Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.


# Supporting Information

## Iridium-Catalyzed Asymmetric Hydrogenation of Cyclic Iminium Salts

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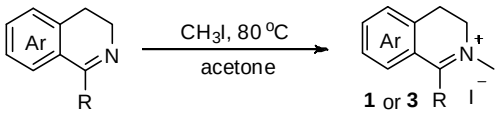
## 1. General

Commercially available reagents were used without further purification. $^{1}$H NMR, $^{13}$C NMR and $^{19}$F NMR spectra were recorded at room temperature in $CDCl_3$ or DMSO on 400 MHz instrument with TMS (tetramethylsilane) as the internal standard. Enantiomeric excess was determined by HPLC using the chiral column described below in detail. Optical rotations were measured by polarimeter. Flash column chromatography was performed on silica gel (200-300 mesh).

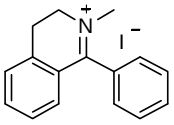
## 2. General Procedure for Synthesis of Cyclic Iminium Salts

1-Substituted 3,4-dihydrosioquinolines and 1-substituted 4,9-dihydro-3-*H*-*β*-carbolines were synthesized according to the known literature procedures.[1] The cyclic iminium salts **1** and **3** were synthesized from the corresponding imines according to the known literature procedures.[2]

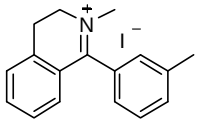
### 2.1 General Procedure for Synthesis of Cyclic Iminium Iodides



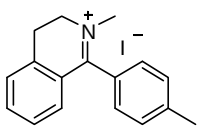

**General Procedure:** A mixture of 1-substituted 3,4-dihydrosioquinoline (or 1-substituted 4,9-dihydro-3-*H*-*β*-carboline) (1.0 mmol) and iodomethane (0.50 mL) in acetone (2.0 mL) was stirred at 80 °C overnight and the solid gradually formed. Afterwards the precipitate was filtered from the solution and washed with ethyl acetate to give the corresponding cyclic iminium iodides.



**2-Methyl-1-phenyl-3,4-dihydroisoquinolin-2-ium iodide (1a):** 5.0 mmol scale, 1.667 g, 95% yield, unknown compound, pale yellow solid, m.p. 217-218 °C; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.77 (dd, *J* = 5.2, 3.3 Hz, 2H), 7.64 (m, 4H), 7.42 (d, *J* = 7.5 Hz, 1H), 7.33 – 7.26 (m, 1H), 7.02 (d, *J* = 7.9 Hz, 1H), 4.56 (t, *J* = 7.8 Hz, 2H), 3.81 (s, 3H), 3.59 (t, *J* = 7.8 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 175.2, 137.4, 137.1, 134.0, 132.1, 129.4, 129.3, 129.0, 128.4, 128.0, 127.5, 53.5, 48.1, 26.0; HRMS calculated for $C_{16}H_{16}N$ $[M\text{-}I]^+$ 222.1277, found 222.1280.



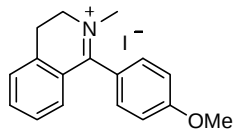
**2-Methyl-1-(*m*-tolyl)-3,4-dihydroisoquinolin-2-ium iodide (1b):** 1.0 mmol scale, 0.323 g, 89% yield, unknown compound, pale yellow solid, m.p. 201-202 °C; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.77 (t, *J* = 7.5 Hz, 1H), 7.61 – 7.54 (m, 3H), 7.42 – 7.39 (m, 3H), 6.97 (d, *J* = 7.9 Hz, 1H), 4.25 (t, *J* = 7.7 Hz, 2H), 3.50 (s, 3H), 3.34 (t, *J* = 7.7 Hz, 2H), 2.42 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 175.2, 139.4, 137.4, 137.0, 134.0, 132.8, 129.3, 129.2, 128.9, 128.4, 128.0, 127.5, 126.0, 53.4, 48.0, 26.0, 21.4; HRMS calculated for $C_{17}H_{18}N$ $[M\text{-}I]^+$ 236.1434, found 236.1436.



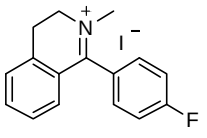
**2-Methyl-1-(*p*-tolyl)-3,4-dihydroisoquinolin-2-ium iodide (1c):** 1.0 mmol scale, 0.330 g, 91% yield, unknown compound, pale yellow solid, m.p. 197-198 °C; $^{1}$H NMR (400 MHz, $CDCl_3$) δ 7.67 – 7.61 (m, 3H), 7.42 – 7.40 (m, 3H), 7.30 (t, *J* = 7.7 Hz, 1H), 7.05 (d, *J* = 7.8 Hz, 1H), 4.55 (t, *J* = 7.7 Hz, 2H), 3.84 (s, 3H), 3.56 (t, *J* = 7.8 Hz, 2H), 2.48 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 175.4, 143.1, 137.5, 137.0, 134.2, 129.9, 129.2, 128.4, 128.0, 127.7, 126.4, 53.5, 48.0, 26.0, 21.7; HRMS calculated for $C_{17}H_{18}N$ $[M\text{-}I]^+$ 236.1434, found 236.1439.

**1-(4-Methoxyphenyl)-2-methyl-3,4-dihydroisoquinolin-2-ium iodide (1d):** 1.0 mmol scale,

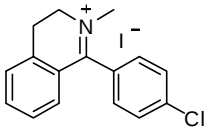
0.231 g, 61% yield, unknown compound, pale yellow solid, m.p. 215-216 °C; $^1$H NMR (400 MHz, DMSO) δ 7.78 (t, *J* = 7.5 Hz, 1H), 7.59 (t, *J* = 7.8 Hz, 3H), 7.43 (t, *J* = 7.7 Hz, 1H), 7.27 (d, *J* = 8.7 Hz, 2H), 7.02 (d, *J* = 7.8 Hz, 1H), 4.26 (t, *J* = 7.6 Hz, 2H), 3.90 (s, 3H), 3.59 (s, 3H), 3.36 (t, *J* = 7.5 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 178.7, 167.2, 143.4, 141.5, 138.5, 136.5, 133.4, 133.1, 133.0, 126.6, 119.7, 60.9, 57.5, 51.2, 29.9; HRMS calculated for $C_{17}H_{18}NO$ $[M\text{-}I]^+$ 252.1383, found 252.1388.



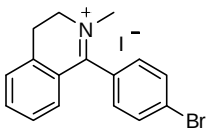

**1-(4-Fluorophenyl)-2-methyl-3,4-dihydroisoquinolin-2-ium iodide (1e):** 0.88 mmol scale, 0.283 g, 81% yield, unknown compound, pale yellow solid, m.p. 188-189 °C; $^1$H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.87 (m, 2H), 7.67 (t, *J* = 7.5 Hz, 1H), 7.41 (d, *J* = 7.5 Hz, 1H), 7.33 – 7.28 (m, 3H), 7.00 (d, *J* = 7.9 Hz, 1H), 4.52 (t, *J* = 7.8 Hz, 2H), 3.80 (s, 3H), 3.58 (t, *J* = 7.8 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ $^{13}$C NMR (100 MHz, $CDCl_3$) δ 174.4, 164.6 (d, *J* = 255.2 Hz), 137.5, 137.2, 133.9, 132.1 (d, *J* = 8.8 Hz), 128.5, 128.1, 127.6, 125.3 (d, *J* = 3.5 Hz), 116.7 (d, *J* = 22.3 Hz), 53.6, 48.2, 25.9; $^{19}$F NMR (376 MHz, $CDCl_3$) δ -105.4; HRMS calculated for $C_{16}H_{15}NF$ $[M\text{-}I]^+$ 240.1183, found 240.1185.



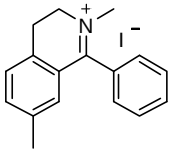

**1-(4-Chlorophenyl)-2-methyl-3,4-dihydroisoquinolin-2-ium iodide (1f):** 1.0 mmol scale, 0.355 g, 92% yield, unknown compound, pale yellow solid, m.p. 234-235 °C;. $^1$H NMR (400 MHz, DMSO) δ 7.83 – 7.71 (m, 3H), 7.73 (d, *J* = 8.5 Hz, 2H), 7.59 (d, *J* = 7.5 Hz, 1H), 7.42 (t, *J* = 7.7 Hz, 1H), 6.99 (d, *J* = 7.9 Hz, 1H), 4.30 (t, *J* = 7.7 Hz, 2H), 3.54 (s, 3H), 3.40 (t, *J* = 7.7 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 173.3, 138.3, 137.3, 137.1, 133.4, 131.0, 129.8, 128.9, 128.8, 128.4, 128.0, 52.9, 46.7, 25.0; HRMS calculated for $C_{16}H_{15}NCl$ $[M\text{-}I]^+$ 256.0888, found 256.0888.



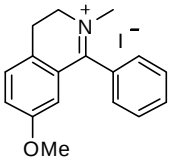

**1-(4-Bromophenyl)-2-methyl-3,4-dihydroisoquinolin-2-ium iodide (1g):** 1.3 mmol scale, 0.523 g, 94% yield, unknown compound, pale yellow solid, m.p. 234-235 °C; $^1$H NMR (400 MHz, DMSO) δ 7.96 (d, *J* = 8.4 Hz, 2H), 7.79 (t, *J* = 7.5 Hz, 1H), 7.65 (d, *J* = 8.4 Hz, 2H), 7.59 (d, *J* = 7.5 Hz, 1H), 7.42 (t, *J* = 7.6 Hz, 1H), 6.99 (d, *J* = 7.8 Hz, 1H), 4.30 (t, *J* = 7.7 Hz, 2H), 3.54 (s, 3H), 3.40 (t, *J* = 7.7 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 173.3, 138.3, 137.1, 133.4, 132.7, 131.1, 129.3, 128.7, 128.4, 127.9, 126.2, 52.9, 46.7, 25.0; HRMS calculated for $C_{16}H_{15}NBr$ $[M\text{-}I]^+$ 300.0382, found 300.0386.




**2,7-Dimethyl-1-phenyl-3,4-dihydroisoquinolin-2-ium iodide (1h):** 1.0 mmol scale, 0.280 g, 77% yield, unknown compound, pale yellow solid, m.p. 202-204 °C; $^1$H NMR (400 MHz, DMSO) δ 7.81 – 7.57 (m, 6H), 7.49 (d, *J* = 7.7 Hz, 1H), 6.74 (s, 1H), 4.29 (t, *J* = 7.7 Hz, 2H), 3.52 (s, 3H), 3.38 – 3.33 (m, 2H), 2.22 (s, 3H); $^{13}$C NMR (100 MHz, DMSO) δ 174.2, 137.7, 135.5, 133.3, 132.3, 130.2, 129.6, 128.8, 128.8, 128.7, 128.0, 52.9, 46.6, 24.7, 21.0; HRMS calculated for $C_{17}H_{18}N$ $[M\text{-}I]^+$ 236.1434, found 236.1435.

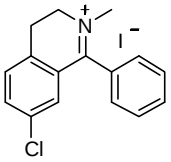



**7-Methoxy-2-methyl-1-phenyl-3,4-dihydroisoquinolin-2-ium iodide (1i):** 1.0 mmol scale, 0.385 g, 93% yield, unknown compound, pale yellow solid, m.p. 233-235 °C; $^1$H NMR (400 MHz, DMSO) δ 7.83 – 7.69 (m, 5H), 7.55 (d, *J* = 8.4 Hz, 1H), 7.44 – 7.42 (m, 1H), 6.35 (d, *J* = 2.5 Hz, 1H), 4.31 (t, *J* = 7.7 Hz, 2H), 3.65 (s, 3H), 3.56 (s, 3H), 3.34 (t, *J* = 7.7 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 173.9,

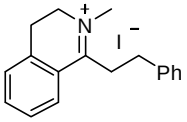


158.5, 132.4, 130.2, 130.0, 129.6, 128.9, 128.9, 128.8, 122.1, 118.7, 56.1, 53.3, 46.8, 24.3; HRMS calculated for $C_{17}H_{18}NO$ $[M\text{-}I]^+$ 252.1383, found 252.1388.

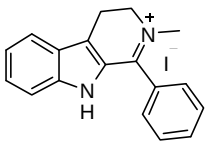
**7-Chloro-2-methyl-1-phenyl-3,4-dihydroisoquinolin-2-ium iodide (1j):** 0.8 mmol scale, 0.244 g, 79% yield, unknown compound, yellow solid, m.p. 237-238 °C; $^1$H NMR (400 MHz, DMSO) δ 7.86 (dd, *J* = 8.2, 1.6 Hz, 1H), 7.80 – 7.67 (m, 5H), 7.64 (d, *J* = 8.2 Hz, 1H), 6.81 (d, *J* = 1.4 Hz, 1H), 4.32 (t, *J* = 7.7 Hz, 2H), 3.55 (s, 3H), 3.41 (t, *J* = 7.7 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 175.1, 139.2, 138.3, 134.5, 134.3, 133.8, 132.7, 131.7, 131.6, 131.5, 130.9, 54.9, 48.9, 26.5; HRMS calculated for $C_{16}H_{15}ClN$ $[M\text{-}I]^+$ 256.0888, found 256.0887.



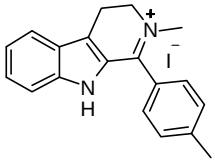
**2-Methyl-1-phenethyl-3,4-dihydroisoquinolinium iodide (1k):** 1.0 mmol scale, 0.309 g, 82% yield, unknown compound, pale yellow solid, m.p. 164-165 °C; $^1$H NMR (400 MHz, DMSO) δ 8.13 (d, *J* = 7.9 Hz, 1H), 7.76 (t, *J* = 7.4 Hz, 1H), 7.52 (dd, *J* = 15.8, 7.7 Hz, 2H), 7.31 (d, *J* = 4.5 Hz, 4H), 7.27 – 7.20 (m, 1H), 4.05 (t, *J* = 7.5 Hz, 2H), 3.74 (s, 3H), 3.56 (t, *J* = 7.9 Hz, 2H), 3.12 (t, *J* = 7.5 Hz, 2H), 3.02 – 2.90 (m, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 177.4, 139.2, 137.8, 136.5, 130.8, 129.1, 129.0, 128.7, 128.6, 127.3, 126.7, 52.9, 45.3, 33.0, 32.4, 25.4; HRMS calculated for $C_{18}H_{20}N$ $[M\text{-}I]^+$ 250.1590, found 250.1593.



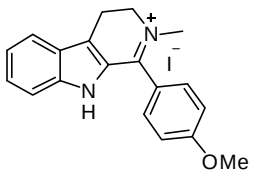
**2-Methyl-1-phenyl-4,9-dihydro-3*H*-pyrido[3,4-*b*]indol-2-ium iodide (3a):** 2.0 mmol scale, 0.630 g, 81% yield, unknown compound, yellow solid, m.p. 230-231 °C; $^1$H NMR (400 MHz, DMSO) δ 11.58 (brs, 1H), 7.87 – 7.68 (m, 6H), 7.50 – 7.36 (m, 2H), 7.23 – 7.19 (m, 1H), 4.34 (t, *J* = 8.6 Hz, 2H), 3.57 – 3.38 (m, 5H); $^{13}$C NMR (100 MHz, DMSO) δ 164.3, 142.1, 132.7, 129.8, 129.4, 129.0, 128.8, 127.6, 124.4, 124.3, 122.3, 122.0, 114.1, 53.8, 44.2, 19.5; HRMS calculated for $C_{17}H_{18}N$ $[M\text{-}I]^+$ 261.1386, found 261.1391.



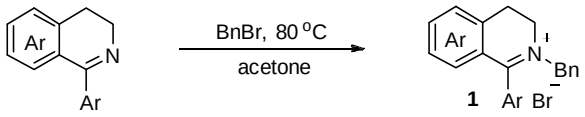
**2-Methyl-1-(*p*-tolyl)-4,9-dihydro-3*H*-pyrido[3,4-*b*]indol-2-ium iodide (3b):** 5.0 mmol scale, 1.875 g, 93% yield, unknown compound, yellow solid, m.p. 237-239 °C; $^1$H NMR (400 MHz, DMSO) δ 11.56 (brs, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.64 (d, *J* = 8.1 Hz, 2H), 7.57 (d, *J* = 8.1 Hz, 2H), 7.47 – 7.37 (m, 2H), 7.21 (ddd, *J* = 7.9, 5.9, 1.8 Hz, 1H), 4.33 (t, *J* = 8.6 Hz, 2H), 3.51 (s, 3H), 3.44 (t, *J* = 8.6 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 164.4, 143.0, 142.1, 130.3, 129.6, 128.9, 127.6, 125.9, 124.4, 124.2, 122.3, 122.0, 114.1, 53.7, 44.2, 21.7, 19.4; HRMS calculated for $C_{17}H_{18}N$ $[M\text{-}I]^+$ 275.1543, found 275.1550.



**1-(4-Methoxyphenyl)-2-methyl-4,9-dihydro-3*H*-pyrido[3,4-*b*]indol-2-ium iodide (3c):** 2.0 mmol scale, 0.795 g, 95% yield, unknown compound, yellow solid, m.p. 254-255 °C; $^1$H NMR (400 MHz, DMSO) δ 11.57 (brs, 1H), 7.81 (d, *J* = 8.2 Hz, 1H), 7.71 (d, *J* = 8.8 Hz, 2H), 7.49 – 7.38 (m, 2H), 7.31 (d, *J* = 8.8 Hz, 2H), 7.25 – 7.17 (m, 1H), 4.31 (t, *J* = 8.5 Hz, 2H), 3.93 (s, 3H), 3.55 (s, 3H), 3.42 (t, *J* = 8.5 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 164.0, 162.8, 141.9, 132.2, 128.8, 127.7, 124.5, 124.1, 122.2, 122.0, 120.5, 115.2, 114.0, 56.3, 53.8, 44.1, 19.4; HRMS calculated for $C_{17}H_{18}N$ $[M\text{-}I]^+$ 291.1492, found 291.1497.



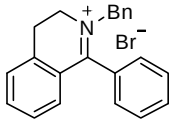
## 2.2 General Procedure for Synthesis of Cyclic Iminium Bromides




**1**

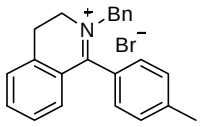
**General Procedure:** A mixture of 1-substituted 3,4-dihydrosioquinoline (1.0 mmol) and (bromomethyl)benzene (1.2 mmol) in acetone (3.0 mL) was stirred at 80 °C overnight and the solid gradually formed. Afterwards the precipitate was filtered from the solution and washed with ethyl acetate. If no precipitate generated, the mixture should be concentrated in vacuum and further purification was performed by a silica gel column eluted with dichloromethane/methanol to give the cyclic iminium bromides **1**.

**2-Benzyl-1-phenyl-3,4-dihydroisoquinolin-2-ium bromide (1l):** 2.7 mmol scale, 0.840 g, 83% yield, unknown compound, pale yellow solid, m.p. 168-170 °C; $^1$H NMR (400 MHz, $CDCl_3$)



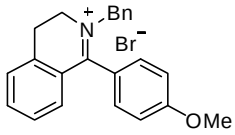

δ 7.93 (dd, *J* = 7.5, 1.7 Hz, 2H), 7.70 – 7.66 (m, 4H), 7.41 – 7.38 (m, 4H), 7.35 – 7.30 (m, 3H), 7.10 (d, *J* = 7.9 Hz, 1H), 5.49 (s, 2H), 4.50 (t, *J* = 7.7 Hz, 2H), 3.34 (t, *J* = 7.7 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 175.7, 137.6, 137.5, 134.7, 132.3, 132.1, 129.6, 129.5, 129.5, 128.9, 128.5, 128.5, 128.4, 128.3, 127.7, 61.7, 50.2, 26.3; HRMS calculated for $C_{22}H_{20}N$ $[M\text{-}Br]^+$ 298.1590, found 298.1599.

**2-Benzyl-1-(*p*-tolyl)-3,4-dihydroisoquinolin-2-ium bromide (1m):** 1.0 mmol scale, 0.274 g, 70% yield, unknown compound, pale yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.0



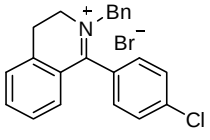

Hz, 2H), 7.66 (t, *J* = 7.5 Hz, 1H), 7.46 (d, *J* = 8.0 Hz, 2H), 7.39 – 7.30 (m, 7H), 7.13 (d, *J* = 7.9 Hz, 1H), 5.54 (s, 2H), 4.50 (t, *J* = 7.7 Hz, 2H), 3.28 (t, *J* = 7.7 Hz, 2H), 2.49 (s, 3H); $^{13}$C NMR (100 MHz, DMSO) δ 176.6, 142.6, 138.7, 137.5, 134.3, 132.9, 130.2, 129.6, 129.3, 128.8, 128.7, 128.6, 128.6, 128.5, 127.3, 60.6, 50.3, 25.6, 21.6; HRMS calculated for $C_{23}H_{22}N$ $[M\text{-}Br]^+$ 312.1747, found 312.1752.

**2-Benzyl-1-(4-methoxyphenyl)-3,4-dihydroisoquinolin-2-ium bromide (1n):** 1.0 mmol scale, 0.224 g, 55% yield, unknown compound, pale yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J*



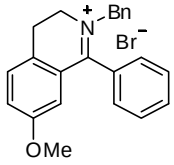

= 8.6 Hz, 2H), 7.65 (t, *J* = 7.5 Hz, 1H), 7.38 – 7.27 (m, 7H), 7.15 (t, *J* = 7.4 Hz, 3H), 5.57 (s, 2H), 4.46 (t, *J* = 7.6 Hz, 2H), 3.91 (s, 3H), 3.22 (t, *J* = 7.5 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 175.6, 162.8, 138.0, 137.2, 134.9, 132.6, 131.7, 129.5, 129.5, 128.4, 128.3, 128.2, 128.0, 121.1, 114.9, 61.3, 55.8, 50.1, 26.4; HRMS calculated for $C_{23}H_{22}NO$ $[M\text{-}Br]^+$ 328.1696, found 328.1698.

**2-Benzyl-1-(4-chlorophenyl)-3,4-dihydroisoquinolin-2-ium bromide (1o):** 1.0 mmol scale, 0.217 g, 53% yield, unknown compound, pale yellow oil; $^1$H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J*



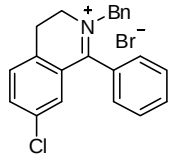

= 8.4 Hz, 2H), 7.71 – 7.63 (m, 3H), 7.42 – 7.39 (m, 4H), 7.36 – 7.28 (m, 3H), 7.08 (d, *J* = 7.9 Hz, 1H), 5.43 (s, 2H), 4.47 (t, *J* = 7.7 Hz, 2H), 3.32 (t, *J* = 7.6 Hz, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 174.9, 138.8, 137.7, 134.5, 131.9, 130.7, 129.9, 129.6, 129.6, 128.5, 128.4, 128.4, 128.3, 127.8, 127.6, 61.8, 50.4, 26.2; HRMS calculated for $C_{22}H_{19}NCl$ $[M\text{-}Br]^+$ 332.1201, found 332.1207.

**2-Benzyl-7-methoxy-1-phenyl-3,4-dihydroisoquinolin-2-ium bromide (1p):** 1.0 mmol scale, 0.286 g, 64% yield, unknown compound, pale yellow oil; $^1$H NMR (400 MHz, DMSO) δ 7.74 – 7.70 (m, 5H), 7.53 (d, *J* = 8.4 Hz, 1H), 7.46 – 7.40 (m, 6H), 6.40 (d, *J* = 2.4 Hz, 1H), 5.06 (s, 2H),



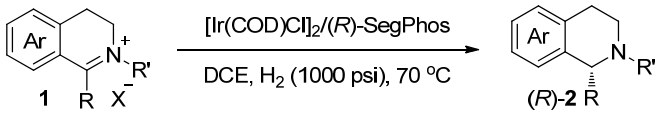
4.12 (t, *J* = 7.5 Hz, 2H), 3.65 (s, 3H), 3.19 (t, *J* = 7.7 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 177.0, 159.4, 133.5, 133.3, 131.4, 130.8, 130.8, 130.5, 130.4, 130.2, 130.0, 129.5, 129.5, 123.6, 120.1, 61.7, 57.0, 51.7, 25.5; HRMS calculated for $C_{23}H_{22}NO$ $[M\text{-}Br]^+$ 328.1696, found 328.1698.

**2-Benzyl-7-chloro-1-phenyl-3,4-dihydroisoquinolin-2-ium bromide (1q):** 0.8 mmol scale, 0.275 g, 83% yield, unknown compound, pale yellow solid, m.p. 214-216 $^{o}$C; $^{1}$H NMR (400 MHz, DMSO) δ 7.93 (dd, *J* = 8.2, 2.1 Hz, 1H), 7.87 (dd, *J* = 7.6, 1.5 Hz, 2H), 7.81 – 7.72 (m, 3H), 7.68 (d, *J* = 8.2 Hz, 1H), 7.53 – 7.39 (m, 5H), 6.90 (d, *J* = 2.1 Hz, 1H), 5.13 (s, 2H), 4.21 (t, *J* = 7.6 Hz, 2H), 3.35 (t, *J* = 7.6 Hz, 2H); $^{13}$C NMR (100 MHz, DMSO) δ 175.5, 137.6, 136.8, 132.7, 132.5, 132.5, 132.4, 130.8, 130.4, 129.9, 129.6, 129.5, 129.4, 128.8, 128.8, 61.1, 50.6, 25.0; HRMS calculated for $C_{22}H_{19}ClN$ $[M\text{-}Br]^+$ 332.1201, found 332.1206.



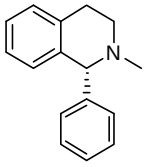
## 3. General Procedure for Iridium-Catalyzed Asymmetric Hydrogenation

### 3.1. Hydrogenation of Cyclic Iminium Salts with a 3,4-Dihydroisoquinoline Core

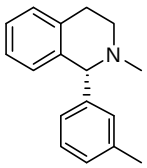



**General Procedure:** A mixture of $[Ir(COD)Cl]_2$ (1.3 mg, 0.002 mmol) and (*R*)-SegPhos (2.7 mg, 0.0044 mmol) in dichloroethane (1.0 mL) was stirred at room temperature for 10 min in glove box. Subsequently, the catalyst was transferred by a syringe to the mixture of 1-substituted 3,4-dihydroisoquinolin-2-ium salts **1** (0.2 mmol) using 4.0 mL dichloroethane. The hydrogenation was performed at 70 °C at a hydrogen pressure of 1000 psi for 24 h. After carefully releasing the hydrogen gas, the mixture was concentrated in vacuum and further purification was performed by a silica gel column eluted with hexanes/ethyl acetate to give the corresponding chiral hydrogenation products (*R*)-**2**.

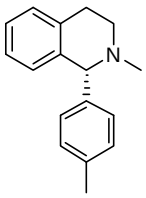
**(*R*)-(-)-2-Methyl-1-phenyl-1,2,3,4-tetrahydroisoquinoline (2a):** 44 mg, 99% yield, 91% ee, known compound,[3] pale yellow oil; $[\alpha]^{20}_D$ = -117.26 (*c* 0.88, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$ = -103.4 (*c* 0.50, $CHCl_3$) for 95% ee], $R_f$ = 0.32 (hexanes/ethyl acetate 5:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.24 (m, 5H), 7.10 (q, *J* = 7.2 Hz, 2H), 6.97 (t, *J* = 7.3 Hz, 1H), 6.63 (d, *J* = 7.8 Hz, 1H), 4.24 (s, 1H), 3.31 – 3.23 (ddd, *J* = 16.3, 11.2, 5.4 Hz, 1H), 3.12 (ddd, *J* = 11.4, 5.4, 2.7 Hz, 1H), 2.82 (dt, *J* = 16.1, 2.8 Hz, 1H), 2.69 – 2.55 (m, 1H), 2.23 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 144.0, 138.6, 134.3, 129.7, 128.6, 128.3, 128.3, 127.3, 126.0, 125.7, 71.6, 52.4, 44.4, 29.6; Enantiomeric excess was determined by HPLC (OD-H column, hexane/ $^i$PrOH 98/2, 0.70 mL/min, 230 nm): $t_1$ = 6.0 min, $t_2$ = 6.3 min (major).




**(*R*)-(-)-2-Methyl-1-*m*-tolyl-1,2,3,4-tetrahydroisoquinoline (2b):** 47 mg, 99% yield, 90% ee, known compound,[3] pale yellow oil; $[\alpha]^{20}_D$ = -115.77 (*c* 0.90, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$ = -118.2 (*c* 0.50, $CHCl_3$) for 91% ee], $R_f$ = 0.23 (hexanes/ethyl acetate 5:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.24 – 7.20 (m, 1H), 7.13 – 7.07 (m, 5H), 6.98 (t, *J* = 7.3 Hz, 1H), 6.64 (d, *J* = 7.8 Hz, 1H), 4.19 (s, 1H), 3.32 – 3.24 (m, 1H), 3.15 – 3.11 (m, 1H), 2.83 – 2.79 (m, 1H), 2.66 – 2.59 (m, 1H), 2.31 (s, 3H), 2.23 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 144.0, 138.7, 138.0, 134.3, 130.1, 128.6, 128.3, 128.1, 128.1, 126.9, 125.9, 125.7, 71.7, 52.6, 44.5, 29.6, 21.5; Enantiomeric excess was determined by HPLC (OJ-H column, hexane/ $^i$PrOH 95/5, 0.70 mL/min, 230 nm): $t_1$ = 6.7 min (major), $t_2$ = 7.7 min.

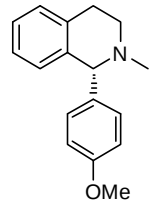



**(*R*)-(-)-2-Methyl-1-*p*-tolyl-1,2,3,4-tetrahydroisoquinoline (2c):** 46 mg, 97% yield, 90% ee, known compound,[3] pale yellow oil; $[\alpha]^{20}_D$ = -114.66 (*c* 0.90, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$ = -111.0 (*c* 0.50, $CHCl_3$) for 94% ee], $R_f$ = 0.25 (hexanes/ethyl acetate 5:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.16 – 7.06 (m, 6H), 6.97 (t, *J* = 7.3 Hz, 1H), 6.64 (d, *J* = 7.8 Hz, 1H), 4.20 (s, 1H), 3.30 – 3.22 (M, 1H), 3.11 (ddd, *J* = 11.5, 5.5, 2.8 Hz, 1H), 2.81 (dt, *J* = 16.1, 2.8 Hz, 1H), 2.62 (td, *J* = 11.3, 3.8 Hz, 1H), 2.33 (s, 3H), 2.23 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 140.9, 138.8, 136.9, 134.3, 129.5, 129.0, 128.6, 128.3, 125.9, 125.7, 71.3, 52.4, 44.4, 29.6, 21.2; Enantiomeric excess was determined by HPLC (OJ-H column, hexane/ $^i$PrOH 95/5, 0.70 mL/min, 230 nm): $t_1$ = 6.8 min (major), $t_2$ = 9.7 min.

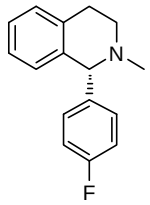



**(*R*)-(-)-1-(4-Methoxyphenyl)-2-methyl-1,2,3,4-tetrahydroisoquinoline (2d):** 46 mg, 91% yield, 89% ee, known compound,[3] pale yellow solid; $[\alpha]^{20}_D$ = -110.96 (*c* 0.62, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$

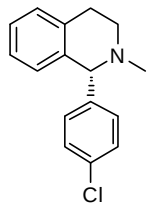
= -111.2 (*c* 0.50, $CHCl_3$) for 91% ee], $R_f$ = 0.25 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.17 (d, *J* = 8.5 Hz, 2H), 7.09 (q, *J* = 7.6 Hz, 2H), 6.98 (t, *J* = 7.2 Hz, 1H), 6.85 (d, *J* = 8.6 Hz, 2H), 6.64 (d, *J* = 7.8 Hz, 1H), 4.20 (s, 1H), 3.80 (s, 3H), 3.29 – 3.21 (m, 1H), 3.11 (ddd, *J* = 11.4, 5.4, 2.8 Hz, 1H), 2.86 – 2.77 (m, 1H), 2.62 (td, *J* = 11.3, 3.8 Hz, 1H), 2.23 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 158.8, 138.9, 136.0, 134.3, 130.6, 128.6, 128.3, 125.9, 125.6, 113.6, 70.9, 55.2, 52.4, 44.3, 29.5. Enantiomeric excess was determined by HPLC (OD-H column, hexane/ $^i$PrOH 90/10, 1.0 mL/min, 230 nm): $t_1$ = 4.1 min, $t_2$ = 4.4 min (major).



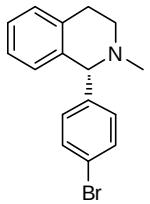

**(*R*)-(-)-1-(4-Fluorophenyl)-2-methyl-1,2,3,4-tetrahydroisoquinoline (2e):** 45 mg, 94% yield, 90% ee, unknown compound, colorless oil; $[\alpha]^{20}_D$ = -114.38 (*c* 0.82, $CHCl_3$), $R_f$ = 0.30 (hexanes/ethyl acetate 5:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.21 (m, 2H), 7.13– 7.07 (m, 2H), 7.02 – 6.96 (m, 3H), 6.60 (d, *J* = 7.8 Hz, 1H), 4.22 (s, 1H), 3.29 – 3.21 (m, 1H), 3.11 (ddd, *J* = 11.5, 5.5, 2.7 Hz, 1H), 2.81 (dt, *J* = 16.1, 3.0 Hz, 1H), 2.63 (td, *J* = 11.3, 3.8 Hz, 1H), 2.22 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 162.1 (d, *J* = 245.2 Hz), 139.9 (d, *J* = 3.2 Hz), 138.4, 134.4, 131.1 (d, *J* = 7.9 Hz), 128.5, 128.4, 126.1, 125.7, 115.1 (d, *J* = 21.3 Hz), 70.8, 52.4, 44.3, 29.5; $^{19}$F NMR (376 MHz, $CDCl_3$) δ -115.41; Enantiomeric excess was determined by HPLC (OD-H column, hexane/ $^i$PrOH 95/5, 1.0 mL/min, 230 nm): $t_1$ = 3.8 min, $t_2$ = 4.2 min (major); HRMS calculated for $C_{16}H_{17}NF$ $[M+H]^+$ 242.1340, found 242.1350.



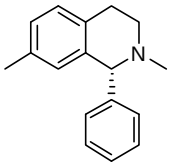

**(*R*)-(-)-1-(4-Chlorophenyl)-2-methyl-1,2,3,4-tetrahydroisoquinoline (2f):** 50 mg, 97% yield, 87% ee, known compound,[3] white solid; $[\alpha]^{20}_D$ = -118.55 (*c* 0.90, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$ = -130.0 (*c* 0.50, $CHCl_3$) for 91% ee], $R_f$ = 0.35 (hexanes/ethyl acetate 5:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.28 (d, *J* = 8.4 Hz, 2H), 7.22 (t, *J* = 7.9 Hz, 2H), 7.13 – 7.07 (m, 2H), 6.98 (t, *J* = 7.2 Hz, 1H), 6.59 (d, *J* = 7.8 Hz, 1H), 4.21 (s, 1H), 3.29 – 3.20 (m, 1H), 3.10 (ddd, *J* = 11.4, 5.4, 2.6 Hz, 1H), 2.88 – 2.74 (m, 1H), 2.62 (td, *J* = 11.3, 3.7 Hz, 1H), 2.22 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 142.7, 138.1, 134.3, 133.0, 130.9, 128.5, 128.5, 128.4, 126.1, 125.8, 70.8, 52.3, 44.3, 29.5; Enantiomeric excess was determined by HPLC (OD-H column, hexane/ $^i$PrOH 90/10, 1.0 mL/min, 230 nm): $t_1$ = 3.7 min, $t_2$ = 4.1 min (major).




**(*R*)-(-)-1-(4-Bromophenyl)-2-methyl-1,2,3,4-tetrahydroisoquinoline (2g):** 59 mg, 98% yield, 87% ee, unknown compound, white solid, m.p. 97-99 °C; $[\alpha]^{20}_D$ = -106.86 (*c* 1.18, $CHCl_3$), $R_f$ = 0.30 (hexanes/ethyl acetate 5:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.45 (d, *J* = 8.3 Hz, 2H), 7.18 – 7.09 (m, 4H), 7.00 (t, *J* = 7.1 Hz, 1H), 6.60 (d, *J* = 7.8 Hz, 1H), 4.22 (s, 1H), 3.30 – 7.21 (m, 1H), 3.12 (ddd, *J* = 11.4, 5.4, 2.6 Hz, 1H), 2.88 – 2.76 (m, 1H), 2.64 (td, *J* = 11.4, 3.8 Hz, 1H), 2.23 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 143.3, 138.0, 134.3, 131.5, 131.3, 128.5, 128.4, 126.2, 125.8, 121.2, 70.9, 52.3, 44.4, 29.5; Enantiomeric excess was determined by HPLC (OD-H column, hexane/ $^i$PrOH 98/2, 0.7 mL/min, 230 nm): $t_1$ = 6.0 min, $t_2$ = 7.2 min (major); HRMS calculated for $C_{16}H_{17}NBr$ $[M+H]^+$ 302.0539, found 302.0541.

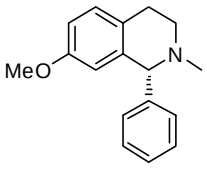



**(*R*)-(-)-2,7-Dimethyl-1-phenyl-1,2,3,4-tetrahydroisoquinoline (2h):** 46 mg, 97% yield, 93% ee, known compound,[3] pale yellow oil; $[\alpha]^{20}_D$ = -72.07 (*c* 0.82, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$ = -73.8 (*c* 0.50, $CHCl_3$) for 93% ee], $R_f$ = 0.50 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.33 – 7.23 (m, 5H), 7.01 (d, *J* = 7.7 Hz, 1H), 6.91 (d, *J* = 7.7 Hz, 1H), 6.44 (s, 1H), 4.19 (s, 1H), 3.25 –

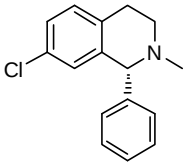


3.17 (m, 1H), 3.10 (ddd, *J* = 11.3, 5.3, 2.8 Hz, 1H), 2.83 – 2.73 (m, 1H), 2.60 (td, *J* = 11.2, 3.8 Hz, 1H), 2.22 (s, 3H), 2.12 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 144.1, 138.4, 135.0, 131.4, 129.7, 129.0, 128.3, 128.2, 127.3, 126.9, 71.5, 52.4, 44.4, 29.2, 21.1; Enantiomeric excess was determined by HPLC (OG column, hexane/ $^{i}$PrOH 99.6/0.4, 0.7 mL/min, 230 nm): $t_1$ = 5.9 min, $t_2$ = 6.5 min (major).

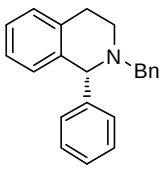
**(*R*)-(-)-7-Methoxy-2-methyl-1-phenyl-1,2,3,4-tetrahydroisoquinoline (2i):** 46 mg, 91% yield, 86% ee, known compound,[3] pale yellow oil; $[\alpha]^{20}_D$ = -52.50 (*c* 0.80, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$ = -58.4 (*c* 0.50, $CHCl_3$) for 86% ee], $R_f$ = 0.35 (hexanes/ethyl acetate 5:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.32 – 7.23 (m, 5H), 7.04 (d, *J* = 8.4 Hz, 1H), 6.68 (dd, *J* = 8.4, 2.6 Hz, 1H), 6.17 (d, *J* = 2.4 Hz, 1H), 4.19 (s, 1H), 3.59 (s, 3H), 3.22 – 3.08 (m, 2H), 2.77 (dd, *J* = 15.7, 3.2 Hz, 1H), 2.60 (td, *J* = 10.9, 3.8 Hz, 1H), 2.23 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 157.5, 143.8, 139.7, 129.6, 129.2, 128.3, 127.3, 126.7, 113.8, 112.0, 71.6, 55.1, 52.5, 44.4, 28.7; Enantiomeric excess was determined by HPLC (OJ-H column, hexane/ $^{i}$PrOH 90/10, 0.7 mL/min, 230 nm): $t_1$ = 12.3 min (major), $t_2$ = 17.4 min.



**(*R*)-(-)-7-Chloro-2-methyl-1-phenyl-1,2,3,4-tetrahydroisoquinoline (2j):** 48 mg, 93% yield, 84% ee, unknown compound, colourless oil; $[\alpha]^{20}_D$ = -34.79 (*c* 0.96, $CHCl_3$), $R_f$ = 0.45 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.22 (m, 5H), 7.13 – 6.99 (m, 2H), 6.61 (s, 1H), 4.18 (s, 1H), 3.25 – 3.06 (m, 2H), 2.84 – 2.73 (m, 1H), 2.63 – 2.56 (m, 1H), 2.21 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 143.1, 140.5, 132.9, 131.3, 129.7, 129.6, 128.5, 128.4, 127.6, 126.2, 71.21, 52.1, 44.3, 29.0; Enantiomeric excess was determined by HPLC (AD-H column, hexane/ $^{i}$PrOH 95/5, 0.8 mL/min, 230 nm): $t_1$ = 4.7 min, $t_2$ = 5.1 min (major); HRMS calculated for $C_{16}H_{17}ClN$ $[M+H]^+$ 258.1044, found 258.1047.



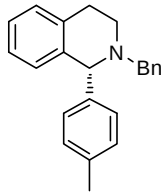
**(*R*)-(+)-2-Methyl-1-phenethyl-1,2,3,4-tetrahydroisoquinoline (2k):** 50 mg, 99% yield, 26% ee, known compound,[4] pale yellow oil; $[\alpha]^{20}_D$ = +1.20 (*c* 1.00, $CHCl_3$), $R_f$ = 0.30 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.28 – 7.24 (m, 2H), 7.22 – 7.04 (m, 7H), 3.50 (t, *J* = 5.3 Hz, 1H), 3.21 – 3.10 (m, 1H), 2.89 – 2.66 (m, 4H), 2.59 – 2.50 (m, 1H), 2.48 (s, 3H), 2.16 – 2.01 (m, 2H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 143.0, 138.1, 134.9, 128.8, 128.5, 128.3, 127.1, 125.9, 125.8, 125.6, 63.1, 48.5, 42.9, 36.7, 31.4, 26.3; Enantiomeric excess was determined by HPLC (OD-H column, hexane/ $^{i}$PrOH 98/2, 0.7 mL/min, 230 nm): $t_1$ = 6.6 min, $t_2$ = 7.2 min (major).



**(*R*)-(-)-2-Benzyl-1-phenyl-1,2,3,4-tetrahydroisoquinoline (2l):** The hydrogenation was performed in dichloroethane (3 mL) at 50 °C; 57 mg, 95% yield, 96% ee, known compound,[3] white solid; $[\alpha]^{20}_D$ = -100.72 (*c* 1.10, $CHCl_3$) [lit[3]: $[\alpha]^{20}_D$ = -94.6 (*c* 0.50, $CHCl_3$) for 95% ee], $R_f$ = 0.41 (hexanes/ethyl acetate 20:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.38 (d, *J* = 7.4 Hz, 2H), 7.34 – 7.20 (m, 8H), 7.12 – 7.07 (m, 2H), 7.02 –6.98 (m, 1H), 6.72 (d, *J* = 7.8 Hz, 1H), 4.60 (s, 1H), 3.81 (d, *J* = 13.6 Hz, 1H), 3.24 (d, *J* = 13.6 Hz, 1H), 3.12 – 3.02 (m, 2H), 2.78 – 2.74 (m, 1H), 2.54 – 2.48 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 144.5, 139.6, 138.6, 134.9, 129.7, 128.9, 128.8, 128.5, 128.3, 128.2, 127.3, 126.9, 125.9, 125.7, 68.9, 58.9, 47.4, 29.3; Enantiomeric excess was determined by HPLC (AD-H column, hexane/ $^{i}$PrOH 90/10, 1.0 mL/min, 230 nm): $t_1$ = 3.5 min (major), $t_2$ = 3.9 min.

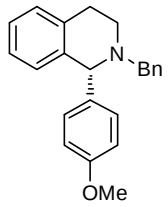
**(*R*)-(-)-2-Benzyl-1-(*p*-tolyl)-1,2,3,4-tetrahydroisoquinoline (2m):** The hydrogenation was performed in dichloroethane (3 mL) at 50 °C; 61 mg, 97% yield, 95% ee, unknown compound, white

solid, m.p. 97-99 °C; $[\alpha]^{20}_D$ = -92.45 (*c* 1.22, $CHCl_3$), $R_f$ = 0.58 (hexanes/ethyl acetate 10:1); $^1$H



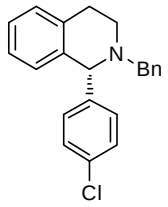
NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.24 (m, 6H), 7.21 – 7.18 (m, 1H), 7.12 – 7.05 (m, 4H), 7.00 – 6.96 (m, 1H), 6.73 (d, *J* = 7.8 Hz, 1H), 4.56 (s, 1H), 3.81 (d, *J* = 13.6 Hz, 1H), 3.22 (d, *J* = 13.6 Hz, 1H), 3.11 – 3.01 (m, 2H), 2.78 – 2.72 (m, 1H), 252 – 2.45 (m, 1H), 2.31 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 141.4, 139.7, 138.9, 136.8, 134.9, 129.6, 129.1, 128.9, 128.8, 128.5, 128.2, 126.8, 125.9, 125.7, 68.6, 58.9, 47.4, 29.4, 21.2; Enantiomeric excess was determined by HPLC (AD-H column, hexane/ $^i$PrOH 98/2, 0.7 mL/min, 230 nm): $t_1$ = 5.2 min (major), $t_2$ = 5.9 min; HRMS calculated for $C_{23}H_{24}N$ $[M+H]^+$ 314.1903, found 314.1908.

**(*R*)-(-)-2-Benzyl-1-(4-methoxyphenyl)-1,2,3,4-tetrahydroisoquinoline (2n):** The hydrogenation was performed in dichloroethane (3 mL) at 50 °C; 63 mg, 96% yield, 96% ee, known



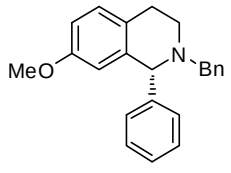
compound,[2] colorless oil; $[\alpha]^{20}_D$ = -98.39 (*c* 1.00, $CHCl_3$), [lit[2]: $[\alpha]^{29}_D$ = -94.6 (c 2.05, $CHCl_3$) for 94% ee], $R_f$ = 0.45 (hexanes/ethyl acetate 10:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.31 – 7.25 (m, 6H), 7.22 – 7.18 (m, 1H), 7.10 – 7.06 (m, 2H), 7.01 – 6.96 (m, 1H), 6.87 – 6.83 (m, 2H), 6.73 (d, *J* = 7.8 Hz, 1H), 4.55 (s, 1H), 3.82 (d, *J* = 13.6 Hz, 1H), 3.77 (s, 3H), 3.22 (d, *J* = 13.6 Hz, 1H), 3.11 – 3.00 (m, 2H), 2.75 (dt, *J* = 7.2, 4.5 Hz, 1H), 2.53 – 2.46 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 158.8, 139.7, 138.9, 136.5, 134.9, 130.7, 128.9, 128.8, 128.5, 128.2, 126.8, 125.9, 125.6, 113.7, 68.2, 58.8, 55.3, 47.4, 29.3; Enantiomeric excess was determined by HPLC (AD-H column, hexane/ $^i$PrOH 99.2/0.8, 0.7 mL/min, 230 nm): $t_1$ = 8.9 min (major), $t_2$ = 10.1 min.

**(*R*)-(-)-2-Benzyl-1-(4-chlorophenyl)-1,2,3,4-tetrahydroisoquinoline (2o):** The hydrogenation was performed in dichloroethane (3 mL) at 50 °C; 62 mg, 93% yield, 95% ee, unknown



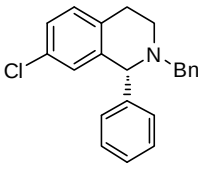
compound, white solid, mp 108-109 °C; $[\alpha]^{20}_D$ = -92.54 (*c* 1.14, $CHCl_3$), $R_f$ = 0.43 (hexanes/ethyl acetate 20:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.24 (m, 9H), 7.15 – 7.12 (m, 2H), 7.07 – 7.03 (m, 1H), 6.73 (d, *J* = 7.7 Hz, 1H), 4.63 (s, 1H), 3.82 (d, *J* = 13.5 Hz, 1H), 3.28 (d, *J* = 13.5 Hz, 1H), 3.15 – 3.04 (m, 2H), 2.80 (dt, *J* = 6.8, 4.2 Hz, 1H), 2.58 – 2.52 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 143.9, 140.1, 138.8, 135.7, 133.8, 131.8, 129.6, 129.5, 129.5, 129.3, 129.1, 127.8, 127.0, 126.6, 68.9, 59.7, 48.1, 30.0; Enantiomeric excess was determined by HPLC (AD-H column, hexane/ $^i$PrOH 98/2, 0.7 mL/min, 230 nm): $t_1$ = 5.9 min (major), $t_2$ = 6.3 min; HRMS calculated for $C_{22}H_{21}NCl$ $[M+H]^+$ 334.1357, found 334.1360.

**(*R*)-(-)-2-Benzyl-7-methoxy-1-phenyl-1,2,3,4-tetrahydroisoquinoline (2p):** The hydrogenation was performed in dichloroethane (3 mL) at 50 °C; 60 mg, 91% yield, 93% ee, unknown



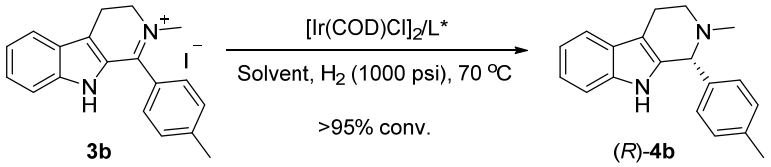
compound, colorless oil; $[\alpha]^{20}_D$ = -41.87 (*c* 1.12, $CHCl_3$), $R_f$ = 0.35 (hexanes/ethyl acetate 20:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.22 (m, 10H), 7.05 (d, *J* = 8.4 Hz, 1H), 6.70 (dd, *J* = 8.4, 2.5 Hz, 1H), 6.29 (d, *J* = 2.6 Hz, 1H), 4.58 (s, 1H), 3.82 (d, *J* = 13.6 Hz, 1H), 3.63 (s, 3H), 3.27 (d, *J* = 13.5 Hz, 1H), 3.10 (dt, *J* = 11.3, 4.7 Hz, 1H), 3.05 – 2.94 (m, 1H), 2.73 (dt, *J* = 15.8, 3.9 Hz, 1H), 2.51 (ddd, *J* = 11.6, 9.9, 4.0 Hz, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 157.5, 144.2, 139.6, 139.5, 129.6, 129.4, 128.8, 128.3, 128.2, 127.3, 127.1, 126.8, 114.0, 112.1, 68.8, 58.9, 55.1, 47.4, 28.2; Enantiomeric excess was determined by HPLC (AD-H column, hexane/ $^i$PrOH 98/2, 0.7 mL/min, 230 nm): $t_1$ = 7.0 min (major), $t_2$ = 9.1 min; HRMS calculated for $C_{23}H_{24}NO$ $[M+H]^+$ 330.1852, found 330.1854.

**(*R*)-(-)-2-Benzyl-7-chloro-1-phenyl-1,2,3,4-tetrahydroisoquinoline (2q):** The hydrogenation was performed in dichloroethane (3 mL) at 50 °C; 64 mg, 96% yield, 95% ee, unknown compound,

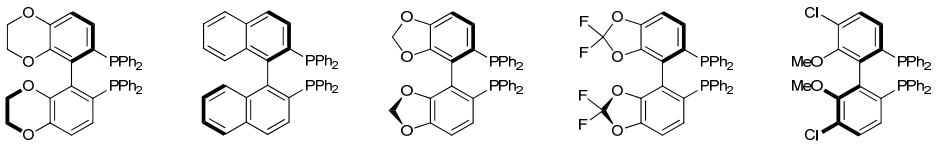



colorless oil; $[\alpha]^{20}_D$ = -27.89 (*c* 1.28, $CHCl_3$), $R_f$ = 0.58 (hexanes/ethyl acetate 10:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.18 (m, 10H), 7.10 – 6.97 (m, 2H), 6.71 (d, *J* = 1.0 Hz, 1H), 4.54 (s, 1H), 3.78 (d, *J* = 13.5 Hz, 1H), 3.23 (d, *J* = 13.5 Hz, 1H), 3.13 – 3.03 (m, 1H), 3.02 – 2.95 (m, 1H), 2.75 – 2.69 (m, 1H), 2.50 – 2.44 (m, 1H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 143.5, 140.4, 139.3, 133.4, 131.2, 129.9, 129.6, 128.7, 128.7, 128.5, 128.2, 127.6, 127.0, 126.2, 68.5, 58.7, 47.1, 28.7; Enantiomeric excess was determined by HPLC (AD-H column, hexane/$^i$PrOH 95/5, 0.8 mL/min, 230 nm): $t_1$ = 4.5 min (major), $t_2$ = 5.2 min; HRMS calculated for $C_{22}H_{21}ClN$ $[M+H]^+$ 334.1357, found 330. 334.1355.

## Optimization of Iridium-Catalyzed Asymmetric Hydrogenation of Cyclic Iminium Salts with a 4,9-Dihydro-3-*H*-*β*-carboline Core



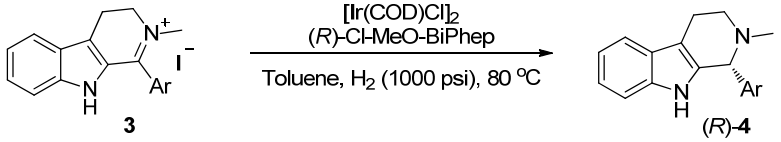

| Entry[a] | Solvent | L* | Ee (%)[c] |
|---|---|---|---|
| 1 | DCE | **L3** | 62 |
| 2 | Toluene | **L3** | 79 |
| 3 | Dioxane | **L3** | 76 |
| 4 | THF | **L3** | 73 |
| 5 | $^i$PrOH | **L3** | 47 |
| 6[b] | Toluene | **L1** | 76 |
| 7 | Toluene | **L4** | 77 |
| 8 | Toluene | **L5** | 85 |
| 9[d] | Toluene | **L5** | 84 |




[a] Reaction condition: **3b** (0.1 mmol), $[Ir(COD)Cl]_2$ (1 mol%), **L*** (2.2 mol%), $H_2$ (1000 psi), solvent (3.0 mL), 24 h, 70 °C; The reaction was conducted with full conversion (determined by $^1$H NMR analysis with 1,3,5-trimethoxy-benzene as the internal standard). [b] 66% conversion [c] Determined by HPLC analysis. [d] 80 °C.

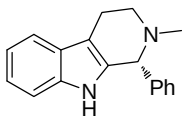
With the optimization of reaction conditions, (*R*)-Cl-MeO-BiPhep and toluene turned out to be the best ligand and solvent for hydrogenation of 2-methyl-1-(*p*-tolyl)-4,9-dihydro-3*H*-pyrido-[3,4-*b*]indol-2-ium iodide, providing the desired product in full conversion and 84% ee.

## 3.2. Hydrogenation of Cyclic Iminium Salts with 4,9-Dihydro-3-*H*-*β*-carboline Core

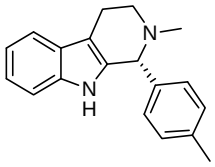



**General Procedure:** A mixture of $[Ir(COD)Cl]_2$ (1.4 mg, 0.002 mmol) and (*R*)-Cl-MeO-BiPhep (3.0 mg, 0.0044 mmol) in toluene (1.0 mL) was stirred at room temperature for 10 min in glove box. Subsequently, the catalyst was transferred by a syringe to the mixture of 1-substituted 2-methyl-2,3,4,9-tetrahydro-1*H*-pyrido[3,4-*b*]indol-2-ium iodide **3** (0.2 mmol) using 4.0 mL toluene. The hydrogenation was performed at 80 °C and at a hydrogen pressure of 1000 psi for 24 h. After carefully releasing the hydrogen, the mixture was concentrated in vacuum and further purification was performed by a silica gel column eluted with hexanes/ethyl acetate to give the chiral hydrogenation product (*R*)-**4**.

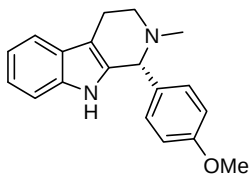
**(*R*)-(-)-2-Methyl-1-phenyl-2,3,4,9-tetrahydro-1*H*-pyrido[3,4-*b*]indole (4a):** 41 mg, 78% yield, 88% ee, known compound,[5] pale yellow solid; $[\alpha]^{20}_D$ = -89.20 (*c* 0.76, $CHCl_3$), $R_f$ = 0.45 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.50 (m, 1H), 7.43 – 7.28 (m, 5H), 7.20 (brs, 1H), 7.16 – 7.11 (m, 1H), 7.11 – 7.04 (m, 2H), 4.28 (s, 1H), 3.34 – 3.15 (m, 1H), 3.15– 3.06 (m, 1H), 2.93 – 2.79 (m, 1H), 2.74 (td, *J* = 11.0, 4.2 Hz, 1H), 2.32 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 140.8, 136.3, 134.9, 129.2, 128.8, 128.2, 127.1, 121.5, 119.4, 118.3, 110.8, 108.9, 67.4, 53.3, 43.6, 21.6; Enantiomeric excess was determined by HPLC (IC column, hexane/ $^i$PrOH 70/30, 0.8 mL/min, 230 nm): $t_1$ = 5.1 min, $t_2$ = 9.9 min (major).




**(*R*)-(-)-2-Methyl-1-p-tolyl-2,3,4,9-tetrahydro-1*H*-pyrido[3,4-*b*]indole (4b):** 54 mg, 98% yield, 84% ee, unknown compound, pale yellow solid, m.p. 158-160 °C; $[\alpha]^{20}_D$ = -85.19 (*c* 1.04, $CHCl_3$), $R_f$ = 0.45 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.51 (m, 1H), 7.24 – 7.20 (m, 3H), 7.18 – 7.13 (m, 3H), 7.13 – 7.05 (m, 2H), 4.26 (s, 1H), 3.31 – 3.19 (m, 1H), 3.14 – 3.06 (m, 1H), 2.88 – 2.67 (m, 2H), 2.34 (s, 3H+3H);$^{13}$C NMR (100 MHz, $CDCl_3$) δ 138.0, 137.7, 136.3, 135.1, 129.4, 129.1, 127.2, 121.5, 119.4, 118.3, 110.8, 108.8, 67.1, 53.3, 43.6, 21.7, 21.2; Enantiomeric excess was determined by HPLC (IC column, hexane/ $^i$PrOH 70/30, 0.7 mL/min, 230 nm): $t_1$ = 6.3 min, $t_2$ = 11.3 min (major); HRMS calculated for $C_{23}H_{24}NO$ $[M+H]^+$ 277.1705 found 277.1714.

