

# Ligand-Enabled $\beta$ -C–H Arylation of $\alpha$ -Amino Acids Without Installing Exogenous Directing Groups

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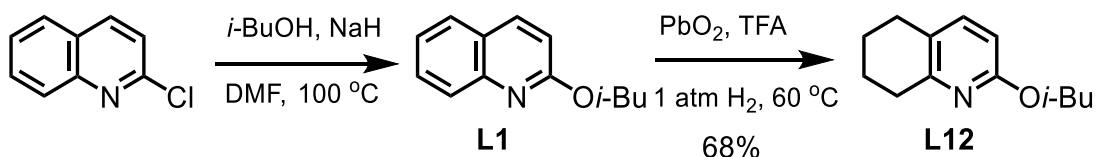
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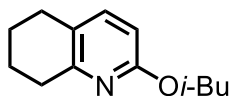
**1. General Information:** Solvents were obtained from Sigma-Aldrich, Alfa-Aesar and Acros and used directly without further purification. Carboxylic acids and carboxylic acid chlorides were obtained from the commercial sources or synthesized following literature procedures, and used to prepare the corresponding amides. Analytical thin layer chromatography was performed on 0.25 mm silica gel 60-F254. Visualization was carried out with UV light and Vogel's permanganate.  $^1\text{H}$  NMR spectra were recorded on Bruker AMX-400 instrument (400 MHz), Bruker DRX-500 instrument (500 MHz) or Bruker DRX-600 instrument (600 MHz). When the  $^1\text{H}$  NMR solvent was  $\text{CDCl}_3$ , chemical shifts were quoted in parts per million (ppm) referenced to 0.00 ppm for chloroform-d; When the  $^1\text{H}$  NMR solvent was Acetone-*d*-6, chemical shifts were quoted in parts per million (ppm) referenced to 2.05 ppm for solvent Acetone-*d*-6. The following abbreviations (or combinations thereof) were used to explain multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, br = broad. Coupling constants, *J*, were reported in Hertz unit (Hz).  $^{13}\text{C}$  NMR spectra were recorded on Bruker AMX-400 instrument (100 MHz), Bruker DRX-500 instrument (125 MHz) or Bruker DRX-600 instrument (150 MHz), and were fully decoupled by broad band proton decoupling. When the  $^{13}\text{C}$  NMR solvent was  $\text{CDCl}_3$ , chemical shifts were reported in ppm referenced to 77.00 ppm for chloroform-d. Optical rotations were obtained on a Perkin-Elmer 341 polarimeter. High-resolution mass spectra (HRMS) were recorded on an Agilent Mass spectrometer using ESI-TOF (electrospray ionization-time of flight). Enantiomeric ratios (er) were determined on a Hitachi LaChrom Elite HPLC system using commercially available chiral columns. The single crystal X-ray diffraction studies were carried out on a Bruker Kappa APEX-II CCD diffractometer equipped with Mo  $\text{K}_\alpha$  radiation ( $\lambda = 0.71073$ ). Melting points were obtained from a Mel-temp II apparatus (uncorrected).

## 2. Experimental Section

### 2.1 Ligand synthesis

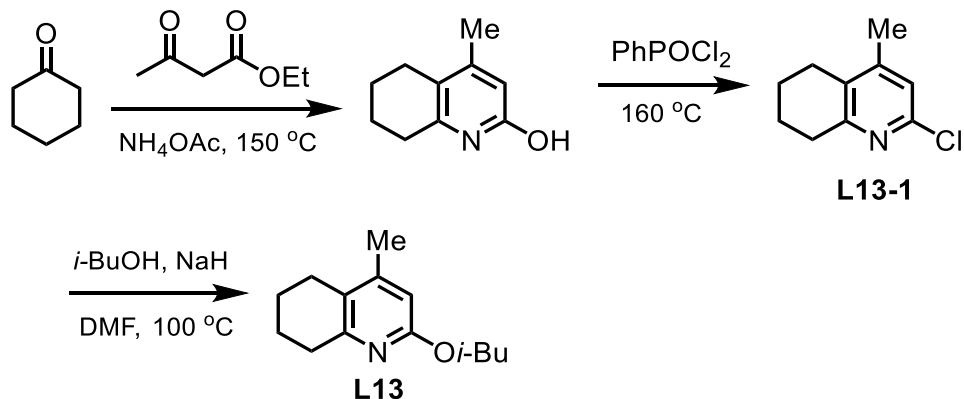


Preparation of **L1** was described in the reference.<sup>[1]</sup> Compound **L1** (1 mmol, 203 mg) was dissolved in the TFA (5 mL), and PbO<sub>2</sub> (10%) was added to the mixture. The mixture was reacted in the 1 atm H<sub>2</sub> gas at 60 °C overnight. After cooled down, the resulting suspension was quenched with 10% aq NaOH in the ice bath, diluted with EtOAc, washed with water and brine. The solvents were removed and the resulting mixture was purified by a silica gel-packed flash chromatography. **L12** was obtained as an oil (140 mg, 68%)

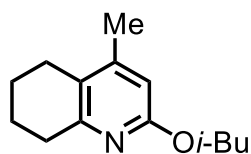


#### 2-Isobutoxy-5,6,7,8-tetrahydroquinoline (**L12**)

<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 7.23 (d, *J* = 8.3 Hz, 1H), 6.48 (d, *J* = 8.3 Hz, 1H), 3.99 (d, *J* = 6.6 Hz, 2H), 2.77 (t, *J* = 6.4 Hz, 2H), 2.65 (t, *J* = 6.3 Hz, 2H), 2.10-2.03 (m, 1H), 1.86-1.82 (m, 2H), 1.79-1.75 (m, 2H), 1.01 (d, *J* = 6.7 Hz, 6H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 161.88, 154.18, 139.67, 124.11, 107.46, 72.12, 32.39, 28.15, 27.83, 23.12, 23.00, 19.39; HRMS (ESI-TOF) Calcd for C<sub>13</sub>H<sub>20</sub>NO [M+H]<sup>+</sup>: 206.1539; found: 206.1542.

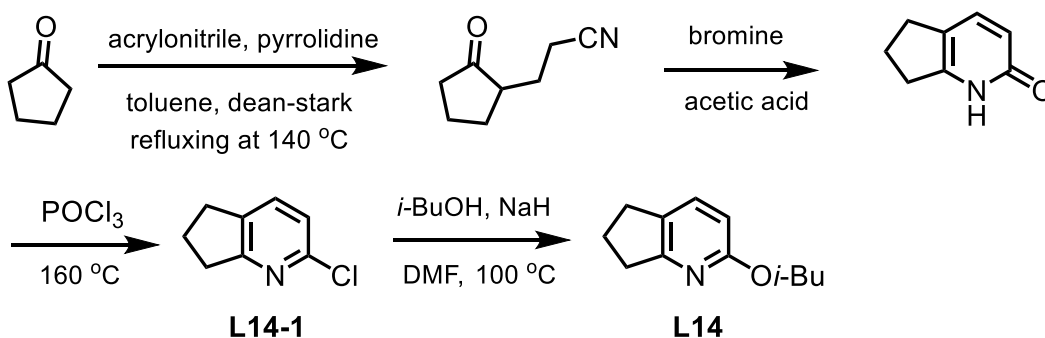


Preparation of **L13-1** was described in the reference.<sup>[2]</sup> To a solution of isobutanol (1.5 equiv.) in DMF was added NaH (1.5 equiv.) slowly, and the reaction mixture was stirred for 1 hour at room temperature. A solution of compound **L13-1** (1 equiv.) was added the above mixture slowly, then reaction mixture was stirred overnight in 100 °C. After cooled down, the resulting suspension was quenched with saturated NH<sub>4</sub>Cl, diluted with EtOAc, washed with water and brine. The solvents were removed and the resulting mixture was purified by a silica gel-packed flash chromatography.

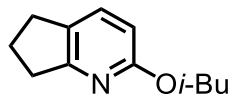


### 2-Isobutoxy-4-methyl-5,6,7,8-tetrahydroquinoline (**L13**)

<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 6.38 (d, *J* = 0.9 Hz, 1H), 3.97 (d, *J* = 6.7 Hz, 2H), 2.77 (t, *J* = 6.0 Hz, 2H), 2.53 (t, *J* = 6.0 Hz, 2H), 2.15 (s, 3H), 2.09-2.02 (m, 1H), 1.82-1.79 (m, 4H), 1.00 (d, *J* = 6.7 Hz, 6H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 161.66, 153.78, 148.71, 123.45, 108.22, 71.97, 32.89, 28.19, 25.13, 23.08, 23.00, 19.40, 19.08; HRMS (ESI-TOF) Calcd for C<sub>14</sub>H<sub>22</sub>NO [M+H]<sup>+</sup>: 220.1696; found: 220.1699.

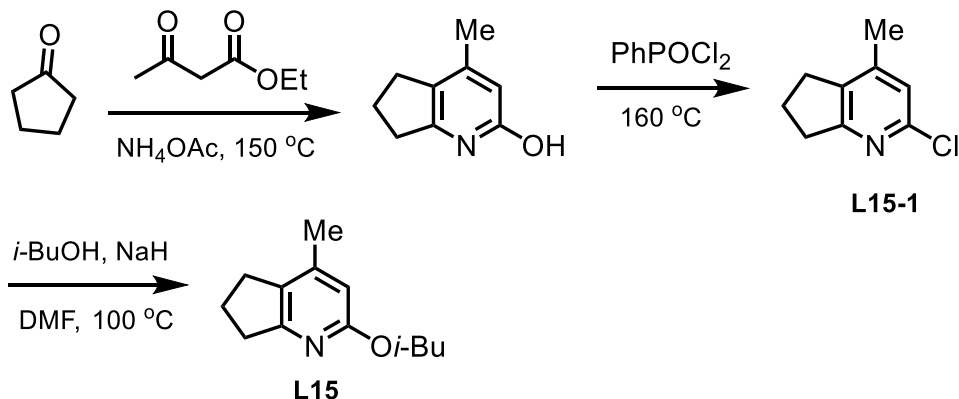


Preparation of **L14-1** was described in the reference.<sup>[3]</sup> To a solution of isobutanol (1.5 equiv.) in DMF was added NaH (1.5 equiv.) slowly, and the reaction mixture was stirred for 1 hour at room temperature. A solution of compound **3** (1 equiv.) was added to the above mixture slowly, then the reaction mixture was stirred overnight at 100 °C. After cooled down, the resulting suspension was quenched with saturated NH<sub>4</sub>Cl, diluted with EtOAc, washed with water and brine. The solvents were removed and the resulting mixture was purified by silica gel-packed flash chromatography.

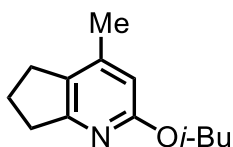


### 2-Isobutoxy-6,7-dihydro-5H-cyclopenta[b]pyridine (**L14**)

<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 7.38 (d, *J* = 8.2 Hz, 1H), 6.48 (d, *J* = 8.3 Hz, 1H), 4.01 (d, *J* = 6.7 Hz, 2H), 2.91 (t, *J* = 7.7 Hz, 2H), 2.83 (t, *J* = 7.4 Hz, 2H), 2.13-2.05 (m, 3H), 1.01 (d, *J* = 6.7 Hz, 6H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 163.87, 162.61, 134.71, 128.61, 107.43, 72.34, 34.27, 29.88, 28.17, 23.36, 19.37; HRMS (ESI-TOF) Calcd for C<sub>12</sub>H<sub>18</sub>NO [M+H]<sup>+</sup>: 192.1383; found: 192.1385.



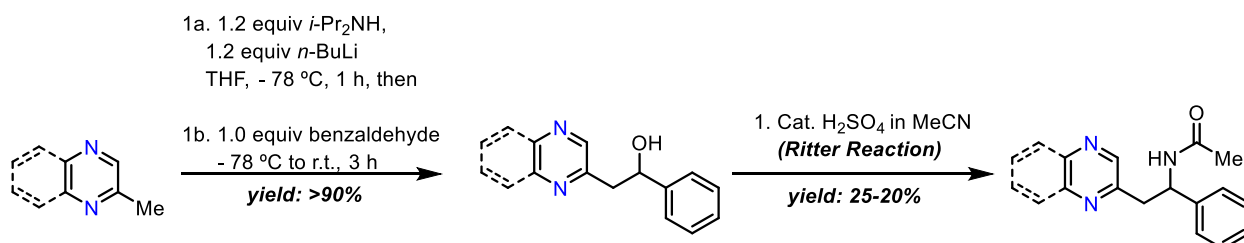
Preparation of **L15-1** was described in the reference.<sup>[2]</sup> To a solution of isobutanol (1.5 equiv.) in DMF was added NaH (1.5 equiv.) slowly, and the reaction mixture was stirred for 1 hour at room temperature. A solution of compound 3 (1 equiv.) was added the above mixture slowly, then reaction mixture was stirred overnight in 100 °C. After cooled down, the resulting suspension was quenched with saturated NH<sub>4</sub>Cl, diluted with EtOAc, washed with water and brine. The solvents were removed and the resulting mixture was purified by a silica gel-packed flash chromatography.



### 2-Isobutoxy-4-methyl-6,7-dihydro-5H-cyclopenta[*b*]pyridine (L15)

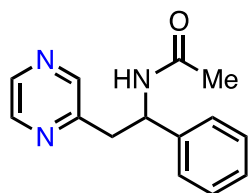
Yellow oil. <sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 6.33 (s, 1H), 3.99 (d, *J* = 6.6 Hz, 2H), 2.91 (t, *J* = 7.7 Hz, 2H), 2.76 (t, *J* = 7.4 Hz, 2H), 2.19 (s, 3H), 2.12-2.03 (m, 3H), 1.01 (d, *J* = 6.7 Hz, 6H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 164.24, 161.82, 145.73, 128.53, 107.61, 72.30, 34.29, 28.42, 28.20, 22.60, 19.36, 19.00; HRMS (ESI-TOF) Calcd for C<sub>13</sub>H<sub>20</sub>NO [M+H]<sup>+</sup>: 206.1539; found: 206.1537.

### Synthesis of L19 and L20.



To a flame dried 25 mL round bottom flask was added 1.2 equivalents of freshly distilled diisopropylamine (506 mg, 700  $\mu$ L, 5 mmol) and 8 mL of dry tetrahydrofuran (THF) under a  $N_2$  atmosphere. After cooling to  $-78\text{ }^\circ\text{C}$  for 30 min, 1.2 equivalents of *n*-BuLi (2.5 M in hexanes, 2 mL, 5 mmol) was added dropwise. The solution was then allowed to stir for 30 min at which point 1.0 equivalents of 2-methyl pyrazine or 2-methyl quinoxaline (4.16 mmol) were added dropwise over 5 min. The solution was then allowed to warm to room temperature for 1 h. The solution was then cooled to  $-78\text{ }^\circ\text{C}$  for 15 min and 1.0 equivalents of benzaldehyde (441 mg, 424  $\mu$ L, 4.16 mmol) was added dropwise over 5 min. The solution was then stirred at  $-78\text{ }^\circ\text{C}$  and after 3 h the solution was then warmed to room temperature, diluted with ethyl acetate and quenched with saturated ammonium chloride aqueous solution. The product was extracted three times with ethyl acetate and the organic layer was washed with brine, then dried over sodium sulfate and the crude benzyl alcohol products were immediately subjected to the *Ritter Reaction*:

To a flame dried 5 mL round bottom flask was added 1 mmol of the corresponding benzyl alcohol, 2 mL of distilled acetonitrile and 150  $\mu$ L of concentrated sulfuric acid ( $H_2SO_4$ ) at  $0\text{ }^\circ\text{C}$ . The solution was gently warmed to  $45\text{ }^\circ\text{C}$  and stirred overnight. The solution was then cooled to room temperature, washed with saturated sodium bicarbonate aqueous solution, extracted three times with ethyl acetate, dried over sodium sulfate. Crude material was purified by preparative thin layer chromatography (pTLC) in an eluent of 7:3 toluene:acetone ( $R_f = 0.3$ ). Note that the corresponding olefins (from dehydration) are the major products.

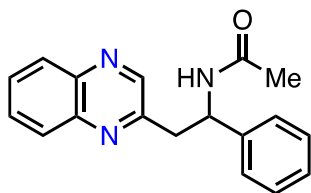


**L19**

### ***N*-(1-Phenyl-2-(pyrazin-2-yl)ethyl)acetamide (L19)**

A white amorphous solid. Yield over two steps: 20%.  $^1\text{H}$  NMR (600 MHz,  $CDCl_3$ )  $\delta$  8.54-8.46 (m, 1H), 8.42 (d,  $J = 2.5$  Hz, 1H), 8.26 (d,  $J = 1.1$  Hz, 1H), 7.27 (t,  $J = 7.4$  Hz, 2H), 7.20 (dd,  $J = 19.7, 7.2$  Hz, 3H), 6.79 (d,  $J = 6.9$  Hz, 1H), 5.45 (td,  $J = 7.4, 5.6$  Hz, 1H), 3.30 (qd,  $J = 14.1, 6.4$

Hz, 2H), 1.99 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.25, 153.85, 145.42, 143.65, 142.90, 140.80, 128.65, 127.52, 126.20, 53.03, 40.91, 23.39; found: 242.1295.



**L20**

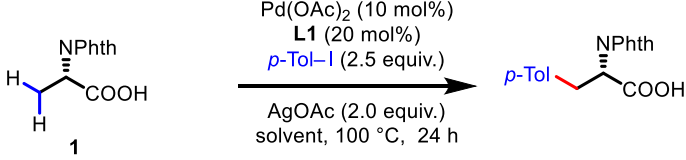
***N*-(1-Phenyl-2-(quinoxalin-2-yl)ethyl)acetamide (L20)**

A light pink flocculent solid. Yield over two steps: 22%.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  8.52 (s, 1H), 8.07-8.04 (m, 2H), 7.79-7.73 (m, 2H), 7.31-7.20 (m, 5H), 6.89 (d,  $J = 7.7$  Hz, 1H), 5.57 (td,  $J = 7.3, 5.6$  Hz, 1H), 3.60-3.44 (m, 2H), 1.99 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.28, 153.56, 146.00, 141.71, 141.40, 140.87, 130.23, 129.52, 129.38, 128.79, 128.71, 127.60, 126.27, 52.93, 41.72, 23.40; HRMS (ESI-TOF) Calcd for  $\text{C}_{18}\text{H}_{18}\text{N}_3\text{O}$   $[\text{M}+\text{H}]^+$ : 292.1444; found: 292.1452.



## 2.2 Optimization of Reaction Conditions for Arylation of Alanine substrate.

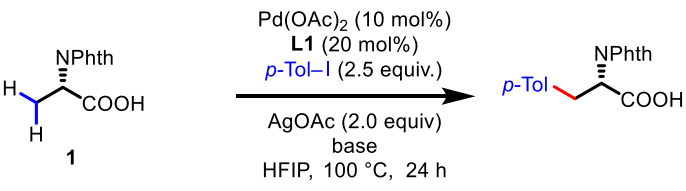
Table S1. Evaluation of Solvents<sup>a</sup>



Entry	Solvent	% Yield of <b>2a</b> <sup>b</sup>
1	<i>t</i> -AmylOH	N.R.
2	Hexane	N.R.
3	C <sub>6</sub> F <sub>6</sub>	N.R.
4	Toluene	N.R.
5	CH <sub>3</sub> CN	N.R.
6	1,4-Dioxane	N.R.
7	DCE	30%
8	DMF	N.R.
9	CF <sub>3</sub> CH <sub>2</sub> OH	17%
10	HFIP	45%

<sup>a</sup> Conditions: Substrate **1** (0.1 mmol), Pd(OAc)<sub>2</sub> (10 mol%), AgOAc (0.2 mmol), Ar-I (0.25 mmol), Ligand **L1** (20 mol%), solvent (1.0 mL), 100 °C, 24 h. <sup>b</sup> Determined by <sup>1</sup>HNMR analysis of the crude product using CH<sub>2</sub>Br<sub>2</sub> as an internal standard.

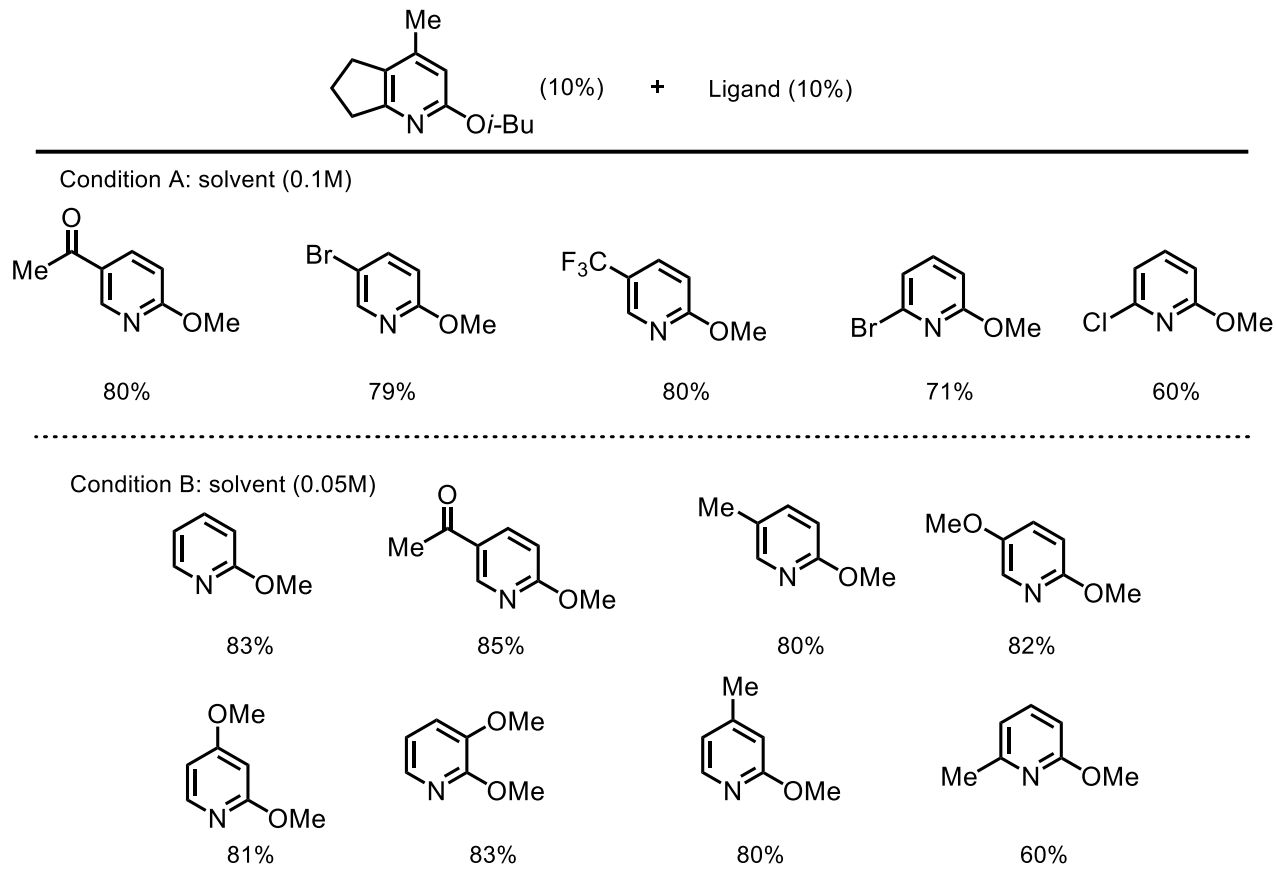
**Table S2. Evaluation of Additives<sup>a</sup>**



Entry	Base	% Yield of <b>2a</b> <sup>b</sup>
1	no base	45%
2	K <sub>2</sub> HPO <sub>4</sub> (1.0 equiv.)	52%
3	K <sub>2</sub> CO <sub>3</sub> (1.0 equiv.)	trace
4	Na <sub>2</sub> HPO <sub>4</sub> (1.0 equiv.)	56%
5	Na <sub>2</sub> HPO <sub>4</sub> ·7H <sub>2</sub> O (1.0 equiv.)	58%
6	NaH <sub>2</sub> PO <sub>4</sub> ·H <sub>2</sub> O (1.0 equiv.)	45%
7	NaOAc (1.0 equiv.)	25%
8	HCO <sub>2</sub> Na (1.0 equiv.)	20%
9	Li <sub>2</sub> CO <sub>3</sub> (1.0 equiv.)	40%
10	LiH <sub>2</sub> PO <sub>4</sub> (1.0 equiv.)	50%
11	Na <sub>2</sub> HPO <sub>4</sub> ·7H <sub>2</sub> O (0.5 equiv.)	23%
12	Na <sub>2</sub> HPO <sub>4</sub> ·7H <sub>2</sub> O (1.5 equiv.)	62%
13	Na <sub>2</sub> HPO <sub>4</sub> ·7H <sub>2</sub> O (2.0 equiv.)	62%

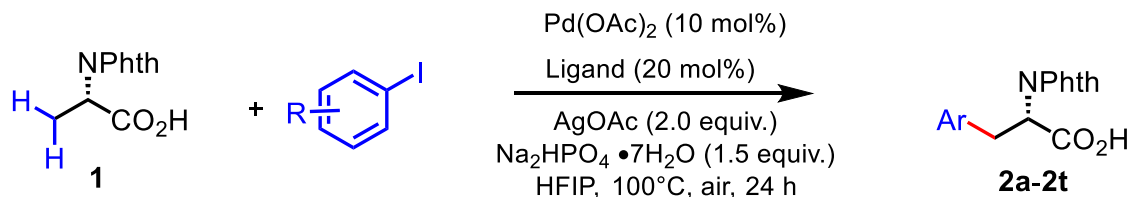
<sup>a</sup> Conditions: Substrate **1** (0.1 mmol), Pd(OAc)<sub>2</sub> (10 mol%), AgOAc (0.2 mmol), *p*-Tol-I (0.25 mmol), base, Ligand **L1** (20 mol%), HFIP (1.0 mL), 100 °C, 24 h. <sup>b</sup> Determined by <sup>1</sup>HNMR analysis of the crude product using CH<sub>2</sub>Br<sub>2</sub> as an internal standard.

**Table S3. Evaluation of mixed ligands<sup>a,b</sup>**

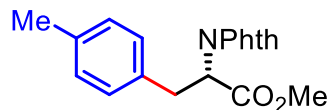


<sup>a</sup> Conditions: Substrate **1** (0.1 mmol), Pd(OAc)<sub>2</sub> (10 mol%), AgOAc (0.2 mmol), *p*-Tol-I (0.25 mmol), base, Ligand **L15** (10 mol%), another ligand (10 mol%), HFIP (1.0 mL), 100 °C, 24 h. <sup>b</sup> Determined by <sup>1</sup>HNMR analysis of the crude product using CH<sub>2</sub>Br<sub>2</sub> as an internal standard.

### 2.3 General Procedure for Arylation of Alanine Substrate (Table 2):

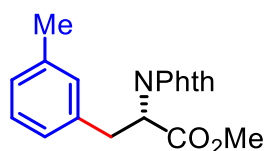


**General procedure for arylation with aryl iodides:** The starting material **1** (0.1 mmol, 22 mg), Pd(OAc)<sub>2</sub> (10 mol%, 2.2 mg), and AgOAc (0.2 mmol, 33.4 mg) were weighed in air and placed in a sealed tube (10 mL) with a magnetic stir bar. To the reaction mixture, aryl iodide (0.25 mmol), Na<sub>2</sub>HPO<sub>4</sub> • 7H<sub>2</sub>O (1.5 equiv., 39.6 mg), Ligand (20 mol%), HFIP (2.0 mL) were added. The reaction mixture was first stirred at room temperature for 10 min and then heated to 100 °C for 24 hours under vigorous stirring. Upon completion, the reaction mixture was cooled to room temperature, added AcOH (0.05 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the resulting mixture was added with DCM (3 mL), cat. DMF, and (COCl)<sub>2</sub> (2 equiv.). After 2 hours, MeOH (0.5 mL) was added the reaction mixture and stirred for another 1 hour. The solvents were removed under reduced pressure and the resulting mixture was purified by preparative TLC. **2a'-2t'** were obtained as corresponding methyl esters of **2a-2t**.



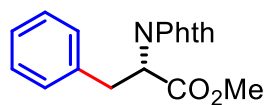
**Methyl (S)-2-(1,3-dioxisoindolin-2-yl)-3-(*p*-tolyl)propanoate (2a')**

Oil, 26.8 mg, 83% yield.  $^1\text{H NMR}$  (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.80-7.77 (m, 2H), 7.70-7.67 (m, 2H), 7.05-7.03 (m, 2H), 6.99-6.98 (m, 2H), 5.13 (dd,  $J_1 = 5.2$  Hz,  $J_2 = 11.3$  Hz, 1H), 3.77 (s, 3H), 3.57-3.48 (m, 2H), 2.22 (s, 3H);  $^{13}\text{C NMR}$  (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.40, 167.46, 136.32, 134.04, 133.54, 131.63, 129.24, 128.65, 123.46, 53.36, 52.85, 34.19, 21.00; HRMS (ESI-TOF) Calcd for  $\text{C}_{19}\text{H}_{18}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 324.1230; found: 324.1232.



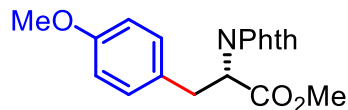
**Methyl (S)-2-(1,3-dioxisoindolin-2-yl)-3-(*m*-tolyl)propanoate (2b')**

Oil, 25.2 mg, 78% yield.  $^1\text{H NMR}$  (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.79-7.77 (m, 2H), 7.70-7.68 (m, 2H), 7.06 (t,  $J = 7.5$  Hz, 1H), 6.9 6.93 (m, 3H), 5.14 (dd,  $J_1 = 5.1$  Hz,  $J_2 = 11.4$  Hz, 1H), 3.78 (s, 3H), 3.58 - 3.47 (m, 2H), 2.20 (s, 3H);  $^{13}\text{C NMR}$  (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.39, 167.44, 138.10, 136.60, 134.04, 131.62, 129.63, 128.38, 127.55, 125.76, 123.43, 53.30, 52.86, 34.54, 21.22; HRMS (ESI-TOF) Calcd for  $\text{C}_{19}\text{H}_{18}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 324.1230; found: 324.1231.



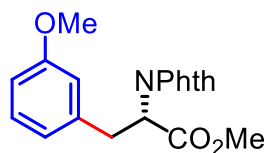
**Methyl (S)-2-(1,3-dioxisoindolin-2-yl)-3-phenylpropanoate (2c')**

Oil, 26.3 mg, 85% yield.  $^1\text{H NMR}$  (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.79-7.76 (m, 2H), 7.70-7.68 (m, 2H), 7.20-7.12 (m, 5H), 5.16 (dd,  $J_1 = 5.1$  Hz,  $J_2 = 11.4$  Hz, 1H), 3.78 (s, 3H), 3.62-3.52 (m, 2H);  $^{13}\text{C NMR}$  (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.33, 167.41, 136.67, 134.06, 131.56, 128.81, 128.53, 126.82, 123.45, 53.24, 52.88, 34.64; HRMS (ESI-TOF) Calcd for  $\text{C}_{18}\text{H}_{16}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 310.1074; found: 310.1077.



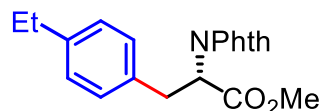
**Methyl (S)-2-(1,3-dioxoisindolin-2-yl)-3-(4-methoxyphenyl)propanoate (2d')**

Oil, 27.1 mg, 80% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.79-7.78 (m, 2H), 7.70-7.68 (m, 2H), 7.07-7.06 (m, 2H), 6.72-6.71 (m, 2H), 5.11 (dd,  $J_1 = 5.3$  Hz,  $J_2 = 11.3$  Hz, 1H), 3.78 (s, 3H), 3.70 (s, 3H), 3.55-3.46 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.38, 167.44, 158.35, 134.05, 131.59, 129.82, 128.61, 123.45, 113.94, 55.10, 53.40, 52.83, 33.76; HRMS (ESI-TOF) Calcd for  $\text{C}_{19}\text{H}_{18}\text{NO}_5$   $[\text{M}+\text{H}]^+$ : 340.1179; found: 340.1182.



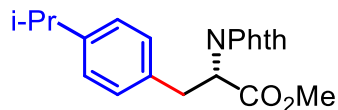
**Methyl (S)-2-(1,3-dioxoisindolin-2-yl)-3-(3-methoxyphenyl)propanoate (2e')**

Oil, 17.6 mg, 52% yield..  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.79-7.79 (m, 2H), 7.70-7.68 (m, 2H), 7.09 (t,  $J = 7.9$  Hz, 1H), 6.76-6.74 (m, 1H), 6.70-6.66(m, 2H), 5.17 (dd,  $J_1 = 5.1$  Hz,  $J_2 = 11.4$  Hz, 1H), 3.78 (s, 3H), 3.67 (s, 3H), 3.60-3.50 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.31, 167.41, 159.59, 138.21, 134.07, 131.60, 129.52, 123.45, 121.12, 114.07, 112.68, 55.04, 53.12, 52.89, 34.62; HRMS (ESI-TOF) Calcd for  $\text{C}_{19}\text{H}_{18}\text{NO}_5$   $[\text{M}+\text{H}]^+$ : 340.1179; found: 340.1178.



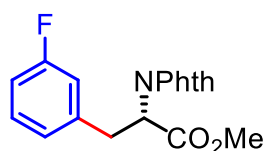
**Methyl (S)-2-(1,3-dioxoisindolin-2-yl)-3-(4-ethylphenyl)propanoate (2f')**

Oil, 25.3 mg, 75% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.79-7.78 (m, 2H), 7.70-7.68 (m, 2H), 7.08-7.06 (m, 2H), 7.02-7.99 (m, 2H), 5.14 (dd,  $J_1 = 5.2$  Hz,  $J_2 = 11.3$  Hz, 1H), 3.78 (s, 3H), 3.58-3.49 (m, 2H), 2.52 (q,  $J = 7.6$  Hz, 2H), 1.13 (t,  $J = 7.6$  Hz, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.43, 167.47, 142.69, 134.03, 133.78, 131.64, 128.72, 128.01, 123.44, 53.34, 52.85, 34.21, 28.35, 15.38; HRMS (ESI-TOF) Calcd for  $\text{C}_{20}\text{H}_{20}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 338.1387; found: 338.1388.



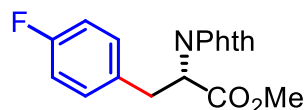
**Methyl (S)-2-(1,3-dioxisoindolin-2-yl)-3-(4-isopropylphenyl)propanoate (2g')**

Oil, 23.5 mg, 67% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.80-7.77 (m, 2H), 7.70-7.68 (m, 2H), 7.09-7.07 (m, 2H), 7.05-7.03 (m, 2H), 5.15 (dd,  $J_1 = 5.2$  Hz,  $J_2 = 11.3$  Hz, 1H), 3.77 (s, 3H), 3.58-3.49 (m, 2H), 2.80-2.76 (m, 1H), 1.15-1.13 (m, 6H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.45, 167.48, 147.30, 134.02, 133.91, 131.66, 128.70, 126.55, 123.41, 53.30, 52.85, 34.20, 33.58, 23.84; HRMS (ESI-TOF) Calcd for  $\text{C}_{21}\text{H}_{22}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 352.1543; found: 352.1547.



**Methyl (S)-2-(1,3-dioxisoindolin-2-yl)-3-(3-fluorophenyl)propanoate (2h')**

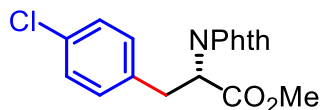
Oil, 20.3 mg, 62% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.81-7.78 (m, 2H), 7.72-7.70 (m, 2H), 7.17-7.14 (m, 1H), 6.96-6.94 (m, 1H), 6.88 (dt,  $J_1 = 2.1$  Hz,  $J_2 = 9.8$  Hz, 1H), 6.85-6.82 (m, 1H), 5.14 (dd,  $J_1 = 5.2$  Hz,  $J_2 = 11.3$  Hz, 1H), 3.78 (s, 3H), 3.62-3.51 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.07, 167.40, 162.74 (d,  $J_{\text{FC}} = 244.5$  Hz), 139.23 (d,  $J_{\text{FC}} = 7.5$  Hz), 134.20, 131.50, 130.05 (d,  $J_{\text{FC}} = 8.1$  Hz), 124.46 (d,  $J_{\text{FC}} = 2.6$  Hz), 123.56, 115.84 (d,  $J_{\text{FC}} = 21.0$  Hz), 113.87 (d,  $J_{\text{FC}} = 20.7$  Hz), 52.96, 34.41;  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -113.23 (s, 1F); HRMS (ESI-TOF) Calcd for  $\text{C}_{18}\text{H}_{15}\text{FNO}_4$   $[\text{M}+\text{H}]^+$ : 328.0980; found: 328.0983.



**Methyl (S)-2-(1,3-dioxisoindolin-2-yl)-3-(4-fluorophenyl)propanoate (2i')**

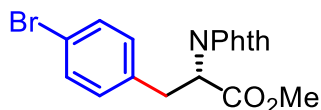
Oil, 22.2 mg, 83% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.80-7.78 (m, 2H), 7.72-7.70 (m, 2H), 7.13-7.11 (m, 2H), 6.88-6.86 (m, 2H), 5.11 (dd,  $J_1 = 5.3$  Hz,  $J_2 = 11.4$  Hz, 1H), 3.78 (s, 3H), 3.58-3.49 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.15, 167.39, 161.72 (d,  $J_{\text{FC}} = 243.0$  Hz), 134.17, 132.33 (d,  $J_{\text{FC}} = 3.3$  Hz), 131.47, 130.33 (d,  $J_{\text{FC}} = 8.0$  Hz), 123.51, 115.43 (d,  $J_{\text{FC}} = 21.2$  Hz), 53.17,

52.91, 33.87;  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -116.08 (s, 1F); HRMS (ESI-TOF) Calcd for  $\text{C}_{18}\text{H}_{15}\text{FNO}_4$   $[\text{M}+\text{H}]^+$ : 328.0980; found: 328.0984.



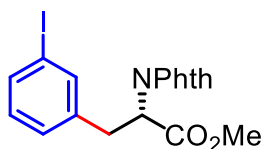
**Methyl (*S*)-3-(4-chlorophenyl)-2-(1,3-dioxisoindolin-2-yl)propanoate (2j')**

Oil, 22.3 mg, 65% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.81-7.78 (m, 2H), 7.72-7.69 (m, 2H), 7.17-7.15 (m, 2H), 7.11-7.09 (m, 2H), 5.12 (dd,  $J_1 = 5.5$  Hz,  $J_2 = 11.1$  Hz, 1H), 3.78 (s, 3H), 3.58-3.50 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.09, 167.41, 135.16, 134.22, 132.71, 131.47, 130.18, 128.73, 123.57, 52.96, 34.03; HRMS (ESI-TOF) Calcd for  $\text{C}_{18}\text{H}_{15}\text{ClNO}_4$   $[\text{M}+\text{H}]^+$ : 344.0684; found: 344.0684.



**Methyl (*S*)-3-(4-bromophenyl)-2-(1,3-dioxisoindolin-2-yl)propanoate (2k')**

Oil, 20.5 mg, 53% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.80-7.78 (m, 2H), 7.72-7.70 (m, 2H), 7.31 (d,  $J = 8.4$  Hz, 2H), 7.04 (d,  $J = 8.3$  Hz, 2H), 5.12 (dd,  $J_1 = 5.6$  Hz,  $J_2 = 11.0$  Hz, 1H), 3.78 (s, 3H), 3.57-3.49 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.06, 167.40, 135.68, 134.21, 131.67, 131.46, 130.54, 123.57, 120.82, 52.96, 52.87, 34.09; HRMS (ESI-TOF) Calcd for  $\text{C}_{18}\text{H}_{15}\text{BrNO}_4$   $[\text{M}+\text{H}]^+$ : 388.0179; found: 388.0179.

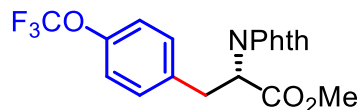


**Methyl (*S*)-2-(1,3-dioxisoindolin-2-yl)-3-(3-iodophenyl)propanoate (2l')**

Oil, 21.3 mg, 49% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.83-7.79 (m, 2H), 7.72-7.70 (m, 2H), 7.51 (t,  $J = 1.8$  Hz, 1H), 7.48-7.46 (m, 1H), 7.15-7.13 (m, 1H), 6.93 (t,  $J = 7.8$  Hz, 1H), 5.10 (dd,  $J_1 = 5.3$  Hz,  $J_2 = 11.1$  Hz, 1H), 3.78 (s, 3H), 3.56-3.44 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$

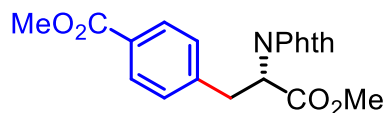


169.00, 167.39, 139.11, 137.94, 135.99, 134.21, 131.49, 130.24, 128.03, 123.58, 94.37, 52.97, 52.92, 34.24; HRMS (ESI-TOF) Calcd for C<sub>18</sub>H<sub>15</sub>INO<sub>4</sub> [M+H]<sup>+</sup>: 436.0040; found: 436.0039.



