Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Enantioselective Synthesis of Axially Chiral Vinylarenes through Palladium-catalyzed C-H Olefination

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General Information

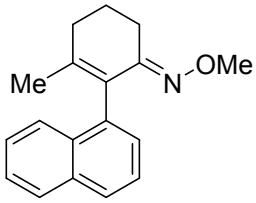
Unless specifically stated, all reagents were commercially obtained and where appropriate, purified prior to use. For example, all the aldehydes recrystallized or distilled prior to use. Dichloromethane, toluene, were freshly distilled from CaH_2, tetrahydrofuran (THF) and 1,4-dioxane were dried and distilled from metal sodium and benzophenone. MeOH solvents were not dried Other commercially available reagents and solvents were used directly without purification. Reactions were monitored by thin layer chromatography (TLC) using silica gel plates. Flash column chromatography was performed over silica (300 - 400 mesh). ^{1}H, ^{13}C NMR spectra were recorded on a Bruker 400 MHz or 500 MHz spectrometer in $CDCl_3$. Multiplicities were given as: s (singlet); d (doublet); dd (doublets of doublet); t (triplet); q (quartet); or m (multiplets). High resolution mass spectra (HRMS) of the products were obtained on a Bruker Daltonics micro TOF-spectrometer. HPLC was carried out with a Agilent 1260 infinity using a chiralcel AD-H column, a chiralcel OJ-H column, a chiralcel AS-H column, a chiralcel IB column, a chiralcel IC column,or a chiralcel OX-H column.

General procedure for the synthesis of parent enones.

Aryl boronic acid (5 mmol) and 2-iodo-3-methylcyclohex-2-en-1-one (5.5 mmol, 1.1 eq) were dissolved in 1,4-dioxane (40 mL) under nitrogen. To this mixture, $Pd(PPh_3)_4$ (5 mol%) was added. The resulting mixture was degassed and purged with nitrogen (3 times) then stirred at room temperature for 10 minutes. An aqueous solution of sodium carbonate (2 M, 3.0 eq) was added via syringe and the reaction mixture was then stirred at 100 ^oC overnight (ca 10 h). The reaction was then cooled to room temperature and concentrated. The residue was diluted with EA (15 mL) and water (20 mL), and neutralized with 2 N HCl (ca 13 mL, until PH=7). The resulting mixture was then extracted with EA (4×15 mL). The combined organic phases were washed with brine (30 mL) and dried over anhydrous sodium sulfate. After removal of the solvent, a short silica gel column filtration of the crude mixture afforded parent enones, which were used directly in the next step without purification[1].

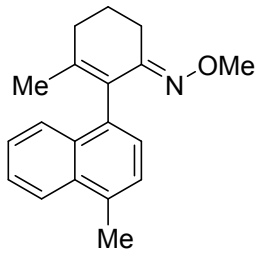
General procedure for the synthesis of substrates 1.

The parent enone (1.95 g, 8.3 mmol) was dissolved in MeOH (20 mL) and methoxylamine hydrochloride (2.08 g, 3.0 equiv) was added. The reaction mixture was stirred at room temperature for 10 min and then $NaHCO_3$ (2.09 g, 3.0 equiv) was gradually added.Stirring was continued for further 6 h. The solution was then diluted with ethyl acetate (30 mL), washed with brine (10 mL), extracted with EA (3×20 mL), dried over anhydrous Na_2SO_4, filtered, and evaporated under vacuum. The crude reaction mixture was purified by column chromatography on silica gel to afford **1a** (87% yield)[2].



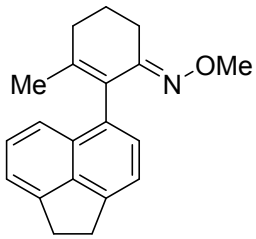
1a

(E)-3-methyl-2-(naphthalen-1-yl)cyclohex-2-en-1-one O-methyl oxime **1 a** (87% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.86 – 7.81 (m, 1H), 7.77 (d, *J* = 8.2 Hz, 1H), 7.66 (d, *J* = 8.0 Hz, 1H), 7.49 – 7.35 (m, 3H), 7.19 (dd, *J* = 7.0, 1.0 Hz, 1H), 3.53 (s, 3H), 2.77 – 2.67 (m, 2H), 2.36 (dd, *J* = 11.1, 5.4 Hz, 2H), 1.99 – 1.88 (m, 2H), 1.46 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 156.88 (s), 143.35 (s), 136.51 (s), 133.49 (s), 132.37 (s), 129.82 (s), 128.12 (s), 127.37 (s), 126.78 (s), 125.88 (s), 125.45 (s), 125.32 (s), 125.25 (s), 61.45 (s), 31.79 (s), 22.99 (s), 21.75 (s), 21.21 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{18}H_{19}NaNO$: 288.1359, found: 288.1361.



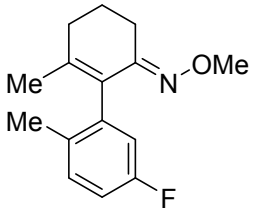
1b

(E)-3-methyl-2-(4-methylnaphthalen-1-yl)cyclohex-2-en-1-one O-methyl oxime **1b** (65% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.99 (d, *J* = 8.2 Hz, 1H), 7.67 (d, *J* = 8.3 Hz, 1H), 7.46 (dd, *J* = 11.1, 4.0 Hz, 1H), 7.39 (t, *J* = 7.0 Hz, 1H), 7.30 (d, *J* = 7.0 Hz, 1H), 7.08 (d, *J* = 7.1 Hz, 1H), 3.54 (s, 3H), 2.79 – 2.63 (m, 5H), 2.35 (dd, *J* = 11.1, 5.4 Hz, 2H), 1.92 (d, *J* = 4.0 Hz, 2H), 1.45 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 157.04 (s), 143.41 (s), 134.72 (s), 132.80 (s), 132.61 (s), 132.39 (s), 129.98 (s), 127.01 (s), 126.48 (s), 126.23 (s), 125.07 (s), 124.25 (s), 61.46 (s), 31.81 (s), 23.05 (s), 21.83 (s), 21.22 (s), 19.50 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{19}H_{21}NNaO$: 302.1515, found: 302.1525.



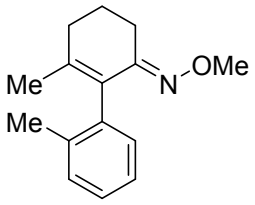
1c

(E)-2-(1,2-dihydroacenaphthylen-5-yl)-3-methylcyclohex-2-en-1-one O-methyl oxime **1c** (66% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.38 – 7.30 (m, 2H), 7.28 (d, *J* = 6.4 Hz, 1H), 7.22 (d, *J* = 6.1 Hz, 1H), 7.14 (d, *J* = 7.0 Hz, 1H), 3.56 (s, 3H), 3.45 – 3.35 (m, 4H), 2.72 (td, *J* = 6.3, 2.8 Hz, 2H), 2.42 – 2.28 (m, 2H), 1.96 – 1.87 (m, 2H), 1.48 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 156.97 (s), 145.95 (s), 144.47 (s), 143.20 (s), 139.33 (s), 131.65 (s), 130.82 (s), 129.19 (d, *J* = 15.8 Hz), 127.19 (s), 121.10 (s), 118.73 (d, *J* = 17.0 Hz), 61.46 (s), 31.87 (s), 30.55 (s), 30.12 (s), 23.08 (s), 21.86 (s), 21.28 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{20}H_{21}NNaO$: 314.1515, found: 314.1528.



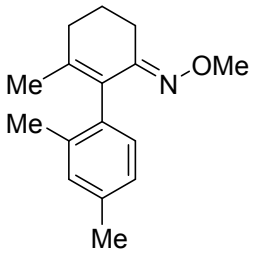
1d

(E)-5'-fluoro-2',6-dimethyl-4,5-dihydro-[1,1'-biphenyl]-2(3H)-one O-methyl oxime **1d** (68% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.14 – 7.07 (m, 1H), 6.85 (td, *J* = 8.5, 2.6 Hz, 1H), 6.69 (dd, *J* = 9.5, 2.5 Hz, 1H), 3.68 (s, 3H), 2.71 – 2.53 (m, 2H), 2.25 (t, *J* = 5.9 Hz, 2H), 2.05 (s, 3H), 1.81 (p, *J* = 6.4 Hz, 2H), 1.52 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 162.02 (s), 159.61 (s), 155.79 (s), 142.05 (s), 139.93 (d, *J* = 7.8 Hz), 132.10 (d, *J* = 3.0 Hz), 130.36 (d, *J* = 7.8 Hz), 116.57 (d, *J* = 20.6 Hz), 113.15 (d, *J* = 20.7 Hz), 61.60 (s), 31.49 (s), 22.77 (s), 21.31 (s), 21.00 (s), 18.62 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{15}H_{19}FNO$: 248.1445, found: 248.1448.



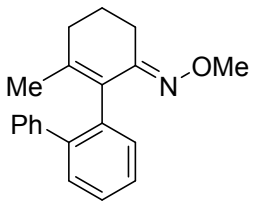
1e

(E)-2',6-dimethyl-4,5-dihydro-[1,1'-biphenyl]-2(3H)-one O-methyl oxime **1e** (68% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.15 (dt, *J* = 9.2, 4.0 Hz, 3H), 6.95 (d, *J* = 6.3 Hz, 1H), 3.67 (s, 3H), 2.73 – 2.49 (m, 2H), 2.25 (t, *J* = 5.8 Hz, 2H), 2.10 (s, 3H), 1.89 – 1.74 (m, 2H), 1.50 (d, *J* = 0.5 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 141.72 (s), 136.51 (s), 129.93 (s), 129.31 (s), 126.53 (s), 125.17 (s), 61.54 (s), 31.55 (s), 22.87 (s), 21.38 (s), 21.11 (s), 19.42 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{15}H_{19}NNaO$: 252.1359, found: 252.1370.



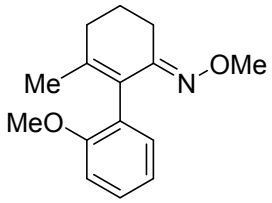
1f

(E)-2',4',6-trimethyl-4,5-dihydro-[1,1'-biphenyl]-2(3H)-one O-methyl oxime **1f** (87% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.02 – 6.92 (m, 2H), 6.83 (d, *J* = 7.6 Hz, 1H), 3.68 (s, 3H), 2.72 – 2.52 (m, 2H), 2.32 (s, 3H), 2.24 (t, *J* = 5.9 Hz, 2H), 2.06 (s, 3H), 1.81 (p, *J* = 6.4 Hz, 2H), 1.50 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 156.43 (s), 141.79 (s), 136.23 (s), 135.83 (s), 135.12 (s), 130.99 (s), 130.19 (s), 129.79 (s), 125.95 (s), 61.51 (s), 31.59 (s), 22.93 (s), 21.43 (s), 21.18 (s), 21.12 (s), 19.36 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{16}H_{21}NNaO$: 266.1515, found: 266.1527.



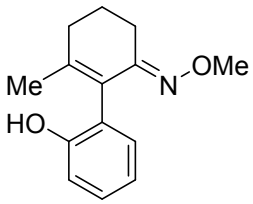
1g

(E)-6-methyl-4,5-dihydro-[1,1':2',1''-terphenyl]-2(3H)-one O-methyl oxime **1g** (51% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.39 – 7.26 (m, 7H), 7.23 (dd, *J* = 6.1, 3.4 Hz, 1H), 7.12 (d, *J* = 6.3 Hz, 1H), 3.69 (s, 3H), 2.55 – 2.34 (m, 2H), 2.16 – 1.89 (m, 2H), 1.77 – 1.54 (m, 2H), 1.40 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 157.15 (s), 142.37 (s), 142.02 (s), 141.85 (s), 136.90 (s), 131.03 (s), 129.28 (s), 128.69 (s), 127.38 (s), 126.84 (s), 126.60 (s), 126.47 (s), 61.53 (s), 31.50 (s), 22.72 (s), 21.74 (s), 20.73 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{20}H_{22}NO$: 292.1696, found: 292.1685.



1h

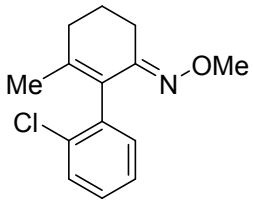
(E)-2'-methoxy-6-methyl-4,5-dihydro-[1,1'-biphenyl]-2(3H)-one O-methyl oxime **1h** (99% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.28 – 7.22 (m, 1H), 7.01 – 6.87 (m, 3H), 3.76 (d, *J* = 6.4 Hz, 3H), 3.67 (s, 3H), 2.73 – 2.52 (m, 2H), 2.34 – 2.17 (m, 2H), 1.90 – 1.72 (m, 2H), 1.57 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 157.21 (s), 156.46 (s), 142.11 (s), 131.61 (s), 128.05 (s), 127.85 (s), 127.71 (s), 120.19 (s), 111.32 (s), 61.40 (s), 55.93 (s), 31.61 (s), 22.84 (s), 21.63 (s), 21.03 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{15}H_{19}NNaO_2$: 268.1308, found: 268.1321.



1i

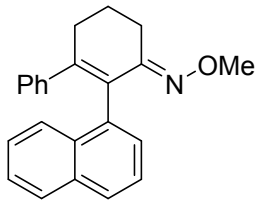
(E)-2'-hydroxy-6-methyl-4,5-dihydro-[1,1'-biphenyl]-2(3H)-one O-methyl oxime **1i** (53% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.25 – 7.18 (m, 1H), 7.01 – 6.94 (m, 2H), 6.90 (t, *J* = 7.3 Hz, 1H), 3.78 (s, 3H), 2.77 – 2.54 (m, 2H), 2.38 – 2.19 (m, 2H), 1.92 – 1.71 (m, 2H), 1.67 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 157.44 (s), 153.57 (s), 147.22 (s), 131.64 (s), 128.77 (s), 127.52 (s), 125.80 (s), 120.25 (s), 117.37 (s), 61.93 (s), 31.97 (s), 23.41 (s), 22.53 (s), 20.57 (s). **HRMS (ESI)**

m/z: $[M+H]^+$calculated for $C_{14}H_{18}NO_2$: 232.1332, found: 232.1336.



1j

(E)-2'-chloro-6-methyl-4,5-dihydro-[1,1'-biphenyl]-2(3H)-one O-methyl oxime **1j** (80.7% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.39 – 7.33 (m, 1H), 7.26 – 7.16 (m, 2H), 7.11 – 7.04 (m, 1H), 3.67 (s, 3H), 2.71 – 2.53 (m, 2H), 2.35 – 2.17 (m, 2H), 1.90 – 1.75 (m, 2H), 1.55 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 155.81 (s), 142.85 (s), 137.46 (s), 133.93 (s), 131.74 (s), 129.39 (s), 128.99 (s), 127.88 (s), 126.12 (s), 61.58 (s), 31.53 (s), 22.74 (s), 21.35 (s), 20.91 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{14}H_{17}ClNO$: 250.0993, found: 250.0994.

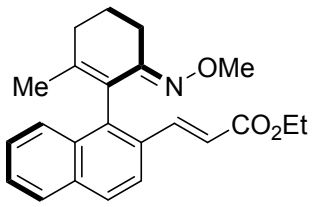


1k

(E)-2-(naphthalen-1-yl)-5,6-dihydro-[1,1'-biphenyl]-3(4H)-one O-methyl oxime **1k** (86% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.84 – 7.76 (m, 1H), 7.73 (dd, *J* = 6.2, 2.9 Hz, 1H), 7.60 (d, *J* = 8.2 Hz, 1H), 7.45 – 7.32 (m, 2H), 7.21 (dd, *J* = 12.4, 4.9 Hz, 1H), 7.00 (d, *J* = 6.9 Hz, 1H), 6.97 – 6.87 (m, 3H), 6.87 – 6.73 (m, 2H), 3.53 (s, 3H), 2.95 – 2.72 (m, 3H), 2.66 (dt, *J* = 17.4, 5.7 Hz, 1H), 2.17 – 1.96 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 156.78 (s), 146.16 (s), 142.33 (s), 136.23 (s), 133.16 (d, *J* = 19.4 Hz), 131.91 (s), 128.49 (s), 128.06 (s), 127.37 (d, *J* = 11.0 Hz), 126.82 (s), 126.49 (d, *J* = 3.9 Hz), 125.38 – 124.88 (m), 61.74 (s), 32.31 (s), 23.28 (s), 21.57 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{23}H_{22}NO$: 328.1696, found: 328.1696.

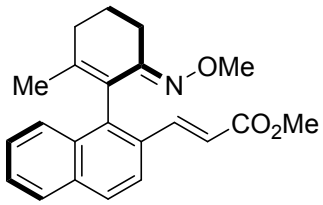
General procedure for the synthesis of products 3.

Under air atmosphere, the racemic substrate **1a-1k** (0.3 mmol), $Pd(OAc)_2$ (6.7 mg, 10 mol%), N-Acetyl-L-alanine (7.9 mg, 20 mol%) and AgOAc(150 mg, 0.9 mmol, 3 equiv) were added to a tube containing a magnetic stir bar. After which, MeOH (3.0 mL) was added using a syringe. Then ethyl acrylate (96 μL, 0.9 mmol, 3 equiv) was added with microsyringe. The reaction mixture was stirred at 40 °C in an oil bath for 48 hours. The reaction mixture was cooled to room temperature. The solvent was then evaporated *in vacuo* and the residue was purified by using flash silica gel column chromatography with EA and PE as eluent to afford the final products.



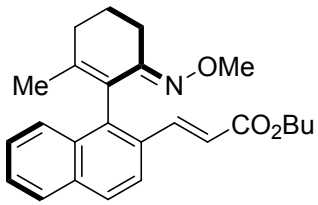
3a

Ethyl (*E*)-3-(1-((*E*)-6(methoxyimino)-2-methylcyclohex-1-en-1-yl)naphthalen-2-yl)acrylate **3a** (77.3 mg, 71% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.75 (d, *J* = 13.0 Hz, 1H), 7.72 (d, *J* = 4.5 Hz, 1H), 7.70 – 7.65 (m, 2H), 7.63 (d, *J* = 8.9 Hz, 1H), 7.42 – 7.16 (m, 2H), 6.38 (d, *J* = 16.0 Hz, 1H), 4.17 (q, *J* = 7.1 Hz, 2H), 3.43 (d, *J* = 17.2 Hz, 3H), 2.80 – 2.56 (m, 2H), 2.34 (t, *J* = 5.9 Hz, 2H), 1.98 – 1.87 (m, 2H), 1.29 (s, 3H), 1.26 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.36 (s), 156.20 (s), 144.93 (s), 143.71 (s), 138.54 (s), 134.11 (s), 132.39 (s), 130.02 (s), 127.99 (s), 127.43 (s), 127.21 (s), 126.73 (s), 126.57 (s), 126.31 (s), 122.63 (s), 118.32 (s), 61.55 (s), 60.28 (s), 31.84 (s), 22.90 (s), 21.49 (s), 21.18 (s), 14.33 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{23}H_{25}NNaO_3$: 386.1727, found: 386.1739. [α]**22 D**= 50 (c = 0.03, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AD-H column (hexanes: 2-propanol = 95:5, 0.8mL/min, 290 nm, 97% *ee*); major enantiomer t_r = 5.97 min, minor enantiomer t_r = 6.82 min.



3b

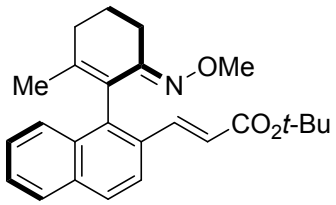
Methyl (E)-3-(1-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)naphthalen-2-yl)acrylate **3b** (70.2 mg, 67% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 5.7 Hz, 1H), 7.81 – 7.65 (m, 4H), 7.44 (dt, *J* = 15.0, 7.2 Hz, 2H), 6.46 (d, *J* = 16.0 Hz, 1H), 3.79 (s, 3H), 3.49 (s, 3H), 2.85 – 2.65 (m, 2H), 2.43 (t, *J* = 6.1 Hz, 2H), 2.04 – 1.95 (m, 2H), 1.37 (s, 3H) **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.78 (s), 156.18 (s), 144.94 (s), 143.95 (s), 138.59 (s), 134.14 (s), 132.37 (s), 129.98 (s), 127.98 (s), 127.44 (s), 127.20 (s), 126.65 (d, *J* = 11.8 Hz), 126.33 (s), 122.63 (s), 117.92 (s), 61.55 (s), 51.55 (s), 31.83 (s), 22.88 (s), 21.46 (s), 21.17 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{22}H_{23}NNaO_3$: 372.1570, found: 372.1579. [α]**22 D**= 58 (c = 0.02, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AD-H column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, 96% *ee*); major enantiomer t_r = 6.21 min, minor enantiomer t_r = 7.31 min.



3c

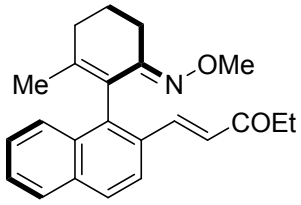
Butyl (E)-3-(1-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)naphthalen-2-yl) acrylate **3c** (63.3 mg, 54% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.82 (d, *J* = 6.7 Hz, 1H), 7.77 (dd, *J* = 14.1, 5.2 Hz, 3H), 7.73 – 7.67 (m, 1H), 7.43 (dt, *J* = 21.7, 6.9 Hz, 2H), 6.46 (d, *J* = 16.0 Hz, 1H), 4.20 (t, *J* = 6.5 Hz, 2H), 3.49 (s, 3H), 2.88 – 2.61 (m, 2H), 2.42 (t, *J* = 6.0 Hz, 2H), 1.99 (p, *J* = 6.4 Hz, 2H), 1.75 – 1.63 (m, 2H), 1.52 – 1.39 (m, 2H), 1.37 (s, 3H), 0.97 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.40 (s), 156.18 (s), 144.91 (s), 143.62 (s), 138.50 (s), 134.11 (s), 132.39 (s), 130.02 (s), 127.98 (s), 127.42 (s), 127.22 (s), 126.64 (d, *J* = 15.6 Hz), 126.30 (s), 122.59 (s), 118.35 (s), 64.19 (s), 61.53 (s), 31.83 (s), 30.81 (s), 22.88 (s), 21.47 (s), 21.16 (s), 19.26 (s), 13.73

(s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{25}H_{29}NNaO_3$: 414.2040, found: 414.2052. $[\alpha]^{22}_{D}$= 57 (c = 0.01, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AD-H column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, 98% *ee*); major enantiomer t_r = 5.77 min, minor enantiomer t_r = 6.74 min.



3d

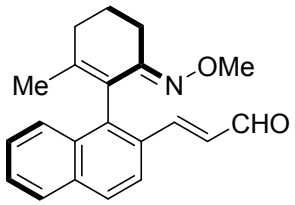
tert-butyl (E)-3-(1-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)naphthalen-2-yl)acrylate **3d** (65.4 mg, 56% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.80 (d, *J* = 7.8 Hz, 1H), 7.77 – 7.73 (m, 2H), 7.70 (dd, *J* = 8.8, 5.4 Hz, 2H), 7.42 (ddd, *J* = 15.1, 13.7, 6.8 Hz, 2H), 6.40 (d, *J* = 16.0 Hz, 1H), 3.49 (s, 3H), 2.84 – 2.65 (m, 2H), 2.42 (t, *J* = 6.0 Hz, 2H), 2.08 – 1.90 (m, 2H), 1.53 (s, 9H), 1.37 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 166.63 (s), 156.23 (s), 144.89 (s), 142.48 (s), 138.25 (s), 134.00 (s), 132.42 (s), 130.13 (s), 127.96 (s), 127.35 (s), 127.20 (s), 126.72 (s), 126.45 (s), 126.25 (s), 122.65 (s), 120.26 (s), 80.12 (s), 61.54 (s), 31.83 (s), 28.29 (s), 22.90 (s), 21.52 (s), 21.19 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{25}H_{29}NNaO_3$: 414.2040, found: 414.2050. $[\alpha]^{22}_{D}$= 44 (c = 0.01, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AD-H column (hexanes: 2-propanol = 97:3, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 5.29 min, minor enantiomer t_r = 6.52 min.



3e

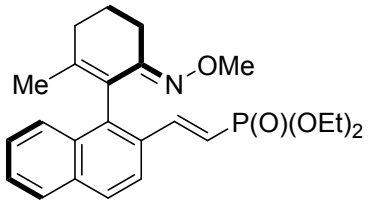
(E)-1-(1-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)naphthalen-2-yl)pent-1-en-3-one **3e** (48.9 mg, 47% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.81 (d, *J* = 8.0 Hz, 1H), 7.80 – 7.75 (m, 2H), 7.73 (t, *J* = 4.9 Hz, 1H), 7.69 (d, *J* = 3.3 Hz, 1H), 7.51 – 7.37 (m, 2H), 6.76 (d, *J* = 16.2 Hz,

1H), 3.49 (s, 3H), 2.89 – 2.61 (m, 4H), 2.43 (t, *J* = 6.0 Hz, 2H), 2.05 – 1.93 (m, 2H), 1.37 (s, 3H), 1.17 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 201.26 (s), 145.09 (s), 141.54 (s), 138.96 (s), 134.18 (s), 132.37 (s), 130.11 (s), 128.05 (s), 127.51 (s), 127.20 (s), 126.68 (s), 126.40 (s), 126.29 (s), 122.50 (s), 61.61 (s), 33.92 (s), 31.85 (s), 22.91 (s), 21.54 (s), 21.25 (s), 8.44 (s). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{23}H_{25}NNaO_2$: 370.1778, found: 370.1789. [α]**22 D**= 62 (c = 0.009, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AS-H column (hexanes: 2-propanol = 94:6, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 8.22 min, minor enantiomer t_r = 10.65 min.



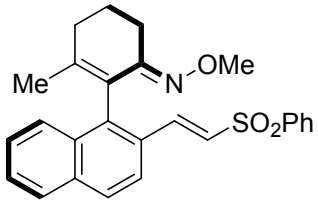
3f

(E)-3-(1-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)naphthalen-2-yl)acrylaldehyde **3f** (15.4 mg, 16% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 9.66 (d, *J* = 7.7 Hz, 1H), 7.89 – 7.78 (m, 2H), 7.78 – 7.69 (m, 2H), 7.59 (d, *J* = 15.9 Hz, 1H), 7.51 (t, *J* = 7.1 Hz, 1H), 7.44 (t, *J* = 7.4 Hz, 1H), 6.76 (dd, *J* = 15.9, 7.7 Hz, 1H), 3.50 (s, 3H), 2.88 – 2.64 (m, 2H), 2.45 (t, *J* = 5.8 Hz, 2H), 2.00 (dt, *J* = 12.9, 6.2 Hz, 2H), 1.39 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 194.18 (s), 156.08 (s), 151.96 (s), 145.39 (s), 139.37 (s), 134.58 (s), 132.24 (s), 129.68 (s), 128.90 (s), 128.16 (s), 127.74 (s), 127.20 (s), 127.00 (s), 126.79 (s), 126.63 (s), 122.61 (s), 61.68 (s), 31.85 (s), 22.87 (s), 21.52 (s), 21.18 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{21}H_{22}NO_2$: 320.1645, found: 320.1647. [α]**22 D**= 83 (c = 0.006, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak IB column (hexanes: 2-propanol = 98:2, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 12.03 min, minor enantiomer t_r = 13.66 min.



3g

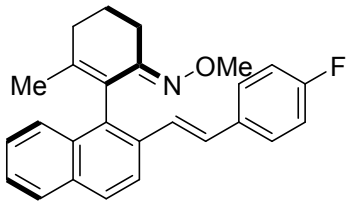
Diethyl ((E)-2-(1-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)naphthalen-2-yl)vinyl)phosphonate **3g** (112.8 mg, 88% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.82 (d, *J* = 7.9 Hz, 1H), 7.78 (d, *J* = 8.8 Hz, 1H), 7.71 (d, *J* = 8.8 Hz, 2H), 7.65 – 7.53 (m, 1H), 7.52 – 7.39 (m, 2H), 6.27 (t, *J* = 18.2 Hz, 1H), 4.12 (dd, *J* = 13.7, 6.8 Hz, 4H), 3.48 (s, 3H), 2.73 (d, *J* = 3.3 Hz, 2H), 2.41 (d, *J* = 5.4 Hz, 2H), 2.03 – 1.95 (m, 2H), 1.42 – 1.31 (m, 9H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 155.06 (s), 143.97 (s), 133.03 (s), 131.20 (s), 127.00 (s), 126.43 (s), 126.01 (s), 125.57 (d, *J* = 2.7 Hz), 125.36 (s), 121.30 (s), 60.83 (d, *J* = 4.2 Hz), 60.51 (s), 30.79 (s), 21.84 (s), 20.53 (s), 20.10 (s), 15.37 (d, *J* = 6.1 Hz). **HRMS (ESI)** m/z: $[M+Na]^+$calculated for $C_{24}H_{30}NNaO_4P$: 450.1805, found: 450.1819. [α]**22 D**= 14 (c = 0.005, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AD-H column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 11.03 min, minor enantiomer t_r = 12.43 min.



3h

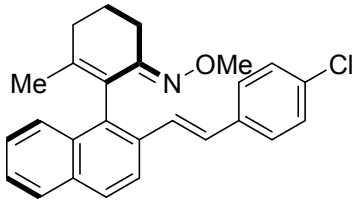
(E)-3-methyl-2-(2-((E)-2-(phenylsulfonyl)vinyl)naphthalen-1-yl)cyclohex-2-en-1-one O-methyl oxime **3h** (112.3 mg, 87% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92 (s, 1H), 7.90 (s, 1H), 7.85 – 7.68 (m, 4H), 7.66 – 7.38 (m, 6H), 6.83 (d, *J* = 15.5 Hz, 1H), 3.43 (s, 3H), 2.86 – 2.65 (m, 2H), 2.43 (t, *J* = 5.9 Hz, 2H), 2.02 (dt, *J* = 12.8, 6.3 Hz, 2H), 1.35 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 156.24 (s), 145.55 (s), 142.30 (s), 141.06 (s), 139.35 (s), 134.39 (s), 133.15 (s), 129.25 (s), 128.27 (s), 128.12 (s), 127.69 (d, *J* = 5.0 Hz), 127.37 (s), 127.13 (s), 126.71 (d, *J* = 8.7 Hz), 122.63 (s), 61.59 (s), 31.82 (s), 22.86 (s), 21.63 (s), 21.11 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{26}H_{26}NO_3S$: 432.1628, found: 432.1618. [α]**22 D**= 12 (c = 0.008, $CHCl_3$).

Enantiomeric excess was determined by HPLC with a Chiralpak AD-H column (hexanes: 2-propanol = 75:25, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 8.03 min, minor enantiomer t_r = 9.24 min.



3i

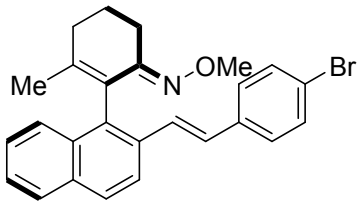
(E)-2-(2-((E)-4-fluorostyryl)naphthalen-1-yl)-3-methylcyclohex-2-en-1-one O-methyl oxime **3i** (81.6 mg, 71% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 8.7 Hz, 1H), 7.81 – 7.74 (m, 2H), 7.66 (dd, *J* = 6.8, 2.8 Hz, 1H), 7.47 – 7.34 (m, 4H), 7.10 (d, *J* = 2.6 Hz, 2H), 7.05 (dd, *J* = 12.1, 5.3 Hz, 2H), 3.51 (s, 3H), 2.91 – 2.68 (m, 2H), 2.43 (t, *J* = 5.7 Hz, 2H), 2.07 – 1.94 (m, 2H), 1.38 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 163.43 (s), 160.98 (s), 155.97 (s), 144.54 (s), 135.09 (s), 134.28 (s), 132.99 (s), 132.61 (s), 132.35 (s), 127.99 – 127.83 (m), 127.79 (s), 127.67 (s), 127.52 (s), 127.17 (s), 126.20 (s), 126.02 (s), 125.41 (s), 122.50 (s), 115.70 (s), 115.49 (s), 61.58 (s), 31.89 (s), 23.00 (s), 21.45 (d, *J* = 4.5 Hz). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{26}H_{25}FNO$: 386.1915, found: 386.1910. [α]**22 D**= 79 (c = 0.02, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 98:2, 0.8 mL/min, 290 nm, 96% *ee*); major enantiomer t_r = 8.89 min, minor enantiomer t_r = 9.78 min.



3j

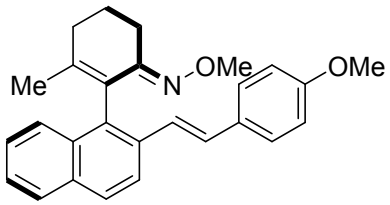
(E)-2-(2-((E)-4-chlorostyryl)naphthalen-1-yl)-3-methylcyclohex-2-en-1-one O-methyl oxime **3j** (88.5 mg, 74% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 8.7 Hz, 1H), 7.79 (dd, *J* = 14.4, 5.5 Hz, 2H), 7.70 – 7.63 (m, 1H), 7.46 – 7.35 (m, 4H), 7.31 (d, *J* = 8.5 Hz, 2H), 7.18 (d, *J* = 16.3 Hz, 1H), 7.07 (d, *J* = 16.3 Hz, 1H), 3.51 (s, 3H), 2.89 – 2.70 (m, 2H), 2.42 (d, *J* = 5.6 Hz, 2H),

2.00 (qt, *J* = 14.3, 7.3 Hz, 2H), 1.38 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 155.97 (s), 144.61 (s), 136.60 (s), 135.34 (s), 133.07 (s), 132.89 (s), 132.59 (s), 132.19 (s), 128.83 (s), 128.39 (s), 127.93 (s), 127.74 (s), 127.59 (d, *J* = 4.0 Hz), 127.21 (s), 126.24 (s), 126.05 (s), 125.51 (s), 122.49 (s), 61.59 (s), 31.89 (s), 29.71 (s), 23.00 (s), 21.45 (d, *J* = 5.9 Hz). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{26}H_{25}ClNO$: 402.1619, found: 402.1616. [α]**22 D**= 123 (c = 0.04, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 98:2, 0.5 mL/min, 290 nm, 97% *ee*); major enantiomer t_r = 9.04 min, minor enantiomer t_r = 9.94 min.



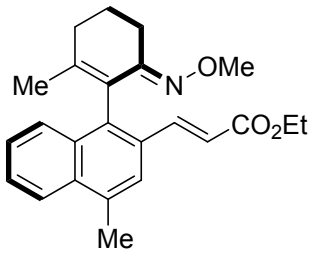
3k

(E)-2-(2-((E)-4-bromostyryl)naphthalen-1-yl)-3-methylcyclohex-2-en-1-one O-methyl oxime **3k** (84.9 mg, 64% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.83 (d, *J* = 8.7 Hz, 1H), 7.81 – 7.74 (m, 2H), 7.71 – 7.61 (m, 1H), 7.47 (d, *J* = 8.5 Hz, 2H), 7.44 – 7.36 (m, 2H), 7.31 (d, *J* = 8.4 Hz, 2H), 7.19 (d, *J* = 16.3 Hz, 1H), 7.05 (d, *J* = 16.3 Hz, 1H), 3.52 (d, *J* = 9.9 Hz, 3H), 2.88 – 2.68 (m, 2H), 2.42 (d, *J* = 5.2 Hz, 2H), 2.07 – 1.91 (m, 2H), 1.38 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 155.97 (s), 144.61 (s), 137.05 (s), 135.38 (s), 133.08 (s), 132.59 (s), 132.17 (s), 131.77 (s), 128.52 (s), 127.94 (s), 127.74 (s), 127.62 (s), 127.23 (s), 126.24 (s), 126.06 (s), 125.53 (s), 122.48 (s), 121.00 (s), 61.59 (s), 31.89 (s), 23.00 (s), 21.45 (d, *J* = 6.2 Hz). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{26}H_{24}BrNO$: 446.1114, found: 446.1115. [α]**22 D**= 91 (c = 0.02, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 98:2, 0.5 mL/min, 290 nm, 96% *ee*); major enantiomer t_r = 9.49 min, minor enantiomer t_r = 10.37 min.



3l

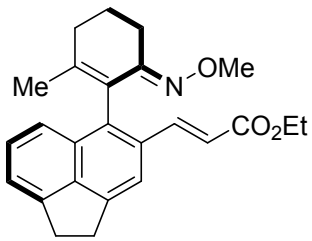
(E)-2-(2-((E)-4-methoxystyryl)naphthalen-1-yl)-3-methylcyclohex-2-en-1-one O-methyl oxime **3l** (58.1 mg, 49% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.85 (d, *J* = 8.7 Hz, 1H), 7.78 (dd, *J* = 14.8, 5.8 Hz, 2H), 7.70 – 7.62 (m, 1H), 7.43 – 7.35 (m, 4H), 7.08 (s, 2H), 6.90 (d, *J* = 8.5 Hz, 2H), 3.83 (s, 3H), 3.51 (s, 3H), 2.86 – 2.71 (m, 2H), 2.42 (t, *J* = 5.8 Hz, 2H), 2.07 – 1.96 (m, 2H), 1.38 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 159.14 (s), 155.98 (s), 144.45 (s), 134.59 (s), 132.78 (d, *J* = 3.3 Hz), 132.67 (s), 130.91 (s), 128.38 (s), 127.89 (s), 127.67 (s), 127.07 (s), 126.15 (s), 125.92 (s), 125.70 (s), 125.17 (s), 122.56 (s), 114.15 (s), 61.58 (s), 55.37 (s), 31.90 (s), 23.02 (s), 21.47 (d, *J* = 3.7 Hz). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{27}H_{28}NO_2$: 398.2115, found: 398.2104. [α]**22 D**= 126 (c = 0.03, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, 96% *ee*); major enantiomer t_r = 6.70 min, minor enantiomer t_r = 8.03 min.



3m

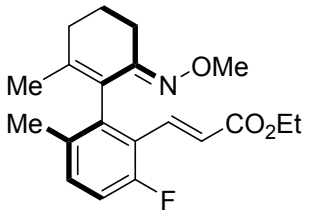
Ethyl (E)-3-(1-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)-4-methylnaphthalen-2-yl)acrylate **3m** (57.5 mg, 51% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.96 (d, *J* = 8.3 Hz, 1H), 7.79 (d, *J* = 16.0 Hz, 1H), 7.72 (d, *J* = 8.3 Hz, 1H), 7.58 (s, 1H), 7.54 – 7.46 (m, 1H), 7.42 (dd, *J* = 11.1, 4.1 Hz, 1H), 6.46 (d, *J* = 16.0 Hz, 1H), 4.25 (q, *J* = 7.1 Hz, 2H), 3.49 (s, 3H), 2.85 – 2.65 (m, 5H), 2.41 (t, *J* = 6.0 Hz, 2H), 2.03 – 1.95 (m, 2H), 1.36 (s, 3H), 1.33 (t, *J* = 7.2 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.43 (s), 156.39 (s), 145.02 (s), 143.80 (s), 136.96 (s), 133.46 (d, *J* = 14.1 Hz), 132.47 (s), 129.50 (s), 127.32 (s), 126.43 (s), 125.95 (s), 124.19 (s), 123.27 (s), 118.02 (s), 67.10 (s), 61.52 (s), 60.24 (s), 31.86 (s), 22.94 (s), 21.53 (s), 21.18 (s), 19.63 (s), 14.32 (s). **HRMS**

(ESI) m/z: $[M+H]^+$calculated for $C_{24}H_{28}NO_3$: 378.2064, found: 378.2066. [α]**22 D**= 54 (c = 0.009, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 98:2, 0.5 mL/min, 290 nm, 98% *ee*); major enantiomer t_r = 12.4 min, minor enantiomer t_r = 13.33 min.



3n

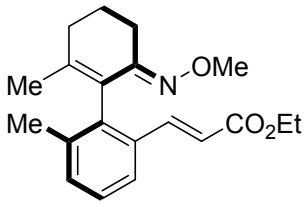
Ethyl (E)-3-(5-((E)-6-(methoxyimino)-2-methylcyclohex-1-en-1-yl)-1,2-dihydroacenaphthylen-4-yl)acrylate **3n** (53.7 mg, 46% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.77 (d, *J* = 16.0 Hz, 1H), 7.48 (s, 1H), 7.31 (d, *J* = 8.3 Hz, 1H), 7.19 (d, *J* = 6.8 Hz, 2H), 6.37 (d, *J* = 15.9 Hz, 1H), 4.17 (q, *J* = 7.1 Hz, 2H), 3.48 – 3.40 (m, 3H), 3.38 – 3.28 (m, 4H), 2.78 – 2.57 (m, 2H), 2.33 (t, *J* = 5.9 Hz, 2H), 1.98 – 1.85 (m, 2H), 1.31 (s, 3H), 1.26 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.51 (s), 156.35 (s), 145.71 (s), 144.96 (d, *J* = 11.6 Hz), 144.63 (s), 140.11 (s), 134.64 (s), 131.77 (s), 130.69 (s), 128.04 (s), 126.84 (s), 121.96 (s), 120.30 (s), 117.74 (s), 115.94 (s), 61.51 (s), 60.19 (s), 31.88 (s), 30.50 (s), 30.02 (s), 22.96 (s), 21.52 (s), 21.24 (s), 14.33 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{25}H_{28}NO_3$: 390.2064, found: 390.2061. [α]**22 D**= 43 (c = 0.01, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 98:2, 0.5 mL/min, 290 nm, 98% *ee*); major enantiomer t_r = 15.91 min, minor enantiomer t_r = 19.29 min.



3o

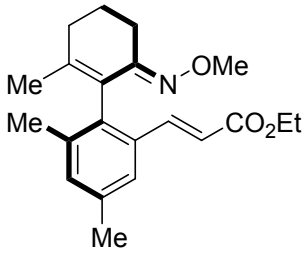
Ethyl (E)-3-((E)-3-fluoro-2'-(methoxyimino)-6,6'-dimethyl-2',3',4',5'-tetrahydro-[1,1'-biphenyl]-2-yl)acrylate **3o** (57.7 mg, 56% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.45 (d, *J* = 16.3 Hz, 1H),

7.13 (dd, *J* = 8.2, 5.5 Hz, 1H), 6.93 (dd, *J* = 11.1, 8.5 Hz, 1H), 6.56 (d, *J* = 16.3 Hz, 1H), 4.22 (q, *J* = 7.0 Hz, 2H), 3.65 (d, *J* = 10.1 Hz, 3H), 2.78 – 2.68 (m, 1H), 2.57 (ddd, *J* = 16.9, 8.0, 5.8 Hz, 1H), 2.37 – 2.23 (m, 2H), 2.05 (s, 3H), 1.93 – 1.80 (m, 2H), 1.43 (s, 3H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.63 (s), 161.58 (s), 159.08 (s), 155.23 (s), 143.50 (s), 141.12 (d, *J* = 2.9 Hz), 138.29 (s), 132.63 (d, *J* = 3.4 Hz), 131.43 (d, *J* = 9.4 Hz), 128.18 (s), 122.52 (s), 122.37 (s), 121.17 (s), 121.07 (s), 114.20 (s), 113.98 (s), 61.67 (s), 60.28 (s), 31.56 (s), 22.76 (s), 21.00 (d, *J* = 7.3 Hz), 19.17 (s), 14.30 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{20}H_{25}FNO_3$: 346.1813, found: 346.1806. [α]**22 D**= 40 (c = 0.03, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak IC column (hexanes: 2-propanol = 96:4, 0.8mL/min, 290 nm, 98% *ee*); major enantiomer t_r = 6.00 min, minor enantiomer t_r = 7.70 min.



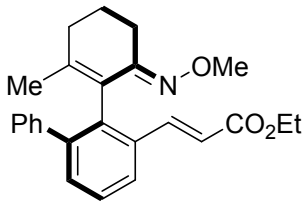
3p

Ethyl (E)-3-((E)-2'-(methoxyimino)-6,6'-dimethyl-2',3',4',5'-tetrahydro-[1,1'-biphenyl]-2-yl)acrylate **3p** (41.7 mg, 43% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.62 (d, *J* = 16.0 Hz, 1H), 7.47 (dt, *J* = 7.8, 3.9 Hz, 1H), 7.24 – 7.14 (m, 2H), 6.31 (d, *J* = 16.0 Hz, 1H), 4.22 (tt, *J* = 7.2, 3.6 Hz, 2H), 3.64 (d, *J* = 7.1 Hz, 3H), 2.74 (ddd, *J* = 16.9, 7.3, 5.5 Hz, 1H), 2.58 (ddd, *J* = 16.9, 8.1, 5.7 Hz, 1H), 2.39 – 2.21 (m, 2H), 2.10 (s, 3H), 1.96 – 1.79 (m, 2H), 1.40 (s, 3H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.32 (s), 155.57 (s), 144.14 (s), 143.30 (s), 139.25 (s), 137.23 (s), 133.23 (s), 131.13 (s), 128.38 (s), 126.81 (s), 123.14 (s), 118.11 (s), 61.60 (s), 60.19 (s), 31.60 (s), 22.81 (s), 21.07 (s), 19.60 (s), 14.30 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{20}H_{26}NO_3$: 328.1907, found: 328.1915. [α]**22 D**=39 (c = 0.04, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OJ-H column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 4.95 min, minor enantiomer t_r = 6.55 min.



3q

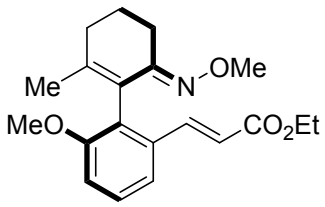
Ethyl (E)-3-((E)-2'-(methoxyimino)-4,6,6'-trimethyl-2',3',4',5'-tetrahydro-[1,1'-biphenyl]-2-yl)acrylate **3q** (48.6 mg, 48% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.60 (d, *J* = 16.0 Hz, 1H), 7.30 (s, 1H), 7.04 (s, 1H), 6.31 (d, *J* = 15.9 Hz, 1H), 4.21 (tt, *J* = 7.2, 3.6 Hz, 2H), 3.64 (s, 3H), 2.73 (ddd, *J* = 16.8, 7.3, 5.5 Hz, 1H), 2.57 (ddd, *J* = 16.8, 8.1, 5.7 Hz, 1H), 2.33 (s, 3H), 2.31 – 2.20 (m, 2H), 2.06 (s, 3H), 1.93 – 1.79 (m, 2H), 1.40 (s, 3H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.40 (s), 155.78 (s), 144.28 (s), 143.43 (s), 136.99 (s), 136.42 (s), 136.08 (s), 132.99 (s), 132.29 (s), 128.29 (s), 123.75 (s), 117.77 (s), 61.58 (s), 60.14 (s), 31.63 (s), 22.86 (s), 21.28 – 20.94 (m), 19.52 (s), 14.30 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{21}H_{28}NO_3$: 342.2064, found: 342.2065. [α]**22 D**= 44 (c = 0.02, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak IC column (hexanes: 2-propanol = 97:3, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 5.93 min, minor enantiomer t_r = 7.33 min.



3r

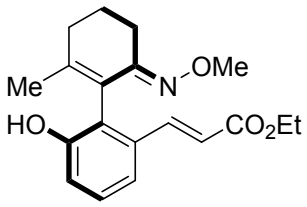
Ethyl (E)-3-((E)-2"-(methoxyimino)-6"-methyl-2",3",4",5"-tetrahydro-[1,1':2',1"-terphenyl]-3'-yl) acrylate **3r** (67.7 mg, 58% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.69 – 7.65 (m, 1H), 7.64 – 7.62 (m, 1H), 7.36 (t, *J* = 7.6 Hz, 1H), 7.34 – 7.30 (m, 1H), 7.29 – 7.25 (m, 3H), 7.25 – 7.22 (m, 2H), 6.37 (d, *J* = 15.9 Hz, 1H), 4.23 (q, *J* = 7.1 Hz, 2H), 3.67 (s, 3H), 2.53 (ddd, *J* = 16.7, 8.6, 4.8 Hz, 1H), 2.31 (ddd, *J* = 16.7, 8.2, 4.8 Hz, 1H), 2.23 – 2.07 (m, 1H), 1.99 – 1.84 (m, 1H), 1.78 – 1.63 (m, 1H), 1.52 – 1.41 (m, 1H), 1.32 (dd, *J* = 8.9, 5.3 Hz, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.24 (s), 156.84 (s), 144.26 (s), 143.79 (s), 142.69 (s), 141.92 (s), 138.07 (s), 133.87 (s), 131.13 (s), 128.62 (s), 128.28 (s), 127.33 (s), 127.09 (s), 126.74 (s), 124.70 (s), 118.52 (s), 61.61 (s),

60.26 (s), 31.44 (s), 22.53 (s), 21.65 (s), 20.60 (s), 14.31 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{25}H_{28}NO_3$: 390.2064, found: 390.2061. [α]**22 D**= -20 (c = 0.03, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak IC column (hexanes: 2-propanol = 96:4, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 6.20 min, minor enantiomer t_r = 7.11 min.