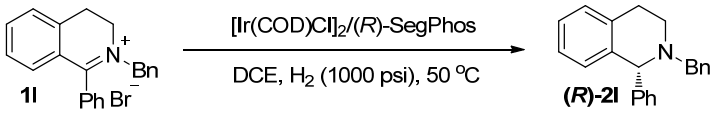



**(*R*)-(-)-1-(4-Methoxyphenyl)-2-methyl-2,3,4,9-tetrahydro-1*H*-pyrido[3,4-*b*]indole (4c):** 48 mg, 83% yield, 88% ee, unknown compound, colorless oil; $[\alpha]^{20}_D$ = -69.88 (*c* 0.90, $CHCl_3$), $R_f$ = 0.40 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.49 (m, 1H), 7.26 – 7.20 (m, 3H), 7.19 – 7.13 (m, 1H), 7.13 – 7.04 (m, 2H), 6.93 – 6.83 (m, 2H), 4.24 (s, 1H), 3.81 (s, 3H), 2.86 – 2.81 (m, 1H), 3.13 – 3.06 (m, 1H), 2.83 (ddd, *J* = 13.3, 4.0, 2.0 Hz, 1H), 2.73 (td, *J* = 11.0, 4.2 Hz, 1H), 2.31 (s, 3H); $^{13}$C NMR (100 MHz, $CDCl_3$) δ 159.5, 136.3, 135.3, 132.8, 130.3, 127.2, 121.5, 119.4, 118.3, 114.1, 110.8, 108.8, 66.7, 55.3, 53.3, 43.5, 21.7; Enantiomeric excess was determined by HPLC (IC column, hexane/ $^i$PrOH 70/30, 0.8 mL/min, 230 nm): $t_1$ = 6.7 min, $t_2$ = 12.2 (major) min; HRMS calculated for $C_{23}H_{24}NO$ $[M+H]^+$



293.1648, found 293.1646.

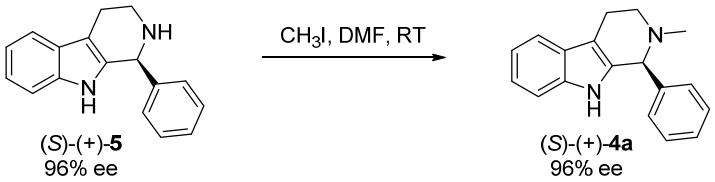
## 4. Asymmetric Hydrogenation at Gram Scale




A mixture of $[Ir(COD)Cl]_2$ (26.8 mg, 0.04 mmol) and (*R*)-SegPhos (53.7 mg, 0.088 mmol) in dichloroethane (5.0 mL) was stirred at room temperature for 10 min in glove box. Subsequently, the catalyst was transferred by a syringe to the mixture of **1l** (1.513 g, 4.0 mmol) using 35 mL of dichloroethane. The hydrogenation was performed at 50 $^{o}$C at a hydrogen pressure of 1000 psi for 24 h. After carefully releasing the hydrogen, the mixture was concentrated in vacuum and further purification was performed by a silica gel column eluted with hexanes/ethyl acetate to give the product (*R*)-**2l** 1.141 g in 95% yield and 96% ee. Enantiomeric excess was determined by HPLC (AD-H column, hexane/ $^{i}$PrOH 90/10, 1.0 mL/min, 230 nm): $t_1$ = 3.6 min (major), $t_2$ = 3.9 min.

## 5. The Determination of Absolute Configuration of (-)-4a

The absolute configuration of (-)-**4a** is unknown. Considering that the absolute configuration of compound **(*S*)-(+)-5** is known,[6] *N*-methylation of **(*S*)-(+)-5** was performed to deliver the product **(*S*)-(+)-4a**, which is the same structure with our hydrogenation product **4a**. By comparison with the optical rotation datum, the absolute configuration of hydrogenation product **4a** could be unambiguously assigned.




(*S*)-(+)-**5**
96% ee

(*S*)-(+)-**4a**
96% ee

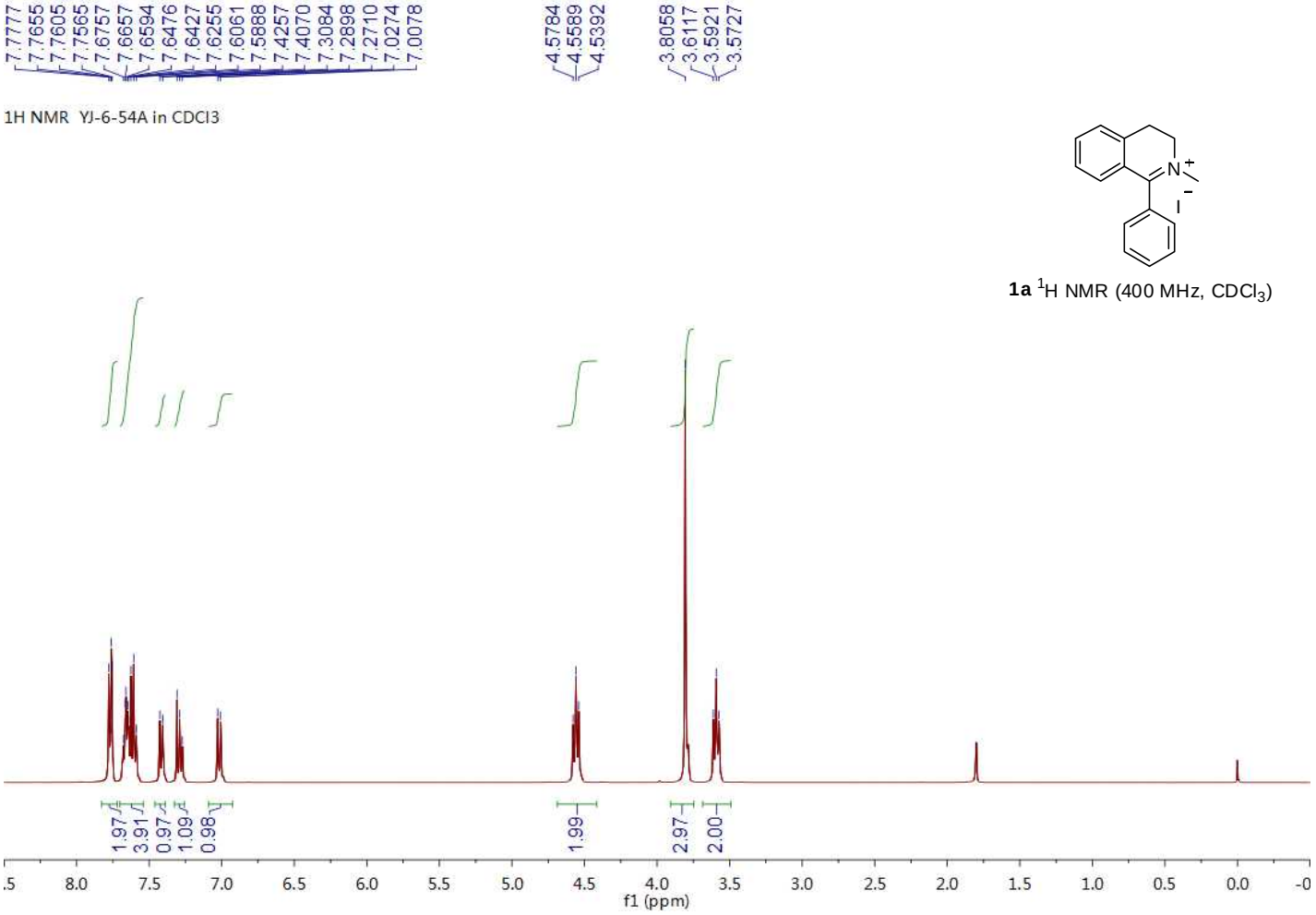
Iodomethane (22 mg, 0.30 mmol) was slowly added to the solution of **(*S*)-(+)-5** (37 mg, 0.15 mmol, 96% ee) and DMF (2 mL). After stirring 2 h, saturated aqueous sodium bicarbonate was added to the mixture until pH reaching to 8-9. The mixture was extracted with dichloromethane twice and the combined organic extracts dried over sodium sulfate. The resulting mixture was concentrated in vacuum and further purification was performed by a silica gel column eluted with hexanes/ethyl acetate to give product (*S*)-(+)-2-methyl-1-phenyl-2,3,4,9-tetrahydro-1*H*-pyrido-[3,4-*b*]indole **4a**. The optical rotation datum of the corresponding product is opposite to our hydrogenation product of iminium salt **3a**. By comparison with the optical rotation datum, the absolute configuration of hydrogenation product **(-)-4a** was assigned as **(*R*)-(-)-4a**.

**(*S*)-(+)-2-Methyl-1-phenyl-2,3,4,9-tetrahydro-1*H*-pyrido[3,4-*b*]indole ((*S*)-(+)-4a):** 20 mg, yield: 51%, ee: 96%, the known compound,[5] pale yellow solid; $[\alpha]^{20}_{D}$ = +102.49 (*c* 0.16, $CHCl_3$), $R_f$ = 0.32 (hexanes/ethyl acetate 2:1); $^1$H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.50 (m, 1H), 7.39 – 7.27 (m, 5H), 7.19 (brs, 1H), 7.15 – 7.05 (m, 3H), 4.27 (s, 1H), 3.22 (ddd, *J* = 11.4, 5.4, 2.3 Hz, 1H), 3.13 – 3.05 (m, 1H), 2.86 – 2.81 (m, 1H), 2.74 (td, *J* = 11.0, 4.2 Hz, 1H), 2.31 (s, 3H); Enantiomeric excess was determined by HPLC (IC column, hexane/ $^i$PrOH 70/30, 0.8 mL/min, 230 nm): $t_1$ = 5.2 min (major), $t_2$ = 10.1 min.

## 6. References

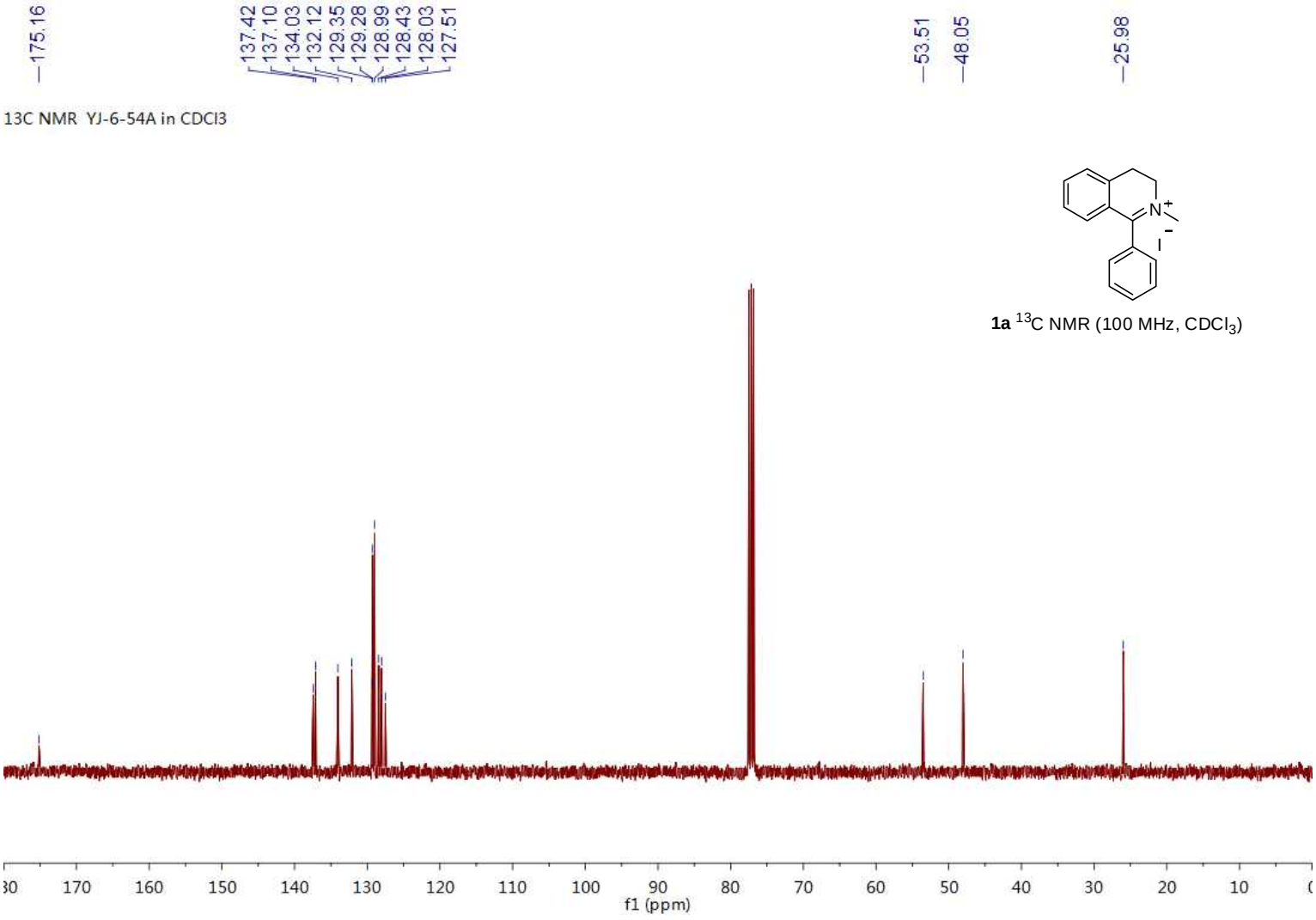

1. (*a*) M. Ružič, A. Pečavar, D. Prudič, D. Kralj, C. Scriban and A. Zanotti-Gerosa, *Org. Process Res. Dev.,* 2012, **16**, 1293; (*b*) J. Dong, X.-X. Shi, J. Xing and J.-J. Yan, *Synth. Commun.*, 2012, **42**, 2806.
2. Z.-S. Ye, R.-N. Guo, X.-F. Cai, M.-W. Chen, L. Shi and Y.-G. Zhou, *Angew. Chem., Int. Ed.,* 2013, **52**, 3685.
3. Y. Ji, L. Shi, M.-W. Chen, G.-S. Feng and Y.-G. Zhou, *J. Am. Chem. Soc.,* 2015, **137**, 10496.
4. A. P. Venkov and S. Statkova-Abeghe, *Synth. Commun.*, 1996, **26**, 2135.
5. K. Freter, H. H. Hübner, H. Merz, H. D. Schroeder and K. Zeile, *Liebigs Ann. Chem.,* 1965, **684**, 159
6. C. Li and J. Xiao, *J. Am. Chem. Soc.,* 2008, **130**, 13208.

