

# Supporting Information

## Enantioselective *aza*-Morita-Baylis-Hillman reaction between acrylates and *N*-Boc isatin ketimines: asymmetric construction of chiral 3-substituted-3-aminooxindoles

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## 1. General Information

Melting points were taken without correction.  $^1\text{H}$ ,  $^{13}\text{C}$  and  $^{31}\text{P}$  NMR spectra were recorded on Bruker 400 spectrometer.  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR spectra were referenced to tetramethylsilane ( $\delta$  0.00) using  $d_6$ -DMSO as solvent. The chemical shifts of  $^{31}\text{P}$  NMR spectra were referenced to 85%  $\text{H}_3\text{PO}_4$  (0.0 ppm). IR spectra were recorded on Nicolet Magna-I 550 spectrometer. High Resolution Mass spectra (HRMS) were recorded on Micromass GCT with Electron Spray Ionization (ESI) resource. Dichloromethane was distilled from  $\text{CaH}_2$ . Thin-layer chromatography (TLC) was performed on Silicycle 10-40  $\mu\text{m}$  silica gel plates. Column chromatography was performed using silica gel (300-400 mesh) eluting with ethyl acetate and petroleum ether.

## 2. General Procedure for the Preparation of Chiral Catalysts **4d**, **4e** and *ent-4e*<sup>1</sup>

To a solution of chiral squaramide<sup>2</sup> (0.35 mmol) in  $\text{CH}_2\text{Cl}_2$  (5 mL) was added the corresponding 2-amino-1-(diphenylphosphino)-cyclohexane (80 mg, 0.28 mmol) in  $\text{CH}_2\text{Cl}_2$  (5 mL). After stirring at room temperature for 5 days, the reaction mixture was filtered, and the precipitate was washed with  $\text{CH}_2\text{Cl}_2$  (3 $\times$ 5 mL) to afford phosphine-squaramide as solid.

### 2.1 3-((1*R*,2*R*)-2-(diphenylphosphino)cyclohexylamino)-4-((*R*)-1-phenylethylamino)cyclobut-3-ene-1,2-dione (**4d**)

White solid, 45% yield, Mp > 300 °C;  $[\alpha]_D^{26}$  -10.4 ( $c$  0.13, DMSO);  $^1\text{H}$  NMR (DMSO- $d_6$ , 400 MHz): 7.47-7.20 (m, 17H), 5.10-5.08 (m, 1H), 3.81-3.79 (m, 1H), 2.61-2.56 (m, 1H), 1.94-1.92 (m, 1H), 1.69-1.60 (m, 3H), 1.49-1.48 (m, 4H), 1.27-1.25 (m, 2H), 0.91-0.89 (m, 1H);  $^{13}\text{C}$  NMR data can not be obtained for the poor solubility of **4d** in organic solvent;  $^{31}\text{P}$  (DMSO- $d_6$ , 162 MHz): -8.19; IR (KBr,  $\text{cm}^{-1}$ ):  $\nu$  3159, 3057, 2933, 2852, 1793, 1641, 1562, 1471, 1206, 1136, 1093, 781, 746, 695; HRMS (ESI) calcd for  $\text{C}_{30}\text{H}_{32}\text{N}_2\text{O}_2\text{P}$  ( $[\text{M}+\text{H}]^+$ ): 483.2201, found: 483.2208.

### 2.2 3-((1*R*,2*R*)-2-(diphenylphosphino)cyclohexylamino)-4-((*S*)-1-phenylethylamino)cyclobut-3-ene-1,2-dione (**4e**)

White solid, 42% yield, Mp > 300 °C;  $[\alpha]_D^{25}$  -41.2 ( $c$  0.25, DMSO);  $^1\text{H}$  NMR (DMSO- $d_6$ , 400 MHz): 7.47-7.21 (m, 17H), 5.09-5.09 (m, 1H), 3.80-3.79 (m, 1H), 2.61-2.56 (m, 1H), 1.94-1.91 (m, 1H), 1.69-1.60 (m, 3H), 1.49-1.48 (m, 4H), 1.27-1.24 (m, 2H), 0.91-0.86 (m, 1H);  $^{13}\text{C}$  NMR data can not be obtained for the poor solubility of **4e** in organic solvent;  $^{31}\text{P}$  (DMSO- $d_6$ , 162 MHz): -8.24; IR (KBr,  $\text{cm}^{-1}$ ):  $\nu$  3160, 3053, 2932, 2854, 1795, 1646, 1572, 1473, 1180, 1133, 1091, 778, 743, 697; HRMS (ESI) calcd for  $\text{C}_{30}\text{H}_{32}\text{N}_2\text{O}_2\text{P}$  ( $[\text{M}+\text{H}]^+$ ): 483.2201, found: 483.2204.

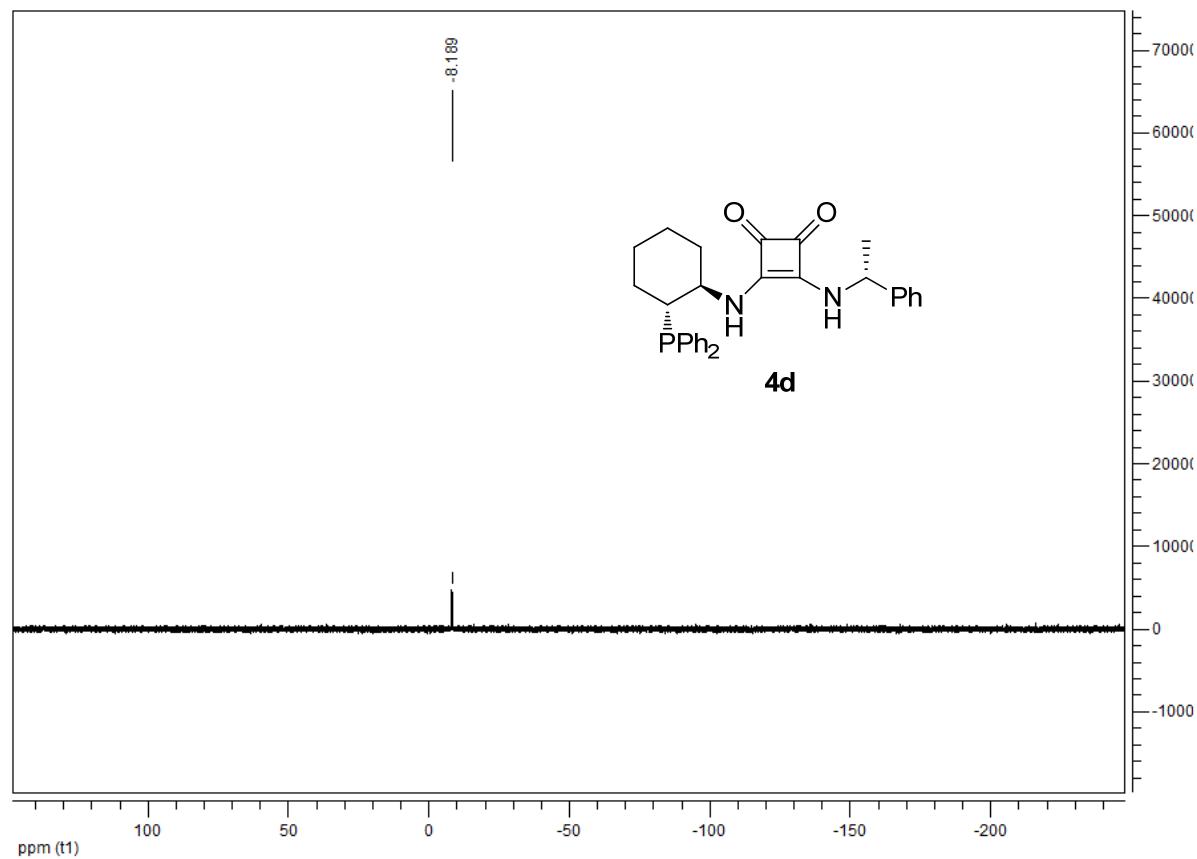
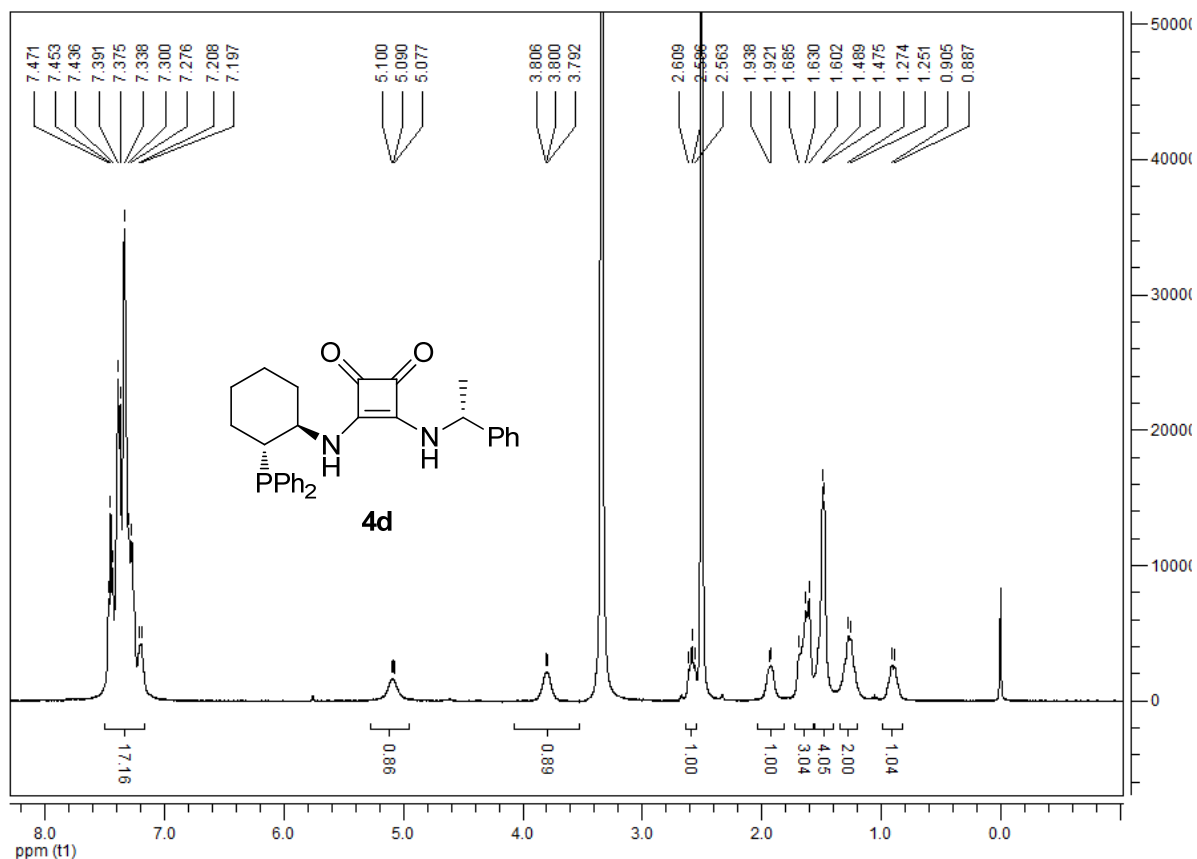
<sup>1</sup> J.-Y. Qian, C.-C. Wang, F. Sha and X.-Y. Wu, *RSC Adv.*, 2012, **2**, 6042.

