

Supporting Information

Palladium-Catalyzed Asymmetric Allenylic Alkylation: Construction of Multiple Chiral Thiochromanone Derivatives

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1. General and Materials

General: All reactions were carried out under an atmosphere of nitrogen using the standard Schlenk techniques, unless otherwise noted. Solvents were treated prior to use according to the standard methods. ^1H NMR, ^{13}C NMR and ^{19}F NMR spectra were recorded at room temperature in CDCl_3 on 400 MHz and 700 MHz instrument with TMS as internal standard. Enantiomeric excess was determined by HPLC analysis, using chiral column described below in detail. Optical rotations were measured by polarimeter. Flash column chromatography was performed on silica gel (200-300 mesh). The heat source for all heating reactions is the oil bath. High-resolution mass spectrometry (HRMS) was measured on an electrospray ionization (ESI) apparatus using the time-of-flight (TOF) mass spectrometry. All reactions were monitored by TLC analysis.

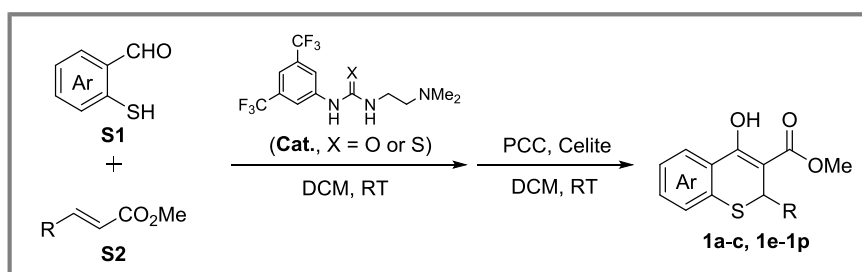
Materials: Commercially available reagents and solvents were used throughout without further purification.

2. Synthesis of Substrates

2.1. The Synthesis of Thiochromanone Derivatives

The thiochromanone derivatives **1a-c** and **1e-1p** were synthesized from (substituted) 2-mercaptobenzaldehydes and α,β -unsaturated ester through two steps according to the known procedure,¹ all of which are the new compounds. Firstly, the known 2-mercaptobenzaldehydes **S1** underwent the organocatalytic domino sulfa-Michael-aldol reactions with α,β -unsaturated ester **S2** to provide the intermediate alcohols. Then, the desired thiochromanone derivatives **1** could be synthesized through the oxidation with PCC.

Besides, thiochromanone derivative with amide group **1d** was synthesized through exchange from the thiochromanone **1c** and piperidine according to the known procedure.²

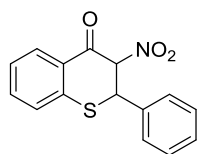


General Procedure: To a solution of (substituted) 2-mercaptobenzaldehydes **S1** (7.0 mmol) in dichloromethane (60 mL) was added organocatalyst (1.4 mmol, 20 mol%) and α,β -unsaturated esters **S2** (9.1 mmol) sequentially under nitrogen atmosphere. The reaction mixture was stirred at room temperature for about 48-120 h. The reaction was complete as monitored by TLC. Then the reaction mixture was concentrated under the reduced pressure to obtain the crude residue. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate (20/1-10/1) as eluent to give the intermediate alcohol compounds.

To a solution of pyridinium chlorochromate (PCC, 2.5 equiv.) in dichloromethane (0.1 M) was added celite (equal in quality to PCC) and the obtained alcohol compounds at ambient temperature. TLC analysis indicated completion of the reactions after about 5-8 h. After filtration through celite, the volatiles were removed under the reduced pressure. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate (50/1) as eluent to give the desirable thiochromanone derivatives **1**.

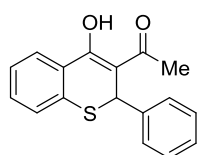
3-Nitro-2-phenylthiochroman-4-one (1a):

0.243 g, 30% yield (two steps), orange solid, mp 173-174 °C, new compound, $R_f = 0.05$ (hexanes/ethyl acetate 3/1), keto. $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.18 (d, $J = 7.6$ Hz, 1H), 7.56-7.45 (m, 3H), 7.42-7.34 (m, 3H), 7.34-7.26 (m, 2H), 6.13 (d, $J = 13.1$ Hz, 1H), 5.27 (d, $J = 13.1$ Hz, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 184.0, 140.6, 135.2, 133.0, 130.7, 129.9, 129.4, 128.9, 128.0, 126.9, 126.2, 95.1, 48.3. HRMS Calculated for $\text{C}_{15}\text{H}_{12}\text{NO}_3\text{S}$ $[\text{M}+\text{H}]^+$ 286.0532, found: 286.0533.



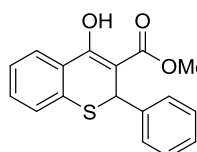
1-(4-Hydroxy-2-phenyl-2H-thiochromen-3-yl)ethan-1-one (1b):

0.324 g, 41% yield (two steps), yellow viscous liquid, new compound, $R_f = 0.79$ (hexanes/ethyl acetate 3/1), enol. $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.05 (dd, $J = 7.8, 1.5$ Hz, 1H), 7.29-7.25 (m, 1H), 7.25-7.15 (m, 6H), 7.15-7.08 (m, 1H), 4.99 (s, 1H), 2.18 (s, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 198.2, 173.9, 142.0, 134.5, 132.3, 129.3, 128.7, 128.0, 127.7, 127.5, 126.8, 125.9, 106.0, 42.0, 25.2. HRMS Calculated for $\text{C}_{17}\text{H}_{15}\text{O}_2\text{S}$ $[\text{M}+\text{H}]^+$ 283.0787, found: 283.0788.



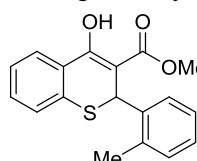
Methyl 4-hydroxy-2-phenyl-2H-thiochromene-3-carboxylate (1c):

1.126 g, 39% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.47$ (hexanes/ethyl acetate 20/1), enol/keto = 14.3/1. The enol isomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 13.04 (s, 1H), 8.01-7.92 (m, 1H), 7.25-7.12 (m, 8H), 5.12 (s, 1H), 3.77 (s, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 171.8, 166.1, 142.7, 134.2, 131.4, 128.5, 127.8, 127.4, 126.6, 126.5, 125.6, 96.9, 52.3, 39.6. HRMS Calculated for $\text{C}_{17}\text{H}_{15}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 299.0736, found: 299.0742.



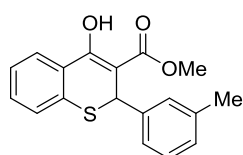
Methyl 4-hydroxy-2-(o-tolyl)-2H-thiochromene-3-carboxylate (1e):

0.701 g, 32% yield (two steps), pale yellow solid, mp 115-116 °C, new compound, $R_f = 0.62$ (hexanes/ethyl acetate 20/1), enol/keto = 12.5/1. The enol isomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 13.08 (s, 1H), 8.06-7.95 (m, 1H), 7.24-7.19 (m, 2H), 7.17-7.14 (m, 1H), 7.12-7.04 (m, 2H), 6.98-6.89 (m, 2H), 5.32 (s, 1H), 3.71 (s, 3H), 2.49 (s, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 171.8, 166.6, 139.8, 134.3, 133.9, 131.4, 130.8, 128.6, 128.1, 127.4, 126.5, 126.2, 126.1, 125.7, 96.5, 52.4, 35.7, 19.7. HRMS Calculated for $\text{C}_{18}\text{H}_{17}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 313.0893, found: 313.0890.



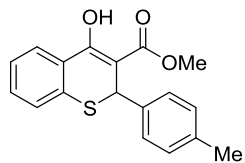
Methyl 4-hydroxy-2-(m-tolyl)-2H-thiochromene-3-carboxylate (1f):

0.575 g, 26% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.62$ (hexanes/ethyl acetate 20/1), enol/keto = 14.3/1. The enol isomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 13.05 (s, 1H), 8.03-7.87 (m, 1H), 7.25-7.14 (m, 3H), 7.11-6.94 (m, 4H), 5.09 (s, 1H), 3.75 (s, 3H), 2.24 (s, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 171.9, 166.1, 142.6, 138.1, 134.2, 131.4, 128.5, 128.3, 128.3, 127.8, 127.4, 126.5, 125.6, 123.7, 96.8, 52.3, 39.6, 21.5. HRMS Calculated for $\text{C}_{18}\text{H}_{17}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 313.0893, found: 313.0889.



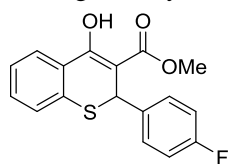
Methyl 4-hydroxy-2-(*p*-tolyl)-2*H*-thiochromene-3-carboxylate (1g):

0.362 g, 17% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.62$ (hexanes/ethyl acetate 20/1), enol/keto = 14.3/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 13.03 (s, 1H), 8.01-7.92 (m, 1H), 7.24-7.14 (m, 3H), 7.08 (d, $J = 8.1$ Hz, 2H), 6.99 (d, $J = 8.0$ Hz, 2H), 5.10 (s, 1H), 3.76 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.9, 166.0, 139.8, 137.2, 134.2, 131.4, 129.2, 128.5, 127.8, 126.5, 126.5, 125.6, 97.0, 52.3, 39.4, 21.1. HRMS Calculated for $\text{C}_{18}\text{H}_{17}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 313.0893, found: 313.0891.



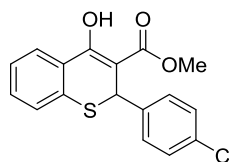
Methyl 2-(4-fluorophenyl)-4-hydroxy-2*H*-thiochromene-3-carboxylate (1h):

0.582 g, 26% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.50$ (hexanes/ethyl acetate 20/1), enol/keto = 20.0/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 13.02 (s, 1H), 8.00-7.93 (m, 1H), 7.30-7.14 (m, 5H), 6.90-6.83 (m, 2H), 5.10 (s, 1H), 3.77 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.7, 166.1, 162.1 (d, $^1J_{\text{F-C}} = 246.0$ Hz), 138.5 (d, $^4J_{\text{F-C}} = 3.0$ Hz), 133.9, 131.5, 128.4, 128.2 (d, $^3J_{\text{F-C}} = 8.3$ Hz), 127.9, 126.5, 125.8, 115.3 (d, $^2J_{\text{F-C}} = 21.7$ Hz), 97.0, 52.4, 39.0. ^{19}F NMR (376 MHz, CDCl_3) δ -115.11. HRMS Calculated for $\text{C}_{17}\text{H}_{14}\text{FO}_3\text{S}$ $[\text{M}+\text{H}]^+$ 317.0642, found: 317.0643.



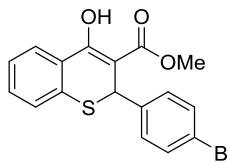
Methyl 2-(4-chlorophenyl)-4-hydroxy-2*H*-thiochromene-3-carboxylate (1i):

0.895 g, 38% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.50$ (hexanes/ethyl acetate 20/1), enol/keto = 14.3/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 13.02 (s, 1H), 7.98-7.93 (m, 1H), 7.29-7.20 (m, 2H), 7.18-7.09 (m, 5H), 5.08 (s, 1H), 3.77 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.6, 166.2, 141.2, 133.7, 133.2, 131.6, 128.6, 128.3, 128.0, 127.9, 126.6, 125.8, 96.7, 52.4, 39.0. HRMS Calculated for $\text{C}_{17}\text{H}_{14}\text{ClO}_3\text{S}$ $[\text{M}+\text{H}]^+$ 333.0347 (^{35}Cl) and 335.0321 (^{37}Cl), found: 333.0350 (^{35}Cl) and 335.0324 (^{37}Cl).



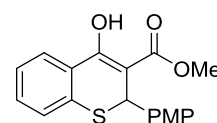
Methyl 2-(4-bromophenyl)-4-hydroxy-2*H*-thiochromene-3-carboxylate (1j):

1.272 g, 48% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.50$ (hexanes/ethyl acetate 20/1), enol/keto = 25.0/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 13.02 (s, 1H), 8.02-7.87 (m, 1H), 7.32-7.14 (m, 5H), 7.12-6.99 (m, 2H), 5.06 (s, 1H), 3.77 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.6, 166.2, 141.7, 133.7, 131.6, 131.6, 128.4, 128.3, 127.9, 126.6, 125.9, 121.4, 96.6, 52.4, 39.1. HRMS Calculated for $\text{C}_{17}\text{H}_{14}\text{BrO}_3\text{S}$ $[\text{M}+\text{H}]^+$ 376.9842 (^{79}Br) and 378.9822 (^{81}Br), found: 376.9844 (^{79}Br) and 378.9832 (^{81}Br).



Methyl 4-hydroxy-2-(4-methoxyphenyl)-2*H*-thiochromene-3-carboxylate (1k):

0.555 g, 34% yield (two steps, 1.0 equivalent amount of organocatalyst was used), light yellow liquid, new compound, $R_f = 0.42$ (hexanes/ethyl acetate 20/1), enol/keto = 11.1/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 13.01 (s, 1H), 7.96 (dd, $J = 7.7, 1.5$ Hz, 1H), 7.26-7.16 (m, 3H), 7.14-7.07 (m, 2H), 6.76-6.68 (m,



2H), 5.09 (s, 1H), 3.77 (s, 3H), 3.71 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.9, 165.9, 158.9, 134.9, 134.2, 131.4, 128.5, 127.9, 127.7, 126.4, 125.6, 113.8, 97.2, 55.2, 52.3, 39.1. HRMS Calculated for $\text{C}_{18}\text{H}_{16}\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 351.0662, found: 351.0665.

Methyl 4-hydroxy-2-methyl-2H-thi chromene-3-carboxylate (1l):

0.488 g, 42% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.67$ (hexanes/ethyl acetate 20/1), enol/keto = 11.1/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 12.67 (s, 1H), 7.95-7.81 (m, 1H), 7.34-7.26 (m, 2H), 7.24-7.19 (m, 1H), 4.02 (q, $J = 6.9$ Hz, 1H), 3.86 (s, 3H), 1.35 (d, $J = 6.9$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.6, 164.5, 134.6, 131.1, 128.2, 128.0, 126.5, 125.4, 100.0, 52.1, 31.9, 23.1. HRMS Calculated for $\text{C}_{12}\text{H}_{16}\text{NO}_3\text{S}$ $[\text{M}+\text{NH}_4]^+$ 254.0845, found: 254.0846.

Methyl 4-hydroxy-6-nitro-2-phenyl-2H-thi chromene-3-carboxylate (1m):

0.296 g, 12% yield (two steps), pale yellow solid, mp 182-183 °C, new compound, $R_f = 0.34$ (hexanes/ethyl acetate 20/1), enol. ^1H NMR (400 MHz, CDCl_3) δ 13.04 (s, 1H), 8.82 (d, $J = 2.5$ Hz, 1H), 8.08 (dd, $J = 8.7, 2.5$ Hz, 1H), 7.30 (d, $J = 8.7$ Hz, 1H), 7.25-7.08 (m, 5H), 5.25 (s, 1H), 3.80 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.3, 163.8, 145.7, 143.3, 141.8, 128.8, 128.7, 128.2, 128.0, 126.5, 125.4, 121.7, 97.6, 52.7, 40.1. HRMS Calculated for $\text{C}_{17}\text{H}_{14}\text{NO}_5\text{S}$ $[\text{M}+\text{H}]^+$ 344.0587, found: 344.0589.

Methyl 4-hydroxy-6-methoxy-2-phenyl-2H-thi chromene-3-carboxylate (1n):

0.092 g, 9% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.54$ (hexanes/ethyl acetate 20/1), enol/keto = 12.5/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 13.07 (s, 1H), 7.51 (d, $J = 2.8$ Hz, 1H), 7.23-7.10 (m, 5H), 7.06 (d, $J = 8.6$ Hz, 1H), 6.84 (dd, $J = 8.6, 2.8$ Hz, 1H), 5.09 (s, 1H), 3.82 (s, 3H), 3.76 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.9, 166.1, 157.9, 142.6, 129.5, 128.9, 128.4, 127.4, 126.7, 124.8, 118.7, 110.9, 97.5, 55.5, 52.3, 39.6. HRMS Calculated for $\text{C}_{18}\text{H}_{16}\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 351.0662, found: 351.0657.

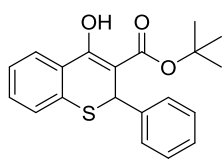
Methyl 4-hydroxy-6-methyl-2-phenyl-2H-thi chromene-3-carboxylate (1o):

0.994 g, 40% yield (two steps), pale yellow solid, mp 143-144 °C, new compound, $R_f = 0.59$ (hexanes/ethyl acetate 20/1), enol/keto = 11.1/1. The enol isomer: ^1H NMR (400 MHz, CDCl_3) δ 13.05 (s, 1H), 7.78 (s, 1H), 7.23-7.10 (m, 5H), 7.10-7.01 (m, 2H), 5.10 (s, 1H), 3.76 (s, 3H), 2.34 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.9, 166.3, 142.8, 135.5, 132.4, 130.6, 128.4, 128.3, 127.7, 127.4, 126.9, 126.6, 97.0, 52.3, 39.6, 21.1. HRMS Calculated for $\text{C}_{18}\text{H}_{17}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 313.0893, found: 313.0892.

tert-Butyl 4-hydroxy-2-phenyl-2H-thi chromene-3-carboxylate (1p):

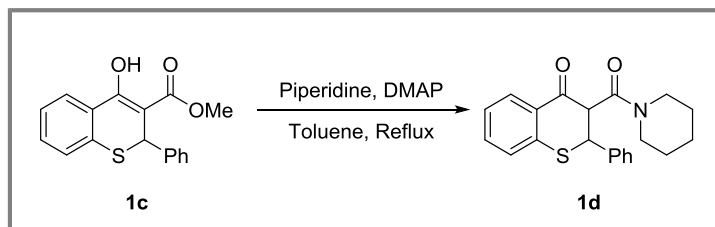
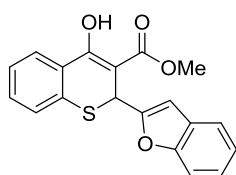
0.250 g, 8% yield (two steps), pale yellow viscous liquid, new compound, $R_f = 0.62$ (hexanes/ethyl acetate 20/1), enol/keto = 2.5/1. The enol and keto mixture: ^1H NMR (400 MHz, CDCl_3) δ 13.24 (s, 1H, enol), 8.15 (dd, $J = 8.0, 1.2$ Hz, 1H, keto), 7.95 (dd, $J = 7.7, 1.5$ Hz, 1H, enol),

7.45-7.16 (m, 16H, enol and keto), 5.05 (s, 1H, enol), 4.93 (d, $J = 12.6$ Hz, 1H, keto), 4.19 (d, $J = 12.6$ Hz, 1H, keto), 1.42 (s, 9H, enol), 1.23 (s, 9H, keto). ^{13}C NMR (100 MHz, CDCl_3) δ 190.9, 171.3, 166.9, 165.3, 143.5, 141.5, 136.5, 134.0, 133.9, 131.1, 129.9, 129.7, 128.8, 128.8, 128.7, 128.4, 128.3, 127.6, 127.3, 126.9, 126.4, 126.3, 125.5, 125.4, 98.6, 82.6, 82.2, 62.6, 47.6, 40.2, 28.1, 27.6. HRMS Calculated for $\text{C}_{20}\text{H}_{21}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 341.1206, found: 341.1203.



Methyl 2-(benzofuran-2-yl)-4-hydroxy-2H-thiochromene-3-carboxylate (**1q**):

0.732 g, 23% yield (two steps), yellow solid, mp 146-147 °C, new compound, $R_f = 0.51$ (hexanes/ethyl acetate 20/1), enol. ^1H NMR (400 MHz, CDCl_3) δ 13.03 (s, 1H), 7.98 (dd, $J = 7.3, 1.8$ Hz, 1H), 7.38 (dd, $J = 18.4, 8.0$ Hz, 2H), 7.27-7.17 (m, 4H), 7.14-7.09 (m, 1H), 6.30 (s, 1H), 5.31 (s, 1H), 3.80 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 171.5, 166.5, 156.5, 155.1, 133.9, 131.6, 128.2, 128.1, 128.0, 126.8, 125.9, 124.3, 122.7, 120.8, 111.3, 104.8, 94.8, 52.4, 34.4. HRMS Calculated for $\text{C}_{19}\text{H}_{14}\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 361.0505, found: 361.0499.



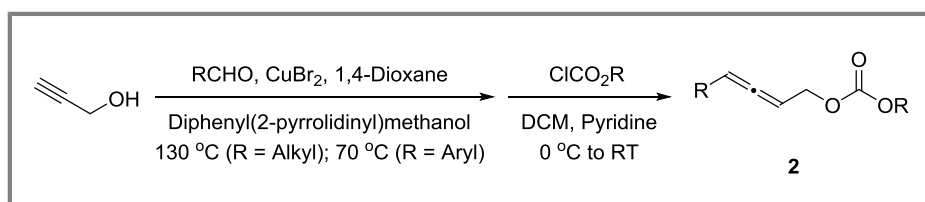
To a solution of thiochromanone derivative **1c** (2.5 mmol, 0.746 g) in toluene (25 mL) was added the piperidine (5.0 mmol, 0.426 g) and 4-dimethylaminopyridine (DMAP) (1.0 mmol, 0.122 g) sequentially. The mixture was refluxed for 24 hours. After cooling to room temperature, the reaction mixture was concentrated under reduced pressure to afford the crude residue. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate/dichloromethane (20/1/1-3/1/1) as eluent to give the desirable thiochromanone derivative with amide **1d**.

2-Phenyl-3-(piperidine-1-carbonyl)thiochroman-4-one (**1d**):

0.335 g, 38% yield, white solid, mp 202-203 °C, new compound, $R_f = 0.43$ (hexanes/ethyl acetate 3/1), keto. ^1H NMR (400 MHz, CDCl_3) δ 8.12 (dd, $J = 8.0, 1.3$ Hz, 1H), 7.51-7.40 (m, 3H), 7.38-7.26 (m, 4H), 7.25-7.18 (m, 1H), 5.27 (d, $J = 12.5$ Hz, 1H), 4.54 (d, $J = 12.5$ Hz, 1H), 3.71-3.55 (m, 1H), 3.53-3.41 (m, 1H), 3.39-3.30 (m, 1H), 3.29-3.11 (m, 1H), 1.65-1.37 (m, 4H), 1.27-1.04 (m, 2H). ^{13}C NMR (100 MHz, CDCl_3) δ 192.0, 166.0, 141.5, 137.3, 133.9, 130.5, 129.9, 128.8, 128.5, 128.1, 127.2, 125.5, 58.5, 48.5, 47.5, 43.1, 26.3, 25.5, 24.5. HRMS Calculated for $\text{C}_{21}\text{H}_{22}\text{NO}_2\text{S}$ $[\text{M}+\text{H}]^+$ 352.1366, found: 352.1367.

2.2. Synthesis of Allenylic Carbonates

The allenylic carbonates **2a-2m** could be conveniently synthesized from the commercially available propargyl alcohol and aldehydes through two steps according to the known procedure,^{3,4} all of which are new compounds. Firstly, the propargyl alcohol underwent copper-catalyzed reactions with aldehydes to provide the intermediate allenylic alcohols.³ Then, the allenylic carbonates **2** were prepared from the above allenylic alcohol intermediates according to the known literature procedure with slight modification.⁴ In addition, allenylic carbonate **2n**, a new compound, could be synthesized through two steps according to the known procedure.^{4,5} Firstly, the propargylic dioxolanone **S1** underwent copper-catalyzed S_N2' substitution with Grignard reagent to provide the intermediate α -hydroxyallene.⁵ Then, the allenylic carbonate **2n** was prepared from the above α -hydroxyallene intermediate according to the known literature procedure with slight modification.⁴

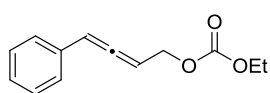


General Procedure: To a dried Schlenk flask were sequentially added copper dibromide (1.787 g, 8.0 mmol), diphenyl(2-pyrrolidinyl)methanol (5.067 g, 20 mmol), 1,4-dioxane (40 mL), aldehydes (30 mmol), and propargyl alcohol (1.682 g, 30 mmol) under the nitrogen atmosphere. The mixture was stirred in an oil bath preheated at 70 °C or 130 °C for 12-20 h. After cooling to room temperature, the resulting mixture was diluted with diethyl ether (60 mL), which was washed with an aqueous solution of hydrochloric acid (3.0 M, 60 mL). After separation, the aqueous layer was extracted with diethyl ether (60 mL \times 3). The combined organic layer was dried over anhydrous sodium sulfate, filtered and concentrated under the reduced pressure. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate (20/1-5/1) as eluent to afford the intermediate allenylic alcohols.

A solution of the above allenylic alcohols (9.7 mmol) and pyridine (2.34 mL, 29.1 mmol) in dichloromethane (25 mL) was cooled to 0 °C. The ethyl chloroformate (1.85 mL, 19.4 mmol) (or isopropyl chloroformate) was added dropwise over a period of 5 minutes. The reaction mixture was allowed to warm to room temperature. When the reaction was completed as monitored by TLC, the reaction mixture was acidified with the hydrogen chloride aqueous solution (3.0 M) to pH 5-6 and extracted three times with dichloromethane. The combined organic layer was dried over anhydrous sodium sulfate, filtered and concentrated under the reduced pressure. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate (50/1) as eluent to give the desirable allenylic carbonates **2**.

Ethyl (4-phenylbuta-2,3-dien-1-yl) carbonate (**2a**):

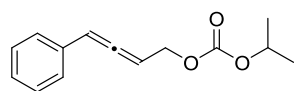
0.184 g, 24% yield (two steps), yellow liquid, new compound, $R_f = 0.49$ (hexanes/ethyl acetate 10/1). ¹H NMR (400 MHz, CDCl₃) δ 7.33-7.28 (m, 4H), 7.25-7.14 (m, 1H), 6.37-6.28 (m, 1H), 5.84-5.68 (m, 1H), 4.78-4.67 (m, 2H), 4.20 (q, $J = 7.1$ Hz, 2H), 1.29 (t, $J = 7.1$ Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.7, 155.0, 133.2, 128.7, 127.4, 127.1, 96.7, 90.8, 65.1, 64.2, 14.3. HRMS Calculated for



C₁₃H₁₈NO₃ [M+NH₄]⁺ 236.1281, found: 236.1280.

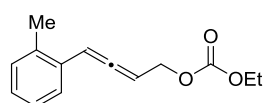
Isopropyl (4-phenylbuta-2,3-dien-1-yl) carbonate (2a'')

1.120 g, 45% yield (two steps), yellow liquid, new compound, R_f = 0.56 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.33-7.27 (m, 4H), 7.25-7.19 (m, 1H), 6.37-6.26 (m, 1H), 5.83-5.64 (m, 1H), 4.92-4.83 (m, 1H), 4.76-4.66 (m, 2H), 1.30 (d, *J* = 6.3 Hz, 3H), 1.26 (d, *J* = 6.3 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.6, 154.5, 133.2, 128.7, 127.4, 127.1, 96.7, 90.9, 72.2, 64.9, 21.8, 21.7. HRMS Calculated for C₁₄H₁₆NaO₃ [M+Na]⁺ 255.0992, found: 255.0993.



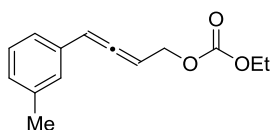
Ethyl (4-(*o*-tolyl)buta-2,3-dien-1-yl) carbonate (2b):

0.191 g, 4% yield (two steps), yellow liquid, new compound, R_f = 0.53 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.39-7.32 (m 1H), 7.18-7.10 (m, 3H), 6.58-6.43 (m, 1H), 5.72 (q, *J* = 6.7 Hz, 1H), 4.77-4.69 (m, 2H), 4.21 (q, *J* = 7.1 Hz, 2H), 2.36 (s, 3H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 207.4, 155.0, 135.3, 131.4, 130.5, 127.6, 127.4, 126.2, 94.0, 89.8, 65.4, 64.2, 19.9, 14.3. HRMS Calculated for C₁₄H₁₇O₃ [M+H]⁺ 233.1172, found: 233.1174.



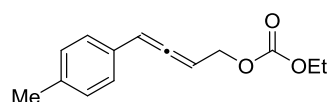
Ethyl (4-(*m*-tolyl)buta-2,3-dien-1-yl) carbonate (2c):

1.212 g, 26% yield (two steps), yellow liquid, new compound, R_f = 0.53 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.20 (t, *J* = 7.5 Hz, 1H), 7.13-7.07 (m, 2H), 7.04 (d, *J* = 7.5 Hz, 1H), 6.33-6.25 (m, 1H), 5.80-5.69 (m, 1H), 4.77-4.68 (m, 2H), 4.20 (q, *J* = 7.1 Hz, 2H), 2.33 (s, 3H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.7, 155.0, 138.3, 133.0, 128.6, 128.3, 127.7, 124.2, 96.7, 90.6, 65.3, 64.2, 21.4, 14.3. HRMS Calculated for C₁₄H₁₆NaO₃ [M+Na]⁺ 255.0992, found: 255.0994.



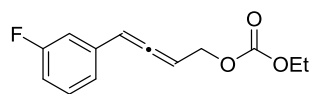
Ethyl (4-(*p*-tolyl)buta-2,3-dien-1-yl) carbonate (2d):

1.571 g, 34% yield (two steps), yellow liquid, new compound, R_f = 0.53 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.19 (d, *J* = 8.0 Hz, 2H), 7.12 (d, *J* = 8.0 Hz, 2H), 6.35-6.21 (m, 1H), 5.84-5.63 (m, 1H), 4.77-4.67 (m, 2H), 4.20 (q, *J* = 7.1 Hz, 2H), 2.33 (s, 3H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.5, 155.0, 137.3, 130.1, 129.4, 127.0, 96.5, 90.6, 65.3, 64.2, 21.3, 14.3. HRMS Calculated for C₁₄H₁₆KO₃ [M+K]⁺ 271.0731, found: 271.0732.



Ethyl (4-(3-fluorophenyl)buta-2,3-dien-1-yl) carbonate (2e):

1.775 g, 38% yield (two steps), yellow liquid, new compound, R_f = 0.44 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.29-7.26 (m, 1H), 7.06 (d, *J* = 7.7 Hz, 1H), 7.00 (d, *J* = 9.9 Hz, 1H), 6.96-6.86 (m, 1H), 6.36-6.22 (m, 1H), 5.90-5.64 (m, 1H), 4.78-4.68 (m, 2H), 4.20 (q, *J* = 7.1 Hz, 2H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.8, 163.1 (d, ¹J_{F-C} = 243.9 Hz), 154.9, 135.7 (d, ³J_{F-C} = 7.9 Hz), 130.1 (d, ³J_{F-C} = 8.3 Hz), 122.8 (d, ⁴J_{F-C} = 2.7 Hz), 114.3 (d, ²J_{F-C} = 21.4 Hz), 113.6 (d, ²J_{F-C} = 22.12 Hz), 96.1 (d, ⁴J_{F-C} = 2.6 Hz), 91.2, 64.8, 64.3, 14.3. ¹⁹F NMR



(376 MHz, CDCl₃) δ -113.32. The HRMS Calculated for C₁₃H₁₄FO₃ [M+H]⁺ 237.0921, found: 237.0922.

4-(3-Chlorophenyl)buta-2,3-dien-1-yl ethyl carbonate (2f):

2.096 g, 42% yield (two steps), yellow liquid, new compound, R_f = 0.39 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.28 (s, 1H), 7.26-7.14 (m, 3H), 6.31-6.23 (m, 1H), 5.87-5.73 (m, 1H), 4.77-4.69 (m, 2H), 4.21 (q, *J* = 7.1 Hz, 2H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.8, 154.9, 135.3, 134.6, 129.9, 127.4, 126.9, 125.2, 95.9, 91.3, 64.7, 64.3, 14.3. HRMS Calculated for C₁₃H₁₇ClNO₃ [M+NH₄]⁺ 270.0891 (³⁵Cl) and 272.0866 (³⁷Cl), found: 270.0889 (³⁵Cl) and 272.0856 (³⁷Cl).

4-(3-Bromophenyl)buta-2,3-dien-1-yl ethyl carbonate (2g):

2.252 g, 38% yield (two steps), yellow liquid, new compound, R_f = 0.38 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.43 (s, 1H), 7.38-7.30 (m, 1H), 7.23-7.13 (m, 2H), 6.37-6.15 (m, 1H), 5.88-5.69 (m, 1H), 4.77-4.68 (m, 2H), 4.21 (q, *J* = 7.1 Hz, 2H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.7, 154.9, 135.5, 130.3, 130.1, 129.8, 125.7, 122.8, 95.8, 91.4, 64.7, 64.3, 14.3. HRMS Calculated for C₁₃H₁₇BrNO₃ [M+NH₄]⁺ 314.0386 (⁷⁹Br) and 316.0367 (⁸¹Br), found: 314.0392 (⁷⁹Br) and 316.0374 (⁸¹Br).

Ethyl 4-(3-methoxyphenyl)buta-2,3-dien-1-yl carbonate (2h):

1.390 g, 28% yield (two steps), yellow liquid, new compound, R_f = 0.34 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.22 (t, *J* = 7.9 Hz, 1H), 6.92-6.825 (m, 2H), 6.78 (dd, *J* = 8.2, 2.3 Hz, 1H), 6.33-6.22 (m, 1H), 5.83-5.65 (m, 1H), 4.77-4.68 (m, 2H), 4.19 (q, *J* = 7.1 Hz, 2H), 3.81 (s, 3H), 1.29 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.7, 159.9, 154.9, 134.6, 129.6, 119.7, 113.3, 112.2, 96.7, 90.9, 65.1, 64.2, 55.2, 14.3. HRMS Calculated for C₁₄H₁₇O₄ [M+H]⁺ 249.1121, found: 249.1119.

4-(3,5-Dimethylphenyl)buta-2,3-dien-1-yl ethyl carbonate (2i):

2.200 g, 45% yield (two steps), pale yellow liquid, new compound, R_f = 0.45 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 6.91 (s, 2H), 6.86 (s, 1H), 6.27-6.20 (m, 1H), 5.83-5.62 (m, 1H), 4.75-4.68 (m, 2H), 4.24-4.16 (m, 2H), 2.29 (s, 6H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 206.7, 155.0, 138.2, 132.9, 129.2, 124.9, 96.7, 90.5, 65.3, 64.2, 21.2, 14.3. HRMS Calculated for C₁₅H₁₉O₃ [M+H]⁺ 247.1329, found: 247.1328.

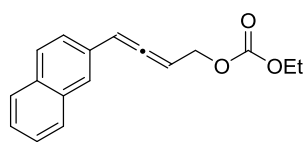
4-([1,1'-Biphenyl]-4-yl)buta-2,3-dien-1-yl ethyl carbonate (2j):

2.123 g, 36% yield (two steps), yellow liquid, new compound, R_f = 0.32 (hexanes/ethyl acetate 20/1). ¹H NMR (400 MHz, CDCl₃) δ 7.60-7.53 (m, 4H), 7.45-7.41 (m, 2H), 7.38-7.31 (m, 3H), 6.38-6.33 (m, 1H), 5.86-5.69 (m, 1H), 4.79-4.69 (m, 2H),

4.24-4.17 (m, 2H), 1.30 (t, $J = 7.1$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 206.9, 155.0, 140.7, 140.3, 132.2, 128.8, 127.5, 127.4, 127.4, 127.0, 96.4, 90.9, 65.1, 64.2, 14.3. HRMS Calculated for $\text{C}_{19}\text{H}_{19}\text{O}_3$ $[\text{M}+\text{H}]^+$ 295.1329, found: 295.1327.

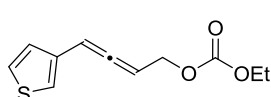
Ethyl (4-(naphthalen-2-yl)buta-2,3-dien-1-yl) carbonate (2k):

1.834 g, 34% yield (two steps), pale yellow liquid, new compound, $R_f = 0.57$ (hexanes/ethyl acetate 20/1). ^1H NMR (400 MHz, CDCl_3) δ 7.82-7.73 (m, 3H), 7.65 (s, 1H), 7.48-7.38 (m, 3H), 6.57-6.42 (m, 1H), 5.94-5.67 (m, 1H), 4.81-4.71 (m, 2H), 4.25-4.14 (m, 2H), 1.28 (t, $J = 7.1$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.2, 155.0, 133.6, 132.9, 130.7, 128.4, 127.8, 127.8, 126.4, 126.1, 125.9, 124.7, 97.1, 91.1, 65.2, 64.2, 14.3. HRMS Calculated for $\text{C}_{17}\text{H}_{20}\text{NO}_3$ $[\text{M}+\text{NH}_4]^+$ 286.1438, found: 286.1437.



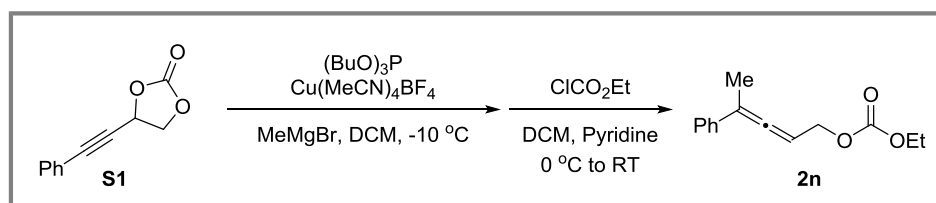
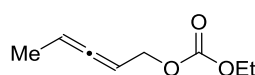
Ethyl (4-(thiophen-3-yl)buta-2,3-dien-1-yl) carbonate (2l):

1.726 g, 38% yield (two steps), yellow liquid, new compound, $R_f = 0.62$ (hexanes/ethyl acetate 20/1). ^1H NMR (400 MHz, CDCl_3) δ 7.27-7.25 (m, 1H), 7.11 (d, $J = 2.8$ Hz, 1H), 7.09-7.02 (m, 1H), 6.45-6.33 (m, 1H), 5.77-5.59 (m, 1H), 4.74-4.65 (m, 2H), 4.19 (q, $J = 7.1$ Hz, 2H), 1.29 (t, $J = 7.1$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.0, 154.9, 134.3, 126.4, 126.1, 121.7, 91.3, 90.0, 65.1, 64.2, 14.3. HRMS Calculated for $\text{C}_{11}\text{H}_{12}\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 247.0399, found: 247.0401.



Ethyl penta-2,3-dien-1-yl carbonate (2m):

0.408 g, 13% yield (two steps), colorless liquid, new compound, $R_f = 0.58$ (hexanes/ethyl acetate 20/1). ^1H NMR (400 MHz, CDCl_3) δ 5.41-5.10 (m, 2H), 4.63-4.56 (m, 2H), 4.20 (q, $J = 7.1$ Hz, 2H), 1.68 (dd, $J = 5.7, 4.5$ Hz, 3H), 1.31 (t, $J = 7.1$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 206.5, 155.0, 87.7, 85.9, 66.0, 64.0, 14.3, 13.8. HRMS Calculated for $\text{C}_8\text{H}_{13}\text{O}_3$ $[\text{M}+\text{H}]^+$ 157.0859, found: 157.0859.



To a dried Schlenk flask were sequentially added catalyst $\text{Cu}(\text{MeCN})_4\text{BF}_4$ (0.189 g, 0.6 mmol), $(n\text{-BuO})_3\text{P}$ (0.32 mL, 1.2 mmol) and dichloromethane (10 mL) under the nitrogen atmosphere. The mixture was stirred at room temperature for 1 h. After cooling to -10 °C, the methylmagnesium bromide (12 mL, 1.0 M in tetrahydrofuran, 12 mmol) was added and the reaction was stirred for 30 min at -10 °C. Then, a solution of the dioxolanone **S1** (1.129 g, 6 mmol) in dichloromethane (5.0 mL) was added and the reaction mixture was stirred at -10 °C for 22 h. Afterwards, the reaction mixture was quenched with ammonium chloride saturated solution. After separation, the aqueous layer was extracted with diethyl ether (20 mL \times 3). The combined organic layer was dried over anhydrous sodium sulfate, filtered and concentrated under the reduced pressure. The residue was purified by flash chromatography on silica gel using hexanes/ethyl

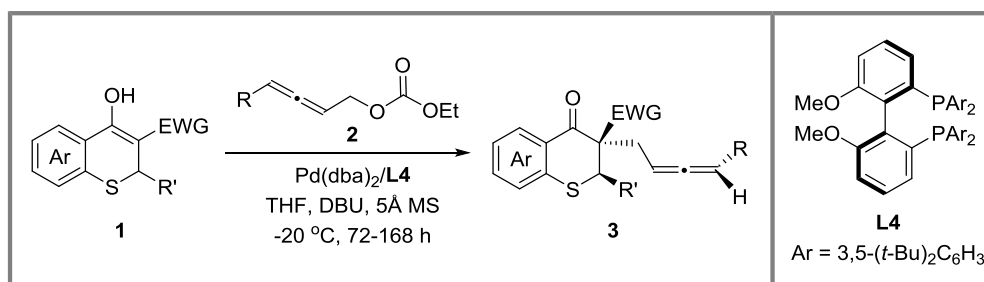
acetate (20/1-10/1) as eluent to afford the intermediate α -hydroxyallene.

A solution of the above α -hydroxyallene (0.343 g, 2.1 mmol) and pyridine (0.51 mL, 6.3 mmol) in dichloromethane (10 mL) was cooled to 0 °C. The ethyl chloroformate (0.40 mL, 4.2 mmol) was added dropwise over a period of 5 minutes. The reaction mixture was allowed to warm to room temperature. When the reaction was completed as monitored by TLC, the reaction mixture was acidified with the hydrogen chloride aqueous solution (3.0 M) to pH 5-6 and extracted three times with dichloromethane. The combined organic layer was dried over anhydrous sodium sulfate, filtered and concentrated under the reduced pressure. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate (50/1) as eluent to give the desirable allenylic carbonate **2n**.

Ethyl (4-phenylpenta-2,3-dien-1-yl) carbonate (2n):

0.451 g, 33% yield (two steps), pale yellow liquid, new compound, $R_f = 0.67$ (hexanes/ethyl acetate 20/1). $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.42-7.37 (m, 2H), 7.35-7.29 (m, 2H), 7.25-7.19 (m, 1H), 5.73-5.57 (m, 1H), 4.70 (d, $J = 6.8$ Hz, 2H), 4.20 (q, $J = 7.1$ Hz, 2H), 2.12 (d, $J = 2.8$ Hz, 3H), 1.30 (t, $J = 7.1$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 205.8, 155.0, 136.0, 128.4, 127.1, 125.9, 102.9, 88.7, 65.7, 64.1, 16.8, 14.3. HRMS Calculated for $\text{C}_{14}\text{H}_{20}\text{NO}_3$ $[\text{M}+\text{NH}_4]^+$ 250.1438, found: 250.1443.

3. Palladium-Catalyzed Asymmetric Allenylic Alkylation



The metal precursor Pd(dba)₂ (0.02 mmol, 11.5 mg, 10 mol%), ligand (*R*)-DTB-BIPHEP (**L4**) (0.022 mmol, 22.7 mg, 11 mol%) and tetrahydrofuran (1.5 mL) were placed in a dried Schlenk tube under nitrogen atmosphere. The mixture was stirred at 30 °C for 30 min. Then the mixture was cooled to -20 °C. Thereafter, the thiochromanone derivatives **1** (0.2 mmol), 5Å MS (50.0 mg) and 1,8-diazabicyclo[5,4,0]undec-7-ene (DBU) (35.9 μL, 0.24 mmol) were added and the reaction was stirred at -20 °C for 10 minutes. Sequentially, the allenylic carbonates **2** (0.3 mmol) and tetrahydrofuran (0.5 mL) were added slowly. The mixture was stirred at -20 °C for 72-168 h. After the completion of the reaction, the volatiles were directly removed under the reduced pressure. The residue was quickly purified by column chromatography on silica gel (hexanes/ethyl acetate/dichloromethane 100/1/2-100/3/6) to give the desirable allenylic alkylation products **3**.

The racemates were prepared by running reactions with an achiral 1,3-bis(diphenylphosphino)propane ligand at 30 °C. It was worth noting that the products **3** were sensitive to water or alcohol, which would lead to partial decrease of dr value.

(-)-Methyl 4-oxo-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (**3ca**):

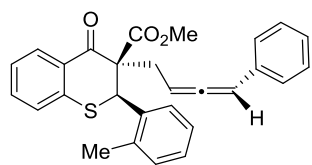
The reaction was conducted at -20 °C for 72 h. 78.5 mg, 92% yield, pale yellow viscous liquid, new compound, R_f = 0.28 (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer), [α]_D²⁰ = -209.67 (*c* 0.63, CHCl₃). The major diastereoisomer: ¹H NMR (400 MHz, CDCl₃) δ 8.17 (d, *J* = 7.9 Hz, 1H), 7.43-7.31 (m, 6H), 7.27-7.22 (m, 4H), 7.20-7.10 (m, 3H), 6.22-5.96 (m, 1H), 5.66-5.43 (m, 1H), 4.98 (s, 1H), 3.65 (s, 3H), 3.22-3.02 (m, 1H), 2.73-2.51 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 207.4, 192.4, 169.7, 141.5, 135.6, 133.9, 133.2, 130.8, 130.5, 129.2, 128.9, 128.6, 128.5, 127.3, 127.1, 126.8, 125.5, 95.5, 89.9, 62.7, 52.4, 51.1, 32.5. HPLC: Chiralpak IC column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 95/5, flow = 1.0 mL/min, retention time 15.0 min (minor) and 16.0 min (major). HRMS Calculated for the C₂₇H₂₃O₃S [M+H]⁺ 427.1362, found: 427.1372.

The mixture with low 2.3:1 dr: ¹H NMR (400 MHz, CDCl₃) δ 8.17 (d, *J* = 7.9 Hz, 1H, major), 7.88 (d, *J* = 7.9 Hz, 1H, minor), 7.40-7.12 (m, 26H, major + minor), 6.16-6.01 (m, 2H, major + minor), 5.62-5.45 (m, 2H, major + minor), 5.09 (s, 1H, minor), 4.98 (s, 1H, major), 3.65 (s, 6H, major + minor), 3.18-3.04 (m, 2H, major + minor), 2.67-2.53 (m, 2H, major + minor). ¹³C NMR (100 MHz, CDCl₃) δ 207.4, 207.2, 192.4, 192.2, 169.7, 169.7, 141.5, 141.0, 135.7, 135.6, 133.9, 133.8, 133.2, 133.0, 130.8, 130.8, 130.5, 130.4, 129.2, 129.0, 128.9, 128.8, 128.6, 128.5, 128.5, 128.4, 127.3, 127.2, 127.1, 127.0, 126.9, 126.8, 125.5, 125.4, 95.9, 95.5, 90.0,

89.9, 62.9, 62.7, 52.4, 52.3, 51.1, 50.9, 32.5, 32.3.

(-)-Methyl 4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)-2-(*o*-tolyl)thiochromane-3-carboxylate (3ea):

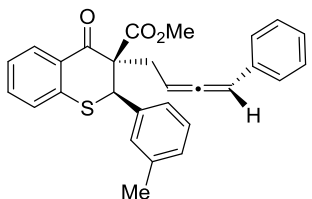
The reaction was conducted at -20 °C for 120 h. 71.9 mg, 82% yield, pale yellow viscous liquid, new compound, $R_f = 0.36$ (hexanes/ethyl acetate 20/1), 24.0:1 dr, 98% ee (major diastereoisomer),



$[\alpha]_D^{20} = -25.30$ (c 0.83, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.20 (dd, $J = 8.0, 1.3$ Hz, 1H), 7.52 (d, $J = 7.7$ Hz, 1H), 7.42-7.34 (m, 1H), 7.29-7.09 (m, 10H), 6.00-5.85 (m, 1H), 5.65-5.43 (m, 1H), 5.04 (s, 1H), 3.62 (s, 3H), 3.15-3.00 (m, 1H), 2.84-2.69 (m, 1H), 2.41 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.0, 192.1, 170.1, 141.3, 136.4, 134.9, 134.1, 133.2, 130.9, 130.8, 130.5, 128.5, 128.5, 128.1, 127.1, 127.0, 126.9, 126.4, 125.4, 94.9, 89.9, 62.0, 52.5, 47.0, 32.8, 20.3. HPLC: Chiralpak ID column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 97/3, flow = 1.0 mL/min, retention time 13.9 min (major) and 16.6 min. HRMS Calculated for $\text{C}_{28}\text{H}_{24}\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 463.1338, found: 463.1341.

(-)-Methyl 4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)-2-(*m*-tolyl)thiochromane-3-carboxylate(3fa):

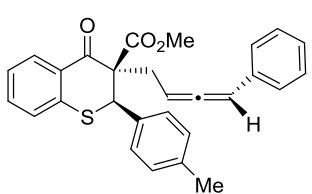
The reaction was conducted at -20 °C for 120 h. 78.1 mg, 89% yield, pale yellow viscous liquid, new compound, $R_f = 0.36$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer),



$[\alpha]_D^{20} = -241.32$ (c 0.90, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.24-8.10 (m, 1H), 7.42-7.37 (m, 1H), 7.27-7.13 (m, 10H), 6.19-6.00 (m, 1H), 5.60-5.41 (m, 1H), 4.97 (s, 1H), 3.65 (s, 3H), 3.22-3.03 (m, 1H), 2.69-2.52 (m, 1H), 2.33 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.5, 192.5, 169.7, 141.7, 138.1, 135.3, 134.0, 133.2, 130.8, 130.5, 130.1, 129.7, 128.6, 128.4, 127.3, 127.1, 126.8, 126.1, 125.5, 95.5, 90.0, 62.7, 52.3, 51.1, 32.4, 21.5. HPLC: Chiralcel OD-3 column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 0.8 mL/min, retention time 10.2 min and 23.6 min (major). HRMS Calculated for $\text{C}_{28}\text{H}_{24}\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 463.1338, found: 463.1342.

(-)-Methyl 4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)-2-(*p*-tolyl)thiochromane-3-carboxylate(3ga):

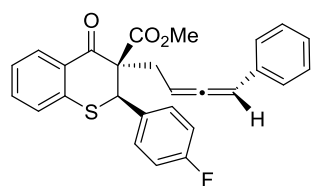
The reaction was conducted at -20 °C for 120 h. 79.3 mg, 90% yield, pale yellow viscous liquid, new compound, $R_f = 0.36$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer),



$[\alpha]_D^{20} = -226.76$ (c 0.93, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.31-8.04 (m, 1H), 7.43-7.37 (m, 1H), 7.27-7.22 (m, 6H), 7.20-7.11 (m, 5H), 6.21-6.00 (m, 1H), 5.61-5.41 (m, 1H), 4.96 (s, 1H), 3.65 (s, 3H), 3.16-3.03 (m, 1H), 2.64-2.55 (m, 1H), 2.34 (s, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.4, 192.6, 169.8, 141.7, 138.8, 134.0, 133.2, 132.4, 130.9, 130.5, 129.2, 129.0, 128.6, 127.3, 127.0, 126.9, 125.5, 95.5, 89.9, 62.8, 52.4, 50.9, 32.4, 21.2. HPLC: Chiralpak IA, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 1.0 mL/min, retention time 13.6 min and 17.4 min (major). HRMS Calculated for $\text{C}_{28}\text{H}_{24}\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 463.1338, found: 463.1340.

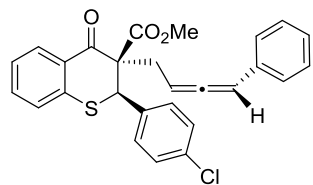
(-)-Methyl 2-(4-fluorophenyl)-4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3ha): The reaction was conducted at -20 °C for 120 hours. 83.4 mg, 94% yield, pale yellow

viscous liquid, new compound, $R_f = 0.40$ (hexanes/ethyl acetate 20/1), 49.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -215.33$ (c 0.73, CHCl_3). The major diastereoisomer:



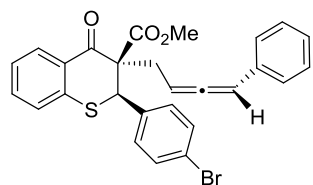
$^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.17 (dd, $J = 8.0, 1.2$ Hz, 1H), 7.44-7.34 (m, 3H), 7.27-7.22 (m, 4H), 7.20-7.12 (m, 3H), 7.07-6.96 (m, 2H), 6.18-5.97 (m, 1H), 5.63-5.41 (m, 1H), 4.95 (s, 1H), 3.65 (s, 3H), 3.17-3.04 (m, 1H), 2.63-2.50 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.4, 192.1, 169.7, 162.8 (d, $^1J_{\text{F-C}} = 248.6$ Hz), 141.2, 133.8, 133.3, 131.4 (d, $^4J_{\text{F-C}} = 3.4$ Hz), 131.0, 131.0, 130.8, 130.5, 128.6, 127.2 (d, $^3J_{\text{F-C}} = 8.9$ Hz), 126.8, 125.7, 115.5 (d, $^2J_{\text{F-C}} = 21.6$ Hz), 95.6, 89.8, 62.6, 52.4, 50.3, 32.4. $^{19}\text{F NMR}$ (376 MHz, CDCl_3) δ -112.38. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 1.0 mL/min, retention time 9.6 min and 15.7 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{21}\text{FNaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 467.1088, found: 467.1087.

(-)-Methyl 2-(4-chlorophenyl)-4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3ia): The reaction was conducted at -20 °C for 120 hours. 88.3 mg, 96% yield, pale yellow viscous liquid, new compound, $R_f = 0.40$ (hexanes/ethyl acetate 20/1), 49.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -200.57$ (c 1.03, CHCl_3). The major diastereoisomer:



$^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.17 (d, $J = 7.9$ Hz, 1H), 7.44-7.38 (m, 1H), 7.35-7.28 (m, 4H), 7.27-7.21 (m, 4H), 7.19-7.13 (m, 3H), 6.19-5.99 (m, 1H), 5.60-5.40 (m, 1H), 4.93 (s, 1H), 3.64 (s, 3H), 3.17-3.04 (m, 1H), 2.64-2.53 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.4, 192.0, 169.6, 141.0, 134.8, 134.1, 133.8, 133.4, 130.8, 130.6, 130.5, 128.7, 128.6, 127.3, 127.2, 126.9, 125.7, 95.6, 89.8, 62.5, 52.5, 50.5, 32.5. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 1.0 mL/min, retention time 10.2 min and 16.5 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{21}\text{ClNaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 483.0792 (^{35}Cl) and 485.0773 (^{37}Cl), found: 483.0793 (^{35}Cl) and 485.0792 (^{37}Cl).

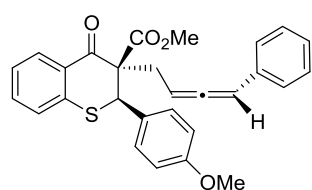
(-)-Methyl 2-(4-bromophenyl)-4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3ja): The reaction was conducted at -20 °C for 120 hours. 94.5 mg, 93% yield, pale yellow viscous liquid, new compound, $R_f = 0.40$ (hexanes/ethyl acetate 20/1), 49.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -186.71$ (c 1.10, CHCl_3). The major diastereoisomer:



$^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.17 (dd, $J = 8.0, 1.2$ Hz, 1H), 7.51-7.35 (m, 3H), 7.28-7.21 (m, 6H), 7.19-7.13 (m, 3H), 6.14-6.00 (m, 1H), 5.57-5.44 (m, 1H), 4.91 (s, 1H), 3.64 (s, 3H), 3.17-3.04 (m, 1H), 2.62-2.52 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.4, 192.0, 169.6, 141.0, 134.6, 133.8, 133.4, 131.7, 130.9, 130.7, 130.5, 128.6, 127.3, 127.2, 126.9, 125.7, 123.0, 95.6, 89.8, 62.5, 52.5, 50.5, 32.5. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 1.0 mL/min, retention time 11.1 min (minor) and 17.2 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{21}\text{BrNaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 527.0287 (^{79}Br) and 529.0270 (^{81}Br), found: 527.0292 (^{79}Br) and 529.0275 (^{81}Br).

(-)-Methyl 2-(4-methoxyphenyl)-4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3ka): The reaction was conducted at -20 °C for 72 h. 76.9 mg, 84% yield, pale yellow viscous liquid, new compound, $R_f = 0.23$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -186.71$ (c 1.10, CHCl_3). The major diastereoisomer:

diastereoisomer), $[\alpha]_D^{20} = -208.12$ (c 1.07, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.21-8.09 (m, 1H), 7.43-7.34 (m, 1H), 7.33-7.27 (m, 2H), 7.26-7.20 (m, 4H),

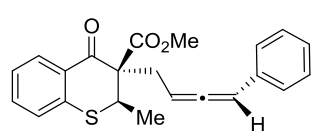


7.19-7.13 (m, 3H), 6.89-6.81 (m, 2H), 6.15-6.00 (m, 1H), 5.59-5.43 (m, 1H), 4.93 (s, 1H), 3.79 (s, 3H), 3.65 (s, 3H), 3.15-3.01 (m, 1H), 2.65-2.52 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.4, 192.6, 169.8, 159.8, 141.8, 134.0, 133.2, 130.8, 130.5, 130.4, 128.6, 127.4, 127.2, 127.0, 126.9, 125.5, 113.8, 95.4, 89.9, 62.8, 55.3, 52.4, 50.5,

32.4. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 94/6, flow = 1.0 mL/min, retention time 13.3 min (minor) and 26.0 min (major). HRMS Calculated for $\text{C}_{28}\text{H}_{24}\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 479.1288, found: 479.1291.

(-)-Methyl 2-methyl-4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3la):

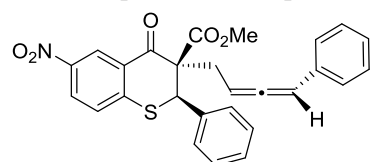
The reaction was conducted at -20 °C for 72 h. 68.2 mg, 94% yield, pale yellow viscous liquid, new compound, $R_f = 0.45$ (hexanes/ethyl acetate 20/1), 9.0:1 dr, 99% ee (major diastereoisomer),



$[\alpha]_D^{20} = -87.47$ (c 0.95, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.16 (d, $J = 7.6$ Hz, 1H), 7.41-7.34 (m, 1H), 7.30-7.14 (m, 7H), 6.29-5.97 (m, 1H), 5.65-5.35 (m, 1H), 3.84 (q, $J = 6.9$ Hz, 1H), 3.63 (s, 3H), 3.39-3.24 (m, 1H), 2.92-2.77 (m, 1H), 1.61 (d, $J = 7.0$ Hz, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.1, 191.7, 170.2, 141.3, 134.0,

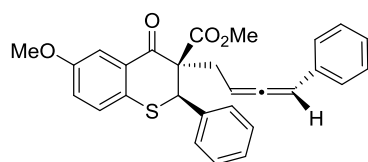
133.0, 130.7, 130.4, 128.6, 127.2, 127.1, 126.9, 125.3, 95.0, 89.3, 61.7, 52.4, 41.8, 31.1, 15.6. HPLC: Chiralpak IC column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 99/1, flow = 1.0 mL/min, retention time 19.7 min (major) and 22.0 min. HRMS Calculated for $\text{C}_{22}\text{H}_{21}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 365.1206, found: 365.1209.

(-)-Methyl 6-nitro-4-oxo-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3ma): The reaction was conducted at -20 °C for 120 h. 86.1 mg, 91% yield, pale yellow viscous liquid, new compound, $R_f = 0.18$ (hexanes/ethyl acetate 20/1), 49.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -207.17$ (c 1.10, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.94 (d, $J = 2.5$ Hz, 1H), 8.16 (dd, $J = 8.7, 2.6$ Hz, 1H), 7.40-7.32 (m, 6H), 7.24-7.19 (m, 2H), 7.18-7.08 (m, 3H), 6.15-5.99 (m, 1H), 5.62-



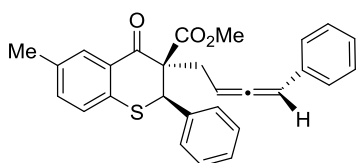
5.48 (m, 1H), 5.07 (s, 1H), 3.66 (s, 3H), 3.22-3.07 (m, 1H), 2.63-2.52 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.5, 190.5, 168.9, 149.7, 145.6, 134.2, 133.6, 130.9, 129.4, 129.2, 128.8, 128.6, 128.1, 127.2, 126.7, 126.7, 125.7, 96.2, 89.3, 62.1, 52.6, 51.0, 32.0. HPLC: Chiralpak IB column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 85/15, flow = 1.0 mL/min, retention time 11.4 min and 18.6 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{22}\text{NO}_5\text{S}$ $[\text{M}+\text{H}]^+$ 472.1213, found: 472.1218.

(-)-Methyl 6-methoxy-4-oxo-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3na): The reaction was conducted at -20 °C for 120 h. 78.8 mg, 86% yield, yellow viscous liquid, new compound, $R_f = 0.21$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -234.07$ (c 0.93, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 7.65 (d, $J = 2.9$ Hz, 1H), 7.39-7.29 (m, 5H), 7.25-7.21 (m, 2H), 7.19-7.09 (m, 4H), 7.05-6.98 (m, 1H), 6.15-6.04 (m, 1H), 5.59-5.43 (m, 1H), 4.96 (s, 1H), 3.84 (s, 3H), 3.65 (s, 3H), 3.19-3.06 (m, 1H), 2.66-2.54 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.4, 192.5, 169.8,

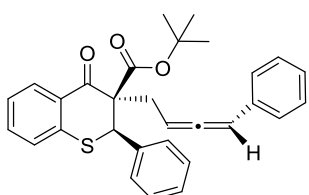


157.8, 135.7, 133.9, 133.0, 131.6, 129.1, 128.8, 128.6, 128.6, 128.5, 127.1, 126.9, 122.3, 112.6, 95.5, 89.9, 62.8, 55.6, 52.4, 51.5, 32.5. HPLC: Chiral- pak AD-3, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 90/10, flow = 0.8 mL/min, retention time 18.2 min and 19.4 min (major). HRMS Calculated for C₂₈H₂₅O₄S [M+ H]⁺ 457.1468, found: 457.1466.

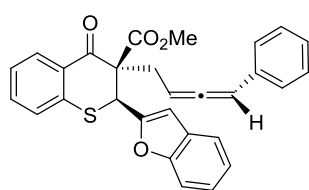
(-)-Methyl 6-methyl-4-oxo-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (30a): The reaction was conducted at -20 °C for 120 hours. 82.9 mg, 94% yield, pale yellow viscous liquid, new compound, R_f = 0.31 (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer), [α]_D²⁰ = -225.21 (*c* 0.88, CHCl₃). The major diastereoisomer: ¹H NMR (400 MHz, CDCl₃) δ 8.00-7.94 (m, 1H), 7.39-7.30 (m, 5H), 7.26-7.21 (m, 3H), 7.20-7.11 (m, 4H), 6.15-6.02 (m, 1H), 5.59-5.45 (m, 1H), 4.96 (s, 1H), 3.64 (s, 3H), 3.17-3.06 (m, 1H), 2.64-2.55 (m, 1H), 2.36 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 207.4, 192.7, 169.8, 138.2, 135.7, 135.5, 134.4, 134.0, 130.6, 129.1, 128.8, 128.5, 128.5, 127.2, 127.0, 126.9, 95.4 89.9, 62.8, 52.3, 51.3, 32.5, 21.0. HPLC: Chiralpak AD-H column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 96/4, flow = 1.0 mL/min, retention time 22.0 min and 25.0 min (major). HRMS Calculated for C₂₈H₂₅O₃S [M+H]⁺ 441.1519, found: 441.1516.



(-)-*t*-Butyl 4-oxo-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3pa): The reaction was conducted at -20 °C for 120 h. 88.7 mg, 95% yield, pale yellow viscous liquid, new compound, R_f = 0.40 (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer), [α]_D²⁰ = -182.51 (*c* 1.03, CHCl₃). The major diastereoisomer: ¹H NMR (400 MHz, CDCl₃) δ 8.18 (dd, *J* = 8.2, 1.5 Hz, 1H), 7.50-7.43 (m, 2H), 7.40-7.31 (m, 4H), 7.26-7.13 (m, 7H), 6.17-6.01 (m, 1H), 5.56-5.41 (m, 1H), 4.92 (s, 1H), 3.19-3.03 (m, 1H), 2.62-2.41 (m, 1H), 1.32 (s, 9H). ¹³C NMR (100 MHz, CDCl₃) δ 207.4, 192.4, 168.1, 141.7, 135.5, 134.2, 132.8, 131.2, 130.3, 129.6, 128.8, 128.5, 128.4, 126.9, 126.9, 126.8, 125.2, 95.2, 90.1, 83.2, 62.2, 51.3, 32.0, 27.7. HPLC: Chiralpak AD-3 column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 96/4, flow = 0.8 mL/min, the retention time 11.2 min and 13.5 min (major). HRMS Calculated for C₃₀H₂₈NaO₃S [M+Na]⁺ 491.1651, found: 491.1656.



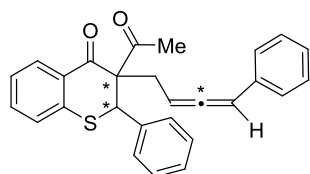
(+)-Methyl 2-(benzofuran-2-yl)-4-oxo-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate (3qa): The reaction was conducted at -20 °C for 72 h. 79.1 mg, 85% yield, pale yellow viscous liquid, new compound, R_f = 0.32 (hexanes/ethyl acetate 20/1), 5.7:1 dr, 97% ee (major diastereoisomer), [α]_D²⁰ = +33.29 (*c* 0.82, CHCl₃). The major diastereoisomer: ¹H NMR (400 MHz, CDCl₃) δ 8.21 (dd, *J* = 8.0, 1.1 Hz, 1H), 7.53-7.47 (m, 1H), 7.43-7.37 (m, 2H), 7.28-7.16 (m, 9H), 6.75 (s, 1H), 6.14-6.01 (m, 1H), 5.65-5.52 (m, 1H), 5.14 (s, 1H), 3.65 (s, 3H), 3.28-3.16 (m, 1H), 2.97-2.85 (m, 1H). ¹³C NMR (100 MHz, CDCl₃) δ 207.7, 190.9, 169.5, 154.3, 152.6, 139.9, 133.8, 133.5, 130.5, 130.4, 128.6, 128.0, 127.3, 127.1, 126.9, 125.8, 124.7, 123.0, 121.3, 111.2, 106.1, 95.3, 89.2, 61.3, 52.7, 44.6, 32.9. HPLC: Chiralpak AD-H column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 93/7, flow = 1.0 mL/min, the



retention time 19.8 min and 22.3 min (major). HRMS Calculated for $C_{29}H_{23}O_4S$ $[M+H]^+$ 467.1312, found: 467.1320.

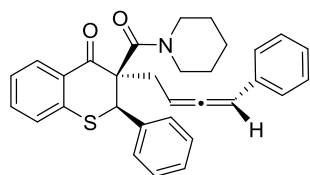
(+)-3-Acetyl-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochroman-4-one (3ba):

The reaction was conducted at 30 °C for 48 hours with commercially available (1*R*,1'*R*,2*S*,2'*S*)-DuanPhos as the chiral ligand. 49.8 mg, 61% yield, pale yellow viscous liquid, new compound, R_f = 0.35 (hexanes/ethyl acetate 20/1), 24.0:1 dr, 74% ee (major isomer), $[\alpha]_D^{20}$ = +0.69 (*c* 0.58, $CHCl_3$). The major diastereoisomer: 1H NMR (400 MHz, $CDCl_3$) δ 8.18 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.46- 7.41 (m, 1H), 7.30-7.23 (m, 9H), 7.21-7.14 (m, 3H), 6.18-6.03 (m, 1H), 5.48-5.37 (m, 1H), 4.86 (s, 1H), 3.24-3.13 (m, 1H), 2.80-2.70 (m, 1H), 2.11 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 207.4, 205.2, 194.4, 140.8, 137.1, 133.9, 133.8, 130.9, 130.2, 128.8, 128.7, 128.6, 128.5, 127.4, 127.1, 126.8, 125.7, 95.5, 89.6, 67.1, 51.2, 33.7, 31.5. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 95/5, flow = 1.0 mL/min, retention time 9.4 min and 11.5 min (major). HRMS Calculated for $C_{27}H_{23}O_2S$ $[M+H]^+$ 411.1413, found: 411.1415. Notably, the absolute and relative configurations of this allenylic alkylation product were not further assigned.

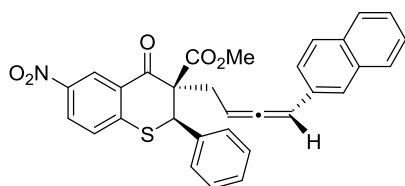


2-Phenyl-3-(4-phenylbuta-2,3-dien-1-yl)-3-(piperidine-1-carbonyl)thiochroman-4-one (3da):

The reaction was conducted at -20 °C for 168 h and the *rac*-**3da** was prepared with *rac*-BINAP at -20 °C. 32.3 mg, 34% yield, pale yellow viscous liquid, new compound, R_f = 0.52 (hexanes/ethyl acetate 5/1), 24.0:1 dr, >99% ee (major diastereoisomer), $[\alpha]_D^{20}$ = -49.90 (*c* 1.08, $CHCl_3$). The major diastereoisomer: 1H NMR (400 MHz, $CDCl_3$) δ 8.09 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.51-7.43 (m, 1H), 7.37-7.33 (m, 1H), 7.33-7.28 (m, 3H), 7.27-7.21 (m, 7H), 7.19-7.14 (m, 1H), 6.22-6.02 (m, 1H), 5.71-5.55 (m, 1H), 4.87 (s, 1H), 4.04-3.14 (m, 2H), 3.14-2.13 (m, 4H), 1.50-1.37 (m, 4H), 1.37-1.10 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 207.7, 192.6, 167.3, 140.5, 137.9, 134.3, 133.7, 131.8, 130.1, 129.1, 128.6, 128.5, 128.3, 127.8, 126.9, 126.9, 126.1, 94.6, 91.0, 63.0, 52.1, 38.5, 24.9, 24.3. HPLC: Chiralpak IB column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 94/6, flow = 1.0 mL/min, retention time 13.1 min and 20.6 min (major). HRMS Calculated for $C_{31}H_{30}NO_2S$ $[M+H]^+$ 480.1992, found: 480.2000.



(-)-Methyl (2*R*,3*S*)-3-((*R*)-4-(naphthalen-2-yl)buta-2,3-dien-1-yl)-6-nitro-4-oxo-2-phenylthiochromane-3-carboxylate (3mk): The reaction was conducted at -20 °C for 168 h. 91.3 mg, 88% yield, pale yellow solid, mp 197-198 °C, new compound, R_f = 0.12 (hexanes/ethyl acetate 20/1),

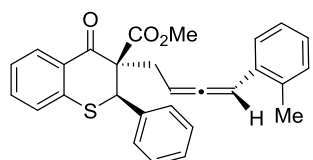


32.3:1 dr, >99% ee (major diastereoisomer), $[\alpha]_D^{20}$ = -223.76 (*c* 1.14, $CHCl_3$). The major diastereoisomer: 1H NMR (400 MHz, $CDCl_3$) δ 8.92 (d, *J* = 2.5 Hz, 1H), 8.03 (dd, *J* = 8.7, 2.5 Hz, 1H), 7.75-7.65 (m, 3H), 7.47 (s, 1H), 7.45-7.35 (m, 7H), 7.31 (dd, *J* = 8.5, 1.4 Hz, 1H), 7.24-7.21 (m, 1H), 6.33-6.18 (m, 1H), 5.70-5.55 (m, 1H), 5.11 (s, 1H), 3.65 (s, 3H), 3.28-3.11 (m, 1H), 2.66-2.50 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 208.1, 190.5, 168.9, 149.6, 145.5, 134.2, 133.5, 132.6, 131.1, 130.8, 129.5, 129.2, 128.8, 128.3, 128.1, 127.7, 127.7, 126.5, 126.4, 125.9, 125.7, 125.6, 124.5, 96.6, 89.6, 62.2, 52.7, 51.0, 32.0. HPLC: Chiralpak IB column, 254 nm, 30 °C,

n-Hexane/*i*-PrOH = 80/20, flow = 1.0 mL/min, retention time 12.7 min (minor) and 22.5 min (major). HRMS Calculated for C₃₁H₂₄NO₅S [M+H]⁺ 522.1370, found: 522.1377.

Methyl 4-oxo-2-phenyl-3-(4-(*o*-tolyl)buta-2,3-dien-1-yl)thiochromane-3-carboxylate (3cb):

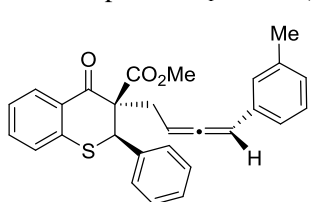
The reaction was conducted at -20 °C for 72 h. 81.7 mg, 93% yield, pale yellow viscous liquid, new compound, R_f = 0.43 (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer),



[α]_D²⁰ = -193.32 (*c* 0.96, CHCl₃). The major diastereoisomer: ¹H NMR (400 MHz, CDCl₃) δ 8.17 (dd, *J* = 8.2, 1.4 Hz, 1H), 7.48-7.21 (m, 9H), 7.20-7.03 (m, 3H), 6.47-6.18 (m, 1H), 5.61-5.38 (m, 1H), 4.99 (s, 1H), 3.64 (s, 3H), 3.23-3.01 (m, 1H), 2.68-2.53 (m, 1H), 2.24 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 208.0, 192.4, 169.7, 141.6, 135.6, 135.0, 133.3, 132.2, 130.8, 130.5, 130.4, 129.2, 128.9, 128.5, 127.5, 127.3, 127.0, 126.1, 125.6, 92.8, 88.9, 62.7, 52.4, 51.2, 32.5, 19.8. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 95/5, flow = 1.0 mL/min, retention time 10.1 min and 25.1 min (major). HRMS Calculated for C₂₈H₂₄NaO₃S [M+Na]⁺ 463.1338, found: 463.1342.

(-)-Methyl -oxo-2-phenyl-3-(4-(*m*-tolyl)buta-2,3-dien-1-yl)thiochromane-3-carboxylate(3cc):

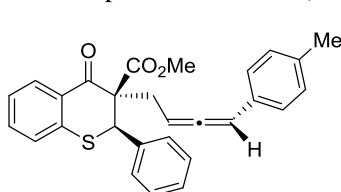
The reaction was conducted at -20 °C for 72 h. 86.1 mg, 98% yield, pale yellow viscous liquid, new compound, R_f = 0.43 (hexanes/ethyl acetate 20/1), 49.0:1 dr, 99% ee (major diastereoisomer),



[α]_D²⁰ = -213.13 (*c* 0.70, CHCl₃). The major diastereoisomer: ¹H NMR (400 MHz, CDCl₃) δ 8.23-8.11 (m, 1H), 7.44-7.31 (m, 6H), 7.26-7.22 (m, 2H), 7.16-7.10 (m, 1H), 7.01-6.95 (m, 3H), 6.16-5.97 (m, 1H), 5.59-5.42 (m, 1H), 4.99 (s, 1H), 3.65 (s, 3H), 3.19-3.07 (m, 1H), 2.65-2.55 (m, 1H), 2.28 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 207.4, 192.4, 169.7, 141.5, 138.1, 135.6, 133.8, 133.2, 130.9, 130.5, 129.1, 128.9, 128.5, 128.5, 127.9, 127.5, 127.3, 125.5, 124.0, 95.6, 89.7, 62.7, 52.3, 51.1, 32.5, 21.3. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 95/5, flow = 1.0 mL/min, retention time 9.7 min and 21.8 min (major). HRMS Calculated for C₂₈H₂₄NaO₃S [M+Na]⁺ 463.1338, found: 463.1341.

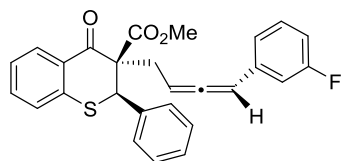
(-)-Methyl 4-oxo-2-phenyl-3-(4-(*p*-tolyl)buta-2,3-dien-1-yl)thiochromane-3-carboxylate (3cd):

The reaction was conducted at -20 °C for 72 h. 84.5 mg, 96% yield, pale yellow viscous liquid, new compound, R_f = 0.43 (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer),



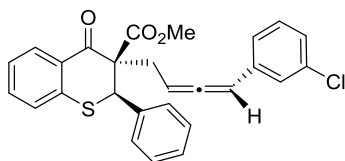
[α]_D²⁰ = -193.85 (*c* 0.57, CHCl₃). The major diastereoisomer: ¹H NMR (400 MHz, CDCl₃) δ 8.22-8.11 (m, 1H), 7.43-7.31 (m, 6H), 7.26-7.22 (m, 2H), 7.12-7.01 (m, 4H), 6.19-5.94 (m, 1H), 5.59-5.40 (m, 1H), 4.99 (s, 1H), 3.65 (s, 3H), 3.19-3.04 (m, 1H), 2.66-2.54 (m, 1H), 2.30 (s, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 207.2, 192.5, 169.7, 141.5, 136.8, 135.6, 133.2, 130.9, 130.9, 130.5, 129.3, 129.1, 128.9, 128.5, 127.3, 126.7, 125.5, 95.4, 89.7, 62.7, 52.3, 51.1, 32.6, 21.2. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 95/5, flow = 1.0 mL/min, retention time 9.6 min and 18.8 min (major). HRMS Calculated for C₂₈H₂₄NaO₃S [M+Na]⁺ 463.1338, found: 463.1342.

(-)-Methyl 3-(4-(3-fluorophenyl)buta-2,3-dien-1-yl)-4-oxo-2-phenylthiochromane-3-carboxylate (3ce): The reaction was conducted at -20 °C for 120 hours. 83.7 mg, 94% yield, pale yellow viscous liquid, new compound, $R_f = 0.38$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major



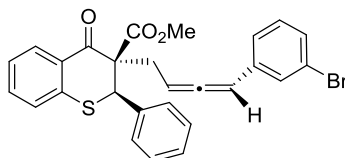
diastereoisomer), $[\alpha]_D^{20} = -179.28$ (c 0.85, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.20-8.13 (m, 1H), 7.43-7.32 (m, 6H), 7.27-7.17 (m, 3H), 6.98-6.92 (m, 1H), 6.91-6.80 (m, 2H), 6.16-5.95 (m, 1H), 5.69-5.48 (m, 1H), 4.94 (s, 1H), 3.65 (s, 3H), 3.20-3.02 (m, 1H), 2.69-2.47 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.6, 192.3, 169.6, 163.1 (d, $^1J_{\text{F-C}} = 245.2$ Hz), 141.5, 136.5 (d, $^3J_{\text{F-C}} = 7.7$ Hz), 135.5, 133.3, 130.8, 130.5, 129.9 (d, $^3J_{\text{F-C}} = 8.3$ Hz), 129.2, 128.9, 128.5, 127.2, 125.6, 122.6 (d, $^4J_{\text{F-C}} = 2.7$ Hz), 113.9 (d, $^2J_{\text{F-C}} = 21.3$ Hz), 113.4 (d, $^2J_{\text{F-C}} = 22.4$ Hz), 94.8 (d, $^4J_{\text{F-C}} = 2.5$ Hz), 90.4, 62.6, 52.4, 51.3, 32.4. $^{19}\text{F NMR}$ (376 MHz, CDCl_3) δ -113.49. HPLC: Chiralcel OD-3 column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 0.8 mL/min, retention time 12.3 min and 35.0 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{21}\text{FNaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 467.1088, found: 467.1084.

(-)-Methyl 3-(4-(3-chlorophenyl)buta-2,3-dien-1-yl)-4-oxo-2-phenylthiochromane-3-carboxylate (3cf): The reaction was conducted at -20 °C for 120 hours. 83.1 mg, 90% yield, pale yellow viscous liquid, new compound, $R_f = 0.38$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major



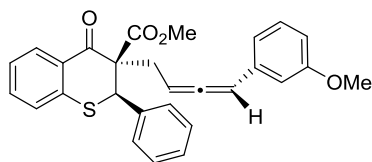
diastereoisomer), $[\alpha]_D^{20} = -188.92$ (c 0.84, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.21-8.14 (m, 1H), 7.44- 7.32 (m, 6H), 7.27-7.23 (m, 2H), 7.20-7.10 (m, 3H), 7.08-7.01 (m, 1H), 6.16-5.92 (m, 1H), 5.67-5.51 (m, 1H), 4.93 (s, 1H), 3.65 (s, 3H), 3.17-3.06 (m, 1H), 2.65-2.55 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.6, 192.3, 169.6, 141.5, 136.1, 135.5, 134.5, 133.3, 130.8, 130.5, 129.7, 129.2, 129.0, 128.5, 127.2, 127.0, 126.7, 125.6, 125.0, 94.6, 90.4, 62.6, 52.4, 51.3, 32.4. HPLC: Chiralcel OD-3 column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 0.8 mL/min, retention time 12.7 min (minor) and 37.3 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{22}\text{ClO}_3\text{S}$ $[\text{M}+\text{H}]^+$ 461.0973 (^{35}Cl) and 463.0953 (^{37}Cl), found: 461.0969 (^{35}Cl) and 463.0938 (^{37}Cl).

(-)-Methyl 3-(4-(3-bromophenyl)buta-2,3-dien-1-yl)-4-oxo-2-phenylthiochromane-3-carboxylate (3cg): The reaction was conducted at -20 °C for 120 hours. 94.4 mg, 93% yield, pale yellow viscous liquid, new compound, $R_f = 0.38$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 98% ee (major



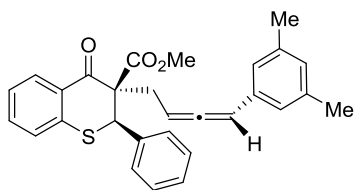
diastereoisomer), $[\alpha]_D^{20} = -173.55$ (c 0.87, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.18 (dd, $J = 7.8$, 1.0 Hz, 1H), 7.43-7.23 (m, 10H), 7.15-7.05 (m, 2H), 6.15-5.93 (m, 1H), 5.73-5.50 (m, 1H), 4.93 (s, 1H), 3.65 (s, 3H), 3.23-3.01 (m, 1H), 2.72-2.48 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.6, 192.3, 169.6, 141.5, 136.3, 135.5, 133.3, 130.8, 130.5, 130.0, 129.9, 129.6, 129.2, 129.0, 128.6, 127.3, 125.6, 125.4, 122.8, 94.5, 90.5, 62.6, 52.4, 51.3, 32.4. HPLC: Chiralcel OD-3 column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 0.8 mL/min, retention time 13.1 min and 39.9 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{22}\text{BrO}_3\text{S}$ $[\text{M}+\text{H}]^+$ 505.0468 (^{79}Br) and 507.0450 (^{81}Br), found: 505.0471 (^{79}Br) and 507.0454 (^{81}Br).

(-)-Methyl 3-(4-(3-methoxyphenyl)buta-2,3-dien-1-yl)-4-oxo-2-phenylthiochromane-3-carboxylate (3ch): The reaction was conducted at -20 °C for 72 hours. 84.6 mg, 93% yield, pale yellow viscous liquid, new compound, $R_f = 0.20$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -192.34$ (c 1.02, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.27-8.04 (m, 1H), 7.42-7.29 (m, 6H), 7.25-7.21 (m, 2H), 7.17-7.12 (m, 1H), 6.80-6.67 (m, 3H), 6.11-5.99 (m, 1H), 5.61-5.42 (m, 1H), 4.98 (s, 1H), 3.76 (s, 3H), 3.64 (s, 3H), 3.17- 3.05 (m, 1H),



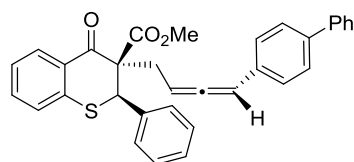
2.65-2.54 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.4, 192.4, 169.7, 159.9, 141.5, 135.6, 135.4, 133.2, 130.8, 130.5, 129.5, 129.2, 128.9, 128.5, 127.3, 125.5, 119.5, 113.1, 111.9, 95.6, 90.0, 62.7, 55.2, 52.3, 51.2, 32.4. HPLC: Chiralcel OD-3 column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 94/6, flow = 0.8 mL/min, retention time 14.7 min and 32.0 min (major). HRMS Calculated for $\text{C}_{28}\text{H}_{25}\text{O}_4\text{S}$ $[\text{M}+\text{H}]^+$ 457.1468, found: 457.1473.

(-)-Methyl 3-(4-(3,5-dimethylphenyl)buta-2,3-dien-1-yl)-4-oxo-2-phenylthiochromane-3-carboxylate (3ci): The reaction was conducted at -20 °C for 120 h. 89.1 mg, 98% yield, pale yellow viscous liquid, new compound, $R_f = 0.33$ (hexanes/ethyl acetate 20/1), 49.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -195.93$ (c 0.74, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.25-8.08 (m, 1H), 7.43-7.29 (m, 6H), 7.26-7.22 (m, 2H), 6.87-6.72 (m, 3H), 6.13-5.92 (m, 1H), 5.57-5.39 (m, 1H), 5.00 (s, 1H), 3.65 (s, 3H), 3.25-3.06 (m, 1H), 2.66-2.53 (m, 1H), 2.24 (s, 6H). $^{13}\text{C NMR}$



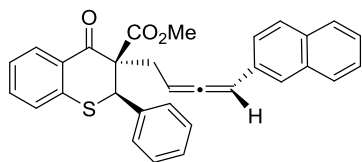
(100 MHz, CDCl_3) δ 207.5, 192.4, 169.8, 141.5, 138.0, 135.6, 133.7, 133.2, 130.9, 130.5, 129.1, 128.8, 128.5, 127.3, 125.5, 124.7, 95.7, 89.5, 62.7, 52.3, 51.0, 32.5, 21.2. HPLC: Chiralcel OD-H column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 96/4, flow = 1.0 mL/min, retention time 9.3 min and 20.1 min (major). HRMS Calculated for $\text{C}_{29}\text{H}_{27}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 455.1675, found: 455.1682.

(-)-Methyl 3-(4-([1,1'-biphenyl]-4-yl)buta-2,3-dien-1-yl)-4-oxo-2-phenylthiochromane-3-carboxylate (3cj): The reaction was conducted at -20 °C for 120 h. 96.2 mg, 96% yield, pale yellow viscous liquid, new compound, $R_f = 0.31$ (hexanes/ethyl acetate 20/1), 49.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -186.99$ (c 1.10, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.22-8.12 (m, 1H), 7.58-7.53 (m, 2H), 7.50-7.45 (m, 2H), 7.43-7.30 (m, 9H), 7.26-7.22 (m, 4H), 6.22-6.04 (m, 1H), 5.66-5.48 (m, 1H), 5.00 (s, 1H), 3.65 (s, 3H), 3.21-3.03 (m, 1H), 2.69-2.56 (m, 1H). $^{13}\text{C NMR}$



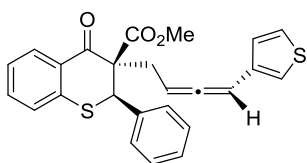
(100 MHz, CDCl_3) δ 207.6, 192.4, 169.7, 141.5, 140.8, 139.9, 135.6, 133.3, 133.0, 130.8, 130.5, 129.2, 128.9, 128.8, 128.5, 127.3, 126.9, 125.6, 95.2, 90.0, 62.7, 52.4, 51.2, 32.5. HPLC: Chiralpak ID + IC column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 94/6, flow = 1.0 mL/min, retention time 43.1 min (major) and 47.4 min (minor). HRMS Calculated for $\text{C}_{33}\text{H}_{27}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 503.1675, found: 503.1673.

(-)-Methyl 3-(4-(naphthalen-2-yl)buta-2,3-dien-1-yl)-4-oxo-2-phenylthiochromane-3-carboxylate (3ck): The reaction was conducted at -20 °C for 120 h. 90.4 mg, 95% yield, pale yellow viscous liquid, new compound, $R_f = 0.30$ (hexanes/ethyl acetate 20/1), 24.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -160.81$ (c 1.10, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.18 (dd, $J = 7.9, 1.1$ Hz, 1H), 7.76-7.67 (m, 3H), 7.55-7.52 (m, 1H), 7.45-7.31 (m, 9H), 7.24-7.19 (m, 2H), 6.35-6.16 (m, 1H), 5.69-5.50 (m, 1H), 5.01 (s, 1H), 3.64 (s, 3H), 3.23-3.07 (m, 1H), 2.70-



2.59 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 208.0, 192.4, 169.7, 141.5, 135.6, 133.6, 133.2, 132.7, 131.5, 130.8, 130.5, 129.2, 128.9, 128.5, 128.2, 127.7, 127.7, 127.3, 126.2, 125.7, 125.6, 124.8, 95.9, 90.2, 62.8, 52.4, 51.2, 32.6. HPLC: Chiralpak IC column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 94/6, flow = 1.0 mL/min, retention time 20.5 min (minor) and 22.8 min (major). HRMS Calculated for $\text{C}_{31}\text{H}_{28}\text{NO}_3\text{S}$ $[\text{M}+\text{NH}_4]^+$ 494.1784, found: 494.1777.

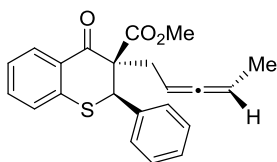
(-)-Methyl 4-oxo-2-phenyl-3-(4-(thiophen-3-yl)buta-2,3-dien-1-yl)thiochromane-3-carboxylate (3cl): The reaction was conducted at -20 °C for 120 h. 78.2 mg, 90% yield, pale yellow viscous liquid, new compound, $R_f = 0.32$ (hexanes/ethyl acetate 20/1), 32.3:1 dr, 98% ee (major diastereoisomer), $[\alpha]_D^{20} = -187.60$ (c 0.92, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.22-8.13 (m, 1H), 7.42-7.32 (m, 6H), 7.25-7.18 (m, 3H), 6.99-6.91 (m, 2H), 6.31-5.97 (m, 1H), 5.52-5.41 (m, 1H), 4.97 (s, 1H), 3.64 (s, 3H), 3.15-3.05 (m, 1H), 2.63-2.54 (m, 1H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.6, 192.4,



169.7, 141.5, 135.6, 135.1, 133.2, 130.8, 130.5, 129.2, 128.9, 128.5, 127.3, 126.3, 125.9, 125.5, 121.0, 90.1, 89.1, 62.7, 52.3, 51.1, 32.6. HPLC: Chiralcel OD-3 column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 93/7, flow = 0.8 mL/min, retention time 11.9 min (minor) and 25.4 min (major). HRMS Calculated for $\text{C}_{25}\text{H}_{24}\text{NO}_3\text{S}_2$ $[\text{M}+\text{NH}_4]^+$ 450.1192, found: 450.1182.

(-)-Methyl 4-oxo-3-(penta-2,3-dien-1-yl)-2-phenylthiochromane-3-carboxylate (3cm):

The reaction was conducted at -20 °C for 120 h. 39.3 mg, 54% yield, pale yellow viscous liquid, new compound, $R_f = 0.39$ (hexanes/ethyl acetate 20/1), 7.3:1 dr, 97% ee (major diastereoisomer),

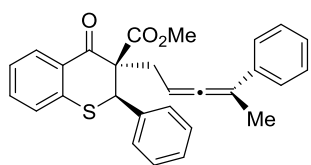


$[\alpha]_D^{20} = -173.75$ (c 0.85, CHCl_3). The major diastereoisomer: ^1H NMR (400 MHz, CDCl_3) δ 8.29-8.02 (m, 1H), 7.44-7.31 (m, 6H), 7.28-7.22 (m, 2H), 5.08-4.92 (m, 3H), 3.66 (s, 3H), 3.06-2.95 (m, 1H), 2.52-2.40 (m, 1H), 1.55-1.48 (m, 3H). ^{13}C NMR (100 MHz, CDCl_3) δ 207.0, 192.6, 169.8, 141.4, 135.7, 133.1, 131.0, 130.4, 129.1, 128.8, 128.4, 127.3, 125.5, 86.8, 85.2, 63.0, 52.3, 50.7, 32.6, 14.1. HPLC: Chiralpak AD-3 column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 97/3, flow = 0.8 mL/min, retention time 18.8 min and 19.8 min (major). HRMS Calculated for $\text{C}_{22}\text{H}_{21}\text{O}_3\text{S}$ $[\text{M}+\text{H}]^+$ 365.1206, found: 365.1208.

(-)-Methyl 4-oxo-2-phenyl-3-(4-phenylpenta-2,3-dien-1-yl)thiochromane-3-carboxylate (3cn):

The reaction was conducted at 30 °C for 120 h. 63.7 mg, 72% yield, pale yellow viscous liquid, new compound, $R_f = 0.41$ (hexanes/ethyl acetate 20/1), 6.7:1 dr, 90% ee (major diastereoisomer),

$[\alpha]_D^{20} = -109.42$ (c 0.88, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.17 (dd, $J = 7.9, 1.1$ Hz, 1H), 7.41-7.37 (m, 1H), 7.36-7.29 (m, 5H), 7.28-7.12 (m, 7H), 5.45-5.32 (m,



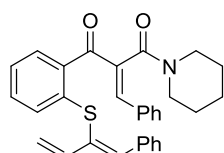
1H), 5.01 (s, 1H), 3.62 (s, 3H), 3.22-3.10 (m, 1H), 2.65-2.50 (m, 1H), 1.99 (d, $J = 2.9$ Hz, 3H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 206.8, 192.3, 169.8, 141.4, 136.7, 135.9, 133.2, 130.7, 130.4, 128.9, 128.8, 128.5, 128.3, 127.3, 126.9, 125.8, 125.4, 101.9, 87.7, 62.7, 52.3, 50.4, 32.7, 16.9. HPLC: Chiralpak AD-H column, 254 nm, 30 °C,

n -Hexane/ i -Pr- OH = 96/4, flow = 1.0 mL/min, retention time 14.0 min and 17.1 min (major).

HRMS Calculated for $\text{C}_{28}\text{H}_{24}\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 463.1338, found: 463.1346.

The Chemo- or Regioselective Isomers with the Different EWG

2-Benzylidene-1-(2-((1-phenylbuta-1,3-dien-2-yl)thio)phenyl)-3-(piperidin-1-yl)propane-1,3-dione (4'da): 46.1 mg, 48% yield, yellow viscous liquid, new compound, $R_f = 0.18$ (hexanes/ethyl acetate 5/1), 16.7/1 (Z/E or E/Z). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 7.56-

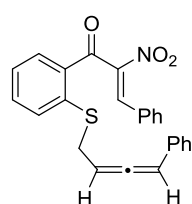


7.42 (m, 4H), 7.41-7.26 (m, 10H), 7.09 (s, 1H), 7.00 (s, 1H), 6.83 (dd, $J = 16.8, 10.5$ Hz, 1H), 5.74 (d, $J = 16.8$ Hz, 1H), 5.28 (d, $J = 10.6$ Hz, 1H), 3.89-3.62 (m, 2H), 3.57-3.26 (m, 2H), 1.77-1.45 (m, 5H), 1.20-0.96 (m, 1H).

