

**Catalytic Enantioselective Ring-Opening and Ring-Closing
Reactions of 3-Isothiocyanato Oxindoles and *N*-(2-Picolinoyl)
Aziridines**

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Table of Contents

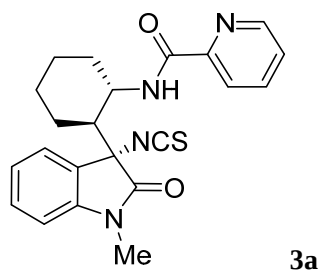
General remarks	S2
General Procedure for the Ring-Opening Reaction	S2-S7
General Procedure for the Ring-Closure Reaction	S7-S15
X-ray Structure of 4e	S16-S17
Representative Procedure for the Modification Process of Amino Acids and Peptides	S17-S19
Representative Procedure for Synthesis of the Organocatalysis	S19-S21
 Procedure for Michael Reaction	 S21-S22
 Copies of HPLC Results	 S23-S47
 Copies of NMR Results	 S48-S106

General Remarks

All reactions were performed under an argon atmosphere and solvents were dried according to established procedures. ^1H NMR (300 M) and ^{13}C NMR (75 M) spectra were obtained in CDCl_3 . The chemical shifts are reported in ppm relative to internal standard TMS (^1H NMR), to residual signals of the solvents (CHCl_3 , 7.26 ppm for ^1H NMR and 77.0 ppm for ^{13}C NMR). The enantiomeric excess was determined by HPLC analysis. Diastereoselectivities were determined by ^1H NMR spectroscopic analysis. MgBu_2 (1.0M in heptane) is commercially available.

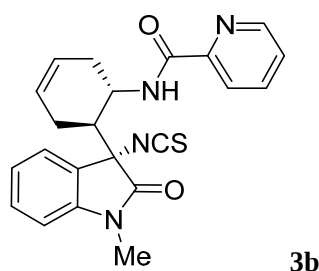
General Procedure for the Ring-Opening Reaction

To a stirred solution of **L5** (9.66 mg, 0.03 mmol) in toluene (1.0 mL) was added MgBu_2 (30 μL , 1.0 M in heptane, 0.03 mmol) under an argon atmosphere and was stirred at room temperature for 30 min. Then 3-isothiocyanato oxindoles (0.22 mmol, 1.1 eq) and aziridines (0.20 mmol) in toluene (1.0 mL) was transferred into the flask containing the catalyst under 0 $^\circ\text{C}$. After the addition, the mixture was stirred at 0 $^\circ\text{C}$ for 1 h and warmed to room temperature. After stirring for 1 h, the mixture was quenched with saturated NH_4Cl and extracted with CH_2Cl_2 . The combined organic layers were dried over Na_2SO_4 and concentrated under vacuum. Then the mixture was purified by silica gel column chromatography (PE/EA = 4/1 to 1/1) to afford product **3**.

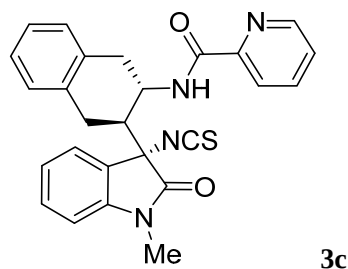


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 189-191 $^\circ\text{C}$; 77.9 mg; 96% yield; >20:1 dr; 97% ee determined by HPLC on a Chiralpak IC-H column (hexane/2-propanol = 80/20, flow rate = 1.0 mL/min, t_{minor} = 18.7 min, t_{major} = 15.0 min); $[\alpha]_{\text{D}}^{25}$ = 60.4 (c = 0.98, CHCl_3); ^1H NMR (300 MHz, CDCl_3): δ 8.63 (d, J = 4.4 Hz, 1H), 7.98 (d, J = 7.8 Hz, 1H),

7.81 (td, $J = 7.6, 1.5$ Hz, 2H), 7.51 – 7.33 (m, 3H), 7.15 (t, $J = 7.5$ Hz, 1H), 6.62 (d, $J = 7.8$ Hz, 1H), 3.69 – 3.48 (m, 1H), 2.67 – 2.48 (m, 2H), 2.46 (s, 3H), 2.03 – 1.62 (m, 4H), 1.43 – 1.21 (m, 3H) ppm; ^{13}C NMR (75 MHz, CDCl_3): δ 172.6, 162.3, 149.4, 148.2, 143.3, 137.2, 130.7, 126.2, 125.0, 124.5, 123.3, 121.9, 108.9, 68.7, 49.2, 48.8, 34.3, 27.3, 26.0, 25.4, 25.0 ppm; IR (neat): 3358, 2933, 2030, 1728, 1678, 1515, 1371, 1101, 752, 621 cm^{-1} ; HRMS (ESI): $\text{C}_{22}\text{H}_{22}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 407.1536, found: 407.1541.

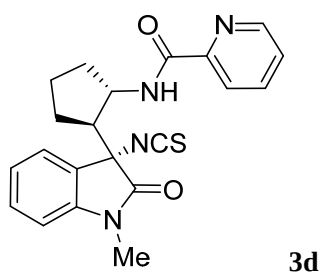


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 75.9 mg; 94% yield; >20:1 dr; 95% ee determined by HPLC on a Chiralpak IC-H column (hexane/2-propanol = 80/20, flow rate = 1.0 mL/min, $t_{\text{minor}} = 19.2$ min, $t_{\text{major}} = 21.4$ min); $[\alpha]_{\text{D}}^{25} = 29.5$ ($c = 0.98$, CHCl_3); ^1H NMR (300 MHz, CDCl_3): δ 8.60 (d, $J = 4.6$ Hz, 1H), 7.91 (d, $J = 7.8$ Hz, 1H), 7.86 – 7.70 (m, 2H), 7.51 (d, $J = 7.4$ Hz, 1H), 7.44 (ddd, $J = 7.4, 4.8, 1.2$ Hz, 1H), 7.35 (td, $J = 7.8, 0.9$ Hz, 1H), 7.16 (t, $J = 7.6$ Hz, 1H), 6.52 (d, $J = 7.8$ Hz, 1H), 5.81 (dd, $J = 9.7, 1.5$ Hz, 1H), 5.67 (dd, $J = 9.7, 2.3$ Hz, 1H), 4.03 (qd, $J = 10.6, 5.5$ Hz, 1H), 2.98 (td, $J = 11.2, 5.5$ Hz, 1H), 2.90 – 2.62 (m, 2H), 2.50 (s, 3H), 2.38 – 2.20 (m, 1H), 2.16 – 1.96 (m, 1H) ppm; ^{13}C NMR (75 MHz, CDCl_3): δ 172.4, 162.3, 149.2, 148.1, 143.1, 137.2, 130.7, 126.3, 125.2, 124.9⁴ (overlapped), 124.9², 124.3, 123.5, 122.0, 108.9, 67.9, 45.8, 44.6, 33.5, 27.8, 26.1 ppm; IR (neat): 3356, 2928, 2026, 1727, 1513, 1371, 1090, 1024, 751, 664 cm^{-1} ; HRMS (ESI): $\text{C}_{22}\text{H}_{20}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 405.1380, found: 405.1391.

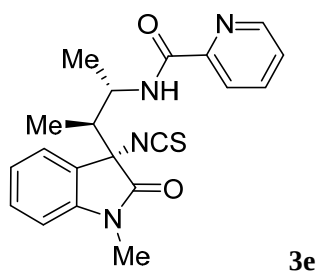


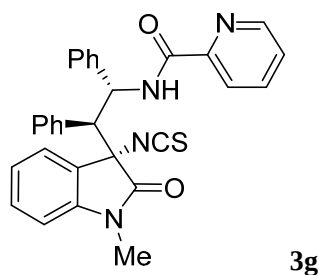
Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 155-157 $^{\circ}\text{C}$; 86.2 mg; 95% yield; >20:1 dr; 98% ee determined by HPLC on a Chiralpak IC-H column

(hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 14.8$ min, $t_{\text{major}} = 24.1$ min); $[\alpha]_{\text{D}}^{25} = 7.7$ ($c = 1.04$, CHCl_3); **¹H NMR** (300 MHz, CDCl_3): δ 8.58 (d, $J = 4.6$ Hz, 1H), 7.99 (d, $J = 7.8$ Hz, 1H), 7.89 (d, $J = 10.2$ Hz, 1H), 7.82 (td, $J = 7.7$, 1.6 Hz, 1H), 7.52 – 7.32 (m, 3H), 7.30 – 7.09 (m, 4H), 7.03 (d, $J = 7.2$ Hz, 1H), 6.64 (d, $J = 7.8$ Hz, 1H), 4.22 (qd, $J = 9.8$, 5.6 Hz, 1H), 3.46 (dd, $J = 16.0$, 5.6 Hz, 1H), 3.37 – 3.23 (m, 1H), 3.07 – 2.86 (m, 2H), 2.78 (dd, $J = 15.9$, 9.1 Hz, 1H), 2.67 (s, 3H) ppm; **¹³C NMR** (75 MHz, CDCl_3): δ 172.0, 162.7, 149.2, 148.2, 143.3, 138.3, 137.3, 134.4, 134.3, 130.8, 128.3³, 128.2⁸, 126.5, 126.3, 125.0, 124.5, 123.5, 122.0, 109.0, 68.0, 46.6, 45.9, 36.9, 30.8, 26.3 ppm; **IR** (neat): 3356, 2929, 2026, 1728, 1678, 1613, 1514, 1470, 1371, 1089, 752 cm^{-1} ; **HRMS** (ESI): $\text{C}_{26}\text{H}_{22}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 455.1536, found: 455.1546.

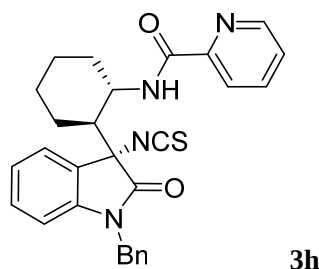


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 153-155 °C; 49.4 mg; 63% yield; >20:1 dr; 98% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 7.7$ min, $t_{\text{major}} = 6.8$ min); $[\alpha]_{\text{D}}^{25} = -43.6$ ($c = 0.96$, CHCl_3); **¹H NMR** (300 MHz, CDCl_3): δ 8.57 (d, $J = 4.6$ Hz, 1H), 8.09 (d, $J = 7.8$ Hz, 1H), 8.03 (d, $J = 9.2$ Hz, 1H), 7.82 (td, $J = 7.7$, 1.6 Hz, 1H), 7.51 – 7.33 (m, 3H), 7.11 (t, $J = 7.6$ Hz, 1H), 6.87 (d, $J = 7.8$ Hz, 1H), 3.98 – 3.78 (m, 1H), 3.02 – 2.81 (m, 1H), 2.93 (s, 3H), 2.40 – 2.13 (m, 1H), 2.13 – 1.87 (m, 2H), 1.87 – 1.69 (m, 1H), 1.69 – 1.46 (m, 2H) ppm; **¹³C NMR** (75 MHz, CDCl_3): δ 171.6, 163.2, 149.4, 148.2, 143.5, 137.2, 130.7, 126.1, 125.3, 124.1, 123.2, 121.8, 109.1, 67.3, 53.7, 50.5, 34.1, 26.7, 26.4, 22.5 ppm; **IR** (neat): 3364, 2962, 2030, 1728, 1469, 1372, 1259, 1122, 1023, 753, 620 cm^{-1} ; **HRMS** (ESI): $\text{C}_{21}\text{H}_{20}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 393.1380, found: 393.1390.





Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 108-110 °C; 94.7 mg; 94% yield; >20:1 dr; 88% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 20.6 min, t_{major} = 9.8 min); $[\alpha]_{\text{D}}^{25} = 150.2$ ($c = 1.99$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.58 (d, $J = 4.4$ Hz, 1H), 8.38 (d, $J = 10.5$ Hz, 1H), 7.94 (d, $J = 7.8$ Hz, 1H), 7.75 (td, $J = 7.7$, 1.6 Hz, 1H), 7.48 – 7.33 (m, 5H), 7.31 – 7.26 (m, 1H), 7.25 – 7.12 (m, 5H), 7.07 (t, $J = 7.4$ Hz, 2H), 7.02 – 6.93 (m, 1H), 6.59 (d, $J = 7.7$ Hz, 1H), 5.68 – 5.56 (m, 1H), 4.46 (d, $J = 12.1$ Hz, 1H), 2.55 (s, 3H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 172.4, 162.3, 149.1, 148.1, 143.4, 140.5, 138.0, 137.1, 135.1, 130.8⁴, 130.7⁶, 128.3, 128.0, 127.9, 127.3, 127.2, 126.3, 125.3, 125.0, 123.3, 122.0, 108.9, 68.2, 55.7, 52.3, 26.2 ppm; **IR** (neat): 3356, 3013, 2026, 1726, 1510, 1371, 1217, 1091, 753, 701, 615 cm^{-1} ; **HRMS** (ESI): $\text{C}_{30}\text{H}_{24}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 505.1693, found: 505.1704.



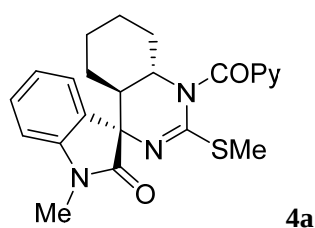
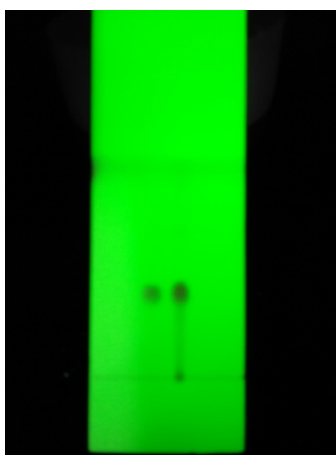
Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 73-75 °C; 86.7 mg; 90% yield; >20:1 dr; 97% ee determined by HPLC on a Chiralpak IC-H column (hexane/2-propanol = 80/20, flow rate = 1.0 mL/min, t_{minor} = 11.4 min, t_{major} = 9.6 min); $[\alpha]_{\text{D}}^{25} = -39.5$ ($c = 2.03$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.65 (d, $J = 4.5$ Hz, 1H), 8.03 (d, $J = 7.8$ Hz, 1H), 7.95 – 7.78 (m, 2H), 7.54 – 7.40 (m, 2H), 7.28 – 7.14 (m, 4H), 7.10 (t, $J = 7.4$ Hz, 1H), 7.06 – 6.96 (m, 2H), 6.48 (d, $J = 7.8$ Hz, 1H), 4.75 (d, $J = 15.7$ Hz, 1H), 3.78 – 3.52 (m, 1H), 3.20 (d, $J = 15.7$ Hz, 1H), 2.65 (td, $J = 12.2$, 3.1 Hz, 1H), 2.52 (d, $J = 13.1$ Hz, 1H), 1.96 (d, $J = 9.3$ Hz, 1H), 1.87 (d, $J = 9.3$ Hz, 1H), 1.82 – 1.63 (m, 2H), 1.43 – 1.21 (m, 3H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 172.9, 162.3, 149.5, 148.3, 142.2, 138.2, 137.2, 134.6, 130.5, 128.7, 127.6, 126.9, 126.2, 125.2, 124.6, 123.4, 122.0, 109.9,

68.8, 49.0, 48.9, 43.4, 34.3, 27.3, 25.4, 25.0 ppm; **IR** (neat): 3359, 2934, 2858, 2022, 1728, 1678, 1514, 1365, 1180, 752, 697, 645 cm^{-1} ; **HRMS** (ESI): $\text{C}_{28}\text{H}_{26}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 483.1849, found: 483.1862.

General Procedure for the Ring-Closure Reaction

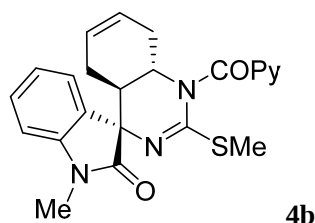
The crude product **3** (0.20 mmol scale) without further purification was dissolved in THF (2.0 mL), MeI (15 μL , 0.24 mmol) and K^tBuO (49 mg, 0.44 mmol) were added respectively under 0 $^{\circ}\text{C}$. After stirring for 10 min, saturated NH_4Cl was added and the aqueous layer was extracted with CH_2Cl_2 . The combined organic layers were dried over Na_2SO_4 and concentrated under vacuum to give a crude product, which was purified by column chromatography (PE/EA = 4/1 to 1/1) to afford **4**.

Note: The cyclization process usually could not be identified by TLC analysis, for the same height of **3** and **4** on thin layer chromatography, for the TLC analysis result of **3a** and **4a** (left is **3a**, right is **4a** on the thin layer chromatography, PE: EA= 2:1) :

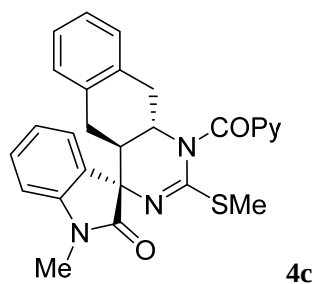


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 166-168 $^{\circ}\text{C}$;

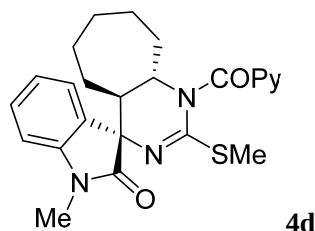
77.3 mg; 92% yield; >20:1 dr; 94% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 9.8$ min, $t_{\text{major}} = 24.0$ min); $[\alpha]_{\text{D}}^{25} = -76.0$ ($c = 1.00$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.69 (d, $J = 4.4$ Hz, 1H), 7.83 (d, $J = 7.8$ Hz, 1H), 7.71 (td, $J = 7.7$, 1.6 Hz, 1H), 7.39 – 7.29 (m, 2H), 7.23 (d, $J = 6.4$ Hz, 1H), 7.15 (d, $J = 7.2$ Hz, 1H), 6.84 (d, $J = 7.7$ Hz, 1H), 4.29 (td, $J = 11.1$, 2.9 Hz, 1H), 3.21 (s, 3H), 2.77 (dd, $J = 11.4$, 2.7 Hz, 1H), 2.08 (s, 3H), 1.99 – 1.87 (m, 1H), 1.76 (d, $J = 12.5$ Hz, 1H), 1.63 (d, $J = 12.5$ Hz, 1H), 1.51 – 0.89 (m, 5H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 174.2, 168.6, 158.0, 154.6, 149.3, 143.4, 136.3, 131.8, 128.8, 124.7, 123.2, 123.0, 122.7, 107.9, 68.3, 57.5, 49.4, 33.1, 26.9, 26.3, 25.7, 25.0, 15.7 ppm; **IR** (neat): 3357, 2933, 1714, 1670, 1439, 1347, 1091, 1001, 753 cm^{-1} ; **HRMS** (ESI): $\text{C}_{23}\text{H}_{24}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 421.1693, found: 421.1703.



Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 109-111 °C; 65.2 mg; 78% yield; 17:1 dr; 94% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 7.6$ min, $t_{\text{major}} = 15.2$ min); $[\alpha]_{\text{D}}^{25} = 21.3$ ($c = 1.04$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.68 (d, $J = 4.6$ Hz, 1H), 7.85 (d, $J = 7.8$ Hz, 1H), 7.69 (td, $J = 7.7$, 1.5 Hz, 1H), 7.40 – 7.29 (m, 2H), 7.24 (d, $J = 6.8$ Hz, 1H), 7.15 (d, $J = 7.4$ Hz, 1H), 6.86 (d, $J = 7.7$ Hz, 1H), 5.72 – 5.61 (m, 1H), 5.55 – 5.43 (m, 1H), 4.46 (td, $J = 11.1$, 4.6 Hz, 1H), 3.31 (d, $J = 16.1$ Hz, 1H), 3.22 (s, 3H), 2.34 – 2.13 (m, 2H), 2.10 (s, 3H), 1.86 – 1.70 (m, 1H), 1.70 – 1.56 (m, 1H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 173.7, 168.1, 158.8, 154.4, 149.3, 143.2, 136.1, 131.2, 129.0, 126.5, 124.7, 124.6, 123.2, 123.1, 122.6, 108.0, 68.0, 54.4, 46.1, 33.9, 27.8, 26.3, 15.5 ppm; **IR** (neat): 3338, 3024, 2925, 2366, 1712, 1670, 1336, 1091, 1018, 753, 667 cm^{-1} ; **HRMS** (ESI): $\text{C}_{23}\text{H}_{22}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 419.1536, found: 419.1545.

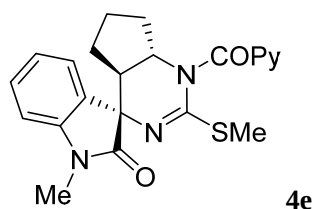


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 150-152 °C; 83.3 mg; 89% yield; >20:1 dr; 97% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 11.6 min, t_{major} = 19.6 min); $[\alpha]_{\text{D}}^{25}$ = 77.0 (c = 1.01, CHCl₃); **¹H NMR** (300 MHz, CDCl₃): δ 8.69 (d, J = 4.5 Hz, 1H), 7.87 (d, J = 7.8 Hz, 1H), 7.70 (td, J = 7.7, 1.5 Hz, 1H), 7.44 – 7.29 (m, 2H), 7.23 (d, J = 6.8 Hz, 1H), 7.14 (dd, J = 13.7, 6.5 Hz, 3H), 7.09 – 7.01 (m, 1H), 6.92 (d, J = 7.8 Hz, 1H), 6.85 (d, J = 7.3 Hz, 1H), 4.63 (td, J = 11.2, 4.5 Hz, 1H), 4.11 – 3.96 (m, 1H), 3.25 (s, 3H), 2.88 (dd, J = 15.1, 11.7 Hz, 1H), 2.62 – 2.28 (m, 3H), 2.12 (s, 3H) ppm; **¹³C NMR** (75 MHz, CDCl₃): δ 173.5, 168.2, 158.9, 154.3, 149.4, 143.4, 136.2, 135.1, 133.6, 131.2, 129.7, 129.2, 128.7, 126.2, 126.0, 124.7, 123.4, 123.2, 122.8, 108.2, 67.9, 54.6, 46.6, 37.4, 31.2, 26.4, 15.6 ppm; **IR** (neat): 3369, 2926, 2372, 1711, 1672, 1583, 1382, 1096, 1019, 751, 664 cm⁻¹; **HRMS** (ESI): C₂₇H₂₄N₄O₂S [M+H]⁺ calcd: 469.1693, found: 469.1703.

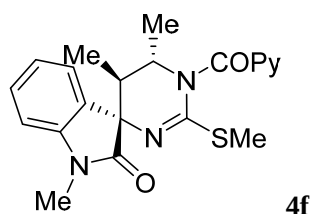


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 32.1 mg; 37% yield; >20:1 dr; 98% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 8.0 min, t_{major} = 10.3 min); $[\alpha]_{\text{D}}^{25}$ = 25.4 (c = 1.07, CHCl₃); **¹H NMR** (300 MHz, CDCl₃): δ 8.66 (d, J = 4.7 Hz, 1H), 7.86 (d, J = 7.8 Hz, 1H), 7.67 (td, J = 7.7, 1.6 Hz, 1H), 7.38 – 7.23 (m, 3H), 7.14 (t, J = 7.4 Hz, 1H), 6.82 (d, J = 7.7 Hz, 1H), 4.52 (td, J = 10.7, 3.7 Hz, 1H), 3.20 (s, 3H), 2.75 – 2.59 (m, 1H), 2.27 (td, J = 10.3, 4.2 Hz, 1H), 2.10 (s, 3H), 1.85 – 1.30 (m, 8H), 1.21 – 1.13 (m, 1H) ppm; **¹³C NMR** (75 MHz, CDCl₃): δ 173.7, 166.0, 159.9, 154.1, 149.1, 143.5, 136.0, 132.6, 128.9, 124.6, 123.2², 123.1⁵, 123.0, 107.8, 69.1, 56.4, 49.9, 34.9, 27.5, 27.0, 26.2, 25.8, 24.7, 15.3 ppm; **IR** (neat): 3403, 2929, 2373, 1712, 1585, 1470, 1345, 1232, 1099, 1021, 753, 666 cm⁻¹;

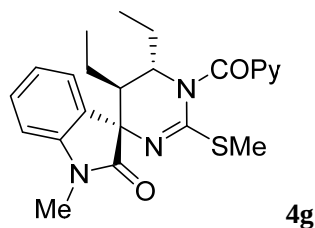
HRMS (ESI): C₂₄H₂₆N₄O₂S [M+H]⁺ calcd: 435.1849, found: 435.1862.



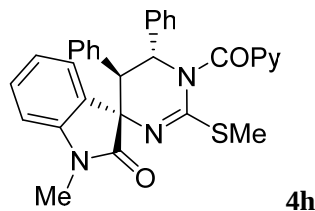
Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 193-195 °C; 48.7 mg; 60% yield; >20:1 dr; >99% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 10.5 min, t_{major} = 16.3 min); $[\alpha]_{\text{D}}^{25}$ = -300.6 (c = 2.05, CHCl₃); **¹H NMR** (300 MHz, CDCl₃): δ 8.70 (d, J = 4.7 Hz, 1H), 7.93 – 7.78 (m, 2H), 7.50 – 7.40 (m, 1H), 7.37 – 7.27 (m, 1H), 7.22 (d, J = 6.8 Hz, 1H), 7.10 (t, J = 7.4 Hz, 1H), 6.86 (d, J = 7.7 Hz, 1H), 4.81 – 4.58 (m, 1H), 3.24 (s, 3H), 2.27 (td, J = 12.0, 7.0 Hz, 1H), 2.15 (s, 3H), 1.63 – 1.47 (m, 3H), 1.40 – 1.21 (m, 2H), 1.18 – 0.99 (m, 1H) ppm; **¹³C NMR** (75 MHz, CDCl₃): δ 174.6, 170.4, 155.0, 153.5, 148.9, 143.0, 136.9, 132.5, 128.7, 126.0, 124.5, 122.9, 108.0, 67.5, 55.6, 48.5, 30.3, 26.2, 22.5, 20.0, 16.5 ppm; **IR** (neat): 3404, 2962, 2373, 1714, 1580, 1470, 1376, 1328, 1216, 1095, 1024, 815, 749, 681, 618 cm⁻¹; **HRMS** (ESI): C₂₂H₂₂N₄O₂S [M+H]⁺ calcd: 407.1536, found: 407.1548.



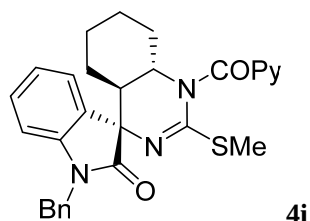
Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 87-89 °C; 70.9 mg; 90% yield; >20:1 dr; 98% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 6.7 min, t_{major} = 16.0 min); $[\alpha]_{\text{D}}^{25}$ = -27.3 (c = 2.02, CHCl₃); **¹H NMR** (300 MHz, CDCl₃): δ 8.67 (d, J = 4.3 Hz, 1H), 7.87 (d, J = 7.8 Hz, 1H), 7.67 (t, J = 7.6 Hz, 1H), 7.41 – 7.20 (m, 3H), 7.14 (t, J = 7.4 Hz, 1H), 6.84 (d, J = 7.7 Hz, 1H), 4.44 – 4.21 (m, 1H), 3.21 (s, 3H), 2.18 – 2.01 (m, 1H), 2.10 (s, 3H), 1.53 (d, J = 6.1 Hz, 3H), 0.77 (d, J = 6.7 Hz, 3H) ppm; **¹³C NMR** (75 MHz, CDCl₃): δ 173.6, 166.5, 159.6, 154.1, 149.2, 143.3, 136.0, 132.2, 128.9, 124.6, 123.2, 123.0, 122.9, 107.8, 69.2, 54.1, 47.1, 26.2, 20.5, 15.3, 14.1 ppm; **IR** (neat): 3343, 2928, 2373, 1713, 1586, 1384, 1223, 1119, 755, 628 cm⁻¹; **HRMS** (ESI): C₂₁H₂₂N₄O₂S [M+H]⁺ calcd: 395.1536, found: 395.1547.



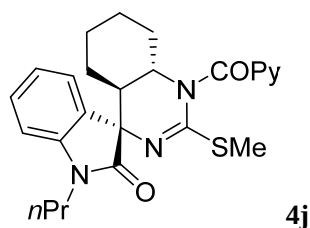
Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). White solid, m.p. 175-177 °C; 76.7 mg; 91% yield; >20:1 dr; >99% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{major}} = 7.4$ min); $[\alpha]_{\text{D}}^{25} = 7.7$ ($c = 1.03$, CHCl_3); **$^1\text{H NMR}$** (300 MHz, CDCl_3): δ 8.68 (d, $J = 4.5$ Hz, 1H), 7.98 (d, $J = 7.8$ Hz, 1H), 7.68 (td, $J = 7.8$, 1.5 Hz, 1H), 7.39 – 7.23 (m, 3H), 7.14 (t, $J = 7.4$ Hz, 1H), 6.83 (d, $J = 7.7$ Hz, 1H), 4.74 – 4.57 (m, 1H), 3.20 (s, 3H), 2.21 – 2.02 (m, 2H), 2.10 (s, 3H), 1.82 – 1.63 (m, 1H), 1.50 – 1.32 (m, 1H), 1.19 – 1.09 (m, 1H), 1.05 (t, $J = 7.4$ Hz, 3H), 0.72 (t, $J = 7.5$ Hz, 3H) ppm; **$^{13}\text{C NMR}$** (75 MHz, CDCl_3): δ 174.0, 166.5, 160.8, 154.1, 149.2, 143.3, 136.0, 133.5, 128.9, 124.6, 123.6, 123.3, 123.1, 107.8, 69.1, 56.5, 50.8, 28.3, 26.3, 23.8, 15.2, 12.4, 9.4 ppm; **IR** (neat): 3329, 2965, 2931, 1713, 1586, 1470, 1342, 1216, 1096, 996, 752, 666 cm^{-1} ; **HRMS** (ESI): $\text{C}_{23}\text{H}_{26}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 423.1849, found: 423.1863.



Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 91.2 mg; 88% yield; >20:1 dr; 89% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 7.6$ min, $t_{\text{major}} = 6.2$ min); $[\alpha]_{\text{D}}^{25} = -111.2$ ($c = 2.30$, CHCl_3); **$^1\text{H NMR}$** (300 MHz, CDCl_3): δ 8.64 (d, $J = 4.6$ Hz, 1H), 7.83 (d, $J = 7.8$ Hz, 1H), 7.65 (td, $J = 7.7$, 1.6 Hz, 1H), 7.36 – 7.26 (m, 2H), 7.16 – 7.07 (m, 4H), 7.05 – 6.93 (m, 6H), 6.93 – 6.83 (m, 2H), 6.43 (d, $J = 7.6$ Hz, 1H), 6.05 (d, $J = 11.1$ Hz, 1H), 3.41 (d, $J = 11.1$ Hz, 1H), 3.02 (s, 3H), 2.26 (s, 3H) ppm; **$^{13}\text{C NMR}$** (75 MHz, CDCl_3): δ 173.7, 166.9, 160.3, 153.8, 148.9, 142.2, 141.7, 136.1, 134.7, 131.5, 129.0, 128.7, 128.2, 127.7, 127.4, 126.9, 126.2, 124.7, 123.5, 123.3, 122.7, 107.6, 69.7, 61.1, 59.6, 26.0, 15.7 ppm; **IR** (neat): 3343, 2927, 2363, 1708, 1583, 1350, 1209, 1089, 1007, 751, 699 cm^{-1} ; **HRMS** (ESI): $\text{C}_{31}\text{H}_{26}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 519.1849, found: 519.1862.

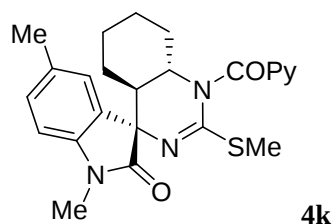


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 80.3 mg; 81% yield; 15:1 dr; 98% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 10.7$ min, $t_{\text{major}} = 13.8$ min); $[\alpha]_{\text{D}}^{25} = -51.6$ ($c = 0.99$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.69 (d, $J = 4.7$ Hz, 1H), 7.84 (d, $J = 7.8$ Hz, 1H), 7.71 (td, $J = 7.7, 1.6$ Hz, 1H), 7.40 – 7.28 (m, 6H), 7.25 – 7.17 (m, 2H), 7.10 (t, $J = 7.2$ Hz, 1H), 6.73 (d, $J = 7.6$ Hz, 1H), 5.15 (d, $J = 15.7$ Hz, 1H), 4.67 (d, $J = 15.7$ Hz, 1H), 4.36 (td, $J = 11.1, 3.0$ Hz, 1H), 2.76 (dd, $J = 11.6, 2.7$ Hz, 1H), 2.10 (s, 3H), 2.04 – 1.92 (m, 1H), 1.77 (d, $J = 14.4$ Hz, 1H), 1.65 (d, $J = 12.7$ Hz, 1H), 1.55 – 1.29 (m, 2H), 1.20 – 0.92 (m, 3H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 174.3, 168.8, 157.9, 154.5, 149.3, 142.7, 136.3, 135.8, 131.9, 128.7, 127.6, 127.2, 124.8, 123.2, 122.8, 108.9, 68.2, 57.5, 49.3, 44.0, 33.1, 27.1, 25.8, 25.0, 15.8 ppm; **IR** (neat): 3355, 2931, 2372, 1712, 1670, 1348, 1260, 1172, 1117, 755, 698, 620 cm^{-1} ; **HRMS** (ESI): $\text{C}_{29}\text{H}_{28}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 497.2006, found: 497.2018.

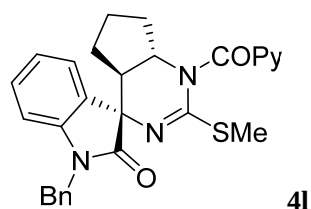


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 68.0 mg; 76% yield; >20:1 dr; 97% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 7.2$ min, $t_{\text{major}} = 11.7$ min); $[\alpha]_{\text{D}}^{25} = -63.4$ ($c = 2.04$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.68 (d, $J = 4.5$ Hz, 1H), 7.82 (d, $J = 7.8$ Hz, 1H), 7.69 (t, $J = 7.2$ Hz, 1H), 7.38 – 7.29 (m, 2H), 7.22 (d, $J = 7.0$ Hz, 1H), 7.12 (t, $J = 7.4$ Hz, 1H), 6.85 (d, $J = 7.7$ Hz, 1H), 4.29 (td, $J = 10.9, 2.4$ Hz, 1H), 3.89 – 3.74 (m, 1H), 3.60 – 3.42 (m, 1H), 2.78 (d, $J = 9.6$ Hz, 1H), 2.08 (s, 3H), 1.93 (t, $J = 10.5$ Hz, 1H), 1.81 – 1.59 (m, 4H), 1.52 – 1.11 (m, 5H), 0.98 (t, $J = 7.3$ Hz, 3H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 174.0, 168.6, 157.8, 154.5, 149.3, 142.9, 136.2, 131.9, 128.7, 124.6, 123.1, 122.8, 122.6, 108.1, 68.1, 57.5, 49.4, 41.7, 33.1, 26.9, 25.7, 24.9, 20.8, 15.6, 11.4 ppm; **IR** (neat): 3398, 2933, 2447, 1711, 1614, 1467, 1368, 1203, 1119, 753, 666 cm^{-1} ; **HRMS** (ESI): $\text{C}_{25}\text{H}_{28}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd:

449.2006, found: 449.2014.

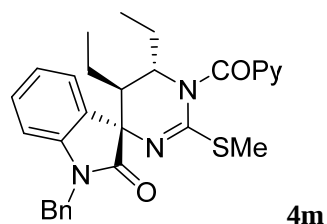


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 74.6 mg; 86% yield; >20:1 dr; 93% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 9.8 min, t_{major} = 27.9 min); $[\alpha]_{\text{D}}^{\text{rt}}$ = -84.2 (c = 1.95, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.68 (d, J = 3.1 Hz, 1H), 7.84 (d, J = 7.5 Hz, 1H), 7.70 (t, J = 7.2 Hz, 1H), 7.41 – 7.30 (m, 1H), 7.12 (d, J = 7.5 Hz, 1H), 7.04 (s, 1H), 6.73 (d, J = 7.6 Hz, 1H), 4.27 (t, J = 10.3 Hz, 1H), 3.19 (s, 3H), 2.77 (d, J = 10.1 Hz, 1H), 2.37 (s, 3H), 2.09 (s, 3H), 1.92 (dd, J = 20.7, 11.2 Hz, 1H), 1.76 (d, J = 12.8 Hz, 1H), 1.63 (d, J = 10.4 Hz, 1H), 1.53 – 0.92 (m, 5H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 174.1, 168.6, 157.7, 154.6, 149.2, 141.0, 136.2, 132.6, 131.7, 129.0, 124.6, 123.8, 122.6, 107.6, 68.4, 57.5, 49.3, 33.1, 26.8, 26.3, 25.7, 24.9, 21.1, 15.6 ppm; **IR** (neat): 3399, 2933, 2860, 1712, 1438, 1363, 1115, 809, 755, 666, 554 cm^{-1} ; **HRMS** (ESI): $\text{C}_{24}\text{H}_{26}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 435.1849, found: 435.1863.

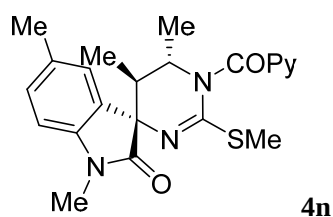


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 44.3 mg; 46% yield; >20:1 dr; 97% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 13.7 min, t_{major} = 25.5 min); $[\alpha]_{\text{D}}^{\text{rt}}$ = -189.0 (c = 2.00, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.70 (d, J = 4.7 Hz, 1H), 7.92 – 7.78 (m, 2H), 7.48 – 7.39 (m, 1H), 7.34 – 7.27 (m, 4H), 7.25 – 7.14 (m, 2H), 7.06 (t, J = 7.3 Hz, 1H), 6.73 (d, J = 7.7 Hz, 1H), 5.04 (d, J = 15.7 Hz, 1H), 4.84 (d, J = 15.8 Hz, 1H), 4.80 – 4.68 (m, 1H), 2.32 (td, J = 12.0, 6.9 Hz, 1H), 2.17 (s, 3H), 1.67 – 1.51 (m, 3H), 1.47 – 1.10 (m, 4H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 174.8, 170.4, 155.0, 153.6, 148.9, 142.3, 137.0, 135.7, 132.6, 128.7, 127.5, 127.1, 126.1, 124.6, 123.1, 123.0, 109.1, 67.4, 55.7, 48.4, 43.9, 30.2, 22.8, 20.2, 16.6 ppm; **IR** (neat): 3351, 2926, 2373, 1674, 1582, 1466, 1382, 1218, 1170, 1102, 1029, 753, 620 cm^{-1} ; **HRMS** (ESI): $\text{C}_{28}\text{H}_{26}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 483.1849, found:

483.1861.