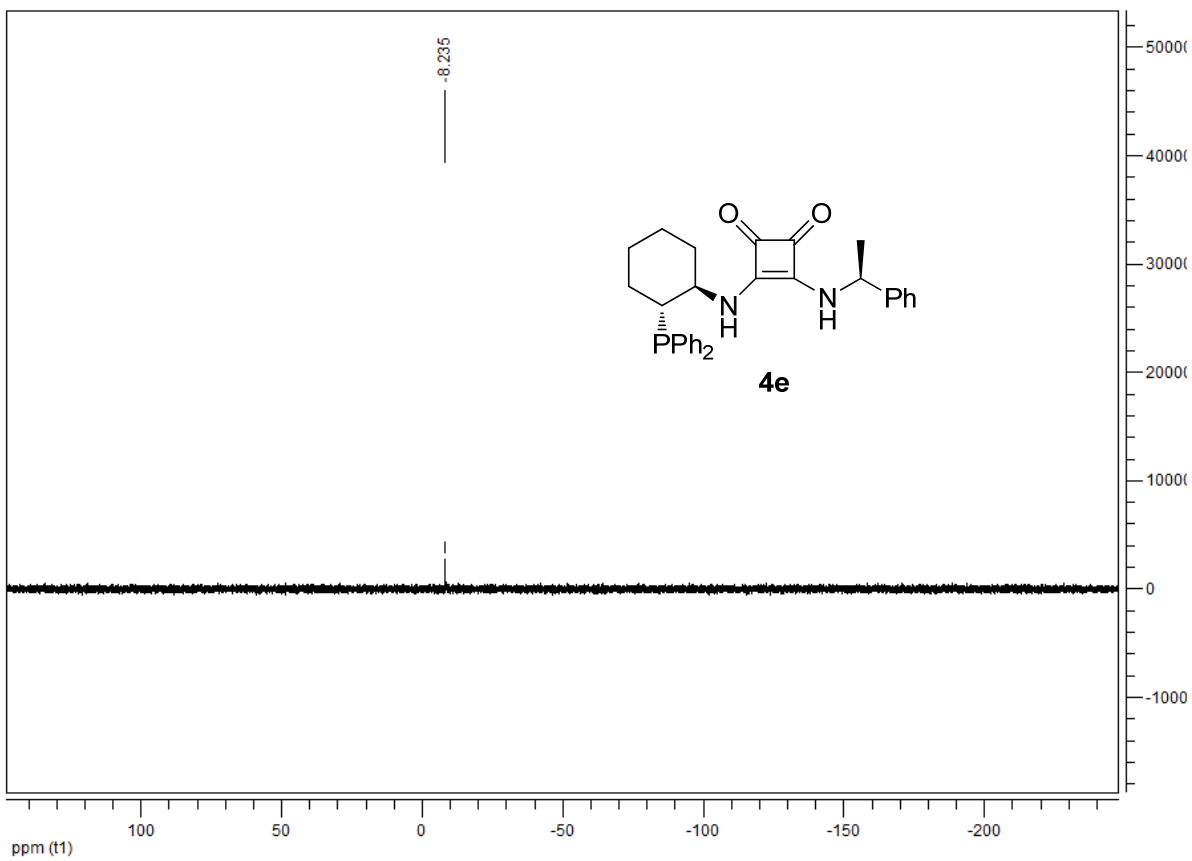
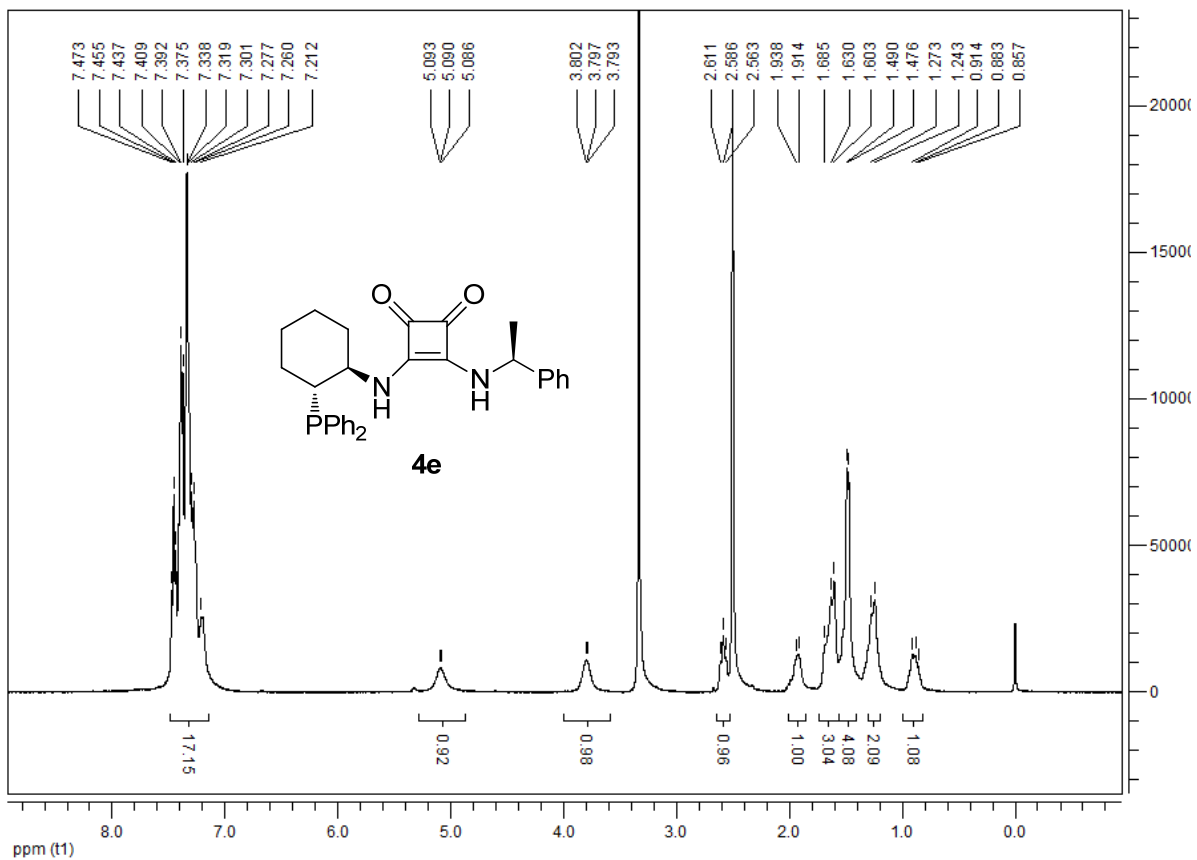
<sup>2</sup> F. Lovering, S. Kirincich, W. Wang, K. Combs, L. Resnick, J. E. Sabalski, J. Butera, J. Liu, K. Parris and J. B. Telliez, *Bioorg. Med. Chem.*, 2009, **17**, 3342.

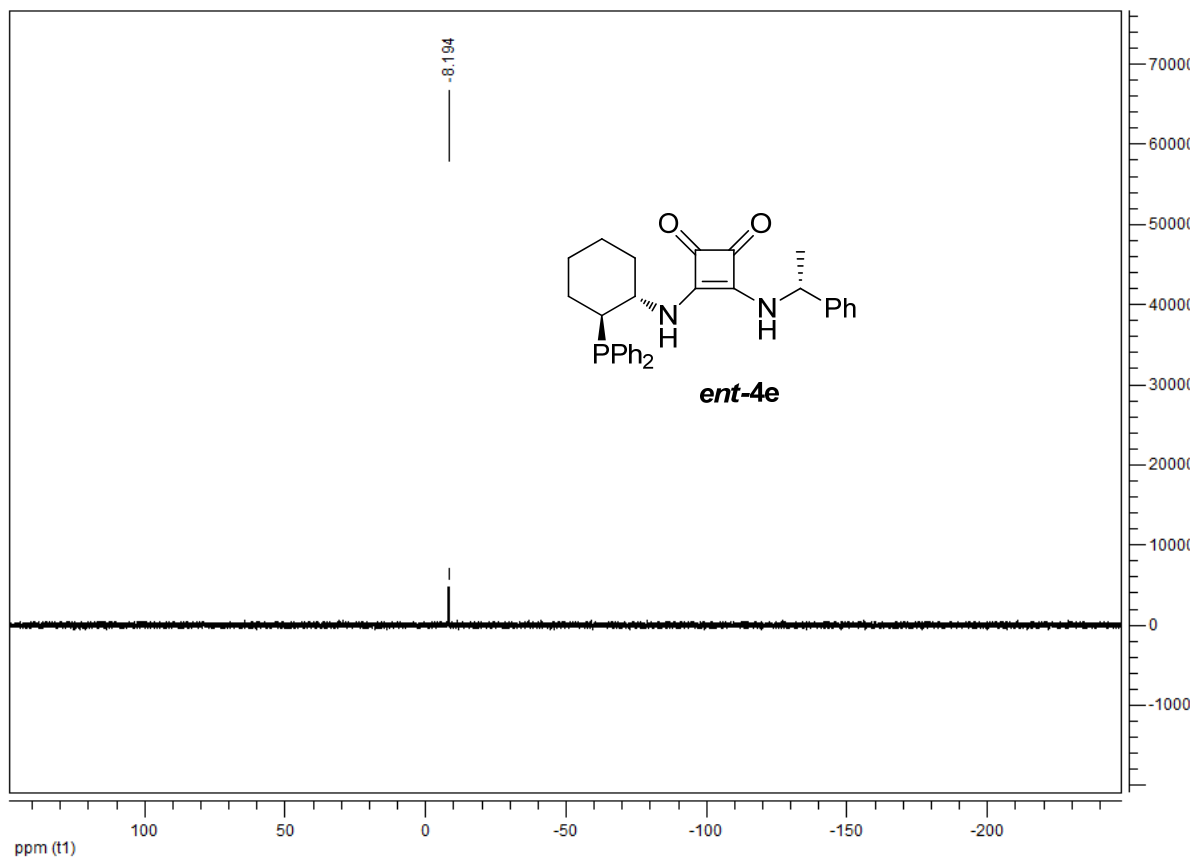
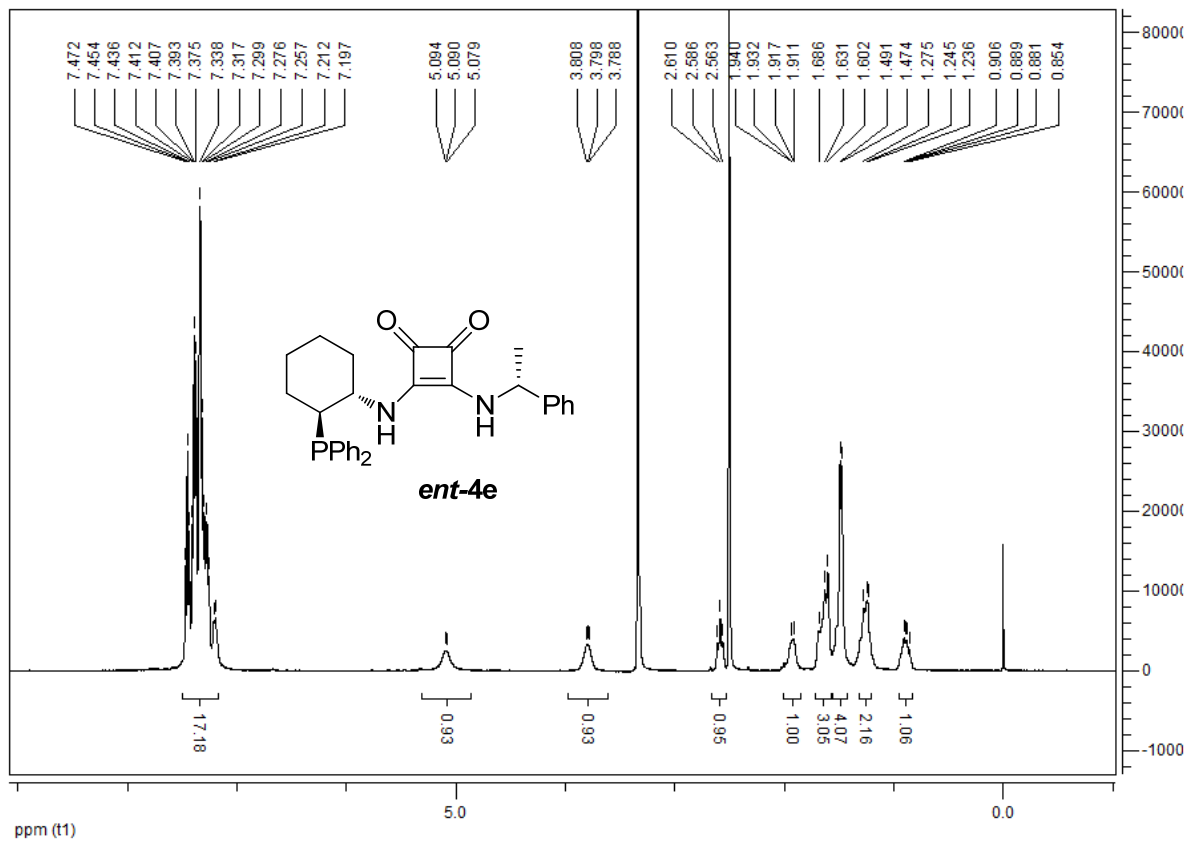
2.3 3-((1*S*,2*S*)-2-(diphenylphosphino)cyclohexylamino)-4-((*R*)-1-phenylethylamino)cyclobut-3-ene-1,2-dione (*ent*-**4e**)

White solid, 39% yield, Mp > 300 °C;  $[\alpha]_D^{25} +40.8$  (*c* 0.25, DMSO);  $^1\text{H}$  NMR (DMSO-*d*<sub>6</sub>, 400 MHz): 7.47-7.20 (m, 17H), 5.09-5.08 (m, 1H), 3.80-3.79 (m, 1H), 2.61-2.56 (m, 1H), 1.94-1.91 (m, 1H), 1.69-1.60 (m, 3H), 1.49-1.47 (m, 4H), 1.28-1.24 (m, 2H), 0.91-0.85 (m, 1H);  $^{13}\text{C}$  NMR data can not be obtained for the poor solubility of *ent*-**4e** in organic solvent;  $^{31}\text{P}$  (DMSO-*d*<sub>6</sub>, 162 MHz): -8.19; IR (KBr,  $\text{cm}^{-1}$ ):  $\nu$  3166, 3068, 2937, 2854, 1800, 1644, 1563, 1477, 1187, 1143, 1088, 778, 748, 735, 694; HRMS (ESI) calcd for C<sub>30</sub>H<sub>30</sub>N<sub>2</sub>O<sub>2</sub>P ([M-H]<sup>-</sup>): 481.2045, found: 481.2047.