$^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 194.7, 165.5, 143.8, 139.2, 137.2, 136.1, 134.4, 133.4, 133.2, 131.7, 131.2, 130.8, 130.6, 130.0, 129.4, 129.0, 128.9, 128.4, 127.9, 126.3, 120.1, 47.8, 42.4, 26.1, 25.3, 24.6. HRMS Calculated for $\text{C}_{31}\text{H}_{30}\text{NO}_2\text{S}$ $[\text{M}+\text{H}]^+$ 480.1992, found: 480.2001. (The Z/E configuration of carbon-carbon double bond is not further assigned)

(-)-2-Nitro-3-phenyl-1-(2-((4-phenylbuta-2,3-dien-1-yl)thio)phenyl)prop-2-en-1-one (4aa):

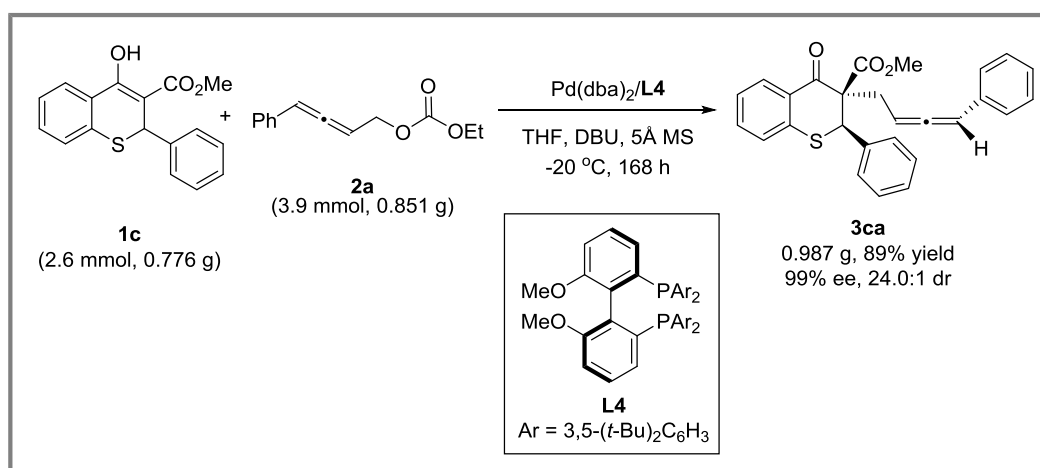
The reaction was conducted at 30 °C for 24 h with **L1**. 59.3 mg, 72% yield, pale yellow viscous



liquid, new compound, $R_f = 0.26$ (hexanes/ethyl acetate 20/1), 84% ee, single isomer, $[\alpha]_D^{20} = -178.56$ (c 0.63, CHCl_3). $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.67-8.48 (m, 1H), 7.61-7.50 (m, 3H), 7.48-7.18 (m, 10H), 7.18-7.12 (m, 1H), 6.15-6.01 (m, 1H), 5.90-5.75 (m, 1H), 3.47-3.32 (m, 2H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 205.8, 179.7, 149.9, 137.5, 136.3, 134.6, 132.8, 131.3, 130.5, 129.5,

129.2, 128.7, 128.6, 128.5, 127.4, 126.8, 126.7, 125.6, 95.6, 93.5, 28.6. HPLC: Chiralpak IA column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 94/6, flow = 1.0 mL/min, retention time 15.2 min and 16.2 min (major). HRMS Calculated for $\text{C}_{25}\text{H}_{19}\text{KNO}_3\text{S}$ $[\text{M}+\text{K}]^+$ 452.0717, found: 452.0731. (The absolute configuration of allene moiety is not further assigned)

4. Scale-up Synthesis

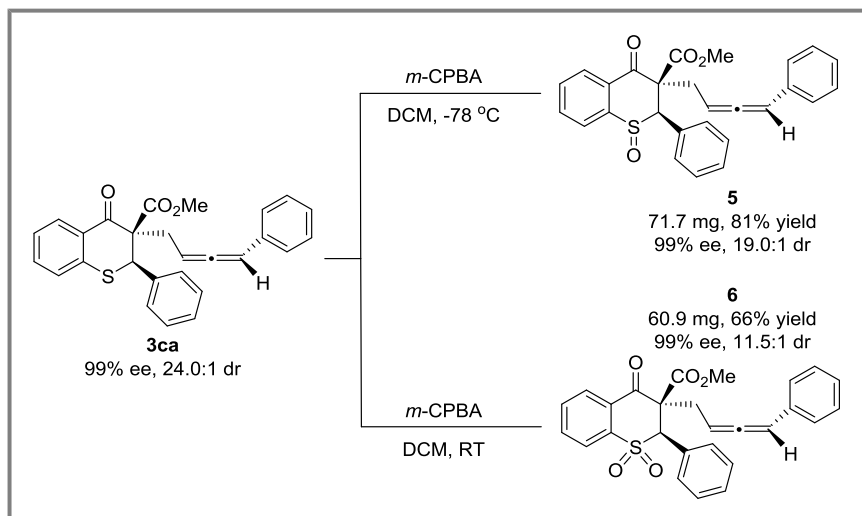


The metal precursor Pd(dba)₂ (0.26 mmol, 0.150 g), the chiral ligand (*R*)-DTB-BIPHEP (**L4**) (0.286 mmol, 0.295 g) and tetrahydrofuran (23 mL) were placed in a dried Schlenk tube under nitrogen atmosphere. The mixture was stirred at 30 °C for 30 min. Then, the mixture was cooled to -20 °C. Then, the substrate thiochromanone **1c** (2.6 mmol, 0.776 g), 5Å MS (0.650 g) and 1,8-diazabicyclo[5,4,0]undec-7-ene (DBU, 3.12 mmol, 0.47 mL) were added, and the reaction was stirred at -20 °C for 10 minutes. Sequentially, allenyllic carbonate **2a** (3.9 mmol, 0.851 g) and tetrahydrofuran (3.0 mL) were added slowly. The mixture was stirred at -20 °C for 168 hours. After the completion of the reaction, the volatiles were directly removed under the reduced pressure. The crude residue was quickly purified by column chromatography on silica gel (hexanes/ethyl acetate /dichloromethane 100/1/2-100/3/6) to give the chiral allenyllic alkylation product **3ca** 0.987 g, 89% isolated yield, 24.0:1 dr and 99% ee for the major diastereoisomer.

The racemate was prepared by running reaction with an achiral 1,3-bis(diphenylphosphino)propane ligand at 30 °C. Notably, the product **3ca** was a little sensitive to water or alcohol, which would lead to slight decrease of dr value.

5. Product Elaborations

5.1. The Oxidation of Sulfide



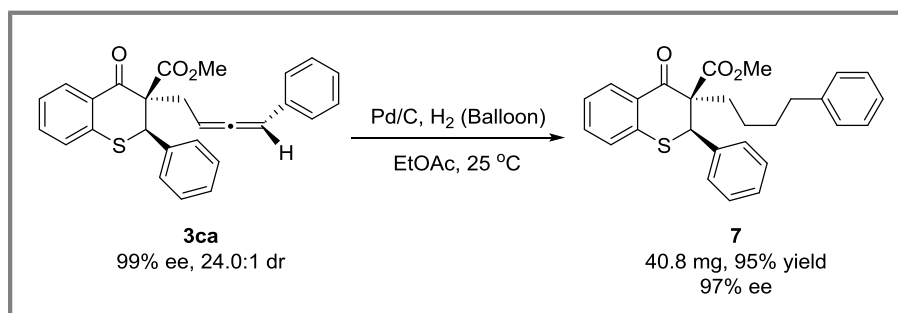
At -78 °C, to a solution of (-)-**3ca** (85.3 mg, 0.2 mmol, 99% ee) in dichloromethane (3.0 mL) was added 3-chloroperoxybenzoic acid (*m*-CPBA) (60.9 mg, 0.3 mmol, 85%) in dichloromethane (2.0 mL). The mixture was stirred at -78 °C for 48 hours. Then, to the reaction mixture was added a solution of *m*-CPBA (60.9 mg, 0.3 mmol, 85%) in dichloromethane (10 mL). The mixture was stirred at -78 °C for another 48 hours. After that, it was quenched with aqueous sodium bicarbonate and warmed to room temperature. The aqueous layer was extracted with dichloromethane. The combined organic layer was dried over anhydrous sodium sulfate, filtered and concentrated under the reduced pressure. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate (5/1-3/1) as eluent to give the oxidative product sulfoxide **5**.

Methyl 4-oxo-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate 1-oxide (5): 71.7 mg, 81% yield, colorless viscous liquid, new compound, $R_f = 0.23$ (hexanes/ethyl acetate 3/1), 19.0:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -357.57$ (c 1.00, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.10 (d, $J = 7.6$ Hz, 1H), 8.03 (d, $J = 7.8$ Hz, 1H), 7.81 (t, $J = 7.3$ Hz, 1H), 7.62 (t, $J = 7.5$ Hz, 1H), 7.45-7.34 (m, 5H), 7.25-7.06 (m, 5H), 6.17-6.01 (m, 1H), 5.38-5.26 (m, 1H), 4.82 (s, 1H), 3.76 (s, 3H), 3.44-3.29 (m, 1H), 2.51-2.37 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.5, 190.8, 169.0, 147.6, 135.0, 133.3, 131.2, 129.9, 129.6, 129.6, 129.4, 129.1, 128.6, 127.3, 126.9, 96.1, 88.4, 70.5, 63.6, 53.1, 32.5. HPLC: Chiralpak AD-3 column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 70/30, flow = 0.7 mL/min, retention time 27.6 min (major) and 32.7 min. HRMS Calculated for $\text{C}_{27}\text{H}_{22}\text{NaO}_4\text{S}$ $[\text{M}+\text{Na}]^+$ 465.1131, found: 465.1139.

At room temperature, to a solution of (-)-**3ca** (85.3 mg, 0.2 mmol, 99% ee) in dichloromethane (3.0 mL) was added *m*-CPBA (121.8 mg, 0.6 mmol, 85%) in dichloromethane (2.0 mL). The mixture was stirred for 24 hours. Then, the reaction mixture was quenched with saturated sodium bicarbonate aqueous solution, and the aqueous layer was extracted three times with dichloromethane. The combined organic layer was dried over anhydrous sodium sulfate, filtered and concentrated under the reduced pressure. The residue was purified by flash chromatography on silica gel using hexanes/ethyl acetate (5/1) as eluent to give the oxidative product sulfone **6**.

(-)-Methyl 4-oxo-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate 1,1-dioxide (6): 60.9 mg, 66% yield, colorless viscous liquid, new compound, $R_f = 0.51$ (hexanes/ ethyl acetate 3/1), 11.5:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -135.23$ (c 1.05, CHCl_3). The major diastereoisomer: $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.33-8.20 (m, 1H), 8.03-7.96 (m, 1H), 7.84-7.72 (m, 2H), 7.64-7.53 (m, 2H), 7.49-7.38 (m, 3H), 7.25-7.10 (m, 3H), 7.12-7.05 (m, 2H), 6.08-5.93 (m, 1H), 5.49-5.38 (m, 1H), 5.11 (s, 1H), 3.69 (s, 3H), 3.31-3.17 (m, 1H), 2.64-2.50 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 207.4, 189.6, 169.0, 141.6, 134.7, 133.4, 133.2, 131.8, 130.7, 130.2, 129.4, 128.7, 128.7, 127.4, 126.8, 125.7, 123.9, 96.5, 88.8, 68.3, 63.1, 53.3, 33.9. HPLC: Chiralpak IC column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 65/35, flow = 0.8 mL/min, retention time 22.8 min and 40.9 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{22}\text{NaO}_5\text{S}$ $[\text{M}+\text{Na}]^+$ 481.1080, found: 481.1078.

5.2. The Hydrogenation of Allenyl Functional Group

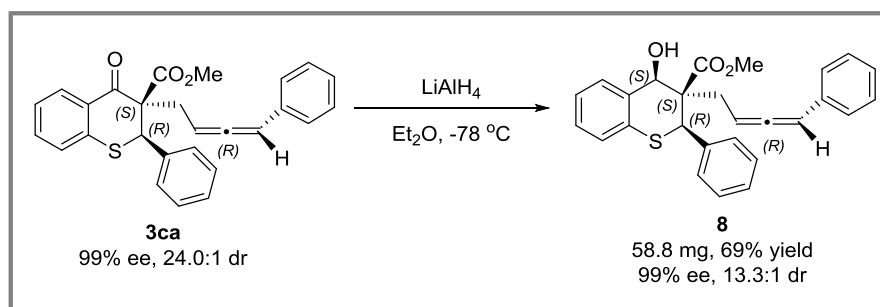


To a solution of the chiral allenyl alkylation product (-)-**3ca** (42.7 mg, 0.1 mmol, 99% ee) in ethyl acetate (1.0 mL) was added 10% Pd/C (5.3 mg, 0.005 mmol). The resulting mixture was degassed and stirred under hydrogen gas balloon pressure for about 13 hours at 25 °C. After the completion of hydrogenation, the volatiles were removed under the reduced pressure. The crude residue was purified by flash column chromatography on silica gel using hexanes/ethyl acetate (30/1-20/1) as eluent to give the desirable allene hydrogenation product (2*R*,3*S*)-(+)-**7**.

(2*R*,3*S*)-(+)-Methyl 4-oxo-2-phenyl-3-(4-phenylbutyl)thiochromane-3-carboxylate (7):

40.8 mg, 95% yield, colorless liquid, new compound, $R_f = 0.28$ (hexanes/ethyl acetate 20/1), 97% ee, $[\alpha]_D^{20} = +14.31$ (c 1.02, CHCl_3). $^1\text{H NMR}$ (400 MHz, CDCl_3) δ 8.16 (dd, $J = 8.2, 1.3$ Hz, 1H), 7.43-7.37 (m, 1H), 7.33-7.22 (m, 9H), 7.18-7.09 (m, 3H), 4.68 (s, 1H), 3.61 (s, 3H), 2.62-2.44 (m, 2H), 2.17-2.05 (m, 1H), 1.93-1.80 (m, 1H), 1.63-1.48 (m, 3H), 1.27-1.17 (m, 1H). $^{13}\text{C NMR}$ (100 MHz, CDCl_3) δ 192.7, 170.4, 142.4, 141.3, 136.1, 133.1, 130.9, 130.4, 129.0, 128.7, 128.5, 128.4, 128.3, 127.2, 125.7, 125.5, 62.6, 52.2, 51.9, 35.5, 32.8, 31.8, 24.2. HPLC: Chiralpak AD-H column, 254 nm, 30 °C, n -Hexane/ i -PrOH = 95/5, flow = 1.0 mL/min, retention time 11.7 min and 14.4 min (major). HRMS Calculated for $\text{C}_{27}\text{H}_{26}\text{NaO}_3\text{S}$ $[\text{M}+\text{Na}]^+$ 453.1495, found: 453.1503.

5.3. The Reduction of Carbonyl Functional Group



To a solution of lithium aluminium tetrahydride (15.2 mg, 0.4 mmol) in diethyl ether (7.0 mL) at -78 °C, the chiral compound (-)-**3ca** (85.3 mg, 0.2 mmol, 99% ee) and diethyl ether (1.0 mL) were added. The mixture was stirred at -78 °C for 5 hours. The reaction was quenched with 0.5 M potassium sodium tartrate aqueous solution (1.0 mL) and warmed to room temperature. After filtration through the celite, the combined organic layer was dried over sodium sulfate, filtered and concentrated under the reduced pressure. The residue was purified by column chromatography on silica gel using hexanes/ethyl acetate (20/1-10/1) as eluent to afford the desirable ketone carbonyl reductive product (-)-**8**.

The relative configuration of the hydroxyl group of the reductive product **8** was assigned as *S* by NOE.

(-)-Methyl 4-hydroxy-2-phenyl-3-(4-phenylbuta-2,3-dien-1-yl)thiochromane-3-carboxylate 8: 58.8 mg, 69% yield, colorless liquid, new compound, $R_f = 0.48$ (hexanes/ethyl acetate 5/1), 13.3:1 dr, 99% ee (major diastereoisomer), $[\alpha]_D^{20} = -33.73$ (c 0.83, CHCl₃). The major diastereoisomer: ¹H NMR (700 MHz, CDCl₃) δ 7.52 (d, $J = 7.5$ Hz, 1H), 7.49-7.42 (m, 2H), 7.29-7.17 (m, 11H), 6.15-6.08 (m, 1H), 5.56-5.53 (m, 1H), 5.17 (d, $J = 6.3$ Hz, 1H), 4.58 (s, 1H), 3.55 (s, 3H), 3.43 (d, $J = 6.4$ Hz, 1H), 2.87-2.82 (m, 1H), 2.52-2.48 (m, 1H). ¹³C NMR (175 MHz, CDCl₃) δ 207.0, 173.6, 138.6, 133.9, 133.9, 132.7, 130.4, 130.2, 128.6, 128.3, 127.9, 127.7, 127.1, 126.9, 125.8, 125.2, 94.8, 89.4, 72.3, 55.4, 52.0, 50.1, 36.4. HPLC: Chiralpak IA + AS-H column, 254 nm, 30 °C, *n*-Hexane/*i*-PrOH = 95/5, flow = 0.8 mL/min, retention time 62.0 min and 72.2 min (major). HRMS Calculated for C₂₇H₂₄NaO₃S [M+Na]⁺ 451.1338, found: 451.1335.

The NOE Result of Carbonyl Reduction (-)-8

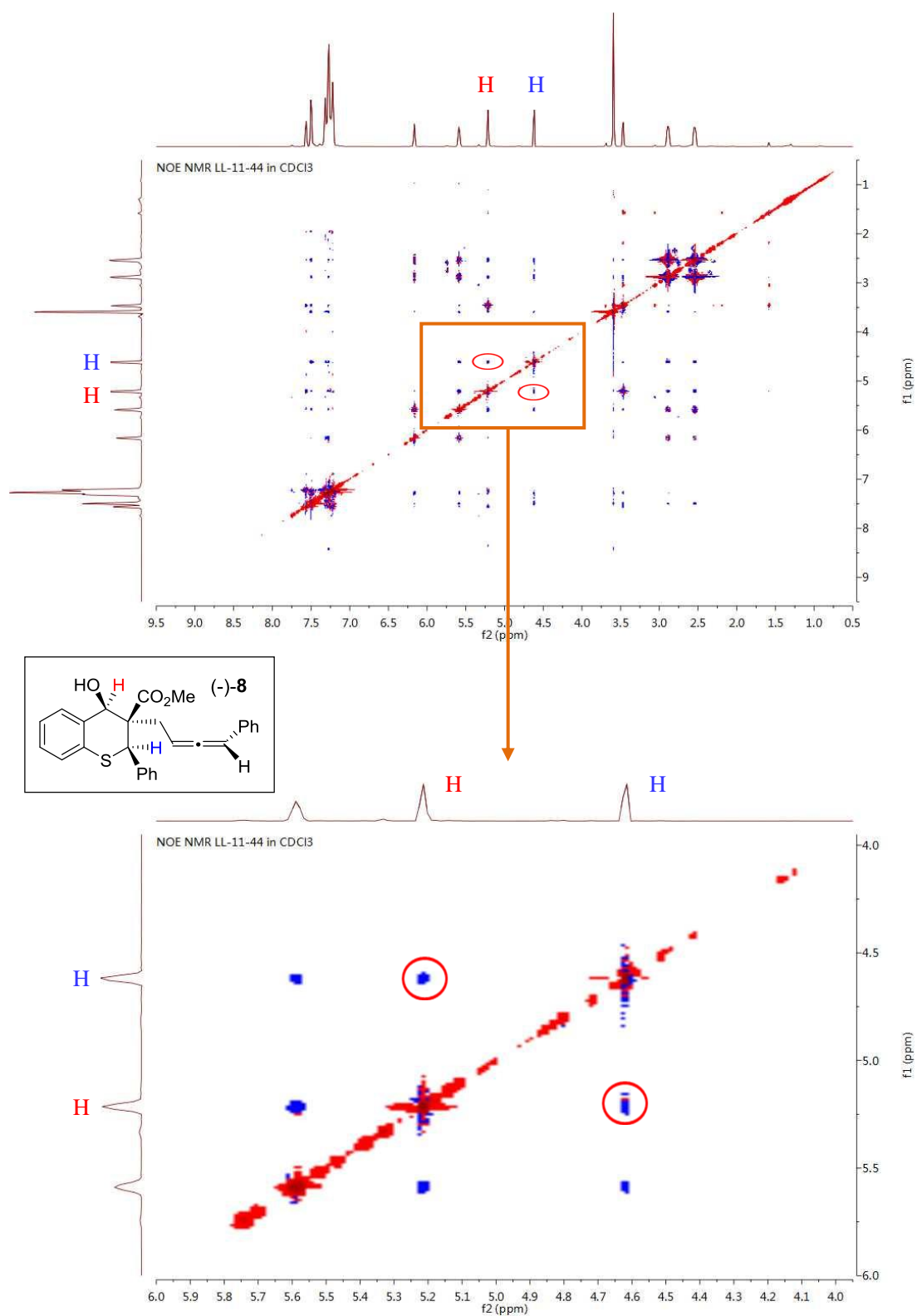


Figure S1. NOE spectrum of (-)-8

6. Determination of Absolute Configuration

To determine the absolute configuration of (-)-methyl 3-(4-(naphthalen-2-yl)buta-2,3 -dien-1-yl)-6-nitro-4-oxo-2-phenylthiochromane-3-carboxylate (**3mk**, 32.3:1 dr, >99% ee): (-)-**3mk** was completely dissolved in dichloromethane (2.0 mL), and *n*-hexane (2.0 mL) was added slowly at room temperature. The solvent diffused slowly, and the single crystal was obtained after about 36 hours. The structure in **Figure S2** showed the absolute configuration is (2*R*,3*S*,*R*_a). The CCDC number is 2214958. These details can be obtained free of charge *via* www.ccdc.com.ac.uk/data_request/cif from the Cambridge Crystallographic Data Centre.

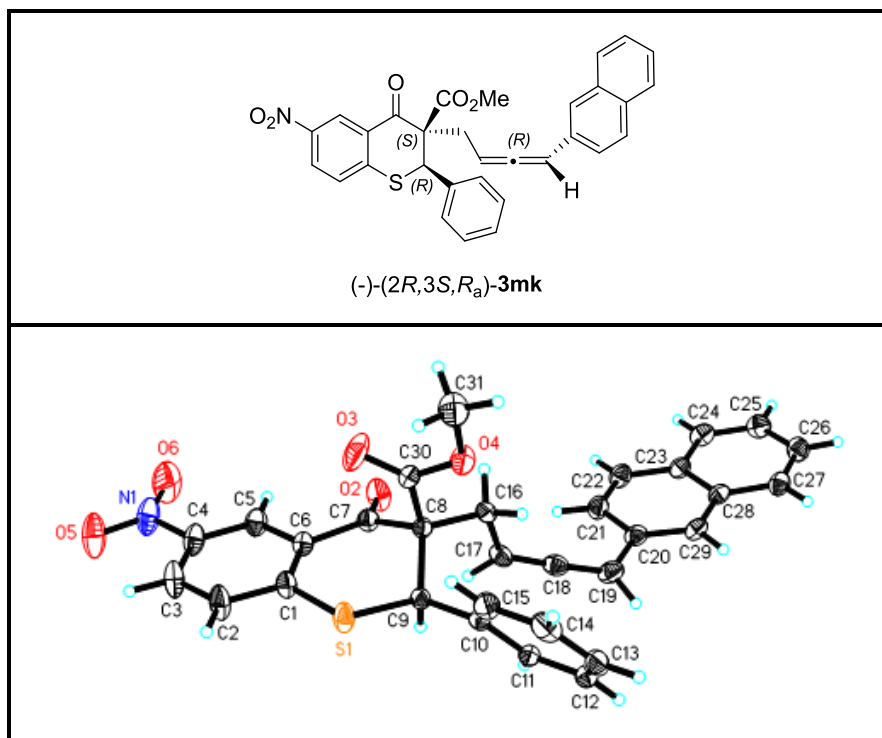


Figure S2. X-Ray Structure of (-)-(2*R*,3*S*,*R*_a)-**3mk**

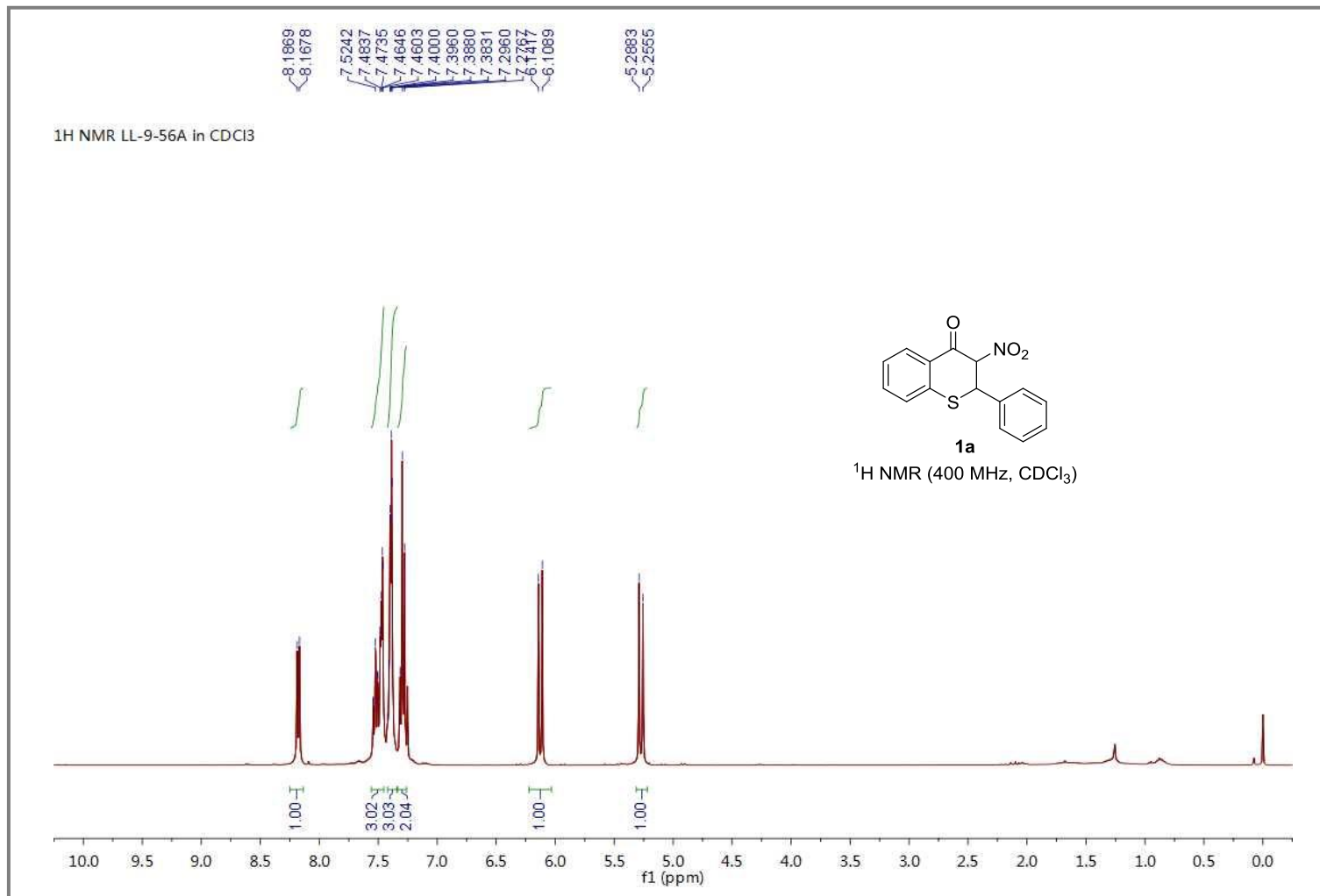
Crystal Data and Structure Refinement for mo_d8v22443_0m for (-)-(2*R*,3*S*,*R*_a)-3mk

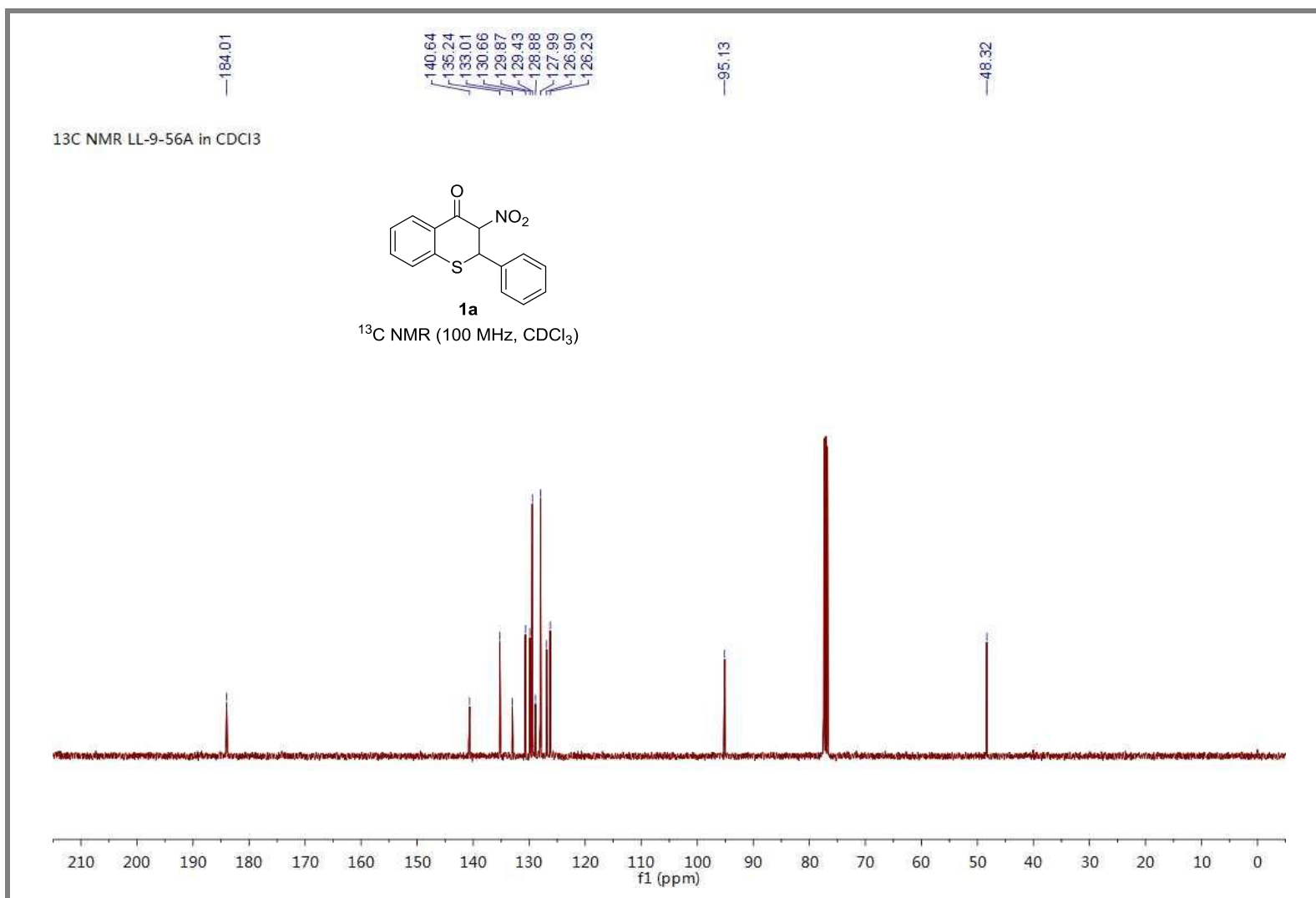
Identification code	mo_d8v22443_0m	
Empirical formula	C ₃₁ H ₂₃ NO ₅ S	
Formula weight	521.56	
Temperature	213(2) K	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P 21 21 21	
Unit cell dimensions	a = 6.8379(3) Å	α = 90°
	b = 16.3952(5) Å	β = 90°
	c = 22.7541(8) Å	γ = 90°
Volume	2550.93(16) Å ³	
Z	4	
Density (calculated)	1.358 Mg/m ³	
Absorption coefficient	0.170 mm ⁻¹	
F(000)	1088	
Crystal size	0.200 x 0.150 x 0.120 mm ³	
Theta range for data collection	2.641 to 25.997°	
Index ranges	-8<=h<=8, -20<=k<=18, -28<=l<=28	
Reflections collected	22409	
Independent reflections	5005 [R(int) = 0.0593]	
Completeness to theta = 25.242°	99.4 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7456 and 0.5174	
Refinement method	Full-matrix least-squares on F ²	
Data / restraints / parameters	5005 / 0 / 344	
Goodness-of-fit on F2	1.025	
Final R indices [I>2sigma(I)]	R1 = 0.0366, wR2 = 0.0887	
R indices (all data)	R1 = 0.0415, wR2 = 0.0925	
Absolute structure parameter	0.02(4)	
Extinction coefficient	n/a	
Largest diff. peak and hole	0.187 and -0.168 e.Å ⁻³	

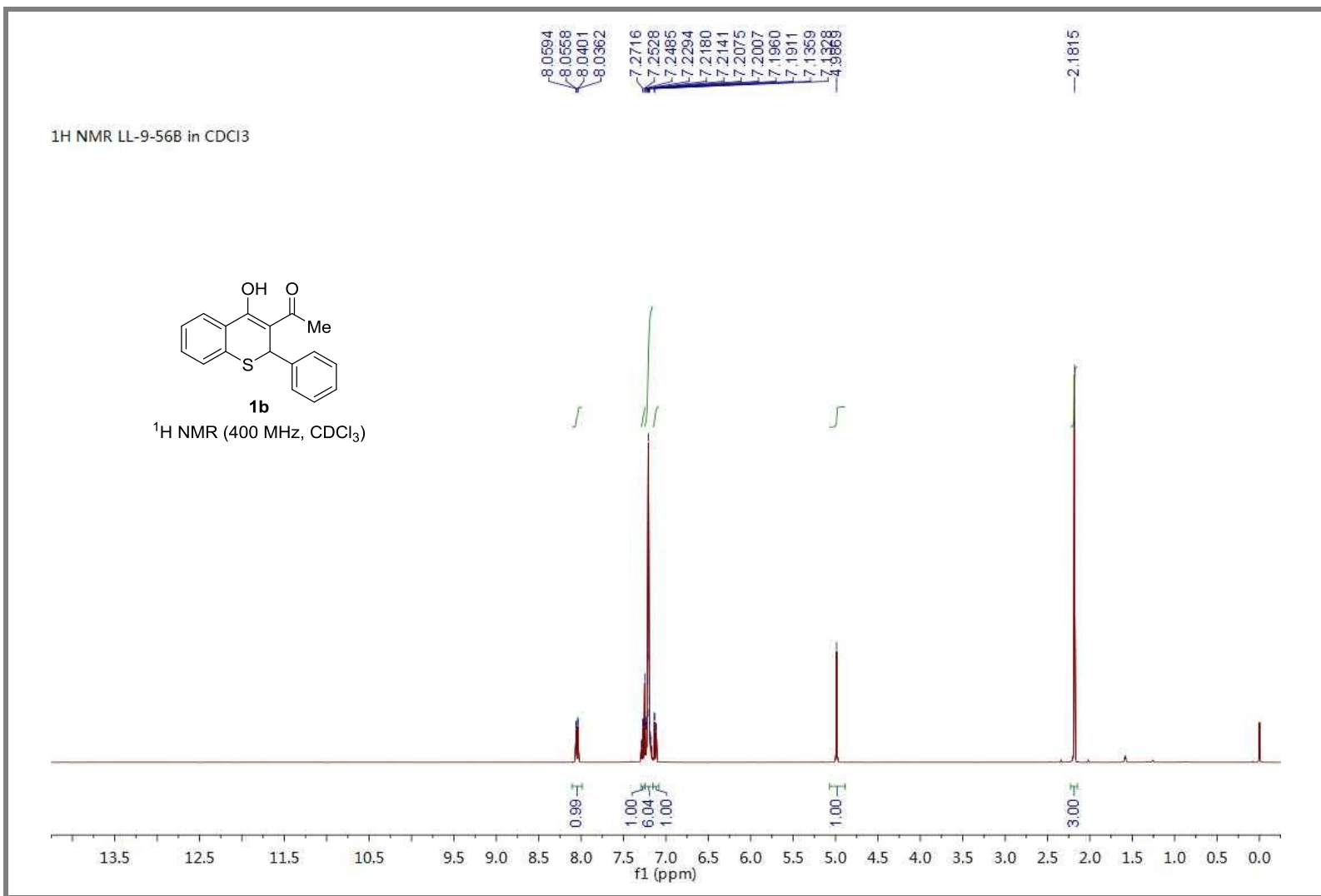
7. References

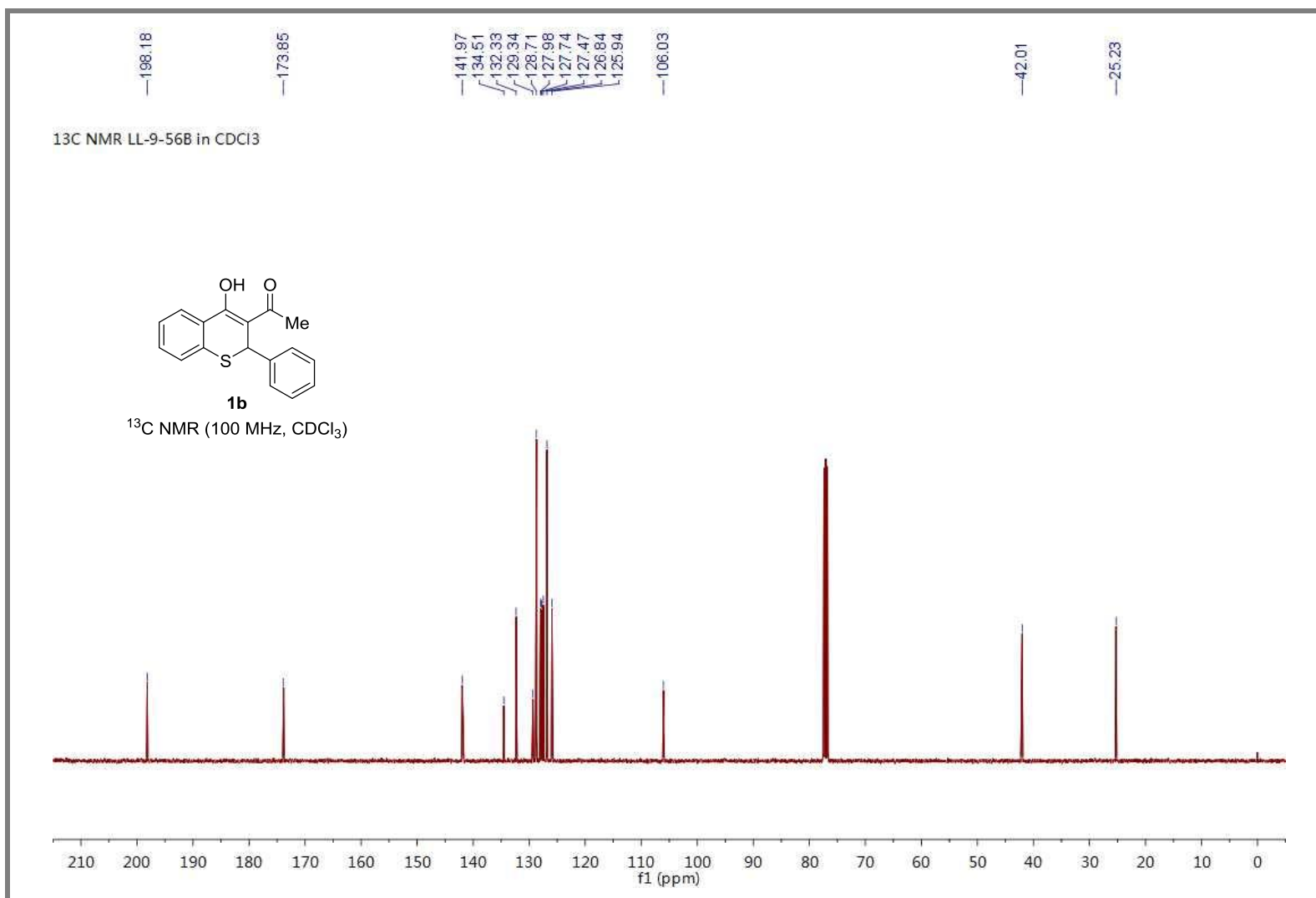
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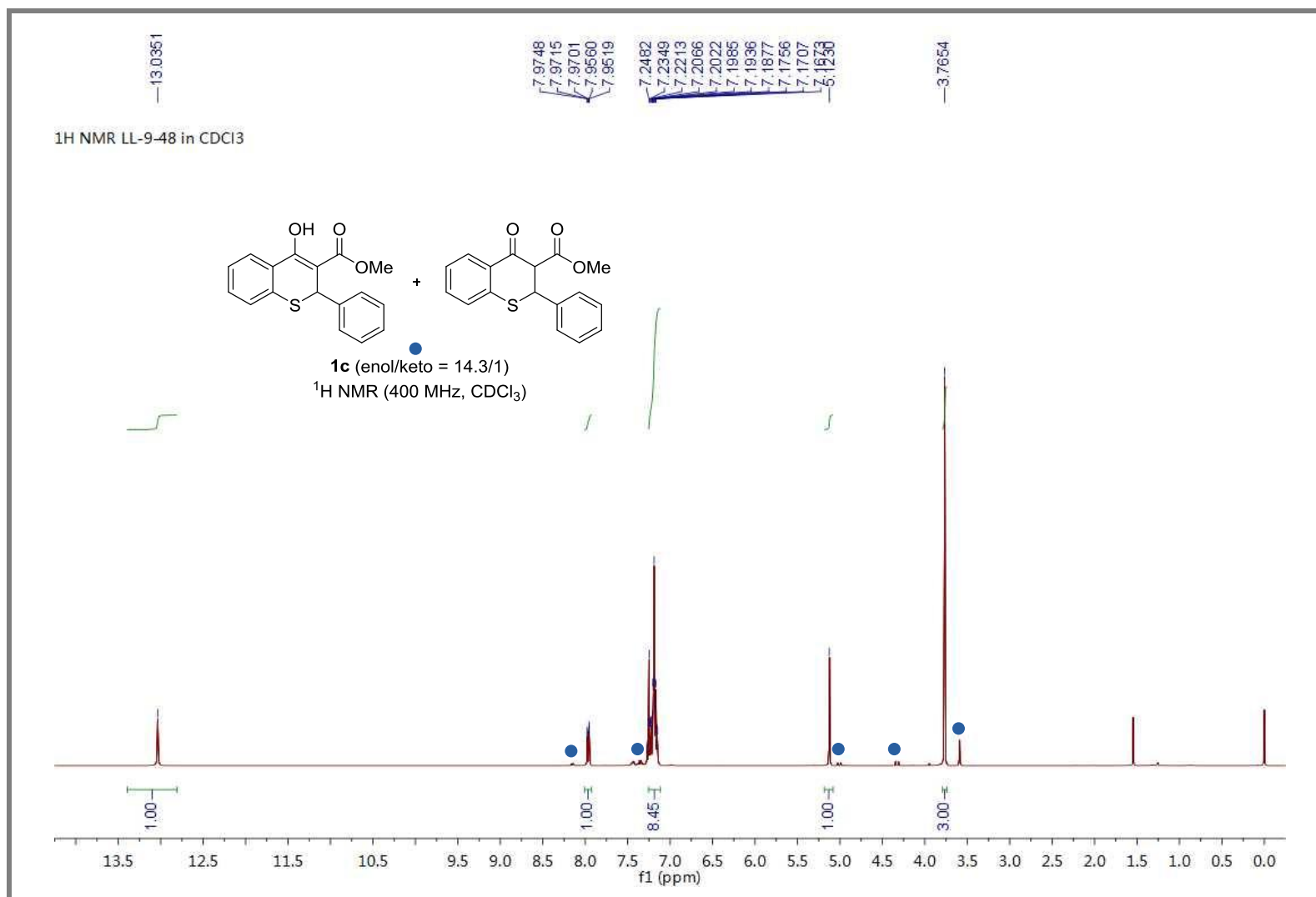
8. Copy of NMR and HPLC Spectra

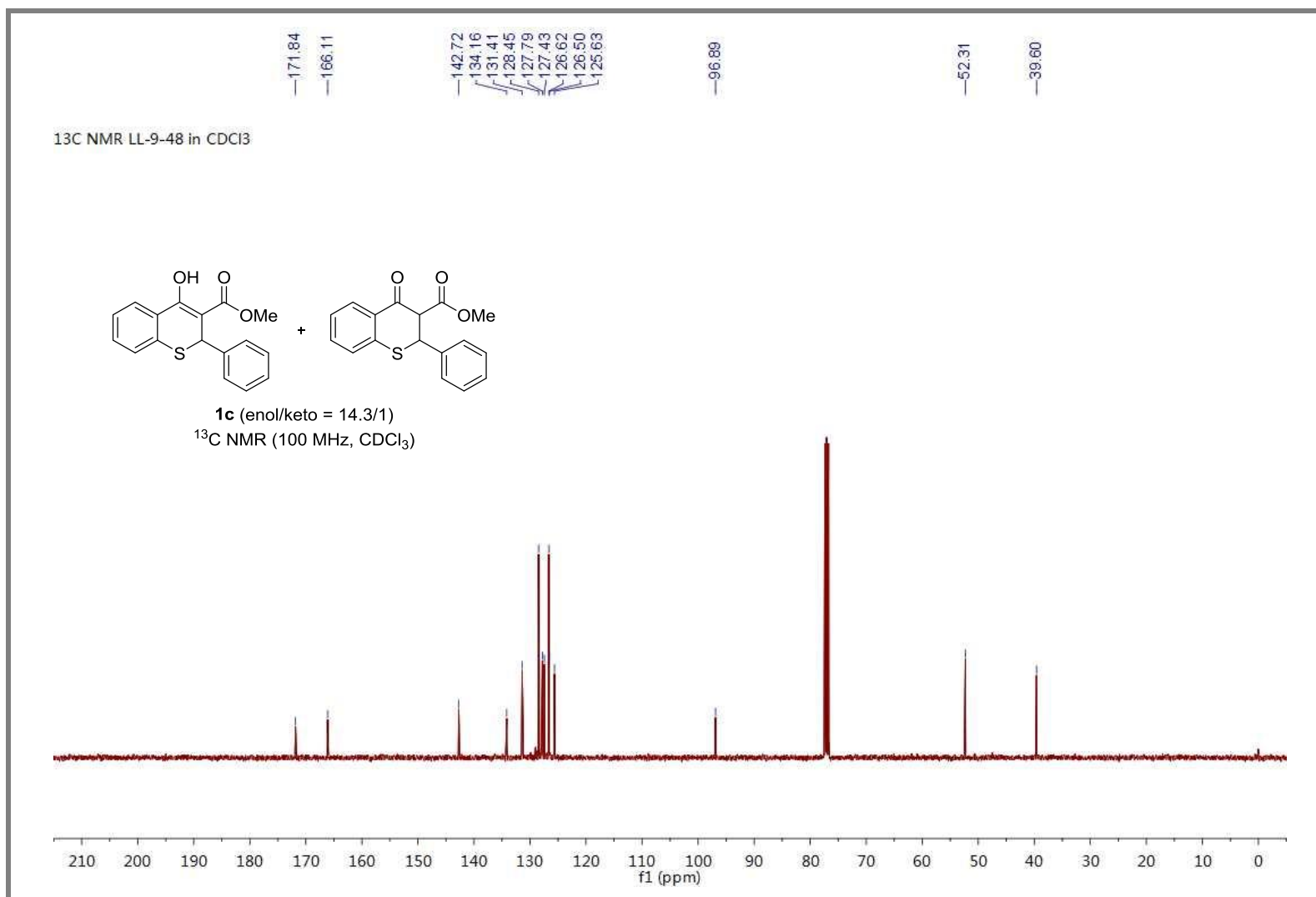


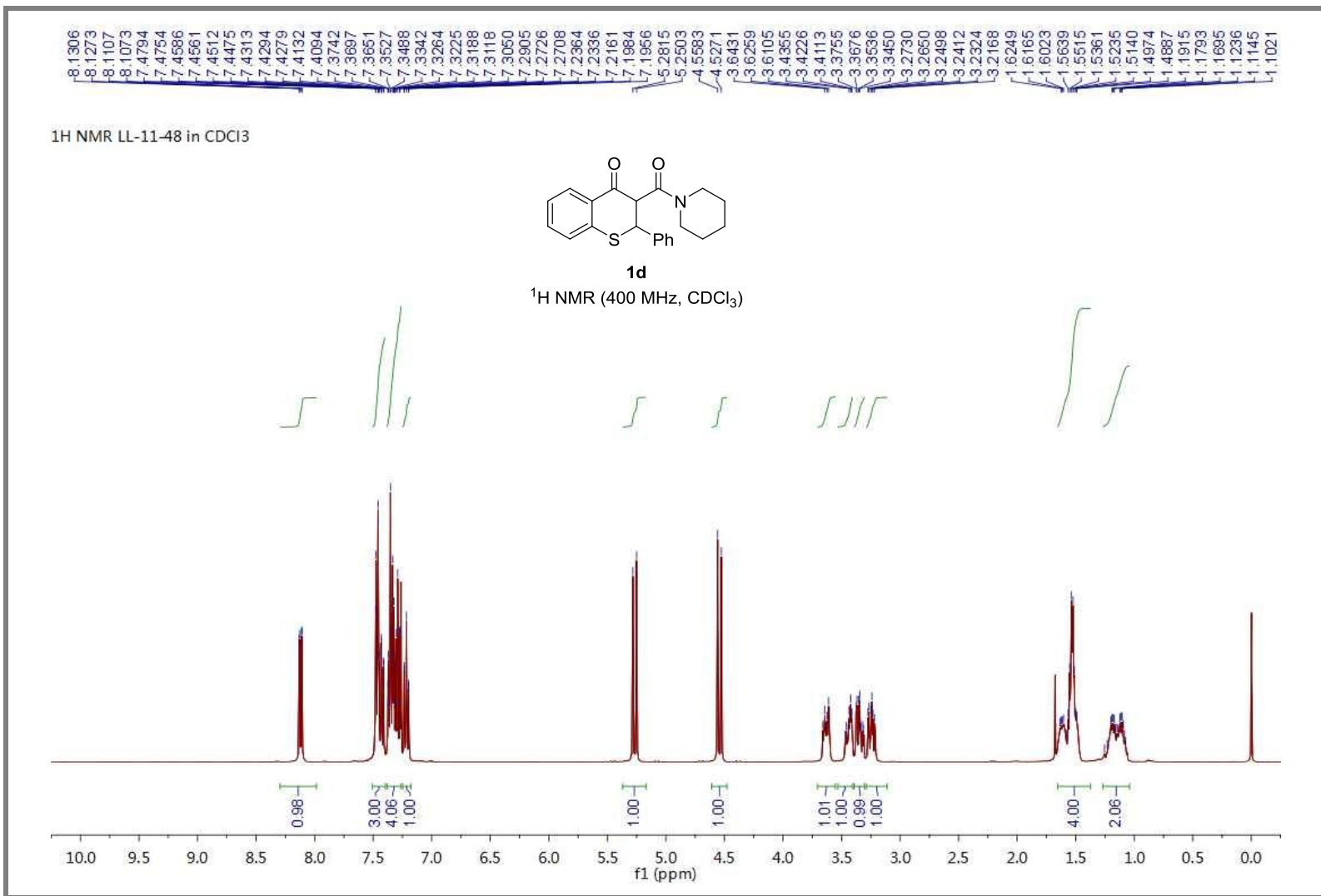


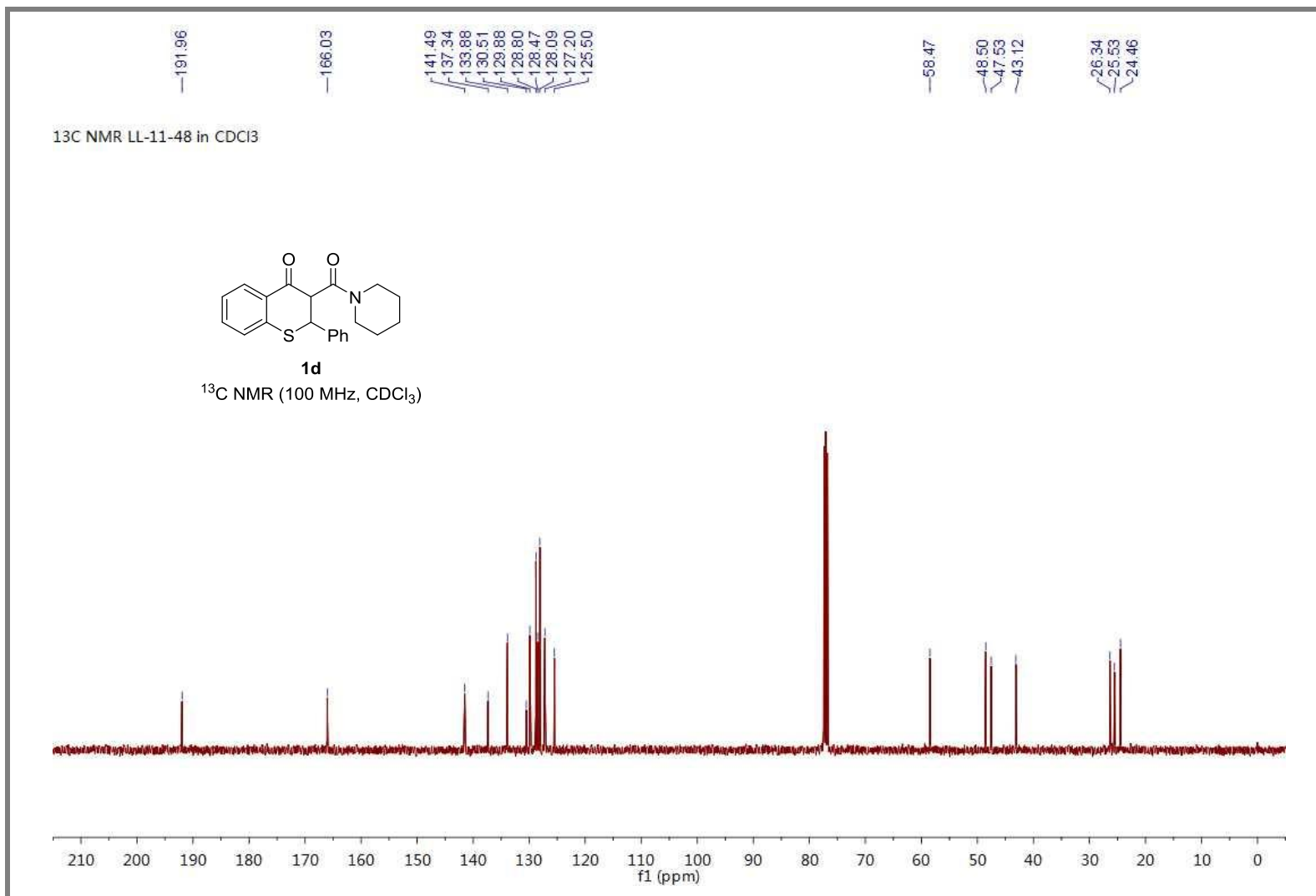


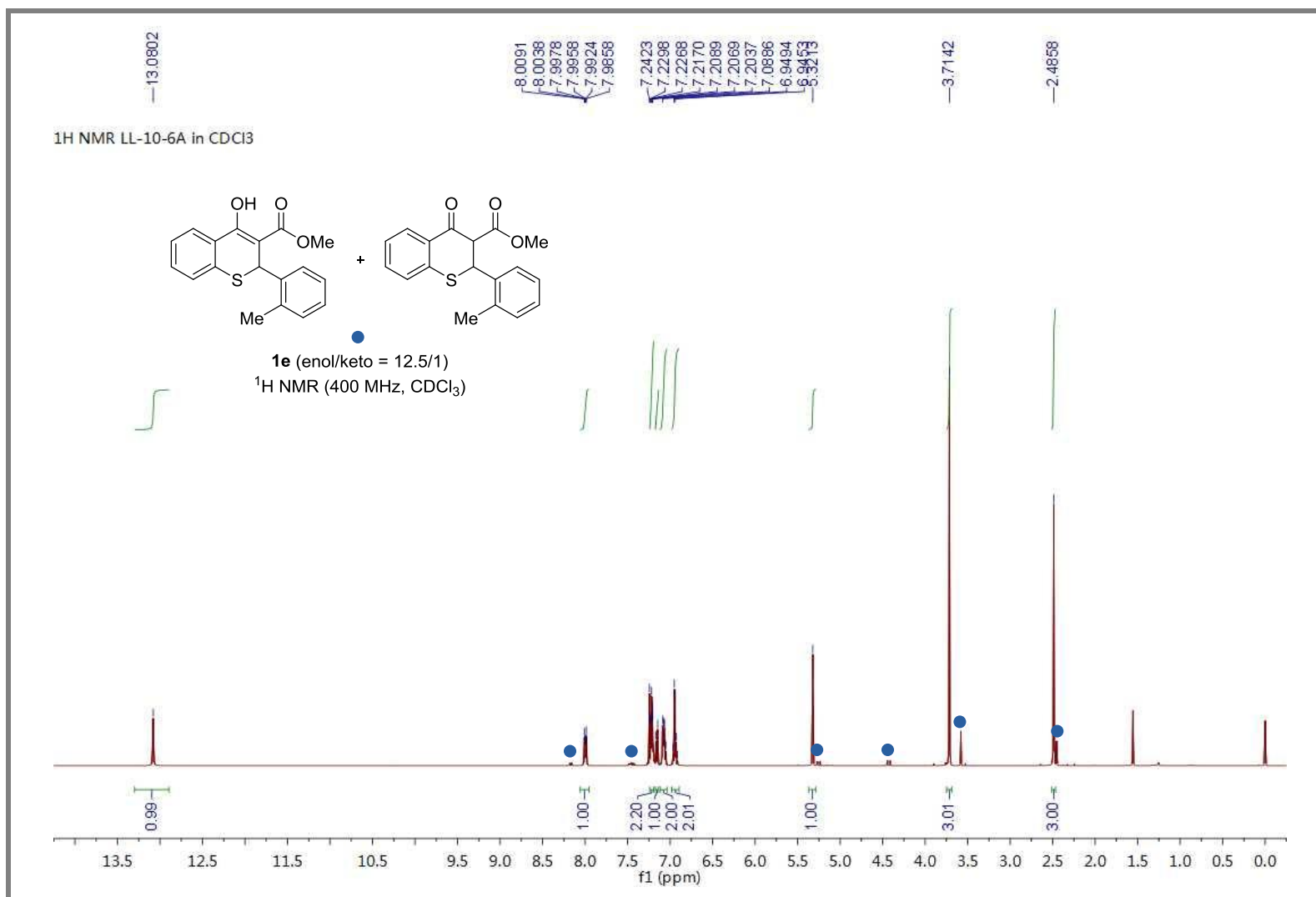


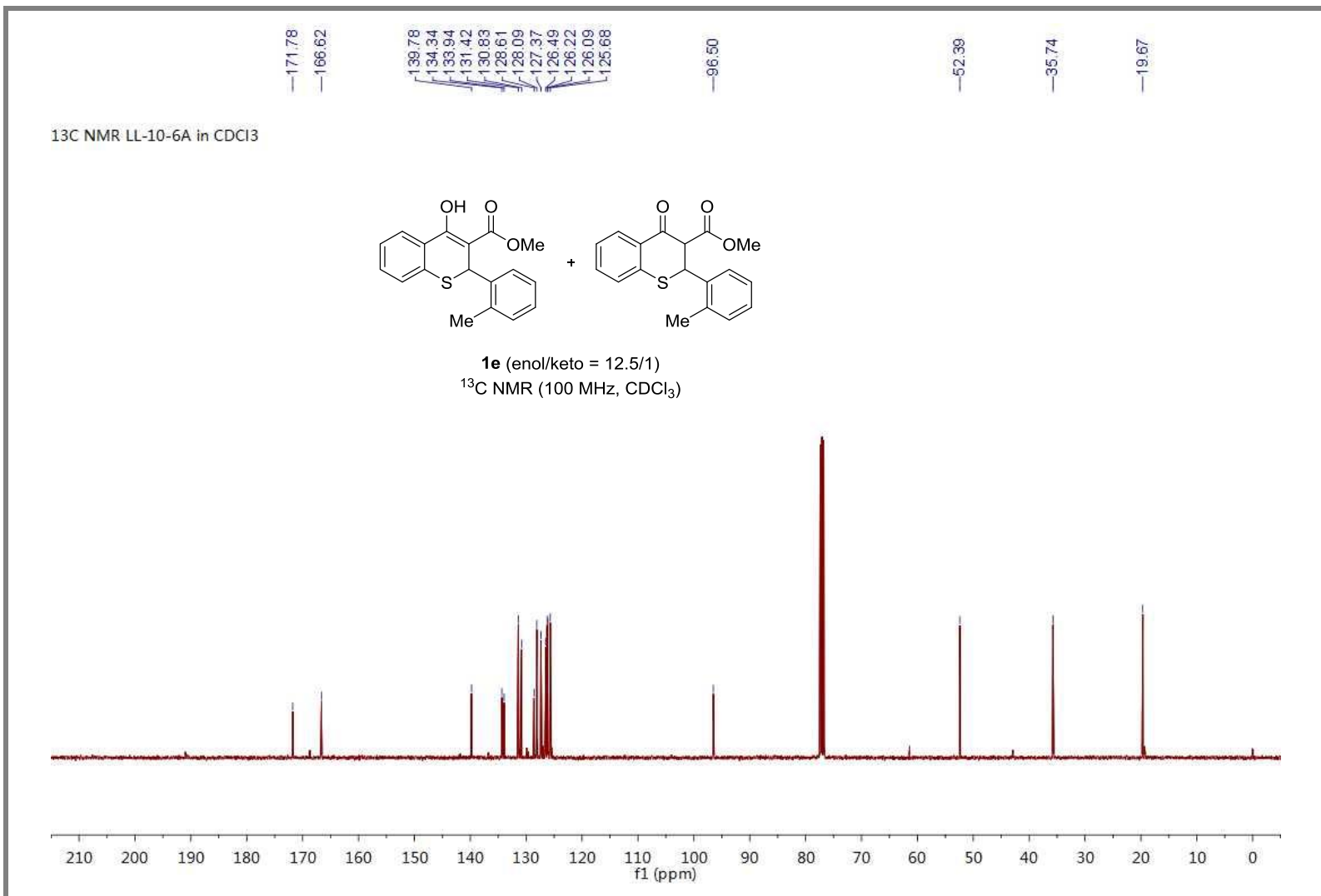


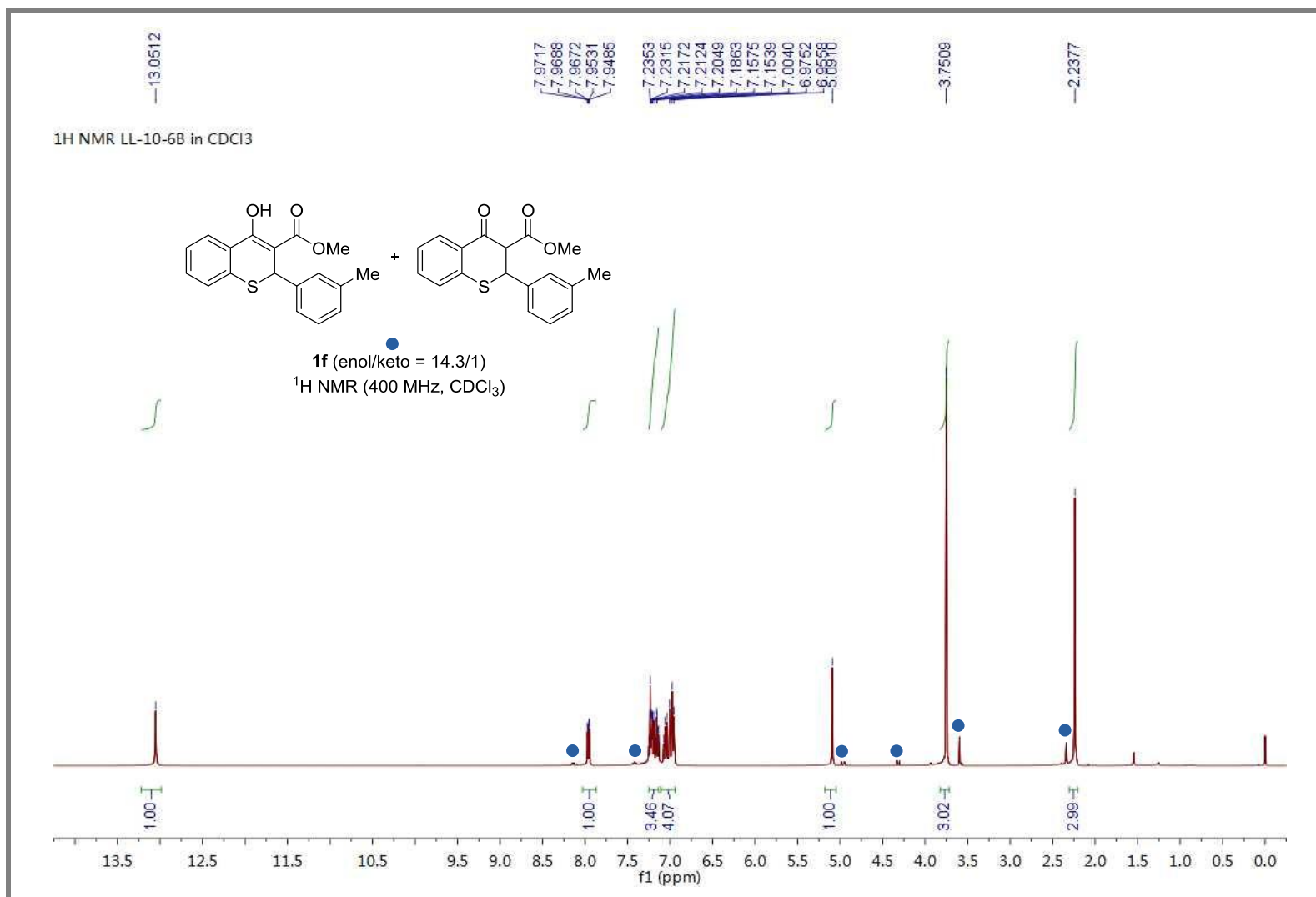


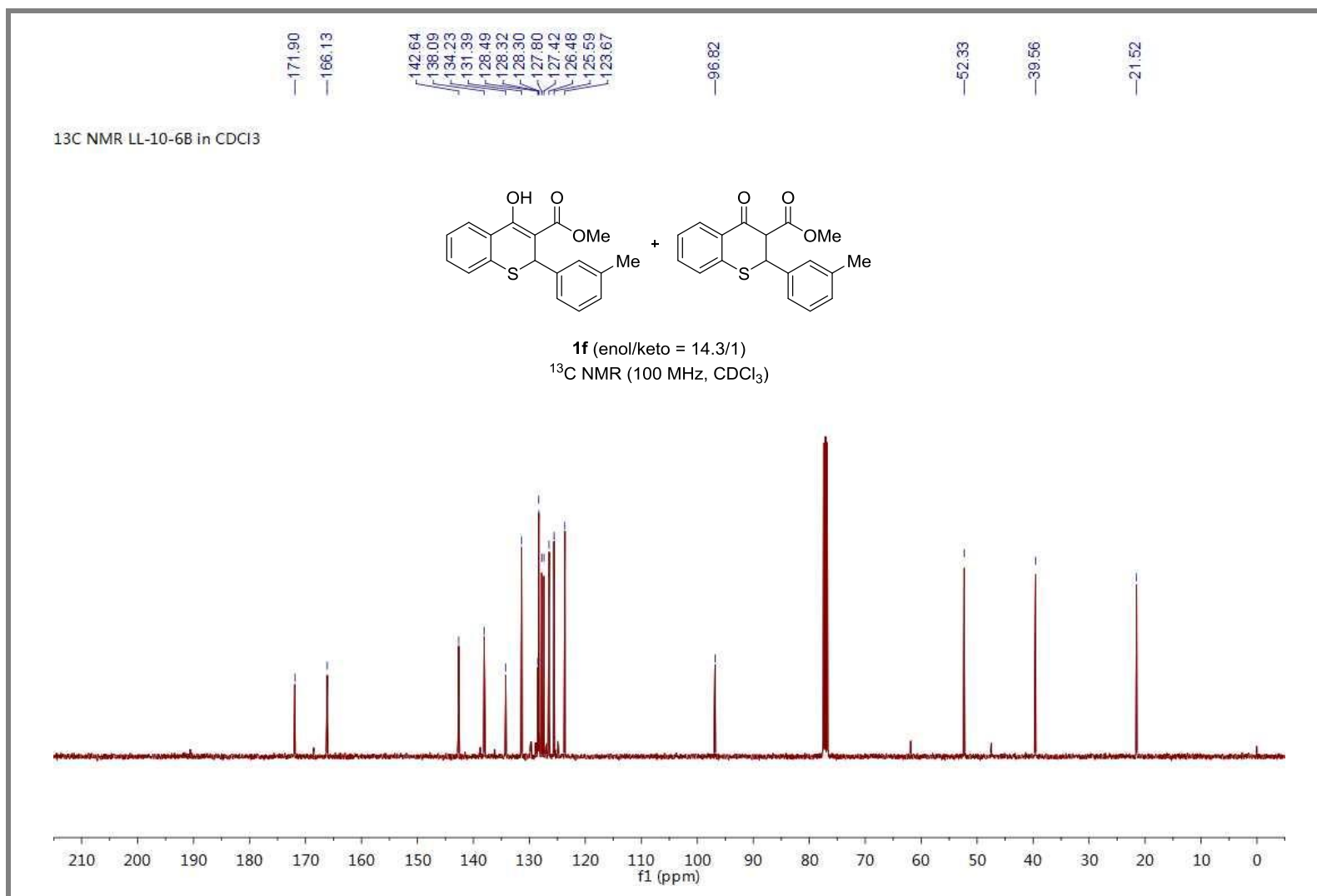


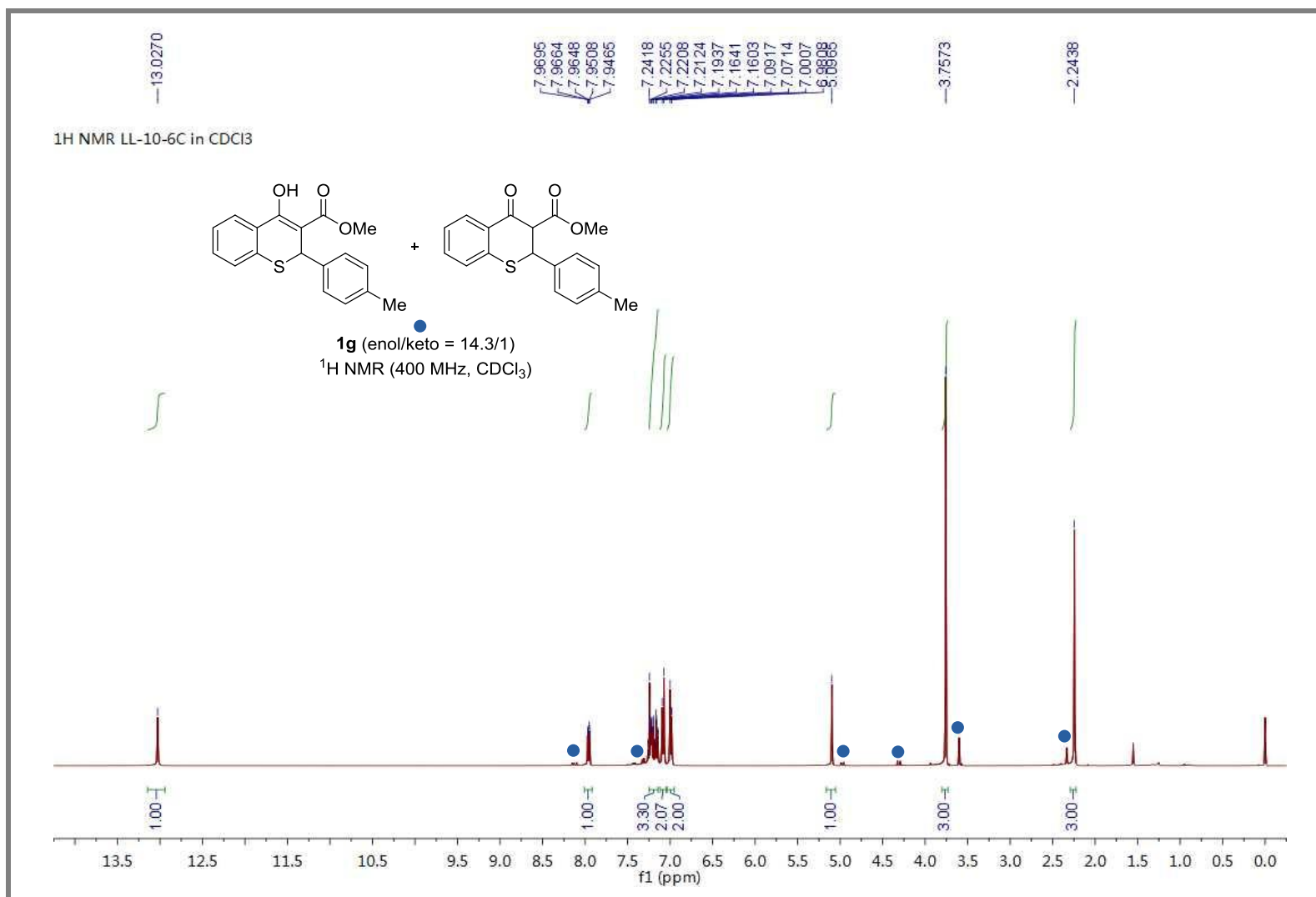


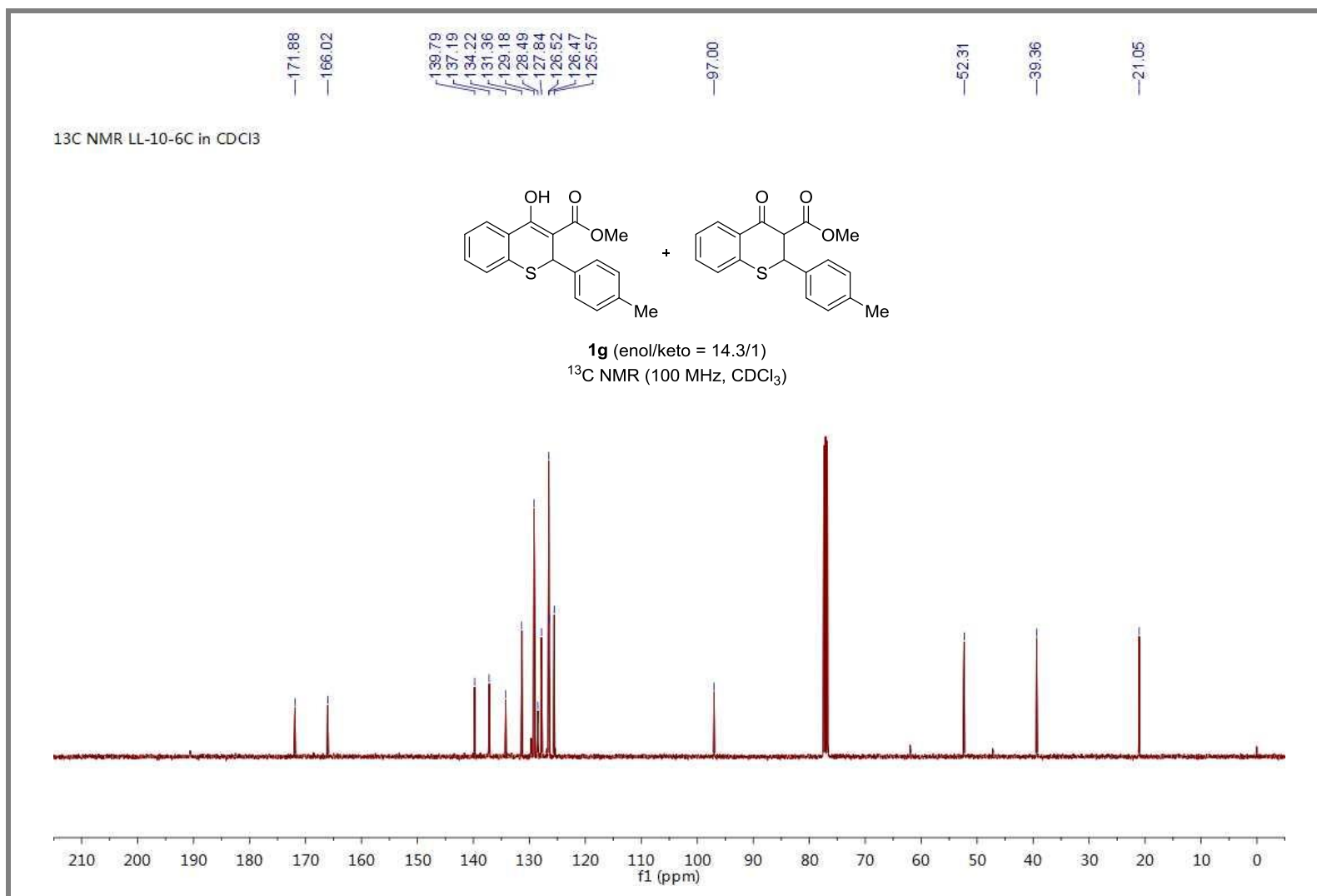


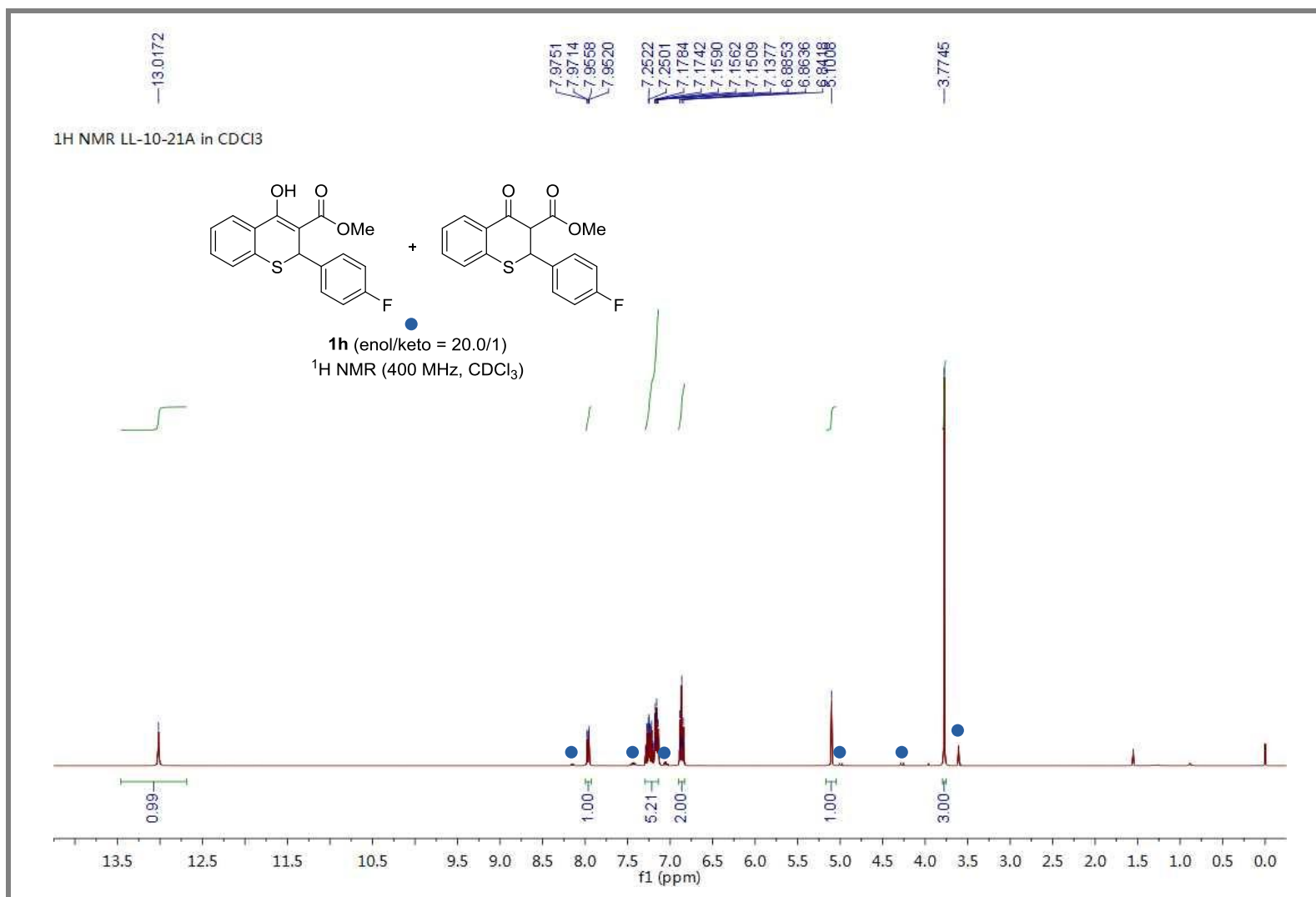


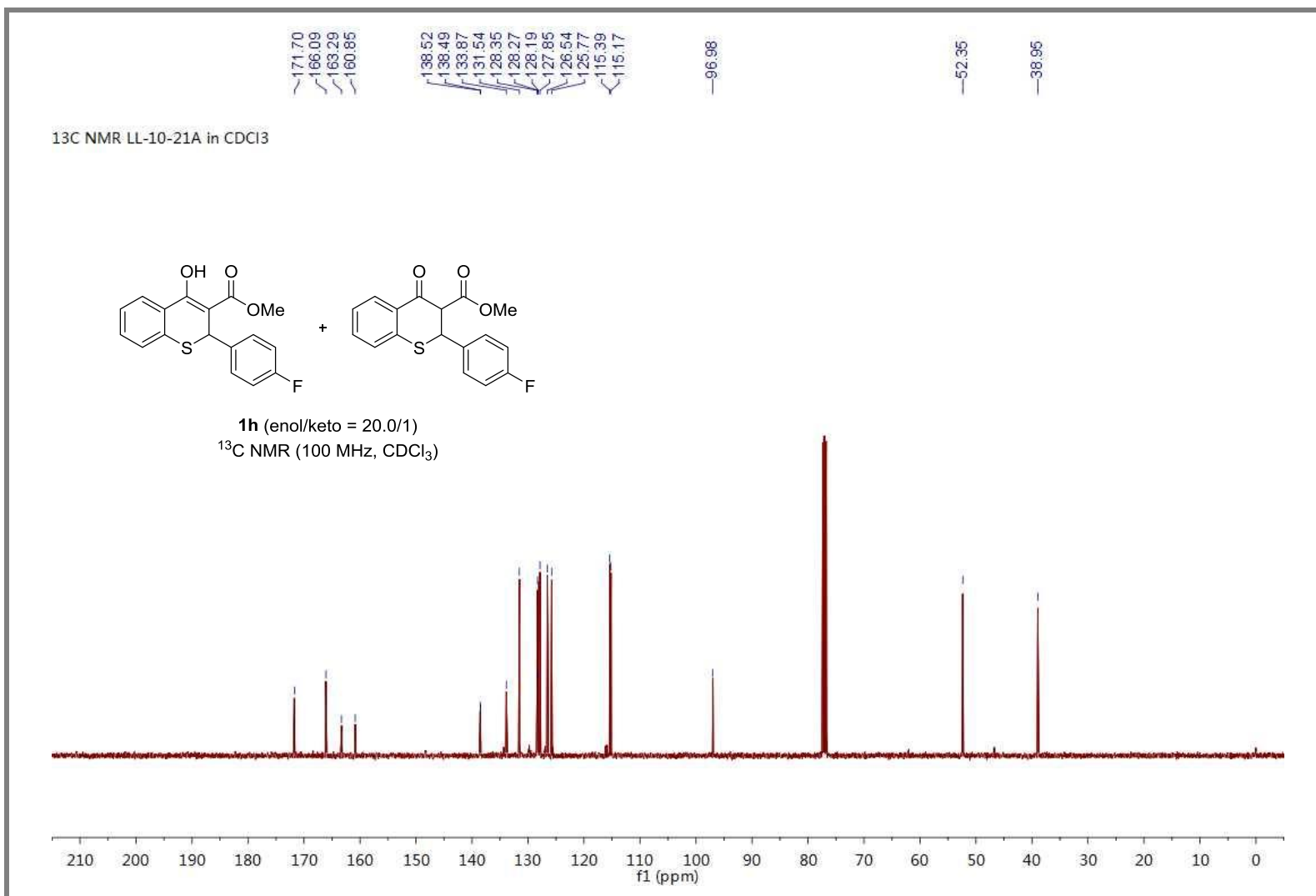




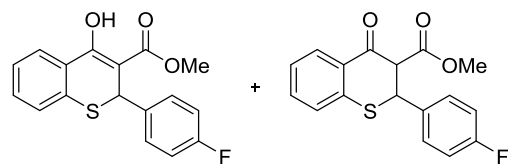




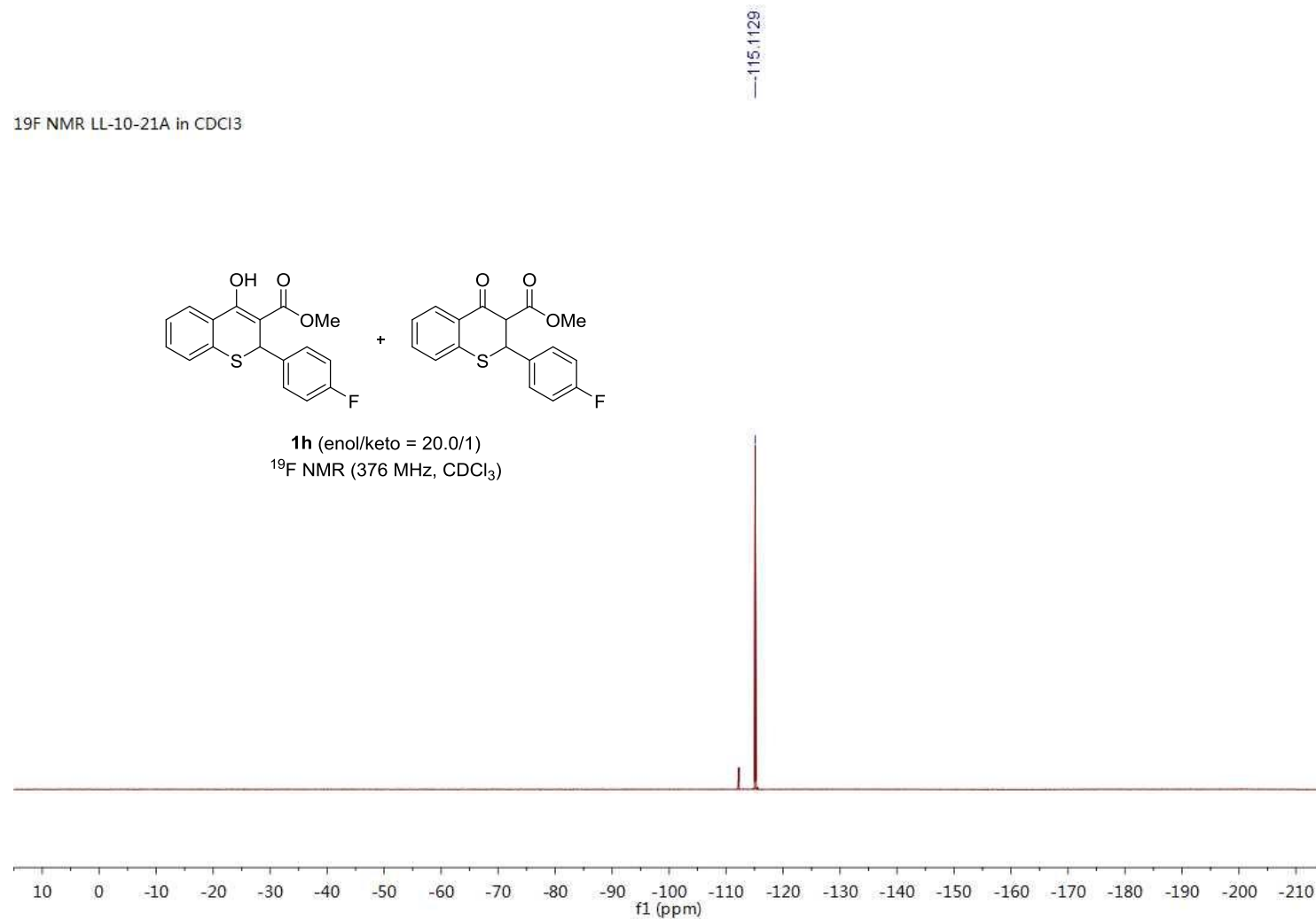


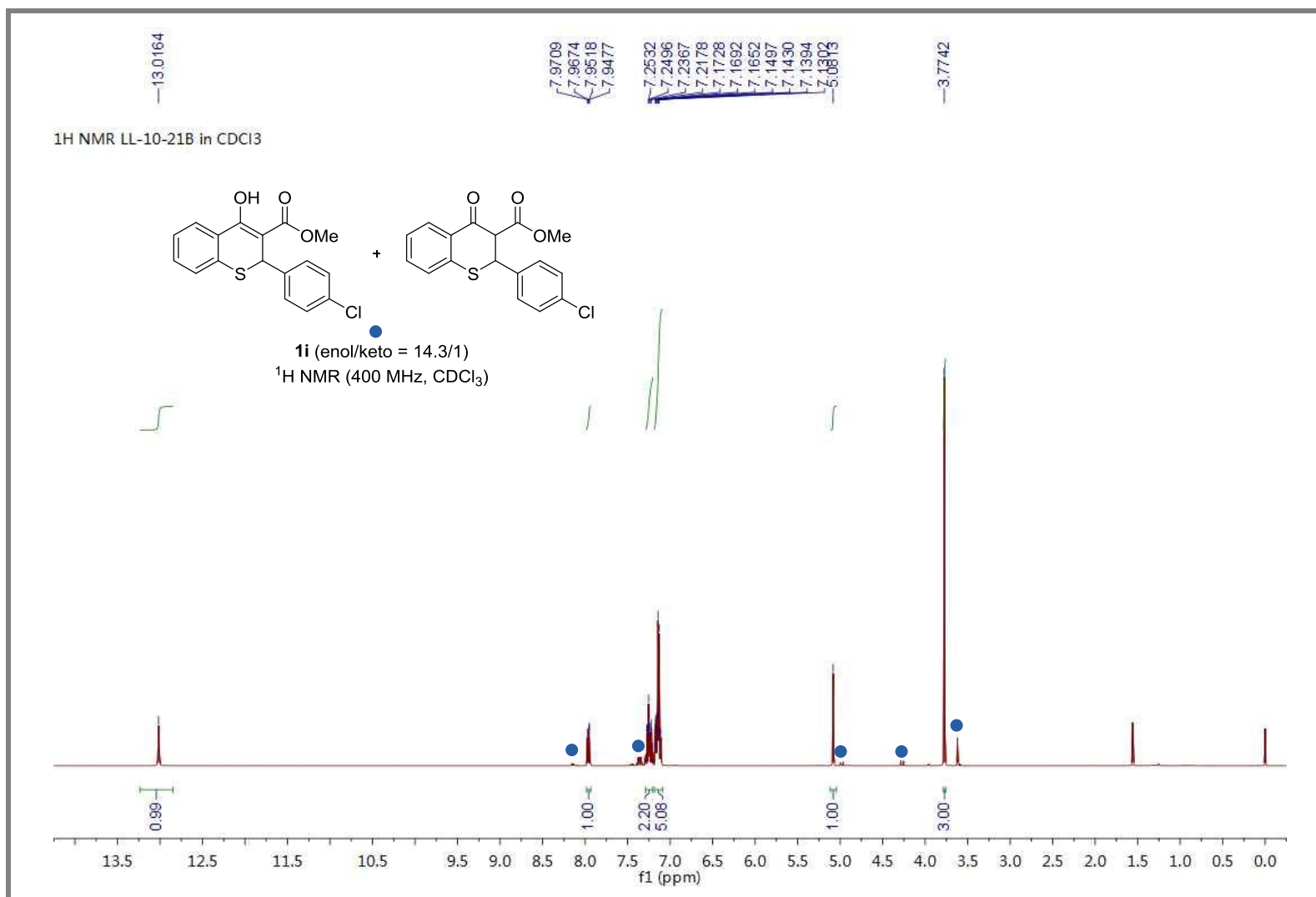


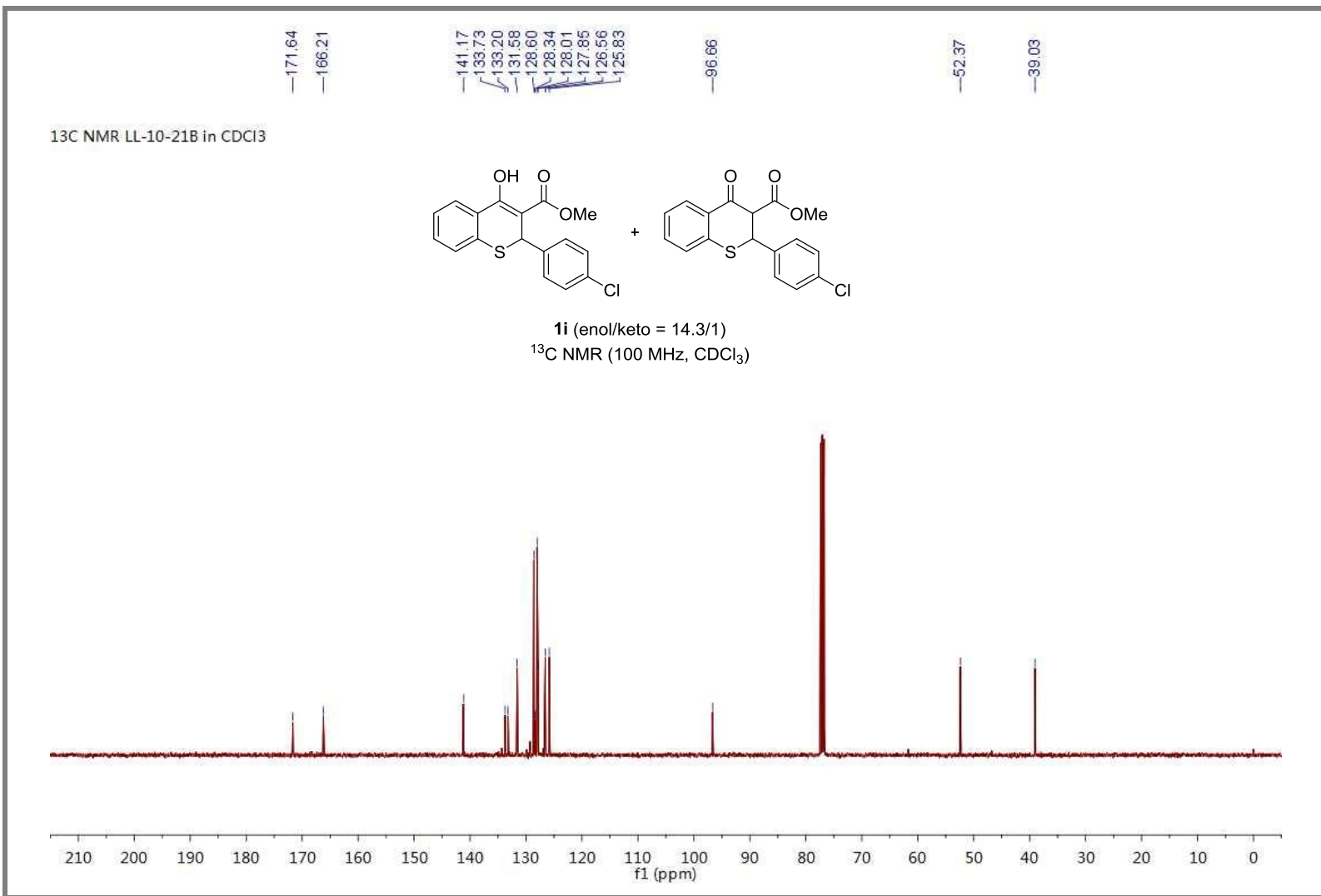
¹⁹F NMR LL-10-21A in CDCl₃

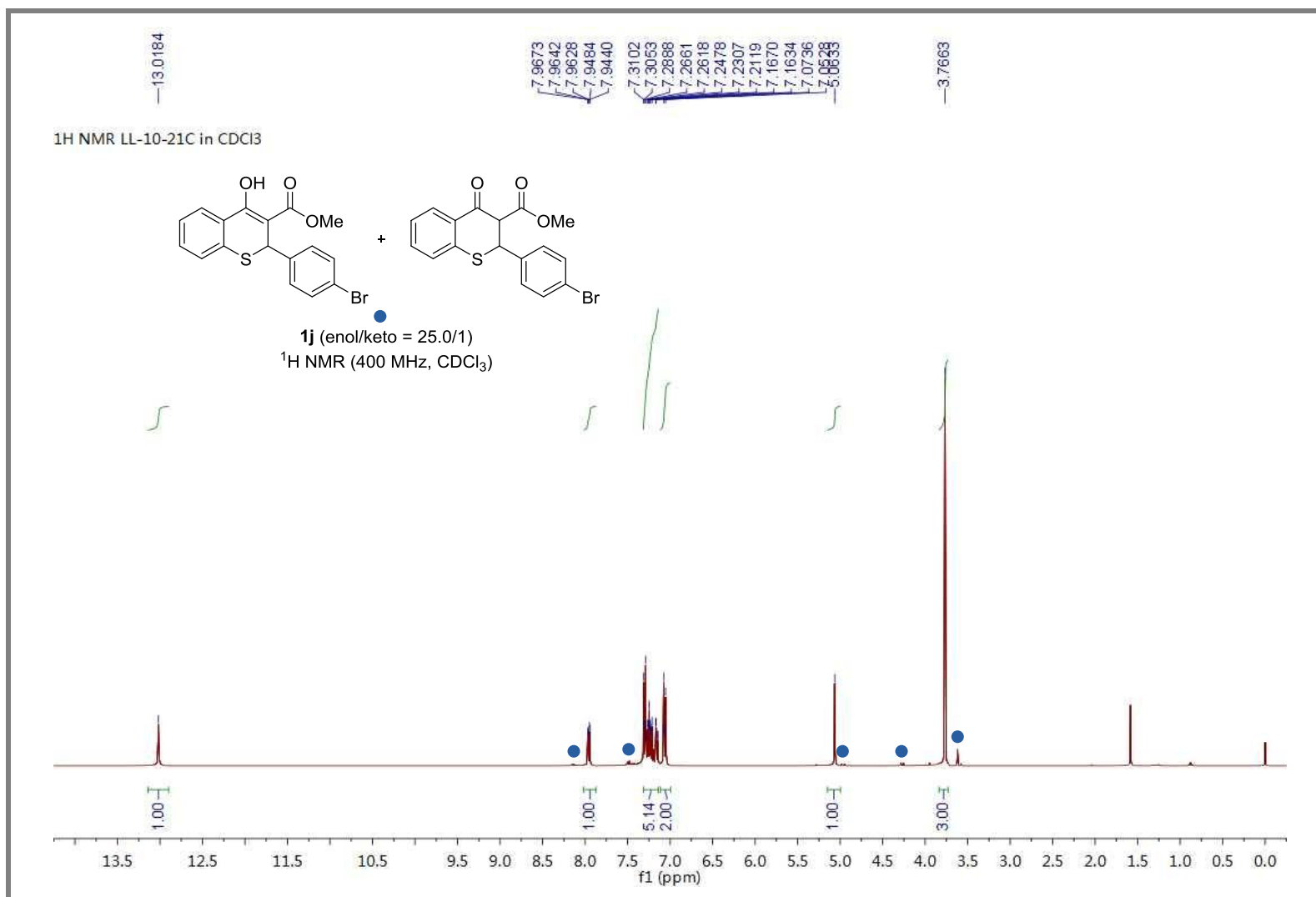


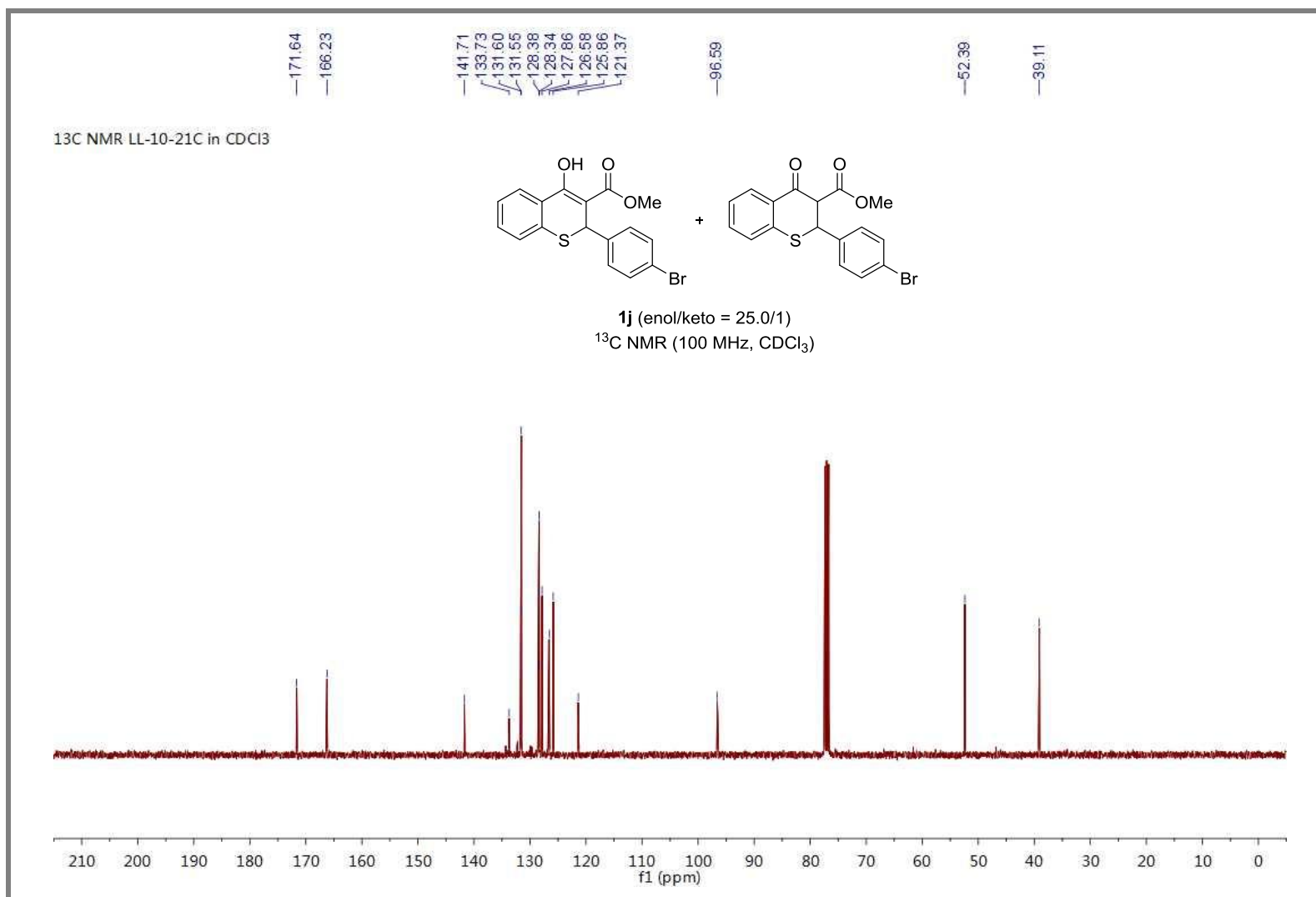
1h (enol/keto = 20.0/1)
¹⁹F NMR (376 MHz, CDCl₃)

