

# General and Efficient Synthesis of 1,2-Dihydropyrrolo[3,4-b]indol-3-ones via a Formal [3+2] Cycloaddition Initiated by C-H Activation

## Supporting Information

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### Table of Contents

General Information-----	S2
Preparation of aldehydes S-3-----	S2
Preparation of alkenes 4-----	S8
Synthesis of 1,2-dihydropyrrolo[3,4-b]indol-3-ones 6 -----	S20
The removal of the pyridyl group from 6aa-----	S35
References-----	S37
NMR Spectra-----	S38
ORTEP Drawing for 6ba-----	

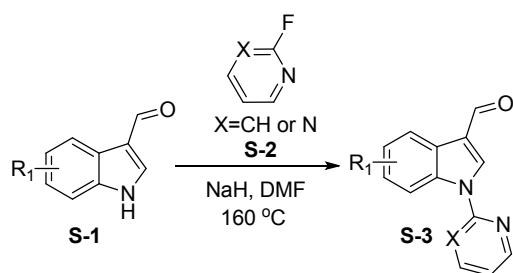
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## General Information

The  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR and  $^{19}\text{F}$  NMR were recorded with Bruker 400 MHz spectrometer instruments in  $\text{CDCl}_3$ . The chemical shifts ( $\delta$ ) of  $^1\text{H}$  NMR,  $^{13}\text{C}$  NMR and  $^{19}\text{F}$  NMR were measured in ppm, referenced to residual  $^1\text{H}$  and  $^{13}\text{C}$  signals of nondeuterated  $\text{CDCl}_3$  ( $\delta = 7.26$  and  $77.00$ ), as internal standards. All solvents were obtained from commercial sources and were purified according to standard procedures. Purification of products was accomplished by flash chromatography using basic alumina (200~300 mesh). Thin layer chromatography (TLC) was performed on Merck silica gel GF254 plates and visualized by UV-light (254 nm). Melting points were obtained on a Yanaco-241 apparatus and are uncorrected. HRMS were recorded on VG ZAB-HS mass spectrometer with ESI resource. **S-3a**<sup>[1]</sup>, **S-3y**<sup>[2]</sup> and **S-4z**<sup>[3]</sup> were synthesized according to the literature procedures.

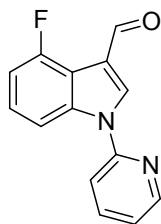
## Preparation of aldehydes S-3



### *General Procedure A.*

Under an argon atmosphere, NaH (6.0 g, 150 mmol, 5 equiv.) was added in portions to a solution of **S-1** (30 mmol, 1 equiv.) in DMF (100 mL) at 0 °C. After stirring at room temperature for 30 min, **S-2** (45 mmol, 1.5 equiv) was added, and the contents were stirred at 150 °C for 24 hours. After completion of reaction, the reaction was quenched with water (100 mL) and extracted with AcOEt (200 mL\*3). The organic phases were combined, washed with water (200 mL), brine (100 mL), dried on  $\text{MgSO}_4$ , and evaporated under reduced pressure. The residue was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate, 20:1~10:1) to afford aldehyde **S-3**.

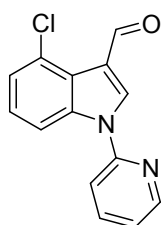
### *4-Fluoro-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3j*



**S-3j** was synthesized from commercially sourced **S-1j** and 2-fluoropyridine according to *General Procedure A*. Yield: 49%.

The data for **S-3j**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.34 (s, 1H), 8.67–8.59 (m, 1H), 8.37 (s, 1H), 7.93 (t,  $J = 7.7$  Hz, 2H), 7.56 (dd,  $J = 8.2, 1.0$  Hz, 1H), 7.39 – 7.28 (m, 2H), 7.06 (dd,  $J = 10.3, 7.9$  Hz, 1H).

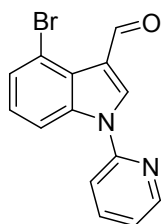
**4-Chloro-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3k**



**S-3k** was synthesized from commercially sourced **S-1k** and 2-fluoropyridine according to *General Procedure A*. Yield: 53%.

The data for **S-3k**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.84 (s, 1H), 8.64 (ddd,  $J = 4.8, 1.9, 0.9$  Hz, 1H), 8.46 (s, 1H), 8.13 (dd,  $J = 8.3, 0.9$  Hz, 1H), 7.94 (ddd,  $J = 8.2, 7.5, 1.9$  Hz, 1H), 7.54 (dt,  $J = 8.3, 0.9$  Hz, 1H), 7.41–7.34 (m, 2H), 7.29 (d,  $J = 8.1$  Hz, 1H).

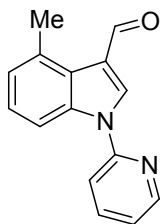
**4-Bromo-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3l**



**S-3l** was synthesized from commercially sourced **S-1l** and 2-fluoropyridine according to *General Procedure A*. Yield: 30%.

The data for **S-3l**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  11.02 (s, 1H), 8.65 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.48 (s, 1H), 8.19 (dd,  $J = 8.4, 0.8$  Hz, 1H), 7.94 (ddd,  $J = 8.2, 7.5, 1.9$  Hz, 1H), 7.58–7.51 (m, 2H), 7.37 (ddd,  $J = 7.5, 4.9, 1.0$  Hz, 1H), 7.22 (dd,  $J = 8.4, 7.7$  Hz, 1H).

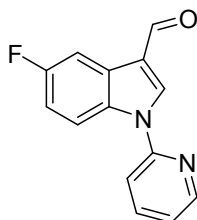
**4-Methyl-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3m**



**S-3m** was synthesized from commercially sourced **S-1m** and 2-fluoropyridine according to *General Procedure A*. Yield: 30%.

The data for **S-3m**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.24 (s, 1H), 8.64 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.39 (s, 1H), 7.96–7.85 (m, 2H), 7.58 (dt,  $J = 8.2, 1.0$  Hz, 1H), 7.34 (ddd,  $J = 7.5, 4.9, 1.0$  Hz, 1H), 7.30–7.27 (m, 1H), 7.15 (dt,  $J = 7.3, 0.9$  Hz, 1H), 2.88 (s, 3H).

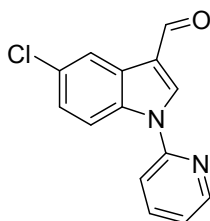
*5-Fluoro-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3n*



**S-3n** was synthesized from commercially sourced **S-1n** and 2-fluoropyridine according to *General Procedure A*. Yield: 51%.

The data for **S-3n**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.11 (s, 1H), 8.63 (dd,  $J = 4.9, 1.8$  Hz, 1H), 8.35 (s, 1H), 8.09–8.01 (m, 2H), 7.94 (td,  $J = 7.8, 1.9$  Hz, 1H), 7.58 (d,  $J = 8.2$  Hz, 1H), 7.36 (dd,  $J = 7.5, 4.9$  Hz, 1H), 7.13 (td,  $J = 9.0, 2.7$  Hz, 1H).

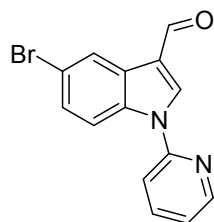
*5-Chloro-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3o*



**S-3o** was synthesized from commercially sourced **S-1o** and 2-fluoropyridine according to *General Procedure A*. Yield: 62%.

The data for **S-3o**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.11 (s, 1H), 8.64 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.38 (dd,  $J = 2.1, 0.5$  Hz, 1H), 8.33 (s, 1H), 8.02 (dd,  $J = 8.9, 0.6$  Hz, 1H), 7.94 (ddd,  $J = 8.2, 7.4, 1.9$  Hz, 1H), 7.57 (dt,  $J = 8.2, 0.9$  Hz, 1H), 7.39–7.31 (m, 2H).

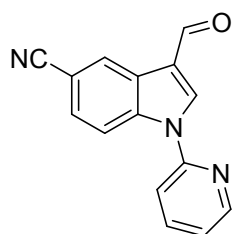
*5-Bromo-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3p*



**S-3p** was synthesized from commercially sourced **S-1p** and 2-fluoropyridine according to *General Procedure A*. Yield: 43%.

The data for **S-3p**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.12 (s, 1H), 8.67–8.61 (m, 1H), 8.56 (d,  $J = 2.1$  Hz, 1H), 8.33 (s, 1H), 8.01–7.88 (m, 2H), 7.58 (d,  $J = 8.2$  Hz, 1H), 7.50 (dd,  $J = 8.9, 2.0$  Hz, 1H), 7.39–7.34 (m, 1H).

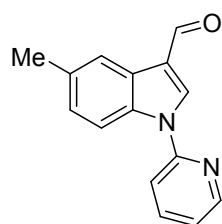
*3-Formyl-1-(pyridin-2-yl)-1H-indole-5-carbonitrile S-3q*



**S-3q** was synthesized from commercially sourced **S-1q** and 2-fluoropyridine according to *General Procedure A*. Yield: 40%.

The data for **S-3q**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.16 (s, 1H), 8.75 (d,  $J = 1.0$  Hz, 1H), 8.67 (dd,  $J = 4.8, 1.1$  Hz, 1H), 8.42 (s, 1H), 8.20 (d,  $J = 8.7$  Hz, 1H), 7.99 (td,  $J = 8.0, 1.9$  Hz, 1H), 7.67 – 7.57 (m, 2H), 7.42 (ddd,  $J = 7.5, 4.9, 0.7$  Hz, 1H).

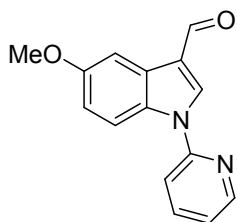
*5-Methyl-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3r*



**S-3r** was synthesized from commercially sourced **S-1r** and 2-fluoropyridine according to *General Procedure A*. Yield: 49%.

The data for **S-3r**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.11 (s, 1H), 8.62 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.32 (s, 1H), 8.23–8.16 (m, 1H), 7.91 (td,  $J = 7.6, 1.6$  Hz, 2H), 7.59 (dt,  $J = 8.2, 1.0$  Hz, 1H), 7.32 (ddd,  $J = 7.5, 4.9, 0.9$  Hz, 1H), 7.21 (dd,  $J = 8.6, 1.8$  Hz, 1H), 2.50 (s, 3H).

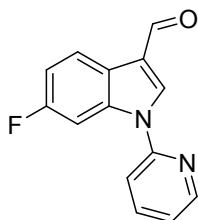
*5-Methoxy-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3s*



**S-3s** was synthesized from commercially sourced **S-1s** and 2-fluoropyridine according to *General Procedure A*. Yield: 41%.

The data for **S-3s**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.11 (s, 1H), 8.62 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.32 (s, 1H), 7.96 (d,  $J = 9.1$  Hz, 1H), 7.92 (ddd,  $J = 8.2, 7.4, 1.9$  Hz, 1H), 7.87 (d,  $J = 2.6$  Hz, 1H), 7.59 (dt,  $J = 8.2, 1.0$  Hz, 1H), 7.33 (ddd,  $J = 7.5, 4.9, 0.9$  Hz, 1H), 7.02 (dd,  $J = 9.1, 2.6$  Hz, 1H), 3.93 (s, 3H).

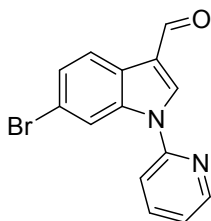
**6-Fluoro-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3t**



**S-3t** was synthesized from commercially sourced **S-1t** and 2-fluoropyridine according to *General Procedure A*. Yield: 45%.

The data for **S-3t**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.11 (s, 1H), 8.64 (ddd,  $J = 4.8, 1.9, 0.9$  Hz, 1H), 8.35–8.26 (m, 2H), 7.94 (ddd,  $J = 8.2, 7.5, 1.9$  Hz, 1H), 7.86 (dd,  $J = 10.1, 2.4$  Hz, 1H), 7.56 (dt,  $J = 8.1, 0.9$  Hz, 1H), 7.35 (ddd,  $J = 7.5, 4.9, 0.9$  Hz, 1H), 7.14 (td,  $J = 9.0, 2.4$  Hz, 1H).

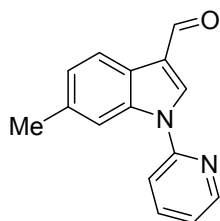
**6-Bromo-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3u**



**S-3u** was synthesized from commercially sourced **S-1u** and 2-fluoropyridine according to *General Procedure A*. Yield: 28%.

The data for **S-3u**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.12 (s, 1H), 8.68–8.62 (m, 1H), 8.33–8.27 (m, 2H), 8.24 (d,  $J = 8.4$  Hz, 1H), 7.95 (td,  $J = 7.8, 1.9$  Hz, 1H), 7.58–7.55 (m, 1H), 7.49 (dt,  $J = 8.5, 1.3$  Hz, 1H), 7.37 (dd,  $J = 7.5, 4.9$  Hz, 1H).

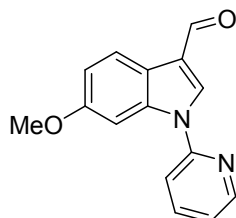
**6-Methyl-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3v**



**S-3v** was synthesized from commercially sourced **S-1v** and 2-fluoropyridine according to *General Procedure A*. Yield: 49%.

The data for **S-3v**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.11 (s, 1H), 8.64 (dd,  $J = 4.8, 1.9$  Hz, 1H), 8.28 (s, 1H), 8.25 (d,  $J = 8.1$  Hz, 1H), 7.93 (td,  $J = 7.8, 1.9$  Hz, 1H), 7.82 (s, 1H), 7.60 (dt,  $J = 8.0, 1.0$  Hz, 1H), 7.38 – 7.30 (m, 1H), 7.22 (dd,  $J = 8.1, 1.4$  Hz, 1H), 2.51 (s, 3H).

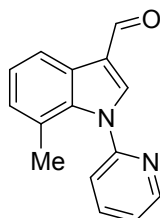
**6-Methoxy-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3w**



**S-3w** was synthesized from commercially sourced **S-1w** and 2-fluoropyridine according to *General Procedure A*. Yield: 55%.

The data for **S-3w**:  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.07 (s, 1H), 8.63 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.24 (d,  $J = 8.7$  Hz, 1H), 8.21 (s, 1H), 7.92 (ddd,  $J = 8.2, 7.5, 1.9$  Hz, 1H), 7.60 (d,  $J = 2.3$  Hz, 1H), 7.57 (dd,  $J = 8.2, 1.0$  Hz, 1H), 7.32 (ddd,  $J = 7.4, 4.9, 0.9$  Hz, 1H), 7.01 (dd,  $J = 8.7, 2.3$  Hz, 1H), 3.88 (s, 3H).

**7-Methyl-1-(pyridin-2-yl)-1H-indole-3-carbaldehyde S-3x**

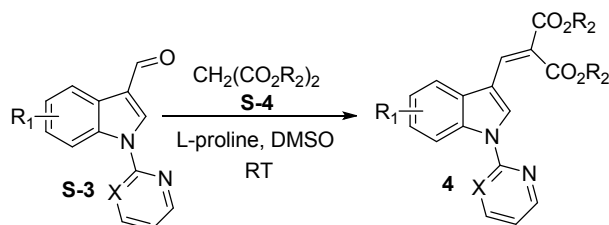


**S-3x** was synthesized from commercially sourced **S-1x** and 2-fluoropyridine according to *General Procedure A*. Yield: 30%.



The data for **S-3x**:  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.09 (s, 1H), 8.69–8.63 (m, 1H), 8.26 (d,  $J = 7.9$  Hz, 1H), 7.95–7.89 (m, 2H), 7.46 (ddd,  $J = 7.5, 4.9, 1.0$  Hz, 1H), 7.41 (dd,  $J = 7.9, 1.0$  Hz, 1H), 7.30 – 7.23 (m, 1H), 7.11 (d,  $J = 7.3$  Hz, 1H), 2.06 (s, 3H).

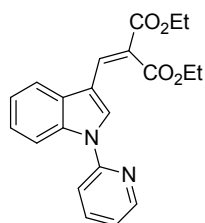
### Preparation of alkenes 4



#### *General Procedure B.*

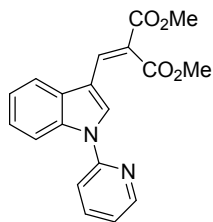
A solution of aldehyde **S-3** (20 mmol) in dry DMSO (10 mL) with 10% of proline (0.23 g, 2 mmol) was stirred for 5 min. Then **S-4** (40 mmol) was added and the mixture was stirred at room temperature overnight. The reaction was diluted with AcOEt (50 mL) and washed twice with water (50 mL). The organic layer was dried over  $\text{Na}_2\text{SO}_4$  and evaporated under reduced pressure. The residue was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate, 10:1~5:1) to afford alkene **4**.

#### *Diethyl 2-((1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4a*



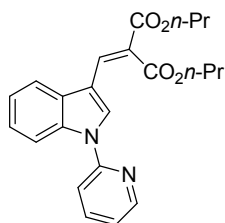
**4a** was synthesized from **S-3a**<sup>[1]</sup> and diethyl malonate according to *General Procedure B*. Yield: 53%; yellow solid; mp: 76~79 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.26 (s, 1H), 8.18 – 8.13 (m, 1H), 8.12 (s, 1H), 7.90 – 7.79 (m, 2H), 7.50 (dt,  $J = 8.3, 1.0$  Hz, 1H), 7.38 – 7.30 (m, 2H), 7.27 – 7.22 (m, 1H), 4.40 (q,  $J = 7.2$  Hz, 2H), 4.33 (q,  $J = 7.1$  Hz, 2H), 1.38 – 1.34 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.6, 165.0, 151.5, 149.2, 138.7, 135.1, 133.8, 130.0, 128.6, 124.2, 122.5, 121.7, 121.3, 118.7, 115.3, 113.3, 112.3, 61.6, 61.3, 14.2, 14.0; HRMS (ESI) Calcd for  $\text{C}_{21}\text{H}_{21}\text{N}_2\text{O}_4$  ( $\text{M}+\text{H}$ )<sup>+</sup>: 365.1496; Found: 365.1498; IR (neat):  $\nu = 577, 740, 789, 848, 941, 1023, 1077, 1205, 1235, 1272, 1322, 1387, 1476, 1533, 1610, 1693, 1719, 2365, 2896, 2982, 3050, 3157, 3428$   $\text{cm}^{-1}$ .

#### *Dimethyl 2-((1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4b*



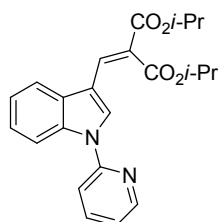
**4b** was synthesized from **S-3a** and dimethyl malonate according to *General Procedure B*. Yield: 38%; yellow solid; mp: 103~106 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.61 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.26 (s, 1H), 8.18 – 8.13 (m, 2H), 7.89 (ddd,  $J = 8.2, 7.4, 1.9$  Hz, 1H), 7.85 – 7.80 (m, 1H), 7.52 (dt,  $J = 8.2, 1.0$  Hz, 1H), 7.39 – 7.30 (m, 2H), 7.31 – 7.26 (m, 1H), 3.92 (s, 3H), 3.88 (s, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.9, 165.4, 151.5, 149.3, 138.7, 135.2, 134.8, 129.6, 128.8, 124.3, 122.6, 121.5, 120.8, 118.7, 115.4, 113.3, 112.3, 52.7, 52.4; HRMS (ESI) Calcd for  $\text{C}_{19}\text{H}_{17}\text{N}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 337.1183; Found: 337.1186; IR (neat):  $\nu = 578, 632, 752, 786, 932, 991, 1077, 1204, 1236, 1339, 1384, 1438, 1469, 1537, 1589, 1617, 1717, 2364, 2952, 3006, 3442$   $\text{cm}^{-1}$ .

*Dipropyl 2-((1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4c*



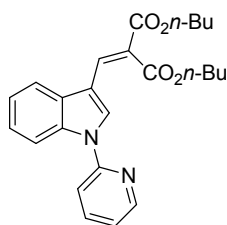
**4c** was synthesized from **S-3a** and dipropyl malonate according to *General Procedure B*. Yield: 41%; yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (d,  $J = 5.0$  Hz, 1H), 8.28 (s, 1H), 8.18 – 8.15 (m, 2H), 7.90 – 7.80 (m, 2H), 7.50 (d,  $J = 8.2$  Hz, 1H), 7.41 – 7.29 (m, 2H), 7.28 – 7.23 (m, 1H), 4.34 – 4.16 (m, 4H), 1.81 – 1.74 (m, 4H), 1.04 (t,  $J = 7.4$  Hz, 3H), 0.98 (t,  $J = 7.4$  Hz, 3H).  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.6, 164.9, 151.4, 149.1, 138.6, 135.1, 133.7, 129.5, 128.4, 124.1, 122.4, 121.7, 121.2, 118.6, 115.1, 113.3, 112.2, 67.2, 66.7, 22.0, 21.8, 10.3; HRMS (ESI) Calcd for  $\text{C}_{23}\text{H}_{25}\text{N}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 393.1809; Found: 393.1810; IR (neat):  $\nu = 580, 624, 744, 788, 959, 986, 1077, 1229, 1332, 1379, 1439, 1467, 1538, 1585, 1619, 1715, 2880, 2967, 3062, 3447$   $\text{cm}^{-1}$ .

*Diisopropyl 2-((1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4d*



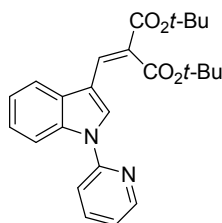
**4d** was synthesized from **S-3a** and di-iso-propyl malonate according to *General Procedure B*. Yield: 30%; yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.63–8.56 (m, 1H), 8.28 (s, 1H), 8.18–8.15 (m, 2H), 8.07 (s, 1H), 7.88–7.83 (m, 2H), 7.50 (d,  $J = 8.2$  Hz, 1H), 7.38–7.28 (m, 2H), 7.26–7.20 (m, 1H), 5.34–5.25 (m, 1H), 5.24–5.15 (m, 1H), 1.35 (d,  $J = 4.3$  Hz, 6H), 1.34 (d,  $J = 4.2$  Hz, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 164.5, 151.5, 149.1, 138.6, 135.1, 132.9, 129.6, 128.3, 124.1, 122.6, 122.4, 121.2, 118.7, 115.1, 113.3, 112.3, 68.9, 68.7, 21.8, 21.6; HRMS (ESI) Calcd for  $\text{C}_{23}\text{H}_{25}\text{N}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 393.1809; Found: 393.1811; IR (neat):  $\nu = 579, 744, 837, 926, 1069, 1106, 1146, 1208, 1237, 1322, 1381, 1467, 1535, 1589, 1620, 1717, 2935, 2980, 3452$   $\text{cm}^{-1}$ .

*Dibutyl 2-((1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4e*



**4e** was synthesized from **S-3a** and dibutyl malonate according to *General Procedure B*. Yield: 68%; yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.58 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.25 (s, 1H), 8.18–8.13 (m, 1H), 8.11 (s, 1H), 7.89–7.79 (m, 2H), 7.48 (dt,  $J = 8.2, 1.0$  Hz, 1H), 7.37–7.29 (m, 2H), 7.29–7.20 (m, 1H), 4.33 (t,  $J = 6.7$  Hz, 2H), 4.28 (t,  $J = 6.6$  Hz, 2H), 1.80–1.66 (m, 4H), 1.52–1.34 (m, 4H), 0.97 (t,  $J = 7.4$  Hz, 3H), 0.90 (t,  $J = 7.4$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.7, 165.0, 151.6, 149.2, 138.7, 135.2, 133.7, 130.0, 128.5, 124.2, 122.5, 121.8, 121.3, 118.7, 115.3, 113.3, 112.3, 65.5, 65.1, 30.7, 30.5, 19.14, 19.06, 13.72, 13.63; HRMS (ESI) Calcd for  $\text{C}_{25}\text{H}_{29}\text{N}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 421.2122; Found: 421.2123; IR (neat):  $\nu = 743, 782, 1073, 1200, 1232, 1323, 1380, 1467, 1535, 1589, 1618, 1719, 2872, 2959, 3450$   $\text{cm}^{-1}$ .

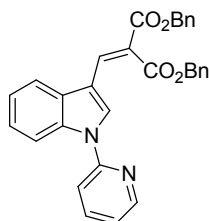
*Di-tert-butyl 2-((1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4f*



**4f** was synthesized from **S-3a** and di-tert-butyl malonate according to *General Procedure B*. Yield: 30%; white solid; mp: 115–118  $^{\circ}\text{C}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.58 (dd,  $J = 4.8, 1.8$  Hz, 1H), 8.29 (s, 1H), 8.24–8.19 (m, 1H), 7.94 (s, 1H), 7.87–7.79 (m, 2H), 7.48 (d,  $J = 8.2$  Hz, 1H), 7.38–

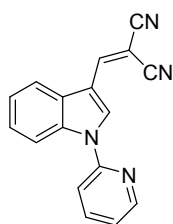
7.30 (m, 2H), 7.23 (dd, J = 7.4, 4.9 Hz, 1H), 1.60 (s, 9H), 1.57 (s, 9H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.1, 164.2, 151.7, 149.1, 138.6, 135.1, 131.0, 130.0, 127.7, 125.0, 124.1, 122.3, 121.0, 118.7, 114.8, 113.4, 112.5, 81.8, 81.5, 28.2, 28.0; HRMS (ESI) Calcd for  $\text{C}_{25}\text{H}_{29}\text{N}_2\text{O}_4$  (M+H) $^+$ : 421.2122; Found: 421.2124; IR (neat):  $\nu$  = 574, 674, 745, 783, 839, 941, 1029, 1077, 1150, 1229, 1320, 1368, 1441, 1475, 1546, 1592, 1699, 1723, 2931, 2971, 3450  $\text{cm}^{-1}$ .

*Dibenzyl 2-((1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4g*



**4g** was synthesized from **S-3a** and dibenzyl malonate according to *General Procedure B*. Yield: 51%; yellow solid; mp: 106–108 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (d, J = 3.4 Hz, 1H), 8.19 (s, 1H), 8.16 (d, J = 8.0 Hz, 1H), 8.10 (s, 1H), 7.87–7.76 (m, 2H), 7.37–7.28 (m, 9H), 7.27–7.19 (m, 5H), 5.34 (s, 2H), 5.31 (s, 2H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.3, 164.7, 151.5, 149.1, 138.7, 135.8, 135.3, 135.2, 135.0, 130.0, 128.9, 128.5, 128.4, 128.4, 128.2, 128.1, 128.0, 124.3, 122.6, 121.3, 120.7, 118.6, 115.4, 113.4, 112.1, 67.3, 66.9; HRMS (ESI) Calcd for  $\text{C}_{31}\text{H}_{25}\text{N}_2\text{O}_4$  (M+H) $^+$ : 489.1809; Found: 489.1812; IR (neat):  $\nu$  = 497, 571, 698, 746, 783, 916, 961, 1072, 1199, 1227, 1323, 1376, 1463, 1537, 1584, 1622, 1721, 3057, 3448  $\text{cm}^{-1}$ .

*2-((1-(Pyridin-2-yl)-1H-indol-3-yl)methylene)malononitrile 4h*

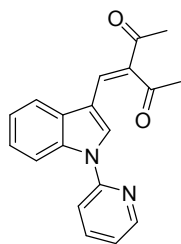


**4h** was synthesized according to the following procedure. Piperidine (1 mL) was added to the solution of aldehyde **S-3h** (20 mmol), malononitrile (26 mmol) in DCM (10 mL) and ethanol (10 mL) at room temperature. Then the mixture was stirred for 8 h. The mixture was extracted with EtOAc (100 mL) and dried over  $\text{Na}_2\text{SO}_4$ . The solvent was evaporated under reduced pressure. The residue was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate, 10:1) to afford **4h**.

Yield: 42%; yellow solid; mp: 175–178 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.95 (s, 1H), 8.67

(ddd,  $J = 4.9, 1.9, 0.8$  Hz, 1H), 8.16 (dd,  $J = 6.8, 1.9$  Hz, 1H), 8.11 (s, 1H), 7.96 (td,  $J = 8.0, 1.9$  Hz, 1H), 7.77 (dd,  $J = 6.5, 2.1$  Hz, 1H), 7.61 (d,  $J = 8.2$  Hz, 1H), 7.47 – 7.35 (m, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  150.62, 149.91, 149.61, 139.19, 135.34, 131.78, 128.34, 125.47, 124.07, 122.85, 118.09, 116.21, 114.90, 114.82, 113.95, 112.64, 75.28; HRMS (ESI) Calcd for  $\text{C}_{17}\text{H}_{11}\text{N}_4(\text{M}+\text{H})^+$ : 271.0978; Found: 271.0980; IR (neat):  $\nu = 548, 615, 729, 779, 829, 949, 1094, 1158, 1229, 1268, 1329, 1372, 1436, 1471, 1520, 1588, 2219, 2368, 3027, 3110, 3415$   $\text{cm}^{-1}$ .

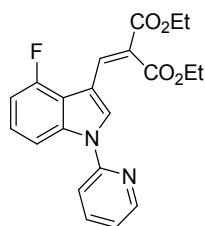
*3-((1-(Pyridin-2-yl)-1H-indol-3-yl)methylene)pentane-2,4-dione* **4i**



**4i** was synthesized according to the following procedure. Acetylacetone (10 g, 10 mmol) was mixed with **S-3i** (10 mmol) and piperidine (1-2 drops) in ethanol (50 ml), and the reaction mixture was stirred thoroughly for a period of 6 h at room temperature. The solvent was evaporated under reduced pressure. The residue was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate, 10:1) to afford **4i**.

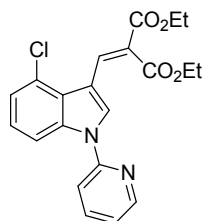
Yield: 15%; yellow solid; mp: 96~99 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.54 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.18 – 8.13 (m, 1H), 7.99 (d,  $J = 0.8$  Hz, 1H), 7.81 (ddd,  $J = 8.2, 7.4, 1.9$  Hz, 1H), 7.76 – 7.71 (m, 2H), 7.43 (dt,  $J = 8.3, 0.9$  Hz, 1H), 7.34 – 7.26 (m, 2H), 7.21 (ddd,  $J = 7.4, 4.9, 0.9$  Hz, 1H), 2.45 (s, 3H), 2.36 (s, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  206.24, 196.64, 151.46, 149.19, 139.18, 138.81, 135.44, 131.22, 129.41, 128.78, 124.50, 122.67, 121.57, 118.25, 115.51, 113.78, 112.13, 31.19, 26.13; HRMS (ESI) Calcd for  $\text{C}_{19}\text{H}_{17}\text{N}_2\text{O}_2(\text{M}+\text{H})^+$ : 305.1285; Found: 305.1288; IR (neat):  $\nu = 608, 735, 787, 910, 1004, 1169, 1225, 1252, 1321, 1350, 1468, 1523, 1591, 1646, 1684, 2365, 2923, 3419$   $\text{cm}^{-1}$ .

*Diethyl 2-((4-fluoro-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate* **4j**



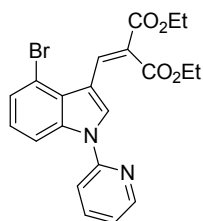
**4j** was synthesized from **S-3j** and diethyl malonate according to *General Procedure B*. Yield: 41%; yellow solid; mp: 82~85 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.59 (ddd, *J* = 4.9, 2.0, 0.8 Hz, 1H), 8.34 (s, 1H), 8.19 (s, 1H), 7.93 (d, *J* = 8.4 Hz, 1H), 7.88 (td, *J* = 7.8, 1.9 Hz, 1H), 7.48 (dd, *J* = 8.3, 1.0 Hz, 1H), 7.3–7.21 (m, 2H), 6.97 (dd, *J* = 10.9, 7.9 Hz, 1H), 4.39 (q, *J* = 7.1 Hz, 2H), 4.33 (q, *J* = 7.1 Hz, 2H), 1.36 (t, *J* = 7.1 Hz, 6H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>): δ 167.6, 164.7, 157.0 (d, *J* = 247.8 Hz), 151.3, 149.2, 138.8, 137.4 (d, *J* = 10.0 Hz), 135.0 (d, *J* = 6.3 Hz), 128.4, 124.6 (d, *J* = 7.7 Hz), 122.5, 121.7, 117.9 (d, *J* = 18.1 Hz), 115.5, 111.1 (d, *J* = 3.5 Hz), 109.4 (d, *J* = 3.9 Hz), 108.2 (d, *J* = 19.2 Hz), 61.6, 61.2, 14.2, 14.0; HRMS (ESI) Calcd for C<sub>21</sub>H<sub>20</sub>FN<sub>2</sub>O<sub>4</sub> (M+H)<sup>+</sup>: 383.1402; Found: 383.1406; IR (neat): ν = 783, 849, 906, 1029, 1069, 1093, 1183, 1222, 1270, 1303, 1387, 1442, 1475, 1530, 1614, 1711, 2366, 2985, 3154, 3448 cm<sup>-1</sup>.

*Diethyl 2-((4-chloro-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate* **4k**



**4k** was synthesized from **S-3k** and diethyl malonate according to *General Procedure B*. Yield: 33%; yellow solid; mp: 84~87 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.82 (s, 1H), 8.60 (ddd, *J* = 4.9, 1.9, 0.8 Hz, 1H), 8.19 (s, 1H), 8.10 (dd, *J* = 8.0, 1.3 Hz, 1H), 7.88 (td, *J* = 7.8, 1.9 Hz, 1H), 7.45 (dd, *J* = 8.3, 1.1 Hz, 1H), 7.30–7.21 (m, 3H), 4.39–4.30 (m, 4H), 1.38–1.31 (m, 6H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>): δ 167.6, 164.6, 151.2, 149.2, 138.9, 136.6, 135.3, 129.2, 126.6, 125.7, 124.5, 123.8, 122.6, 121.8, 115.7, 112.7, 112.1, 61.7, 61.3, 14.2, 14.0; HRMS (ESI) Calcd for C<sub>21</sub>H<sub>20</sub>ClN<sub>2</sub>O<sub>4</sub> (M+H)<sup>+</sup>: 399.1106; Found: 399.1110; IR (neat): ν = 583, 614, 738, 781, 838, 941, 1025, 1075, 1188, 1222, 1270, 1300, 1386, 1442, 1472, 1532, 1610, 1718, 2364, 2986, 3451 cm<sup>-1</sup>.

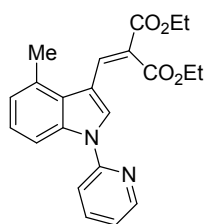
*Diethyl 2-((4-bromo-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate* **4l**



**4l** was synthesized from **S-3l** and diethyl malonate according to *General Procedure B*. Yield: 39%; orange solid; mp: 88~91 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.88 (s, 1H), 8.53 (d, *J* = 4.9 Hz, 1H),

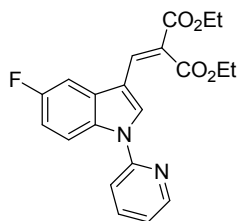
8.22 – 8.05 (m, 2H), 7.89 – 7.77 (m, 1H), 7.47 – 7.34 (m, 2H), 7.22 – 7.16 (m, 1H), 7.14 – 7.03 (m, 1H), 4.28–4.25 (m, 4H), 1.32 – 1.19 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.6, 164.7, 151.3, 149.3, 138.9, 136.6, 135.2, 129.4, 127.3, 127.1, 124.8, 122.6, 121.7, 115.7, 114.3, 113.3, 112.7, 61.6, 61.3, 14.2, 14.0; HRMS (ESI) Calcd for  $\text{C}_{21}\text{H}_{20}\text{BrN}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 443.0601; Found: 443.0606; IR (neat):  $\nu$  = 587, 615, 733, 782, 821, 937, 967, 1017, 1072, 1218, 1298, 1374, 1445, 1473, 1532, 1606, 1714, 2365, 2901, 2990, 3449  $\text{cm}^{-1}$ .

Diethyl 2-((4-methyl-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate **4m**



**4m** was synthesized from **S-3m** and diethyl malonate according to *General Procedure B*. Yield: 60%; yellow solid; mp: 74~77 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (ddd,  $J$  = 4.7, 1.9, 0.9 Hz, 1H), 8.42 (s, 1H), 8.15 (s, 1H), 8.03–7.96 (m, 1H), 7.86 (ddd,  $J$  = 8.2, 7.5, 2.0 Hz, 1H), 7.48 (dd,  $J$  = 8.2, 1.0 Hz, 1H), 7.26–7.23 (m, 1H), 7.23–7.16 (m, 1H), 7.05 (dt,  $J$  = 7.2, 0.9 Hz, 1H), 4.39–4.29 (m, 4H), 2.79 (s, 3H), 1.38–1.31 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.6, 164.8, 151.6, 149.2, 138.6, 136.5, 135.7, 131.3, 128.4, 127.7, 124.6, 124.0, 122.4, 121.3, 115.7, 113.8, 111.1, 61.6, 61.2, 21.2, 14.2, 14.0; HRMS (ESI) Calcd for  $\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 379.1652; Found: 379.1655; IR (neat):  $\nu$  = 584, 621, 751, 780, 1030, 1068, 1094, 1180, 1220, 1305, 1339, 1370, 1444, 1470, 1532, 1602, 1714, 2364, 2905, 2983, 3448  $\text{cm}^{-1}$ .

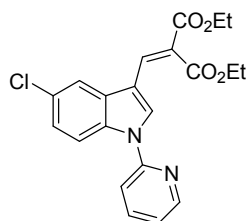
Diethyl 2-((5-fluoro-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate **4n**



**4n** was synthesized from **S-3n** and diethyl malonate according to *General Procedure B*. Yield: 53%; yellow solid; mp: 97~100 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (ddd,  $J$  = 4.9, 2.0, 0.9 Hz, 1H), 8.27 (s, 1H), 8.20 (dd,  $J$  = 9.1, 4.5 Hz, 1H), 7.99 (s, 1H), 7.88 (ddd,  $J$  = 8.2, 7.4, 1.9 Hz, 1H), 7.49–7.42 (m, 2H), 7.30–7.26 (m, 1H), 7.08 (td,  $J$  = 9.0, 2.5 Hz, 1H), 4.39 (q,  $J$  = 7.1 Hz, 2H), 4.33 (q,  $J$  = 7.1 Hz, 2H), 1.38–1.34 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.4, 164.8,

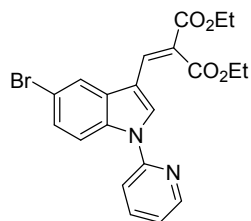
159.3 (d,  $J = 239.7$  Hz), 151.5, 149.1, 138.8, 133.3, 131.7, 130.5 (d,  $J = 9.9$  Hz), 129.6, 122.0, 121.5, 114.9 (d,  $J = 9.1$  Hz), 114.9, 112.42 (d,  $J = 25.2$  Hz), 112.19 (d,  $J = 4.3$  Hz), 104.12 (d,  $J = 24.3$  Hz), 61.7, 61.4, 14.2, 14.1; HRMS (ESI) Calcd for  $C_{21}H_{20}FN_2O_4$  (M+H)<sup>+</sup>: 383.1402; Found: 383.1405; IR (neat):  $\nu = 588, 786, 842, 1028, 1093, 1180, 1244, 1295, 1384, 1473, 1533, 1589, 1619, 1697, 1732, 2365, 2983, 3451$  cm<sup>-1</sup>.

*Diethyl 2-((5-chloro-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4o*



**4o** was synthesized from **S-3o** and diethyl malonate according to *General Procedure B*. Yield: 59%; yellow solid; mp: 119~122 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  8.60 (dd,  $J = 4.9, 1.9$  Hz, 1H), 8.26 (s, 1H), 8.17 (d,  $J = 8.8$  Hz, 1H), 7.99 (s, 1H), 7.89 (td,  $J = 7.8, 2.0$  Hz, 1H), 7.78 (d,  $J = 2.1$  Hz, 1H), 7.46 (d,  $J = 8.2$  Hz, 1H), 7.31–7.24 (m, 2H), 4.42–4.31 (m, 4H), 1.39–1.34 (m, 6H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>):  $\delta$  167.4, 164.8, 151.3, 149.2, 138.9, 133.6, 133.1, 130.7, 129.4, 128.4, 124.5, 122.4, 121.6, 118.4, 115.0, 114.9, 111.8, 61.7, 61.4, 14.2, 14.1; HRMS (ESI) Calcd for  $C_{21}H_{20}ClN_2O_4$  (M+H)<sup>+</sup>: 399.1106; Found: 399.1111; IR (neat):  $\nu = 621, 728, 779, 867, 1024, 1076, 1204, 1254, 1294, 1338, 1366, 1401, 1446, 1474, 1540, 1590, 1626, 1691, 1728, 2367, 2926, 2979, 3453$  cm<sup>-1</sup>.

*Diethyl 2-((5-bromo-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4p*

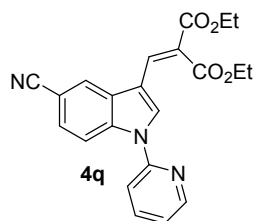


**4p** was synthesized from **S-3p** and diethyl malonate according to *General Procedure B*. Yield: 71%; white solid; mp: 120~123 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  8.60 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.24 (s, 1H), 8.12 (d,  $J = 8.8$  Hz, 1H), 7.99 (s, 1H), 7.94 (d,  $J = 1.9$  Hz, 1H), 7.89 (ddd,  $J = 8.2, 7.4, 1.9$  Hz, 1H), 7.49–7.41 (m, 2H), 7.29 (ddd,  $J = 7.4, 4.9, 0.9$  Hz, 1H), 4.42–4.31 (m, 4H), 1.39–1.34 (m, 6H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>):  $\delta$  167.3, 164.8, 151.4, 149.2, 138.9, 134.0, 133.0, 131.3, 129.3, 127.2, 122.6, 121.6, 121.5, 116.0, 115.3, 115.1, 111.8, 61.7, 61.4, 14.2, 14.1;



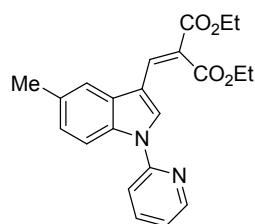
HRMS (ESI) Calcd for  $C_{21}H_{20}BrN_2O_4$  (M+H)<sup>+</sup>: 443.0601; Found: 443.0604; IR (neat):  $\nu = 593, 622, 736, 779, 856, 948, 1023, 1070, 1154, 1222, 1289, 1377, 1446, 1474, 1534, 1585, 1616, 1714, 2366, 2975, 3418$  cm<sup>-1</sup>.

*Diethyl 2-((5-cyano-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate* **4q**



**4q** was synthesized from **S-3q** and diethyl malonate according to *General Procedure B*. Yield: 55%; white solid; mp: 169~172 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  8.64 – 8.61 (m, 1H), 8.35 – 8.31 (m, 2H), 8.15 (d,  $J = 1.5$  Hz, 1H), 7.99 (s, 1H), 7.93 (td,  $J = 7.8, 1.9$  Hz, 1H), 7.59 (dd,  $J = 8.7, 1.6$  Hz, 1H), 7.48 (d,  $J = 8.2$  Hz, 1H), 7.34 (dd,  $J = 7.0, 4.9$  Hz, 1H), 4.36 (dt,  $J = 15.4, 7.2$  Hz, 4H), 1.37 (dt,  $J = 8.9, 7.1$  Hz, 6H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>)  $\delta$  167.08, 164.51, 151.01, 149.33, 139.13, 136.85, 132.12, 130.27, 129.37, 127.15, 123.94, 123.76, 122.19, 119.73, 115.43, 114.83, 112.48, 105.87, 61.84, 61.60, 14.22, 14.07; HRMS (ESI) Calcd for  $C_{22}H_{20}N_3O_4$  (M+H)<sup>+</sup>: 390.1448; Found: 390.1451; IR (neat):  $\nu = 534, 640, 738, 778, 817, 874, 1016, 1067, 1095, 1168, 1233, 1297, 1335, 1384, 1437, 1474, 1539, 1588, 1626, 1718, 2220, 2366, 2983, 3105, 3418$  cm<sup>-1</sup>.

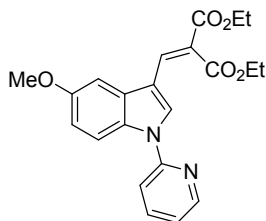
*Diethyl 2-((5-methyl-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate* **4r**



**4r** was synthesized from **S-3r** and diethyl malonate according to *General Procedure B*. Yield: 59%; yellow solid; mp: 85~88 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  8.59 (ddd,  $J = 4.9, 2.0, 0.8$  Hz, 1H), 8.23 (s, 1H), 8.08 (s, 1H), 8.05 (d,  $J = 8.5$  Hz, 1H), 7.86 (ddd,  $J = 8.4, 7.4, 1.9$  Hz, 1H), 7.60 (dt,  $J = 1.8, 0.9$  Hz, 1H), 7.49 (dd,  $J = 8.3, 1.1$  Hz, 1H), 7.26–7.22 (m, 1H), 7.17 (dd,  $J = 8.6, 1.7$  Hz, 1H), 4.42–4.31 (m, 4H), 2.51 (s, 3H), 1.39–1.34 (m, 6H); <sup>13</sup>C {<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>):  $\delta$  167.7, 165.0, 151.6, 149.2, 138.6, 133.9, 133.4, 132.1, 129.9, 128.5, 125.7, 121.4, 121.1, 118.5, 115.0, 113.1, 112.0, 61.6, 61.3, 14.3, 14.1; HRMS (ESI) Calcd for  $C_{22}H_{23}N_2O_4$  (M+H)<sup>+</sup>: 379.1652;

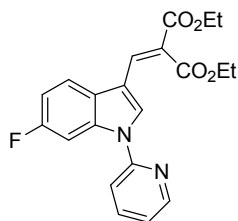
Found: 379.1655; IR (neat):  $\nu = 603, 701, 744, 792, 1023, 1075, 1173, 1206, 1250, 1303, 1337, 1377, 1443, 1476, 1536, 1590, 1620, 1689, 1727, 2364, 2909, 2983, 3066, 3449 \text{ cm}^{-1}$ .

*Diethyl 2-((5-methoxy-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4s*



**4s** was synthesized from **S-3s** and diethyl malonate according to *General Procedure B*. Yield: 64%; yellow solid; mp: 94~96 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.57 (dd,  $J = 5.0, 1.8 \text{ Hz}$ , 1H), 8.21 (s, 1H), 8.11 (d,  $J = 9.1 \text{ Hz}$ , 1H), 8.07 (s, 1H), 7.85 (td,  $J = 7.8, 1.9 \text{ Hz}$ , 1H), 7.46 (d,  $J = 8.2 \text{ Hz}$ , 1H), 7.25–7.19 (m, 2H), 6.98 (dd,  $J = 9.1, 2.5 \text{ Hz}$ , 1H), 4.42–4.31 (m, 4H), 3.91 (s, 3H), 1.38–1.34 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.6, 165.1, 156.0, 151.6, 149.1, 138.6, 133.9, 130.6, 130.1, 128.6, 121.3, 121.1, 114.7, 114.6, 114.0, 112.1, 100.4, 61.6, 61.3, 55.8, 14.2, 14.0; HRMS (ESI) Calcd for  $\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 395.1601; Found: 395.1605; IR (neat):  $\nu = 604, 779, 821, 1026, 1072, 1117, 1200, 1248, 1391, 1435, 1477, 1528, 1593, 1697, 2363, 2826, 2932, 2981, 3162, 3447 \text{ cm}^{-1}$ .

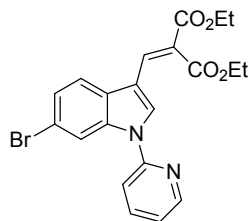
*Diethyl 2-((6-fluoro-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4t*



**4t** was synthesized from **S-3t** and diethyl malonate according to *General Procedure B*. Yield: 60%; yellow solid; mp: 73~76 °C;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.60 (ddd,  $J = 4.9, 1.9, 0.9 \text{ Hz}$ , 1H), 8.21 (s, 1H), 8.06–7.98 (m, 2H), 7.89 (ddd,  $J = 8.3, 7.5, 2.0 \text{ Hz}$ , 1H), 7.73 (dd,  $J = 8.7, 5.2 \text{ Hz}$ , 1H), 7.45 (dt,  $J = 8.3, 1.0 \text{ Hz}$ , 1H), 7.30–7.26 (m, 1H), 7.09 (td,  $J = 8.9, 2.4 \text{ Hz}$ , 1H), 4.41–4.31 (m, 4H), 1.38–1.33 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.4, 164.8, 160.9 (d,  $J = 240.2 \text{ Hz}$ ), 151.6, 149.1, 138.9, 135.3 (d,  $J = 12.8 \text{ Hz}$ ), 133.4, 128.4, 126.0, 122.5, 121.4, 119.5 (d,  $J = 10.2 \text{ Hz}$ ), 114.7, 112.5, 111.2 (d,  $J = 24.4 \text{ Hz}$ ), 101.0 (d,  $J = 28.1 \text{ Hz}$ ), 61.7, 61.4, 14.2, 14.1; HRMS (ESI) Calcd for  $\text{C}_{21}\text{H}_{20}\text{FN}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 383.1402; Found: 383.1407; IR (neat):  $\nu = 559, 630, 738,$

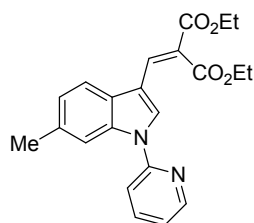
772, 845, 911, 1031, 1080, 1208, 1236, 1278, 1337, 1387, 1451, 1481, 1534, 1604, 1702, 2366, 2919, 2982, 3450 cm<sup>-1</sup>.

*Diethyl 2-((6-bromo-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4u*



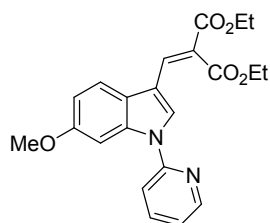
**4u** was synthesized from **S-3u** and diethyl malonate according to *General Procedure B*. Yield: 42%; yellow oil; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.65–8.59 (m, 1H), 8.44 (d, J = 1.7 Hz, 1H), 8.21 (s, 1H), 8.02 (s, 1H), 7.89 (td, J = 7.8, 1.9 Hz, 1H), 7.67 (d, J = 8.4 Hz, 1H), 7.49–7.41 (m, 2H), 7.29 (dd, J = 7.5, 4.9 Hz, 1H), 4.41–4.31 (m, 4H), 1.38–1.33 (m, 6H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>): δ 167.4, 164.8, 151.3, 149.2, 138.9, 135.9, 133.2, 128.7, 128.4, 125.8, 122.5, 121.6, 120.0, 118.0, 116.8, 115.1, 112.3, 61.7, 61.4, 14.2, 14.1; HRMS (ESI) Calcd for C<sub>21</sub>H<sub>20</sub>BrN<sub>2</sub>O<sub>4</sub> (M+H)<sup>+</sup>: 443.0601; Found: 443.0605; IR (neat): ν = 621, 739, 786, 852, 1021, 1066, 1207, 1246, 1303, 1338, 1371, 1445, 1475, 1530, 1594, 1624, 1717, 2364, 2927, 2978, 3449 cm<sup>-1</sup>.

*Diethyl 2-((6-methyl-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4v*



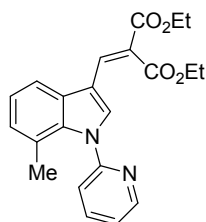
**4v** was synthesized from **S-3v** and diethyl malonate according to *General Procedure B*. Yield: 64%; yellow oil; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.52 (d, J = 4.9 Hz, 1H), 8.10 (s, 1H), 8.01 (s, 1H), 7.88 (s, 1H), 7.79 (td, J = 7.9, 2.0 Hz, 1H), 7.62 (d, J = 8.2 Hz, 1H), 7.41 (d, J = 8.2 Hz, 1H), 7.19–7.14 (m, 1H), 7.08 (d, J = 8.1 Hz, 1H), 4.34–4.23 (m, 4H), 2.43 (s, 3H), 1.30–1.26 (m, 6H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>): δ 167.6, 165.0, 151.7, 149.2, 138.6, 135.6, 134.3, 134.0, 128.2, 127.5, 124.2, 121.5, 121.2, 118.3, 115.4, 113.2, 112.3, 61.6, 61.2, 21.9, 14.2, 14.0; HRMS (ESI) Calcd for C<sub>22</sub>H<sub>23</sub>N<sub>2</sub>O<sub>4</sub> (M+H)<sup>+</sup>: 379.1652; Found: 379.1653; IR (neat): ν = 553, 603, 710, 740, 781, 863, 1022, 1070, 1196, 1236, 1331, 1376, 1442, 1469, 1533, 1616, 1719, 2363, 2981, 3451 cm<sup>-1</sup>.

*Diethyl 2-((6-methoxy-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4w*



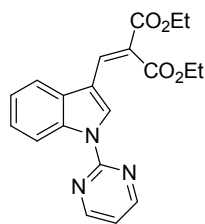
**4w** was synthesized from **S-3w** and diethyl malonate according to *General Procedure B*. Yield: 73%; yellow oil;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.63–8.57 (m, 1H), 8.11 (s, 1H), 8.05 (s, 1H), 7.87 (td,  $J = 7.8, 1.9$  Hz, 1H), 7.77 (d,  $J = 2.3$  Hz, 1H), 7.68 (d,  $J = 8.7$  Hz, 1H), 7.48–7.42 (m, 1H), 7.26–7.23 (m, 1H), 6.97 (dd,  $J = 8.7, 2.3$  Hz, 1H), 4.41–4.30 (m, 4H), 3.88 (s, 3H), 1.38–1.33 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.6, 165.0, 157.8, 151.9, 149.1, 138.7, 136.1, 133.9, 127.5, 123.7, 121.8, 121.1, 119.2, 115.1, 112.5, 111.8, 97.8, 61.6, 61.3, 55.7, 14.2, 14.1; HRMS (ESI) Calcd for  $\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 395.1601; Found: 395.1604; IR (neat):  $\nu = 628, 708, 780, 862, 1025, 1071, 1130, 1206, 1309, 1335, 1382, 1443, 1471, 1536, 1615, 1720, 2366, 2980, 3450$   $\text{cm}^{-1}$ .