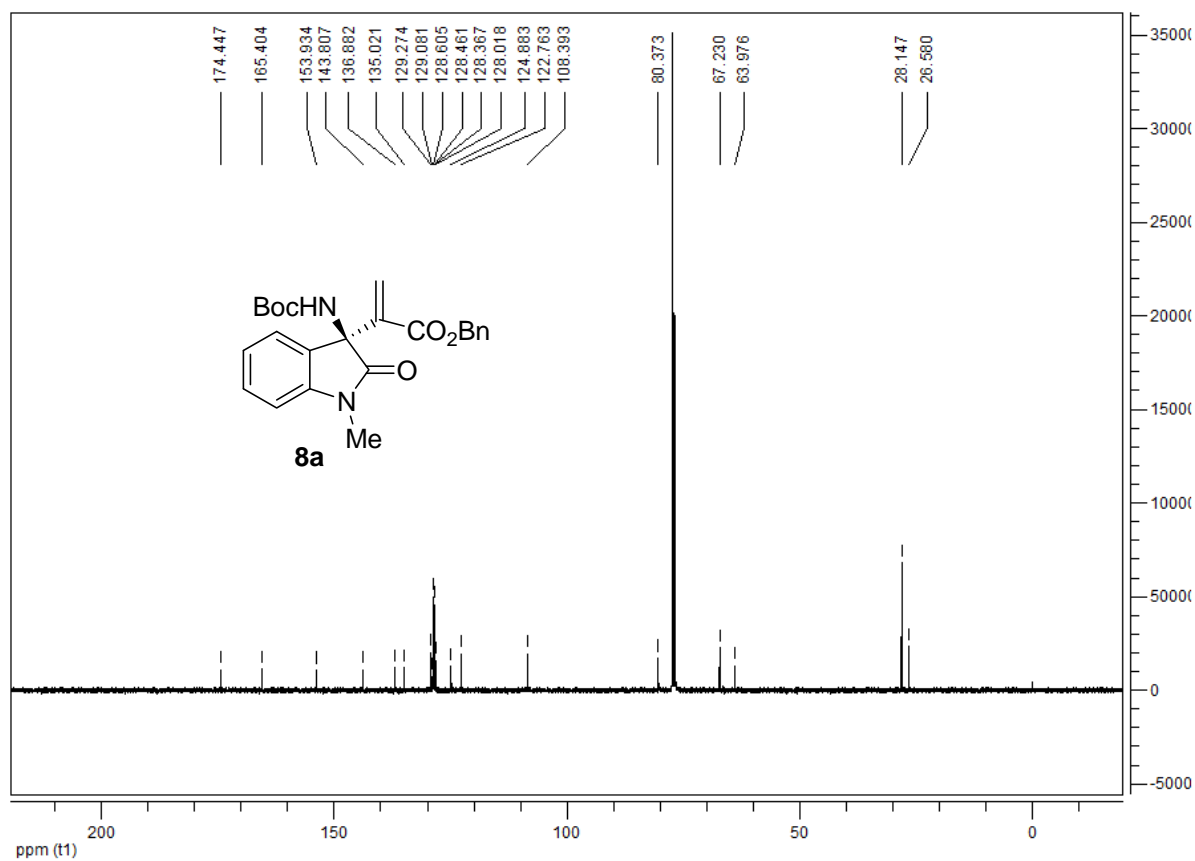
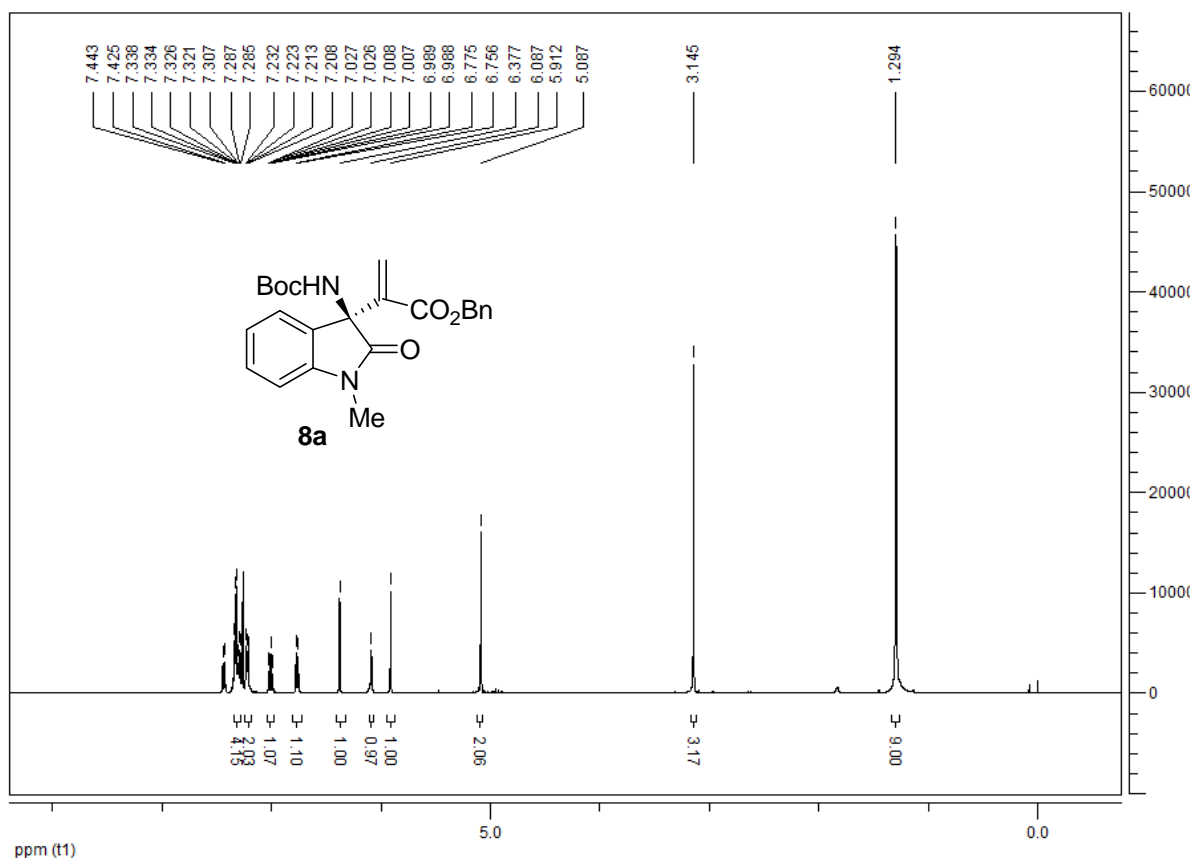
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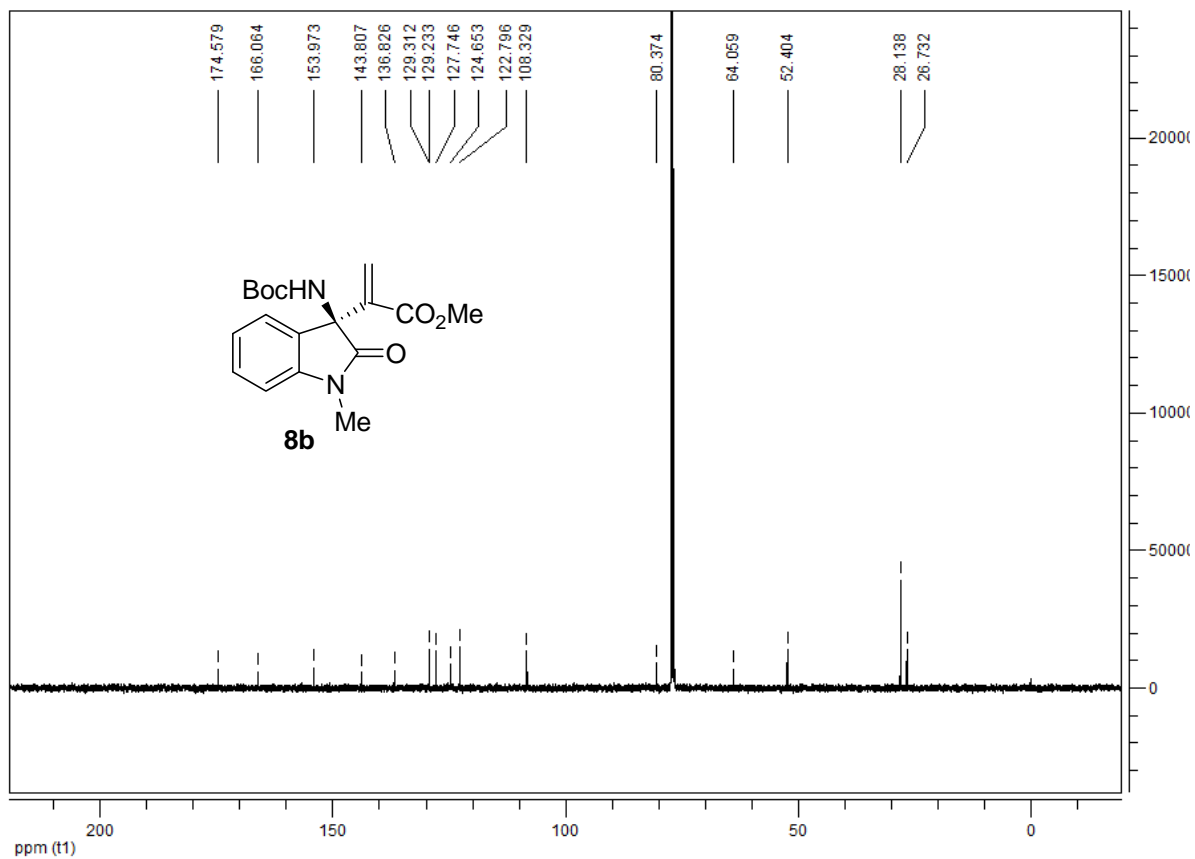
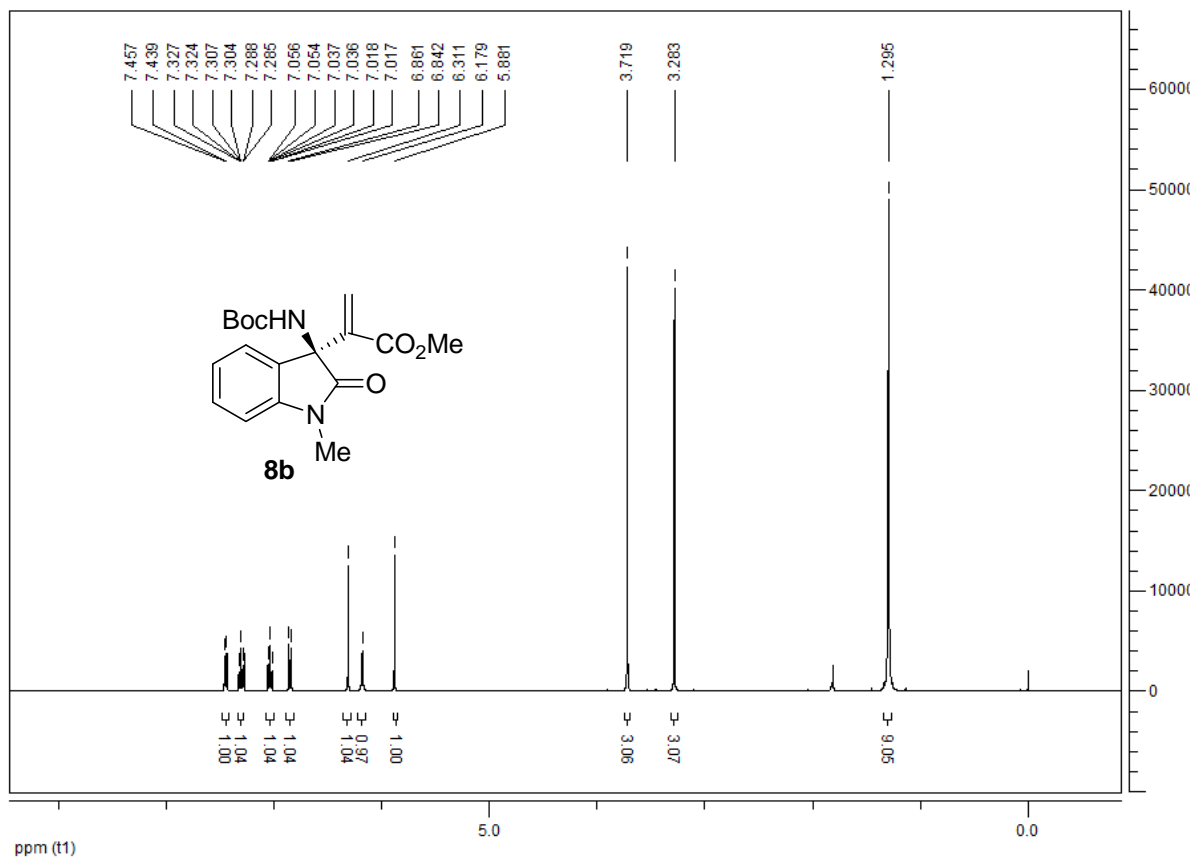