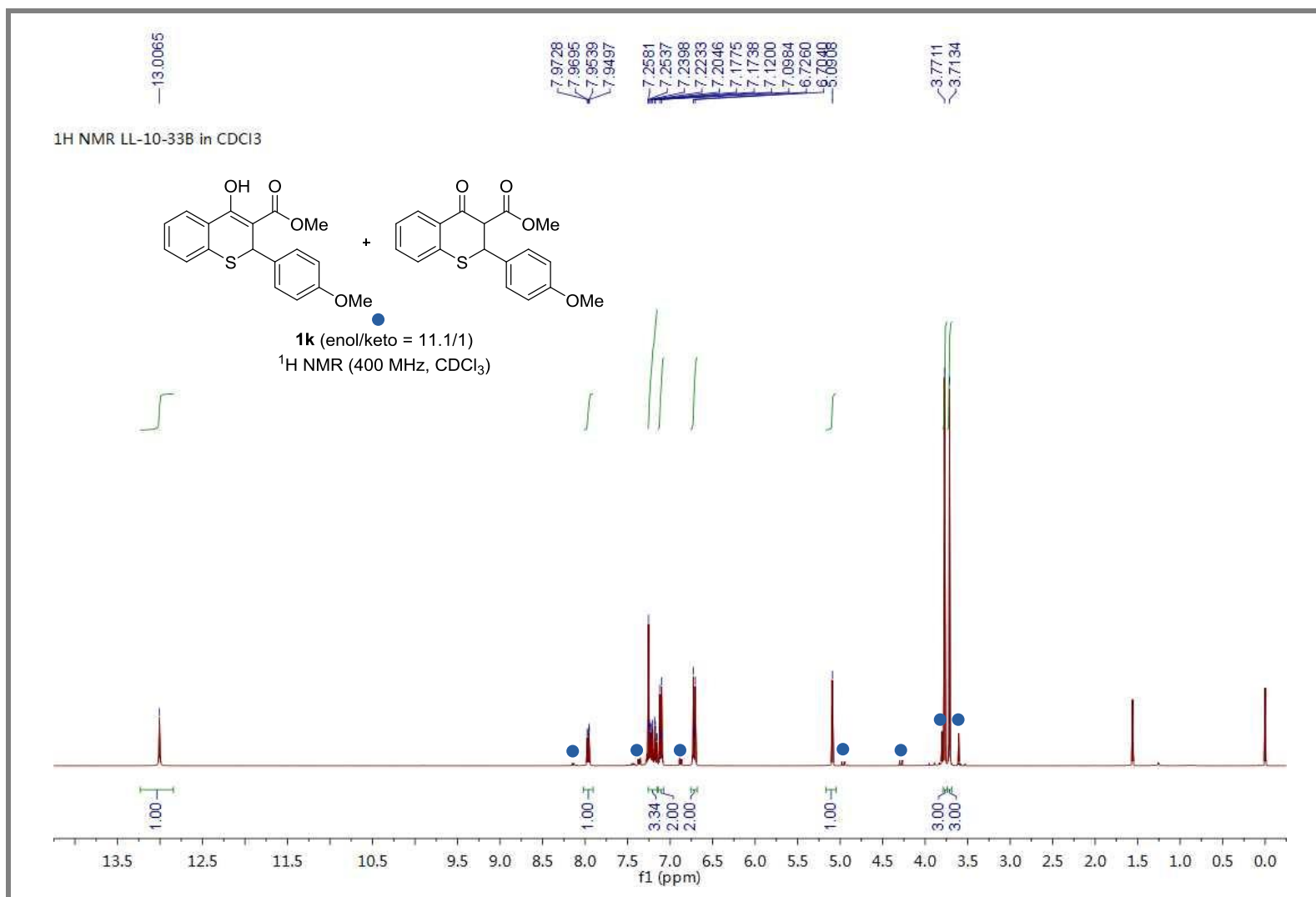


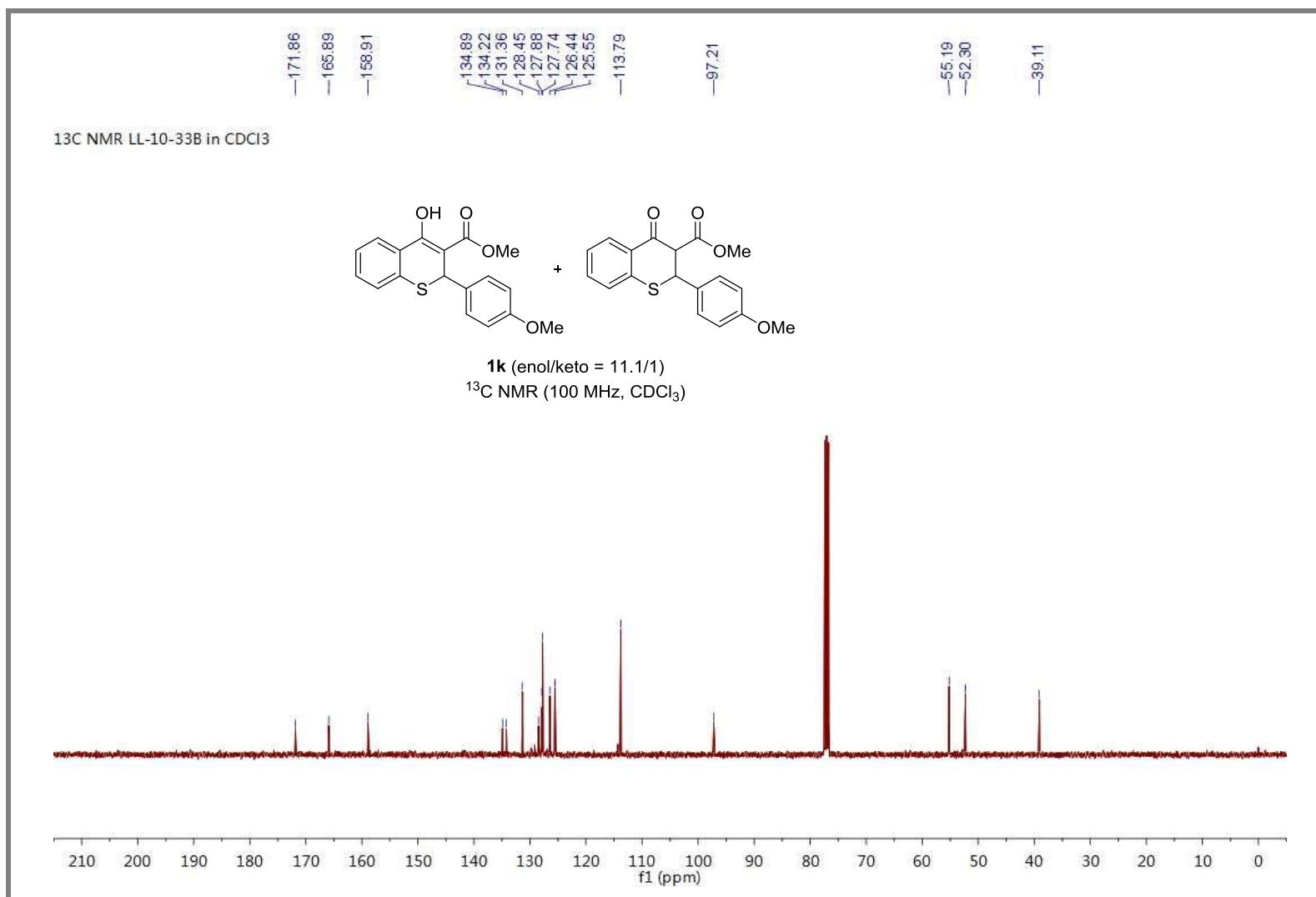


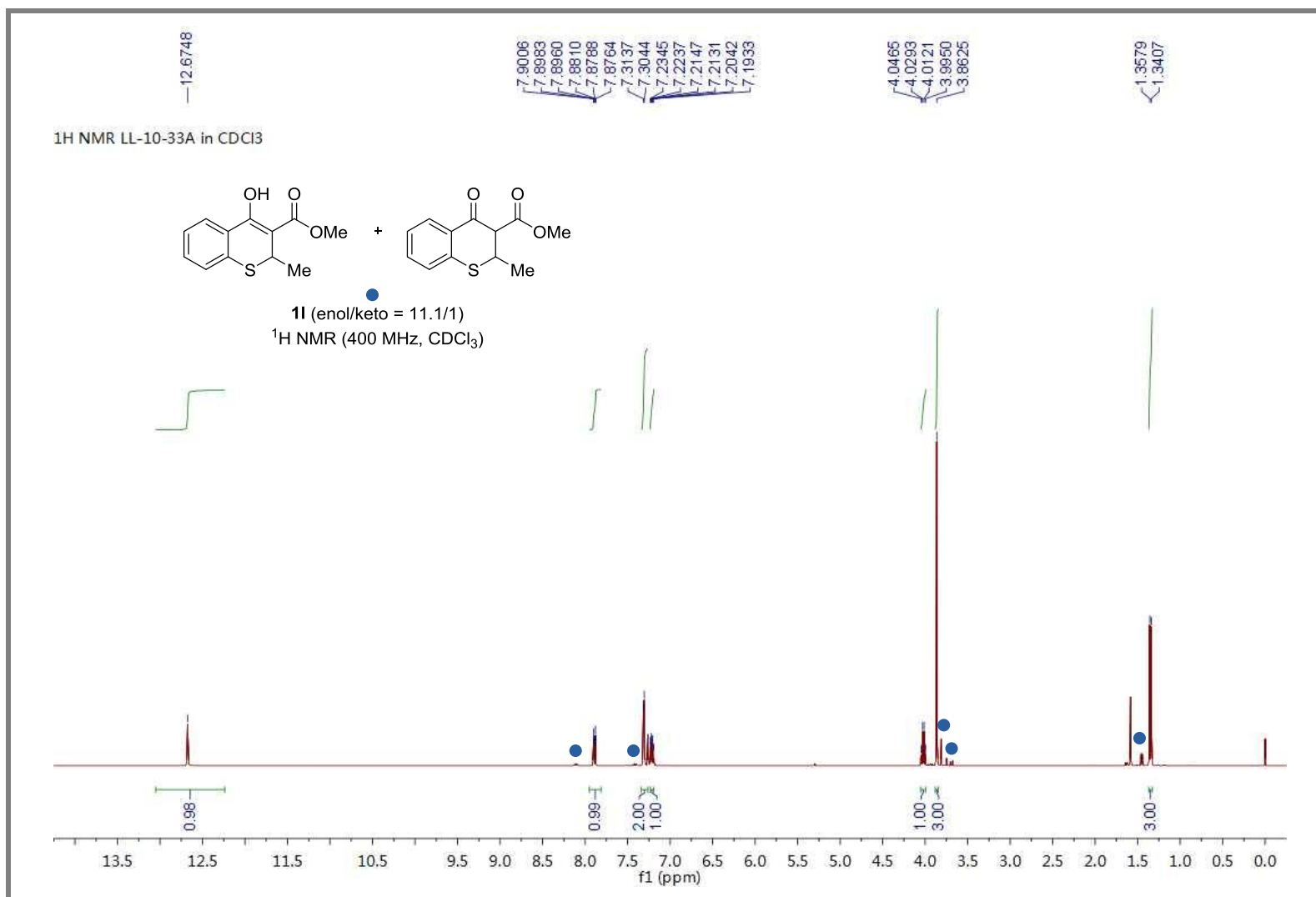


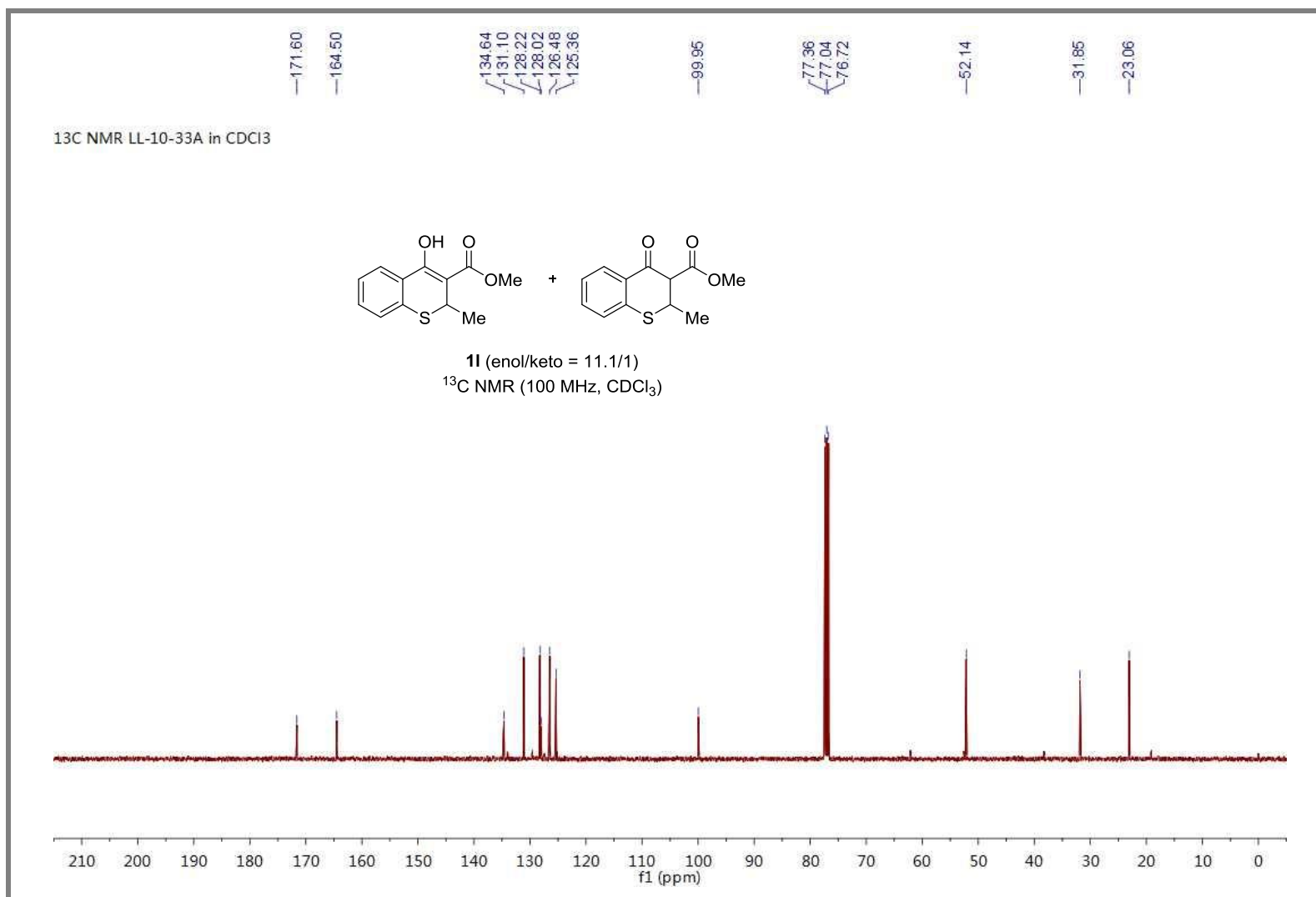


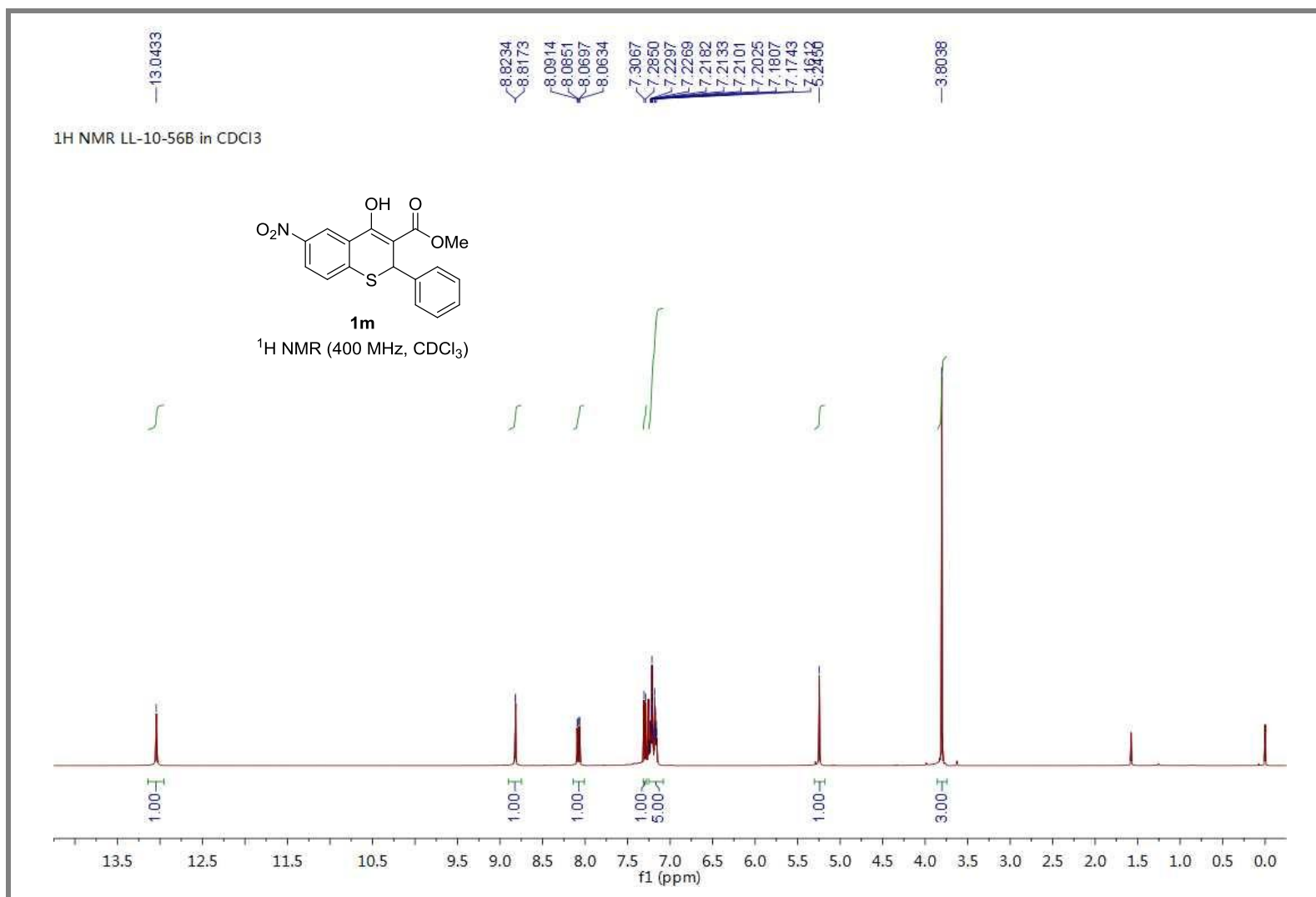


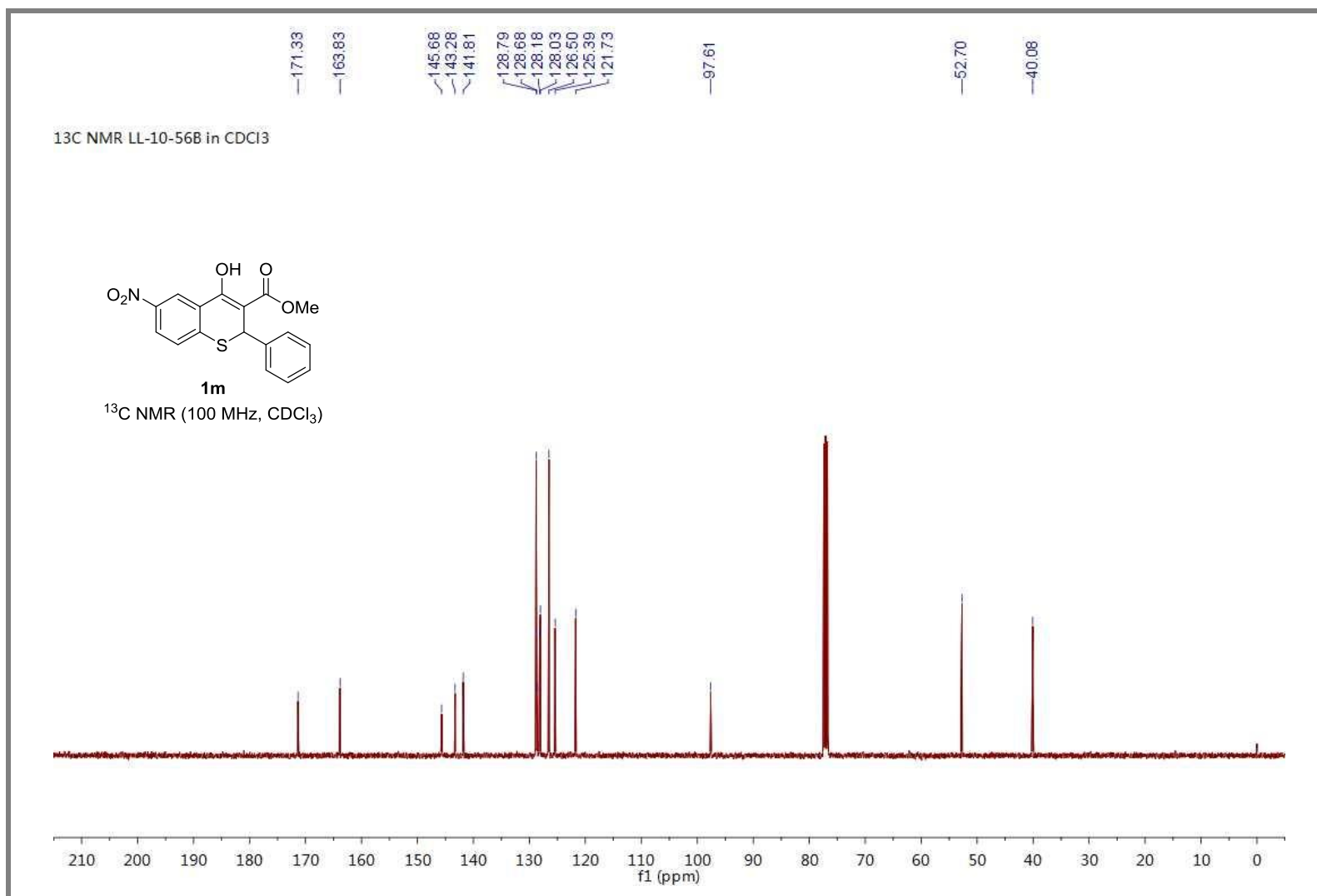


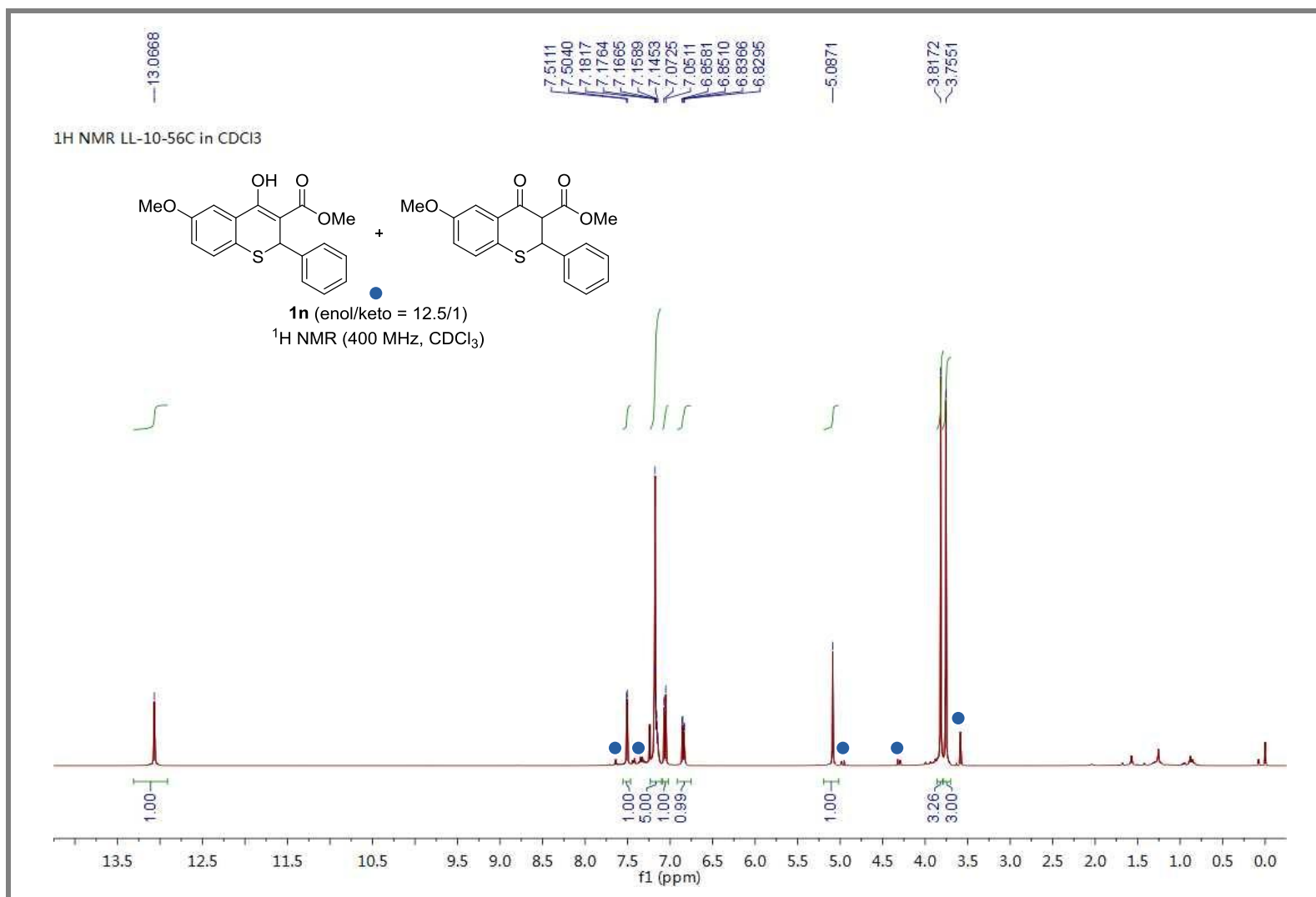


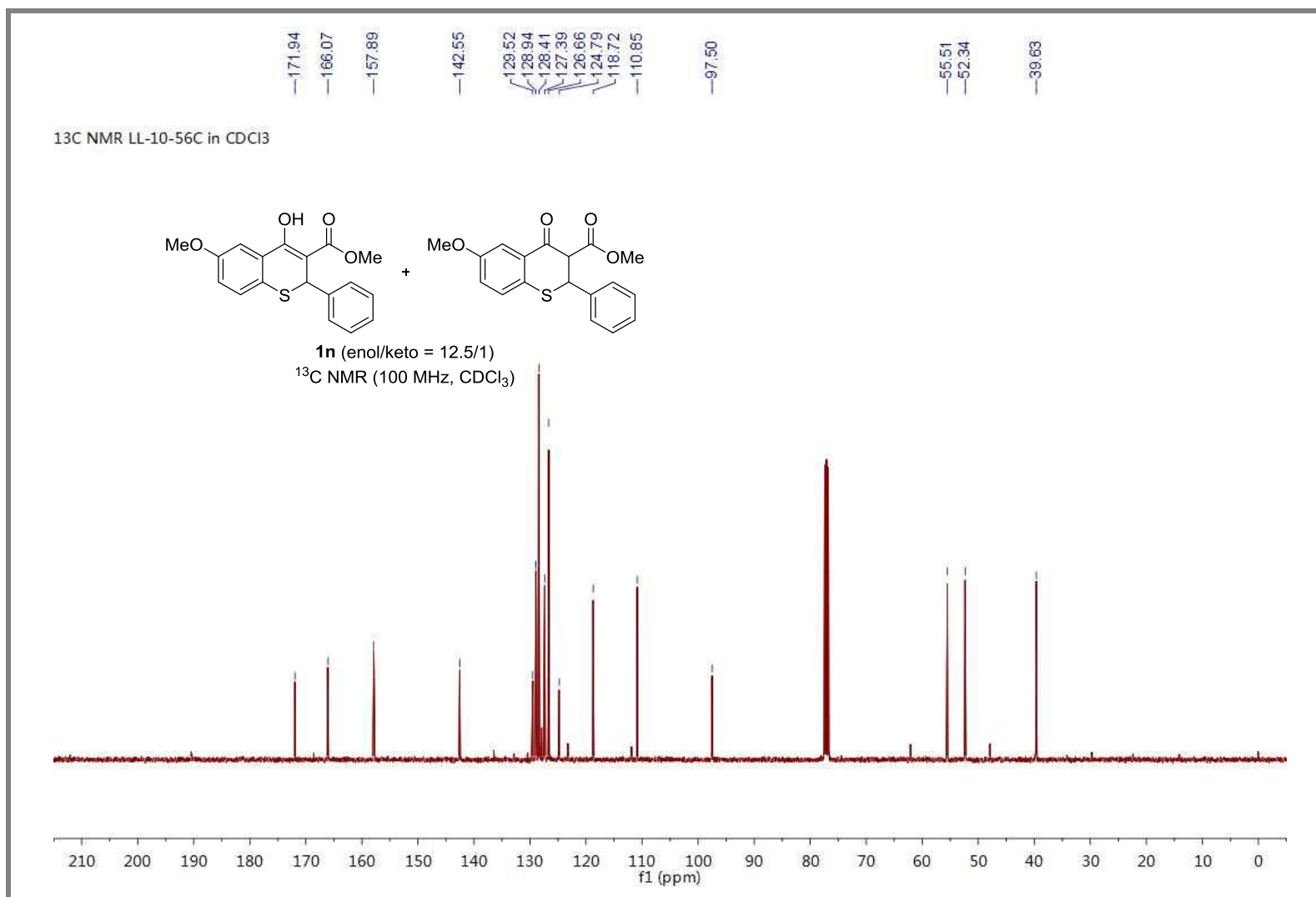


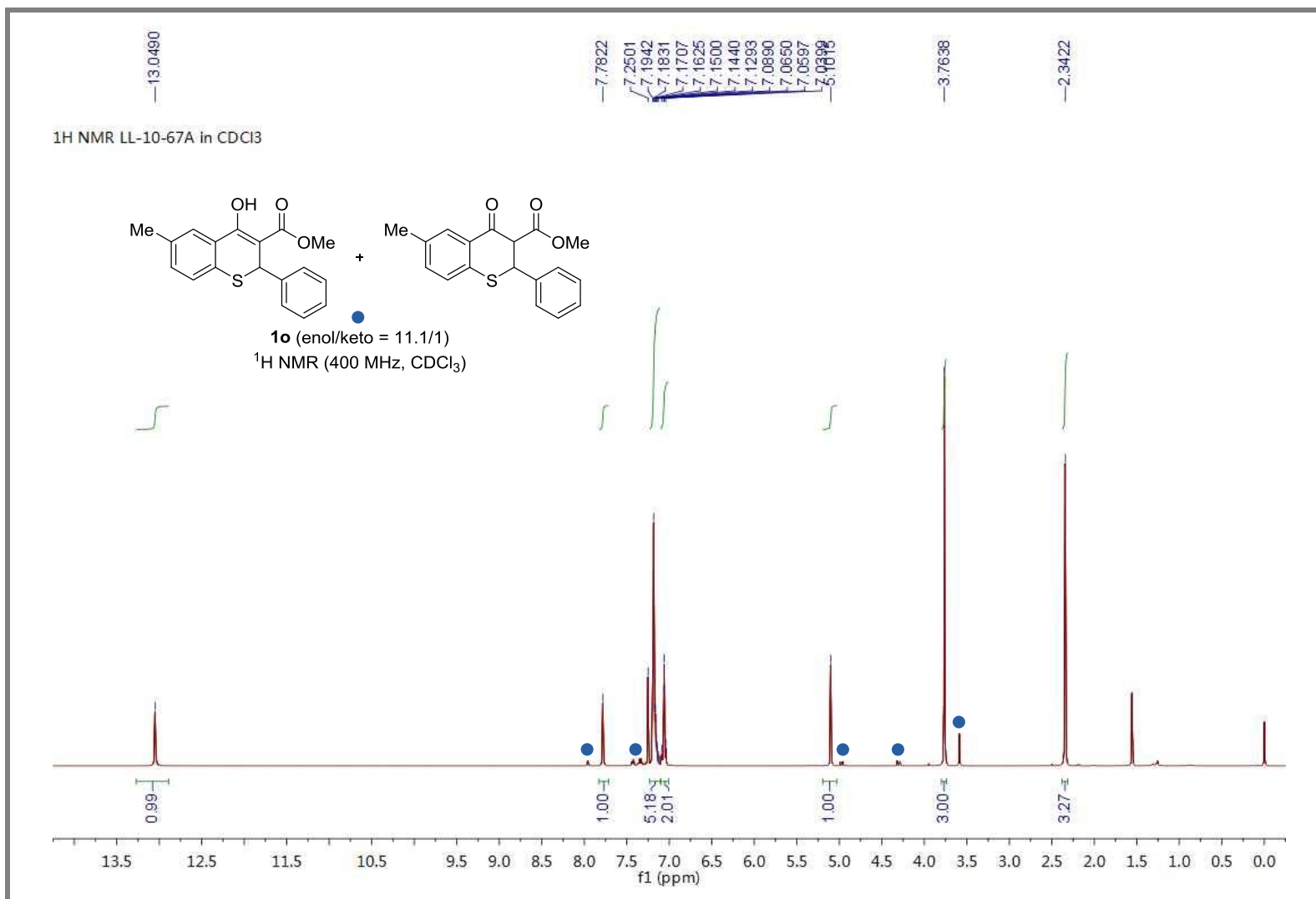


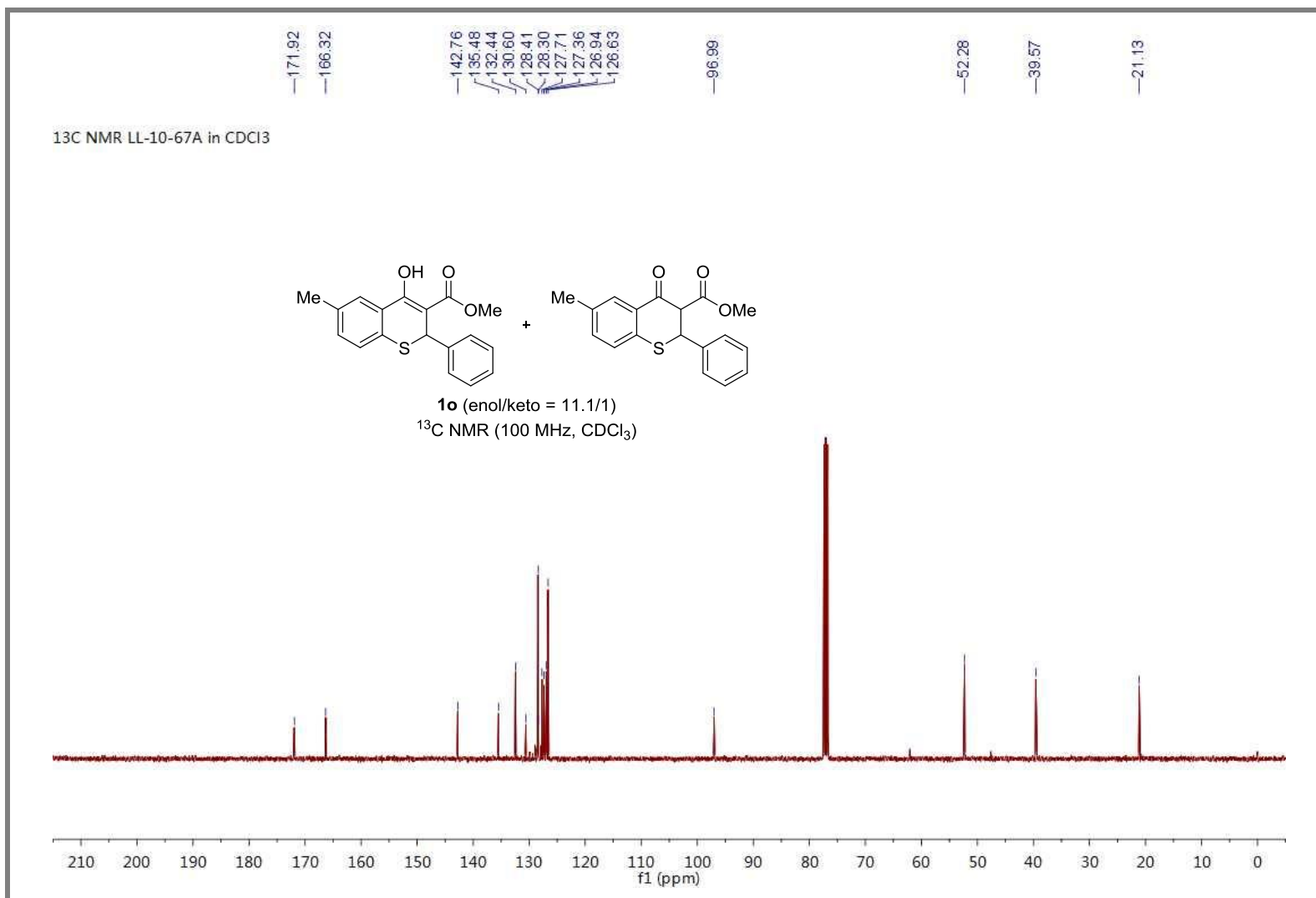


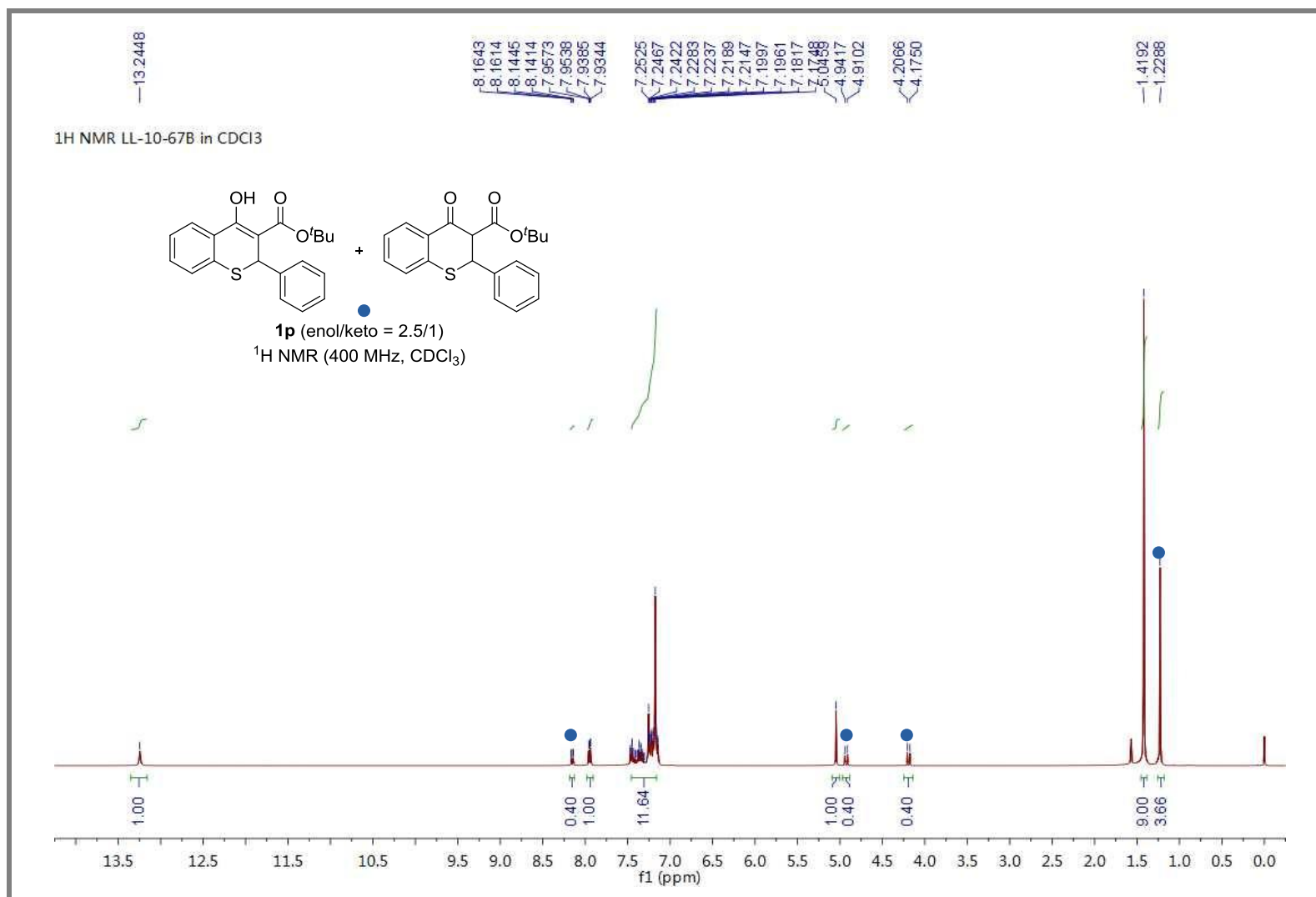


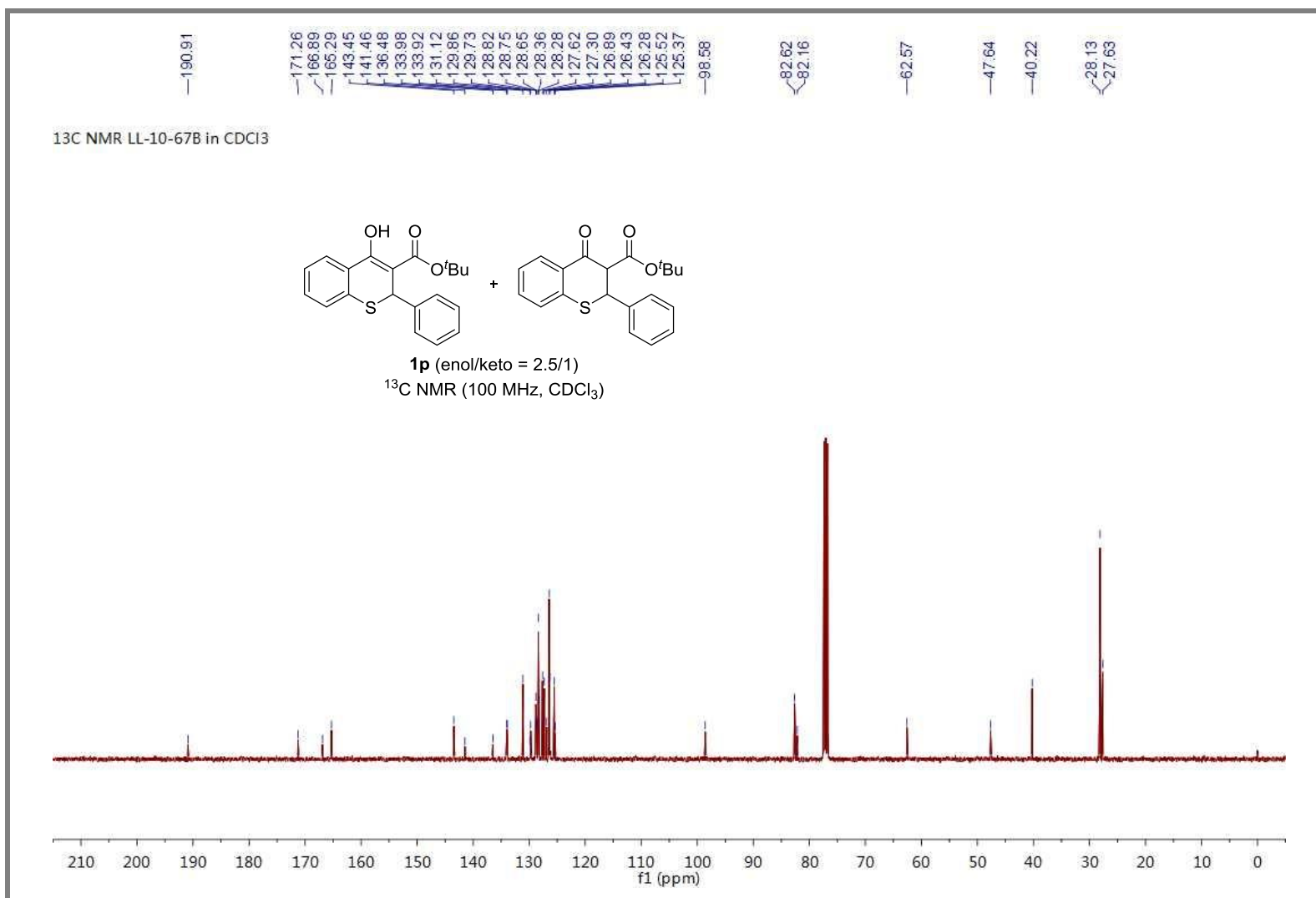


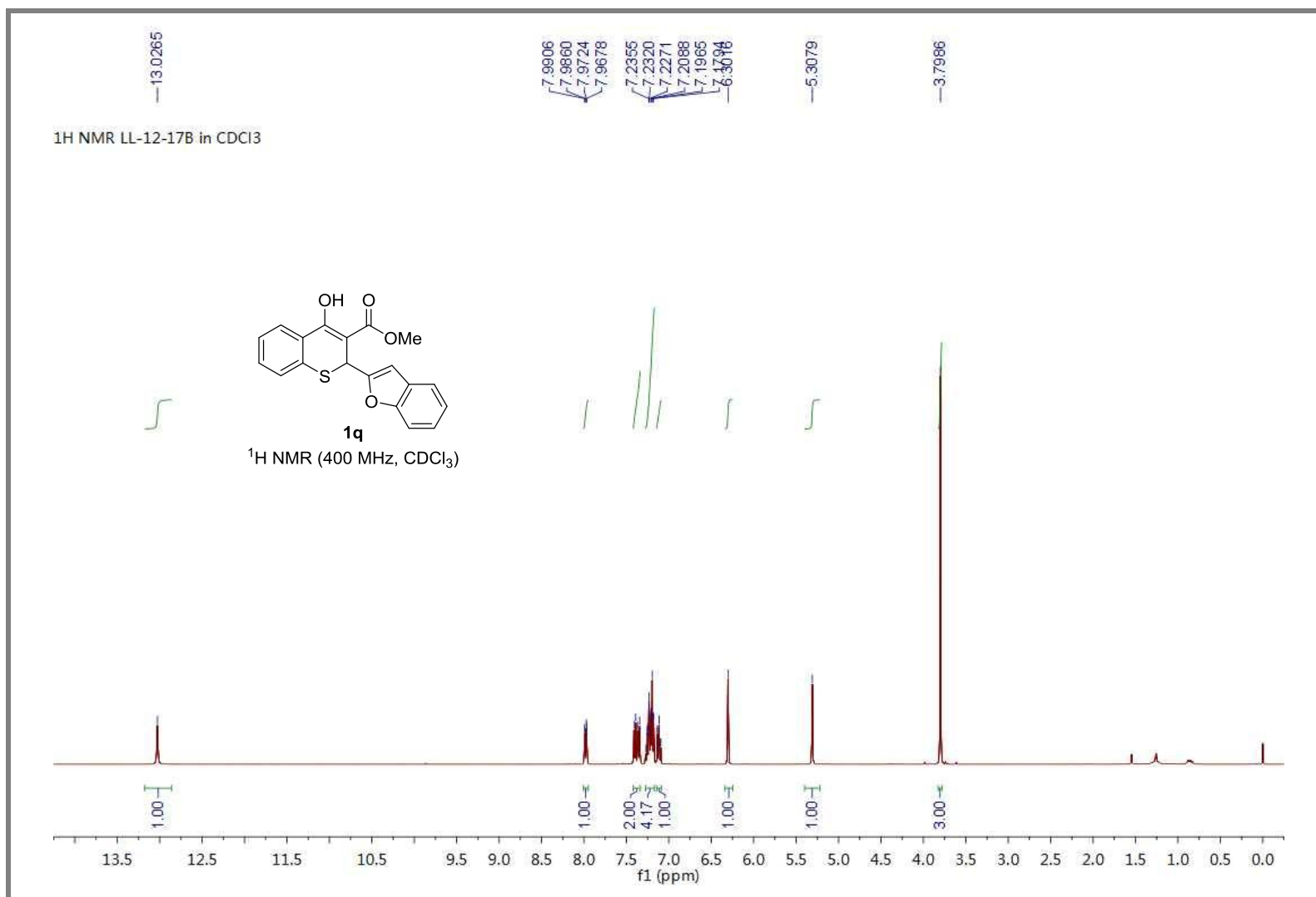


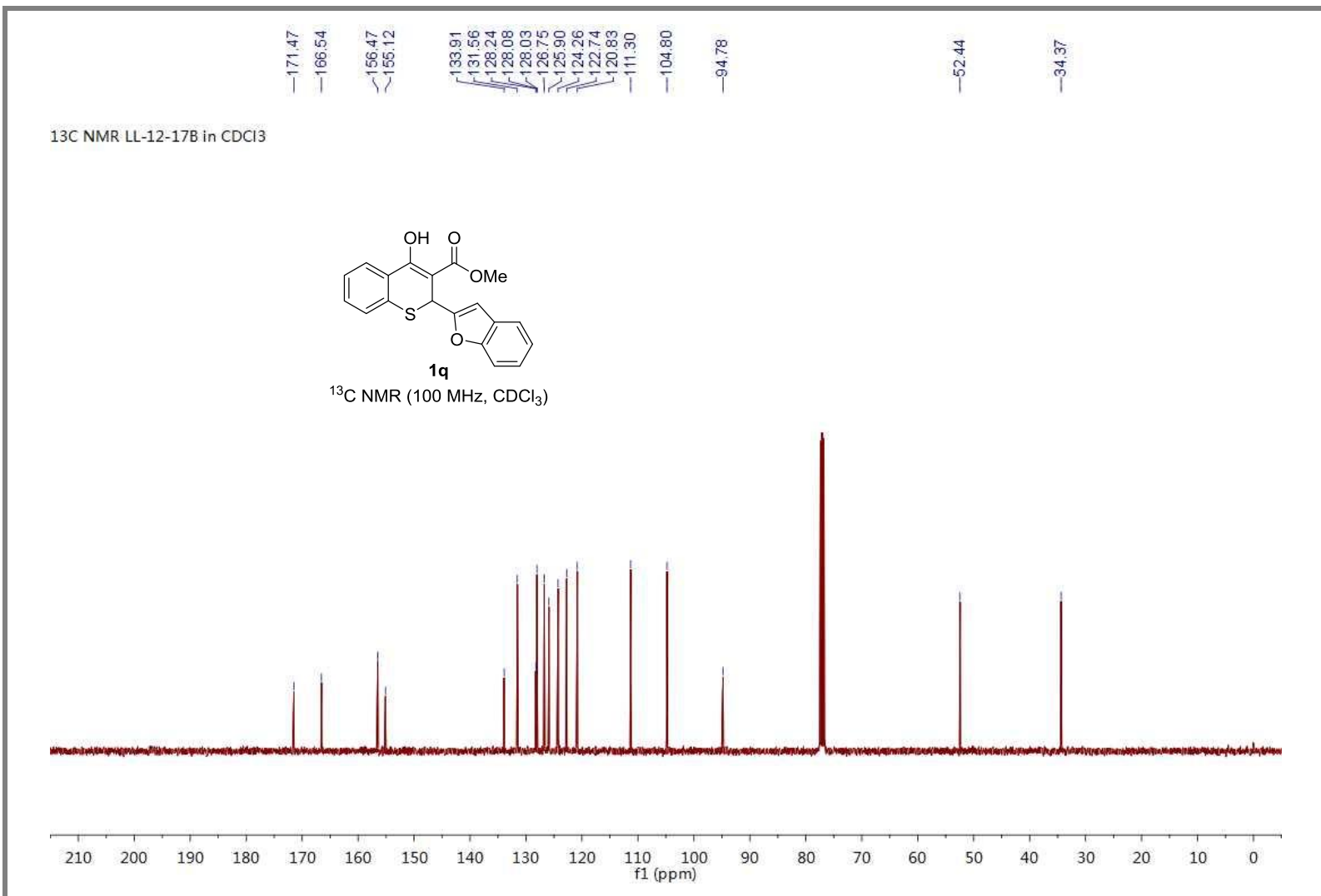


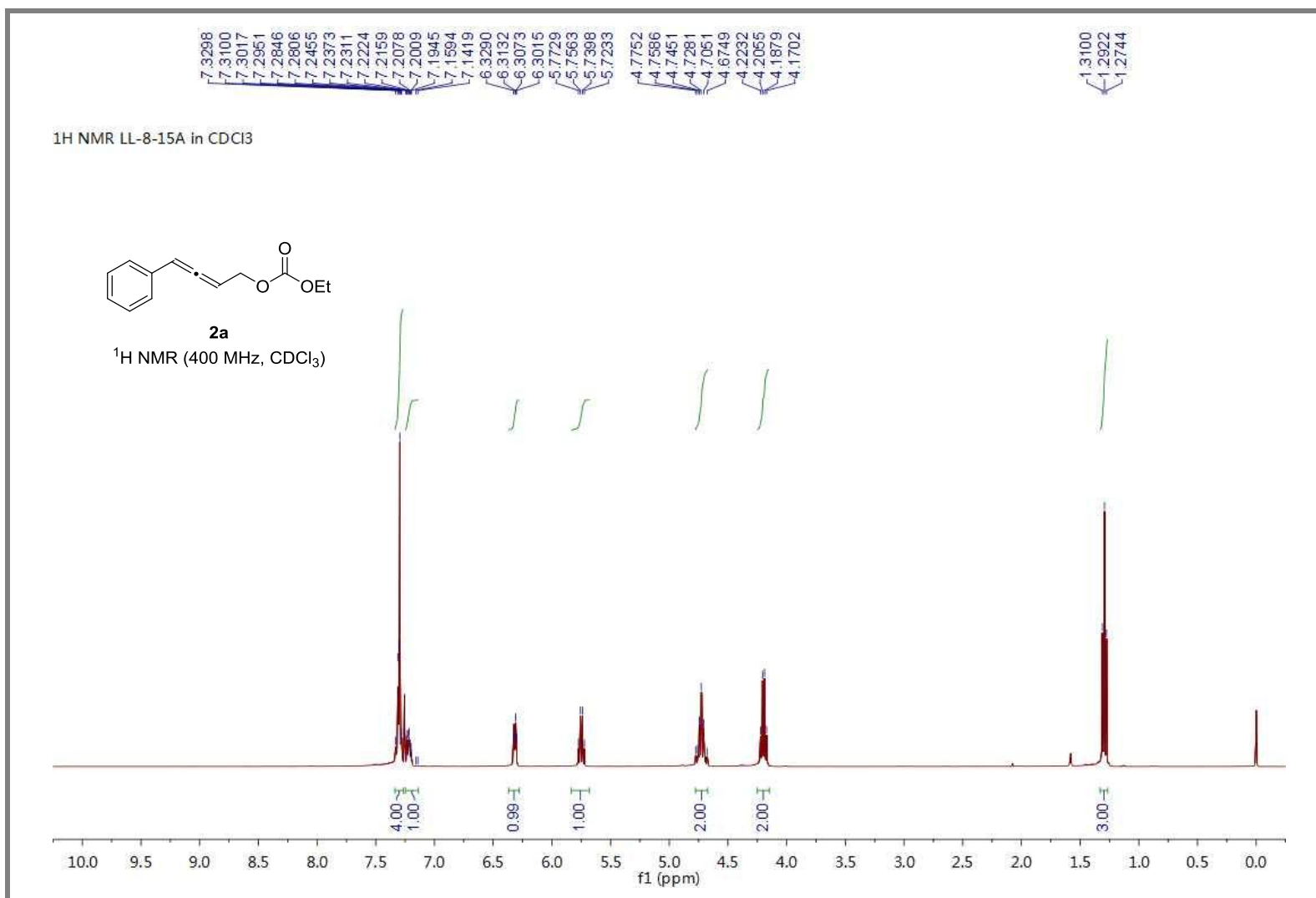


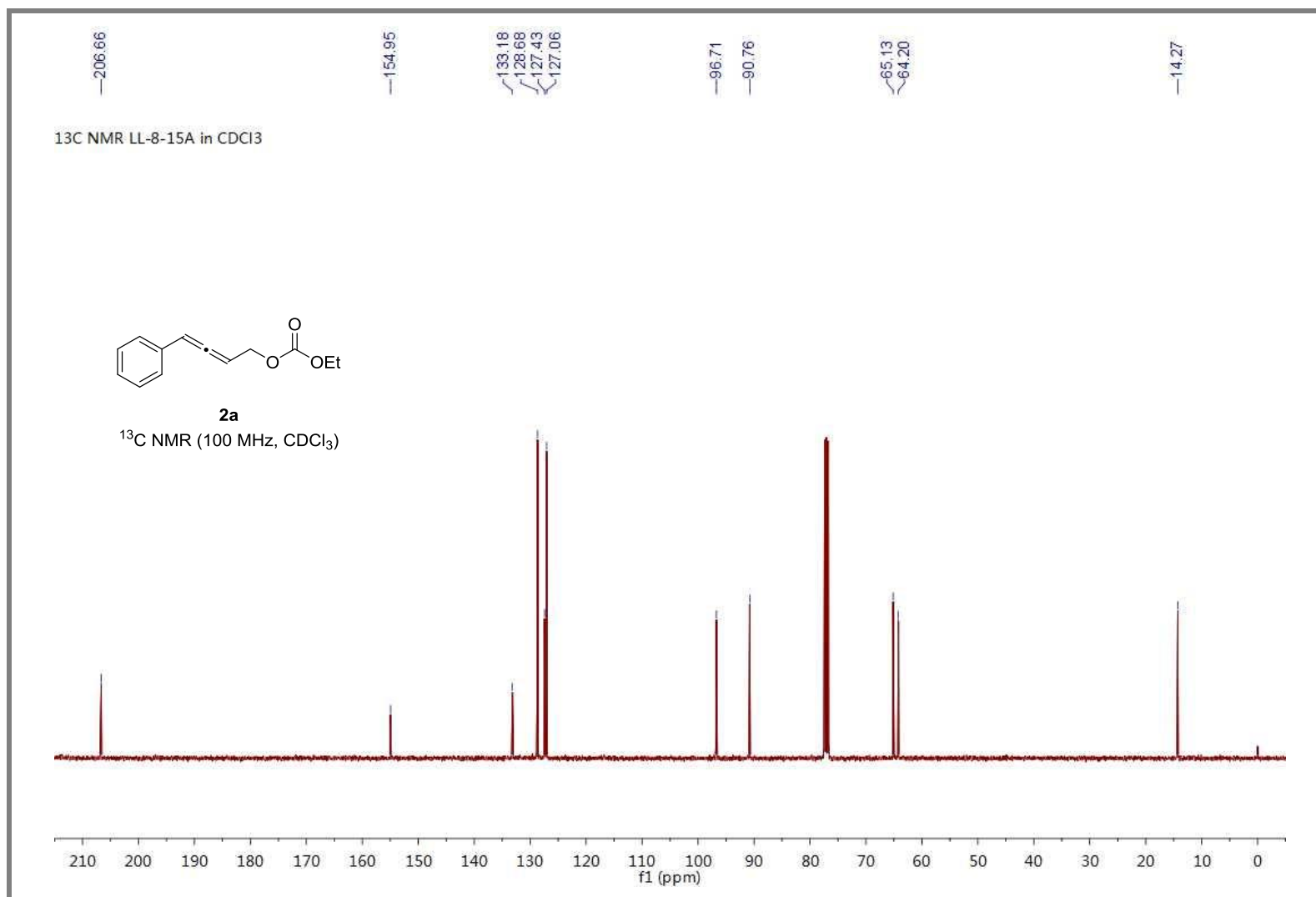


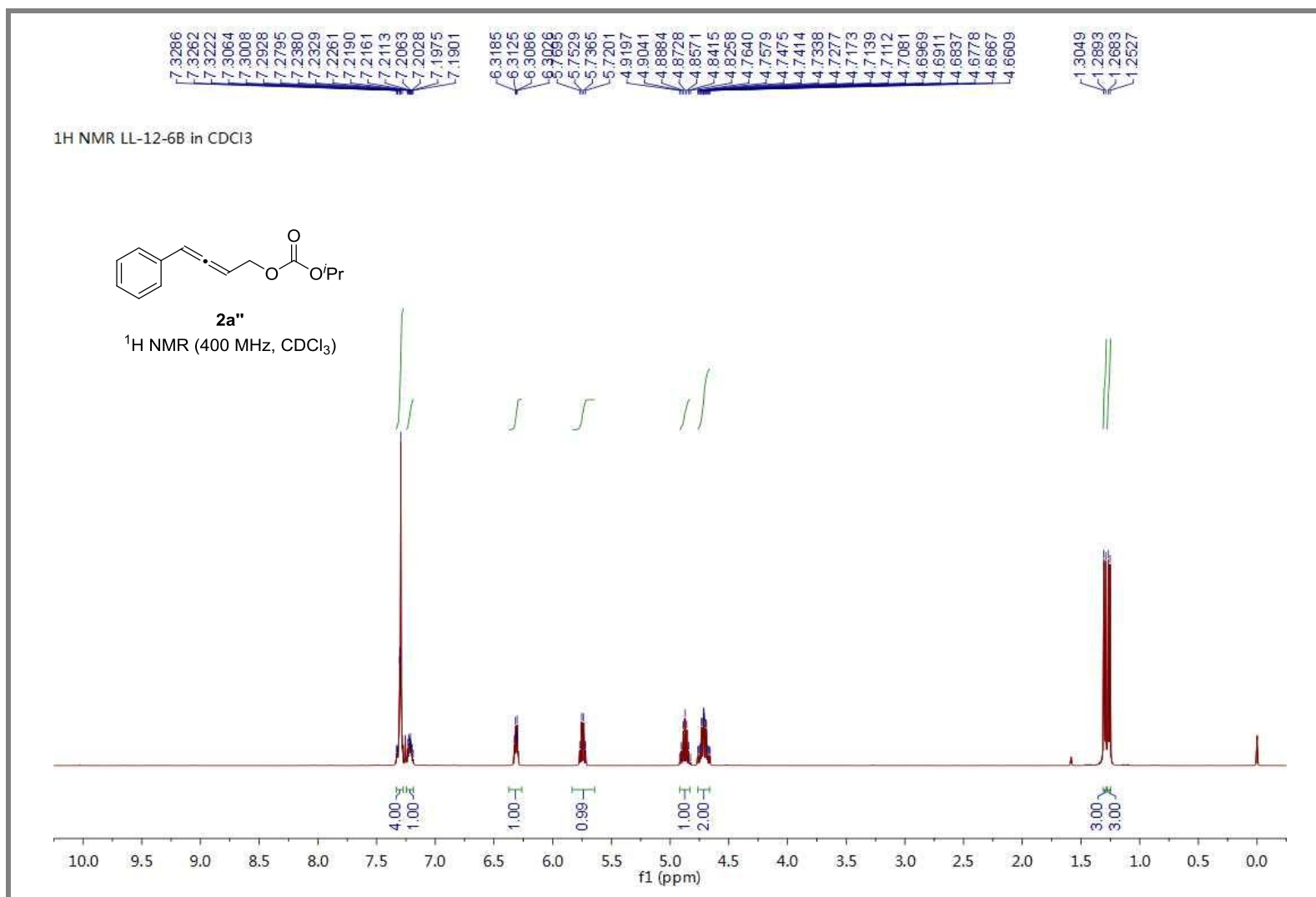


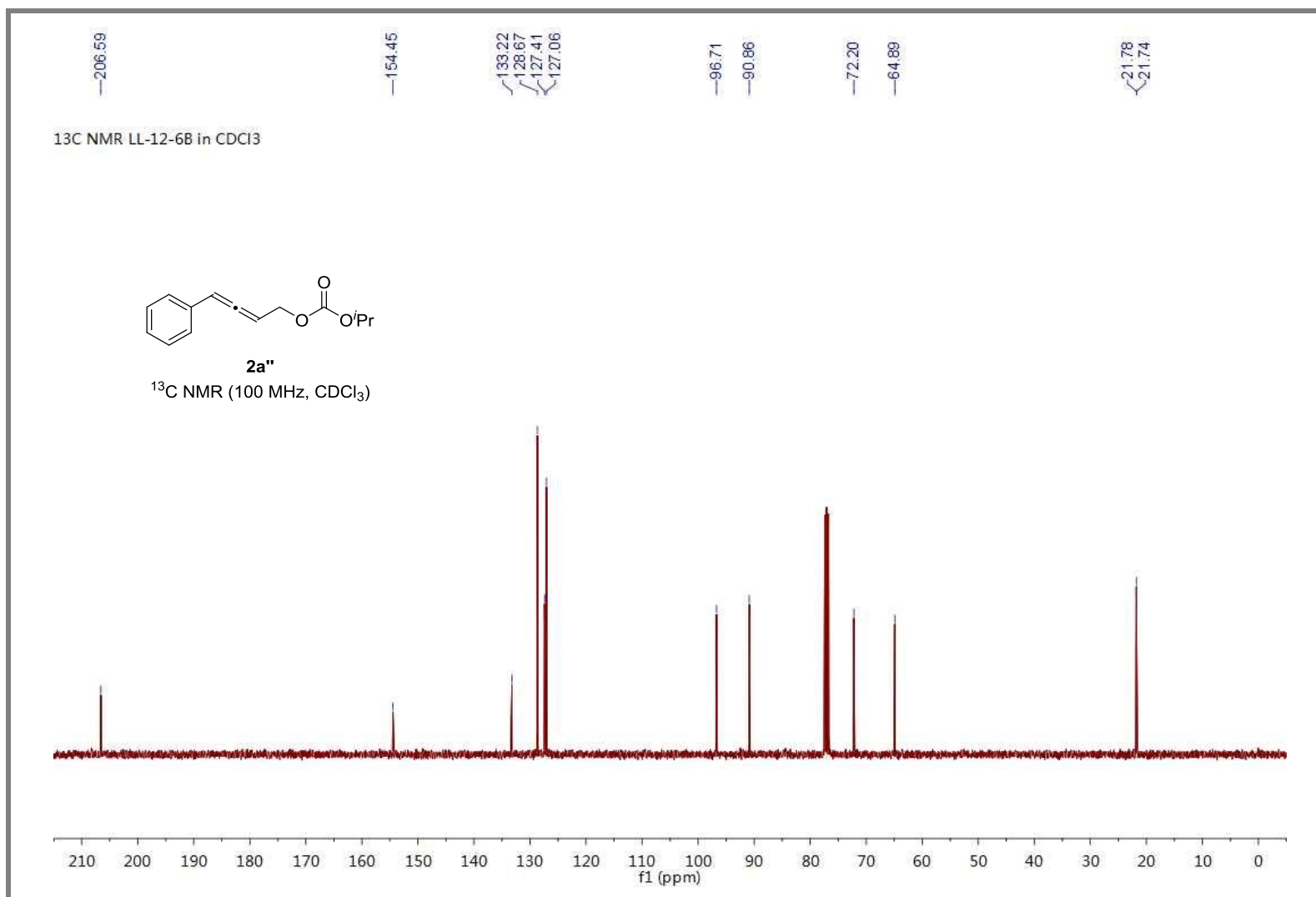


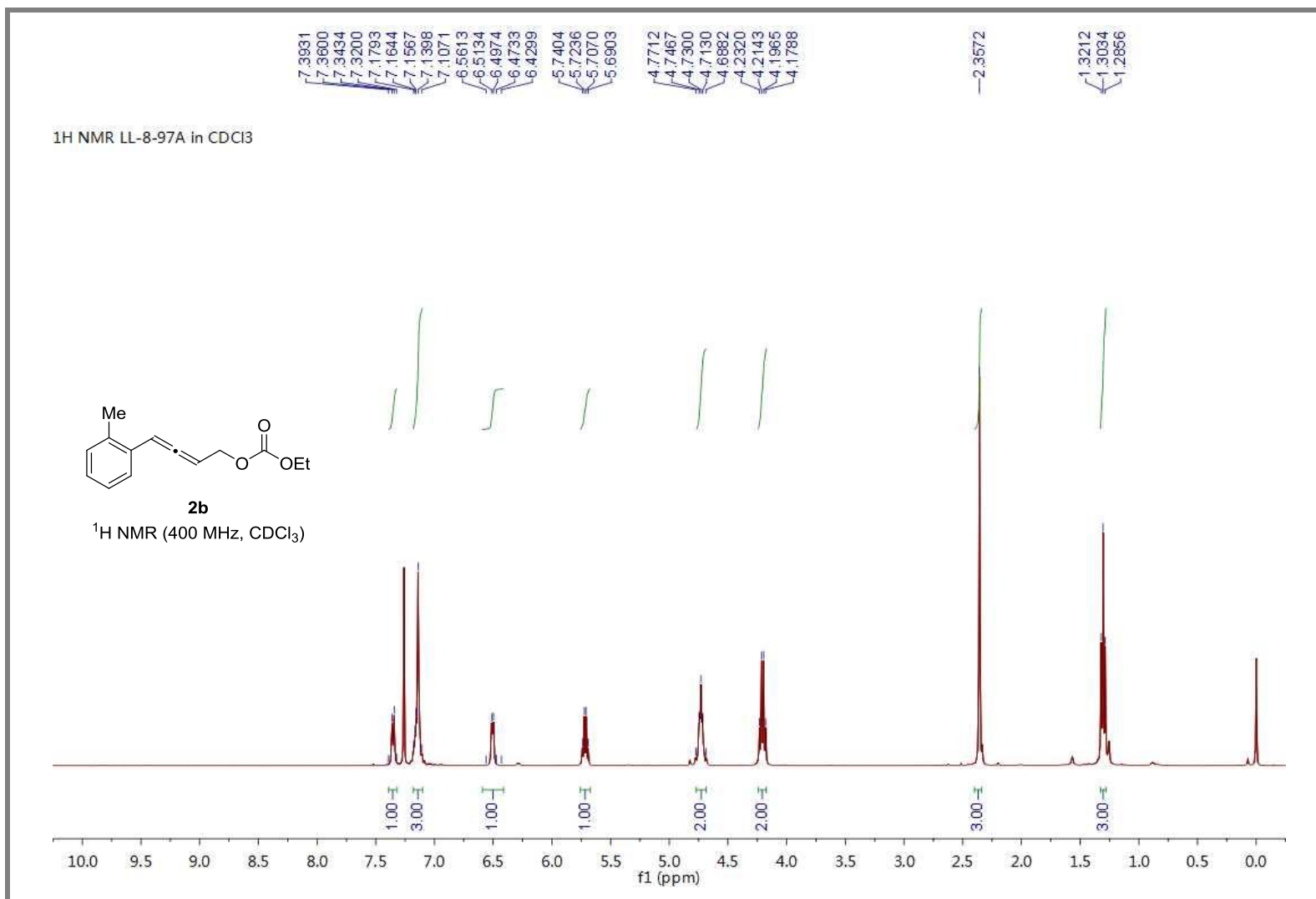


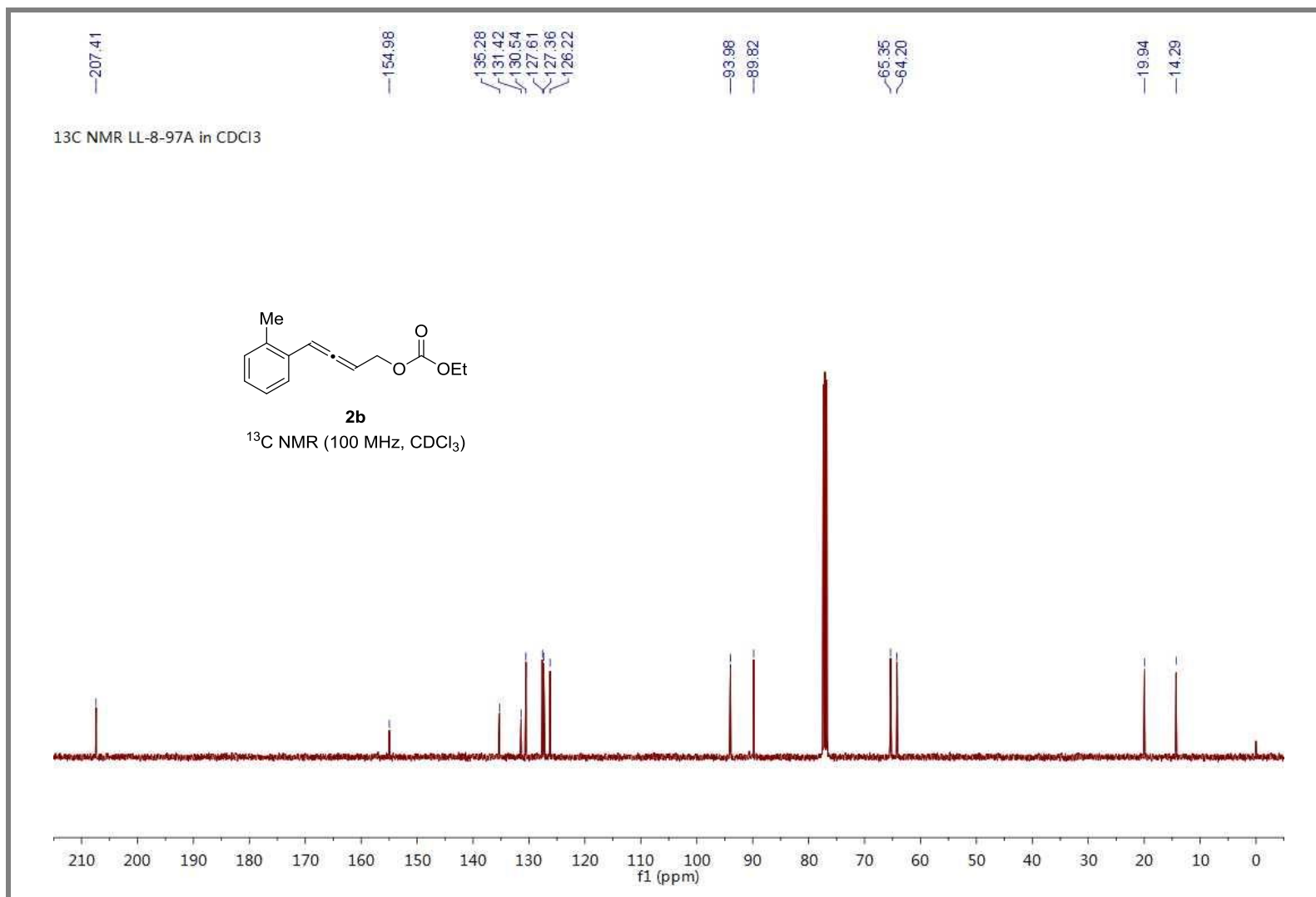


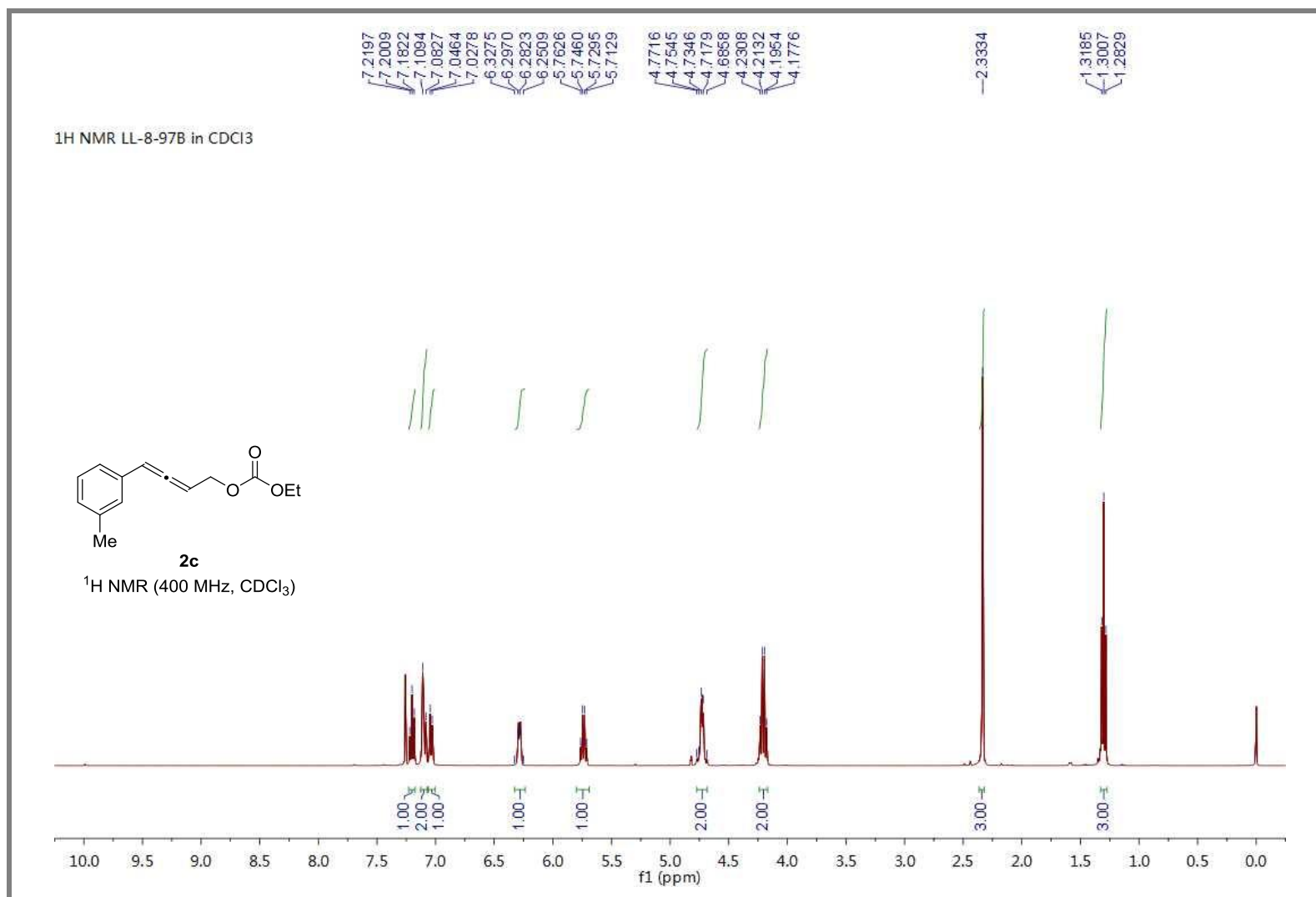


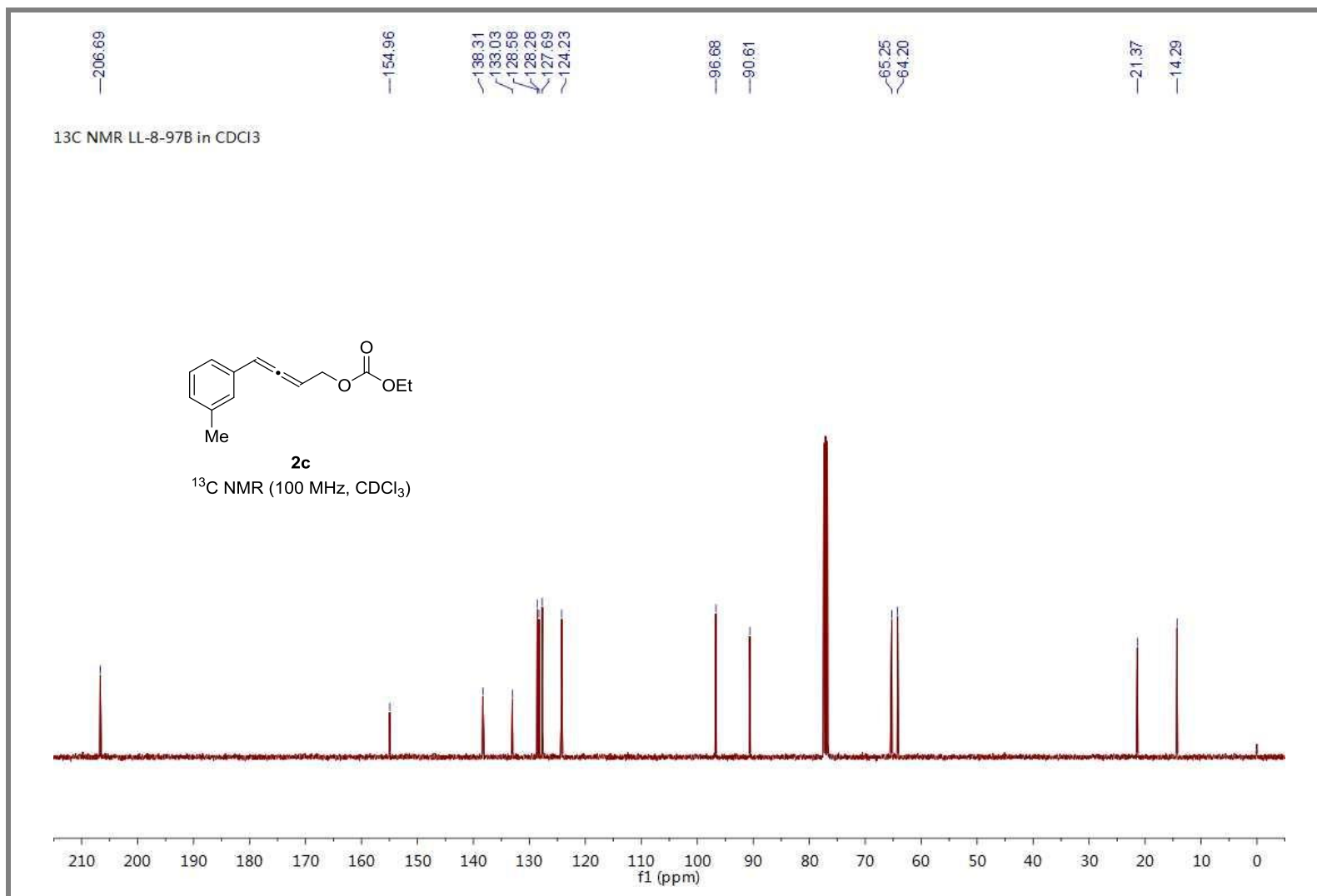


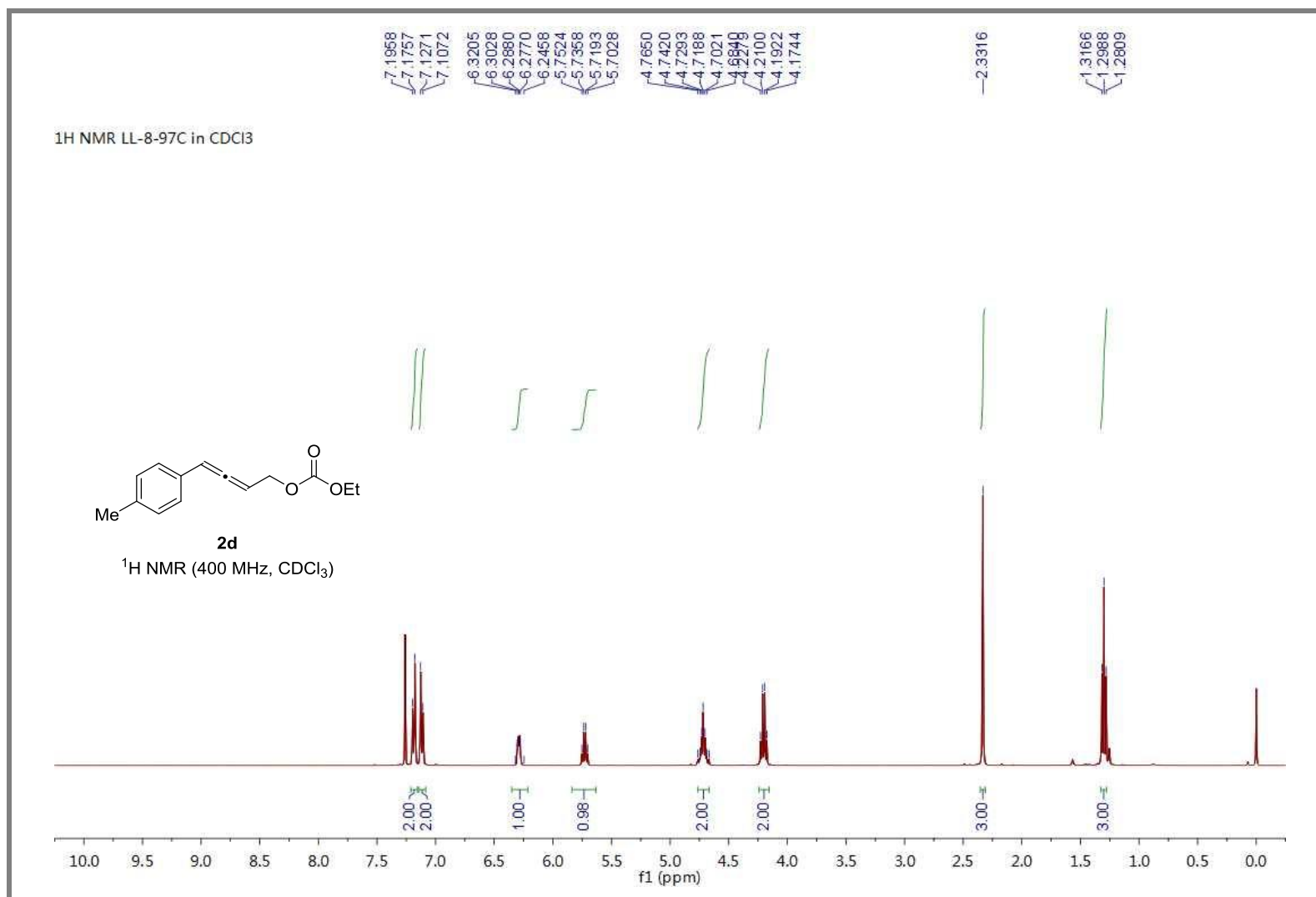


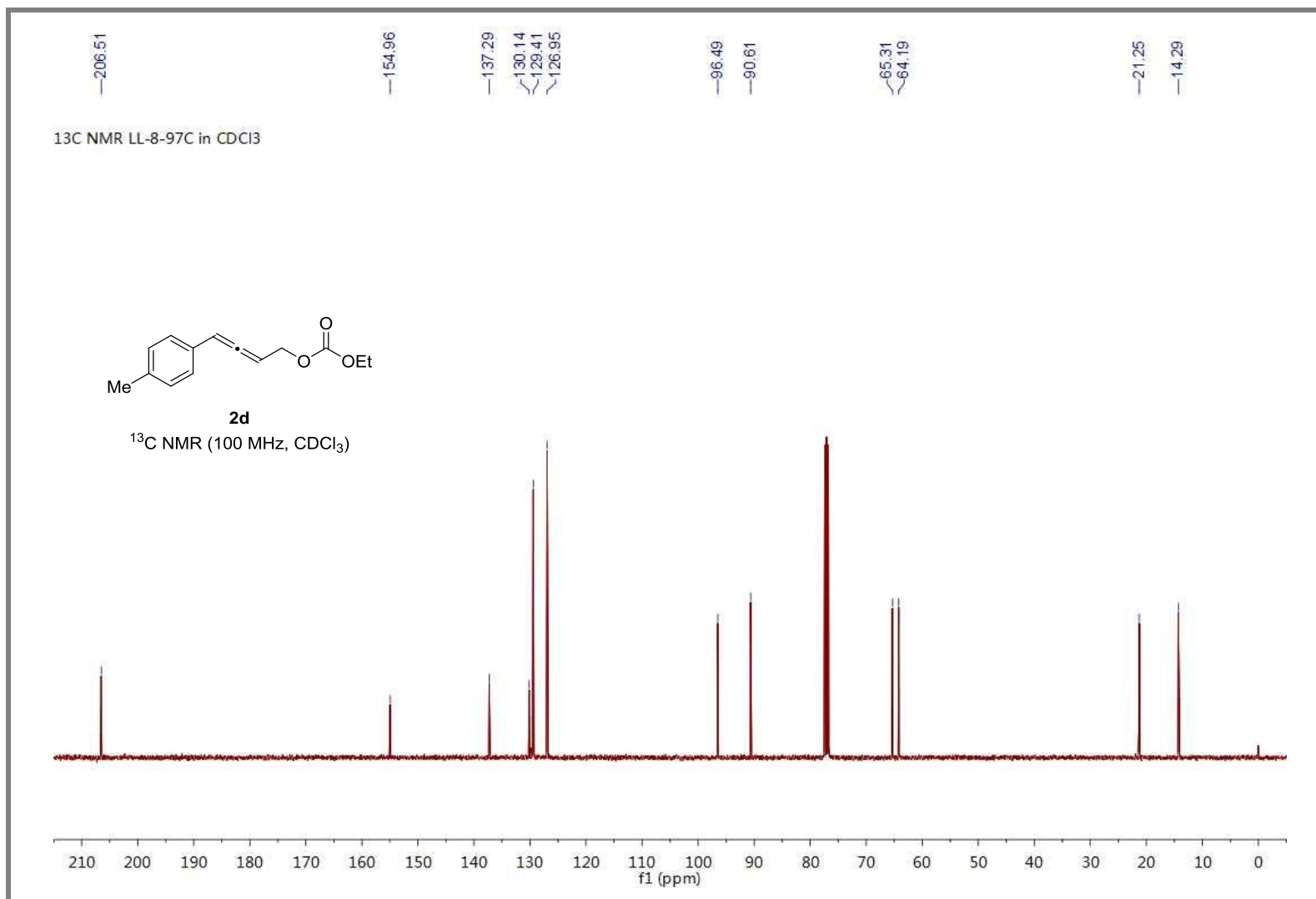


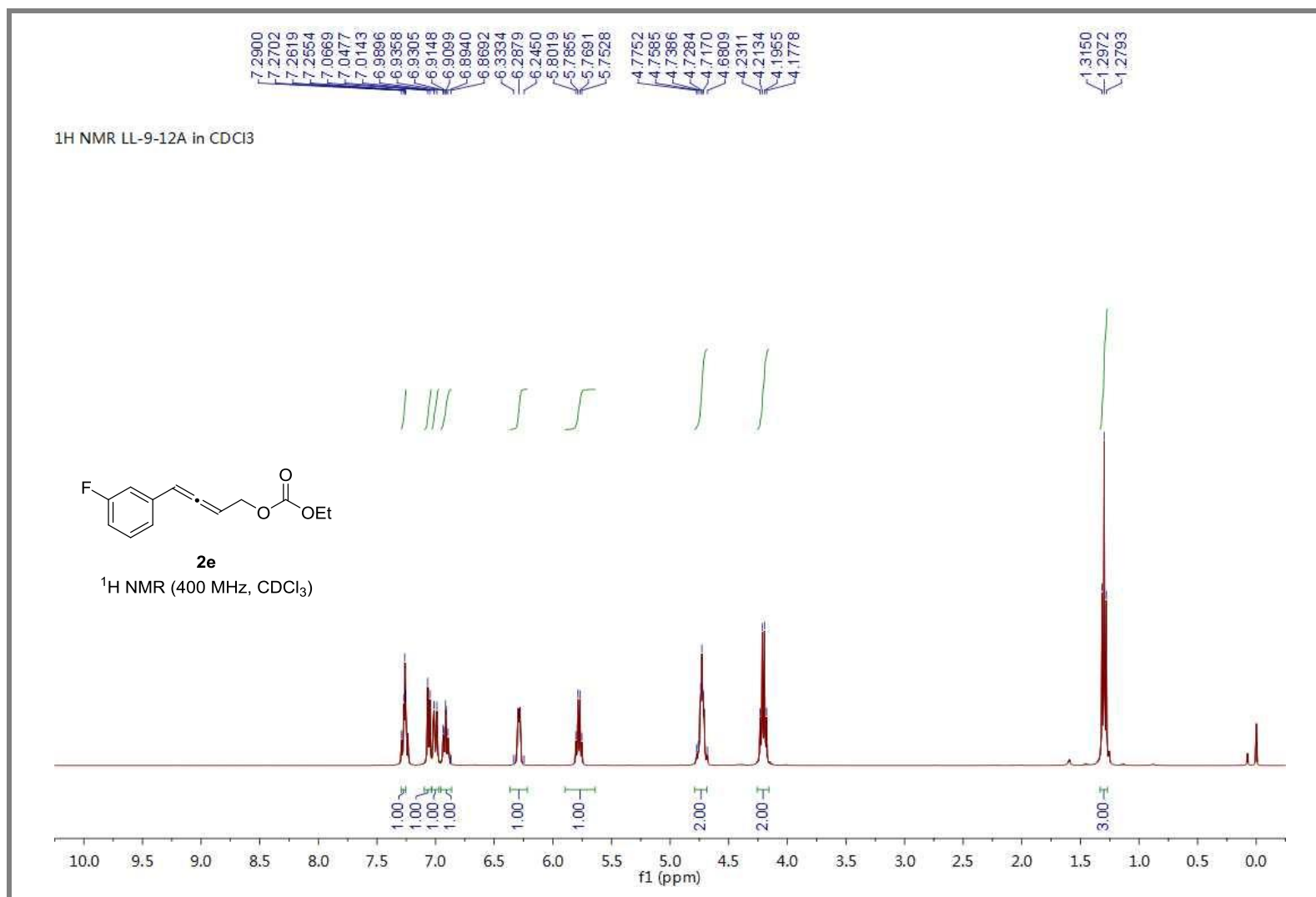


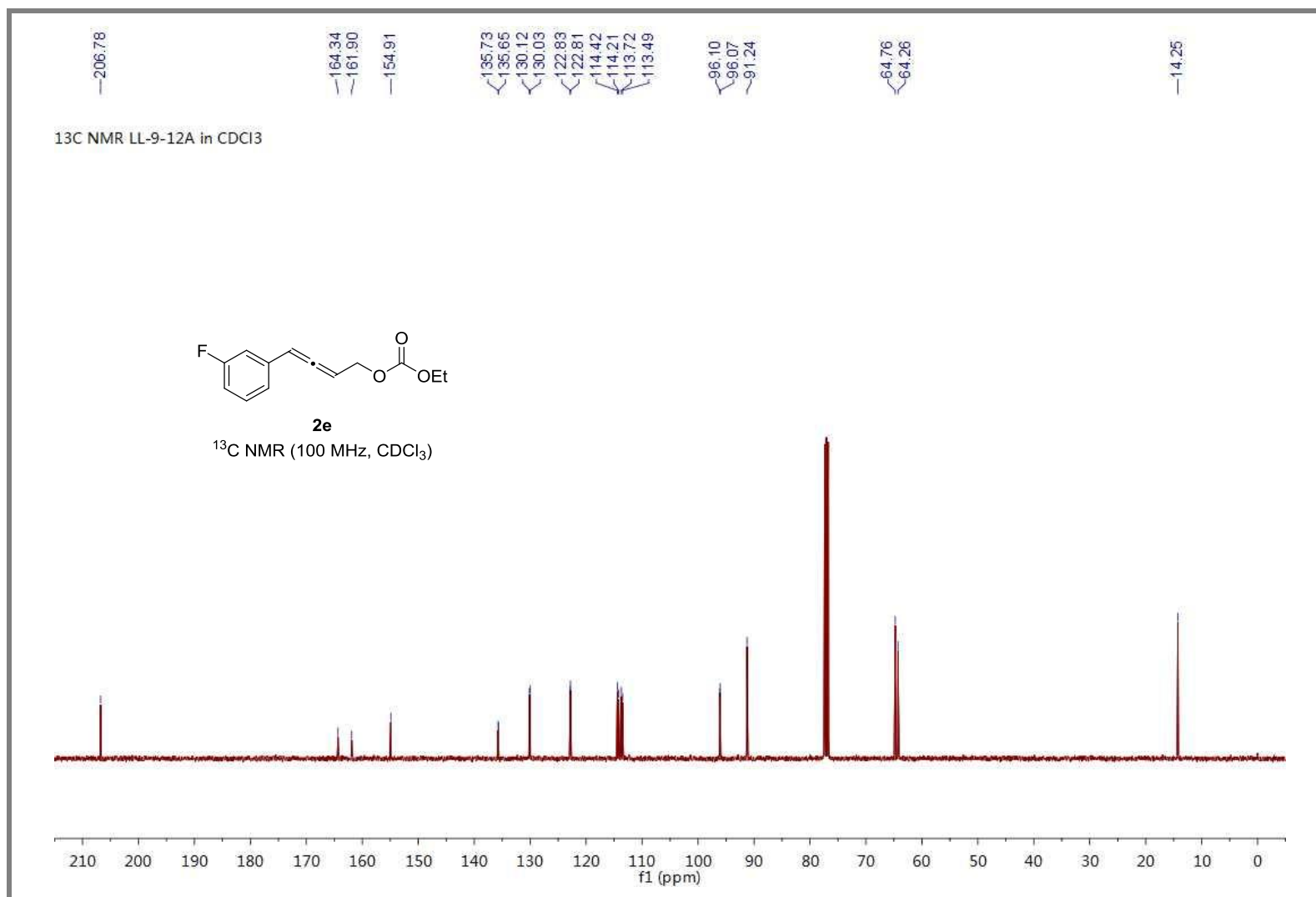




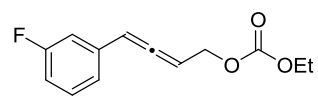








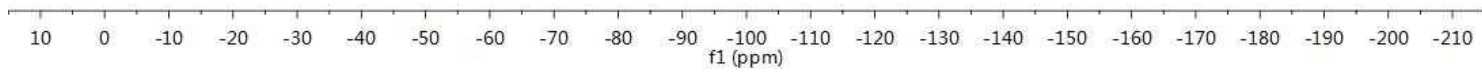
¹⁹F NMR LL-9-12A in CDCl₃

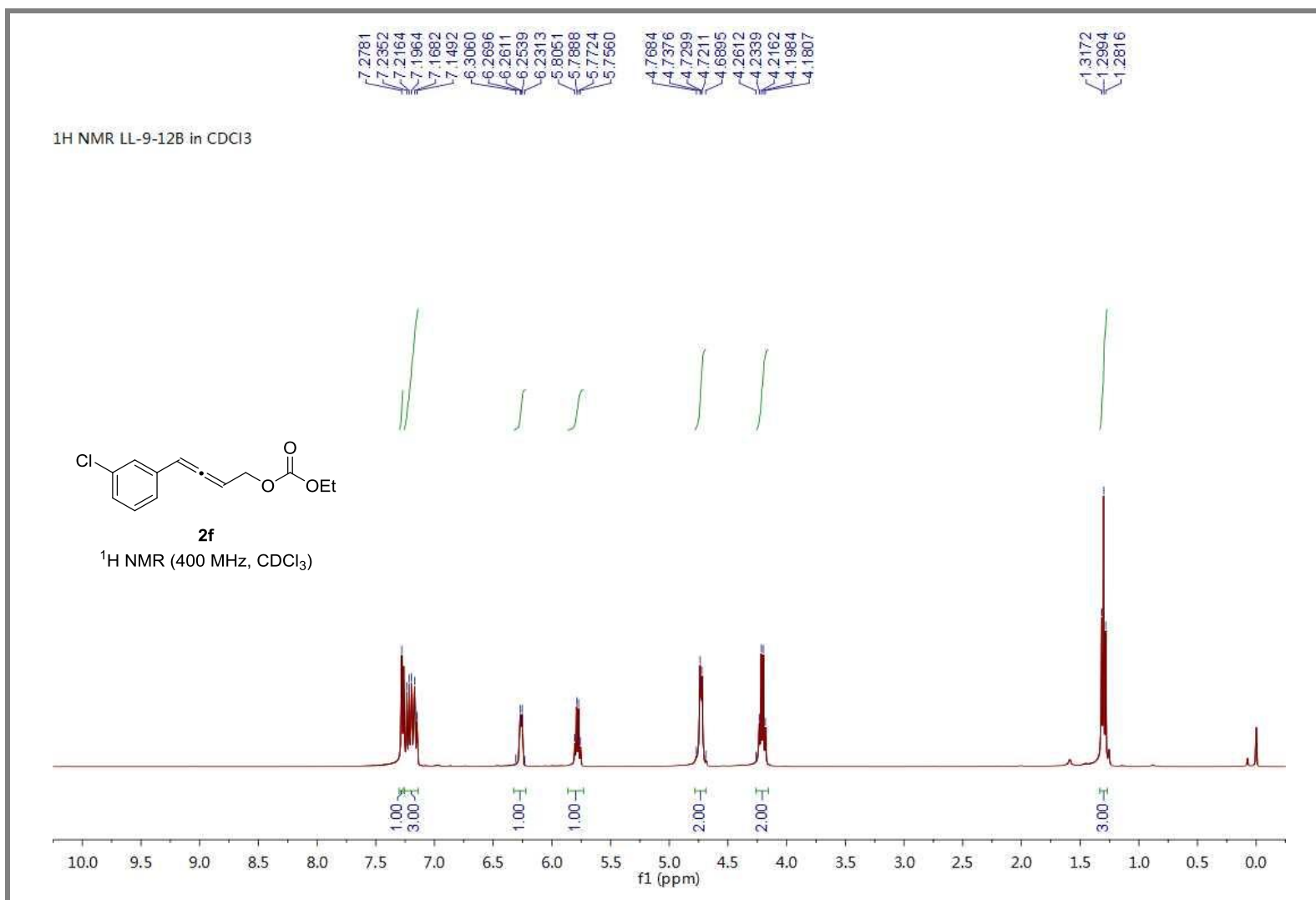


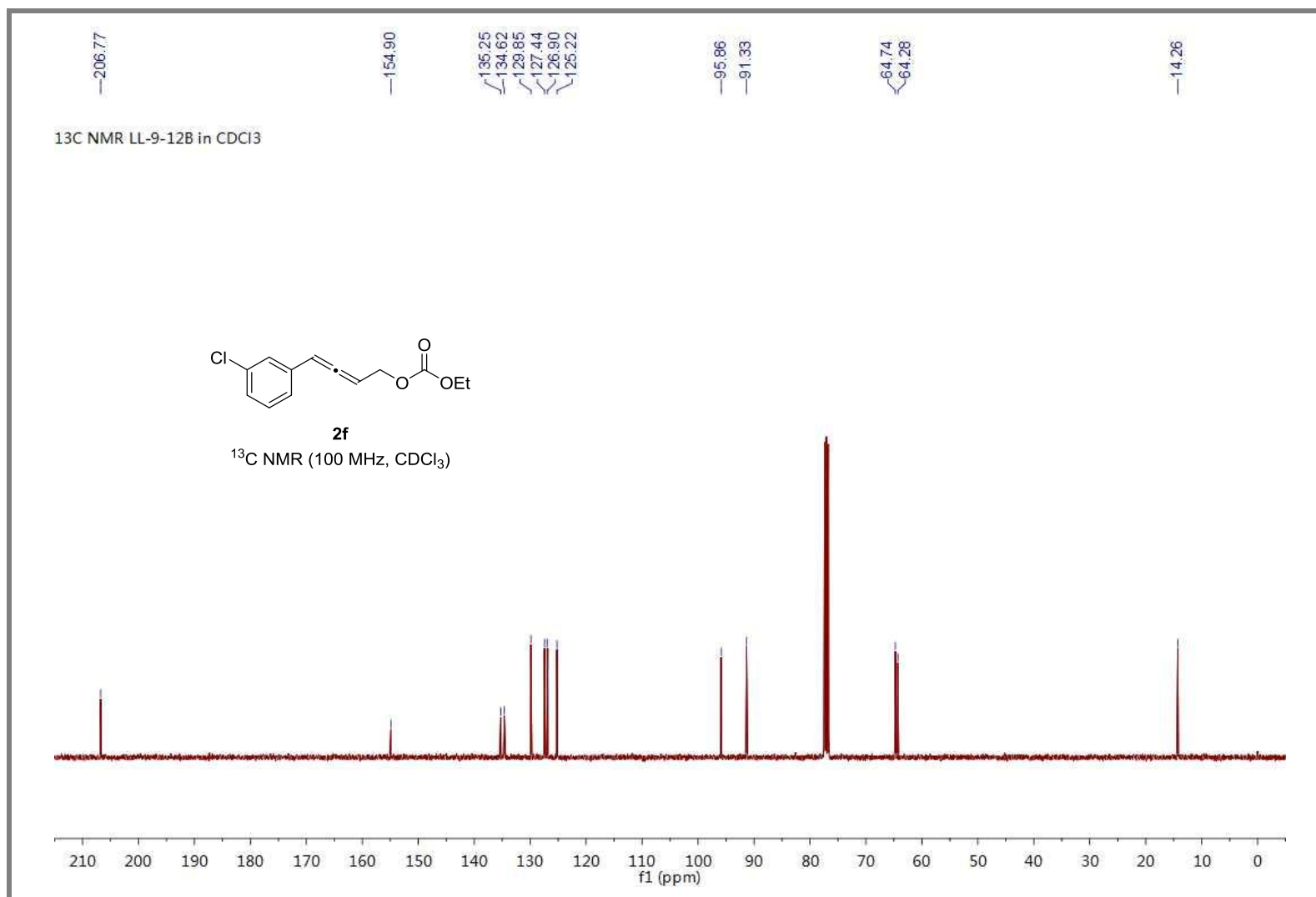
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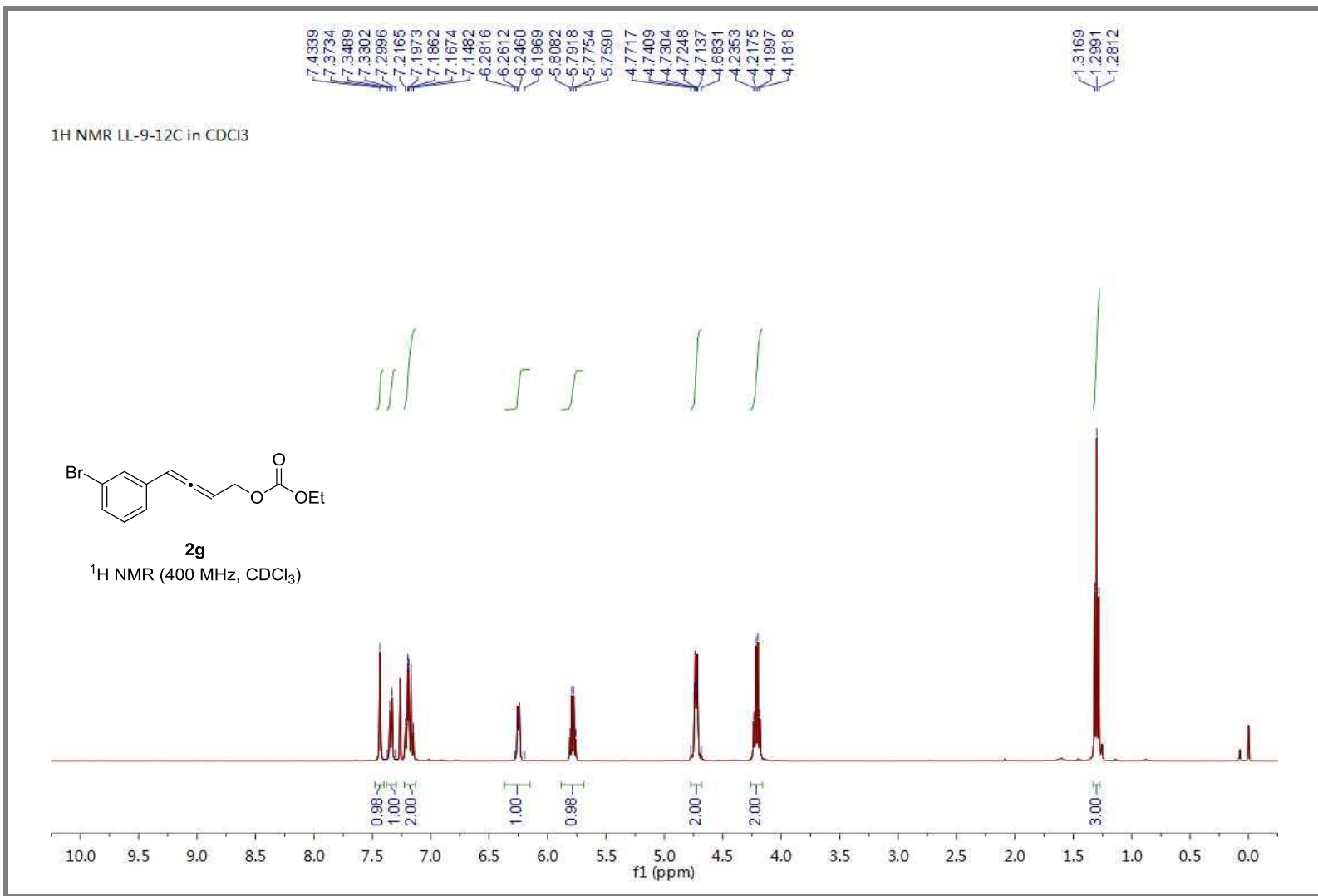
¹⁹F NMR (376 MHz, CDCl₃)

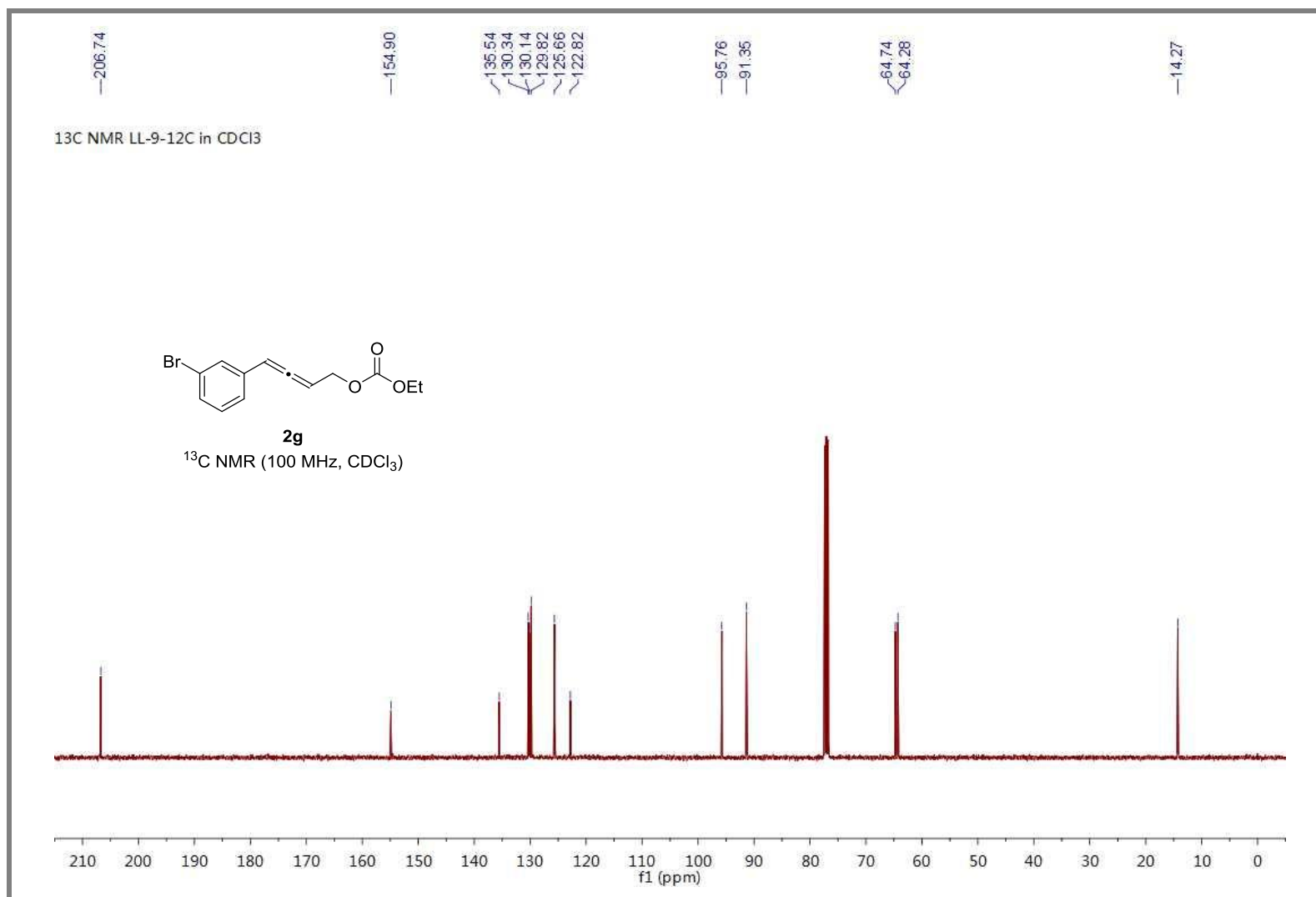
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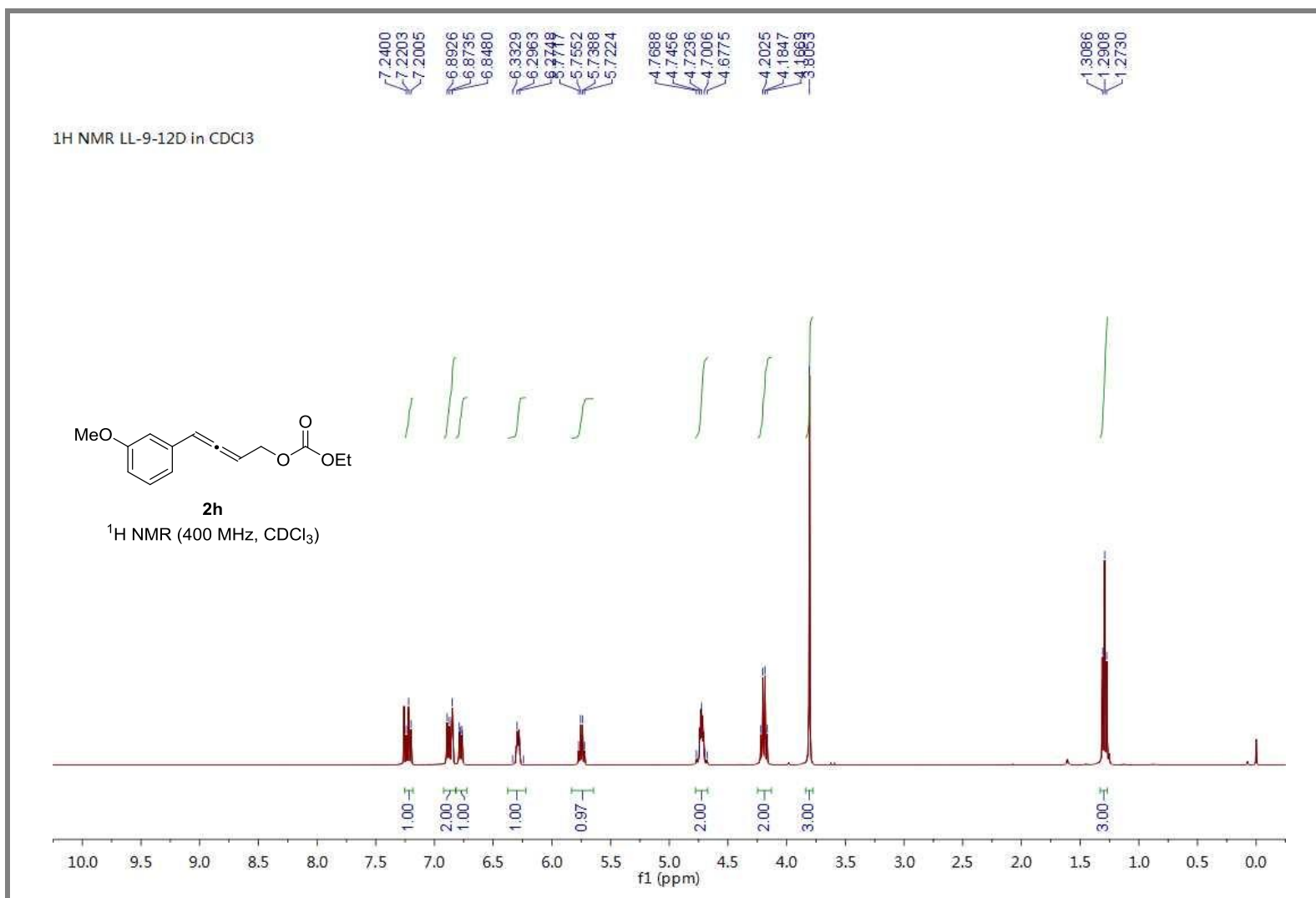