## 6. Copy of NMR and HPLC for Compounds

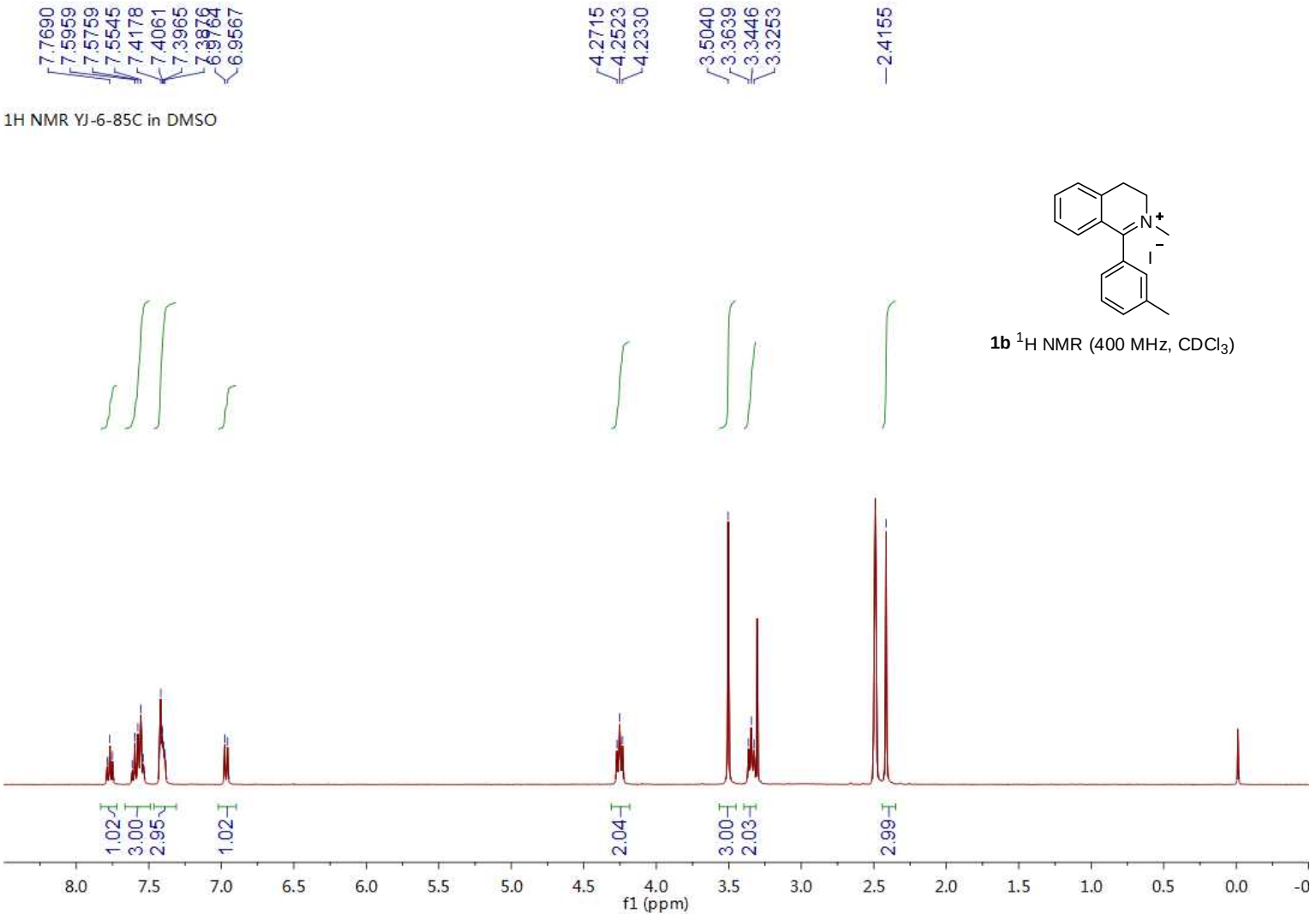




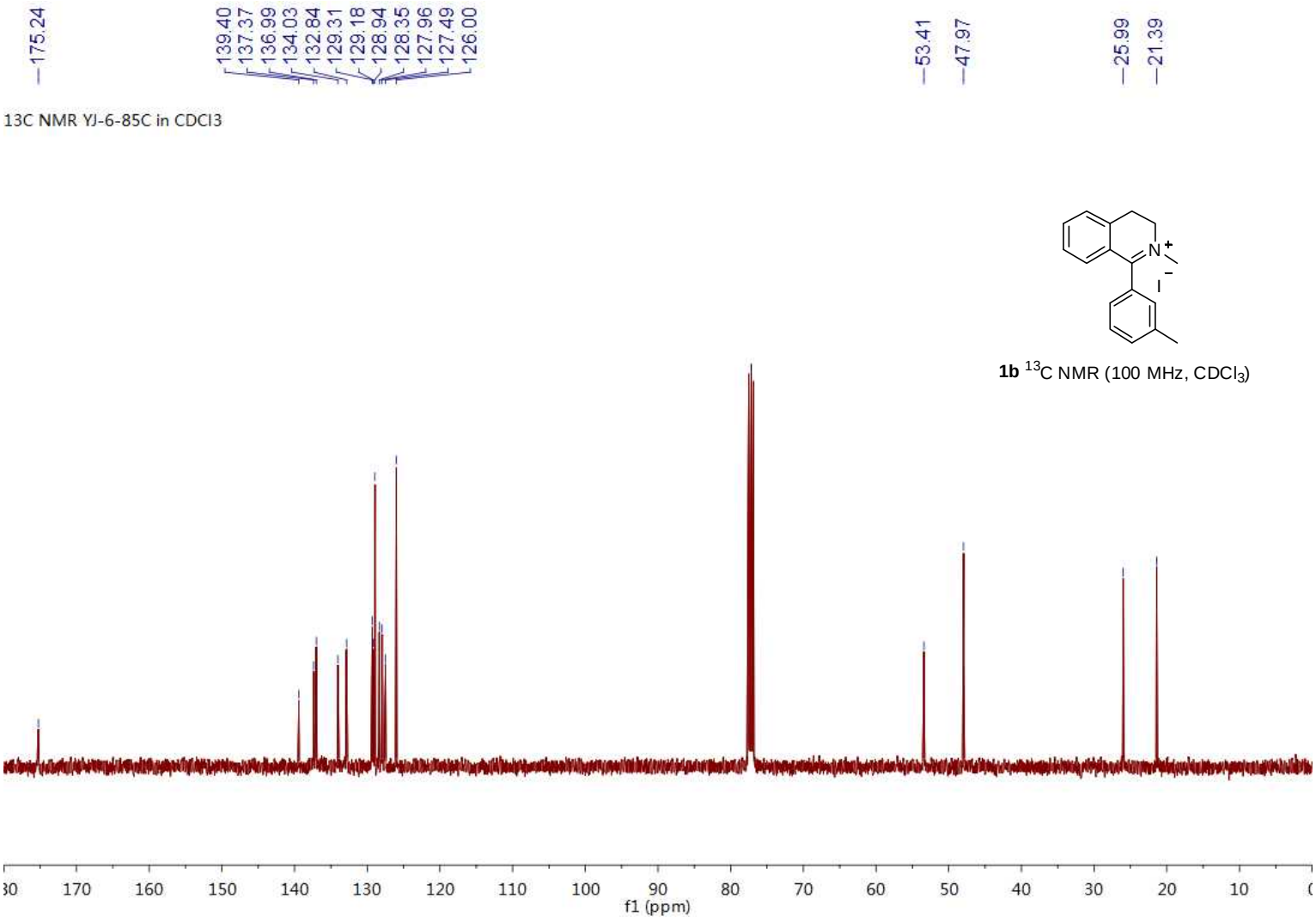

**1a** $^{1}$H NMR (400 MHz, $CDCl_3$)



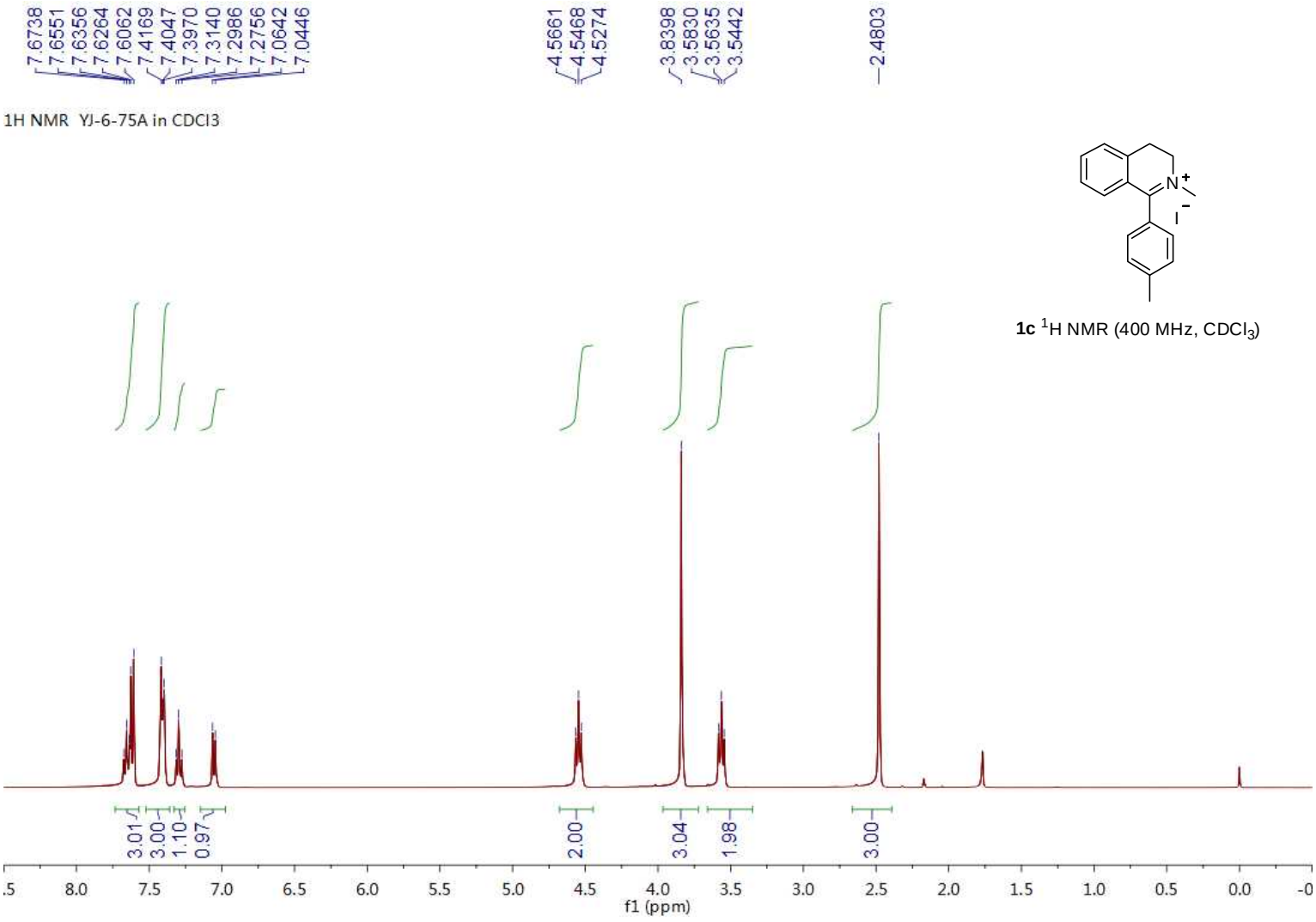

**1a** $^{13}$C NMR (100 MHz, $CDCl_3$)



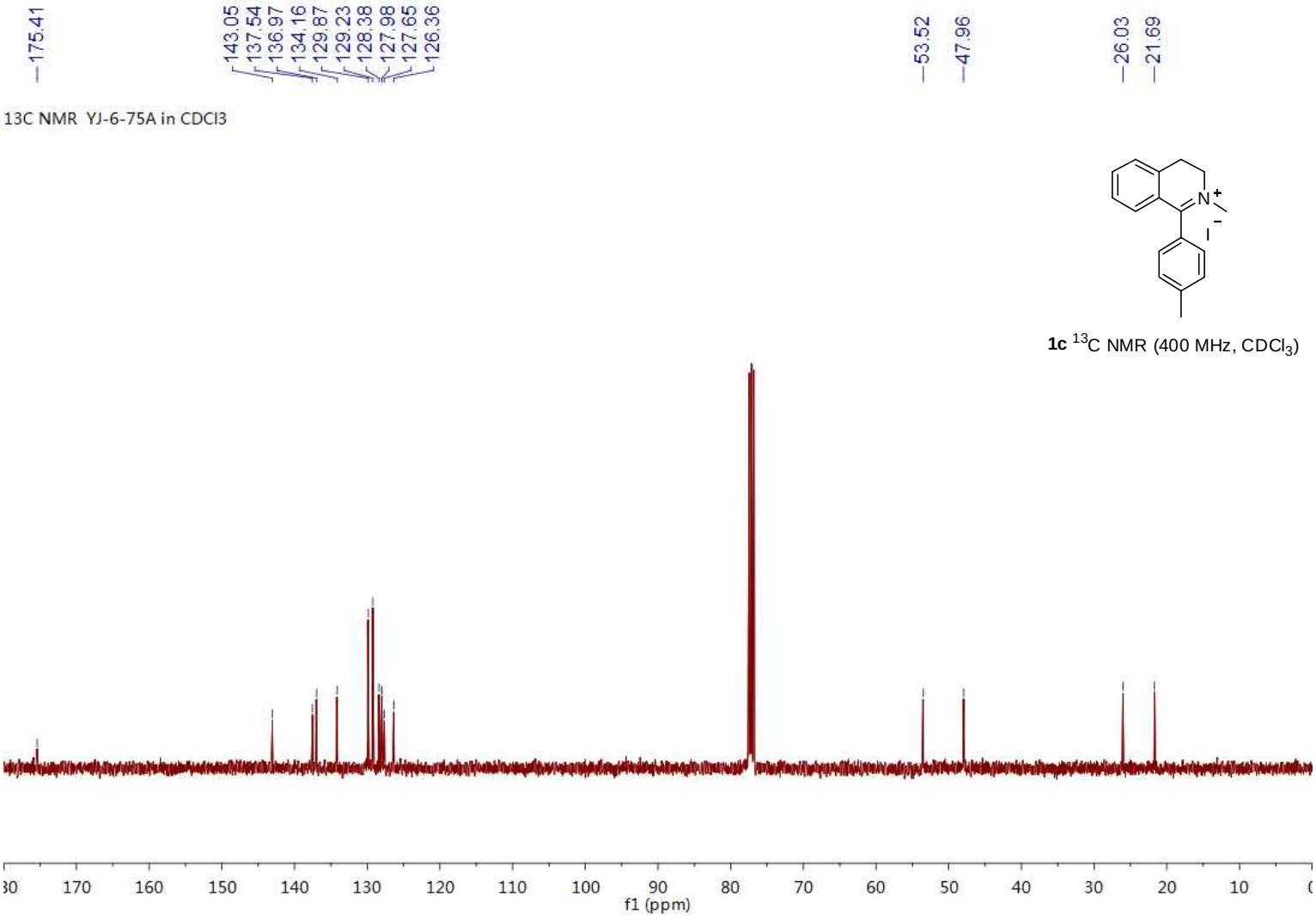

**1b** $^{1}$H NMR (400 MHz, $CDCl_3$)



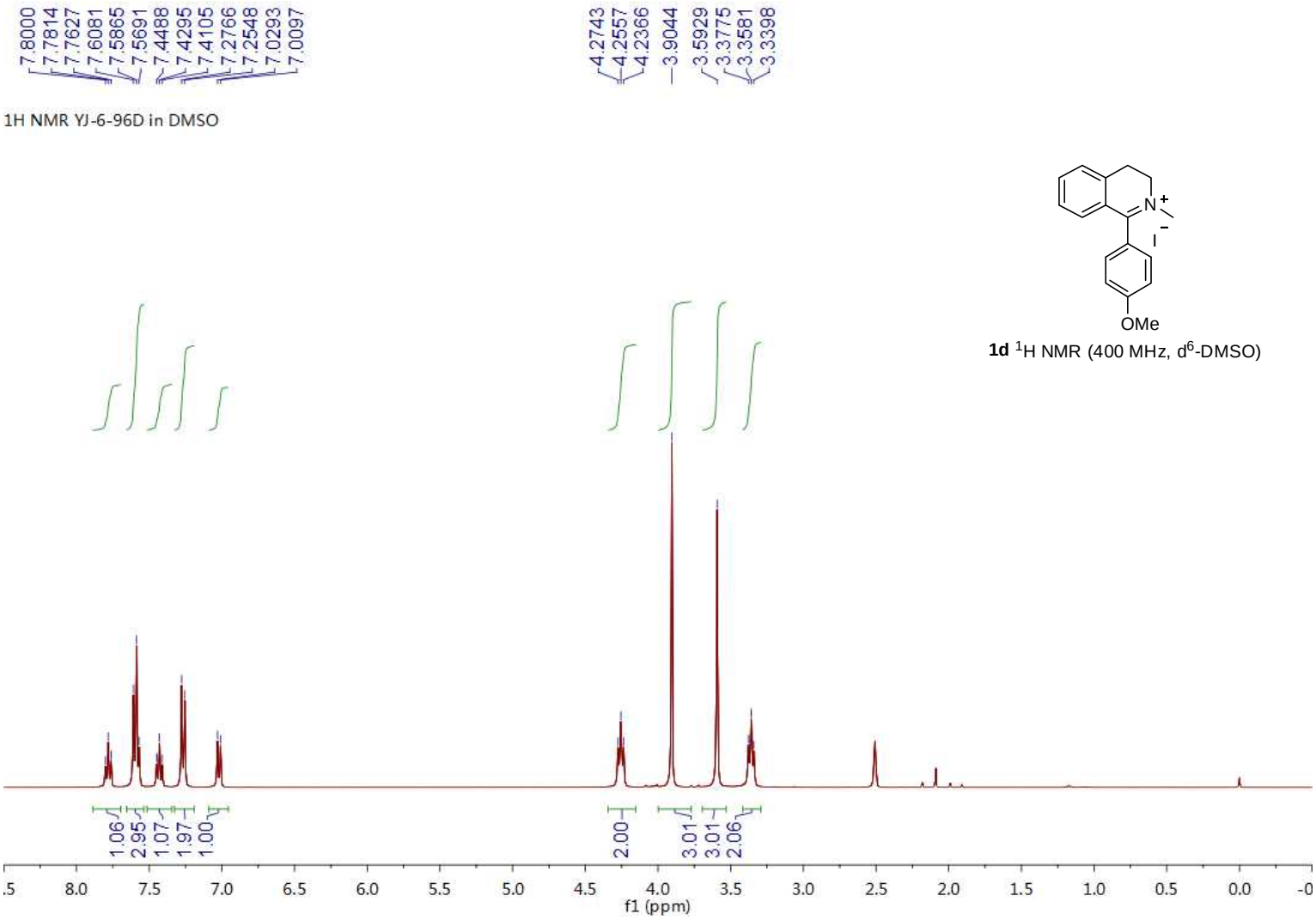

**1b** $^{13}$C NMR (100 MHz, $CDCl_3$)



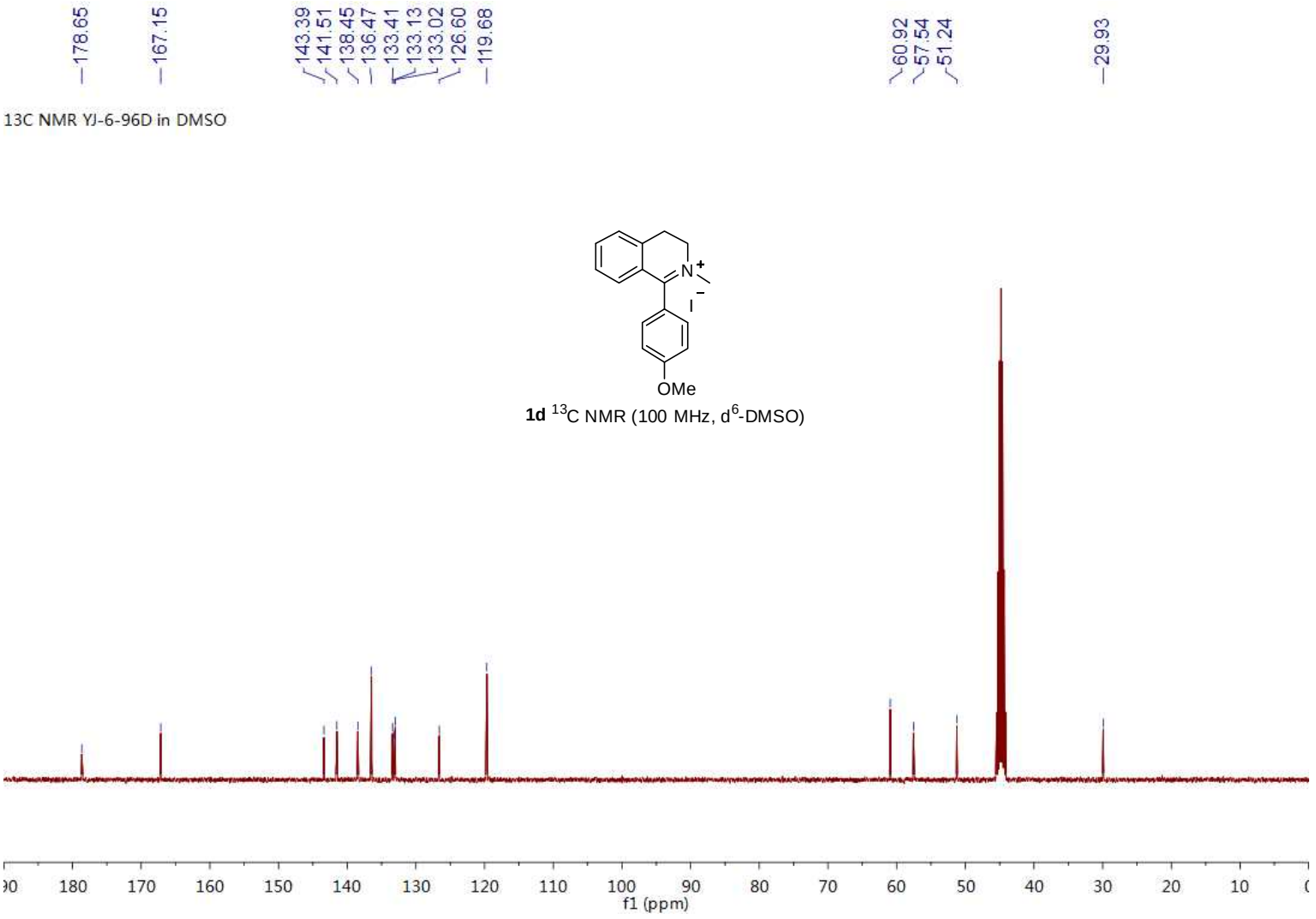

**1c** $^{1}$H NMR (400 MHz, $CDCl_3$)



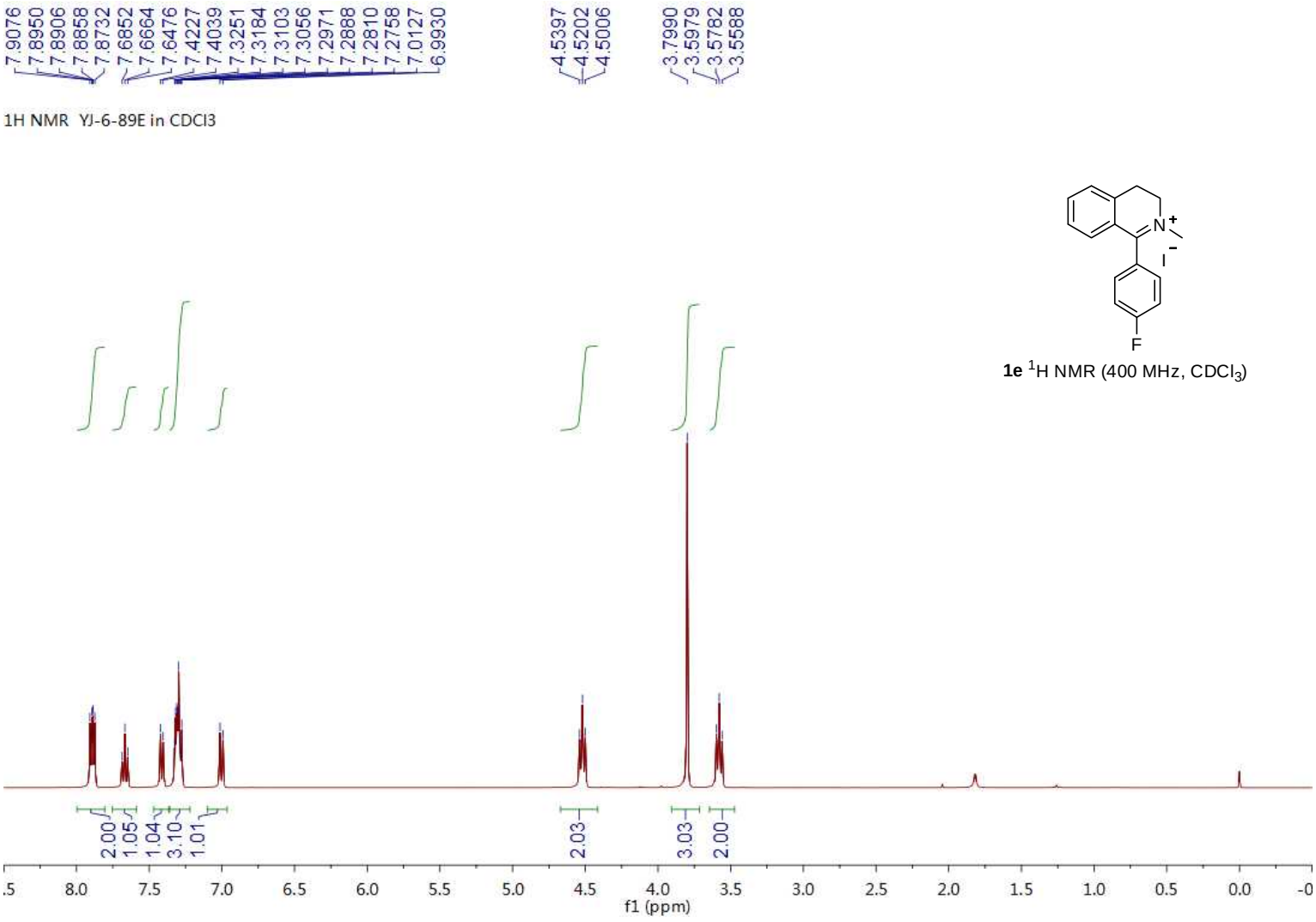

**1c** $^{13}C$ NMR (400 MHz, $CDCl_3$)



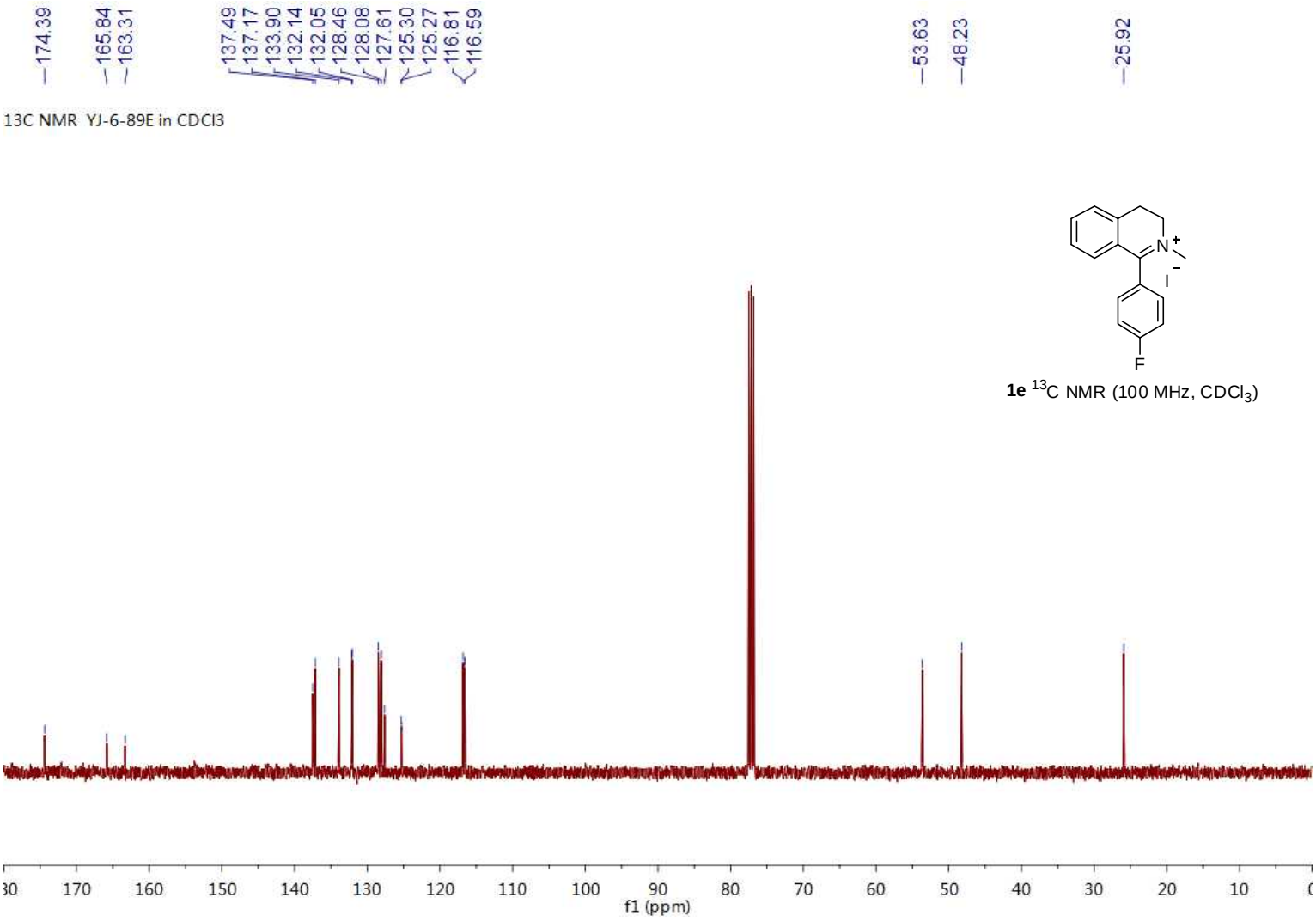

**1d** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)



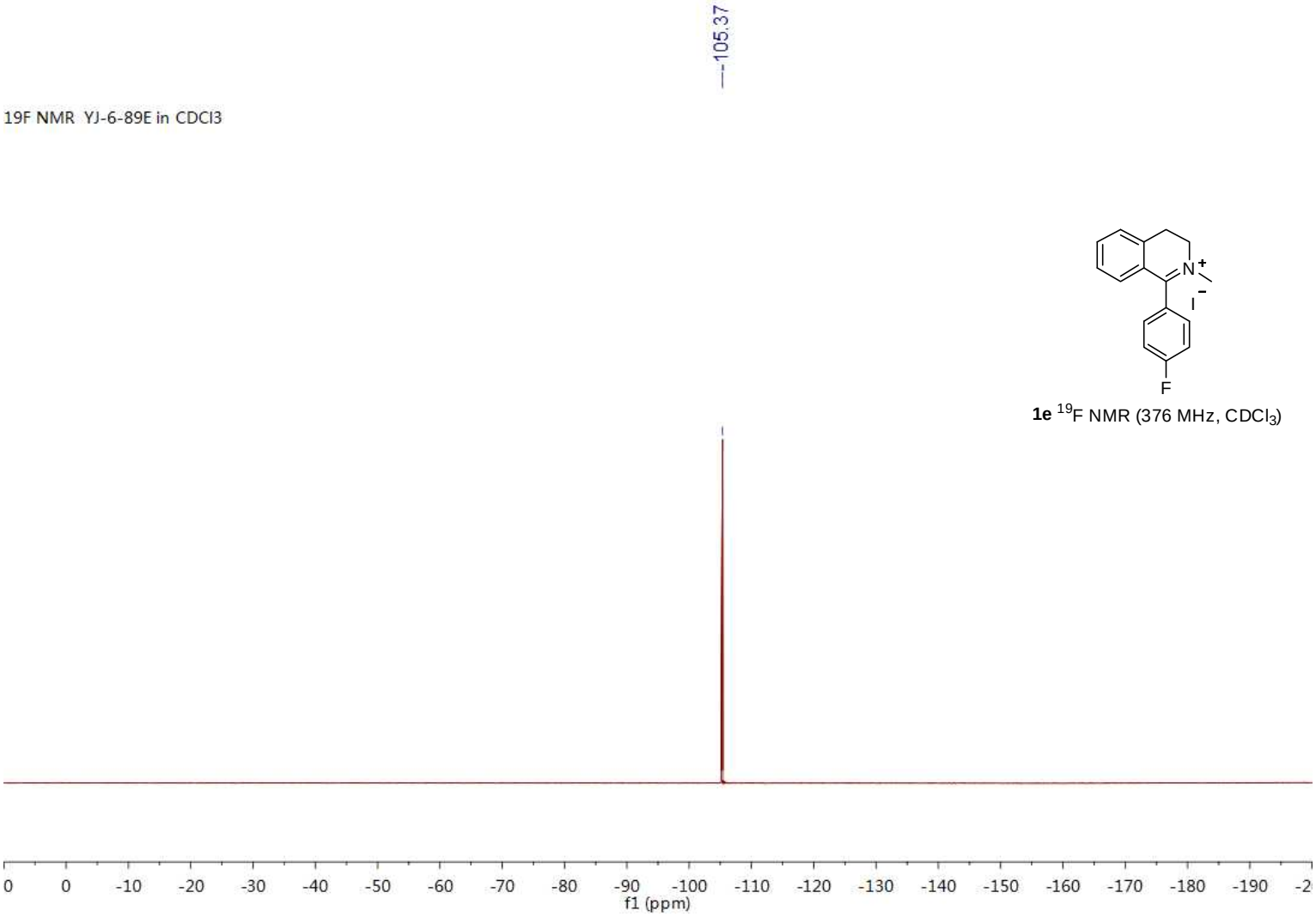

**1d** $^{13}$C NMR (100 MHz, d$^{6}$-DMSO)



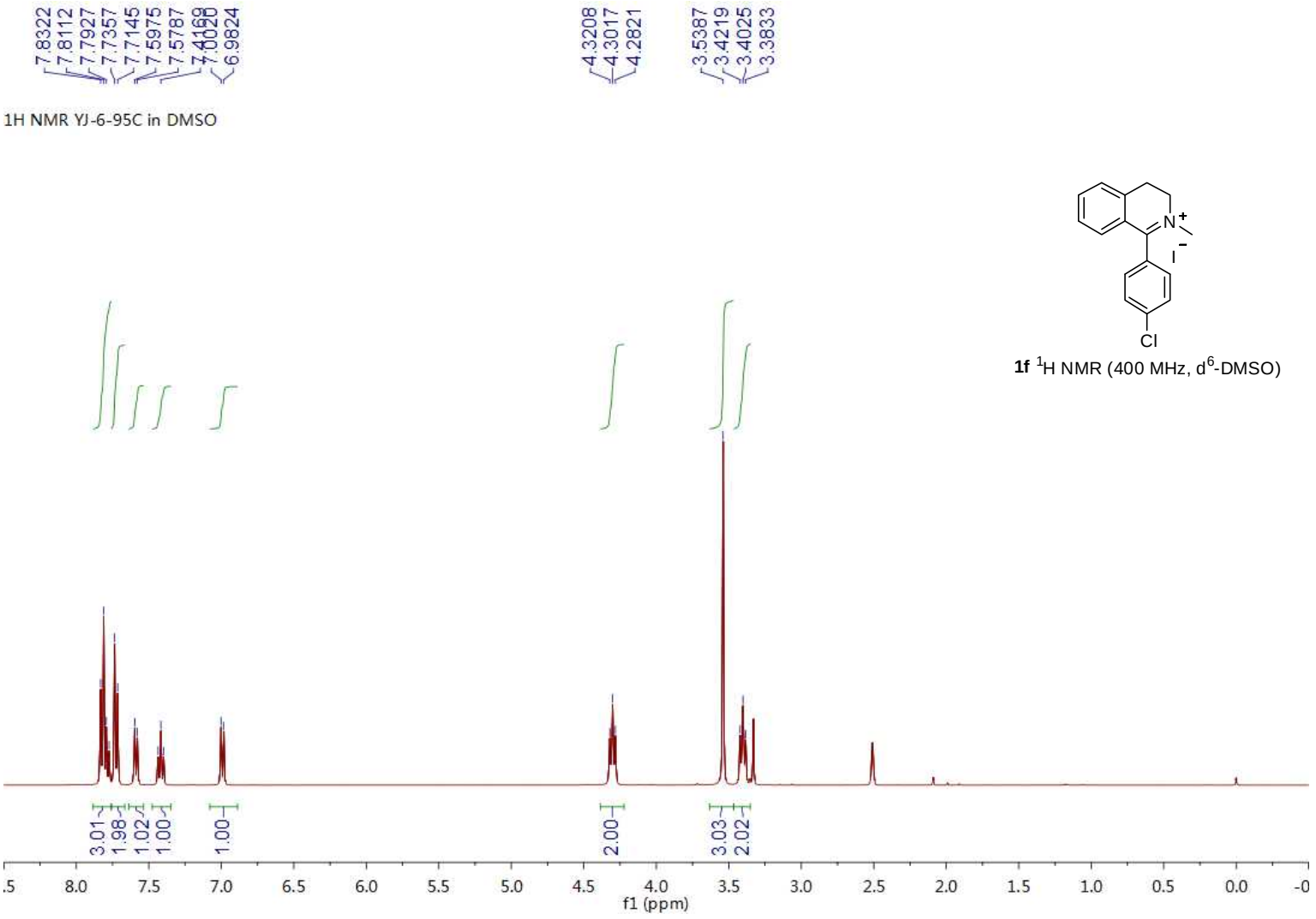

**1e** $^{1}$H NMR (400 MHz, $CDCl_3$)



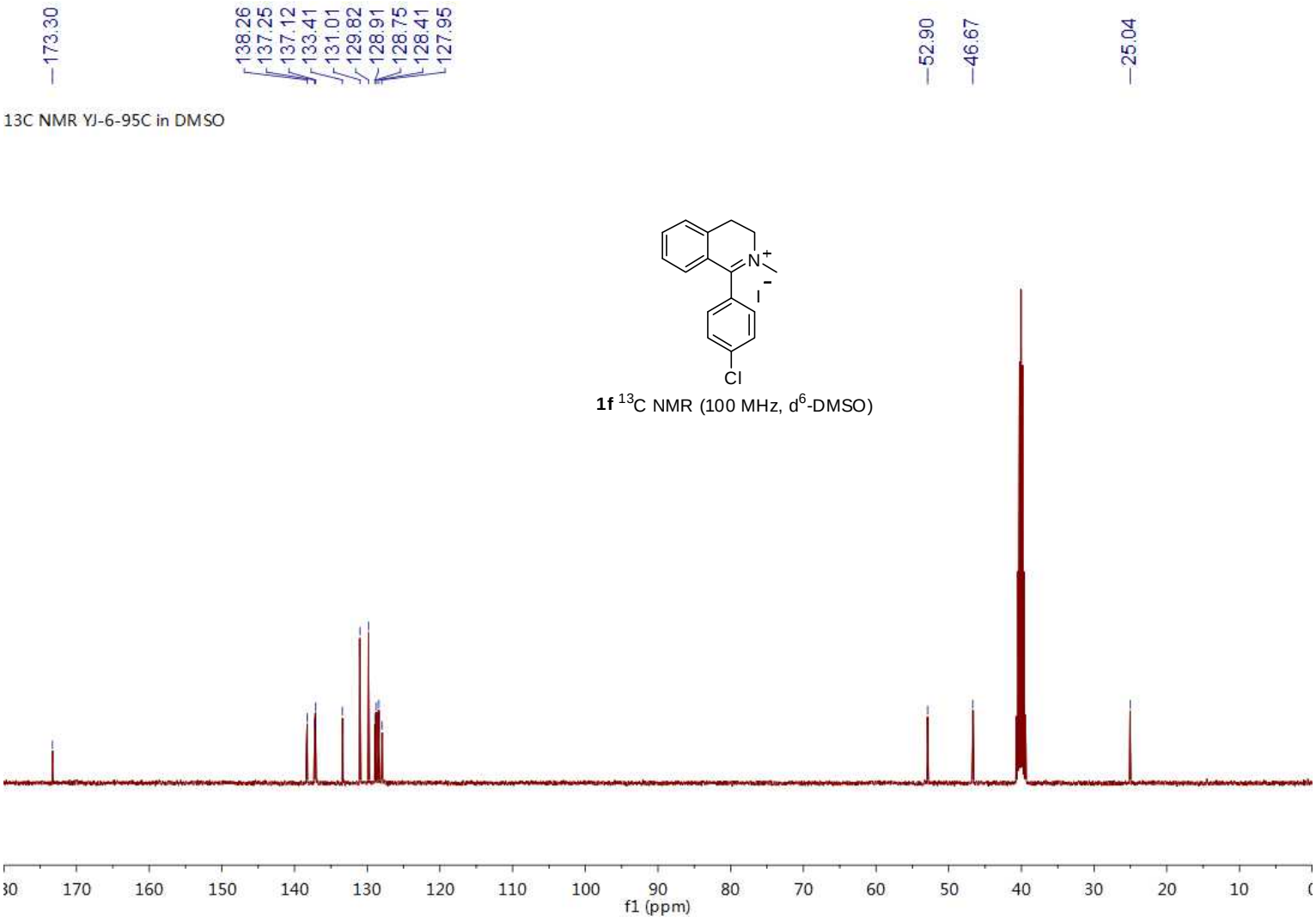

**1e** $^{13}$C NMR (100 MHz, $CDCl_3$)



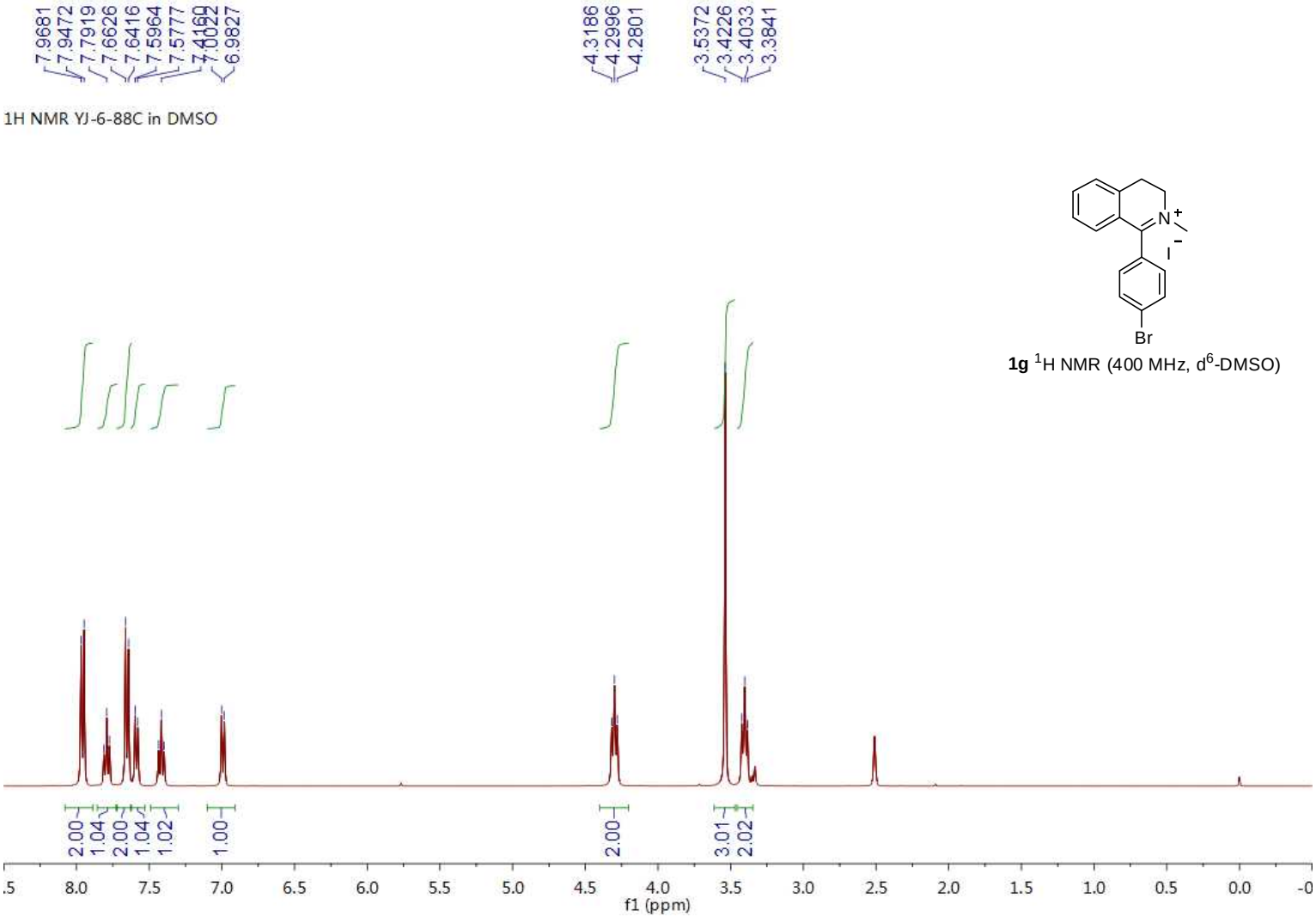

**1e** $^{19}$F NMR (376 MHz, $CDCl_3$)




**1f** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)



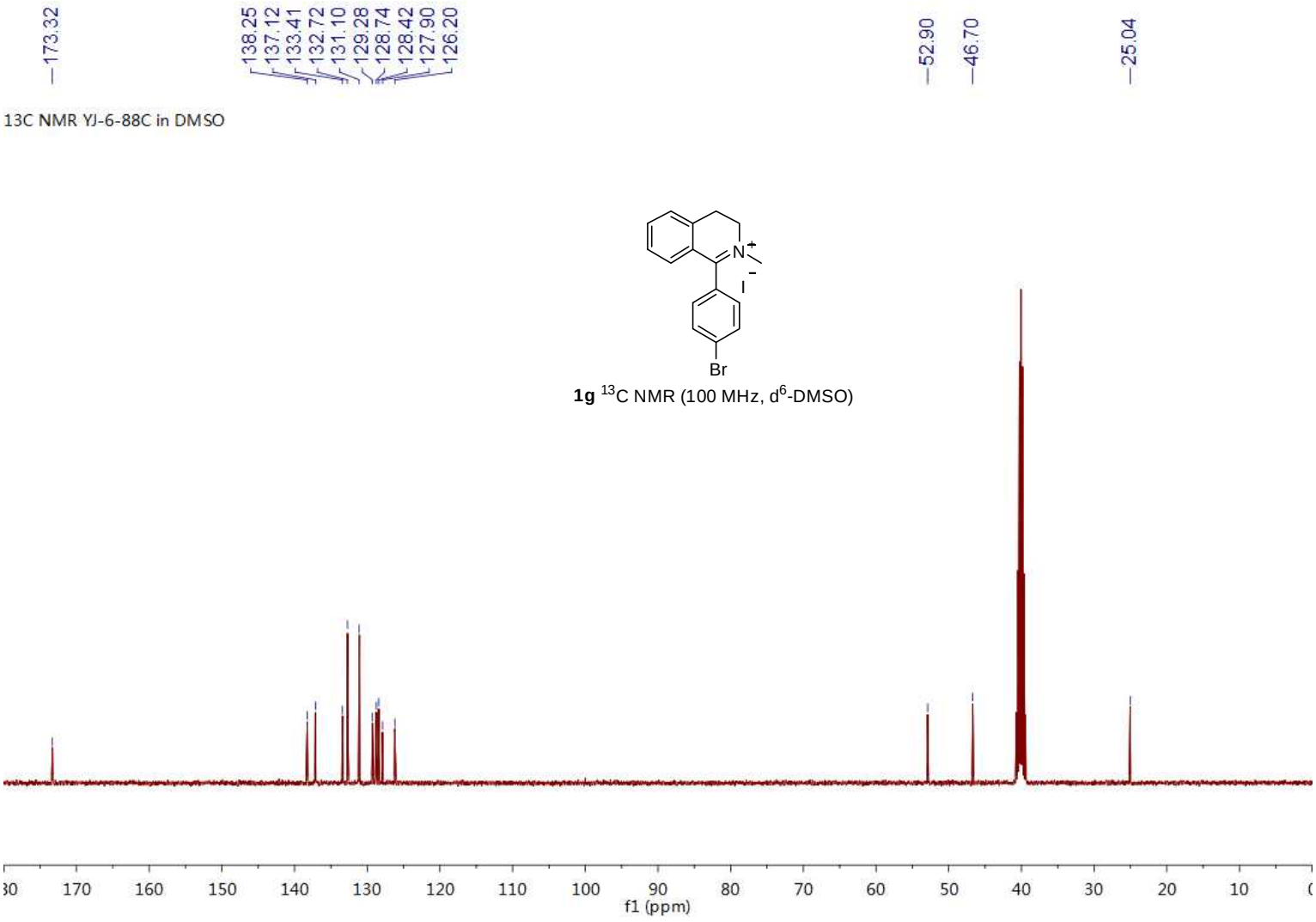

**1f** $^{13}$C NMR (100 MHz, d$^6$-DMSO)







**1g** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)

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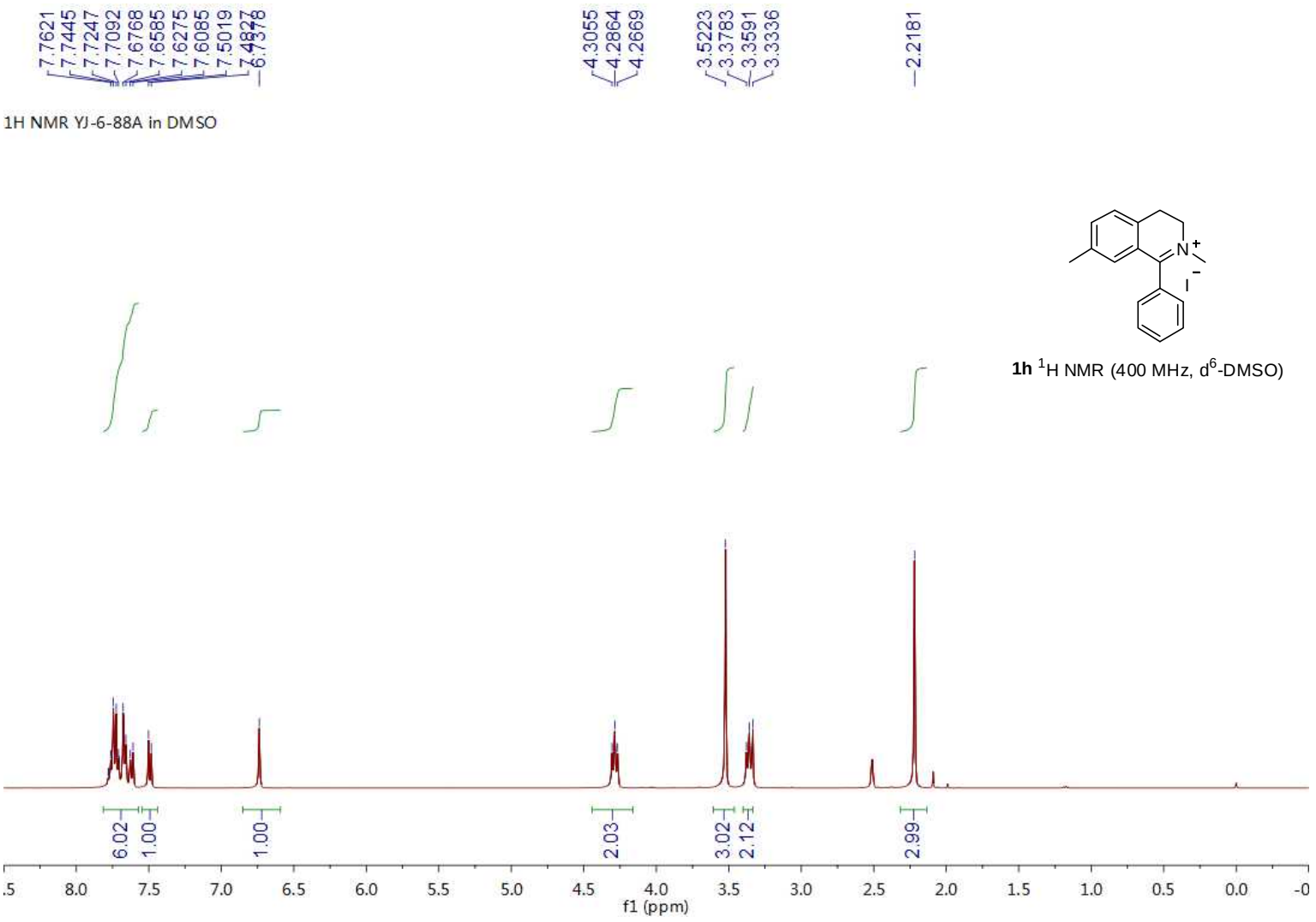
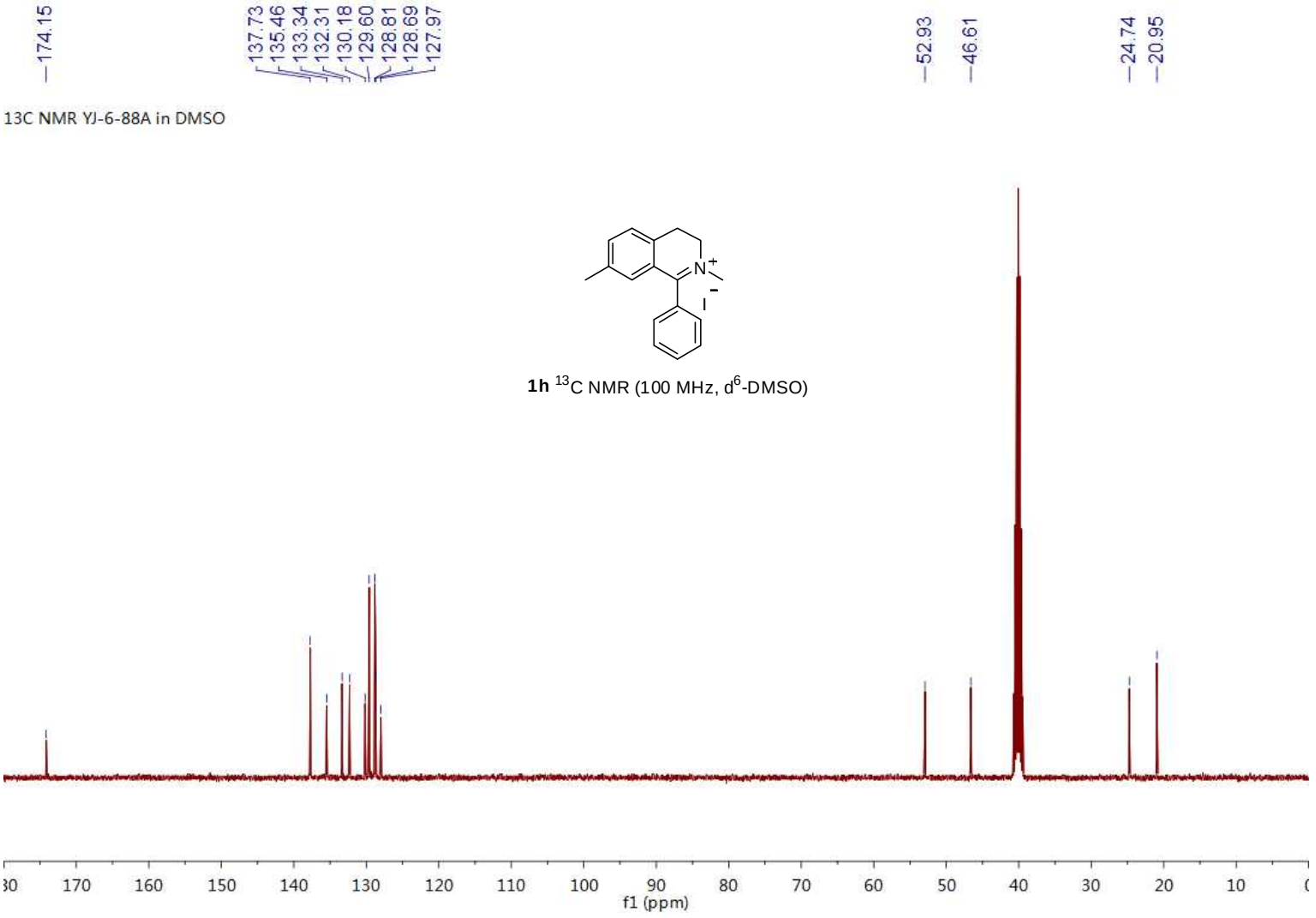
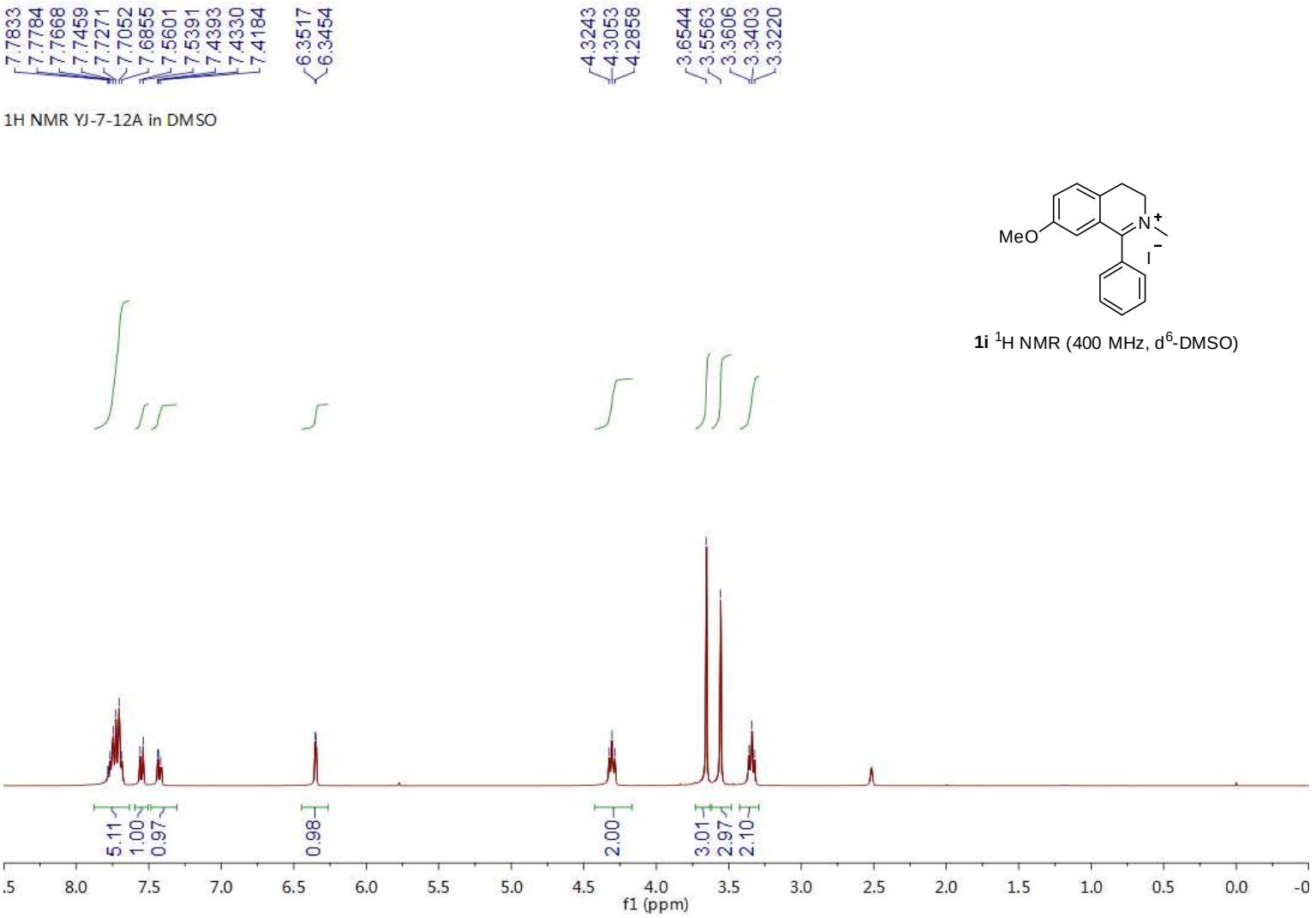


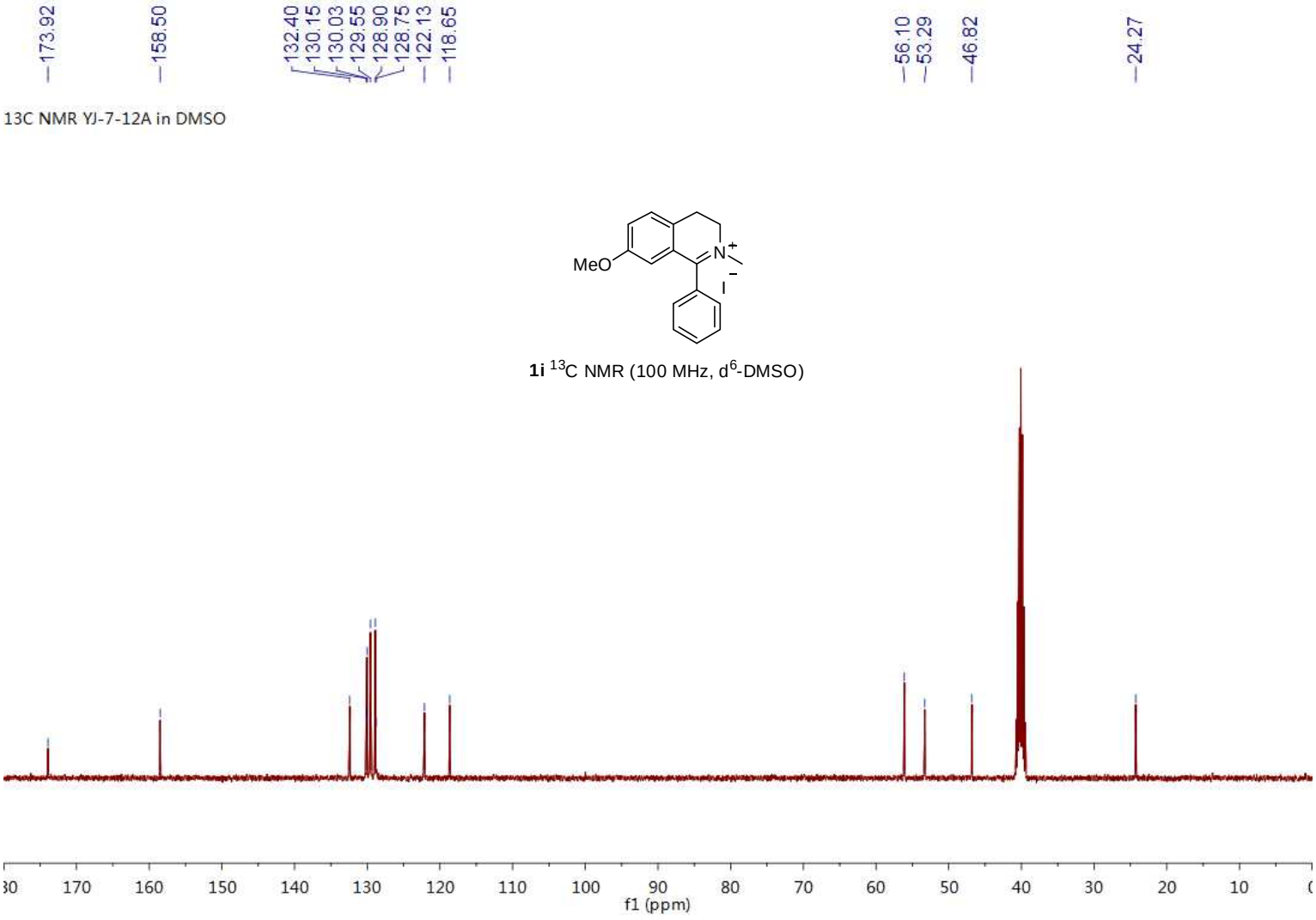

**1h** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)



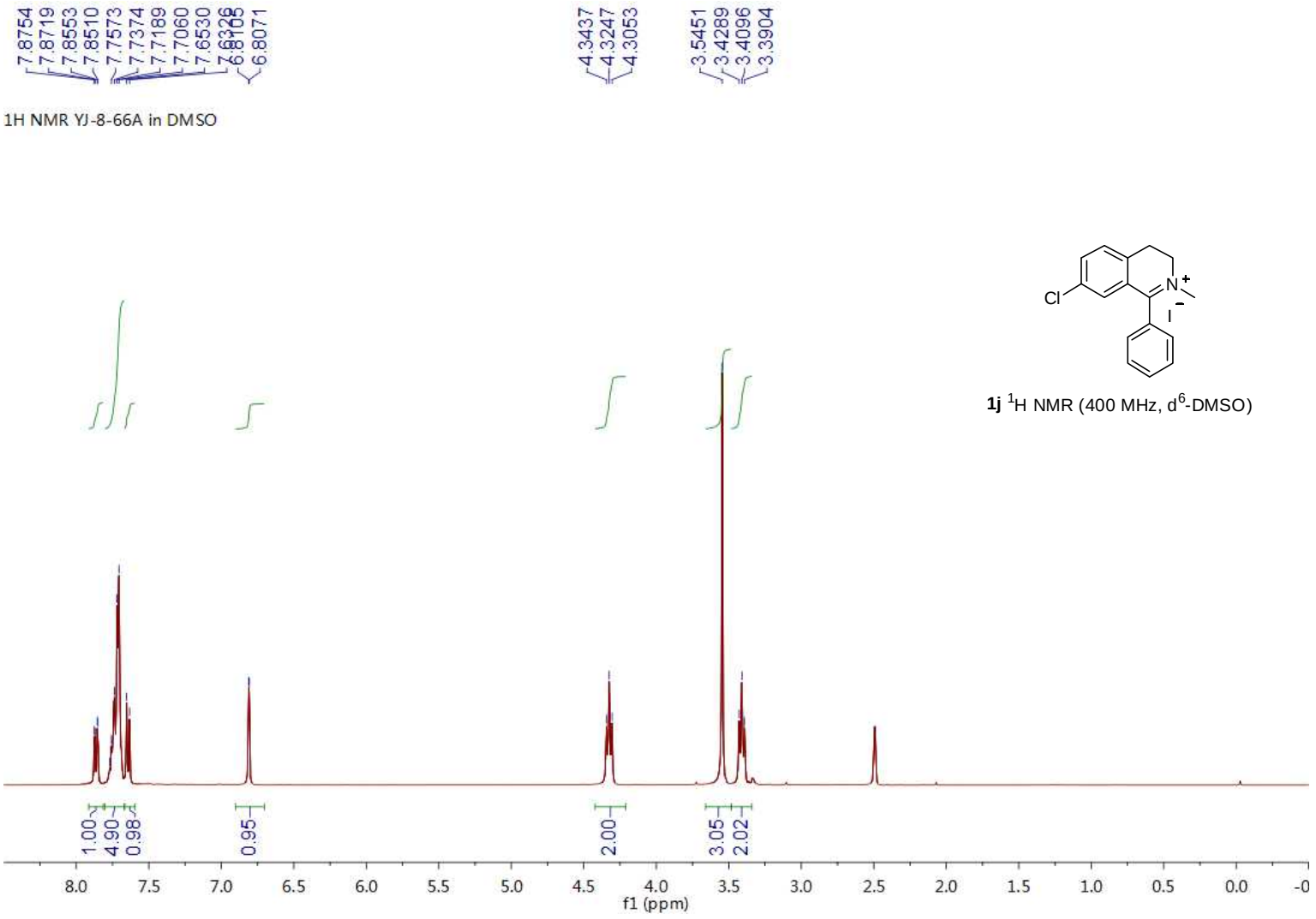

**1h** $^{13}$C NMR (100 MHz, d$^6$-DMSO)




**1i** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)



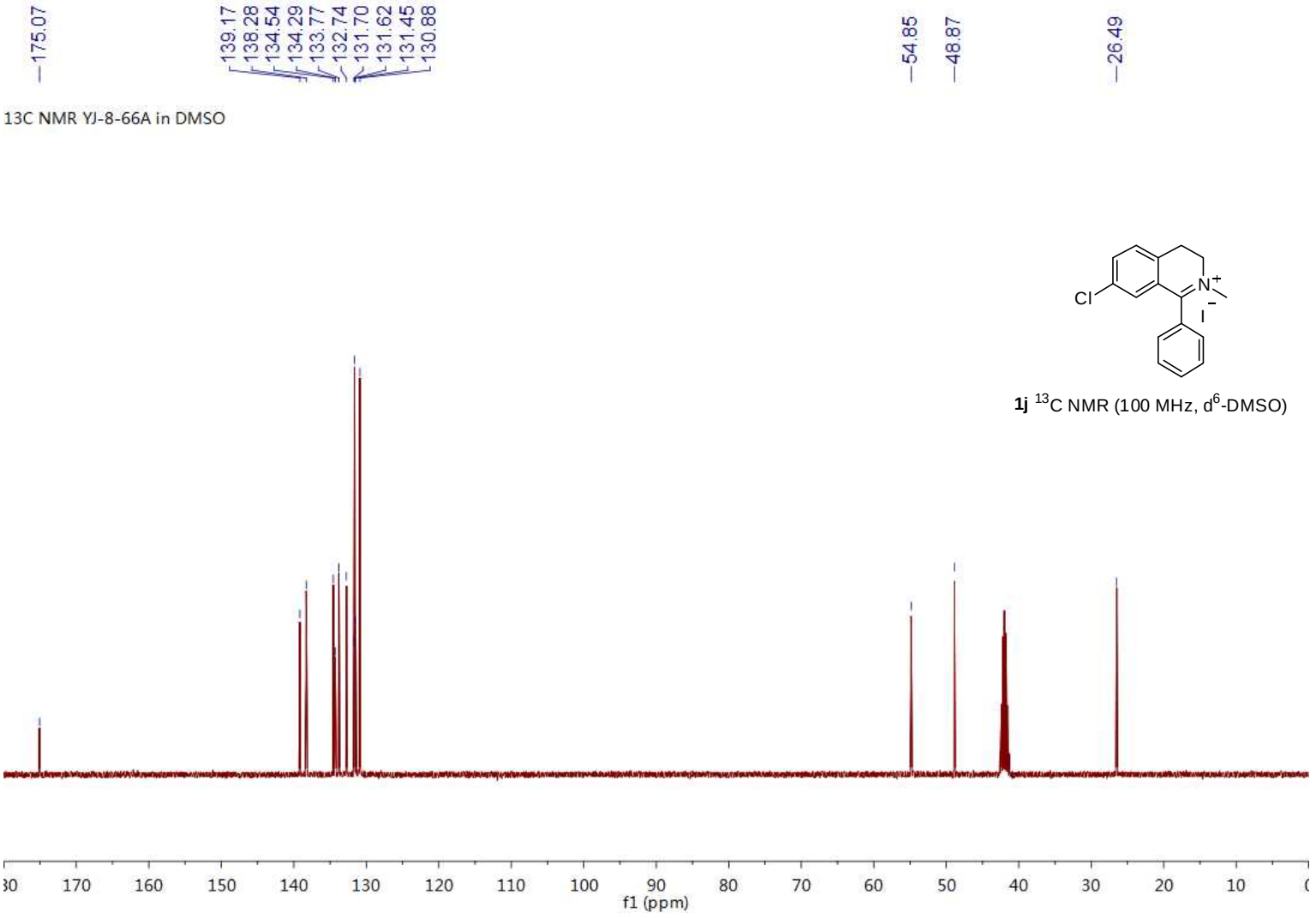

**1i** $^{13}$C NMR (100 MHz, d$^6$-DMSO)







**1j** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)

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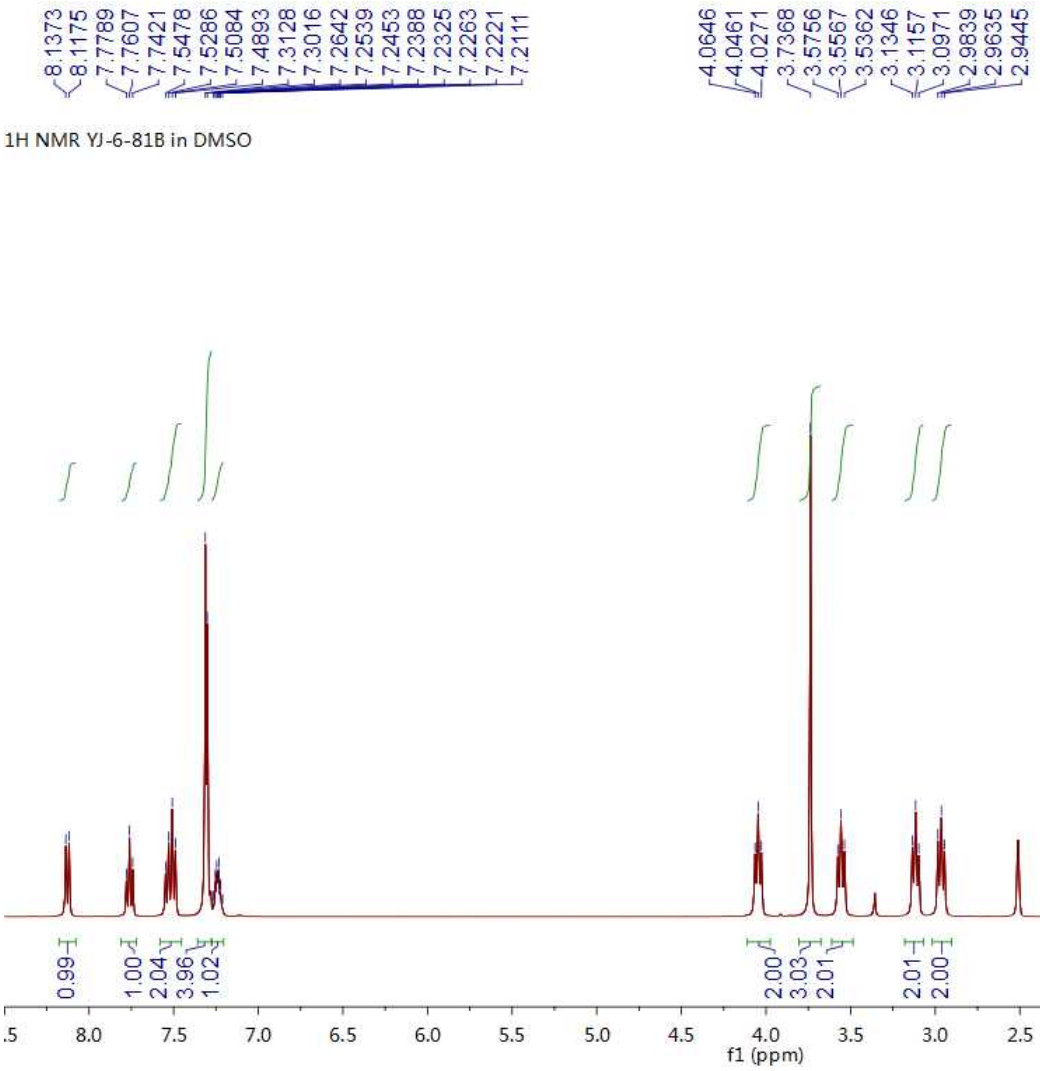
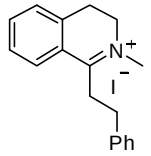
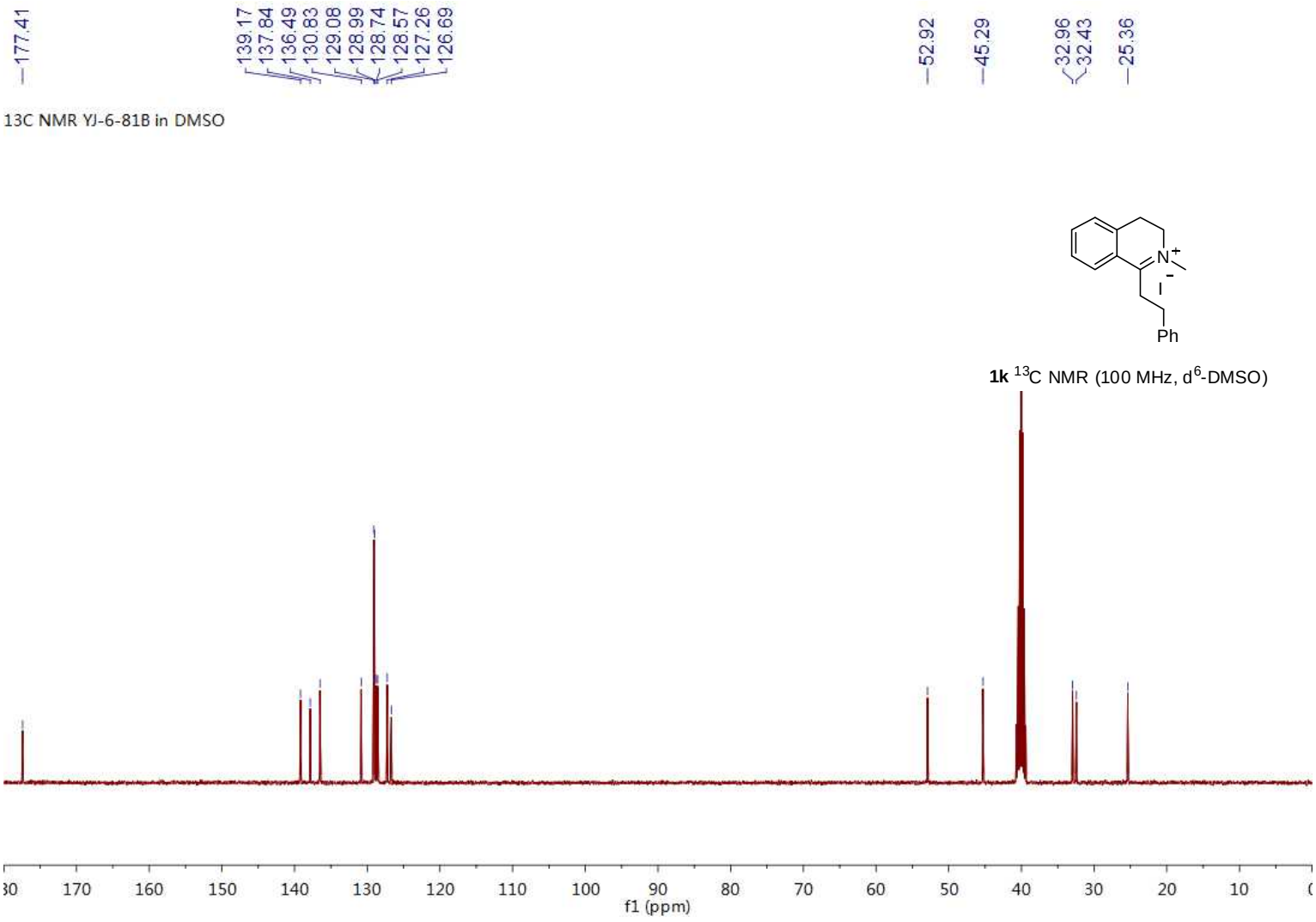
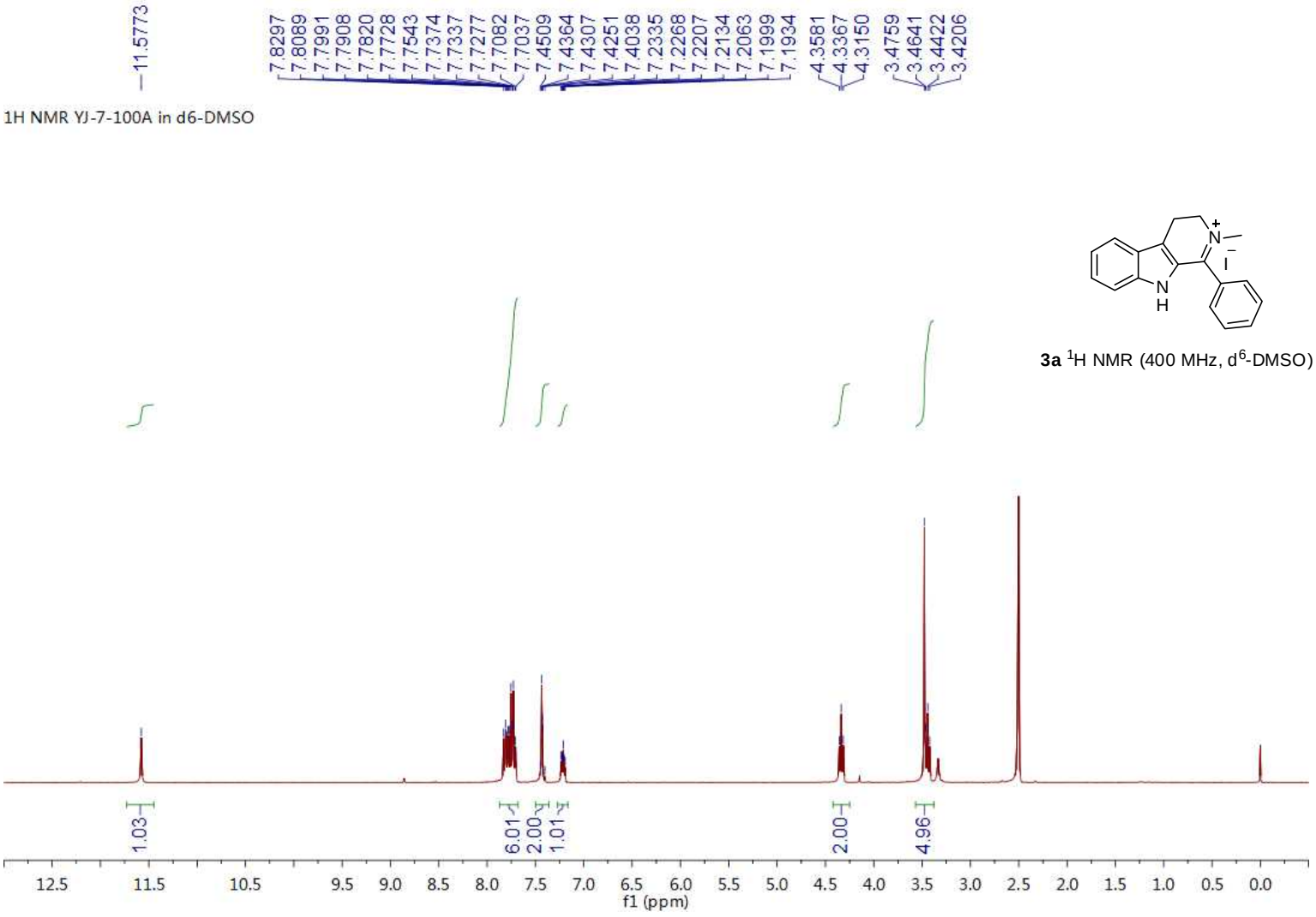



1H NMR YJ-6-81B in DMSO

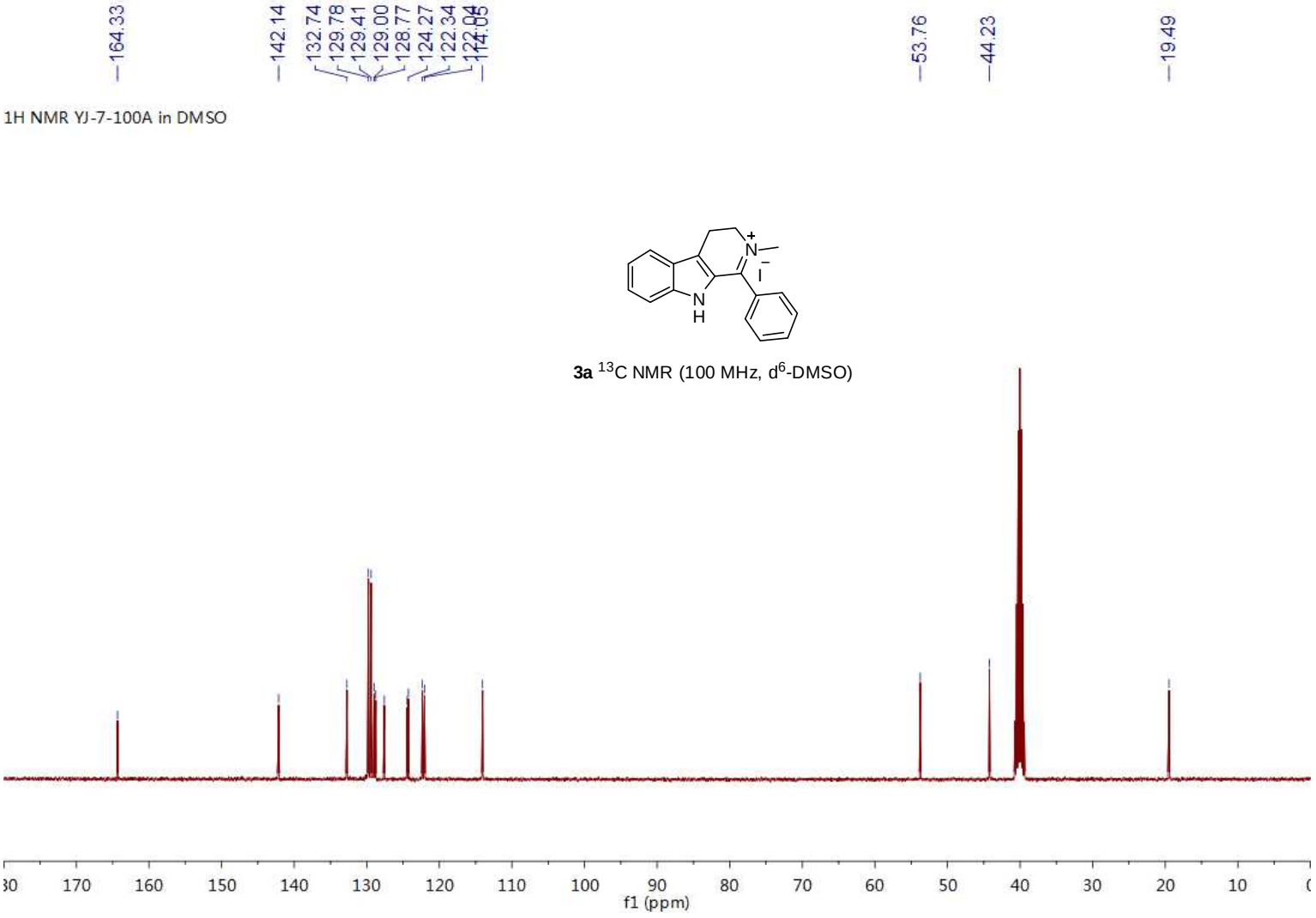



**1k** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)

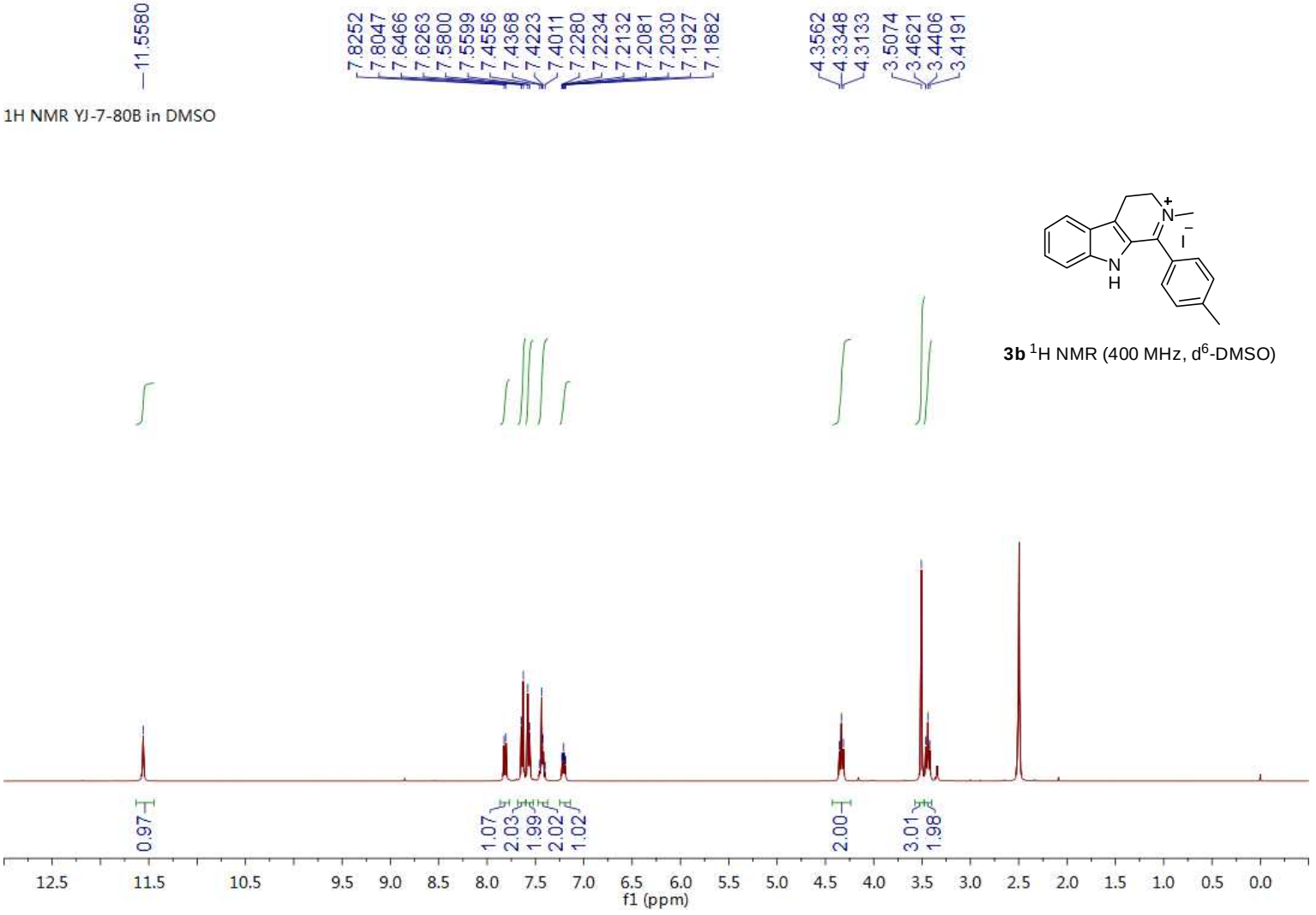

177.41
139.17
137.84
136.49
130.83
129.08
128.99
128.74
128.57
127.26
126.69
52.92
45.29
32.96
32.43
25.36
13C NMR YJ-6-81B in DMSO
N+
I-
Ph
1k 13C NMR (100 MHz, d6-DMSO)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)