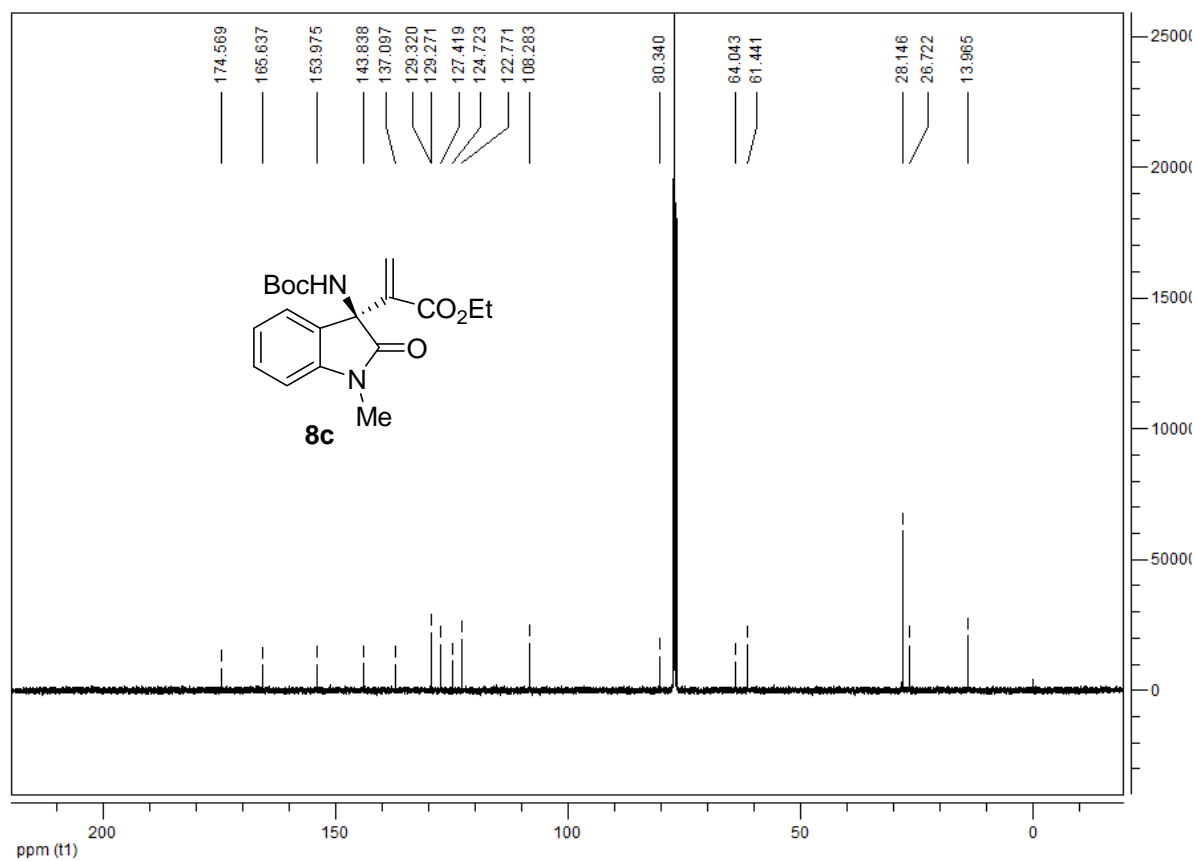
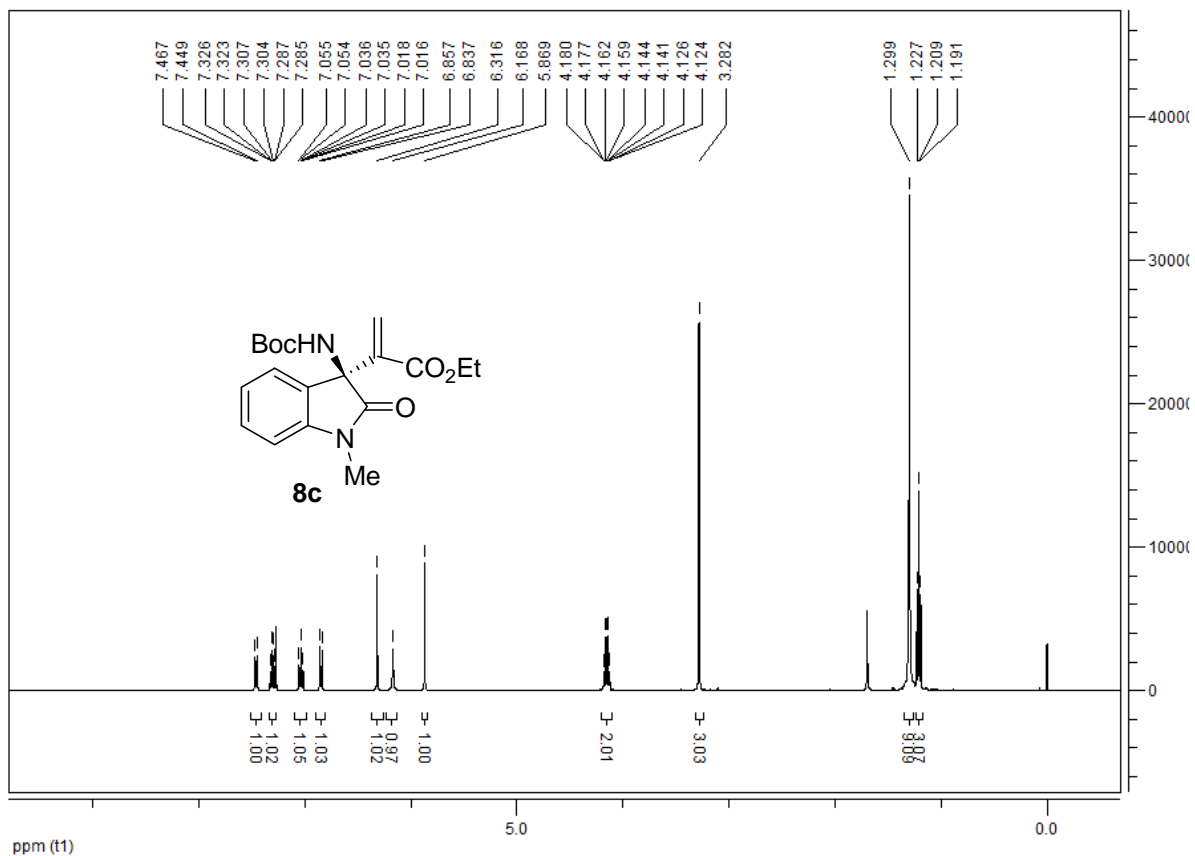


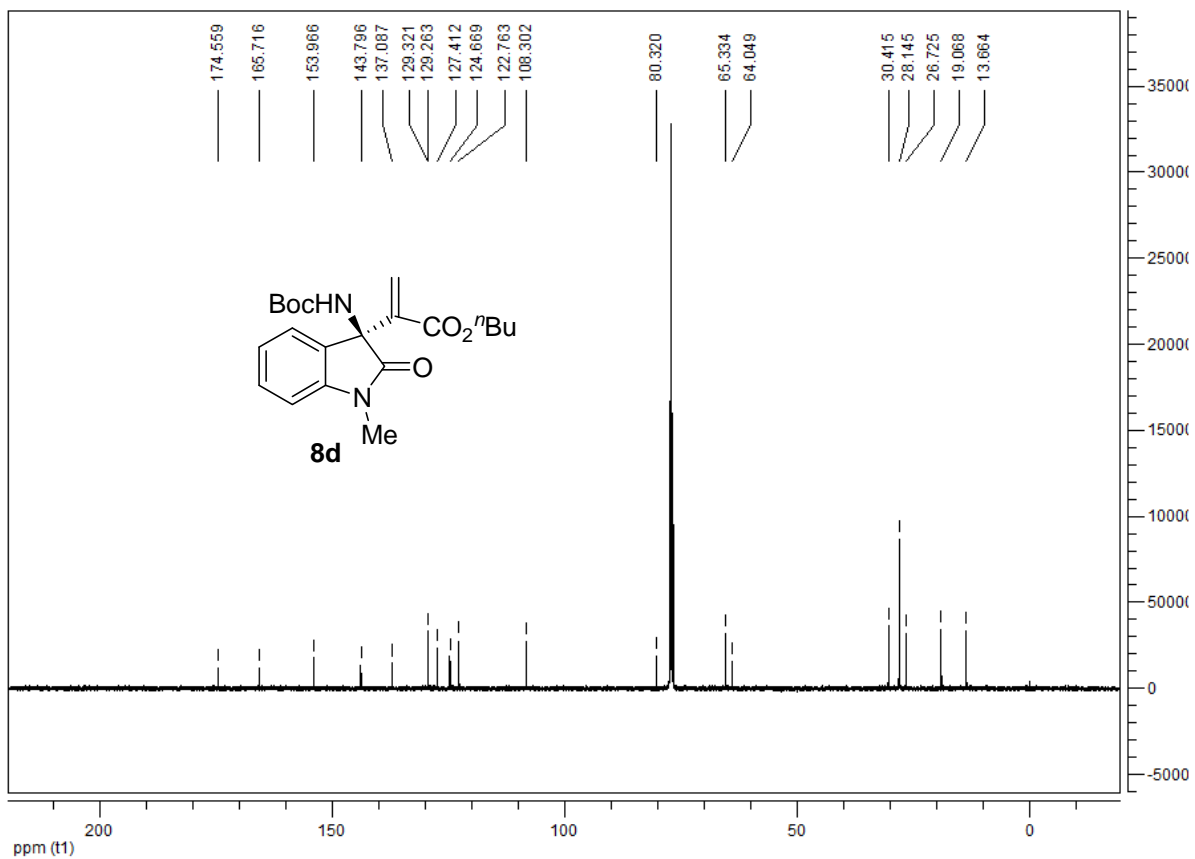
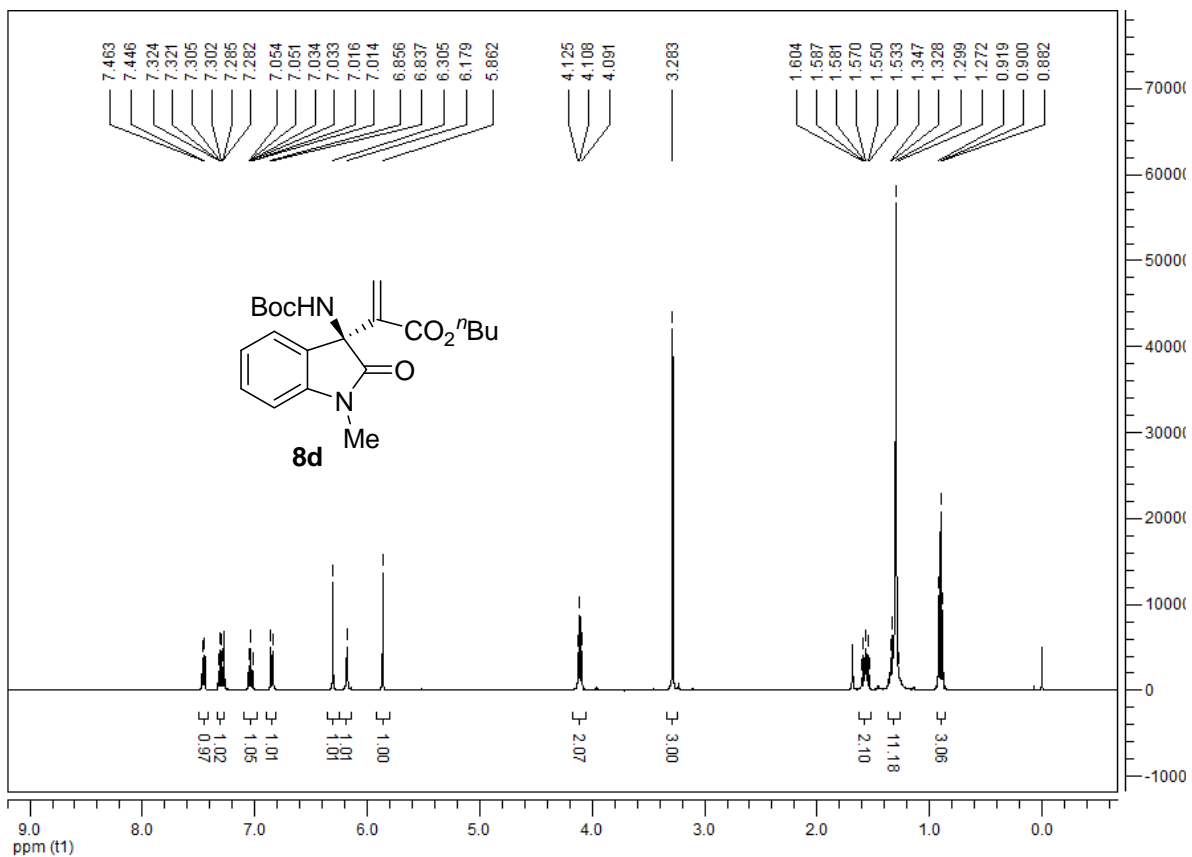
#### 4. Copies of NMR Spectra of Products 8a-s