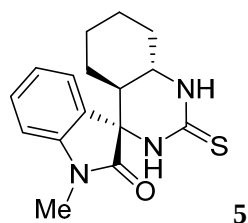


Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 72.7 mg; 73% yield; >20:1 dr; 97% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 5.7$ min, $t_{\text{major}} = 9.5$ min); $[\alpha]_{\text{D}}^{20} = 2.0$ ($c = 0.99$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.67 (d, $J = 4.2$ Hz, 1H), 7.96 (d, $J = 7.8$ Hz, 1H), 7.67 (t, $J = 7.6$ Hz, 1H), 7.40 – 7.26 (m, 7H), 7.21 (d, $J = 7.6$ Hz, 1H), 7.10 (t, $J = 7.4$ Hz, 1H), 6.74 (d, $J = 7.7$ Hz, 1H), 5.05 (d, $J = 15.6$ Hz, 1H), 4.79 – 4.64 (m, 2H), 2.27 – 2.01 (m, 2H), 2.11 (s, 3H), 1.83 – 1.66 (m, 1H), 1.55 – 1.38 (m, 1H), 1.22 – 1.12 (m, 1H), 1.07 (t, $J = 7.3$ Hz, 3H), 0.72 (t, $J = 7.4$ Hz, 3H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 173.9, 166.6, 161.0, 154.0, 149.1, 142.6, 136.0, 135.8, 133.7, 128.8, 128.7, 127.6, 127.5, 124.6, 123.7, 123.4, 123.1, 108.8, 69.0, 56.7, 50.9, 44.0, 28.6, 24.2, 15.3, 12.6, 9.5 ppm; **IR** (neat): 3368, 2926, 2372, 1656, 1588, 1460, 1384, 1215, 1115, 1045, 770, 625 cm^{-1} ; **HRMS** (ESI): $\text{C}_{29}\text{H}_{30}\text{N}_4\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 499.2162, found: 499.2174.



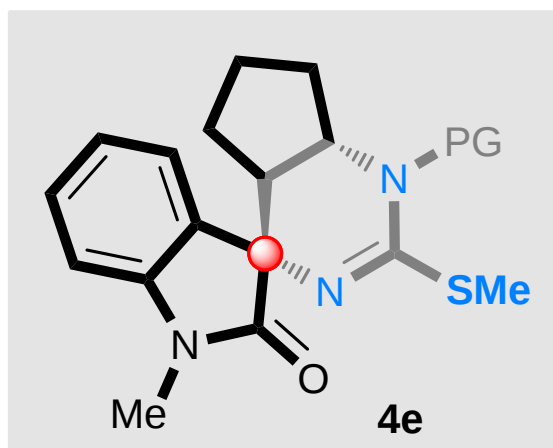
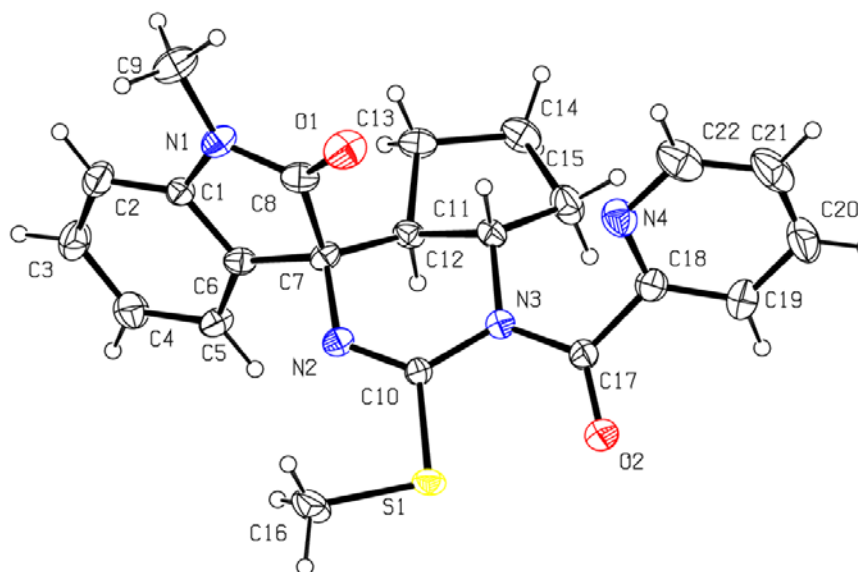
Purified by silica gel column chromatography (PE/EA = 4/1 to 1/1). Colorless oil; 66.9 mg; 82% yield; >20:1 dr; 98% ee determined by HPLC on a Chiralpak IA-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 6.2$ min, $t_{\text{major}} = 18.5$ min); $[\alpha]_{\text{D}}^{20} = -57.6$ ($c = 1.98$, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 8.67 (d, $J = 4.4$ Hz, 1H), 7.88 (d, $J = 7.8$ Hz, 1H), 7.67 (t, $J = 7.3$ Hz, 1H), 7.37 – 7.29 (m, 1H), 7.13 (d, $J = 7.8$ Hz, 1H), 7.06 (s, 1H), 6.72 (d, $J = 7.8$ Hz, 1H), 4.41 – 4.23 (m, 1H), 3.19 (s, 3H), 2.37 (s, 3H), 2.10 (s, 3H), 2.17 – 2.00 (m, 1H), 1.52 (d, $J = 6.1$ Hz, 3H), 0.76 (d, $J = 6.7$ Hz, 3H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 173.5, 166.6, 159.4, 154.2, 149.2, 140.9, 136.0, 132.7, 132.1, 129.1, 124.5, 123.8, 122.9, 107.5, 69.3, 54.2, 47.1, 26.2, 21.1, 20.5, 15.3, 14.2 ppm; **IR** (neat): 3334,

2969, 2372, 1710, 1585, 1357, 1225, 1108, 913, 755, 668, 552 cm^{-1} ; **HRMS** (ESI): $\text{C}_{22}\text{H}_{24}\text{N}_4\text{O}_2\text{S}$
 $[\text{M}+\text{H}]^+$ calcd: 409.1693, found: 409.1702.



3a (122 mg, 0.30 mmol) was dissolved in DCM (5.0 mL) and NaH (18mg, 60%, 0.45 mmol) was added slowly under 0 °C. After stirring for 3 h, saturated NH_4Cl was added and the aqueous layer was extracted with CH_2Cl_2 . The combined organic layers were dried over Na_2SO_4 and concentrated under vacuum. The residue was purified by column chromatography (PE/EA = 4/1 to 2/1) to afford **5** (82 mg, 91% yield). White solid, m.p. 228-230 °C; 91% yield; >20:1 dr; 95% ee determined by HPLC on a Chiralpak OD-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, t_{minor} = 9.9 min, t_{major} = 13.2 min); $[\alpha]_{\text{D}}^{25}$ = -276.3 (c = 1.01, CHCl_3); **^1H NMR** (300 MHz, CDCl_3): δ 7.37 (t, J = 7.7 Hz, 1H), 7.31 (d, J = 7.3 Hz, 1H), 7.12 (t, J = 7.5 Hz, 1H), 6.83 (d, J = 8.0 Hz, 2H), 6.75 (s, 1H), 3.95 (td, J = 10.4, 3.9 Hz, 1H), 3.18 (s, 3H), 2.12 – 1.97 (m, 1H), 1.88 – 1.72 (m, 2H), 1.63 (d, J = 12.0 Hz, 1H), 1.32 (t, J = 10.4 Hz, 2H), 1.14 (d, J = 11.1 Hz, 2H), 0.93 – 0.81 (m, 1H) ppm; **^{13}C NMR** (75 MHz, CDCl_3): δ 176.4, 174.2, 143.8, 130.4, 126.7, 123.5, 123.4, 108.4, 63.4, 50.1, 43.2, 31.6, 26.3, 25.0, 23.7, 23.6 ppm; **IR** (neat): 3199, 2929, 2437, 1718, 1470, 1261, 1092, 1022, 755, 664, 628 cm^{-1} ; **HRMS** (ESI): $\text{C}_{16}\text{H}_{19}\text{N}_3\text{OS}$ $[\text{M}+\text{H}]^+$ calcd: 302.1322, found: 302.1330.

X-Ray Analysis of 4e



Bond precision: C-C = 0.0087 Å Wavelength=0.71073

Cell: a=10.363(3) b=9.318(2) c=11.453(4)
alpha=90 beta=112.70(4) gamma=90

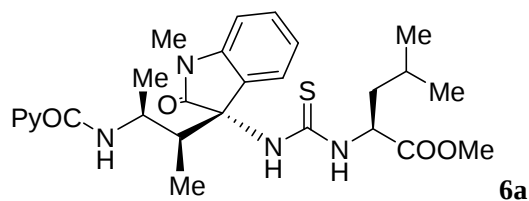
Temperature: 292 K

	Calculated	Reported
Volume	1020.3(6)	1020.2(5)
Space group	P 21	P 1 21 1
Hall group	P 2yb	P 2yb
Moiety formula	C22 H22 N4 O2 S	C22 H22 N4 O2 S

Sum formula	C22 H22 N4 O2 S	C22 H22 N4 O2 S
Mr	406.50	406.50
Dx,g cm-3	1.323	1.323
Z	2	2
Mu (mm-1)	0.185	0.185
F000	428.0	428.0
F000'	428.40	
h,k,lmax	14,12,15	14,12,15
Nref	5354[2836]	2969
Tmin,Tmax	0.962,0.971	0.455,1.000
Tmin'	0.962	
Correction method= # Reported T Limits: Tmin=0.455 Tmax=1.000		
AbsCorr = MULTI-SCAN		
Data completeness= 1.05/0.55	Theta(max)= 28.870	
R(reflections)= 0.0598(1936)	wR2(reflections)= 0.1618(2969)	
S = 0.994	Npar= 264	

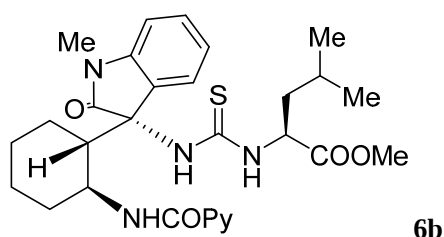
Representative Procedure for the Modification Process of Amino Acids and Peptides

Amino acids or peptides methyl esters hydrochloride (0.13 mmol) was dissolved in CH₂Cl₂ (0.5 mL), and saturated aqueous NaHCO₃ (0.5 mL). The biphasic mixture was stirred vigorously for 10 minutes. The stirring was stopped, and ring-opening product **3** (0.1 mmol) was added via syringe to the organic layer. Stirring was immediately restarted, and the reaction was allowed to stir at room temperature for 20 h. The layers were separated and the aqueous layer was extracted with CH₂Cl₂ and washed with water. The combined organics were dried over Na₂SO₄, concentrated under vacuum. The residue mixture was purified by flash column chromatography on silica gel to give the coupling product.

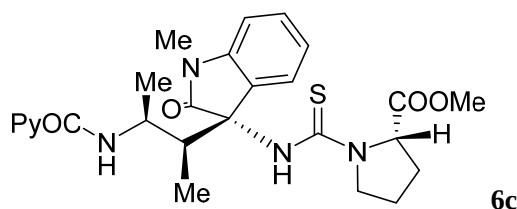


Purified by column chromatography (PE/EA = 4/1 to 0/1). Colorless oil; 36,2 mg; 69% yield; >20:1 dr;

$[\alpha]_D^{25} = -53.9$ ($c = 1.02$, CHCl_3); **$^1\text{H NMR}$** (300 MHz, CDCl_3): δ 8.57 (d, $J = 4.5$ Hz, 1H), 8.15 (d, $J = 7.7$ Hz, 1H), 8.07 (s, 1H), 7.87 (td, $J = 7.7, 1.6$ Hz, 1H), 7.47 (ddd, $J = 7.5, 4.8, 1.0$ Hz, 1H), 7.32 (t, $J = 7.7$ Hz, 1H), 7.22 (d, $J = 3.3$ Hz, 1H), 7.08 (t, $J = 7.4$ Hz, 1H), 6.73 (d, $J = 7.7$ Hz, 1H), 5.16 – 4.97 (m, 1H), 4.53 (s, 1H), 3.73 (s, 3H), 3.01 (s, 3H), 2.67 (s, 1H), 1.85 – 1.62 (m, 3H), 1.34 – 1.10 (m, 4H), 1.07 – 0.64 (m, 10H) ppm; **$^{13}\text{C NMR}$** (75 MHz, CDCl_3): δ 182.0, 175.2, 173.3, 163.9, 149.1, 148.2, 144.0, 137.4, 130.9, 129.3, 128.7, 126.5, 123.1, 122.2, 108.2, 67.0, 52.1, 45.4, 41.6, 34.1, 30.5, 26.4, 25.0, 24.0, 22.6, 22.3 ppm; **IR** (neat): 3369, 2958, 2370, 1721, 1524, 1465, 1384, 1218, 1126, 1042, 752, 667, 622 cm^{-1} ; **HRMS** (ESI): $\text{C}_{27}\text{H}_{35}\text{N}_5\text{O}_4\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 526.2483, found: 526.2508.

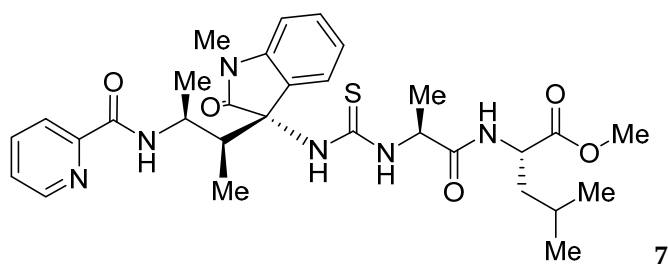


Purified by column chromatography (PE/EA = 4/1 to 0/1). Colorless oil; 46.2 mg; 84% yield; >20:1 dr; $[\alpha]_D^{25} = -83.8$ ($c = 1.01$, CHCl_3); **$^1\text{H NMR}$** (300 MHz, CDCl_3): δ 9.37 (d, $J = 7.3$ Hz, 1H), 8.54 (d, $J = 4.2$ Hz, 1H), 7.87 (d, $J = 7.7$ Hz, 1H), 7.74 (t, $J = 7.7$ Hz, 1H), 7.66 (d, $J = 10.5$ Hz, 1H), 7.51 – 7.26 (m, 3H), 7.12 (t, $J = 7.6$ Hz, 1H), 6.51 (d, $J = 7.8$ Hz, 1H), 6.03 (s, 1H), 5.08 – 4.89 (m, 1H), 3.67 (s, 3H), 3.64 – 3.50 (m, 1H), 2.90 – 2.71 (m, 1H), 2.38 (s, 3H), 2.19 (d, $J = 12.7$ Hz, 1H), 1.91 (d, $J = 12.8$ Hz, 1H), 1.87 – 1.57 (m, 6H), 1.41 – 1.26 (m, 1H), 1.26 – 1.12 (m, 2H), 1.00 (dd, $J = 10.6, 5.7$ Hz, 6H) ppm; **$^{13}\text{C NMR}$** (75 MHz, CDCl_3): δ 183.3, 176.6, 173.0, 162.2, 149.3, 148.1, 143.0, 137.2, 130.8, 126.9, 126.2, 124.0, 123.7, 122.0, 109.0, 67.6, 57.7, 52.2, 49.6, 44.9, 41.2, 34.6, 27.0, 26.0, 25.6, 25.3, 25.0, 23.0, 21.8 ppm; **IR** (neat): 3358, 2931, 2371, 1687, 1613, 1469, 1384, 1217, 1129, 1025, 763, 666 cm^{-1} ; **HRMS** (ESI): $\text{C}_{29}\text{H}_{37}\text{N}_5\text{O}_4\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 552.2639, found: 552.2664.



Purified by column chromatography (PE/EA = 4/1 to 0/1). Colorless oil; 40.2 mg; 79% yield; >20:1 dr; $[\alpha]_D^{25} = -7.1$ ($c = 0.99$, CHCl_3); **$^1\text{H NMR}$** (300 MHz, CDCl_3): δ 8.73 (s, 1H), 8.56 (d, $J = 4.1$ Hz, 1H), 8.12 (dd, $J = 24.0, 6.6$ Hz, 2H), 7.88 (t, $J = 7.5$ Hz, 1H), 7.59 – 7.39 (m, 1H), 7.22 (d, $J = 7.5$ Hz, 1H),

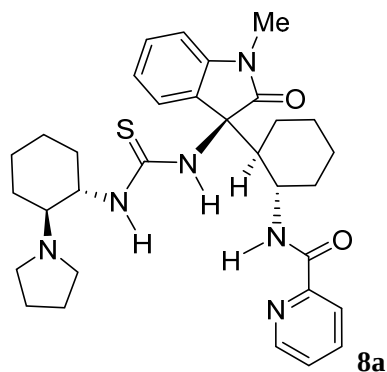
7.13 – 6.93 (m, 2H), 6.73 (d, $J = 7.7$ Hz, 1H), 5.00 – 4.79 (m, 1H), 4.26 – 3.46 (m, 5H), 3.21 (s, 3H), 2.51 (s, 1H), 2.35 – 1.80 (m, 4H), 1.48 – 1.12 (m, 4H), 0.53 (d, $J = 7.3$ Hz, 3H) ppm; ^{13}C NMR (75 MHz, CDCl_3): δ 178.5, 174.4, 172.8, 164.5, 149.2, 148.2, 145.0, 137.4, 131.0, 128.1, 126.5, 122.4, 122.0, 120.8, 107.5, 67.7, 52.2, 45.8, 45.1, 30.5, 26.9, 24.0, 19.1, 15.9, 8.4 ppm; IR (neat): 3383, 3269, 2961, 2372, 2027, 1719, 1554, 1366, 1215, 1091, 1043, 999, 754, 666, 539 cm^{-1} ; HRMS (ESI): $\text{C}_{26}\text{H}_{31}\text{N}_5\text{O}_4\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 510.2170, found: 510.2191.



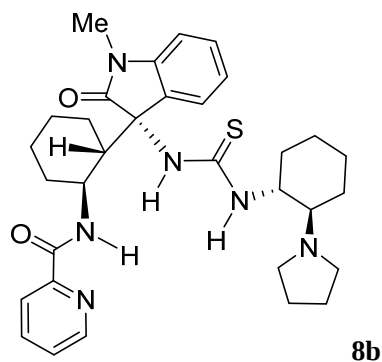
Purified by column chromatography (PE/EA = 4/1 to 0/1). White solid, m.p. 113-115 $^{\circ}\text{C}$; 45.2 mg; 76% yield; >20:1 dr; $[\alpha]_{\text{D}}^{25} = -67.0$ ($c = 1.02$, CHCl_3); ^1H NMR (300 MHz, CDCl_3): δ 8.50 (d, $J = 4.5$ Hz, 1H), 8.14 (d, $J = 7.8$ Hz, 2H), 7.83 (td, $J = 7.7, 1.4$ Hz, 1H), 7.41 (dd, $J = 6.9, 5.0$ Hz, 1H), 7.26 – 7.15 (m, 2H), 7.11 – 7.01 (m, 1H), 6.96 (t, $J = 7.4$ Hz, 2H), 6.68 (d, $J = 7.7$ Hz, 1H), 5.04 – 4.84 (m, 1H), 4.63 (s, 1H), 4.58 – 4.42 (m, 1H), 3.64 (s, 3H), 3.04 (s, 3H), 2.40 (s, 1H), 1.70 – 1.48 (m, 3H), 1.38 (d, $J = 6.9$ Hz, 3H), 1.19 (d, $J = 6.2$ Hz, 4H), 0.84 (t, $J = 5.9$ Hz, 6H), 0.62 (s, 3H) ppm; ^{13}C NMR (75 MHz, CDCl_3): δ 180.8, 174.6, 173.2, 171.9, 164.6, 148.8, 148.2, 144.4, 137.5, 130.9, 128.7, 126.6, 122.8, 122.3, 121.6, 107.9, 66.9, 52.1, 50.8, 45.2, 41.1, 30.5, 26.5, 24.7, 22.8, 21.7, 19.1, 17.8, 13.7 ppm; IR (neat): 3324, 2959, 2369, 1721, 1524, 1467, 1217, 1126, 1042, 755, 666, 540 cm^{-1} ; HRMS (ESI): $\text{C}_{30}\text{H}_{40}\text{N}_6\text{O}_5\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 597.2854, found: 597.2880.

Representative Procedure for Synthesis of the Organocatalysis

The ring-opening product **3a** (0.25 mmol) and cyclohexanediamine moiety (0.30 mmol) was dissolved in CH_2Cl_2 , and the reaction was allowed to stir at room temperature for 24 h. Then concentrated under vacuum conditions. The residue mixture was purified by flash column chromatography on silica gel to give the bifunctional amine-thioureas.



Purified by column chromatography (PE/EA/MeOH/NH₃(H₂O) = 4/1/0/0 to 0/1/0.05/0.05). White solid, m.p. 135-137 °C; 123.4 mg; 86% yield; >20:1 dr; $[\alpha]_D^{25} = -48.5$ ($c = 0.99$, CHCl₃); **¹H NMR** (300 MHz, CDCl₃): δ 8.96 (s, 1H), 8.62 (d, $J = 4.4$ Hz, 1H), 7.95 (d, $J = 7.7$ Hz, 1H), 7.82 (td, $J = 7.7$, 1.5 Hz, 1H), 7.72 (d, $J = 10.3$ Hz, 1H), 7.53 – 7.40 (m, 2H), 7.36 (t, $J = 7.7$ Hz, 1H), 7.16 (t, $J = 7.5$ Hz, 1H), 6.56 (d, $J = 7.7$ Hz, 1H), 5.94 (s, 1H), 4.53 – 4.29 (m, 1H), 3.75 – 3.51 (m, 1H), 2.92 – 2.77 (m, 1H), 2.67 (d, $J = 23.4$ Hz, 4H), 2.44 (s, 3H), 2.30 (d, $J = 12.8$ Hz, 2H), 1.96 (d, $J = 11.5$ Hz, 1H), 1.91 – 1.60 (m, 10H), 1.60 – 1.47 (m, 2H), 1.47 – 1.11 (m, 6H) ppm; **¹³C NMR** (75 MHz, CDCl₃): δ 181.6, 176.6, 162.2, 149.5, 148.2, 143.2, 137.3, 130.6, 127.1, 126.2, 124.0, 123.7, 122.0, 108.8, 67.3, 62.1, 56.5, 49.5, 49.3, 45.3, 34.6, 29.8, 27.0, 25.8, 25.0, 24.6, 23.7, 23.3, 22.7⁴, 22.7² (overlapped) ppm; **IR** (neat): 3360, 2929, 2372, 1675, 1382, 1217, 1095, 1023, 755, 665, 621 cm⁻¹; **HRMS** (ESI): C₃₂H₄₂N₆O₂S [M+H]⁺ calcd: 575.3163, found: 575.3191.

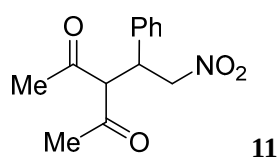


Purified by column chromatography (PE/EA/MeOH/NH₃(H₂O) = 4/1/0/0 to 0/1/0.05/0.05). White solid, m.p. 148-150 °C; 127.7 mg; 89% yield; >20:1 dr; $[\alpha]_D^{25} = -89.4$ ($c = 1.01$, CHCl₃); **¹H NMR** (300 MHz, CDCl₃): δ 9.20 (s, 1H), 8.63 (d, $J = 4.3$ Hz, 1H), 7.97 (d, $J = 7.8$ Hz, 1H), 7.81 (td, $J = 7.7$, 1.5 Hz, 1H), 7.78 – 7.66 (m, 1H), 7.52 – 7.39 (m, 2H), 7.36 (t, $J = 7.6$ Hz, 1H), 7.16 (t, $J = 7.5$ Hz, 1H), 6.58 (d, $J = 7.8$ Hz, 1H), 5.86 (s, 1H), 4.20 (s, 1H), 3.75 – 3.49 (m, 1H), 3.04 – 2.89 (m, 1H), 2.84 (dd, $J = 27.2$, 4.4

Hz, 4H), 2.45 (s, 3H), 2.34 (d, $J = 12.8$ Hz, 1H), 2.02 – 1.60 (m, 11H), 1.60 – 1.12 (m, 9H) ppm; ^{13}C NMR (75 MHz, CDCl_3): δ 180.3, 176.7, 162.2, 149.4, 148.2, 143.1, 137.2, 130.8, 130.5, 127.3, 126.1, 123.7, 121.9, 108.8, 67.6, 65.5, 62.6, 57.4, 49.4, 48.5, 44.8, 34.5, 30.4, 27.0, 25.9, 25.4, 24.9, 24.3, 24.0, 23.9, 19.1, 13.6 ppm; IR (neat): 3244, 2931, 2858, 2370, 1695, 1518, 1216, 1130, 1023, 751, 665, 540 cm^{-1} ; HRMS (ESI): $\text{C}_{32}\text{H}_{42}\text{N}_6\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ calcd: 575.3163, found: 575.3189.

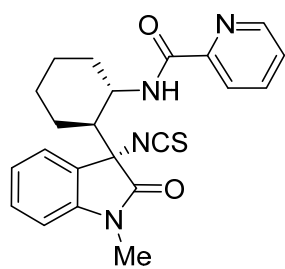
Procedure for Michael Reaction

The acetylacetone **9** (0.40 mmol) and nitroalkenes **10** (0.20 mmol) and thioureas catalysis (0.02 mmol) was dissolved in toluene (0.5 mL), and the reaction was allowed to stir at room temperature for 24 h. Then concentrated under vacuum conditions. The residue mixture was purified by flash column chromatography on silica gel to give the conjugate adduct **11**.

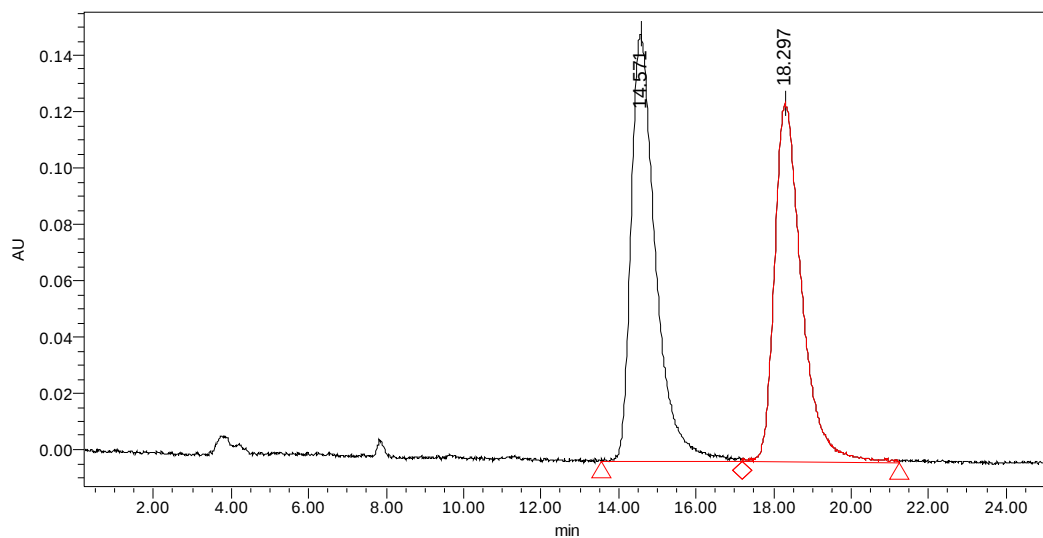


Purified by column chromatography (PE/EA = 20/1 to 7/1). White solid, m.p. 105-107 °C; From **8a**: 41.8 mg; 84% yield; 33% ee determined by HPLC on a Chiralpak OD-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 14.1$ min, $t_{\text{major}} = 9.3$ min); $[\alpha]_{\text{D}}^{25} = 78.1$ ($c = 0.97$, CHCl_3); From **8b**: 45.8 mg; 92% yield; -90% ee determined by HPLC on a Chiralpak OD-H column (hexane/2-propanol = 60/40, flow rate = 1.0 mL/min, $t_{\text{minor}} = 9.3$ min, $t_{\text{major}} = 13.8$ min); $[\alpha]_{\text{D}}^{25} = -183.2$ ($c = 1.00$, CHCl_3); ^1H NMR (300 MHz, CDCl_3): δ 7.39 – 7.23 (m, 3H), 7.23 – 7.13 (m, 2H), 4.65 (d, $J = 2.5$ Hz, 1H), 4.63 (s, 1H), 4.38 (d, $J = 10.8$ Hz, 1H), 4.25 (ddd, $J = 10.8, 7.3, 5.3$ Hz, 1H), 2.29 (s, 3H), 1.94 (s, 3H) ppm; ^{13}C NMR (75 MHz, CDCl_3): δ 201.7, 201.0, 135.9, 129.3, 128.5, 127.9, 78.1, 70.6, 42.7, 30.4, 29.6 ppm; IR (neat): 3395, 2923, 2376, 1718, 1551, 1383, 1261, 1216, 1095, 1023, 761, 702, 536 cm^{-1} ; HRMS (ESI): $\text{C}_{13}\text{H}_{15}\text{NO}_4$ $[\text{M}+\text{Na}]^+$ calcd: 272.0893, found: 272.0904.

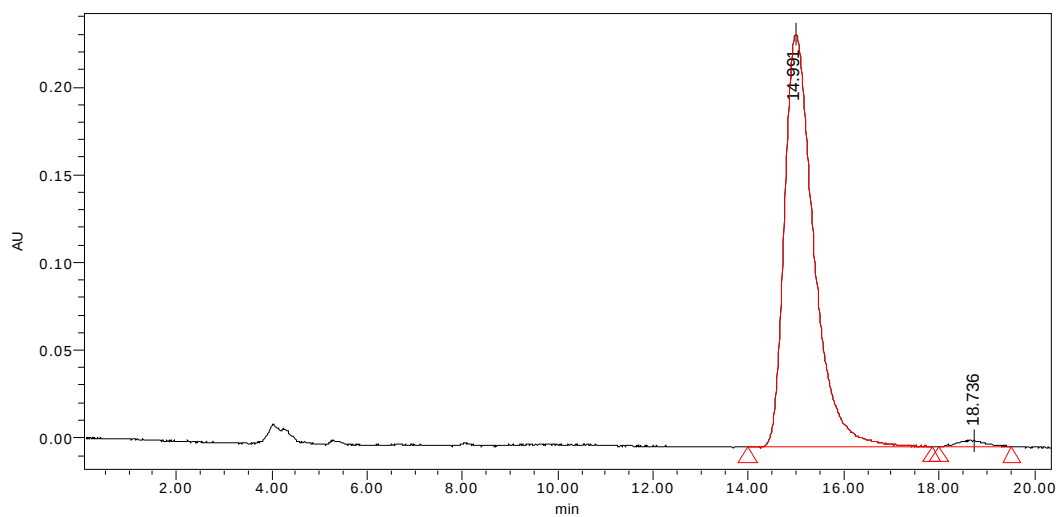
Copies of HPLC Results



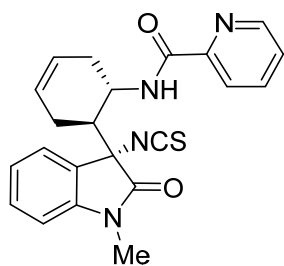
HPLC using an IC-H (*n*-Hexane/*i*-PrOH=80/20, flow rate 1.0 mL/min)



	Retention Time	Area	% Area	Height
1	14.571	6687404	51.97	151478
2	18.297	6180339	48.03	127215

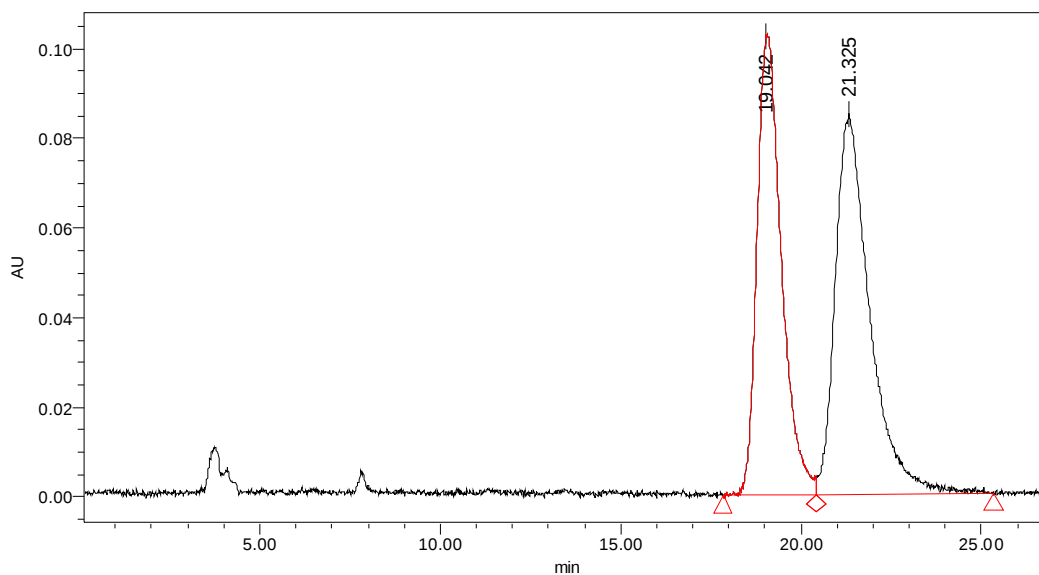


	Retention Time	Area	% Area	Height
1	14.991	10055054	98.53	235460
2	18.736	149811	1.47	3492

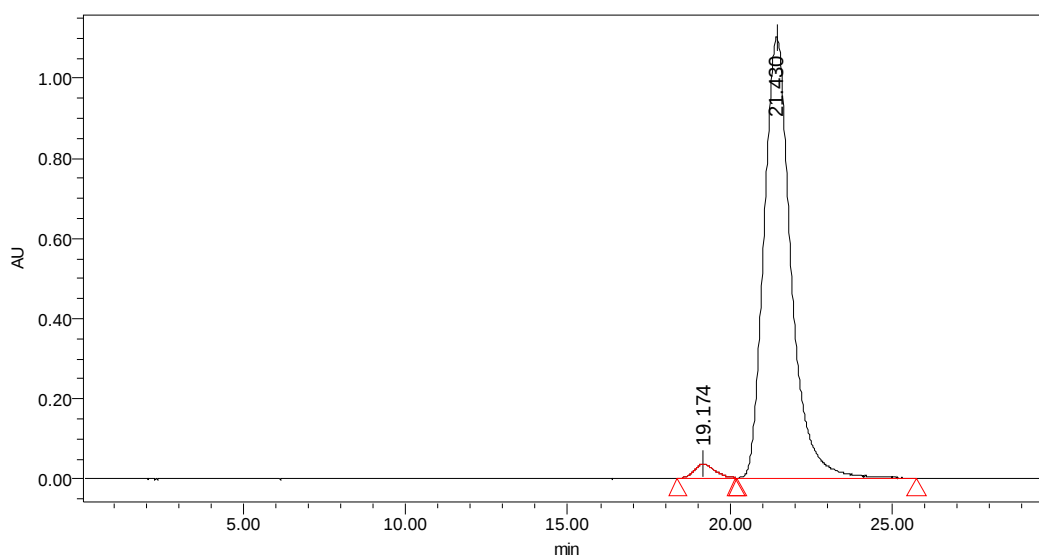


3b

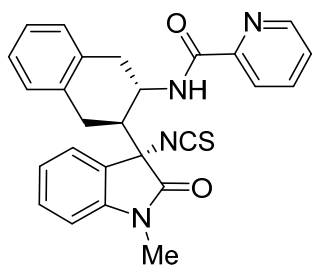
HPLC using an IC-H (*n*-Hexane/*i*-PrOH=80/20, flow rate 1.0 mL/min)



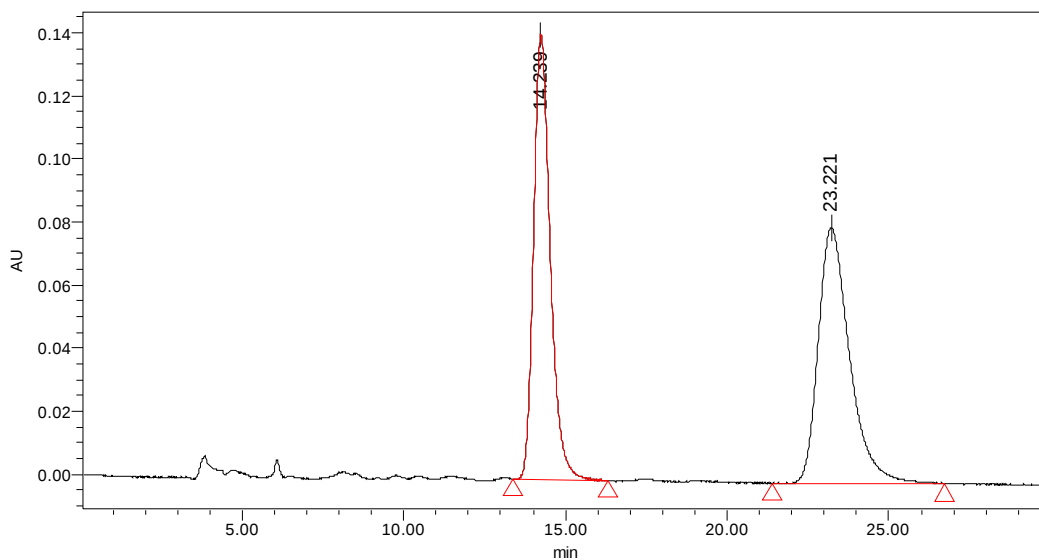
	Retention Time	Area	% Area	Height
1	19.042	4856005	46.29	102594
2	21.325	5635106	53.71	84517



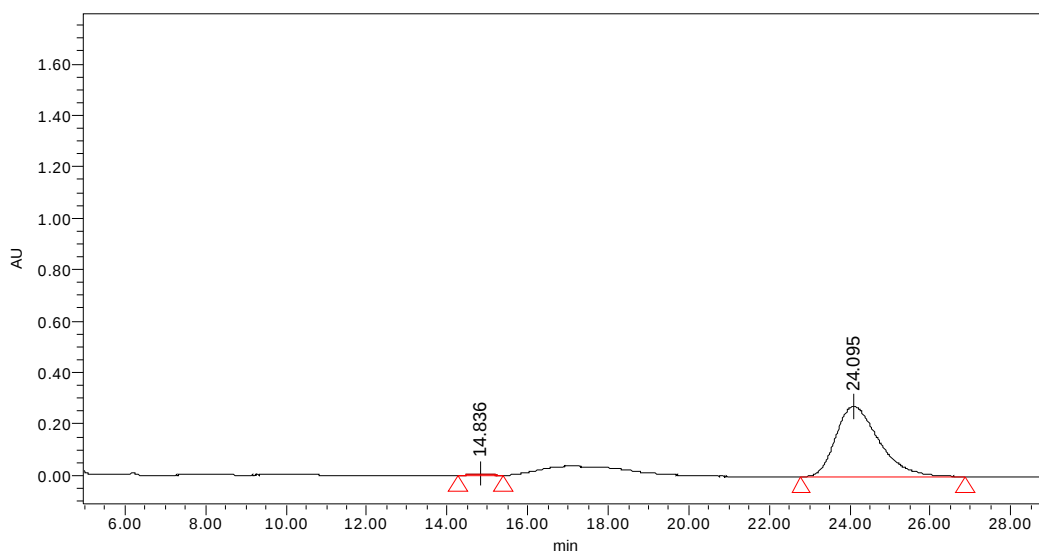
	Retention Time	Area	% Area	Height
1	19.174	1542096	2.36	35318
2	21.430	63818256	97.64	1099584



