction mixture was stirred for 10 min. To this was added N-(3-(Dimethylamino)propyl)-N'-ethylcarbodiimide hydrochloride (EDC, 1.2 mmol) at 0 °C and the resultant suspension was stirred for 10 min. A solution of **a_{13}** (316 mg, 1.0 mmol) in CH_2Cl_2 was then added at 0 °C, and the cooling bath was removed, and the reaction mixture was stirred at room temperature for 16 h. The solution was diluted by the addition of saturated aqueous NH_4Cl solution and CH_2Cl_2 at room temperature. The organic phase was dried with anhydrous Na_2SO_4, and then concentrated by removing the solvent under vacuum. Finally, the residue was purified by silica gel column chromatography (silica, 2:3 EtOAc/Hexane) to furnish **a_{14}** (350 mg, 84%) as a white solid. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 9.00 (dd, *J* = 4.2, 1.7 Hz, 1H), 8.58 (d, *J* = 1.7 Hz, 1H), 8.31 (dd, *J* = 8.8, 1.9 Hz, 1H), 8.27 (dd, *J* = 8.3, 1.1 Hz, 1H), 8.14 (d, *J* = 8.8 Hz, 1H), 7.47 (dd, *J* = 8.3, 4.2 Hz, 1H), 5.44 (d, *J* = 3.9 Hz, 1H), 4.98 – 4.89 (m, 1H), 2.57 – 2.52 (m, 3H), 2.13 (s, 3H), 2.08 – 1.93 (m, 5H), 1.86 – 1.78 (m, 2H), 1.71 – 1.61 (m, 4H), 1.53 – 1.46 (m, 3H), 1.29 – 1.28 (m, 1H), 1.23 – 1.15 (m, 2H), 1.09 (s, 3H), 0.65 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 209.6, 165.6, 152.2, 150.1, 139.7, 137.4, 130.9, 129.8, 129.2, 128.9, 127.5, 122.7, 121.9, 75.1, 63.8, 56.9, 50.0, 44.1, 38.9, 38.3, 37.2, 36.8, 31.9, 31.9, 31.7, 28.0, 24.6, 22.9, 21.2, 19.5, 13.3. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{31}H_{38}NO_3$ 472.2852; found 472.2842. Melting Point: 234-235 °C

4.4. Preparation of (E)-5-styrylisoquinoline:[3]

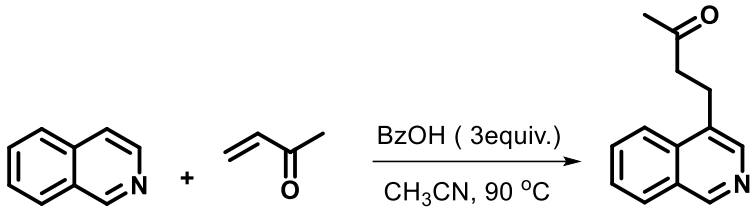


a_{15} **a_{16}** **a_{17}**

A 50 mL round-bottomed flask containing a stirring bar was sequentially charged under nitrogen with $PdCl_2(PPh_3)_2$ (35.0 mg, 5 mol%), 5-Br-isoquinoline (**a_{15},** 208 mg, 1.0 mmol), **a_{16}** (156 mg, 1.5 eq), and K_2CO_3 (483 mg, 3.5 eq), in dry DMF (4 mL), and the round-bottom flask was sealed and set in an oil bath at 160 °C

for 24 h. When the reaction was complete, the crude reaction mixture was allowed to reach room temperature. Then, 50 mL of EtOAc was added, and the mixture was filtered under gravity and the solid residue was washed with EtOAc (3 x 5 mL). The solvent was removed under reduced pressure. Finally, the reaction mixture was purified by silica gel column chromatography (1:9 EtOAc/hexane mixtures) obtaining the desired product **a_{17}** (207 mg, 89 %) as a brown oil. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 9.25 (s, 1H), 8.56 (d, *J* = 6.0 Hz, 1H), 7.97 (d, *J* = 6.0 Hz, 1H), 7.94 (d, *J* = 7.2 Hz, 1H), 7.89 (d, *J* = 8.1 Hz, 1H), 7.75 (d, *J* = 16.0 Hz, 1H), 7.62 – 7.58 (m, 3H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.33 – 7.30 (m, 1H), 7.18 (d, *J* = 16.0 Hz, 1H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 153.2, 143.3, 137.2, 134.2, 134.1, 132.9, 129.1, 128.9, 128.3, 127.5, 127.4, 127.2, 126.9, 123.9, 116.8. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{14}N$ 232.1126; found 232.1119.

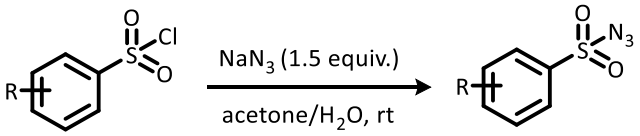
4.5. Preparation of 4-(isoquinolin-4-yl)butan-2-one[3] :



a_{18} **a_{19}** **a_{20}**

In a 25 mL round-bottomed flask containing a stirring bar, isoquinoline (500 mg, 3.87 mmol, 1.0 equiv.), benzoic acid (1.42 g, 3.0 equiv.), vinyl ketone (1.08 g, 4.0 equiv.), and MeCN (6.0 mL) were added, and the flask was placed in a pre-heated oil bath at 90 °C for 24 h. The reaction mixture was diluted in CH_2Cl_2 and quenched with K_2CO_3 solution. The layers were separated, and the aqueous phase was further extracted with CH_2Cl_2. The combined organic extracts were dried over Na_2SO_4, filtered, and concentrated in vacuo. The residue was purified by flash column chromatography (5/95% MeOH/DCM) to furnish **a_{20}** (560 mg, 73%) as a brown oil.

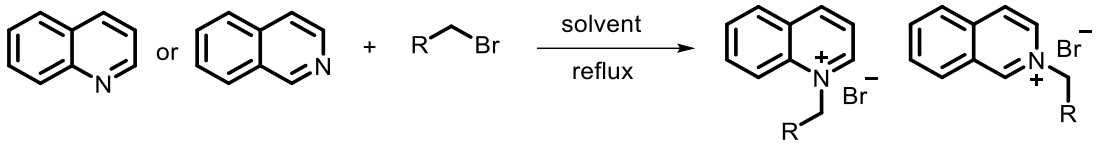
4.6. General Procedure A for the Preparation of Sulfonyl Azides:[4]



To the solution of NaN_3 (1.5 equiv) in water (0.5 mL) was added a solution of sulfonyl chloride (1.0 mmol, 1.0 equiv) in acetone (1 mL) at 0 °C dropwise. The reaction mixture was warmed up to room temperature and stirred for 12 h. Acetone was removed under reduced pressure and the reaction mixture was extracted with EtOAc. The combined organic layers were dried over Na_2SO_4 and the solvent was removed under reduced pressure. The crude product was used without further purification.

Caution! Organic azides are potentially explosive substances (initial temperature of the explosive decomposition is about 120 °C) that can and will decompose with the slightest input of energy from external sources (heat, light, pressure) and should be handled with great care. They should not be heated too much when concentrating. They should be stored at low temperature in a refrigerator.

4.7. General Procedure B for the synthesis of quinolinium and isoquinolinium salts:[5a-5h]



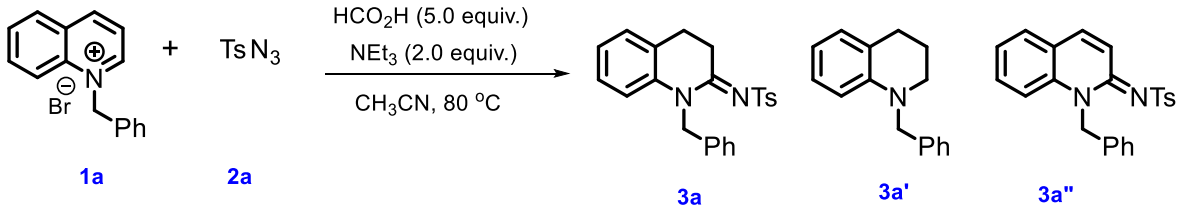
A mixture of the corresponding quinoline/isoquinoline (1.0 equiv.) and alkyl halide (1.2 equiv.) in CH_3CN/1,4-dioxane was refluxed for 24-30 h. The solvent was removed under reduced pressure. The resulting precipitate was washed with diethyl ether and dried under vacuum to give the desired quinolinium and isoquinolinium salts.

- Acetonitrile was used as a solvent for **1a-1n, 1r-1z, 4a-4n.**
- 1,4-Dioxane was used as a solvent for **1o** and **1p**.
- Neat reaction was performed for **1q.**

5. General Procedure C for the Synthesis of Cyclic Amidines

An oven-dried Schlenk tube was charged with quinolinium/isoquinolinium salt (**1/4**, 0.3 mmol, 1.0 equiv.) and organic azide (**2**, 0.6 mmol, 2.0 equiv.), and exchanged with nitrogen and vacuum three times. To this was added Et_3N (85 µL, 2.0 equiv.) and MeCN (3 mL) followed by the addition of HCOOH (56 µL, 5.0 equiv.), and the reaction mixture was heated to 80 °C for 16 hours. The reaction was cooled after the completion of the reaction (monitored by TLC), diluted with EtOAc, and quenched with an aqueous K_2CO_3 solution. The organic phase was separated, and the aqueous phase was extracted with EtOAc. The combined organic phase was washed with H_2O and dried over Na_2SO_4. The solvent was removed under reduced pressure. The resulting residue was purified by column chromatography on silica gel (PE/EA = 4:1 to 1:1) to give the corresponding cyclic amidine product **3/5**.

6. Optimization of reaction conditions:

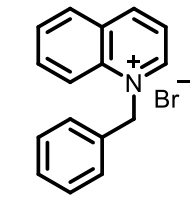


Entry	Azide (2 equiv)	HCOOH	NEt_3	Solvent	Temp.	Yield (%) of 3a	Yield (%) of 3a'	Yield (%) of 3a"
1	TsN_3	5 equiv.	2 equiv.	CH_3CN	80 °C	78(72)	trace	n.d.
2	DPPA	"	"	"	"	n.d.	n.d.	n.d.
3	TMSA	"	"	"	"	n.d.	n.d.	n.d.
4	TsN_3	"	"	neat	"	48	trace	n.d.
5	"	"	"	DCE	"	70	trace	n.d.
6	"	"	"	THF	"	72	trace	n.d.

7	″	″	″	MeOH	″	14	trace	n.d.
8	″	″	″	Toluene	″	74	trace	n.d.
9	″	″	″	CF_3-Toluene	″	40	trace	n.d.
10	″	″	″	DMF	″	60	trace	n.d.
11	″	″	″	CH_3CN	90	72	trace	n.d.
12	(1.5 equiv)	″	″	″	90	72	trace	n.d.
13	(2.0 equiv)	″	″	″	60	50	trace	n.d.
14	″	″	″	THF	″	60	trace	n.d.
15	″	2 equiv.	5 equiv.	CH_3CN	90	66	trace	n.d.
16	″	2 equiv.	2 equiv.	″	″	72	trace	n.d.
17	″	8 equiv.	2 equiv.	″	″	44	trace	n.d.
18	″	5 equiv.	-	″	80	n.d.	trace	n.d.
19	″	-	2 equiv.	″	80	n.d.	n.d.	60
20[c]	″	-	-	EtOH	90	28	n.d.	15
21[d]	″	-	-	CH_3CN	80	72	trace	n.d.
22[e]	″	″	-	″	″	61	trace	n.d.
23[f]	″	″	-	″	″	62	trace	n.d.
24	-	″	″	″	″	n.d.	53	n.d.

[a]Reaction conditions: **1a** (1.0 equiv.), **2a** (2.0 equiv.), HCOOH (5.0 equiv.), NEt_3 (2.0 equiv.) at 80 °C for 16 h. ^{1}H NMR yield using 1,3,5-trimethoxybenzene as internal standard. n.d. = not detected. [b]Isolated yield in parenthesis.[c]$[IrCp^*Cl_2]_2$(1.0 mol%), PhCONHOMe (2.0 mol%), KI (3.0 equiv.), DABCO (1.0 equiv.), ethanol, 90 °C.[d] $HCOONH_4$ (5.0 equiv) as a hydrogen source. [e] DIPEA base (2.0 equiv.). [f]DABCO base (2.0 equiv.). DPPA = Diphenylphosphoryl azide, TMSA = Trimethylsilyl azide, DIPEA = N,N-Diisopropylethylamine, DABCO = (1,4-diazabicyclo[2.2.2]octane), DCE = 1,2-dichloroethane, THF = Tetrahydrofuran

7. Substrates employed in the reaction: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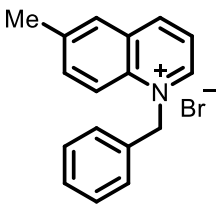
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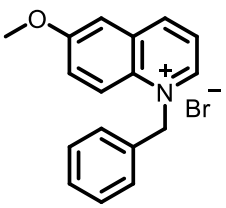
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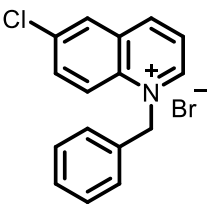
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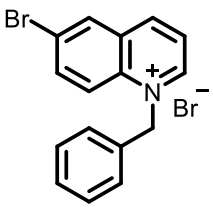
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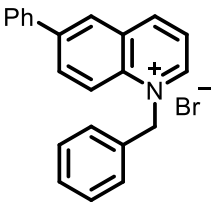
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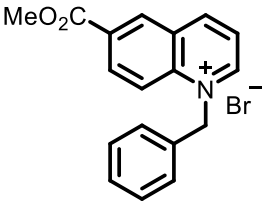
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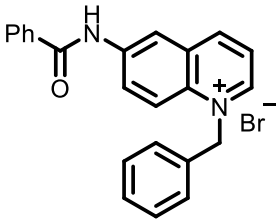
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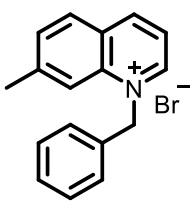
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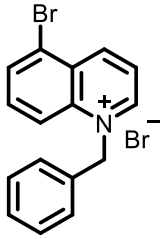
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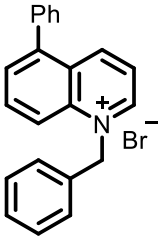
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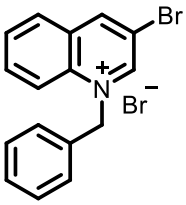
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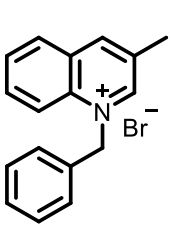
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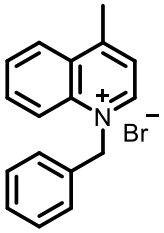
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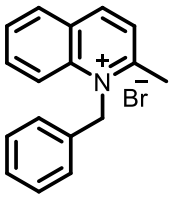
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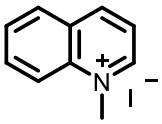
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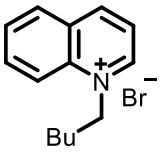
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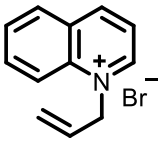
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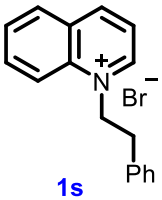
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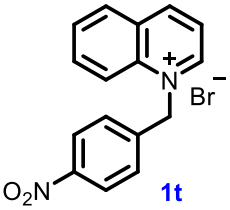
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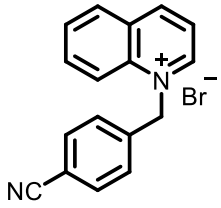
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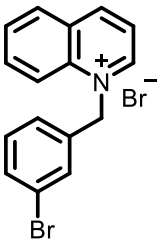
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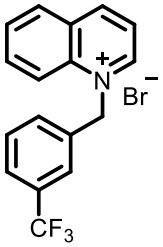
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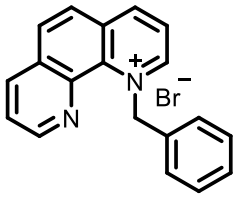
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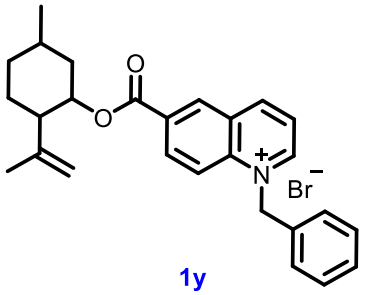
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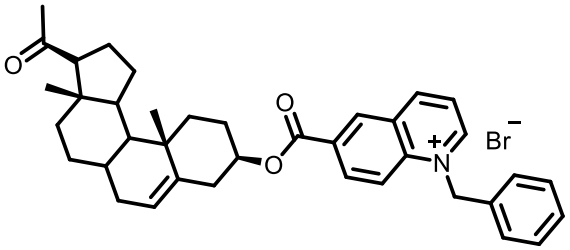
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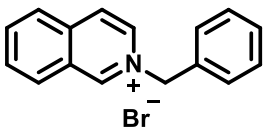

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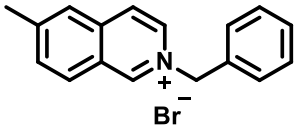

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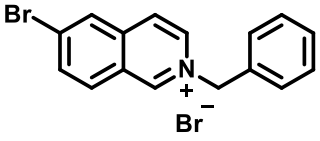

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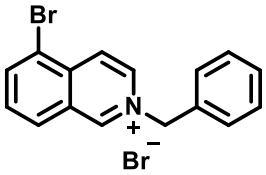

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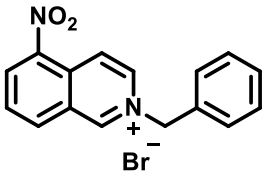

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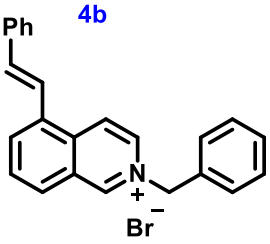

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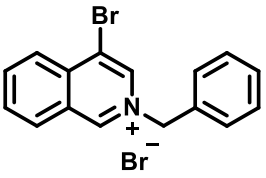

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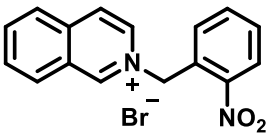

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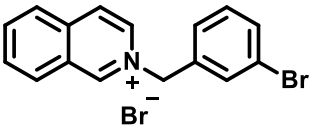

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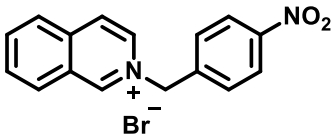

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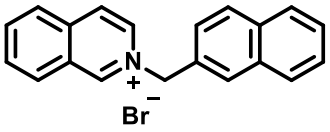

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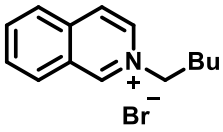

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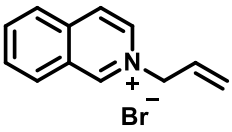

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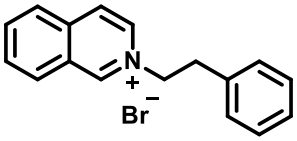

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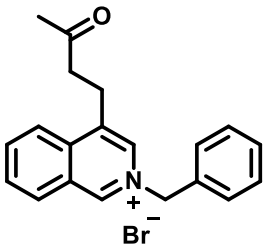

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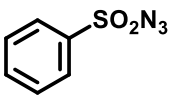

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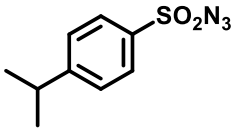

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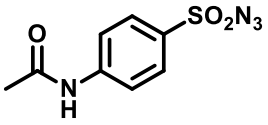

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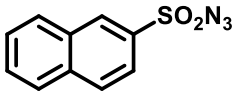

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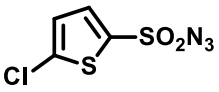

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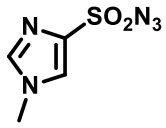

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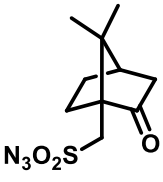

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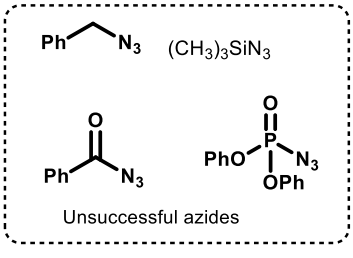
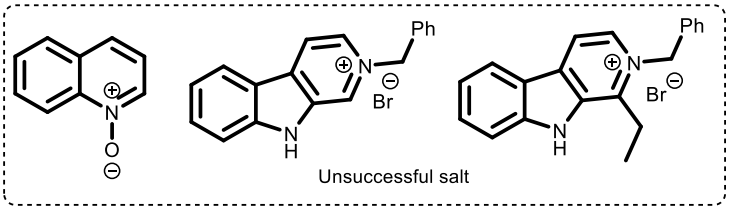
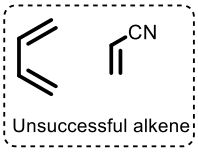
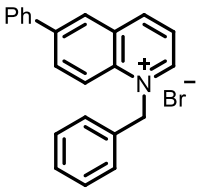






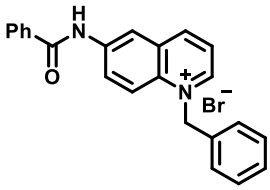
8. Characterization data of Starting materials

1-benzyl-6-phenylquinolin-1-ium bromide (1f):



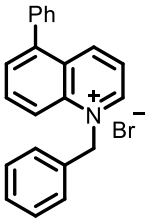
The representative general procedure **B** was followed, using 6-Phenyl quinoline (250 mg, 1.2 mmol) under reflux for 24 h to afford **1f** (380 mg, 84%) as a hygroscopic yellow solid. **^{1}H NMR (400 MHz, DMSO-d$_6$):** δ 9.76 (s, 1H), 9.40 (d, *J* = 8.4 Hz, 1H), 8.86 (s, 1H), 8.61–8.55 (m, 2H), 8.34 – 8.31 (m, 1H), 7.92 (d, *J* = 7.5 Hz, 2H), 7.61 – 7.57 (m, 2H), 7.53– 7.49 (m, 1H), 7.43 – 7.38 (m, 5H), 6.43 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d$_6$):** δ 150.1, 148.1, 141.0, 137.0, 136.9, 134.5, 133.9, 130.5, 129.3, 129.1, 128.8, 127.5, 127.4, 127.2, 122.8, 119.9, 59.9. **HRMS** (ESI) m/z: [M-Br]$^+$ calcd for $C_{22}H_{18}N$ 296.1434; found 296.1445.

6-benzamido-1-benzylquinolin-1-ium bromide (1h):



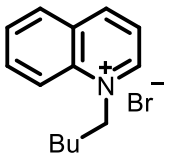
The representative general procedure **B** was followed, using N-(quinolin-6-yl)benzamide (250 mg, 1.0 mmol) and benzyl bromide (1.2 equiv.) under reflux for 24 h to afford **1h** (377 mg, 90%) as a yellow solid. **^{1}H NMR (400 MHz, DMSO-d$_6$):** δ 10.98 (s, 1H), 9.65 (dd, *J* = 5.8, 1.1 Hz, 1H), 9.36 (d, *J* = 8.4 Hz, 1H), 9.05 (d, *J* = 2.3 Hz, 1H), 8.58 (d, *J* = 9.6 Hz, 1H), 8.44 (dd, *J* = 9.6, 2.4 Hz, 1H), 8.24 (dd, *J* = 8.4, 5.7 Hz, 1H), 8.06 – 8.03 (m, 2H), 7.68 – 7.64 (m, 1H), 7.61 – 7.57 (m, 2H), 7.41 – 7.36 (m, 5H), 6.38 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d$_6$):** δ 166.4, 148.3, 147.3, 139.9, 134.2, 133.9, 133.8, 132.2, 130.9, 129.6, 129.1, 128.7, 128.5, 127.9, 127.3, 122.6, 120.0, 117.3, 59.7. **HRMS** (ESI) m/z: [M-Br]$^+$ calcd for $C_{23}H_{19}N_2O$ 339.1497; found 339.1499. Melting Point: 252-253 °C.

1-benzyl-5-phenylquinolin-1-ium bromide (1k):



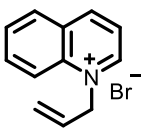
The representative general procedure **B** was followed, using 5-Phenyl quinoline (250 mg, 1.2 mmol) under reflux for 24 h to afford **1k** (350 mg, 76%) as a hygroscopic yellow solid. **^{1}H NMR (400 MHz, DMSO-d$_6$):** δ 9.96 – 9.91 (m, 1H), 9.03 (d, *J* = 8.5 Hz, 1H), 8.59 (d, *J* = 8.9 Hz, 1H), 8.28– 8.23 (m, 2H), 7.95 (d, *J* = 7.1 Hz, 1H), 7.64 – 7.55 (m, 5H), 7.47– 7.35 (m, 5H) 6.50 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d$_6$):** δ 150.3, 145.9, 142.5, 138.1, 136.7, 135.1, 133.9, 130.5, 130.2, 129.1, 128.9, 128.8, 128.7, 128.2, 127.3, 122.6, 118.7, 60.3. **HRMS** (ESI) m/z: [M-Br]$^+$ calcd for $C_{22}H_{18}N$ 296.1434; found 296.1436.

1-pentylquinolin-1-ium bromide (1q):



The representative general procedure **B** was followed, using quinoline (250 mg, 1.9 mmol) and pentyl bromide (1.2 equiv.) under reflux for 24 h to afford **1q** (531 mg, 98%) as a sticky white solid.**^{1}H NMR (400 MHz, DMSO-d$_6$):** δ 9.70 (dd, *J* = 5.8, 1.3 Hz, 1H), 9.35 (d, *J* = 8.3 Hz, 1H), 8.66 (d, *J* = 8.9 Hz, 1H), 8.53 (dd, *J* = 8.2, 1.3 Hz, 1H), 8.31– 8.26 (m, 1H), 8.22 (dd, *J* = 8.3, 5.8 Hz, 1H), 8.08 – 8.04 (m, 1H), 5.14 – 5.09 (m, 2H), 2.01– 1.93 (m, 2H), 1.42 – 1.27 (m, 4H), 0.85 (t, *J* = 7.1 Hz, 3H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d$_6$):** δ 149.6, 147.3, 137.3, 135.6, 130.7, 129.8, 129.6, 122.1, 118.9, 57.2, 29.2, 27.8, 21.6, 13.7. **HRMS** (ESI) m/z: [M-Br]$^+$ calcd for $C_{14}H_{18}N$ 200.1439; found 200.1431.

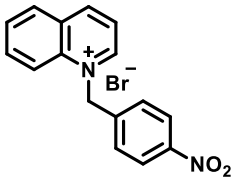
1-allylquinolin-1-ium bromide (1r):



The representative general procedure **B** was followed, using quinoline (250 mg, 1.9 mmol) and allyl bromide (1.2 equiv.) under reflux for 24 h to afford **1r** (458 mg, 95%) as a white solid. **^{1}H NMR (400 MHz, DMSO-d$_6$):** δ 9.76 – 9.72 (m, 1H), 9.40 (d, *J* = 8.3 Hz, 1H), 8.59 –

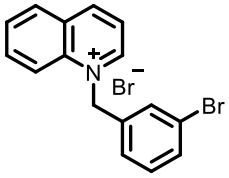
8.53 (m, 2H), 8.29 – 8.25 (m, 2H), 8.07 – 8.03 (m, 1H), 6.28 – 6.19 (m, 1H), 5.84 – 5.83 (m, 2H), 5.41– 5.33 (m, 2H). **$^{13}C\{^1H\}$ NMR (100 MHz, DMSO-d_6):** δ 149.8, 147.7, 137.5, 135.5, 131.3, 130.6, 129.8, 129.6, 122.3, 120.4, 119.2, 58.9. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{12}H_{12}N$ 170.0970; found 170.0962. Melting Point: 160-165 °C.

1-(4-nitrobenzyl)quinolin-1-ium bromide (1t):



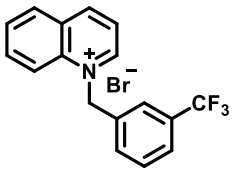
The representative general procedure **B** was followed, using quinoline (250 mg, 1.9 mmol) and 4-nitro benzyl bromide (1.2 equiv.) under reflux for 24 h to afford **1t** (646 mg, 97%) as a white solid. **^1H NMR (400 MHz, DMSO-d_6):** δ 9.93 (d, *J* = 5.5 Hz, 1H), 9.48 (d, *J* = 8.3 Hz, 1H), 8.57 (d, *J* = 8.2 Hz, 1H), 8.45 (d, *J* = 8.9 Hz, 1H), 8.39 – 8.35 (m, 1H), 8.23 – 8.19 (m, 3H), 8.06 – 8.02 (m, 1H), 7.65 (d, *J* = 8.5 Hz, 2H), 6.64 (s, 2H). **$^{13}C\{^1H\}$ NMR (100 MHz, DMSO-d_6):** δ 150.9, 148.6, 147.4, 141.2, 137.5, 135.9, 130.9, 130.0, 129.9, 128.5, 123.9, 122.6, 119.1, 59.0. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{16}H_{13}N_2O_2$ 265.0977; found 265.0976. Melting Point: 219-220 °C.

1-(3-bromobenzyl)quinolin-1-ium bromide (1v):



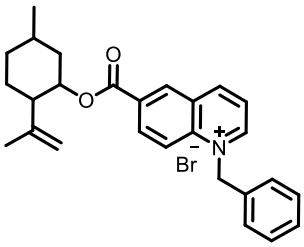
The representative general procedure **B** was followed, using quinoline (250 mg, 1.9 mmol) and 3-bromo benzyl bromide (1.2 equiv.) under reflux for 24 h to afford **1v** (648 mg, 99%) as a white solid. **^1H NMR (400 MHz, DMSO-d_6):** δ 9.85 (d, *J* = 5.8 Hz, 1H), 9.43 (d, *J* = 8.3 Hz, 1H), 8.56 – 8.52 (m, 2H), 8.32 (dd, *J* = 8.4, 5.8 Hz, 1H), 8.26 – 8.22 (m, 1H), 8.05 – 8.02 (m, 1H), 7.76 (s, 1H), 7.58 – 7.55 (m, 1H), 7.39 – 7.32 (m, 2H), 6.44 (s, 2H). **$^{13}C\{^1H\}$ NMR (100 MHz, DMSO-d_6):** δ 150.7, 148.3, 137.4, 136.4, 135.8, 131.7, 131.1, 130.9, 130.2, 129.9, 129.8, 126.4, 122.5, 122.2, 119.1, 58.9. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{16}H_{13}BrN$ 298.0231; found 298.0226. Melting Point: 175-176 °C.

1-(3-(trifluoromethyl)benzyl)quinolin-1-ium bromide (1w):



The representative general procedure **B** was followed, using quinoline (250 mg, 1.9 mmol) and 1-(bromomethyl)-3-(trifluoromethyl)benzene (1.2 equiv.) under reflux for 24 h to afford **1w** (750 mg, 99%) as a white solid**. ^1H NMR (400 MHz, D_2O)**: δ 9.35 (d, *J* = 5.7 Hz, 1H), 9.15 (d, *J* = 8.4 Hz, 1H), 8.29 (d, *J* = 8.2 Hz, 1H), 8.24 (d, *J* = 9.0 Hz, 1H), 8.09 – 8.02 (m, 2H), 7.90 – 7.86 (m, 1H), 7.63 (d, *J* = 7.5 Hz, 1H), 7.59 (s, 1H), 7.52 – 7.45 (m, 2H), 6.30 (s, 2H). **$^{13}C\{^1H\}$ NMR (100 MHz, D_2O):** δ 149.4, 148.8, 137.9, 136.2, 133.8, 130.9, 130.7 (d, *J* = 32.9 Hz), 130.3, 130.1, 130.0, 125.9 (d, *J* = 3.5 Hz), 123.9 (d, *J* = 3.5 Hz), 123.5 (d, *J* = 271.7 Hz), 121.9, 118.4, 60.3. **^{19}F NMR** (376 MHz, CDCl3): δ - 62.58. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{17}H_{13}F_3N$ 288.0995; found 288.0996. Melting Point: 211-212 °C.

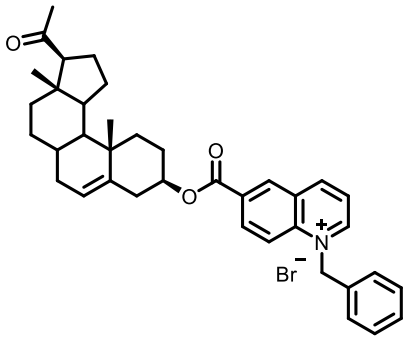
1-benzyl-6-(((5-methyl-2-(prop-1-en-2-yl)cyclohexyl)oxy)carbonyl)quinolin-1-ium bromide (1y):



The representative general procedure **B** was followed, using **a_{11}** (300 mg, 0.97 mmol) and benzyl bromide (1.2 equiv.) under reflux for 48 h to afford **1y** (325 mg, 70%) as a sticky brown solid. **^1H NMR (400 MHz, CD_3OD-d_4)**: δ 9.69 (d, *J* = 5.8, 1H), 9.47 (d, *J* = 8.3 Hz, 1H), 9.06 (s, 1H), 8.64 (s, 2H), 8.29 (dd, *J* = 8.3, 5.8 Hz, 1H), 7.47 – 7.39 (m, 5H), 6.43 (s, 2H), 5.16 (dt, *J* = 10.9, 4.4 Hz, 1H), 4.69 – 4.68 (m, 1H), 2.45 – 2.38 (m, 1H), 2.17 – 2.13 (m, 1H), 1.84 – 1.75 (m, 2H), 1.71 (s, 3H), 1.68 – 1.62 (m, 1H), 1.31 – 1.28 (m, 4H), 1.01 (d, *J* = 6.5 Hz, 3H). **$^{13}C\{^1H\}$ NMR (100 MHz, CD_3OD):** δ 164.8, 152.6, 151.0, 147.3, 141.4, 135.9, 134.1, 133.9, 133.2, 131.5, 130.6, 130.5, 128.8, 124.3, 121.2,

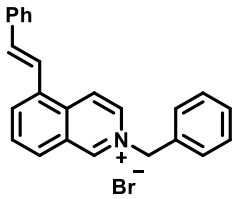
112.9, 76.9, 62.4, 52.3, 41.4, 35.1, 32.7, 31.4, 22.4, 19.6. HRMS (ESI) m/z: $[M-Br]^+$ calcd for $C_{27}H_{30}NO_2$ 400.2271; found 400.2268. HRMS (ESI) m/z: $[M-Br]^+$ calcd for $C_{27}H_{30}NO_2$ 400.2271; found 400.2268.

6-((((3S,3aS,9R,11aS)-3-acetyl-3a,11a-dimethyl-2,3,3a,4,5,5a,6,8,9,10,11,11a,11b,11c-tetradecahydro-1H-cyclopenta[c]phenanthren-9-yl)oxy)carbonyl)-1-benzylquinolin-1-ium bromide (1z):



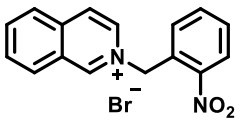
The representative general procedure **B** was followed, using **a_{14}** (300 mg, 0.64 mmol) and benzyl bromide (1.2 equiv.) under reflux for 48 h to afford **1z** (308 mg, 75%) as an off white solid. **^{1}H NMR (400 MHz, CD_3OD-d_4):** δ 9.65 (d, *J* = 5.8, 1H), 9.45 (d, *J* = 8.3 Hz, 1H), 9.11 (d, *J* = 1.6 Hz, 1H), 8.69 – 8.61 (m, 2H), 8.27 (dd, *J* = 8.3, 5.9 Hz, 1H), 7.47 – 7.37 (m, 5H), 6.40 (s, 2H), 5.46 (d, *J* = 4.9 Hz, 1H), 2.71 – 2.63 (m, 1H), 2.58 – 2.49 (m, 2H), 2.17 –2.11 (m, 4H), 2.10 – 1.98 (m, 4H), 1.91 – 1.84 (m, 1H), 1.75 – 1.61 (m, 4H), 1.58 – 1.48 (m, 3H), 1.30 – 1.16 (m, 4H), 1.12 – 1.06 (m, 4H), 0.64 (s, 3H).**^{13}C{^{1}H} NMR (100 MHz, CD_3OD-d_4):** δ 212.3, 164.9, 152.6, 151.0, 141.4, 140.7, 136.1, 134.1, 134.0, 133.3, 131.6, 130.6, 130.5, 128.8, 124.2, 123.9, 121.0, 77.4, 64.6, 62.4, 57.9, 51.4, 45.1, 39.8, 39.0, 38.2, 37.8, 33.1, 32.9, 31.6, 28.7, 25.4, 23.8, 22.2, 19.7, 13.6. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{38}H_{44}BrNO_3$ 562.3316; found 562.3317. Melting Point: 210-211 °C.

(E)-2-benzyl-5-styrylisoquinolin-2-ium bromide (4f):



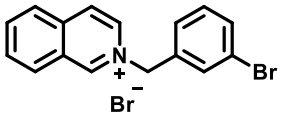
The representative general procedure **B** was followed, using (E)-5-styrylisoquinoline (200 mg, 0.86 mmol) and benzyl bromide (1.2 equiv.) under reflux for 24 h to afford **4f** (294 mg, 85%) as a yellow solid. **^{1}H NMR (400 MHz, DMSO-d_6):** δ 10.39 (s, 1H), 9.11 (d, *J* = 6.9 Hz, 1H), 8.95 (d, *J* = 6.7 Hz, 1H), 8.62 (d, *J* = 7.3 Hz, 1H), 8.46 (d, *J* = 8.0 Hz, 1H), 8.09 – 8.06 (m, 2H), 7.82 (d, *J* = 7.4 Hz, 2H), 7.65 (d, *J* = 6.6 Hz, 2H), 7.54 (d, *J* = 16.1 Hz, 1H), 7.45 – 7.29 (m, 6H), 6.04 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d_6):** δ 150.2, 136.3, 134.5, 134.4, 134.3, 134.2, 132.5, 131.1, 129.8, 129.1, 128.9, 128.6, 128.5, 128.4, 127.9, 127.2, 123.1, 121.5, 62.8. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{24}H_{20}N$ 322.1596; found 322.1587.

2-(2-nitrobenzyl)isoquinolin-2-ium bromide (4g):



The representative general procedure **B** was followed, using Isoquinoline (250 mg, 1.9 mmol) and 2-nitro benzyl bromide (1.2 equiv.) under reflux for 24 h to afford **4g** (653 mg, 98%) as a white solid. **^{1}H NMR (400 MHz, DMSO-d_6):** δ 10.24 (s, 1H), 8.82 (d, *J* = 6.5 Hz, 1H), 8.70 (d, *J* = 6.8 Hz, 1H), 8.58 (d, *J* = 8.3 Hz, 1H), 8.43 (d, *J* = 8.3 Hz, 1H), 8.34 – 8.28 (m, 2H), 8.13 – 8.09 (m, 1H), 7.83 – 7.74 (m, 2H), 7.34 (d, *J* = 7.4 Hz, 1H), 6.42 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d_6):** δ 151.0, 147.6, 137.3, 137.2, 135.2, 134.9, 131.3, 130.9, 130.8, 130.5, 129.0, 127.3, 127.2, 126.1, 125.5, 60.5. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{16}H_{13}N_2O_2$ 265.0977; found 265.0967. Melting Point: 223-224 °C.

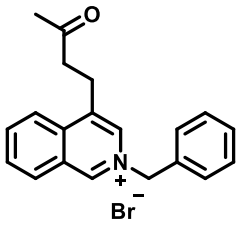
2-(3-bromobenzyl)isoquinolin-2-ium bromide (4h):



The representative general procedure **B** was followed, using Isoquinoline (250 mg, 1.9 mmol) and 3-bromo benzyl bromide (1.2 equiv.) under reflux for 24 h to afford **4h** (648 mg, 99%) as a white solid. **^{1}H NMR (400 MHz, DMSO-d_6):** δ 10.46 (s, 1H), 8.93 – 8.91 (m, 1H), 8.64 (d, *J* = 6.8 Hz, 1H), 8.55 (d, *J* = 8.3 Hz, 1H), 8.37 (d, *J* = 8.3 Hz, 1H),

8.29 – 8.25 (m, 1H), 8.11 – 8.07 (m, 1H), 7.96 – 7.95 (m, 1H), 7.68 (dd, *J* = 7.6, 0.7 Hz, 1H), 7.62 (d, *J* = 7.9 Hz, 1H), 7.41 (t, *J* = 7.9 Hz, 1H), 6.06 (s, 2H). **$^{13}C\{^1H\}$ NMR (100 MHz, DMSO-d_6):** δ 150.4, 137.1, 137.0, 136.6, 134.6, 132.1, 131.7, 131.2, 131.1, 130.6, 128.1, 127.2, 127.2, 126.2, 122.1, 62.1. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{16}H_{13}BrN$ 298.0231; found 298.0228. Melting Point: 220-222 °C.

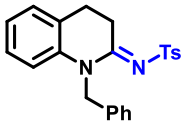
2-benzyl-4-(3-oxobutyl)isoquinolin-2-ium bromide (4n):



The representative general procedure **B** was followed, using 4-(isoquinolin-4-yl)butan-2-one (200 mg, 1.0 mmol) and benzyl bromide (1.2 equiv.) under reflux for 24 h to afford **4n** (315 mg, 85%) as a yellow solid. **^1H NMR (400 MHz, DMSO-d_6):** δ 10.26 (s, 1H), 8.85 (s, 1H), 8.55 (d, *J* = 8.2 Hz, 1H), 8.44 (d, *J* = 8.5 Hz, 1H), 8.29 (t, *J* = 7.5 Hz, 1H), 8.10 – 8.07 (m, 1H), 7.64 – 7.62 (m, 2H), 7.47 – 7.40 (m, 3H), 5.99 (s, 2H), 3.36 (t, *J* = 7.3 Hz, 2H), 3.01 (t, *J* = 7.3 Hz, 2H), 2.14 (s, 3H). **$^{13}C\{^1H\}$ NMR (100 MHz, DMSO-d_6):** δ 206.5, 148.4, 138.1, 137.1, 136.0, 134.4, 133.4, 131.3, 131.0, 129.2, 129.1, 128.8, 127.2, 124.1, 63.1, 41.9, 29.7, 23.2. **HRMS** (ESI) m/z: $[M-Br]^+$ calcd for $C_{20}H_{20}BrNO$ 290.1539; found 290.1549. Melting Point: 179-180 °C.

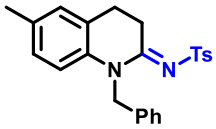
9. Characterization data of isolated products

(E)-N-(1-benzyl-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3a):



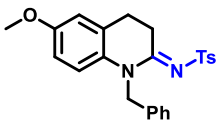
Prepared according to the general procedure **C** from *1-benzylquinolin-1-ium bromide* (**1a**) (90 mg, 0.3 mmol). Flash column chromatography (22-22% EtOAc/Hex) afforded the desired product **3a** as a yellow solid (84 mg, 0.21 mmol, 72% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 140-142 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^1H NMR (400 MHz, $CDCl_3$)**: δ 7.61 (d, *J* = 8.3 Hz, 2H), 7.31 – 7.24 (m, 3H), 7.19 – 7.12 (m, 6H), 7.06 – 7.02 (m, 1H), 6.97 (d, *J* = 8.1 Hz, 1H), 5.25 (s, 2H), 3.45 – 3.41 (m, 2H), 2.95 – 2.91 (m, 2H) 2.36 (s, 3H). **$^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$):** δ 165.8, 142.3, 140.4, 138.8, 136.0, 129.1, 128.8, 127.9, 127.8, 127.3, 127.2 126.3, 124.5, 116.8, 49.6, 28.0, 24.0, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ Calcd for $C_{23}H_{23}N_2O_2S$ 391.1480; found 391.1497. The analytical data of the compound are in accordance with the literature.[6]

(E)-N-(1-benzyl-6-methyl-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3b):



Prepared according to the general procedure **C** from *1-benzyl-6-methylquinolin-1-ium bromide* (**1b**) (94 mg, 0.3 mmol). Flash column chromatography (20-22% EtOAc/Hex) afforded the desired product **3b** as a white solid (92 mg, 0.23 mmol, 76% yield). Reaction time: 18 h. Reaction temperature: 80 °C. Melting point: 128-130 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^1H NMR (400 MHz, CD_3OD + $CDCl_3$)**: δ 7.57 (d, *J* = 7.9 Hz, 2H), 7.29 – 7.21 (m, 5H), 7.13 (d, *J* = 7.2 Hz, 2H), 7.03 (s, 1H), 6.98 – 6.93 (m, 2H), 5.29 (s, 2H), 3.30 – 3.27 (m, 2H), 2.87 – 2.83 (m, 2H), 2.38 (s, 3H), 2.26 (s, 3H). **$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 165.6, 142.3, 140.6, 136.4, 136.2, 134.3, 129.2, 128.8, 128.6, 128.3, 127.3, 127.1, 126.4, 126.3, 116.7, 49.5, 28.2, 24.1, 21.5, 20.7. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{25}N_2O_2S$ 405.1637; found 405.1643.

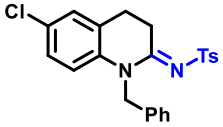
(E)-N-(1-benzyl-6-methoxy-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3c):



Prepared according to the general procedure **C** from *1-benzyl-6-methoxyquinolin-1-ium bromide* (**1c**) (99 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **3c** as a pale yellow solid (78 mg, 0.18 mmol, 62% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 142-143 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^1H NMR (400 MHz, $CDCl_3$):** δ 7.63 (d, *J* = 8.3 Hz, 2H), 7.30 – 7.24 (m, 3H), 7.16 – 7.11 (m, 4H), 6.89 (d, *J* = 8.9 Hz, 1H), 6.72 (d, *J* = 2.8 Hz, 1H), 6.66 – 6.63 (m, 1H), 5.22 (s, 2H), 3.74 (s, 3H), 3.42 –

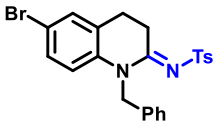
3.38 (m, 2H), 2.90 – 2.86 (m, 2H), 2.36 (s, 3H). **$^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$):** δ 165.2, 156.4, 142.2, 140.6, 136.1, 132.2, 129.2, 128.9, 128.8, 127.3, 126.4, 126.3, 117.9, 113.7, 112.5, 55.6, 49.6, 27.9, 24.4, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{25}N_2O_3S$ 421.1586; found 421.1579.

(E)-N-(1-benzyl-6-chloro-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3d):



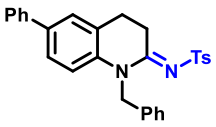
Prepared according to the general procedure **C** from *1-benzyl-6-chloroquinolin-1-ium bromide* (**1d**) (100 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3d** as a yellow solid (87.7 mg, 0.21 mmol, 69% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 135-136 °C. R_f = 0.35 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.62 (d, *J* = 8.2 Hz, 2H), 7.29 – 7.23 (m, 3H), 7.17 – 7.15 (m, 3H), 7.10 – 7.07 (m, 3H), 6.88 (d, *J* = 8.7, 1H), 5.22 (s, 2H), 3.44 – 3.41 (m, 2H), 2.92 – 2.88 (m, 2H), 2.36 (s, 3H). **$^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$):** δ 165.3, 142.5, 140.1, 137.3, 135.5, 129.7, 129.2, 128.9, 127.8, 127.6, 127.4, 126.3, 126.2, 118.0, 49.5, 27.7, 23.9, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_2O_2SCl$ 425.1091; found 425.1082.

(E)-N-(1-benzyl-6-bromo-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3e):



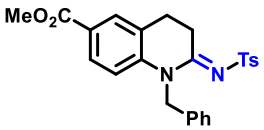
Prepared according to the general procedure **C** from *1-benzyl-6-bromoquinolin-1-ium bromide* (**1e**) (113 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3e** as a white solid (89.9 mg, 0.19 mmol, 64% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 140-141 °C. R_f = 0.35 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.62 (d, *J* = 8.2 Hz, 2H), 7.32 – 7.23 (m, 5H), 7.16 (d, *J* = 8.0 Hz, 2H), 7.09 (d, *J* = 6.7 Hz, 2H), 6.83 (d, *J* = 8.7, 1H), 5.21 (s, 2H), 3.44 – 3.42 (m, 2H), 2.92 – 2.89 (m, 2H), 2.36 (s, 3H). **$^{13}C\{^{1}H\}$ NMR (125 MHz, $CDCl_3$):** δ 165.4, 142.5, 140.2, 137.9, 135.6, 130.8, 130.7, 129.3, 129.2, 128.9, 127.5, 126.4, 126.3, 118.4, 117.4, 49.5, 27.8, 23.9, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_2O_2SBr$ 469.0585; found 469.0582.

(E)-N-(1-benzyl-6-phenyl-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3f):



Prepared according to the general procedure **C** from *1-benzyl-6-phenylquinolin-1-ium bromide* (**1f**) (112 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3f** as a yellow solid (95 mg, 0.203 mmol, 68% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 131-132 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.63 (d, *J* = 8.3 Hz, 2H), 7.52 – 7.49 (m, 2H), 7.43 – 7.39 (m, 3H), 7.37 – 7.27 (m, 5H), 7.17 – 7.14 (m, 4H), 7.04 (d, *J* = 8.5 Hz, 1H), 5.28 (s, 2H), 3.49 – 3.45 (m, 2H), 3.01 – 2.97 (m, 2H), 2.37 (s, 3H). **$^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$):** δ 165.7, 142.4, 140.4, 139.9, 138.1, 137.5, 136.0, 129.2, 129.0, 128.9, 127.6, 127.5, 127.4, 126.9, 126.6, 126.4, 126.4, 117.2, 49.6, 28.1, 24.3, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{29}H_{27}N_2O_2S$ 467.1793; found 467.1792.

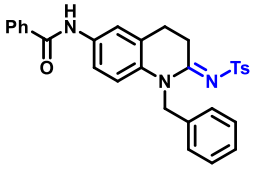
methyl (E)-1-benzyl-2-(tosylimino)-1,2,3,4-tetrahydroquinoline-6-carboxylate (3g):



Prepared according to the general procedure **C** from *1-benzyl-6-(methoxycarbonyl)quinolin-1-ium bromide* (**1g**) (107 mg, 0.3 mmol). Flash column chromatography (25-27% EtOAc/Hex) afforded the desired product **3g** as a white solid (57.5 mg, 0.13 mmol, 43% yield). Reaction time: 18 h. Reaction temperature: 80 °C. Melting point: 216-217 °C. R_f = 0.25 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.86 (d, *J* = 1.8 Hz, 1H), 7.81 (dd, *J* = 8.6, 1.9 Hz, 1H), 7.62 (d, *J* = 8.3 Hz, 2H), 7.31 – 7.25 (m, 3H), 7.17 (d, *J* = 8.0 Hz, 2H), 7.12 – 7.09 (m, 2H), 7.01 (d, *J* = 8.6 Hz, 1H), 5.26 (s, 2H), 3.88 (s, 3H), 3.48 – 3.45 (m, 2H), 3.00 – 2.96 (m, 2H), 2.37 (s, 3H). **$^{13}C\{^{1}H\}$ NMR (100 MHz, $CDCl_3$):** δ 166.3, 165.8, 142.6, 142.5, 140.0, 135.5, 129.6, 129.2, 129.2, 128.9, 127.5, 126.9, 126.4, 126.3, 125.9, 116.6, 52.3, 49.5, 27.8, 23.9, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd

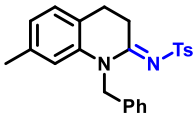
for $C_{25}H_{25}N_2O_4S$ 449.1535; found 449.1534.

(E)-N-(1-benzyl-2-(tosylimino)-1,2,3,4-tetrahydroquinolin-6-yl)benzamide (3h):



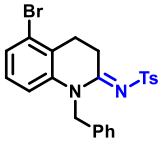
Prepared according to the general procedure **C** from *6-benzamido-1-benzylquinolin-1-ium bromide* (**1h**) (126 mg, 0.3 mmol). Flash column chromatography (0-100% MeOH/DCM) afforded the desired product **3h** as a white solid (50.8 mg, 0.1 mmol, 33% yield). Reaction time: 30 h. Reaction temperature: 80 °C. Melting point:257-258 °C. R_f = 0.3 (EtOAc/Hex 3:2).**^{1}H NMR (400 MHz, DMSO-d_6):** δ 10.00 (s, 1H), 7.67 (d, *J* = 7.2 Hz, 2H), 7.48 (s, 1H), 7.36 – 7.25 (m, 6H), 7.08 – 6.98 (m, 5H), 6.93 (d, *J* = 7.3 Hz, 2H), 6.86 (d, *J* = 8.9 Hz, 1H), 5.06 (s, 2H), 3.08 – 3.04 (m, 2H+DMSO water), 2.64 – 2.61 (m, 2H), 2.10 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d_6):** δ 165.5, 165.4, 142.1, 140.5, 136.0, 135.6, 134.7, 133.5, 131.6, 129.3, 128.6, 128.4, 127.6, 127.5, 127.0, 126.3, 125.7, 119.6, 119.1, 117.2, 47.8, 27.1, 23.3, 20.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{30}H_{28}N_3O_3S$ 510.1851; found 510.1841.

(E)-N-(1-benzyl-7-methyl-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3i):



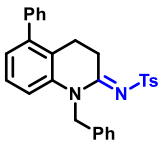
Prepared according to the general procedure **C** from *1-benzyl-7-methylquinolin-1-ium bromide* (**1i**) (94 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3i** as a white solid (79.8 mg, 0.198 mmol, 66% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 130-131 °C. R_f = 0.3 (EtOAc/Hex 1:4).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.58 (d, *J* = 8.3 Hz, 2H), 7.29 – 7.24 (m, 3H), 7.14 – 7.12 (m, 4H), 7.06 (d, *J* = 7.5 Hz, 1H), 6.86 (d, *J* = 7.1 Hz, 1H), 6.79 (s, 1H), 5.22 (s, 2H), 3.41 – 3.37 (m, 2H), 2.89 – 2.85 (m, 2H), 2.36 (s, 3H), 2.22 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 165.7, 142.1, 140.4, 138.7, 137.6, 136.1, 129.0, 128.7, 127.6, 127.2, 126.3, 126.2, 125.1, 124.1, 117.4, 49.5, 28.2, 23.6, 21.5, 21.4. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{25}N_2O_2S$ 405.1637; found 405.1639.

(E)-N-(1-benzyl-5-bromo-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3j):



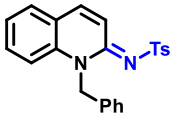
Prepared according to the general procedure **C** from *1-benzyl-5-bromoquinolin-1-ium bromide* (**1j**) (113 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3j** as a white solid (80.7 mg, 0.17 mmol, 57% yield). Reaction time: 21 h. Reaction temperature: 80 °C. Melting point: 207-208 °C. R_f = 0.35 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.62 (d, *J* = 8.3 Hz, 2H), 7.31 – 7.25 (m, 4H), 7.16 (d, *J* = 7.9 Hz, 2H), 7.11 – 7.09 (m, 2H), 7.02 – 6.98 (m, 1H), 6.94 – 6.92 (m, 1H), 5.23 (s, 2H), 3.45 – 3.41 (m, 2H), 3.07 – 3.04 (m, 2H), 2.37 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 165.5, 142.5, 140.3, 140.2, 135.7, 129.3, 128.9, 128.6, 128.5, 127.5, 127.3, 126.4, 126.3, 123.5, 116.2, 49.9, 27.4, 24.0, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_2O_2SBr$ 469.0585; found 469.0582.

(E)-N-(1-benzyl-5-phenyl-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3k):



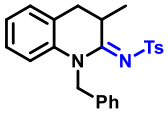
Prepared according to the general procedure **C** from *1-benzyl-5-phenylquinolin-1-ium bromide* (**1k**) (113 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3k** as a yellow solid (86.6 mg, 0.186 mmol, 62% yield). Reaction time: 24 h. Reaction temperature: 80 °C. Melting point: 177-178 °C. R_f = 0.3 (EtOAc/Hex 1:4).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.59 (d, *J* = 8.3 Hz, 2H), 7.46 – 7.36 (m, 3H), 7.33 – 7.27 (m, 5H), 7.21 – 7.13 (m, 5H), 7.08 – 7.06 (m, 1H), 7.01 (d, *J* = 8.1 Hz, 1H), 5.30 (s, 2H), 3.30 – 3.27 (m, 2H), 2.88 – 2.85 (m, 2H), 2.36 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 166.0, 142.3, 141.2, 140.5, 139.8, 139.5, 136.1, 129.2, 129.1, 128.9, 128.5, 127.7, 127.3, 127.3, 126.4, 126.3, 125.3, 116.2, 50.2, 27.9, 21.8, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{29}H_{27}N_2O_2S$ 467.1793; found 467.1781.

(E)-N-(1-benzylquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3a"):



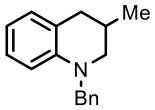
Prepared according to the general procedure **C** from *1-benzyl-3-bromoquinolin-1-ium bromide* (**1l**) (113 mg, 0.3 mmol). Flash column chromatography (30-35% EtOAc/Hex) afforded the desired product **3a"** as a yellow solid (31 mg, 0.08 mmol, 26% yield). Reaction time: 19 h. Reaction temperature: 80 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 8.03 (d, *J* = 9.6 Hz, 1H), 7.86 (d, *J* = 9.6 Hz, 1H), 7.76 (d, *J* = 8.3 Hz, 2H), 7.65 (dd, *J* = 7.8, 1.3 Hz, 1H), 7.55-7.51 (m, 1H), 7.46 (d, *J* = 8.6 Hz, 1H), 7.32 – 7.29 (m, 1H), 7.26 – 7.24 (m, 3H), 7.17 (d, *J* = 8.3 Hz, 2H), 7.12 – 7.11 (m, 2H), 5.76 (s, 2H), 2.36 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 156.2, 142.1, 140.9, 139.8, 138.9, 135.3, 132.2, 129.4, 129.2, 128.9, 127.7, 126.7, 126.5, 124.1, 122.2, 117.4, 116.4, 49.1, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{21}N_2O_2S$ 389.1324; found 389.1324.

(E)-N-(1-benzyl-3-methyl-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3m):



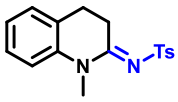
Prepared according to the general procedure **C** from *1-benzyl-3-methylquinolin-1-ium bromide* (**1m**) (94 mg, 0.3 mmol). Flash column chromatography (16-18% EtOAc/Hex) afforded the desired product **3m** as a viscous oil (22 mg, 0.054 mmol, 18% yield). Reaction time: 21 h. Reaction temperature: 80 °C. R_f = 0.3 (EtOAc/Hex 1:4).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.63 (d, *J* = 8.3 Hz, 2H), 7.31 – 7.24 (m, 3H), 7.19 – 7.15 (m, 3H), 7.13 – 7.10 (m, 3H), 7.08 – 7.04 (m, 1H), 6.97 (d, *J* = 8.1 Hz, 1H), 5.58 (d, *J* = 16.2 Hz, 1H), 4.83 (d, *J* = 16.1 Hz, 1H), 4.34 – 4.27 (m, 1H), 3.24 (dd, *J* = 15.8, 4.9 Hz, 1H), 2.64 (dd, *J* = 15.9, 1.9 Hz, 1H), 2.36 (s, 3H), 1.21 (d, *J* = 7.1 Hz, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 168.8, 142.2, 140.7, 138.3, 136.3, 129.2, 129.1, 128.9, 127.8, 127.3, 126.3, 126.2, 125.1, 124.7, 116.5, 49.6, 31.8, 31.3, 21.5, 15.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{25}N_2O_2S$ 405.1637; found 405.1626.

1-benzyl-3-methyl-1,2,3,4-tetrahydroquinoline (3m'):



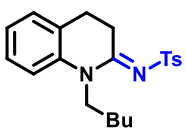
Flash column chromatography (4-5% EtOAc/Hex) afforded the desired product **3m'** as a viscous oil (27 mg, 0.11 mmol, 38% yield). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.31 –7.20 (m, 5H), 6.98 – 6.92 (m, 2H), 6.58 – 6.53 (m, 1H), 6.51 – 6.47 (m, 1H), 4.45 (s, 2H), 3.28 – 3.23 (m, 1H), 3.03 –2.97 (m, 1H), 2.83 –2.76 (m, 1H), 2.52 –2.46 (m, 1H), 2.19 – 2.09 (m, 1H), 1.04 –1.01 (m, 1H).**^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 145.3, 139.1, 129.2, 128.7, 127.3, 126.9, 126.7, 121.9, 116.0, 110.8, 56.9, 55.3, 36.6, 27.4, 19.2.**HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{20}N$ 238.1596; found 238.1594.

(E)-4-methyl-N-(1-methyl-3,4-dihydroquinolin-2(1H)-ylidene)benzenesulfonamide (3p):



Prepared according to the general procedure **C** from *1-methylquinolin-1-ium iodide* (**1p**) (81 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3p** as a yellow solid (34 mg, 0.108 mmol, 36% yield). Reaction time: 15 h. Melting point: 168-170 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.87 (d, *J* = 8.3 Hz, 2H), 7.29 – 7.25 (m, 3H), 7.17 (d, *J* = 6.4 Hz, 1H), 7.10 – 7.08 (m, 1H), 7.05 (d, *J* = 8.5 Hz, 1H), 3.44 (s, 3H), 3.33 – 3.30 (m, 2H), 2.86 – 2.82 (m, 2H), 2.41 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 166.1, 142.5, 140.7, 139.4, 129.4, 127.8, 127.8, 127.2, 126.5, 124.5, 116.2, 33.4, 28.1, 23.9, 21.6. **HRMS** (ESI) m/z: [M+H]+ calcd for $C_{17}H_{19}N_2O_2S$ 315.1167; found 315.1158.

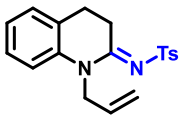
(E)-4-methyl-N-(1-pentyl-3,4-dihydroquinolin-2(1H)-ylidene)benzenesulfonamide (3q):



Prepared according to the general procedure **C** from *1-pentylquinolin-1-ium bromide* (**1q**) (84 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3q** as a white solid (72 mg, 0.194 mmol, 65% yield). Reaction time: 15 h. Melting point: 137-138 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.85 (d, *J* = 8.3 Hz, 2H), 7.28 – 7.24 (m, 3H), 7.16 (d, *J* = 6.3 Hz, 1H), 7.08 – 7.05 (m, 2H), 3.97 – 3.94 (m, 2H), 3.32 – 3.29 (m, 2H), 2.84 – 2.81 (m, 2H), 2.41 (s, 3H), 1.69 – 1.64 (m, 2H), 1.28 – 1.25 (m, 4H), 0.83 (t, *J* = 6.9 Hz,

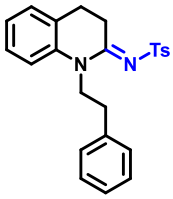
3H). **$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 165.0, 142.3, 140.9, 138.5, 129.3, 128.1, 127.8, 127.4, 126.4, 124.3, 116.2, 45.9, 29.1, 28.1, 26.4, 24.1, 22.3, 21.6, 14.0. **HRMS** (ESI) m/z: [M+H]+ calcd for $C_{21}H_{27}N_2O_2S$ (ESI^+, $[M+H]^+$): 371.1793; found 371.1798.

(E)-N-(1-allyl-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3r):



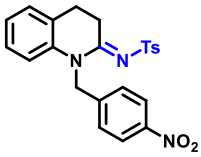
Prepared according to the general procedure **C** from *1-allylquinolin-1-ium bromide* (**1r**) (75 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3r** as a white solid (59.4 mg, 0.178 mmol, 59% yield). Reaction time: 15 h. Melting point: 92-94 °C. R_f = 0.3 (EtOAc/Hex 1:4). **^1H NMR (500 MHz, $CDCl_3$):** δ 7.83 (d, *J* = 8.2 Hz, 2H), 7.26 (d, *J* = 8.2 Hz, 2H), 7.22 (t, *J* = 7.8 Hz, 1H), 7.16 (d, *J* = 7.3 Hz, 1H), 7.09 – 7.05 (m, 2H), 5.91 – 5.83 (m, 1H), 5.20 (d, *J* = 10.4 Hz, 1H), 5.11 (d, *J* = 17.3 Hz, 1H), 4.62 (d, *J* = 4.9 Hz, 2H), 3.35 – 3.32 (m, 2H), 2.87 – 2.84 (m, 2H), 2.40 (s, 3H). **$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 165.3, 142.4, 140.7, 138.8, 131.6, 129.3, 127.9, 127.8, 127.2, 126.5, 124.4, 117.4, 116.6, 48.7, 28.0, 24.1, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{21}N_2O_2S$ 341.1324; found 341.1319.

(E)-4-methyl-N-(1-phenethyl-3,4-dihydroquinolin-2(1H)-ylidene)benzenesulfonamide (3s):



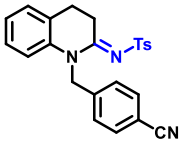
Prepared according to the general procedure **C** from *1-phenethylquinolin-1-ium bromide* (**1s**) (95 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3s** as a yellow solid (89.6 mg, 0.22 mmol, 74% yield). Reaction time: 28 h. Reaction temperature: 95 °C. Melting point: 170-171 °C. R_f = 0.4 (EtOAc/Hex 3:7).**^1H NMR (400 MHz, $CDCl_3$):** δ 7.89 (d, *J* = 8.3 Hz, 2H), 7.32 –7.26 (m, 3H), 7.22 – 7.17 (m, 4H), 7.14 – 7.07 (m, 2H), 7.03 – 7.01 (m, 2H), 4.18 – 4.14 (m, 2H), 3.35 – 3.32 (m, 2H), 2.97 – 2.93 (m, 2H), 2.83 – 2.79 (m, 2H), 2.44 (s, 3H). **$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 164.9, 142.5, 140.8, 138.4, 138.1, 129.3, 128.8, 128.6, 128.1, 127.9, 127.4, 126.7, 126.5, 124.4, 116.0, 47.5, 33.0, 28.2, 24.0, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{25}N_2O_2S$ 405.1637; found 405.1638.

(E)-4-methyl-N-(1-(4-nitrobenzyl)-3,4-dihydroquinolin-2(1H)-ylidene)benzenesulfonamide (3t):



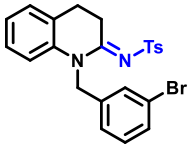
Prepared according to the general procedure **C** from *1-(4-nitrobenzyl)quinolin-1-ium bromide* (**1t**) (103 mg, 0.3 mmol). Flash column chromatography (40-45% EtOAc/Hex) afforded the desired product **3t** as a yellow solid (60 mg, 0.137 mmol, 46% yield). Reaction time: 15 h. Melting point: 225-226 °C. R_f = 0.3 (EtOAc/Hex 2:3). **^1H NMR (500 MHz, $CDCl_3$):** δ 8.09 (d, *J* = 8.8 Hz, 2H), 7.58 (d, *J* = 8.3 Hz, 2H), 7.25 – 7.22 (m, 3H), 7.18 – 7.14 (m, 3H), 7.10 – 7.07 (m, 1H), 6.85 (d, *J* = 8.1 Hz, 1H), 5.29 (s, 2H), 3.46 – 3.43 (m, 2H), 2.96 – 2.93 (m, 2H), 2.37 (s, 3H). **$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 165.7, 147.3, 143.9, 142.8, 140.1, 138.5, 129.3, 128.3, 128.1, 127.2, 127.2, 126.3, 124.9, 124.1, 116.2, 49.3, 27.9, 24.0, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_3O_4S$ (ESI^+, $[M+H]^+$): 436.1331; found 436.1320.

(E)-N-(1-(4-cyanobenzyl)-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3u):



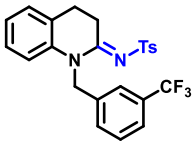
Prepared according to the general procedure **C** from *1-(4-cyanobenzyl)quinolin-1-ium bromide* (**1u**) (97 mg, 0.3 mmol). Flash column chromatography (35-40% EtOAc/Hex) afforded the desired product **3u** as a yellow solid (91 mg, 0.21 mmol, 73% yield). Reaction time: 28 h. Reaction temperature: 95 °C. Melting point: 210-212 °C. R_f = 0.3 (EtOAc/Hex 2:3).**^1H NMR (500 MHz, $CDCl_3$):** δ 7.57 (d, *J* = 8.3 Hz, 2H), 7.54 (d, *J* = 8.4 Hz, 2H), 7.22 – 7.15 (m, 6H), 7.09 – 7.06 (m, 1H), 6.84 (d, *J* = 8.1 Hz, 1H), 5.25 (s, 2H), 3.45 – 3.42 (m, 2H), 2.95 – 2.92 (m, 2H), 2.39 (s, 3H). **$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 165.7, 142.7, 141.8, 140.1, 138.5, 132.6, 129.2, 128.2, 128.1, 127.2, 127.1, 126.3, 124.9, 118.6, 116.3, 111.3, 49.5, 27.9, 24.0, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{22}N_3O_2S$ 416.1433; found 416.1423.

(E)-N-(1-(3-bromobenzyl)-3,4-dihydroquinolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3v):



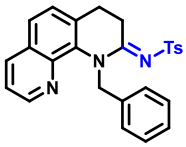
Prepared according to the general procedure **C** from *1-(3-bromobenzyl)quinolin-1-ium bromide* (**1v**) (113 mg, 0.3 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3v** as a white solid (96.5 mg, 0.205 mmol, 68% yield). Reaction time: 15 h. Melting point: 177-178 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.62 (d, *J* = 8.3 Hz, 2H), 7.38 (dd, *J* = 7.9, 0.7 Hz, 1H), 7.24 (s, 1H), 7.19 (d, *J* = 7.8 Hz 3H), 7.17 – 7.12 (m, 2H), 7.08 – 7.03 (m, 2H), 6.92 (d, *J* = 8.0 Hz, 1H), 5.19 (s, 2H), 3.43 – 3.39 (m, 2H), 2.94 – 2.91 (m, 2H), 2.38 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 165.8, 142.5, 140.2, 138.8, 138.6, 130.6, 130.5, 129.5, 129.3, 128.1, 128.0, 127.2, 126.4, 124.9, 124.7, 122.9, 116.6, 49.2, 27.9, 24.0, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_2O_2S^{79}Br$ 469.0585; found 469.0598.

(E)-4-methyl-N-(1-(3-(trifluoromethyl)benzyl)-3,4-dihydroquinolin-2(1H)-ylidene)benzenesulfonamide (3w):



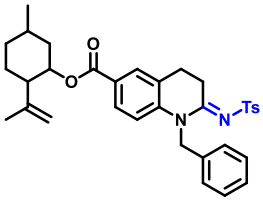
Prepared according to the general procedure **C** from *1-(3-(trifluoromethyl)benzyl)quinolin-1-ium bromide* (**1w**) (110 mg, 0.3 mmol). Flash column chromatography (22-25% EtOAc/Hex) afforded the desired product **3w** as a white solid (116.3 mg, 0.255 mmol, 84% yield). Reaction time: 30 h. Melting point: 144-146 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.59 (d, *J* = 8.3 Hz, 2H), 7.51 (d, *J* = 7.8 Hz, 1H), 7.42 – 7.38 (m, 2H), 7.28 (d, *J* = 7.9 Hz, 1H), 7.21 (d, *J* = 7.5 Hz, 1H), 7.16 – 7.14 (m, 3H), 7.09 – 7.05 (m, 1H), 6.91 (d, *J* = 8.1 Hz, 1H), 5.27 (s, 2H), 3.45 – 3.41 (m, 2H), 2.96 – 2.92 (m, 2H), 2.36 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 165.8, 142.6, 140.1, 138.7, 137.4, 131.2 (q, *J* = 32.3 Hz), 129.6, 129.4, 129.2, 128.1, 128.0, 127.2, 126.2, 124.0 (q, *J* = 272.5 Hz), 124.7, 124.2 (q, *J* = 3.7 Hz), 123.2 (q, *J* = 3.7 Hz), 116.4, 49.4, 27.9, 23.9, 21.5. **^{19}F NMR (376 MHz, $CDCl_3$):** δ -62.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{22}F_3N_2O_2S$ 459.1354; found 459.1351.

(E)-N-(1-benzyl-3,4-dihydro-1,10-phenanthrolin-2(1H)-ylidene)-4-methylbenzenesulfonamide (3x):



Prepared according to the general procedure **C** from *1-benzyl-1,10-phenanthrolin-1-ium bromide* (**1x**) (105 mg, 0.3 mmol). Flash column chromatography (40% EtOAc/Hex) afforded the desired product **3x** as a colorless oil (80.5 mg, 0.182 mmol, 61% yield). Reaction time: 16 h. Reaction temperature: 80 °C. R_f = 0.25 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 8.88 (dd, *J* = 4.1, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.73 (d, *J* = 8.2 Hz, 2H), 7.59 (d, *J* = 8.2 Hz, 1H), 7.40 (dd, *J* = 8.3, 4.1 Hz, 1H), 7.37 (d, *J* = 8.2 Hz, 1H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.08 – 7.05 (m, 3H), 6.97 – 6.95 (m, 2H), 6.11 (s, 2H), 3.36 (brs, 2H), 2.93 – 2.90 (m, 2H), 2.42 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 167.8, 148.8, 142.2, 140.5, 138.3, 136.8, 134.9, 132.6, 129.7, 129.2, 128.7, 128.1, 127.6, 126.9, 126.5, 126.1, 125.5, 120.9, 52.2, 28.8, 25.4, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{26}H_{24}N_3O_2S$ 442.1589; found 442.1585.

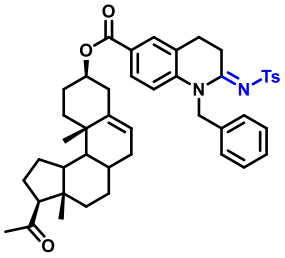
5-methyl-2-(prop-1-en-2-yl)cyclohexyl (E)-1-benzyl-2-(tosylimino)-1,2,3,4-tetrahydroquinoline-6-carboxylate (3y):



Prepared according to the general procedure **C** from *1-benzyl-6-(((5-methyl-2-(prop-1-en-2-yl)cyclohexyl)oxy)carbonyl)quinolin-1-ium bromide* (**1y**) (96 mg, 0.2 mmol). Flash column chromatography (18-20% EtOAc/Hex) afforded the desired product **3y** as a sticky solid (46.7mg, 0.08 mmol, 41% yield). Reaction time: 66 h. Reaction temperature: 95 °C. R_f = 0.3 (EtOAc/Hex 1:4).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.81 (d, *J* = 1.7 Hz, 1H), 7.77 (dd, *J* = 8.5, 1.9 Hz, 1H), 7.62 (d, *J* = 8.3 Hz, 2H), 7.30 – 7.25 (m, 3H), 7.16 (d, *J* = 8.0 Hz, 2H), 7.11 – 7.09 (m, 2H), 6.99 (d, *J* = 8.6 Hz, 1H), 5.30-5.20 (m, 2H), 4.99 (td, *J* = 10.8, 4.4 Hz, 1H), 4.75 (s, 1H), 4.69 – 4.68 (m, 1H), 3.50 – 3.41 (m, 2H), 2.97 (t, *J* = 7.3 Hz, 2H), 2.37 (s, 3H), 2.29 – 2.22 (m, 1H), 2.12 – 2.09 (m, 1H),

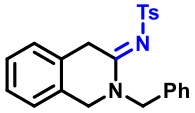
1.78 – 1.70 (m, 2H), 1.66 (s, 3H+1H (water)), 1.63 – 1.59 (m, 1H), 1.49 – 1.37 (m, 1H), 1.15 – 1.06 (m, 1H), 1.05 – 0.97 (m, 1H), 0.94 (d, *J* = 6.5 Hz, 3H), 0.89 – 0.86 (m, 1H). **$^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$):** δ 165.9, 165.2, 146.2, 142.6, 142.4, 140.1, 135.6, 129.6, 129.3, 129.2, 128.9, 127.5, 126.9, 126.7, 126.4, 126.3, 116.5, 112.1, 74.5, 51.0, 49.5, 40.6, 34.3, 31.5, 30.6, 27.9, 23.9, 22.1, 21.6, 19.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{34}H_{39}N_2O_4S$ 571.2631; found 571.2627.

(3R,9S,13S,17S)-17-acetyl-9,13-dimethyl-2,3,4,8,9,9,10,11,12,13,14,15,16,17-tetradecahydro-1H-cyclopenta[c]phenanthren-3-yl (E)-1-benzyl-2-(tosylimino)-1,2,3,4-tetrahydroquinoline-6-carboxylate (3z):



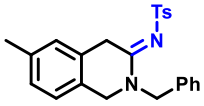
Prepared according to the general procedure **C** from *6-((((3R,3aS,9R,11aS)-3-acetyl-3a,11a-dimethyl-2,3,3a,4,5,5a,6,8,9,10,11,11a,11b,11c-tetradecahydro-1H-cyclopenta[c]phenanthren-9-yl)oxy)carbonyl)-1-benzylquinolin-1-ium bromide* (**1z**) (96 mg, 0.15 mmol). Flash column chromatography (22-25% EtOAc/Hex) afforded the desired product **3z** as a white solid (73.5 mg, 0.10 mmol, 67% yield). Reaction time: 30 h. Reaction temperature: 95 °C. Melting point: 210-212 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^1H NMR (400 MHz, $CDCl_3$):** δ 7.86 – 7.81 (m, 2H), 7.63 (d, *J* = 8.3 Hz, 2H), 7.28 – 7.25 (m, 3H), 7.17 (d, *J* = 8.0 Hz, 2H), 7.11 – 7.09 (m, 2H), 7.01 (d, *J* = 8.6 Hz, 1H), 5.41 (d, *J* = 3.8 Hz, 1H), 5.26 (s, 2H), 4.86 – 4.78 (m, 1H), 3.49 – 3.45 (m, 2H), 3.01 – 2.98 (m, 2H), 2.54 (t, *J* = 8.9 Hz, 1H), 2.43 (d, *J* = 7.7 Hz, 2H), 2.37 (s, 3H), 2.22 – 2.17 (m, 1H), 2.13 (s, 3H), 2.07 – 1.89 (m, 4H), 1.75 – 1.65 (m, 3H), 1.56 – 1.42 (m, 4H), 1.28 – 1.16 (m, 4H), 1.05 (s, 4H), 0.64 (s, 3H). **$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 209.6, 165.8, 165.2, 142.6, 142.4, 140.1, 139.7, 135.6, 129.6, 129.3, 129.2, 128.9, 127.5, 126.9, 126.6, 126.4, 126.3, 122.7, 116.6, 74.7, 63.8, 56.9, 50.0, 49.5, 44.1, 38.9, 38.3, 37.1, 36.8, 31.9, 31.9, 31.6, 27.9, 27.9, 24.6, 23.9, 22.9, 21.6, 21.2, 19.5, 13.3. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{45}H_{53}N_2O_5S$ 733.3675; found 733.3678.

(E)-N-(2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5a):



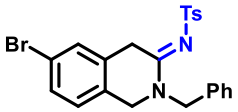
Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* (**4a**) (90 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5a** as a yellow solid (110 mg, 0.28 mmol, 94% yield). Reaction time: 16 h. Reaction temperature: 80 °C. Melting point: 164-165 °C. R_f = 0.2 (EtOAc/Hex 1:4).**^1H NMR (400 MHz, $CDCl_3$):** δ 7.82 (d, *J* = 8.3 Hz, 2H), 7.29 – 7.27 (m, 3H), 7.26 – 7.24 (m, 3H), 7.23 – 7.19 (m, 4H), 7.04 (d, *J* = 7.5 Hz, 1H), 4.85 (s, 2H), 4.41 (s, 4H), 2.38 (s, 3H). **$^{13}C\{^1H\}$ NMR (100 MHz, $CDCl_3$):** δ 164.7, 142.1, 141.1, 135.3, 130.2, 129.9, 129.3, 128.9, 128.3, 128.2, 128.1, 127.6, 127.2, 126.4, 125.0, 53.1, 50.9, 33.8, 21.5. **HRMS** (ESI) m/z: [M+H]+ calcd for $C_{23}H_{23}N_2O_2S$ 391.1480; found 391.1474. The analytical data of the compound was in complete agreement with the literature.[7]

(E)-N-(2-benzyl-6-methyl-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5b):



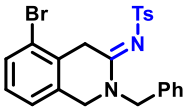
Prepared according to the general procedure **C** from *2-benzyl-6-methylisoquinolin-2-ium bromide* (**4b**) (94 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5b** as a white solid (90.4 mg, 0.22 mmol, 74% yield). Reaction time: 16 h. Reaction temperature: 80 °C. Melting point: 167 °C. R_f = 0.2 (EtOAc/Hex 1:4).**^1H NMR (500 MHz, $CDCl_3$):** δ 7.83 (d, *J* = 8.2 Hz, 2H), 7.29 – 7.23 (m, 5H), 7.20 – 7.19 (m, 2H), 7.06 (s, 1H), 7.02 (d, *J* = 7.7 Hz, 1H), 6.92 (d, *J* = 7.7 Hz, 1H), 4.86 (s, 2H), 4.38 (s, 2H), 2.39 (s, 3H), 2.32 (s, 3H).**$^{13}C\{^1H\}$ NMR (125 MHz, $CDCl_3$):** δ 164.9, 142.3, 140.9, 138.2, 135.1, 129.7, 129.3, 128.9, 128.2, 128.1, 128.1, 128.0, 127.1, 126.5, 124.9, 53.3, 50.8, 33.8, 21.6, 21.2. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{25}N_2O_2S$ 405.1637; found 405.1632.

(E)-N-(2-benzyl-6-bromo-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5c):



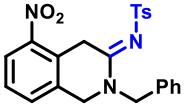
Prepared according to the general procedure **C** from *2-benzyl-6-bromoisoquinolin-2-ium bromide* **(4c)** (113 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5c** as a pale yellow solid (85.6 mg, 0.18 mmol, 61% yield). Reaction time: 15 h. Reaction temperature: 80 °C. Melting point: 183-184 °C. R_f = 0.3 (EtOAc/Hex 2:3).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.81 (d, *J* = 8.3 Hz, 2H), 7.38 (d, *J* = 1.5 Hz, 1H), 7.34 – 7.31 (m, 1H), 7.29 – 7.26 (m, 3H), 7.24 (d, *J* = 7.9 Hz, 2H), 7.19 – 7.17 (m, 2H), 6.91 (d, *J* = 8.1 Hz, 1H), 4.83 (s, 2H), 4.38 (s, 2H), 4.35 (s, 2H), 2.39 (s, 3H).**^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 163.9, 142.3, 140.9, 135.0, 132.2, 130.5, 130.4, 129.3, 129.2, 128.9, 128.2, 126.7, 126.4, 122.0, 53.1, 50.3, 33.4, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_2O_2SBr$ 469.0585; found 469.0582.

(E)-N-(2-benzyl-5-bromo-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5d):



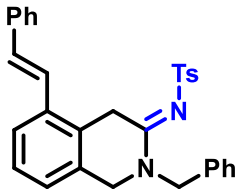
Prepared according to the general procedure **C** from *2-benzyl-5-bromoisoquinolin-2-ium bromide* **(4d)** (113 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5d** as a pale yellow solid (95.6 mg, 0.203 mmol, 68% yield). Reaction time: 17 h. Reaction temperature: 80 °C. Melting point: 163-165 °C. R_f = 0.35 (EtOAc/Hex 2:3).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.85 (d, *J* = 8.3 Hz, 2H), 7.46 (d, *J* = 7.6 Hz, 1H), 7.29 – 7.26 (m, 3H), 7.26 – 7.22 (m, 4H), 7.05 (t, *J* = 7.8 Hz, 1H), 6.97 (d, *J* = 7.5 Hz, 1H), 4.88 (s, 2H), 4.43 (s, 2H), 4.39 (s, 2H), 2.38 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 163.7, 142.3, 140.7, 135.0, 131.9, 131.8, 129.5, 129.3, 128.9, 128.5, 128.3, 128.1, 126.6, 124.2, 123.3, 52.9, 50.6, 33.7, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_2O_2S^{81}Br$ 471.0565; found 471.0565.

(E)-N-(2-benzyl-5-nitro-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5e):



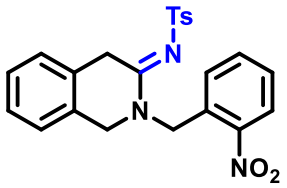
Prepared according to the general procedure **C** from *2-benzyl-5-bromoisoquinolin-2-ium bromide* **(4e)** (103 mg, 0.3 mmol). Flash column chromatography (50-52% EtOAc/Hex) afforded the desired product **5e** as a yellow solid (101.5 mg, 0.233 mmol, 78% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 192 °C. R_f = 0.3 (EtOAc/Hex 1:1).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.98 (d, *J* = 8.1 Hz, 1H), 7.88 (d, *J* = 8.0 Hz, 2H), 7.42 – 7.39 (m, 1H), 7.34 – 7.32 (m, 4H), 7.29 – 7.26 (m, 4H), 4.94 (s, 2H), 4.71 (s, 2H), 4.50 (s, 2H), 2.41 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 162.8, 147.8, 142.5, 140.4, 134.8, 132.9, 130.3, 129.4, 129.1, 128.4, 128.0, 126.9, 125.5, 124.7, 53.0, 49.9, 30.2, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_3O_4S$ 436.1331; found 436.1328.

N-((E)-2-benzyl-5-((E)-styryl)-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5f):



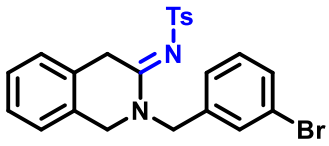
Prepared according to the general procedure **C** from *(E)-2-benzyl-5-styrylisoquinolin-2-ium bromide* **(4f)** (120 mg, 0.3 mmol). Flash column chromatography (1-99% acetone/DCM) afforded the desired product **5f** as a white solid (109.3 mg, 0.222 mmol, 74% yield). Reaction time: 19 h. Reaction temperature: 80 °C. Melting point: 148-150 °C. R_f = 0.25 (EtOAc/Hex 2:3).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.84 (d, *J* = 8.2 Hz, 1H), 7.60 (d, *J* = 7.4 Hz, 2H), 7.57 (d, *J* = 7.8 Hz, 2H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.36 – 7.31 (m, 4H), 7.29 – 7.23 (m, 4H), 7.14 (d, *J* = 8.1 Hz, 2H), 7.03 – 6.96 (m, 2H), 4.94 (s, 2H), 4.47 (s, 2H), 4.45 (s, 2H), 2.33 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.7, 142.2, 140.9, 137.1, 136.0, 135.2, 132.7, 130.7, 129.3, 128.9, 128.9, 128.3, 128.2, 128.1, 127.5, 127.4, 126.9, 126.5, 125.5, 124.2, 124.1, 53.0, 50.9, 30.9, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{31}H_{29}N_2O_2S$ 493.1950; found 493.1946.

(E)-4-methyl-N-(2-(2-nitrobenzyl)-1,4-dihydroisoquinolin-3(2H)-ylidene)benzenesulfonamide (5g):



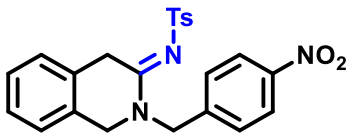
Prepared according to the general procedure **C** from *2-(2-nitrobenzyl)isoquinolin-2-ium bromide* **(4g)** (103 mg, 0.3 mmol). Flash column chromatography (80-20% DCM/Hex) afforded the desired product **5g** as a yellow solid (110.7 mg, 0.254 mmol, 85% yield). Reaction time: 30 h. Melting point: 217-218 °C. R_f = 0.25 (EtOAc/Hex 2:3). **^{1}H NMR (500 MHz, $CDCl_3$):** δ 8.04 (d, *J* = 7.5 Hz, 1H), 7.67 (d, *J* = 8.0 Hz, 2H), 7.49 – 7.46 (m, 1H), 7.43 – 7.40 (m, 1H), 7.35 – 7.29 (m, 2H), 7.28 – 7.26 (m, 1H), 7.19 (d, *J* = 7.9 Hz, 2H), 7.14 (d, *J* = 7.6 Hz, 1H), 7.09 (d, *J* = 7.4 Hz, 1H), 5.20 (s, 2H), 4.52 (s, 2H), 4.47 (s, 2H), 2.37 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 165.4, 148.5, 142.3, 140.6, 134.0, 131.0, 130.1, 129.9, 129.3, 128.6, 128.5, 127.8, 127.5, 126.3, 125.4, 125.1, 52.1, 50.8, 33.9, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_3O_4S$ 436.1331; found 436.1330.

(E)-N-(2-(3-bromobenzyl)-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5h):



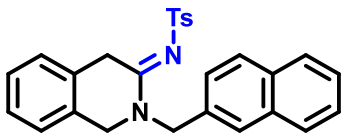
Prepared according to the general procedure **C** from *2-(3-bromobenzyl)isoquinolin-2-ium bromide* **(4h)** (113 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5h** as a white solid (135.1 mg, 0.287 mmol, 96% yield). Reaction time: 30 h. Melting point: 153 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.81 (d, *J* = 8.3 Hz, 2H), 7.41 – 7.38 (m, 1H), 7.36 – 7.35 (m, 1H), 7.30 – 7.20 (m, 5H), 7.15 – 7.12 (m, 2H), 7.07 (d, *J* = 7.4 Hz, 1H), 4.79 (s, 2H), 4.43 (s, 2H), 4.40 (s, 2H), 2.39 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 164.8, 142.3, 140.9, 137.7, 131.3, 131.2, 130.5, 129.9, 129.8, 129.4, 128.4, 127.7, 127.3, 126.7, 126.4,125.0, 122.9, 52.7, 51.2, 33.7, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_2O_2S^{79}Br$ 469.0585; found 469.0587.

(E)-4-methyl-N-(2-(4-nitrobenzyl)-1,4-dihydroisoquinolin-3(2H)-ylidene)benzenesulfonamide (5i):



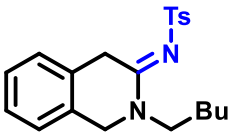
Prepared according to the general procedure **C** from *2-(4-nitrobenzyl)isoquinolin-2-ium bromide* **(4i)** (103 mg, 0.3 mmol). Flash column chromatography (2-98% acetone/DCM) afforded the desired product **5i** as a yellow solid (104 mg, 0.239 mmol, 79% yield). Reaction time: 30 h. Melting point: 210-212 °C. R_f = 0.2 (EtOAc/Hex 3:2).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.09 (d, *J* = 8.7 Hz, 2H), 7.74 (d, *J* = 8.3 Hz, 2H), 7.33 – 7.29 (m, 3H), 7.28 – 7.25 (m, 2H), 7.22 (d, *J* = 7.9 Hz, 2H), 7.08 (d, *J* = 7.3 Hz, 1H), 4.91 (s, 2H), 4.49 (s, 2H), 4.44 (s, 2H), 2.39 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.9, 147.6, 142.9, 142.5, 140.7, 129.9, 129.8, 129.3, 128.6, 128.5, 127.7, 127.4, 126.3, 125.0, 124.0, 52.8, 51.7, 33.7, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{22}N_3O_4S$ 436.1331; found 436.1322.

(E)-4-methyl-N-(2-(naphthalen-2-ylmethyl)-1,4-dihydroisoquinolin-3(2H)-ylidene)benzenesulfonamide



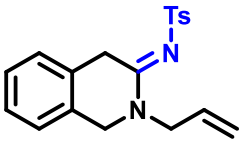
(5j): Prepared according to the general procedure **C** from *2-(naphthalen-1-ylmethyl)isoquinolin-2-ium bromide* **(4j)** (105 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5j** as a yellow solid (129.5 mg, 0.29 mmol, 98% yield). Reaction time: 30 h. Melting point: 167-168 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.84 (d, *J* = 8.1 Hz, 2H), 7.81 – 7.79 (m, 1H), 7.75 (d, *J* = 8.4 Hz, 1H), 7.72 – 7.70 (m, 1H), 7.62 (d, 1H), 7.48 – 7.45 (m, 2H), 7.33 – 7.31 (m, 1H), 7.28– 7.24 (m, 2H), 7.21 – 7.17 (m, 3H), 7.01 (d, *J* = 7.5 Hz, 1H), 5.00 (s, 2H), 4.45 (s, 2H), 4.44 (s, 2H), 2.37 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.8, 142.1, 141.1, 133.3, 133.1, 132.8, 130.2, 130.0, 129.3, 128.9, 128.3, 127.9, 127.8, 127.6, 127.3, 127.2, 126.5, 126.4, 126.3, 125.8, 125.0, 53.3, 50.9, 33.9, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{27}H_{25}N_2O_2S$ 441.1637; found 441.1639.

(E)-4-methyl-N-(2-pentyl-1,4-dihydroisoquinolin-3(2H)-ylidene)benzenesulfonamide (5k):



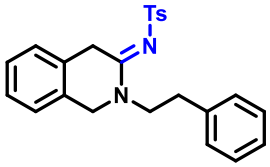
Prepared according to the general procedure **C** from *2-pentylisoquinolin-2-ium bromide* **(4k)** (84 mg, 0.3 mmol). Flash column chromatography (22-25% EtOAc/Hex) afforded the desired product **5k** as a yellow solid (85.4 mg, 0.23 mmol, 77% yield). Reaction time: 15 h. Reaction temperature: 80 °C. Melting point: 148-150 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.84 (d, *J* = 8.2 Hz, 2H), 7.30 – 7.22 (m, 5H), 7.15 (d, *J* = 6.7 Hz, 1H), 4.47 (s, 2H), 4.32 (s, 2H), 3.62 – 3.58 (m, 2H) 2.39 (s, 3H), 1.64 – 1.57 (m, 2H), 1.31 – 1.21 (m, 4H), 0.84 (t, *J* = 6.9 Hz, 3H).**^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 164.1, 141.9, 141.4, 130.5, 130.3, 129.2, 128.3, 127.6, 127.2, 126.3, 124.9, 51.6, 50.5, 33.8, 29.0, 26.3, 22.4, 21.5, 13.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{21}H_{27}N_2O_2S$ 371.1793; found 371.1796.

(E)-N-(2-allyl-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5l):



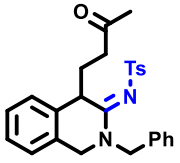
Prepared according to the general procedure **C** from *2-allylisoquinolin-2-ium bromide* **(4l)** (75 mg, 0.3 mmol). Flash column chromatography (25-27% EtOAc/Hex) afforded the desired product **5l** as a yellow solid (98 mg, 0.287 mmol, 96% yield). Reaction time: 15 h. Melting point: 130-132 °C. R_f = 0.3 (EtOAc/Hex 3:7). **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.84 (d, *J* = 8.2 Hz, 2H), 7.29 – 7.22 (m, 5H), 7.13 (d, *J* = 7.1 Hz, 1H), 5.81 – 5.73 (m, 1H), 5.23 – 5.20 (m, 1H), 5.19 – 5.15 (m, 1H), 4.44 (s, 2H), 4.35 (s, 2H), 4.25 (d, *J* = 6.0 Hz, 2H), 2.39 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.4, 142.1, 141.2, 130.9, 130.3, 130.1, 129.3, 128.3, 127.6, 127.2, 126.4, 125.0, 119.1, 52.4, 50.7, 33.8, 21.5. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{21}N_2O_2S$ 341.1324; found 341.1322.

(E)-4-methyl-N-(2-phenethyl-1,4-dihydroisoquinolin-3(2H)-ylidene)benzenesulfonamide (5m):



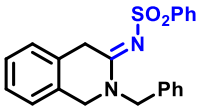
Prepared according to the general procedure **C** from *2-phenethylisoquinolin-2-ium bromide* **(4m)** (94 mg, 0.3 mmol). Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5m** as a yellow solid (106.4 mg, 0.263 mmol, 88% yield). Reaction time: 30 h. Melting point: 144-145 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.88 (d, *J* = 8.1 Hz, 2H), 7.28 – 7.25 (m, 3H), 7.23 – 7.18 (m, 5H), 7.05 – 7.03 (m, 2H), 6.97 (d, *J* = 7.4 Hz, 1H), 4.33 (s, 2H), 4.26 (s, 2H), 3.79 (t, *J* = 7.3 Hz, 2H), 2.90 (t, *J* = 7.3 Hz, 2H), 2.41 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.1, 142.1, 141.4, 138.4, 130.5, 130.2, 129.3, 128.9, 128.8, 128.2, 127.6, 127.1, 126.7, 126.4, 125.0, 52.8, 52.7, 33.9, 33.0, 21.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{25}N_2O_2S$ 405.1637; found 405.1635.

(E)-N-(2-benzyl-4-(3-oxobutyl)-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-methylbenzenesulfonamide (5n):



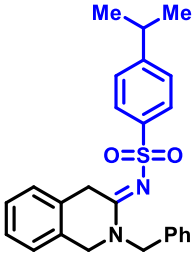
Prepared according to the general procedure **C** from *2-benzyl-4-(3-oxobutyl)isoquinolin-2-ium bromide* (**4n**) (111 mg, 0.3 mmol). Flash column chromatography (5-95% Acetone/DCM) afforded the desired product **5n** as a sticky pale yellow solid (116 mg, 0.25 mmol, 84% yield). Reaction time: 19 h. R_f = 0.3 (acetone/DCM 1:19). **^{1}H NMR (400 MHz, $CDCl_3$)**: δ 7.77 (d, *J* = 8.2 Hz, 2H), 7.28 – 7.25 (m, 4H), 7.24 – 7.18 (m, 4H), 7.15 – 7.13 (m, 2H), 7.06 (d, *J* = 7.3, Hz, 1H), 4.93 (dd, *J* = 10.1, 4.9 Hz, 1H), 4.80 (s, 2H), 4.68 (d, *J* = 16.2 Hz, 1H), 4.24 (d, *J* = 16.2 Hz, 1H), 2.78 – 2.70 (m, 1H), 2.48 – 2.39 (m, 1H), 2.36 (s, 3H), 2.34 – 2.28 (m, 1H), 2.08 (s, 3H), 1.92 – 1.82 (m, 1H).**^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 207.6, 167.4, 142.0, 141.3, 135.3, 134.3, 131.1, 129.2, 128.9, 128.1, 128.0, 128.0, 127.9, 127.4, 126.2, 125.6, 53.3, 50.5, 43.8, 40.9, 30.0, 26.6, 21.5.HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{27}H_{29}N_2O_3S$ 461.1899; found 461.1900.

(E)-N-(2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)benzenesulfonamide (5o):



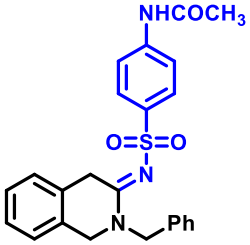
Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* (**4a**) (75 mg, 0.25 mmol) and *benzenesulfonyl azide* **(4o)** (91.6 mg, 0.5 mmol) Flash column chromatography (28-30% EtOAc/Hex) afforded the desired product **5o** as a paleyellow solid (92 mg, 0.235 mmol, 94% yield). Reaction time: 18 h. Melting point: 147-148 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.95 – 7.93 (m, 2H), 7.50 – 7.47 (m, 1H), 7.45 – 7.42 (m, 2H), 7.29 – 7.25 (m, 5H), 7.23 – 7.19 (m, 3H), 7.05 (d, *J* = 7.5 Hz, 1H), 4.86 (s, 2H), 4.43 (s, 2H), 4.42 (s, 2H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.9, 143.9, 135.2, 131.7, 130.2, 129.9, 128.9, 128.7, 128.4, 128.2, 128.1, 127.7, 127.3, 126.4, 125.0, 53.3, 50.9, 33.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{22}H_{21}N_2O_2S$ 377.1324; found 377.1319.