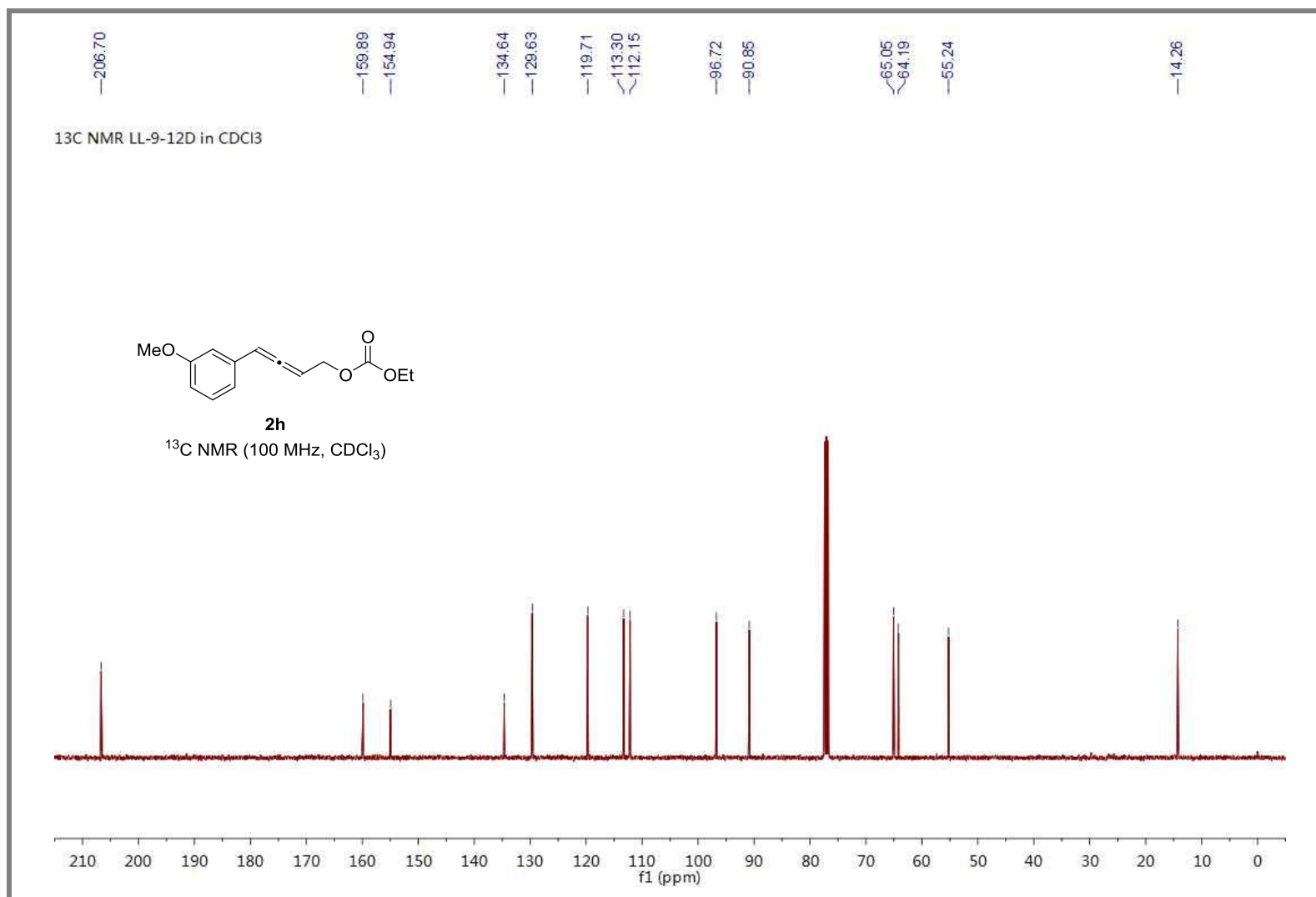


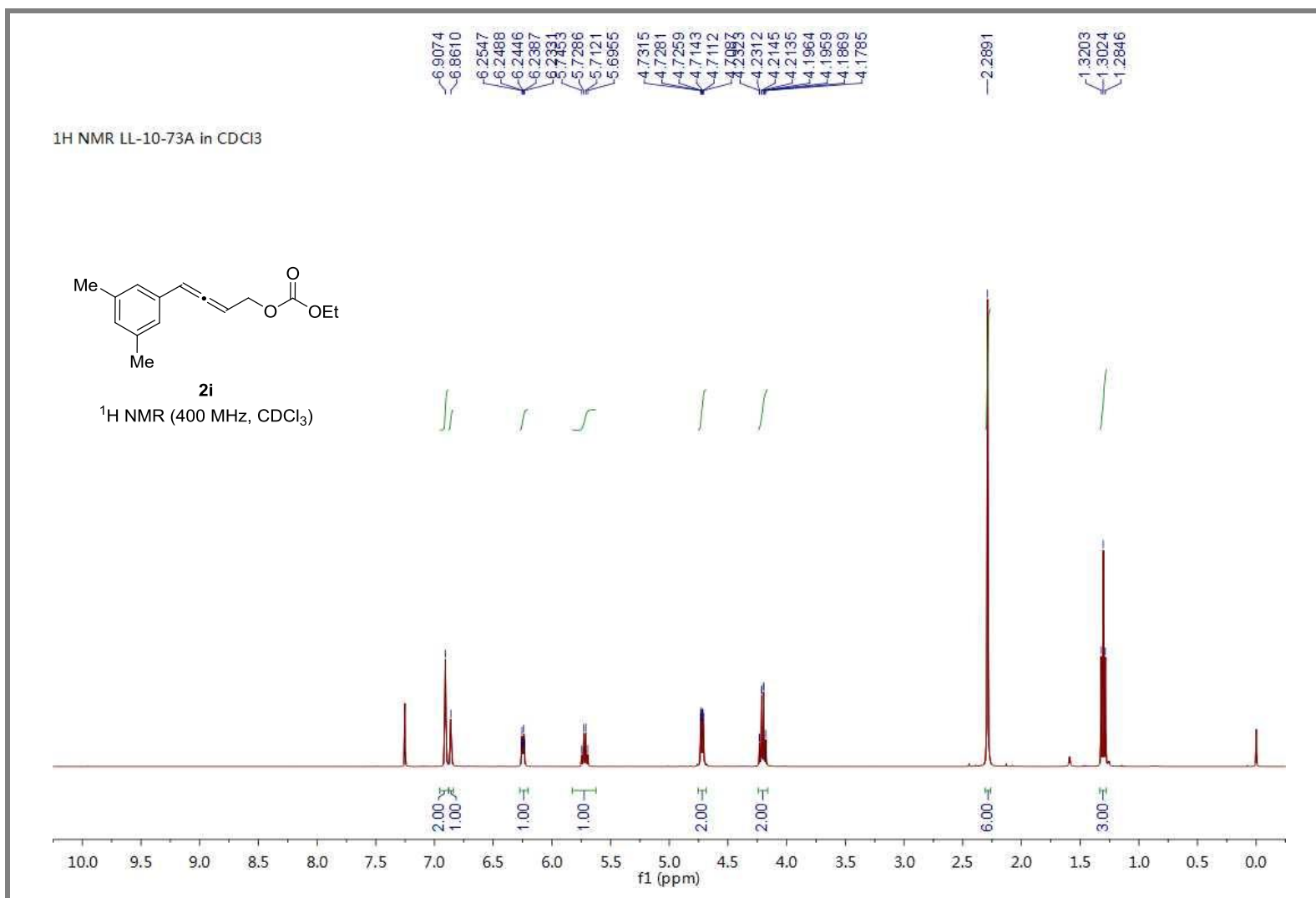


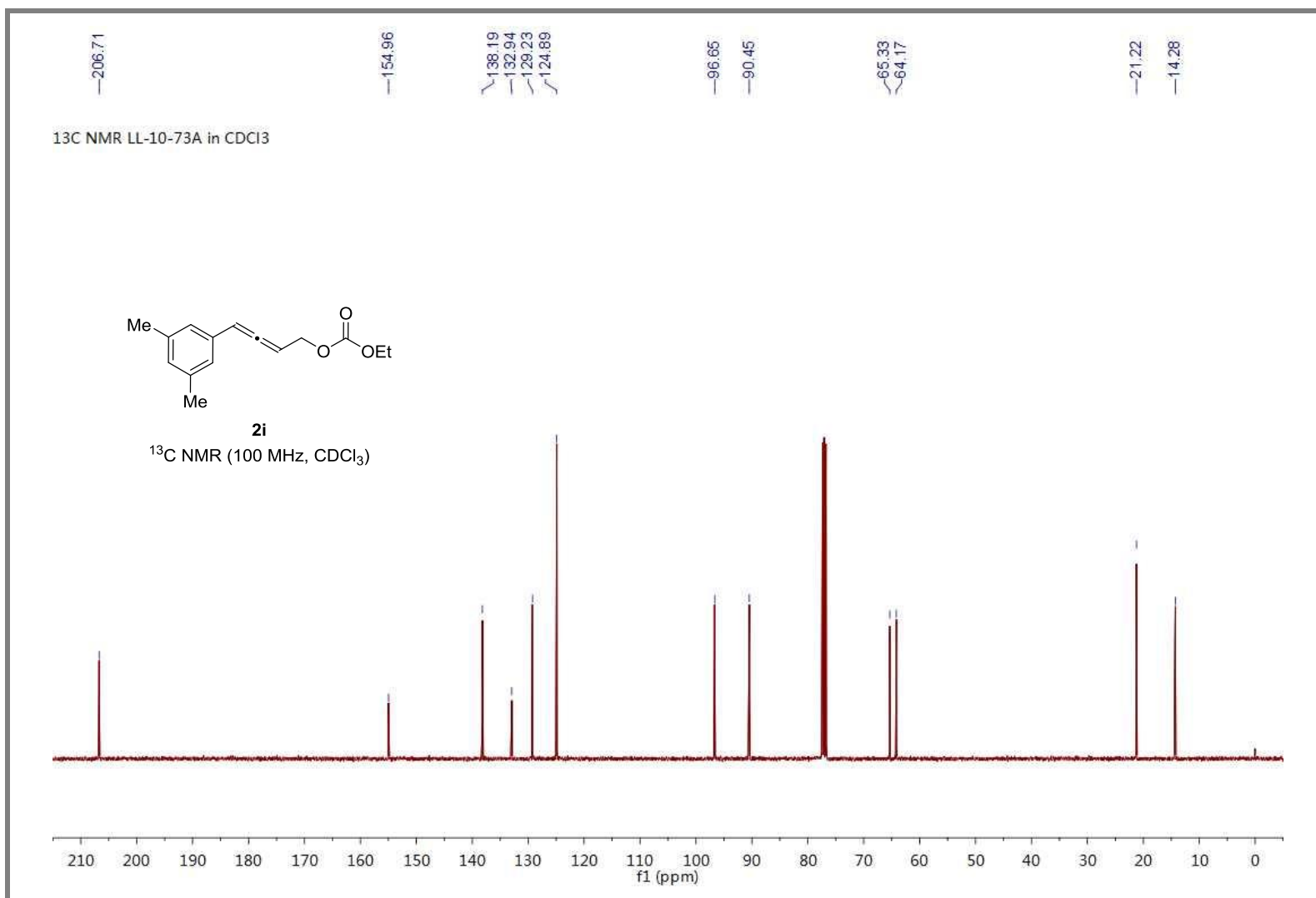


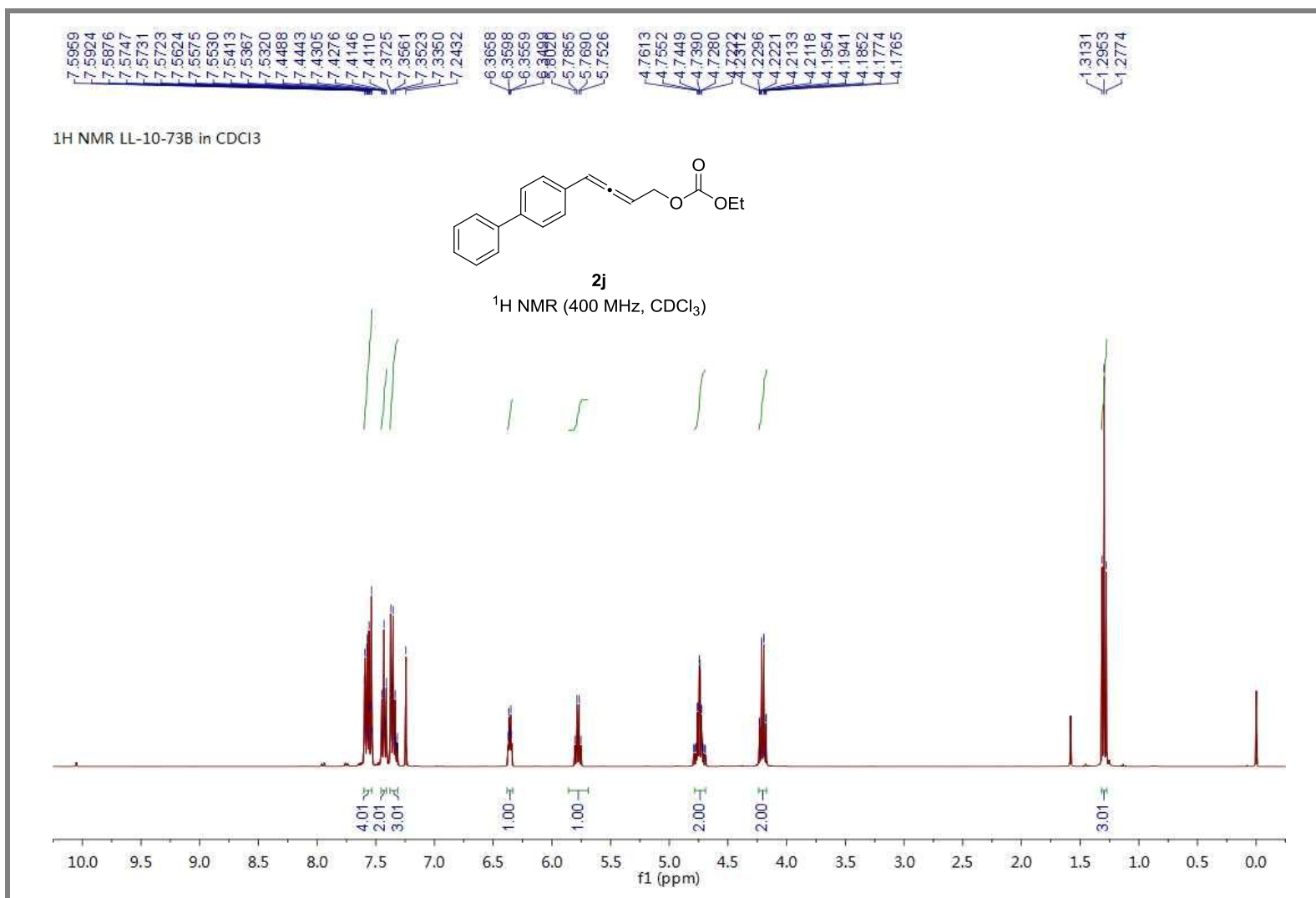


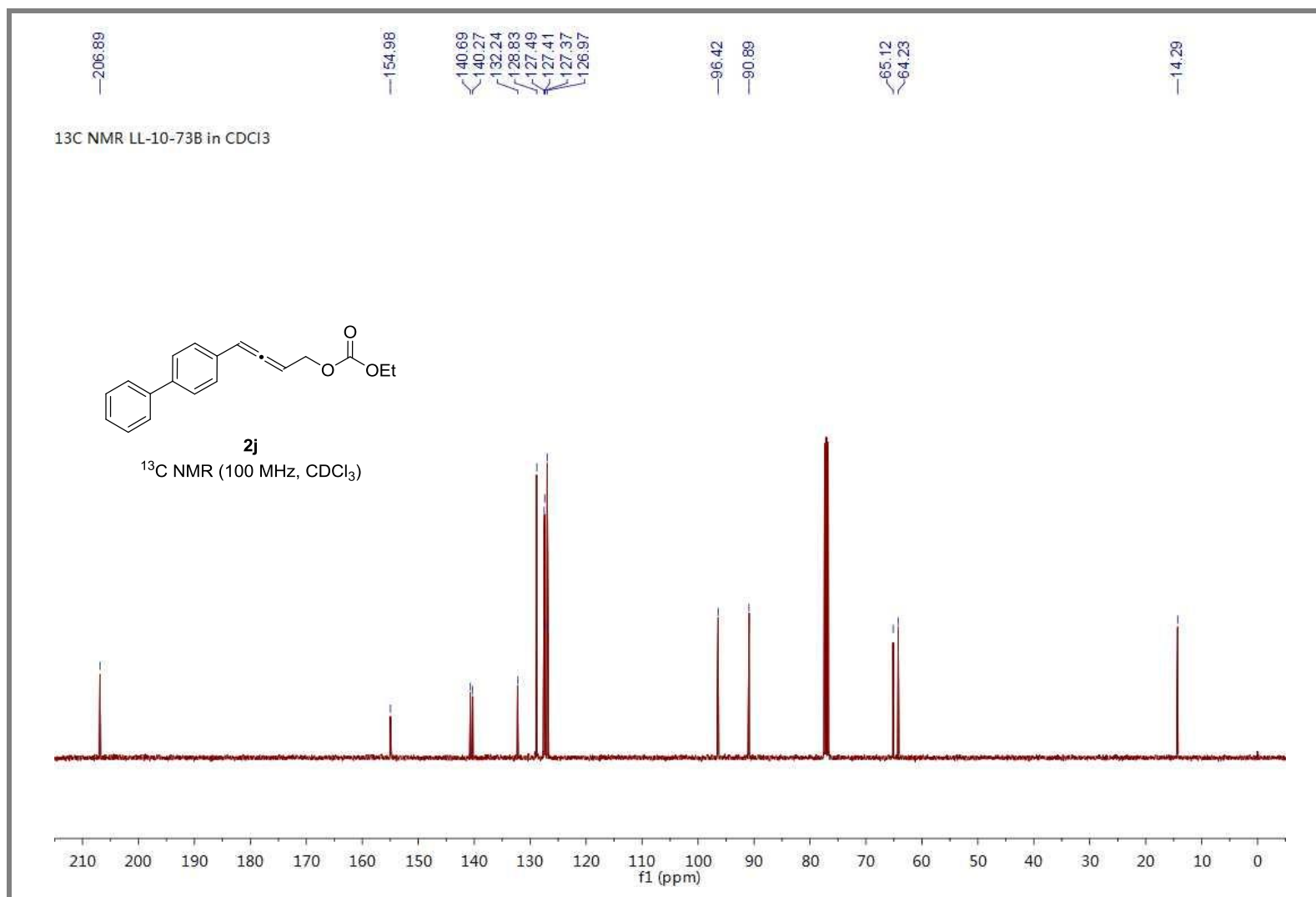


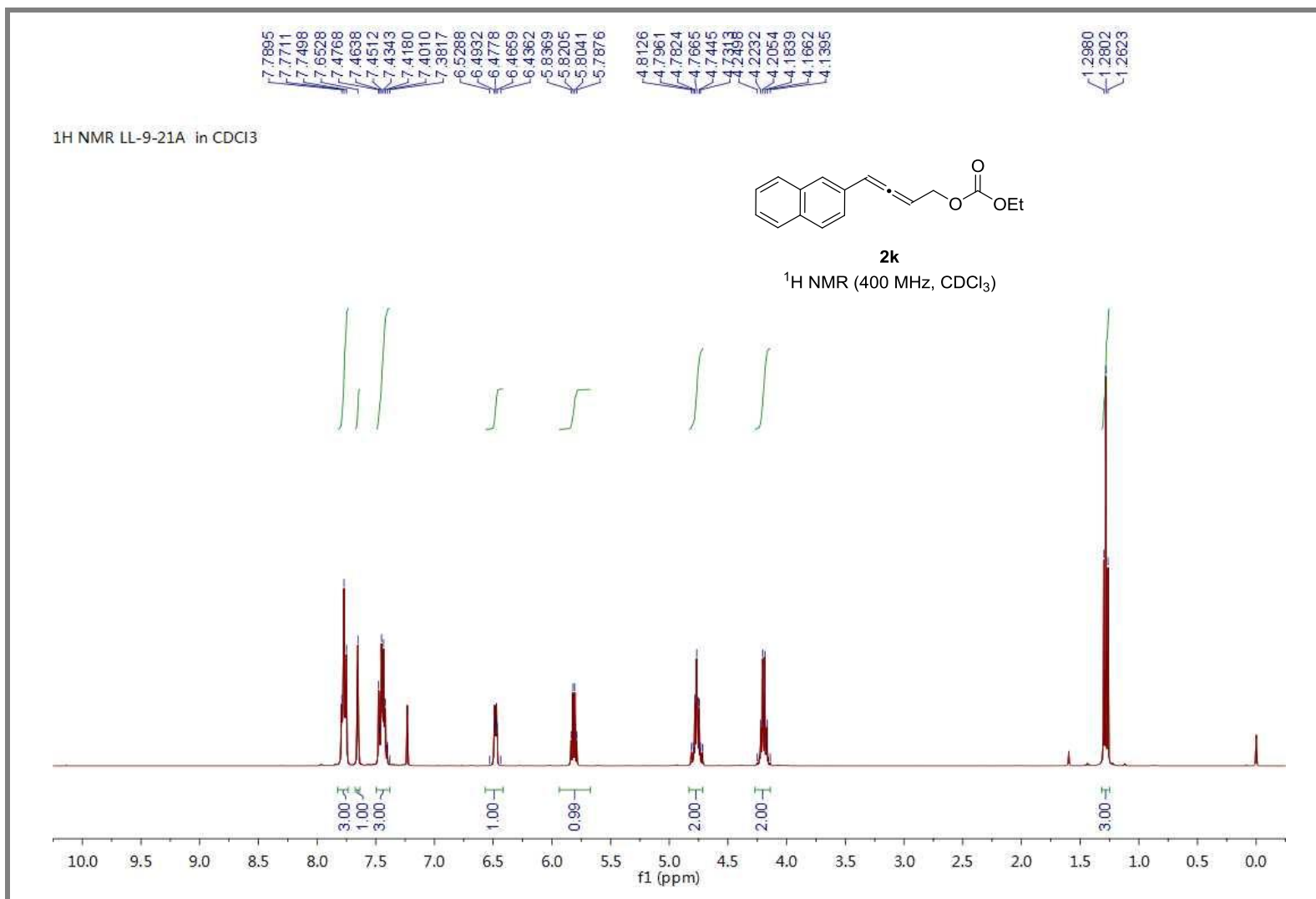


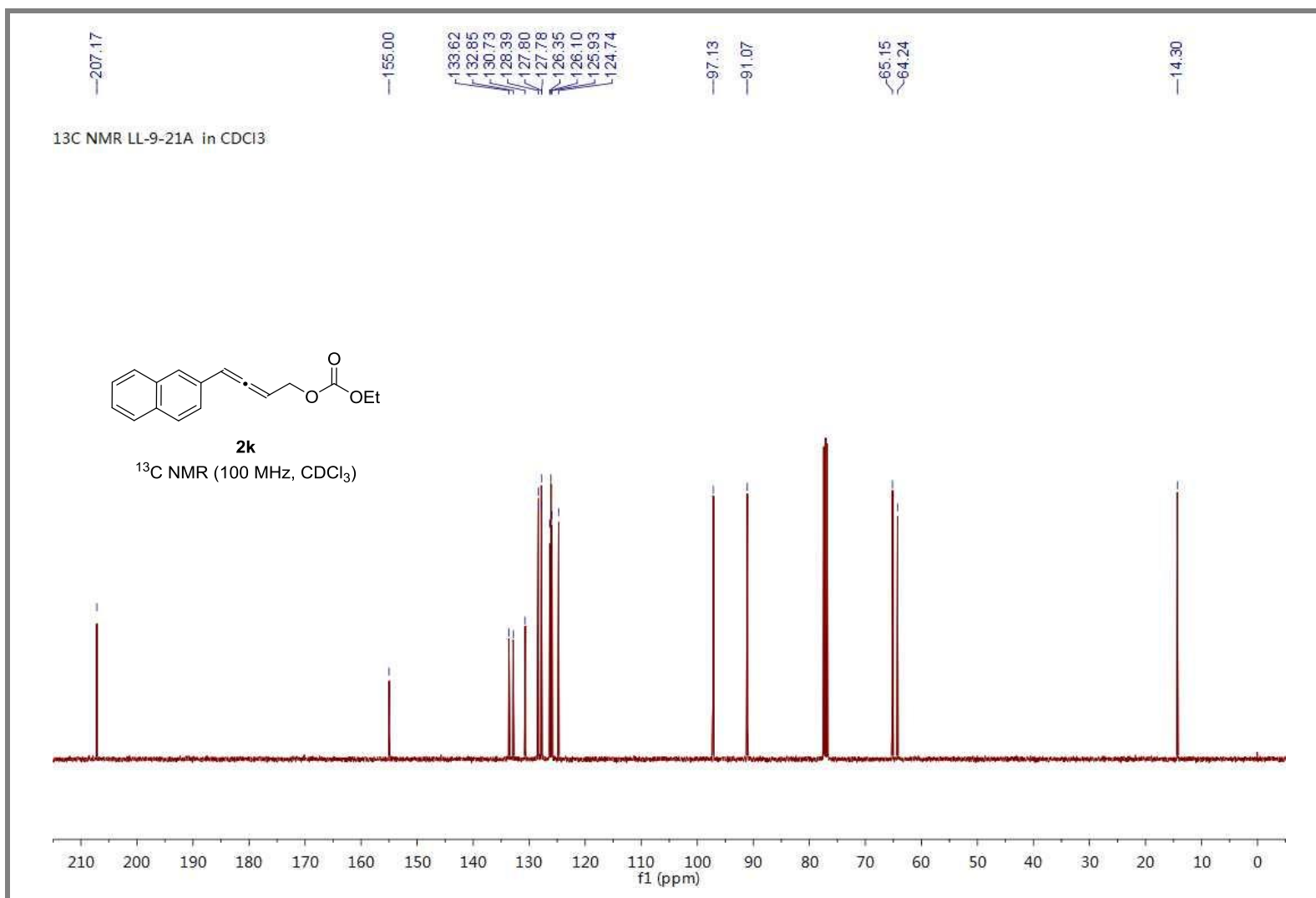


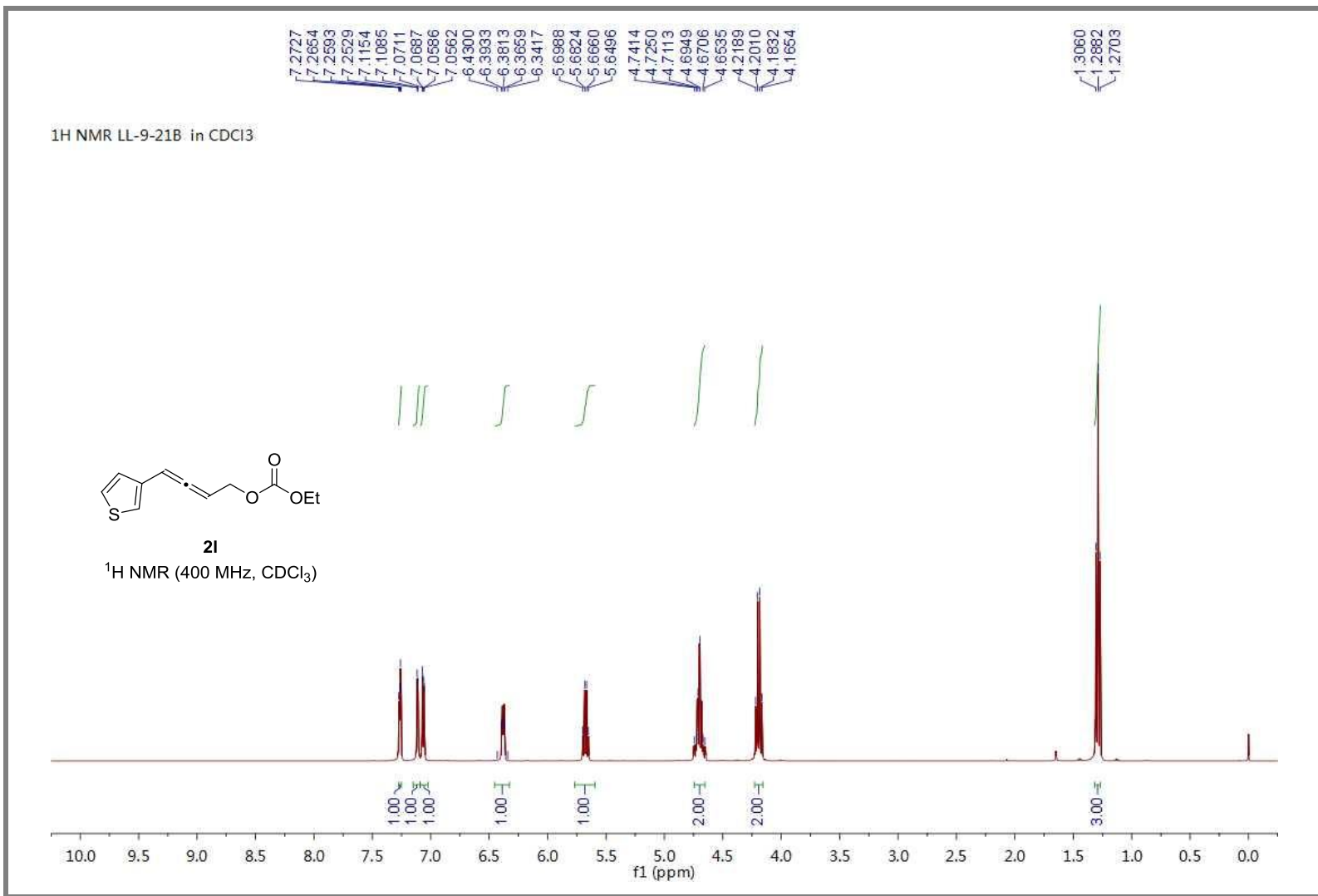


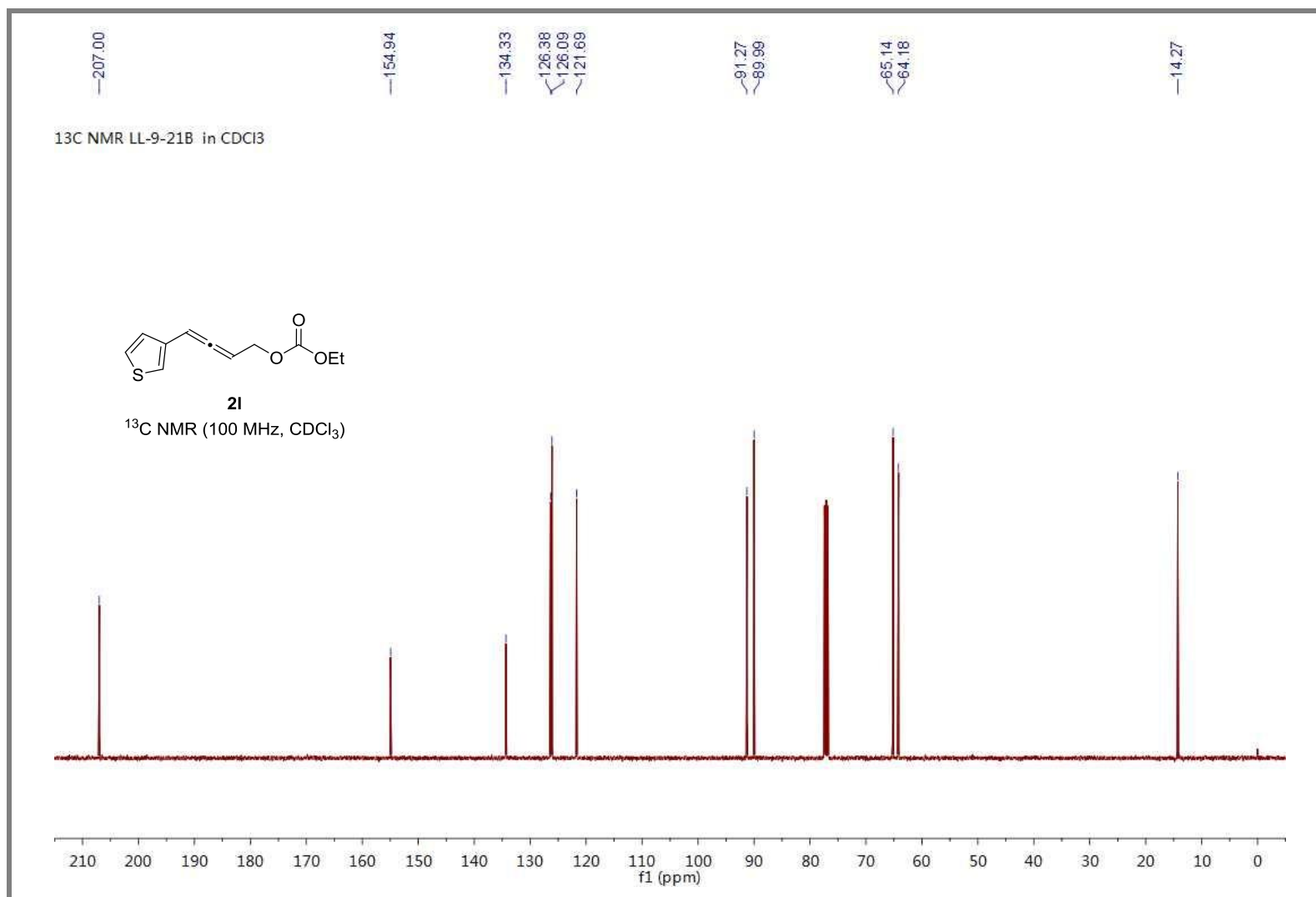


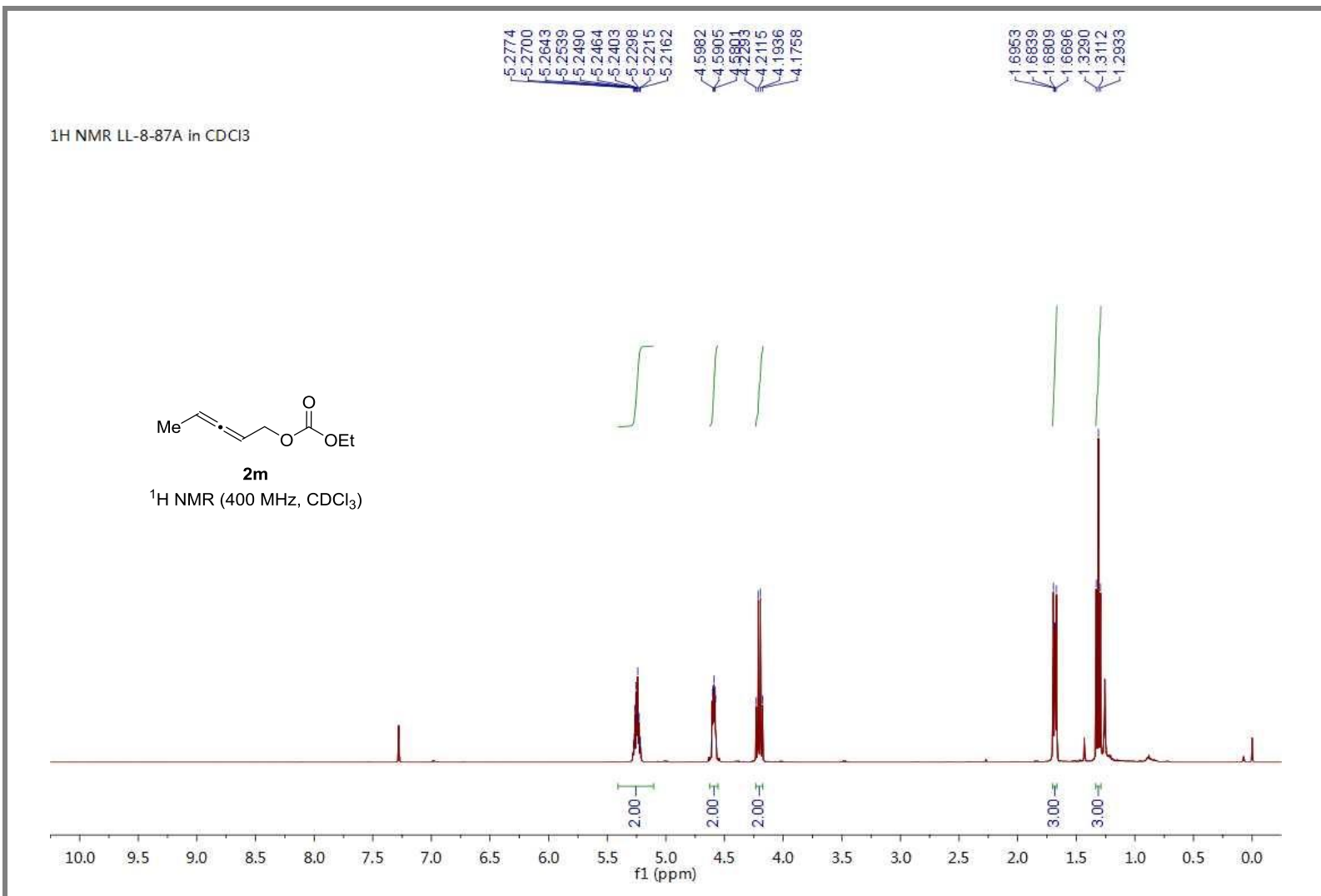


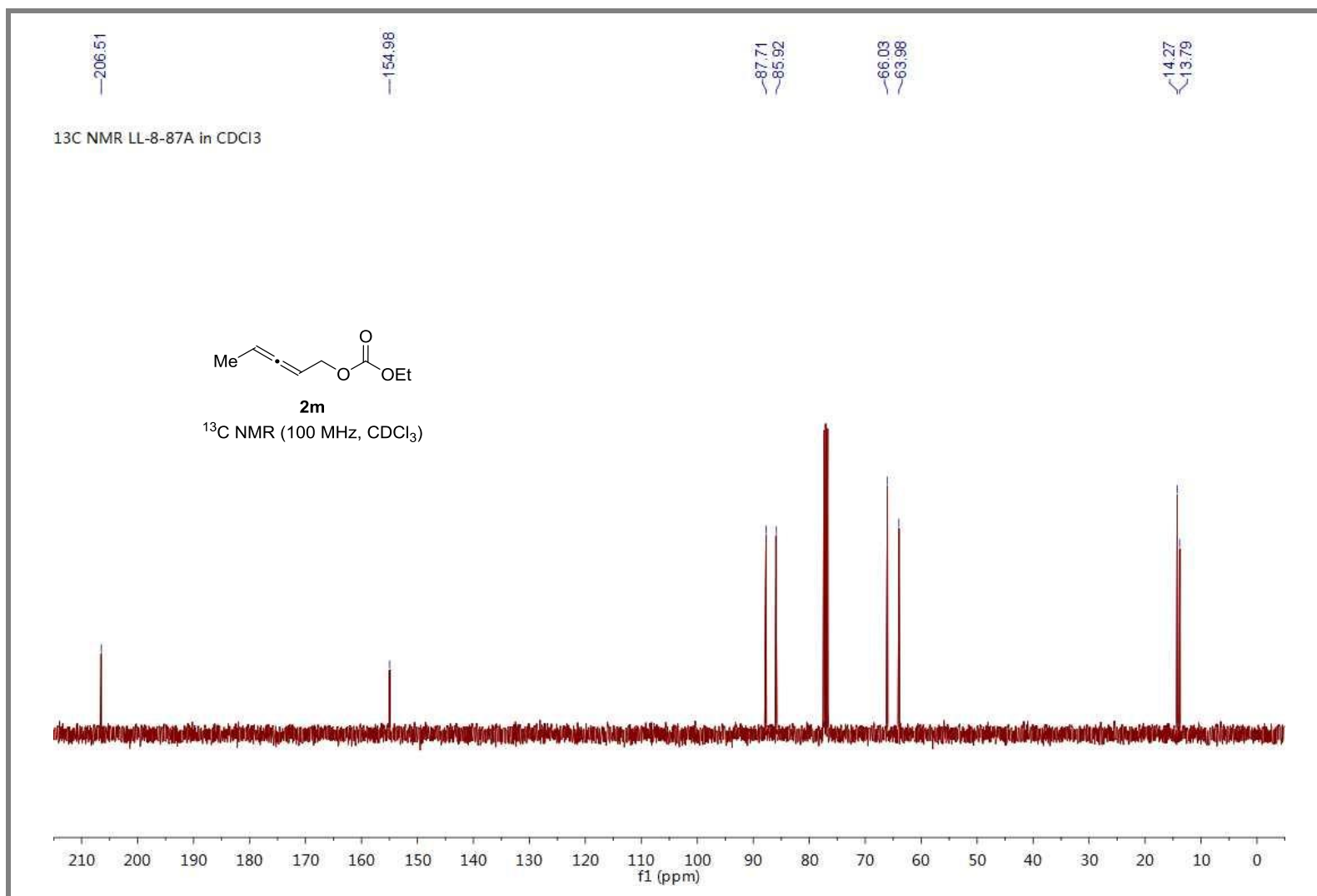


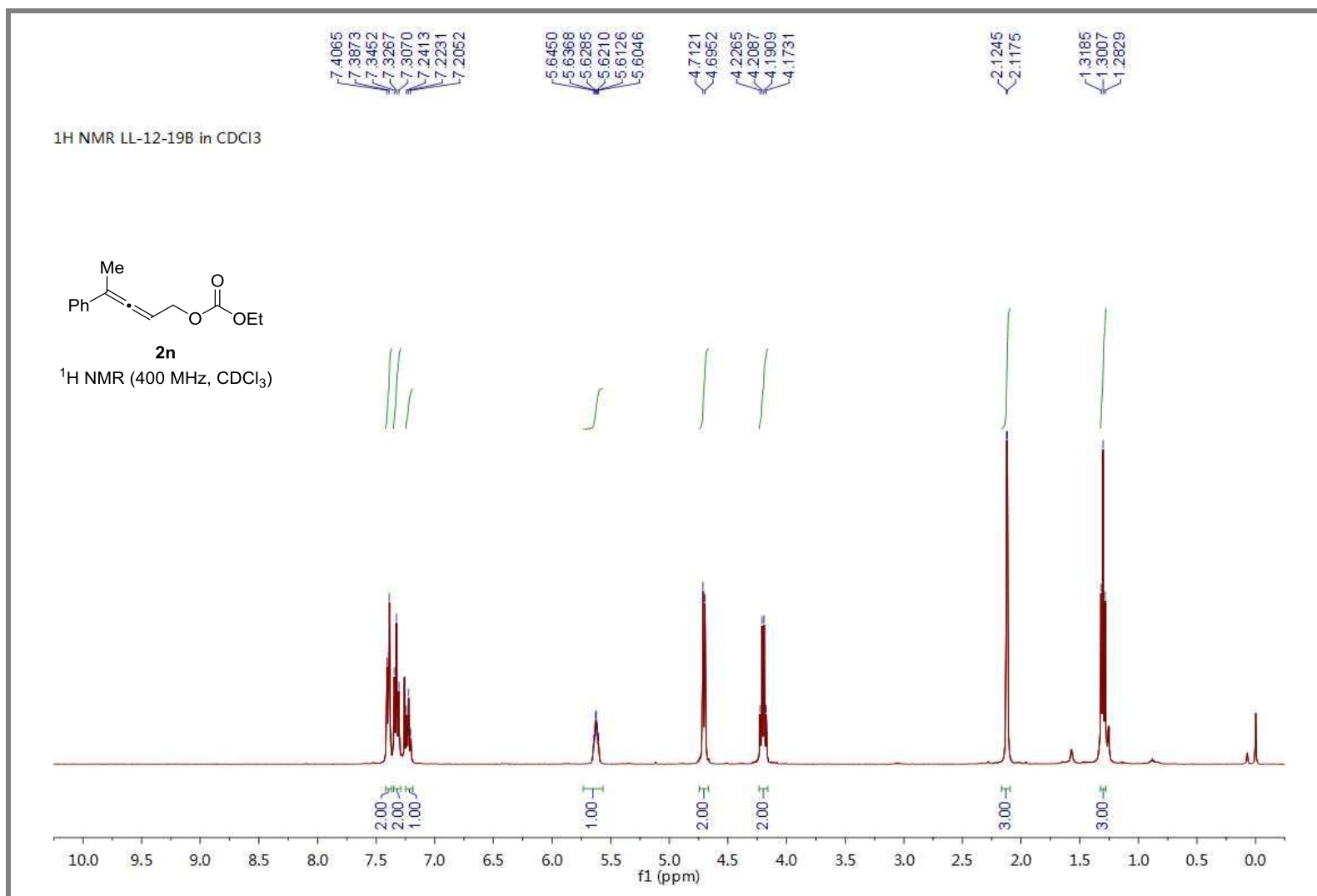


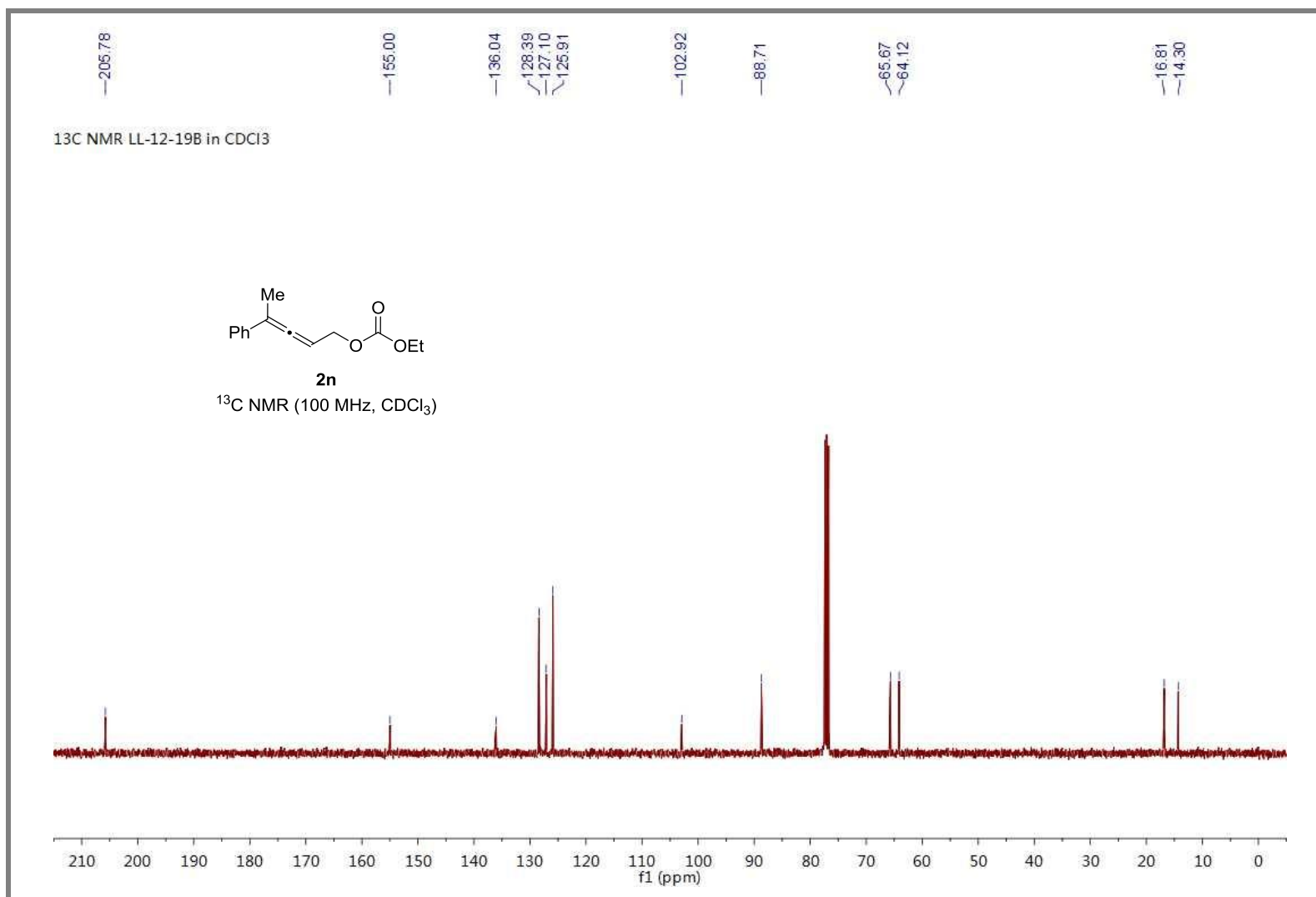


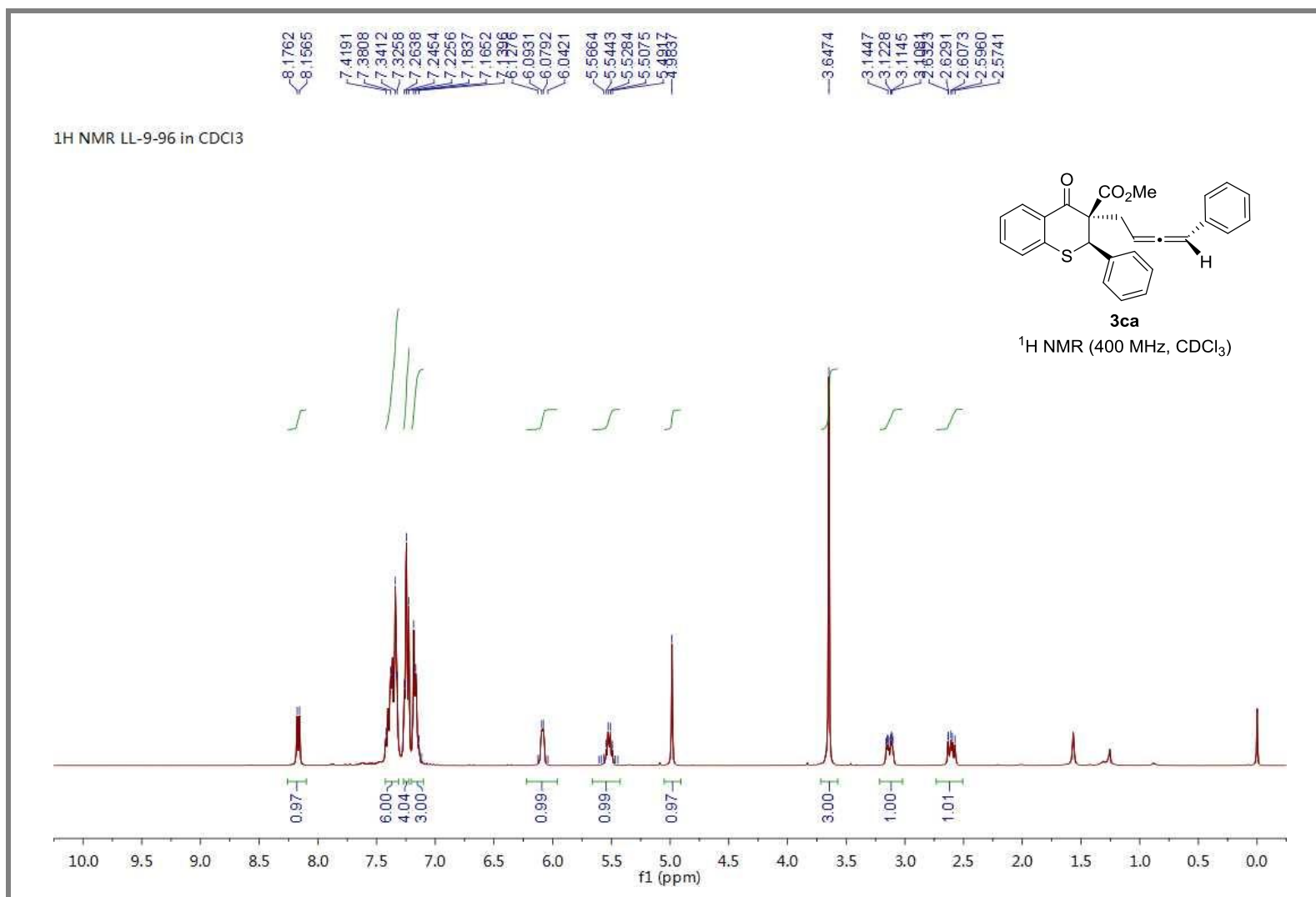


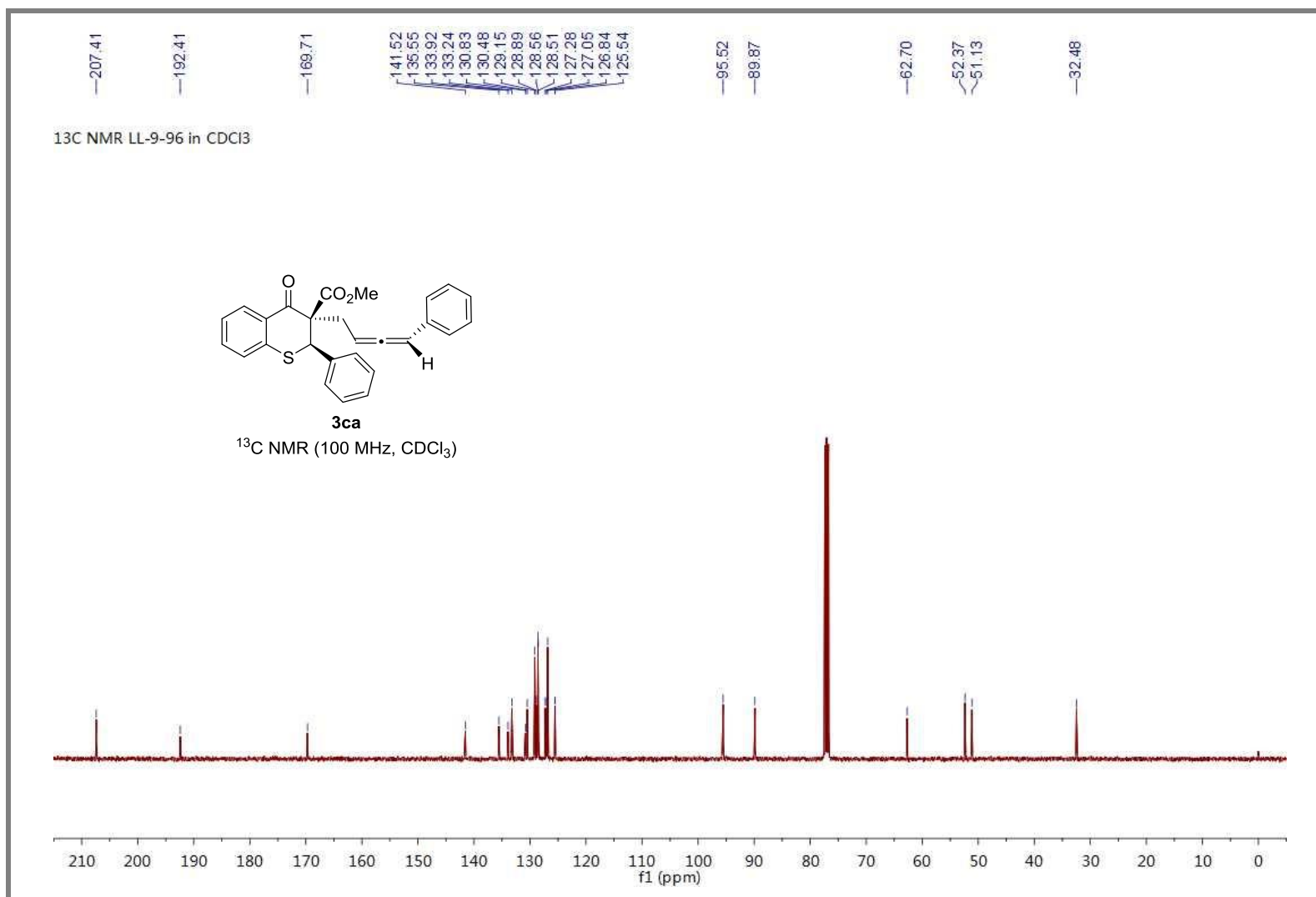


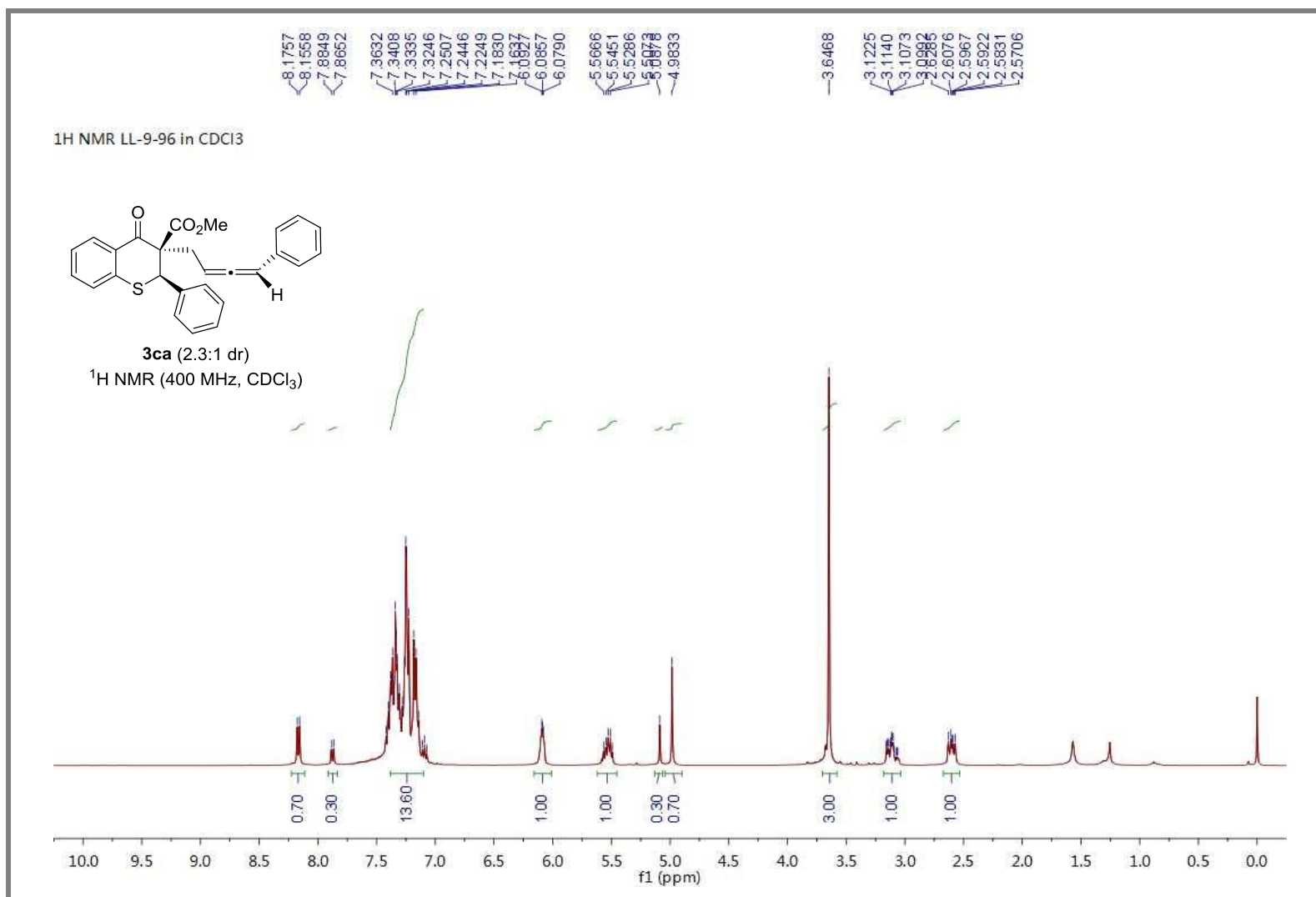


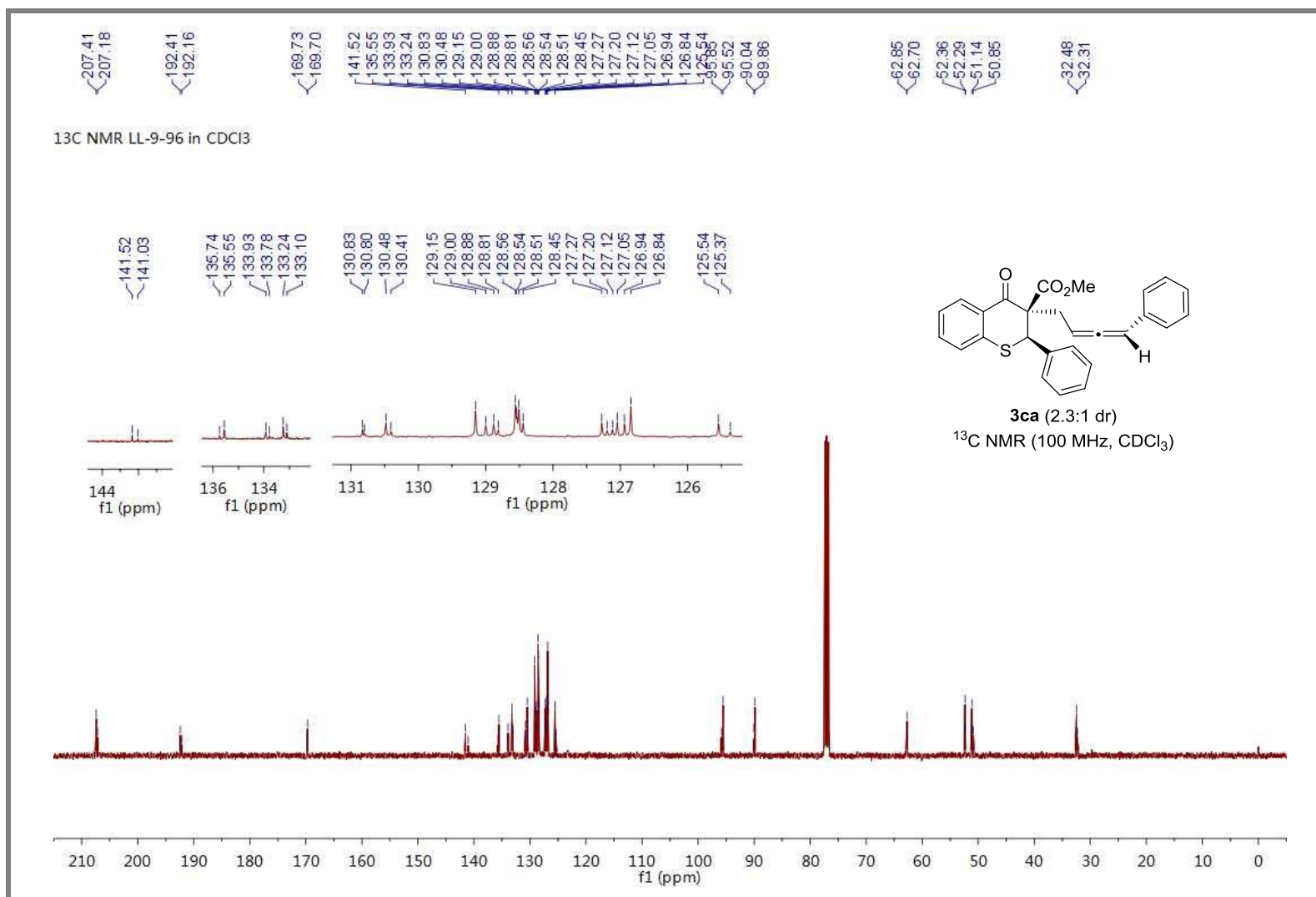


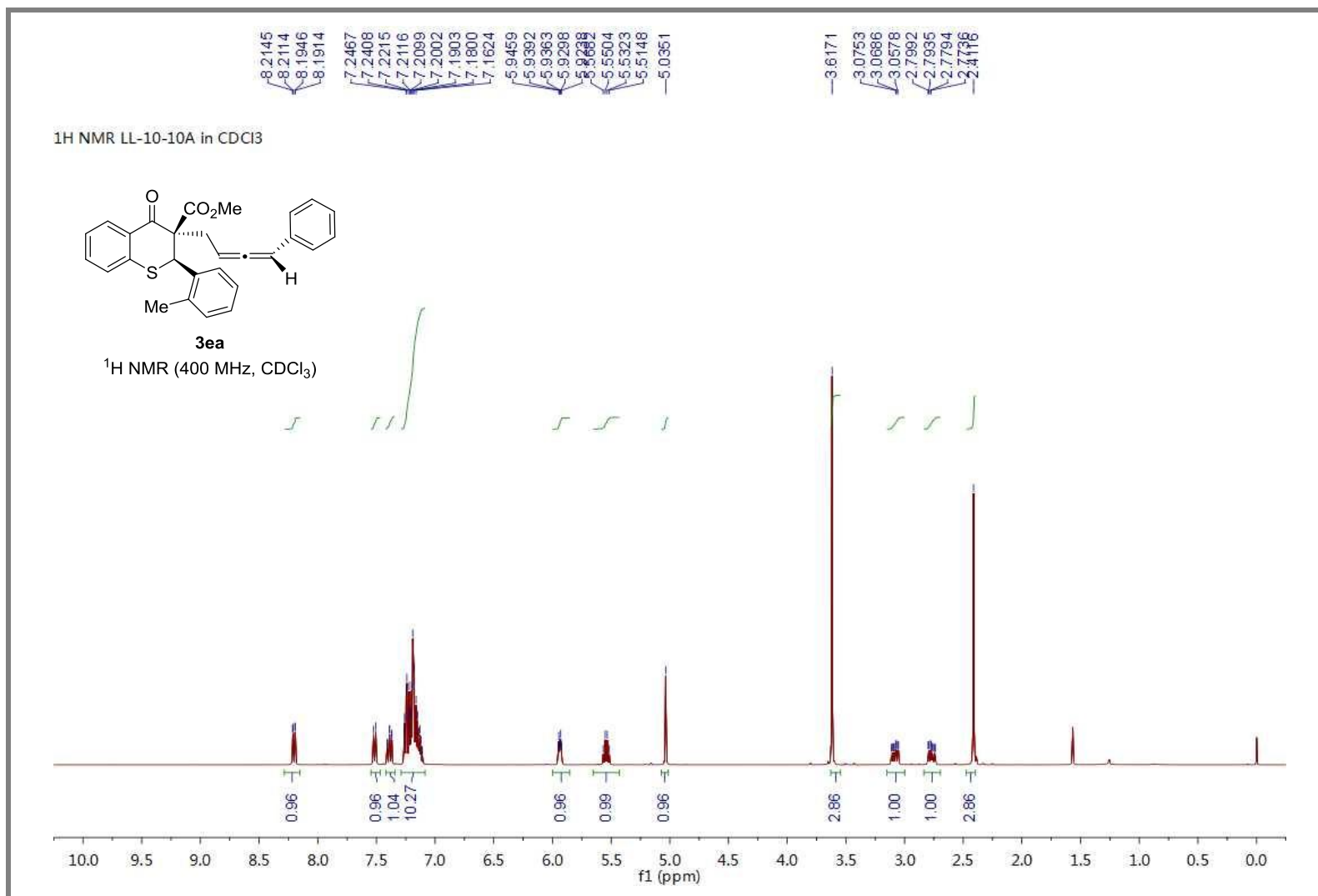


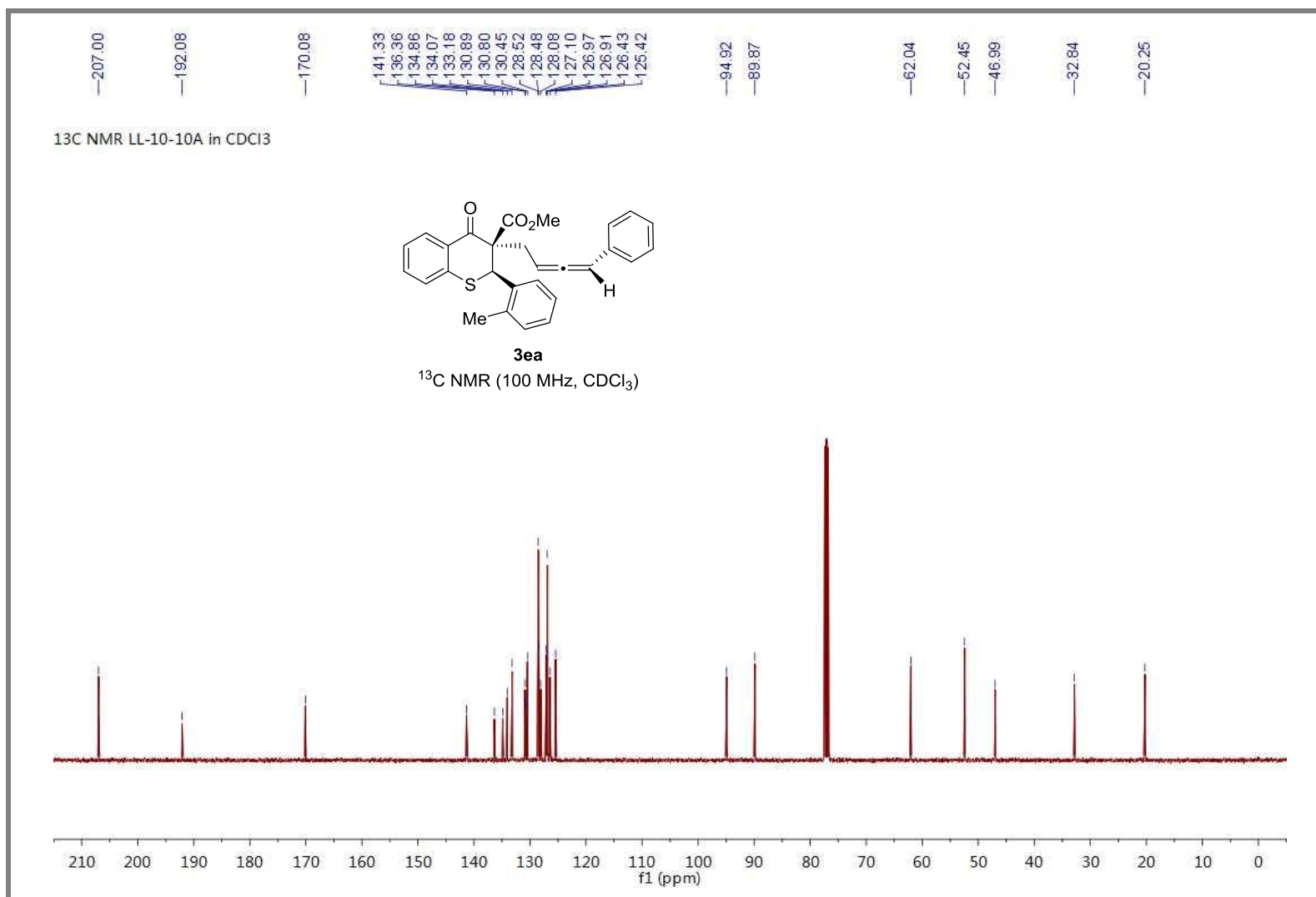


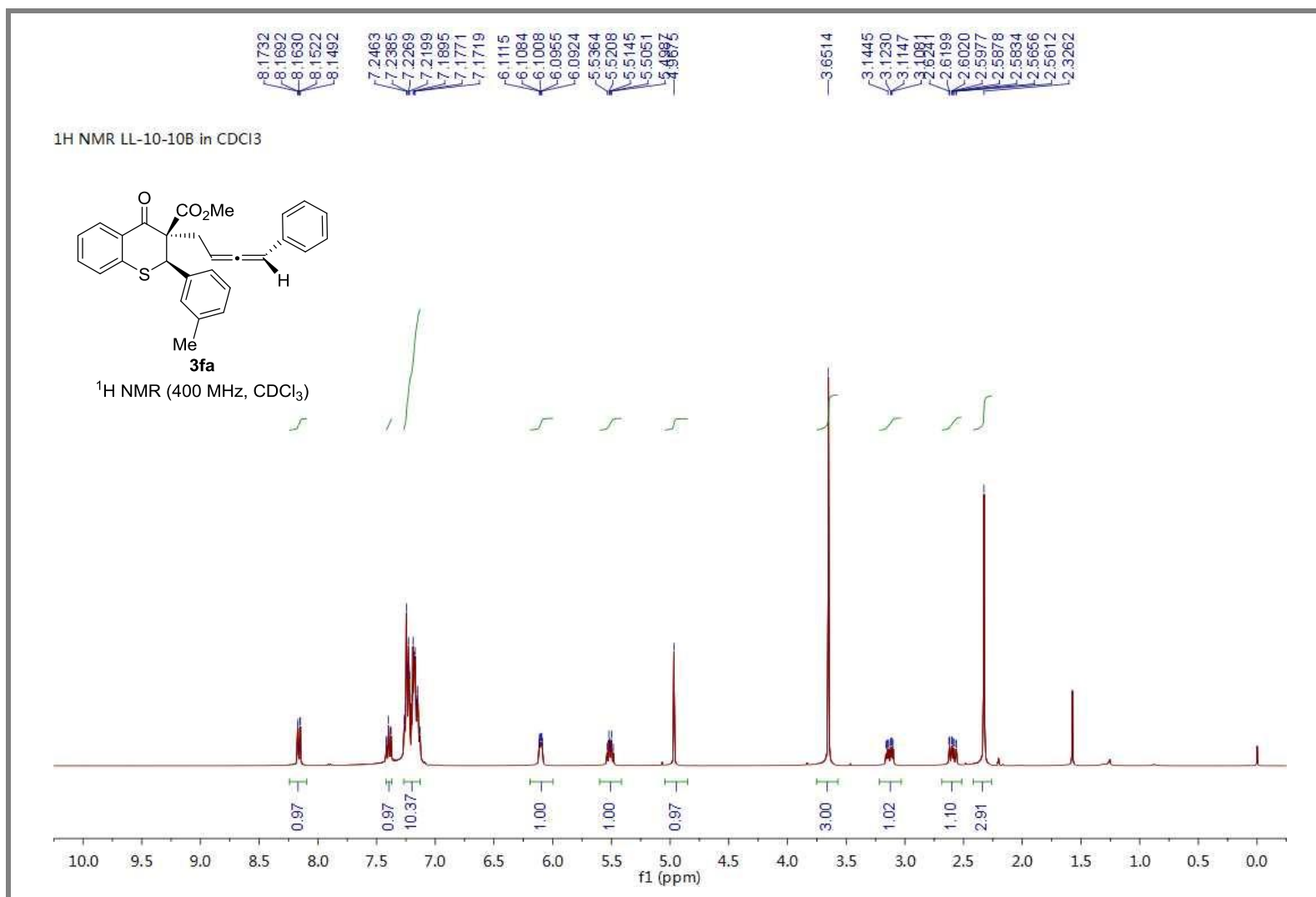


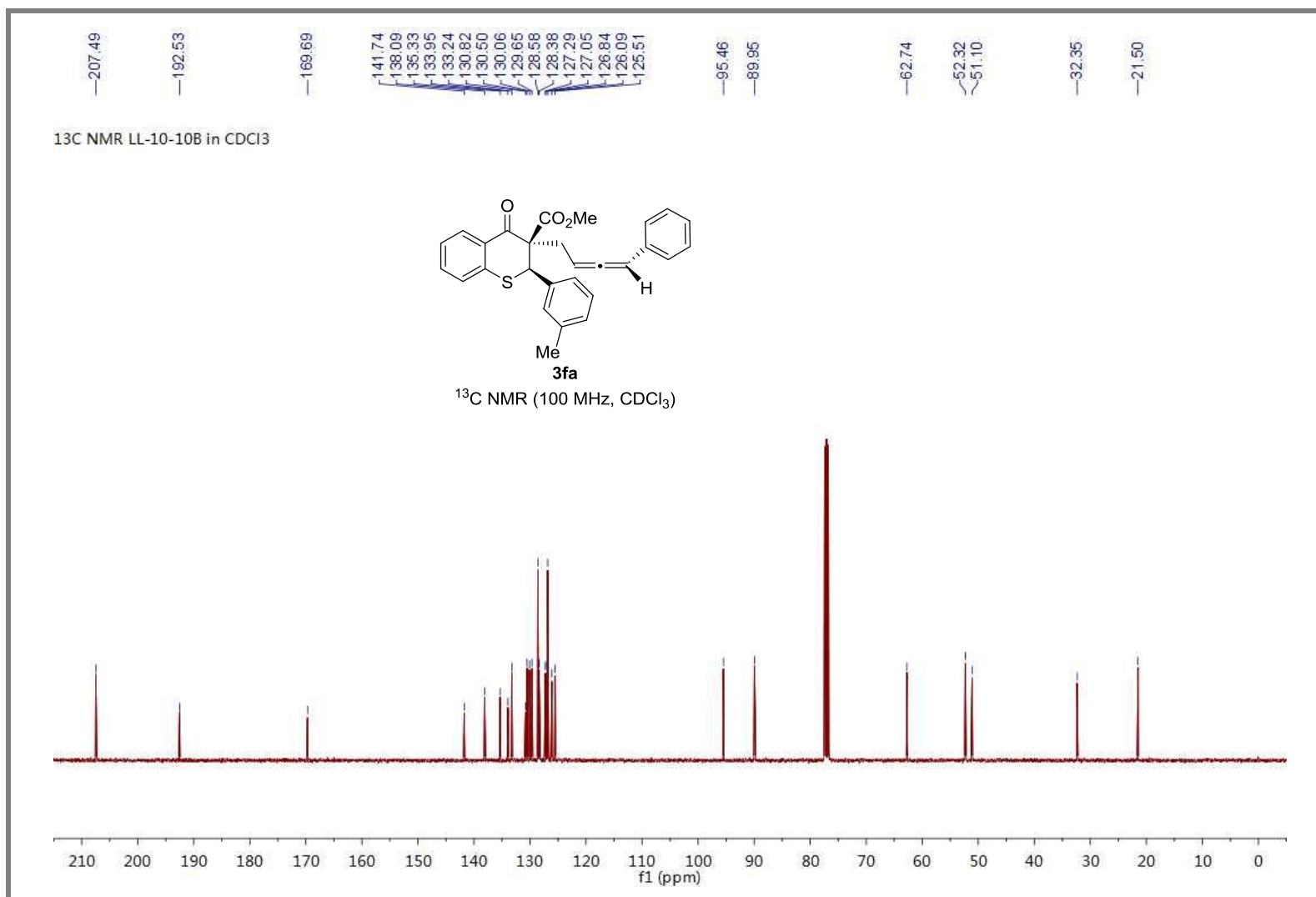


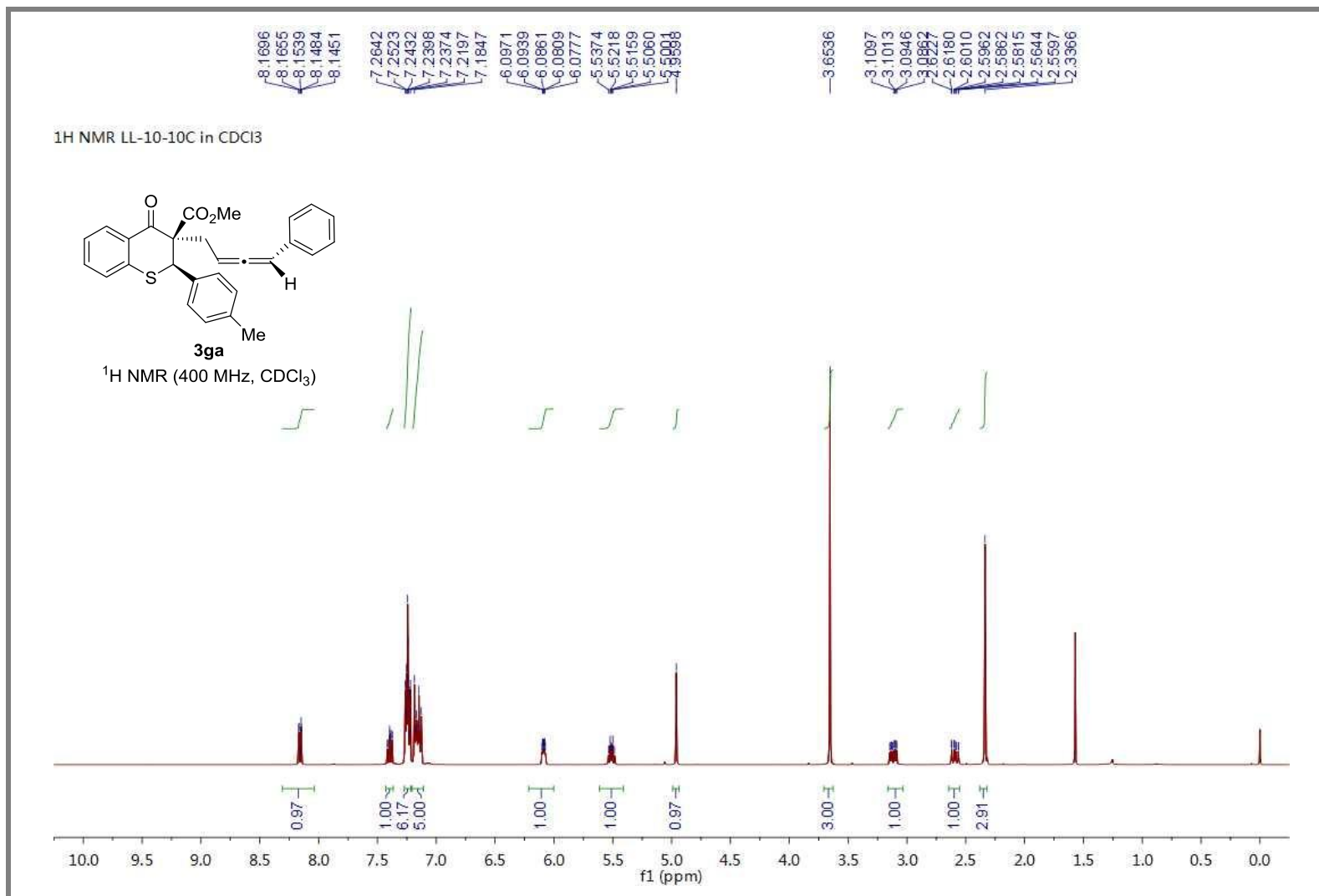


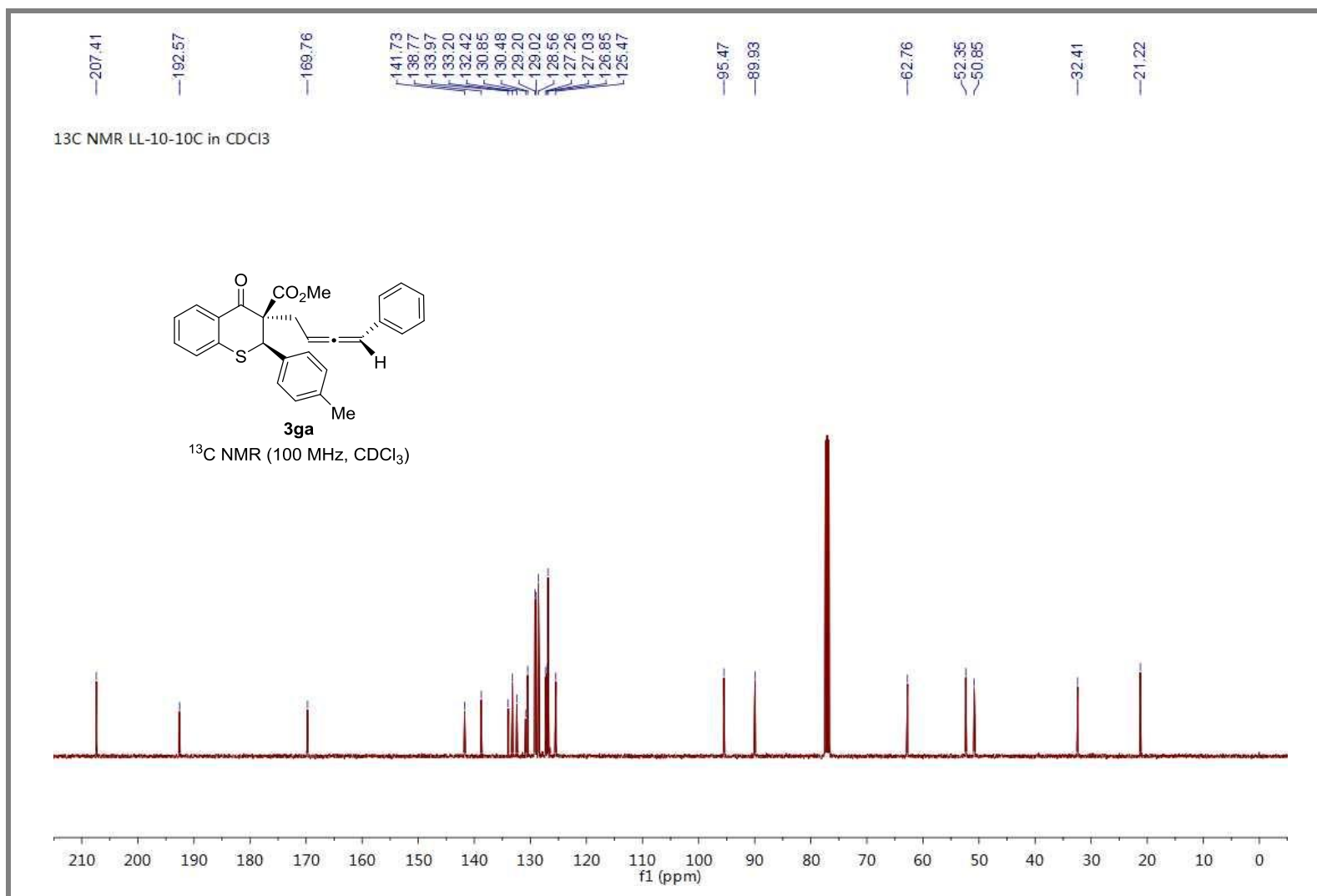


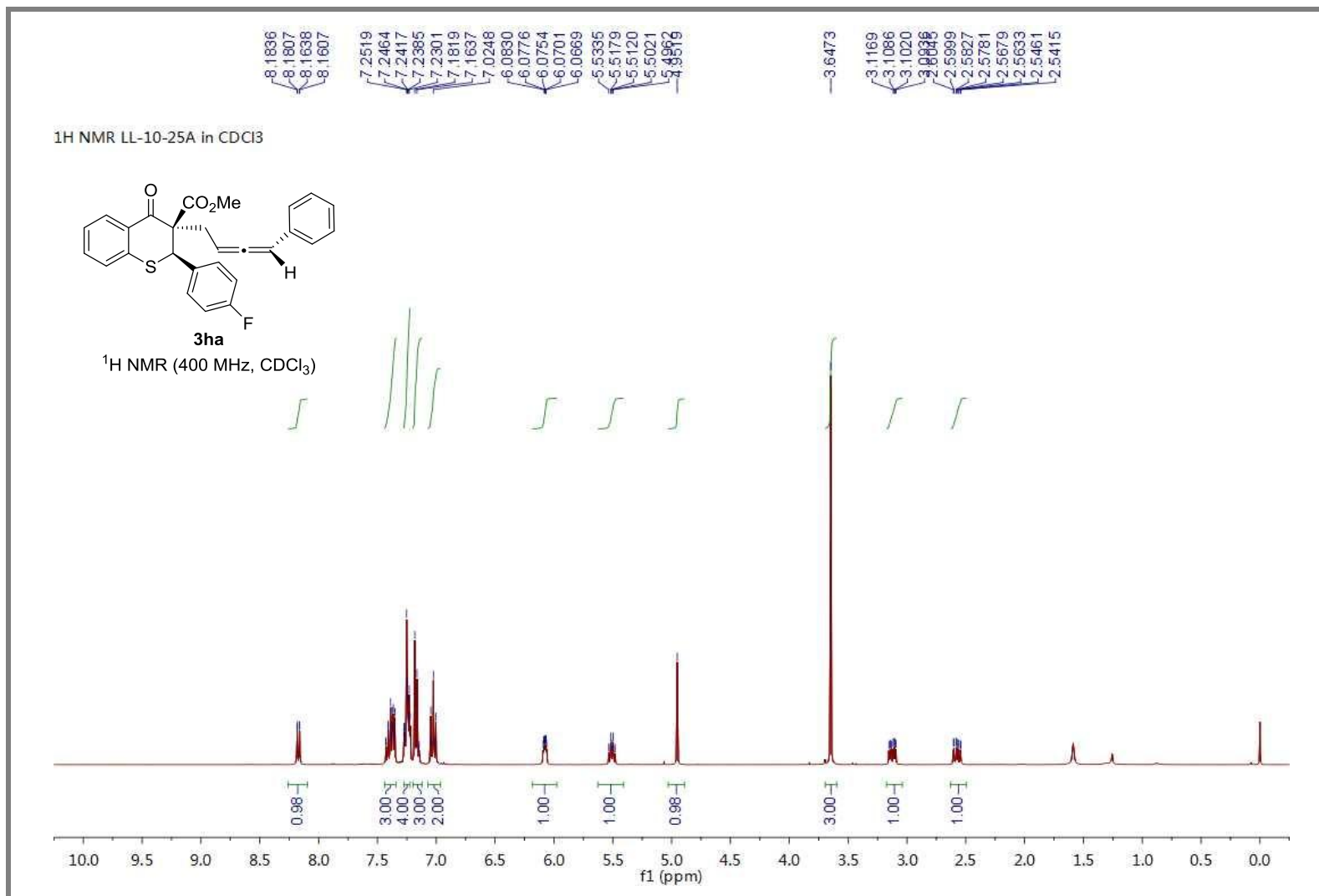


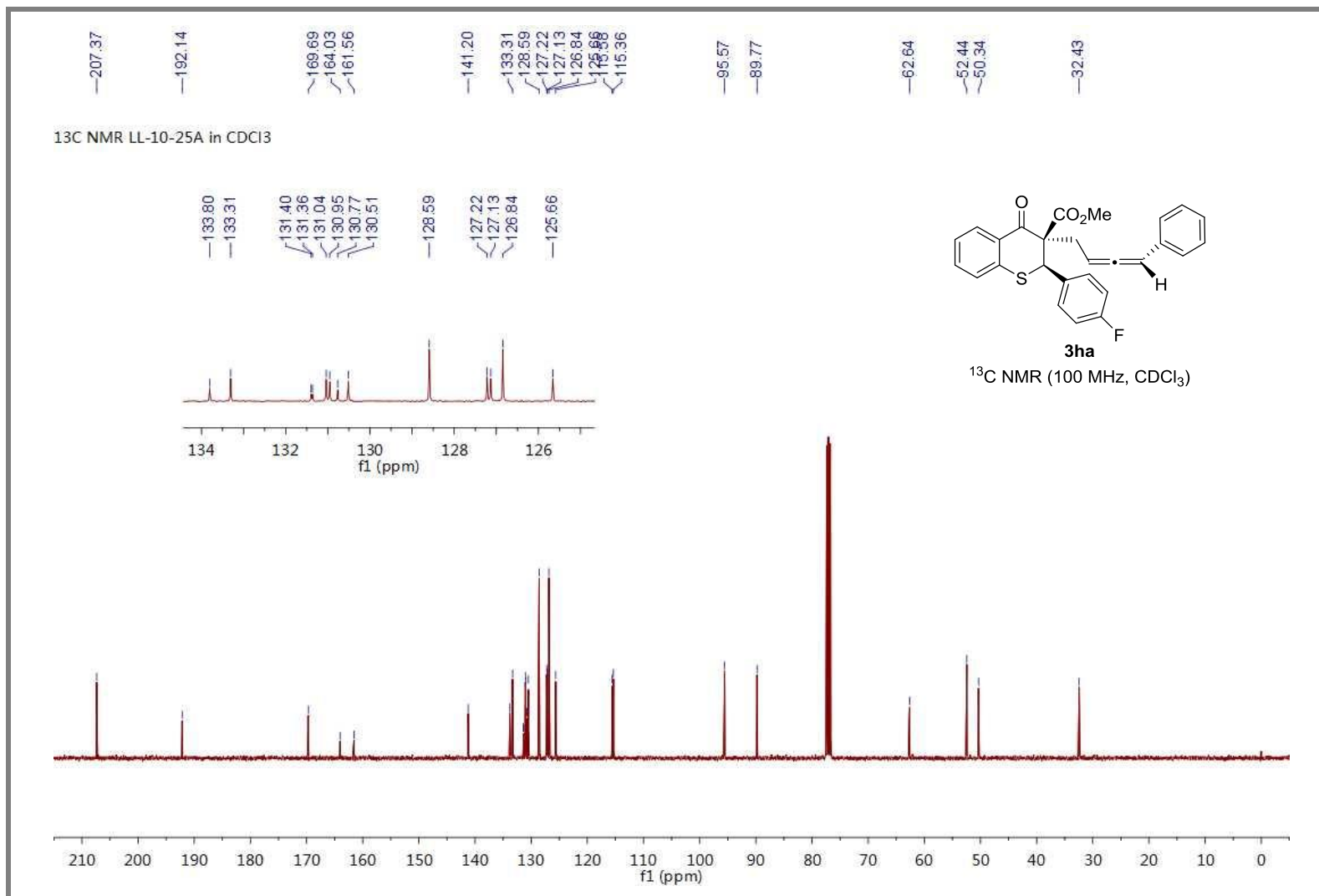




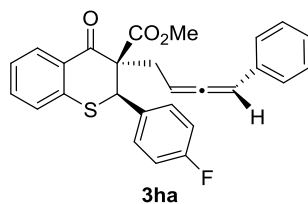




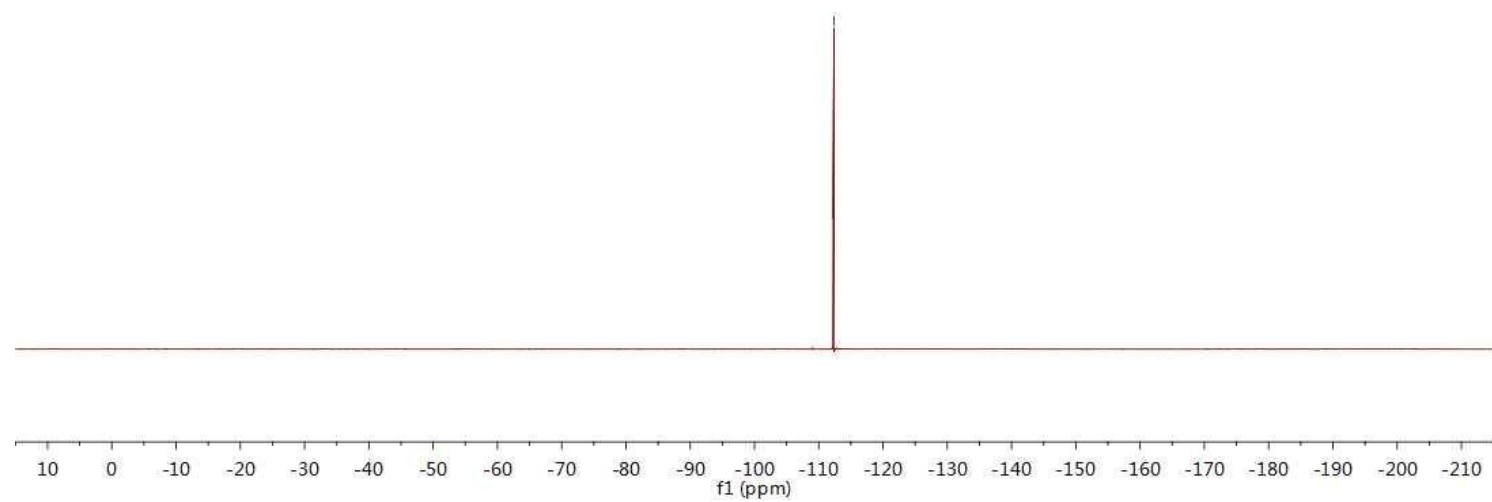


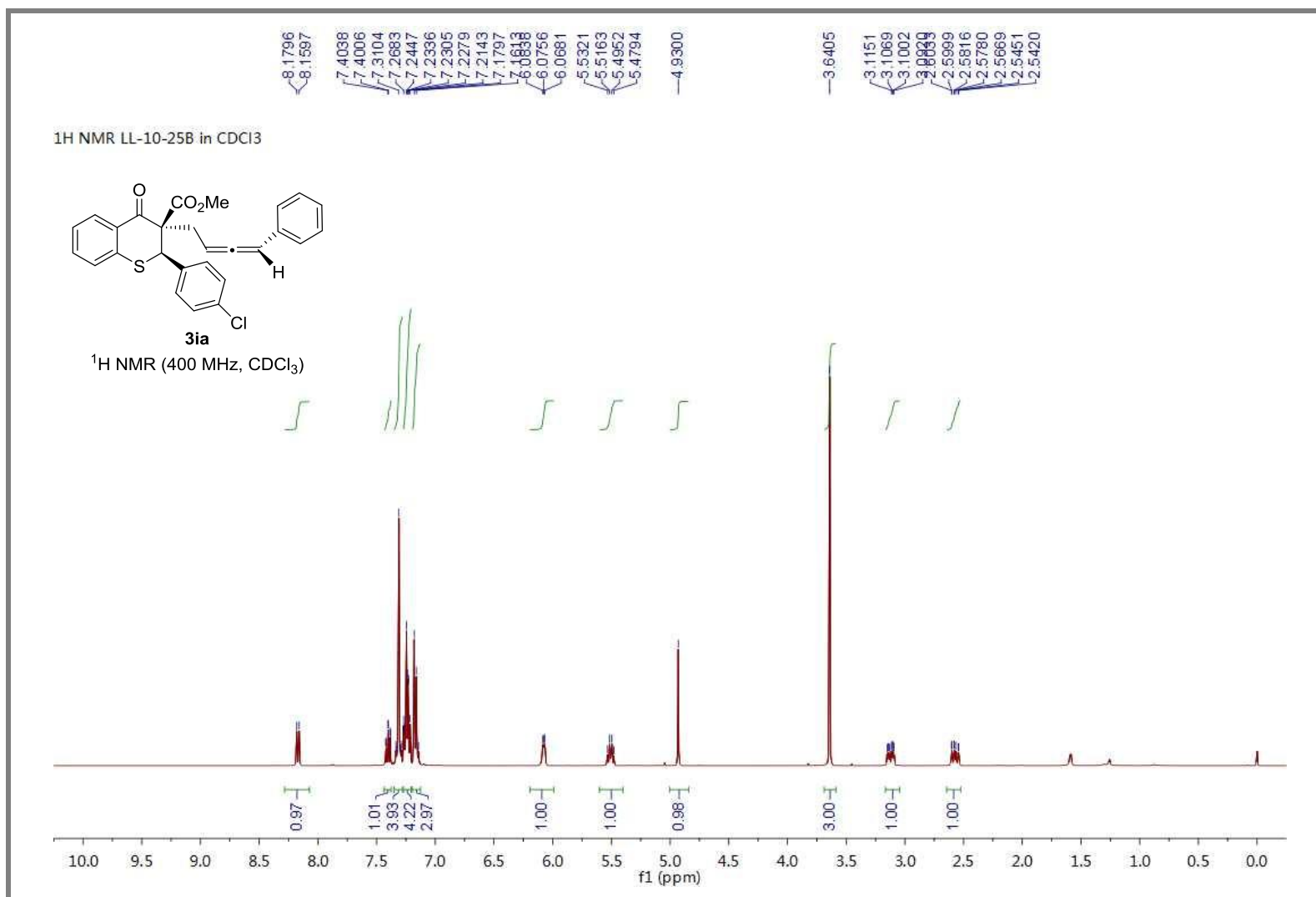


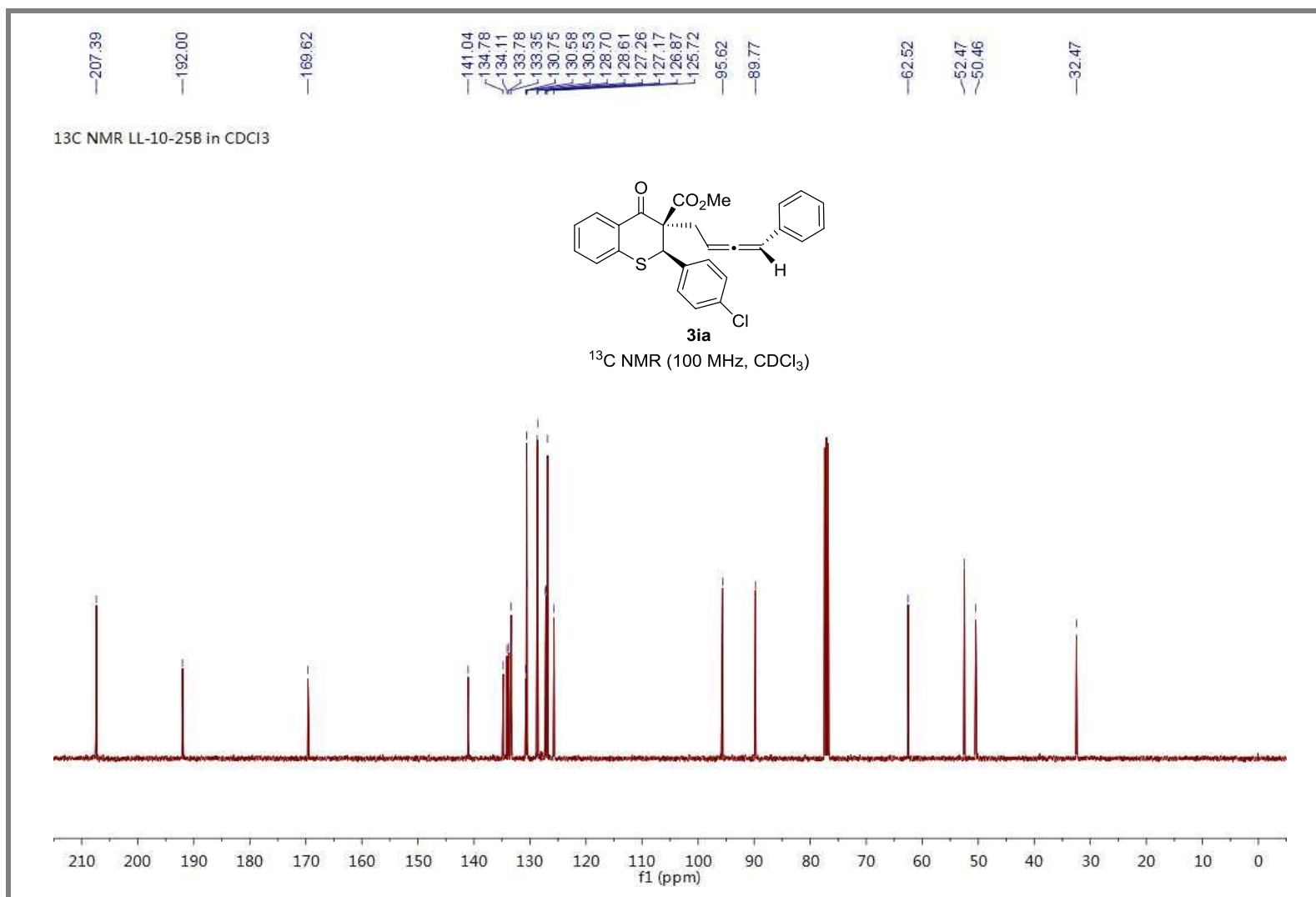
¹⁹F NMR LL-10-25A in CDCl₃

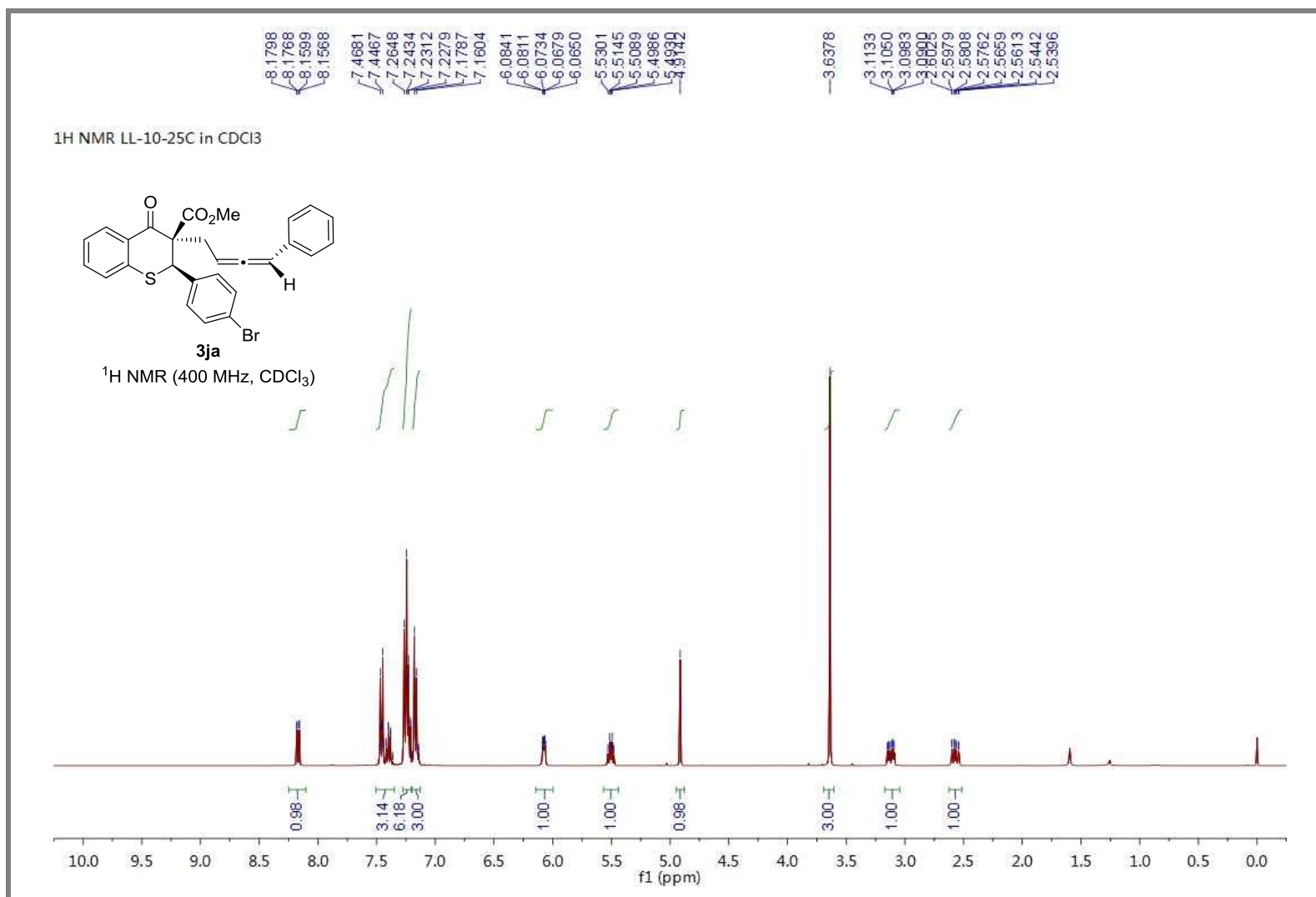


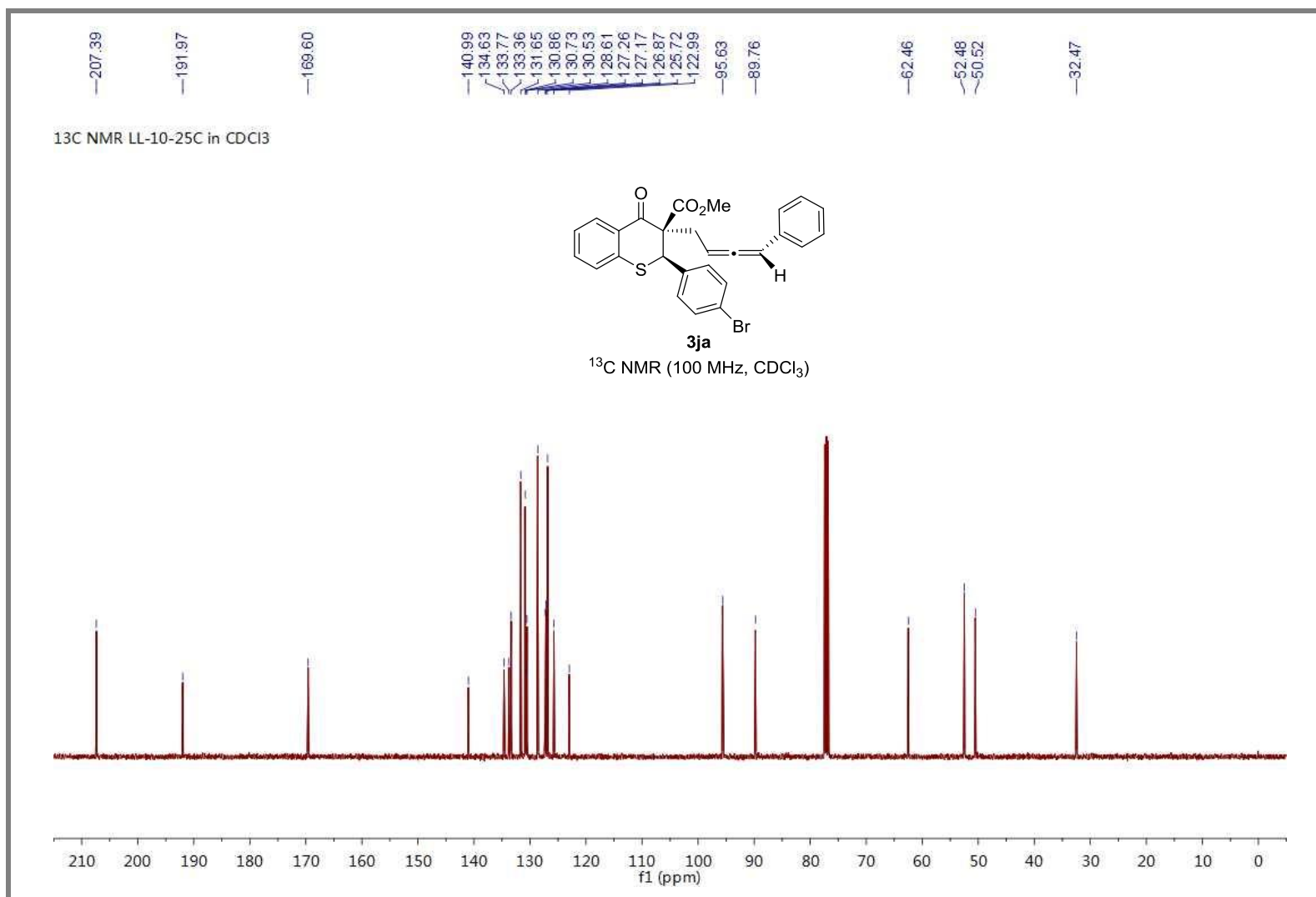
¹⁹F NMR (376 MHz, CDCl₃)