3s

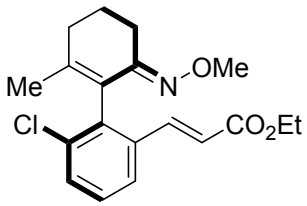
Ethyl (E)-3-((E)-6-methoxy-2'-(methoxyimino)-6'-methyl-2',3',4',5'-tetrahydro-[1,1'-biphenyl]-2-yl) acrylate **3s** (74.3 mg, 72% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.59 (d, *J* = 16.0 Hz, 1H), 7.28 – 7.24 (m, 2H), 6.96 – 6.84 (m, 1H), 6.33 (d, *J* = 16.0 Hz, 1H), 4.22 (q, *J* = 7.1 Hz, 2H), 3.75 (s, 3H), 3.62 (s, 3H), 2.75 (dt, *J* = 16.7, 6.1 Hz, 1H), 2.55 (ddd, *J* = 16.7, 8.3, 5.9 Hz, 1H), 2.29 (d, *J* = 5.7 Hz, 2H), 1.91 – 1.81 (m, 2H), 1.45 (s, 3H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.22 (s), 157.35 (s), 156.00 (s), 143.71 (d, *J* = 4.6 Hz), 134.58 (s), 129.09 (s), 127.84 (s), 125.33 (s), 118.58 (s), 118.04 (s), 112.39 (s), 61.46 (s), 60.23 (s), 56.19 (s), 31.62 (s), 22.78 (s), 21.38 (s), 21.04 (s), 14.29 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{20}H_{26}NO_4$: 344.1856, found: 344.1852. [α]**22 D**= 59 (c = 0.04, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak IC column (hexanes: 2-propanol = 90:10, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 5.86 min, minor enantiomer t_r = 7.30 min.



3t

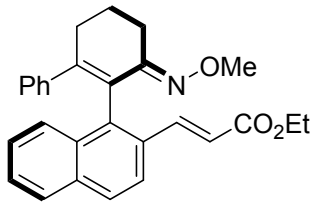
Ethyl (E)-3-((E)-6-hydroxy-2'-(methoxyimino)-6'-methyl-2',3',4',5'-tetrahydro-[1,1'-biphenyl]-2-yl) acrylate **3t** (68.4 mg, 69% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.55 (d, *J* = 15.9 Hz, 1H), 7.26 – 7.18 (m, 2H), 6.98 (dd, *J* = 7.0, 2.0 Hz, 1H), 6.34 (d, *J* = 15.9 Hz, 1H), 5.45 (d, *J* = 82.7 Hz, 1H),

4.22 (dt, *J* = 13.4, 6.7 Hz, 2H), 3.71 (s, 3H), 2.87 – 2.56 (m, 2H), 2.42 – 2.24 (m, 2H), 1.89 (dd, *J* = 11.8, 5.8 Hz, 2H), 1.51 (s, 3H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.18 (s), 156.15 (s), 153.41 (s), 148.92 (s), 143.30 (s), 134.46 (s), 128.52 (s), 126.21 (s), 123.85 (s), 118.78 (s), 118.44 (s), 117.59 (s), 61.93 (s), 60.35 (s), 31.86 (s), 23.16 (s), 21.80 (s), 20.77 (s), 14.30 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{19}H_{24}NO_4$: 330.1700, found: 330.1690. [α]**22 D**= -24 (c = 0.01, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, 96% *ee*); major enantiomer t_r = 8.93 min, minor enantiomer t_r = 10.41 min.



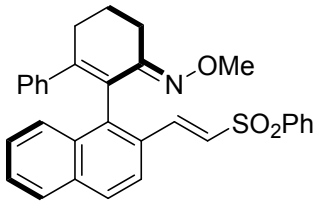
3u

Ethyl (E)-3-((E)-6-chloro-2'-(methoxyimino)-6'-methyl-2',3',4',5'-tetrahydro-[1,1'-biphenyl]-2-yl) acrylate **3u** (36.5 mg, 35% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.57 (d, *J* = 16.1 Hz, 1H), 7.53 (d, *J* = 8.2 Hz, 1H), 7.41 (d, *J* = 7.9 Hz, 1H), 7.23 (t, *J* = 7.9 Hz, 1H), 6.34 (d, *J* = 16.0 Hz, 1H), 4.23 (q, *J* = 7.1 Hz, 2H), 3.63 (s, 3H), 2.73 (dt, *J* = 16.8, 6.3 Hz, 1H), 2.58 (ddd, *J* = 16.8, 7.8, 6.0 Hz, 1H), 2.32 (t, *J* = 6.0 Hz, 2H), 1.93 – 1.82 (m, 2H), 1.46 (s, 3H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 166.87 (s), 155.19 (s), 144.40 (s), 142.95 (s), 138.22 (s), 135.57 (s), 134.80 (s), 130.33 (s), 127.95 (s), 126.99 (s), 124.01 (s), 119.61 (s), 61.64 (s), 60.41 (s), 31.59 (s), 22.66 (s), 21.09 (s), 20.86 (s), 14.27 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{19}H_{23}ClNO_3$: 348.1361, found: 348.1357. [α]**22 D**= 81 (c = 0.01, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OJ-H column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 5.53 min, minor enantiomer t_r = 6.68 min.



3v

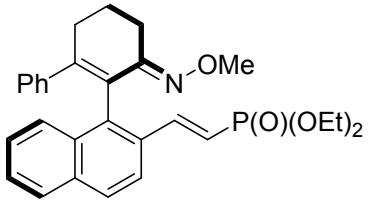
Ethyl (E)-3-(1-((E)-3-(methoxyimino)-3,4,5,6-tetrahydro-[1,1'-biphenyl]-2-yl)naphthalen-2-yl)acrylate **3v** (79.5 mg, 62% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.89 (d, *J* = 16.0 Hz, 1H), 7.85 (d, *J* = 9.3 Hz, 1H), 7.74 – 7.67 (m, 1H), 7.61 (d, *J* = 8.6 Hz, 1H), 7.49 (d, *J* = 8.7 Hz, 1H), 7.41 (p, *J* = 6.3 Hz, 2H), 6.87 (q, *J* = 6.0 Hz, 3H), 6.77 (d, *J* = 6.4 Hz, 2H), 6.24 (d, *J* = 15.9 Hz, 1H), 4.35 – 4.17 (m, 2H), 3.49 (d, *J* = 13.9 Hz, 3H), 3.03 – 2.77 (m, 3H), 2.71 (dt, *J* = 11.7, 5.6 Hz, 1H), 2.14 (d, *J* = 4.2 Hz, 2H), 1.35 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.34 (s), 156.32 (s), 147.92 (s), 144.06 (s), 141.78 (s), 138.13 (s), 133.62 (s), 133.24 (s), 130.15 (s), 128.81 (s), 127.89 (s), 127.46 (s), 127.39 (s), 127.26 (s), 126.73 (s), 126.65 (s), 126.29 (s), 126.13 (s), 122.38 (s), 118.13 (s), 61.79 (s), 60.25 (s), 32.39 (s), 23.18 (s), 21.51 (s), 14.39 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{28}H_{28}NO_3$: 426.2064, found: 426.2066. [α]**22 D**= 21 (c = 0.05, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak IC column (hexanes: 2-propanol = 95:5, 0.8 mL/min, 290 nm, 96% *ee*); major enantiomer t_r = 6.84 min, minor enantiomer t_r = 8.52 min.



3W

(E)-2-(2-((E)-2-(phenylsulfonyl)vinyl)naphthalen-1-yl)-5,6-dihydro-[1,1'-biphenyl]-3(4H)-one O-methyl oxime **3w** (88.9 mg, 60% yield). **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.92 (s, 1H), 7.90 (s, 1H), 7.87 (d, *J* = 9.3 Hz, 1H), 7.82 (d, *J* = 15.4 Hz, 1H), 7.72 – 7.67 (m, 1H), 7.64 – 7.52 (m, 4H), 7.44 (p, *J* = 6.8 Hz, 2H), 7.31 (d, *J* = 8.7 Hz, 1H), 6.85 (dt, *J* = 24.1, 7.1 Hz, 3H), 6.73 (d, *J* = 7.2 Hz, 2H), 6.62 (d, *J* = 15.4 Hz, 1H), 3.47 (s, 3H), 2.86 (ddd, *J* = 14.4, 8.1, 5.3 Hz, 3H), 2.71 (dt, *J* = 11.6, 5.5 Hz, 1H), 2.25 – 2.07 (m, 2H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 156.35 (s), 148.53 (s),

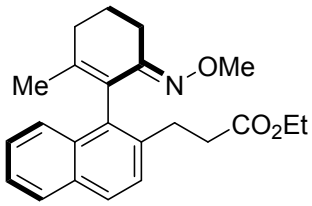
142.14 (s), 141.50 (s), 141.10 (s), 139.29 (s), 133.21 (d, *J* = 6.1 Hz), 129.25 (s), 128.45 (s), 128.16 (s), 128.02 (s), 127.73 (s), 127.66 (s), 127.52 (s), 127.41 (s), 126.99 – 126.84 (m), 126.67 (s), 126.49 (s), 122.45 (s), 61.83 (s), 32.39 (s), 23.16 (s), 21.48 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{31}H_{28}NO_3S$: 494.1784, found: 494.1780. [α]**22 D**= 37 (c = 0.02, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AD-H column (hexanes: 2-propanol = 80:20, 0.8 mL/min, 290 nm, >99% *ee*); major enantiomer t_r = 8.28 min, minor enantiomer t_r =10.78 min.



3x

Diethyl ((E)-2-(1-((E)-3-(methoxyimino)-3,4,5,6-tetrahydro-[1,1'-biphenyl]-2-yl)naphthalen-2-yl)vinyl)phosphonate **3x** (105.7 mg, 72% yield) **^{1}H NMR (400 MHz, $CDCl_3$)** δ 7.88 – 7.82 (m, 1H), 7.73 – 7.69 (m, 1H), 7.63 (dd, *J* = 15.9, 7.0 Hz, 2H), 7.49 (d, *J* = 8.7 Hz, 1H), 7.45 – 7.38 (m, 2H), 6.92 – 6.83 (m, 3H), 6.79 (d, *J* = 6.7 Hz, 2H), 6.07 (t, *J* = 18.2 Hz, 1H), 4.18 – 4.02 (m, 4H), 3.51 (s, 3H), 2.89 – 2.78 (m, 3H), 2.71 (dt, *J* = 17.4, 5.5 Hz, 1H), 2.13 (td, *J* = 12.6, 6.5 Hz, 2H), 1.36 (t, *J* = 7.0 Hz, 6H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 155.25 (s), 146.85 (s), 140.70 (s), 136.57 (s), 132.57 (s), 126.88 (s), 126.44 (s), 126.35 (s), 126.17 (s), 125.71 (s), 125.29 (s), 125.17 (s), 121.05 (s), 60.73 (s), 31.33 (s), 22.14 (s), 20.45 (s), 15.42 (d, *J* = 6.5 Hz). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{29}H_{33}NO_4P$: 490.2142, found: 490.2157. [α]**22 D**= 58 (c = 0.03, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak IC column (hexanes: 2-propanol = 85:15, 0.8 mL/min, 290 nm, 98% *ee*); major enantiomer t_r = 13.11 min, minor enantiomer t_r = 16.16 min.

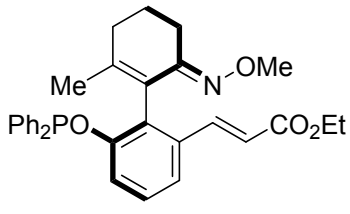
General procedure for the synthesis of 4, 5



4

The **3a** (72.6 mg, 0.2 mmol) and Pd/C (20 wt%) (5 mol%) were added in methanol (2 mL). The resulting mixture were degassed, purged with hydrogen (3 times) and then stirred at room temperature for overnight. The mixture were filtered through Celite plug and the Celite was washed with EA. The combined organic layer were concentrated under reduced pressure to give **4** (32.9 mg, 55% yield, 97% ee). The crude material were purified by silica gel column chromatography (eluent: PE/EA = 10:1).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (dd, *J* = 5.2, 3.8 Hz, 1H), 7.73 (d, *J* = 8.4 Hz, 1H), 7.66 – 7.59 (m, 1H), 7.37 (dd, *J* = 7.8, 4.2 Hz, 3H), 4.14 (q, *J* = 7.1 Hz, 2H), 3.53 (s, 3H), 2.91 (t, *J* = 8.2 Hz, 2H), 2.80 – 2.69 (m, 2H), 2.69 – 2.50 (m, 2H), 2.39 (d, *J* = 2.3 Hz, 2H), 2.04 – 1.88 (m, 2H), 1.38 (s, 3H), 1.25 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 173.54 (s), 156.19 (s), 143.77 (s), 135.79 (s), 134.34 (s), 132.39 (s), 132.21 (s), 128.09 (s), 127.90 (s), 127.04 (d, *J* = 3.8 Hz), 125.73 (d, *J* = 11.0 Hz), 124.80 (s), 61.48 (s), 60.31 (s), 35.19 (s), 31.74 (s), 29.10 (s), 22.97 (s), 21.59 (s), 21.24 (s), 14.26 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{23}H_{28}NO_3$: 366.2064 , found: 366.2064. [α]**22 D**= 108.7 (c = 0.01, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak OX-H column (hexanes: 2-propanol = 98:2, 0.8 mL/min, 254 nm, 97% *ee*); major enantiomer t_r = 7.70 min, minor enantiomer t_r = 8.27 min.

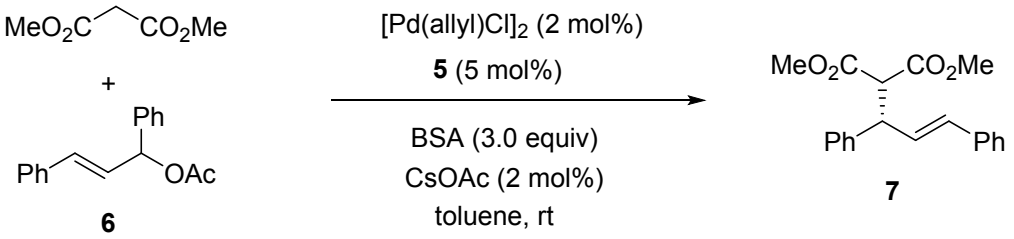


5

3t (32.9 mg, 1 mmol) and Et_3N (0.16 mL, 1.1 eq) were dissolved in THF (6 mL) under nitrogen and then added dropwise to a solution of PPh_2Cl (0.27 mL, 1.5 eq) at 0 °C under argon. The resulting solution was allowed to warm to room temperature and stirred for overnight. The mixture was filtered through Celite plug and the Celite was washed with EA. The combined organic layer was concentrated under reduced pressure to give **5** (265.5 mg, 52% yield) The crude material was purified by silica gel column chromatography (eluent: PE/EA = 2:1).

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, *J* = 16.0 Hz, 1H), 7.49 – 7.36 (m, 4H), 7.25 (s, 7H), 7.12 (dd, *J* = 18.4, 10.5 Hz, 1H), 7.01 (d, *J* = 7.8 Hz, 1H), 6.27 (d, *J* = 16.0 Hz, 1H), 4.13 (q, *J* = 6.9 Hz, 2H), 3.57 (s, 3H), 2.66 – 2.51 (m, 1H), 2.22 – 2.10 (m, 2H), 2.02 – 1.92 (m, 1H), 1.77 – 1.52 (m, 2H), 1.34 (s, 3H), 1.21 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 167.19 (s), 155.63 (s), 155.11 (d, *J* = 10.0 Hz), 144.10 (s), 143.34 (s), 141.89 (s), 141.70 (d, *J* = 4.4 Hz), 141.50 (s), 134.78 (s), 131.31 (d, *J* = 3.0 Hz), 130.24 (d, *J* = 3.3 Hz), 130.01 (d, *J* = 2.9 Hz), 129.49 (d, *J* = 8.6 Hz), 128.36 (dd, *J* = 7.0, 5.6 Hz), 127.95 (s), 125.58 (s), 119.95 (s), 119.01 (s), 118.84 (s), 61.60 (s), 60.32 (s), 31.55 (s), 22.74 (s), 21.67 (s), 20.73 (s), 14.33 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{31}H_{33}NO_5P$: 530.2091 , found: 530.2084. [α]**22 D**= 14.8 (c = 0.01, $CHCl_3$).

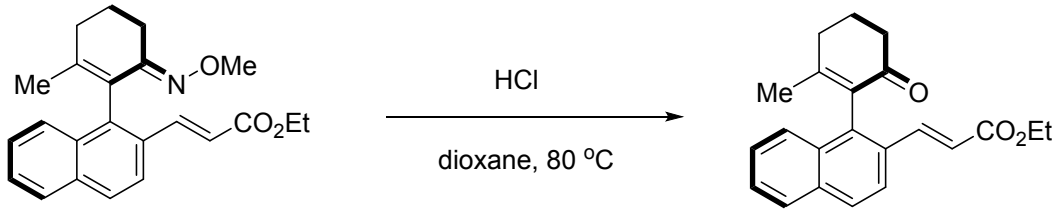
General procedure for the synthesis of 7



5 (2.6 mg, 5 mol%) and $[Pd(C_3H_5)Cl]_2$ (0.7 mg, 2 mol%) were dissolved in toluene (0.5 mL) in a Schlenk tube under N_2. The resulting solution was stirred at room temperature for 1 h, then allylic acetate (25.3 mg, 0.1 mmol) in toluene (1 mL) was added to this solution. After stirring for 15 mins, malonate (39.7 mg, 0.3 mmol), BSA (61.1 mg, 0.3 mmol) and CsOAc (3.9 mg, 2 mol%) were added. The mixture was stirred at room temperature for 12h, diluted with diethyl ether and washed with saturated NH_4Cl (aq.). The organic layers were dried over Na_2SO_4, filtered, and concentrated *in vacuo*. The residue was purified by flash column chromatography, eluting with PE

and EA to afford the corresponding product **7** (19.6 mg, 60% yield, 37% ee)[3].

General procedure for the synthesis of 8

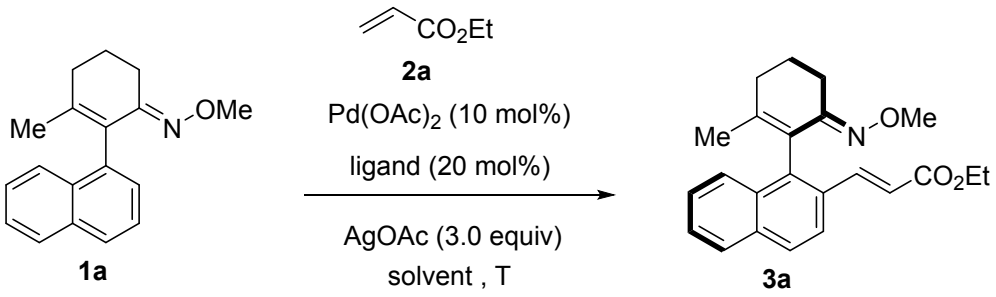


3a **8**

To a solution of **3a** (108 mg, 0.3 mmol) in dioxane (3 mL), was added aqueous HCl (6 M, 3 mL) and the mixture was heated at 80 °C (oil bath temperature) for 3 h. The resulting mixture was cooling to room temperature, and was extracted twice with EA. The combine organic extracts were washed three times with brine, dried over anhydrous Na_2SO_4, and concentrated *in vacuo* after filtration. Purification by silica gel column chromatography (eluent: PE/EA = 5:1) gave product **8** (56 mg, 56% yield, 99% ee)[4].

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.82 (dd, *J* = 8.0, 5.2 Hz, 2H), 7.72 (dd, *J* = 18.6, 12.3 Hz, 2H), 7.57 (d, *J* = 8.2 Hz, 1H), 7.51 – 7.37 (m, 2H), 6.47 (d, *J* = 15.9 Hz, 1H), 4.24 (q, *J* = 7.1 Hz, 2H), 2.67 (t, *J* = 6.3 Hz, 4H), 2.33 – 2.19 (m, 2H), 1.32 (t, *J* = 7.1 Hz, 3H), 1.26 (s, 3H). **^{13}C NMR (101 MHz, $CDCl_3$)** δ 197.51 (s), 167.08 (s), 161.00 (s), 142.48 (s), 135.88 (s), 134.23 (s), 133.75 (s), 132.12 (s), 130.49 (s), 128.36 (s), 126.85 (d, *J* = 11.5 Hz), 125.79 (s), 122.77 (s), 119.28 (s), 60.42 (s), 37.97 (s), 32.62 (s), 29.70 (s), 22.51 (d, *J* = 6.3 Hz), 14.32 (s). **HRMS (ESI)** m/z: $[M+H]^+$calculated for $C_{22}H_{23}O_3$: 335.1642 , found: 335.1644. [α]**22 D**= 12.5 (c = 0.03, $CHCl_3$). Enantiomeric excess was determined by HPLC with a Chiralpak AS-H column (hexanes: 2-propanol = 97:3, 1 mL/min, 270 nm, 99% *ee*); major enantiomer t_r = 25.09 min, minor enantiomer t_r = 34.66 min.

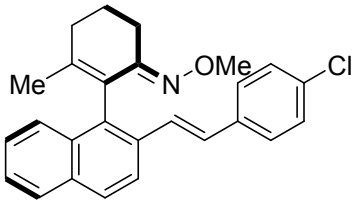
Table S1. Optimization of the Reaction Conditions[a] .



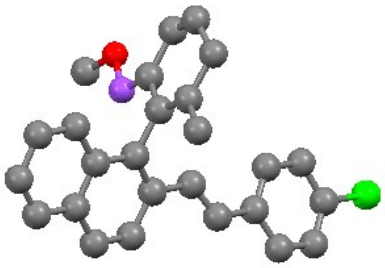
Entry	L	Solvent	T [°C]	Yield [%][b]	ee [%][c]
1	L1	CF_3CH_2OH	80	81	48
2	L1	CF_3CH_2OH	60	76	54
3	L1	CF_3CH_2OH	50	70	60
4	L1	CF_3CH_2OH	40	66	72
5	L1	toluene	40	14	66
6	L1	THF	40	38	94
7	L1	HFIP	40	10	46
8	L1	*t*-AmOH	40	26	96
9	L1	CH_3OH	40	41	96
10	L2	CH_3OH	40	27	96
11	L3	CH_3OH	40	21	90
12	L4	CH_3OH	40	31	88
13	L5	CH_3OH	40	18	84
14	L6	CH_3OH	40	18	94
15	L7	CH_3OH	40	45	96
16	L8	CH_3OH	40	71	97
17[d]	L8	CH_3OH	40	trace	-
18[e]	L8	CH_3OH	40	9	99

[a] Unless otherwise noted, the reaction was carried out using **1a** (0.3 mmol), **2a** (0.3 mmol), AgOAc (0.9 mmol), $Pd(OAc)_2$ (10 mol %), and ligand (20 mol %) in solvent (3 mL) under air for 48 hours. [b] yield of isolated product. [c] ee value determined by HPLC analysis using a chiral stationary phase. [d] Benzoquinone was used instead of AgOAc. [e] 0.1 equiv of AgOAc under O_2 ballon was used. **L1** = Boc-L-Phe-OH, **L2** = Boc-L-Tle-OH, **L3** = Boc-Ile-OH, **L4** = Boc-D-Val-OH, **L5** = CBZ-L-Val-OH, **L6** = CBZ-L-Phe-OH, **L7** = Ac-L-Leu-OH, **L8** = Ac-L-Ala-OH, HFIP = hexafluoroisopropanol.

X-ray structures of chiral product 3j (CCDC 1827731)



3j



References:

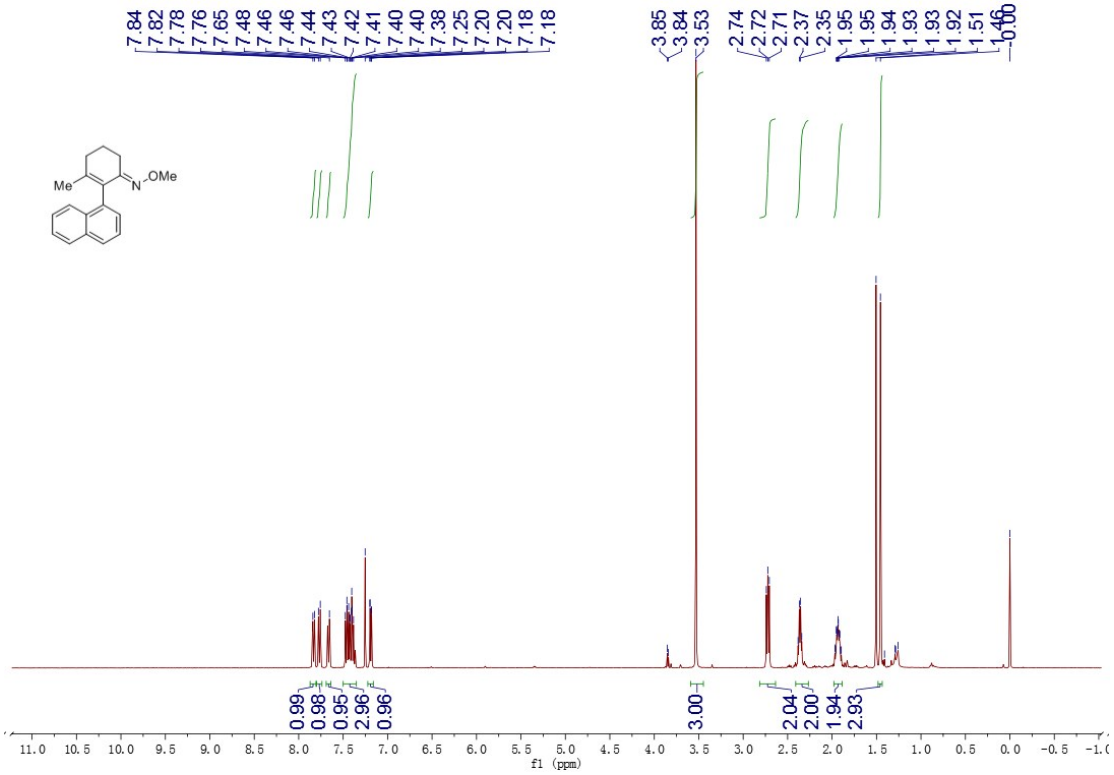
[1] Q.-L. Li and H.-B. Zhang. *Chem. Eur. J.* **2015**, 21, 16379.

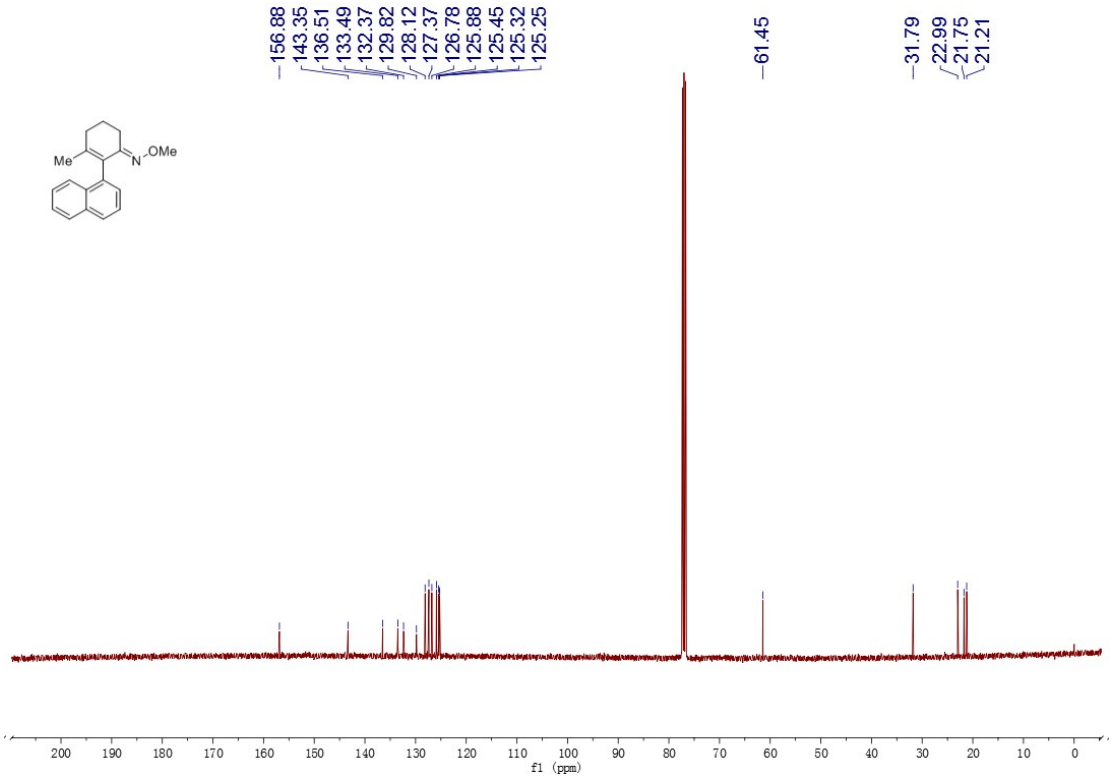
[2] Liang, Y.-F.; Wang, X.-Y.; Yuan, Y.-Z.; Liang, Y.-J.; Li, X.-Y.; Jiao, N. *ACS Catal*. **2015**, 5, 6148.

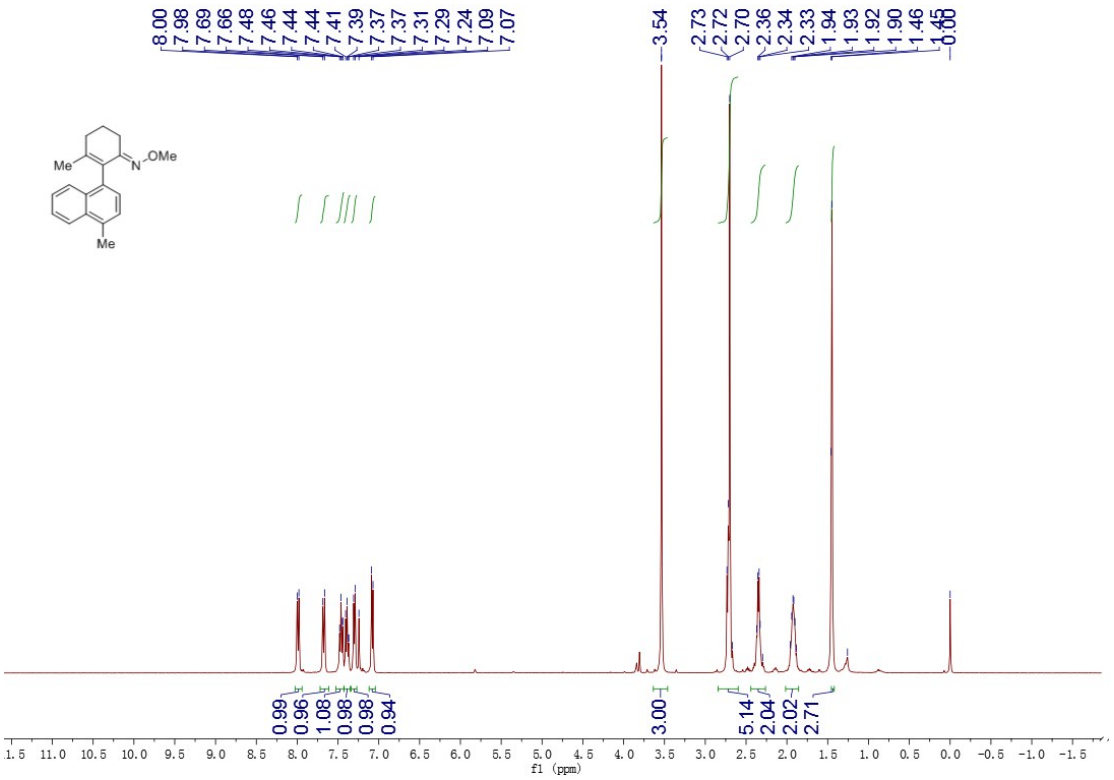
[3] Q.-L. Liu; W.-F. Chen; Q.-Y. Jiang; X.-F. Bai; Z.- F. Li; Z. Xu; and L.-W. Xu. *ChemCatChem* **2016**, 8, 1495.

[4] Y.-X. Yang; B. Zhou; and Y.-C. Li. *Adv. Synth. Catal.* **2012**, 354, 2916.