(E)-N-(2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)-4-isopropylbenzenesulfonamide (5p):



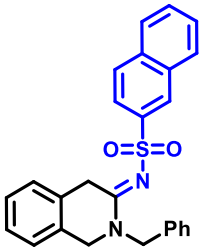
Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* **(4a)** (90 mg, 0.3 mmol) and *4-isopropylbenzenesulfonyl azide* **(4p)** (135 mg, 0.6 mmol) Flash column chromatography (20-22% EtOAc/hexane) afforded the desired product **5p** as a yellow solid (91 mg, 0.217 mmol, 72% yield). Reaction time: 15 h. Melting point: 134-135 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.86 (d, *J* = 8.3 Hz, 2H), 7.29 – 7.26 (m, 5H), 7.25 – 7.19 (m, 5H), 7.04 (d, *J* = 7.4 Hz, 1H), 4.86 (s, 2H), 4.43 (s, 2H), 4.41 (s, 2H), 2.98 – 2.91 (m, 1H), 1.25 (d, *J* = 6.9 Hz, 6H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.8, 152.9, 141.3, 135.3, 130.2, 130.0, 128.9, 128.3, 128.2, 128.1, 127.6, 127.2, 126.8, 126.5, 125.0, 53.2, 50.8, 34.2, 33.9, 23.8. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{25}H_{27}N_2O_2S$ 419.1793; found 419.1791.

(E)-N-(4-(N-(2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)sulfamoyl)phenyl)acetamide (5q):



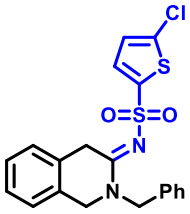
Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* **(4a)** (90 mg, 0.3 mmol) and *4-acetamidobenzenesulfonyl azide* **(4q)** (144 mg, 0.6 mmol) Flash column chromatography (6-94% acetone/DCM) afforded the desired product **5q** as a white solid (113 mg, 0.260 mmol, 87% yield). Reaction time: 15 h. Melting point: 130-132 °C. R_f = 0.3 (1-9% acetone/DCM).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.35 (brs, 1H), 7.78 (d, *J* = 8.7 Hz, 2H), 7.58 (d, *J* = 8.4 Hz, 2H), 7.28 – 7.24 (m, 4H), 7.22 – 7.16 (m, 4H), 7.04 (d, *J* = 7.3 Hz, 1H), 4.83 (s, 2H), 4.41 (s, 2H), 4.33 (s, 2H), 2.14 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 169.2, 164.9, 141.5, 138.4, 134.9, 130.1, 129.6, 129.0, 128.4, 128.2, 128.0, 127.5, 127.3, 127.3, 125.0, 119.4, 53.2, 51.0, 33.7, 24.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{24}H_{24}N_3O_3S$ 434.1538; found 434.1537.

(E)-N-(2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)naphthalene-2-sulfonamide (5r):



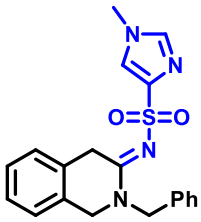
Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* **(4a)** (90 mg, 0.3 mmol) and *naphthalene-2-sulfonyl azide* **(4r)** (144 mg, 0.6 mmol) Flash column chromatography (22-25% EtOAc/Hex) afforded the desired product **5r** as a yellow solid (121 mg, 0.284 mmol, 94% yield). Reaction time: 20 h. Melting point: 133-134 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.49 (br, 1H), 7.93 – 7.85 (m, 4H), 7.59 – 7.53 (m, 2H), 7.28 – 7.24 (m, 5H), 7.22 – 7.18 (m, 3H), 7.05 (d, *J* = 7.5 Hz, 1H), 4.86 (s, 2H), 4.49 (s, 2H), 4.43 (s, 2H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 164.8, 140.9, 135.2, 134.5, 132.3, 130.1, 129.9, 129.3, 128.9, 128.9, 128.3, 128.2, 128.1, 128.1, 127.9, 127.7, 127.3, 127.2, 126.7, 125.0, 122.8, 53.3, 51.0, 33.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{26}H_{23}N_2O_2S$ 427.1480; found 427.1473.

(E)-N-(2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)-5-chlorothiophene-2-sulfonamide (5s):



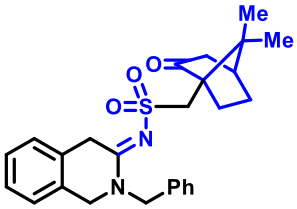
Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* **(4a)** (90 mg, 0.3 mmol) and *5-chlorothiophene-2-sulfonyl azide* **(4s)** (134 mg, 0.6 mmol) Flash column chromatography (22-25% EtOAc/Hex) afforded the desired product **5s** as a yellow solid (70 mg, 0.168 mmol, 56% yield). Reaction time: 20 h. Melting point: 185-186 °C. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.39 (d, *J* = 3.9 Hz, 1H), 7.33 – 7.30 (m, 3H), 7.28 – 7.25 (m, 4H), 7.23 – 7.21 (m, 1H), 7.06 (d, *J* = 7.4 Hz, 1H), 6.84 (d, *J* = 3.9 Hz, 1H), 4.90 (s, 2H), 4.44 (s, 2H), 4.41 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 164.9, 143.6, 135.5, 134.9, 129.8, 129.5, 129.1, 128.5, 128.3, 128.2, 127.6, 127.4, 126.1, 125.1, 53.4, 50.9, 33.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{20}H_{18}ClN_2O_2S_2$ 417.0498; found 417.0493.

(E)-N-(2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)-1-methyl-1H-imidazole-4-sulfonamide (5t):



Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* **(4a)** (90 mg, 0.3 mmol) and *1-methyl-1H-imidazole-4-sulfonyl azide* **(4t)** (112 mg, 0.6 mmol) Flash column chromatography (10-90% acetone/DCM) afforded the desired product **5t** as a yellow solid (62 mg, 0.163 mmol, 54% yield). Reaction time: 15 h. Melting point: 214-216 °C. R_f = 0.3 (1-9% acetone/DCM).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.42 – 7.41 (m, 2H), 7.34 – 7.27 (m, 7H), 7.24 – 7.21 (m, 1H), 7.05 (d, *J* = 7.5 Hz, 1H), 4.93 (s, 2H), 4.63 (s, 2H), 4.41 (s, 2H), 3.70 (s, 3H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 166.1, 144.4, 138.2, 135.4, 130.5, 130.3, 128.9, 128.3, 128.2, 127.9, 127.7, 127.1, 124.9, 122.2, 53.1, 50.7, 34.1, 33.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{20}H_{21}N_4O_2S$ 381.1385; found 381.1381.

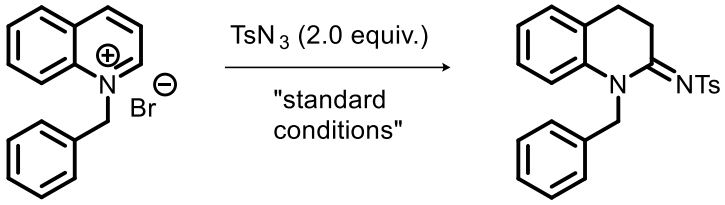
N-((E)-2-benzyl-1,4-dihydroisoquinolin-3(2H)-ylidene)-1-((1S,4S)-7,7-dimethyl-2-oxobicyclo[2.2.1]heptan-1-yl)methanesulfonamide (5u):



Prepared according to the general procedure **C** from *2-benzylisoquinolin-2-ium bromide* **(4a)** (90 mg, 0.3 mmol) and **4u** (154 mg, 0.6 mmol) Flash column chromatography (20-22% EtOAc/hexane) afforded the desired product **5u** as a sticky yellow solid (95.4 mg, 0.211 mmol, 70% yield). Reaction time: 15 h. R_f = 0.3 (EtOAc/Hex 3:7).**^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.36 – 7.33 (m, 2H), 7.31 – 7.28 (m, 3H), 7.24 – 7.23 (m, 3H), 7.07 (d, *J* = 7.4 Hz, 1H), 4.96 – 4.84 (m, 2H), 4.55 – 4.51 (m, 1H), 4.48 – 4.39 (m, 3H), 3.71 (d, *J* = 14.9 Hz 1H), 3.03 (d, *J* = 14.9 Hz 1H), 2.66 – 2.60 (m, 1H), 2.35 – 2.30 (m, 1H), 2.05 (t, *J* = 4.4 Hz, 1H), 1.99 – 1.94 (m, 1H), 1.84 (d, *J* = 18.3 Hz 1H), 1.63 – 1.57 (m, 1H), 1.32 – 1.28 (m, 2H), 1.11 (s, 3H), 0.86 (s, 3H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 215.4, 164.9, 135.4, 130.3, 130.2, 128.9, 128.3, 127.9, 127.6, 127.2, 124.9, 58.4, 52.8, 51.4, 50.9, 48.1, 42.8, 42.6, 34.0, 27.1, 24.3, 20.0, 19.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{26}H_{31}N_2O_3S$ 451.2055; found 451.2053.

10. Applications and Synthetic transformations

10.1. Gram scale synthesis of 3a:

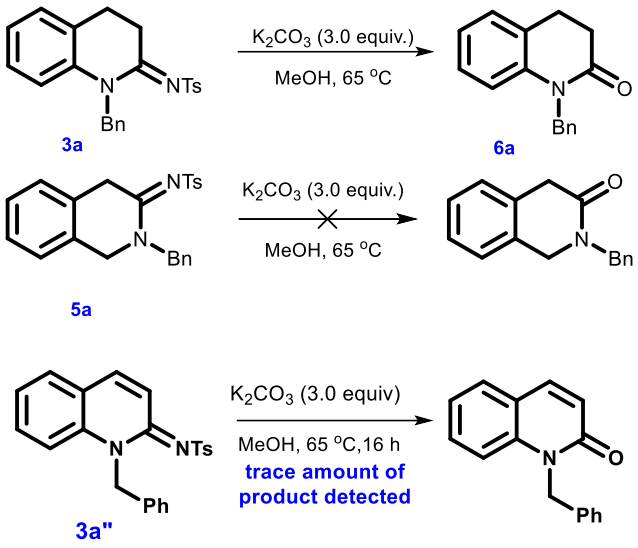


(1a) 1.44 g, 4.79 mmol

(3a) 1.25 g, 3.2 mmol, 67%

To an oven-dried Schlenk tube, was charged with **1a** (1.44 g, 4.8 mmol, 1.0 equiv.) and Tosyl azide (1.97 g, 2.0 equiv.), and exchanged with nitrogen and vacuum three times. To this was added NEt_3 (1.4 mL, 2.0 equiv), and 30 mL of MeCN followed by HCOOH (56 µL, 5.0 equiv). The reaction mixture was heated to 80 °C for 24 hours. After the completion of the reaction (monitored by TLC), the reaction was quenched with a K_2CO_3 aqueous solution after being diluted with EtOAc. The organic phase was separated, and the aqueous phase was extracted with EtOAc. The combined organic phase was washed with H_2O and dried over Na_2SO_4. The solvent was removed under reduced pressure. The resulting residue was purified by column chromatography on silica gel (PE/EA = 4:1) to give the corresponding product (1.25 g, 3.2 mmol, 67%).

10.2. General Procedure D for the Synthesis of 1-benzyl-3,4-dihydroquinolin-2(1H)-one (6a)

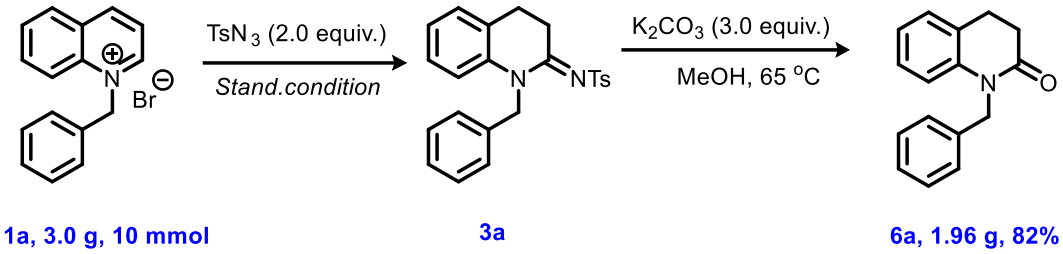


To a stirred solution of **3a** (100 mg, 0.25 mmol, 1.0 equiv.) in MeOH (3 mL) was added K_2CO_3 (106 mg, 3.0 equiv.) and heated at 65°C for 12 h. The solvent was evaporated under reduced pressure. The resultant residue was dissolved in ethyl acetate, washed with H_2O, dried over Na_2SO_4, filtered and concentrated under reduced pressure to afford the crude product which was purified by silica gel column chromatography (10-12% ethyl acetate/hexane) to afford the desired product **6a** as a white solid (56.7 mg, 0.24 mmol, 98%). R_f = 0.35 (EtOAc/Hex 1:4).

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.29 – 7.26 (m, 2H), 7.21 – 7.19 (m, 3H), 7.14 (d, *J* = 7.4 Hz, 1H), 7.09 – 7.06 (m, 1H), 6.94 (td, *J* = 7.4, 0.8 Hz, 1H), 6.86 (d, *J* = 8.1 Hz, 1H), 5.17 (s, 2H), 2.97 – 2.94 (m, 2H), 2.78 – 2.75 (m, 2H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 170.6, 139.9, 137.1, 128.8, 127.9, 127.5, 127.1, 126.4, 126.4, 122.9, 115.6, 46.2, 31.9, 25.6. HRMS (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{16}NO$ 238.1232; found 238.1231.

However, the hydrolysis of **5a** was not successful under the present conditions.

10.3. Step-wise synthesis of 1-benzyl-3,4-dihydroquinolin-2(1H)-one (6a)

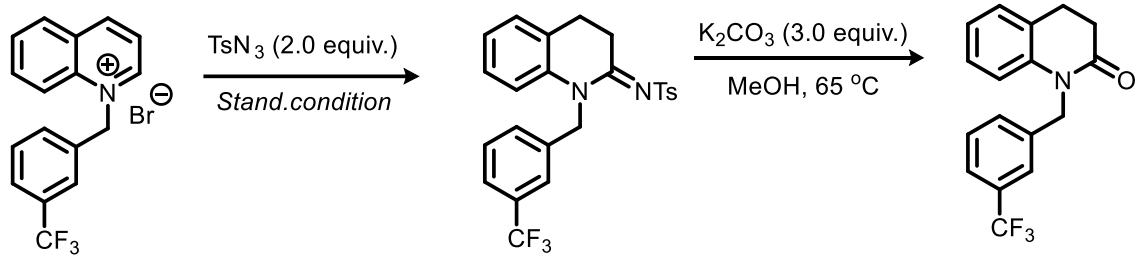


1a, 3.0 g, 10 mmol **3a** **6a, 1.96 g, 82%**

Step 1: In an oven-dried Schlenk tube, was charged with **1a** (3.0 g, 10 mmol, 1.0 equiv.) and Tosyl azide (3.94 g, 2.0 equiv.), and exchanged with nitrogen and vacuum three times. Then, 2.8 mL (2.0 equiv) of Et_3N and MeCN (60 mL) were added. The reaction mixture was heated to 80 °C for 24 hours after the addition of 1.9 mL (5.0 equiv) of HCOOH. After the completion of the reaction (monitored by TLC), the reaction was quenched with a K_2CO_3 aqueous solution after being diluted with EtOAc. The organic phase was separated, and the aqueous phase was extracted with EtOAc. The combined organic phase was washed with H_2O and dried over Na_2SO_4. The solvent was removed under reduced pressure. The resulting residue was washed with HPLC hexane to remove excess TsN_3, dried, and processed for the next step without column purification.

Step 2: To a stir solution of the above reaction mixture in MeOH (25 mL) was added K_2CO_3 (3.0 equiv) and heated at 65 °C for 12 h. The solvent was evaporated under reduced pressure. The resultant residue was dissolved in ethyl acetate, washed with H_2O, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The crude mixture was purified by silica gel column chromatography (10-12% ethyl acetate/hexane) to afford the desired product **6a** as a sticky white solid (1.96 g, 8.26 mmol, 82%).

10.4. Gram scale synthesis of 1-(3-(trifluoromethyl)benzyl)-3,4-dihydroquinolin-2(1H)-one (6w)

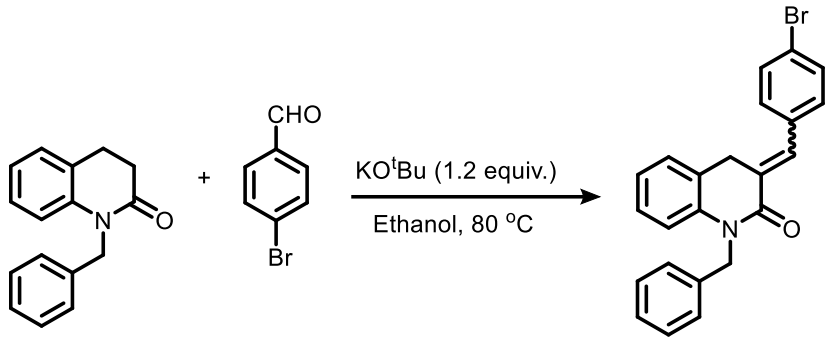


1w **3w** **6w**

Step 1: The compound **3w** was prepared according to the general procedure **C** from **1w** (174 mg, 0.47 mmol). The resulting residue was washed with HPLC hexane to remove excess TsN_3, dried, and processed for the next step without purification.

Step: 2 To stir solution of the above reaction mixture in MeOH (4-5 mL) was added K_2CO_3 (3.0 equiv) and heated at 65 °C for 12 h. The reaction was evaporated under reduced pressure. The resultant residue was dissolved in ethyl acetate, washed with H_2O, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. The crude mixture was purified by silica gel column chromatography (10-12% ethyl acetate/hexane) to afford the desired product **6w** as a white solid (110 mg, 0.36 mmol, 76%). Melting point: 128-129 °C. **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.50 – 7.48 (m, 2H), 7.43 – 7.36 (m, 2H), 7.18 (d, *J* = 7.3 Hz, 1H), 7.14 – 7.09 (m, 1H), 7.01 – 6.97 (m, 1H), 6.80 (d, *J* = 8.1 Hz, 1H), 5.22 (s, 2H), 3.01 – 2.97 (m, 2H), 2.82 – 2.78 (m, 2H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 170.7, 139.7, 138.3, 131.2 (q, *J* = 32.3 Hz), 129.8, 129.4, 128.2, 127.7, 126.5, 124.1 (q, *J* = 272.3 Hz), 124.1 (q, *J* = 3.7 Hz), 123.4 (q, *J* = 3.9 Hz), 123.3, 115.4, 46.0, 31.9, 25.6. **^{19}F NMR (376 MHz, CDCl3):** δ -62.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{15}F_3NO$ 306.1106; found 306.1103.

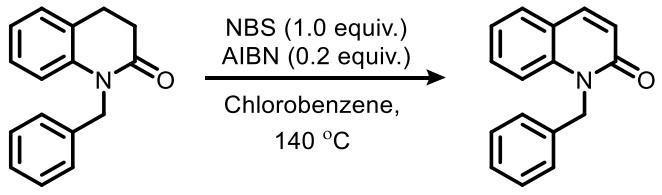
10.5. Synthesis of 1-benzyl-3-(4-bromobenzylidene)-3,4-dihydroquinolin-2(1H)-one (8):[8]



6a **7** **8**

To a stirred solution of **6a** (100 mg, 0.42 mmol, 1 equiv.) and **7** (2.5 equiv.) in 3 mL EtOH, was added t-BuOK (1.2 equiv.) slowly and the reaction was refluxed at 80 °C for 24 h. Another 1.5 equiv. of aldehyde **7** was added (**6a** was not full converted) after 24 h, and the mixture was refluxed for another 12 h. After cooling to 0 °C, the reaction was quenched with saturated NH_4Cl and diluted with EtOAc and washed with water and brine (3×100 mL), dried over anhydrous Na_2SO_4, and evaporated under reduced pressure. The residue was purified by column chromatography (10% EtOAc/ hexane) to afford the desired product **8** as a yellow oil (77 mg, 0.19 mmol, 45%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.45 (d, *J* = 8.1 Hz, 3H), 7.38 – 7.34 (m, 2H), 7.29 – 7.24 (m, 3H), 7.22 – 7.18 (m, 5H), 7.16 – 7.12 (m, 1H), 5.56 (s, 2H), 3.97 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 162.4, 138.7, 138.3, 136.6, 136.5, 132.8, 131.8, 131.3, 129.9, 128.9, 128.5, 127.4, 126.7, 122.3, 120.8, 120.4, 114.9, 46.5, 36.7. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{23}H_{19}NOBr$ 404.0650; found 404.0645.

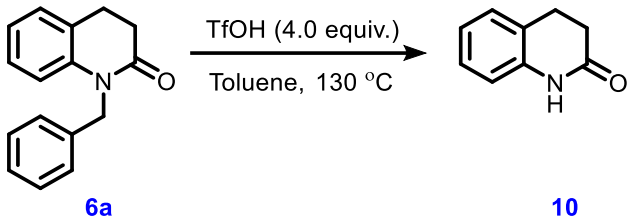
10.6. Synthesis of 1-benzylquinolin-2(1H)-one (9):



6a **9**

To a solution of **6a** (100 mg, 0.42 mmol, 1 equiv.) in chlorobenzene (2.0 mL) was added NBS (74 mg, 1 equiv.) and AIBN (14 mg, 0.2 equiv.), and refluxed for 4 h. To this was added further AIBN (0.2 equiv.) and NBS (0.1 equiv.) and heated for 20 h. The reaction mixture was cooled, filtered, washed with DCM, and concentrated. The crude product was purified by silica gel column chromatography (18-20% EtOAc/hexane) to afford the desired product **9** as a yellow oil (93 mg, 0.39 mmol, 94%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.71 (d, *J* = 9.5 Hz, 2H), 7.53 (dd, *J* = 7.7, 1.1 Hz, 2H), 7.41 – 7.37 (m, 1H), 7.29 – 7.25 (m, 3H), 7.23 – 7.19 (m, 3H), 7.17 – 7.14 (m, 1H), 6.79 (d, *J* = 9.5 Hz, 1H), 5.54 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 162.5, 139.6, 139.5, 136.4, 130.7, 128.9, 128.8, 127.3, 126.6, 122.2, 121.6, 120.9, 115.1, 45.9. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{14}NO$ 236.1075; found 236.1069.

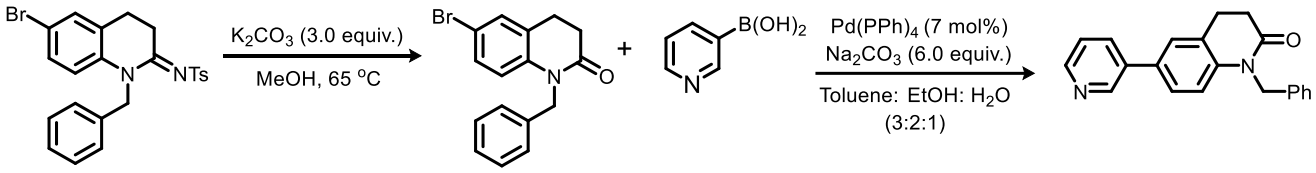
10.7. Synthesis of 3,4-dihydroquinolin-2(1H)-one (10):[8]



6a **10**

Trifluromethansulfonic acid (2.0 mL, 4.0 equiv.) was added to a solution of **6a** (1.3 g, 5.48 mmol, 1 equiv.) in toluene (8 mL). The mixture was heated at 130 °C for 30 h. Then the reaction mixture was poured into aqueous $NaHCO_3$, extracted with EtOAc, and washed with brine solution. The combined organic fraction was dried over Na_2SO_4, filtered, and concentrated under reduced pressure to afford the crude product which was purified by silica gel column chromatography (3% acetone/DCM) to afford the desired product **10** as a brown solid (754 mg, 5.13 mmol, 93%). Melting Point: 168-169 °C. **^{1}H NMR (500 MHz, $CDCl_3$):** δ 9.60 (s, 1H), 7.19 – 7.16 (m, 2H), 7.01 – 6.98 (m, 1H), 6.89 (d, *J* = 7.8 Hz, 1H), 2.99 – 2.98 (m, 2H), 2.68 – 2.65 (m, 2H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 172.6, 137.5, 127.9, 127.6, 123.7, 123.1, 115.7, 30.8, 25.4. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_9H_{10}NO$ 148.0762; found 148.0759.

10.8. Synthesis of CYP11B2 inhibitor 14



3e **6e** **13** **14**

Step 1: Synthesis of 1-benzyl-6-bromo-3,4-dihydroquinolin-2(1H)-one (6e)

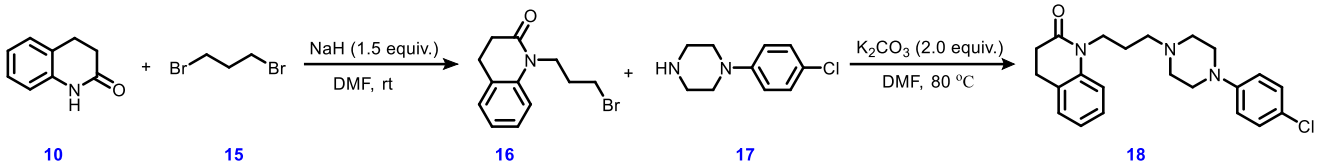
6e was prepared according to the general procedure **D** from **3e** (151 mg, 0.32 mmol). Flash column chromatography (18-20% EtOAc/hexane) afforded the desired product **6e** as a sticky white soild (94.1 mg, 0.29 mmol, 93% yield). **^{1}H NMR (500 MHz, $CDCl_3$):** δ 7.31 – 7.27 (m, 3H), 7.25 – 7.17 (m, 4H), 6.73 (d, *J* = 8.7 Hz, 1H), 5.14 (s, 2H), 2.96 – 2.93 (m, 2H), 2.79 – 2.75 (m, 2H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 170.1, 139.1, 136.6, 130.8, 130.3, 128.9, 128.6, 127.3, 126.5, 117.3, 115.7, 46.2, 31.6, 25.4. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{15}NOBr$ 316.0337; found 316.0337.

Step 2: Synthesis of 1-benzyl-6-(pyridin-3-yl)-3,4-dihydroquinolin-2(1H)-one (14)

A reaction tube was charged with **6e** (66 mg, 0.21 mmol), **13** (45 mg, 0.35 mmol), Na_2CO_3 (153 mg, 6 equiv), and $Pd(PPh)_4$ (20 mg, 7 mol%). To this was added toluene (1.5 mL), water (1 mL), and EtOH (0.5 mL) under a nitrogen atmosphere, and the mixture was refluxed at 120 °C for 24 h. Thereafter reaction mixture was cooled, and filtered through a plug of celite. The resulting mixture was diluted with water and extracted with ethyl acetate. The combined extracts were dried over Na_2SO_4, concentrated, and purified by flash chromatography on silica gel (Acetone/DCM, 4:96%) to afford the desired CYP11B2 inhibitors **14** as a white solid (59.7 mg, 0.19 mmol, 90%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.78 (d, *J* = 1.8 Hz, 1H), 8.55 (dd, *J* = 4.8, 1.5 Hz, 1H), 7.81 – 7.78 (m, 1H), 7.39 (d, *J* = 1.9 Hz, 1H), 7.34 – 7.30 (m, 4H), 7.26 – 7.22 (m, 3H), 6.97 (d, *J* = 8.4 Hz, 1H), 5.22 (s, 2H), 3.08 – 3.05 (m, 2H), 2.86 – 2.82 (m, 2H). **^{13}C{^{1}H} NMR (125 MHz, $CDCl_3$):** δ 170.4, 148.4, 148.0, 140.0, 136.9, 135.8, 134.0, 132.5, 128.9, 127.3, 127.2, 126.6, 126.5, 126.2, 123.7,

116.3, 46.2, 31.9, 25.8. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{21}H_{19}N_2O$ 315.1497; found 315.1497. The analytical data of the compound are in accordance with the literature.[9]

10.9. Synthesis of D_4R antagonist 18[10]



Step 1: Synthesis of 1-(3-bromopropyl)-3,4-dihydroquinolin-2(1H)-one (16)

A solution of **10** (100 mg, 0.68 mmol) in DMF was added dropwise to a suspension of NaH (1.5 equiv.) in DMF (1.5 mL). The resulting mixture was stirred at room temperature for 20 min., followed by the addition of a solution of **15** (1.1 equiv.) in DMF (0.5 mL), and the resulting mixture was stirred at room temperature for 1 h. After that, the mixture was diluted with water and extracted with ethyl acetate. The combined extracts were dried over Na_2SO_4, concentrated, and purified by flash chromatography on silica gel (eluent: 10:90% EtOAc/hexane) to afford the desired **16** as a brown oil (106 mg, 0.39 mmol, 58%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.28 – 7.24 (m, 1H), 7.17 (d, *J* = 7.3 Hz, 1H), 7.07 (d, *J* = 8.0 Hz, 1H), 7.01 (td, *J* = 7.4, 0.9 Hz, 1H), 4.10 – 4.07 (m, 2H), 3.47 (t, *J* = 6.5 Hz, 2H), 2.91 – 2.88 (m, 2H), 2.66 – 2.63 (m, 2H), 2.27 – 2.20 (m, 2H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 170.5, 139.5, 128.2, 127.7, 126.6, 123.1, 114.7, 41.3, 31.9, 30.9, 30.4, 25.6. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{12}H_{15}BrNO$ 268.0337; found 268.0338.

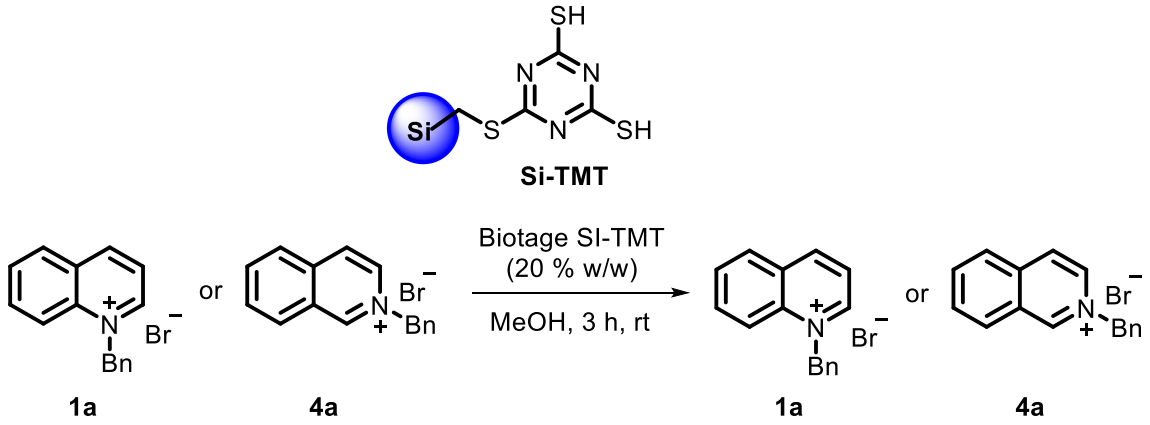
Step 2: Synthesis of 1-(3-(4-(4-chlorophenyl)piperazin-1-yl)propyl)-3,4-dihydroquinolin-2(1H)-one (18)

To a solution of **16** (85 mg, 0.32 mmol) in DMF (1.5 mL) was added a solution of **17** (94 mg, 1.5 equiv) in dropwise followed by K_2CO_3 (66 mg, 1.5 equiv.) in DMF (1.5 mL). The reaction mixture was stirred at 80 °C for 12 h; then, it was diluted with water (20 mL) and extracted with EtOAc (2× 20 mL). The organic layer was washed with brine and dried over anhydrous Na_2SO_4. The evaporation of the solvent under reduced pressure afforded a residue, which was purified by flash chromatography, (eluent: 6:94% MeOH/DCM) to afford the desired D_4 antagonist **18** as a white solid (94 mg, 0.24 mmol, 76%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 7.18 – 7.08 (m, 4H), 7.02 (d, *J* = 8.0 Hz, 1H), 6.94 – 6.91 (m, 1H), 6.76 (d, *J* = 9.0 Hz, 2H), 3.96 – 3.92 (m, 2H), 3.10 – 3.08 (m, 4H), 2.83 – 2.79 (m, 2H), 2.59 – 2.51 (m, 6H), 2.40 (t, *J* = 7.1 Hz, 2H), 1.84 – 1.77 (m, 2H). **^{13}C{^{1}H} NMR (100 MHz, $CDCl_3$):** δ 170.3, 149.9, 139.7, 128.9, 128.1, 127.5, 126.6, 124.5, 122.8, 117.2, 114.9, 55.7, 53.1, 49.2, 40.5, 32.0, 25.7, 24.7. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for$C_{22}H_{27}ClN_3O$ 384.1843; found 384.1832.

11. Control Experiments

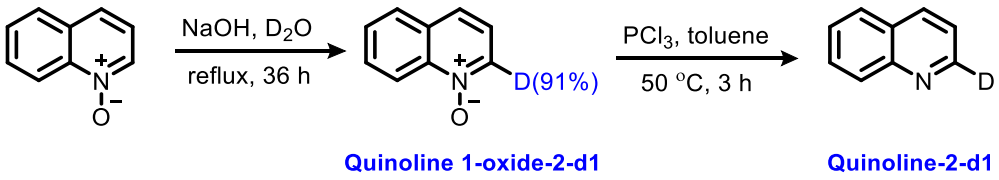
11.1. Palladium Scavenging Experiments:[11]

Biotage ISOLUTE Si-TMT scavenging resin, which is highly efficient to remove trace amounts of palladium, rhodium, ruthenium, nickel, and platinum, was applied to quinolinium and isoquinolinium substrates. These substances showed no change in reactivity after treatment.

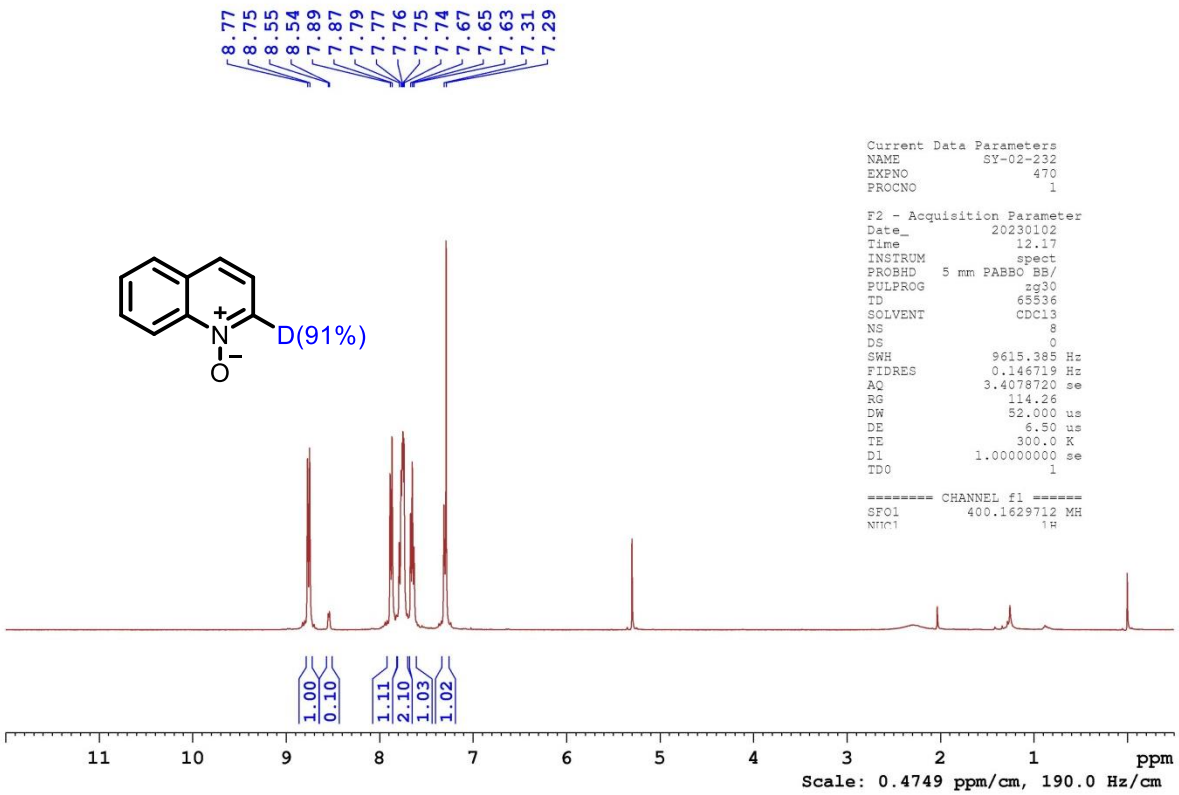


1a and **2a** (200 mg) was dissolved in MeOH (5 mL) and Biotage ISOLUTE Si-TMT scavenging resin (40 mg, 20% w/w) was added and the solution was stirred at room temperature for 3 h. The solution was filtered and concentrated in vacuo to return "purified" **1a** and **4a**. These substrates were subjected to the standard reaction conditions utilizing new glassware and gave **3a** and **5a** in 69% and 88% (16 hours) NMR yield, respectively indicating no loss of reactivity.

11.2. Synthesis of Quinoline 1-oxide-2-d1 and Quinoline-2-d1:[12]

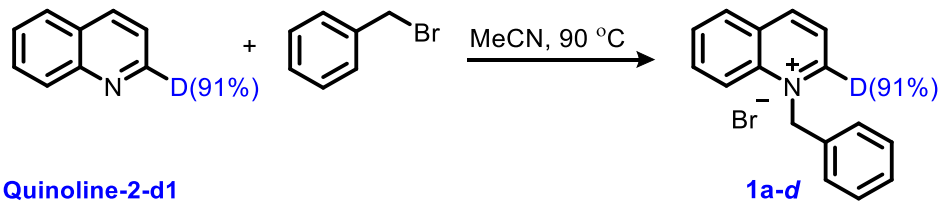


Step 1: Quinoline N-oxide (500 mg, 3.4 mmol), D_2O (3 mL) and NaOH (344 mg, 2.5 equiv) were weighed into a pressure vial sealed with a Teflon cap. The reaction mixture was stirred at 95 °C in an oil bath for 36 h. After cooling to room temperature, the mixture was then extracted with ethyl acetate (3×10 mL), washed with saturated NaCl solution (3×5 mL), dried over Na_2SO_4, and filtered. Ethyl acetate was under reduced pressure to obtain the crude **2-d1-quinoline N-oxide** product which was employed for the next step without further purification (471 mg, 94%). **^{1}H NMR (400 MHz, $CDCl_3$):** δ 8.76 (d, *J* = 8.7 Hz, 1H), 8.54 (d, *J* = 5.5 Hz, 0.093 H), 7.87 (d, *J* = 8.1 Hz, 1H), 7.79 – 7.74 (m, 2H), 7.65 (t, *J* = 7.3 Hz, 1H), 7.31 – 7.28 (m, 1H).

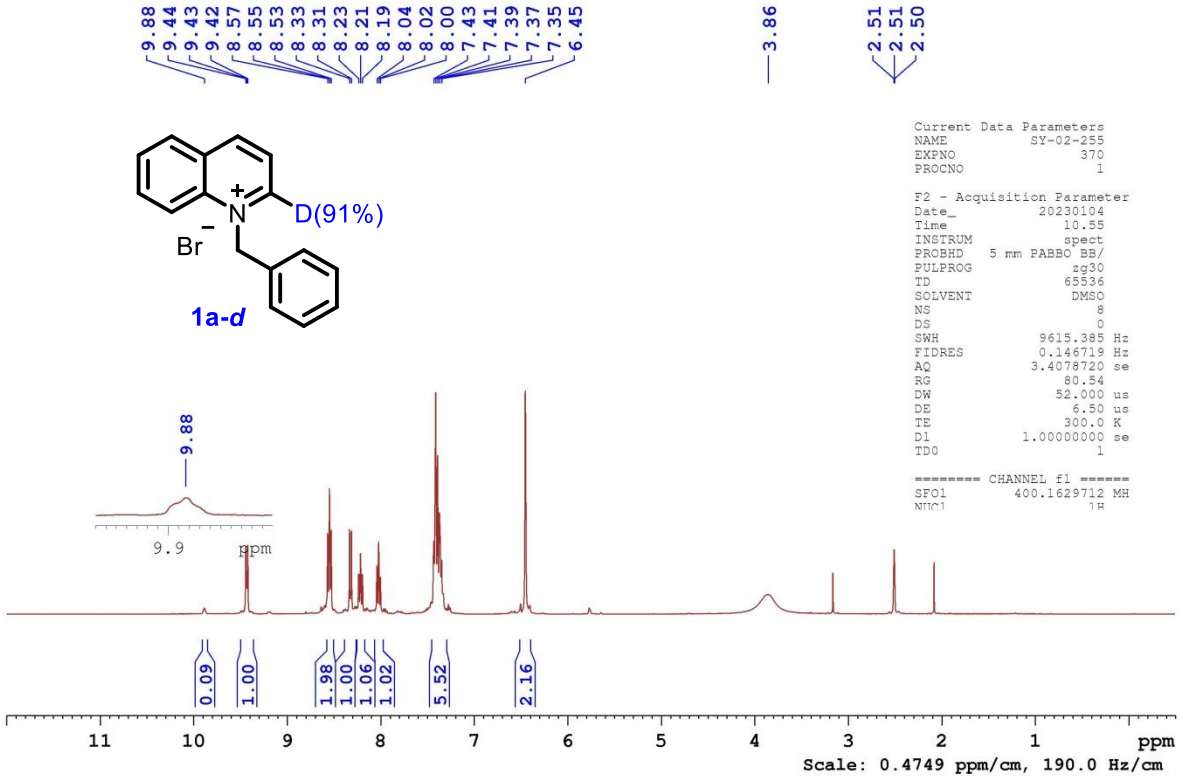


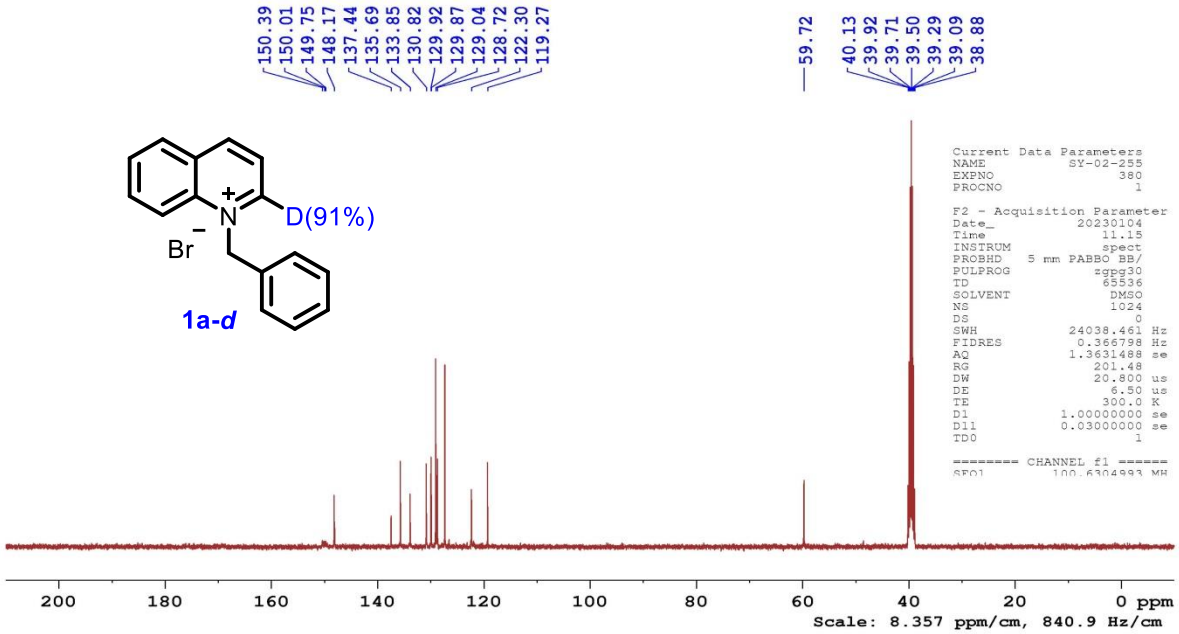
Step 2: 2-d1-Quinoline N-oxide (471 mg, 3.22 mmol) was dissolved in toluene in round bottom flask with stirring at room temperature. To this, PCl_3 (530 mg, 1.3 equiv) was added, and stirred at 50 °C for 3 h. Saturated $NaHCO_3$ was added to the reaction mixture, and extracted with ethyl acetate, washed with saturated NaCl, dried over anhydrous Na_2SO_4, filtered, and evaporated. The crude mixture was purified by column chromatography on silica gel (20% ethyl acetate in hexane) to give **quinoline-2-d1** (288 mg, 69%).

11.3. Synthesis of 1-benzylquinolin-1-ium-2-d1 bromide (1a-*d*):



The representative general procedure **B** was followed, using **quinoline-2-d1** (260 mg, 2.0 mmol) under reflux for 24 h to give **1a-*d*** (540 mg, 89%) as an off-white solid. **^{1}H NMR (400 MHz, DMSO-d$_6$):** δ 9.88 (s, 0.092H), 9.44 –9.42 (m, 1H), 8.56 – 8.53 (m, 2H), 8.32 (d, *J* = 8.4 Hz, 1H), 8.23 – 8.19 (m, 1H), 8.04 – 8.00 (m, 1H), 7.43 – 7.34 (m, 5H), 6.45 (s, 2H). **^{13}C{^{1}H} NMR (100 MHz, DMSO-d$_6$):** δ 150.0 (t, *J* = 25.8 Hz), 149.7, 148.2, 137.4, 135.7, 133.8, 130.8, 129.9, 129.8, 129.0, 128.7, 122.3, 119.3, 59.7. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{13}DN$ 221.1184; found 221.1182.


9.88
9.44
9.43
9.42
8.57
8.55
8.53
8.33
8.31
8.23
8.21
8.19
8.04
8.02
8.00
7.43
7.41
7.39
7.37
7.35
6.45
3.86
2.51
2.51
2.50
D(91%)
Br
1a-d
Current Data Parameters
NAME SY-02-255
EXPNO 370
PROCNO 1
F2 - Acquisition Parameter
Date_ 20230104
Time 10.55
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT DMSO
NS 8
DS 0
SWH 9615.385 Hz
FIDRES 0.146719 Hz
AQ 3.4078720 se
RG 80.54
DW 52.000 us
DE 6.50 us
TE 300.0 K
D1 1.00000000 se
TD0 1
======== CHANNEL f1 ======
SFO1 400.1629712 MH
NUC1 1H
9.88
9.9
ppm
0.09
1.00
1.98
1.00
1.06
1.02
5.52
2.16
11
10
9
8
7
6
5
4
3
2
1
ppm
Scale: 0.4749 ppm/cm, 190.0 Hz/cm


150.39
150.01
149.75
148.17
137.44
135.69
133.85
130.82
129.92
129.87
129.04
128.72
122.30
119.27
59.72
40.13
39.92
39.71
39.50
39.29
39.09
38.88
D(91%)
Br
1a-d
Current Data Parameters
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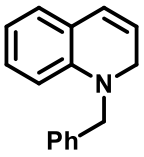
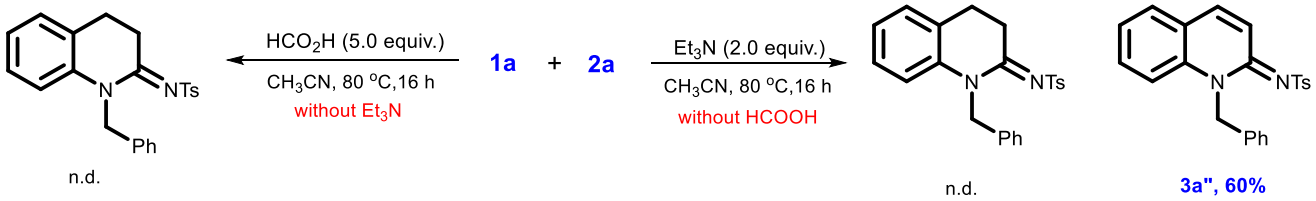
EXPNO 380
PROCNO 1
F2 - Acquisition Parameter
Date_ 20230104
Time 11.15
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zgpg30
TD 65536
SOLVENT DMSO
NS 1024
DS 0
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631488 se
RG 201.48
DW 20.800 us
DE 6.50 us
TE 300.0 K
D1 1.00000000 se
D11 0.03000000 se
TD0 1
======== CHANNEL f1 ======
SFO1 100.6304993 MH
200
180
160
140
120
100
80
60
40
20
0 ppm
Scale: 8.357 ppm/cm, 840.9 Hz/cm

11.4. Synthesis of 1-benzyl-1,2-dihydroquinoline (A):[13]



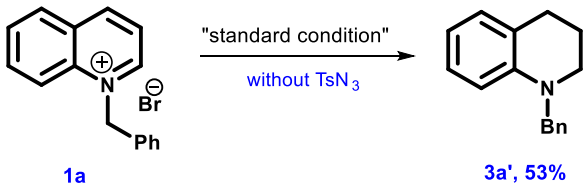
To a suspension of 1-benzylquinolin-1-ium bromide **1a** (0.5 g, 1.66 mmol) in 5 mL of THF was slowly added lithium aluminium hydride (69 mg, 1.1 equiv.) at room temperature. The reaction was stirred at room temperature for 20 min, then slowly quenched with 0.1 mL of water and stirred for an additional 10 min. To the reaction was added 0.2 mL 10% sodium hydroxide solution and stirred at room temperature for an additional 10 min. To the reaction mixture was added 5% Na2CO3 solution and extracted with ethyl acetate, dried with anhydrous sodium sulfate, and then concentrated by removing the solvent under vacuum to give the unstable crude 1-benzyl-1,2-dihydroquinoline as a yellow oil (350 mg, 1.58 mmol, 95%). This oil was used immediately in our mechanistic investigations.

11.5. Control experiments without base and formic acid:



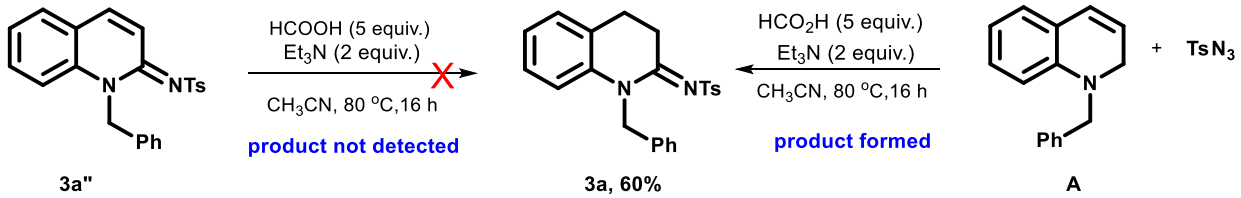
Under the standard conditions, the control experiments were performed. When the reaction was performed without Et_3N, **3a** was not detected. However, without formic acid, **3a''** is obtained in 60% yield.

11.6. Control experiment without azide:[13]



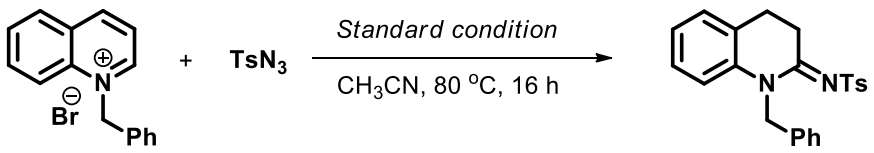
Without the TsN_3, the reaction was performed under the standard conditions. The simple hydrogenation product **3a'** is obtained in 53% yield.

11.7. Control experiments with possible intermediates 3a" and A:



Possible intermediates **3a"** and **A** were subjected to standard conditions following the general procedure C. The desired product **3a** is formed in 60% yield with **A** whereas no product was detected with **3a"**.

11.8. Radical trapping reaction

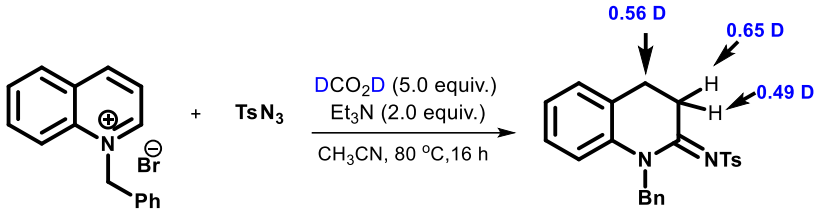


1a 2a

With TEMPO (2.0 equiv) **3a** = 73%
With BHT (2.0 equiv) **3a** = 76%

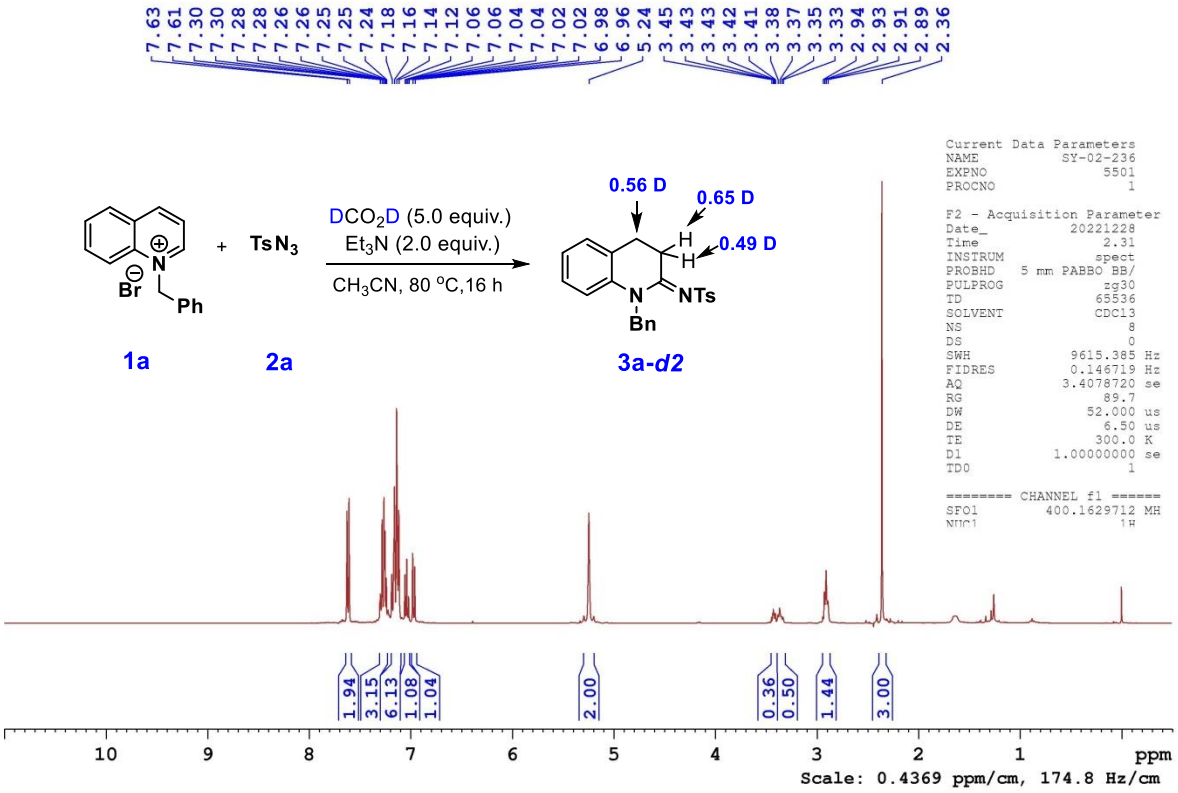
The reaction between **1a** and **2a** was performed along with TEMPO (2 equiv.) and BHT (2 equiv.) under standard conditions following the general procedure **C**. After completion of the reaction, the NMR yields were calculated. In the presence of TEMPO, the yield of **3a** was 73% and in the presence of BHT, the yield of **3a** was 76%.

11.9. Deuterium labelling experiment 1

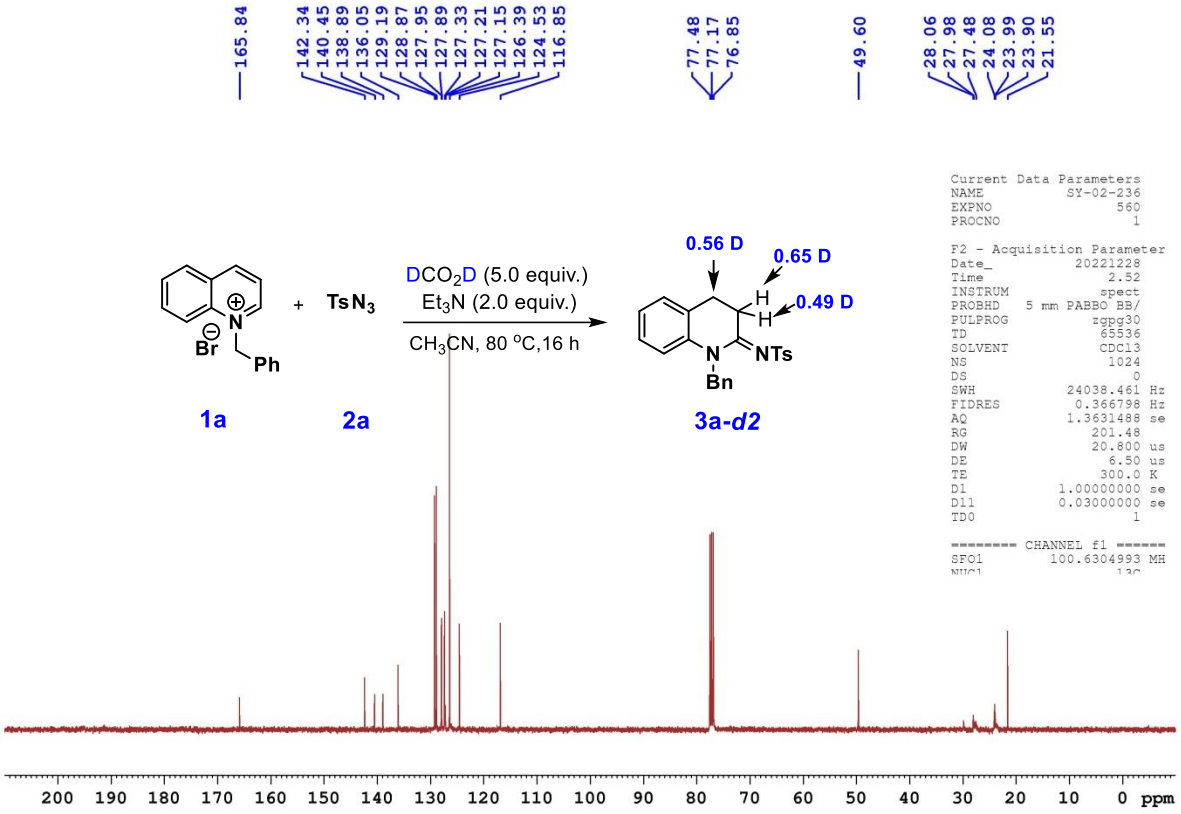


1a 2a 3a-*d2*

The reaction between **1a** and **2a** was performed with DCO_2D (5 equiv.) under standard conditions following the general procedure **C**. After completion of the reaction, the deuterium incorporation was calculated from the isolated product **3a-d2** by NMR analysis.

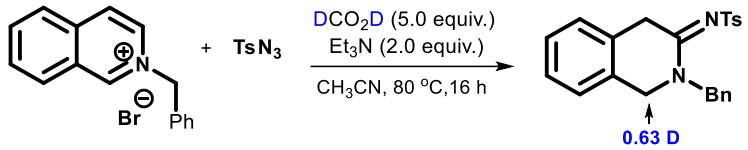


^{1}H NMR (400 MHz, $CDCl_3$) of 3a-*d2*

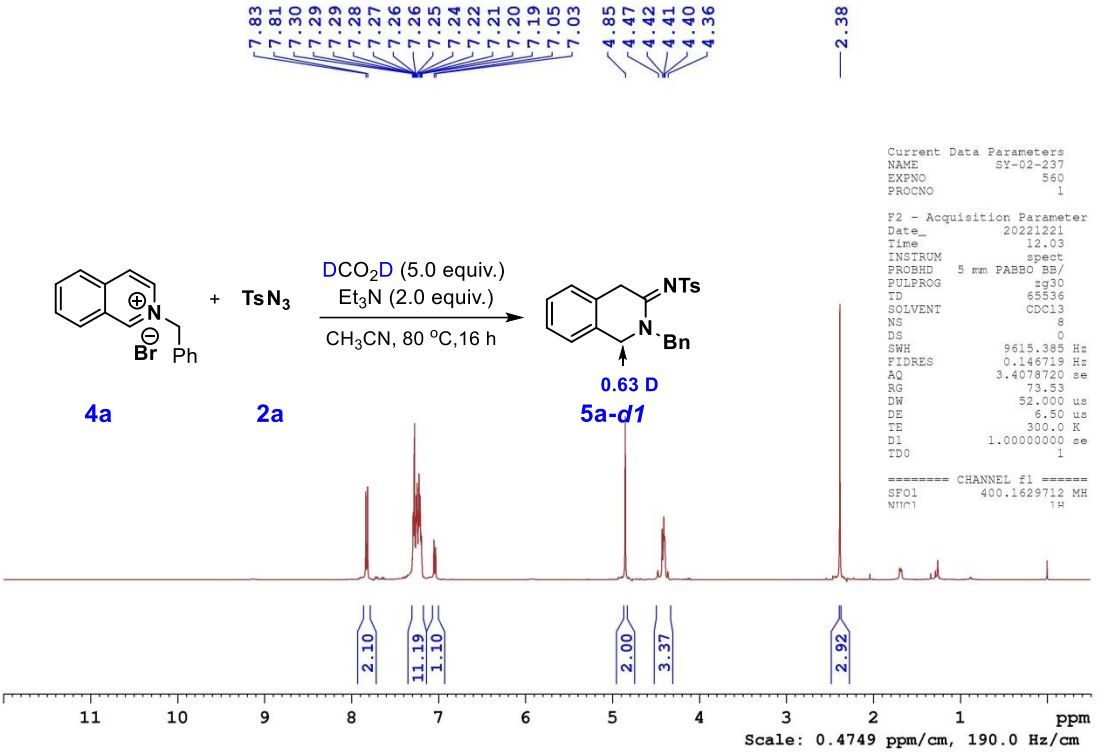


^{13}C NMR (100 MHz, $CDCl_3$) of 3a-*d2*

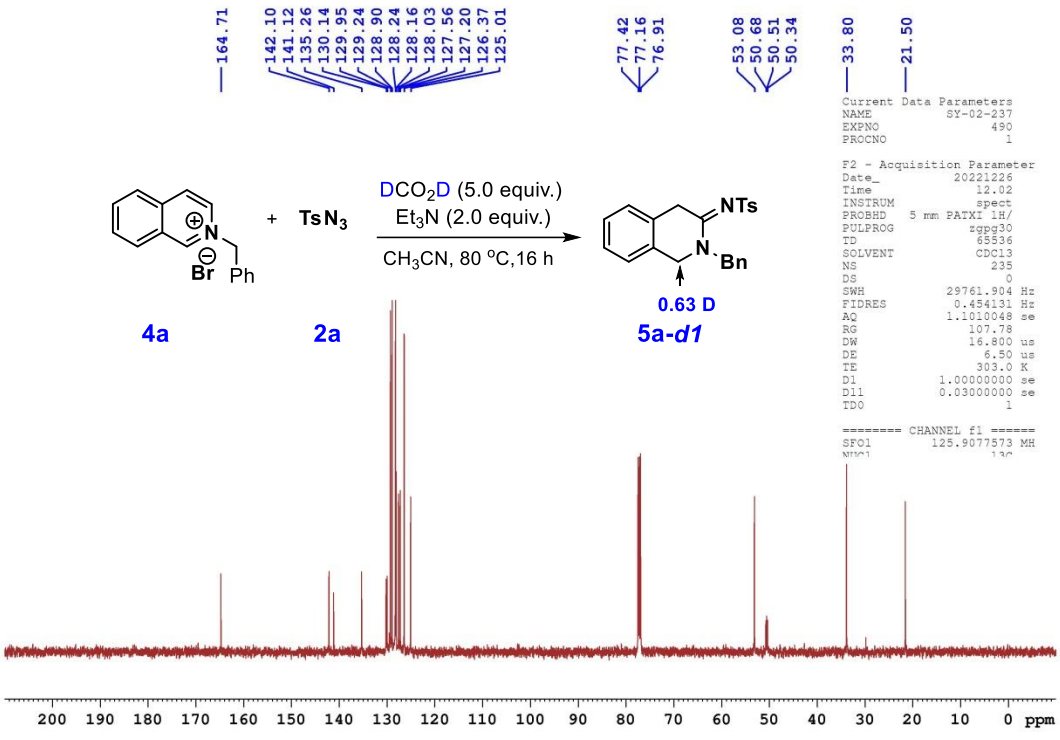
11.10. Deuterium labelling experiment 2



The reaction between **4a** and **2a** was performed with DCO_2D (5 equiv.) under standard conditions following the general procedure **C**. After completion of the reaction, the deuterium incorporation was calculated from the isolated product **3a-d1** by NMR analysis.

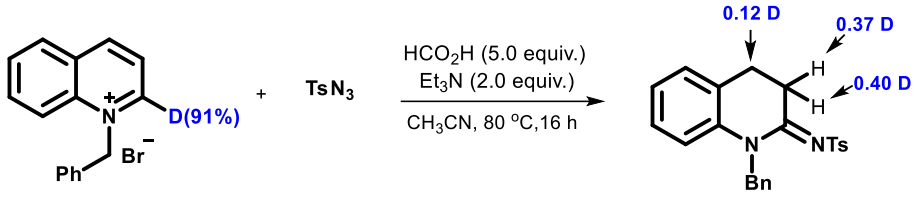


^{1}H NMR (400 MHz, $CDCl_3$) of 5a-*d1*



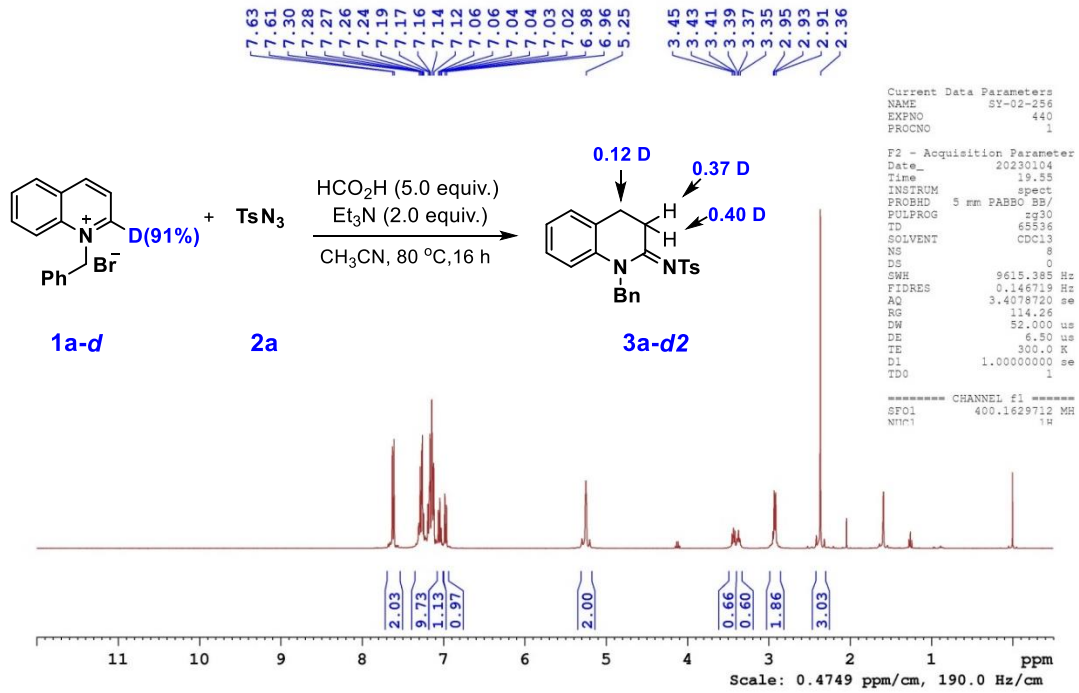
^{13}C NMR (125 MHz, $CDCl_3$) of 5a-*d1*

11.11. Deuterium labelling experiment 3

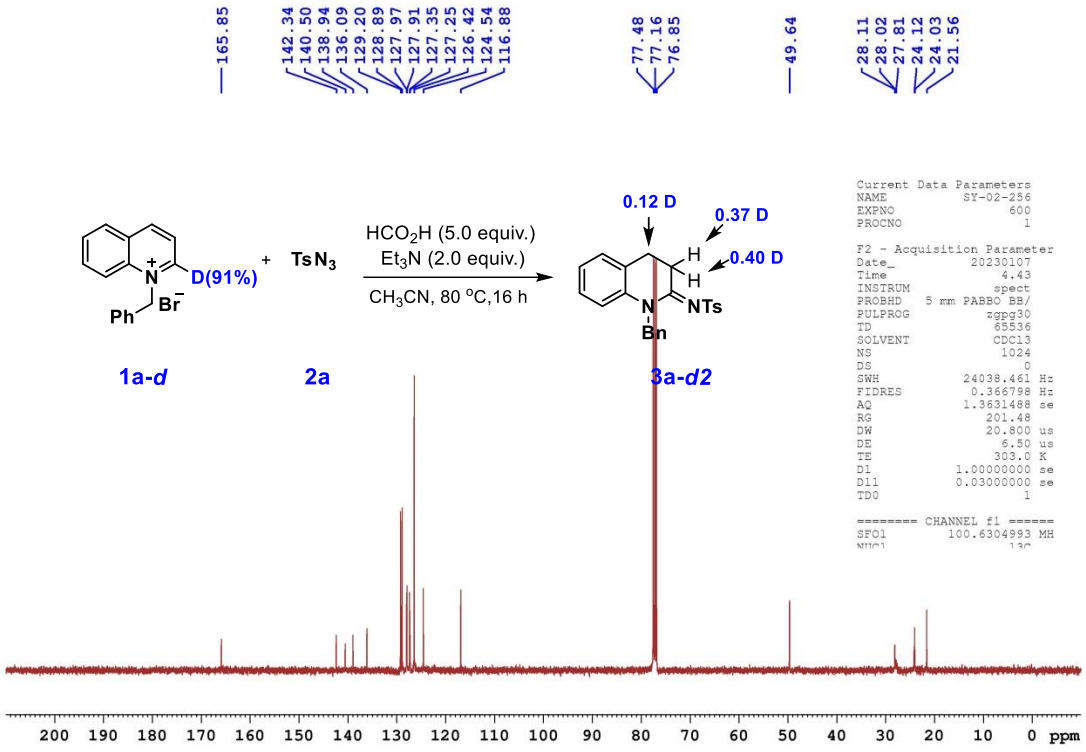


1a-*d* **2a** **3a-*d2***

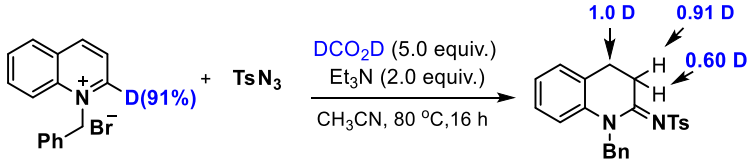
The reaction between **1a-d** and **2a** was performed with HCO_2H (2 equiv.) under standard conditions following the general procedure **C**. After completion of the reaction, the deuterium incorporation was calculated from the isolated product **3a-d2** by NMR analysis.



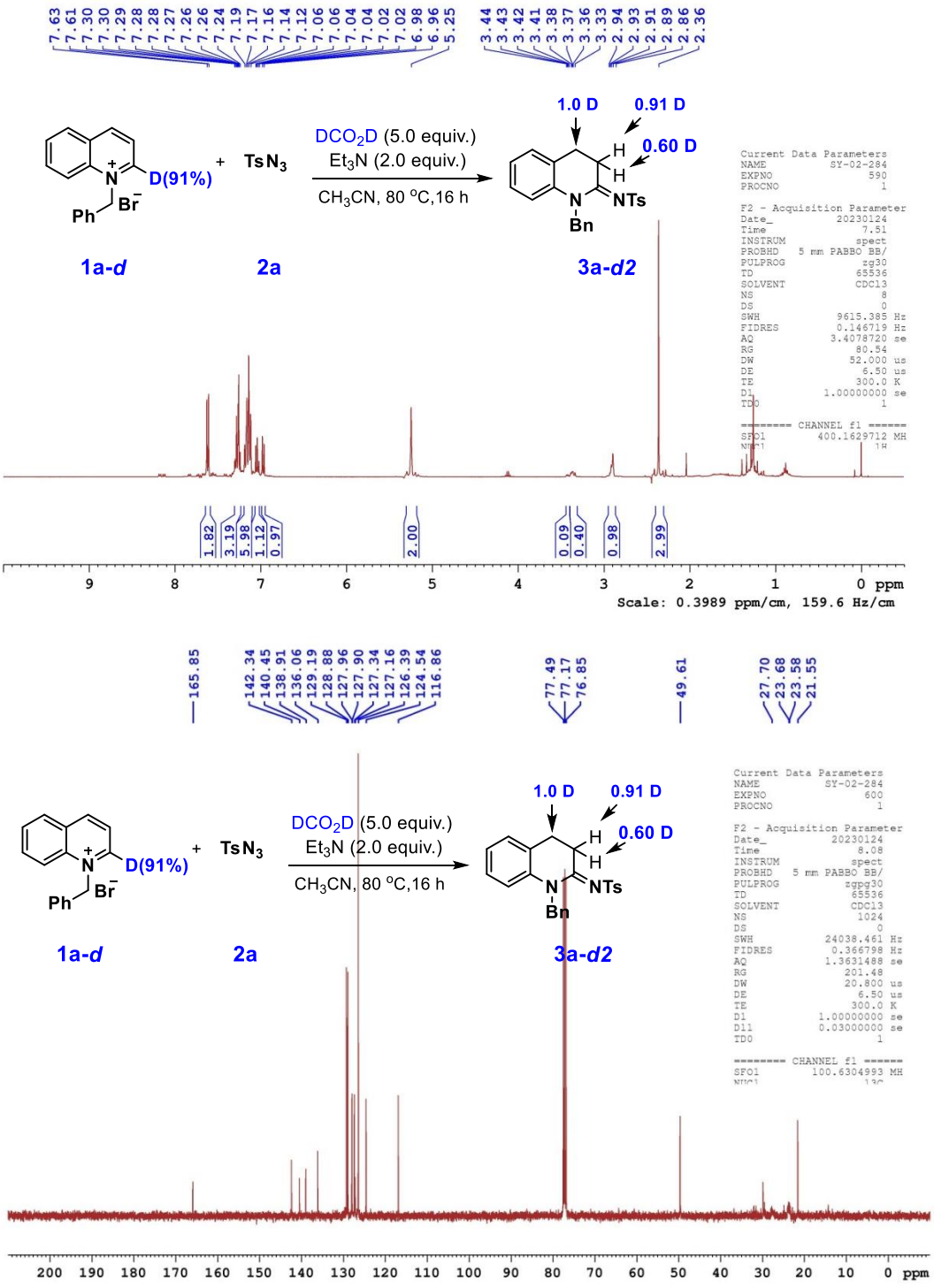
^{1}H NMR (400 MHz, $CDCl_3$) of 3a-*d2*



11.12. Deuterium labelling experiment 4



The reaction between **1a-d** and **2a** was performed with DCO_2D (5 equiv.) under standard conditions following the general procedure **C**. After completion of the reaction, the deuterium incorporation was calculated from the isolated product **3a-d2** by NMR analysis.


7.63 7.61 7.30 7.30 7.29 7.28 7.28 7.27 7.26 7.26 7.24 7.19 7.17 7.16 7.14 7.12 7.06 7.06 7.04 7.04 7.02 7.02 6.98 6.96 5.25
3.44 3.43 3.42 3.41 3.38 3.37 3.36 3.33 2.94 2.93 2.91 2.89 2.86 2.36
D(91%)
Ph
Br
+ TsN3
DCO2D (5.0 equiv.)
Et3N (2.0 equiv.)
CH3CN, 80 °C,16 h
1.0 D
0.91 D
0.60 D
H
H
N
NTs
Bn
1a-d
2a
3a-d2
Current Data Parameters
NAME SY-02-284
EXPNO 590
PROCNO 1
F2 - Acquisition Parameter
Date_ 20230124
Time 7.51
INSTRUM spect
PROBHD 5 mm PABBO BB/
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 8
DS 0
SWH 9615.385 Hz
FIDRES 0.146719 Hz
AQ 3.4078720 se
RG 80.54
DW 52.000 us
DE 6.50 us
TE 300.0 K
D1 1.00000000 se
TD0 1
======== CHANNEL f1 ======
SFO1 400.1629712 MH
1.82 3.19 5.98 1.12 0.97 2.00 0.09 0.40 0.98 2.99
9 8 7 6 5 4 3 2 1 0 ppm
Scale: 0.3989 ppm/cm, 159.6 Hz/cm
165.85 142.34 140.45 138.91 136.06 129.19 128.88 127.96 127.90 127.34 127.16 126.39 124.54 116.86
77.49 77.17 76.85
49.61
27.70 23.68 23.58 21.55
Current Data Parameters
NAME SY-02-284
EXPNO 600
PROCNO 1
F2 - Acquisition Parameter
Date_ 20230124
Time 8.08
INSTRUM spect
PROBHD 5 mm PABBO BB/
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SOLVENT CDCl3
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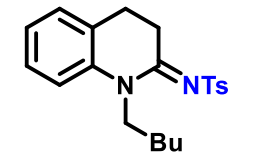
RG 201.48
DW 20.800 us
DE 6.50 us
TE 300.0 K
D1 1.00000000 se
D11 0.03000000 se
TD0 1
======== CHANNEL f1 ======
SFO1 100.6304993 MH
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 ppm

12. Crystal Structure of 3q and 5a

X-Ray Data Collection and Structure Refinement Details:

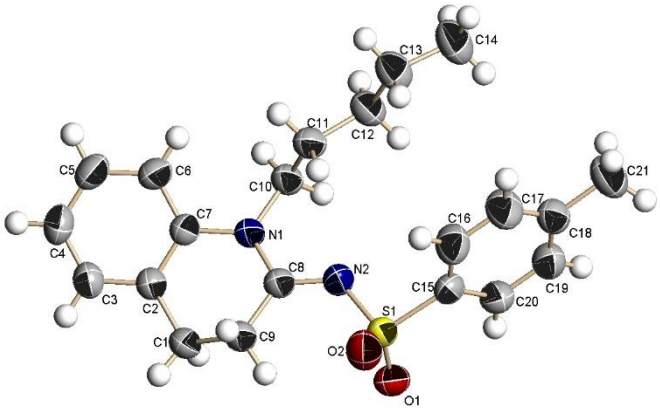
A good quality single crystals of size 0.95 x 0.09 x 0.04 mm and 0.16 x 0.10 x 0.08 mm, were selected under a polarizing microscope and was mounted on a glass fiber for data collection. Single crystal X-ray data for compounds **3q** and **5a** were collected on the Rigaku XtaLAB Synergy-S single crystal X-ray diffractometer equipped with a HyPix-6000HE Hybrid Photon Counting (HPC)detector and dual Mo and Cu microfocus sealed X-ray source with kappa goiniometer at 293 (2) K. Data collection cell determination, and data reduction was performed using the CrysAlisPro[1] software. Structure solution and refinement were performed by using SHELX-97[2]. Refinement of coordinates and anisotropic thermal parameters of non-hydrogen atoms were carried out by the full-matrix least-squares method. The hydrogen atoms attached to carbon atoms were generated with idealized geometries and isotropically refined using a riding model.

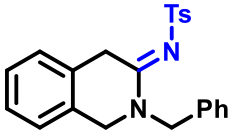
1. CrysAlisPro, Oxford Diffraction /Agilent Technologies UK Ltd, Yarnton, England.
2. Sheldrick, G. M. Acta Crystallogr. Sect. A 2008, 64, 112–122.



3q

CCDC No. 2261351





5a

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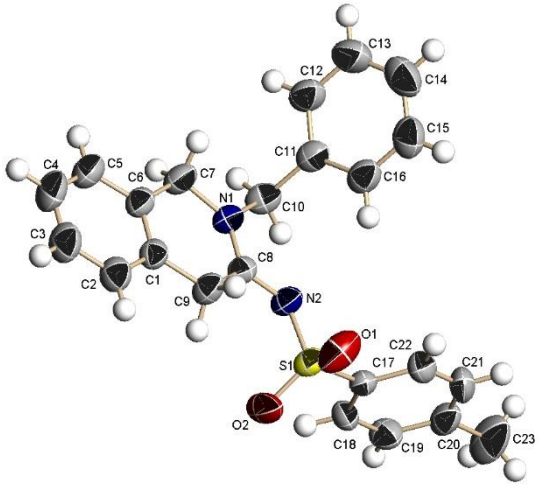

Table 1 Crystal data and structure refinement details for **3q.**

Compound	**3q**	**5a**
Empirical formula	C_{21} H_{26} N_2 O_2 S	C_{23} H_{22} N_2 O_2 S
Formula weight	370.50	390.49
Crystal System	Monoclinic	Orthorhombic
Space group	P 2_1/c	P b c a
a (Å)	8.68400(10)	15.7372(4)
b (Å)	16.4916(4)	13.4885(2)
c (Å)	13.6197(2)	18.8423(3)
α (°)	90.00	90.00
β (°)	92.3000(10)	90.00
γ (°)	90.00	90.00
V (Å^3)	1948.95(6)	3999.68(13)
Z	4	8
D_c (g/cm^3)	1.263	1.297
F_{000}	792	1648
μ (mm^{-1})	0.183	1.601
θ_{max} (°)	26.77	77.81
Total reflections	14006	15938
Unique reflections	3855	3992
Reflections [$I > 2\sigma(I)$]	3113	3450
Parameters	237	255
R_{int}	0.0391	0.0275
Goodness-of-fit	1.025	1.078
R [$F^2 > 2\sigma(F^2)$]	0.0454	0.0407
wR (F^2, all data)	0.1362	0.1256
CCDC No.	2261351	2261352

13. References

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9271–9278.

C Yang, J.; Zhao, H.; Tan, Z.; Cao, L.; Jiang, H.; Ci, C.; Dixneuf, P. H.; Zhang, M. syn-Selective Construction of fused heterocycles by Catalytic Reductive Tandem Functionalization of N-Heteroarenes. *ACS Catal.* **2021,** *11*, 9271–9278.