**3a** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)

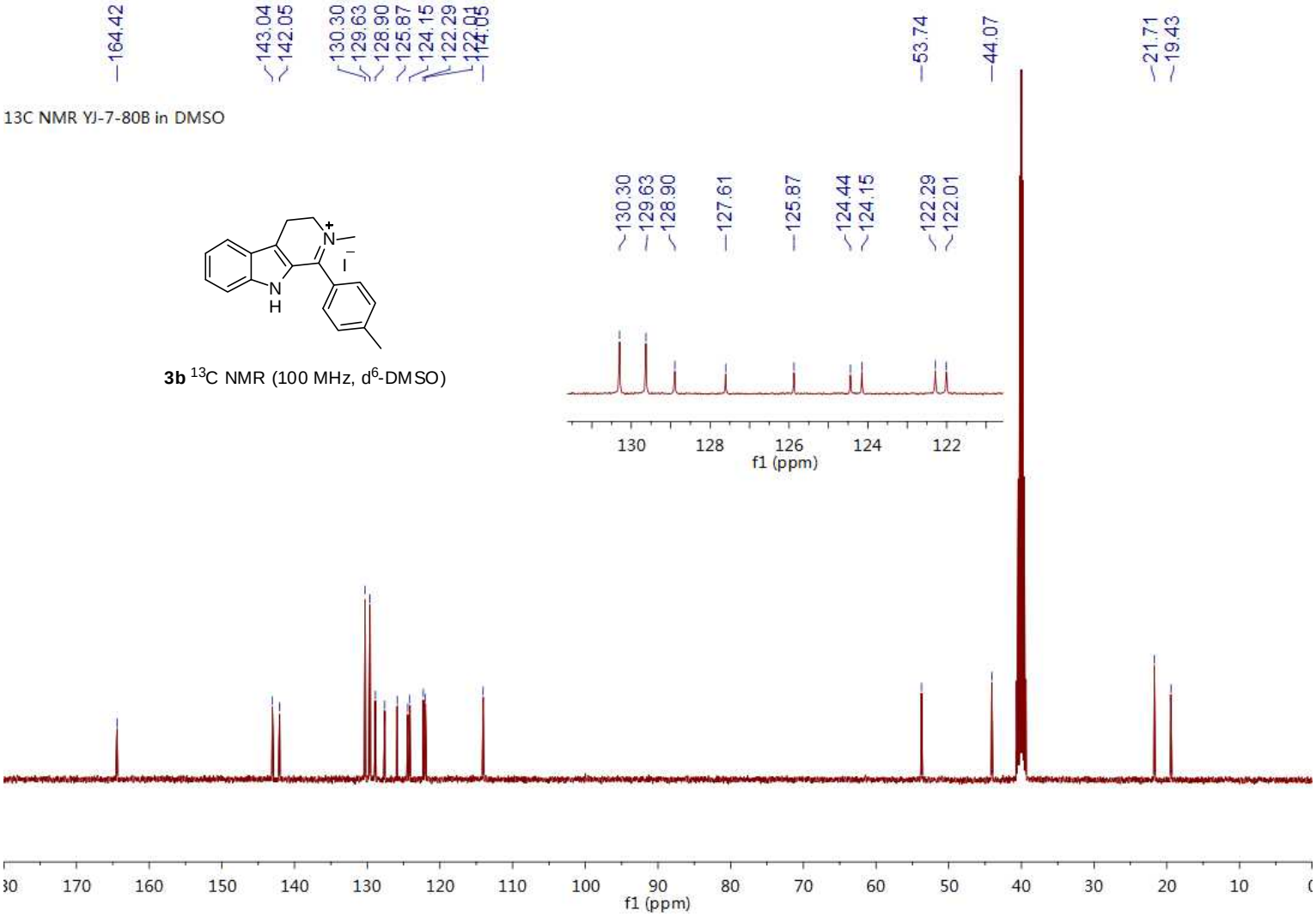



**3a** $^{13}$C NMR (100 MHz, d$^6$-DMSO)

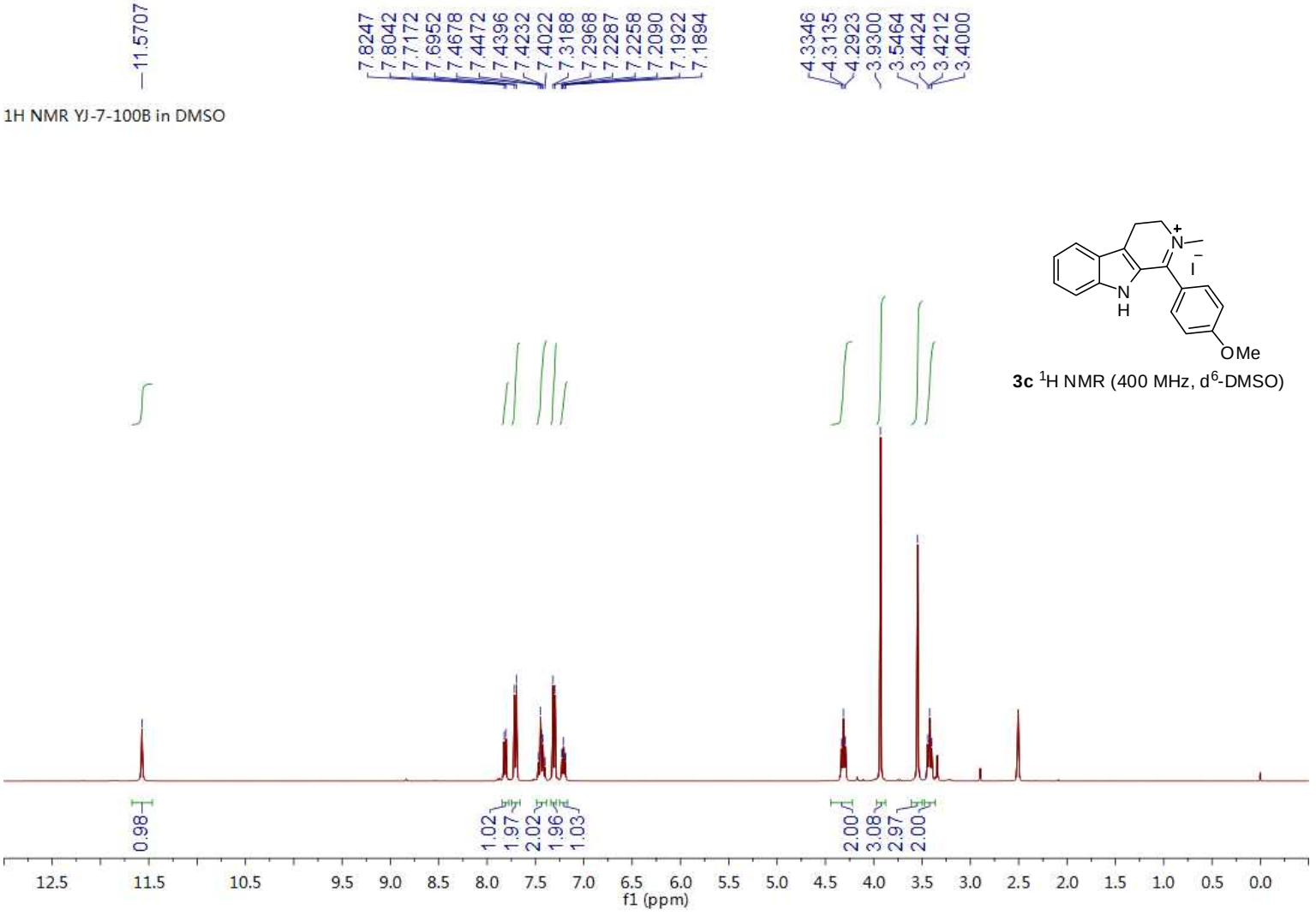




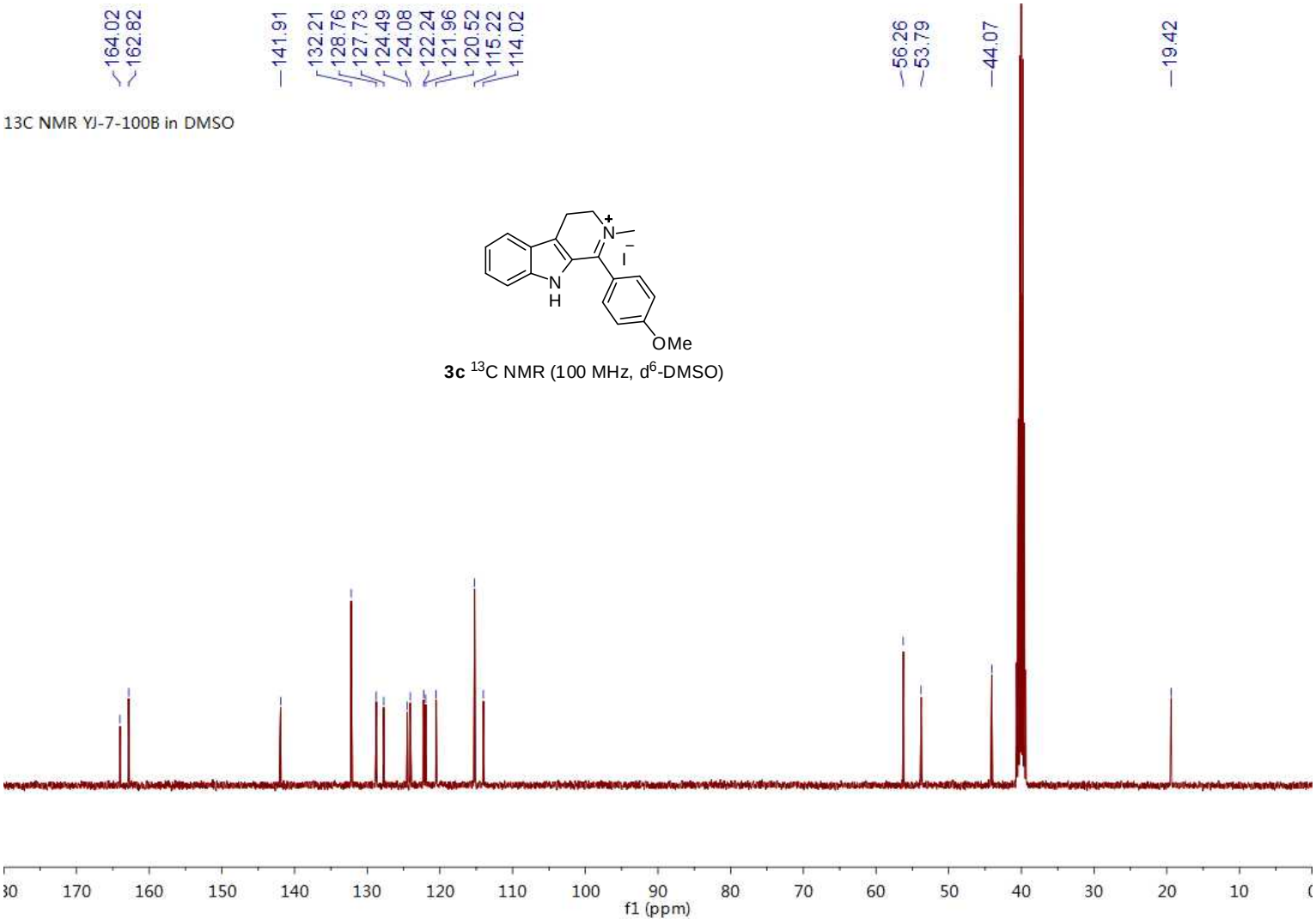

**3b** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)




**3b** $^{13}$C NMR (100 MHz, d$^6$-DMSO)

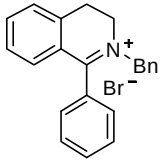



**3c** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)

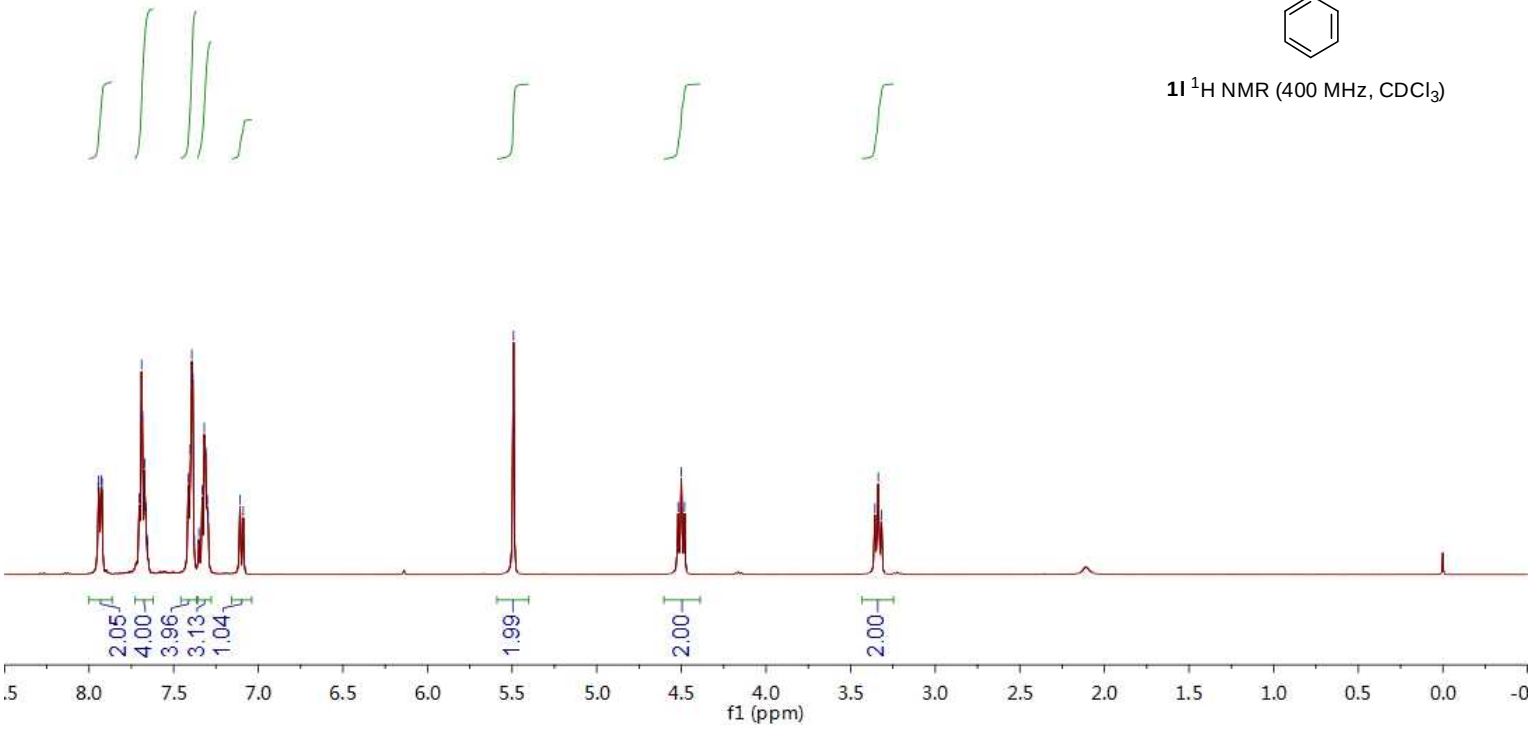


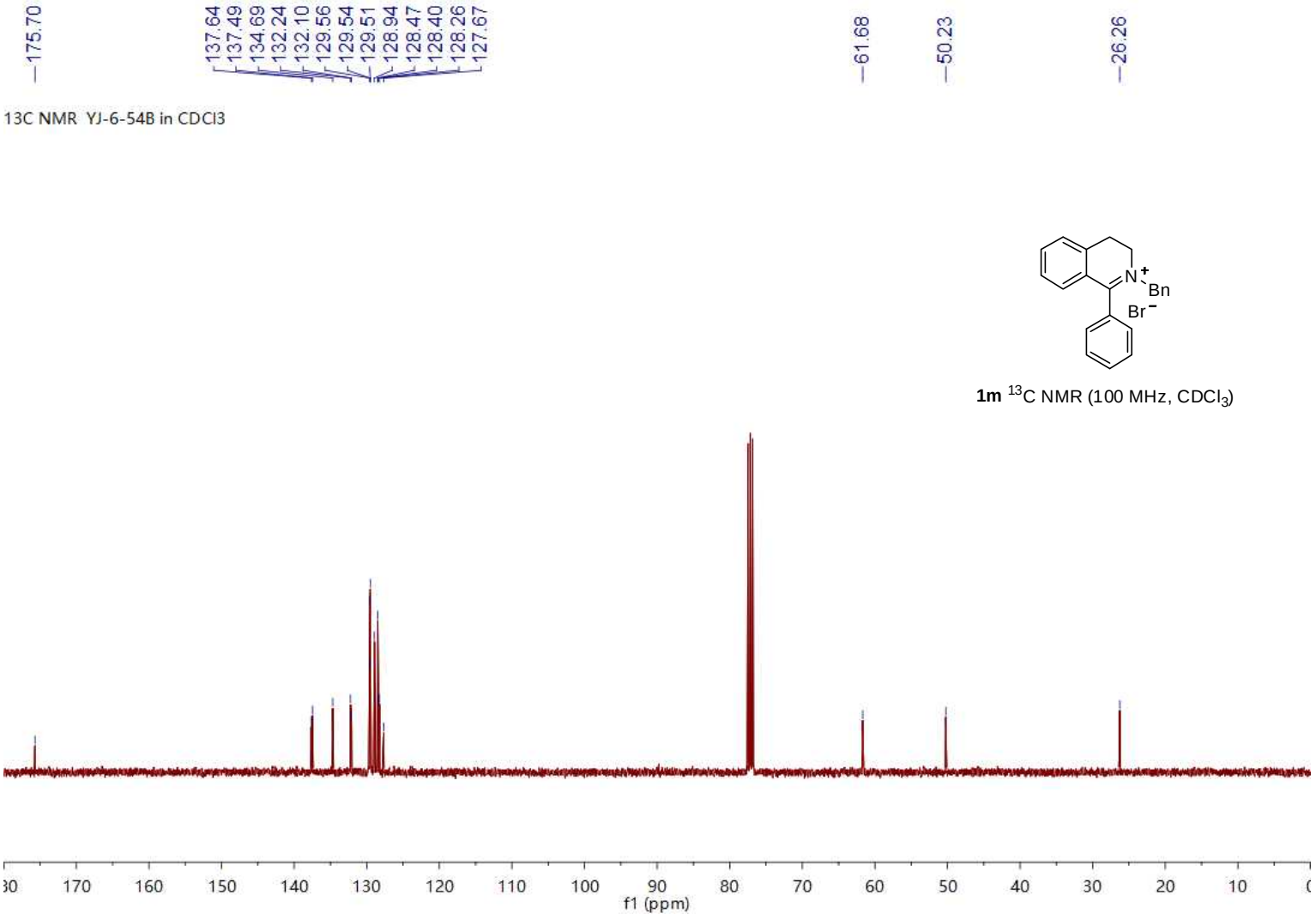

**3c** $^{13}$C NMR (100 MHz, d$^6$-DMSO)


1H NMR YJ-6-54B in CDCl3



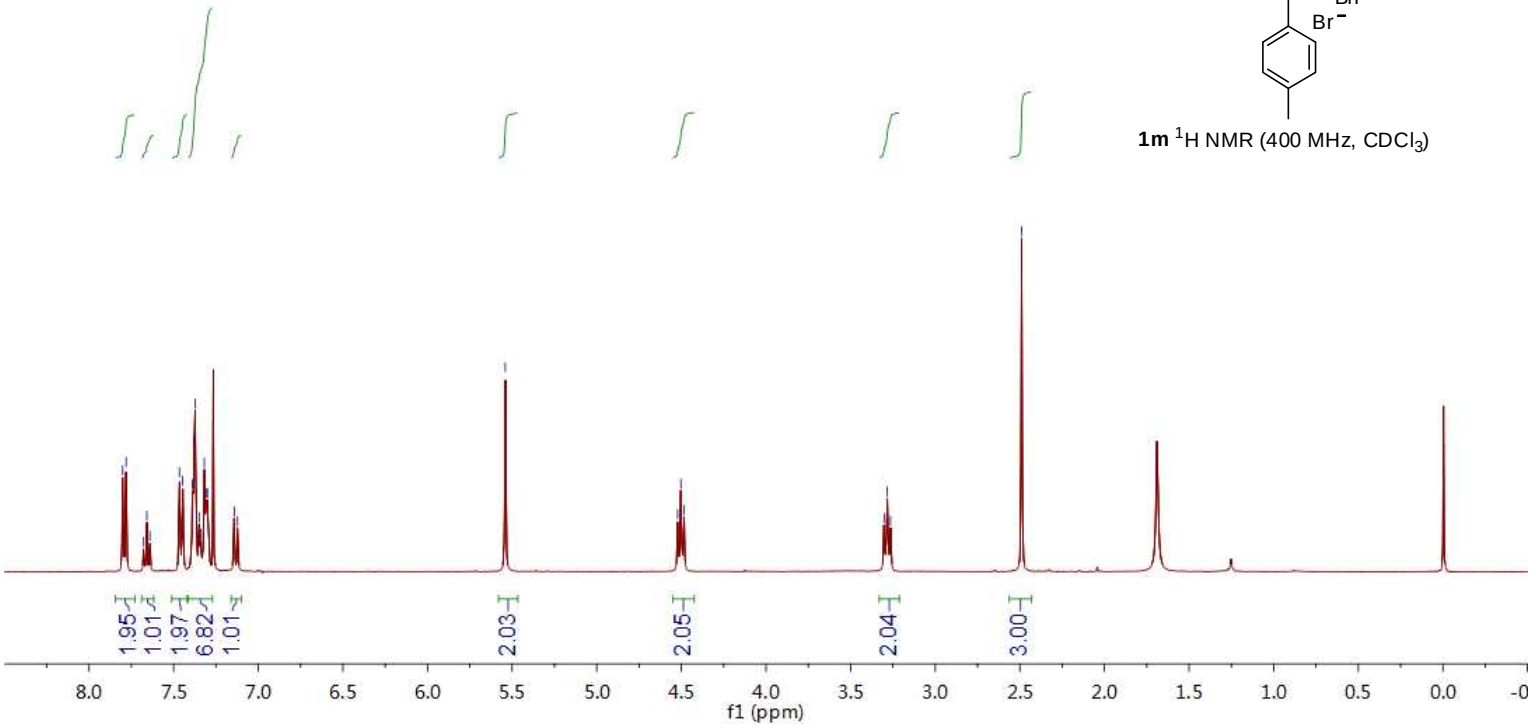

**1l** $^1$H NMR (400 MHz, $CDCl_3$)

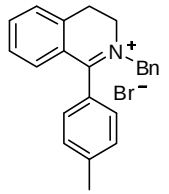




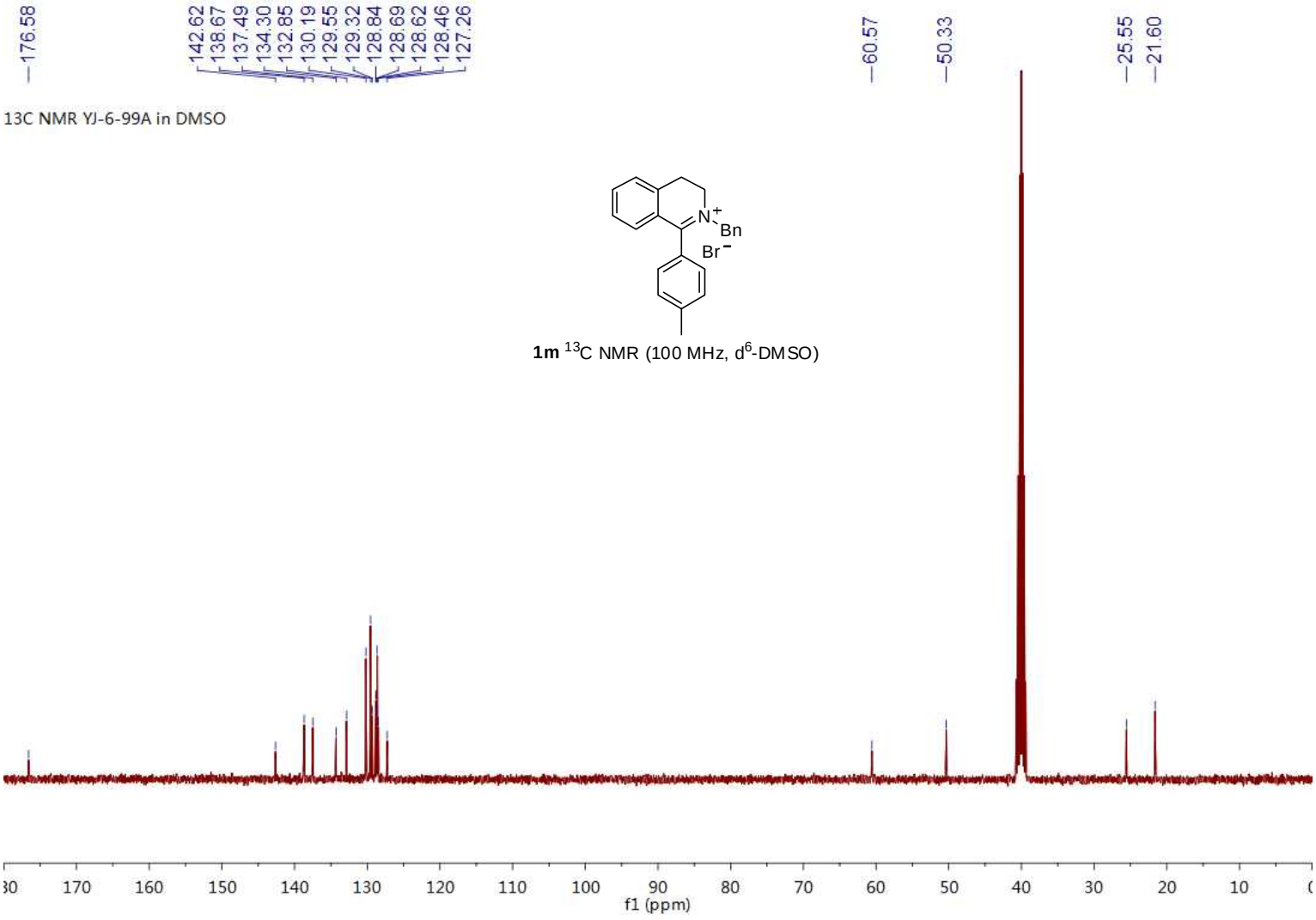

**1m** $^{13}$C NMR (100 MHz, $CDCl_3$)


1H NMR YJ-6-99A in CDCl3

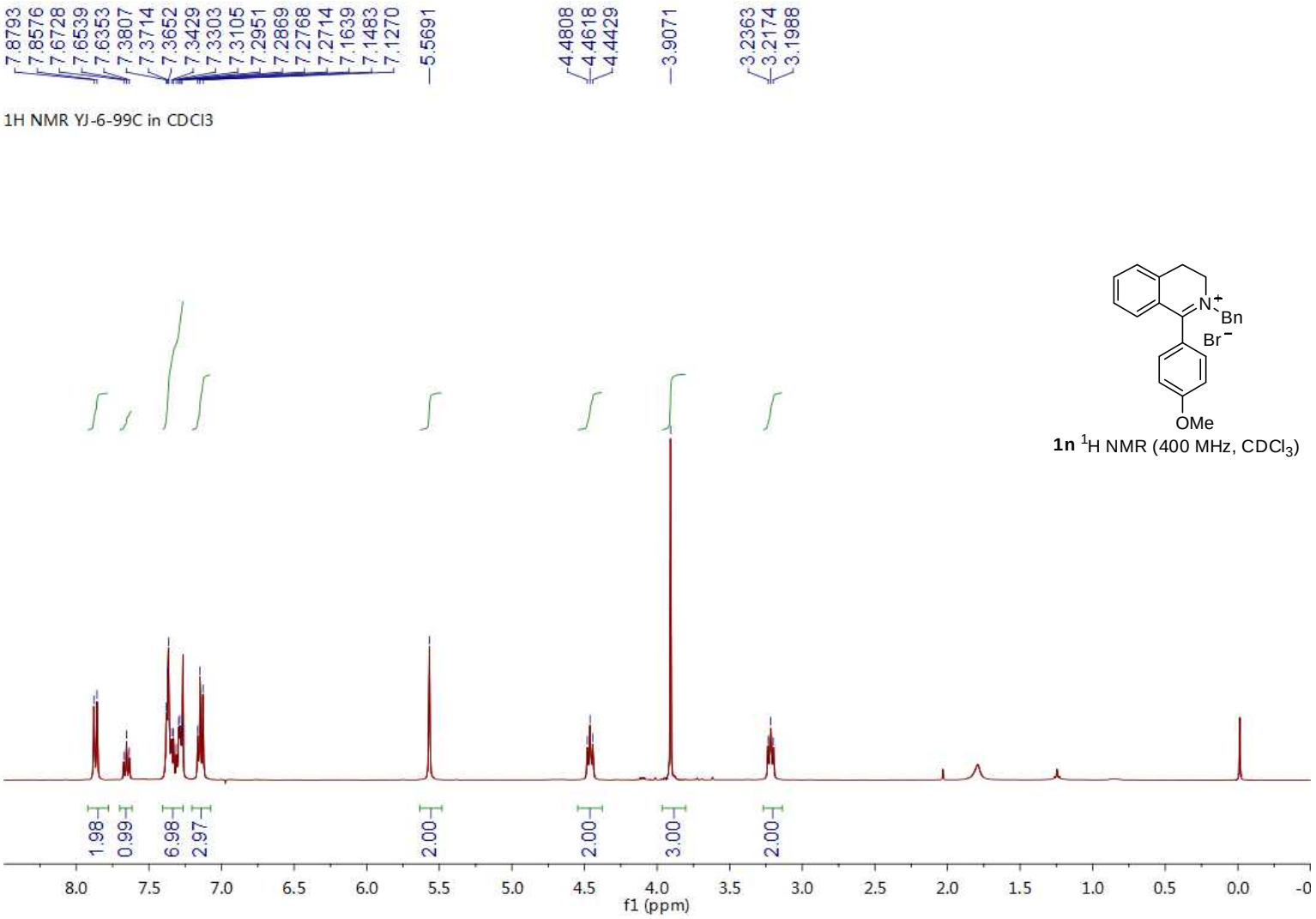



**1m** $^{1}$H NMR (400 MHz, $CDCl_3$)




**1m** $^{13}$C NMR (100 MHz, d$^6$-DMSO)

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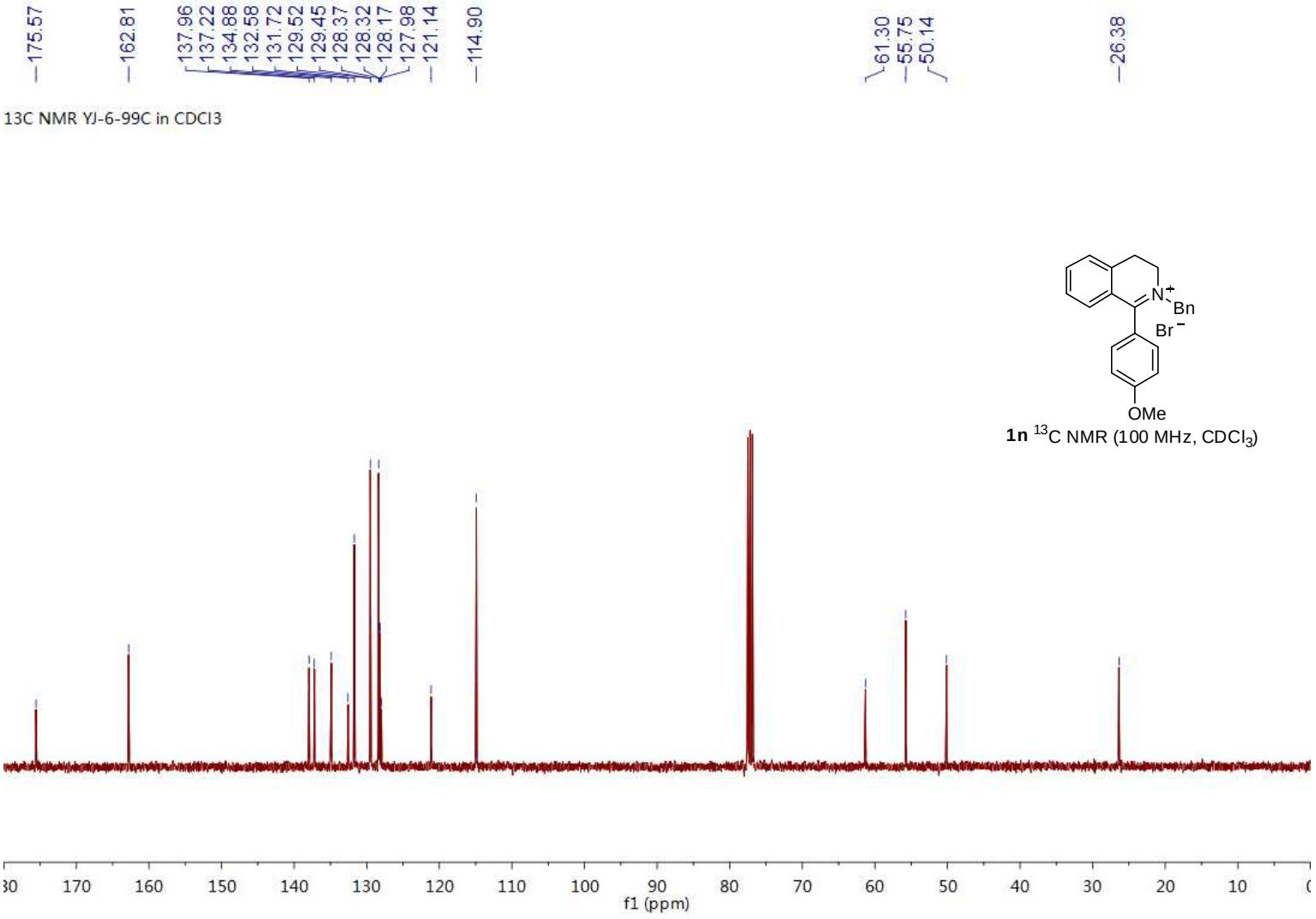
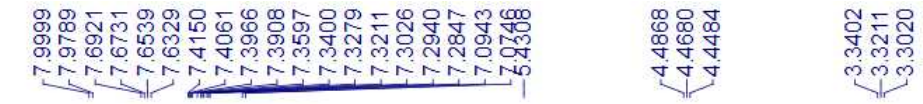
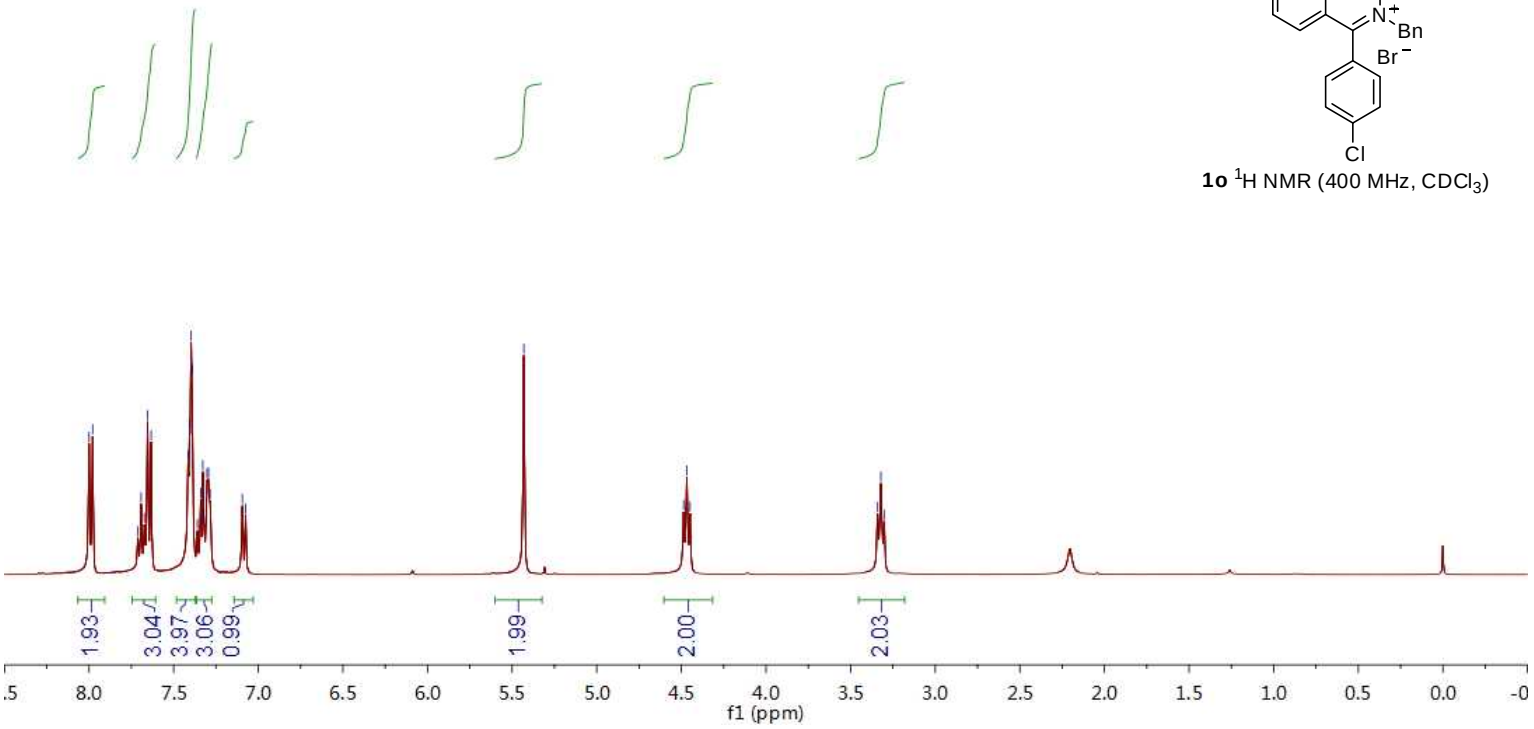
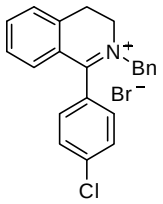



**1n** $^{13}$C NMR (100 MHz, $CDCl_3$)

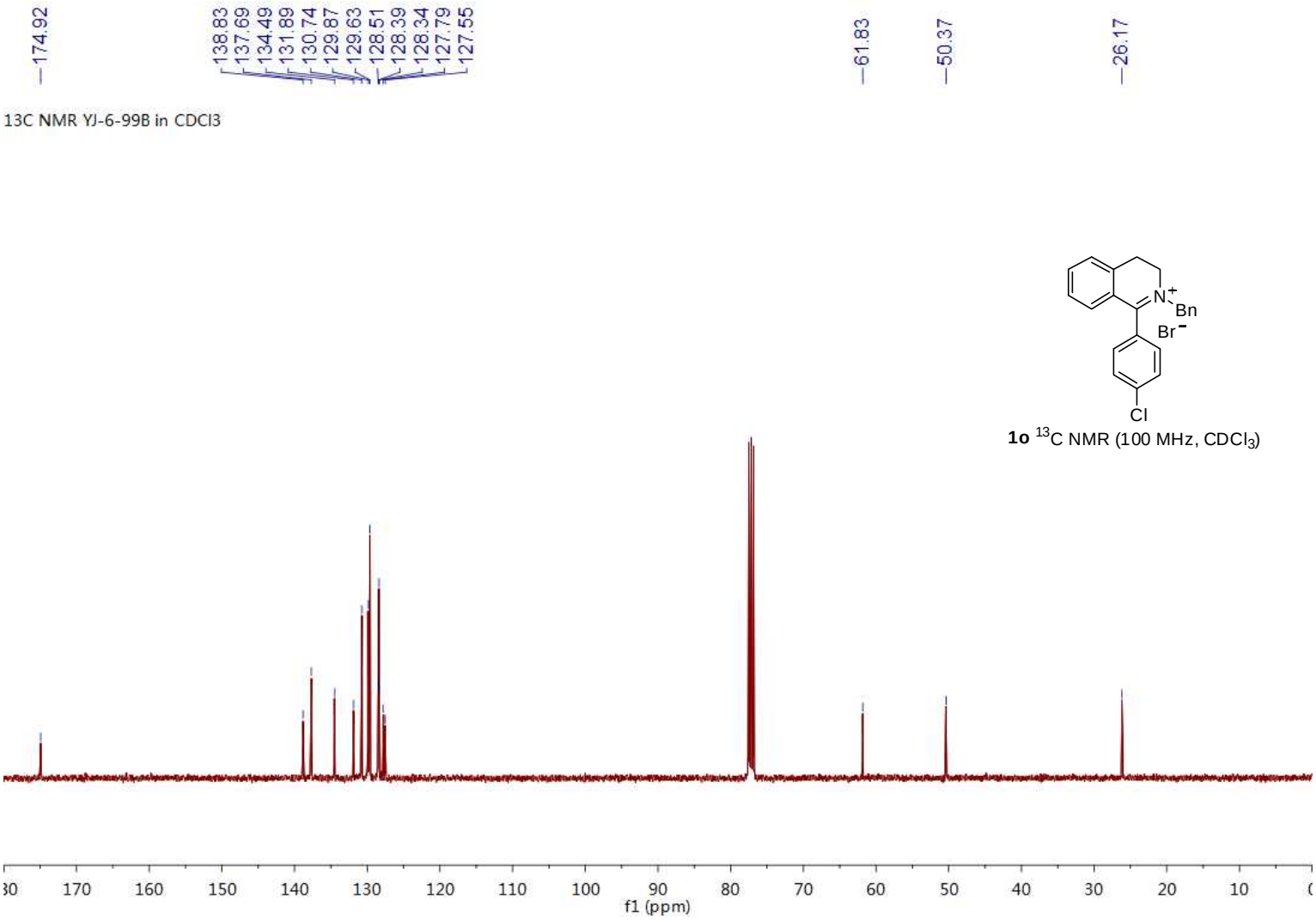



1H NMR YJ-6-99B in CDCl3

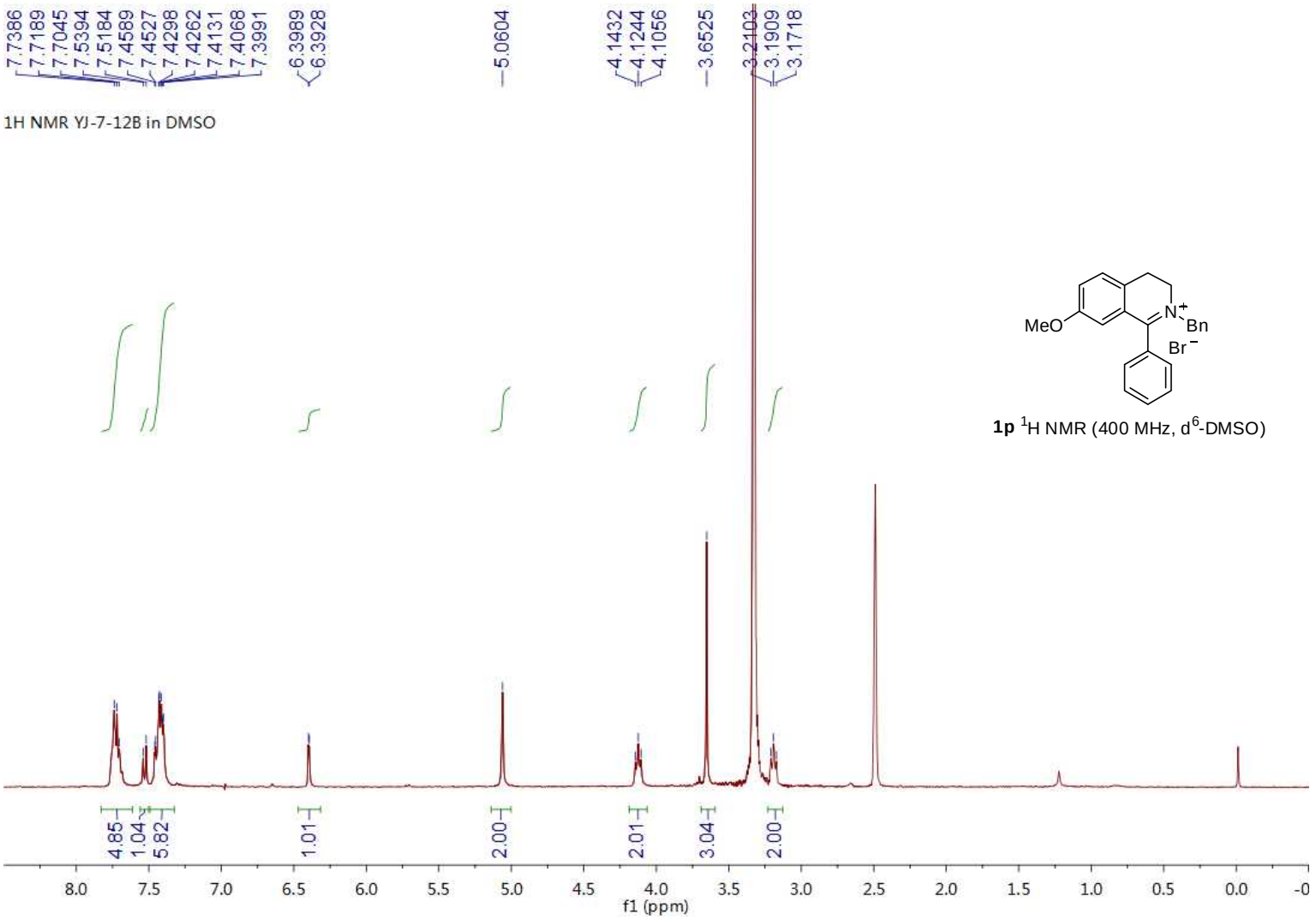



**1o** $^{1}$H NMR (400 MHz, $CDCl_3$)



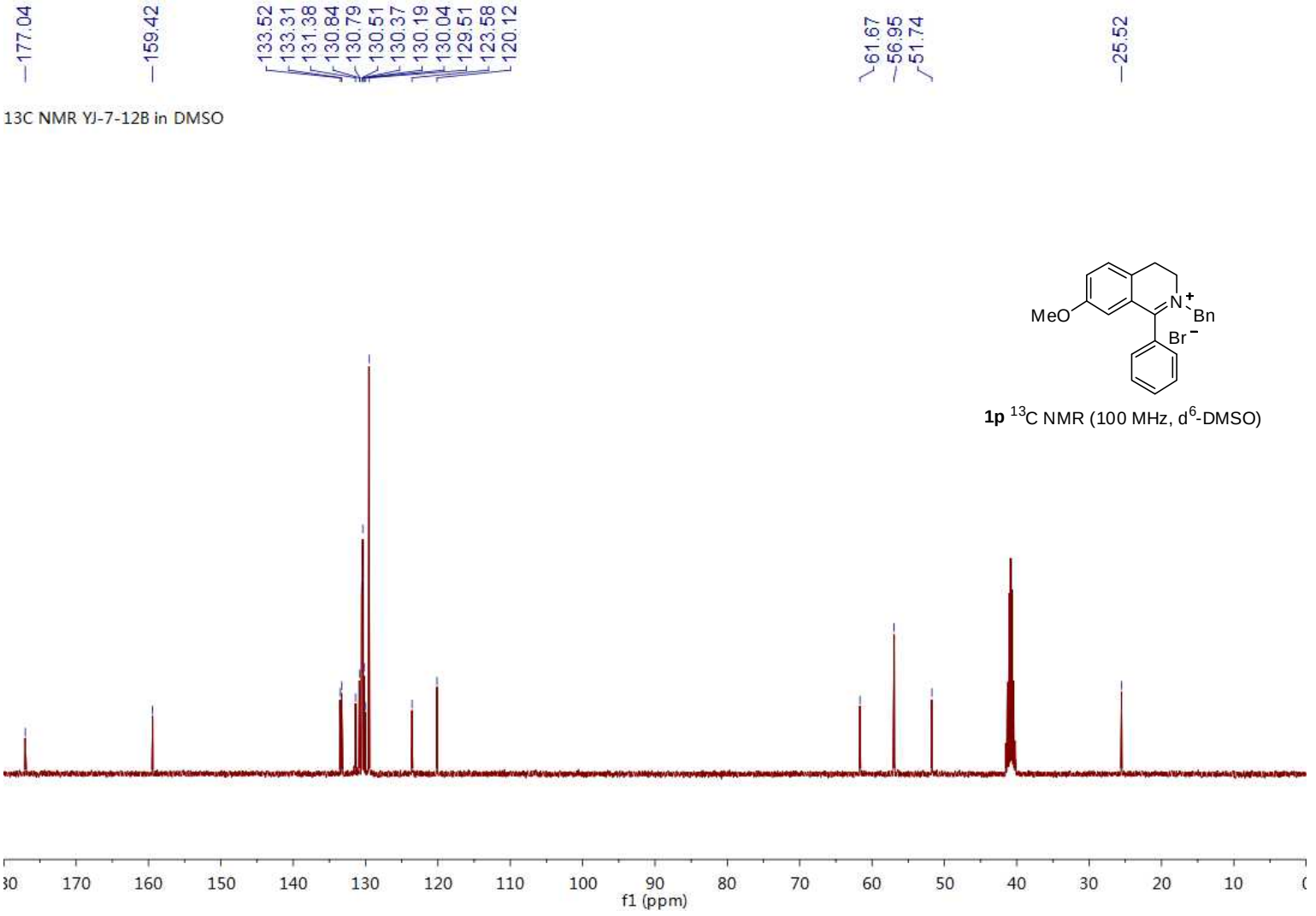

**1o** $^{13}C$ NMR (100 MHz, $CDCl_3$)



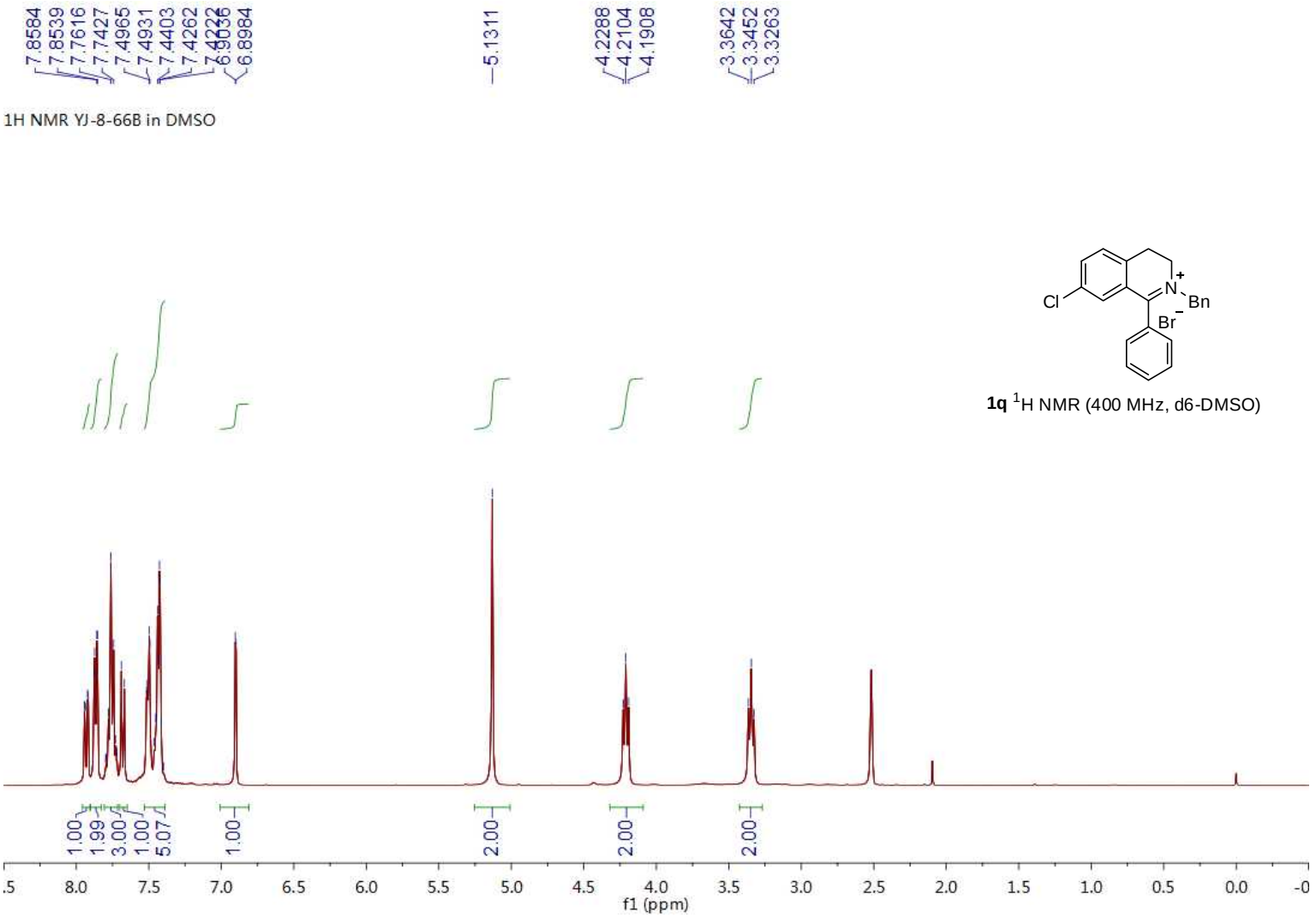




**1p** $^{1}$H NMR (400 MHz, d$^{6}$-DMSO)



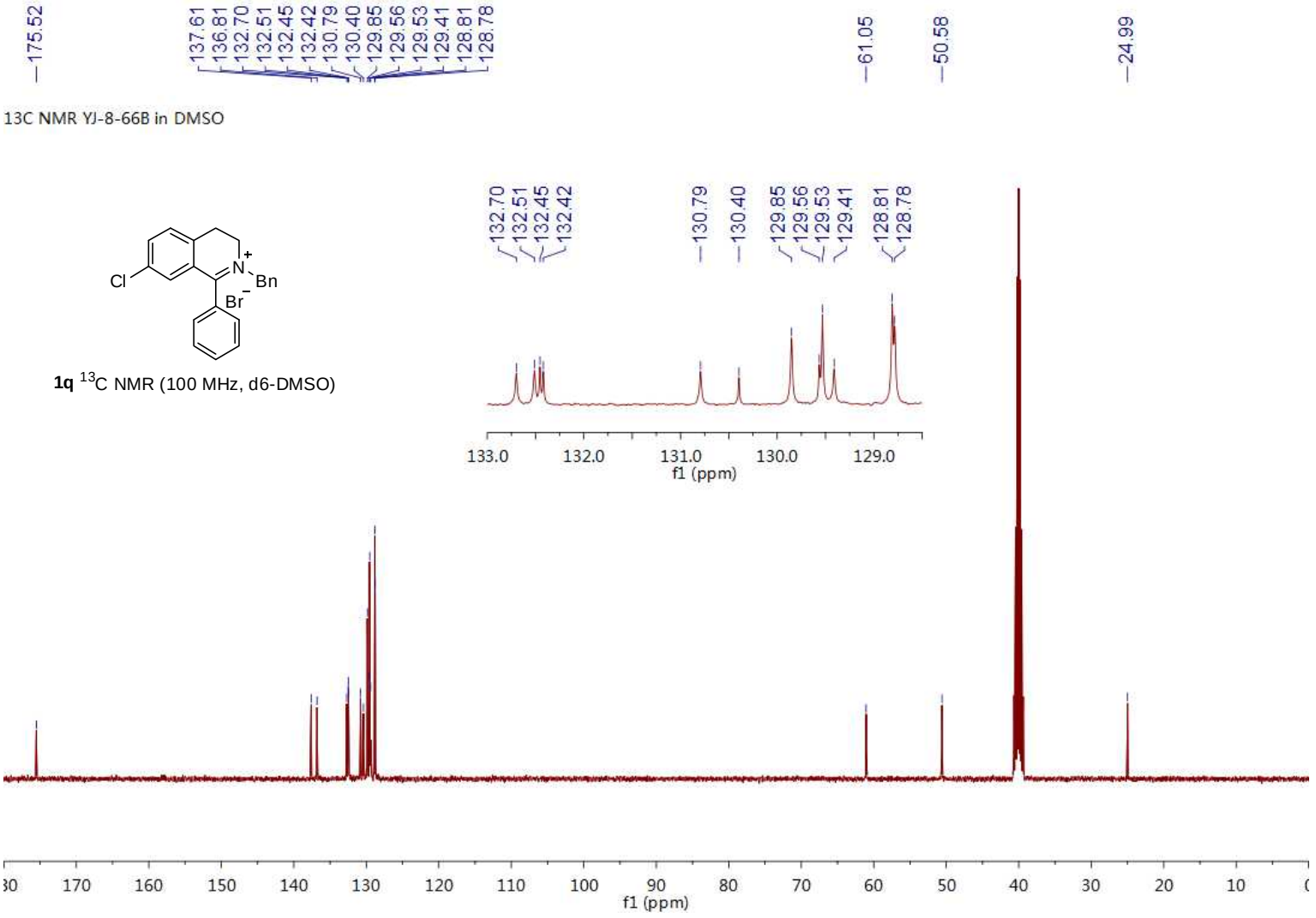

**1p** $^{13}$C NMR (100 MHz, d$^{6}$-DMSO)



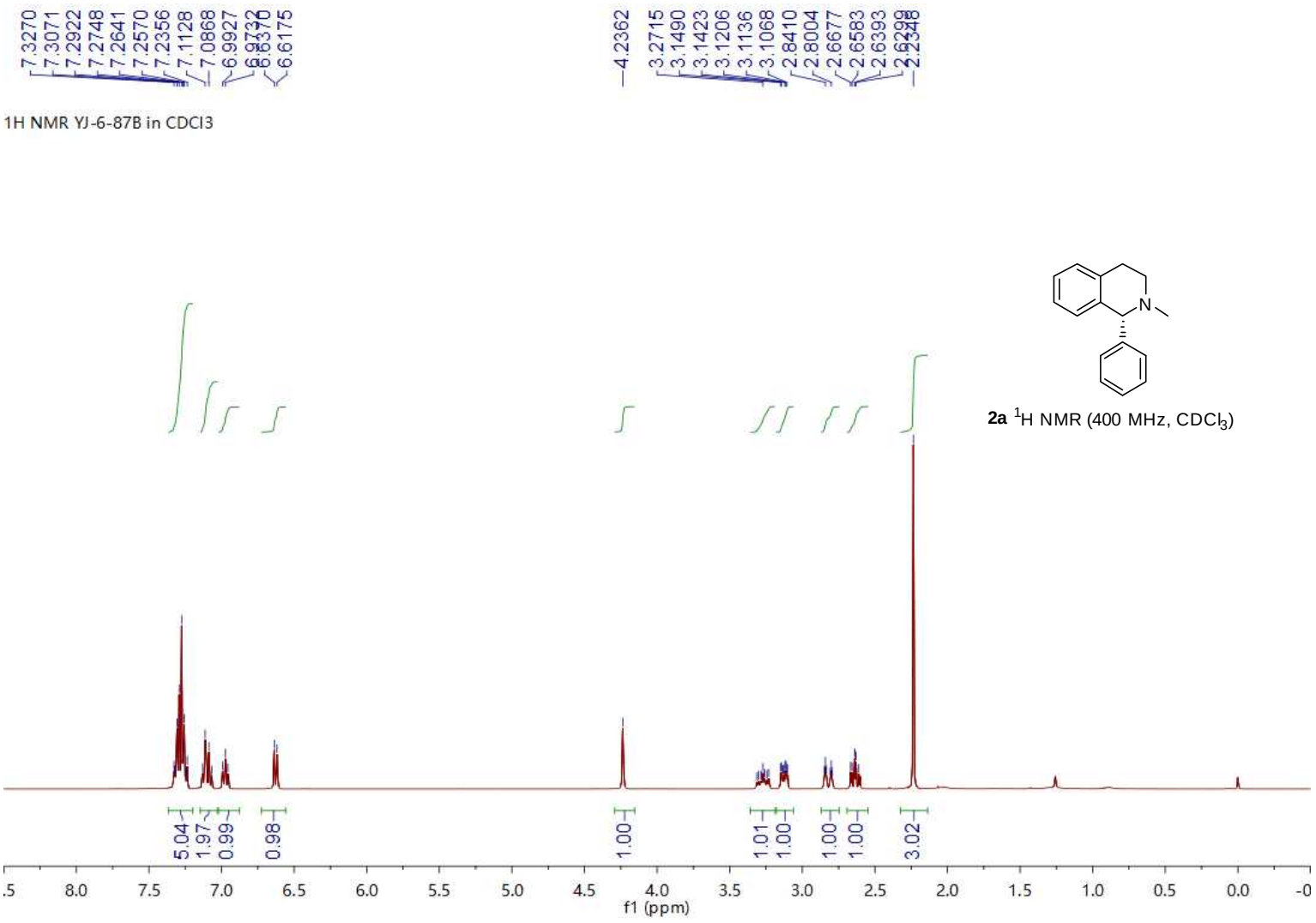




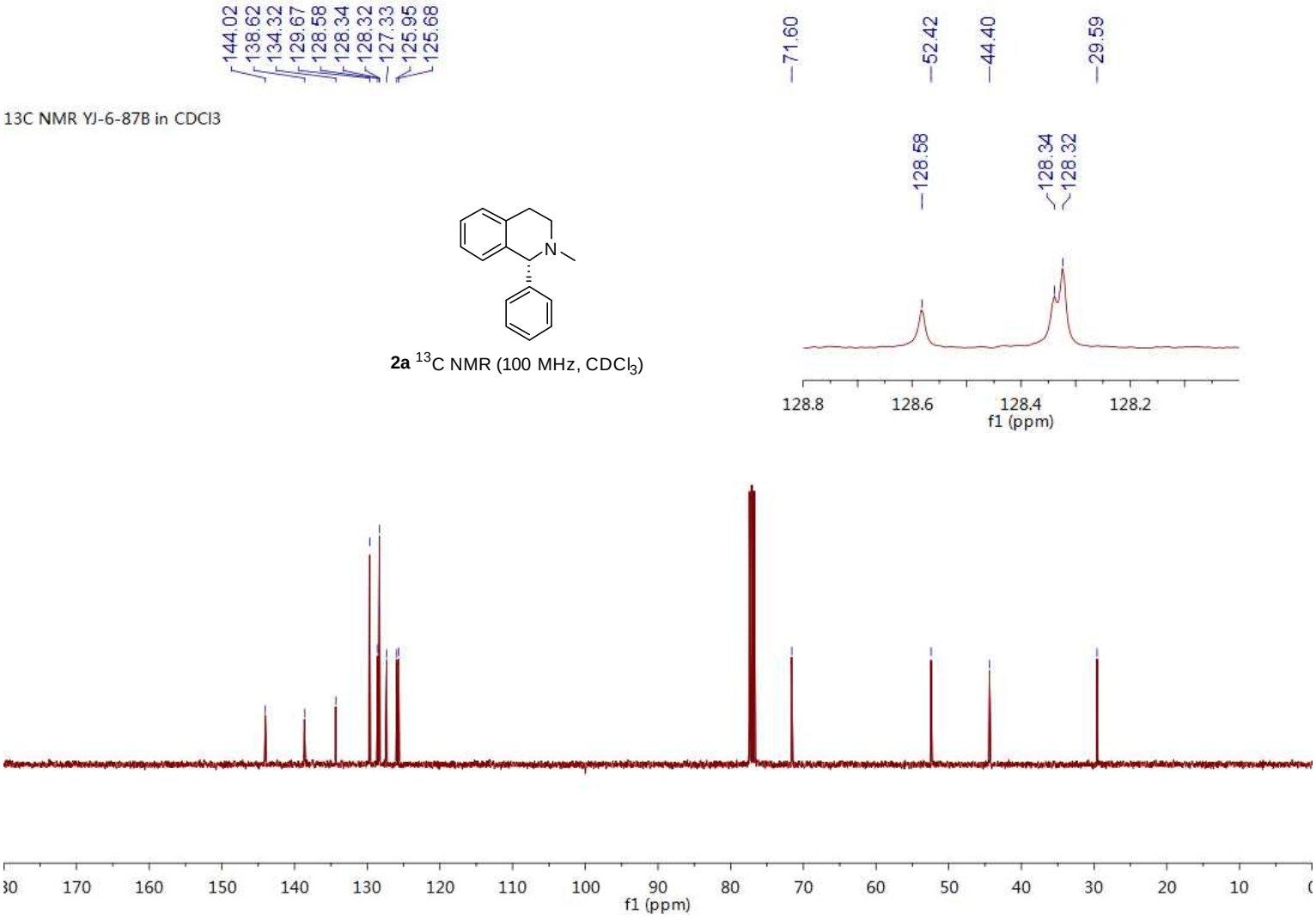
**1q** $^{1}$H NMR (400 MHz, d6-DMSO)