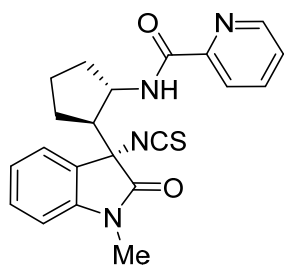
HPLC using an IC-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



	Retention Time	Area	% Area	Height
1	14.239	5076928	48.04	141093
2	23.221	5491410	51.96	80980

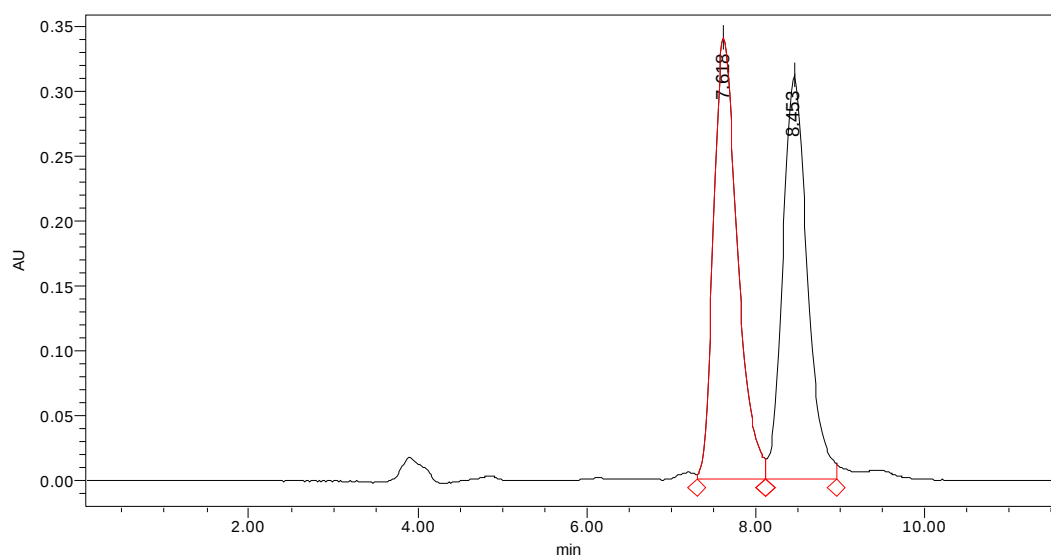


	Retention Time	Area	% Area	Height
1	14.836	212187	1.02	6085
2	24.095	20503157	98.98	273991

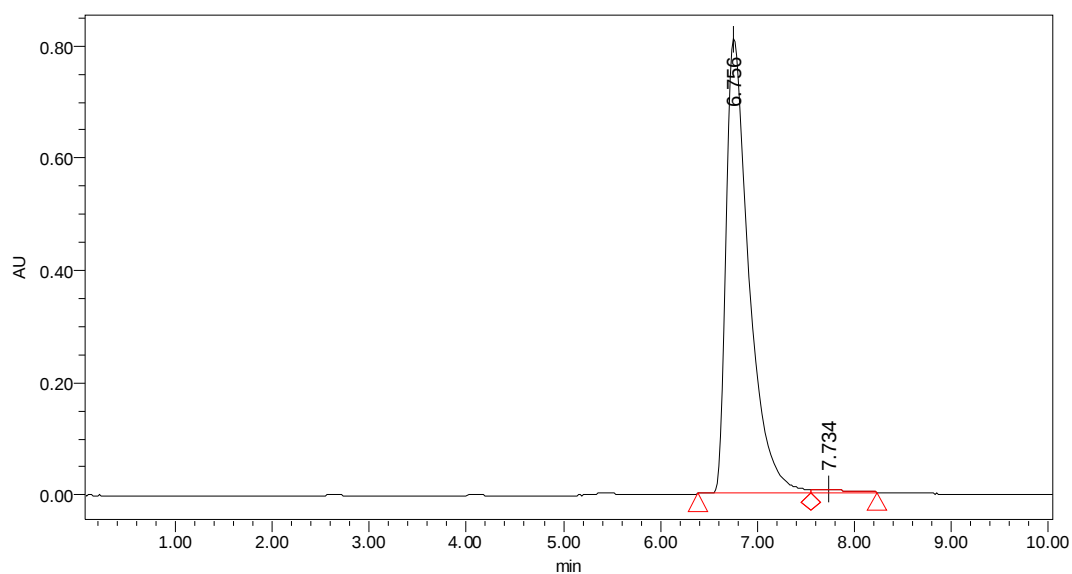


3d

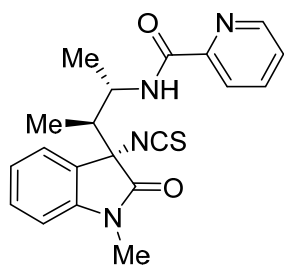
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



	Retention Time	Area	% Area	Height
1	7.618	6731372	51.63	339974
2	8.453	6306681	48.37	311289

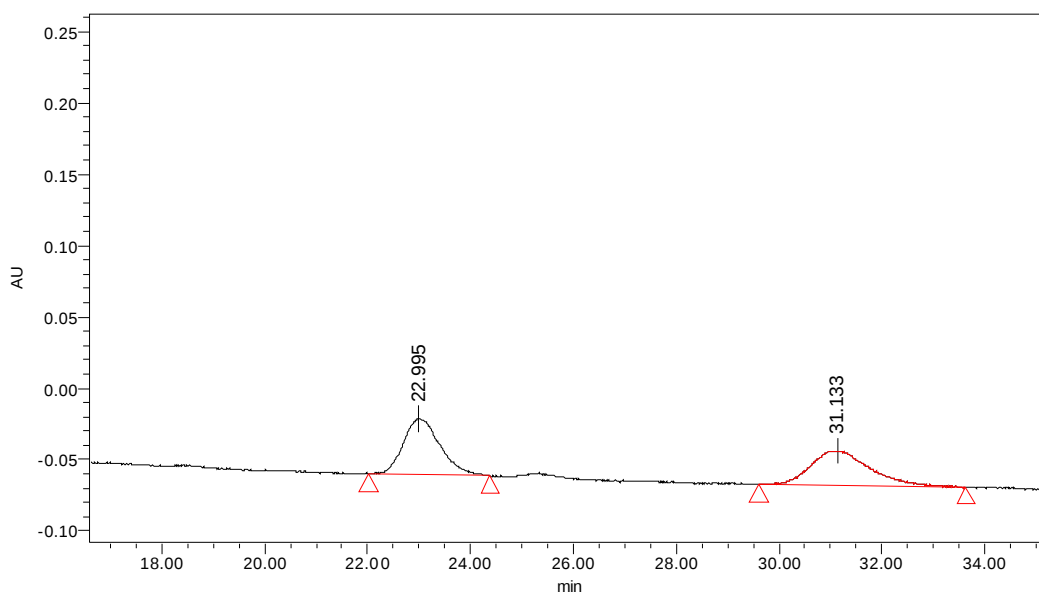


	Retention Time	Area	% Area	Height
1	6.756	13308782	98.99	812532
2	7.734	136451	1.01	6383

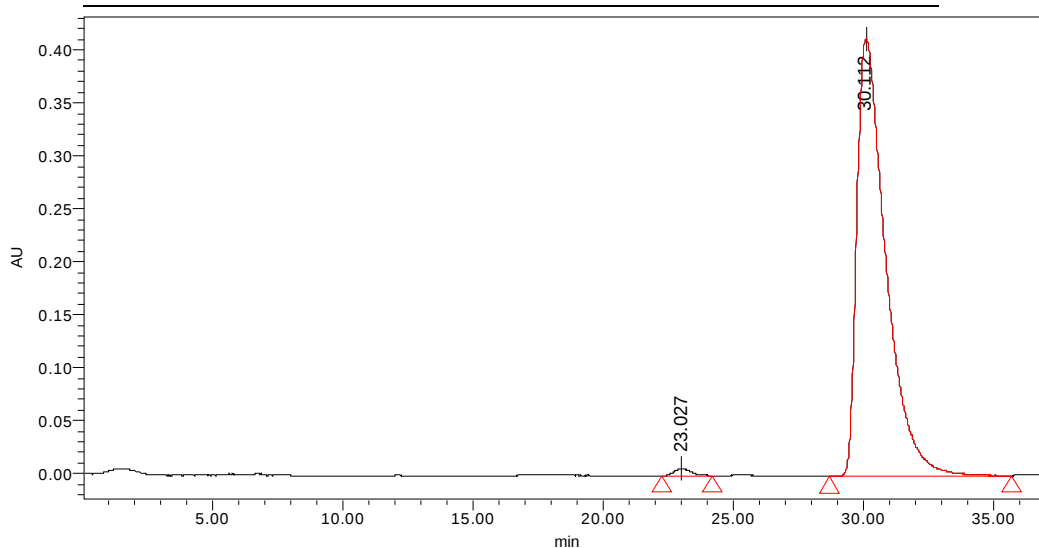


3e

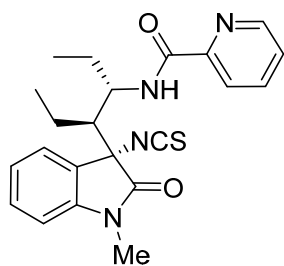
HPLC using an IC-H (*n*-Hexane/*i*-PrOH=80/20, flow rate 1.0 mL/min)



	Retention Time	Area	% Area	Height
1	22.995	1957011	50.06	39331
2	31.133	1952401	49.94	24286

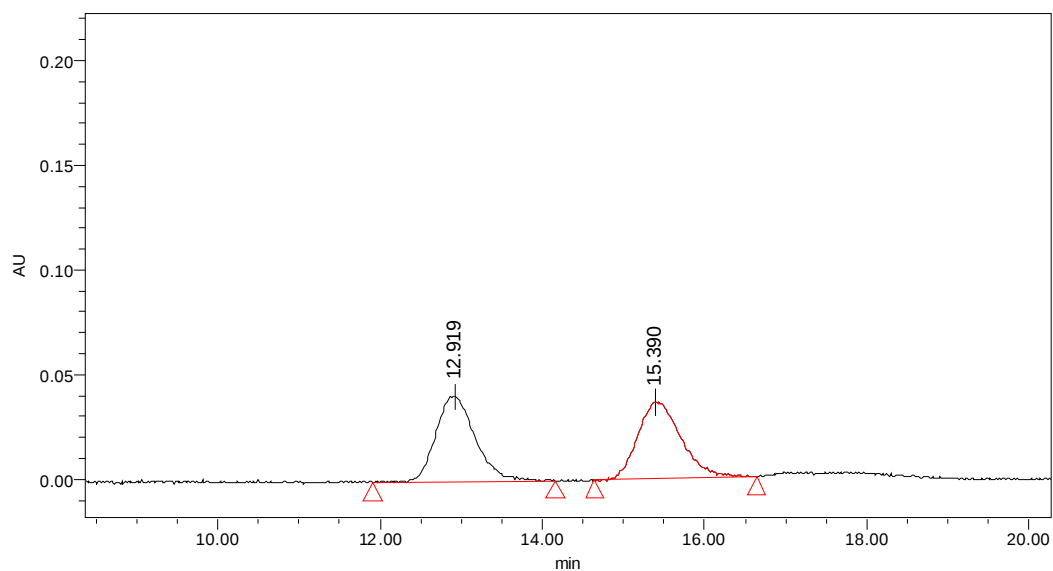


	Retention Time	Area	% Area	Height
1	23.027	311409	0.97	6677
2	30.112	31925073	99.03	412846

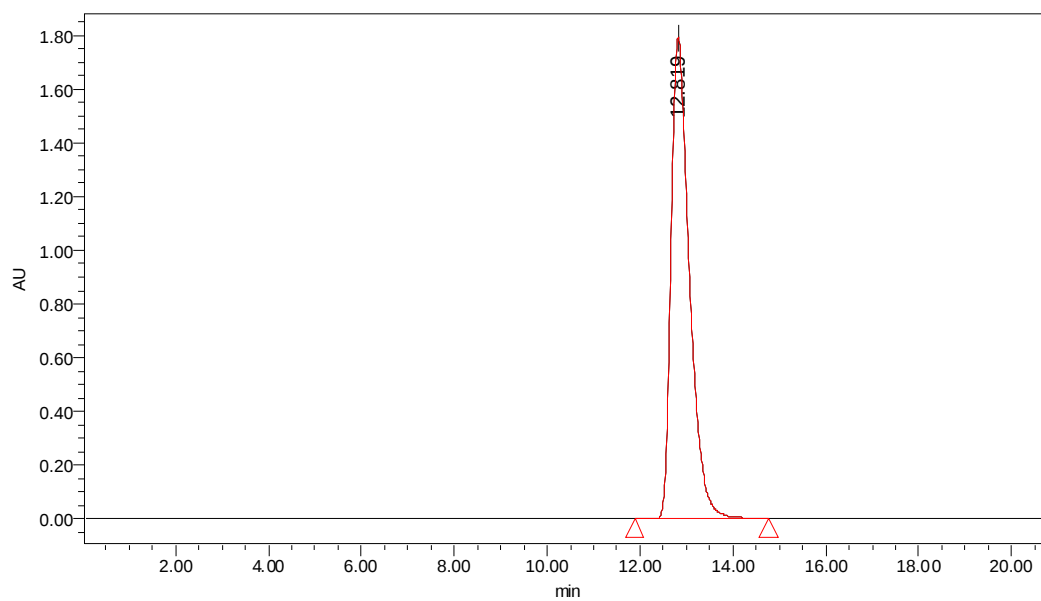


3f

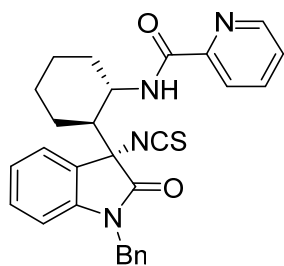
HPLC using an IC-H (*n*-Hexane/*i*-PrOH=80/20, flow rate 1.0 mL/min)



	Retention Time	Area	% Area	Height
1	12.919	1405950	50.76	41089
2	15.390	1363667	49.24	36791

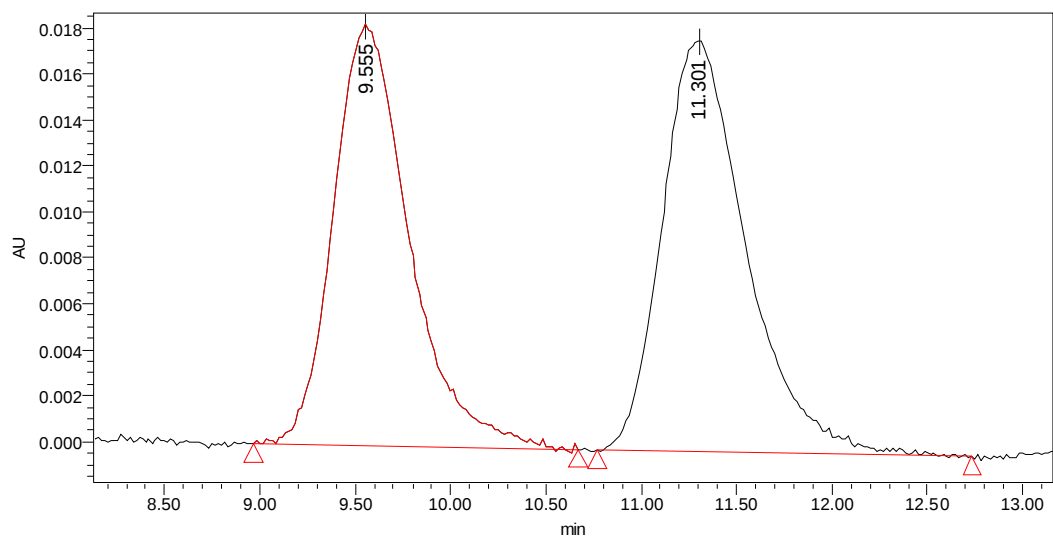


	Retention Time	Area	% Area	Height
1	12.819	49278143	100.00	1790705

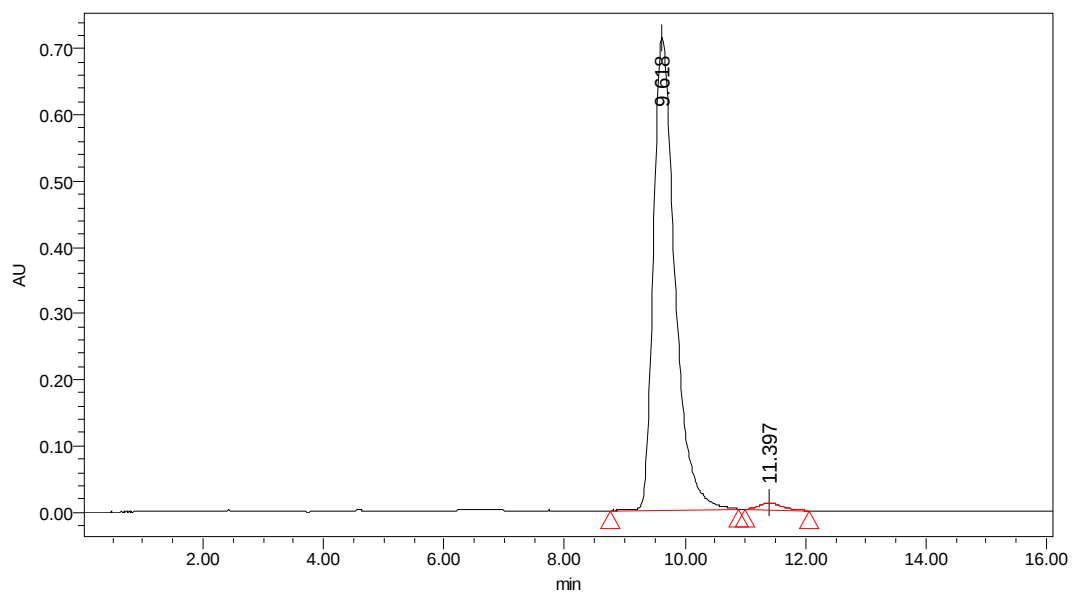


3h

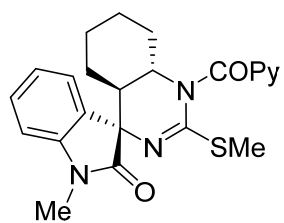
HPLC using an IC-H (*n*-Hexane/*i*-PrOH=80/20, flow rate 1.0 mL/min)



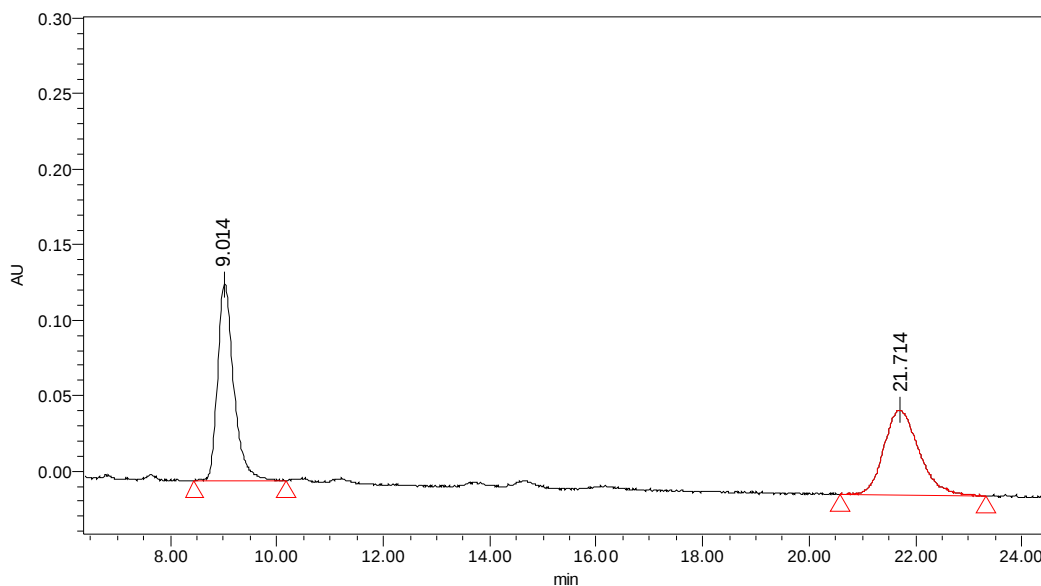
	Retention Time	Area	% Area	Height
1	9.555	509680	47.91	18249
2	11.301	554067	52.09	17914



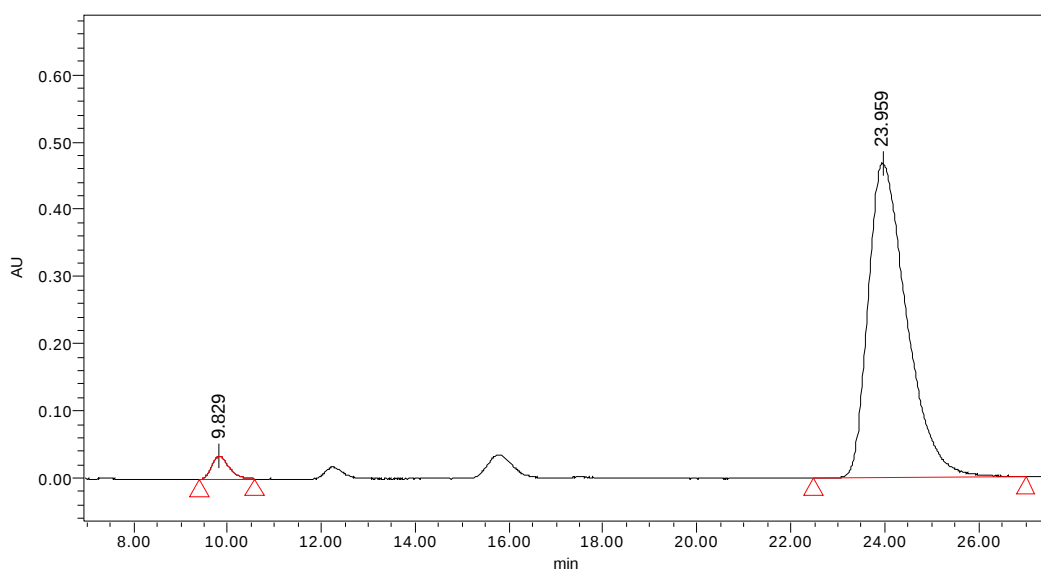
	Retention Time	Area	% Area	Height
1	9.618	17547664	98.52	714550
2	11.397	264455	1.48	10065



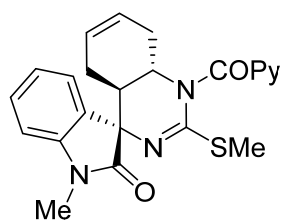
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



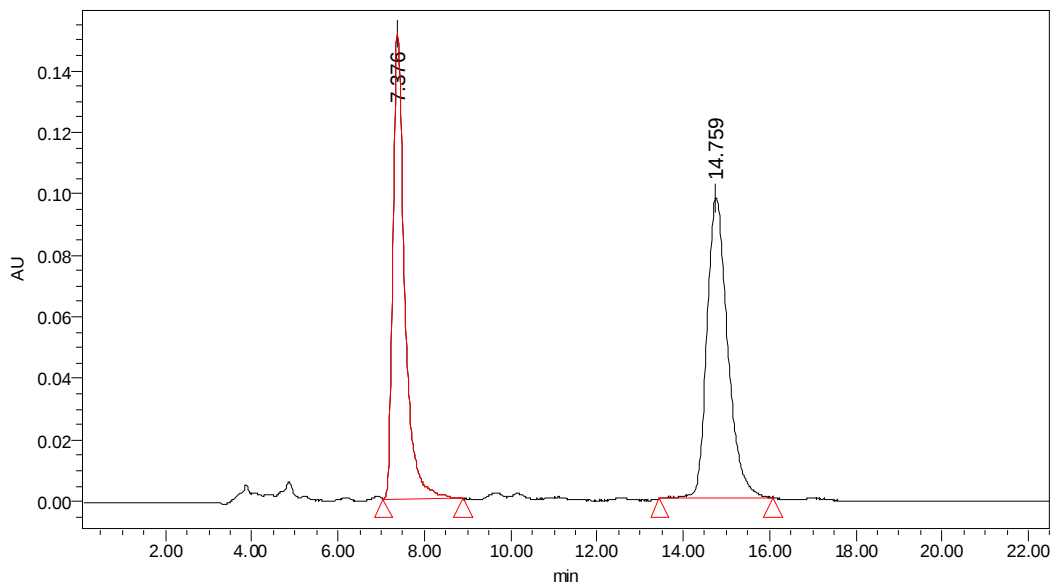
	Retention Time	Area	% Area	Height
1	9.014	2726493	51.33	130447
2	21.714	2585371	48.67	56313



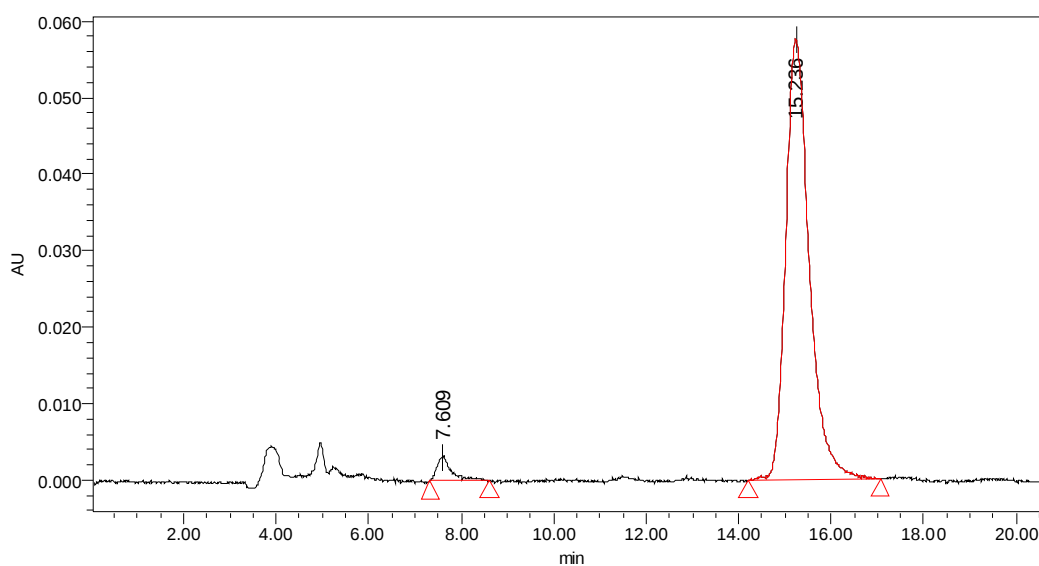
	Retention Time	Area	% Area	Height
1	9.829	897177	3.24	34350
2	23.959	26754406	96.76	467834



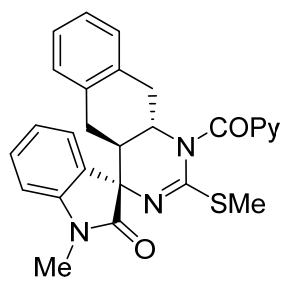
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



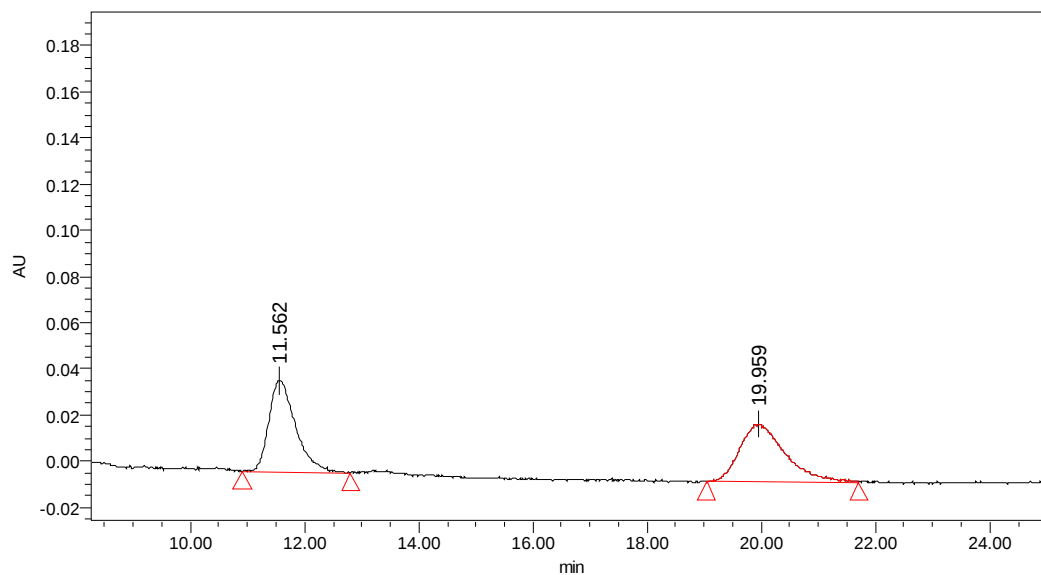
	Retention Time	Area	% Area	Height
1	7.376	2895039	46.78	151527
2	14.759	3293694	53.22	97845



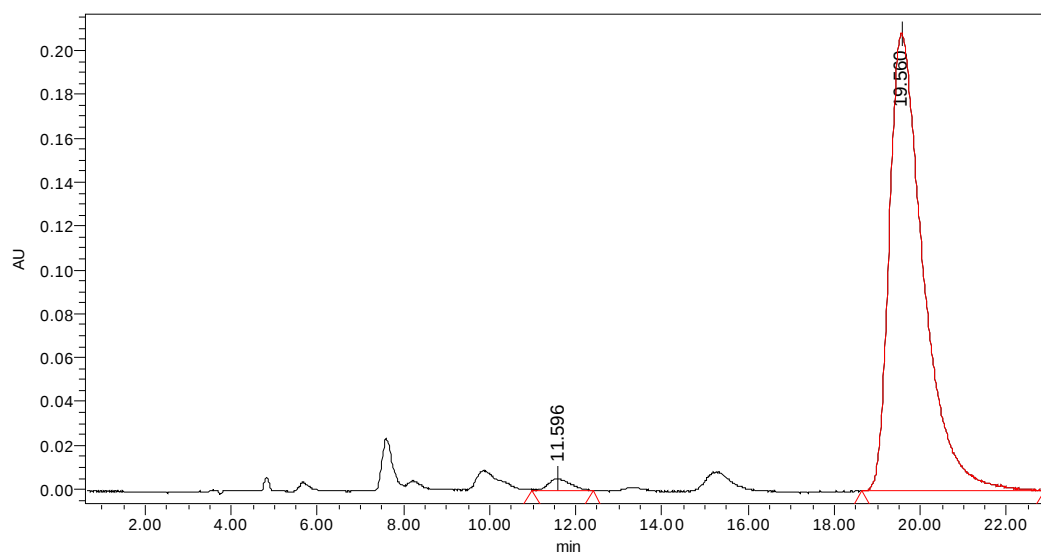
	Retention Time	Area	% Area	Height
1	7.609	66753	3.19	3123
2	15.236	2027259	96.81	57447



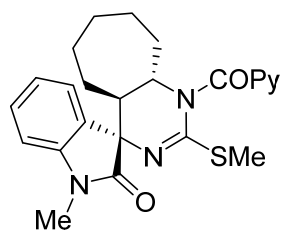
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



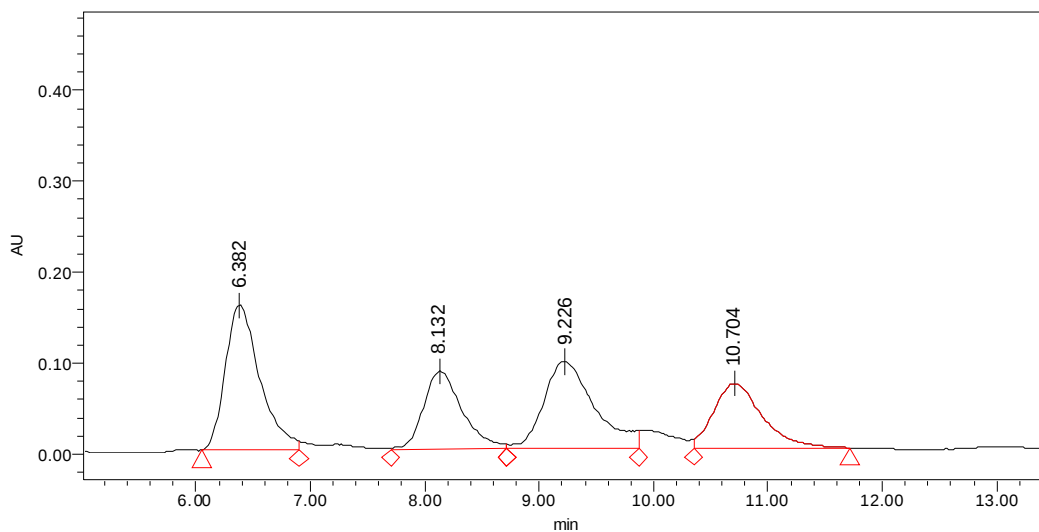
	Retention Time	Area	% Area	Height
1	11.562	1289970	48.42	39581
2	19.959	1374111	51.58	24764



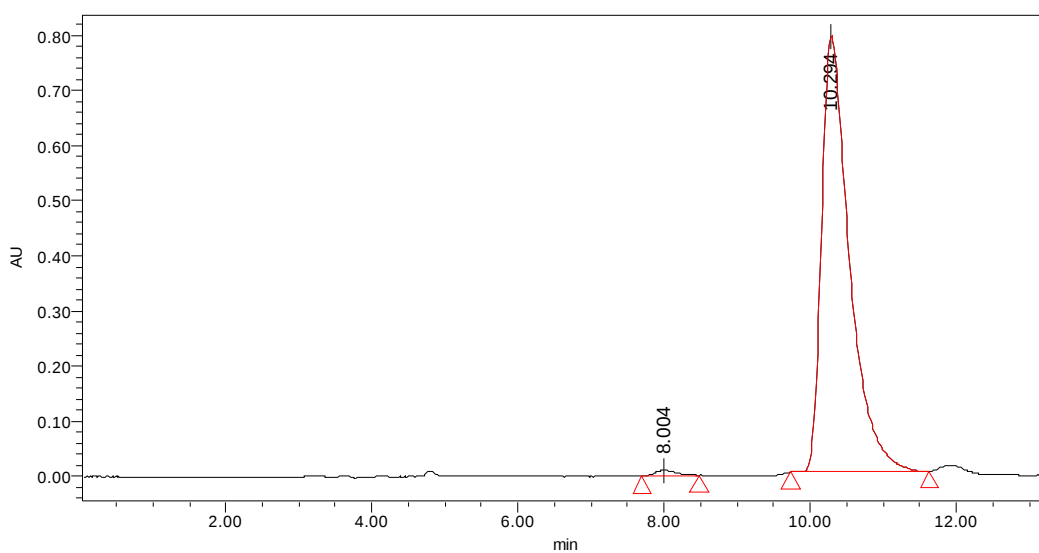
	Retention Time	Area	% Area	Height
1	11.596	174451	1.51	5149
2	19.560	11400206	98.49	208658



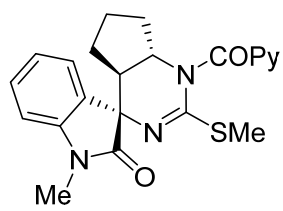
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



	Retention Time	Area	% Area	Height
1	6.382	3339552	32.07	158672
2	8.132	2013166	19.33	85622
3	9.226	2968583	28.51	95973
4	10.704	2092821	20.10	71054

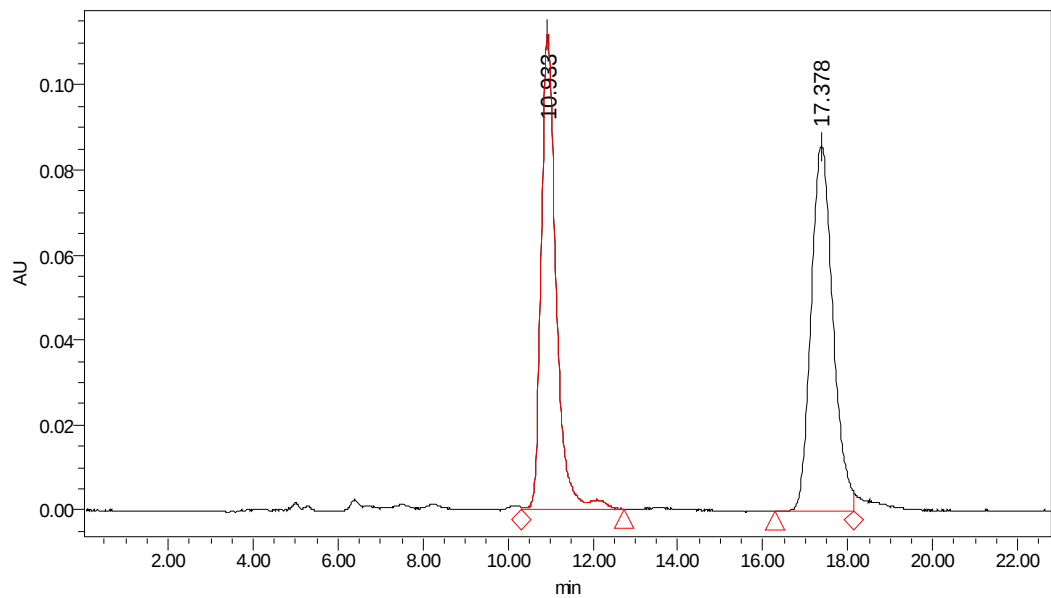


	Retention Time	Area	% Area	Height
1	8.004	204455	0.96	10029
2	10.294	21025790	99.04	790387