^{1}H , ^{13}C NMR Spectra



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2.34
2.33
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1.93
1.92
1.90
1.46
1.45
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Me
N
OMe
Me
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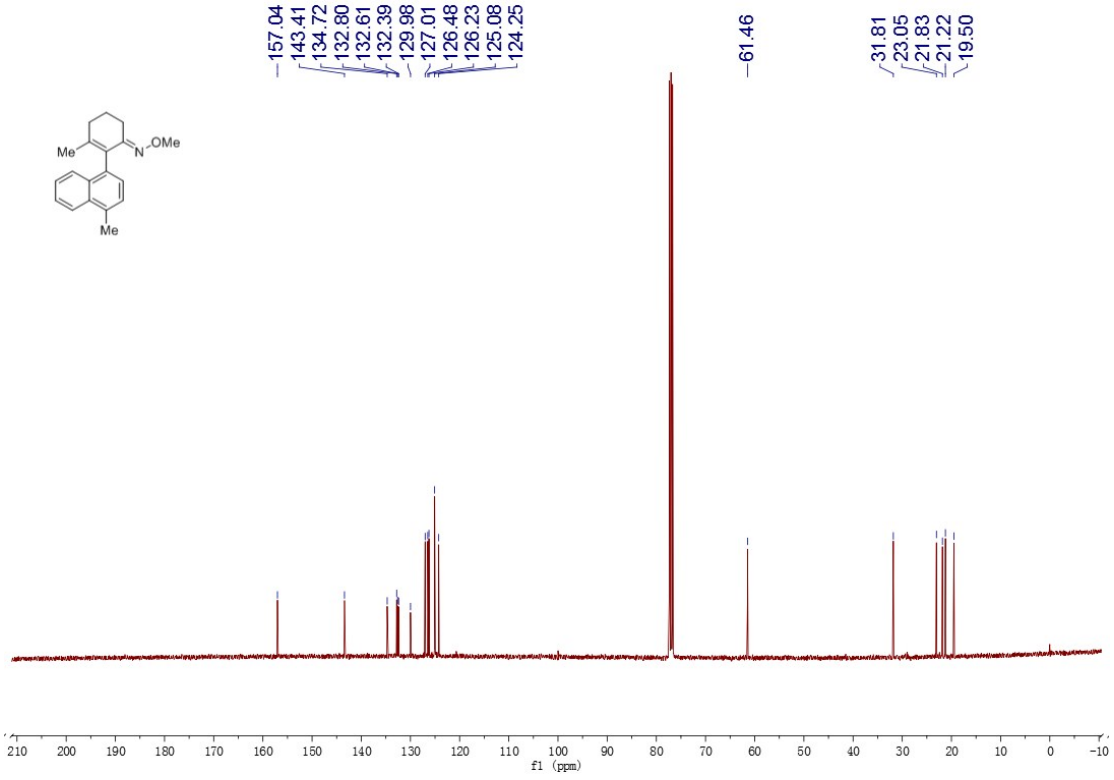
f1 (ppm)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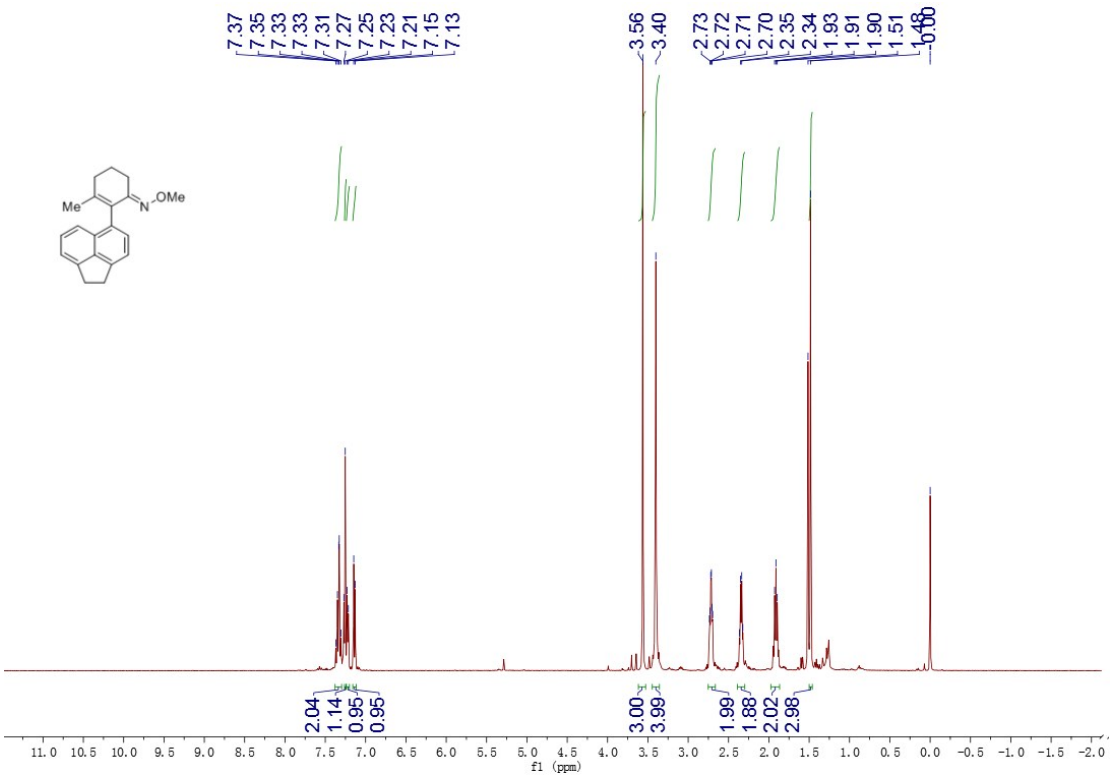
f1 (ppm)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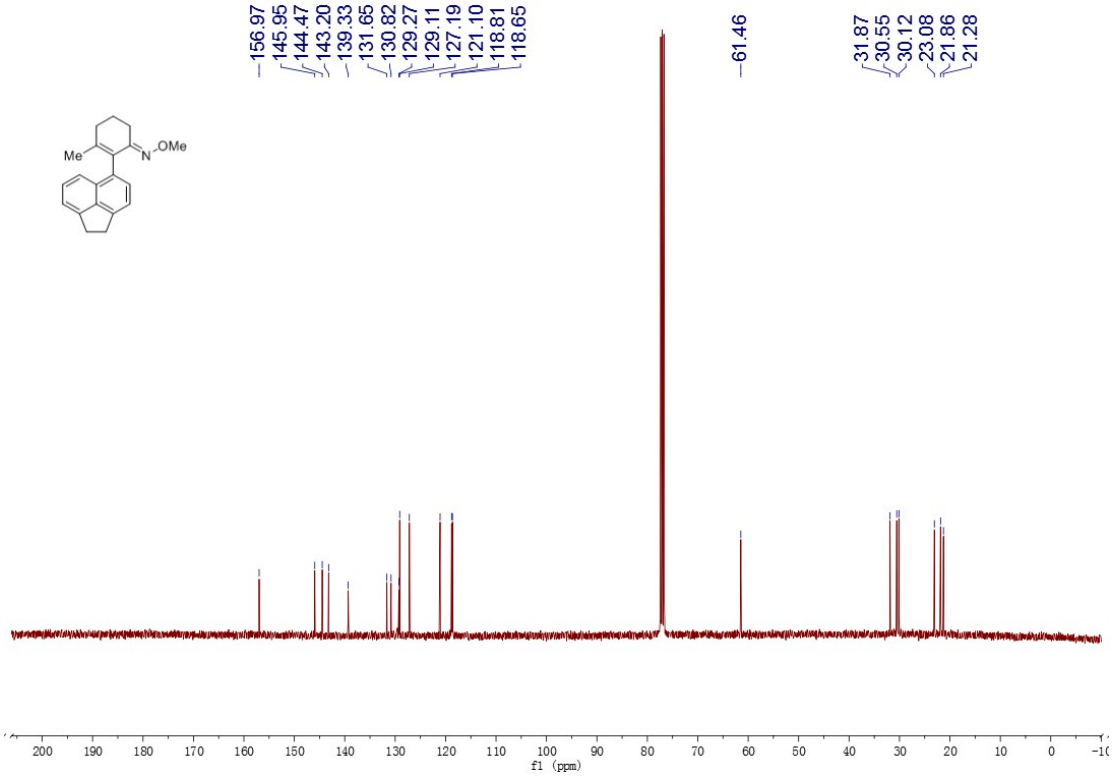
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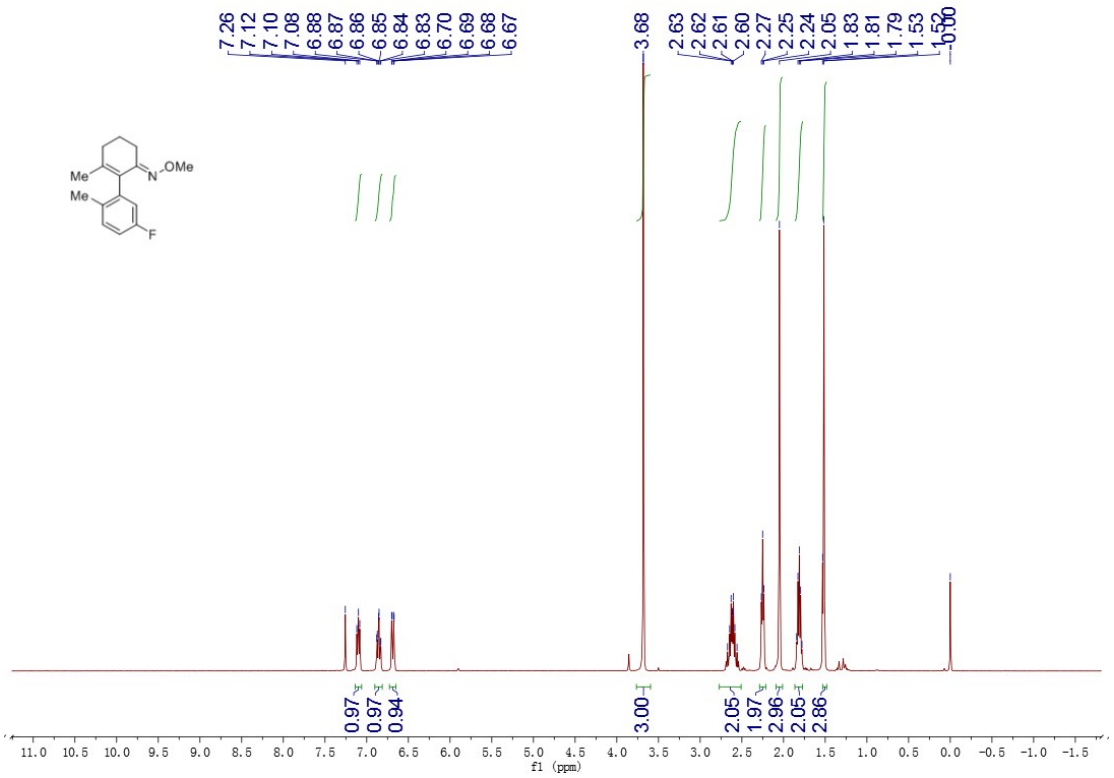
f1 (ppm)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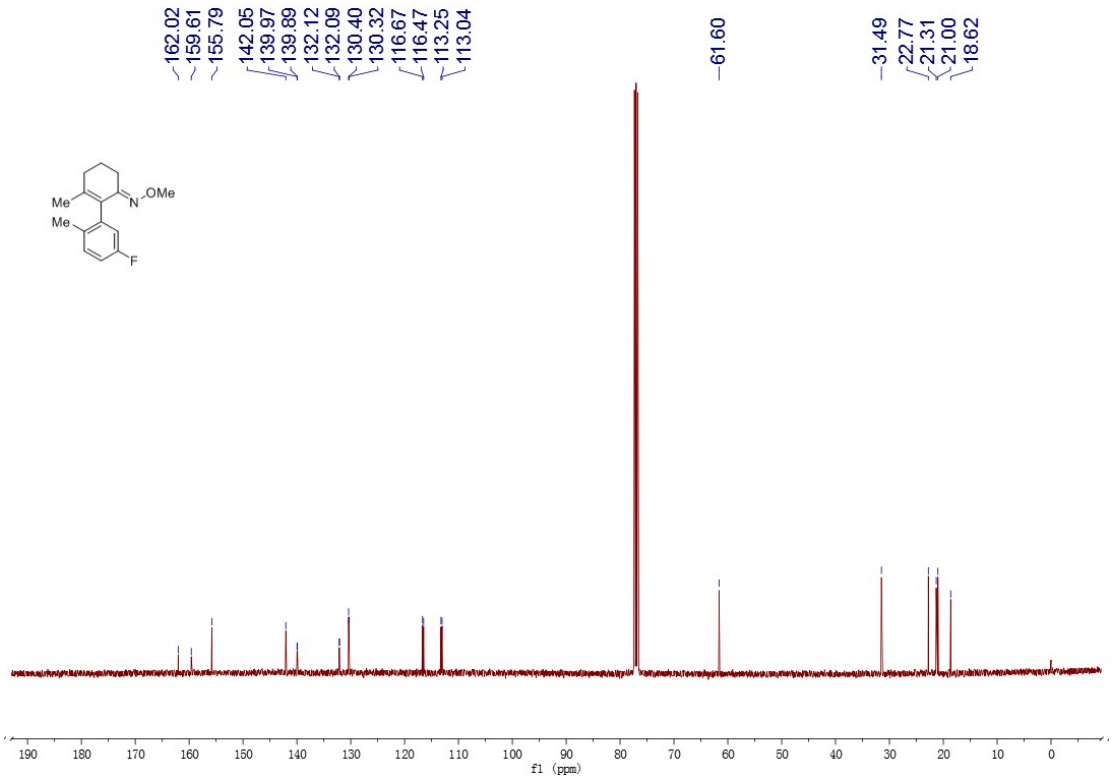
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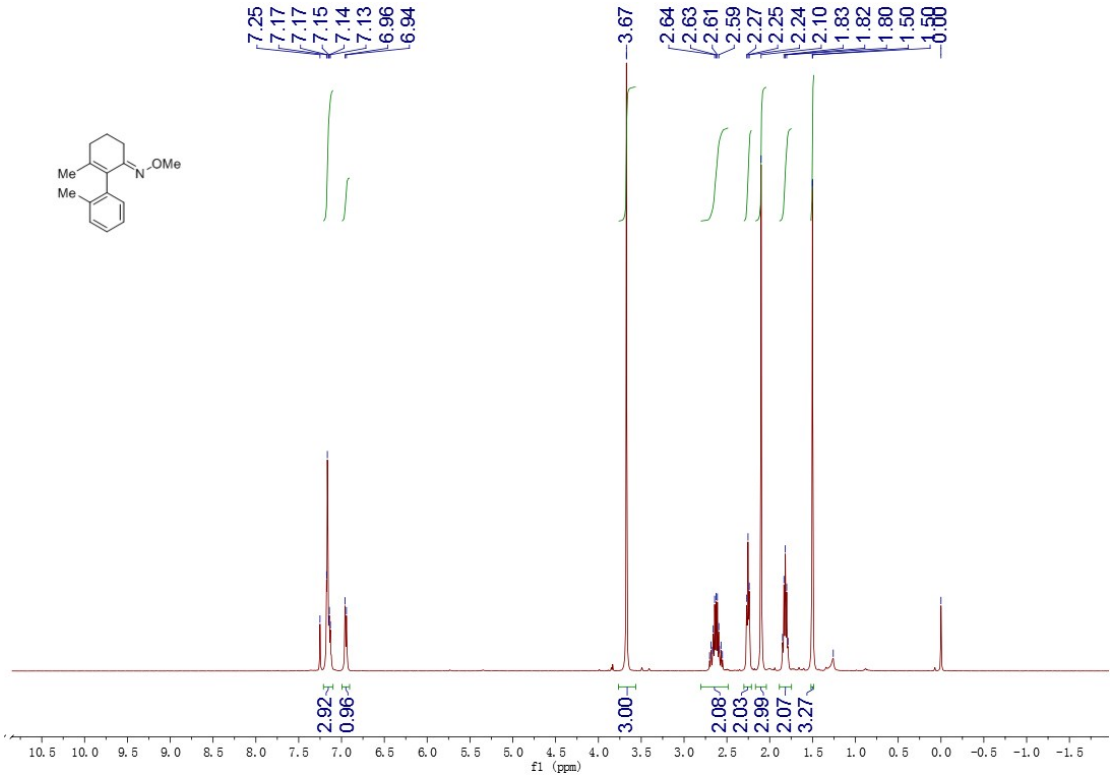
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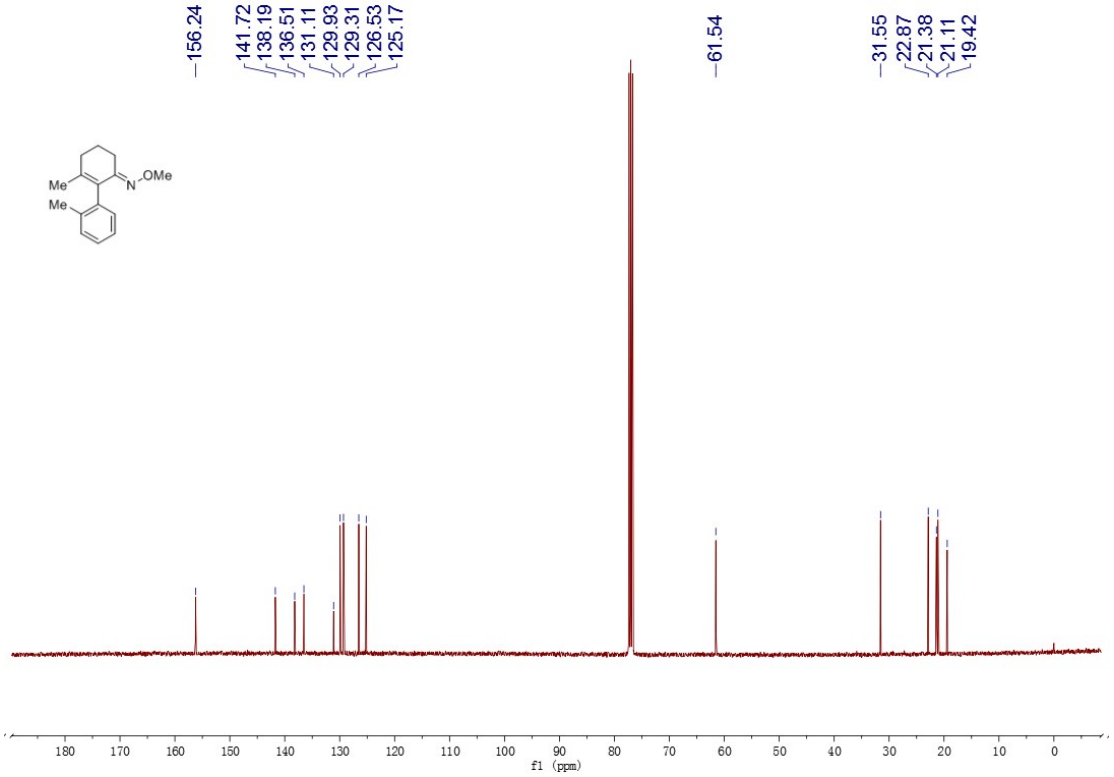
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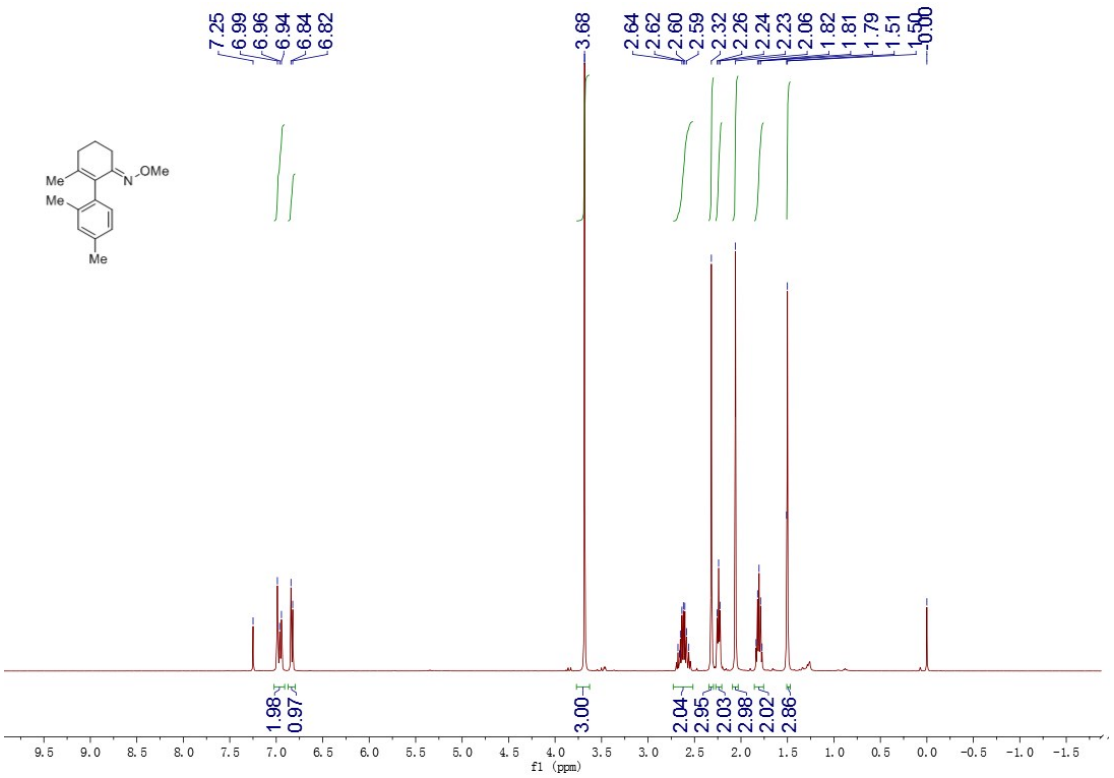
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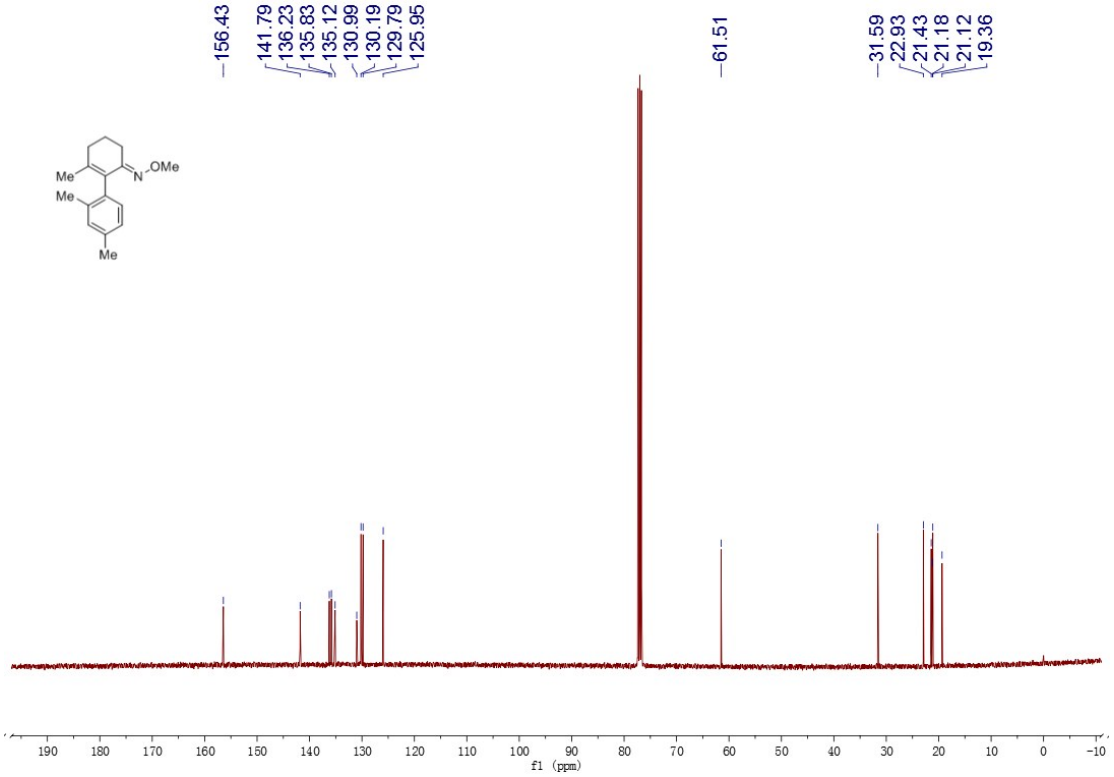
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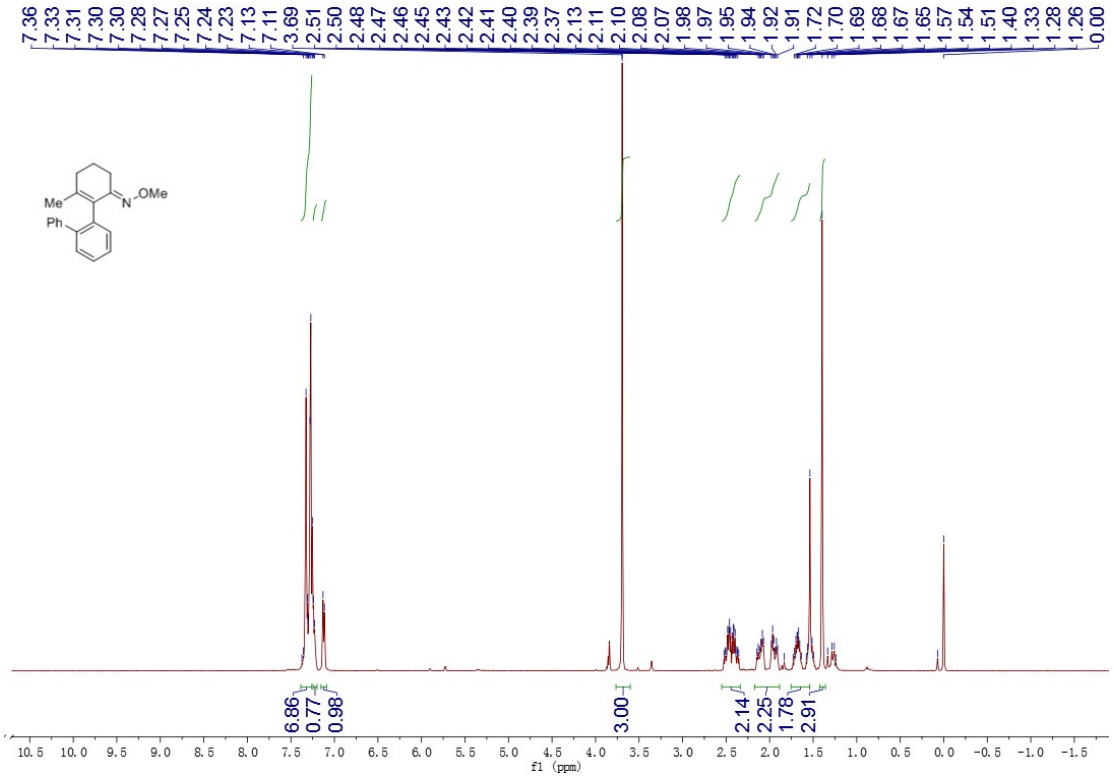
N
OMe
f1 (ppm)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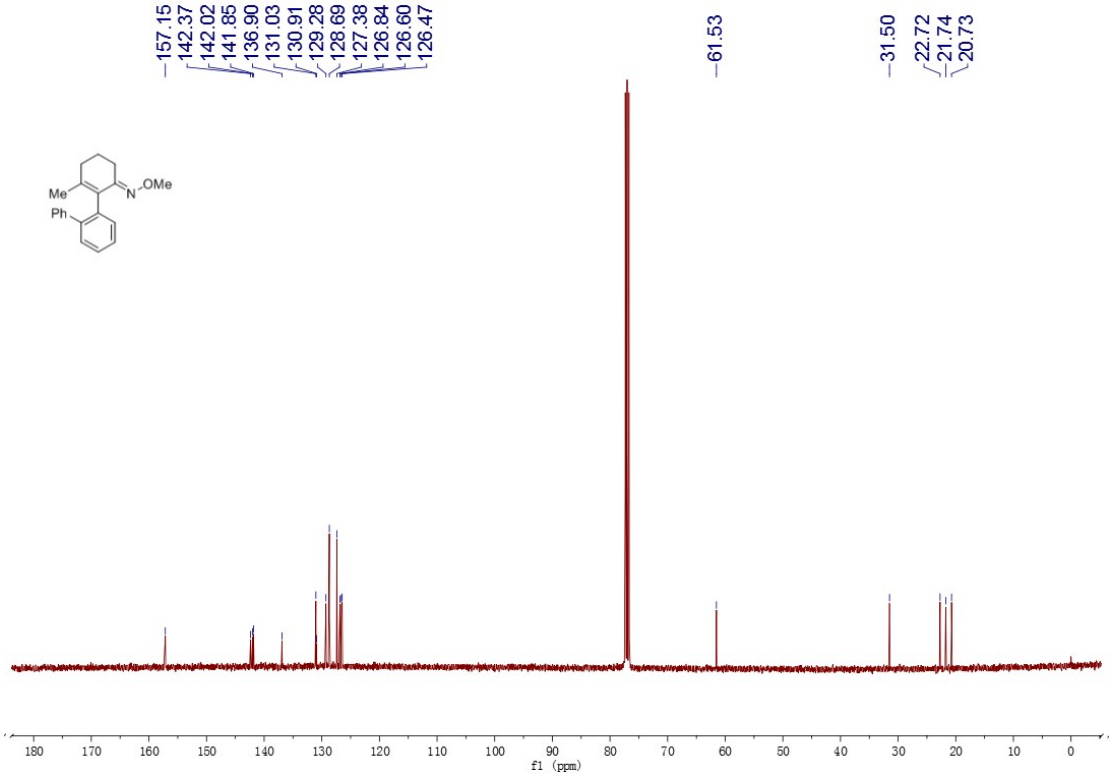
f1 (ppm)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61.53
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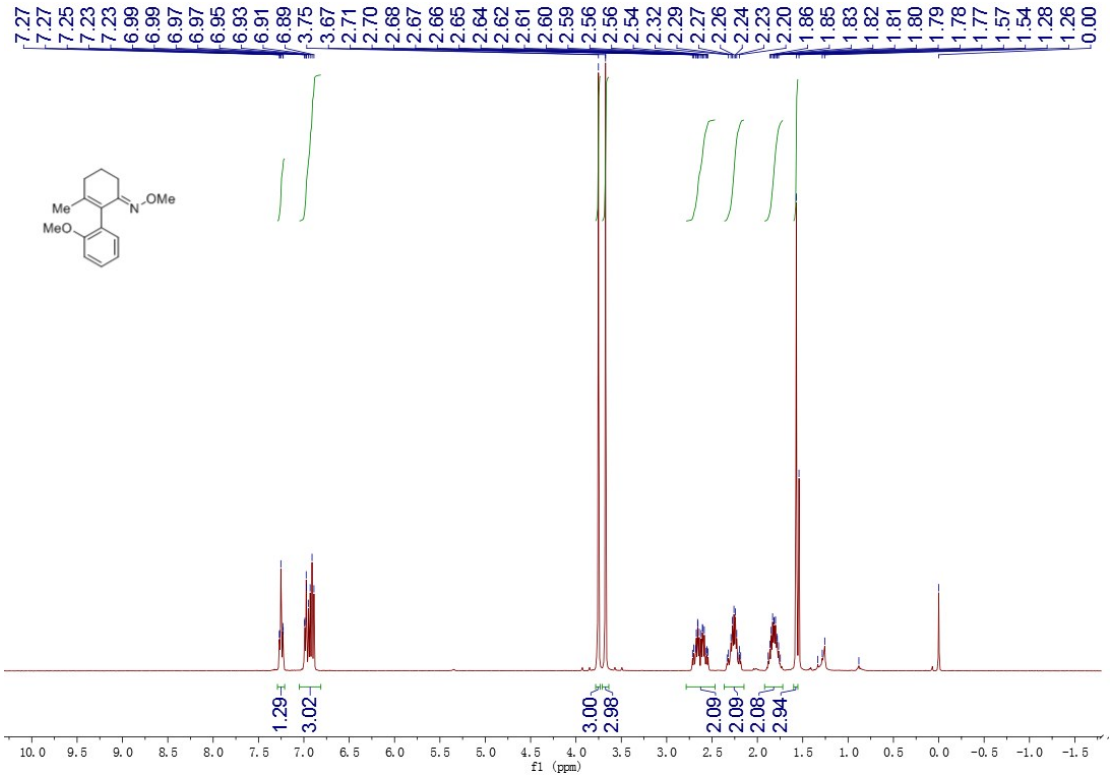
21.74
20.73
Me
N
OMe
Ph
f1 (ppm)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6.89
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2.71
2.70
2.68
2.67
2.66
2.65
2.64
2.62
2.61
2.60
2.59
2.56
2.56
2.54
2.32
2.29
2.27
2.26
2.24
2.23
2.20
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1.85
1.83
1.82
1.81
1.80
1.79
1.78
1.77
1.57
1.54
1.28
1.26
0.00
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3.02
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2.98
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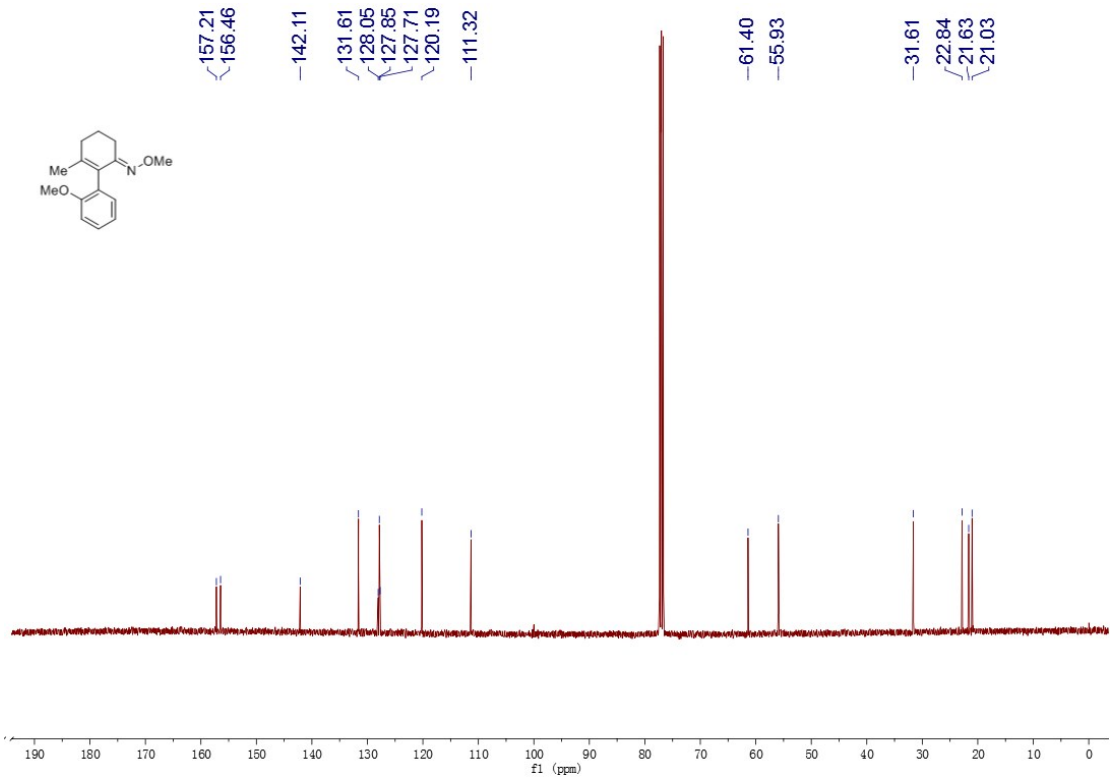
2.09
2.08
2.94
f1 (ppm)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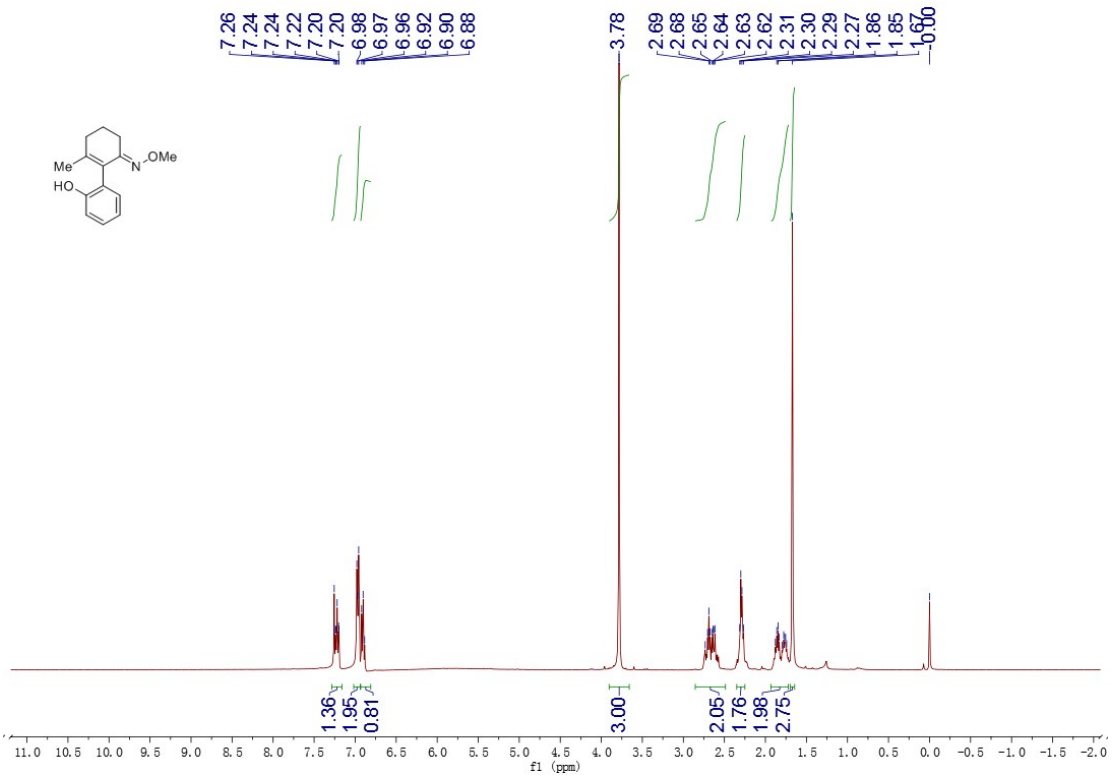
21.63
21.03
Me
MeO
N
OMe
f1 (ppm)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6.88
3.78
2.69
2.68
2.65
2.64
2.63
2.62
2.31
2.30
2.29
2.27
1.86
1.85
1.67
0.00
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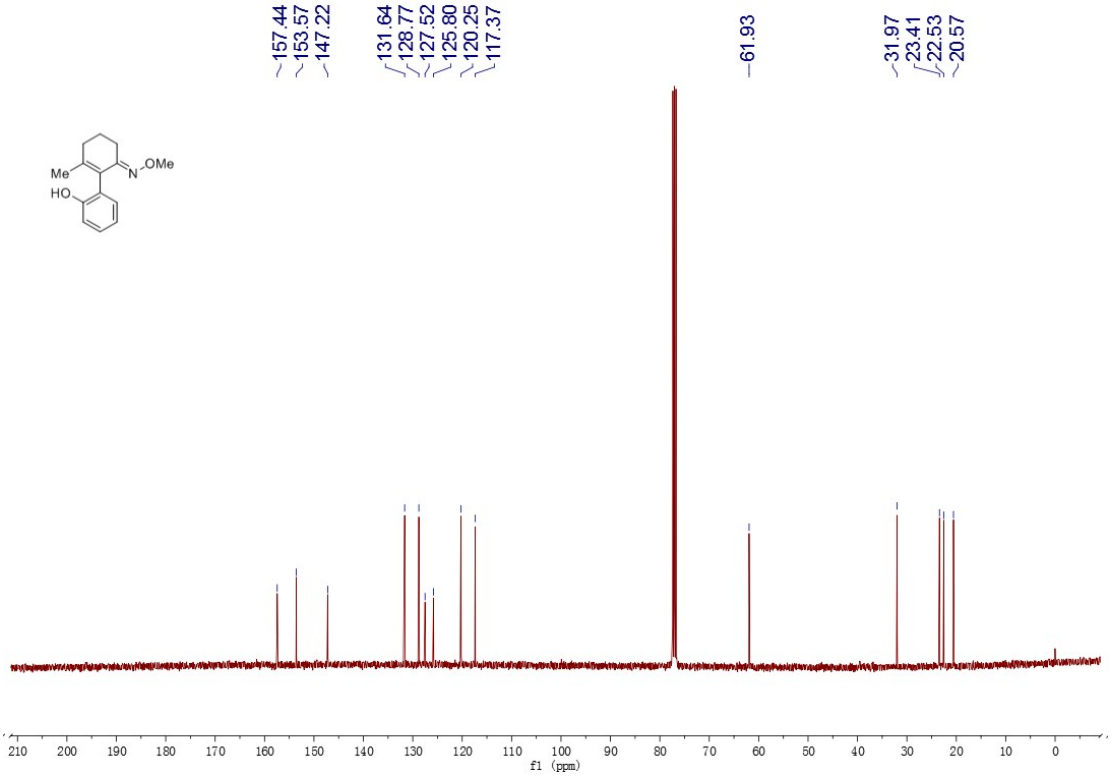
1.98
2.75
f1 (ppm)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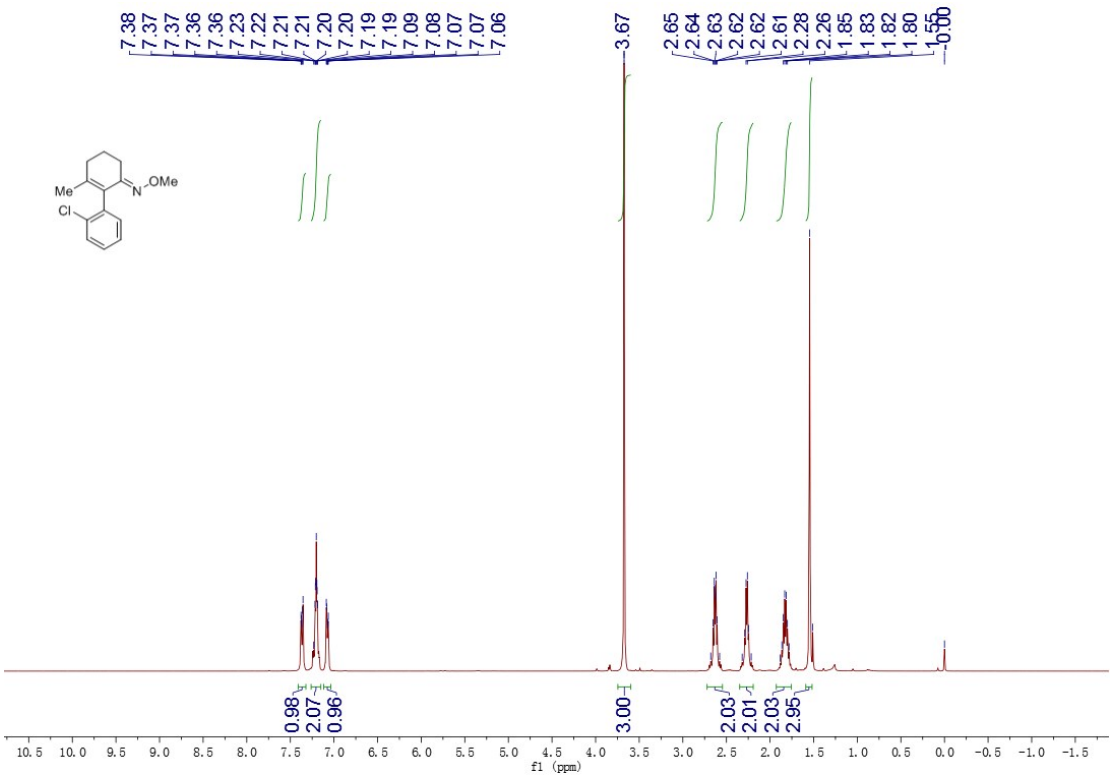
31.97
23.41
22.53
20.57
Me
HO
N
OMe
f1 (ppm)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7.19
7.19
7.09
7.08
7.07
7.07
7.06
3.67
2.65
2.64
2.63
2.62
2.62
2.61
2.28
2.26
1.85
1.83
1.82
1.80
1.55
0.00
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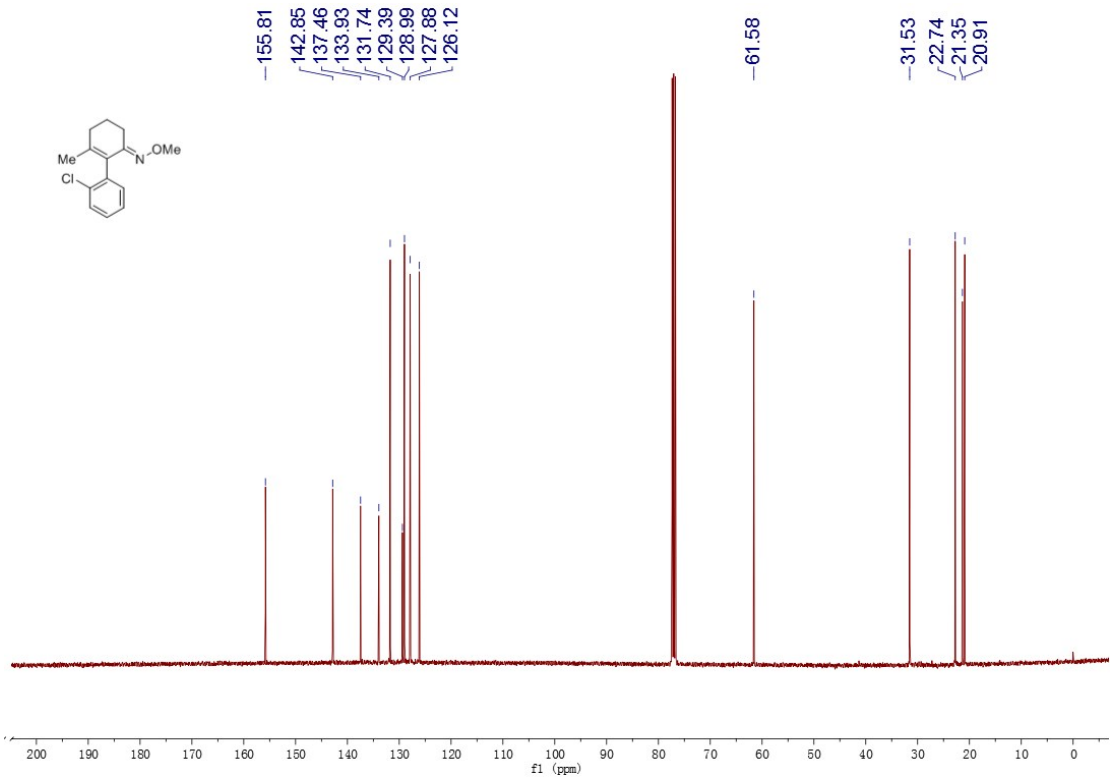
0.96
3.00
2.03
2.01
2.03
2.95
f1 (ppm)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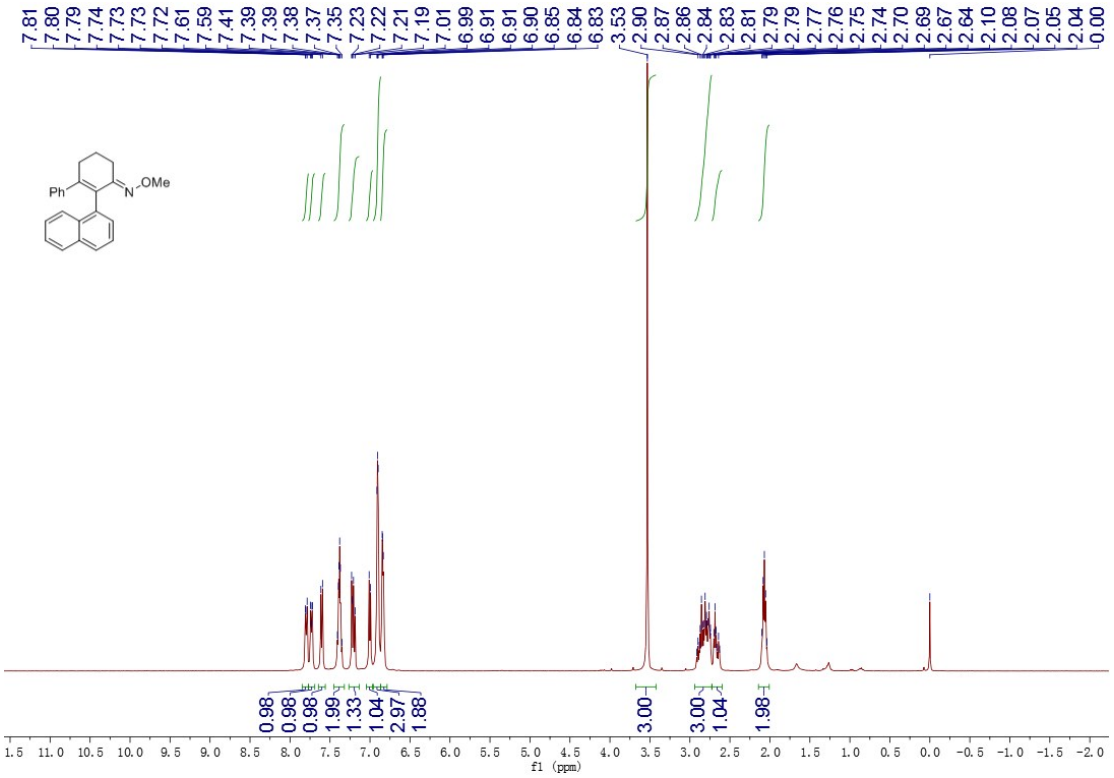
20.91
Me
Cl
N
OMe
f1 (ppm)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7.38
7.37
7.35
7.23
7.22
7.21
7.19
7.01
6.99
6.91
6.91
6.90
6.85
6.84
6.83
3.53
2.90
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2.81
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2.69
2.67
2.64
2.10
2.08
2.07
2.05
2.04
0.00
Ph
N
OMe
0.98
0.98
0.98
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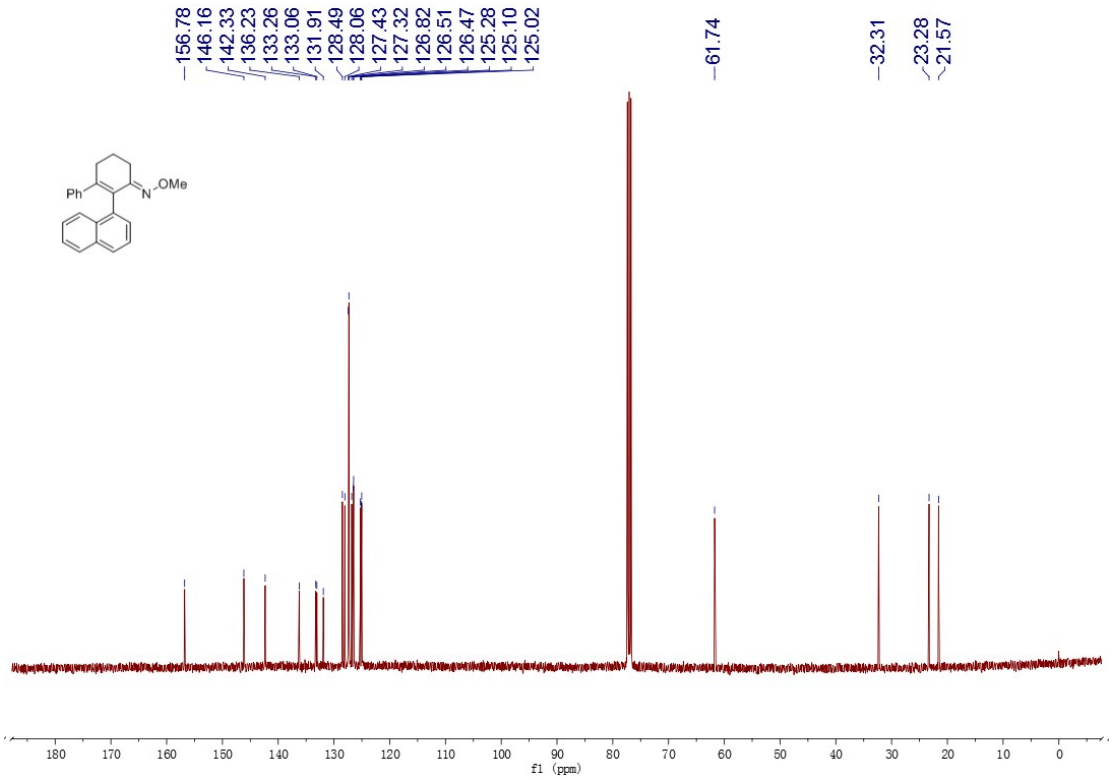
1.33
1.04
2.97
1.88
3.00
3.00
1.04
1.98
f1 (ppm)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133.06
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127.43
127.32
126.82
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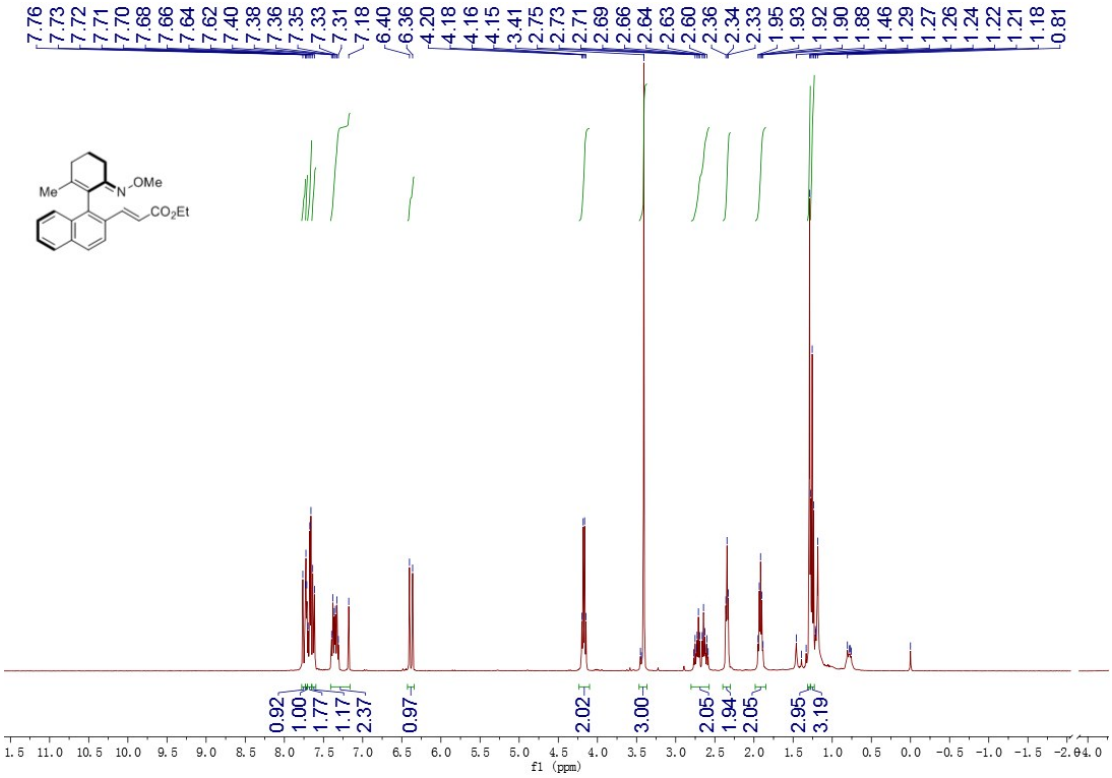
125.28
125.10
125.02
61.74
32.31
23.28
21.57
Ph
N
OMe
f1 (ppm)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7.66
7.64
7.62
7.40
7.38
7.36
7.35
7.33
7.31
7.18
6.40
6.36
4.20
4.18
4.16
4.15
3.41
2.75
2.73
2.71
2.69
2.66
2.64
2.63
2.60
2.36
2.34
2.33
1.95
1.93
1.92
1.90
1.88
1.46
1.29
1.27
1.26
1.24
1.22
1.21
1.18
0.81
Me
OMe
N
CO2Et
0.92
1.00
1.77
1.17
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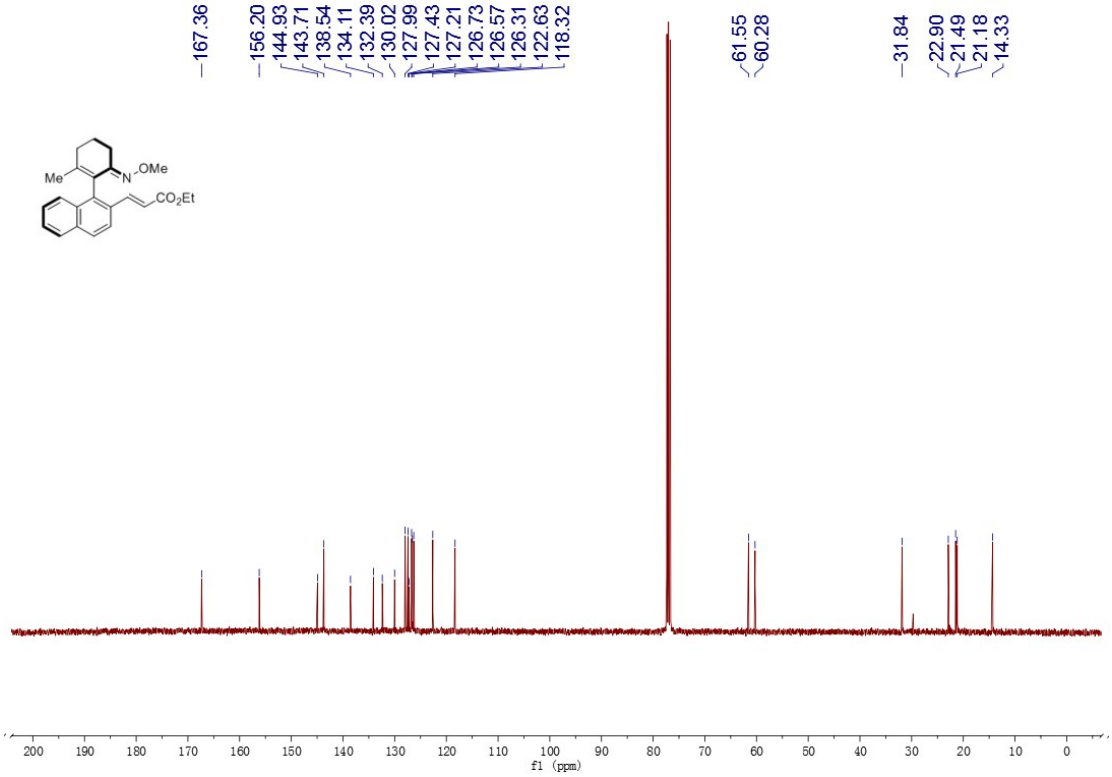
0.97
2.02
3.00
2.05
1.94
2.05
2.95
3.19
f1 (ppm)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127.43
127.21
126.73
126.57
126.31
122.63
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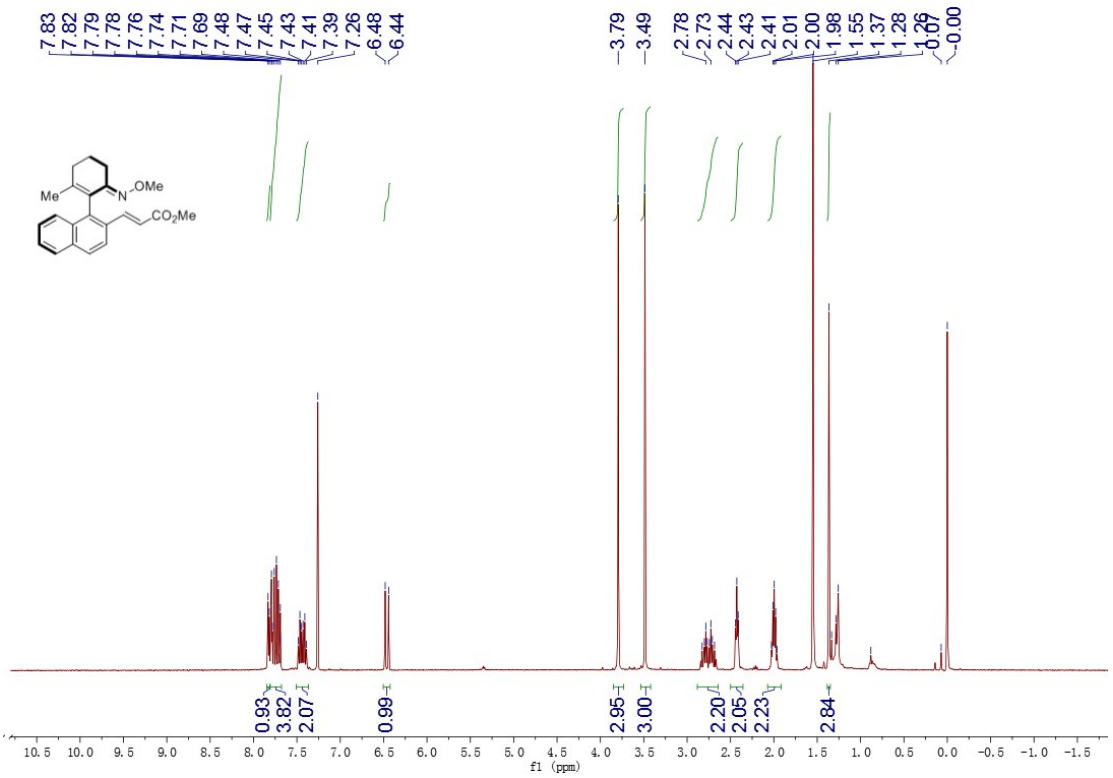
31.84
22.90
21.49
21.18
14.33
Me
OMe
N
CO2Et
f1 (ppm)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7.47
7.45
7.43
7.41
7.39
7.26
6.48
6.44
3.79
3.49
2.78
2.73
2.44
2.43
2.41
2.01
2.00
1.98
1.55
1.37
1.28
1.26
0.07
0.00
Me
OMe
N
CO2Me
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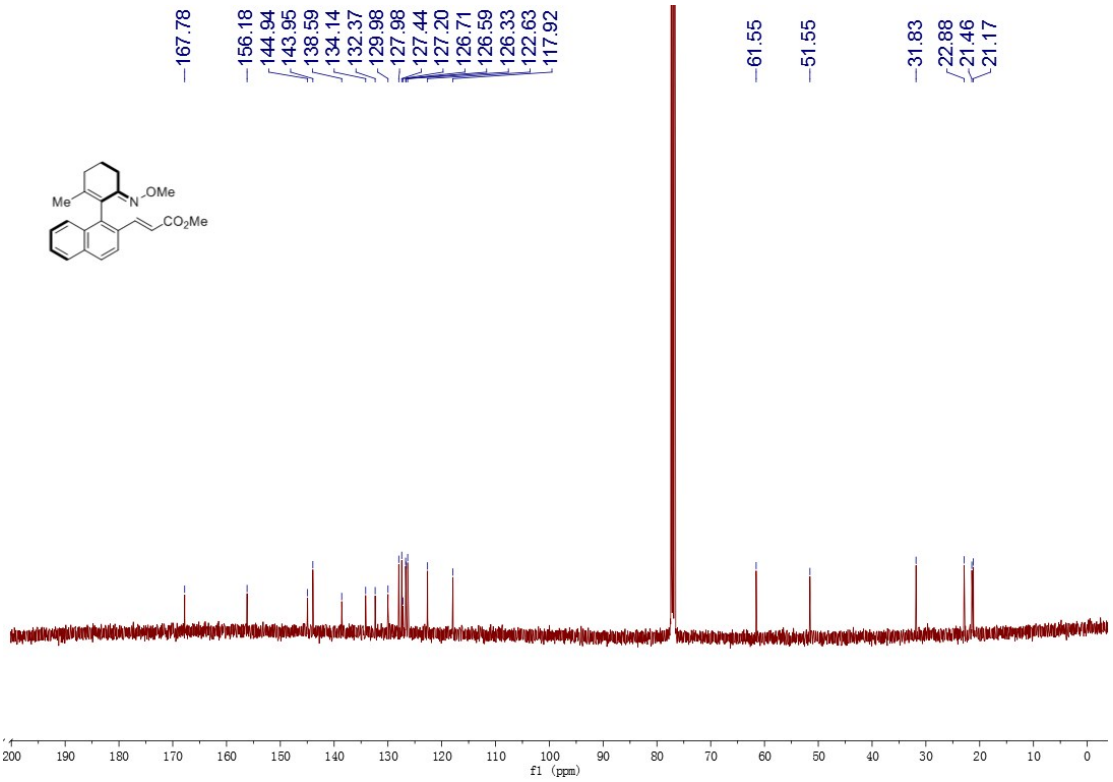
2.07
0.99
2.95
3.00
2.20
2.05
2.23
2.84
f1 (ppm)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127.20
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126.59
126.33
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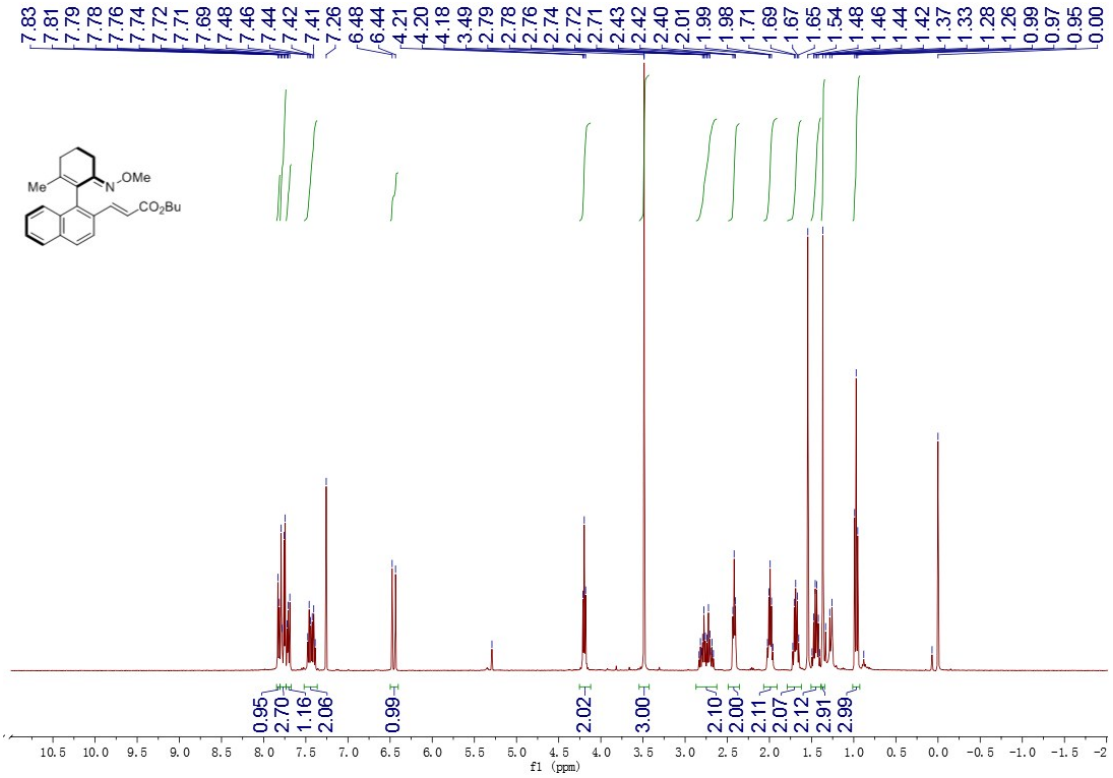
51.55
31.83
22.88
21.46
21.17
Me
OMe
N
CO2Me
f1 (ppm)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7.74
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7.48
7.46
7.44
7.42
7.41
7.26
6.48
6.44
4.21
4.20
4.18
3.49
2.79
2.78
2.76
2.74
2.72
2.71
2.43
2.42
2.40
2.01
1.99
1.98
1.71
1.69
1.67
1.65
1.54
1.48
1.46
1.44
1.42
1.37
1.33
1.28
1.26
0.99
0.97
0.95
0.00
Me
N
OMe
CO2Bu
0.95
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1.16
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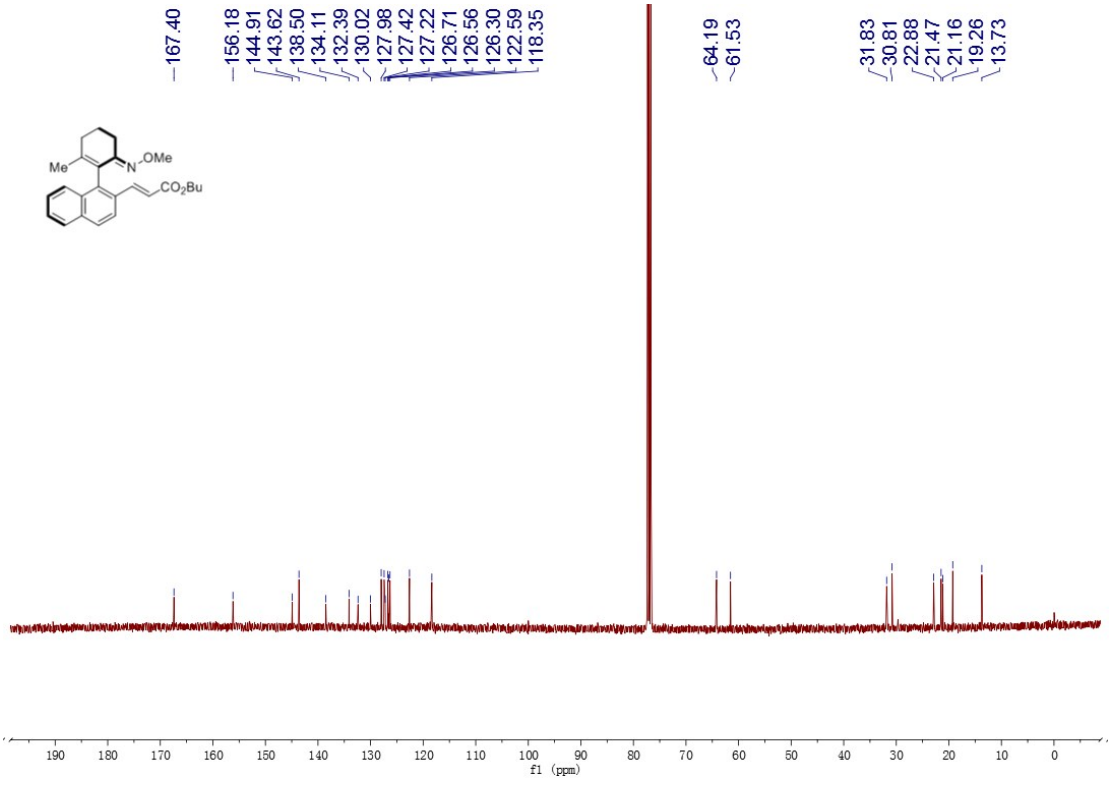
3.00
2.10
2.00
2.11
2.07
2.12
2.91
2.99
f1 (ppm)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127.42
127.22
126.71
126.56
126.30
122.59
118.35
64.19
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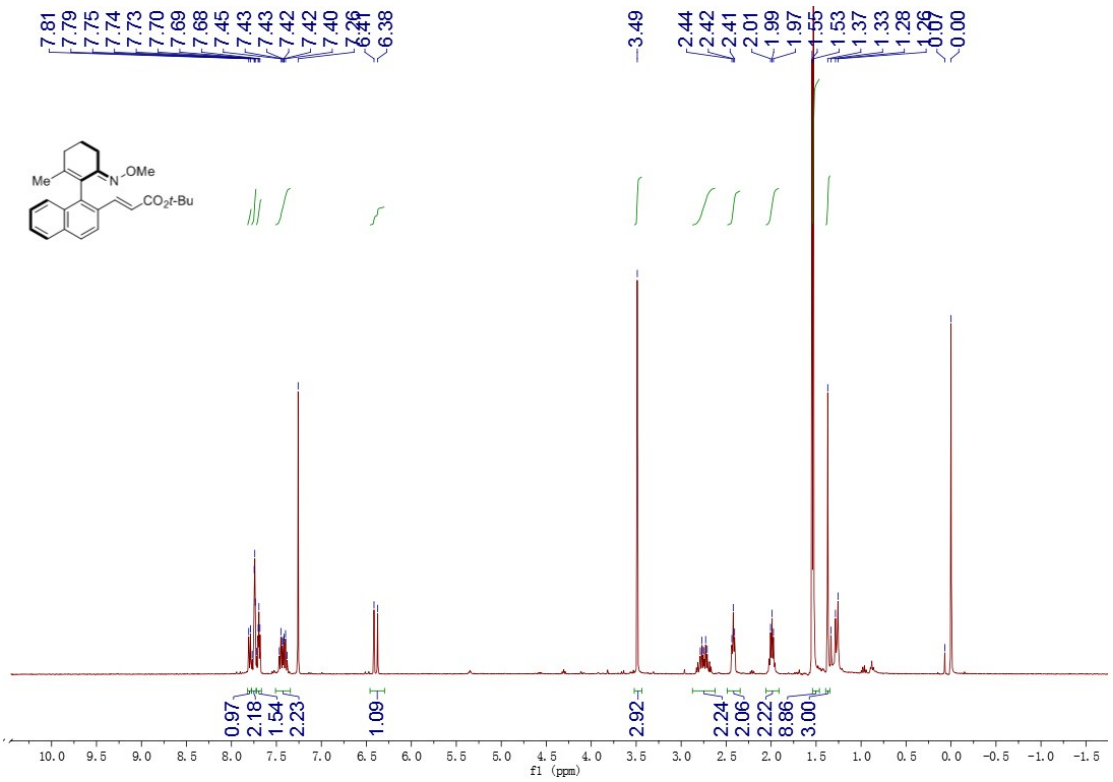
22.88
21.47
21.16
19.26
13.73
Me
N
OMe
CO2Bu
f1 (ppm)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7.42
7.42
7.40
6.41
6.38
3.49
2.44
2.42
2.41
2.01
1.99
1.97
1.55
1.53
1.37
1.33
1.28
0.07
0.00
Me
N
OMe
CO2t-Bu
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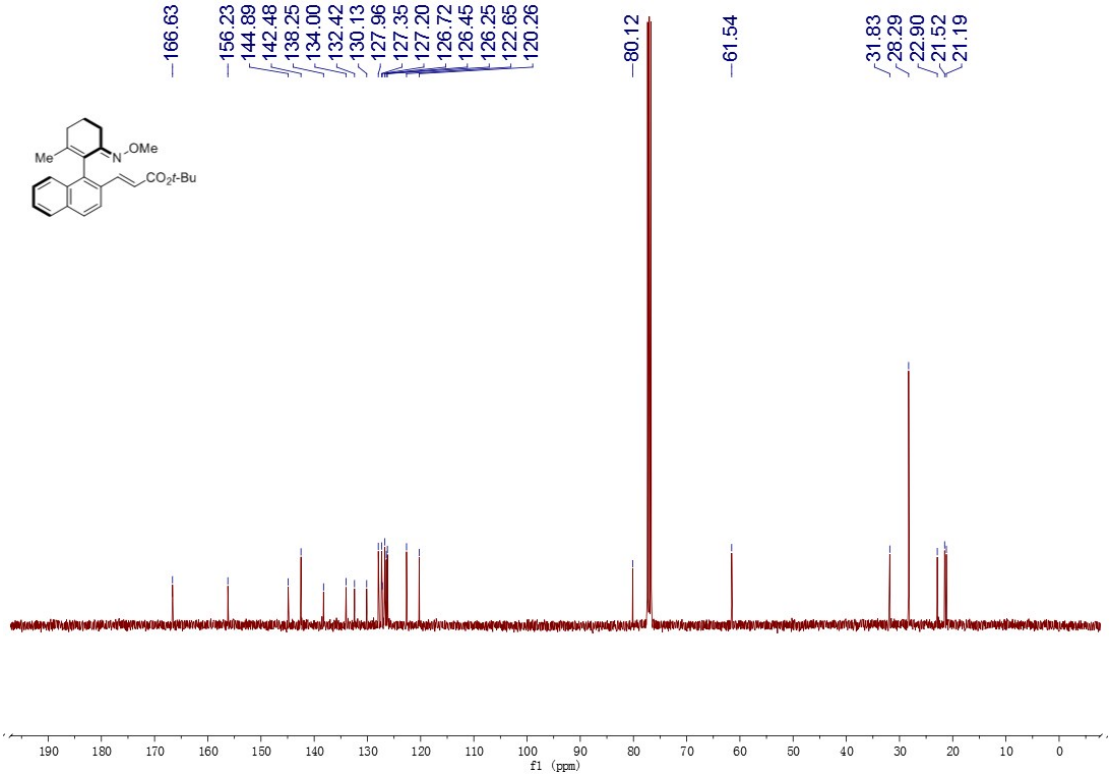
2.23
1.09
2.92
2.24
2.06
2.22
8.86
3.00
f1 (ppm)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126.45
126.25
122.65
120.26
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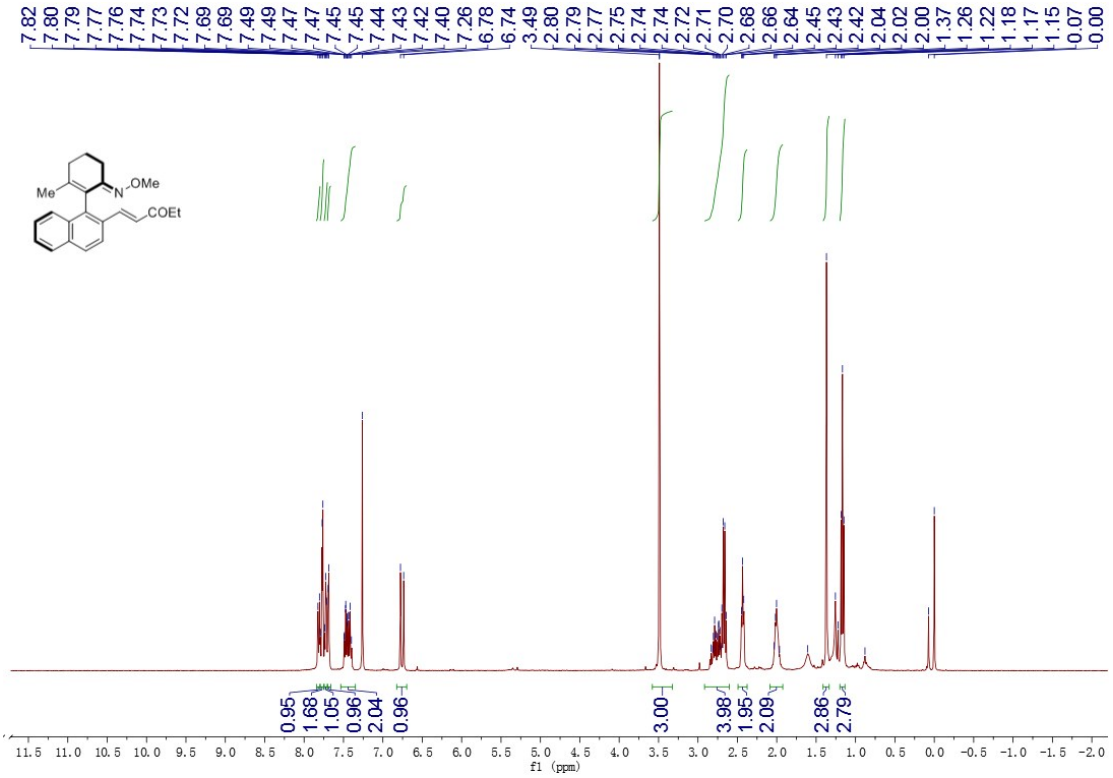
31.83
28.29
22.90
21.52
21.19
Me
N
OMe
CO2t-Bu
f1 (ppm)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7.69
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7.47
7.45
7.45
7.44
7.43
7.42
7.40
7.26
6.78
6.74
3.49
2.80
2.79
2.77
2.75
2.74
2.74
2.72
2.71
2.70
2.68
2.66
2.64
2.45
2.43
2.42
2.04
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2.00
1.37
1.26
1.22
1.18
1.17
1.15
0.07
0.00
Me
N
OMe
COEt
0.95
1.68
1.05
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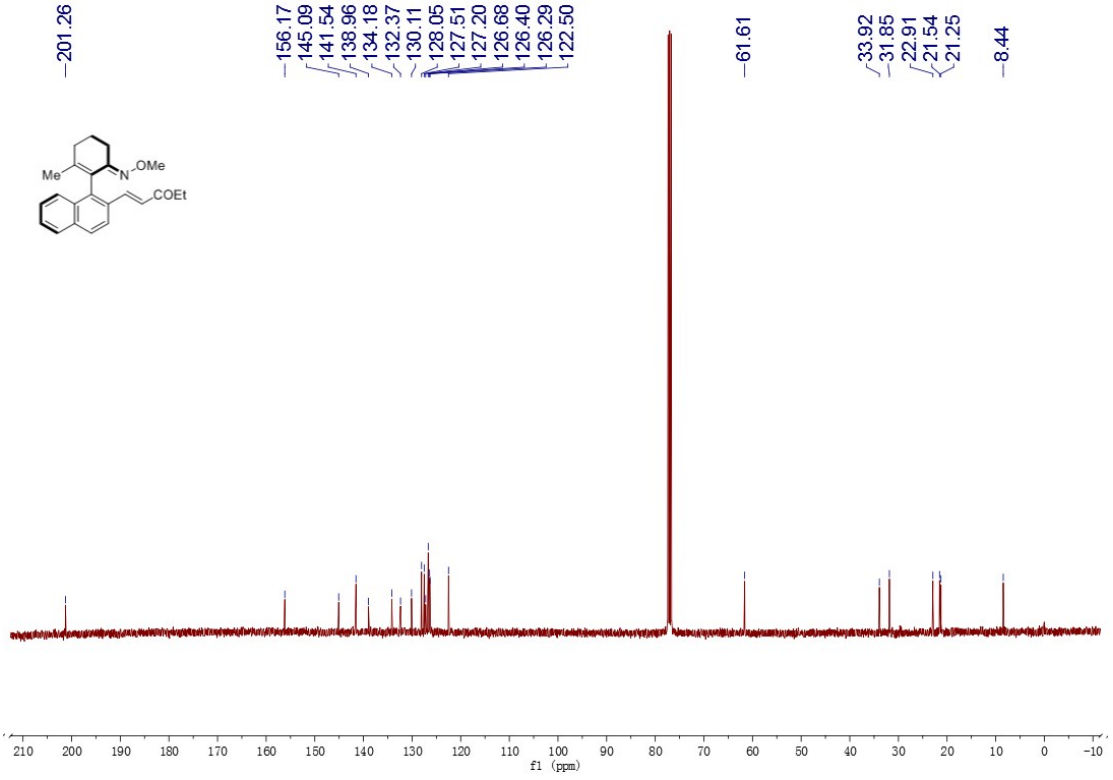
2.04
0.96
3.00
3.98
1.95
2.09
2.86
2.79
f1 (ppm)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126.40
126.29
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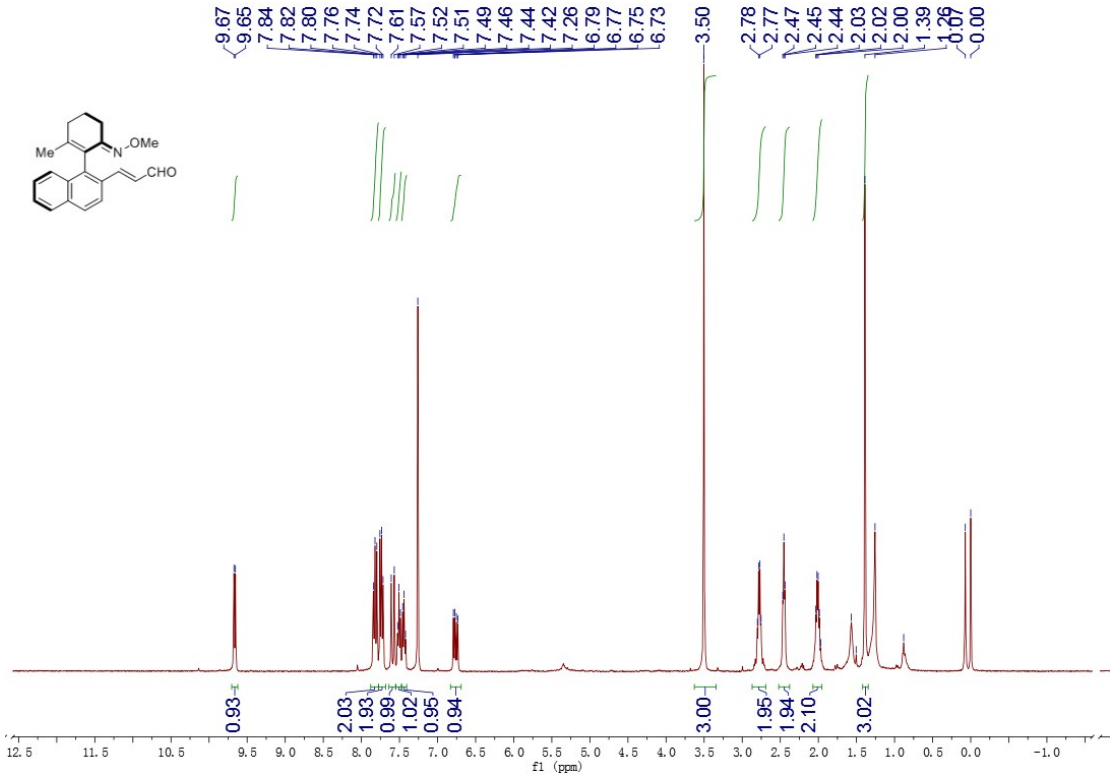
31.85
22.91
21.54
21.25
8.44
Me
N
OMe
COEt
f1 (ppm)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7.72
7.61
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7.52
7.51
7.49
7.46
7.44
7.42
7.26
6.79
6.77
6.75
6.73
3.50
2.78
2.77
2.47
2.45
2.44
2.03
2.02
2.00
1.39
1.26
0.07
0.00
Me
N
OMe
CHO
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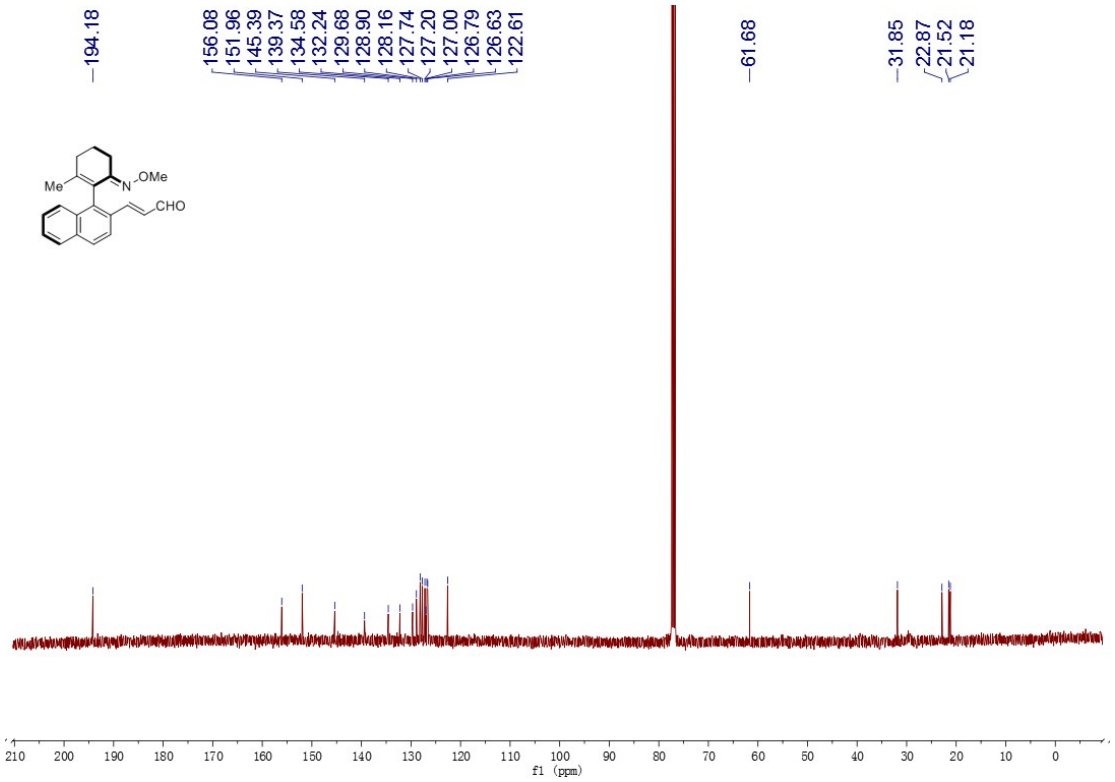
1.02
0.95
0.94
3.00
1.95
1.94
2.10
3.02
f1 (ppm)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128.16
127.74
127.20
127.00
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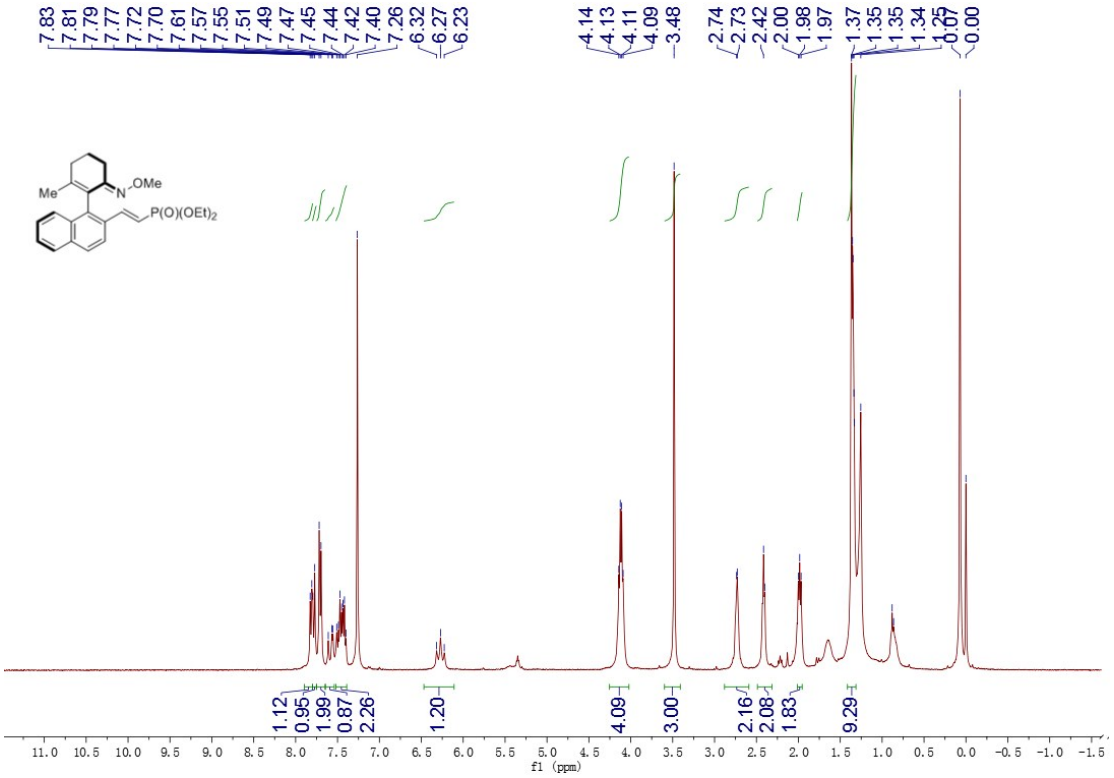
122.61
61.68
31.85
22.87
21.52
21.18
Me
N
OMe
CHO
f1 (ppm)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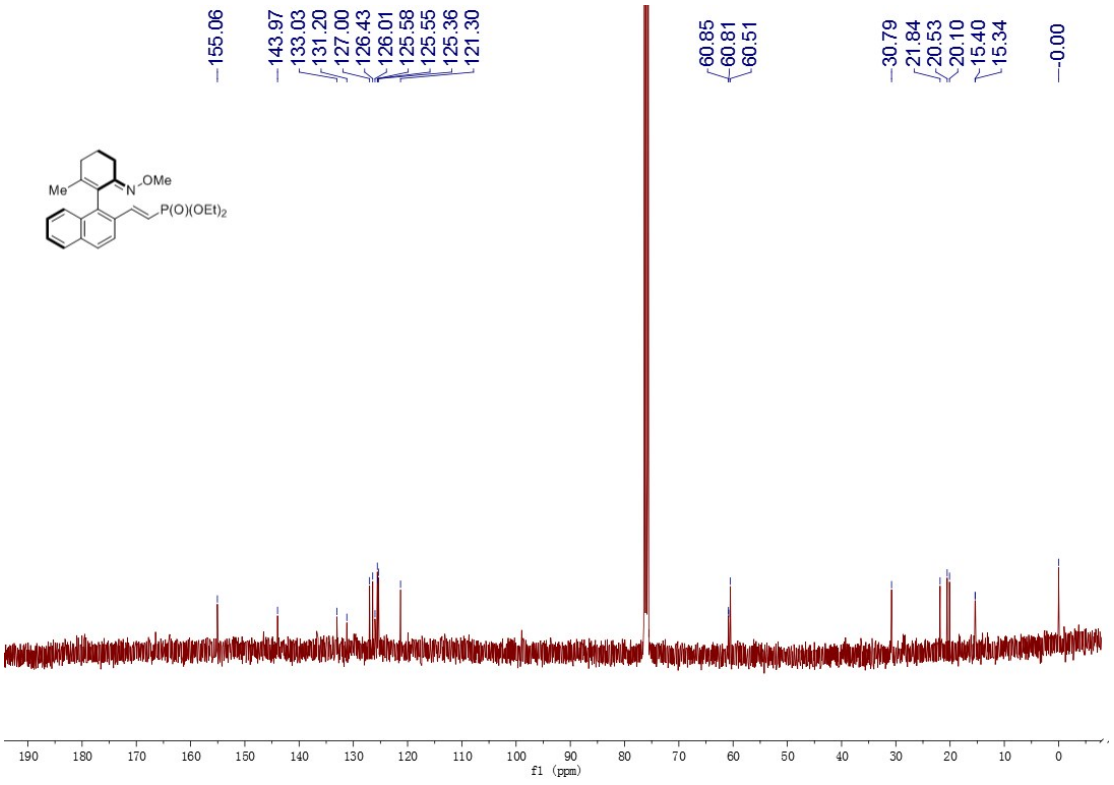
7.57
7.55
7.51
7.49
7.47
7.45
7.44
7.42
7.40
7.26
6.32
6.27
6.23
4.14
4.13
4.11
4.09
3.48
2.74
2.73
2.42
2.00
1.98
1.97
1.37
1.35
1.35
1.34
0.07
0.00
Me
OMe
N
P(O)(OEt)2
1.12
0.95
1.99
0.87
2.26
1.20
4.09
3.00
2.16
2.08
1.83
9.29
f1 (ppm)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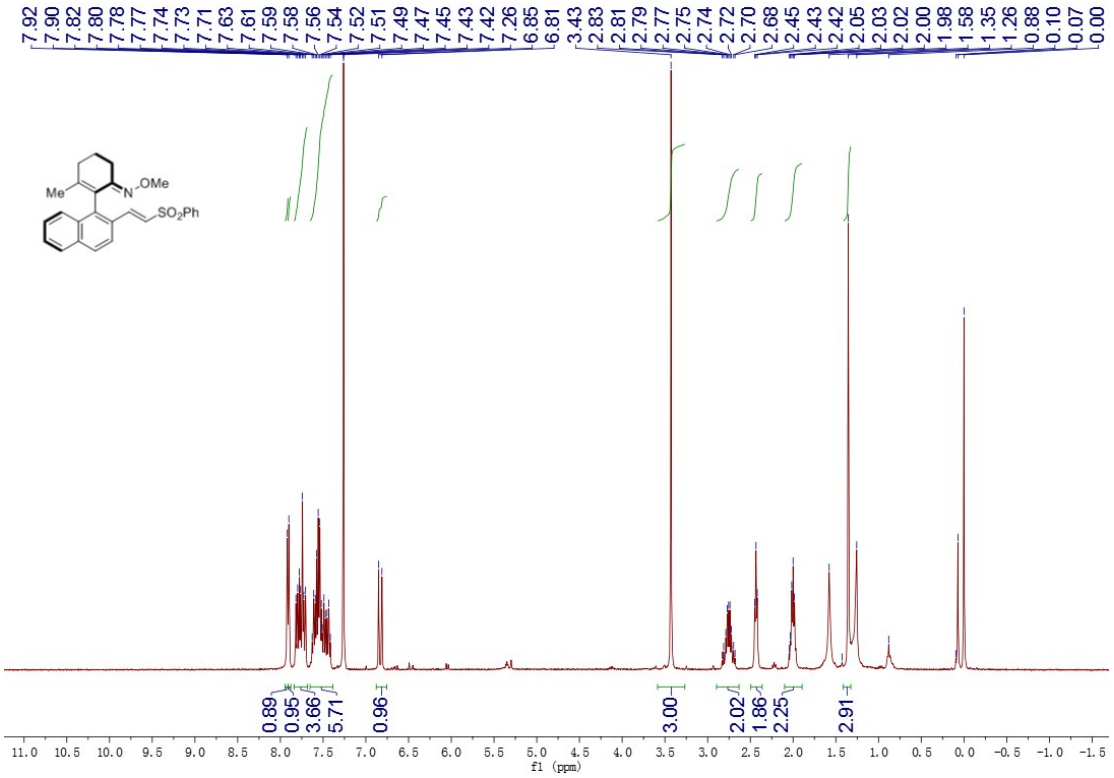
126.01
125.58
125.55
125.36
121.30
60.85
60.81
60.51
30.79
21.84
20.53
20.10
15.40
15.34
0.00
Me
OMe
N
P(O)(OEt)2
f1 (ppm)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7.56
7.54
7.52
7.51
7.49
7.47
7.45
7.43
7.42
7.26
6.85
6.81
3.43
2.83
2.81
2.79
2.77
2.75
2.74
2.72
2.70
2.68
2.45
2.43
2.42
2.05
2.03
2.02
2.00
1.98
1.58
1.35
1.26
0.88
0.10
0.07
0.00
Me
OMe
N
SO2Ph
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5.71
0.96
3.00
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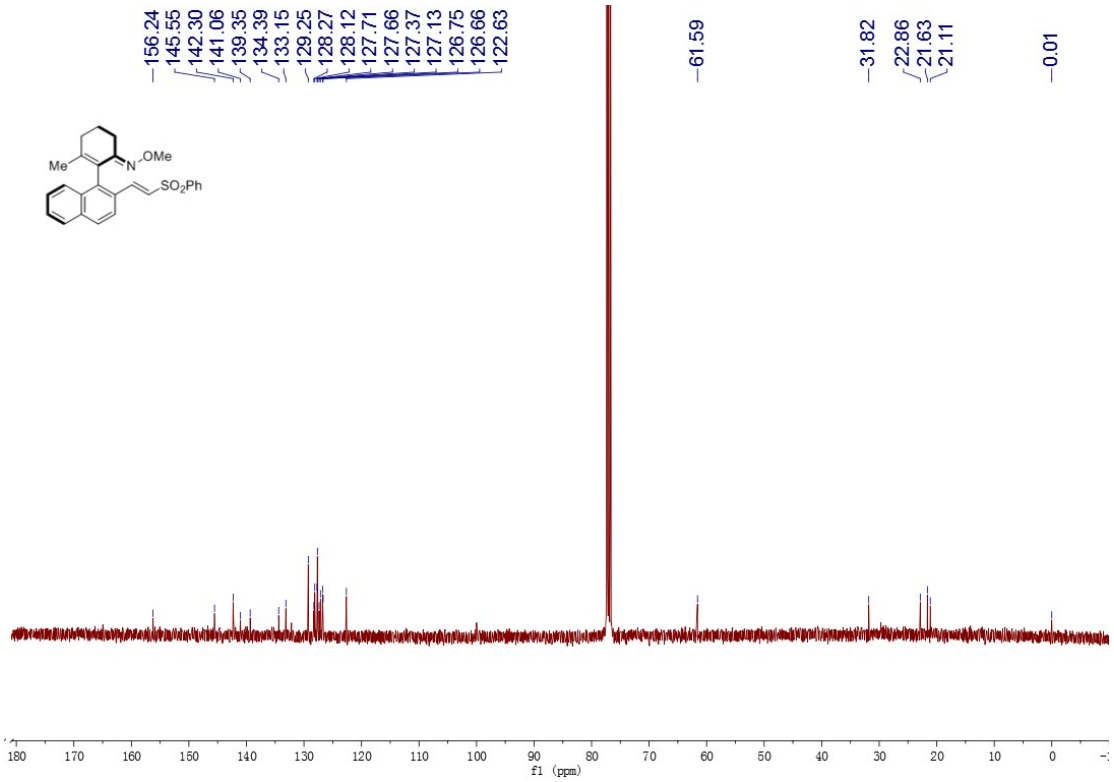
1.86
2.25
2.91
f1 (ppm)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128.12
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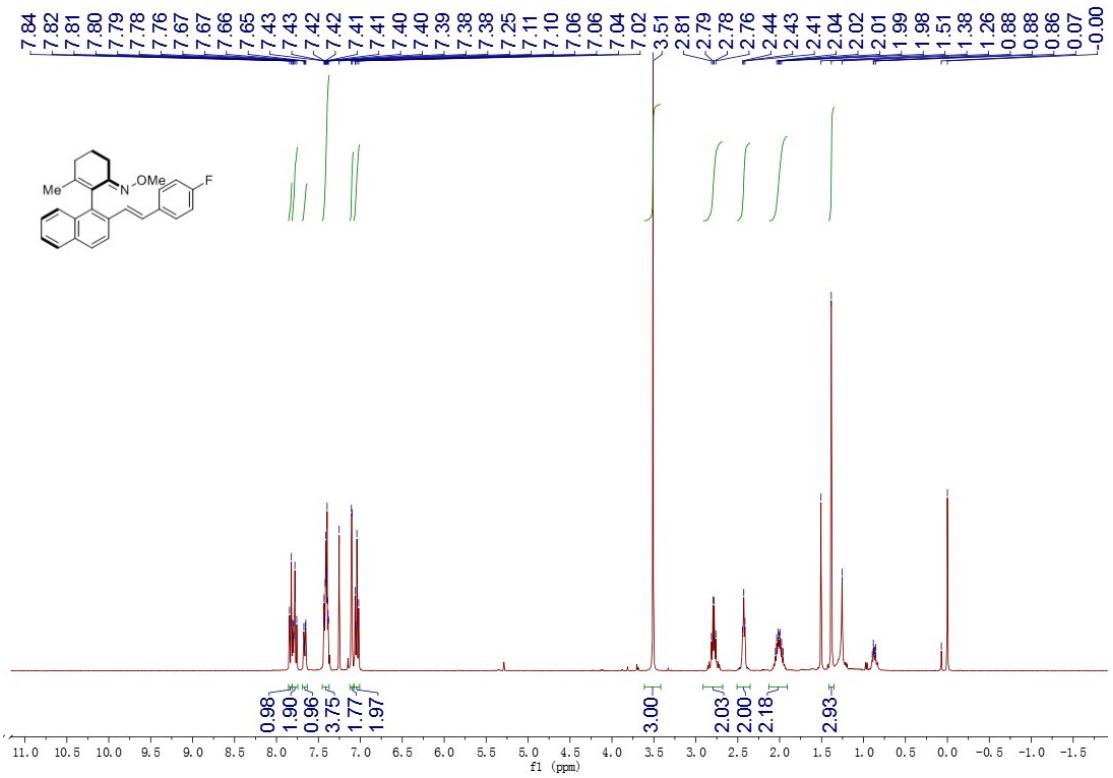
127.66
127.37
127.13
126.75
126.66
122.63
61.59
31.82
22.86
21.63
21.11
0.01
Me
OMe
N
SO2Ph
f1 (ppm)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7.42
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7.41
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7.40
7.39
7.38
7.38
7.25
7.11
7.10
7.06
7.06
7.04
7.02
3.51
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2.78
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2.43
2.41
2.04
2.02
2.01
1.99
1.98
1.51
1.38
1.26
0.88
0.86
0.07
-0.00
Me
N
OMe
F
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2.00
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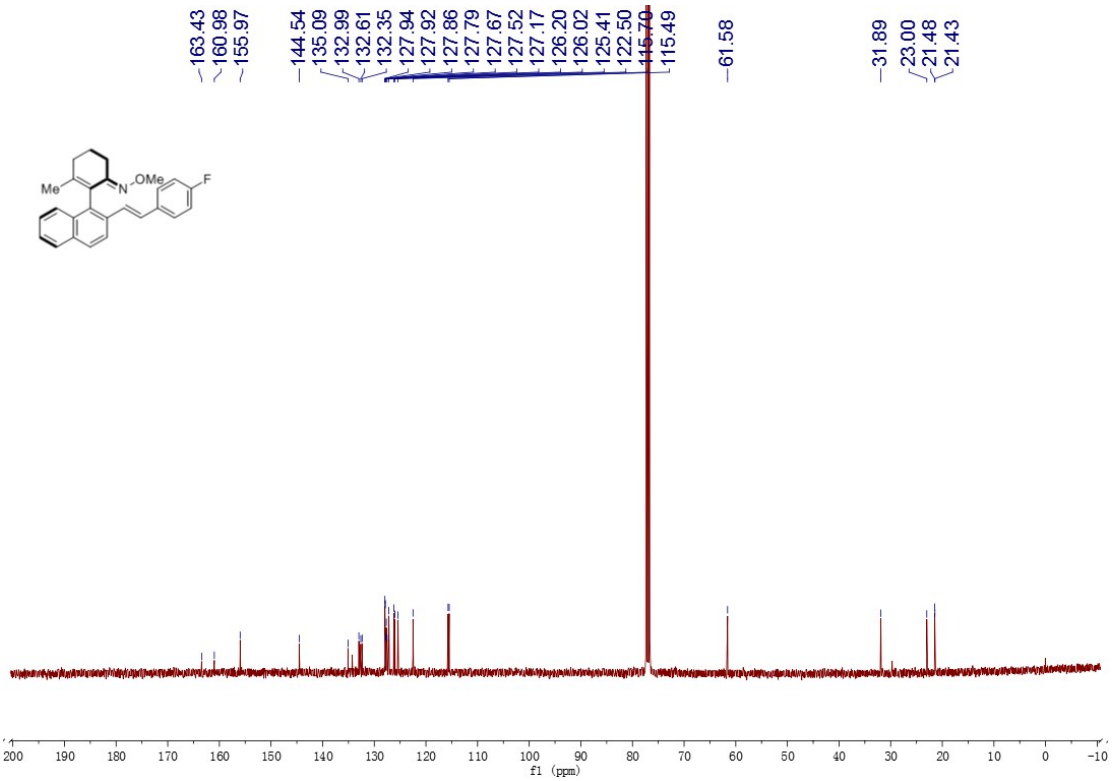
f1 (ppm)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127.79
127.67
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127.17
126.20
126.02
125.41
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115.49
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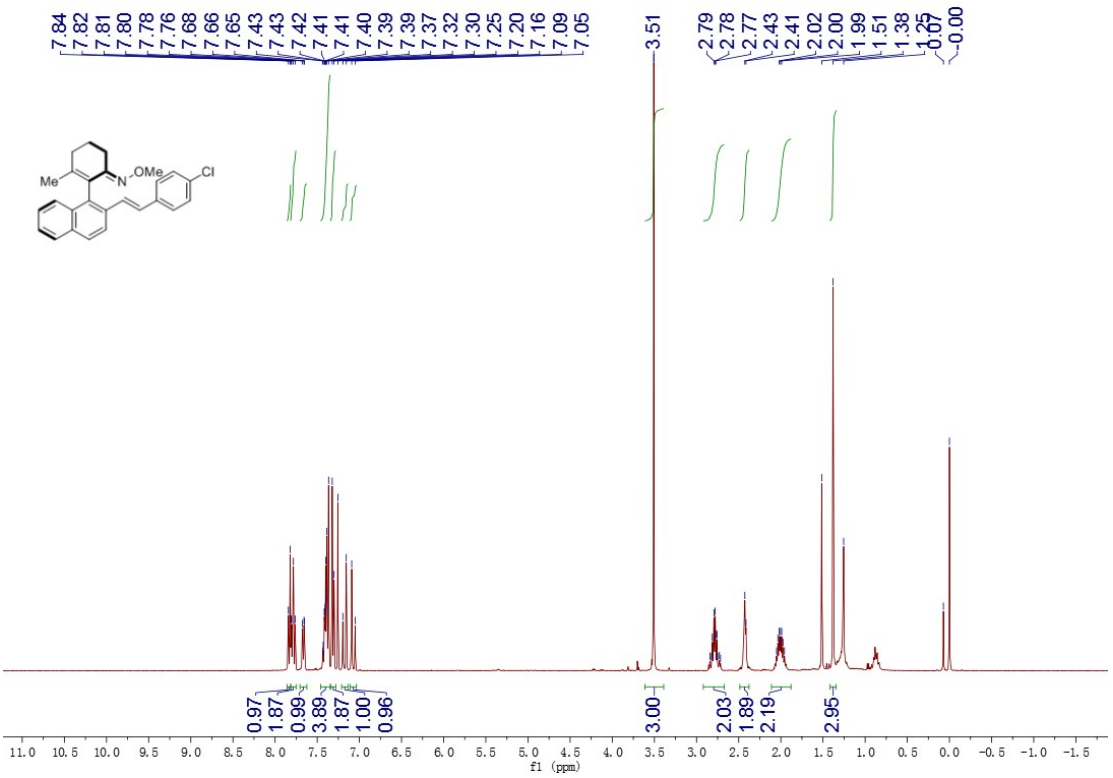
21.43
Me
N
OMe
F
f1 (ppm)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7.37
7.32
7.30
7.25
7.20
7.16
7.09
7.05
3.51
2.79
2.78
2.77
2.43
2.41
2.02
2.00
1.99
1.51
1.38
1.25
0.07
0.00
Me
N
OMe
Cl
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1.87
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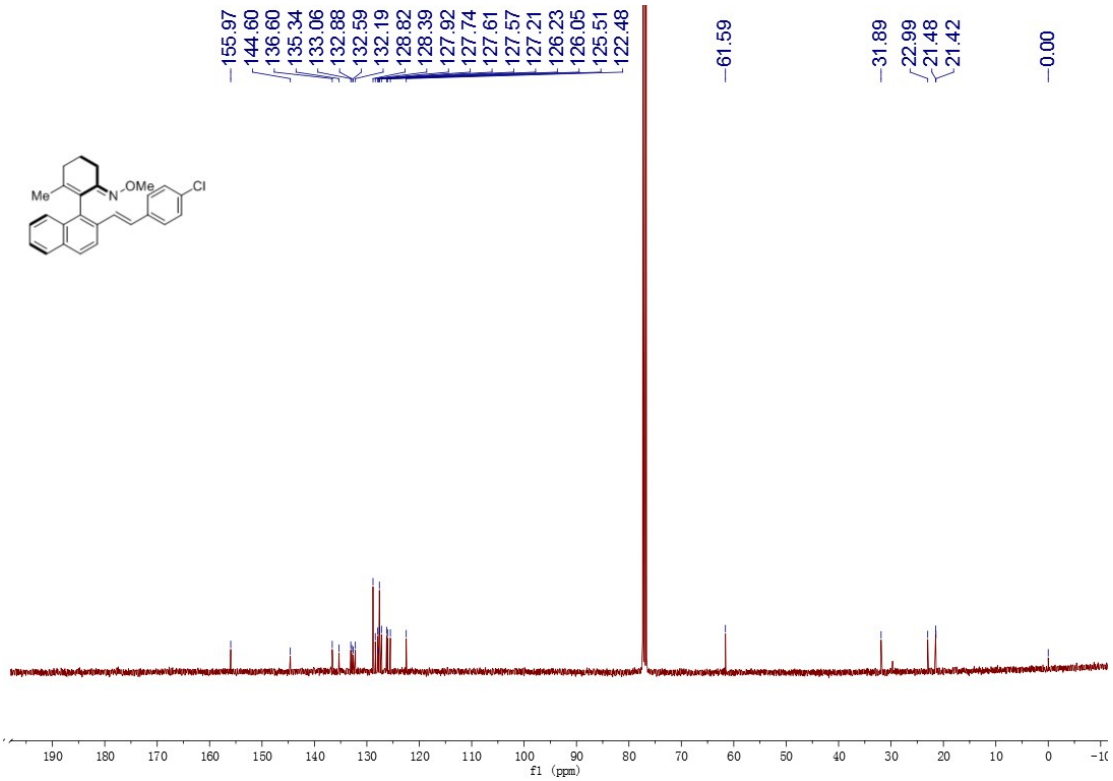
0.96
3.00
2.03
1.89
2.19
2.95
f1 (ppm)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127.61
127.57
127.21
126.23
126.05
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31.89
22.99
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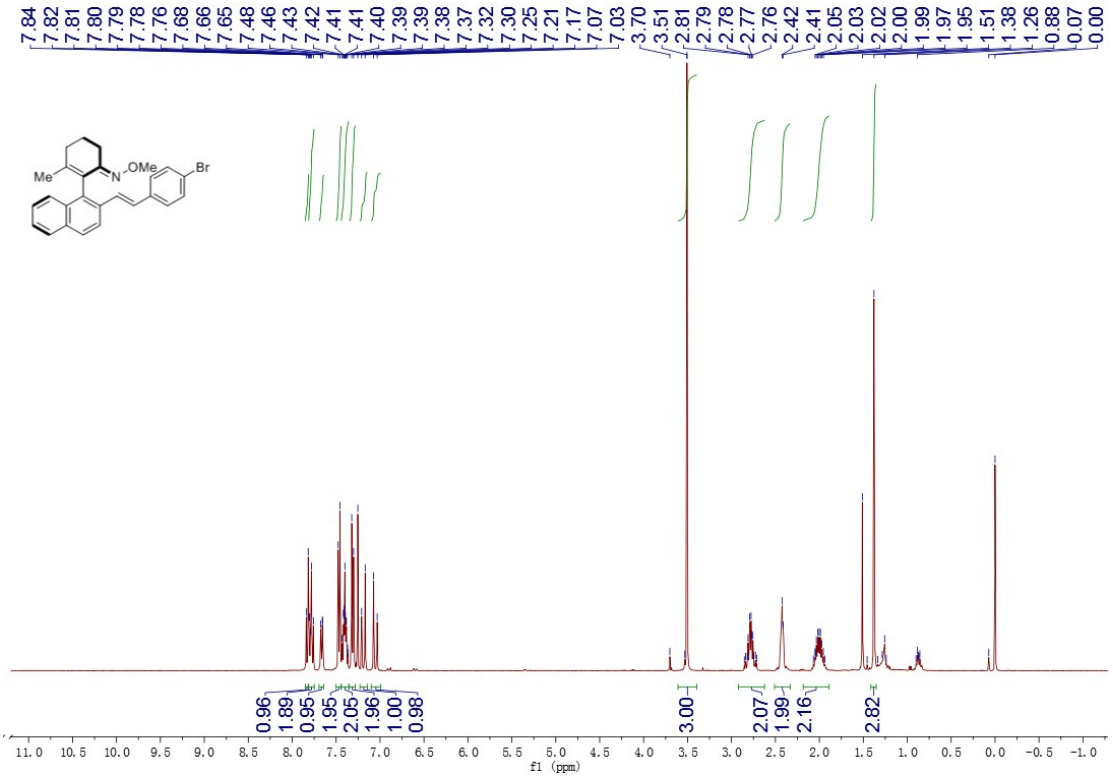
21.42
0.00
Me
N
OMe
Cl
f1 (ppm)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7.41
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7.39
7.39
7.38
7.37
7.32
7.30
7.25
7.21
7.17
7.07
7.03
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3.51
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2.79
2.78
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2.76
2.42
2.41
2.05
2.03
2.02
2.00
1.99
1.97
1.95
1.51
1.38
1.26
0.88
0.07
0.00
Me
N
OMe
Br
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1.89
0.95
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1.96
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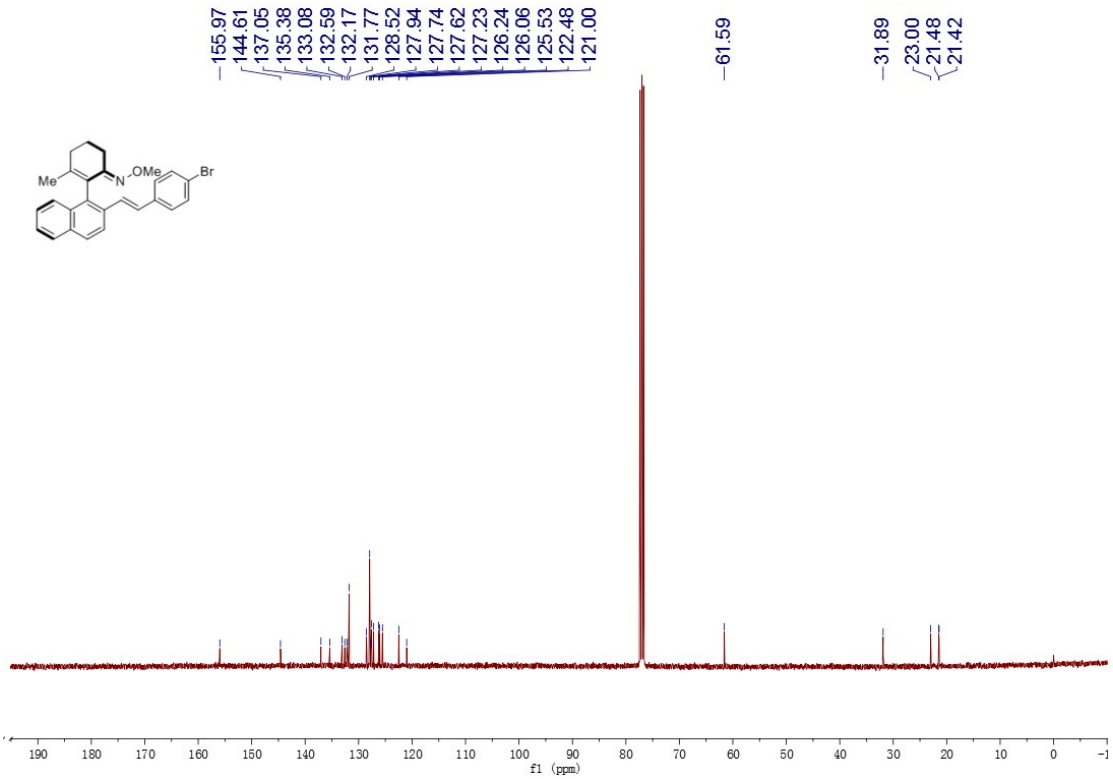
0.98
3.00
2.07
1.99
2.16
2.82
f1 (ppm)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127.23
126.24
126.06
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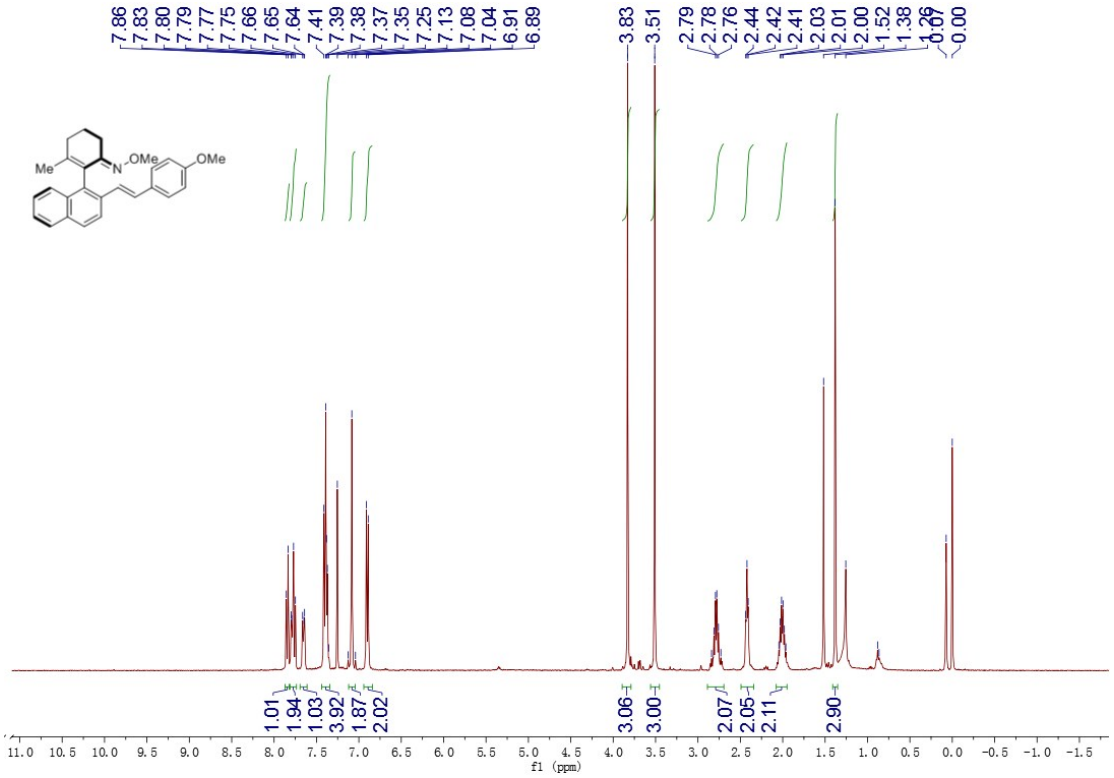
61.59
31.89
23.00
21.48
21.42
Me
N
OMe
Br
f1 (ppm)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7.66
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7.64
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7.38
7.37
7.35
7.25
7.13
7.08
7.04
6.91
6.89
3.83
3.51
2.79
2.78
2.76
2.44
2.42
2.41
2.03
2.01
2.00
1.52
1.38
0.07
0.00
Me
N
OMe
OMe
1.01
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1.03
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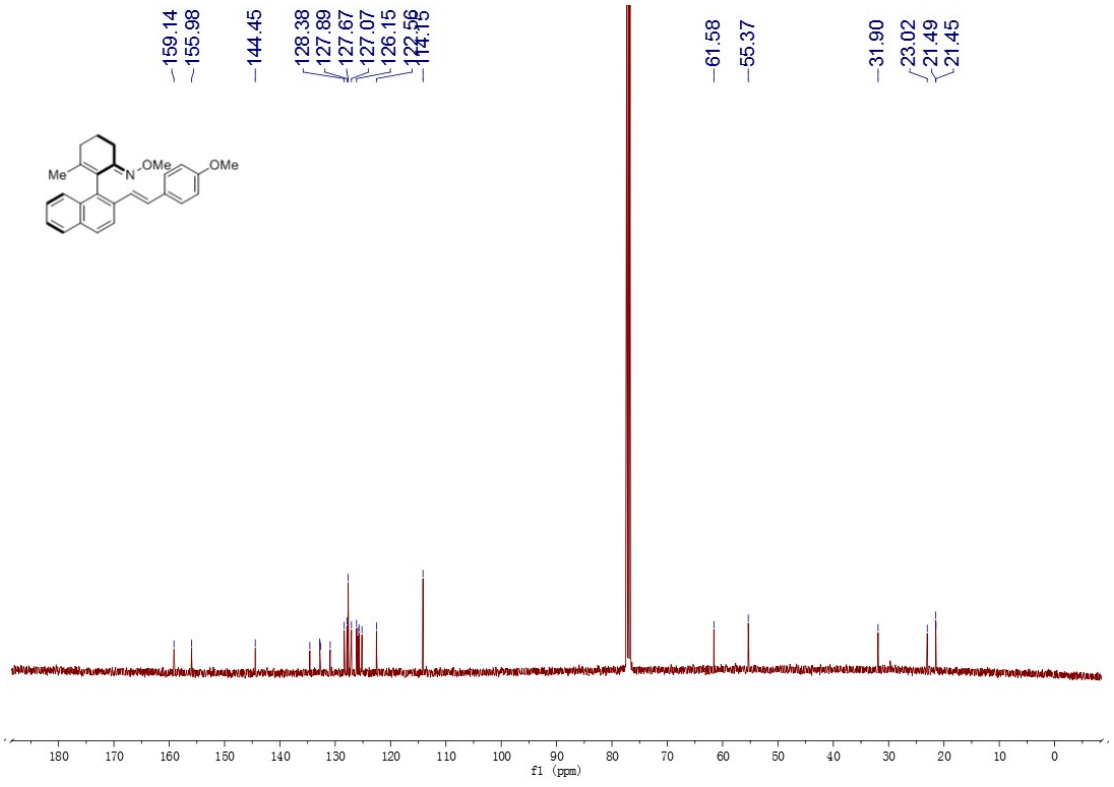