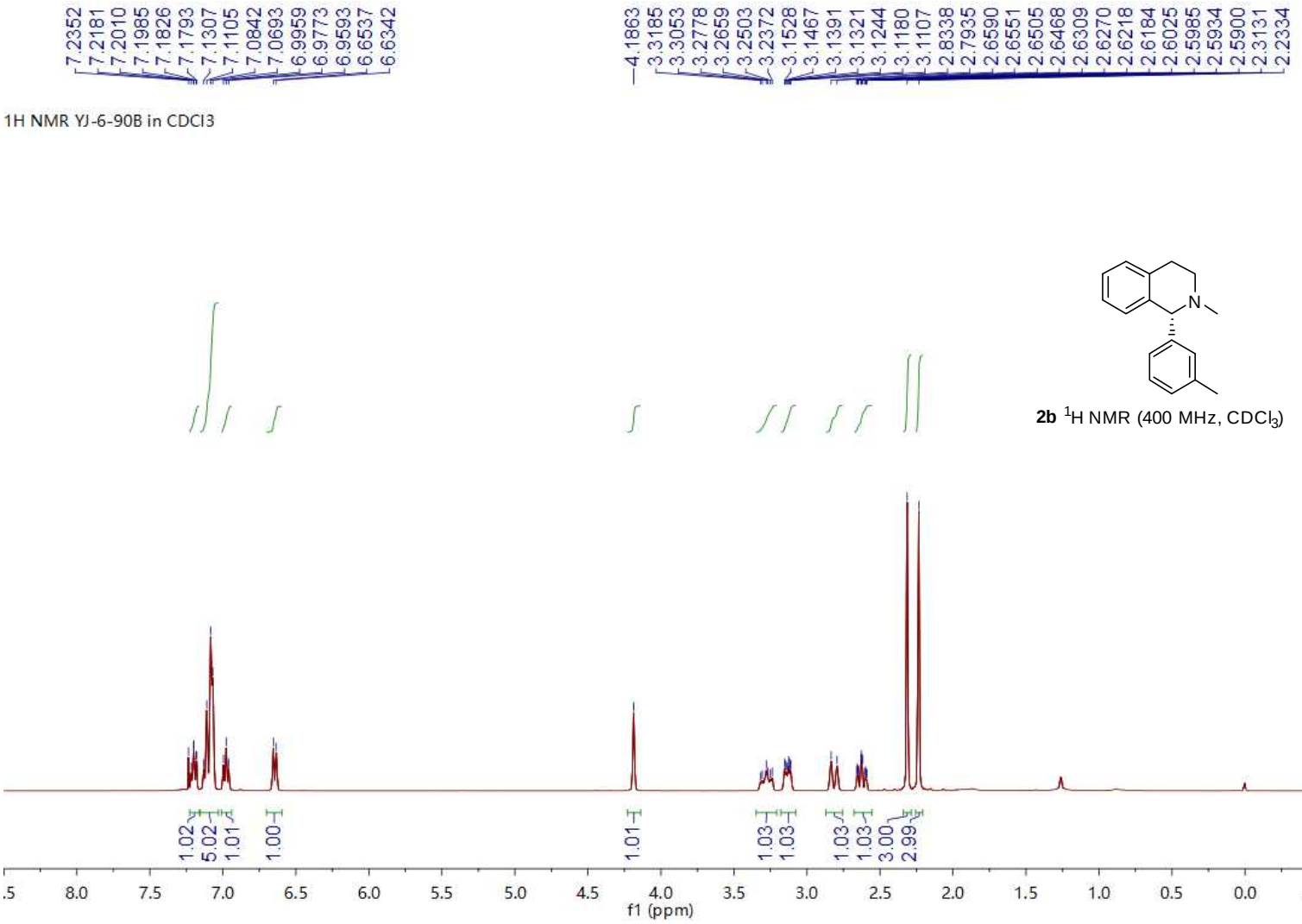

**1q** $^{13}$C NMR (100 MHz, d6-DMSO)




**2a** $^{1}$H NMR (400 MHz, $CDCl_3$)

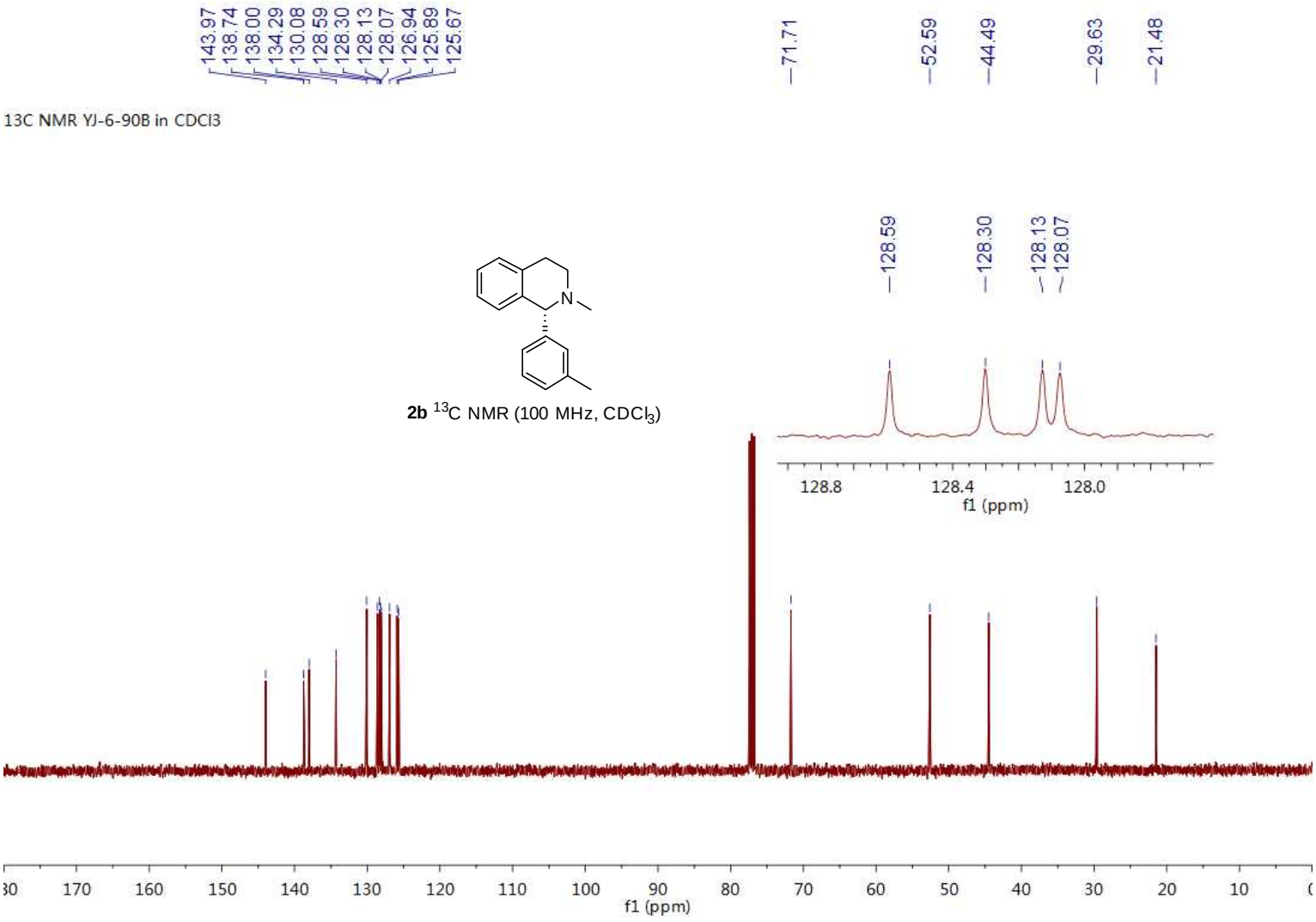



**2a** $^{13}$C NMR (100 MHz, $CDCl_3$)

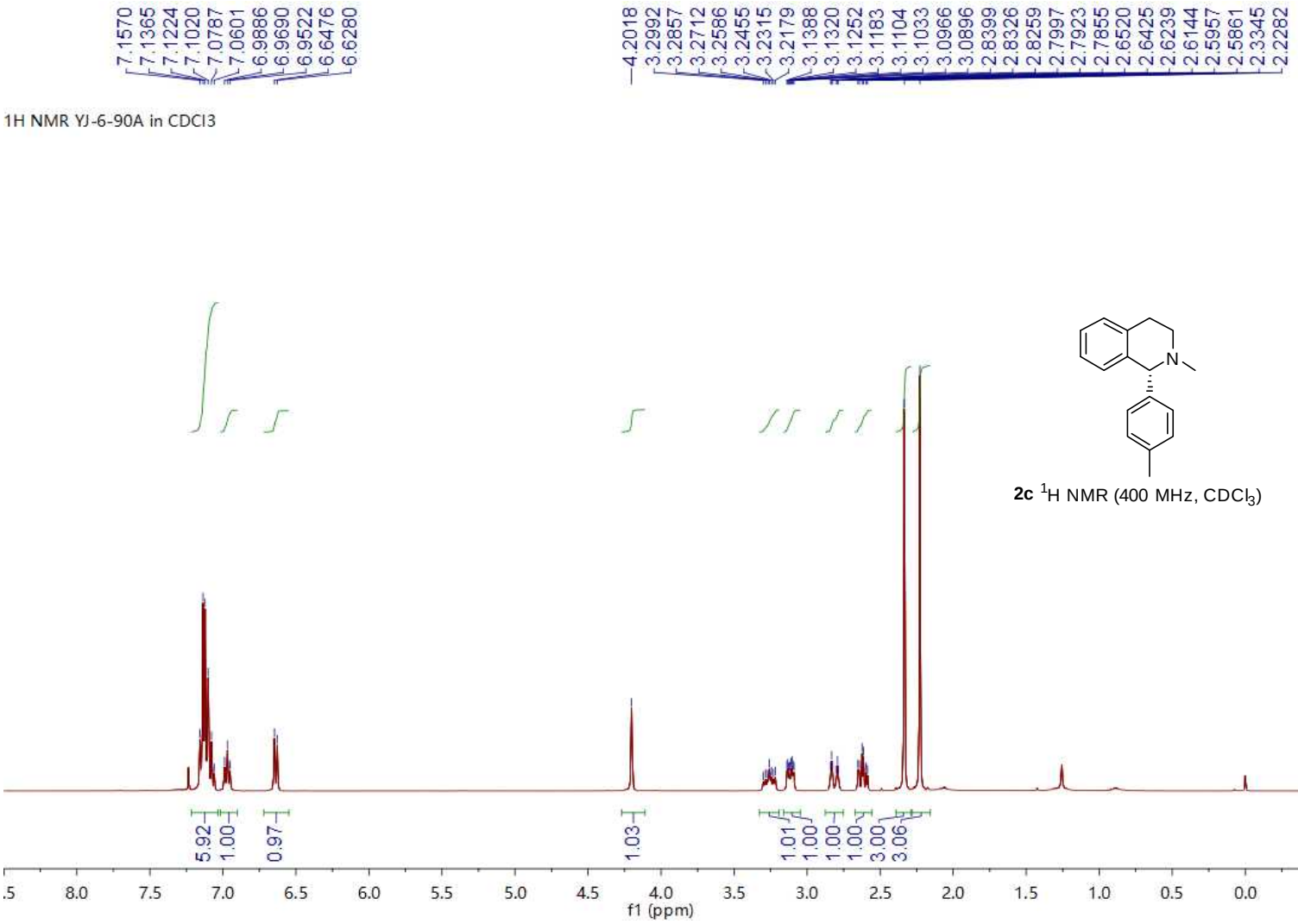




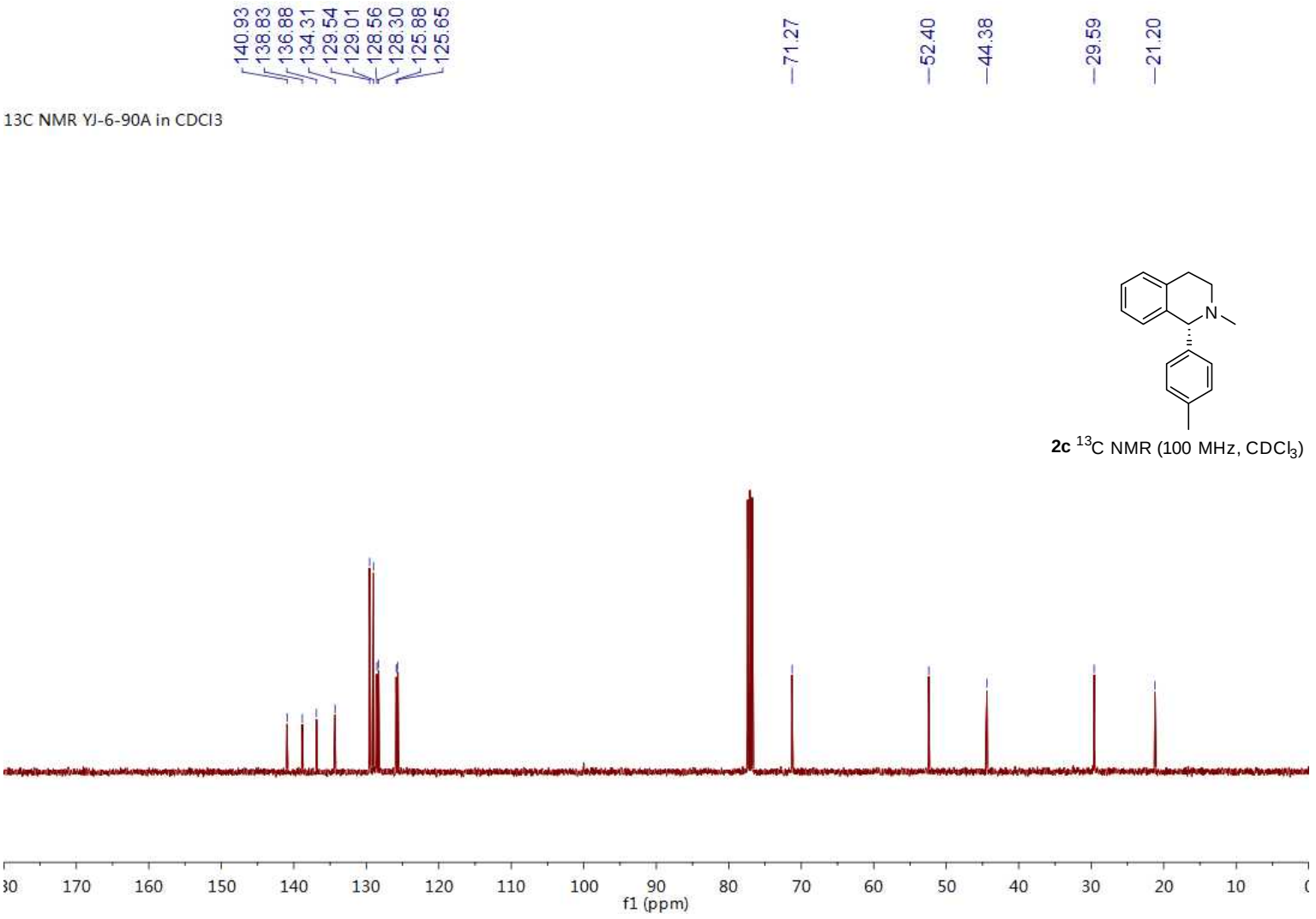

**2b** $^{1}$H NMR (400 MHz, $CDCl_3$)



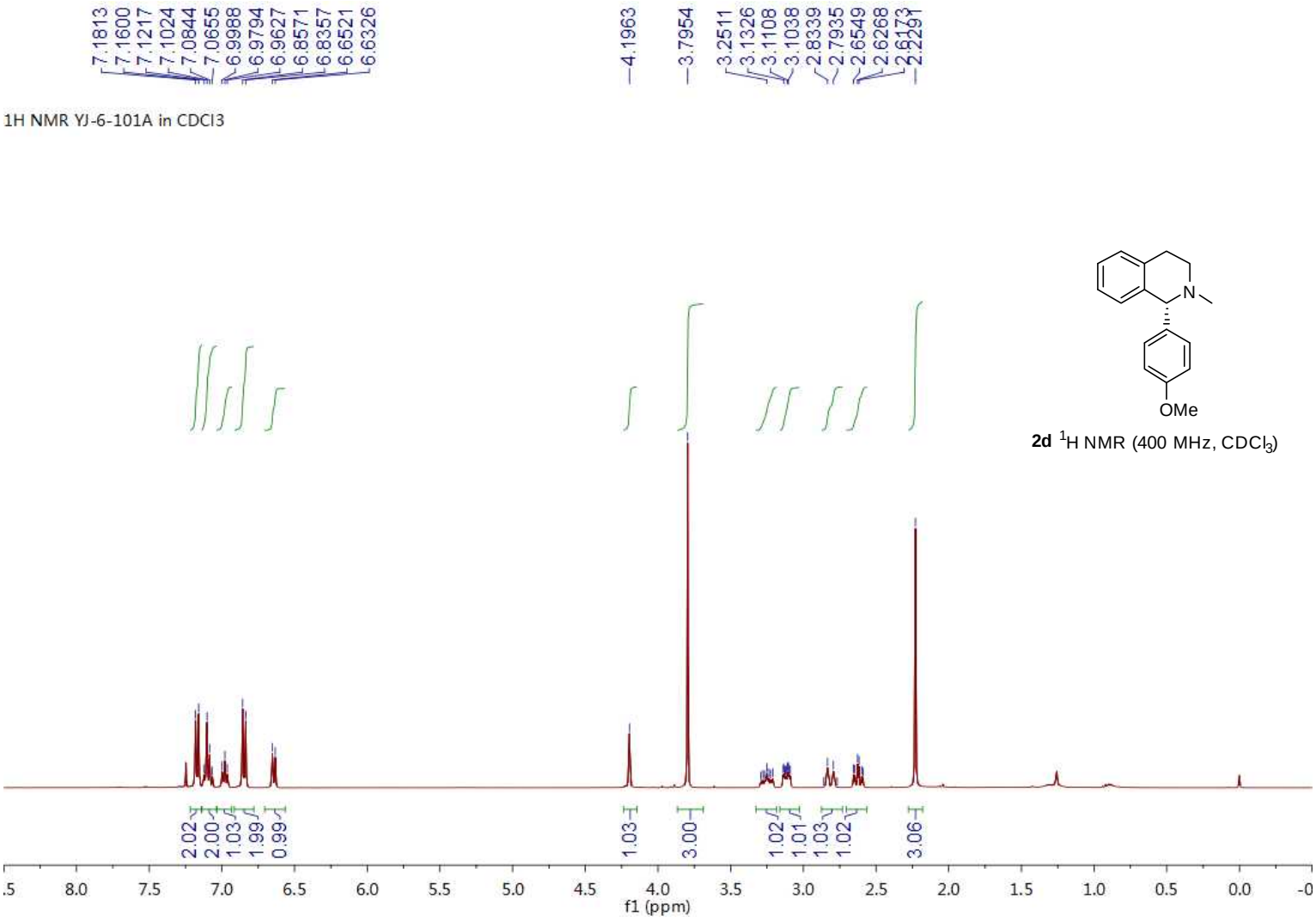

**2b** $^{13}$C NMR (100 MHz, $CDCl_3$)




**2c** $^{1}$H NMR (400 MHz, $CDCl_3$)



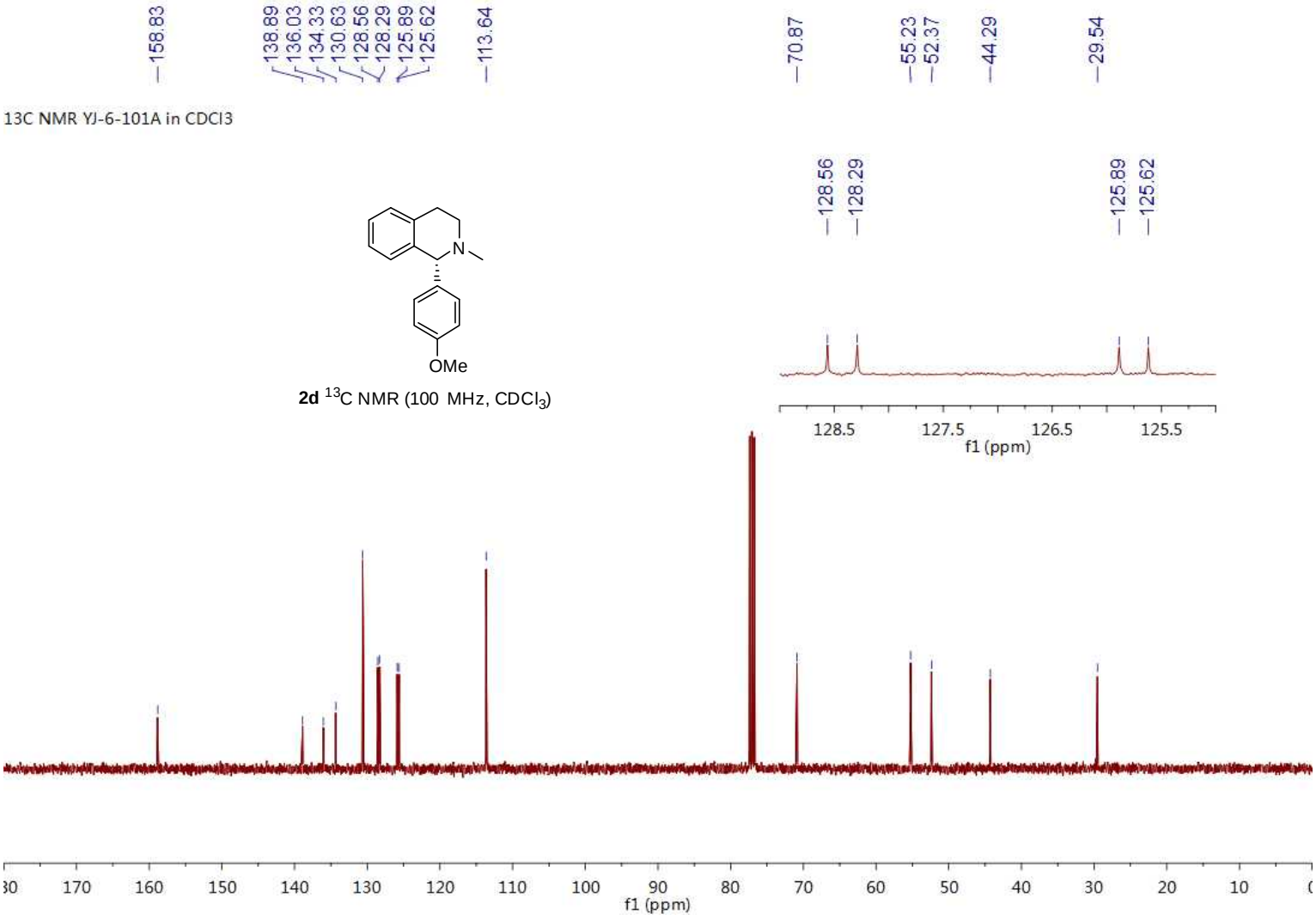

**2c** $^{13}C$ NMR (100 MHz, $CDCl_3$)



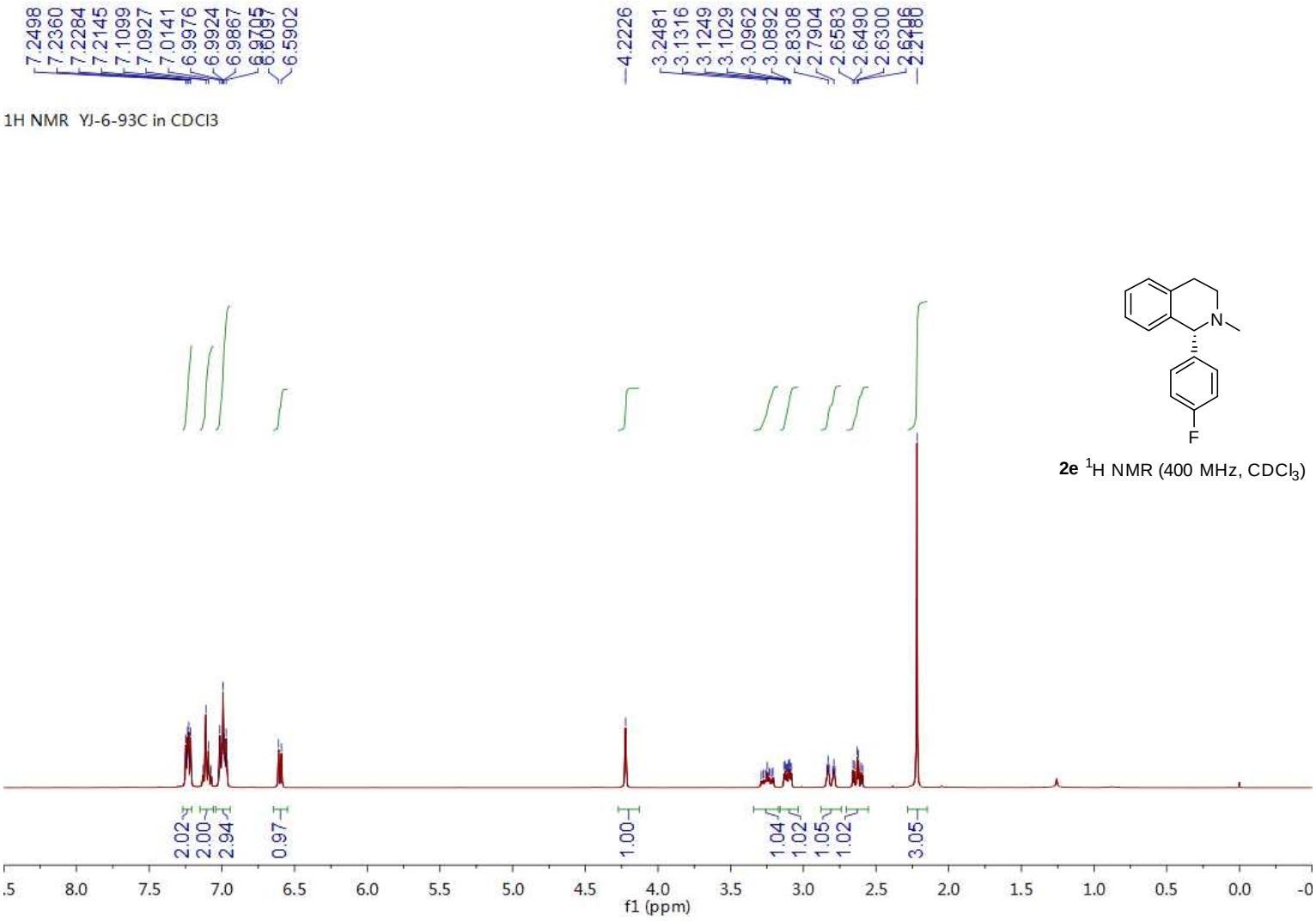


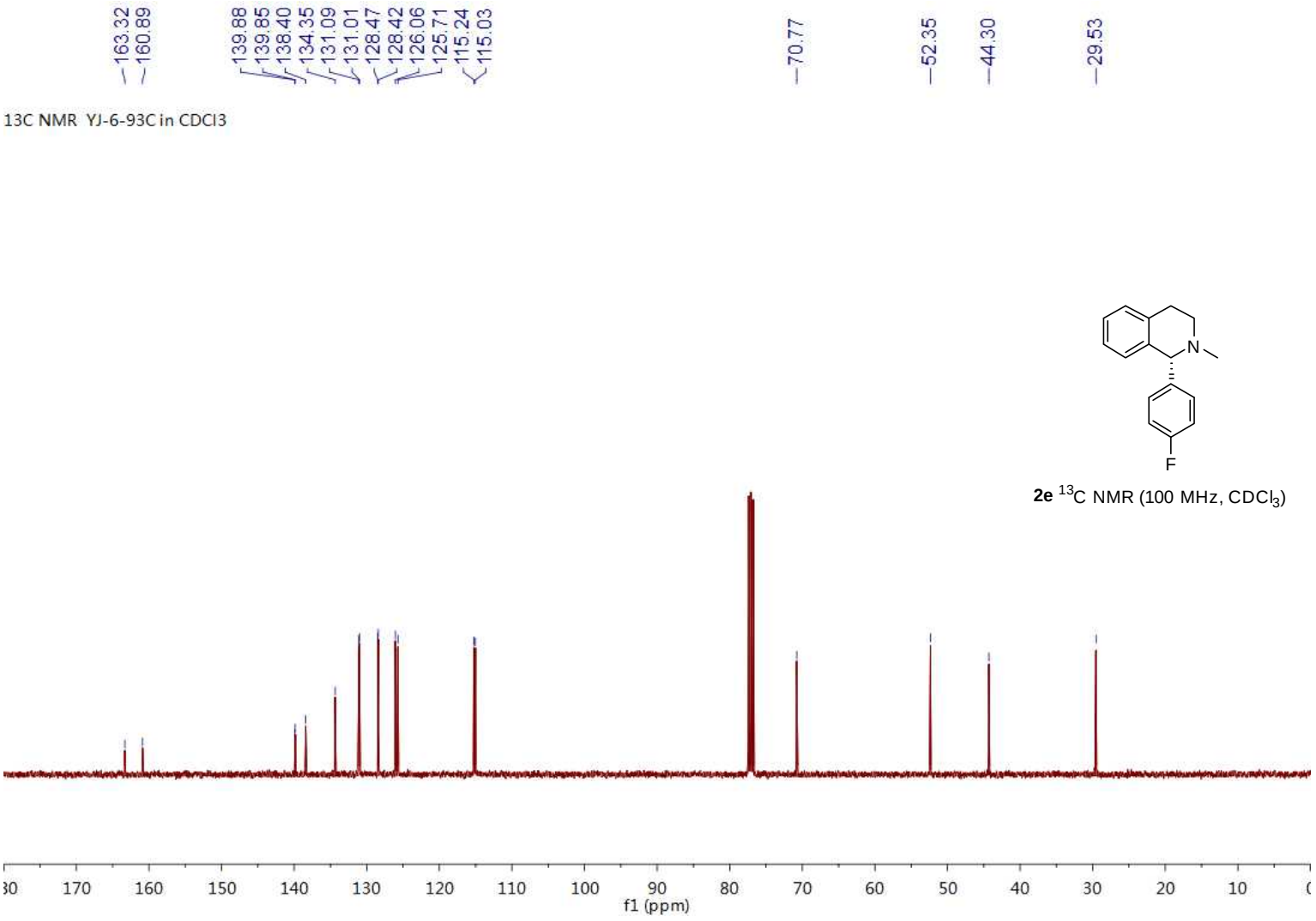


**2d** $^{1}$H NMR (400 MHz, $CDCl_3$)

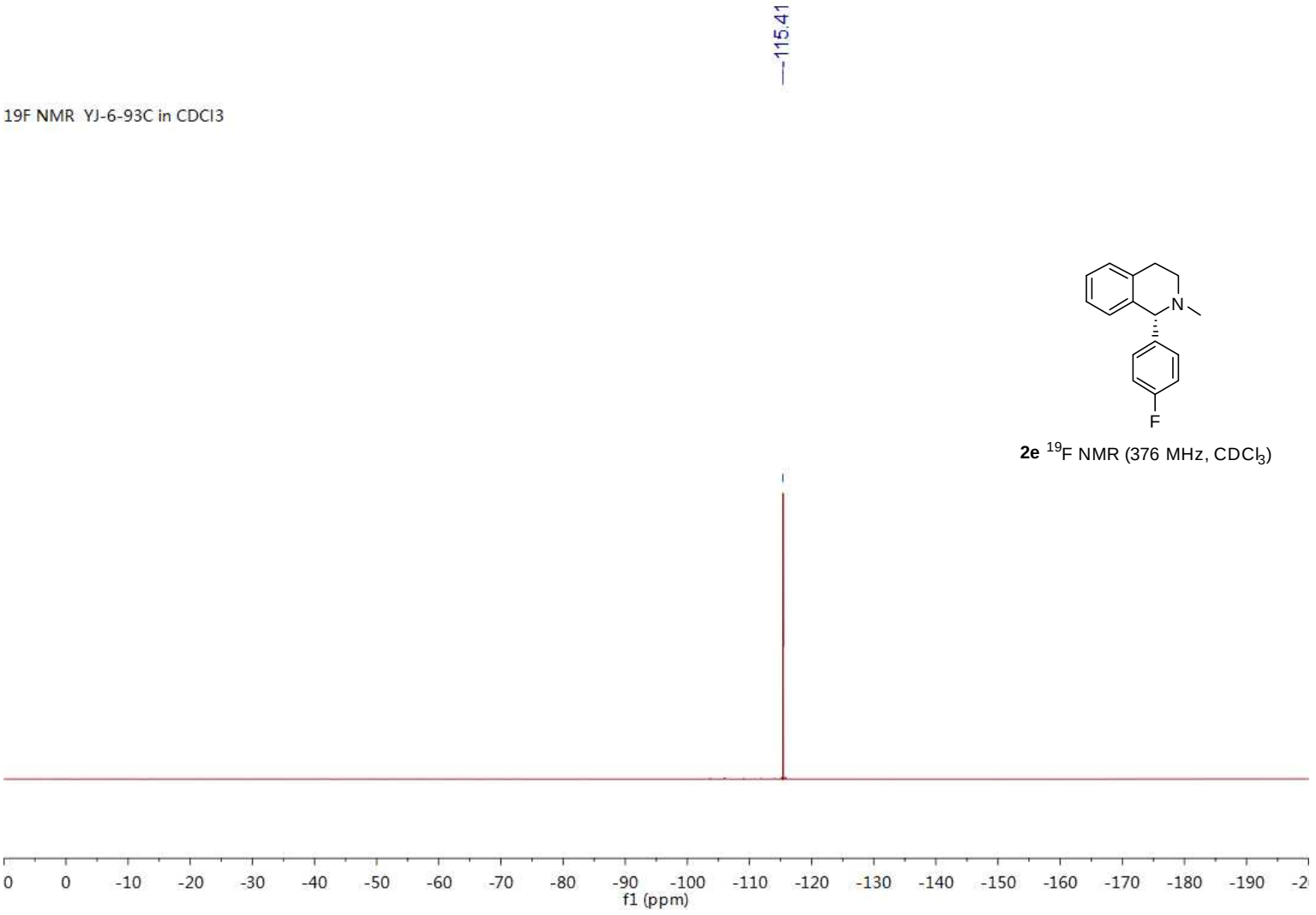



**2d** $^{13}$C NMR (100 MHz, $CDCl_3$)

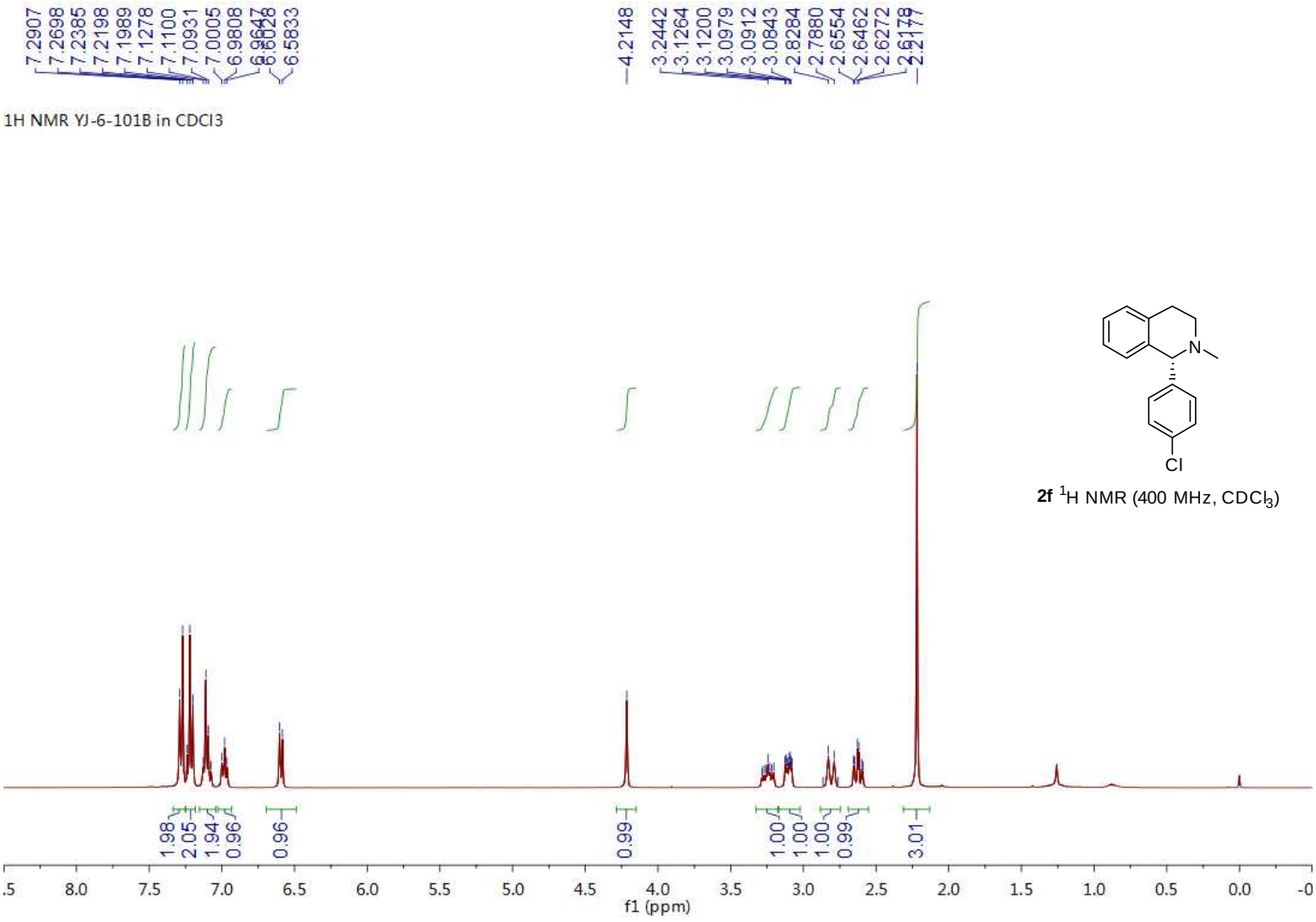

7.2498
7.2360
7.2284
7.2145
7.1099
7.0927
7.0141
6.9976
6.9924
6.9867
6.9705
6.6097
6.5902
4.2226
3.2481
3.1316
3.1249
3.1029
3.0962
3.0892
2.8308
2.7904
2.6583
2.6490
2.6300
1H NMR YJ-6-93C in CDCl3
N
F
2e $^1$H NMR (400 MHz, $CDCl_3$)
2.02
2.00
2.94
0.97
1.00
1.04
1.02
1.05
1.02
3.05
f1 (ppm)




**2e** $^{13}C$ NMR (100 MHz, $CDCl_3$)

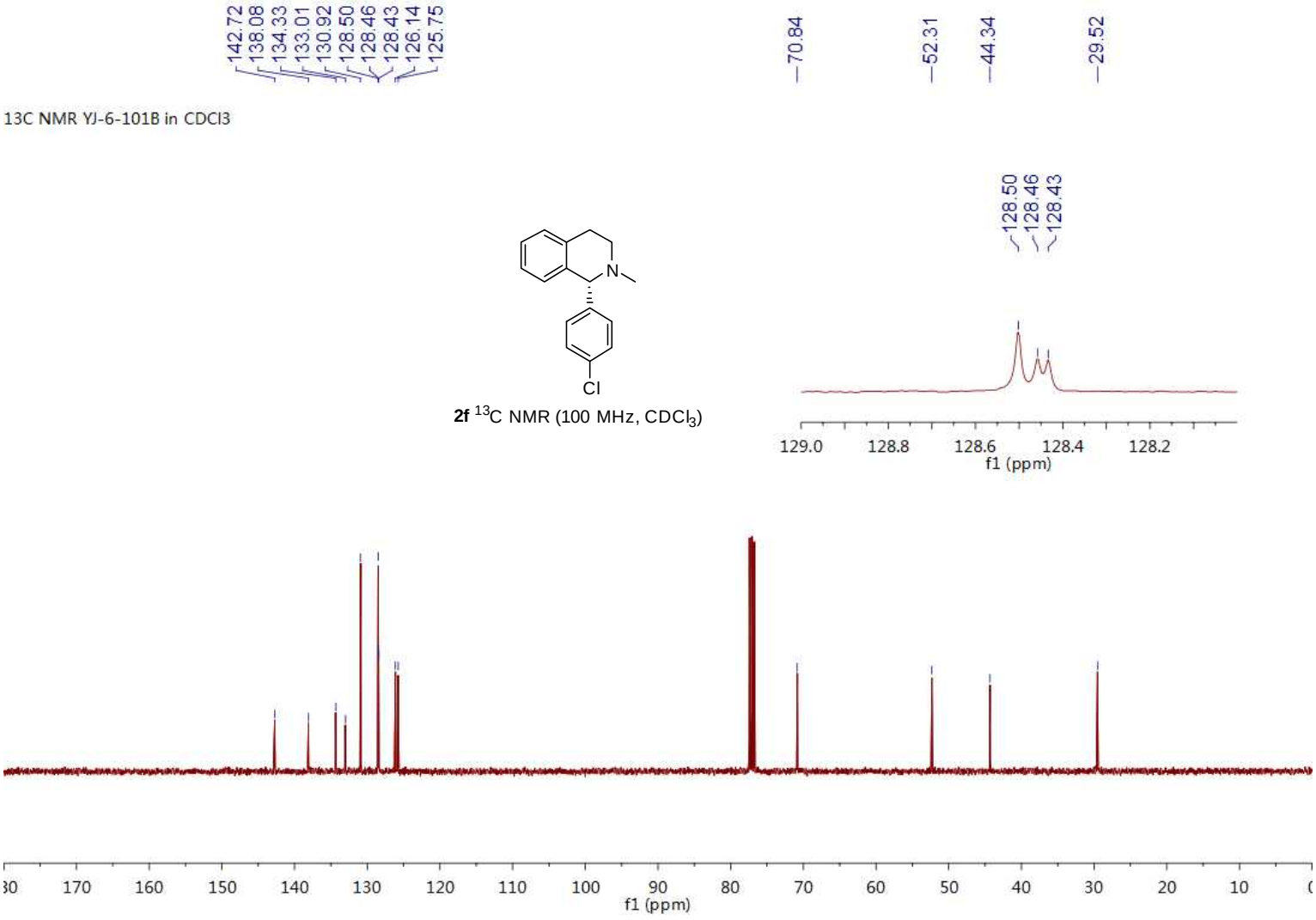



**2e** $^{19}$F NMR (376 MHz, $CDCl_3$)

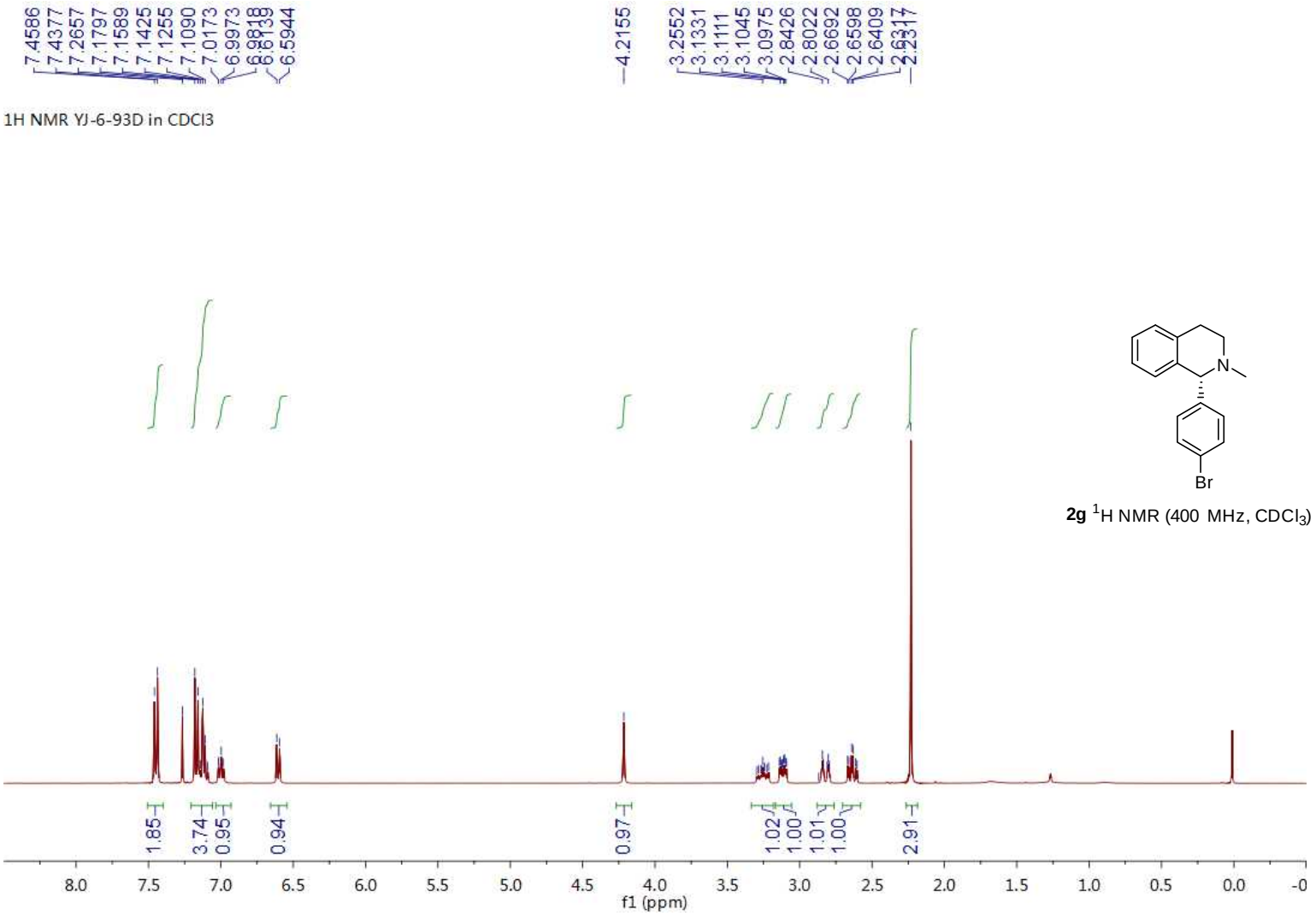



1H NMR YJ-6-101B in CDCl3

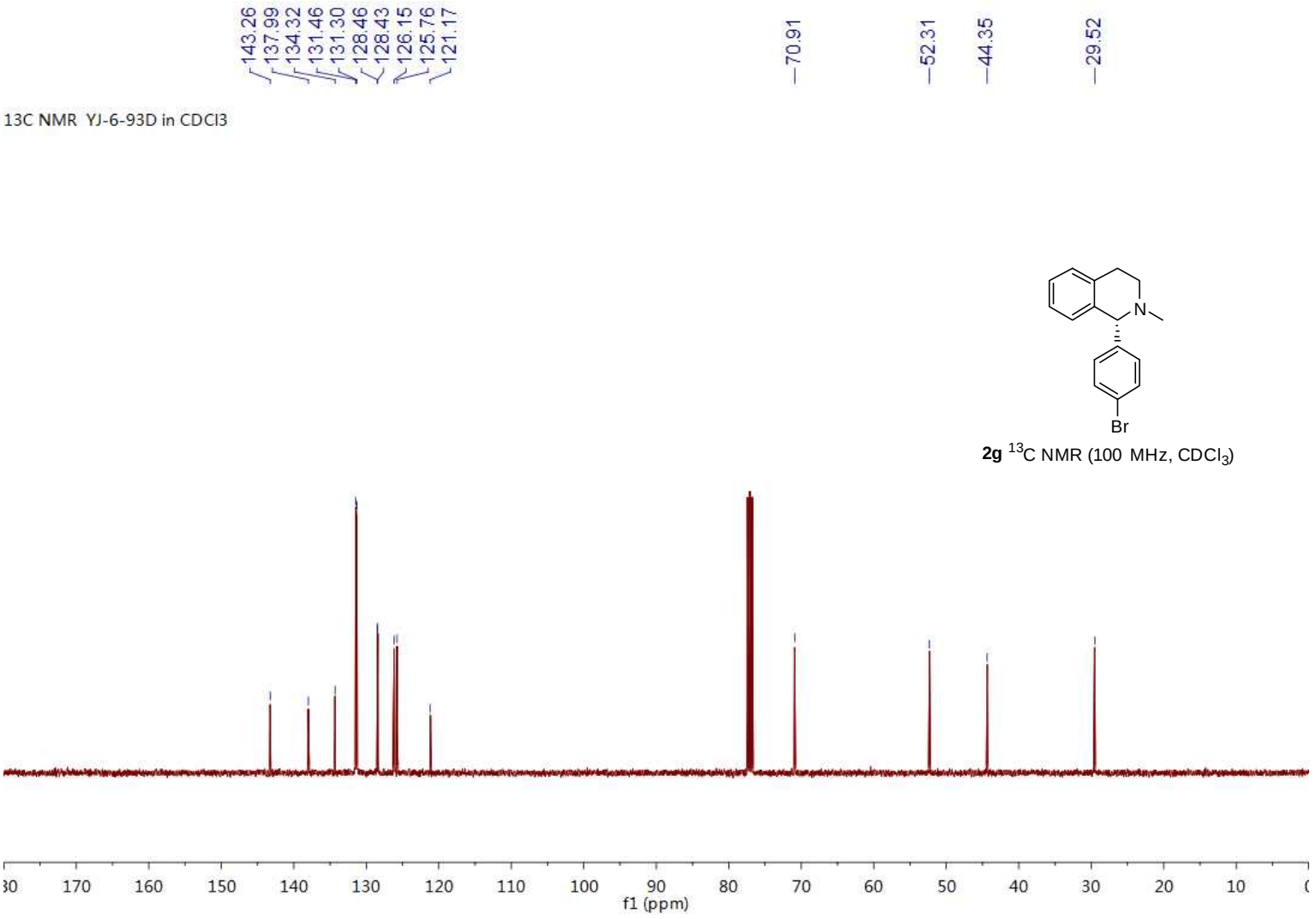
**2f** $^{1}$H NMR (400 MHz, $CDCl_3$)