*Diethyl 2-((7-methyl-1-(pyridin-2-yl)-1H-indol-3-yl)methylene)malonate 4x*



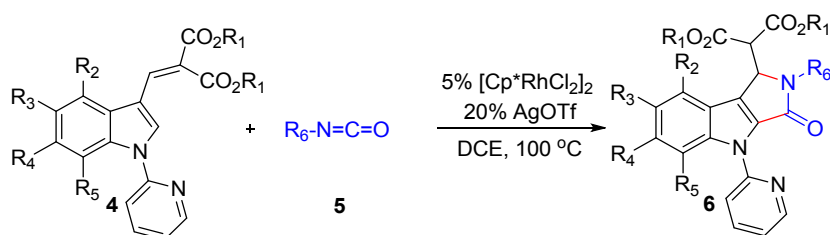
**4x** was synthesized from **S-3x** and diethyl malonate according to *General Procedure B*. Yield: 49%; yellow oil;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.61 (ddd,  $J = 4.9, 1.9, 0.8$  Hz, 1H), 8.13 (s, 1H), 7.91–7.84 (m, 2H), 7.70 (d,  $J = 8.0$  Hz, 1H), 7.40 (ddd,  $J = 7.5, 4.9, 1.0$  Hz, 1H), 7.35 (dd,  $J = 7.9, 1.0$  Hz, 1H), 7.21 (t,  $J = 7.6$  Hz, 1H), 7.07 (dt,  $J = 7.2, 1.0$  Hz, 1H), 4.36–4.29 (m, 4H), 2.05 (s, 3H), 1.37–1.30 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.7, 165.1, 152.6, 149.0, 138.2, 135.1, 134.2, 131.9, 129.5, 126.6, 123.3, 122.5, 122.3, 121.0, 120.9, 116.5, 111.4, 61.5, 61.2, 20.0, 14.2, 14.0; HRMS (ESI) Calcd for  $\text{C}_{22}\text{H}_{23}\text{N}_2\text{O}_4$  ( $\text{M}+\text{H}$ ) $^+$ : 379.1652; Found: 379.1654; IR (neat):  $\nu = 589, 675, 747, 780, 1023, 1068, 1203, 1230, 1303, 1333, 1371, 1440, 1469, 1535, 1587, 1618, 1718, 2366, 2929, 2980, 3452$   $\text{cm}^{-1}$ .

*Diethyl 2-((1-(pyrimidin-2-yl)-1H-indol-3-yl)methylene)malonate 4y*



**4y** was synthesized from **S-3y**<sup>[2]</sup> and diethyl malonate according to *General Procedure B*. Yield: 55%; yellow solid; mp: 112~115 °C; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.84–8.77 (m, 1H), 8.75 (s, 1H), 8.69 (d, *J* = 4.8 Hz, 2H), 8.06 (s, 1H), 7.77 (dd, *J* = 7.5, 1.4 Hz, 1H), 7.43–7.30 (m, 2H), 7.09 (t, *J* = 4.8 Hz, 1H), 4.45 (q, *J* = 7.1 Hz, 2H), 4.34 (q, *J* = 7.1 Hz, 2H), 1.38 (q, *J* = 7.2 Hz, 6H); <sup>13</sup>C {<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>): δ 167.2, 164.6, 158.2, 157.1, 135.2, 133.0, 130.2, 127.6, 124.6, 123.1, 123.0, 118.3, 117.1, 116.5, 113.2; 61.7, 61.3, 14.2, 13.9; HRMS (ESI) Calcd for C<sub>20</sub>H<sub>20</sub>N<sub>3</sub>O<sub>4</sub> (M+H)<sup>+</sup>: 366.1448; Found: 366.1450; IR (neat): ν = 577, 621, 746, 813, 849, 1018, 1082, 1171, 1204, 1236, 1275, 1316, 1426, 1456, 1541, 1571, 1620, 1710, 2982, 3414 cm<sup>-1</sup>.

#### Synthesis of 1,2-dihydropyrrolo[3,4-b]indol-3-ones **6**

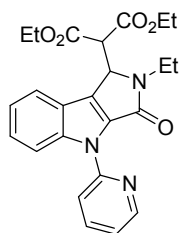


#### *General Procedure C.*

A sealed tube contained [Cp\*RhCl<sub>2</sub>]<sub>2</sub> (5 mol %, 0.01 mmol) and AgOTf (20 mol %, 0.4 mmol) was evacuated and purged with nitrogen gas three times. Then, **4** (0.2 mmol) and **5** (0.4 mmol) in DCE (2.0 mL) were added to the system via syringe under a nitrogen atmosphere and the reaction was allowed to stir at 100 °C for 40 h. The reaction solution was concentrated in vacuo and the residue was purified by column chromatography on silica gel (petroleum ether/ethyl acetate, 5:1) to afford the desired pure products **6**.

*Diethyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

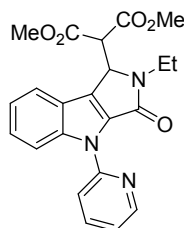
**6aa**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.64 – 8.52 (m, 1H), 8.38 (d,  $J = 8.5$  Hz, 1H), 7.99 (d,  $J = 8.3$  Hz, 1H), 7.92 – 7.81 (m, 1H), 7.73 (d,  $J = 7.0$  Hz, 1H), 7.38 (ddt,  $J = 8.4, 7.0, 1.2$  Hz, 1H), 7.28 – 7.22 (m, 1H), 5.38 (d,  $J = 3.7$  Hz, 1H), 4.29 (q,  $J = 7.2$  Hz, 2H), 4.15 – 3.87 (m, 4H), 3.28 (dq,  $J = 14.1, 7.0$  Hz, 1H), 1.30 – 1.22 (m, 6H), 0.91 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.1, 166.2, 161.8, 150.6, 148.0, 141.7, 138.2, 133.2, 130.7, 125.8, 122.5, 122.3, 121.2, 120.8, 119.3, 155.2, 62.1, 61.7, 54.3, 53.1, 36.2, 14.0, 13.8, 13.6; HRMS (ESI) Calcd for  $\text{C}_{24}\text{H}_{26}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 436.1867; Found: 436.1869; IR (neat):  $\nu = 489, 612, 743, 800, 1027, 1089, 1156, 1254, 1315, 1374, 1465, 1635, 1689, 1731, 2922, 3458$   $\text{cm}^{-1}$ .

*Dimethyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

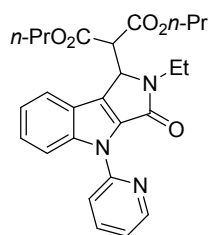
#### 6ba



Yellow solid; mp: 162~165  $^{\circ}\text{C}$ ;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.38 (d,  $J = 8.6$  Hz, 1H), 7.99 (d,  $J = 8.2$  Hz, 1H), 7.87 (td,  $J = 8.4, 7.9, 2.0$  Hz, 1H), 7.68 (d,  $J = 8.3$  Hz, 1H), 7.39 (ddd,  $J = 8.5, 7.1, 1.3$  Hz, 1H), 7.30 – 7.26 (m, 1H), 7.26 – 7.22 (m, 1H), 5.39 (d,  $J = 4.2$  Hz, 1H), 4.08 (d,  $J = 4.2$  Hz, 1H), 4.06 – 3.99 (m, 1H), 3.83 (s, 3H), 3.54 (s, 3H), 3.23 (dq,  $J = 14.1, 7.0$  Hz, 1H), 1.26 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.5, 166.7, 161.8, 150.6, 148.1, 141.8, 138.2, 133.3, 130.6, 125.9, 122.3, 122.3, 121.2, 120.6, 119.4, 115.4, 54.4, 53.2, 53.1, 52.7, 36.3, 13.7; HRMS (ESI) Calcd for  $\text{C}_{22}\text{H}_{22}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 408.1554; Found: 408.1557; IR (neat):  $\nu = 481, 612, 743, 780, 1034, 1172, 1204, 1254, 1301, 1355, 1441, 1477, 1546, 1637, 1683, 1735, 2923, 3458$   $\text{cm}^{-1}$ .

*Dipropyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

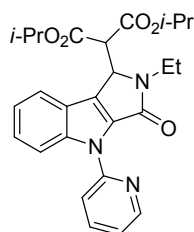
#### 6ca



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.58 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.38 (d,  $J = 8.6$  Hz, 1H), 7.99 (d,  $J = 8.3$  Hz, 1H), 7.86 (ddd,  $J = 8.3, 7.4, 2.0$  Hz, 1H), 7.71 (d,  $J = 8.0$  Hz, 1H), 7.38 (ddd,  $J = 8.5, 7.1, 1.3$  Hz, 1H), 7.26 – 7.21 (m, 2H), 5.39 (d,  $J = 3.8$  Hz, 1H), 4.25 – 4.14 (m, 2H), 4.11 (d,  $J = 3.9$  Hz, 1H), 4.03 (dq,  $J = 14.6, 7.3$  Hz, 1H), 3.93 – 3.80 (m, 2H), 3.28 (dq,  $J = 14.2, 7.0$  Hz, 1H), 1.67 – 1.63 (m, 1H), 1.62 – 1.58 (m, 1H), 1.41 – 1.29 (m, 2H), 1.27 (t,  $J = 7.1$  Hz, 3H), 0.86 (t,  $J = 7.4$  Hz, 3H), 0.67 (t,  $J = 7.4$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 166.4, 161.8, 150.6, 148.0, 141.7, 138.1, 133.2, 130.8, 125.8, 122.4, 122.2, 121.1, 120.8, 119.3, 115.3, 67.7, 67.3, 54.3, 53.2, 36.2, 21.8, 21.5, 13.8, 10.2, 10.0; HRMS (ESI) Calcd for  $\text{C}_{26}\text{H}_{30}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 464.2180; Found: 464.2183; IR (neat):  $\nu = 482, 616, 744, 778, 918, 1057, 1160, 1218, 1320, 1371, 1441, 1477, 1556, 1592, 1618, 1690, 1732, 2969, 3414$   $\text{cm}^{-1}$ .

*Diisopropyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

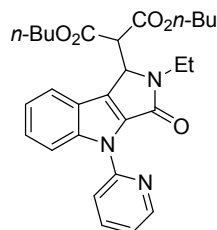
#### Malonate **6da**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.57 (dd,  $J = 4.8, 1.7$  Hz, 1H), 8.37 (d,  $J = 8.6$  Hz, 1H), 7.99 (d,  $J = 8.1$  Hz, 1H), 7.86 (td,  $J = 7.8, 1.9$  Hz, 1H), 7.77 (d,  $J = 7.0$  Hz, 1H), 7.37 (ddd,  $J = 8.5, 7.0, 1.3$  Hz, 1H), 7.26 – 7.20 (m, 2H), 5.36 (d,  $J = 3.4$  Hz, 1H), 5.19 (hept,  $J = 6.3$  Hz, 1H), 4.79 (hept,  $J = 6.2$  Hz, 1H), 4.08 – 3.97 (m, 2H), 3.31 (dq,  $J = 14.2, 7.0$  Hz, 1H), 1.31 – 1.23 (m, 9H), 0.90 (d,  $J = 6.3$  Hz, 3H), 0.75 (d,  $J = 6.3$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  166.8, 165.6, 161.8, 150.7, 148.0, 141.7, 138.2, 133.3, 130.9, 125.7, 122.8, 122.2, 121.1, 121.1, 119.3, 115.3, 69.8, 69.3, 54.4, 53.2, 36.1, 21.6, 21.2, 20.8, 13.8; HRMS (ESI) Calcd for  $\text{C}_{26}\text{H}_{30}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 464.2180; Found: 464.2185; IR (neat):  $\nu = 482, 615, 743, 778, 1023, 1103, 1177, 1221, 1299, 1371, 1442, 1476, 1555, 1592, 1619, 1690, 1725, 2934, 2980, 3418$   $\text{cm}^{-1}$ .

*Dibutyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

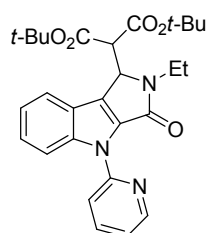
**6ea**



Yellow oil;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.58 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.40 (d,  $J = 8.6$  Hz, 1H), 8.01 (d,  $J = 8.3$  Hz, 1H), 7.86 (ddd,  $J = 8.3, 7.4, 2.0$  Hz, 1H), 7.71 (d,  $J = 8.0$  Hz, 1H), 7.38 (ddd,  $J = 8.5, 7.1, 1.3$  Hz, 1H), 7.27 – 7.21 (m, 2H), 5.38 (d,  $J = 3.8$  Hz, 1H), 4.28 – 4.17 (m, 2H), 4.10 (d,  $J = 3.8$  Hz, 1H), 4.04 (dq,  $J = 14.6, 7.3$  Hz, 1H), 3.98 – 3.81 (m, 2H), 3.27 (dq,  $J = 14.1, 7.0$  Hz, 1H), 1.61 – 1.54 (m, 2H), 1.33 – 1.17 (m, 7H), 1.10 – 1.01 (m, 2H), 0.86 (t,  $J = 7.4$  Hz, 3H), 0.72 (t,  $J = 7.3$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 166.3, 161.8, 150.6, 148.0, 141.7, 138.1, 133.2, 130.8, 125.8, 122.4, 122.2, 121.1, 120.8, 119.2, 115.4, 65.9, 65.6, 54.3, 53.2, 36.2, 30.4, 30.1, 18.9, 18.7, 13.8, 13.6, 13.5; HRMS (ESI) Calcd for  $\text{C}_{28}\text{H}_{34}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 492.2493; Found: 492.2497; IR (neat):  $\nu = 485, 674, 745, 778, 919, 1028, 1063, 1160, 1218, 1321, 1370, 1441, 1477, 1555, 1591, 1690, 1732, 2961, 3455$   $\text{cm}^{-1}$ .

*Di-tert-butyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

**Malonate 6fa**

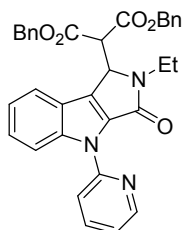


Yellow oil;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.58 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.38 (dt,  $J = 8.6$  Hz, 1H), 7.97 (d,  $J = 8.3$  Hz, 1H), 7.88–7.83 (m, 2H), 7.39–7.33 (m, 1H), 7.26–7.20 (m, 2H), 5.30 (d,  $J = 3.0$  Hz, 1H), 4.09–4.00 (m, 1H), 3.97 (d,  $J = 3.0$  Hz, 1H), 3.31 (dq,  $J = 14.2, 7.1$  Hz, 1H), 1.49 (s, 9H), 1.30 (t,  $J = 7.2$  Hz, 3H), 1.01 (s, 9H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  166.5, 165.2, 161.7, 150.6, 148.0, 141.6, 138.2, 133.1, 131.3, 125.7, 123.0, 122.1, 121.6, 121.1, 119.3, 115.1, 82.6, 82.1, 54.4, 35.9, 28.0, 27.3, 13.9; HRMS (ESI) Calcd for  $\text{C}_{28}\text{H}_{34}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 492.2493; Found: 492.2496; IR (neat):  $\nu = 477, 619, 742, 781, 1149, 1261, 1318, 1370, 1440, 1477, 1619, 1693, 1726, 2973, 3415$   $\text{cm}^{-1}$ .



Dibenzyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate

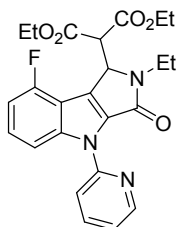
**6ga**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.57 (ddd,  $J = 5.0, 1.9, 1.0$  Hz, 1H), 8.39 (d,  $J = 8.5$  Hz, 1H), 7.88–7.78 (m, 2H), 7.62 (d,  $J = 8.1$  Hz, 1H), 7.38 (ddd,  $J = 8.5, 7.1, 1.3$  Hz, 1H), 7.28–7.13 (m, 10H), 6.99–6.91 (m, 2H), 5.39 (d,  $J = 3.8$  Hz, 1H), 5.22 (d,  $J = 1.0$  Hz, 2H), 4.97–4.85 (m, 2H), 4.21 (d,  $J = 3.8$  Hz, 1H), 3.98 (dq,  $J = 14.6, 7.3$  Hz, 1H), 3.20 (dq,  $J = 14.1, 7.0$  Hz, 1H), 1.20 (t,  $J = 7.2$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  166.8, 166.0, 161.6, 150.5, 147.9, 141.7, 138.0, 134.7, 134.4, 133.2, 130.5, 128.6, 128.5, 128.4, 128.3, 128.2, 125.8, 122.3, 121.1, 120.7, 119.3, 115.5, 67.8, 67.6, 54.3, 53.2, 36.2, 13.7; HRMS (ESI) Calcd for  $\text{C}_{34}\text{H}_{30}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 560.2180; Found: 560.2184; IR (neat):  $\nu = 483, 697, 742, 911, 1025, 1153, 1217, 1321, 1372, 1442, 1478, 1555, 1592, 1688, 1733, 2931, 3459$   $\text{cm}^{-1}$ .

Diethyl 2-(2-ethyl-8-fluoro-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)

malonate **6ja**

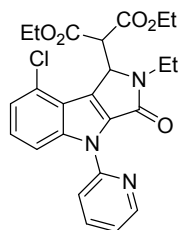


Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.57 (dd,  $J = 4.9, 1.8$  Hz, 1H), 8.24 (d,  $J = 8.6$  Hz, 1H), 8.08 (d,  $J = 8.2$  Hz, 1H), 7.88 (td,  $J = 7.8, 1.9$  Hz, 1H), 7.32 (td,  $J = 8.3, 5.6$  Hz, 1H), 7.26–7.23 (m, 1H), 6.97 (dd,  $J = 10.2, 8.0$  Hz, 1H), 5.54 (d,  $J = 1.8$  Hz, 1H), 4.40 (d,  $J = 1.8$  Hz, 1H), 4.36–4.22 (m, 2H), 4.09–4.00 (m, 2H), 3.92 (dq,  $J = 10.8, 7.1$  Hz, 1H), 3.31 (dq,  $J = 14.1, 7.0$  Hz, 1H), 1.31–1.26 (m, 6H), 0.93 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.8, 165.4, 161.6, 155.6 (d,  $J = 246.5$  Hz), 150.4, 148.0, 143.6 (d,  $J = 9.6$  Hz), 138.4, 133.3, 128.8, 126.5 (d,  $J = 7.7$  Hz), 121.5, 119.1, 112.0, 111.9 (d,  $J = 25.9$  Hz), 107.2 (d,  $J = 18.2$  Hz), 62.2, 61.4, 53.6, 53.5, 37.0, 13.9, 13.8, 13.6;  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -118.89; HRMS (ESI) Calcd for

$C_{24}H_{25}FN_3O_5$  (M+H)<sup>+</sup>: 454.1773; Found: 454.1776; IR (neat):  $\nu = 513, 638, 730, 778, 1028, 1149, 1244, 1275, 1315, 1370, 1399, 1440, 1479, 1557, 1594, 1633, 1690, 1729, 2976, 3452$  cm<sup>-1</sup>.

*Diethyl 2-(8-chloro-2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

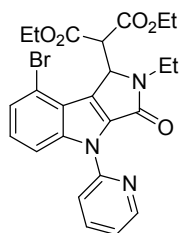
*malonate 6ka*



Yellow oil; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  8.65–8.51 (m, 1H), 8.36 (d, J = 8.0 Hz, 1H), 8.04 (d, J = 8.2 Hz, 1H), 7.88 (td, J = 7.9, 2.0 Hz, 1H), 7.34–7.25 (m, 3H), 5.65 (d, J = 1.4 Hz, 1H), 4.82 (d, J = 1.4 Hz, 1H), 4.42–4.29 (m, 2H), 4.15–3.96 (m, 2H), 3.87 (dq, J = 10.7, 7.1 Hz, 1H), 3.29 (dq, J = 14.0, 6.9 Hz, 1H), 1.35 (t, J = 7.1 Hz, 3H), 1.27 (t, J = 7.1 Hz, 3H), 0.91 (t, J = 7.1 Hz, 3H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>):  $\delta$  168.3, 165.4, 161.4, 150.2, 148.0, 142.4, 138.4, 134.1, 130.1, 126.4, 125.2, 122.3, 121.6, 121.2, 119.3, 114.5, 62.2, 61.3, 54.3, 53.5, 37.1, 14.0, 13.8, 13.5; HRMS (ESI) Calcd for  $C_{24}H_{25}ClN_3O_5$  (M+H)<sup>+</sup>: 470.1477; Found: 470.1480; IR (neat):  $\nu = 517, 545, 674, 738, 783, 852, 1042, 1093, 1176, 1213, 1250, 1296, 1323, 1345, 1394, 1440, 1478, 1560, 1590, 1627, 1693, 1741, 2982, 3450$  cm<sup>-1</sup>.

*Diethyl 2-(8-bromo-2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

*malonate 6la*

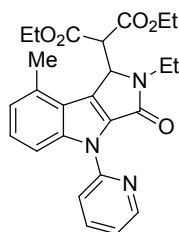


Yellow oil; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  8.63–8.55 (m, 1H), 8.40 (d, J = 8.5 Hz, 1H), 8.02 (d, J = 8.2 Hz, 1H), 7.88 (td, J = 7.8, 2.0 Hz, 1H), 7.45 (d, J = 7.7 Hz, 1H), 7.27 (d, J = 5.8 Hz, 1H), 7.26–7.22 (m, 1H), 5.68 (d, J = 1.3 Hz, 1H), 4.93 (d, J = 1.4 Hz, 1H), 4.44–4.29 (m, 2H), 4.10–3.97 (m, 2H), 3.88 (dq, J = 10.8, 7.1 Hz, 1H), 3.29 (dq, J = 14.0, 7.0 Hz, 1H), 1.36 (t, J = 7.1 Hz, 3H), 1.27 (t, J = 7.1 Hz, 3H), 0.92 (t, J = 7.1 Hz, 3H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>):  $\delta$  168.4, 165.4, 161.4, 150.1, 148.0, 142.3, 138.4, 134.3, 130.6, 126.5, 125.5, 123.0, 121.6, 119.4, 115.0, 113.3, 62.2, 61.4, 54.7, 53.2, 37.1, 14.1, 13.8, 13.5; HRMS (ESI) Calcd for  $C_{24}H_{25}BrN_3O_5$  (M+H)<sup>+</sup>:

514.0972; Found: 514.0976; IR (neat):  $\nu = 517, 551, 669, 737, 784, 840, 1041, 1090, 1157, 1178, 1213, 1294, 1317, 1339, 1398, 1437, 1479, 1562, 1592, 1692, 1735, 2933, 2980, 3451 \text{ cm}^{-1}$ .

*Diethyl 2-(2-ethyl-8-methyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

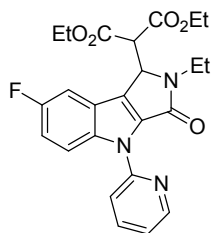
*malonate 6ma*



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.58 (ddd,  $J = 4.9, 2.0, 0.9 \text{ Hz}$ , 1H), 8.23 (d,  $J = 8.6 \text{ Hz}$ , 1H), 7.97 (d,  $J = 8.2 \text{ Hz}$ , 1H), 7.86 (td,  $J = 7.8, 1.9 \text{ Hz}$ , 1H), 7.30 (dd,  $J = 8.6, 7.2 \text{ Hz}$ , 1H), 7.23 (ddd,  $J = 7.4, 4.9, 1.1 \text{ Hz}$ , 1H), 7.07 (d,  $J = 7.2 \text{ Hz}$ , 1H), 5.60 (d,  $J = 1.5 \text{ Hz}$ , 1H), 4.41–4.27 (m, 3H), 4.12–3.99 (m, 2H), 3.90 (dq,  $J = 10.7, 7.1 \text{ Hz}$ , 1H), 3.26 (dq,  $J = 14.1, 7.0 \text{ Hz}$ , 1H), 2.64 (s, 3H), 1.33 (t,  $J = 7.1 \text{ Hz}$ , 3H), 1.26 (t,  $J = 7.1 \text{ Hz}$ , 3H), 0.94 (t,  $J = 7.1 \text{ Hz}$ , 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  168.2, 165.3, 161.9, 150.5, 148.0, 142.0, 138.2, 133.0, 131.3, 129.5, 126.1, 123.2, 122.2, 121.2, 119.4, 113.0, 62.3, 61.5, 54.6, 53.6, 36.9, 20.7, 14.0, 13.8, 13.5; HRMS (ESI) Calcd for  $\text{C}_{25}\text{H}_{28}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 450.2023; Found: 450.2027; IR (neat):  $\nu = 482, 620, 742, 781, 1038, 1155, 1207, 1241, 1318, 1396, 1440, 1477, 1558, 1592, 1620, 1686, 1731, 2927, 2979, 3415 \text{ cm}^{-1}$ .

*Diethyl 2-(2-ethyl-7-fluoro-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

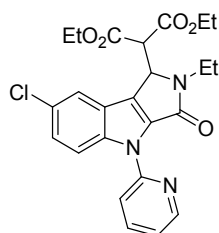
*malonate 6na*



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.56 (dd,  $J = 4.9, 1.9 \text{ Hz}$ , 1H), 8.37 (dd,  $J = 9.3, 4.7 \text{ Hz}$ , 1H), 8.02 (d,  $J = 8.3 \text{ Hz}$ , 1H), 7.87 (td,  $J = 7.9, 1.9 \text{ Hz}$ , 1H), 7.44 (dd,  $J = 9.5, 2.6 \text{ Hz}$ , 1H), 7.24 (ddd,  $J = 7.4, 4.9, 1.0 \text{ Hz}$ , 1H), 7.12 (td,  $J = 9.1, 2.6 \text{ Hz}$ , 1H), 5.33 (d,  $J = 3.6 \text{ Hz}$ , 1H), 4.38–4.28 (m, 2H), 4.11–3.89 (m, 4H), 3.28 (dq,  $J = 14.2, 7.0 \text{ Hz}$ , 1H), 1.28 (t,  $J = 7.2 \text{ Hz}$ , 6H), 0.89 (t,  $J = 7.1 \text{ Hz}$ , 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.3, 165.8, 161.4, 158.8 (d,  $J = 238.5 \text{ Hz}$ ), 150.4, 148.0, 138.3, 138.1, 134.6, 130.0 (d,  $J = 4.5 \text{ Hz}$ ), 123.0 (d,  $J = 10.9 \text{ Hz}$ ), 121.3, 119.1,

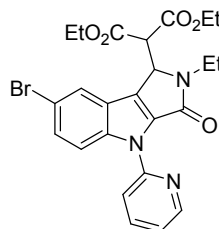
116.6 (d,  $J = 9.1$  Hz), 114.1 (d,  $J = 25.9$  Hz), 106.0 (d,  $J = 24.9$  Hz), 62.3, 61.7, 54.3, 52.6, 36.1, 14.0, 13.7, 13.6;  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -120.50; HRMS (ESI) Calcd for  $\text{C}_{24}\text{H}_{25}\text{FN}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 454.1773; Found: 454.1776; IR (neat):  $\nu = 547, 675, 736, 781, 1036, 1096, 1174, 1255, 1309, 1371, 1442, 1480, 1593, 1688, 1732, 2981, 3453$   $\text{cm}^{-1}$ .

*Diethyl 2-(7-chloro-2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 60a*



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.56 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.35 (d,  $J = 9.1$  Hz, 1H), 8.02 (d,  $J = 8.3$  Hz, 1H), 7.87 (ddd,  $J = 8.2, 7.4, 2.0$  Hz, 1H), 7.73 (d,  $J = 2.1$  Hz, 1H), 7.32 (dd,  $J = 9.1, 2.2$  Hz, 1H), 7.26–7.23 (m, 1H), 5.34 (d,  $J = 3.7$  Hz, 1H), 4.40–4.26 (m, 2H), 4.08 (d,  $J = 3.7$  Hz, 1H), 4.05–3.98 (m, 1H), 3.97–3.92 (m, 2H), 3.28 (dq,  $J = 14.1, 7.0$  Hz, 1H), 1.28 (t,  $J = 7.2$  Hz, 6H), 0.92 (t,  $J = 7.2$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 165.9, 161.4, 150.3, 148.0, 140.0, 138.3, 134.4, 129.7, 127.9, 125.9, 123.4, 121.4, 120.4, 119.2, 116.7, 62.3, 61.7, 54.4, 52.8, 36.2, 14.0, 13.8, 13.6; HRMS (ESI) Calcd for  $\text{C}_{24}\text{H}_{25}\text{ClN}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 470.1477; Found: 470.1480; IR (neat):  $\nu = 476, 616, 771, 1030, 1166, 1301, 1394, 1439, 1620, 1682, 1728, 2369, 2926, 3414$   $\text{cm}^{-1}$ .

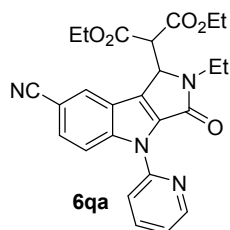
*Diethyl 2-(7-bromo-2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 6pa*



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.62–8.53 (m, 1H), 8.30 (d,  $J = 9.1$  Hz, 1H), 8.02 (d,  $J = 8.2$  Hz, 1H), 7.92–7.80 (m, 2H), 7.45 (dd,  $J = 9.1, 1.9$  Hz, 1H), 7.26–7.22 (m, 1H), 5.33 (d,  $J = 3.7$  Hz, 1H), 4.40–4.26 (m, 2H), 4.07 (d,  $J = 3.8$  Hz, 1H), 3.99 (dq,  $J = 21.7, 7.2$  Hz, 3H), 3.28 (dq,  $J = 14.2, 7.0$  Hz, 1H), 1.28 (t,  $J = 7.1$  Hz, 6H), 0.92 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 165.8, 161.3, 150.2, 148.0, 140.3, 138.3, 134.2, 129.6, 128.5, 124.0, 123.5, 121.4,

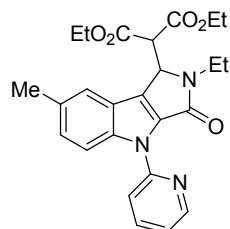
119.2, 117.0, 115.6, 62.3, 61.7, 54.4, 52.8, 36.2, 14.0, 13.7, 13.6; HRMS (ESI) Calcd for  $C_{24}H_{25}BrN_3O_5$  (M+H)<sup>+</sup>: 514.0972; Found: 514.0975; IR (neat):  $\nu = 482, 619, 777, 1034, 1156, 1308, 1369, 1440, 1478, 1621, 1689, 1730, 2979, 3419$  cm<sup>-1</sup>.

*Diethyl 2-(7-cyano-2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 6qa*



White solid, mp: 164–167 °C; <sup>1</sup>H NMR (400 MHz, Chloroform-*d*)  $\delta$  8.59 (ddd,  $J = 4.9, 1.9, 0.9$  Hz, 1H), 8.46 (dd,  $J = 8.9, 0.7$  Hz, 1H), 8.22 (dd,  $J = 1.7, 0.7$  Hz, 1H), 7.99 (dt,  $J = 8.2, 1.0$  Hz, 1H), 7.91 (ddd,  $J = 8.2, 7.3, 1.9$  Hz, 1H), 7.59 (dd,  $J = 8.9, 1.7$  Hz, 1H), 7.31 (ddd,  $J = 7.4, 4.9, 1.1$  Hz, 1H), 5.35 (d,  $J = 3.5$  Hz, 1H), 4.38 (dddd,  $J = 17.9, 10.8, 7.1, 3.6$  Hz, 2H), 4.12 (d,  $J = 3.5$  Hz, 1H), 4.03 (dt,  $J = 14.7, 7.4$  Hz, 1H), 3.90 (qd,  $J = 7.1, 1.0$  Hz, 2H), 3.31 (dq,  $J = 14.2, 7.0$  Hz, 1H), 1.31 (dt,  $J = 9.5, 7.2$  Hz, 6H), 0.86 (t,  $J = 7.1$  Hz, 3H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>):  $\delta$  167.34, 165.46, 160.85, 149.66, 148.21, 142.93, 138.52, 135.64, 130.20, 128.00, 126.93, 122.47, 122.11, 119.93, 119.57, 116.44, 105.63, 62.56, 61.71, 54.42, 52.26, 36.15, 14.07, 13.76, 13.60; HRMS (ESI) Calcd for  $C_{25}H_{25}N_4O_5$  (M+H)<sup>+</sup>: 461.1819; Found: 461.1822; IR (neat):  $\nu = 638, 670, 746, 811, 899, 1040, 1168, 1208, 1245, 1310, 1371, 1399, 1467, 1560, 1587, 1653, 1696, 1739, 2219, 2338, 2366, 2852, 2925, 3395$  cm<sup>-1</sup>.

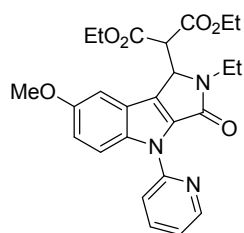
*Diethyl 2-(2-ethyl-7-methyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 6ra*



Yellow oil; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):  $\delta$  8.56 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.29 (d,  $J = 8.7$  Hz, 1H), 8.02 (d,  $J = 8.3$  Hz, 1H), 7.85 (ddd,  $J = 8.3, 7.3, 1.9$  Hz, 1H), 7.46 (dt,  $J = 1.7, 0.8$  Hz, 1H), 7.24–7.16 (m, 2H), 5.36 (d,  $J = 3.7$  Hz, 1H), 4.28 (q,  $J = 7.1$  Hz, 2H), 4.08 (d,  $J = 3.7$  Hz, 1H), 4.07–3.94 (m, 3H), 3.26 (dq,  $J = 14.1, 7.0$  Hz, 1H), 2.46 (s, 3H), 1.27 (t,  $J = 7.2$  Hz, 3H), 1.23 (t,  $J$

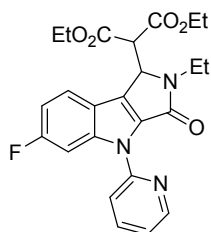
= 7.1 Hz, 3H), 0.96 (t, J = 7.1 Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.0, 166.4, 161.9, 150.7, 148.0, 140.1, 138.1, 133.2, 131.6, 130.5, 127.5, 122.6, 120.9, 120.2, 119.0, 115.1, 62.0, 61.7, 54.3, 53.2, 36.2, 21.5, 14.0, 13.7, 13.6; HRMS (ESI) Calcd for  $\text{C}_{25}\text{H}_{28}\text{N}_3\text{O}_5$  (M+H) $^+$ : 450.2023; Found: 450.2026; IR (neat):  $\nu$  = 495, 744, 1036, 1079, 1230, 1319, 1373, 1440, 1475, 1591, 1624, 1688, 1725, 2371, 2927, 3453  $\text{cm}^{-1}$ .

*Diethyl 2-(2-ethyl-7-methoxy-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 6sa*



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59–8.52 (m, 1H), 8.35 (d, J = 9.3 Hz, 1H), 8.05 (d, J = 8.3 Hz, 1H), 7.89–7.81 (m, 1H), 7.24–7.13 (m, 2H), 7.02 (dd, J = 9.3, 2.6 Hz, 1H), 5.35 (d, J = 3.7 Hz, 1H), 4.32–4.27 (m, 2H), 4.07 (d, J = 3.7 Hz, 1H), 4.06–3.90 (m, 3H), 3.87 (s, 3H), 3.26 (dq, J = 14.1, 7.0 Hz, 1H), 1.29–1.24 (m, 6H), 0.92 (t, J = 7.1 Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.3, 166.2, 161.7, 155.4, 150.7, 147.9, 138.1, 136.8, 133.4, 130.3, 123.0, 120.9, 118.9, 116.4, 115.9, 102.1, 62.1, 61.7, 55.6, 54.2, 53.0, 36.1, 14.0, 13.7, 13.6; HRMS (ESI) Calcd for  $\text{C}_{25}\text{H}_{28}\text{N}_3\text{O}_6$  (M+H) $^+$ : 466.1973; Found: 466.1977; IR (neat):  $\nu$  = 471, 635, 675, 781, 810, 854, 918, 1037, 1110, 1175, 1207, 1247, 1318, 1372, 1440, 1481, 1592, 1618, 1688, 1732, 2935, 2980, 3415  $\text{cm}^{-1}$ .

*Diethyl 2-(2-ethyl-6-fluoro-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 6ta*

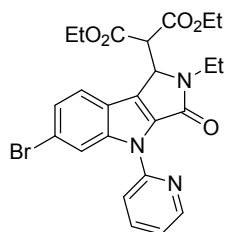


Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.56 (ddd, J = 4.9, 2.0, 0.9 Hz, 1H), 8.19 (dd, J = 10.9, 2.4 Hz, 1H), 8.06 (d, J = 8.3 Hz, 1H), 7.87 (ddd, J = 8.3, 7.4, 2.0 Hz, 1H), 7.70 (dd, J = 8.9, 5.5 Hz, 1H), 7.23 (ddd, J = 7.4, 4.9, 1.0 Hz, 1H), 7.03 (td, J = 9.0, 2.4 Hz, 1H), 5.33 (d, J = 3.6 Hz, 1H), 4.35–4.27 (m, 2H), 4.07 (d, J = 3.6 Hz, 1H), 4.03–3.98 (m, 1H), 3.97–3.90 (m, 2H), 3.27 (dq, J =

14.1, 7.0 Hz, 1H), 1.29–1.25 (m, 6H), 0.90 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.3, 165.9, 161.6 (d,  $J = 242.1$  Hz), 161.4, 150.5, 148.0, 141.9 (d,  $J = 12.7$  Hz), 138.3, 133.7 (d,  $J = 3.4$  Hz), 130.9, 122.0 (d,  $J = 10.2$  Hz), 121.3, 119.1, 118.9, 111.3 (d,  $J = 25.0$  Hz), 102.3 (d,  $J = 28.3$  Hz), 62.2, 61.7, 54.3, 52.8, 36.1, 14.0, 13.8, 13.6;  $^{19}\text{F}$  NMR (376 MHz,  $\text{CDCl}_3$ )  $\delta$  -114.59; HRMS (ESI) Calcd for  $\text{C}_{24}\text{H}_{25}\text{FN}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 454.1773; Found: 454.1776; IR (neat):  $\nu = 492, 619, 676, 770, 856, 951, 1037, 1176, 1209, 1259, 1308, 1372, 1441, 1478, 1557, 1592, 1619, 1690, 1732, 2936, 2981, 3415$   $\text{cm}^{-1}$ .

*Diethyl 2-(6-bromo-2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

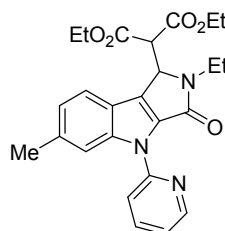
*malonate 6ua*



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.62 (d,  $J = 1.8$  Hz, 1H), 8.59 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.00 (d,  $J = 8.2$  Hz, 1H), 7.88 (ddd,  $J = 8.3, 7.4, 2.0$  Hz, 1H), 7.64 (d,  $J = 8.6$  Hz, 1H), 7.38 (dd,  $J = 8.6, 1.8$  Hz, 1H), 7.25 (dd,  $J = 4.9, 1.0$  Hz, 1H), 5.35 (d,  $J = 3.6$  Hz, 1H), 4.37–4.26 (m, 2H), 4.08 (d,  $J = 3.6$  Hz, 1H), 4.08–3.87 (m, 4H), 3.28 (dq,  $J = 14.1, 7.0$  Hz, 1H), 1.30–1.24 (m, 6H), 0.91 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 165.9, 161.4, 150.2, 148.1, 142.1, 138.3, 133.8, 130.4, 125.7, 122.1, 121.5, 121.4, 119.6, 119.1, 118.4, 62.2, 61.7, 54.3, 52.7, 36.1, 14.0, 13.7, 13.6; HRMS (ESI) Calcd for  $\text{C}_{24}\text{H}_{25}\text{BrN}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 514.0972; Found: 514.0975; IR (neat):  $\nu = 507, 541, 592, 672, 736, 782, 828, 861, 924, 1039, 1090, 1151, 1176, 1245, 1305, 1341, 1371, 1407, 1439, 1481, 1539, 1595, 1698, 1743, 2929, 2985, 3454$   $\text{cm}^{-1}$ .

*Diethyl 2-(2-ethyl-6-methyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)*

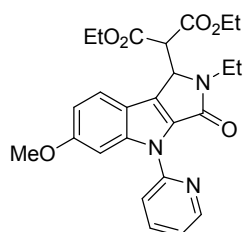
*malonate 6va*



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.16 (s, 1H), 7.95 (d,  $J = 8.2$  Hz, 1H), 7.90–7.81 (m, 1H), 7.60 (d,  $J = 8.2$  Hz, 1H), 7.23 (ddd,  $J = 7.3, 4.9, 1.1$  Hz,

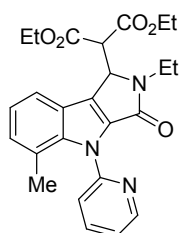
1H), 7.09 (dd, J = 8.3, 1.5 Hz, 1H), 5.35 (d, J = 3.8 Hz, 1H), 4.28 (q, J = 7.1 Hz, 2H), 4.14–3.83 (m, 4H), 3.26 (dq, J = 14.2, 7.0 Hz, 1H), 2.49 (s, 3H), 1.27–1.24 (m, 6H), 0.93 (t, J = 7.1 Hz, 3H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>): δ 167.1, 166.2, 161.9, 150.6, 148.0, 142.1, 138.1, 136.1, 132.6, 130.9, 124.1, 121.1, 120.4, 120.3, 119.4, 114.7, 62.0, 61.6, 54.3, 53.1, 36.1, 22.1, 14.0, 13.8, 13.6; HRMS (ESI) Calcd for C<sub>25</sub>H<sub>28</sub>N<sub>3</sub>O<sub>5</sub> (M+H)<sup>+</sup>: 450.2023; Found: 450.2027; IR (neat): ν = 517, 544, 675, 736, 789, 857, 943, 1037, 1095, 1153, 1177, 1210, 1245, 1306, 1372, 1440, 1477, 1552, 1591, 1687, 1733, 2365, 2933, 2979, 3455 cm<sup>-1</sup>.

*Diethyl 2-(2-ethyl-6-methoxy-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 6wa*



Yellow oil; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.61–8.55 (m, 1H), 8.01 (d, J = 8.3 Hz, 1H), 7.96 (d, J = 2.4 Hz, 1H), 7.86 (td, J = 7.9, 2.0 Hz, 1H), 7.61 (d, J = 8.9 Hz, 1H), 7.25–7.19 (m, 1H), 6.91 (dd, J = 8.9, 2.4 Hz, 1H), 5.32 (d, J = 3.8 Hz, 1H), 4.30 (q, J = 6.9 Hz, 2H), 4.05 (d, J = 3.8 Hz, 1H), 4.04–3.92 (m, 3H), 3.88 (s, 3H), 3.24 (dq, J = 14.2, 7.1 Hz, 1H), 1.28–1.24 (m, 6H), 0.93 (t, J = 7.1 Hz, 3H); <sup>13</sup>C{<sup>1</sup>H} NMR (100 MHz, CDCl<sub>3</sub>): δ 167.2, 166.2, 161.8, 158.9, 150.9, 147.9, 143.0, 138.2, 132.2, 131.6, 121.6, 121.0, 119.2, 116.8, 112.7, 98.2, 62.1, 61.7, 55.5, 54.3, 53.2, 36.1, 14.0, 13.8, 13.7; HRMS (ESI) Calcd for C<sub>25</sub>H<sub>28</sub>N<sub>3</sub>O<sub>6</sub> (M+H)<sup>+</sup>: 466.1973; Found: 466.1978; IR (neat): ν = 526, 586, 673, 735, 786, 1040, 1153, 1268, 1309, 1344, 1371, 1442, 1475, 1555, 1625, 1690, 1743, 2929, 2977, 3460 cm<sup>-1</sup>.

*Diethyl 2-(2-ethyl-5-methyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl) malonate 6xa*



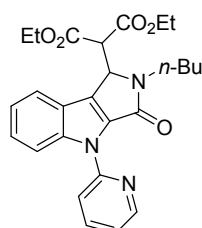
Yellow oil; <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>): δ 8.57 (dd, J = 5.0, 1.9 Hz, 1H), 7.88 (td, J = 7.7, 1.9 Hz, 1H), 7.67 (d, J = 7.9 Hz, 1H), 7.58 (d, J = 7.9 Hz, 1H), 7.36 (dd, J = 7.6, 4.9 Hz, 1H), 7.15 (t, J =



7.6 Hz, 1H), 7.08 (d,  $J = 7.2$  Hz, 1H), 5.35 (d,  $J = 4.0$  Hz, 1H), 4.29 (q,  $J = 7.1$  Hz, 2H), 4.10–3.93 (m, 4H), 3.19 (dq,  $J = 14.1, 6.9$  Hz, 1H), 2.03 (s, 3H), 1.28–1.22 (m, 6H), 0.98 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 166.4, 161.8, 150.6, 148.4, 141.4, 137.7, 135.1, 128.6, 127.8, 124.1, 123.2, 123.1, 122.8, 122.0, 118.9, 62.1, 61.7, 54.5, 53.3, 35.8, 20.1, 14.0, 13.8, 13.7; HRMS (ESI) Calcd for  $\text{C}_{25}\text{H}_{28}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 450.2023; Found: 450.2026; IR (neat):  $\nu = 498, 619, 746, 780, 1034, 1094, 1154, 1214, 1258, 1305, 1371, 1440, 1472, 1588, 1694, 1732, 2931, 2977, 3415$   $\text{cm}^{-1}$ .

*Diethyl 2-(2-butyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

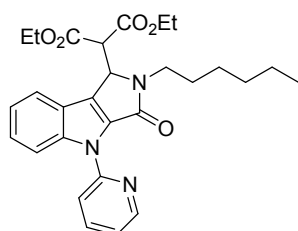
**6ab**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.45–8.41 (m, 1H), 8.02 (d,  $J = 8.4$  Hz, 1H), 7.83 (d,  $J = 8.2$  Hz, 1H), 7.79–7.73 (m, 1H), 7.40 (d,  $J = 7.5$  Hz, 1H), 7.34 (d,  $J = 7.5$  Hz, 1H), 7.12–7.03 (m, 2H), 4.98 (d,  $J = 8.9$  Hz, 1H), 4.04–3.80 (m, 5H), 3.25 (d,  $J = 8.9$  Hz, 1H), 2.69–2.59 (m, 1H), 1.68–1.60 (m, 2H), 1.40–1.30 (m, 2H), 1.08 (t,  $J = 7.1$  Hz, 3H), 1.00 (t,  $J = 7.1$  Hz, 3H), 0.95 (t,  $J = 7.4$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  166.6, 166.1, 163.6, 151.5, 147.5, 144.1, 137.9, 131.1, 126.7, 124.9, 122.7, 119.9, 116.5, 115.0, 98.1, 80.7, 67.8, 62.2, 62.1, 53.6, 43.8, 28.1, 19.8, 13.7, 13.7, 13.5; HRMS (ESI) Calcd for  $\text{C}_{26}\text{H}_{30}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 464.2180; Found: 464.2184; IR (neat):  $\nu = 523, 611, 674, 744, 777, 947, 1033, 1093, 1156, 1221, 1251, 1320, 1370, 1442, 1478, 1555, 1591, 1690, 1733, 2961, 3418$   $\text{cm}^{-1}$ .

*Diethyl 2-(2-hexyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

**6ac**

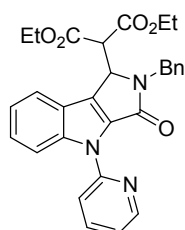


Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.51 (dt,  $J = 5.1, 1.3$  Hz, 1H), 8.32 (d,  $J = 8.6$  Hz, 1H), 7.92 (dd,  $J = 8.3, 1.0$  Hz, 1H), 7.85 – 7.74 (m, 1H), 7.66 (dt,  $J = 8.0, 1.0$  Hz, 1H), 7.31 (ddd,  $J =$

8.5, 7.1, 1.3 Hz, 1H), 7.21 – 7.14 (m, 2H), 5.29 (d,  $J = 3.7$  Hz, 1H), 4.23 (qd,  $J = 7.1, 1.7$  Hz, 2H), 4.01 (d,  $J = 3.8$  Hz, 1H), 3.98 – 3.81 (m, 3H), 3.13 – 3.06 (m, 1H), 1.63 – 1.54 (m, 2H), 1.28 – 1.15 (m, 9H), 0.85 – 0.76 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.2, 166.1, 161.8, 150.6, 148.0, 141.7, 138.1, 133.2, 130.6, 125.7, 122.5, 122.2, 121.1, 120.8, 119.3, 115.2, 62.1, 61.6, 54.5, 53.0, 41.2, 31.5, 28.5, 26.5, 22.5, 14.0, 14.0, 13.6; HRMS (ESI) Calcd for  $\text{C}_{28}\text{H}_{34}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}^+$ ): 492.2493; Found: 492.2496; IR (neat):  $\nu = 475, 745, 777, 1036, 1092, 1156, 1254, 1320, 1371, 1441, 1477, 1557, 1627, 1687, 1733, 2930, 3456$   $\text{cm}^{-1}$ .

*Diethyl 2-(2-benzyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

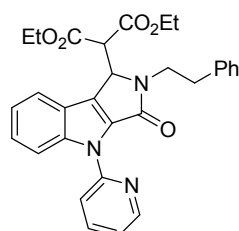
**6ad**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.65–8.57 (m, 1H), 8.38 (d,  $J = 8.6$  Hz, 1H), 8.02 (d,  $J = 8.3$  Hz, 1H), 7.94–7.84 (m, 1H), 7.70 (d,  $J = 8.0$  Hz, 1H), 7.41–7.26 (m, 7H), 7.25–7.22 (m, 1H), 5.35 (d,  $J = 15.8$  Hz, 1H), 5.23 (d,  $J = 3.7$  Hz, 1H), 4.33 (d,  $J = 15.9$  Hz, 1H), 4.30–4.20 (m, 2H), 4.10 (d,  $J = 3.8$  Hz, 1H), 4.02–3.85 (m, 2H), 1.21 (t,  $J = 7.1$  Hz, 3H), 0.89 (t,  $J = 7.2$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.0, 166.0, 162.2, 150.5, 148.1, 141.9, 138.3, 137.1, 132.7, 131.3, 128.9, 127.7, 127.6, 126.0, 122.5, 122.3, 121.3, 121.0, 119.4, 115.2, 62.1, 61.7, 54.6, 52.8, 44.9, 14.0, 13.6; HRMS (ESI) Calcd for  $\text{C}_{29}\text{H}_{28}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}^+$ ): 498.2023; Found: 498.2026; IR (neat):  $\nu = 496, 604, 700, 743, 1028, 1151, 1222, 1259, 1368, 1440, 1476, 1639, 1690, 1730, 2976, 3459$   $\text{cm}^{-1}$ .

*Diethyl 2-(3-oxo-2-phenethyl-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

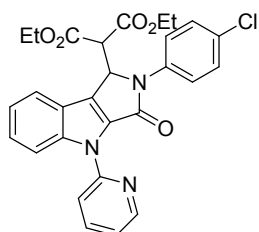
**Malonate 6ae**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.59 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.38 (d,  $J = 8.6$  Hz, 1H), 7.96 (d,  $J = 8.3$  Hz, 1H), 7.88 (ddd,  $J = 8.2, 7.3, 1.9$  Hz, 1H), 7.70 (d,  $J = 8.0$  Hz, 1H),

7.39 (ddd,  $J = 8.5, 7.1, 1.3$  Hz, 1H), 7.33–7.26 (m, 5H), 7.25–7.19 (m, 2H), 5.28 (d,  $J = 3.6$  Hz, 1H), 4.33–4.19 (m, 3H), 4.05 (d,  $J = 3.6$  Hz, 1H), 4.03–3.91 (m, 2H), 3.44–3.36 (m, 1H), 3.09–2.92 (m, 2H), 1.21 (t,  $J = 7.1$  Hz, 3H), 0.93 (t,  $J = 7.2$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  166.9, 166.3, 161.9, 150.5, 148.1, 141.8, 138.7, 138.2, 133.0, 130.8, 128.8, 128.6, 126.5, 125.9, 122.4, 122.3, 121.2, 120.8, 119.3, 115.3, 62.1, 61.8, 55.0, 53.1, 43.1, 34.9, 14.0, 13.6; HRMS (ESI) Calcd for  $\text{C}_{30}\text{H}_{30}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 512.2180; Found: 512.2185; IR (neat):  $\nu = 508, 673, 701, 743, 1031, 1155, 1218, 1320, 1369, 1440, 1478, 1558, 1593, 1689, 1734, 2367, 2981, 3453, 3752$   $\text{cm}^{-1}$ .

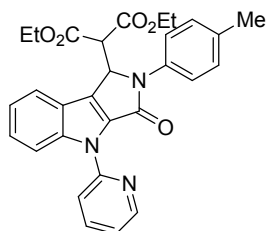
*Diethyl 2-(2-(4-chlorophenyl)-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate* **6af**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.53 (d,  $J = 4.8$  Hz, 1H), 8.26 (d,  $J = 8.6$  Hz, 1H), 7.82 (dd,  $J = 18.8, 8.0$  Hz, 3H), 7.43–7.33 (m, 5H), 7.21 (dd,  $J = 15.3, 7.1$  Hz, 2H), 5.87 (d,  $J = 2.7$  Hz, 1H), 4.27–4.20 (m, 1H), 4.19–4.06 (m, 1H), 3.84 (d,  $J = 2.7$  Hz, 1H), 3.73–3.70 (m, 2H), 1.18 (t,  $J = 7.0$  Hz, 3H), 0.71 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.4, 165.4, 160.4, 150.2, 148.2, 142.1, 138.2, 135.1, 132.4, 131.8, 130.5, 129.4, 126.4, 126.3, 122.6, 122.5, 121.7, 121.5, 119.6, 115.0, 62.1, 61.5, 56.5, 52.6, 13.9, 13.4; HRMS (ESI) Calcd for  $\text{C}_{28}\text{H}_{25}\text{ClN}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 518.1477; Found: 518.1480; IR (neat):  $\nu = 460, 618, 743, 802, 907, 1030, 1092, 1150, 1260, 1319, 1367, 1441, 1478, 1558, 1592, 1618, 1693, 1732, 2963, 3415$   $\text{cm}^{-1}$ .

*Diethyl 2-(3-oxo-4-(pyridin-2-yl)-2-(p-tolyl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate*

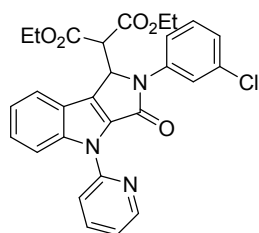
**6ag**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.52 (ddd,  $J = 4.9, 2.0, 0.9$  Hz, 1H), 8.29 (dt,  $J = 8.6, 1.0$  Hz, 1H), 7.95 – 7.87 (m, 1H), 7.83 – 7.69 (m, 2H), 7.37 – 7.27 (m, 3H), 7.25 – 7.16 (m, 4H), 5.85 (d,  $J = 3.4$  Hz, 1H), 4.24 – 4.10 (m, 2H), 3.87 (d,  $J = 3.4$  Hz, 1H), 3.71 (qd,  $J = 7.1, 4.7$  Hz,

2H), 2.31 (s, 3H), 1.17 (t,  $J = 7.3$  Hz, 3H), 0.71 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.6, 165.5, 160.6, 150.3, 148.1, 141.9, 138.2, 136.4, 133.7, 132.8, 130.4, 129.9, 126.2, 125.3, 122.6, 122.4, 121.7, 121.3, 119.6, 115.0, 62.05, 61.4, 56.7, 52.6, 21.0, 13.9, 13.4; HRMS (ESI) Calcd for  $\text{C}_{29}\text{H}_{28}\text{N}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 498.2023; Found: 498.2027; IR (neat):  $\nu = 515, 612, 742, 1034, 1149, 1318, 1364, 1440, 1477, 1514, 1634, 1694, 1731, 2963, 3461$   $\text{cm}^{-1}$ .