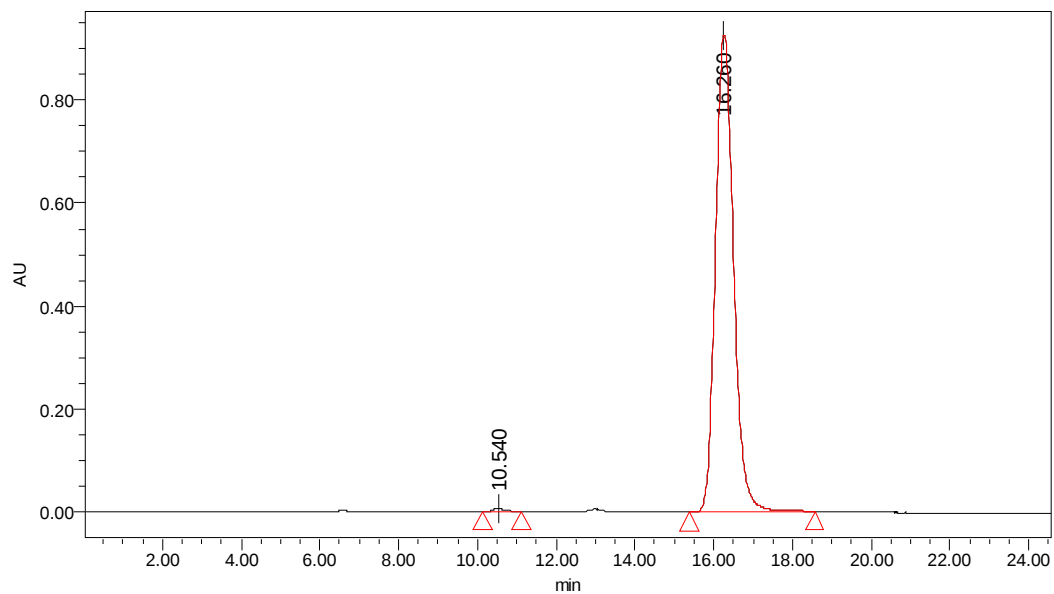


4e

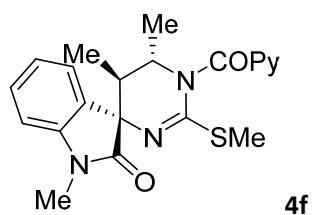
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



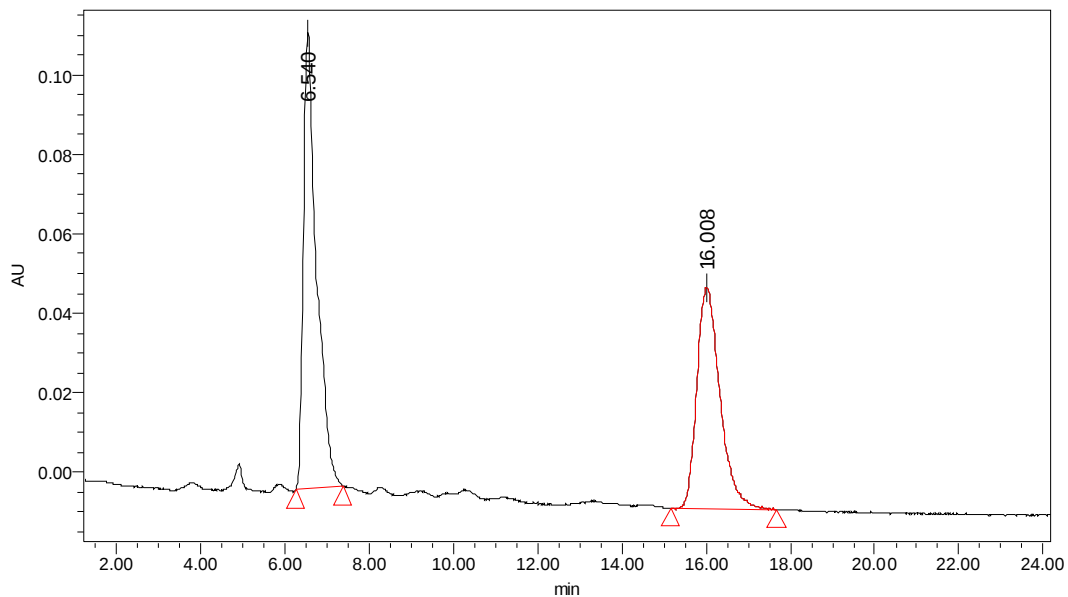
	Retention Time	Area	% Area	Height
1	10.933	2759004	47.25	111927
2	17.378	3079589	52.75	85635



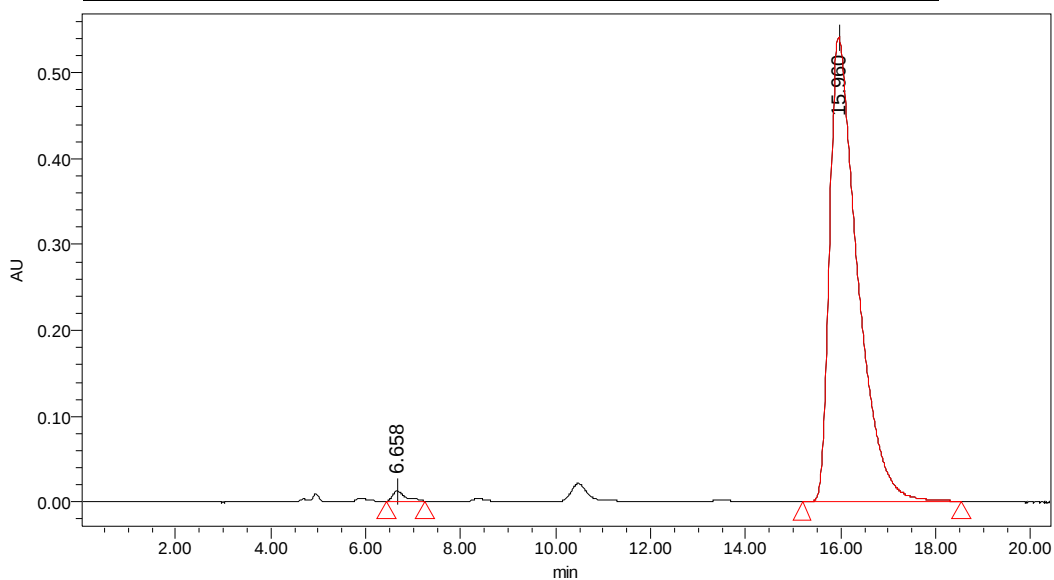
	Retention Time	Area	% Area	Height
1	10.540	134103	0.45	5810
2	16.260	29717041	99.55	927278



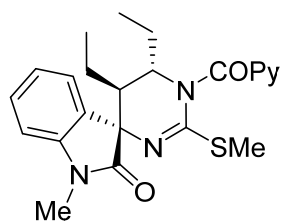
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



	Retention Time	Area	% Area	Height
1	6.540	2507446	54.10	114875
2	16.008	2127186	45.90	55685

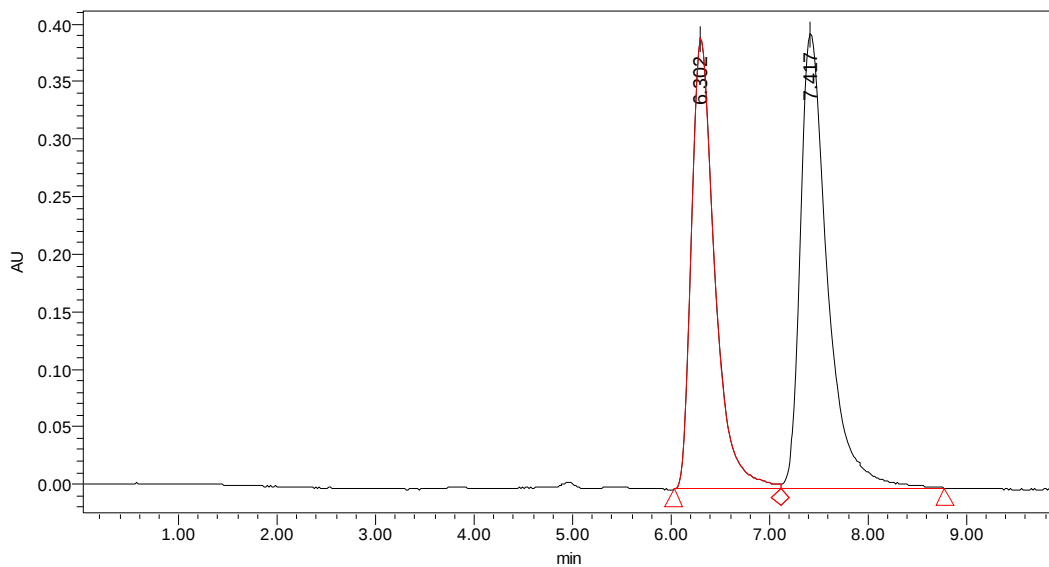


	Retention Time	Area	% Area	Height
1	6.658	226813	1.01	11879
2	15.960	22276669	98.99	541154

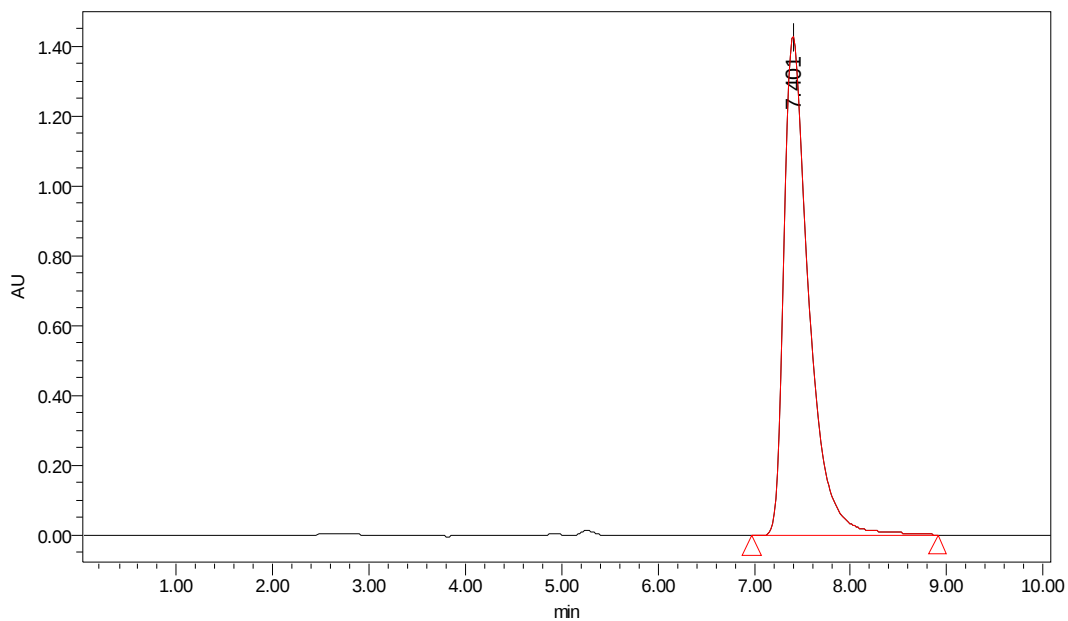


4g

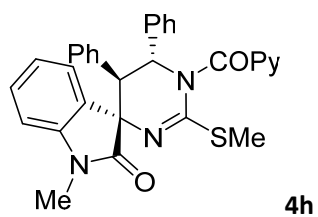
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



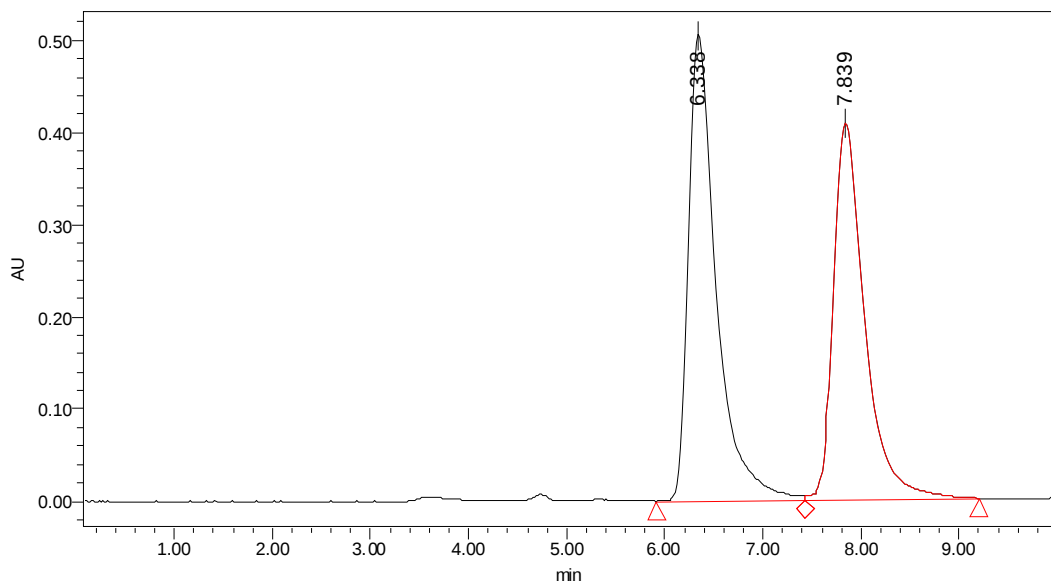
	Retention Time	Area	% Area	Height
1	6.302	6565299	46.06	391957
2	7.417	7687421	53.94	395873



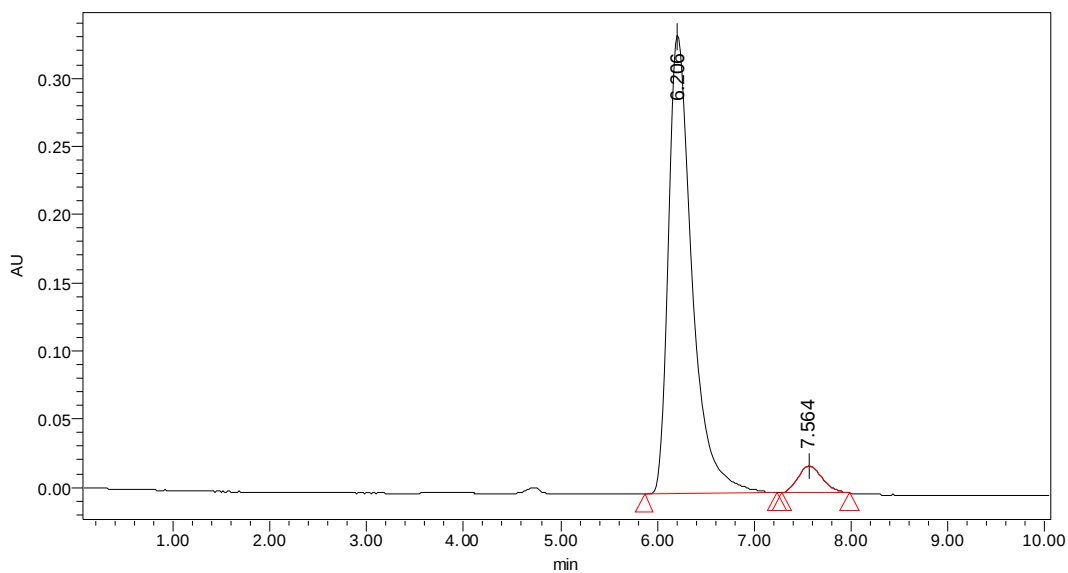
	Retention Time	Area	% Area	Height
1	7.401	25796102	100.00	1431230



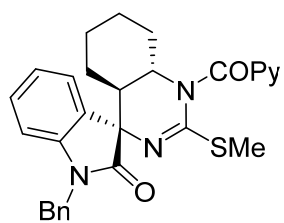
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



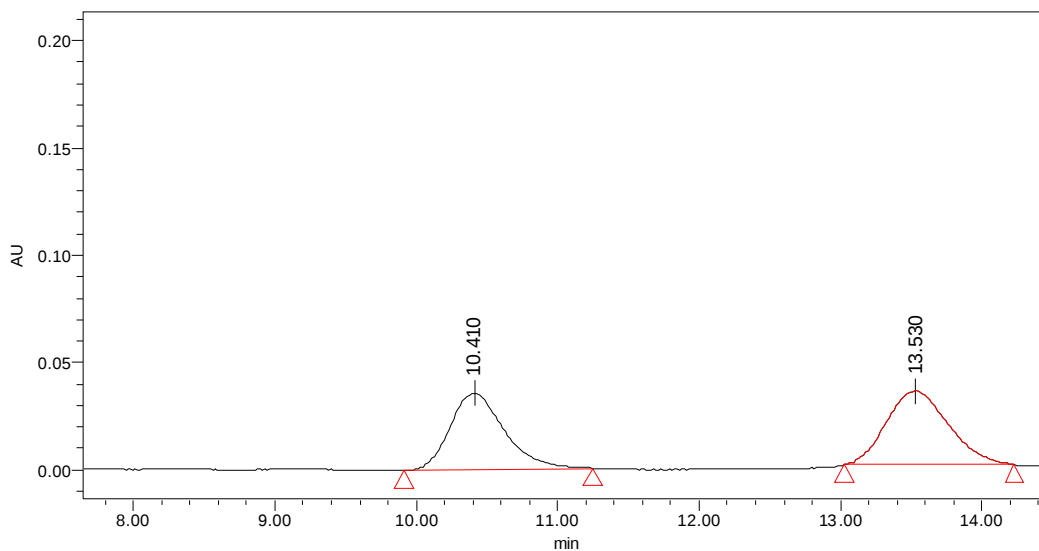
	Retention Time	Area	% Area	Height
1	6.338	10064404	52.58	505512
2	7.839	9075668	47.42	408771



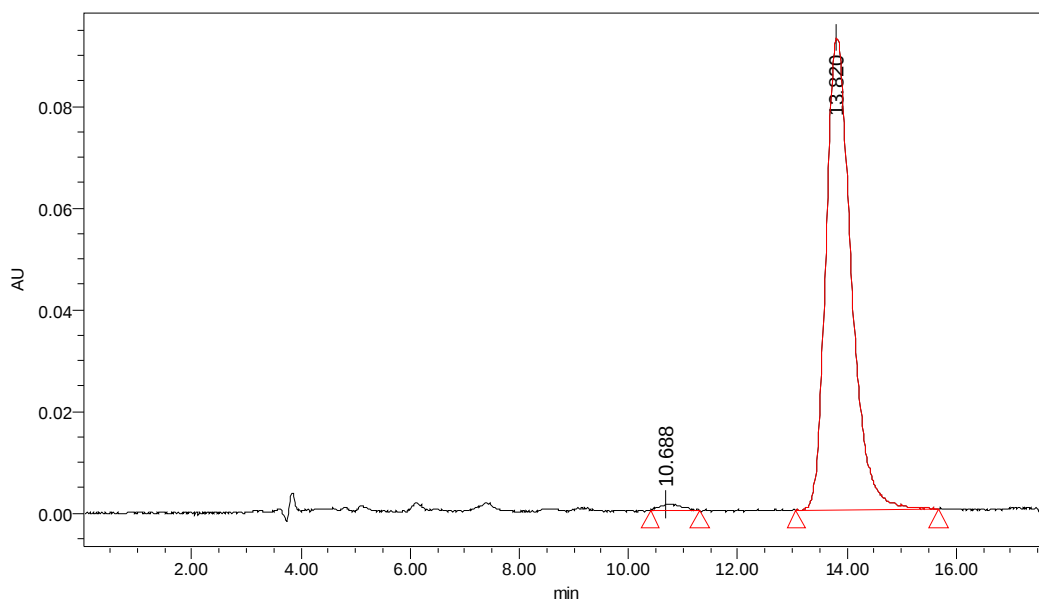
	Retention Time	Area	% Area	Height
1	6.206	5724252	94.34	336459
2	7.564	343303	5.66	19642



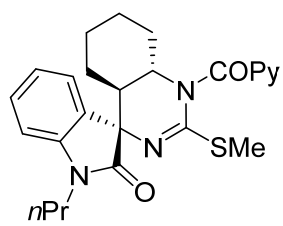
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



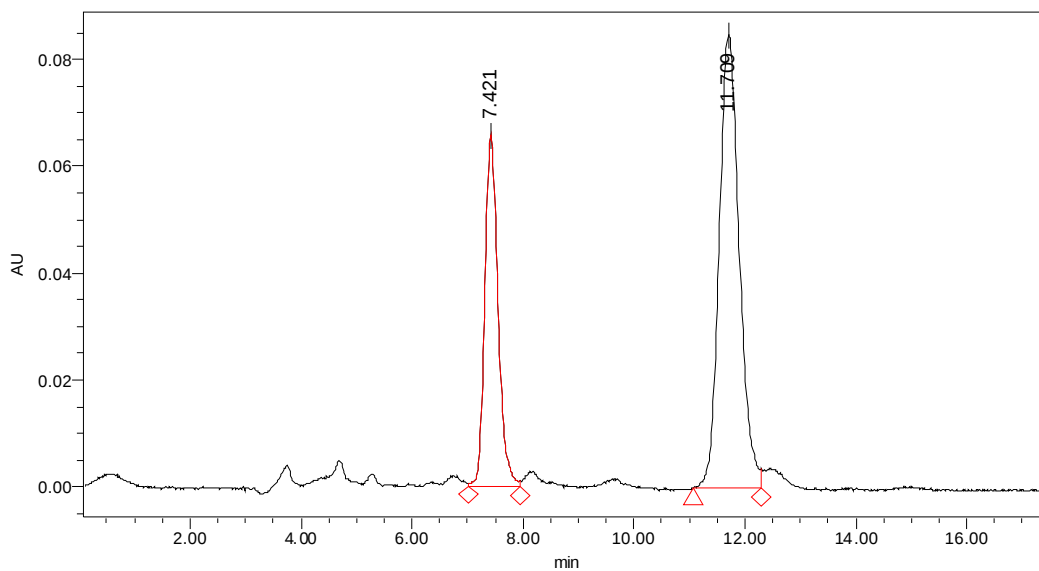
	Retention Time	Area	% Area	Height
1	10.410	951551	47.63	35727
2	13.530	1046402	52.37	34215



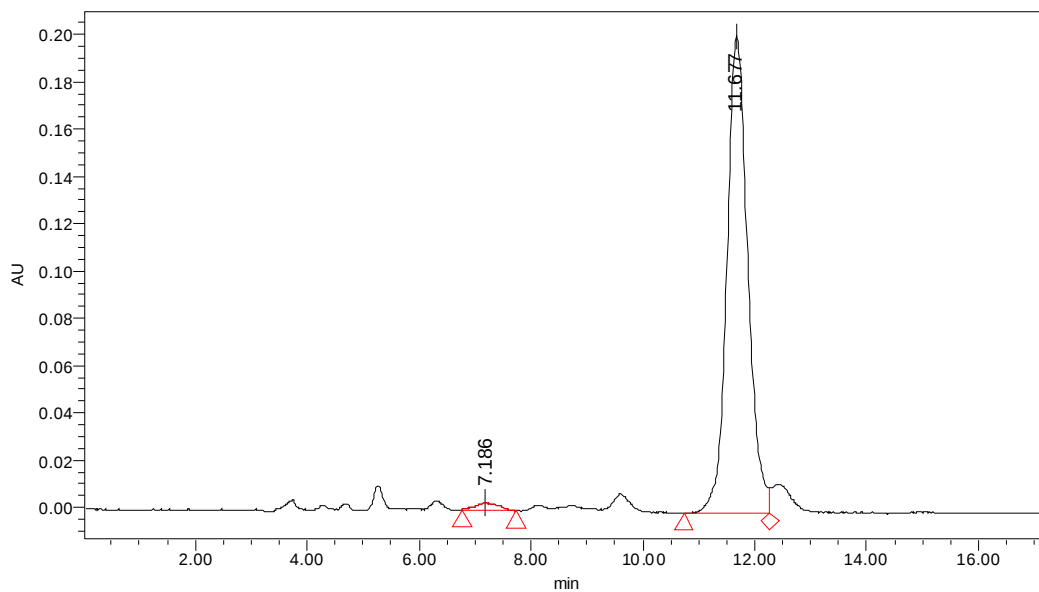
	Retention Time	Area	% Area	Height
1	10.688	32949	1.09	1138
2	13.820	2995725	98.91	92920



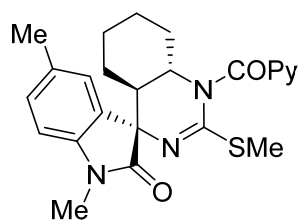
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



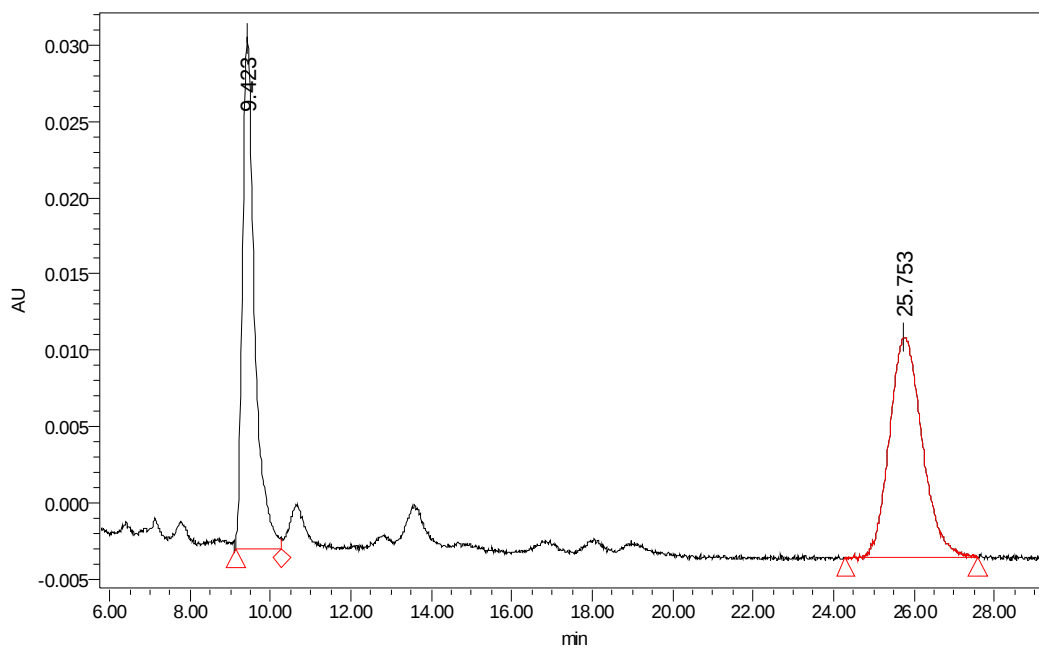
	Retention Time	Area	% Area	Height
1	7.421	1054507	32.93	64819
2	11.709	2147670	67.07	84358



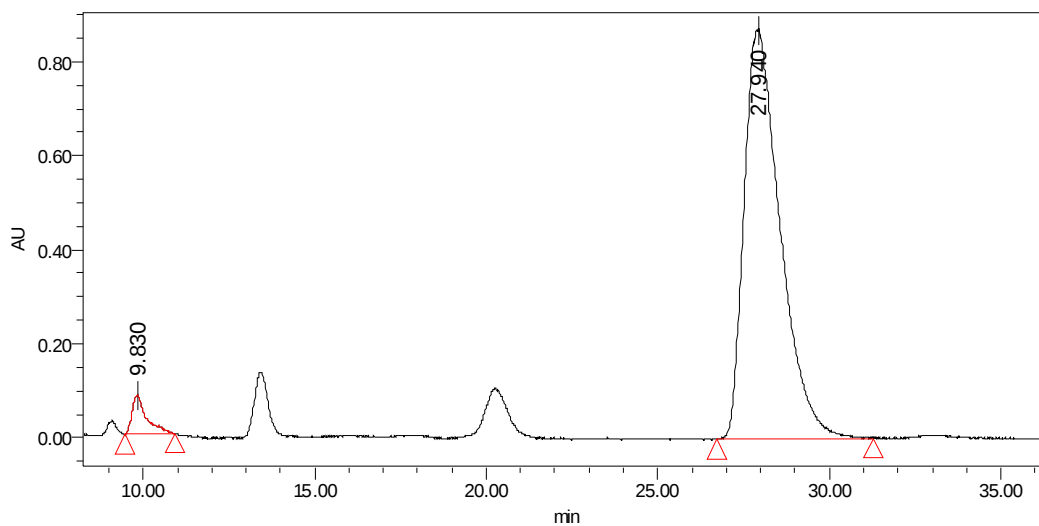
	Retention Time	Area	% Area	Height
1	7.186	84740	1.60	3179
2	11.677	5218792	98.40	201675



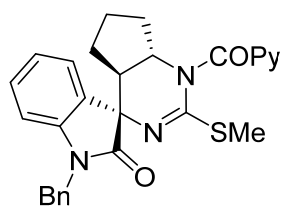
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



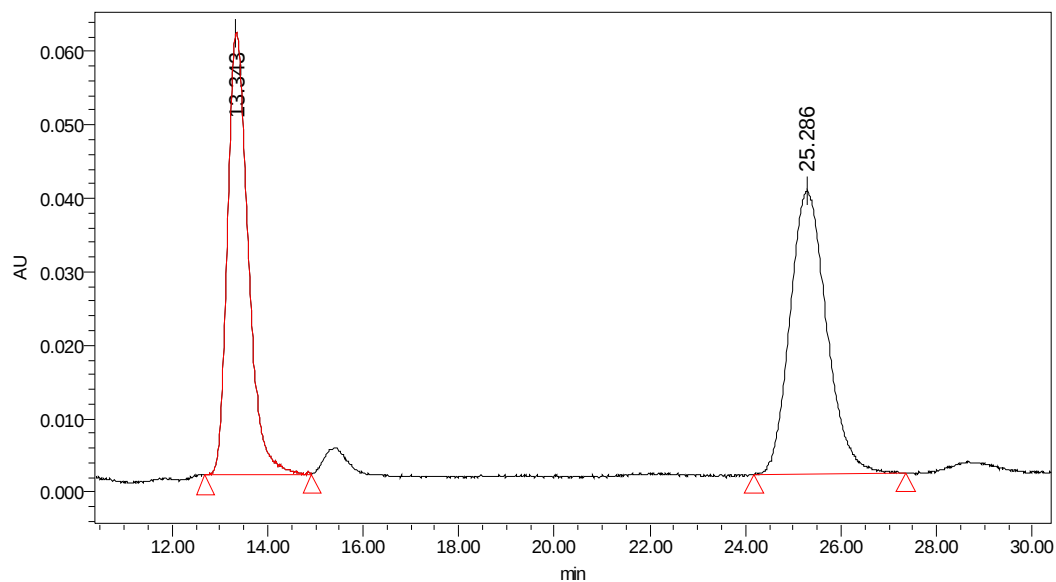
	Retention Time	Area	% Area	Height
1	9.423	774626	47.07	36188
2	25.753	871054	52.93	15471



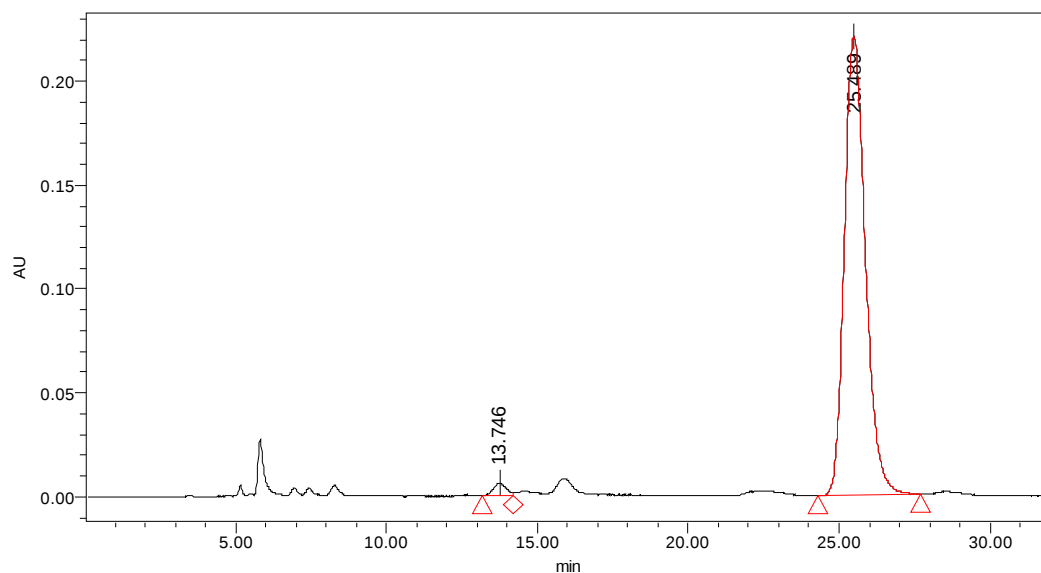
	Retention Time	Area	% Area	Height
1	9.830	2428689	3.67	82118
2	27.940	63662235	96.33	870223



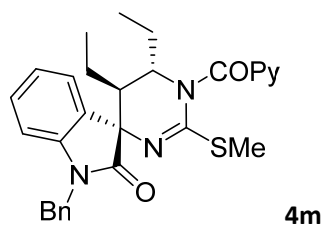
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



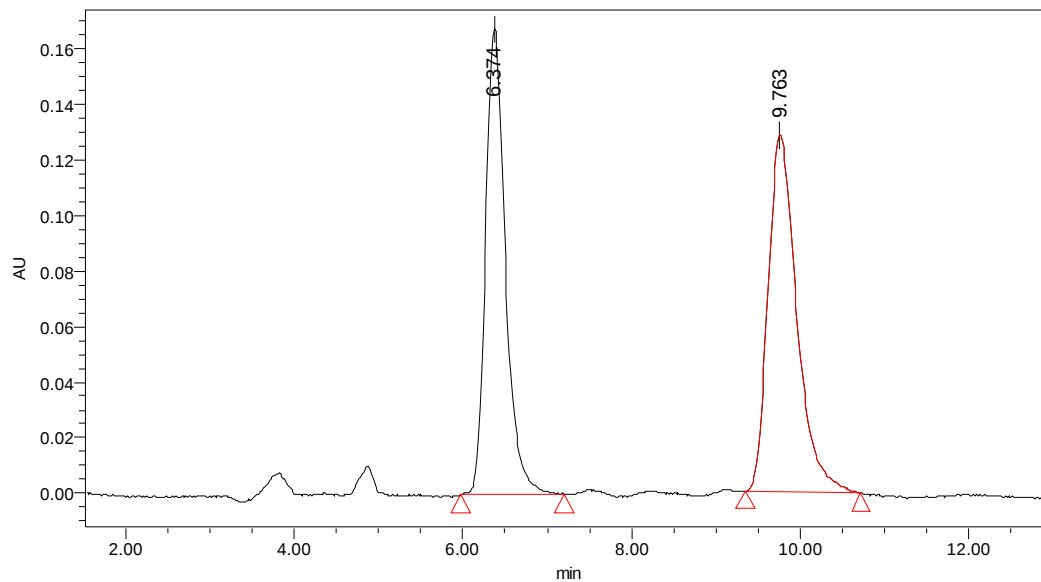
	Retention Time	Area	% Area	Height
1	13.343	1806727	46.99	60250
2	25.286	2038009	53.01	38433



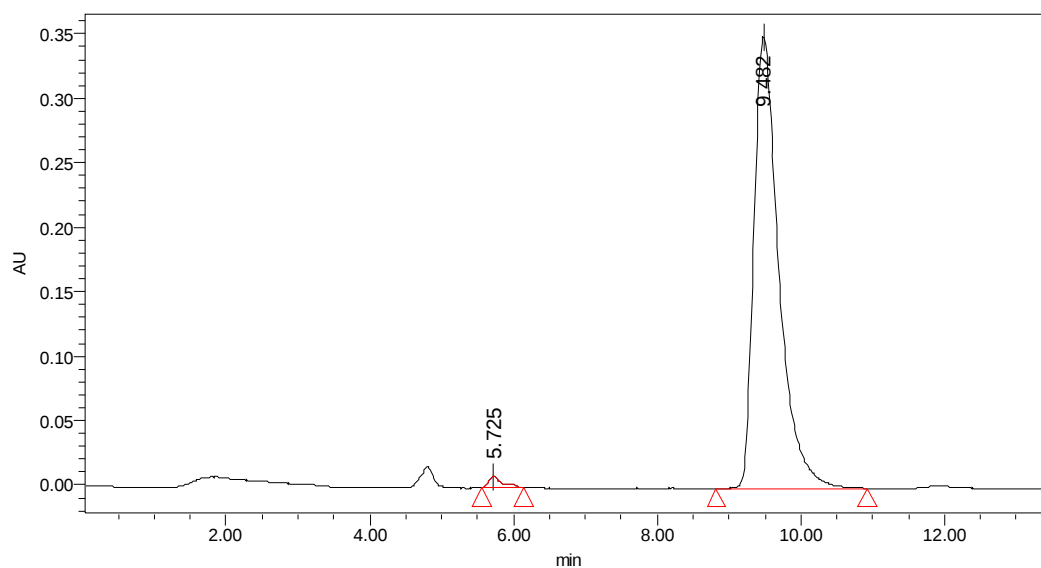
	Retention Time	Area	% Area	Height
1	13.746	180710	1.67	6002
2	25.489	10648040	98.33	221086



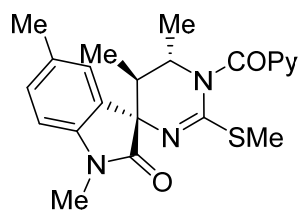
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



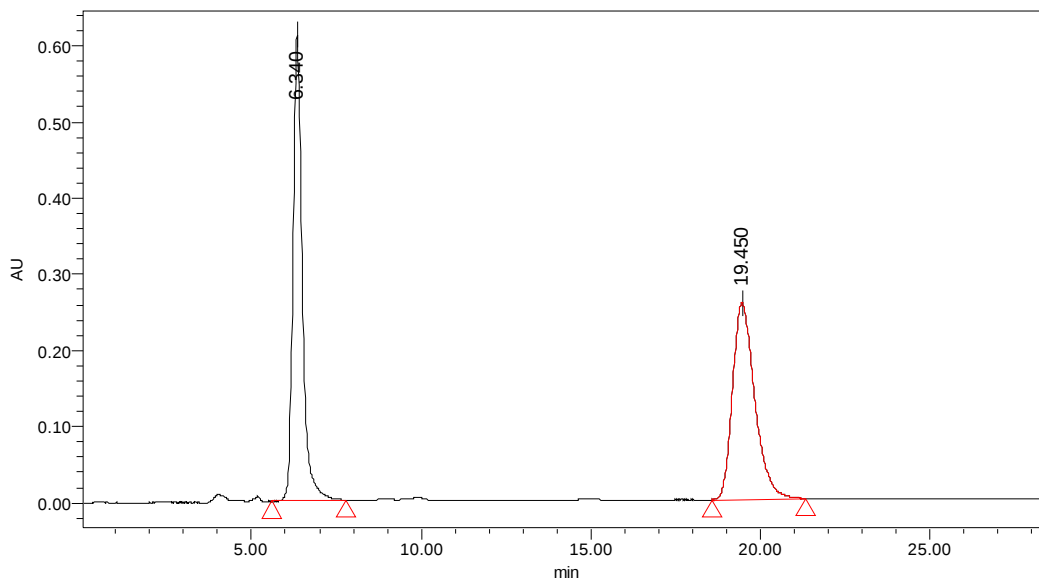
	Retention Time	Area	% Area	Height
1	6.374	2743917	47.40	168159
2	9.763	3045182	52.60	128369