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14. Copies of Spectra

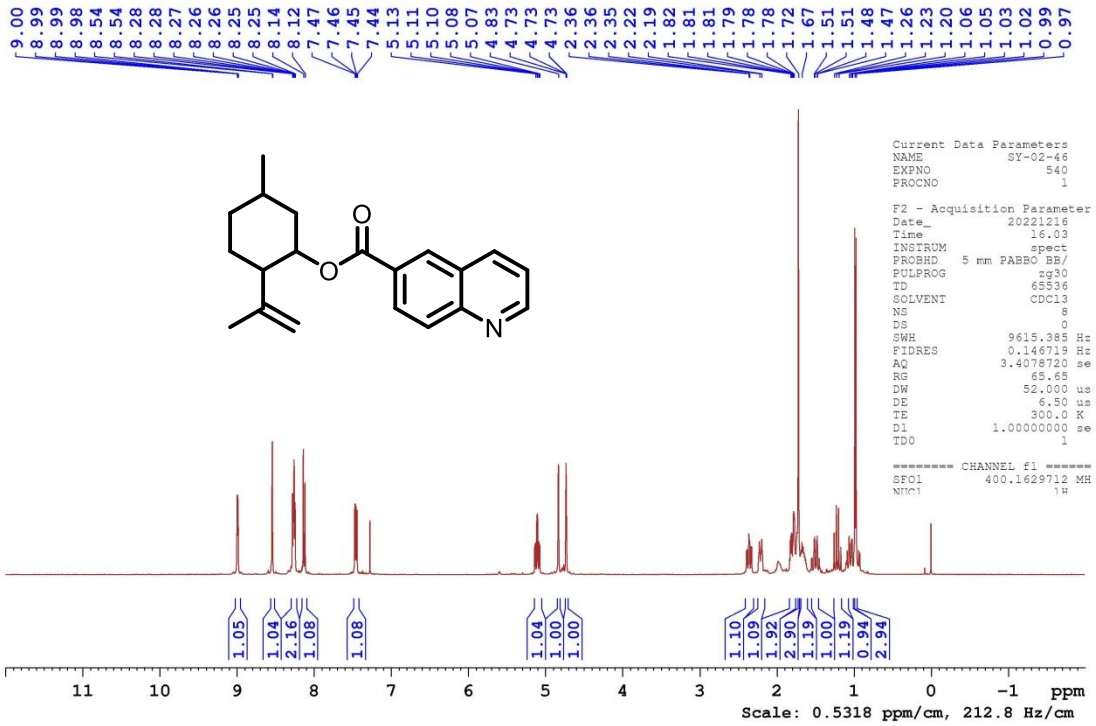

Figure S-1: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **a_{11}**

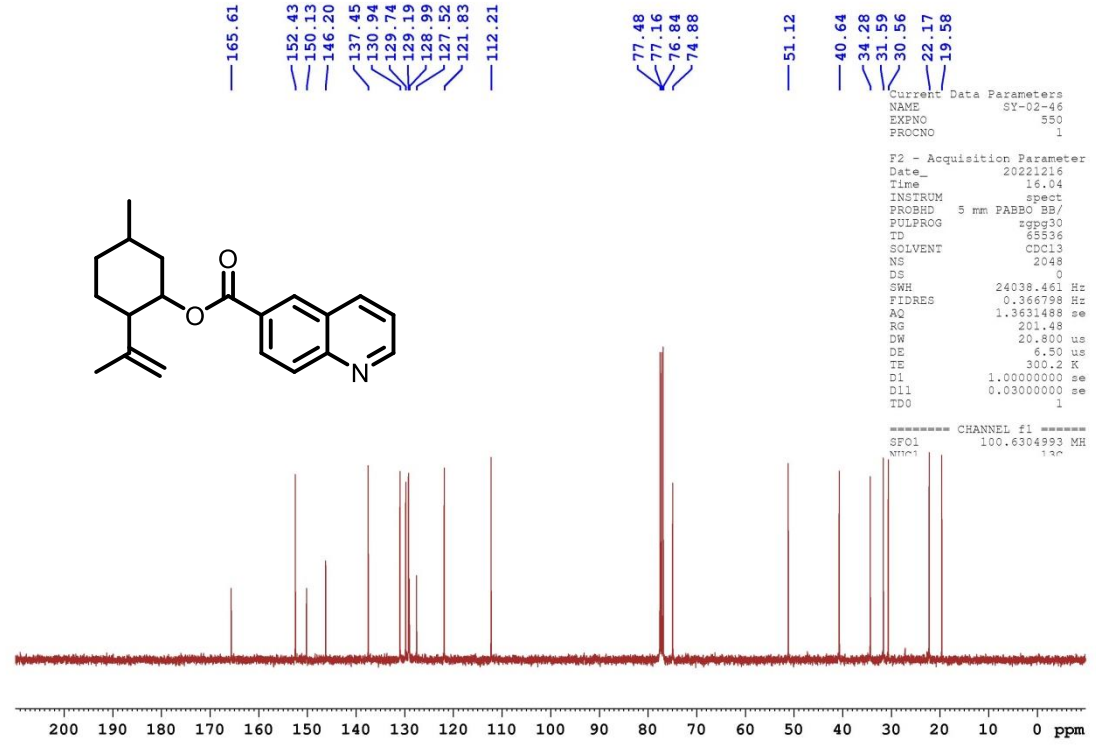

Figure S-2: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **a_{11}**

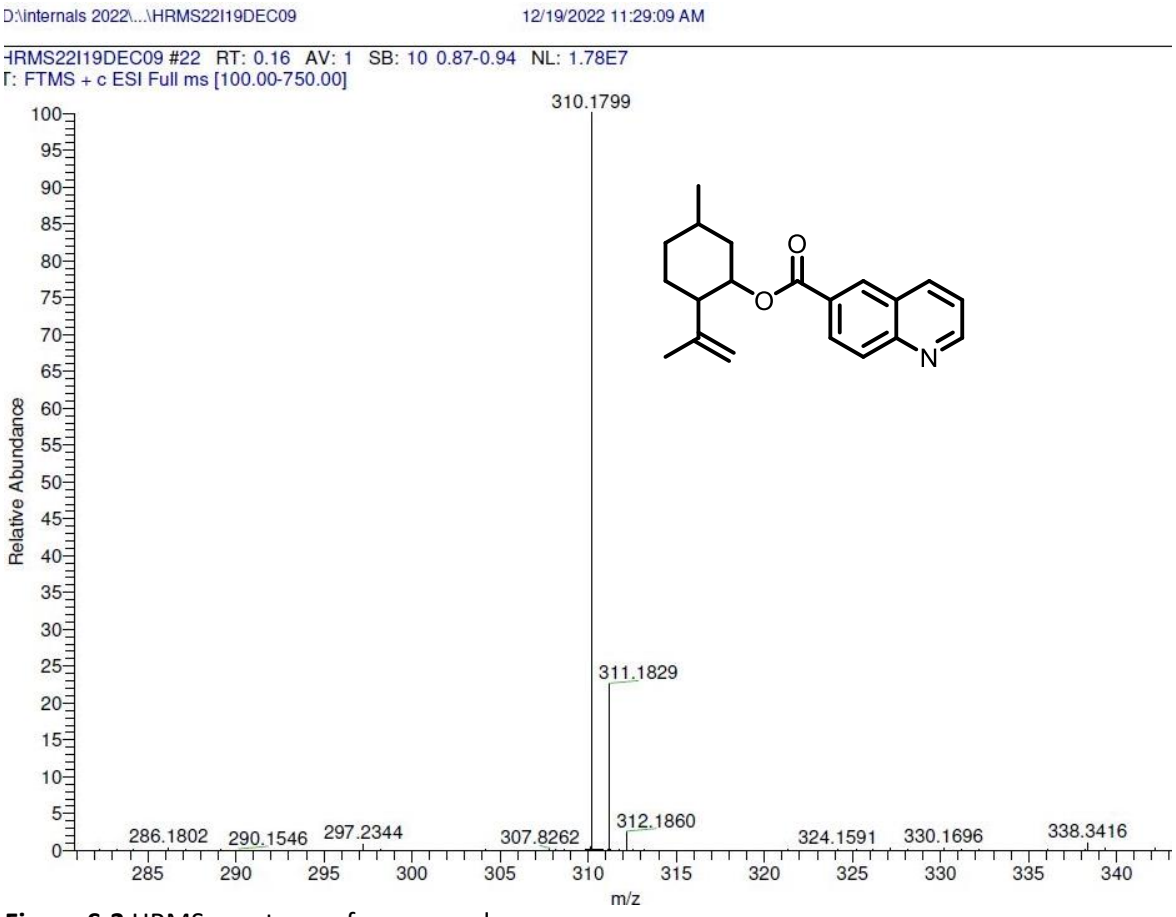

Figure S-3 HRMS spectrum of compound **a$_{11}$**

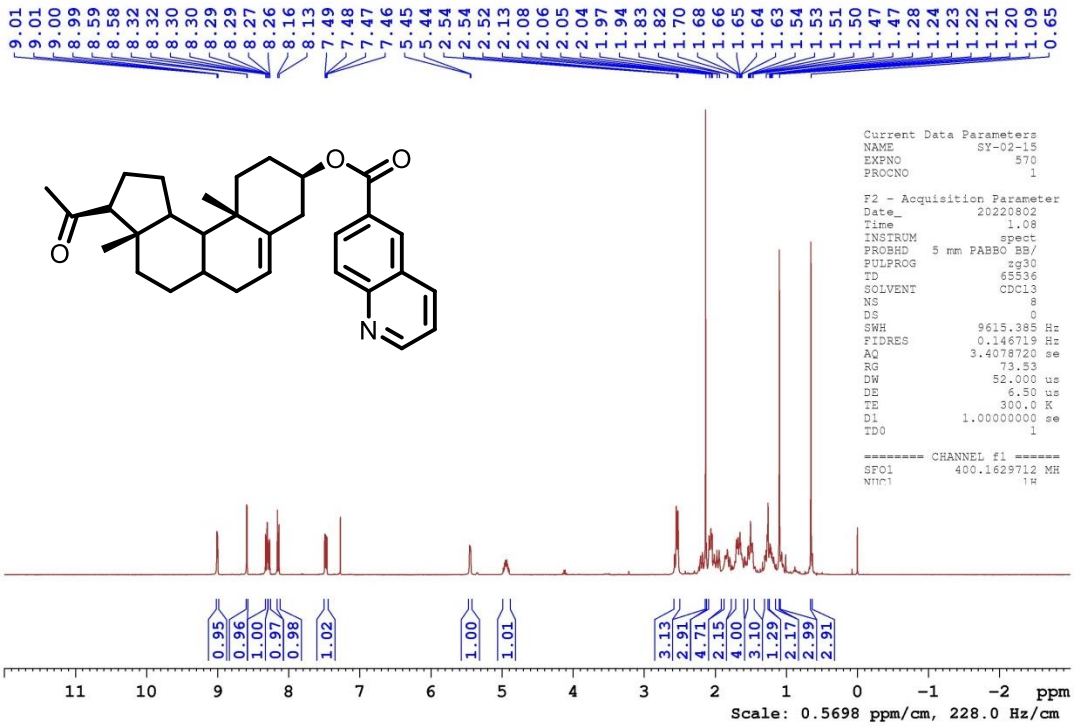

Figure S-4: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **a$_{14}$**

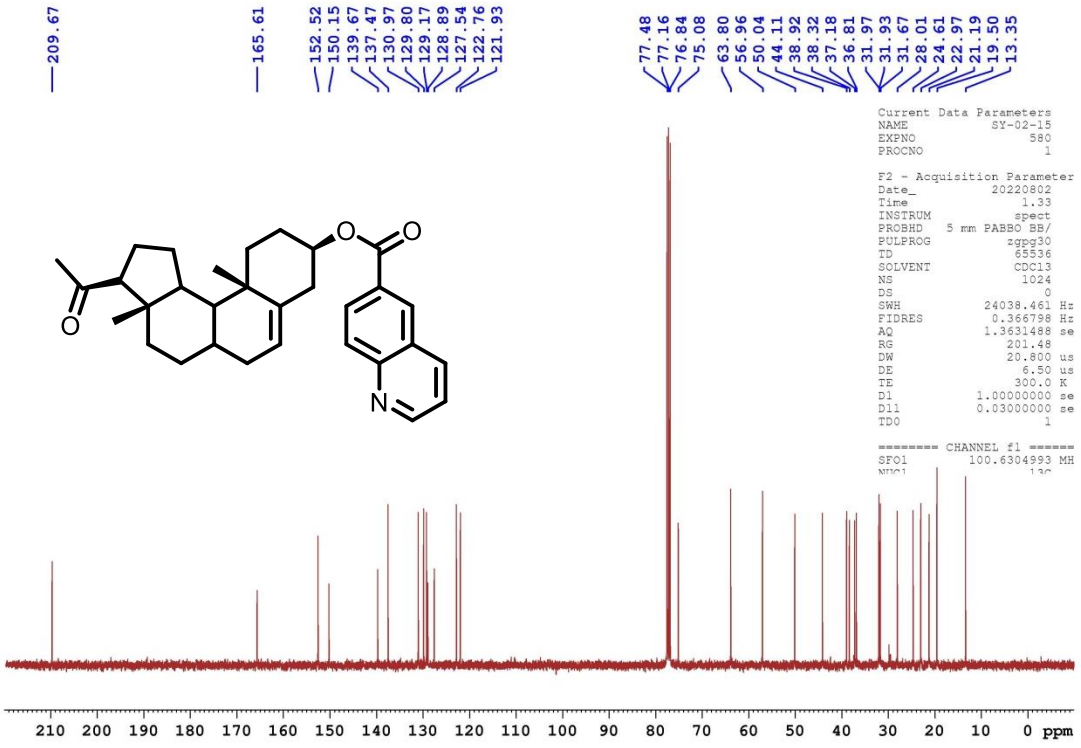

Figure S-5: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **a_{14}**

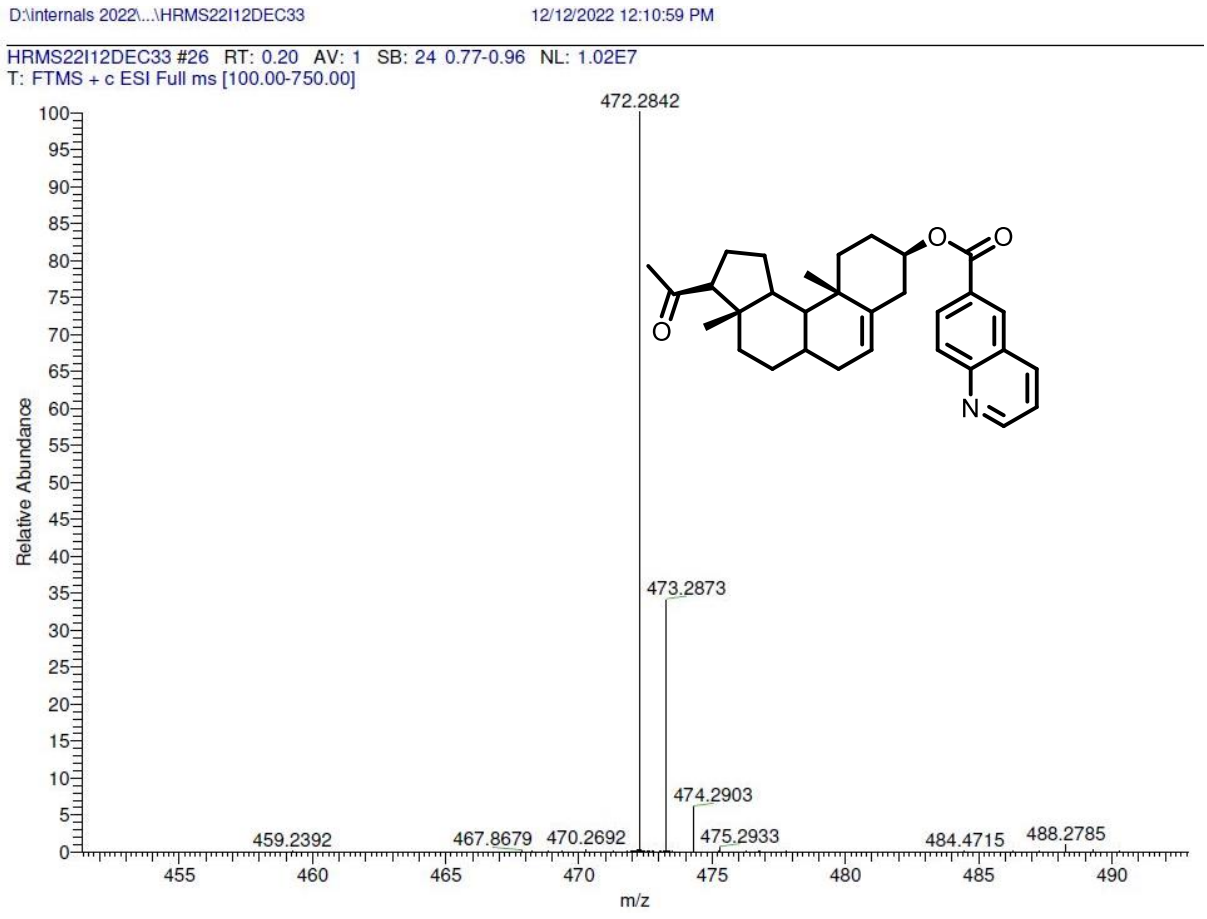

Figure S-6 HRMS spectrum of compound **a_{14}**

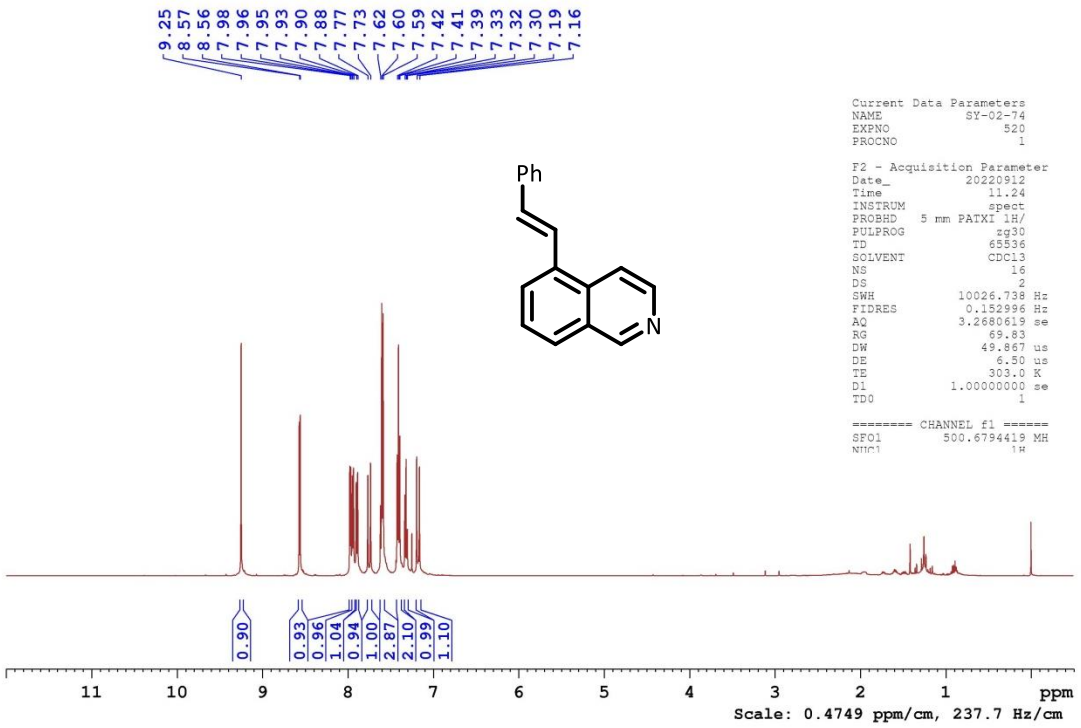

Figure S-7: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **a_{17}**

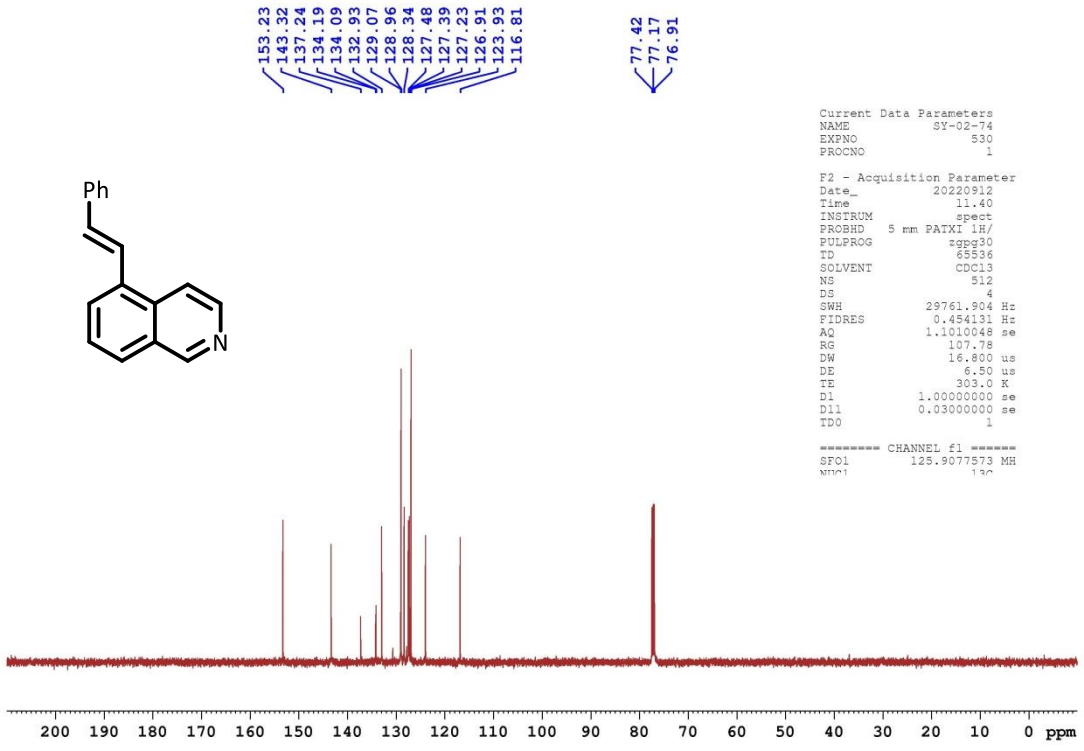

Figure S-8: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **a_{17}**

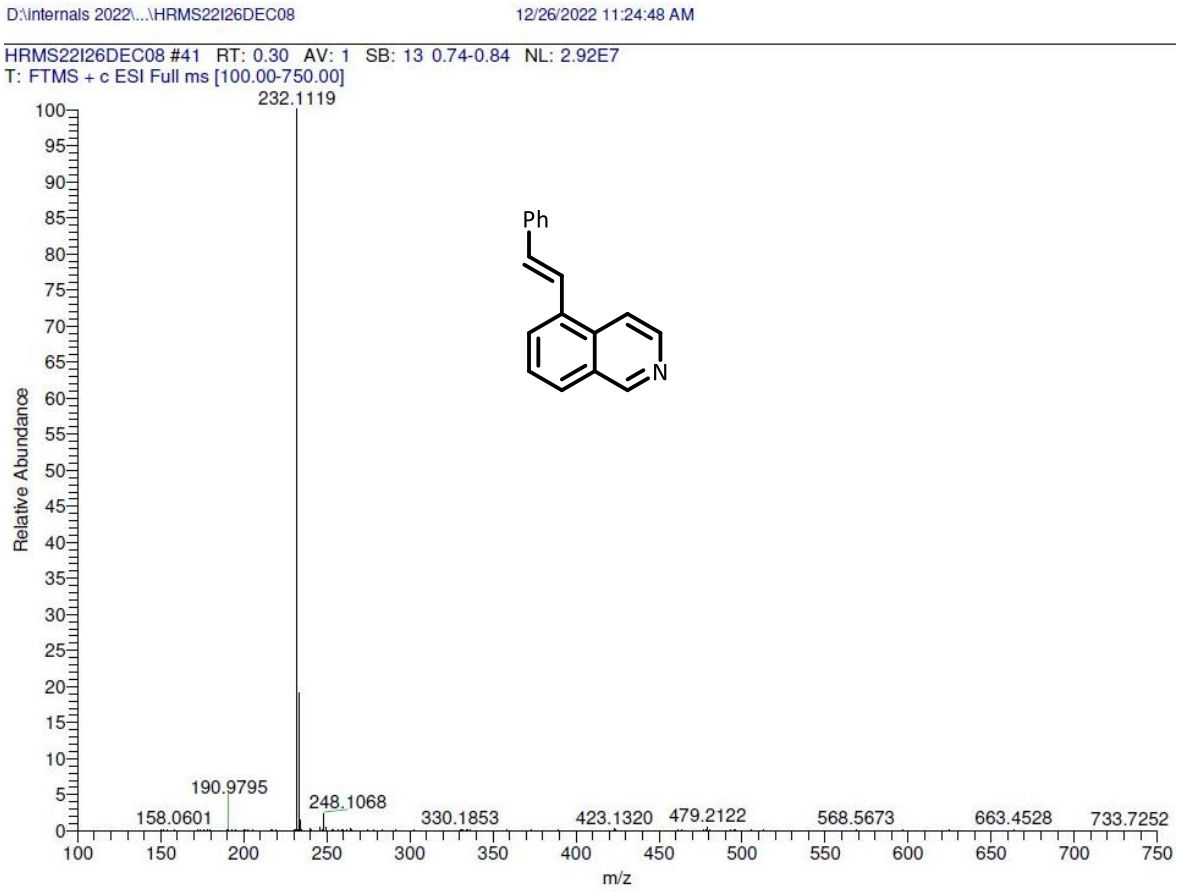

Figure S-9 HRMS spectrum of compound **a$_{17}$**

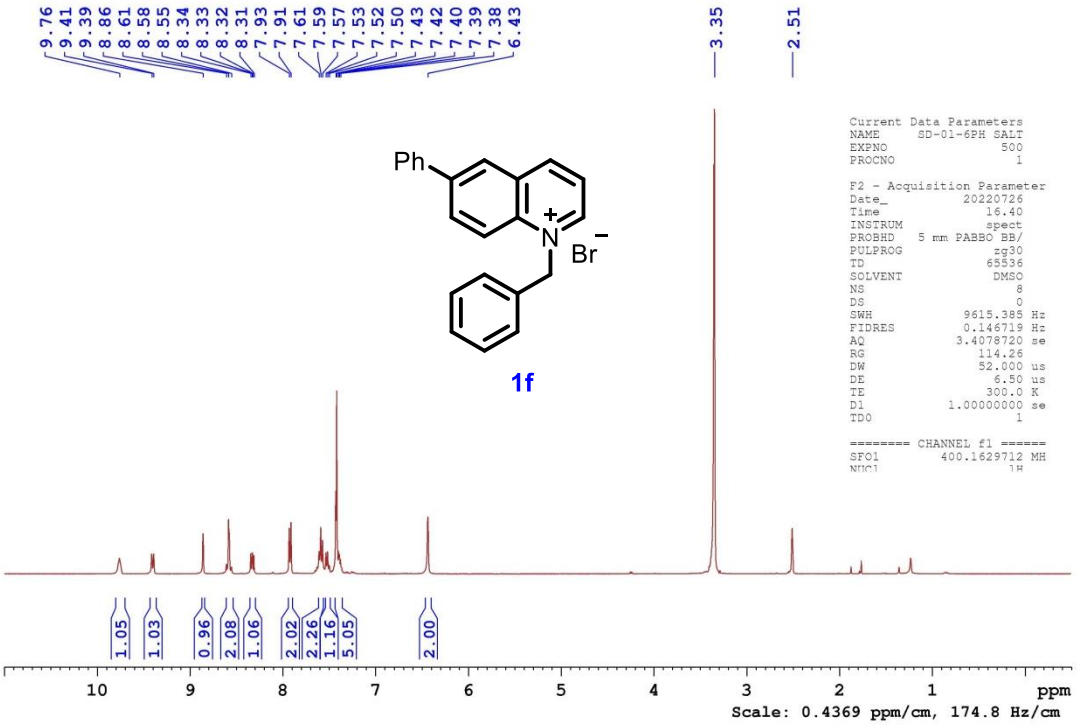

Figure S-10: ^{1}H NMR (400 MHz, DMSO-d$_6$) spectrum of compound **1f**

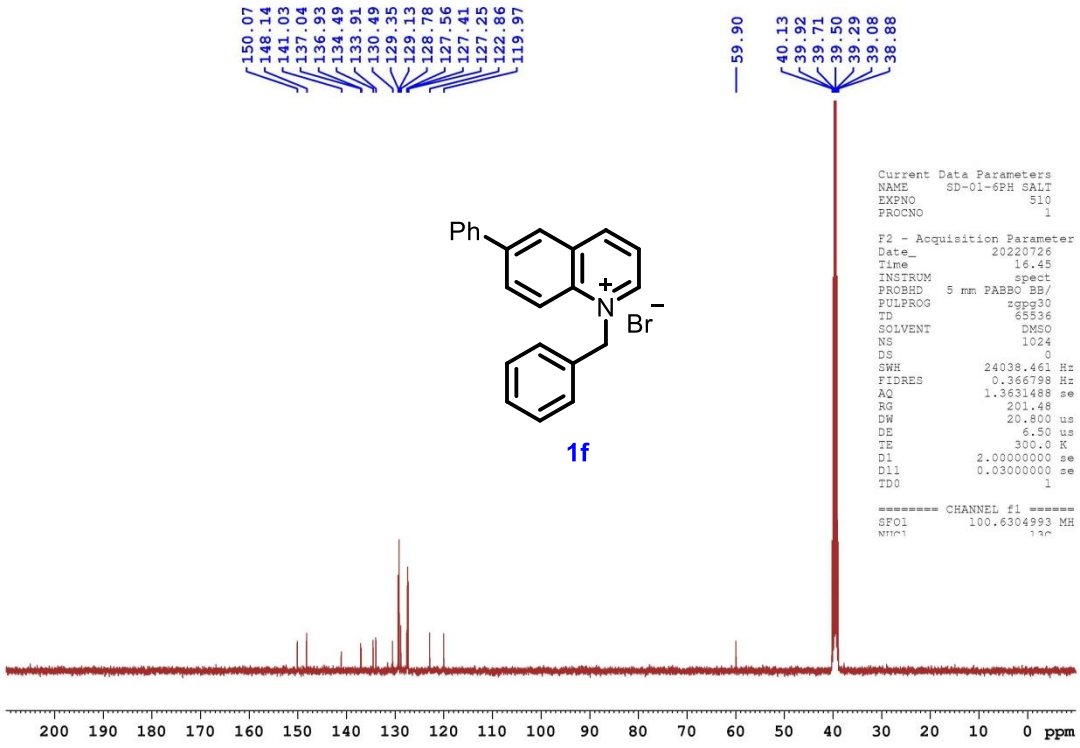

Figure S-11: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **1f**

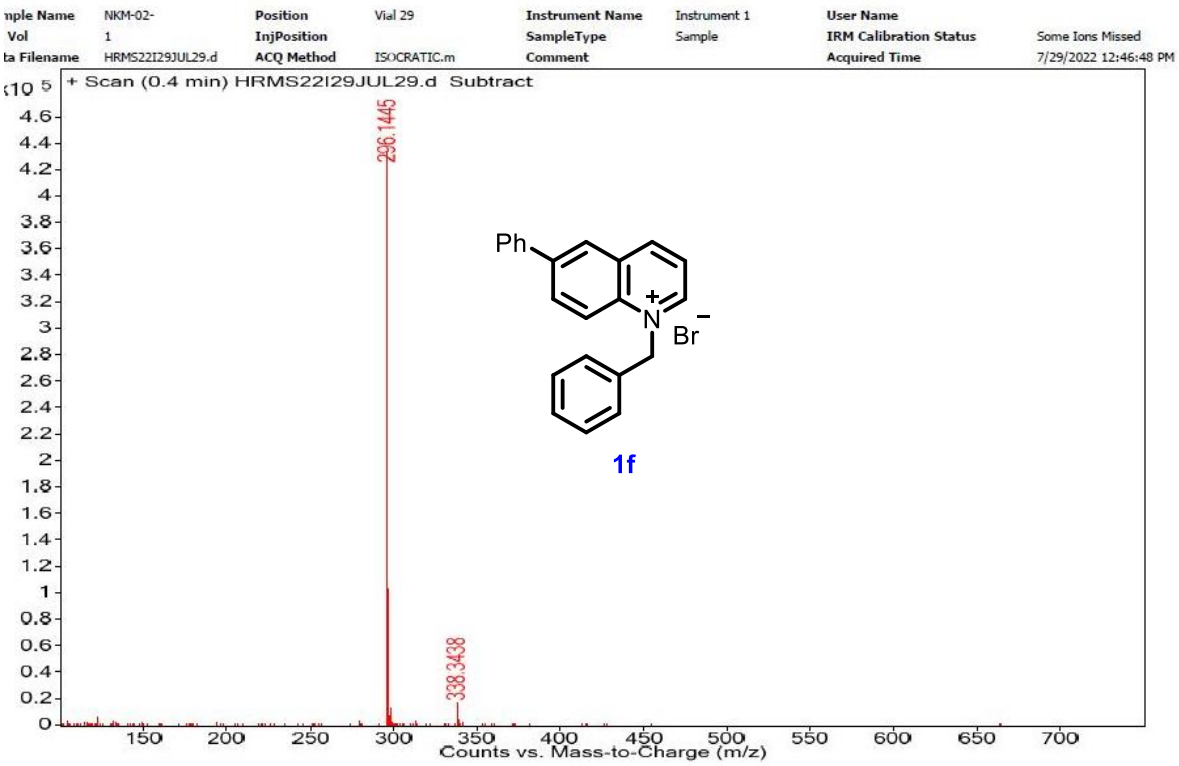

Figure S-12 HRMS spectrum of compound **1f**

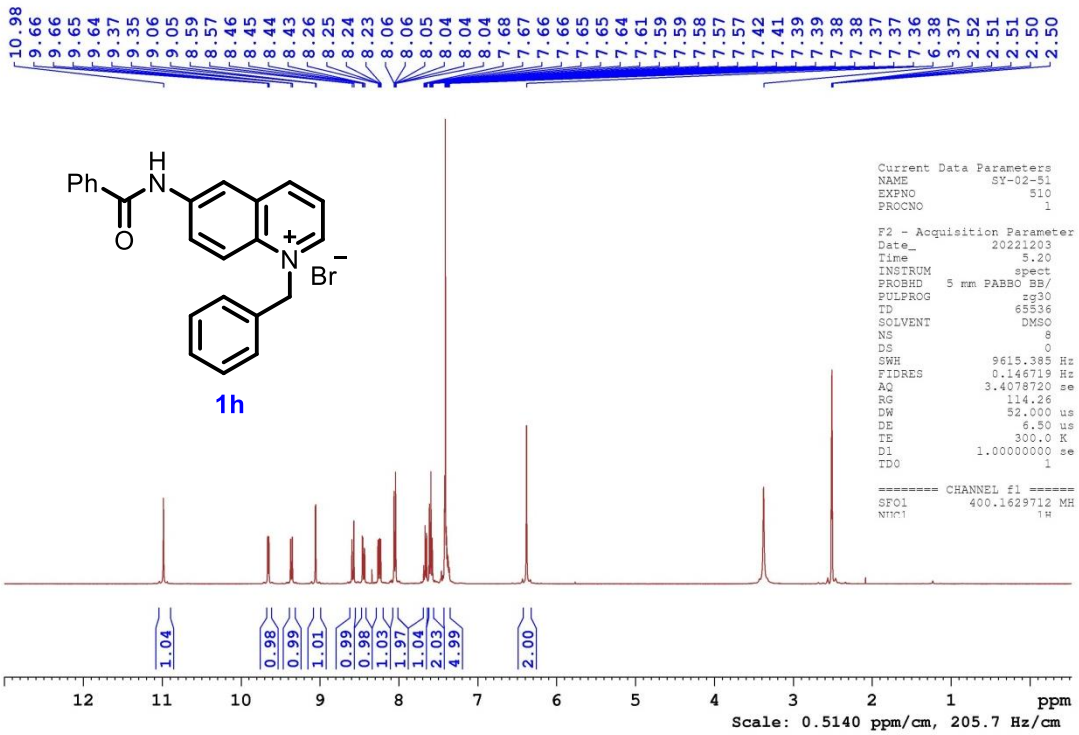

Figure S-13: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **1h**

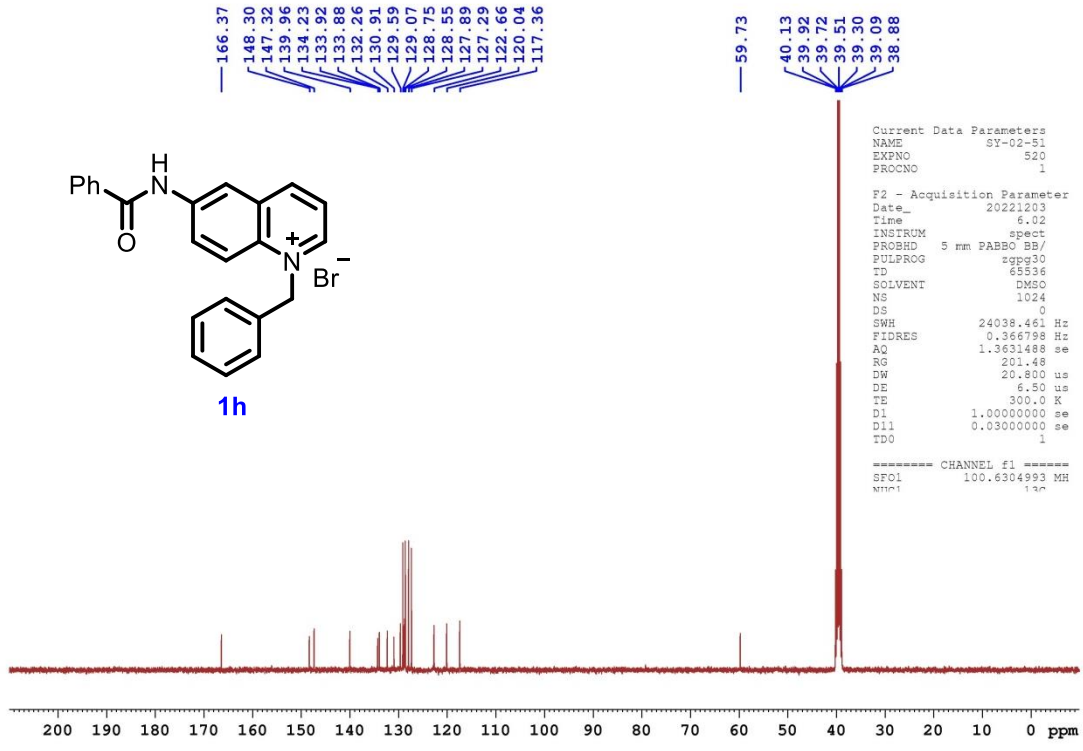

Figure S-14: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **1h**

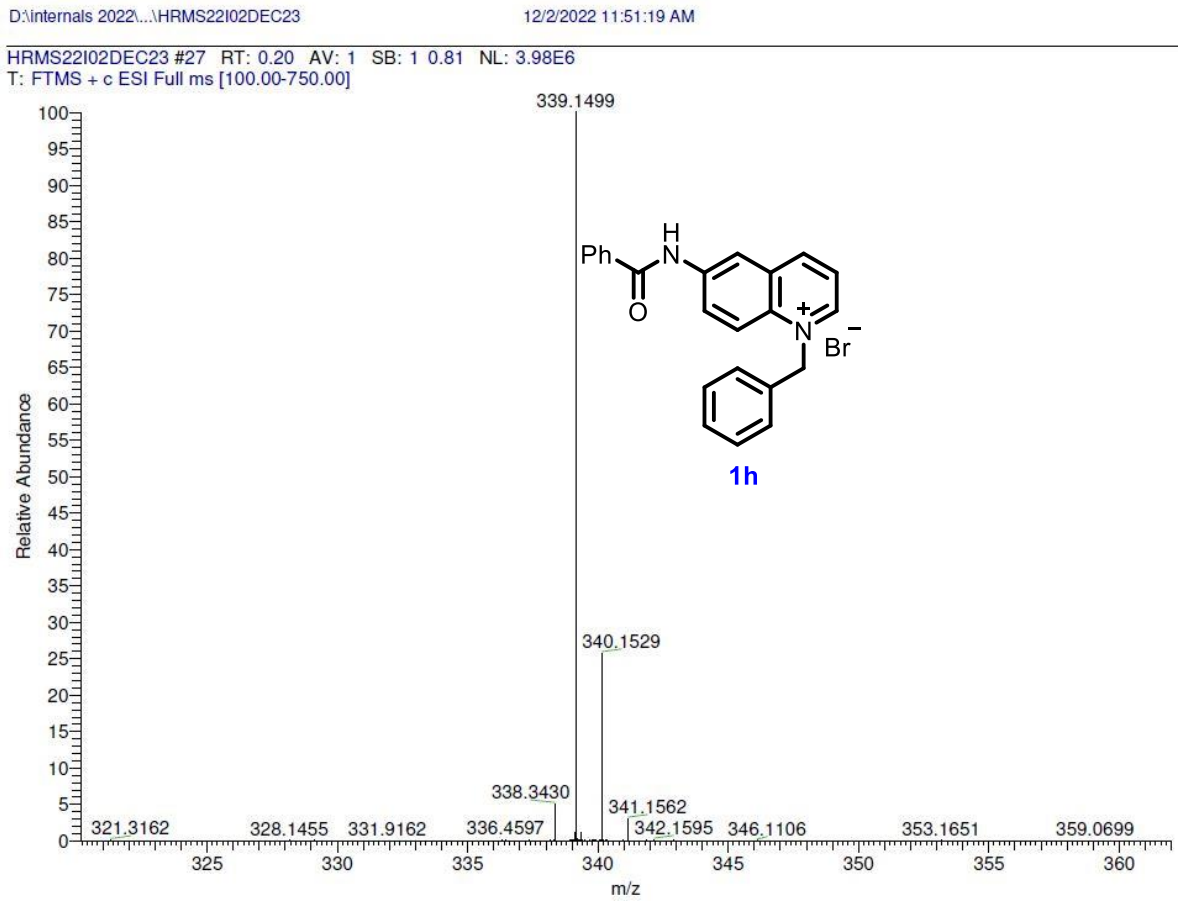

Figure S-15 HRMS spectrum of compound **1h**

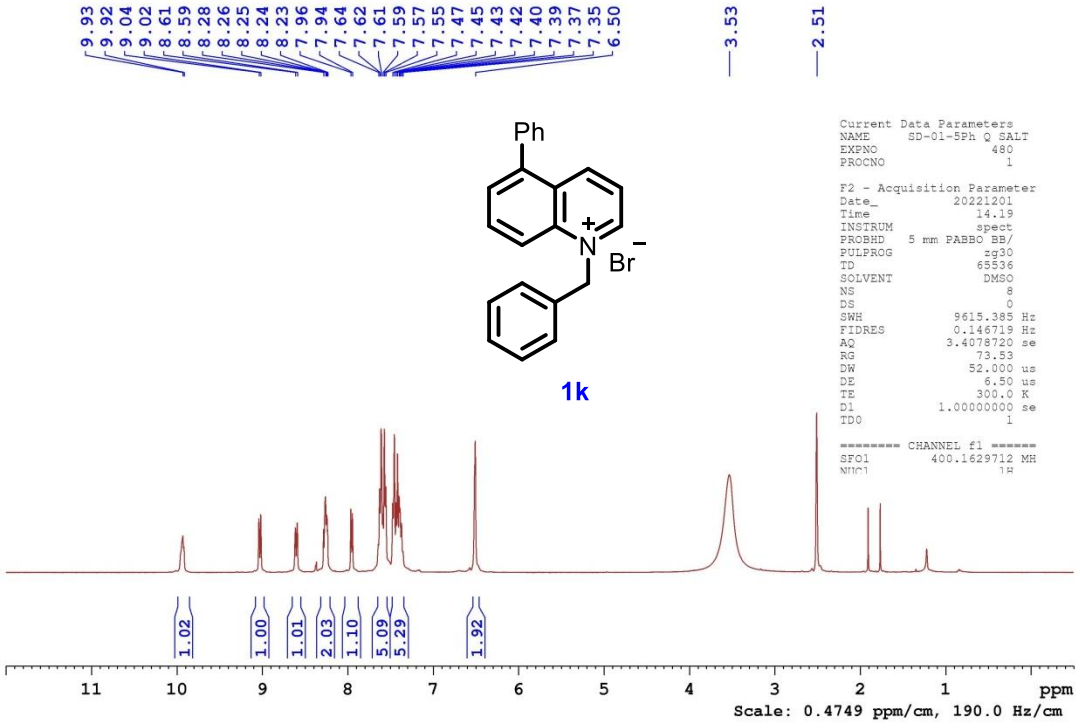

Figure S-16: ^{1}H NMR (500 MHz, DMSO-d_6) spectrum of compound **1k**

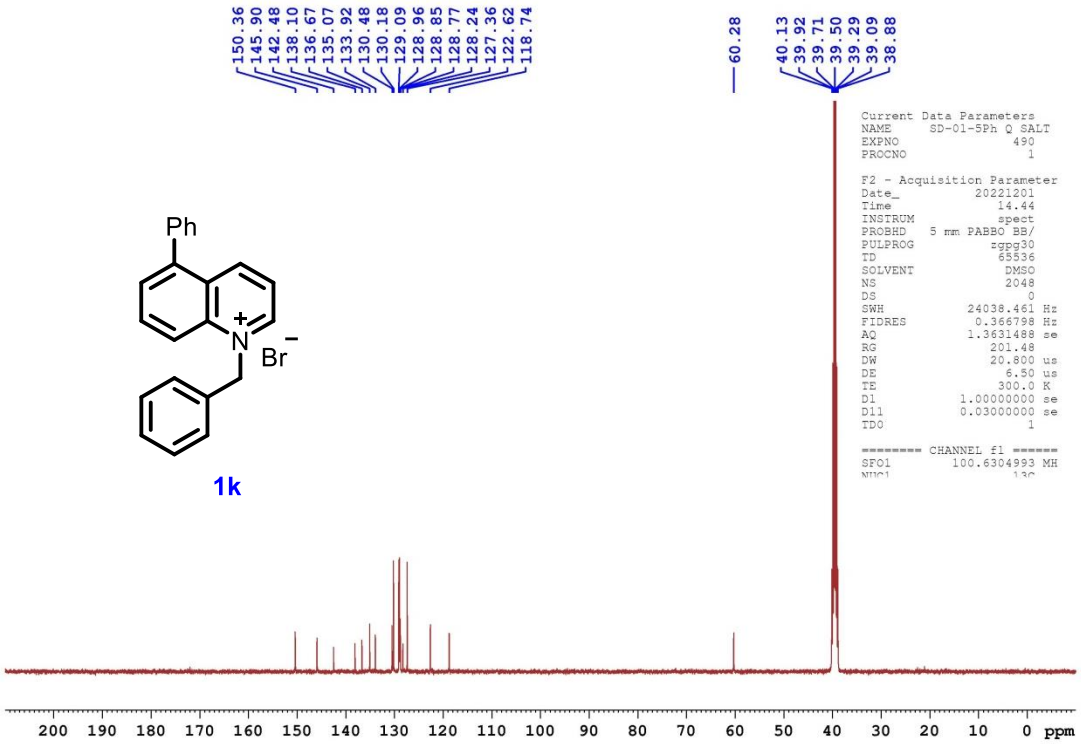

Figure S-17: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **1k**

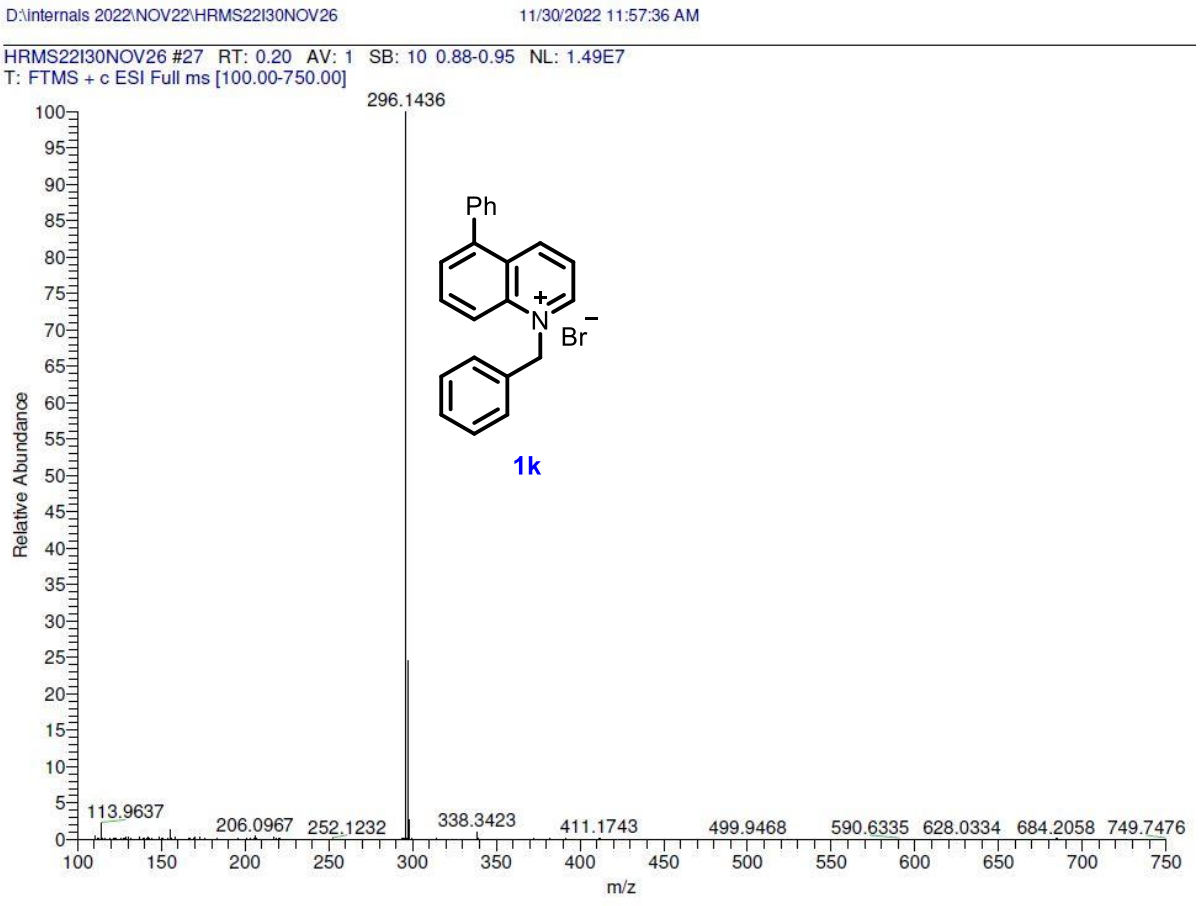

Figure S-18 HRMS spectrum of compound **1k**

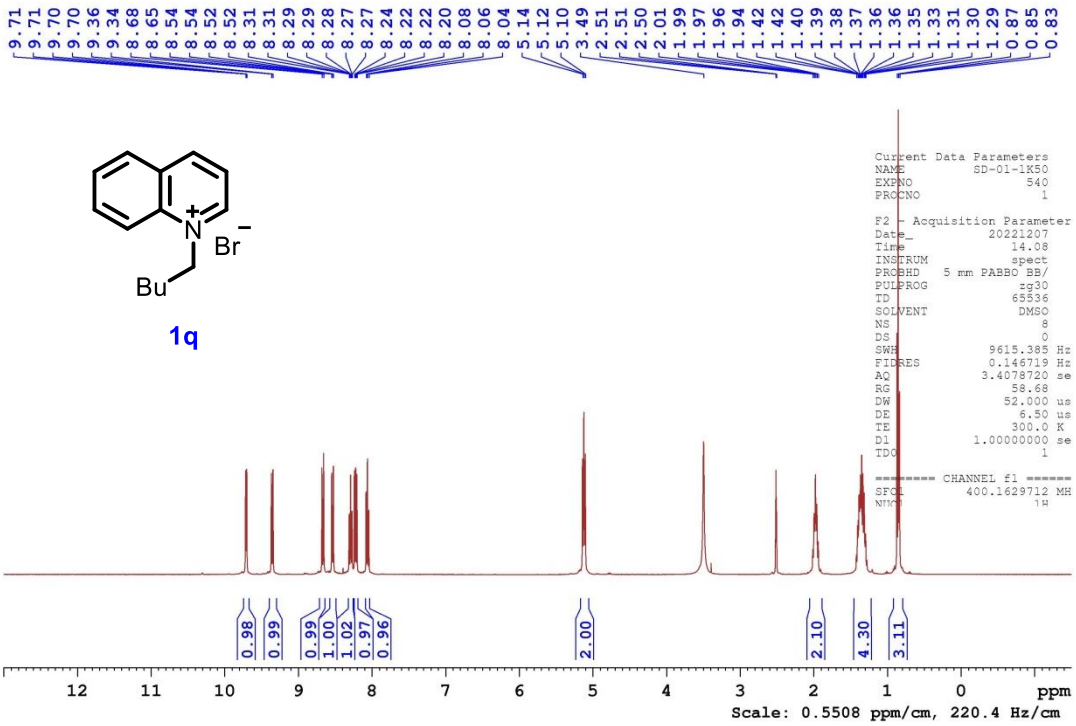

Figure S-19: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **1q**

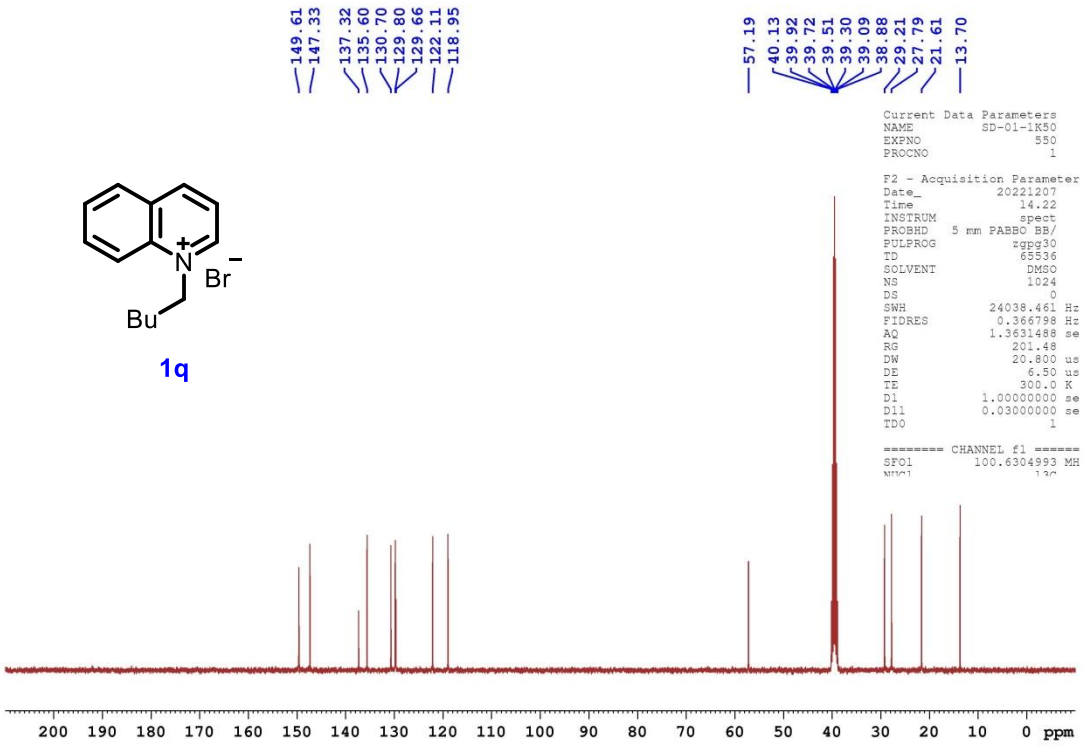

Figure S-20: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **1q**

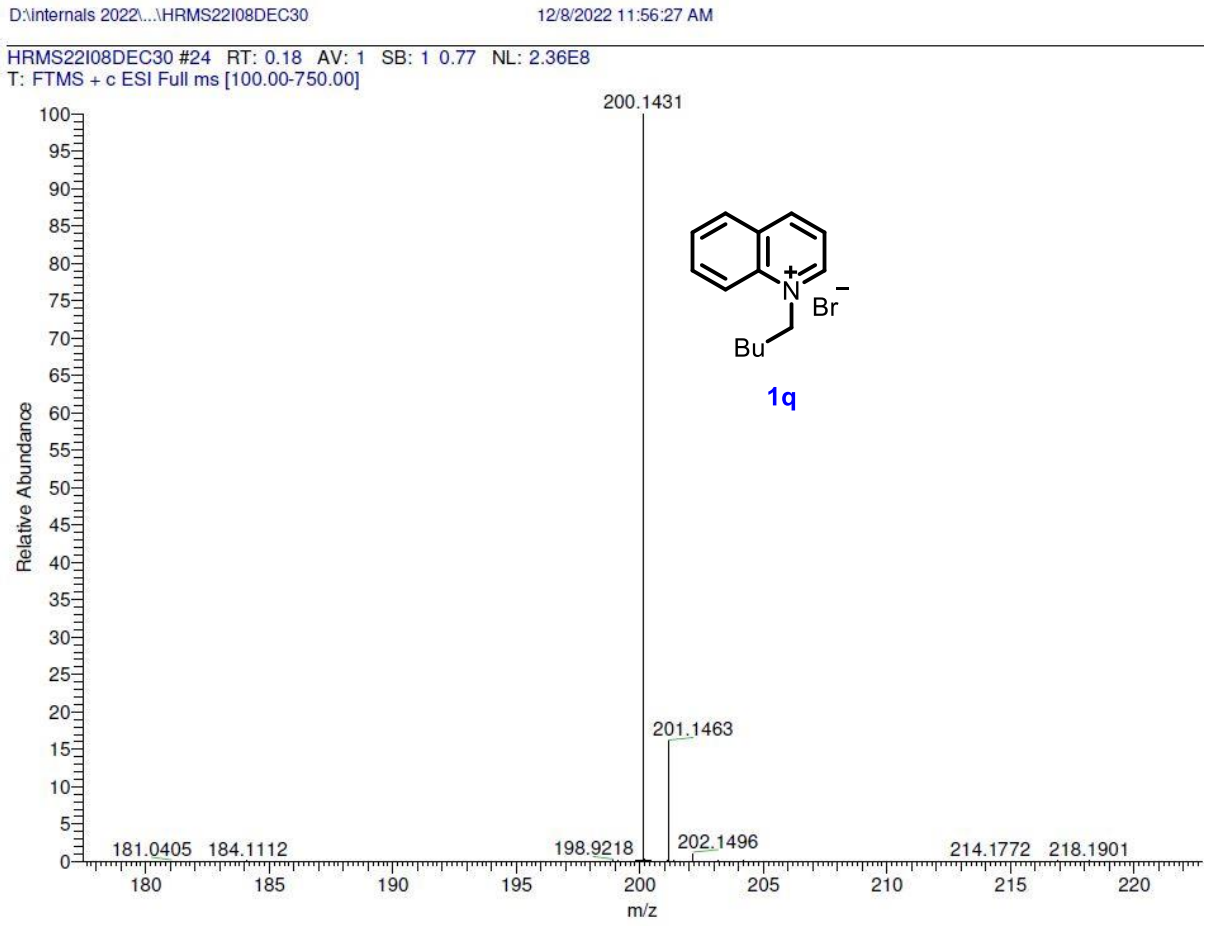

Figure S-21 HRMS spectrum of compound **1q**

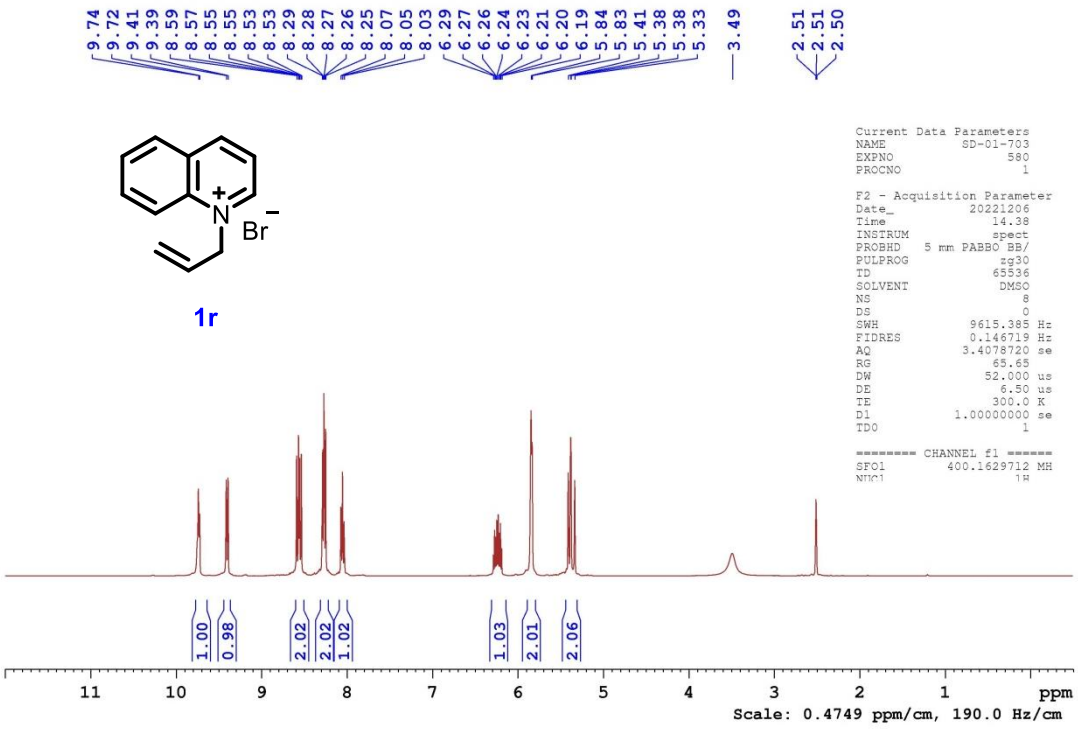

Figure S-22: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **1r**

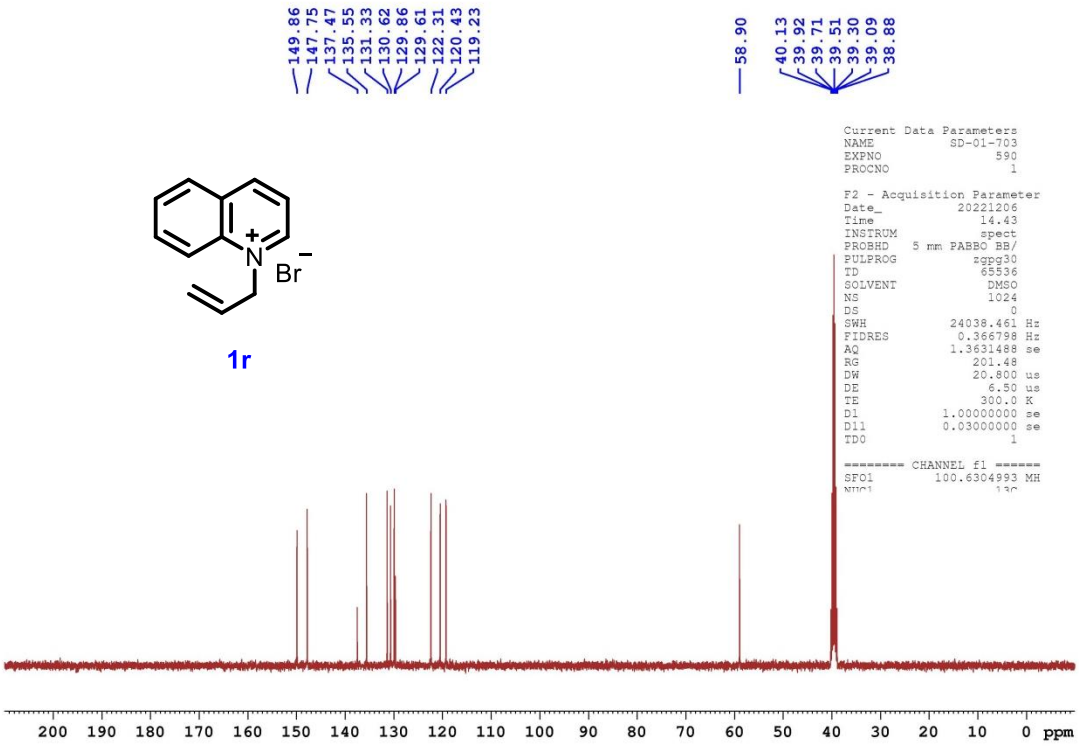

Figure S-23: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **1r**

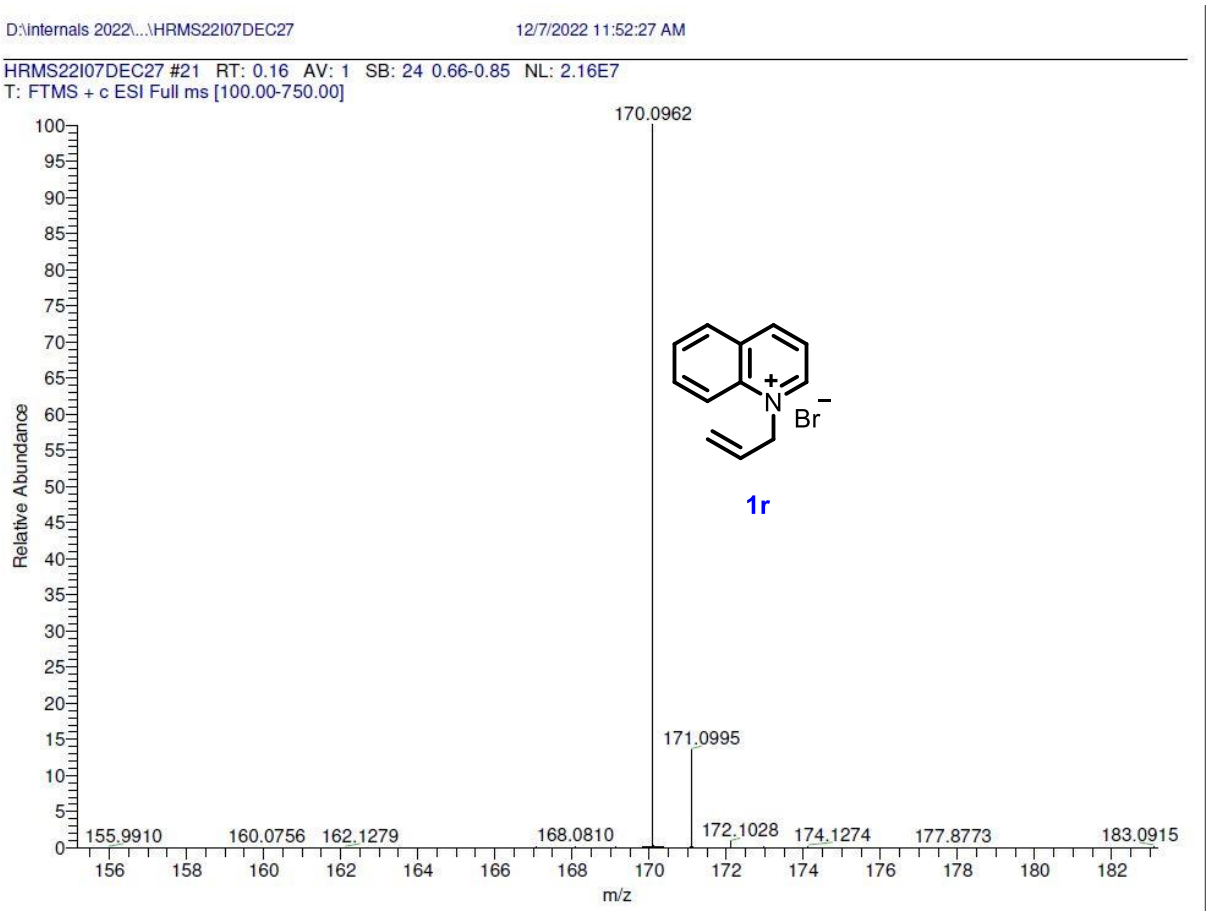

Figure S-24 HRMS spectrum of compound **1r**

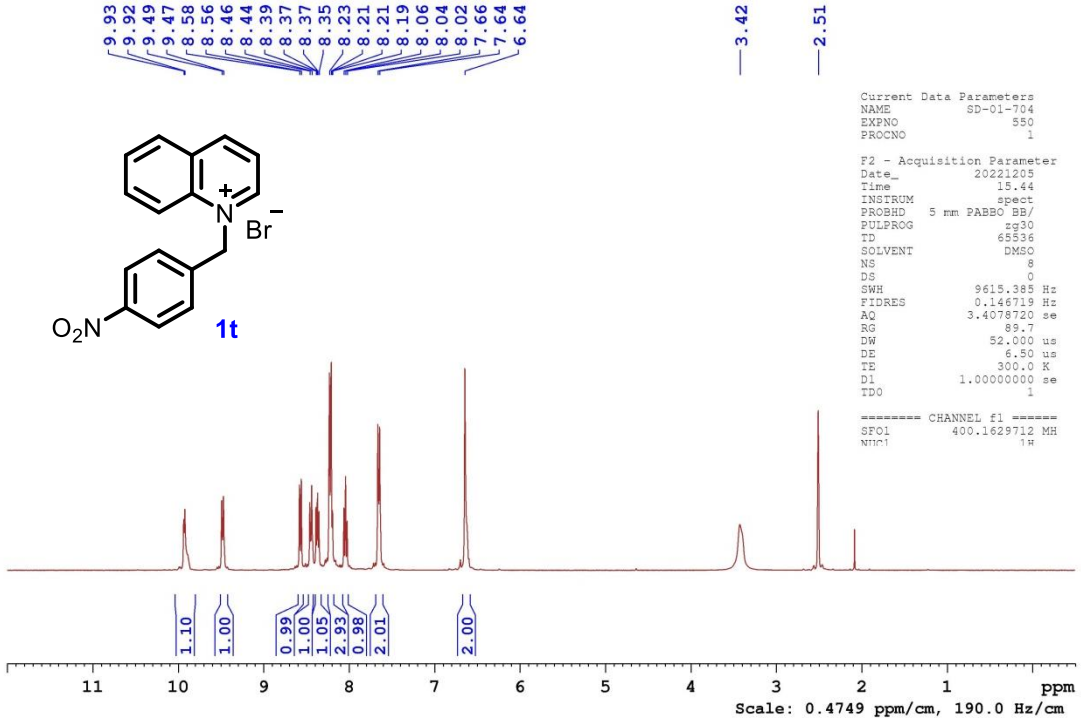

Figure S-25: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **1t**

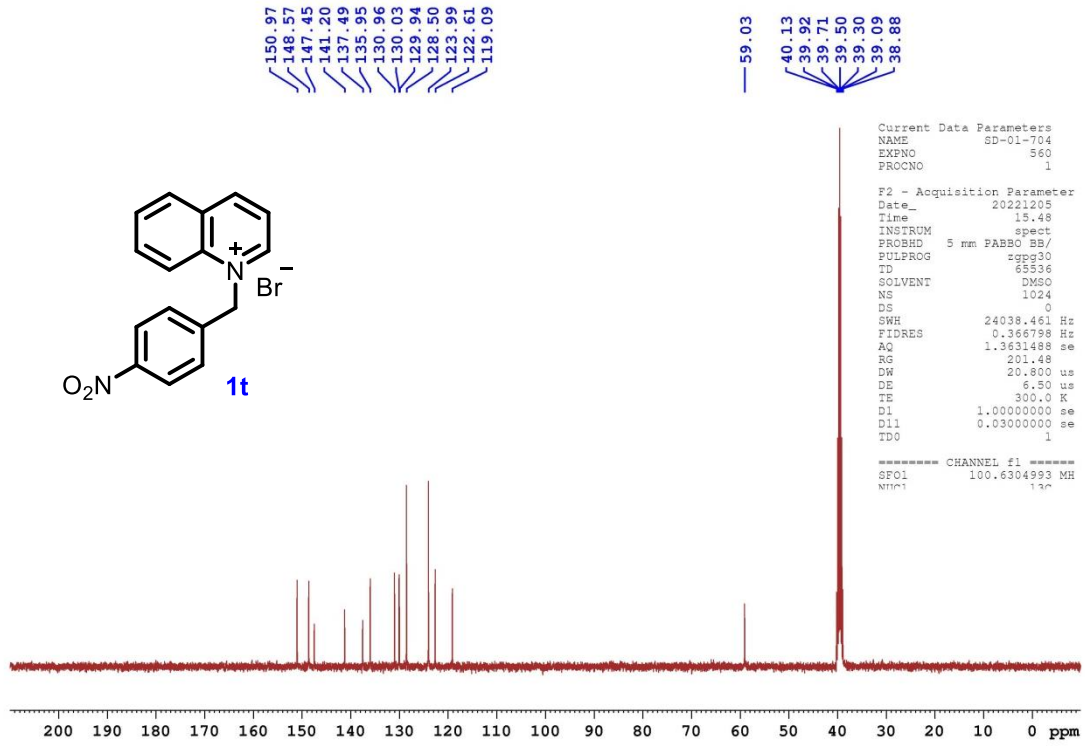

Figure S-26: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **1t**

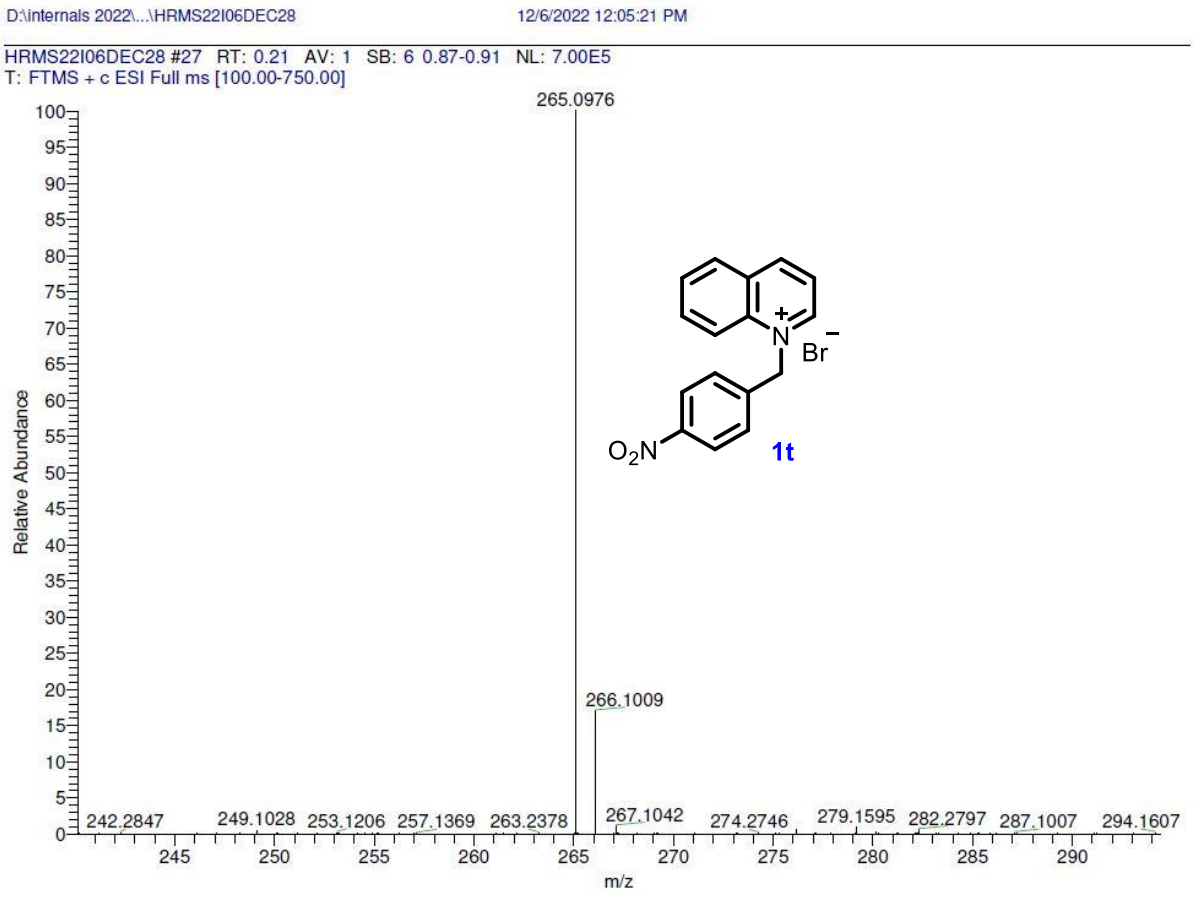

Figure S-27 HRMS spectrum of compound **1t**

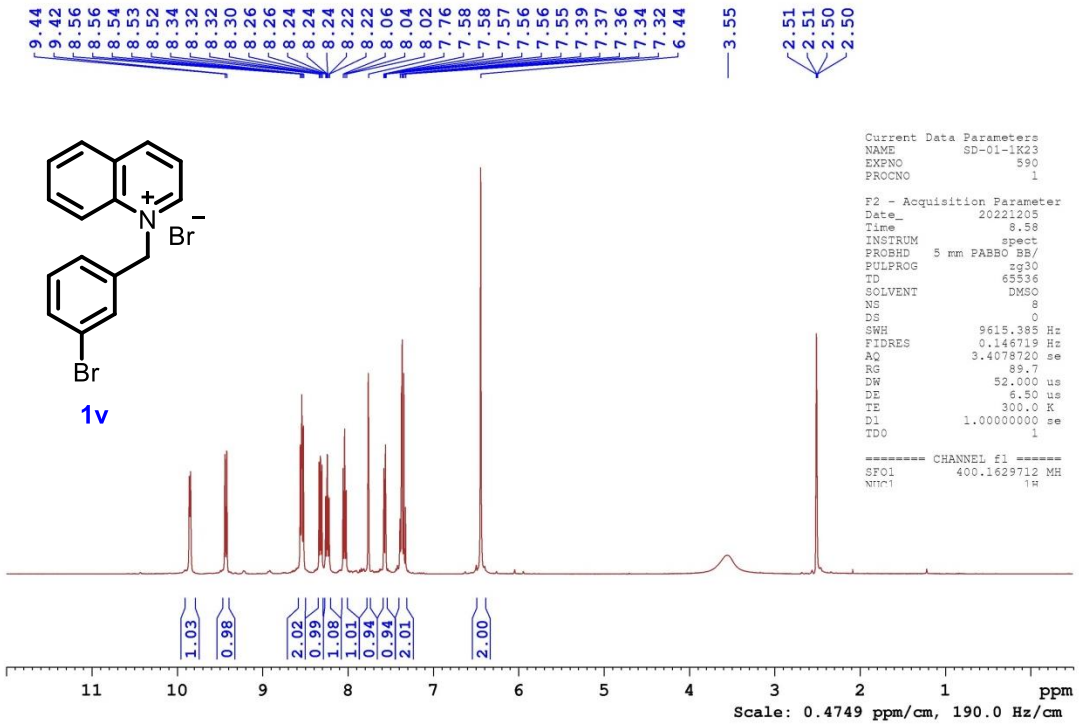

Figure S-28: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **1v**

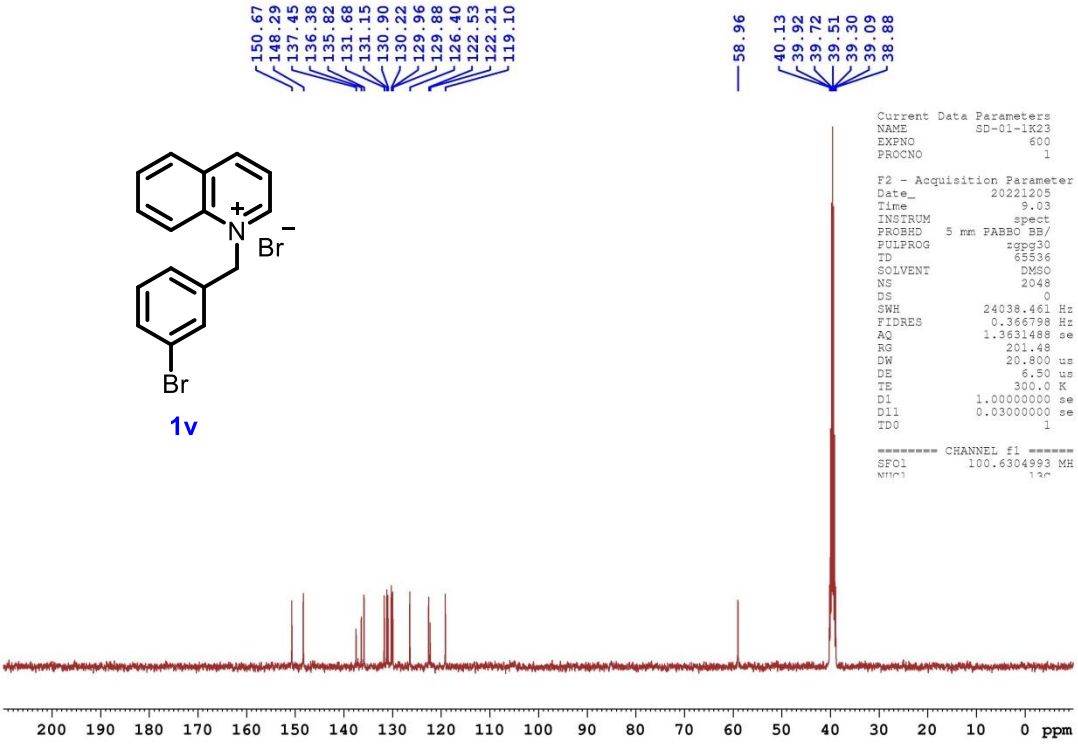

Figure S-29: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **1v**

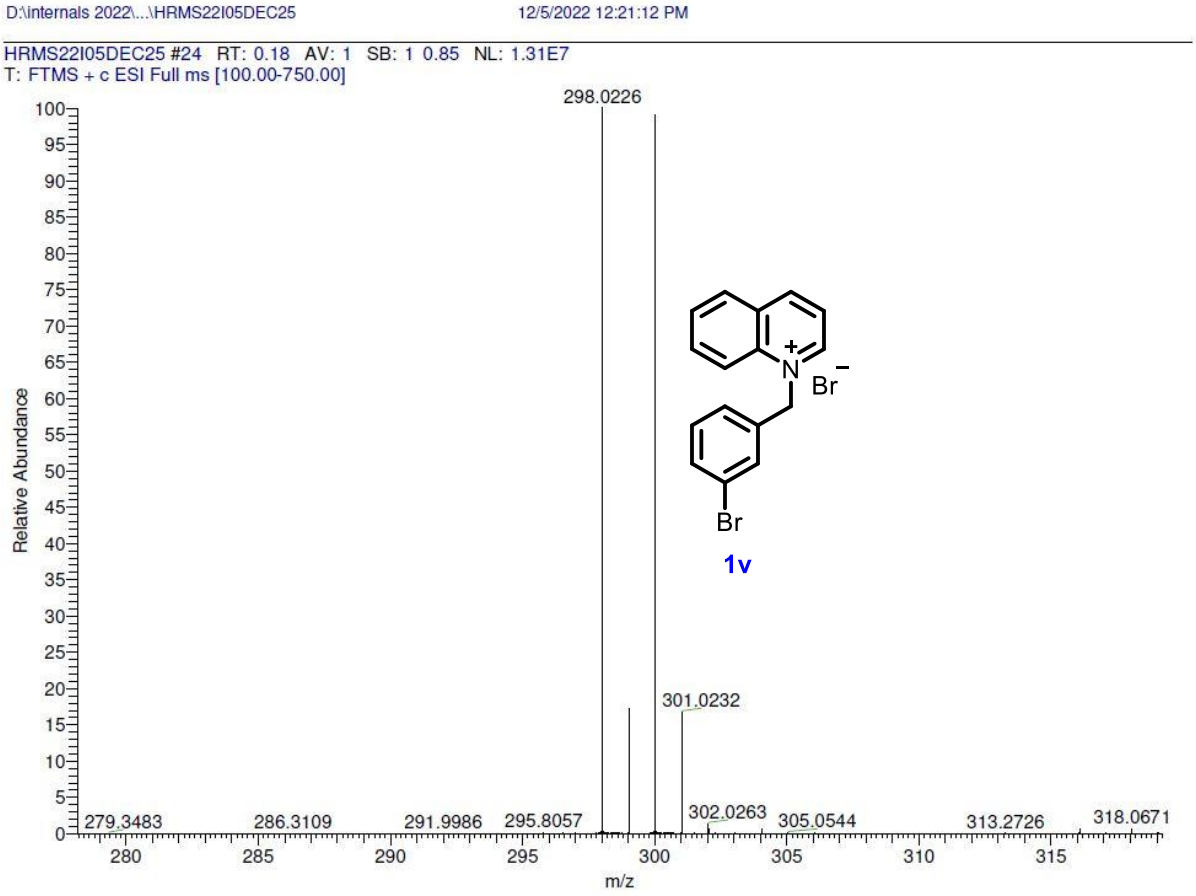

Figure S-30 HRMS spectrum of compound **1v**

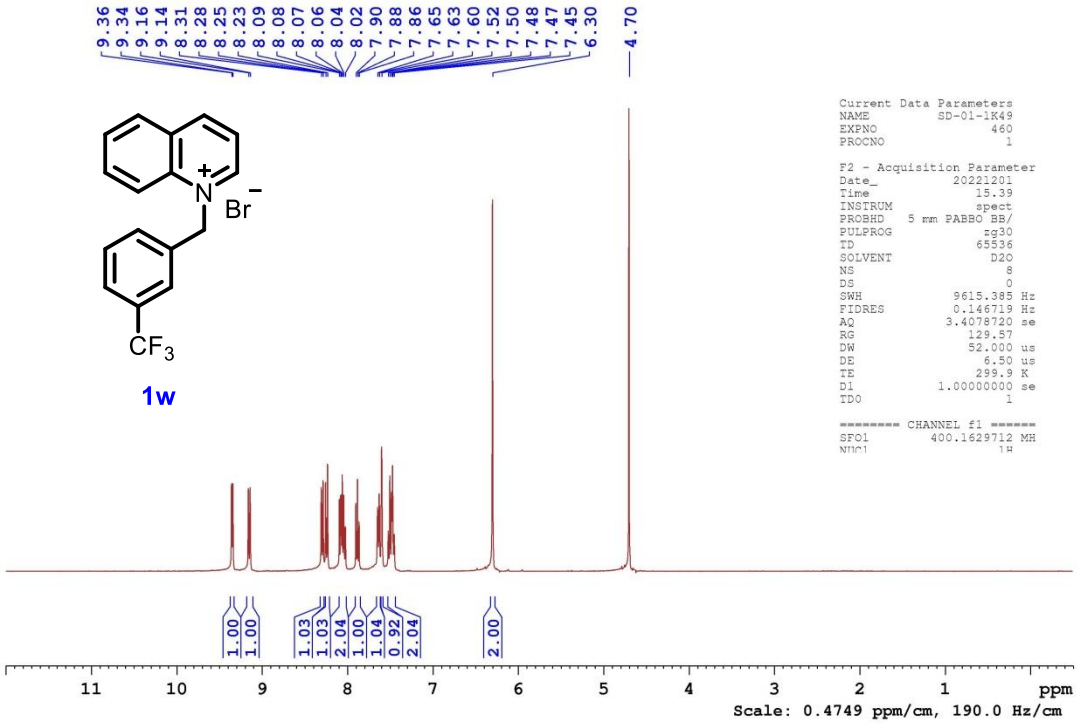

Figure S-31: ^{1}H NMR (400 MHz, D_2O) spectrum of compound **1w**

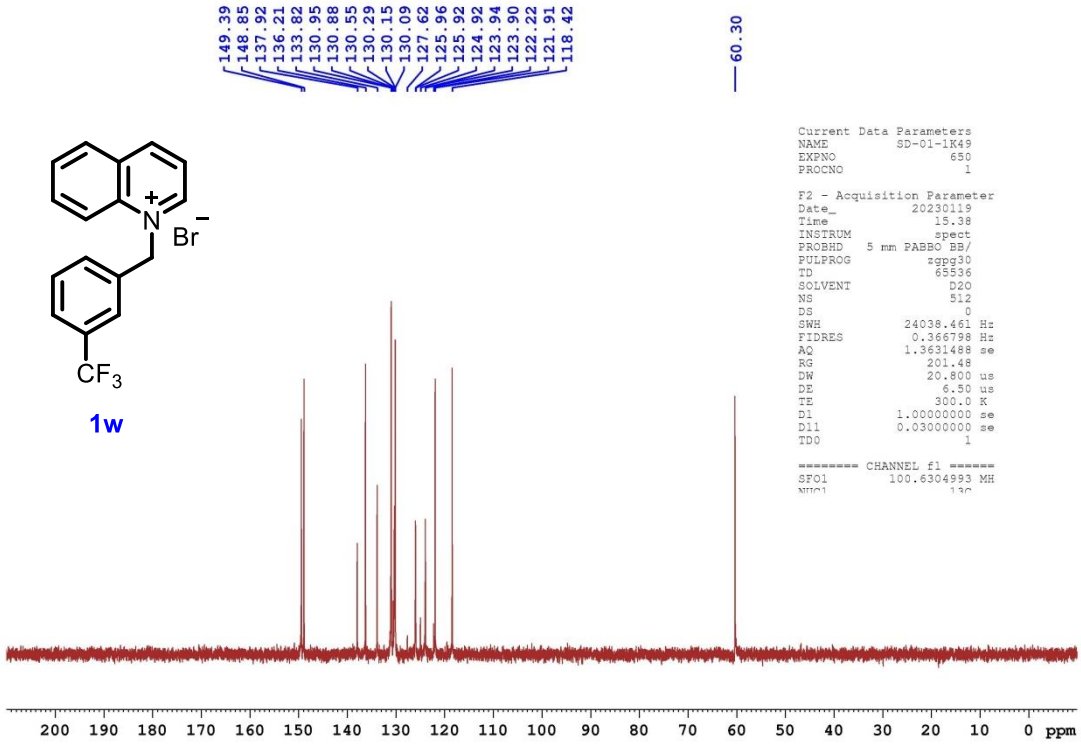

Figure S-32: ^{13}C NMR (100 MHz, D_2O) spectrum of compound **1w**

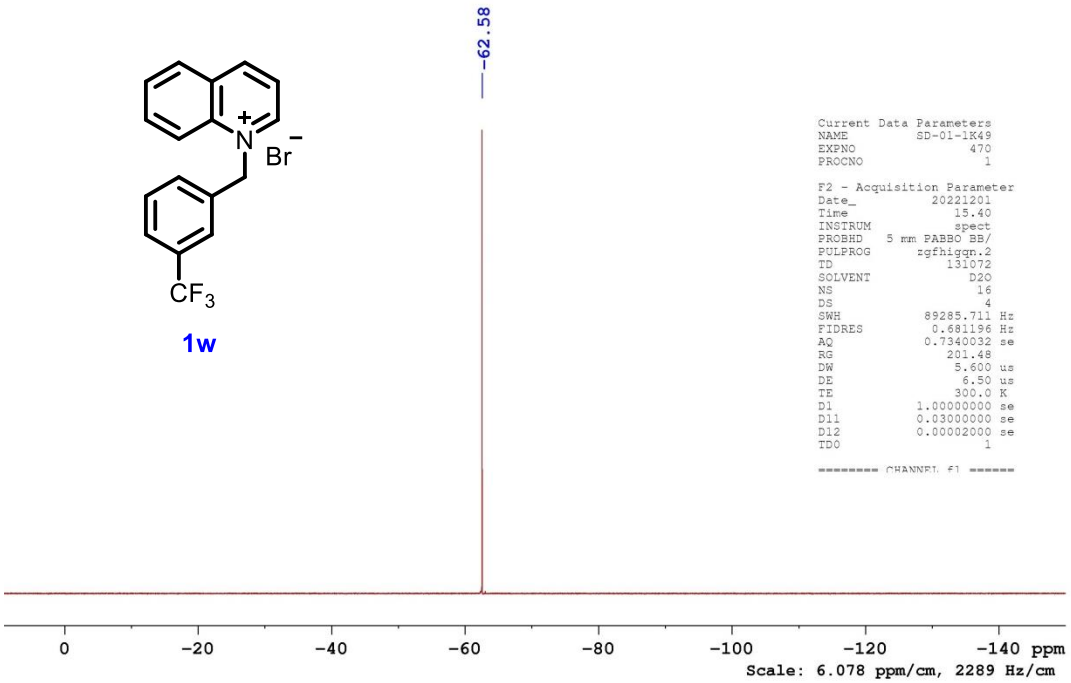

Figure S-33: ^{19}F NMR (376 MHz, D_2O) spectrum of compound **1w**

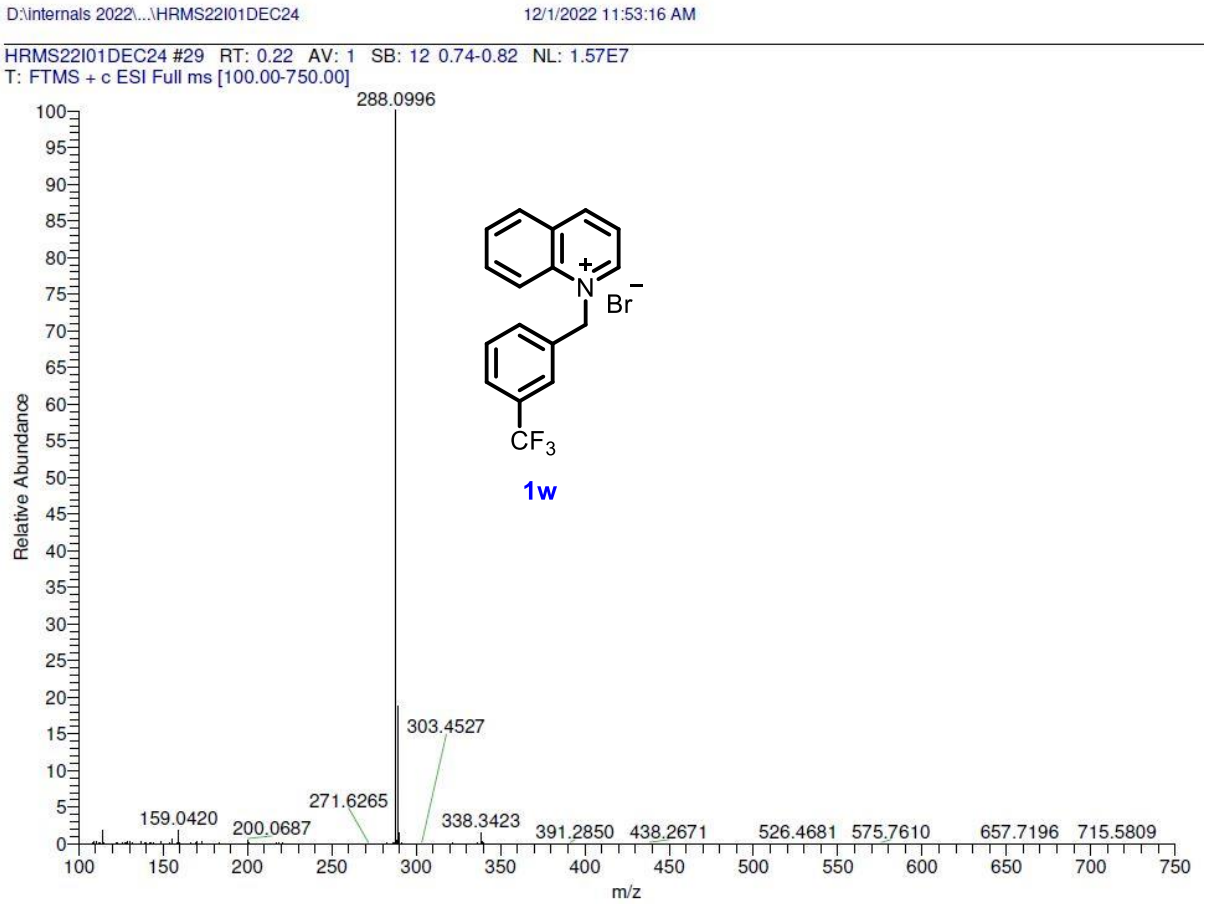

Figure S-34 HRMS spectrum of compound **1w**

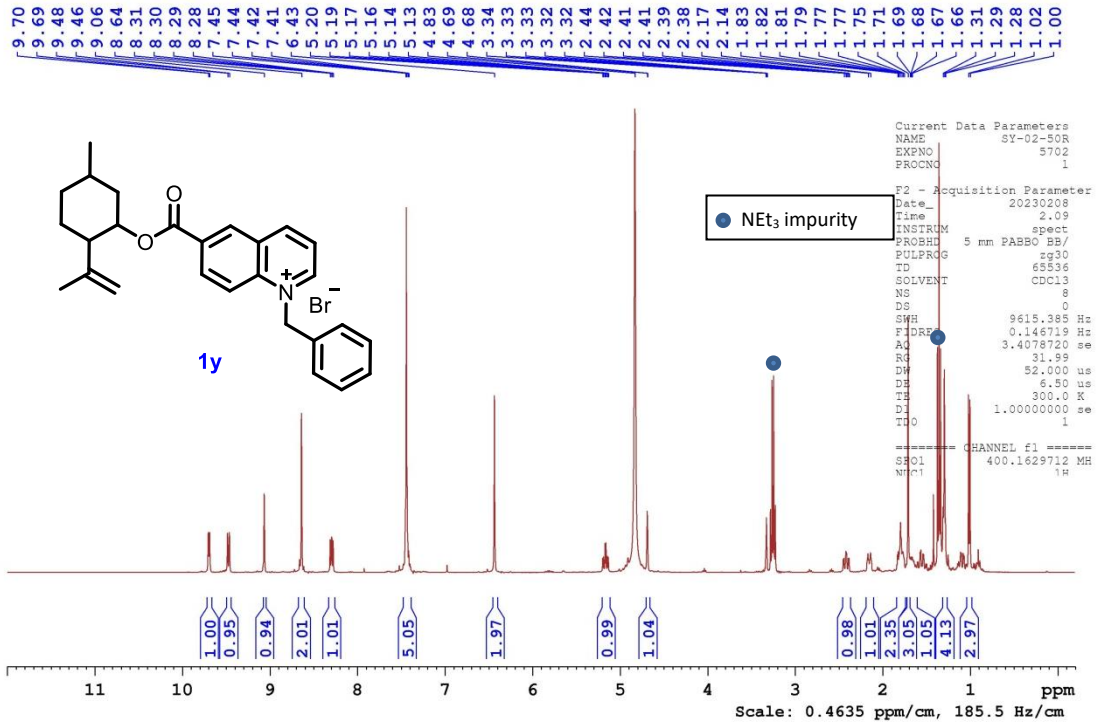

Figure S-35: ^{1}H NMR (400 MHz, MeOH-d_4) spectrum of compound **1y**

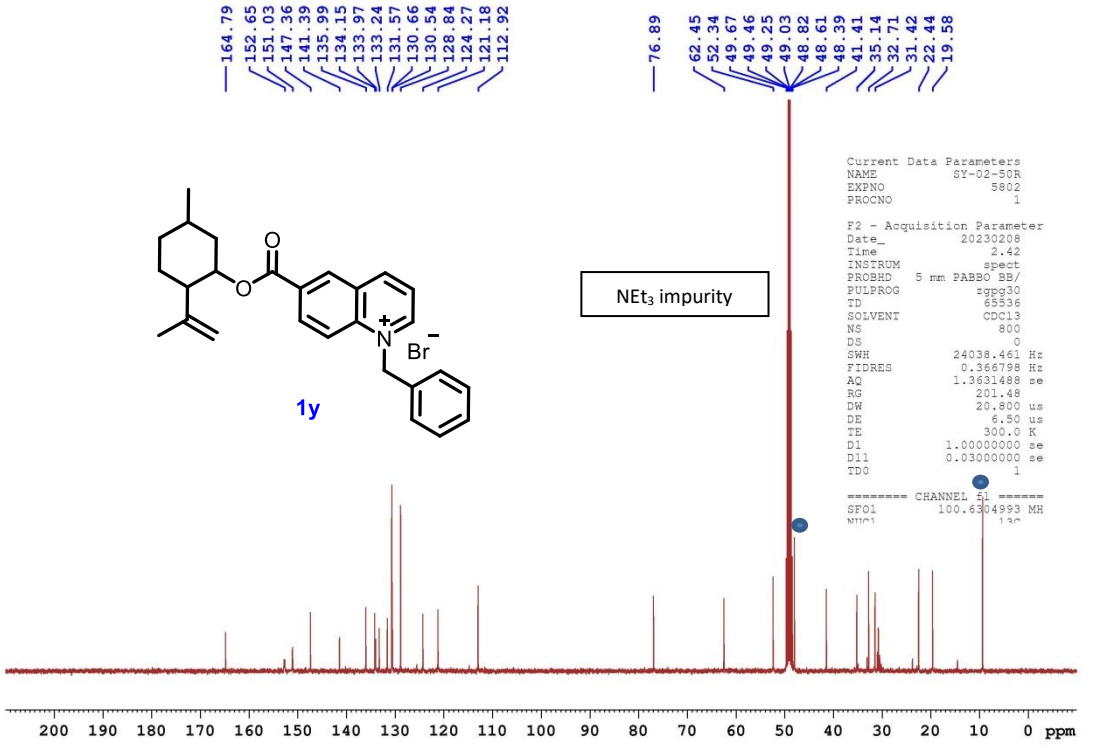