3.00
2.07
2.05
2.11
2.90
f1 (ppm)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127.67
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126.15
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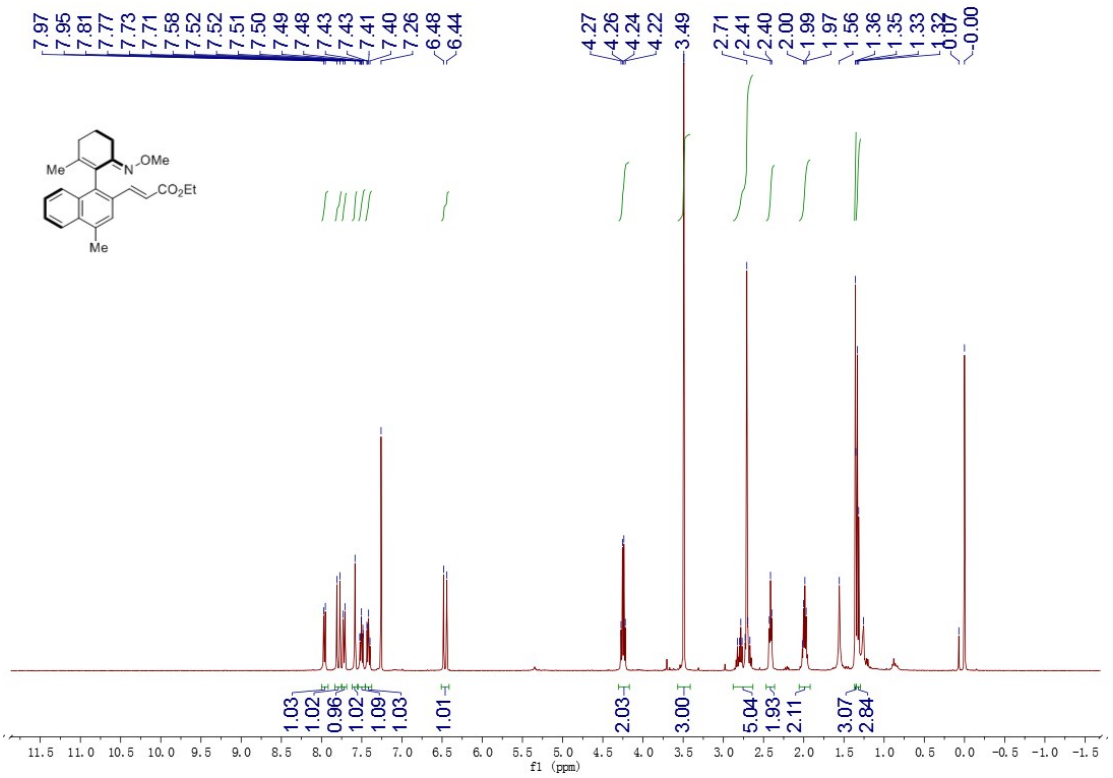
55.37
31.90
23.02
21.49
21.45
Me
N
OMe
OMe
f1 (ppm)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7.48
7.43
7.43
7.41
7.40
7.26
6.48
6.44
4.27
4.26
4.24
4.22
3.49
2.71
2.41
2.40
2.00
1.99
1.97
1.56
1.36
1.35
1.33
1.32
0.07
-0.00
Me
N
OMe
CO2Et
Me
1.03
1.02
0.96
1.02
1.09
1.03
1.01
2.03
3.00
5.04
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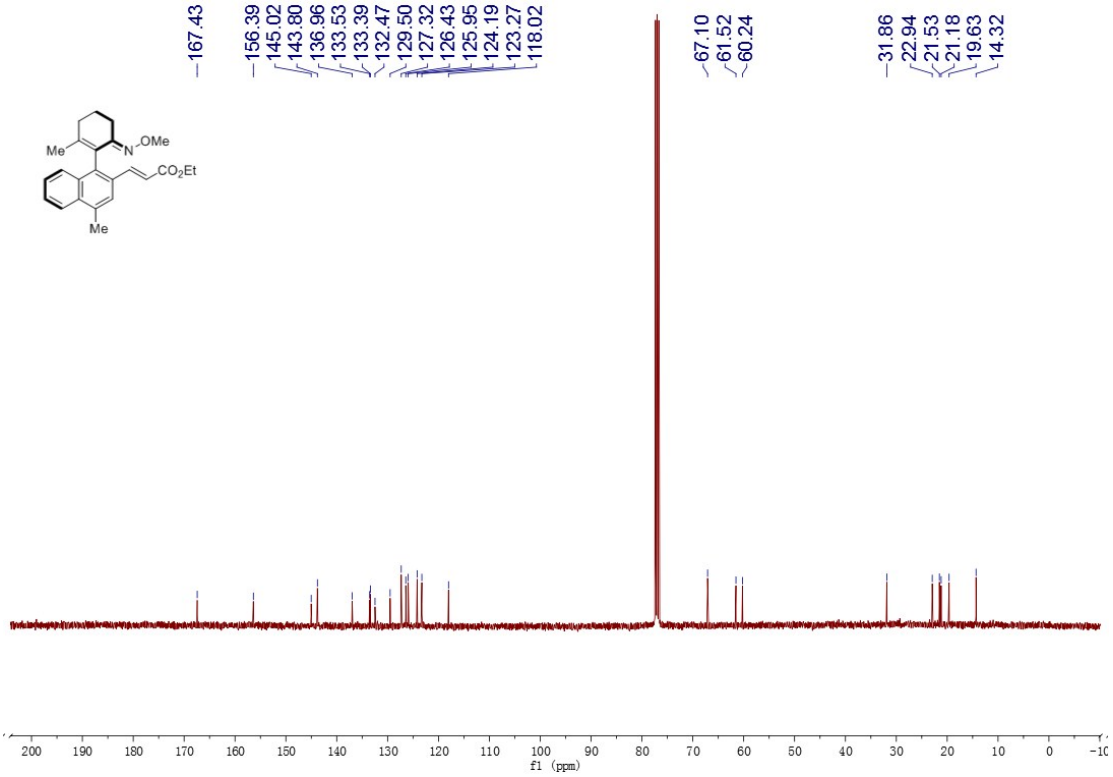
2.11
3.07
2.84
f1 (ppm)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132.47
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126.43
125.95
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123.27
118.02
67.10
61.52
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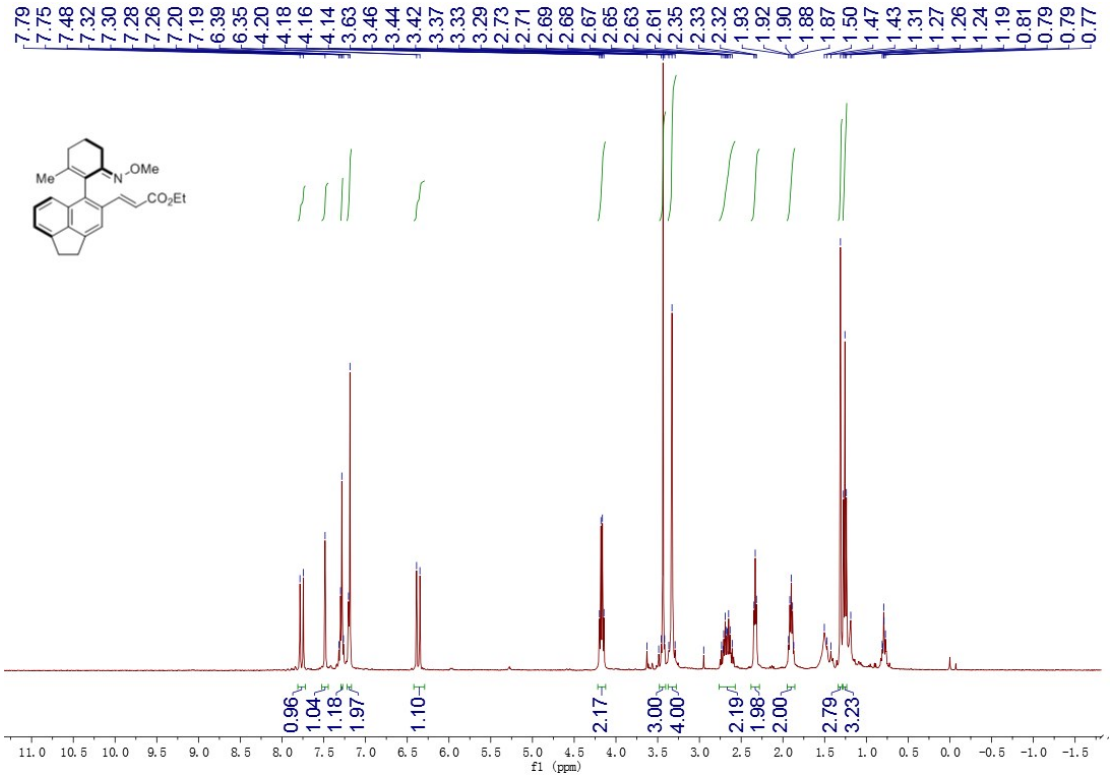
22.94
21.53
21.18
19.63
14.32
Me
N
OMe
CO2Et
Me
f1 (ppm)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4.18
4.16
4.14
3.63
3.46
3.44
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3.33
3.29
2.73
2.71
2.69
2.68
2.67
2.65
2.63
2.61
2.35
2.33
2.32
1.93
1.92
1.90
1.88
1.87
1.50
1.47
1.43
1.31
1.27
1.26
1.24
1.19
0.81
0.79
0.79
0.77
Me
N
OMe
CO2Et
0.96
1.04
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4.00
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2.00
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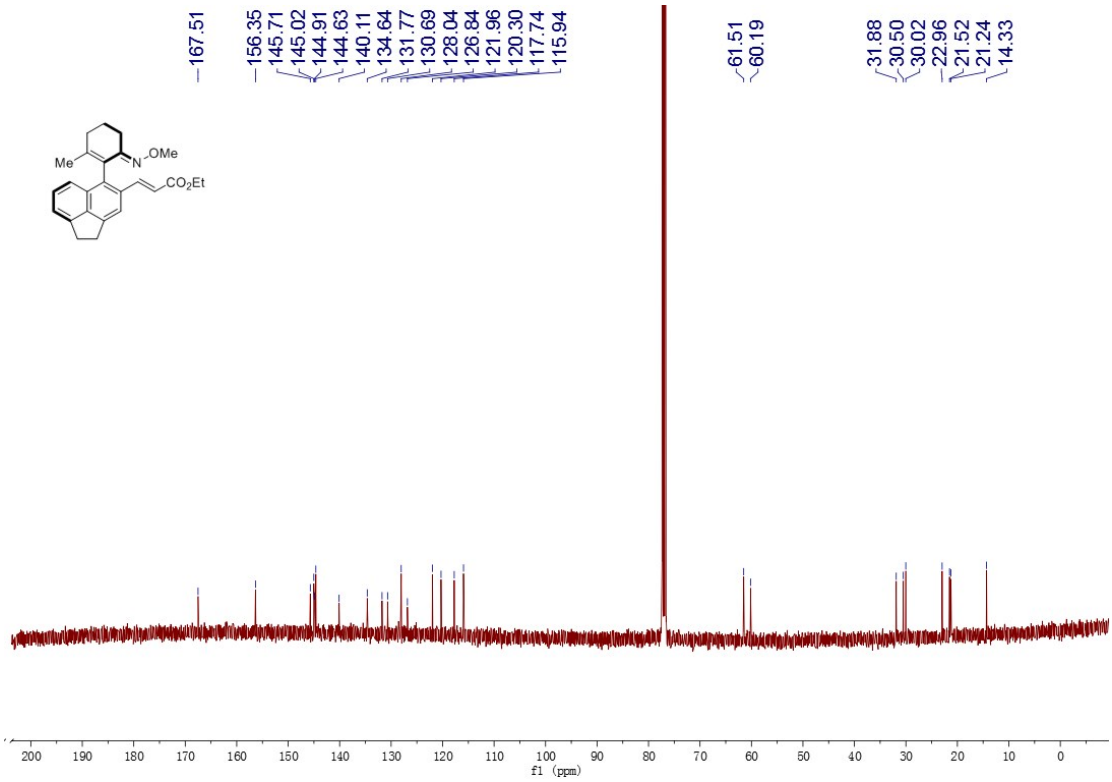
3.23
f1 (ppm)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130.69
128.04
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121.96
120.30
117.74
115.94
61.51
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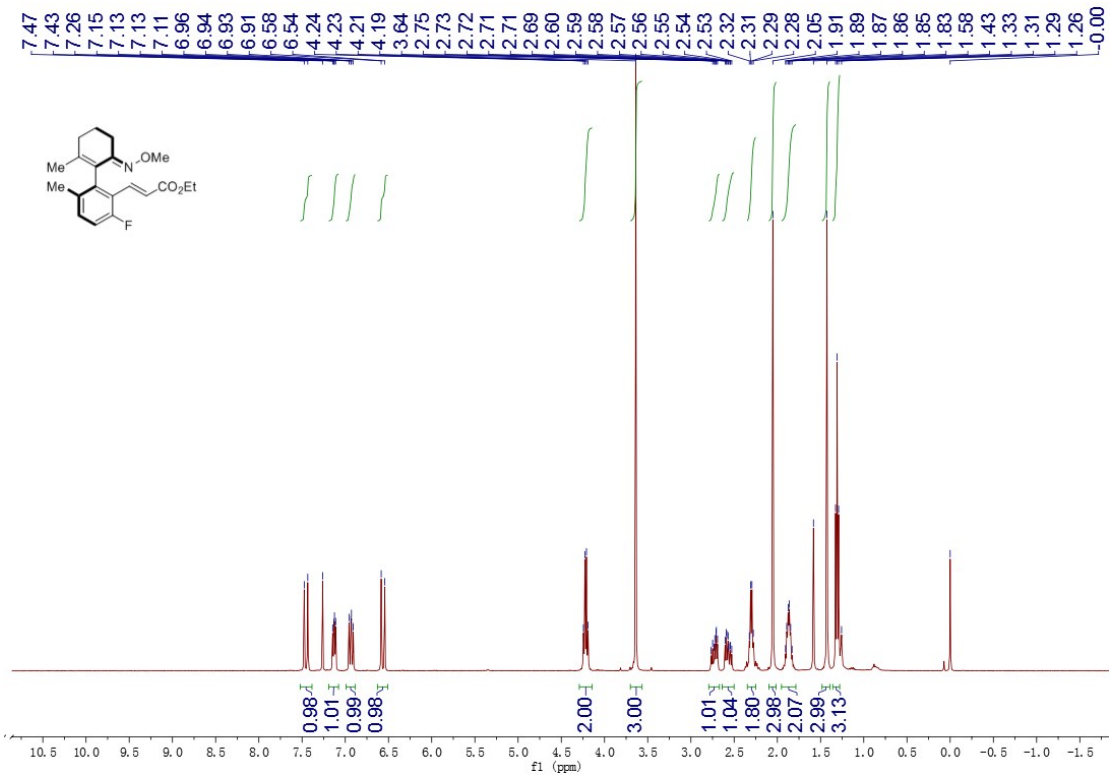
30.02
22.96
21.52
21.24
14.33
Me
N
OMe
CO2Et
f1 (ppm)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6.91
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2.71
2.71
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2.58
2.57
2.56
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2.53
2.32
2.31
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2.28
2.05
1.91
1.89
1.87
1.86
1.85
1.83
1.58
1.43
1.33
1.31
1.29
1.26
0.00
Me
Me
N
OMe
CO2Et
F
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1.01
0.99
0.98
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3.00
1.01
1.04
1.80
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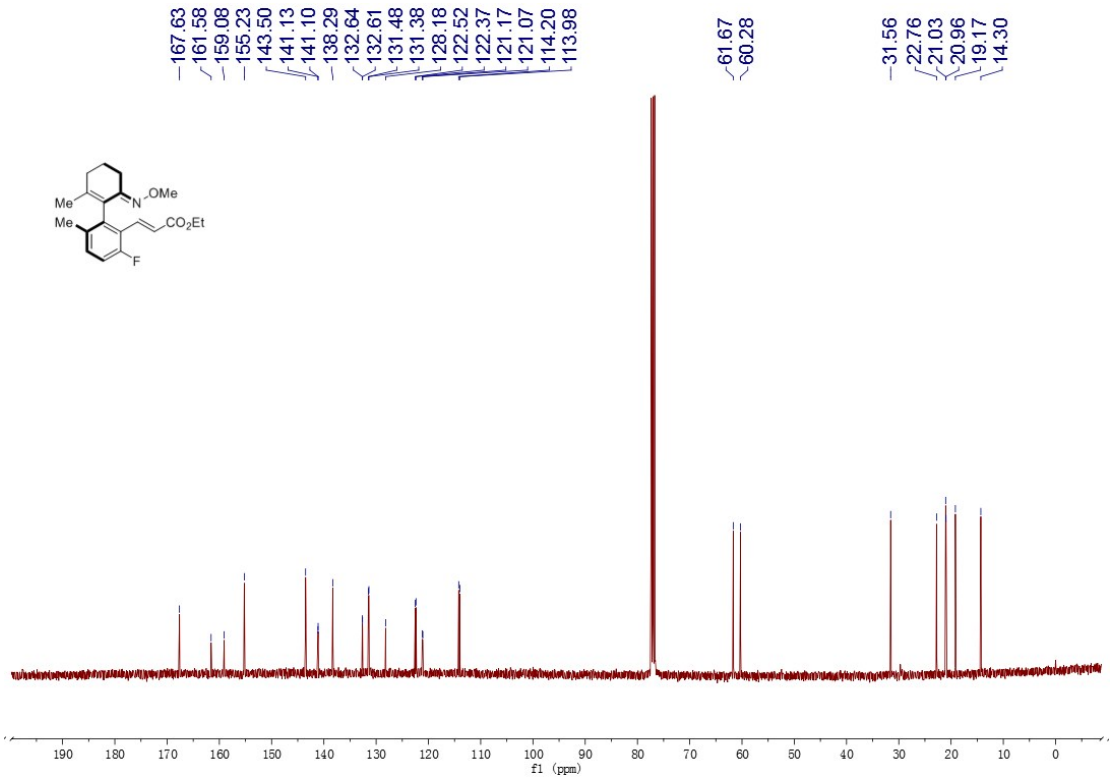
2.07
2.99
3.13
f1 (ppm)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131.48
131.38
128.18
122.52
122.37
121.17
121.07
114.20
113.98
61.67
60.28
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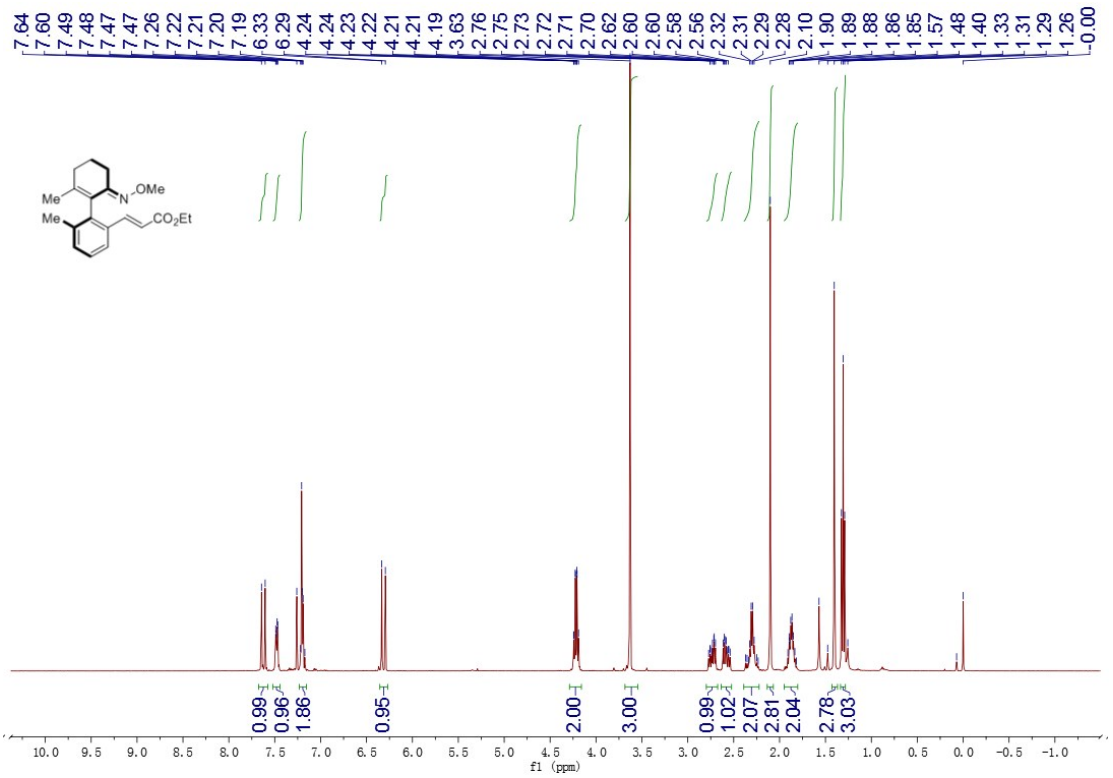
21.03
20.96
19.17
14.30
Me
Me
N
OMe
CO2Et
F
f1 (ppm)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6.29
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4.23
4.22
4.21
4.21
4.19
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2.76
2.75
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2.72
2.71
2.70
2.62
2.60
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2.56
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2.29
2.28
2.10
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1.89
1.88
1.86
1.85
1.57
1.48
1.40
1.33
1.31
1.29
1.26
0.00
Me
Me
N
OMe
CO2Et
0.99
0.96
1.86
0.95
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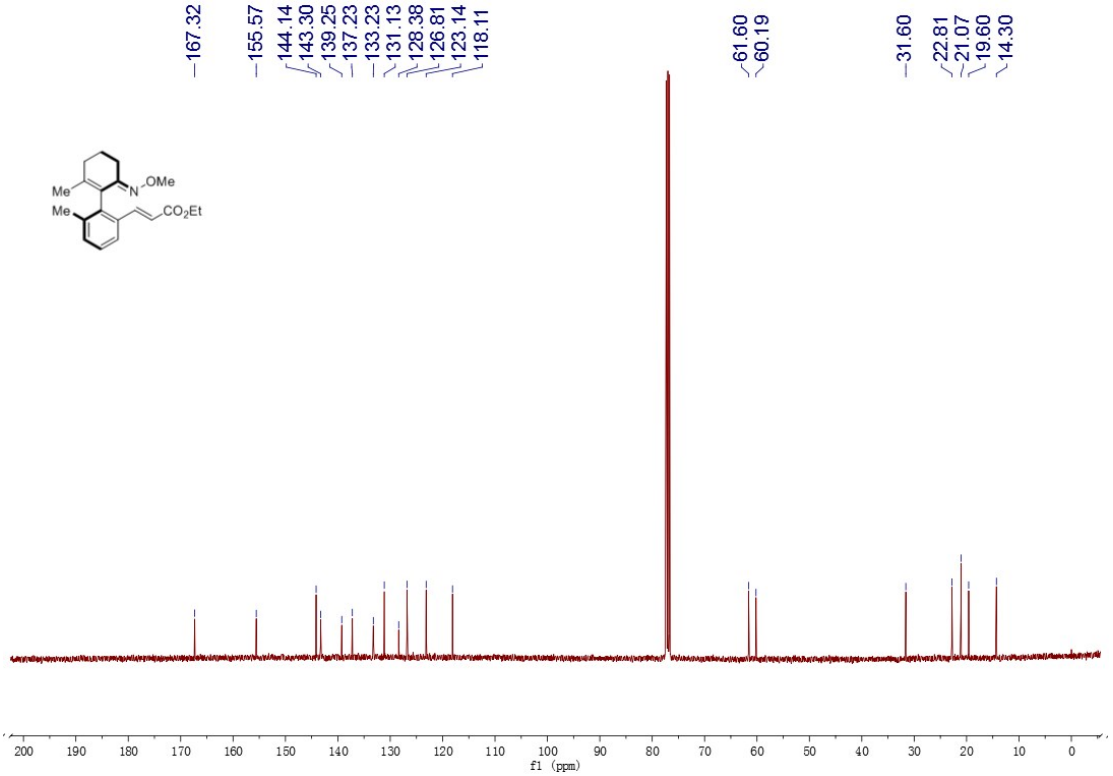
3.00
0.99
1.02
2.07
2.81
2.04
2.78
3.03
f1 (ppm)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131.13
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126.81
123.14
118.11
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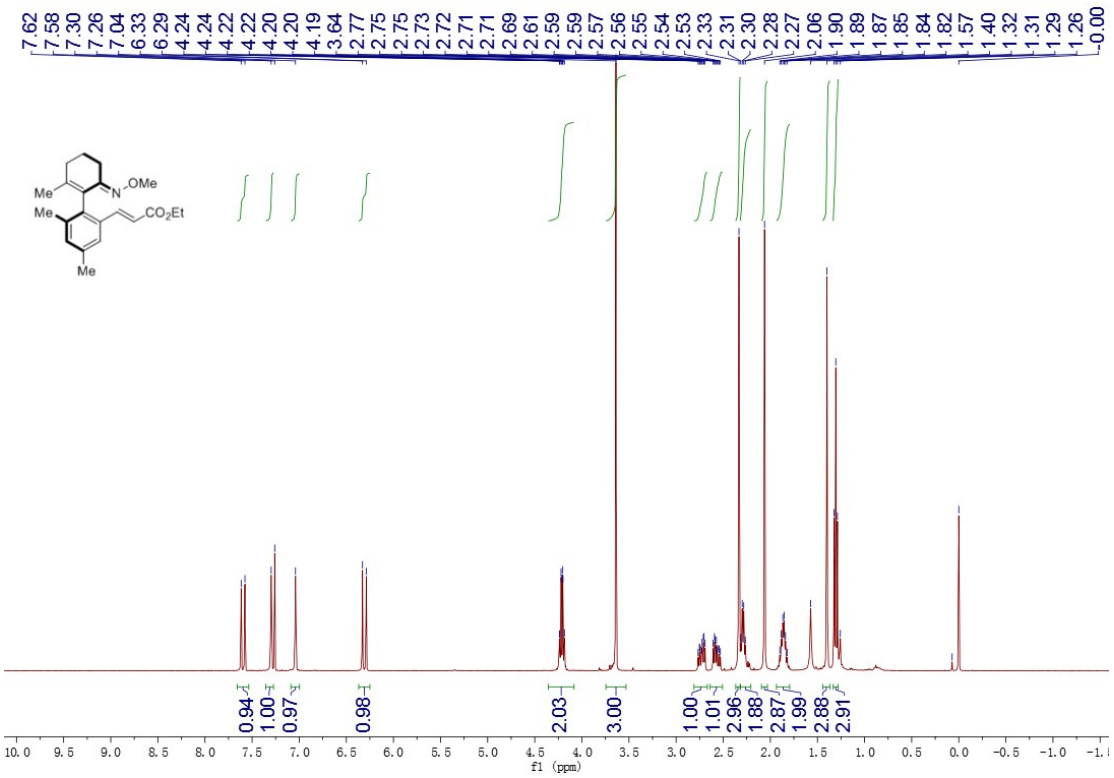
31.60
22.81
21.07
19.60
14.30
Me
Me
N
OMe
CO2Et
f1 (ppm)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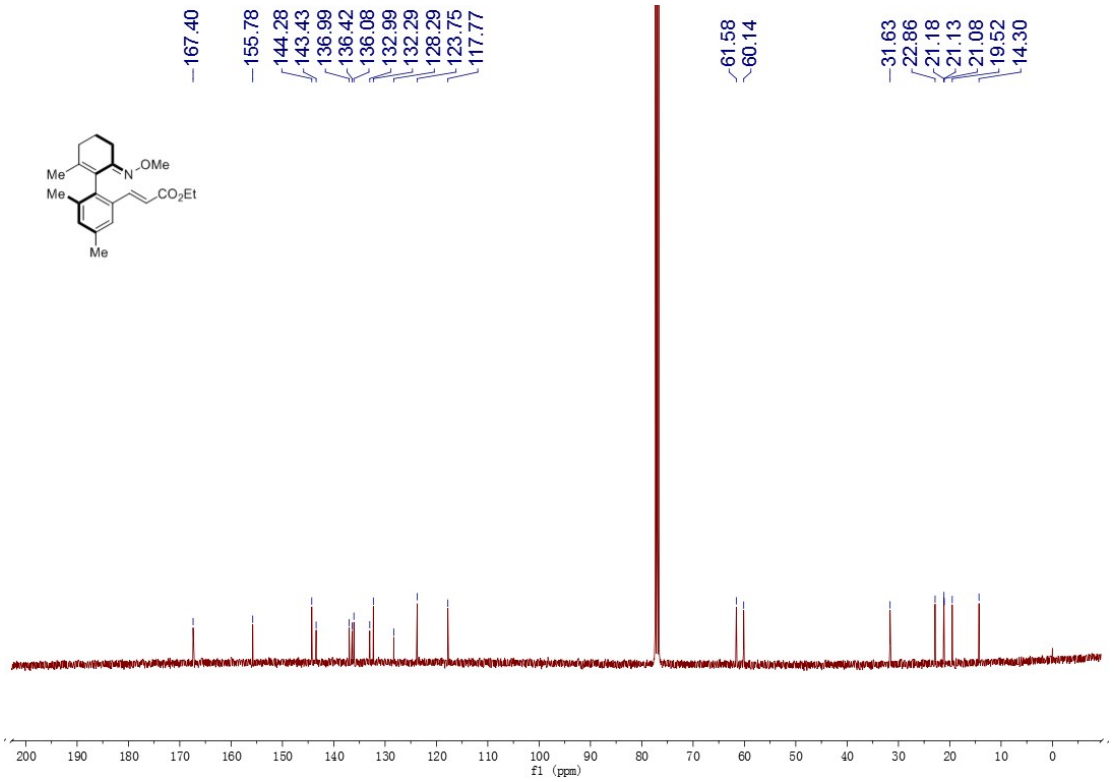
6.29
4.24
4.24
4.22
4.20
4.20
4.19
3.64
2.77
2.75
2.75
2.73
2.72
2.71
2.71
2.69
2.61
2.59
2.59
2.57
2.56
2.55
2.54
2.53
2.33
2.31
2.30
2.28
2.27
2.06
1.90
1.89
1.87
1.85
1.84
1.82
1.57
1.40
1.32
1.31
1.29
1.26
0.00
Me
Me
N
OMe
CO2Et
Me
0.94
1.00
0.97
0.98
2.03
3.00
1.00
1.01
2.96
1.88
2.87
1.99
2.88
2.91
f1 (ppm)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128.29
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60.14
31.63
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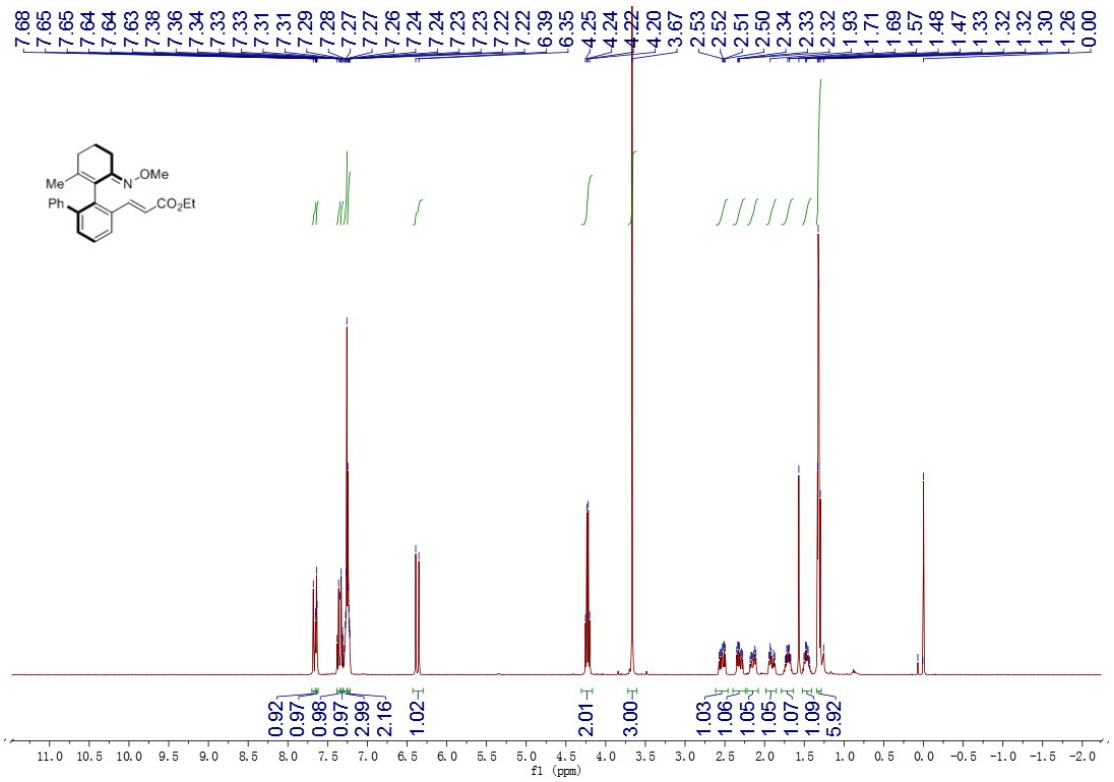
21.13
21.08
19.52
14.30
Me
Me
N
OMe
CO2Et
Me
f1 (ppm)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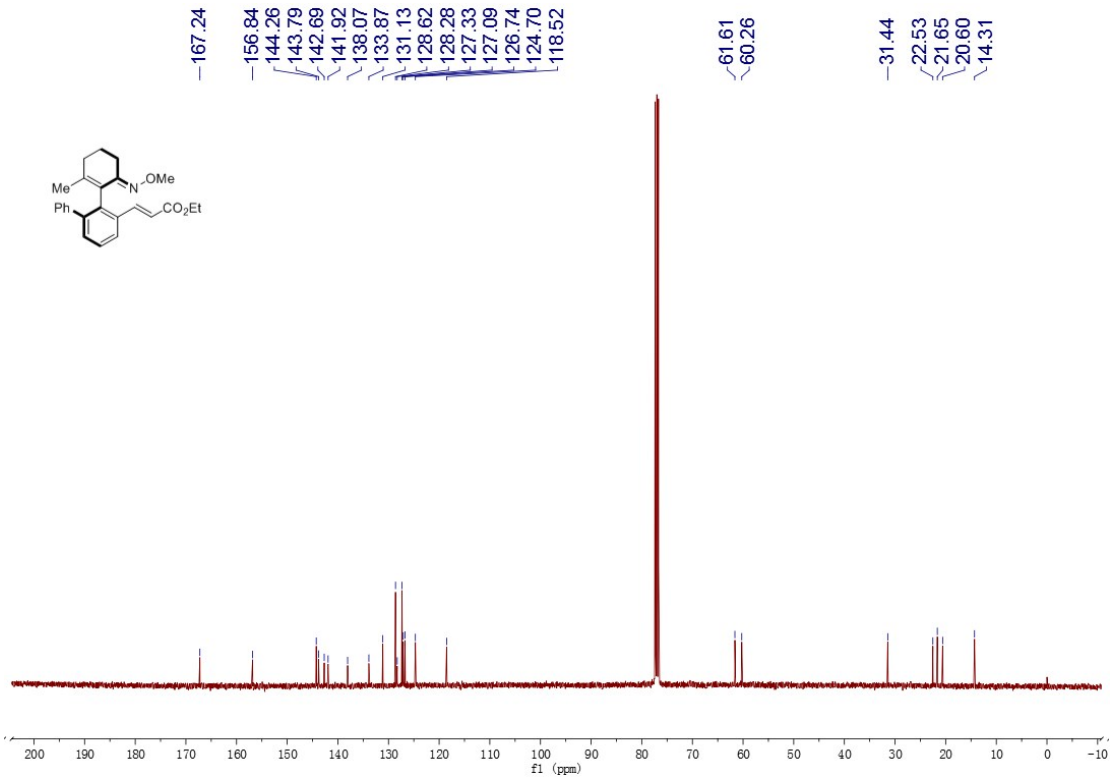
Me
N
OMe
Ph
CO2Et
0.92 0.97 0.98 0.97 2.99 2.16 1.02 2.01 3.00 1.03 1.06 1.05 1.05 1.07 1.09 5.92
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5 -2.0
f1 (ppm)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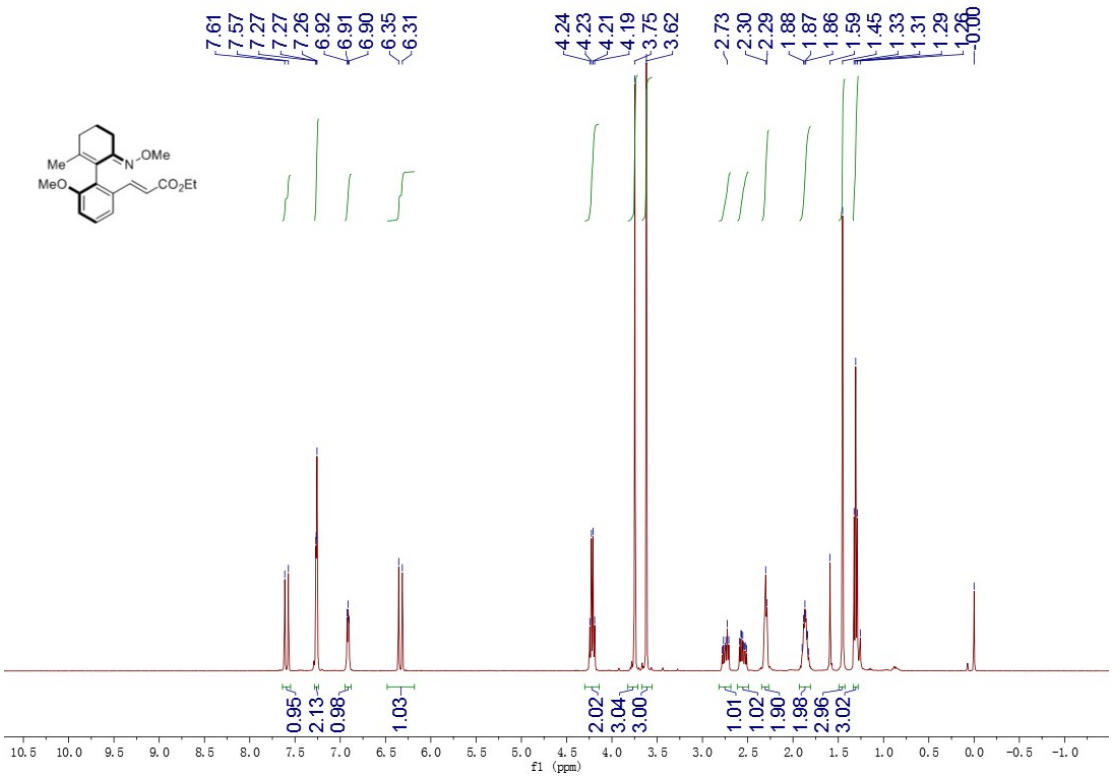
61.61 60.26
31.44 22.53 21.65 20.60 14.31
Me
N
OMe
Ph
CO2Et
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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6.90
6.35
6.31
4.24
4.23
4.21
4.19
3.75
3.62
2.73
2.30
2.29
1.88
1.87
1.86
1.59
1.45
1.33
1.31
1.29
1.26
0.00
Me
MeO
N
OMe
CO2Et
0.95
2.13
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3.04
3.00
1.01
1.02
1.90
1.98
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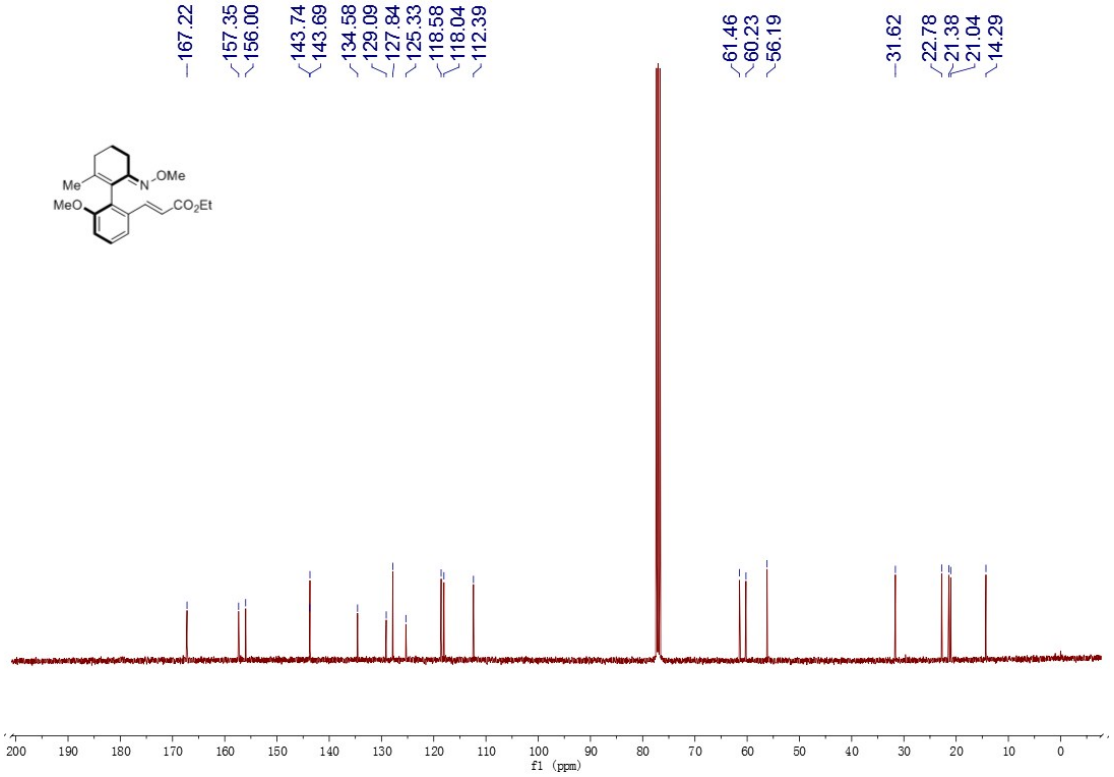
3.02
f1 (ppm)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118.58
118.04
112.39
61.46
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56.19
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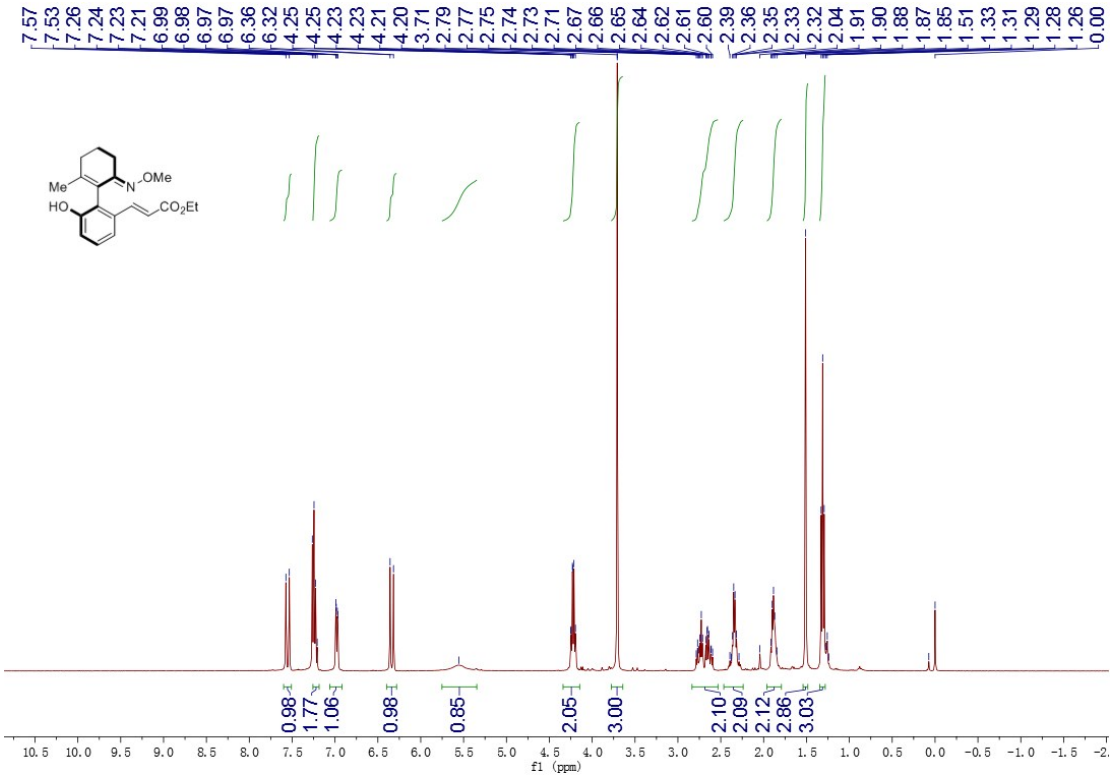
22.78
21.38
21.04
14.29
Me
MeO
N
OMe
CO2Et
f1 (ppm)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6.97
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4.25
4.23
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2.62
2.61
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2.39
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2.32
2.04
1.91
1.90
1.88
1.87
1.85
1.51
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1.31
1.29
1.28
1.26
0.00
Me
HO
N
OMe
CO2Et
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1.77
1.06
0.98
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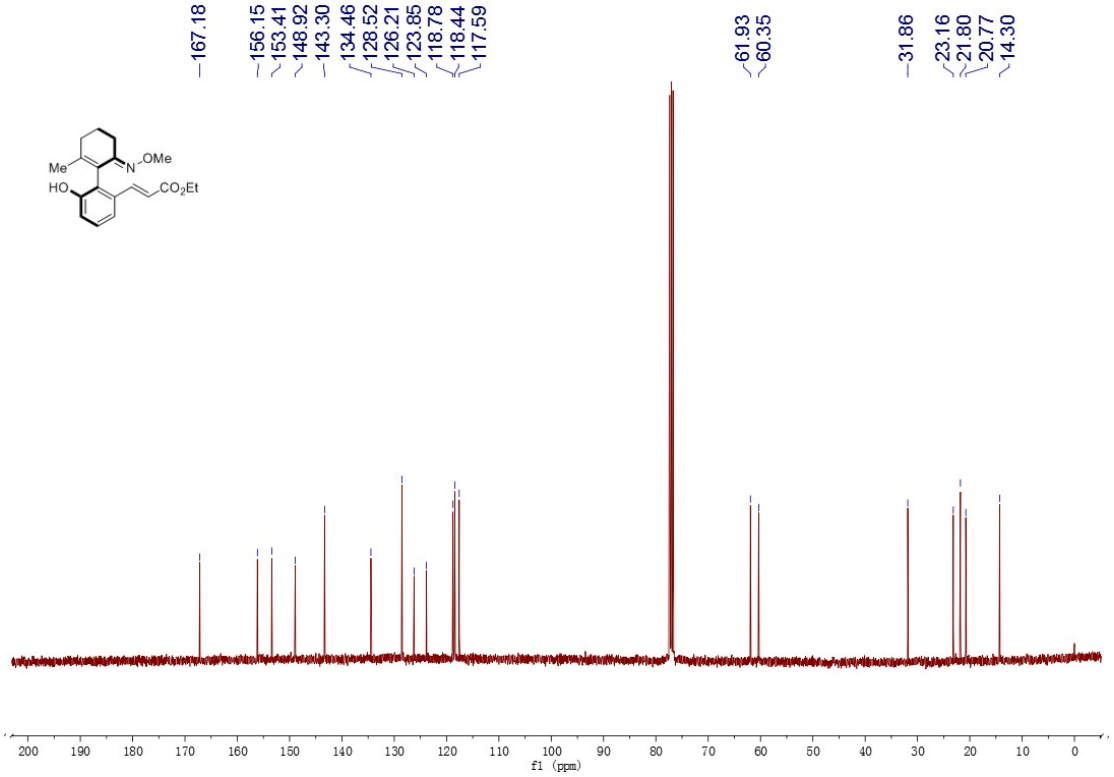
2.05
3.00
2.10
2.09
2.12
2.86
3.03
f1 (ppm)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143.30
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126.21
123.85
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118.44
117.59
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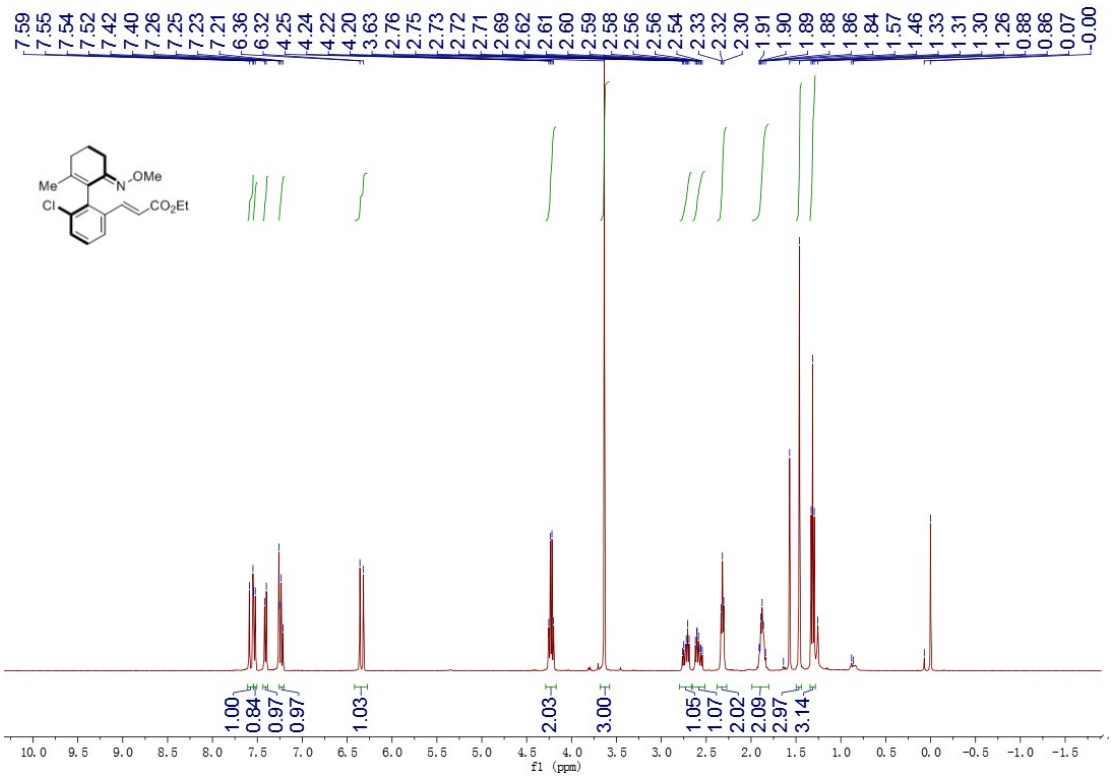
23.16
21.80
20.77
14.30
Me
HO
N
OMe
CO2Et
f1 (ppm)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6.32
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4.24
4.22
4.20
3.63
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2.75
2.73
2.72
2.71
2.69
2.62
2.61
2.60
2.59
2.58
2.56
2.56
2.54
2.33
2.32
2.30
1.91
1.90
1.89
1.88
1.86
1.84
1.57
1.46
1.33
1.31
1.30
1.26
0.88
0.86
0.07
0.00
Me
Cl
N
OMe
CO2Et
1.00
0.84
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0.97
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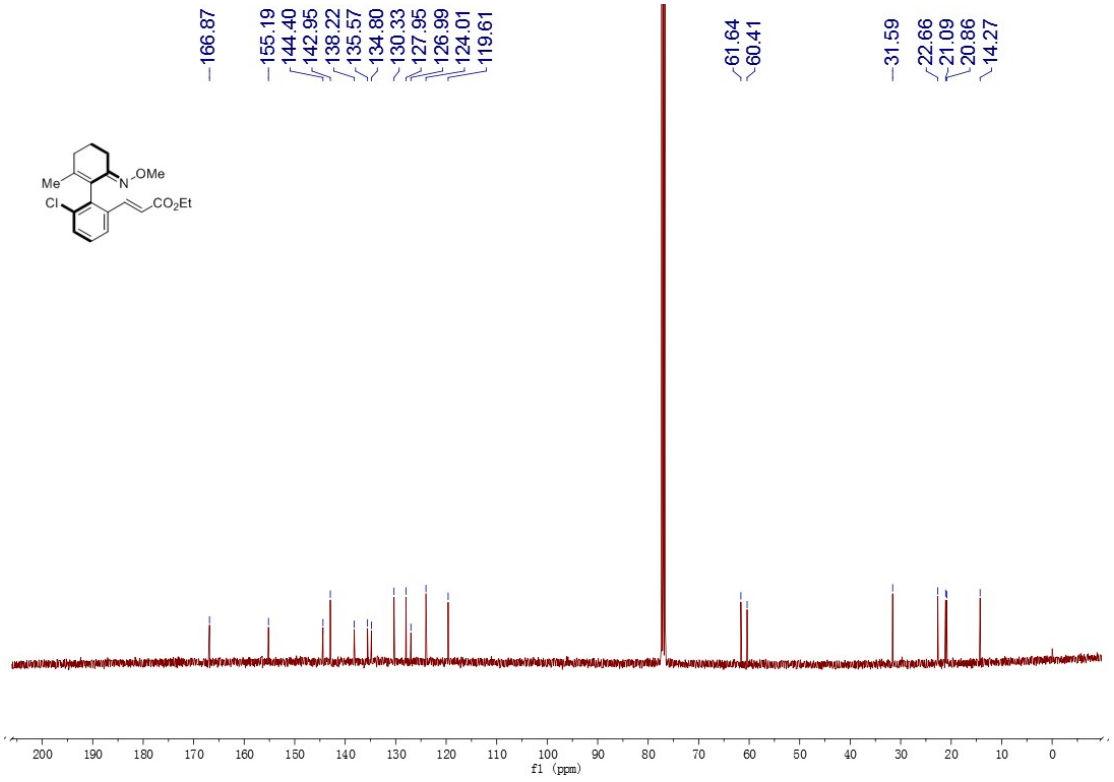
2.03
3.00
1.05
1.07
2.02
2.09
2.97
3.14
f1 (ppm)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14.27
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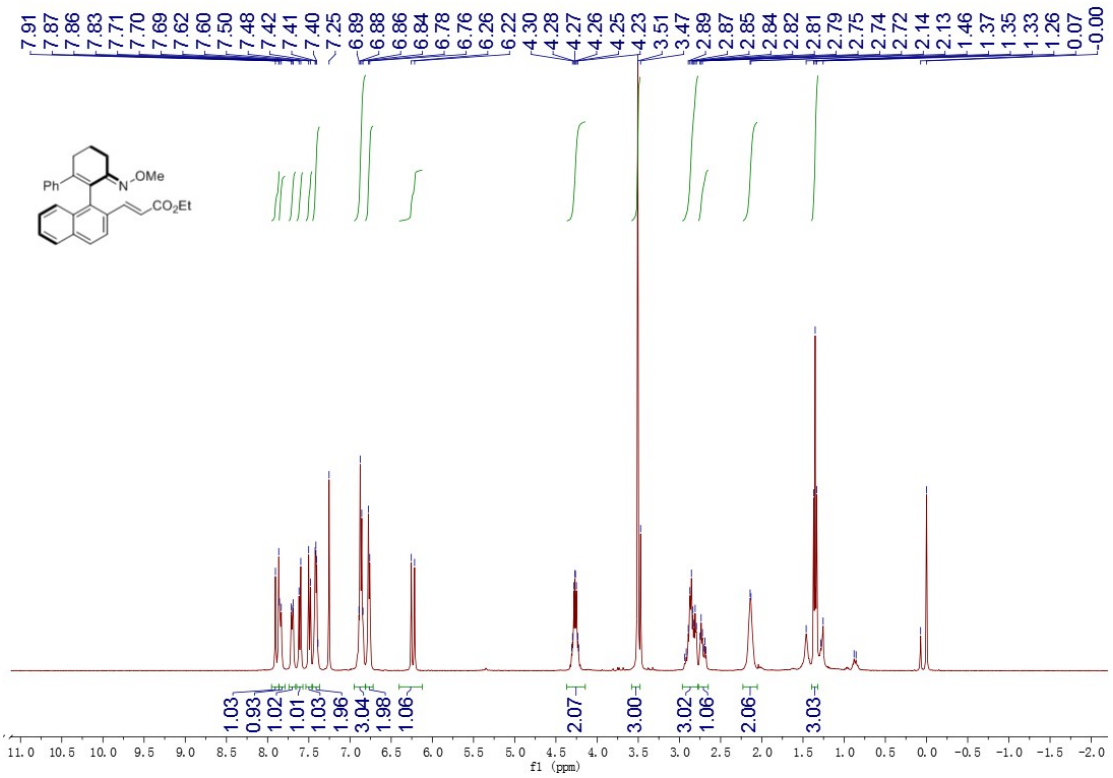
Cl
N
OMe
CO2Et
f1 (ppm)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4.27
4.26
4.25
4.23
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3.47
2.89
2.87
2.85
2.84
2.82
2.81
2.79
2.75
2.74
2.72
2.14
2.13
1.46
1.37
1.35
1.33
1.26
0.07
-0.00
Ph
N
OMe
CO2Et
1.03
0.93
1.02
1.01
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1.98
1.06
2.07
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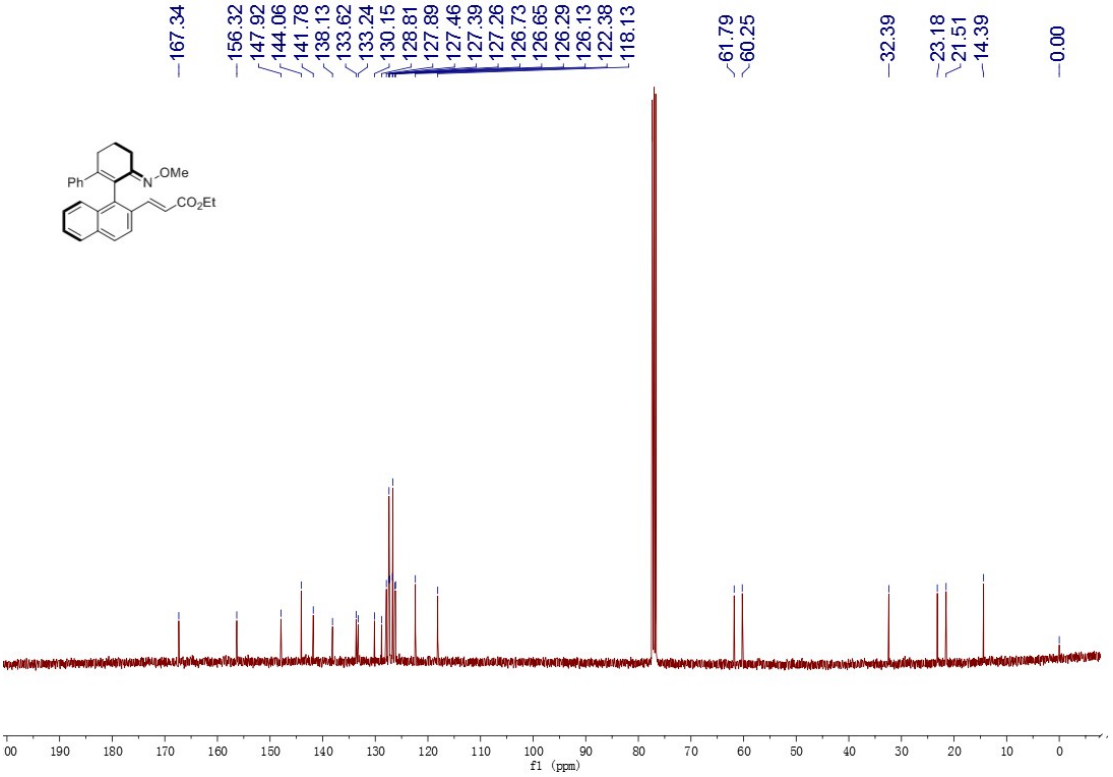
3.02
1.06
2.06
3.03
f1 (ppm)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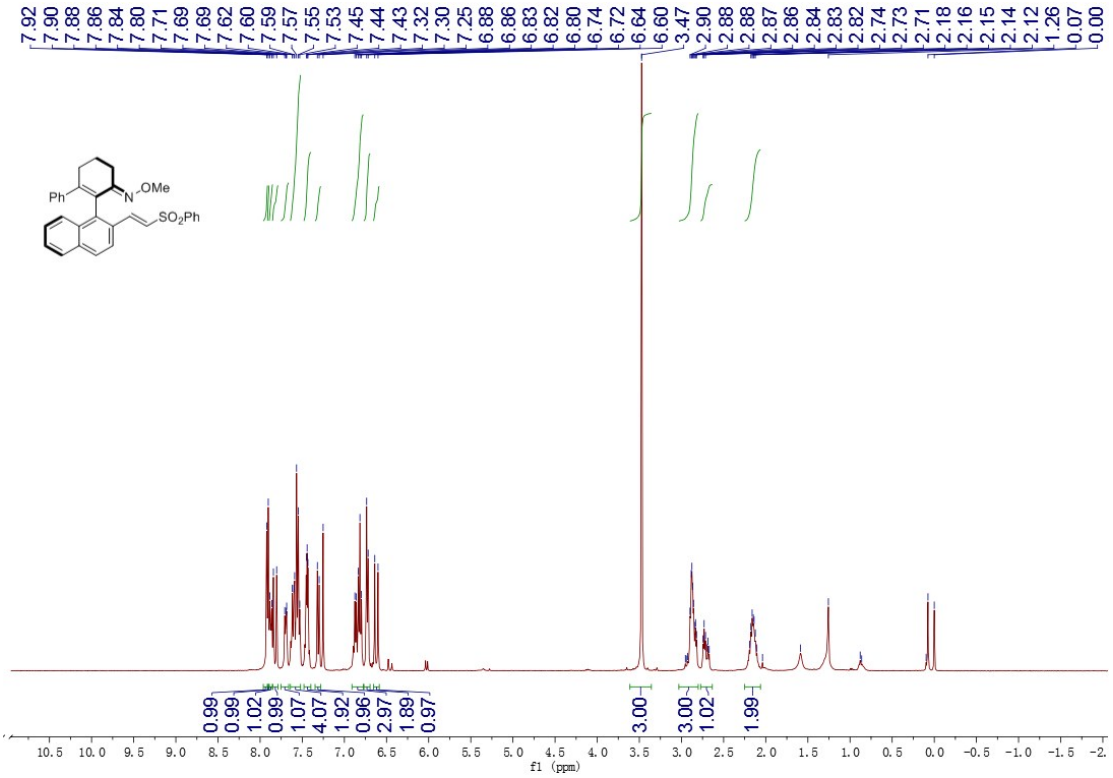
Ph
N
OMe
CO2Et
f1 (ppm)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2.15
2.14
2.12
1.26
0.07
0.00
Ph
N
OMe
SO2Ph
0.99
0.99
1.02
0.99
1.07
4.07
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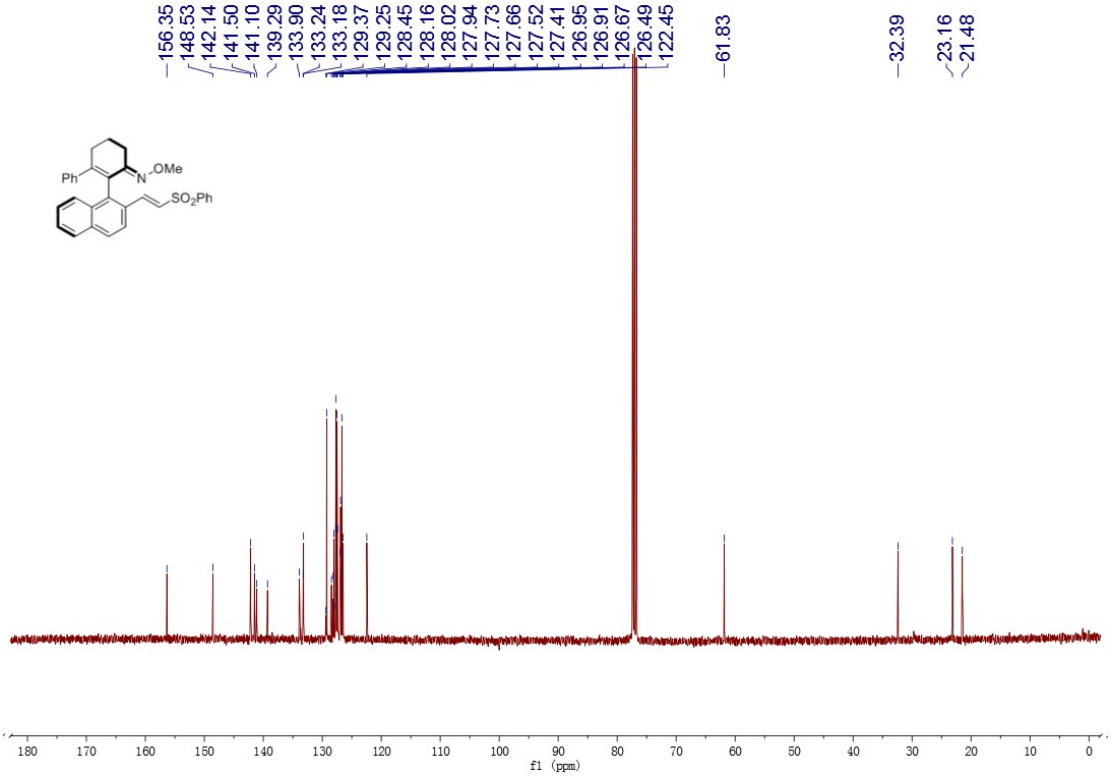
0.96
2.97
1.89
0.97
3.00
3.00
1.02
1.99
f1 (ppm)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129.25
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128.16
128.02
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127.73
127.66
127.52
127.41
126.95
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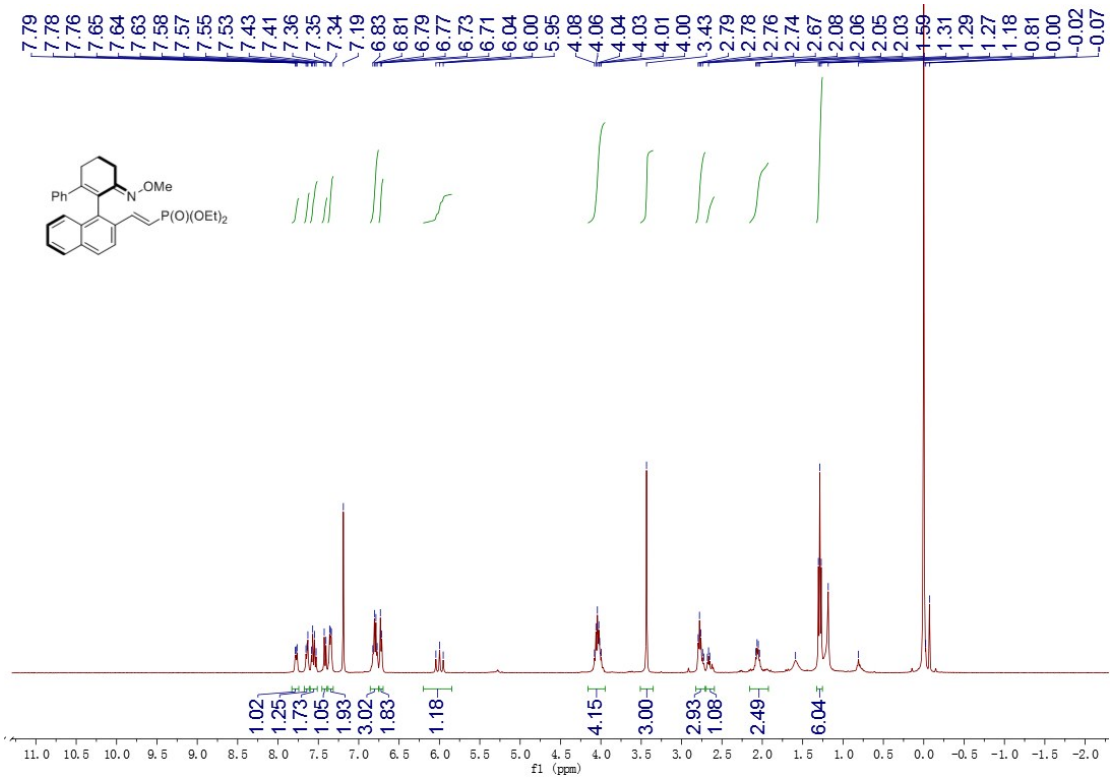
32.39
23.16
21.48
Ph
N
OMe
SO2Ph
f1 (ppm)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6.79
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4.06
4.04
4.03
4.01
4.00
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2.78
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2.08
2.06
2.05
2.03
1.59
1.31
1.29
1.27
1.18
0.81
0.00
-0.02
-0.07
Ph
N
OMe
P(O)(OEt)2
1.02
1.25
1.73
1.05
1.93
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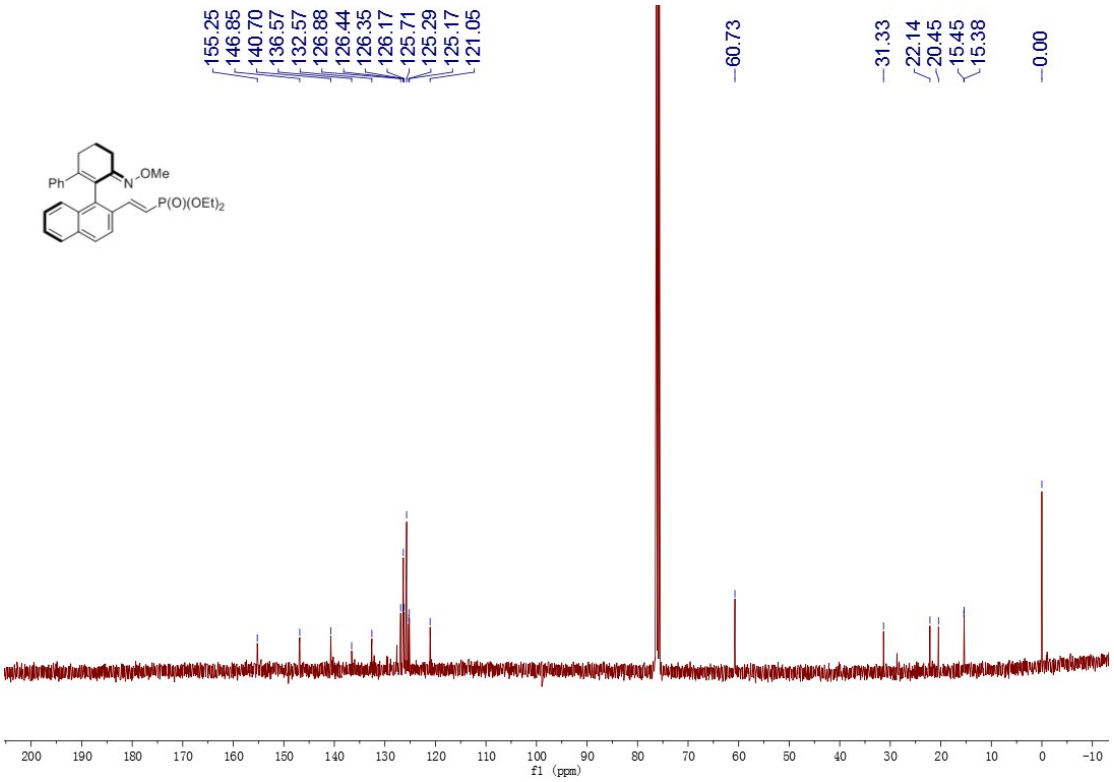
1.83
1.18
4.15
3.00
2.93
1.08
2.49
6.04
f1 (ppm)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126.35
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125.71
125.29
125.17
121.05
60.73
31.33
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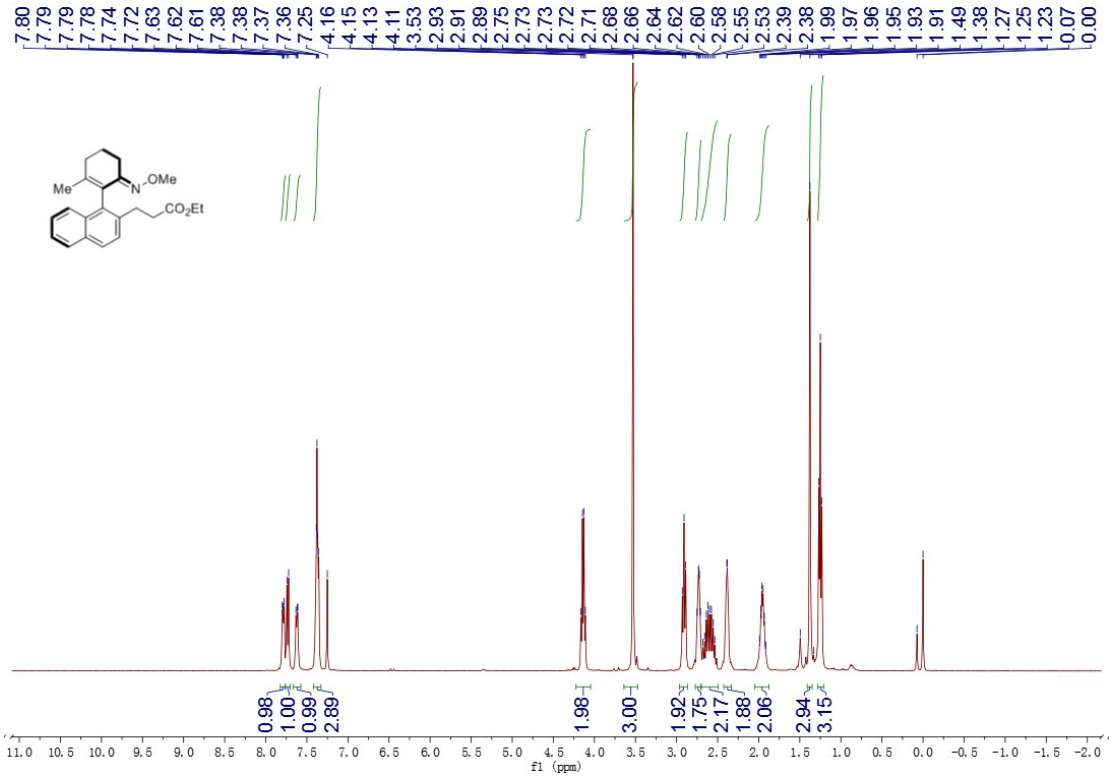
20.45
15.45
15.38
0.00
Ph
N
OMe
P(O)(OEt)2
f1 (ppm)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4.15
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4.11
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2.91
2.89
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2.73
2.72
2.71
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2.53
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1.96
1.95
1.93
1.91
1.49
1.38
1.27
1.25
1.23
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0.00
Me
N
OMe
CO2Et
0.98
1.00
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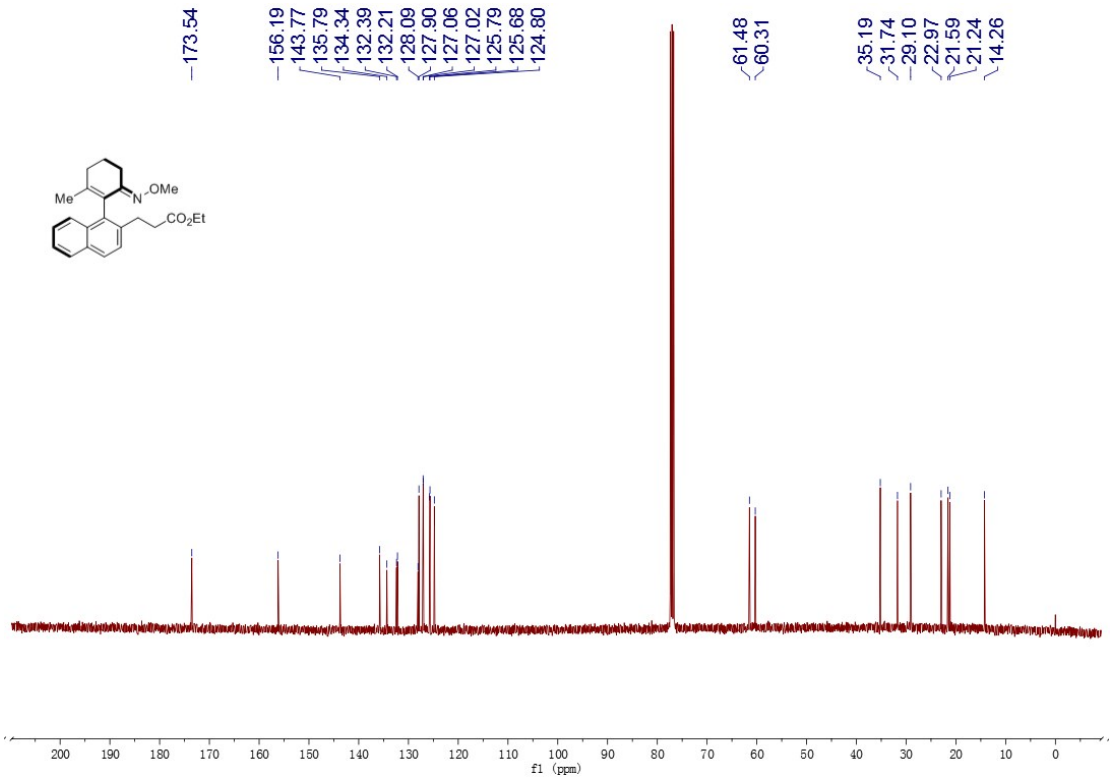
3.00
1.92
1.75
2.17
1.88
2.06
2.94
3.15
f1 (ppm)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22.97
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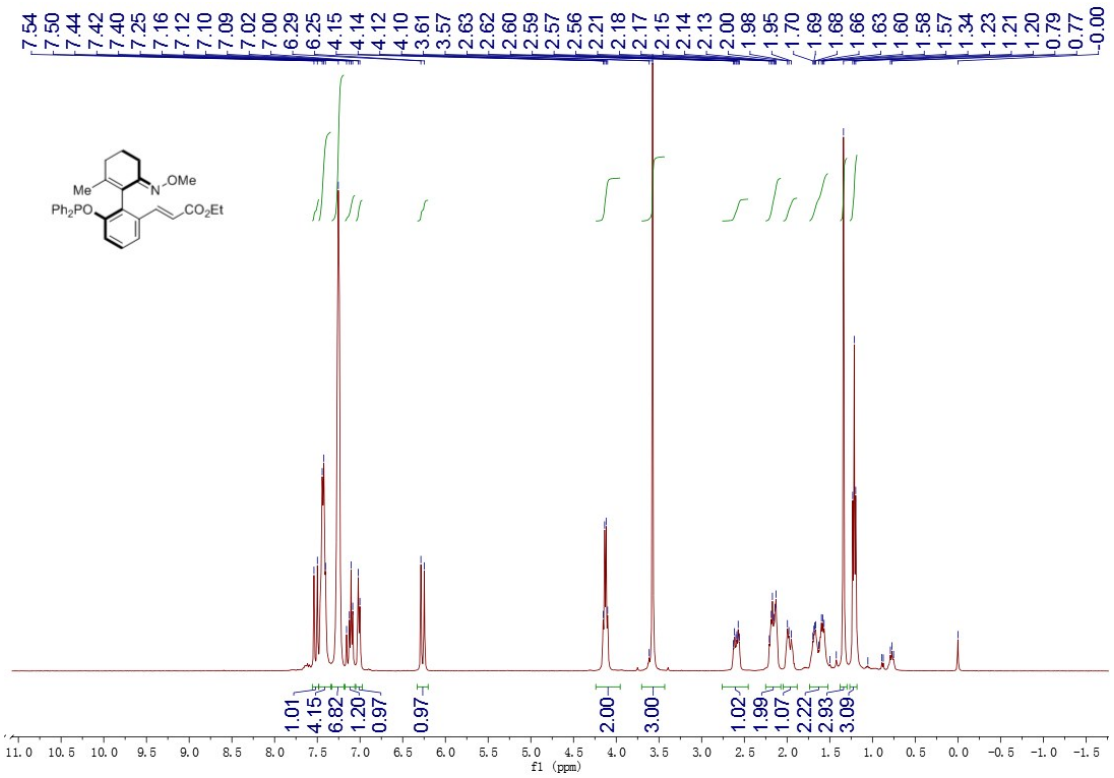
21.24
14.26
Me
N
OMe
CO2Et
f1 (ppm)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7.02
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6.25
4.15
4.14
4.12
4.10
3.61
3.57
2.63
2.62
2.60
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2.57
2.56
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2.18
2.17
2.15
2.14
2.13
2.00
1.98
1.95
1.70
1.69
1.68
1.66
1.63
1.60
1.58
1.57
1.34
1.23
1.21
1.20
0.79
0.77
-0.00
Me
OMe
N
Ph2PO
CO2Et
1.01
4.15
6.82
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0.97
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2.00
3.00
1.02
1.99
1.07
2.22
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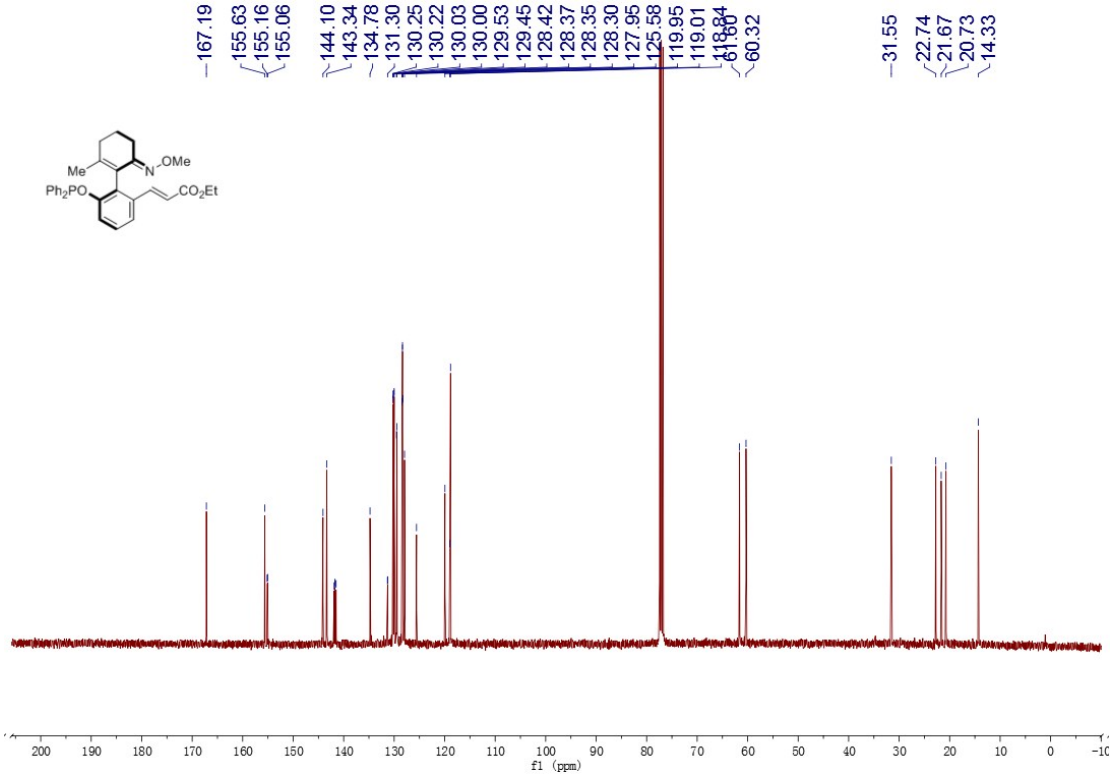
3.09
f1 (ppm)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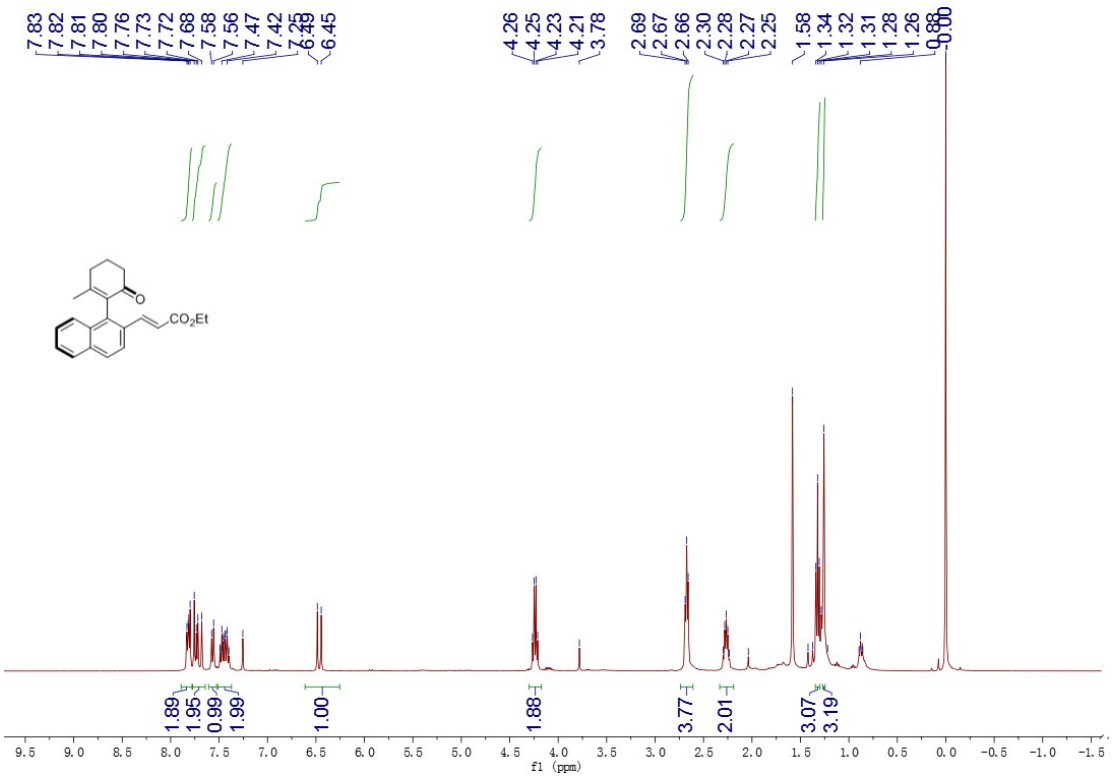
155.16
155.06
144.10
143.34
134.78
131.30
130.25
130.22
130.03
130.00
129.53
129.45
128.42
128.37
128.35
128.30
127.95
125.58
119.95
119.01
61.60
60.32
31.55
22.74
21.67
20.73
14.33
Me
OMe
N
Ph2PO
CO2Et
f1 (ppm)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7.47
7.42
6.45
4.26
4.25
4.23
4.21
3.78
2.69
2.67
2.66
2.30
2.28
2.27
2.25
1.58
1.34
1.32
1.31
1.28
1.26
0.88
0.00
CO2Et
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0.99
1.99
1.00
1.88
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2.01
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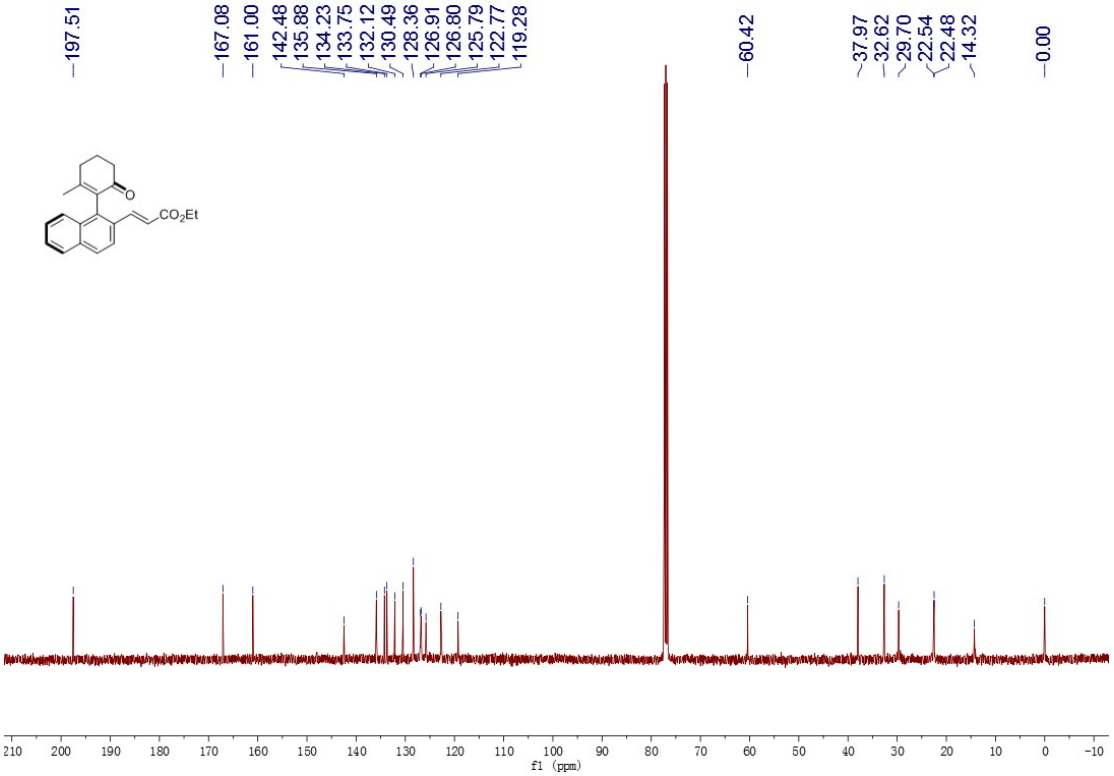
3.19
f1 (ppm)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126.91
126.80
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119.28
60.42
37.97
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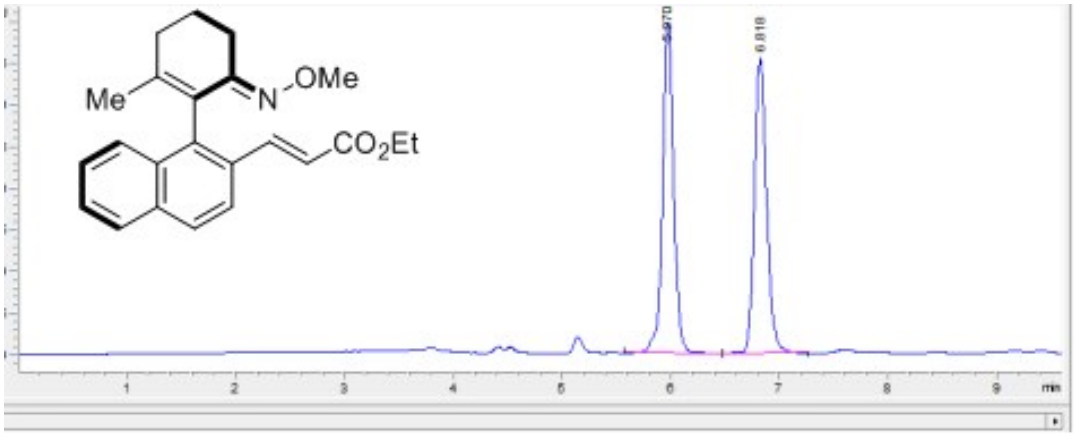
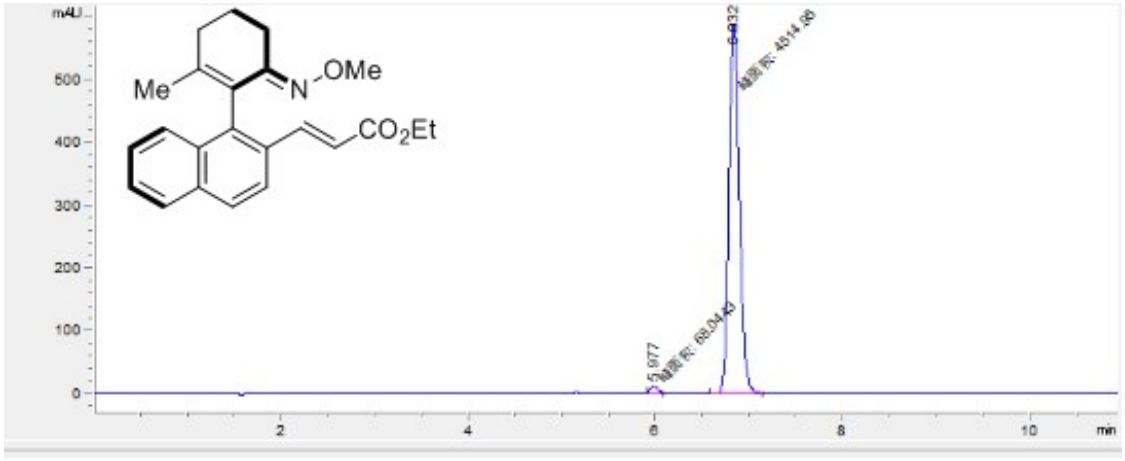
29.70
22.54
22.48
14.32
0.00
CO2Et
f1 (ppm)