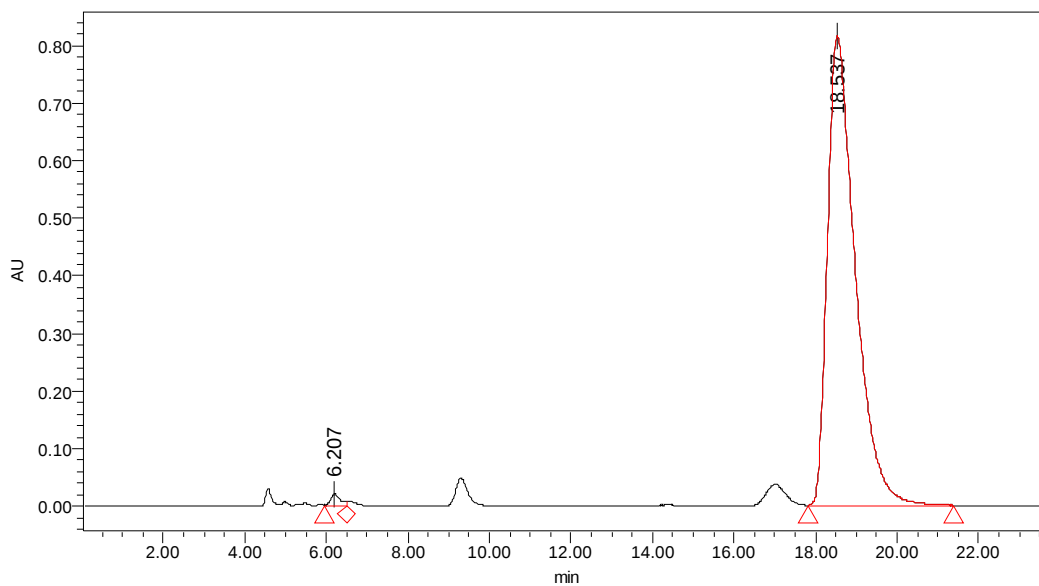
	Retention Time	Area	% Area	Height
1	5.725	118659	1.38	8704
2	9.482	8489299	98.62	351045



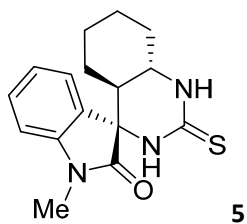
HPLC using an IA-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



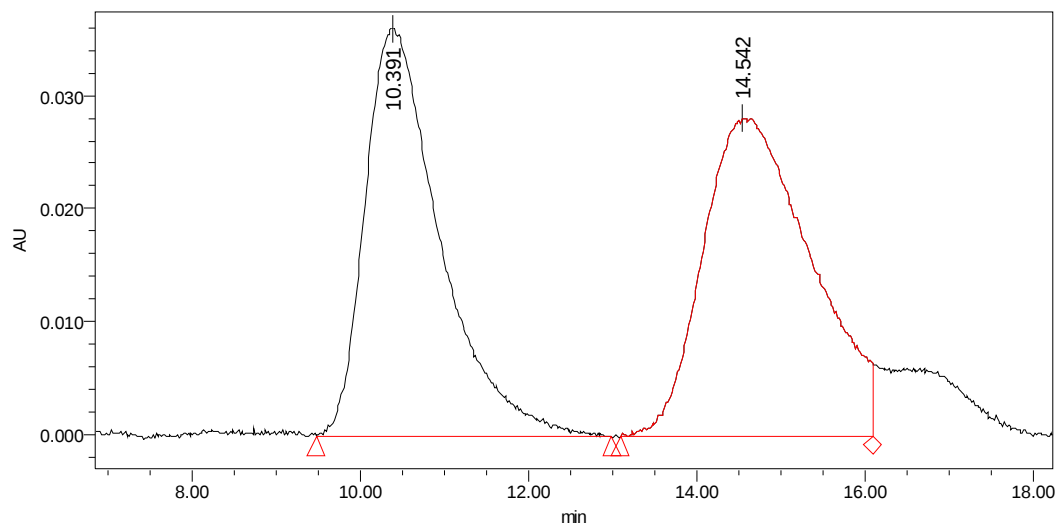
	Retention Time	Area	% Area	Height
1	6.340	11580265	49.64	612134
2	19.450	11747169	50.36	257925



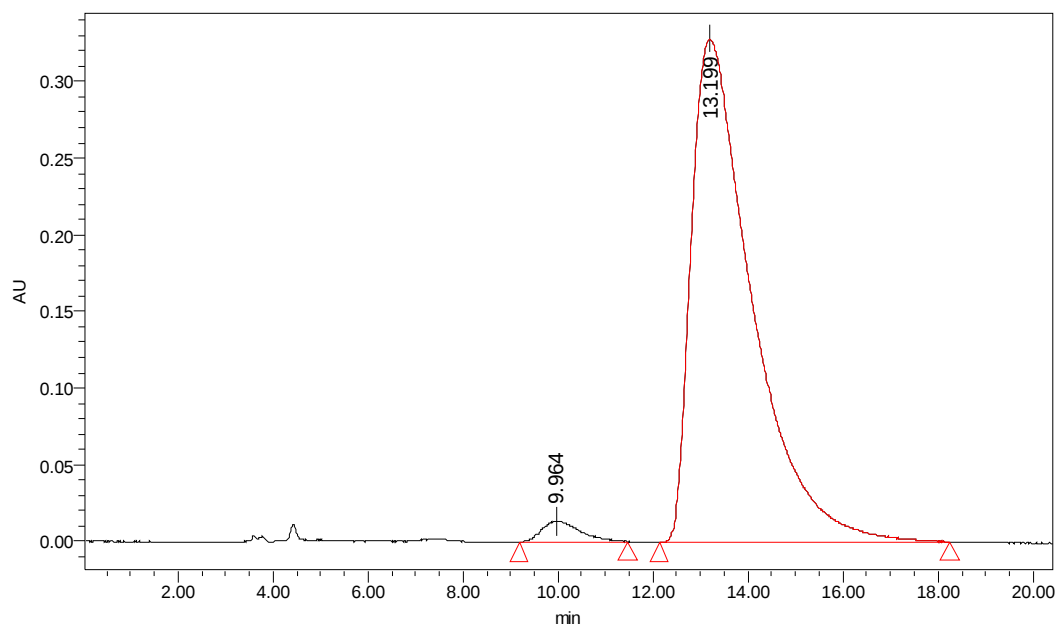
	Retention Time	Area	% Area	Height
1	6.207	300897	0.78	19133
2	18.537	38395449	99.22	815643



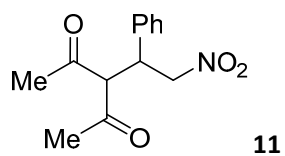
HPLC using an OD-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



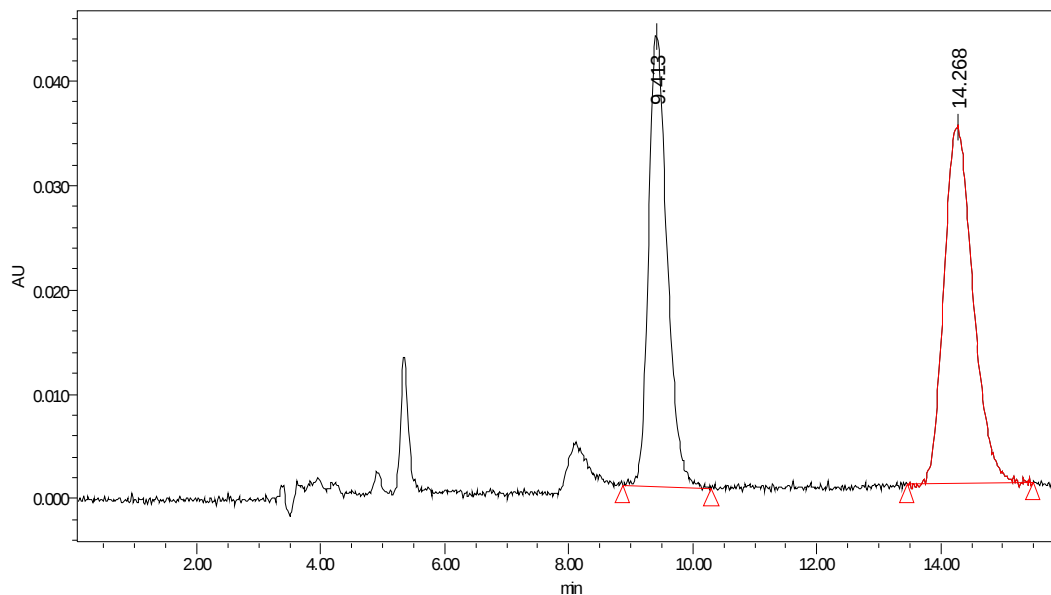
	Retention Time	Area	% Area	Height
1	10.391	2245073	47.14	36227
2	14.542	2517068	52.86	28165



	Retention Time	Area	% Area	Height
1	9.964	783156	2.62	13816
2	13.199	29132841	97.38	328564

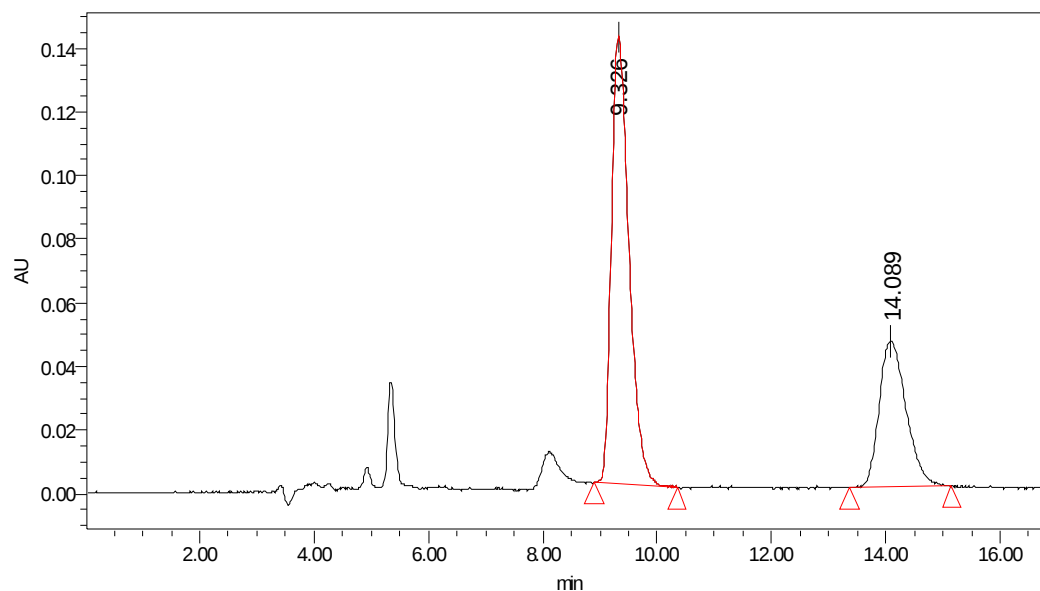


HPLC using an OD-H (*n*-Hexane/*i*-PrOH=60/40, flow rate 1.0 mL/min)



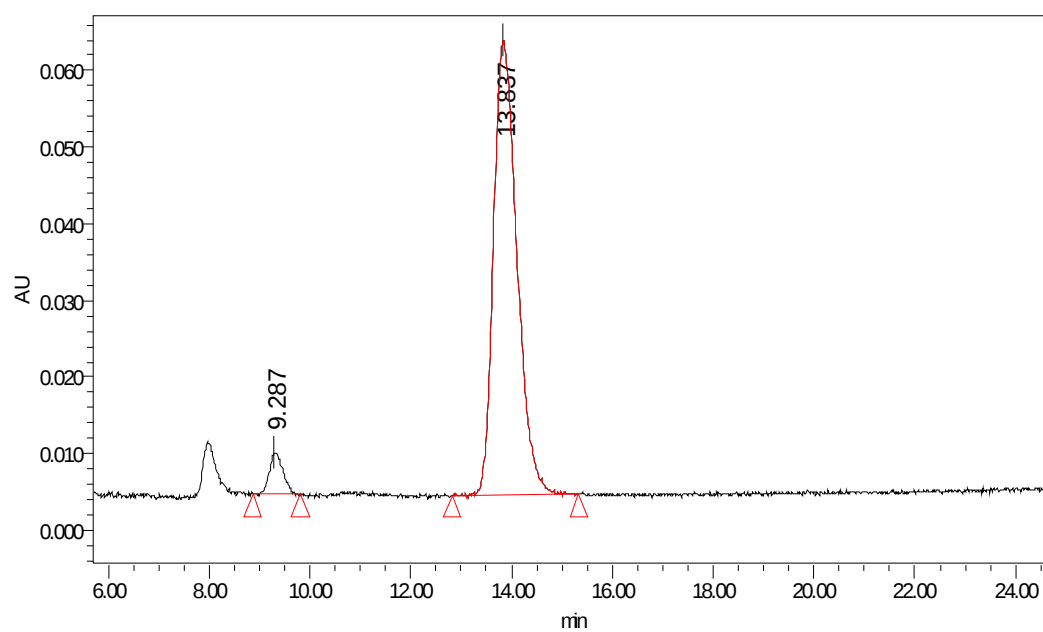
	Retention Time	Area	% Area	Height
1	9.413	900917	44.57	43214
2	14.268	1120302	55.43	34255

From **8a**:



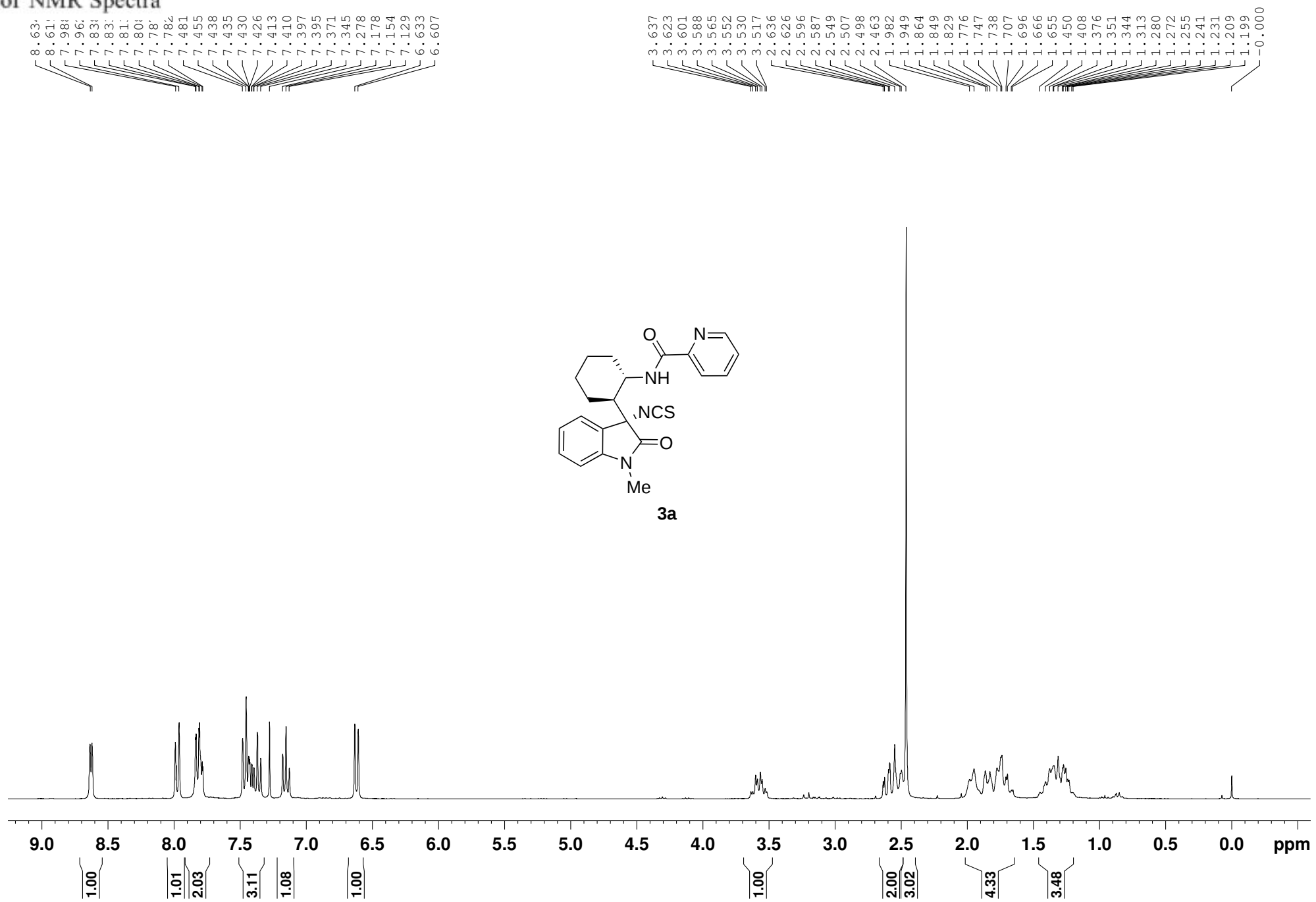
	Retention Time	Area	% Area	Height
1	9.326	3016265	66.63	141084
2	14.089	1510635	33.37	45866

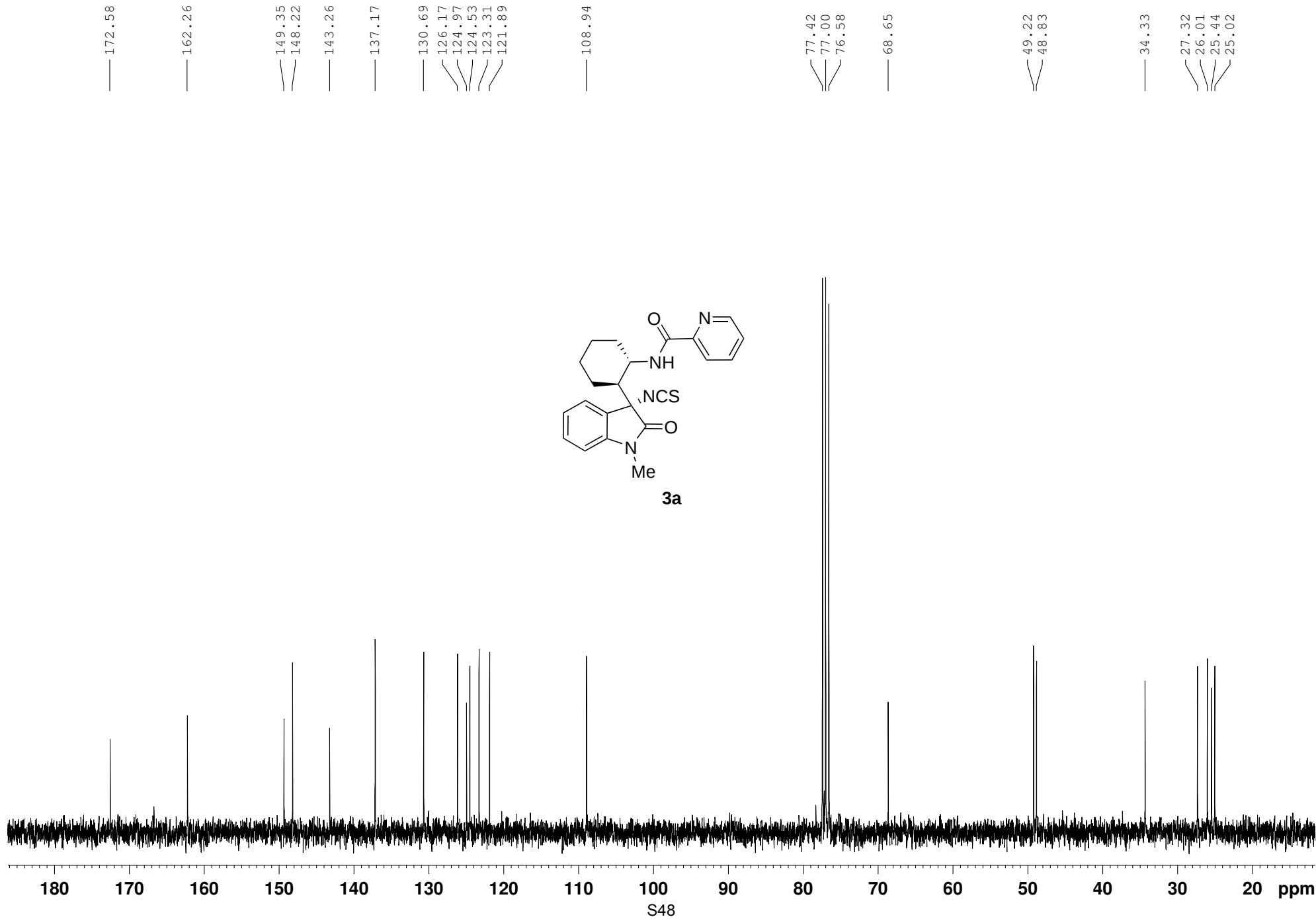
From **8b**:

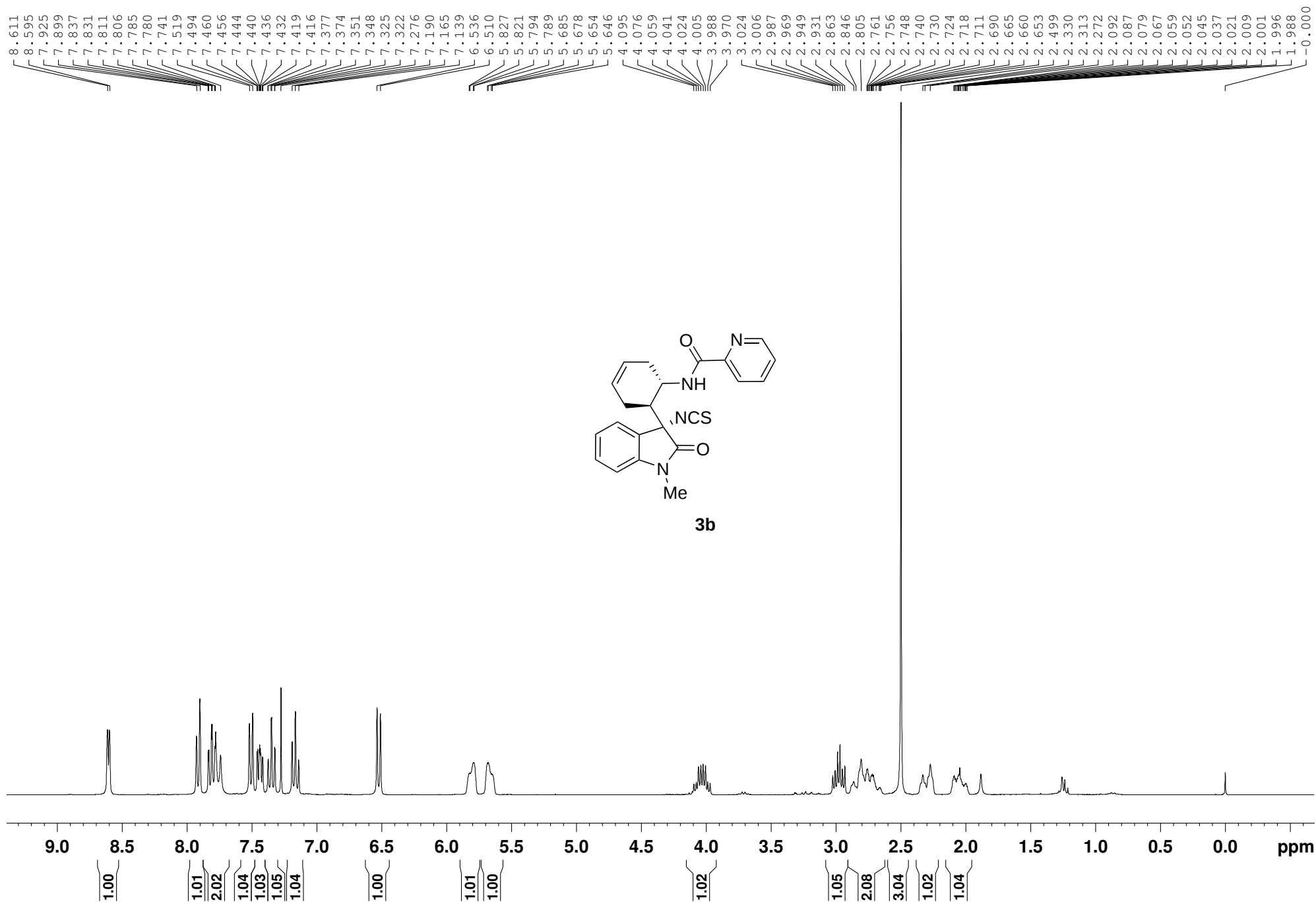


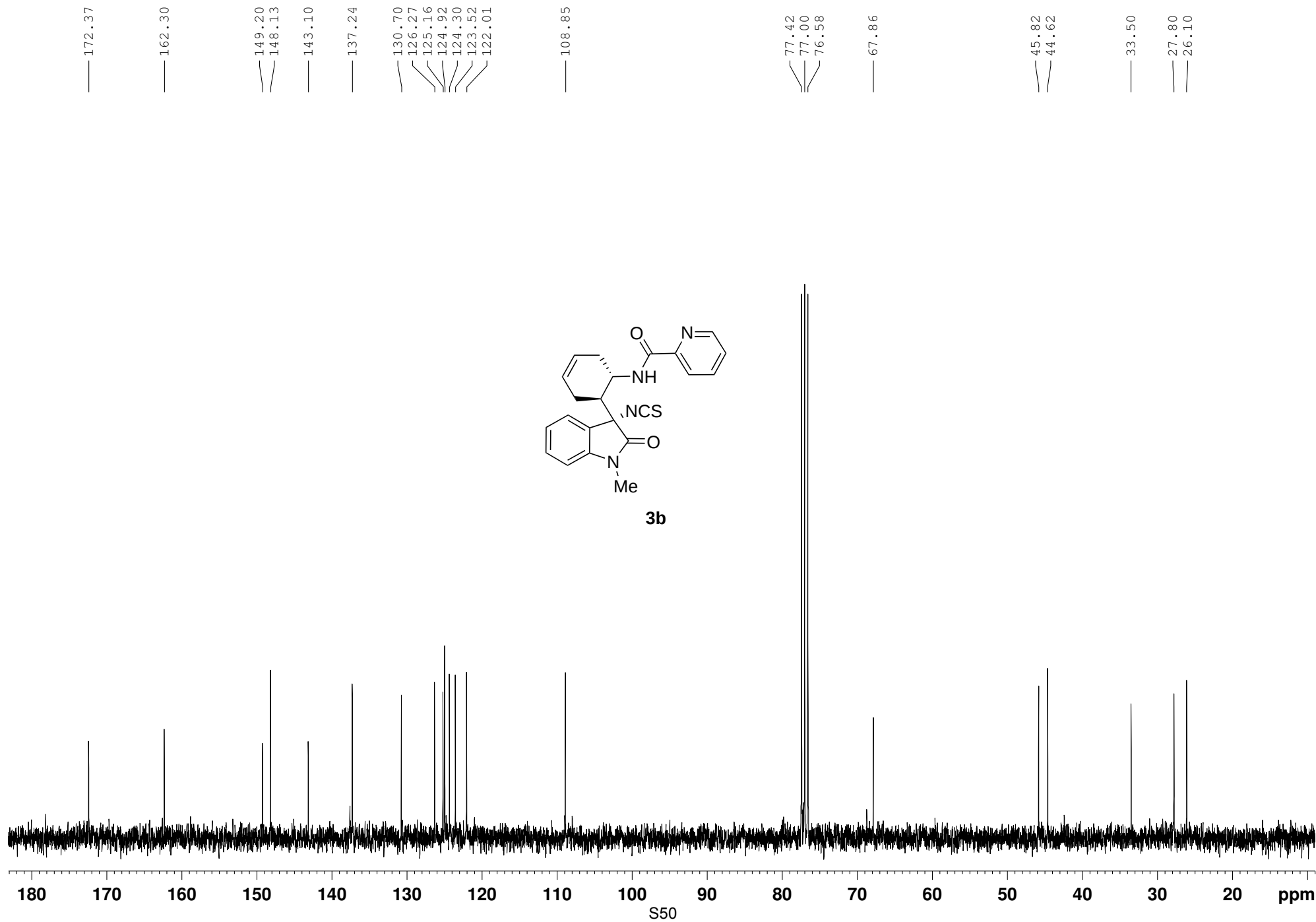
	Retention Time	Area	% Area	Height
1	9.287	104791	5.19	5453
2	13.837	1913157	94.81	59286

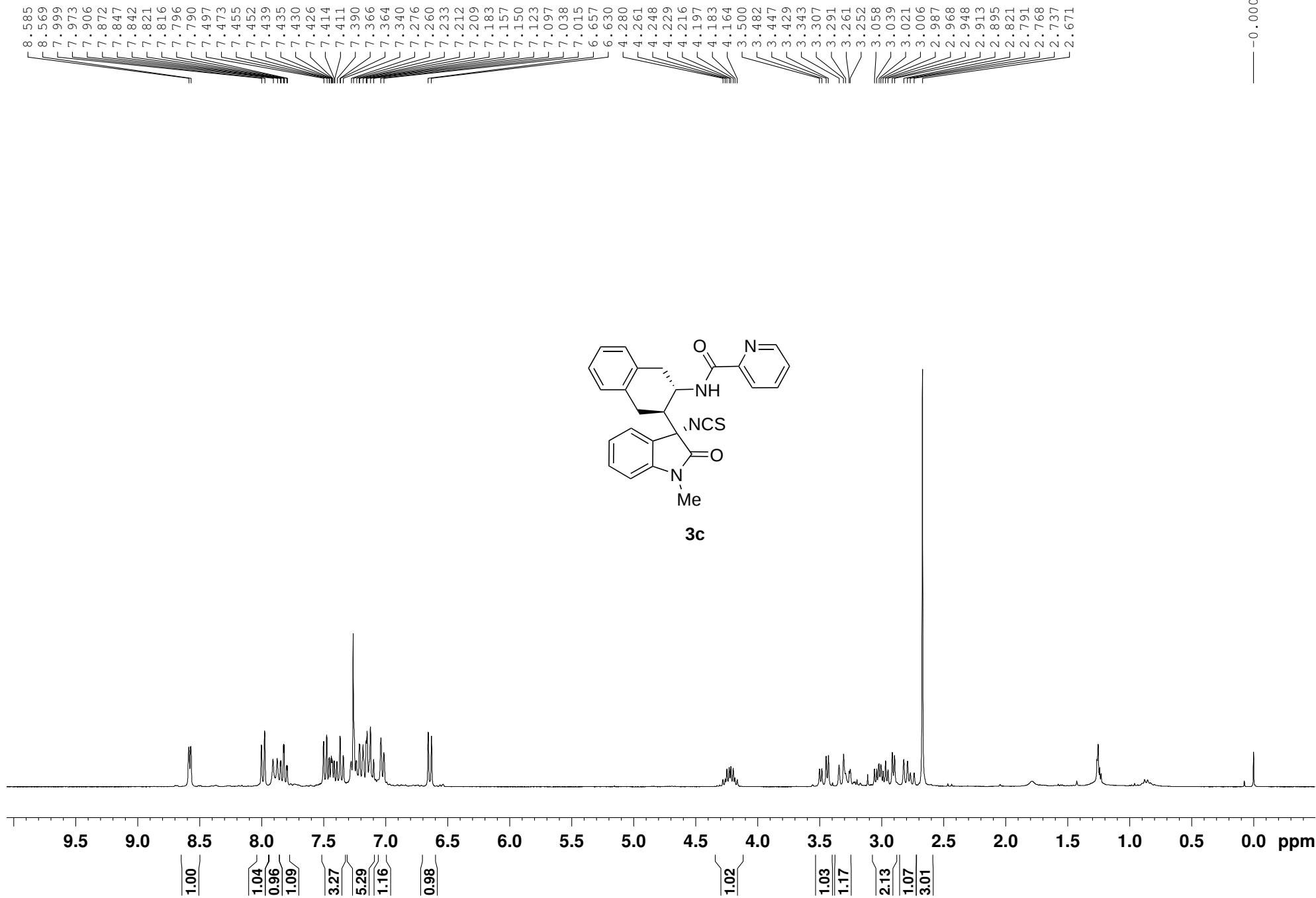
Copies of NMR Spectra



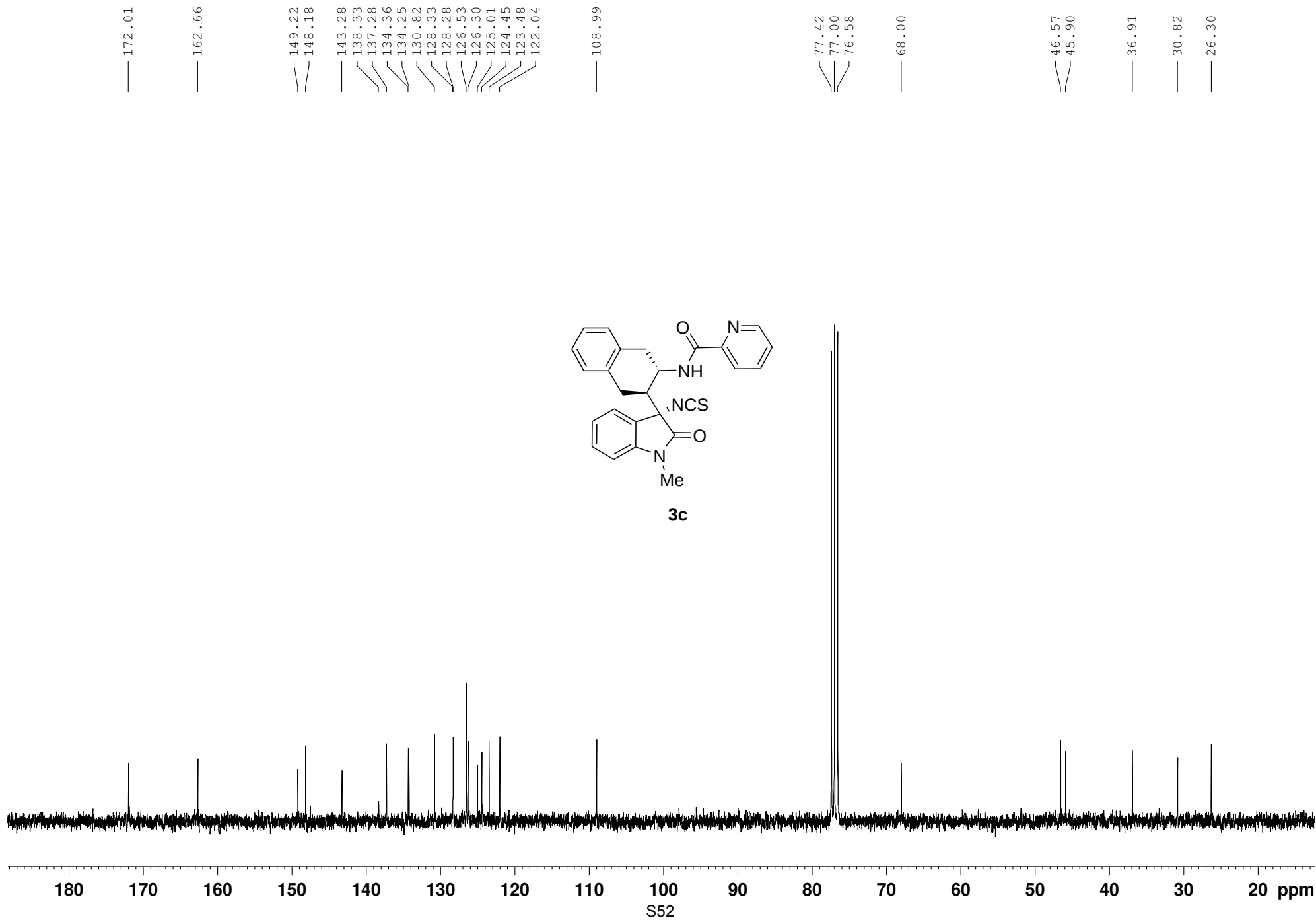






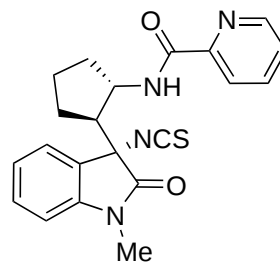


— 0.000

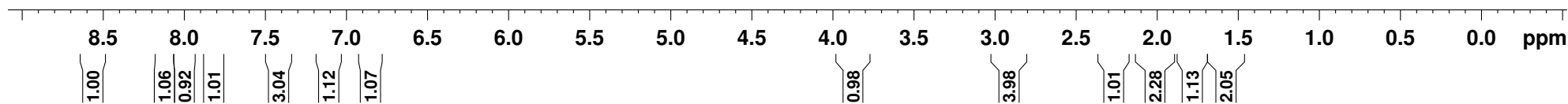


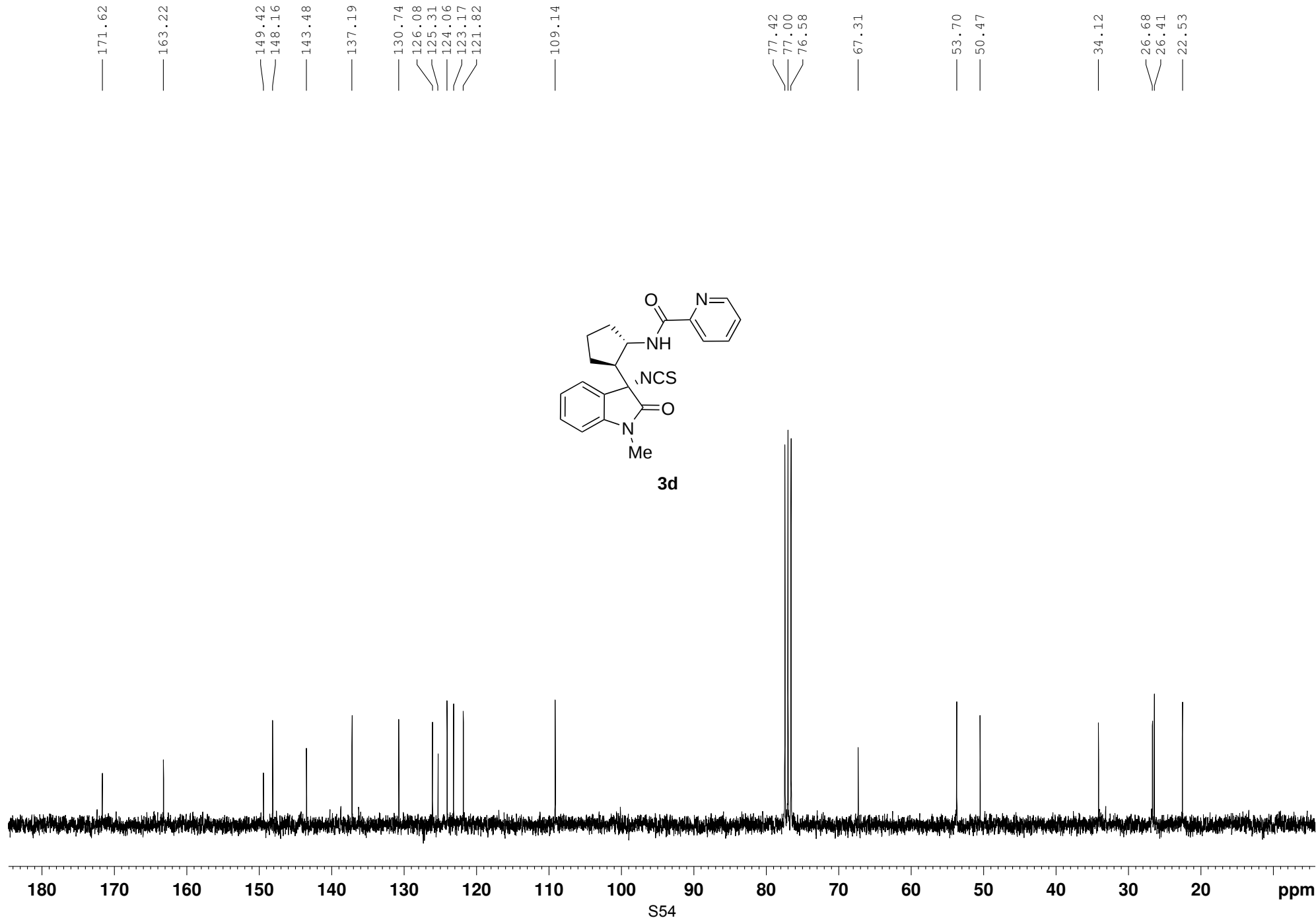
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8.017
7.848
7.843
7.822
7.817
7.797
7.791
7.461
7.436
7.426
7.423
7.419
7.413
7.409
7.404
7.401
7.378
7.375
7.275
7.137
7.112
7.087
6.878
6.853