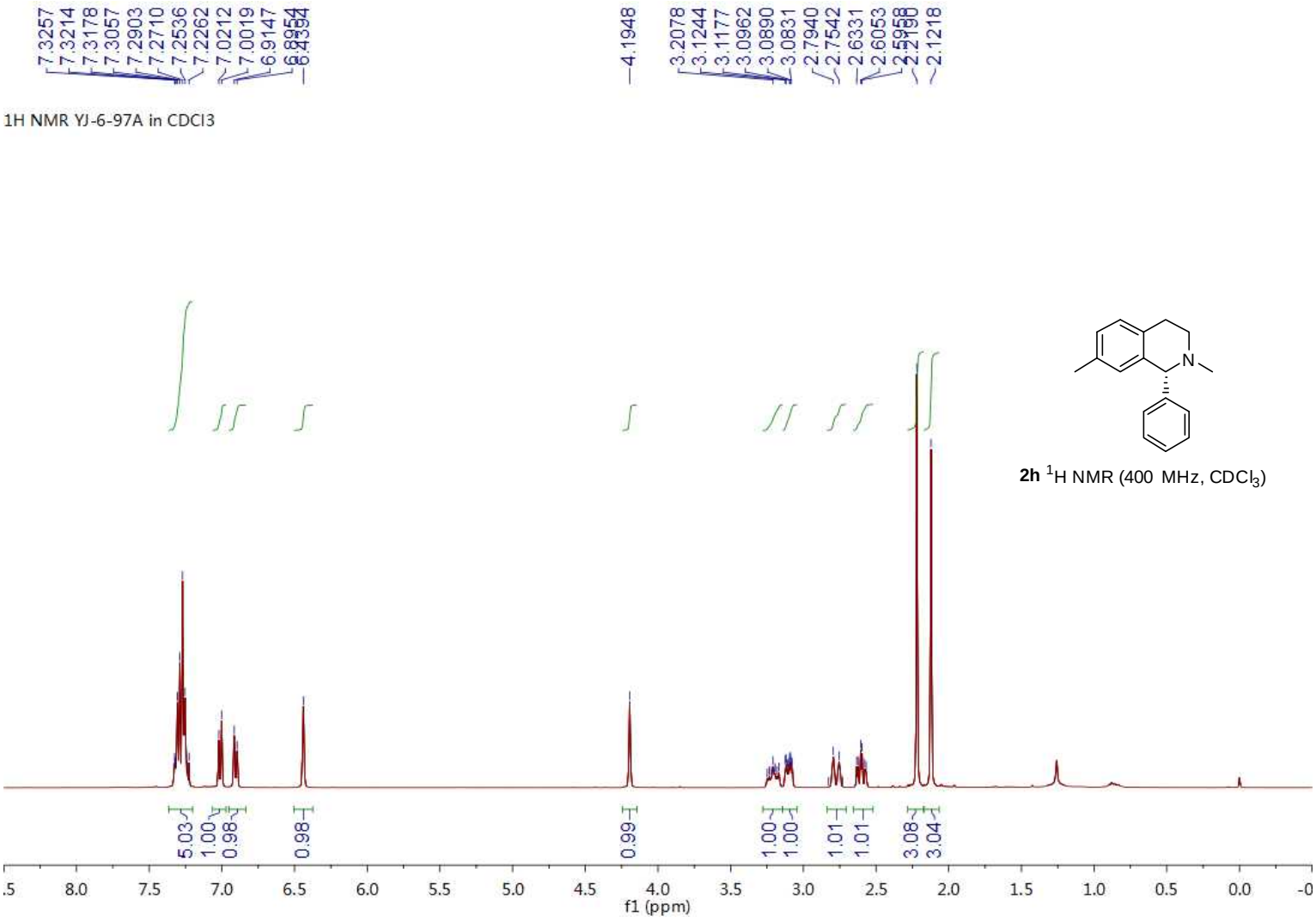

**2f** $^{13}$C NMR (100 MHz, $CDCl_3$)



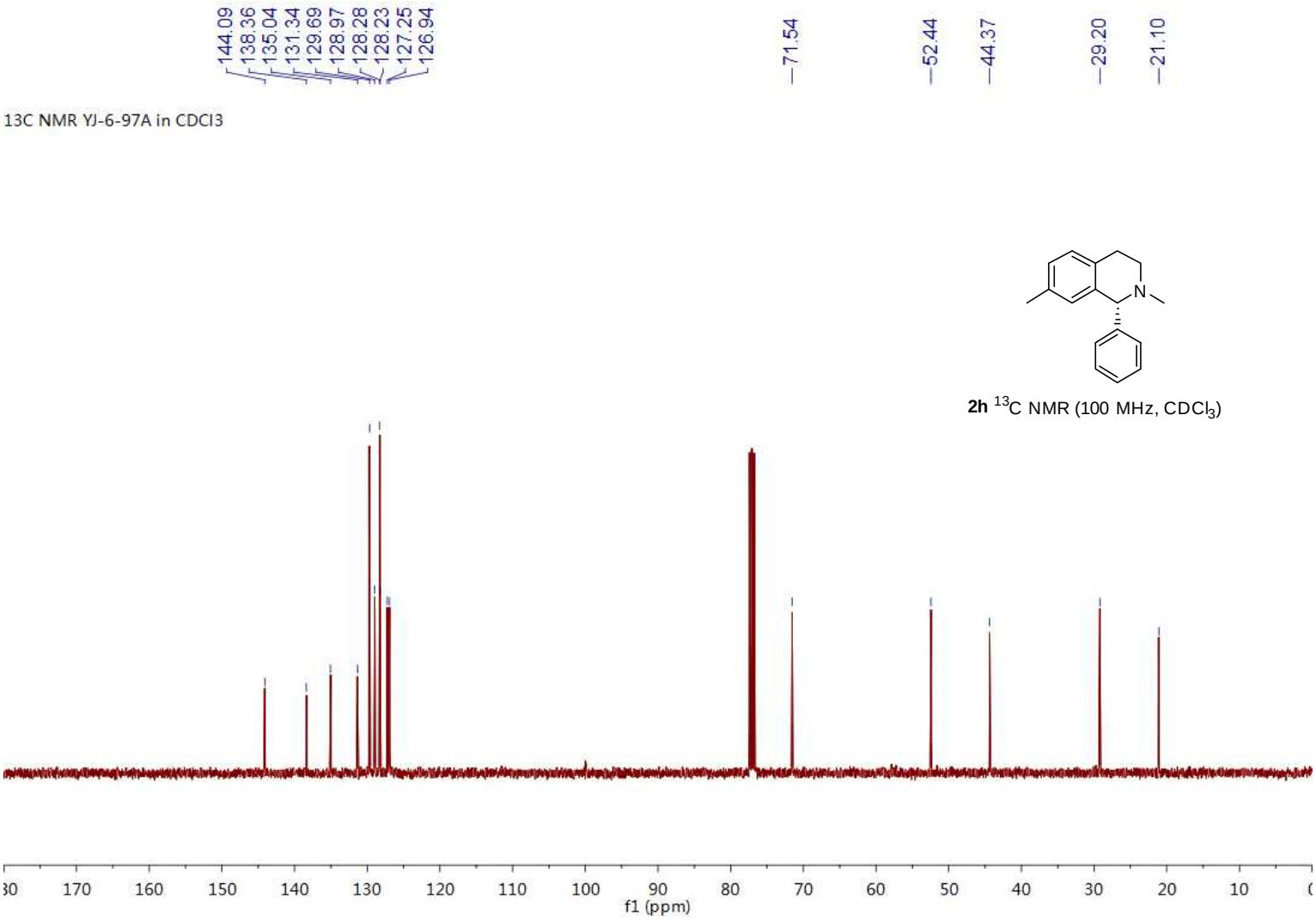

**2g** $^{1}$H NMR (400 MHz, $CDCl_3$)



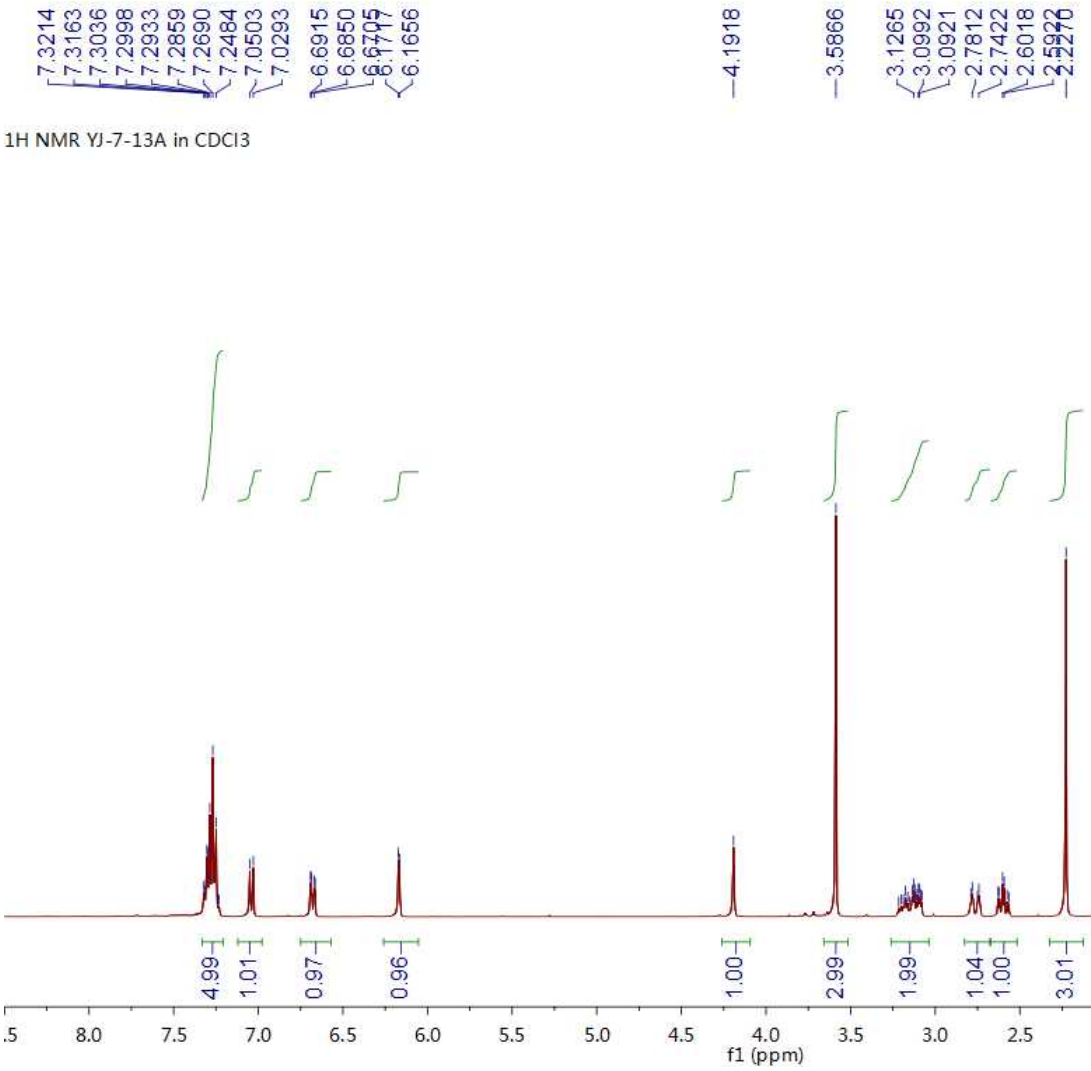

**2g** $^{13}C$ NMR (100 MHz, $CDCl_3$)

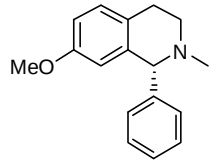



**2h** $^{1}$H NMR (400 MHz, $CDCl_3$)

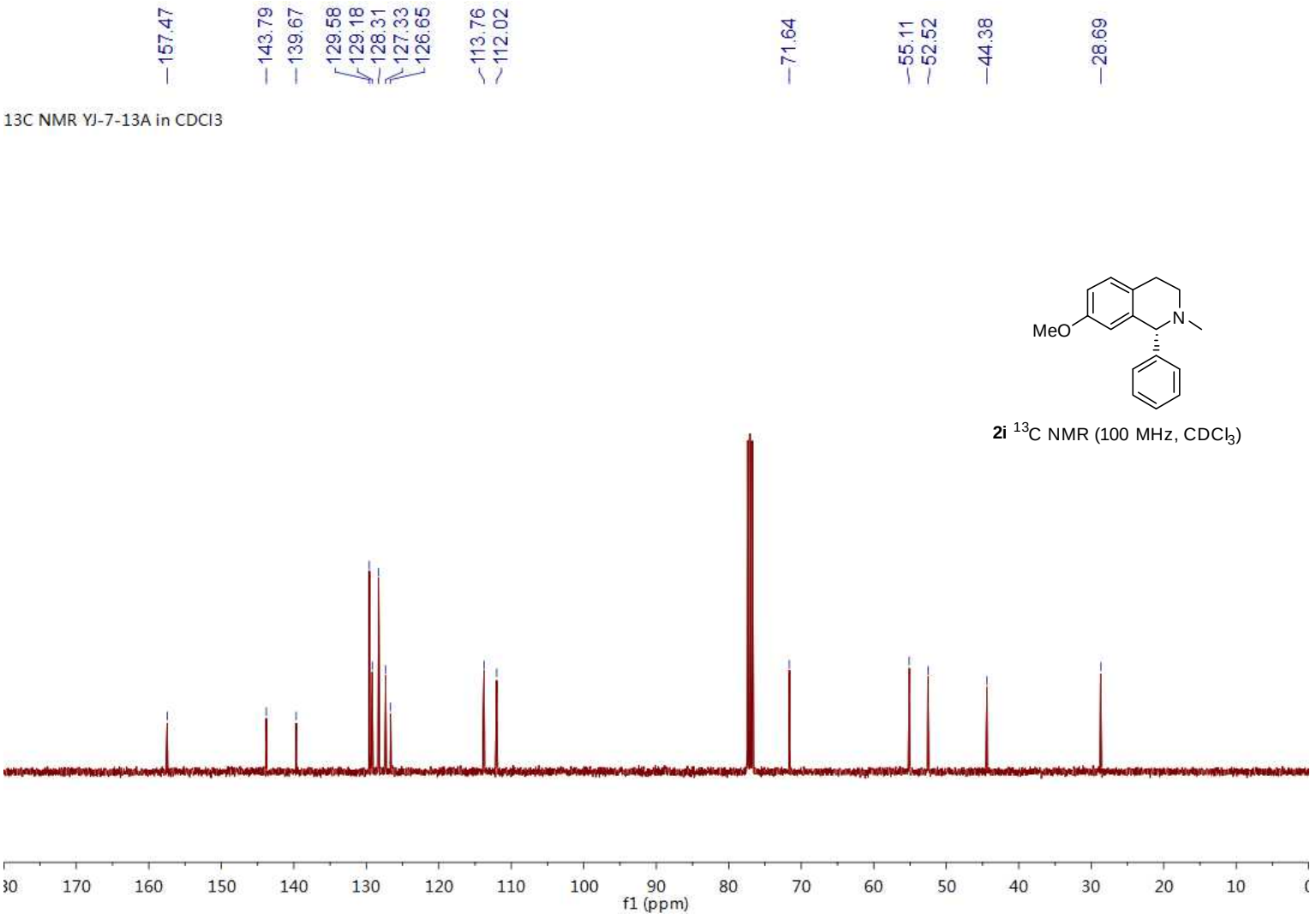



**2h** $^{13}C$ NMR (100 MHz, $CDCl_3$)

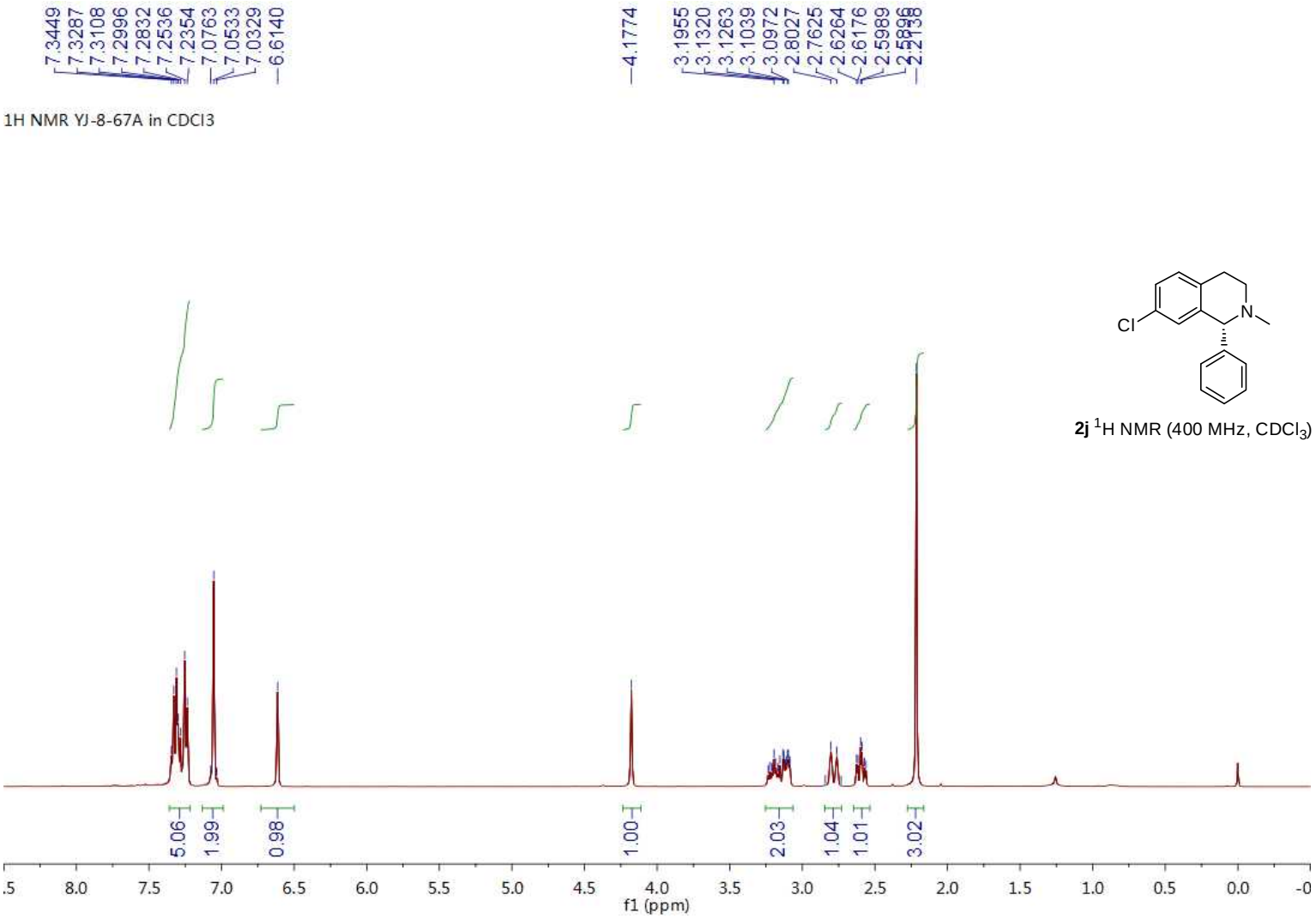



**2i** $^{1}$H NMR (400 MHz, $CDCl_3$)



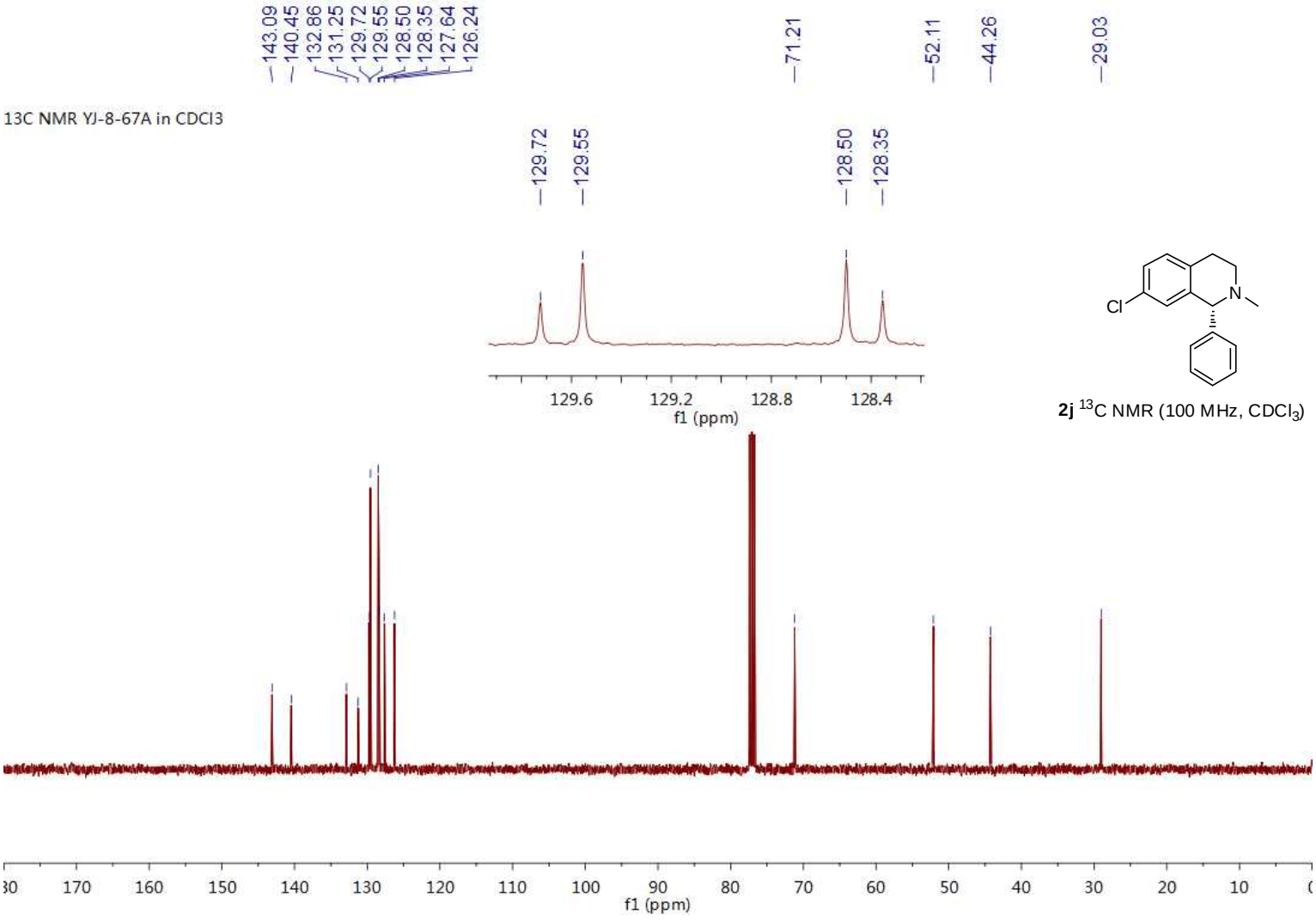

**2i** $^{13}C$ NMR (100 MHz, $CDCl_3$)



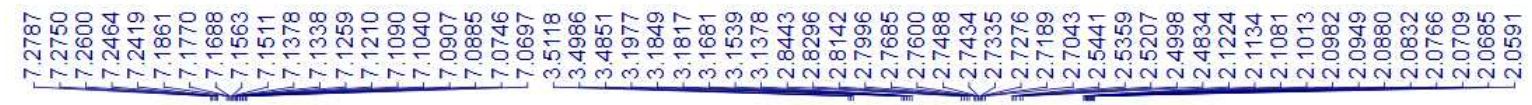




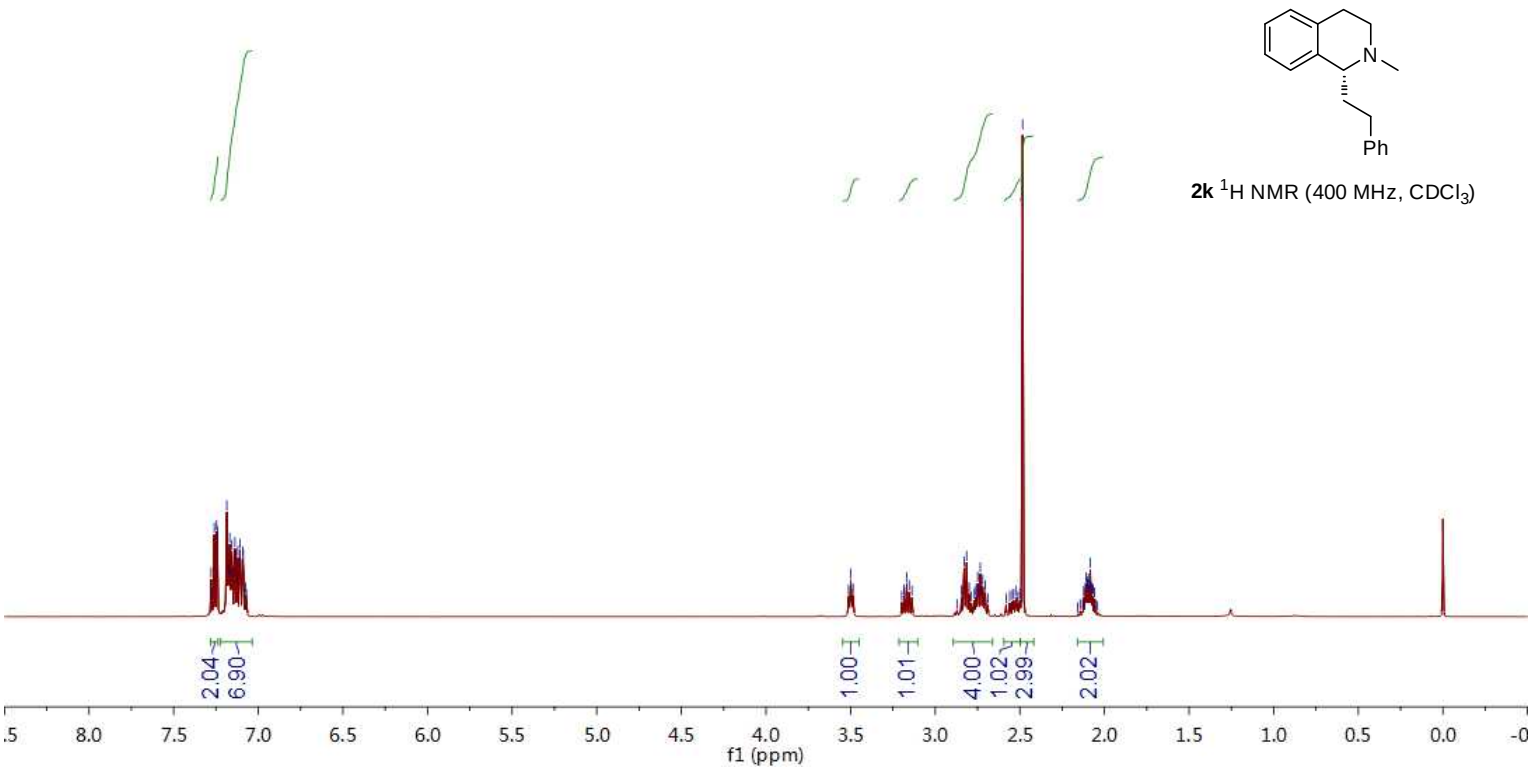
**2j** $^{1}$H NMR (400 MHz, $CDCl_3$)



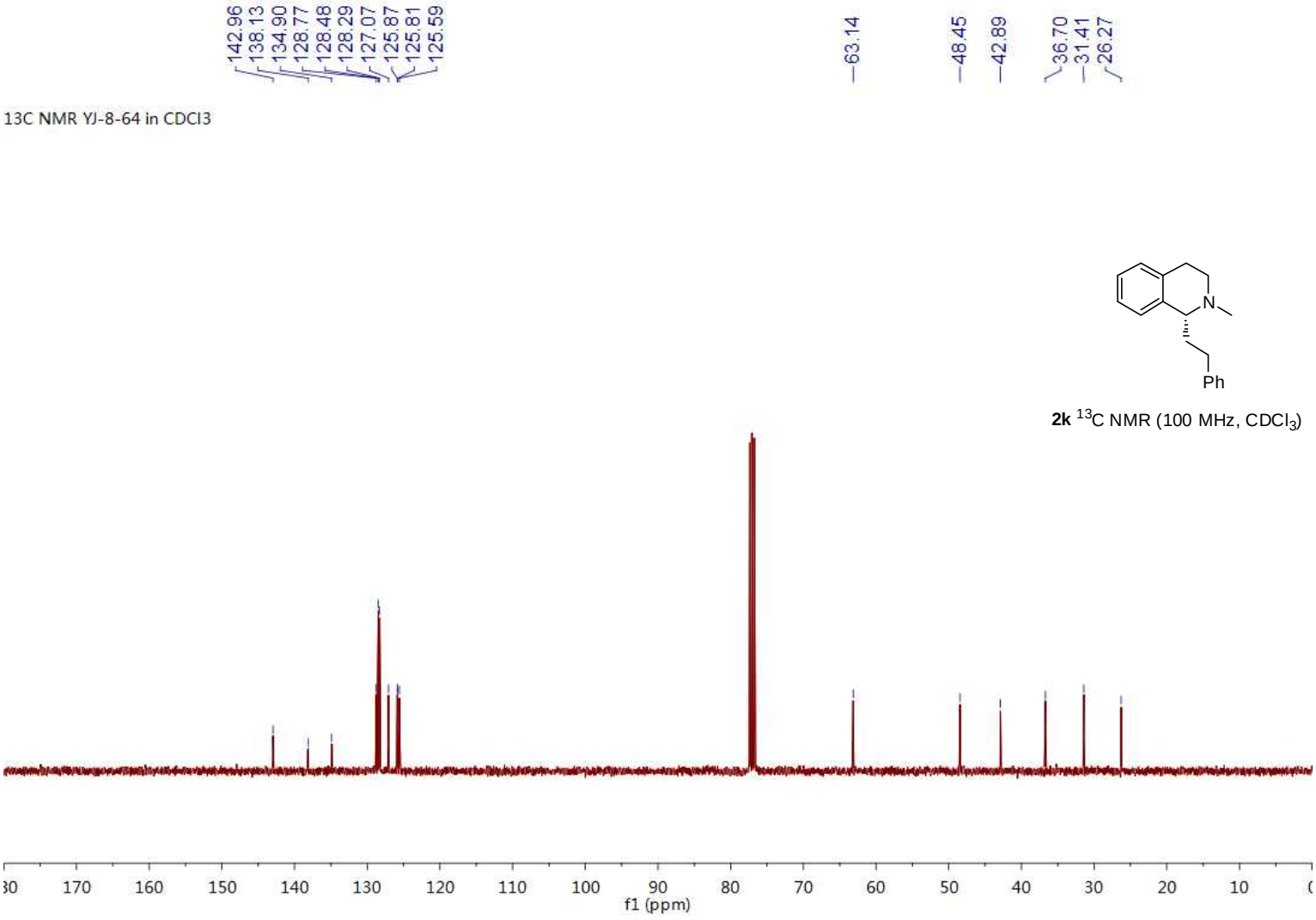

**2j** $^{13}$C NMR (100 MHz, $CDCl_3$)




1H NMR YJ-8-64 in CDCl3

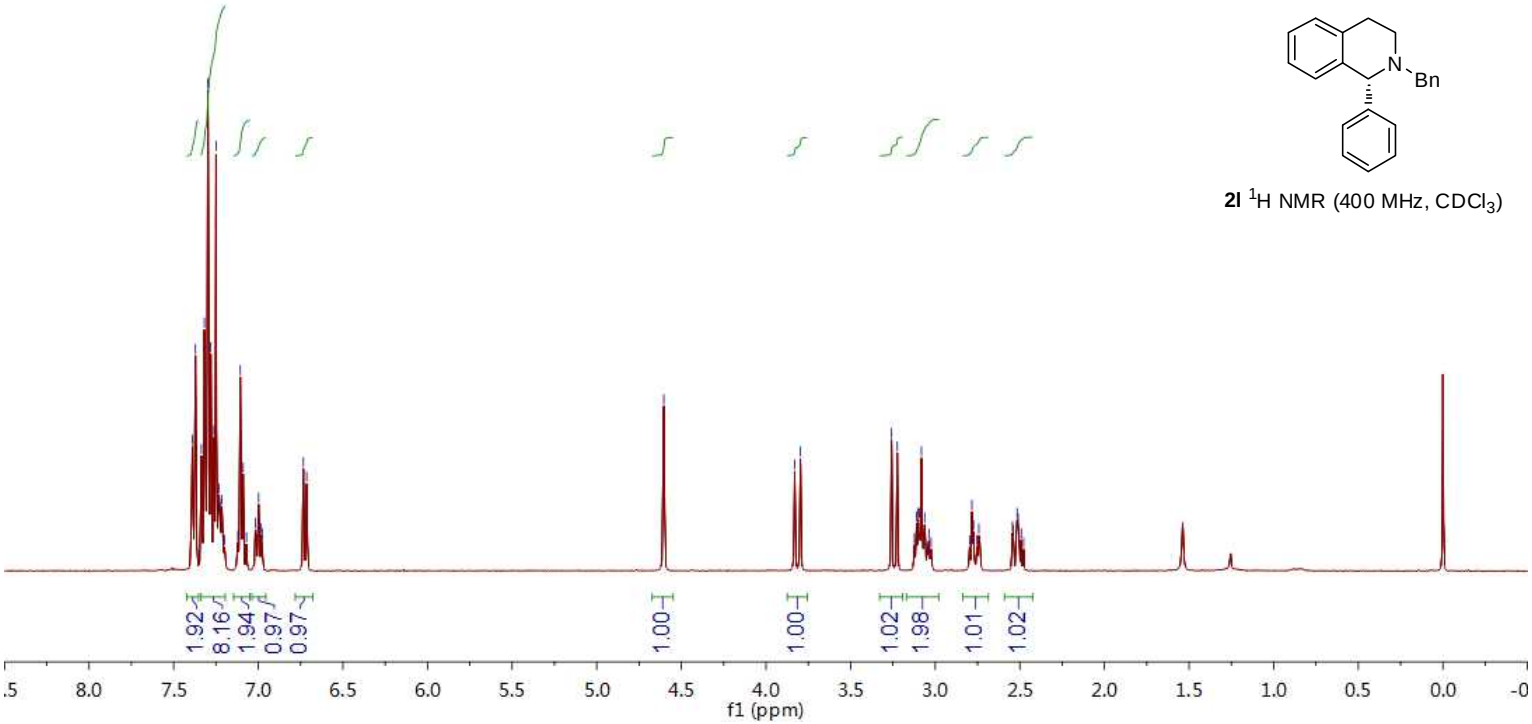



**2k** $^{1}$H NMR (400 MHz, $CDCl_3$)




**2k** $^{13}C$ NMR (100 MHz, $CDCl_3$)

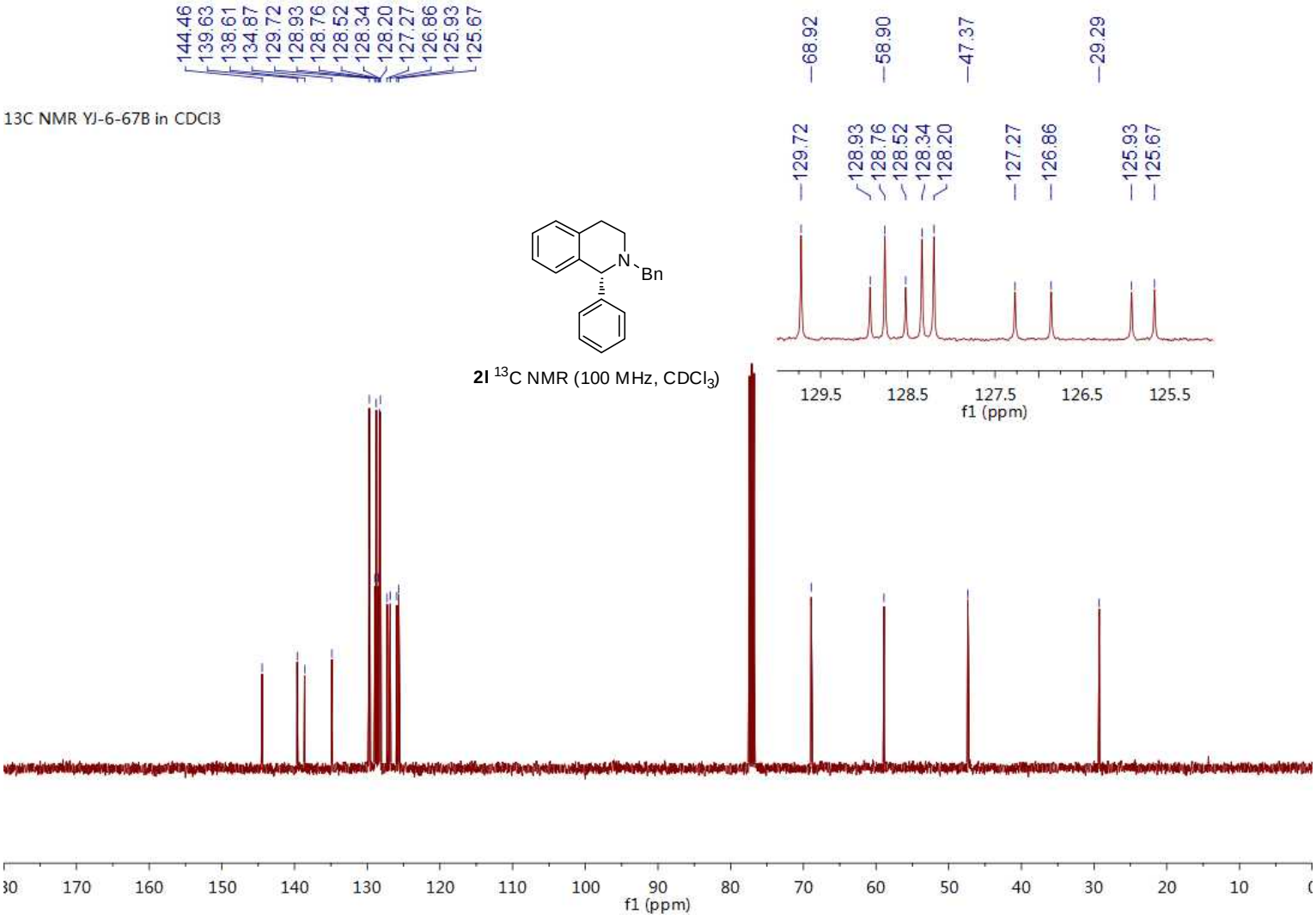

1H NMR YJ-6-67B in CDCl3



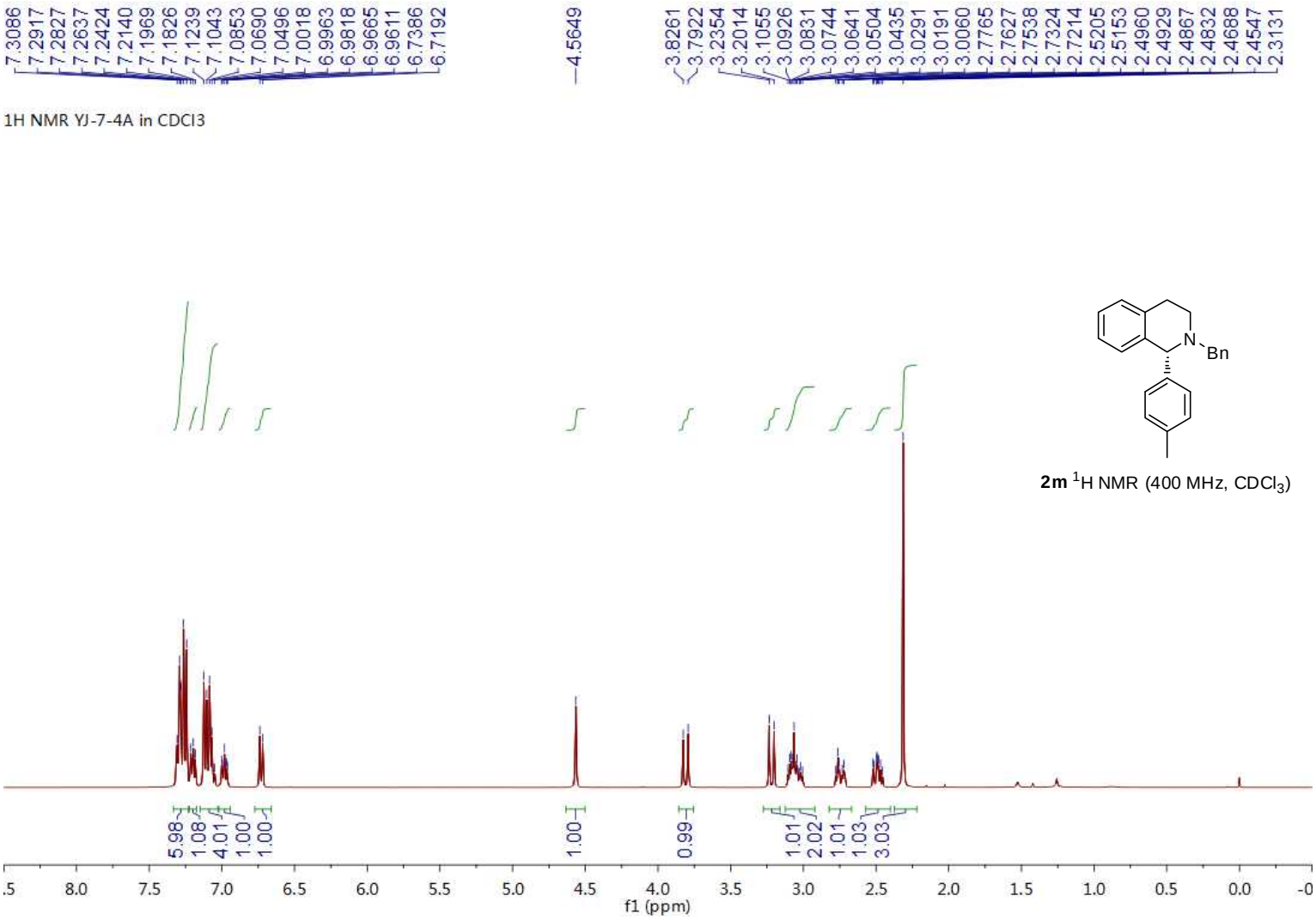




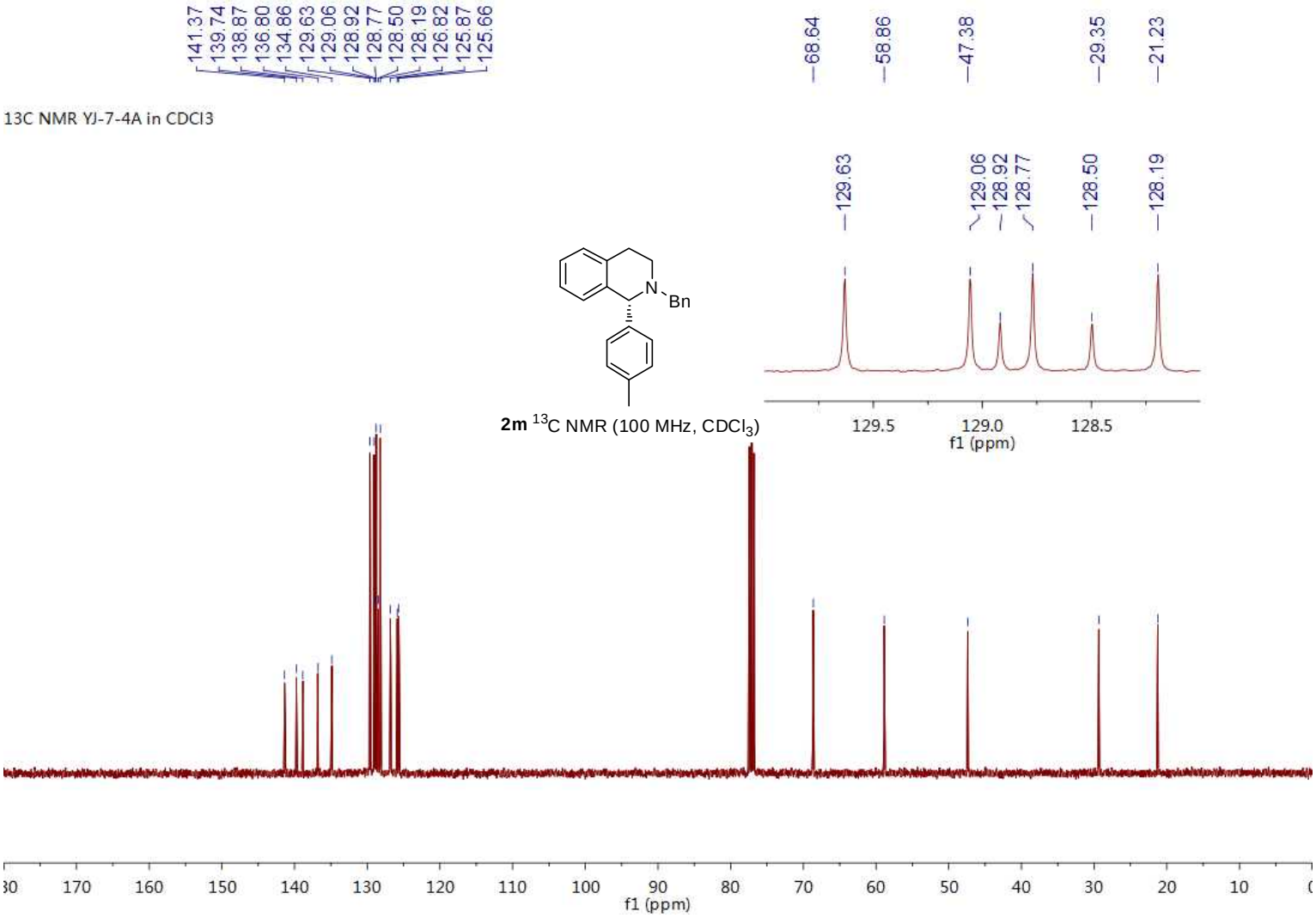
**2l** $^{1}$H NMR (400 MHz, $CDCl_3$)

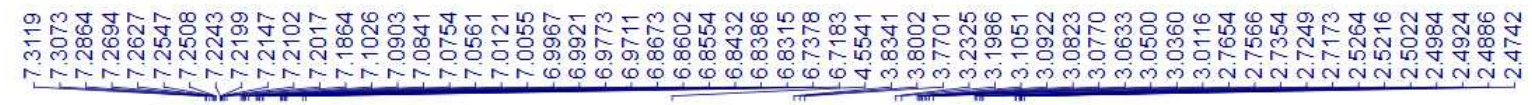



**2l** $^{13}$C NMR (100 MHz, $CDCl_3$)

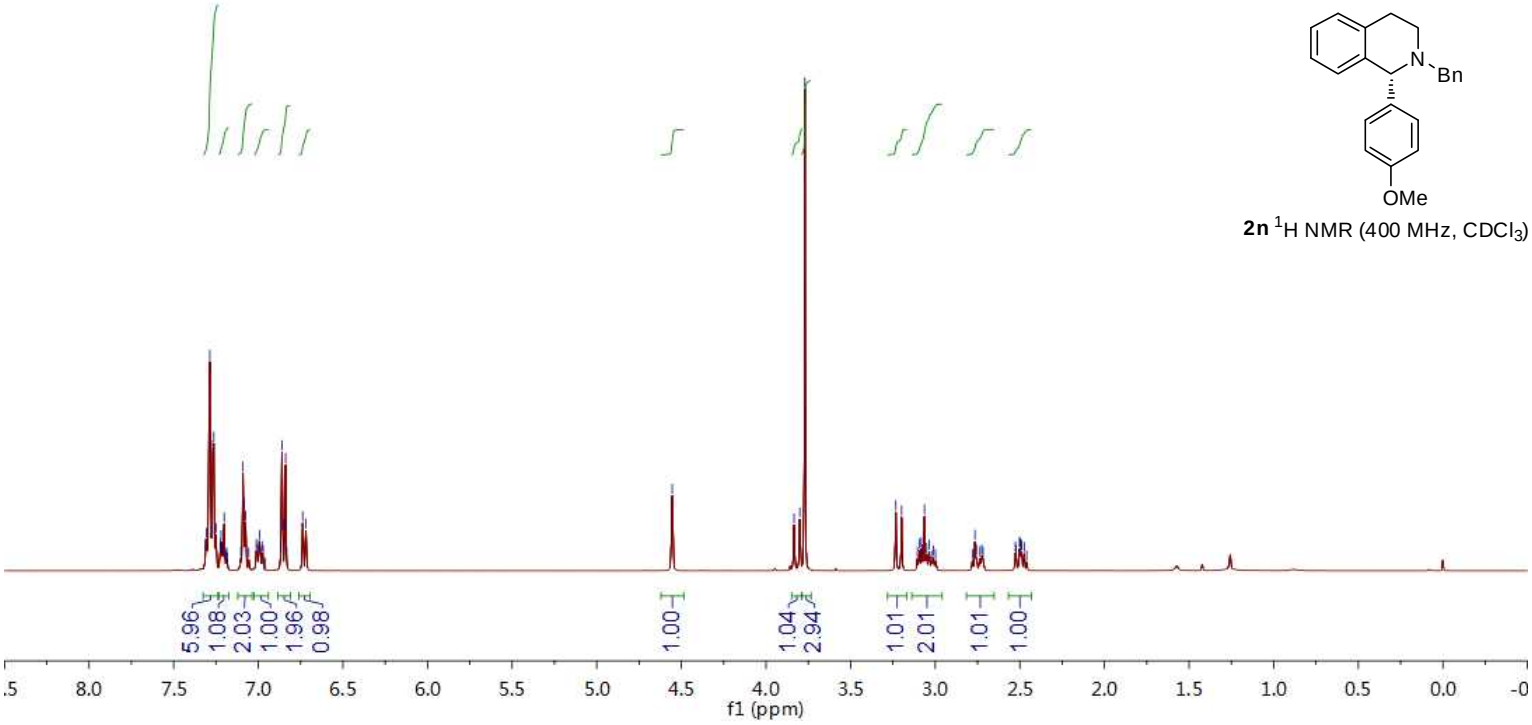



**2m** $^{1}$H NMR (400 MHz, $CDCl_3$)

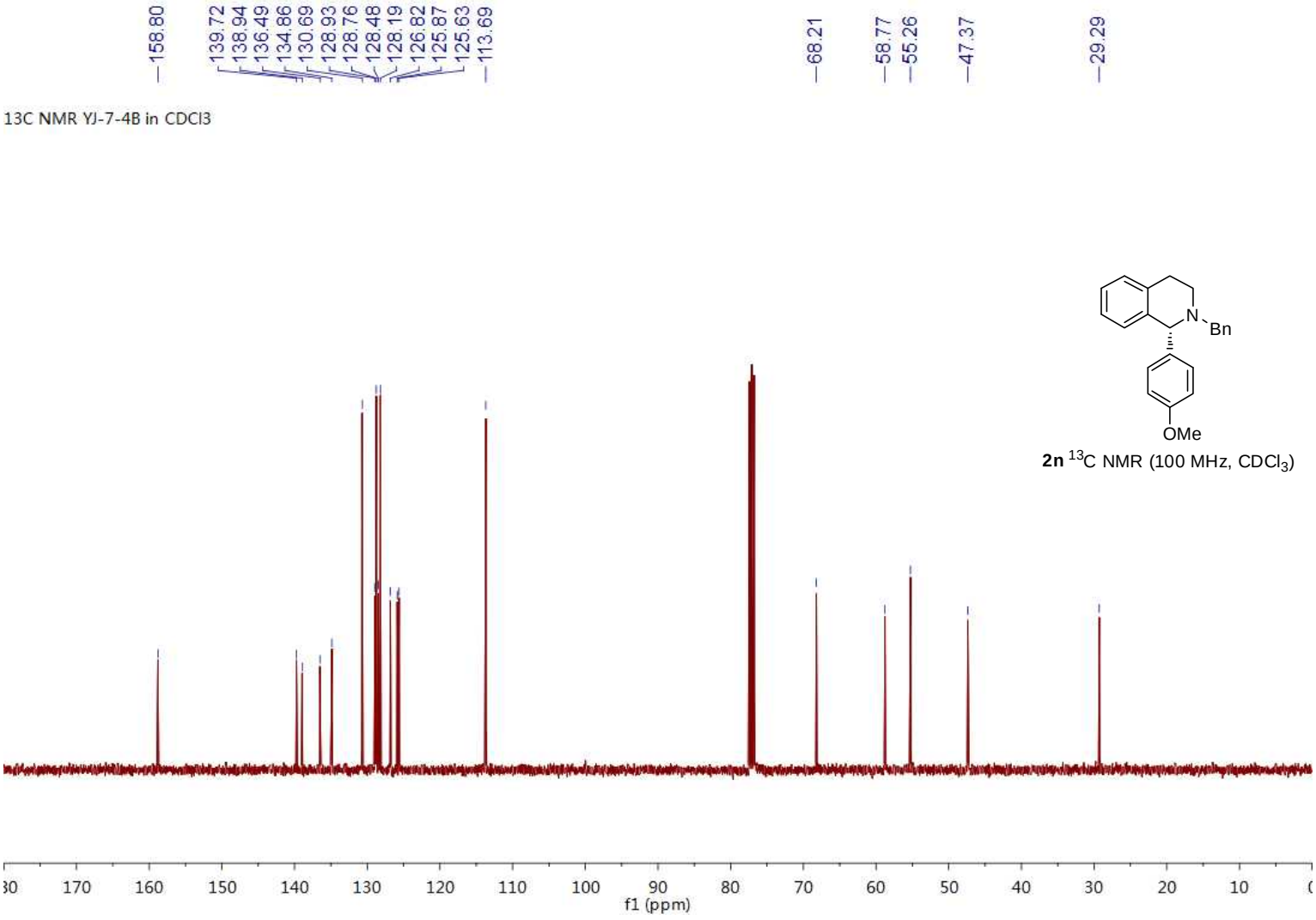

141.37
139.74
138.87
136.80
134.86
129.63
129.06
128.92
128.77
128.50
128.19
126.82
125.87
125.66
68.64
58.86
47.38
29.35
21.23
13C NMR YJ-7-4A in CDCl3
129.63
129.06
128.92
128.77
128.50
128.19
N
Bn
2m 13C NMR (100 MHz, CDCl3)
129.5
129.0
128.5
f1 (ppm)
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)