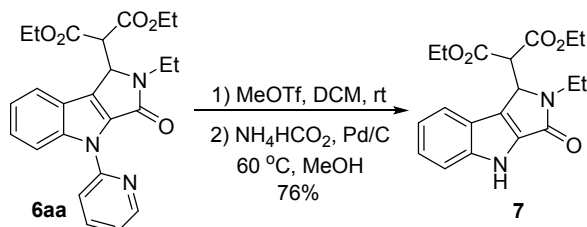
*Diethyl 2-(2-(3-chlorophenyl)-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate* **6ah**



Yellow oil;  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.66–8.54 (m, 1H), 8.32 (d,  $J = 8.6$  Hz, 1H), 7.93–7.81 (m, 3H), 7.63–7.61 (m, 1H), 7.48–7.37 (m, 3H), 7.33–7.26 (m, 3H), 5.97 (d,  $J = 3.4$  Hz, 1H), 4.35–4.26 (m, 1H), 4.25–4.18 (m, 1H), 3.94 (d,  $J = 3.4$  Hz, 1H), 3.86–3.73 (m, 2H), 1.26 (t,  $J = 7.1$  Hz, 3H), 0.80 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.4, 165.4, 160.3, 150.1, 148.2, 142.1, 138.2, 137.7, 134.9, 132.3, 130.5, 130.2, 126.5, 126.3, 125.1, 122.7, 122.6, 122.4, 121.7, 121.5, 119.6, 114.9, 62.2, 61.6, 56.4, 52.6, 13.9, 13.4; HRMS (ESI) Calcd for  $\text{C}_{28}\text{H}_{25}\text{ClN}_3\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 518.1477; Found: 518.1480; IR (neat):  $\nu = 481, 619, 741, 863, 1036, 1146, 1319, 1351, 1439, 1478, 1619, 1695, 1731, 2976, 3415$   $\text{cm}^{-1}$ .

### Transformation reaction of 6aa

*Diethyl 2-(2-ethyl-3-oxo-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)malonate* **7**

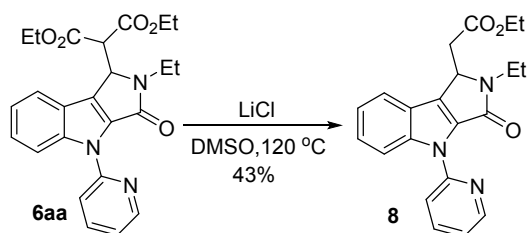


To a solution of **6aa** (218 mg, 0.5 mmol) in DCM (1 mL) was added MeOTf (90.3 mg, 0.55 mmol, 1.1 equiv.) dropwise at 0 °C. After 30 min the mixture was allowed to warm up to 25 °C and stirred for 16 h. After removal of the solvent in vacuo  $\text{Pd}(\text{OH})_2/\text{C}$  (27.1 mg, 10 wt.-%) and ammonium formate (315 mg, 5 mmol, 10 equiv.) were added. The mixture was diluted in MeOH (2 mL, 0.25M) and stirred at 60 °C for 20 h. After addition of EtOAc (10 mL) at ambient

temperature, the mixture was filtered through a short pad of celite and the solvents were removed in vacuo. The residue was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate, 20:1~10:1) to afford product **7** (136 mg, 0.38 mmol, yield: 76%).

Yellow oil;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  10.44 (s, 1H), 7.67 – 7.61 (m, 1H), 7.47 (dt,  $J = 8.4$ , 1.0 Hz, 1H), 7.23 (ddd,  $J = 8.3$ , 7.0, 1.2 Hz, 1H), 7.09 (ddd,  $J = 8.1$ , 7.0, 1.0 Hz, 1H), 5.28 (d,  $J = 4.0$  Hz, 1H), 4.27 – 4.17 (m, 2H), 4.09 – 3.99 (m, 1H), 3.97 (d,  $J = 4.0$  Hz, 1H), 3.87 – 3.79 (m, 2H), 3.23 (dq,  $J = 14.2$ , 7.0 Hz, 1H), 1.24 (t,  $J = 7.2$  Hz, 3H), 1.17 (t,  $J = 7.2$  Hz, 3H), 0.77 (t,  $J = 7.1$  Hz, 3H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  167.3, 166.1, 163.3, 141.6, 134.5, 126.7, 124.4, 122.0, 120.9, 120.7, 113.4, 62.0, 61.5, 55.4, 55.3, 53.0, 36.0, 14.0, 13.5; HRMS (ESI) Calcd for  $\text{C}_{19}\text{H}_{23}\text{N}_2\text{O}_5$  ( $\text{M}+\text{H}$ ) $^+$ : 359.1601; Found: 359.1604; IR (neat):  $\nu = 476$ , 610, 747, 1038, 1176, 1209, 1258, 1307, 1372, 1416, 1447, 1556, 1673, 1732, 2981, 3455  $\text{cm}^{-1}$ .

*Ethyl 2-(2-ethyl-3-oxo-4-(pyridin-2-yl)-1,2,3,4-tetrahydropyrrolo[3,4-b]indol-1-yl)acetate* **8**



A mixture of **6aa** (130 mg, 0.30 mmol, 1.0 equiv.), LiCl (63mg, 1.50 mmol, 5.0 equiv.) and wet DMSO (6 mL) was heated at 120 °C for 1h. The mixture was cooled to room temperature and diluted with water (50 mL) and extracted with ether (30 mL  $\times$  5). The combined organic fractions were washed with water (60 mL), dried over  $\text{Na}_2\text{SO}_4$  and evaporated under reduced pressure. The residue was purified by flash column chromatography on silica gel (petroleum ether/ethyl acetate, 100:1) to afford compound **8** (47 mg, 0.129 mmol, yield: 43%).

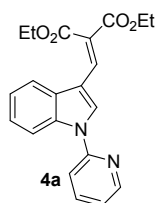
Yellow oil;  $^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  8.51 (ddd,  $J = 4.9$ , 2.0, 0.9 Hz, 1H), 8.35 (d,  $J = 8.6$  Hz, 1H), 7.99 (d,  $J = 8.3$  Hz, 1H), 7.80 (ddd,  $J = 8.3$ , 7.4, 2.0 Hz, 1H), 7.56 (d,  $J = 7.9$  Hz, 1H), 7.33 (ddd,  $J = 8.5$ , 7.1, 1.3 Hz, 1H), 7.22 – 7.19 (m, 1H), 7.18 – 7.15 (m, 1H), 5.05 (dd,  $J = 7.4$ , 5.7 Hz, 1H), 4.19 (qd,  $J = 7.1$ , 2.7 Hz, 2H), 3.90 (dq,  $J = 14.6$ , 7.3 Hz, 1H), 3.21 (dq,  $J = 14.2$ , 7.0 Hz, 1H), 2.91 (dd,  $J = 16.0$ , 5.7 Hz, 1H), 2.69 (dd,  $J = 16.0$ , 7.5 Hz, 1H), 1.22 – 1.17 (m, 6H);  $^{13}\text{C}\{^1\text{H}\}$  NMR (100 MHz,  $\text{CDCl}_3$ ):  $\delta$  170.83, 161.54, 150.78, 148.03, 141.79, 138.19, 132.98, 132.85, 125.77, 122.21, 122.11, 121.08, 120.04, 119.17, 115.67, 61.19, 52.39, 37.84, 36.04, 14.10, 14.02; HRMS (ESI) Calcd for  $\text{C}_{21}\text{H}_{22}\text{N}_3\text{O}_3$  ( $\text{M}+\text{H}$ ) $^+$ : 364.1656; Found: 364.1660; IR (neat):  $\nu =$

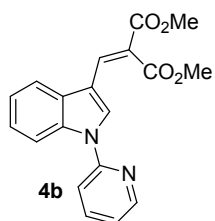
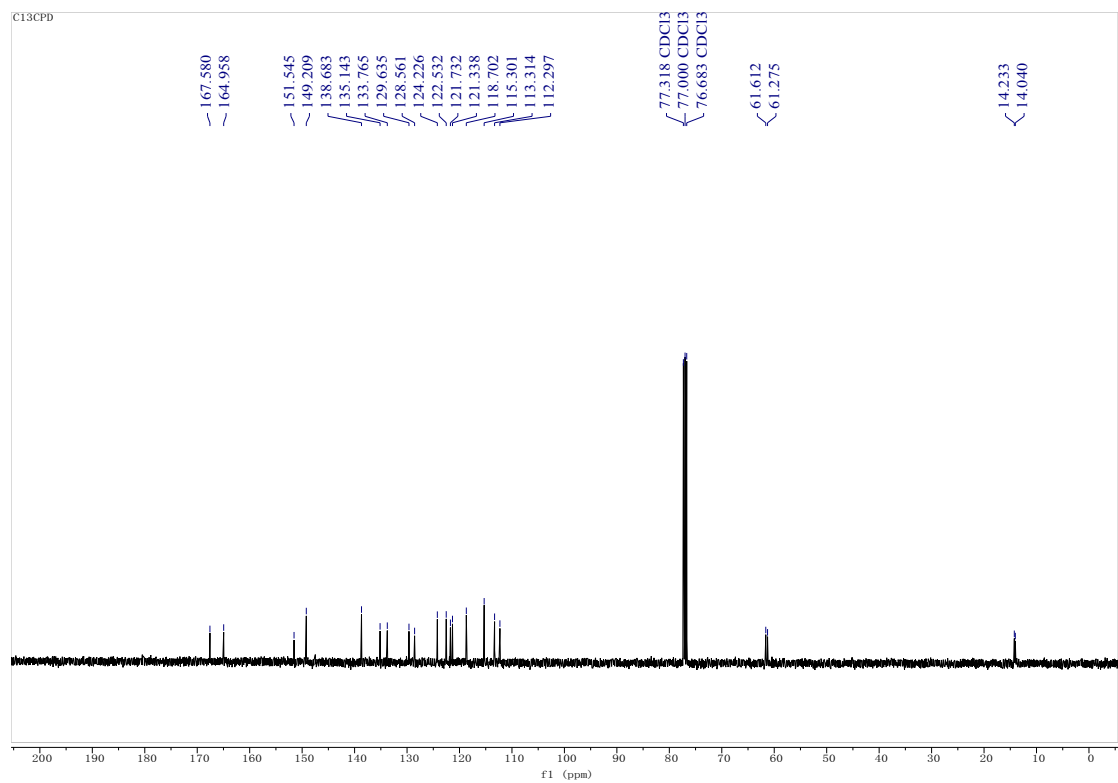
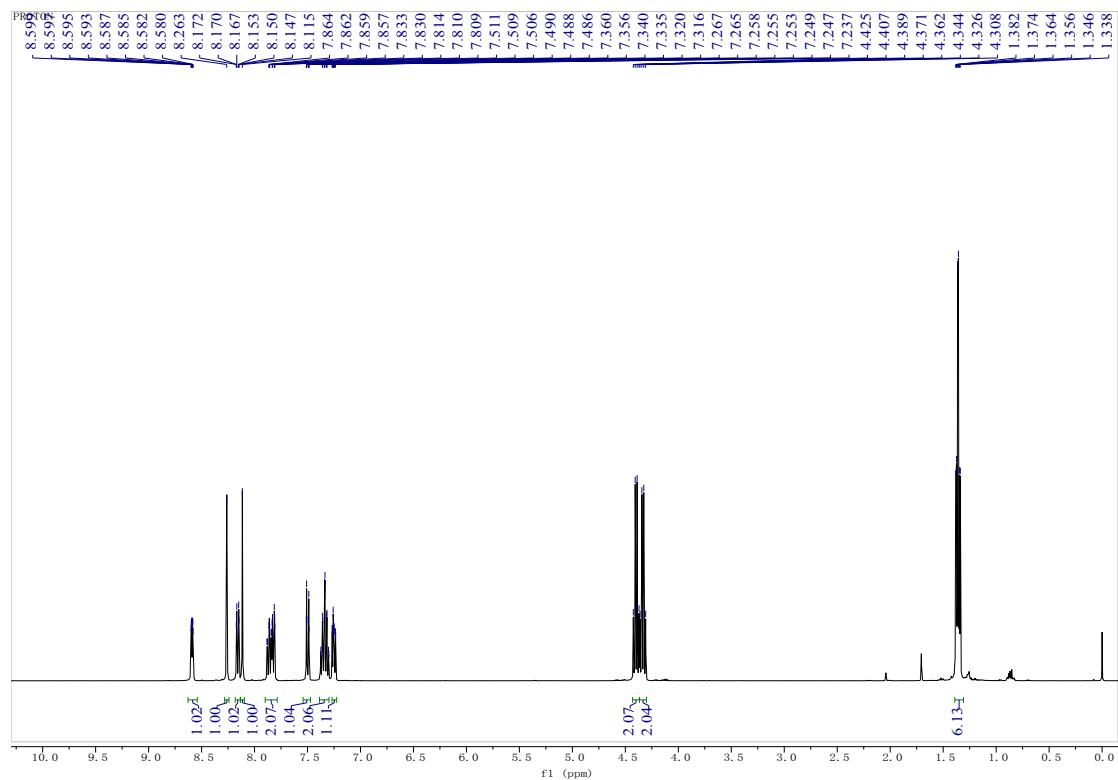
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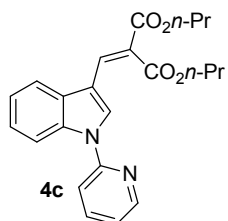
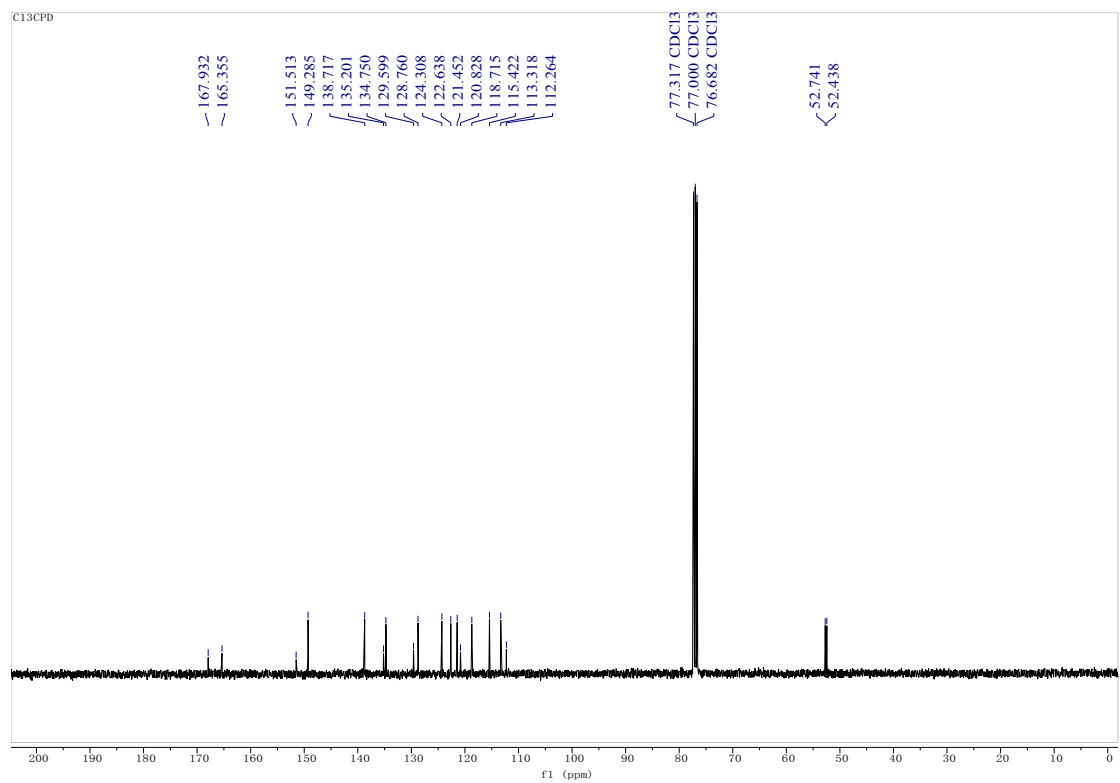
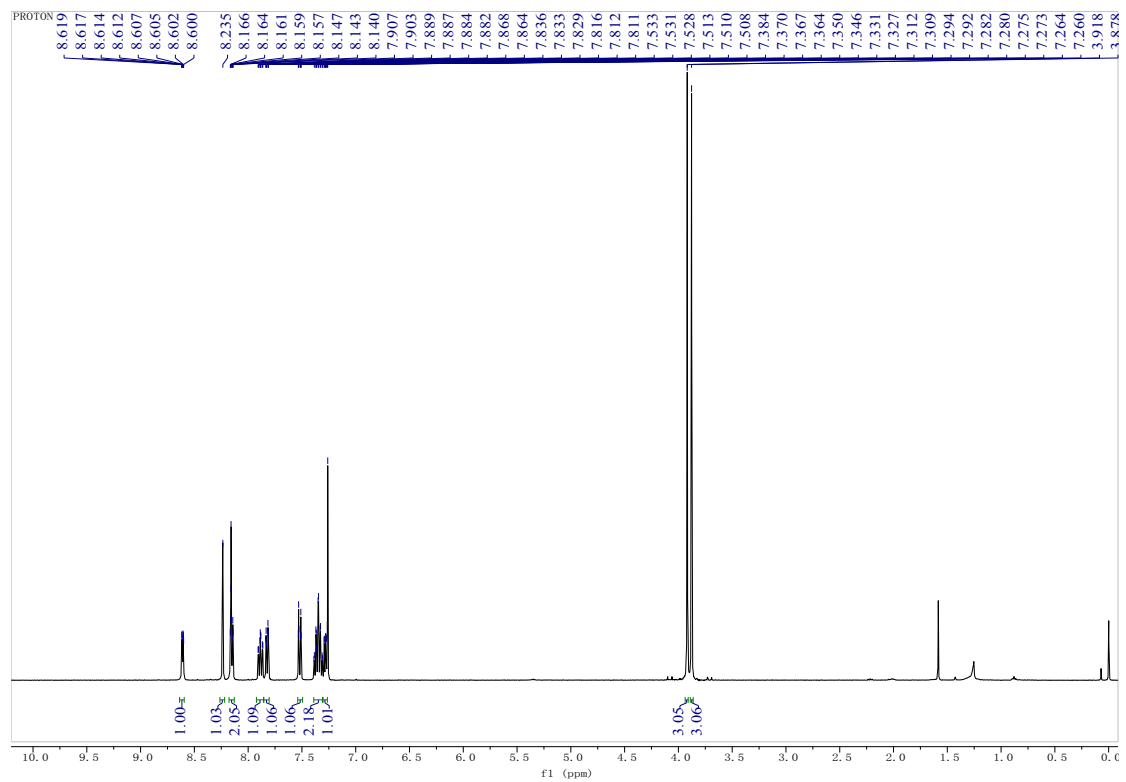
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- [2] Sharma, P.; Rohilla, S.; Jain, N. *J. Org. Chem.* **2015**, *80*, 4116.
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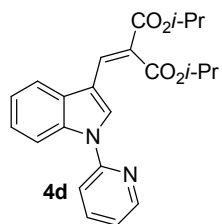
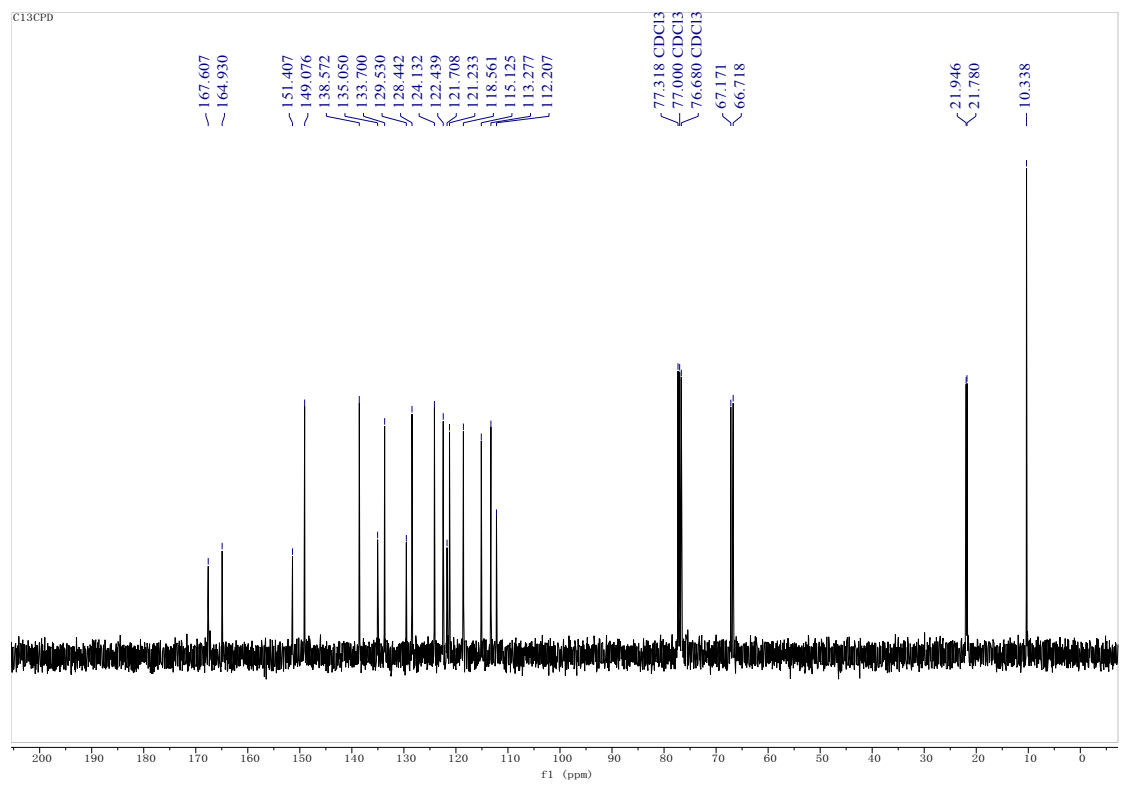
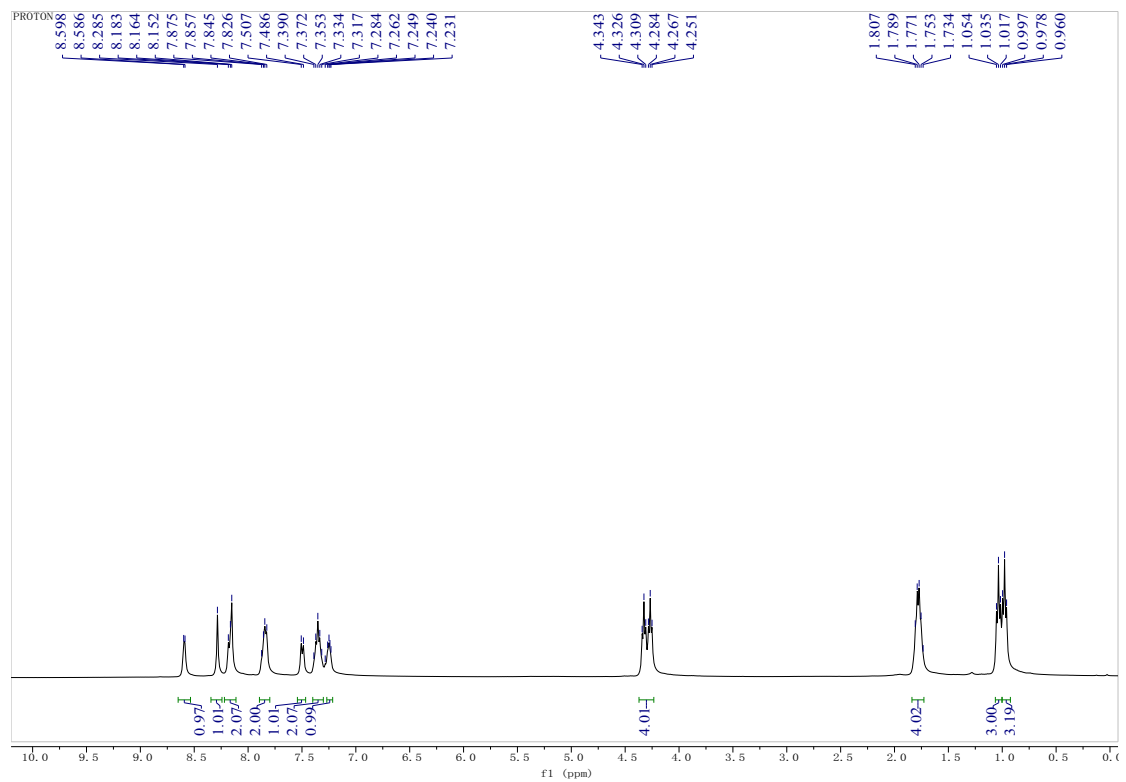
### NMR Spectra

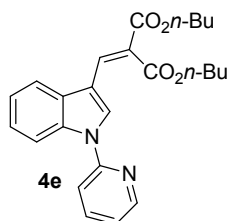
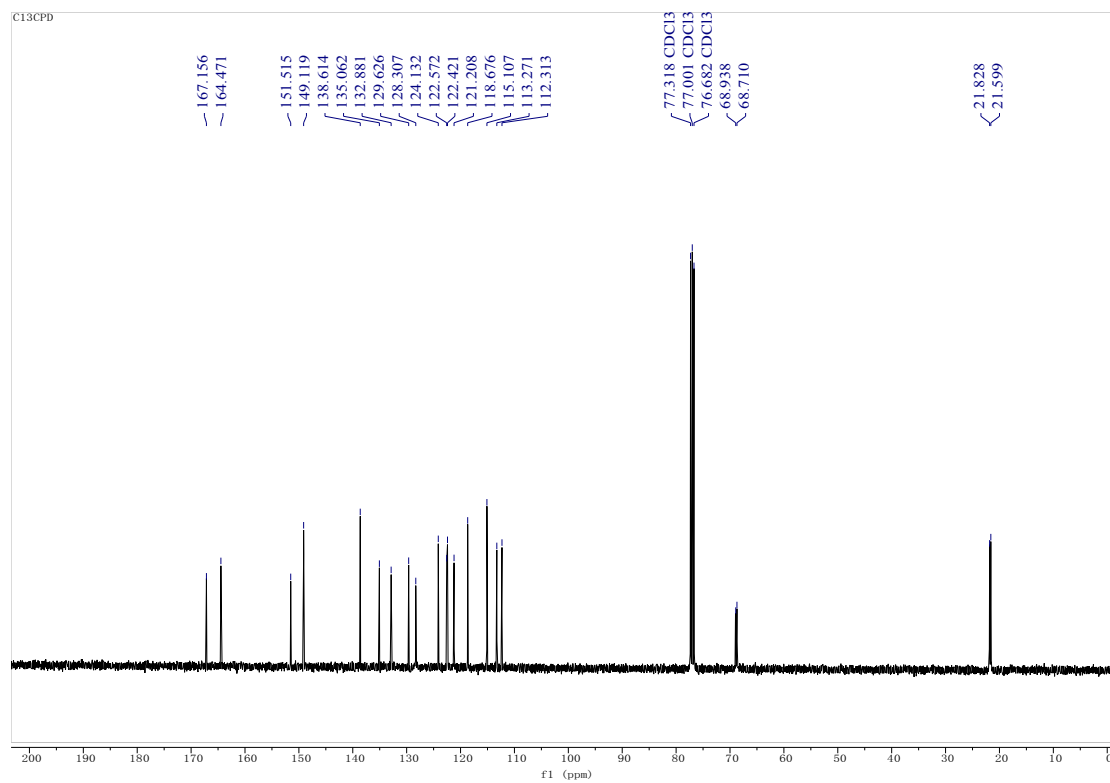
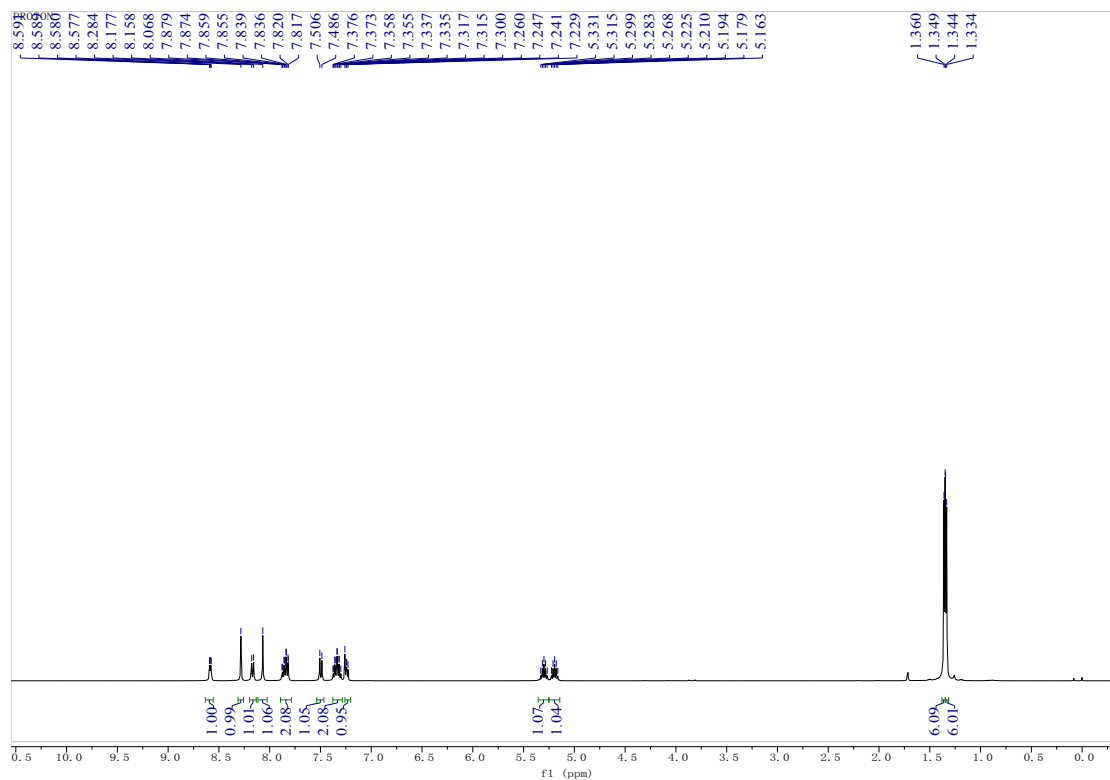


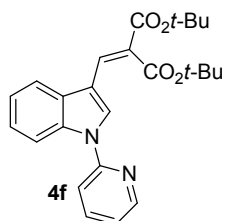
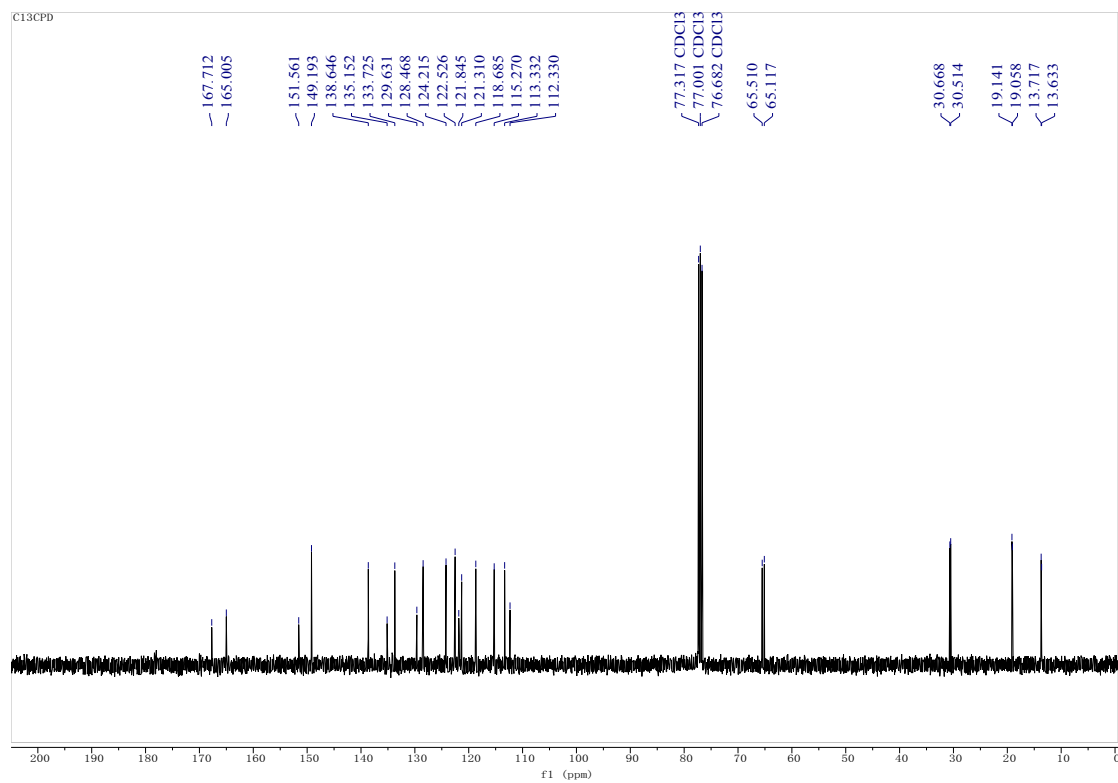
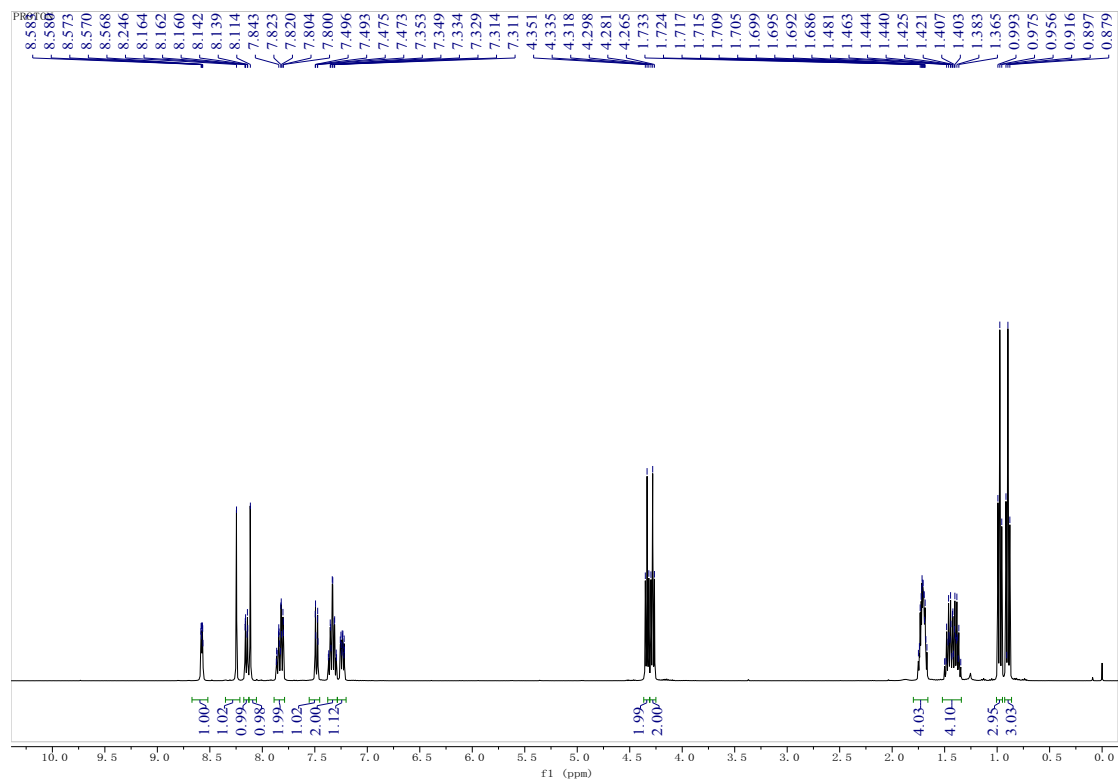


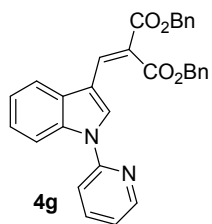
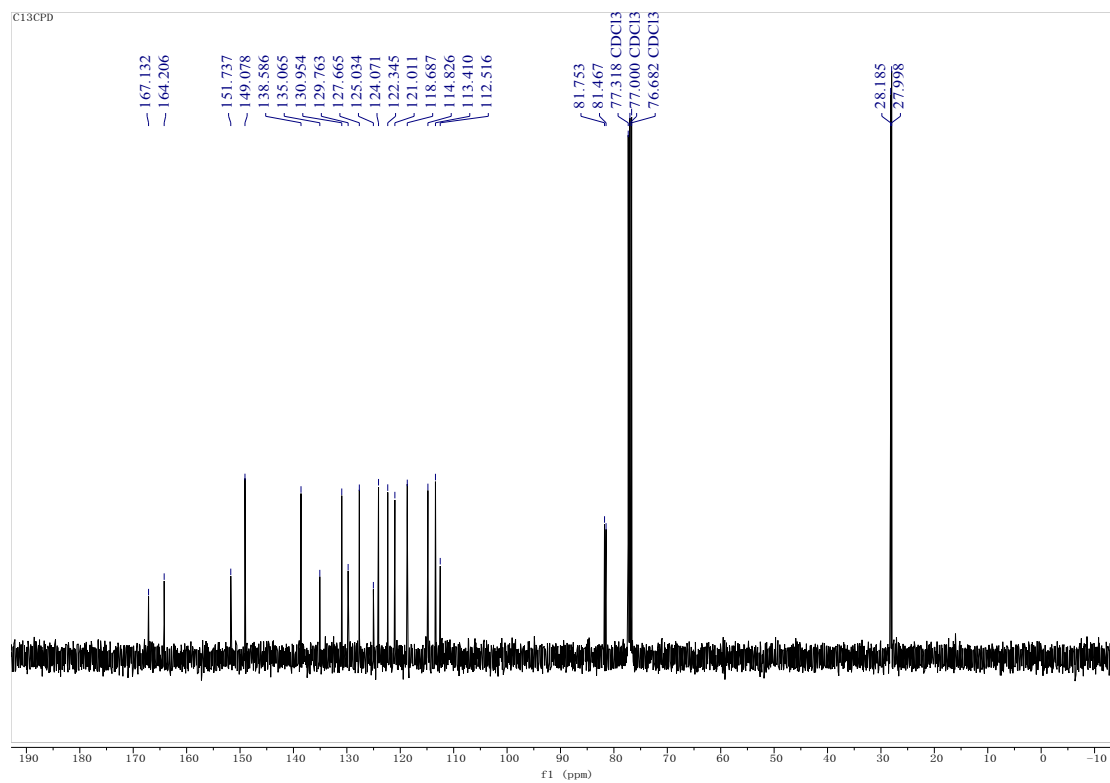
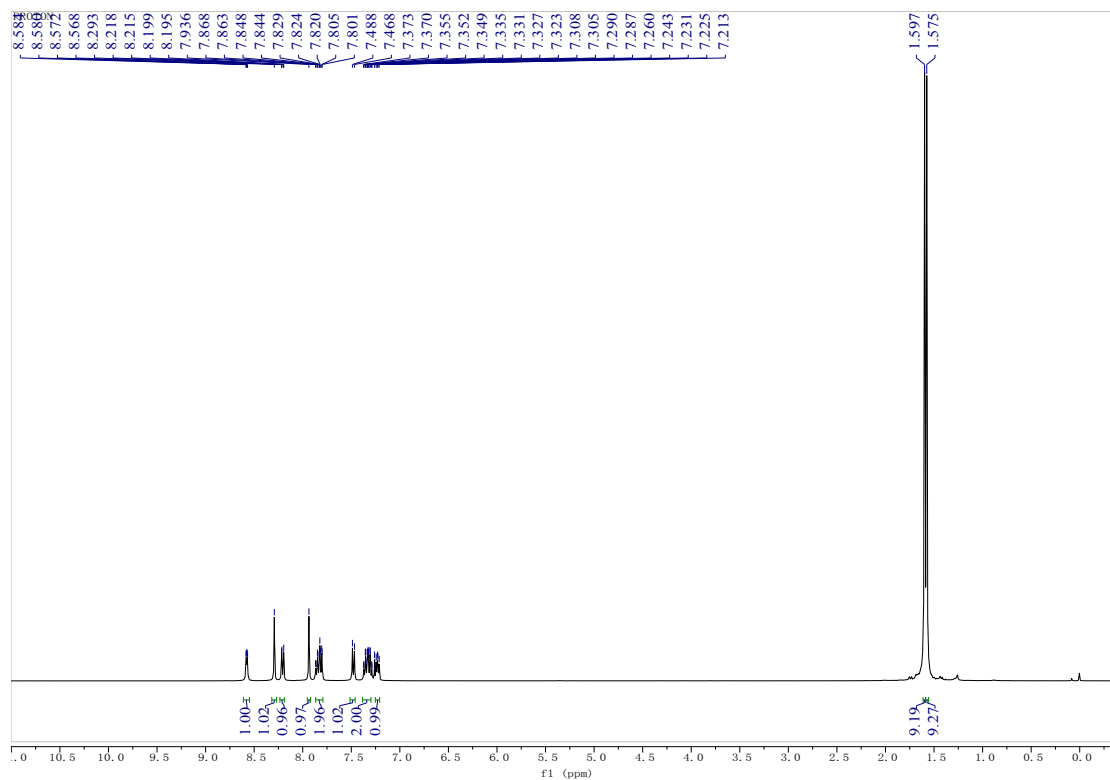


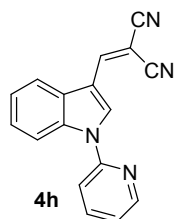
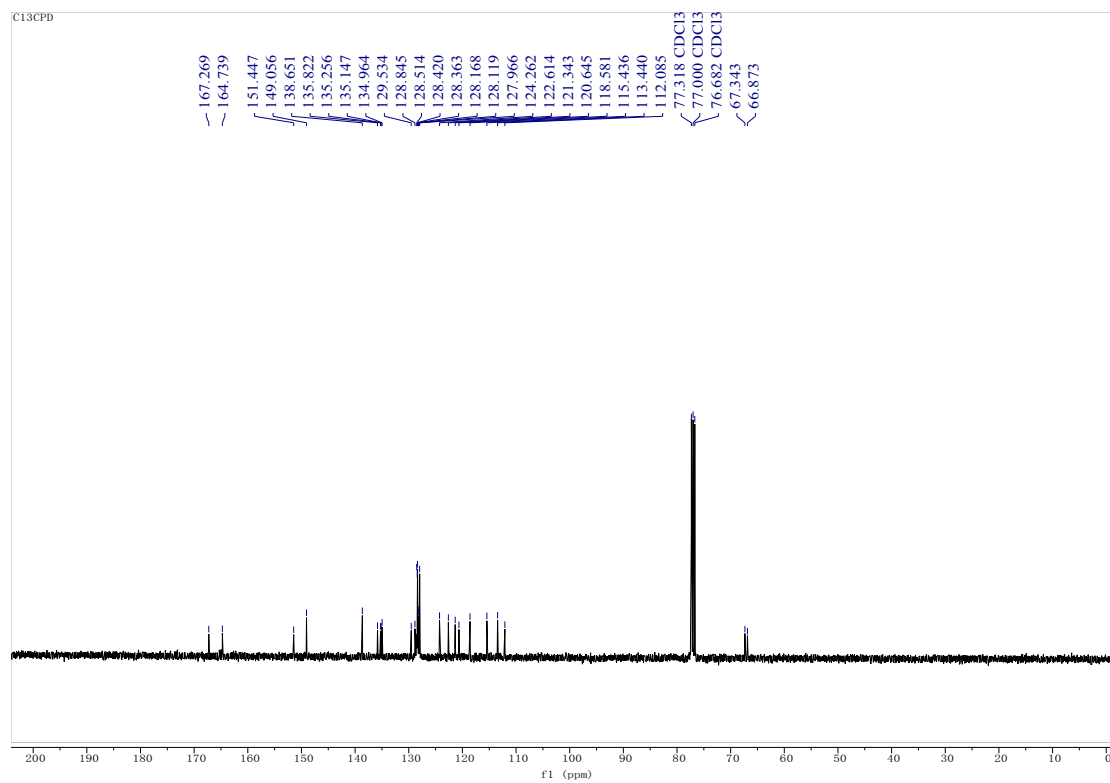
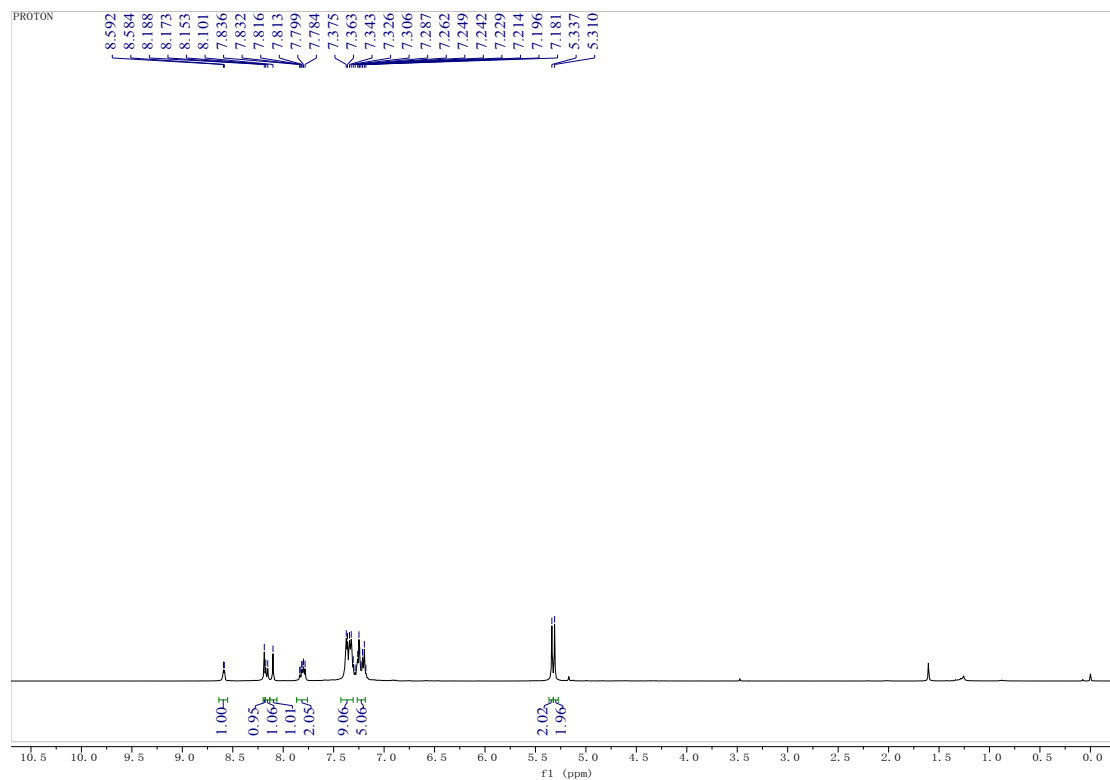


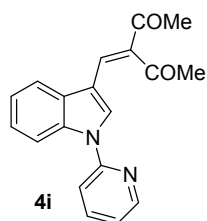
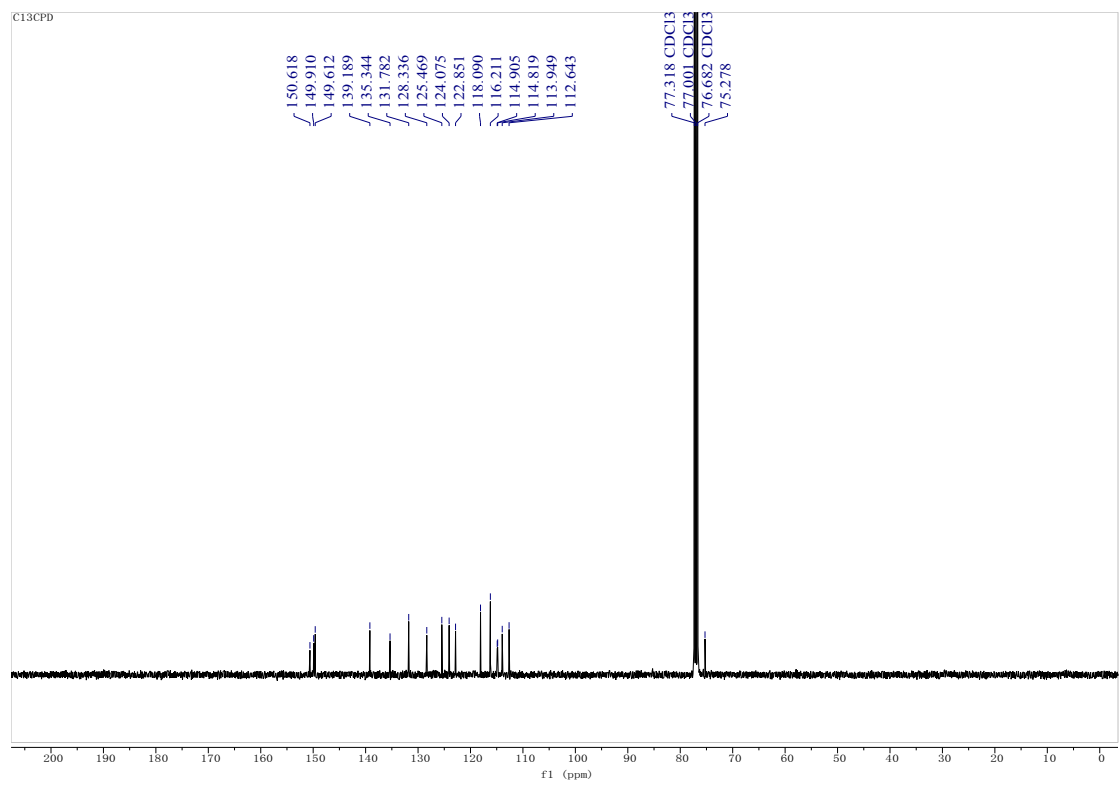
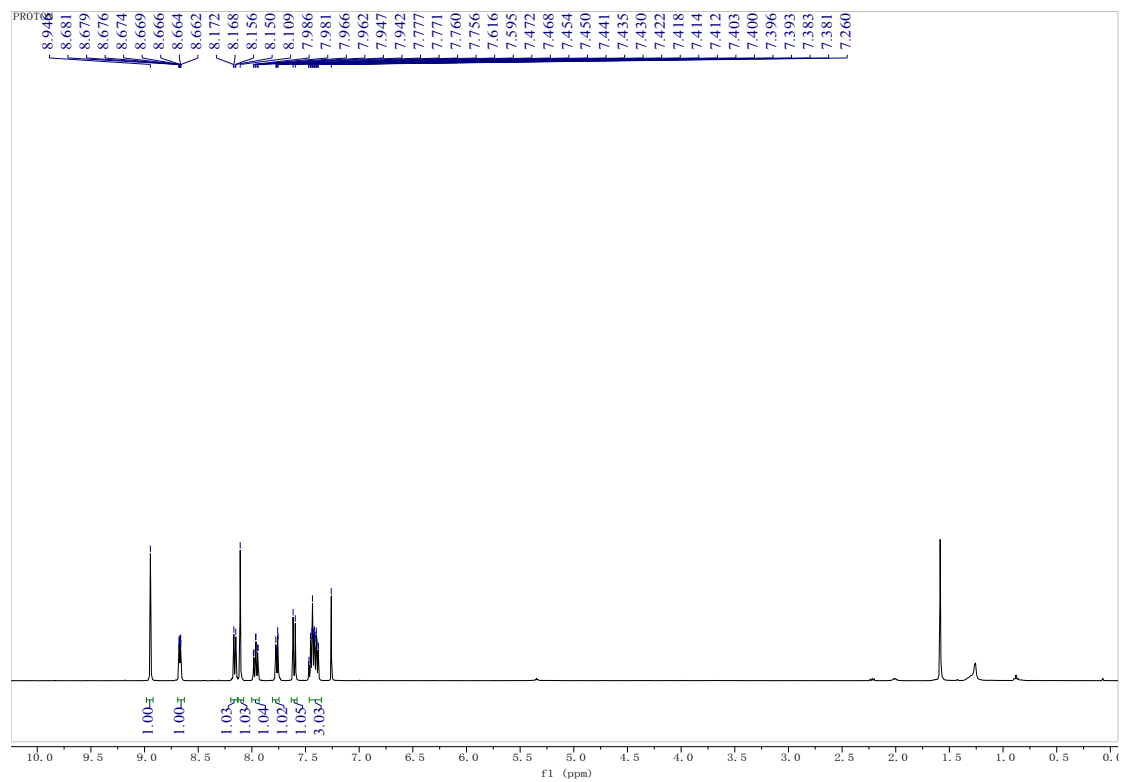