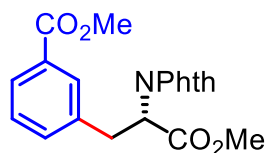
**Methyl (S)-2-(1,3-dioxisoindolin-2-yl)-3-(4-(trifluoromethoxy)phenyl)propanoate (2m')**

Oil, 17.7 mg, 45% yield. <sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 7.81-7.78 (m, 2H), 7.72-7.69 (m, 2H), 7.20-7.18 (m, 2H), 7.04-7.03 (m, 2H), 5.14 (dd, *J*<sub>1</sub> = 5.3 Hz, *J*<sub>2</sub> = 11.1 Hz, 1H), 3.78 (s, 3H), 3.62-3.53 (m, 2H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 169.07, 167.41, 148.08, 135.41, 134.23, 131.45, 130.21, 123.54, 121.02, 120.34 (q, *J*<sub>FC</sub> = 255.0 Hz), 52.97, 52.94, 34.01; <sup>19</sup>F NMR (376 MHz, CDCl<sub>3</sub>) δ -58.19 (s, 3F); HRMS (ESI-TOF) Calcd for C<sub>19</sub>H<sub>15</sub>F<sub>3</sub>NO<sub>5</sub> [M+H]<sup>+</sup>: 394.0897; found: 394.0896.



**Methyl (S)-4-(2-(1,3-dioxisoindolin-2-yl)-3-methoxy-3-oxopropyl)benzoate (2n')**

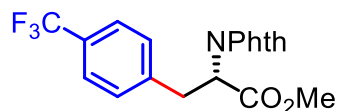
Oil, 23.1 mg, 63% yield. <sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 7.87-7.85 (m, 2H), 7.79-7.76 (dd, *J* = 5.4, 3.1 Hz, 2H), 7.71-7.68 (dd, m, 2H), 7.25-7.23 (m, 2H), 5.18 (dd, *J*<sub>1</sub> = 5.5 Hz, *J*<sub>2</sub> = 11.0 Hz, 1H), 3.85 (s, 3H), 3.79 (s, 3H), 3.67-3.59 (m, 2H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 169.01, 167.33, 166.80, 142.09, 134.21, 131.41, 129.86, 128.90, 128.82, 123.55, 52.99, 52.78, 51.99, 34.65; HRMS (ESI-TOF) Calcd for C<sub>20</sub>H<sub>18</sub>NO<sub>6</sub> [M+H]<sup>+</sup>: 368.1129; found: 368.1130.



**Methyl (S)-3-(2-(1,3-dioxisoindolin-2-yl)-3-methoxy-3-oxopropyl)benzoate (2o')**

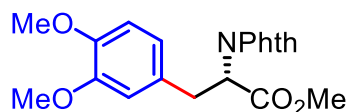
Oil, 19.8 mg, 54% yield. <sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 7.86-7.84 (m, 1H), 7.83 (dt, *J*<sub>1</sub> = 1.5 Hz, *J*<sub>2</sub> = 7.7 Hz, 1H), 7.80-7.77 (m, 2H), 7.71-7.68 (m, 2H), 7.37-7.35 (m, 1H), 7.27 (t, *J* = 6.0 Hz,

1H), 5.16 (dd,  $J_1 = 5.1$  Hz,  $J_2 = 11.5$  Hz, 1H), 3.83 (s, 3H), 3.79 (s, 3H), 3.67-3.56 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.07, 167.36, 166.73, 137.13, 134.15, 133.34, 131.50, 130.46, 130.04, 128.64, 128.21, 123.54, 53.06, 52.96, 52.04, 34.48; HRMS (ESI-TOF) Calcd for  $\text{C}_{20}\text{H}_{18}\text{NO}_6$   $[\text{M}+\text{H}]^+$ : 368.1129; found: 368.1129.



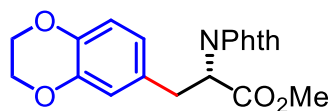
**Methyl (S)-2-(1,3-dioxoisindolin-2-yl)-3-(4-(trifluoromethyl)phenyl)propanoate (2p')**

Oil, 18.5 mg, 49% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.81-7.79 (m, 2H), 7.73-7.71 (m, 2H), 7.46 (d,  $J = 8.0$  Hz, 2H), 7.30 (d,  $J = 8.0$  Hz, 2H), 5.18 (dd,  $J_1 = 5.5$  Hz,  $J_2 = 11.0$  Hz, 1H), 3.79 (s, 3H), 3.67-3.60 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  168.97, 167.40, 140.85, 134.28, 131.43, 129.24 (q,  $J_{\text{FC}} = 31.5$  Hz), 129.18, 126.73, 125.51 (q,  $J_{\text{FC}} = 3.0$  Hz), 124.02 (q,  $J_{\text{FC}} = 270.0$  Hz), 123.60, 53.03, 52.72, 34.49;  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -62.80 (s, 3F); HRMS (ESI-TOF) Calcd for  $\text{C}_{19}\text{H}_{15}\text{F}_3\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 378.0948; found: 378.0947.



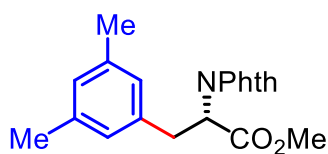
**Methyl (S)-3-(3,4-dimethoxyphenyl)-2-(1,3-dioxoisindolin-2-yl)propanoate (2q')**

Oil, 24.0 mg, 65% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.80-7.77 (m, 2H), 7.71-7.68 (m, 2H), 6.72-6.67 (m, 2H), 6.64 (d,  $J = 1.9$  Hz, 1H), 5.15 (dd,  $J_1 = 5.4$  Hz,  $J_2 = 11.4$  Hz, 1H), 3.79 (s, 3H), 3.77 (s, 3H), 3.69 (s, 3H), 3.56-3.47 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.33, 167.41, 148.68, 147.70, 134.10, 131.55, 129.00, 123.41, 120.95, 111.70, 111.14, 55.69, 55.62, 53.19, 52.84, 34.10; HRMS (ESI-TOF) Calcd for  $\text{C}_{20}\text{H}_{20}\text{NO}_6$   $[\text{M}+\text{H}]^+$ : 370.1285; found: 370.1289.



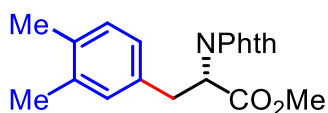
**Methyl (S)-3-(2,3-dihydrobenzo[b][1,4]dioxin-6-yl)-2-(1,3-dioxoisindolin-2-yl)propanoate (2r')**

Oil, 25.0 mg, 68% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.82-7.78 (m, 2H), 7.71-7.68 (m, 2H), 6.68 (d,  $J = 2.1$  Hz, 1H), 6.66 (d,  $J = 8.2$  Hz, 1H), 6.60 (dd,  $J_1 = 2.1$  Hz,  $J_2 = 8.3$  Hz, 1H), 5.09 (dd,  $J_1 = 5.1$  Hz,  $J_2 = 11.3$  Hz, 1H), 4.18-4.13 (m, 4H), 3.77 (s, 3H), 3.50-3.41 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.34, 167.46, 143.36, 142.32, 134.04, 131.64, 129.87, 123.48, 121.68, 117.59, 117.20, 64.17, 53.37, 52.84, 33.89; HRMS (ESI-TOF) Calcd for  $\text{C}_{20}\text{H}_{18}\text{NO}_6$   $[\text{M}+\text{H}]^+$ : 368.1129; found: 368.1128.



**Methyl (*S*)-3-(3,5-dimethylphenyl)-2-(1,3-dioxisoindolin-2-yl)propanoate (2s')**

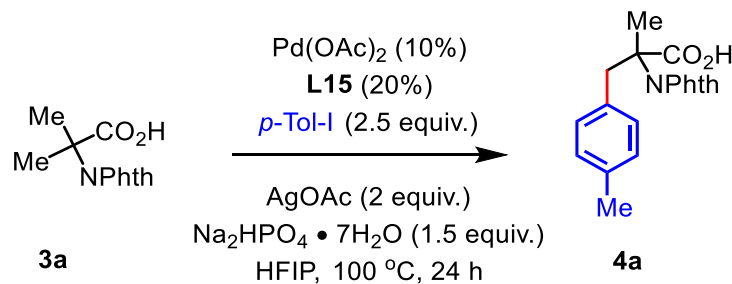
Oil, 28.3 mg, 84% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.80-7.78 (m, 2H), 7.70-7.68 (m, 2H), 6.76-6.75 (m, 3H), 5.13 (dd,  $J_1 = 5.1$  Hz,  $J_2 = 11.3$  Hz, 1H), 3.77 (s, 3H), 3.43-3.43 (m, 2H), 2.15 (s, , 6H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.45, 167.46, 137.92, 136.54, 134.01, 131.66, 128.41, 126.60, 123.39, 53.33, 52.83, 34.43, 21.09; HRMS (ESI-TOF) Calcd for  $\text{C}_{20}\text{H}_{20}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 338.1387; found: 338.1389.



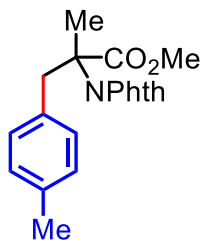
**Methyl (*S*)-3-(3,4-dimethylphenyl)-2-(1,3-dioxisoindolin-2-yl)propanoate (2t')**

Oil, 23.9 mg, 71% yield.  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.80-7.77 (m, 2H), 7.70-7.67 (m, 2H), 6.93-6.92 (m, 2H), 6.87 (dd,  $J_1 = 1.7$  Hz,  $J_2 = 7.6$  Hz, 1H), 5.13 (dd,  $J_1 = 5.2$  Hz,  $J_2 = 11.3$  Hz, 1H), 3.77 (s, 3H), 3.55-3.45 (m, 2H), 2.13 (s, 3H), 2.11 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  169.47, 167.49, 136.62, 134.91, 134.00, 133.98, 131.66, 130.09, 129.72, 126.03, 123.42, 53.39, 52.82, 34.13, 19.56, 19.28; HRMS (ESI-TOF) Calcd for  $\text{C}_{20}\text{H}_{20}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 338.1387; found: 338.1389.

## 2.4 Procedure for Arylation of other Amino Acids and acids. (Table 3)

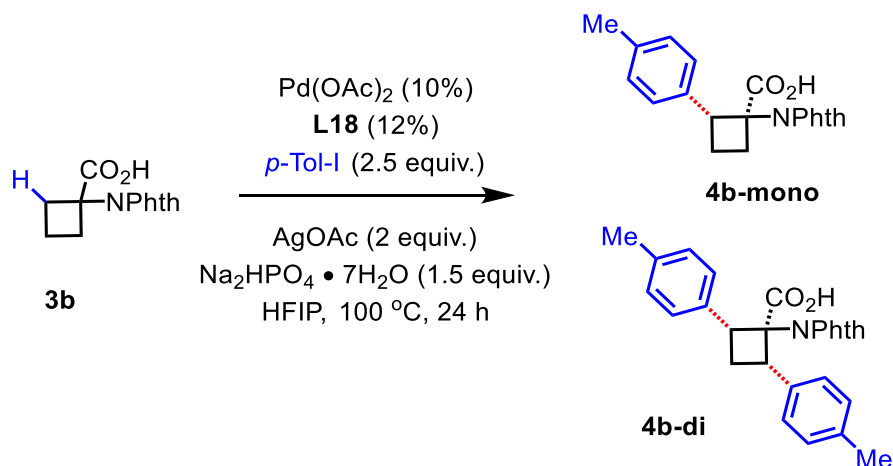


The substrate **3a** (0.1 mmol, 23.3 mg), Pd(OAc)<sub>2</sub> (10 mol%, 2.2 mg), and AgOAc (0.2 mmol, 33.4 mg) were weighed in air and placed in a sealed tube (10 mL) with a magnetic stir bar. To the reaction mixture, aryl iodide (0.25 mmol), Na<sub>2</sub>HPO<sub>4</sub> · 7H<sub>2</sub>O (1.5 equiv., 39.6 mg), L15 (20 mol%), HFIP (1.0 mL) were added. The reaction mixture was first stirred at room temperature for 10 min and then heated to 100 °C for 24 hours under vigorous stirring. Upon completion, the reaction mixture was cooled to room temperature, added AcOH (0.05 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the resulting mixture was treated with Cs<sub>2</sub>CO<sub>3</sub> (0.2 mmol) and MeI (0.2 mmol) in DMF (1 mL). The reaction mixture was stirred at room temperature for 3 hours. After completion, water (5 mL) and EtOAc (5 mL) were added to the reaction mixture, and the organic phase was separated and dried by Na<sub>2</sub>SO<sub>4</sub>. The solvents were removed under reduced pressure and the resulting mixture was purified by a preparative TLC using toluene/EtOAc (20/1) as the eluent. **4a'** was obtained as an oil (15.2 mg, 45%).

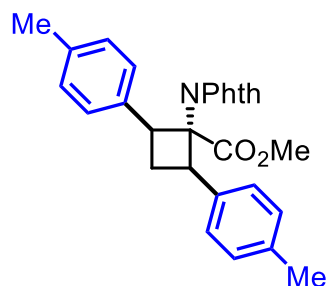


**Methyl 2-(1,3-dioxoisindolin-2-yl)-2-methyl-3-(*p*-tolyl)propanoate (4a')**

$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.77 (dd,  $J = 5.4, 3.1$  Hz, 2H), 7.71 (dd,  $J = 5.5, 3.0$  Hz, 2H), 6.97 (d,  $J = 7.8$  Hz, 2H), 6.92 (d,  $J = 8.0$  Hz, 2H), 3.76-3.73 (s, 4H), 3.22 (d,  $J = 13.9$  Hz, 1H), 2.25 (s, 3H), 1.87 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  172.89, 168.36, 136.53, 134.02, 132.40, 131.54, 130.28, 128.89, 123.15, 64.10, 52.59, 40.80, 21.72, 21.03; HRMS (ESI-TOF) Calcd for  $\text{C}_{20}\text{H}_{20}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 338.1387; found: 338.1387.

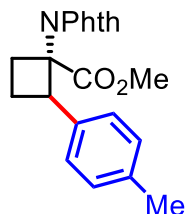


The substrate **3b** (0.1 mmol, 24.5 mg),  $\text{Pd}(\text{OAc})_2$  (10 mol%, 2.2 mg), ligand **L18** (0.012 mmol, 4.8 mg),  $\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$  (0.15 mmol, 39.6 mg) and  $\text{AgOAc}$  (0.20 mmol, 33.4 mg) were weighed in air and placed in a sealed tube (10 mL) with a magnetic stir bar. To the reaction mixture, aryl iodide (0.25 mmol) and HFIP (1.0 mL) were added. The reaction mixture was first stirred at room temperature for 10 min and then heated to 100 °C for 26 hours under vigorous stirring. Upon completion, the reaction mixture was cooled to room temperature, then added 0.05 mL AcOH, filtered with celite using  $\text{CH}_2\text{Cl}_2$ . The solvents were removed under reduced pressure and the resulting mixture was treated with  $\text{Cs}_2\text{CO}_3$  (0.2 mmol), MeI (0.2 mmol) and DMF (1 mL). The reaction mixture was stirred at room temperature for 3 hours. After completion, water (5 mL) and EtOAc (5 mL) were added to the reaction mixture, and the organic phase was separated and dried by  $\text{Na}_2\text{SO}_4$ . The solvents were removed under reduced pressure and the resulting mixture was purified by a preparative TLC using hexanes/DCM (2/3) as the eluent (twice). **4b'-di** was obtained as an oil (7.0 mg, 16%), **4b'-mono** was obtained as an oil (14.0 mg, 40%).



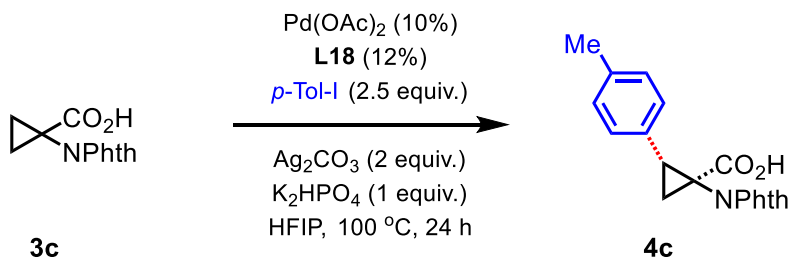
**Methyl 1-(1,3-dioxisoindolin-2-yl)-2,4-di-*p*-tolylcyclobutane-1-carboxylate (4b'-di)**

$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.88 (dd,  $J = 5.4, 3.0$  Hz, 2H), 7.75 (dd,  $J = 5.5, 3.0$  Hz, 2H), 7.32 (d,  $J = 8.1$  Hz, 4H), 7.12 (d,  $J = 7.9$  Hz, 4H), 4.77- 4.69 (m, 2H), 3.17-3.12 (m, 4H), 2.59 (dt,  $J = 10.3, 9.0$  Hz, 1H), 2.32 (s, 6H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  168.23, 167.50, 136.37, 135.26, 134.17, 131.80, 128.67, 128.35, 123.40, 72.06, 51.47, 44.70, 26.33, 21.06; HRMS (ESI-TOF) Calcd for  $\text{C}_{28}\text{H}_{26}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 440.1856; found: 440.1856.



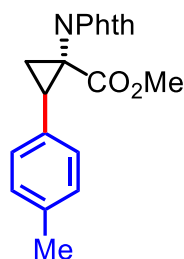
**Methyl 1-(1,3-dioxisoindolin-2-yl)-2-(*p*-tolyl)cyclobutane-1-carboxylate (4b'-mono)**

$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.85-7.83 (m, 2H), 7.74-7.72 (m, 2H), 7.36 (d,  $J = 8.0$  Hz, 2H), 7.12 (d,  $J = 8.0$  Hz, 2H), 5.04 (t,  $J = 7.8$  Hz, 1H), 3.40 (s, 3H), 3.19-3.12 (m, 1H), 2.74-2.63 (m, 1H), 2.42-2.31 (m, 5H).



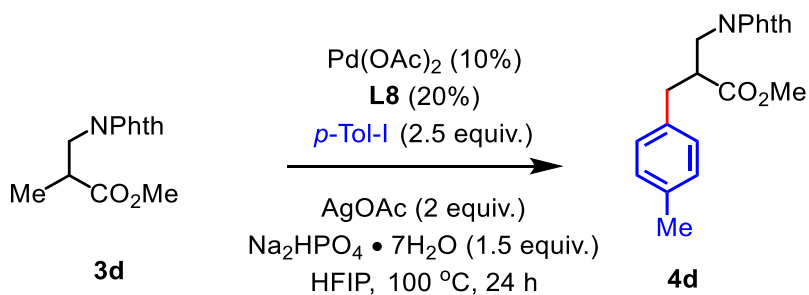
The substrate **3c** (0.1 mmol, 23.1 mg),  $\text{Pd}(\text{OAc})_2$  (10 mol%, 2.2 mg), ligand **L18** (0.012 mmol, 4.8 mg),  $\text{K}_2\text{HPO}_4$  (0.1 mmol, 17.4 mg) and  $\text{Ag}_2\text{CO}_3$  (0.20 mmol, 55.2 mg) were weighed in air and placed in a sealed tube (10 mL) with a magnetic stir bar. To the reaction mixture, aryl iodide (0.25

mmol) and HFIP (1.0 mL) were added. The reaction mixture was first stirred at room temperature for 10 min and then heated to 100 °C for 24 hours under vigorous stirring. Upon completion, the reaction mixture was cooled to room temperature, then added 0.05 mL AcOH, filtered with celite using CH<sub>2</sub>Cl<sub>2</sub>. The solvents were removed under reduced pressure and the resulting mixture was treated with Cs<sub>2</sub>CO<sub>3</sub> (0.2 mmol) and MeI (0.2 mmol) in DMF (1 mL). The reaction mixture was stirred at room temperature for 3 hours. After completion, water (5 mL) and EtOAc (5 mL) were added to the reaction mixture, and the organic phase was separated and dried by Na<sub>2</sub>SO<sub>4</sub>. The solvents were removed under reduced pressure and the resulting mixture was purified by a preparative TLC using toluene/EtOAc (20/1) as the eluent. **4c'** was obtained as an oil (21.1 mg, 63%).



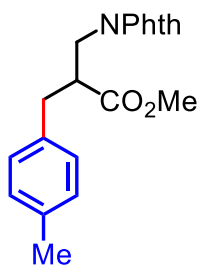
### Methyl 1-(1,3-dioxoisindolin-2-yl)-2-(*p*-tolyl)cyclopropane-1-carboxylate (**4c'**)

<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 7.91 (dd, *J* = 5.5, 3.0 Hz, 2H), 7.77 (dd, *J* = 5.5, 3.0 Hz, 2H), 7.47 (d, *J* = 7.8 Hz, 2H), 7.15 (d, *J* = 7.8 Hz, 2H), 3.37 (s, 3H), 3.13 (t, *J* = 9.5 Hz, 1H), 2.47 (dd, *J* = 9.2, 6.1 Hz, 1H), 2.34 (s, 3H), 1.87 (dd, *J* = 9.9, 6.1 Hz, 1H).



The substrate **3d** (0.1 mmol, 23.3 mg), Pd(OAc)<sub>2</sub> (10 mol%, 2.2 mg), and AgOAc (0.2 mmol, 33.4 mg) were weighed in air and placed in a sealed tube (10 mL) with a magnetic stir bar. To the reaction mixture, aryl iodide (0.25 mmol), Na<sub>2</sub>HPO<sub>4</sub> · 7H<sub>2</sub>O (1.5 equiv., 39.6 mg), **L8** (20 mol%,

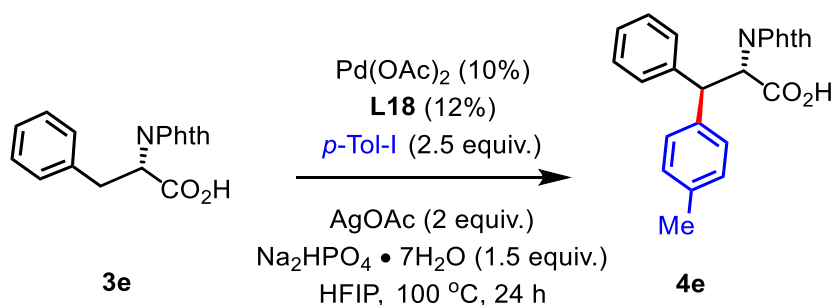
3.4 mg), HFIP (1.0 mL) were added. The reaction mixture was first stirred at room temperature for 10 min and then heated to 100 °C for 24 hours under vigorous stirring. Upon completion, the reaction mixture was cooled to room temperature, added AcOH (0.05 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the resulting mixture was added with DCM (3 mL), cat. DMF, and (COCl)<sub>2</sub> (2 equiv.). After 2 hours, MeOH (0.5 mL) was added the reaction mixture and stirred for another 1 hour. The solvents were removed under reduced pressure and the resulting mixture was purified by preparative TLC. **4d'** was obtained as an oil (11.8 mg, 35%).



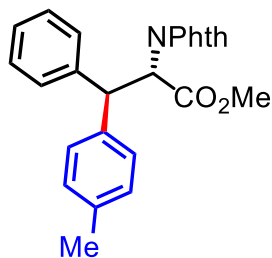
**Methyl 3-(1,3-dioxoisindolin-2-yl)-2-(4-methylbenzyl)propanoate (4d')**

<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 7.81 (dd, *J* = 5.4, 3.0 Hz, 2H), 7.70 (dd, *J* = 5.5, 3.0 Hz, 2H), 7.07 (d, *J* = 8.0 Hz, 2H), 7.02 (d, *J* = 7.9 Hz, 2H), 3.99 (dd, *J* = 13.9, 8.1 Hz, 1H), 3.86 (dd, *J* = 13.9, 6.2 Hz, 1H), 3.59 (s, 3H), 3.29-3.24 (m, 1H), 3.04 (dd, *J* = 14.1, 8.2 Hz, 1H), 2.81 (dd, *J* = 14.1, 6.8 Hz, 1H), 2.24 (s, 3H); <sup>13</sup>C NMR (150 MHz, CDCl<sub>3</sub>) δ 173.31, 167.99, 136.00, 134.86, 133.94, 131.90, 129.13, 128.54, 123.26, 51.97, 45.68, 39.52, 35.52, 20.95; HRMS (ESI-TOF) Calcd for C<sub>20</sub>H<sub>20</sub>NO<sub>4</sub> [M+H]<sup>+</sup>: 338.1387; found: 338.1389.



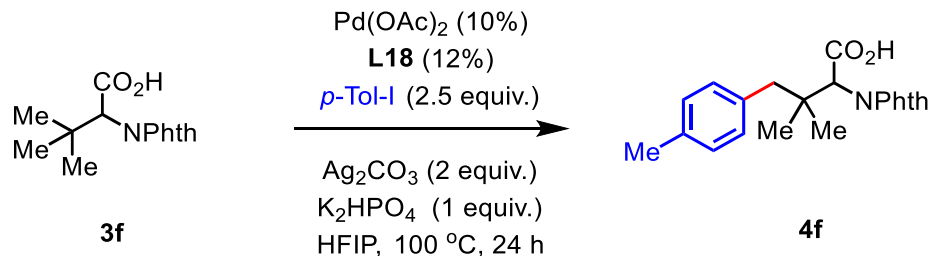


Same reaction conditions as substrate **3b**. Work up: Upon completion, the reaction mixture was cooled to room temperature, added AcOH (0.05 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the resulting mixture was added with DCM (3 mL), cat. DMF, and  $(\text{COCl})_2$  (2 equiv.). After 2 hours, MeOH (0.5 mL) was added the reaction mixture and stirred for another 1 hour. The solvents were removed under reduced pressure and the resulting mixture was purified by preparative TLC using DCM/Hexanes (2/1) as the eluent (twice). **4e'** was obtained as an oil (4.0 mg, 10%).

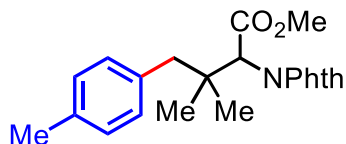


**Methyl (2S,3R)-2-(1,3-dioxoisindolin-2-yl)-3-phenyl-3-(*p*-tolyl)propanoate (**4e'**)**

$^1\text{H NMR}$  (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.73 (dd,  $J = 5.4, 3.1$  Hz, 2H), 7.64 (dd,  $J = 5.5, 3.0$  Hz, 2H), 7.38 (d,  $J = 7.8$  Hz, 2H), 7.23 (d,  $J = 7.6$  Hz, 2H), 7.14 (d,  $J = 7.8$  Hz, 2H), 7.07 (t,  $J = 7.6$  Hz, 2H), 6.96 (t,  $J = 7.4$  Hz, 1H), 5.72 (d,  $J = 11.9$  Hz, 1H), 5.22 (d,  $J = 11.9$  Hz, 1H), 3.58 (s, 3H), 2.30 (s, 3H);  $^{13}\text{C NMR}$  (150 MHz,  $\text{CDCl}_3$ )  $\delta$  168.70, 167.27, 140.58, 138.50, 136.41, 134.03, 131.32, 129.44, 128.45, 127.90, 127.50, 126.76, 123.38, 54.81, 52.60, 50.16, 21.03; HRMS (ESI-TOF) Calcd for  $\text{C}_{25}\text{H}_{22}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 400.1543; found: 400.1533.

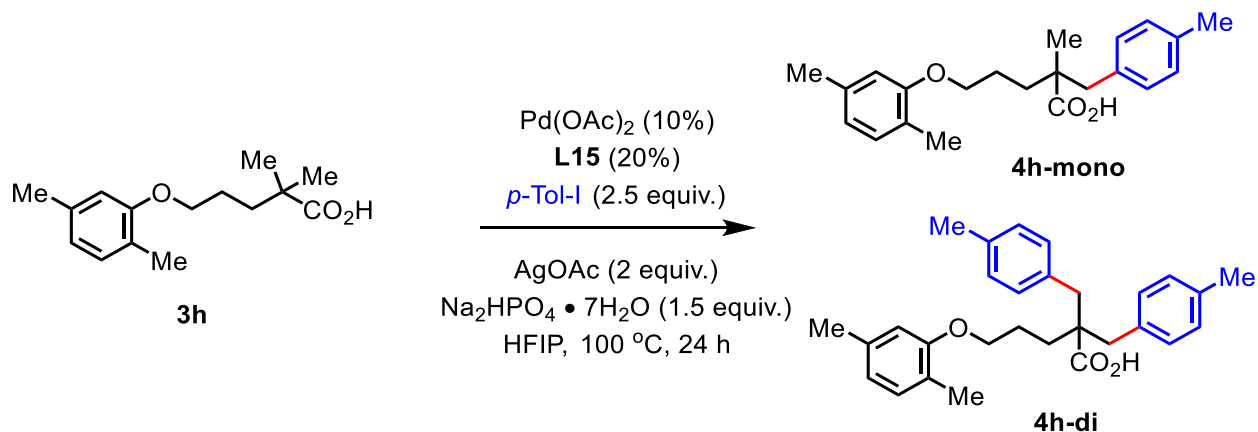


Same reaction conditions as substrate **3c**. Work up: Upon completion, the reaction mixture was cooled to room temperature, added AcOH (0.05 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the resulting mixture was added with DCM (3 mL), cat. DMF, and  $(\text{COCl})_2$  (2 equiv.). After 2 hours, MeOH (0.5 mL) was added the reaction mixture and stirred for another 1 hour. The solvents were removed under reduced pressure and the resulting mixture was purified by preparative TLC using Toluene/EtOAc (20/1) as the eluent (twice). **4f** was obtained as an oil (8.4 mg, 23%).

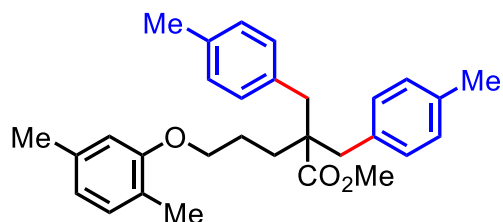


**Methyl 2-(1,3-dioxoisindolin-2-yl)-3,3-dimethyl-4-(*p*-tolyl)butanoate (**4f**)**

$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.87 (dd,  $J = 5.4, 3.1$  Hz, 2H), 7.75 (dd,  $J = 5.5, 3.0$  Hz, 2H), 7.09-7.05 (m, 4H), 4.73 (s, 1H), 3.70 (s, 3H), 3.05 (d,  $J = 13.2$  Hz, 1H), 2.83 (d,  $J = 13.1$  Hz, 1H), 2.32 (s, 3H), 1.15 (s, 3H), 1.00 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  168.39, 168.07, 135.64, 134.81, 134.21, 131.71, 130.78, 128.55, 123.58, 58.93, 52.15, 44.72, 39.38, 27.81, 24.76, 24.40, 21.02; HRMS (ESI-TOF) Calcd for  $\text{C}_{22}\text{H}_{24}\text{NO}_4$   $[\text{M}+\text{H}]^+$ : 366.1700; found: 366.1699.

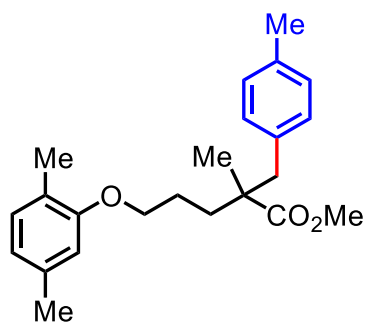


Same reaction conditions as substrate **3a**. Work up: Upon completion, the reaction mixture was cooled to room temperature, added AcOH (0.05 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the resulting mixture was added with DCM (3 mL), cat. DMF, and  $(\text{COCl})_2$  (2 equiv.). After 2 hours, MeOH (0.5 mL) was added the reaction mixture and stirred for another 1 hour. The solvents were removed under reduced pressure and the resulting mixture was purified by preparative TLC using Toluene/EtOAc (30/1) as the eluent (twice). **4h'-di** was obtained as an oil (5.2 mg, 12%), **4h'-mono** was obtained as an oil (20.4 mg, 60%).



**Methyl 5-(2,5-dimethylphenoxy)-2-(4-methylbenzyl)-2-(*p*-tolyl)pentanoate (**4h'-di**)**

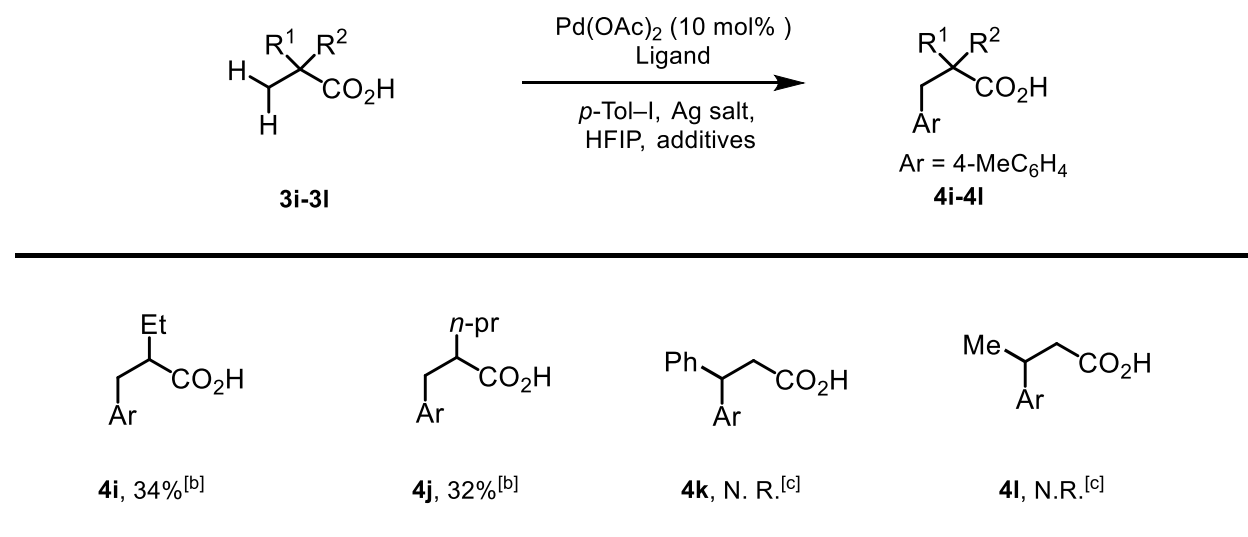
$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.08-7.04 (m, 4H), 7.03-6.98 (m, 5H), 6.66 (d,  $J = 7.4$  Hz, 1H), 6.59 (s, 1H), 3.90 (t,  $J = 6.4$  Hz, 2H), 3.63 (s, 3H), 3.07 (d,  $J = 14.0$  Hz, 2H), 2.86 (d,  $J = 14.0$  Hz, 2H), 2.31 (s, 9H), 2.16 (s, 3H), 2.00-1.93 (m, 2H), 1.67-1.60 (m, 2H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  176.24, 156.88, 136.43, 136.02, 134.23, 130.28, 129.78, 128.89, 123.55, 120.62, 111.76, 67.83, 51.87, 51.36, 41.41, 28.11, 25.19, 24.31, 21.41, 21.02, 15.87; HRMS (ESI-TOF) Calcd for  $\text{C}_{29}\text{H}_{35}\text{O}_3$   $[\text{M}+\text{H}]^+$ : 431.2581; found: 431.2583.



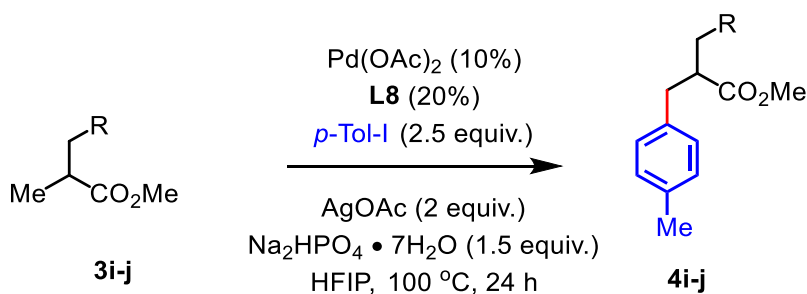
**Methyl 5-(2,5-dimethylphenoxy)-2-methyl-2-(*p*-tolyl)pentanoate (4h'-mono)**

$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.07-7.04 (m, 2H), 7.03-6.96 (m, 3H), 6.66 (d,  $J = 7.4$  Hz, 1H), 6.60 (s, 1H), 3.96-3.87 (m, 2H), 3.65 (s, 3H), 2.99 (d,  $J = 13.4$  Hz, 1H), 2.72 (d,  $J = 13.4$  Hz, 1H), 2.31 (s, 6H), 2.17 (s, 3H), 1.92 (td,  $J = 12.6, 4.2$  Hz, 1H), 1.87-1.77 (m, 1H), 1.76-1.66 (m, 1H), 1.61-1.56 (m, 1H), 1.14 (s, 3H);  $^{13}\text{C}$  NMR (150 MHz,  $\text{CDCl}_3$ )  $\delta$  177.12, 156.90, 136.44, 135.98, 134.35, 130.28, 129.96, 128.74, 123.58, 120.67, 111.90, 67.80, 51.56, 47.25, 45.08, 35.53, 25.18, 25.01, 21.02, 20.94, 15.76; HRMS (ESI-TOF) Calcd for  $\text{C}_{22}\text{H}_{28}\text{O}_3$   $[\text{M}+\text{H}]^+$ : 341.2111; found: 341.2114.

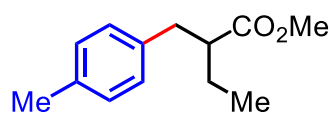
**Table S4.** Arylation of Other Amino Acids and Carboxylic Acids.<sup>[a]</sup>



[a] Isolated yields are shown based on corresponding methyl ester. [b] Conditions: substrate (0.1 mmol),  $\text{Pd}(\text{OAc})_2$  (10 mol %),  $\text{AgOAc}$  (0.2 mmol), Ar-I (0.25 mmol),  $\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$  (0.15 mmol), **L8** (20 mol%), HFIP (1.0 mL), 100 °C, 24 h. [c] Conditions: substrate (0.1 mmol),  $\text{Pd}(\text{OAc})_2$  (10 mol%),  $\text{AgOAc}$  (0.2 mmol), Ar-I (0.25 mmol),  $\text{Na}_2\text{HPO}_4 \cdot 7\text{H}_2\text{O}$  (0.15 mmol), **L18** (12 mol%), HFIP (1.0 mL), 100 °C, 24 h.

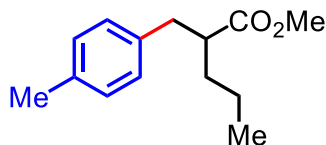


The substrate (0.2 mmol), Pd(OAc)<sub>2</sub> (10 mol%, 4.4 mg), and AgOAc (0.4 mmol, 66.8 mg) were weighed in air and placed in a sealed tube (10 mL) with a magnetic stir bar. To the reaction mixture, aryl iodide (0.5 mmol), Na<sub>2</sub>HPO<sub>4</sub> • 7H<sub>2</sub>O (1.5 equiv., 80.0 mg), **L8** (20 mol%, 6.8 mg), HFIP (2.0 mL) were added. The reaction mixture was first stirred at room temperature for 10 min and then heated to 100 °C for 24 hours under vigorous stirring. Upon completion, the reaction mixture was cooled to room temperature, added AcOH (0.1 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the resulting mixture was added with DCM (3 mL), cat. DMF, and (COCl)<sub>2</sub> (2 equiv.). After 2 hours, MeOH (0.5 mL) was added the reaction mixture and stirred for another 1 hour. The solvents were removed under reduced pressure and the resulting mixture was purified by preparative TLC. **4i'** or **4j**, was obtained as an oil.



**Methyl 2-(4-methylbenzyl)butanoate (**4i'**)**

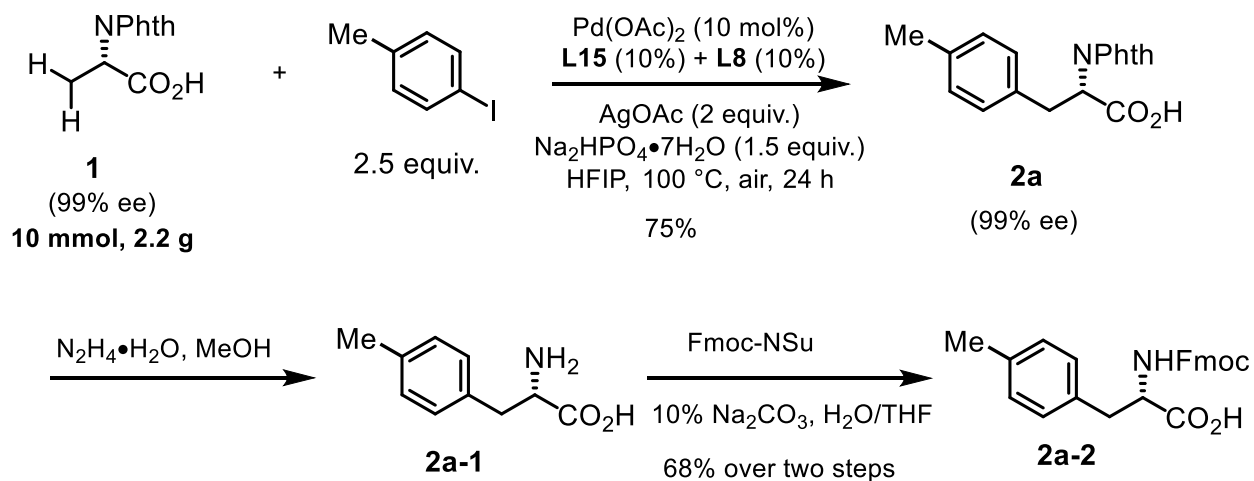
Oil, 14.1mg. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.06 (q, *J* = 8.1 Hz, 4H), 3.61 (s, 3H), 2.90 (dd, *J* = 13.4, 8.1 Hz, 1H), 2.70 (dd, *J* = 13.6, 6.9 Hz, 1H), 2.61-2.53 (m, 1H), 2.31 (s, 3H), 1.68-1.55 (m, 2H), 0.90 (t, *J* = 7.4 Hz, 3H).