Figure S-36: ^{13}C NMR (100 MHz, MeOH-d_4) spectrum of compound **1y**

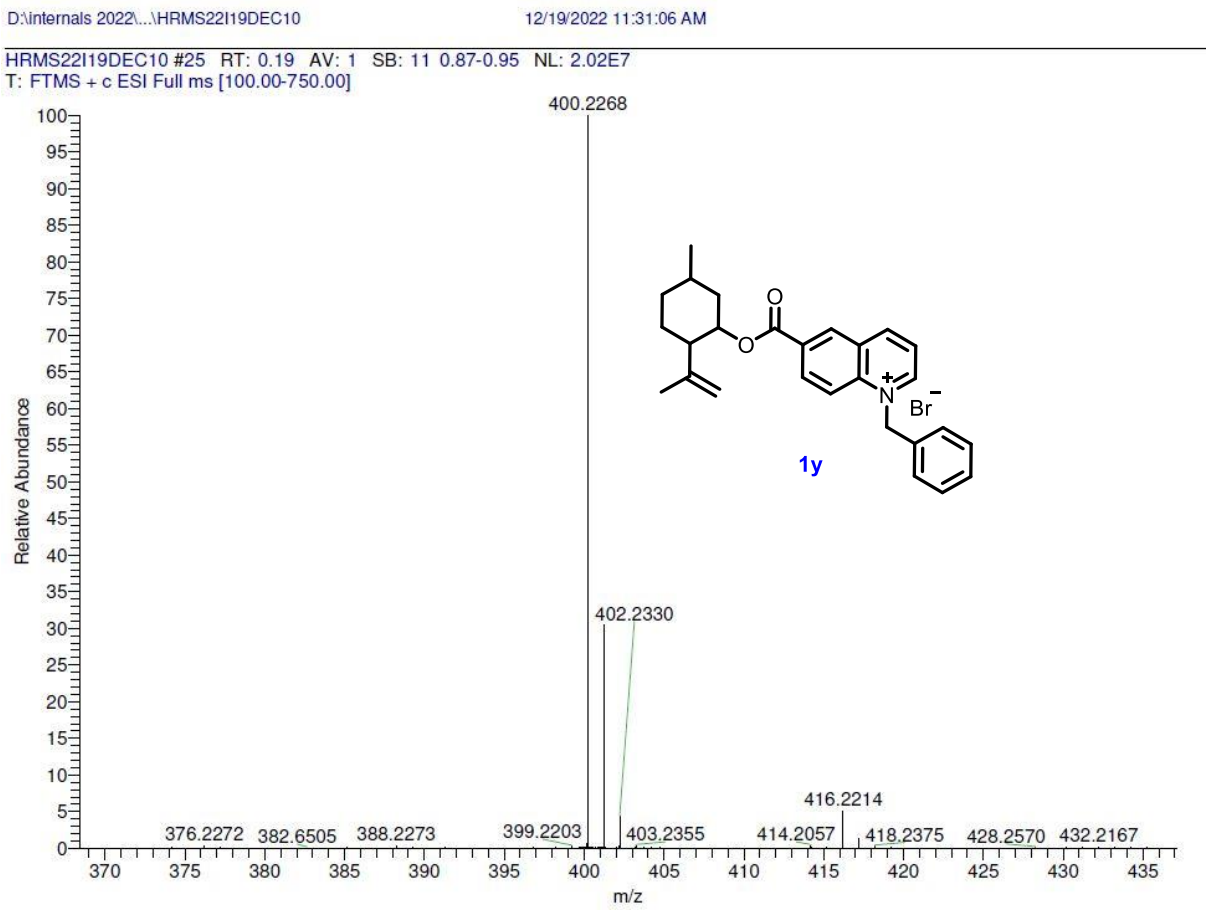

Figure S-37 HRMS spectrum of compound **1y**

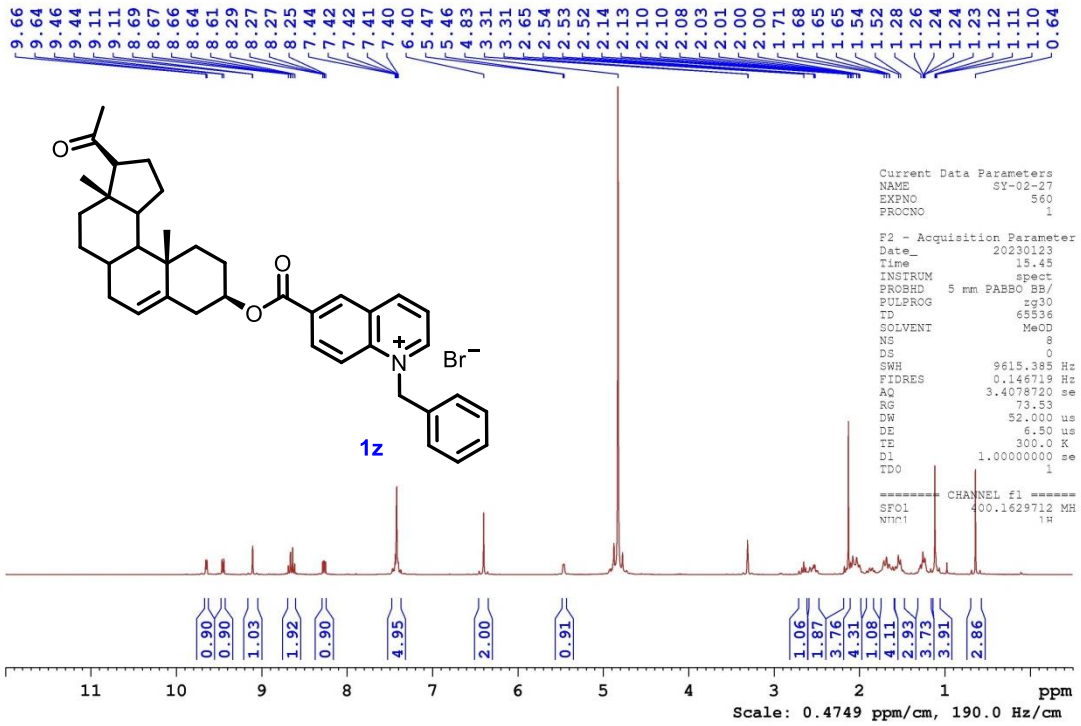

Figure S-38: ^{1}H NMR (400 MHz, MeOH-d_4) spectrum of compound **1z**

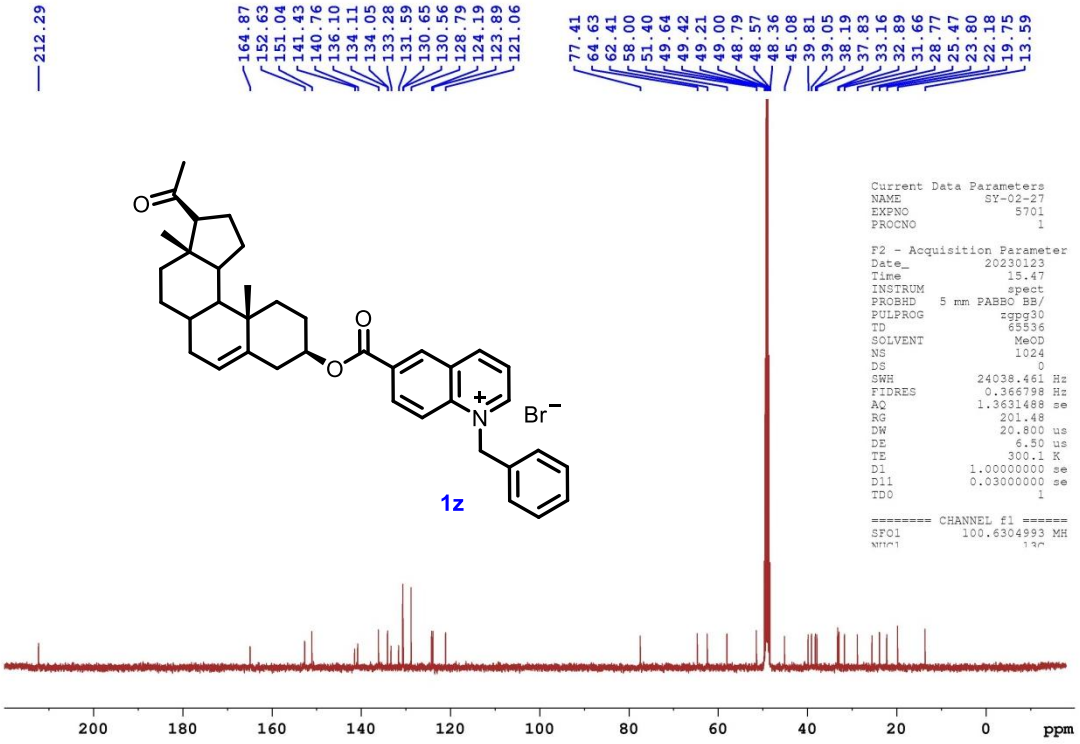

Figure S-39: ^{13}C NMR (100 MHz, MeOH-d_4) spectrum of compound **1z**

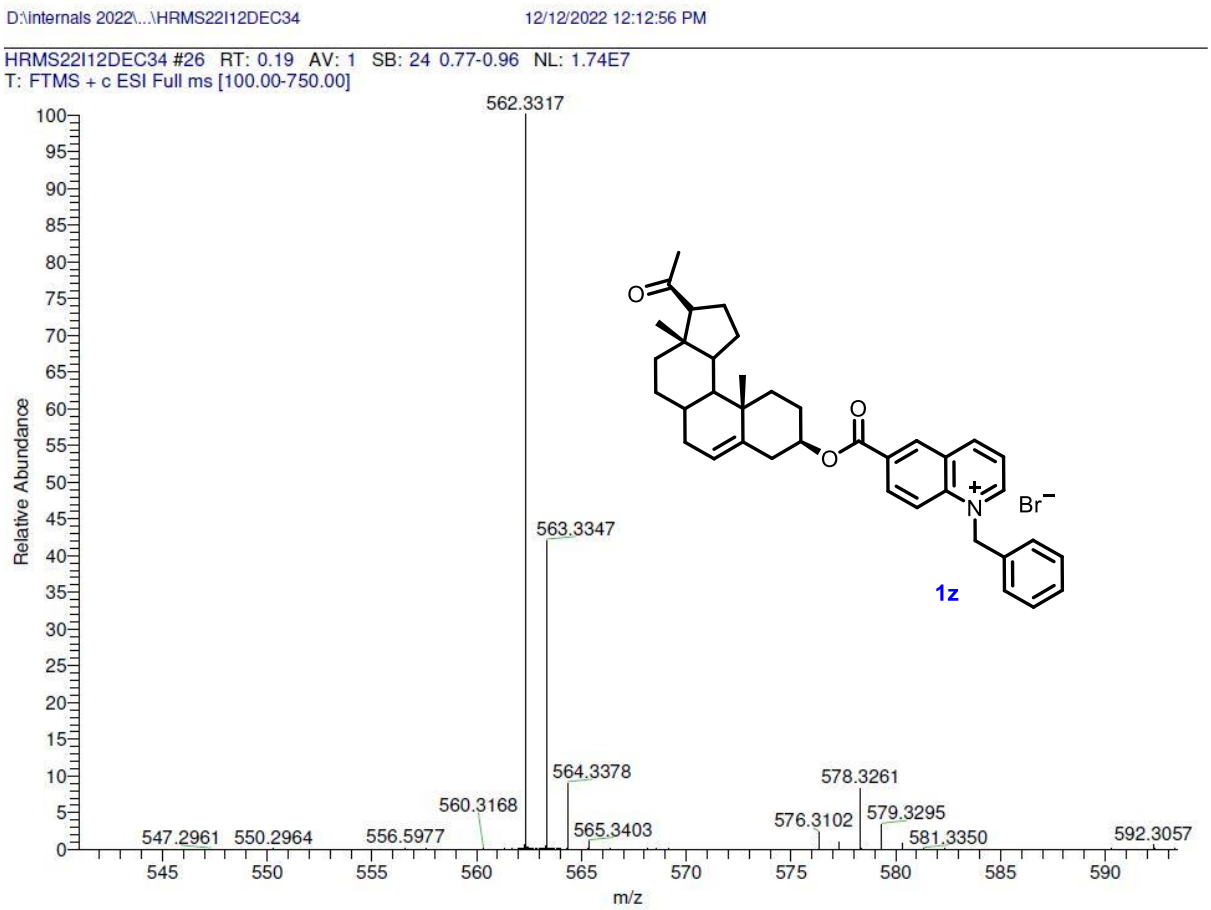

Figure S-40 HRMS spectrum of compound **1z**

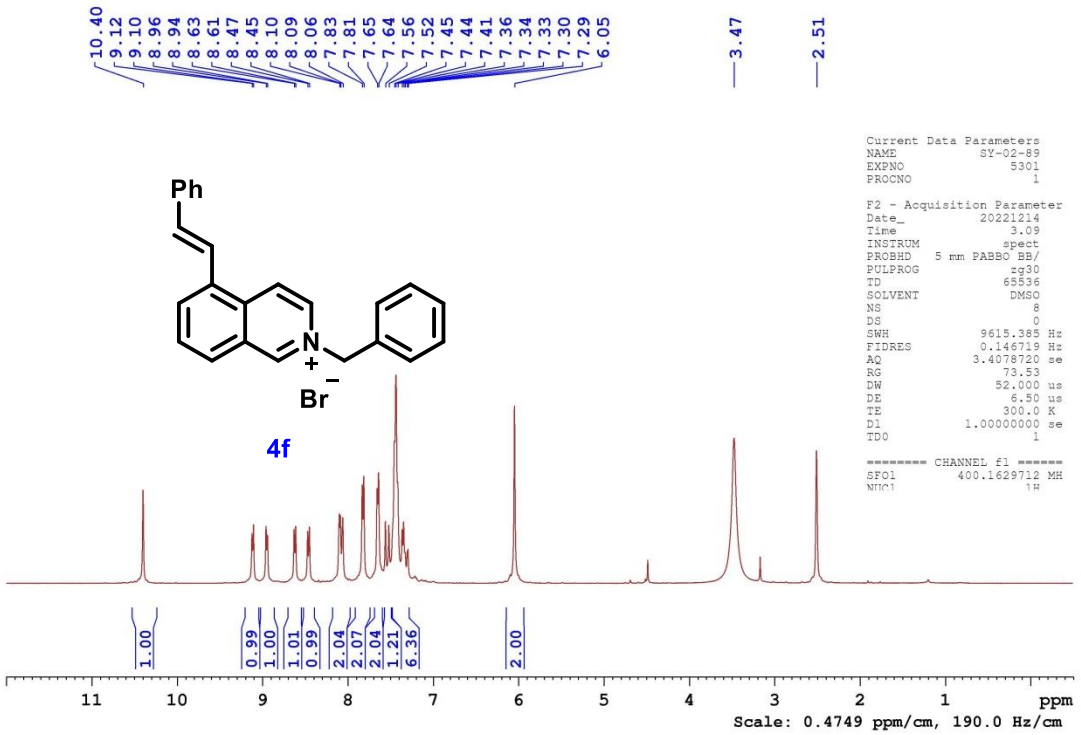

Figure S-41: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **4f**

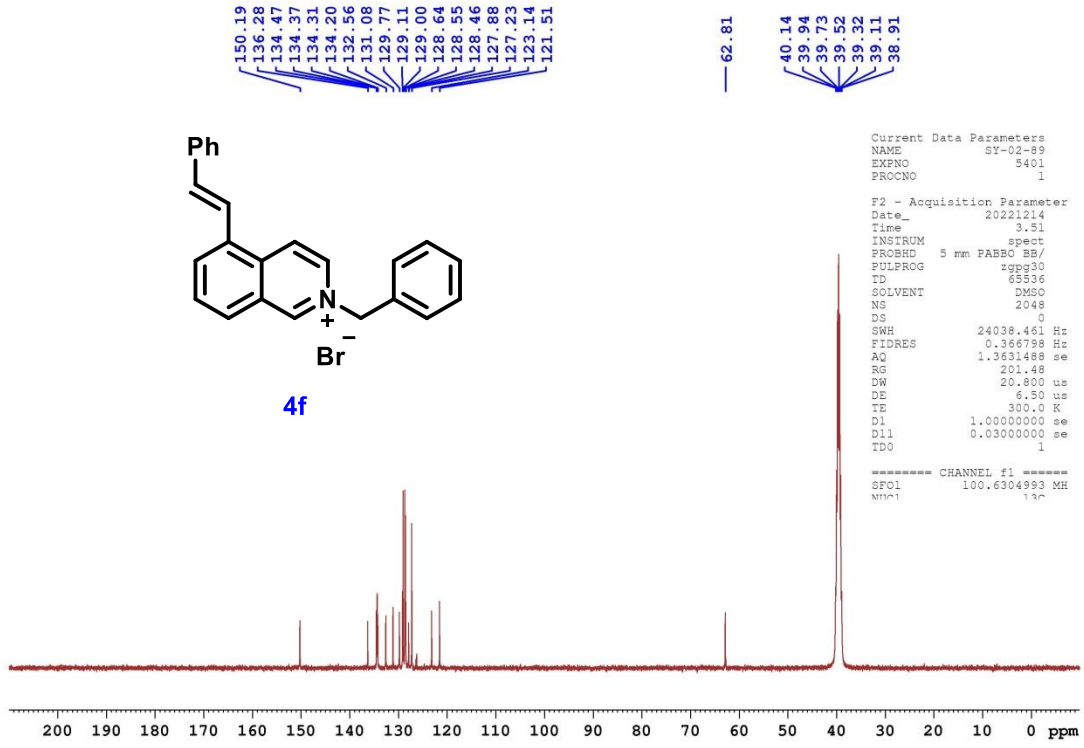

Figure S-42: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **4f**

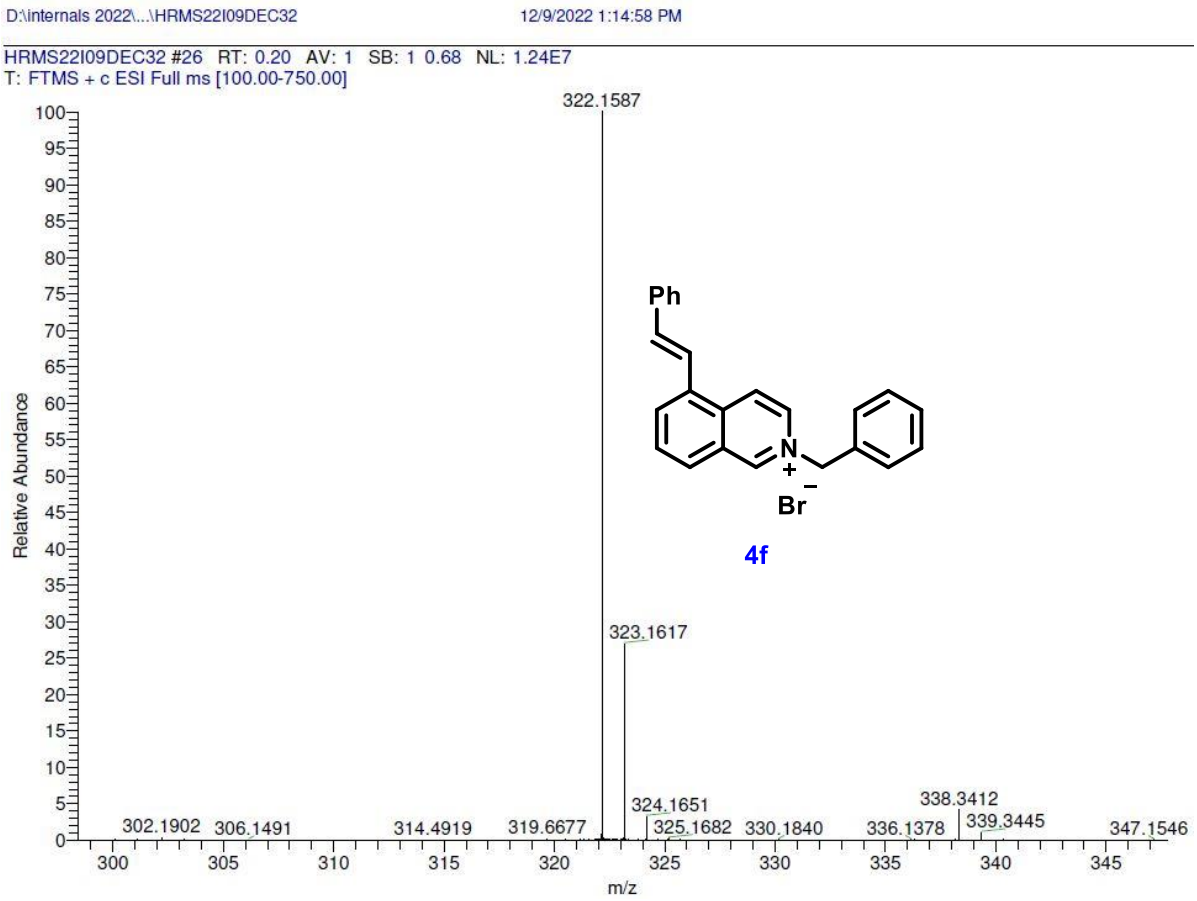

Figure S-43 HRMS spectrum of compound **4f**

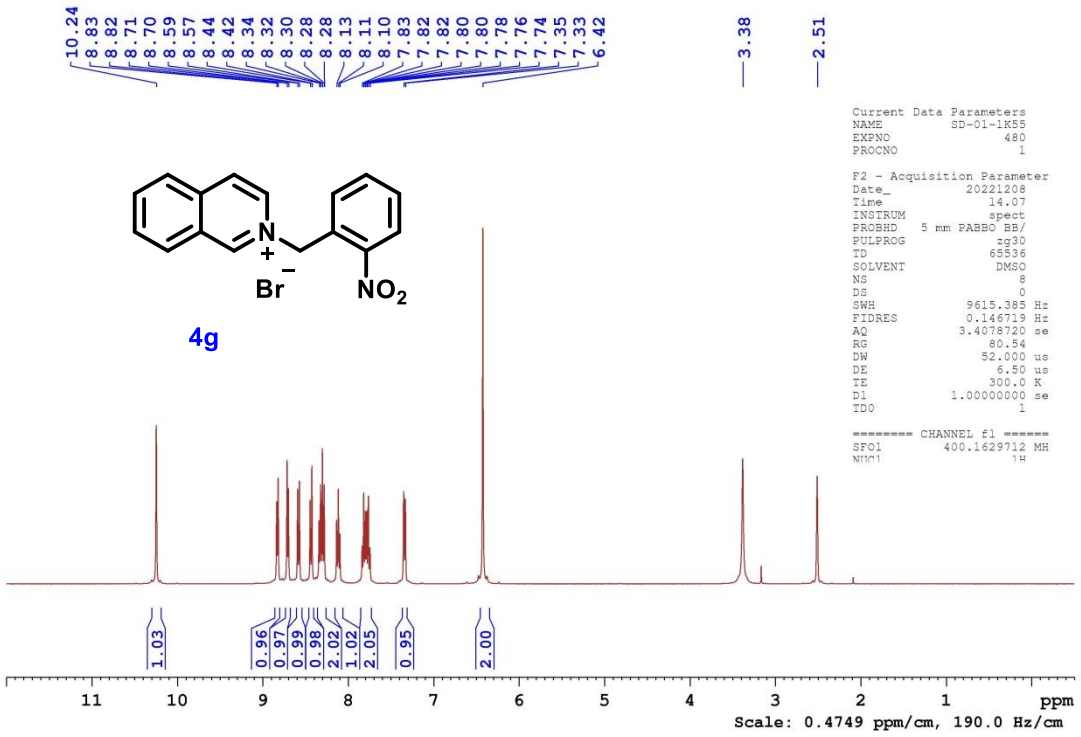

Figure S-44: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **4g**

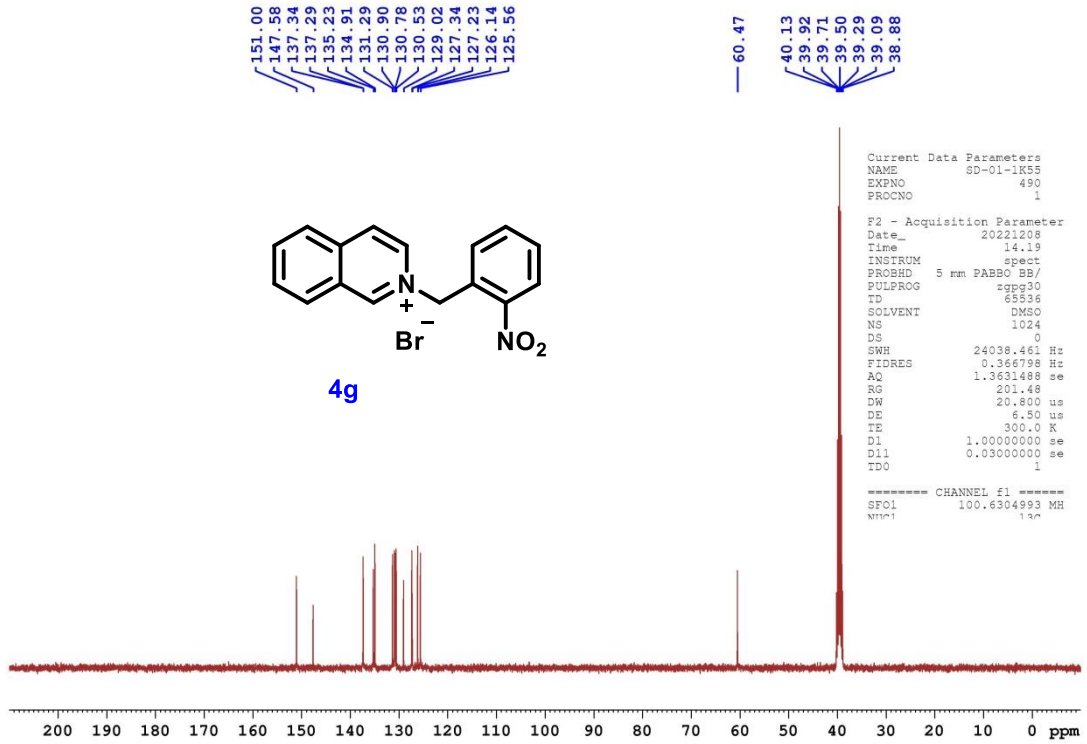

Figure S-45: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **4g**

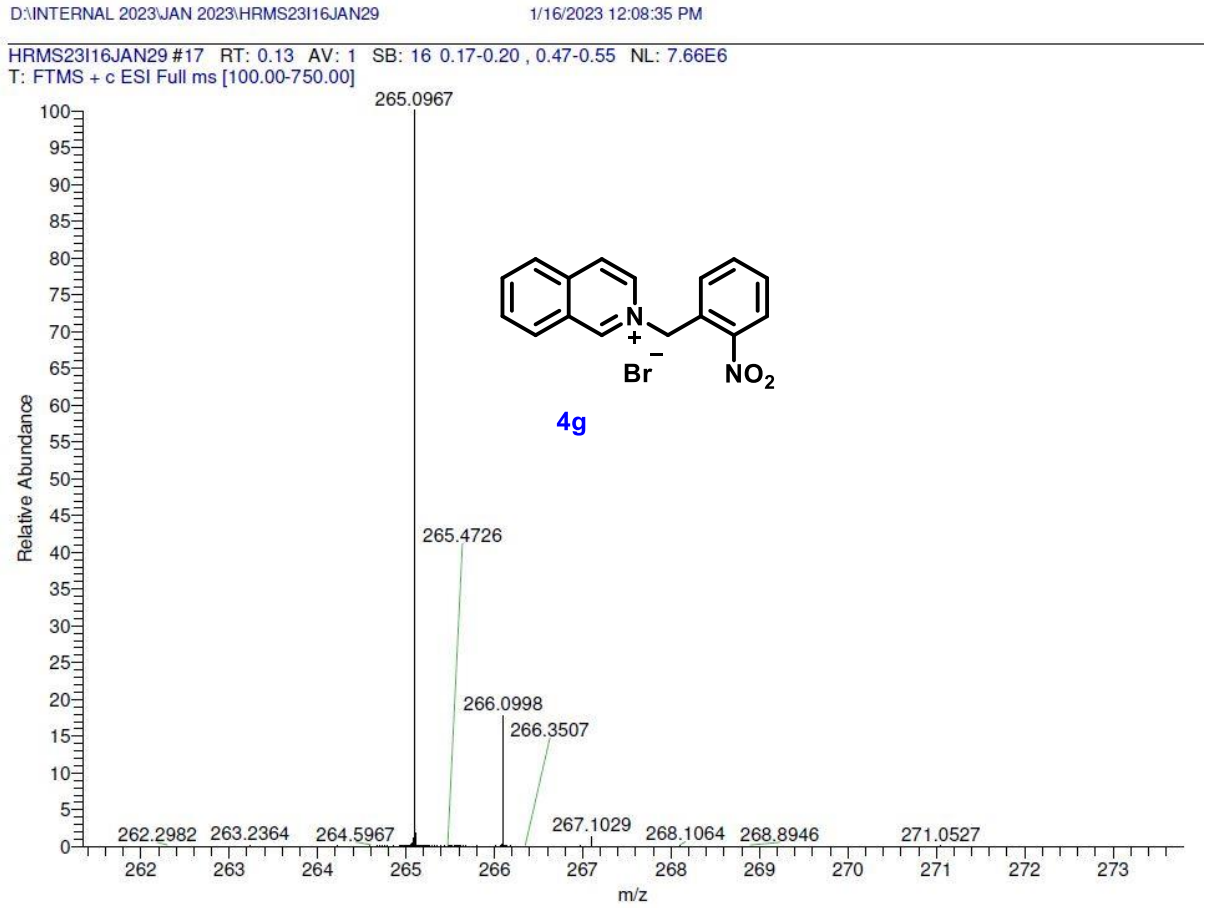

Figure S-46 HRMS spectrum of compound **4g**

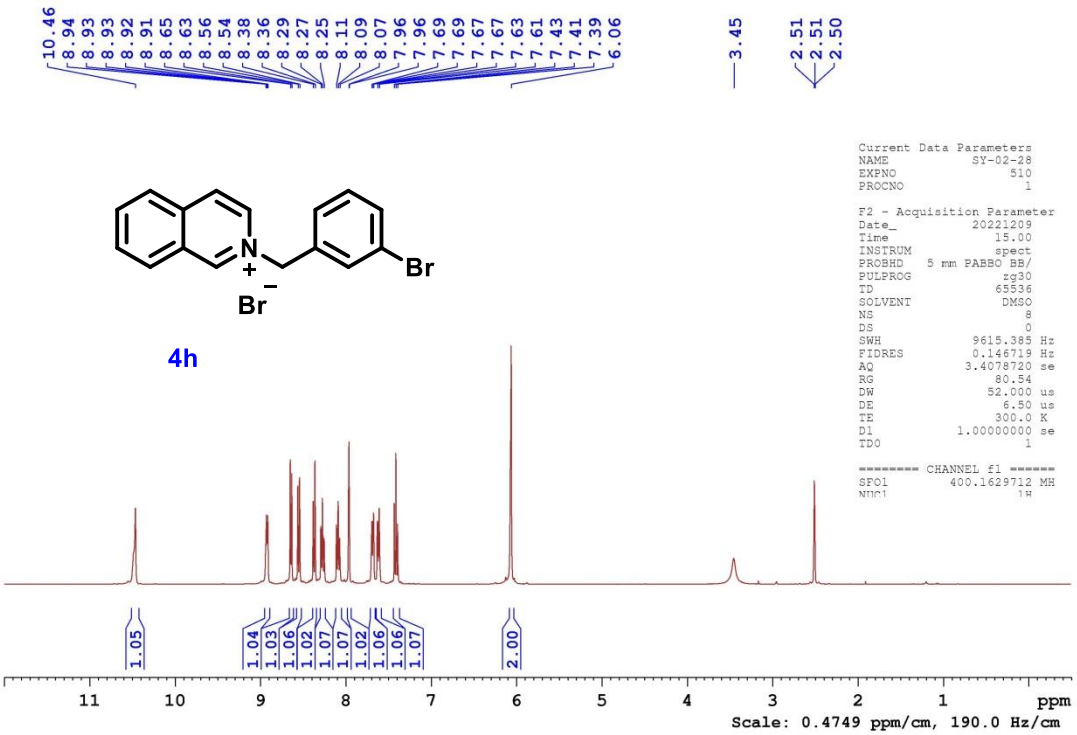

Figure S-47: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **4h**

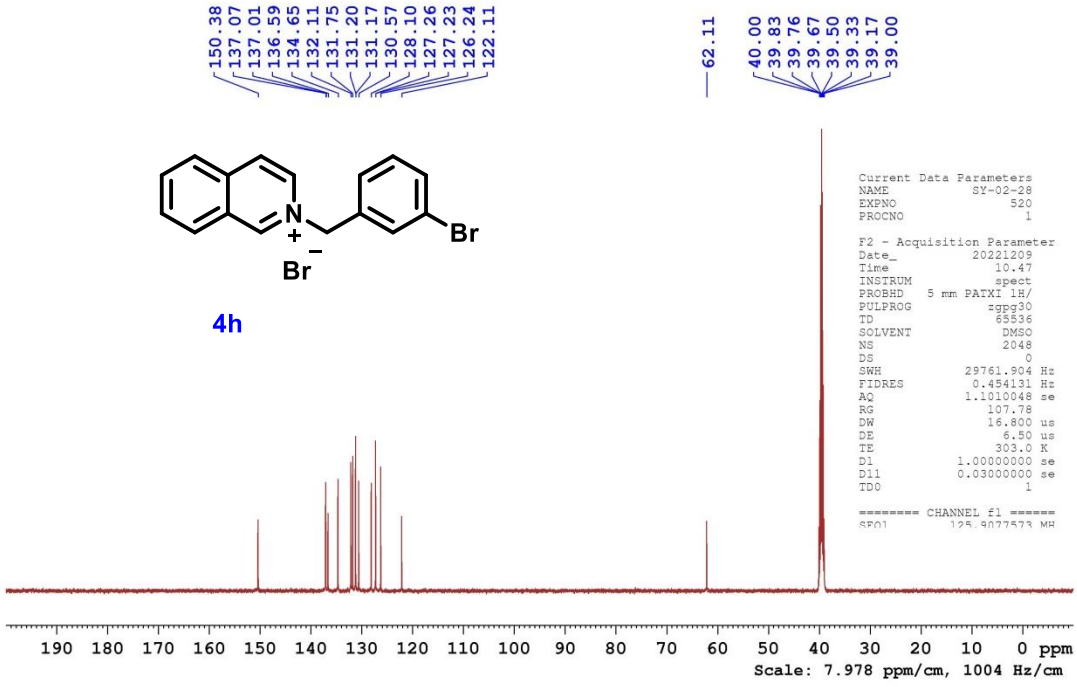

Figure S-48: ^{13}C NMR (125 MHz, DMSO-d_6) spectrum of compound **4h**

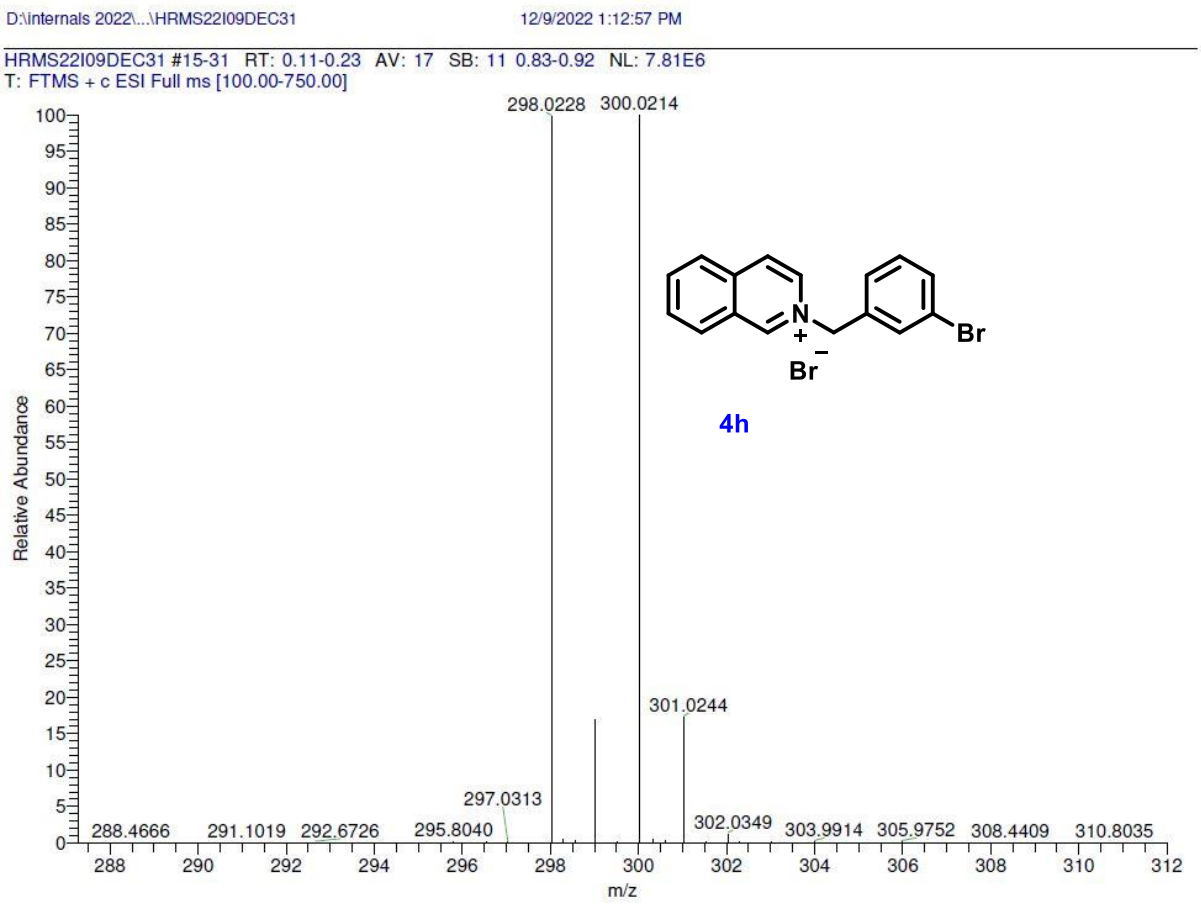

Figure S-49 HRMS spectrum of compound **4h**

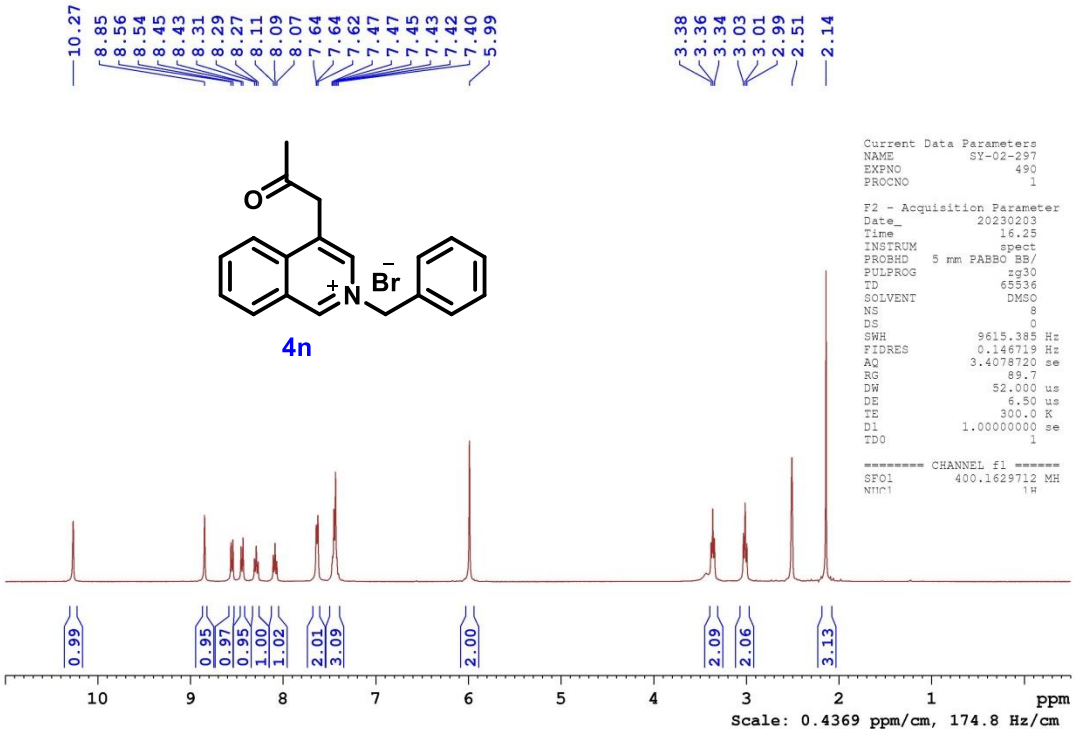

Figure S-50: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **4n**

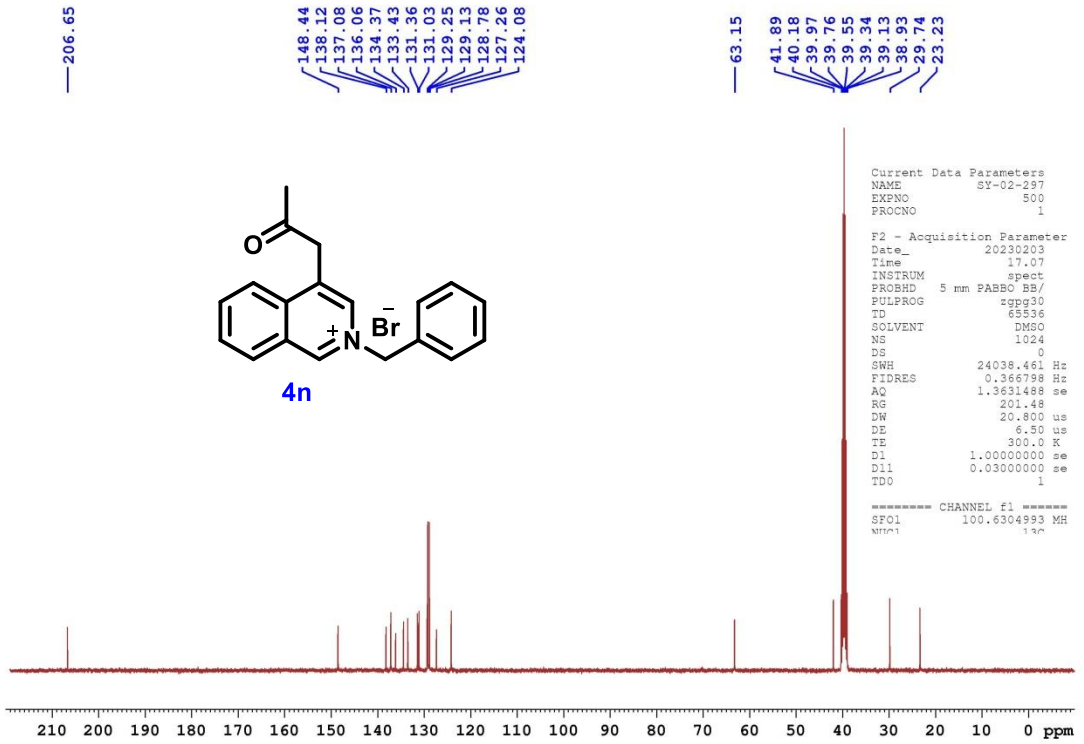

Figure S-51: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **4n**

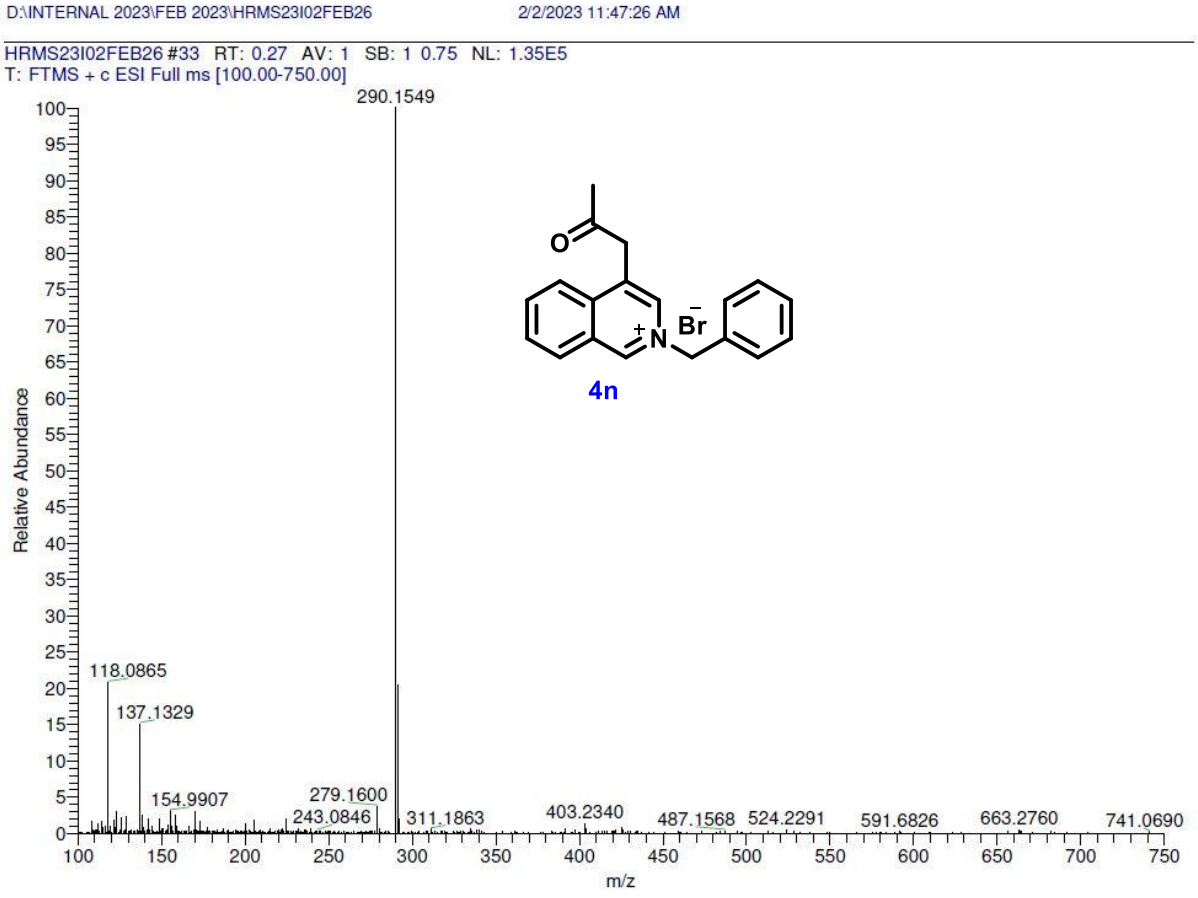

Figure S-52 HRMS spectrum of compound **4n**

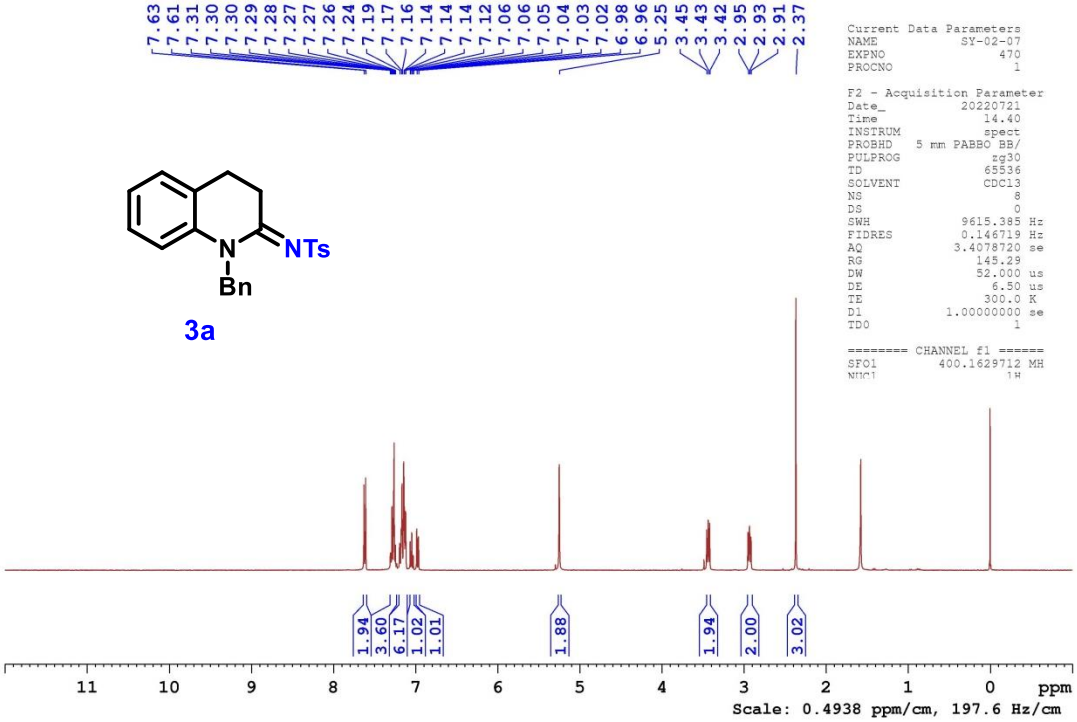

Figure S-53: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3a**

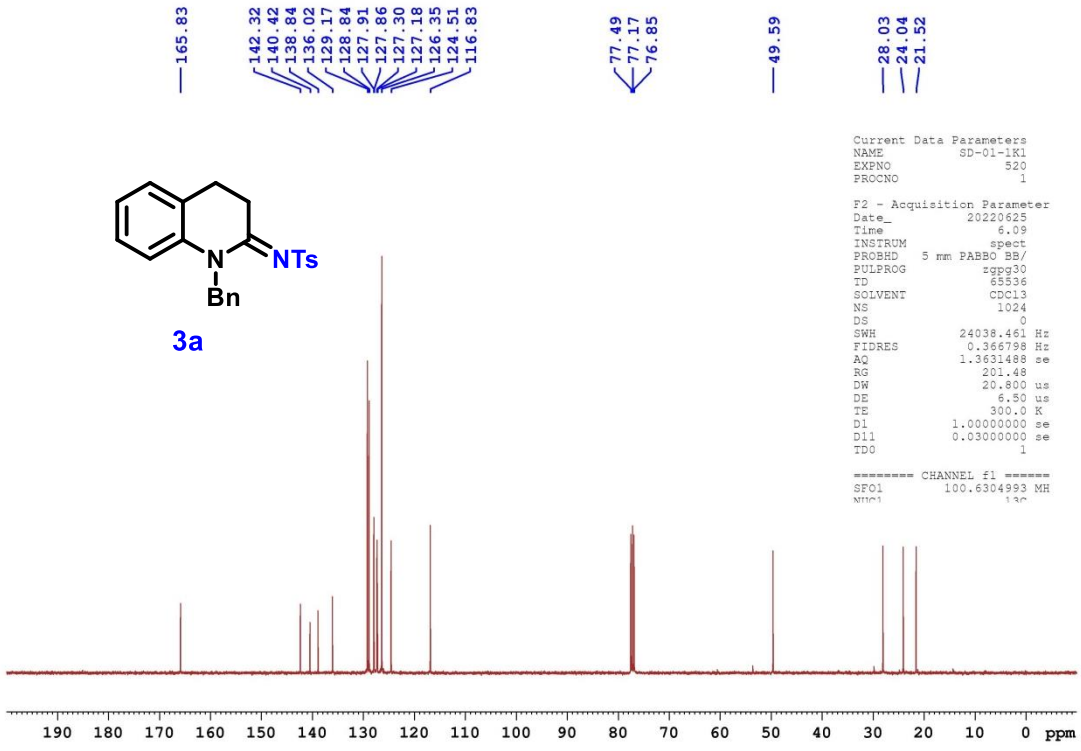

Figure S-54: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3a**

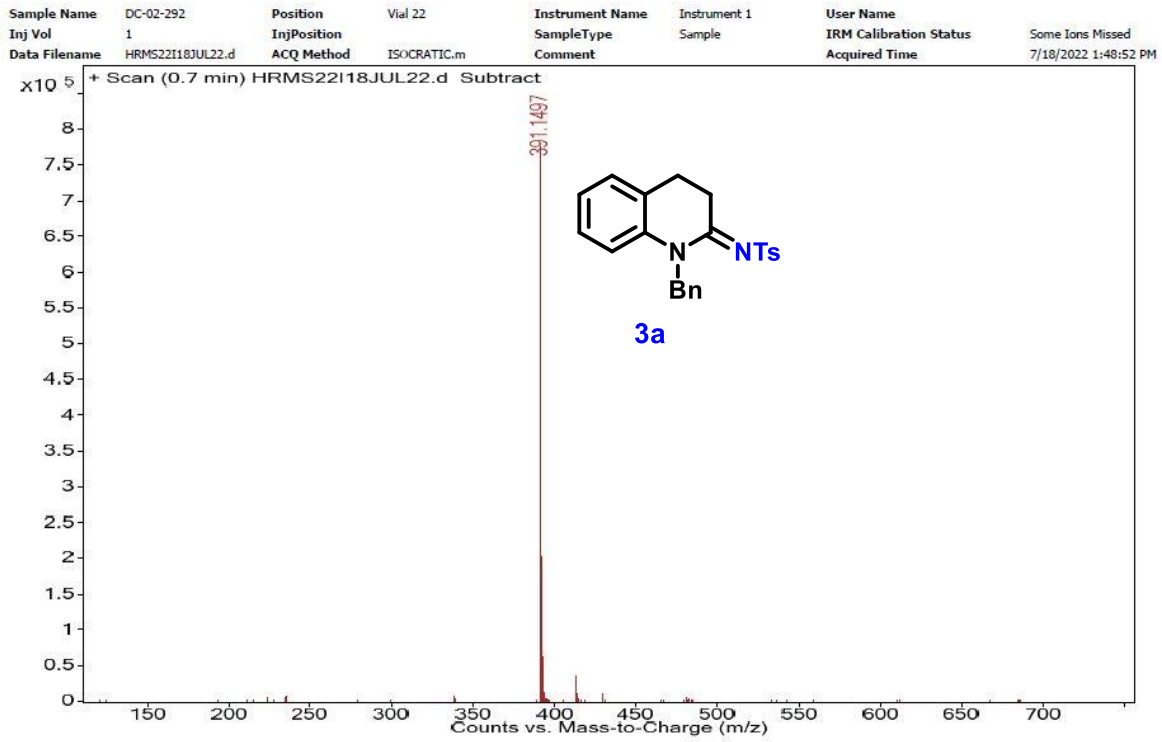

Figure S-55 HRMS spectrum of compound **3a**

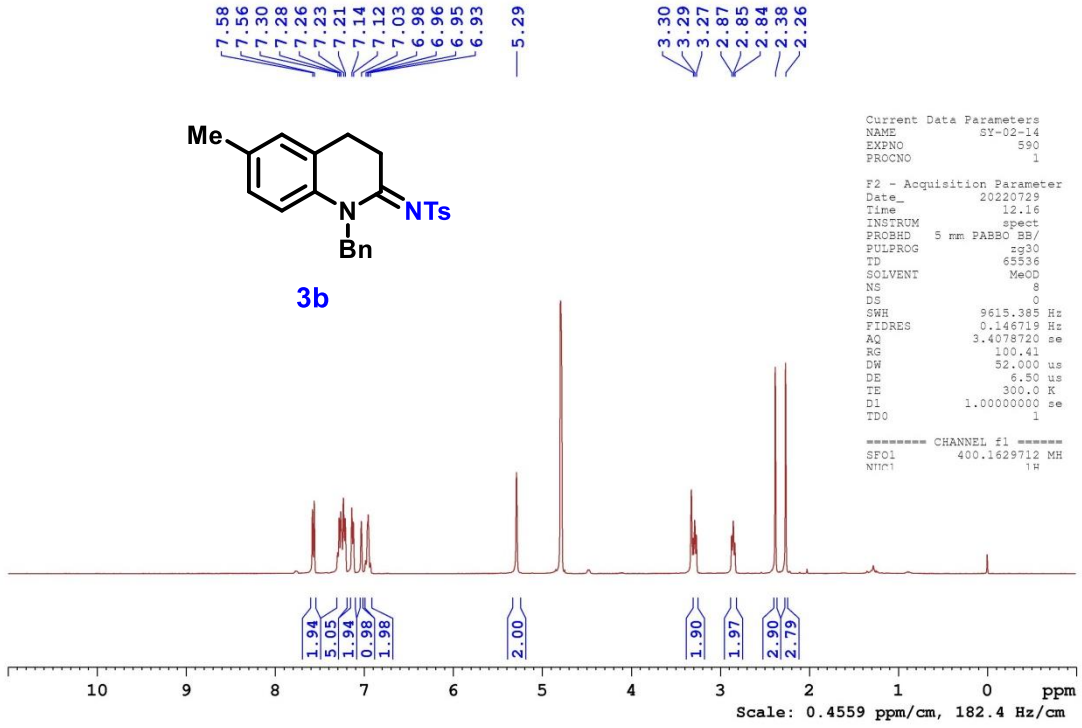

Figure S-56: ^{1}H NMR (400 MHz, CD_3OD+$CDCl_3$) spectrum of compound **3b**

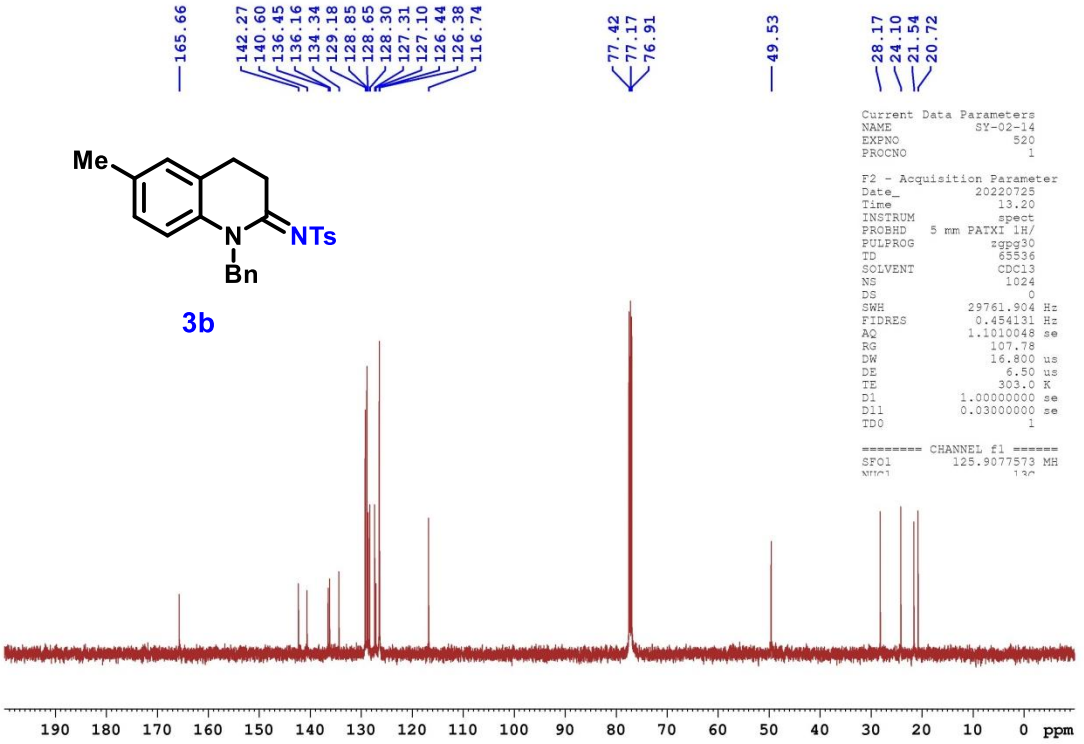

Figure S-57: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3b**

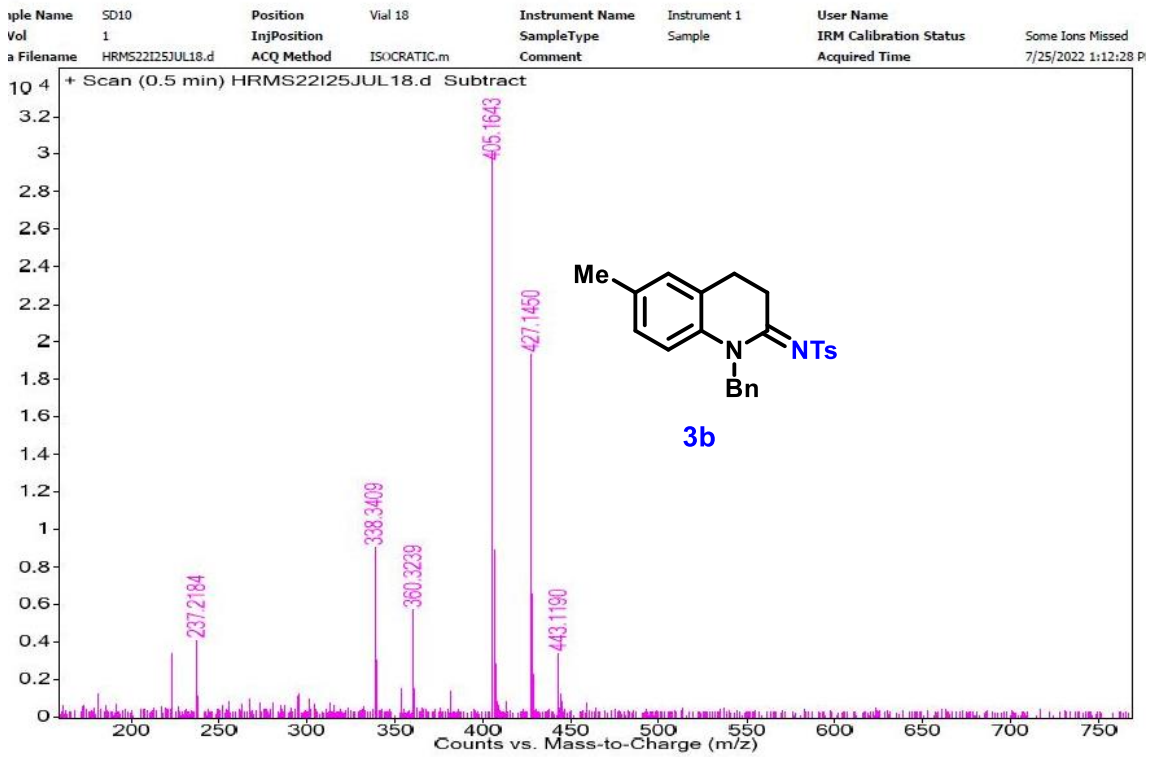

Figure S-58 HRMS spectrum of compound **3b**

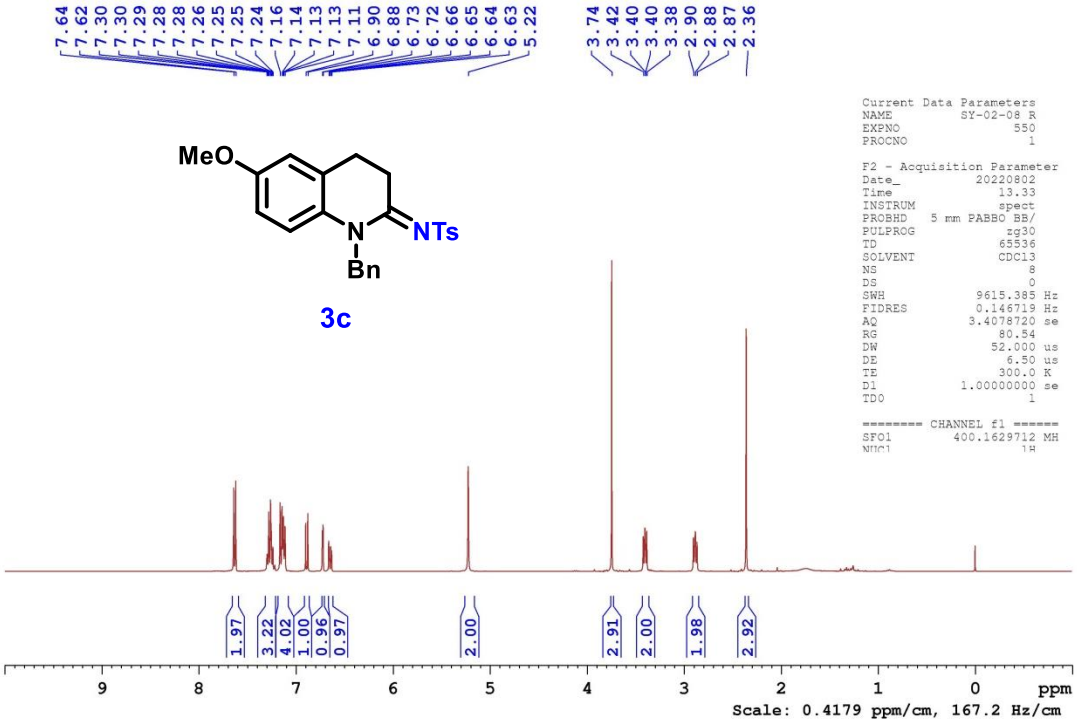

Figure S-59: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3c**

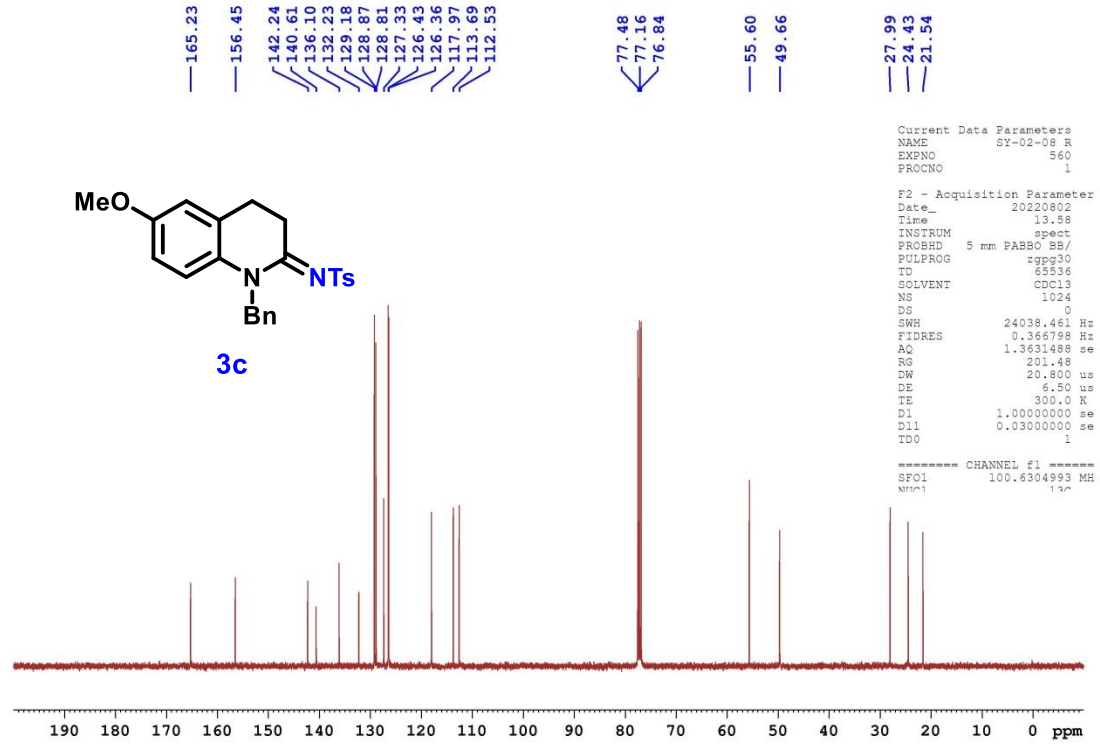

Figure S-60: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3c**

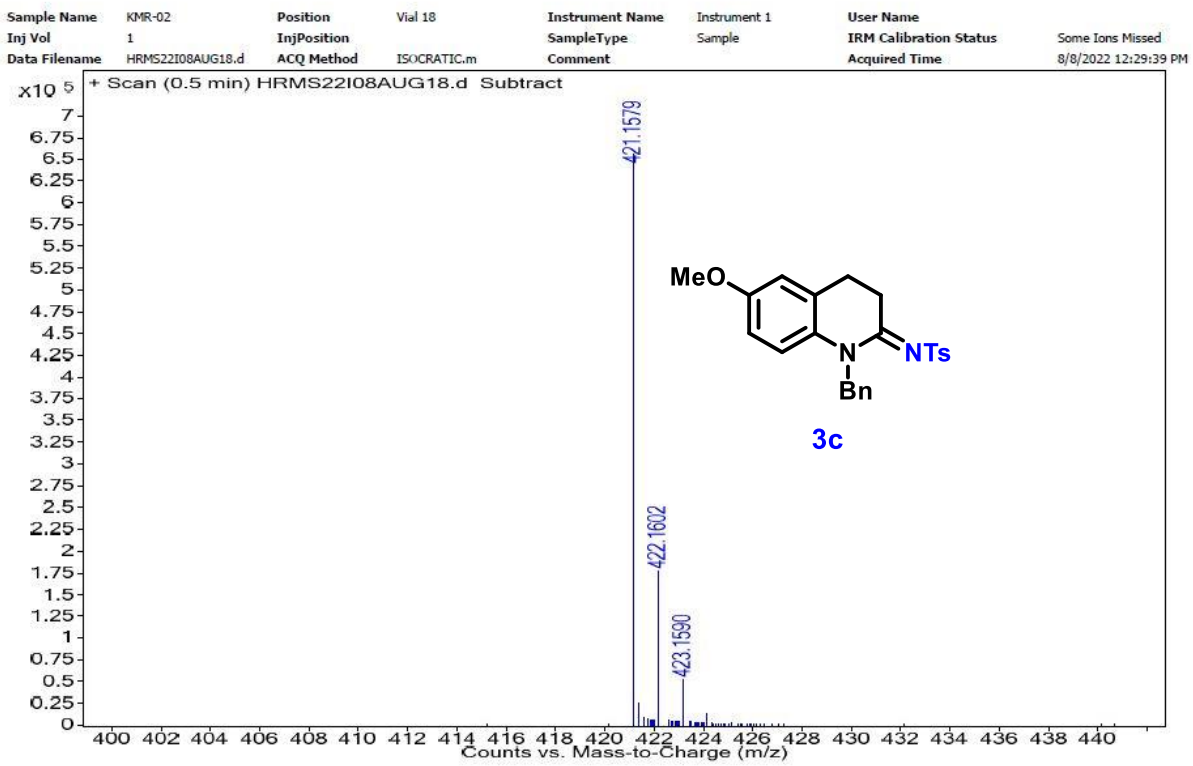

Figure S-61 HRMS spectrum of compound **3c**

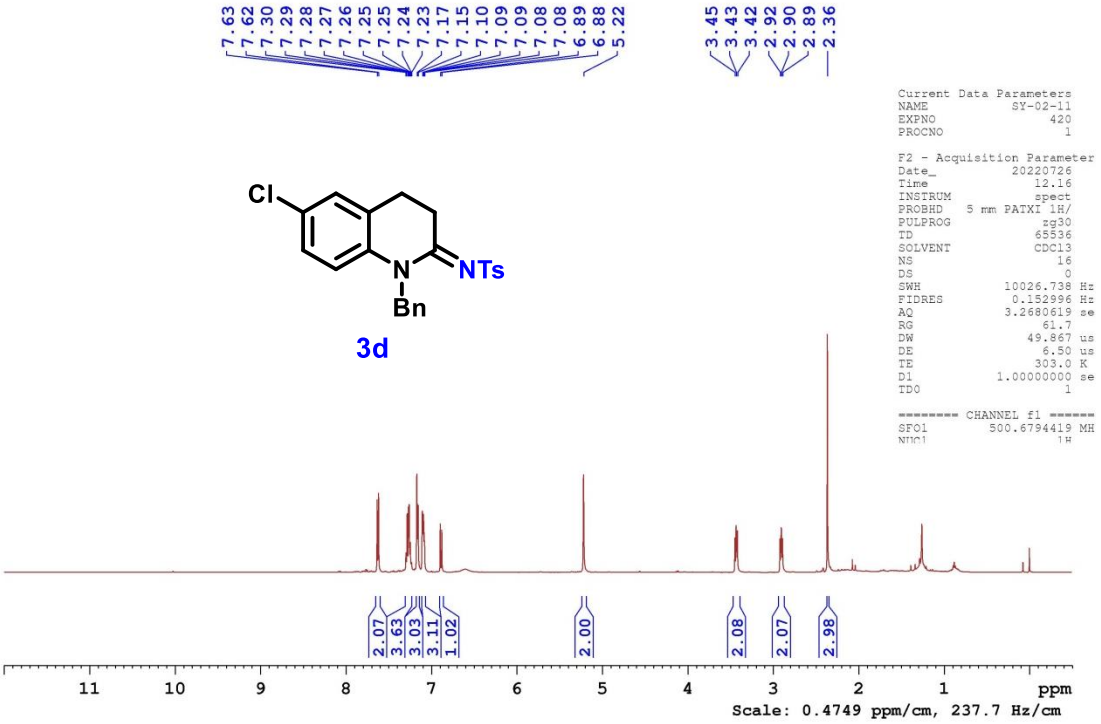

Figure S-62: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3d**

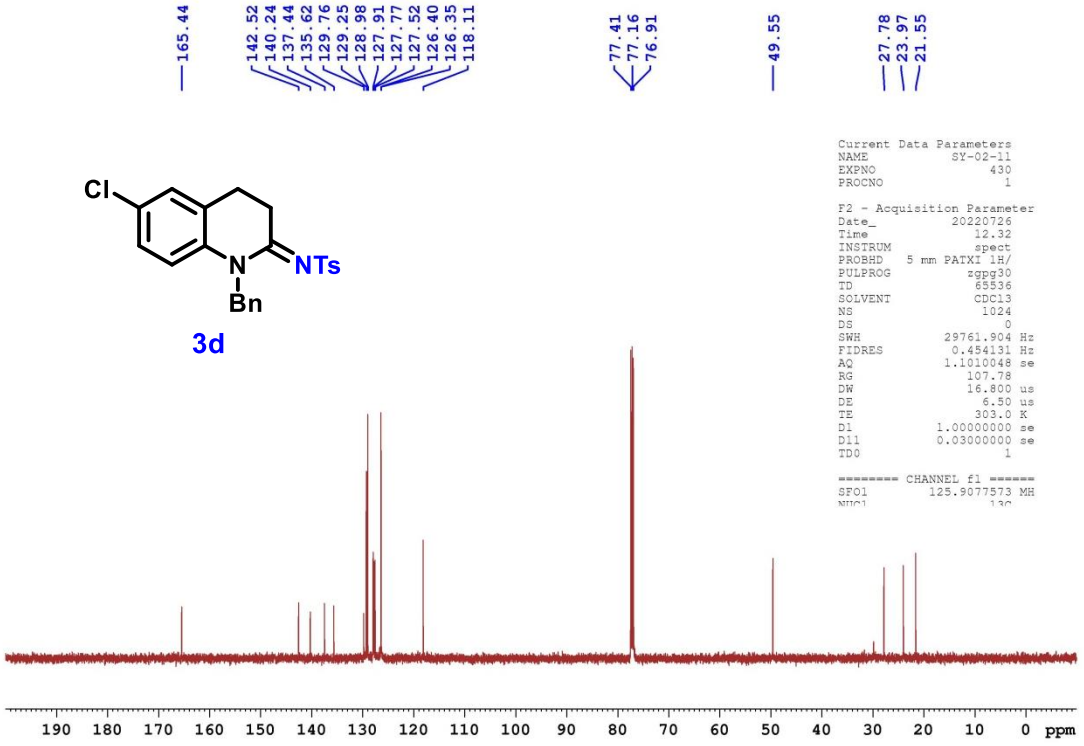

Figure S-63: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3d**

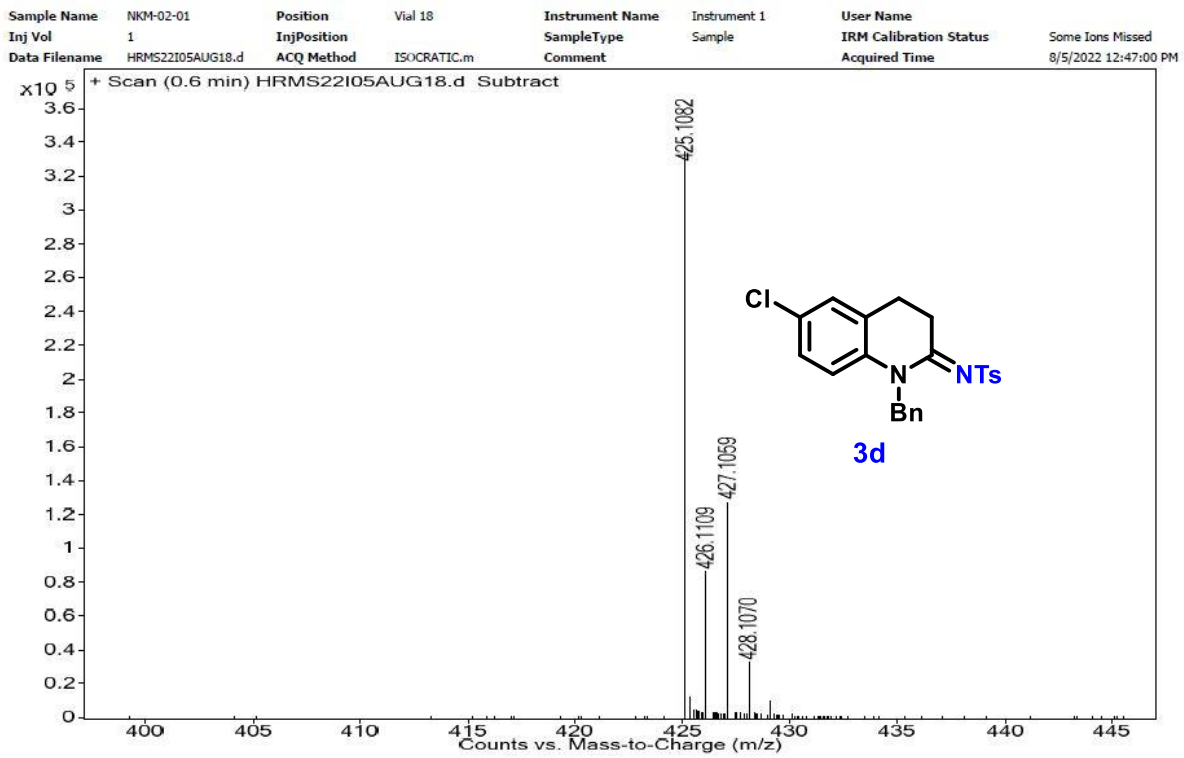

Figure S-64 HRMS spectrum of compound **3d**

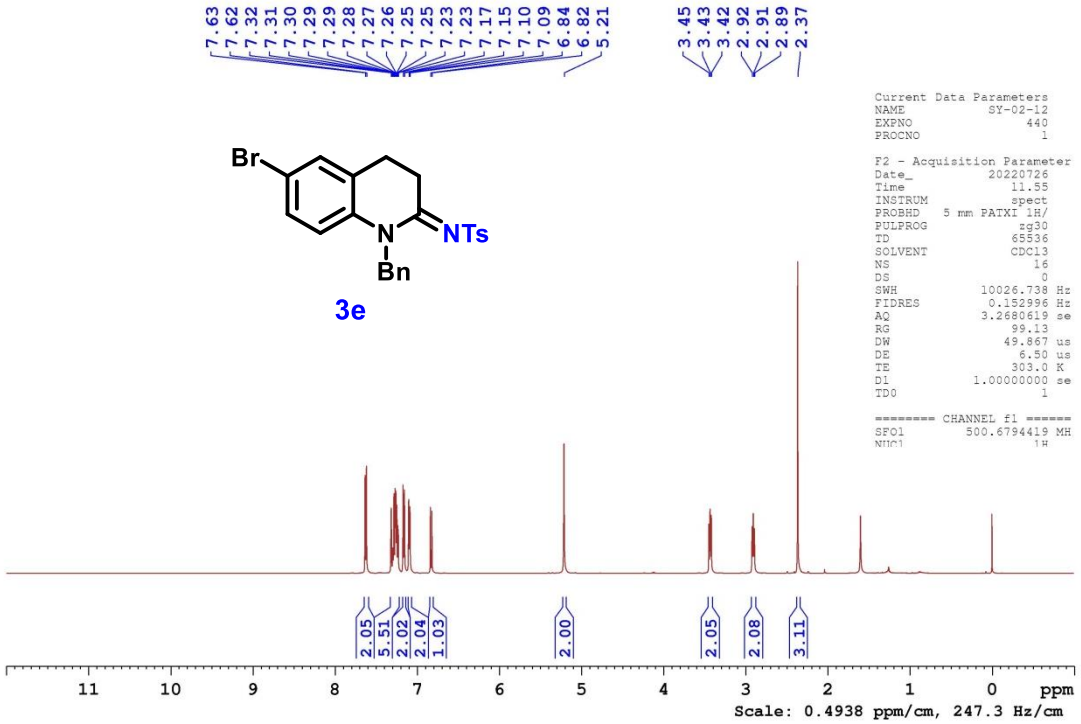

Figure S-65: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3e**

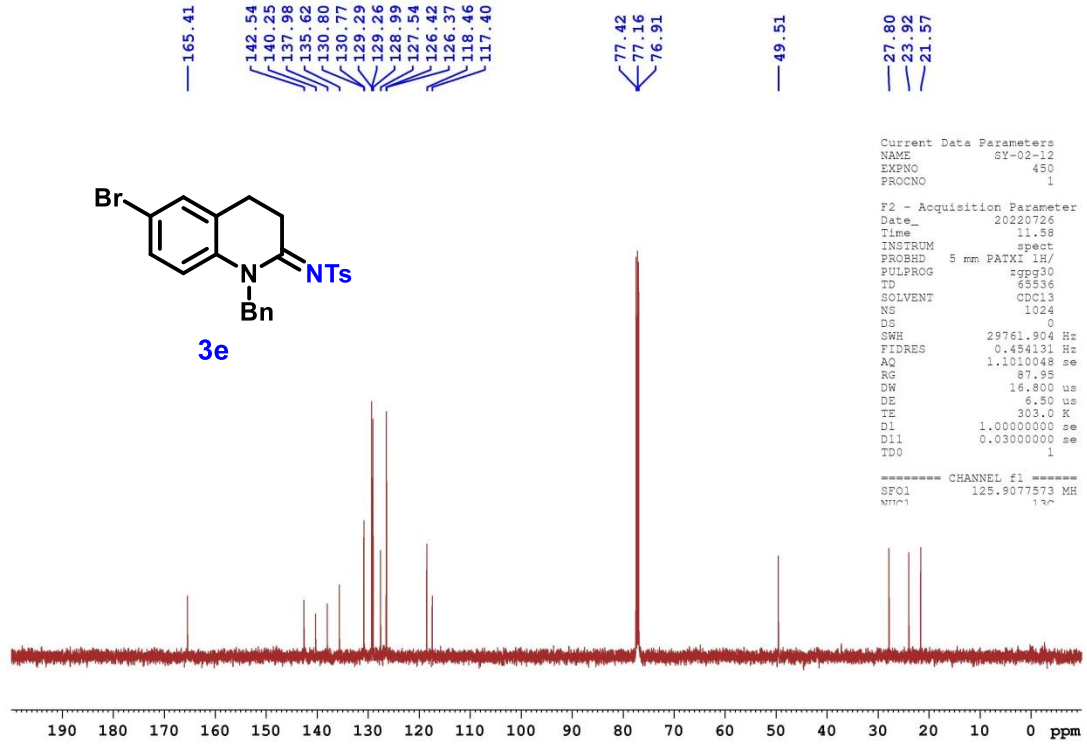

Figure S-66: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3e**

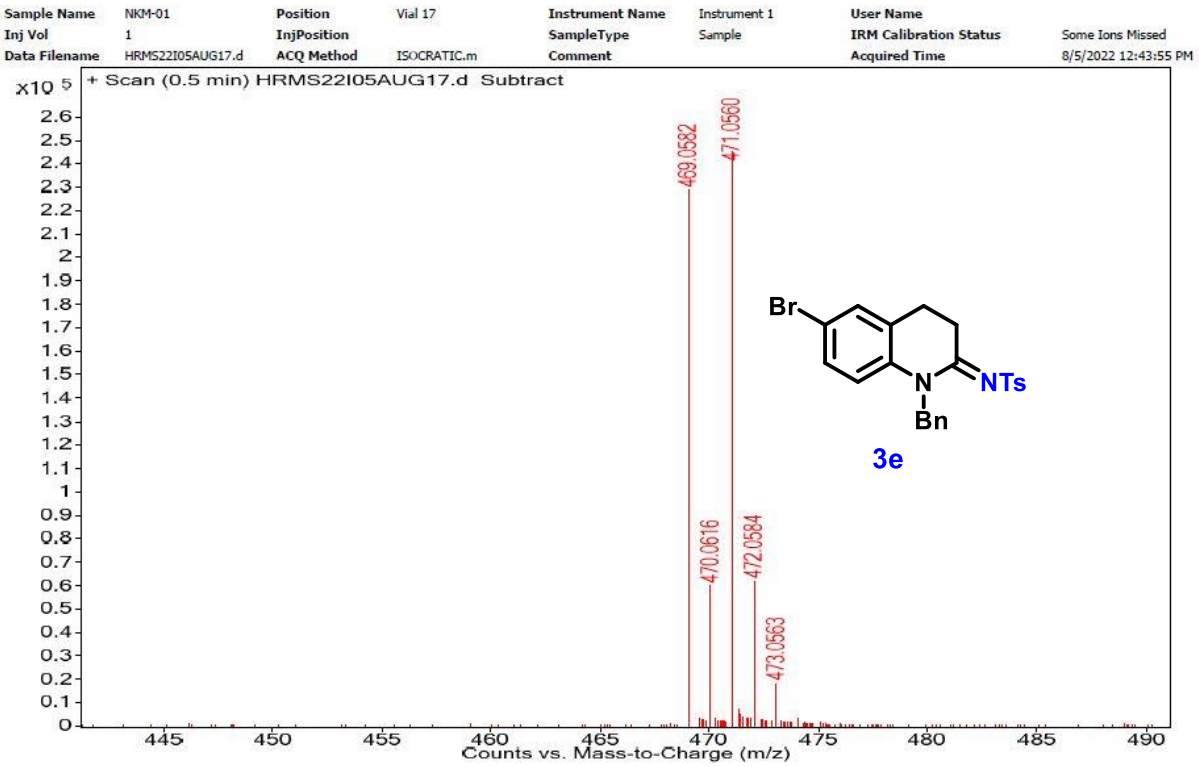

Figure S-67 HRMS spectrum of compound **3e**

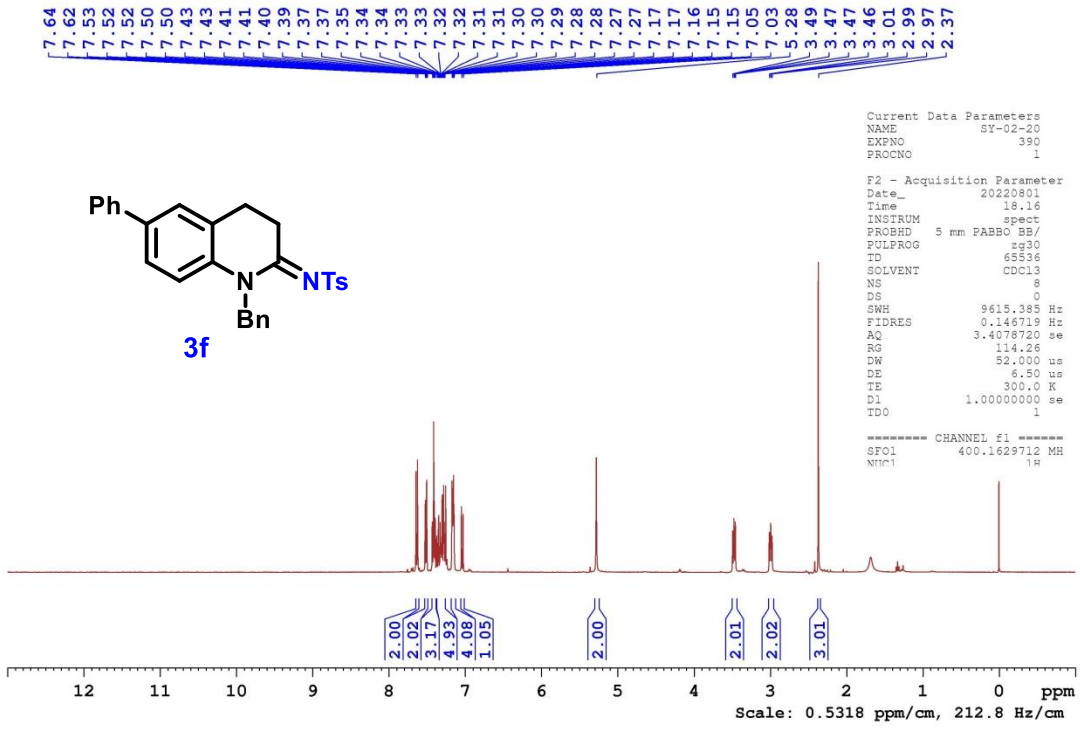

Figure S-68: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3f**

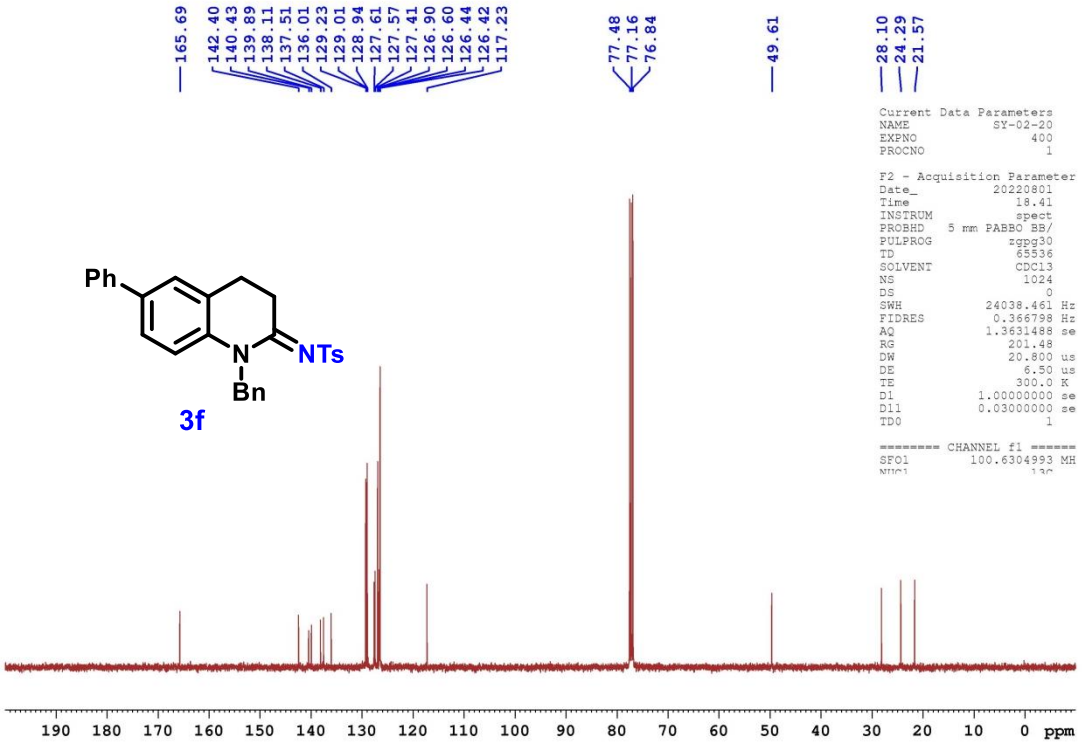

Figure S-69: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3f**

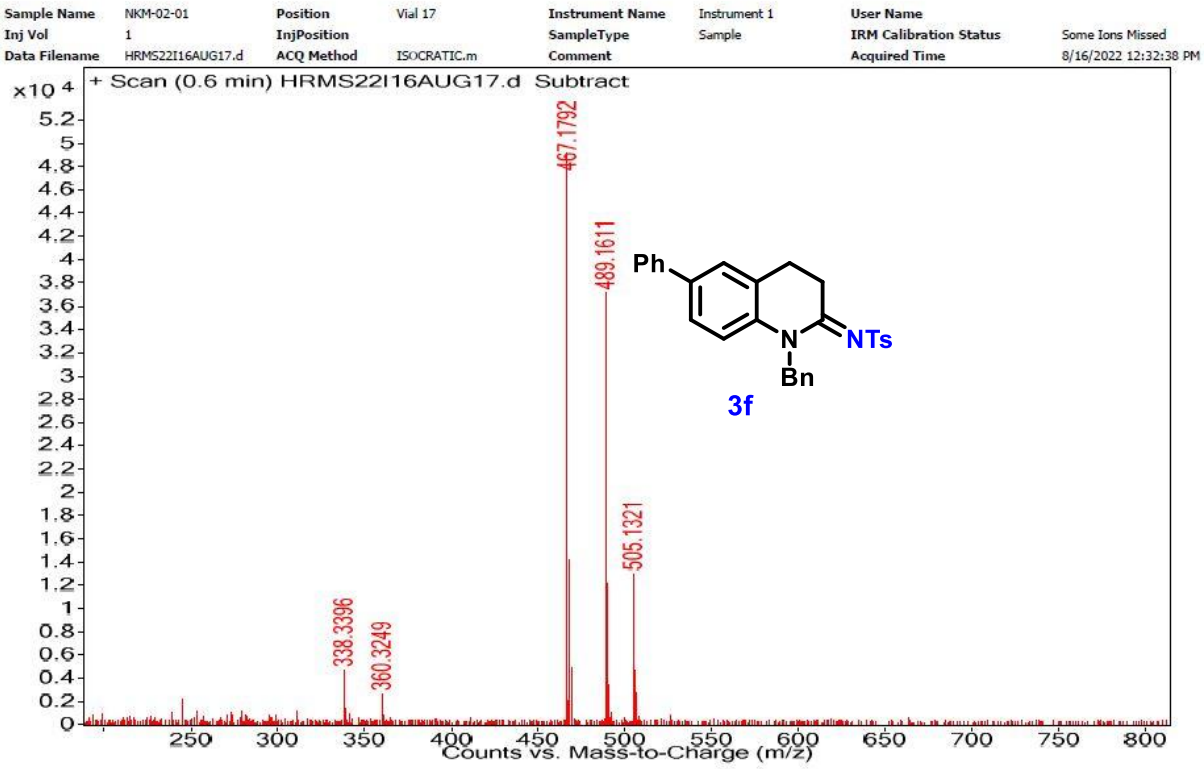

Figure S-70 HRMS spectrum of compound **3f**

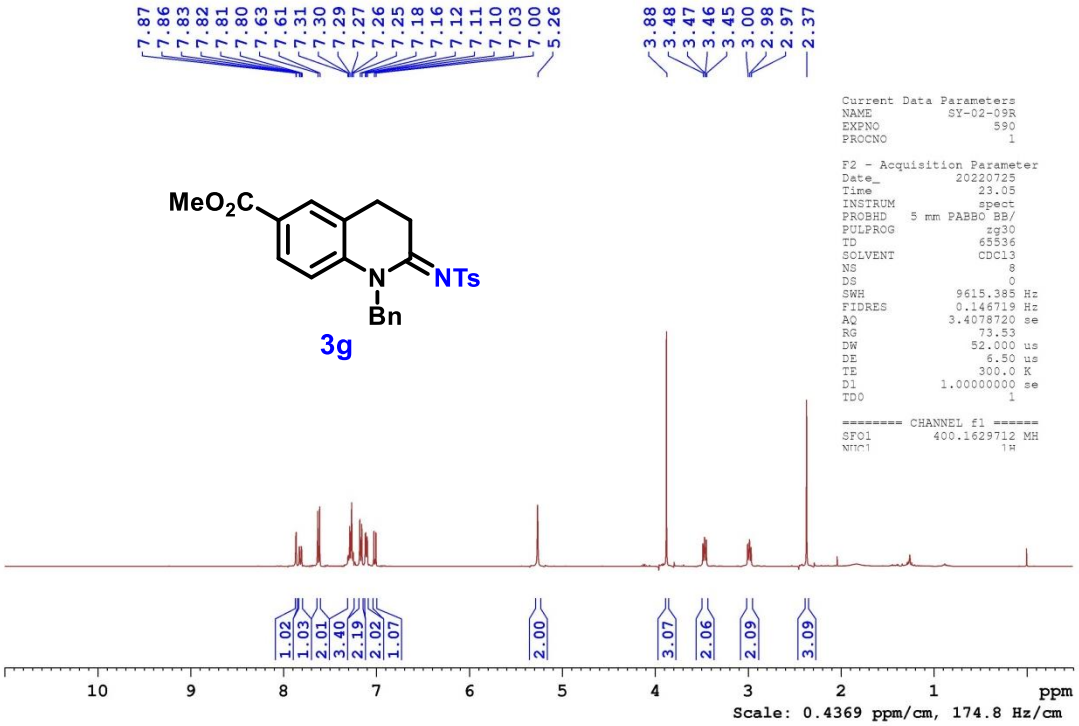

Figure S-71: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3g**

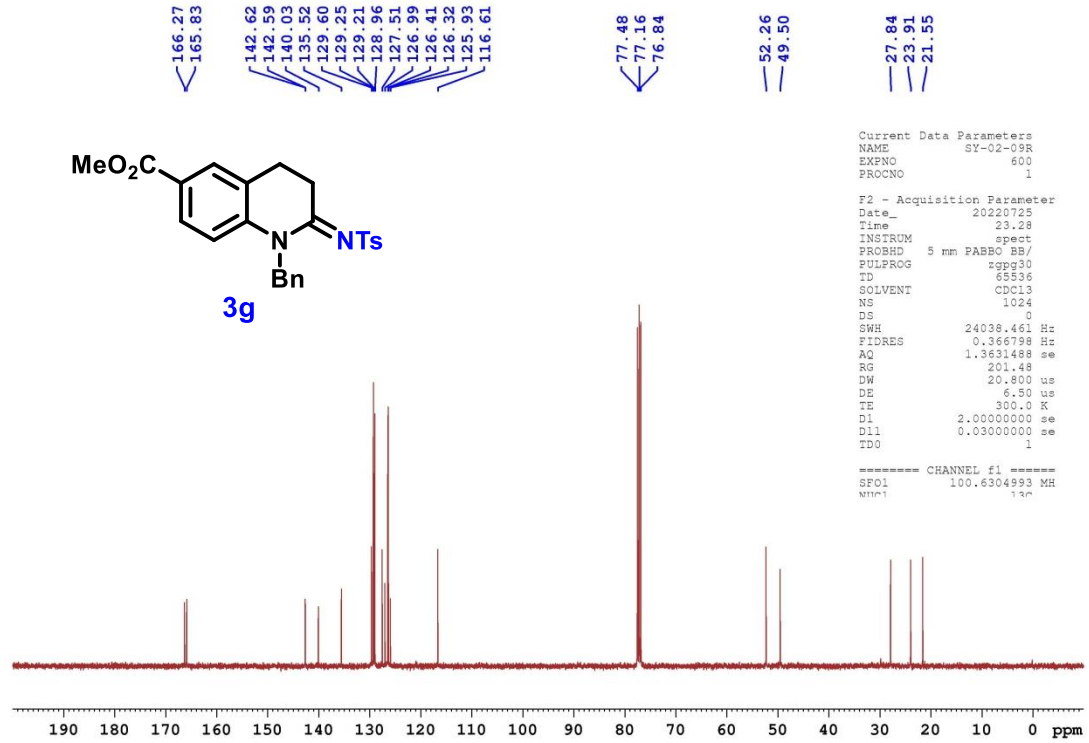

Figure S-72: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3g**

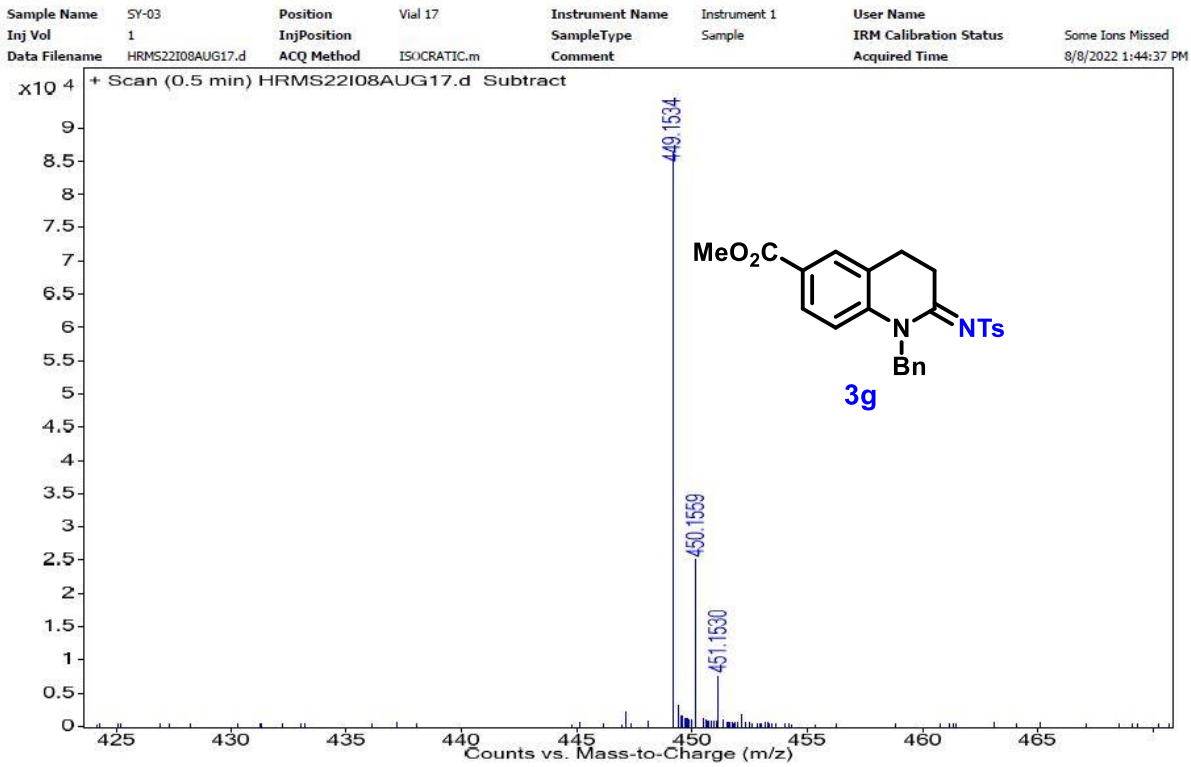