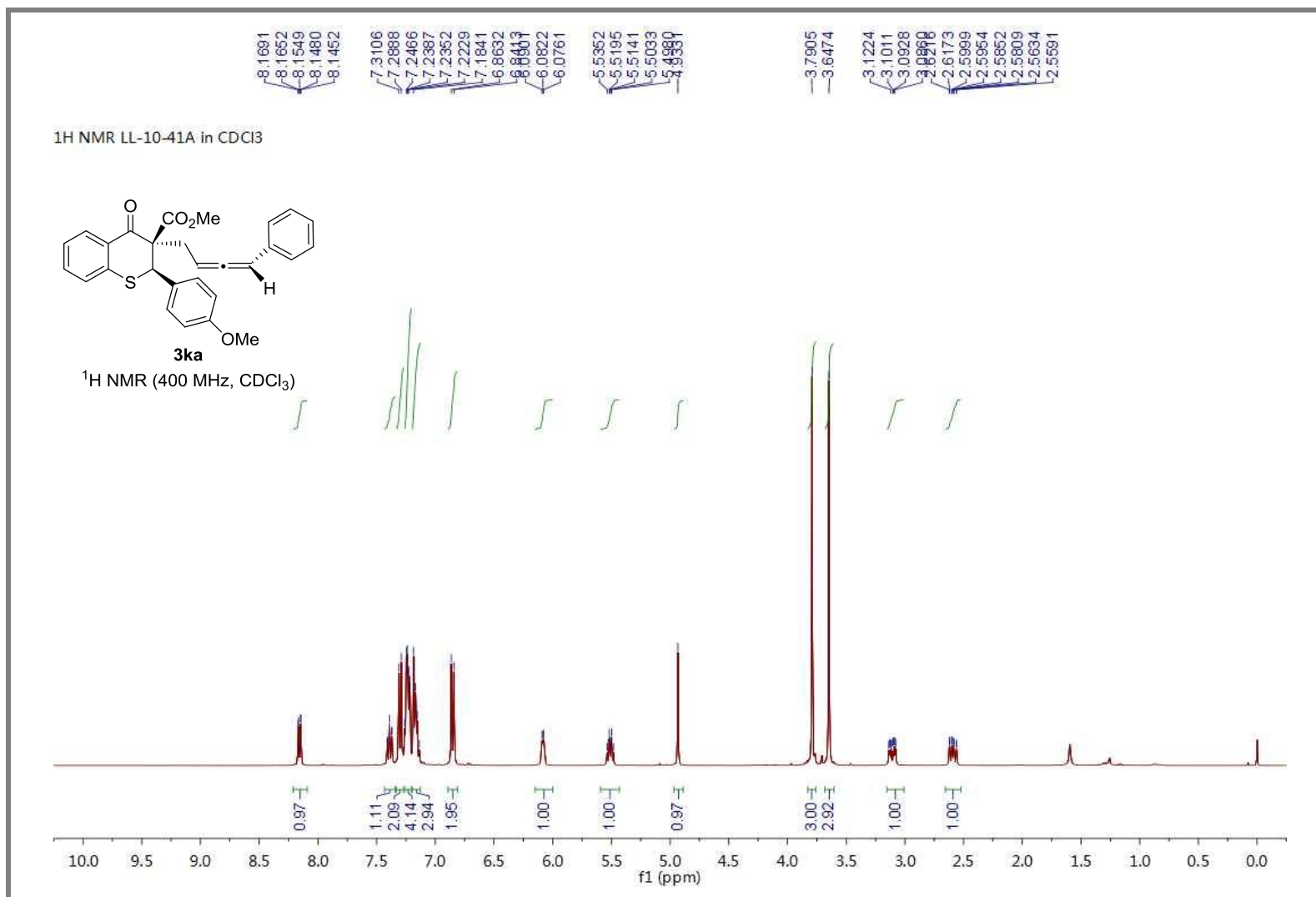


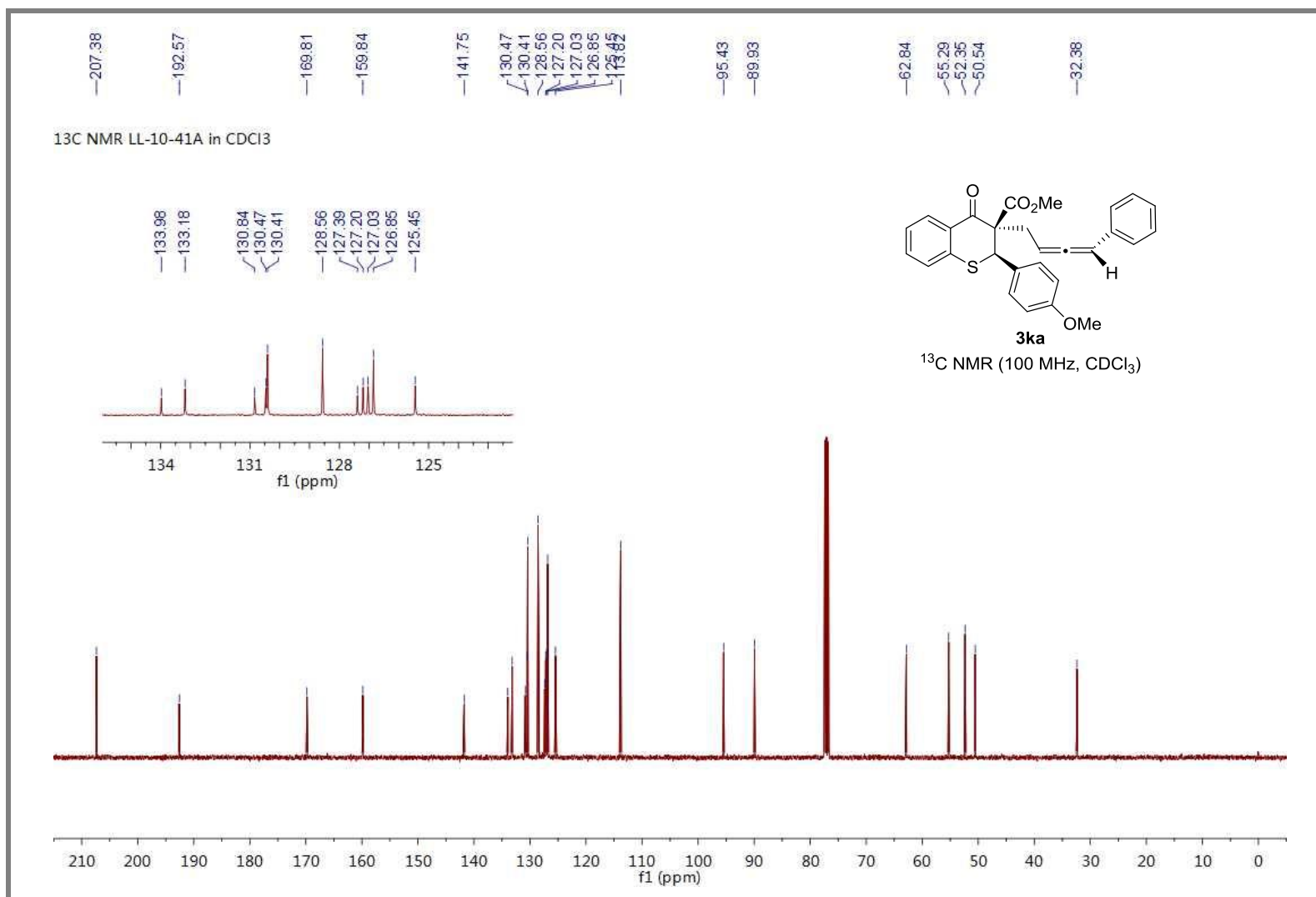


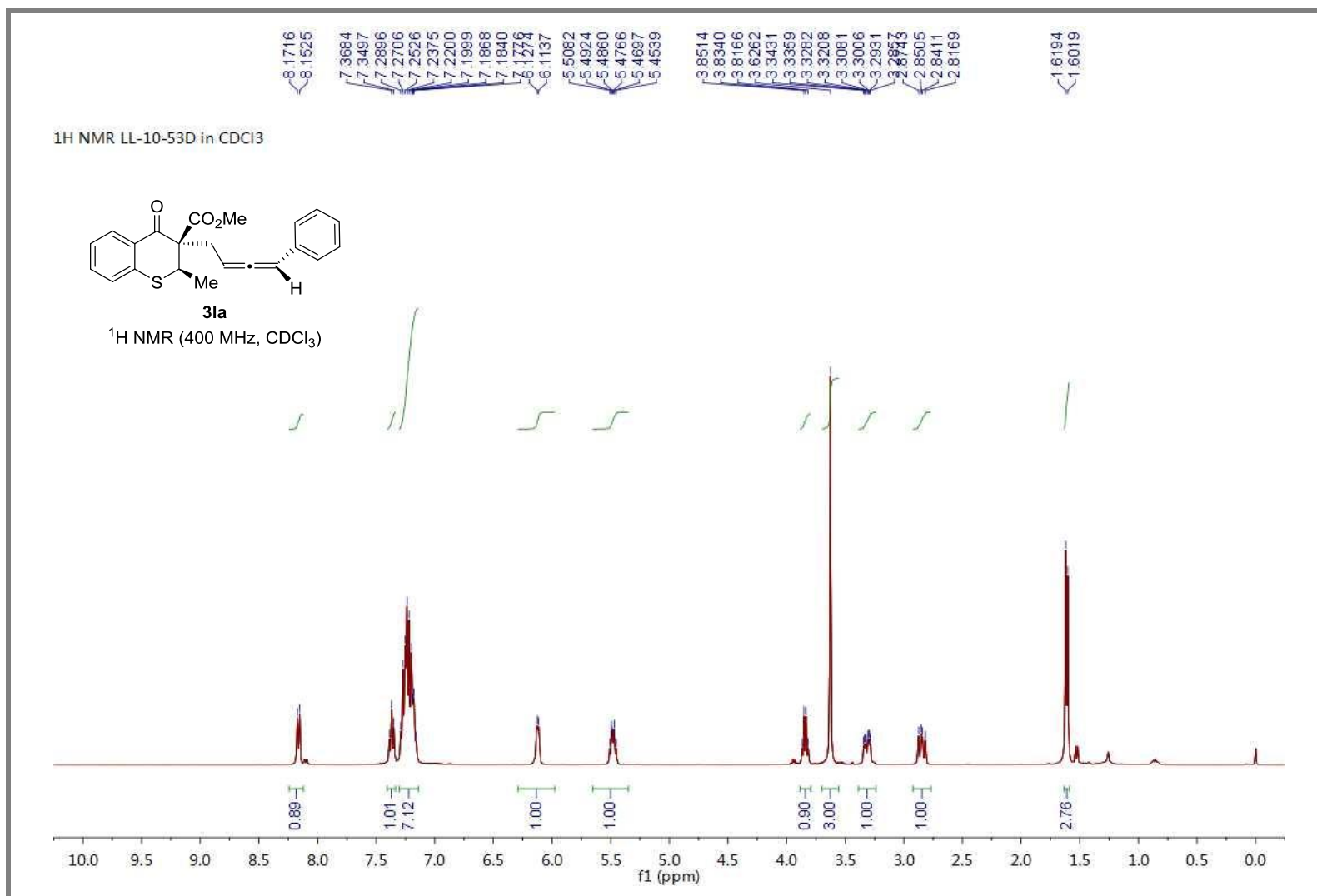


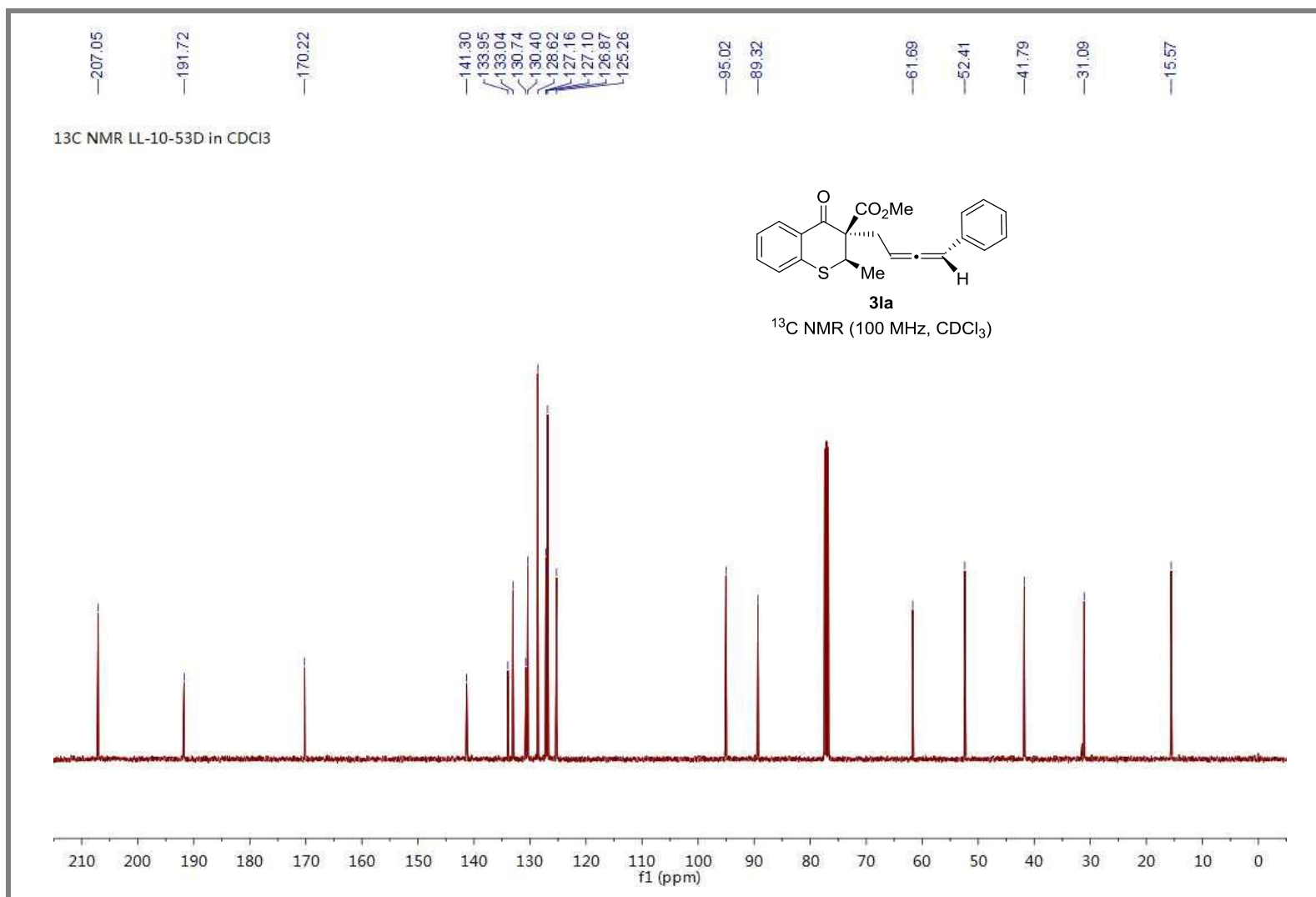


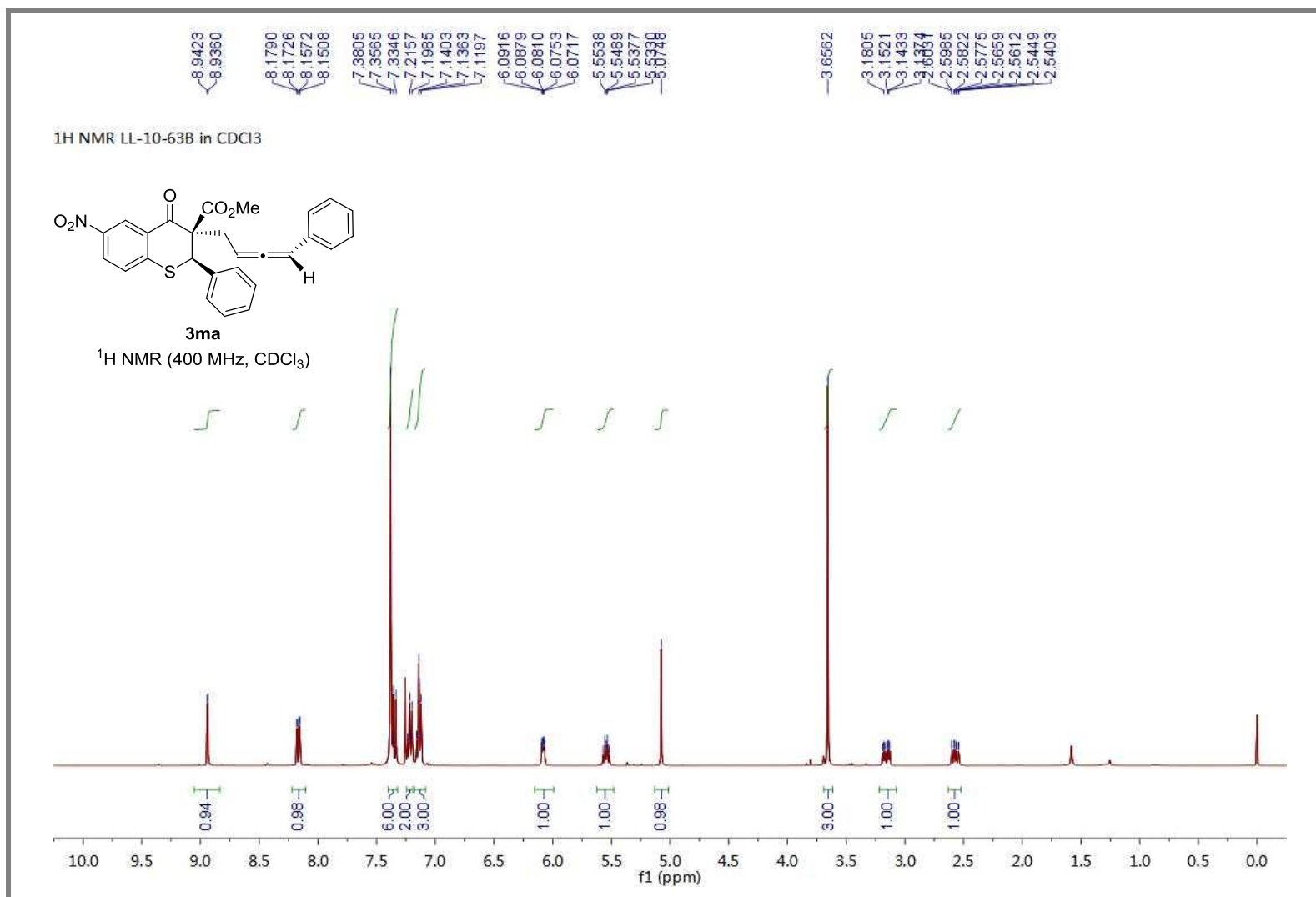


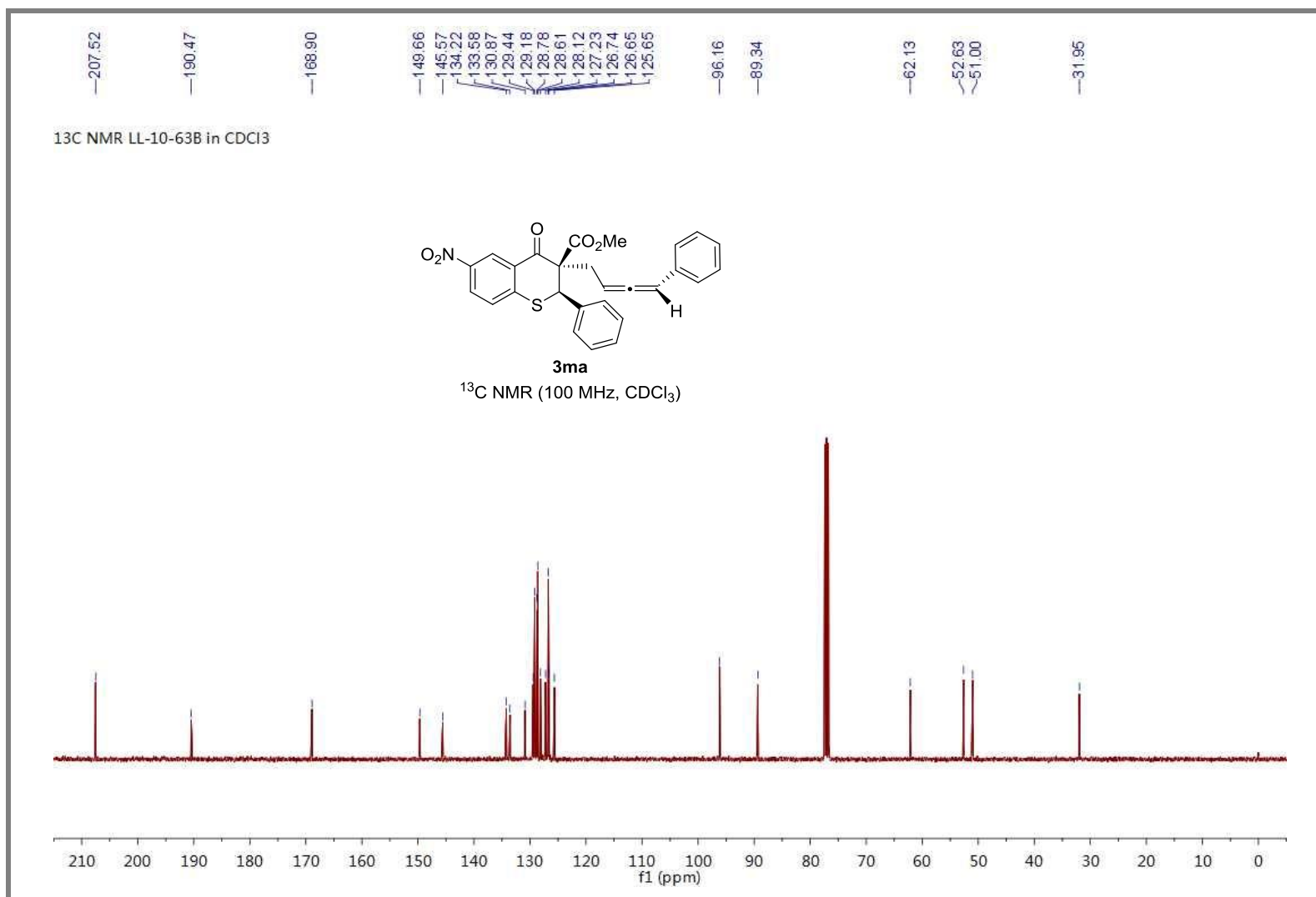


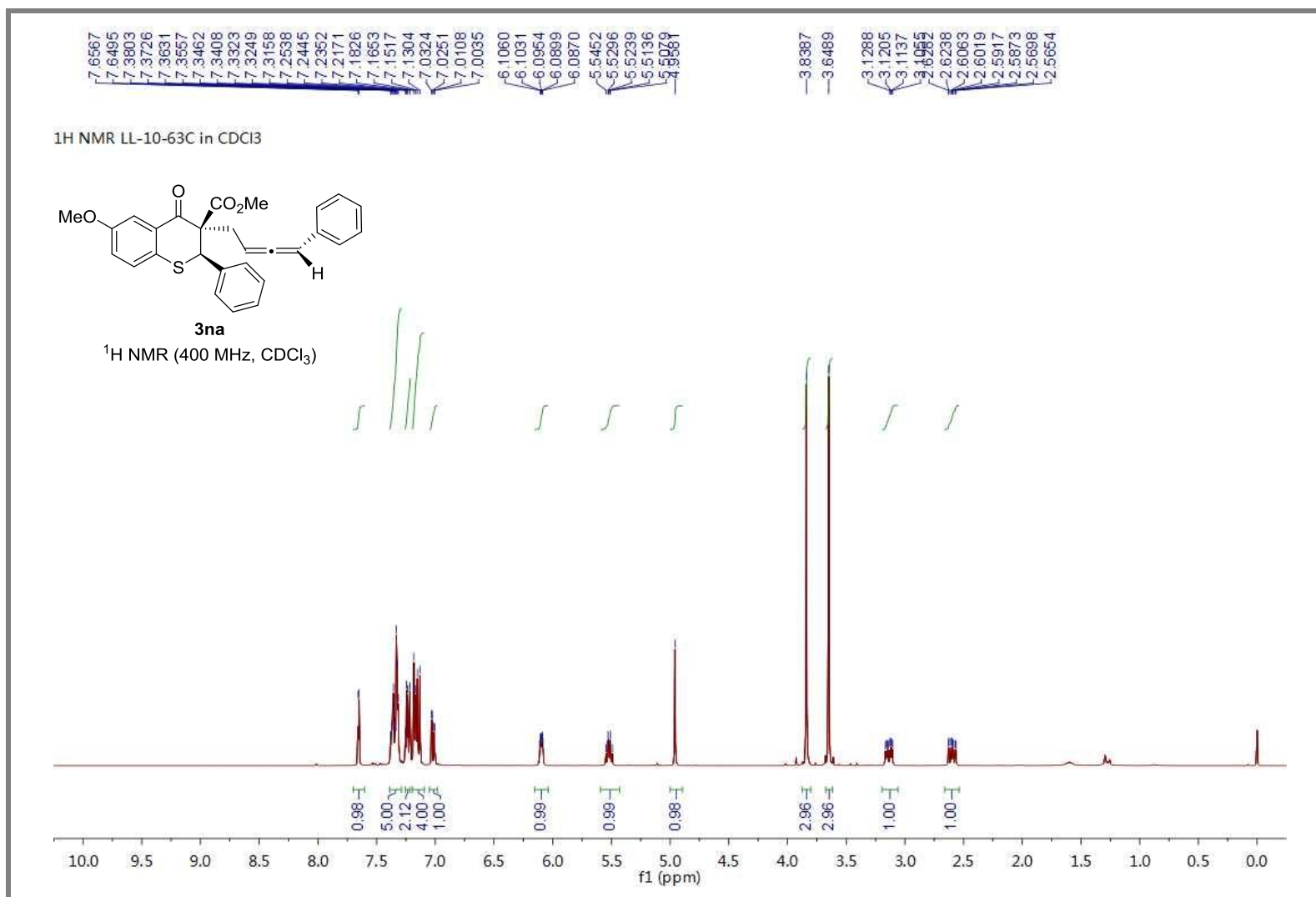


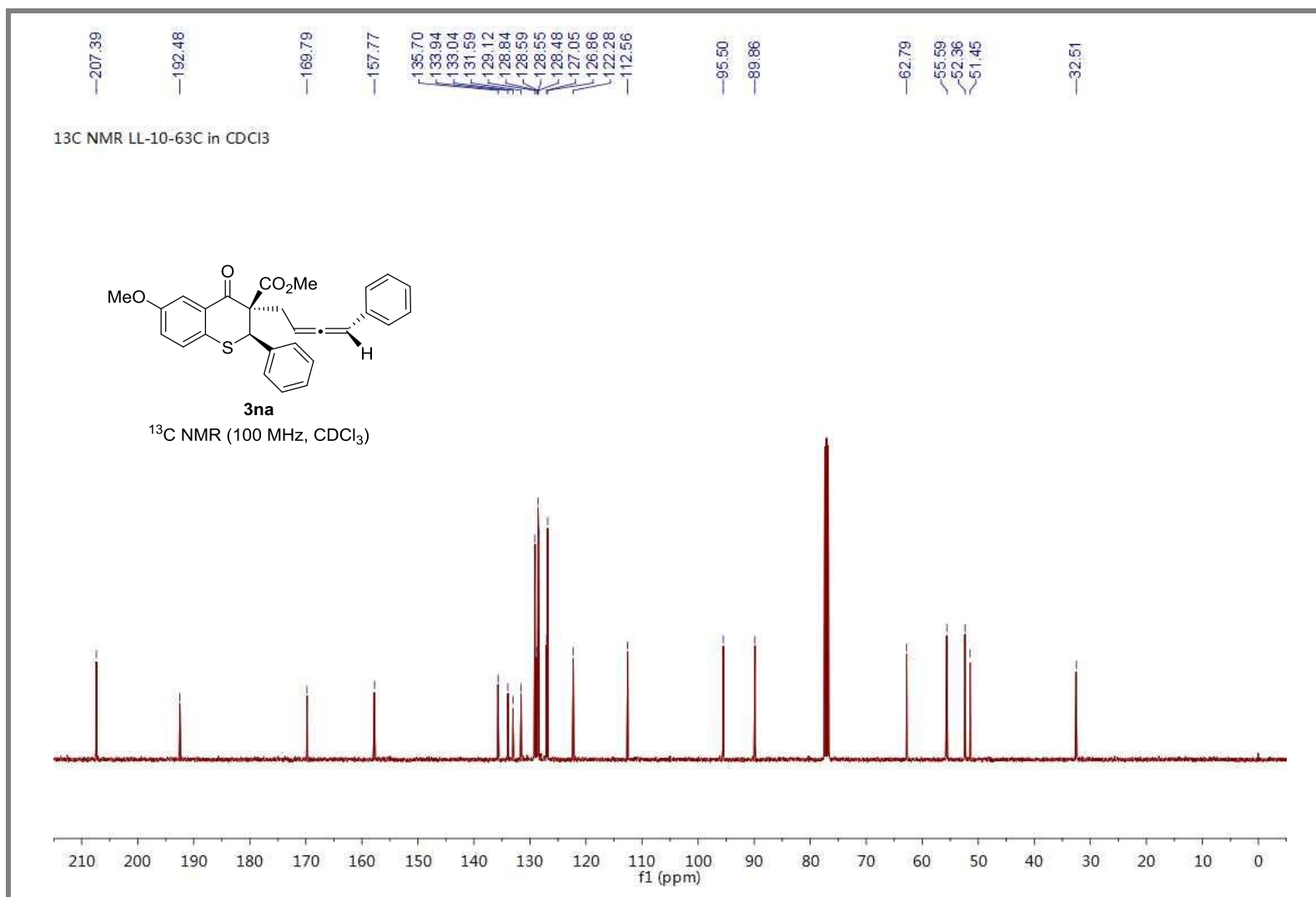


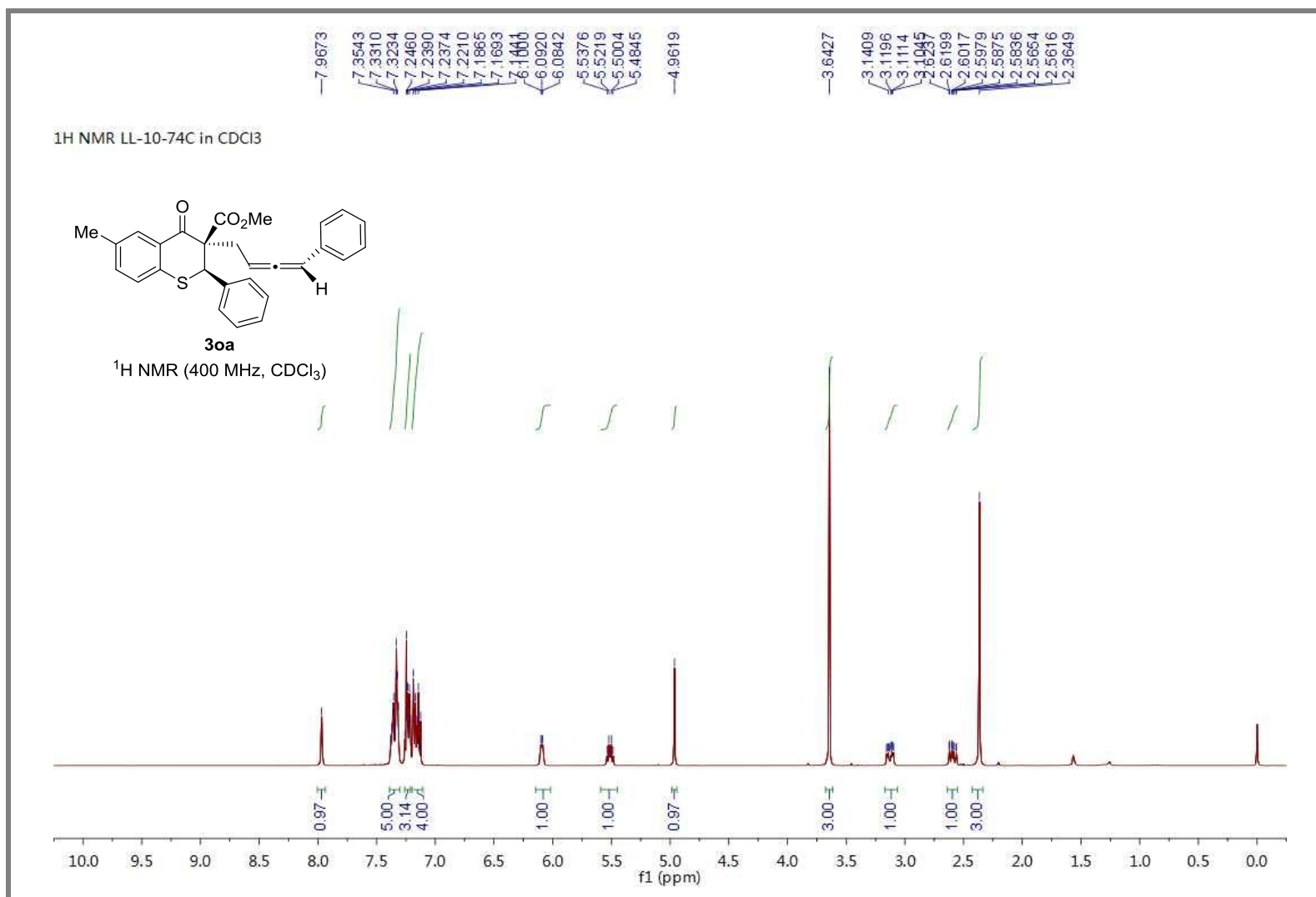


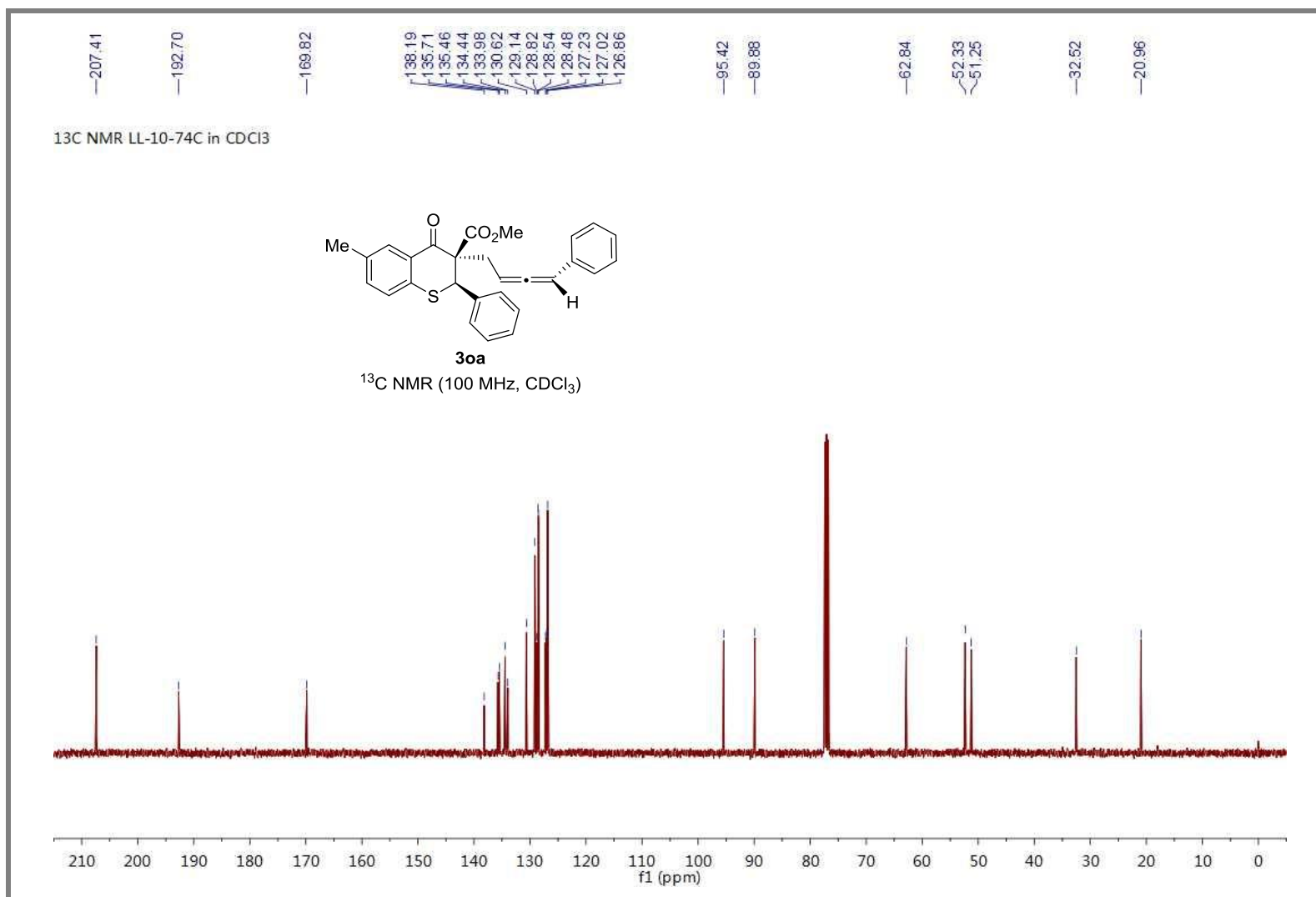


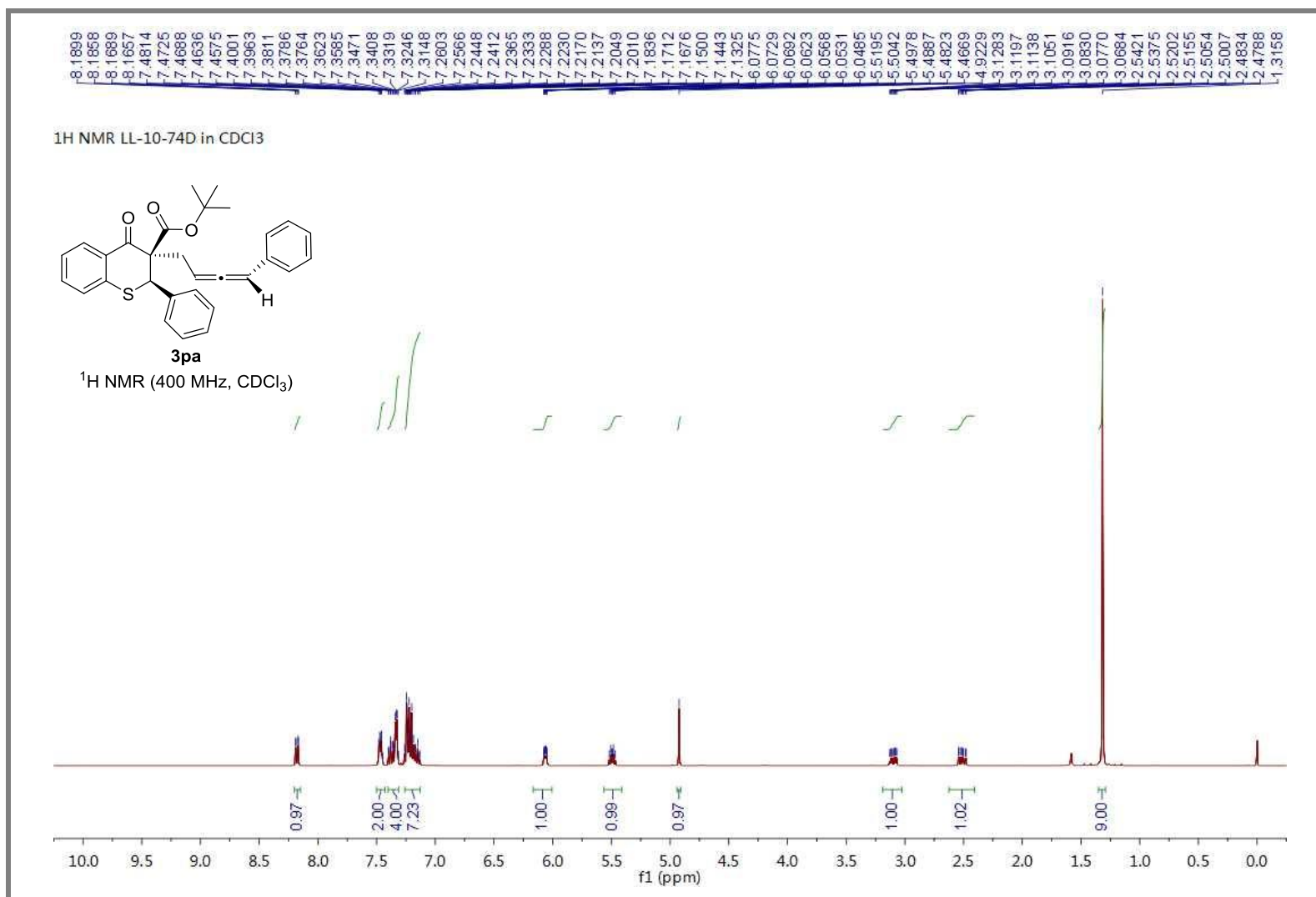


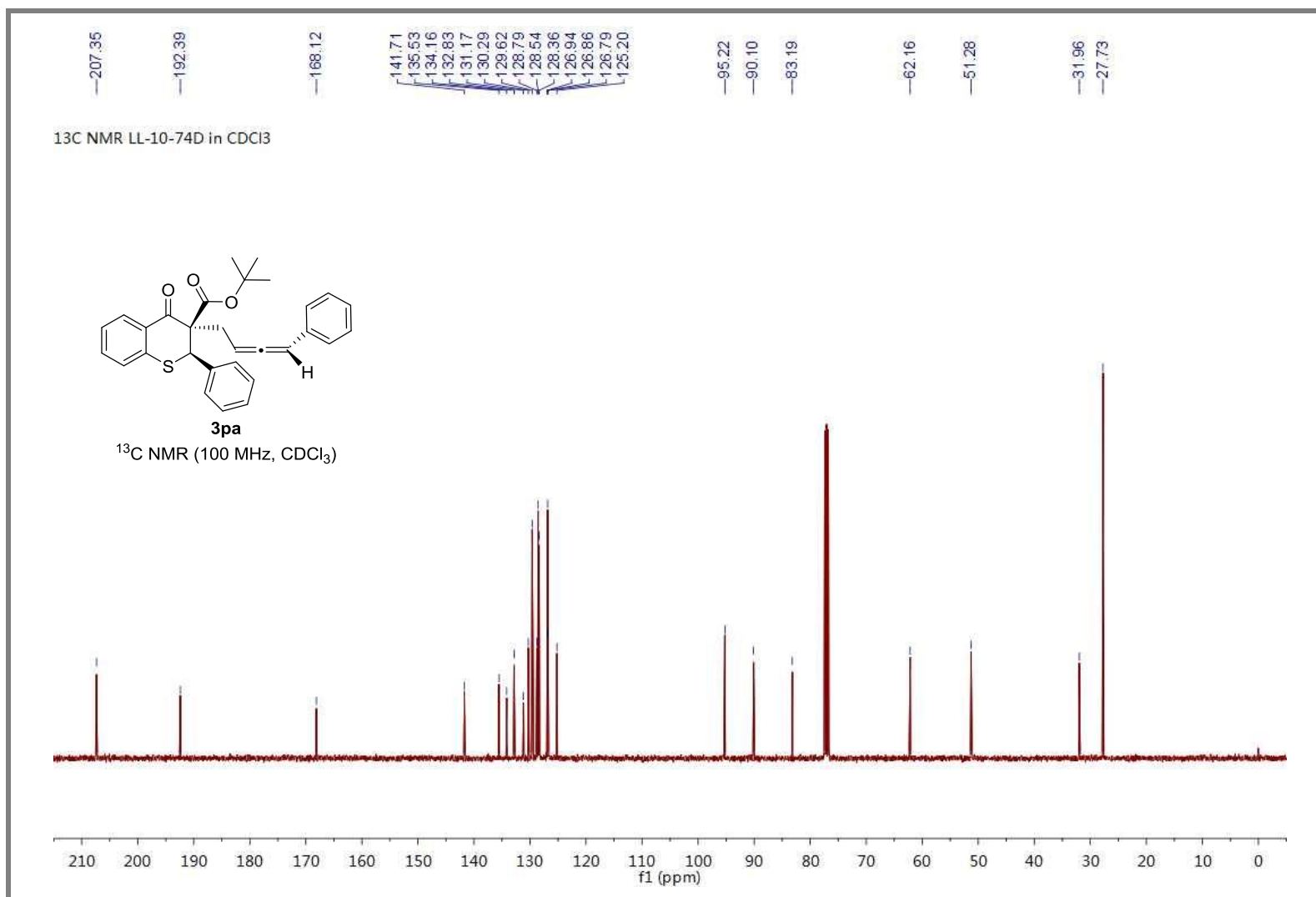


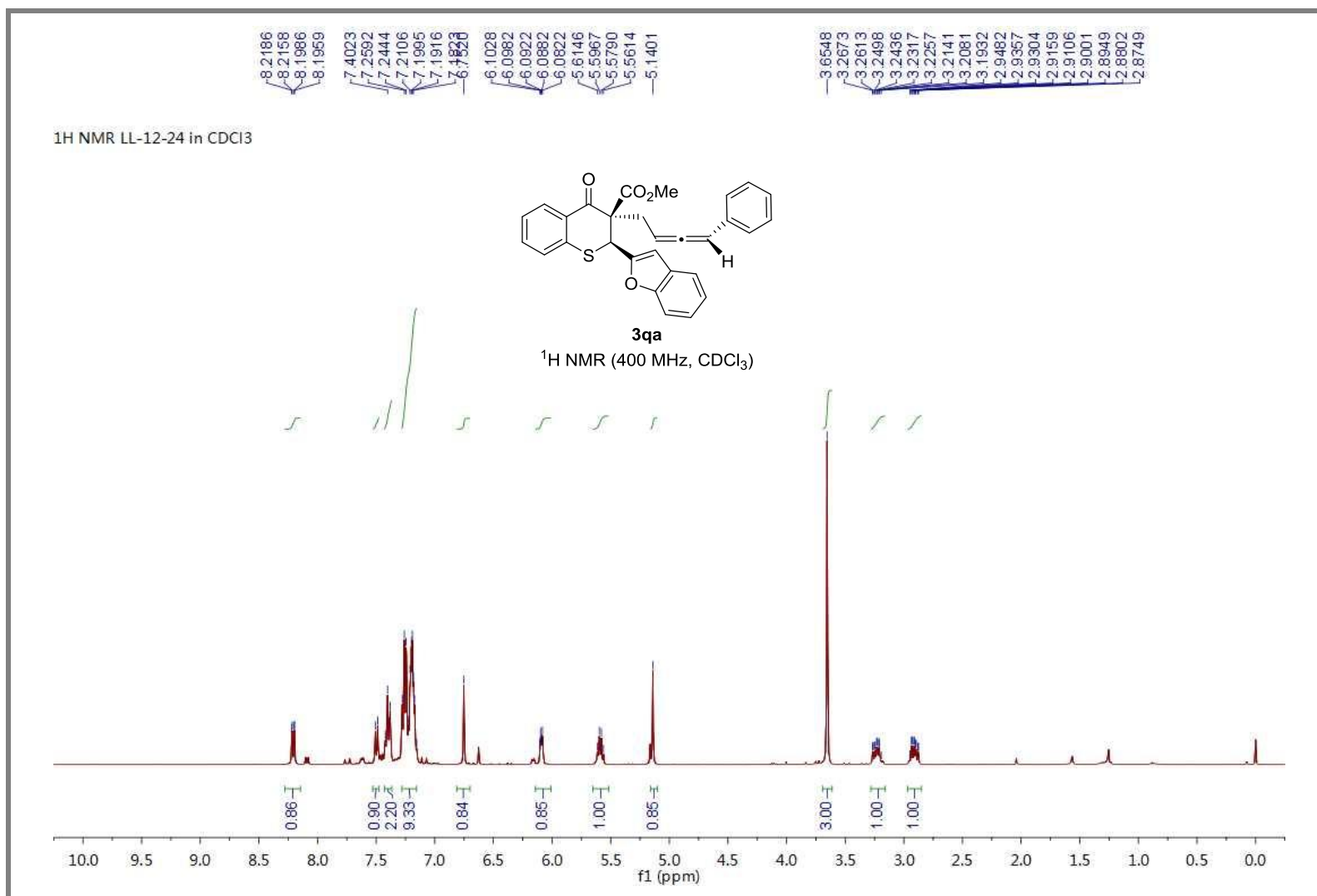


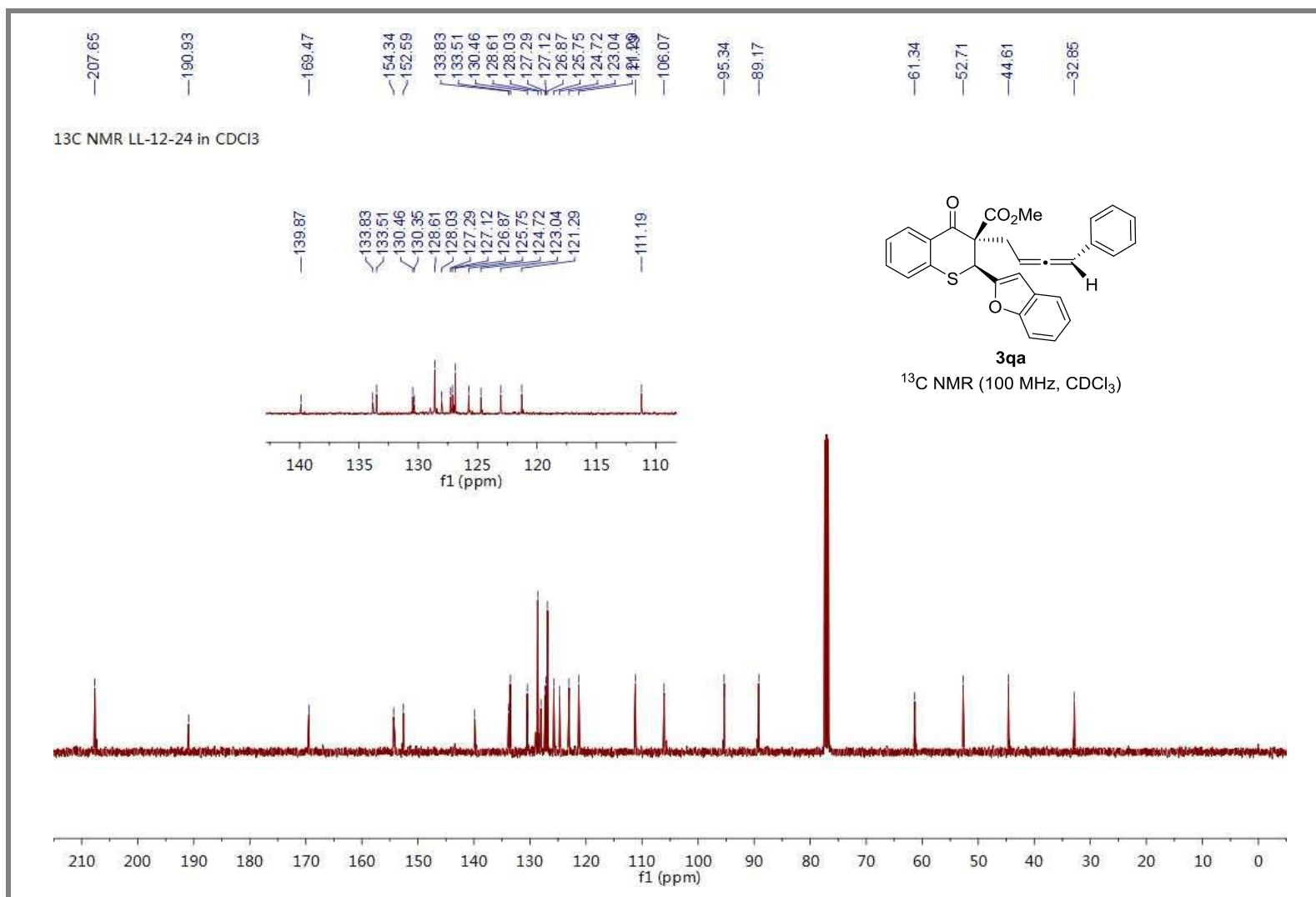


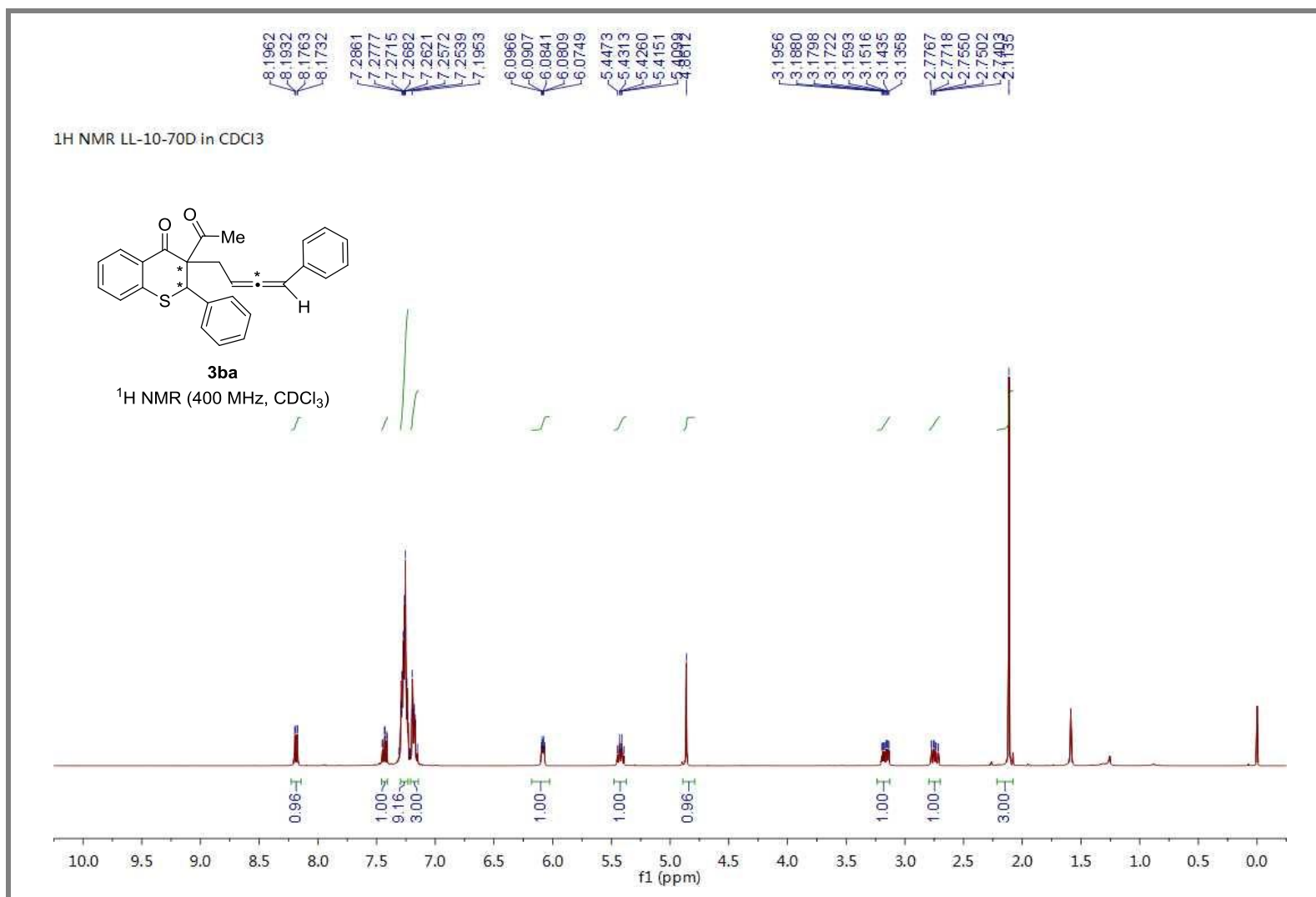


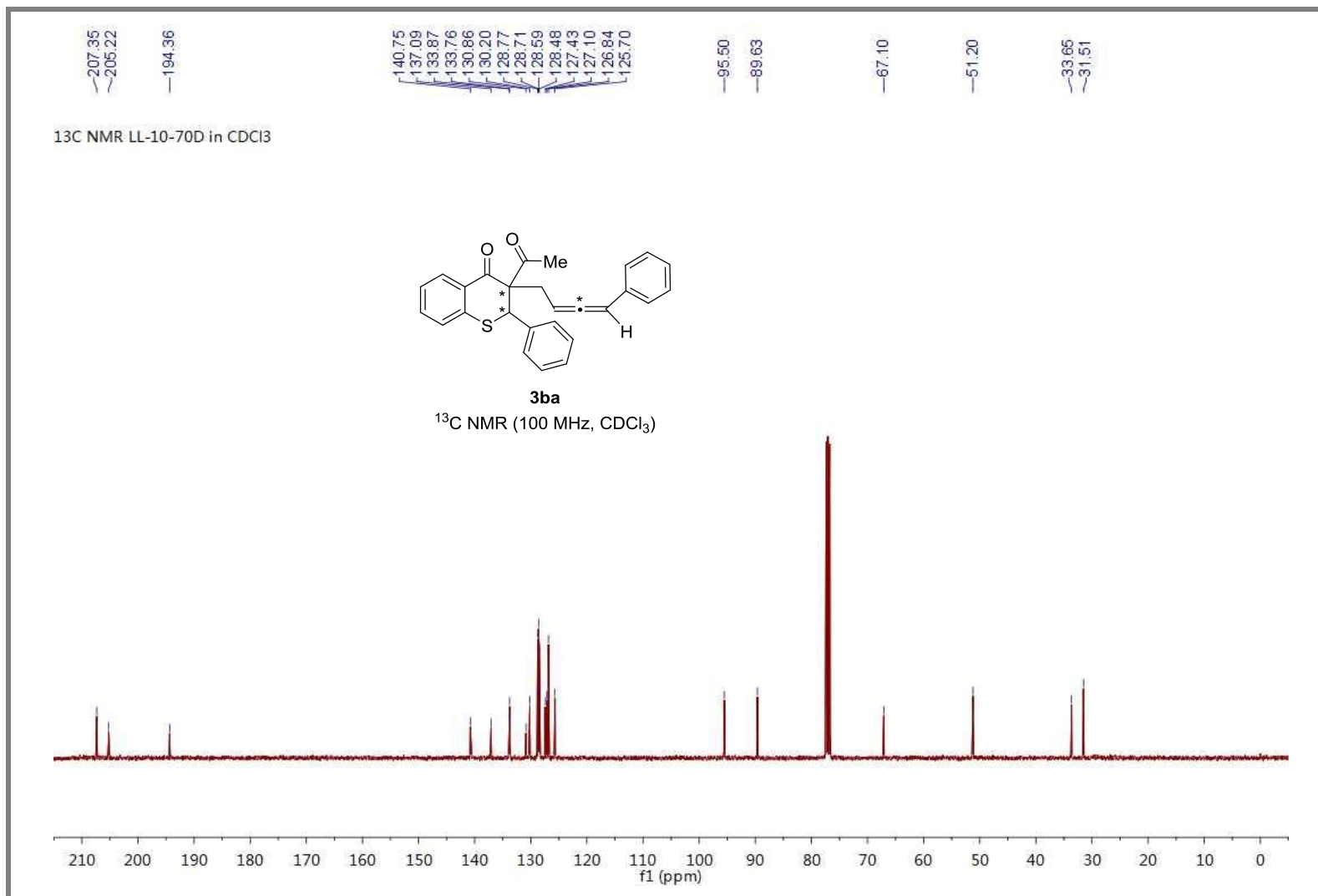


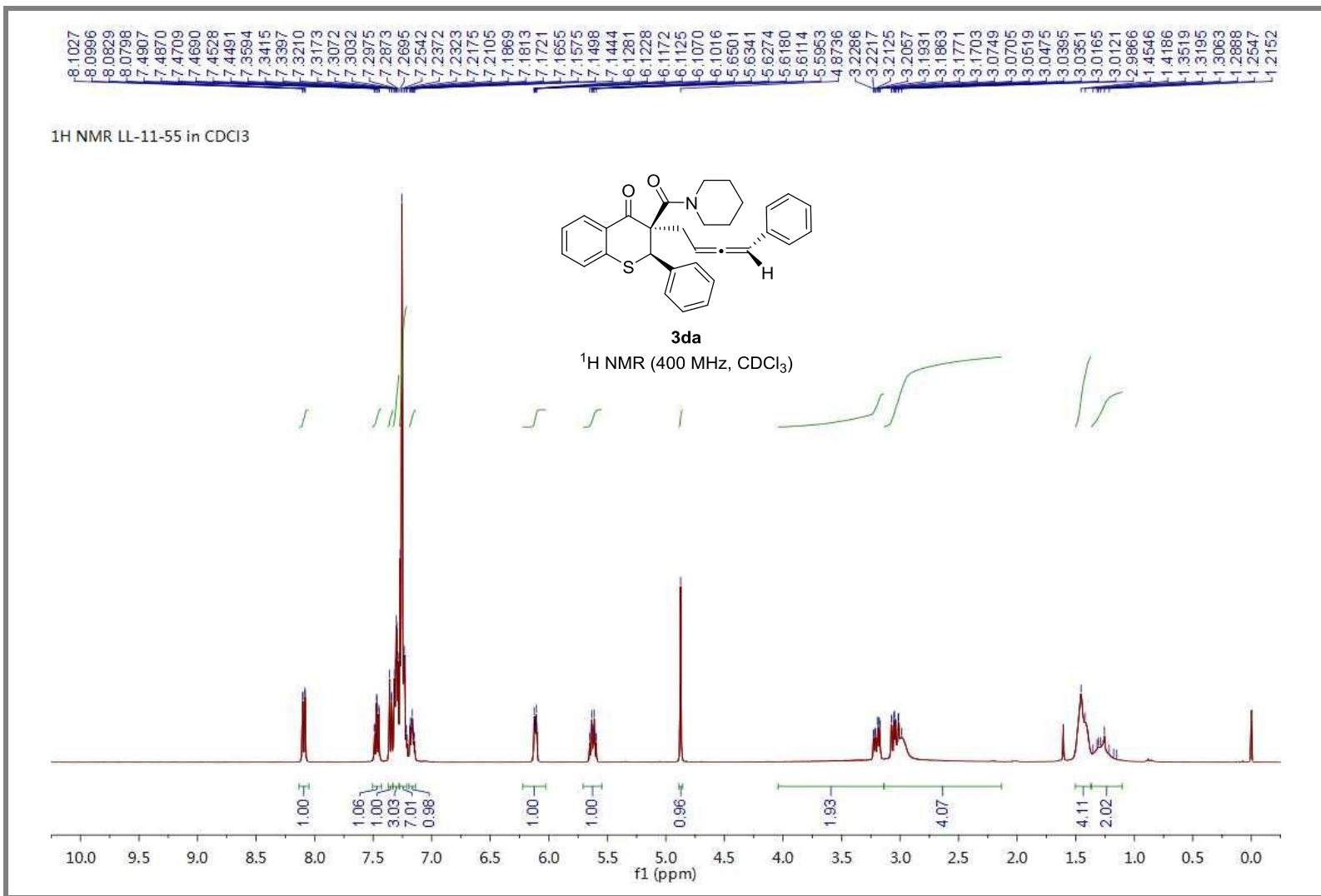


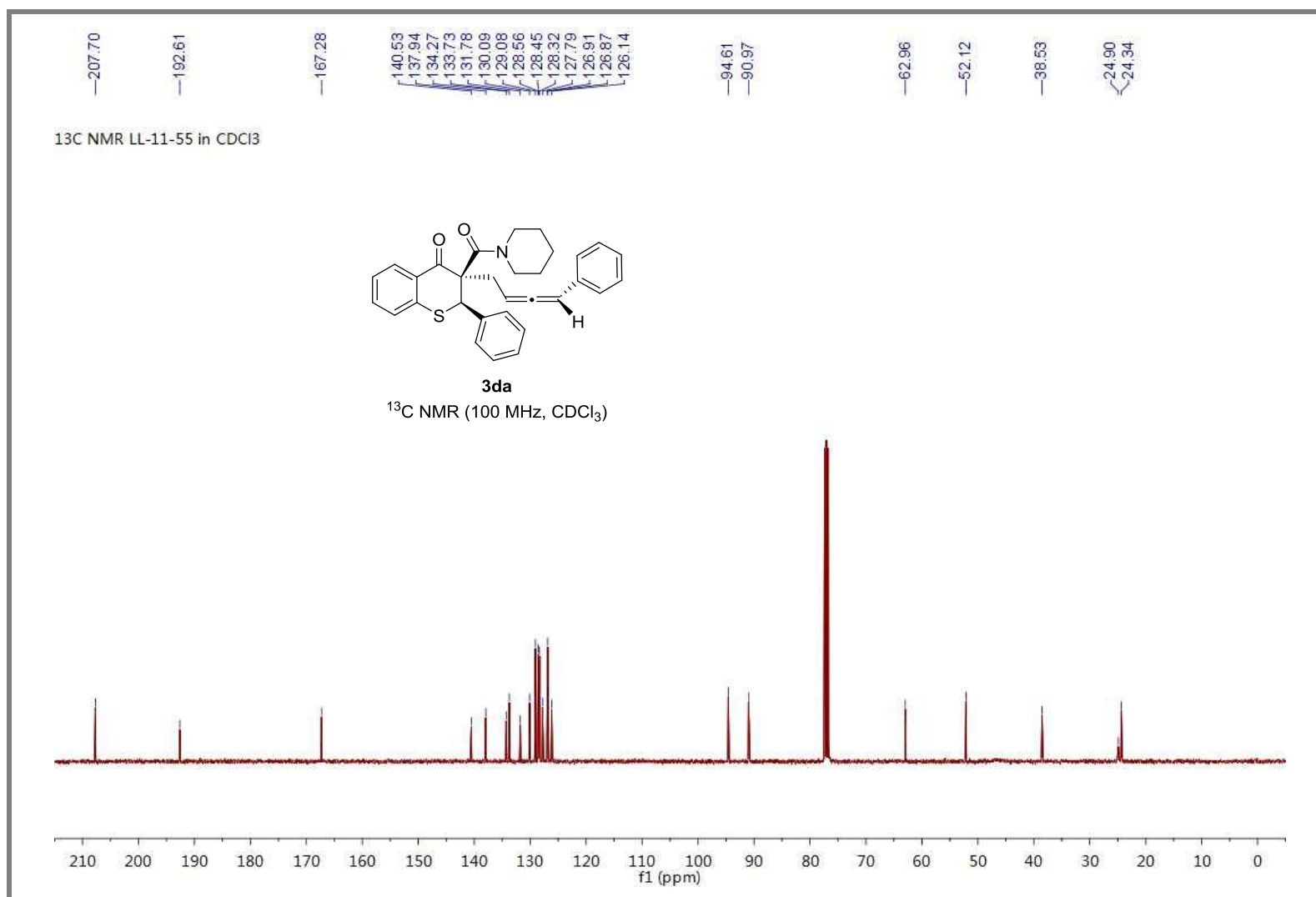