### Methyl 2-(4-methylbenzyl)pentanoate (4j')

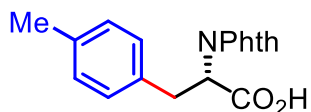
Oil, 14.0 mg.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  7.05 (q,  $J = 8.1$  Hz, 4H), 3.60 (s, 3H), 2.89 (dd,  $J = 13.1, 7.7$  Hz, 1H), 2.72-2.61 (m, 2H), 2.31 (s, 3H), 1.67-1.57 (m, 1H), 1.50-1.42 (m, 1H), 1.36-1.27 (m, 2H), 0.88 (t,  $J = 7.3$  Hz, 3H).

### 2.5 Procedure for scale-up unnatural amino acid synthesis. (Scheme 3)



The starting material **1** (10 mmol, 2.2 g), Pd(OAc)<sub>2</sub> (10 mol%, 220 mg), and AgOAc (20 mmol, 3.34 g) were weighed in air and placed in a sealed tube (350 mL) with a magnetic stir bar. To the reaction mixture, aryl iodide (25 mmol), Na<sub>2</sub>HPO<sub>4</sub>·7H<sub>2</sub>O (1.5 equiv. 3.96 g), **L15** (10 mol%, 205 mg), **L8** (10 mol%, 151 mg) and HFIP (150 mL) were added. The reaction mixture was first stirred at room temperature for 10 min and then heated to 100 °C for 24 hours under vigorous stirring. Upon completion, the reaction mixture was cooled to room temperature, added AcOH (5 mL), and filtered with celite using DCM. The solvents were removed under reduced pressure and the

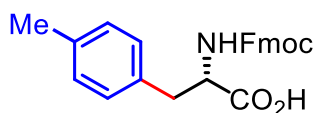
resulting mixture was purified by a silica gel-packed flash chromatography column using Hexanes/acetone (10/1-5/1-2/1) as the eluent. **2a** was obtained as a yellow oil (3.32 g, 75%).



**(S)-2-((1,3-Dioxoisindolin-2-yl)-3-(*p*-tolyl)propanoic acid (**2a**)**

$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  7.77-7.75 (m, 2H), 7.66 (dd,  $J = 5.4, 2.9$  Hz, 2H), 7.03 (d,  $J = 7.8$  Hz, 2H), 6.98 (d,  $J = 7.6$  Hz, 2H), 5.22-5.21 (m, 1H), 3.54-3.52 (m, 2H), 2.21 (s, 3H).

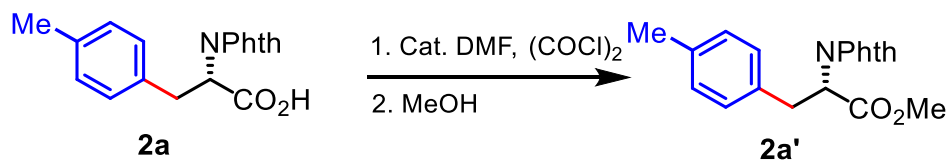
Starting phthalimide acid **2a** (1 mmol, 309 mg) was dissolved in MeOH (10 mL), and  $\text{N}_2\text{H}_4\text{-H}_2\text{O}$  (4 equiv.) was added at room temperature. The reaction was stirred for 24 h (sometimes a white solid precipitates out). The solvent was removed in vacuo (if solid was present, the mixture was first filtered). The crude free amino acid **2a-1** was dissolved in 10% aq.  $\text{Na}_2\text{CO}_3$  (5 mL) and the solution cooled to 0 °C. A solution of Fmoc-ONSu (3 equiv.) in 1,4-dioxane (5 mL) was added dropwise, and the ice bath removed to allow the reaction to warm to room temperature. After stirring for 3 h, the solvent was removed in vacuo,  $\text{H}_2\text{O}$  was added, and the mixture was extracted with EtOAc. The aqueous layer was acidified using 2N HCl and also extracted with EtOAc. The combined organic layers were dried with  $\text{Na}_2\text{SO}_4$ , filtered, and concentrated. Purify by column chromatography using Hexanes/acetone (10/1-5/1-2/1) as the eluent. **2a-2** was obtained as a white solid (272.3 mg, 68% over two steps).



**(S)-2-(((9*H*-fluoren-9-yl)methoxy)carbonyl)amino)-3-(*p*-tolyl)propanoic acid (**2a-2**)**

$^1\text{H}$  NMR (500 MHz, Acetone- $d_6$ )  $\delta$  7.85 (d,  $J = 7.6$  Hz, 2H), 7.70-7.56 (m, 2H), 7.40 (t,  $J = 7.8$  Hz, 2H), 7.30 (s, 2H), 7.19 (d,  $J = 7.6$  Hz, 2H), 7.09 (d,  $J = 7.5$  Hz, 2H), 6.62 (br, 1H), 4.48 (m, 1H), 4.37-4.15 (m, 3H), 3.21-3.18 (m, 1H), 3.04-2.97 (m, 1H), 2.26 (s, 3H).

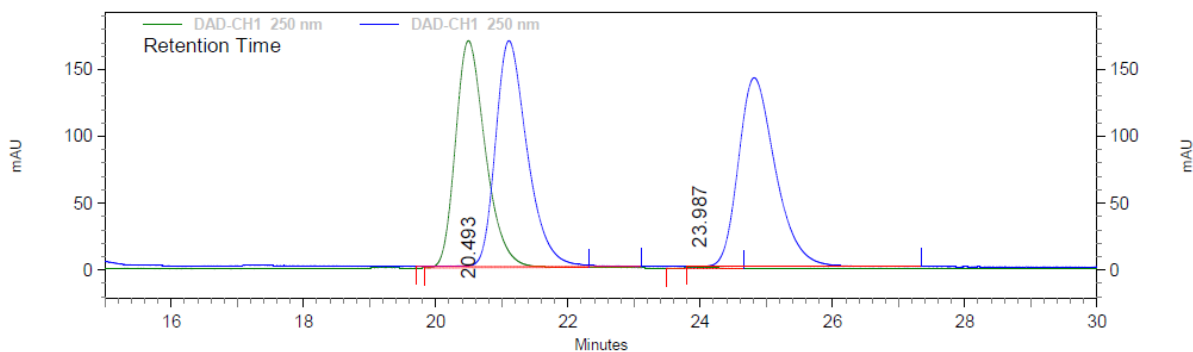
Ee value was tested based on ester product **2a'**.



### Area % Report

Data File: C:\EZChrom Elite\Enterprise\Projects\Default\Data\gangchen\ACID\gangchen-11--103-2chrail-10% ADH 0.5 MI MIN

Method: C:\EZChrom Elite\Methods\A 45 min without fc 0.5 ml per min.met



<b>DAD-CH1 250 nm Results</b>				
Retention Time	Area	Area %	Height	Height %
20.493	21411695	99.55	679712	99.56
23.987	96554	0.45	3036	0.44
<b>Totals</b>				
	21508249	100.00	682748	100.00

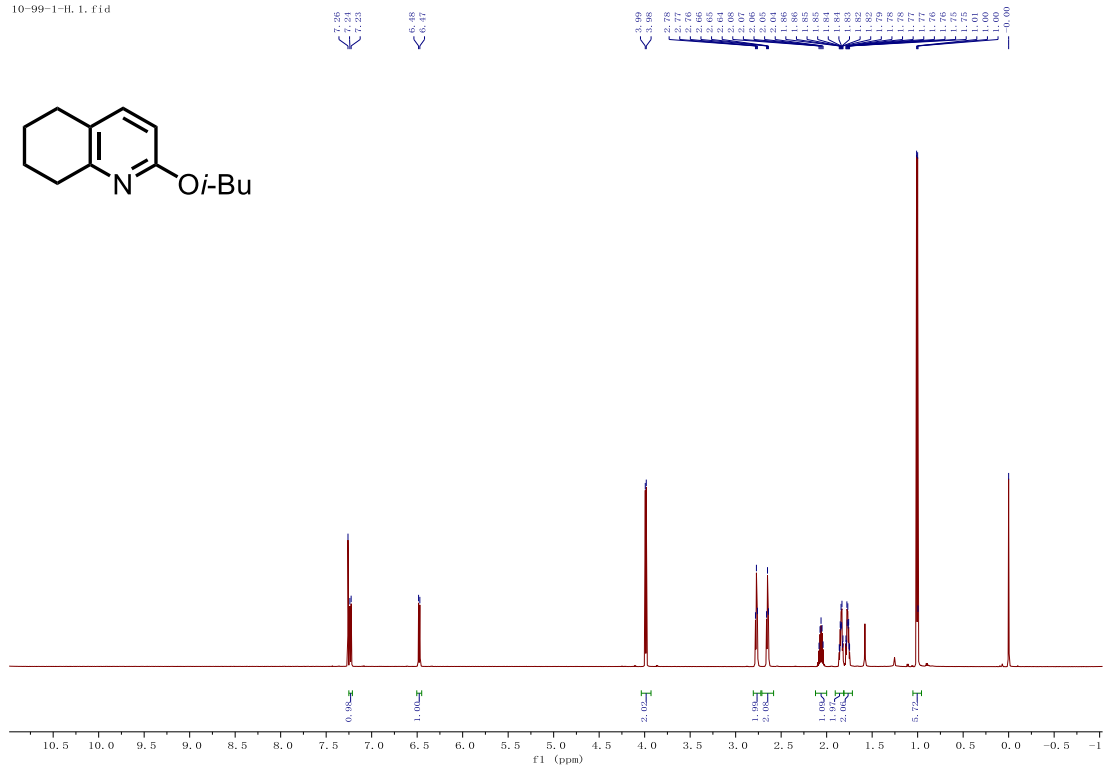


### 3. References

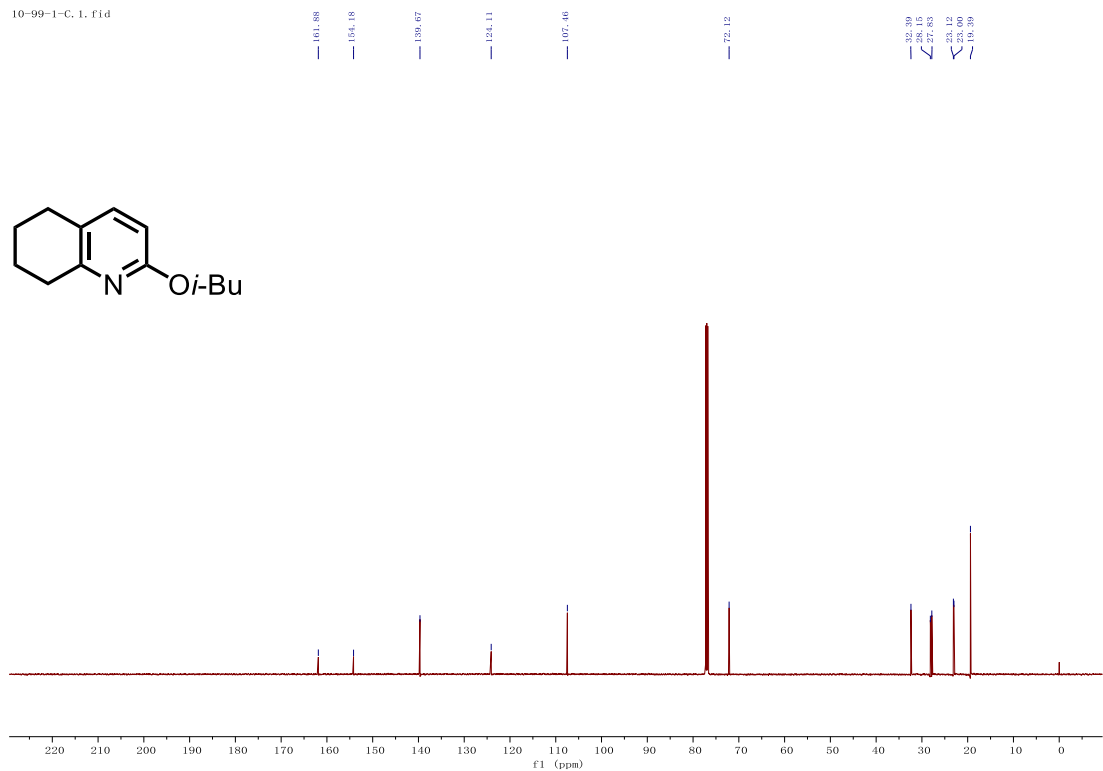
- [1] M. Wasa, K. S. L. Chan, X.-G. Zhang, J. He, M. Miura, J.-Q. Yu, *J. Am. Chem. Soc.* **2012**, *134*, 18570.
- [2] M. P. A. Lyle, P. D. Wilson, *Org. Lett.* **2004**, *6*, 855.
- [3] K. K.-C. Liu, P. Cornelius, T. A. Patterson, Y. Zeng, S. Santucci, E. Tomlinson, C. Gibbons, T. S. Maurer, R. Marala, J. Brown, J. X. Kong, E. Lee, W. Werner, Z. Wenzel, C. Vage, *Bioorg. Med. Chem. Lett.* **2010**, *20*, 266.

## 4. NMR Spectra

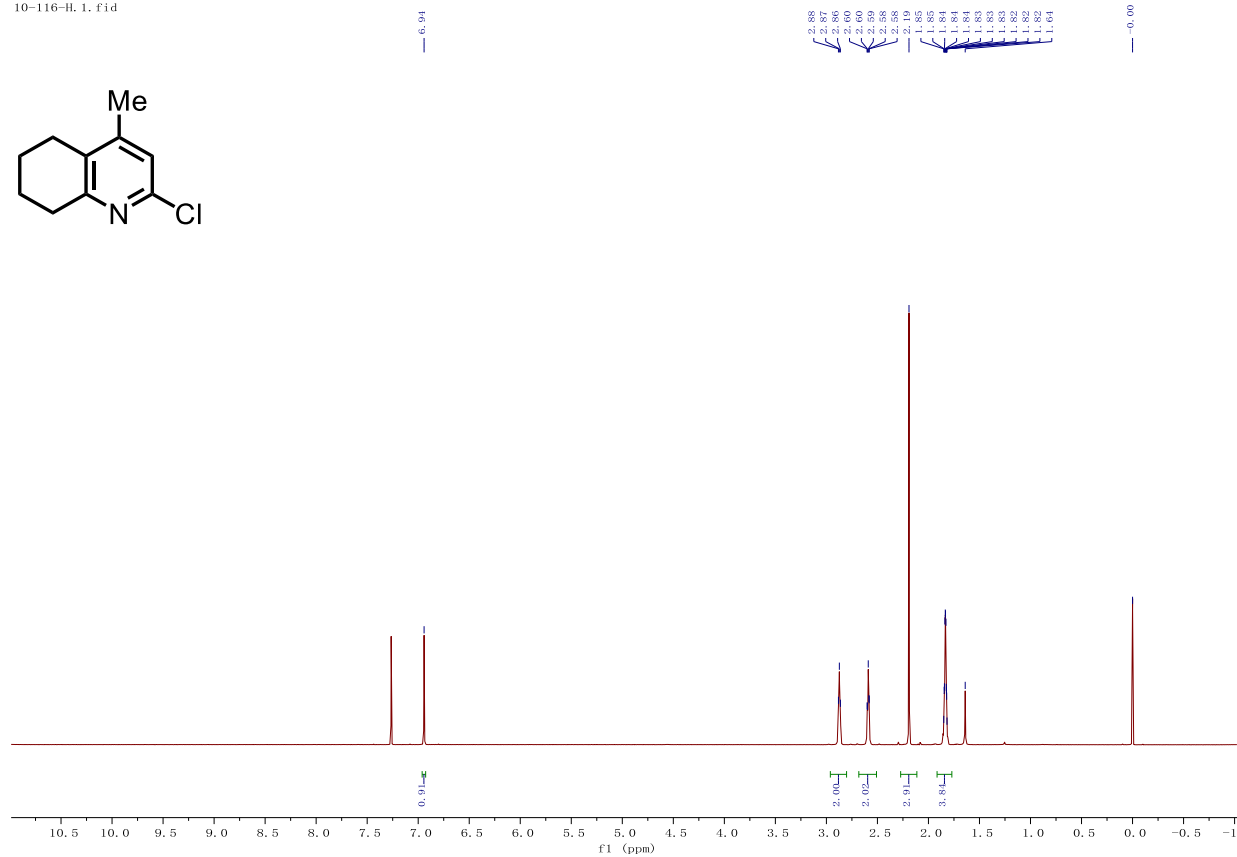
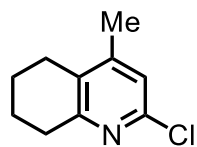
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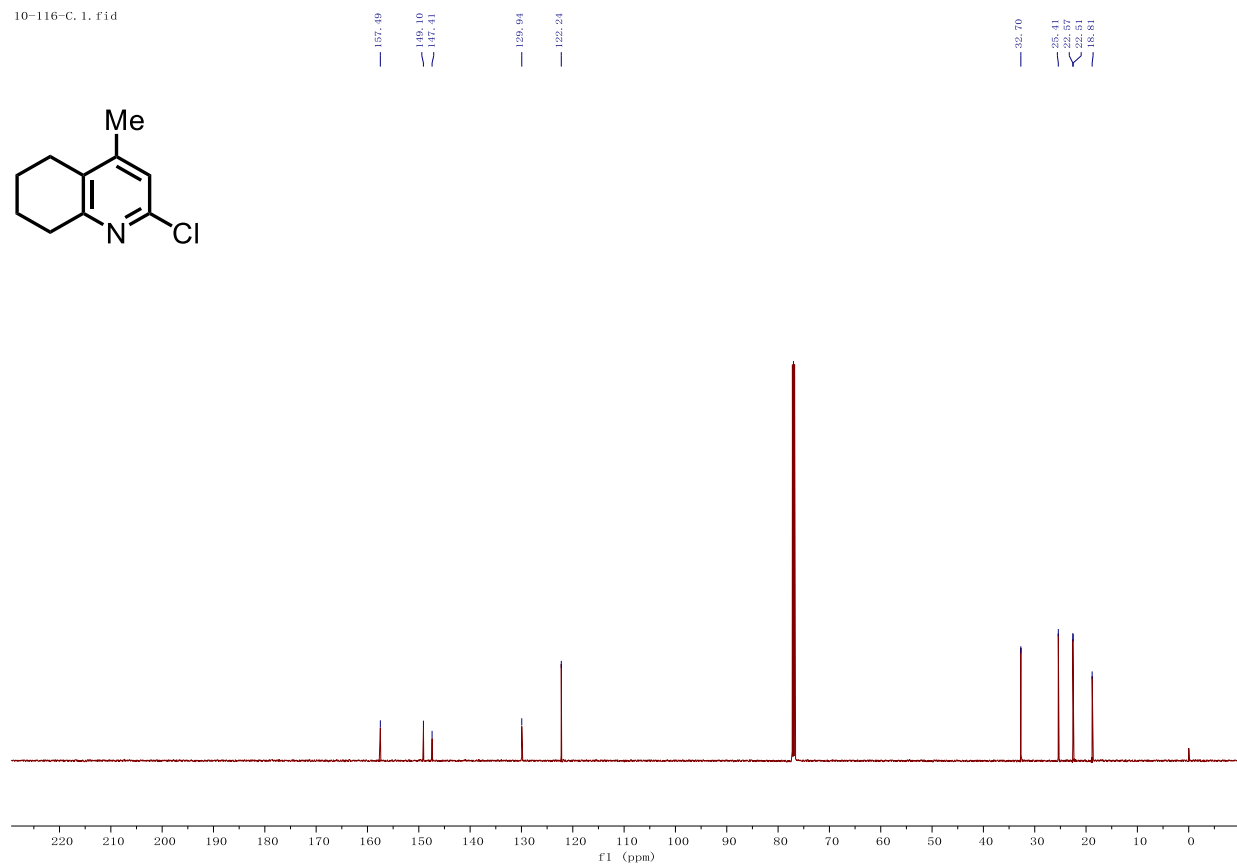
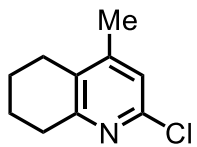
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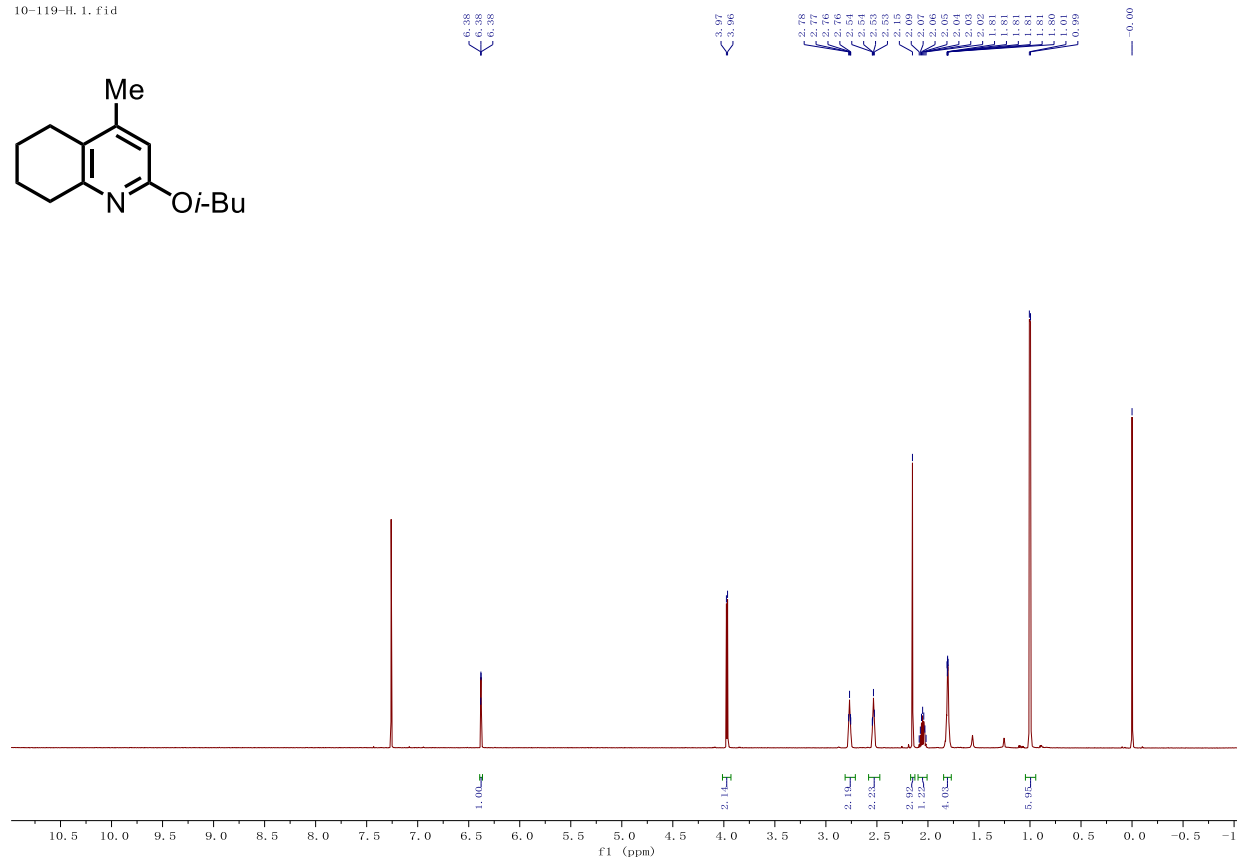
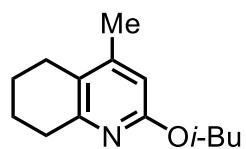
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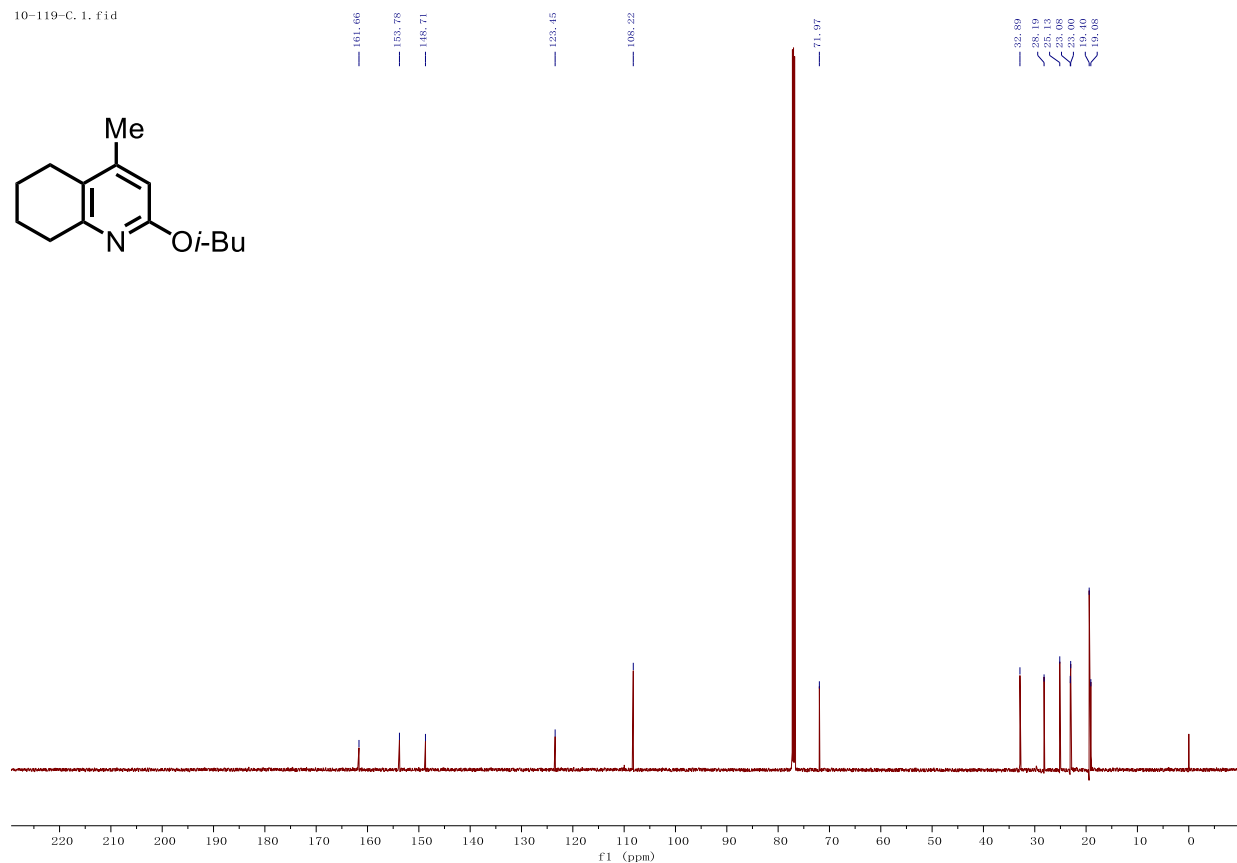
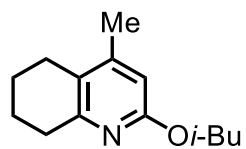
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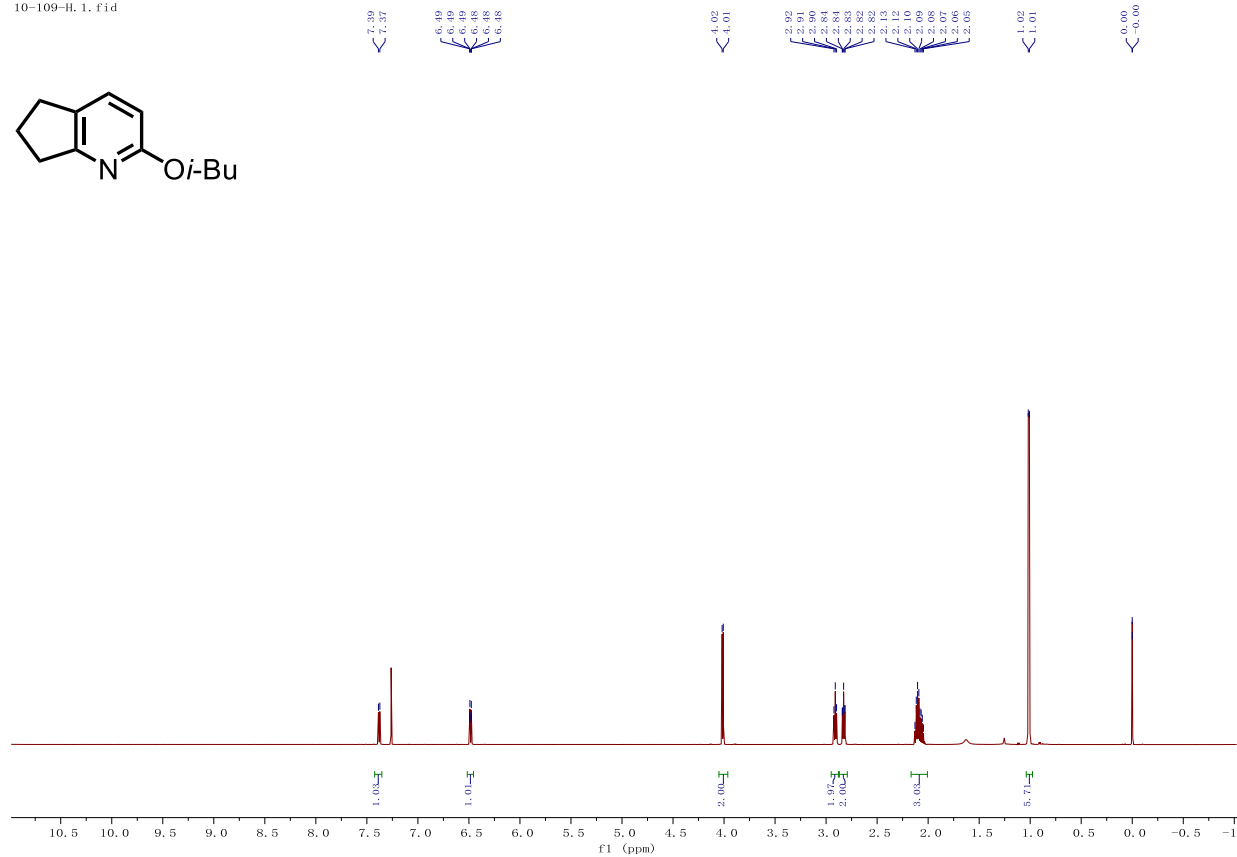
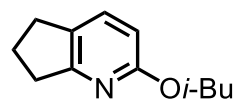
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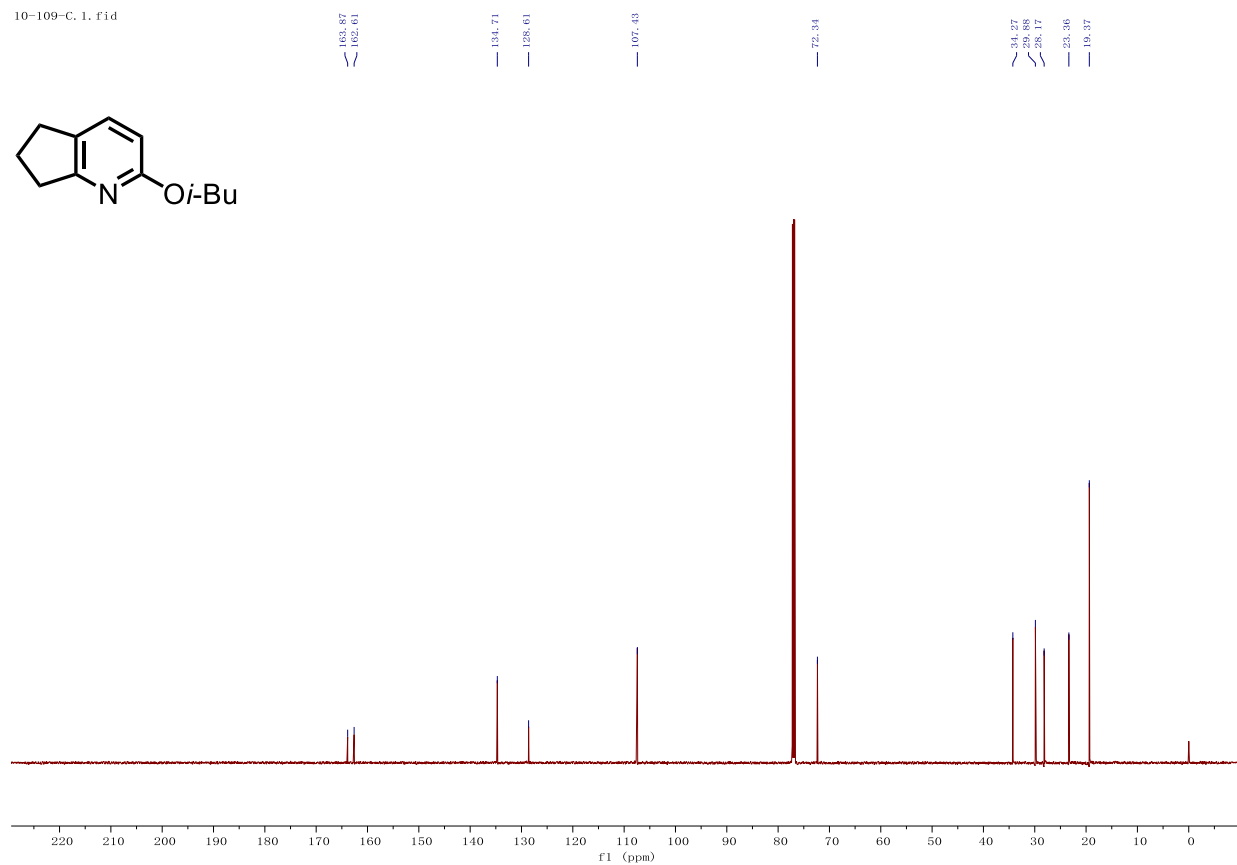
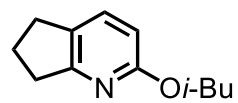
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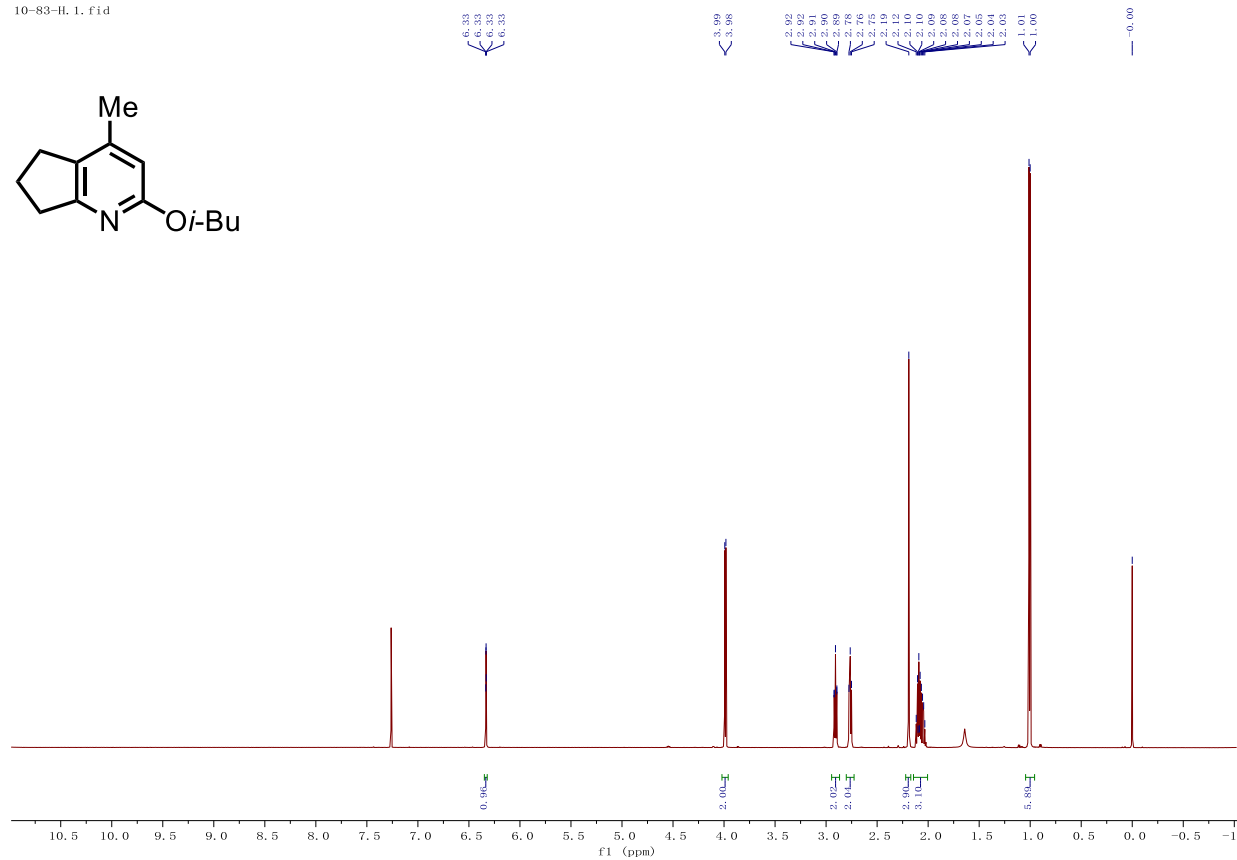
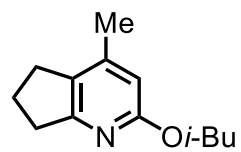
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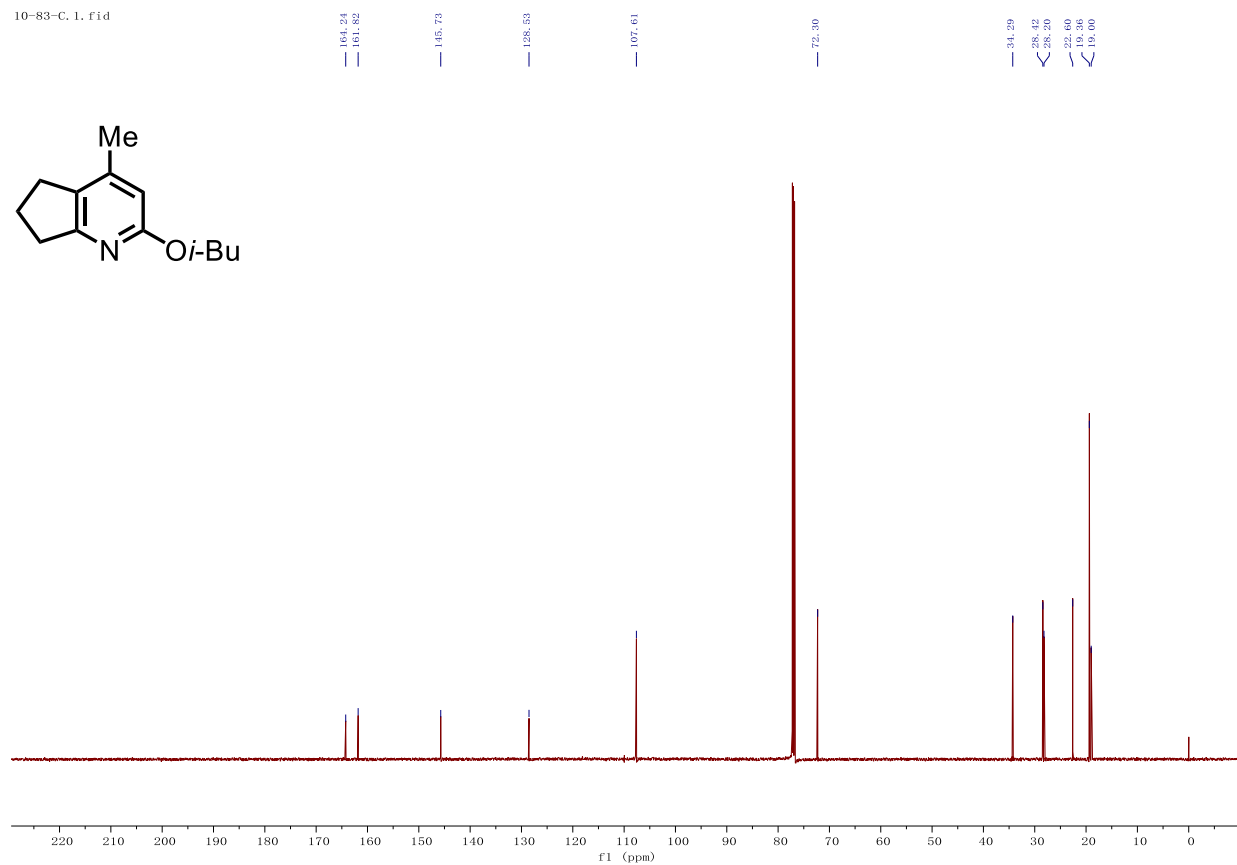
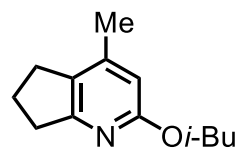
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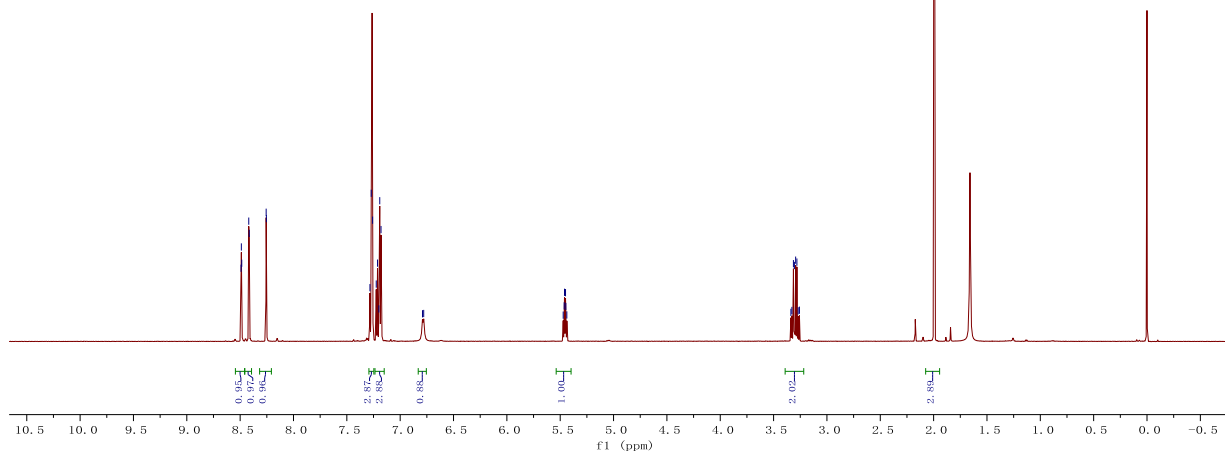
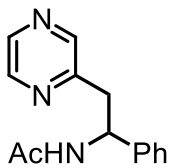