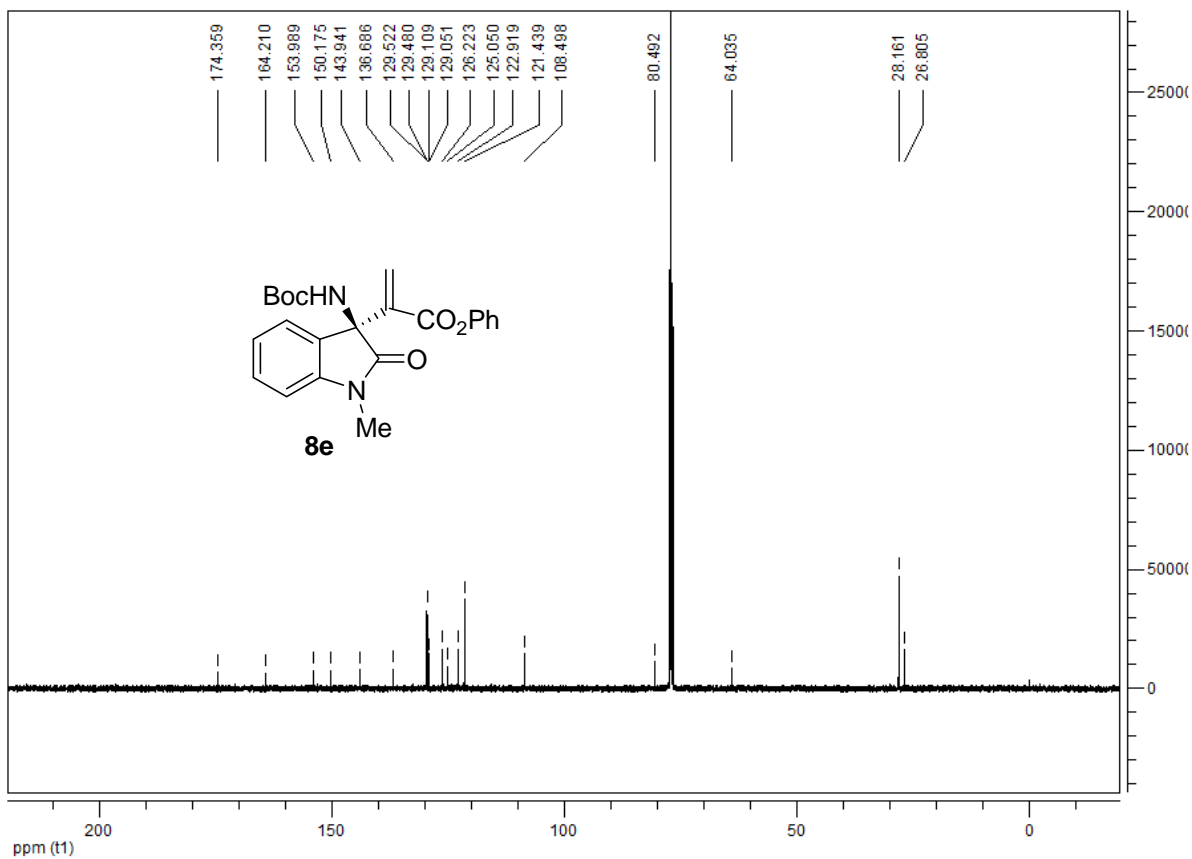
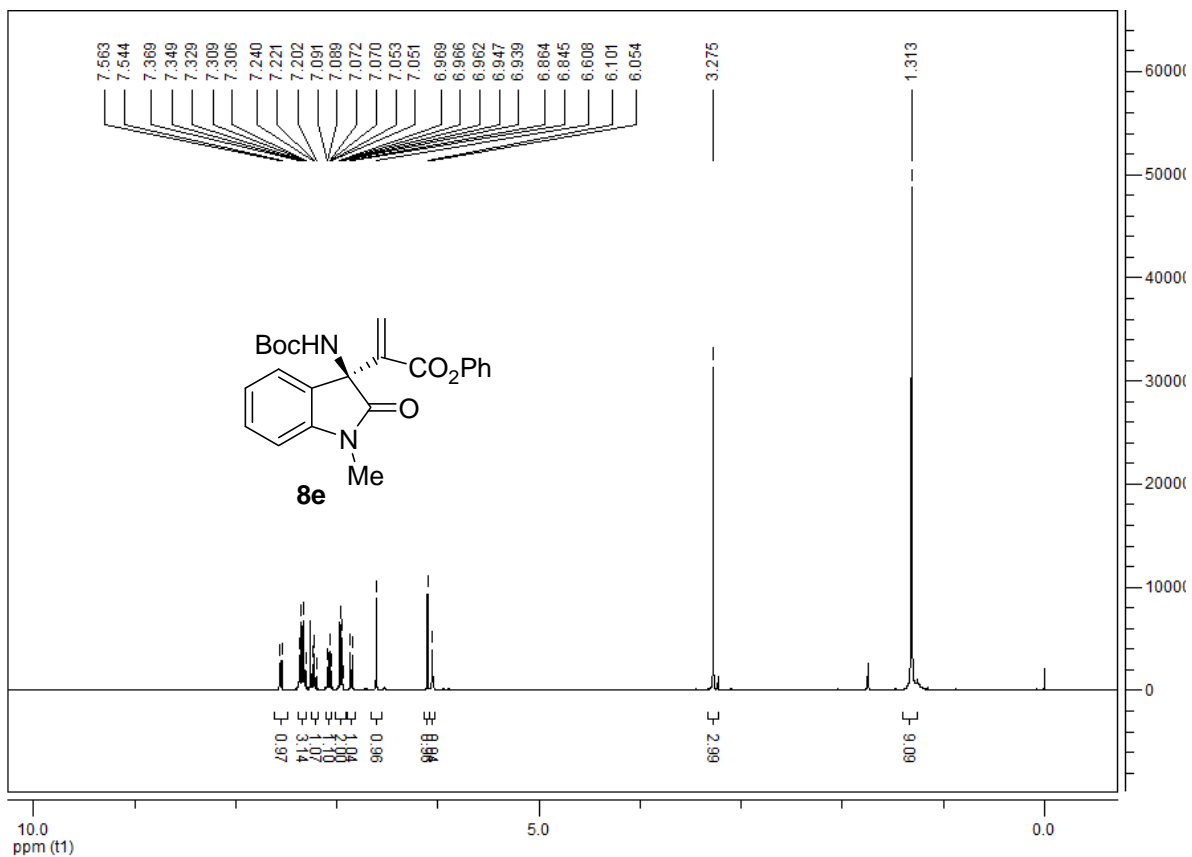