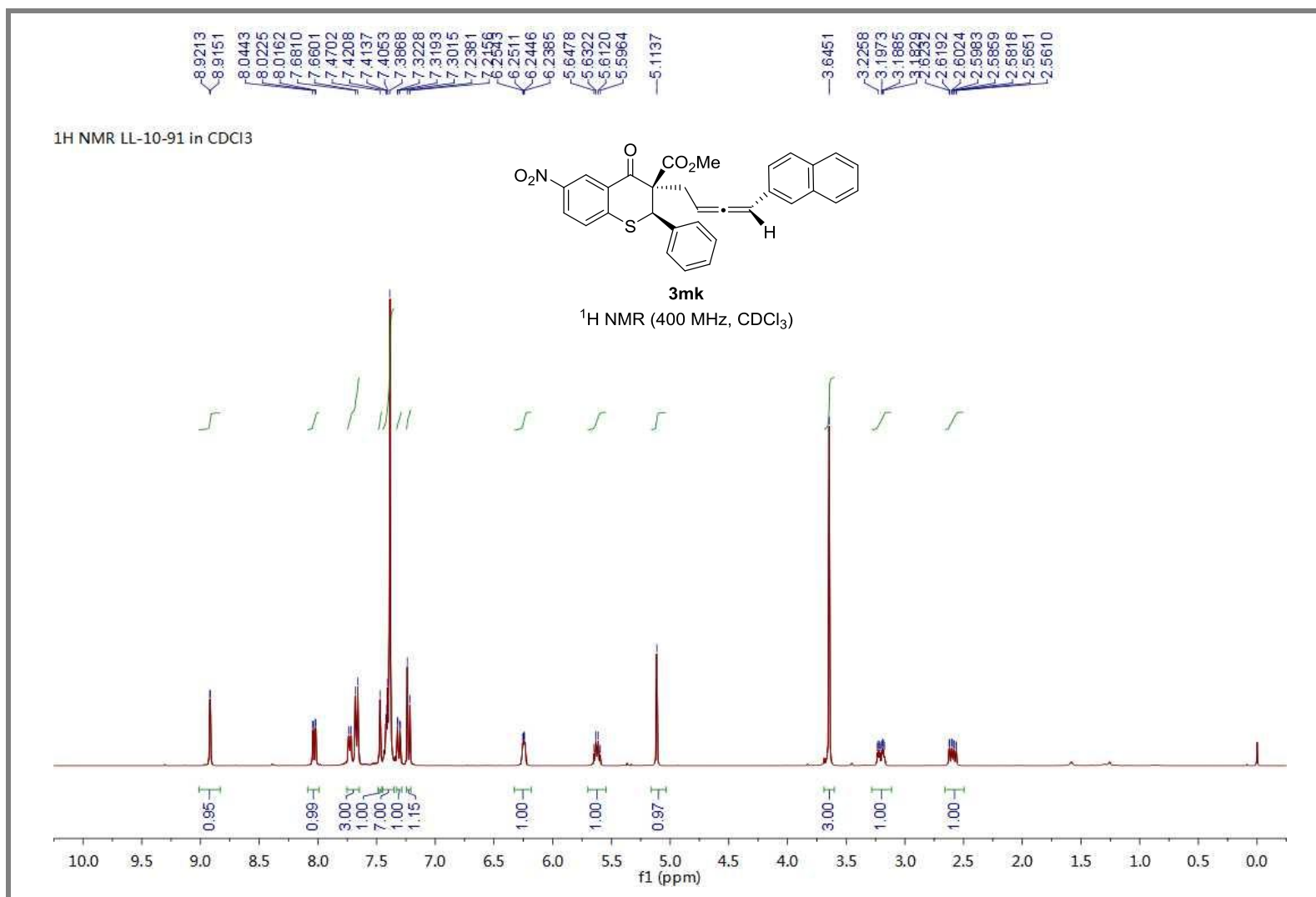


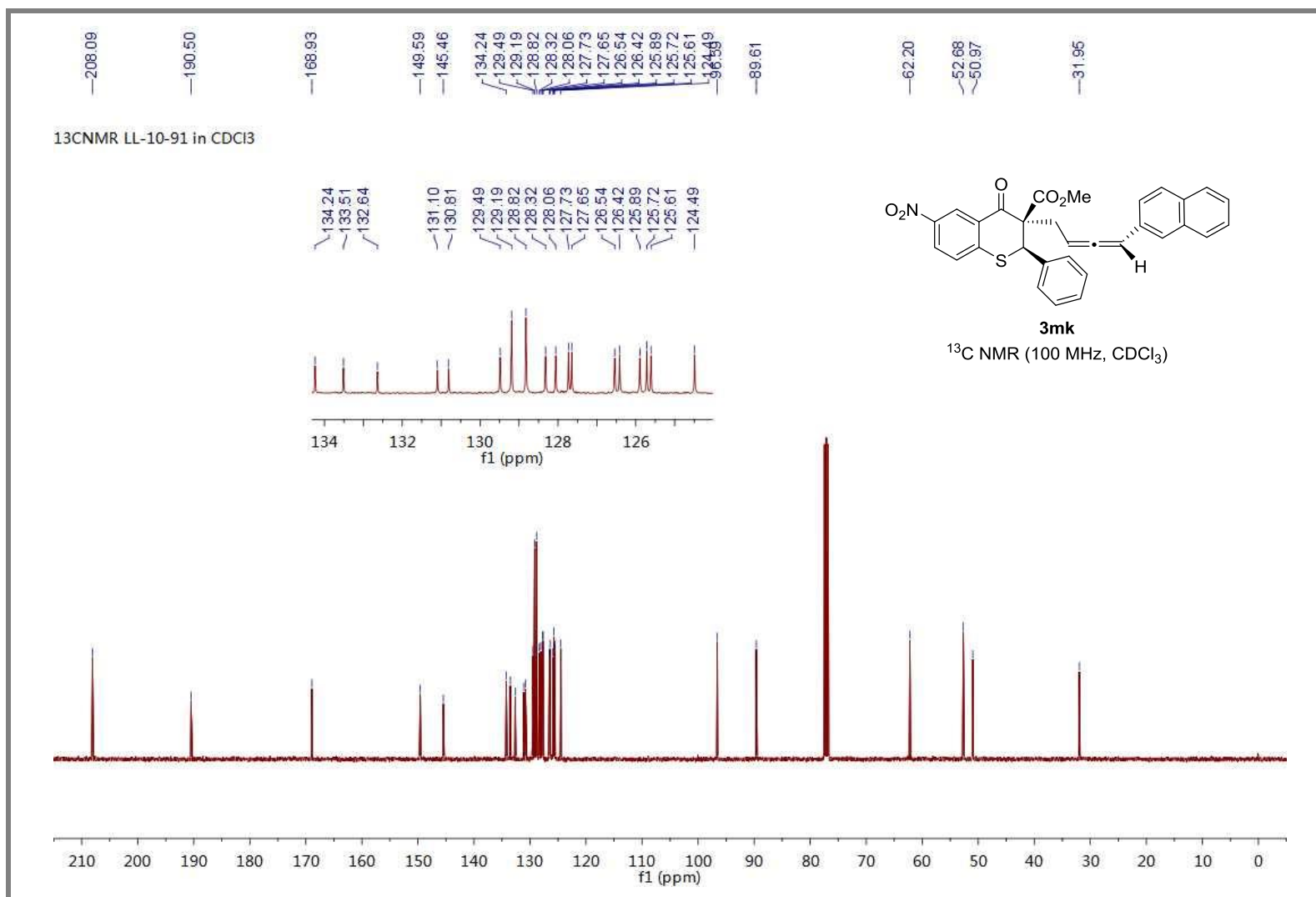


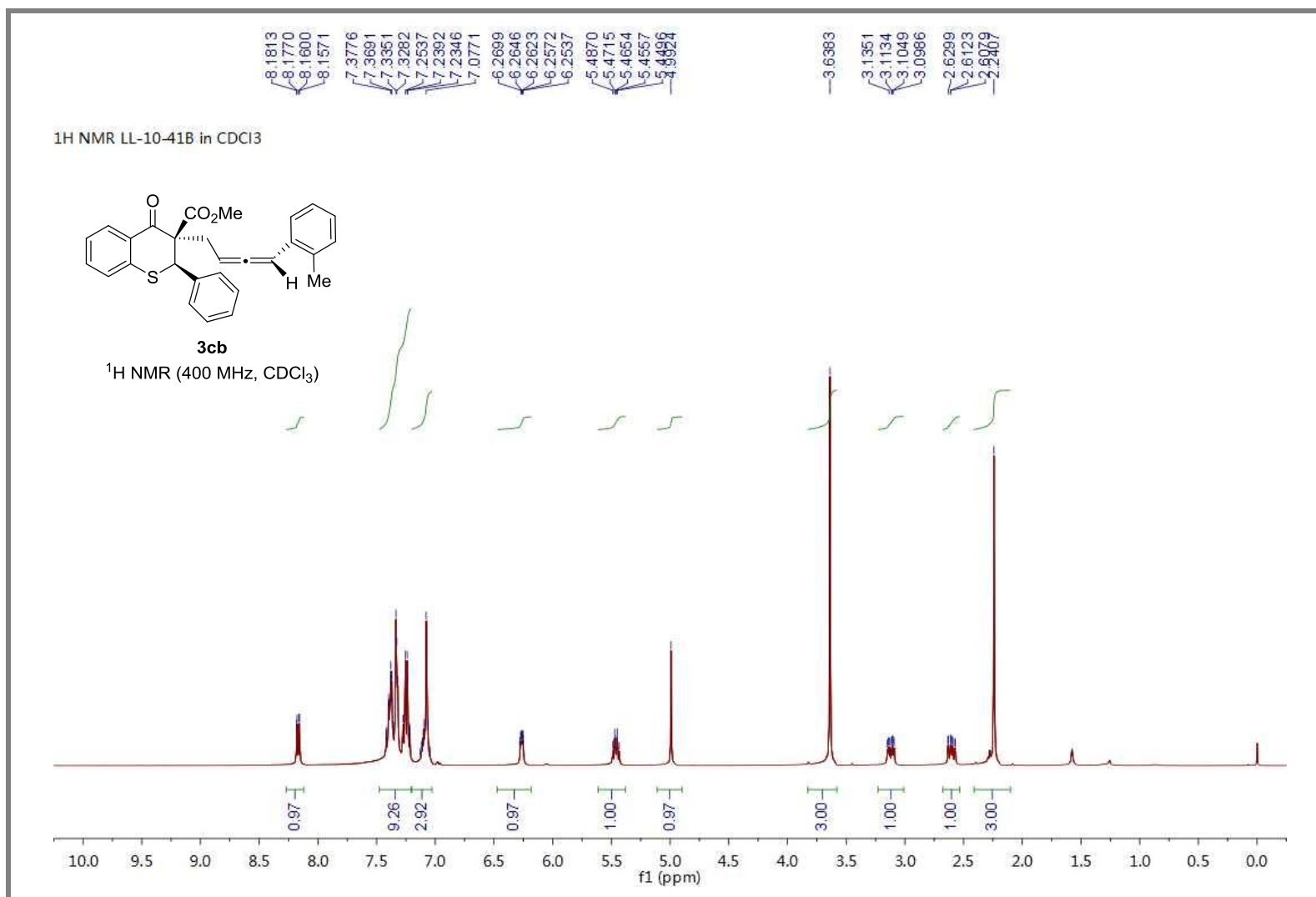


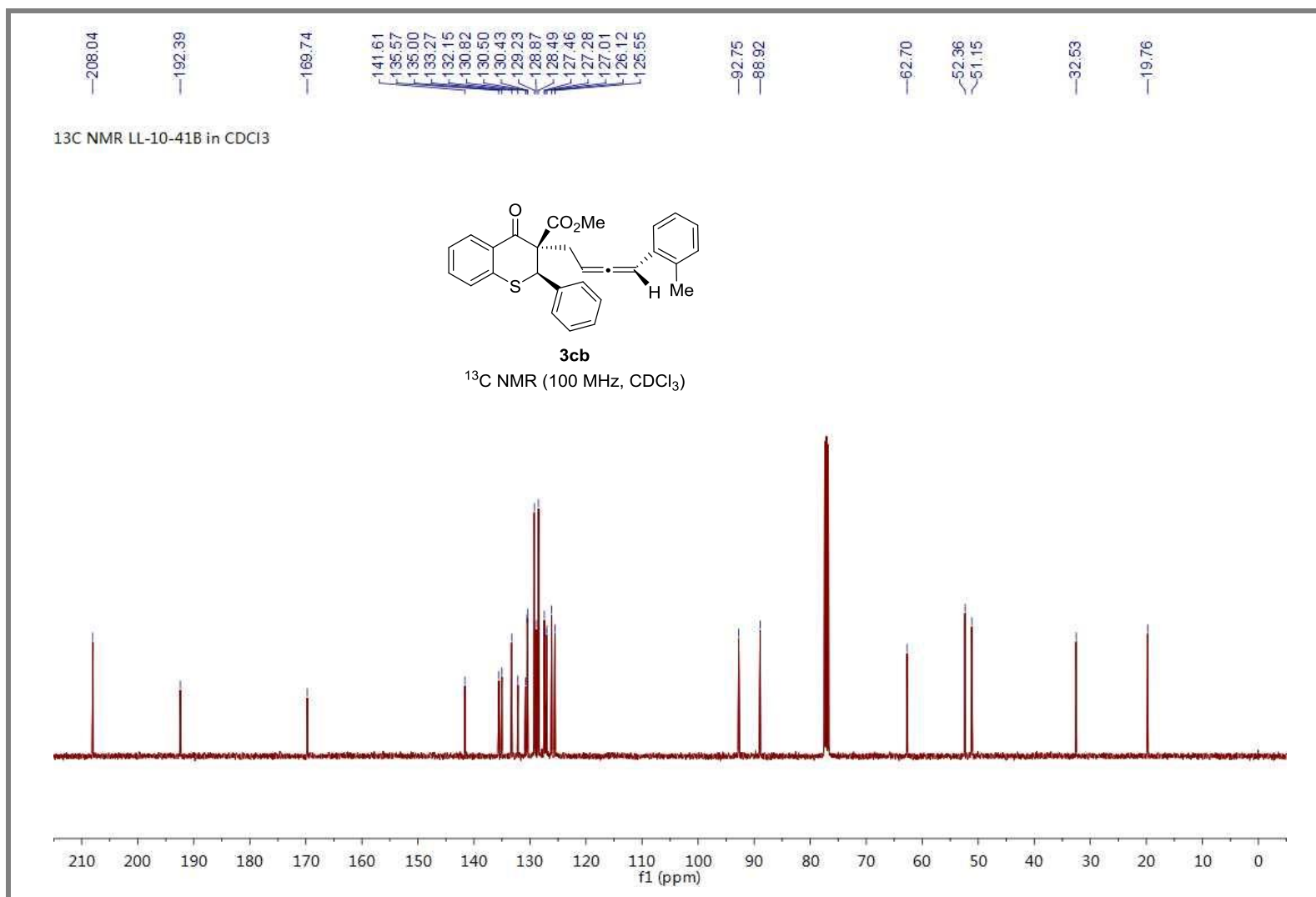


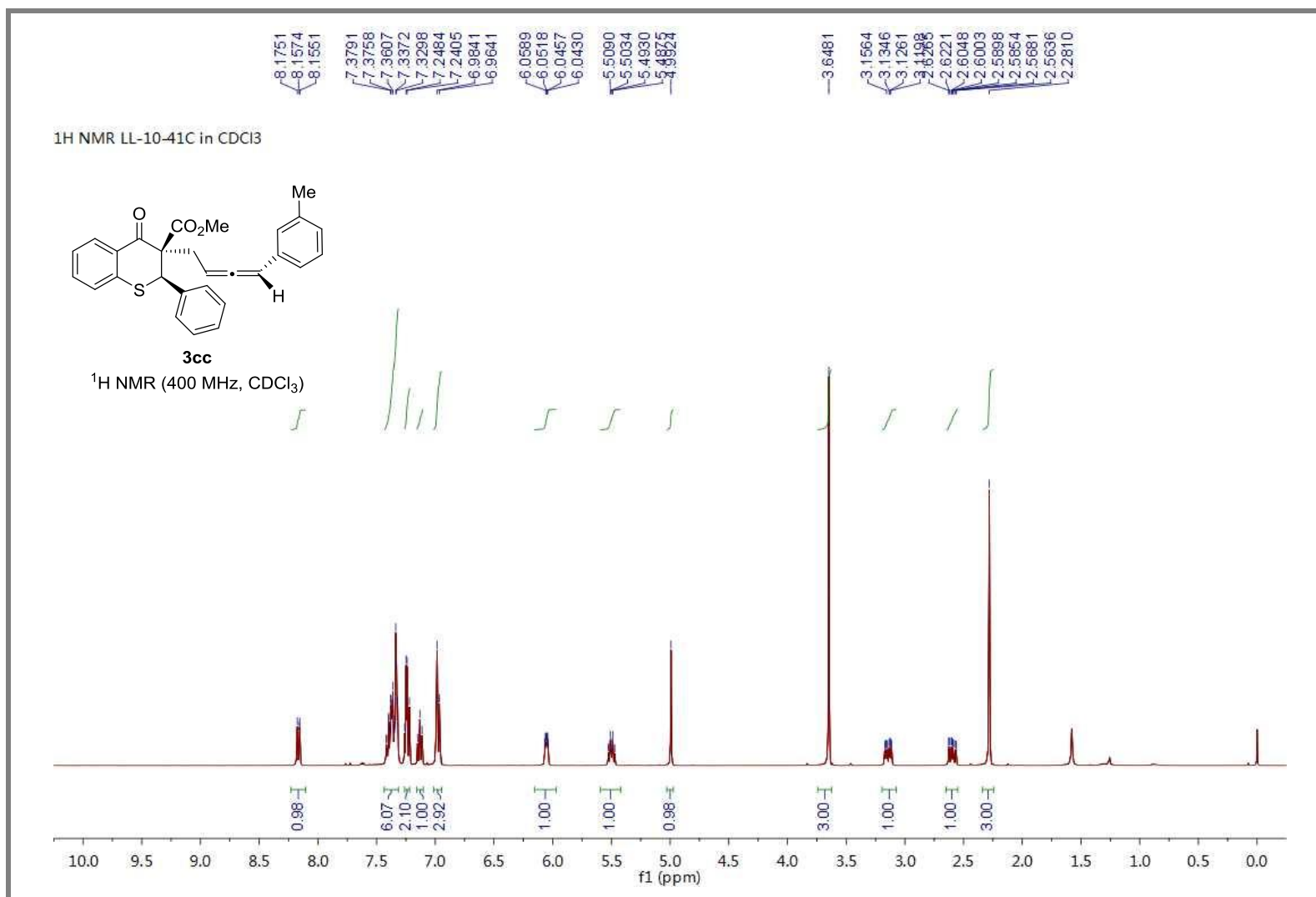


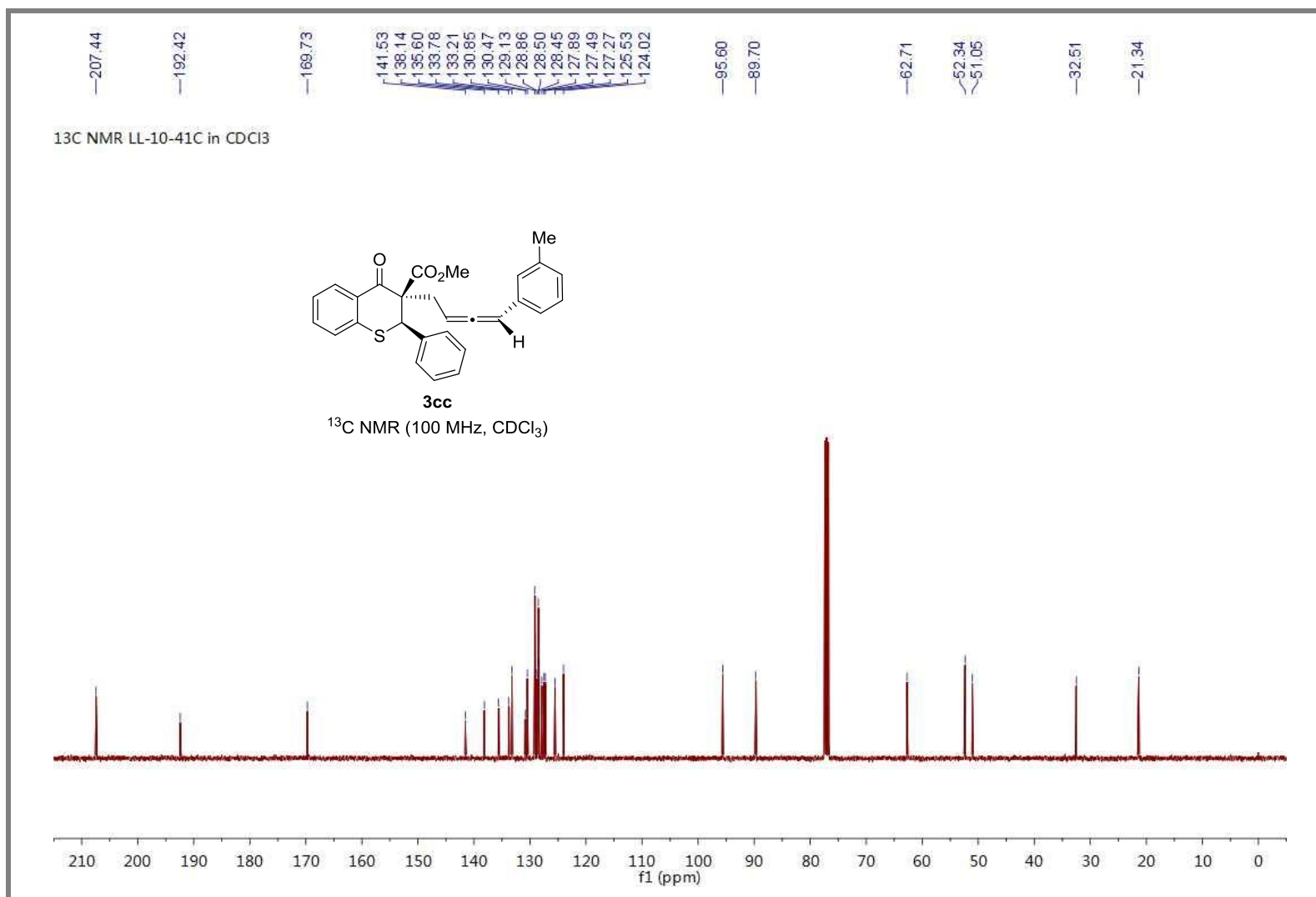


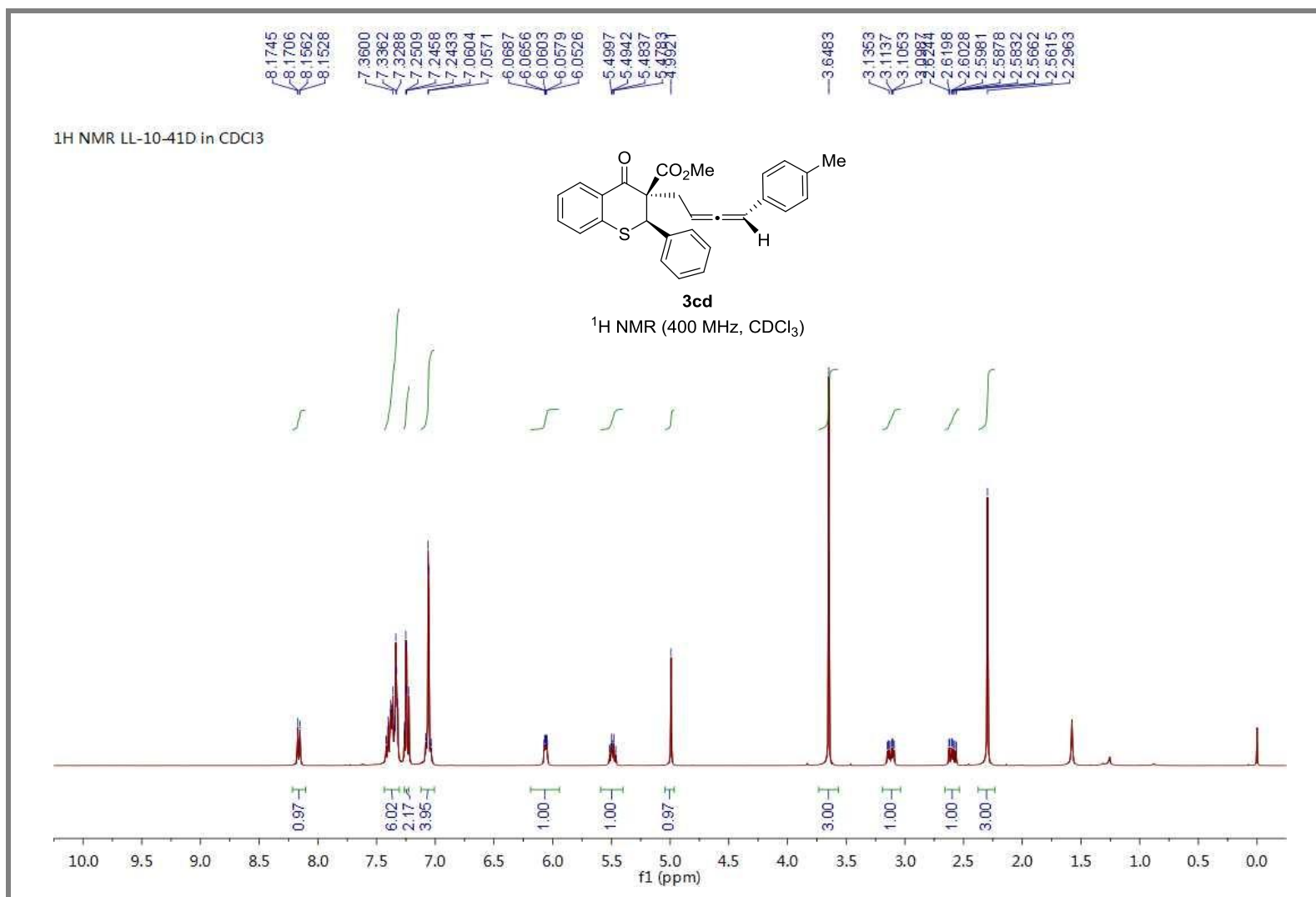


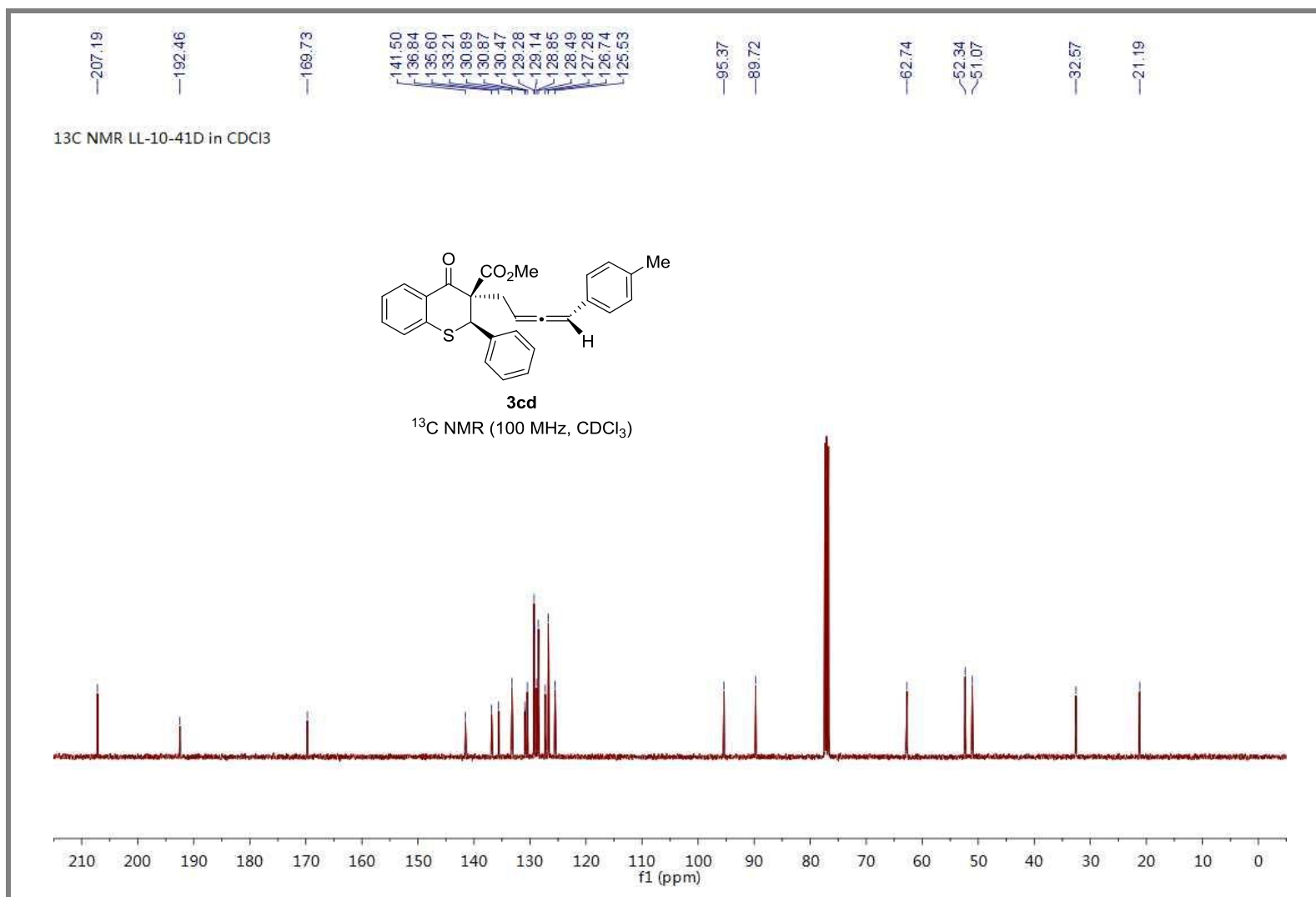


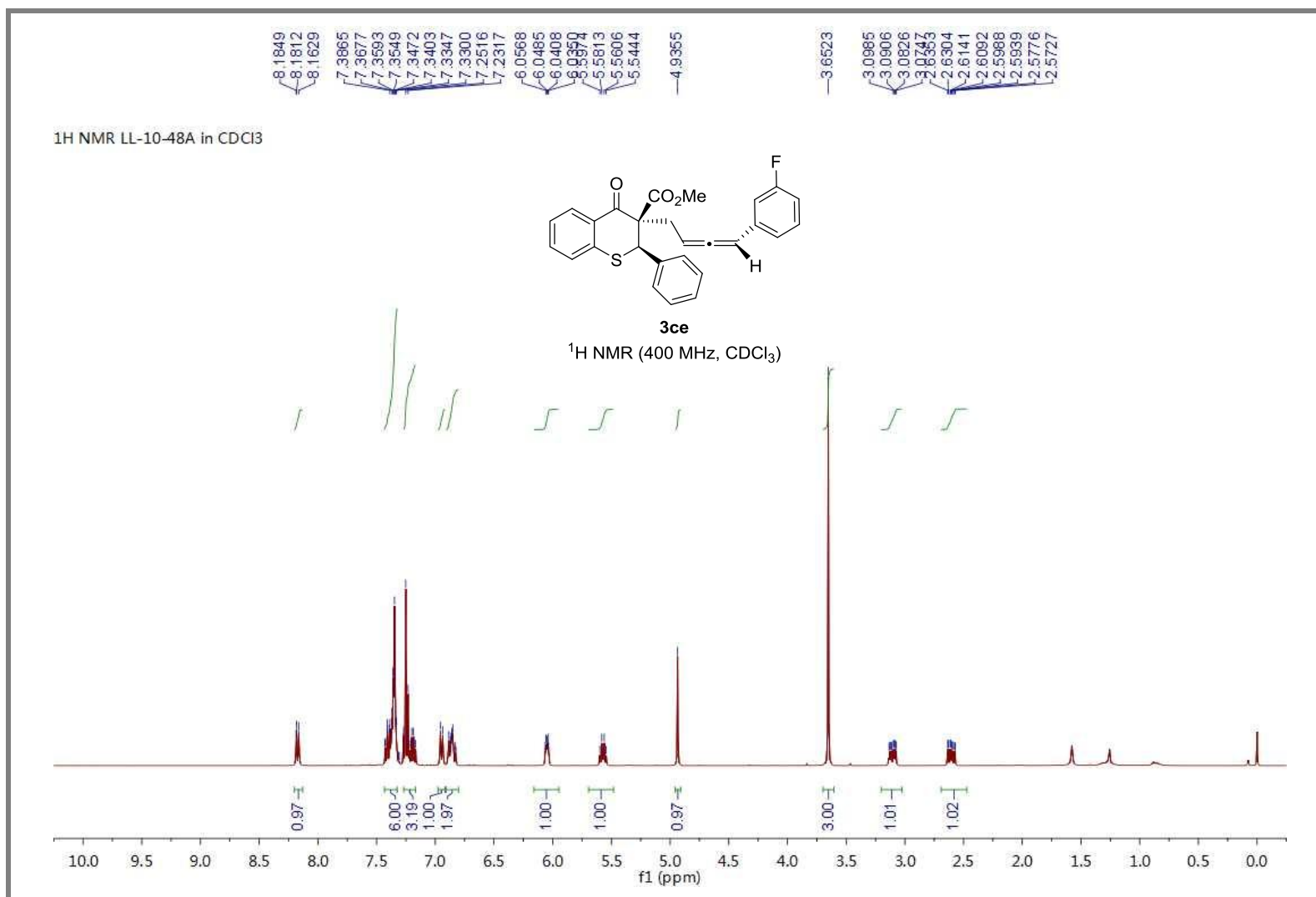


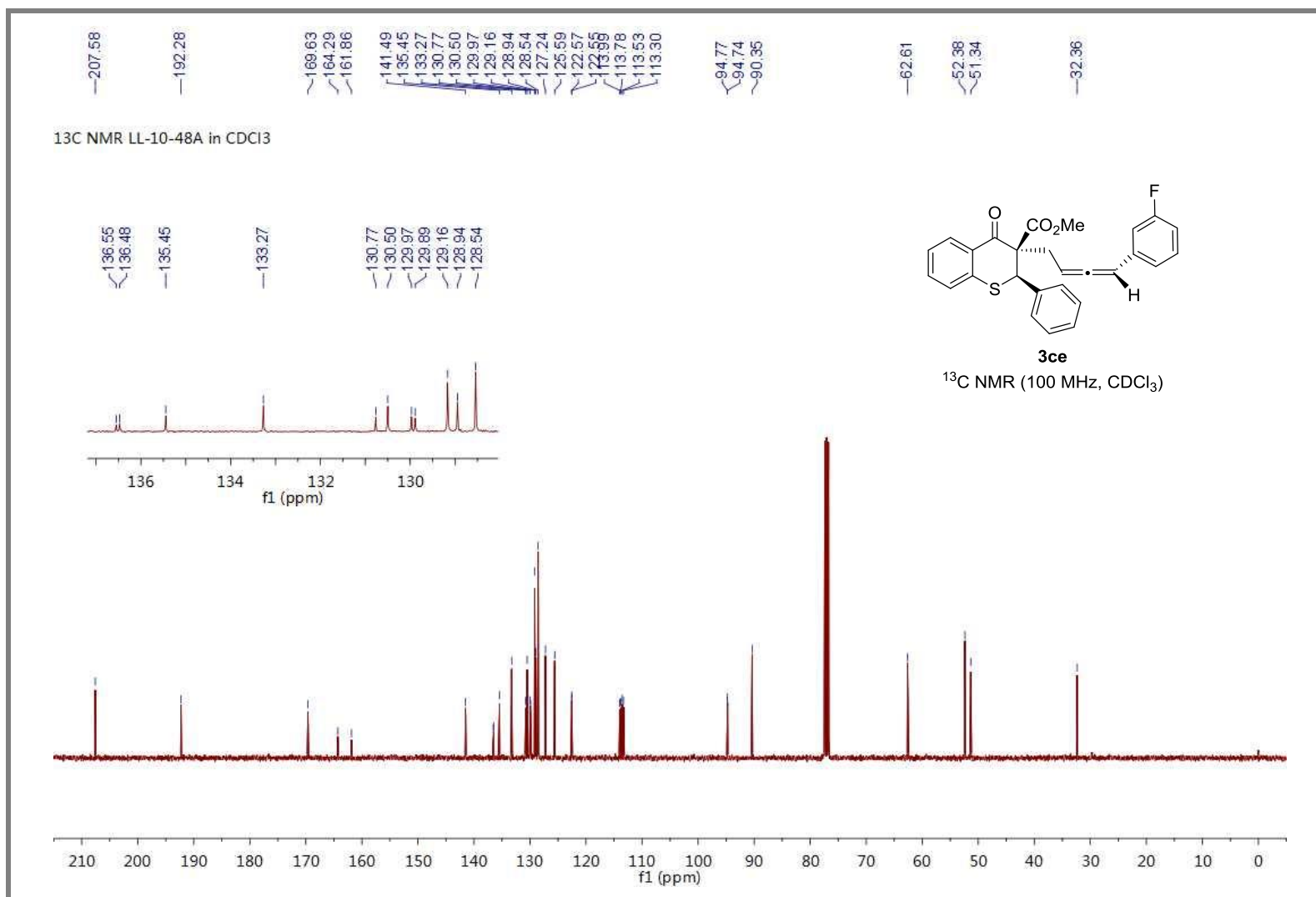




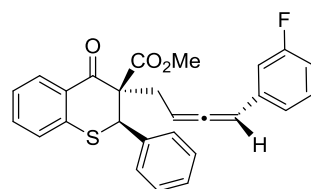






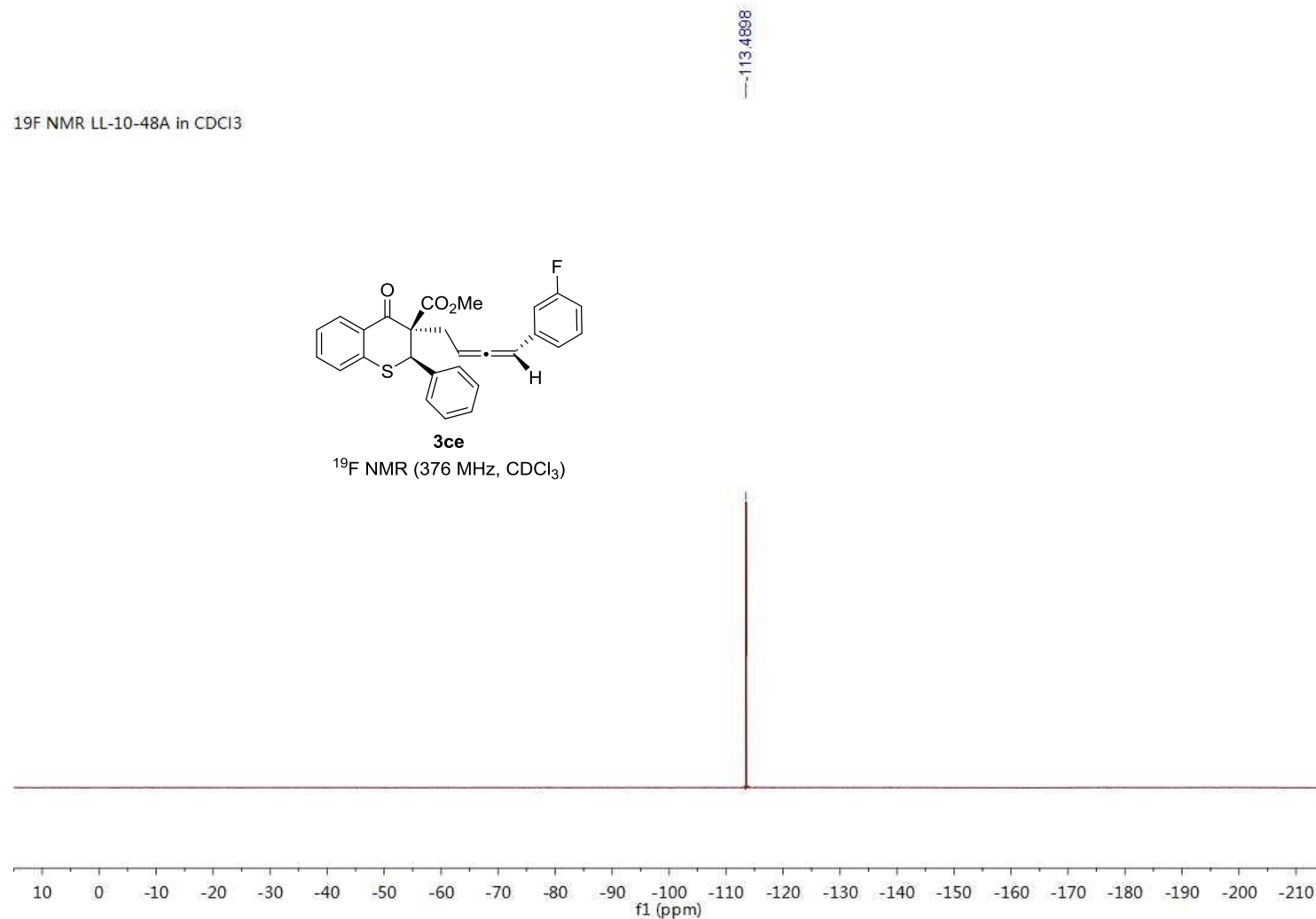


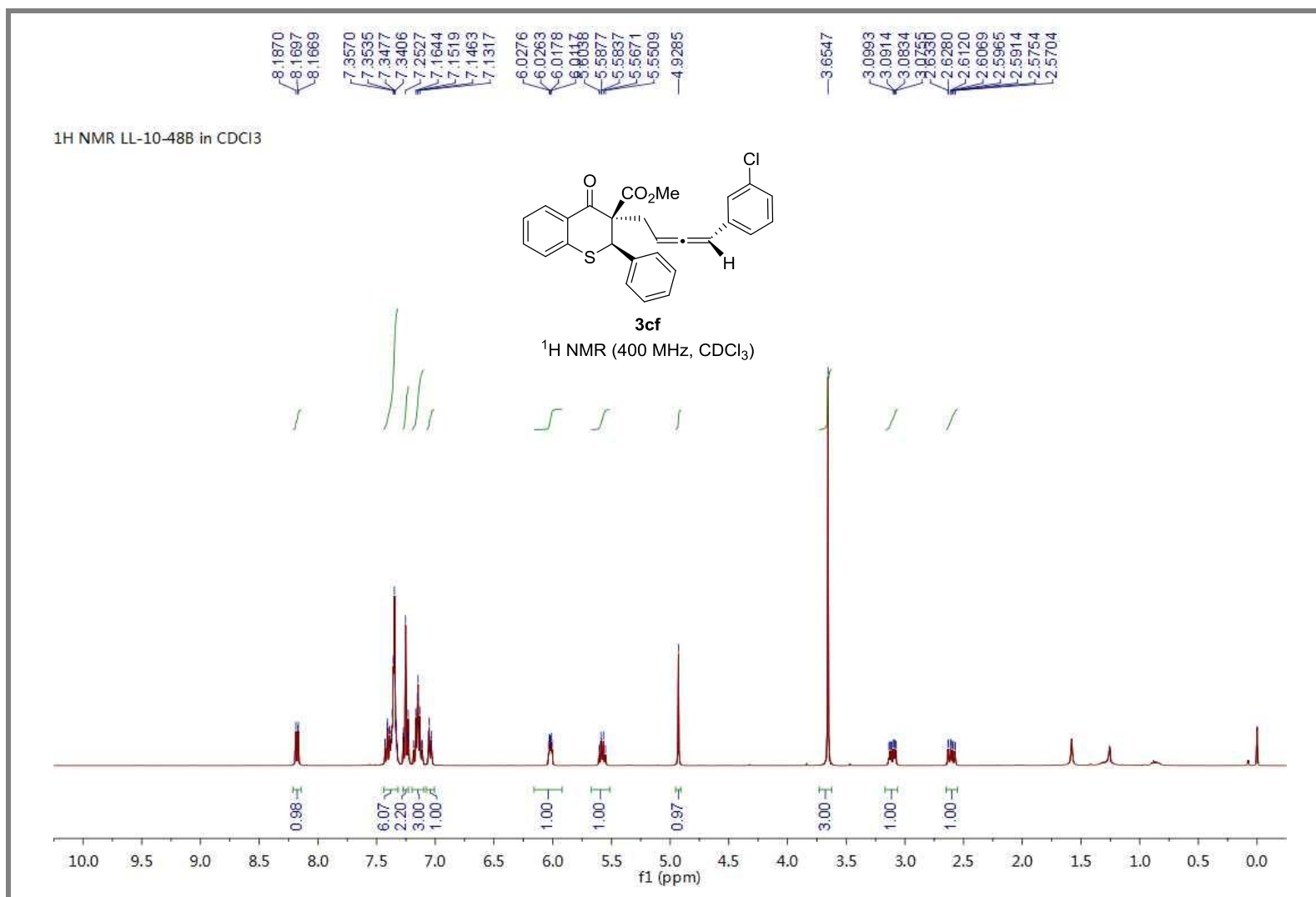
¹⁹F NMR LL-10-48A in CDCl₃

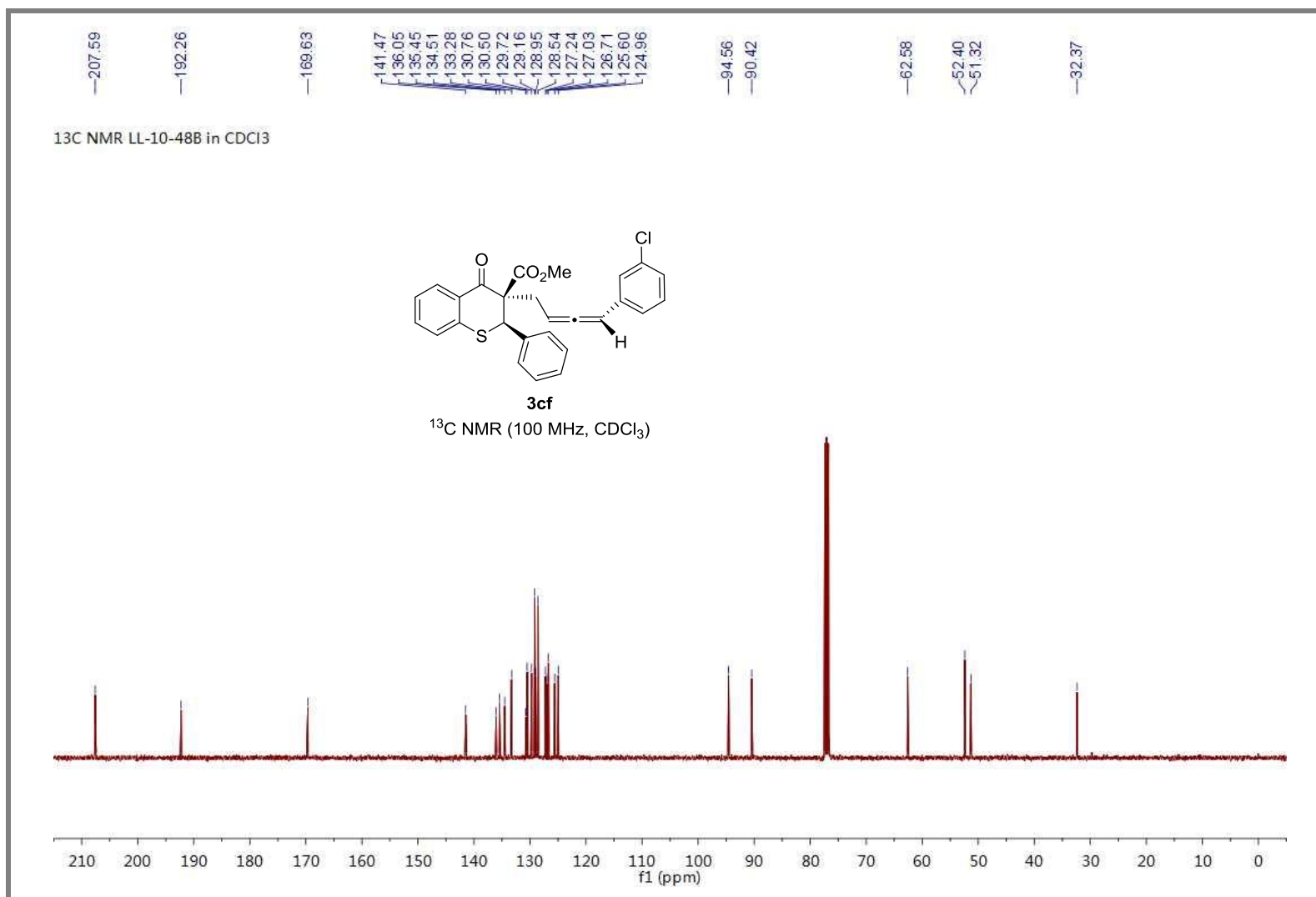


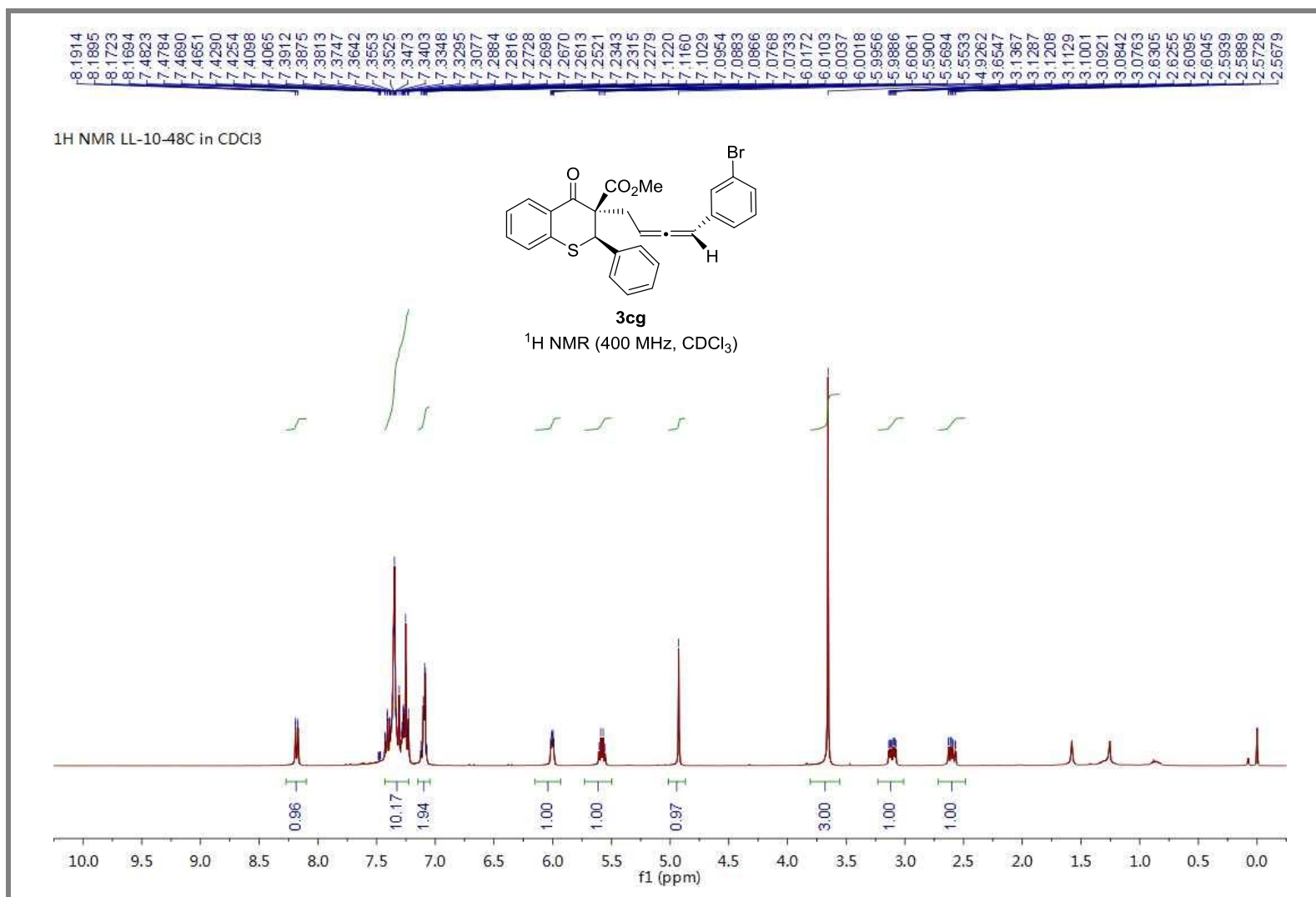
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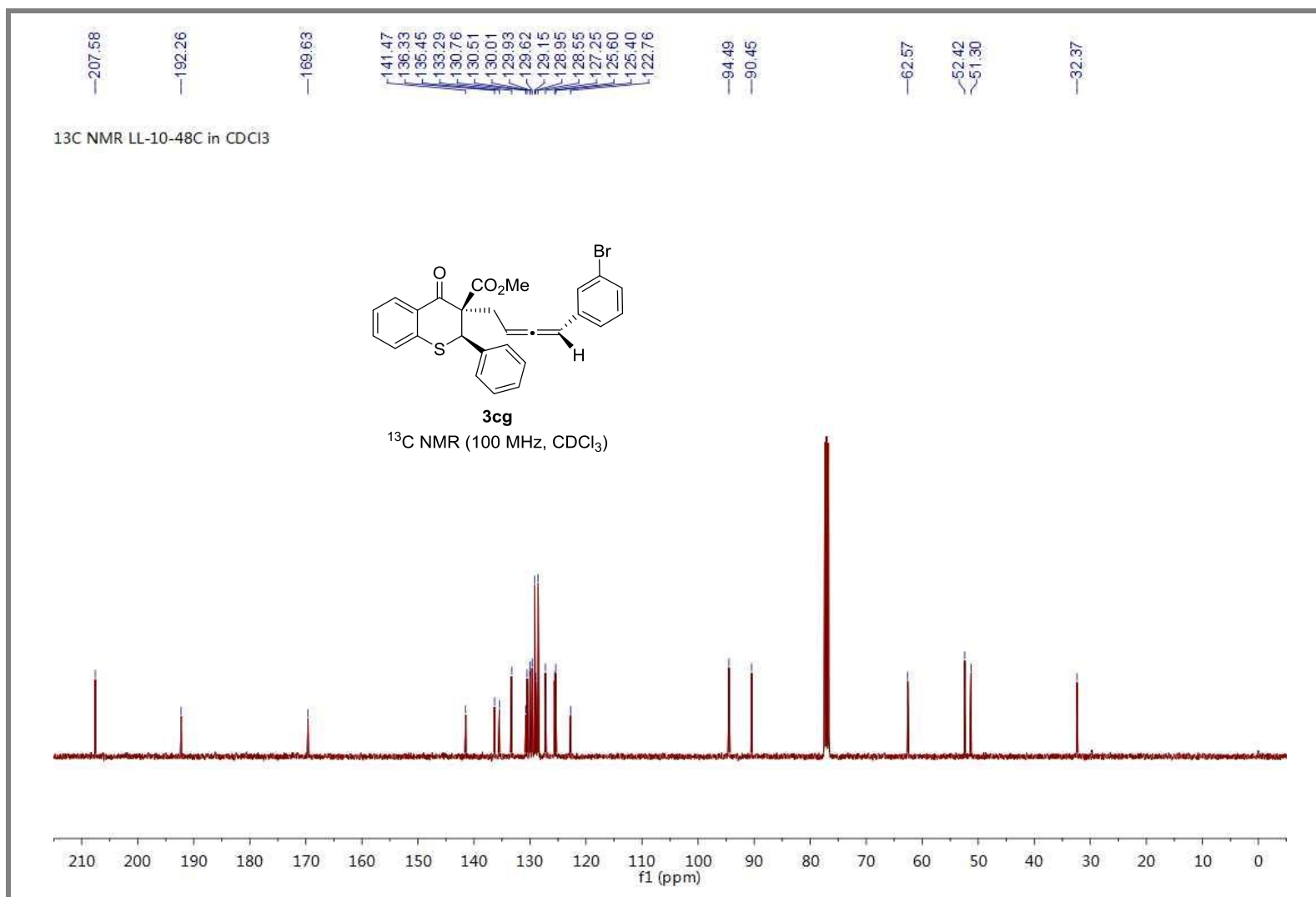
¹⁹F NMR (376 MHz, CDCl₃)