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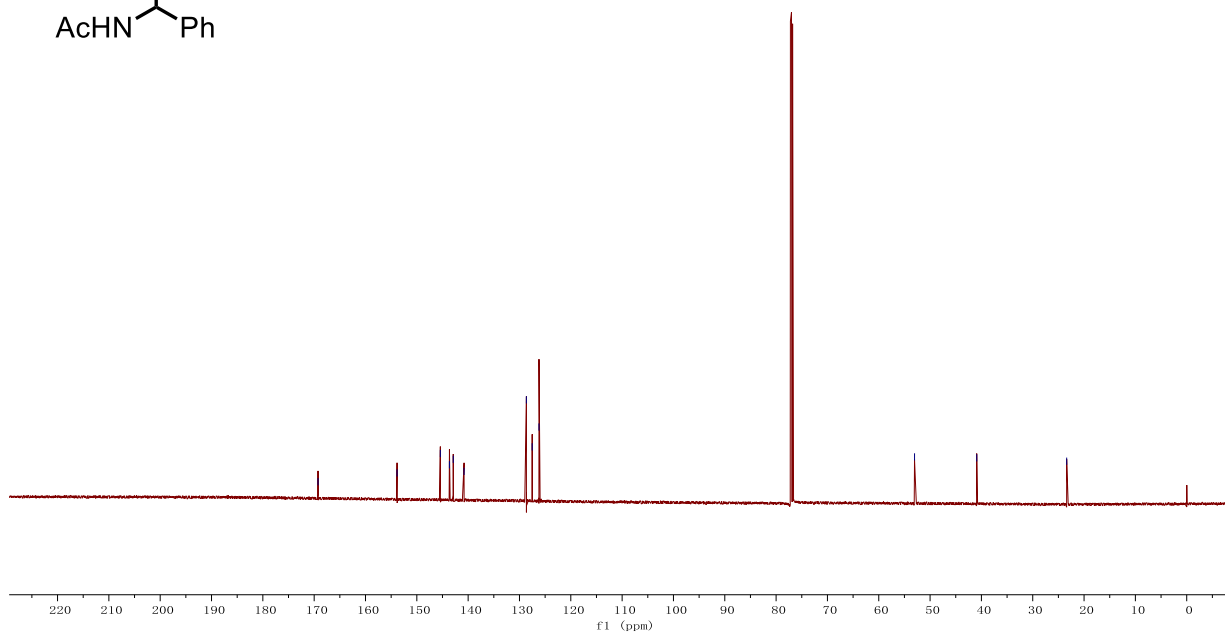
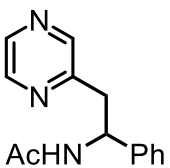
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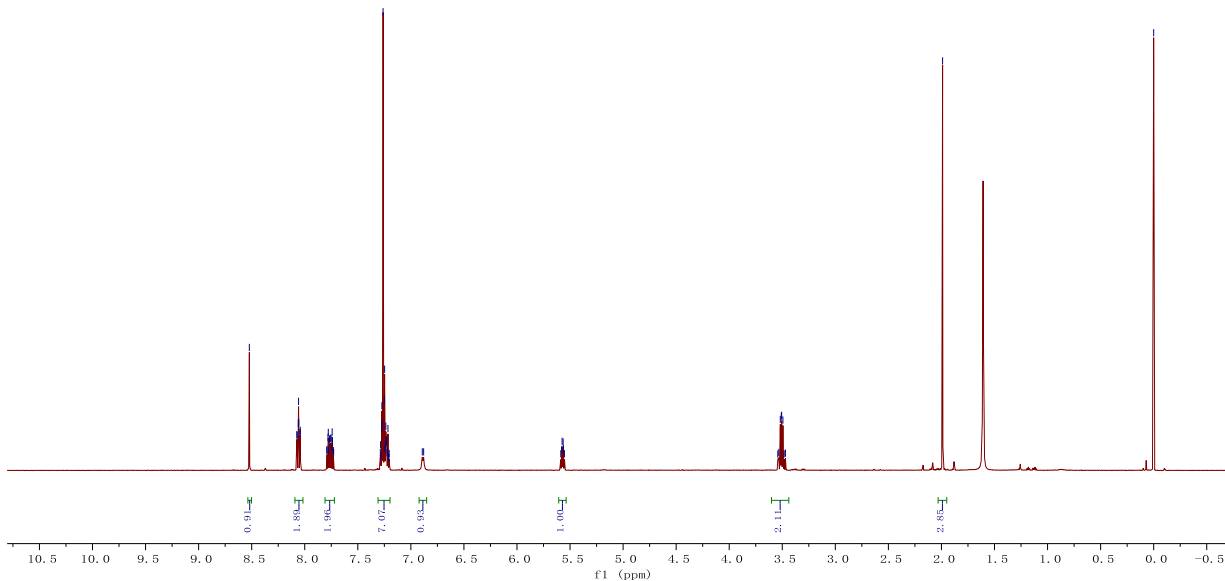
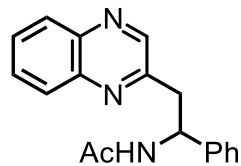


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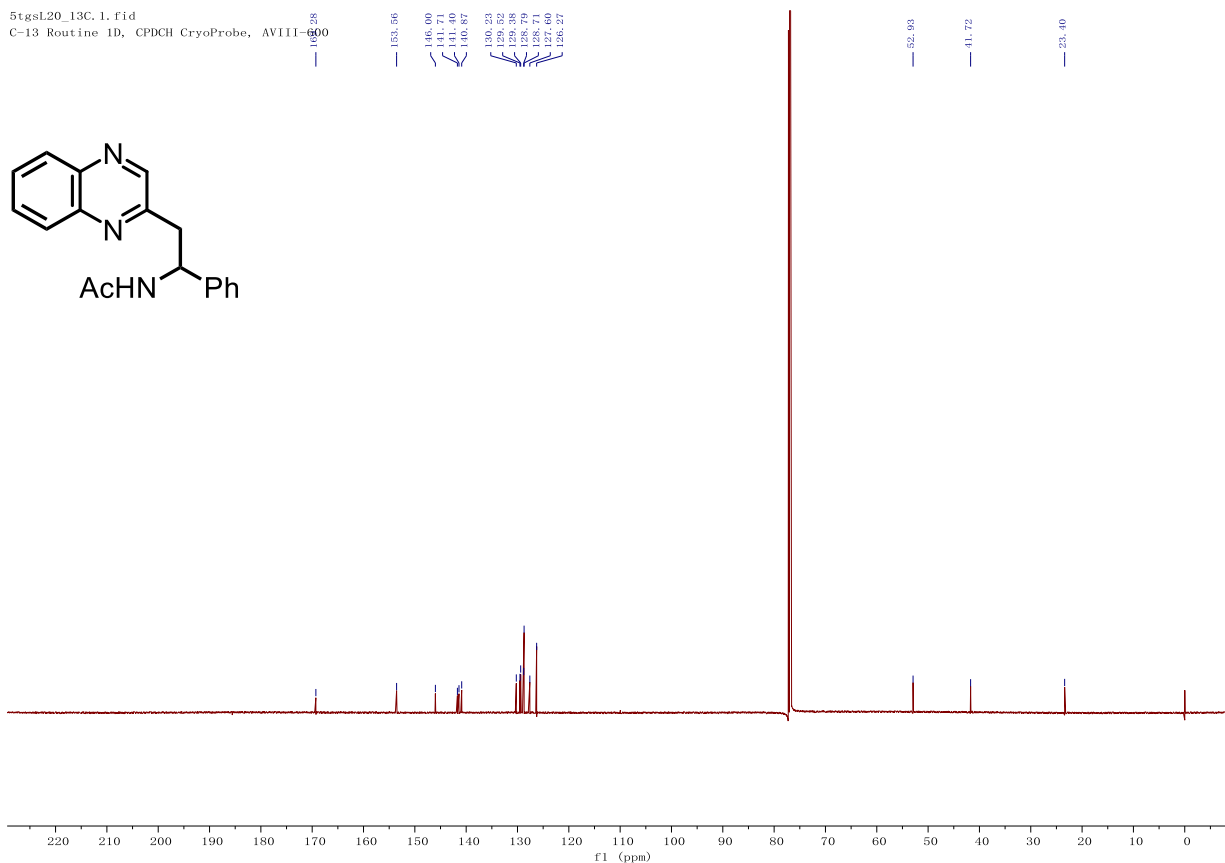
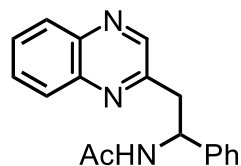
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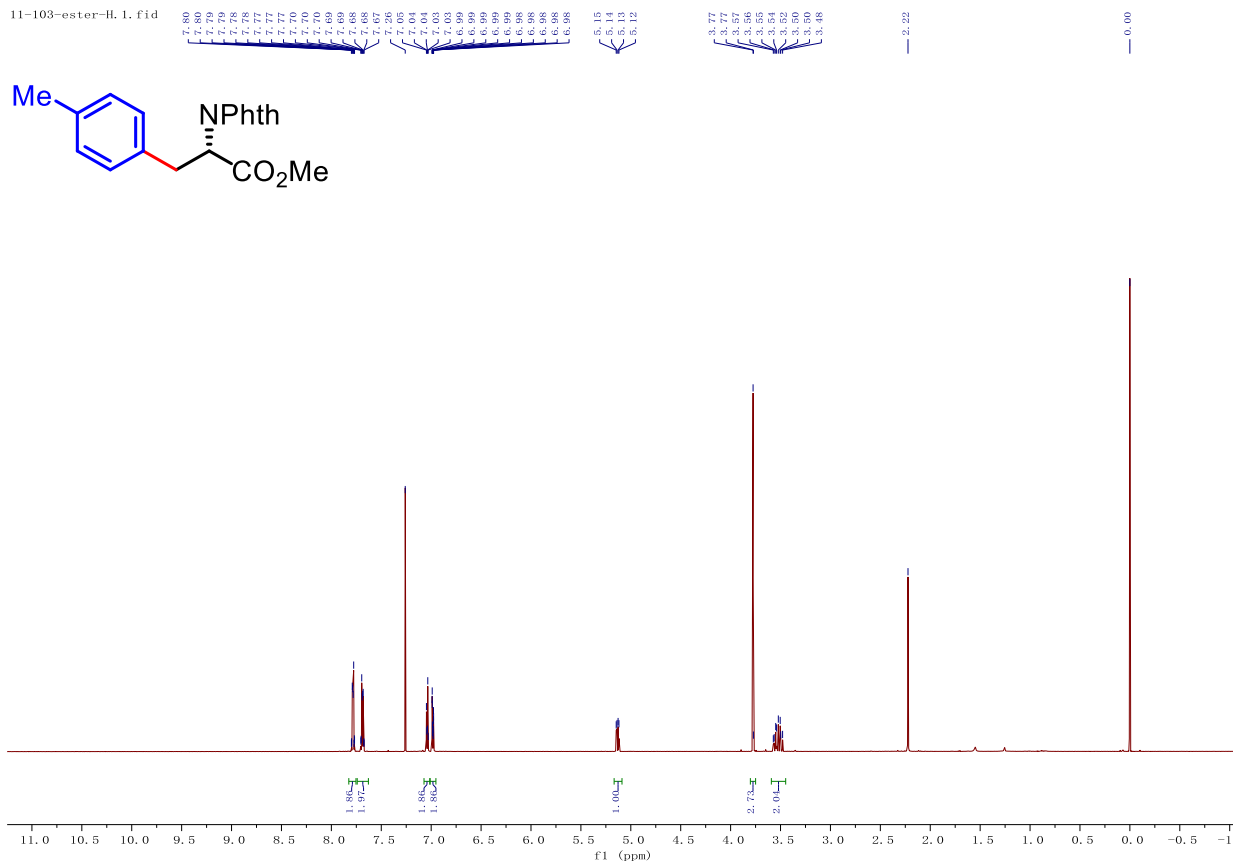
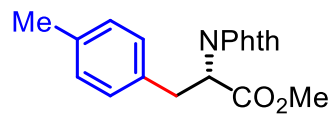


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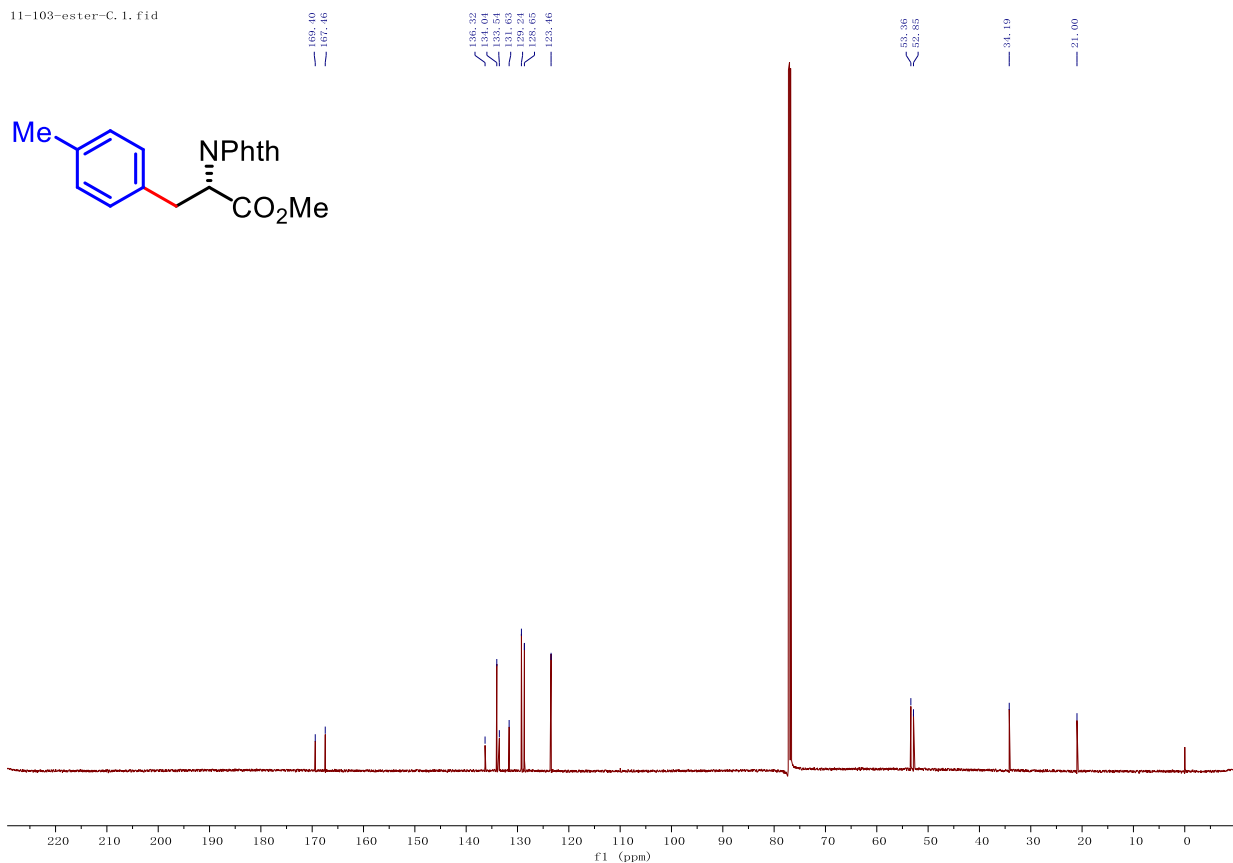
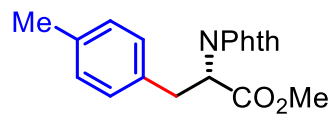




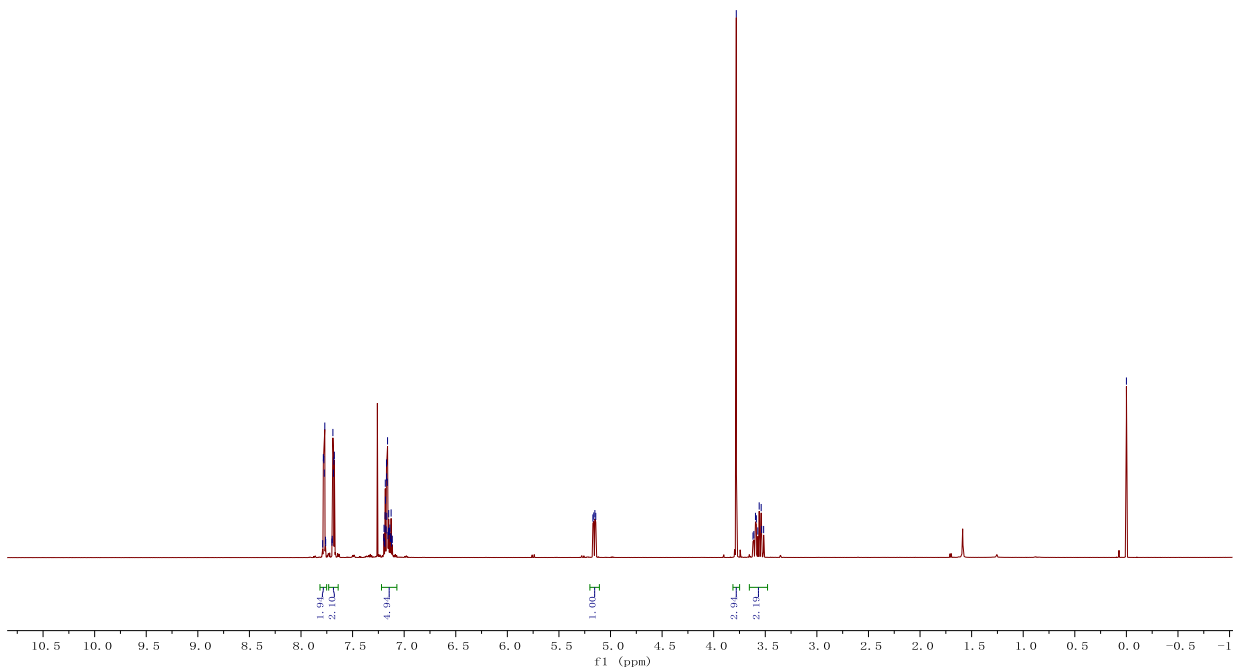
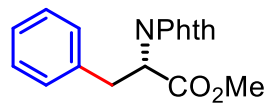
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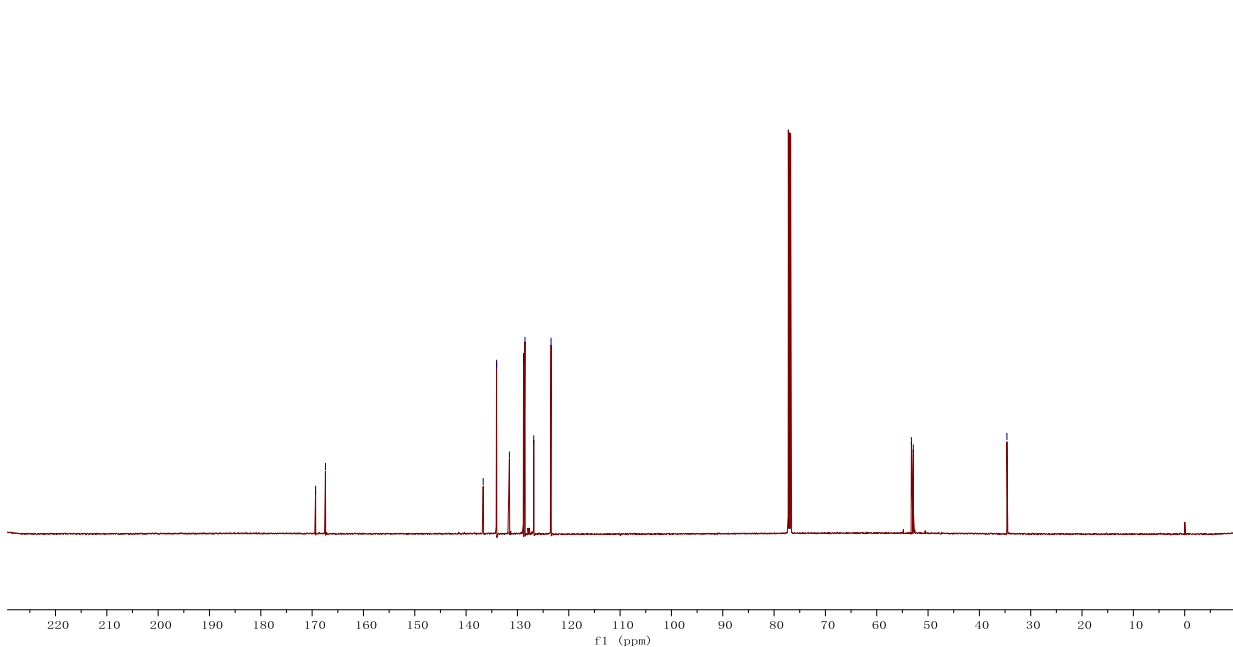
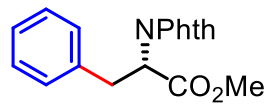
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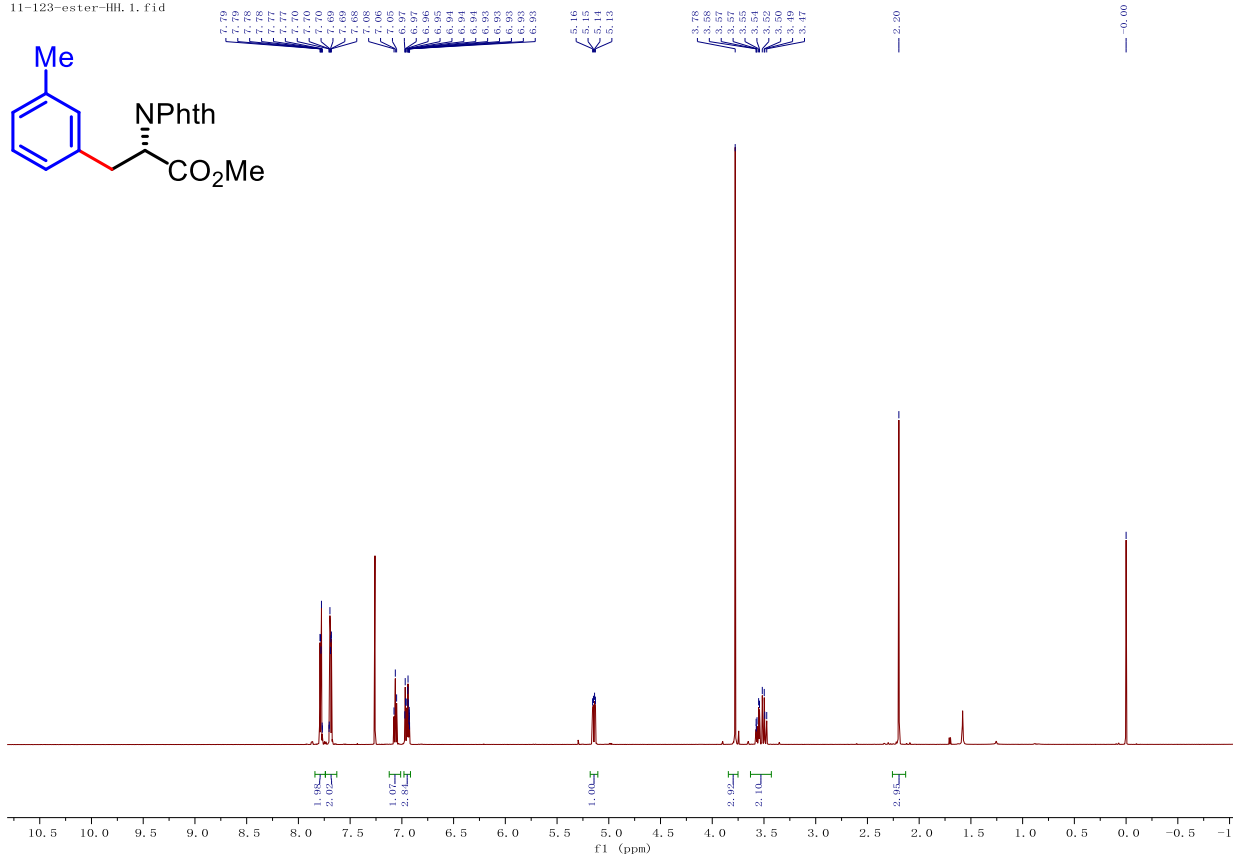
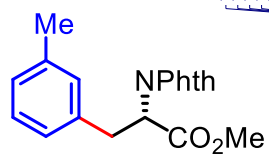
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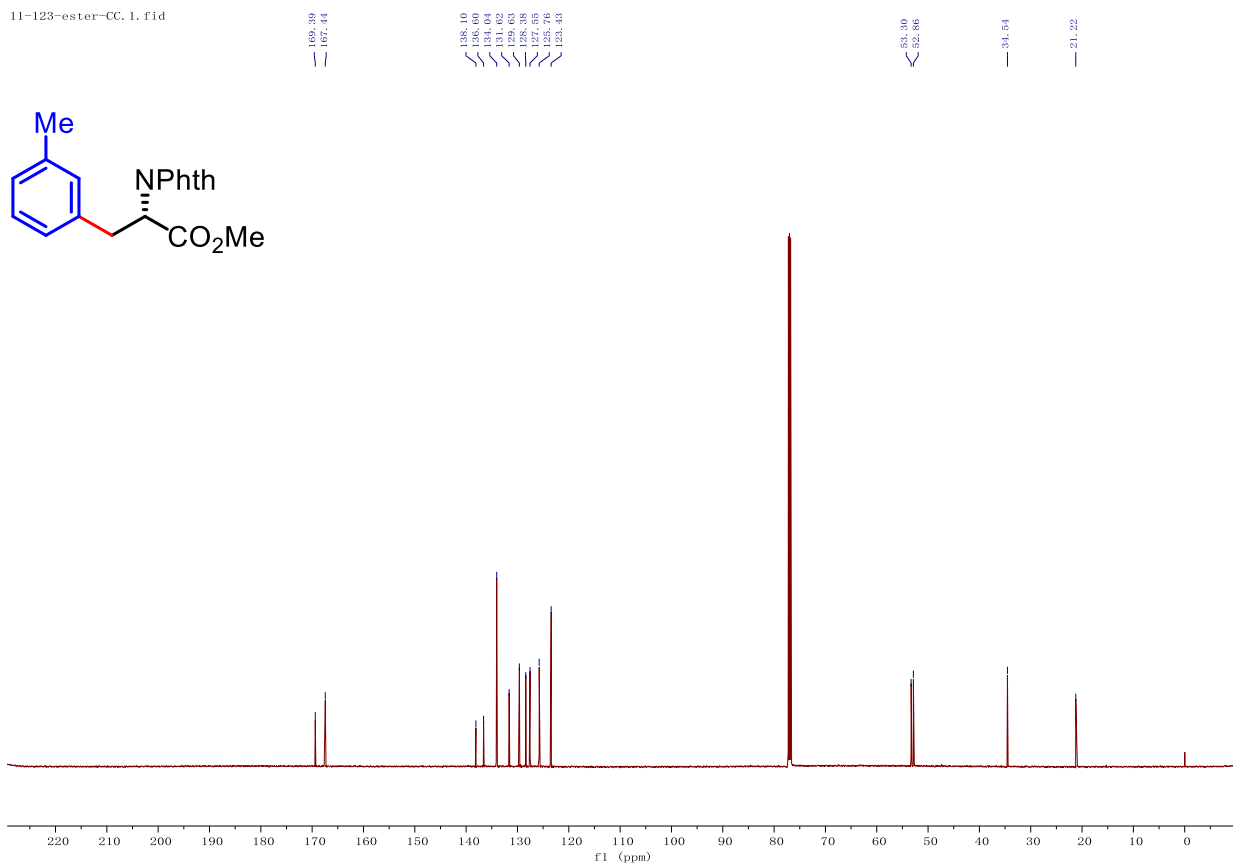
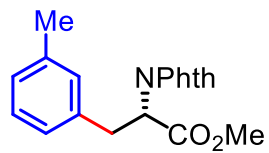
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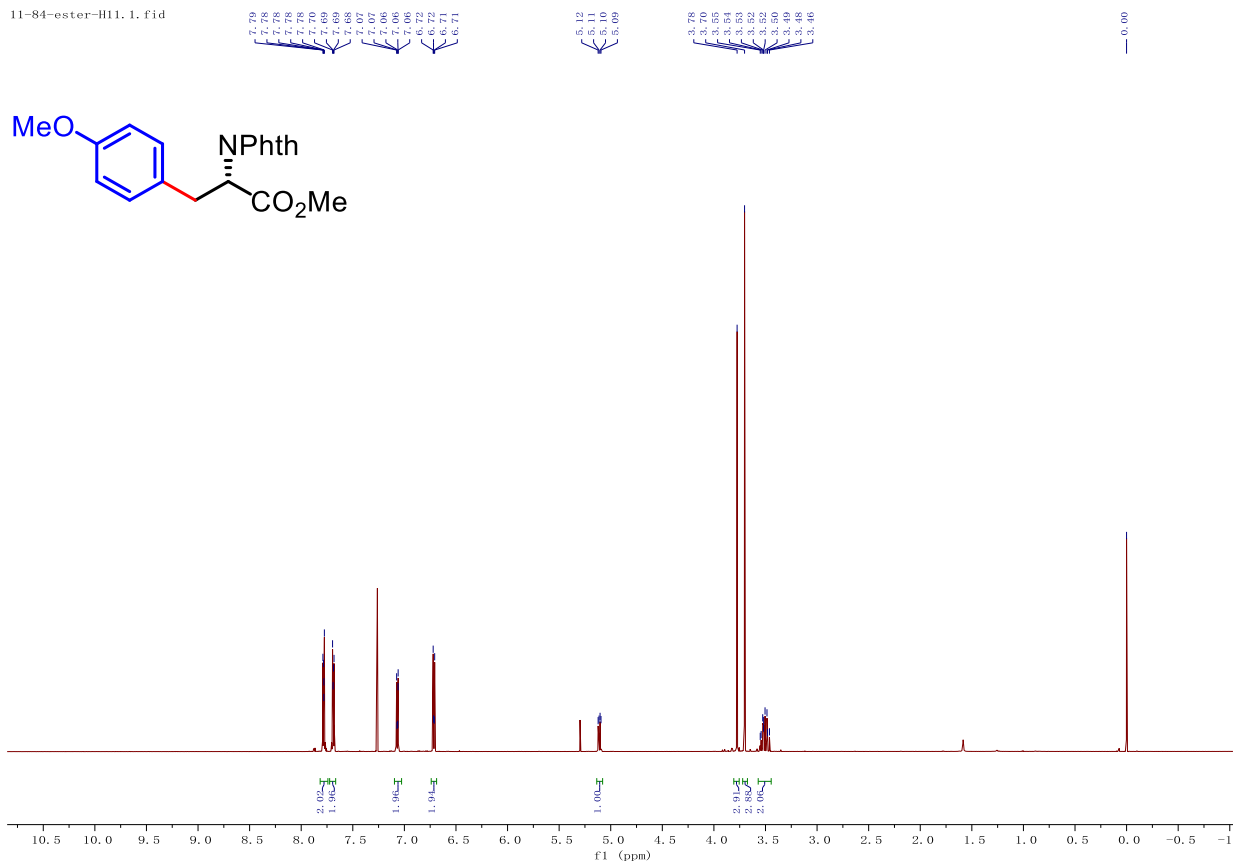
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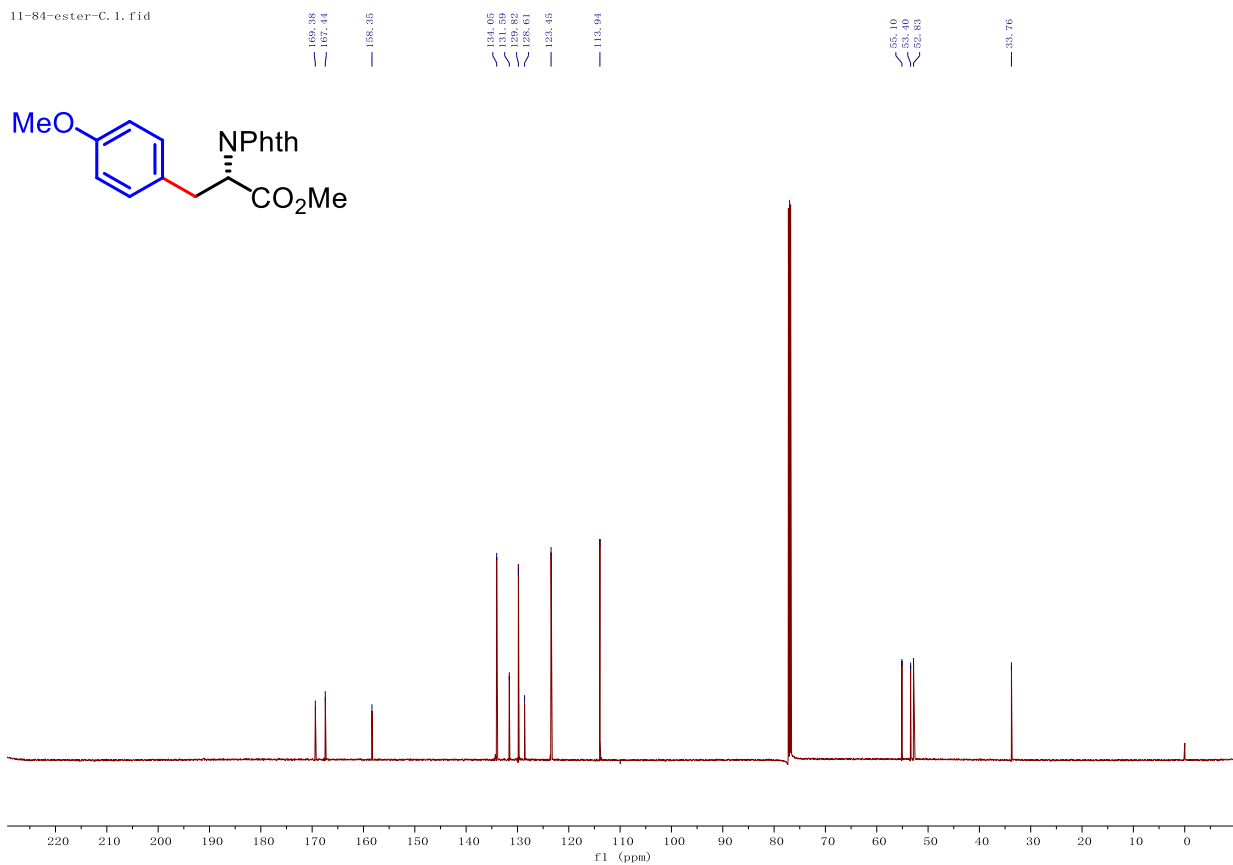
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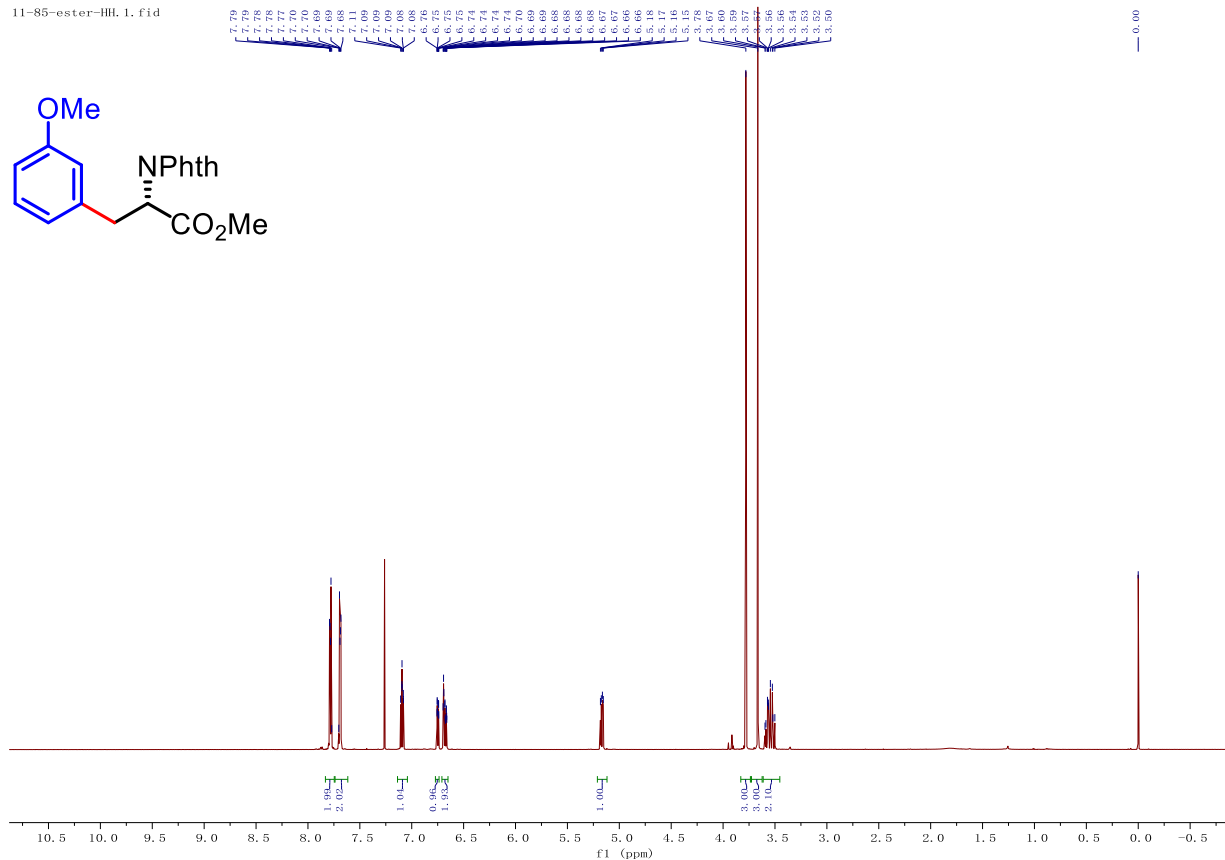
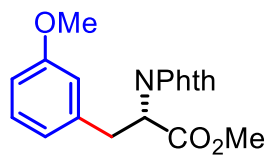
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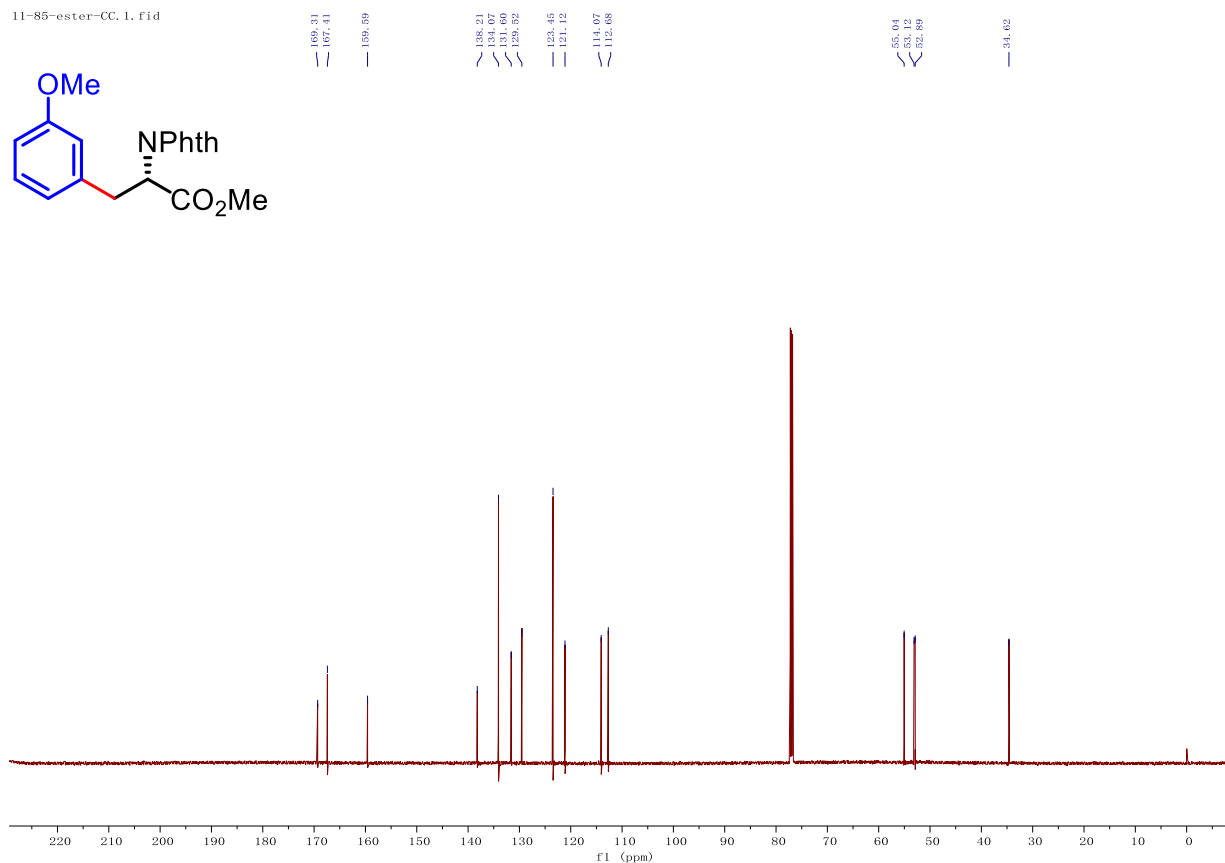
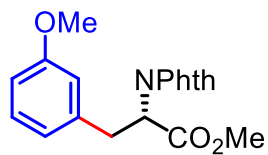
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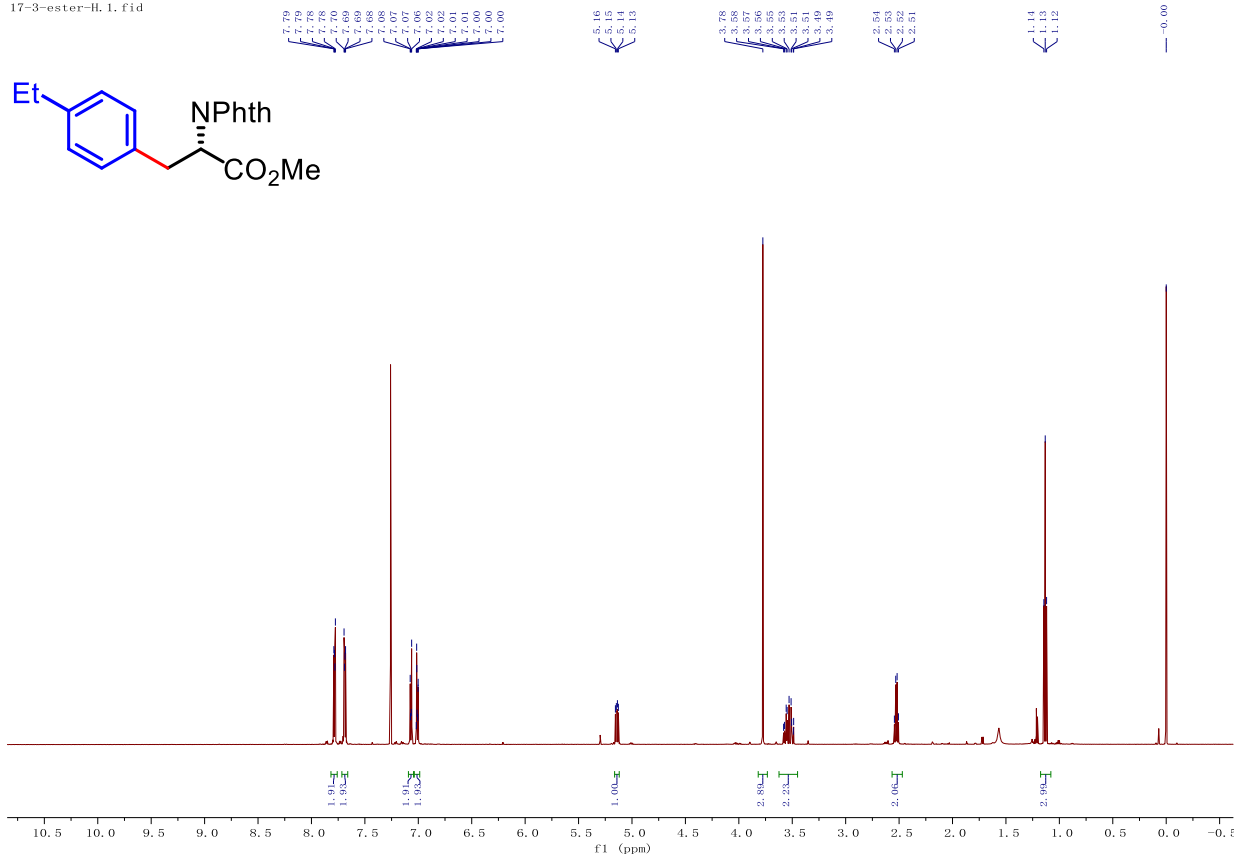
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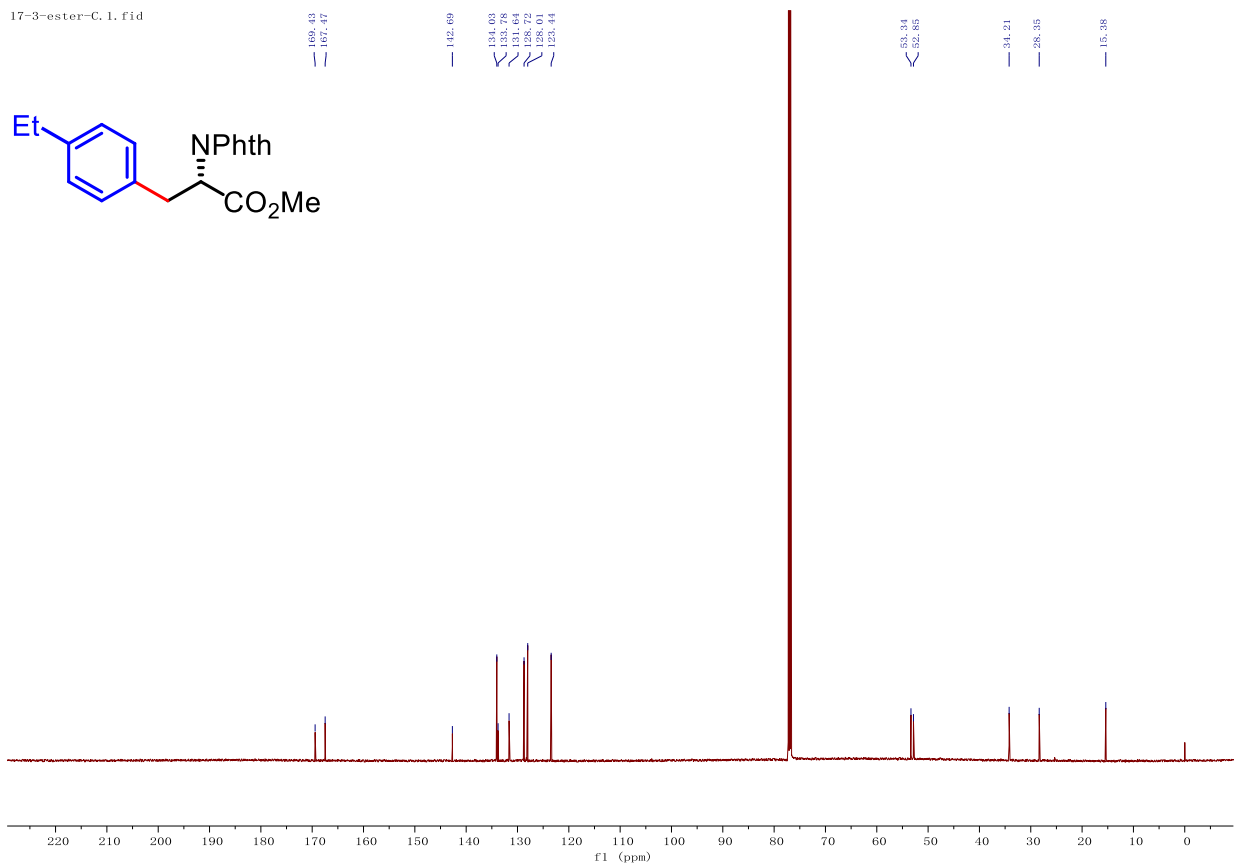
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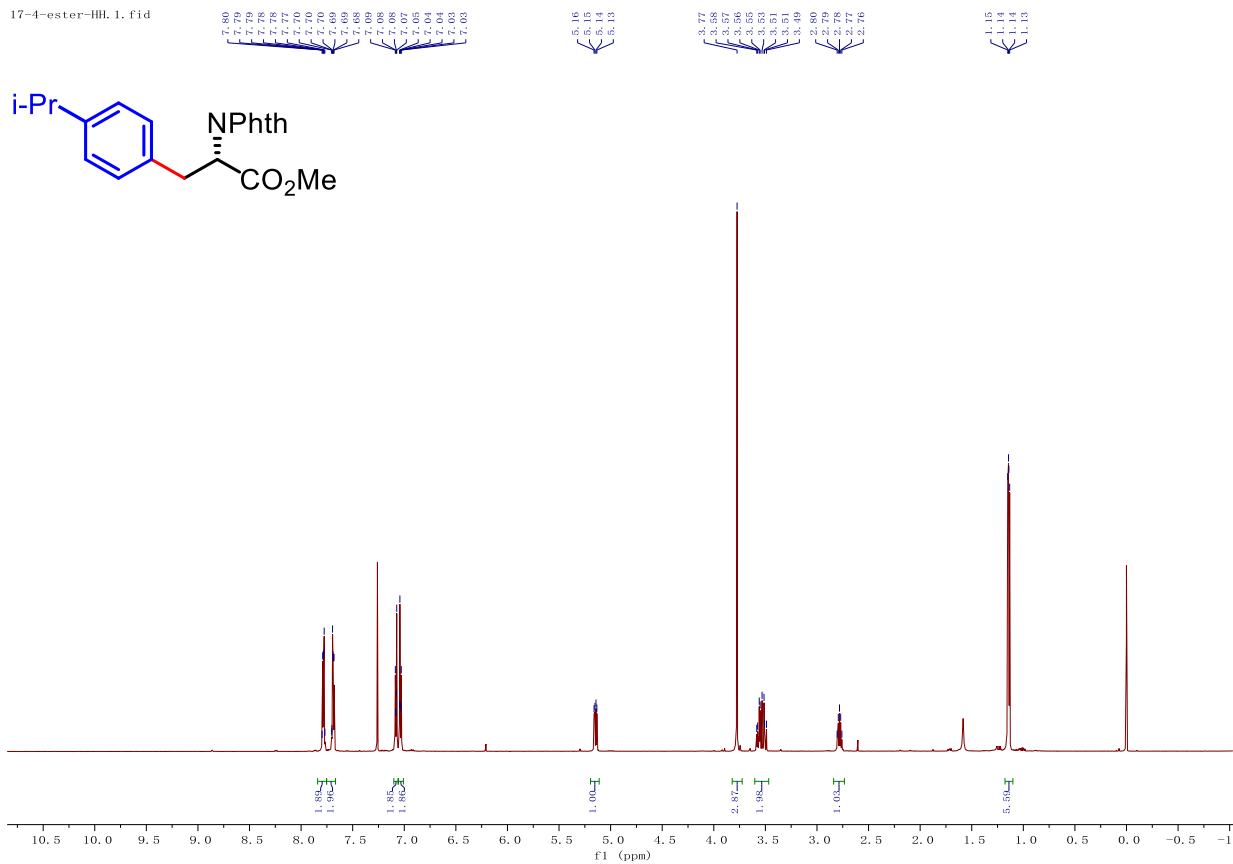
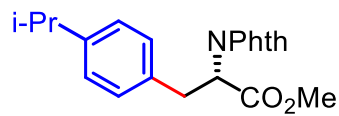
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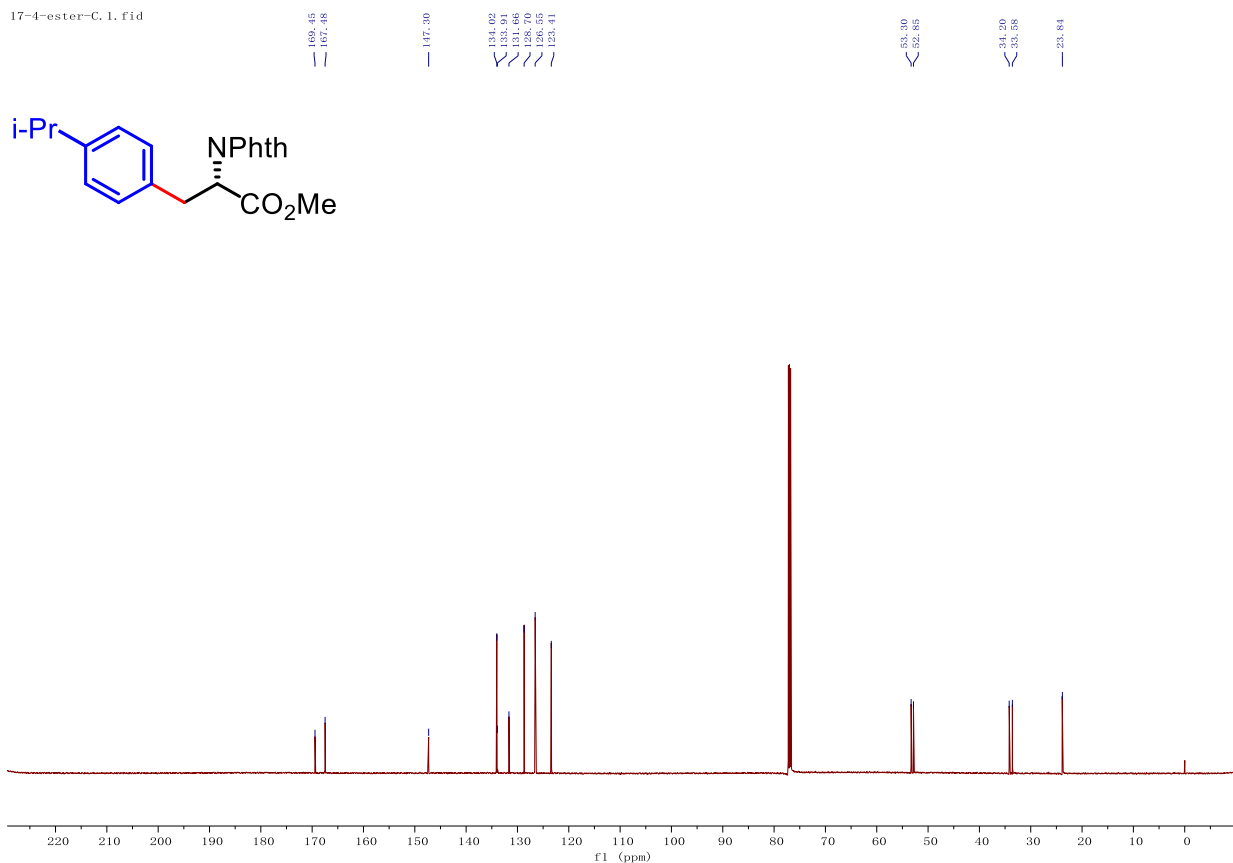
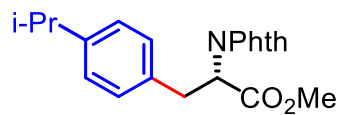
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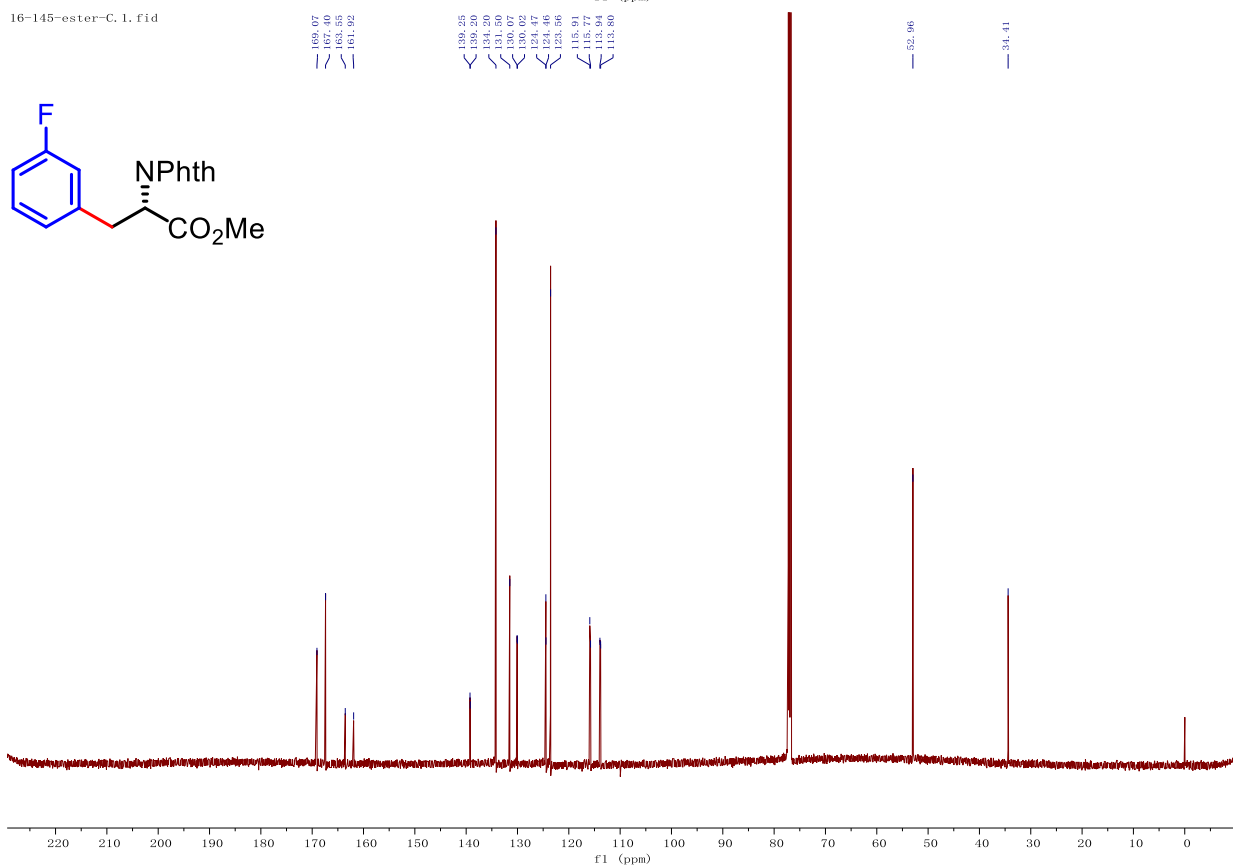
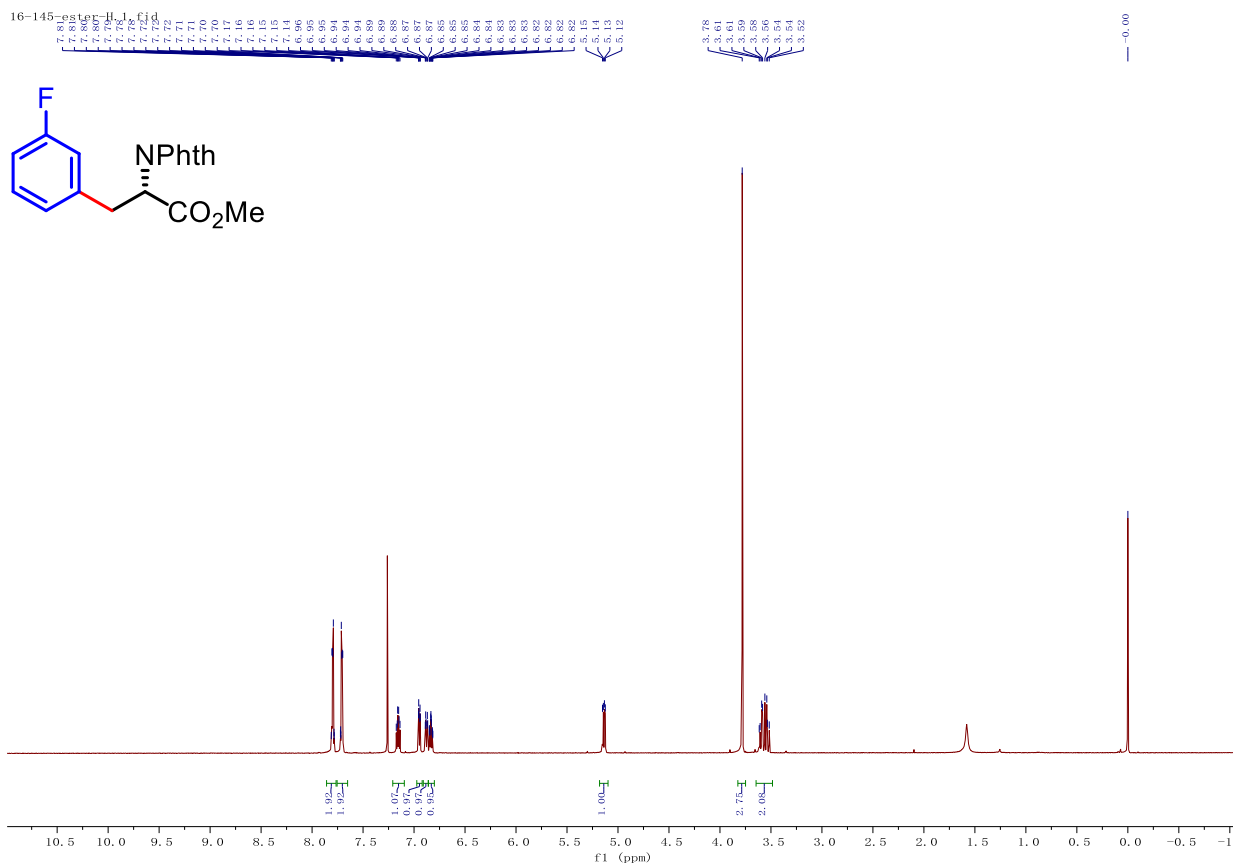