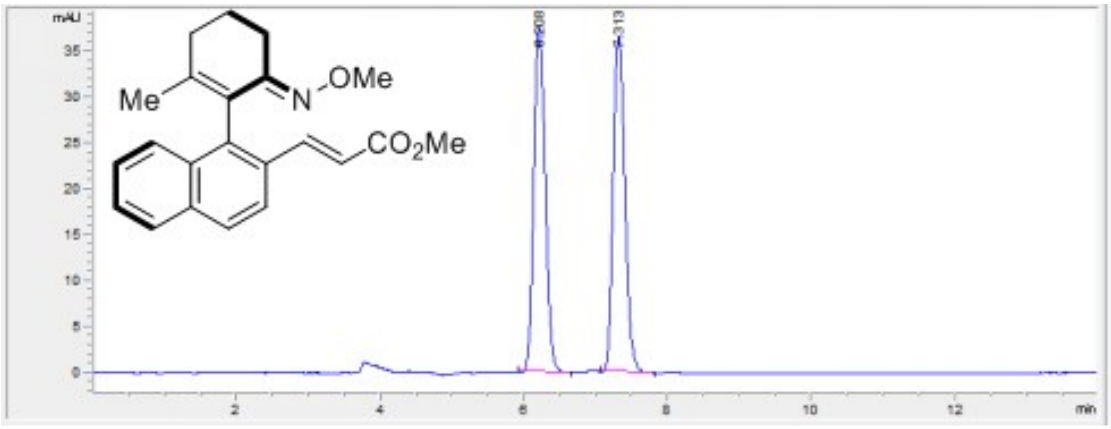
HPLC spectrum of product 3.