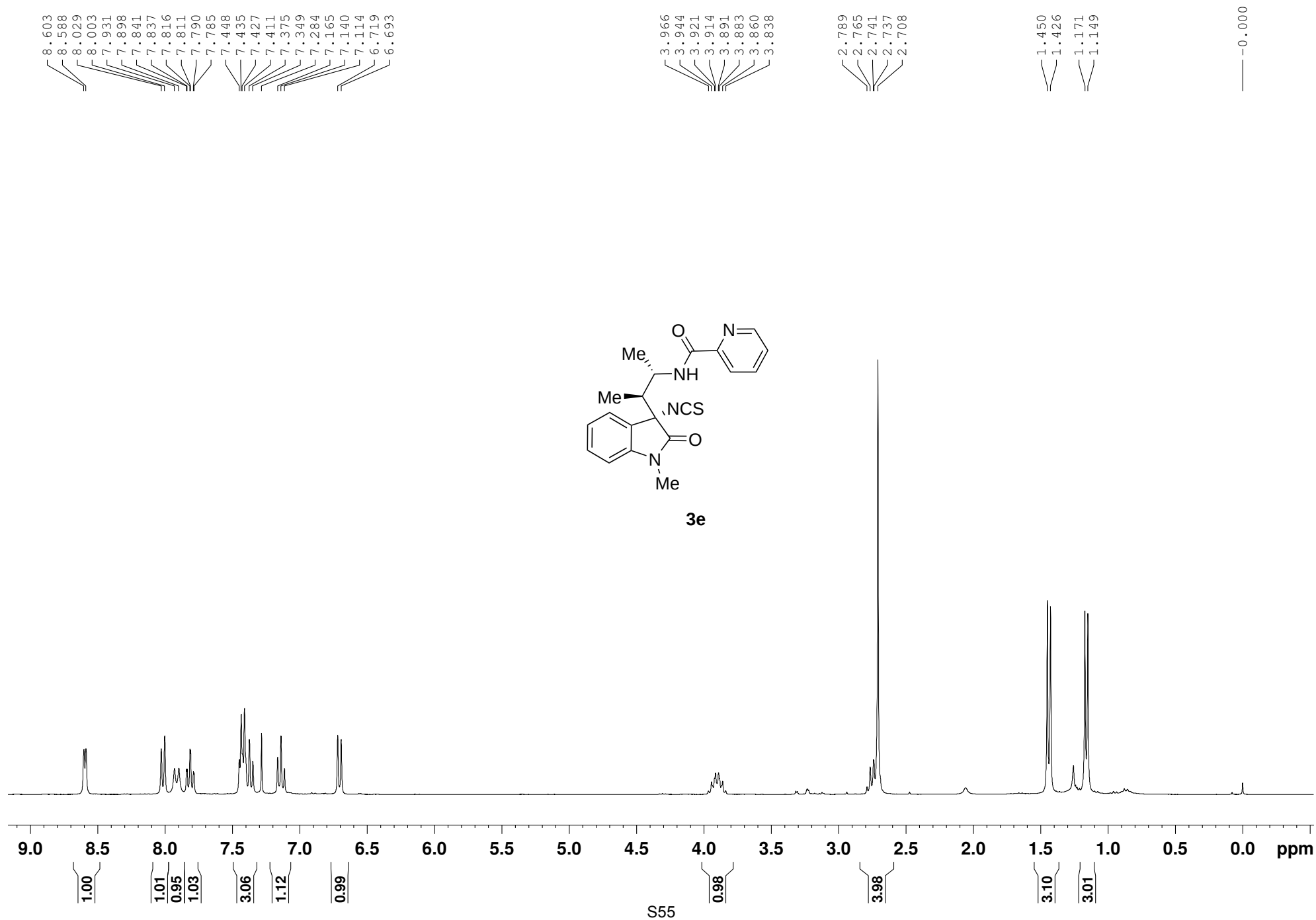
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3.907
3.878
3.849
3.823
2.947
2.929
2.918
2.888
2.859
2.313
2.287
2.269
2.242
2.224
2.196
2.092
2.065
2.039
2.013
1.996
1.990
1.969
1.948
1.850
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1.806
1.799
1.781
1.765
1.757
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1.732
1.698
1.672
1.653
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1.516
1.490
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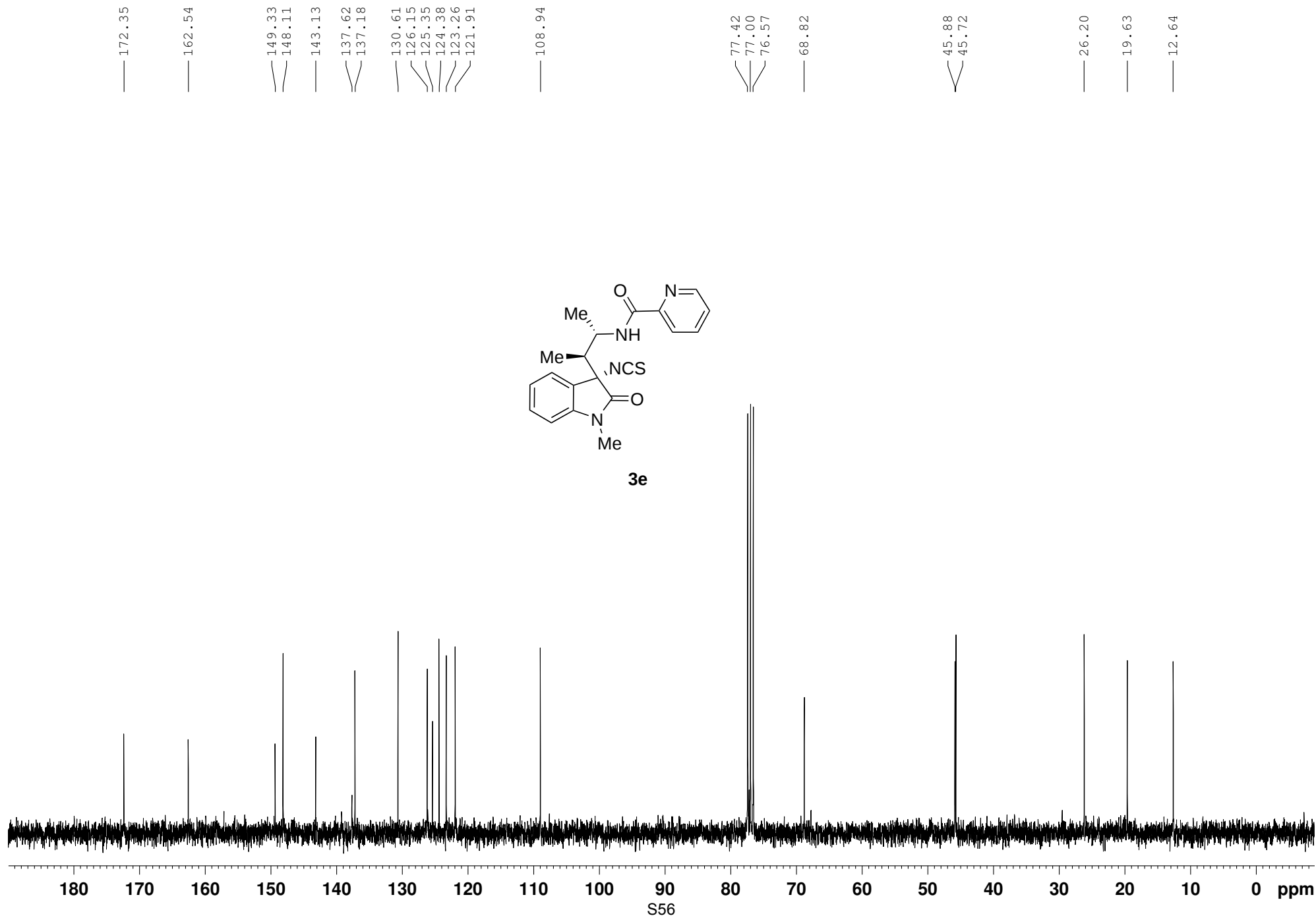


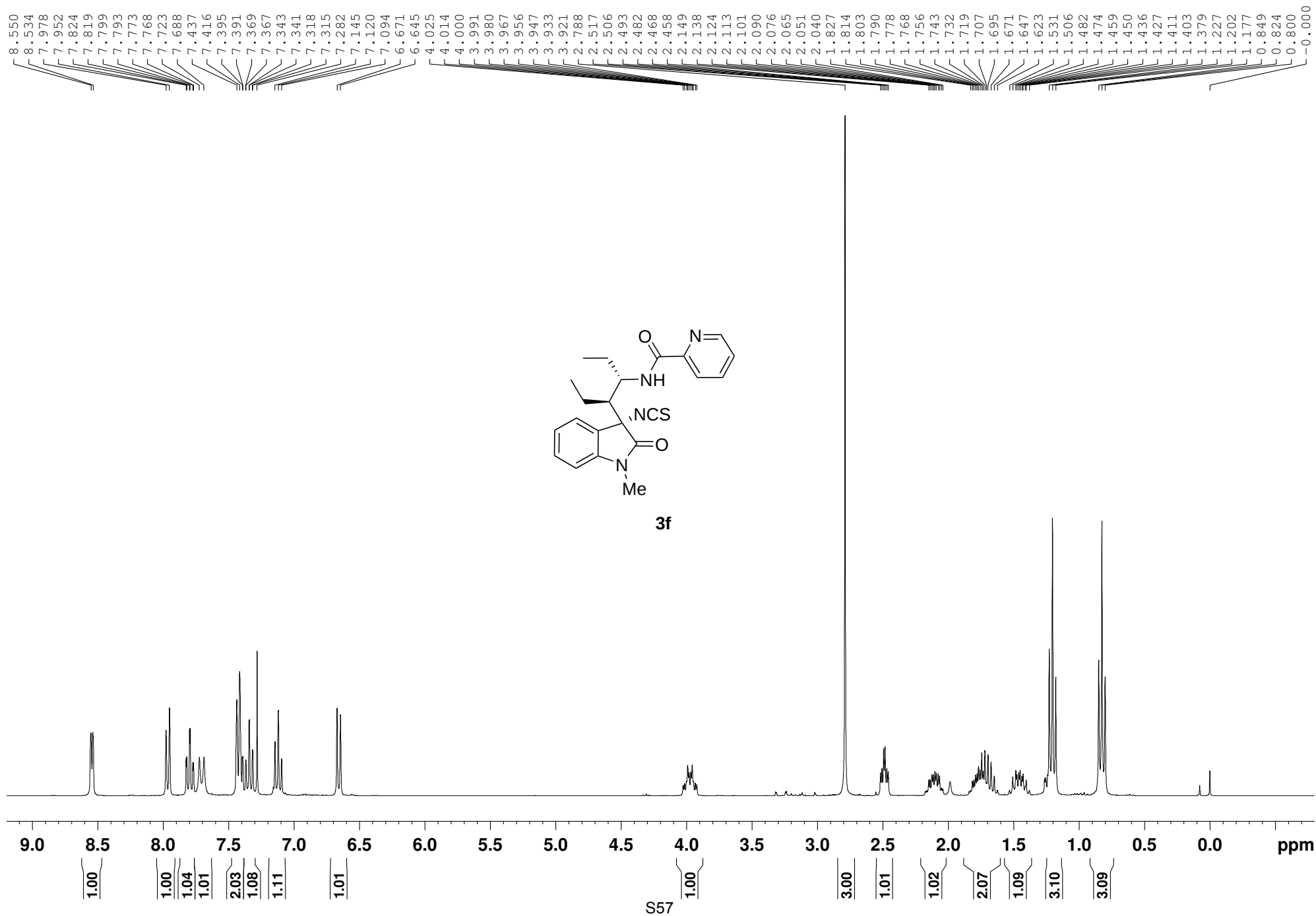
3d

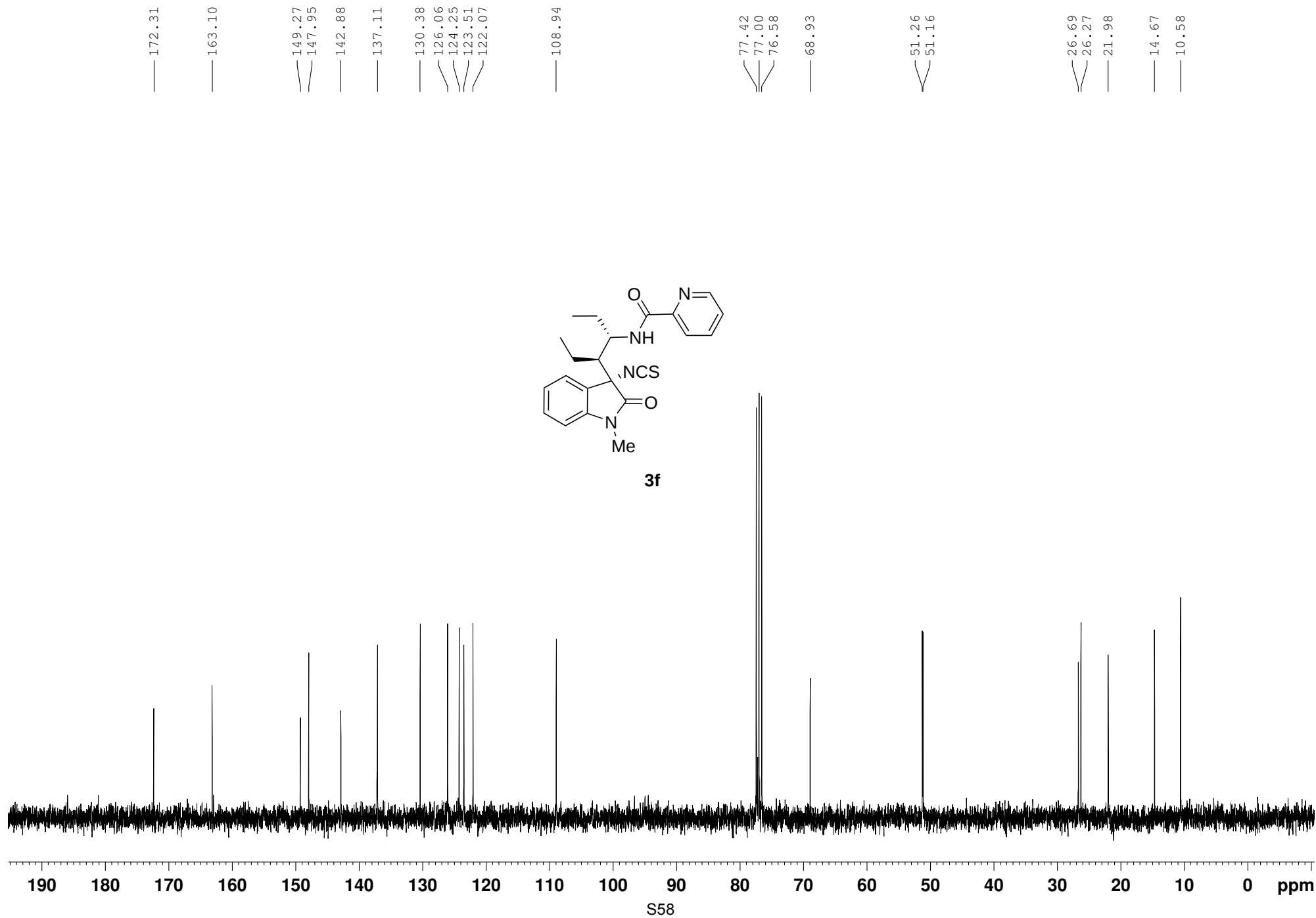


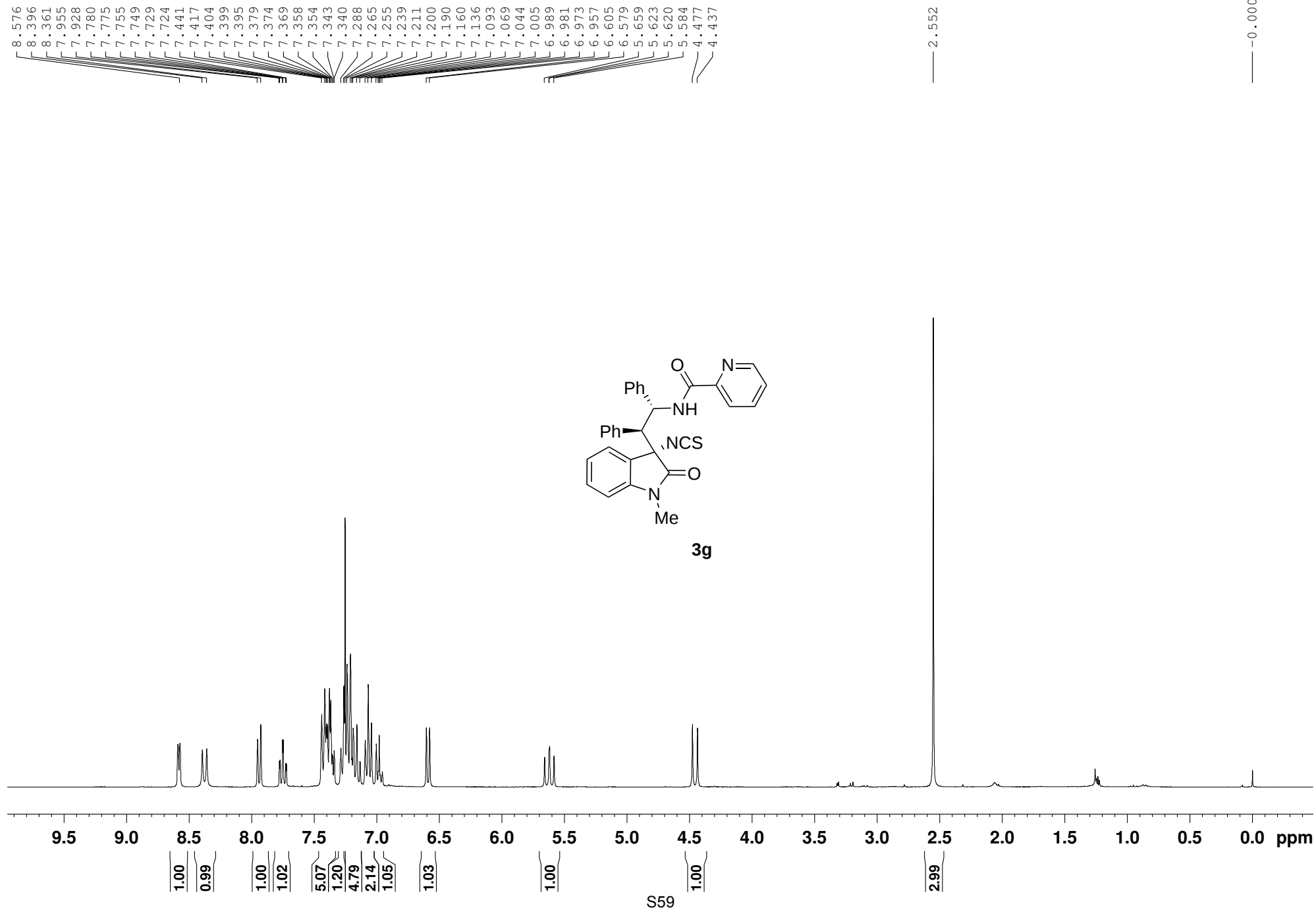


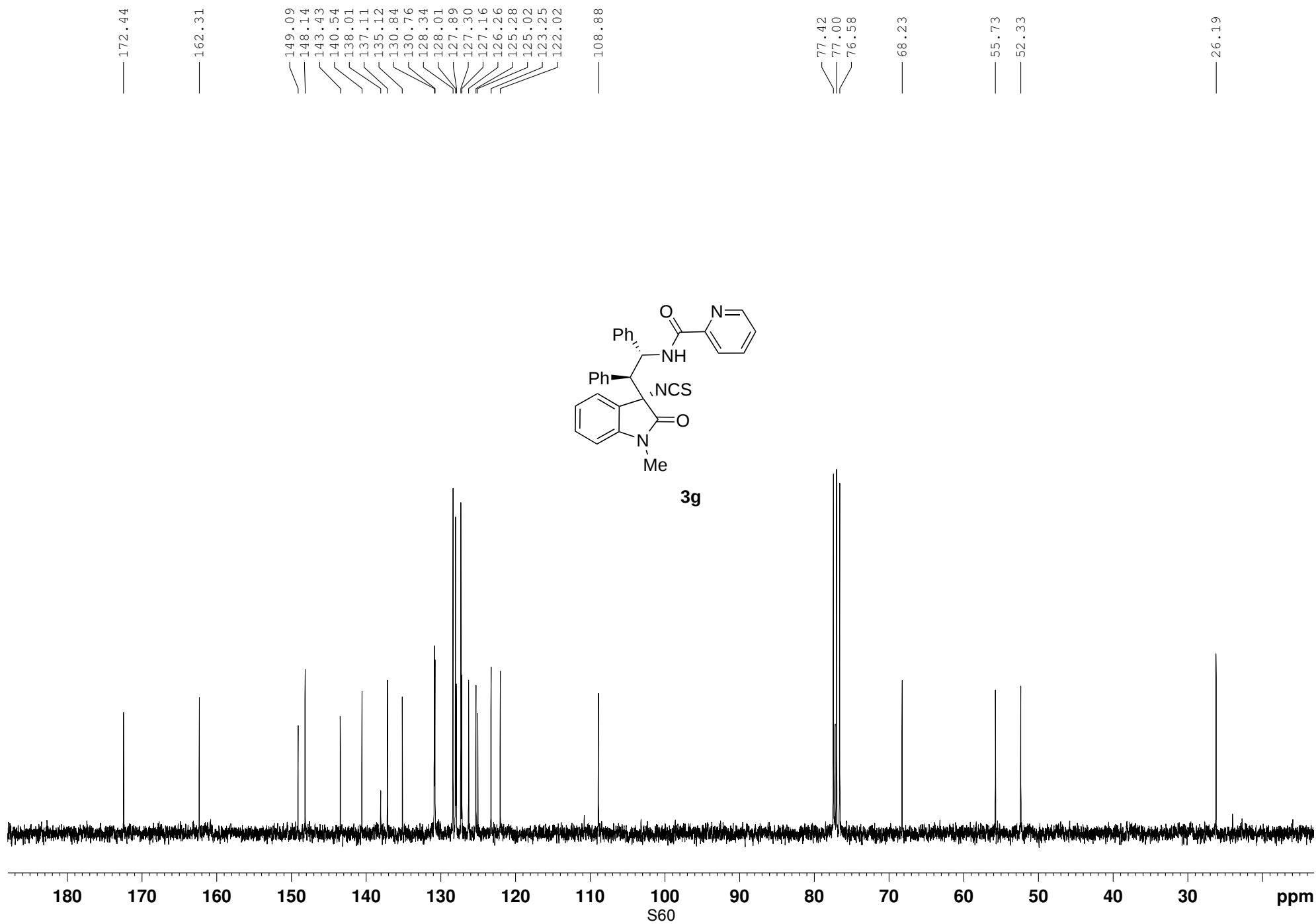


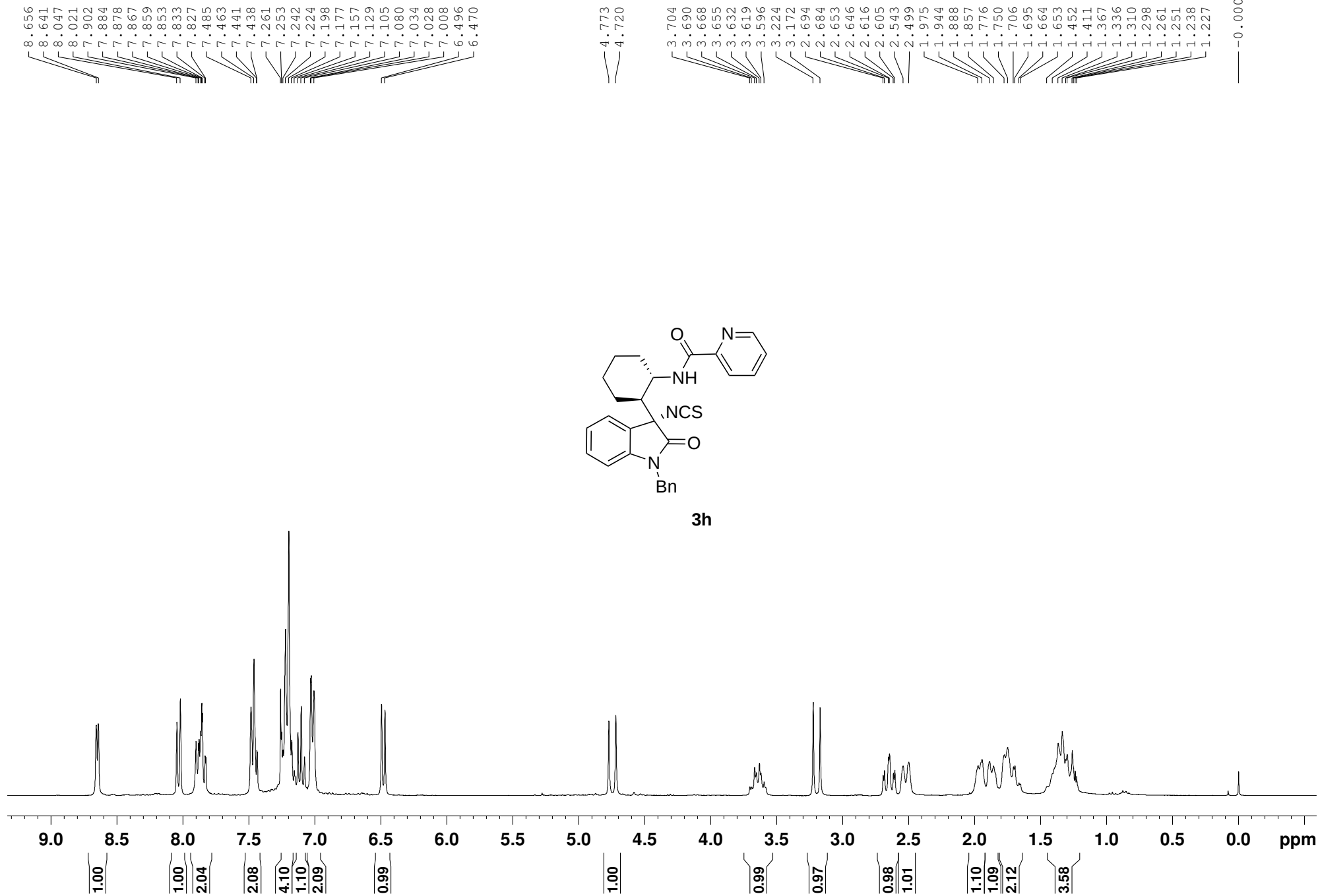


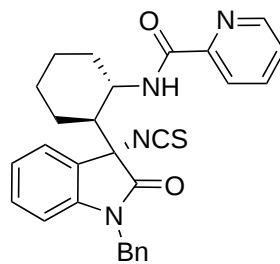
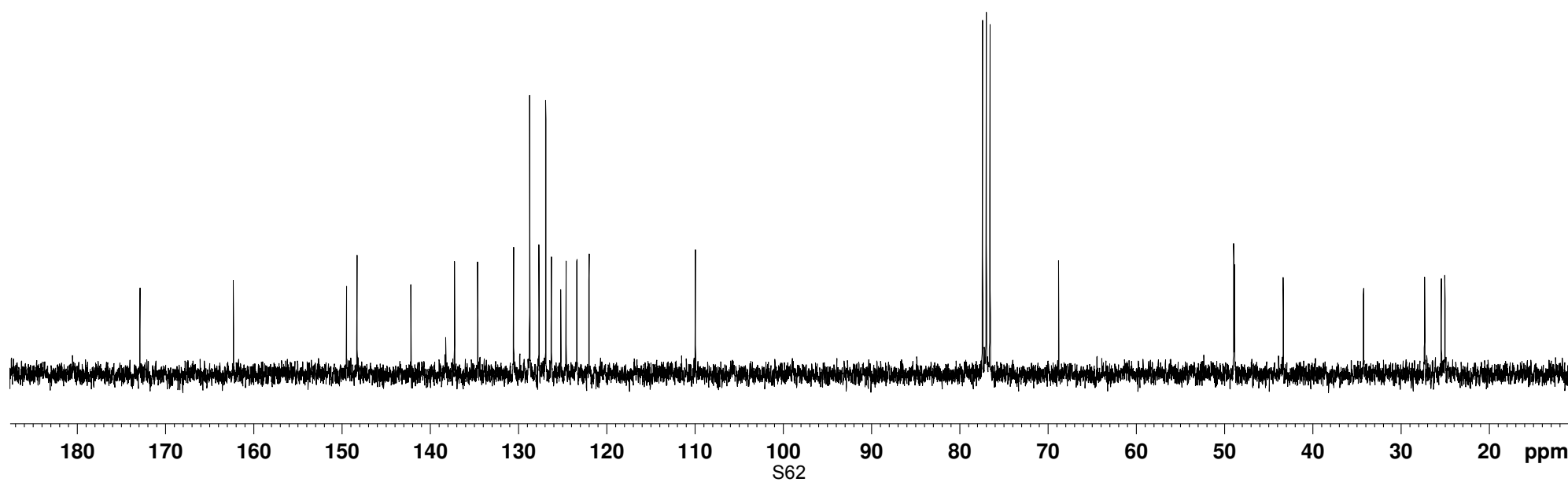












3h

— 172.86

— 162.27

— 149.45
— 148.26

— 142.16
— 138.21
— 137.22
— 134.58
— 130.52
— 128.70
— 127.64
— 126.87
— 126.24
— 125.18
— 124.56
— 123.35
— 121.97