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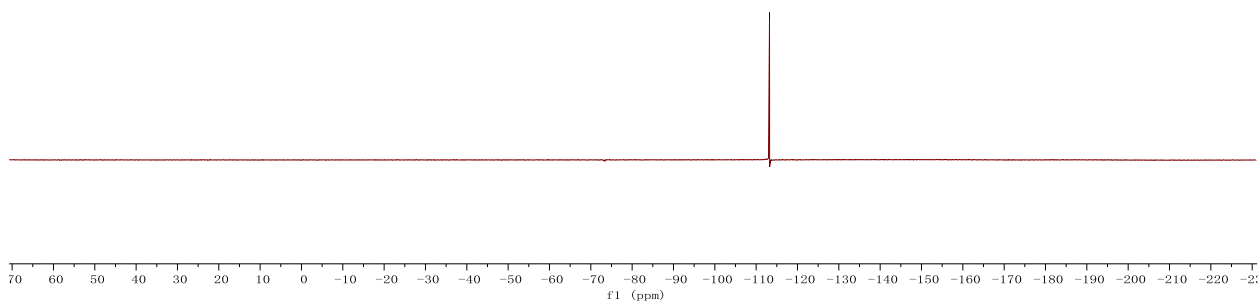
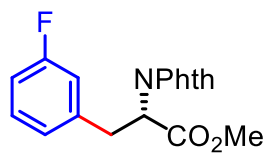


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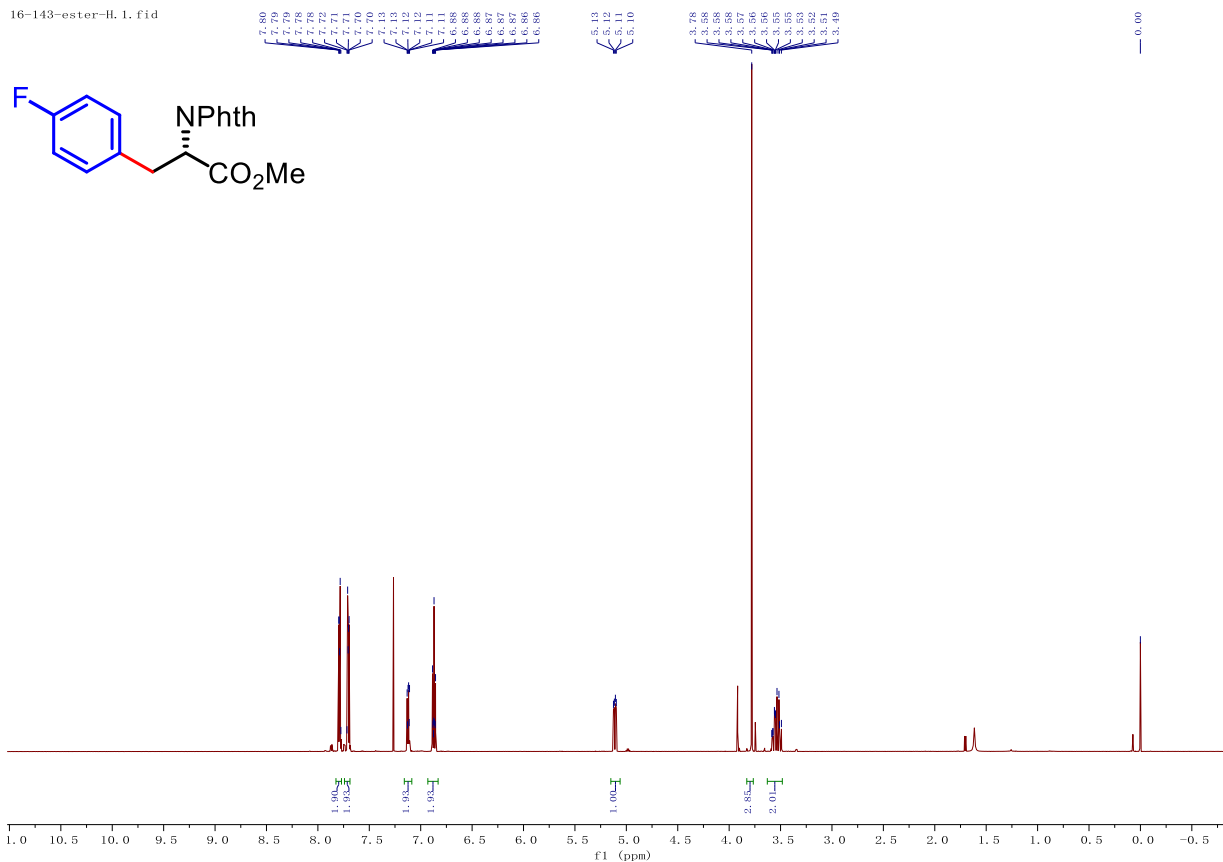




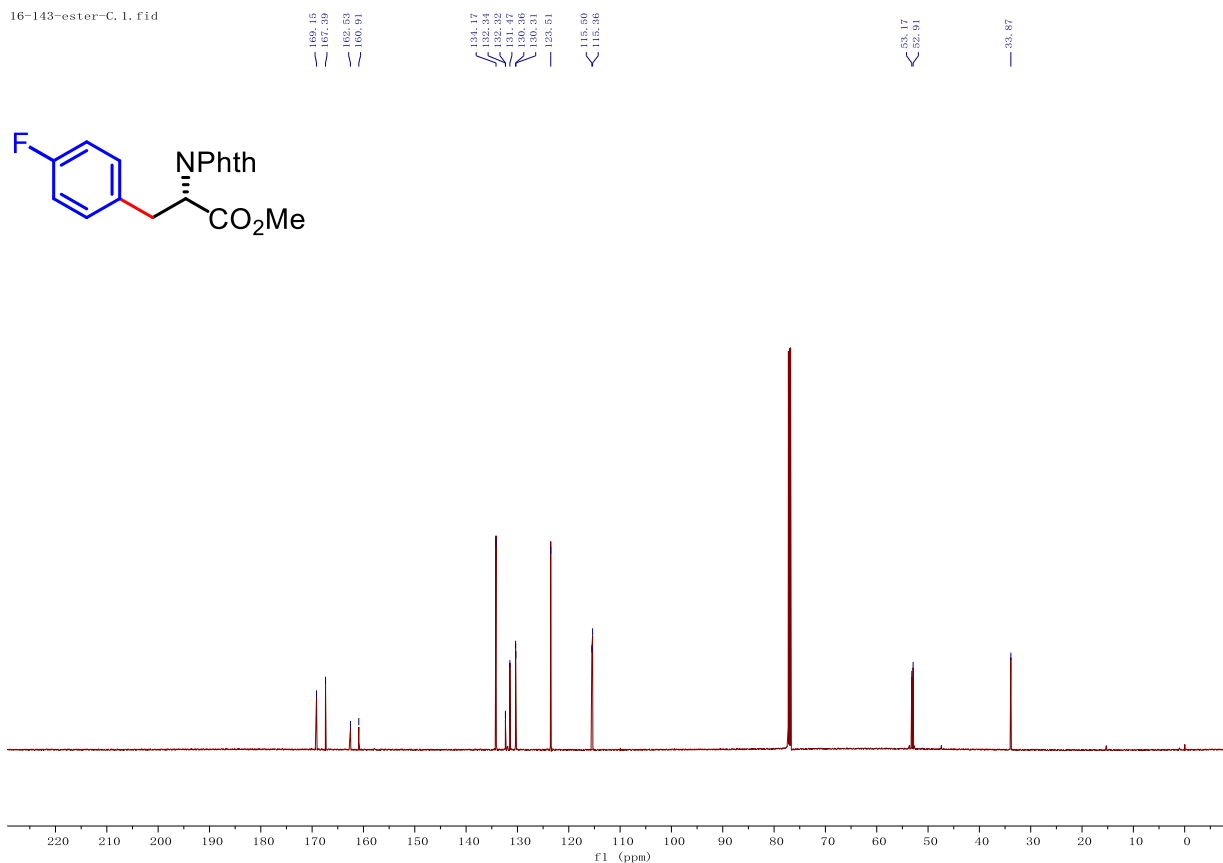


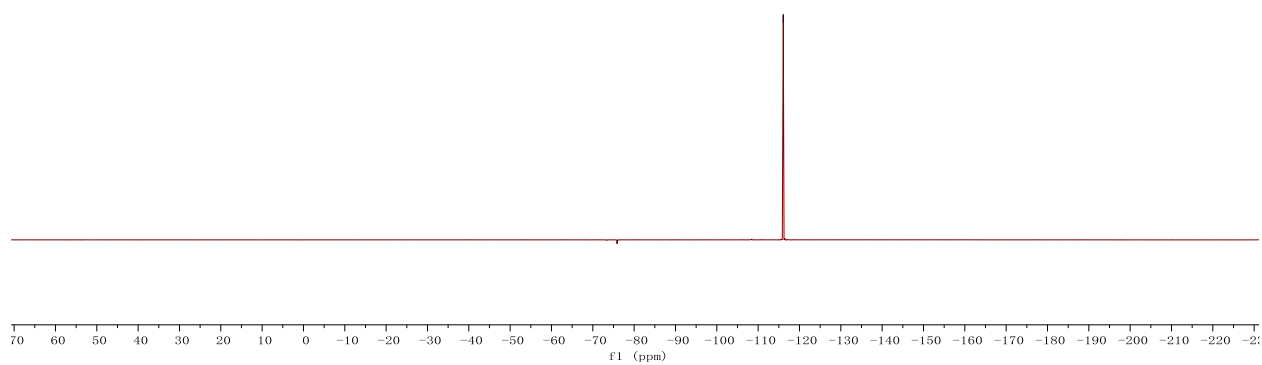
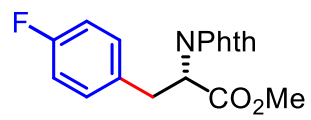


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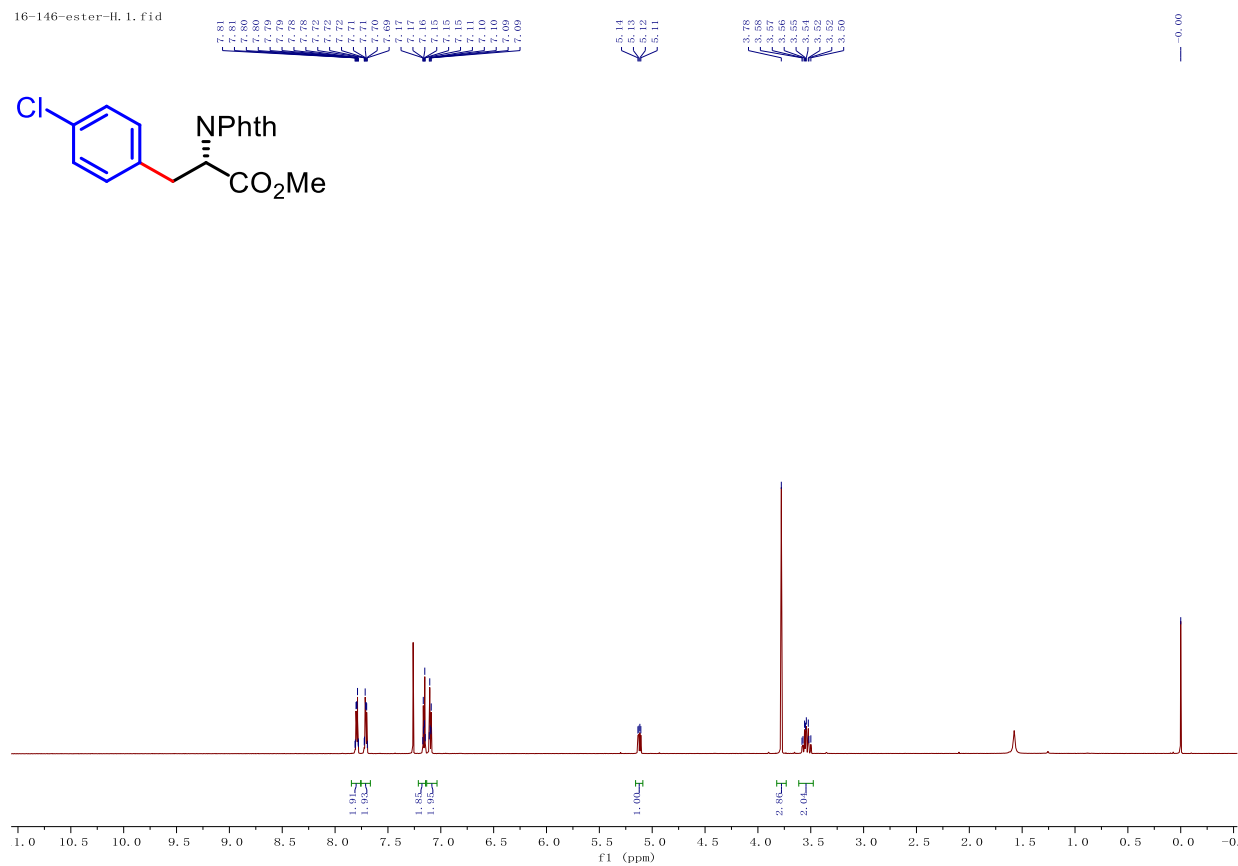
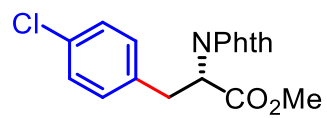


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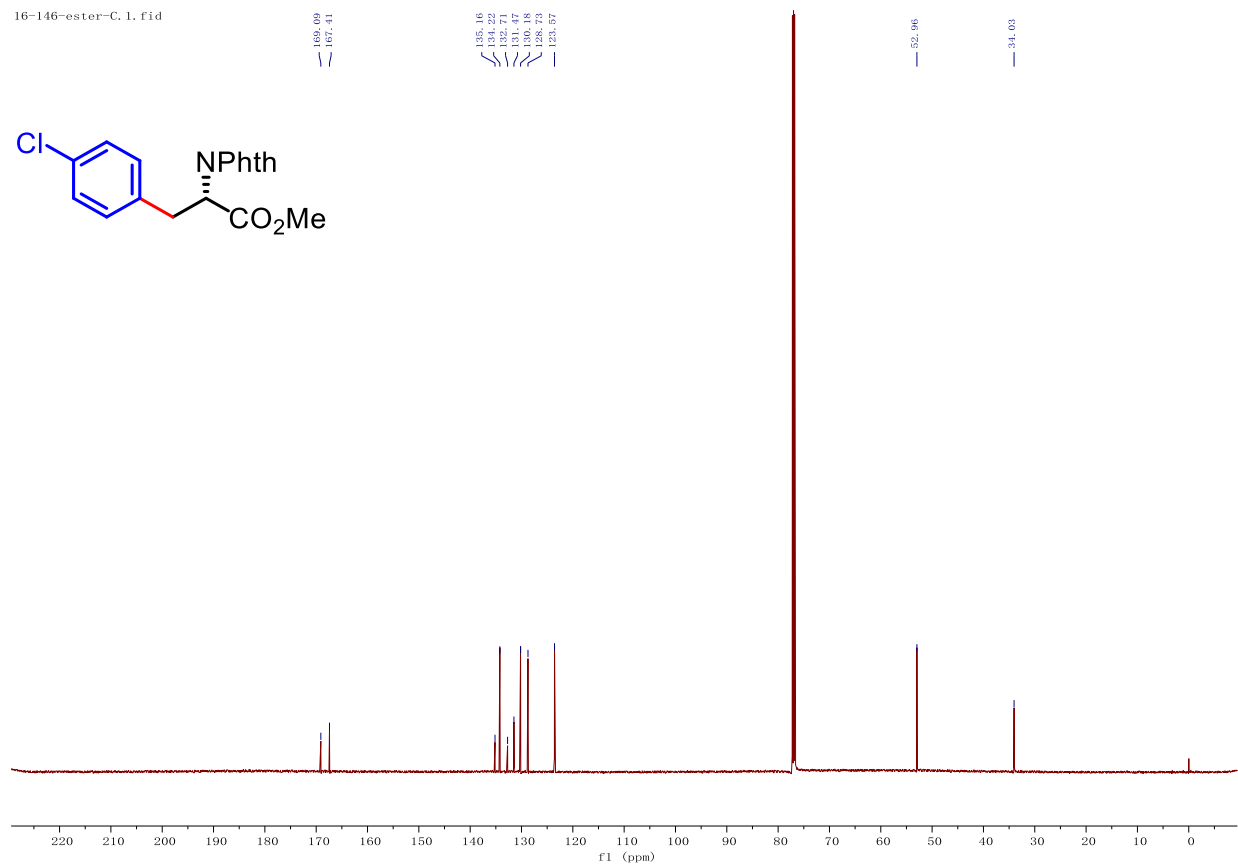
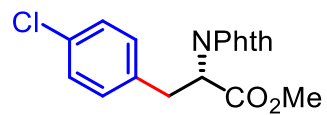