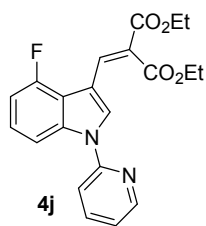
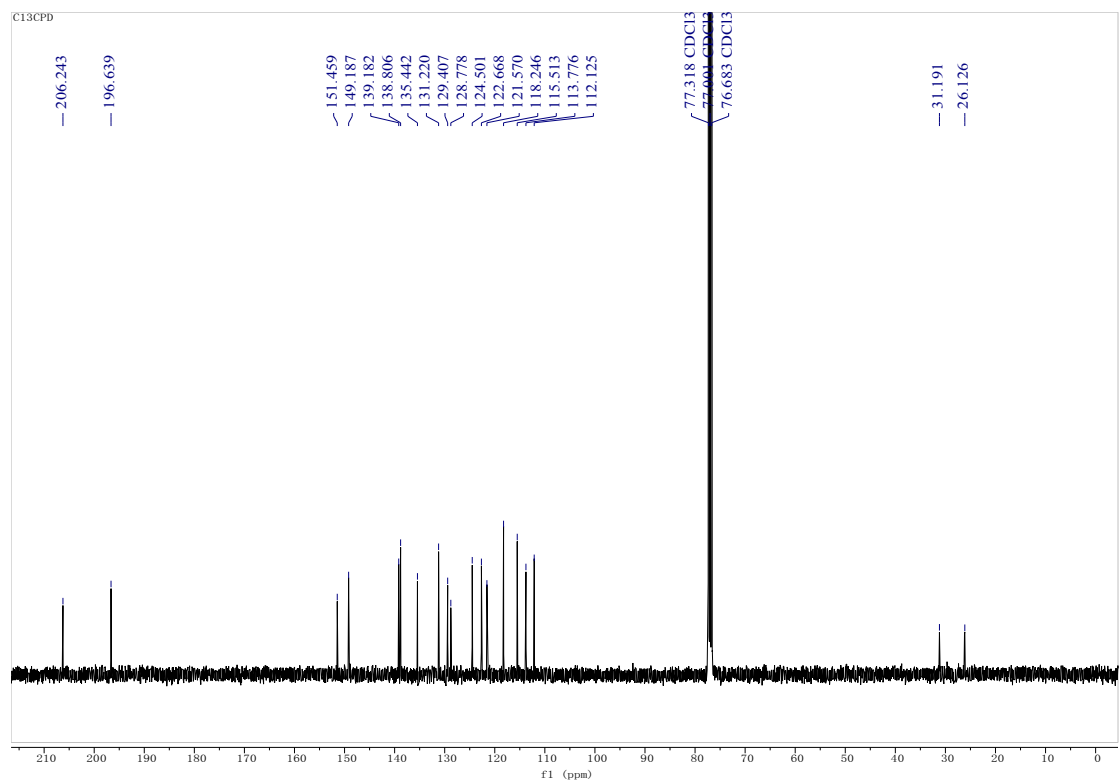
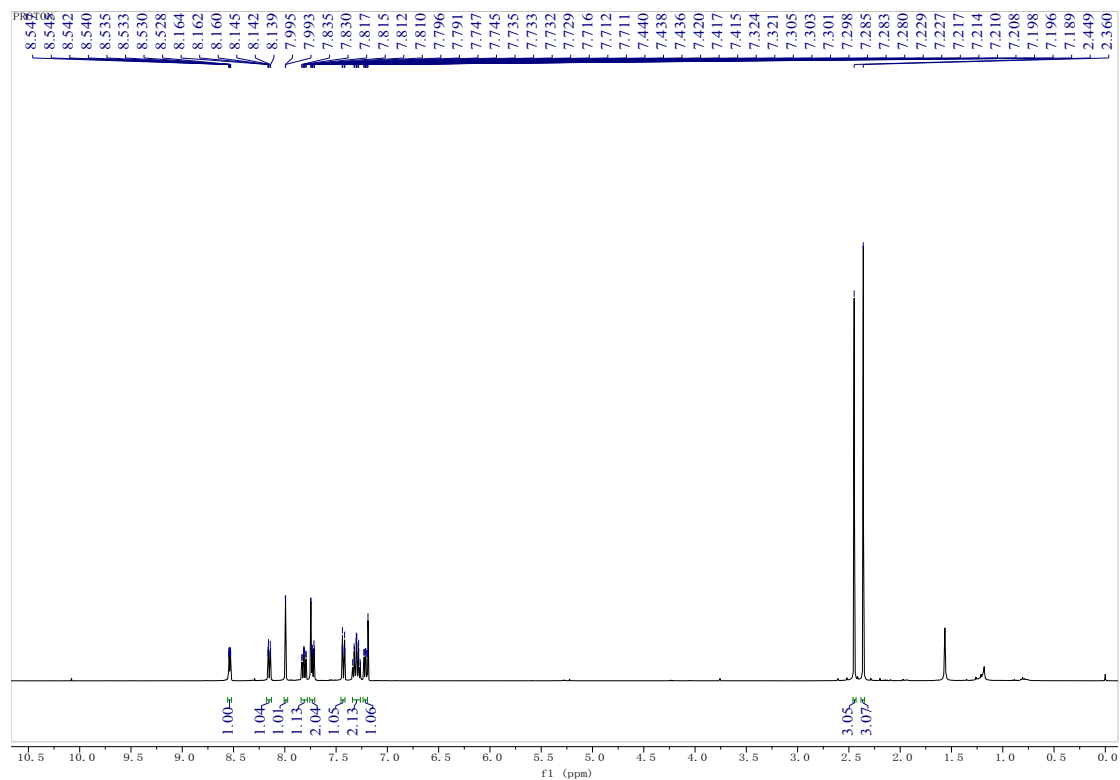


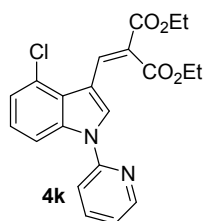
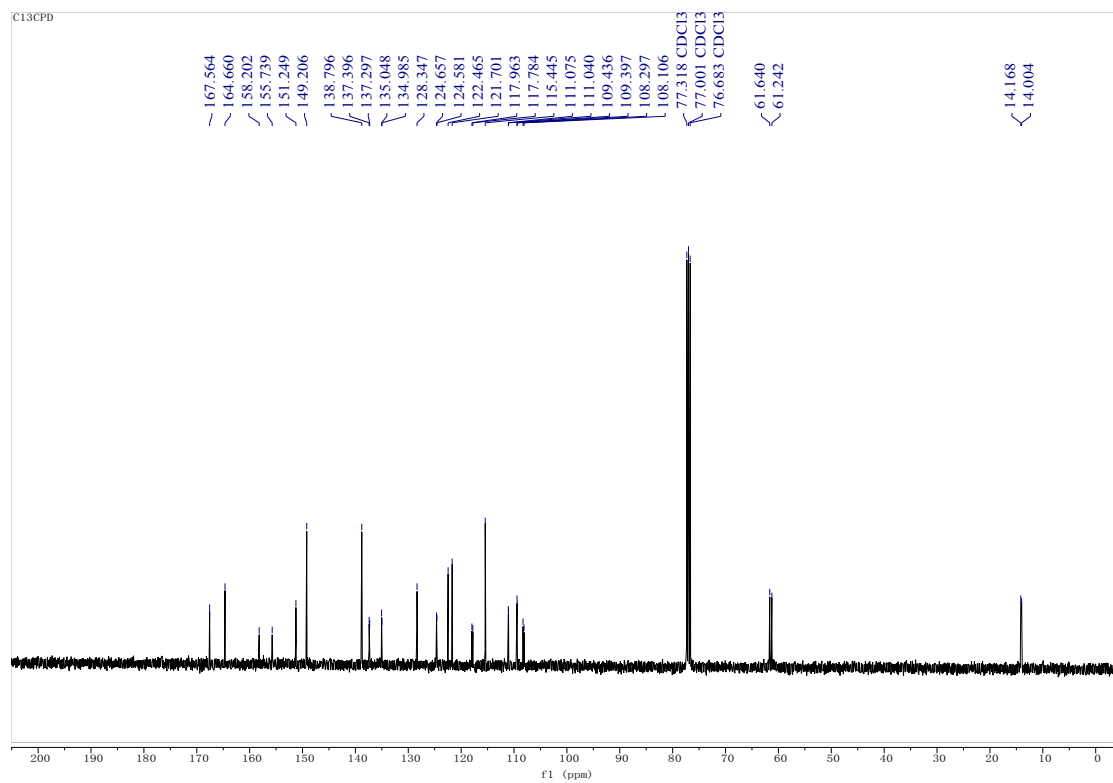
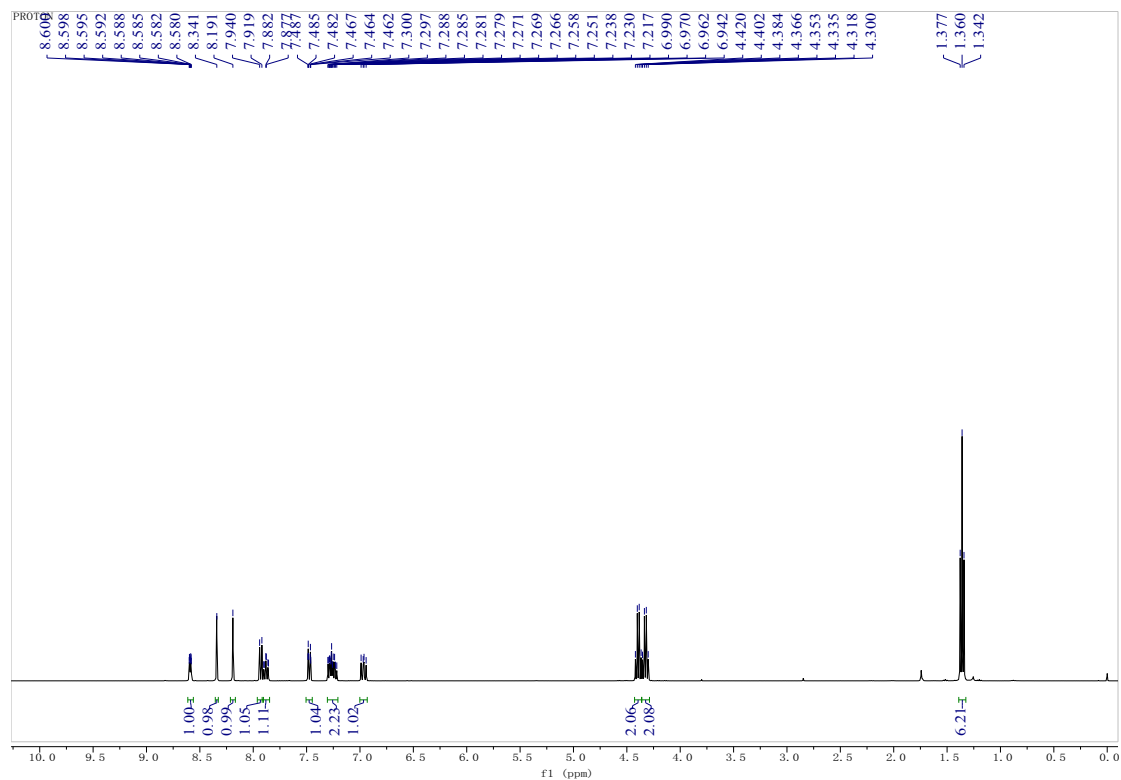




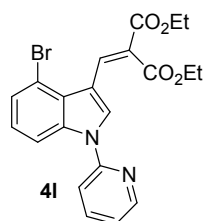
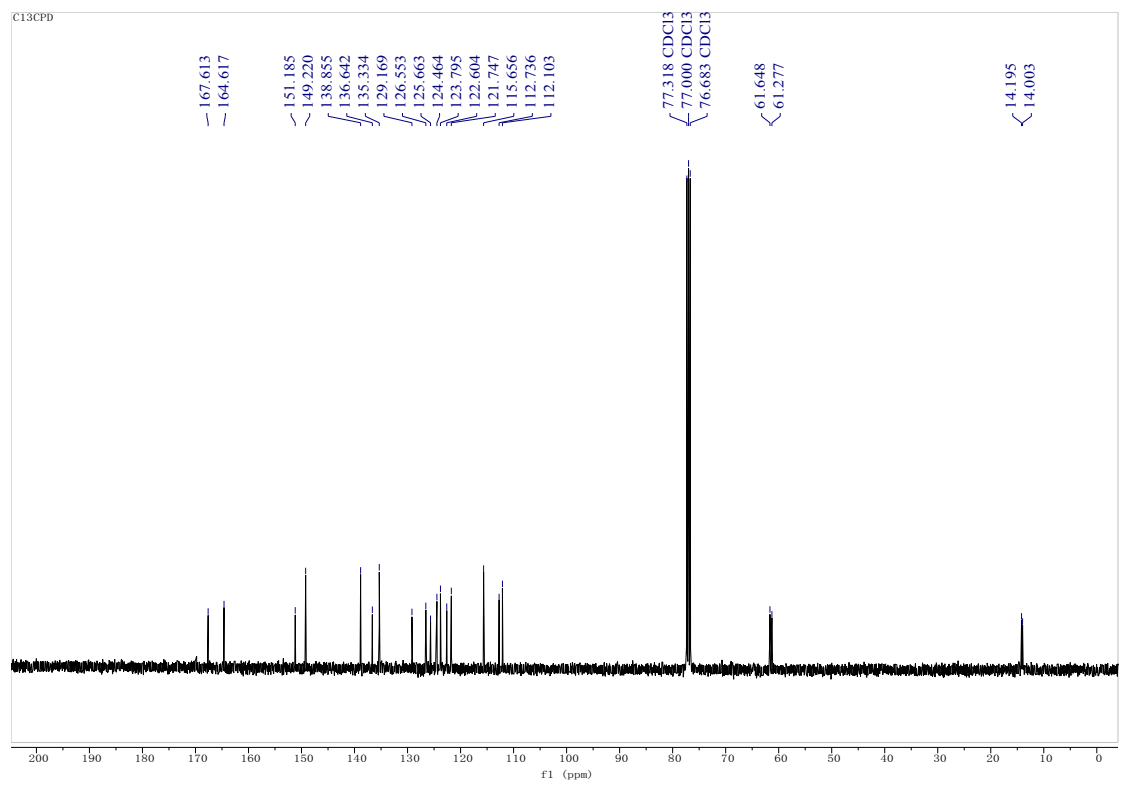
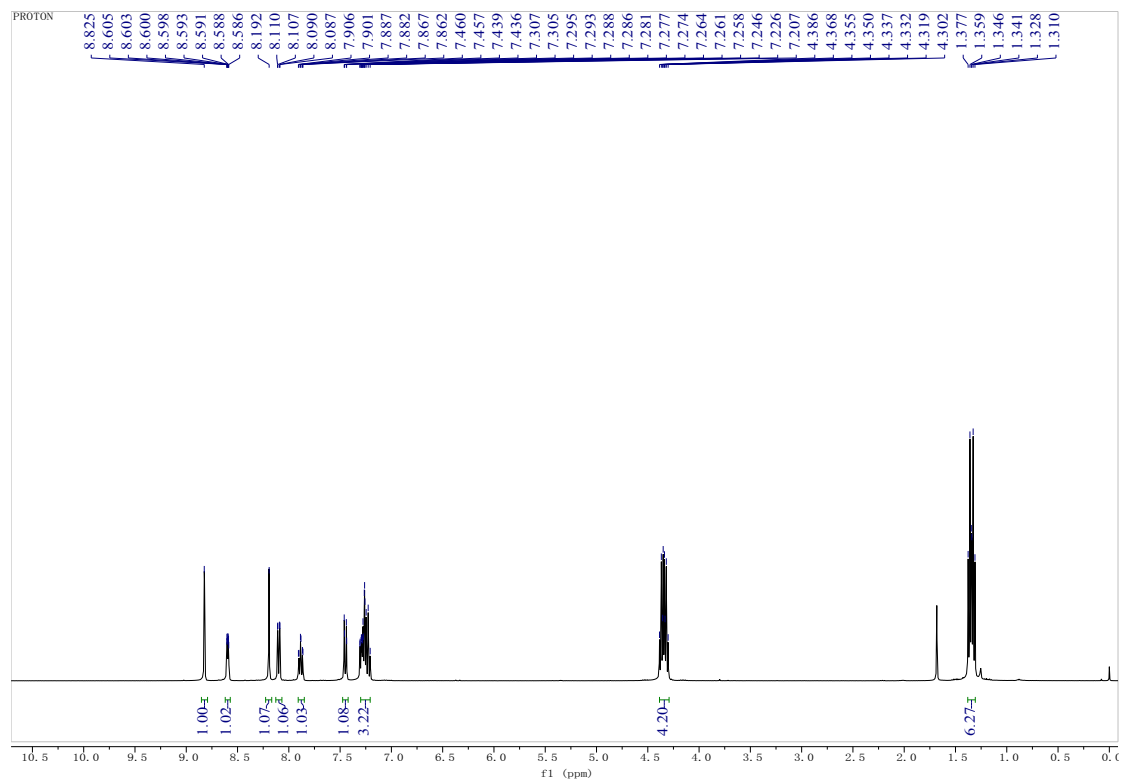


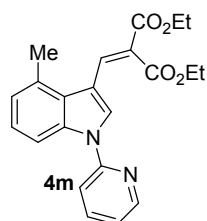
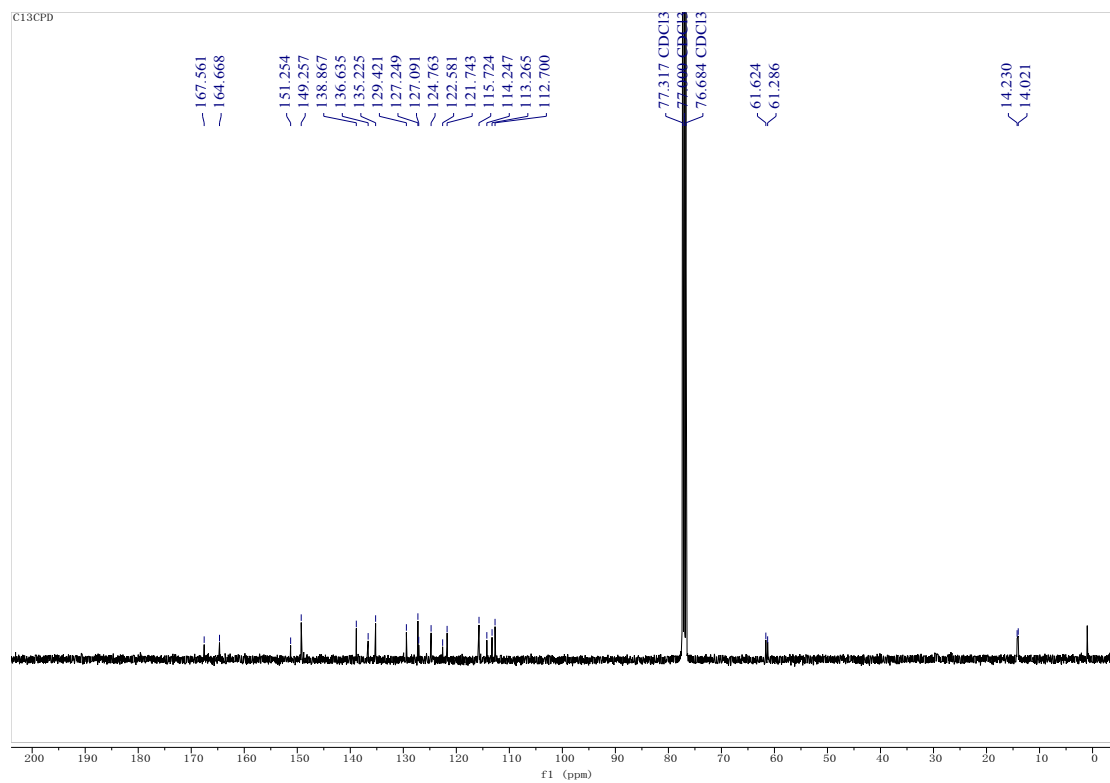
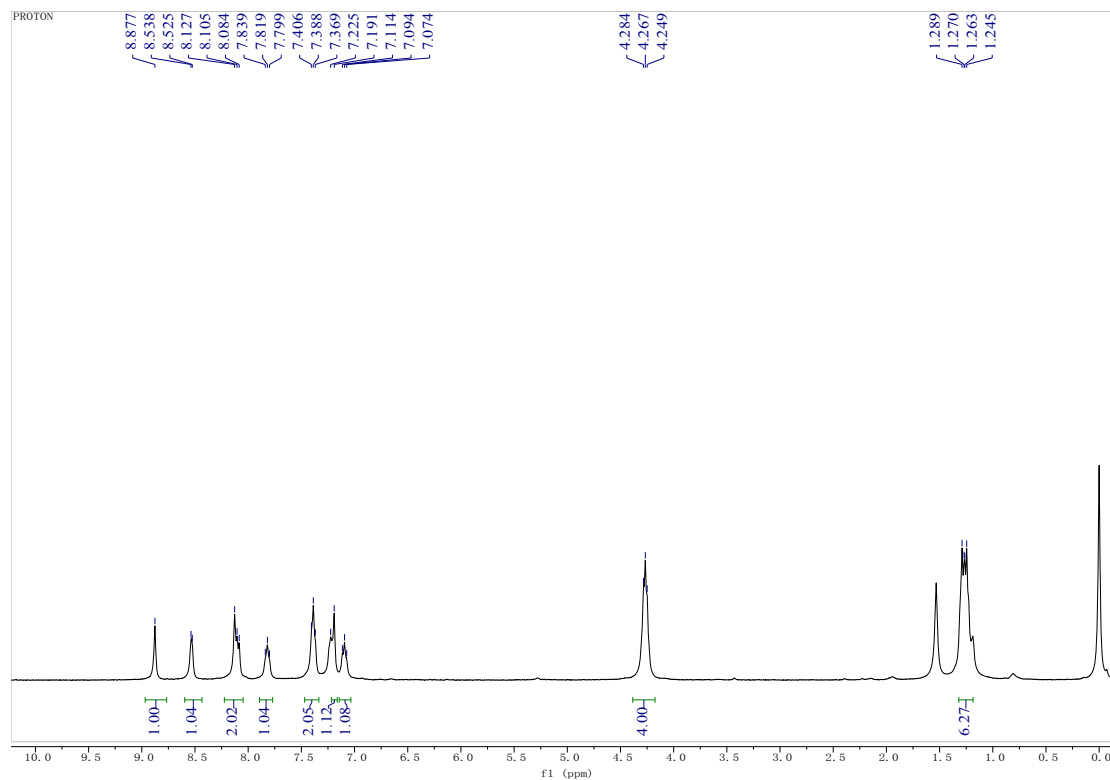


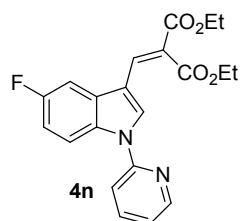
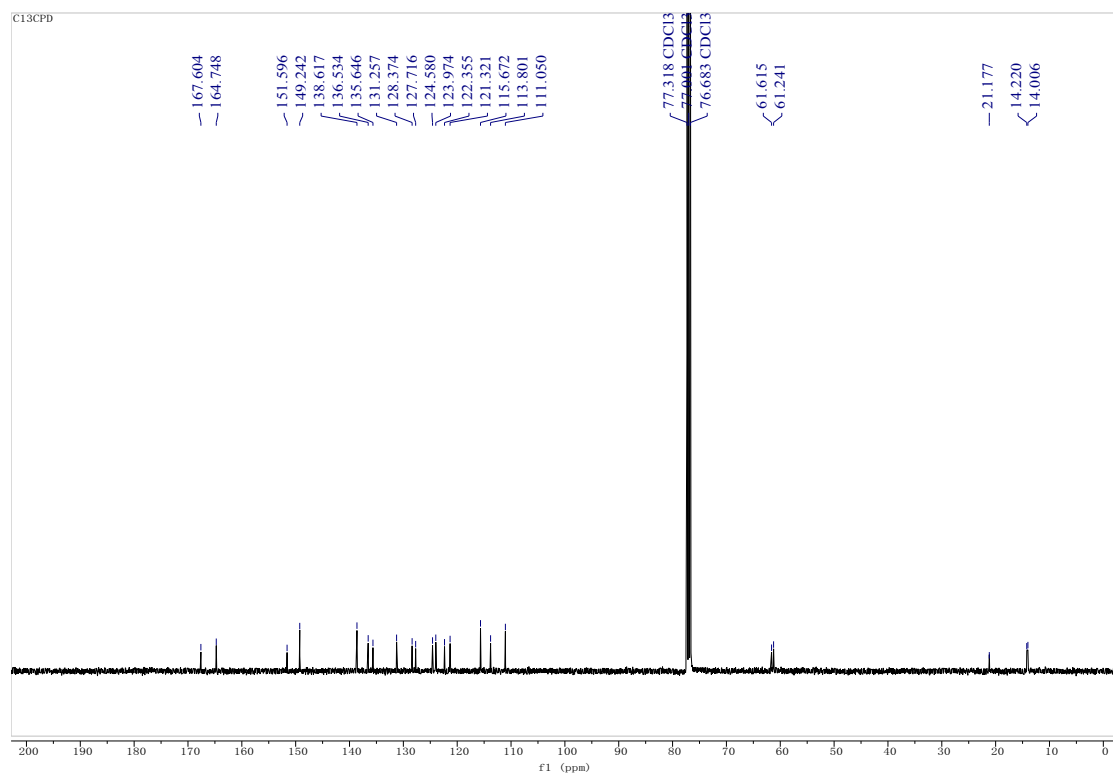
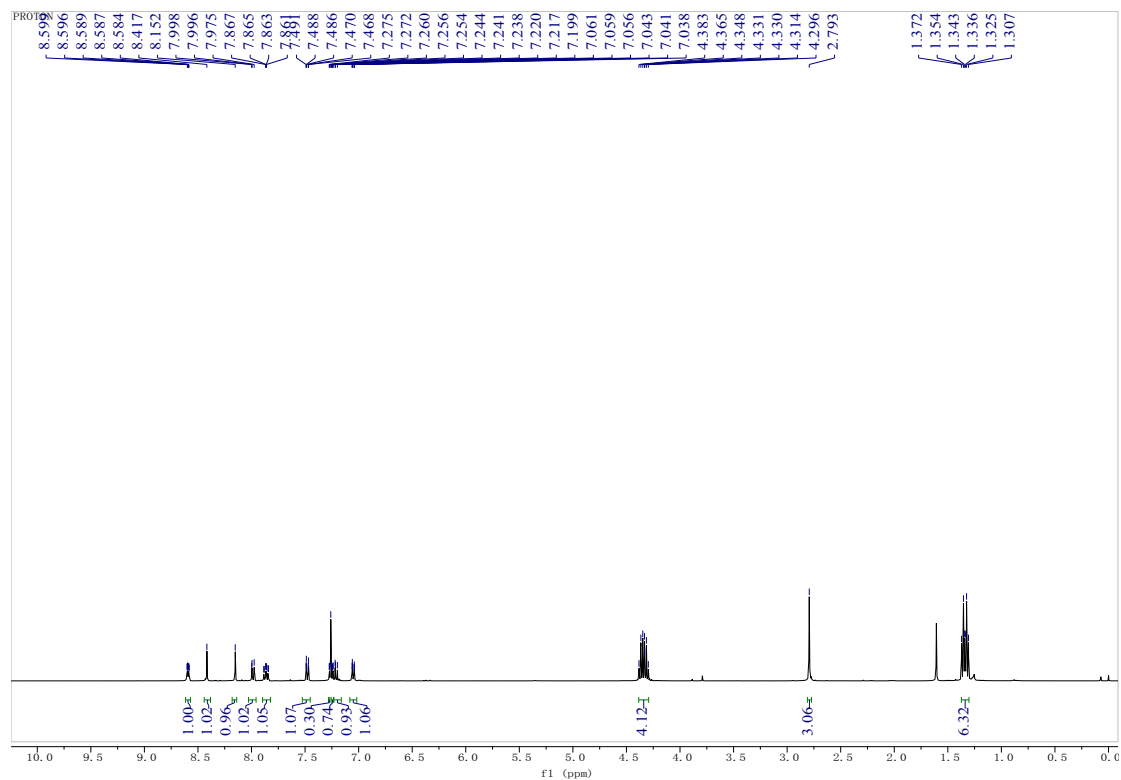


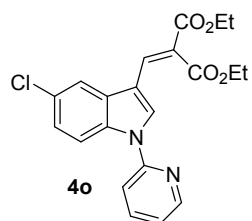
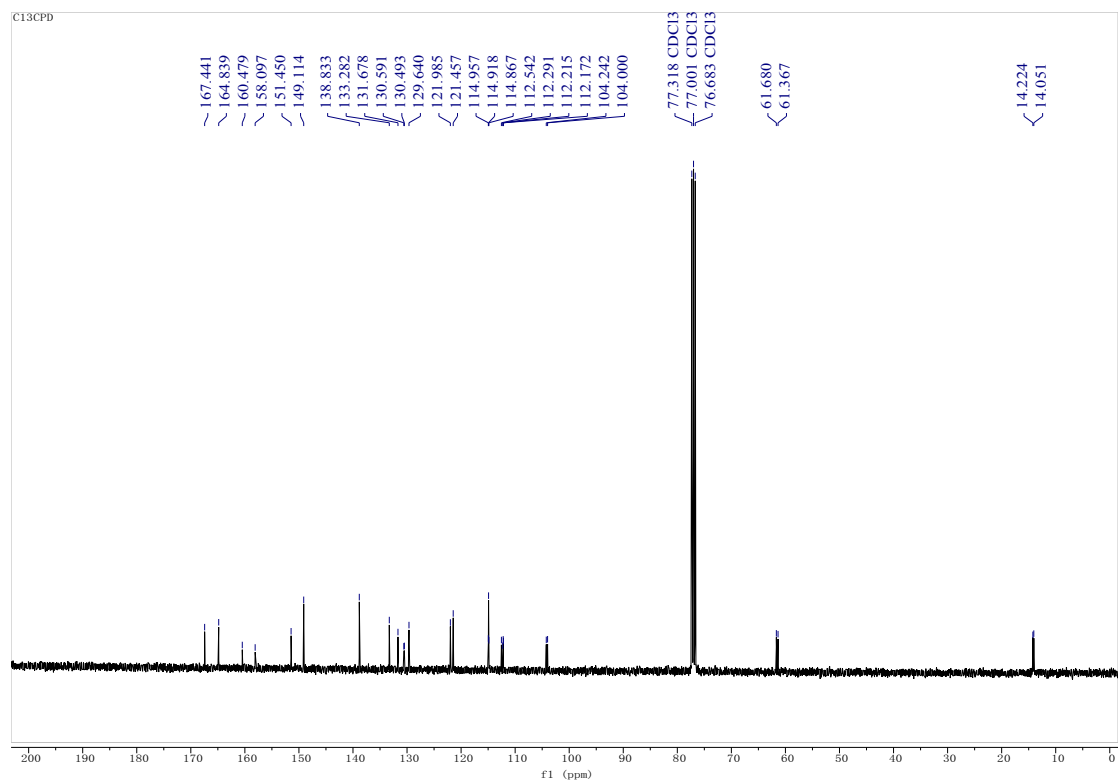
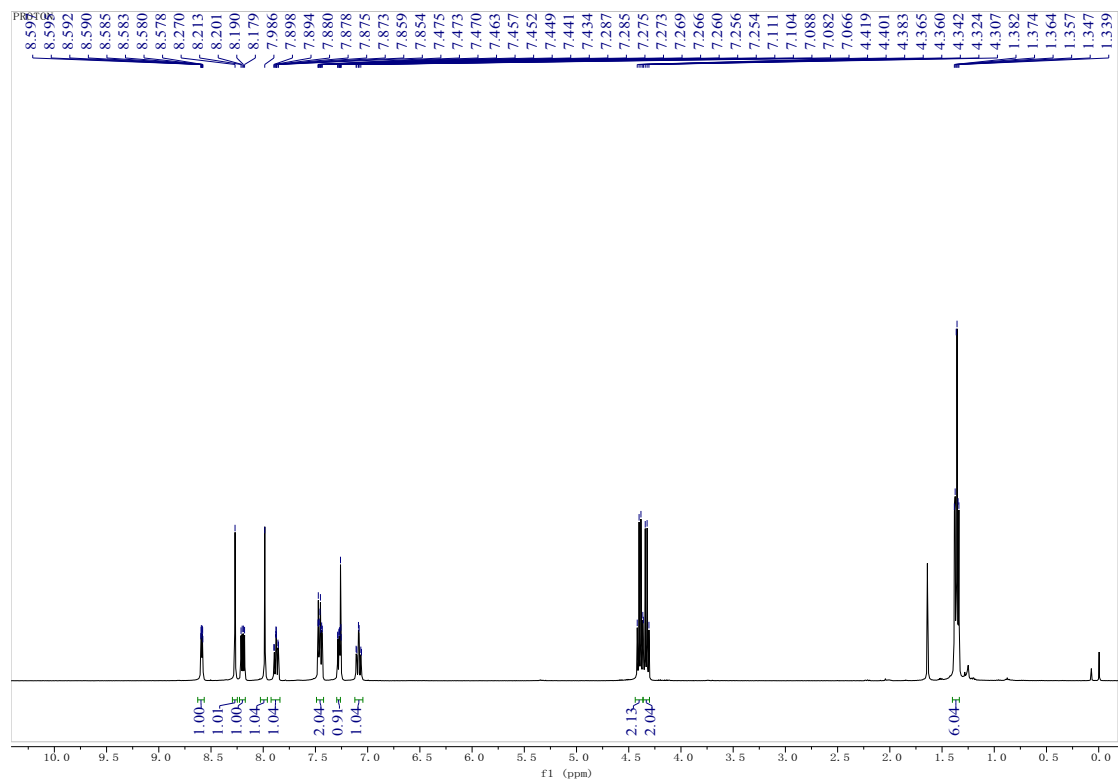


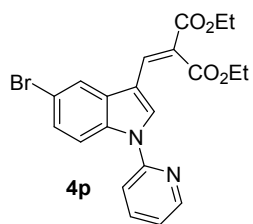
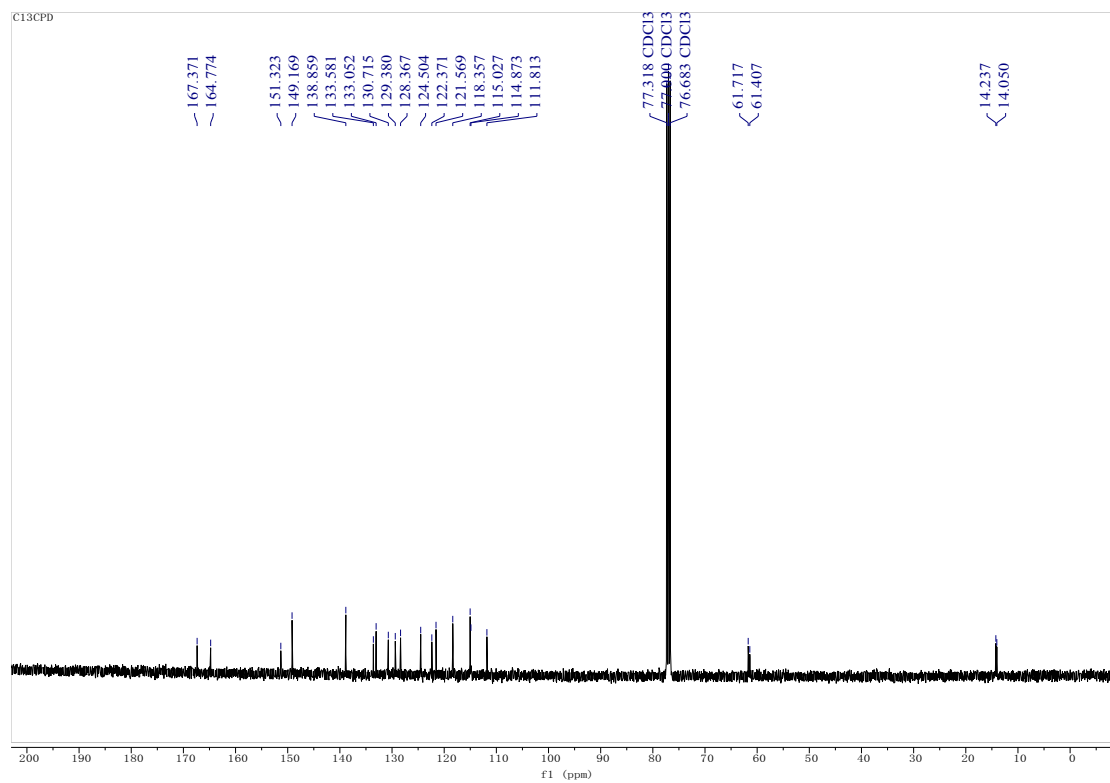
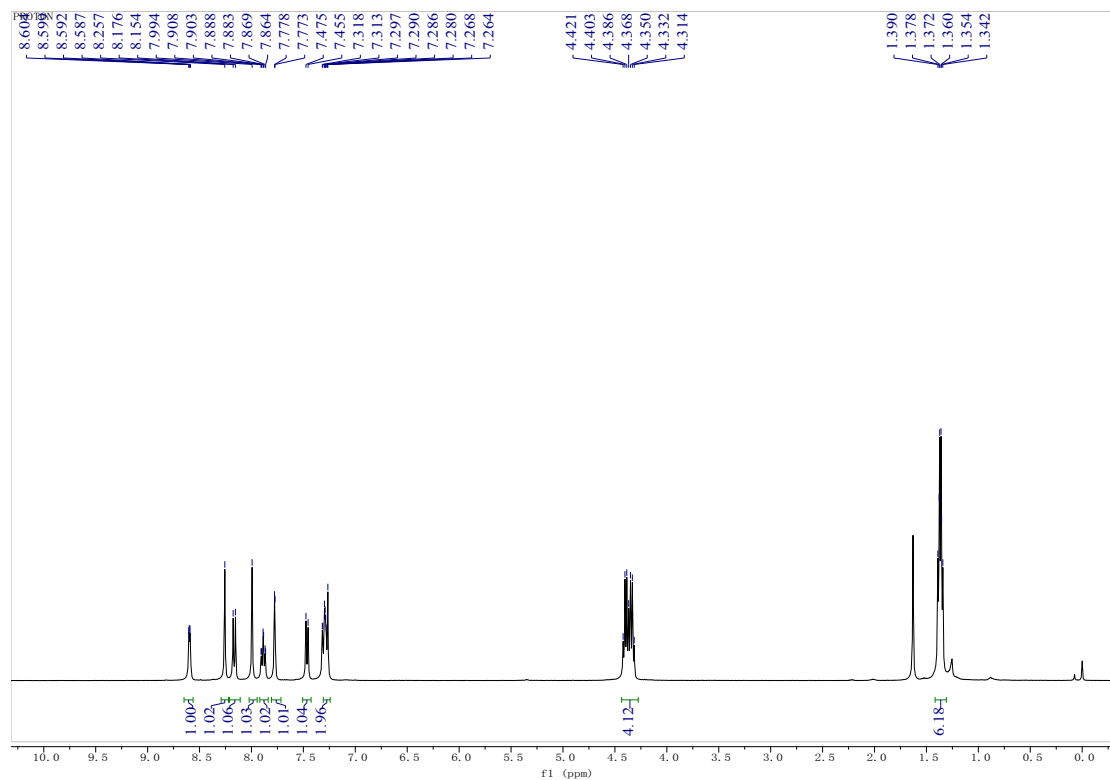


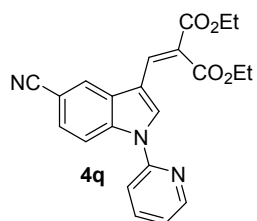
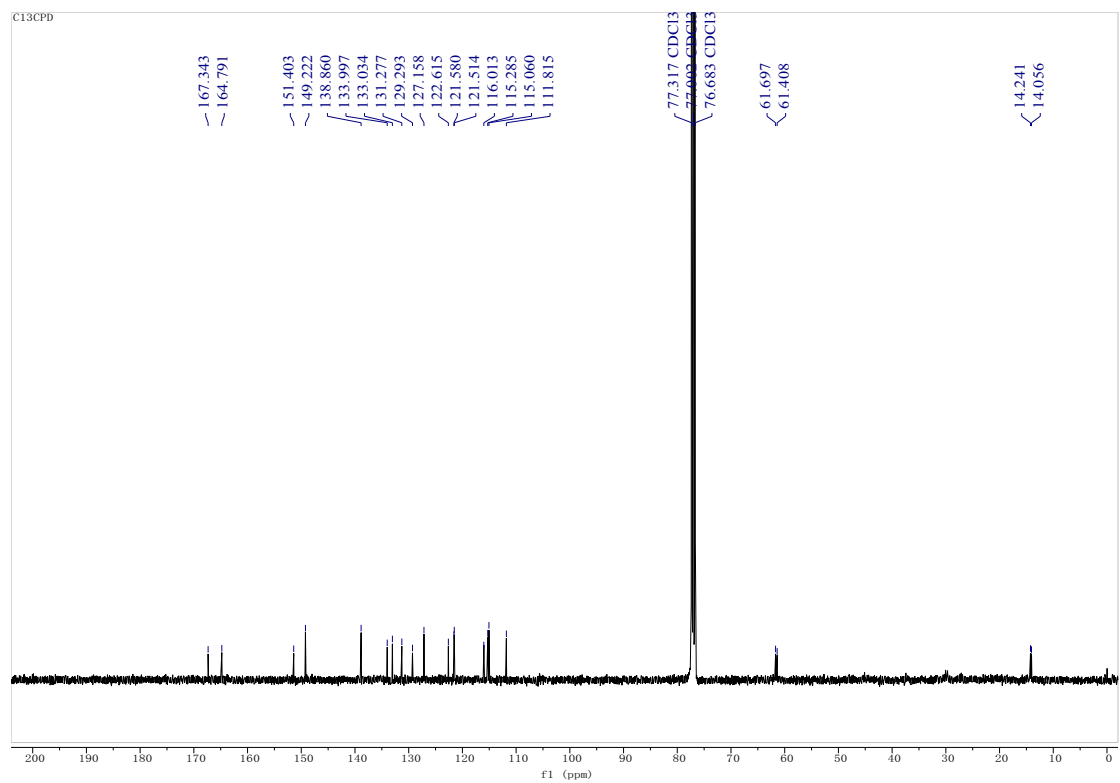
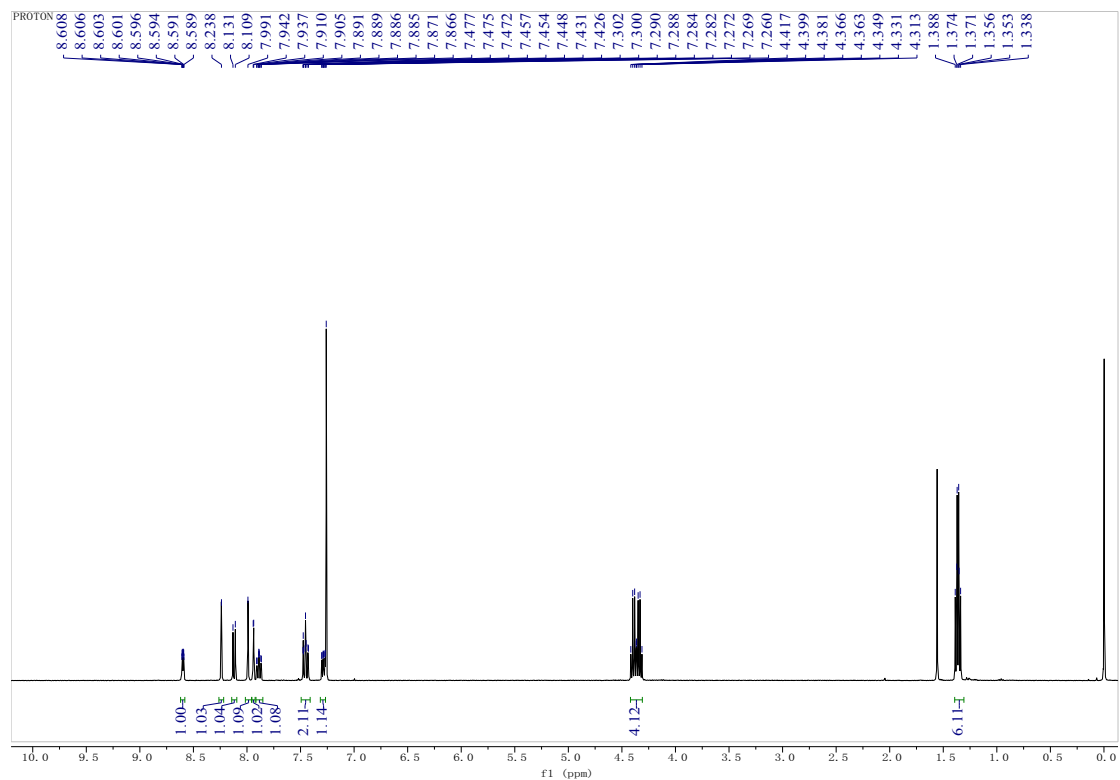


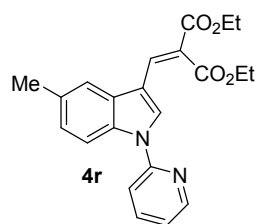
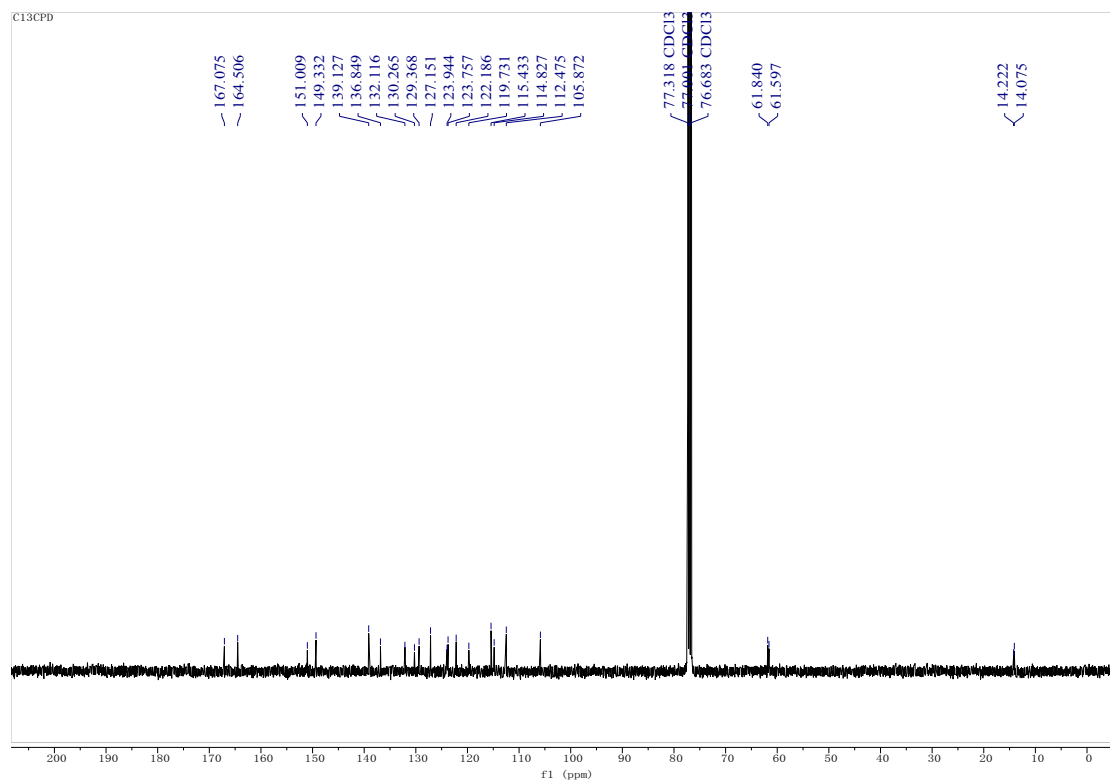
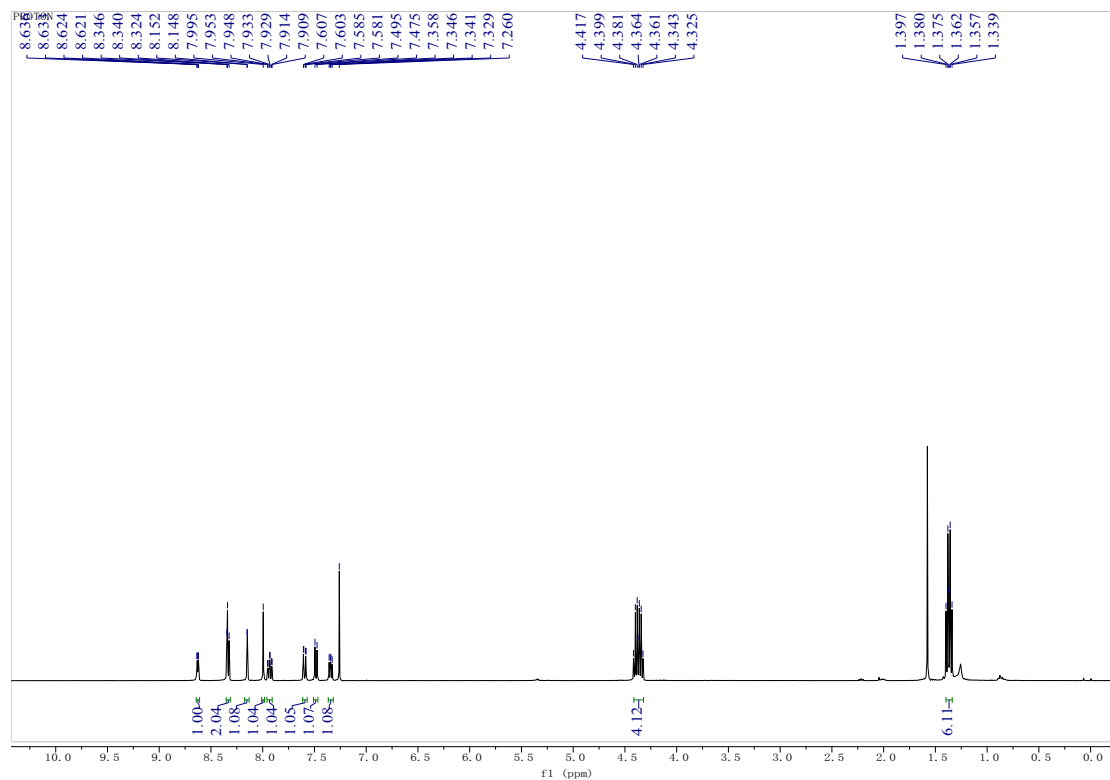


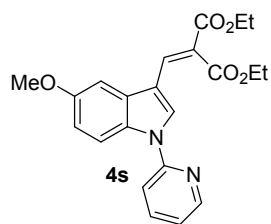
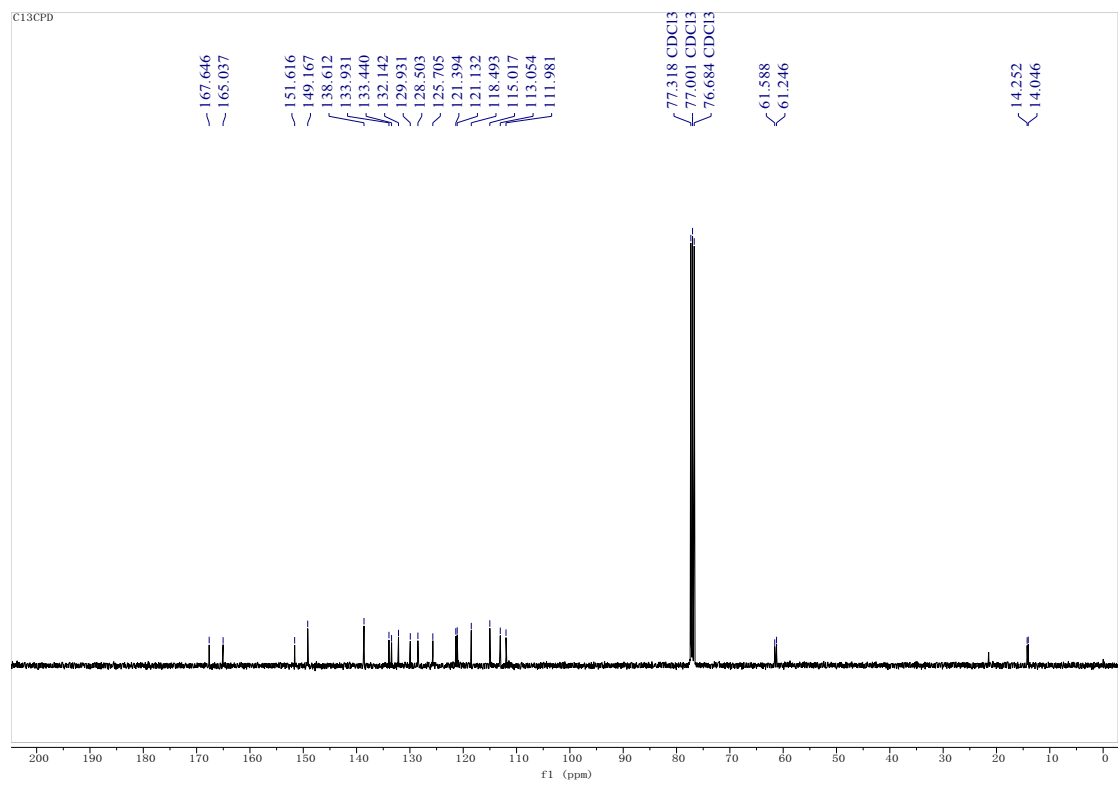
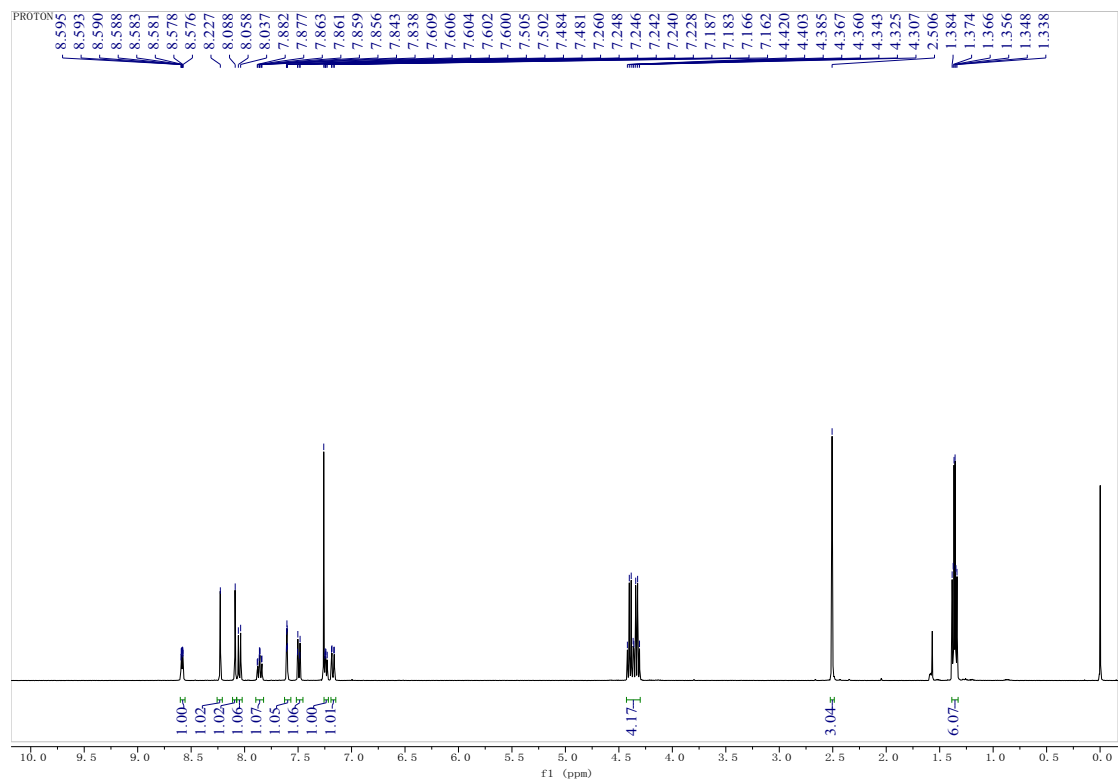