— 109.92

— 77.42
— 77.00
— 76.58

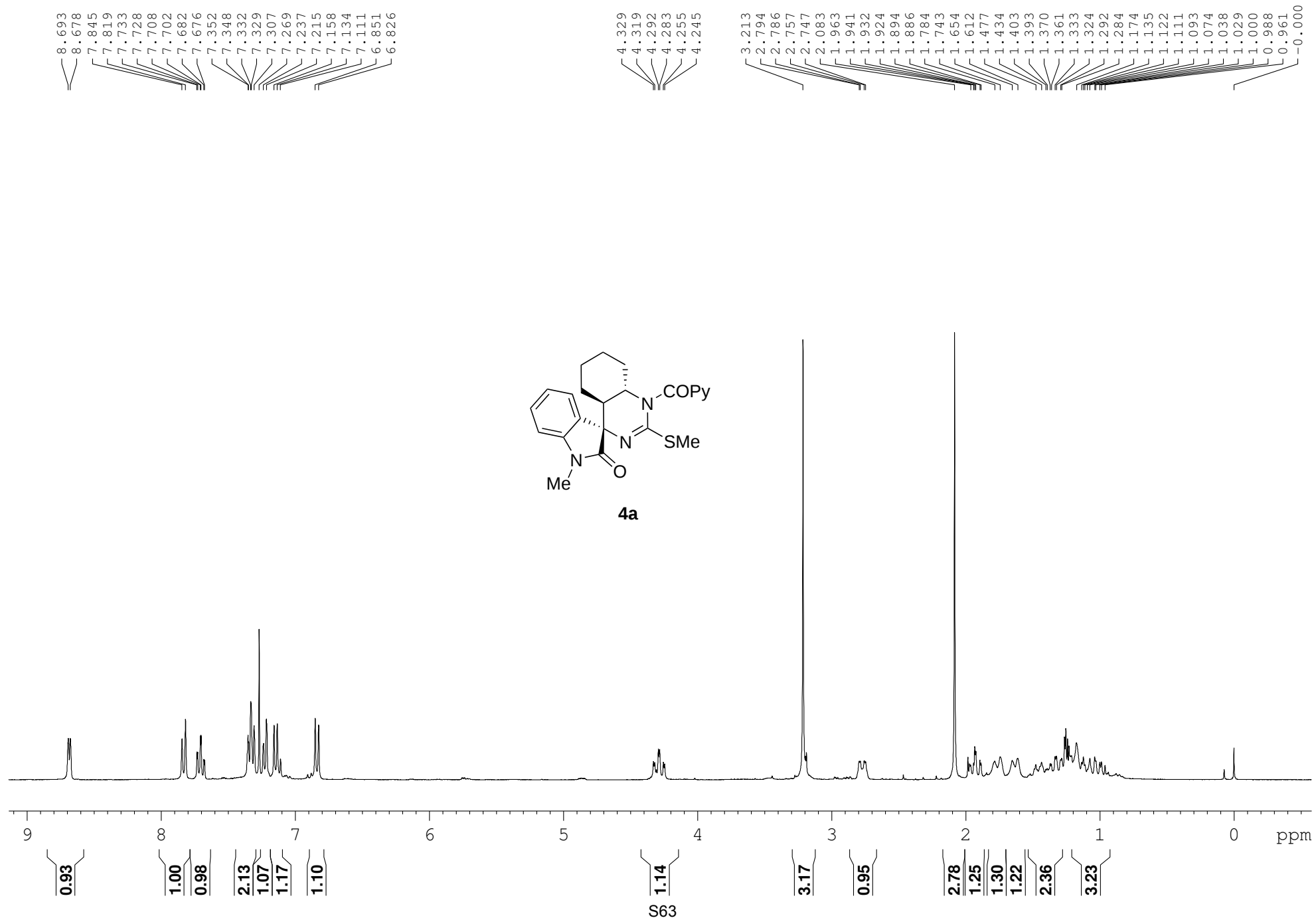
— 68.80

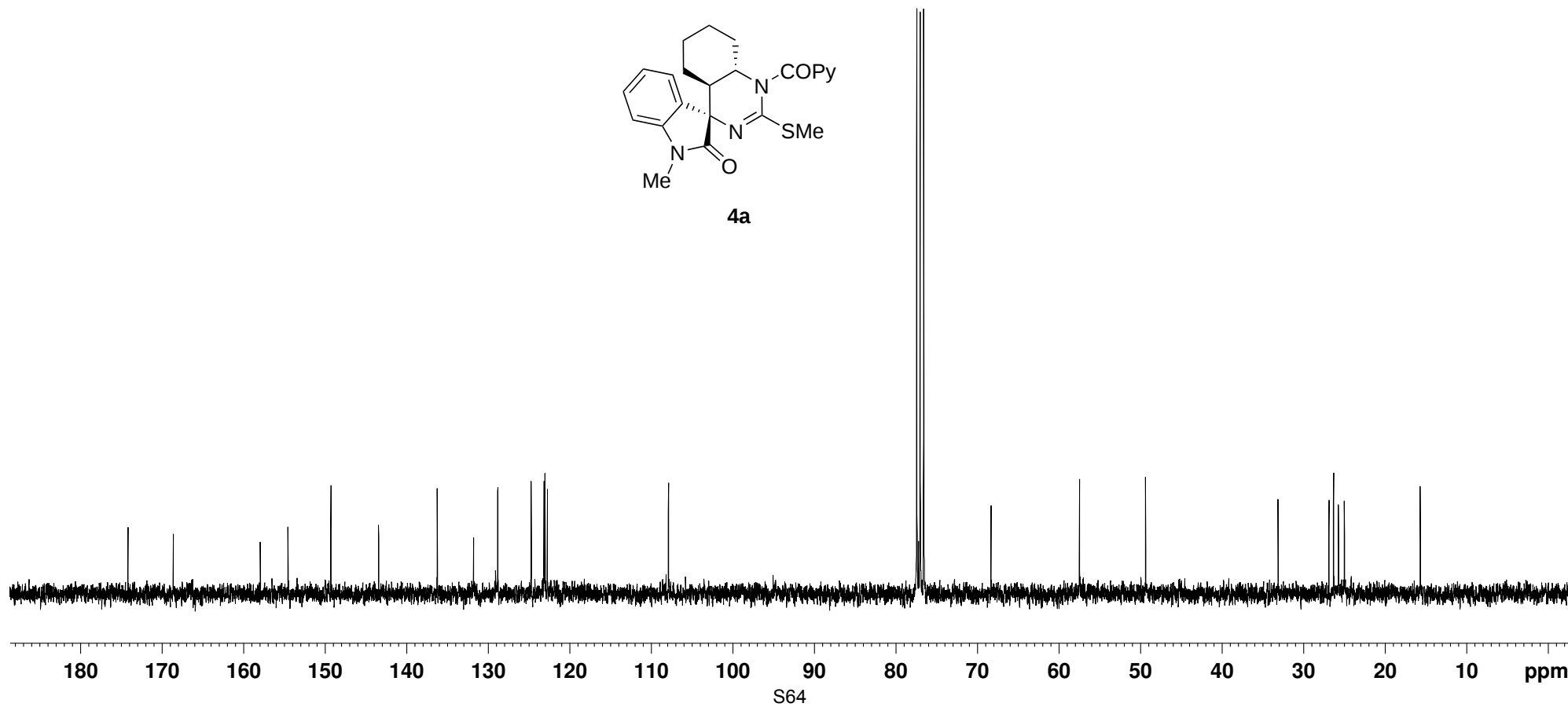
— 48.96
— 48.88

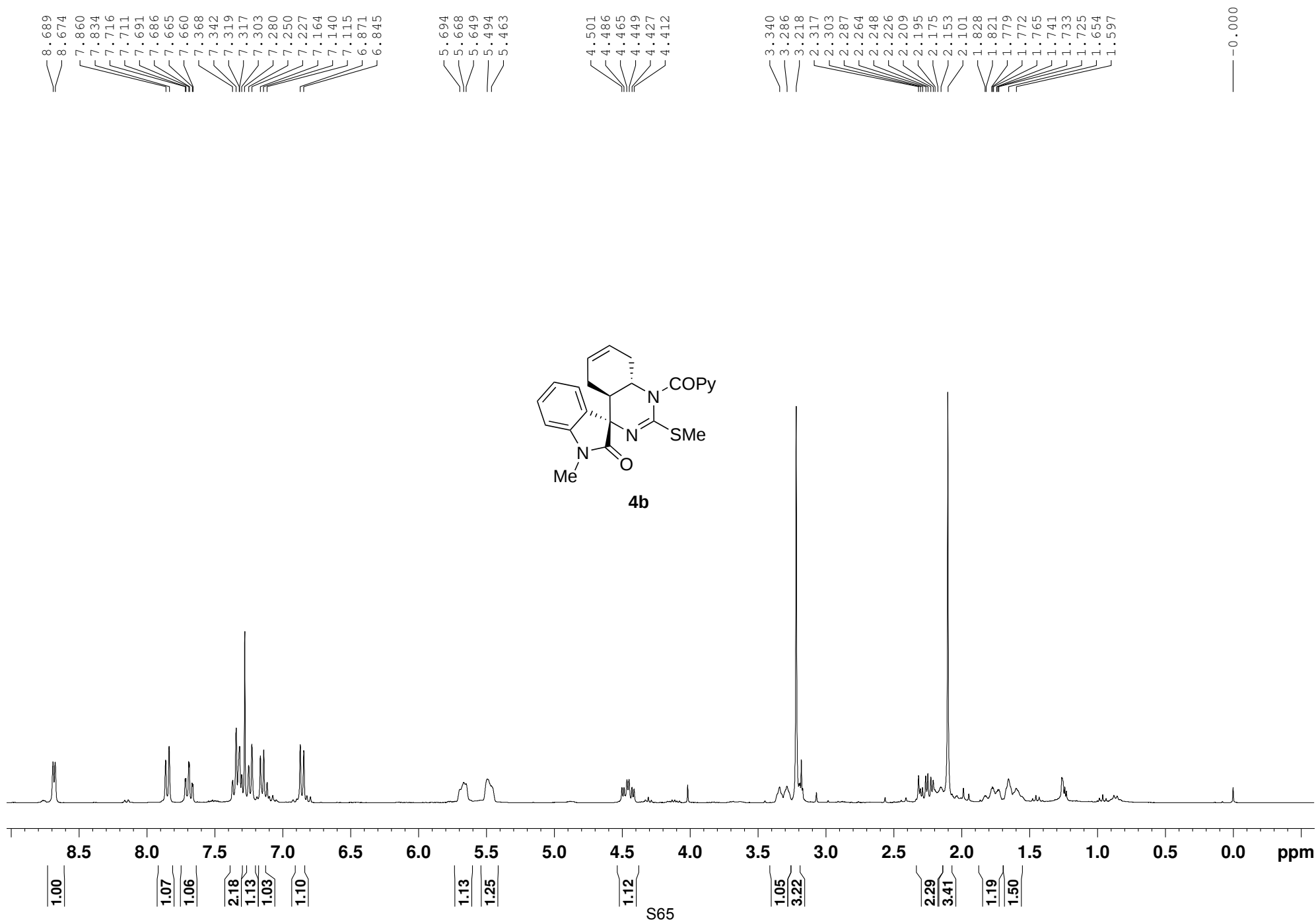
— 43.35

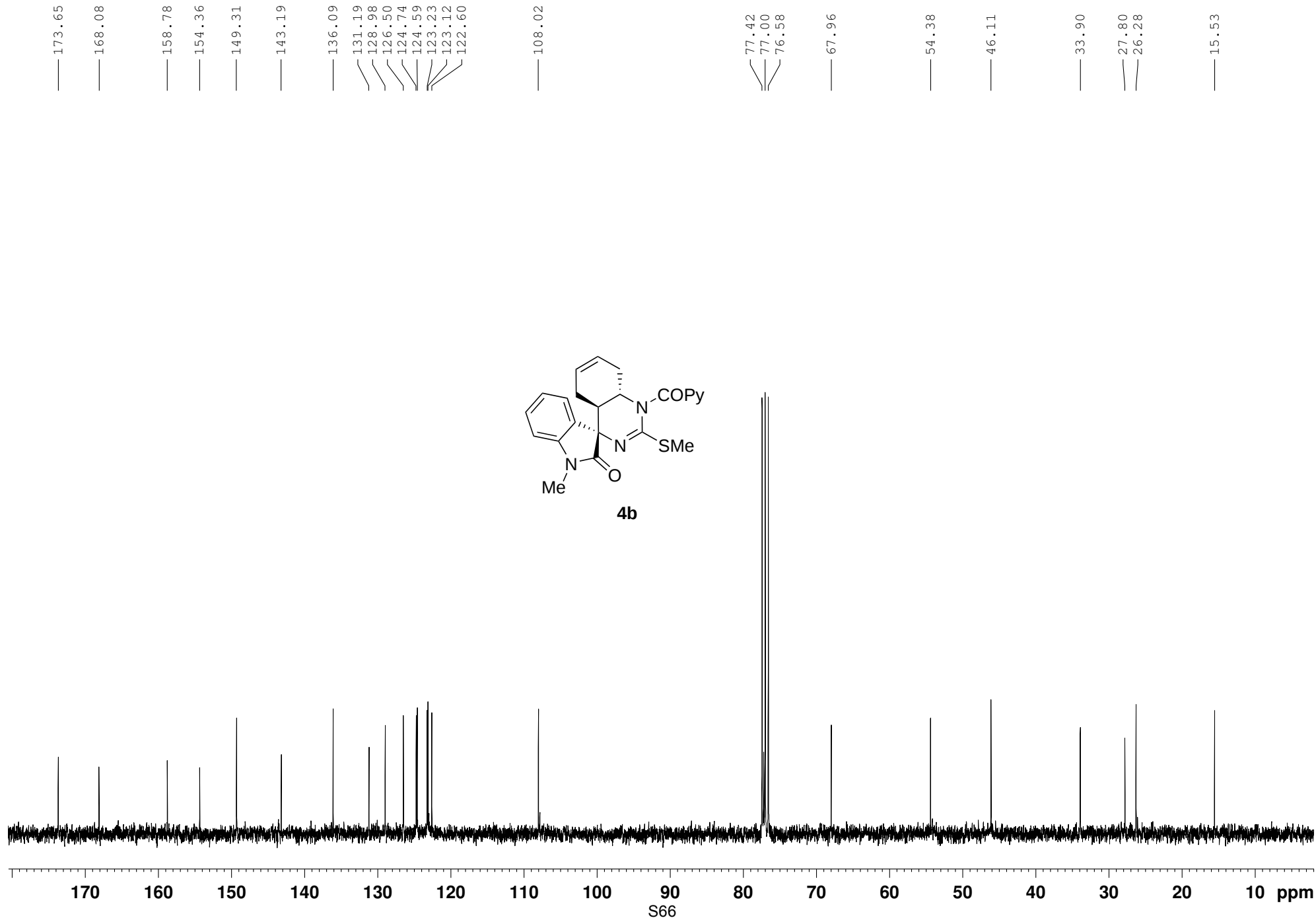
— 34.26

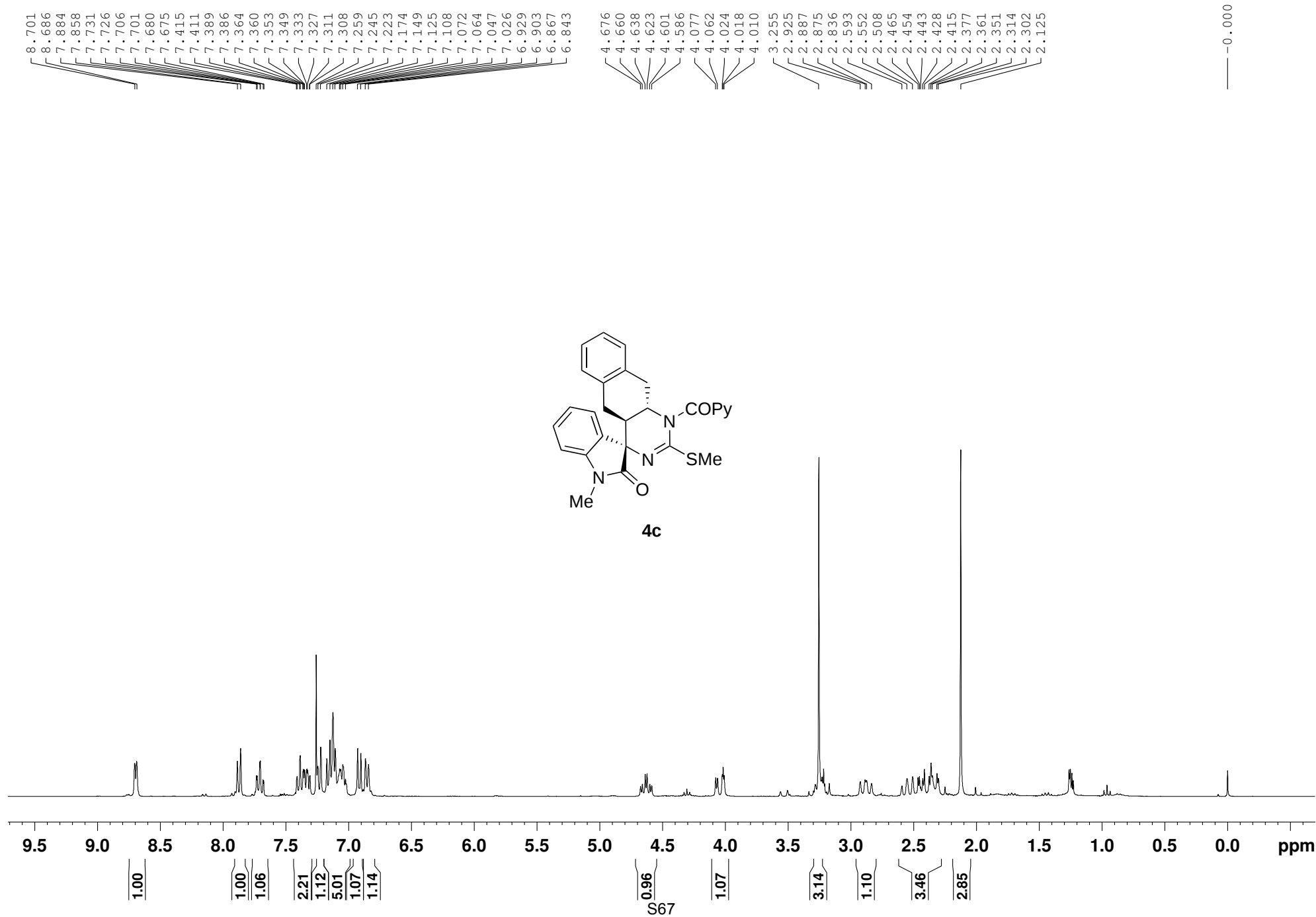
— 27.33
— 25.44
— 25.04

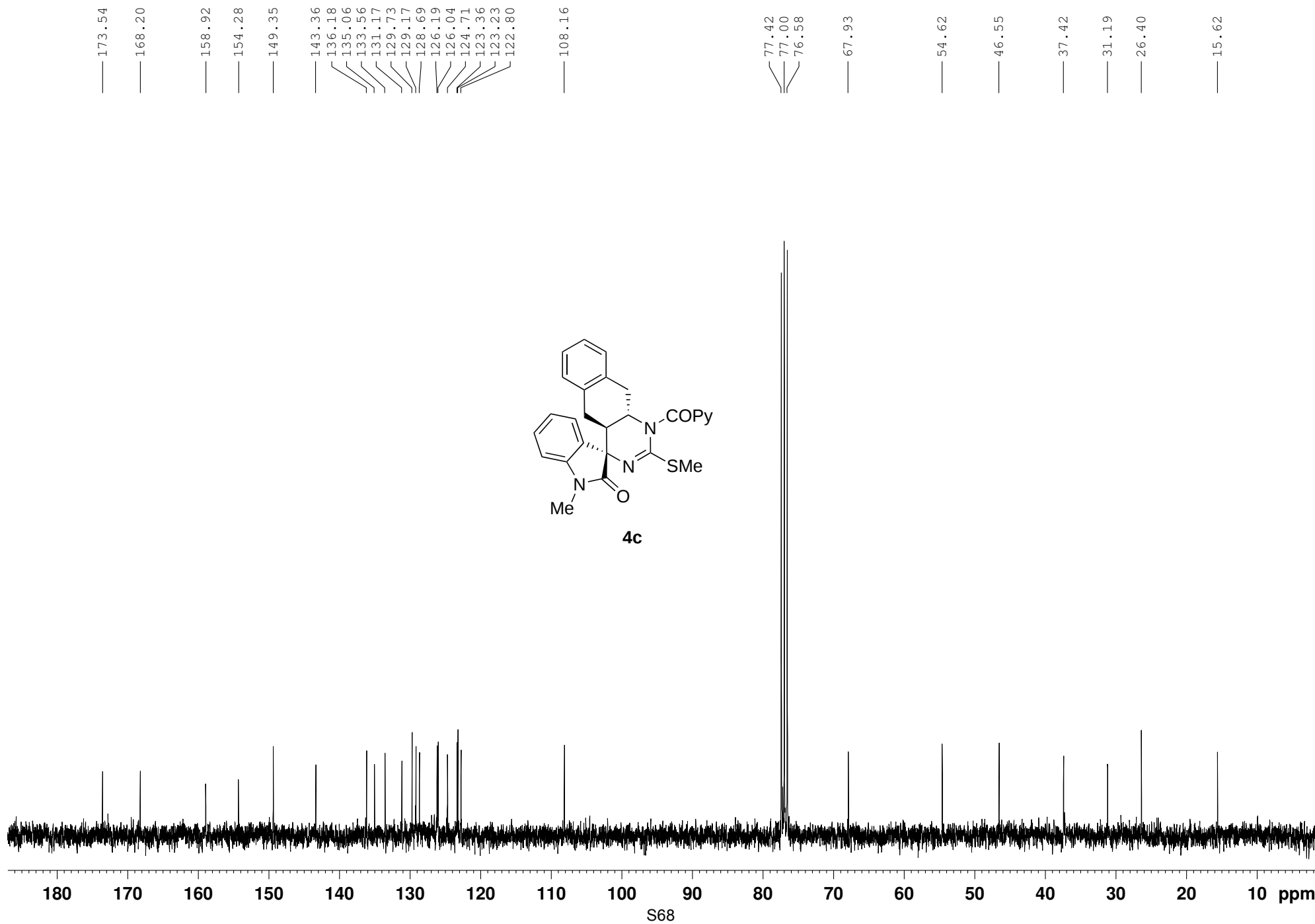






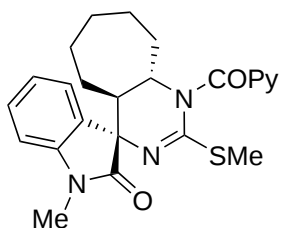




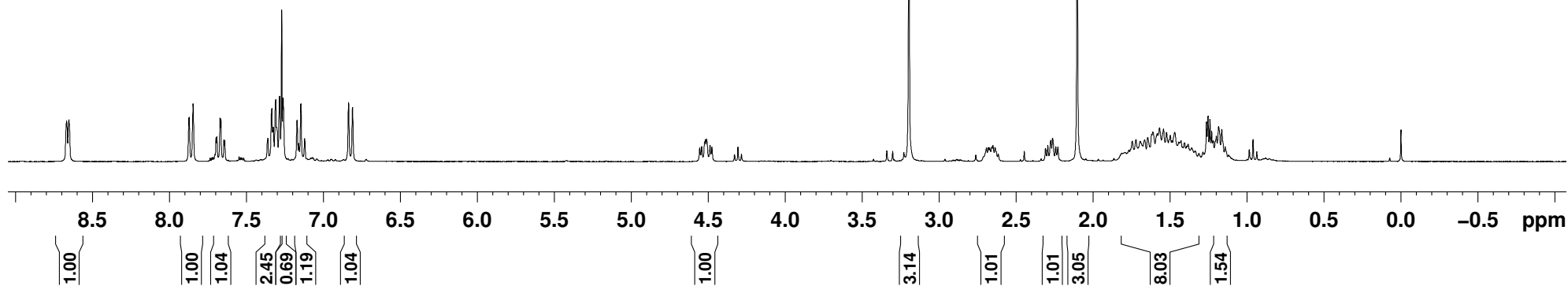


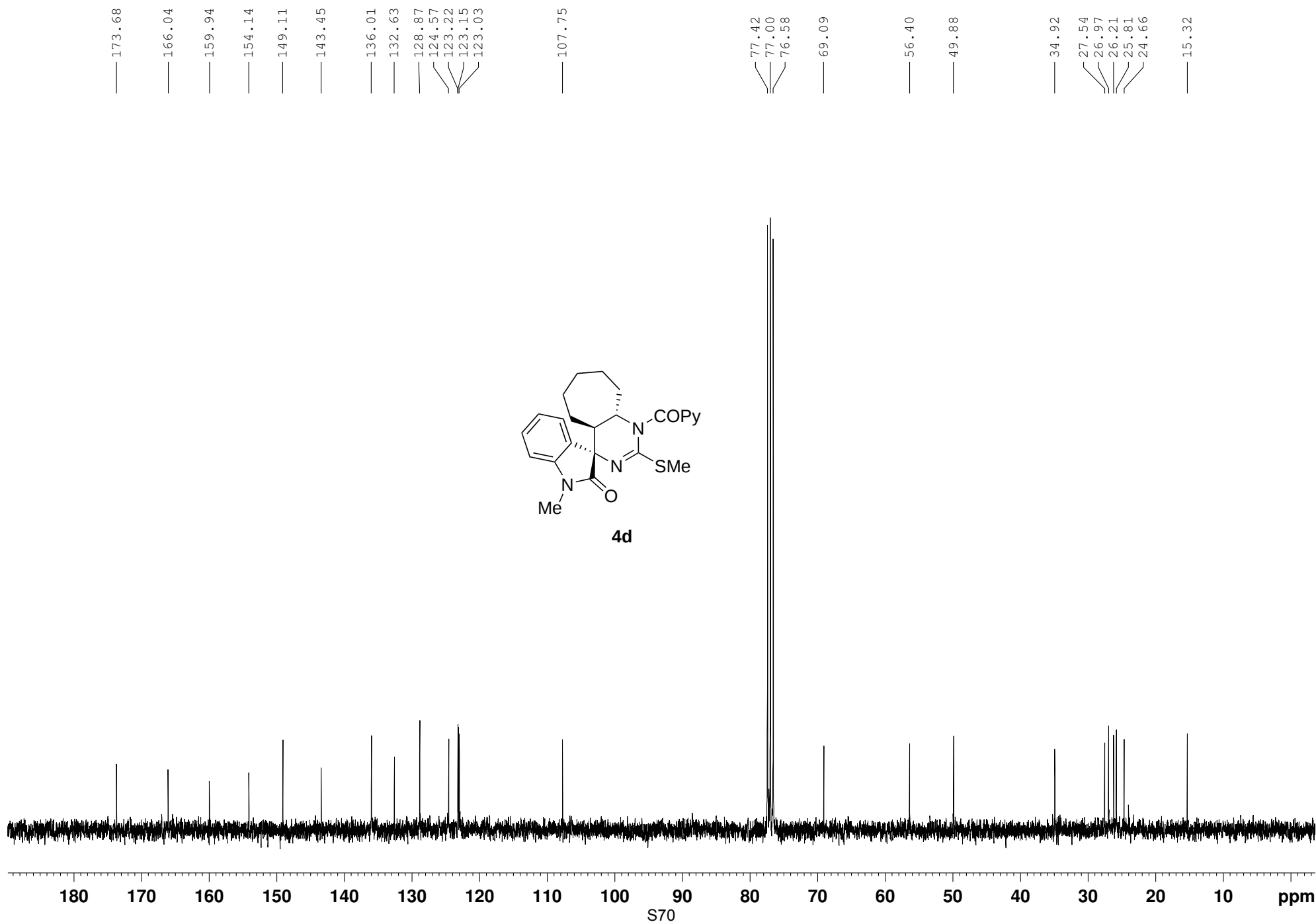
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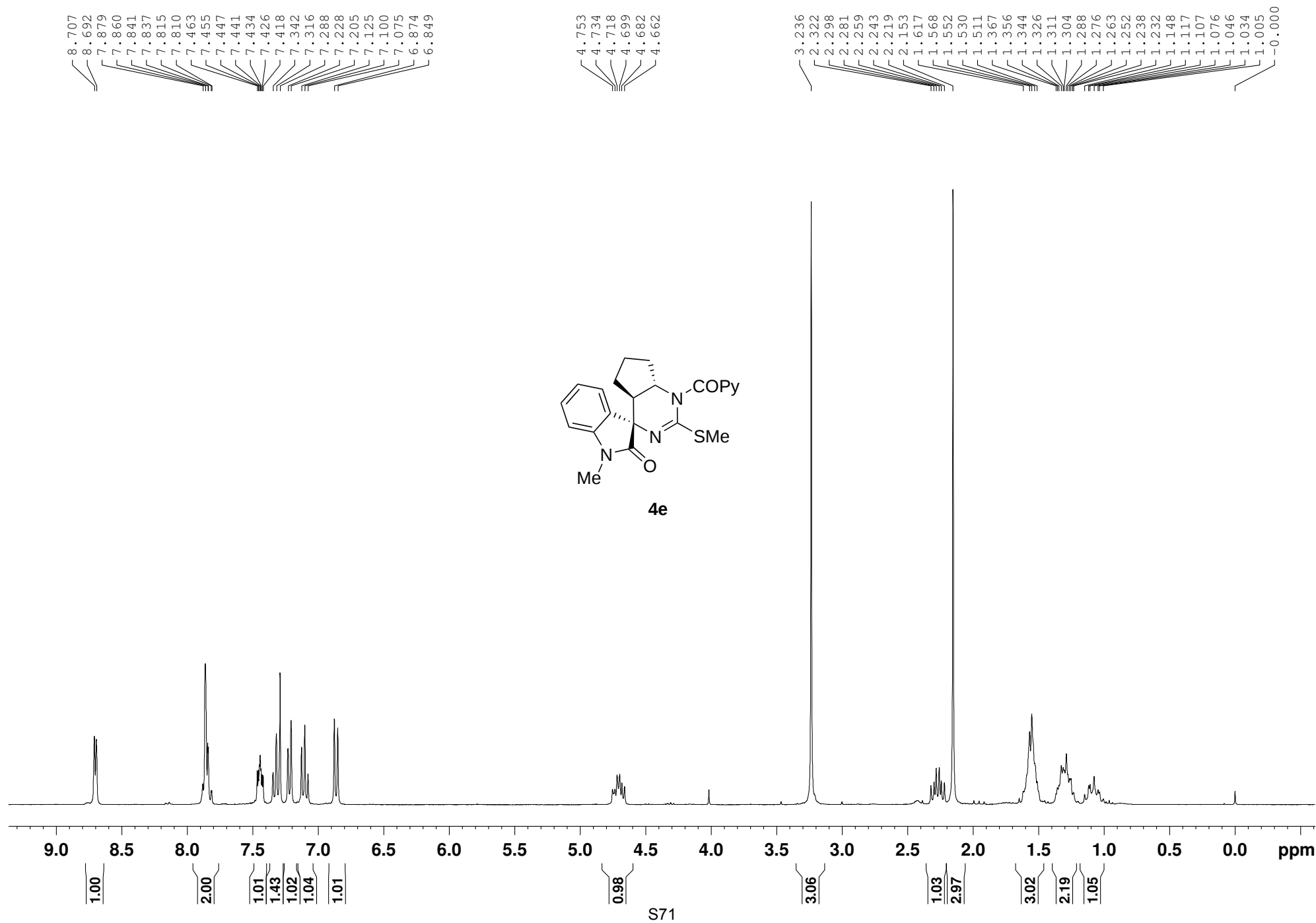
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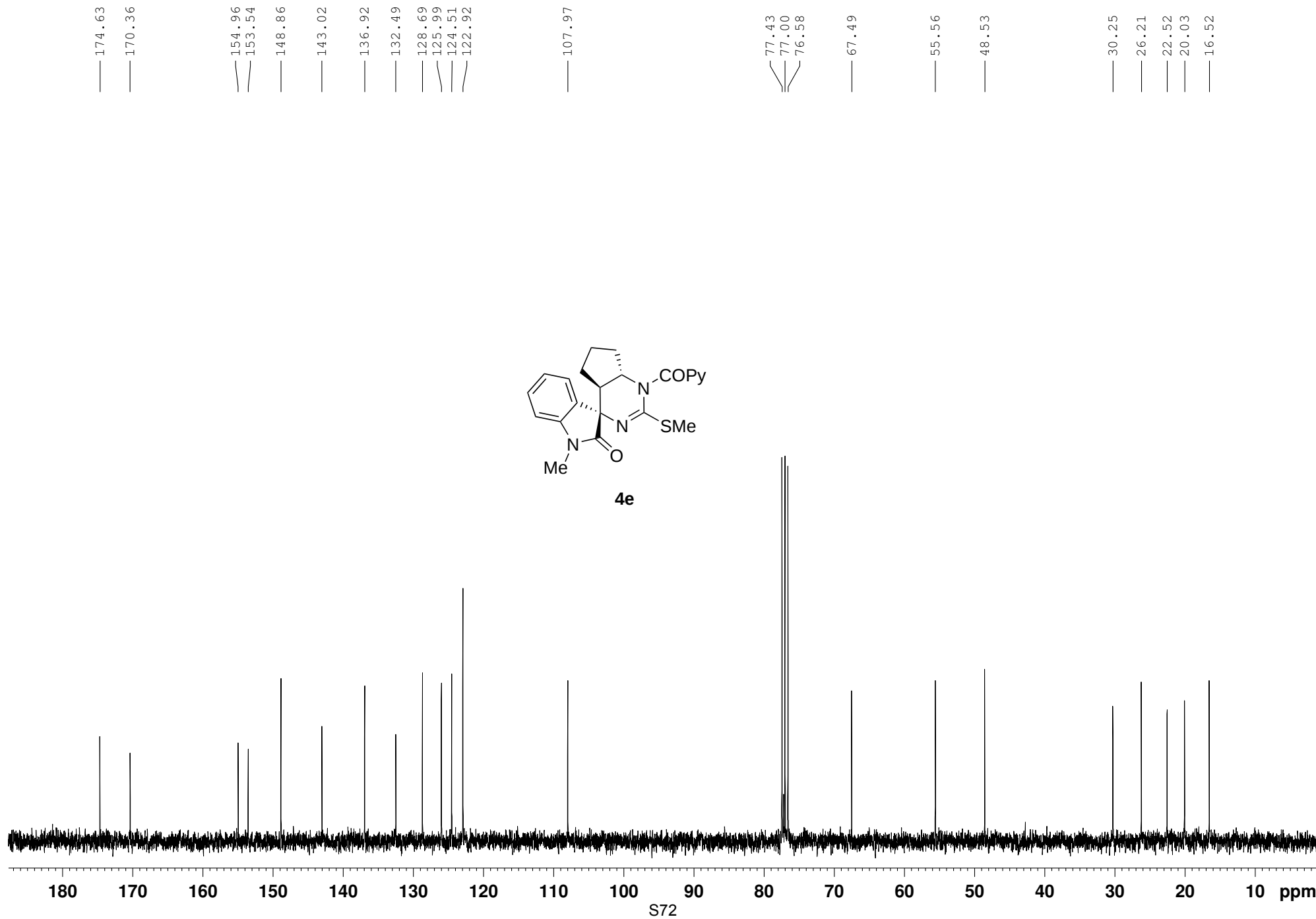


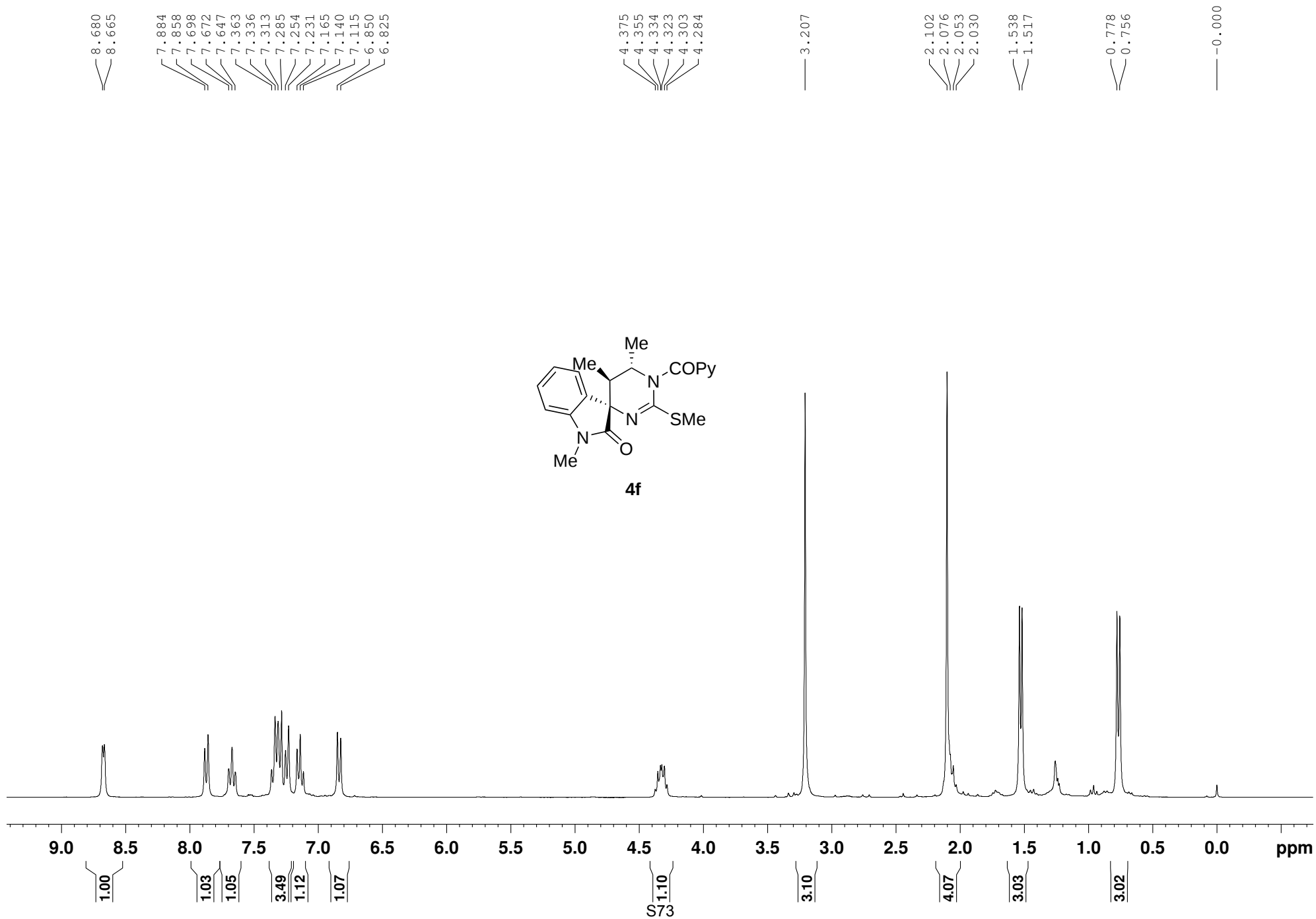
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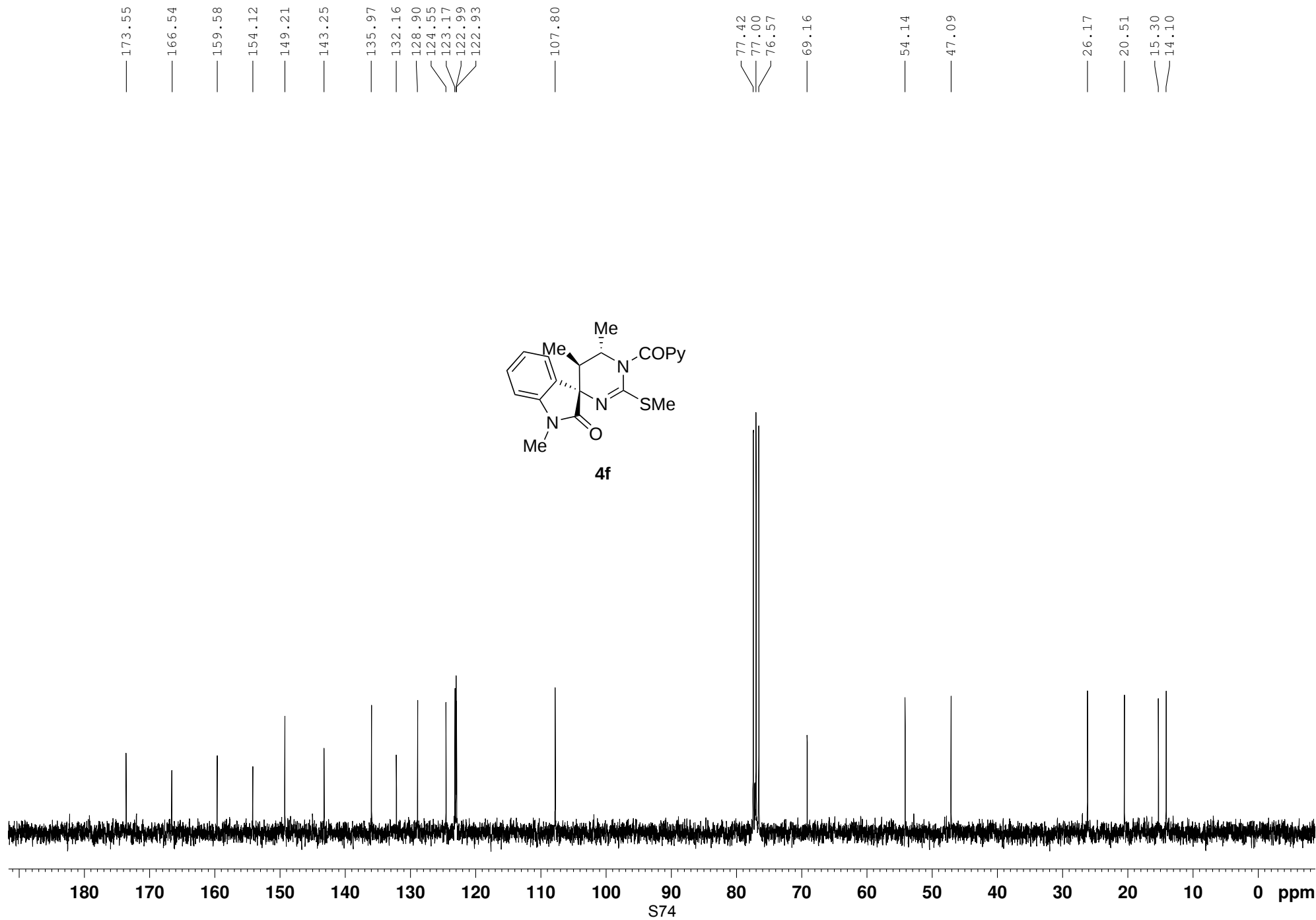