Figure S-73 HRMS spectrum of compound **3g**

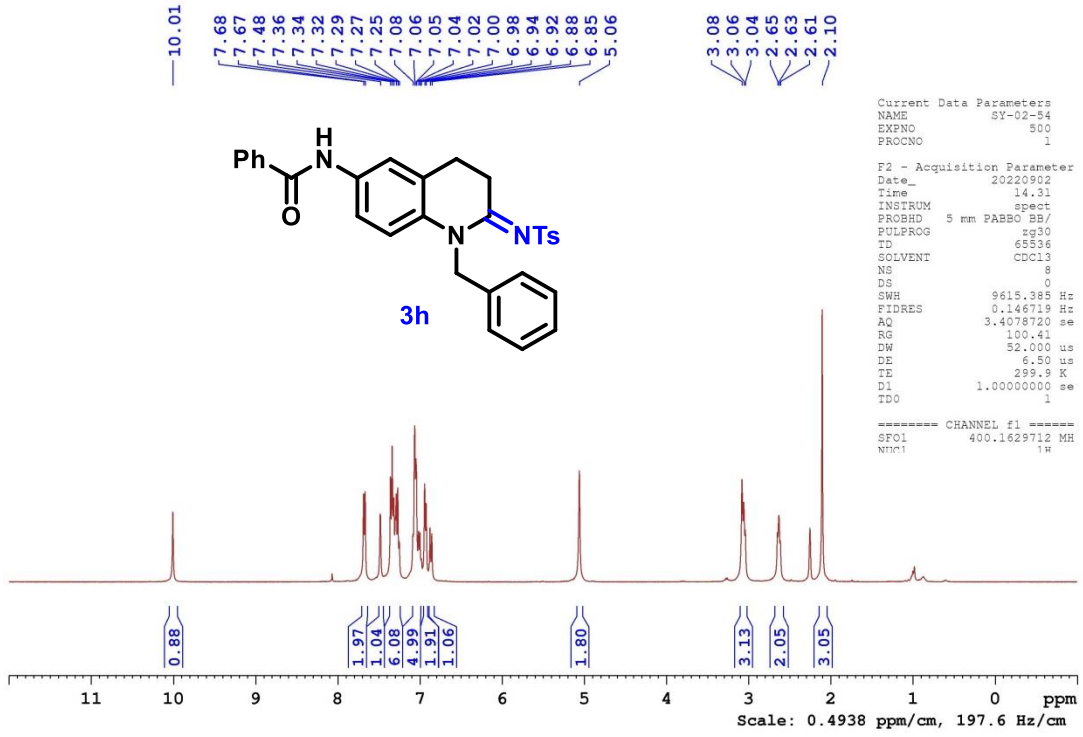

Figure S-74: ^{1}H NMR (400 MHz, DMSO-d_6) spectrum of compound **3h**

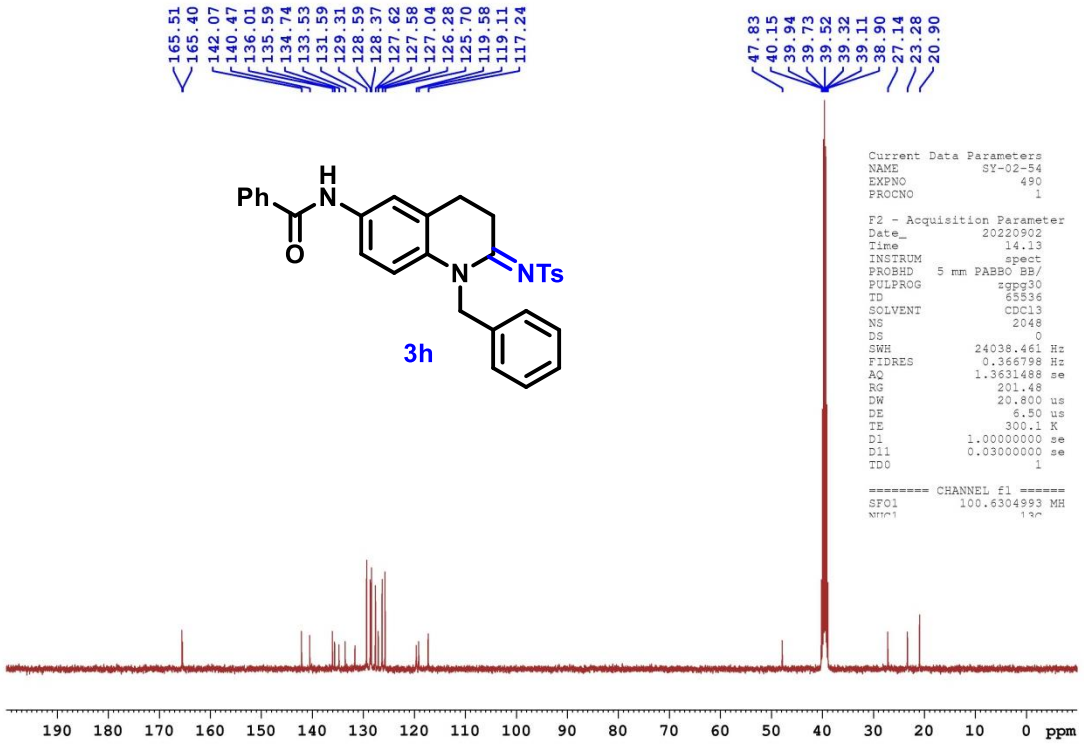

Figure S-75: ^{13}C NMR (100 MHz, DMSO-d_6) spectrum of compound **3h**

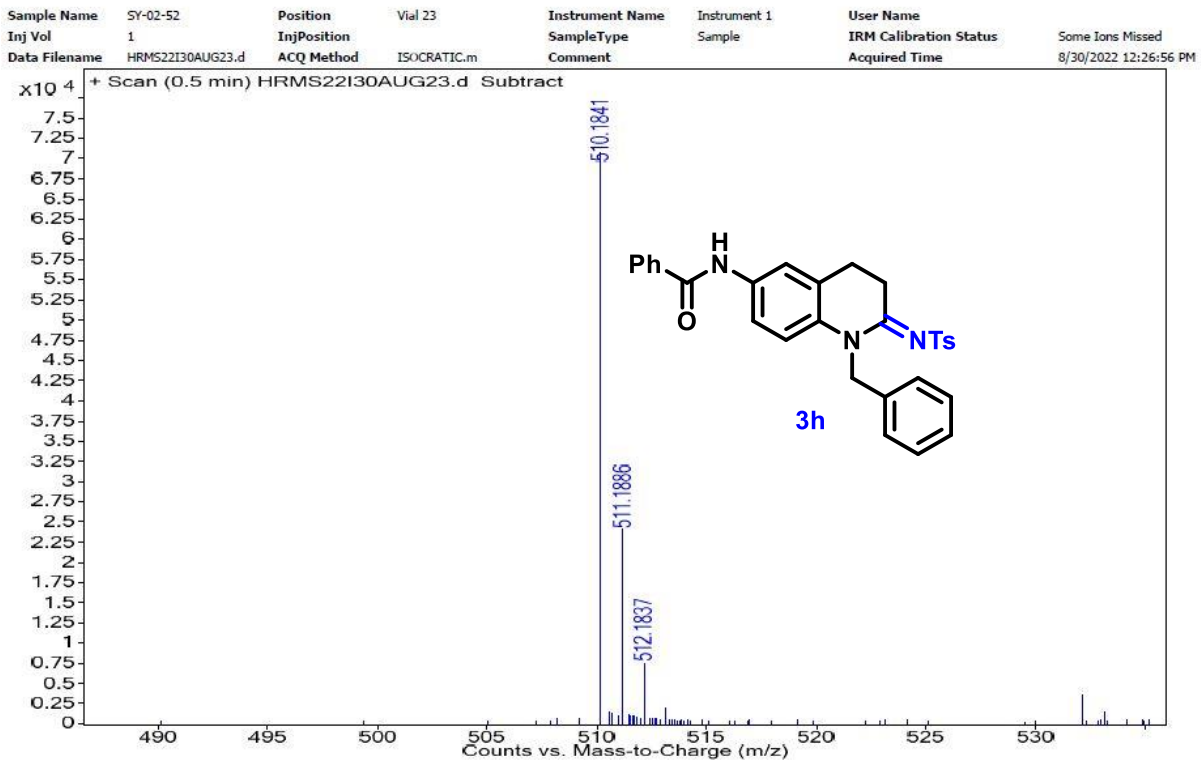

Figure S-76 HRMS spectrum of compound **3h**

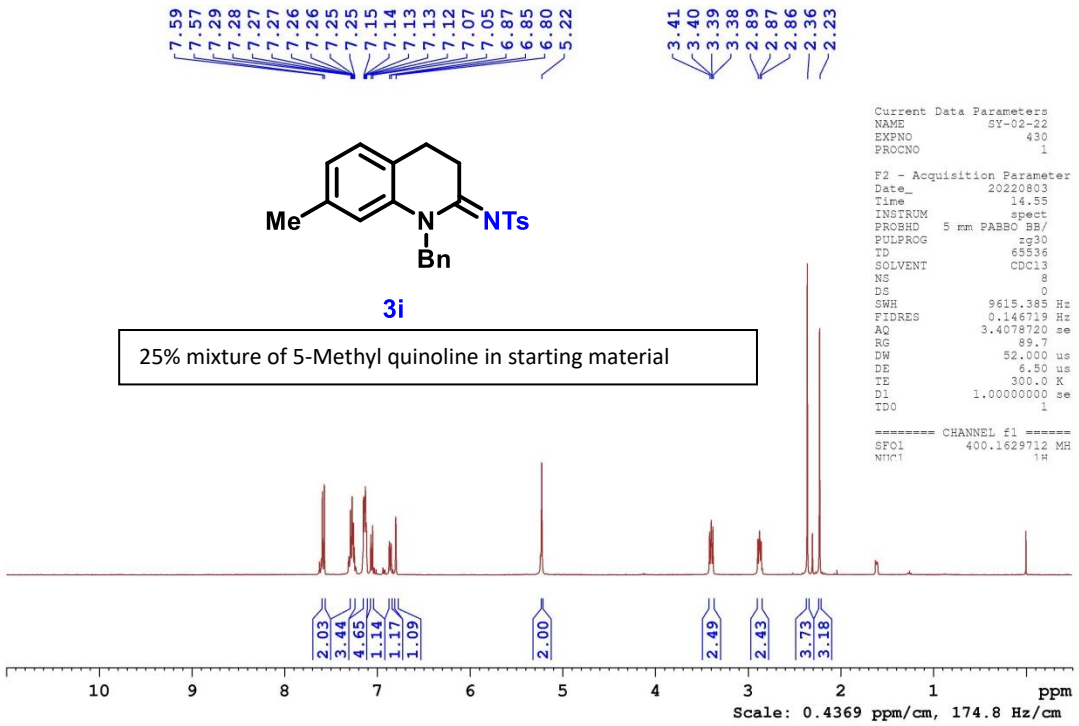

Figure S-77: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3i**

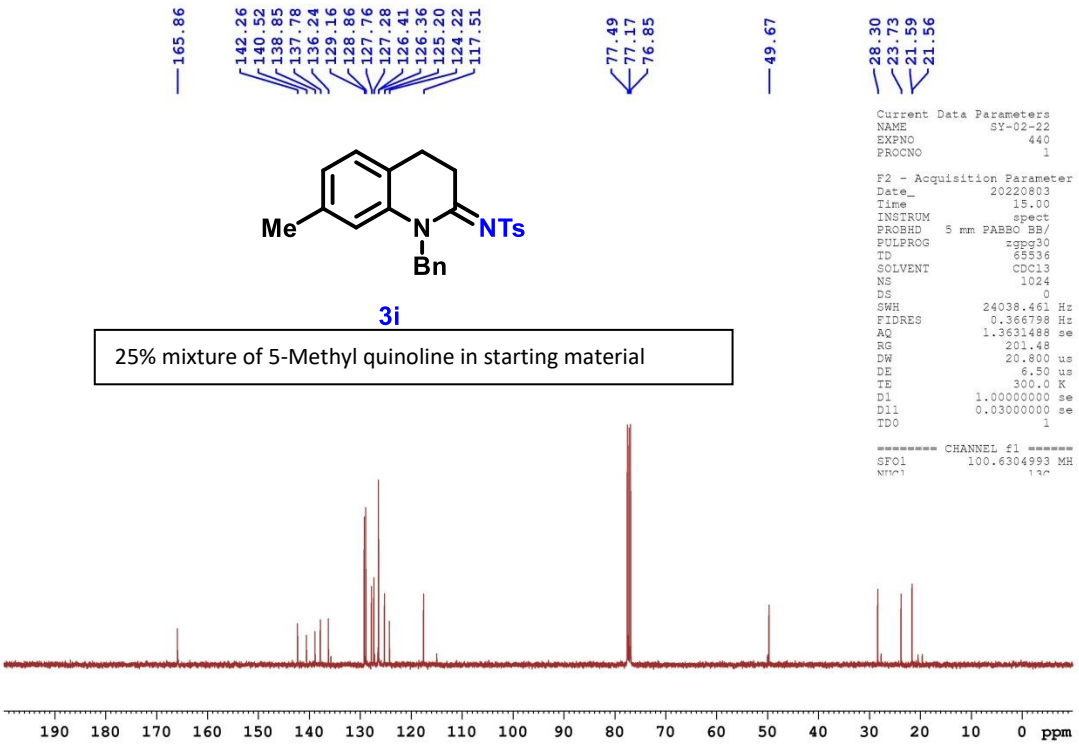

Figure S-78: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3i**

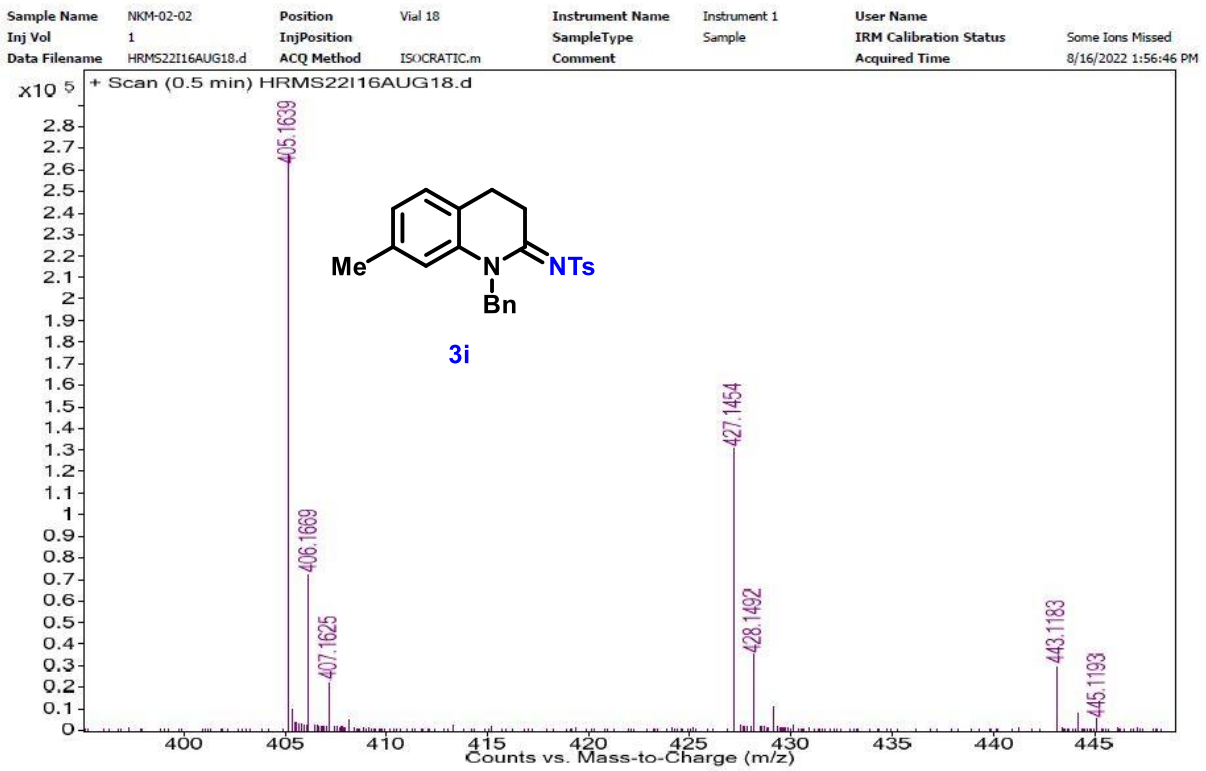

Figure S-79 HRMS spectrum of compound **3i**

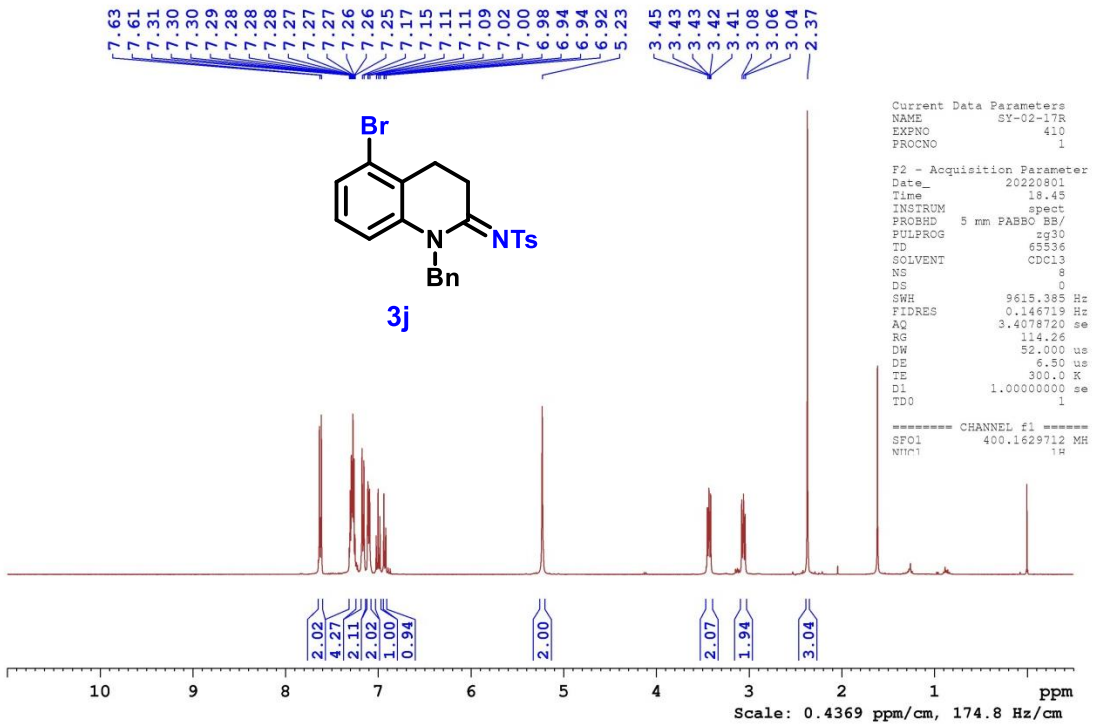

Figure S-80: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3j**

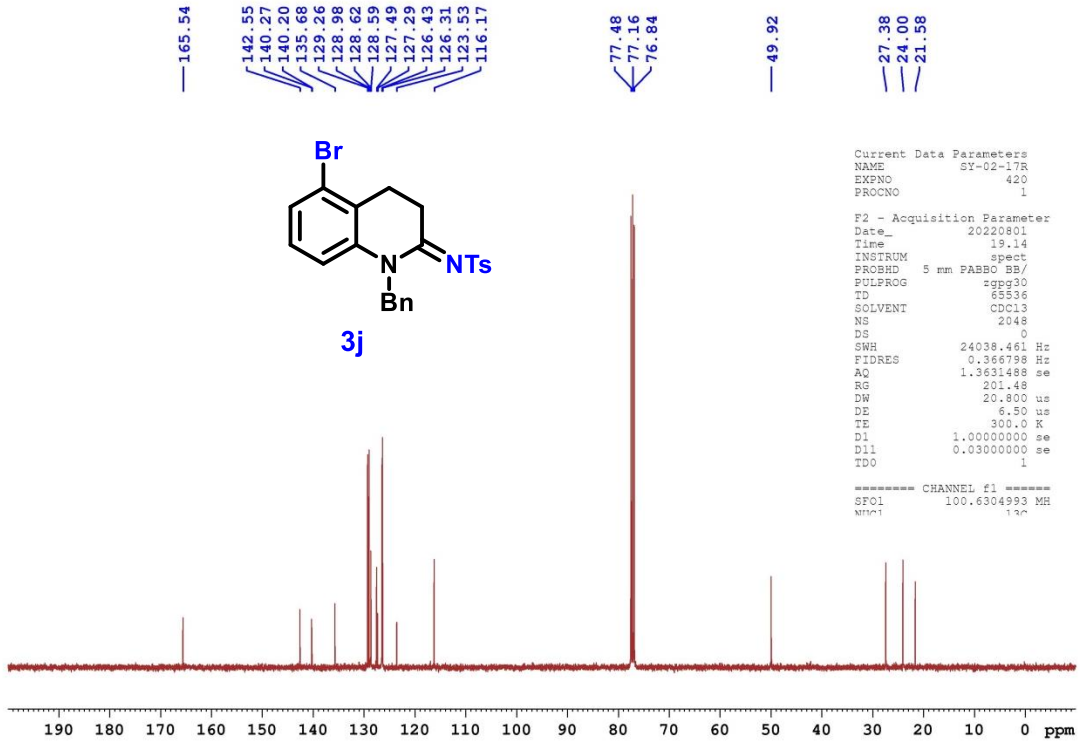

Figure S-81: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3j**

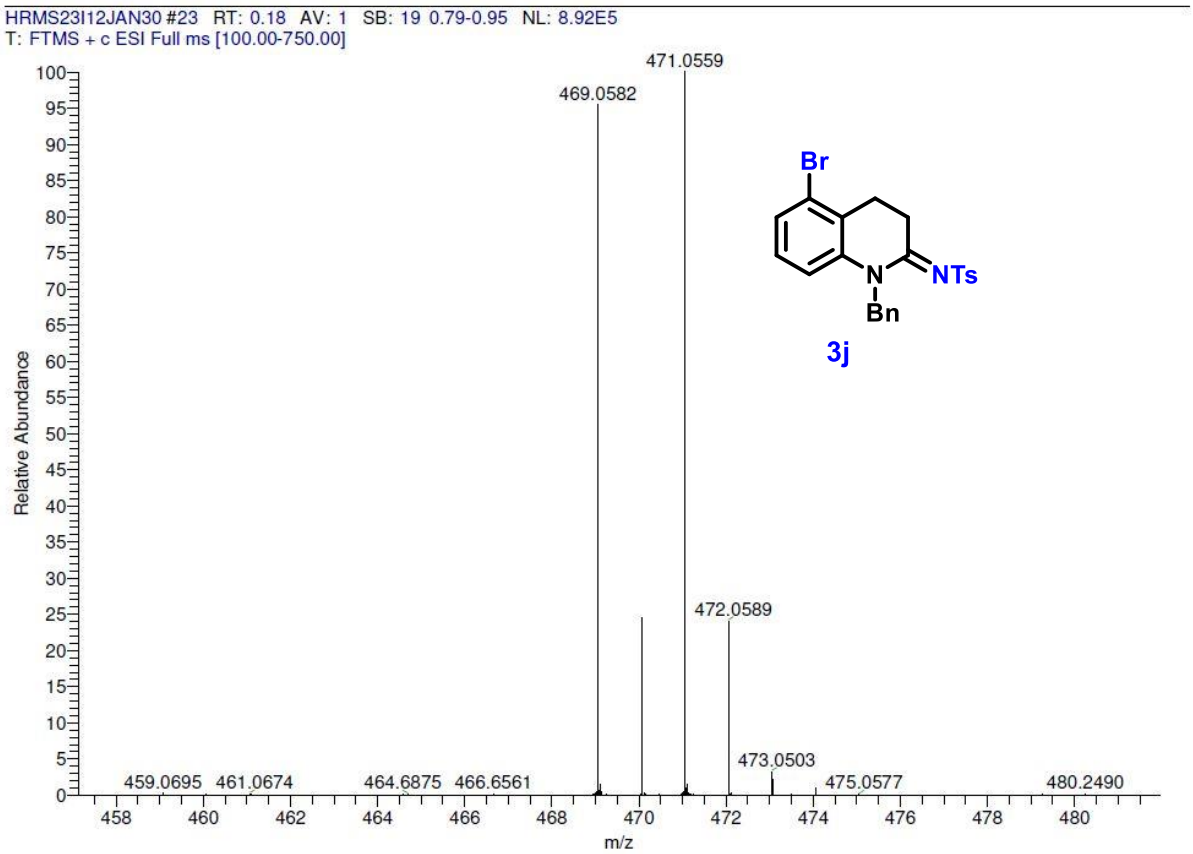

Figure S-82 HRMS spectrum of compound **3j**

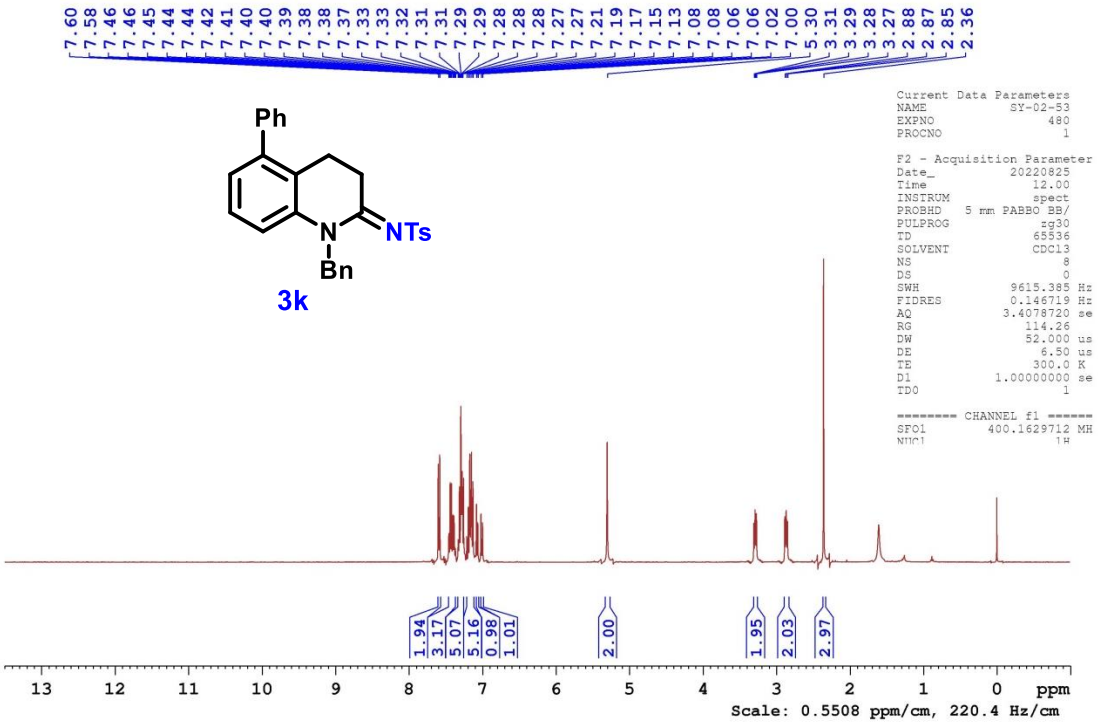

Figure S-83: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3k**

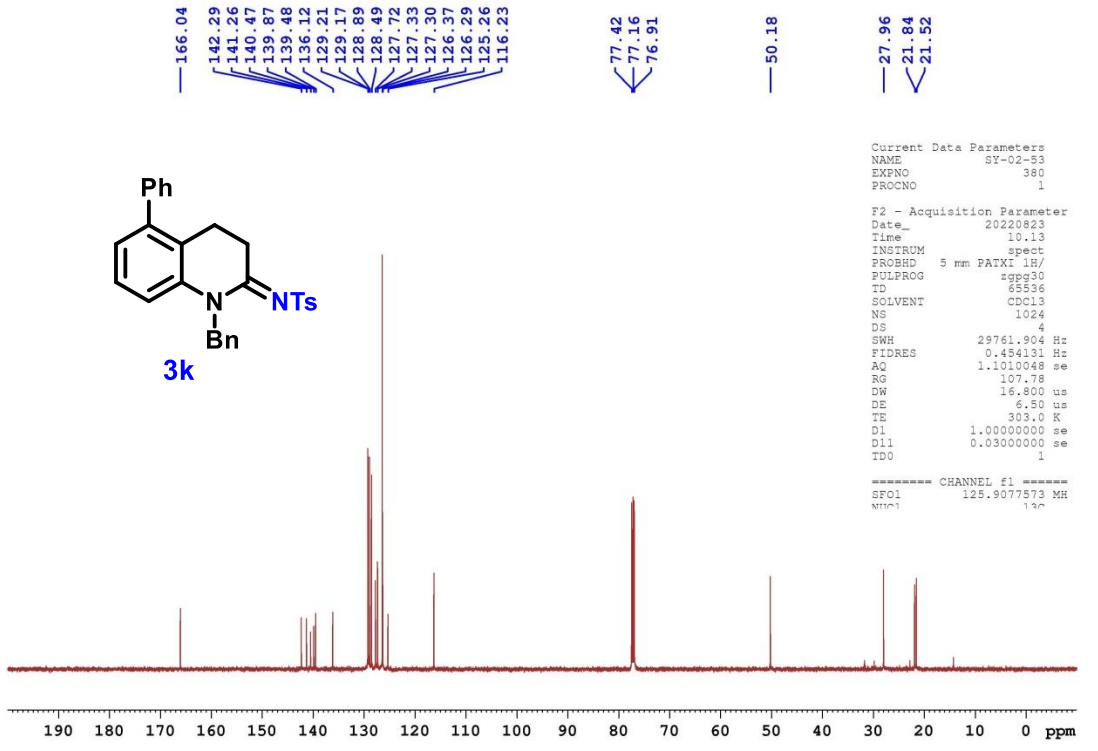

Figure S-84: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3k**

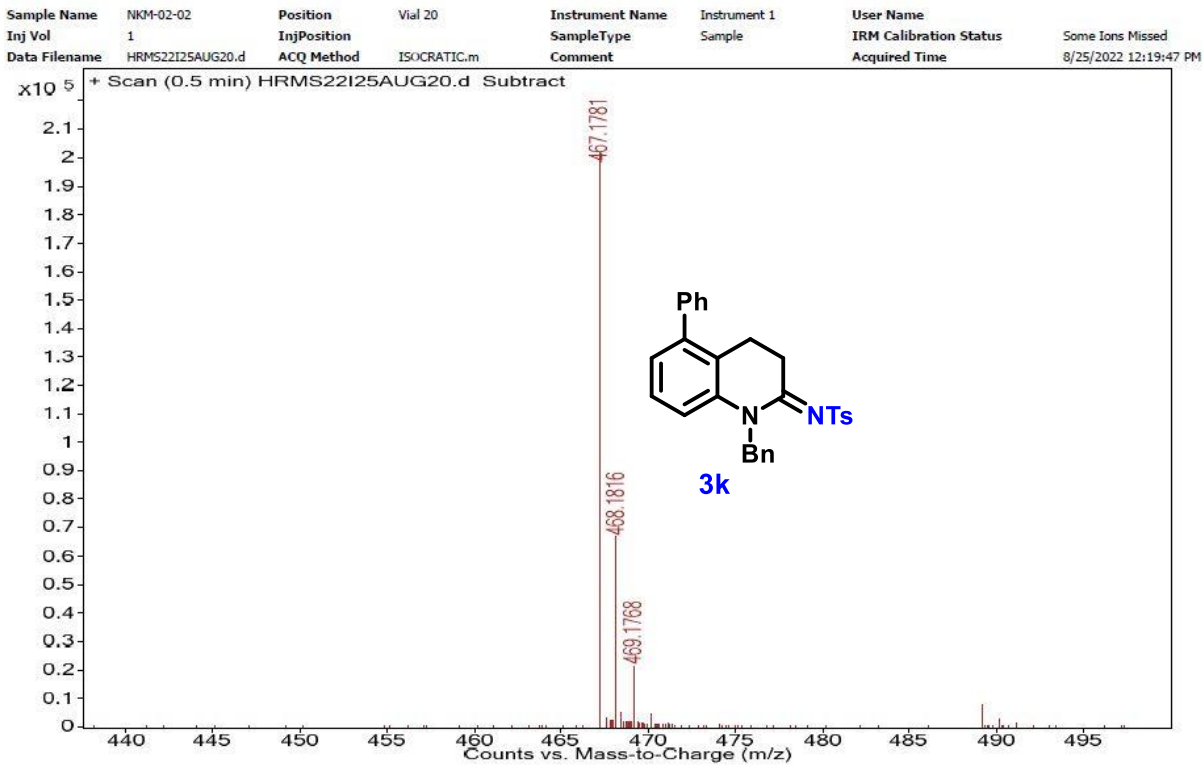

Figure S-85 HRMS spectrum of compound **3k**

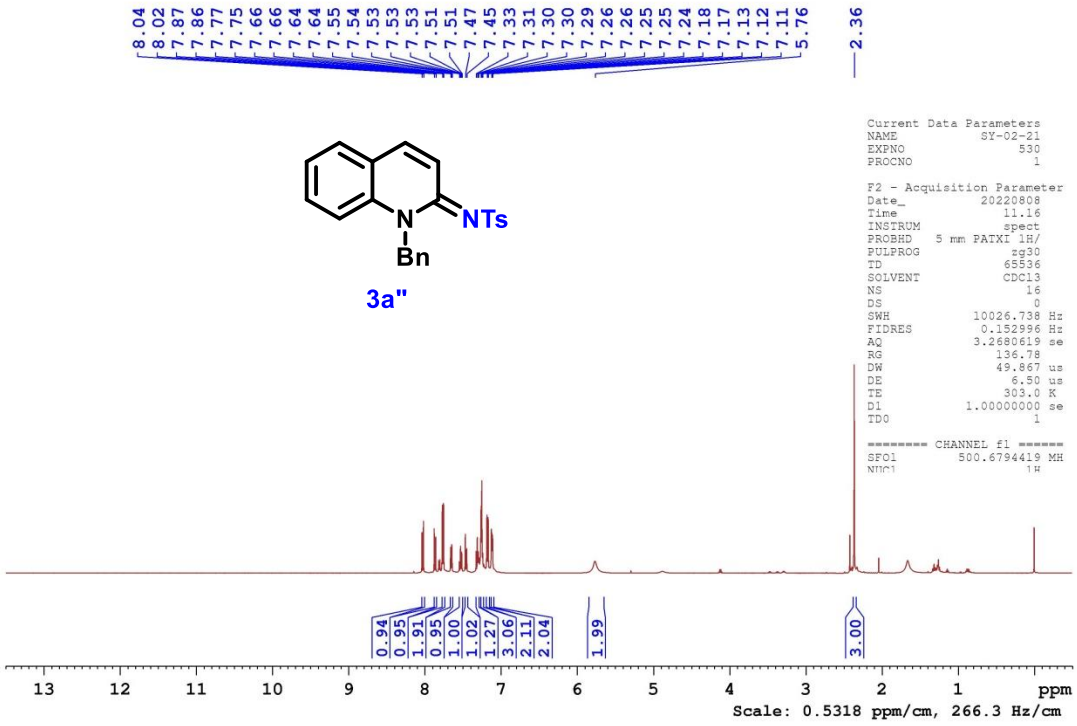

Figure S-86: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3a"**

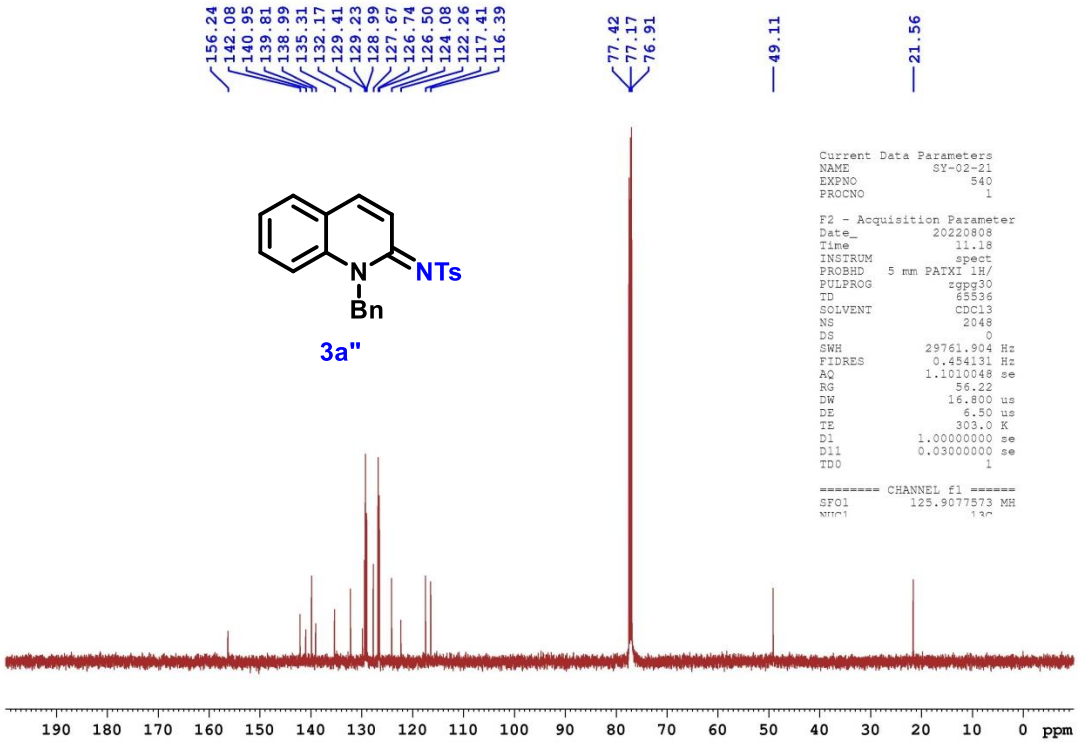

Figure S-87: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3a"**

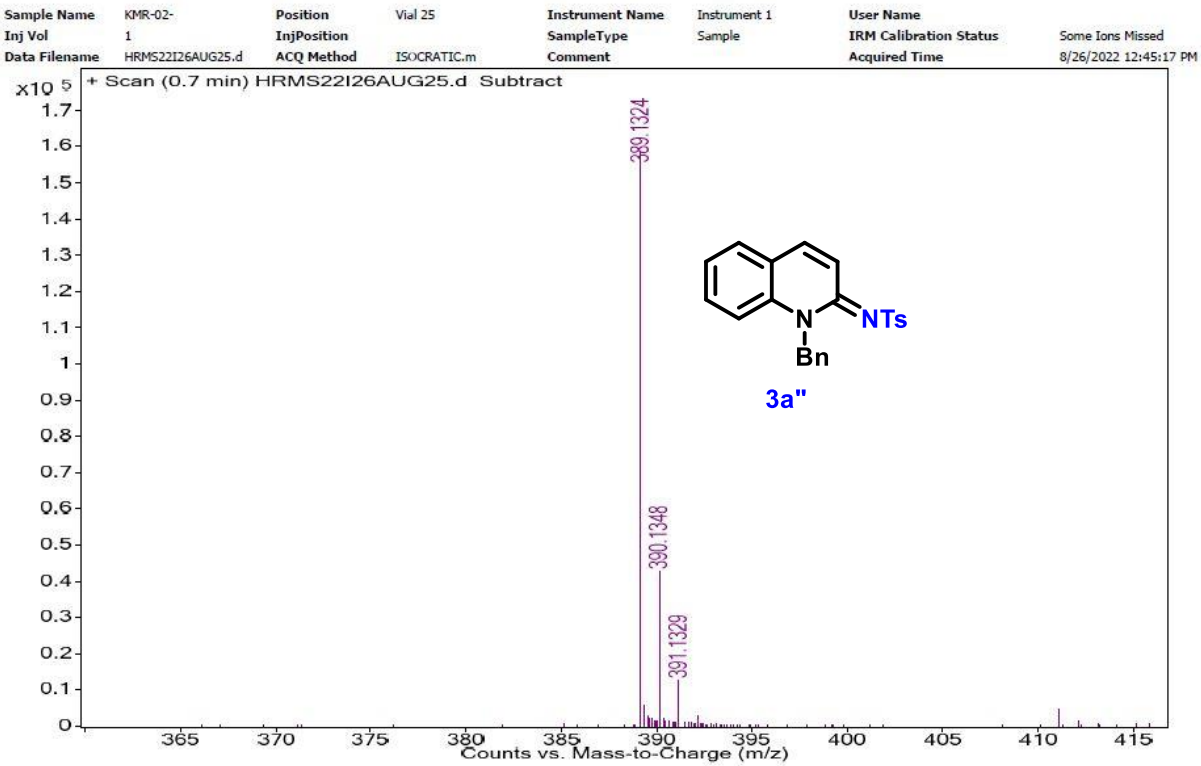

Figure S-88 HRMS spectrum of compound **3a"**

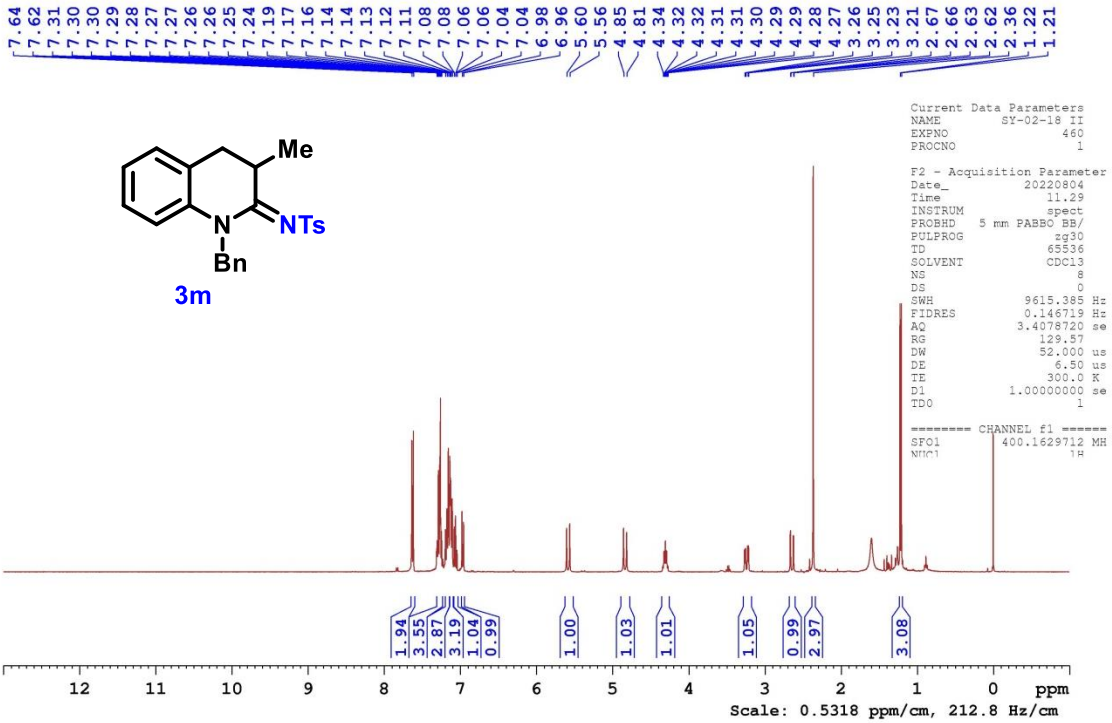

Figure S-89: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3m**

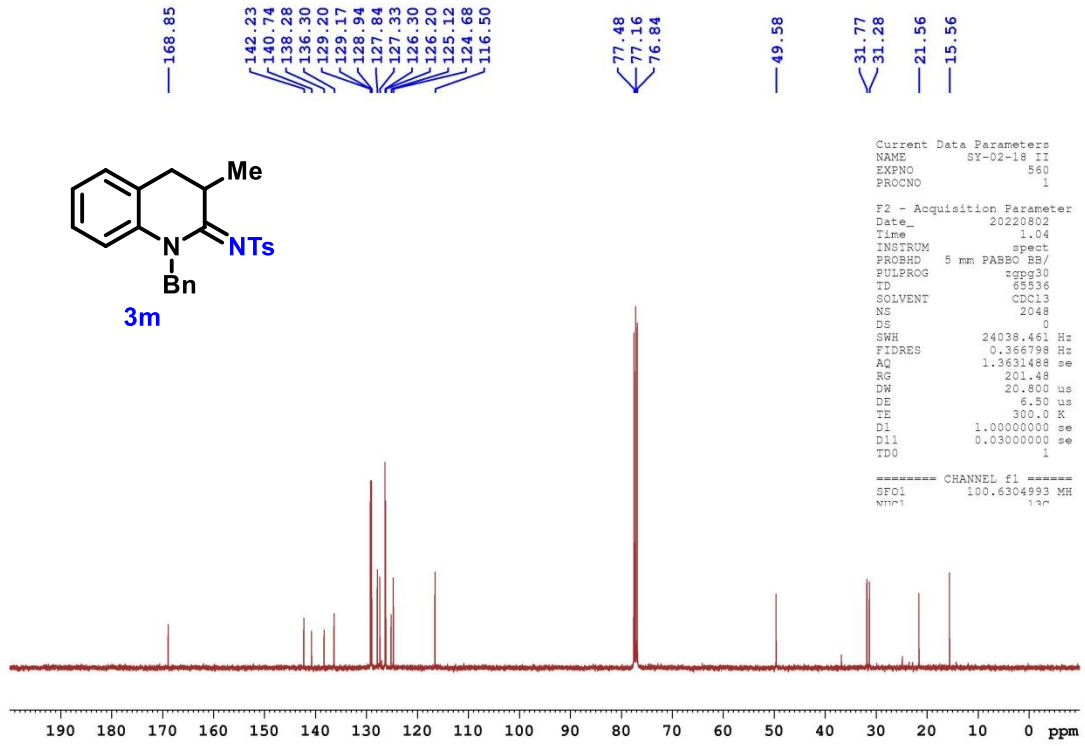

Figure S-90: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3m**

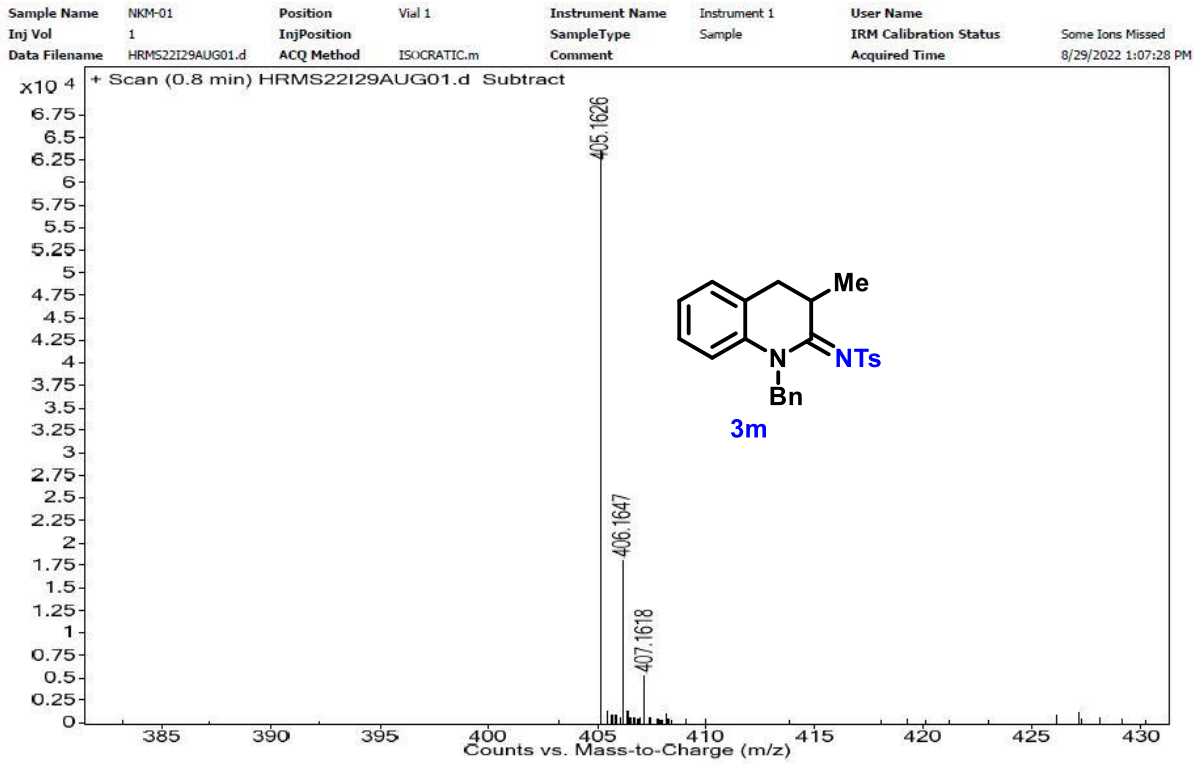

Figure S-90 HRMS spectrum of compound **3m**

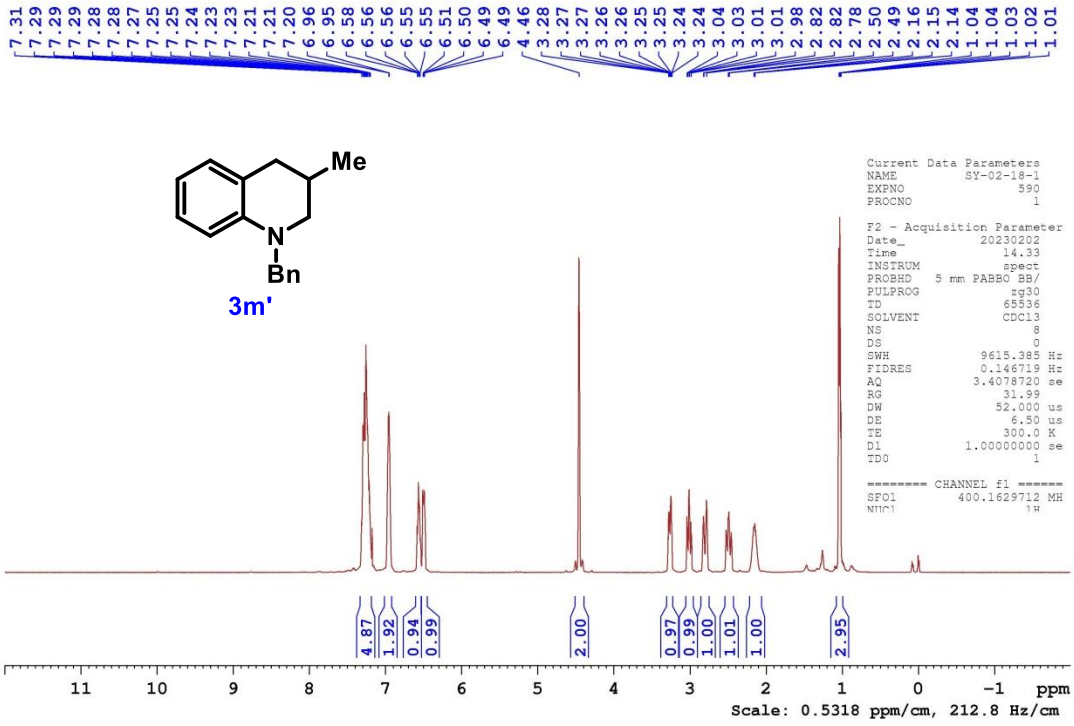

Figure S-91: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3m'**

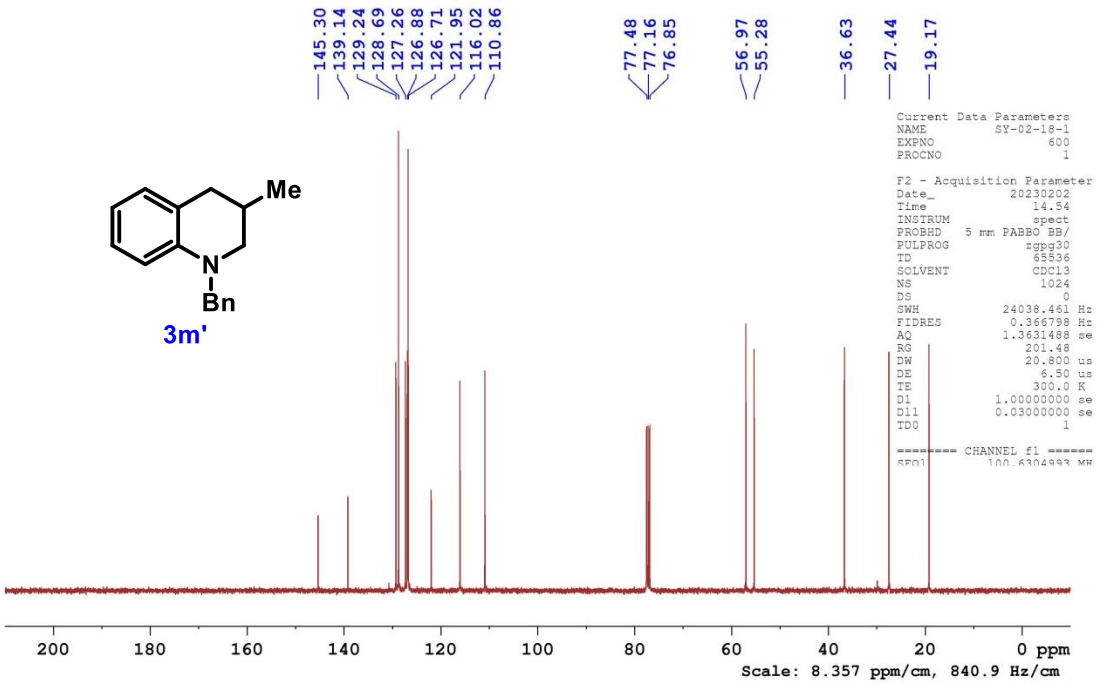

Figure S-92: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3m'**

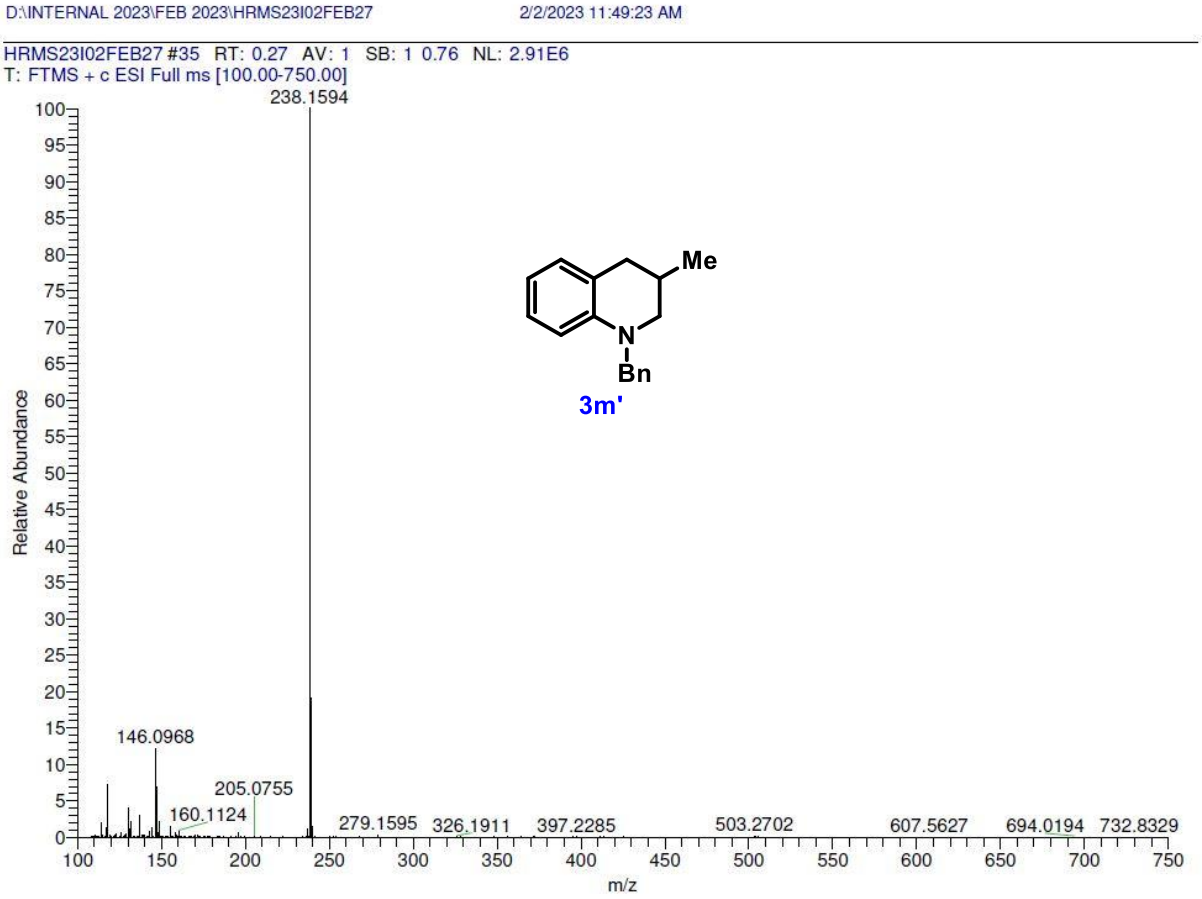

Figure S-93 HRMS spectrum of compound **3m'**

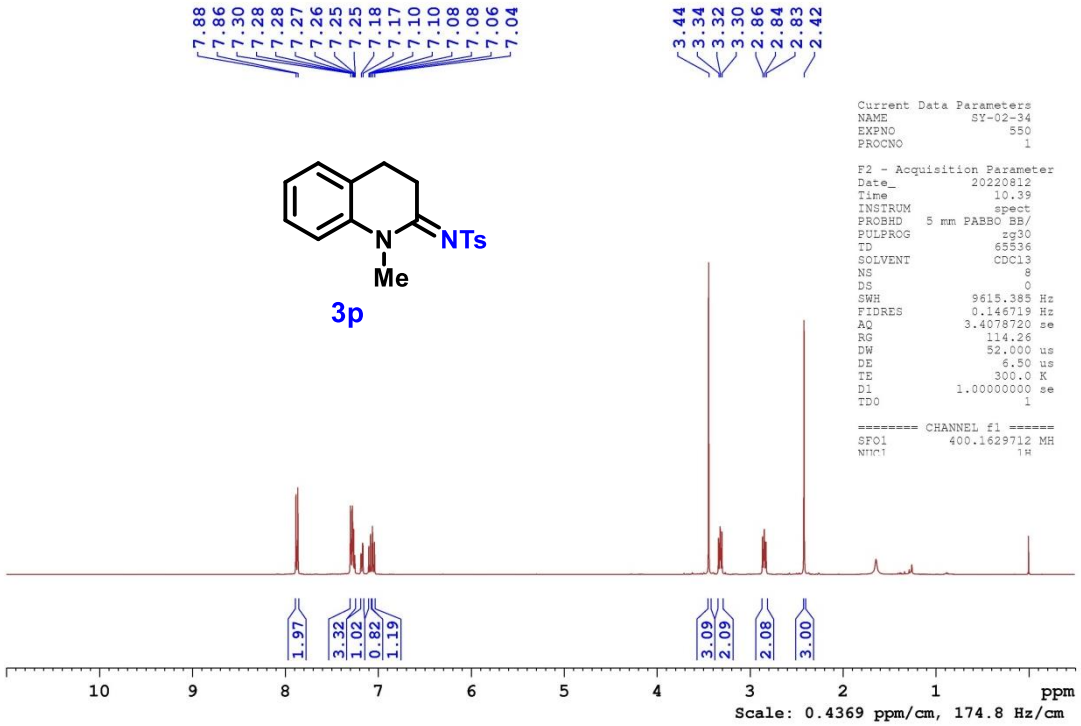

Figure S-94: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3p**

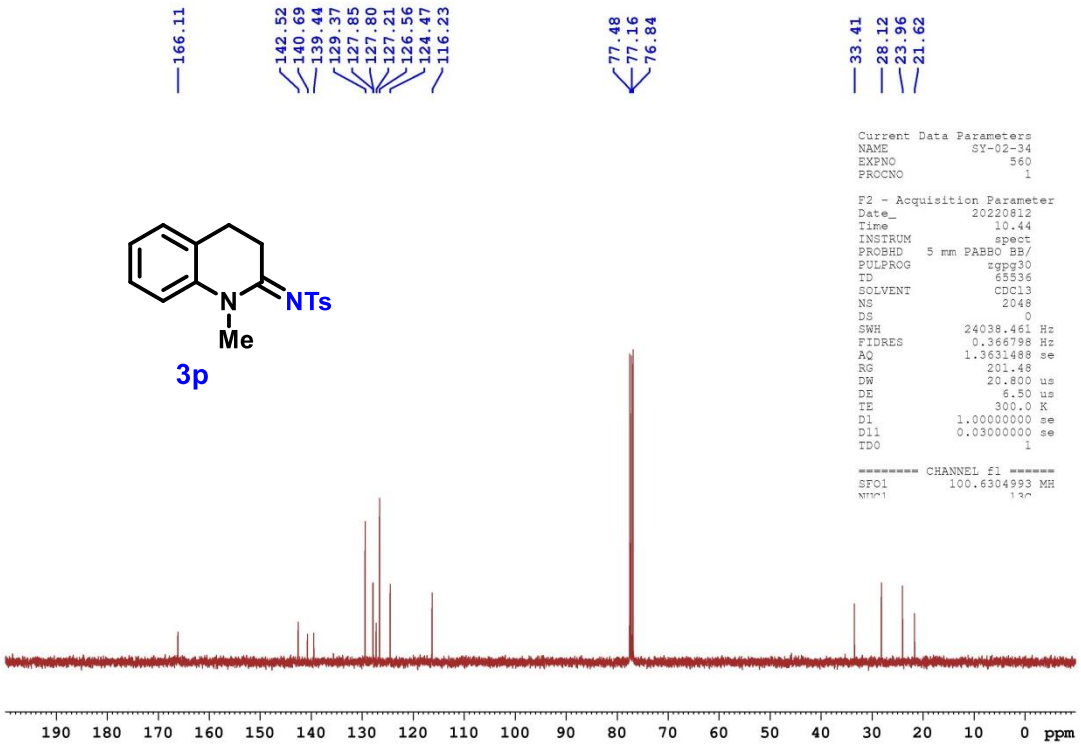

Figure S-95: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3p**

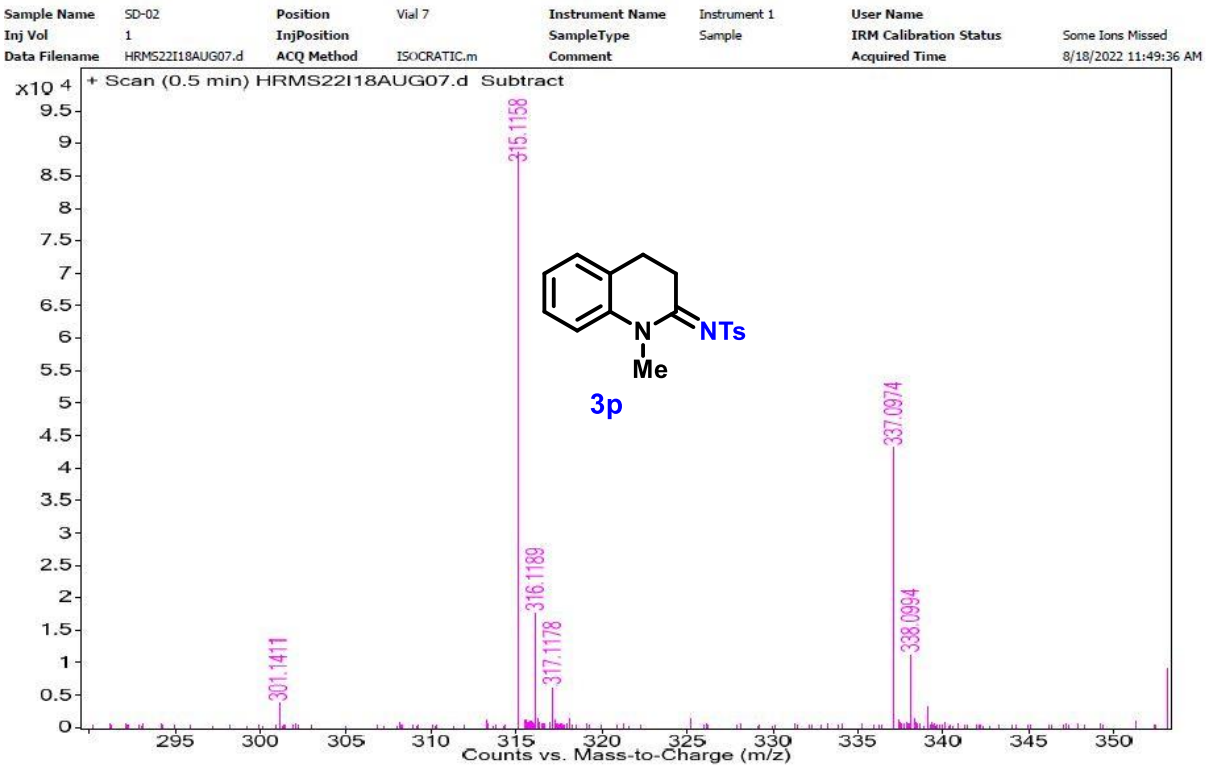

Figure S-96 HRMS spectrum of compound **3p**

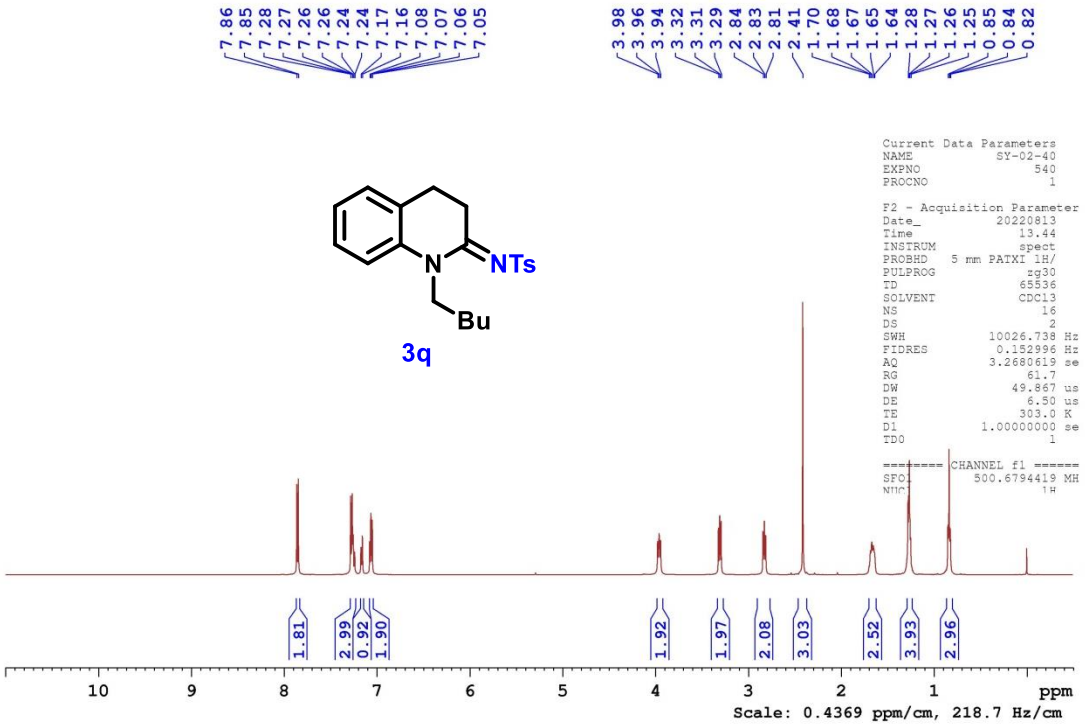

Figure S-97: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3q**

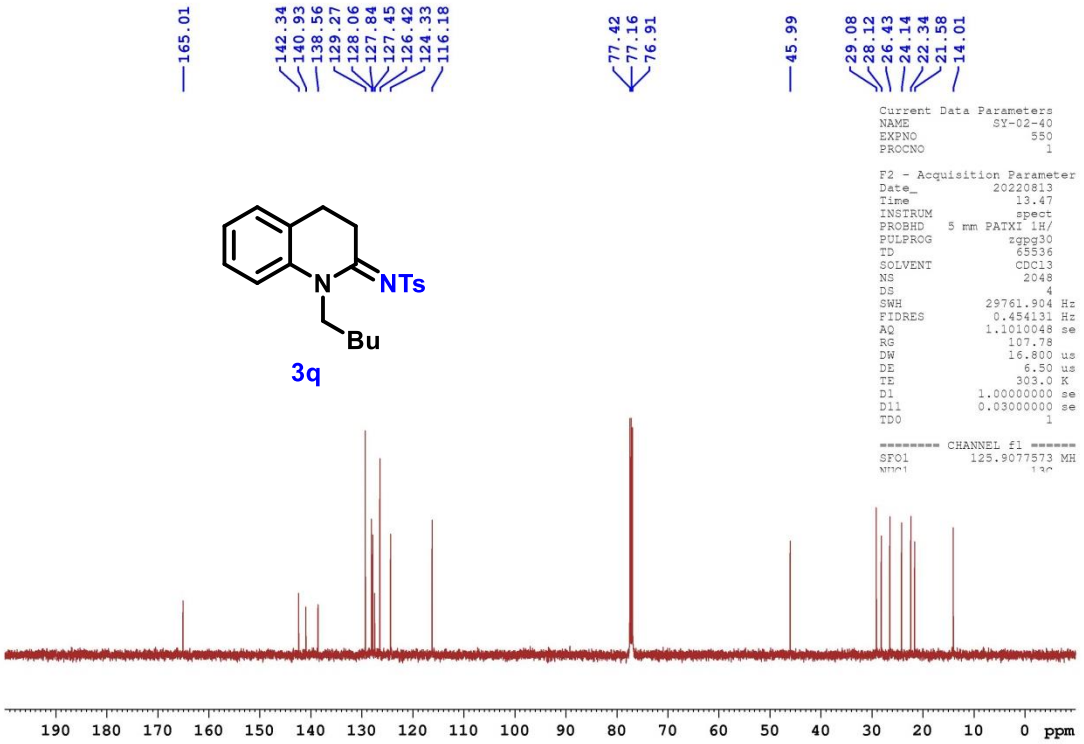

Figure S-98: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3q**

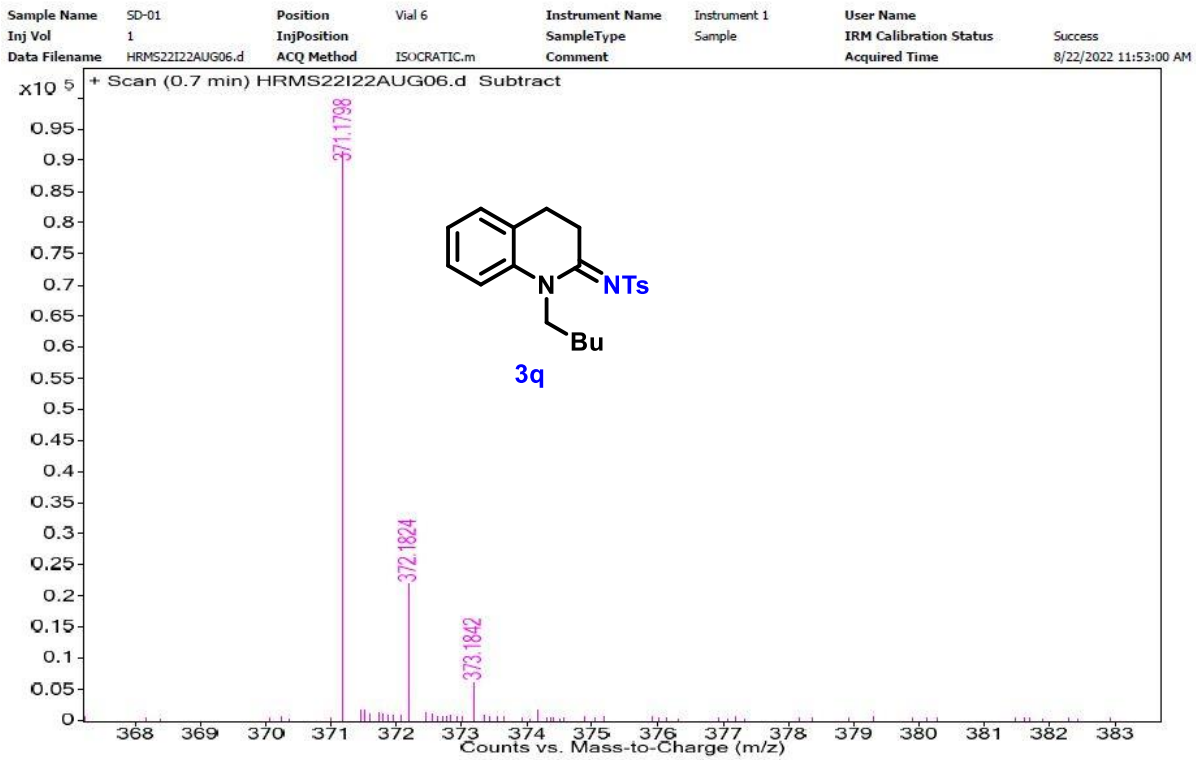

Figure S-99 HRMS spectrum of compound **3q**

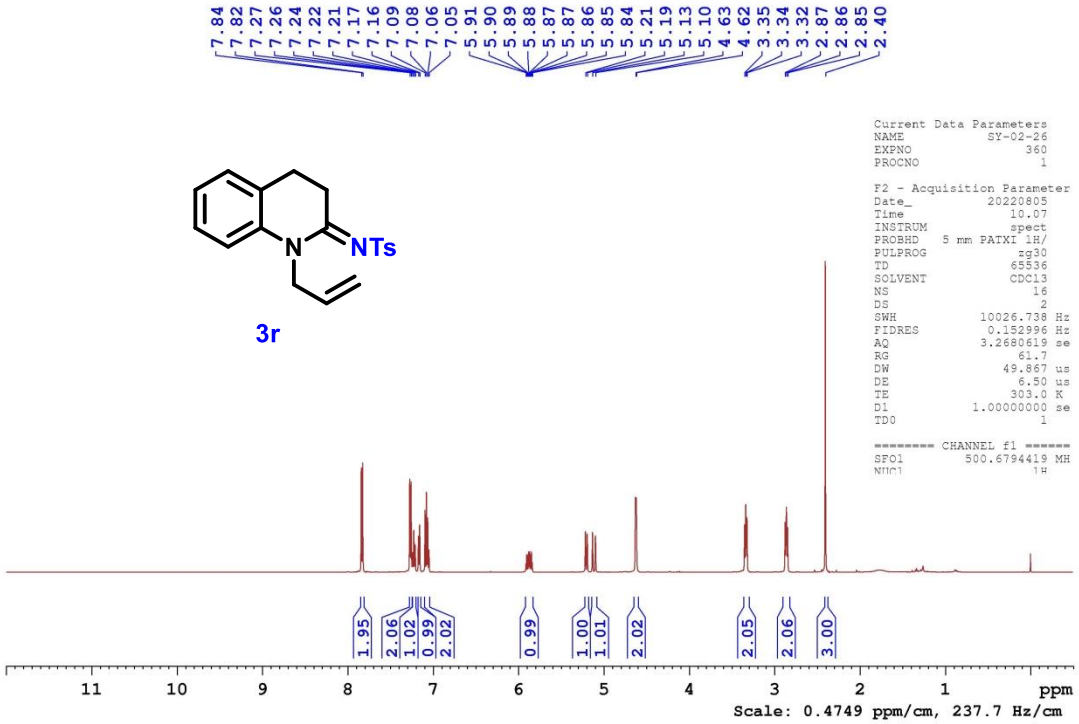

Figure S-100: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3r**

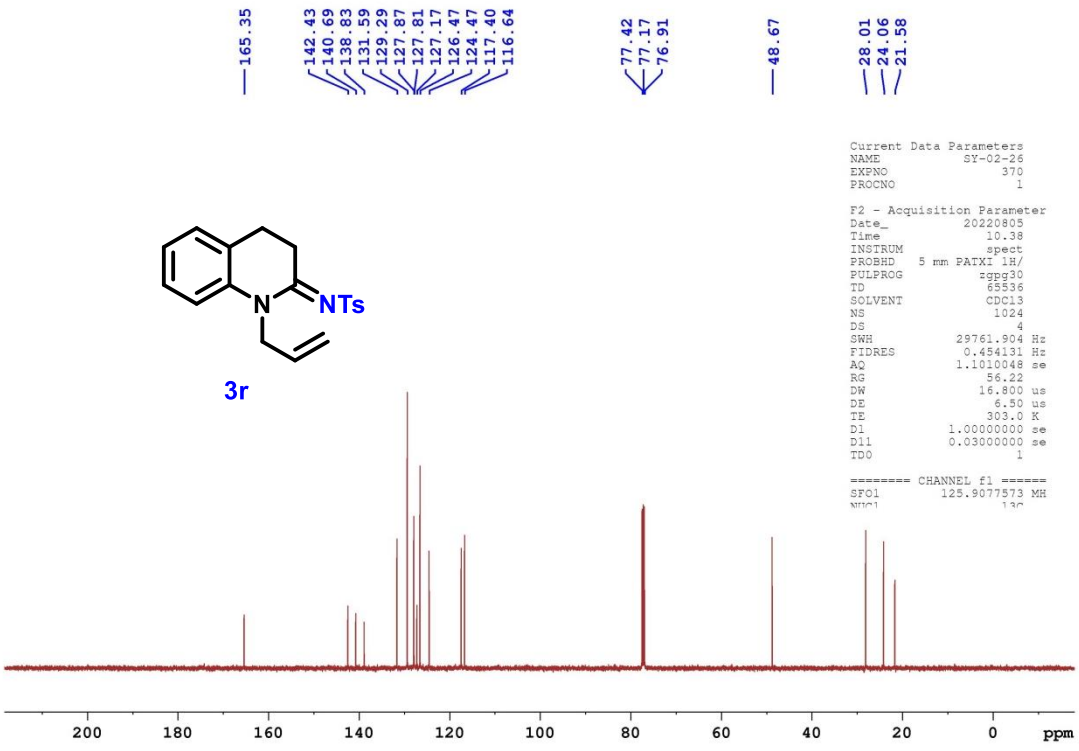

Figure S-101: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3r**

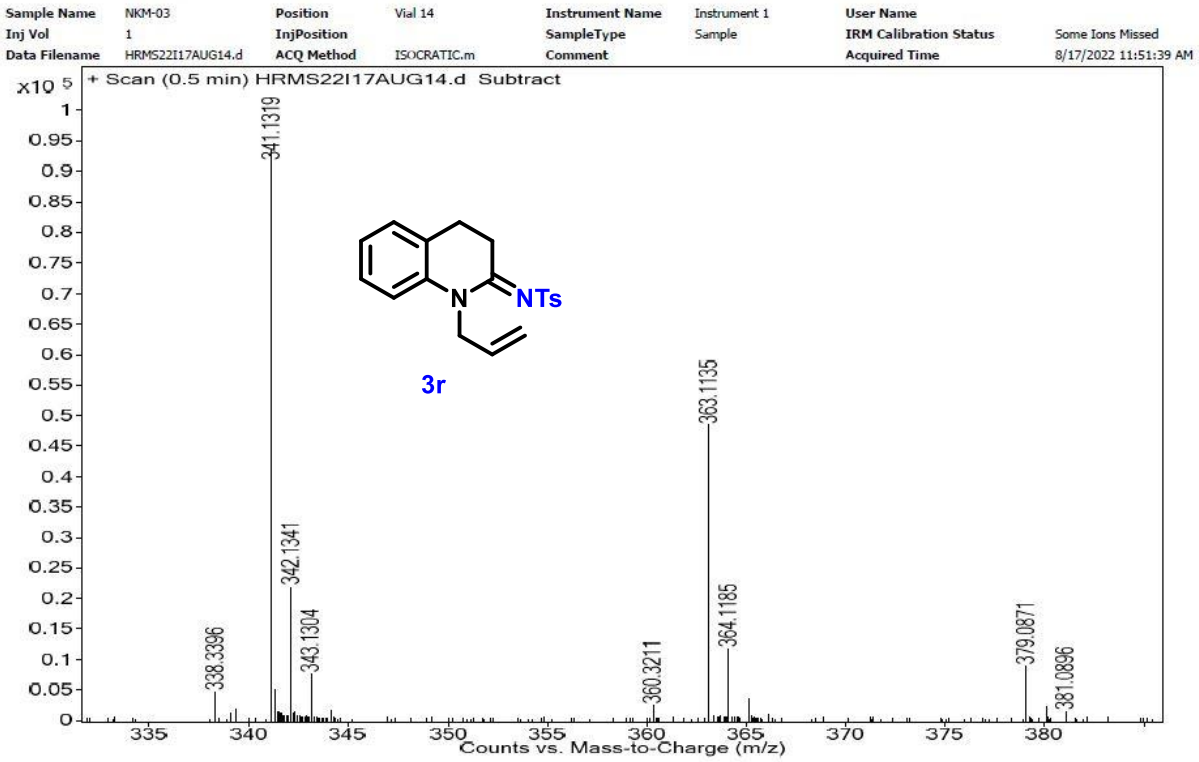

Figure S-102 HRMS spectrum of compound **3r**

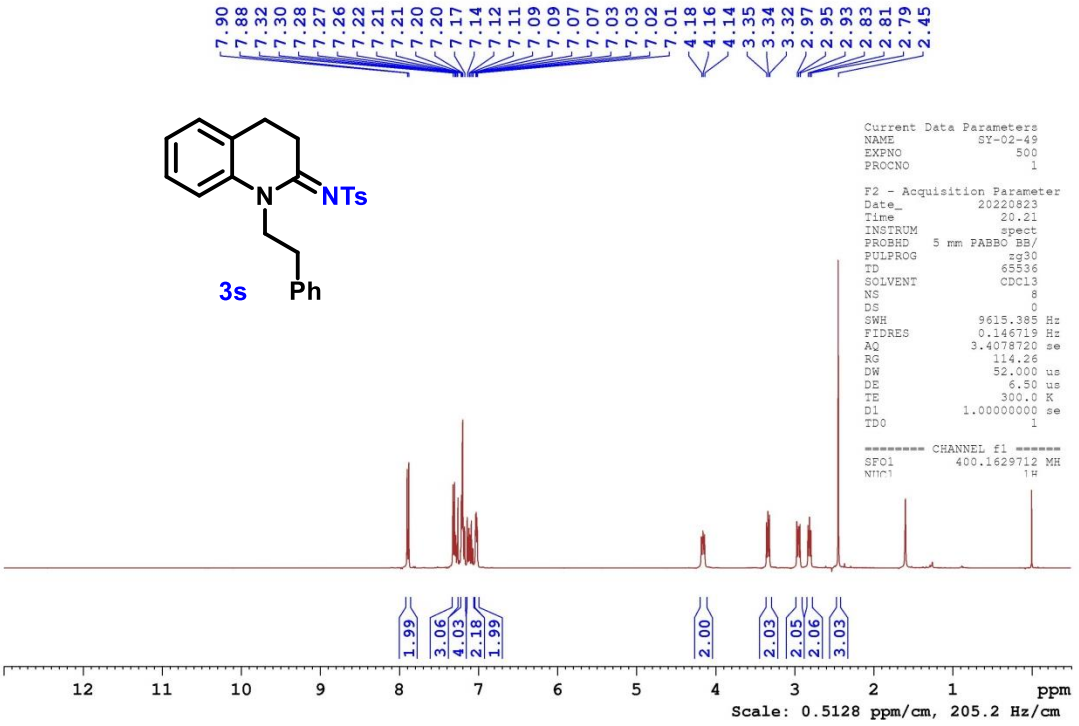

Figure S-103: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3s**

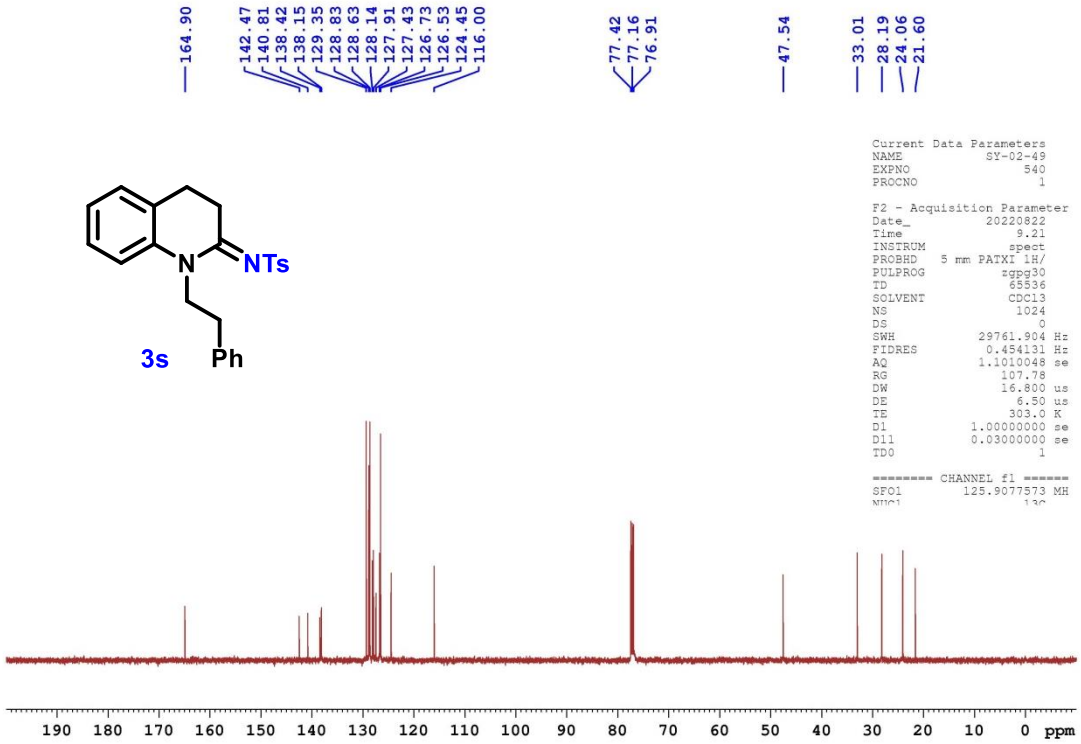

Figure S-104: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3s**

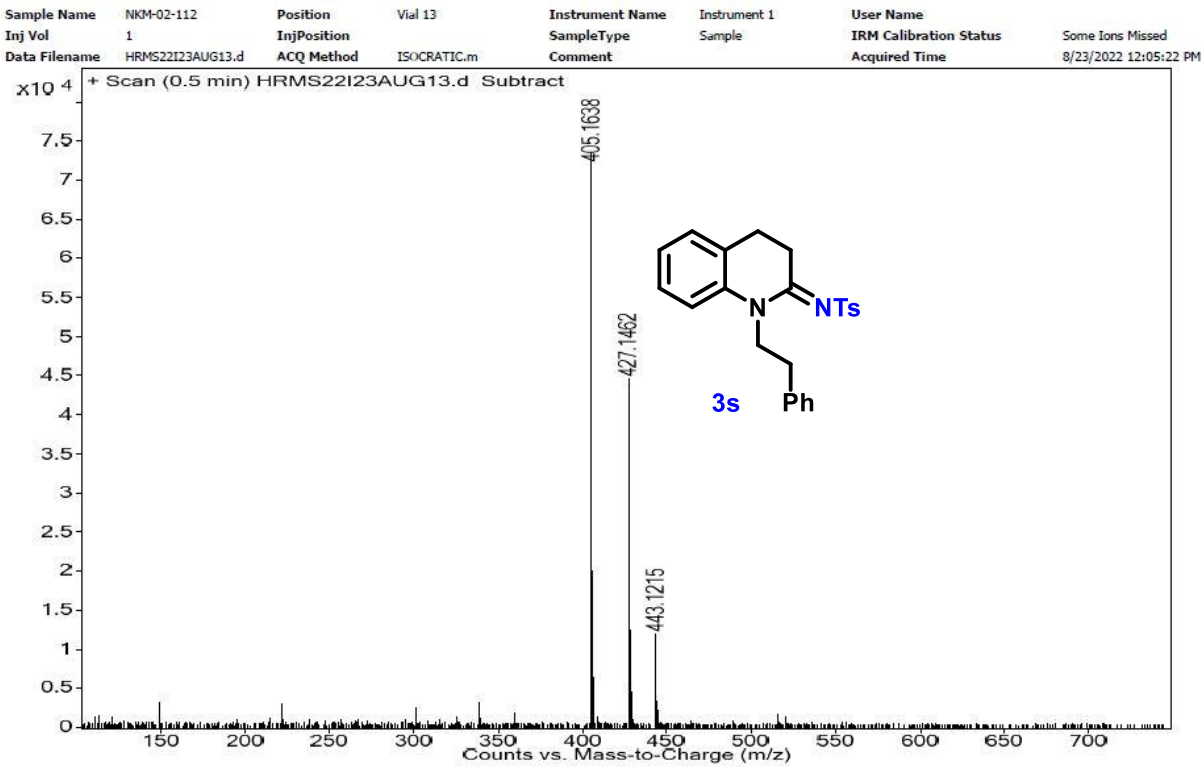

Figure S-105 HRMS spectrum of compound **3s**

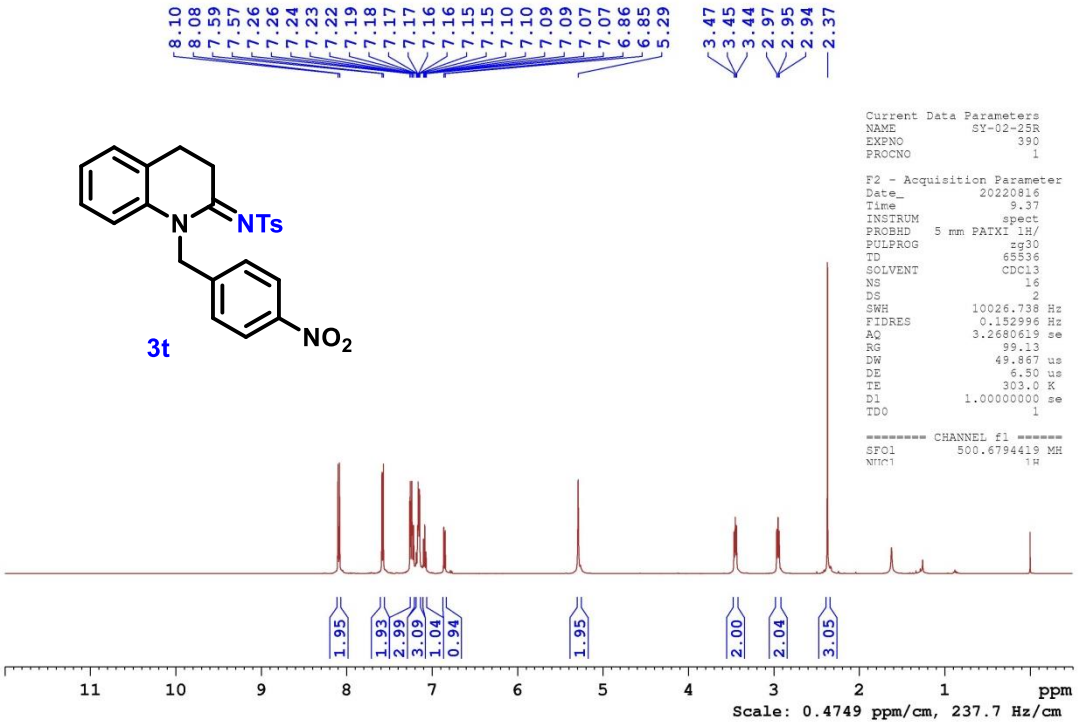

Figure S-106: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3t**

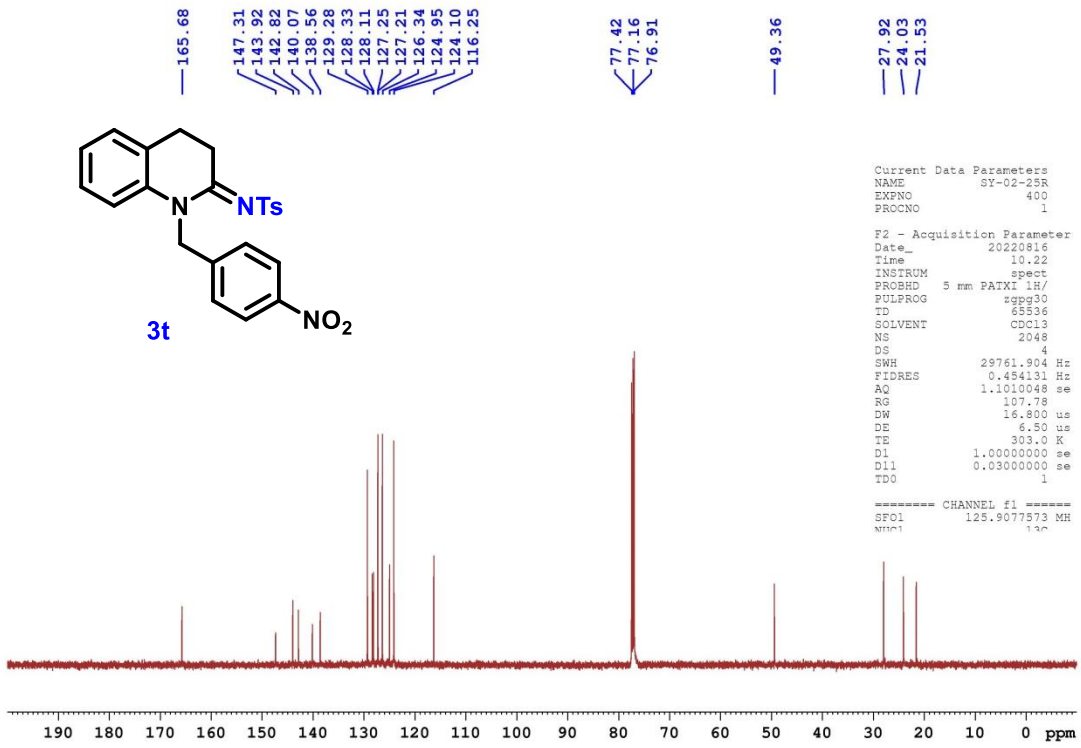

Figure S-107: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3t**

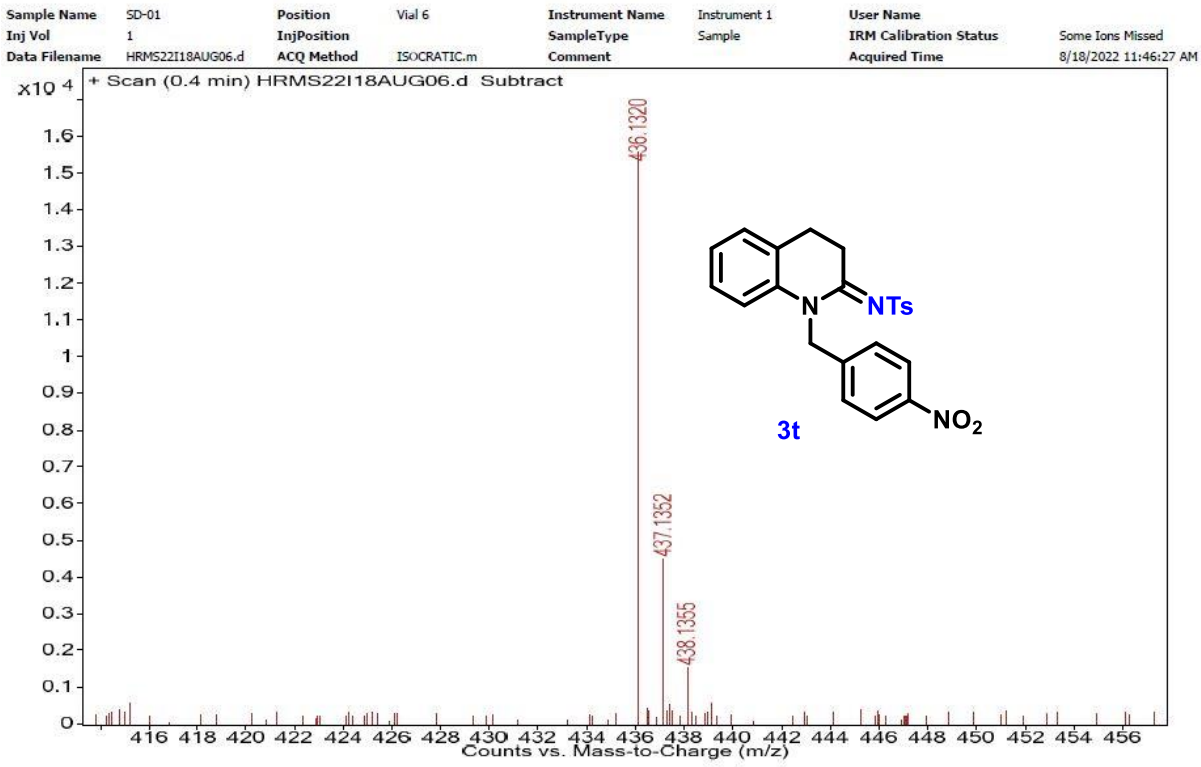

Figure S-108 HRMS spectrum of compound **3t**

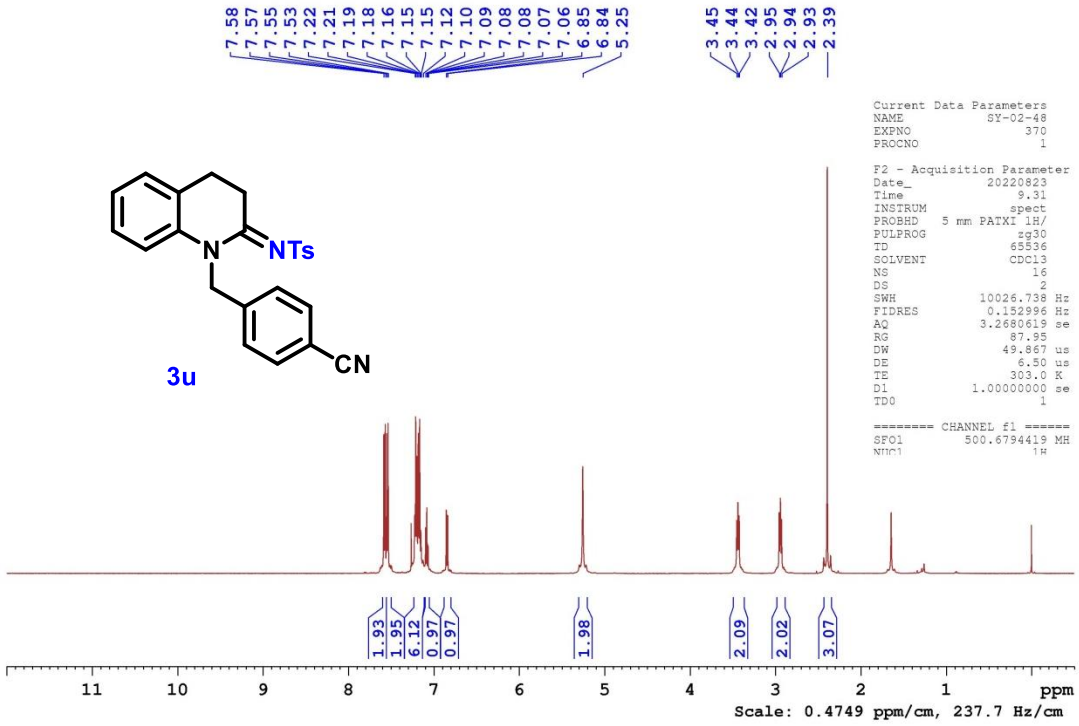