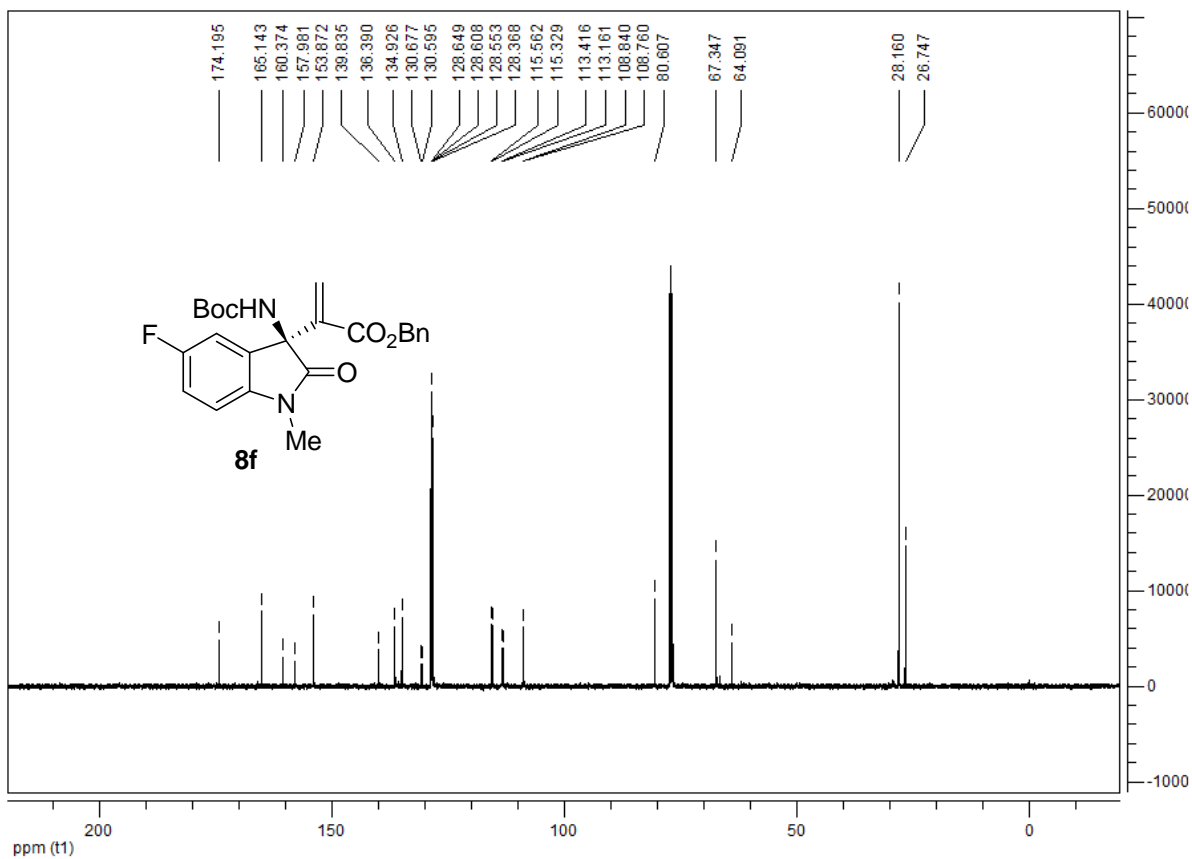
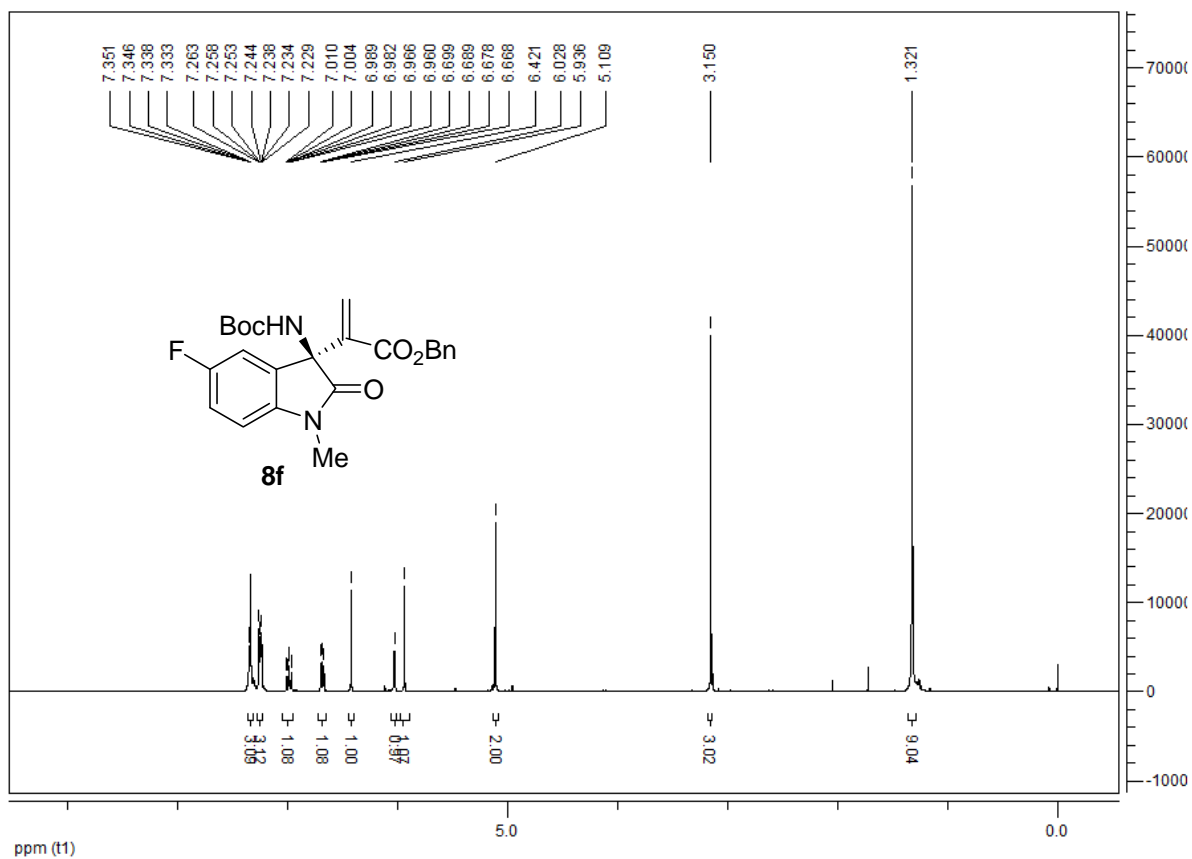


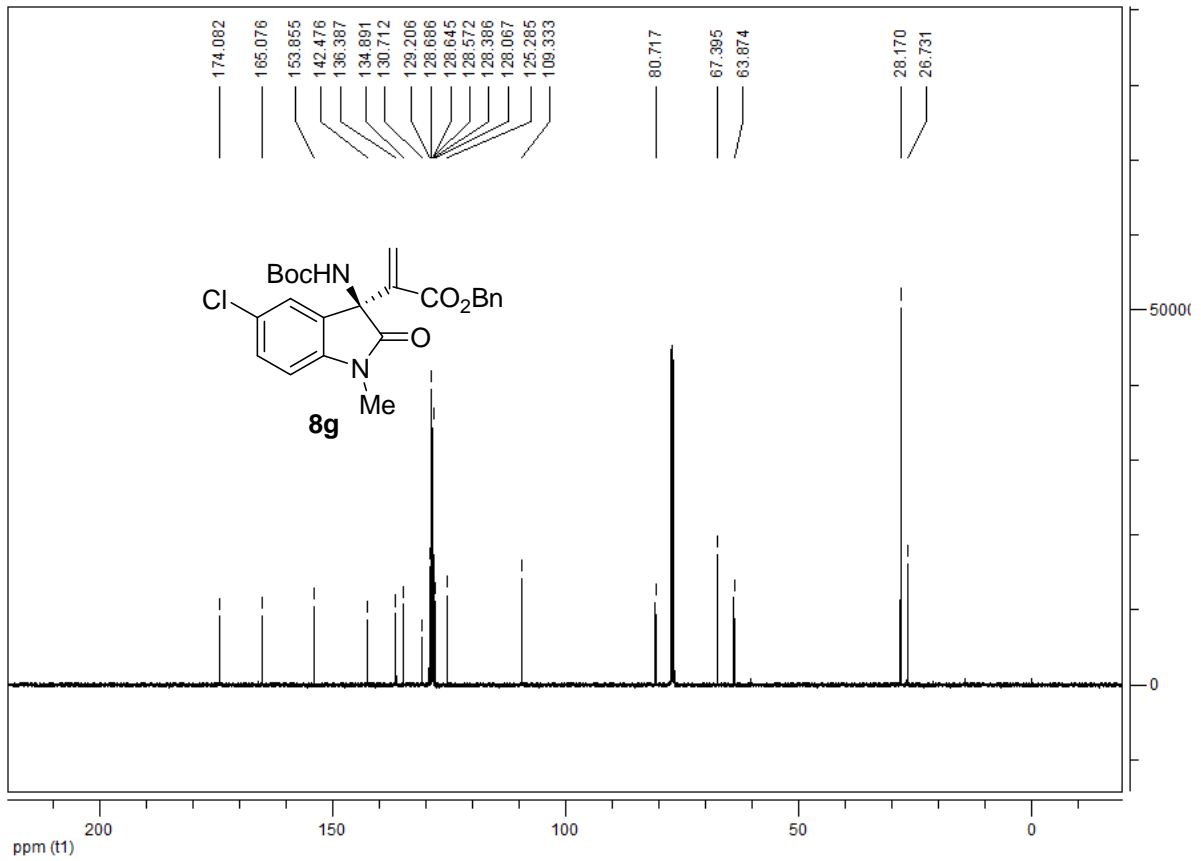
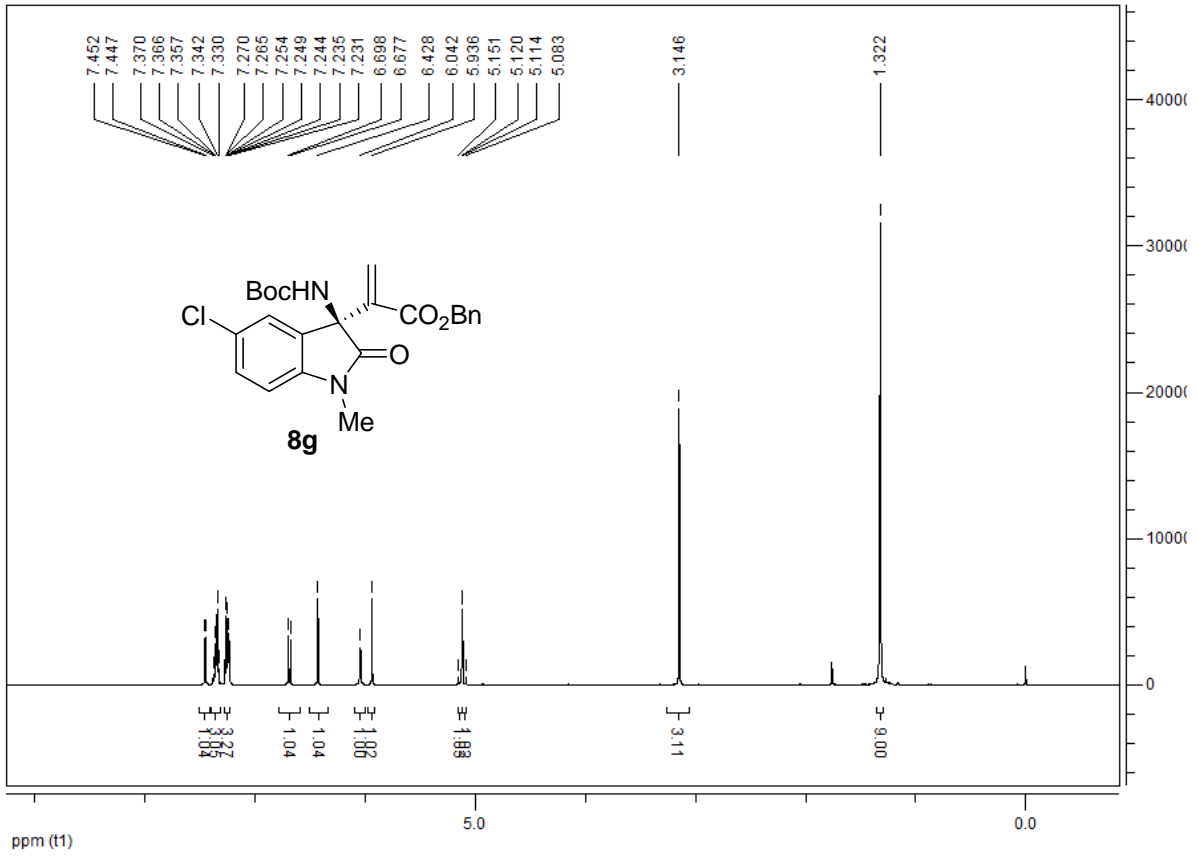