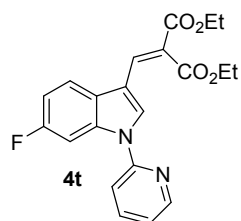
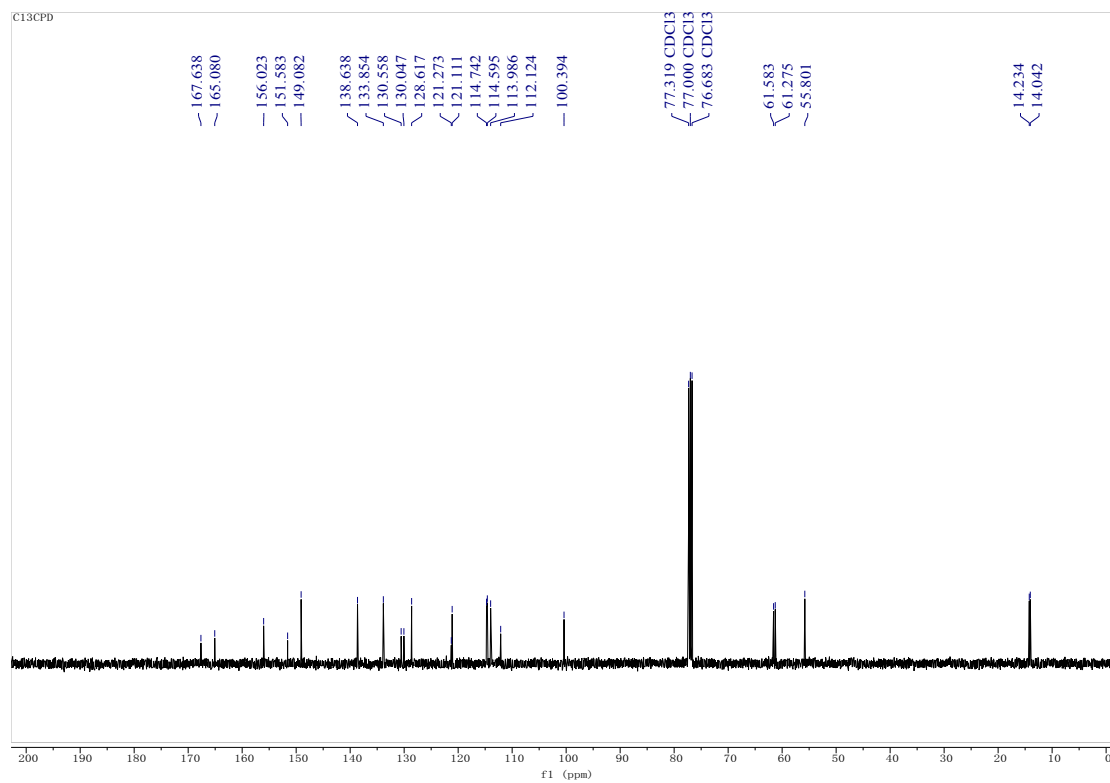
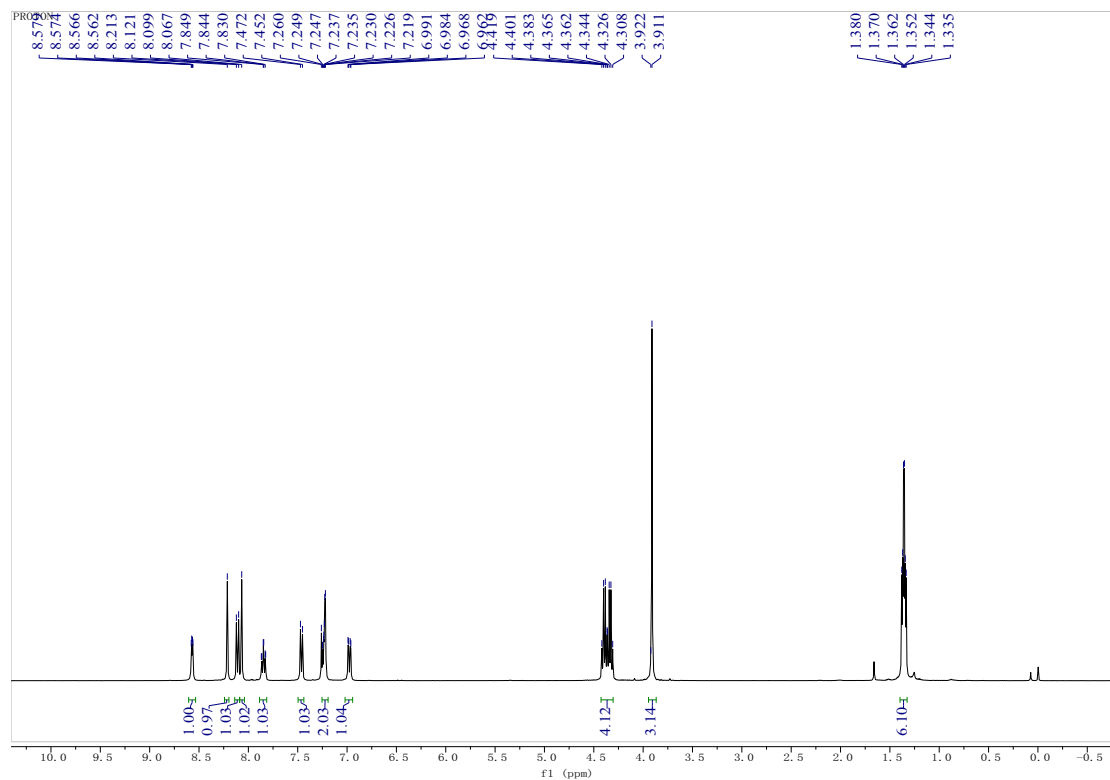


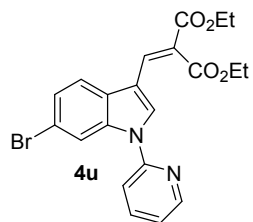
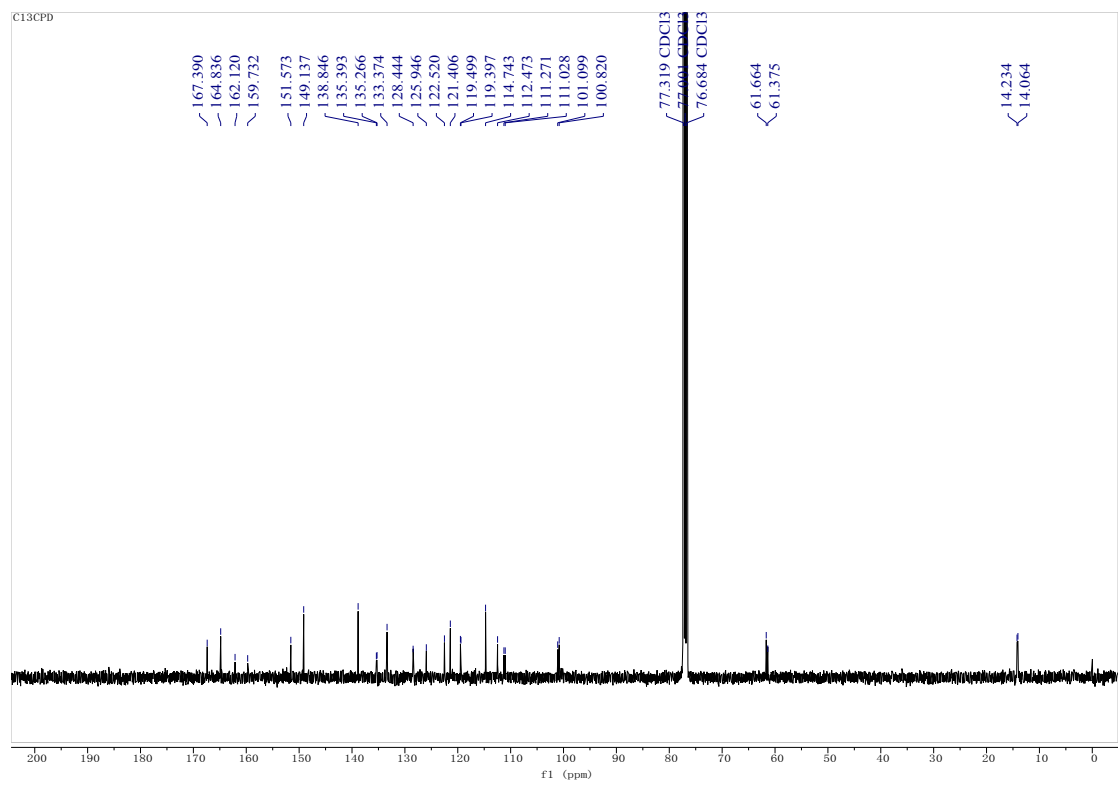
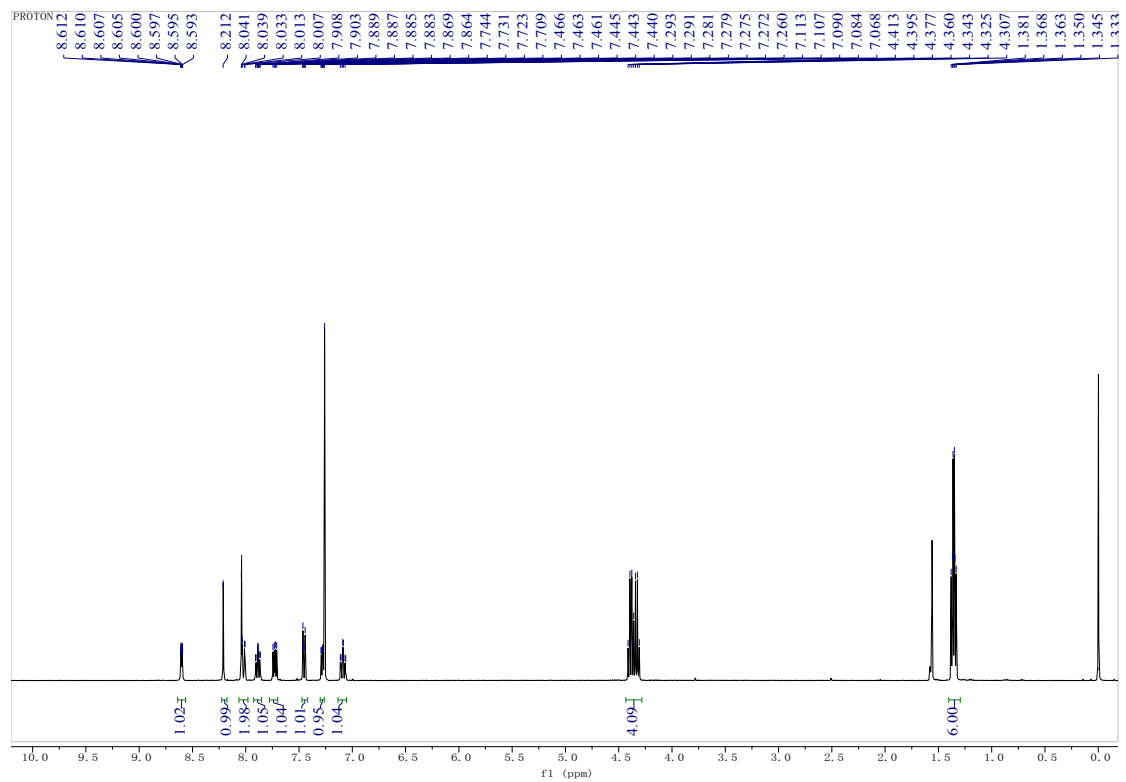


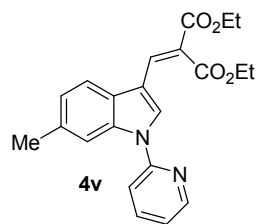
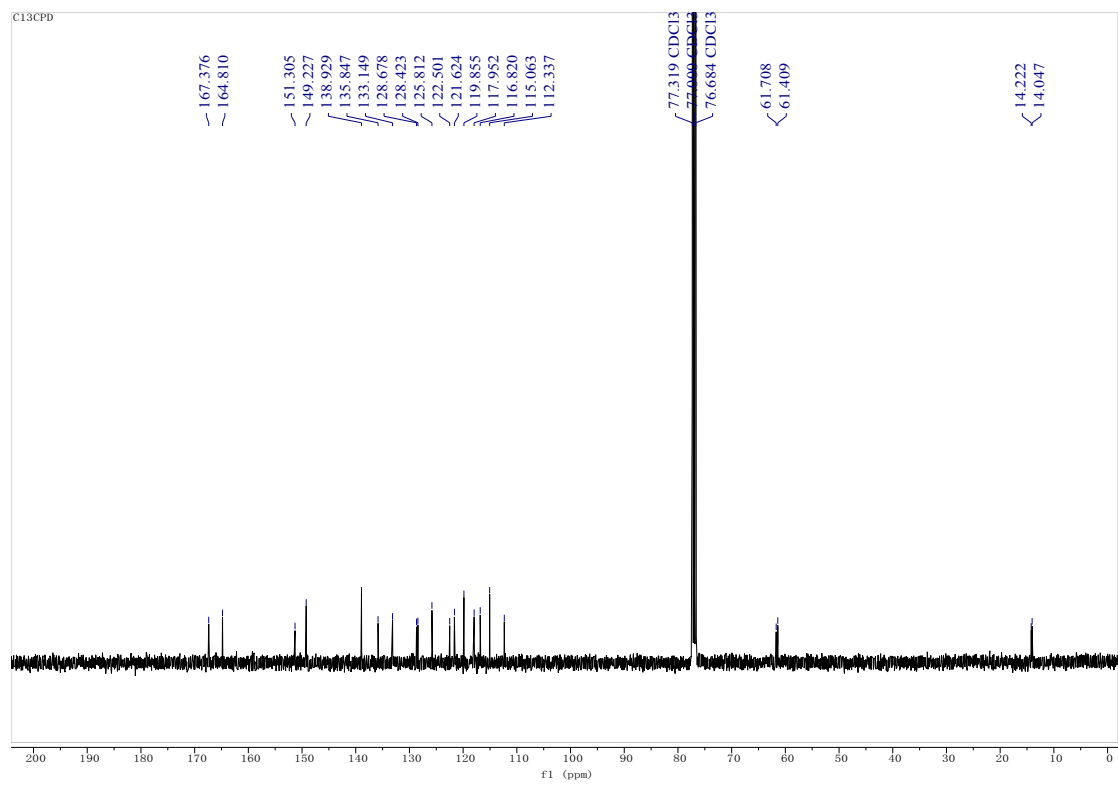
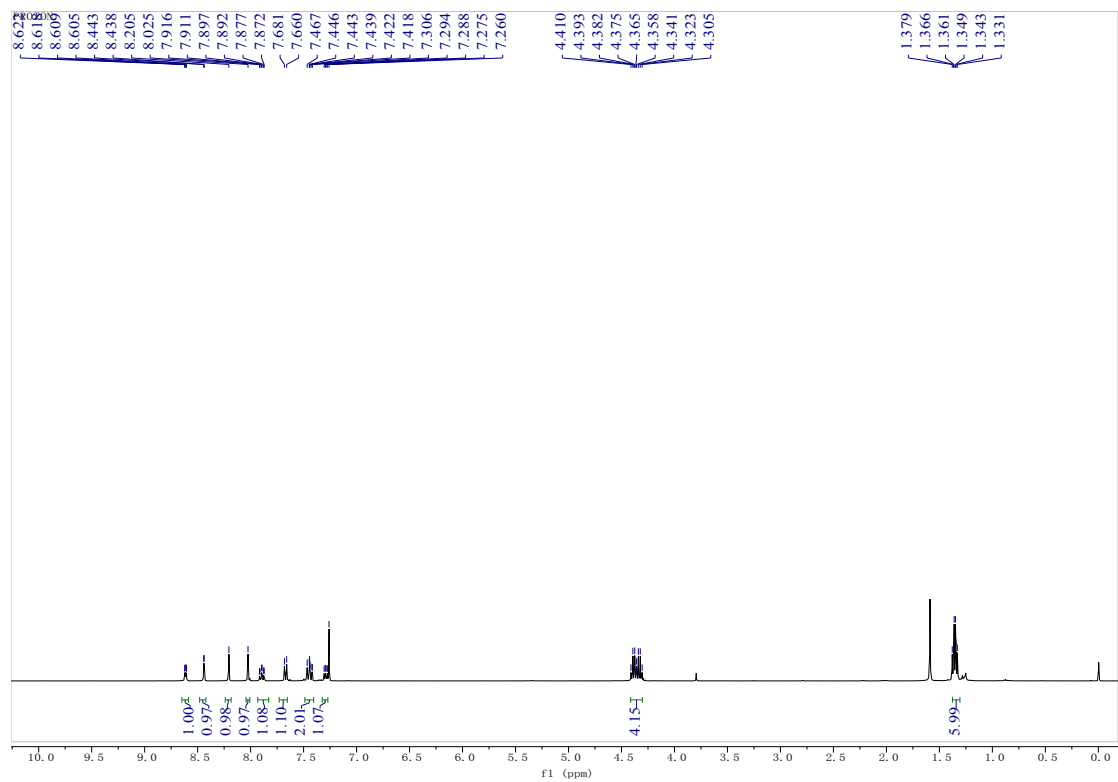


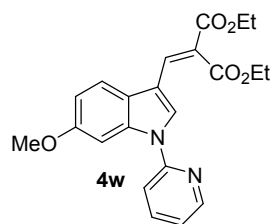
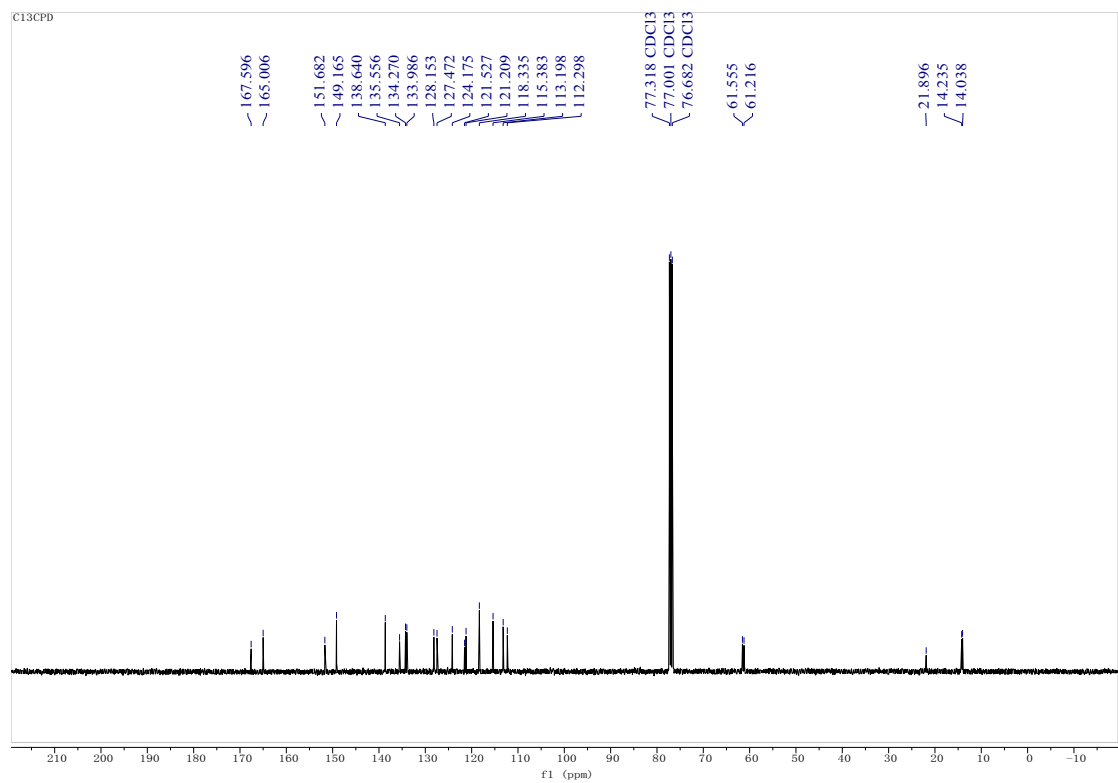
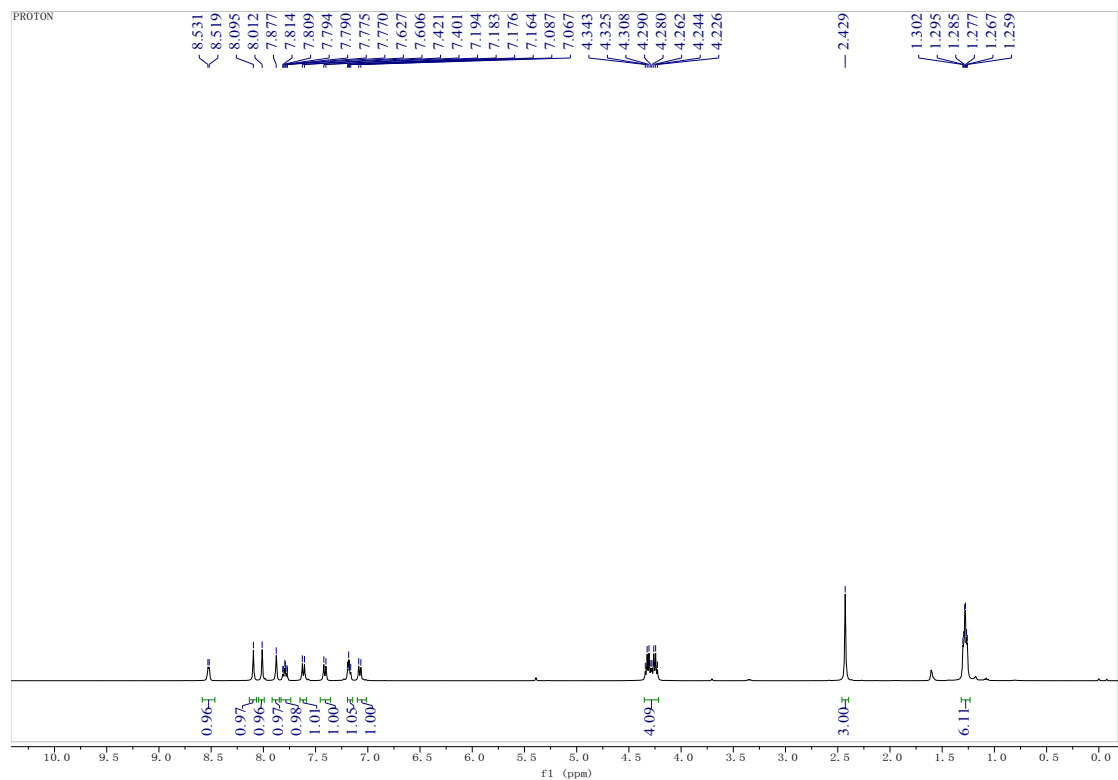


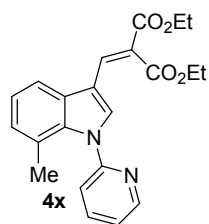
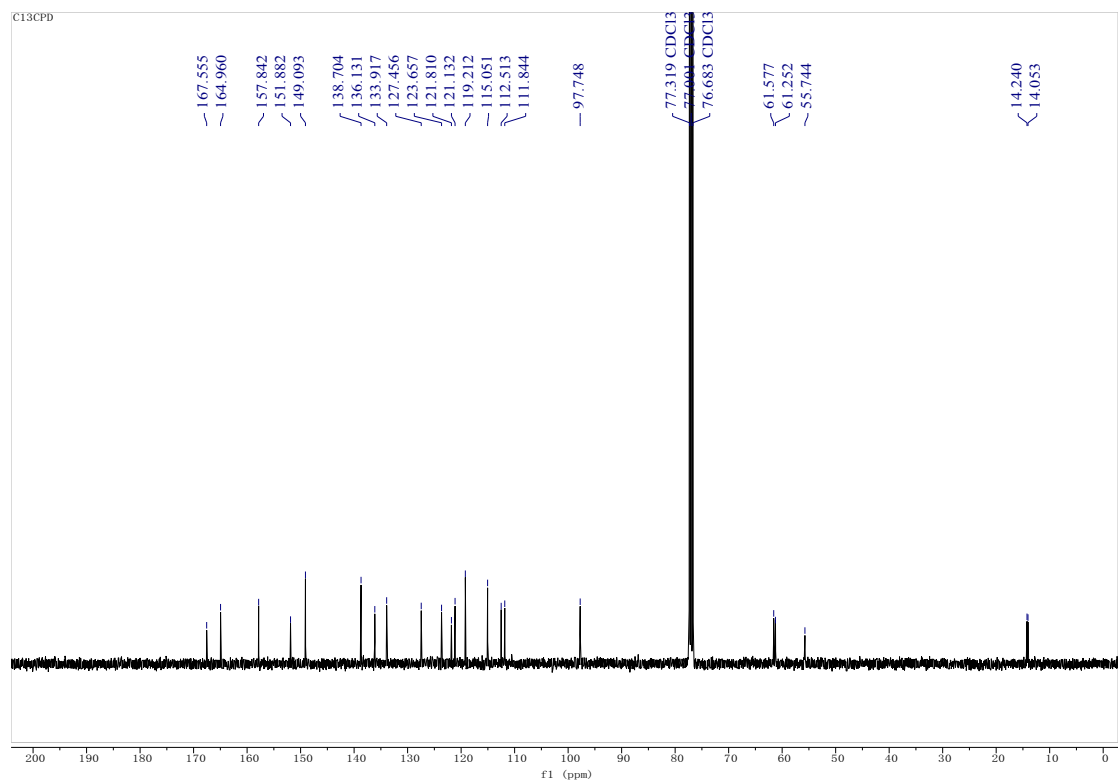
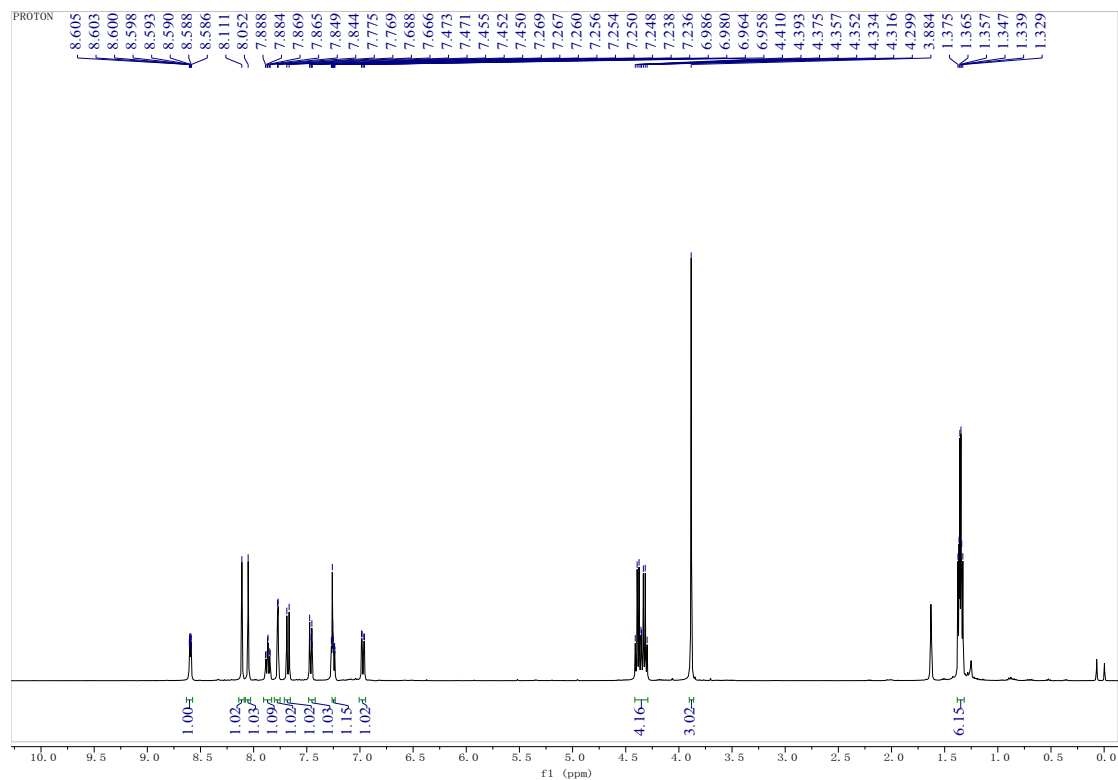


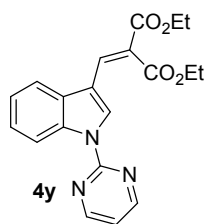
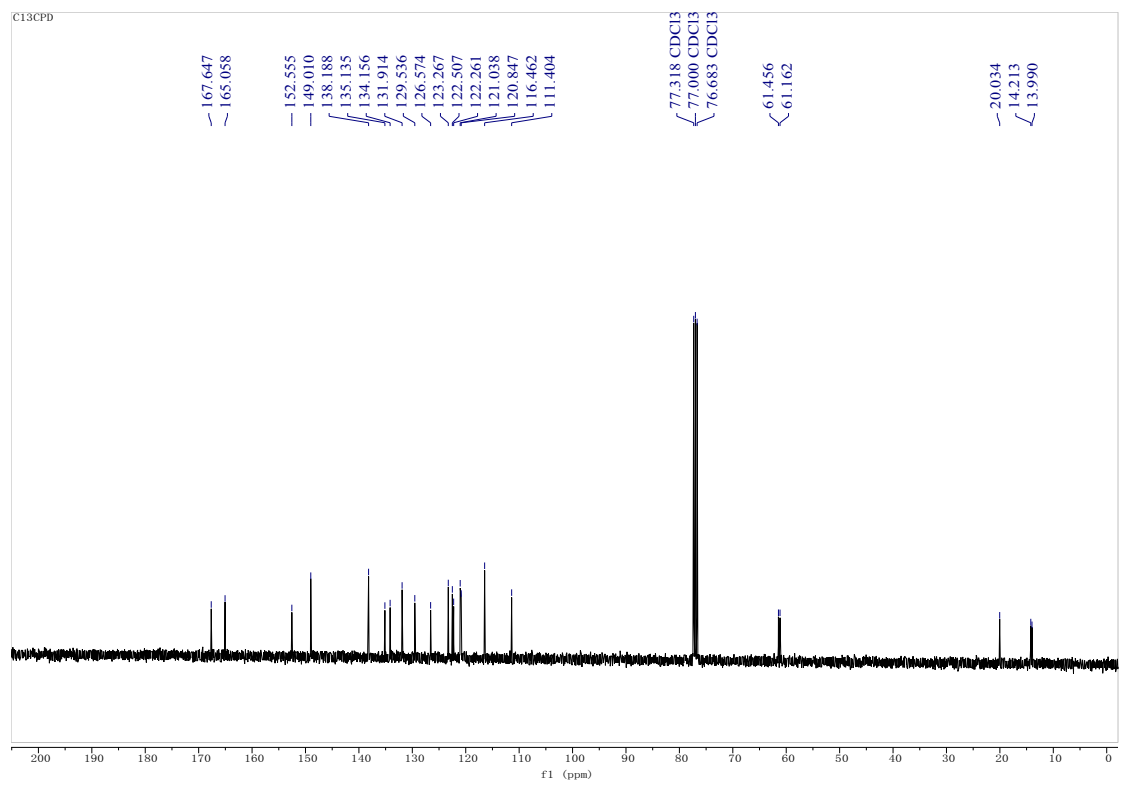
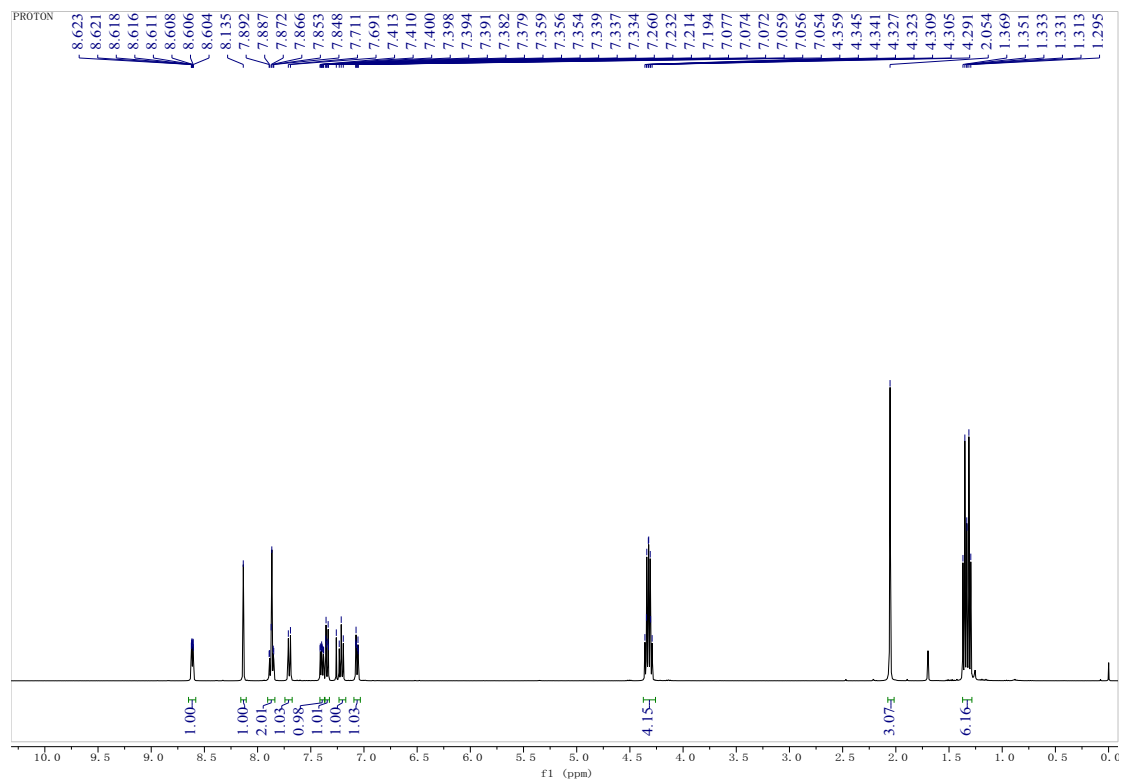


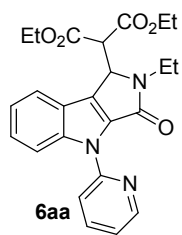
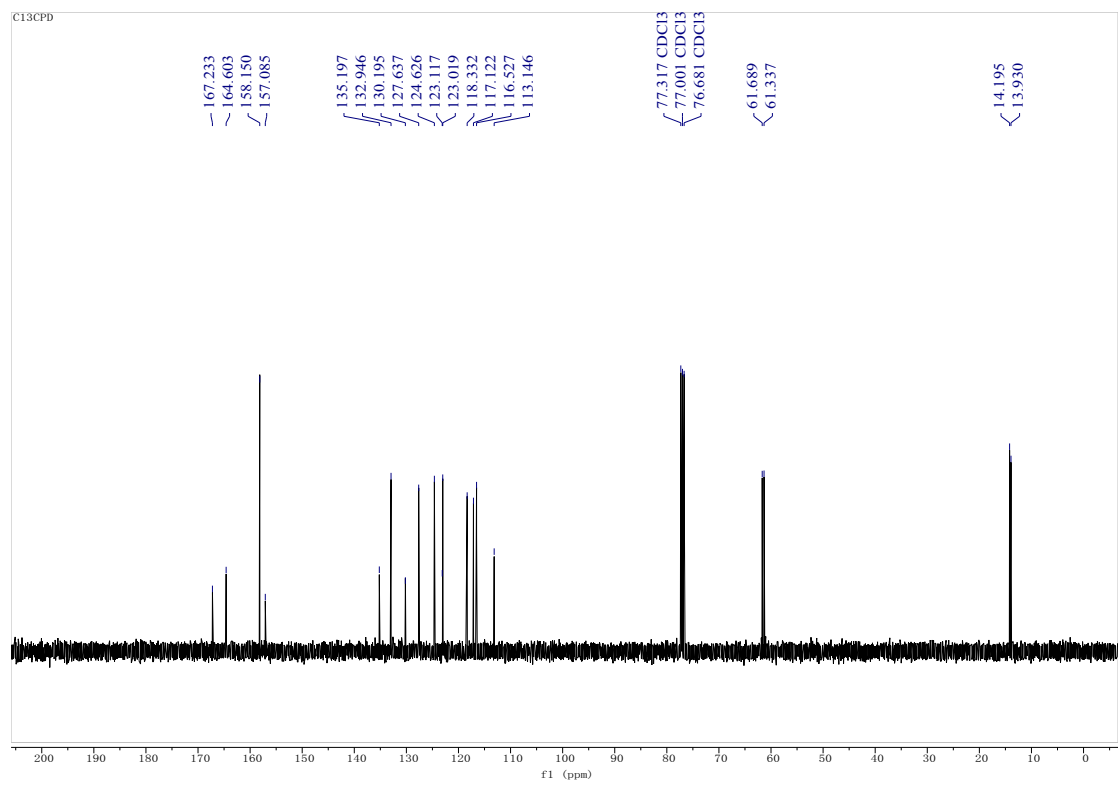
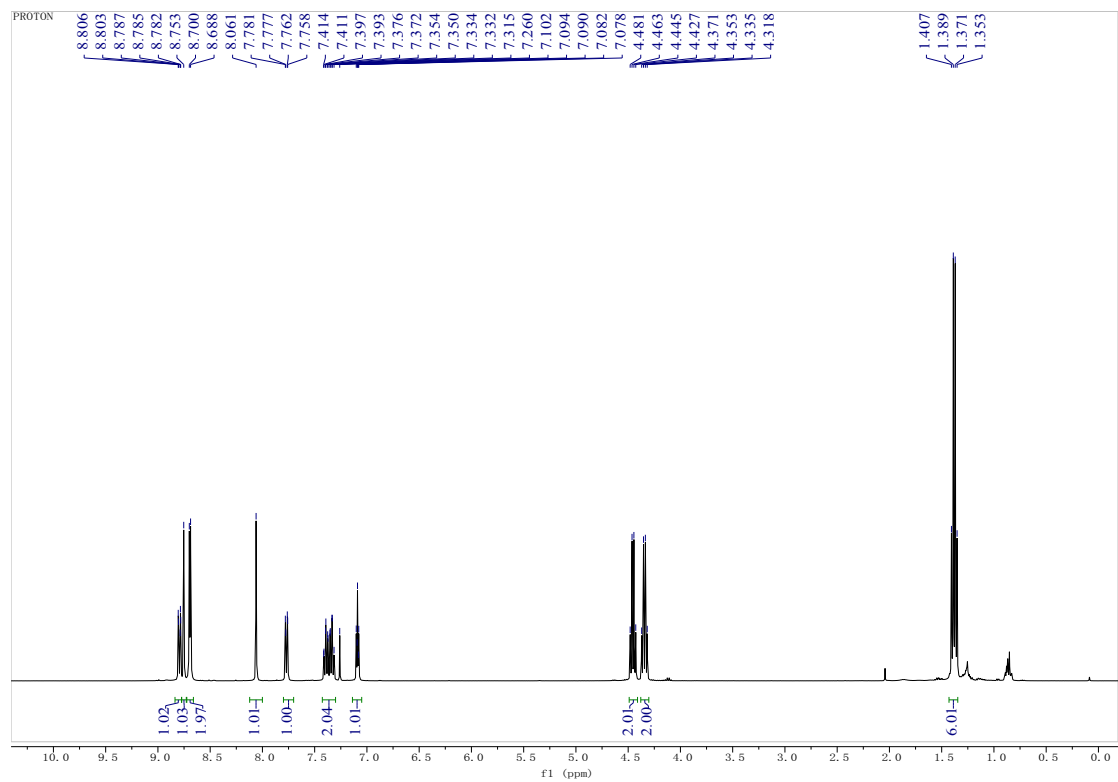


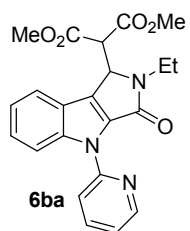
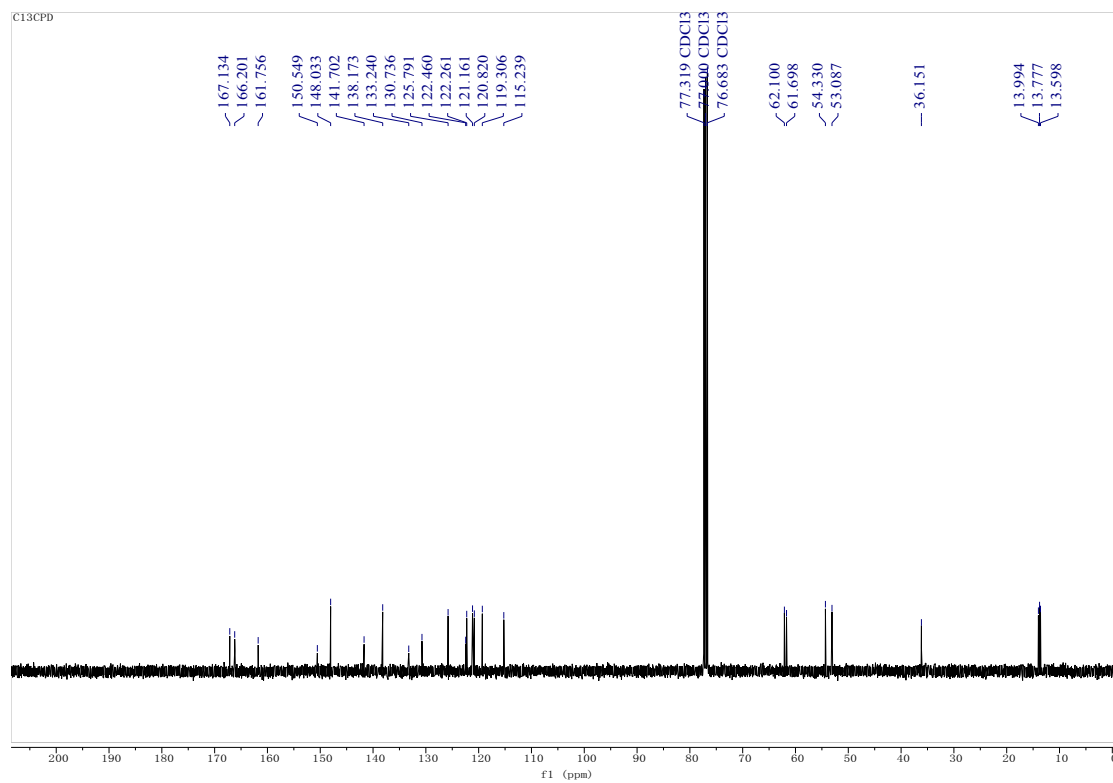
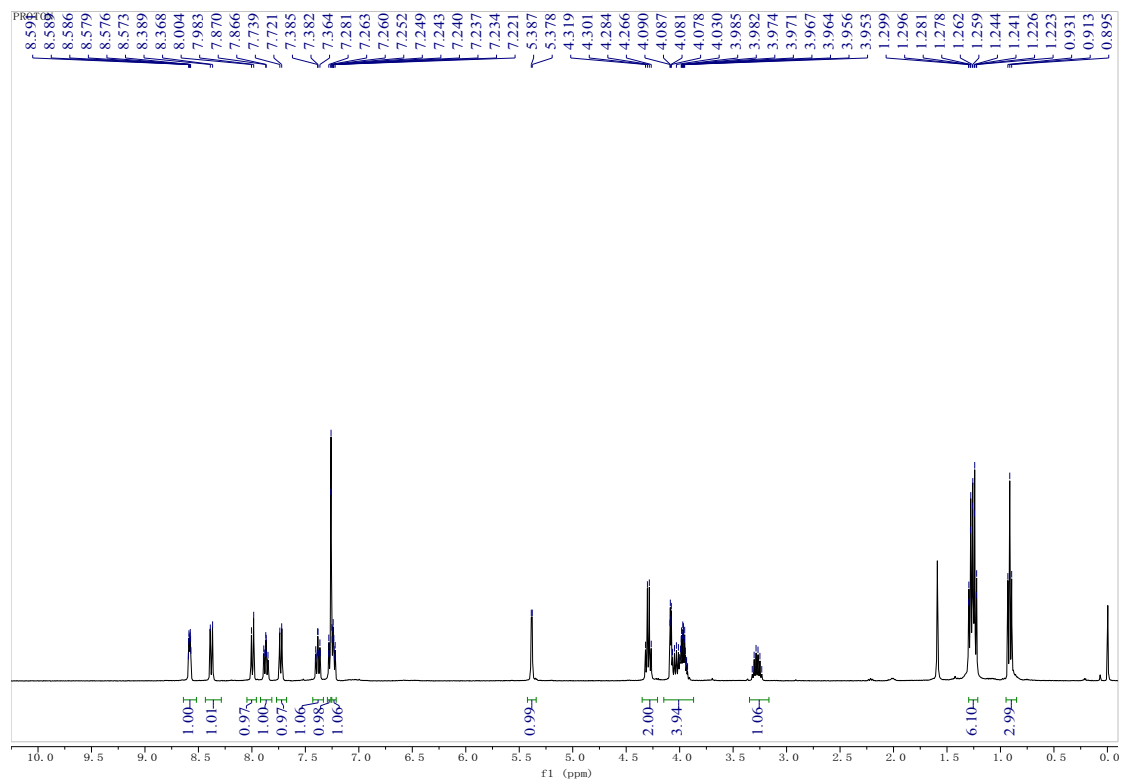




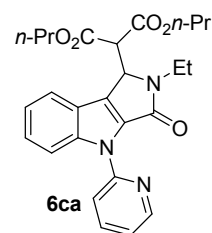
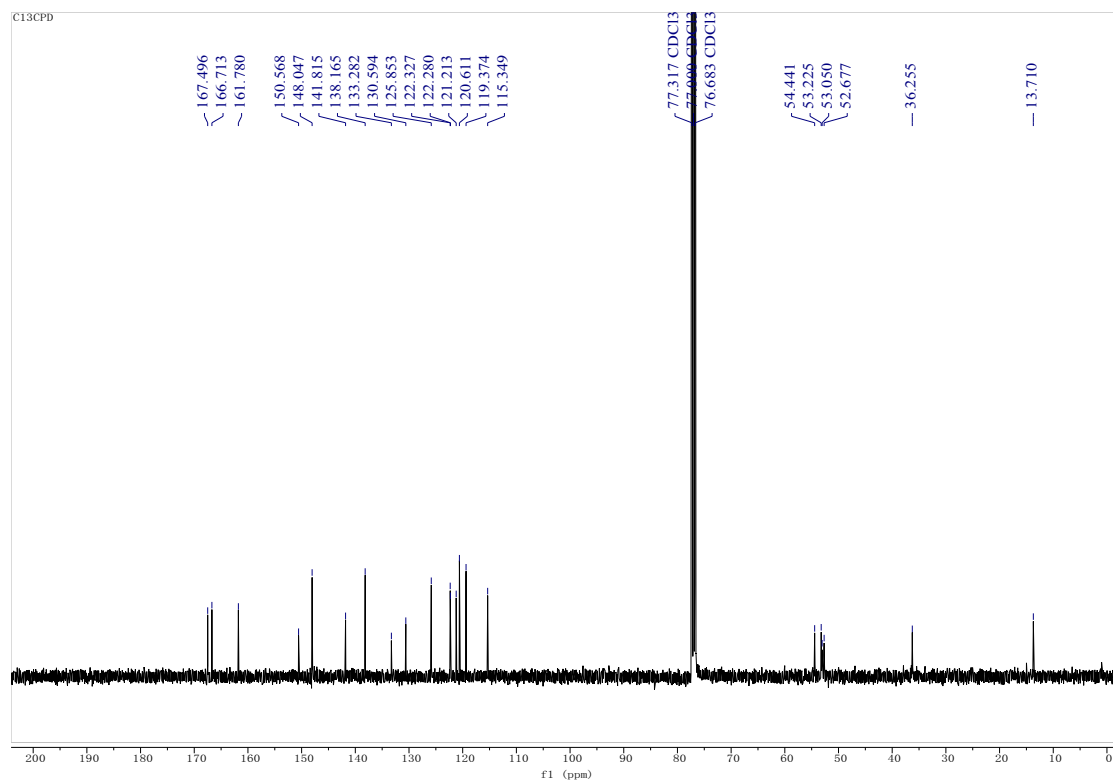
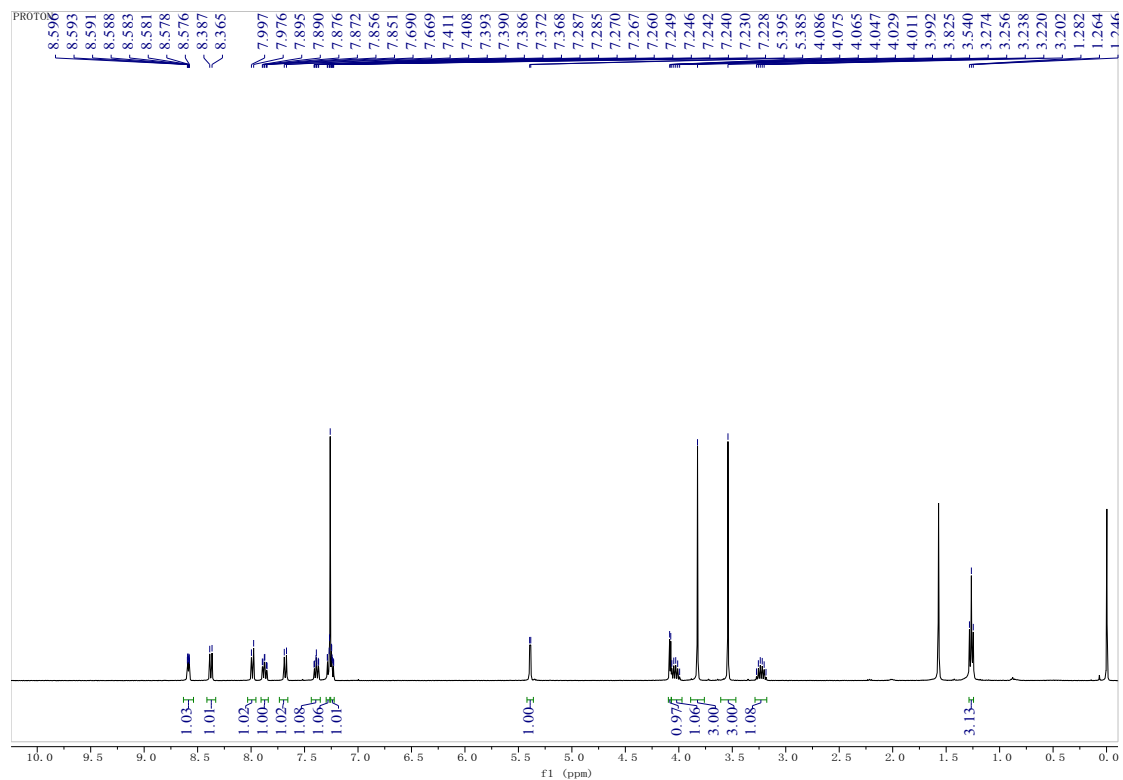


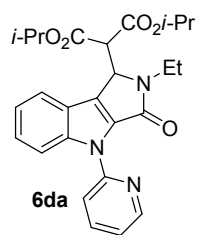
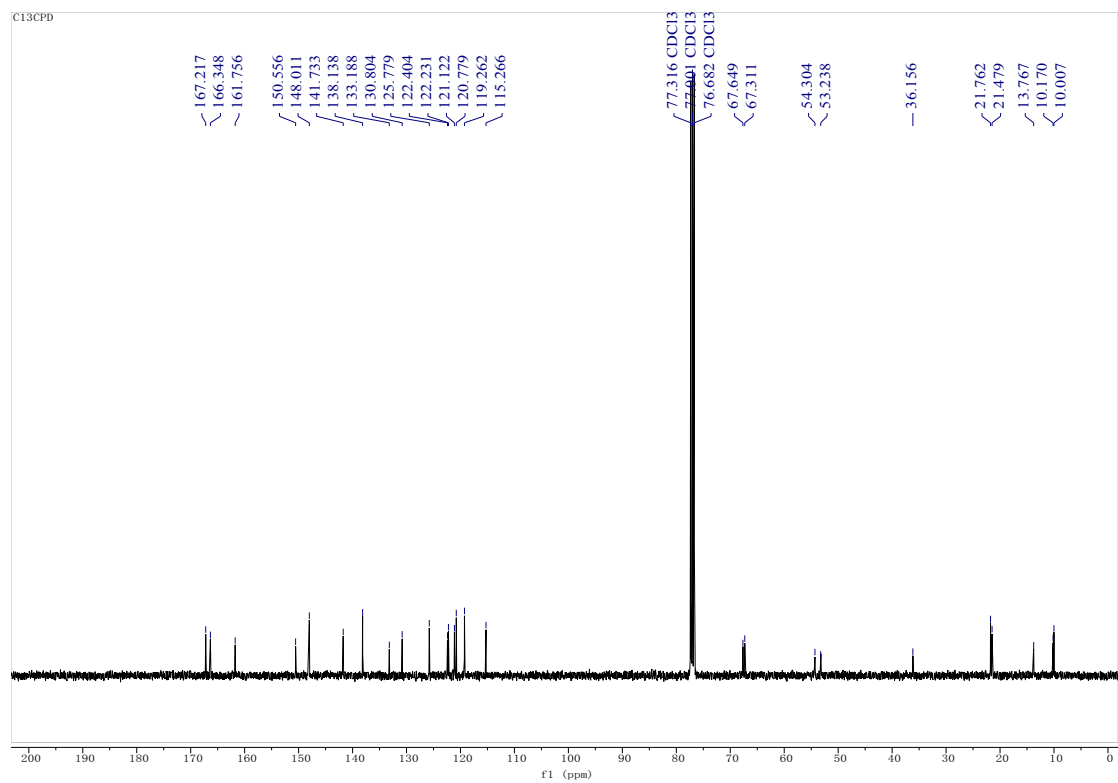
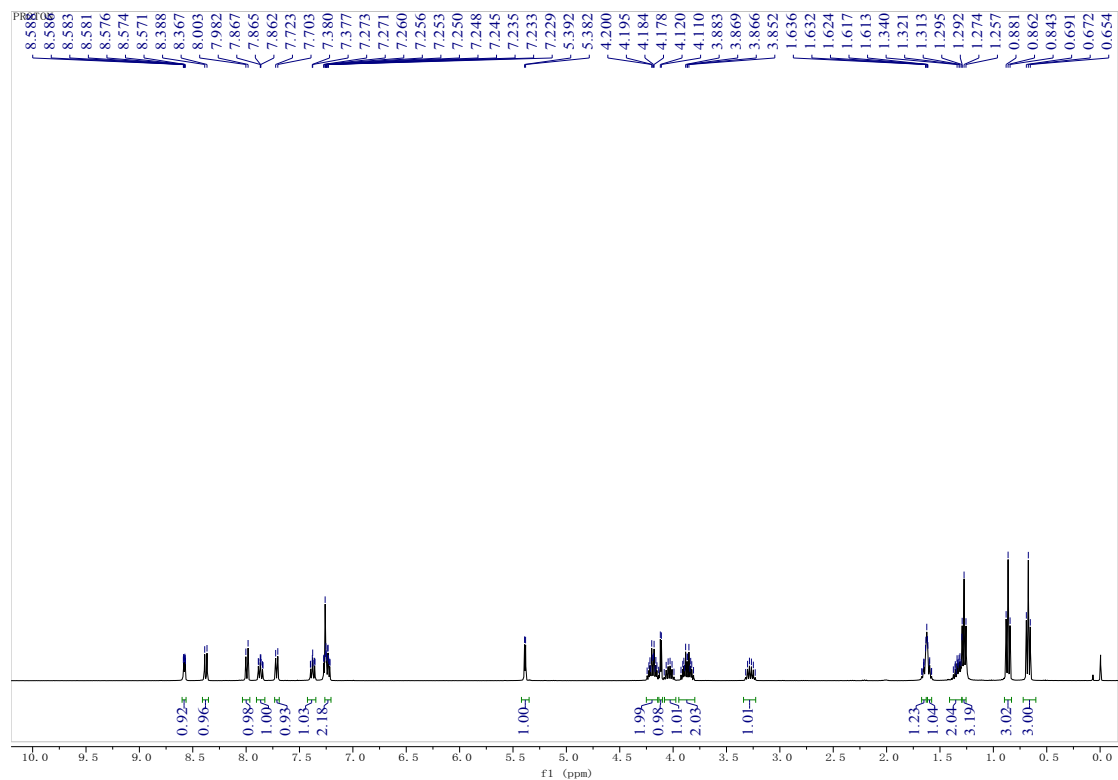