Figure S-109: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3u**

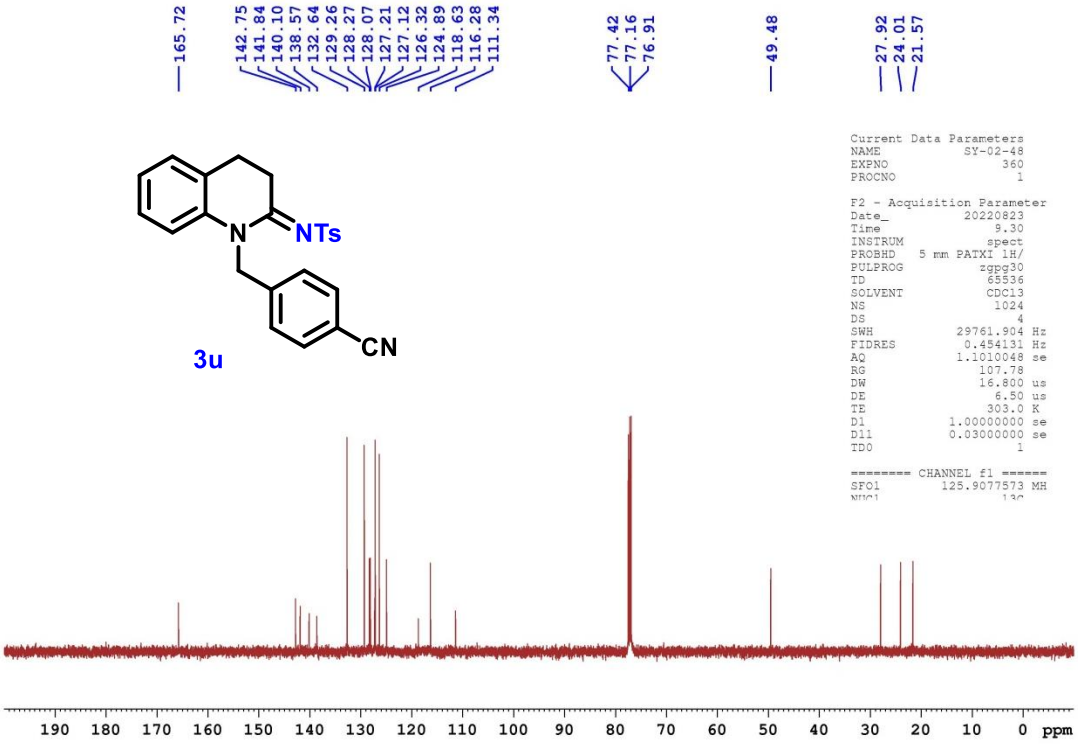

Figure S-110: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3u**

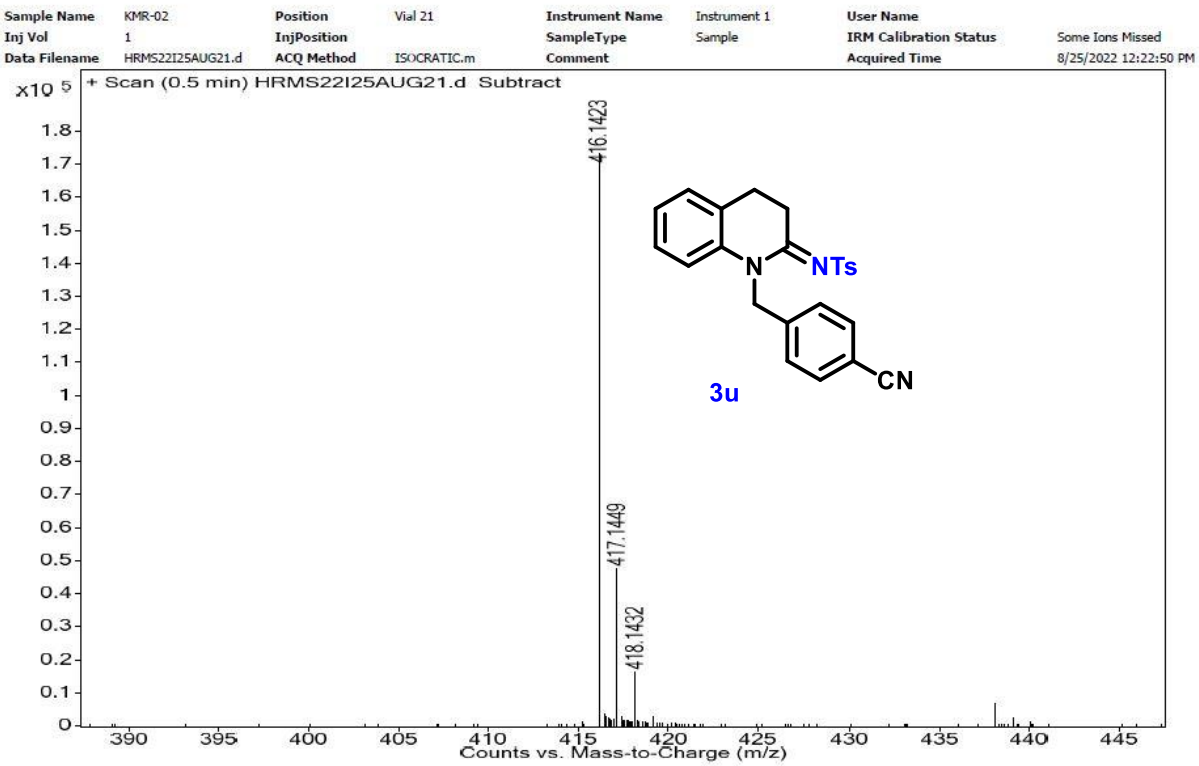

Figure S-111 HRMS spectrum of compound **3u**

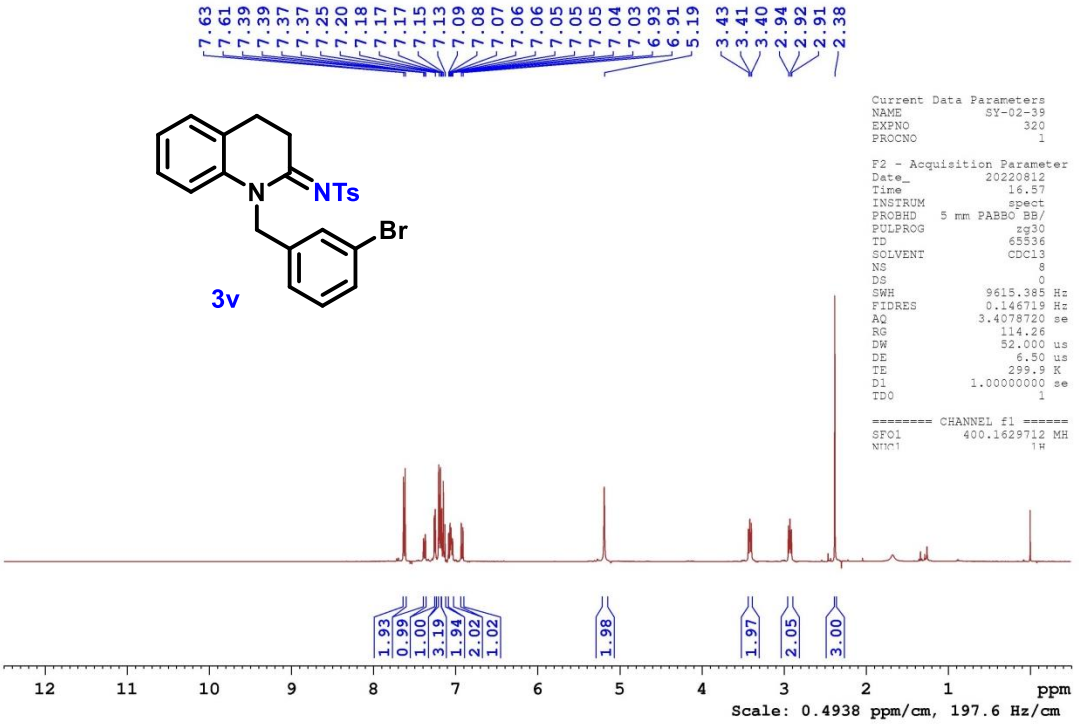

Figure S-112: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3v**

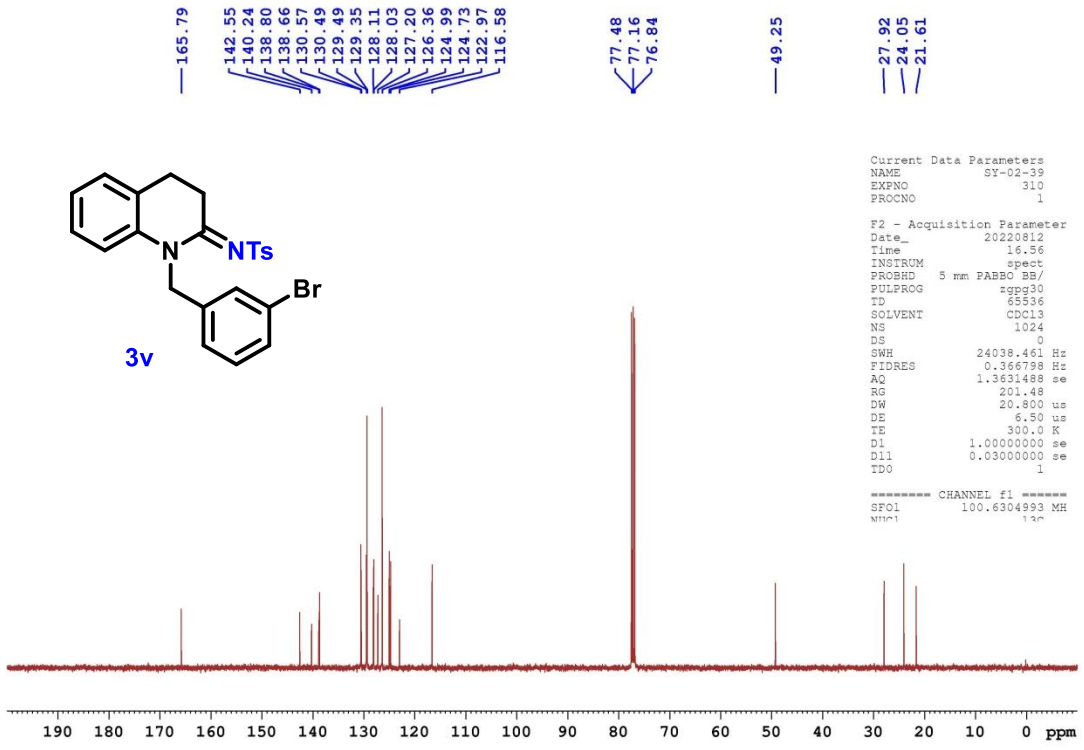

Figure S-113: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3v**

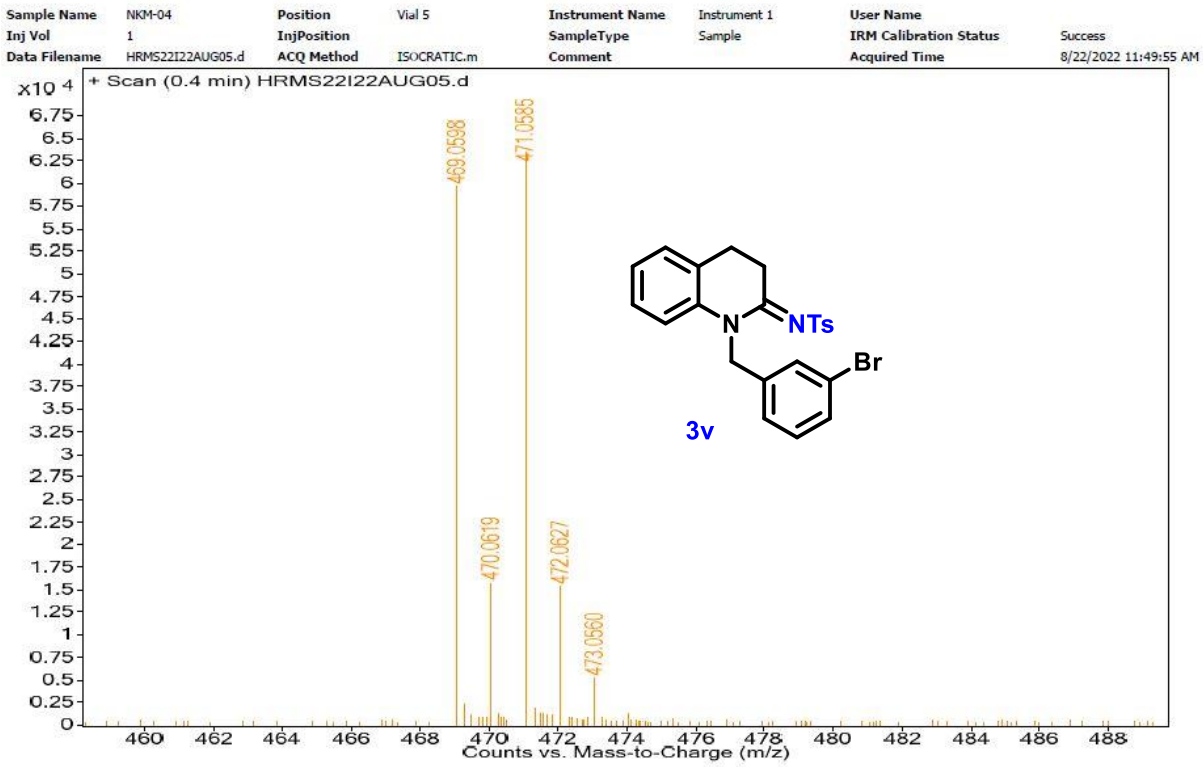

Figure S-114 HRMS spectrum of compound **3v**

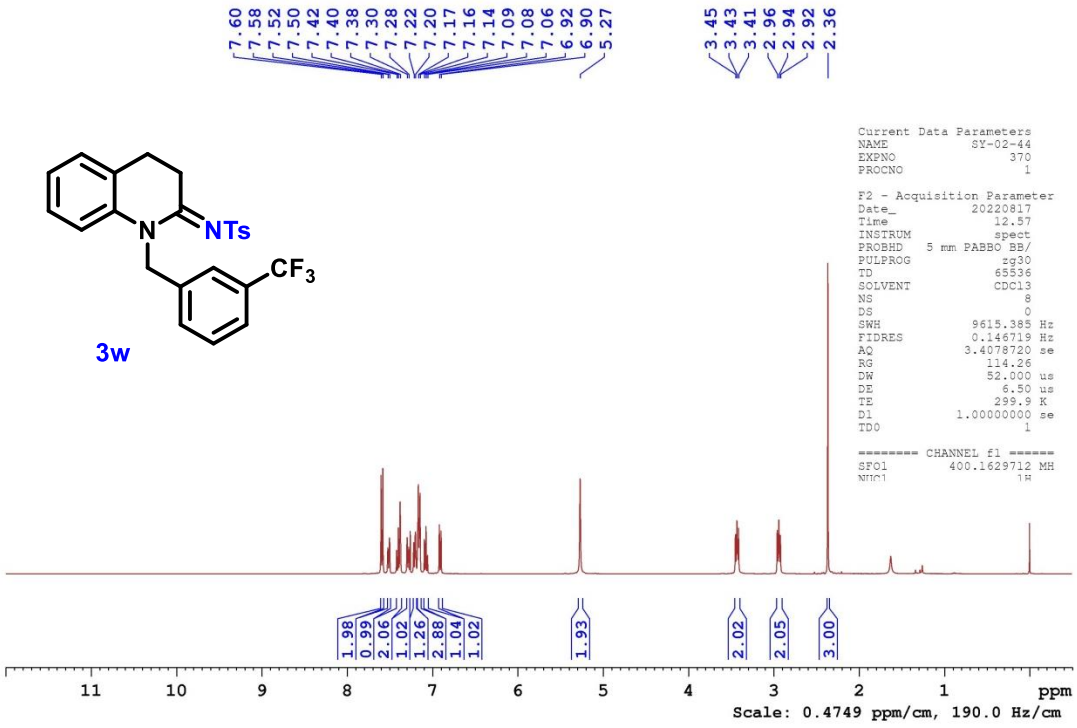

Figure S-115: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3w**

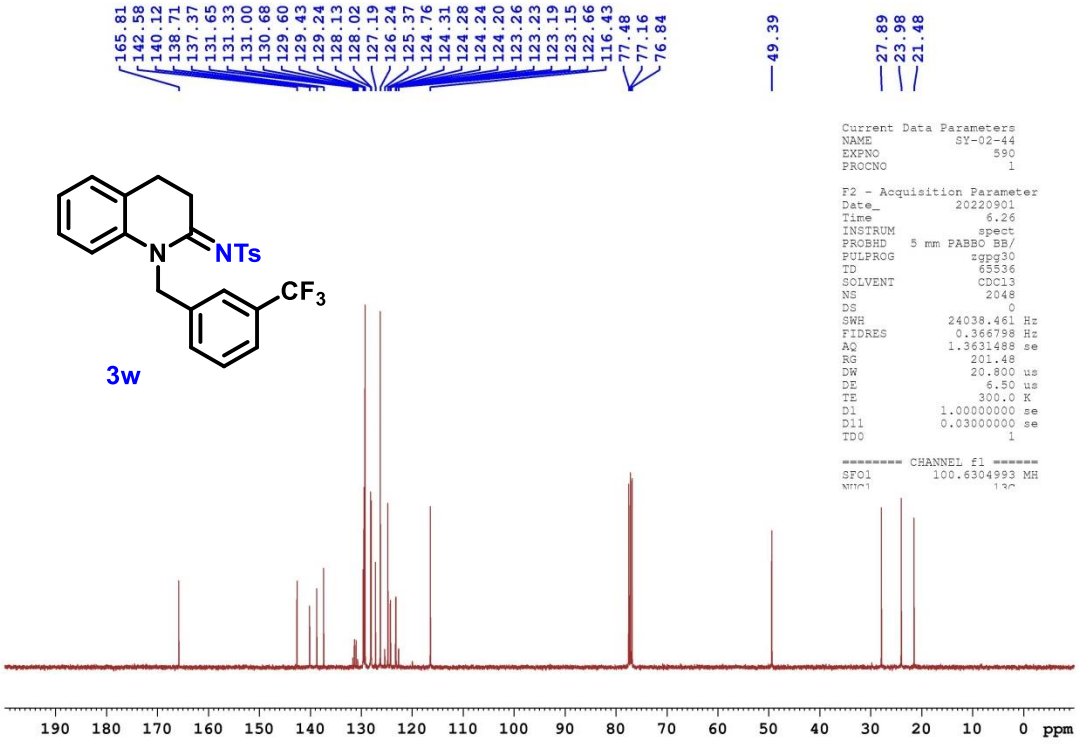

Figure S-116: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3w**

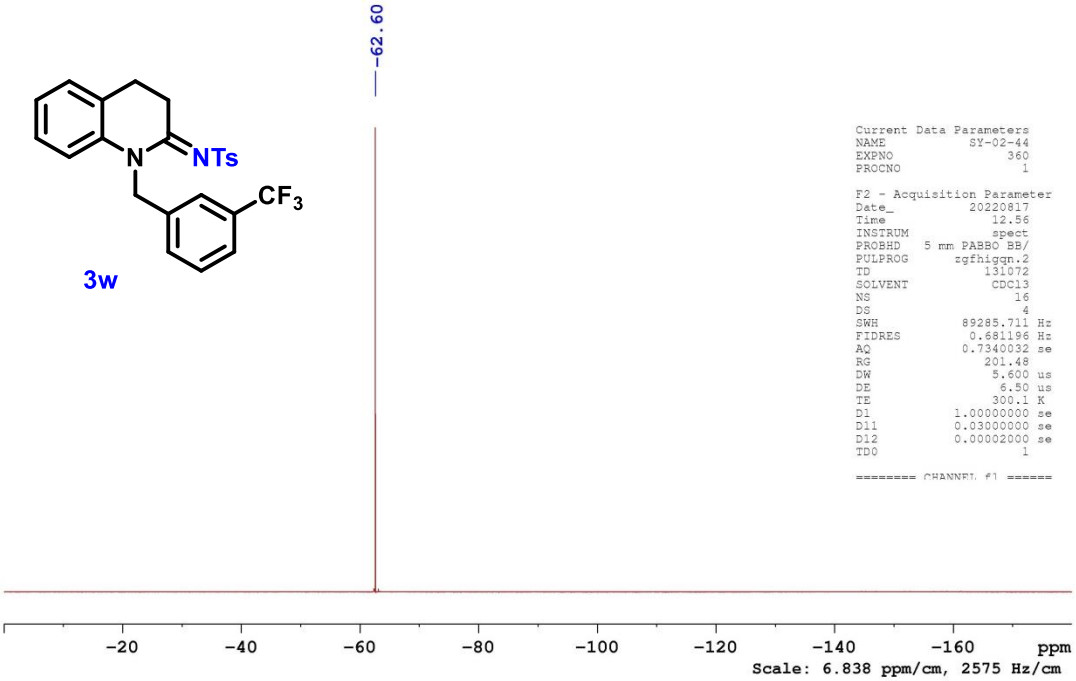

Figure S-117: ^{19}F NMR (376 MHz, $CDCl_3$) spectrum of compound **3w**

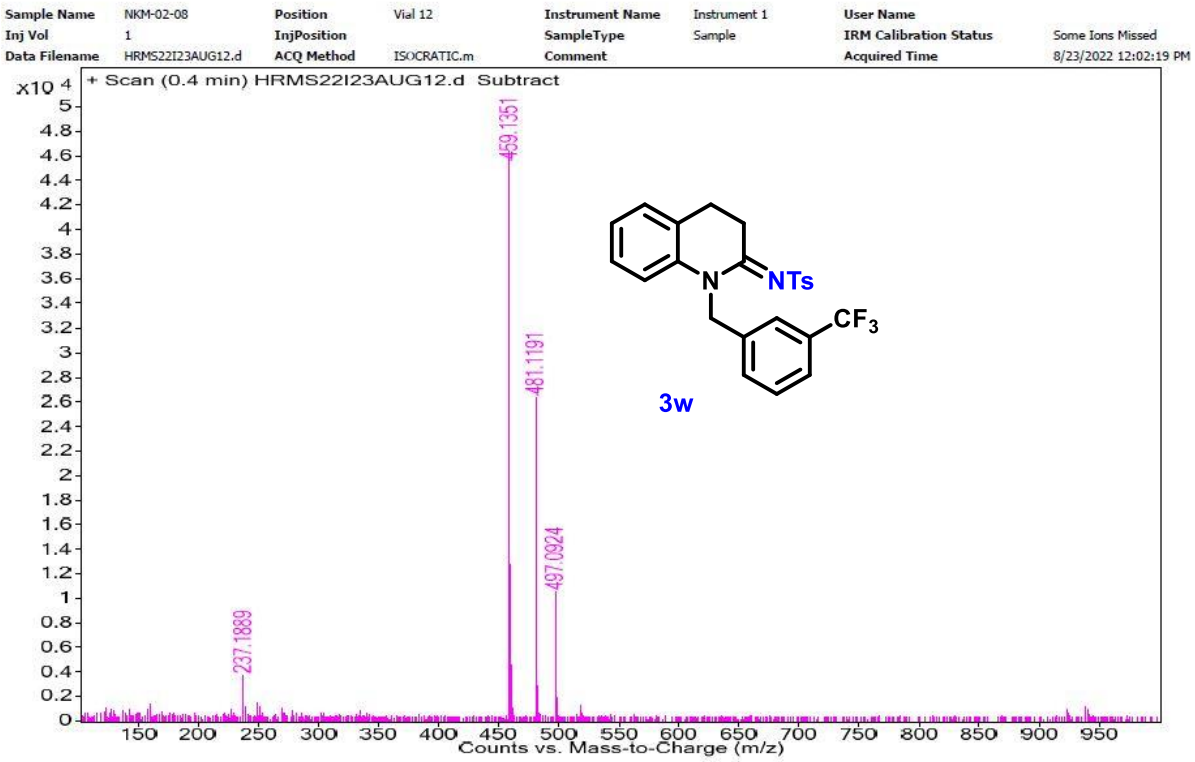

Figure S-118 HRMS spectrum of compound **3w**

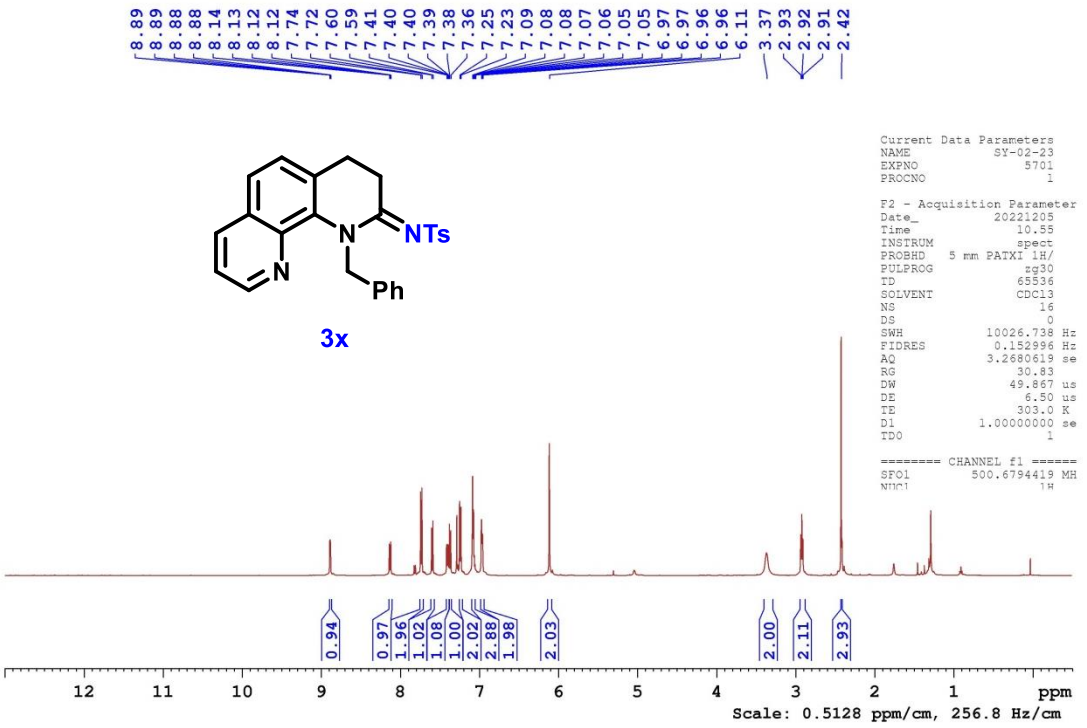

Figure S-119: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **3x**

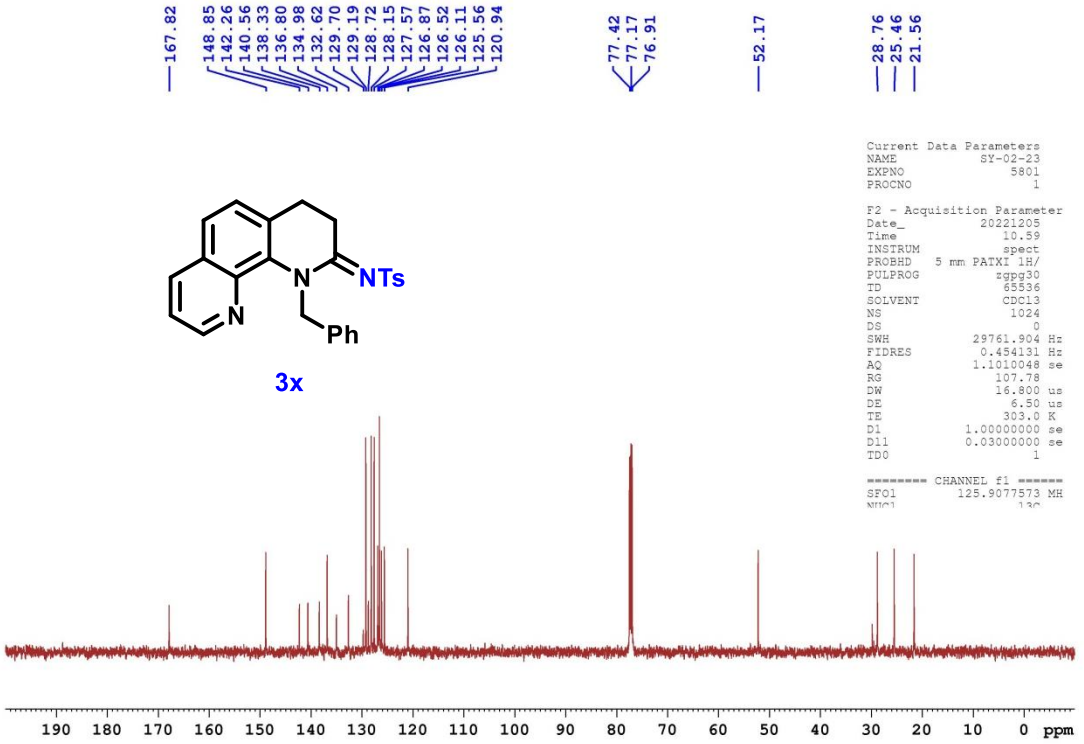

Figure S-120: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3x**

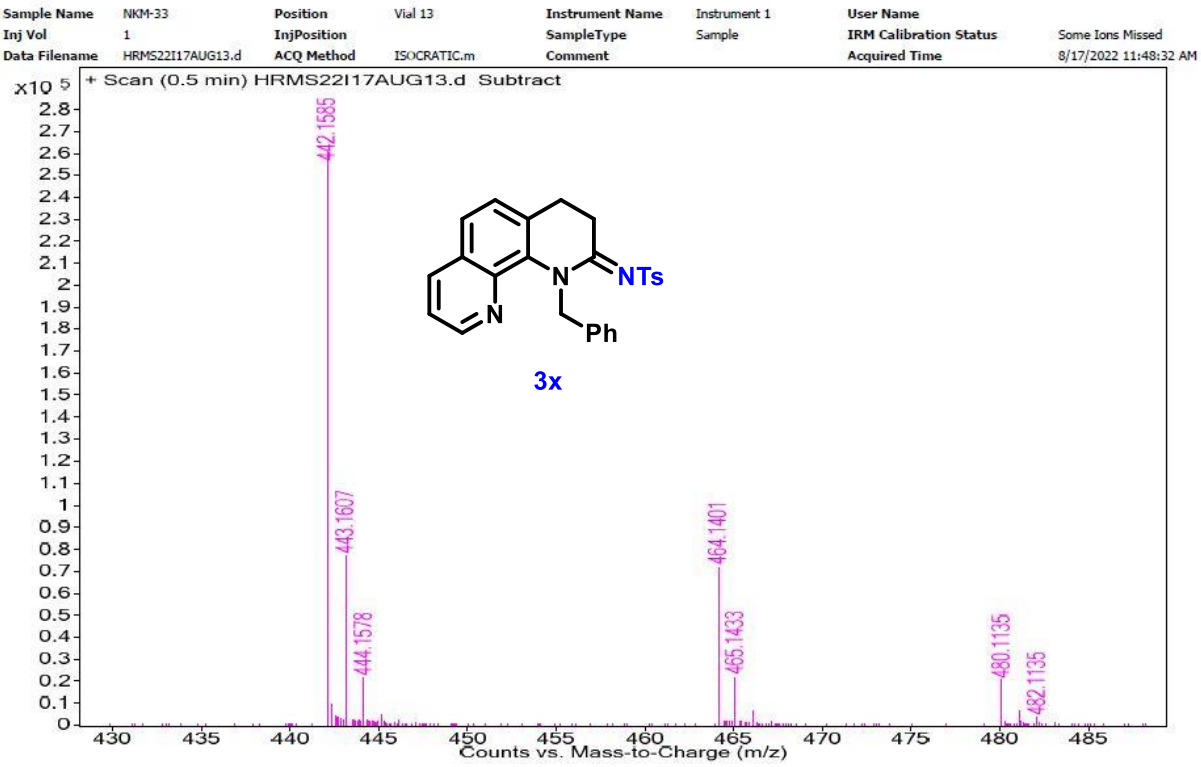

Figure S-121 HRMS spectrum of compound **3x**

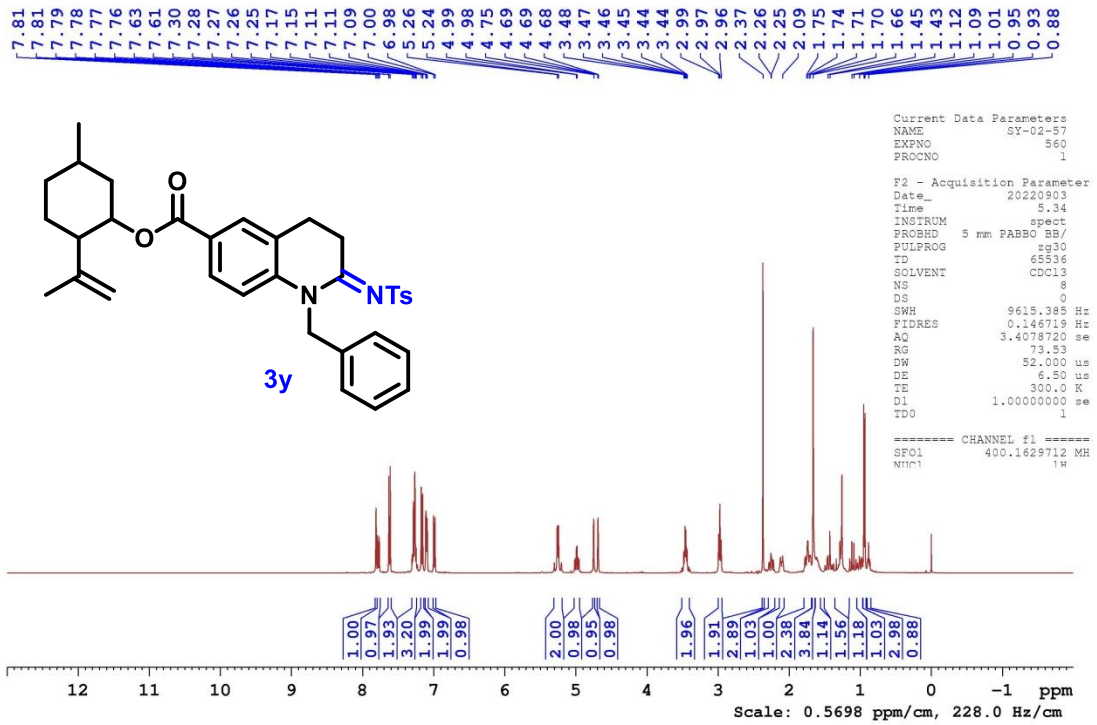

Figure S-122: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3y**

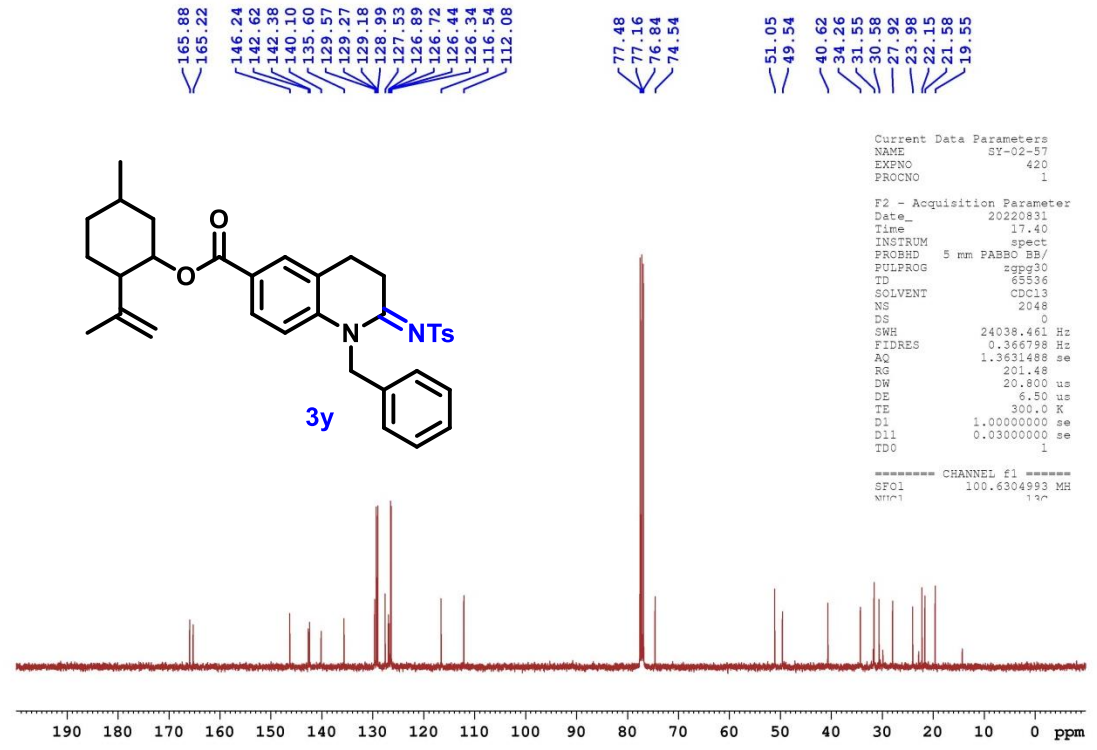

Figure S-123: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **3y**

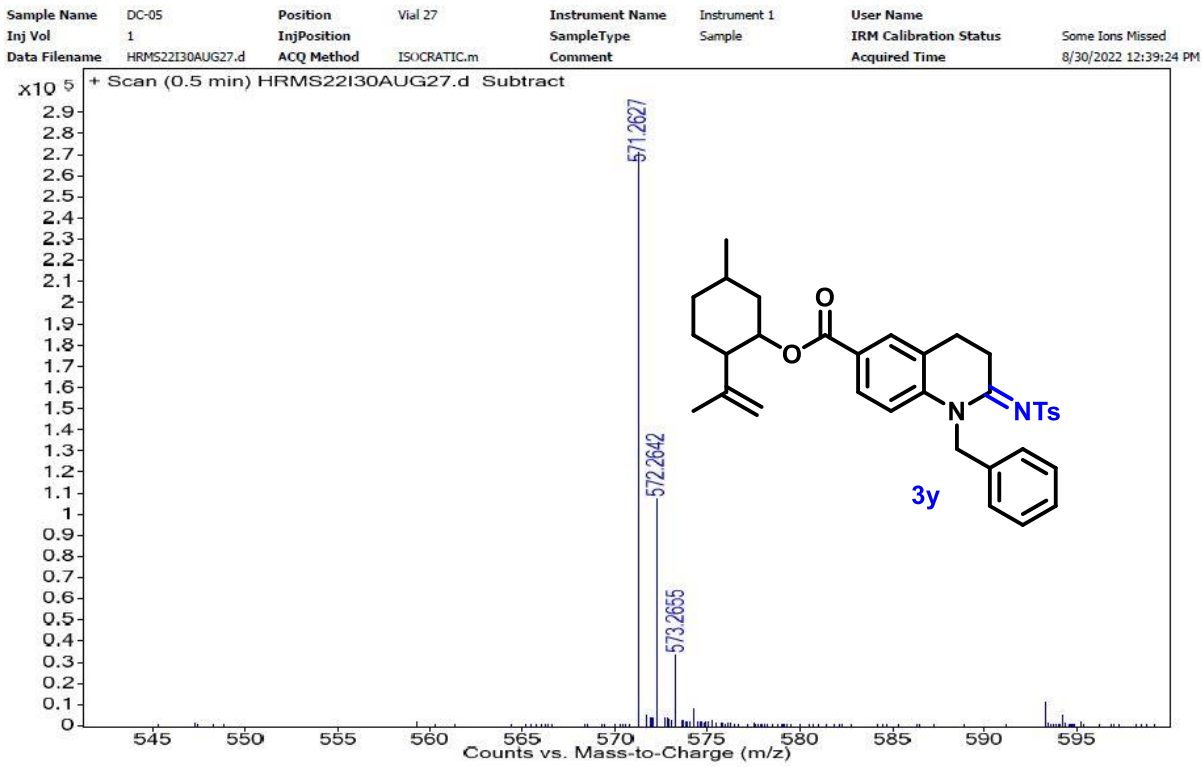

Figure S-124 HRMS spectrum of compound **3y**

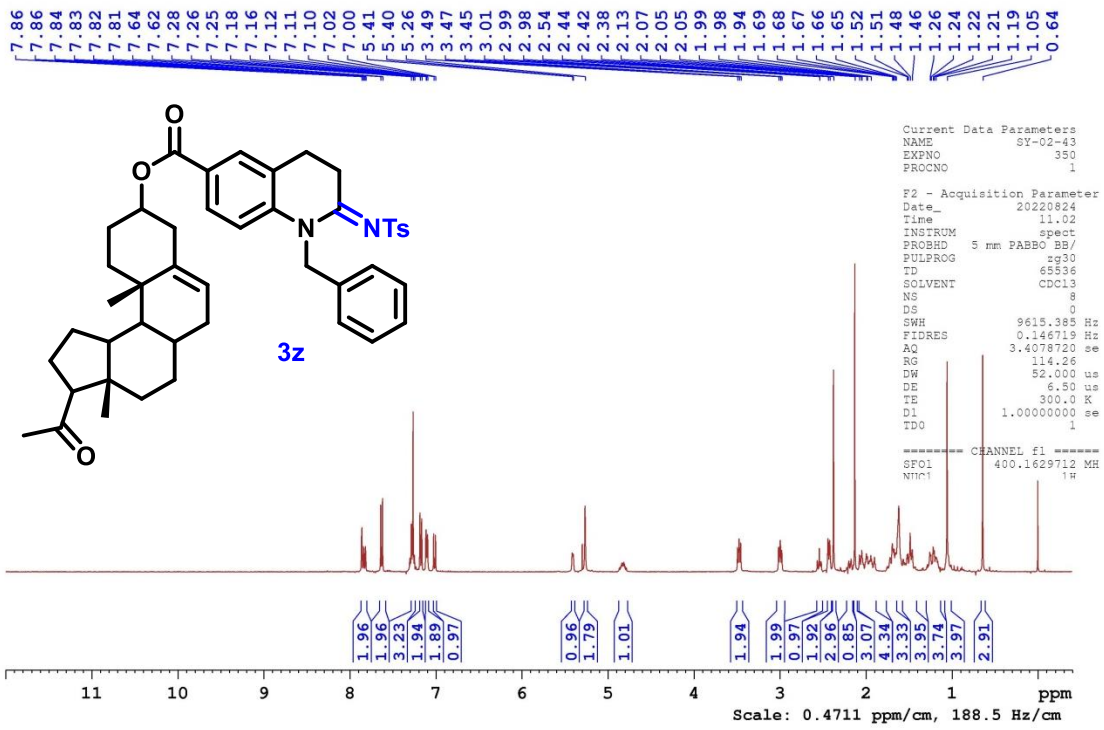

Figure S-125: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **3z**

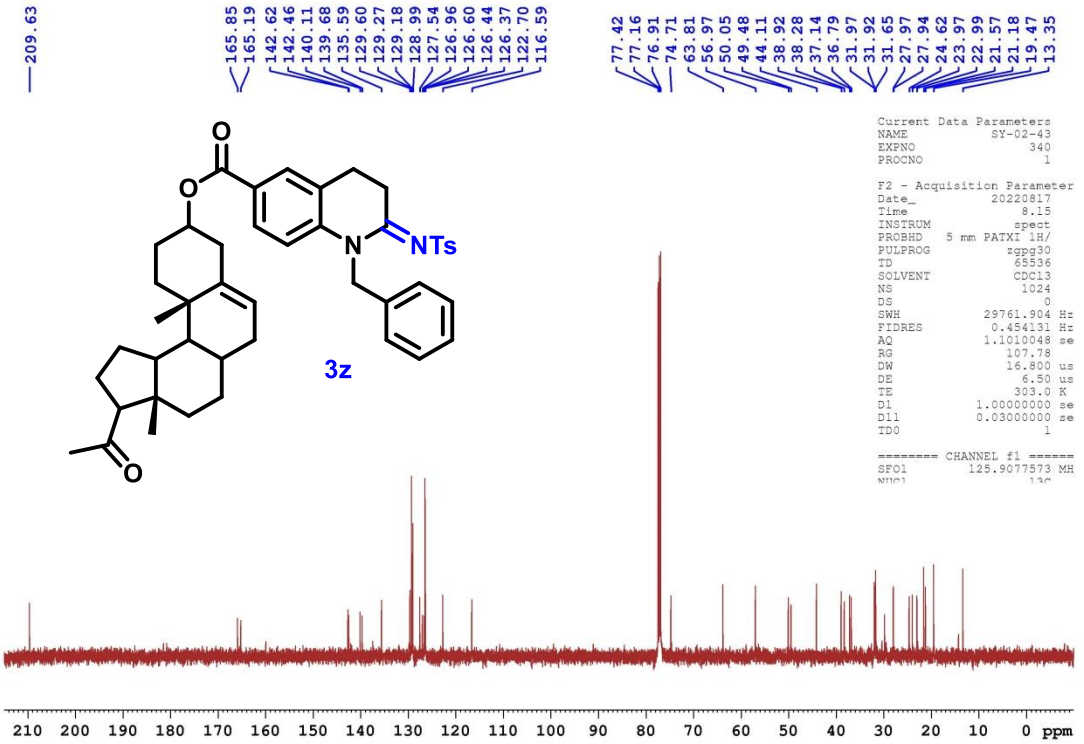

Figure S-126: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **3z**

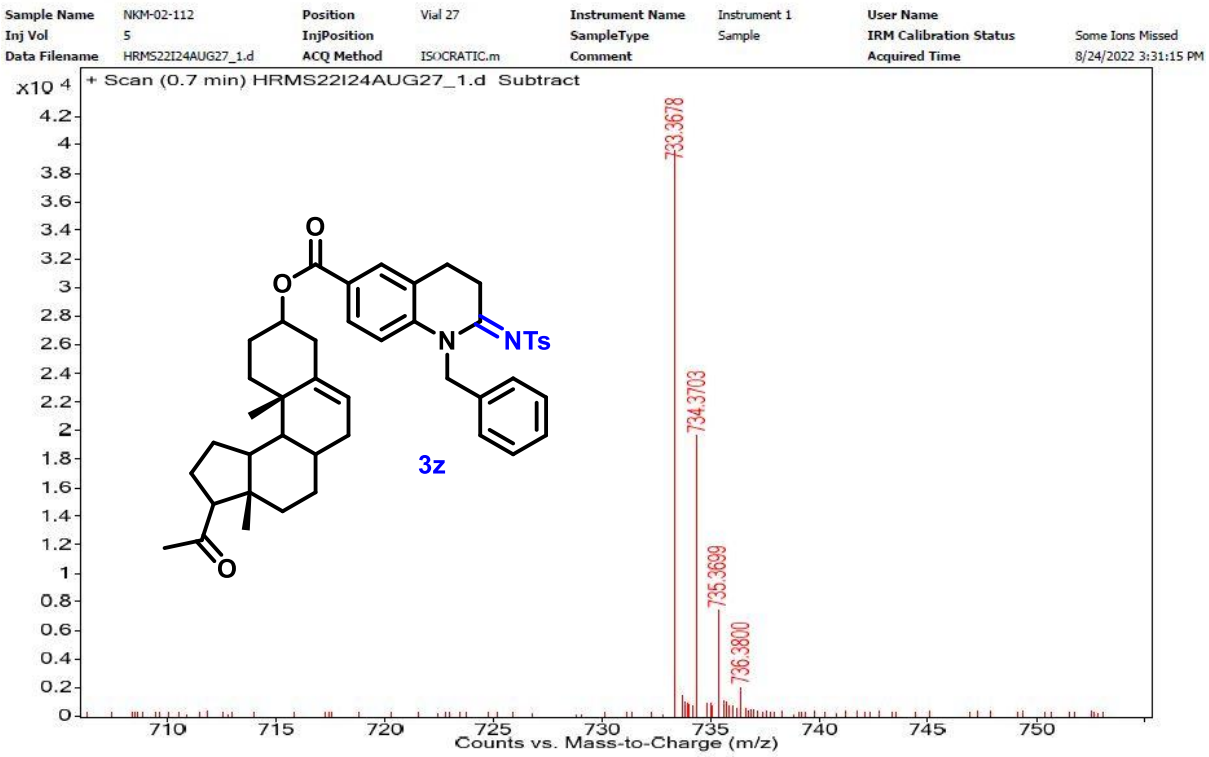

Figure S-127 HRMS spectrum of compound **3z**

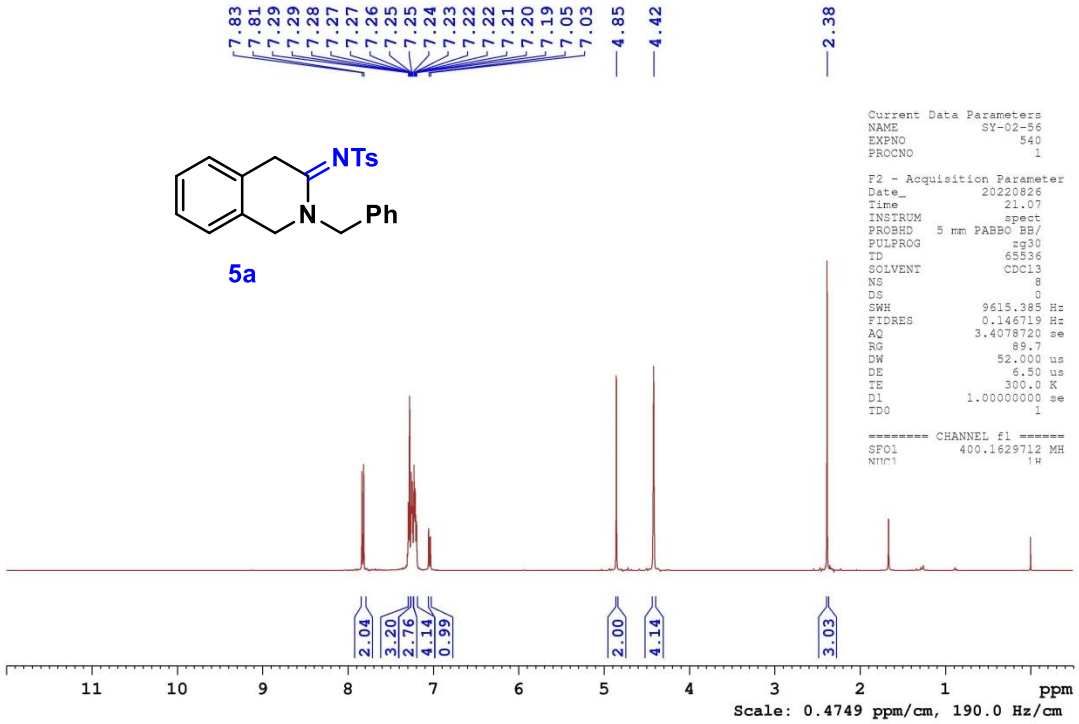

Figure S-128: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5a**

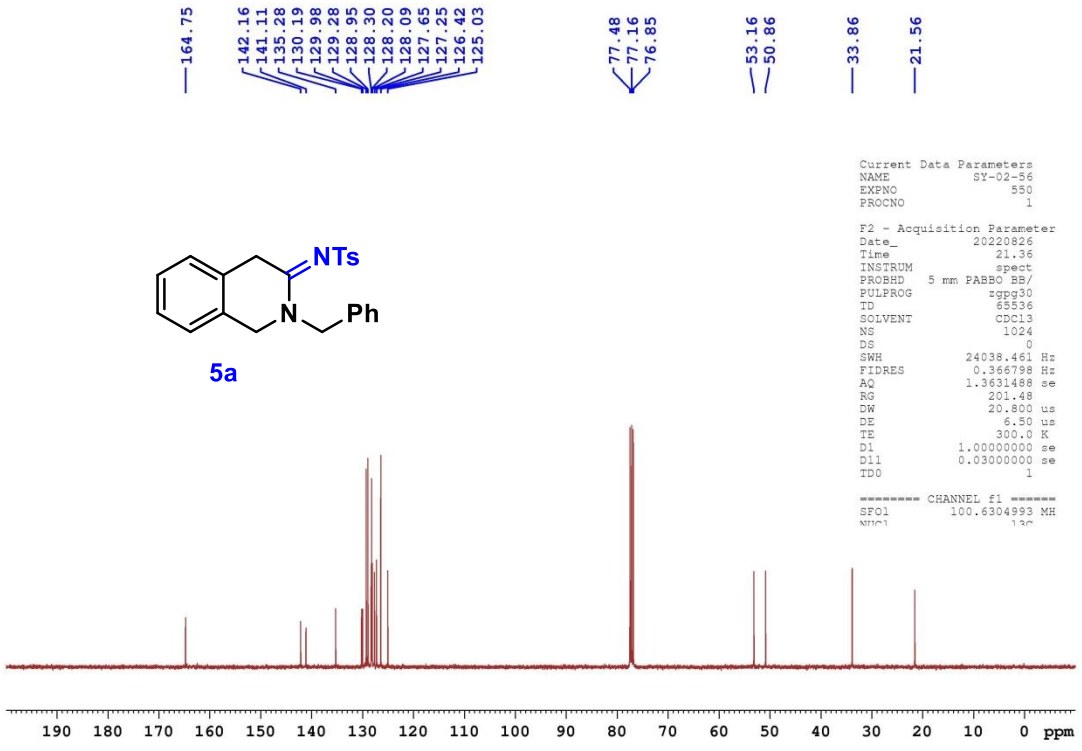

Figure S-129: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **5a**

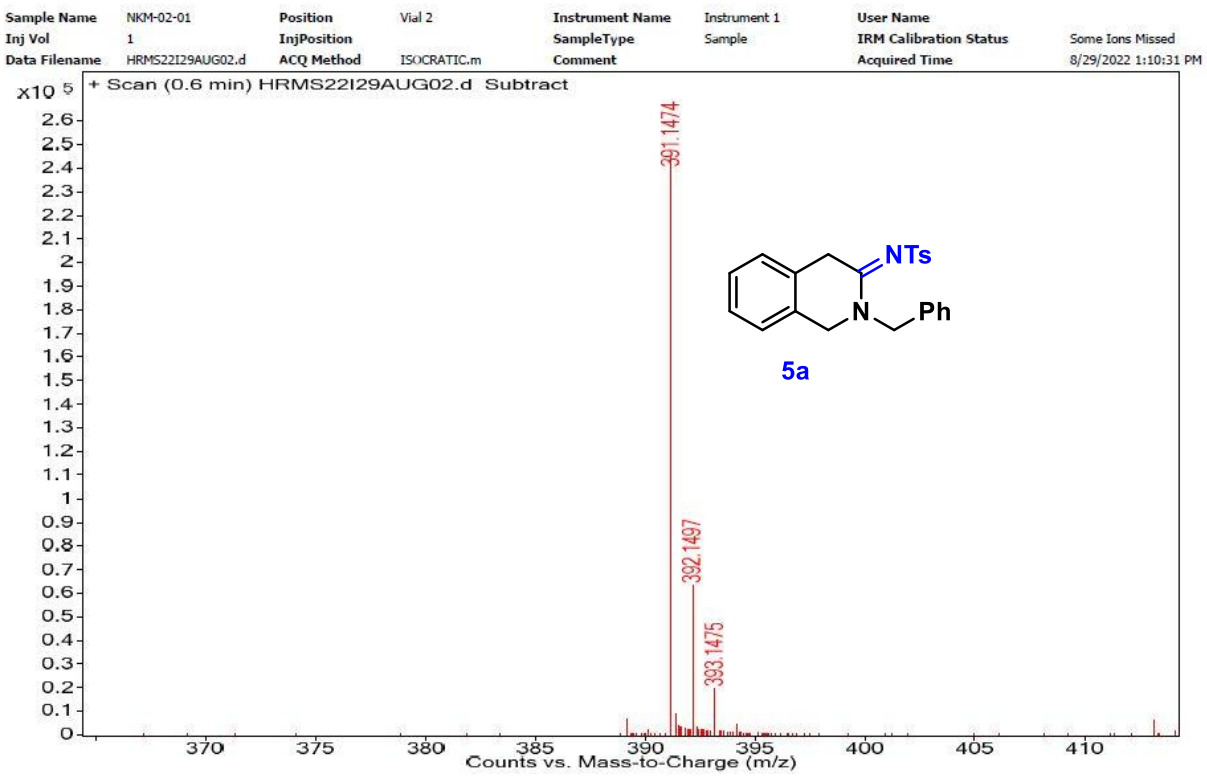

Figure S-130 HRMS spectrum of compound **5a**

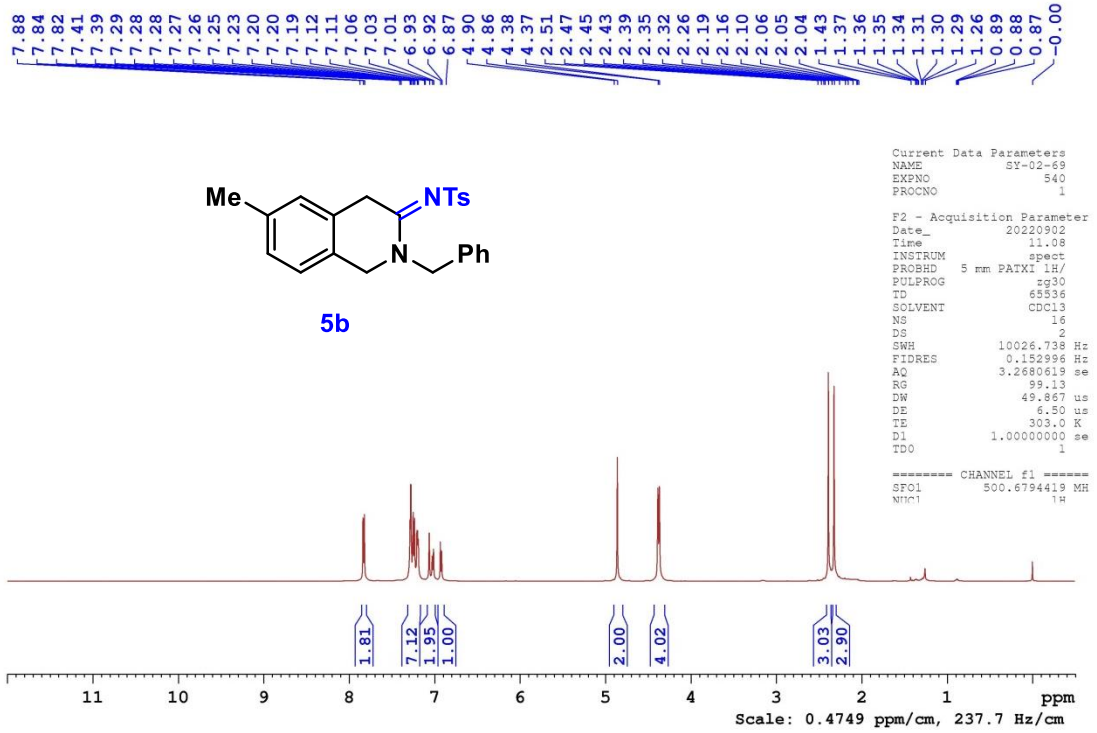

Figure S-131: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5b**

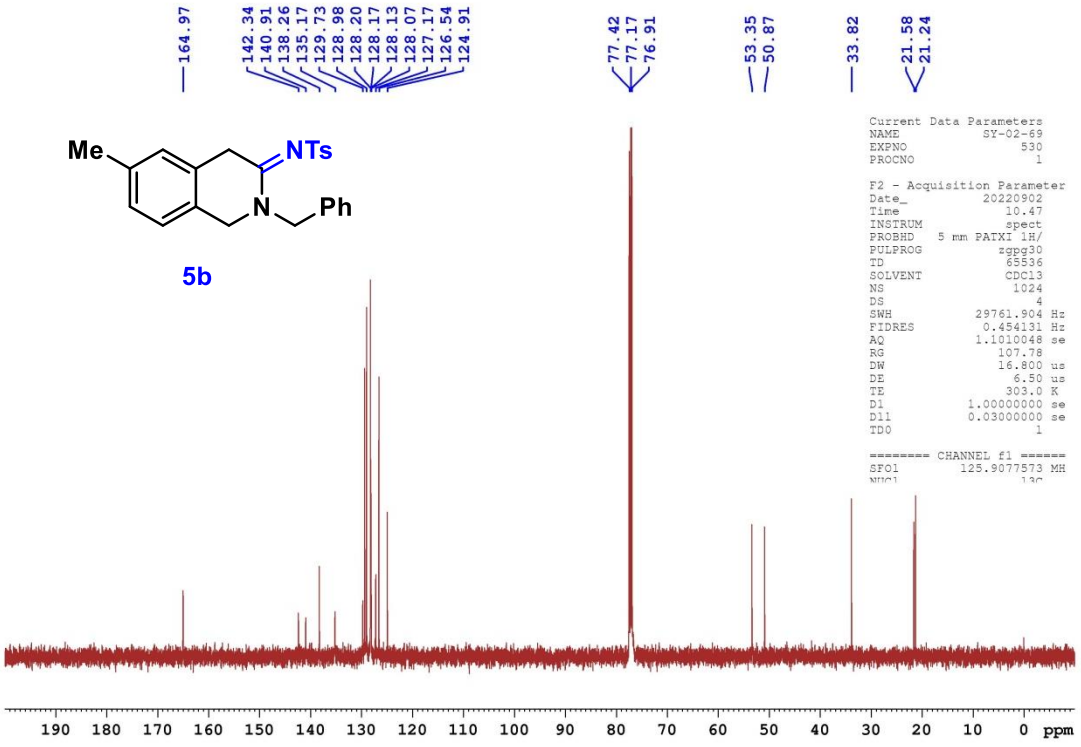

Figure S-132: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5b**

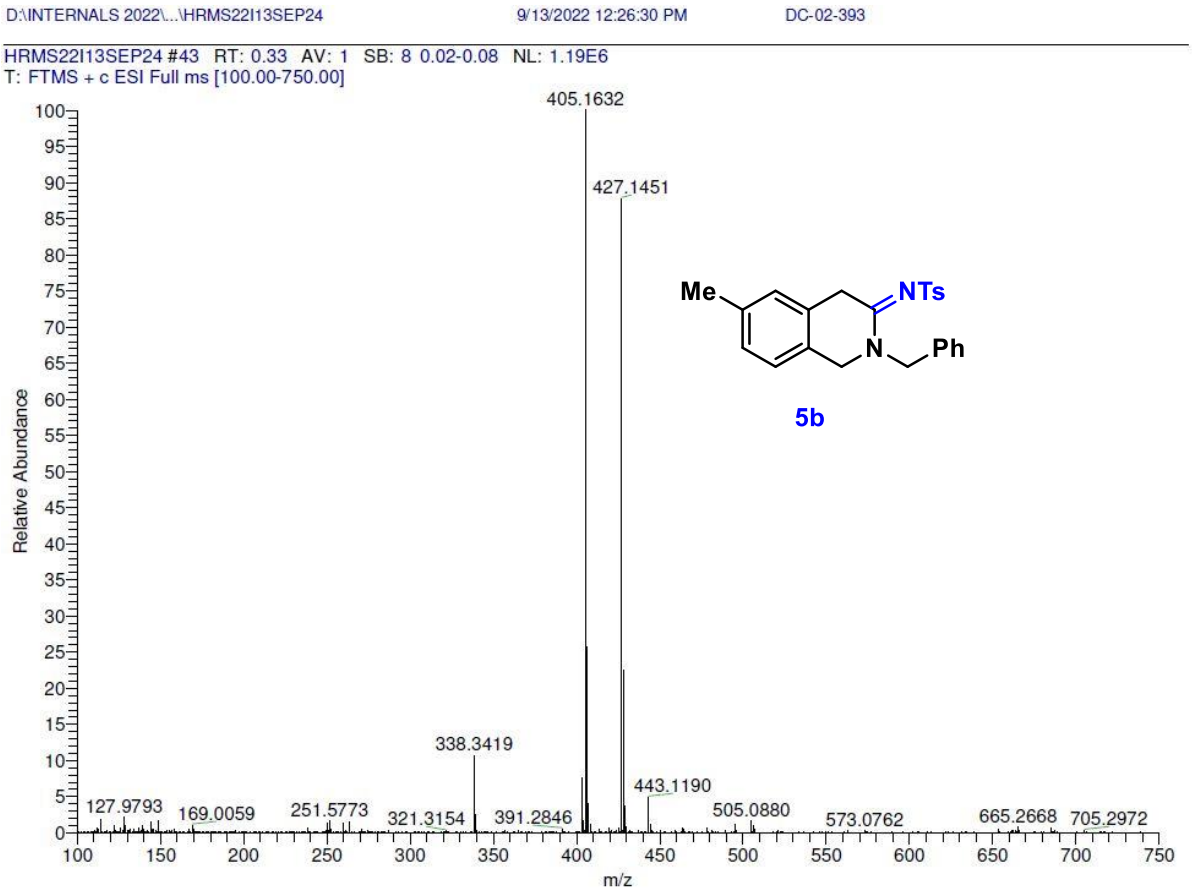

Figure S-133 HRMS spectrum of compound **5b**

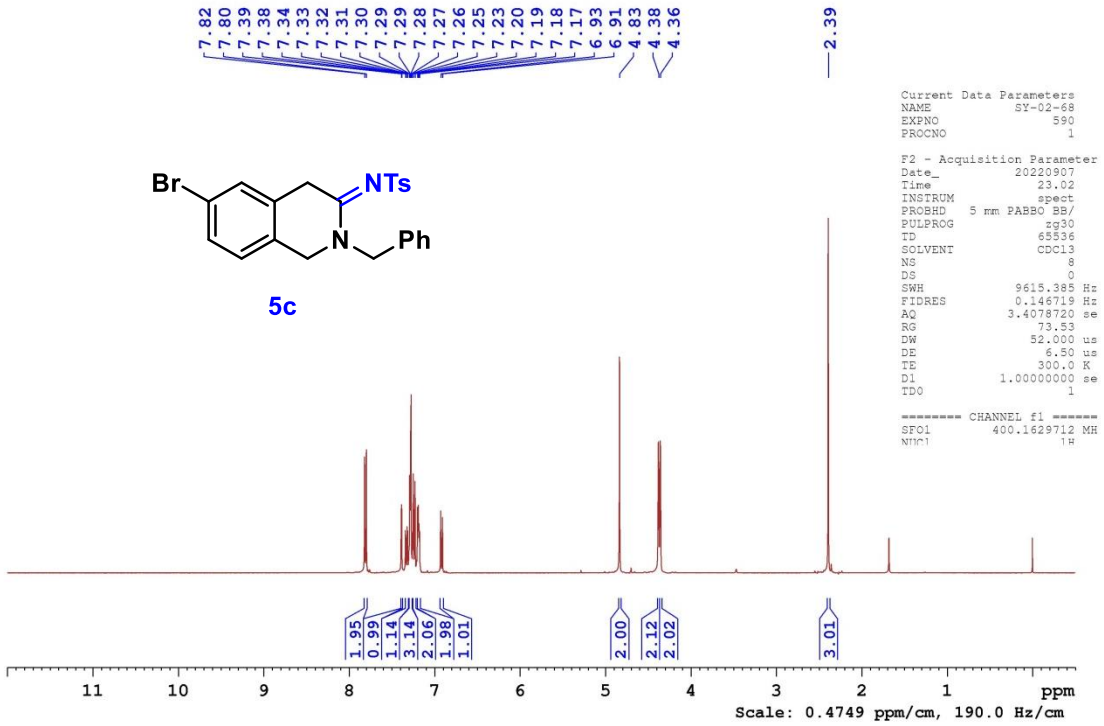

Figure S-134: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5c**

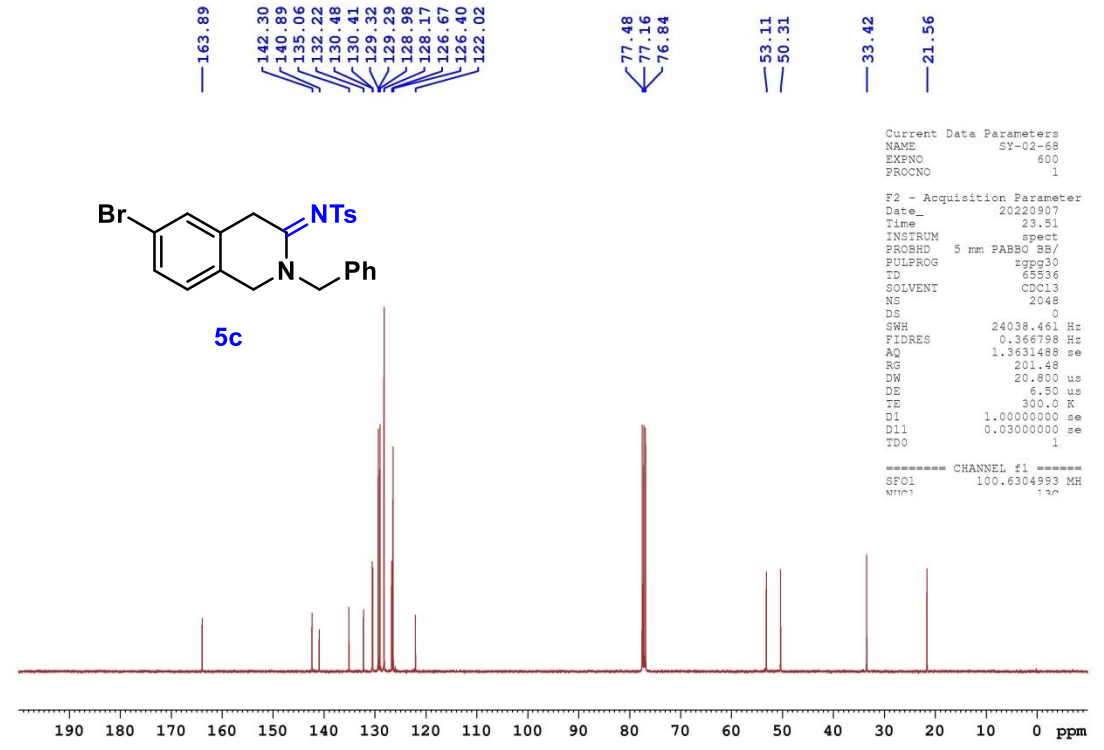

Figure S-135: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **5c**

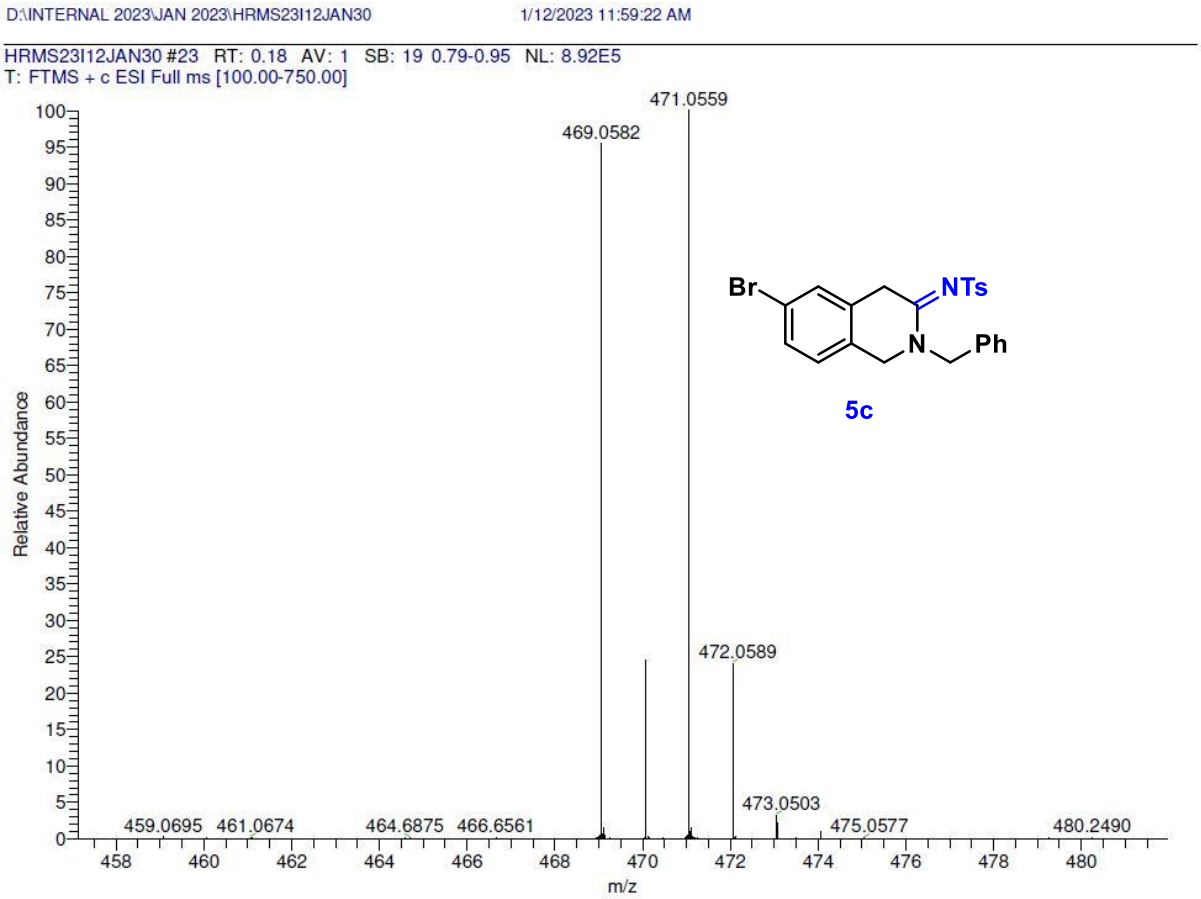

Figure S-136 HRMS spectrum of compound **5c**

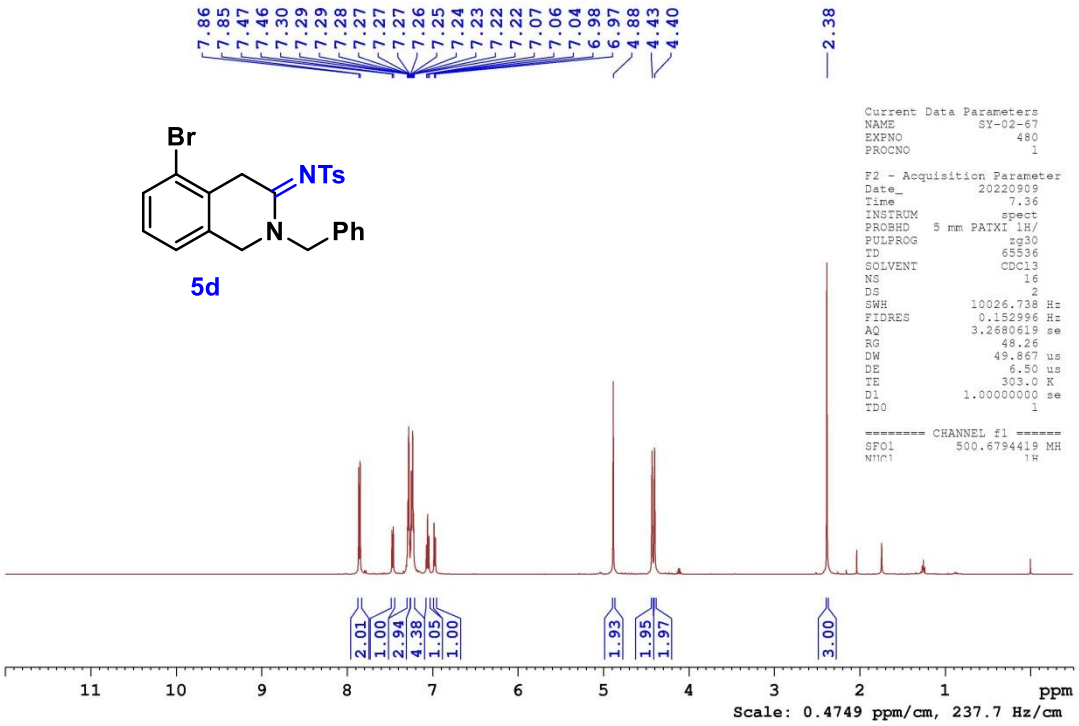

Figure S-137: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5d**

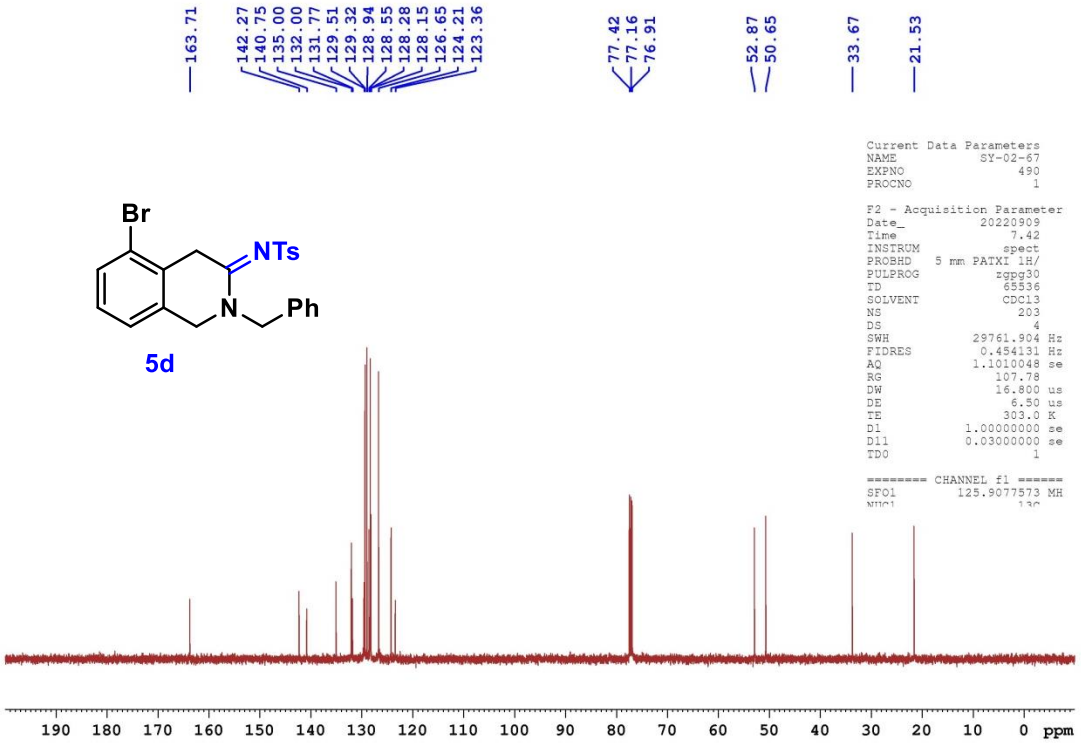

Figure S-138: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5d**

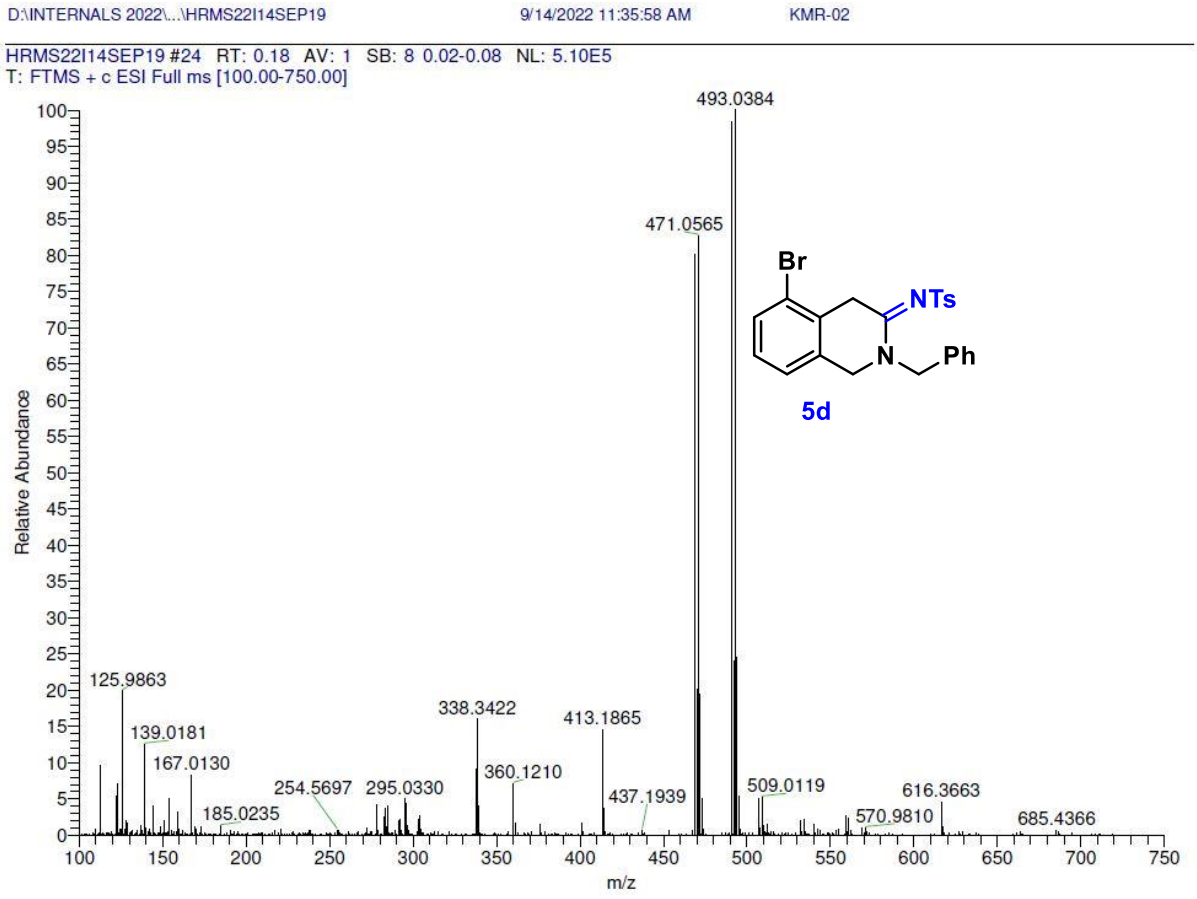

Figure S-139 HRMS spectrum of compound **5d**

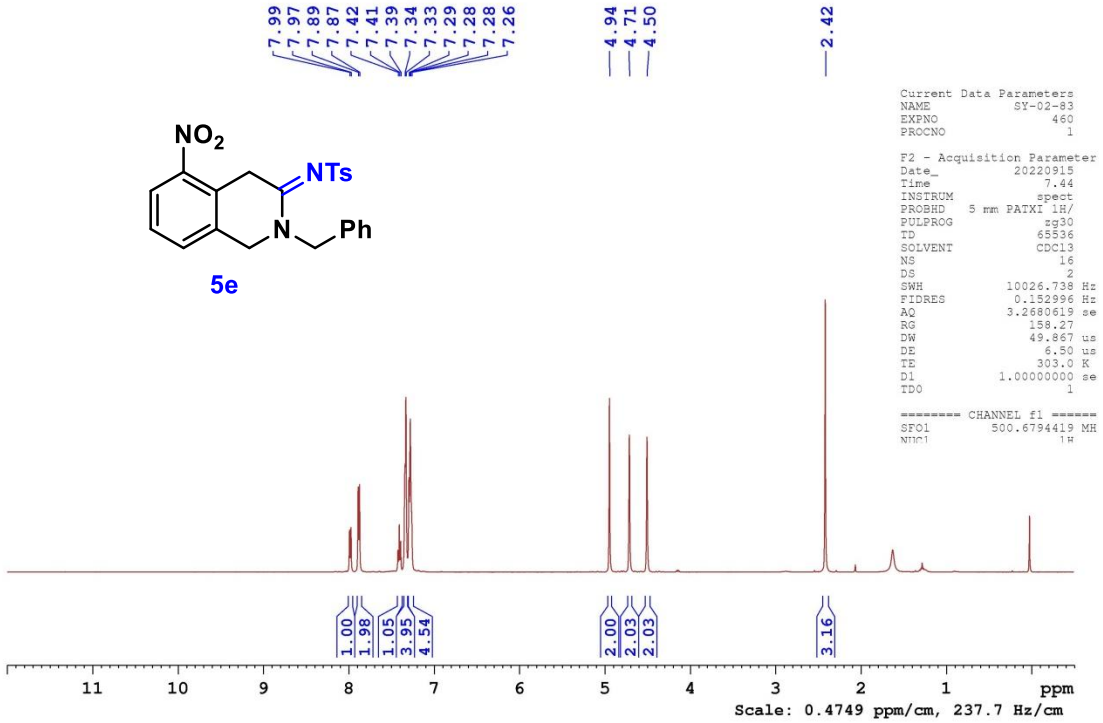

Figure S-140: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5e**

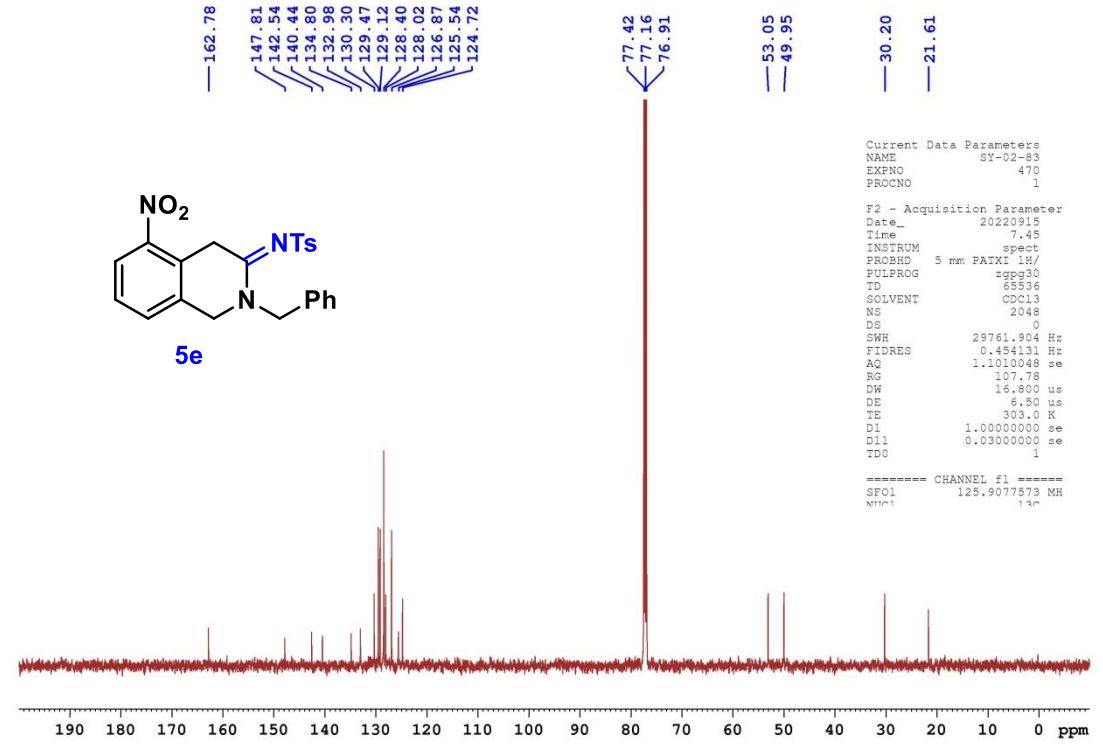

Figure S-141: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5e**

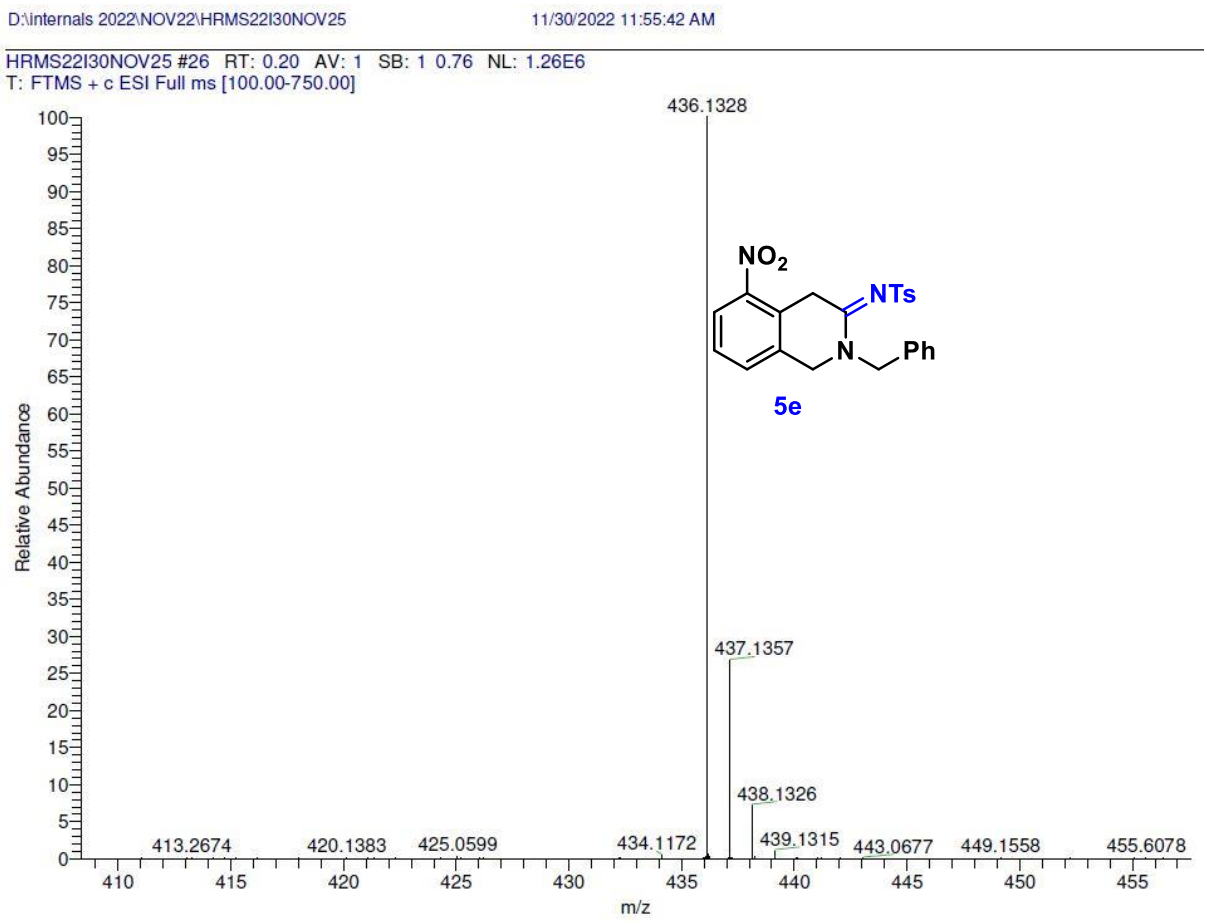

Figure S-142 HRMS spectrum of compound **5e**

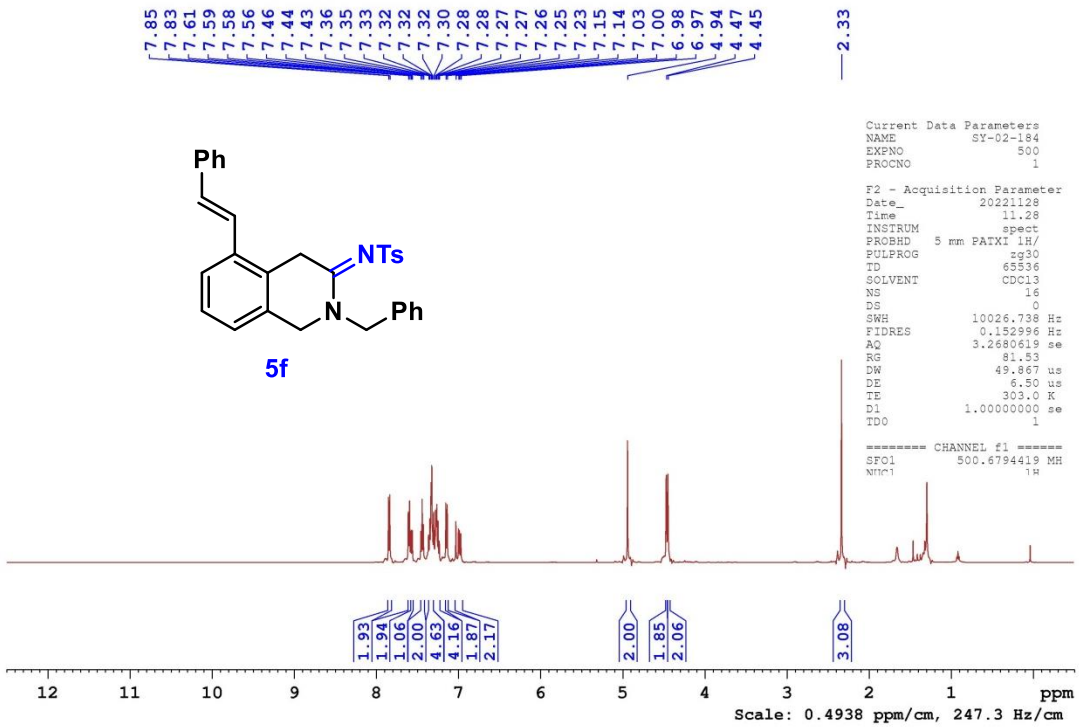

Figure S-143: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5f**

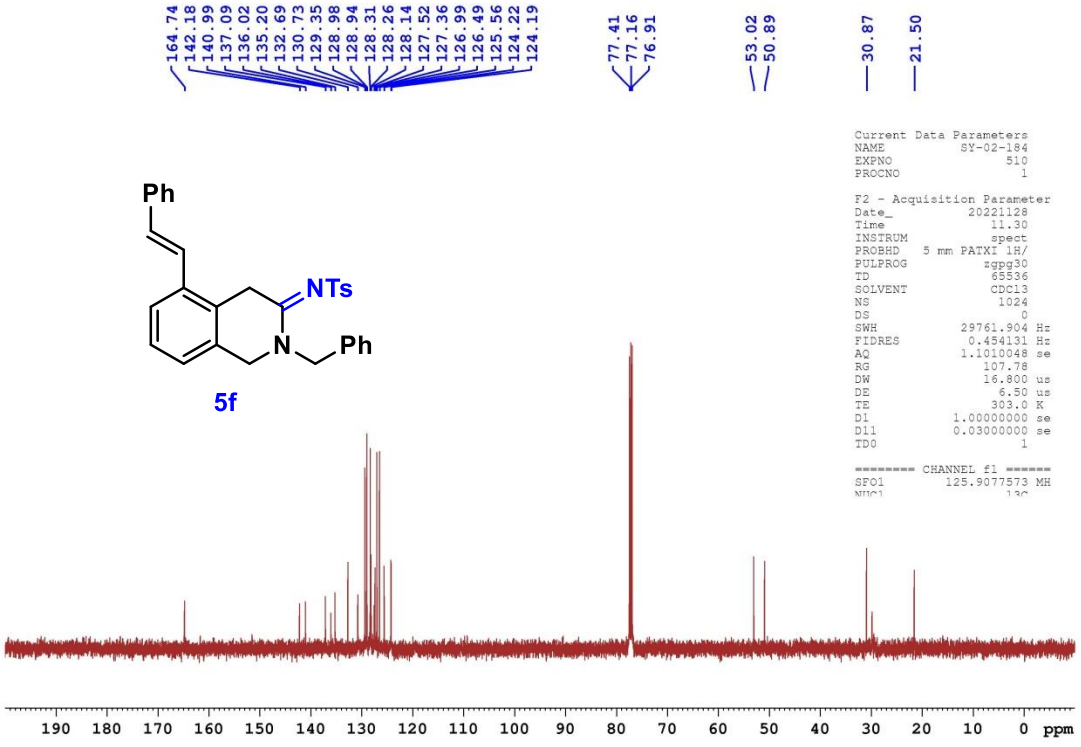

Figure S-144: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5f**

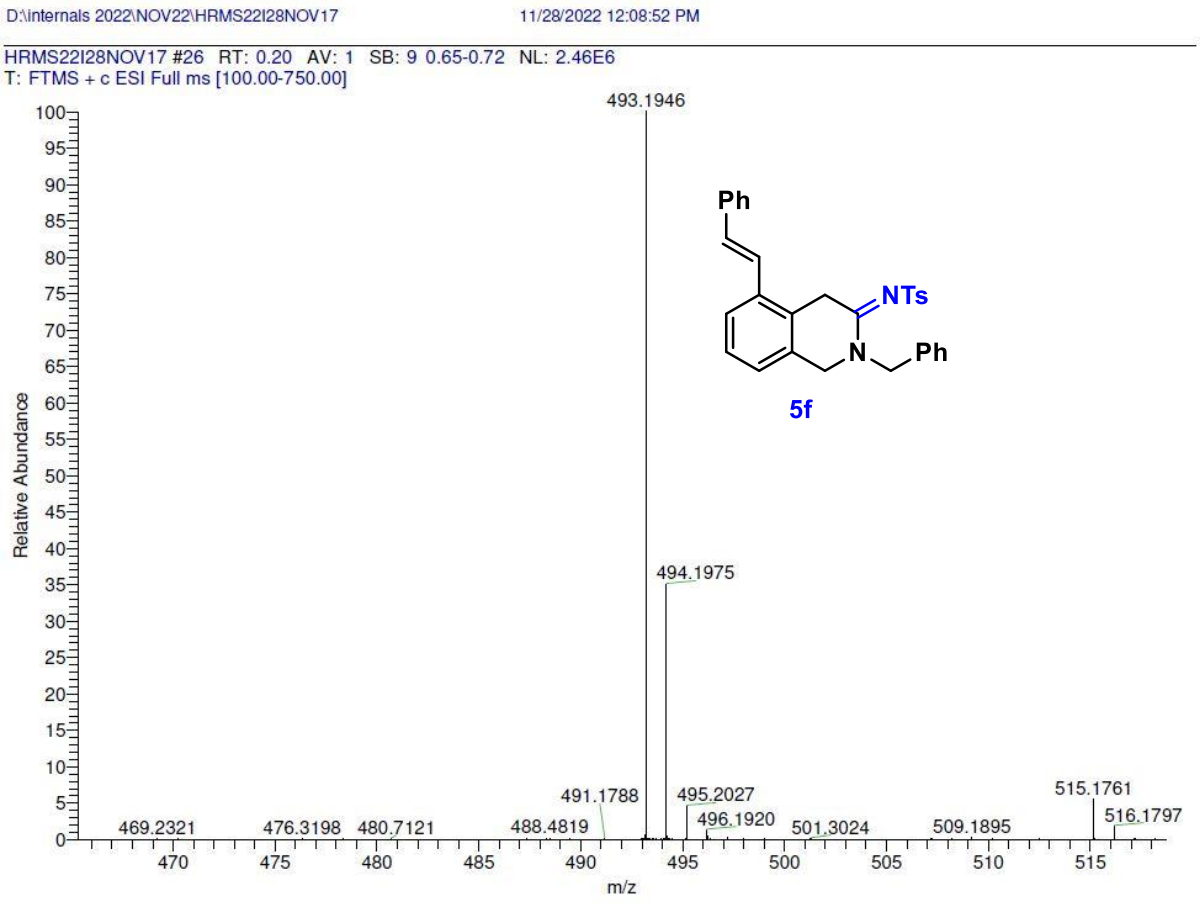

Figure S-145 HRMS spectrum of compound **5f**