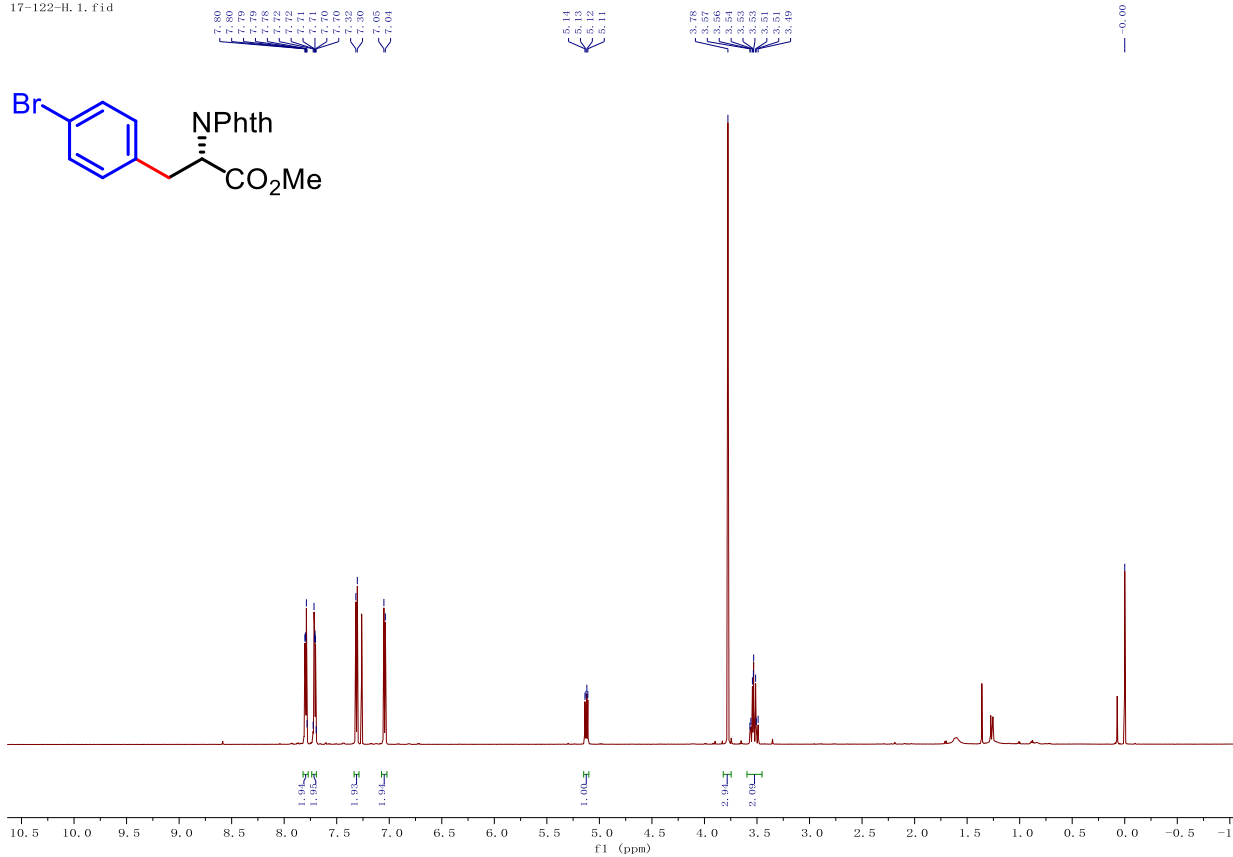
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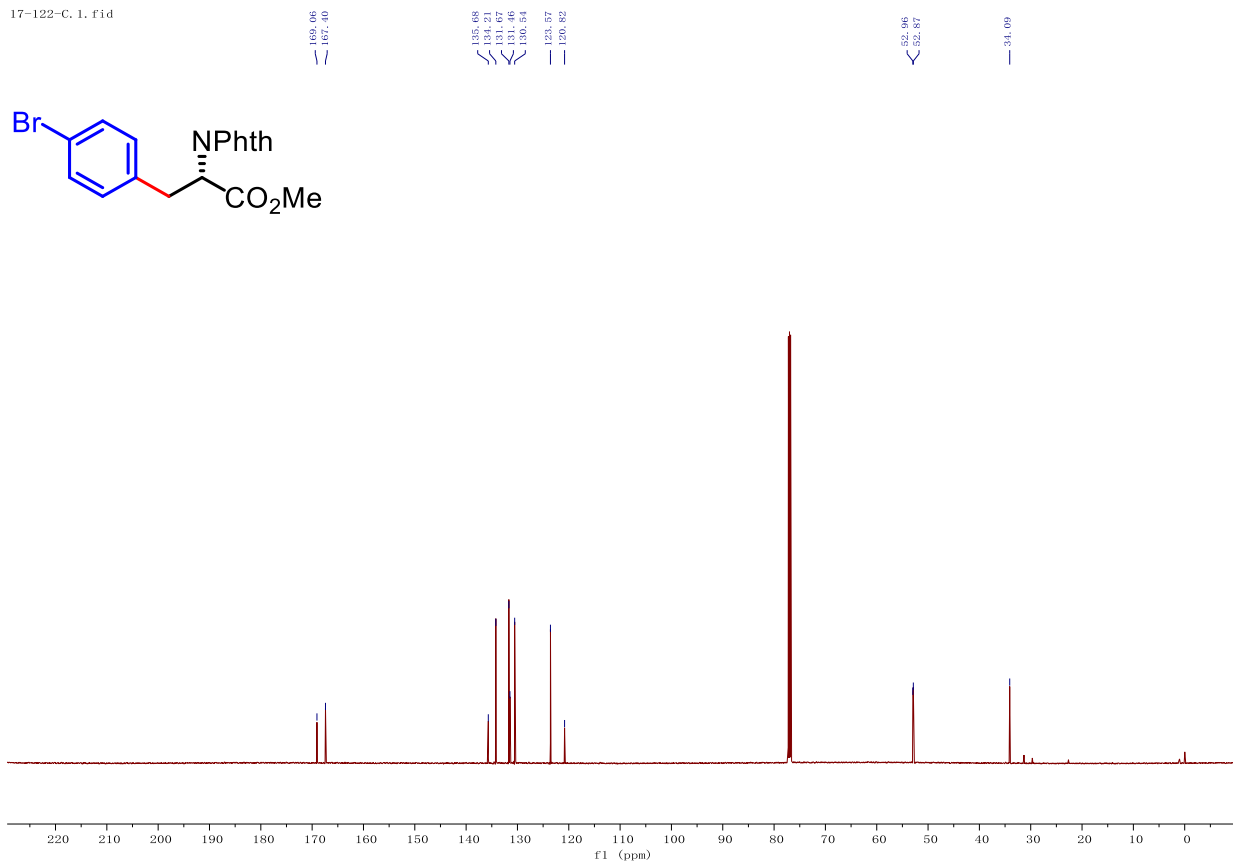
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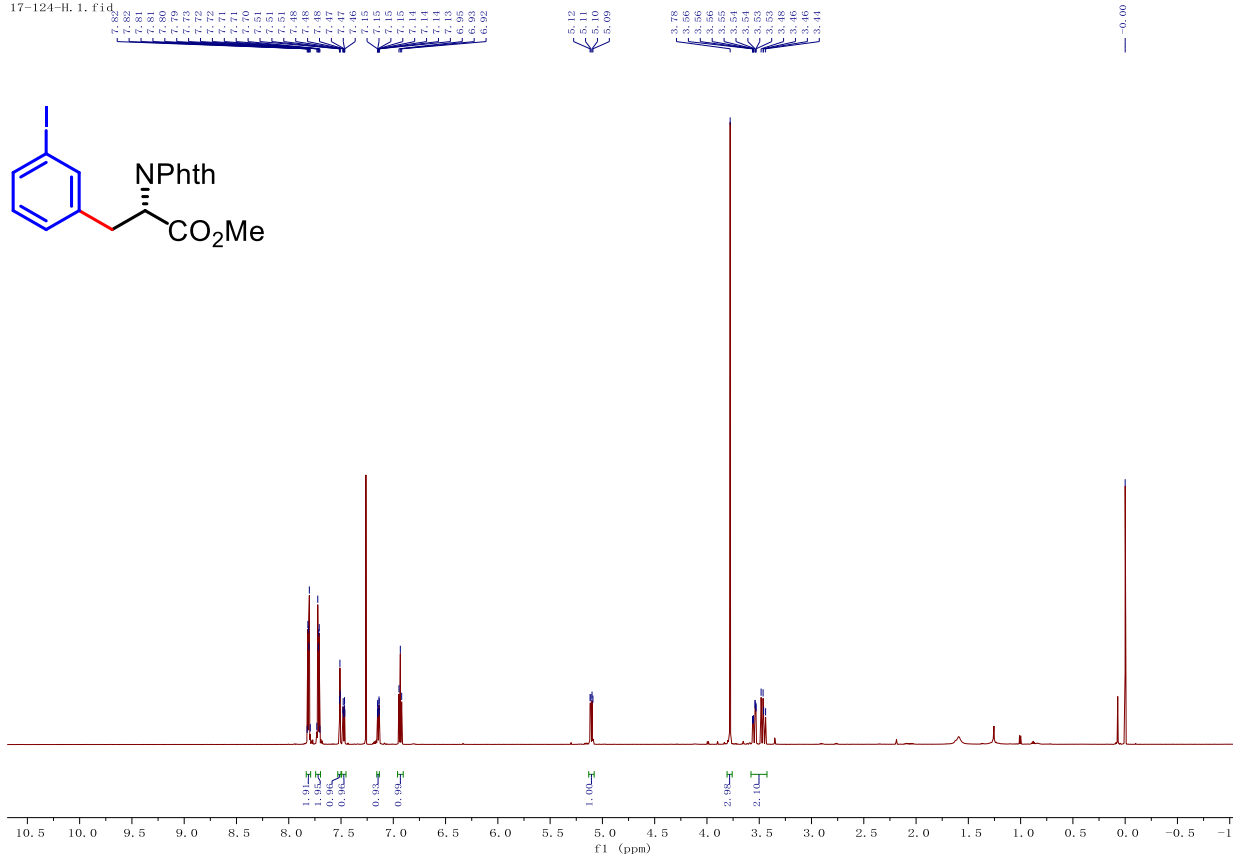
17-122-H. 1. fid



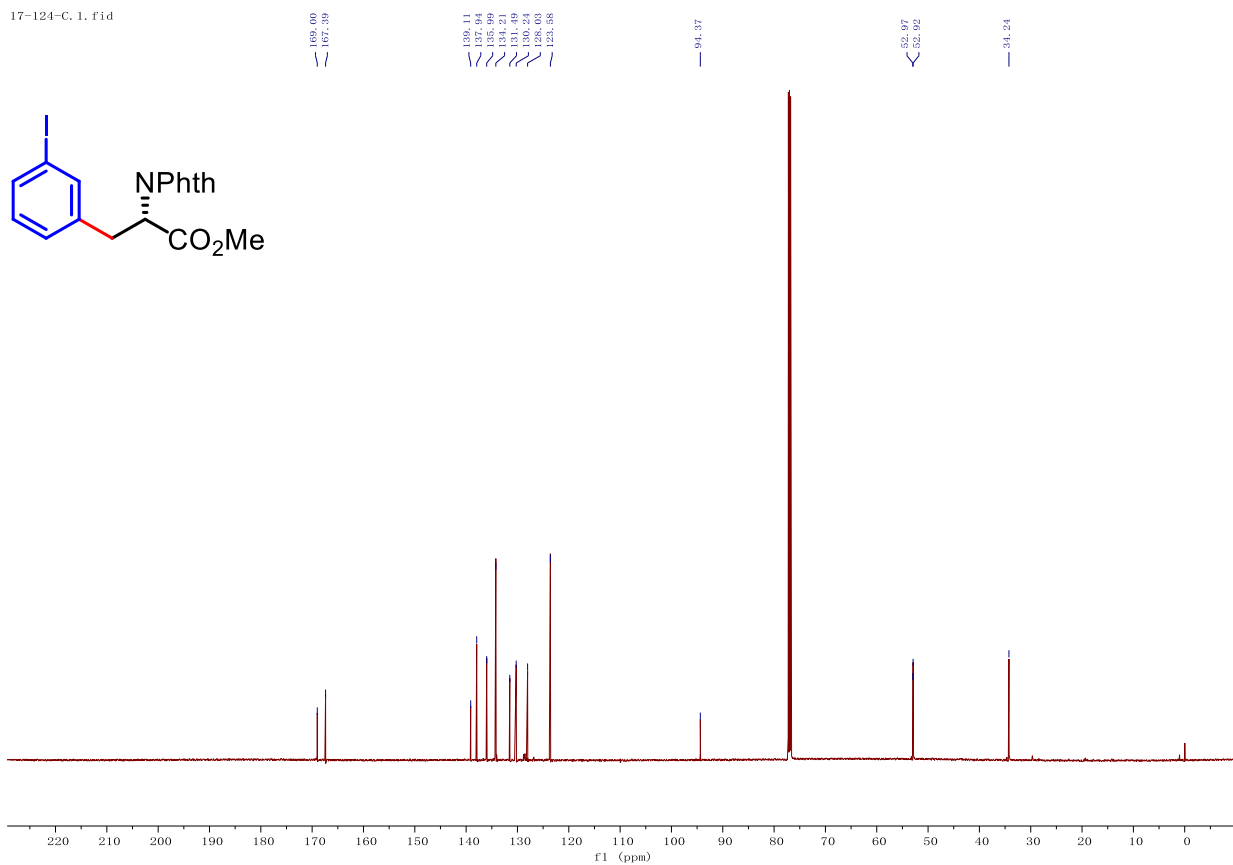
17-122-C. 1. fid



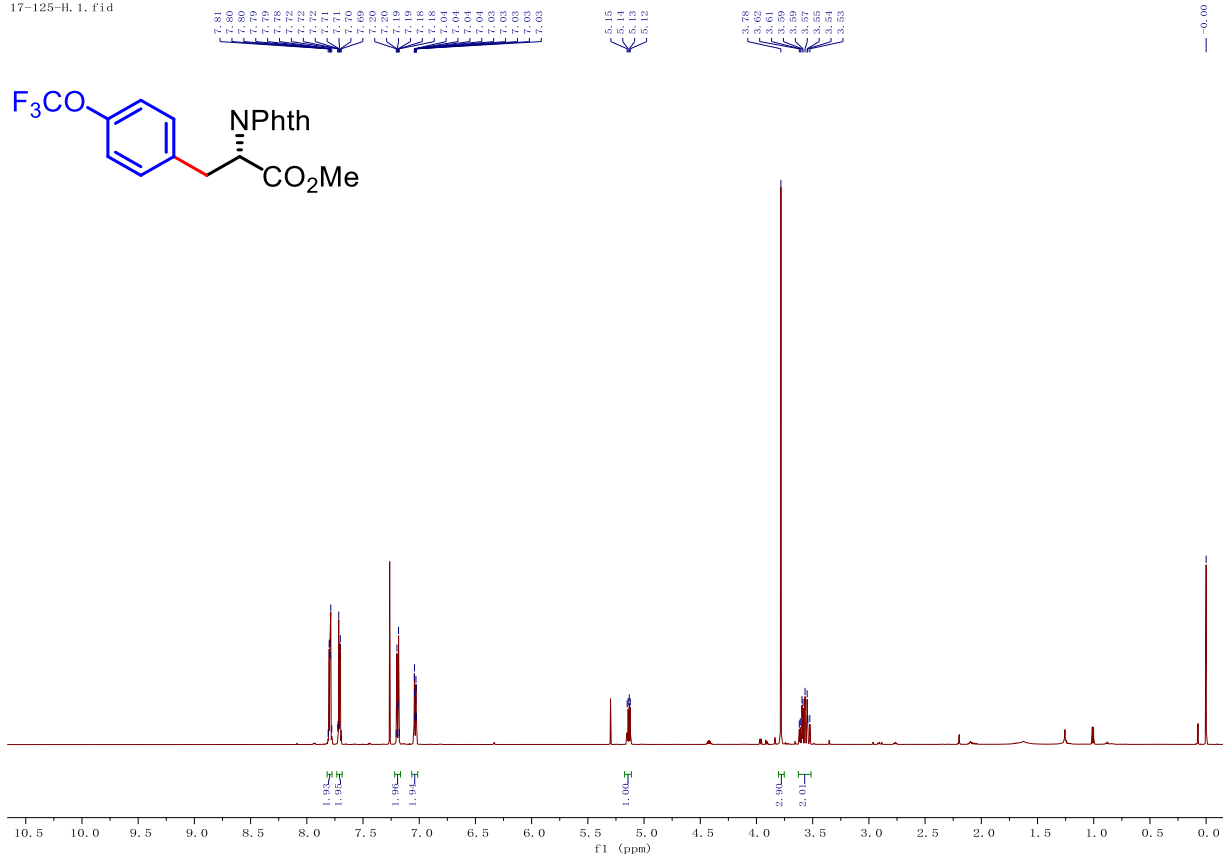
17-124-H. 1. Fid



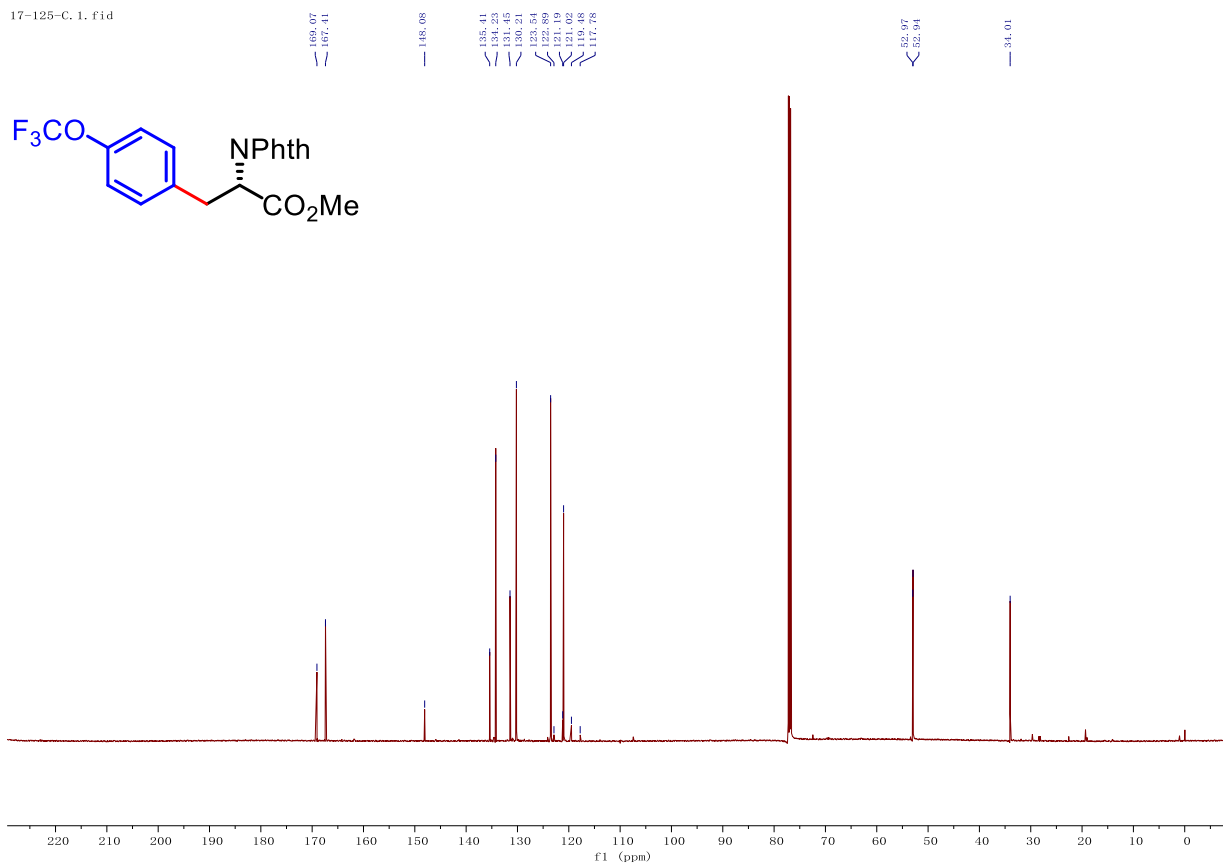
17-124-C. 1. Fid

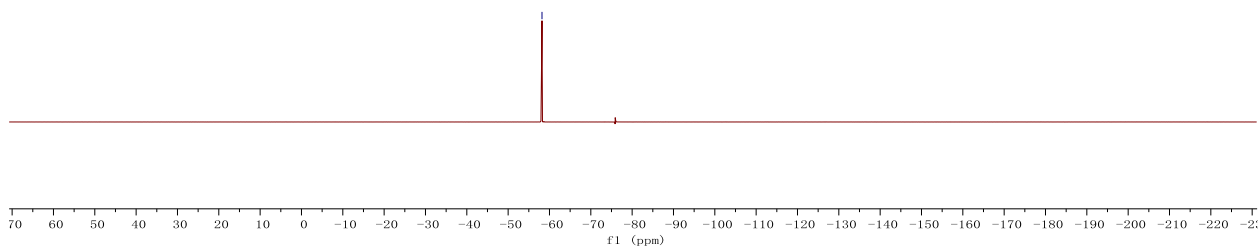
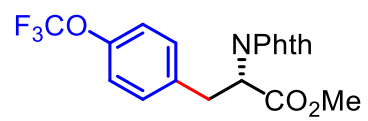


17-125-H. 1. fid



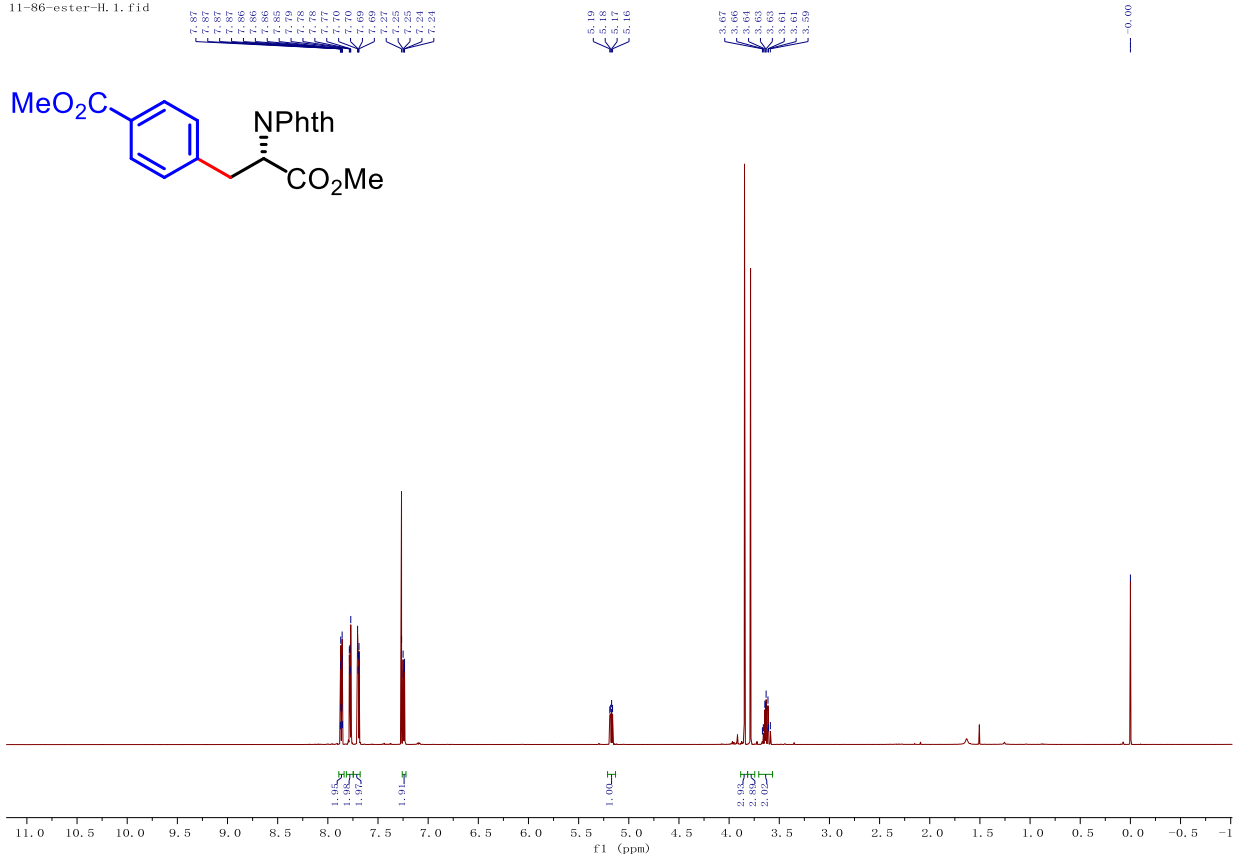
17-125-C. 1. fid



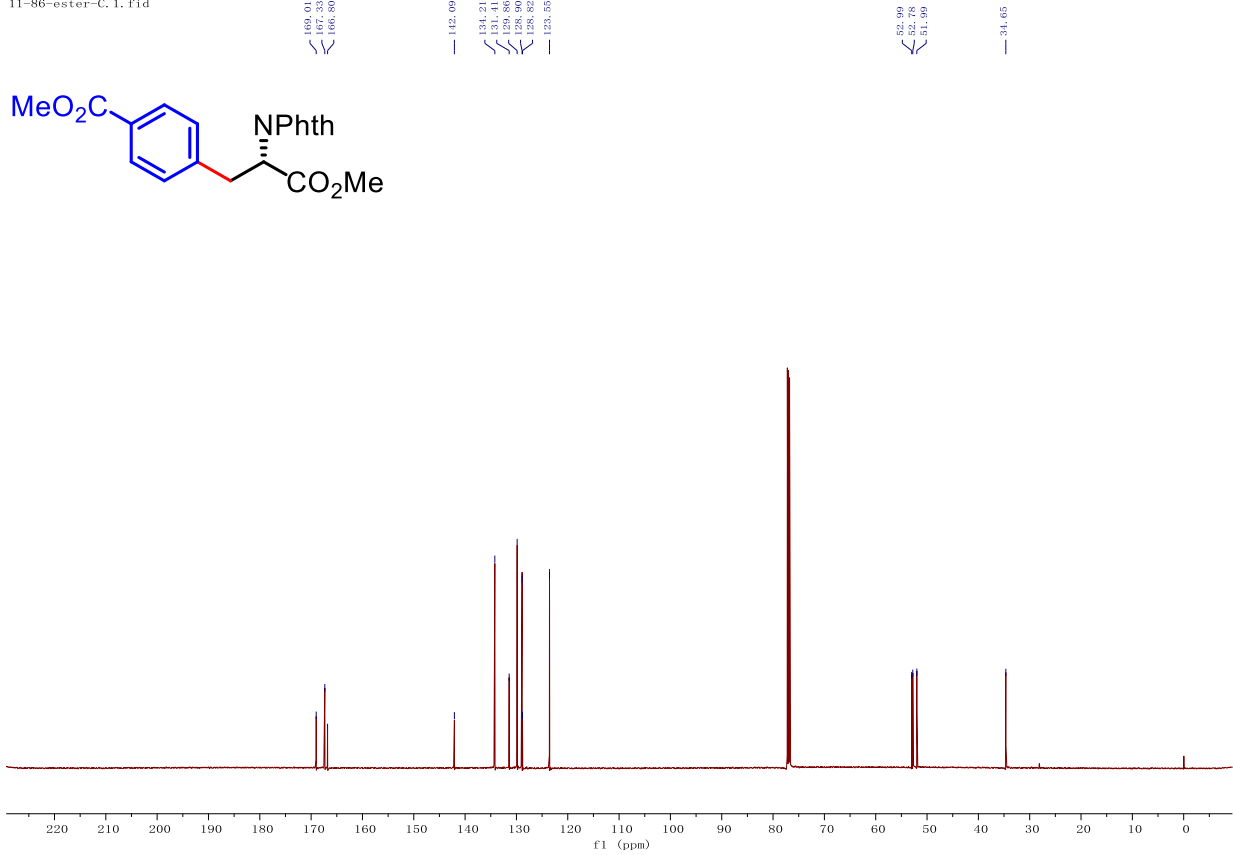




11-86-ester-H. 1. fid

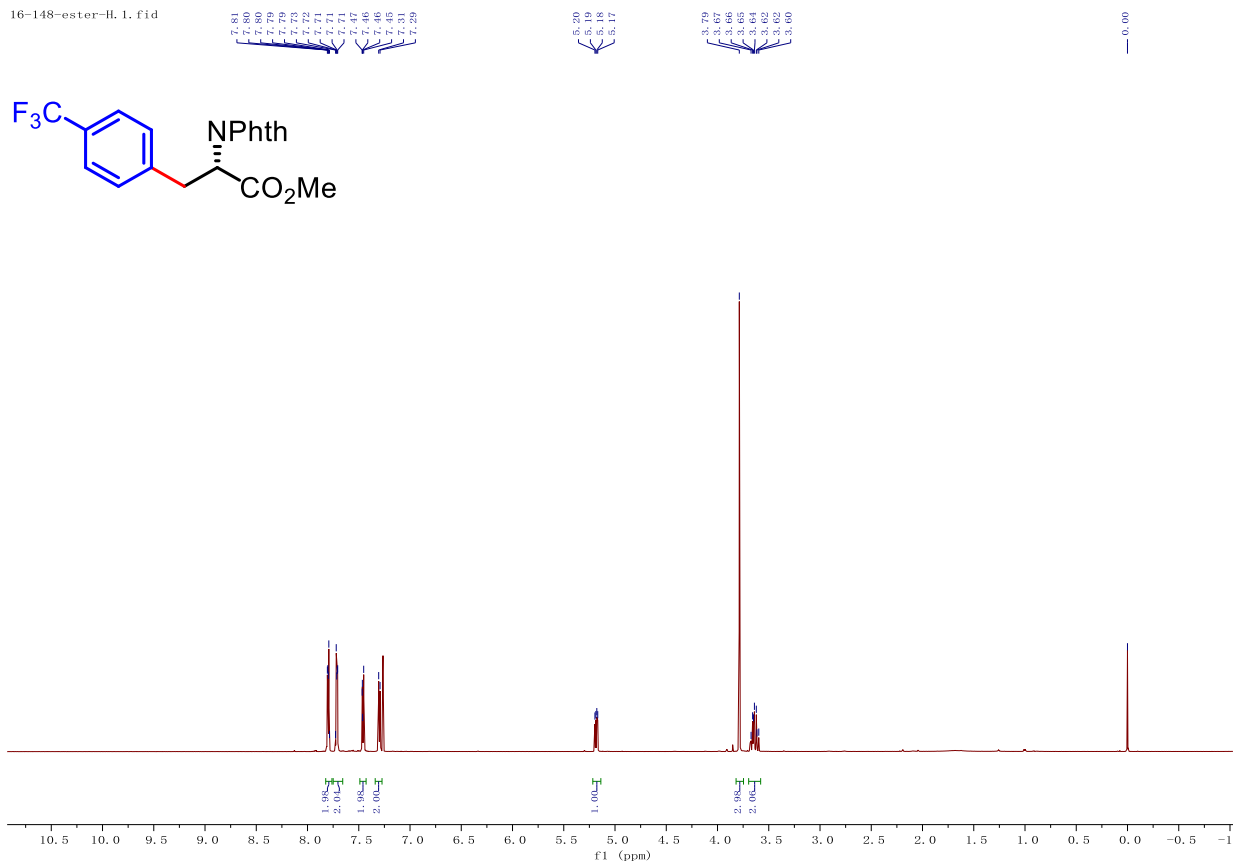
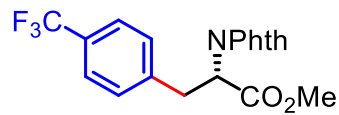


11-86-ester-C. 1. fid

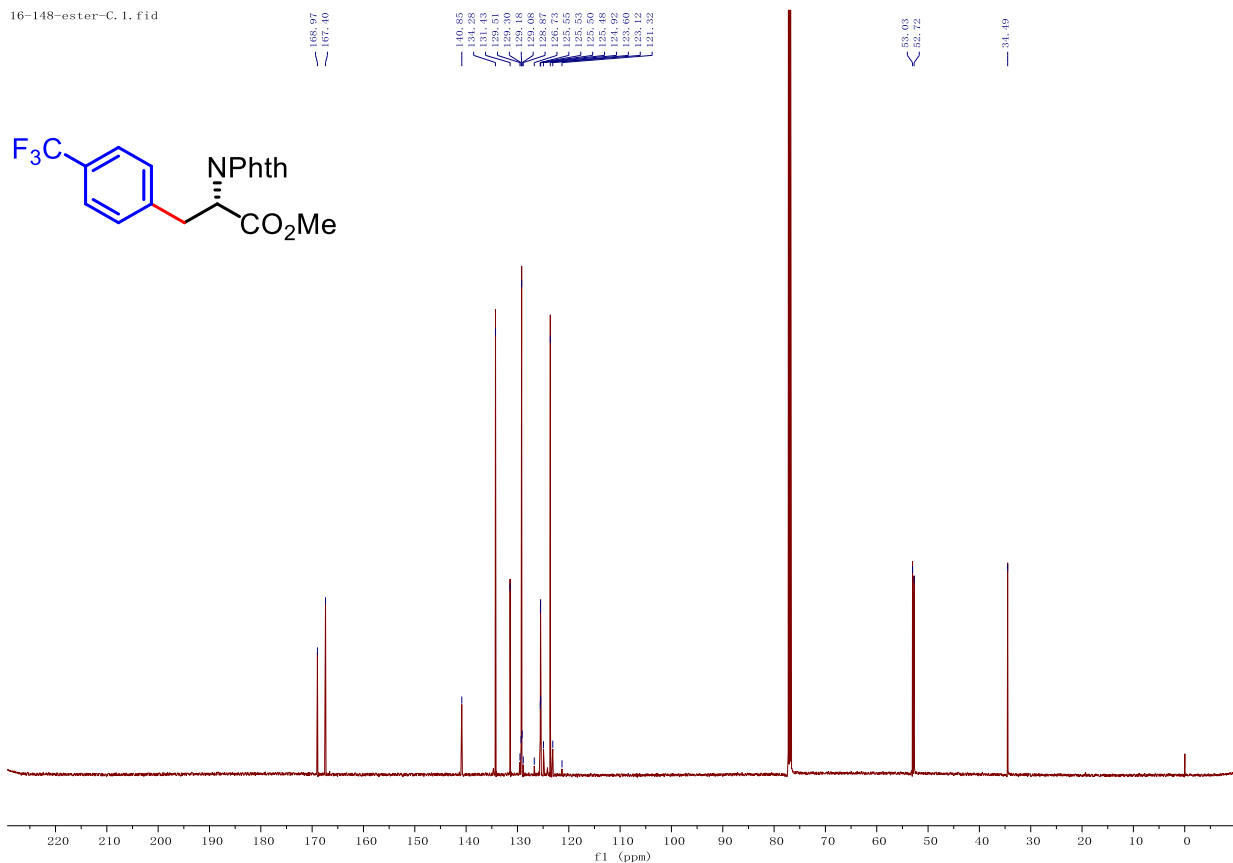
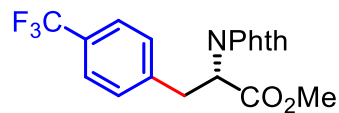


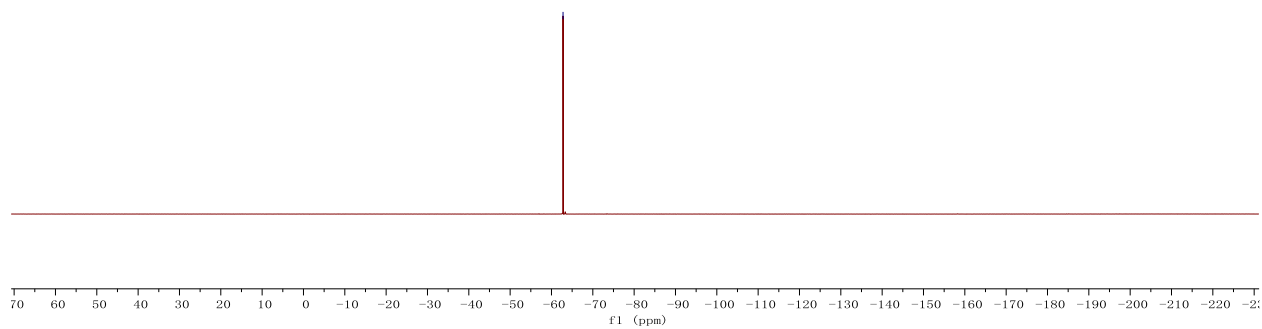
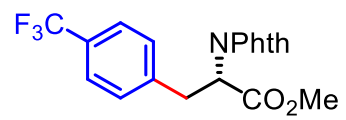


16-148-ester-H.1.fid

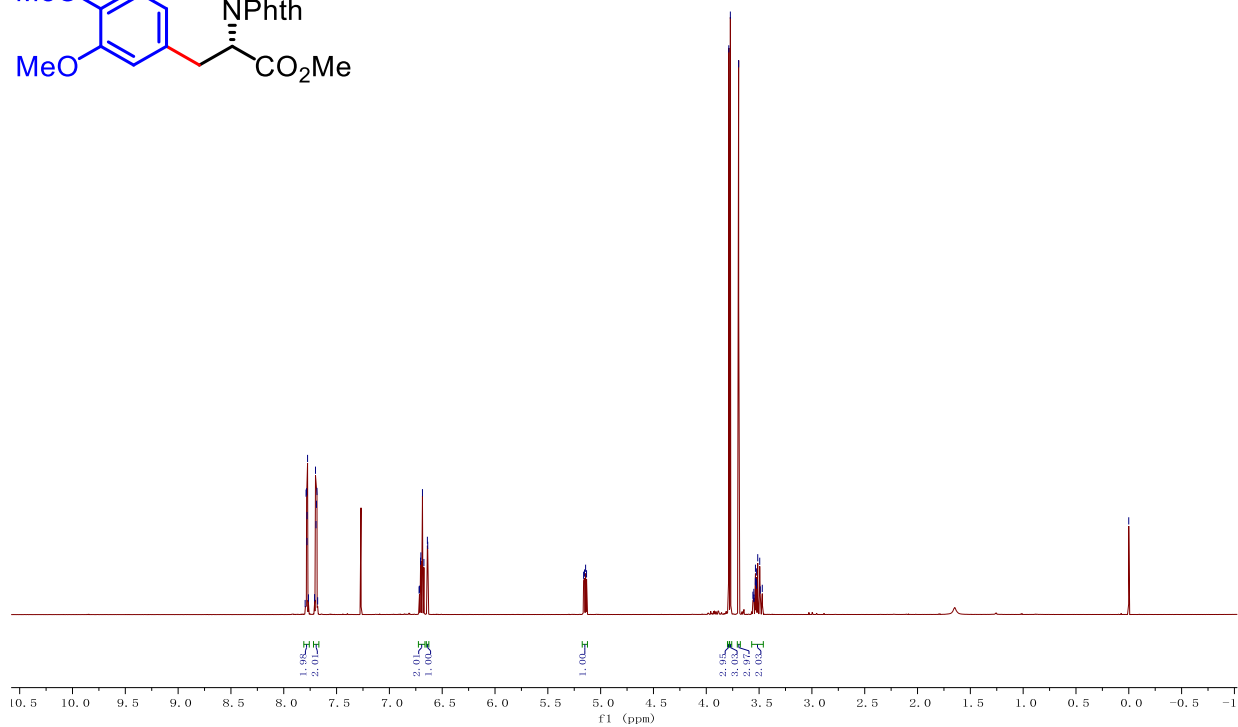
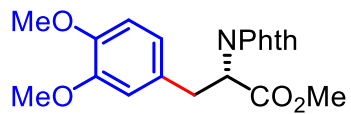


16-148-ester-C.1.fid

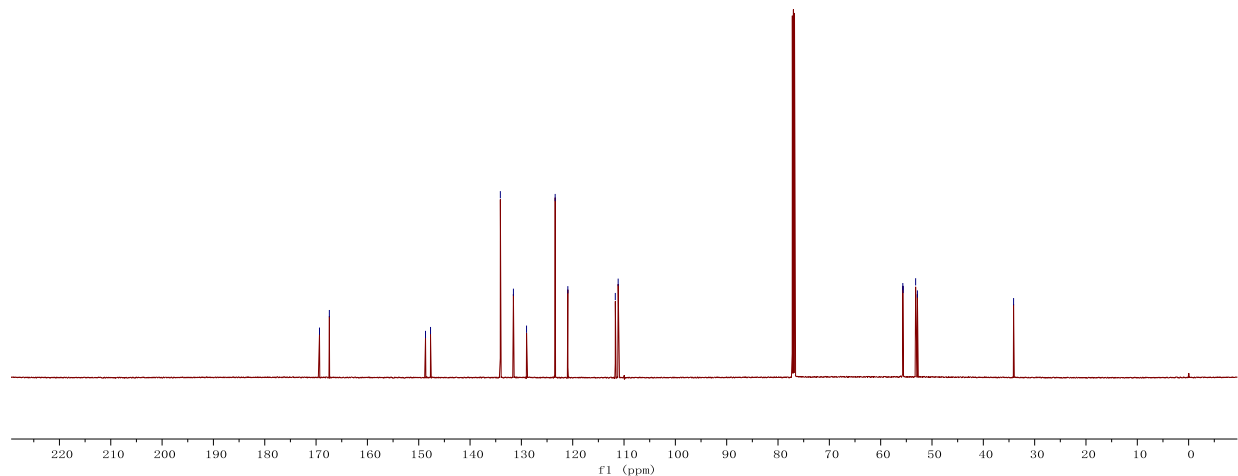
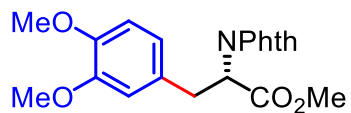