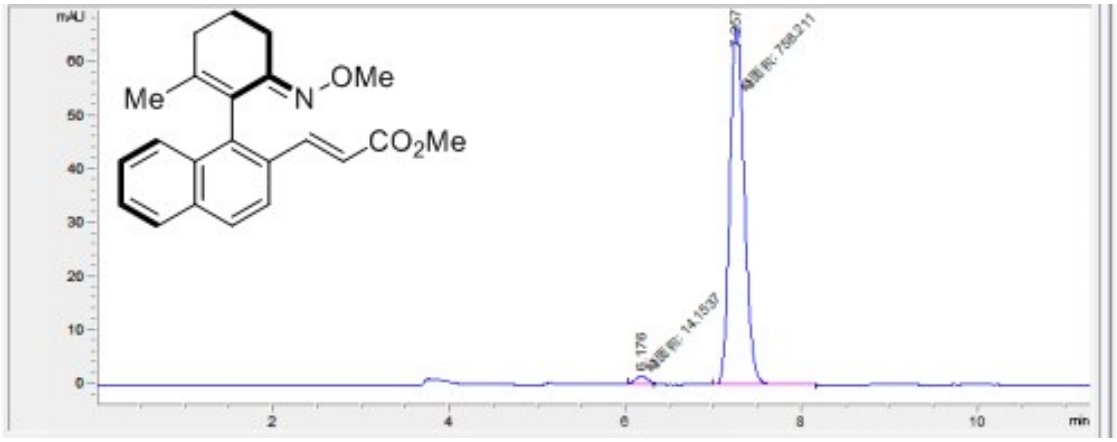
	Time/min	Area	Height	Area%
1	5.97	281.8	39.7	50.360
2	6.818	277.8	35.5	49.640