1H NMR YJ-7-4B in CDCl3

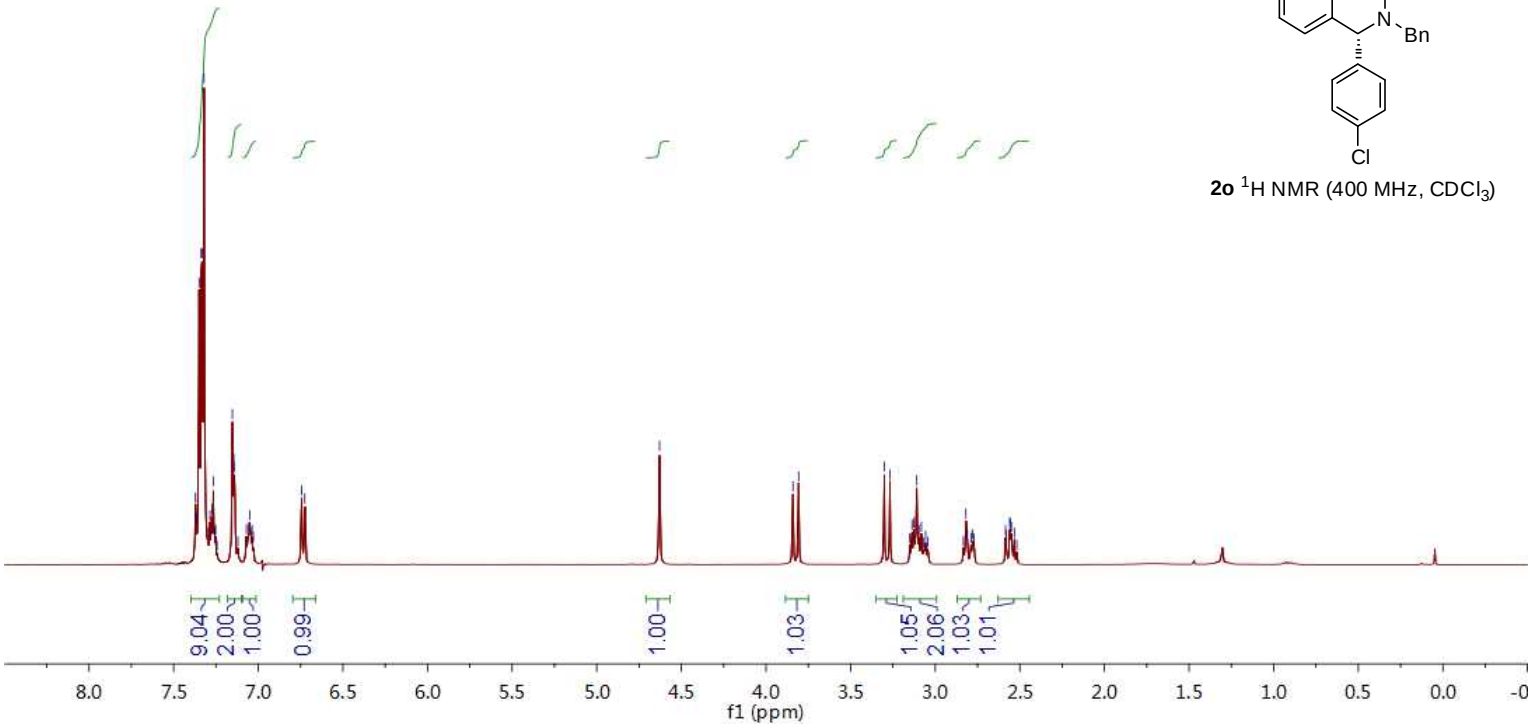


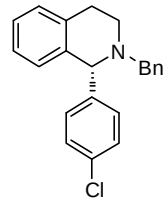

**2n** $^{1}$H NMR (400 MHz, $CDCl_3$)



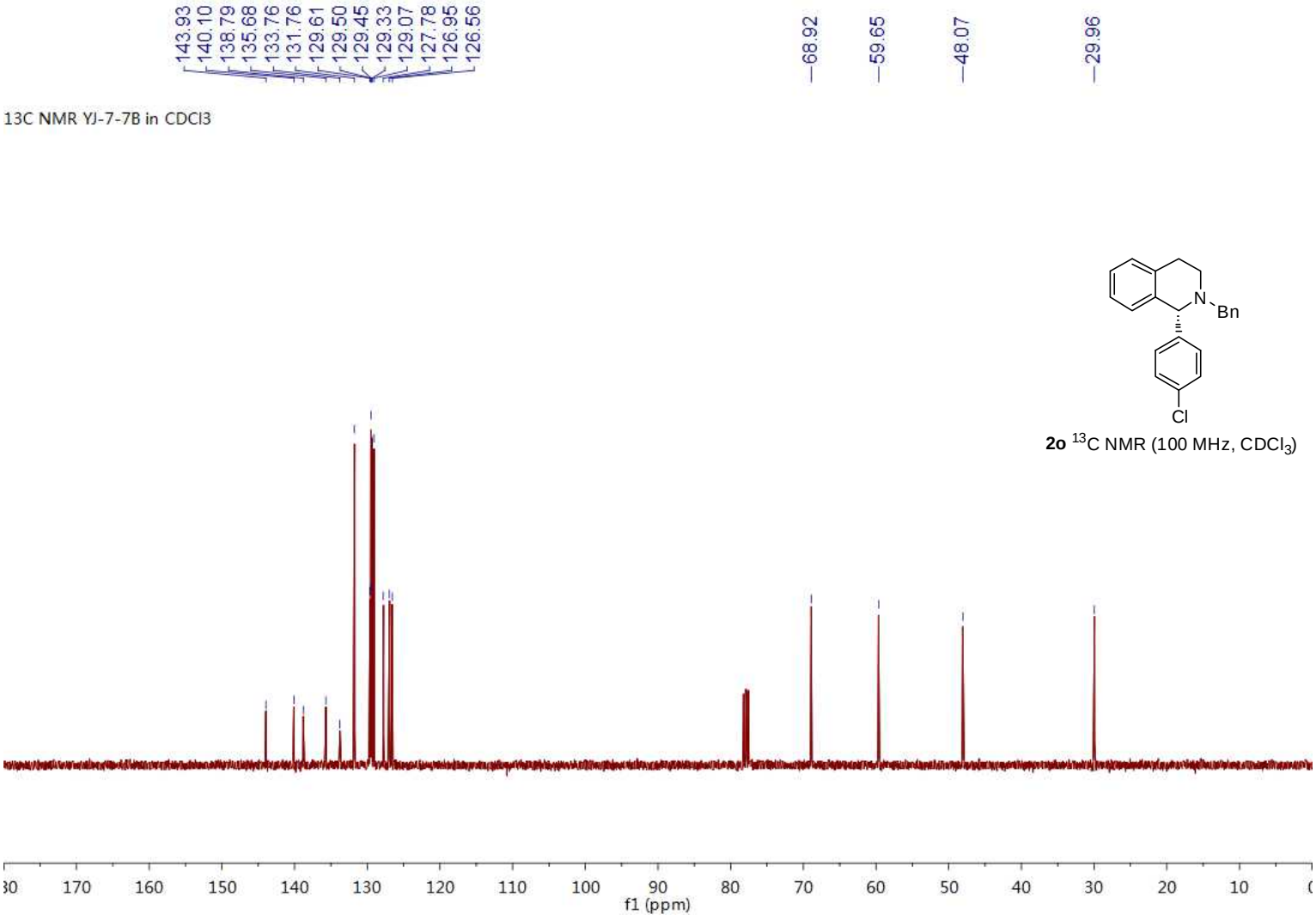

**2n** $^{13}$C NMR (100 MHz, $CDCl_3$)


1H NMR YJ-7-7B in CDCl3

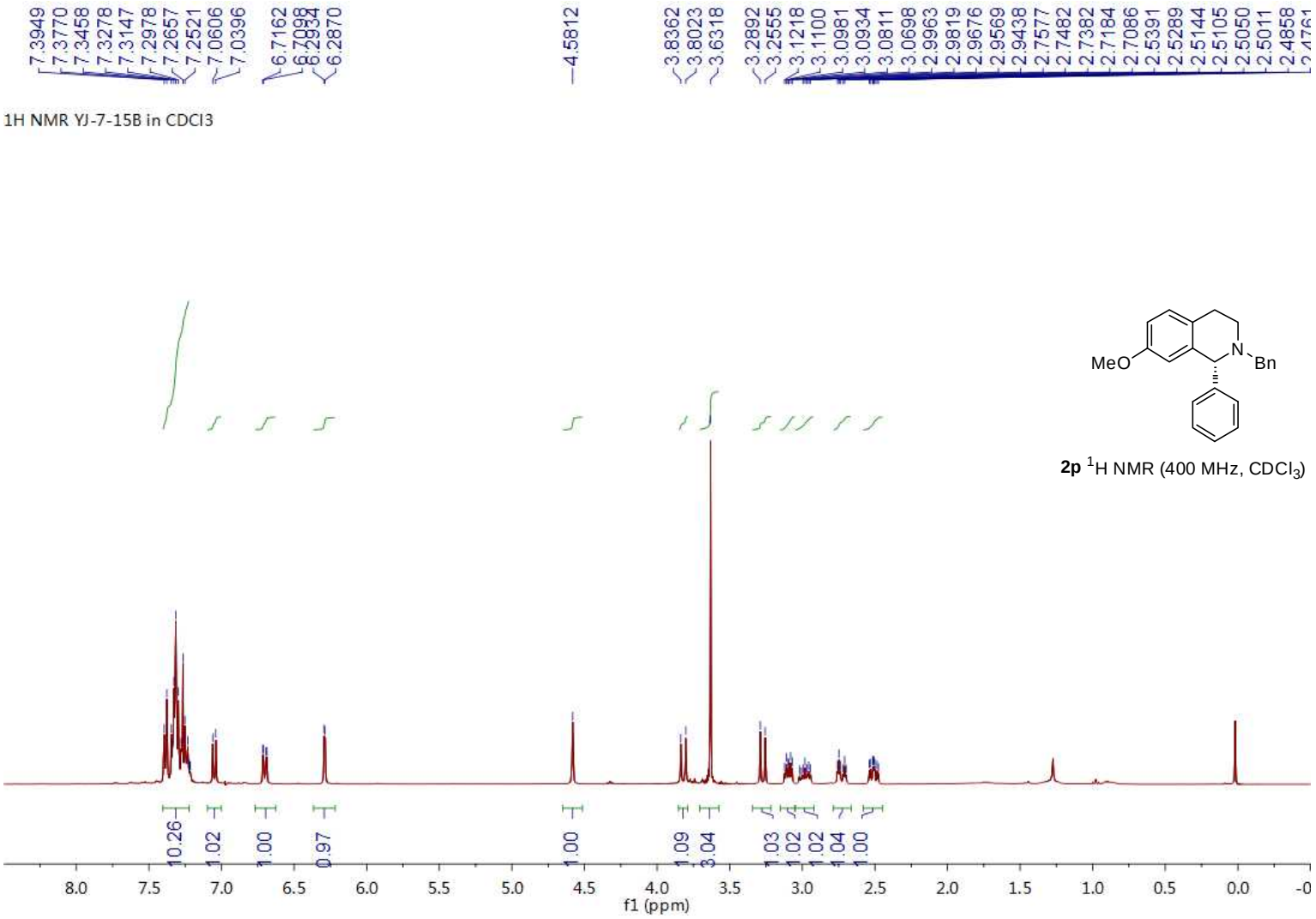


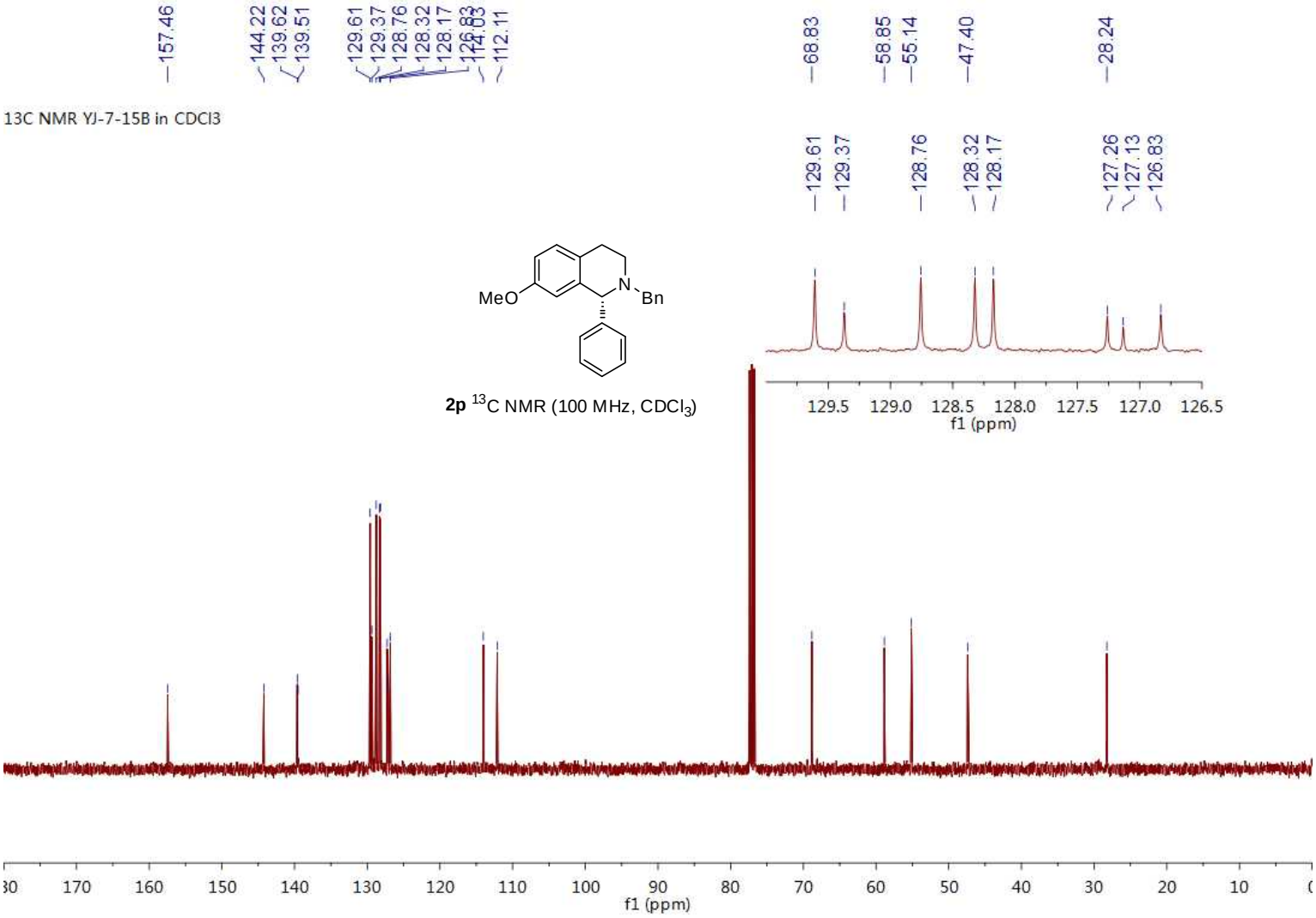

**2o** $^{1}$H NMR (400 MHz, $CDCl_3$)

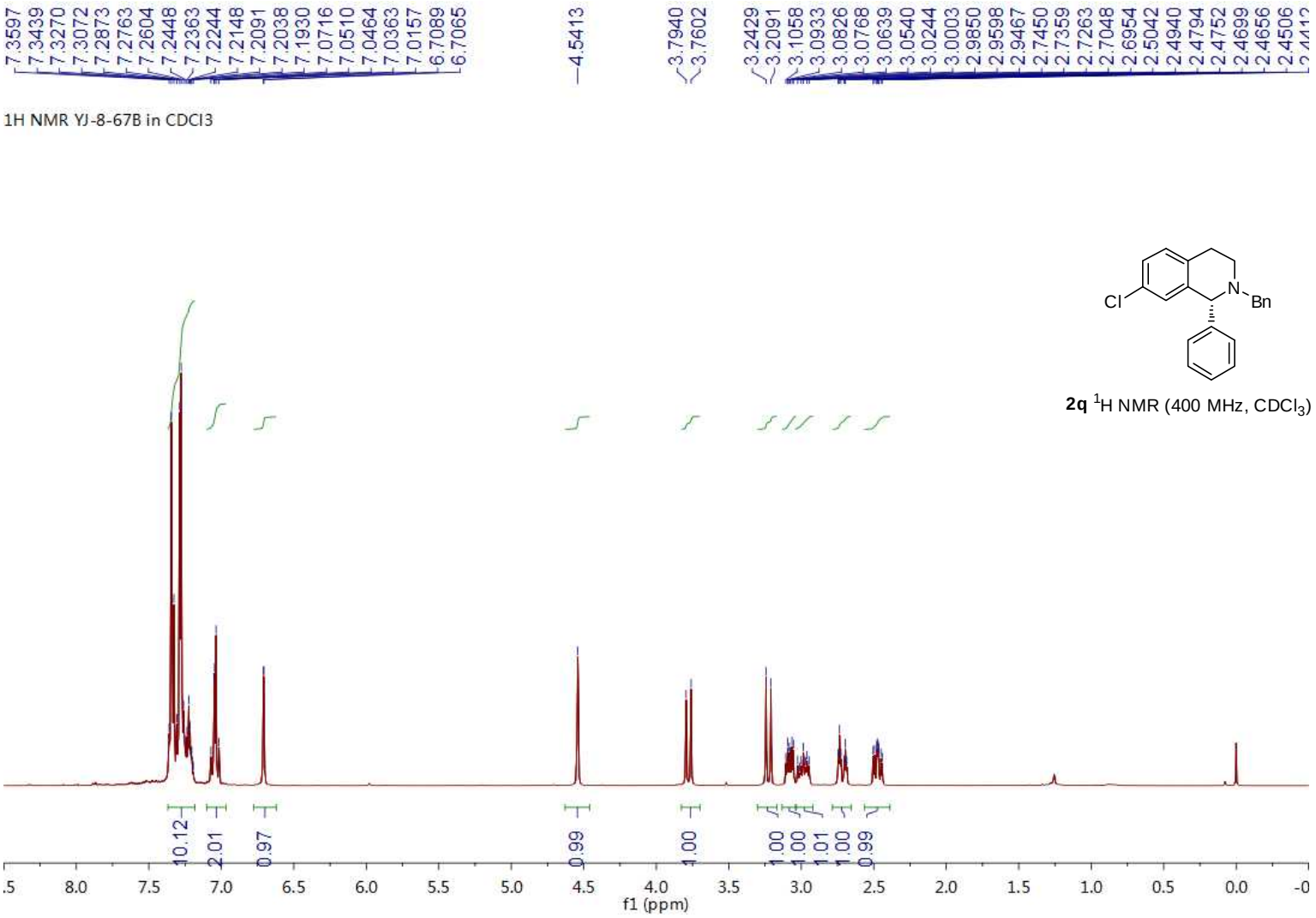



**2o** $^{13}C$ NMR (100 MHz, $CDCl_3$)

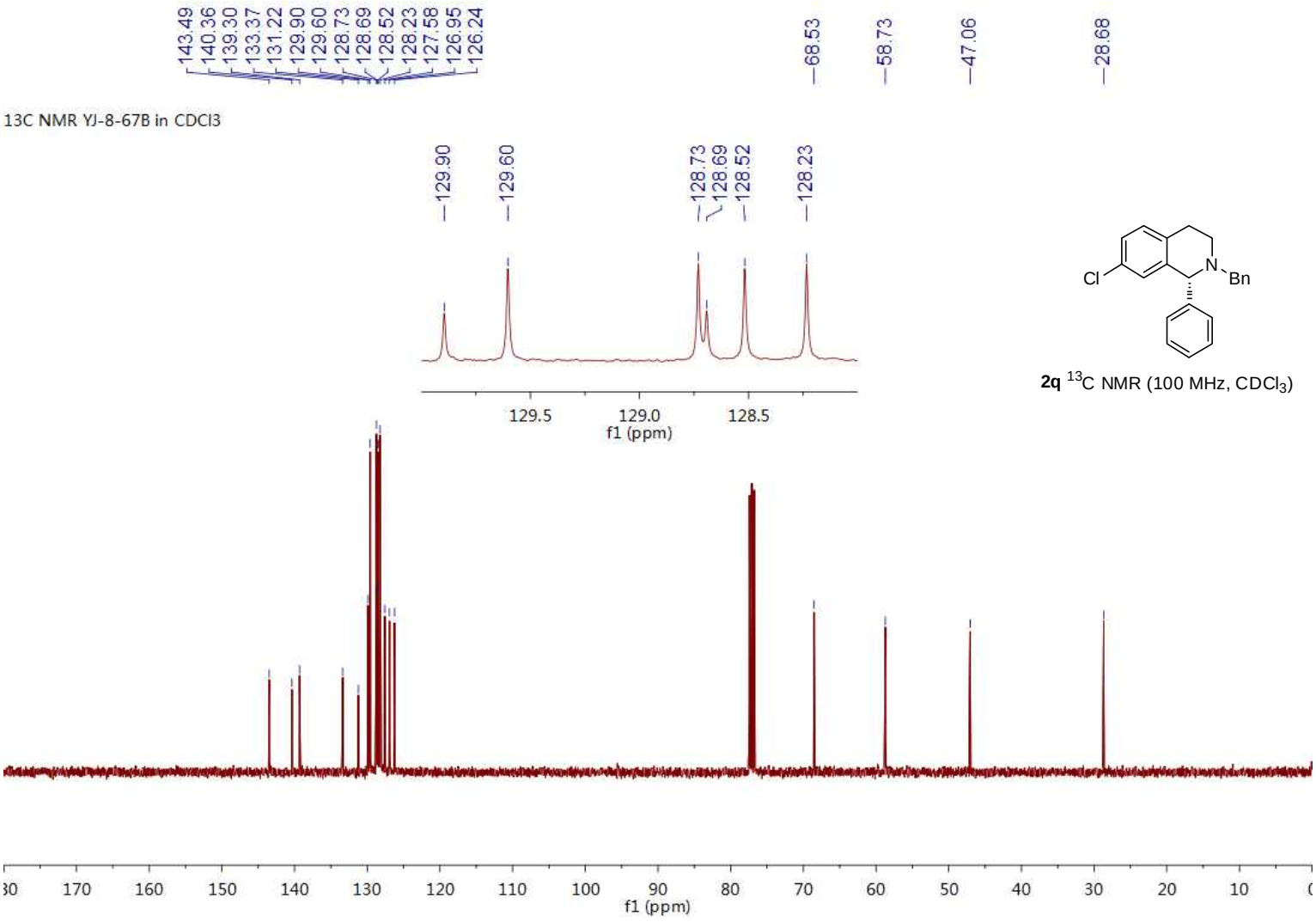



**2p** $^{1}$H NMR (400 MHz, $CDCl_3$)

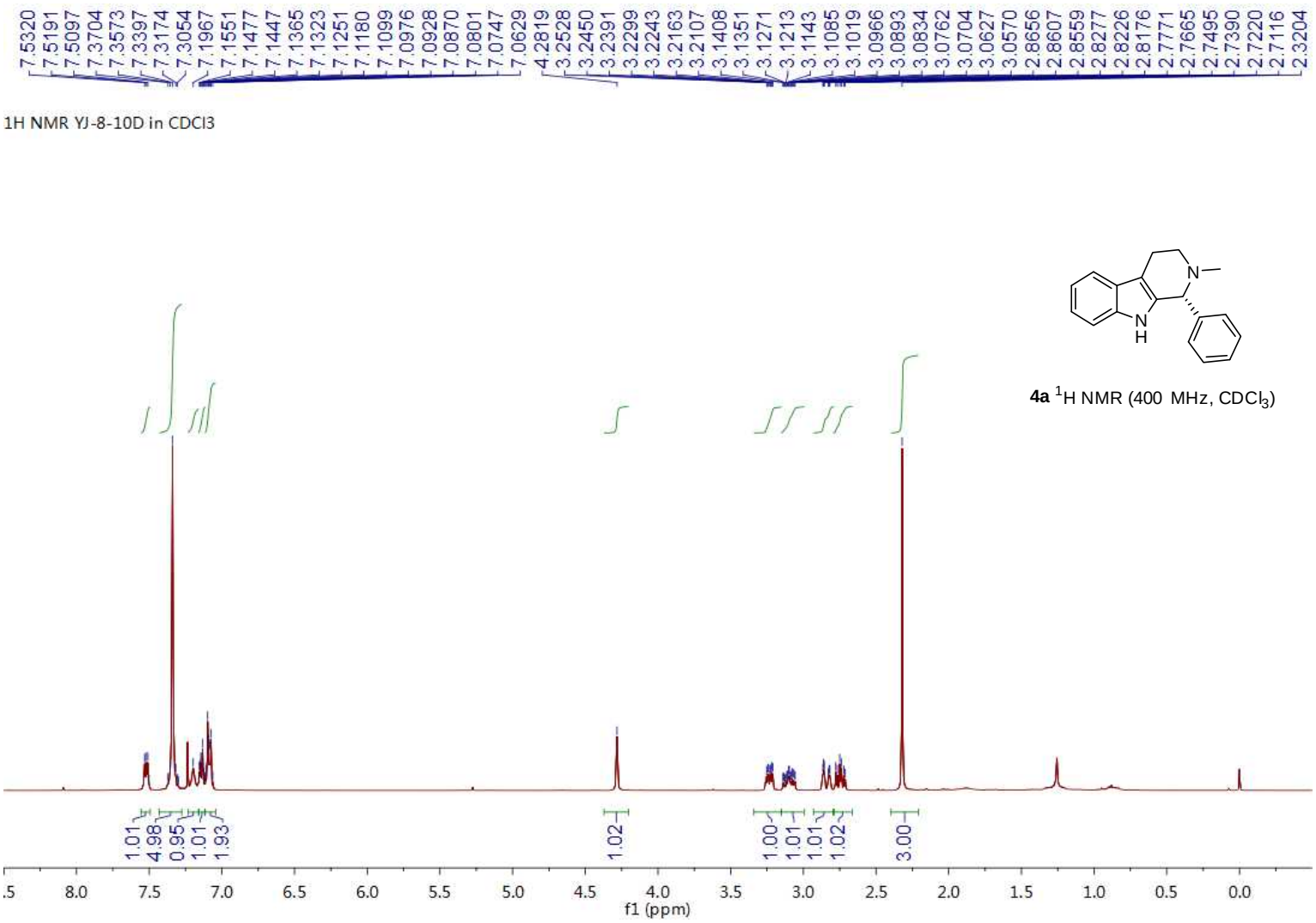

157.46
144.22
139.62
139.51
129.61
129.37
128.76
128.32
128.17
126.83
114.03
112.11
68.83
58.85
55.14
47.40
28.24
13C NMR YJ-7-15B in CDCl3
129.61
129.37
128.76
128.32
128.17
127.26
127.13
126.83
MeO
N
Bn
2p 13C NMR (100 MHz, CDCl3)
129.5 129.0 128.5 128.0 127.5 127.0 126.5
f1 (ppm)
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10
f1 (ppm)

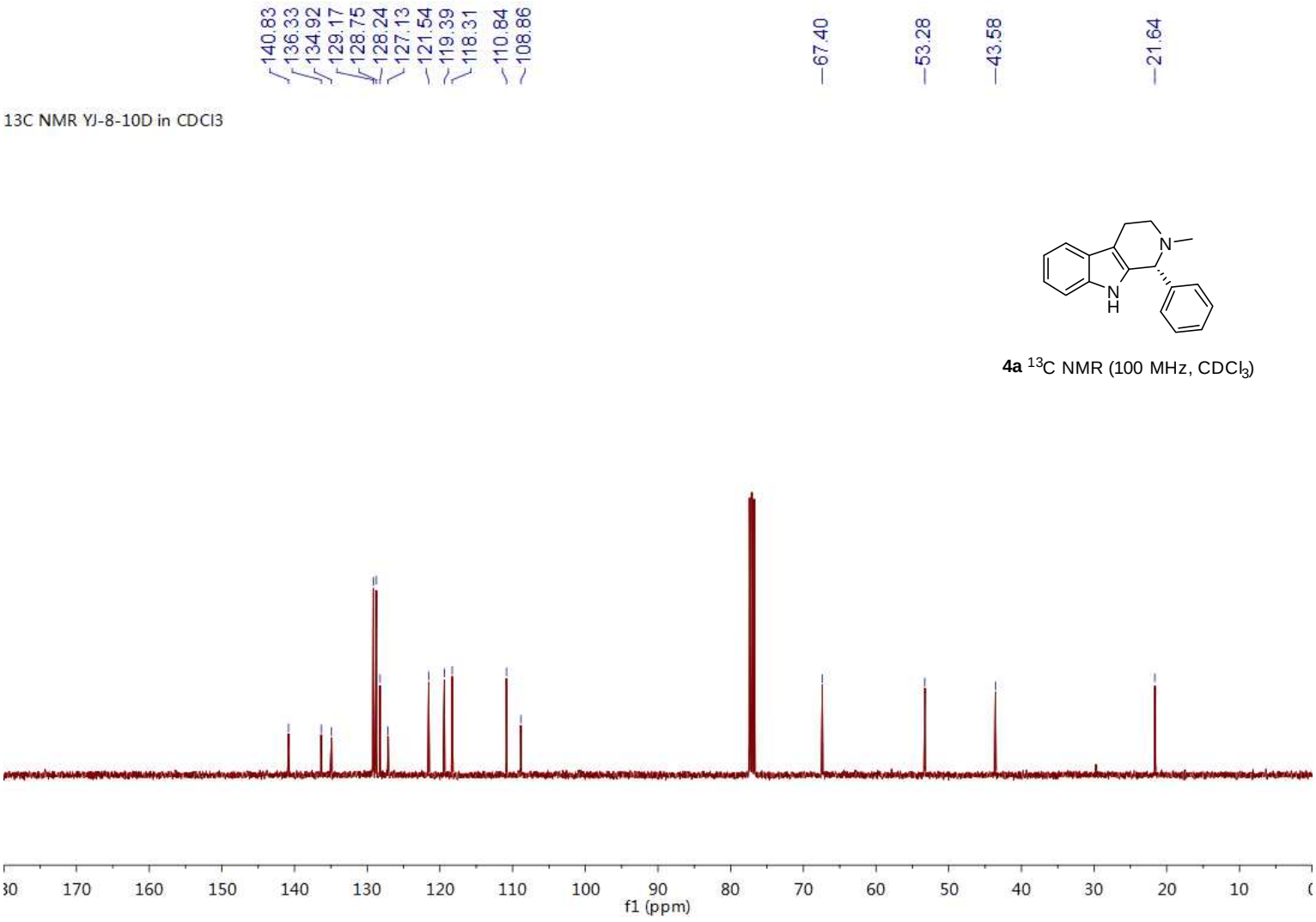



**2q** $^{1}$H NMR (400 MHz, $CDCl_3$)



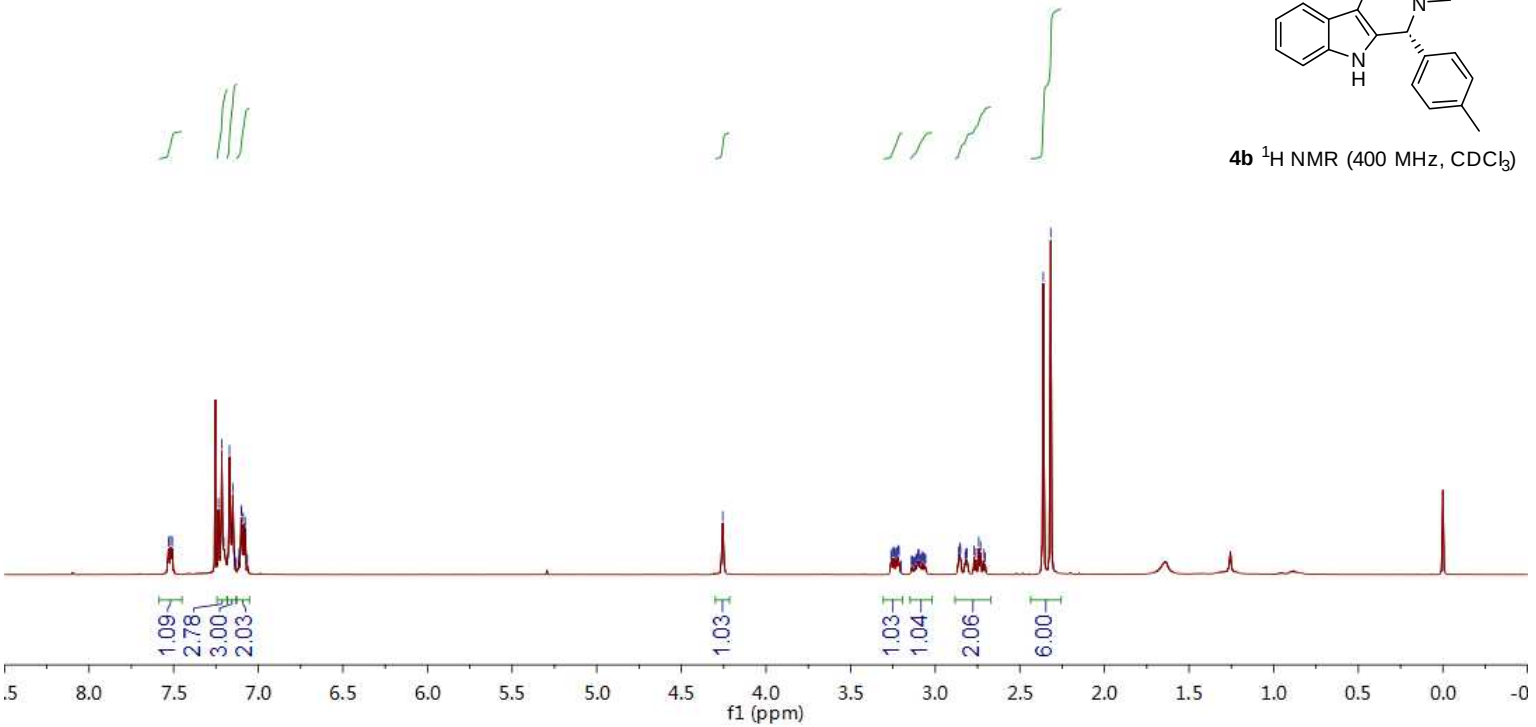

**2q** $^{13}$C NMR (100 MHz, $CDCl_3$)

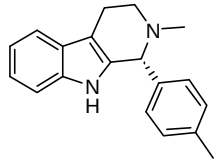

7.5320
7.5191
7.5097
7.3704
7.3573
7.3397
7.3174
7.3054
7.1967
7.1551
7.1477
7.1447
7.1365
7.1323
7.1251
7.1180
7.1099
7.0976
7.0928
7.0870
7.0801
7.0747
7.0629
4.2819
3.2528
3.2450
3.2391
3.2299
3.2243
3.2163
3.2107
3.1408
3.1351
3.1271
3.1213
3.1143
3.1085
3.1019
3.0966
3.0893
3.0834
3.0762
3.0704
3.0627
3.0570
2.8656
2.8607
2.8559
2.8277
2.8226
2.8176
2.7771
2.7665
2.7495
2.7390
2.7220
2.7116
2.3204
1H NMR YJ-8-10D in CDCl3
N
H
4a 1H NMR (400 MHz, CDCl3)
1.01
4.98
0.95
1.01
1.93
1.02
1.00
1.01
1.01
1.02
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)



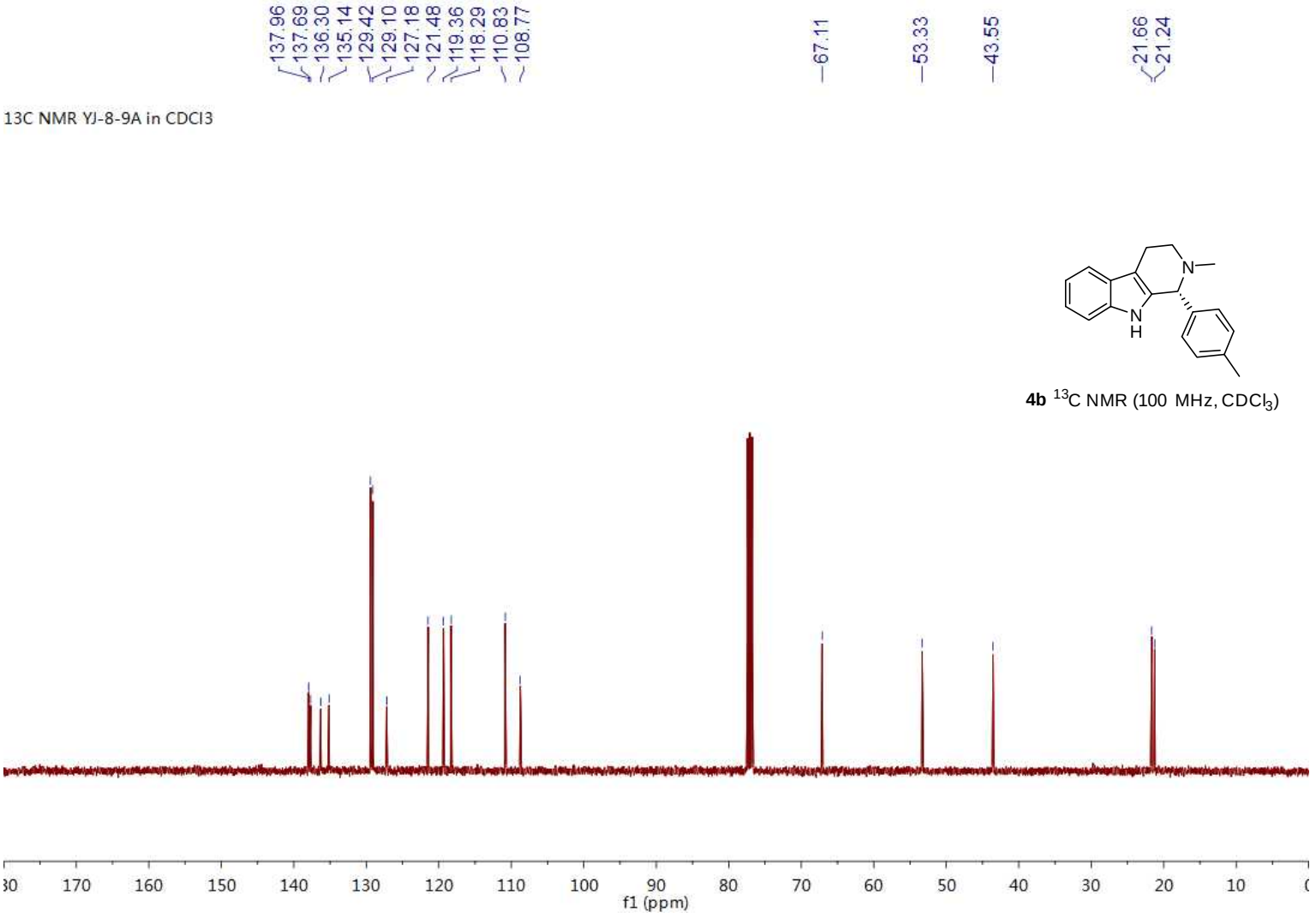

**4a** $^{13}C$ NMR (100 MHz, $CDCl_3$)


1H NMR YJ-8-9A in CDCl3

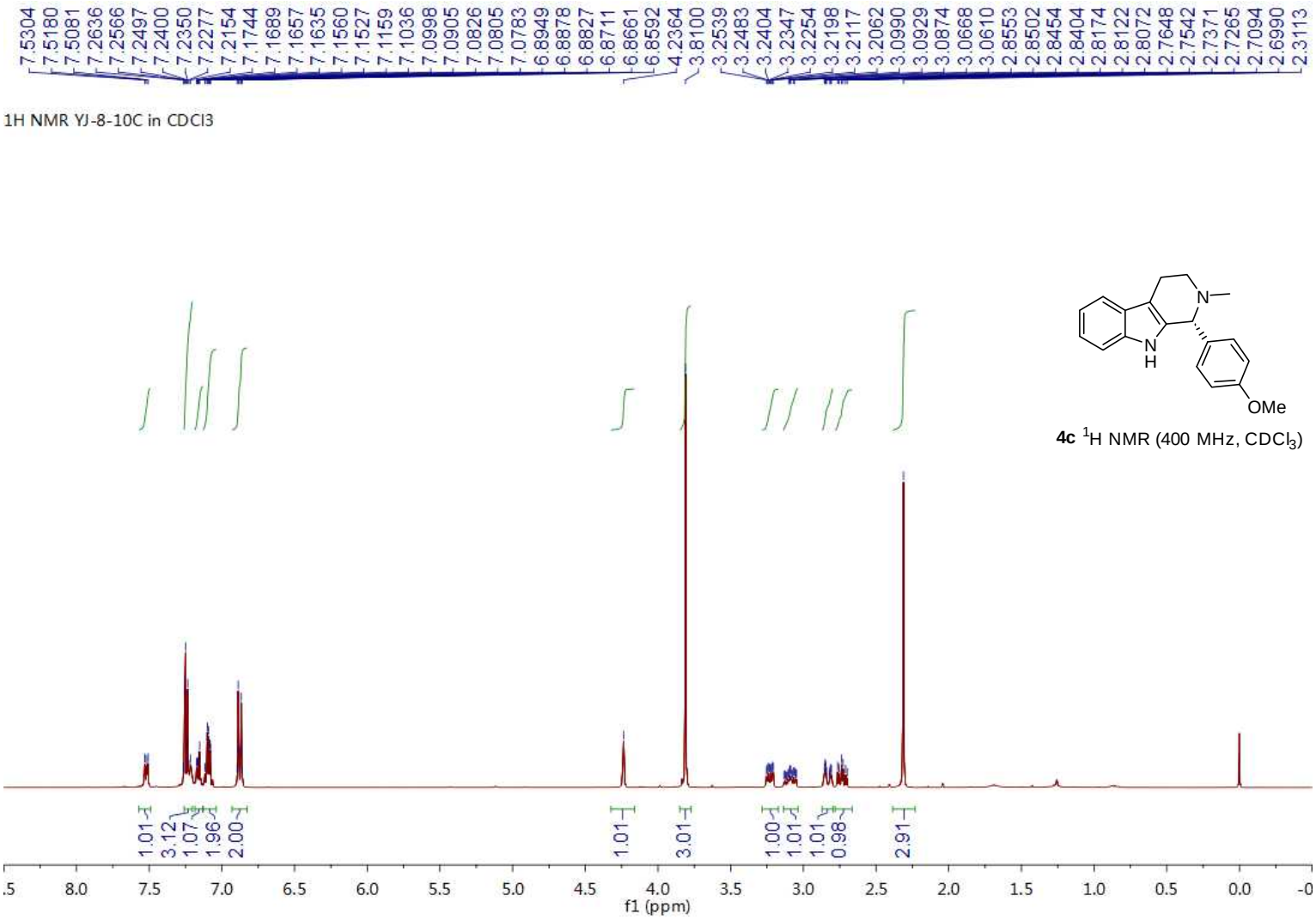


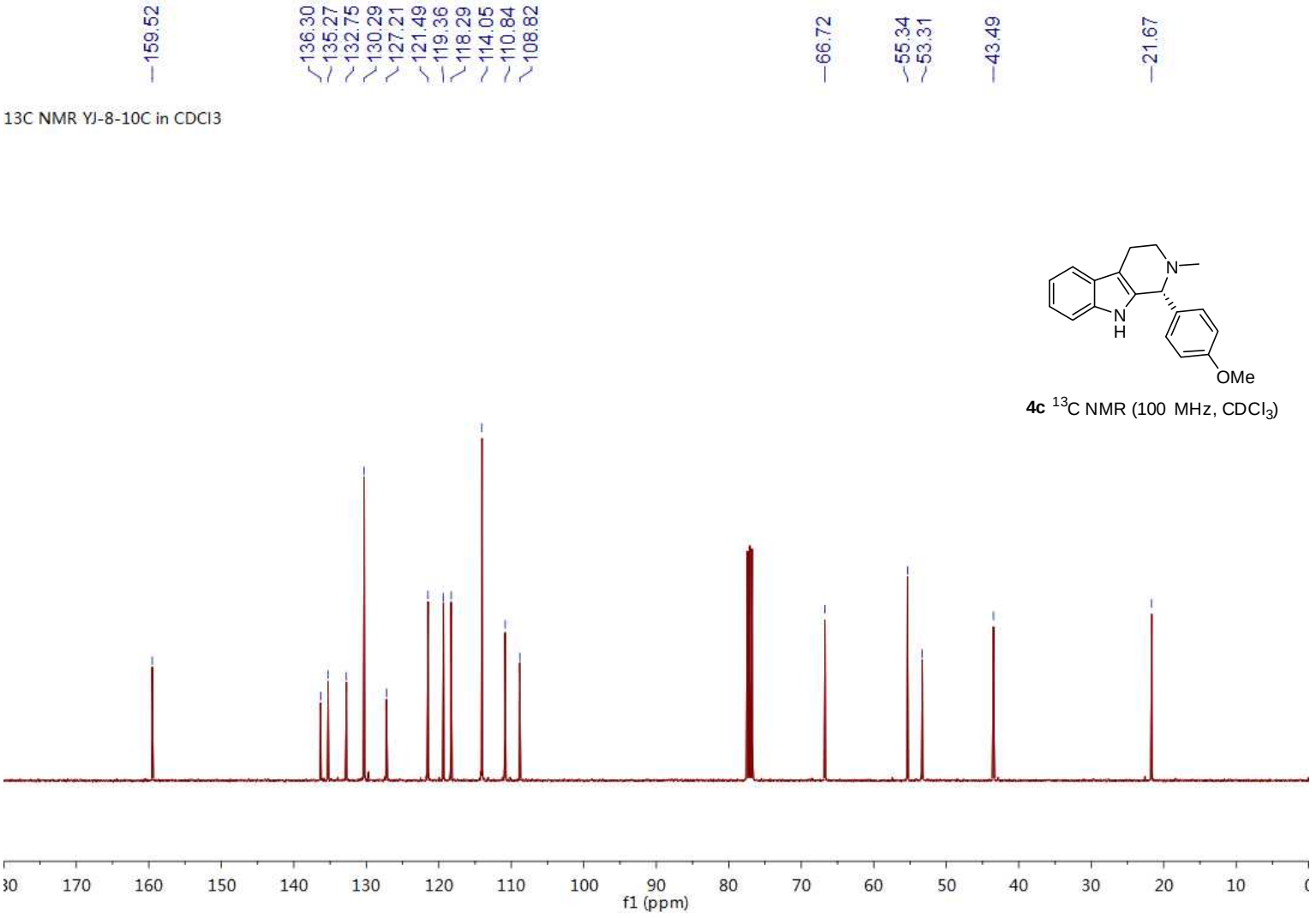




**4b** $^{1}$H NMR (400 MHz, $CDCl_3$)

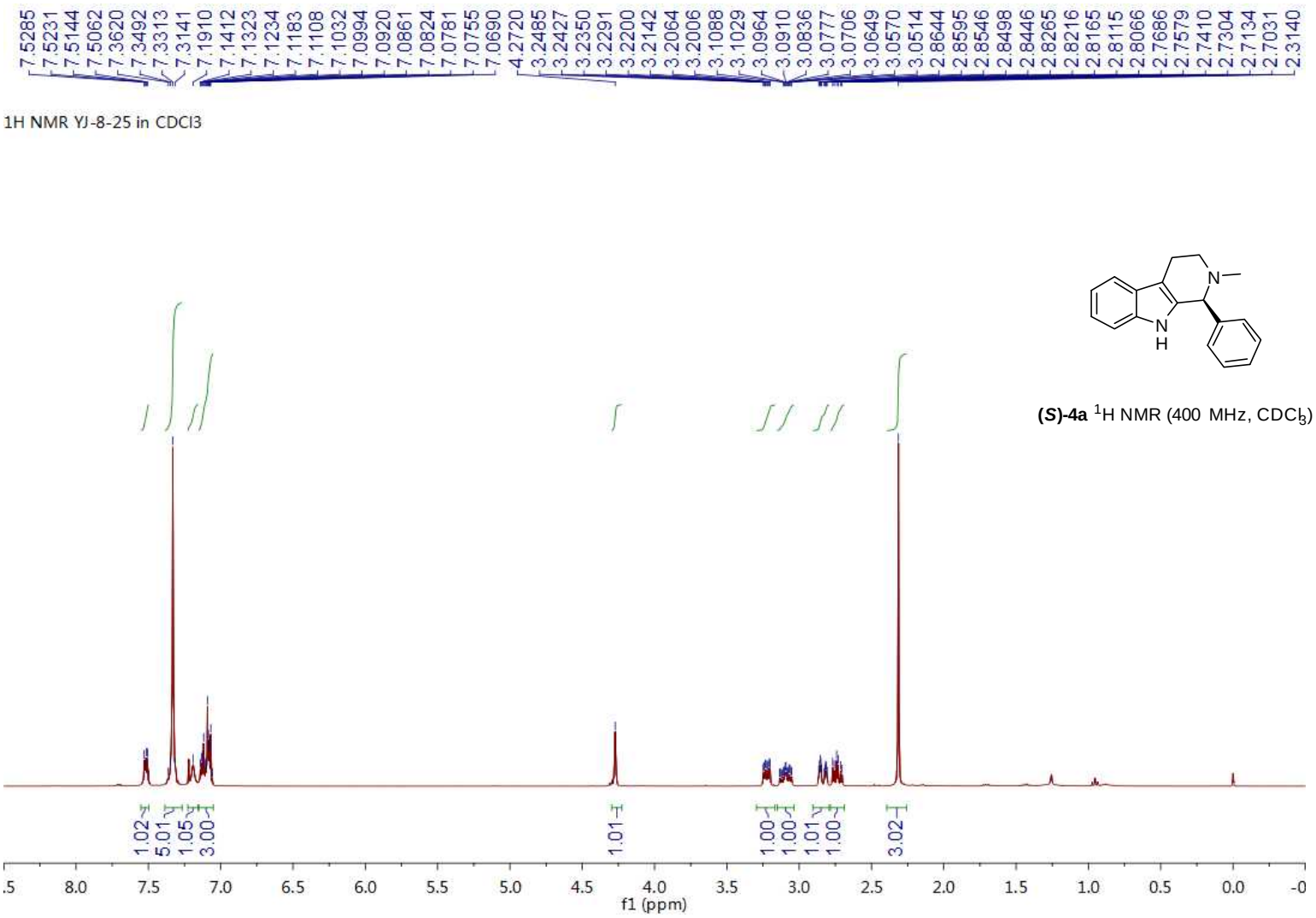



**4b** $^{13}C$ NMR (100 MHz, $CDCl_3$)


7.5304
7.5180
7.5081
7.2636
7.2566
7.2497
7.2400
7.2350
7.2277
7.2154
7.1744
7.1689
7.1657
7.1635
7.1560
7.1527
7.1159
7.1036
7.0998
7.0905
7.0826
7.0805
7.0783
6.8949
6.8878
6.8827
6.8711
6.8661
6.8592
4.2364
3.8100
3.2539
3.2483
3.2404
3.2347
3.2254
3.2198
3.2117
3.2062
3.0990
3.0929
3.0874
3.0668
3.0610
2.8553
2.8502
2.8454
2.8404
2.8174
2.8122
2.8072
2.7648
2.7542
2.7371
2.7265
2.7094
2.6990
2.3113
1H NMR YJ-8-10C in CDCl3
1.01
3.12
1.07
1.96
2.00
1.01
3.01
1.00
1.01
1.01
0.98
2.91
f1 (ppm)
N
H
OMe
4c 1H NMR (400 MHz, CDCl3)



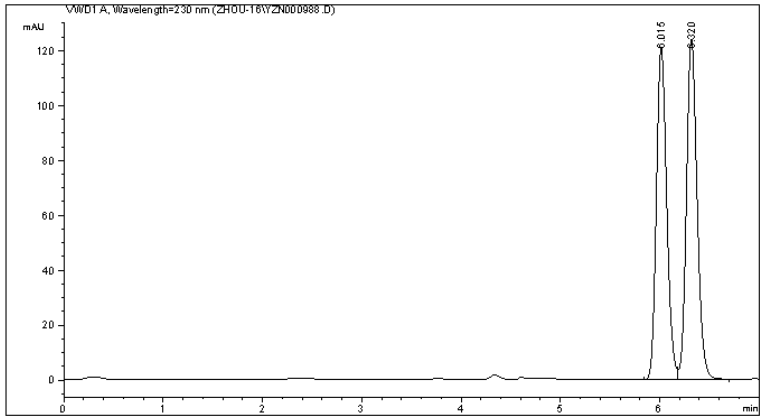

**4c** $^{13}C$ NMR (100 MHz, $CDCl_3$)




**(*S*)-4a** $^{1}$H NMR (400 MHz, $CDCl_3$)

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN000988.D
Sample Name: YJ-6-87+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/12/2016 9:47:05 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/12/2016 9:45:42 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 7:47:19 PM
                  (modified after loading)
Sample Info     : OD-H, Hex/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

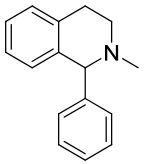
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #  [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   6.015 BV    0.1118  872.79413  121.08356  48.6320
   2   6.320 VB    0.1143  921.89819  124.11383  51.3680

Totals :                  1794.69232  245.19739

                          *** End of Report ***
```

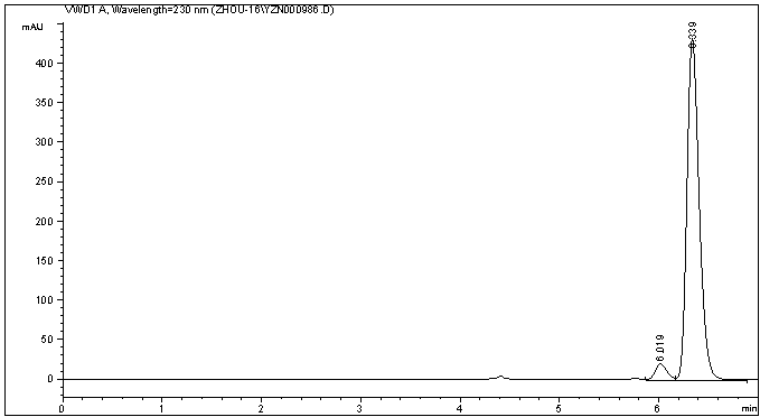


**(+/-)-2a**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN000986.D
Sample Name: YJ-6-87B

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/12/2016 9:28:57 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/12/2016 9:18:21 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 7:47:19 PM
                  (modified after loading)
Sample Info     : OD-H, Hex/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #  [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   6.019 VV    0.1283  168.95340   20.17665   4.3576
   2   6.339 VB    0.1307 3708.29297  432.08823  95.6424

Totals :                  3877.24637  452.26488

                          *** End of Report ***
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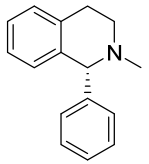
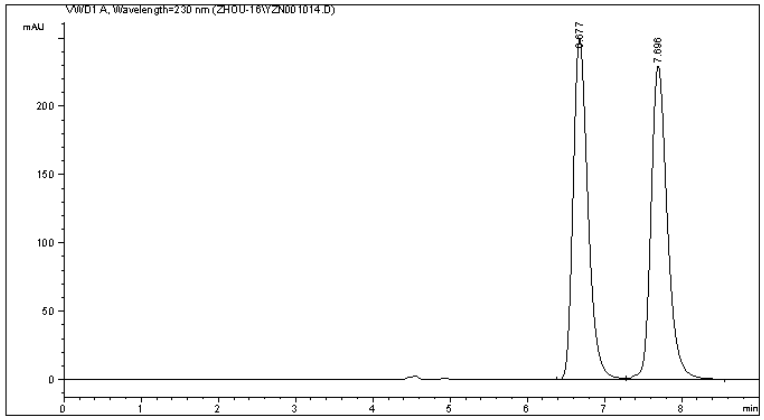


**(-)-2a**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001014.D
Sample Name: YJ-6-90B+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/14/2016 9:56:55 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/14/2016 9:55:26 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 7:50:25 PM
                  (modified after loading)
Sample Info     : OJ-H, Hex/i-PrOH = 95/5, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

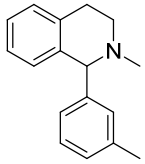
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #  [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|--------|
   1   6.677 VV    0.2050 3323.76807  249.38417  49.7525
   2   7.696 VB    0.2231 3356.83643  229.42706  50.2475

Totals :                  6680.60449  478.81123

                          *** End of Report ***
```

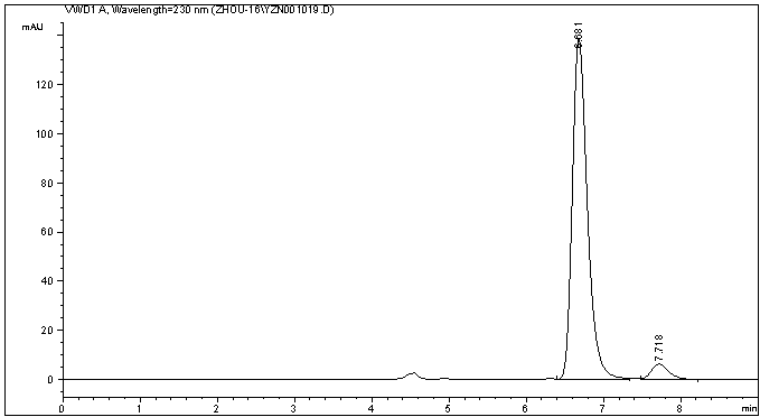


**(+/-)-2b**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001019.D
Sample Name: YJ-6-90B

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/14/2016 11:01:42 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/14/2016 10:58:07 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 7:50:25 PM
                  (modified after loading)
Sample Info     : OJ-H, Hex/i-PrOH = 95/5, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

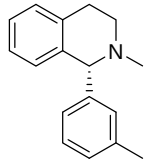
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #  [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|--------|
   1   6.681 VB    0.2076 1879.85925  138.68797  94.9097
   2   7.718 VB    0.2405  100.82166    6.30243   5.0903

Totals :                  1980.68091  144.99041

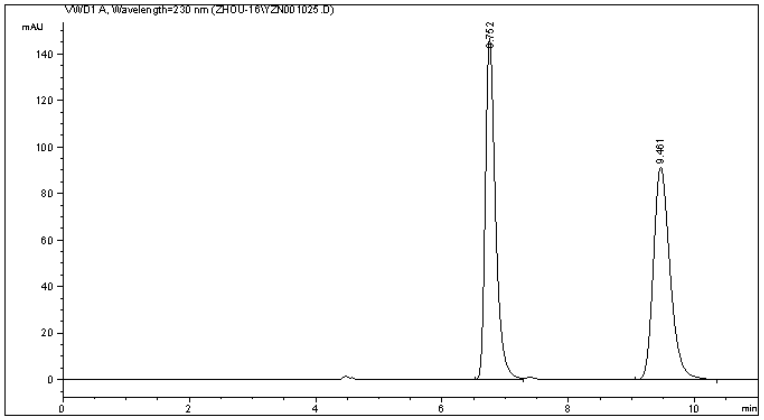
                          *** End of Report ***
```



**(-)-2b**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001025.D
Sample Name: YJ-6-90A+-

```
    ====================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 4/15/2016 5:15:52 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 4/15/2016 5:09:35 PM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:52:28 PM
                      (modified after loading)
    Sample Info     : OJ-H, Hex/i-PrOH = 95/5, 0.7 mL/min, 30oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

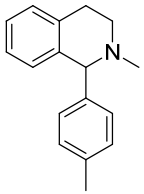
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|----------|-------|
       1   6.752 BV    0.1700 1642.48145  146.59044  49.5974
       2   9.461 BB    0.2800 1669.14624   91.40023  50.4026

    Totals :                   3311.62769  237.99067

    ====================================================================
                            *** End of Report ***
```

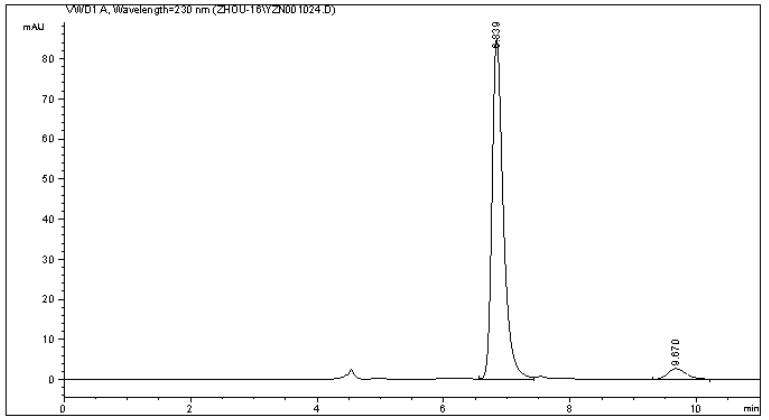



**(+/-)-2c**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001024.D
Sample Name: YJ-6-90A

```
    ====================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 4/15/2016 4:56:53 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 4/15/2016 4:47:41 PM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:52:28 PM
                      (modified after loading)
    Sample Info     : OJ-H, Hex/i-PrOH = 95/5, 0.7 mL/min, 30oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

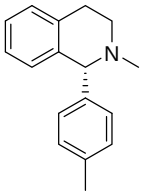
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|----------|-------|
       1   6.839 BV    0.1866 1049.71289   84.79782  95.1694
       2   9.670 BB    0.3106   53.28136    2.66300   4.8306

    Totals :                   1102.99425   87.46082

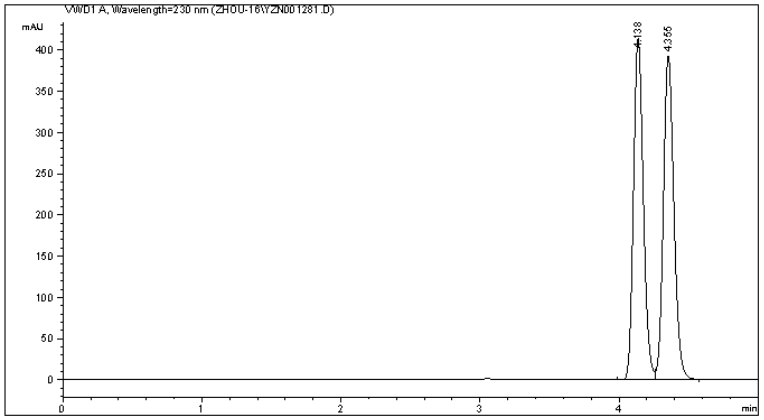
    ====================================================================
                            *** End of Report ***
```




**(-)-2c**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001281.D
Sample Name: YJ-6-101A+-

```
    ====================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 5/7/2016 11:17:37 AM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 5/7/2016 11:16:29 AM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:55:08 PM
                      (modified after loading)
    Sample Info     : OD-H, Hex/i-PrOH = 90/10, 1.0 mL/min, 30oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

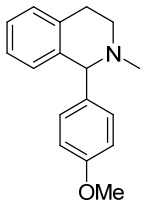
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|--------|
       1   4.138 VV    0.0747 2034.47632  414.56564  49.5893
       2   4.355 VV    0.0817 2068.17554  393.52551  50.4107

    Totals :                   4102.65186  808.09116

    ====================================================================
                            *** End of Report ***
```

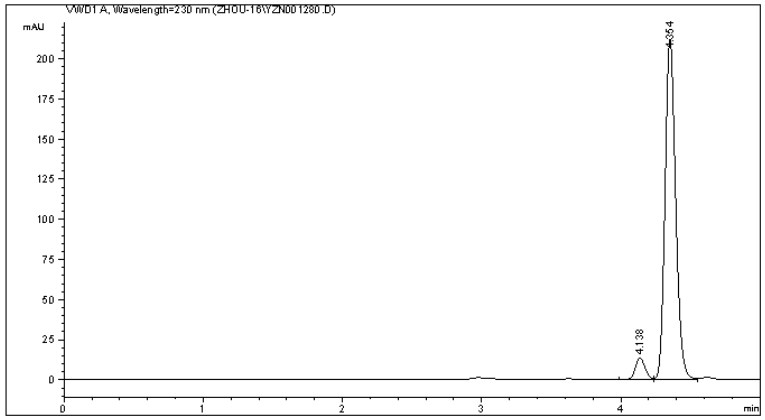



**(+/-)-2d**

Instrument 1 7/25/2016 7:55:31 PM Page 1 of 1

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001280.D
Sample Name: YJ-6-101A

```
    ====================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 5/7/2016 11:10:12 AM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 5/7/2016 11:09:28 AM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:55:08 PM
                      (modified after loading)
    Sample Info     : OD-H, Hex/i-PrOH = 90/10, 1.0 mL/min, 30oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

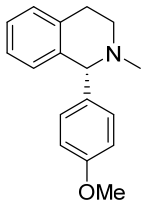
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|--------|
       1   4.138 BV    0.0778   68.04399   13.48343   5.6933
       2   4.354 VV    0.0808 1127.11353  212.41176  94.3067

    Totals :                   1195.15752  225.89518

    ====================================================================
                            *** End of Report ***
```

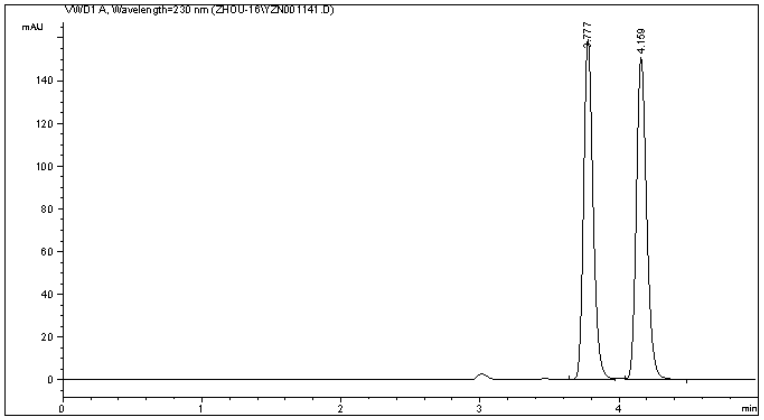



**(-)-2d**

Instrument 1 7/25/2016 7:55:52 PM Page 1 of 1

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001141.D
Sample Name: YJ-6-92C+-

```
    ======================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 4/22/2016 10:09:32 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 4/22/2016 10:06:06 PM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:55:08 PM
                      (modified after loading)
    Sample Info     : OD-H, Hex/i-PrOH = 95/5, 1.0 mL/min, 30oC, 230 nm
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

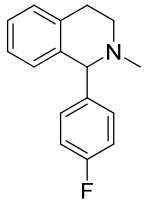
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   3.777 VV    0.0728  756.84216  159.51071  49.2602
       2   4.159 VB    0.0793  779.57513  150.73552  50.7398

    Totals :                  1536.41730  310.24623

    ======================================================================
                               *** End of Report ***
```

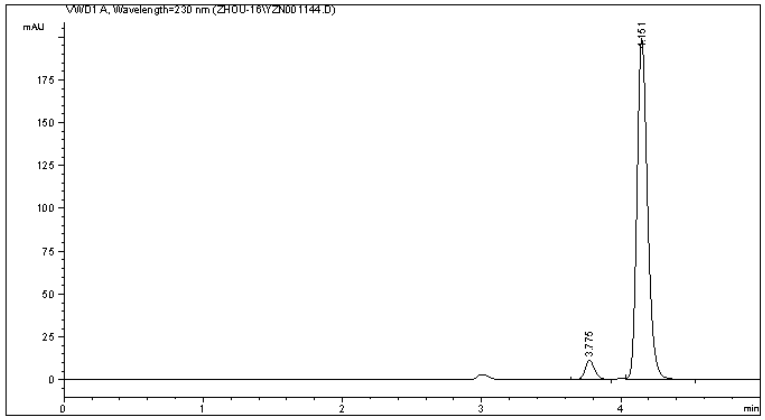



**(+/-)-2e**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001144.D
Sample Name: YJ-6-92C

```
    ======================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 4/22/2016 10:30:03 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 4/22/2016 10:28:41 PM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:55:08 PM
                      (modified after loading)
    Sample Info     : OD-H, Hex/i-PrOH = 95/5, 1.0 mL/min, 30oC, 230 nm
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

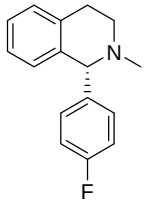
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   3.775 BV    0.0744   55.18276   11.30744   4.9818
       2   4.151 VB    0.0806 1052.50842  198.99071  95.0182

    Totals :                  1107.69118  210.29815

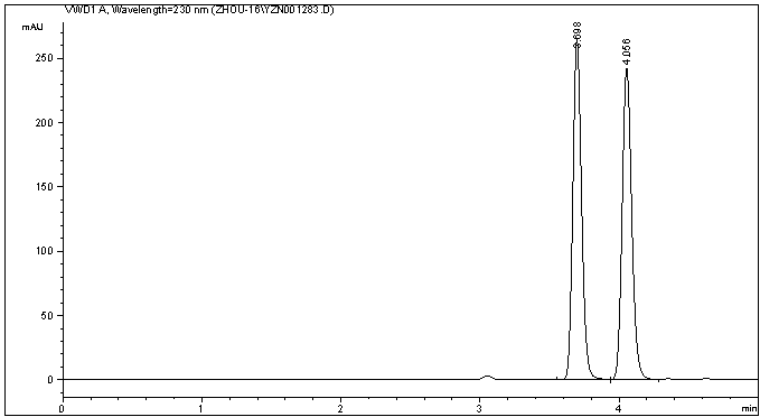
    ======================================================================
                               *** End of Report ***
```




**(-)-2e**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001283.D
Sample Name: YJ-6-101B+-

```
    ======================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 5/7/2016 11:29:50 AM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 5/7/2016 11:29:16 AM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:55:08 PM
                      (modified after loading)
    Sample Info     : OD-H, Hex/i-PrOH = 90/10, 1.0 mL/min, 30oC, 230 nm
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

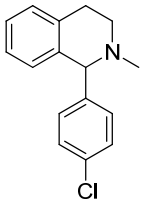
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   3.698 VV    0.0670 1157.58936  265.09619  49.8513
       2   4.056 VV    0.0735 1164.49731  242.44028  50.1487

    Totals :                   2322.08667  507.53647

    ======================================================================
                               *** End of Report ***
```

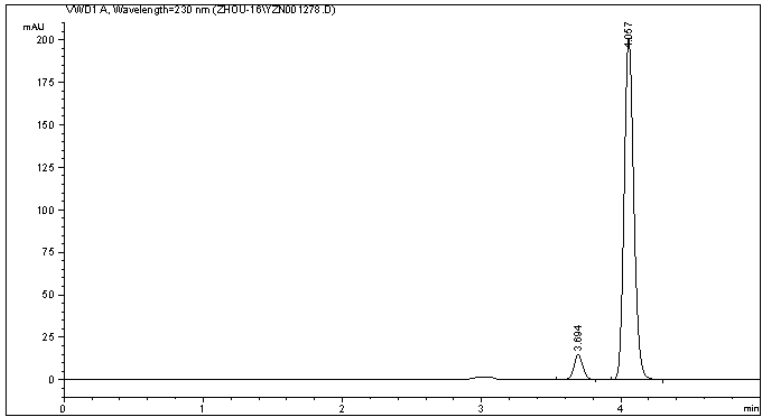



**(+/-)-2f**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001278.D
Sample Name: YJ-6-101B

```
    ======================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 5/7/2016 10:57:17 AM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 5/7/2016 10:56:56 AM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 7:55:08 PM
                      (modified after loading)
    Sample Info     : OD-H, Hex/i-PrOH = 90/10, 1.0 mL/min, 30oC, 230 nm
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

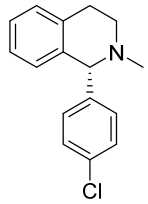
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   3.694 VV    0.0686   66.68333   14.78734   6.4298
       2   4.057 VV    0.0754  970.41309  200.56610  93.5702

    Totals :                   1037.09642  215.35345

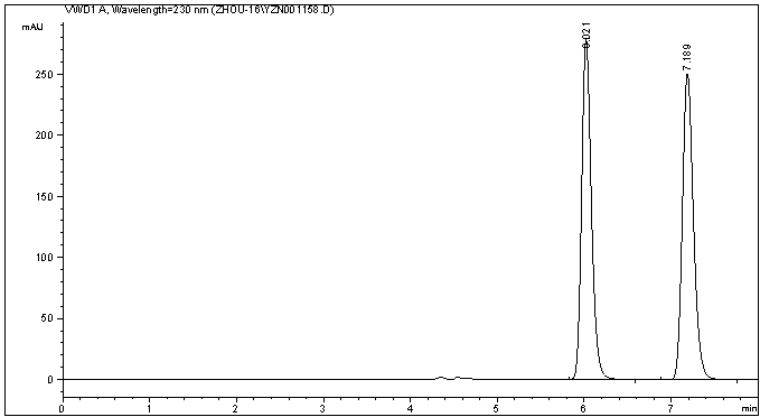
    ======================================================================
                               *** End of Report ***
```




**(-)-2f**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001158.D
Sample Name: YJ-6-93D+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/23/2016 3:59:44 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/23/2016 3:57:44 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:01:48 PM
                  (modified after loading)
Sample Info     : OD-H, Hex/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

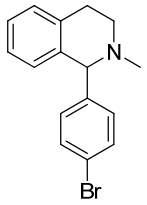
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   6.021 VB    0.1200 2174.69897  279.14999  49.4372
   2   7.189 BB    0.1370 2224.21753  250.62343  50.5628

Totals :                  4398.91650  529.77342

                          *** End of Report ***
```

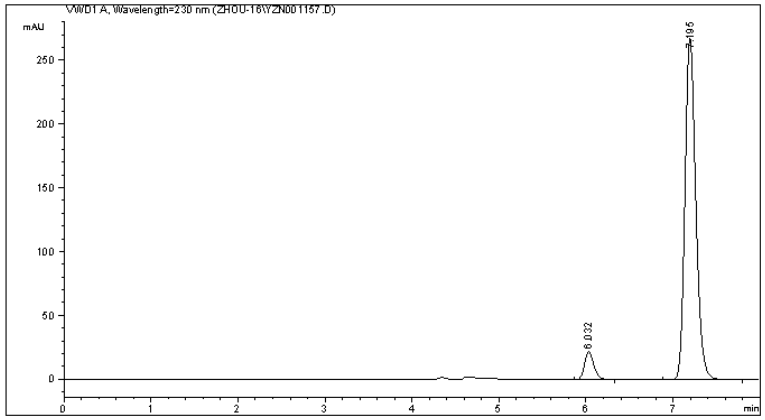



**(+/-)-2g**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001157.D
Sample Name: YJ-6-93D

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/23/2016 3:49:47 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/23/2016 3:48:08 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:01:48 PM
                  (modified after loading)
Sample Info     : OD-H, Hex/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

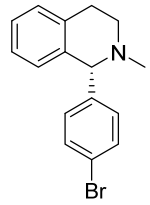
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   6.032 VB    0.1147  164.21527   22.00098   6.6115
   2   7.195 BB    0.1332 2319.56982  267.58517  93.3885