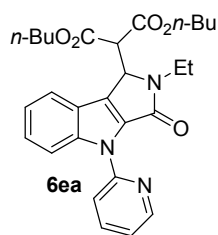
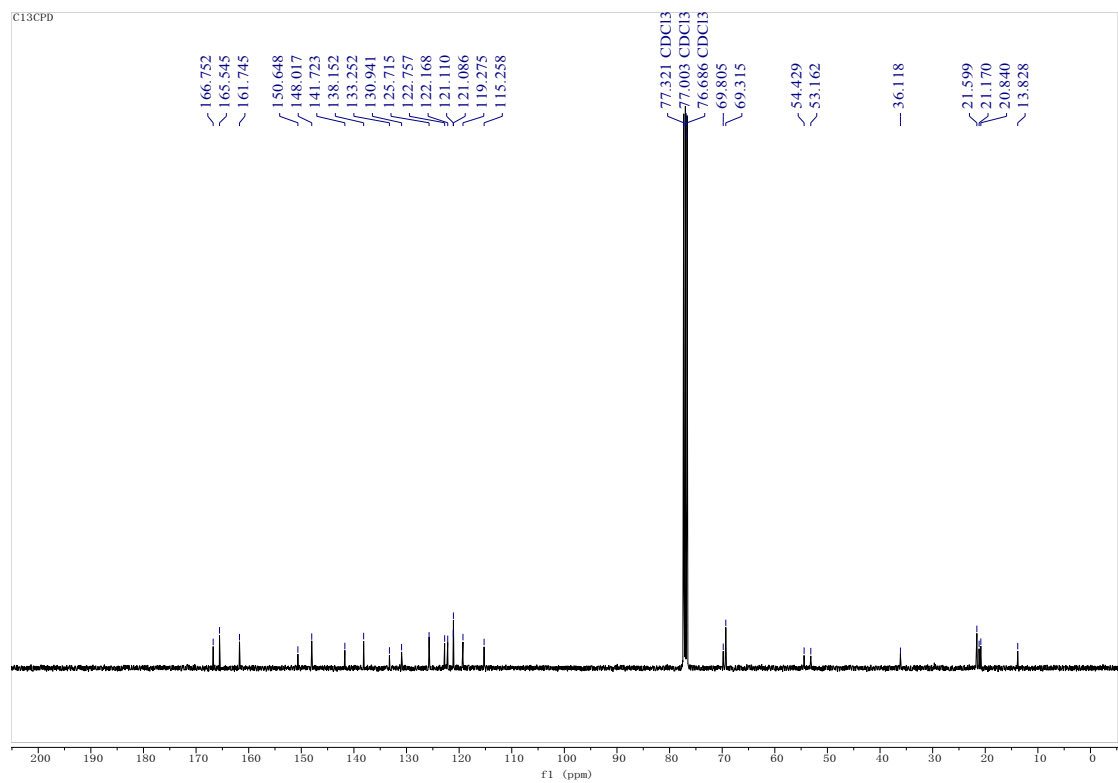
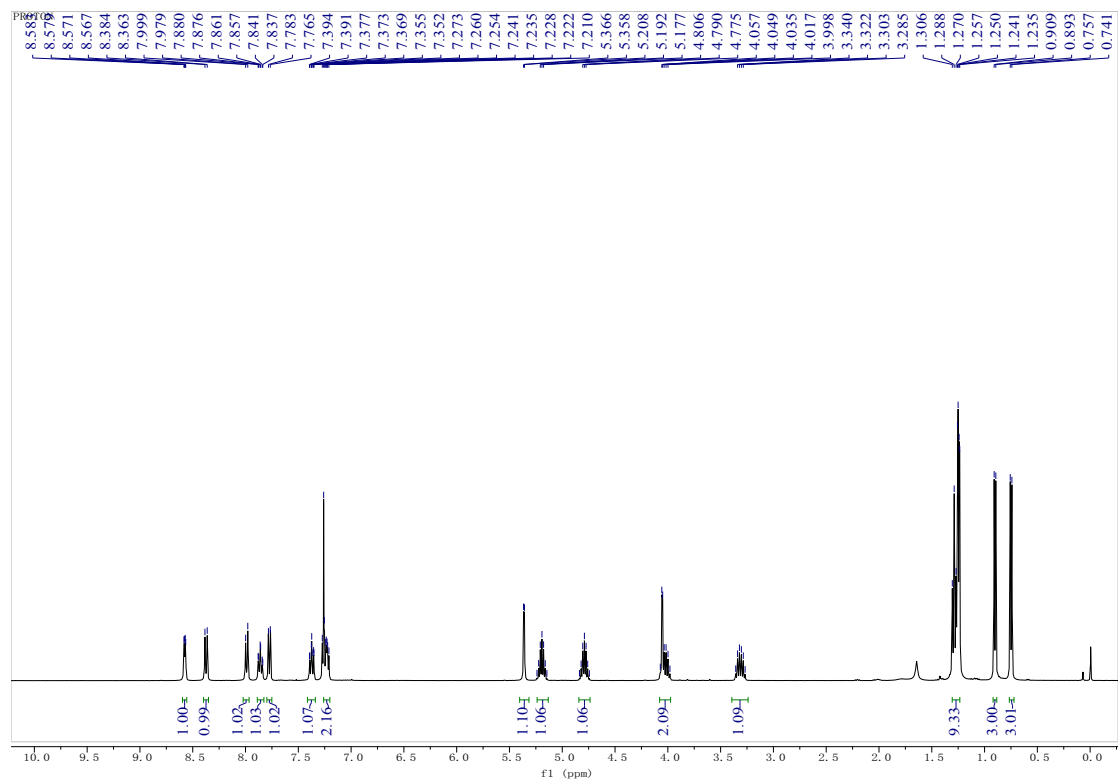


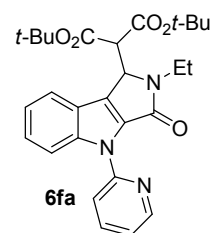
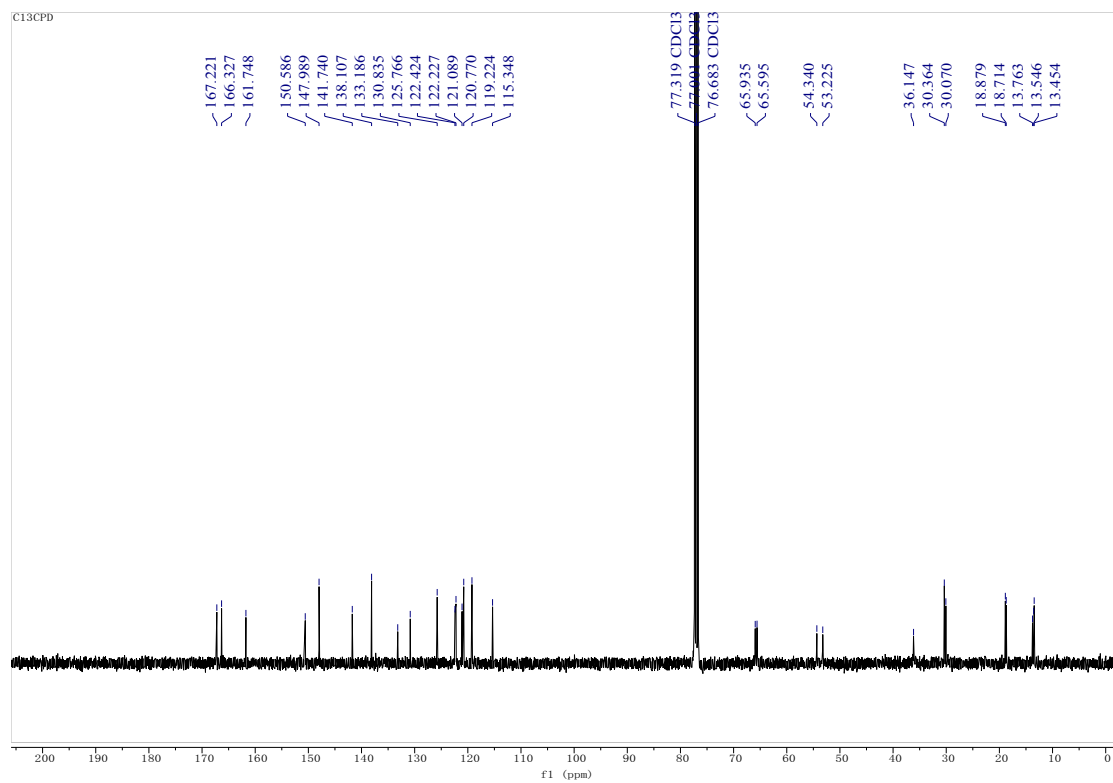
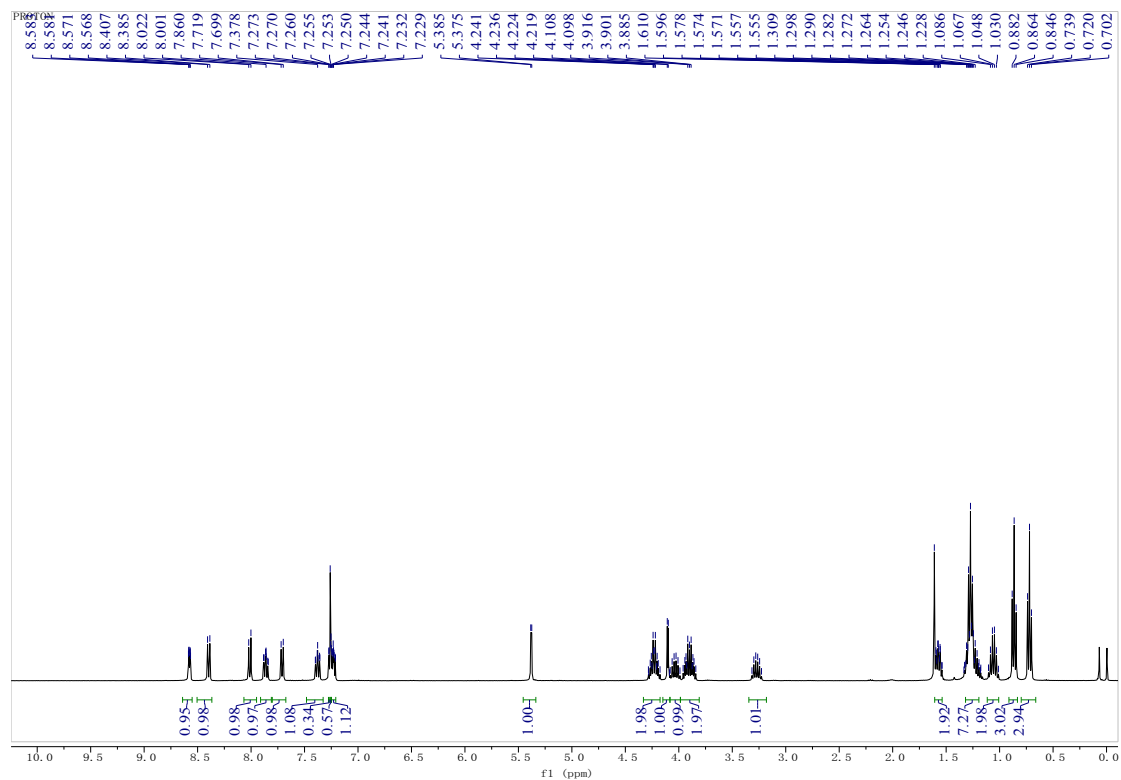


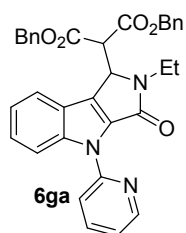
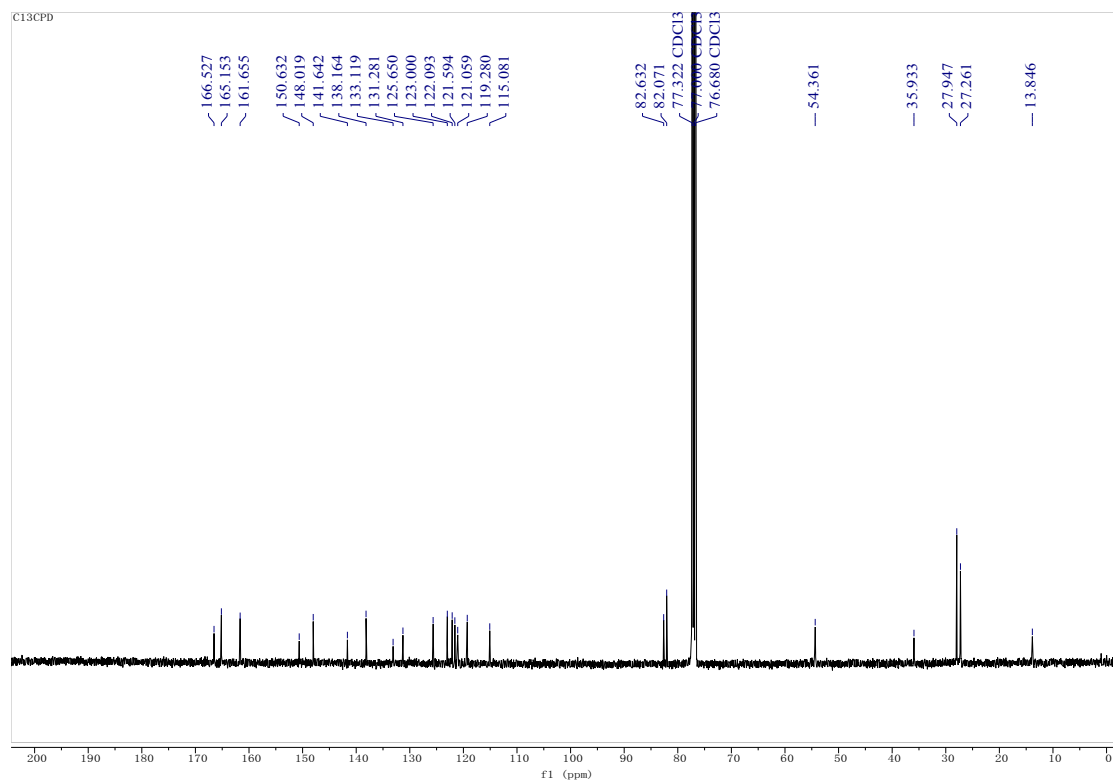
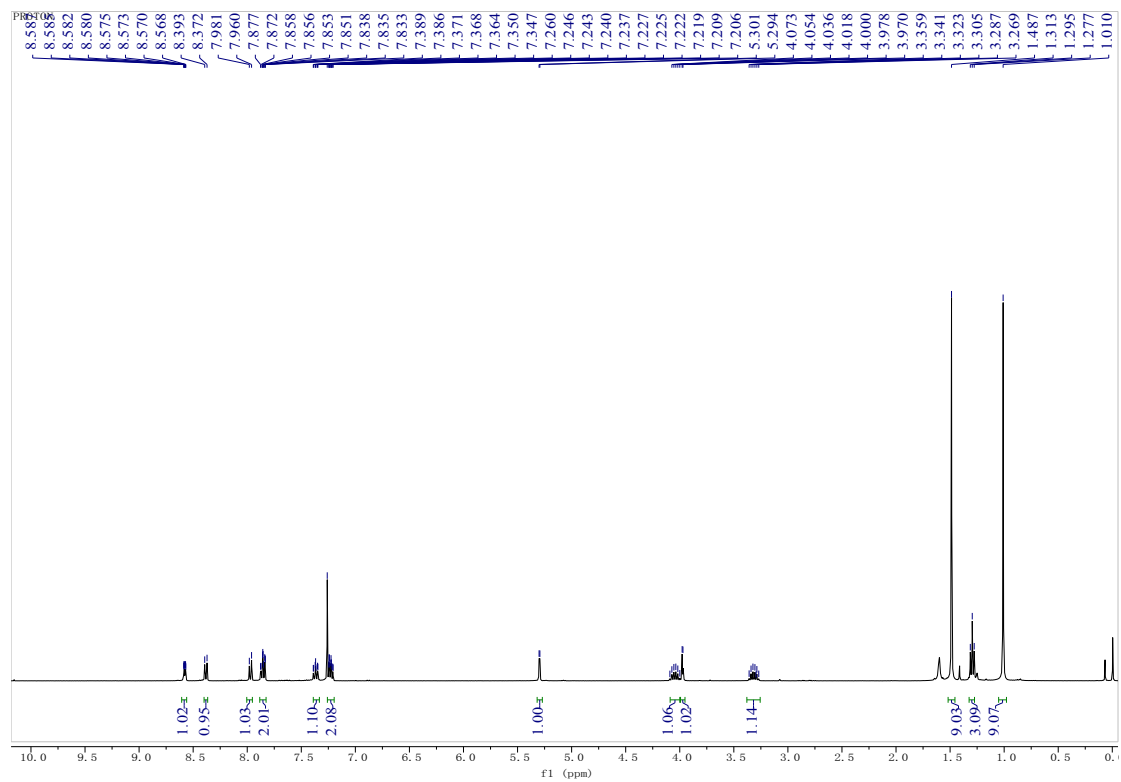


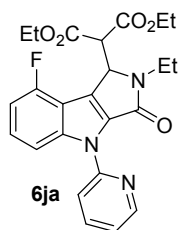
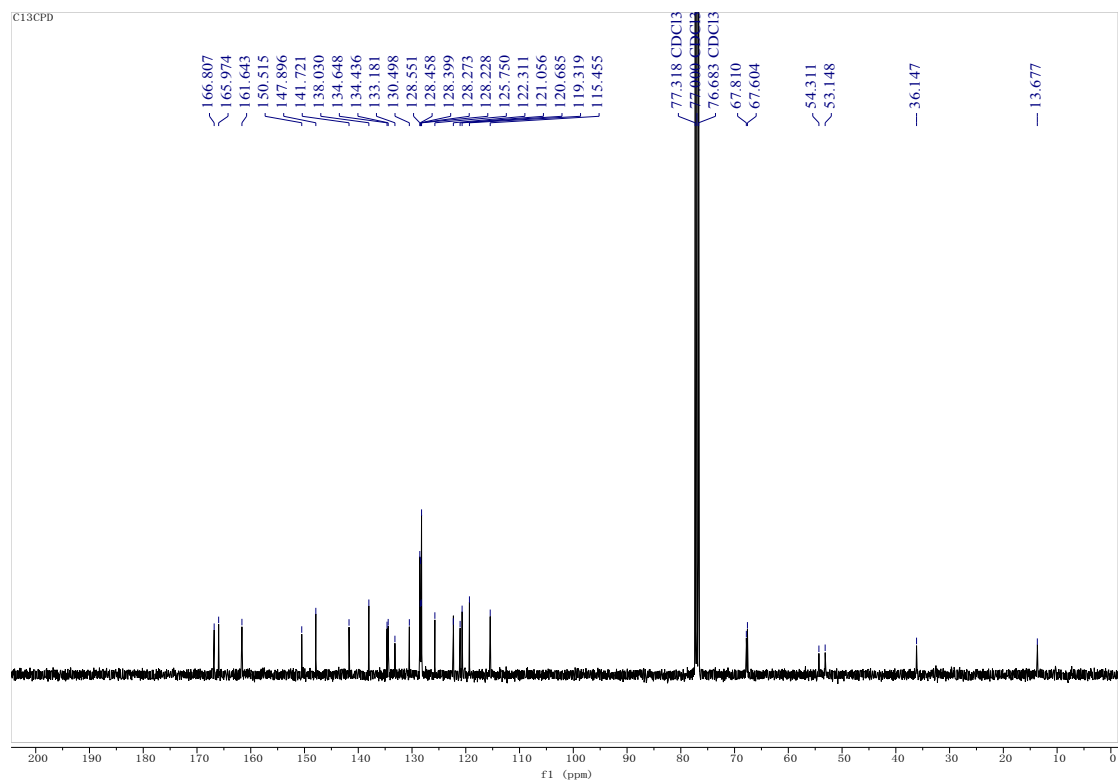
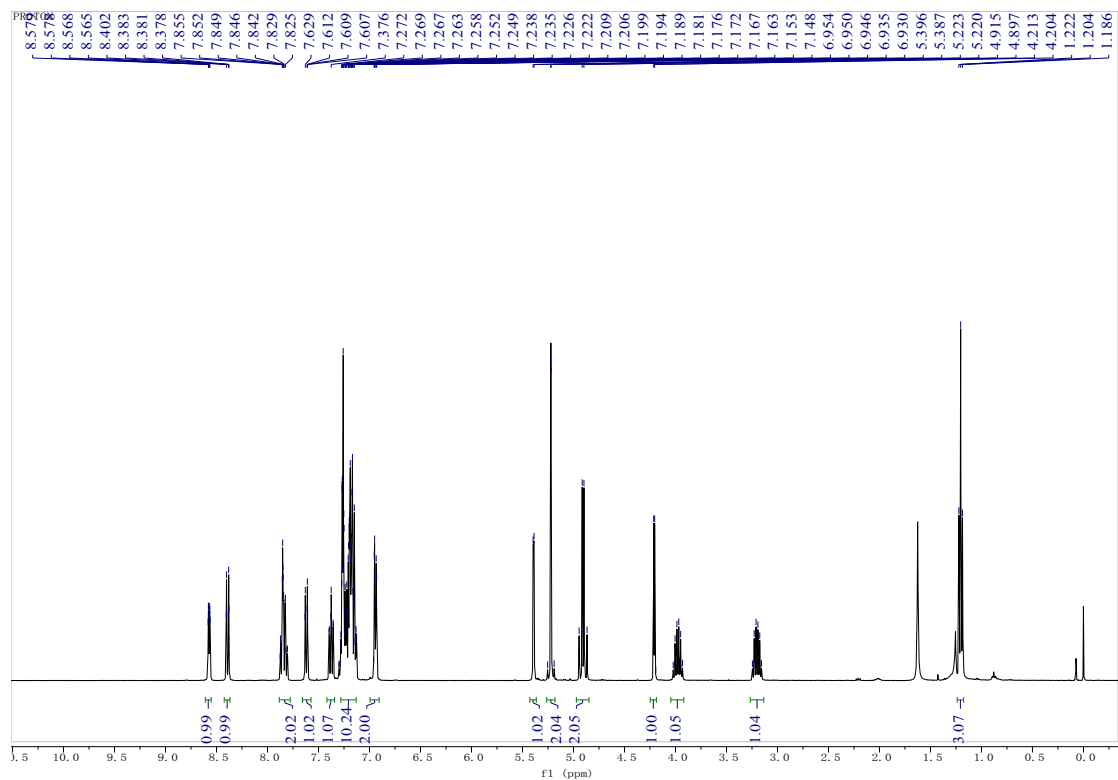


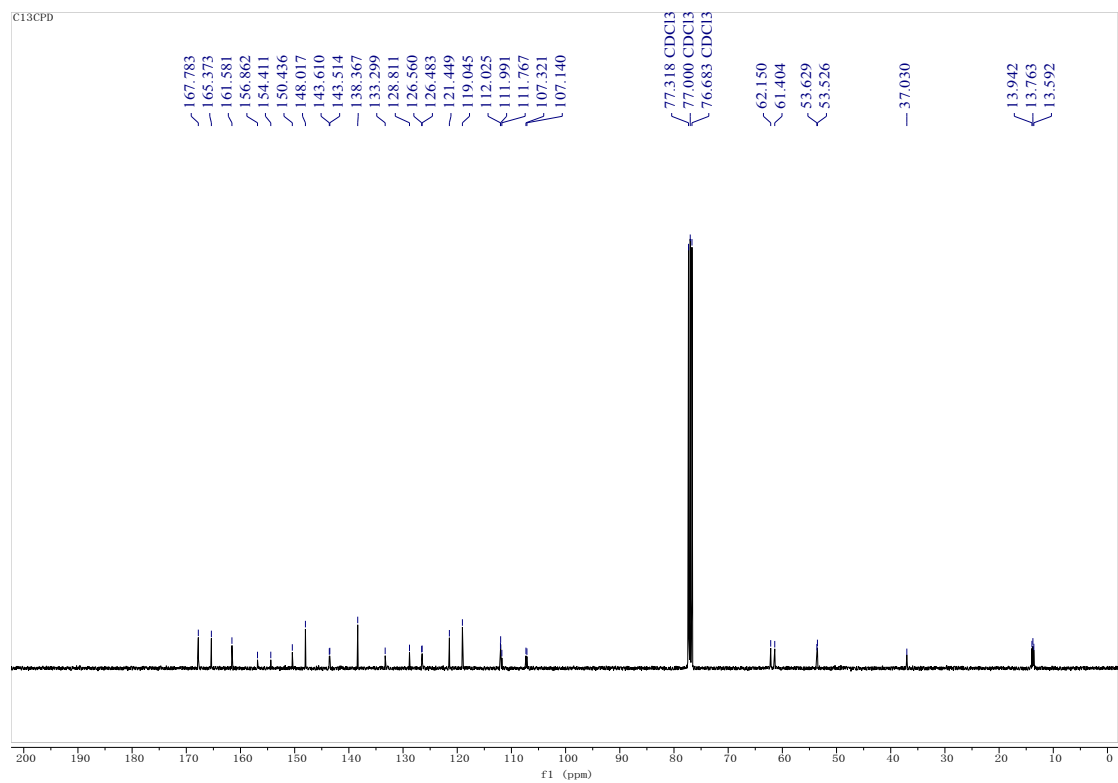
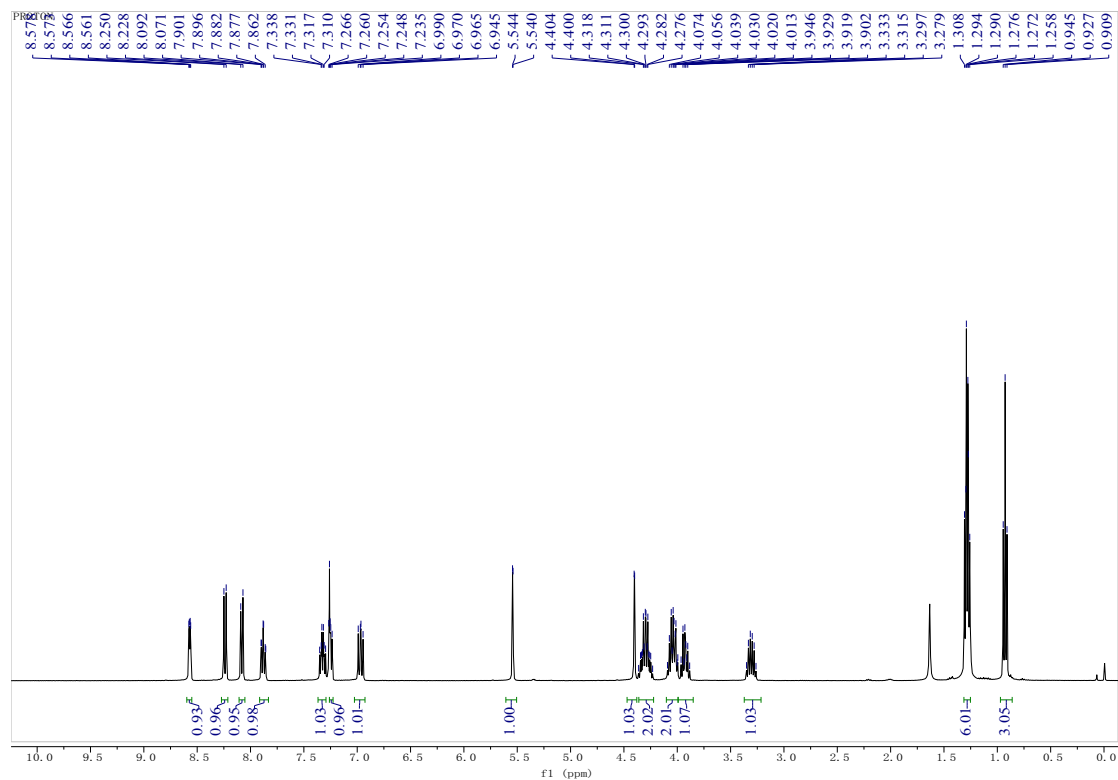


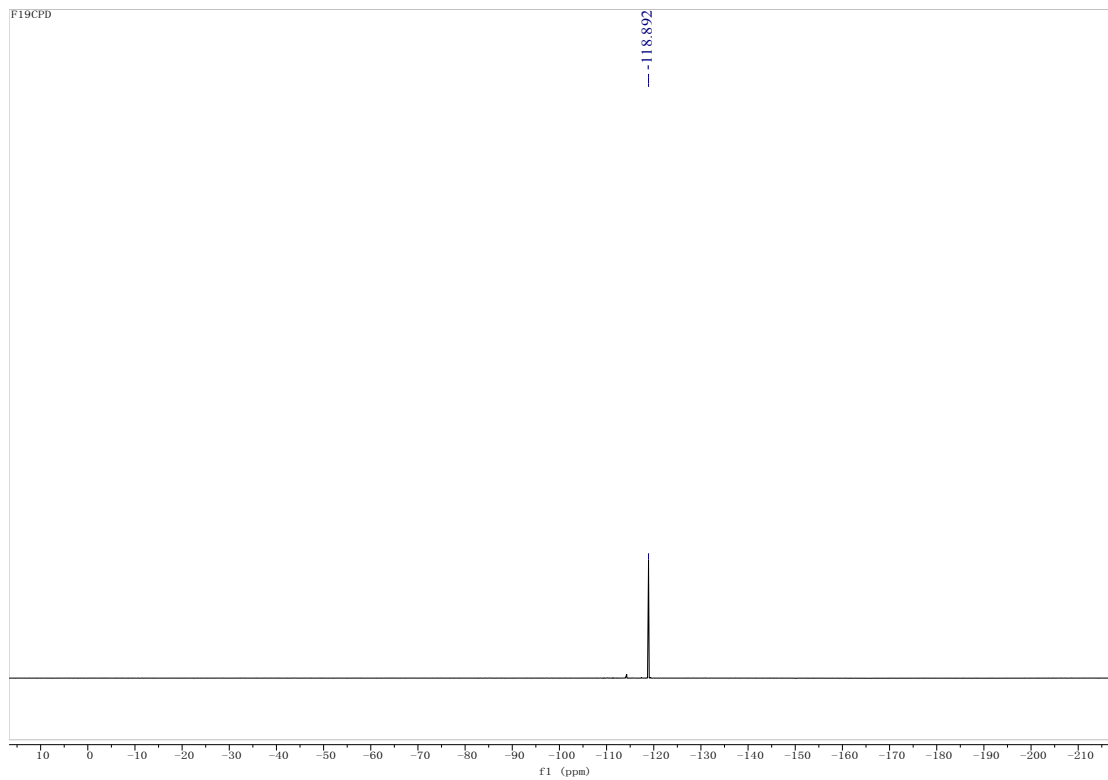




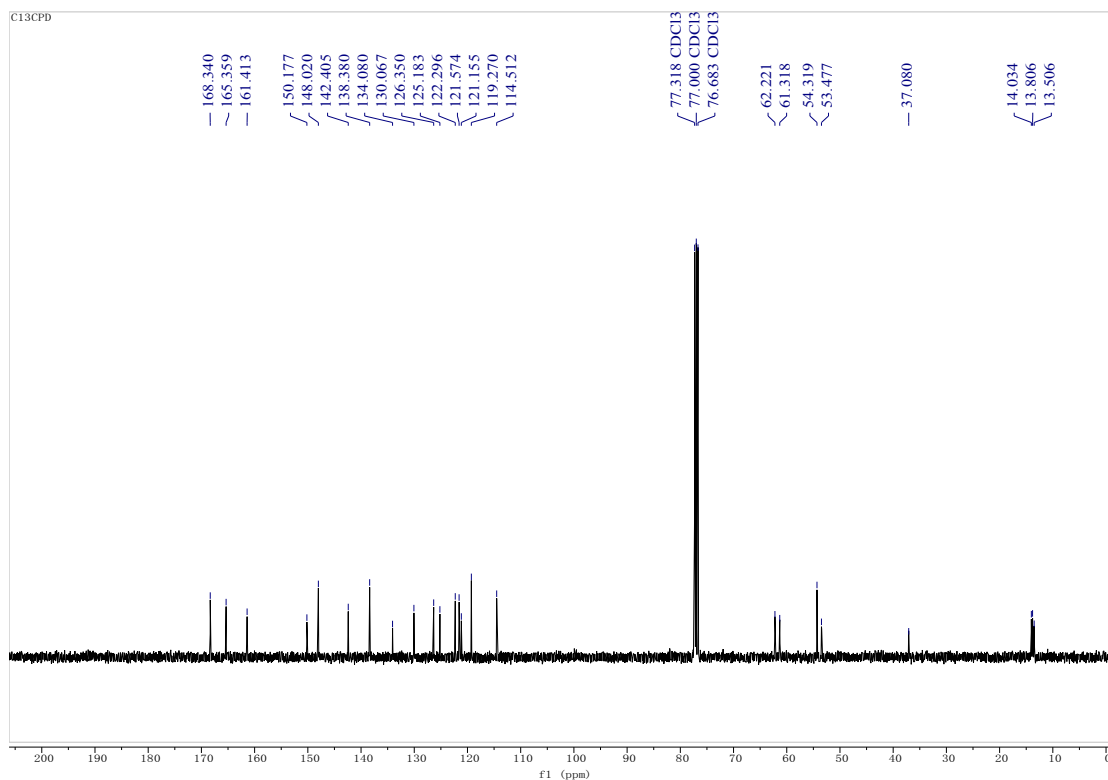
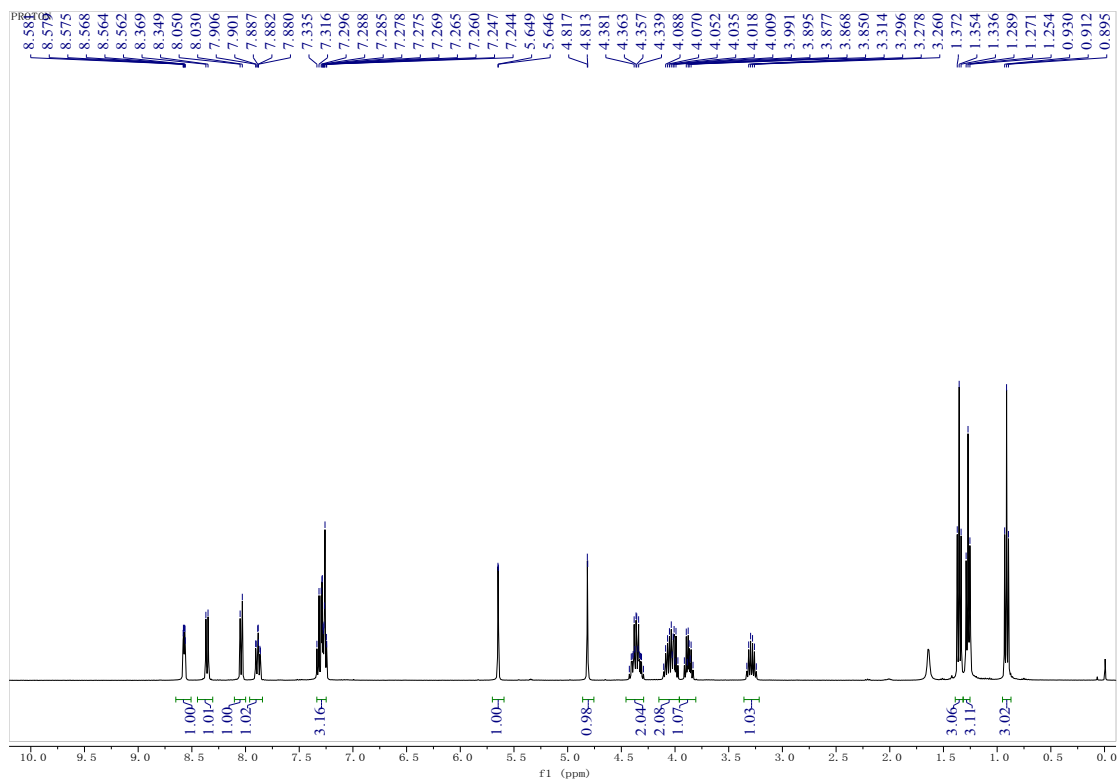
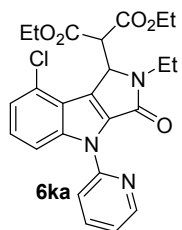


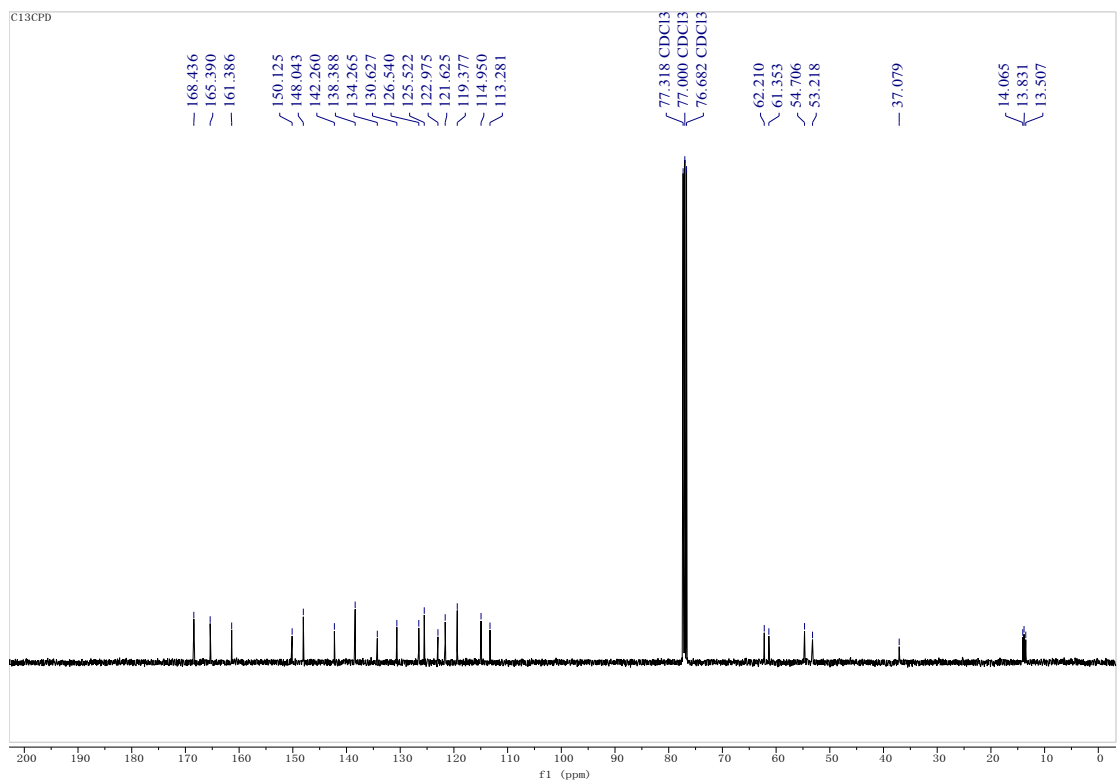
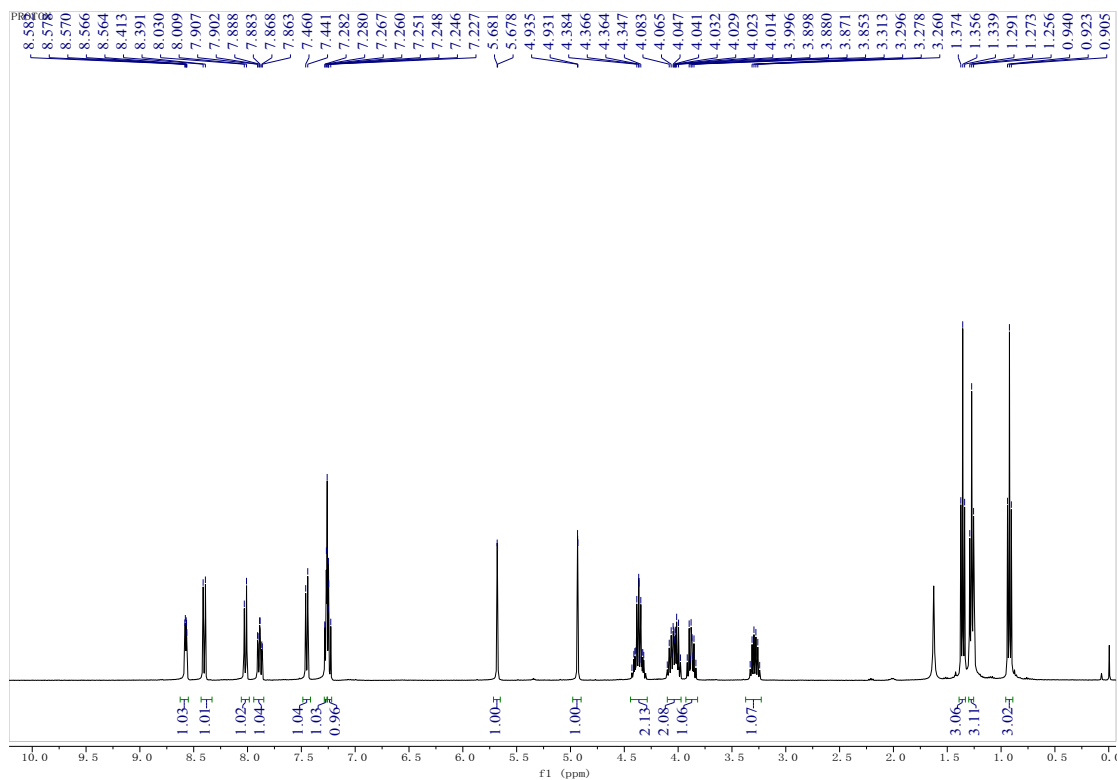
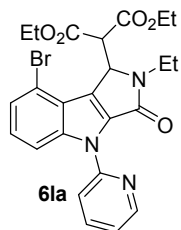


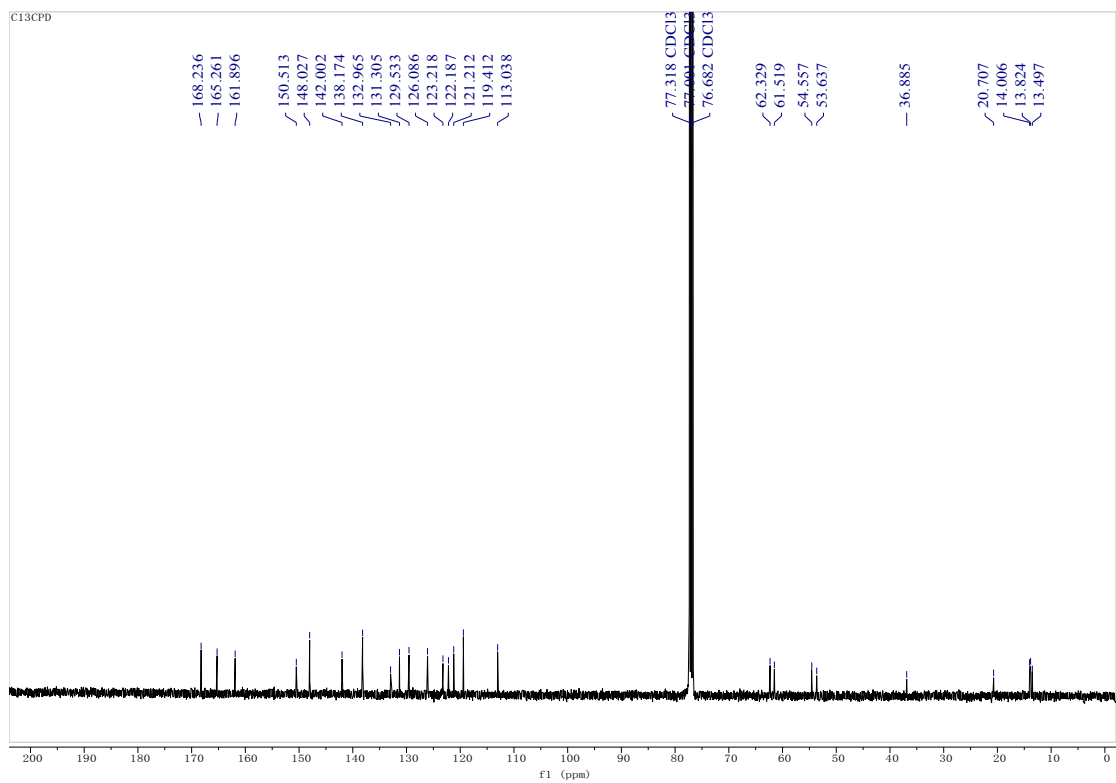
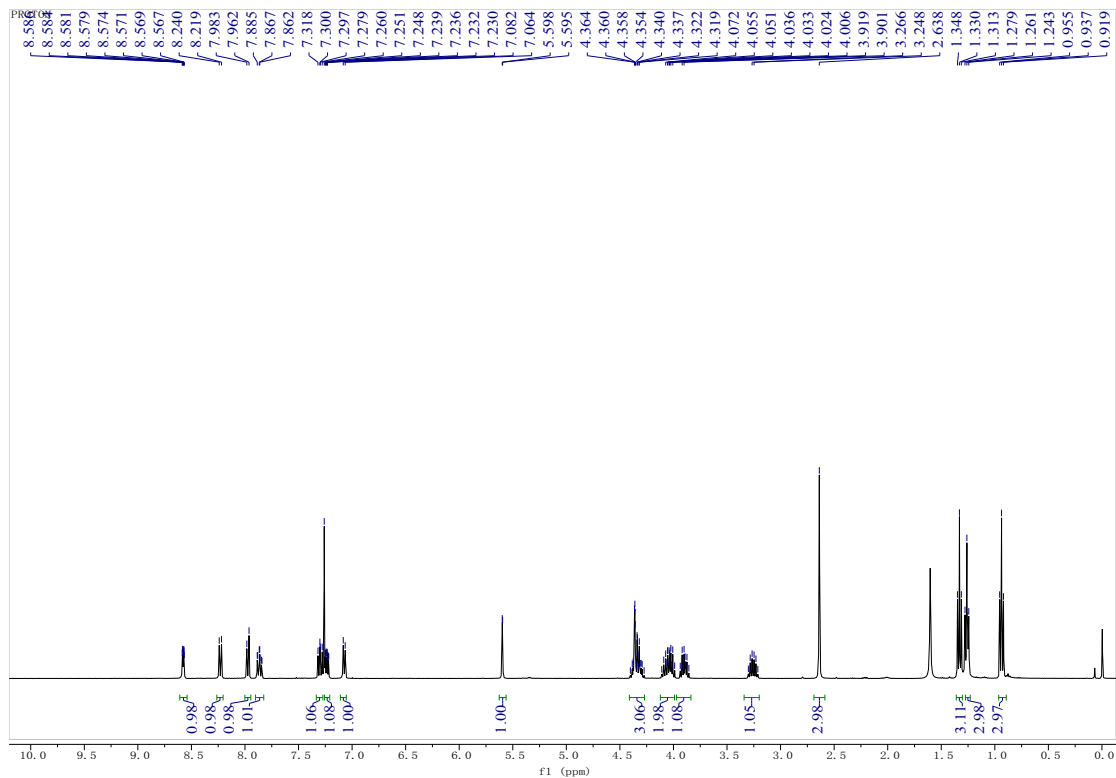
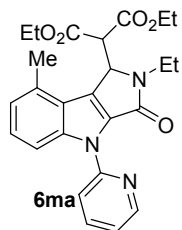


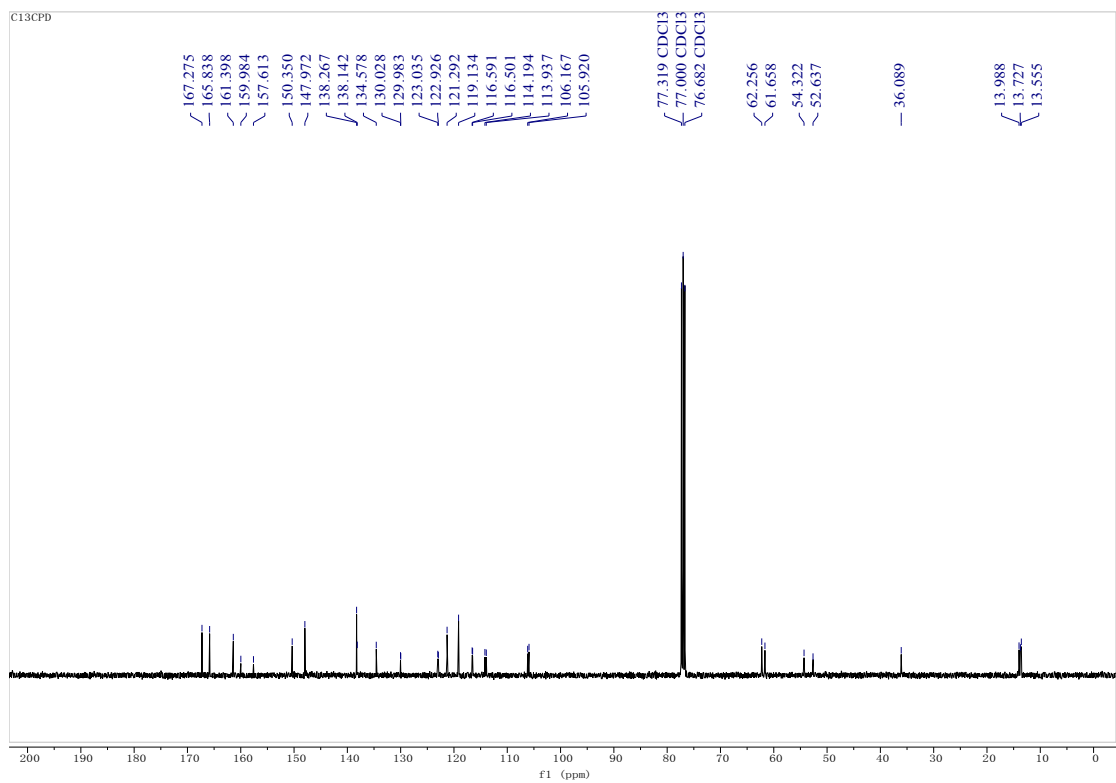
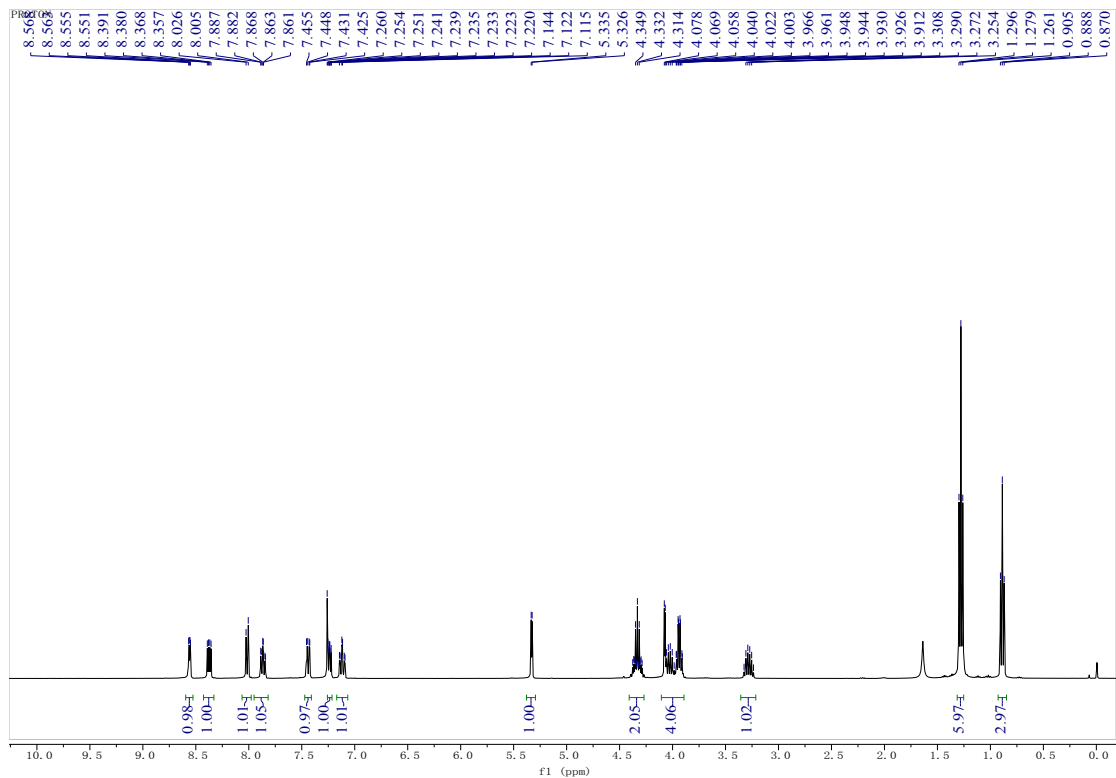
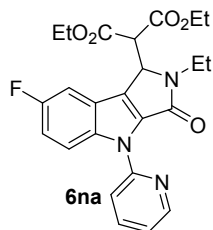