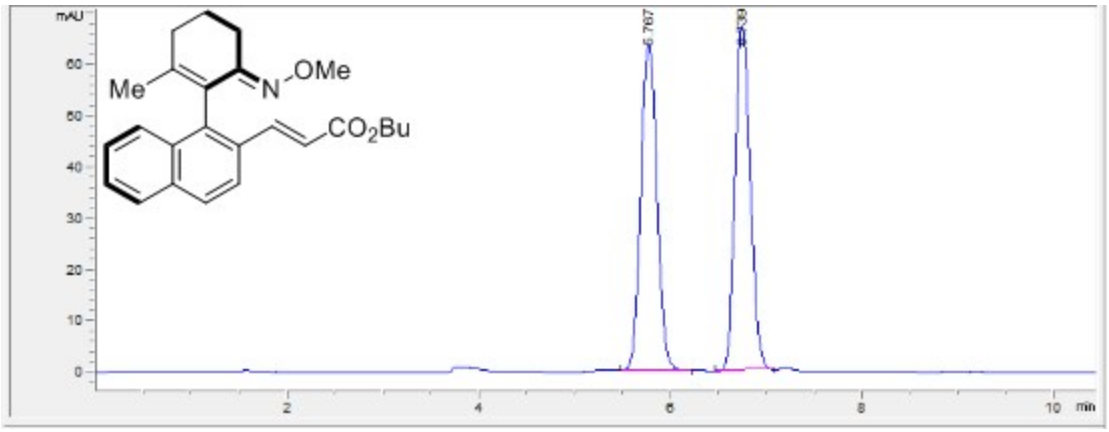
	Time/min	Area	Height	Area%
1	5.977	68	11.3	1.485
2	6.832	4515	588.9	98.515



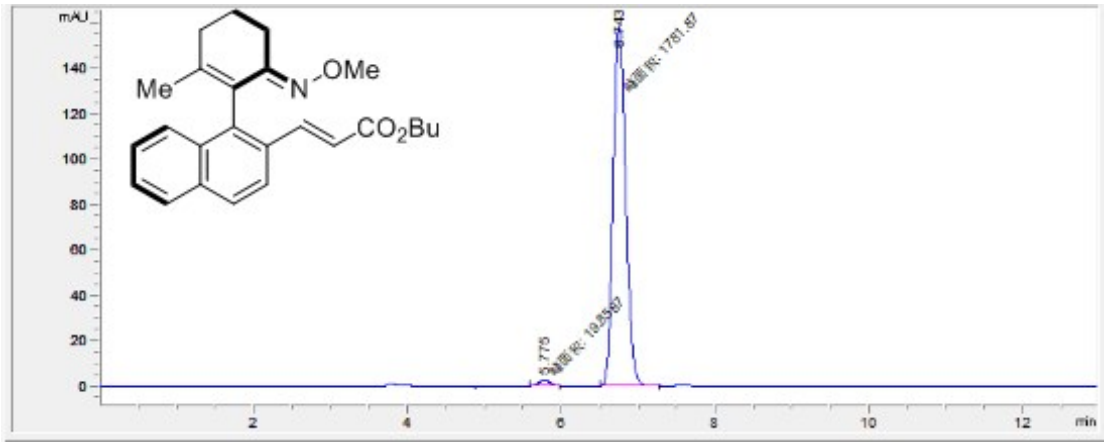
	Time/min	Area	Height	Area%
1	6.208	416.2	37.6	50.136
2	7.313	414	36.6	49.864



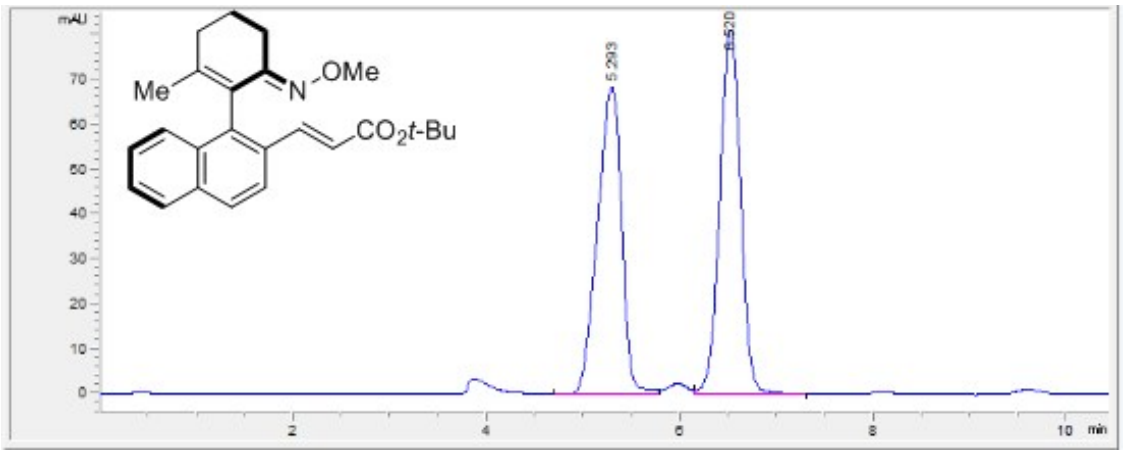
	Time/min	Area	Height	Area%
1	6.176	14.2	1.4	1.833
2	7.257	758.2	66.6	98.167



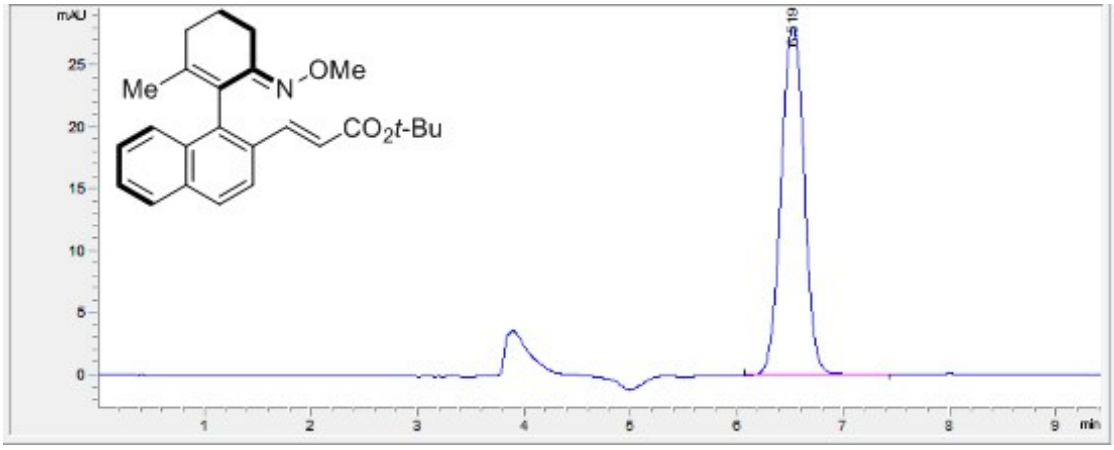
	Time/min	Area	Height	Area%
1	5.767	752.3	63.7	50.327
2	6.739	742.5	67.3	49.673



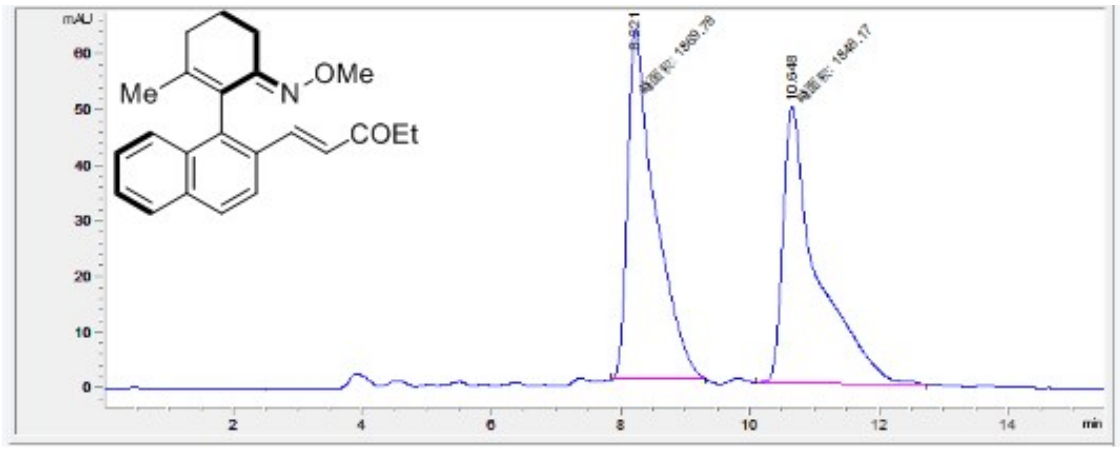
	Time/min	Area	Height	Area%
1	5.775	19.9	1.9	1.102
2	6.743	1781.9	157.9	98.898



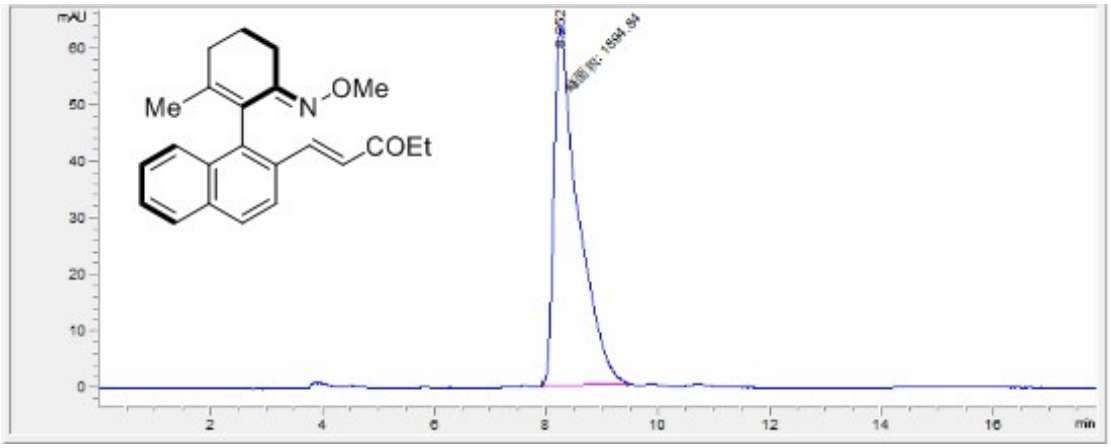
	Time/min	Area	Height	Area%
1	5.293	1186.9	68.4	49.269
2	6.52	1222.1	81.2	50.731



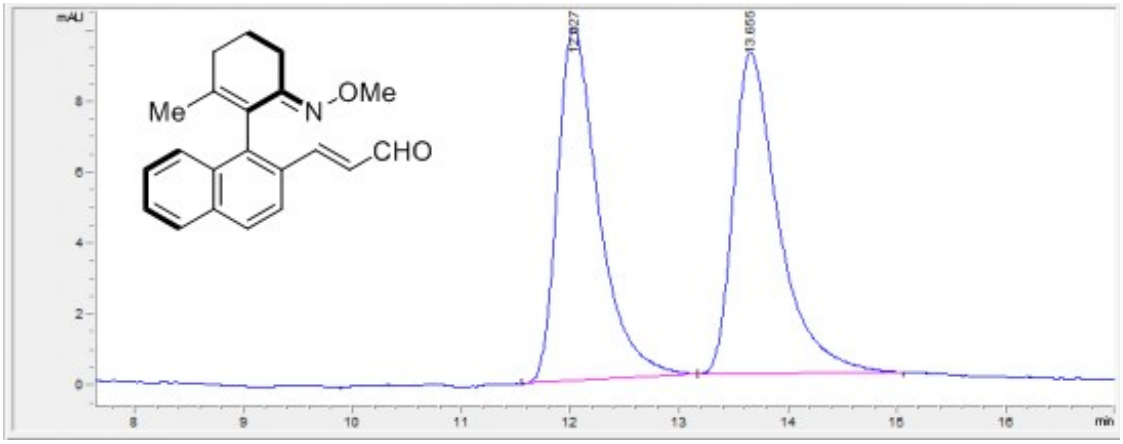
	Time/min	Area	Height	Area%
1	6.519	424.8	28.2	100.000



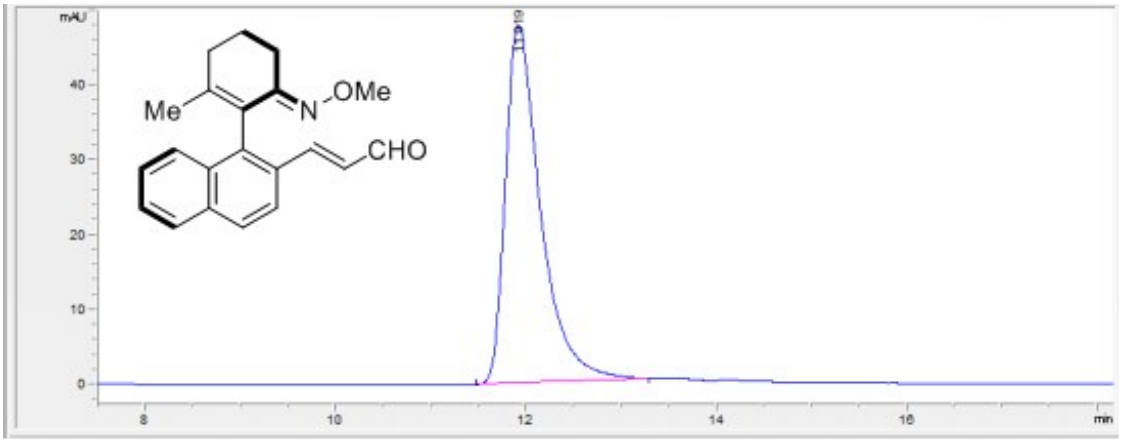
	Time/min	Area	Height	Area%
1	8.221	1869.8	62.9	50.291
2	10.648	1848.2	49.8	49.709



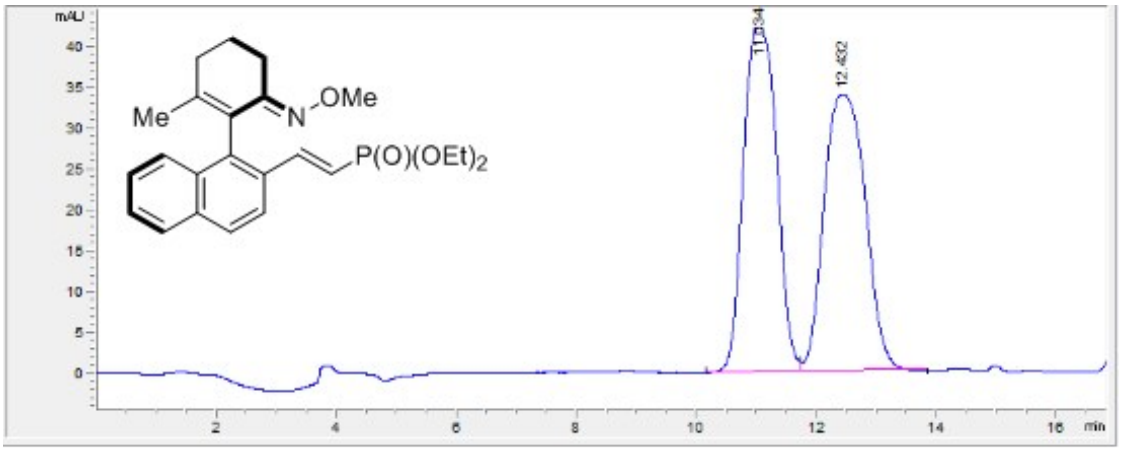
	Time/min	Area	Height	Area%
1	8.252	1894.8	63.3	100.000



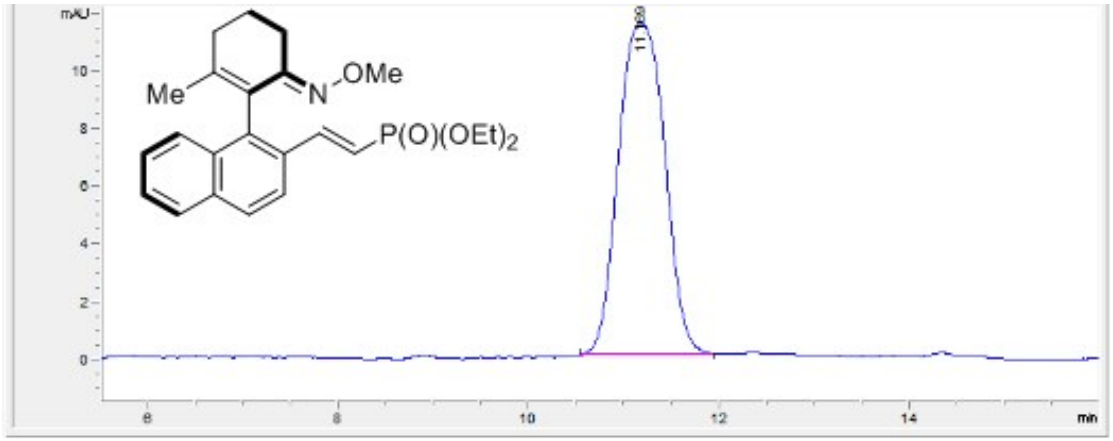
	Time/min	Area	Height	Area%
1	12.027	262.1	9.9	50.014
2	13.655	262	9.1	49.986



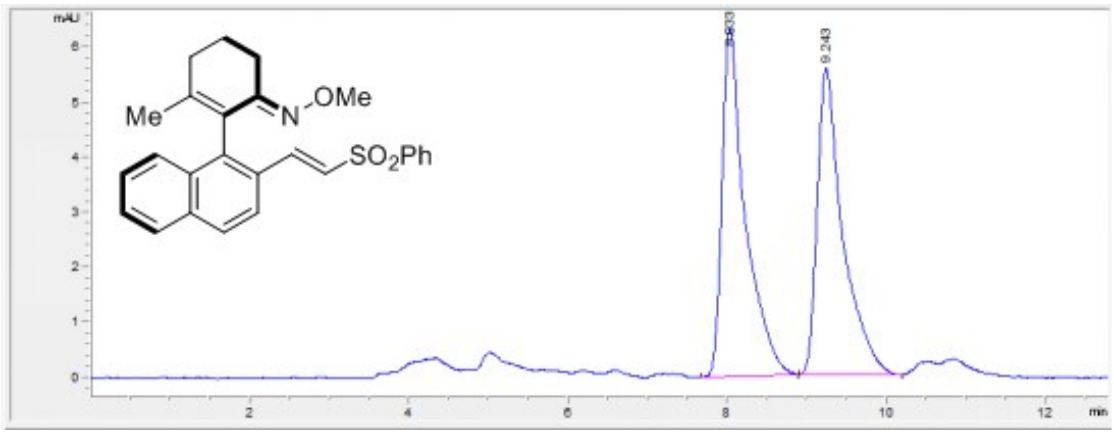
	Time/min	Area	Height	Area%
1	11.919	1233.7	47.8	100.000



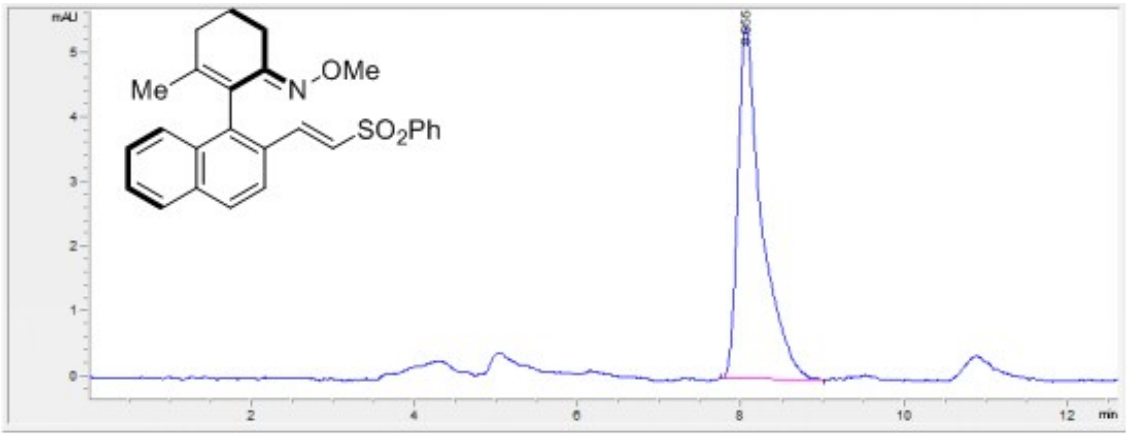
	Time/min	Area	Height	Area%
1	11.034	1630.2	42.3	50.051
2	12.432	1626.9	33.9	49.949



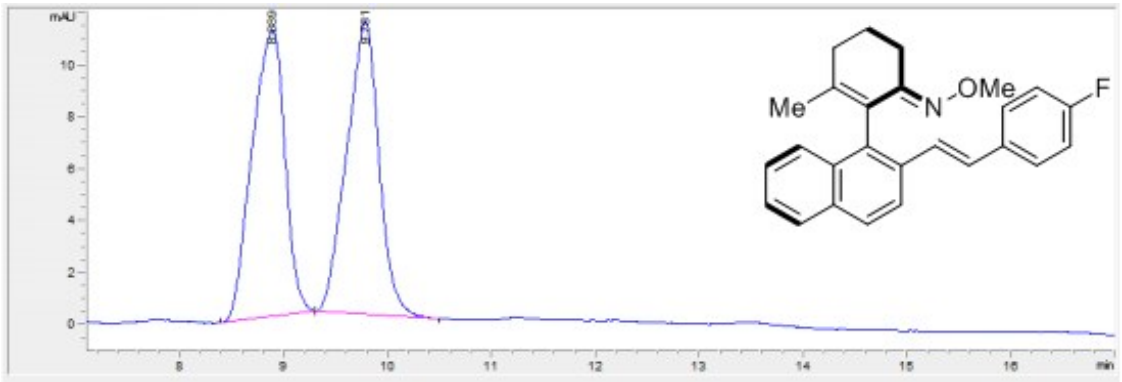
	Time/min	Area	Height	Area%
1	11.169	388.9	11.5	100.000



	Time/min	Area	Height	Area%
1	8.033	129.2	6.3	50.971
2	9.243	124.3	5.6	49.029

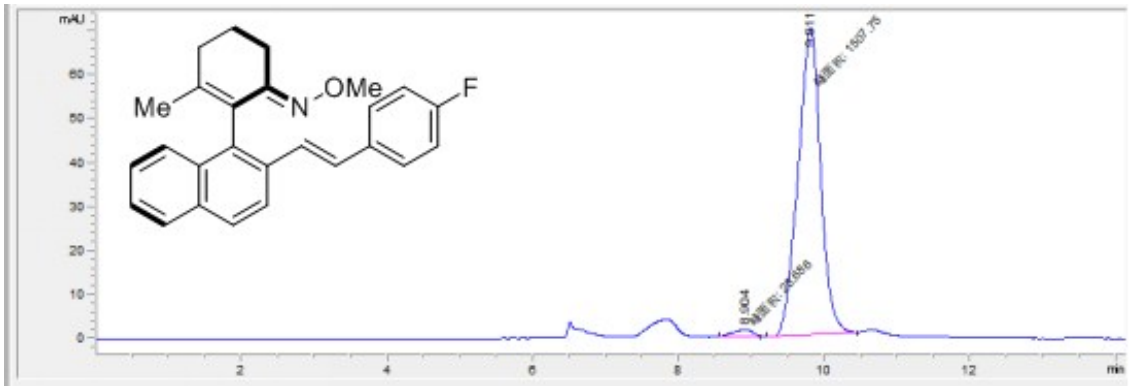


	Time/min	Area	Height	Area%
1	8.055	110	5.4	100.000

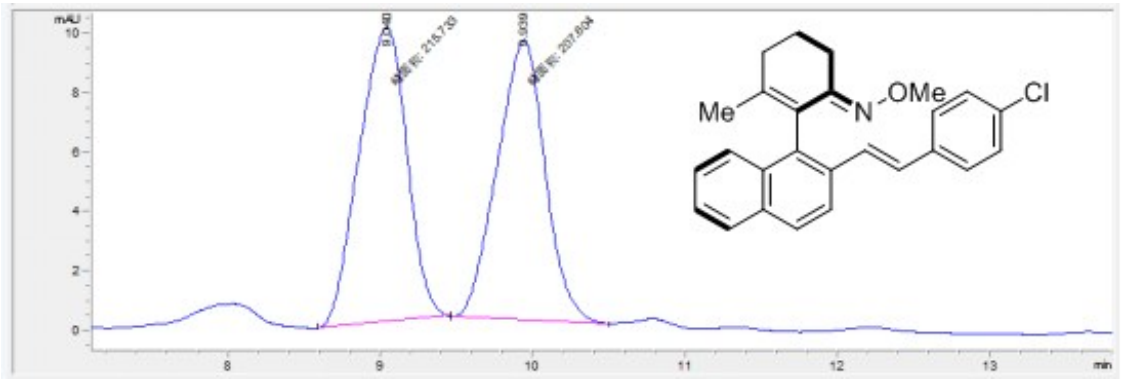


	Time/min	Area	Height	Area%
1	8.889	242.9	11	49.884

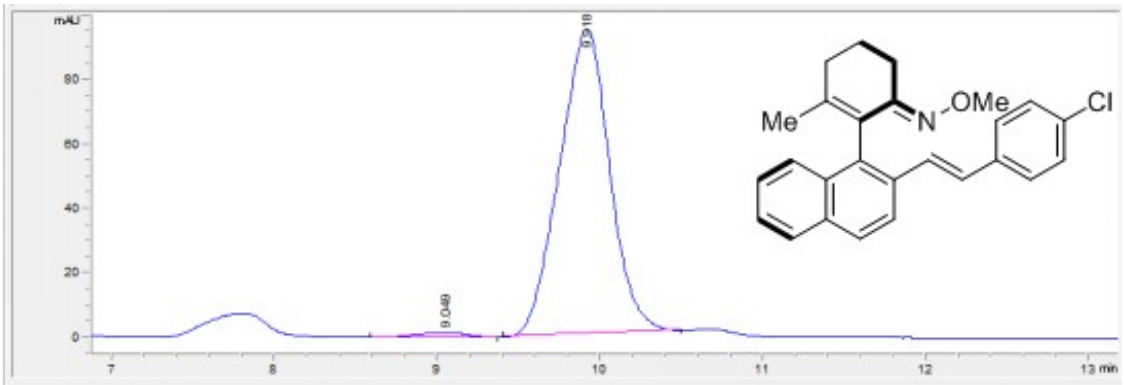
2	9.781	244	11.3	50.116



	Time/min	Area	Height	Area%
1	8.904	28.7	1.5	1.867
2	9.811	1507.7	69.9	98.133

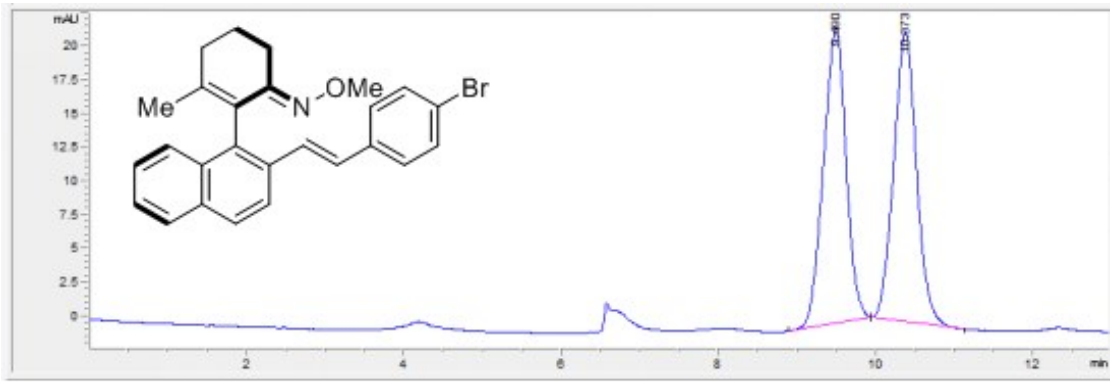


	Time/min	Area	Height	Area%
1	9.04	215.7	9.9	50.960
2	9.939	207.6	9.5	49.040

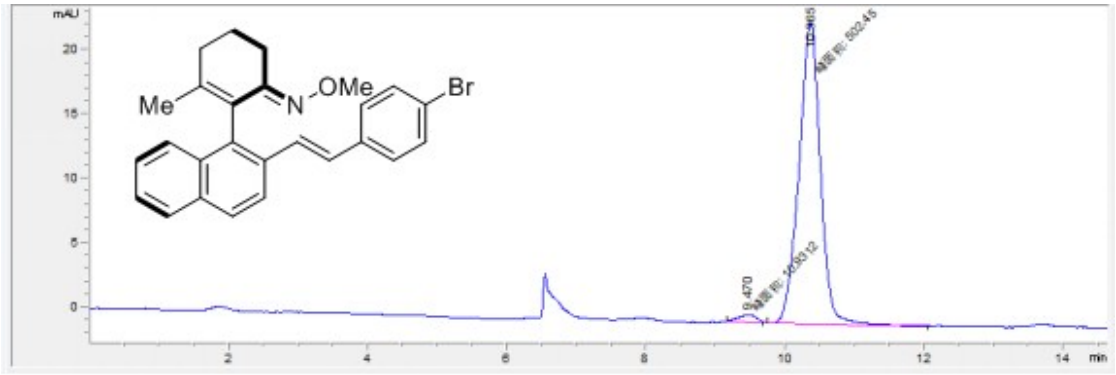


	Time/min	Area	Height	Area%

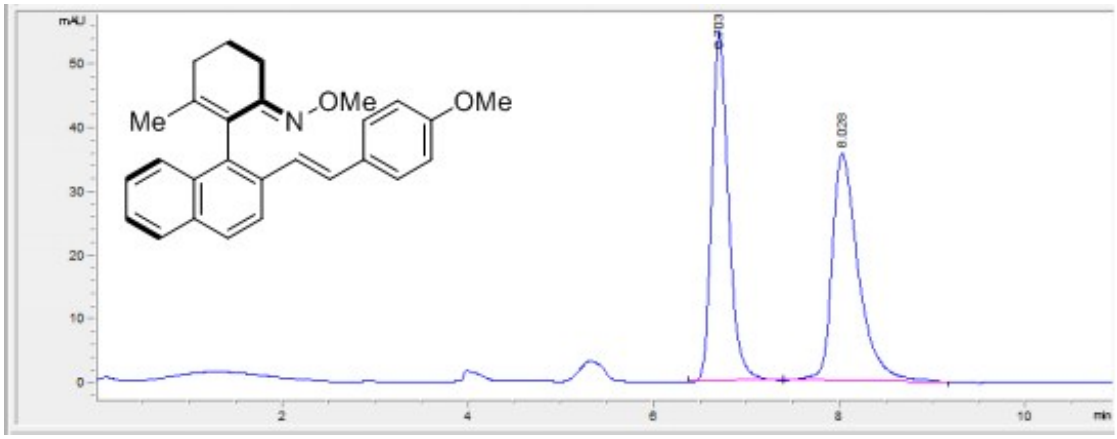
1	9.049	30.4	1.4	1.478
2	9.918	2028.4	94.7	98.522



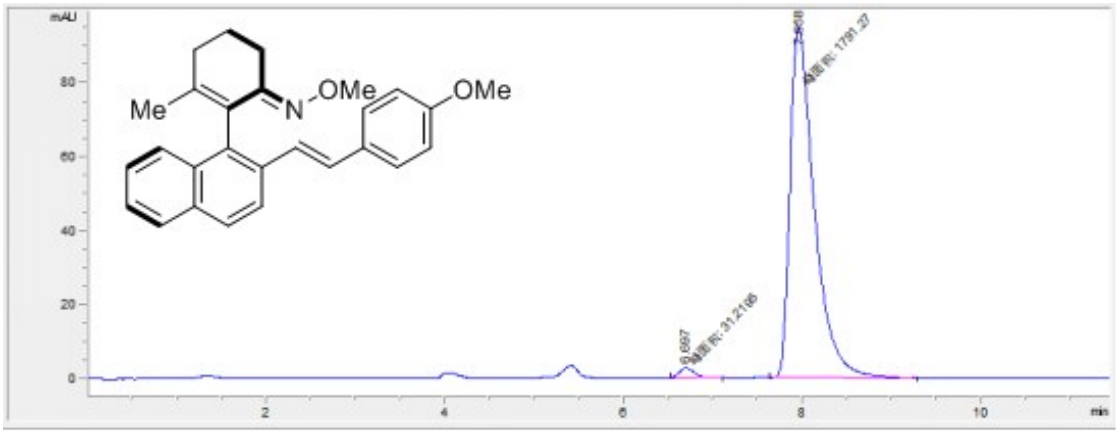
	Time/min	Area	Height	Area%
1	9.49	436.4	21.9	50.341
2	10.373	430.5	21.4	49.659



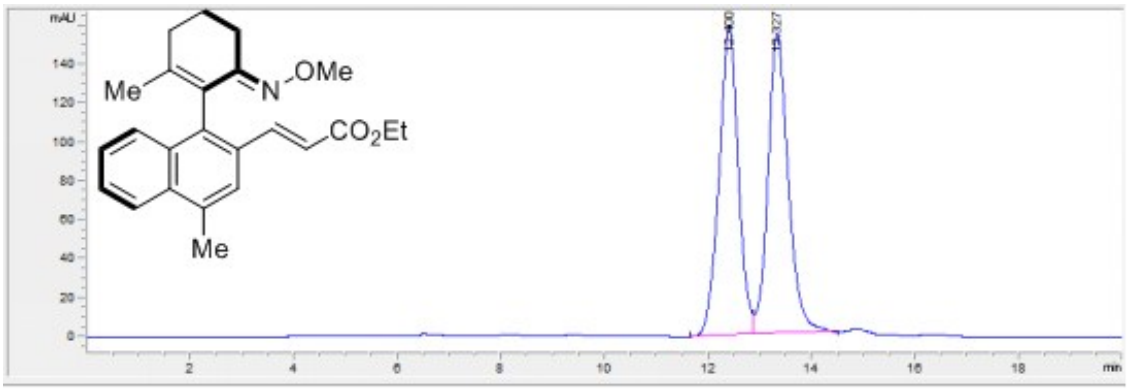
	Time/min	Area	Height	Area%
1	9.47	10.9	6E-1	2.129
2	10.365	502.4	23.5	97.871