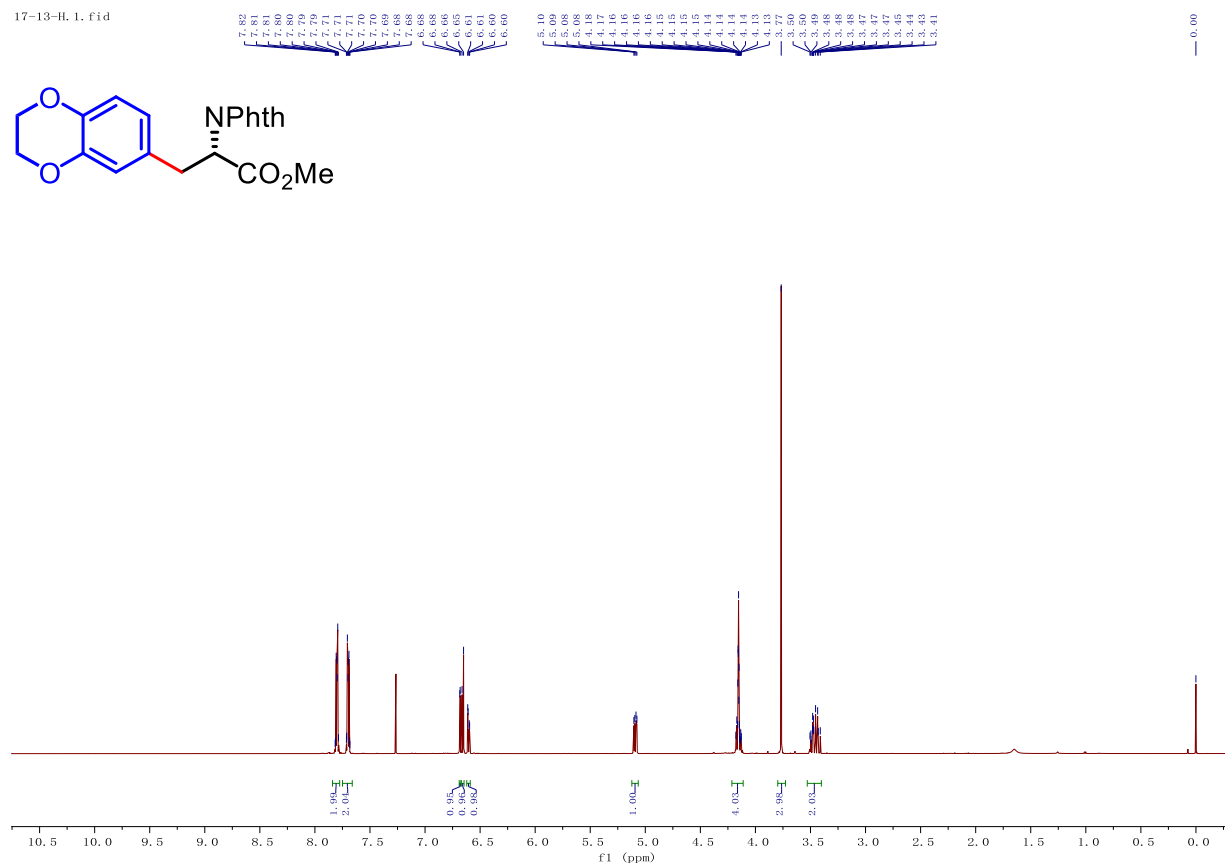
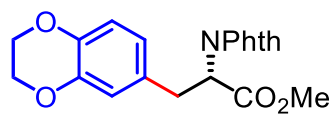
17-12-H, 1. fid



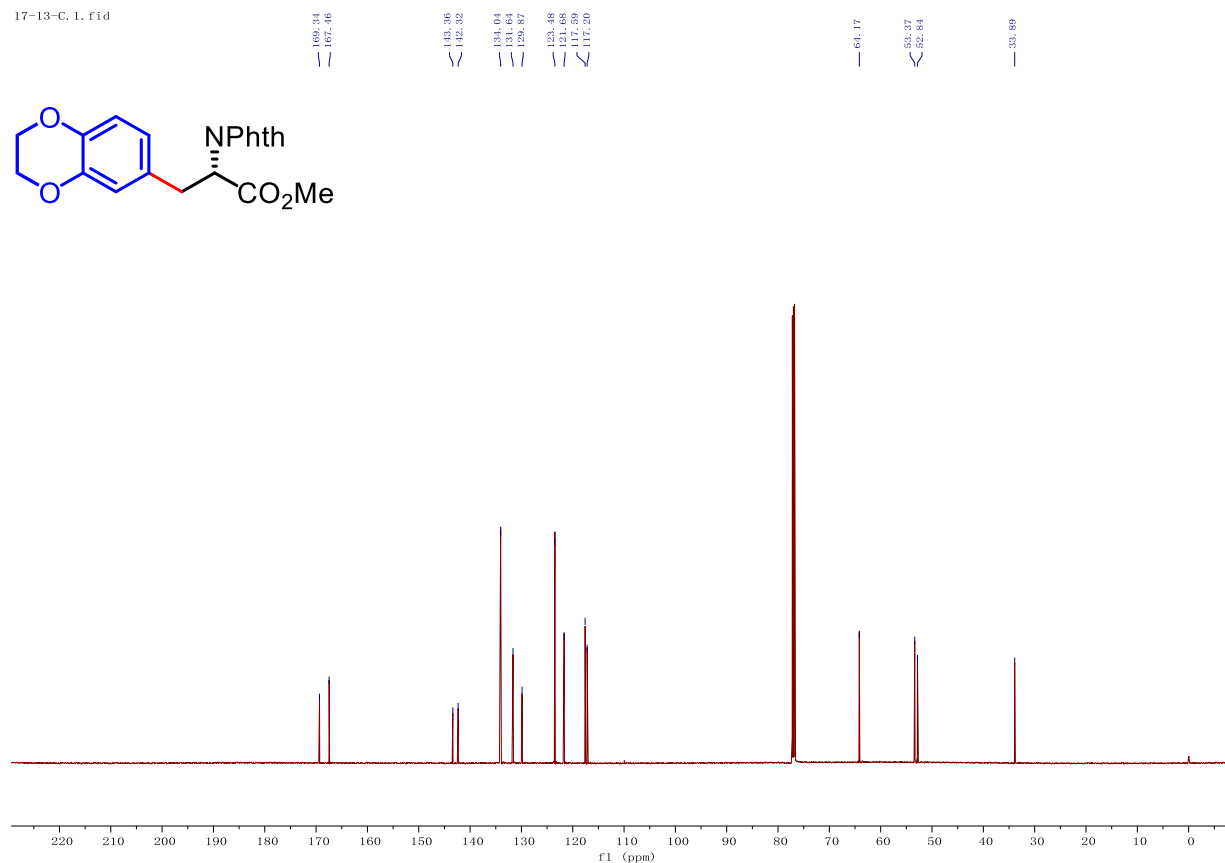
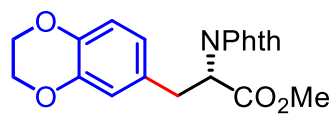
17-12-C, 1. fid



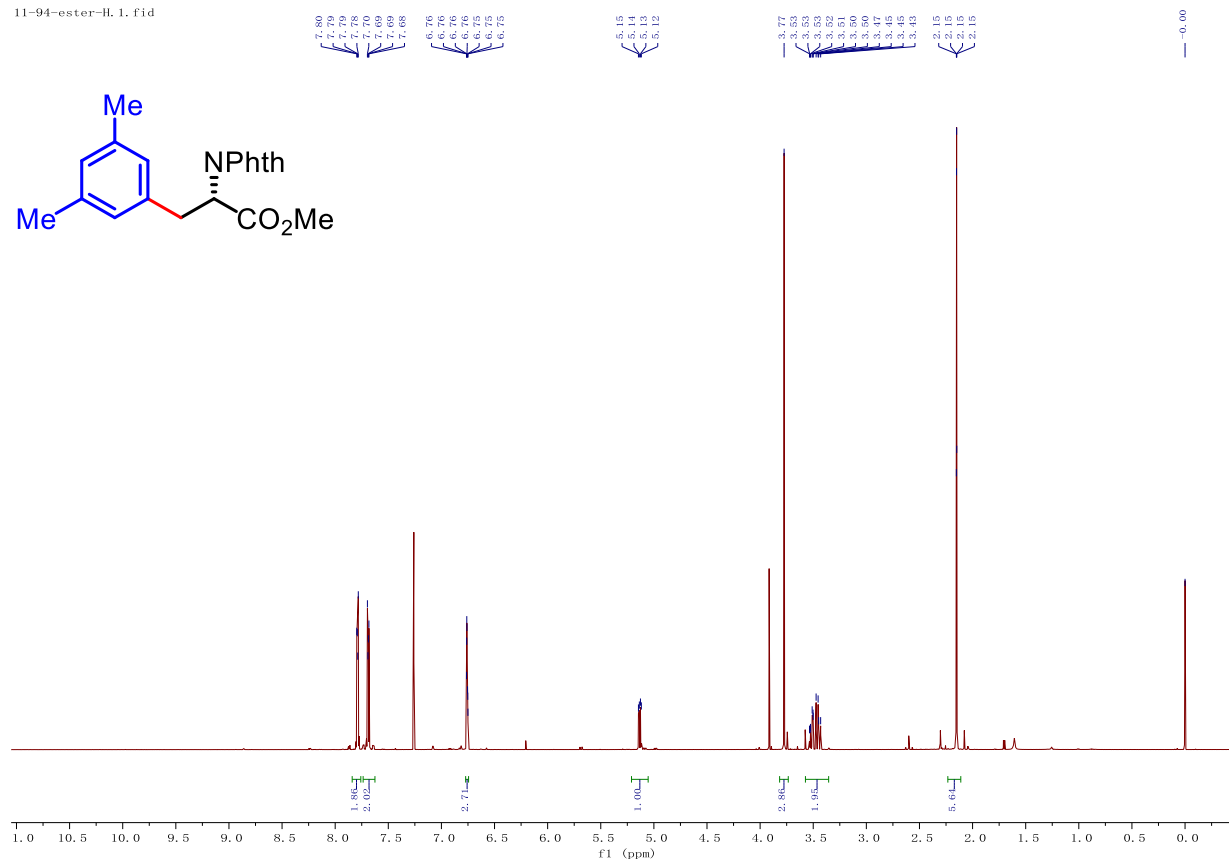
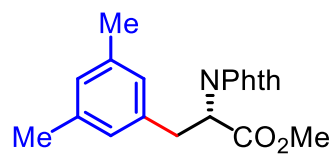
17-13-H, 1. fid



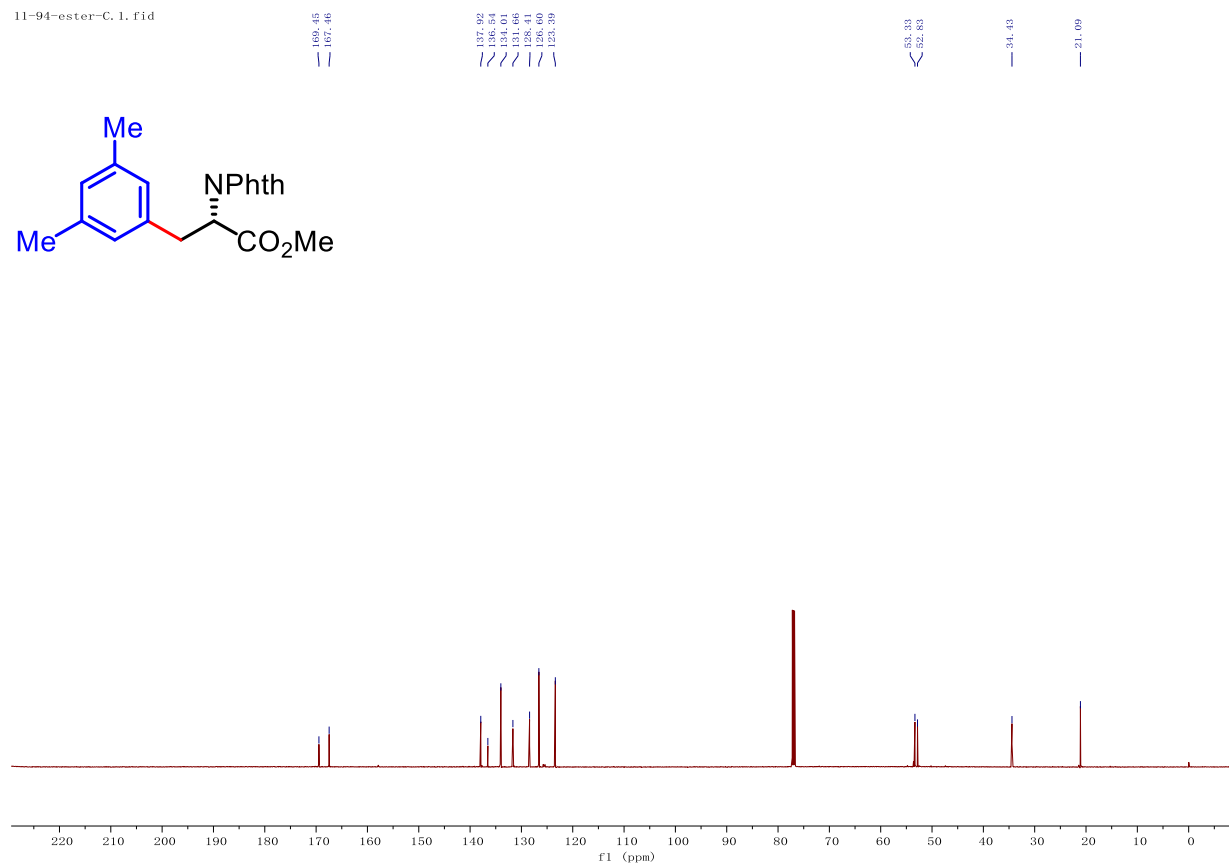
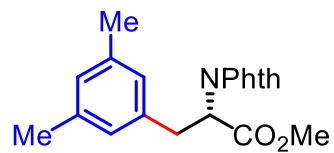
17-13-C, 1. fid



11-94-ester-H.1.fid

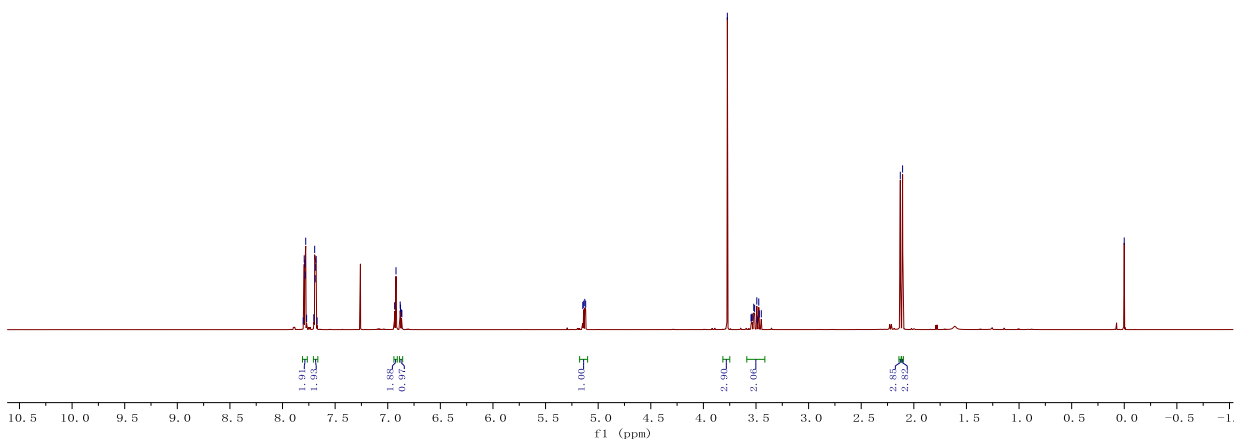
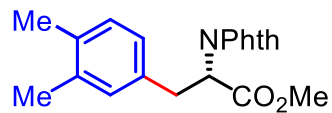


11-94-ester-C.1.fid



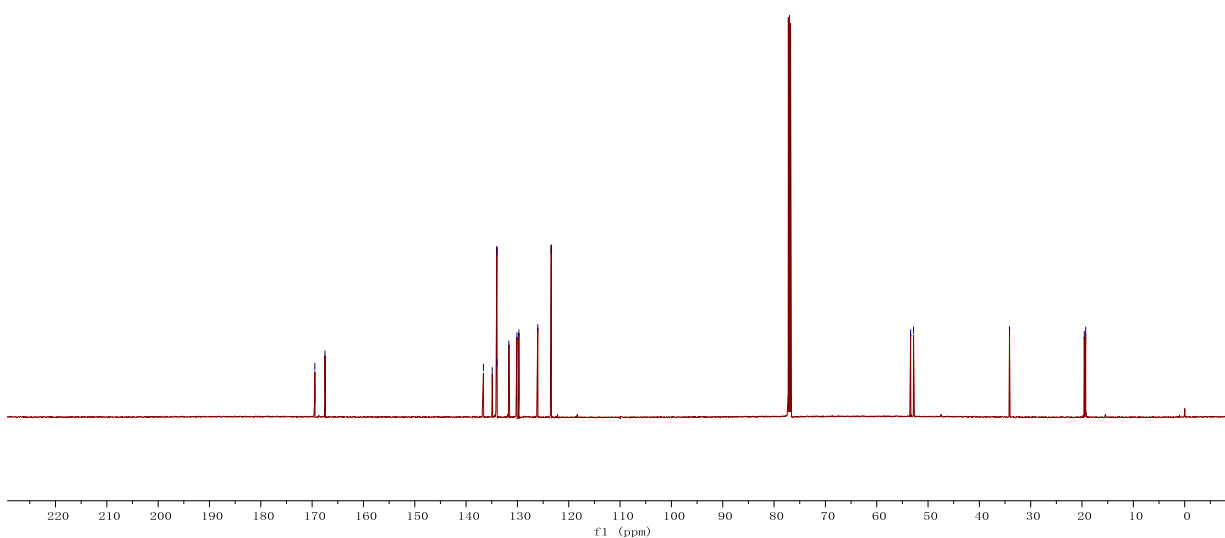
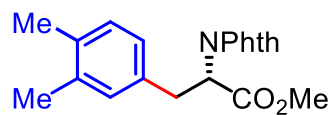
17-126-H. 1. fid

7.80  
7.79  
7.78  
7.78  
7.77  
7.77  
7.69  
7.69  
7.67  
6.93  
6.88  
6.88  
6.87  
5.15  
5.14  
5.12  
3.77  
3.55  
3.54  
3.54  
3.52  
3.51  
3.49  
3.47  
3.45  
2.13  
2.11  
0.00



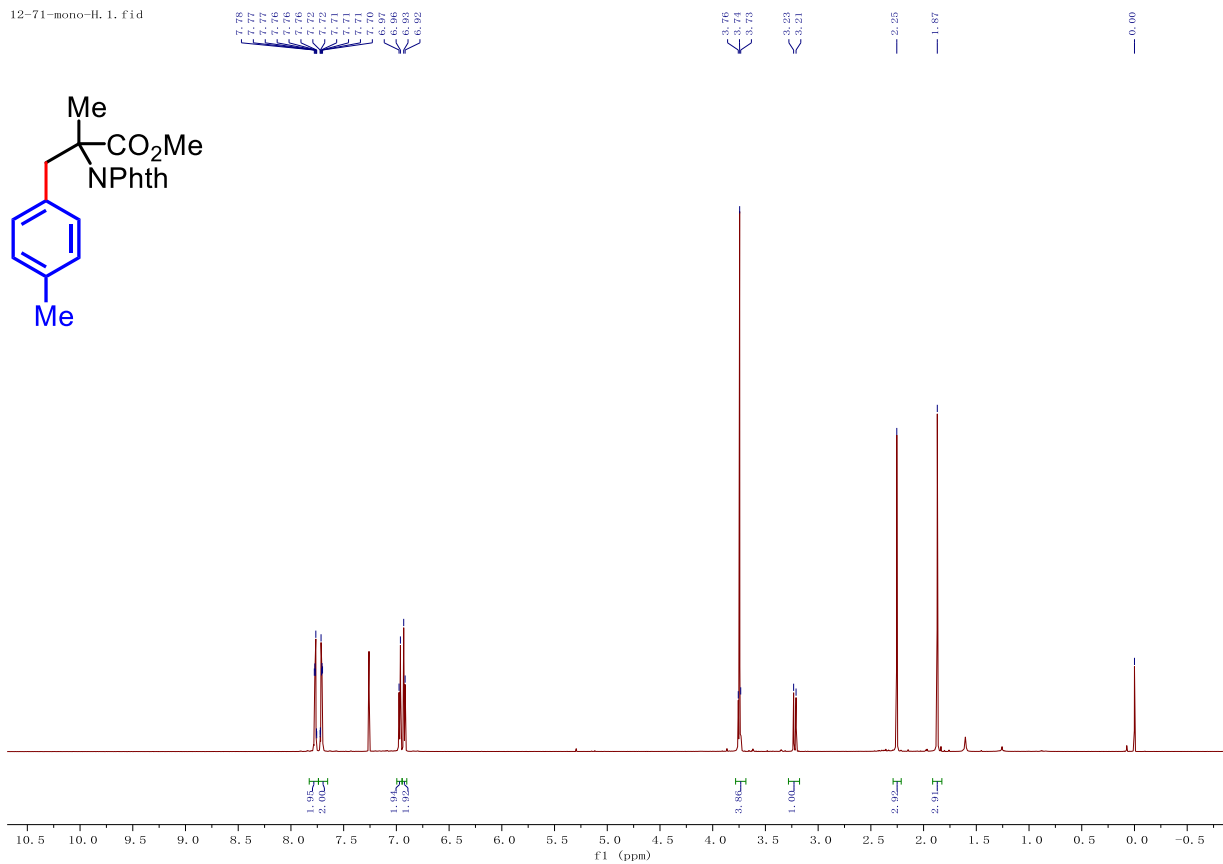
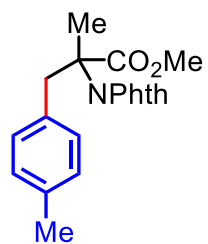
17-126-C. 1. fid

169.17  
167.10  
136.62  
134.91  
134.00  
133.68  
131.66  
130.09  
129.72  
128.93  
123.12  
53.20  
52.82  
34.13  
19.56  
19.28

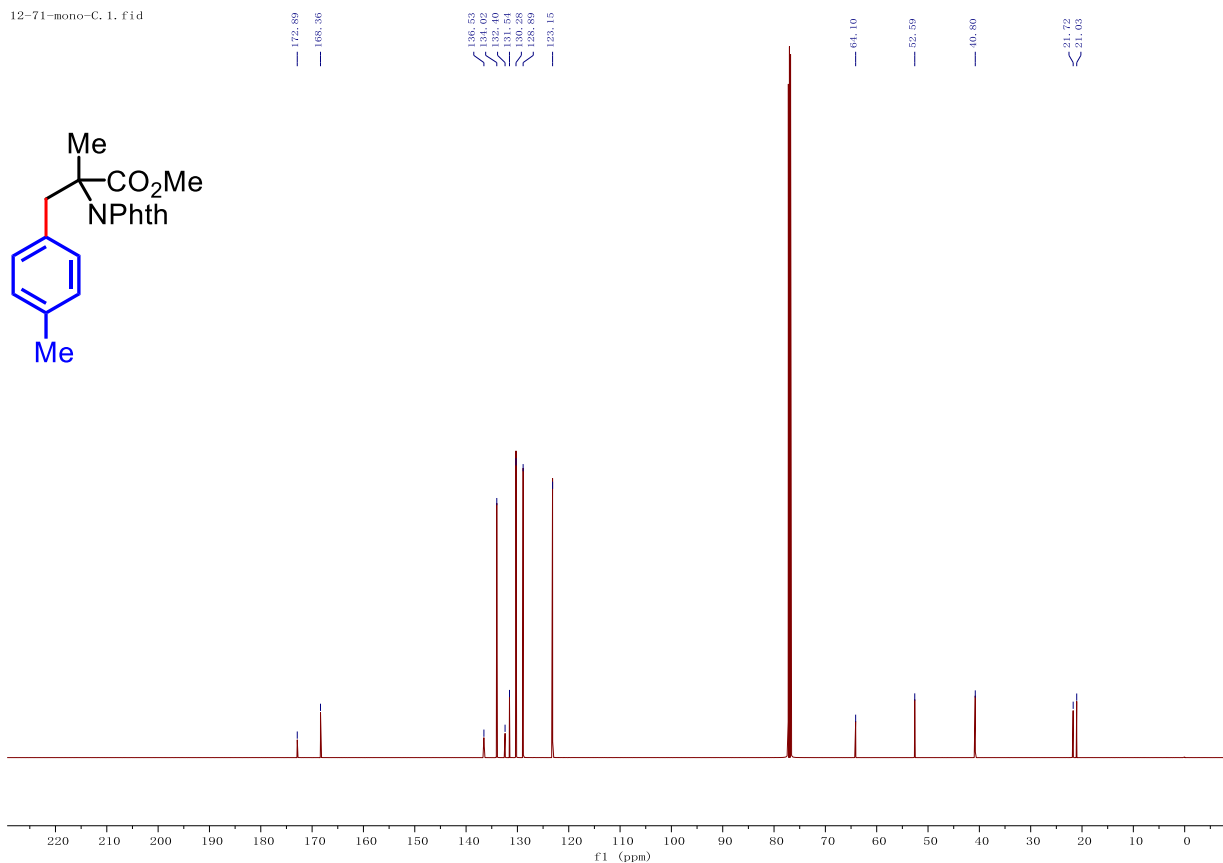
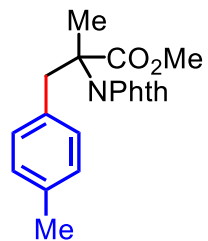




12-71-mono-H. 1. fid



12-71-mono-C. 1. fid



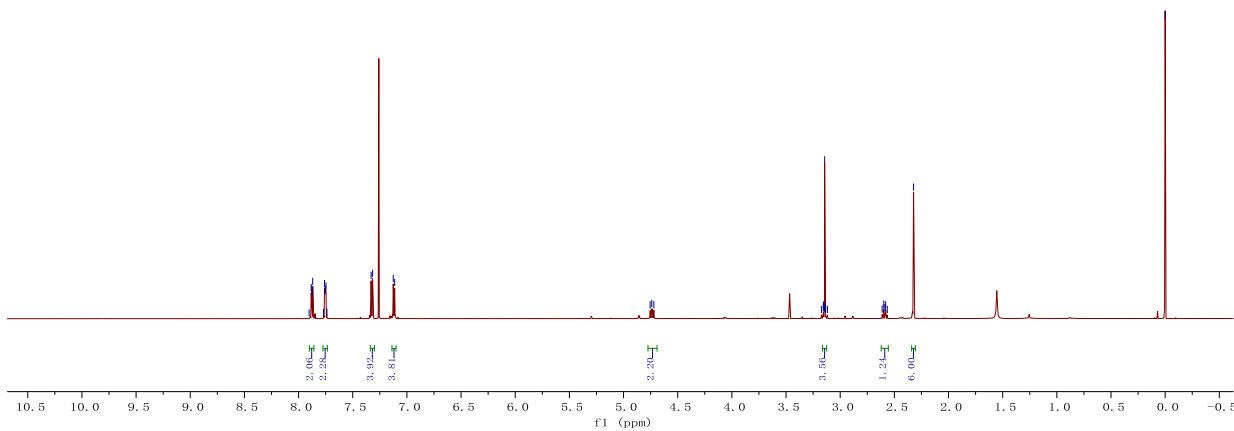
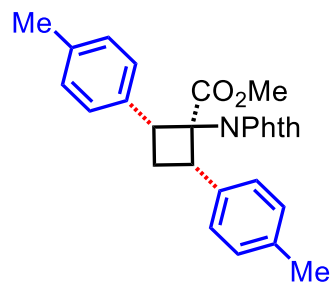
17-128-di-H.1.fid

7.69  
7.88  
7.88  
7.87  
7.77  
7.76  
7.76  
7.75  
7.74  
7.33  
7.13  
7.11

4.75  
4.72

3.17  
3.15  
3.15  
3.14  
3.14  
3.14  
3.12  
2.60  
2.58  
2.57  
2.32

0.00



17-128-di-C.1.fid

168.33  
157.23

136.37  
135.26  
134.17  
131.80  
128.33  
123.40

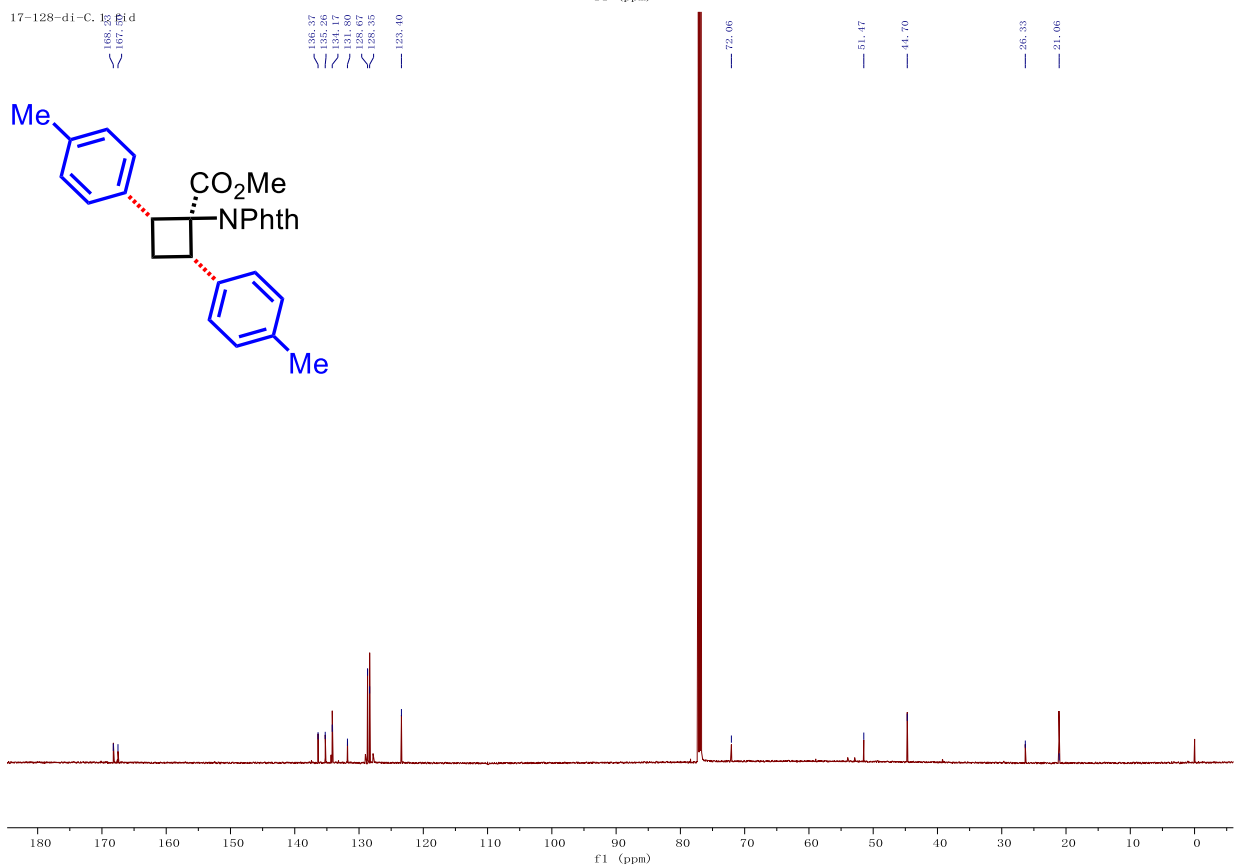
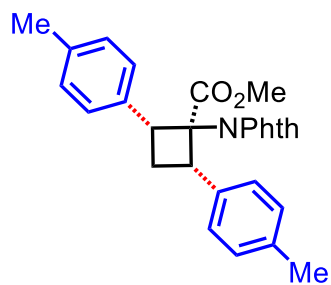
72.06

51.47

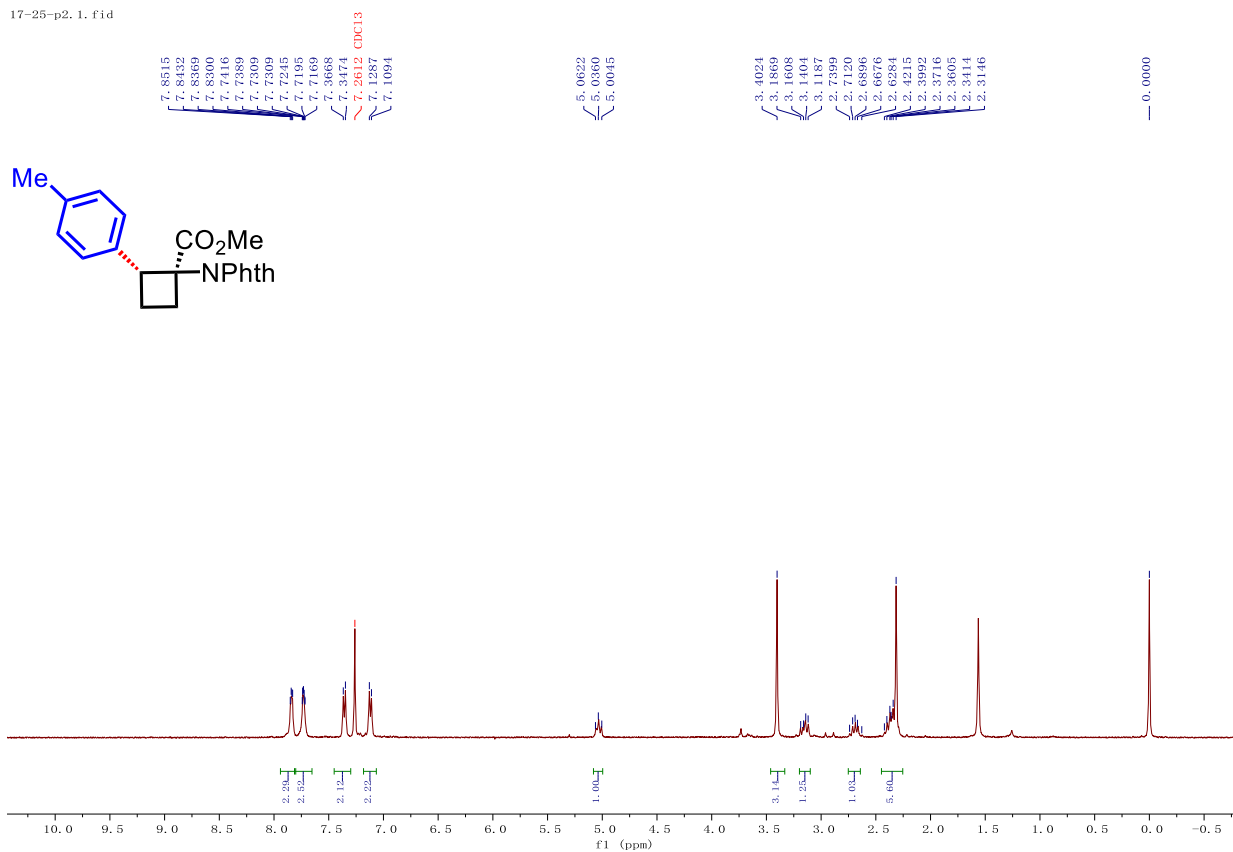
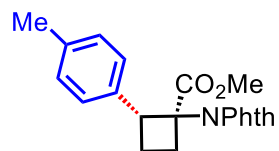
41.70

26.33

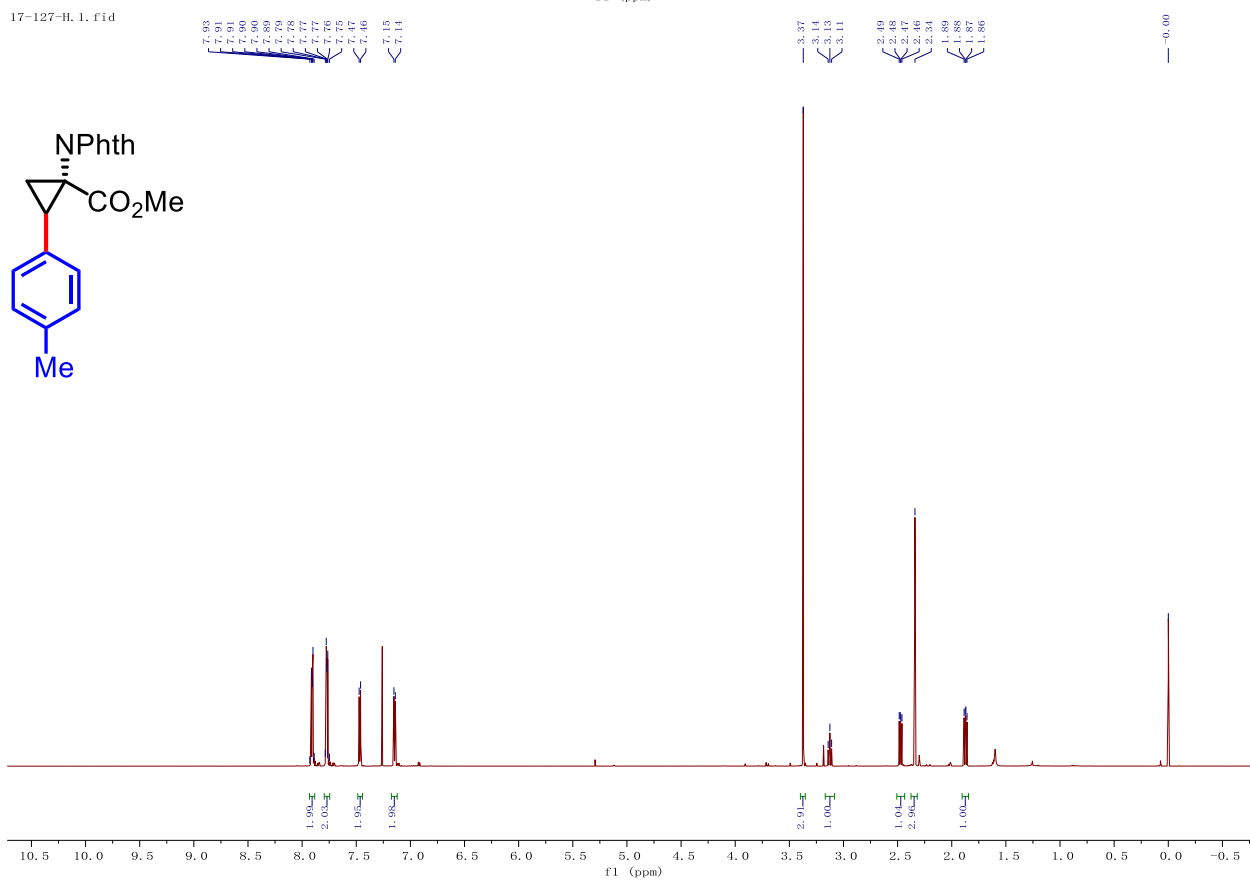
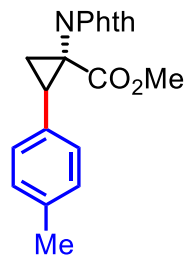
21.06