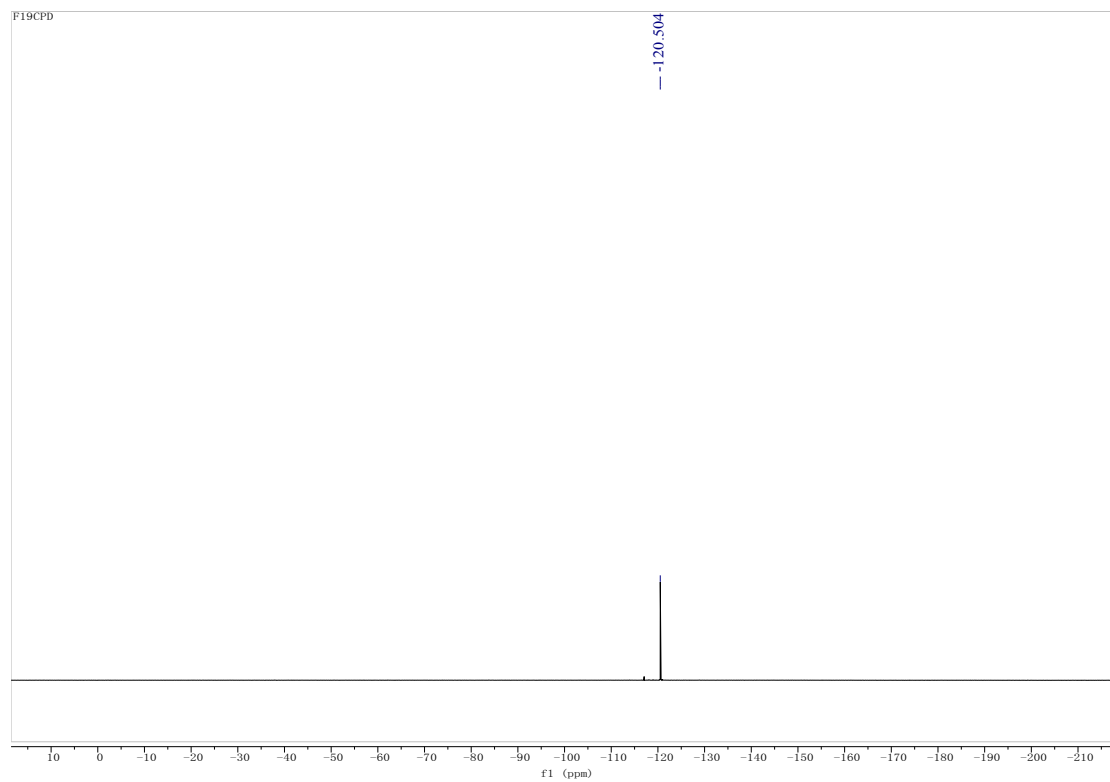


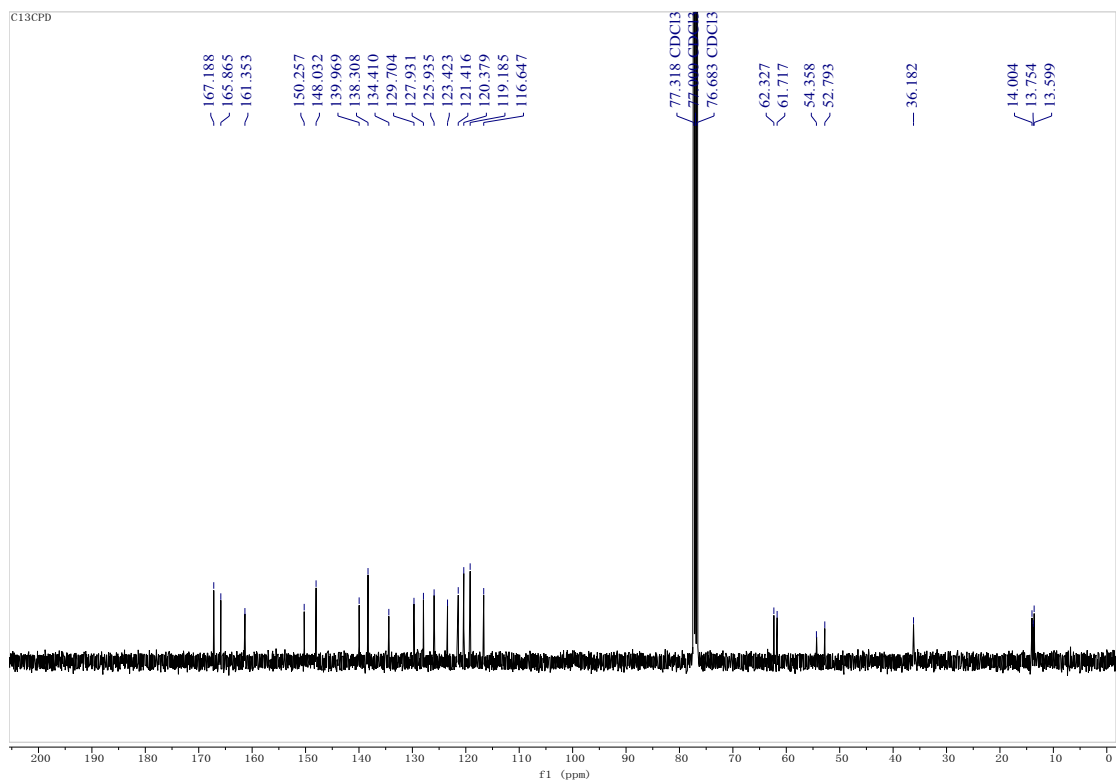
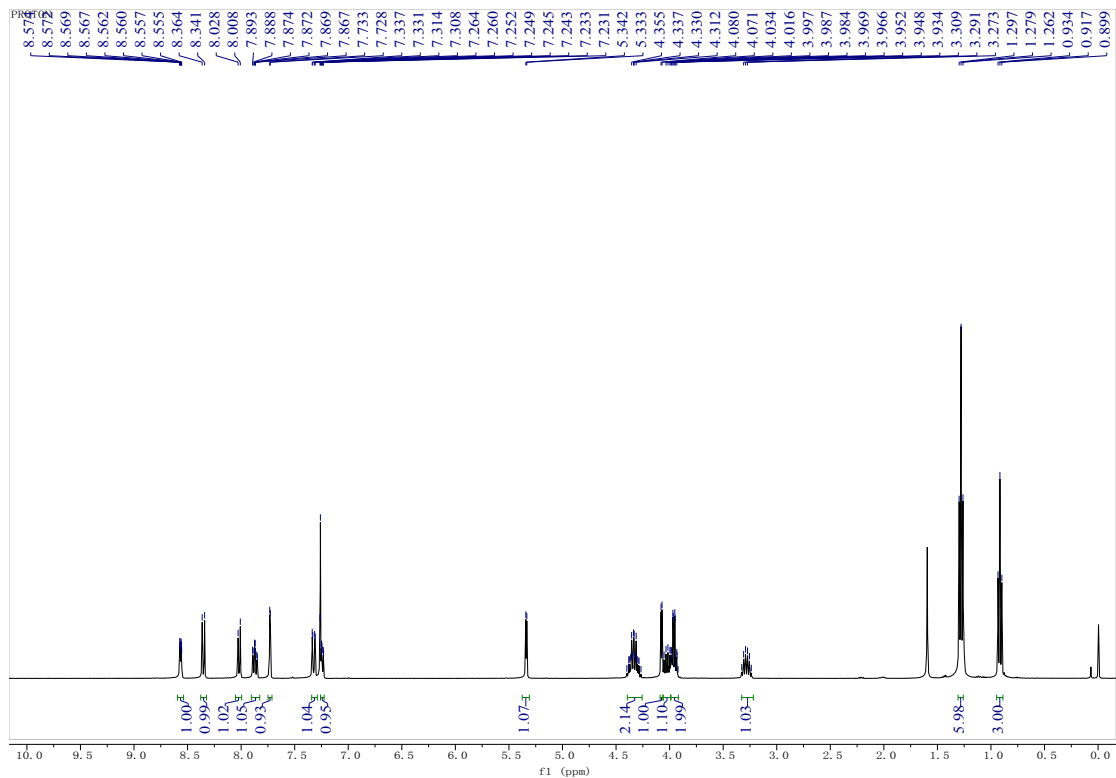
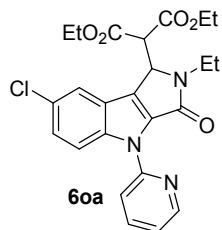


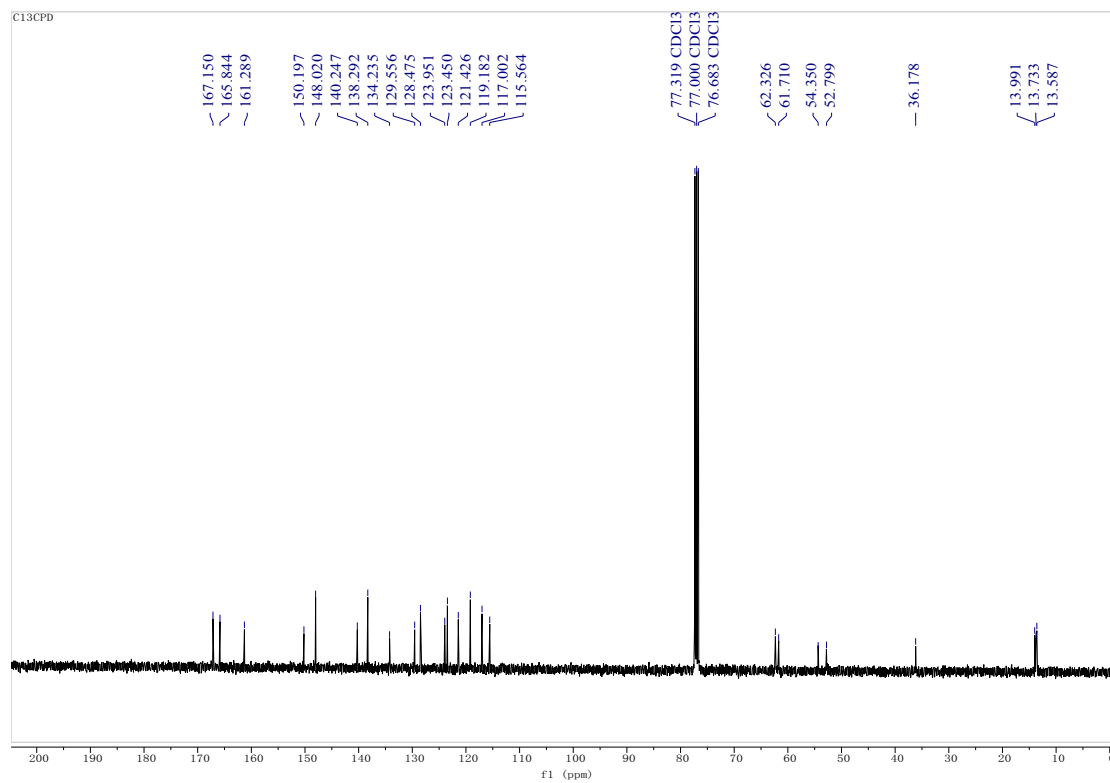
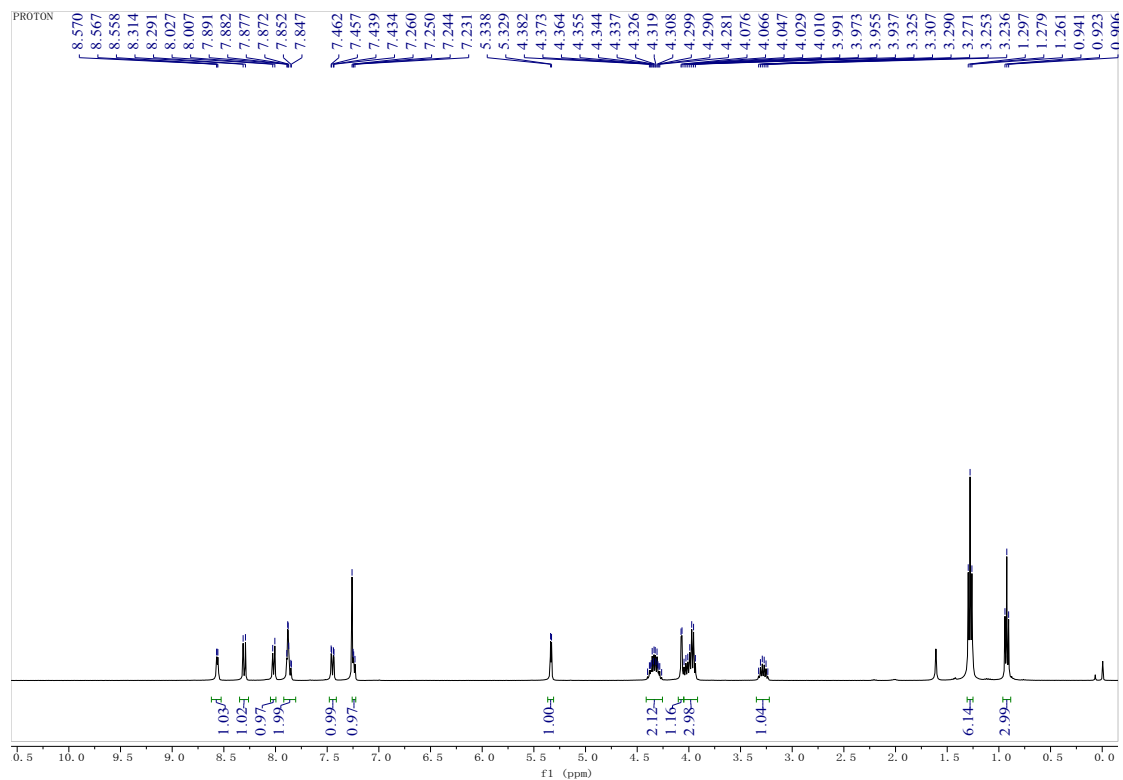
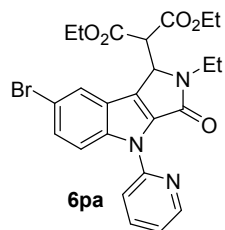


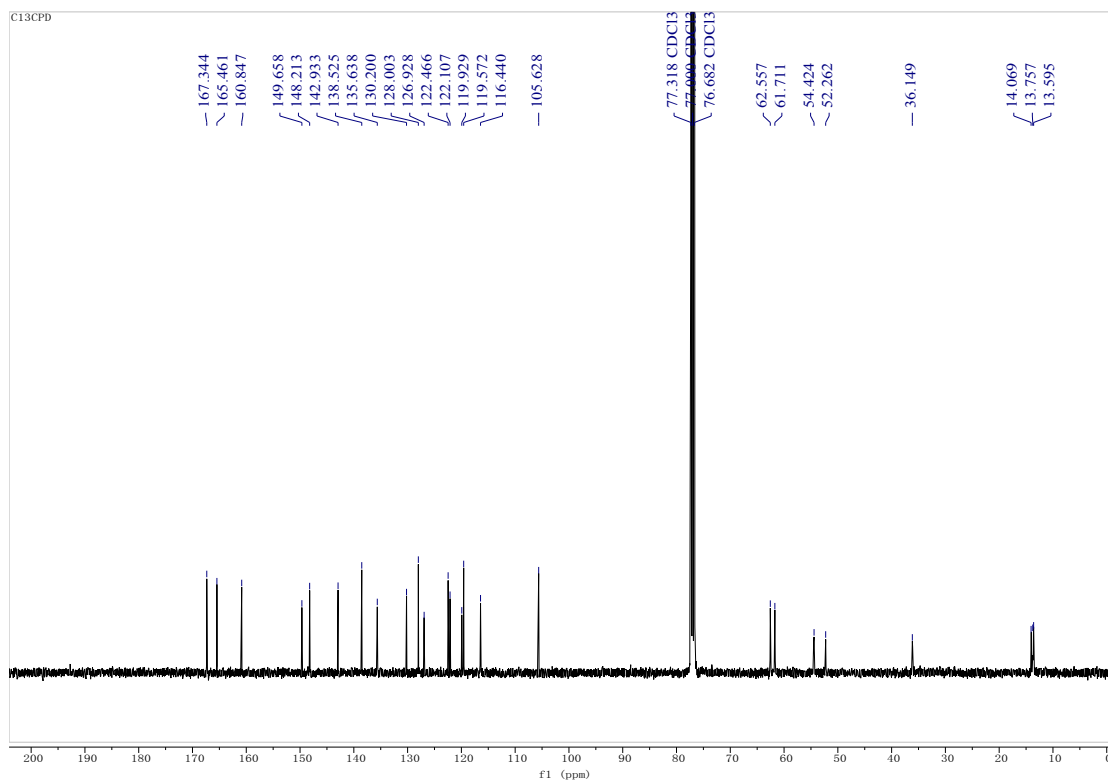
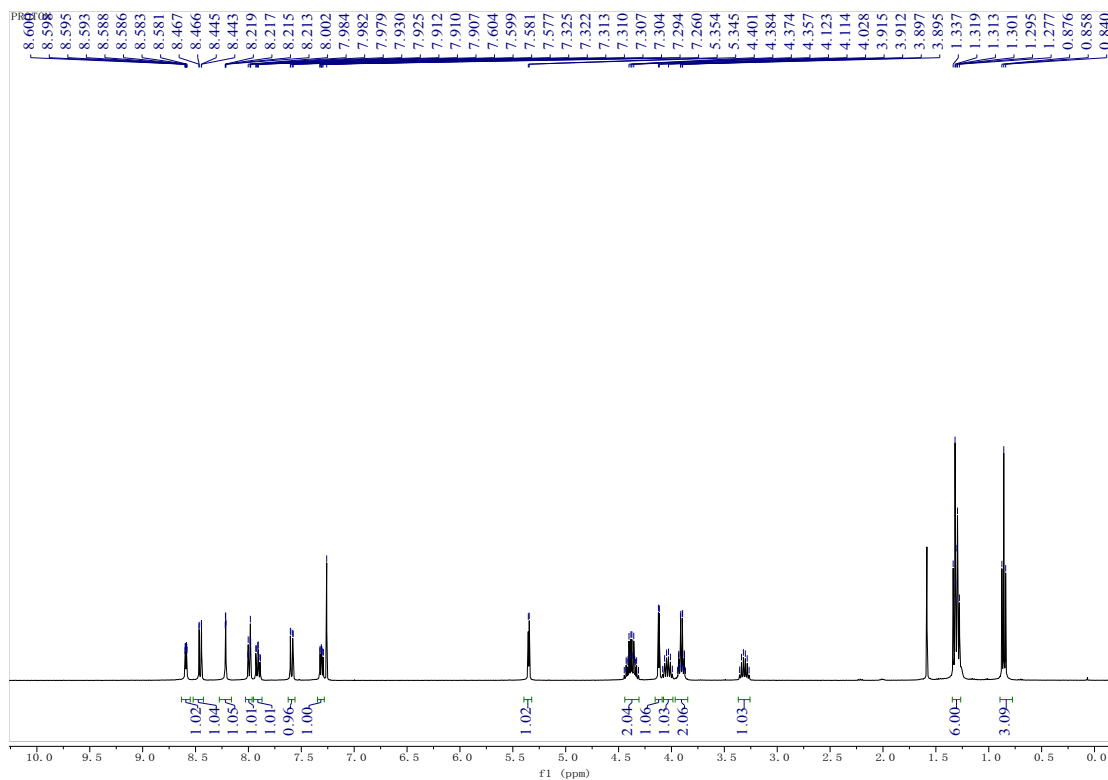
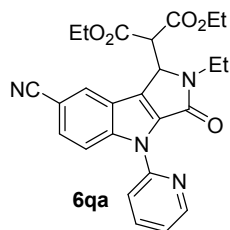




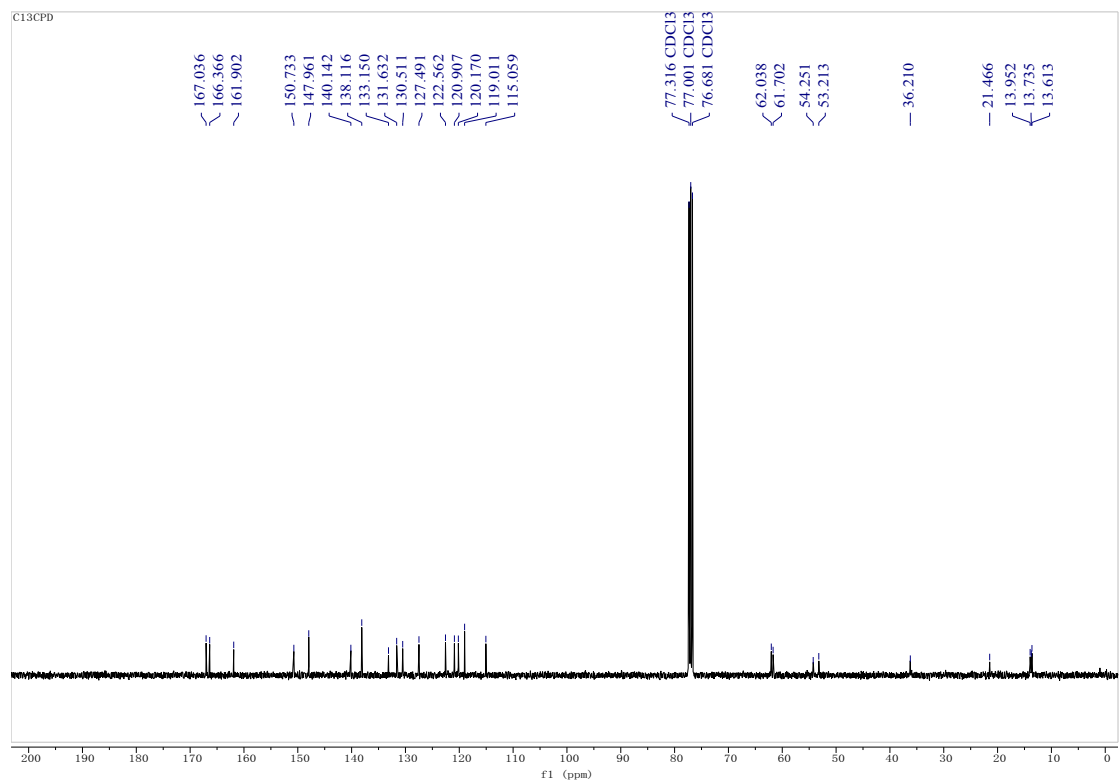
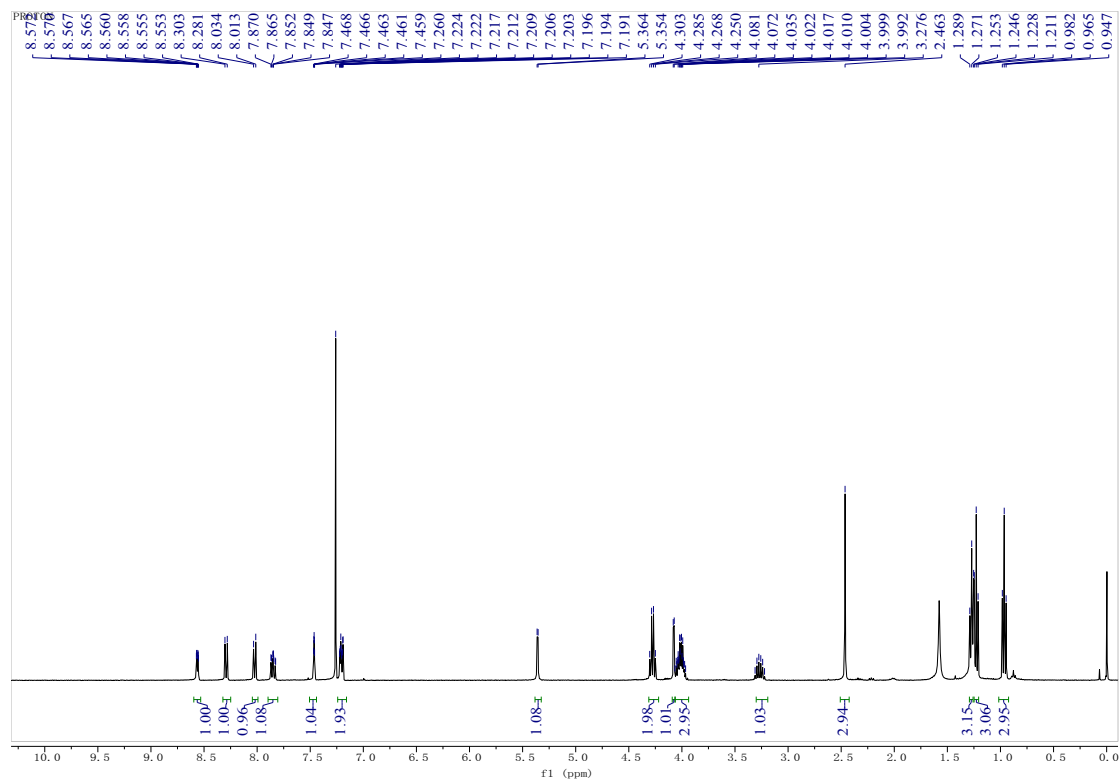
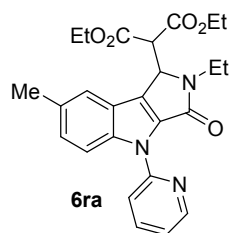


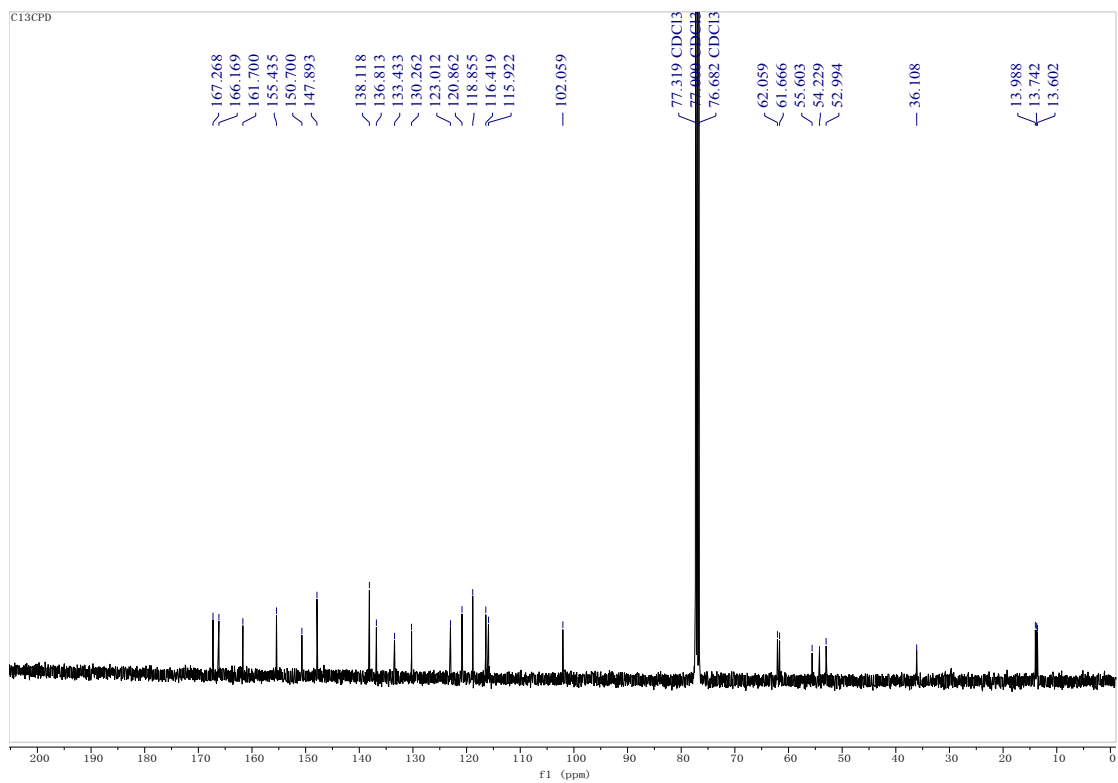
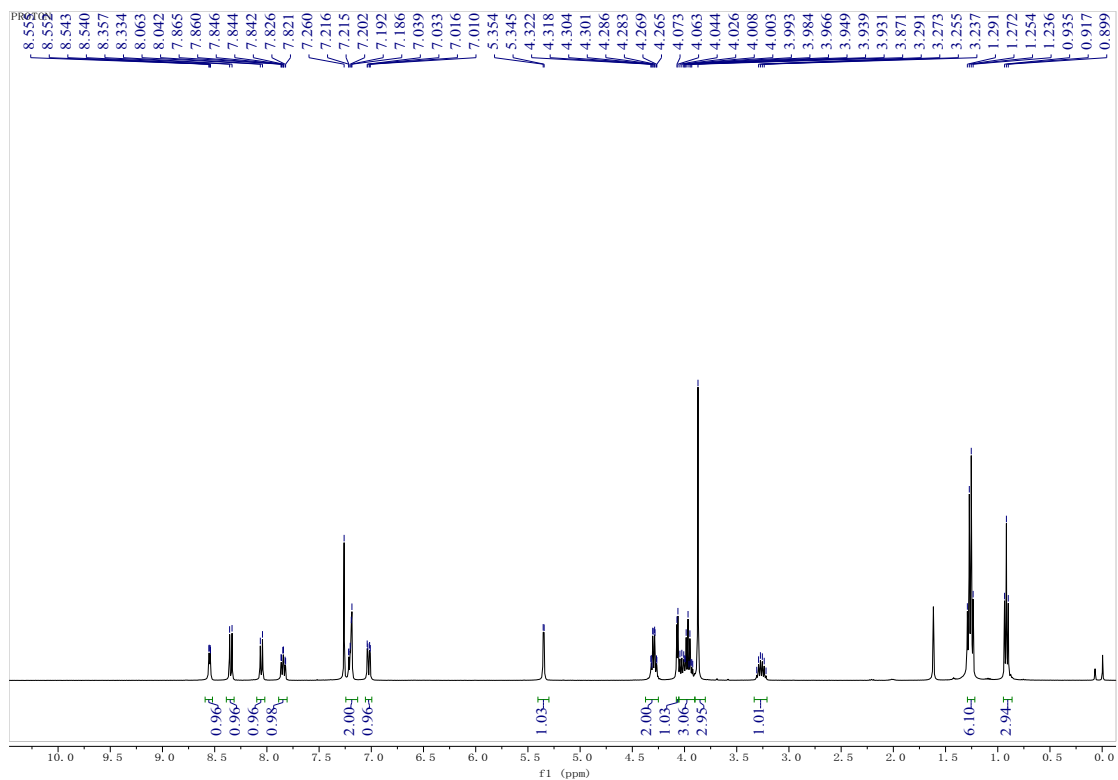
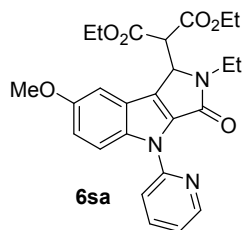


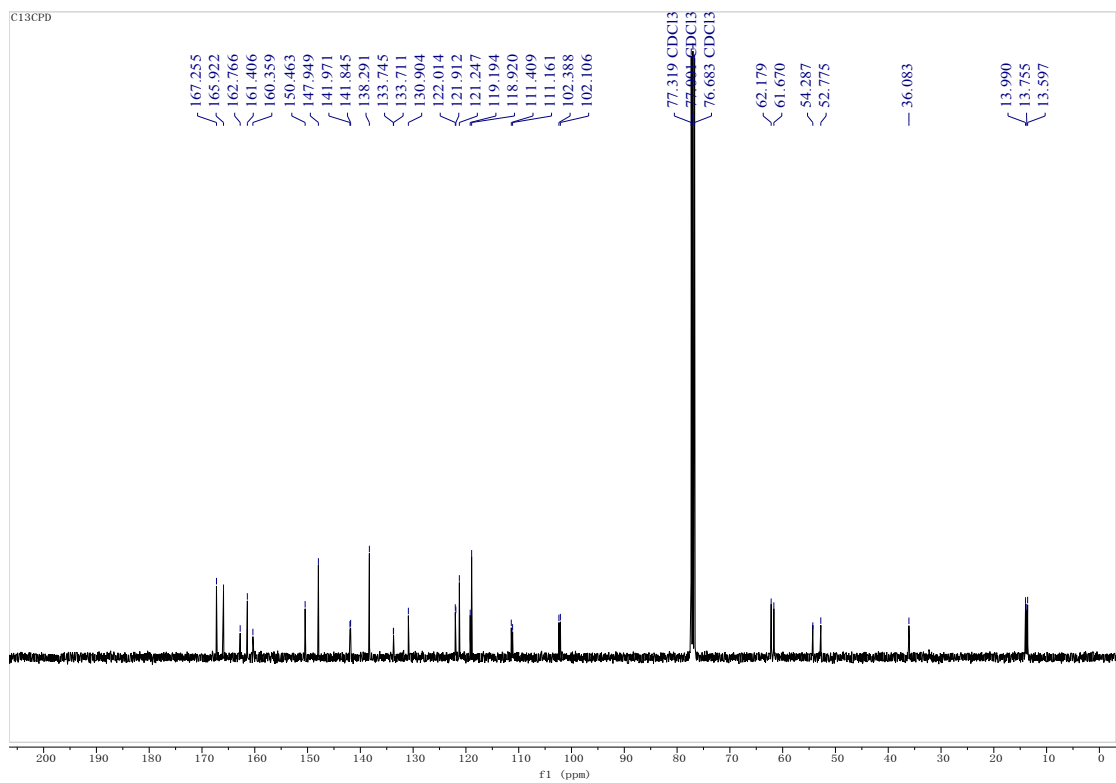
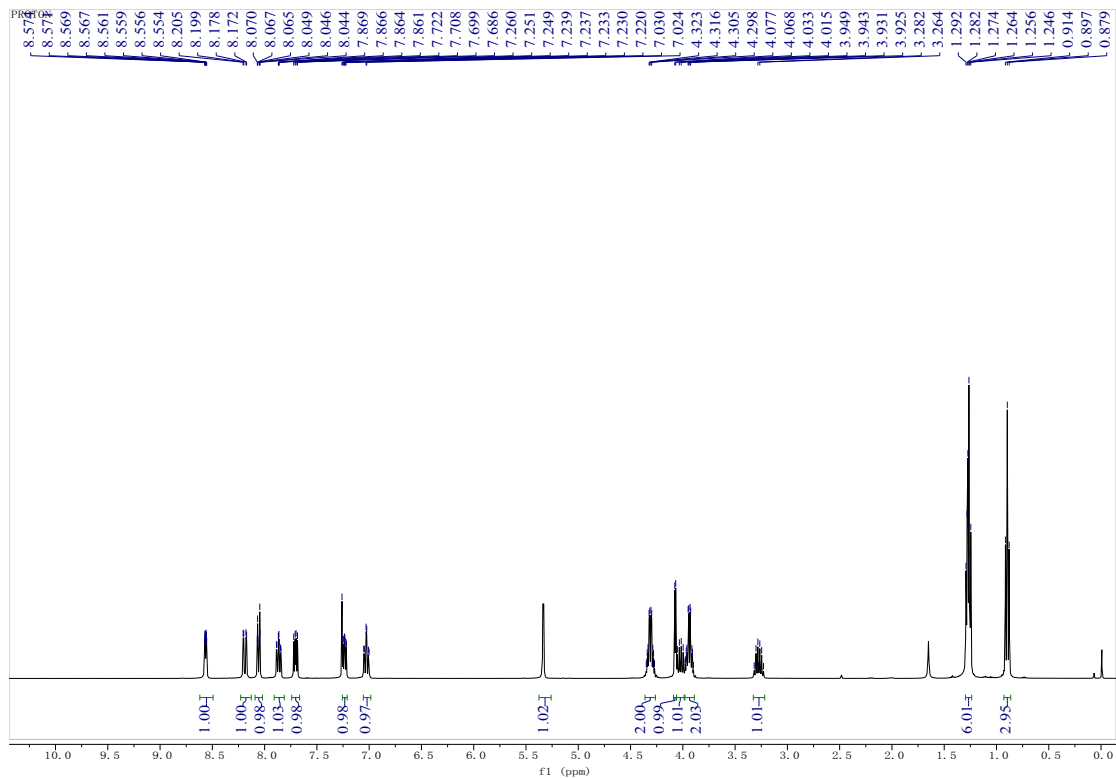
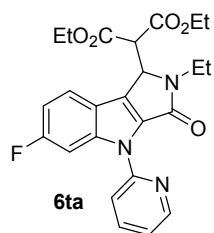


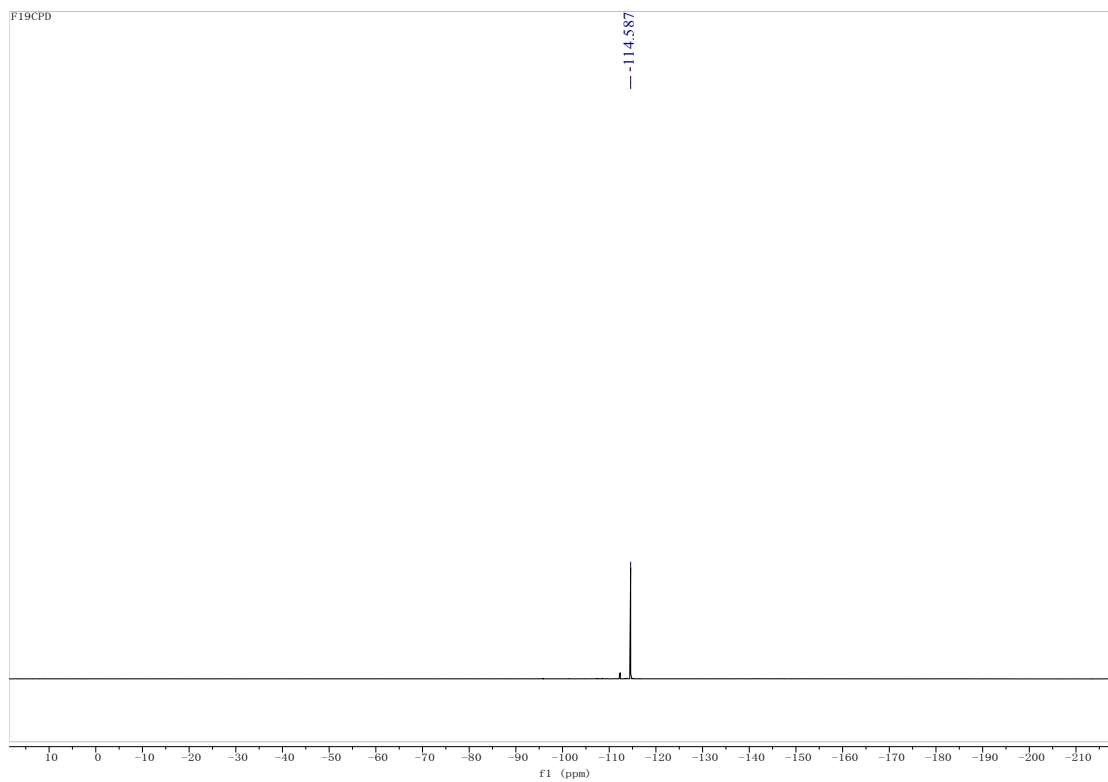


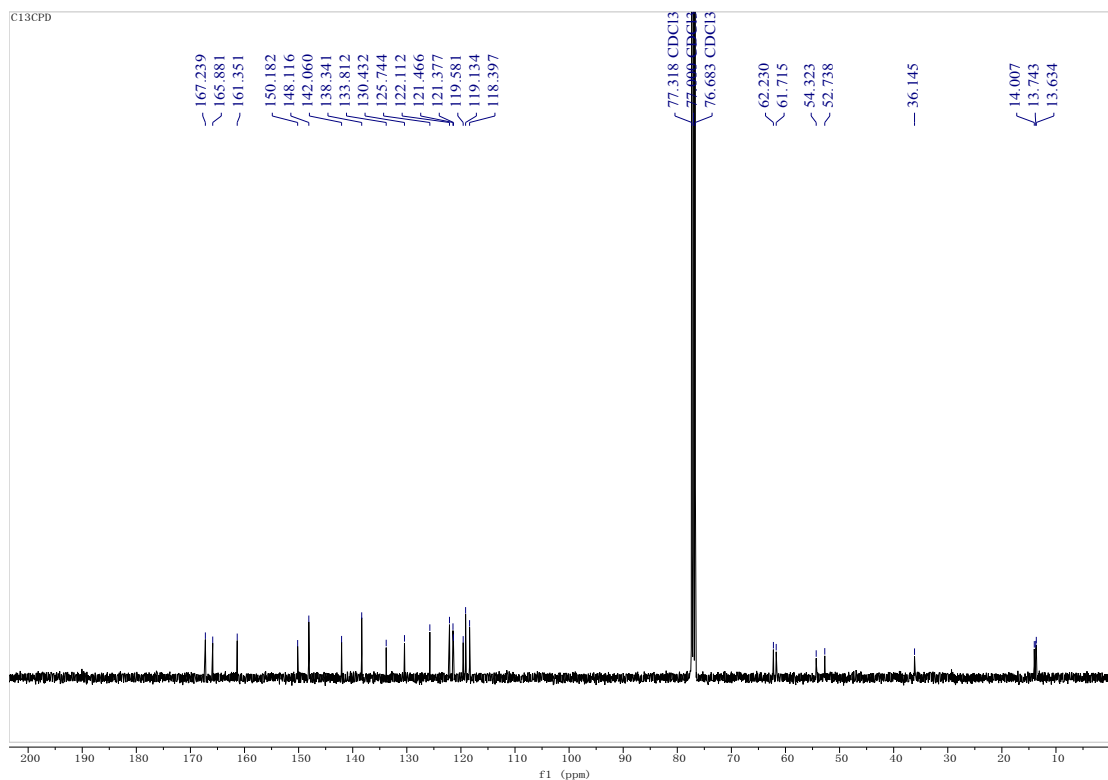
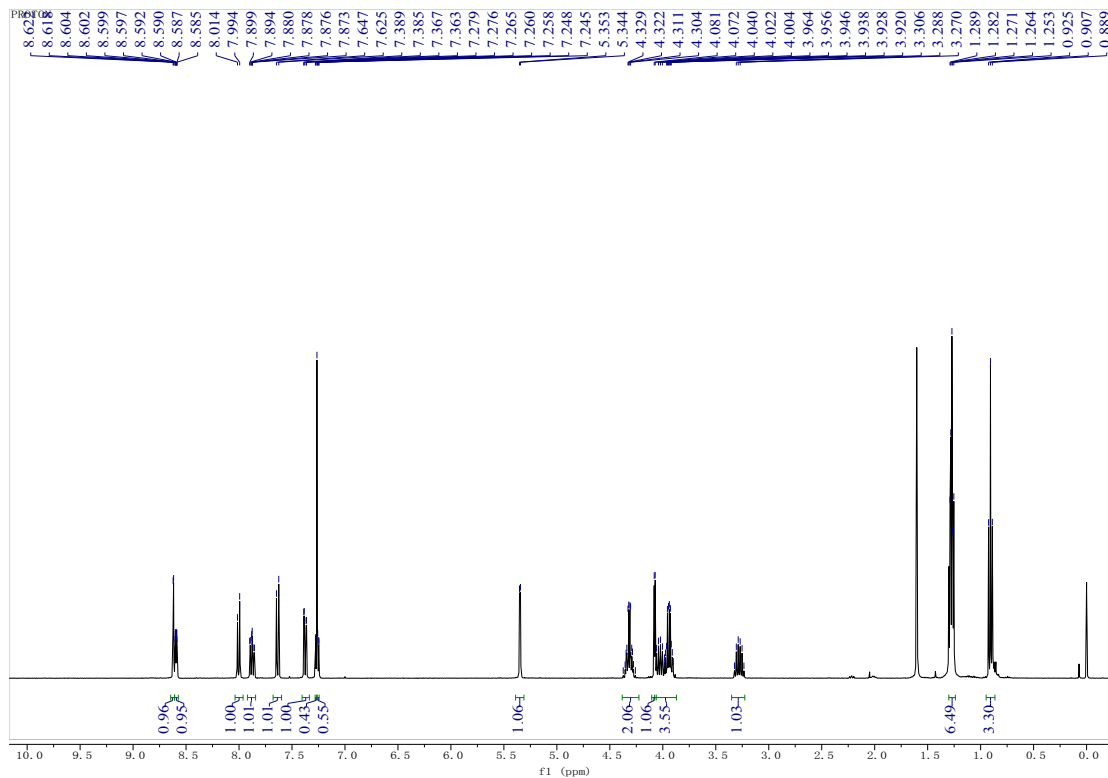
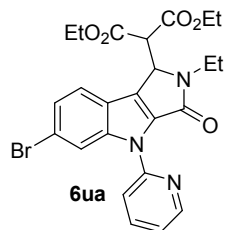


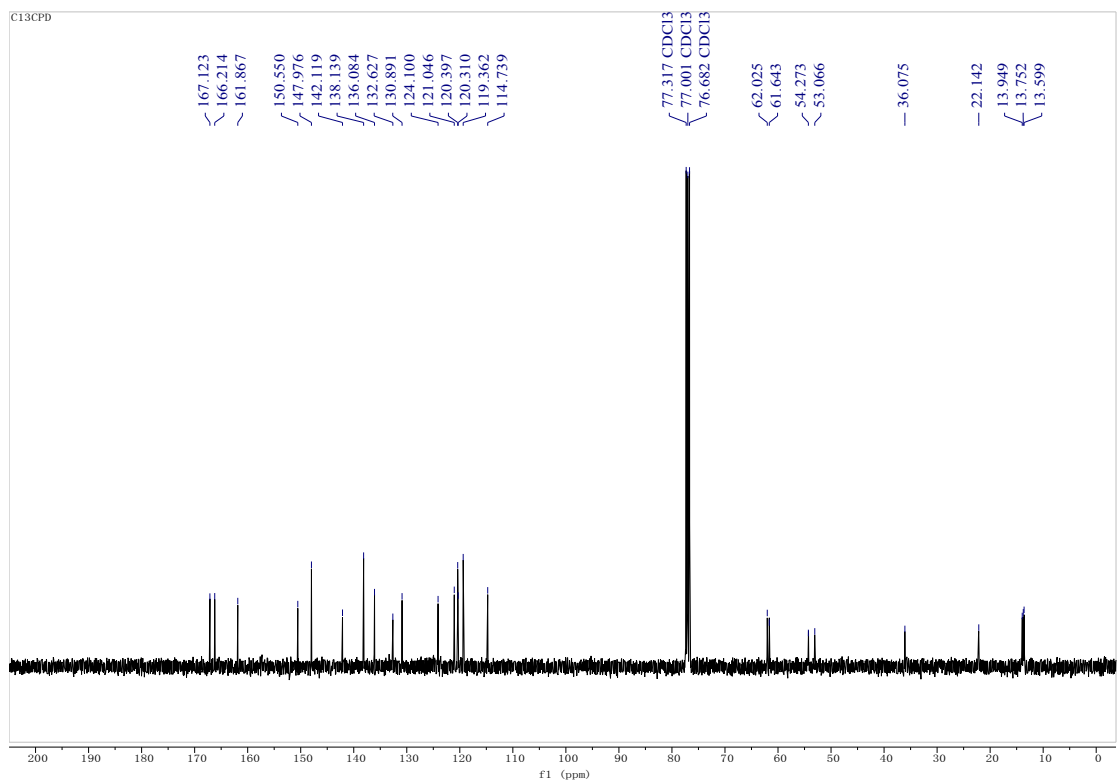
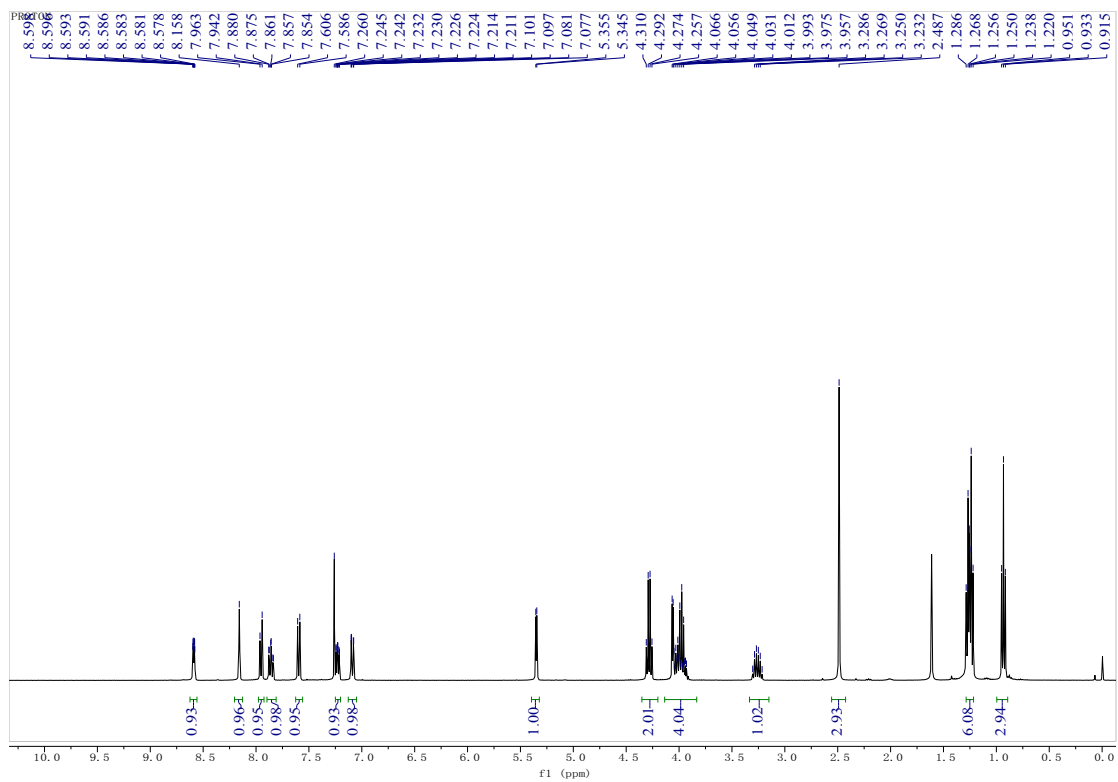
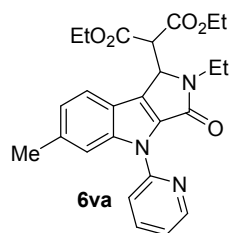


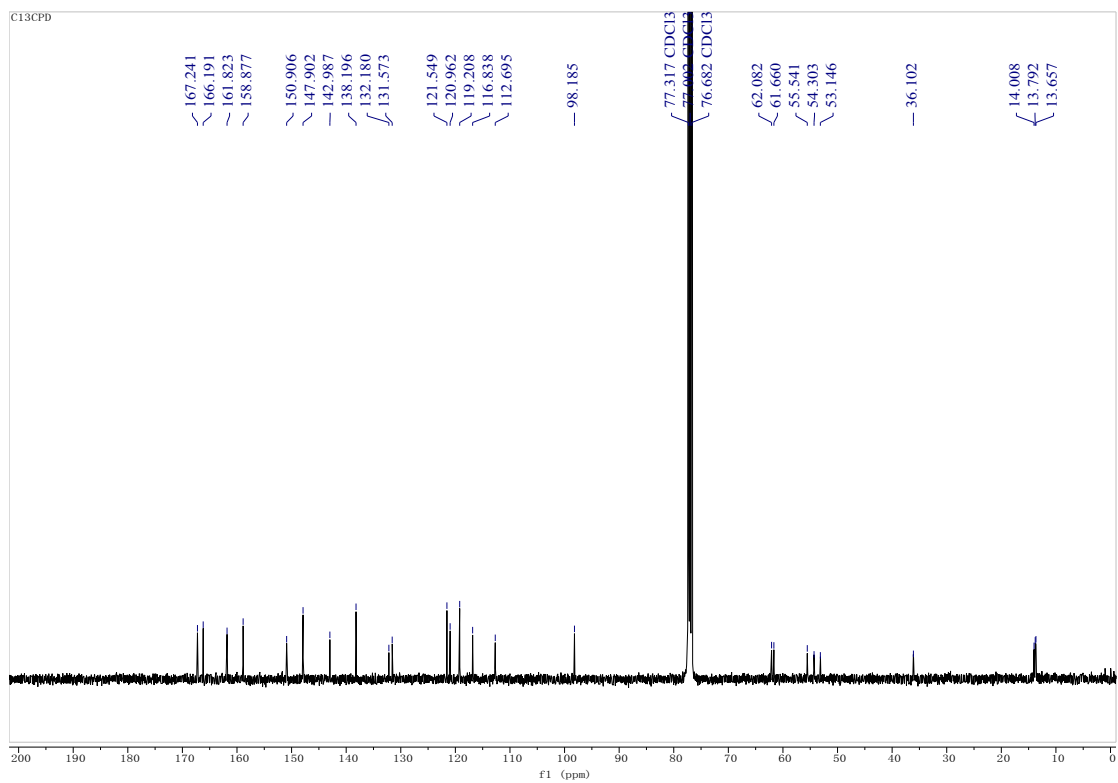
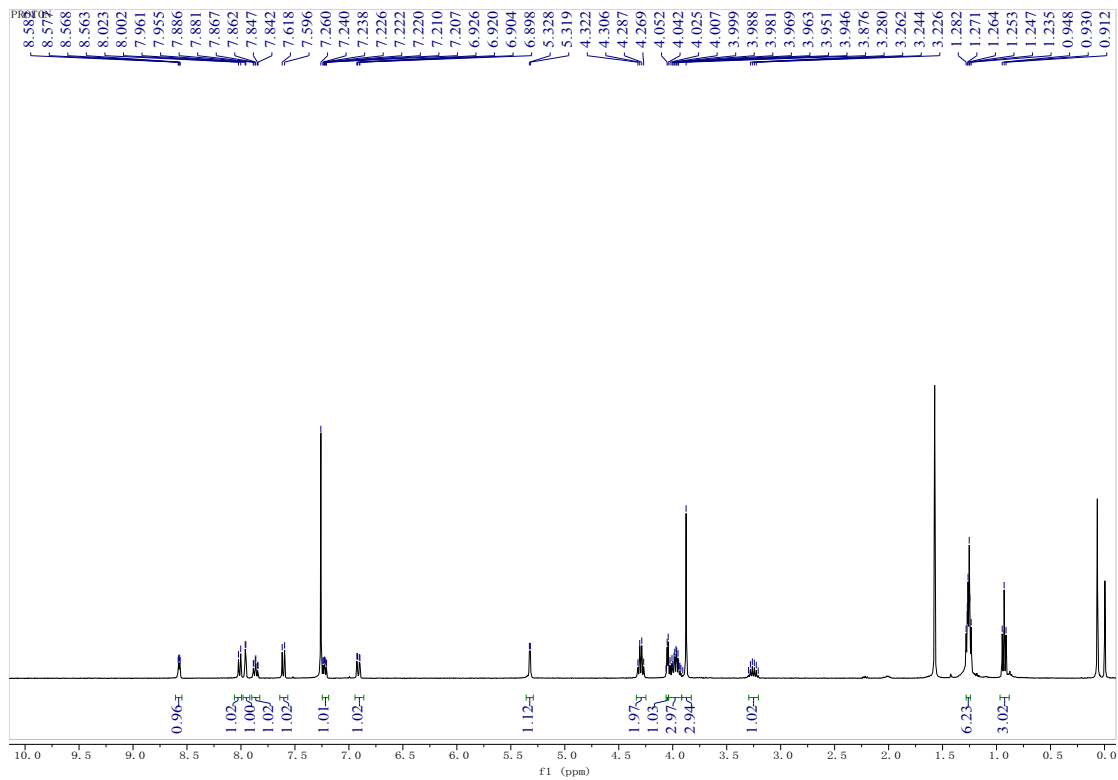
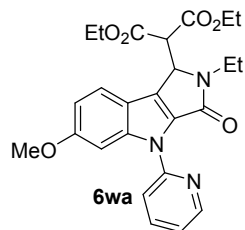