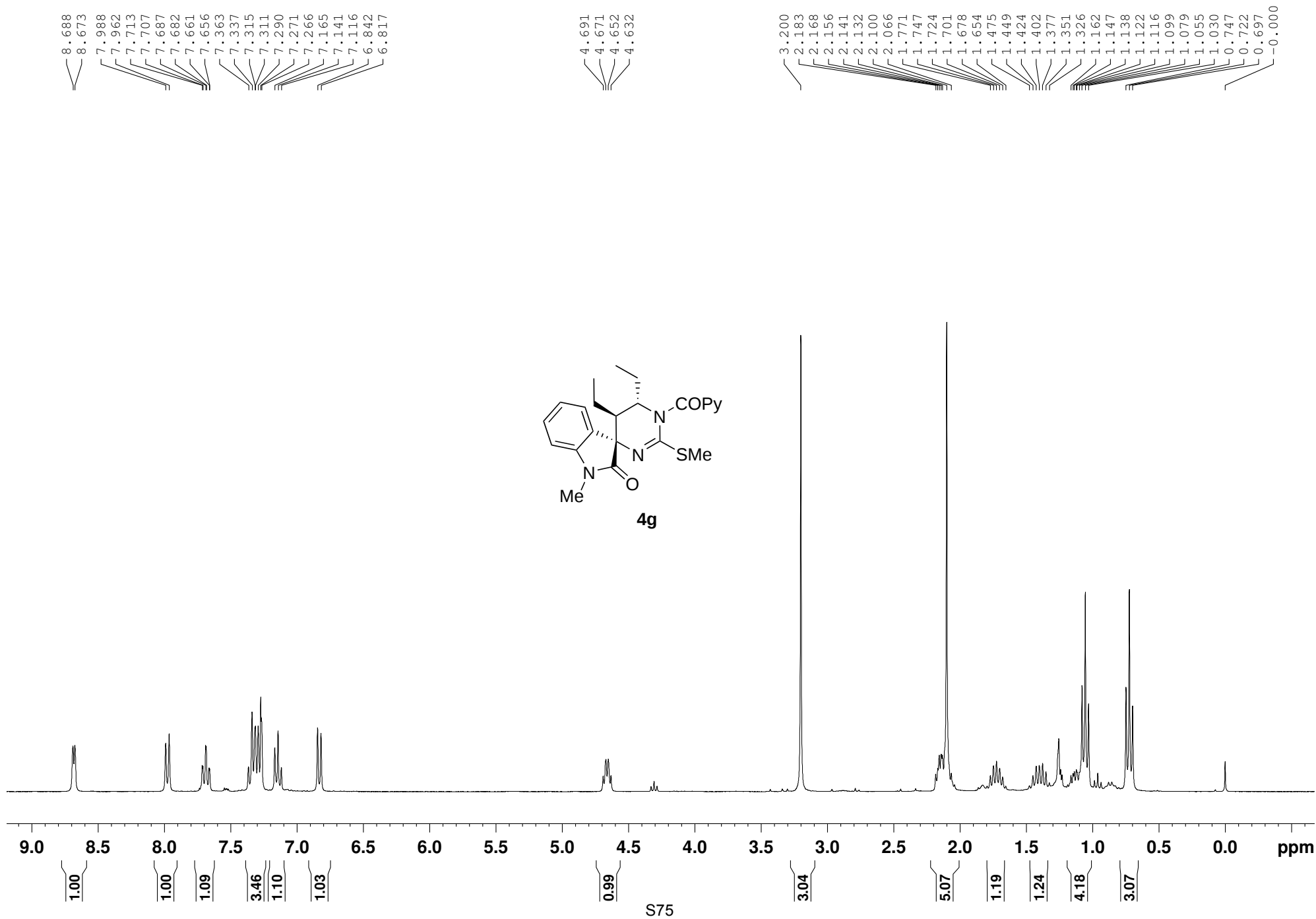


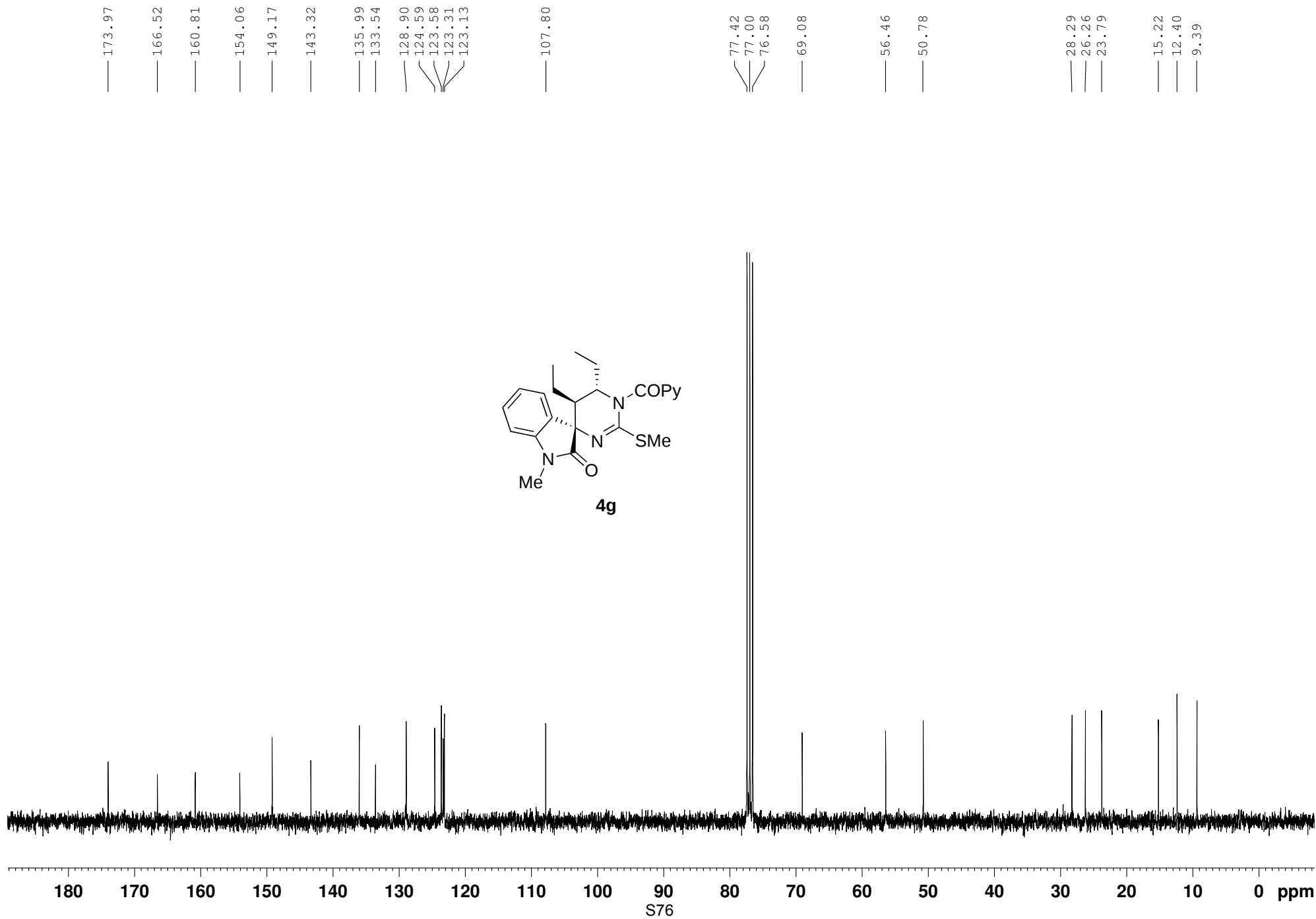


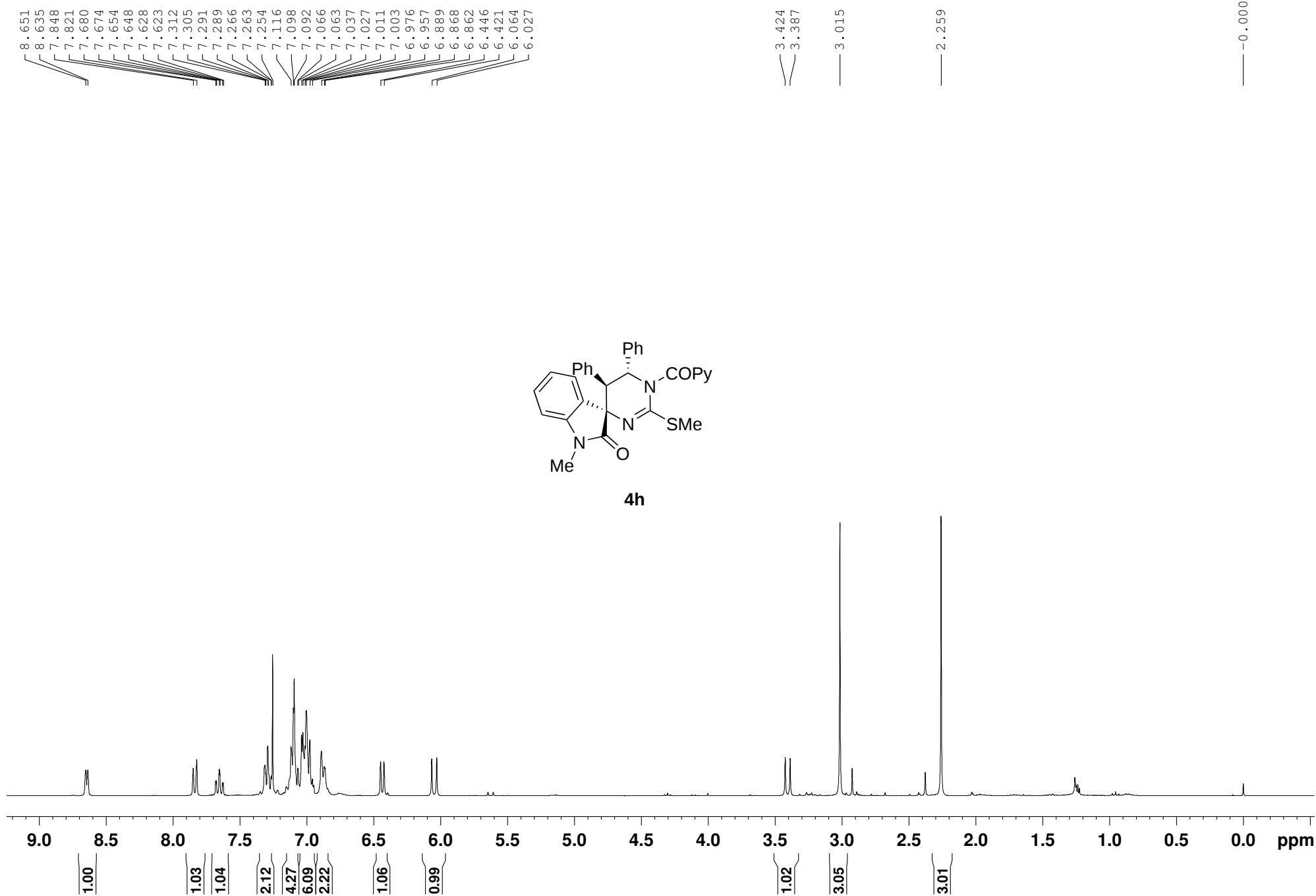


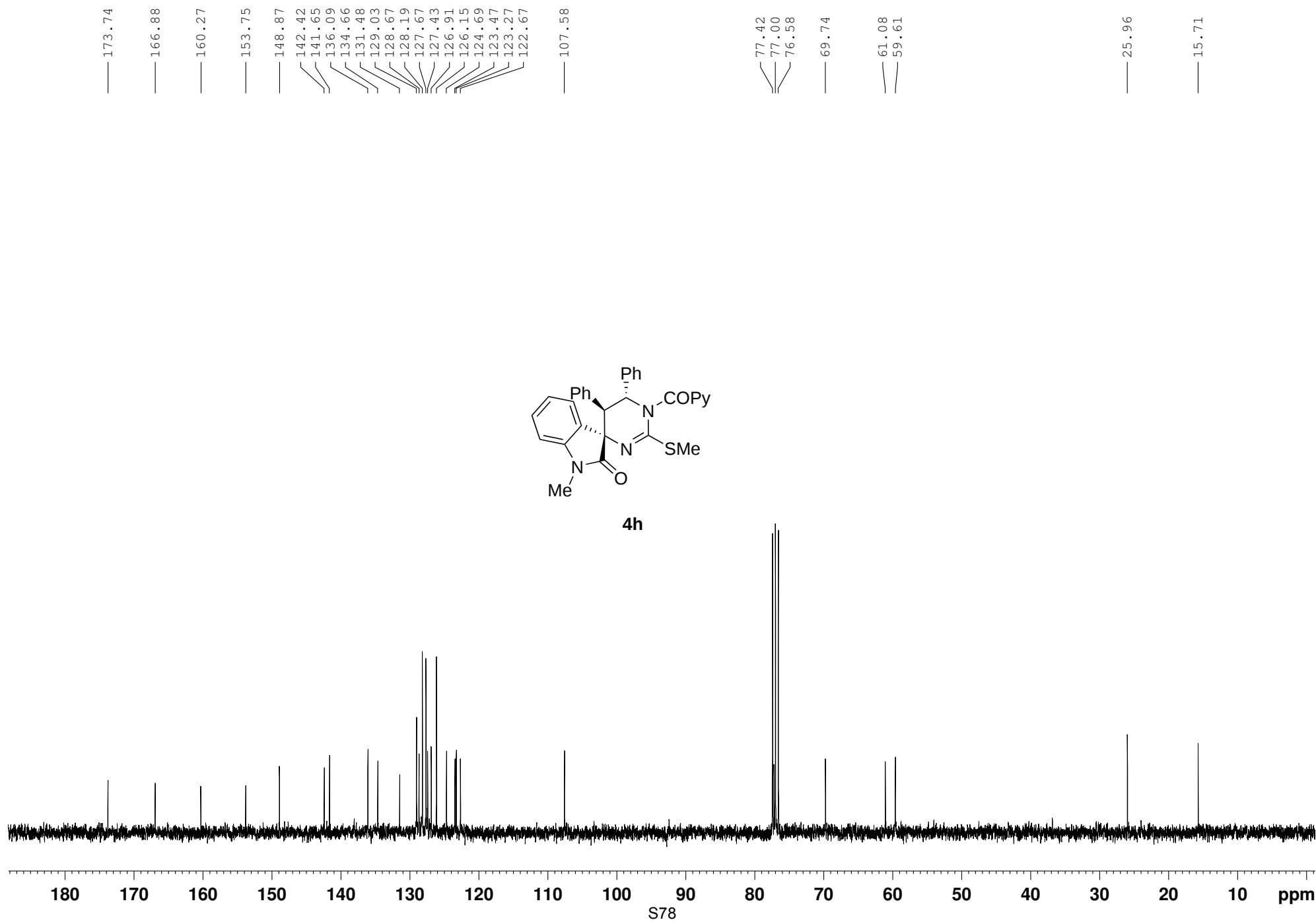


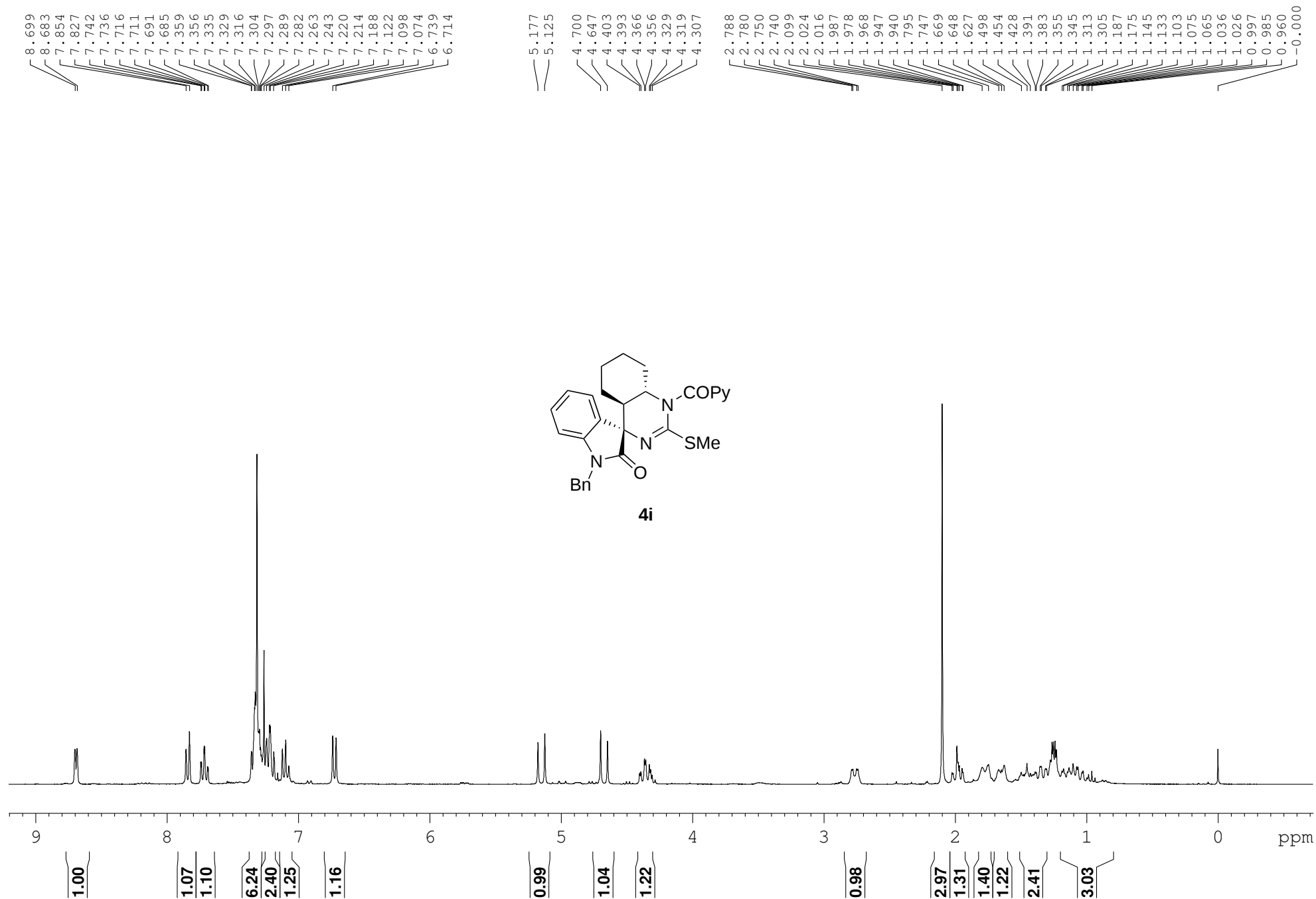


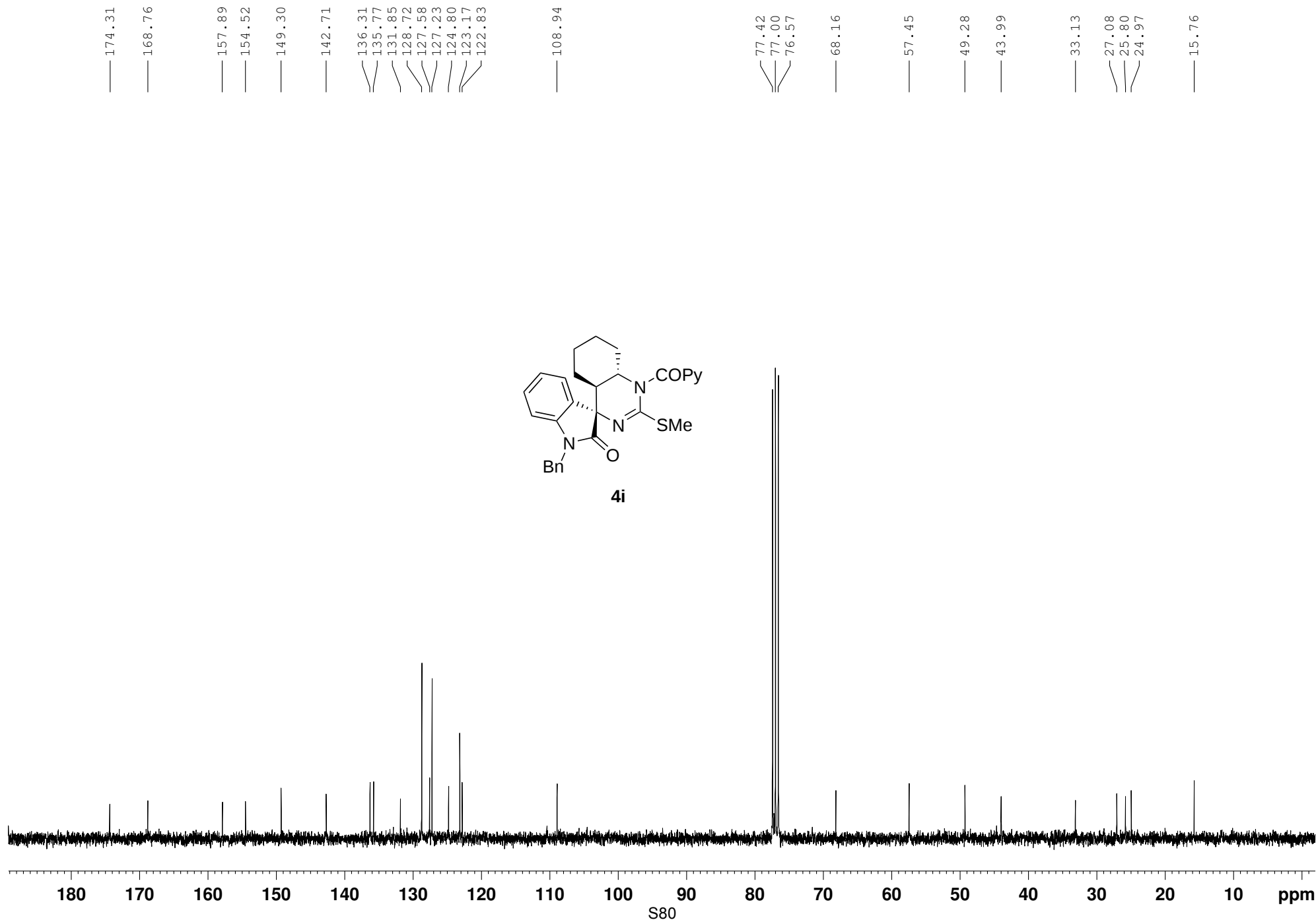


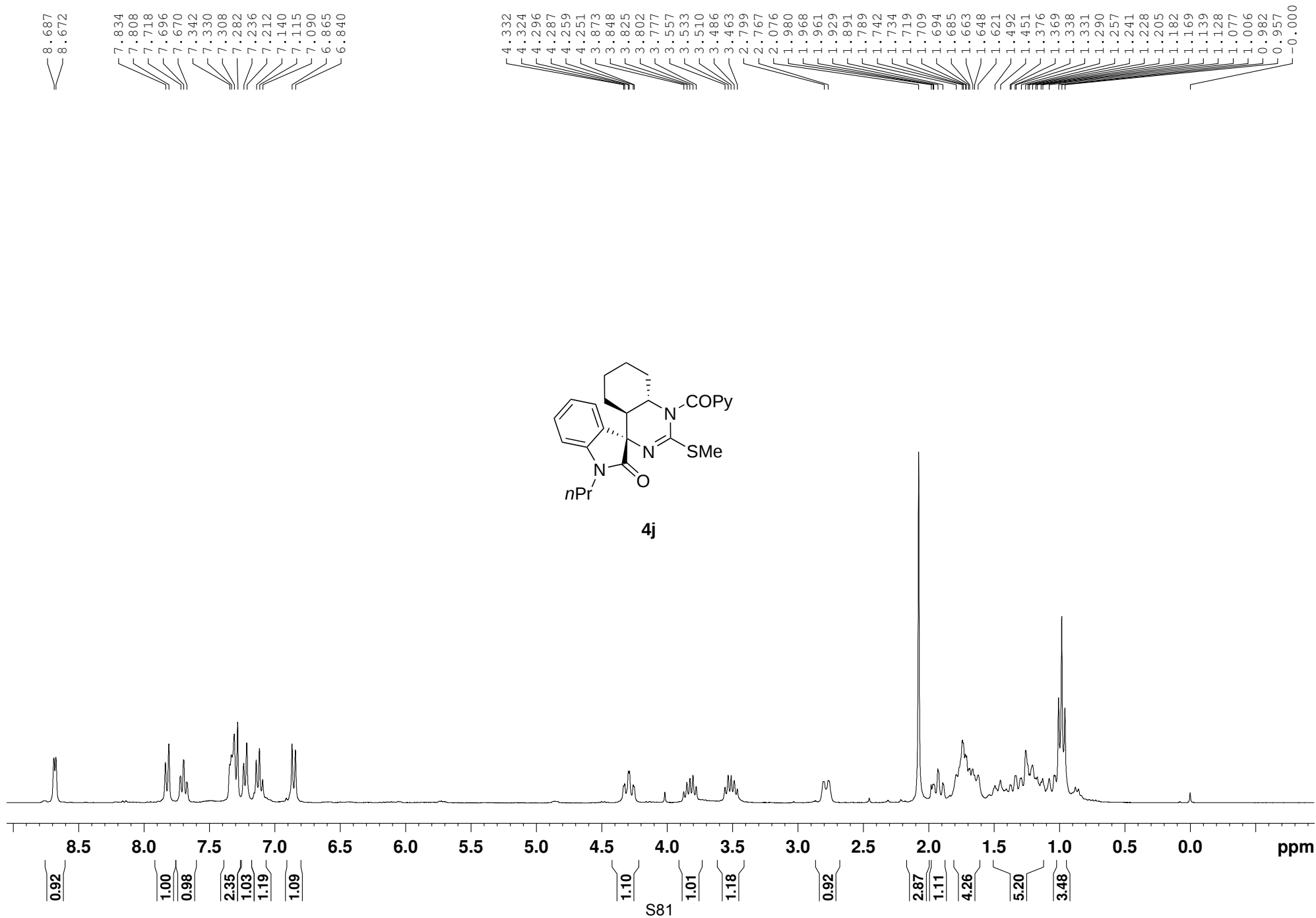


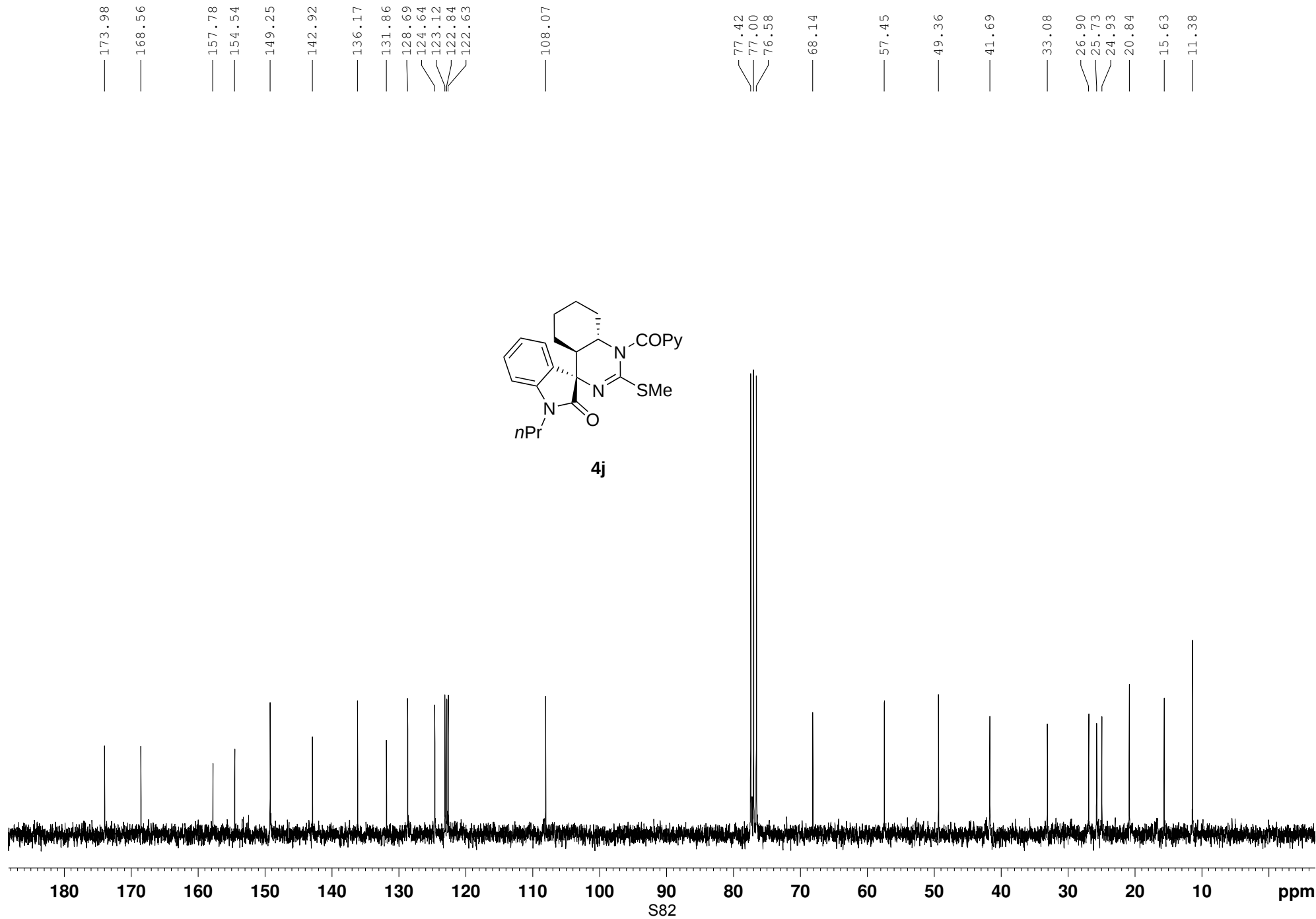


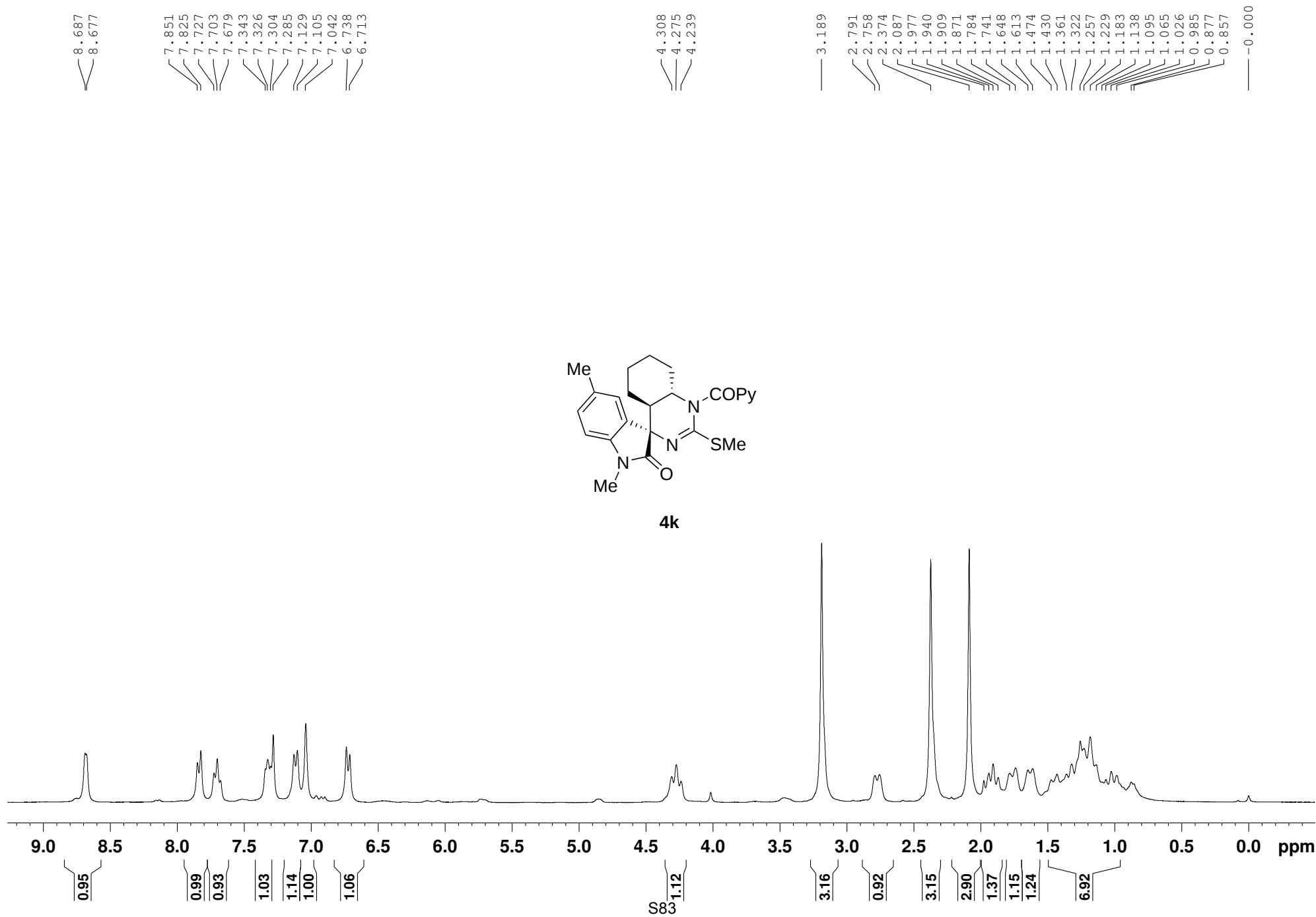


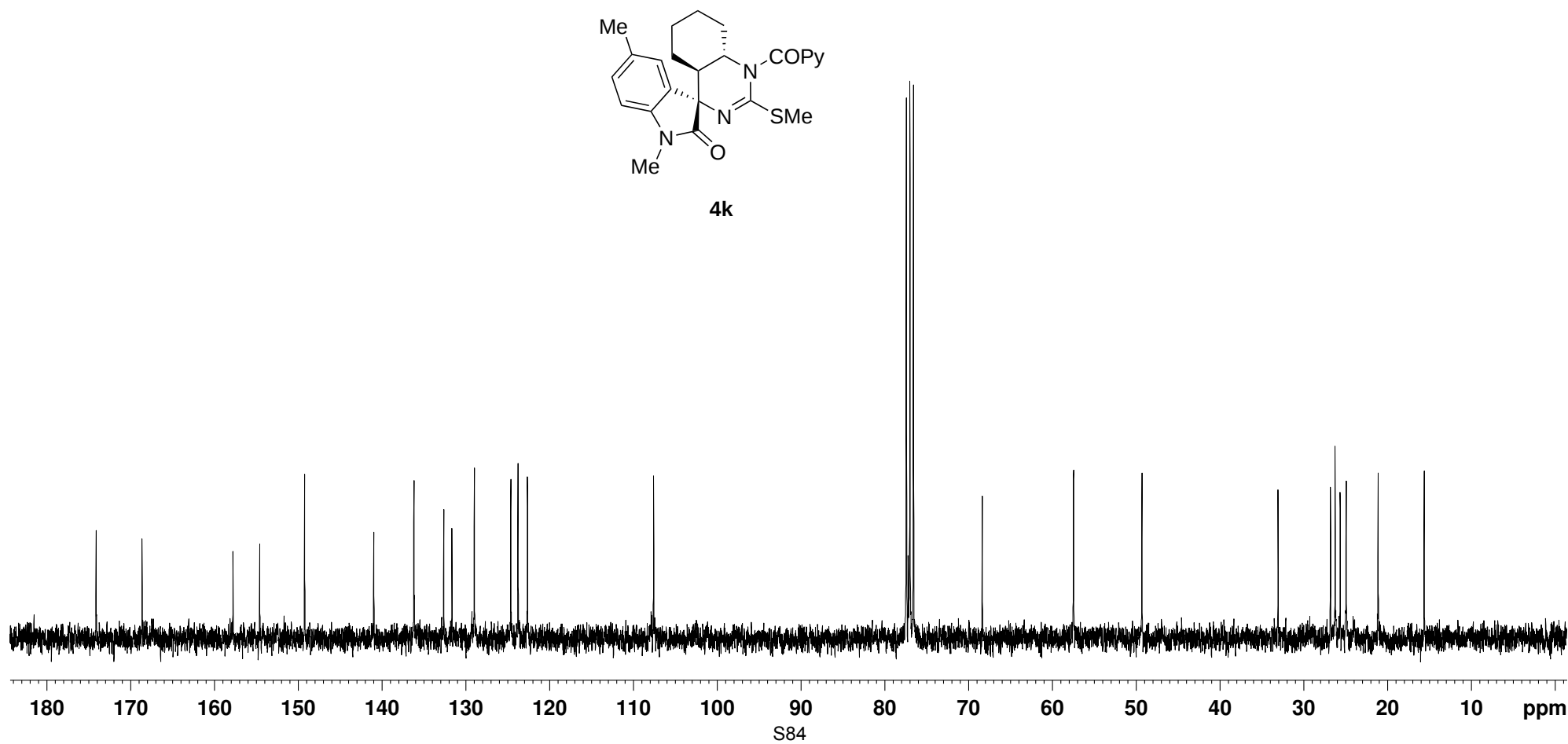


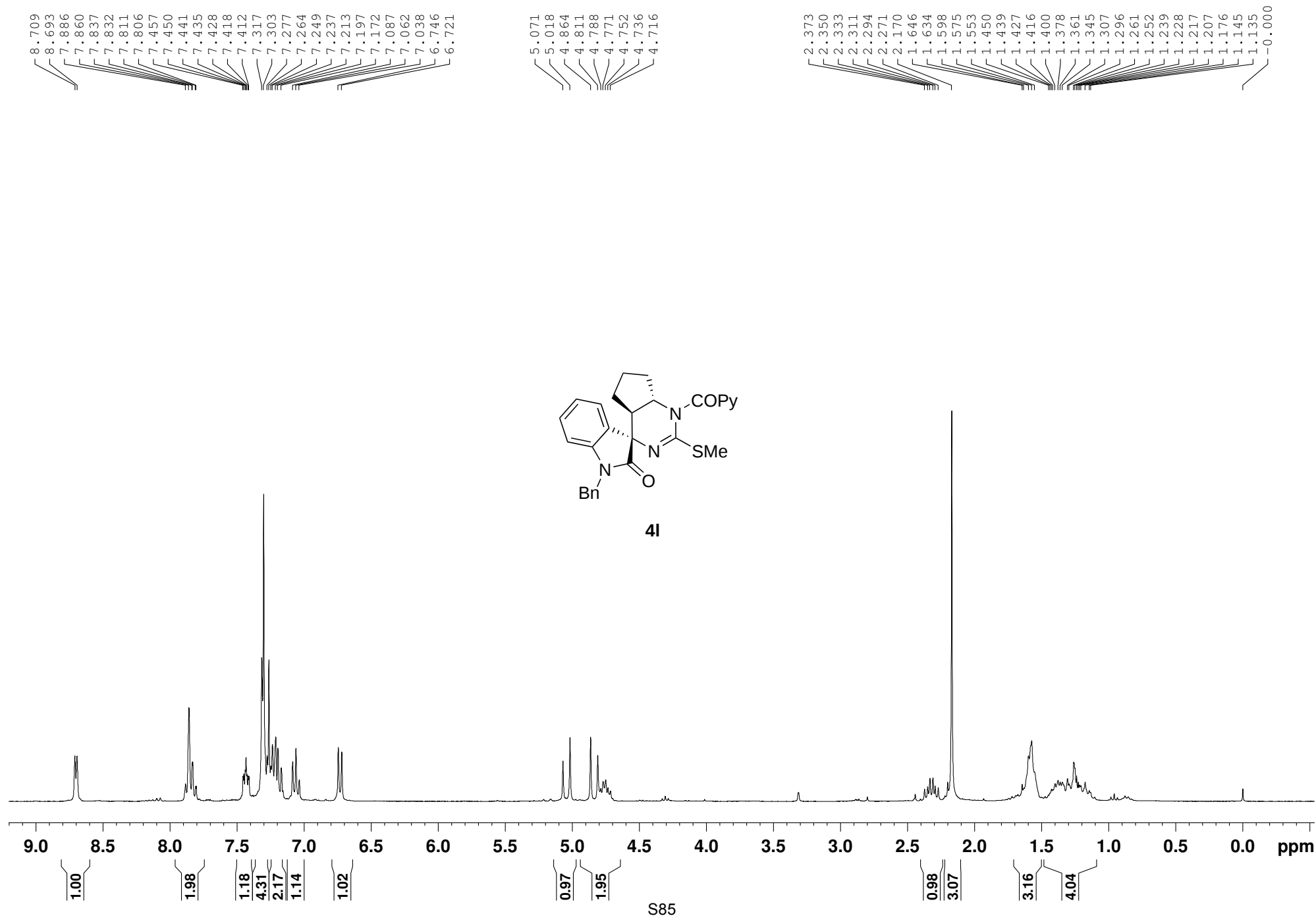


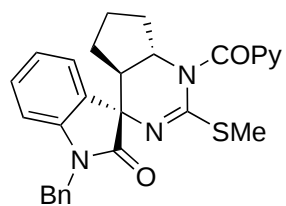












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