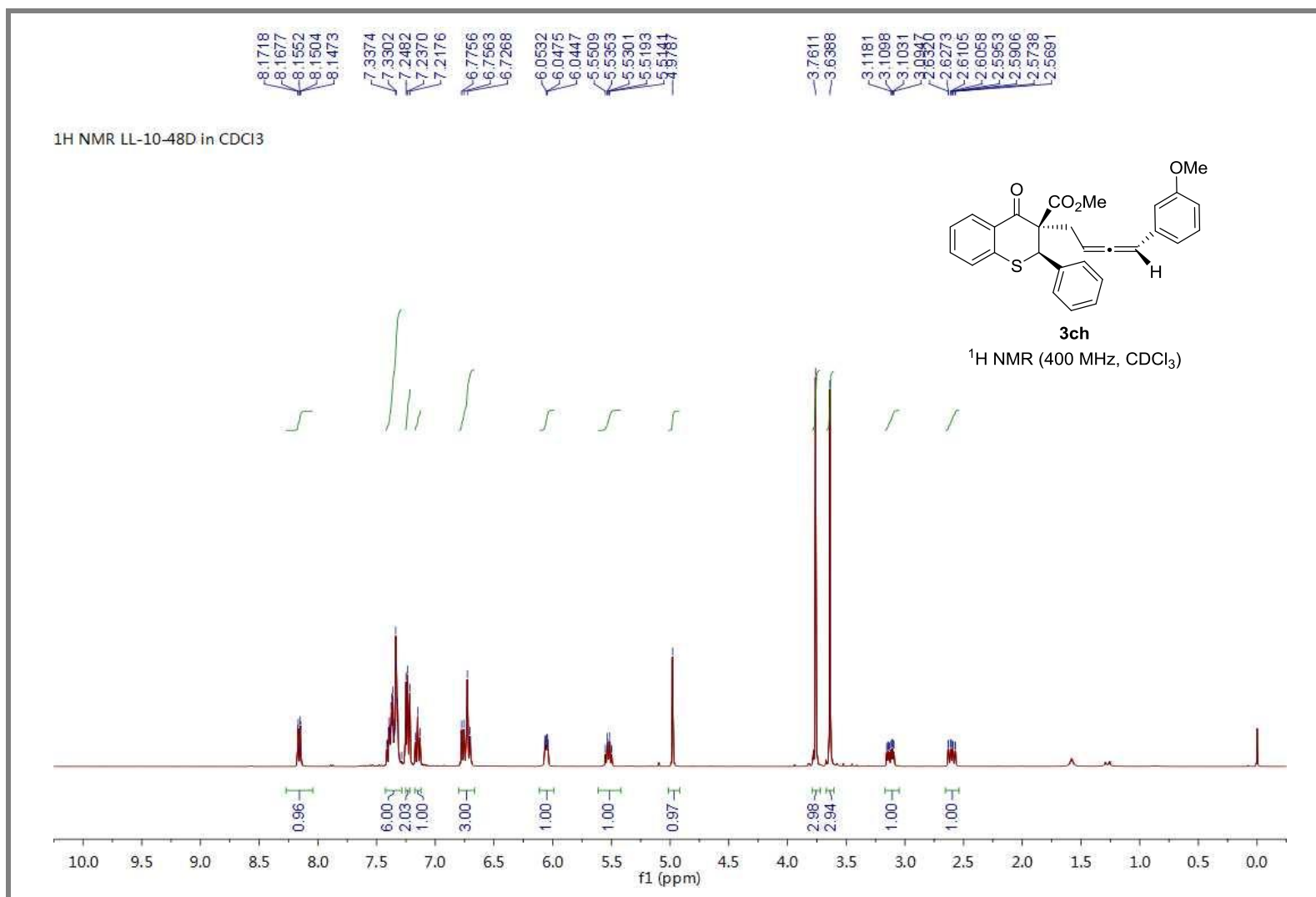


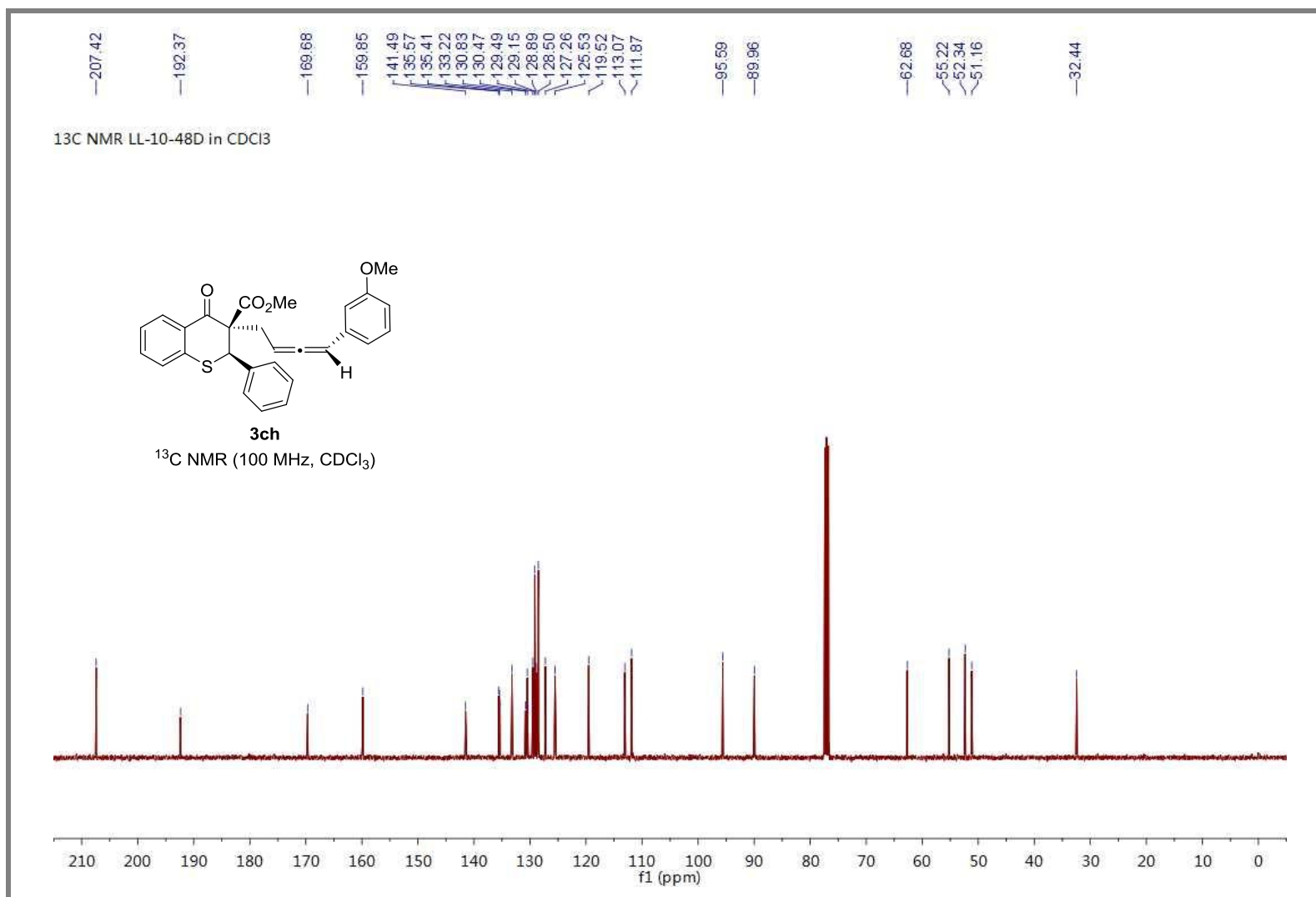


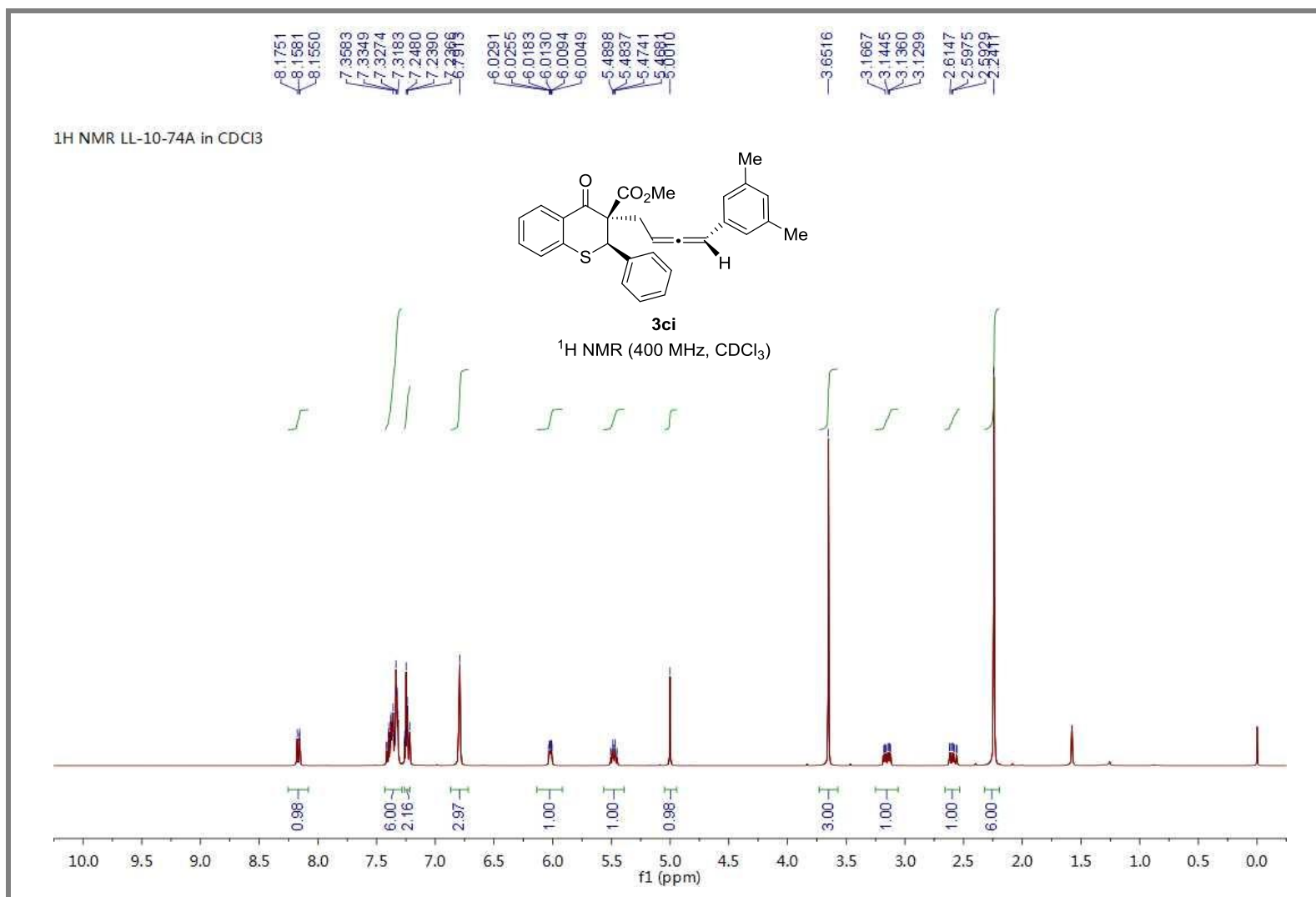


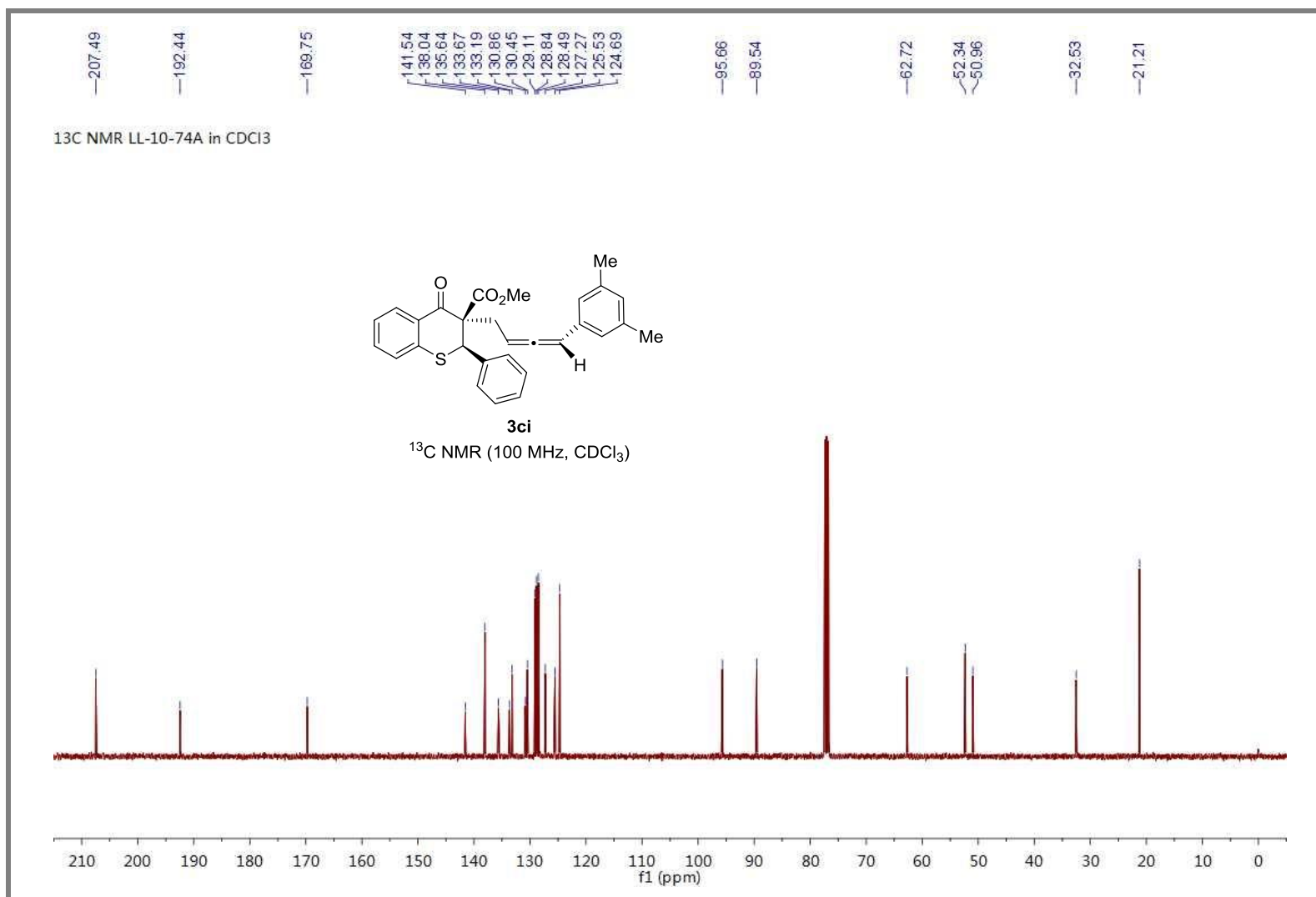


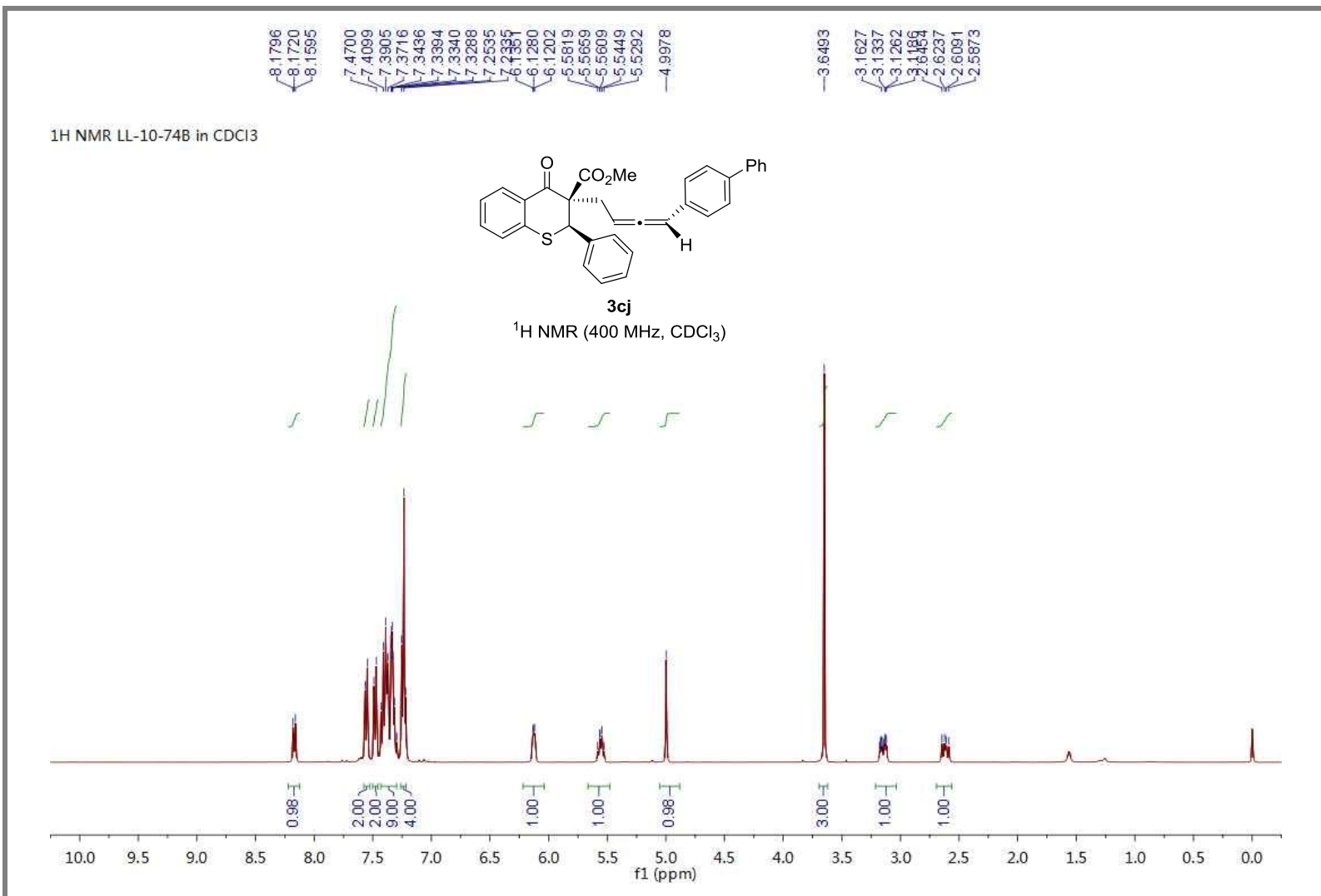


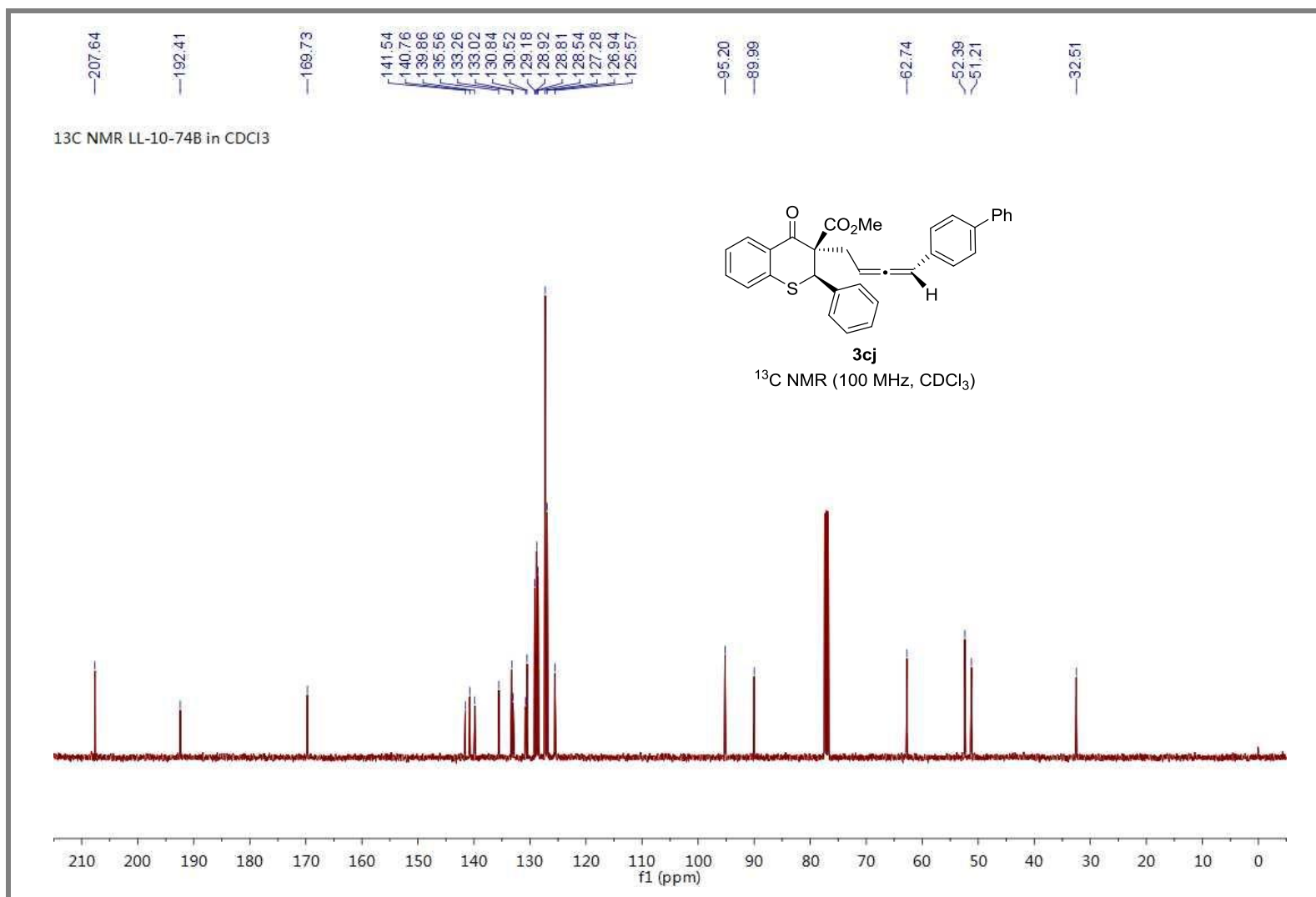


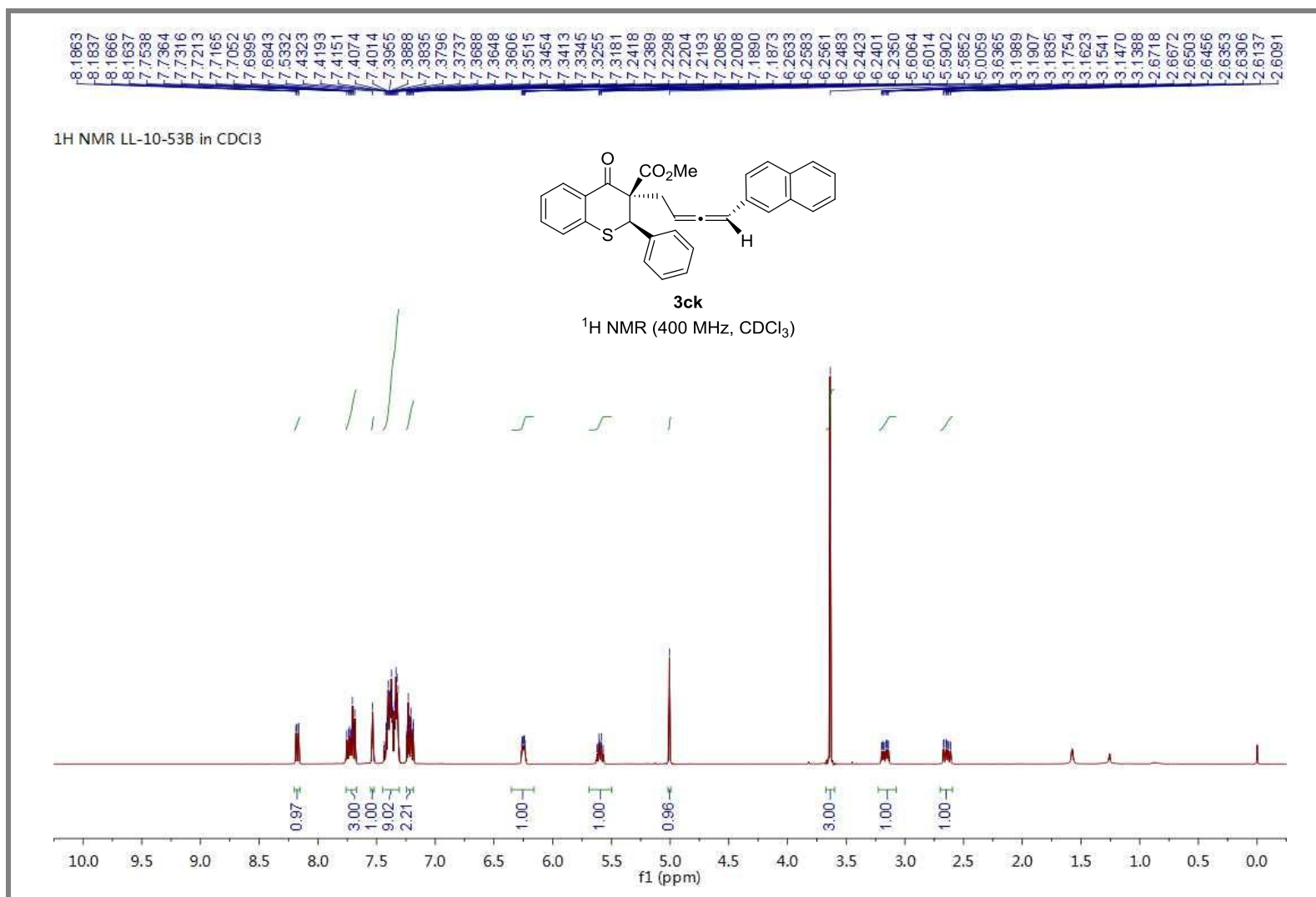


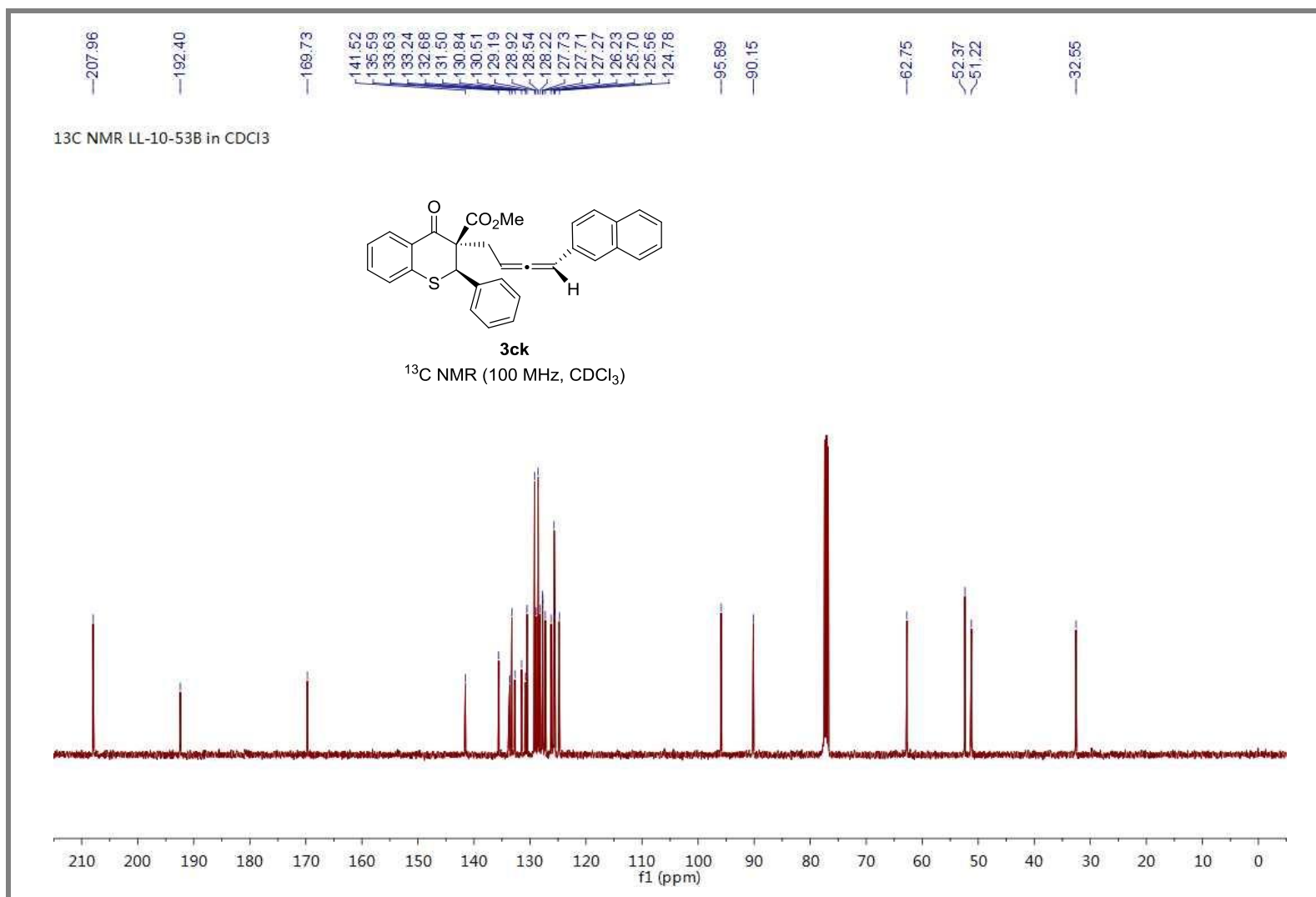


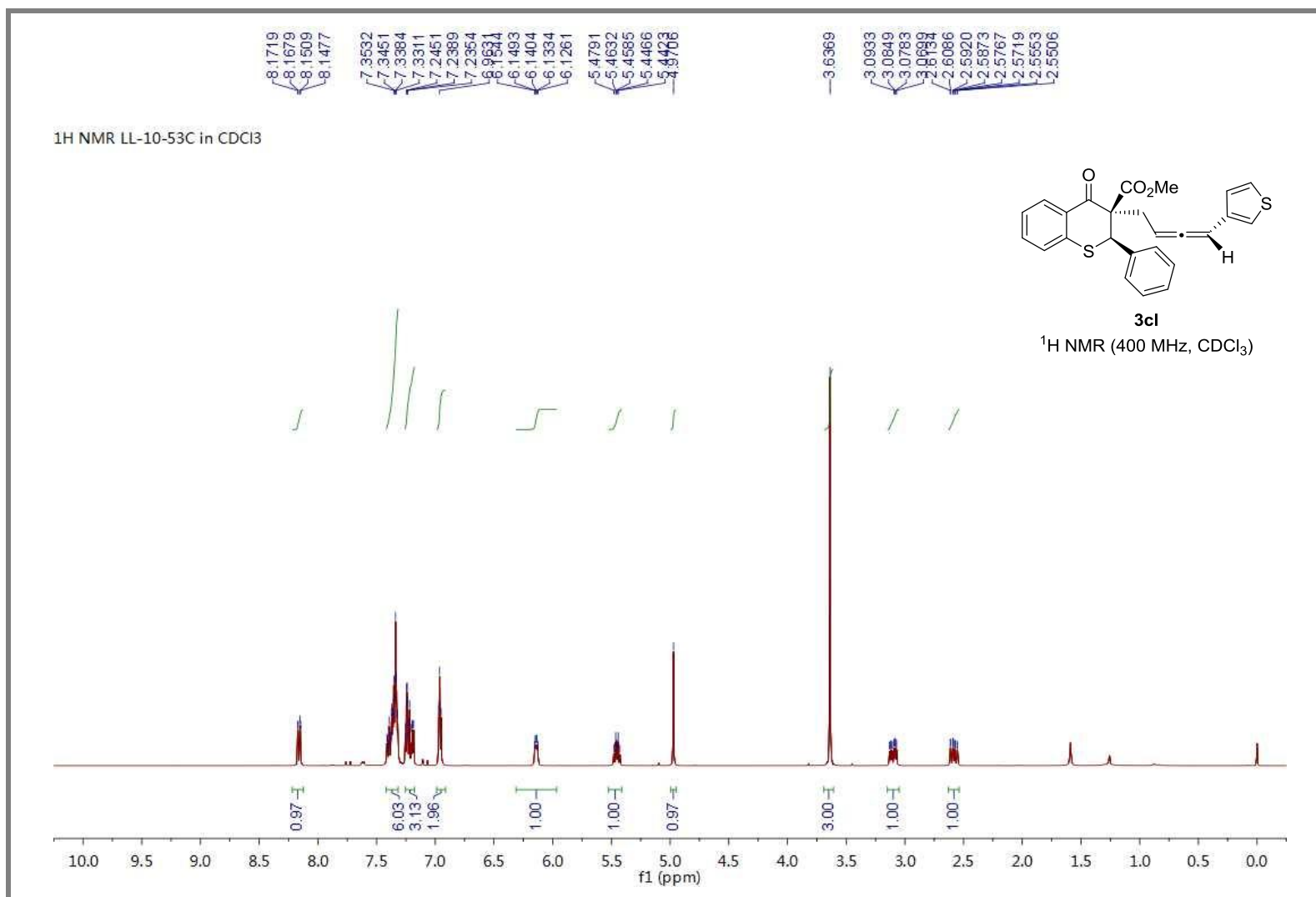


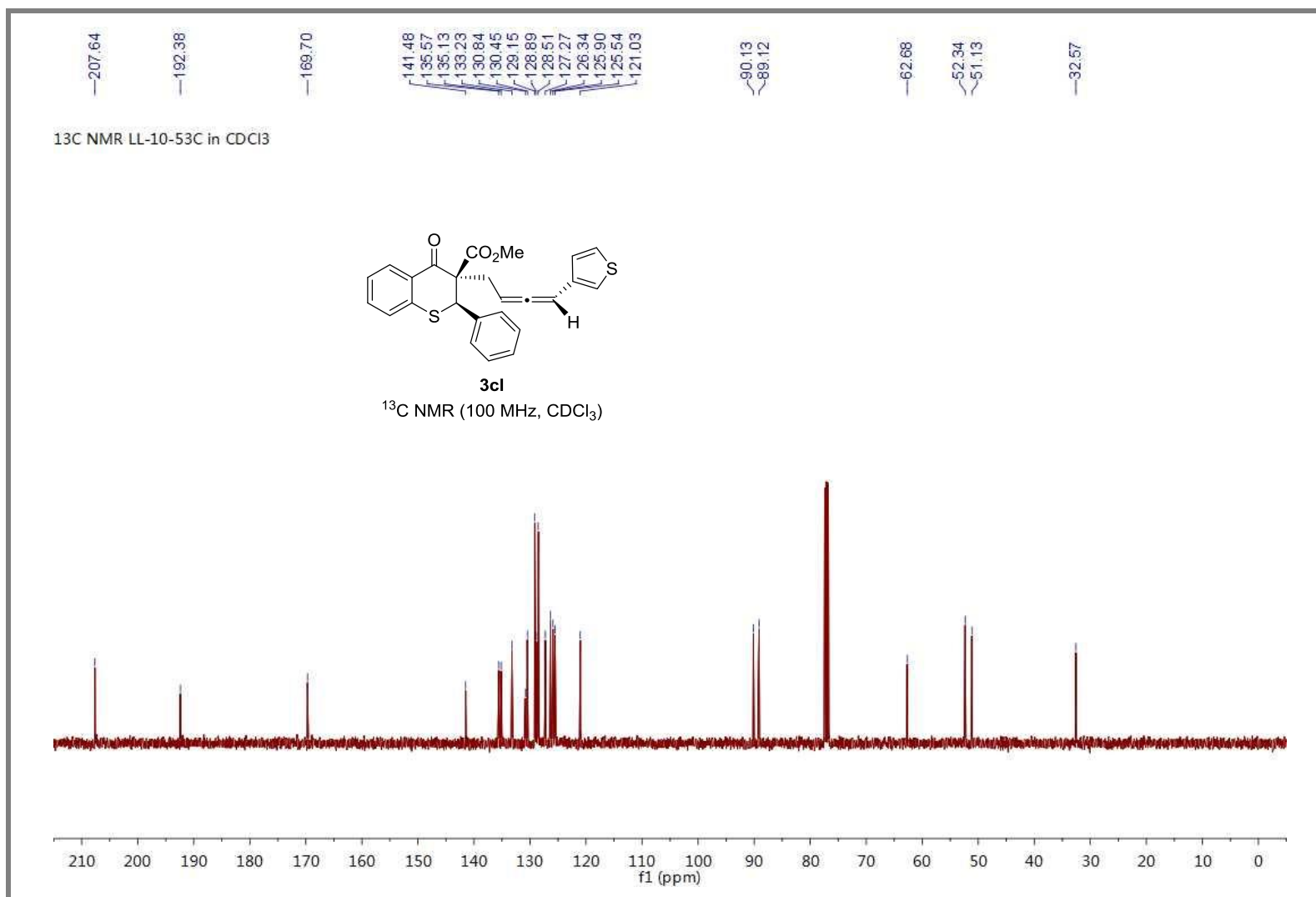


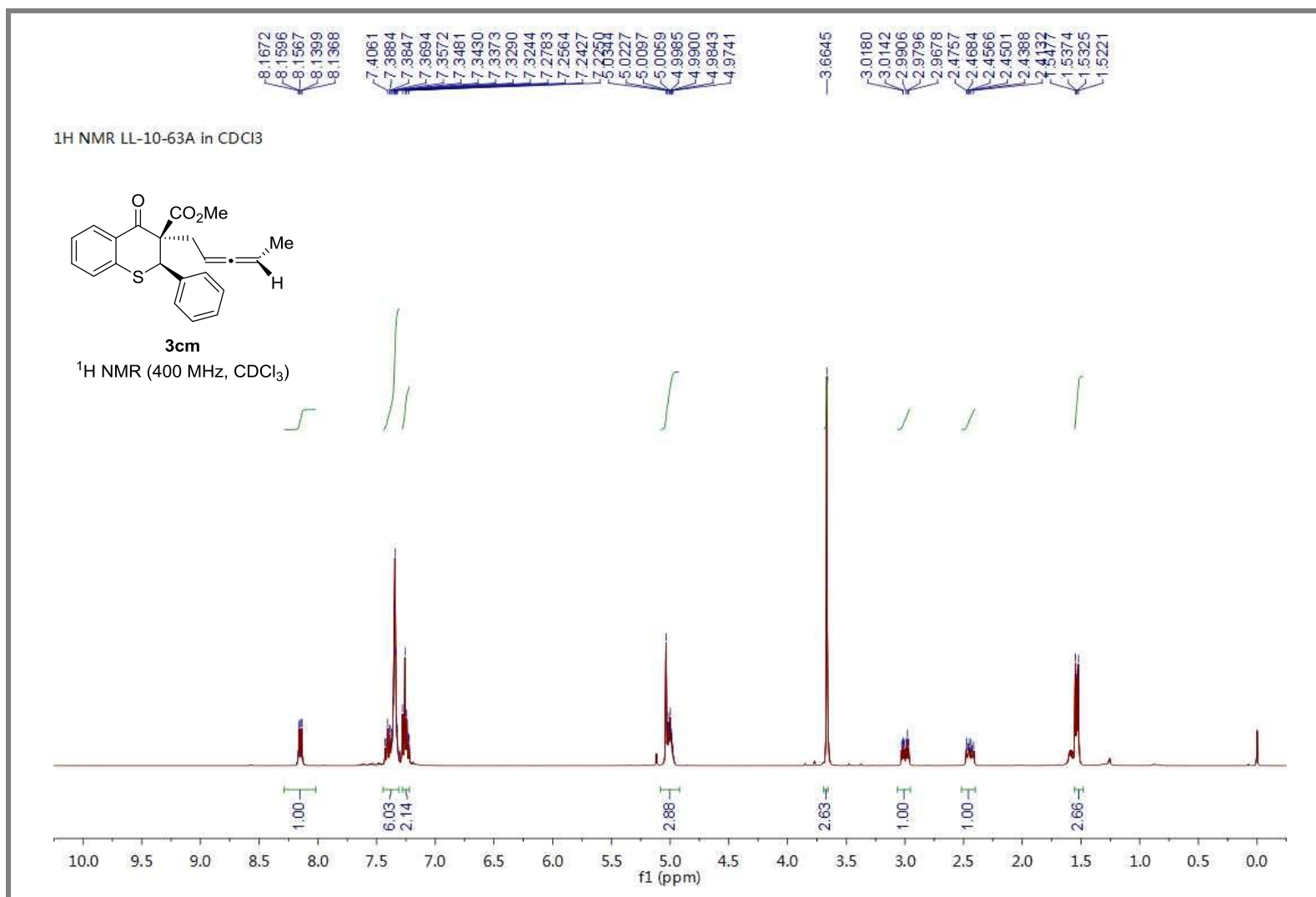


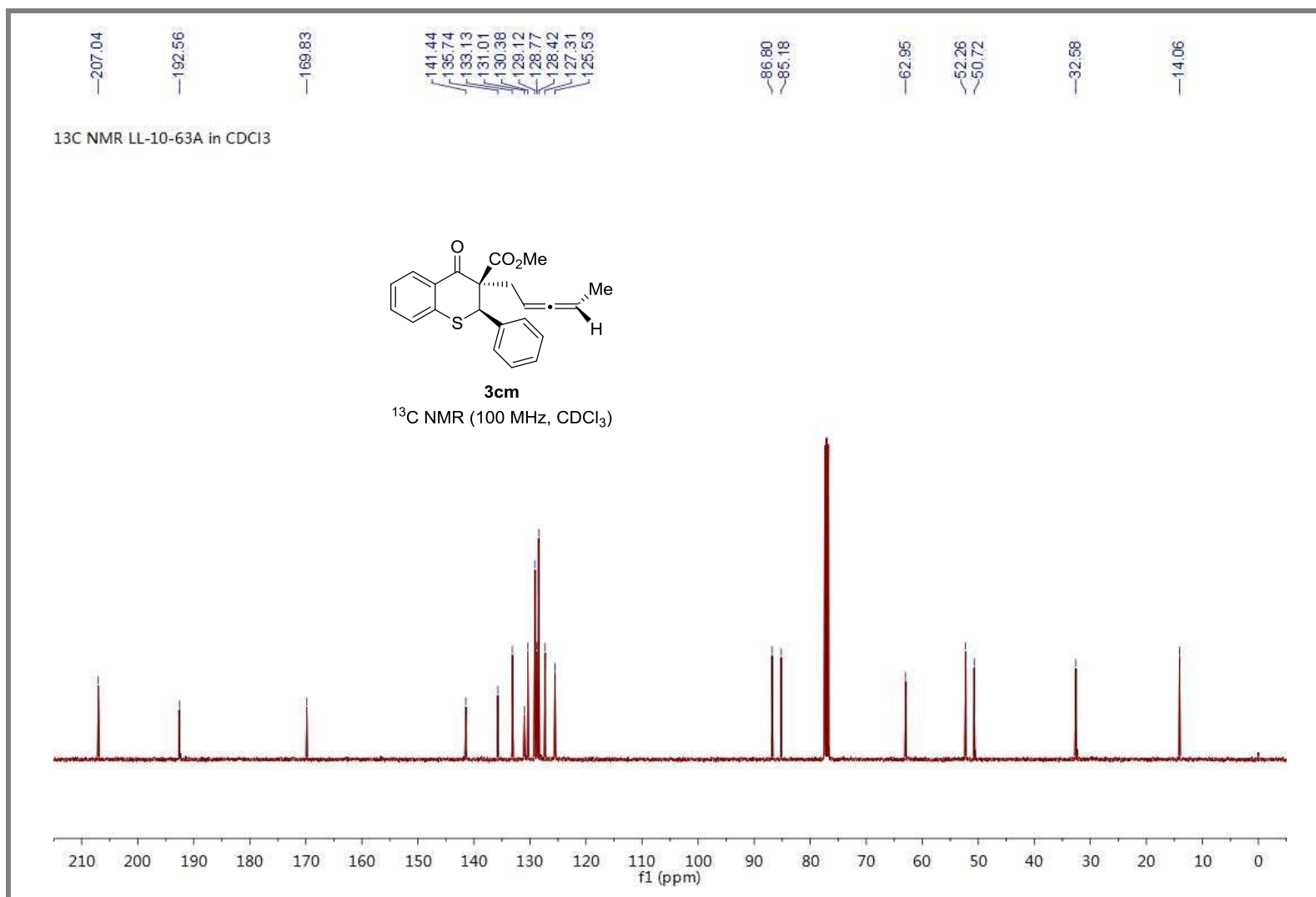


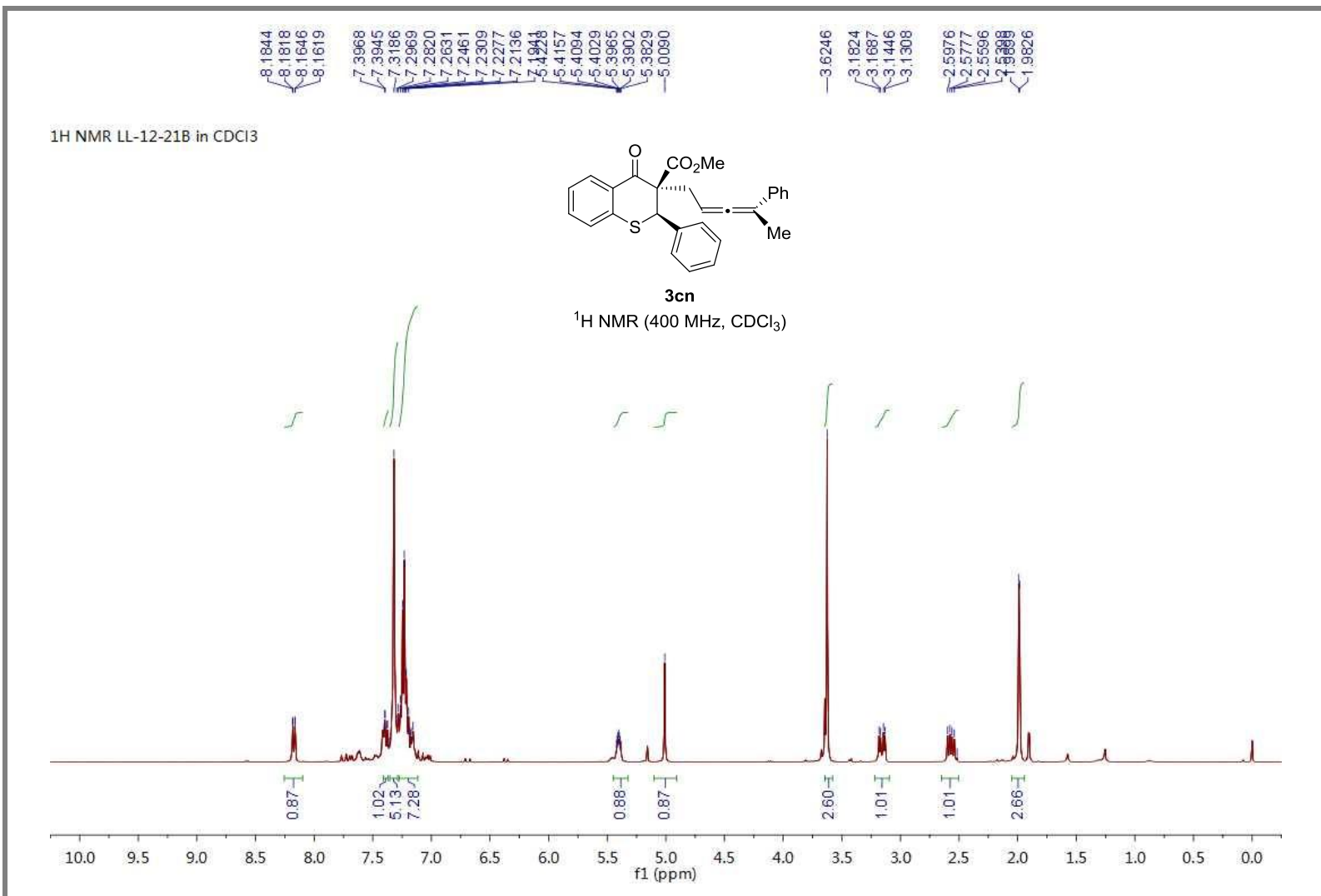


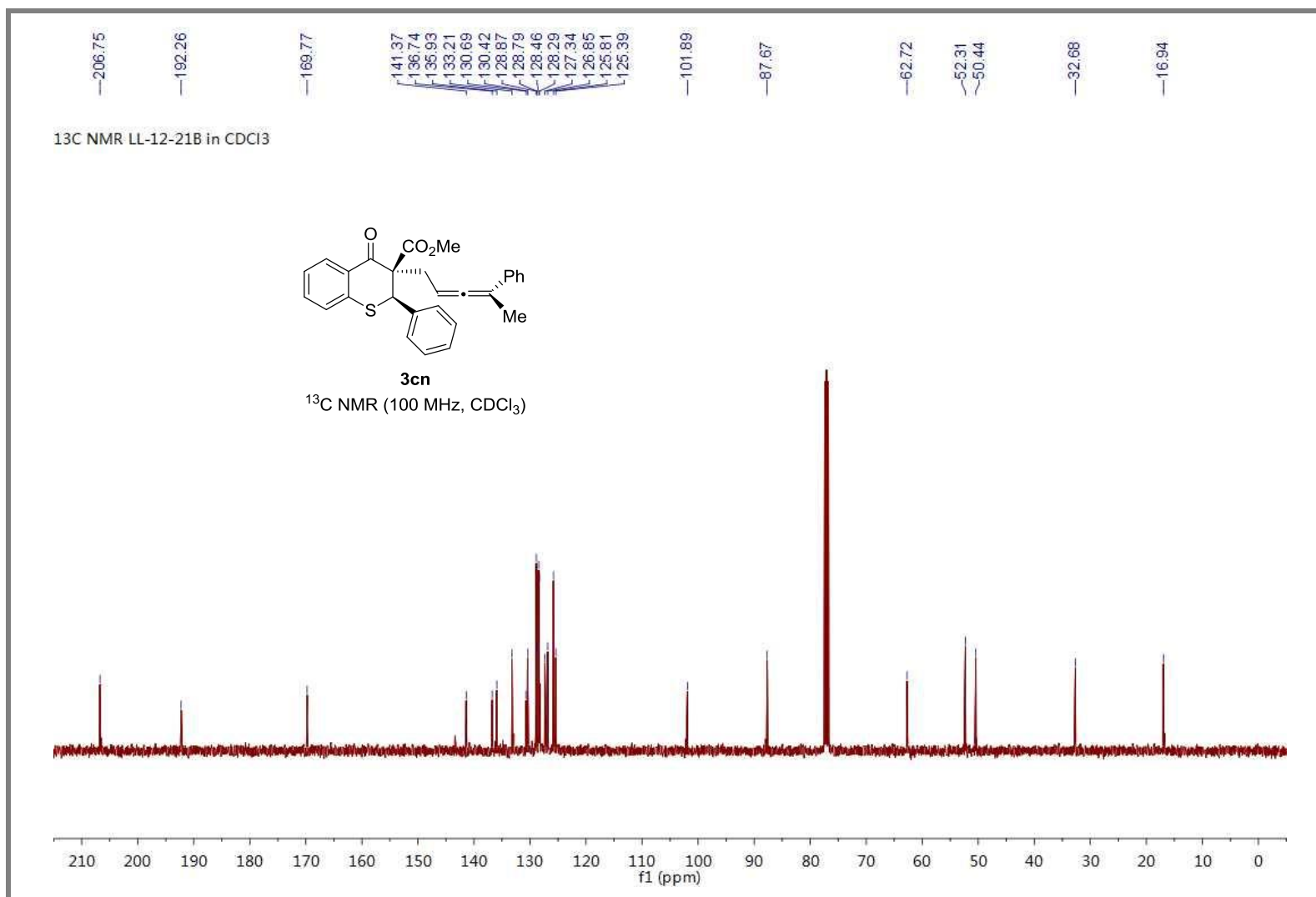


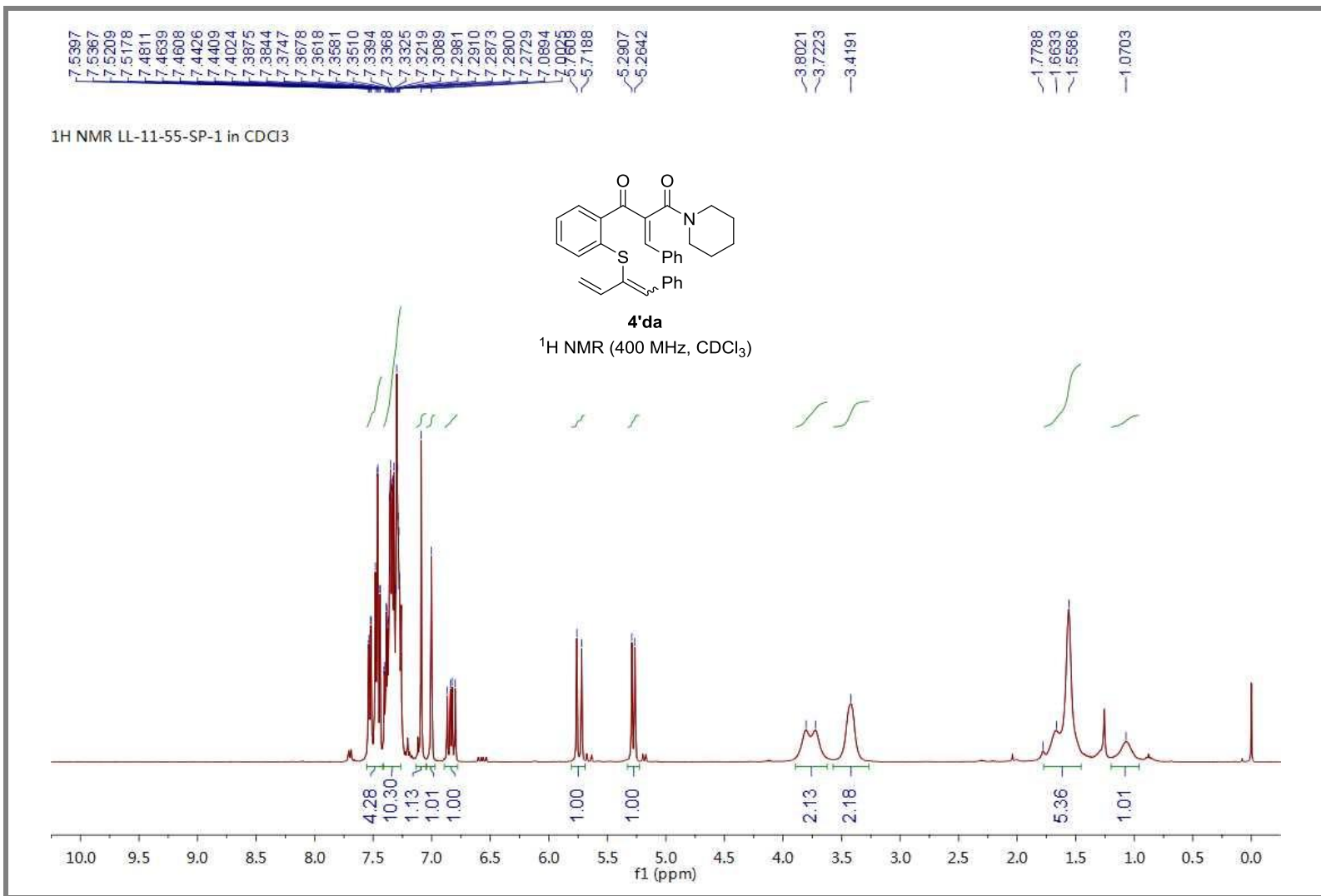


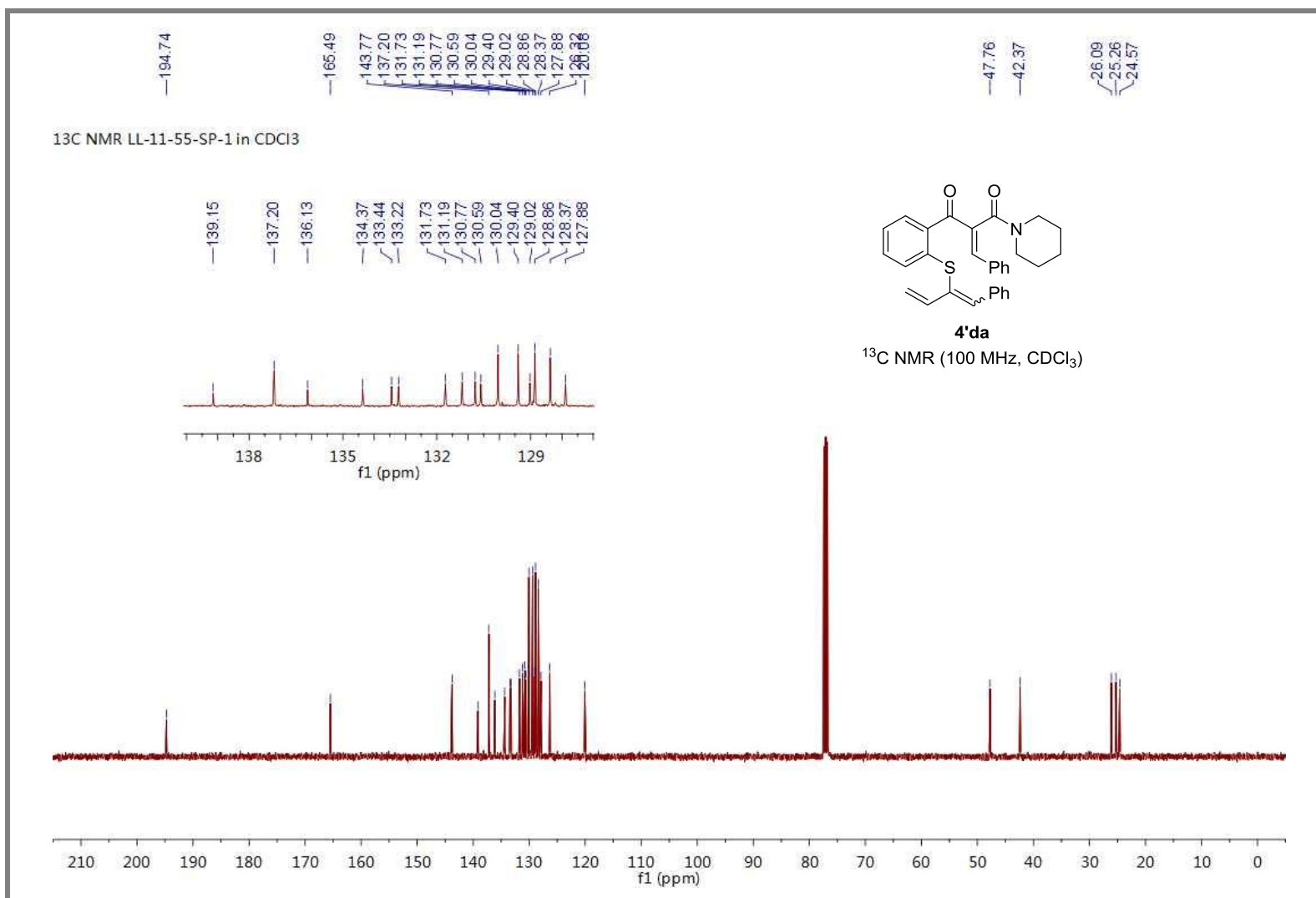


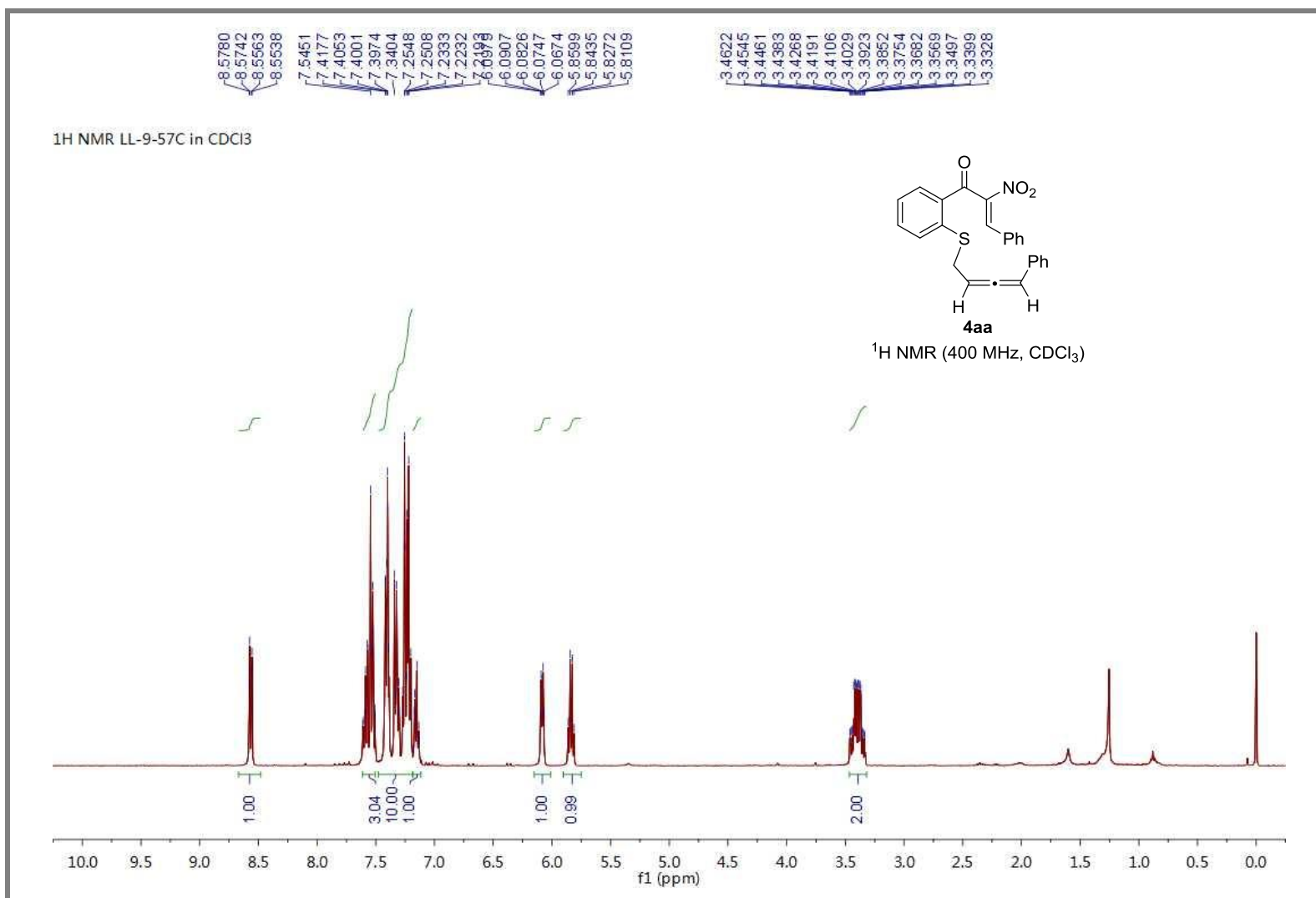


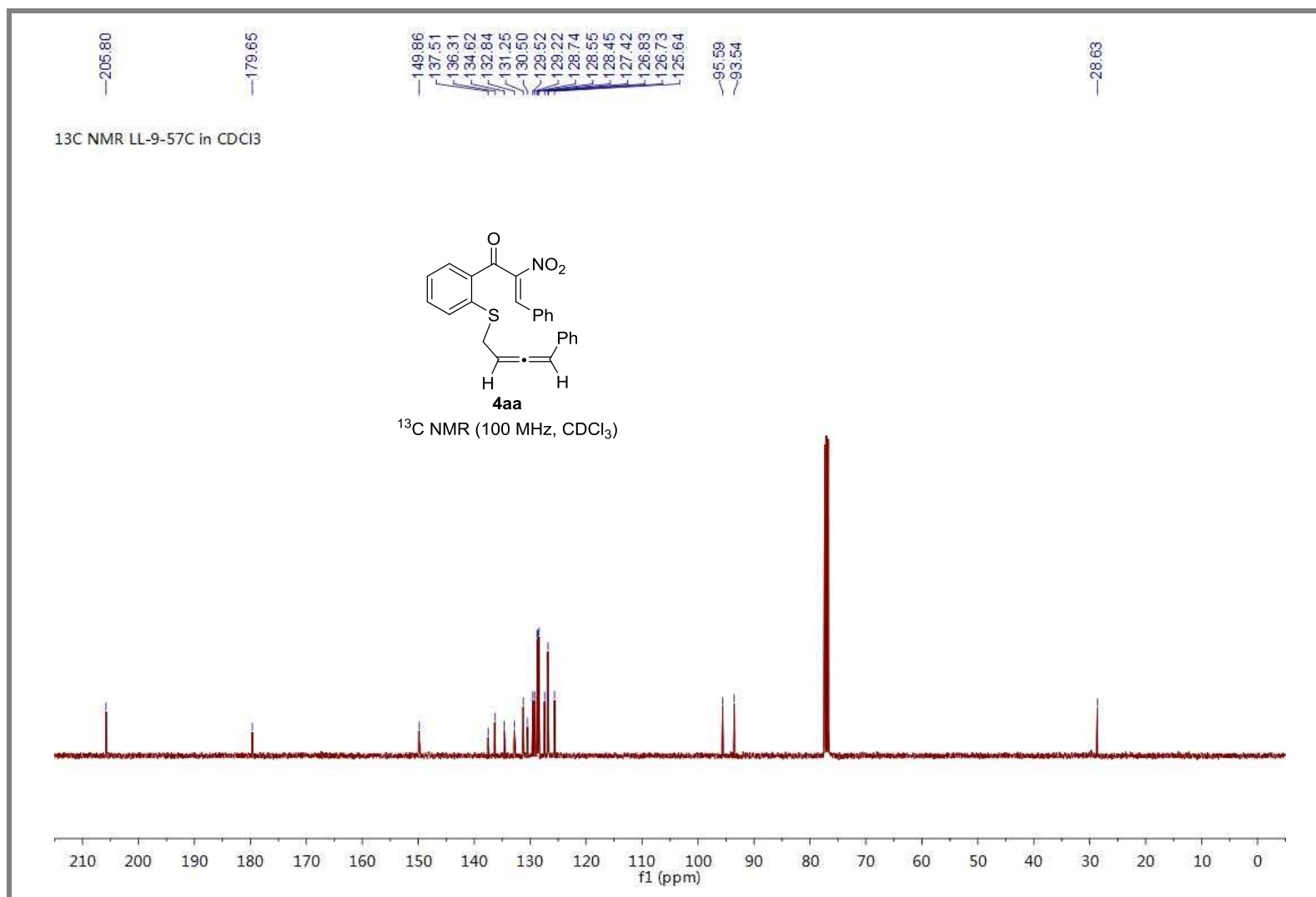


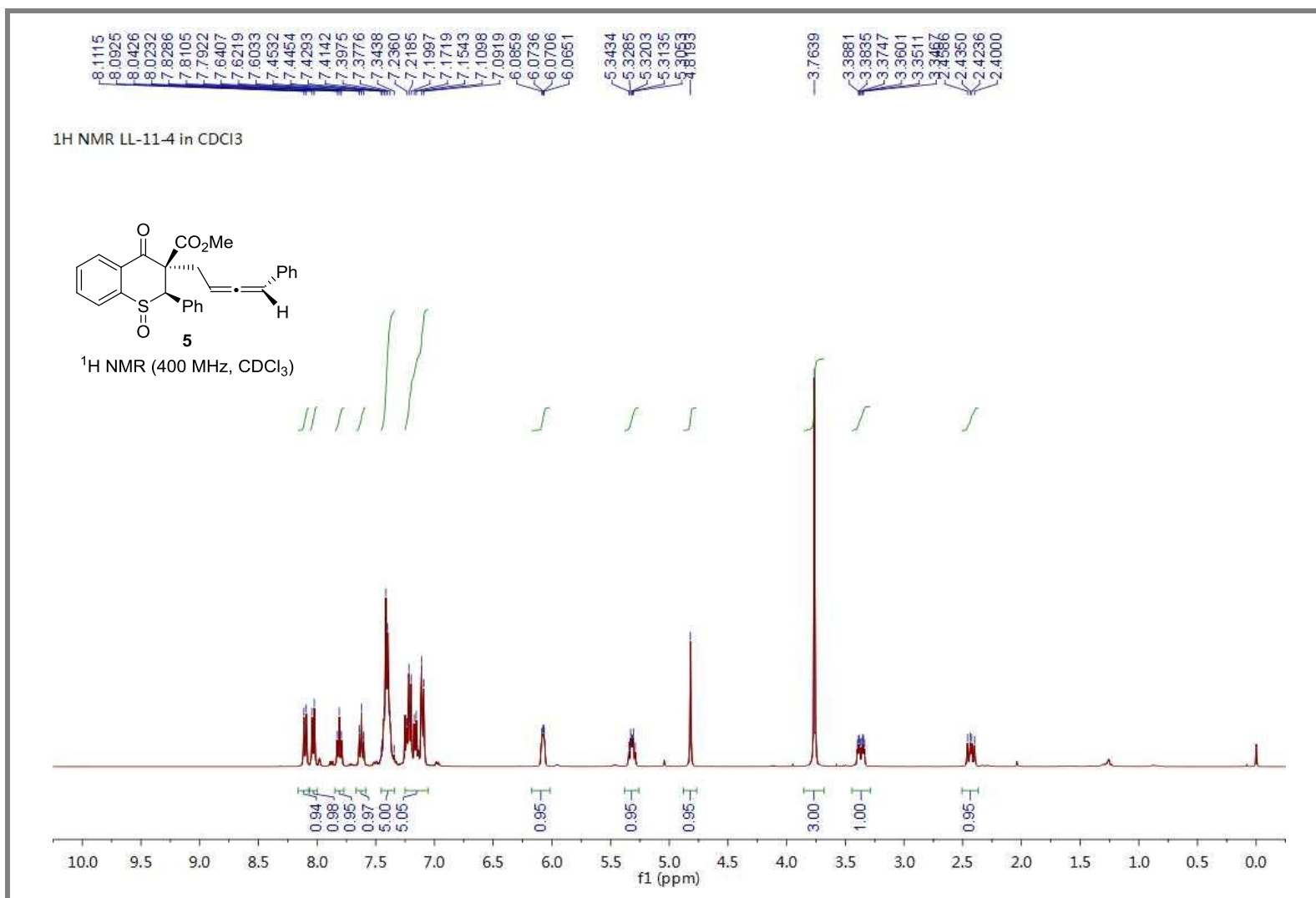


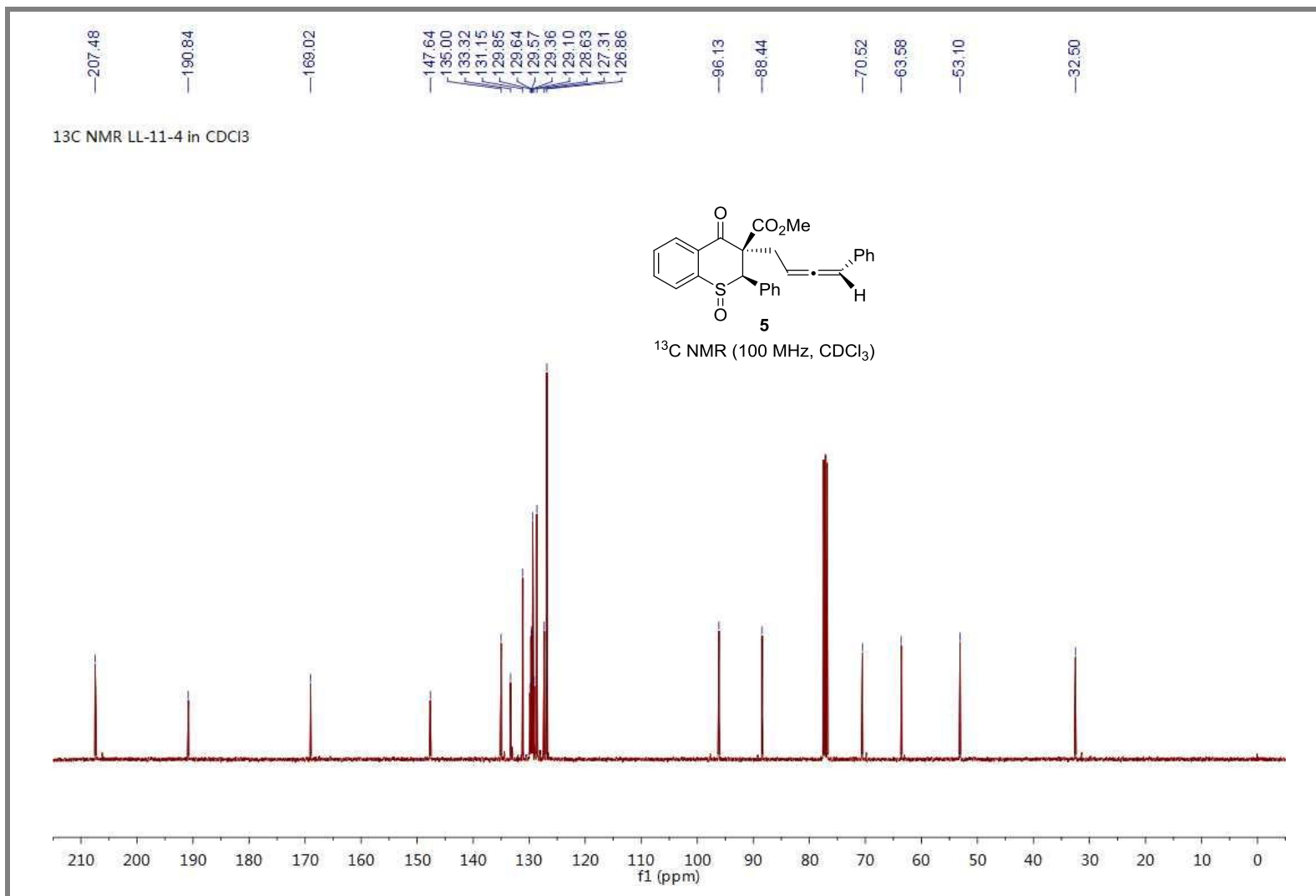


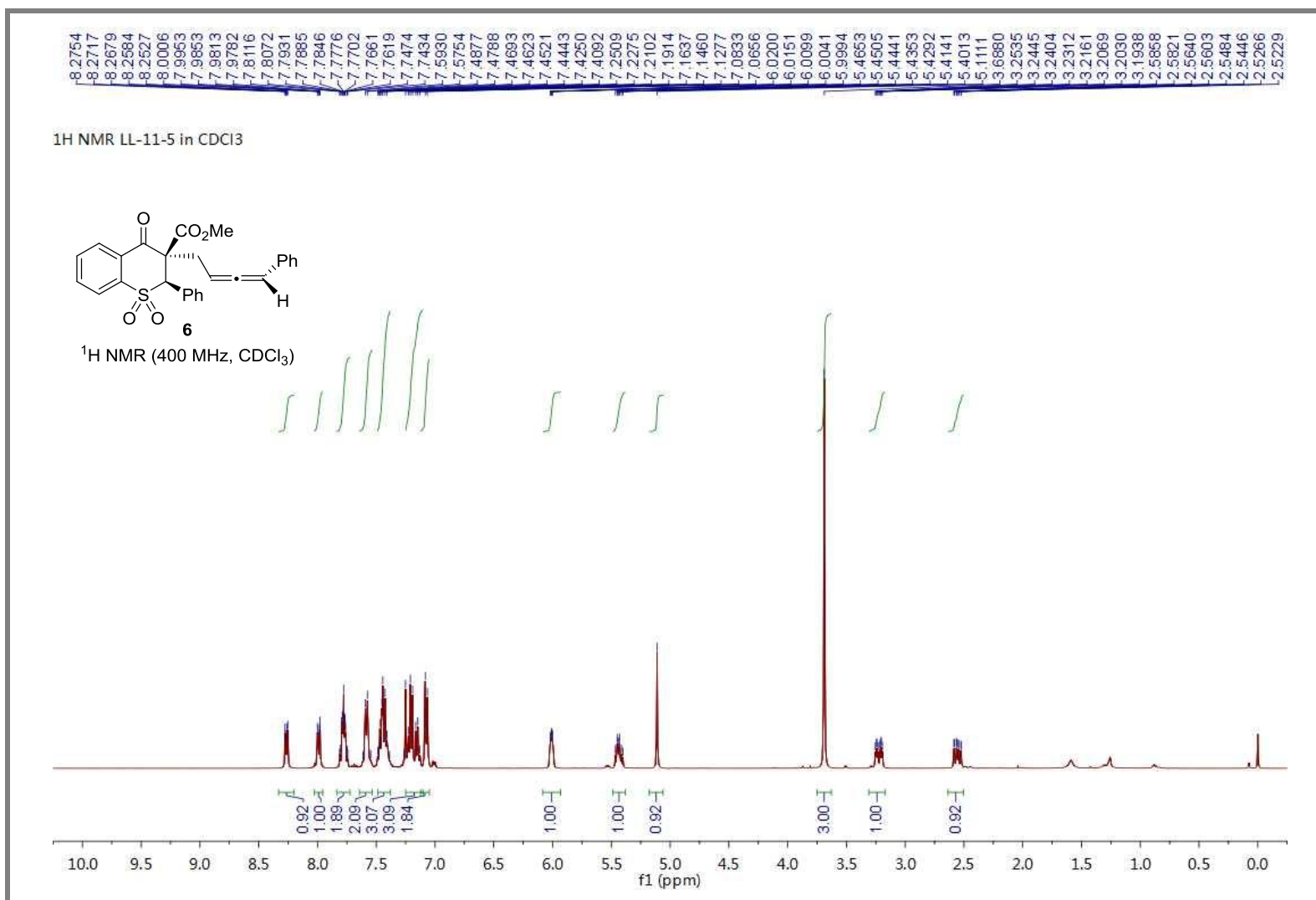


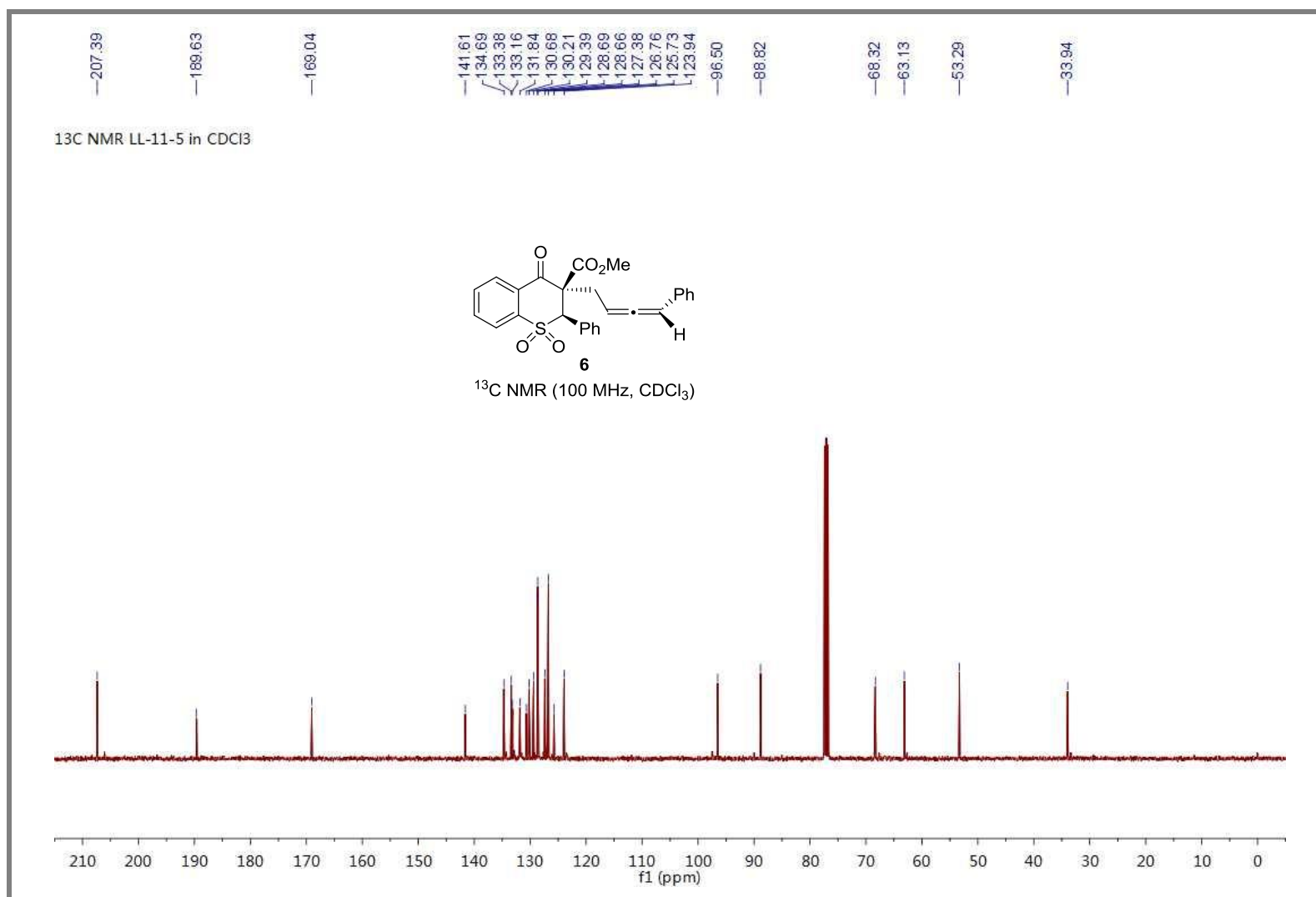


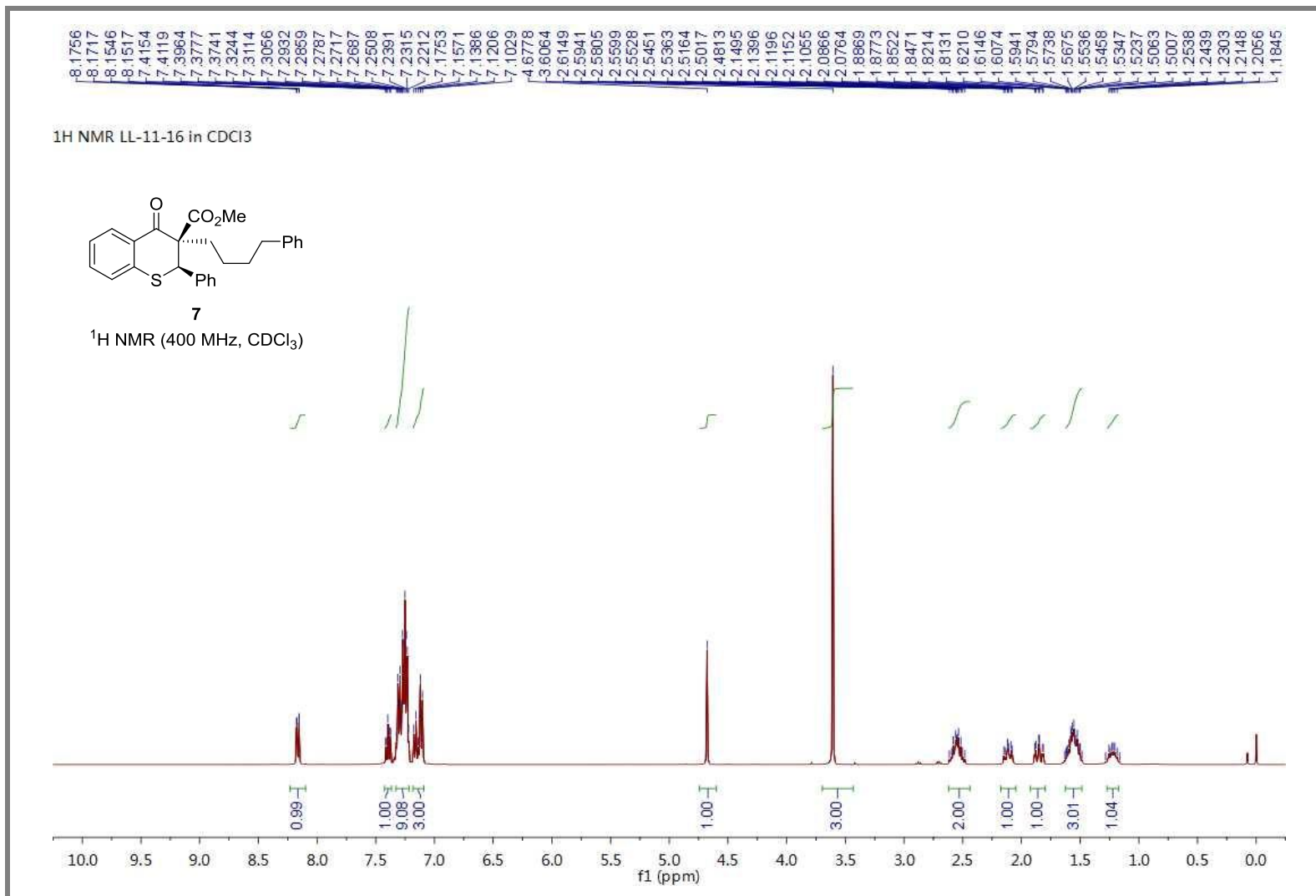


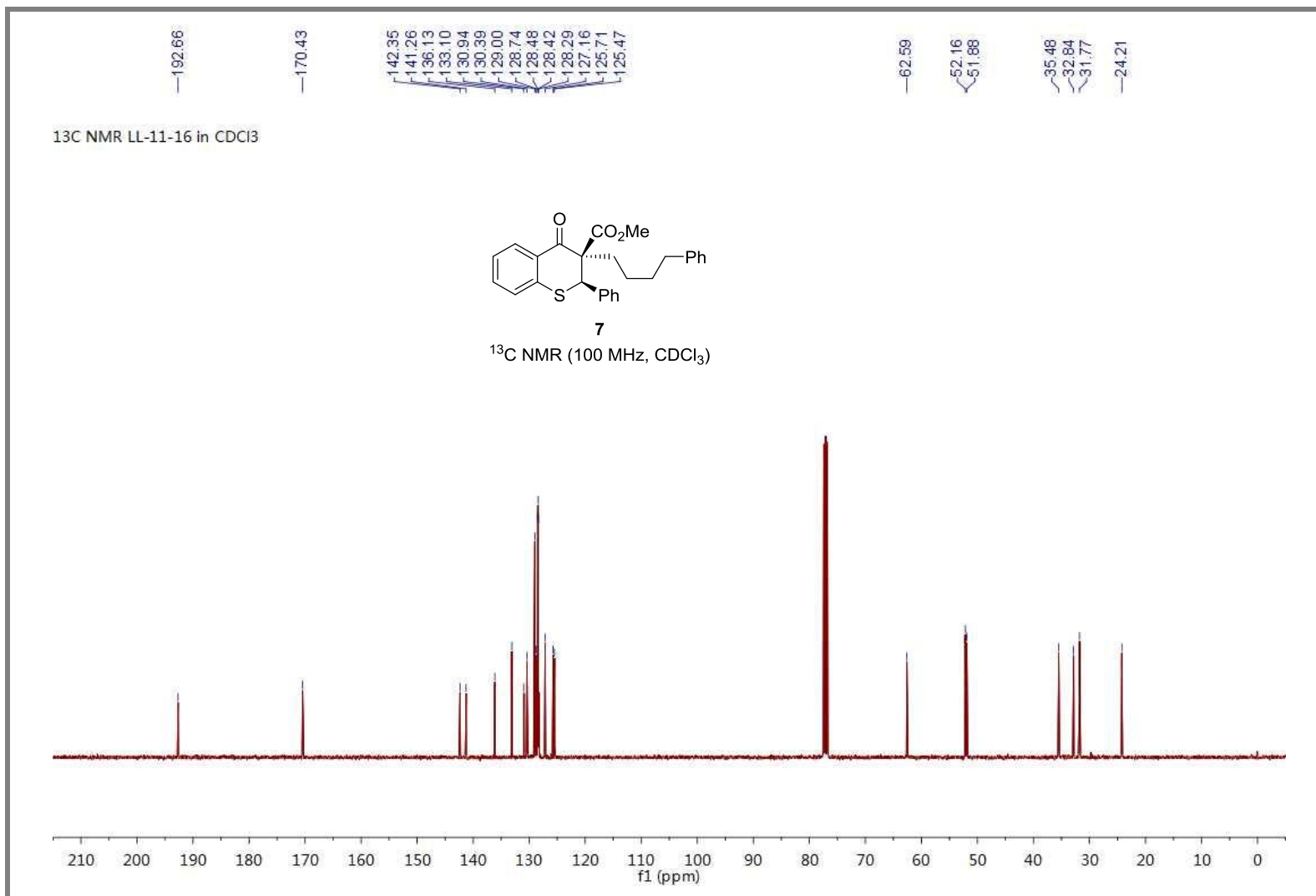


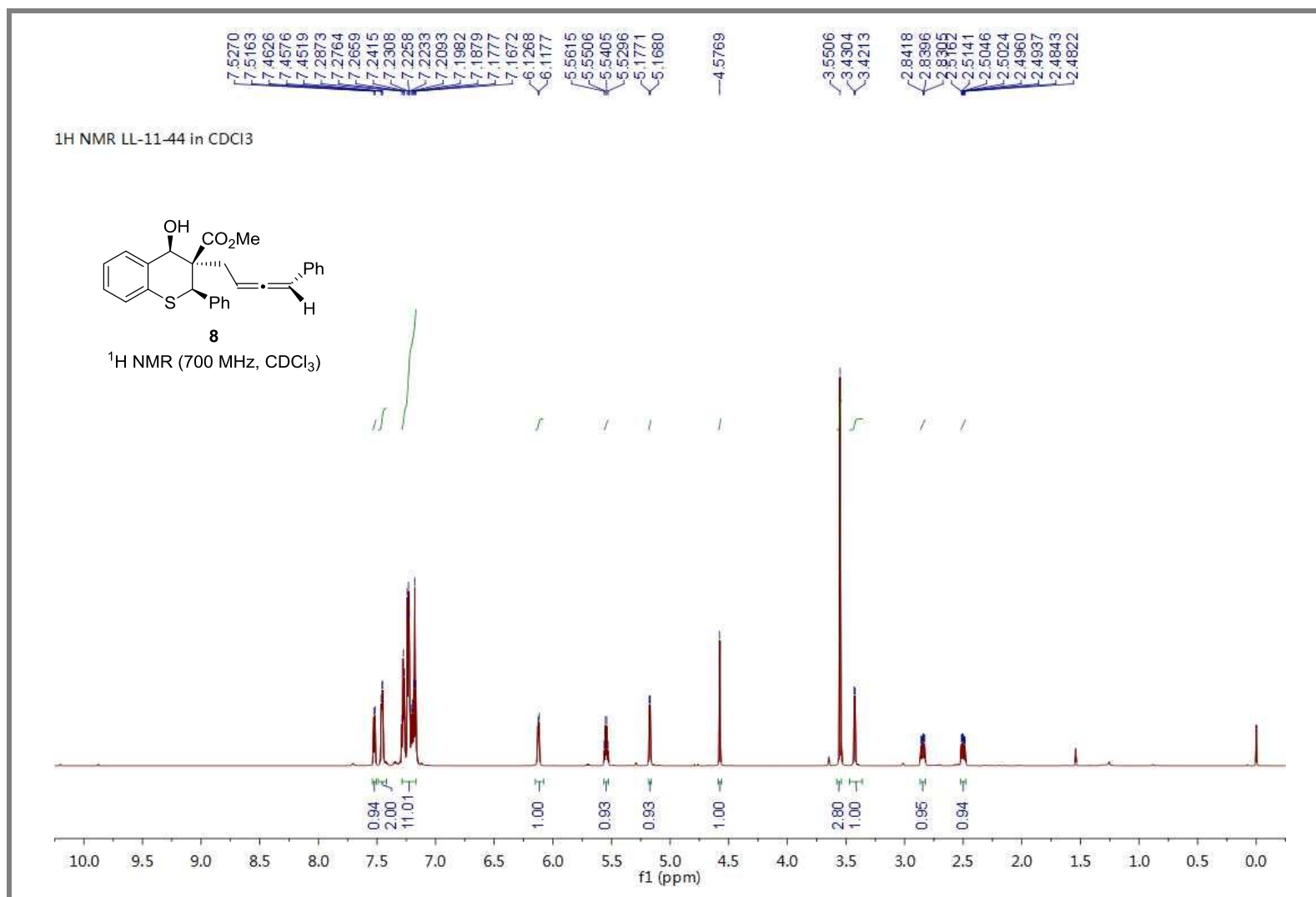


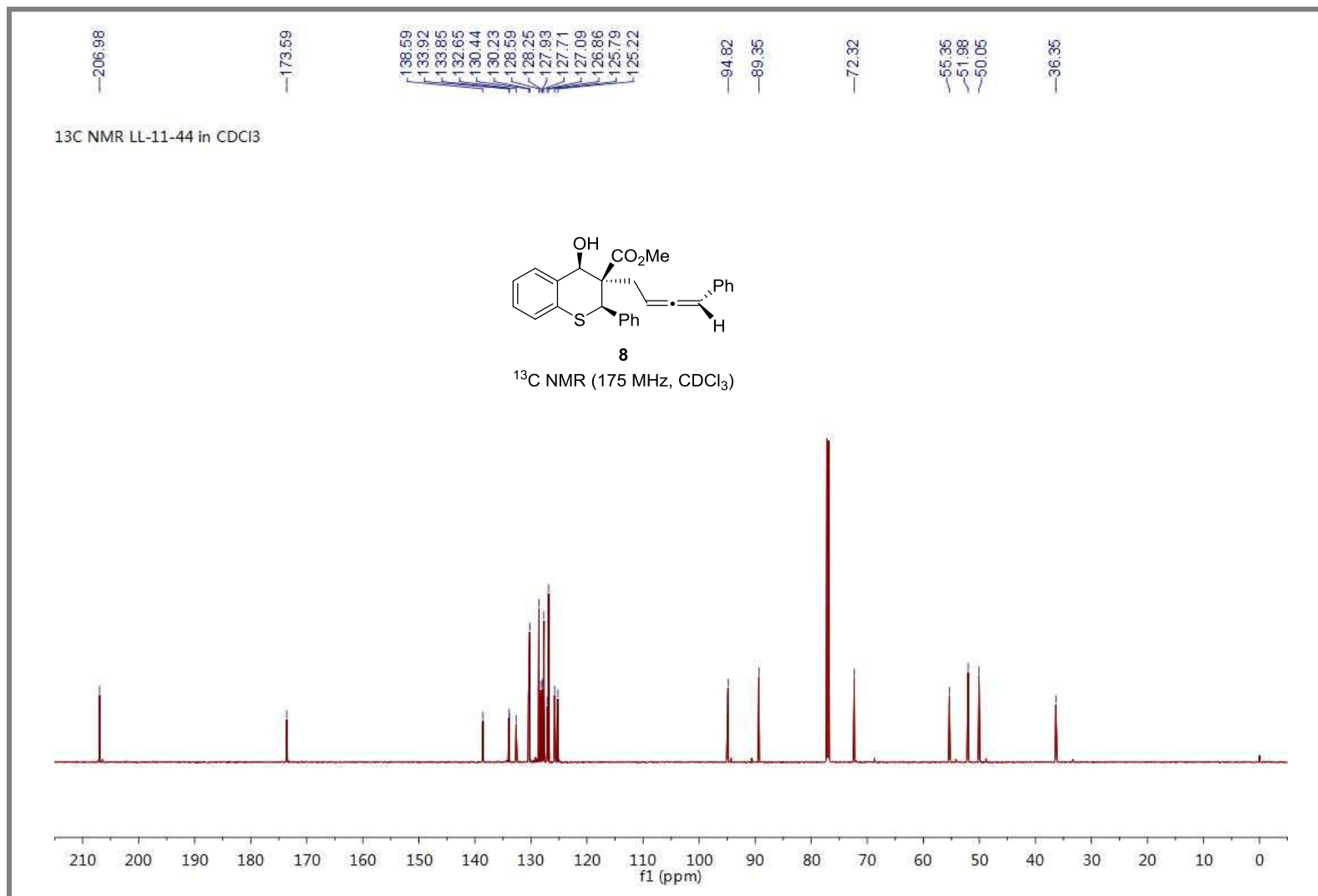






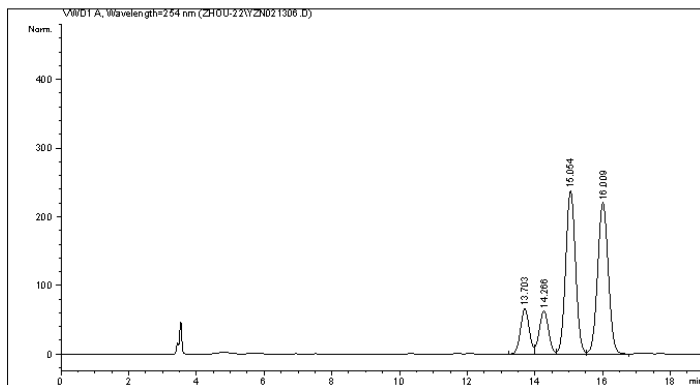






Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021306.D
 Sample Name: LL-9-96 +/-

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 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 5/31/2022 10:04:59 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 5/31/2022 10:03:56 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/2/2022 9:05:02 AM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

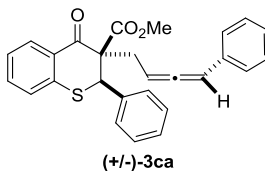
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.703	BV	0.2796	1181.40186	65.72604	9.8469
2	14.266	VV	0.2934	1184.59485	62.63682	9.8735
3	15.054	VV	0.3161	4809.14453	237.68280	40.0840
4	16.009	VB	0.3413	4822.53174	220.28629	40.1956

Totals : 1.19977e4 586.33195

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 *** End of Report ***

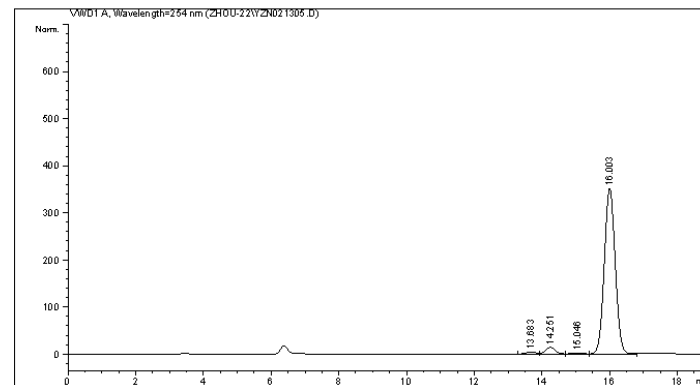
Instrument 1 6/2/2022 9:05:10 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021305.D
 Sample Name: LL-9-96

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 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 5/31/2022 9:44:46 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 5/31/2022 9:30:21 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/2/2022 9:05:56 AM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



=====
 Area Percent Report
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Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

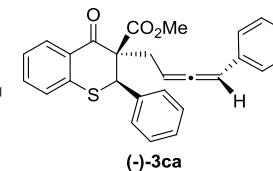
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1	13.683	BV	0.2830	84.60534	4.63237	1.0251
2	14.251	VV	0.2991	264.45209	13.81320	3.2040
3	15.046	VV	0.2989	37.25450	1.90967	0.4514
4	16.003	VB	0.3487	7867.43896	351.24875	95.3196

Totals : 8253.75089 371.60400

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

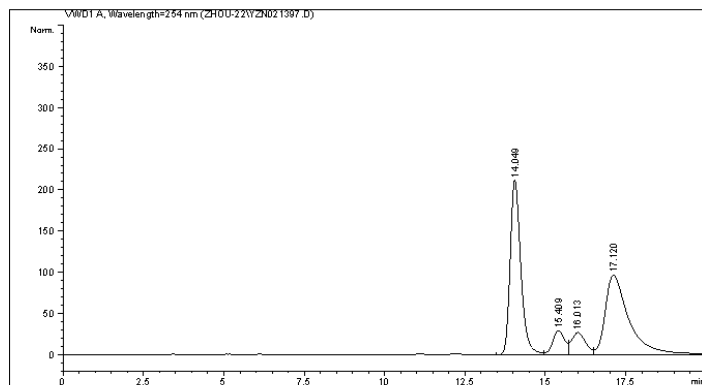
Instrument 1 6/2/2022 9:07:21 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021397.D
 Sample Name: LL-10-10A +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/16/2022 9:58:20 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/16/2022 9:50:17 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/17/2022 9:57:36 AM
 (modified after loading)
 Sample Info : ID, Hexane/i-PrOH = 97/3, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

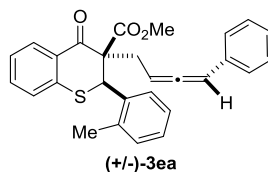
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.049	VV	0.3526	4865.26904	211.67204	42.6194
2	15.409	VV	0.3884	746.58508	29.21757	6.5400
3	16.013	VV	0.4594	821.14044	26.80166	7.1931
4	17.120	VBA	0.7535	4982.61914	96.54684	43.6474

Totals : 1.14156e4 364.23812

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

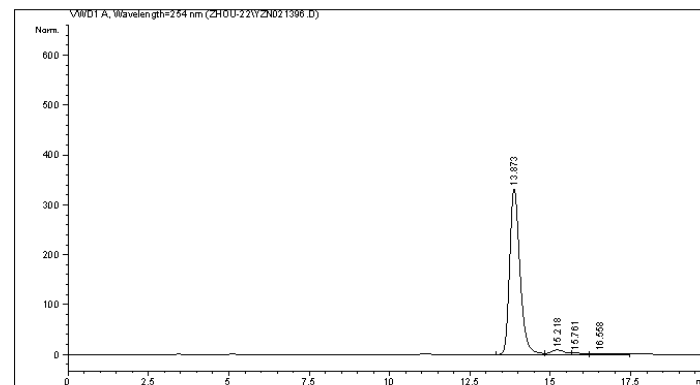
Instrument 1 6/17/2022 9:57:44 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021396.D
 Sample Name: LL-10-10A

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/16/2022 9:28:37 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/16/2022 9:13:30 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/17/2022 9:56:51 AM
 (modified after loading)
 Sample Info : ID, Hexane/i-PrOH = 97/3, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

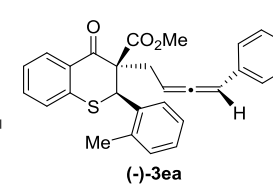
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.873	VV	0.3277	7385.88330	332.60446	94.6470
2	15.218	VV	0.4480	263.34531	8.87867	3.3747
3	15.761	VV	0.3517	69.32341	2.84078	0.8884
4	16.558	VV	0.7494	85.05629	1.57499	1.0900

Totals : 7803.60831 345.89890

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

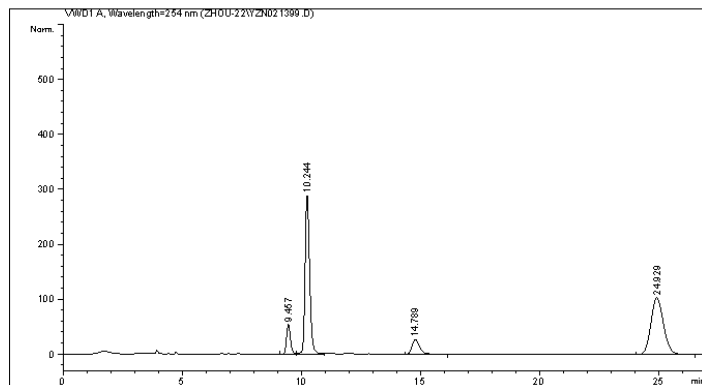
Instrument 1 6/17/2022 9:57:00 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021399.D
Sample Name: LL-10-10B +/-

=====
Acq. Operator :
Acq. Instrument : Instrument 1 Location : -
Injection Date : 6/16/2022 11:12:53 PM
Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed : 6/16/2022 11:11:23 PM
(modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed : 6/17/2022 10:03:43 AM
(modified after loading)
Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

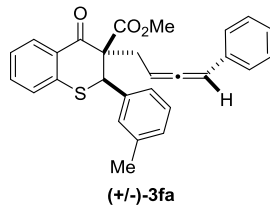
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	9.457	VV	0.1777	618.70984	53.87775	6.9623
2	10.244	VV	0.2054	3865.48975	289.33228	43.4980
3	14.789	VB	0.3386	599.61310	26.90870	6.7474
4	24.929	BB	0.5717	3802.77173	103.42006	42.7923

Totals : 8886.58441 473.53879

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

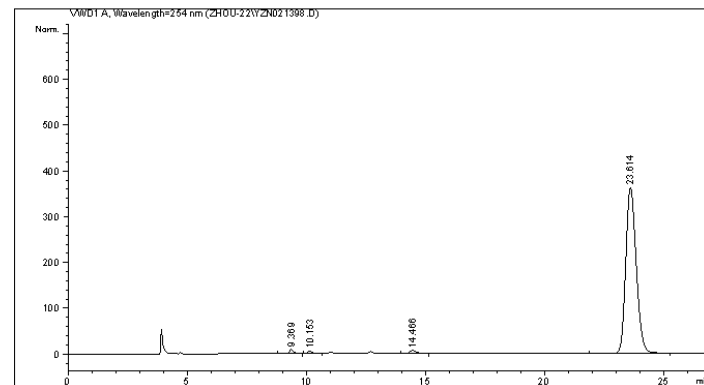
Instrument 1 6/17/2022 10:03:47 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021398.D
Sample Name: LL-10-10B

=====
Acq. Operator :
Acq. Instrument : Instrument 1 Location : -
Injection Date : 6/16/2022 10:37:23 PM
Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed : 6/16/2022 10:20:50 PM
(modified after loading)
Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
Last changed : 6/17/2022 10:03:08 AM
(modified after loading)
Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

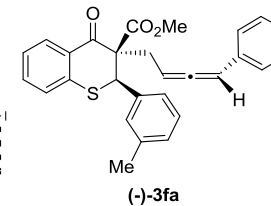
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	9.369	VB	0.1970	126.27138	9.42724	1.0969
2	10.153	BB	0.2182	80.58767	5.57237	0.7000
3	14.466	VB	0.3299	141.23883	6.48234	1.2269
4	23.614	VV	0.4786	1.11640e4	362.64539	96.9763

Totals : 1.15121e4 384.12733

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

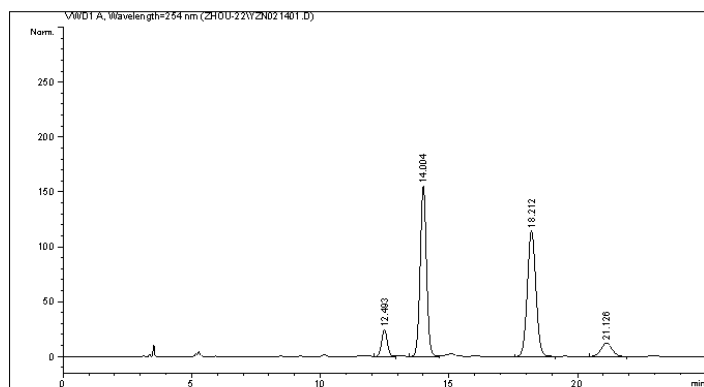
Instrument 1 6/17/2022 10:03:14 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021401.D
 Sample Name: LL-10-10C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/17/2022 12:22:05 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/17/2022 12:20:56 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/18/2022 1:56:11 AM
 (modified after loading)
 Sample Info : IA, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

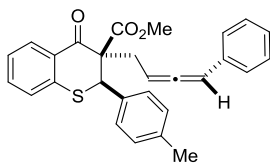
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	12.493	VB	0.2410	379.17752	24.40358	6.2095
2	14.004	VB	0.2654	2677.81982	155.15761	43.8525
3	18.212	EB	0.3598	2676.45337	114.61832	43.8301
4	21.126	BB	0.4633	372.97498	12.39067	6.1079

Totals : 6106.42569 306.57018

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

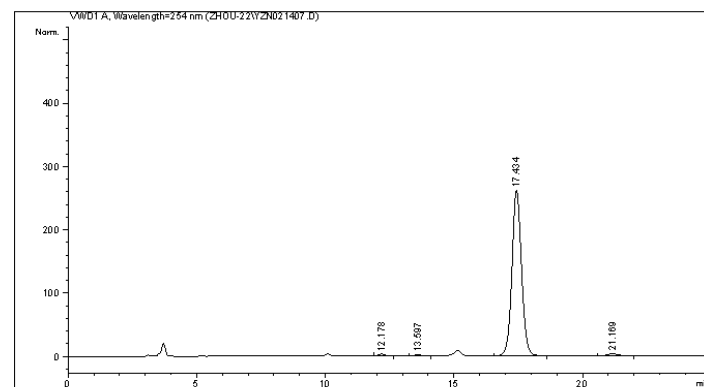
Instrument 1 6/18/2022 1:56:15 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021407.D
 Sample Name: LL-10-10C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/17/2022 8:25:19 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/17/2022 8:01:10 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/18/2022 1:55:37 AM
 (modified after loading)
 Sample Info : IA, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

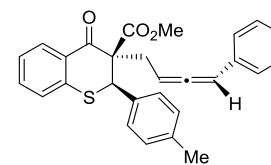
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	12.178	VB	0.2871	63.09805	3.25846	0.9013
2	13.597	VB	0.3102	46.35885	2.30663	0.6622
3	17.434	EB	0.3974	6776.02734	262.32910	96.7889
4	21.169	BB	0.4919	115.34654	3.64128	1.6476

Totals : 7000.83079 271.53548

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

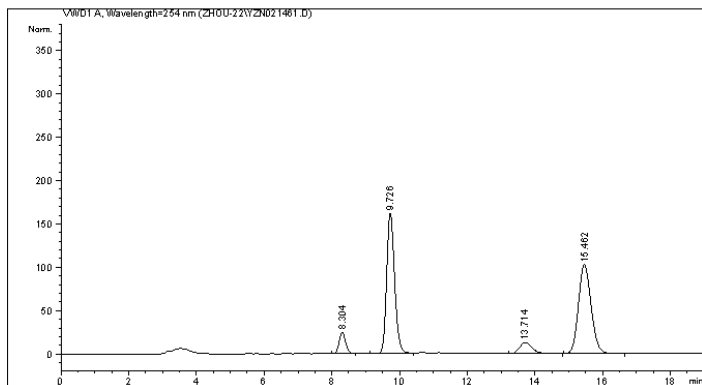
Instrument 1 6/18/2022 1:55:48 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021461.D
 Sample Name: LL-10-25A +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/30/2022 9:14:24 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/30/2022 9:11:25 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/1/2022 4:41:13 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

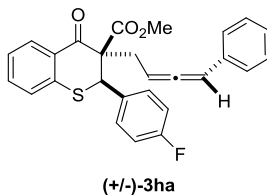
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	8.304	BV	0.2048	332.16351	24.95156	5.5432
2	9.726	VV	0.2535	2674.45972	162.17827	44.6315
3	13.714	BB	0.3957	333.42480	12.85673	5.5642
4	15.462	BB	0.4010	2652.26978	102.46486	44.2612

Totals : 5992.31781 302.45142

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

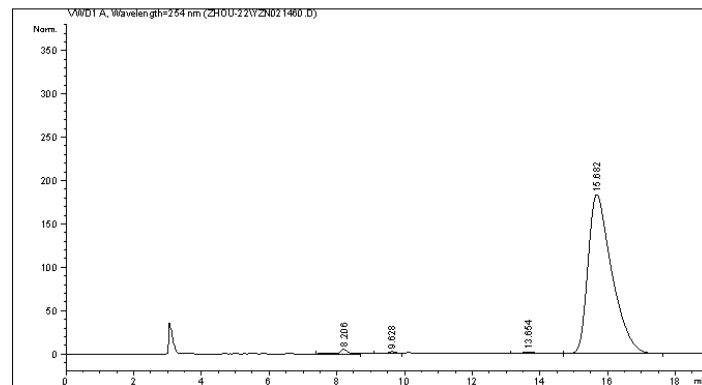
Instrument 1 7/1/2022 4:41:54 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021460.D
 Sample Name: LL-10-25A

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/30/2022 8:49:54 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/30/2022 7:50:37 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/1/2022 4:41:13 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

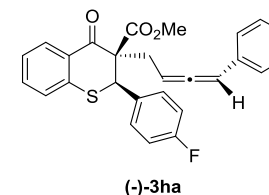
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	8.206	BB	0.2224	74.65000	5.03600	0.8207
2	9.628	BV	0.2763	42.77714	2.35195	0.4703
3	13.654	BV	0.4673	52.19173	1.65324	0.5738
4	15.682	VB	0.7245	8926.16309	183.59103	98.1352

Totals : 9095.78195 192.63221

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

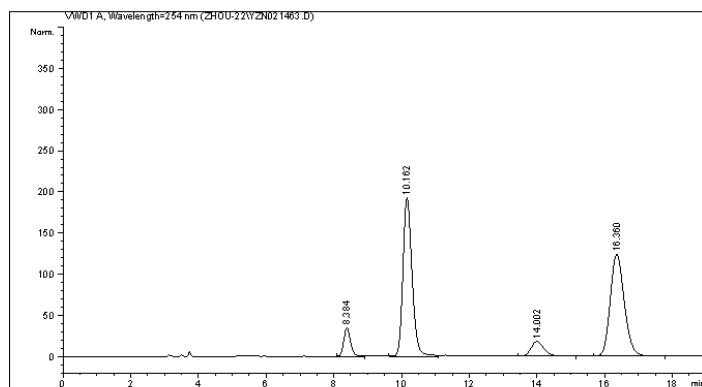
Instrument 1 7/1/2022 4:41:24 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021463.D
 Sample Name: LL-10-25B +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/30/2022 10:00:41 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/30/2022 9:58:43 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/1/2022 4:46:27 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

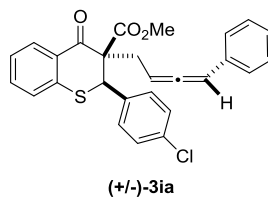
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.384	BV	0.2152	482.19040	34.56851	5.9241
2	10.162	VV	0.2885	3604.76440	192.39569	44.2875
3	14.002	EB	0.4158	484.23416	17.99613	5.9492
4	16.360	BB	0.4444	3568.27002	123.64312	43.8392

Totals : 8139.45898 368.60345

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

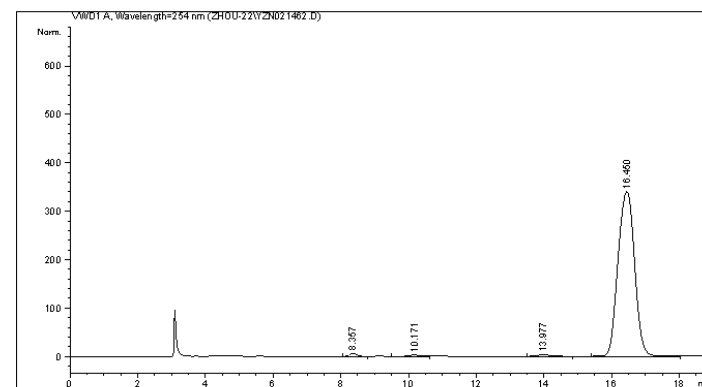
Instrument 1 7/1/2022 4:46:30 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021462.D
 Sample Name: LL-10-25B

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/30/2022 9:38:03 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/30/2022 9:33:48 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/1/2022 4:46:02 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

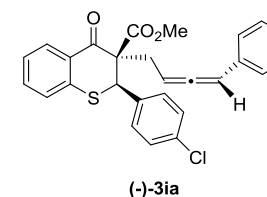
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.357	BV	0.2143	91.02782	6.55875	0.7722
2	10.171	VV	0.3167	58.77496	2.77823	0.4986
3	13.977	EB	0.4041	86.74761	3.28612	0.7359
4	16.450	BB	0.5535	1.15518e4	340.12857	97.9934