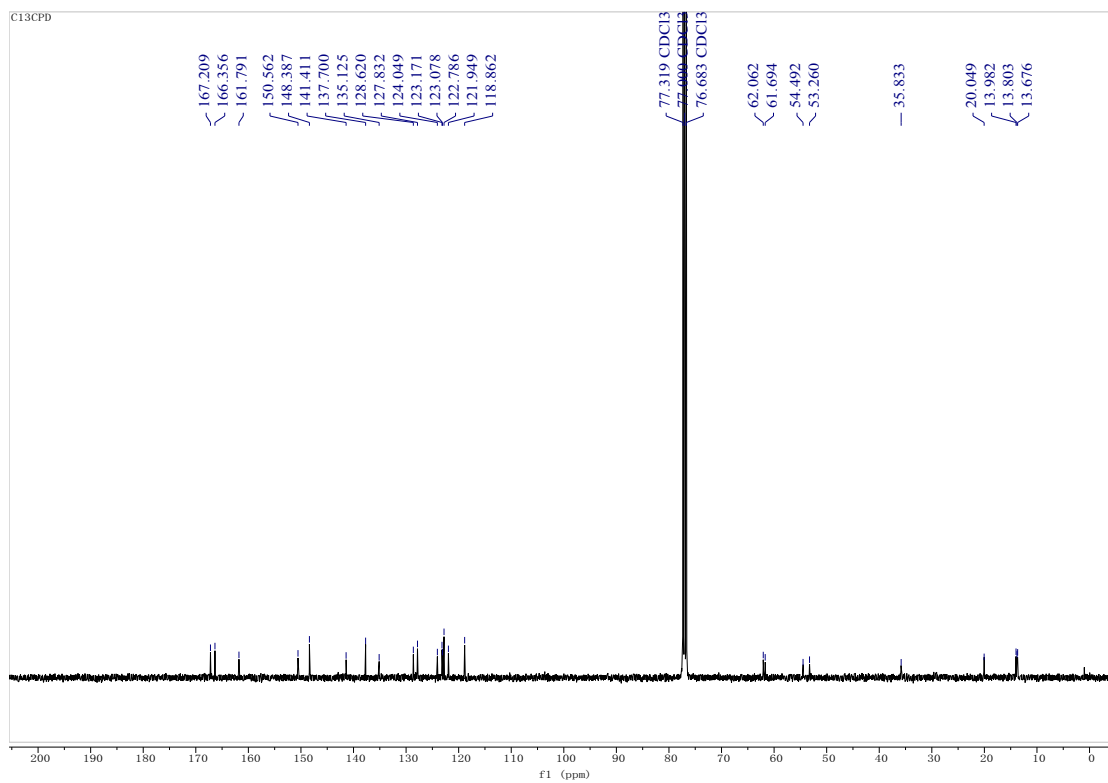
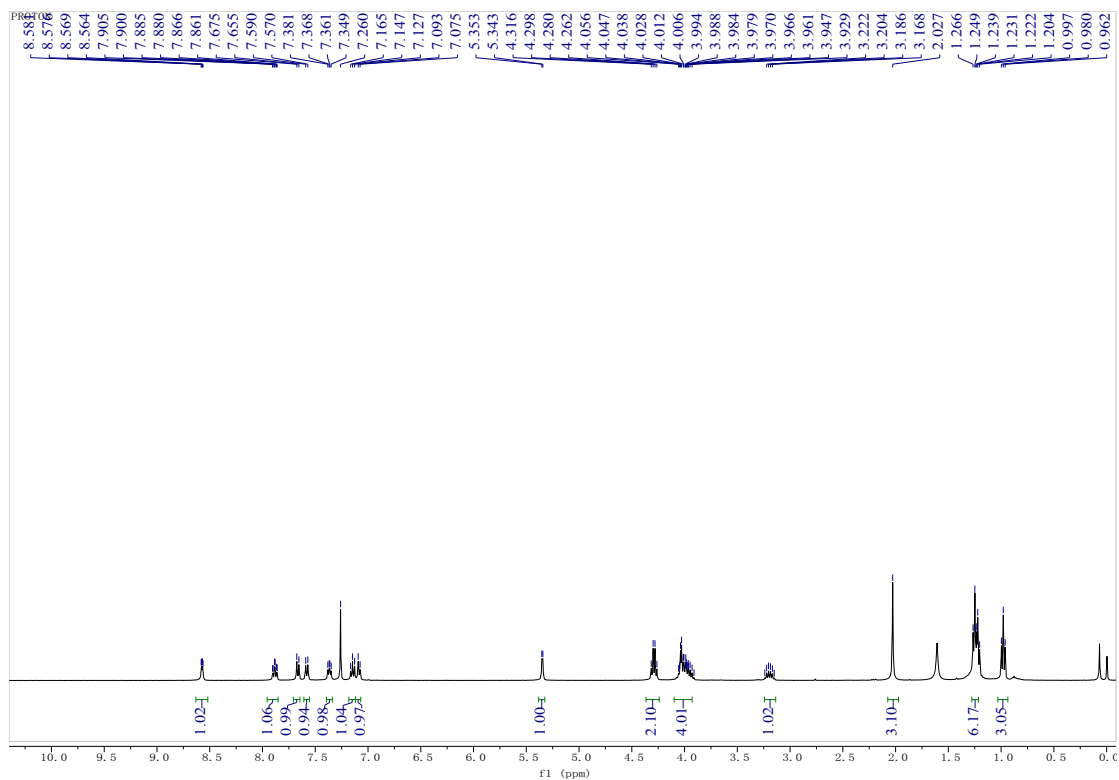
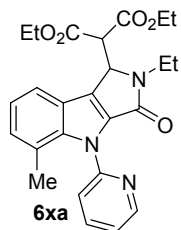




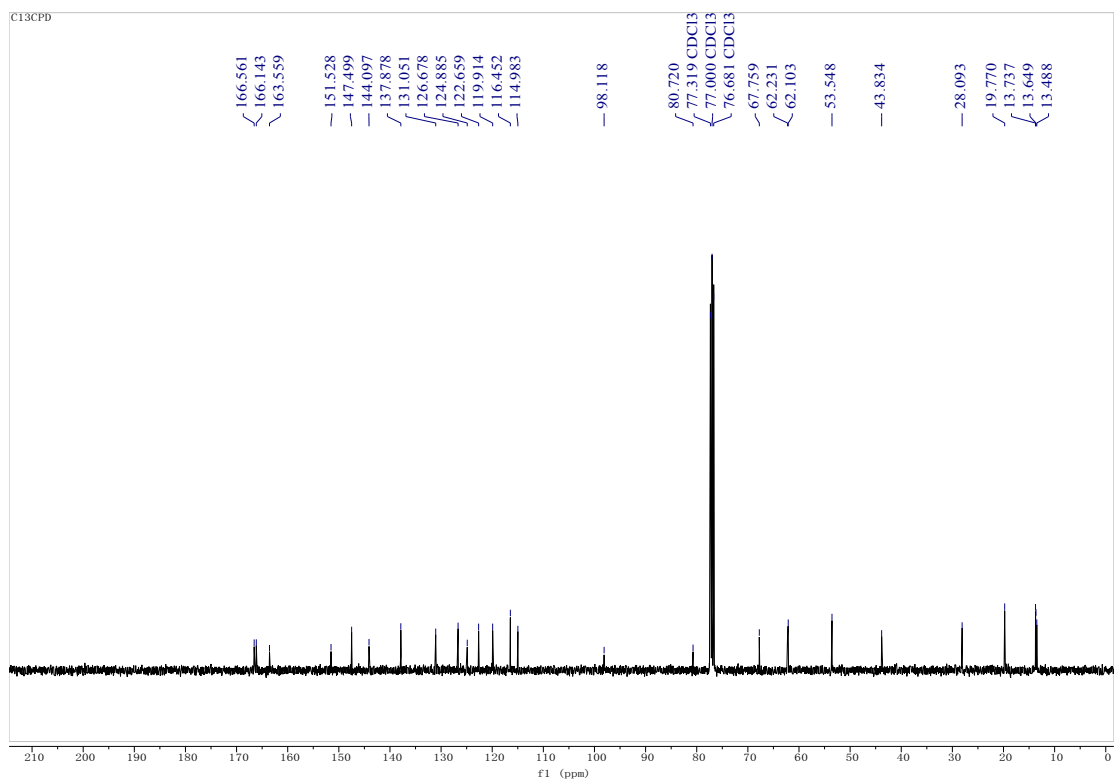
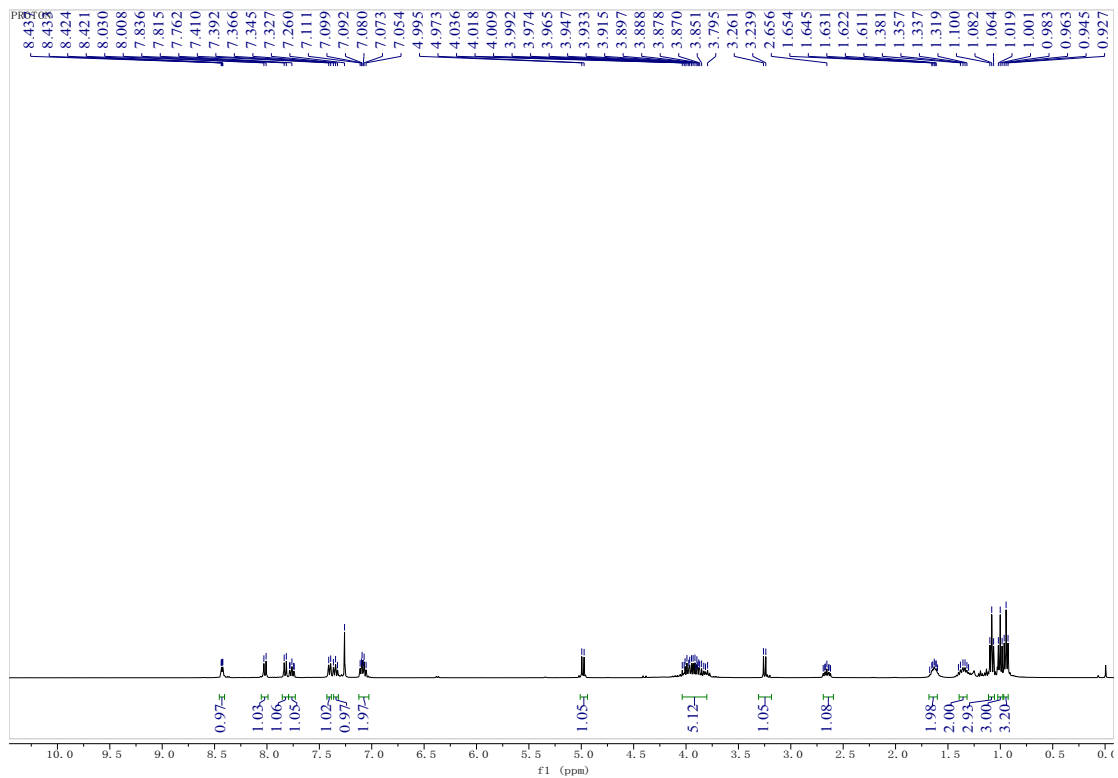
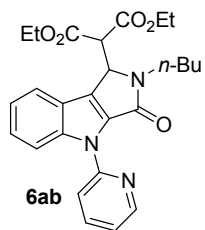


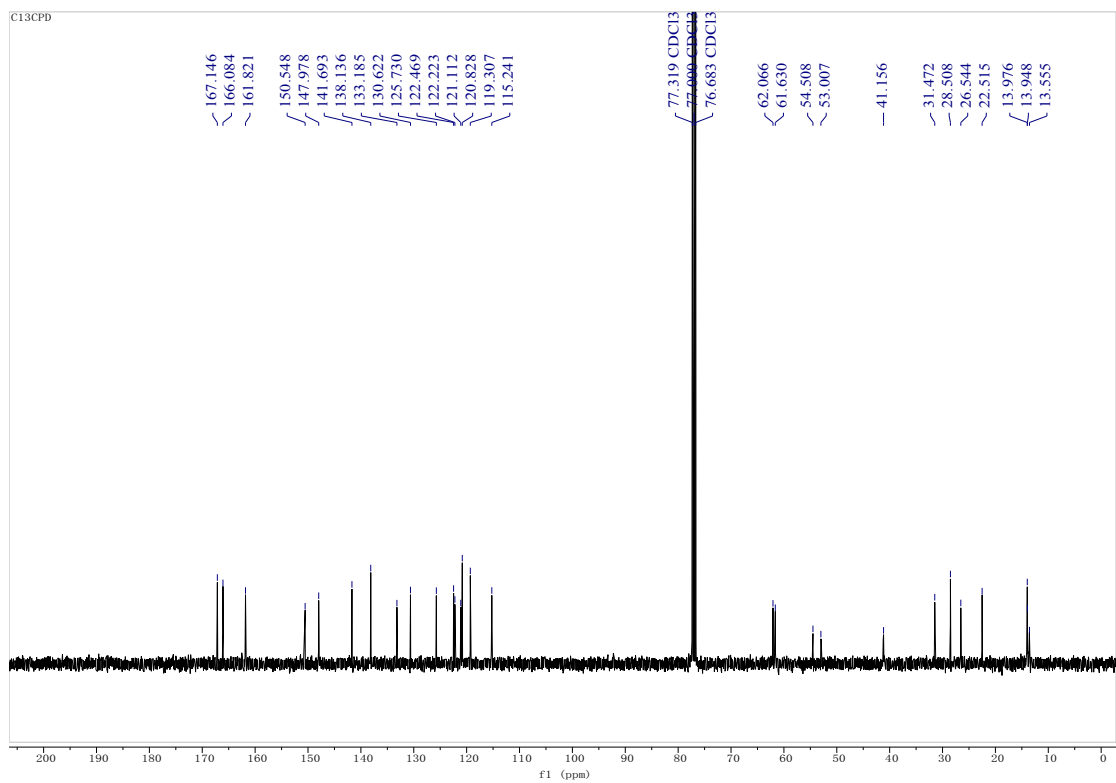
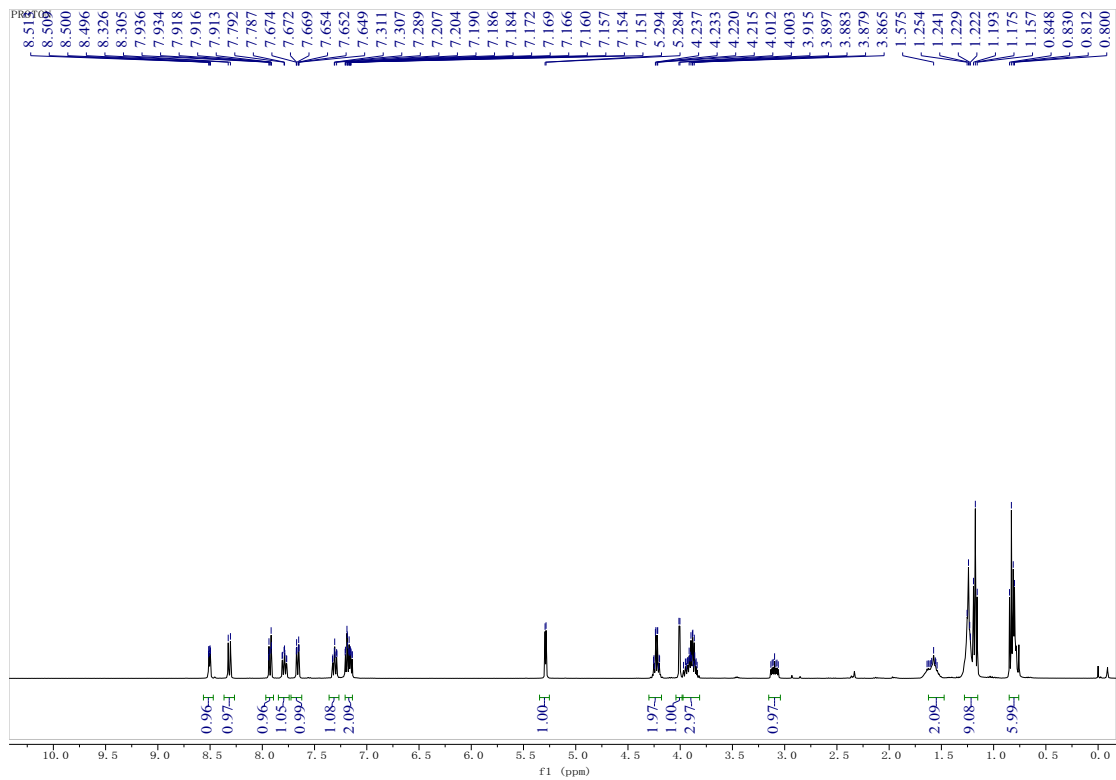
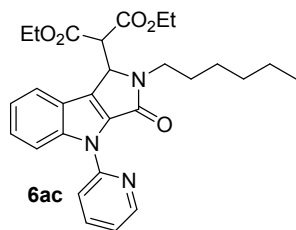


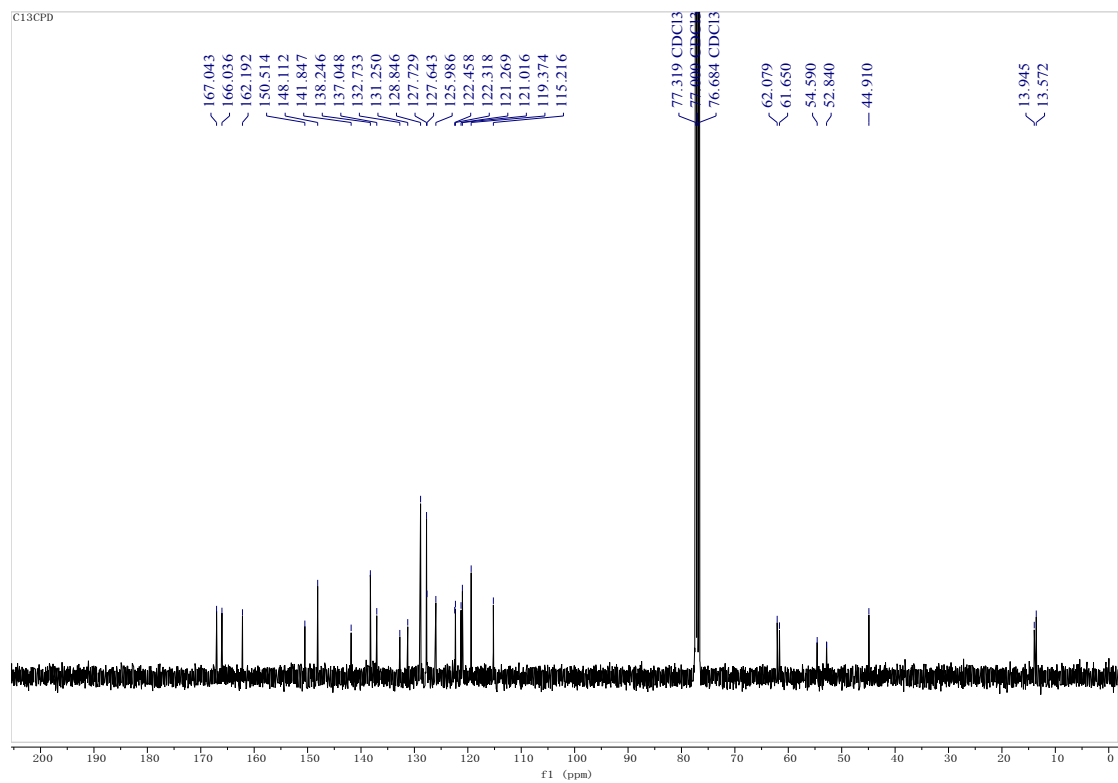
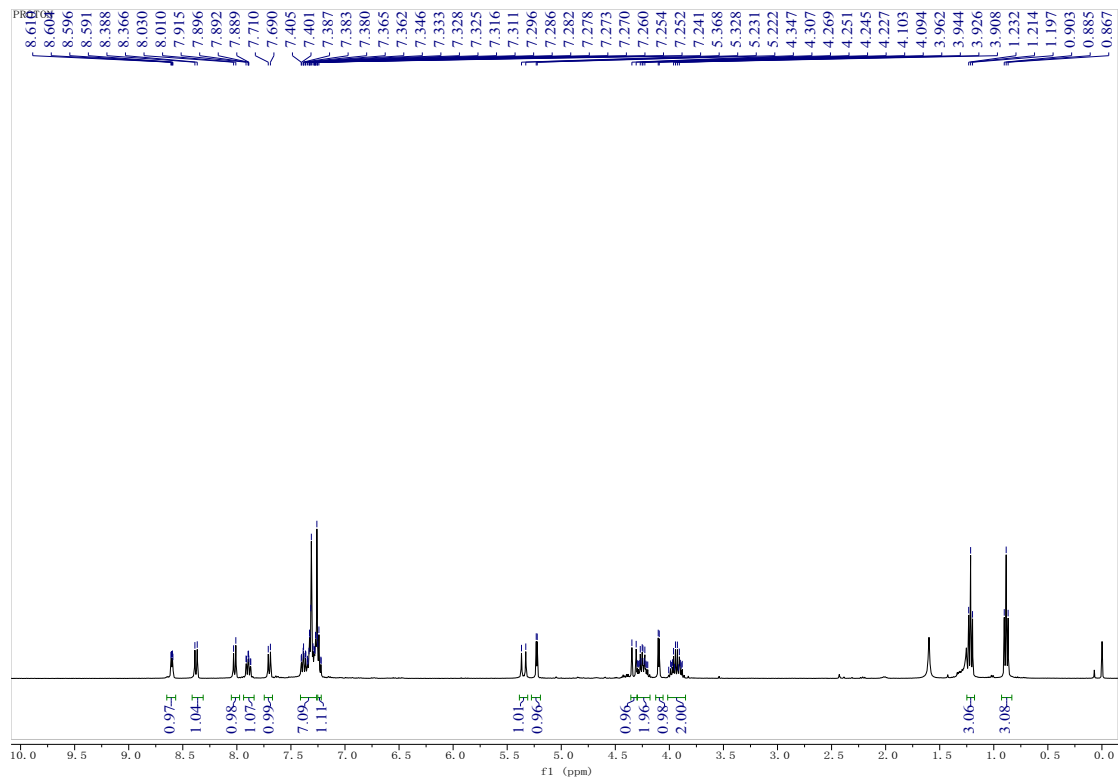
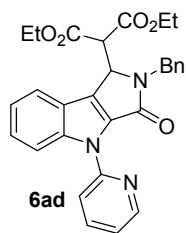


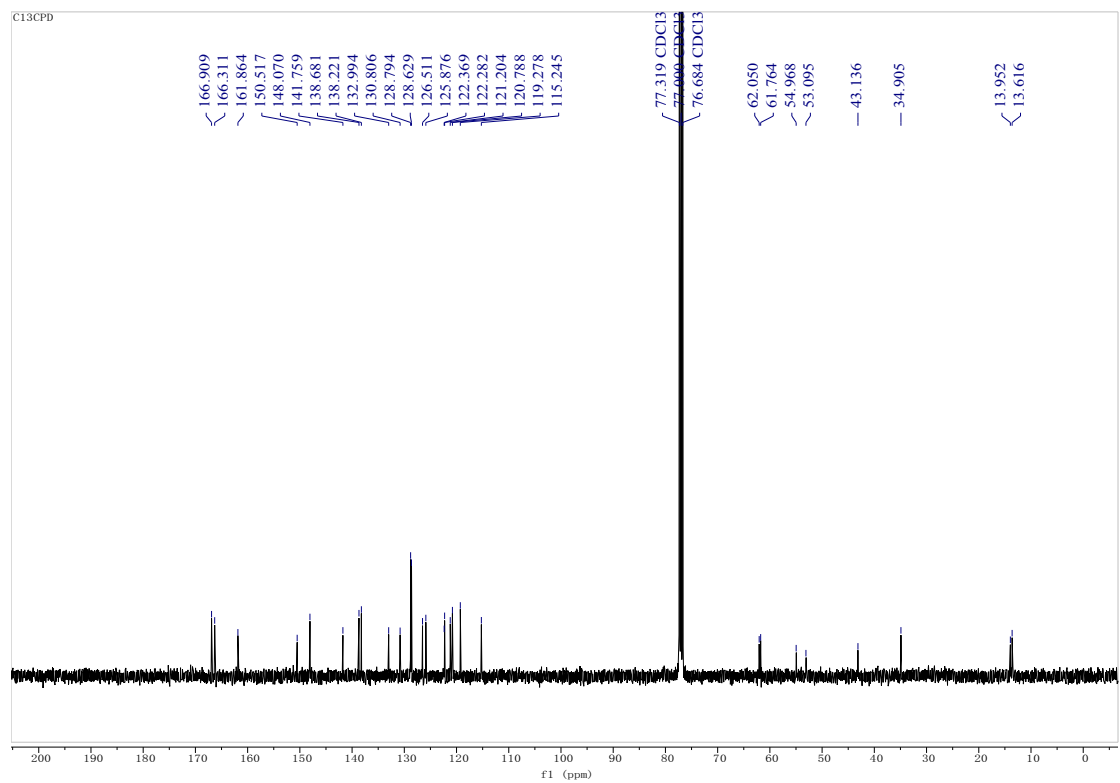
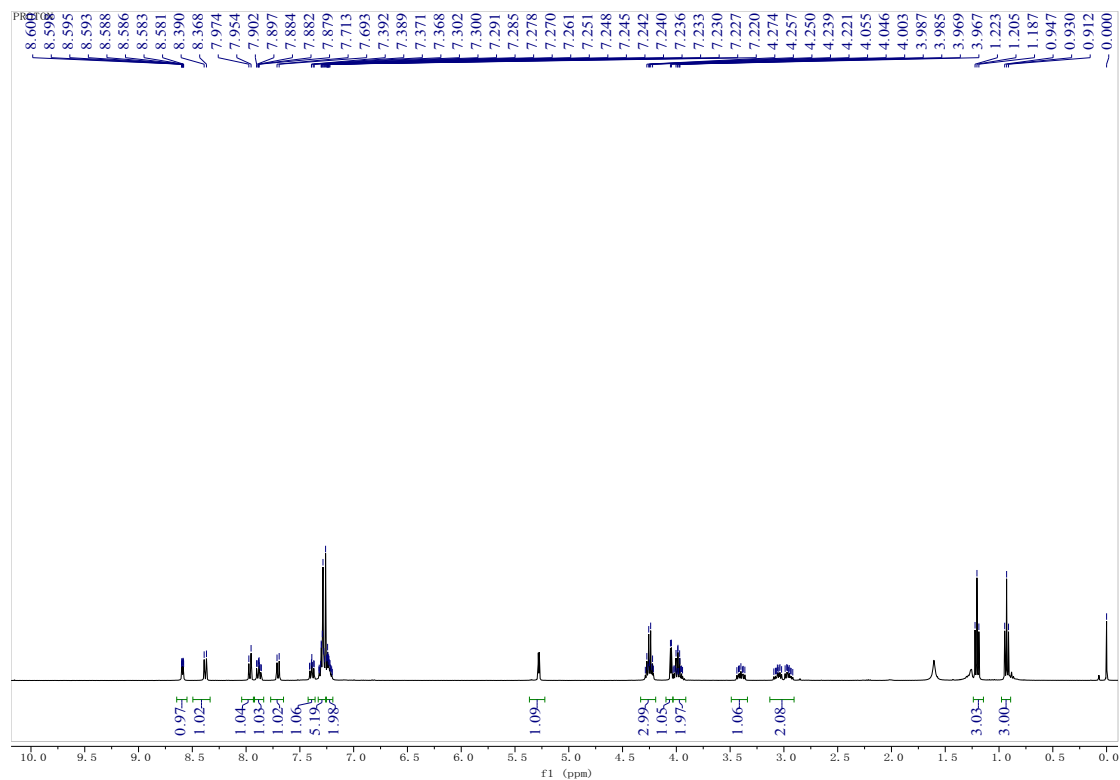
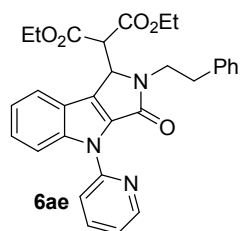


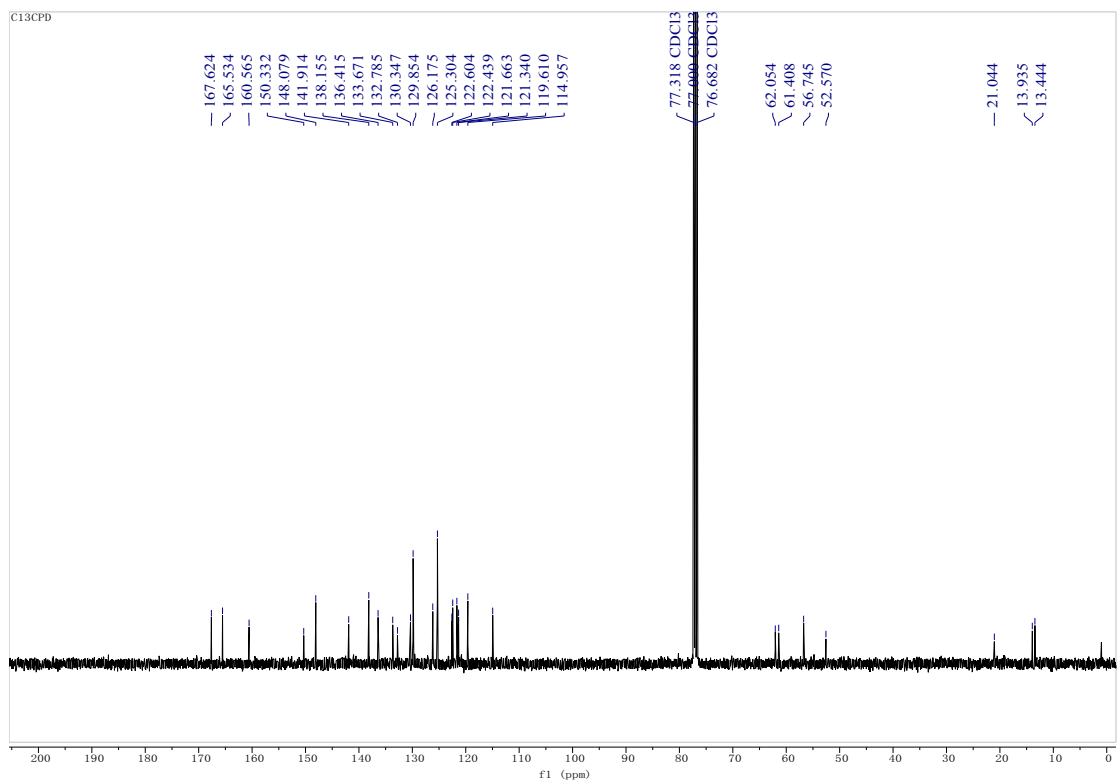
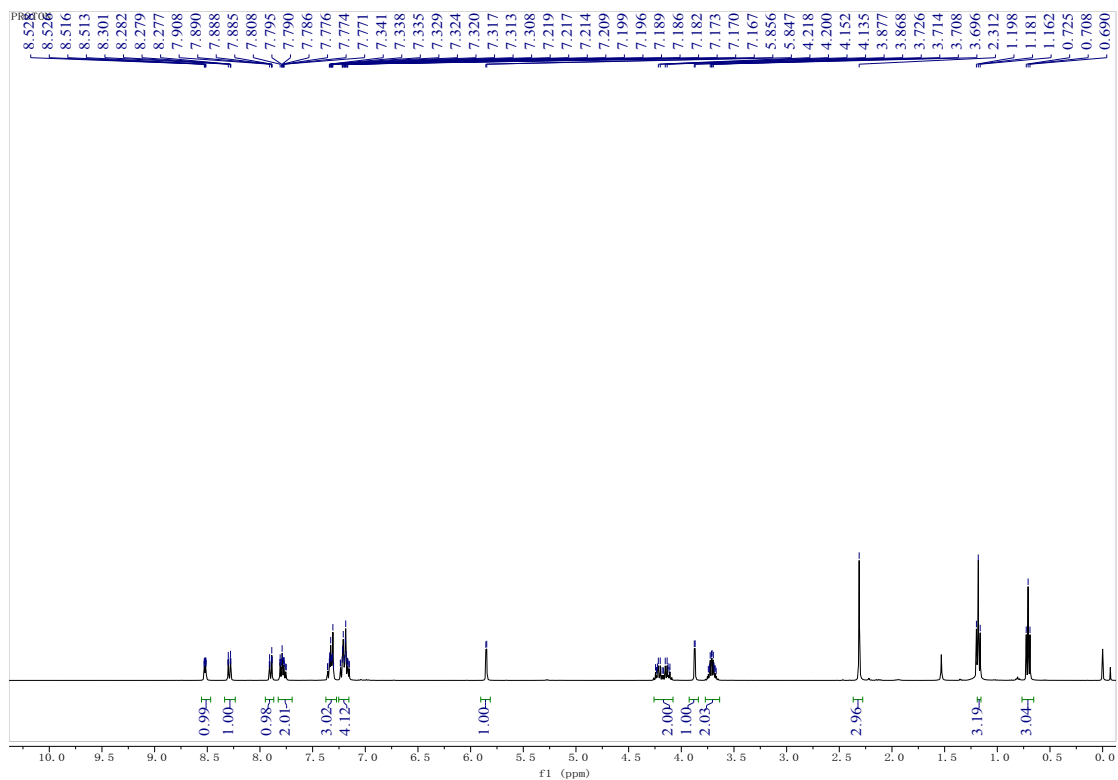
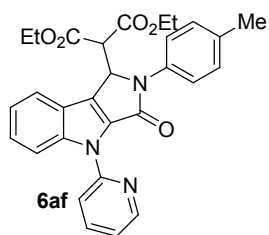


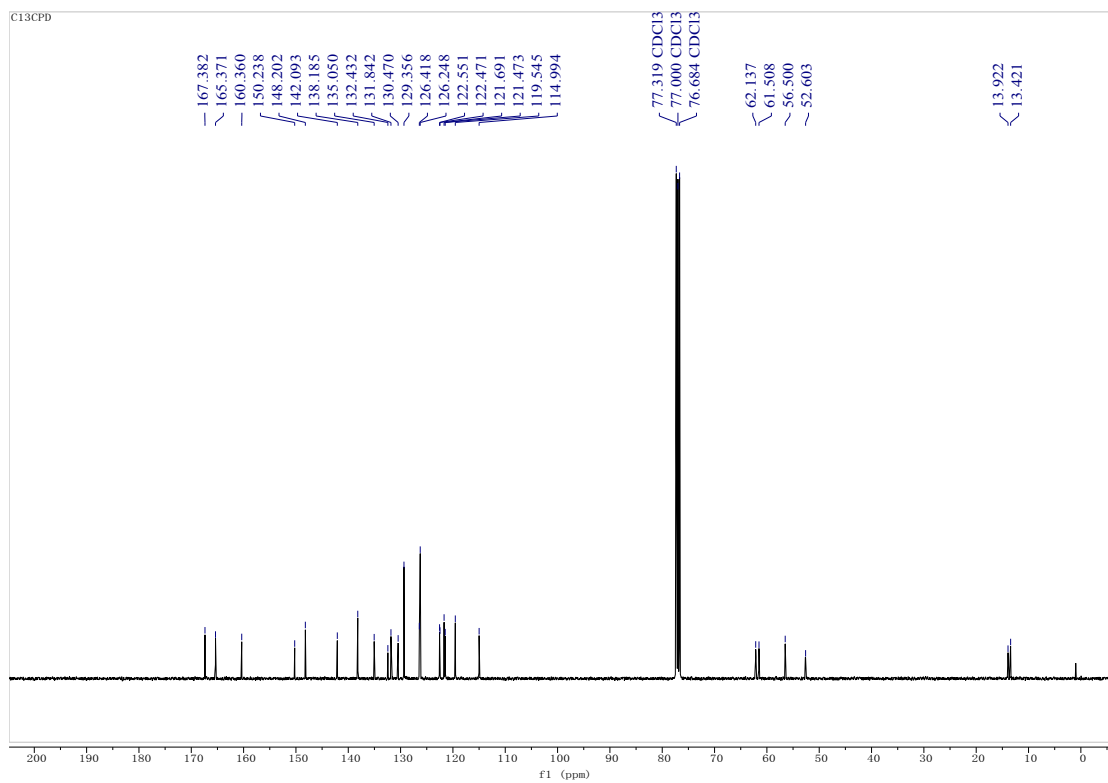
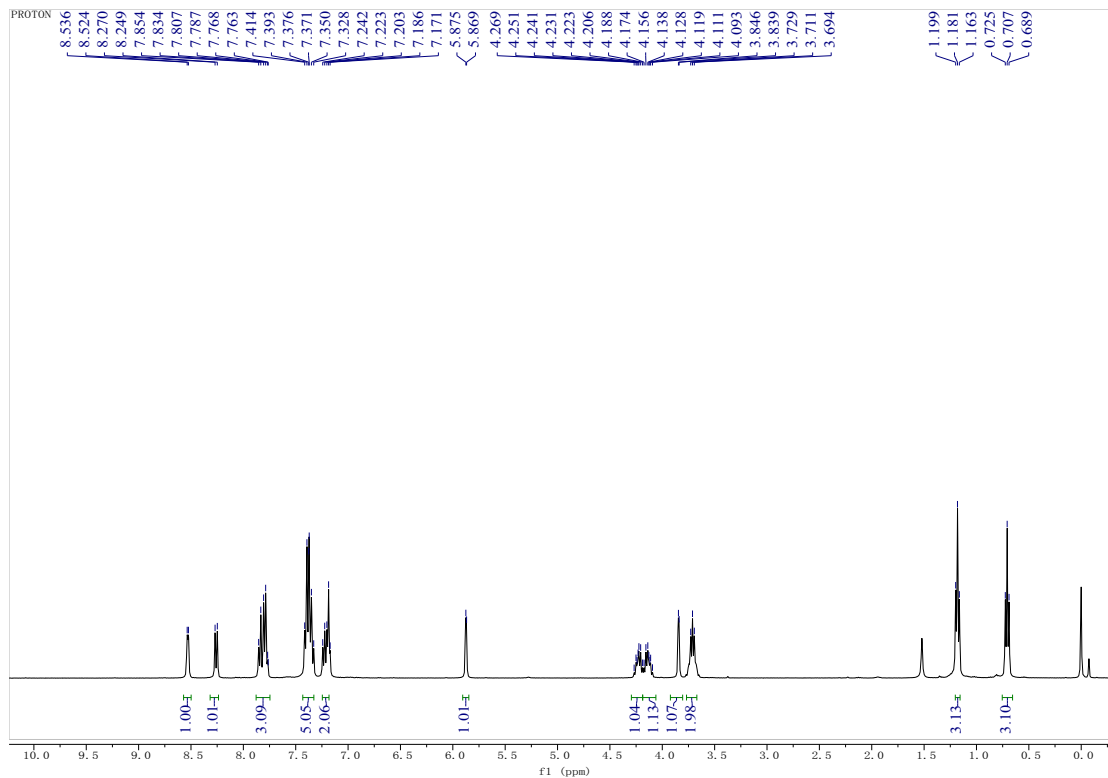
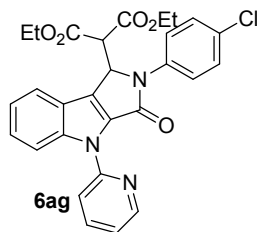


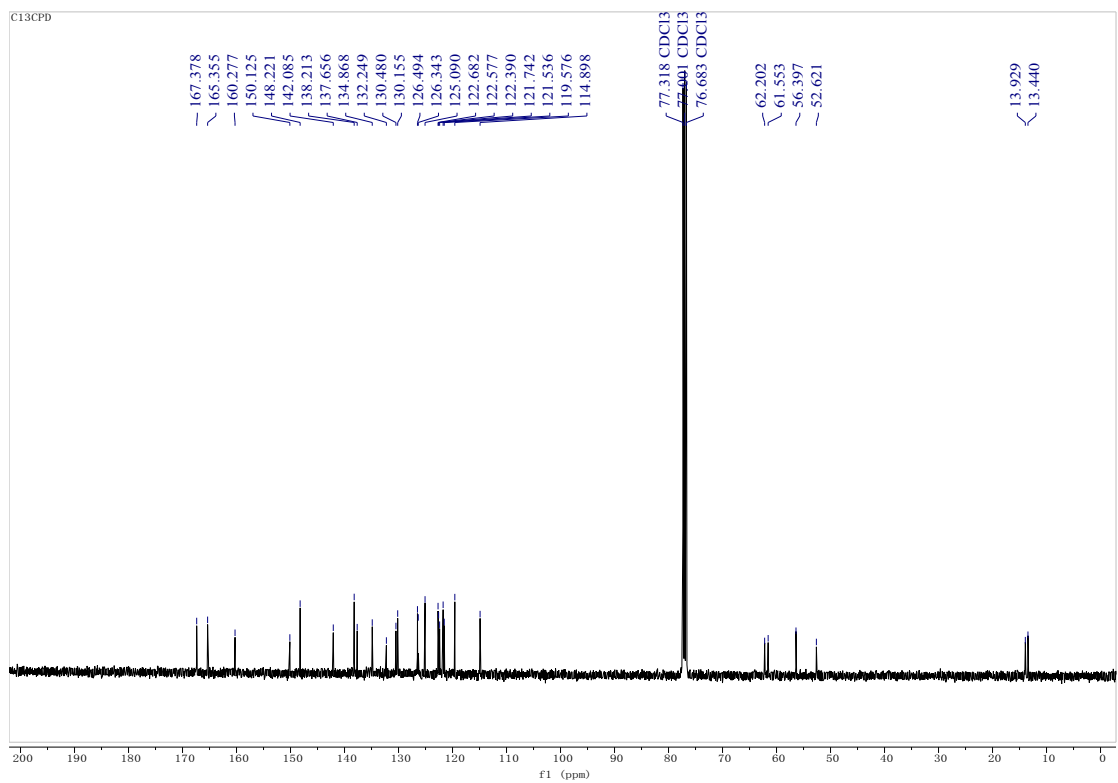
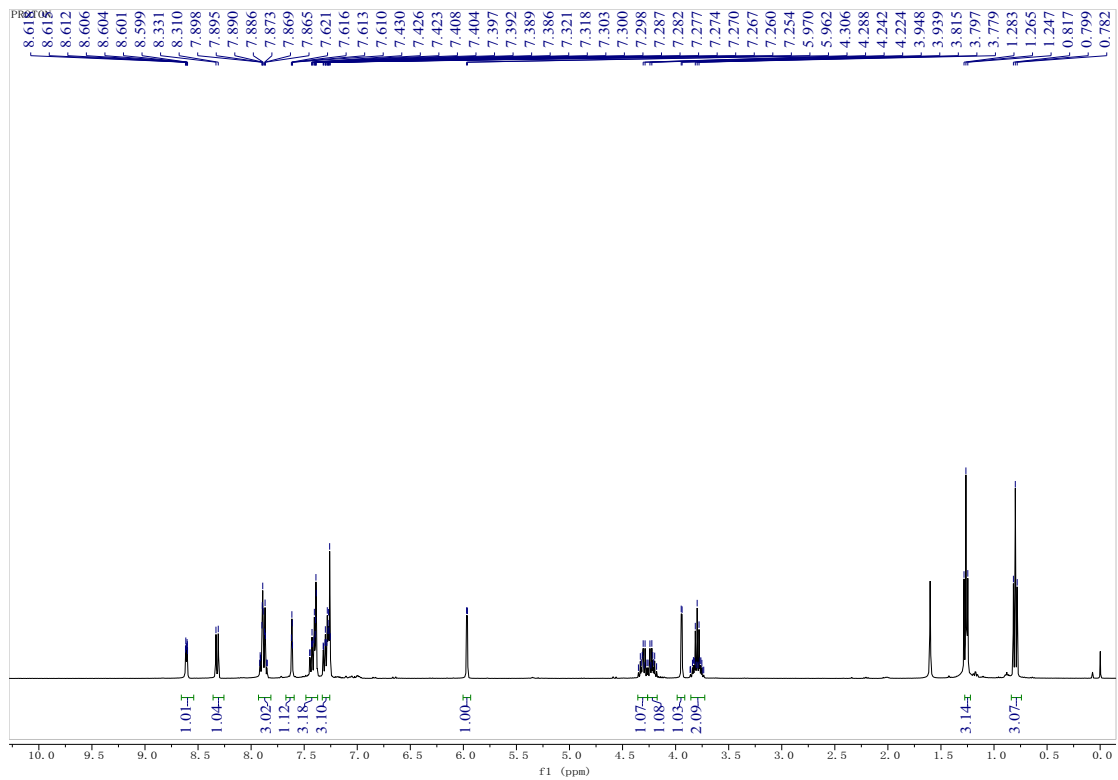
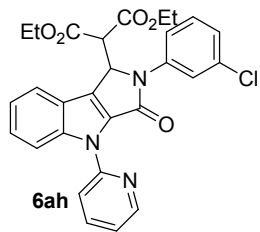


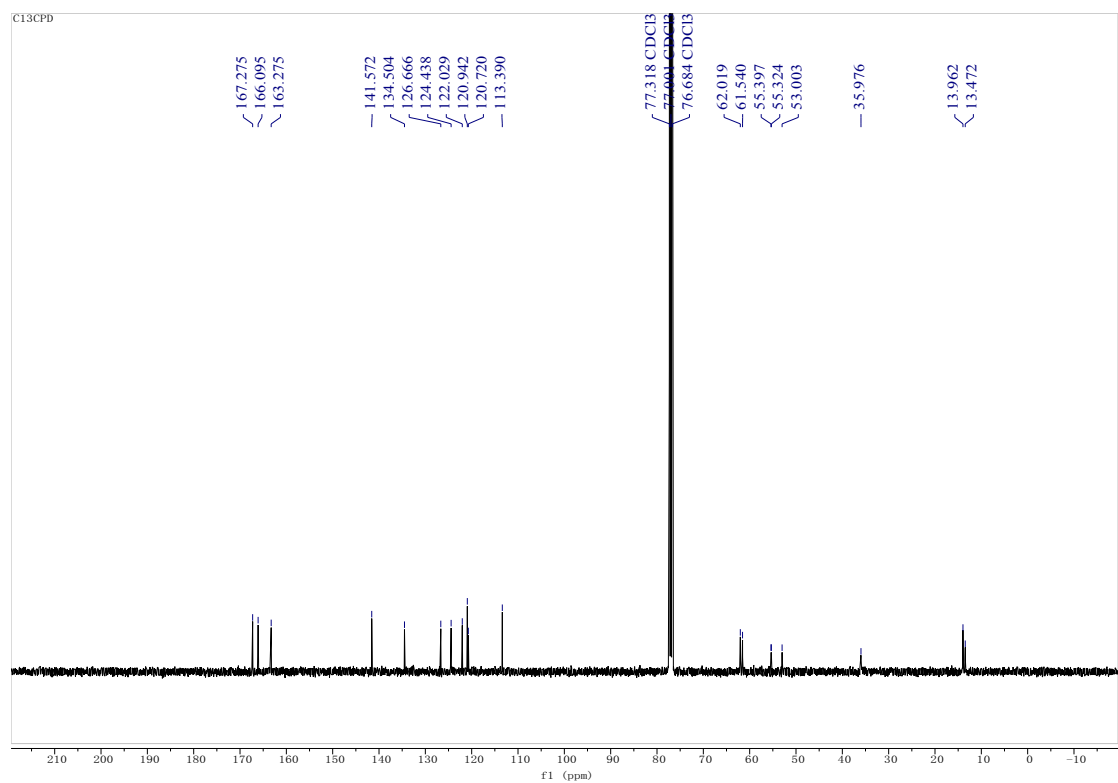
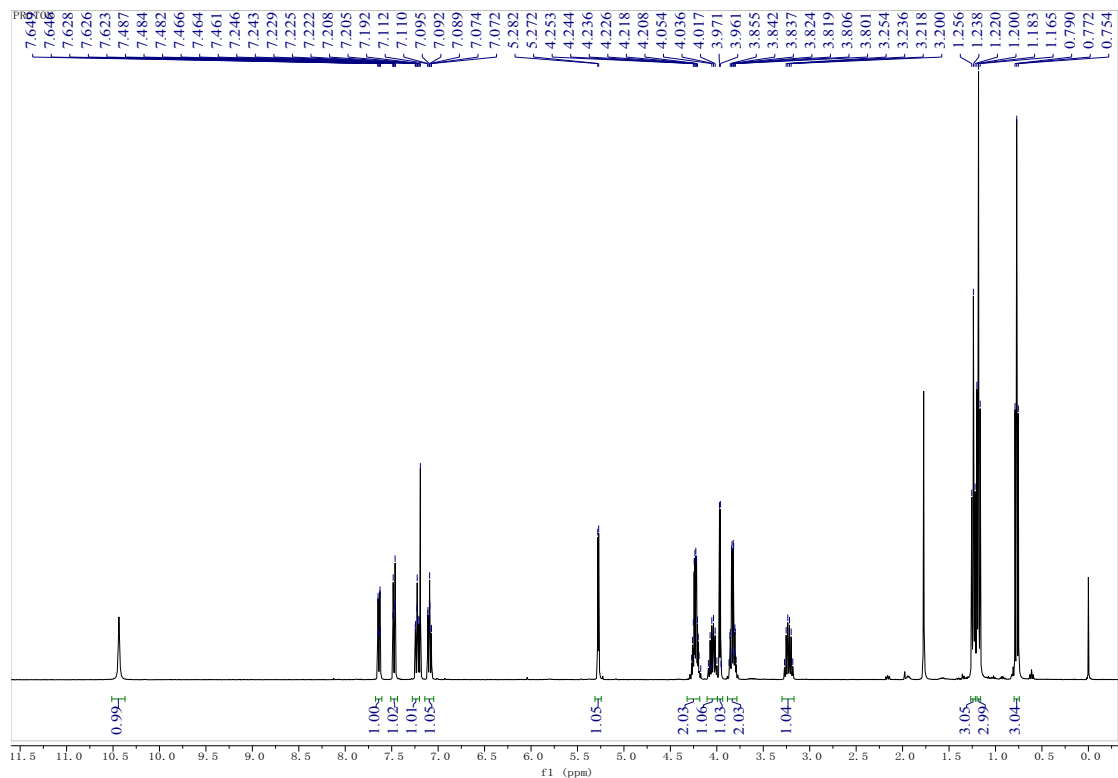
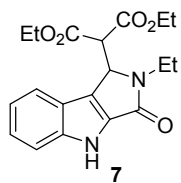




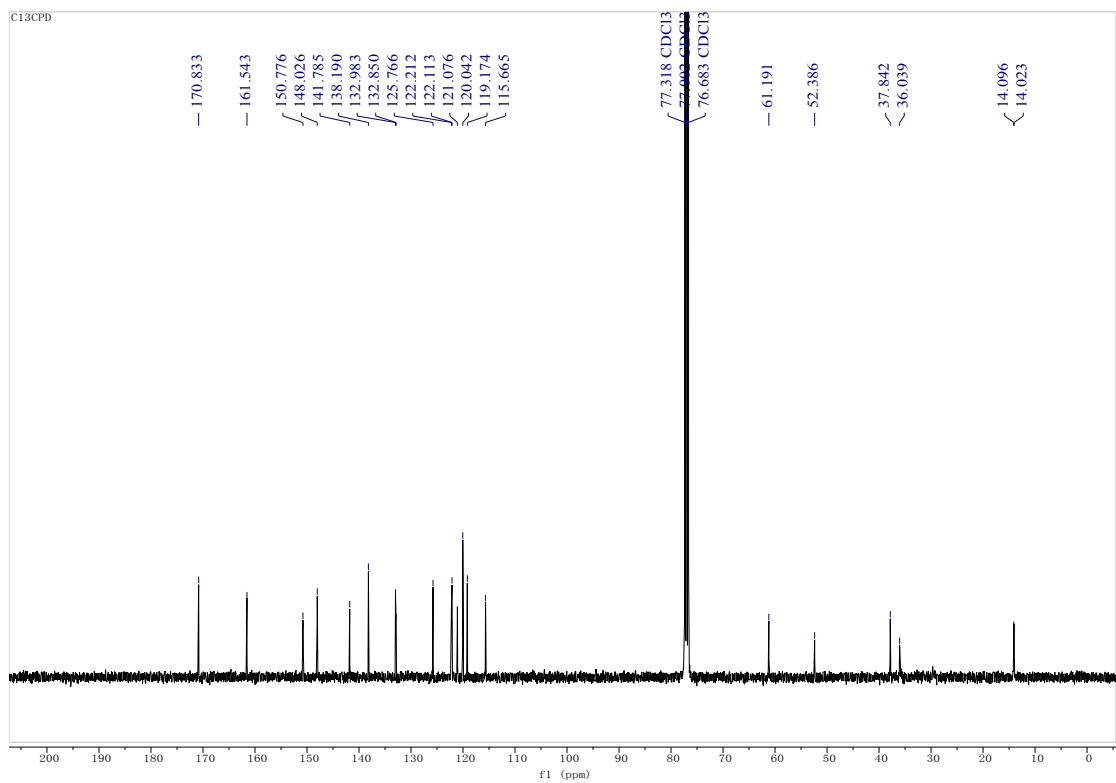
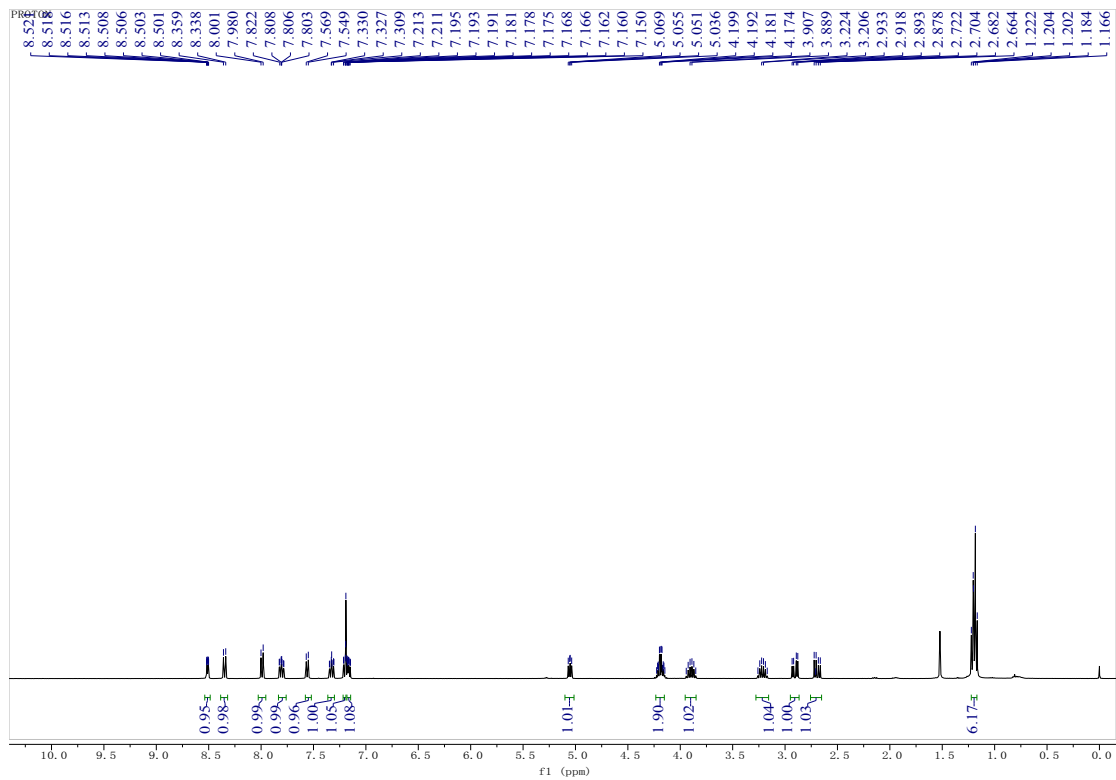
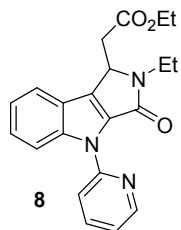












ORTEP Drawing for 6ba