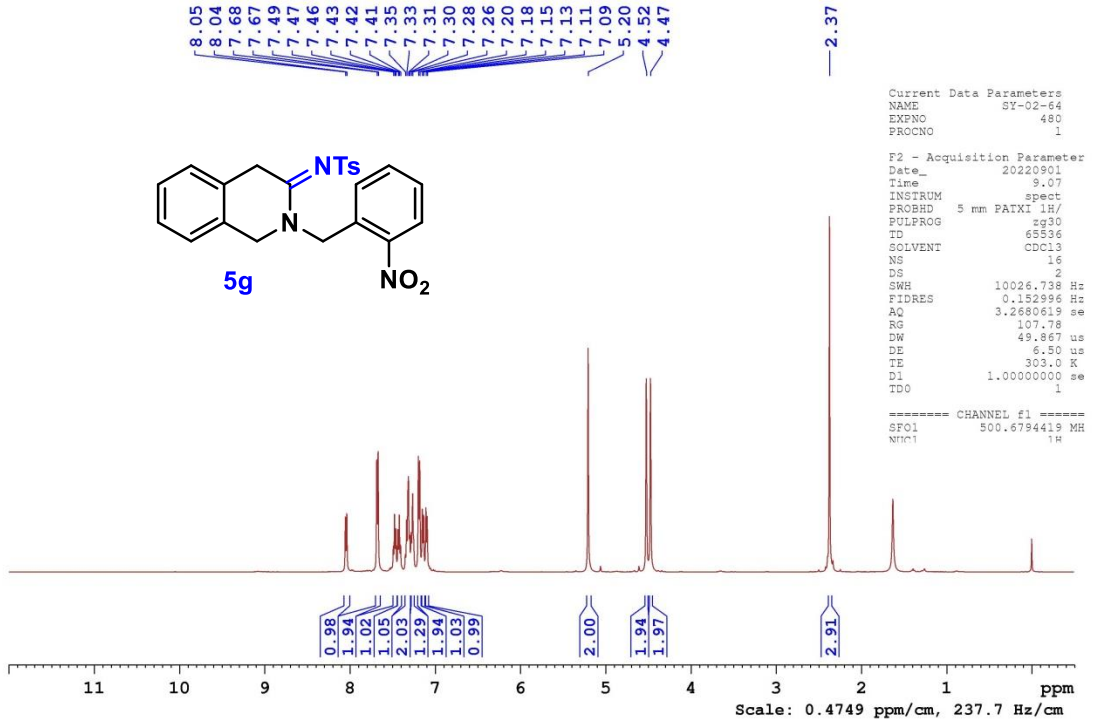

Figure S-146: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5g**

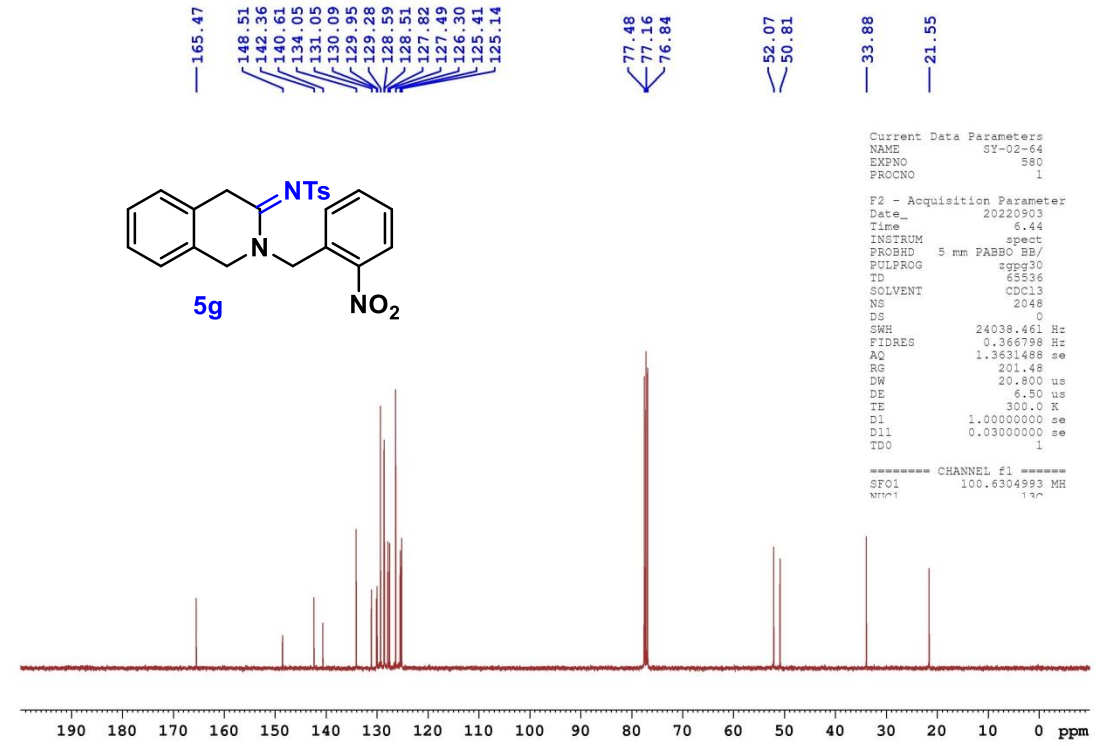

Figure S-147: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **5g**

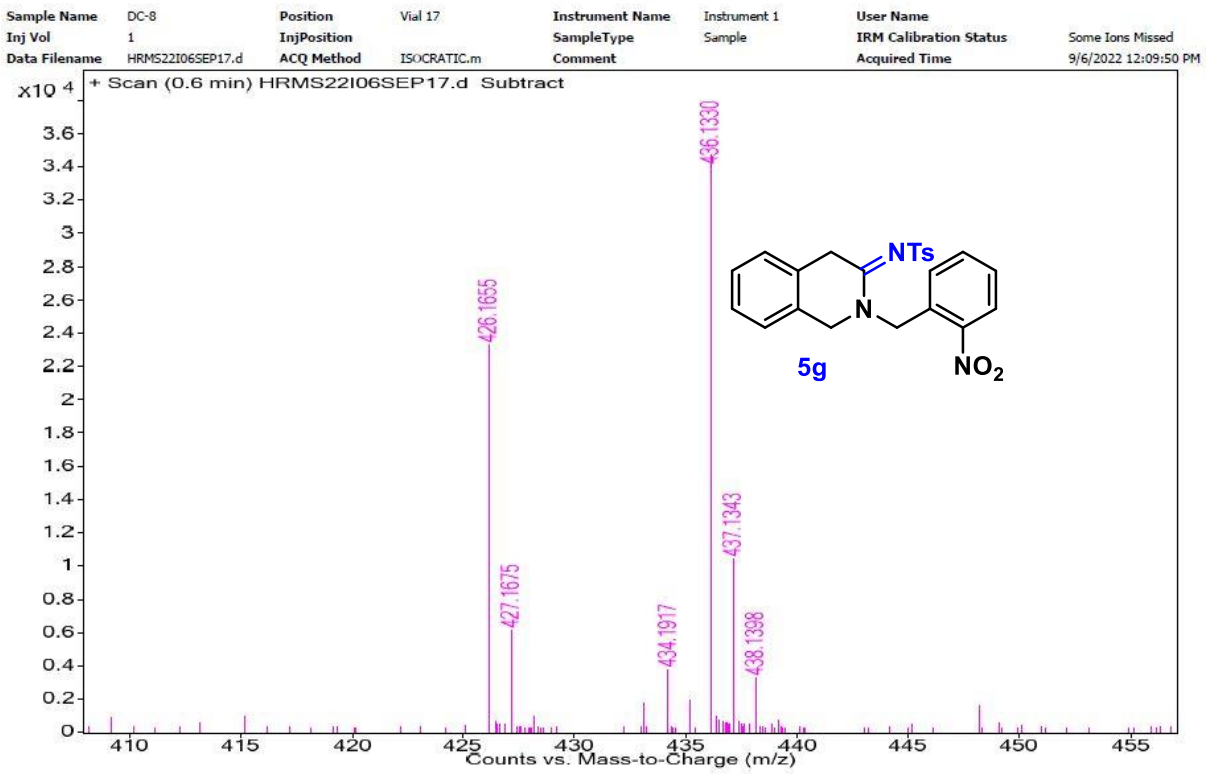

Figure S-148 HRMS spectrum of compound **5g**

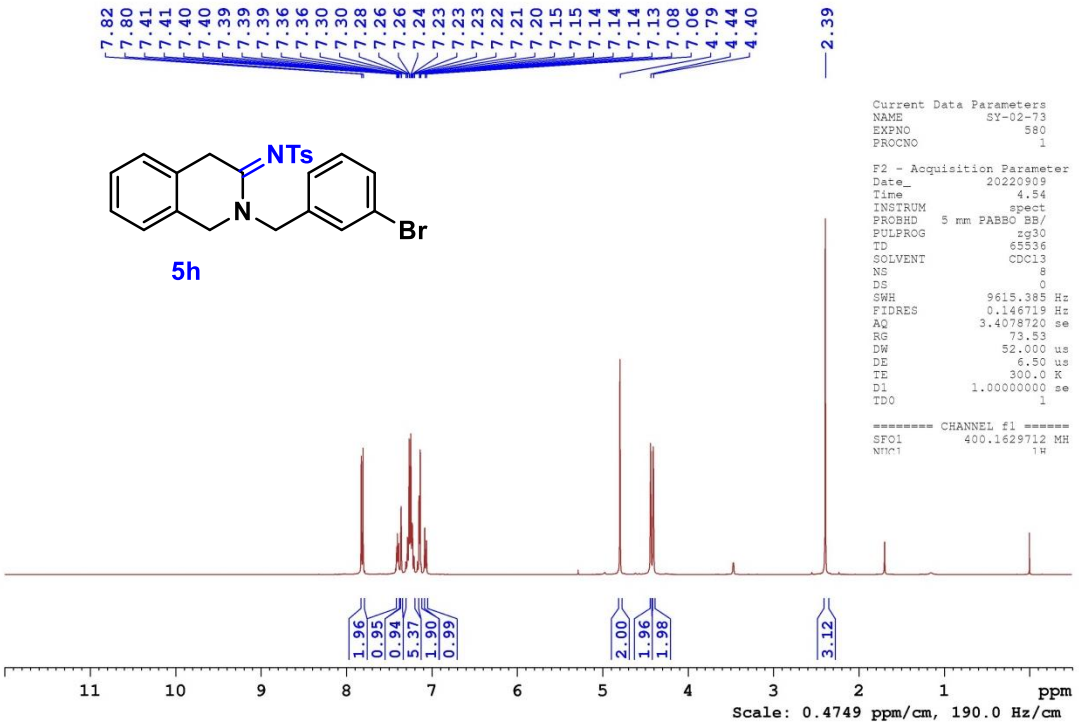

Figure S-149: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5h**

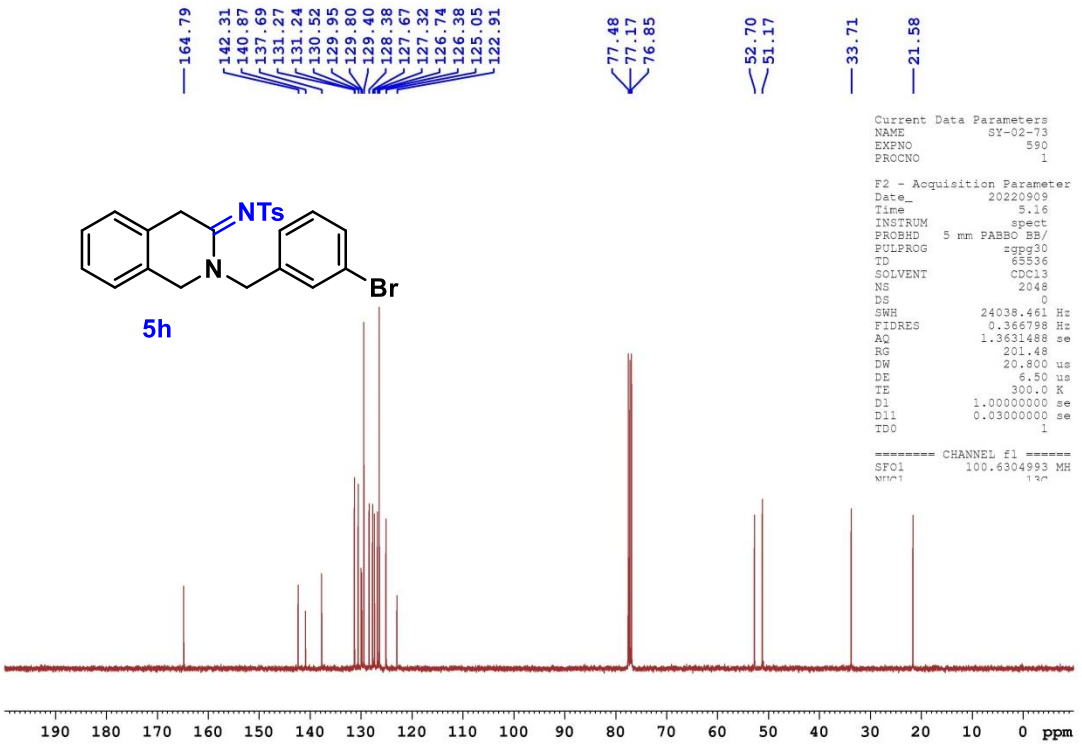

Figure S-150: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **5h**

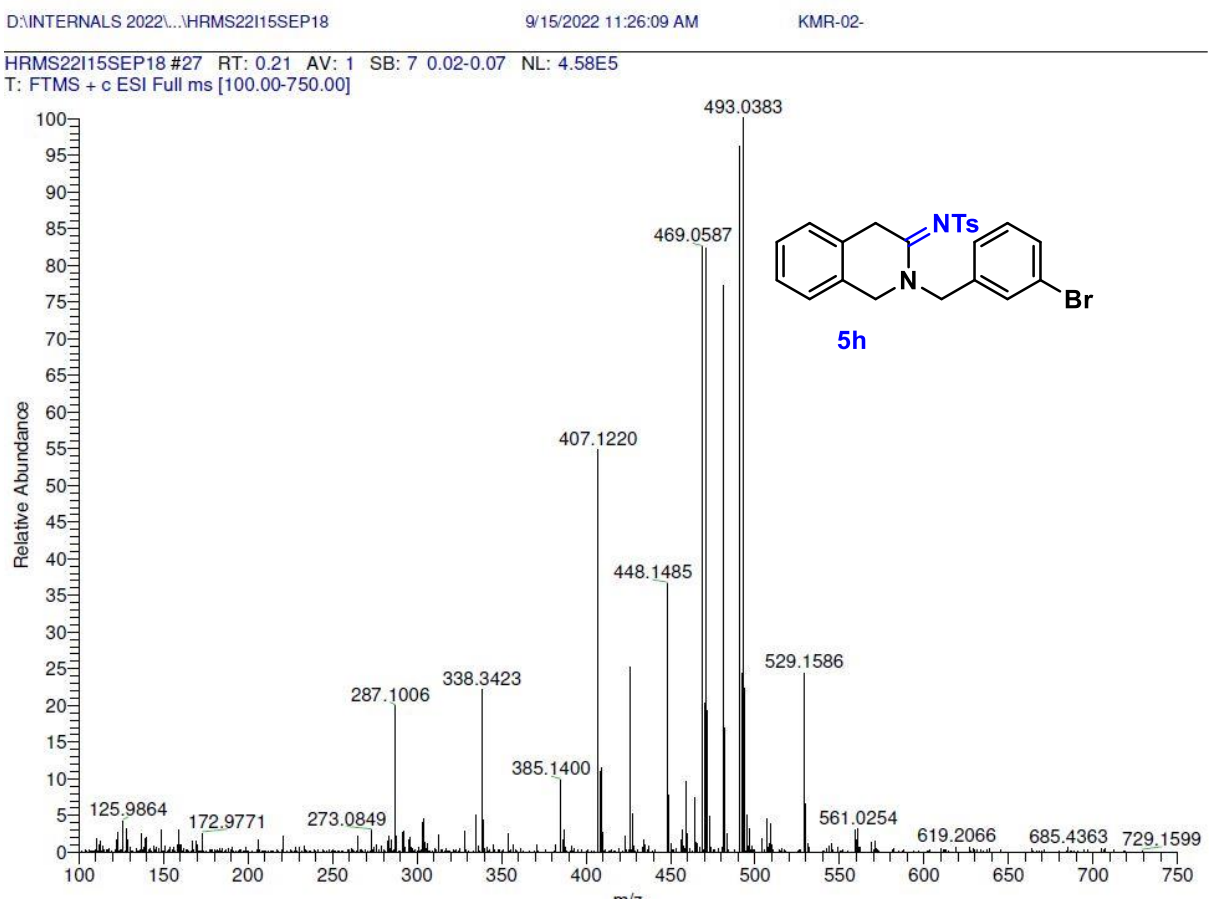

Figure S-151 HRMS spectrum of compound **5h**

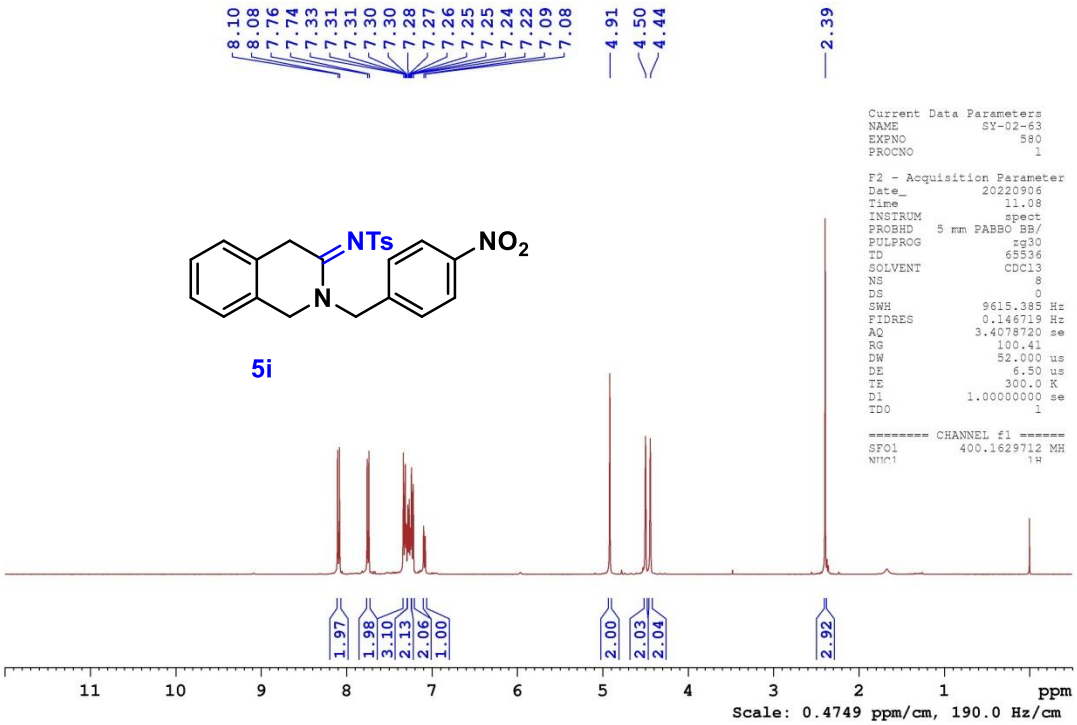

Figure S-152: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5i**

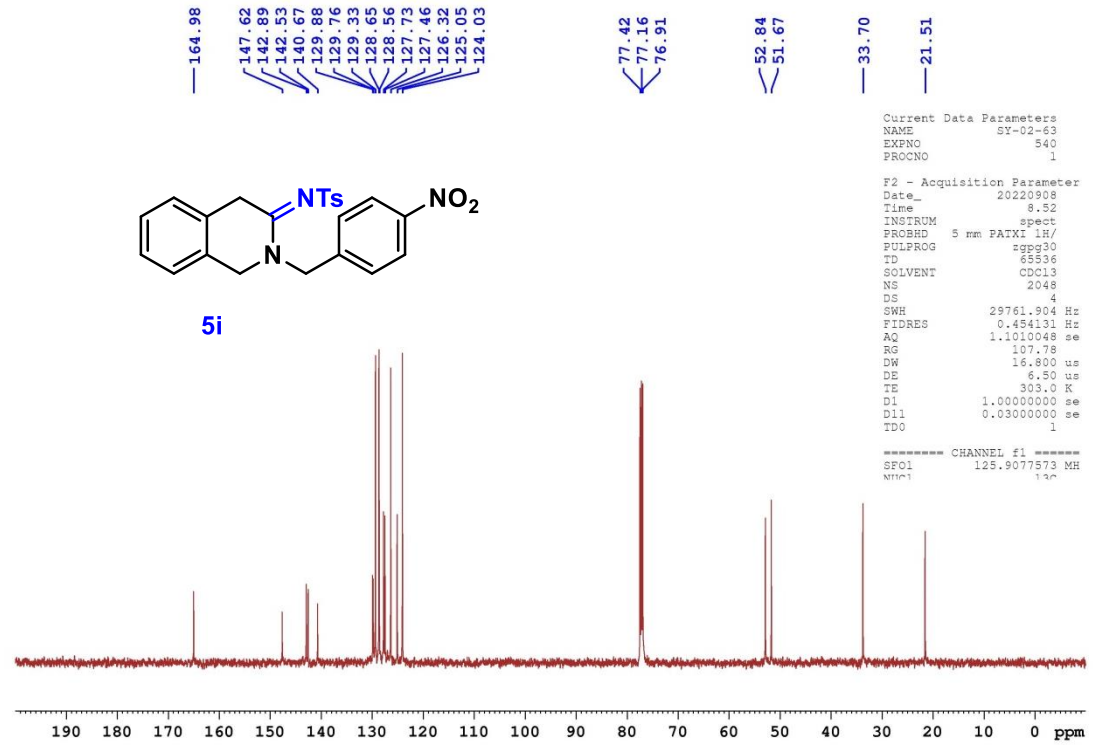

Figure S-153: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5i**

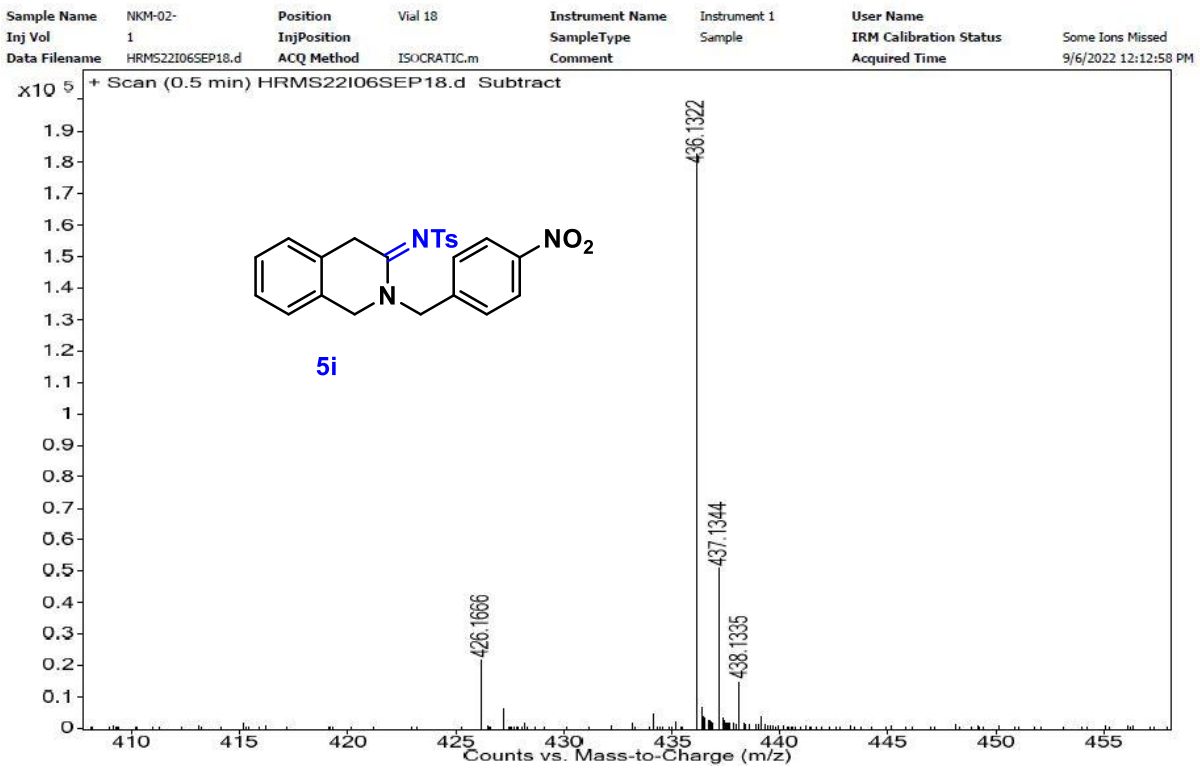

Figure S-154 HRMS spectrum of compound **5i**

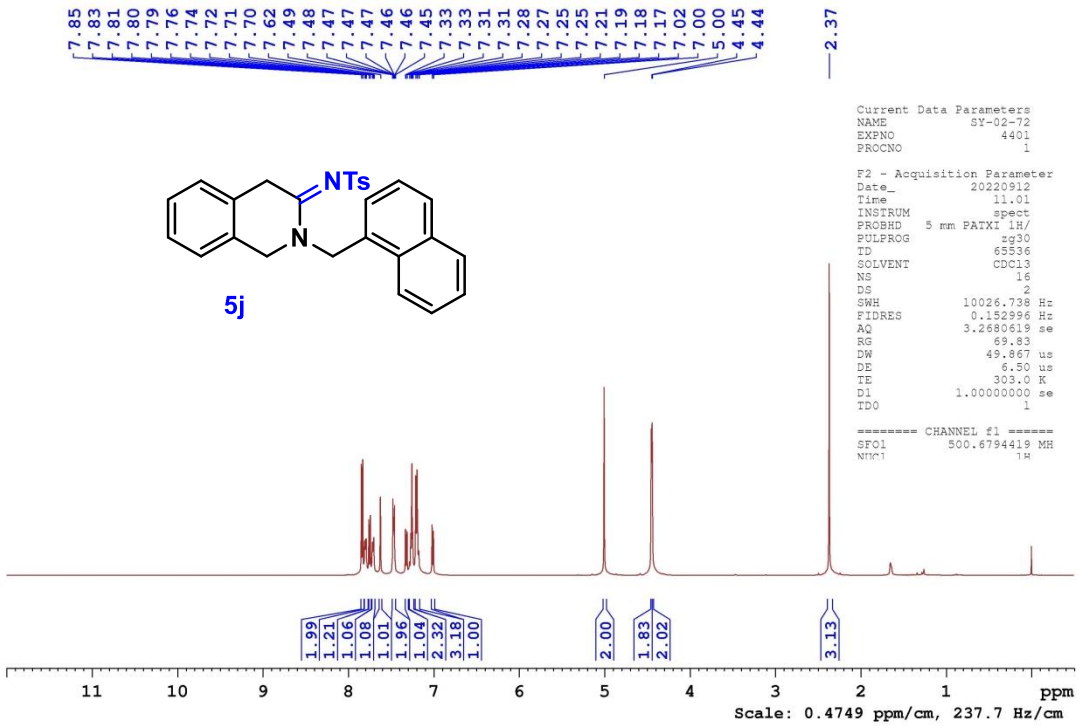

Figure S-155: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5j**

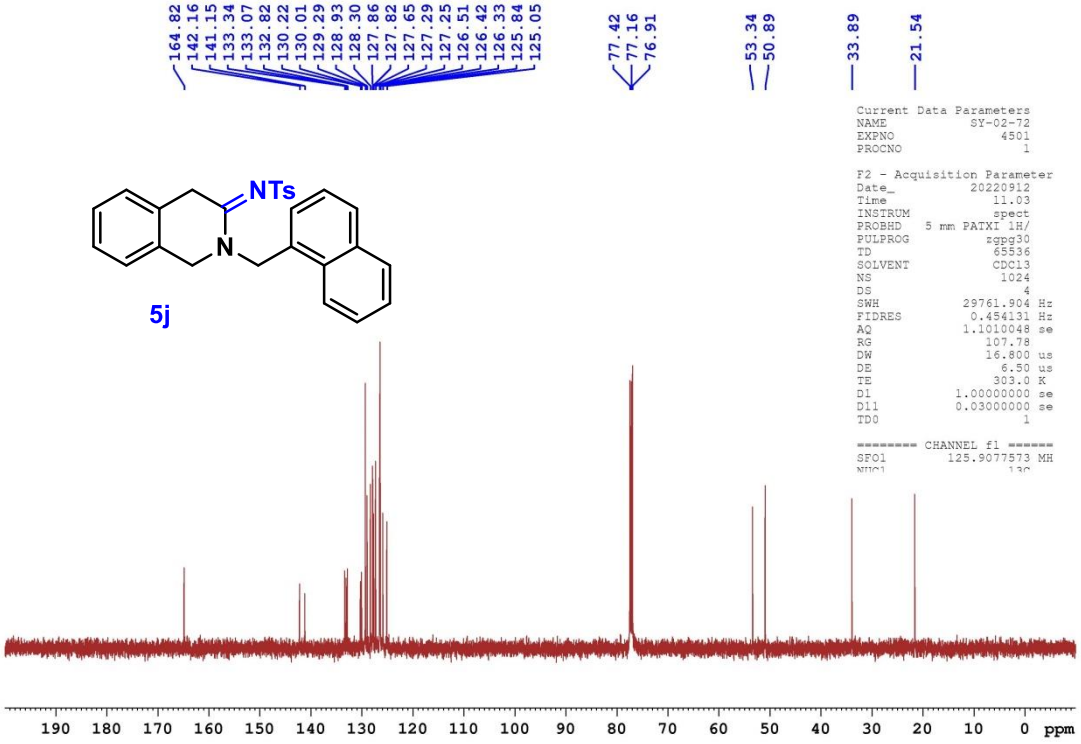

Figure S-156: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5j**

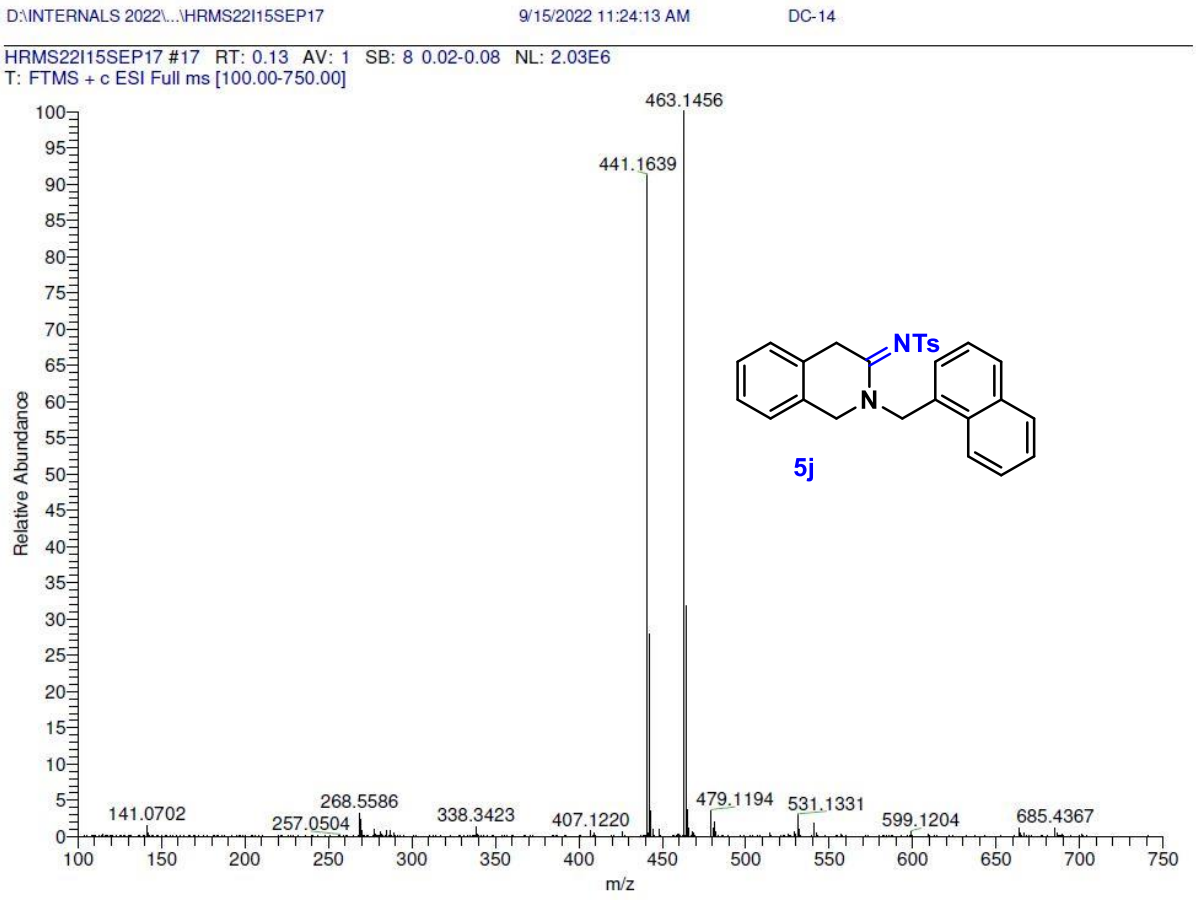

Figure S-157 HRMS spectrum of compound **5j**

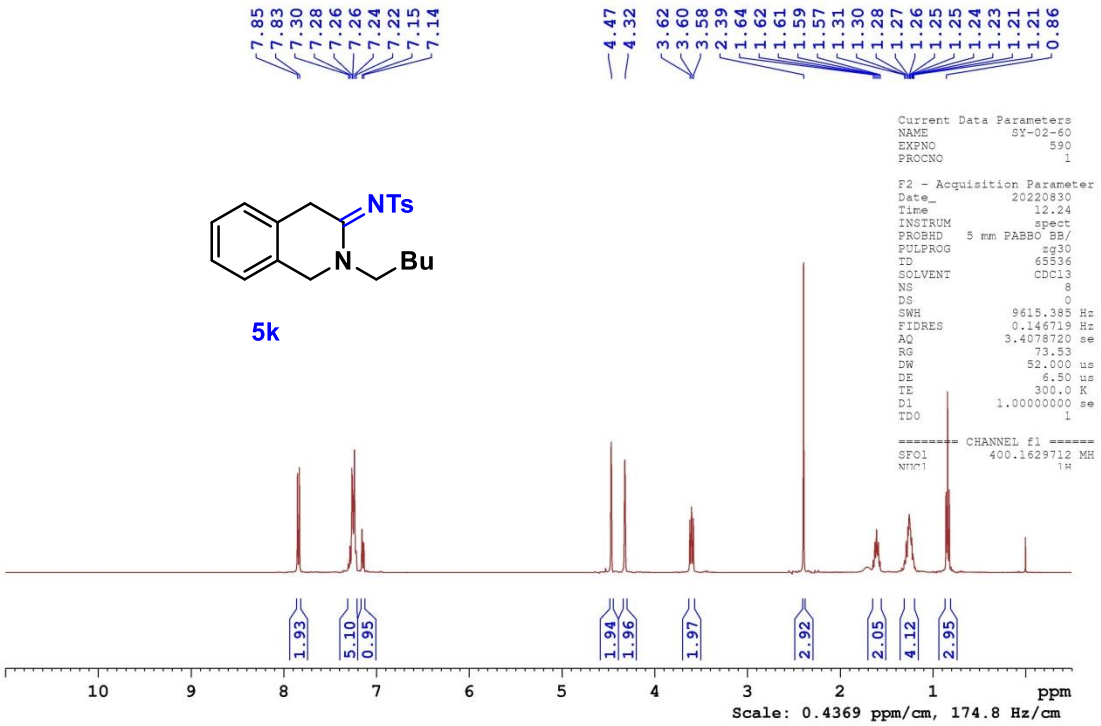

Figure S-158: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5k**

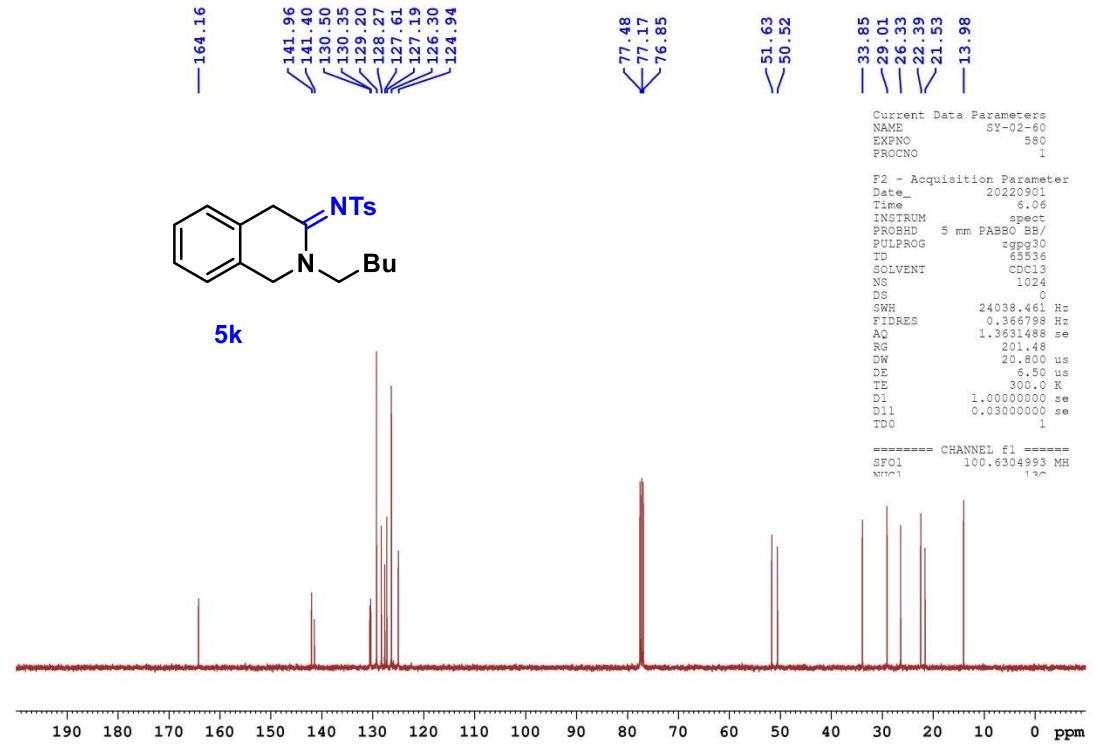

Figure S-159: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **5k**

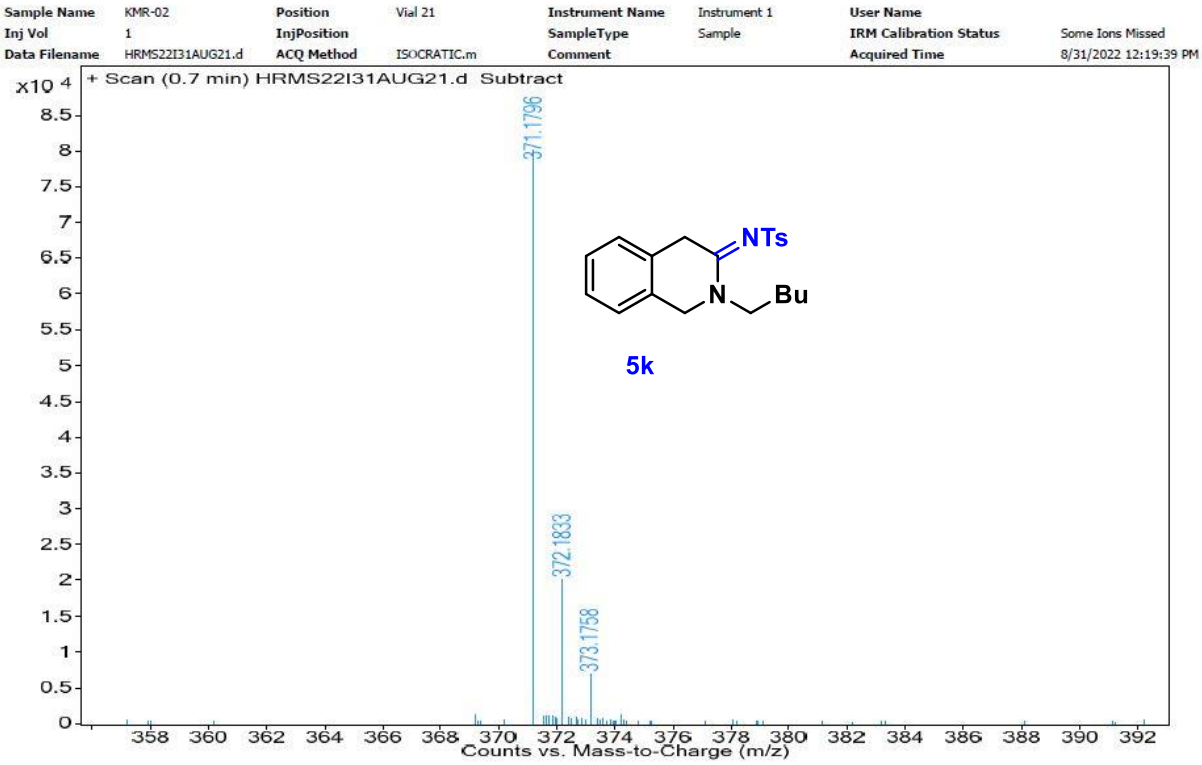

Figure S-160 HRMS spectrum of compound **5k**

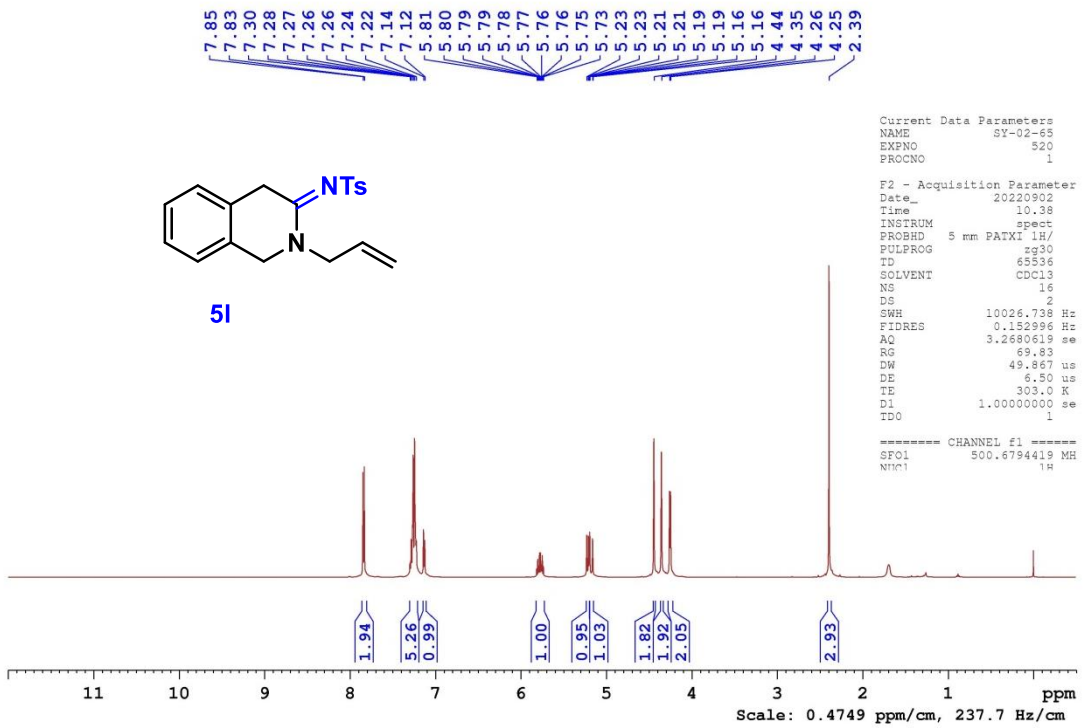

Figure S-161: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5l**

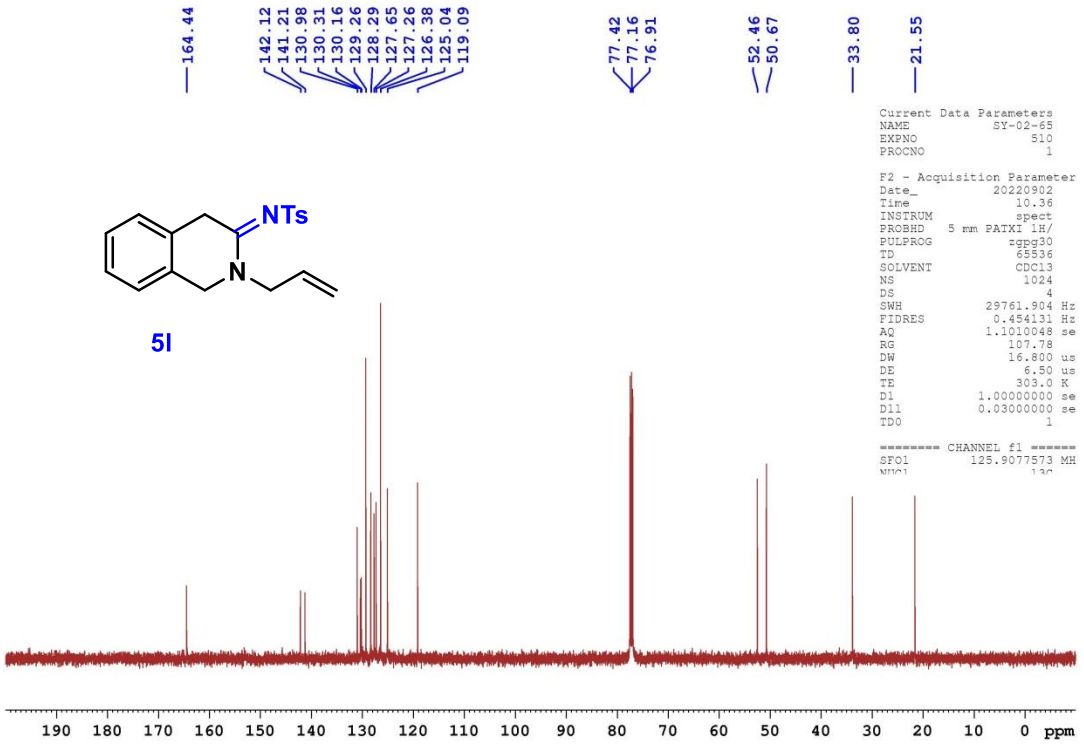

Figure S-162: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5l**

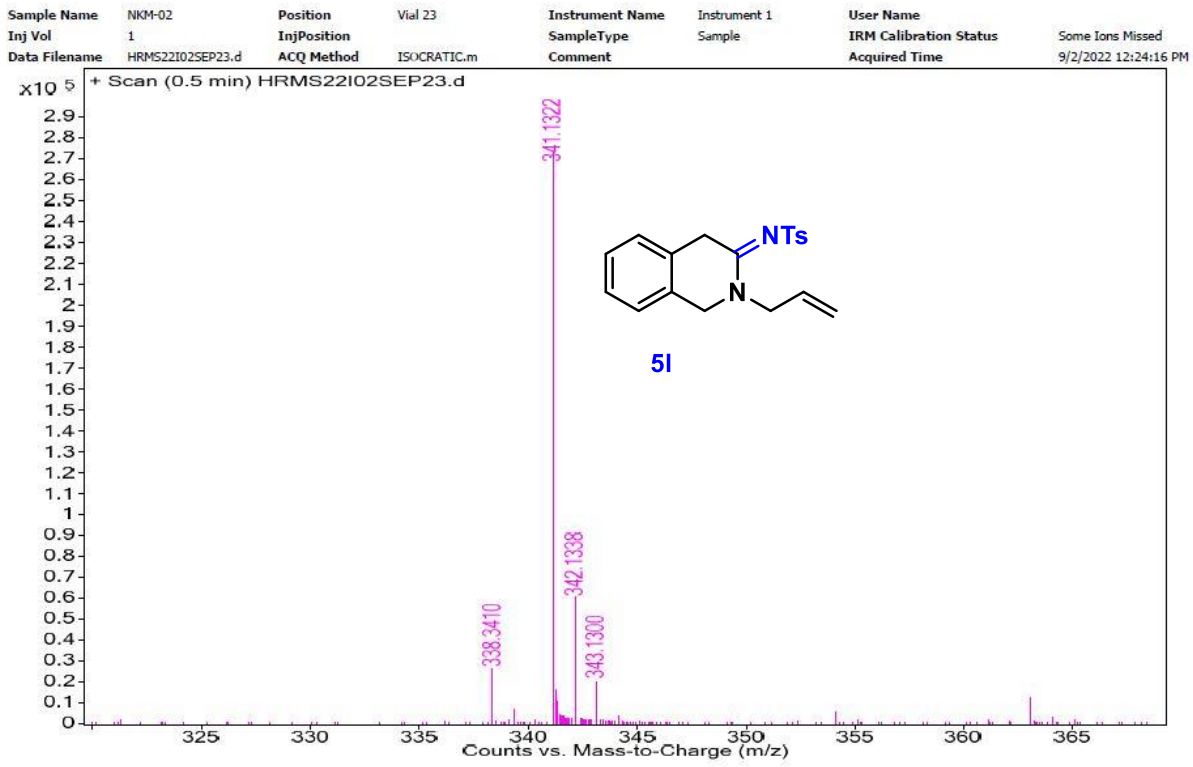

Figure S-163 HRMS spectrum of compound **5l**

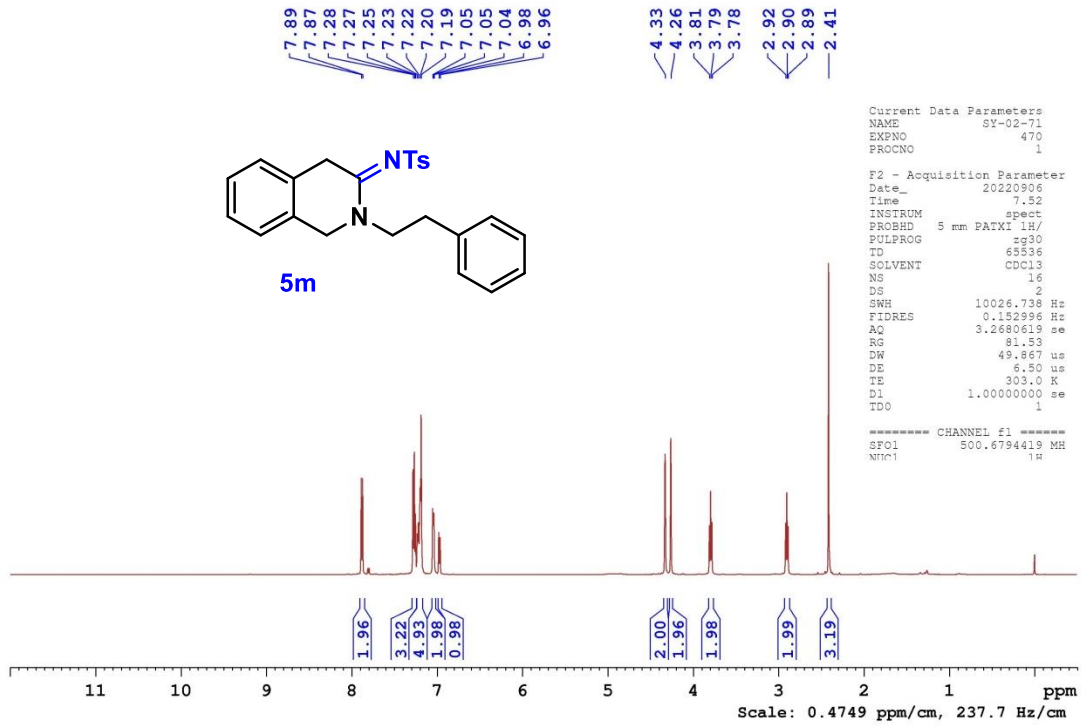

Figure S-164: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5m**

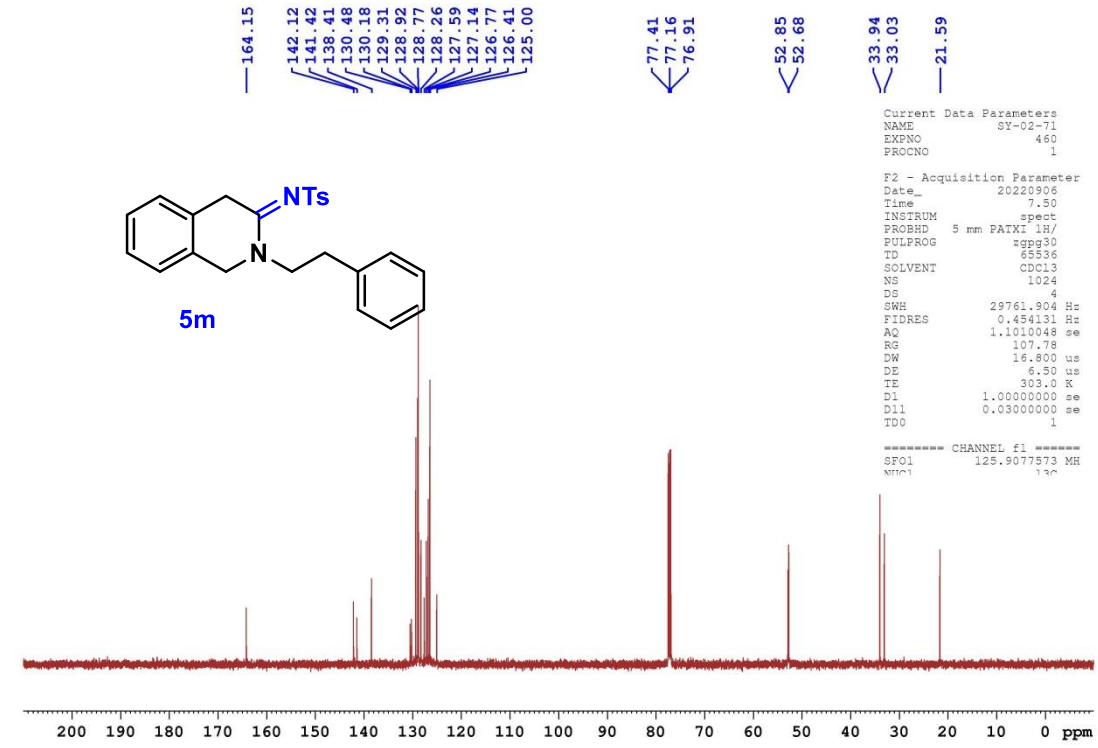

Figure S-165: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5m**

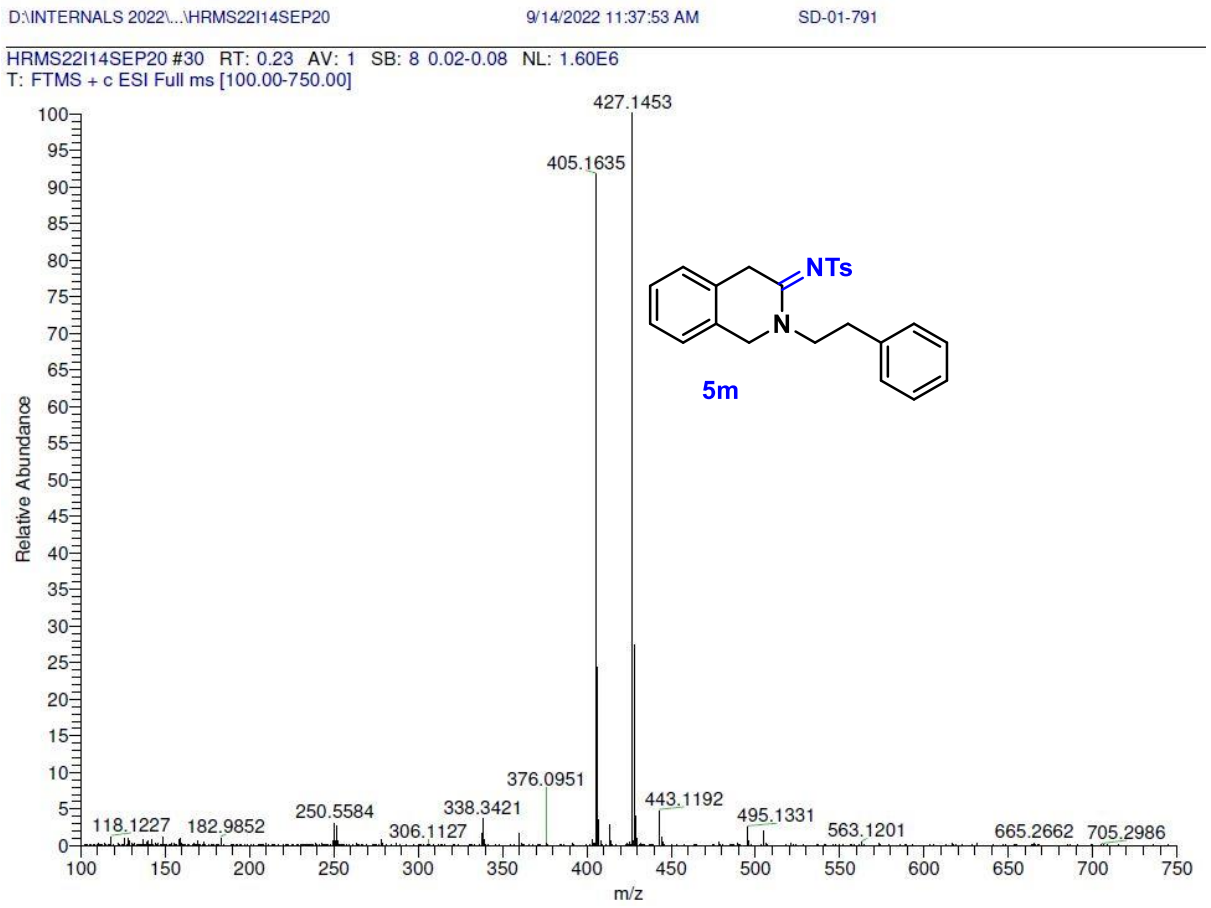

Figure S-166 HRMS spectrum of compound **5m**

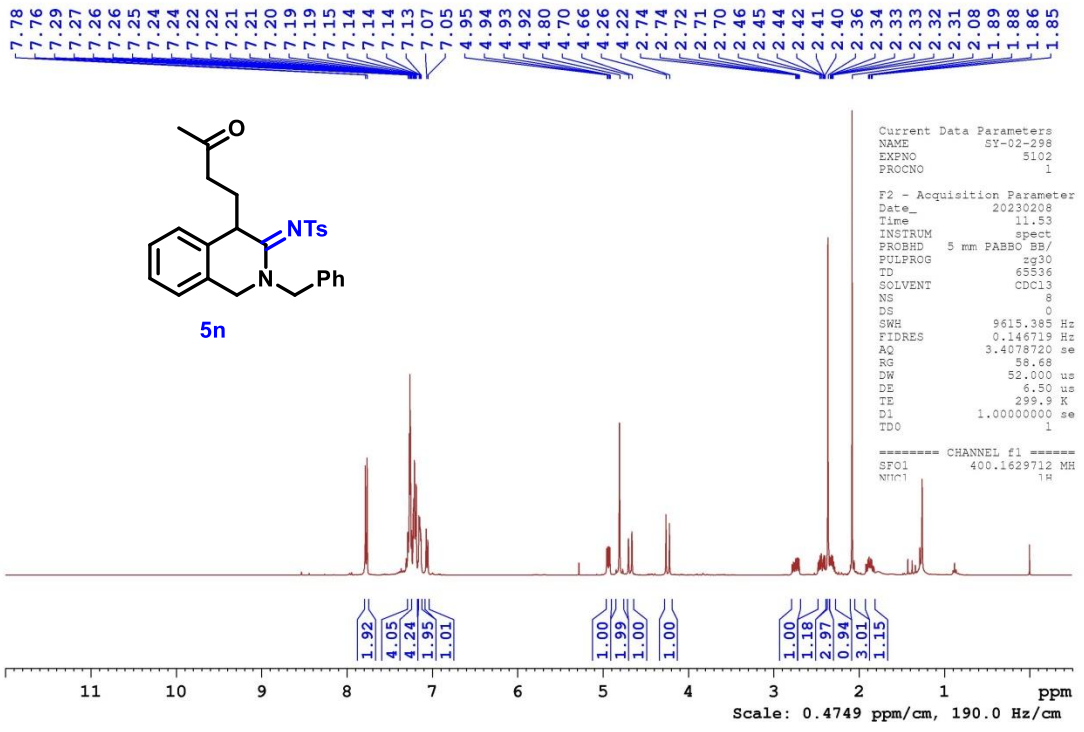

Figure S-167: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5n**

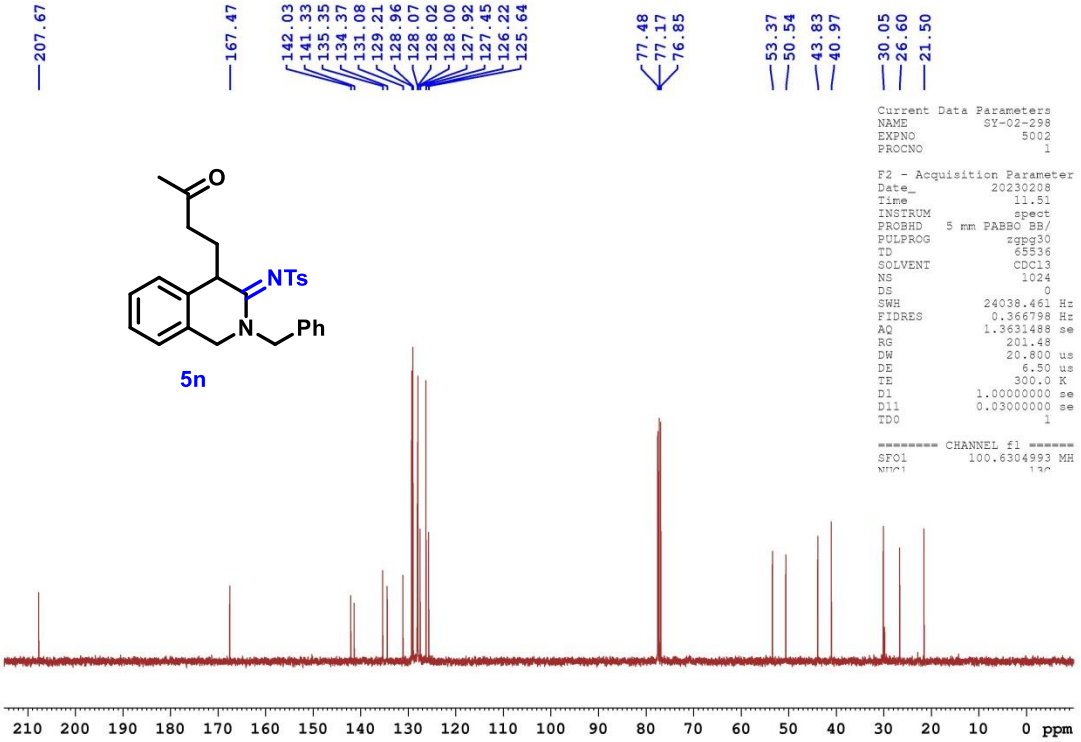

Figure S-168: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5n**

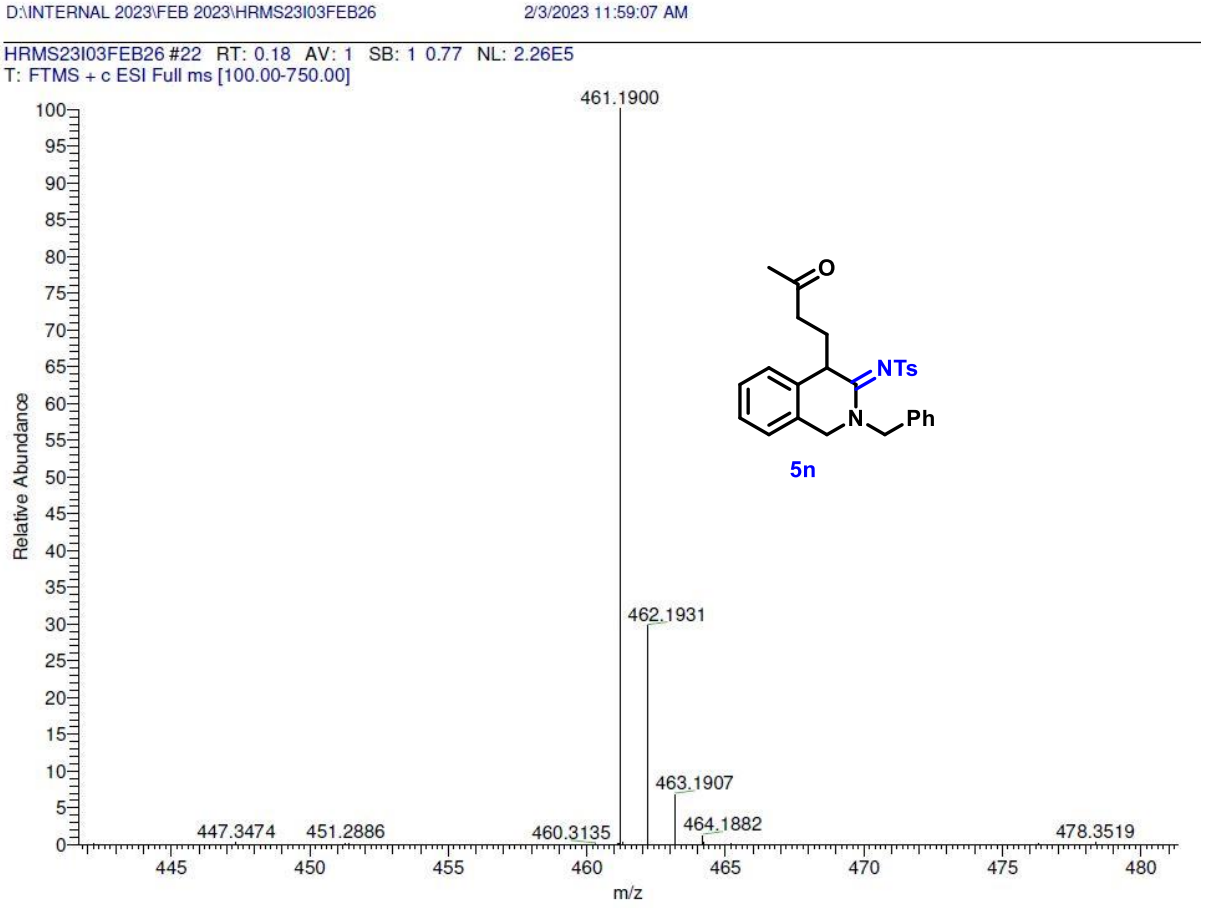

Figure S-169 HRMS spectrum of compound **5n**

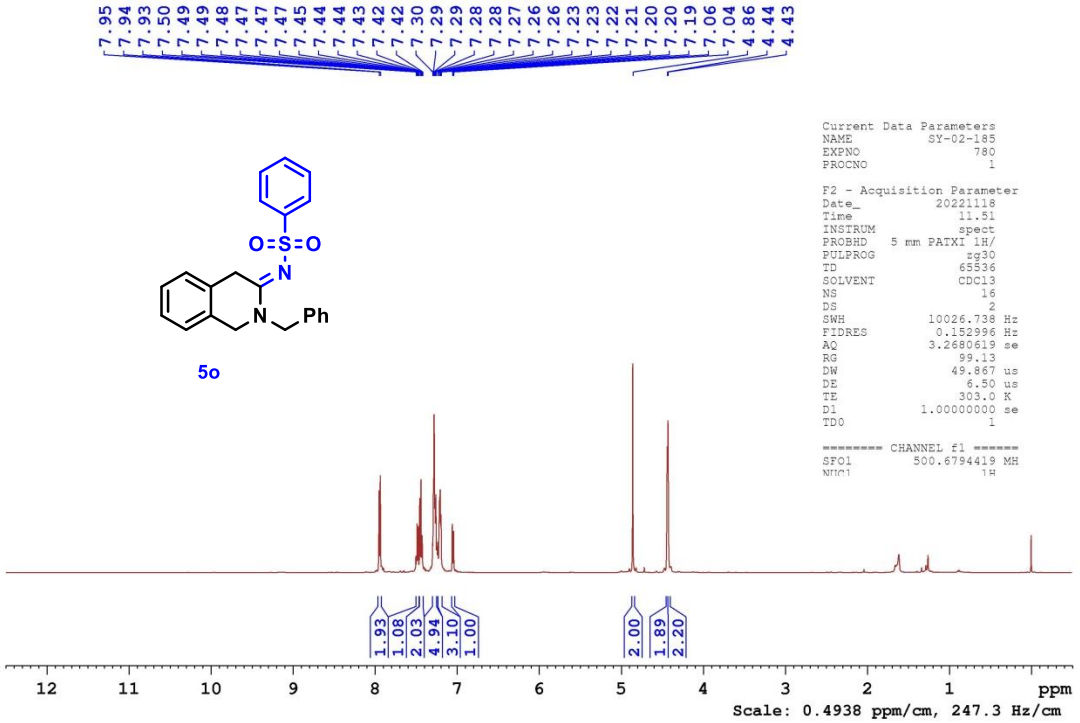

Figure S-170: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5o**

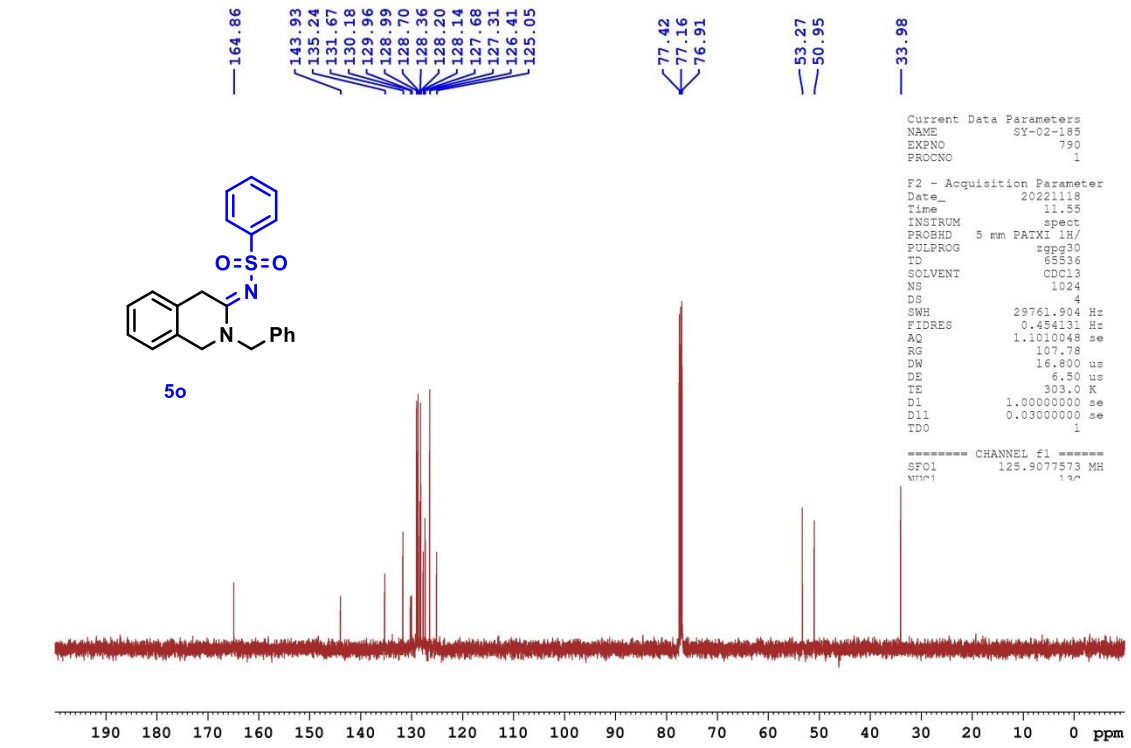

Figure S-171: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5o**

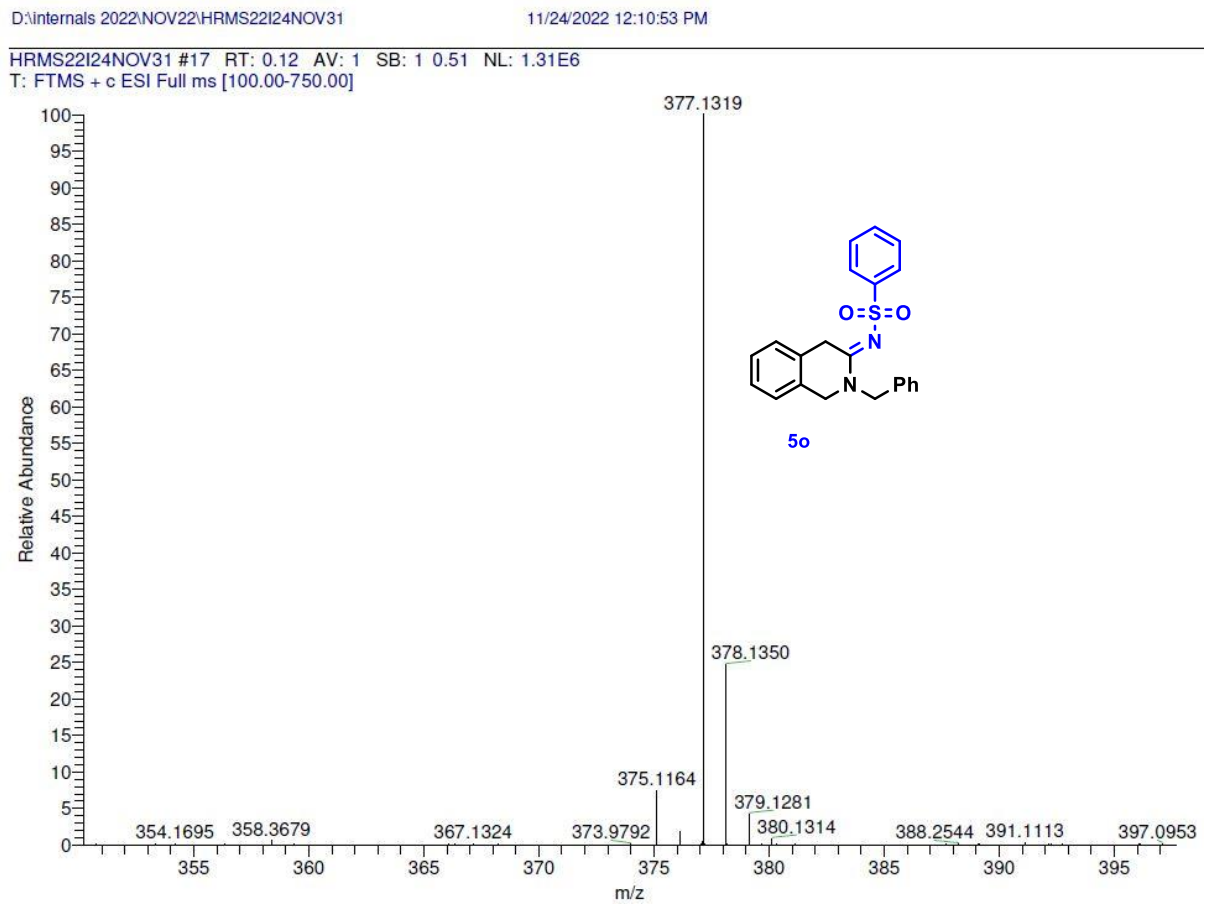

Figure S-172 HRMS spectrum of compound **5o**

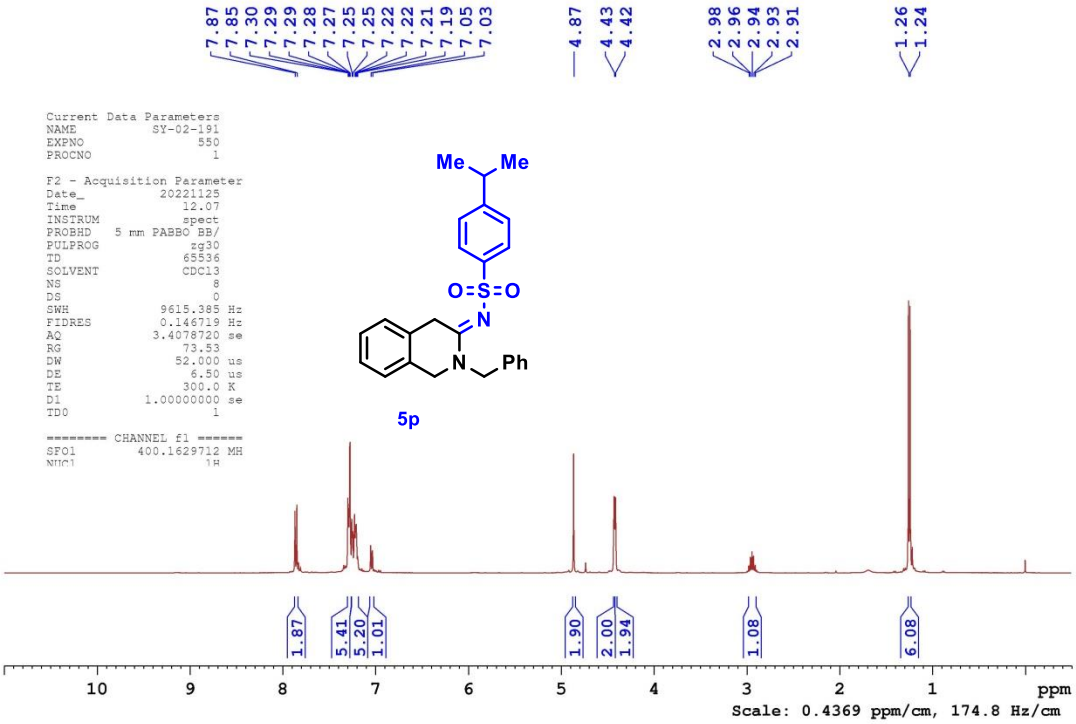

Figure S-173: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5p**

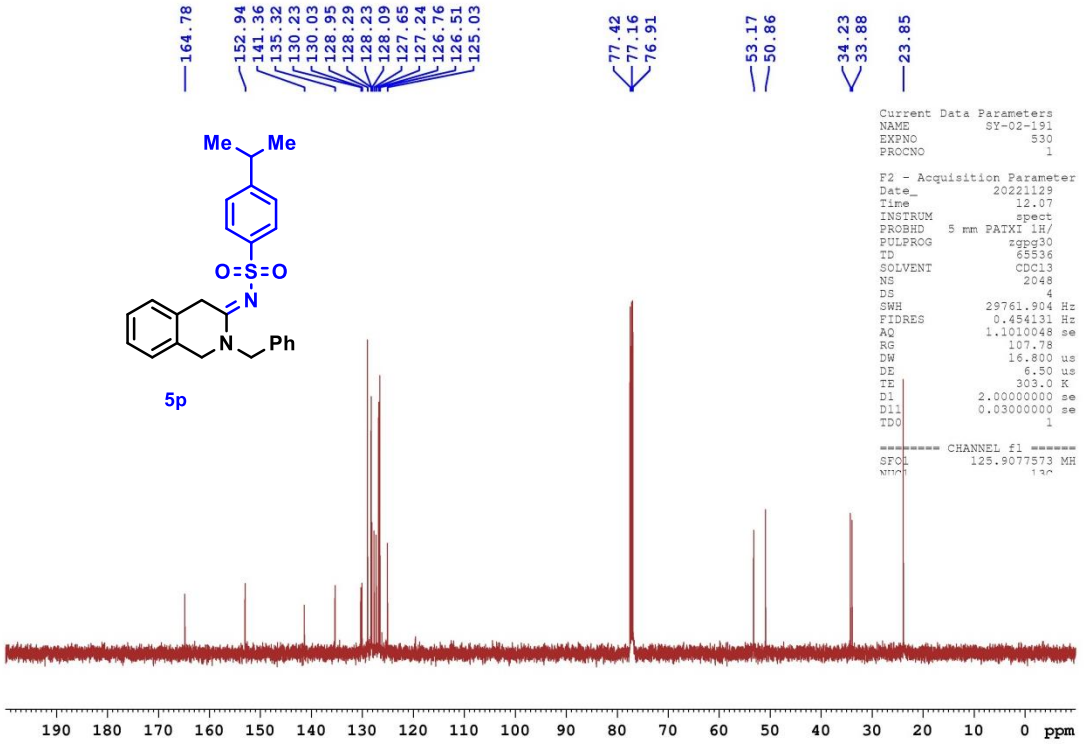

Figure S-174: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5p**

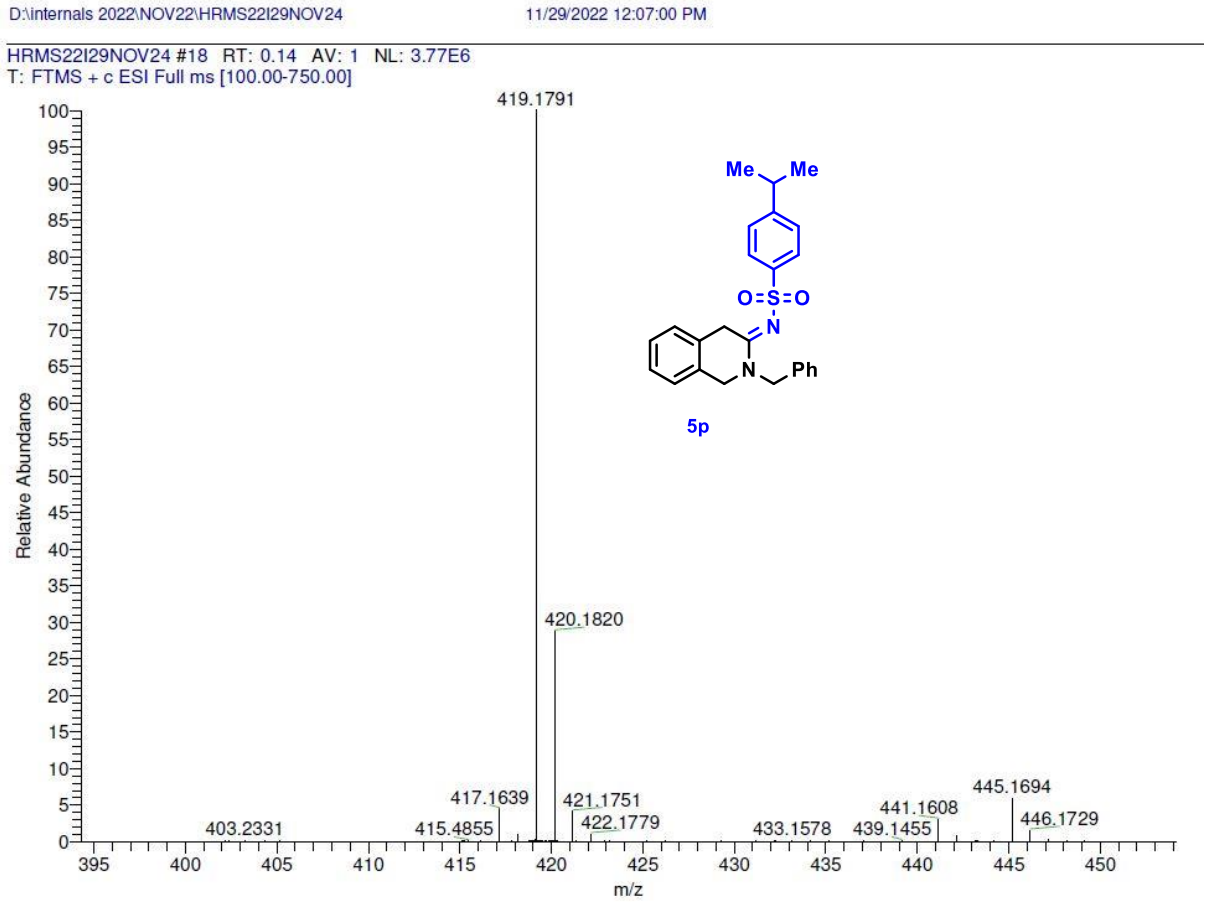

Figure S-175 HRMS spectrum of compound **5p**

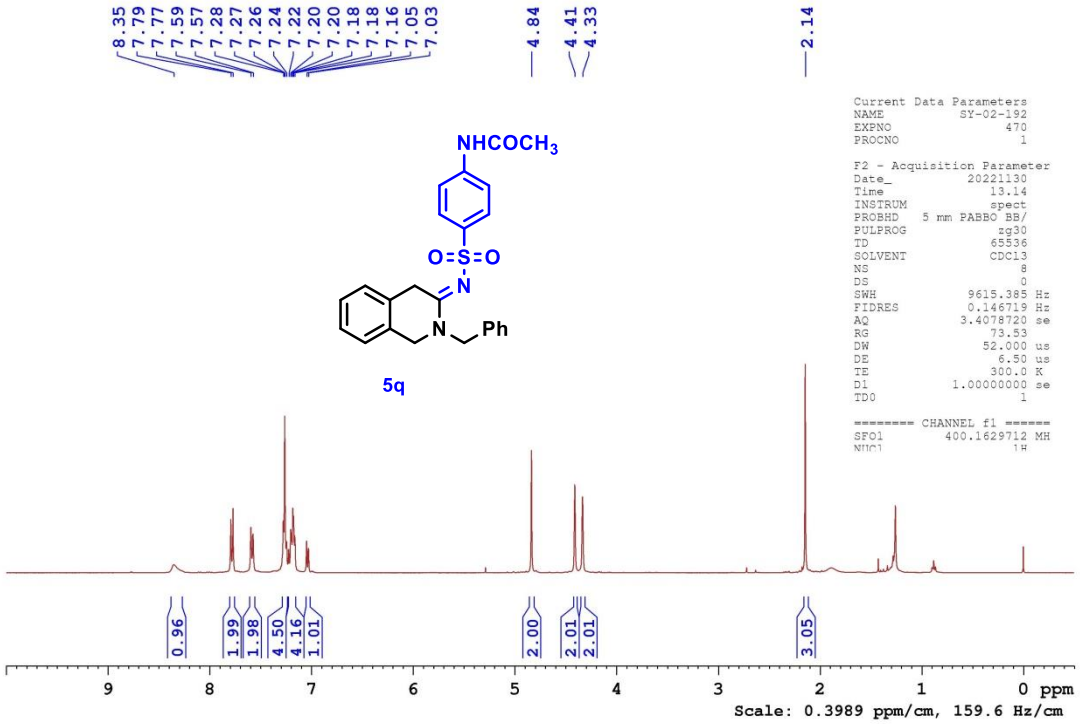

Figure S-176: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5q**

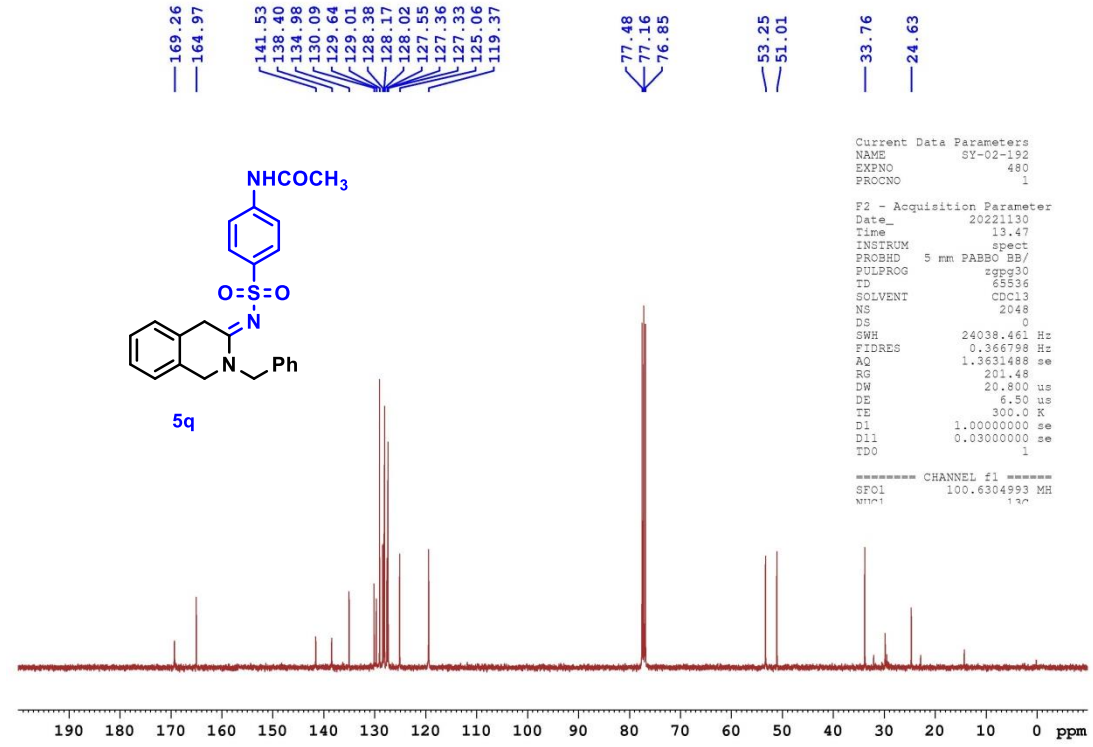

Figure S-177: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **5q**

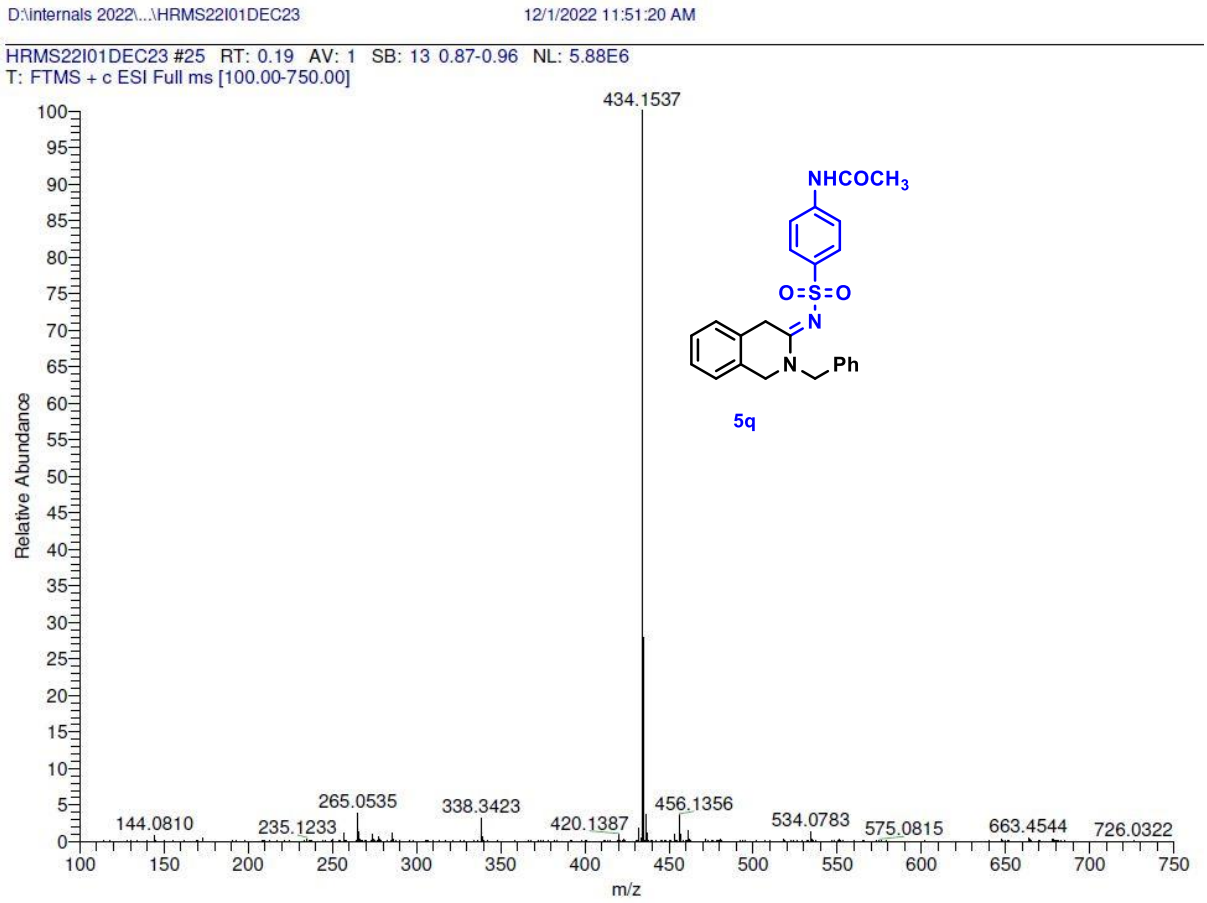

Figure S-178 HRMS spectrum of compound **5q**

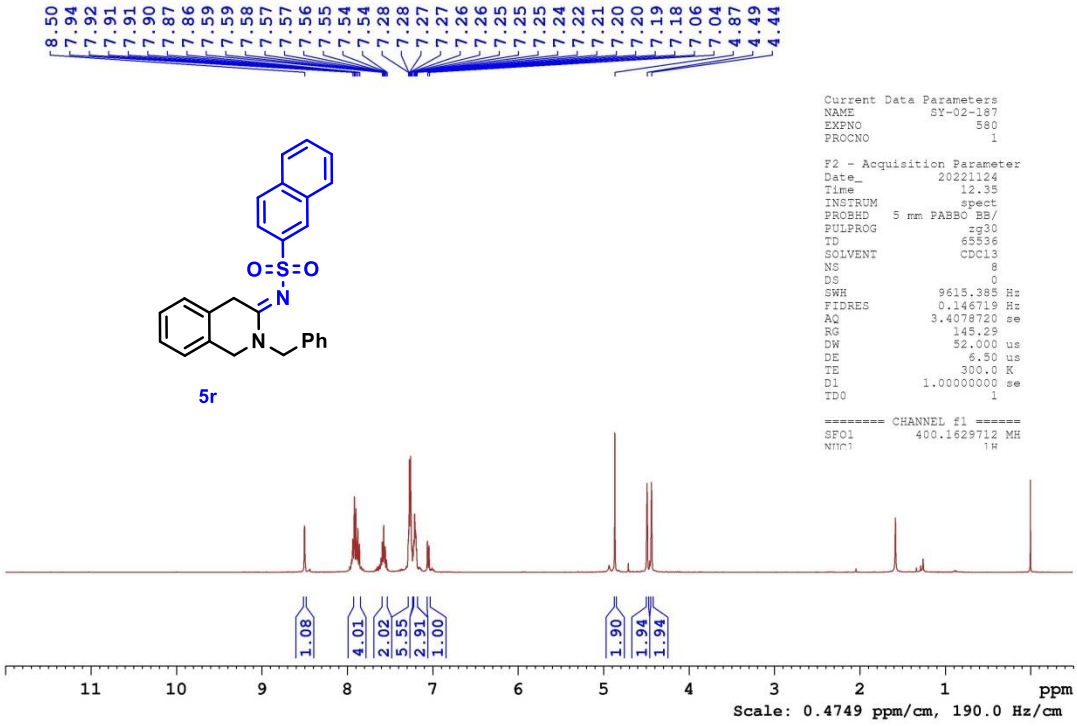

Figure S-179: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5r**

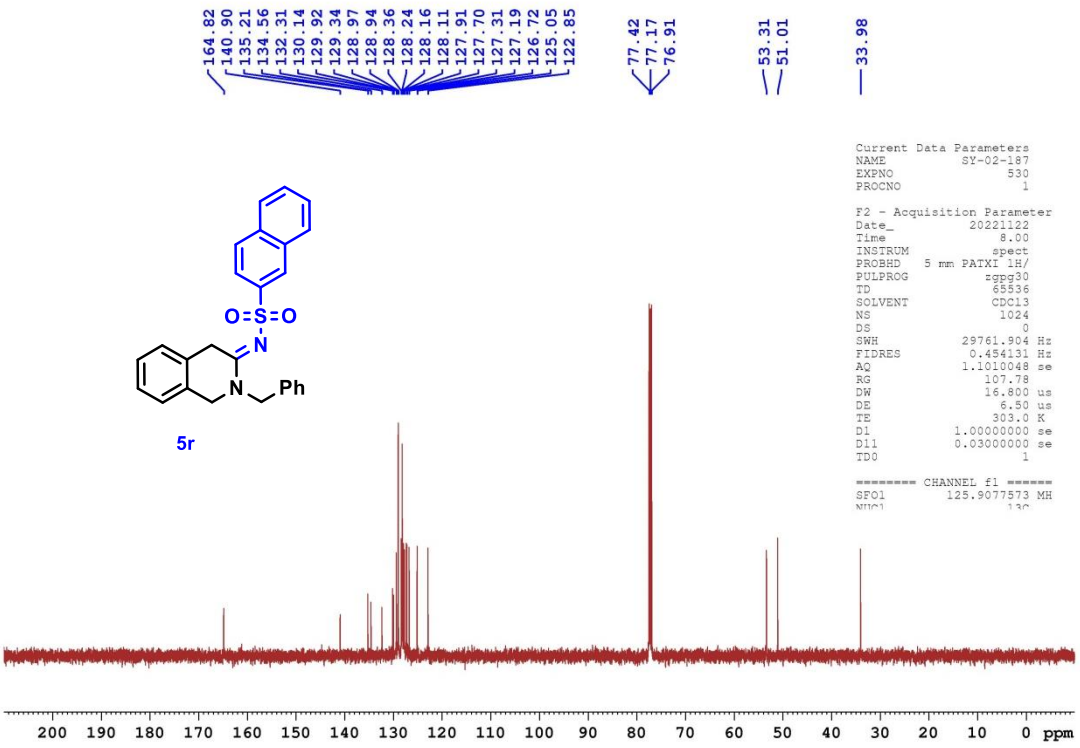

Figure S-180: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5r**

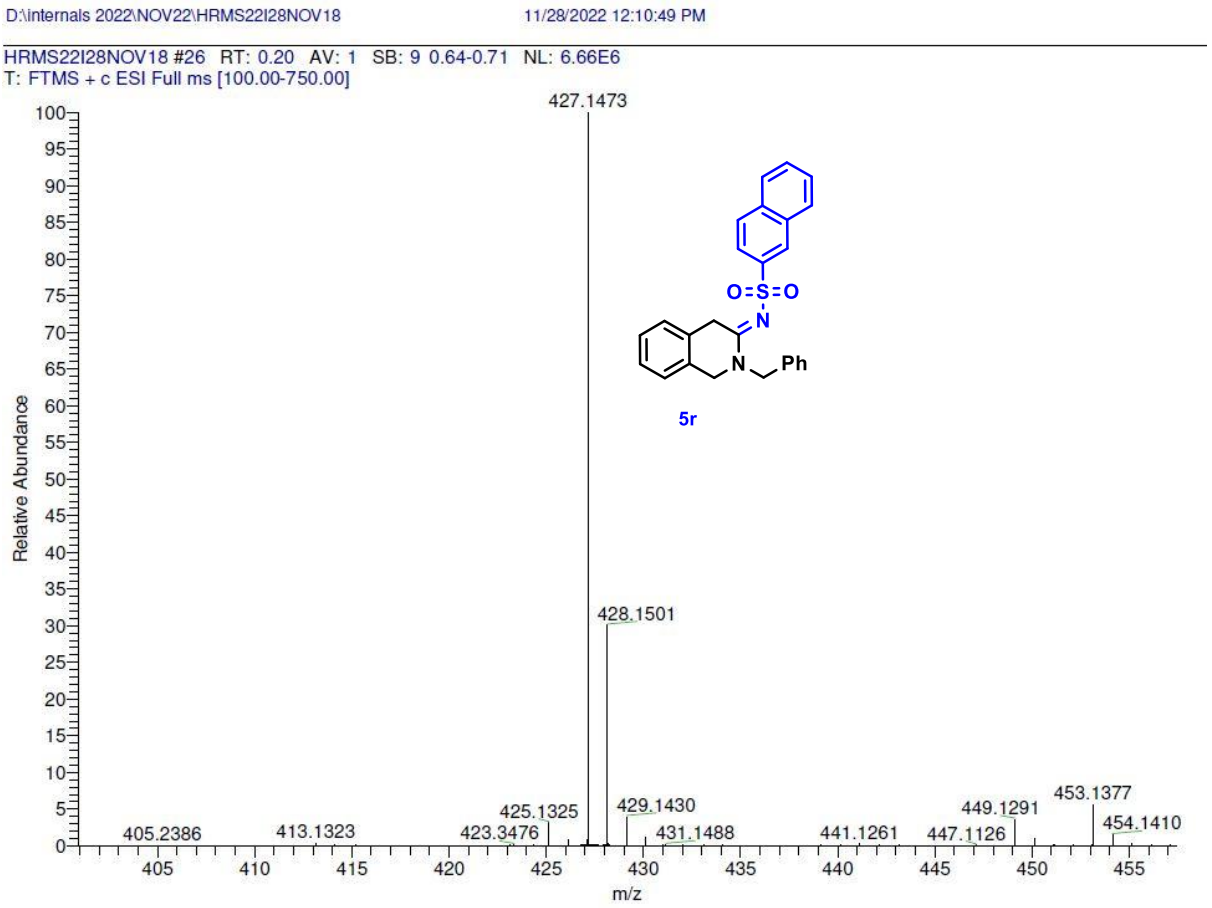

Figure S-181 HRMS spectrum of compound **5r**

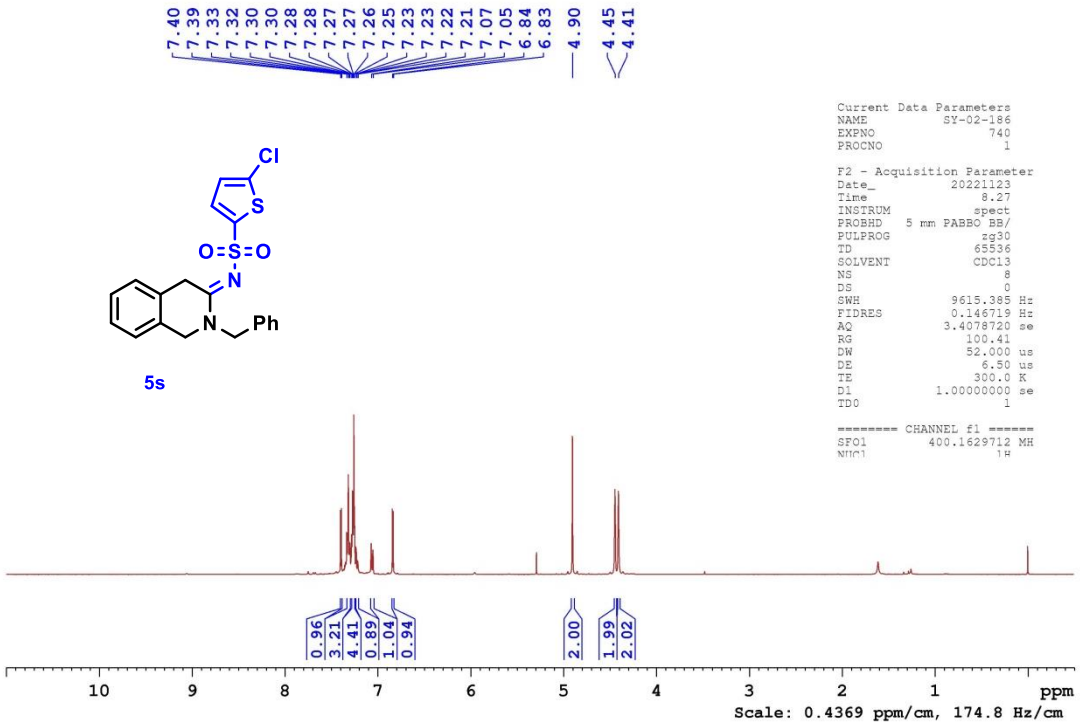