Totals : 1.17884e4 352.75168

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

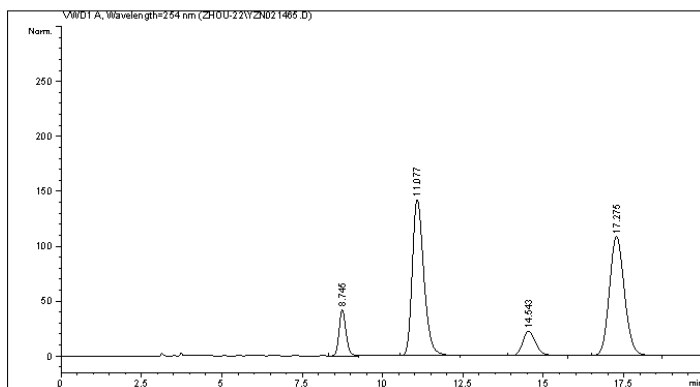
Instrument 1 7/1/2022 4:46:06 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021465.D
 Sample Name: LL-10-25C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/30/2022 10:53:03 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/30/2022 10:51:05 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/1/2022 4:50:40 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

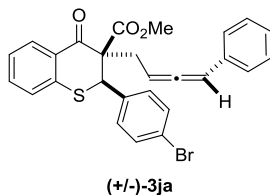
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	8.745	VV	0.2287	625.18262	42.06327	7.5051
2	11.077	VB	0.3851	3562.41309	142.35739	42.7654
3	14.543	VB	0.4303	623.19031	22.33843	7.4812
4	17.275	BB	0.5038	3519.34717	108.44839	42.2484

Totals : 8330.13318 315.20749

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

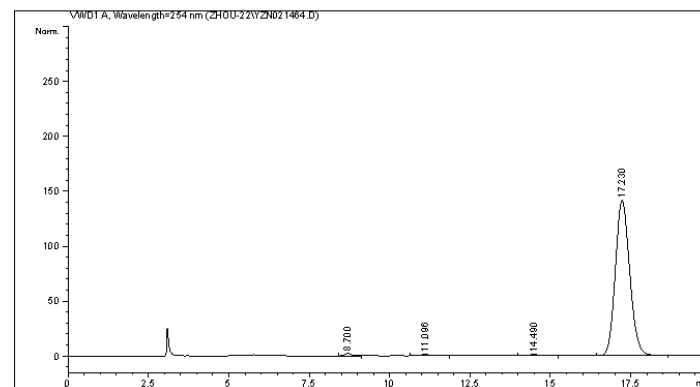
Instrument 1 7/1/2022 4:51:05 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021464.D
 Sample Name: LL-10-25C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 6/30/2022 10:29:22 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 6/30/2022 10:23:14 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/1/2022 4:50:40 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

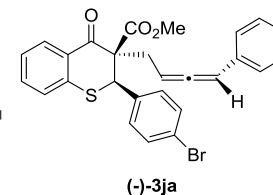
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	8.700	BB	0.2285	32.55314	2.19361	0.7245
2	11.096	BB	0.3843	27.47681	1.09014	0.6115
3	14.490	BB	0.4159	29.13189	1.04390	0.6483
4	17.230	BB	0.4828	4404.18799	141.39259	98.0157

Totals : 4493.34983 145.72023

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

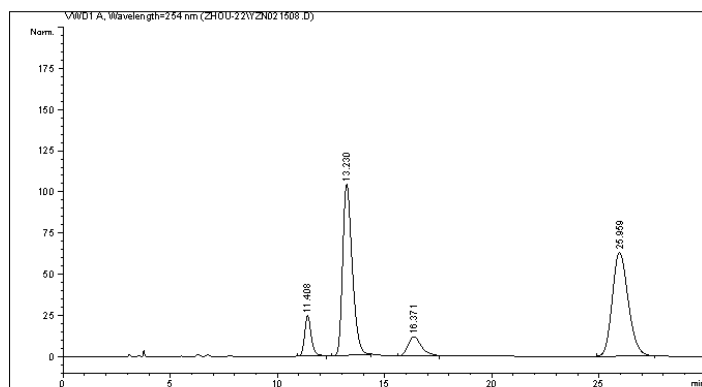
Instrument 1 7/1/2022 4:50:46 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021508.D
 Sample Name: LL-10-41A +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/12/2022 9:34:30 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/12/2022 9:33:12 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 9:54:45 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

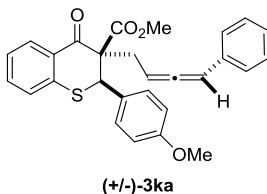
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.408	BB	0.3305	528.32330	24.47416	7.0115
2	13.230	BB	0.4760	3226.41968	103.85638	42.8184
3	16.371	BB	0.6728	510.24002	11.64561	6.7715
4	25.959	BB	0.8072	3270.14917	63.07744	43.3987

Totals : 7535.13217 203.05359

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

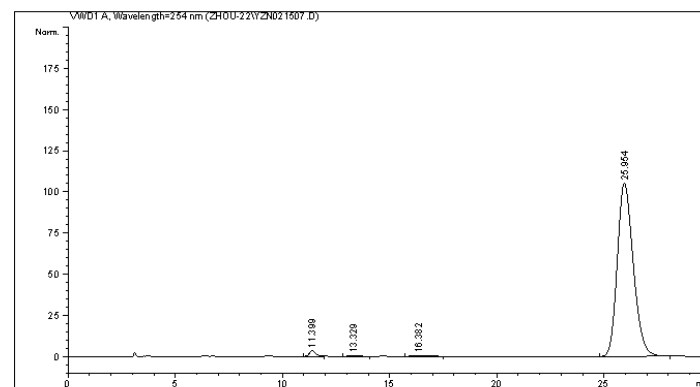
Instrument 1 7/13/2022 9:54:47 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021507.D
 Sample Name: LL-10-41A

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/12/2022 9:00:46 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/12/2022 8:48:05 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/12/2022 10:01:46 PM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

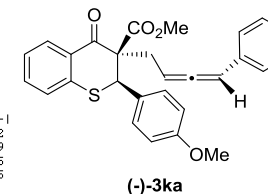
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.399	BB	0.3295	71.07248	3.38412	1.2782
2	13.329	BB	0.4364	16.56297	5.33641e-1	0.2979
3	16.382	BB	0.6242	31.66577	6.64726e-1	0.5695
4	25.954	BB	0.8004	5441.19580	105.13624	97.8545

Totals : 5560.49702 109.71872

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

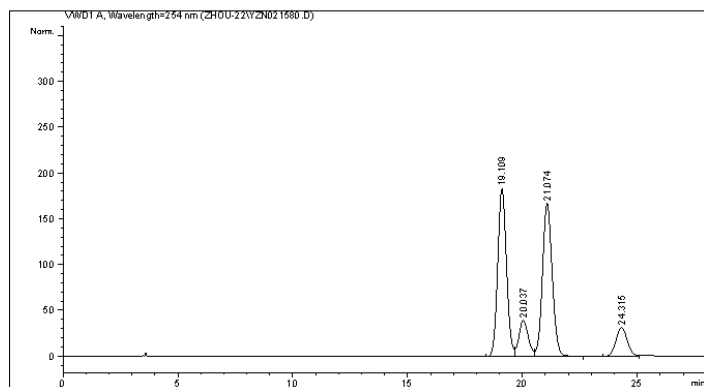
Instrument 1 7/12/2022 10:01:49 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021580.D
 Sample Name: LL-10-53D +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/27/2022 8:40:40 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/27/2022 8:37:30 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/27/2022 9:14:13 AM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 99/1, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

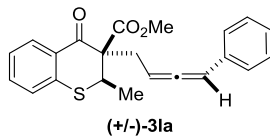
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	19.109	BV	0.4115	4856.06885	183.02740	40.6086
2	20.037	VV	0.4314	1103.95667	39.26189	9.2318
3	21.074	VB	0.4557	4915.48437	166.89432	41.1054
4	24.315	BV	0.5321	1082.72046	31.49474	9.0542

Totals : 1.19582e4 420.67836

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

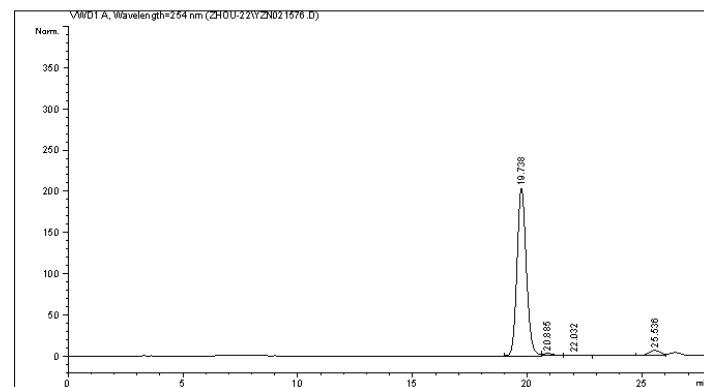
Instrument 1 7/27/2022 9:14:58 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021576.D
 Sample Name: LL-10-53D

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/26/2022 9:00:16 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/26/2022 8:19:57 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/27/2022 9:09:48 AM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 99/1, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

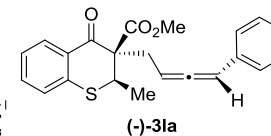
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	19.738	BV	0.4350	5717.60791	202.95280	93.9247
2	20.885	VV	0.4792	92.30535	2.80027	1.5163
3	22.032	VB	0.4718	29.17776	8.37778e-1	0.4793
4	25.536	BV	0.5708	248.34492	6.65473	4.0796

Totals : 6087.43595 213.24558

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

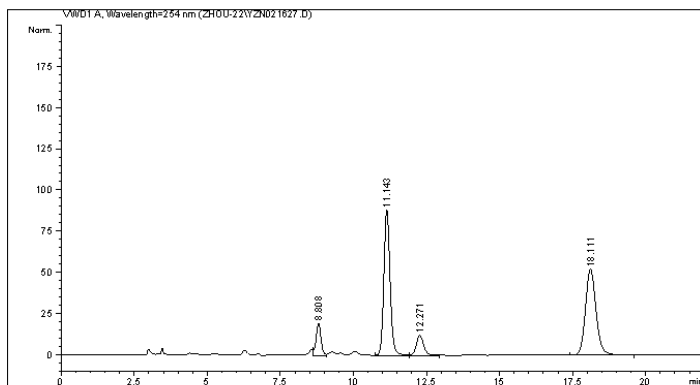
Instrument 1 7/27/2022 9:09:58 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021627.D
 Sample Name: LL-10-63B +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 8/25/2022 9:23:11 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/25/2022 9:21:55 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/26/2022 9:08:17 PM
 (modified after loading)
 Sample Info : IB, Hexane/i-PrOH = 85/15, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

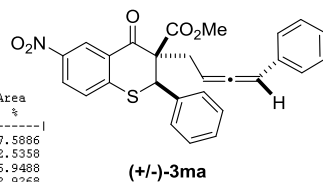
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	8.808	VV	0.1801	232.57033	19.67810	7.5886
2	11.143	BV	0.2279	1303.60742	88.15347	42.5358
3	12.271	VB	0.2674	212.96240	12.21845	6.9488
4	18.111	VB	0.3880	1315.58972	52.06441	42.9268

Totals : 3064.72987 172.11444

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

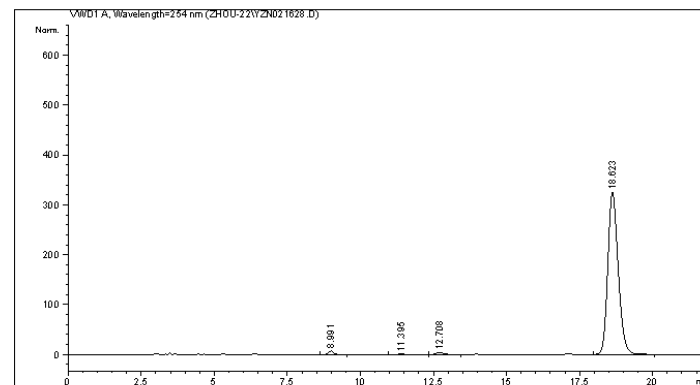
Instrument 1 8/26/2022 9:08:21 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021628.D
 Sample Name: LL-10-63B

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 8/25/2022 9:48:11 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/25/2022 9:46:45 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/26/2022 8:57:54 PM
 (modified after loading)
 Sample Info : IB, Hexane/i-PrOH = 85/15, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

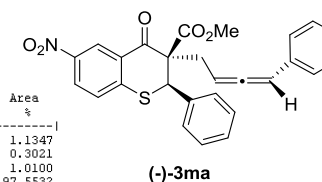
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	8.891	BV	0.1997	93.60039	6.99972	1.1347
2	11.395	VB	0.3694	24.92332	9.25774e-1	0.3021
3	12.708	BB	0.2929	83.31068	4.24815	1.0100
4	18.623	BB	0.3821	8047.06543	324.92776	97.5532

Totals : 8248.89981 337.10141

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

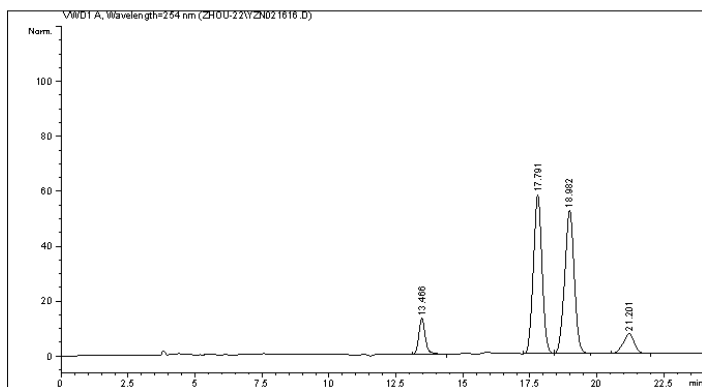
Instrument 1 8/26/2022 8:58:03 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021616.D
 Sample Name: LL-10-63C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 8/23/2022 2:03:58 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/23/2022 1:49:44 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/26/2022 9:41:43 PM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 90/10, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

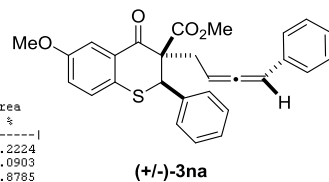
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	13.466	BB	0.2546	218.44931	13.07639	7.2224
2	17.791	BV	0.3474	1303.31104	57.82098	43.0903
3	18.982	VB	0.3782	1296.90649	52.01914	42.8785
4	21.201	BB	0.4330	205.93846	7.19370	6.8088

Totals : 3024.60530 130.11022

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

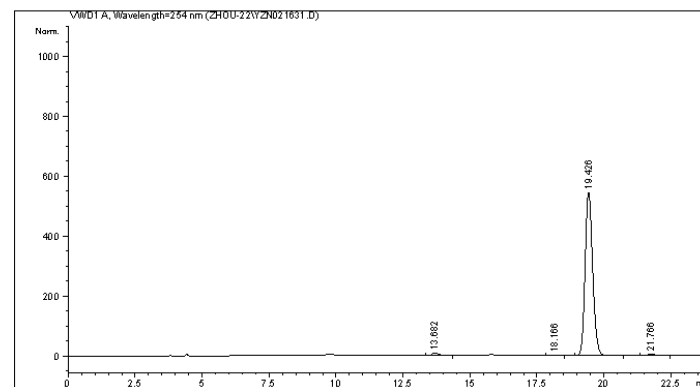
Instrument 1 8/26/2022 9:41:47 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021631.D
 Sample Name: LL-10-63C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 8/25/2022 11:33:14 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/25/2022 11:26:21 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/26/2022 9:38:23 PM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 90/10, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

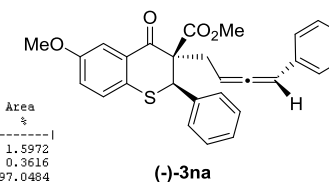
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	13.682	VB	0.2632	175.35739	9.63931	1.5972
2	18.166	VV	0.2730	39.70545	2.24793	0.3616
3	19.426	VB	0.3034	1.06550e4	545.97540	97.0484
4	21.766	VB	0.3436	108.99452	4.90750	0.9928

Totals : 1.09790e4 562.77014

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

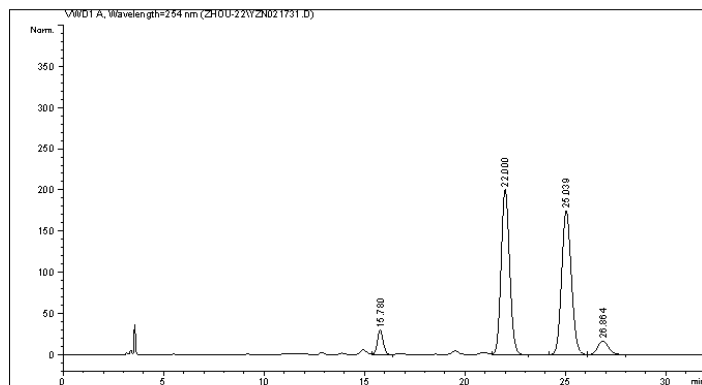
Instrument 1 8/26/2022 9:39:49 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021731.D
 Sample Name: LL-10-74C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/29/2022 10:31:50 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 10:28:25 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 11:26:15 PM
 (modified after loading)
 Sample Info : AD-H, Hexane/i-PrOH = 96/4, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

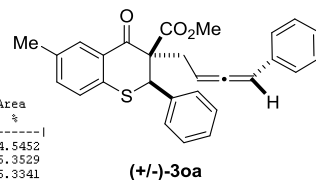
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	15.780	VV	0.3096	589.07922	29.38743	4.5452
2	22.000	VB	0.4587	5877.99072	200.36493	45.3529
3	25.039	VV	0.5261	5875.54785	174.82314	45.3341
4	26.864	VB	0.5741	617.93982	16.59704	4.7678

Totals : 1.29606e4 421.17253

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

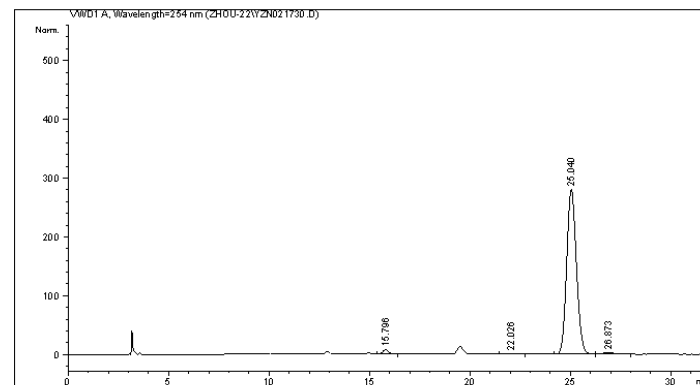
Instrument 1 9/29/2022 11:26:17 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021730.D
 Sample Name: LL-10-74C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/29/2022 9:50:45 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 9:29:36 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 11:26:47 PM
 (modified after loading)
 Sample Info : AD-H, Hexane/i-PrOH = 96/4, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

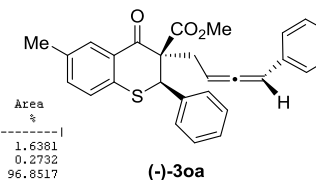
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	15.796	VB	0.3152	159.12651	7.84813	1.6381
2	22.026	BB	0.4457	26.53791	9.16074e-1	0.2732
3	25.040	EV	0.5227	9408.33594	280.25143	96.8517
4	26.873	VB	0.5841	120.17010	3.15510	1.2371

Totals : 9714.17046 292.17074

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

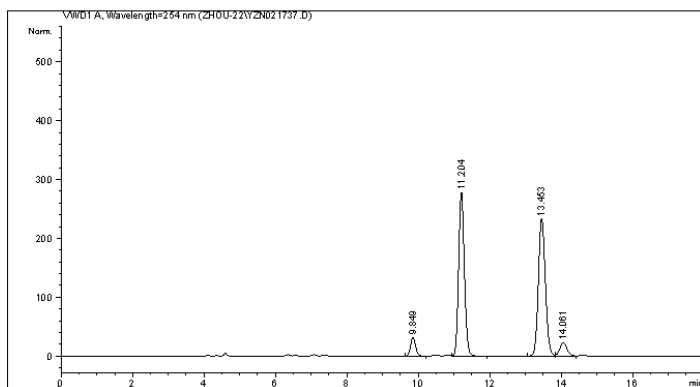
Instrument 1 9/29/2022 11:28:52 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021737.D
 Sample Name: LL-10-74D +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/30/2022 4:09:33 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/30/2022 3:22:41 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/30/2022 10:30:07 AM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 96/4, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

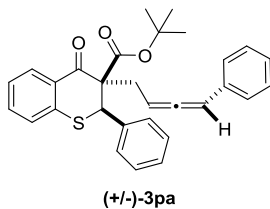
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	9.849	EV	0.1524	313.24661	31.90422	4.5283
2	11.204	VB	0.1747	3124.62256	278.28778	45.1701
3	13.453	EV	0.2107	3161.98291	233.03334	45.7102
4	14.061	VV	0.2167	317.61075	22.55185	4.5914

Totals : 6917.46283 565.77719

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

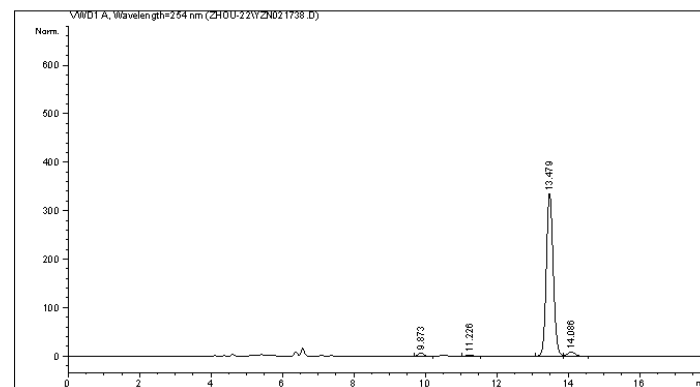
Instrument 1 9/30/2022 10:30:10 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021738.D
 Sample Name: LL-10-74D

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/30/2022 4:36:43 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/30/2022 4:35:06 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/30/2022 10:31:58 AM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 96/4, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

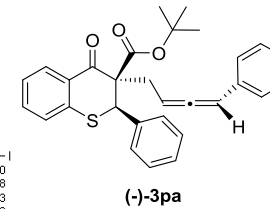
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	9.873	EB	0.1520	64.97693	6.64180	1.3830
2	11.226	BB	0.1724	23.62246	2.14162	0.5028
3	13.479	EV	0.2086	4488.53320	335.39087	95.5353
4	14.086	VB	0.2211	121.16512	8.52858	2.5789

Totals : 4698.29771 352.70287

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

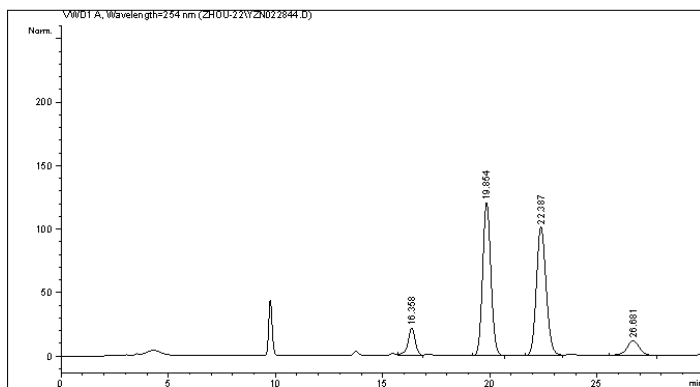
Instrument 1 9/30/2022 10:32:01 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022844.D
 Sample Name: LL-12-24 +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 4/7/2023 7:29:20 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/7/2023 7:13:23 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/7/2023 8:39:19 AM
 (modified after loading)
 Sample Info : AD-H, Hexane/1-PrOH = 93/7, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

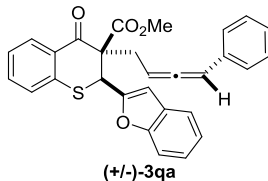
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.358	VV	0.3672	524.67554	21.54059	7.0267
2	19.854	BB	0.4169	3234.56738	120.34997	43.3188
3	22.387	BB	0.4919	3219.40454	101.22676	43.1157
4	26.681	BB	0.6375	488.24710	11.68464	6.5388

Totals : 7466.89456 254.80195

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

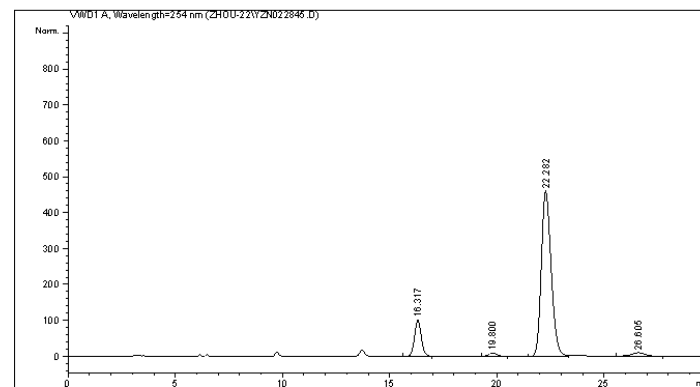
Instrument 1 4/7/2023 8:39:24 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022845.D
 Sample Name: LL-12-24

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 4/7/2023 8:07:17 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/7/2023 8:05:23 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/7/2023 8:41:35 AM
 (modified after loading)
 Sample Info : AD-H, Hexane/1-PrOH = 93/7, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

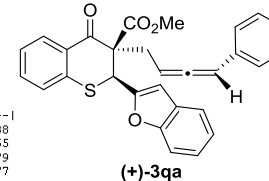
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.317	VB	0.3393	2188.46094	100.18697	12.4988
2	19.800	BB	0.4179	235.59383	8.78028	1.3455
3	22.282	BB	0.4926	1.46637e4	460.16486	83.7479
4	26.605	BB	0.6436	421.57547	9.79131	2.4077

Totals : 1.75094e4 578.92341

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

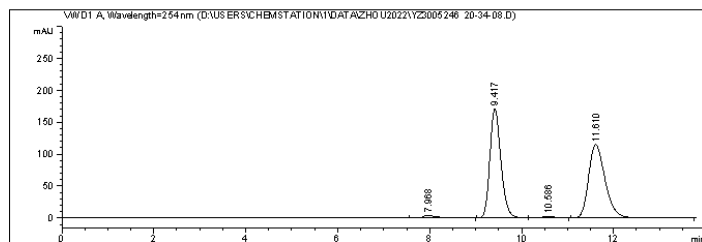
Instrument 1 4/7/2023 8:41:43 AM

Page 1 of 1



Data File D:\USERS\CHEMSTATION\1\DATA\ZHOU2022\YZ3005246 20-34-08.D
 Sample Name: LL-10-70 D +/-

=====
 Acq. Operator : SYSTEM
 Sample Operator : SYSTEM
 Acq. Instrument : 1260II Location : -
 Injection Date : 9/29/2022 8:34:08 PM Inj : 1
 Inj Volume : No inj
 Acq. Method : C:\Users\Public\Documents\ChemStation\1\Methods\def_LC.M
 Last changed : 9/29/2022 6:41:47 PM by SYSTEM
 (modified after loading)
 Analysis Method : C:\Users\Public\Documents\ChemStation\1\Methods\def_LC.M
 Last changed : 9/29/2022 10:32:32 PM by SYSTEM
 (modified after loading)
 Sample Info : OD-H, n-Hexane/1-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

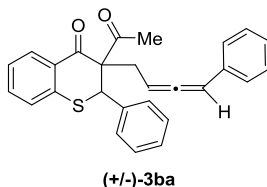
Sorted By : Signal
 Multiplier : 1.0000
 Dilution : 1.0000
 Do not use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.968	BB	0.3140	95.62804	4.22667	1.6388
2	9.417	BB	0.2554	2837.91357	171.22769	48.6328
3	10.586	BB	0.2802	42.20076	2.32035	0.7232
4	11.610	BB	0.3819	2859.64502	115.07438	49.0052

Totals : 5835.38739 292.84909

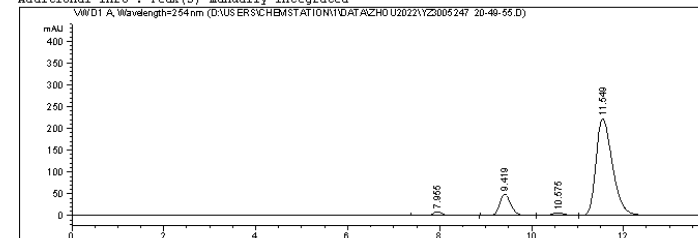
=====
 *** End of Report ***



Data File D:\USERS\CHEMSTATION\1\DATA\ZHOU2022\YZ3005247 20-49-55.D
 Sample Name: LL-10-70 D

=====
 Acq. Operator : SYSTEM
 Sample Operator : SYSTEM
 Acq. Instrument : 1260II Location : -
 Injection Date : 9/29/2022 8:49:55 PM Inj : 1
 Inj Volume : No inj
 Acq. Method : C:\Users\Public\Documents\ChemStation\1\Methods\def_LC.M
 Last changed : 9/29/2022 6:41:47 PM by SYSTEM
 (modified after loading)
 Analysis Method : C:\Users\Public\Documents\ChemStation\1\Methods\def_LC.M
 Last changed : 9/29/2022 10:34:30 PM by SYSTEM
 (modified after loading)
 Sample Info : OD-H, n-Hexane/1-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm

Additional Info : Peak(s) manually integrated



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

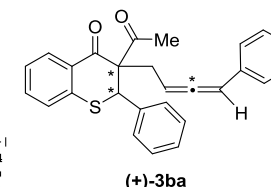
Sorted By : Signal
 Multiplier : 1.0000
 Dilution : 1.0000
 Do not use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.955	BB	0.2151	128.63974	9.09024	1.9534
2	9.419	BB	0.2575	820.85236	49.23763	12.4649
3	10.575	VB	0.2909	110.45456	5.83479	1.6773
4	11.549	VB	0.3810	5525.35205	222.30194	83.9043

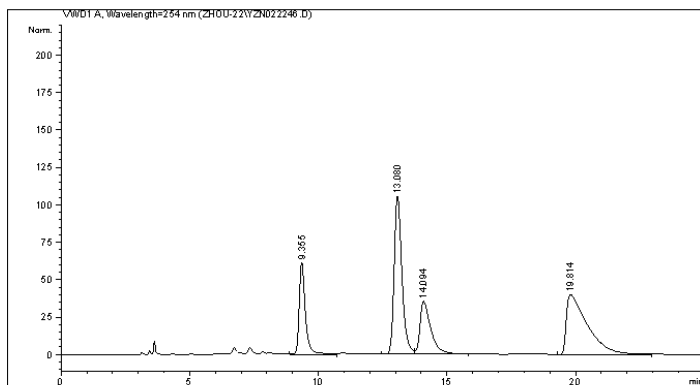
Totals : 6585.29871 286.46461

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



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022246.D
 Sample Name: LL-11-55 +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 12/28/2022 3:07:07 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 12/28/2022 2:38:29 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 12/28/2022 7:07:08 AM
 (modified after loading)
 Sample Info : IB, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

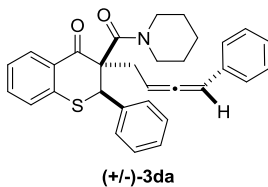
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	9.355	VV	0.2485	1026.85571	61.56679	15.6667
2	13.080	BV	0.3230	2235.13110	105.44186	34.1014
3	14.094	VB	0.4324	1035.48242	35.31476	15.7983
4	19.814	VB	0.8030	2256.90283	39.87349	34.4335

Totals : 6554.37207 242.19690

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

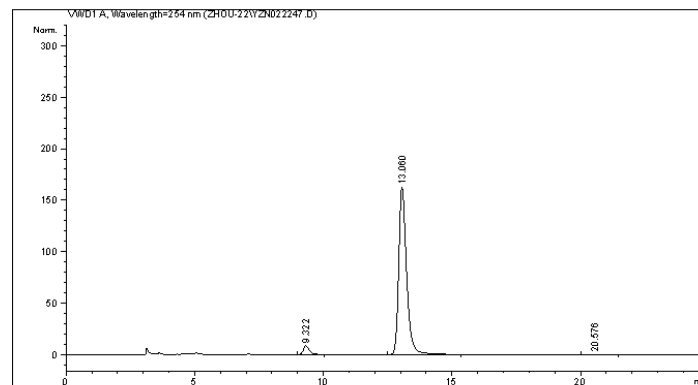
Instrument 1 12/28/2022 7:07:16 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022247.D
 Sample Name: LL-11-55

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 12/28/2022 3:40:27 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 12/28/2022 3:38:28 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 12/28/2022 7:11:09 AM
 (modified after loading)
 Sample Info : IB, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

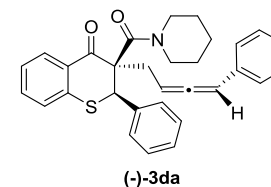
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	9.322	BB	0.2406	133.84752	8.42971	3.7125
2	13.060	BB	0.3217	3467.33984	162.54366	96.1728
3	20.576	BB	0.5043	4.13658	9.73773e-2	0.1147

Totals : 3605.32394 171.07074

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

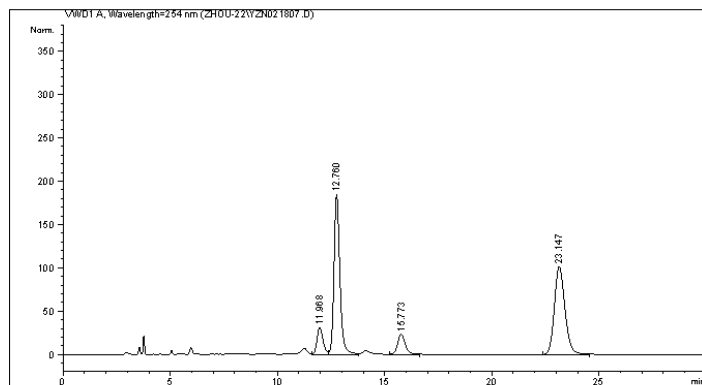
Instrument 1 12/28/2022 7:11:14 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021807.D
 Sample Name: LL-10-91 +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/19/2022 9:35:00 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/19/2022 9:33:18 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/20/2022 9:17:15 AM
 (modified after loading)
 Sample Info : IB, Hexane/i-PrOH = 80/20, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

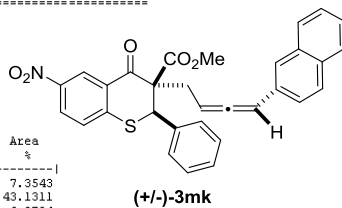
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	11.968	VV	0.2969	599.92419	31.03337	7.3543
2	12.760	VV	0.2895	3518.40283	184.44260	43.1311
3	15.773	BB	0.3779	568.60596	23.06100	6.9704
4	23.147	BB	0.5238	3470.52051	101.58165	42.5442

Totals : 8157.45349 340.11861

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

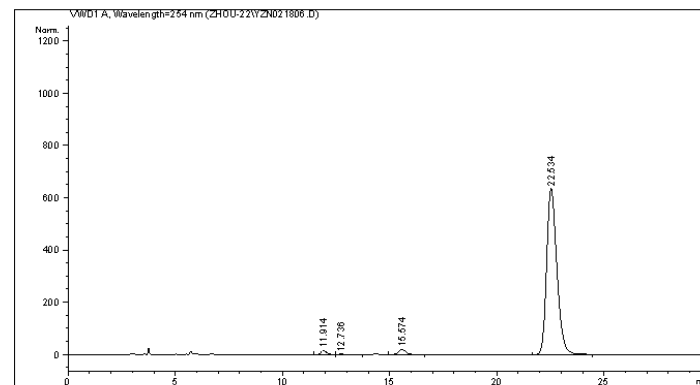
Instrument 1 10/20/2022 9:17:21 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021806.D
 Sample Name: LL-10-91

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/19/2022 8:20:31 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/19/2022 7:51:35 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/20/2022 9:19:44 AM
 (modified after loading)
 Sample Info : IB, Hexane/i-PrOH = 80/20, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

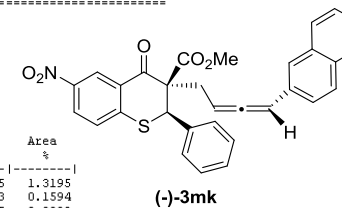
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	11.914	VV	0.3045	288.89047	15.81055	1.3195
2	12.736	VB	0.3716	34.89754	1.56533	0.1594
3	15.574	VB	0.4055	486.77145	20.00565	2.2233
4	22.534	BB	0.5537	2.10831e4	634.59418	96.2977

Totals : 2.18936e4 671.97571

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

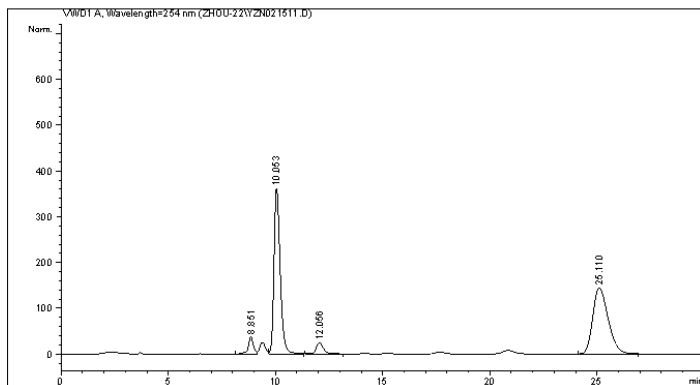
Instrument 1 10/20/2022 9:19:49 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021511.D
 Sample Name: LL-10-41B +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/12/2022 11:43:50 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/12/2022 11:42:35 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 9:48:22 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

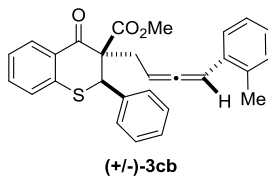
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.851	EV	0.2473	609.97455	37.34377	3.8930
2	10.053	VB	0.3069	7261.25586	361.86163	46.3432
3	12.056	BB	0.3781	604.73486	24.14730	3.8596
4	25.110	BB	0.7700	7192.47559	144.86612	45.9042

Totals : 1.56684e4 568.21882

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

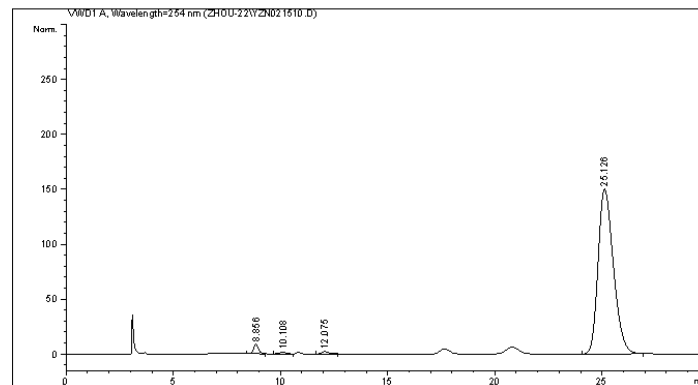
Instrument 1 7/13/2022 9:51:09 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021510.D
 Sample Name: LL-10-41B

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/12/2022 11:11:48 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/12/2022 10:52:16 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 9:52:38 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

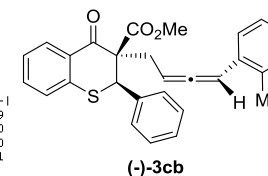
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.856	BB	0.2383	131.87021	8.54310	1.7209
2	10.108	EV	0.3297	36.70646	1.70549	0.4790
3	12.075	BB	0.3454	49.80859	2.15486	0.6500
4	25.126	BB	0.7652	7444.52246	150.05699	97.1501

Totals : 7662.90771 162.46044

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

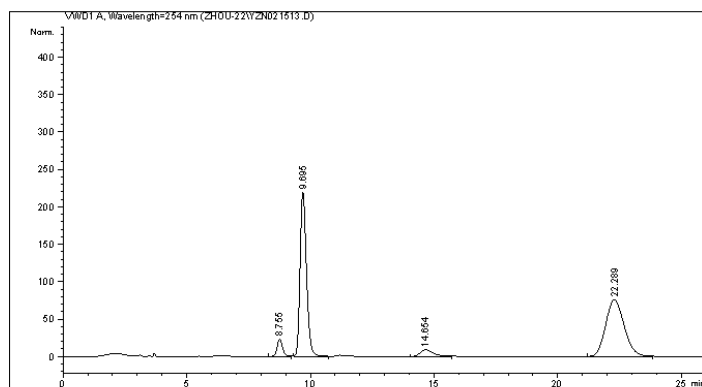
Instrument 1 7/13/2022 9:52:40 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021513.D
 Sample Name: LL-10-41C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/13/2022 2:40:13 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 2:36:21 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 9:57:16 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

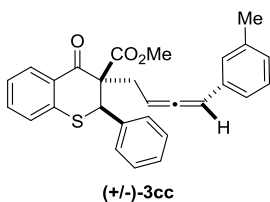
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.755	BB	0.2370	355.48538	23.01476	4.1674
2	9.695	BB	0.2763	3939.74927	219.56552	46.1862
3	14.654	BB	0.5372	319.35623	8.91707	3.7439
4	22.289	BB	0.8076	3915.56177	75.65646	45.9026

Totals : 8530.15265 327.15382

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

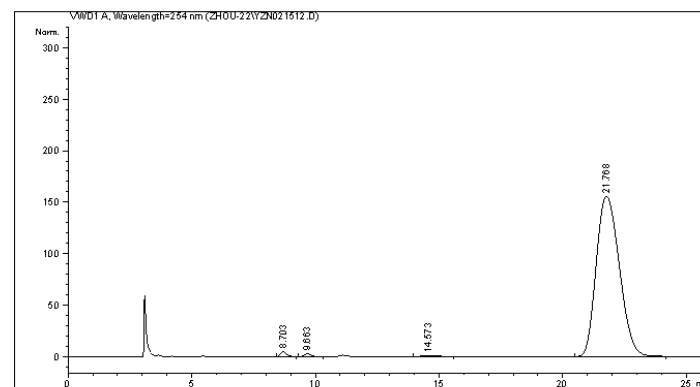
Instrument 1 7/13/2022 9:57:19 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021512.D
 Sample Name: LL-10-41C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/13/2022 2:03:52 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 1:18:45 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 9:59:51 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

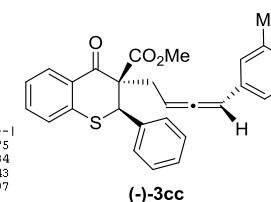
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.703	BB	0.2401	75.96688	4.87356	0.7375
2	9.663	BB	0.2808	48.24833	2.63208	0.4684
3	14.573	BB	0.5498	41.64367	1.12108	0.4043
4	21.768	BB	1.0323	1.01341e4	155.85570	98.3897

Totals : 1.03000e4 164.48252

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

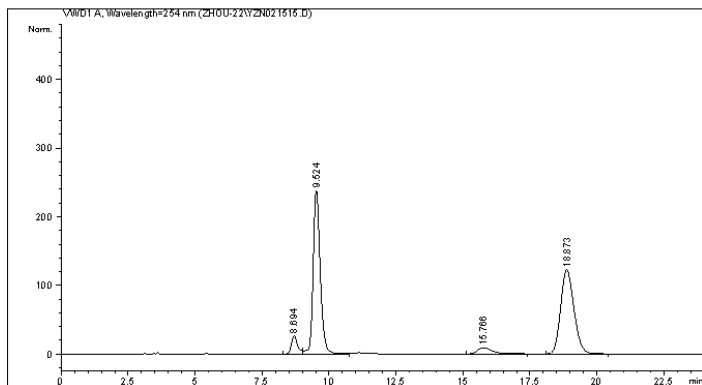
Instrument 1 7/13/2022 9:59:54 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021515.D
 Sample Name: LL-10-41D +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/13/2022 3:44:48 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 3:43:33 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 10:04:33 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

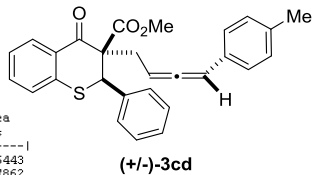
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	8.694	VV	0.2425	427.73480	26.45411	4.5443
2	9.524	VV	0.2810	4403.81104	238.46748	46.7862
3	15.766	BB	0.5838	353.51495	8.99354	3.7557
4	18.873	BB	0.5337	4227.57227	122.49112	44.9138

Totals : 9412.63306 396.40625

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

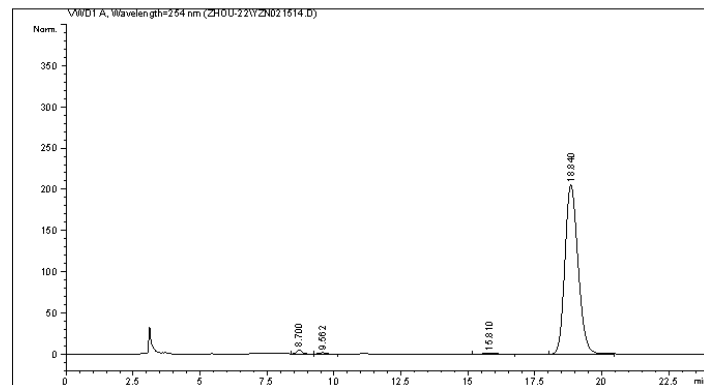
Instrument 1 7/13/2022 10:04:37 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021514.D
 Sample Name: LL-10-41D

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/13/2022 3:15:37 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 3:07:28 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/13/2022 10:06:41 AM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

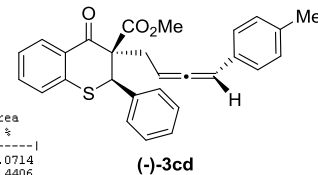
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	8.700	VV	0.2391	76.16090	4.83464	1.0714
2	9.562	VB	0.2840	31.32374	1.66183	0.4406
3	15.810	BB	0.4785	22.21332	5.92009e-1	0.3125
4	18.840	BB	0.5308	6978.90723	205.18338	98.1755

Totals : 7108.60519 212.27186

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

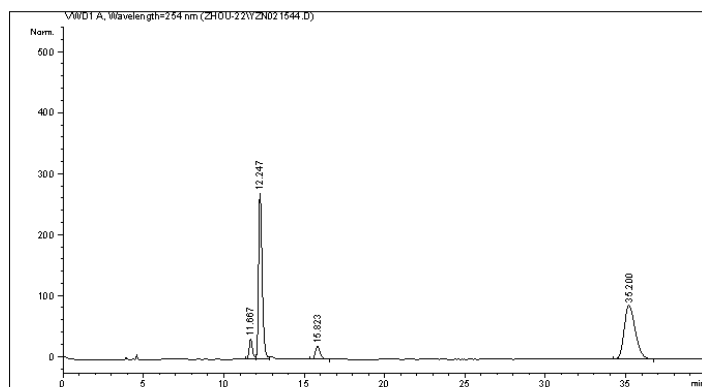
Instrument 1 7/13/2022 10:06:43 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021544.D
 Sample Name: LL-10-48A +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/21/2022 9:23:56 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/21/2022 9:23:44 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/21/2022 11:39:52 PM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

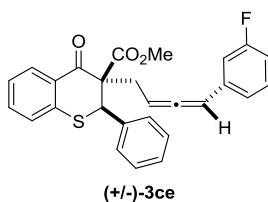
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.667	VV	0.2227	487.38809	33.38966	5.1570
2	12.247	VV	0.2406	4294.65479	272.57999	45.4412
3	15.823	VB	0.3153	437.54269	21.18040	4.6296
4	35.200	BB	0.7468	4231.42529	88.31273	44.7722

Totals : 9451.01086 415.46278

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

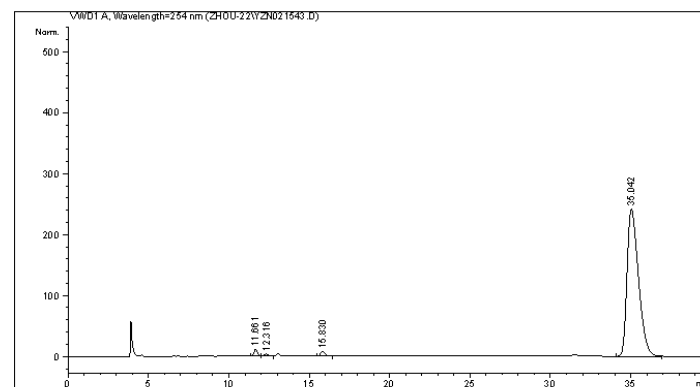
Instrument 1 7/21/2022 11:41:35 PM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021543.D
 Sample Name: LL-10-48A

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/21/2022 8:43:11 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/21/2022 7:55:42 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/21/2022 11:39:52 PM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

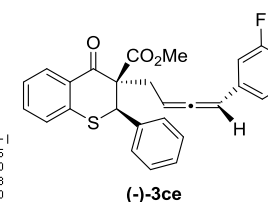
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.661	BV	0.2154	163.26605	11.68452	1.3286
2	12.316	VB	0.2666	64.76287	3.67800	0.5270
3	15.830	BB	0.3145	155.72932	7.60719	1.2673
4	35.042	BB	0.7585	1.19044e4	241.51691	96.8770

Totals : 1.22881e4 264.48662

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

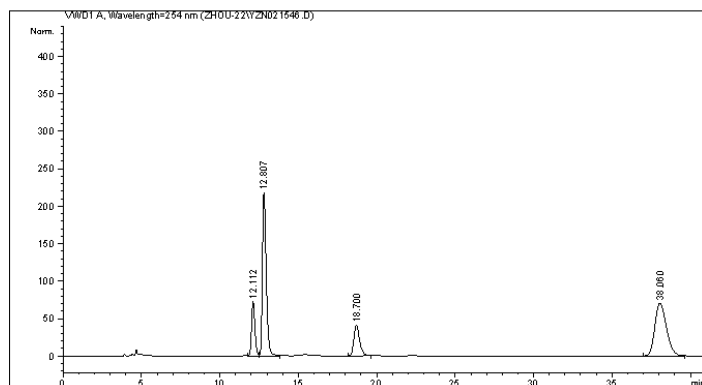
Instrument 1 7/21/2022 11:39:56 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021546.D
 Sample Name: LL-10-48B +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/21/2022 10:48:39 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/21/2022 10:48:12 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/22/2022 10:06:38 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

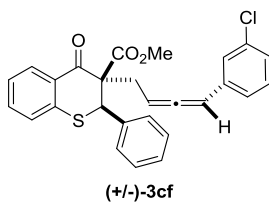
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	12.112	VV	0.2295	1082.02344	72.47380	11.4343
2	12.807	VB	0.2594	3699.03784	217.69196	39.0898
3	18.700	EB	0.3912	1055.68799	41.12384	11.1560
4	38.060	BB	0.7947	3626.18237	70.56090	38.3199

Totals : 9462.93164 401.85050

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

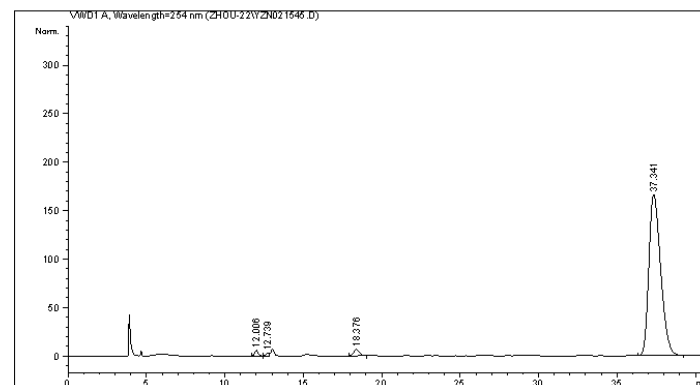
Instrument 1 7/22/2022 10:07:05 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021545.D
 Sample Name: LL-10-48B

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/21/2022 10:05:32 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/21/2022 10:04:30 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/22/2022 10:04:30 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

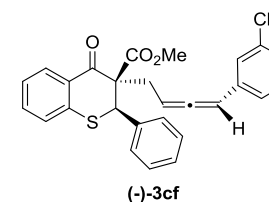
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	12.006	EB	0.2282	85.89397	5.79628	0.9573
2	12.739	EV	0.2121	43.48048	3.11931	0.4846
3	18.376	EB	0.3801	162.03986	6.58871	1.8060
4	37.341	BB	0.8133	8680.69629	166.17635	96.7520

Totals : 8972.11060 181.68064

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

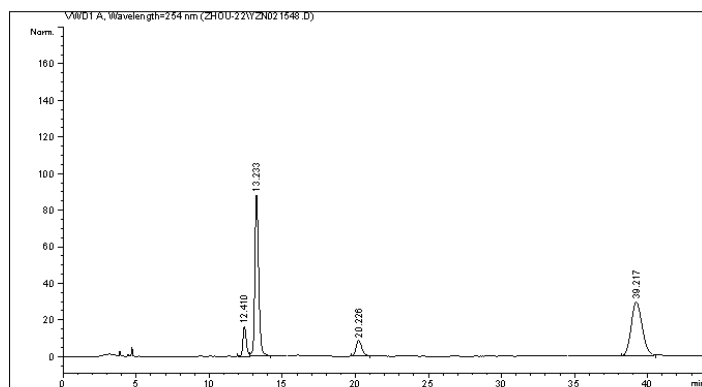
Instrument 1 7/22/2022 10:04:39 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021548.D
 Sample Name: LL-10-48C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/22/2022 12:16:30 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/22/2022 12:15:50 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/22/2022 10:14:58 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

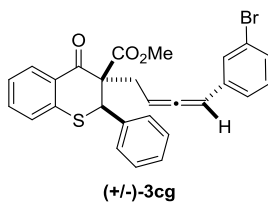
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	12.410	BV	0.2463	260.25967	16.14247	7.2047
2	13.233	VB	0.2767	1596.99915	88.23946	44.2091
3	20.226	EB	0.4272	237.74484	8.64189	6.5814
4	39.217	BB	0.8056	1517.37439	29.34702	42.0049

Totals : 3612.37805 142.37085

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

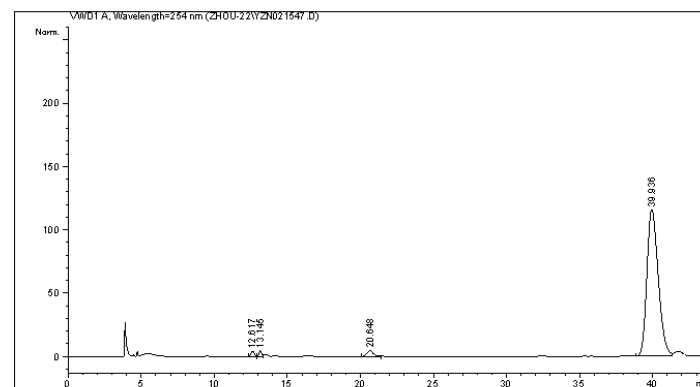
Instrument 1 7/22/2022 10:15:03 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021547.D
 Sample Name: LL-10-48C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/21/2022 11:31:27 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/21/2022 11:31:04 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/22/2022 10:13:11 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

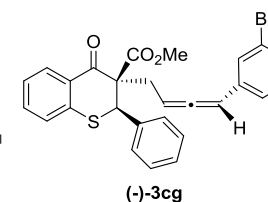
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	12.617	BV	0.2411	66.40042	4.23675	1.0209
2	13.145	VV	0.1952	58.21764	4.57029	0.8951
3	20.648	EB	0.4388	126.19016	4.50699	1.9402
4	39.936	BV	0.8360	6253.27637	115.93504	96.1438

Totals : 6504.08458 129.24908

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

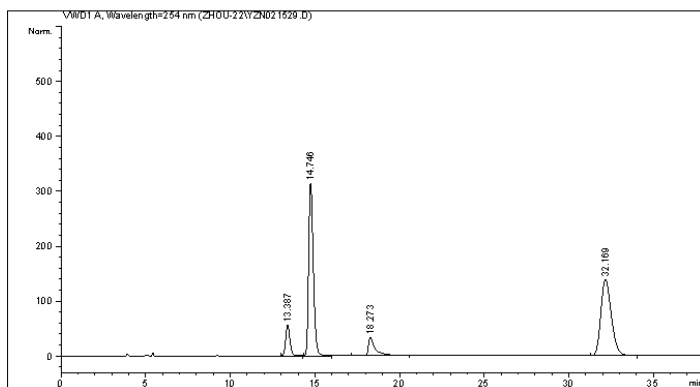
Instrument 1 7/22/2022 10:13:15 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021529.D
 Sample Name: LL-10-48D +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/19/2022 9:39:10 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/19/2022 9:37:20 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/20/2022 3:16:36 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 94/6, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

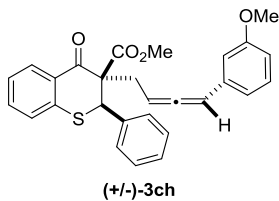
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	13.387	BB	0.2705	982.42444	55.91048	7.0429
2	14.746	BB	0.2928	5998.19287	313.98233	43.0003
3	18.273	VB	0.4124	990.43689	33.74031	7.1003
4	32.169	BB	0.6657	5978.12354	138.77162	42.8565

Totals : 1.39492e4 542.40474

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

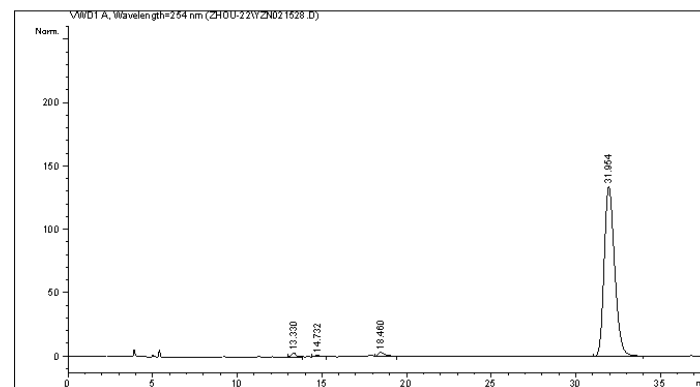
Instrument 1 7/20/2022 3:16:46 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021528.D
 Sample Name: LL-10-48D

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/19/2022 8:54:08 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/19/2022 8:07:12 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/20/2022 3:17:36 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 94/6, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

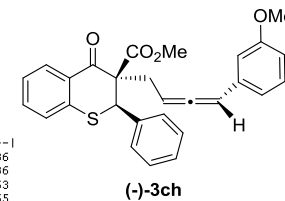
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	13.330	BB	0.2755	56.67506	3.20063	0.9536
2	14.732	BB	0.2897	20.42396	1.08425	0.3436
3	18.460	VB	0.4683	104.38224	3.24607	1.7563
4	31.954	BB	0.6648	5761.81055	133.98936	96.9465

Totals : 5943.29180 141.52031

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

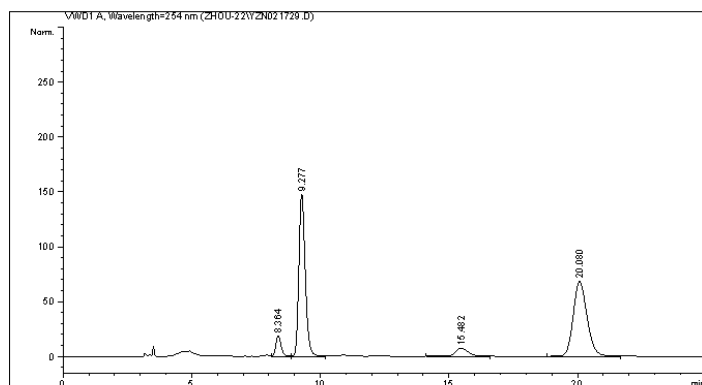
Instrument 1 7/20/2022 3:17:46 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021729.D
 Sample Name: LL-10-74A +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/29/2022 9:03:32 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 8:58:52 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 11:14:30 PM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 96/4, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

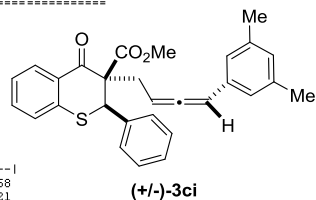
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.364	VV	0.2272	277.44485	18.67989	4.9168
2	9.277	VB	0.2654	2550.08911	147.77696	45.1921
3	15.482	EB	0.5470	275.74170	7.57428	4.8866
4	20.080	BB	0.5712	2539.49609	68.20557	45.0044

Totals : 5642.77176 242.23669

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

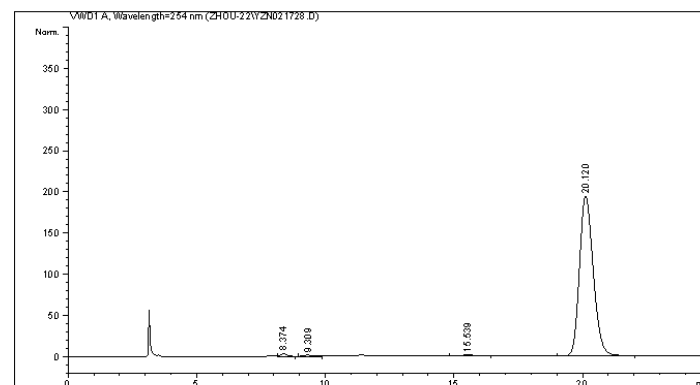
Instrument 1 9/29/2022 11:14:34 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021728.D
 Sample Name: LL-10-74A

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/29/2022 8:33:03 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 7:49:40 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 11:15:41 PM
 (modified after loading)
 Sample Info : OD-H, Hexane/i-PrOH = 96/4, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

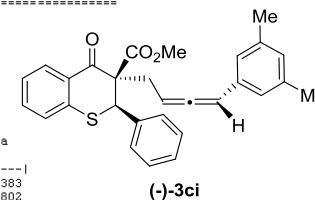
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.374	VB	0.2196	46.83584	3.29737	0.6383
2	9.309	EB	0.2758	27.89707	1.59160	0.3802
3	15.539	EB	0.4939	47.86770	1.43521	0.6524
4	20.120	BB	0.5762	7214.99951	194.17969	98.3291

Totals : 7337.60013 200.50386

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

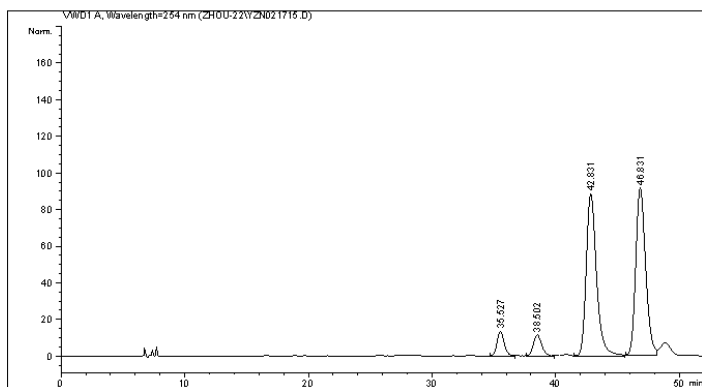
Instrument 1 9/29/2022 11:15:45 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021715.D
 Sample Name: LL-10-74B +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/28/2022 9:40:16 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/28/2022 8:27:29 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/30/2022 10:27:10 AM
 (modified after loading)
 Sample Info : ID+IC, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

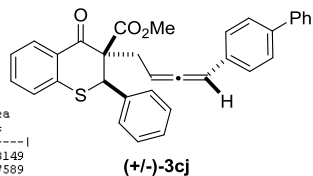
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	35.527	BB	0.6267	544.41461	13.44718	4.8149
2	38.502	BB	0.7234	538.08063	11.44043	4.7589
3	42.831	VB	0.8775	5104.59961	88.40113	45.1458
4	46.831	BV	0.8589	5119.81348	91.58820	45.2804

Totals : 1.13069e4 204.87693

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

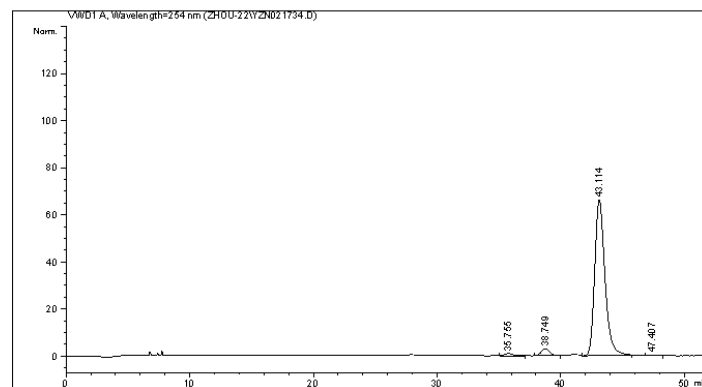
Instrument 1 9/30/2022 10:27:12 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021734.D
 Sample Name: LL-10-74B

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 9/30/2022 12:25:01 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/29/2022 11:54:09 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 9/30/2022 10:23:42 AM
 (modified after loading)
 Sample Info : ID+IC, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

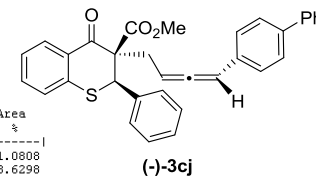
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	35.755	BB	0.6426	43.35707	9.66871e-1	1.0808
2	38.749	BB	0.7249	145.61395	3.07175	3.6298
3	43.114	VB	0.8817	3812.06421	66.17386	95.0265
4	47.407	BB	0.5337	10.54632	2.52585e-1	0.2629

Totals : 4011.58155 70.46507

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

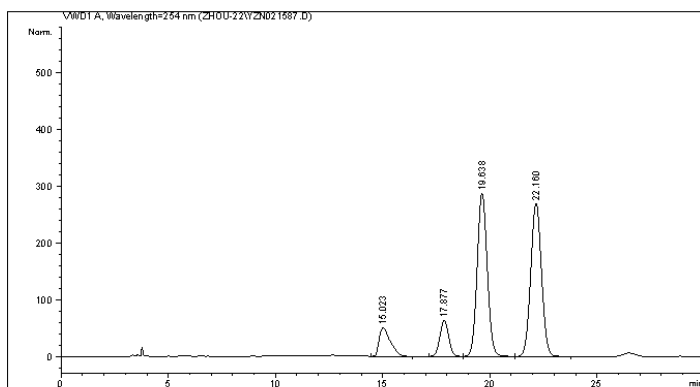
Instrument 1 9/30/2022 10:23:55 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021587.D
 Sample Name: LL-10-53B +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/29/2022 2:53:24 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/29/2022 2:52:48 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/29/2022 4:35:49 AM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

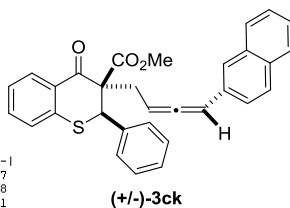
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	15.023	BB	0.5436	1811.80005	49.99577	8.0487
2	17.877	BV	0.4428	1806.43420	63.45760	8.0248
3	19.638	VV	0.5112	9447.49902	287.71786	41.9691
4	22.160	VB	0.5446	9444.86133	270.23135	41.9574

Totals : 2.25106e4 671.40259

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

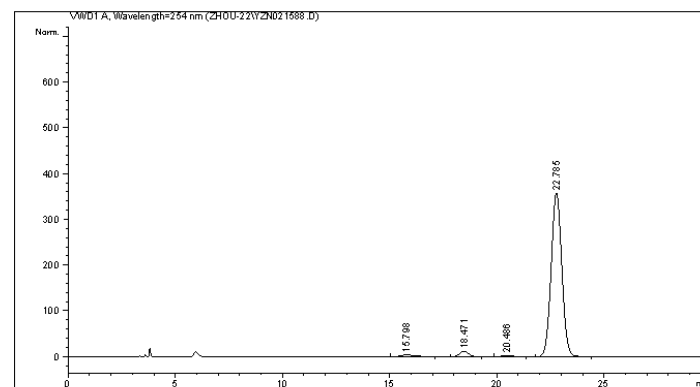
Instrument 1 7/29/2022 4:35:55 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021588.D
 Sample Name: LL-10-53B

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/29/2022 3:28:15 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/29/2022 3:26:18 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/29/2022 4:34:04 AM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

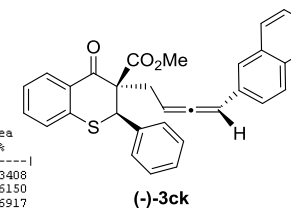
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	15.798	VB	0.6727	173.94283	3.61031	1.3408
2	18.471	BB	0.4384	339.25488	12.02127	2.6150
3	20.486	BB	0.5023	89.74234	2.76555	0.6917
4	22.785	BB	0.5372	1.23705e4	357.86490	95.3525

Totals : 1.29734e4 376.26203

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

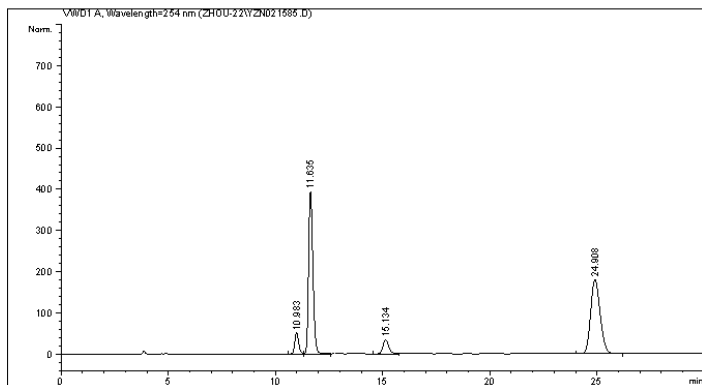
Instrument 1 7/29/2022 4:34:08 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021585.D
 Sample Name: LL-10-53C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/28/2022 11:13:46 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/28/2022 11:11:35 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/29/2022 4:48:25 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 93/7, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

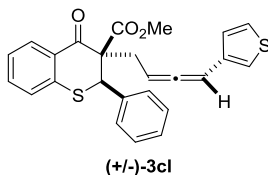
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	10.983	VV	0.1991	658.74353	50.87207	5.3293
2	11.635	VB	0.2163	5523.64844	393.20840	44.6868
3	15.134	VV	0.2871	649.02606	34.62311	5.2507
4	24.908	VB	0.4777	5529.38184	180.06413	44.7332

Totals : 1.23608e4 658.76772

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

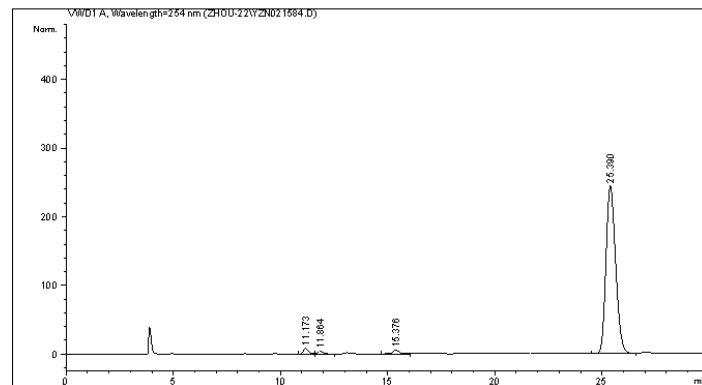
Instrument 1 7/29/2022 4:48:29 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021584.D
 Sample Name: LL-10-53C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 7/28/2022 10:38:21 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/28/2022 10:37:54 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 7/29/2022 4:46:30 AM
 (modified after loading)
 Sample Info : OD-3, Hexane/i-PrOH = 93/7, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

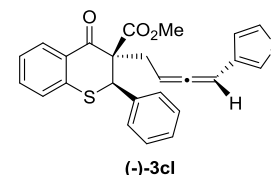
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [mAU]	Area %
1	11.173	EV	0.2393	129.58018	8.21898	1.6320
2	11.864	VB	0.2325	64.47478	4.24672	0.8120
3	15.376	EV	0.3116	113.67928	5.55369	1.4317
4	25.390	VV	0.4868	7632.28809	244.31071	96.1243

Totals : 7940.02232 262.33011

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

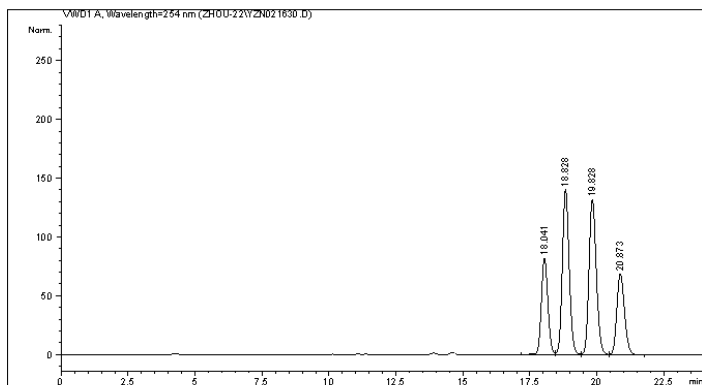
Instrument 1 7/29/2022 4:46:33 AM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021630.D
 Sample Name: LL-10-63A +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 8/25/2022 11:00:22 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/25/2022 10:59:11 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/26/2022 9:11:15 PM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 97/3, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

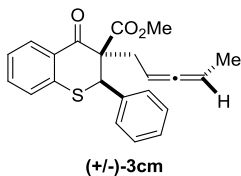
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.041	VV	0.2632	1408.25598	82.50092	18.0563
2	18.828	VV	0.2746	2500.16602	140.51218	32.0565
3	19.828	VV	0.2947	2508.90479	131.92908	32.1685
4	20.873	VB	0.3121	1381.92310	69.06464	17.7187

Totals : 7799.24988 424.00681

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

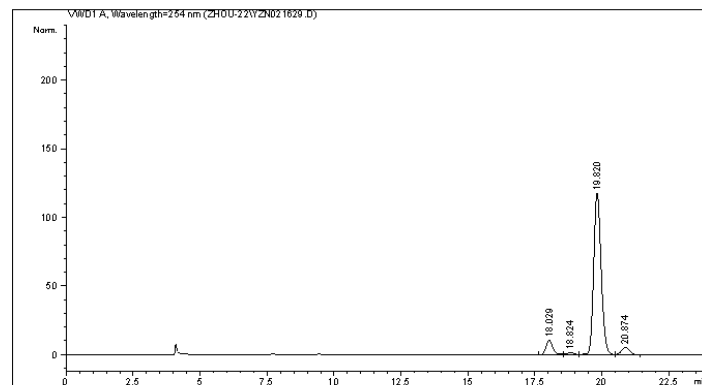
Instrument 1 8/26/2022 9:11:27 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021629.D
 Sample Name: LL-10-63A

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 8/25/2022 10:31:46 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/25/2022 10:13:46 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 8/26/2022 9:29:54 PM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 97/3, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: WVD1 A, Wavelength=254 nm

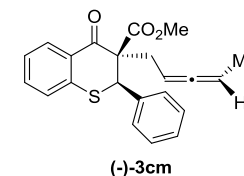
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	18.029	VV	0.2715	188.61549	10.68129	7.2438
2	18.824	VV	0.2767	30.36503	1.68906	1.1662
3	19.820	VV	0.2983	2274.95874	117.72143	87.3704
4	20.874	VB	0.3135	109.87061	5.39045	4.2196

Totals : 2603.80988 135.48223

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

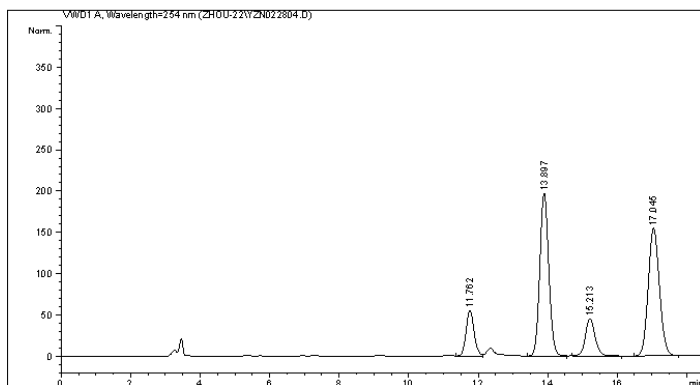
Instrument 1 8/26/2022 9:31:10 PM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022804.D
 Sample Name: LL-12-21B +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 4/2/2023 4:16:47 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/2/2023 3:58:06 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/7/2023 8:20:59 AM
 (modified after loading)
 Sample Info : AD-H, Hexane/i-PrOH = 96/4, 1.0 mL/min, 30 oC, 254 nm



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

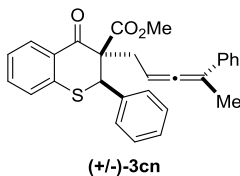
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.762	VV	0.2461	884.03217	55.33675	10.0786
2	13.897	BB	0.2779	3541.40186	197.28014	40.3747
3	15.213	BB	0.2984	885.45581	45.20324	10.0949
4	17.045	BB	0.3474	3460.45874	154.38235	39.4518

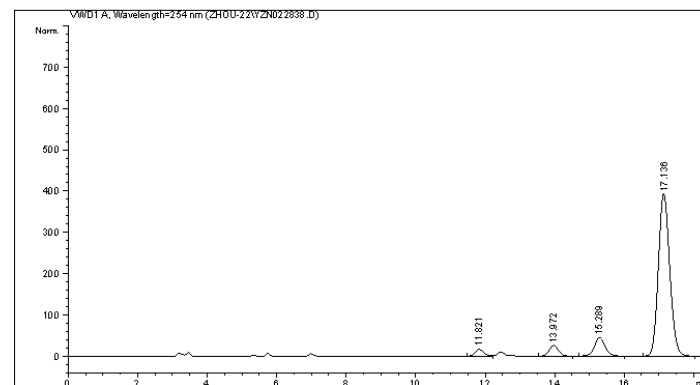
Totals : 8771.34857 452.20248

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



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022838.D
 Sample Name: LL-12-21B

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 4/7/2023 2:08:13 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/7/2023 1:43:00 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/7/2023 8:22:14 AM
 (modified after loading)
 Sample Info : AD-H, Hexane/i-PrOH = 96/4, 1.0 mL/min, 30 oC, 254 nm



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

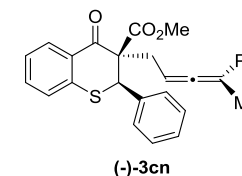
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.821	EV	0.2516	282.20267	16.90334	2.6509
2	13.972	BB	0.2823	473.63223	26.01060	4.4492
3	15.289	BB	0.3257	954.33020	44.54163	8.9647
4	17.136	BB	0.3544	8935.21973	392.48340	83.9352

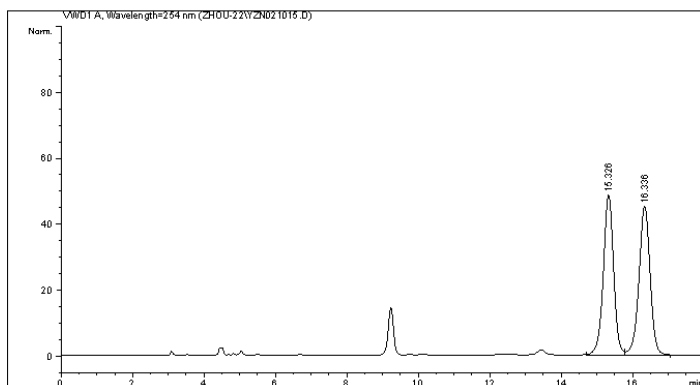
Totals : 1.06454e4 479.93896

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



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021015.D
 Sample Name: LL-9-57C +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 4/21/2022 9:12:58 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/21/2022 9:06:36 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 1/6/2023 8:34:42 PM
 (modified after loading)
 Sample Info : IA, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

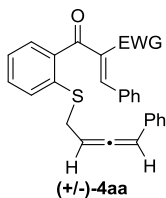
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	15.326	BV	0.3082	973.04175	48.52695	49.8425
2	16.336	VB	0.3318	979.19135	45.12582	50.1575

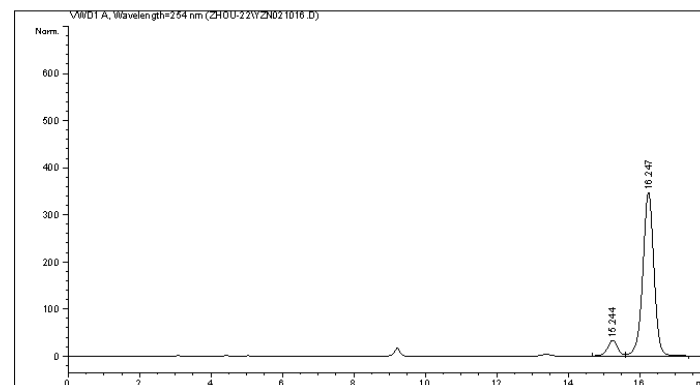
Totals : 1952.23309 93.65277

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



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021016.D
 Sample Name: LL-9-57C

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 4/21/2022 9:32:34 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 4/21/2022 9:31:05 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 1/6/2023 8:35:12 PM
 (modified after loading)
 Sample Info : IA, Hexane/i-PrOH = 94/6, 1.0 mL/min, 30 oC, 254 nm



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

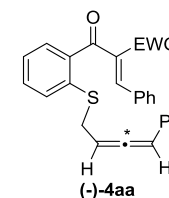
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	15.244	BV	0.3005	657.08240	33.45493	8.0540
2	16.247	VB	0.3304	7501.42480	347.58792	91.9460

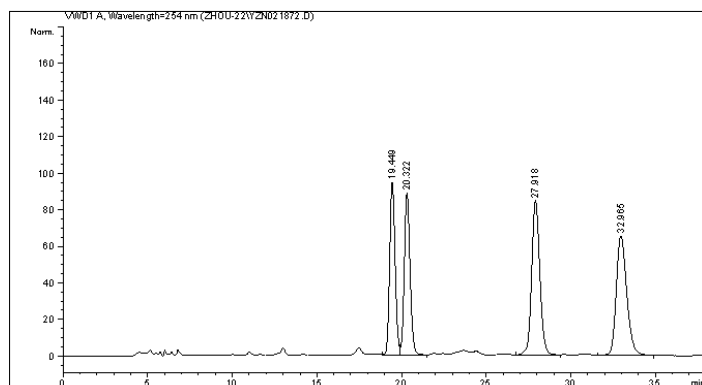
Totals : 8158.50720 381.04285

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



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021872.D
 Sample Name: LL-11-4 +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/24/2022 10:30:45 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/24/2022 10:29:24 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/24/2022 11:53:01 PM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 70/30, 0.7 mL/min, 30 oC, 254 nm



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 Area Percent Report
 =====

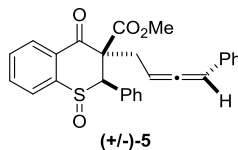
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area %
1	19.449	VV	0.3459	2128.38428	94.98555	21.3251
2	20.322	VV	0.3698	2130.66040	88.91367	21.3479
3	27.918	VB	0.5186	2875.06445	84.64687	28.8064
4	32.965	VB	0.6695	2846.55029	65.57854	28.5207

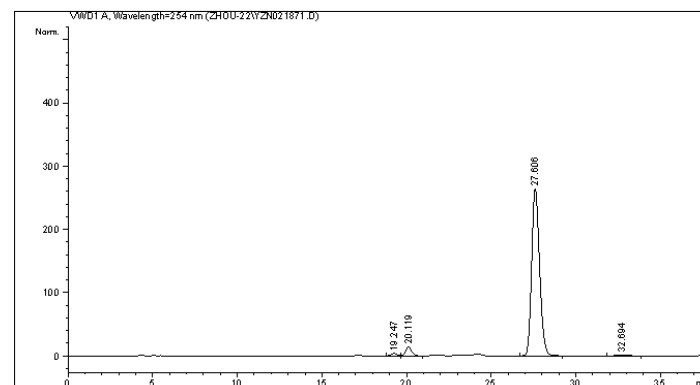
Totals : 9980.65942 334.12463

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



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021871.D
 Sample Name: LL-11-4

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/24/2022 9:50:34 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/24/2022 9:29:28 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/24/2022 11:54:40 PM
 (modified after loading)
 Sample Info : AD-3, Hexane/i-PrOH = 70/30, 0.7 mL/min, 30 oC, 254 nm



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

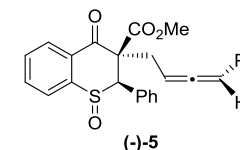
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area %
1	19.247	EV	0.3477	84.40138	3.78293	0.9343
2	20.119	VB	0.3672	331.54840	14.11645	3.6701
3	27.606	EB	0.5067	8566.81055	264.04214	94.8319
4	32.694	BB	0.7352	50.92006	1.03840	0.5637

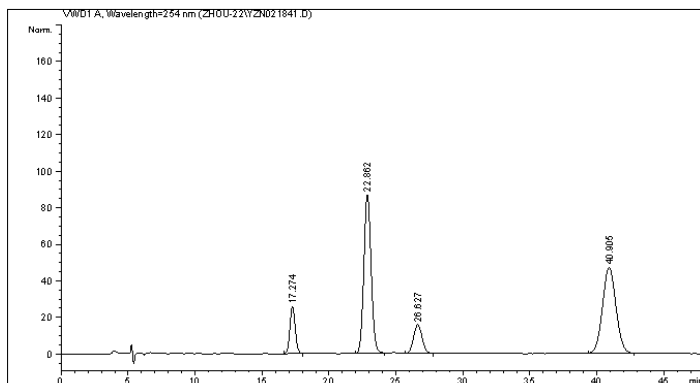
Totals : 9033.68039 282.97992

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



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021841.D
 Sample Name: LL-11-5 +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/22/2022 3:08:51 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/22/2022 3:04:06 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/22/2022 10:51:46 PM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 65/35, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

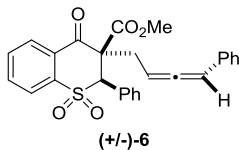
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area %
1	17.274	BB	0.4320	715.35370	25.74029	8.9740
2	22.862	BB	0.5889	3294.61182	86.98376	41.3303
3	26.627	BB	0.6896	700.55835	15.74153	8.7884
4	40.905	BB	1.0814	3260.90479	46.85238	40.9074

Totals : 7971.42865 175.31795

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

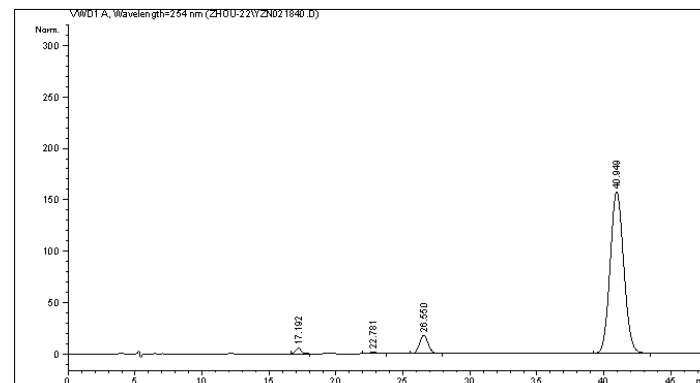
Instrument 1 10/22/2022 10:51:52 PM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021840.D
 Sample Name: LL-11-5

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/22/2022 2:15:24 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/22/2022 1:41:04 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/22/2022 10:53:50 PM
 (modified after loading)
 Sample Info : IC, Hexane/i-PrOH = 65/35, 0.8 mL/min, 30 oC, 254 nm



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

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

Signal 1: VWD1 A, Wavelength=254 nm

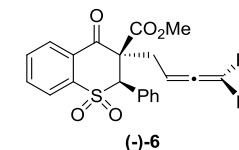
Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area %
1	17.192	BB	0.4332	159.04973	5.70220	1.3105
2	22.781	BB	0.6010	60.96534	1.57199	0.5023
3	26.550	BB	0.7082	808.95935	17.88644	6.6653
4	40.949	BB	1.1047	1.11079e4	157.05879	91.5219

Totals : 1.21369e4 182.21943

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

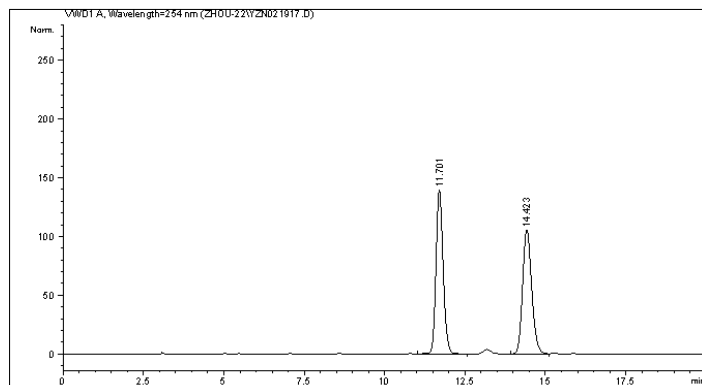
Instrument 1 10/22/2022 10:55:27 PM

Page 1 of 1



Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021917.D
 Sample Name: LL-11-16 +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/30/2022 3:52:27 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/30/2022 3:50:56 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/30/2022 4:16:07 AM
 (modified after loading)
 Sample Info : AD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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 Area Percent Report
 =====

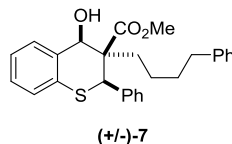
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	11.701	VB	0.2371	2156.65771	139.52293	50.8865
2	14.423	VV	0.3026	2081.51245	105.66568	49.1135

Totals : 4238.17017 245.18861

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

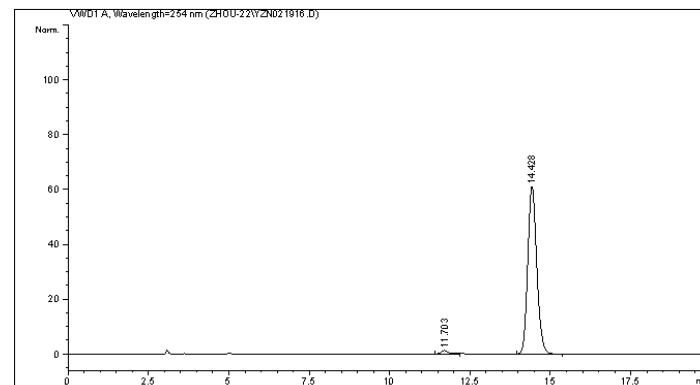


Instrument 1 10/30/2022 4:16:15 AM

Page 1 of 1

Data File C:\CHEM32\1\DATA\ZHOU-22\YZN021916.D
 Sample Name: LL-11-16

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 10/30/2022 3:28:32 AM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/30/2022 3:04:05 AM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 10/30/2022 4:17:32 AM
 (modified after loading)
 Sample Info : AD-H, Hexane/i-PrOH = 95/5, 1.0 mL/min, 30 oC, 254 nm



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

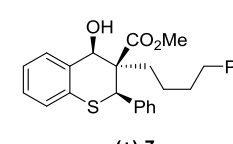
Sorted By : Signal
 Multiplier: : 1.0000
 Dilution: : 1.0000
 Use Multiplier & Dilution Factor with ISTDs

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	Height [%]	Area [%]
1	11.703	VB	0.2459	19.75402	1.21869	1.6311
2	14.428	EB	0.3005	1191.35352	61.03853	98.3689

Totals : 1211.10754 62.25722

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 *** End of Report ***

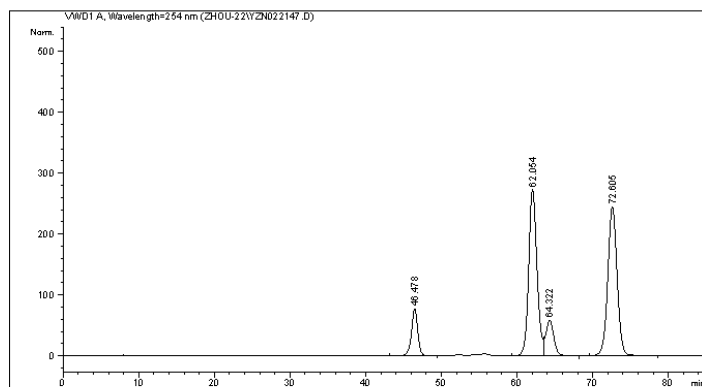


Instrument 1 10/30/2022 4:17:48 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022147.D
 Sample Name: LL-11-44 +/-

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 11/30/2022 11:30:47 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 11/30/2022 11:29:14 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 12/1/2022 2:31:03 AM
 (modified after loading)
 Sample Info : IA+AS-H, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 n
 m

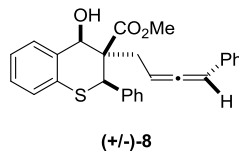


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 Area Percent Report
 =====

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

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	%	Height [mAU]	Area %
1	46.478	BB	0.8766	4460.64746	77.35817	8.8316	
2	62.054	BV	1.1644	2.06928e4	272.83978	40.9695	
3	64.322	VB	1.1556	4356.79199	58.02239	8.6260	
4	72.605	BB	1.3270	2.09975e4	244.75700	41.5729	
Totals :				5.05077e4	652.97735		



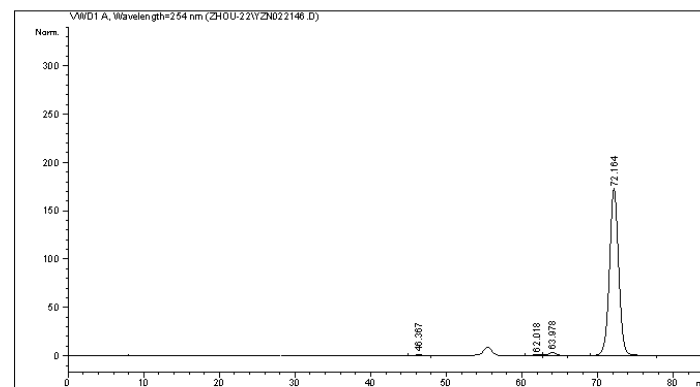
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 *** End of Report ***

Instrument 1 12/1/2022 2:31:11 AM

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Data File C:\CHEM32\1\DATA\ZHOU-22\YZN022146.D
 Sample Name: LL-11-44

=====
 Acq. Operator :
 Acq. Instrument : Instrument 1 Location : -
 Injection Date : 11/30/2022 9:53:50 PM
 Acq. Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 11/30/2022 9:51:30 PM
 (modified after loading)
 Analysis Method : C:\CHEM32\1\METHODS\DEF_LC.M
 Last changed : 12/1/2022 2:28:53 AM
 (modified after loading)
 Sample Info : IA+AS-H, Hexane/i-PrOH = 95/5, 0.8 mL/min, 30 oC, 254 n
 m

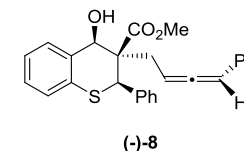


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 Area Percent Report
 =====

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

Signal 1: VWD1 A, Wavelength=254 nm

Peak #	RetTime [min]	Type	Width [min]	Area [mAU]	%	Height [mAU]	Area %
1	46.367	BB	0.8741	62.76188	1.09244	0.4206	
2	62.018	BV	1.1131	68.22928	9.22701e-1	0.4573	
3	63.978	VB	1.1444	235.30170	3.15277	1.5770	
4	72.164	BB	1.2935	1.45549e4	172.42085	97.5451	
Totals :				1.49212e4	177.58876		



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 *** End of Report ***

Instrument 1 12/1/2022 2:28:56 AM

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