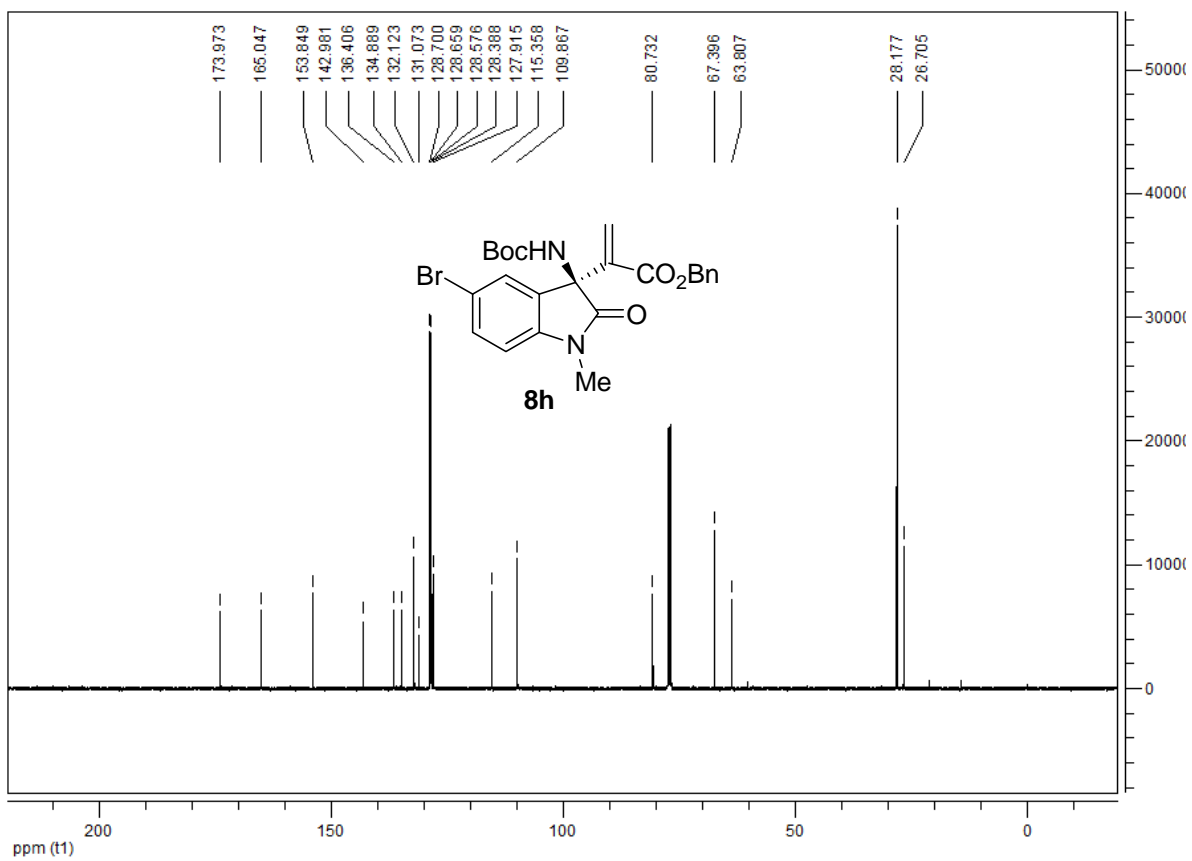
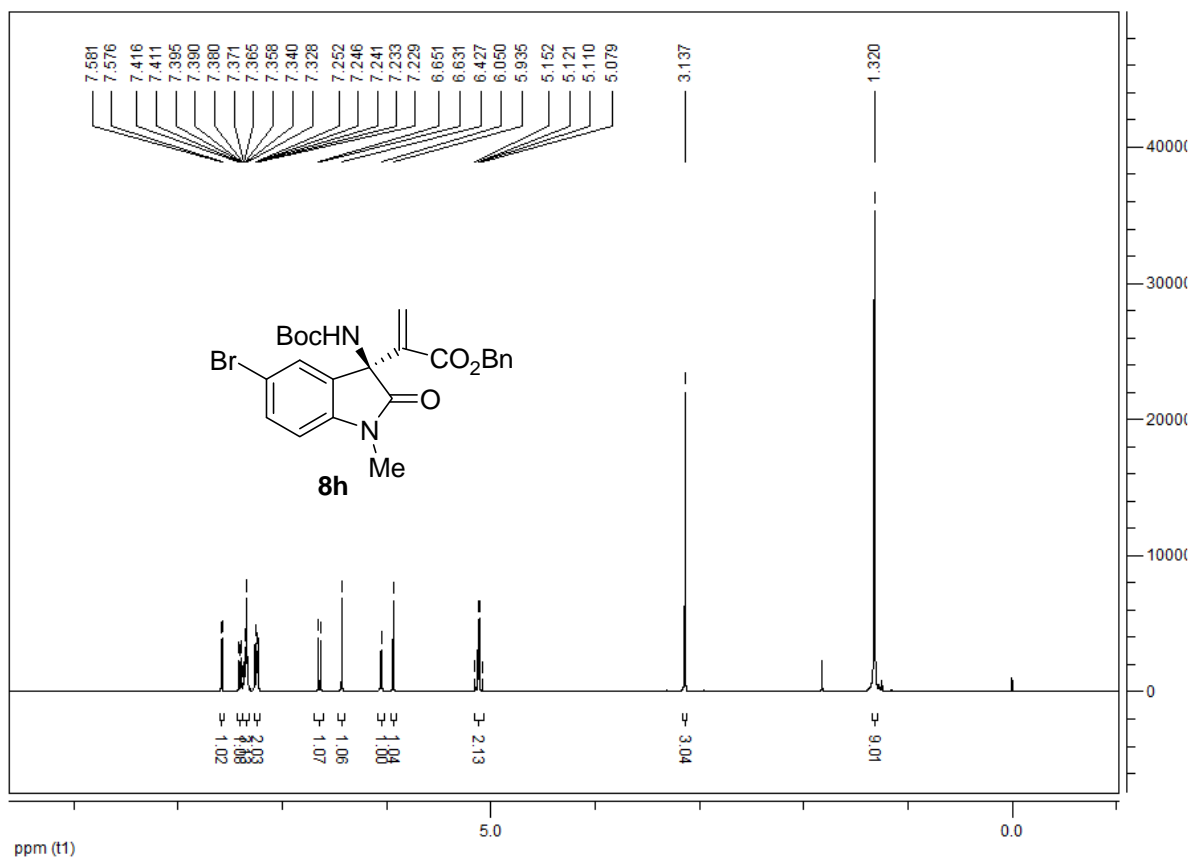


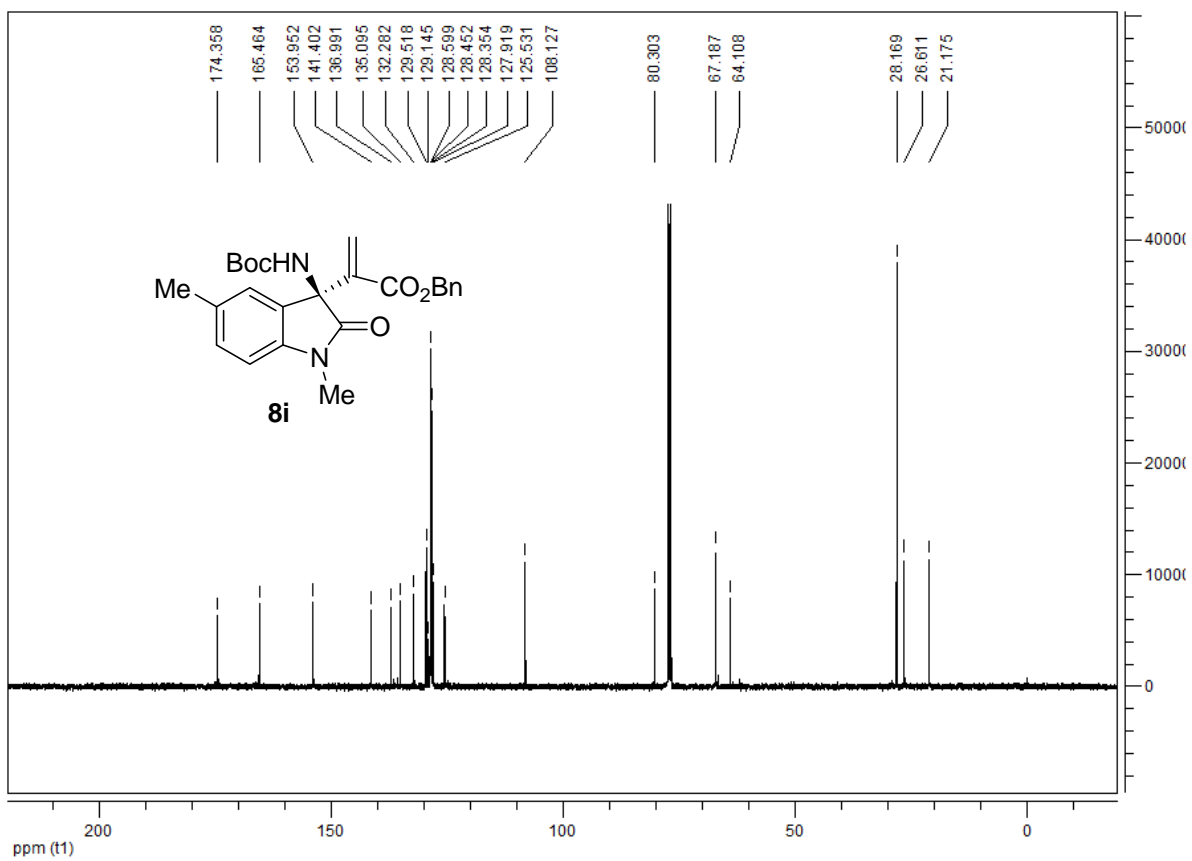
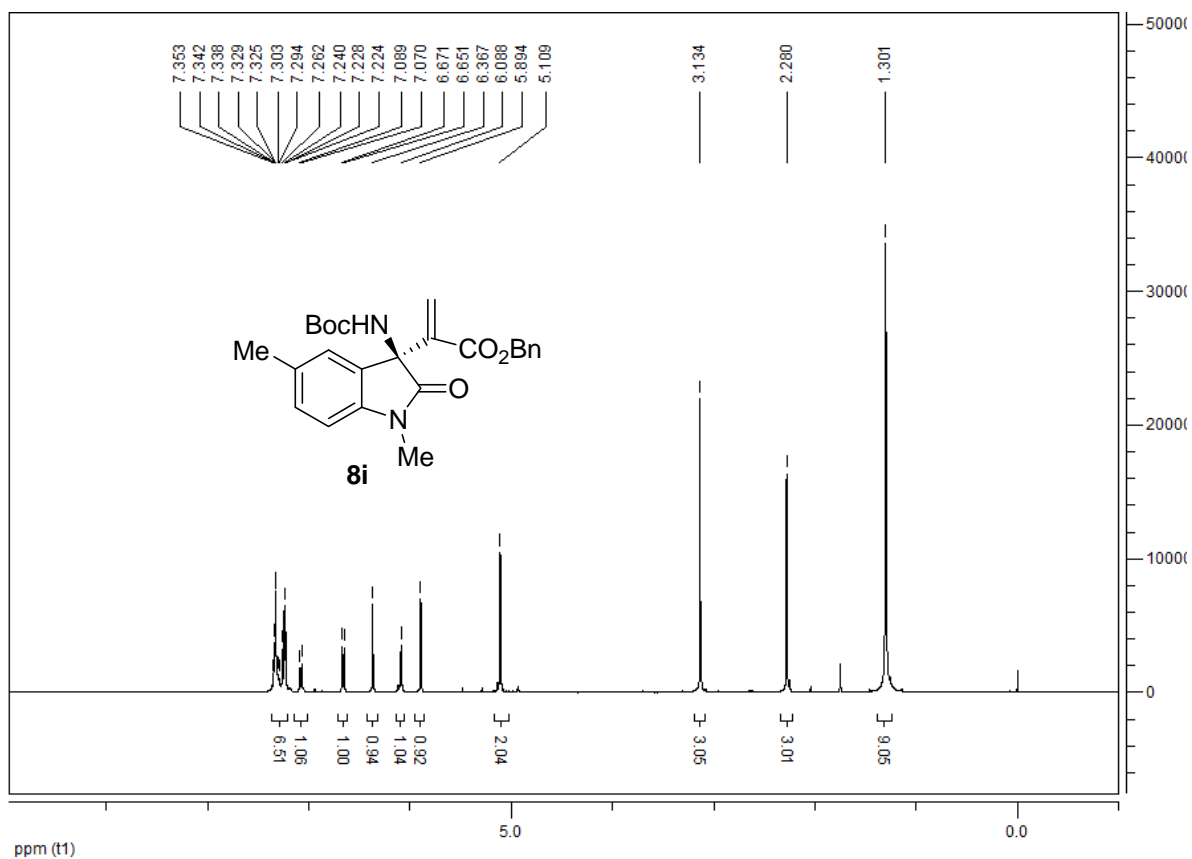