Totals :                  2483.78510  289.58615

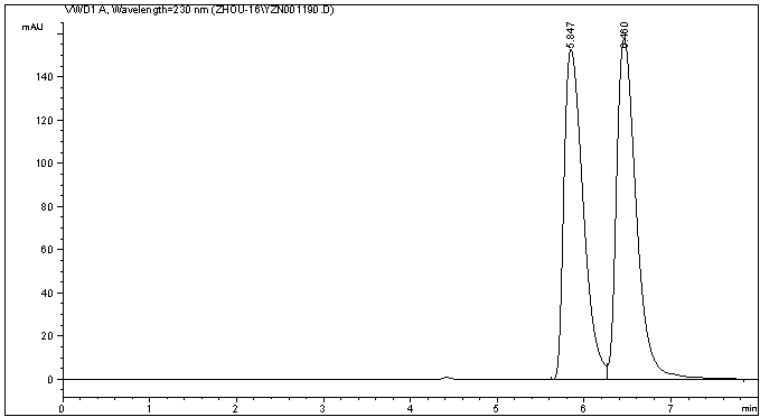
                          *** End of Report ***
```




**(-)-2g**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001190.D
Sample Name: YJ-6-97A+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/26/2016 6:19:45 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/26/2016 6:19:05 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:05:43 PM
                  (modified after loading)
Sample Info     : 0G, Hex/i-PrOH = 99.6/0.4, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

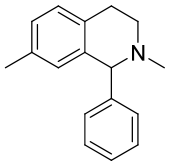
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   5.847 BV    0.2412 2342.20557  153.01801  48.4621
   2   6.460 VB    0.2439 2490.86523  157.74657  51.5379

Totals :                  4833.07080  310.76457

                          *** End of Report ***
```

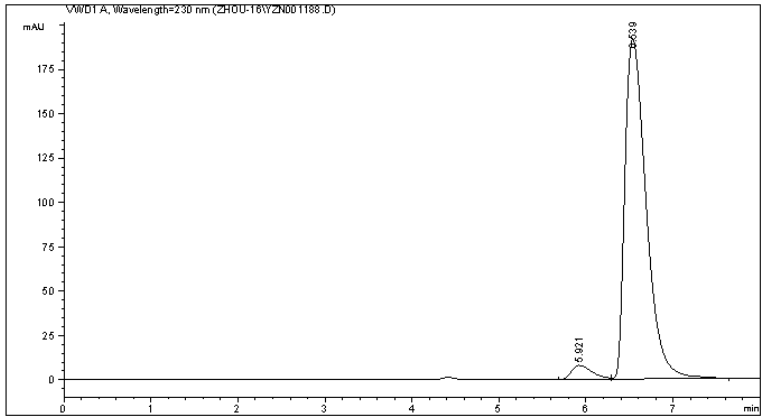


(+/-)-2h



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001188.D
Sample Name: YJ-6-97A

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 4/26/2016 5:59:34 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 4/26/2016 5:58:43 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:05:43 PM
                  (modified after loading)
Sample Info     : 0G, Hex/i-PrOH = 99.6/0.4, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

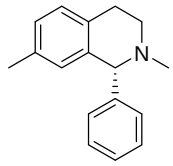
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   5.921 BV    0.2533  126.44871    7.79561   3.7467
   2   6.539 VB    0.2647 3248.46802  191.68631  96.2533

Totals :                  3374.91673  199.48192

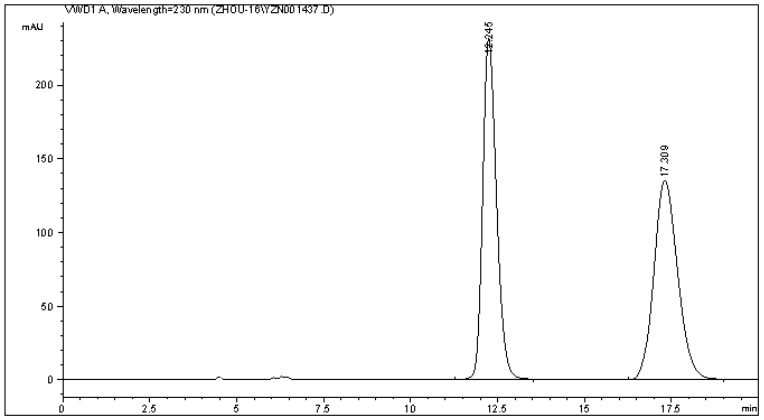
                          *** End of Report ***
```



(-)-2h

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001437.D
Sample Name: YJ-7-13A+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 5/23/2016 10:41:44 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 5/23/2016 10:39:32 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 9:44:36 PM
                  (modified after loading)
Sample Info     : OJ-H, Hex/i-PrOH = 90/10, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

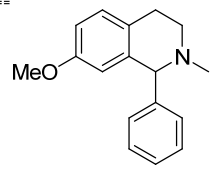
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1  12.245 BB    0.4236 6374.08203  231.14511  49.8491
   2  17.309 BB    0.7351 6412.67432  135.25278  50.1509

Totals :                  1.27868e4   366.39789

                          *** End of Report ***
```

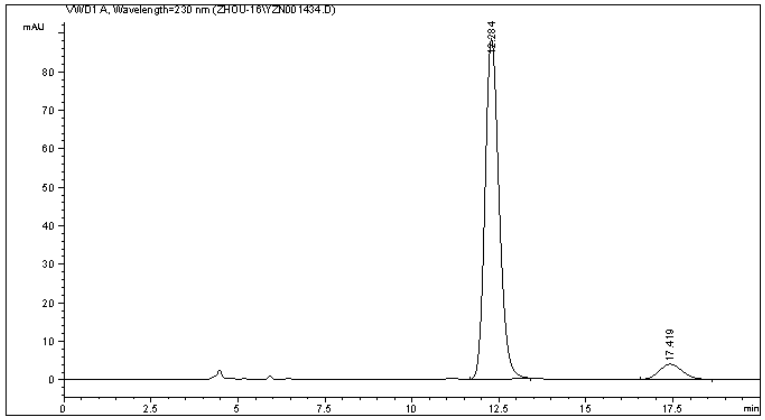



**(+/-)-2i**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001434.D
Sample Name: YJ-7-13A

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 5/23/2016 9:41:12 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 5/23/2016 9:40:02 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:14:31 PM
                  (modified after loading)
Sample Info     : OJ-H, Hex/i-PrOH = 90/10, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

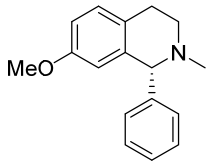
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1  12.284 BB    0.4330 2485.96509   88.37807  92.9638
   2  17.419 BB    0.7181  188.15681    3.98641   7.0362

Totals :                  2674.12190   92.36447

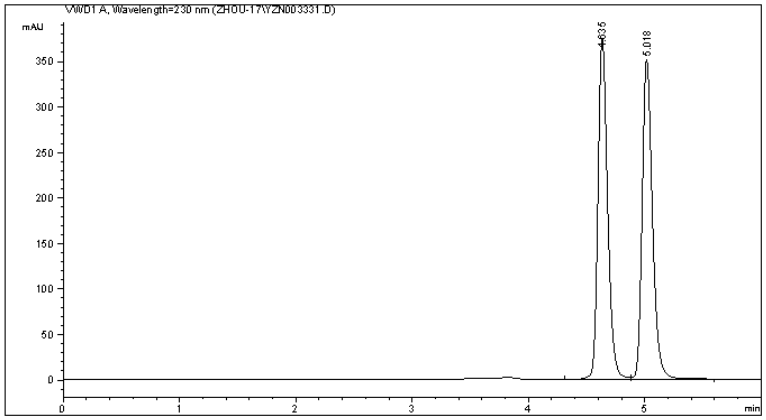
                          *** End of Report ***
```




**(-)-2i**

Data File C:\CHEM32\1\DATA\ZHOU-17\YZN003331.D
Sample Name: YJ-8-67A+-

```
    ====================================================================
    Acq. Operator   : 0
    Acq. Instrument : Instrument 1                  Location : Vial 1
    Injection Date  : 2/18/2017 10:13:45 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/18/2017 10:12:41 PM by 0
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/19/2017 7:15:55 PM by 0
                      (modified after loading)
    Sample Info     : AD-H, Hexane/i-PrOH = 95/5, 0.8mL/min, 30oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

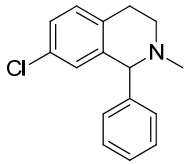
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s   [mAU   ]      %
    ----|-------|----|-------|---------|---------|--------|
       1   4.635 BV    0.0893 2161.72510  373.91660  50.0947
       2   5.018 VB    0.0933 2153.55273  351.52271  49.9053

    Totals :                   4315.27783  725.43930

    ====================================================================
                            *** End of Report ***
```

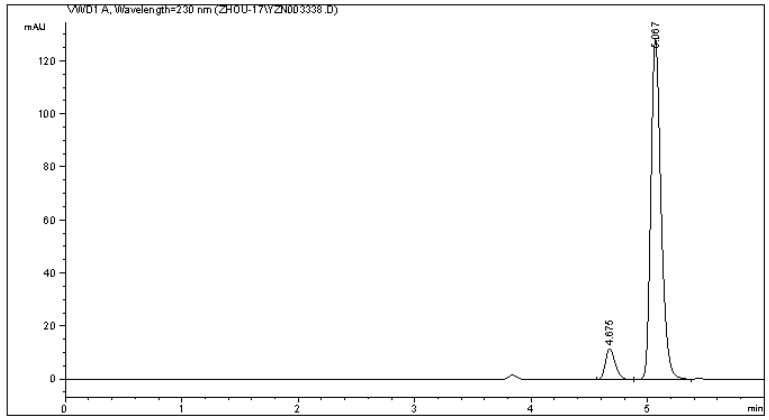



**(+/-)-2j**



Data File C:\CHEM32\1\DATA\ZHOU-17\YZN003338.D
Sample Name: YJ-8-67A

```
    ====================================================================
    Acq. Operator   : 0
    Acq. Instrument : Instrument 1                  Location : Vial 1
    Injection Date  : 2/19/2017 6:51:42 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/19/2017 6:45:41 PM by 0
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/19/2017 7:15:55 PM by 0
                      (modified after loading)
    Sample Info     : AD-H, Hexane/i-PrOH = 95/5, 0.8mL/min, 30oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

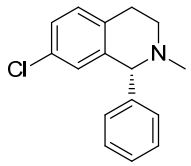
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s   [mAU   ]      %
    ----|-------|----|-------|---------|---------|--------|
       1   4.675 BV    0.0886   68.86459   11.77551   8.0686
       2   5.067 VV    0.0930  784.62659  128.58344  91.9314

    Totals :                   853.49118  140.35894

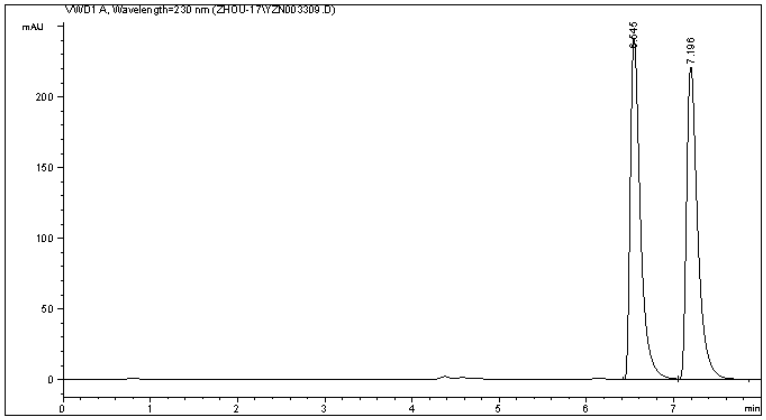
    ====================================================================
                            *** End of Report ***
```




**(-)-2j**

Data File C:\CHEM32\1\DATA\ZHOU-17\YZN003309.D
Sample Name: YJ-8-64+-

```
    ======================================================================
    Acq. Operator   : 0
    Acq. Instrument : Instrument 1                  Location : Vial 1
    Injection Date  : 2/15/2017 9:48:37 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/15/2017 9:47:28 PM by 0
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/19/2017 7:22:10 PM by 0
                      (modified after loading)
    Sample Info     : OD-H, Hexane/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230 nm
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

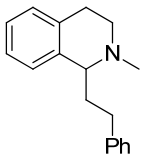
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s   [mAU   ]      %
    ----|-------|----|-------|---------|---------|--------|
       1   6.545 VV    0.1235 1952.82532  241.28810  49.7971
       2   7.196 VB    0.1358 1968.74060  221.35089  50.2029

    Totals :                  3921.56592  462.63899

    ======================================================================
                               *** End of Report ***
```

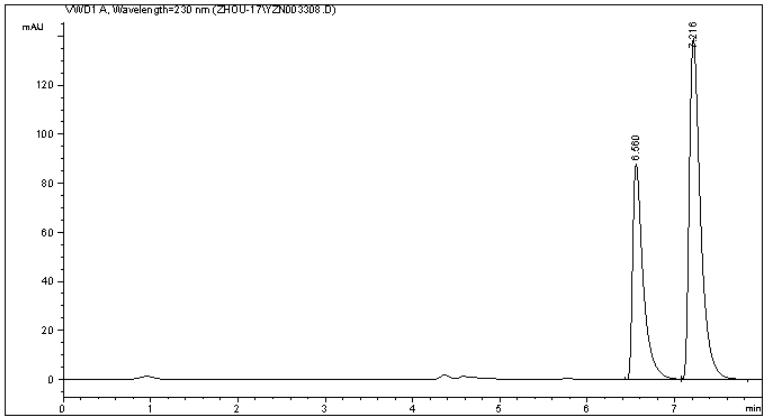



**(+/-)-2k**



Data File C:\CHEM32\1\DATA\ZHOU-17\YZN003308.D
Sample Name: YJ-8-64

```
    ======================================================================
    Acq. Operator   : 0
    Acq. Instrument : Instrument 1                  Location : Vial 1
    Injection Date  : 2/15/2017 9:38:40 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/15/2017 9:37:50 PM by 0
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 2/19/2017 7:22:10 PM by 0
                      (modified after loading)
    Sample Info     : OD-H, Hexane/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230 nm
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

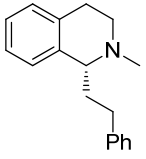
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s   [mAU   ]      %
    ----|-------|----|-------|---------|---------|--------|
       1   6.560 BV    0.1235  734.09674   88.00777  37.1689
       2   7.216 VB    0.1348 1240.93079  138.96794  62.8311

    Totals :                  1975.02753  226.97572

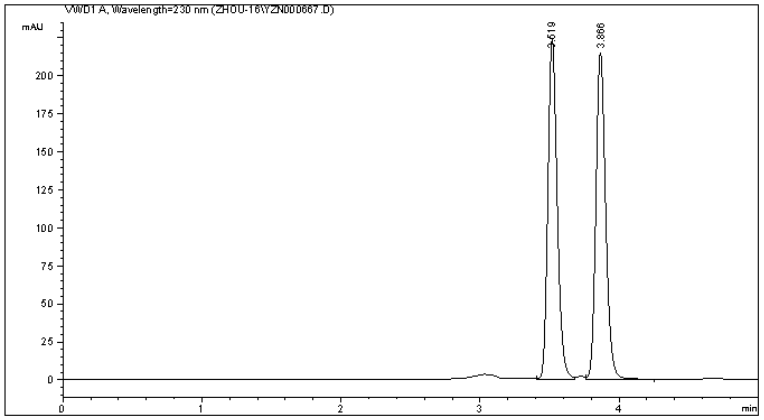
    ======================================================================
                               *** End of Report ***
```




**(+)-2k**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN000667.D
Sample Name: YJ-6-67B+-

```
    ====================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 3/19/2016 3:22:12 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 3/19/2016 3:05:26 PM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 9:44:36 PM
                      (modified after loading)
    Sample Info     : AD-H, H/i-PrOH = 90/10, 1.0 mL/min, 30 oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

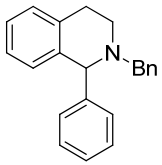
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   3.519 VV    0.0718 1043.47729  224.11391  49.7838
       2   3.866 VB    0.0744 1052.54089  215.67365  50.2162

    Totals :                   2096.01819  439.78755

    ====================================================================
                            *** End of Report ***
```

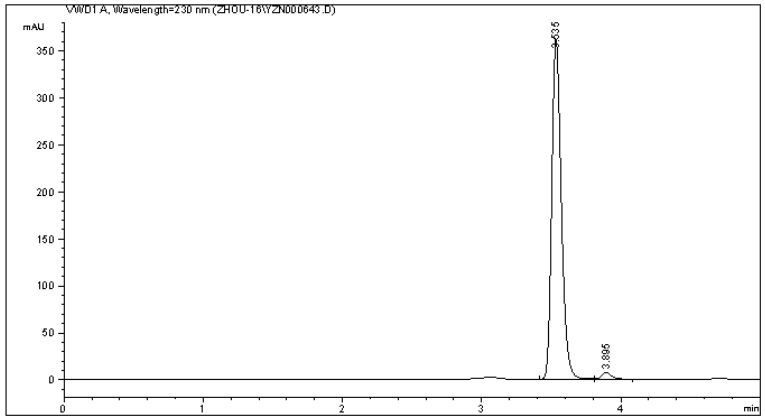



**(+/-)-2l**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN000643.D
Sample Name: YJ-6-67B

```
    ====================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 3/18/2016 4:37:37 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 3/18/2016 4:28:33 PM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 8:08:34 PM
                      (modified after loading)
    Sample Info     : AD-H, H/i-PrOH = 90/10, 1.0 mL/min, 30 oC, 230 nm
```




```
    ====================================================================
                            Area Percent Report
    ====================================================================

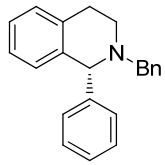
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   3.535 VV    0.0732 1733.31335  362.79758  97.7554
       2   3.895 VV    0.0809   39.79905    7.32114   2.2446

    Totals :                   1773.11240  370.11872

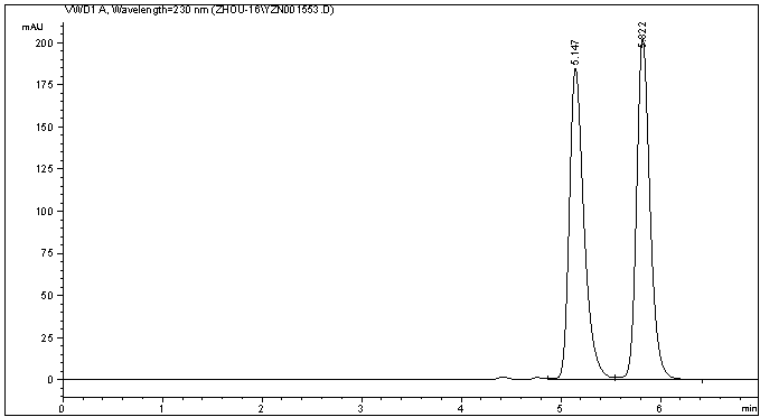
    ====================================================================
                            *** End of Report ***
```




**(-)-2l**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001553.D
Sample Name: YJ-7-4A+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 6/8/2016 4:00:54 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 6/8/2016 3:32:26 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 9:43:18 PM
                  (modified after loading)
Sample Info     : AD-H, Hex/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

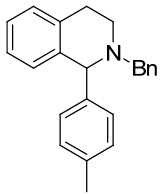
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   5.147 VV    0.1549 1899.97949  184.84914  49.9071
   2   5.822 VB    0.1434 1907.05432  202.39923  50.0929

Totals :                  3807.03381  387.24837

                          *** End of Report ***
```

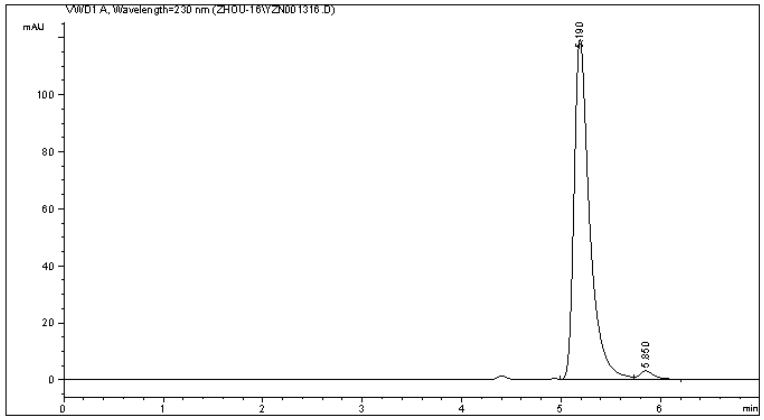



**(+/-)-2m**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001316.D
Sample Name: YJ-7-4A

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 5/10/2016 3:54:07 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 5/10/2016 3:51:28 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 9:43:18 PM
                  (modified after loading)
Sample Info     : AD-H, Hex/i-PrOH = 98/00, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

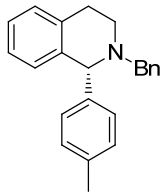
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   5.190 VV    0.1597 1293.68225  119.53790  97.5849
   2   5.850 VB    0.1508   32.01711    3.06859   2.4151

Totals :                  1325.69936  122.60649

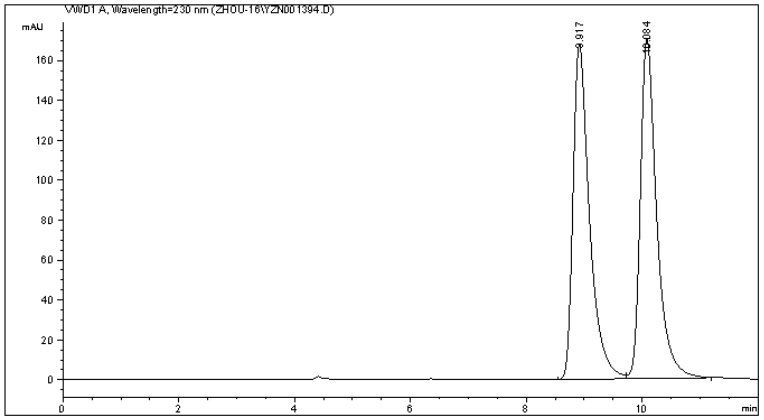
                          *** End of Report ***
```




**(-)-2m**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001394.D
Sample Name: YJ-7-4B+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 5/17/2016 10:06:35 AM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 5/17/2016 10:04:29 AM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:12:06 PM
                  (modified after loading)
Sample Info     : AD-H, Hex/i-PrOH =99.2/0.8, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

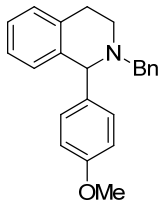
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   8.917 BV    0.2942 3309.72656  167.81749  49.8220
   2  10.084 VB    0.2926 3333.36963  170.19594  50.1780

Totals :                  6643.09619  338.01343

                          *** End of Report ***
```

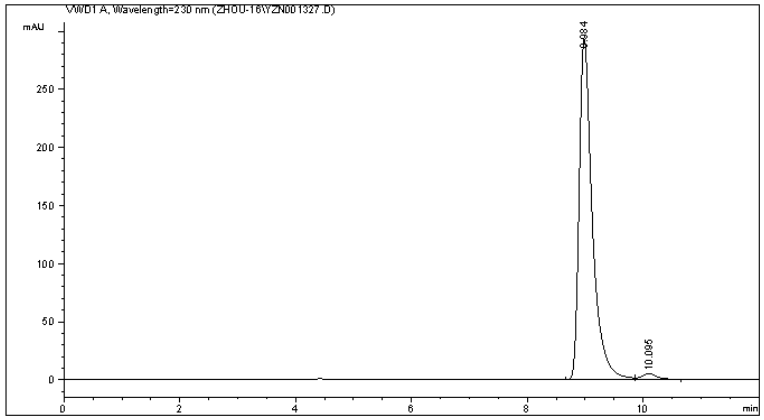



(+/-)-2n



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001327.D
Sample Name: YJ-7-4B

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 5/10/2016 6:36:22 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 5/10/2016 6:35:37 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:12:06 PM
                  (modified after loading)
Sample Info     : AD-H, Hex/i-PrOH = 99.2/0.8, 0.7 mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

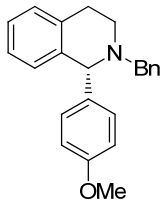
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   8.984 BV    0.2371 4647.17334  293.51337  97.9049
   2  10.095 VB    0.2849   99.44447    5.15190   2.0951

Totals :                  4746.61781  298.66526

                          *** End of Report ***
```

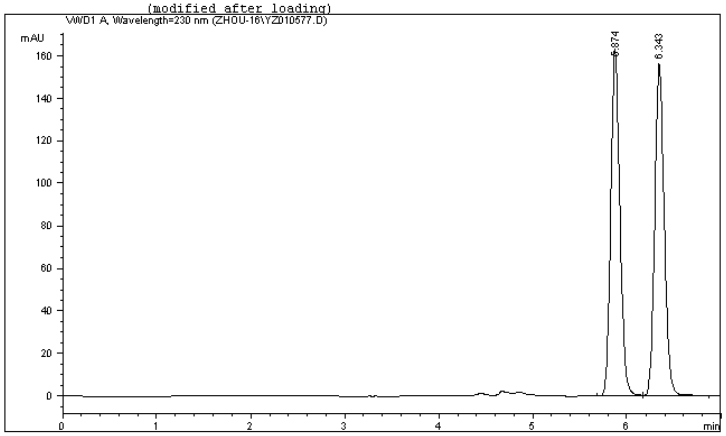



(-)-2n

Data File C:\HPCHEM\1\DATA\ZHOU-16\YZ010577.D Sample Name: YJ-7-7B+-

AD-H, H/i-PrOH = 98/2, 0.7 mL/min, 30 oC, 230 nm

```
====================================================================
Injection Date  : 16/05/2016 11:09:02
Sample Name     : YJ-7-7B+-                    Location : Vial 1
Acq. Operator   :
Acq. Method     : C:\HPCHEM\1\METHODS\DEF LC.M
Last changed    : 16/05/2016 10:22:30  by
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 25/07/2016 19:39:08  by
                  (modified after loading)
```




```
====================================================================
                        Area Percent Report
====================================================================

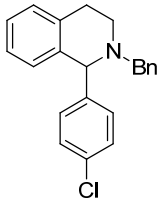
Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Sample Amount         :      1.00000  [ng/ul]   (not used in calc.)

Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   5.874 VV    0.1036 1102.66138  163.18604  50.1811
   2   6.343 VB    0.1092 1094.70215  156.58330  49.8189

Totals :                  2197.36353  319.76933

 Results obtained with enhanced integrator!
====================================================================
                        *** End of Report ***
```



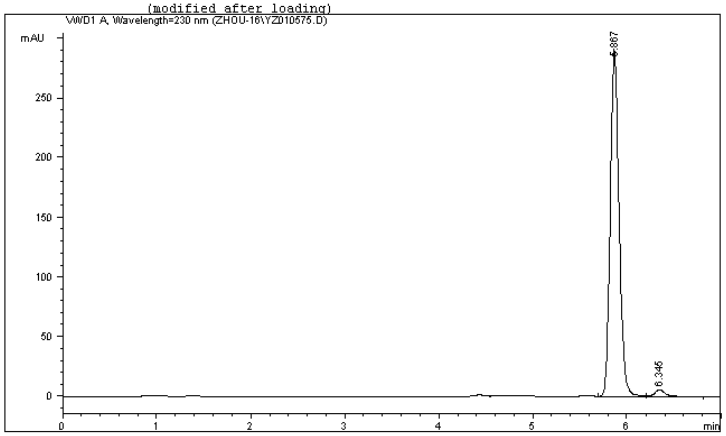

**(+/-)-2o**

Instrument 1 25/07/2016 19:39:11 Page 1 of 1

Data File C:\HPCHEM\1\DATA\ZHOU-16\YZ010575.D Sample Name: YJ-7-7B

AD-H, H/i-PrOH = 98/2, 0.7 mL/min, 30 oC, 230 nm

```
====================================================================
Injection Date  : 16/05/2016 10:51:53
Sample Name     : YJ-7-7B                      Location : Vial 1
Acq. Operator   :
Acq. Method     : C:\HPCHEM\1\METHODS\DEF LC.M
Last changed    : 16/05/2016 10:22:30  by
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 25/07/2016 19:38:12  by
                  (modified after loading)
```




```
====================================================================
                        Area Percent Report
====================================================================

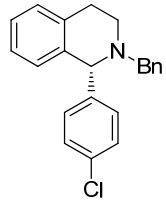
Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000
Sample Amount         :      1.00000  [ng/ul]   (not used in calc.)

Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   5.867 VV    0.0996 1897.85339  290.34201  97.7297
   2   6.345 VV    0.1163   44.08792    5.71054   2.2703

Totals :                  1941.94132  296.05255

 Results obtained with enhanced integrator!
====================================================================
                        *** End of Report ***
```

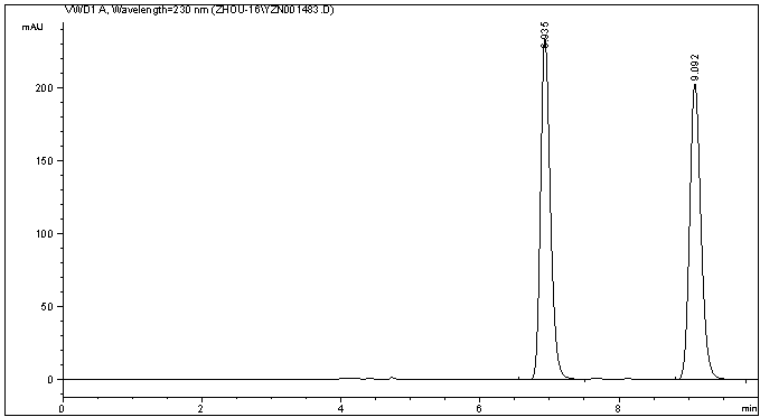



**(-)-2o**

Instrument 1 25/07/2016 19:38:16 Page 1 of 1

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001483.D
Sample Name: YJ-7-15B+-

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 5/28/2016 7:11:28 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 5/28/2016 7:10:43 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:15:59 PM
                  (modified after loading)
Sample Info     : AD-H, Hex/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230  nm
```




```
                          Area Percent Report

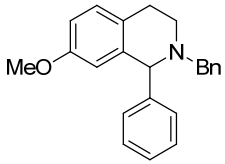
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s    [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   6.935 BB    0.1513 2301.68066  233.74991  50.0196
   2   9.092 BB    0.1744 2299.87524  202.99535  49.9804

Totals :                  4601.55591  436.74525

                          *** End of Report ***
```

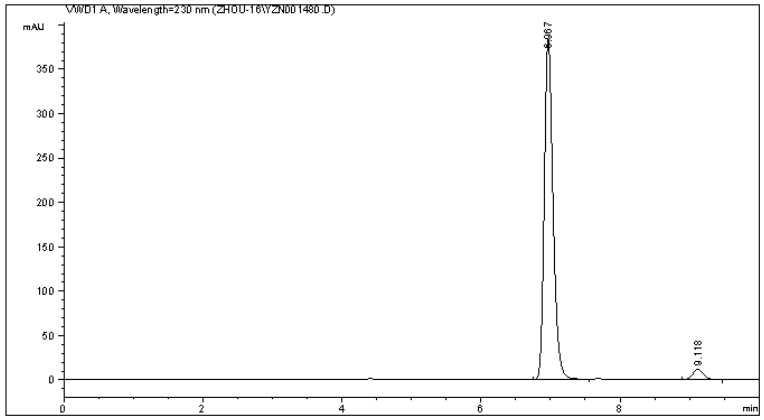



**(+/-)-2p**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN001480.D
Sample Name: YJ-7-15B

```
Acq. Operator   :
Acq. Instrument : Instrument 1                    Location : Vial 1
Injection Date  : 5/28/2016 6:38:18 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 5/28/2016 6:37:35 PM
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed    : 7/25/2016 8:15:59 PM
                  (modified after loading)
Sample Info     : AD-H, Hex/i-PrOH = 98/2, 0.7 mL/min, 30oC, 230  nm
```




```
                          Area Percent Report

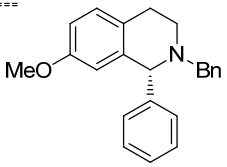
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s    [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   6.967 VB    0.1345 3374.26196  384.25894  96.3851
   2   9.118 BB    0.1654  126.55072   11.84902   3.6149

Totals :                  3500.81268  396.10796

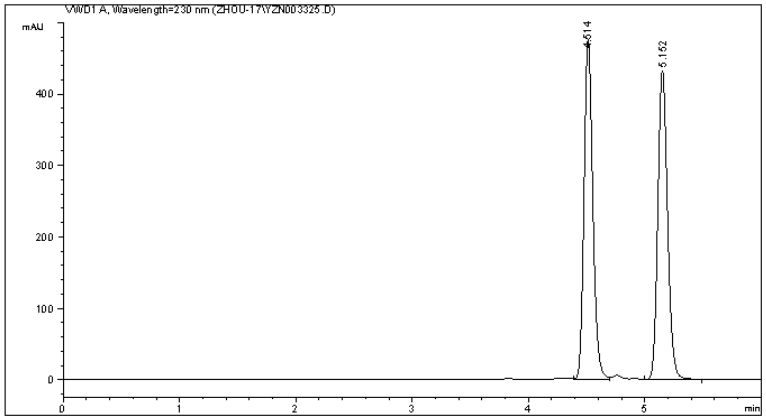
                          *** End of Report ***
```




**(-)-2p**

Data File C:\CHEM32\1\DATA\ZHOU-17\YZN003325.D
Sample Name: YJ-8-67B+-

```
Acq. Operator   : 0
Acq. Instrument : Instrument 1                  Location : Vial 1
Injection Date  : 2/18/2017 4:16:47 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
Last changed    : 2/18/2017 4:15:19 PM by 0
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
Last changed    : 2/19/2017 7:15:55 PM by 0
                  (modified after loading)
Sample Info     : AD-H, Hexane/i-PrOH = 95/5, 0.8mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

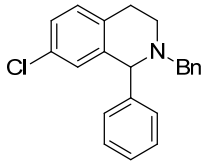
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   4.514 VV    0.0805 2516.94360  477.26559  49.9573
   2   5.152 VV    0.0897 2521.24121  433.69730  50.0427

Totals :                  5038.18481  910.96289

                          *** End of Report ***
```

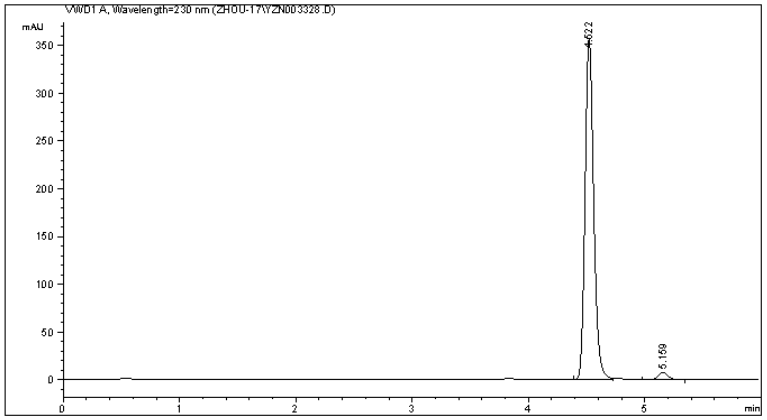



**(+/-)-2q**



Data File C:\CHEM32\1\DATA\ZHOU-17\YZN003328.D
Sample Name: YJ-8-67B

```
Acq. Operator   : 0
Acq. Instrument : Instrument 1                  Location : Vial 1
Injection Date  : 2/18/2017 5:06:43 PM
Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
Last changed    : 2/18/2017 5:05:14 PM by 0
                  (modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
Last changed    : 2/19/2017 7:15:55 PM by 0
                  (modified after loading)
Sample Info     : AD-H, Hexane/i-PrOH = 95/5, 0.8mL/min, 30oC, 230 nm
```




```
                          Area Percent Report

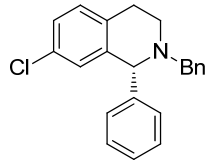
Sorted By             :      Signal
Multiplier:                   :      1.0000
Dilution:                     :      1.0000
Use Multiplier & Dilution Factor with ISTDs


Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|---------|---------|-------|
   1   4.522 VV    0.0809 1855.14490  357.57715  97.3386
   2   5.159 VV    0.0962   50.72193    7.95742   2.6614

Totals :                  1905.86683  365.53456

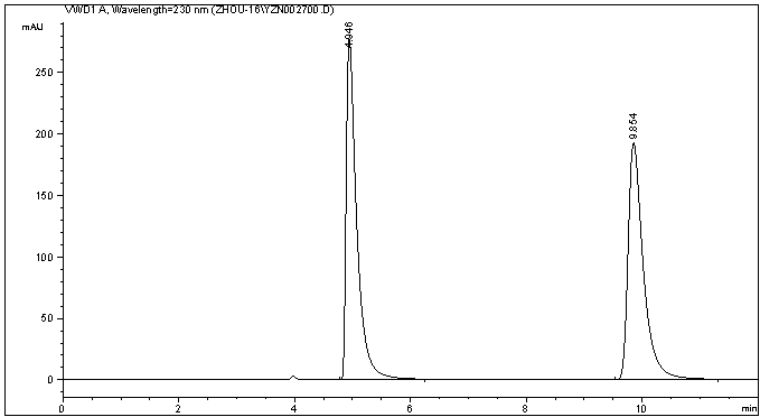
                          *** End of Report ***
```




**(-)-2q**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN002700.D
Sample Name: YJ-8-10D+-

| | | | |
|---|---|---|---|
| Acq. Operator | : 0 | | |
| Acq. Instrument | : Instrument 1 | Location | : Vial 1 |
| Injection Date | : 10/31/2016 3:17:26 PM | | |
| Acq. Method | : C:\CHEM32\1\METHODS\DEF LC.M | | |
| Last changed | : 10/31/2016 3:16:19 PM by 0 (modified after loading) | | |
| Analysis Method | : C:\CHEM32\1\METHODS\DEF LC.M | | |
| Last changed | : 12/17/2016 11:12:34 AM by 0 (modified after loading) | | |
| Sample Info | : IC, Hexane/i-PrOH = 70/30, 0.8 mL/min, 30oC, 230 nm | | |

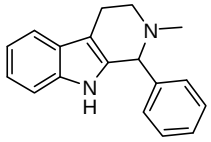



Area Percent Report

Sorted By : Signal
Multiplier: : 1.0000
Dilution: : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=230 nm

| Peak # | RetTime [min] | Type | Width [min] | Area mAU *s | Height [mAU ] | Area % |
|---|---|---|---|---|---|---|
| 1 | 4.946 | VB | 0.1857 | 3514.16748 | 277.30234 | 49.9325 |
| 2 | 9.854 | BB | 0.2715 | 3523.67017 | 192.78810 | 50.0675 |
| Totals : | | | | 7037.83765 | 470.09044 | |



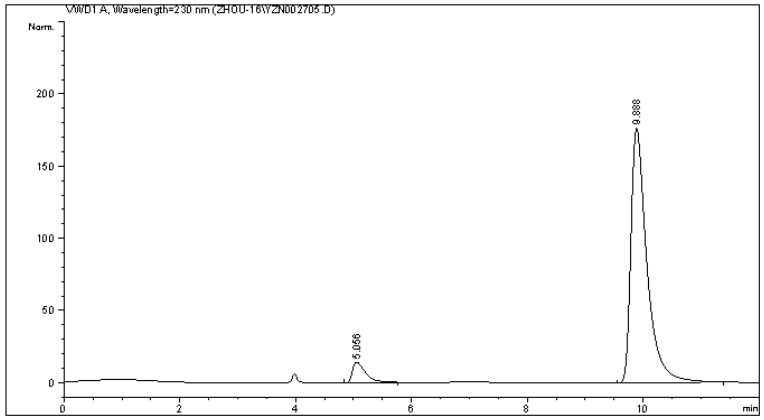
(+/-)-4a

*** End of Report ***



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN002705.D
Sample Name: YJ-8-10D

| | | | |
|---|---|---|---|
| Acq. Operator | : 0 | | |
| Acq. Instrument | : Instrument 1 | Location | : Vial 1 |
| Injection Date | : 10/31/2016 8:55:15 PM | | |
| Acq. Method | : C:\CHEM32\1\METHODS\DEF LC.M | | |
| Last changed | : 10/31/2016 8:51:06 PM by 0 (modified after loading) | | |
| Analysis Method | : C:\CHEM32\1\METHODS\DEF LC.M | | |
| Last changed | : 12/17/2016 11:14:05 AM by 0 (modified after loading) | | |
| Sample Info | : IC, Hexane/i-PrOH = 70/30, 0.8 mL/min, 30oC, 230 nm | | |

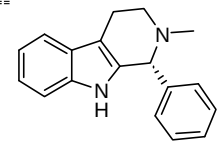



Area Percent Report

Sorted By : Signal
Multiplier: : 1.0000
Dilution: : 1.0000
Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=230 nm

| Peak # | RetTime [min] | Type | Width [min] | Area mAU *s | Height [mAU ] | Area % |
|---|---|---|---|---|---|---|
| 1 | 5.056 | BB | 0.2261 | 218.57561 | 14.09365 | 6.0728 |
| 2 | 9.888 | BB | 0.2849 | 3380.66309 | 176.29660 | 93.9272 |
| Totals : | | | | 3599.23869 | 190.39025 | |



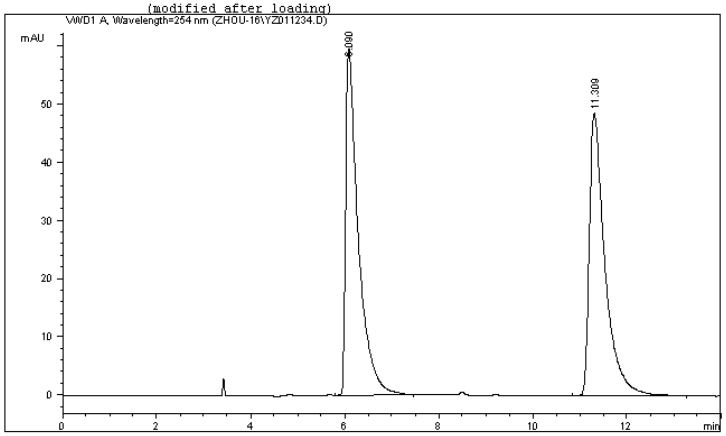
(-)-4a

*** End of Report ***

Data File C:\HPCHEM\1\DATA\ZHOU-16\YZ011234.D Sample Name: YJ-7-81+-

IC, Hexane/iPrOH = 70/30, 0.7 mL/min, 30 oC, 254 nm

```
==================================================================
Injection Date  : 21/09/2016 09:49:04
Sample Name     : YJ-7-81+-                    Location : Vial 1
Acq. Operator   :
Acq. Method     : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 21/09/2016 09:39:09  by
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 17/12/2016 10:57:23  by
                  (modified after loading)
```




```
==================================================================
                        Area Percent Report
==================================================================

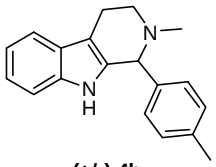
Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000

Signal 1: VWD1 A, Wavelength=254 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   6.090 VB    0.2667 1115.77148   59.53540  49.8372
   2  11.309 BB    0.3364 1123.06030   48.62826  50.1628

Totals :                  2238.83179  108.16366

 Results obtained with enhanced integrator!
==================================================================
                        *** End of Report ***
```



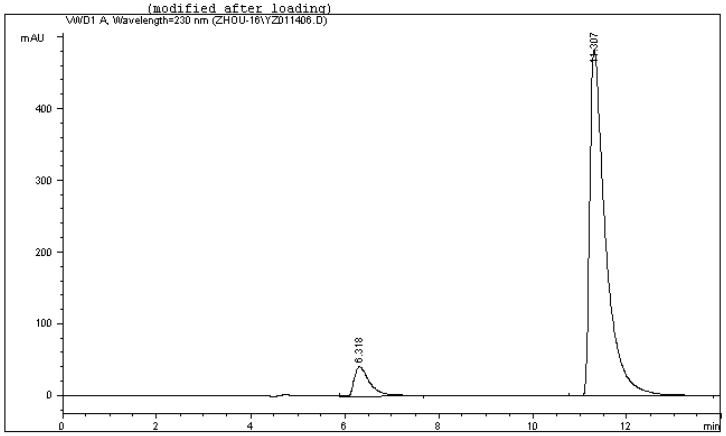
(+/-)-4b

Instrument 1 17/12/2016 10:57:26 Page 1 of 1

Data File C:\HPCHEM\1\DATA\ZHOU-16\YZ011406.D Sample Name: YJ-8-9A

IC, Hexane/iPrOH = 70/30, 0.7 mL/min, 30 oC, 230 nm

```
==================================================================
Injection Date  : 01/11/2016 09:10:29
Sample Name     : YJ-8-9A                      Location : Vial 1
Acq. Operator   :
Acq. Method     : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 01/11/2016 08:49:50  by
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 17/12/2016 10:55:34  by
                  (modified after loading)
```




```
==================================================================
                        Area Percent Report
==================================================================

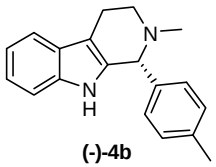
Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000

Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]        [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   6.318 VV    0.3679 1008.58759   41.09137   8.2139
   2  11.307 VV    0.3390 1.12705e4   483.37457  91.7861

Totals :                  1.22791e4   524.46594

 Results obtained with enhanced integrator!
==================================================================
                        *** End of Report ***
```

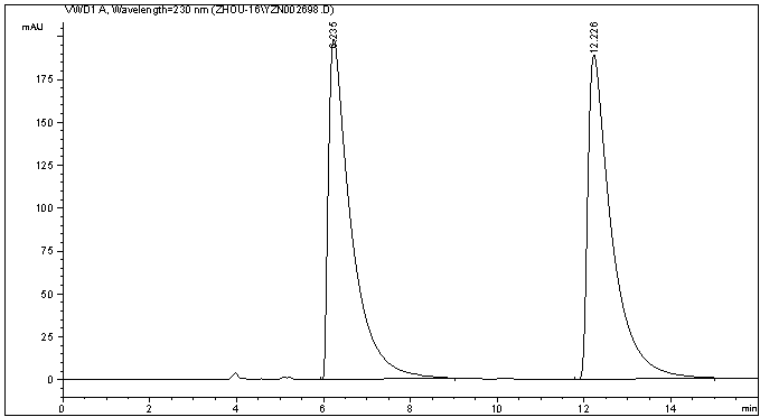


(-)-4b

Instrument 1 17/12/2016 10:55:38 Page 1 of 1

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN002698.D
Sample Name: YJ-8-10C+-

```
    ==================================================================
    Acq. Operator   : 0
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 10/31/2016 2:40:44 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 10/31/2016 2:27:18 PM by 0
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 12/17/2016 11:10:28 AM by 0
                      (modified after loading)
    Sample Info     : IC, Hexane/i-PrOH = 70/30, 0.8 mL/min, 30oC, 230 nm
```




```
    ==================================================================
                            Area Percent Report
    ==================================================================

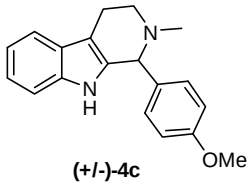
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   6.235 VB    0.5162 7172.03760  198.48344  49.9516
       2  12.226 BB    0.5453 7185.93018  189.08002  50.0484

    Totals :                  1.43580e4   387.56346

    ==================================================================
                            *** End of Report ***
```

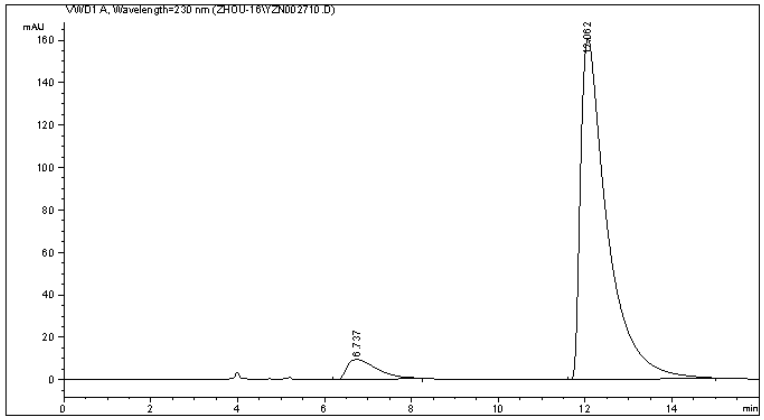



**(+/-)-4c**



Data File C:\CHEM32\1\DATA\ZHOU-16\YZN002710.D
Sample Name: YJ-8-10C

```
    ==================================================================
    Acq. Operator   : 0
    Acq. Instrument : Instrument 1                    Location : Vial 1
    Injection Date  : 10/31/2016 10:24:55 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 10/31/2016 10:16:44 PM by 0
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF LC.M
    Last changed    : 12/17/2016 11:11:38 AM by 0
                      (modified after loading)
    Sample Info     : IC, Hexane/i-PrOH = 70/30, 0.8 mL/min, 30oC, 230 nm
```




```
    ==================================================================
                            Area Percent Report
    ==================================================================

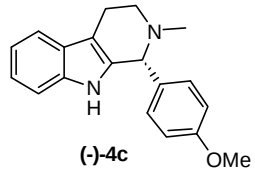
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]       [min]  mAU   *s    [mAU   ]      %
    ----|-------|----|-------|---------|---------|-------|
       1   6.737 VB    0.7350  452.88751    9.38207   6.2161
       2  12.062 BB    0.6189 6832.87402  160.52557  93.7839

    Totals :                  7285.76154  169.90764

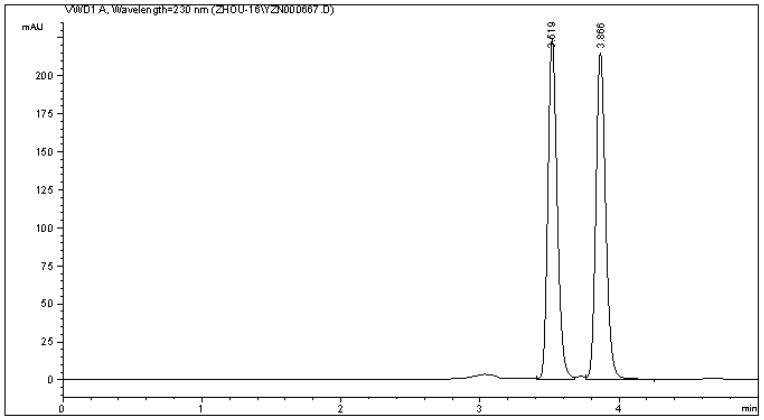
    ==================================================================
                            *** End of Report ***
```




**(-)-4c**

Data File C:\CHEM32\1\DATA\ZHOU-16\YZN000667.D
Sample Name: YJ-6-67B+-

```
    ======================================================================
    Acq. Operator   :
    Acq. Instrument : Instrument 1                  Location : Vial 1
    Injection Date  : 3/19/2016 3:22:12 PM
    Acq. Method     : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 3/19/2016 3:05:26 PM
                      (modified after loading)
    Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
    Last changed    : 7/25/2016 9:44:36 PM
                      (modified after loading)
    Sample Info     : AD-H, H/i-PrOH = 90/10, 1.0 mL/min, 30 oC, 230 nm
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

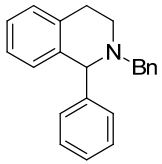
    Sorted By             :      Signal
    Multiplier:                   :      1.0000
    Dilution:                     :      1.0000
    Use Multiplier & Dilution Factor with ISTDs


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]  mAU   *s   [mAU   ]      %
    ----|-------|----|-------|---------|----------|--------|
       1   3.519 VV    0.0718 1043.47729  224.11391  49.7838
       2   3.866 VB    0.0744 1052.54089  215.67365  50.2162

    Totals :                  2096.01819  439.78755

    ======================================================================
                               *** End of Report ***
```



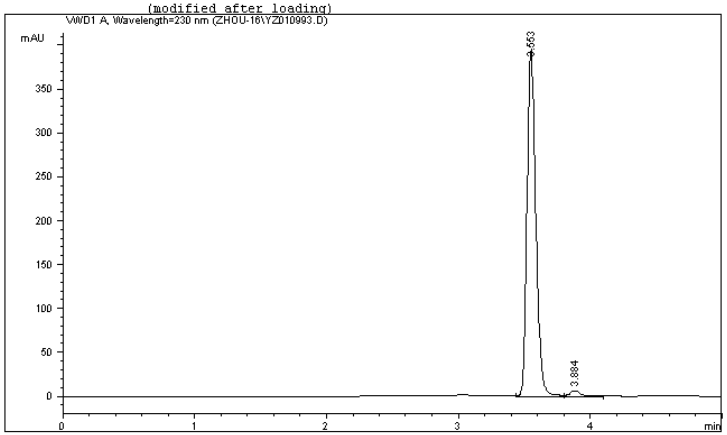

**(+/-)-2l**



Data File C:\HPCHEM\1\DATA\ZHOU-16\YZ010993.D  Sample Name: YJ-7-62

```
    AD-H, H/i-PrOH = 90/10, 1.0 mL/min, 30 oC, 230 nm

    ======================================================================
    Injection Date  : 23/08/2016 21:01:10
    Sample Name     : YJ-7-62                       Location : Vial 1
    Acq. Operator   :
    Acq. Method     : C:\HPCHEM\1\METHODS\DEF LC1.M
    Last changed    : 23/08/2016 20:42:07  by
                      (modified after loading)
    Analysis Method : C:\HPCHEM\1\METHODS\DEF LC1.M
    Last changed    : 27/08/2016 09:12:59  by
                      (modified after loading)
```




```
    ======================================================================
                               Area Percent Report
    ======================================================================

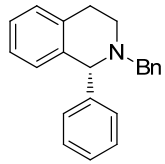
    Sorted By             :      Signal
    Multiplier            :      1.0000
    Dilution              :      1.0000


    Signal 1: VWD1 A, Wavelength=230 nm

    Peak RetTime Type  Width     Area      Height     Area
      #   [min]        [min]  mAU   *s   [mAU   ]      %
    ----|-------|----|-------|---------|----------|--------|
       1   3.553 VV    0.0721 1843.46289  393.63498  97.8740
       2   3.884 VV    0.0861   40.04324    6.81000   2.1260

    Totals :                  1883.50613  400.44498

     Results obtained with enhanced integrator!
    ======================================================================
                               *** End of Report ***
```

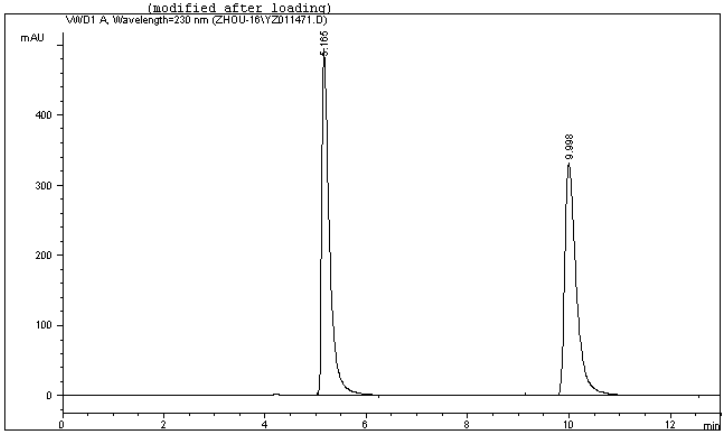



**(-)-2l**

Data File C:\HPCHEM\1\DATA\ZHOU-16\YZ011471.D Sample Name: YJ-8-25+-

IC, Hexane/iPrOH = 70/30, 0.8 mL/min, 30 oC, 230 nm

```
==================================================================
Injection Date  : 19/11/2016 10:44:16
Sample Name     : YJ-8-25+-                    Location : Vial 1
Acq. Operator   :
Acq. Method     : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 19/11/2016 10:41:46  by
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 17/12/2016 10:59:15  by
                  (modified after loading)
```




```
==================================================================
                      Area Percent Report
==================================================================

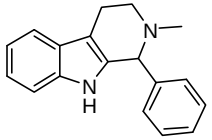
Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000

Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   5.165 VV    0.1545 5257.52881  494.95844  49.8449
   2   9.998 VB    0.2386 5290.25732  331.52563  50.1551

Totals :                  1.05478e4   826.48407

 Results obtained with enhanced integrator!
==================================================================
                      *** End of Report ***
```



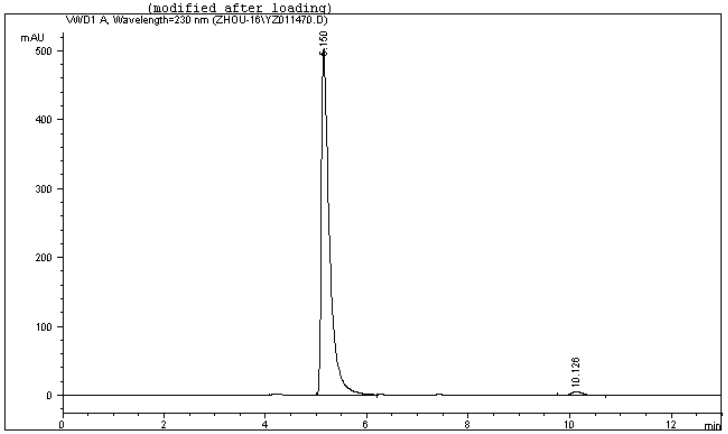
**(+/-)-4a**

Instrument 1 17/12/2016 10:59:17 Page 1 of 1

Data File C:\HPCHEM\1\DATA\ZHOU-16\YZ011470.D Sample Name: YJ-8-25

IC, Hexane/iPrOH = 70/30, 0.8 mL/min, 30 oC, 230 nm

```
==================================================================
Injection Date  : 19/11/2016 10:26:50
Sample Name     : YJ-8-25                      Location : Vial 1
Acq. Operator   :
Acq. Method     : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 19/11/2016 10:07:11  by
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\DEF LC1.M
Last changed    : 17/12/2016 11:00:49  by
                  (modified after loading)
```




```
==================================================================
                      Area Percent Report
==================================================================

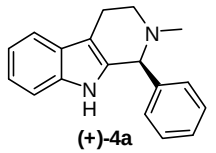
Sorted By             :      Signal
Multiplier            :      1.0000
Dilution              :      1.0000

Signal 1: VWD1 A, Wavelength=230 nm

Peak RetTime Type  Width     Area      Height     Area
  #   [min]       [min]  mAU   *s   [mAU   ]      %
----|-------|----|-------|----------|----------|--------|
   1   5.150 VV    0.1624 5630.19727  503.70303  98.1682
   2  10.126 VV    0.2794  105.06016    5.65505   1.8318

Totals :                  5735.25742  509.35809

 Results obtained with enhanced integrator!
==================================================================
                      *** End of Report ***
```



**(+)-4a**

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