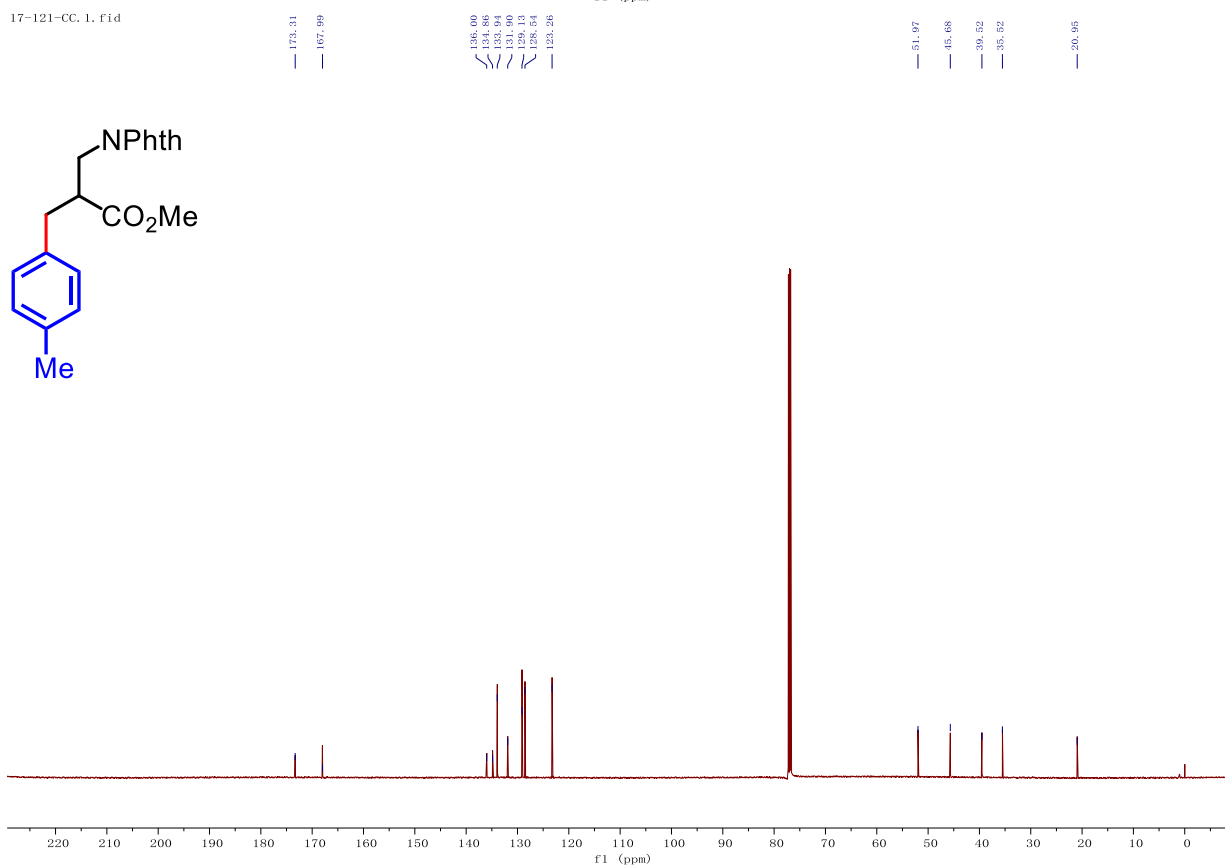
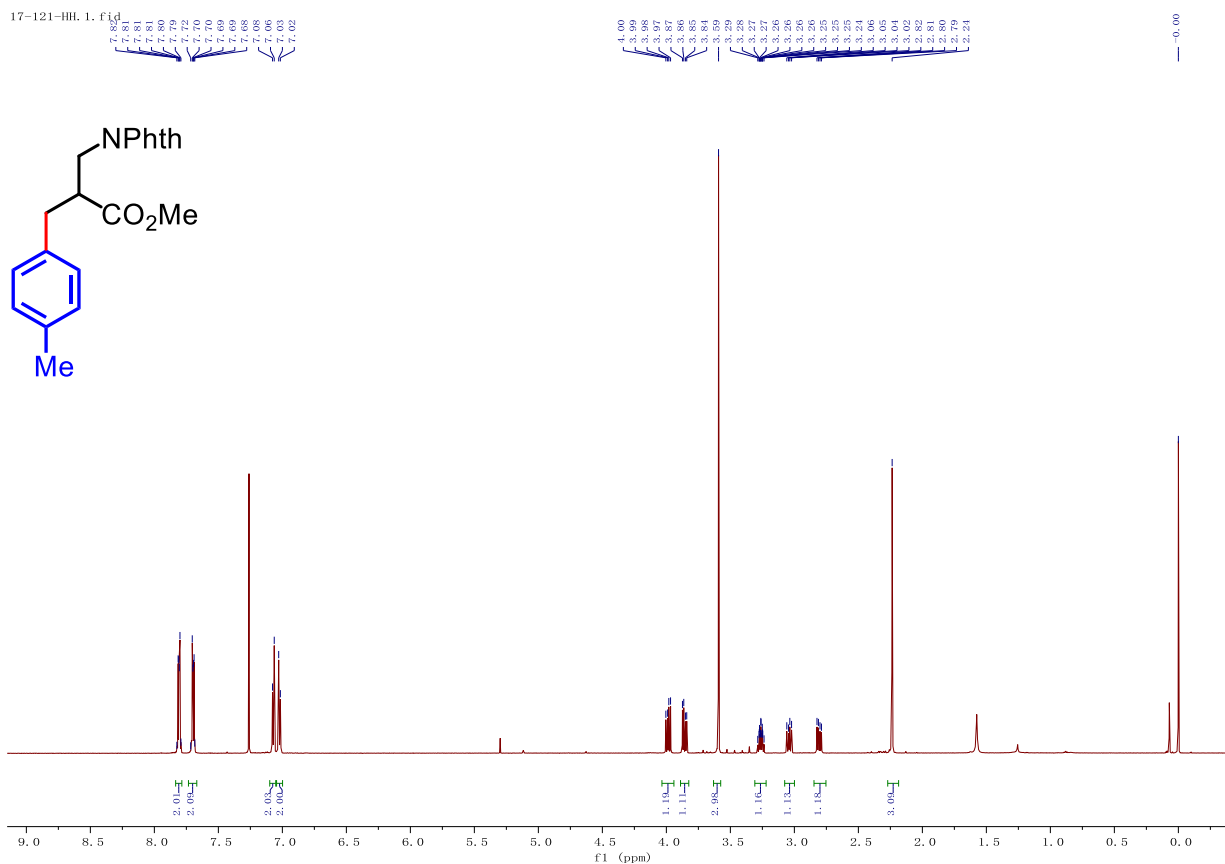


17-25-p2. 1. fid

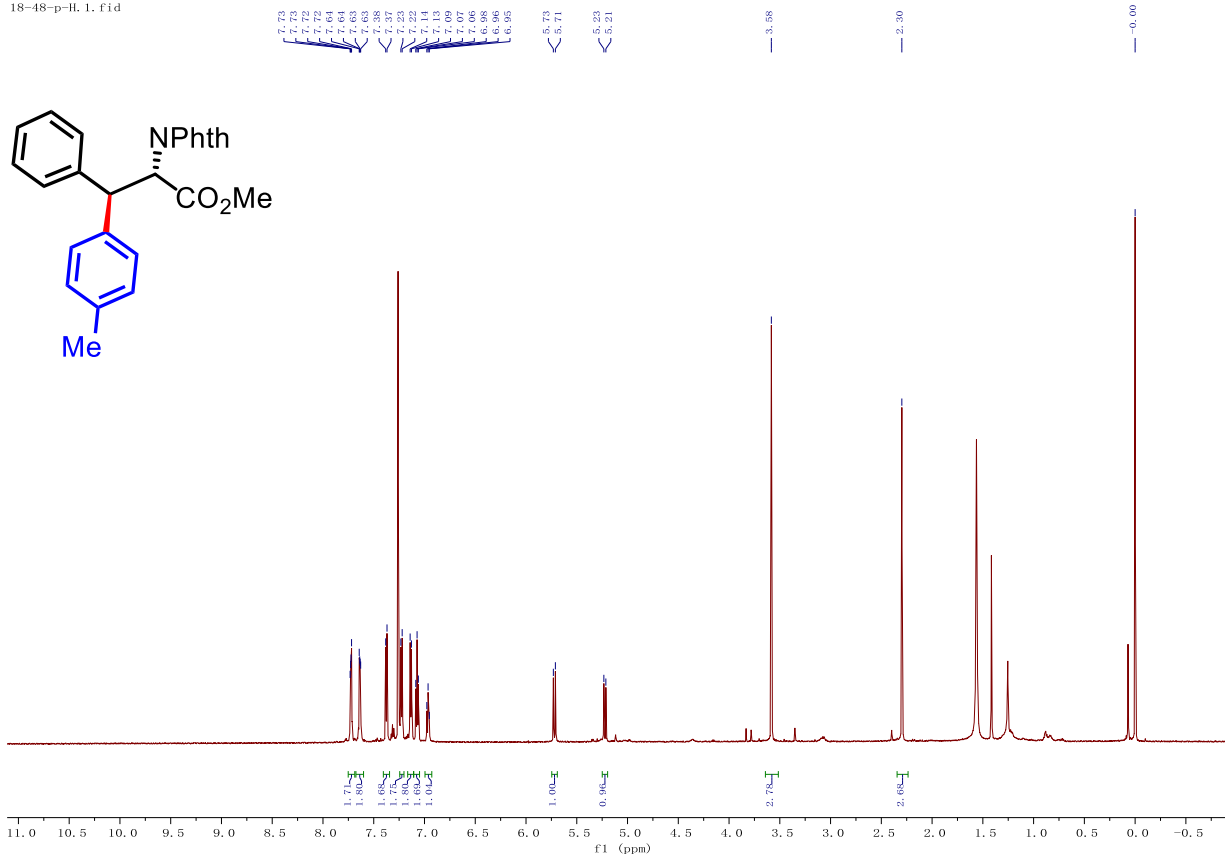


17-127-H. 1. fid

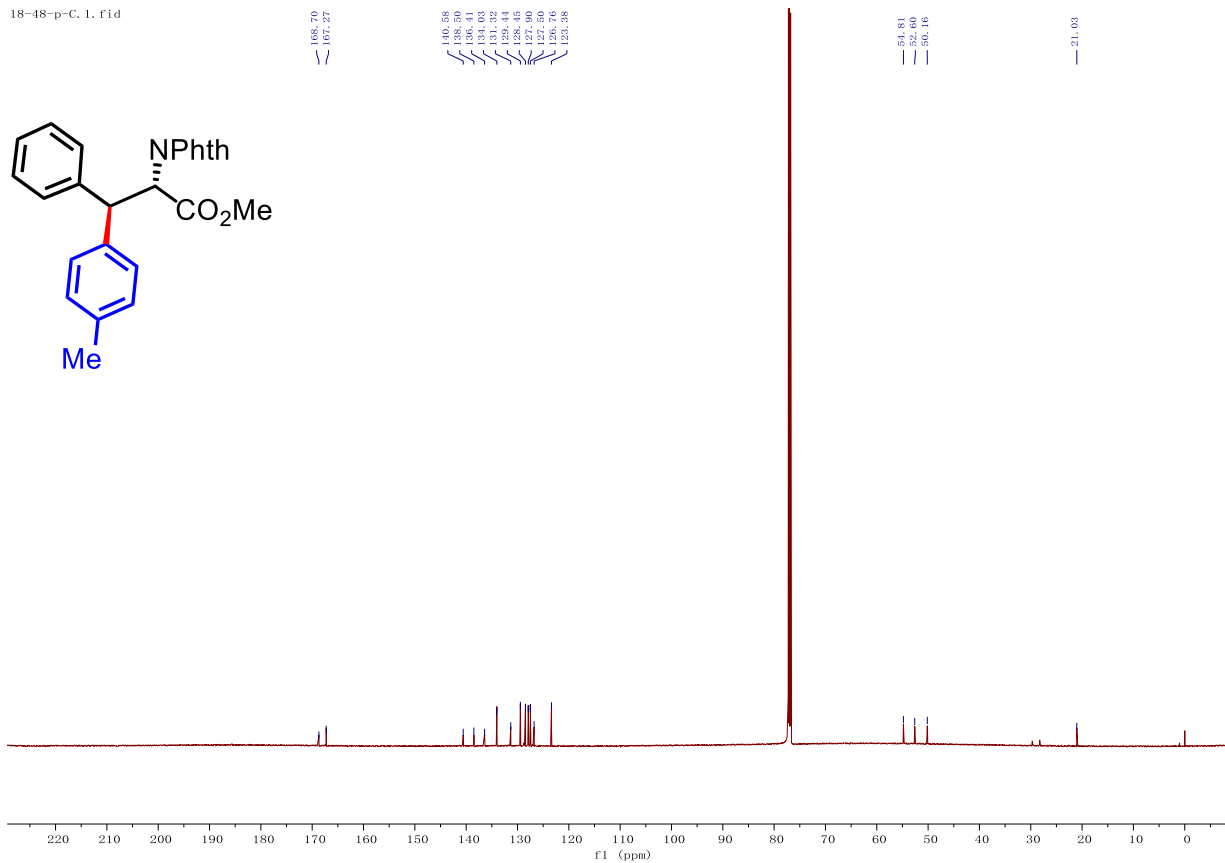




18-48-p-H, 1, f1d



18-48-p-C, 1, f1d



18-50-p-HH, 1, f1d

7.86  
7.84  
7.82  
7.87  
7.76  
7.75  
7.75

7.09  
7.07  
7.05

4.73

3.70

3.06

3.04

2.85

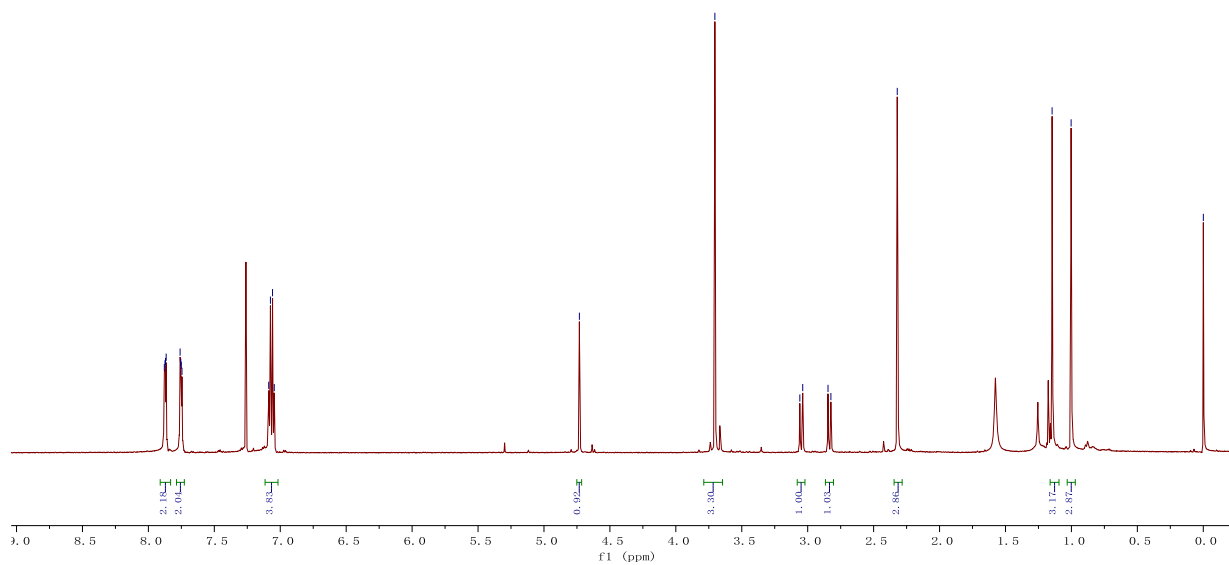
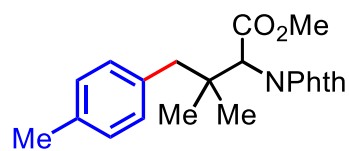
2.82

2.32

1.15

1.00

0.00



18-50-p-C, 1, f1d

168.39

168.07

135.04

134.21

131.71

130.78

123.18

58.93

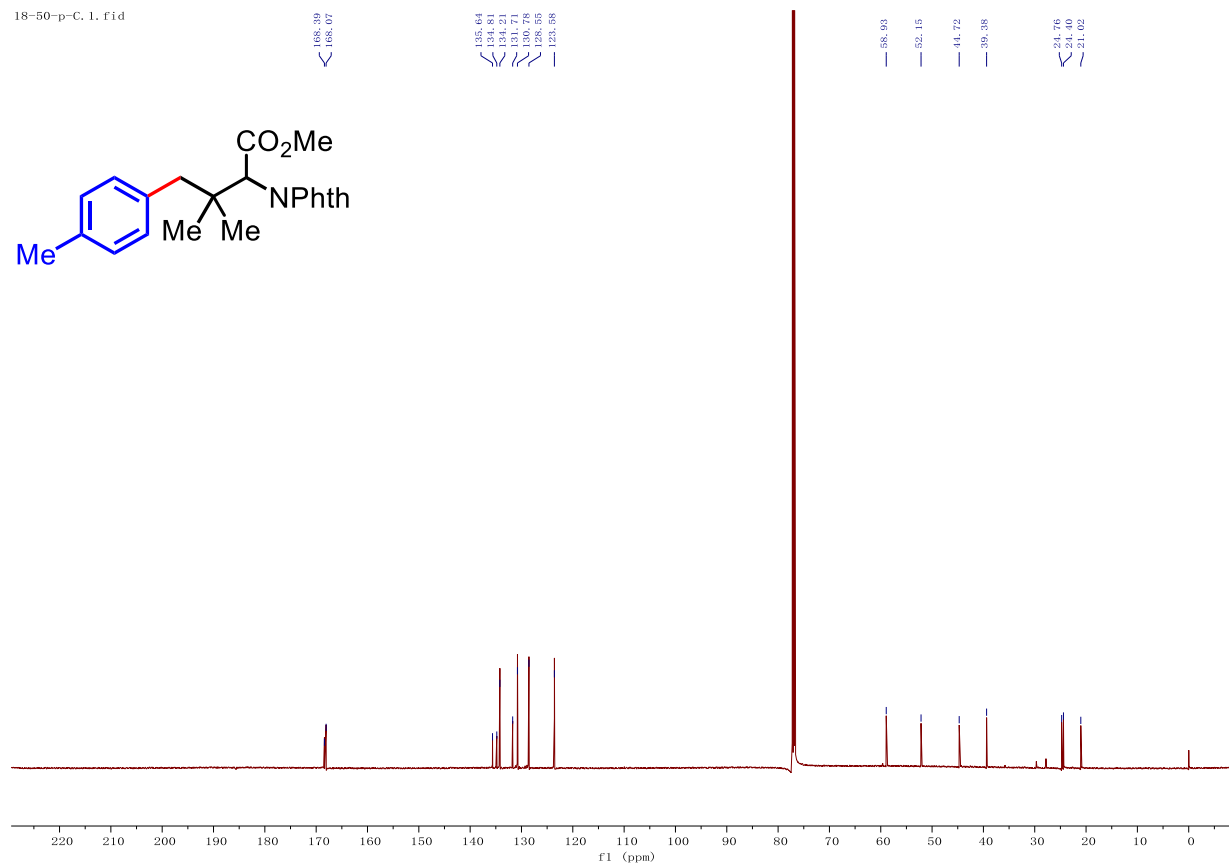
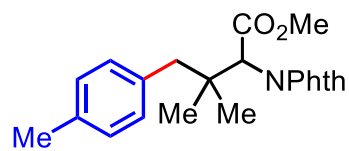
52.15

41.72

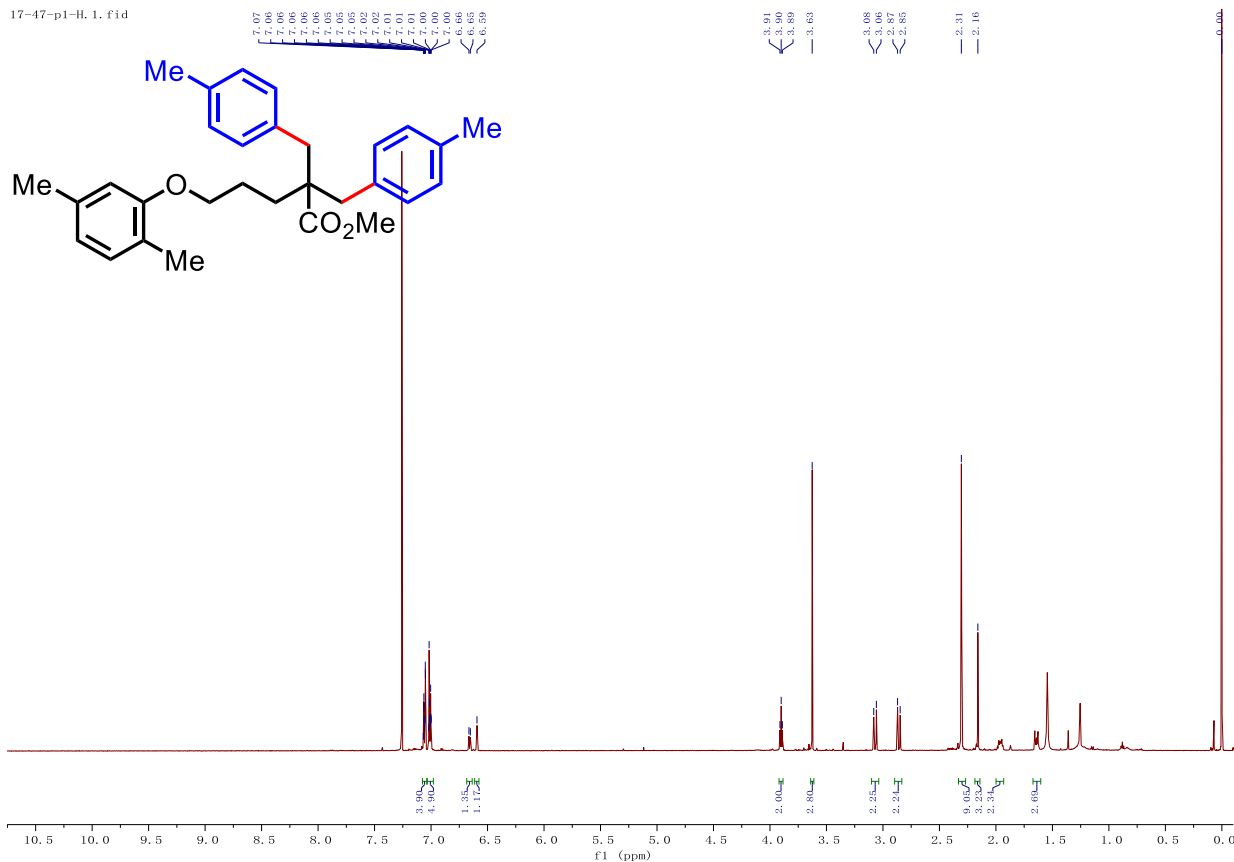
39.38

24.76

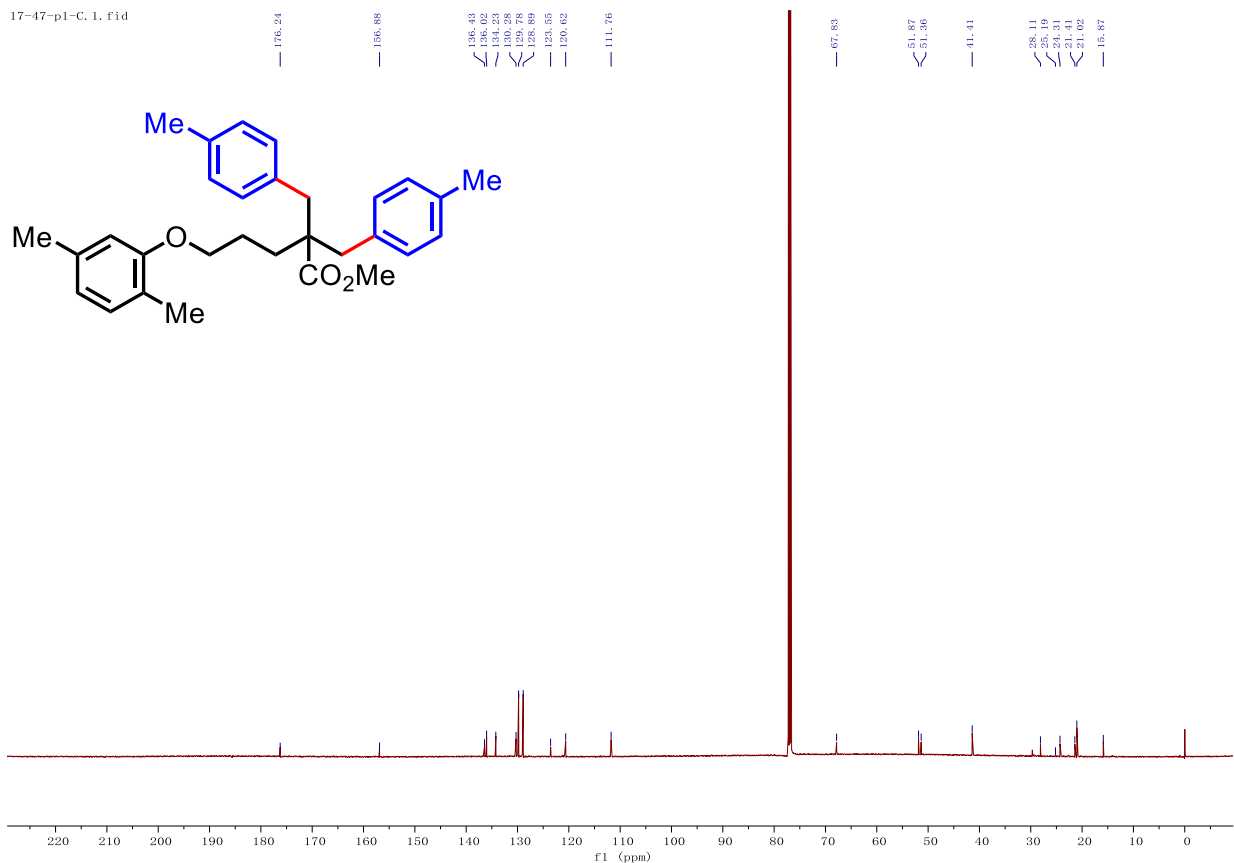
21.02

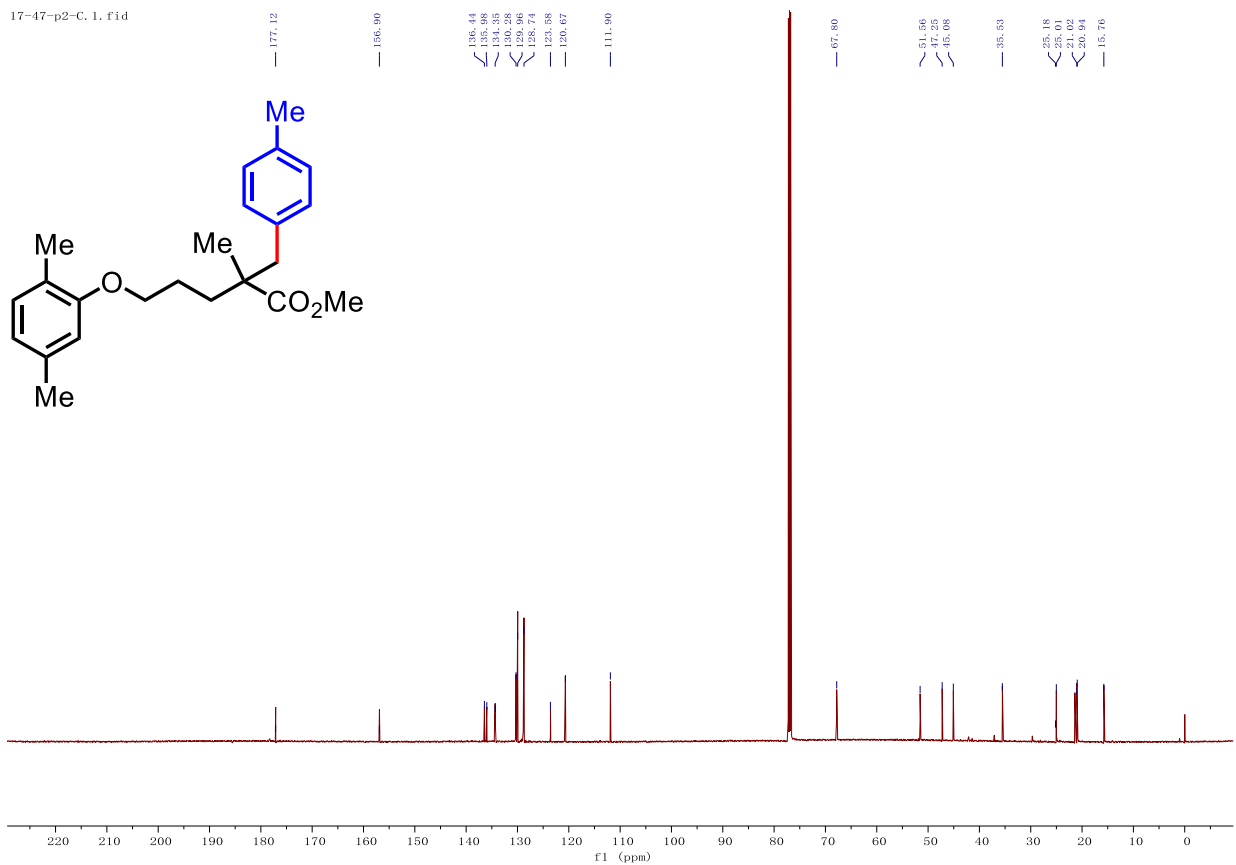
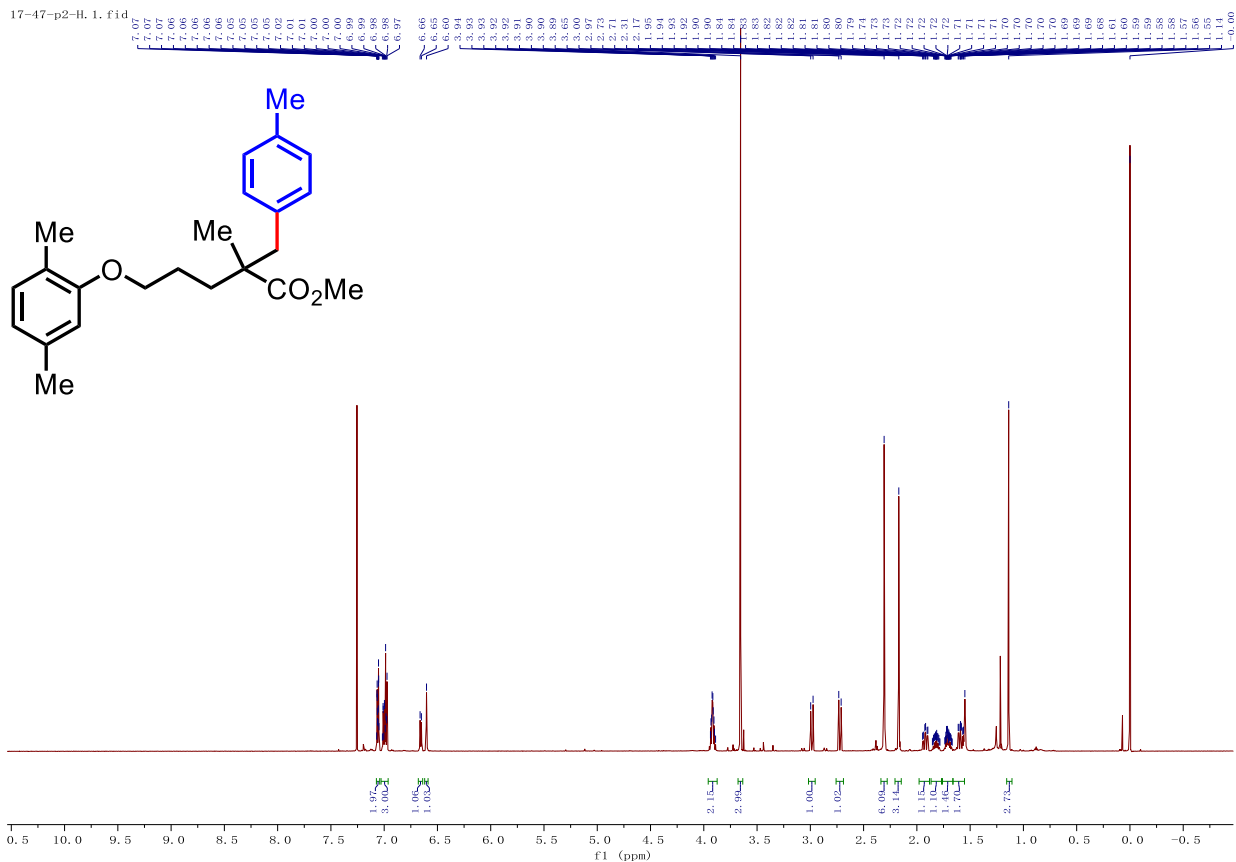


17-47-p1-H.1.fid



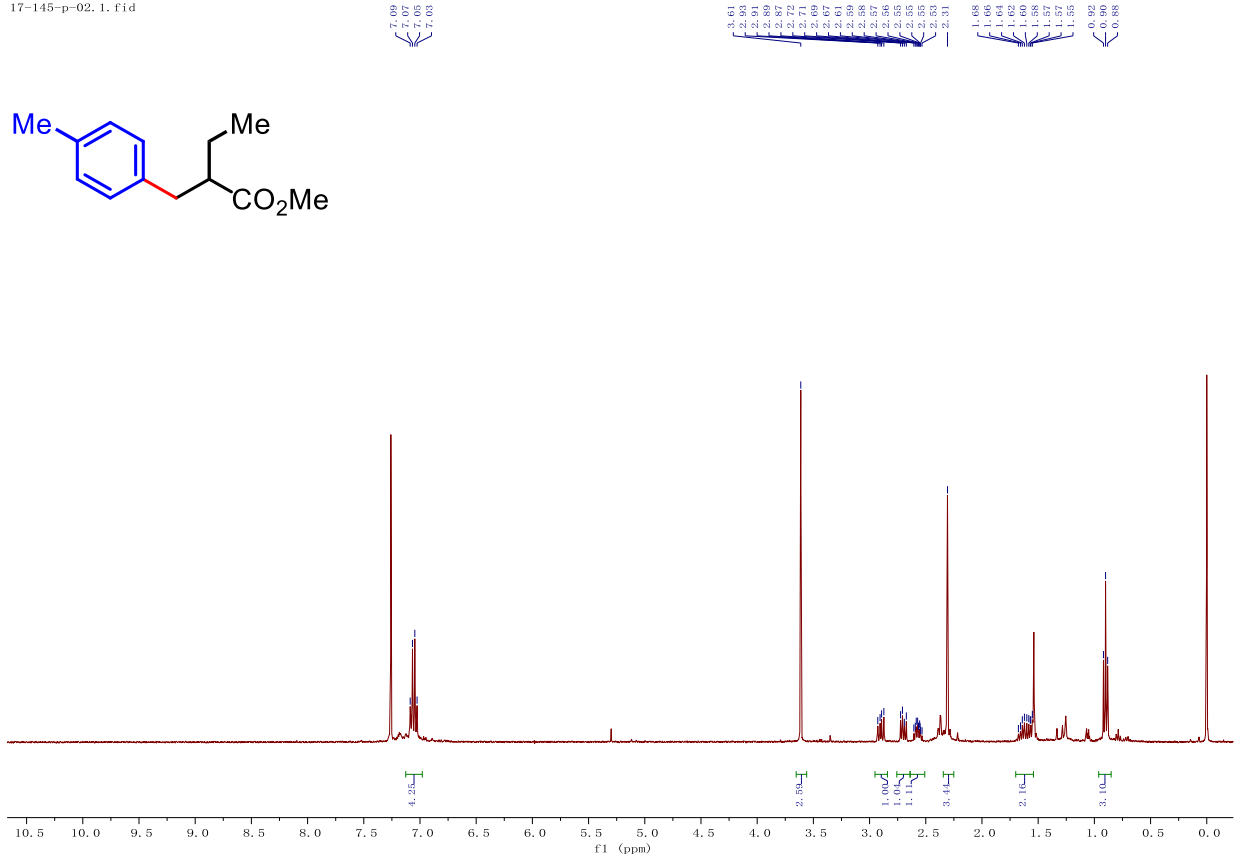
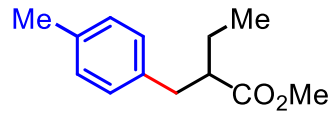
17-47-p1-C.1.fid



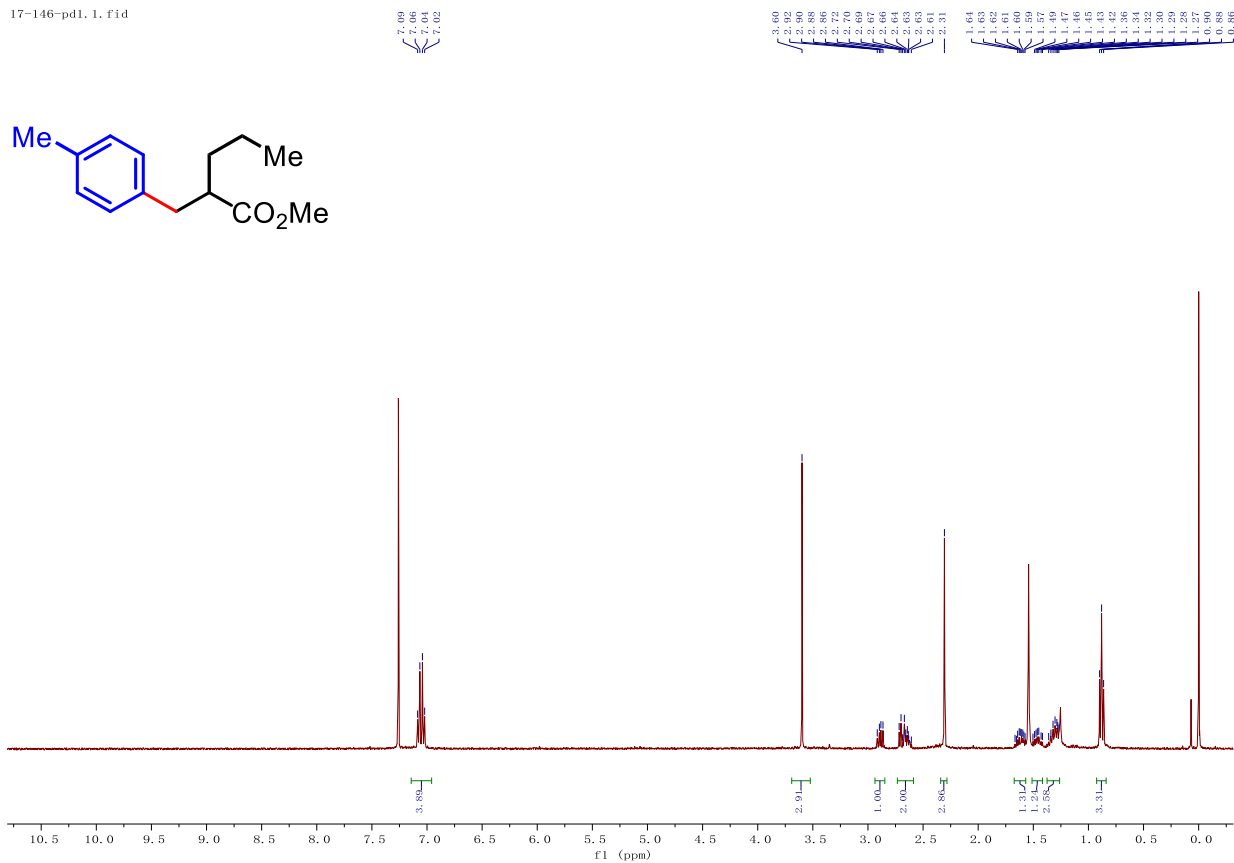
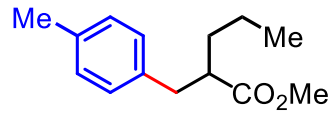




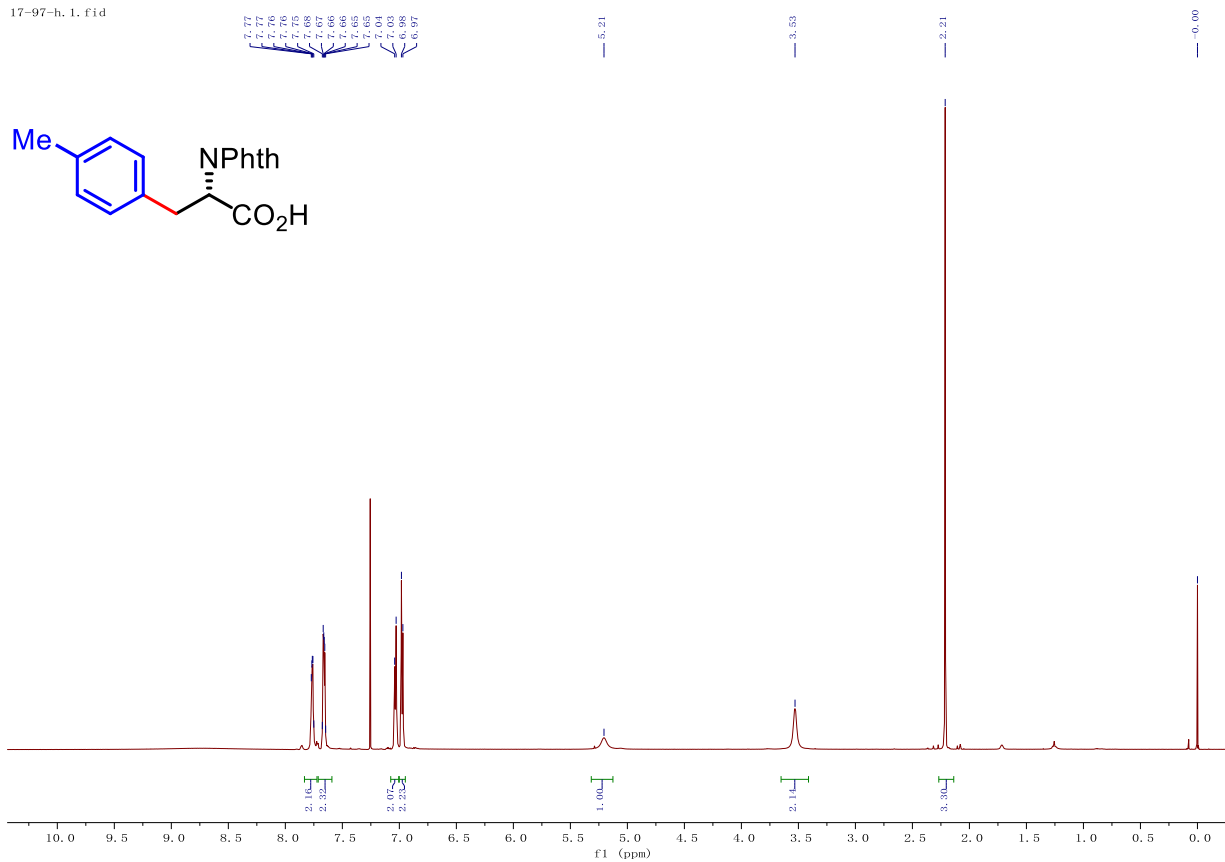
17-145-p-02.1.fid



17-146-pd1.1.fid



17-97-h. 1. fid



18-44-acetone. 1. fid