Figure S-182: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **5s**

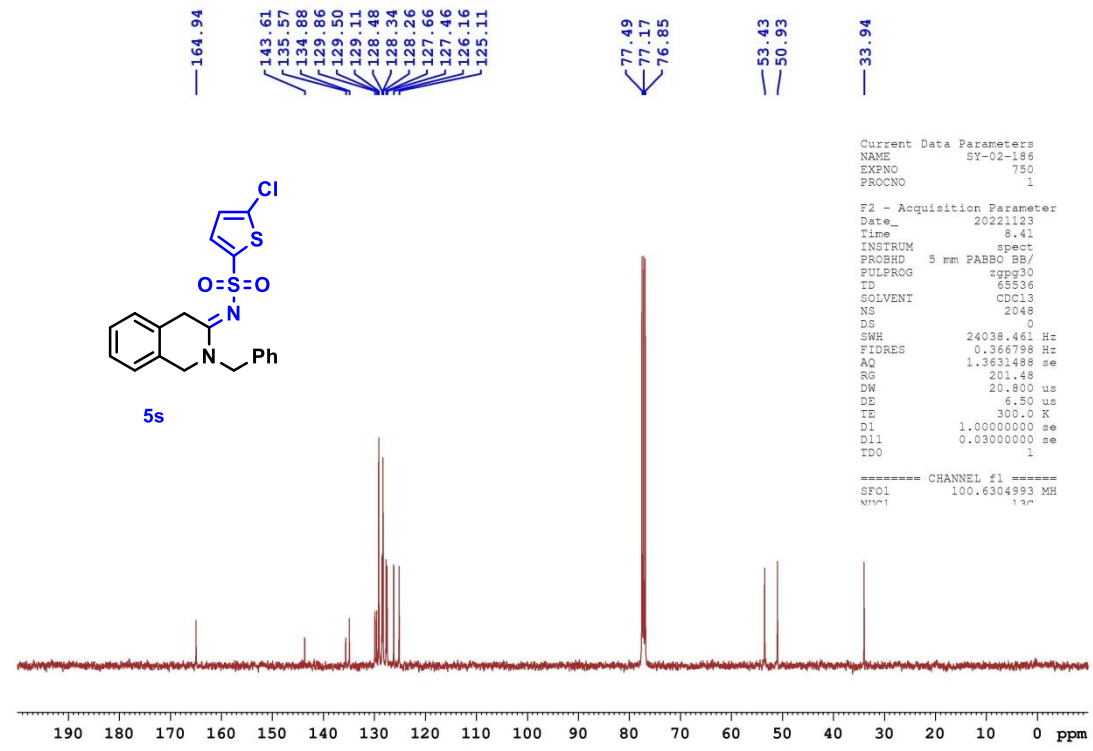

Figure S-183: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **5s**

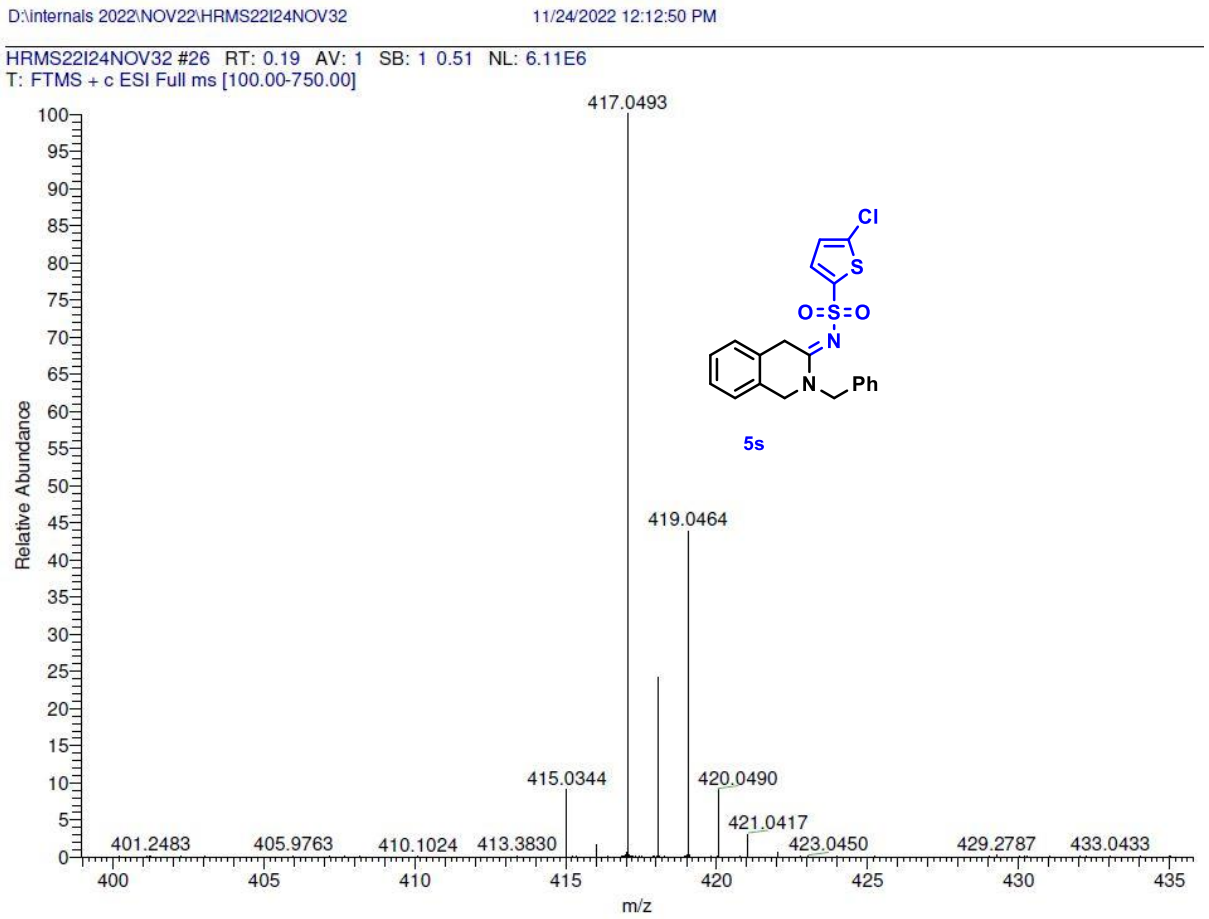

Figure S-184 HRMS spectrum of compound **5s**

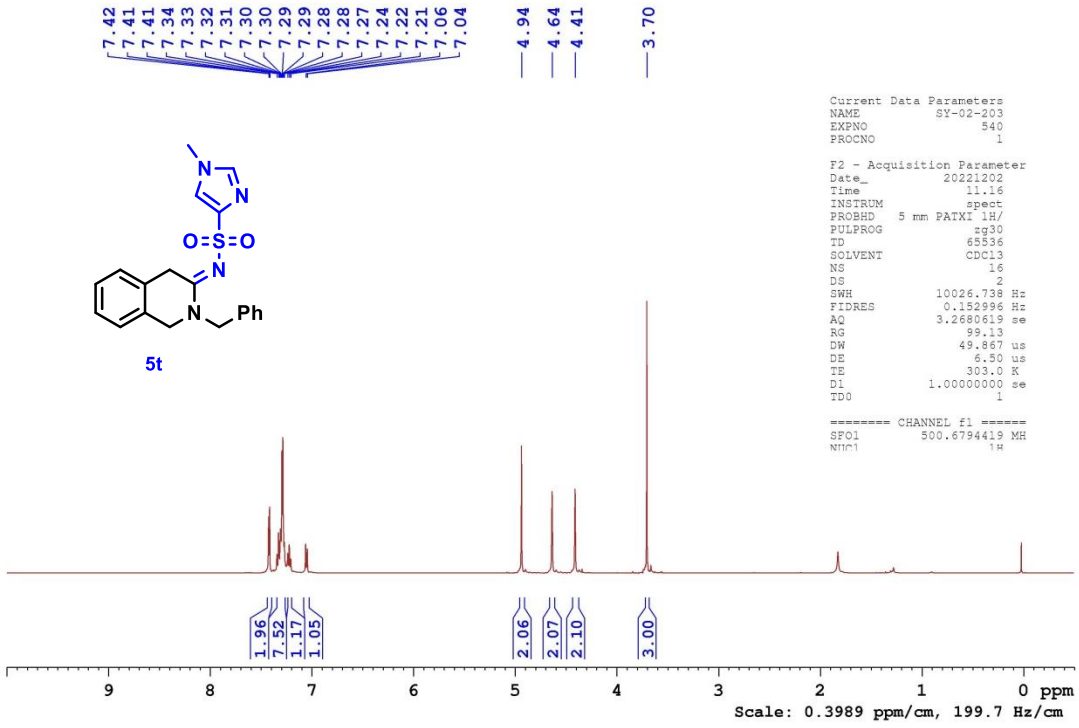

Figure S-185: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5t**

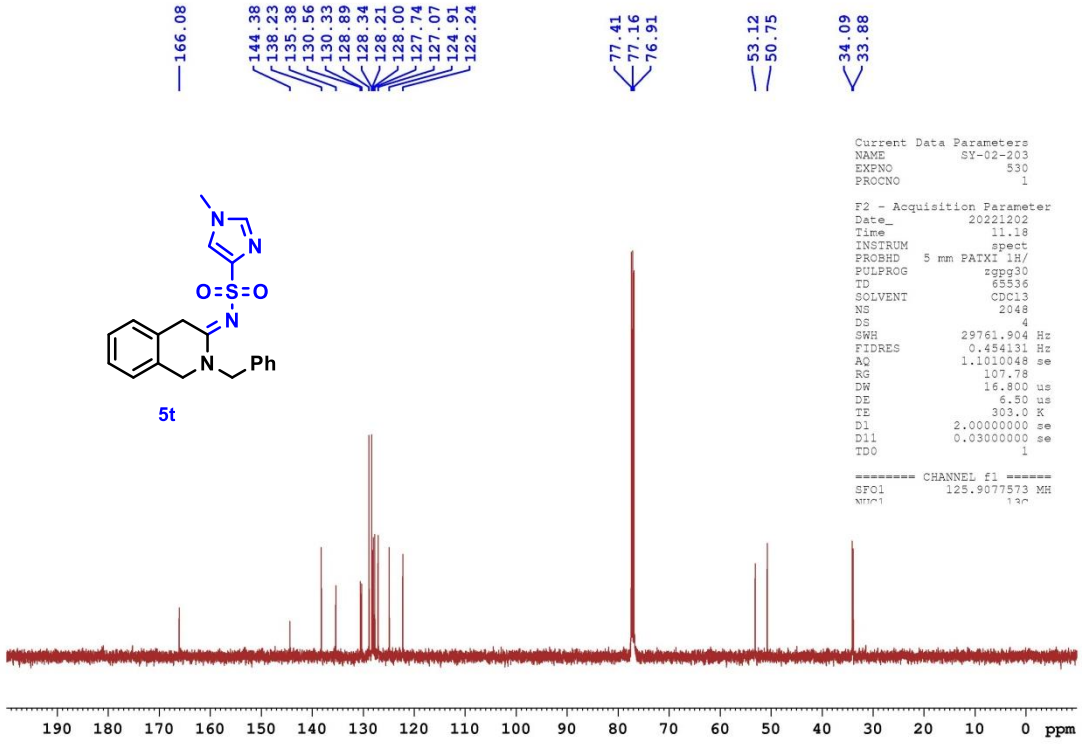

Figure S-186: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5t**

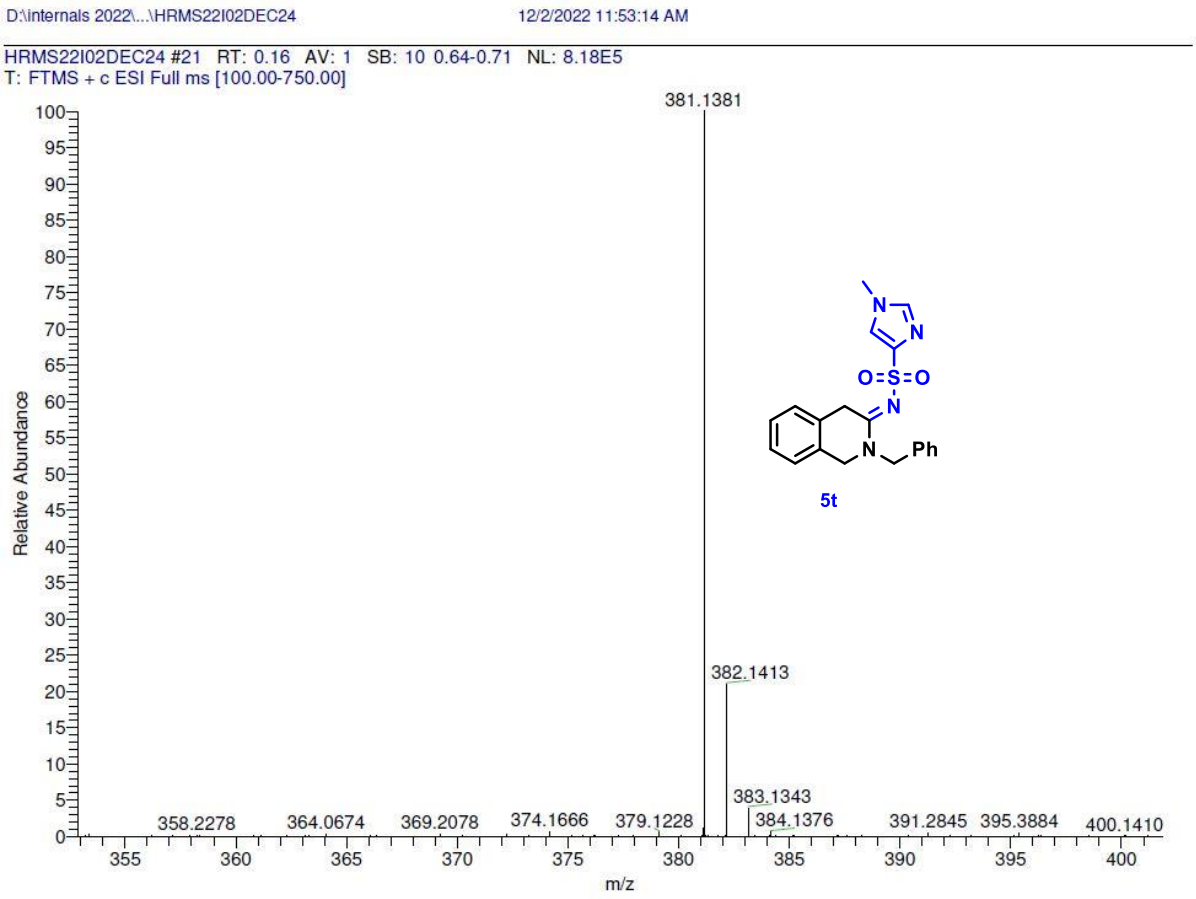

Figure S-187 HRMS spectrum of compound **5t**

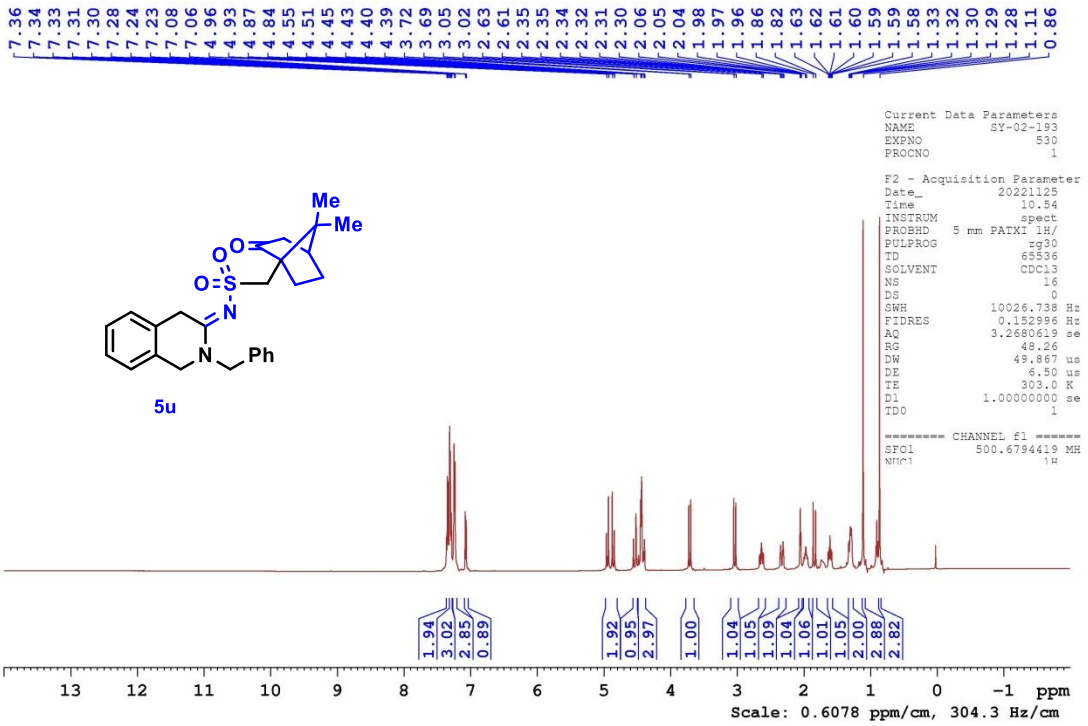

Figure S-188: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **5u**

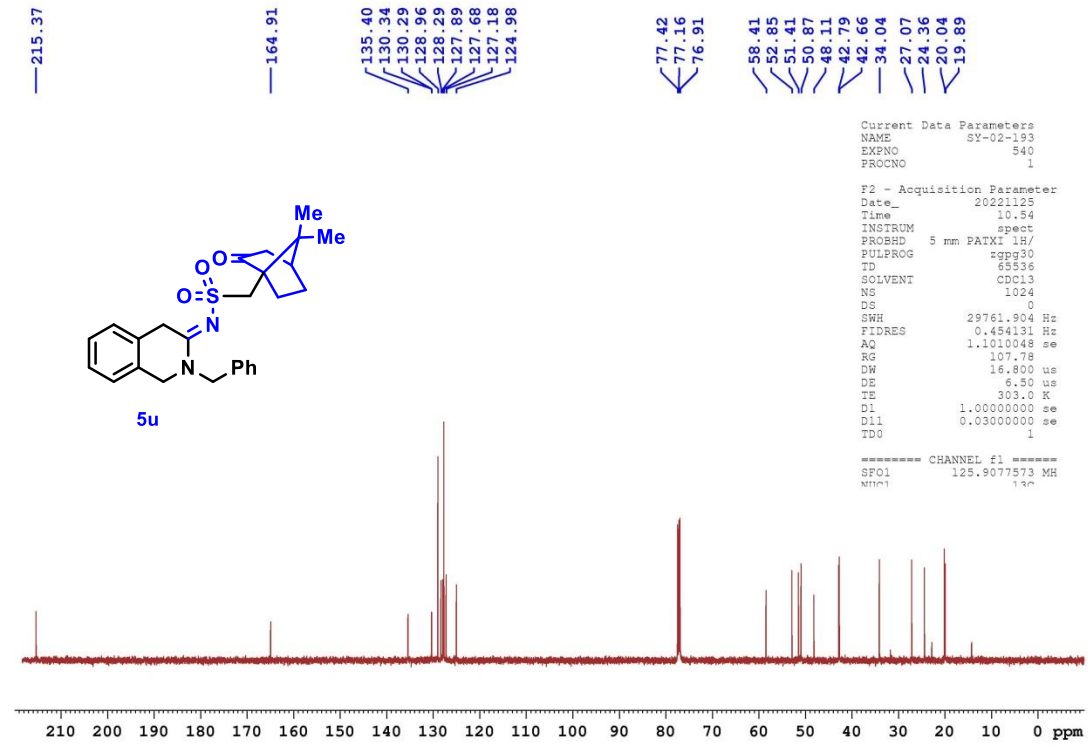

Figure S-189: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **5u**

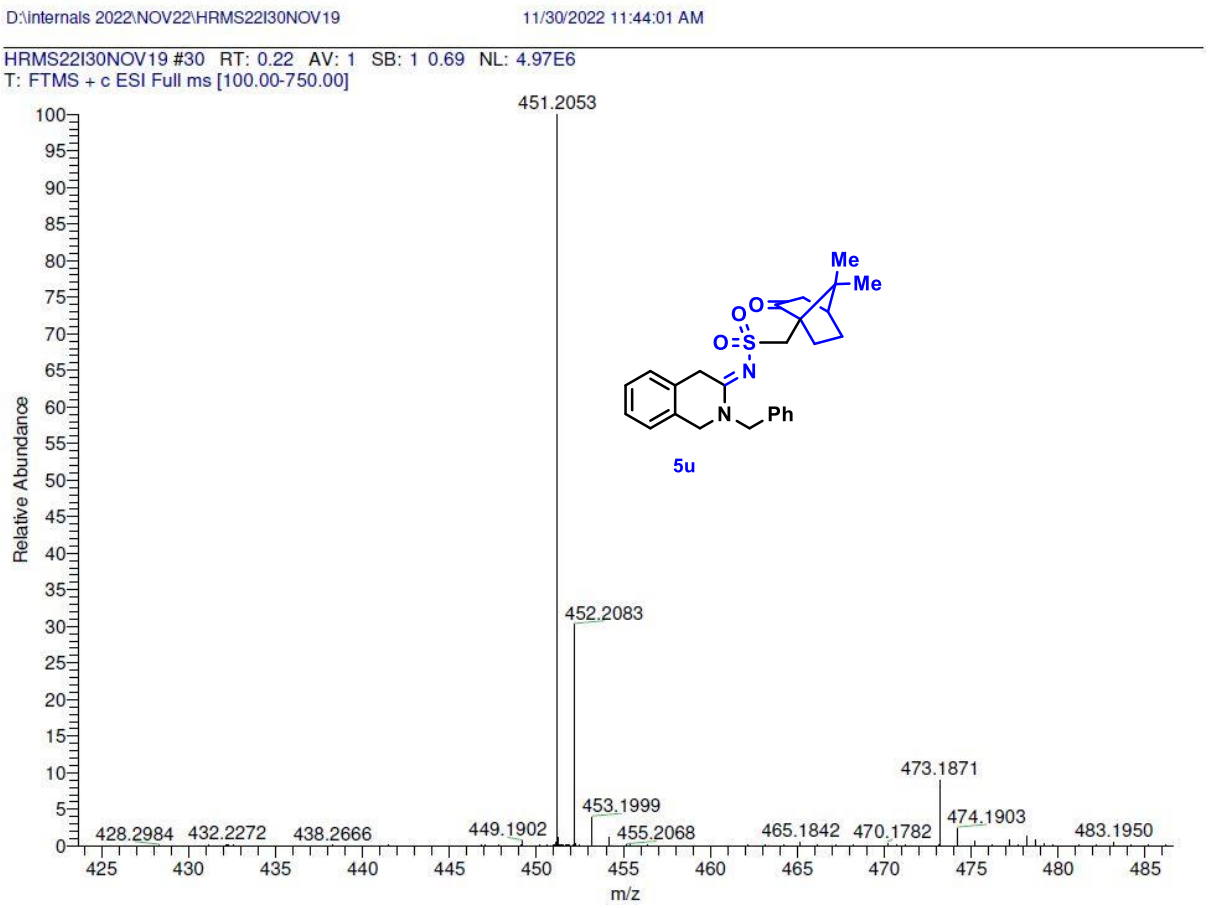

Figure S-190 HRMS spectrum of compound **5u**

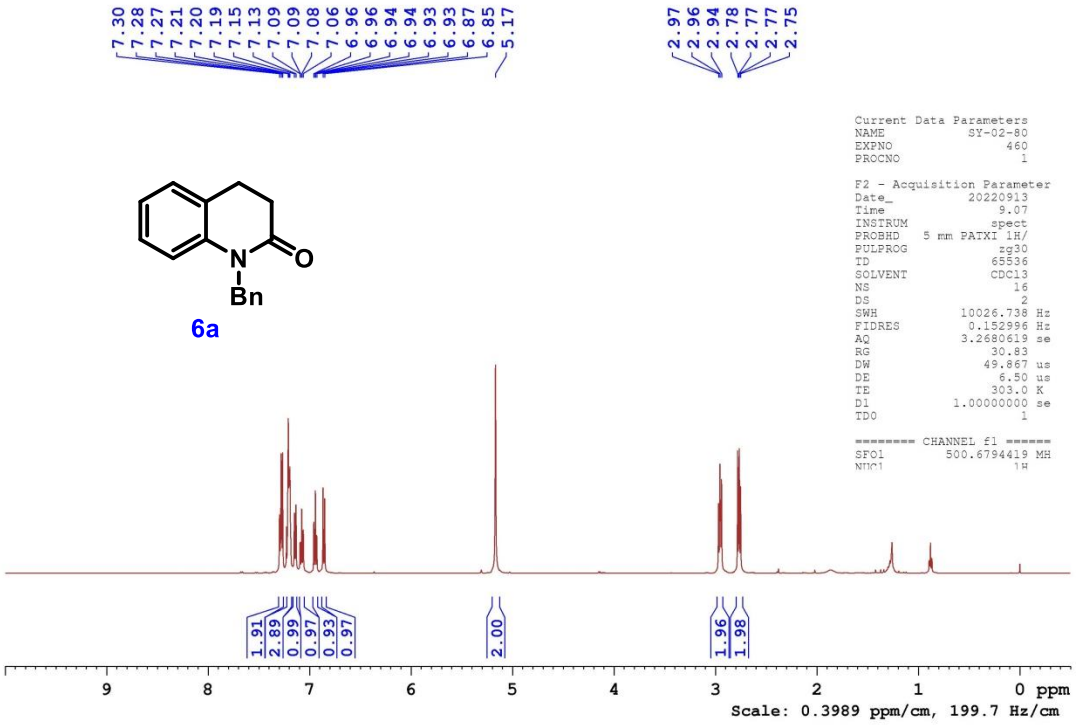

Figure S-191: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **6a**

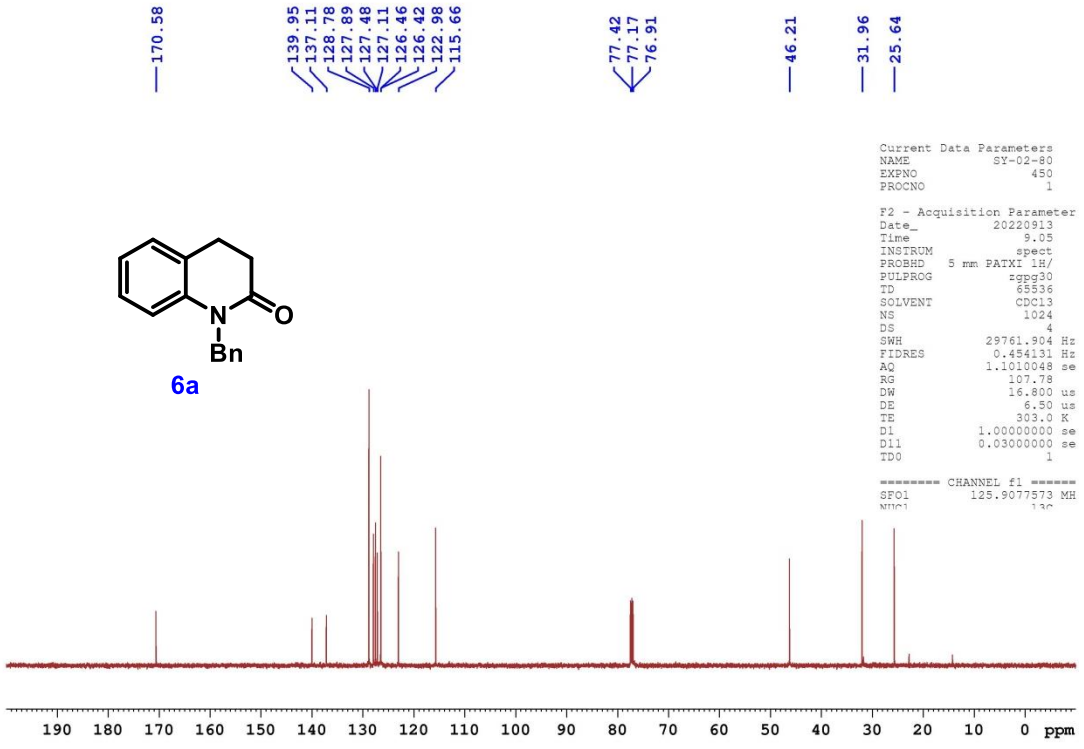

Figure S-192: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **6a**

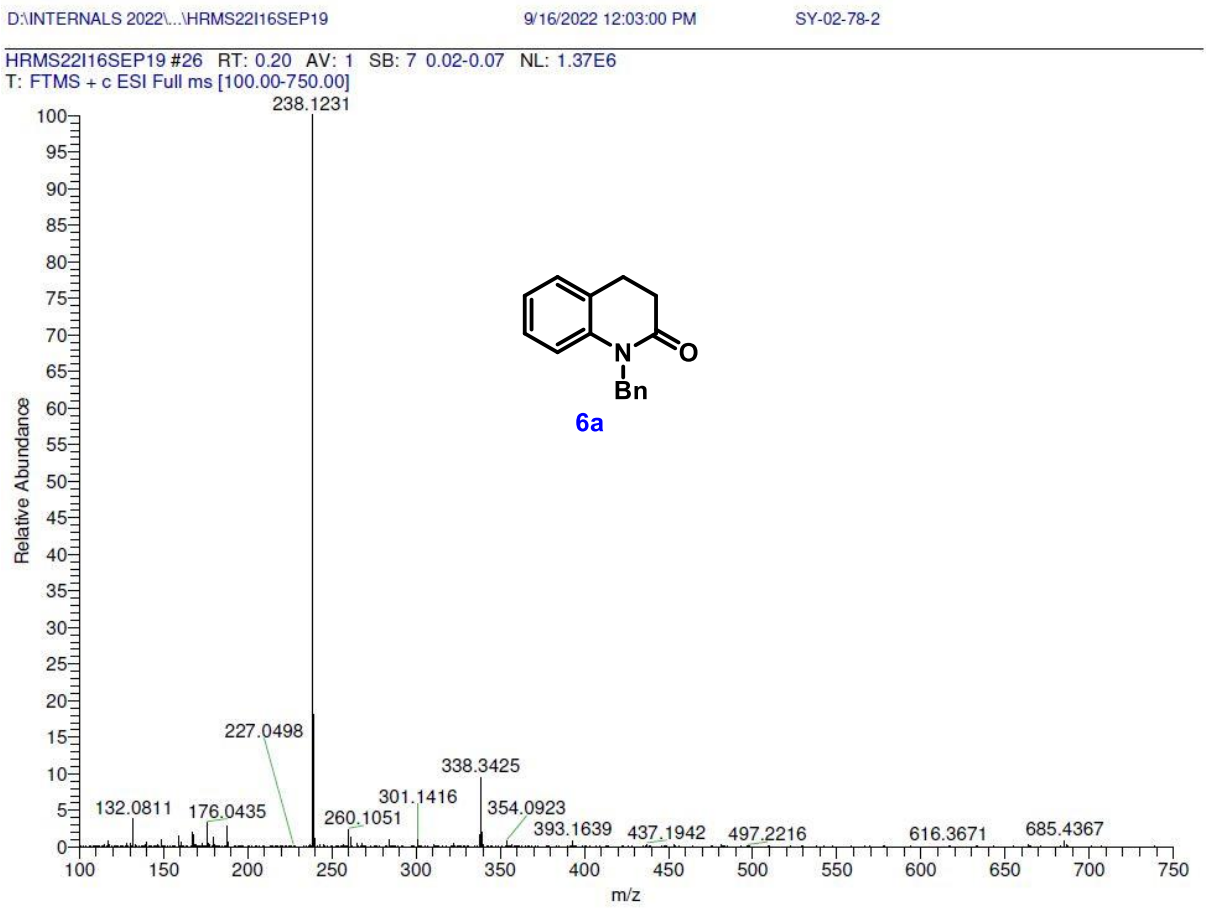

Figure S-193 HRMS spectrum of compound **6a**

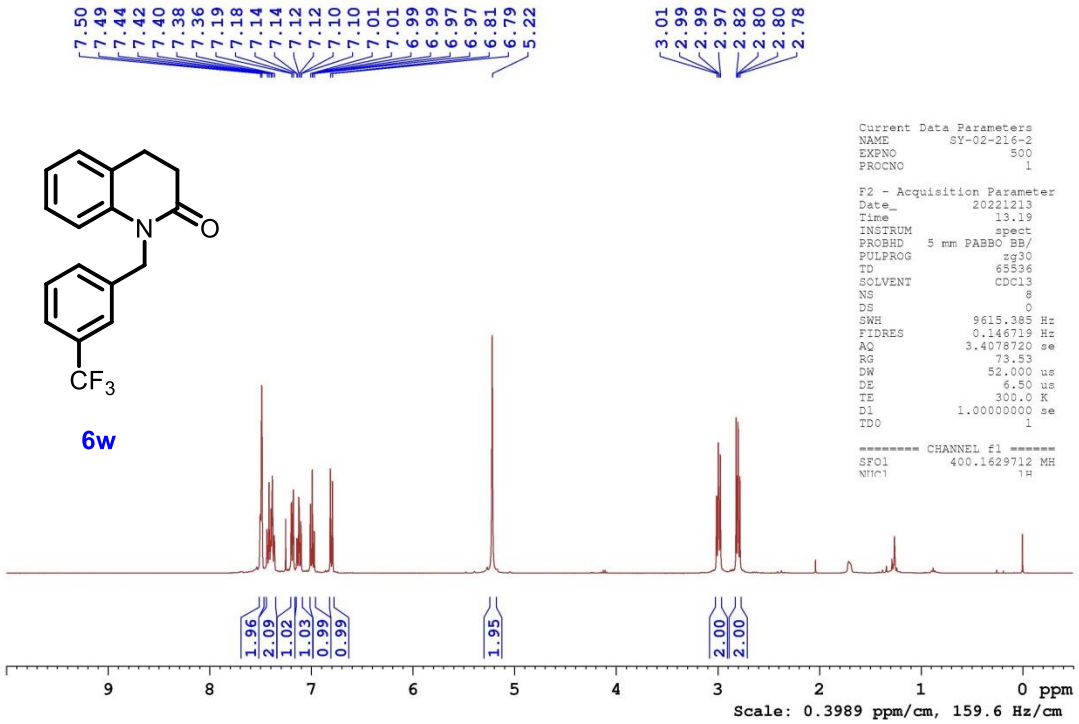

Figure S-194: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **6w**

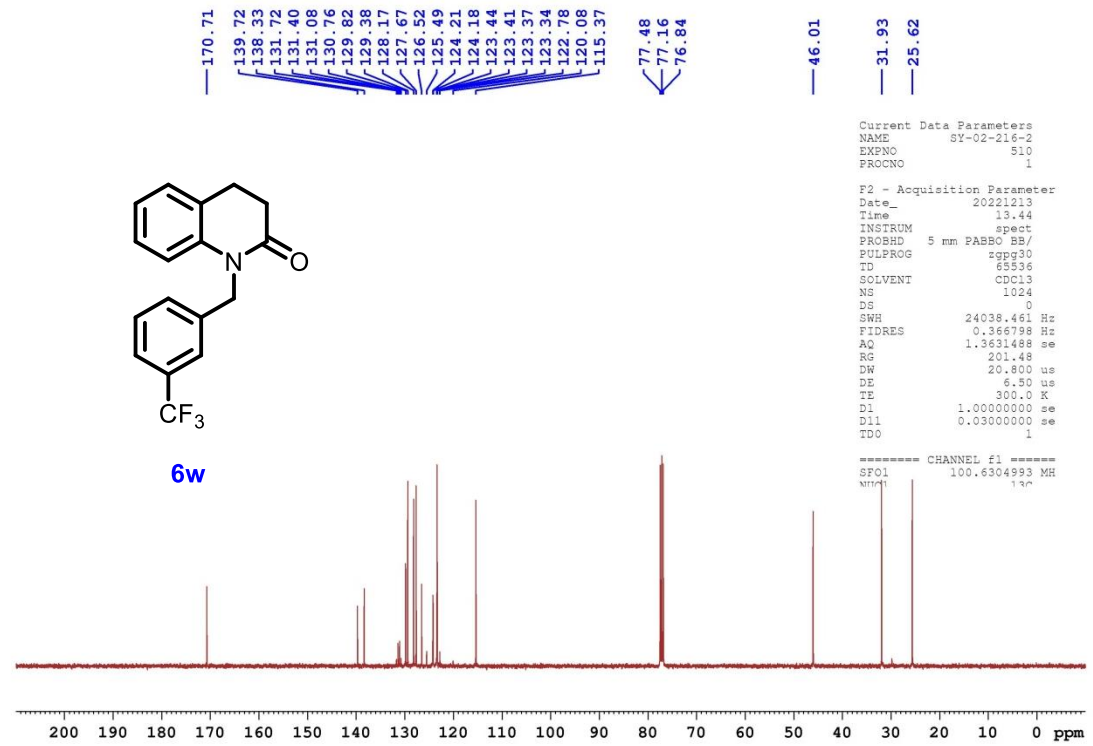

Figure S-195: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **6w**

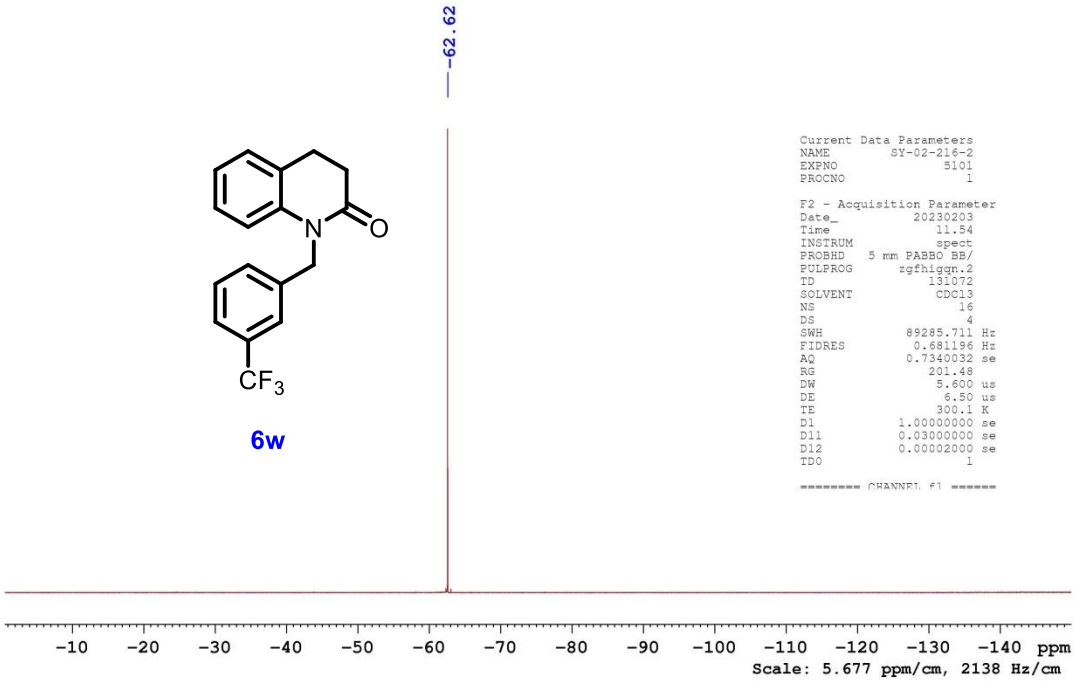

Figure S-196: ^{19}F NMR (376 MHz, $CDCl_3$) spectrum of compound **6w**

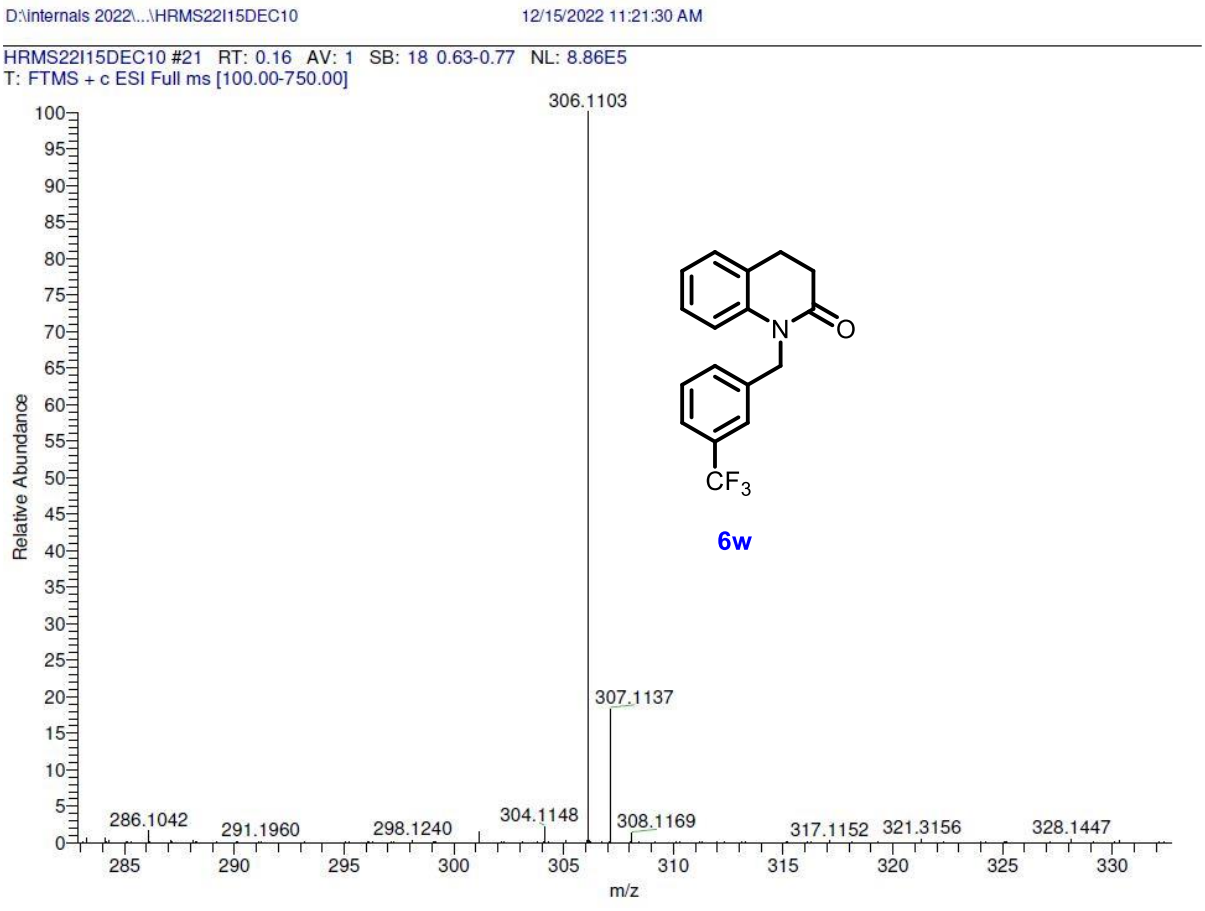

Figure S-197 HRMS spectrum of compound **6w**

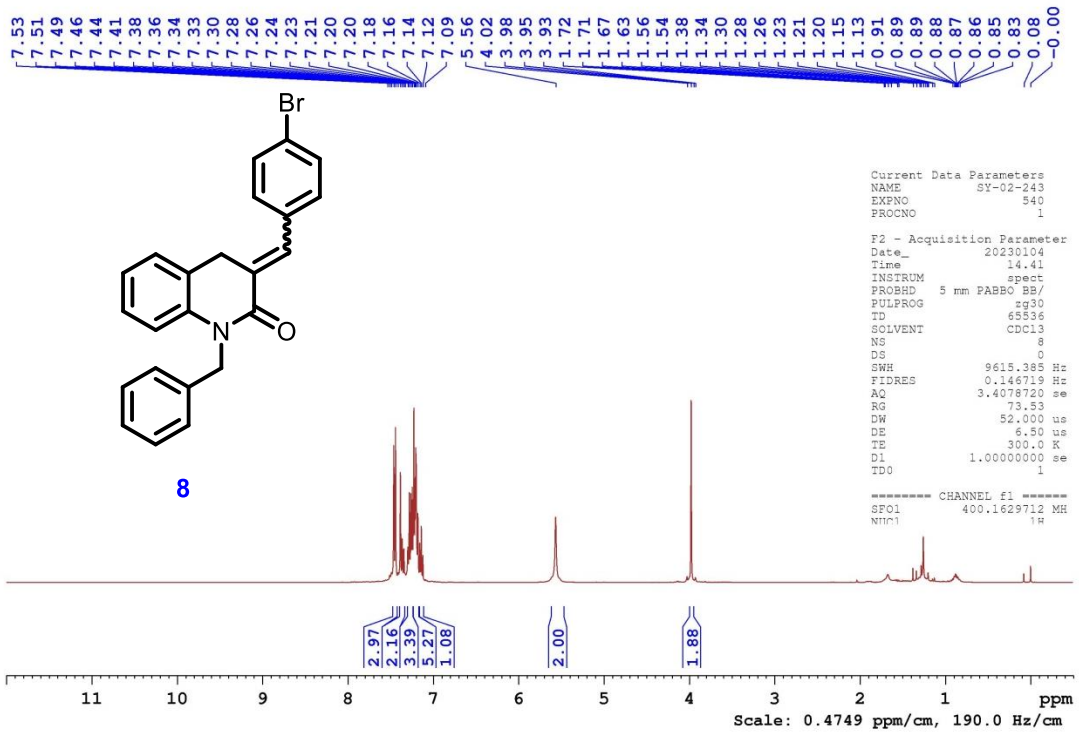

Figure S-198: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **8**

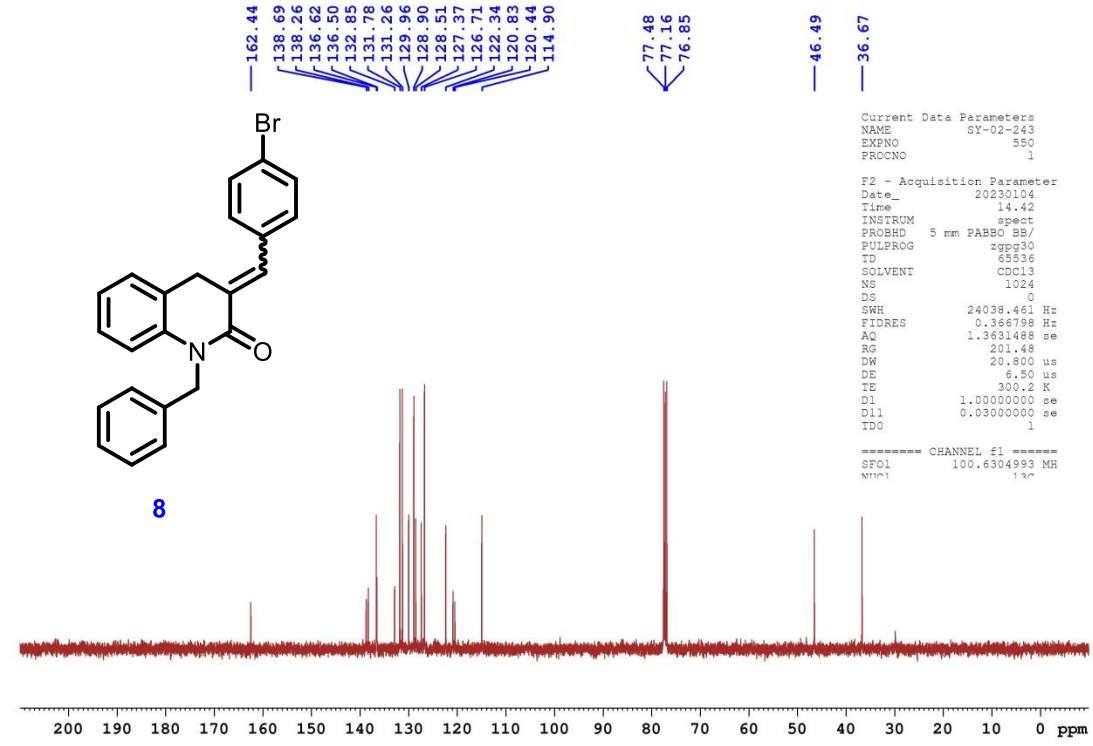

Figure S-199: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **8**

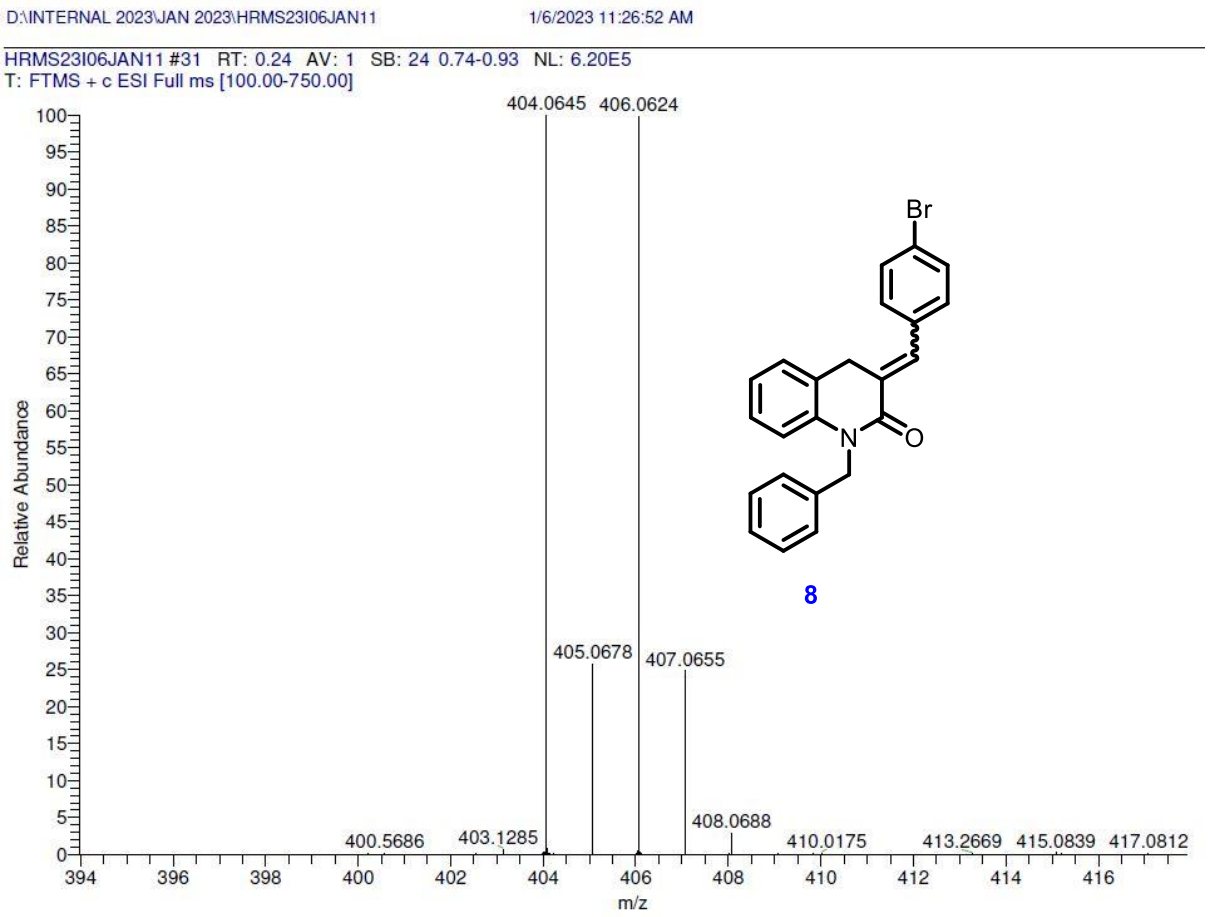

Figure S-200 HRMS spectrum of compound **8**

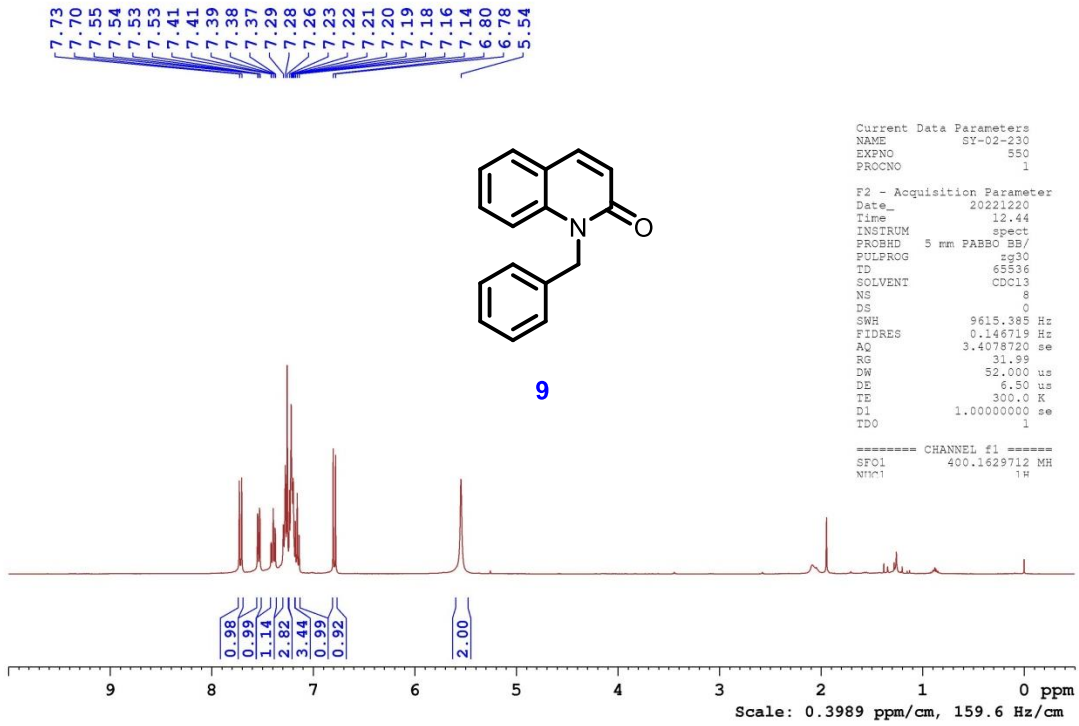

Figure S-201: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **9**

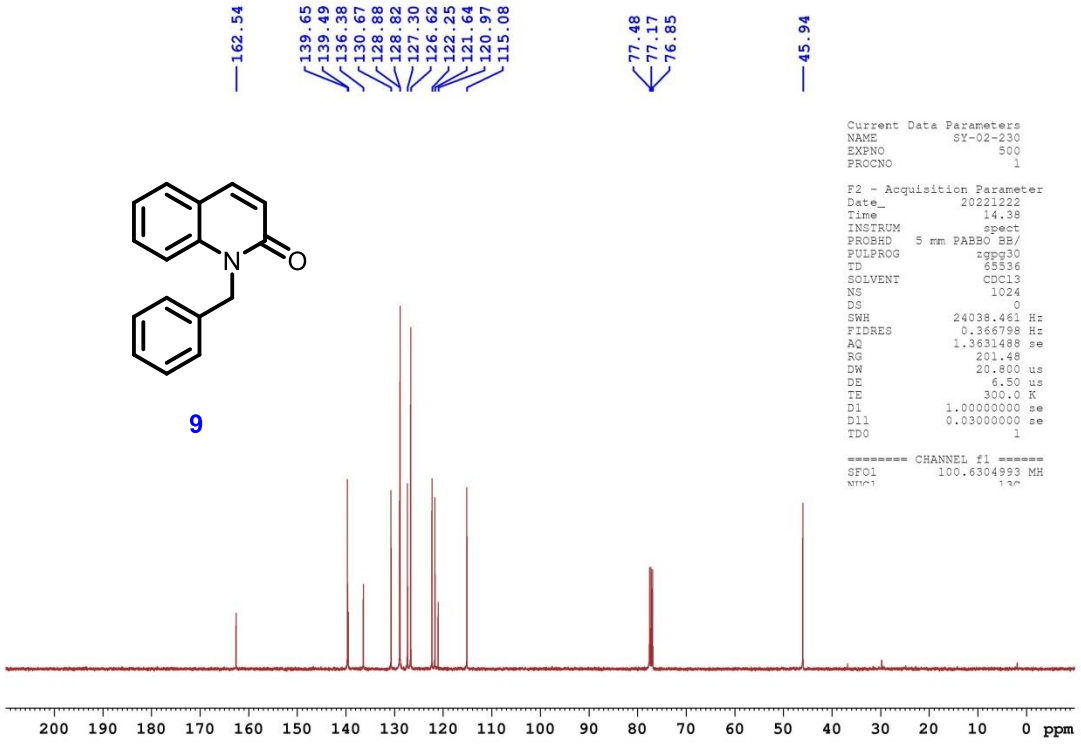

Figure S-202: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **9**

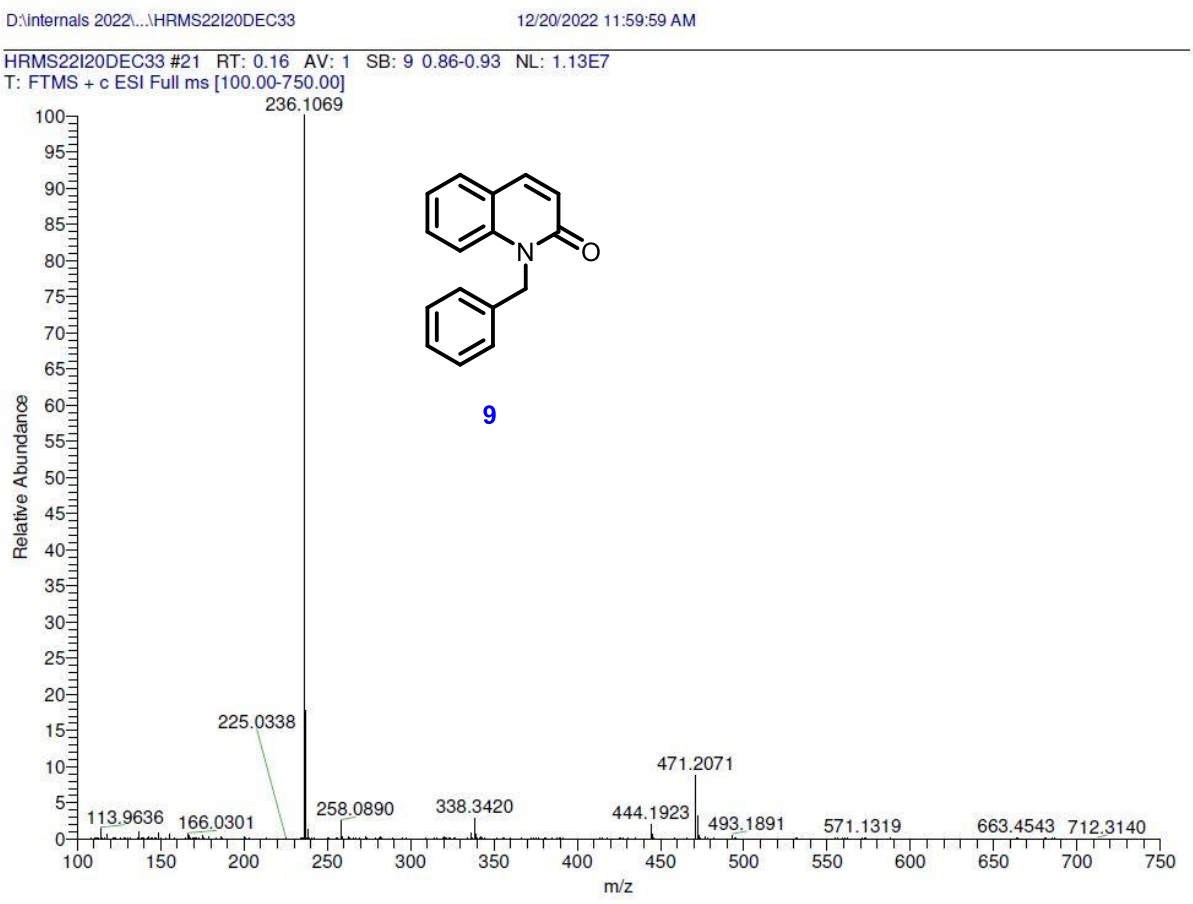

Figure S-203 HRMS spectrum of compound **9**

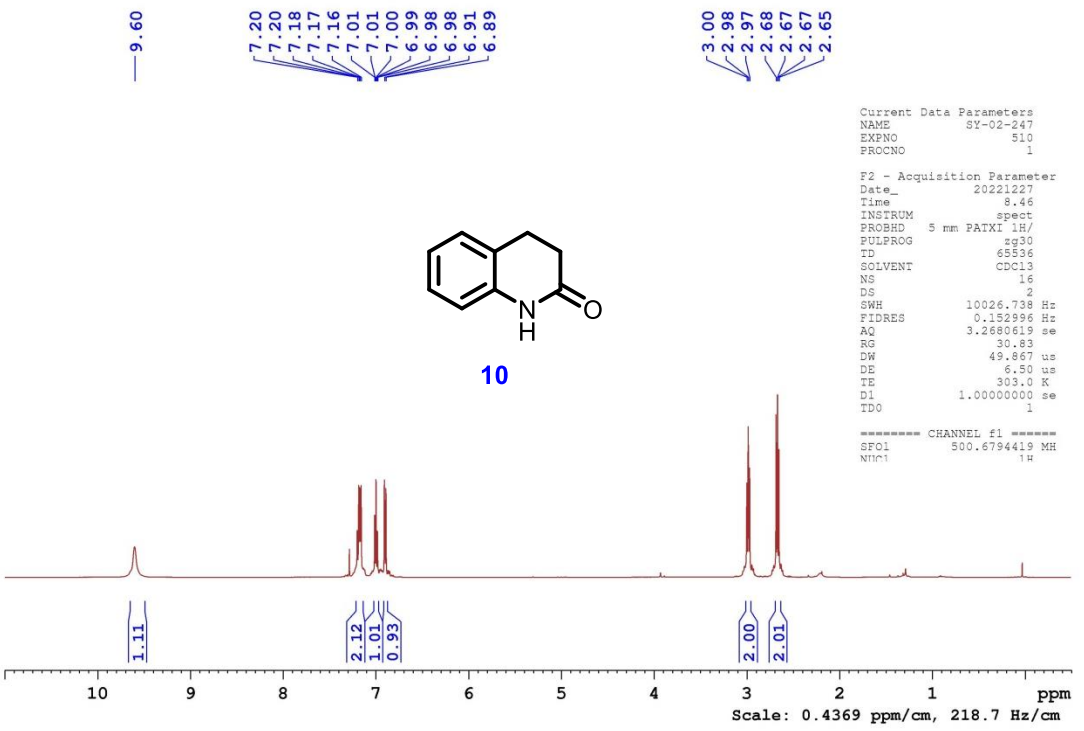

Figure S-204: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **10**

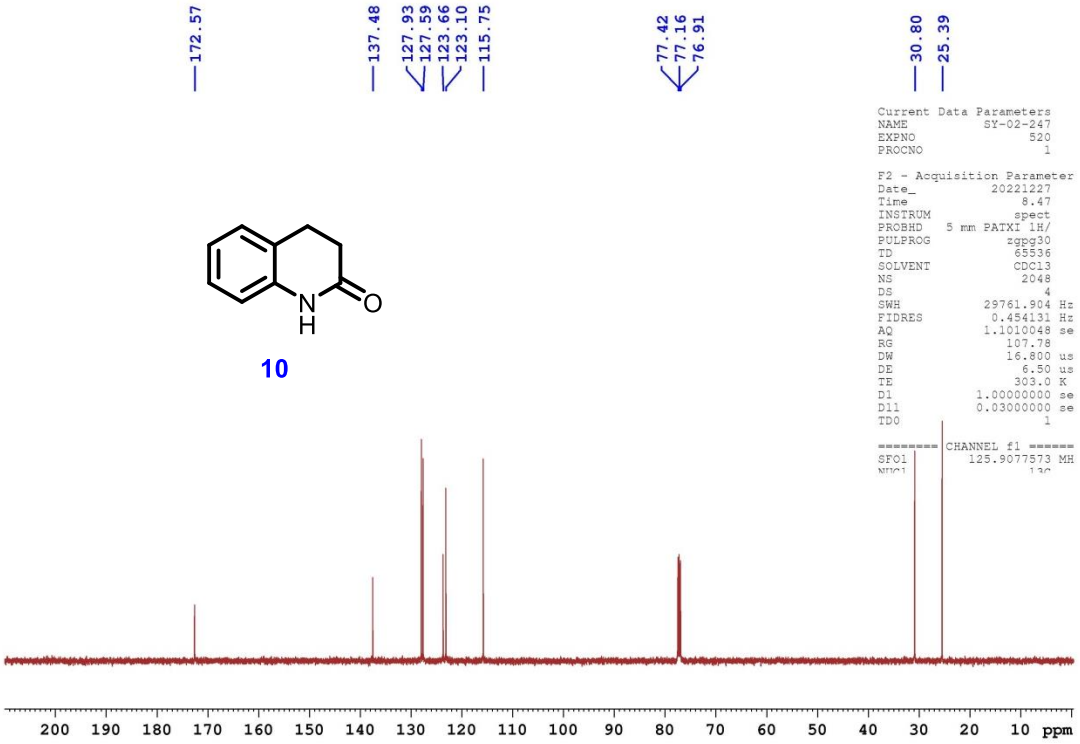

Figure S-205: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **10**

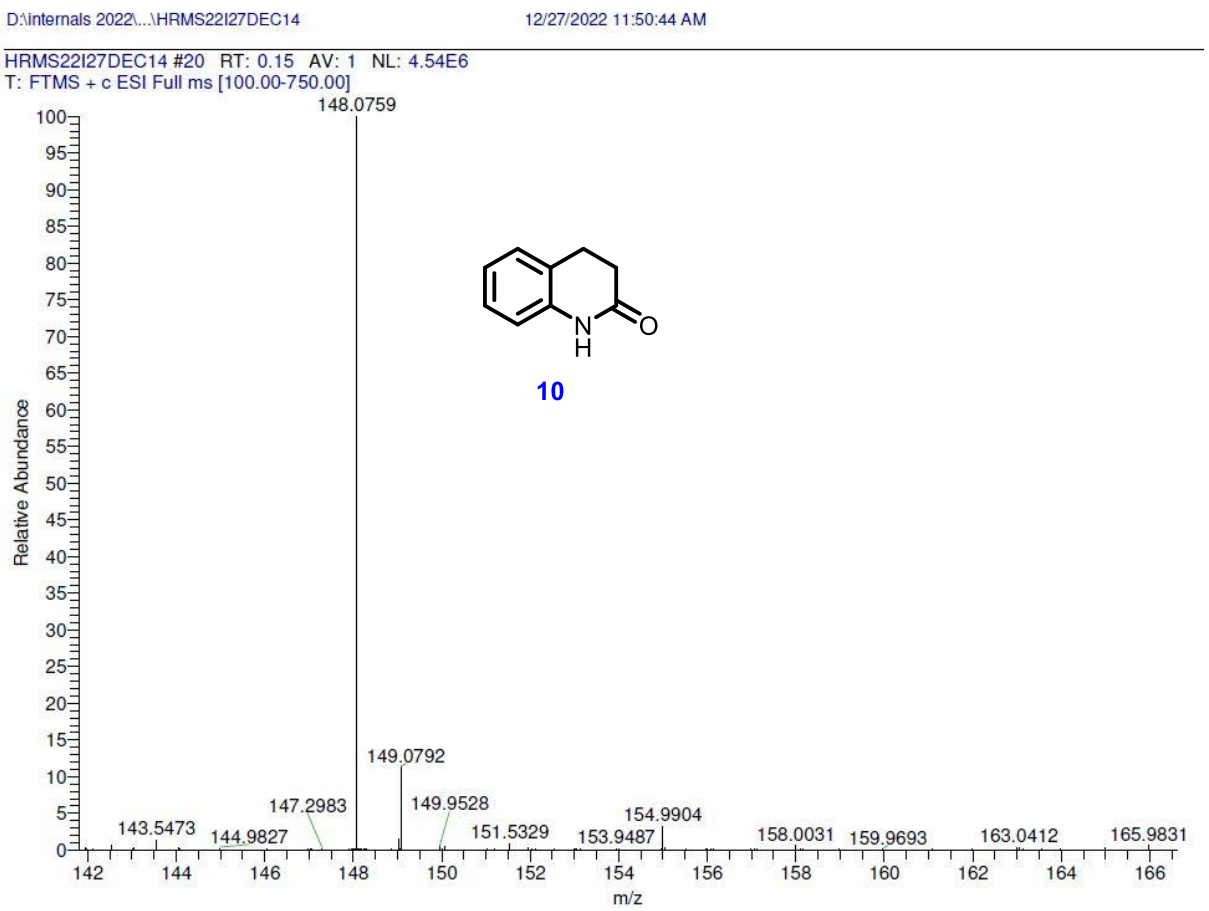

Figure S-206 HRMS spectrum of compound **10**

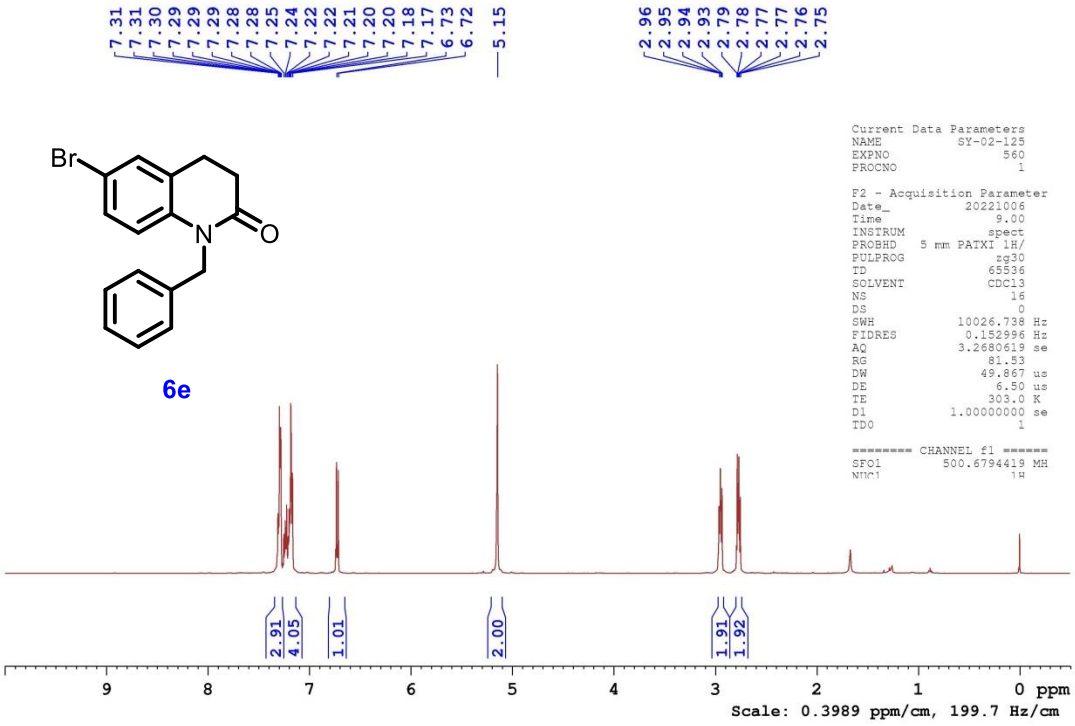

Figure S-207: ^{1}H NMR (500 MHz, $CDCl_3$) spectrum of compound **6e**

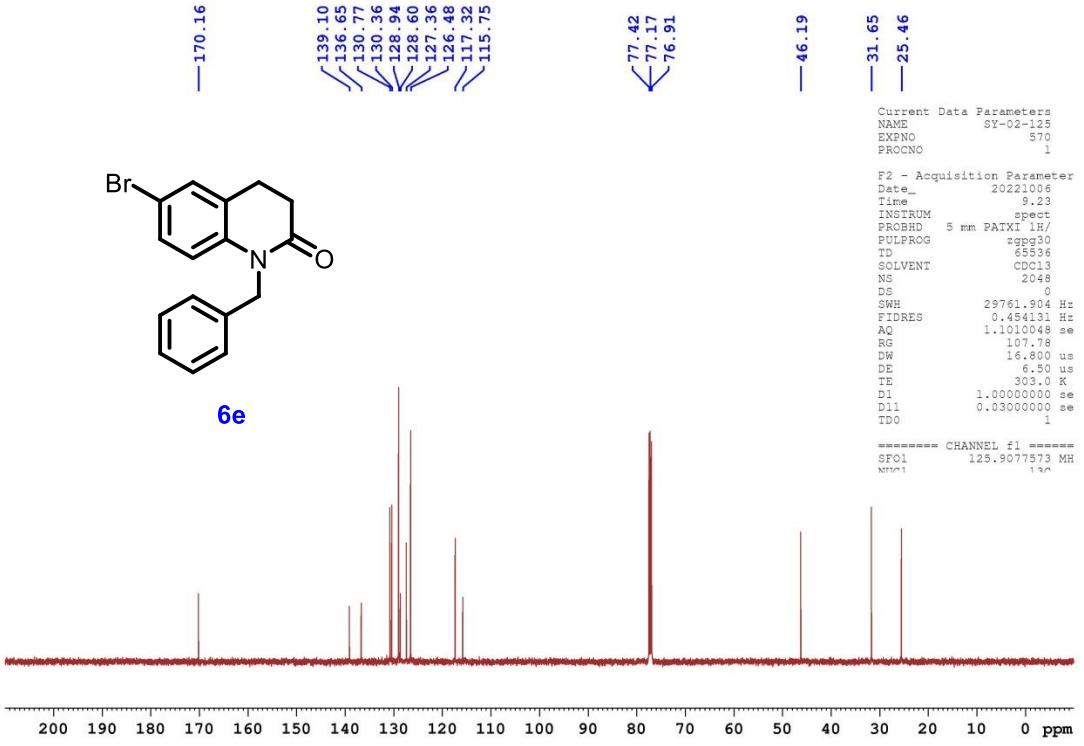

Figure S-208: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **6e**

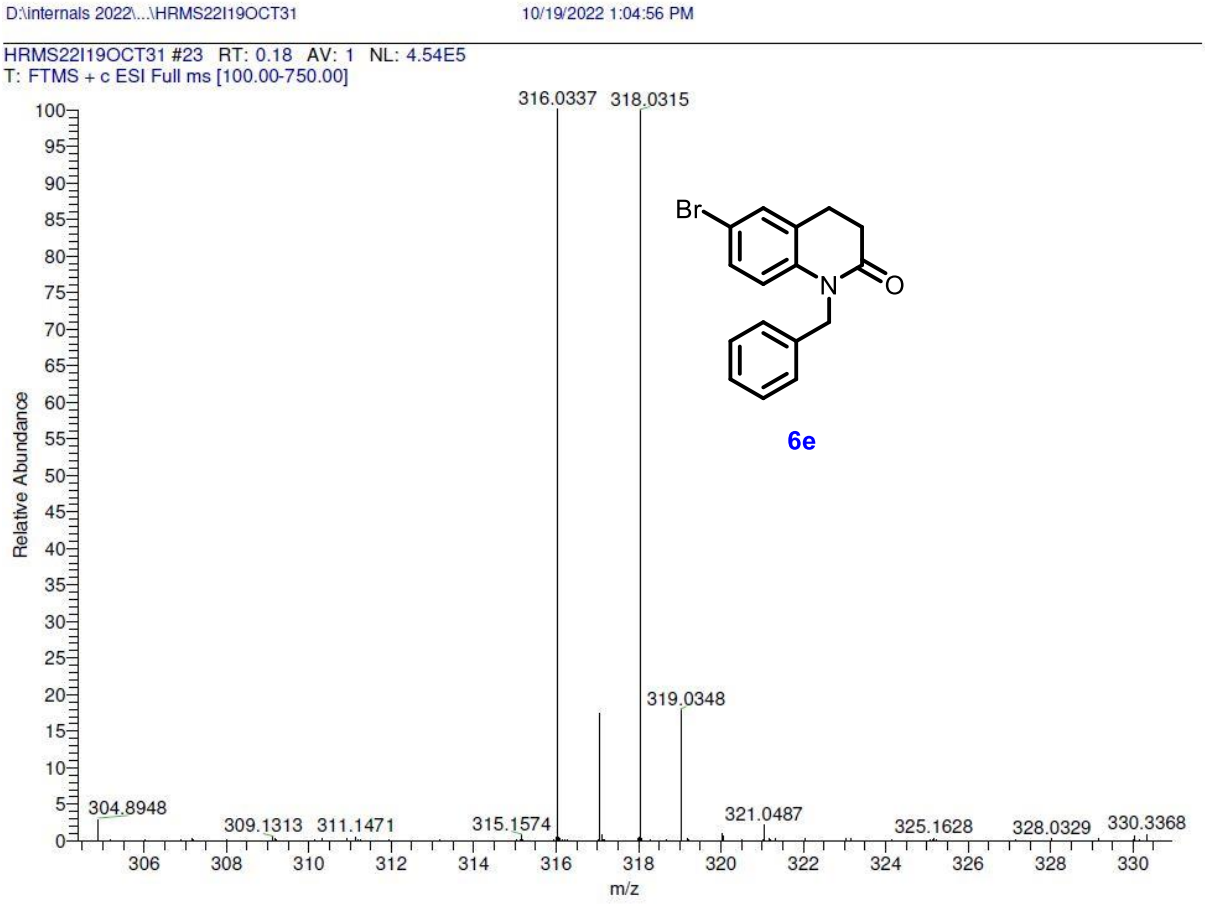

Figure S-209 HRMS spectrum of compound **6e**

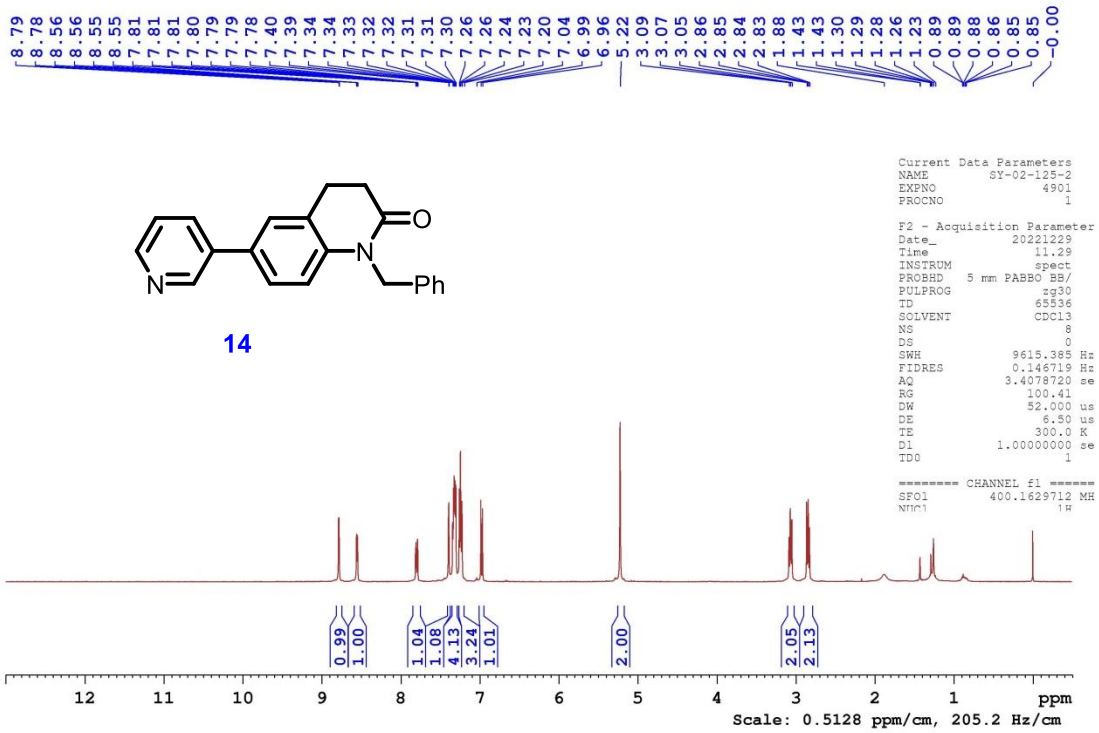

Figure S-210: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **14**

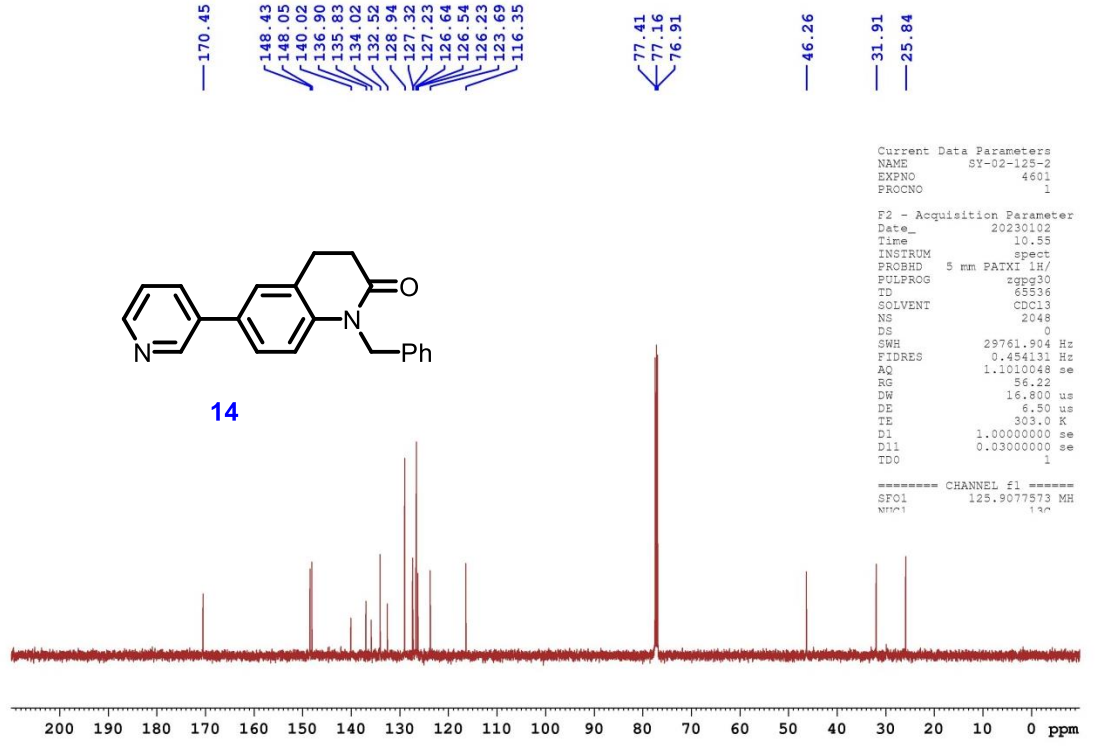

Figure S-211: ^{13}C NMR (125 MHz, $CDCl_3$) spectrum of compound **14**

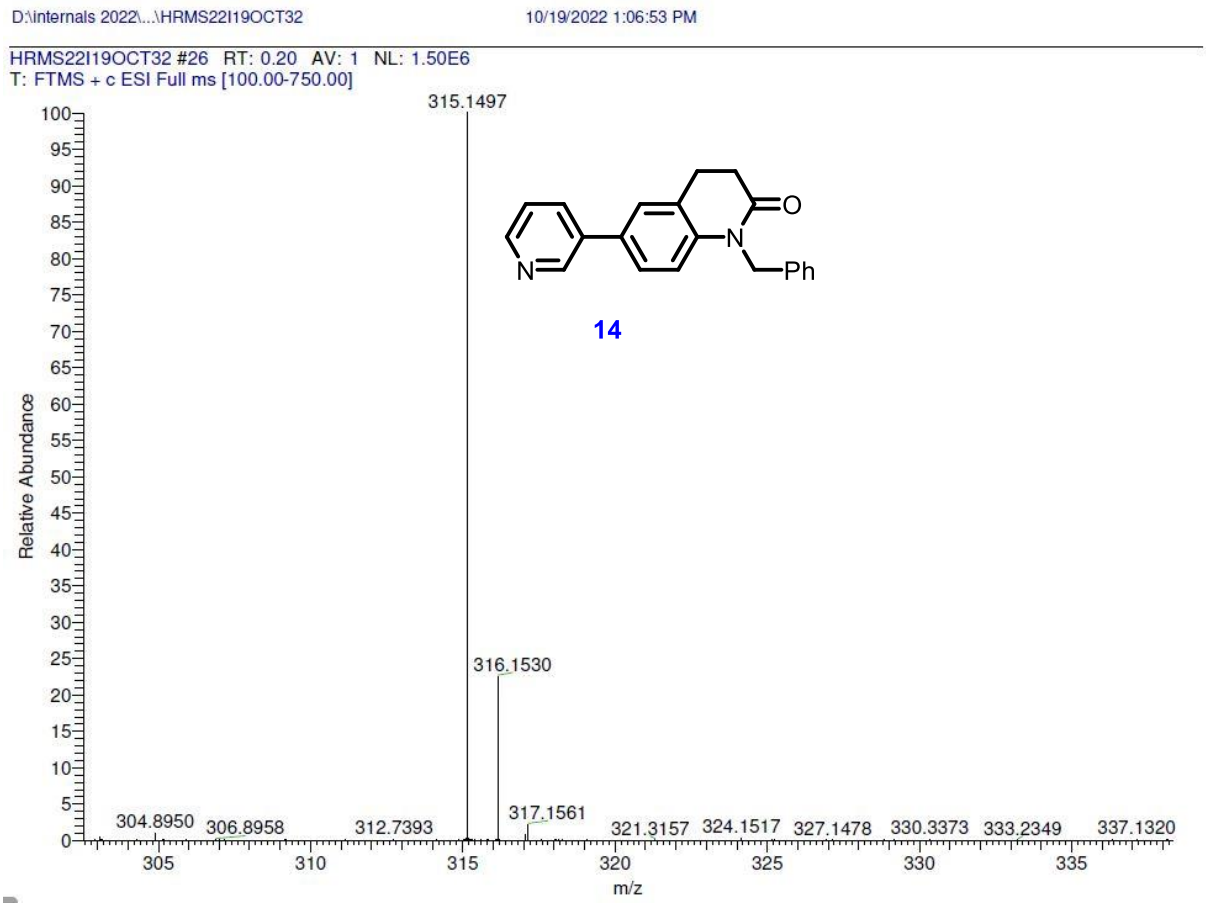

Figure S-212 HRMS spectrum of compound **14**

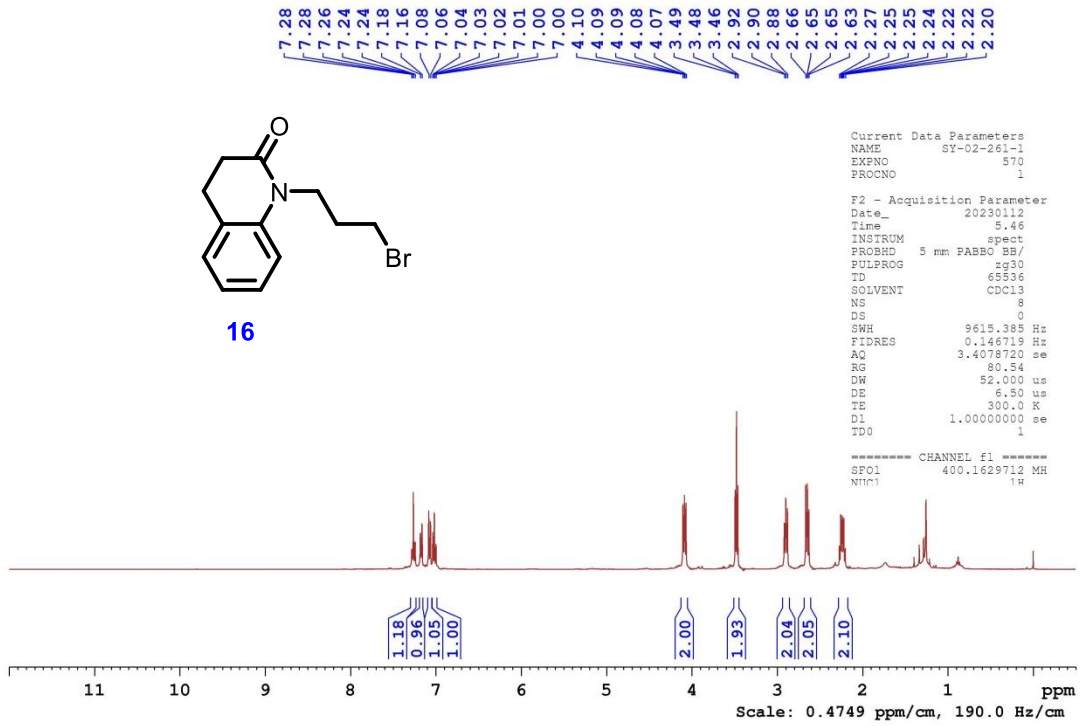

Figure S-213: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **16**

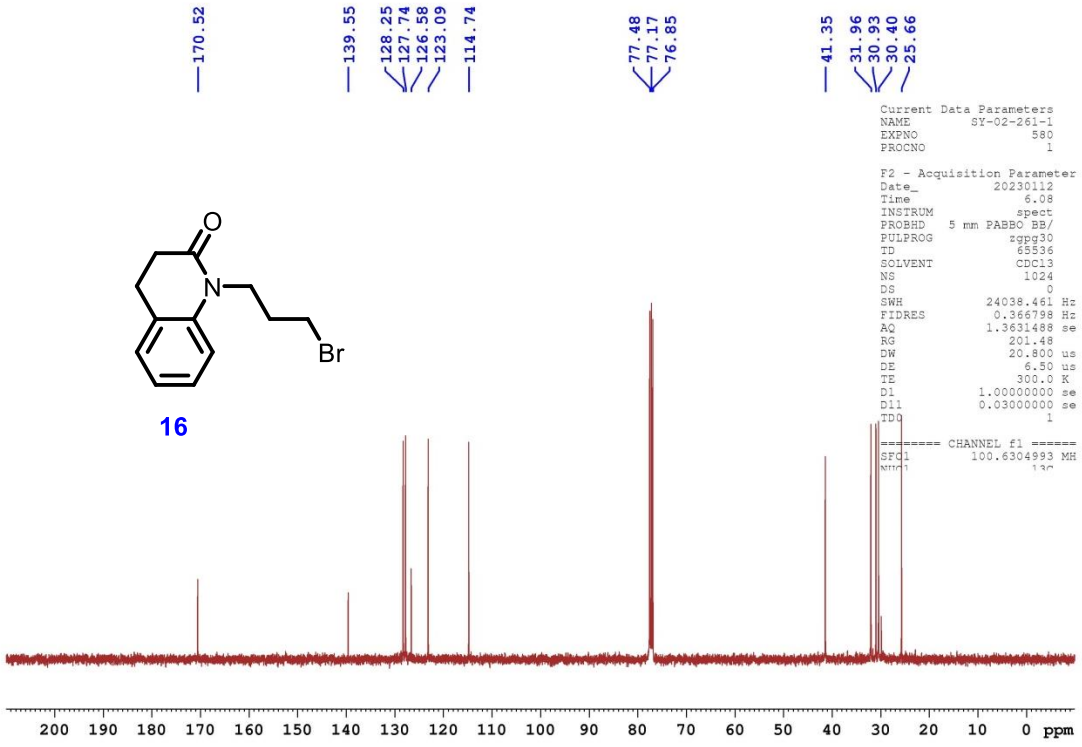

Figure S-214: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **16**

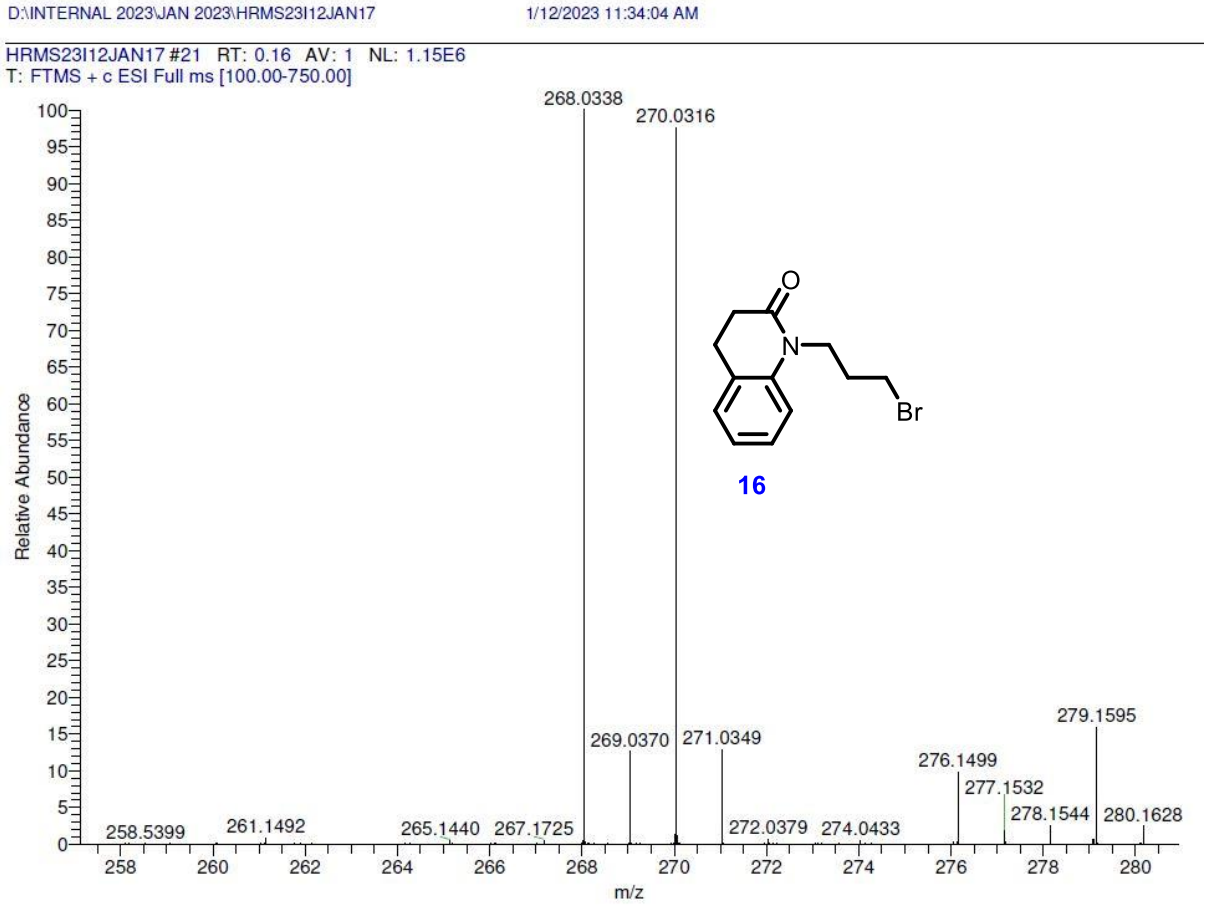

Figure S-215 HRMS spectrum of compound **16**

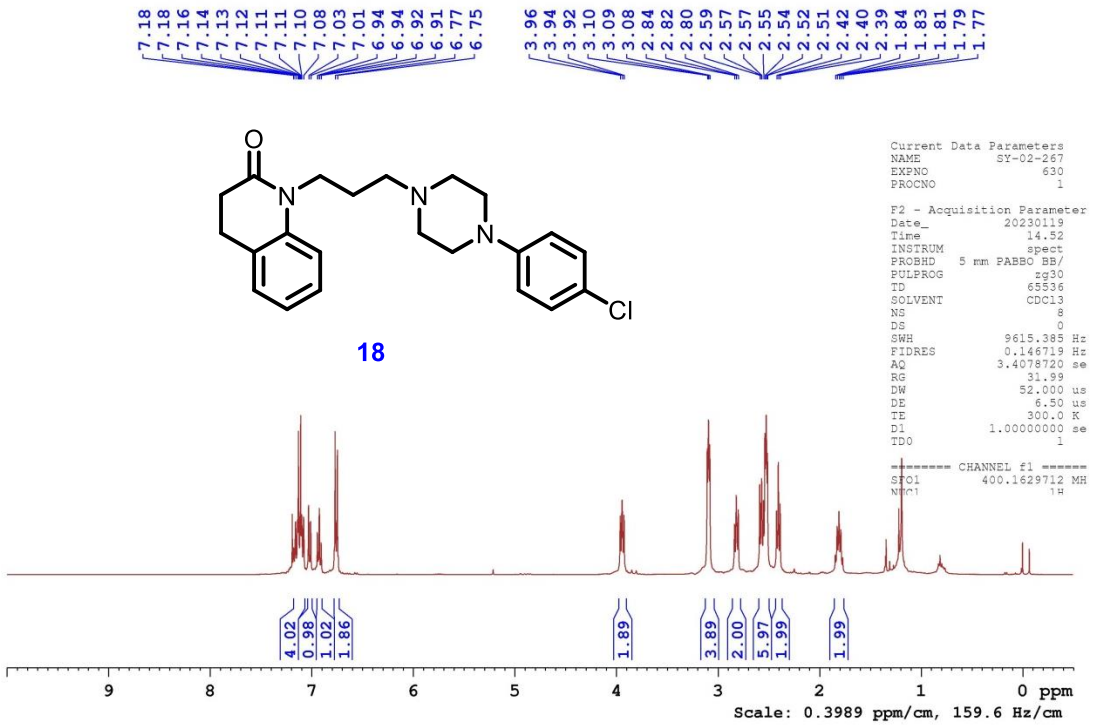

Figure S-216: ^{1}H NMR (400 MHz, $CDCl_3$) spectrum of compound **18**

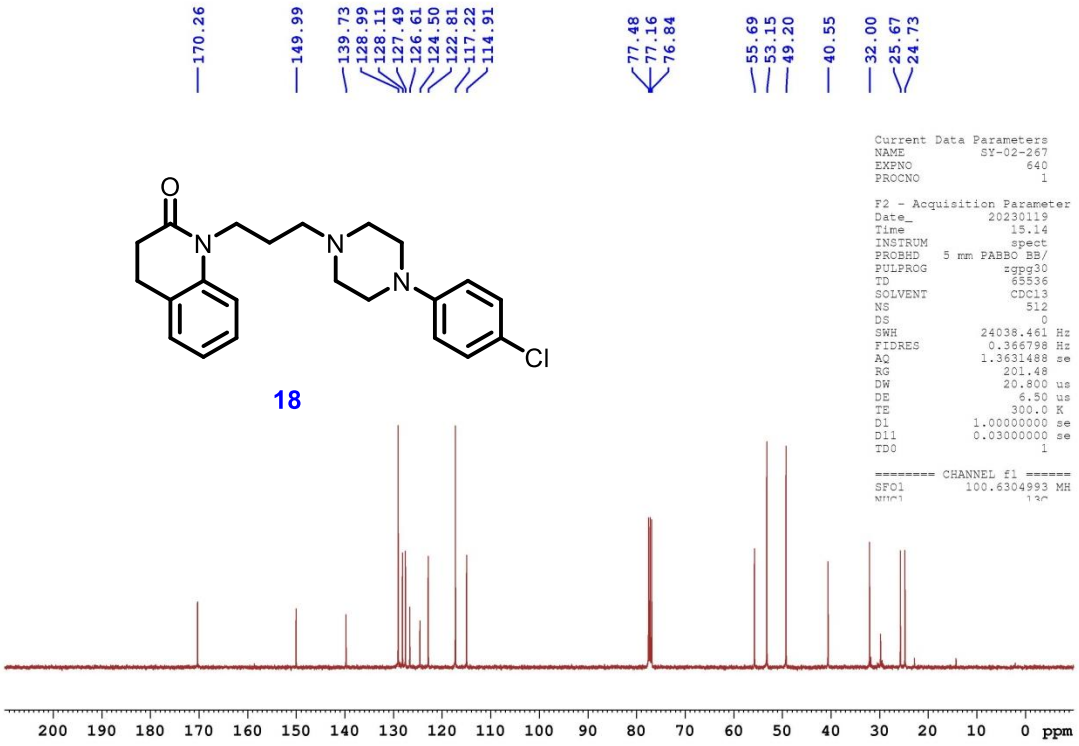

Figure S-217: ^{13}C NMR (100 MHz, $CDCl_3$) spectrum of compound **18**

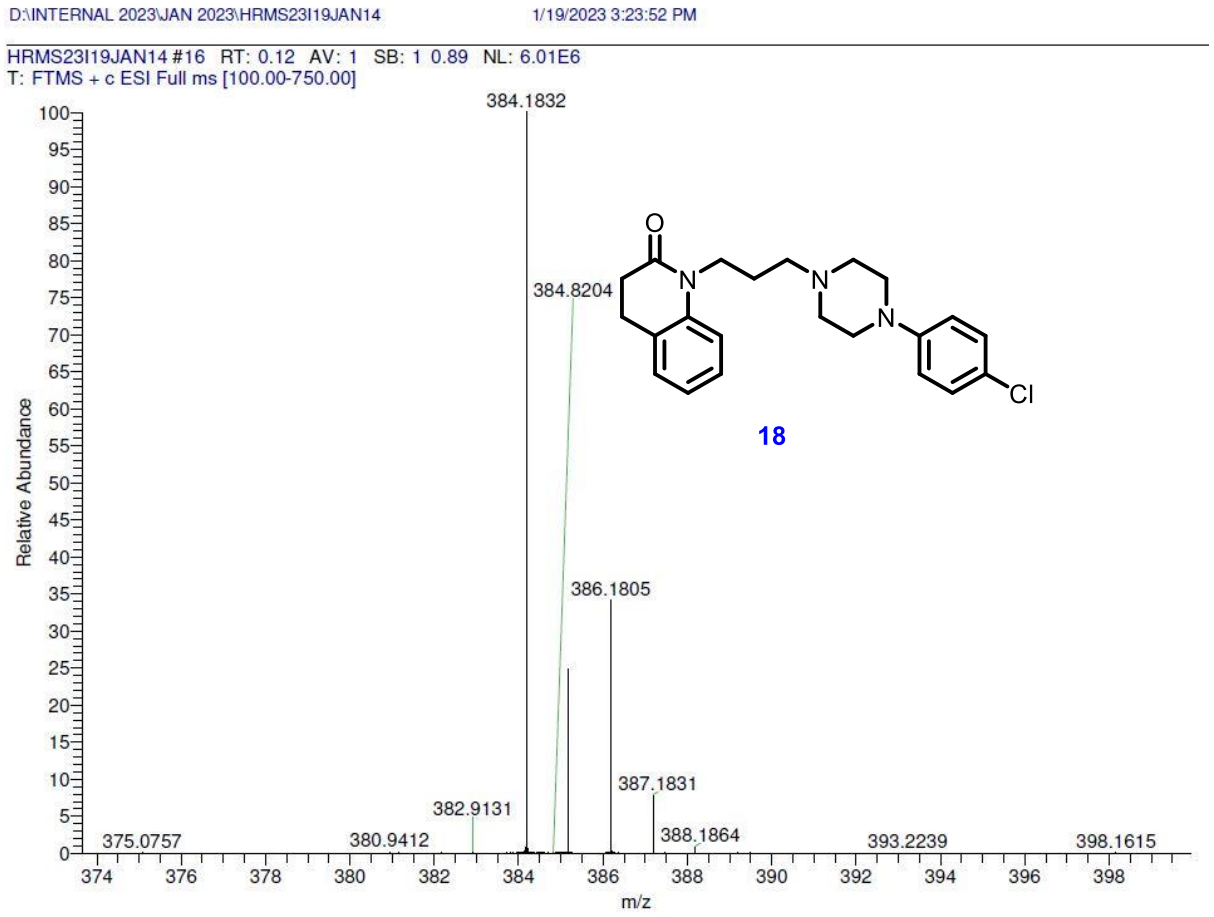

Figure S-218 HRMS spectrum of compound **18**