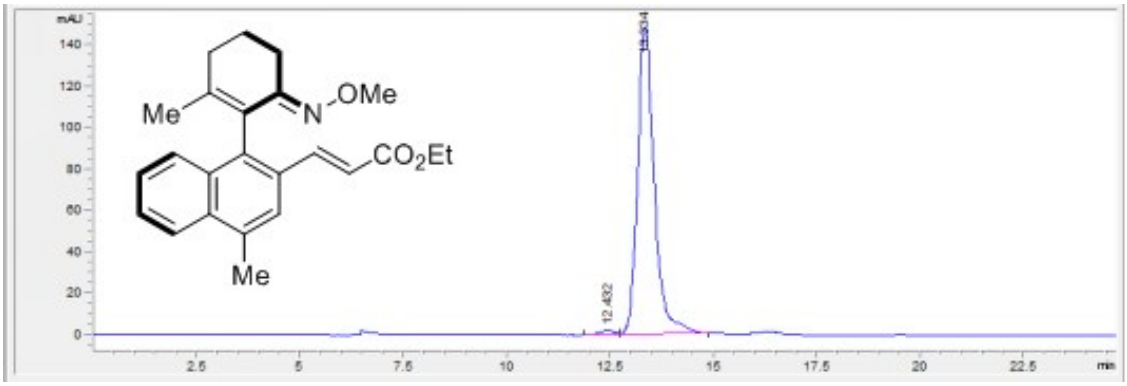
	Time/min	Area	Height	Area%
1	6.703	689.8	54.9	49.314
2	8.028	709	35.7	50.686



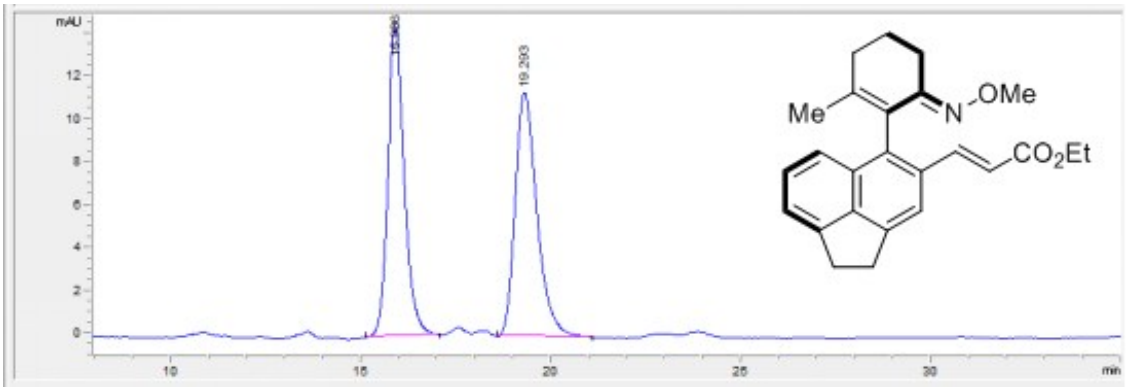
	Time/min	Area	Height	Area%
1	6.697	31.2	2.7	1.713
2	7.958	1791.3	94.6	98.287



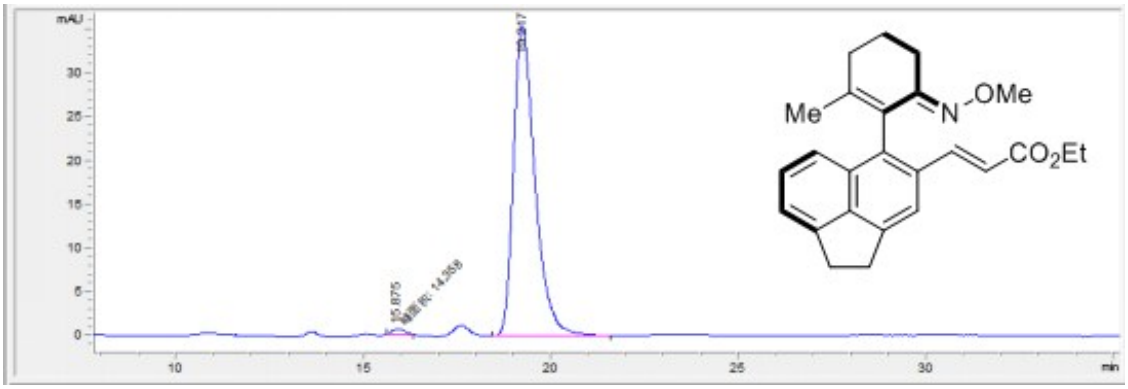
	Time/min	Area	Height	Area%
1	12.4	4121.7	158.7	49.337
2	13.327	4232.4	154.4	50.663



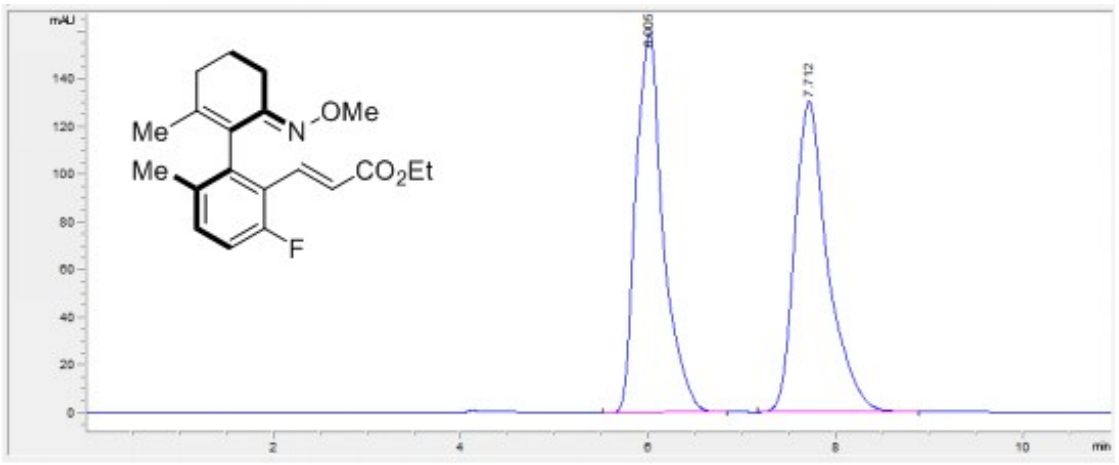
	Time/min	Area	Height	Area%
1	12.432	49.2	2.1	1.138
2	13.334	4157.8	148.2	98.832



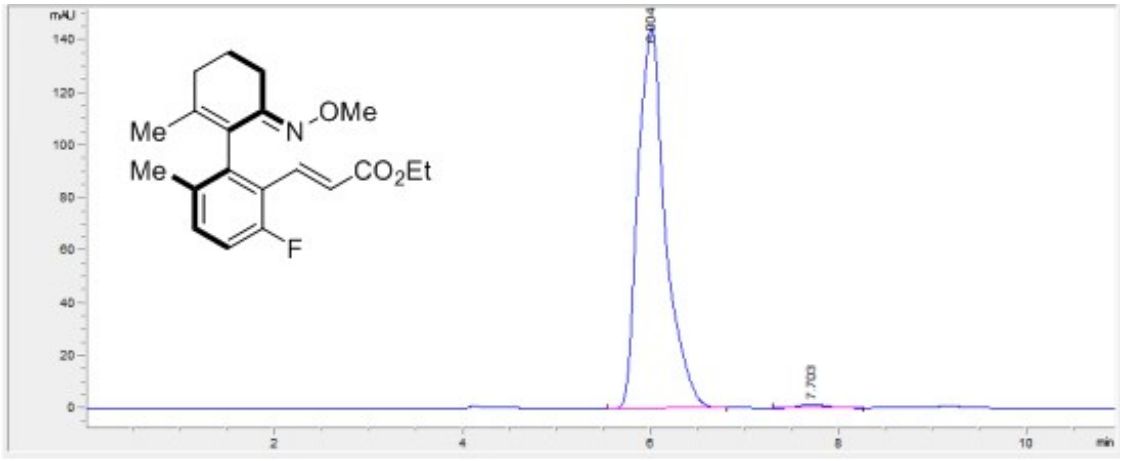
	Time/min	Area	Height	Area%
1	15.906	451.8	14.5	49.962
2	19.293	452.5	11.4	50.038



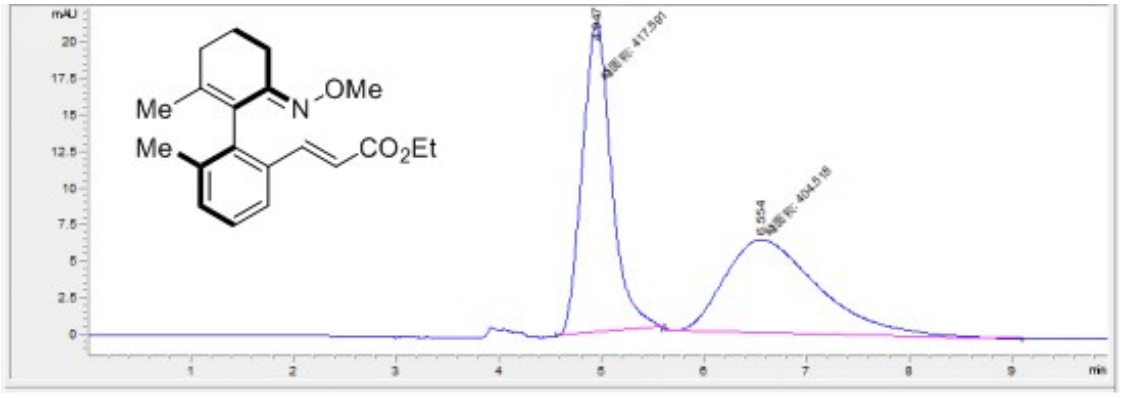
	Time/min	Area	Height	Area%
1	15.876	14.4	6.3E-1	1.015
2	19.217	1400.2	35.4	98.985



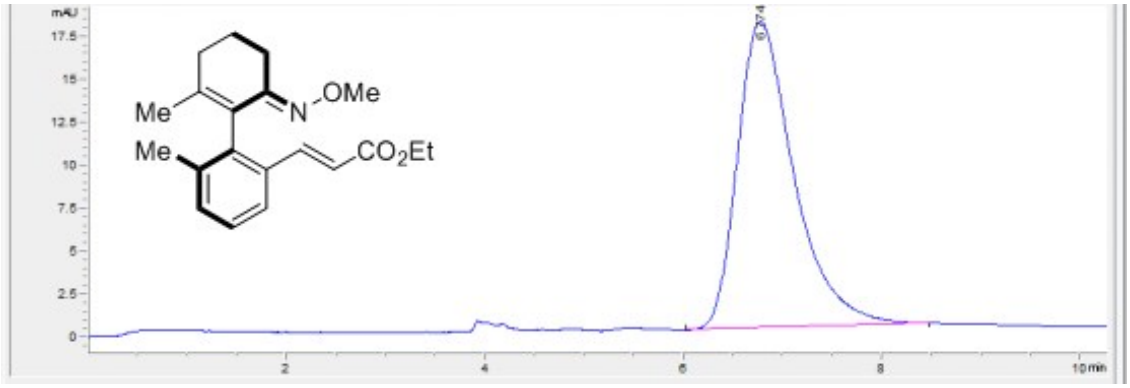
	Time/min	Area	Height	Area%
1	6.005	3227.3	159.5	50.109
2	7.712	3212.3	130.4	49.891



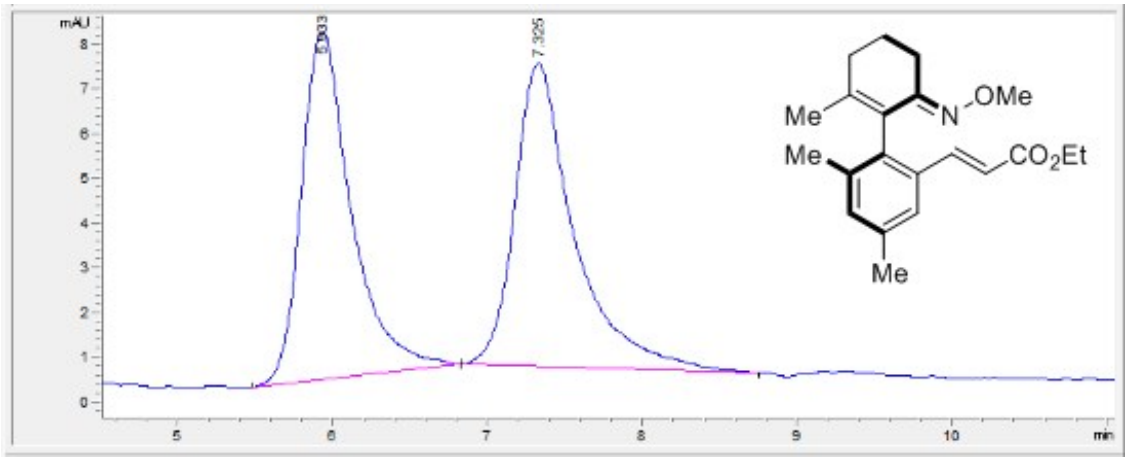
	Time/min	Area	Height	Area%
1	6.004	2936.5	144.9	98.880
2	7.703	33.3	1.5	1.120



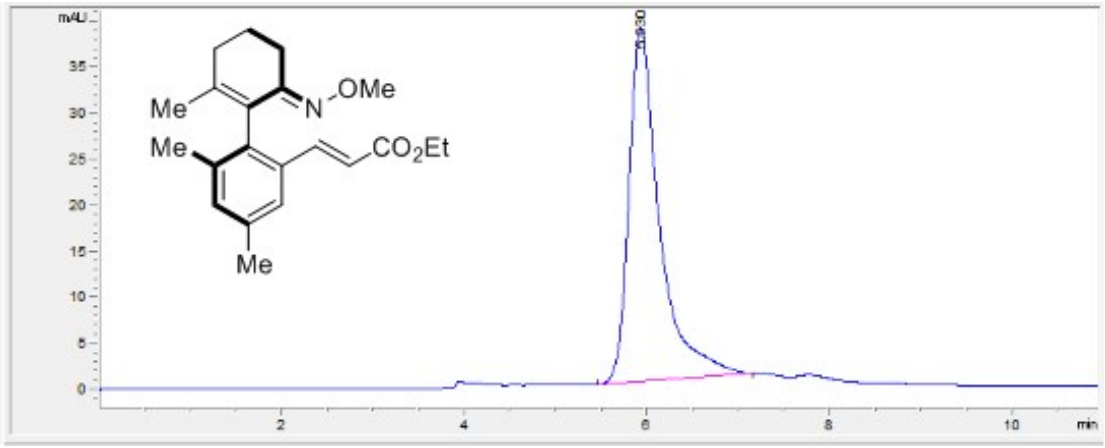
	Time/min	Area	Height	Area%
1	4.947	417.6	21.2	50.795
2	6.554	404.5	6.4	49.205



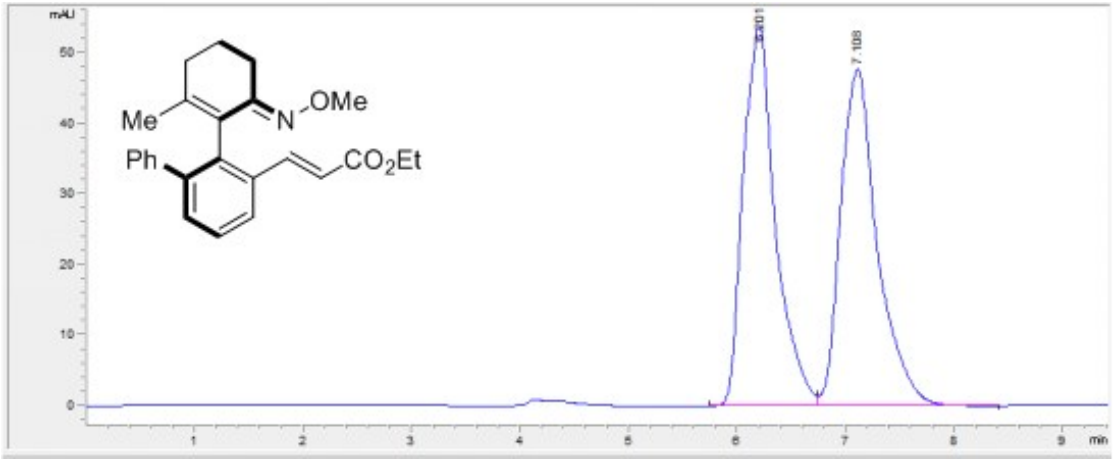
	Time/min	Area	Height	Area%
1	6.774	707.6	17.8	100.000



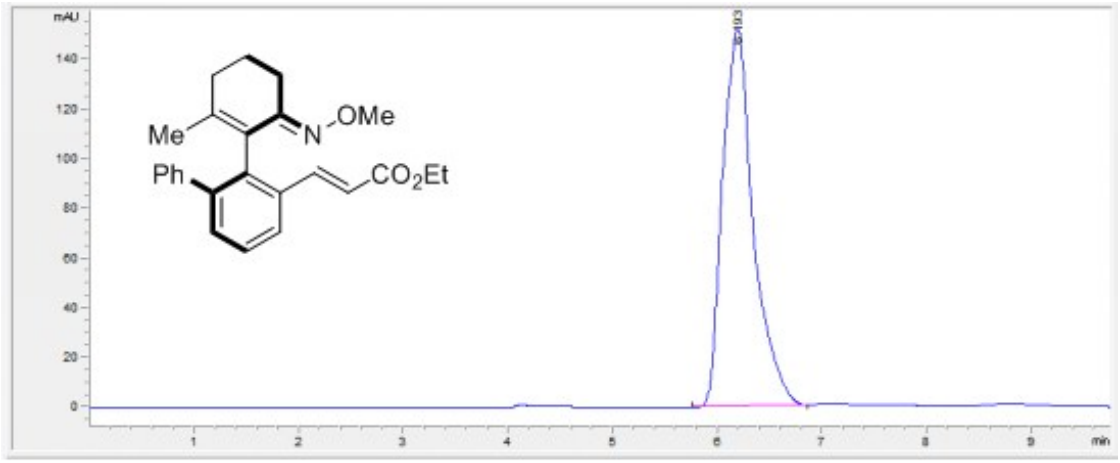
	Time/min	Area	Height	Area%
1	5.933	174.8	7.8	49.091
2	7.325	181.3	6.8	50.909



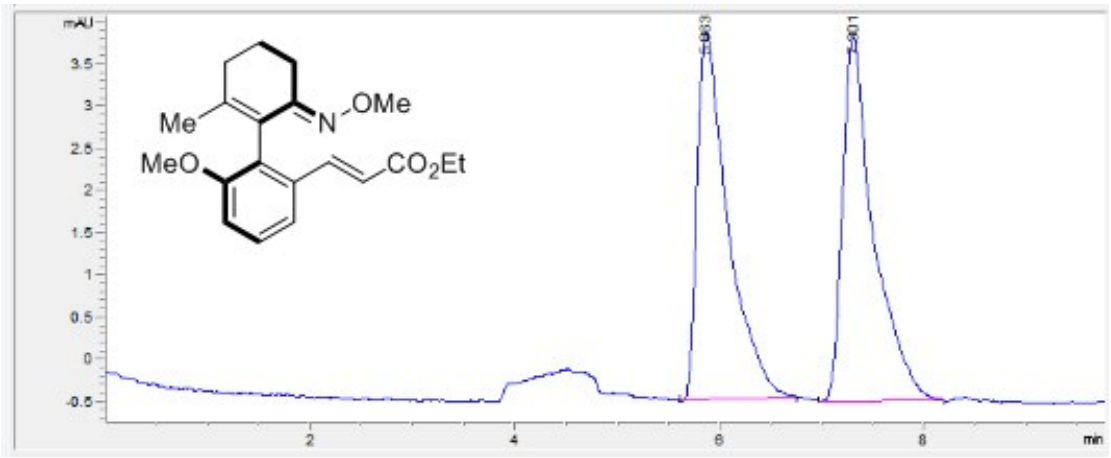
	Time/min	Area	Height	Area%
1	5.93	895.6	38.4	100.000



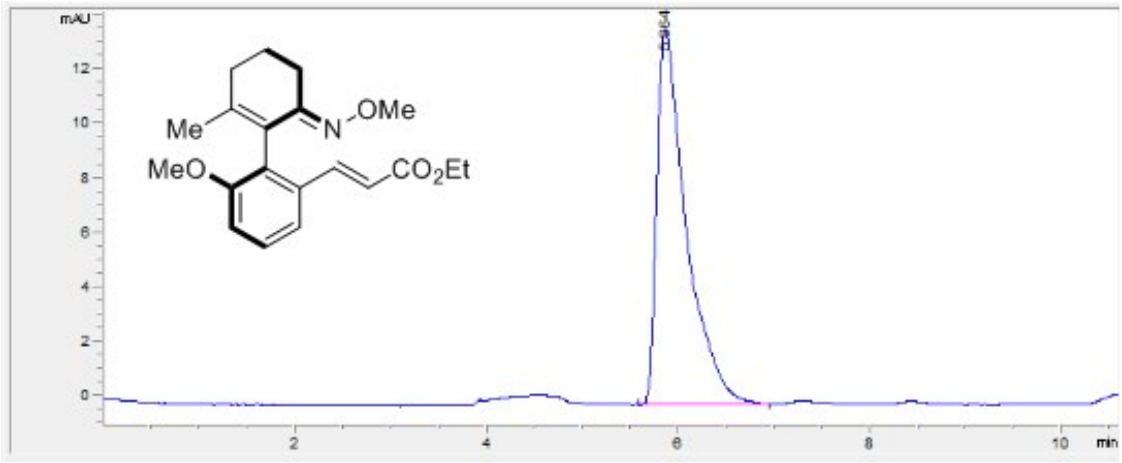
	Time/min	Area	Height	Area%
1	6.201	1110.2	53.7	49.768
2	7.108	1120.6	47.7	50.232



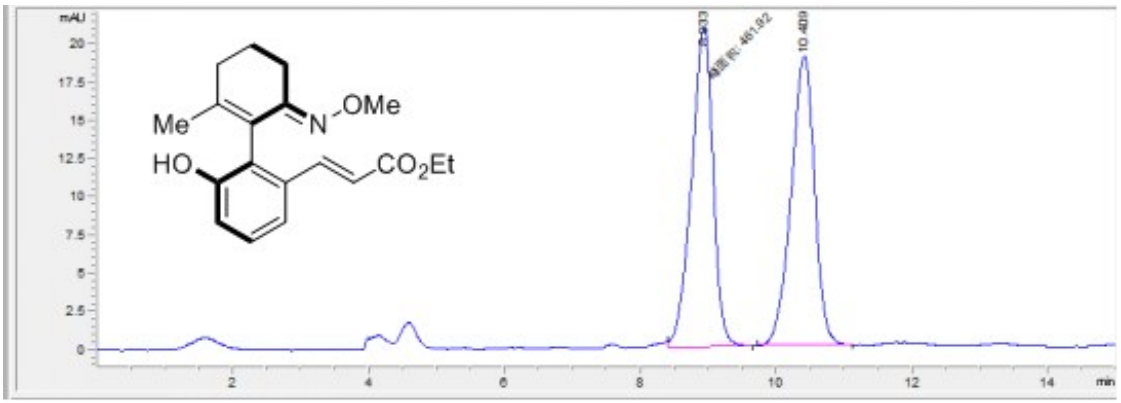
	Time/min	Area	Height	Area%
1	6.193	3100.8	151.8	100.000



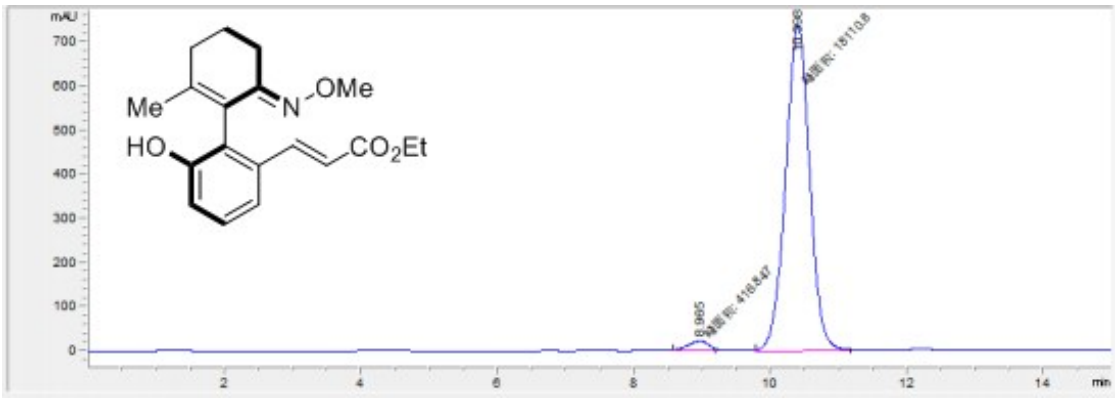
	Time/min	Area	Height	Area%
1	5.863	91.7	4.4	49.922
2	7.301	92	4.3	50.078



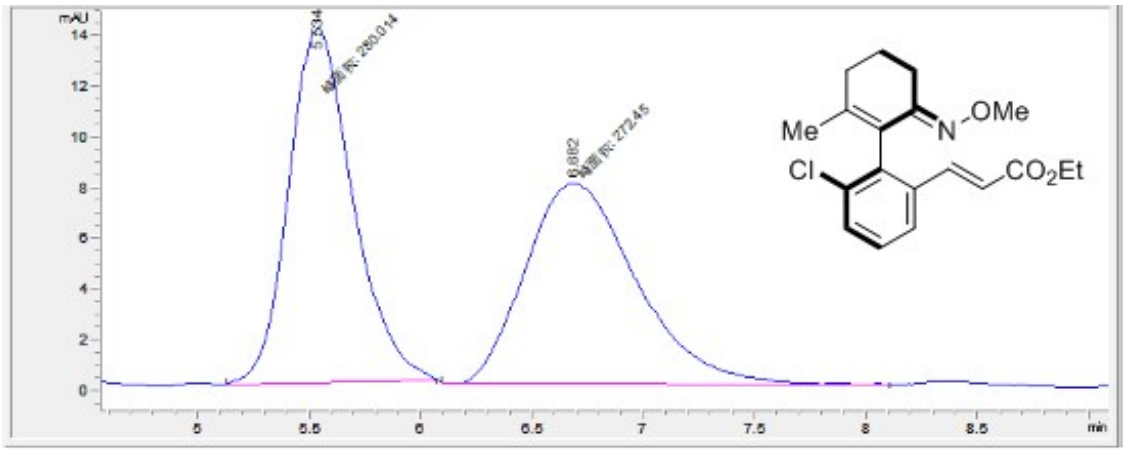
	Time/min	Area	Height	Area%
1	5.864	293.8	13.8	100.000



	Time/min	Area	Height	Area%
1	8.933	461.9	20.9	50.291
2	10.409	456.6	19	49.709

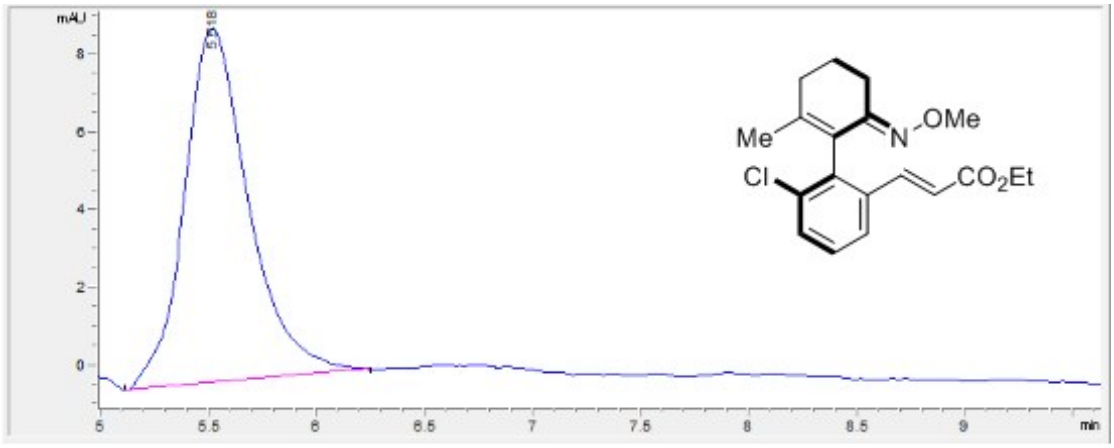


	Time/min	Area	Height	Area%
1	8.965	416.8	20.5	2.250
2	10.398	18110.8	736.9	97.750

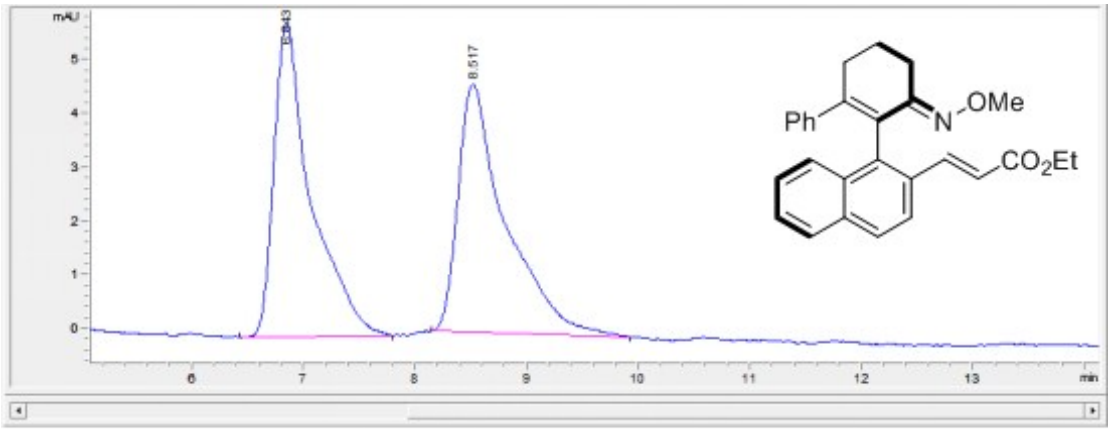


	Time/min	Area	Height	Area%
1	5.534	280	14	50.685

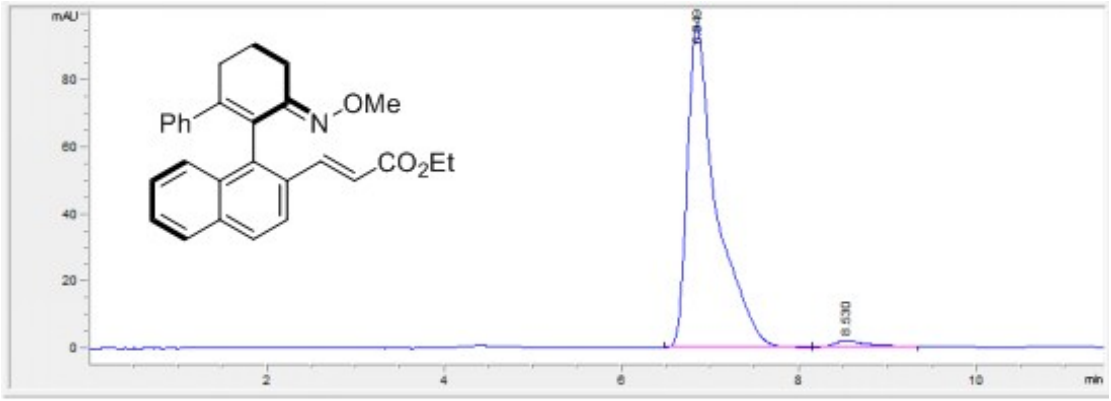
2	6.682	272.4	7.9	49.315



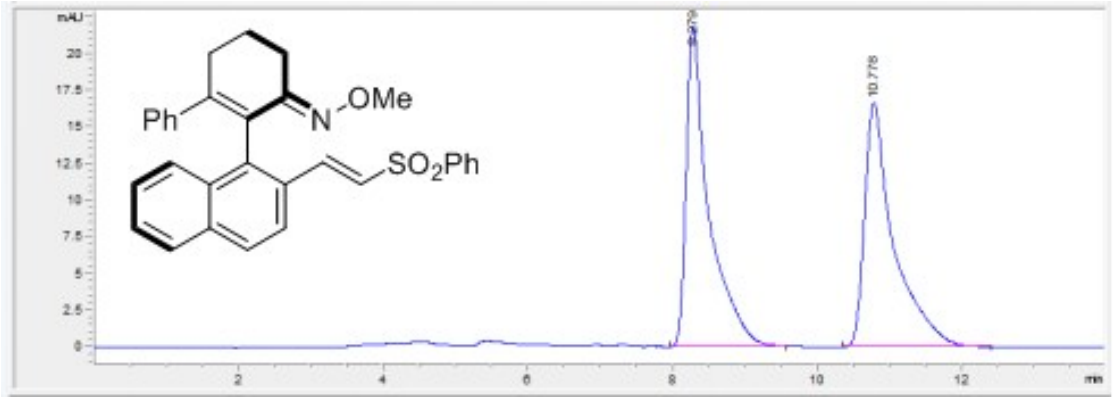
	Time/min	Area	Height	Area%
1	5.518	190.2	9.1	100.000



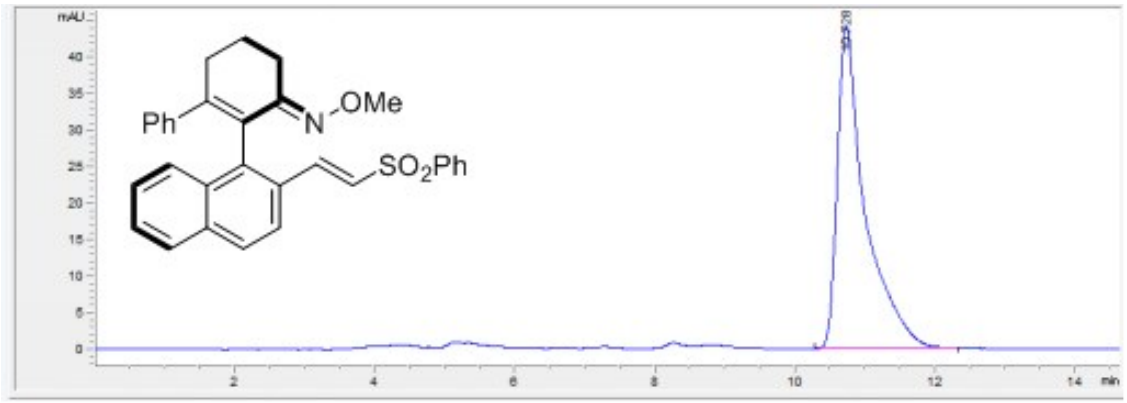
	Time/min	Area	Height	Area%
1	6.843	135.2	5.8	49.890
2	8.517	135.8	4.6	50.110



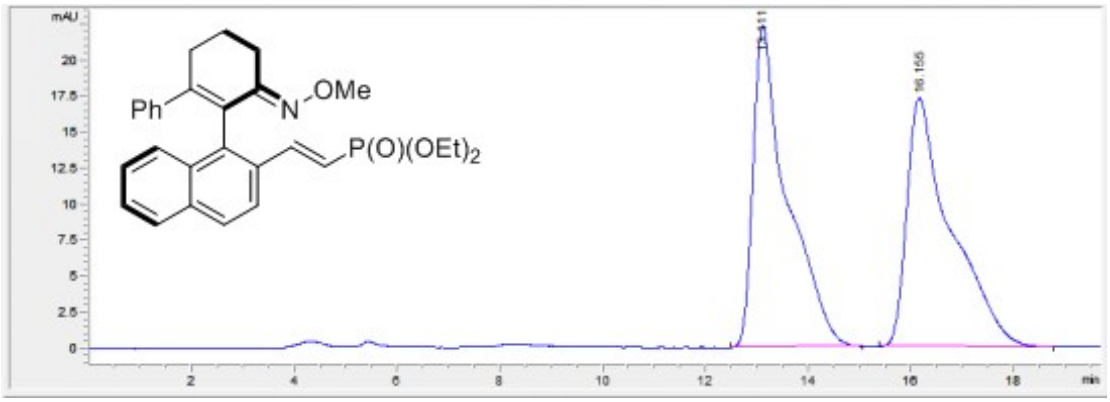
	Time/min	Area	Height	Area%
1	6.849	2195.5	96.2	97.781
2	8.53	49.8	1.9	2.219



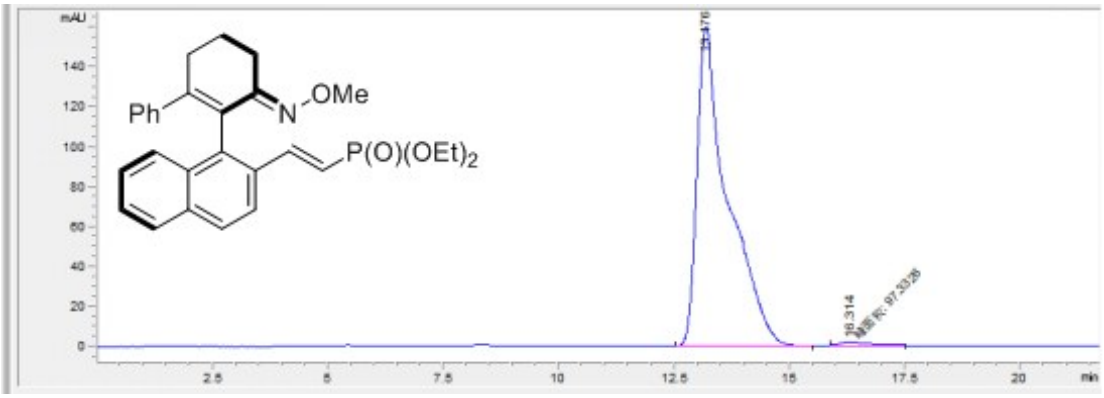
	Time/min	Area	Height	Area%
1	8.279	473	21.8	50.358
2	10.778	466.3	16.7	49.672



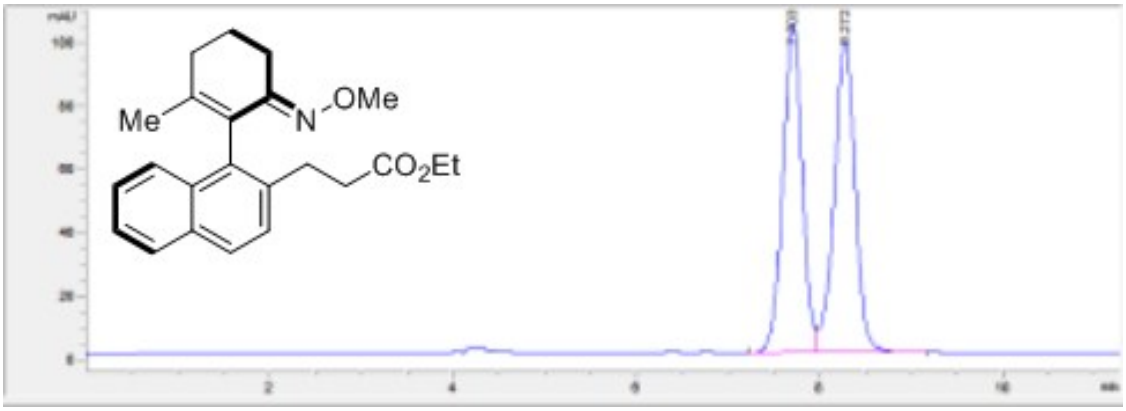
	Time/min	Area	Height	Area%
1	10.728	1225.9	44.3	100.000



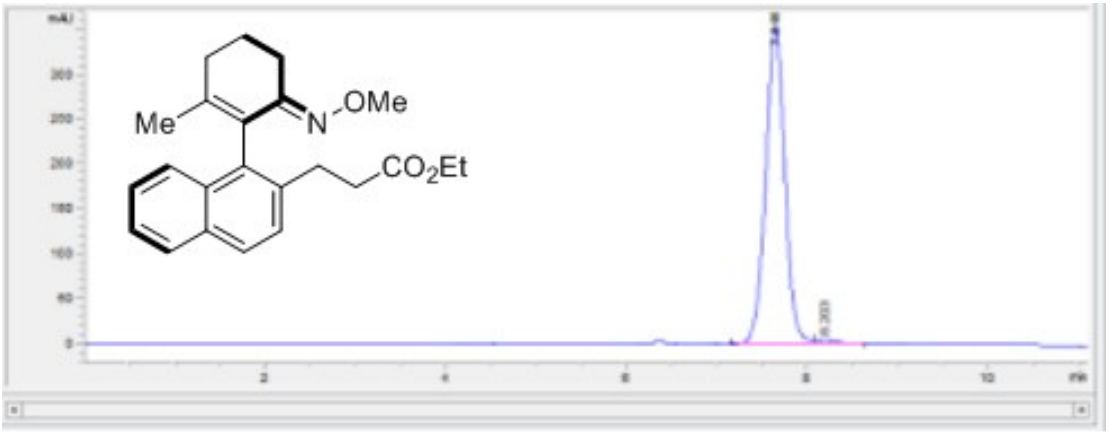
	Time/min	Area	Height	Area%
1	13.111	1031.4	22.3	50.062
2	16.155	1028.8	17.3	49.938



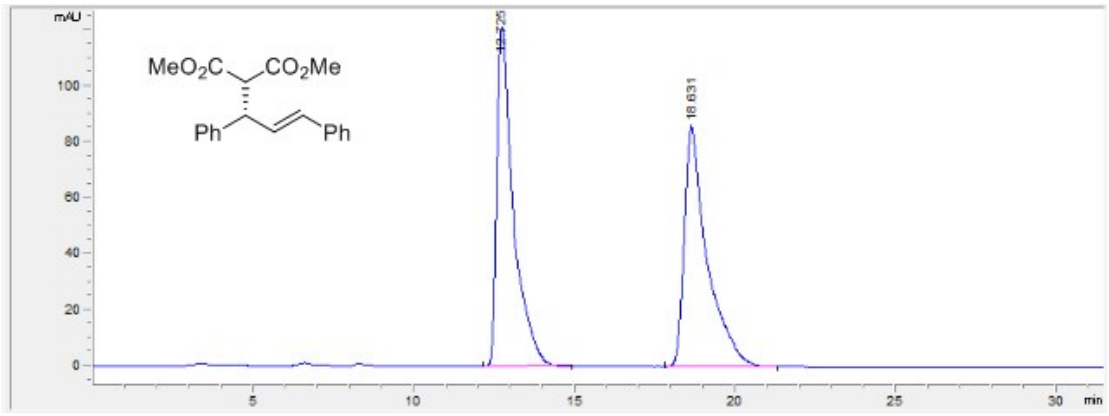
	Time/min	Area	Height	Area%
1	13.176	7483.4	159.9	98.716
2	16.314	97.3	1.9	1.284



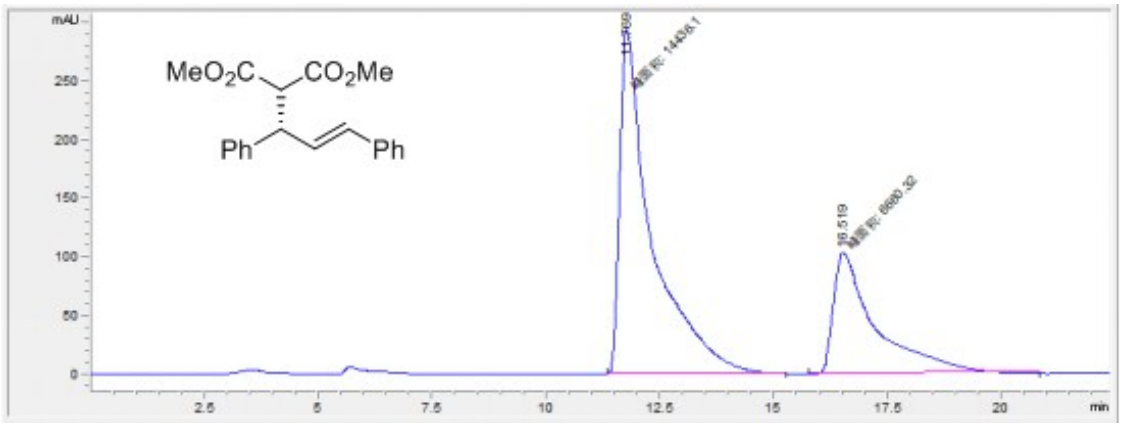
	Time/min	Area	Height	Area%
1	7.703	1515.7	103.1	49.603
2	8.272	1540	97.9	50.397



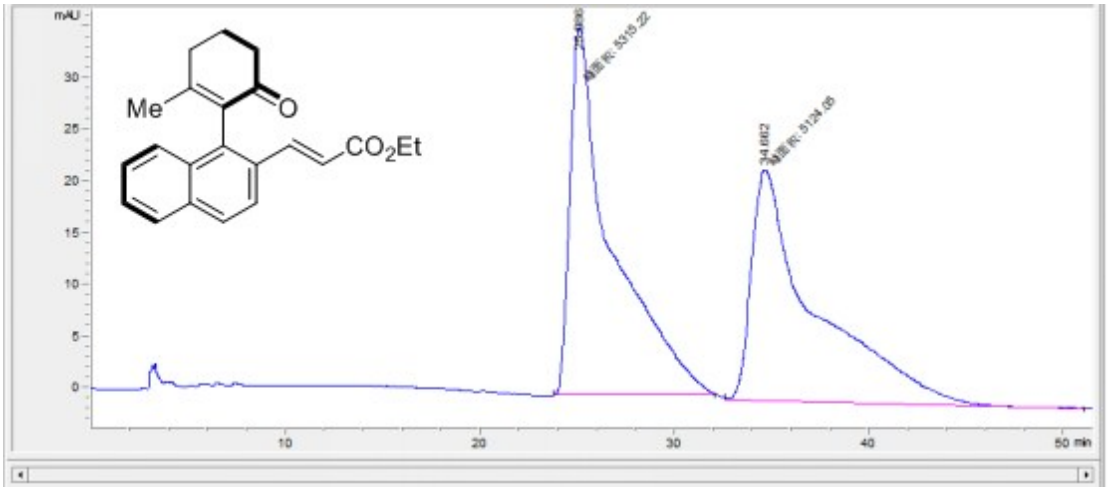
	Time/min	Area	Height	Area%
1	7.646	5205.6	352.2	98.637
2	8.203	71.9	4.7	1.363



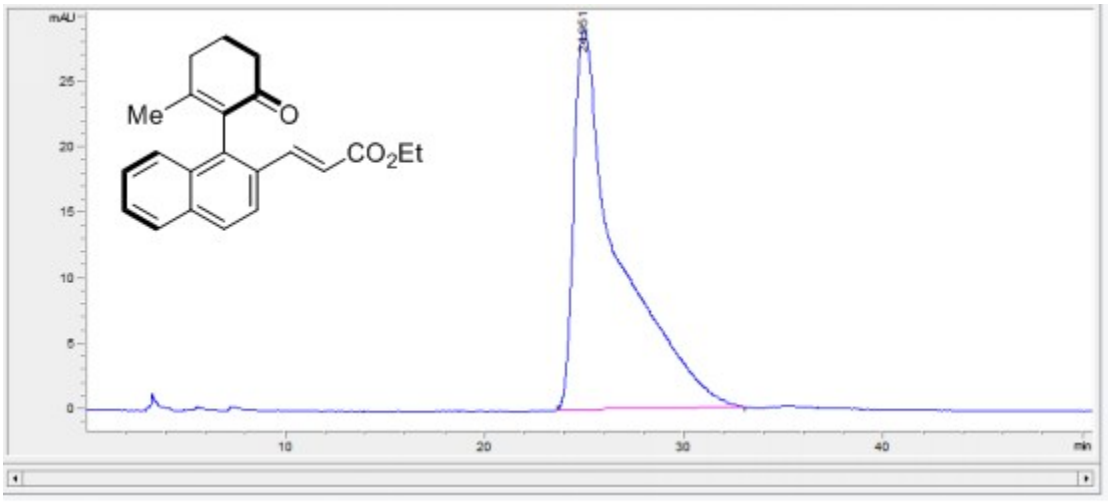
	Time/min	Area	Height	Area%
1	12.725	4340.2	121.3	50.005
2	18.631	4339.3	86.1	49.995



	Time/min	Area	Height	Area%
1	11.769	14436.1	294	68.429
2	16.519	6660.3	103.7	31.571



	Time/min	Area	Height	Area%
1	25.086	5315.2	35.6	50.916
2	34.662	5124	22.3	49.084



	Time/min	Area	Height	Area%
1	24.951	4536.2	29	100