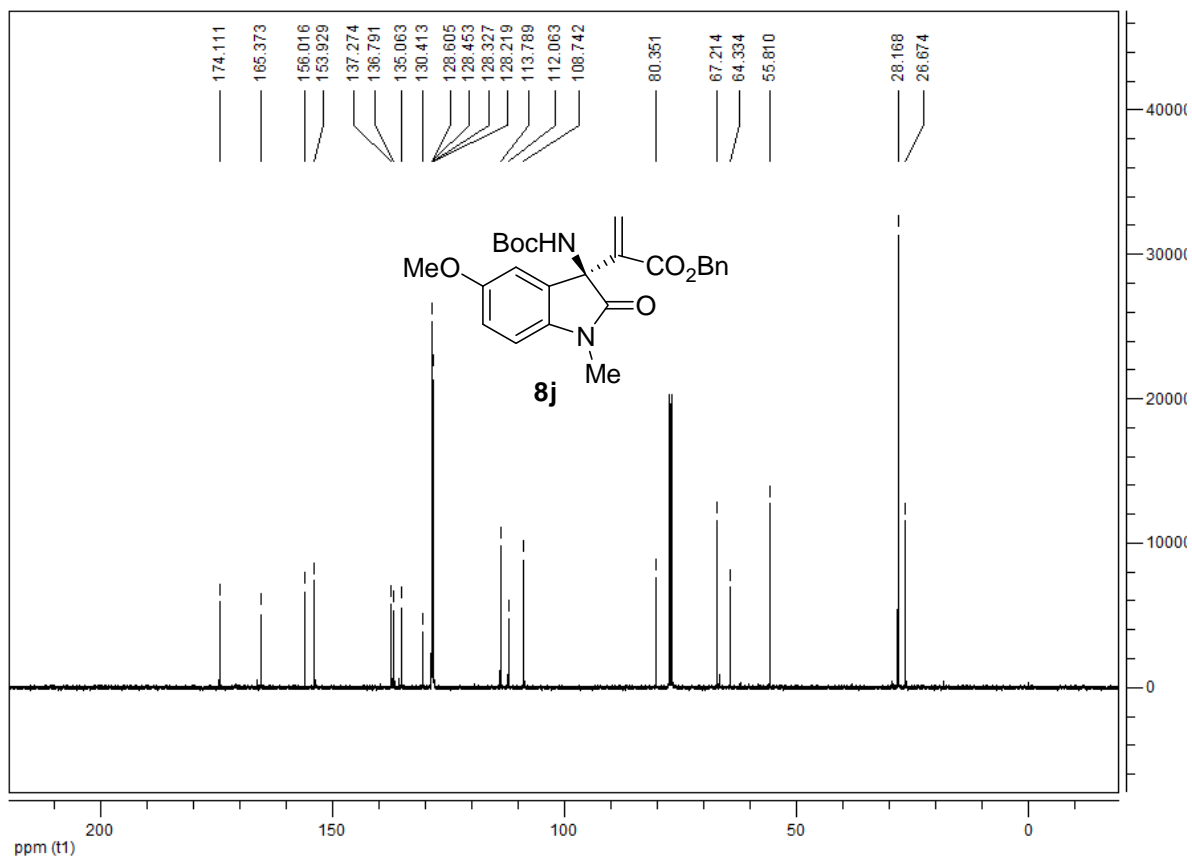
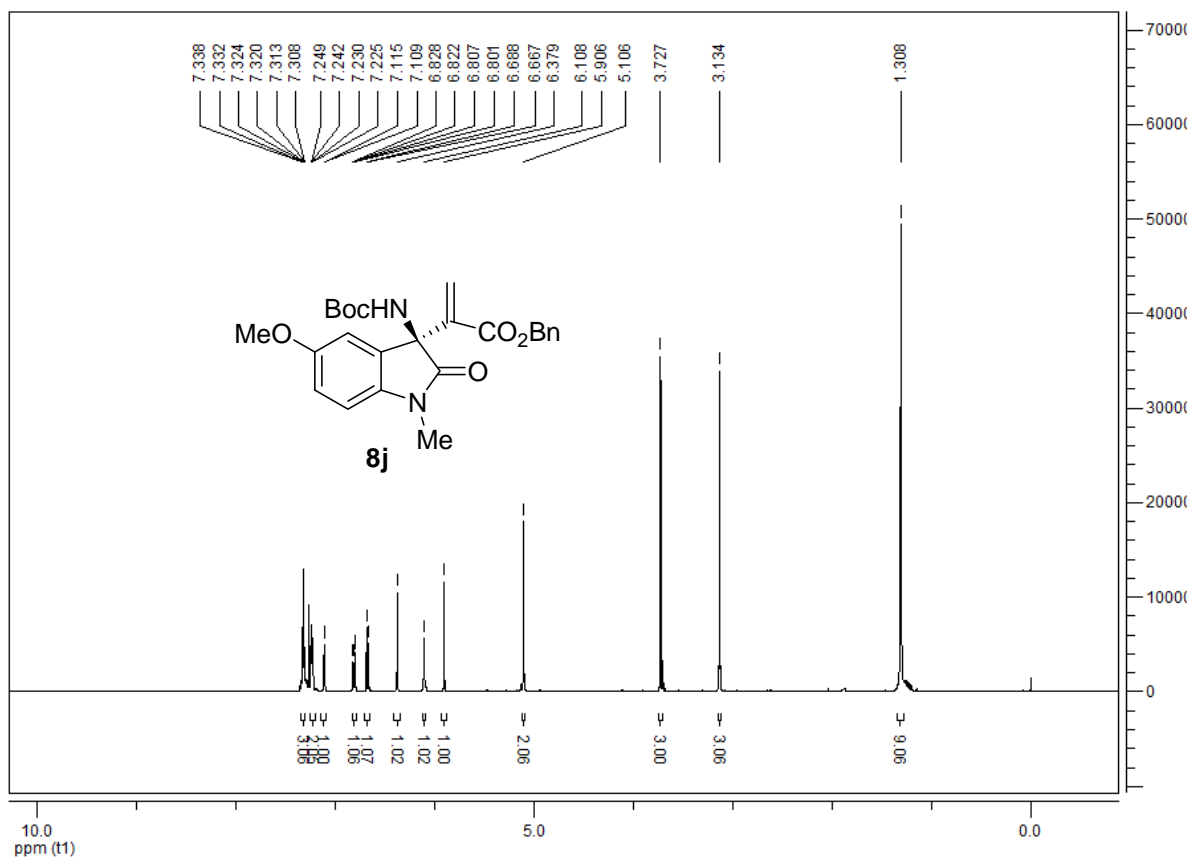




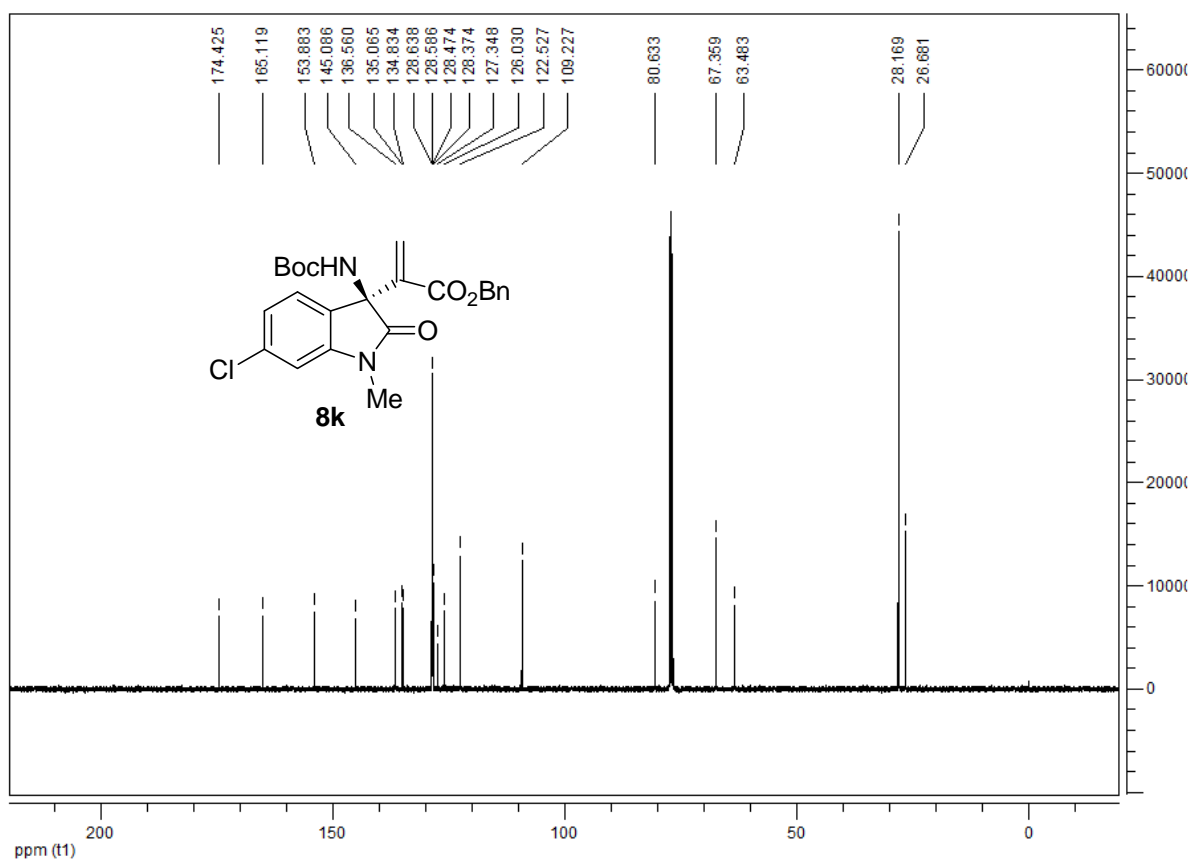
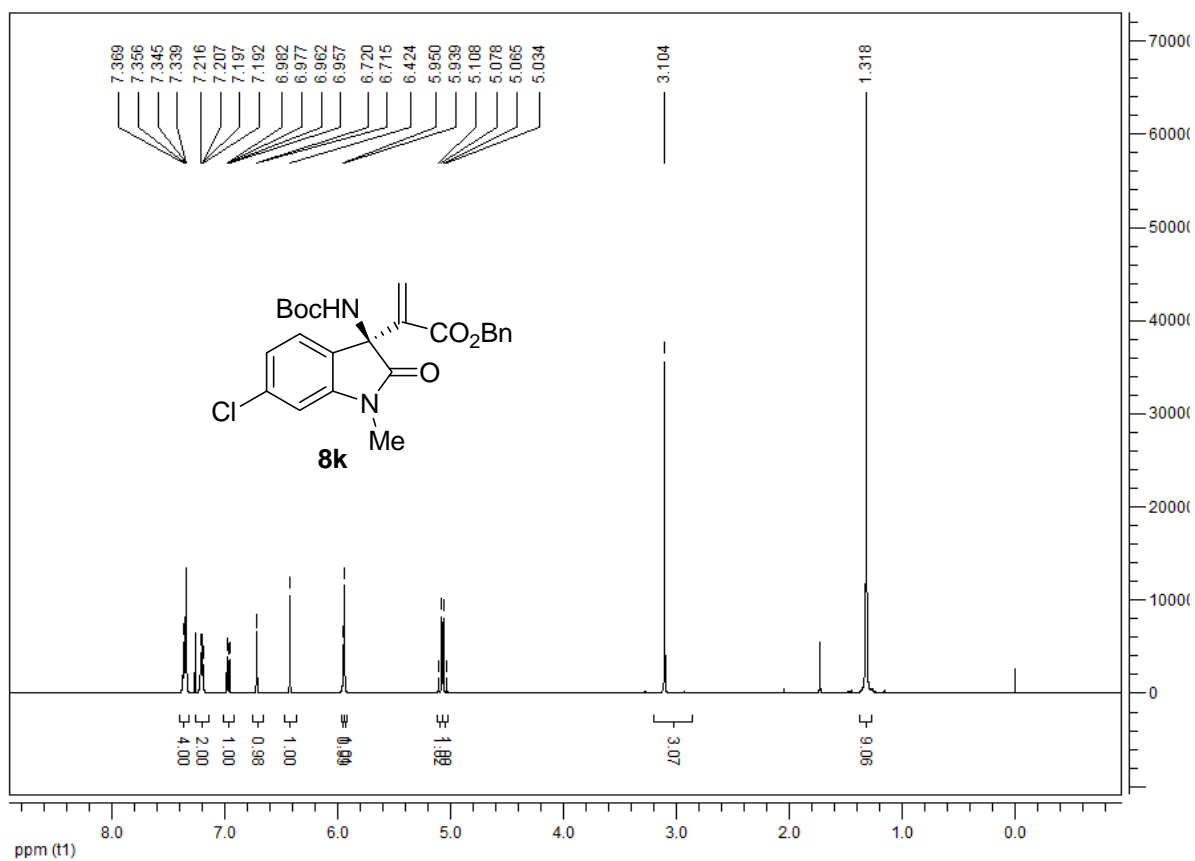


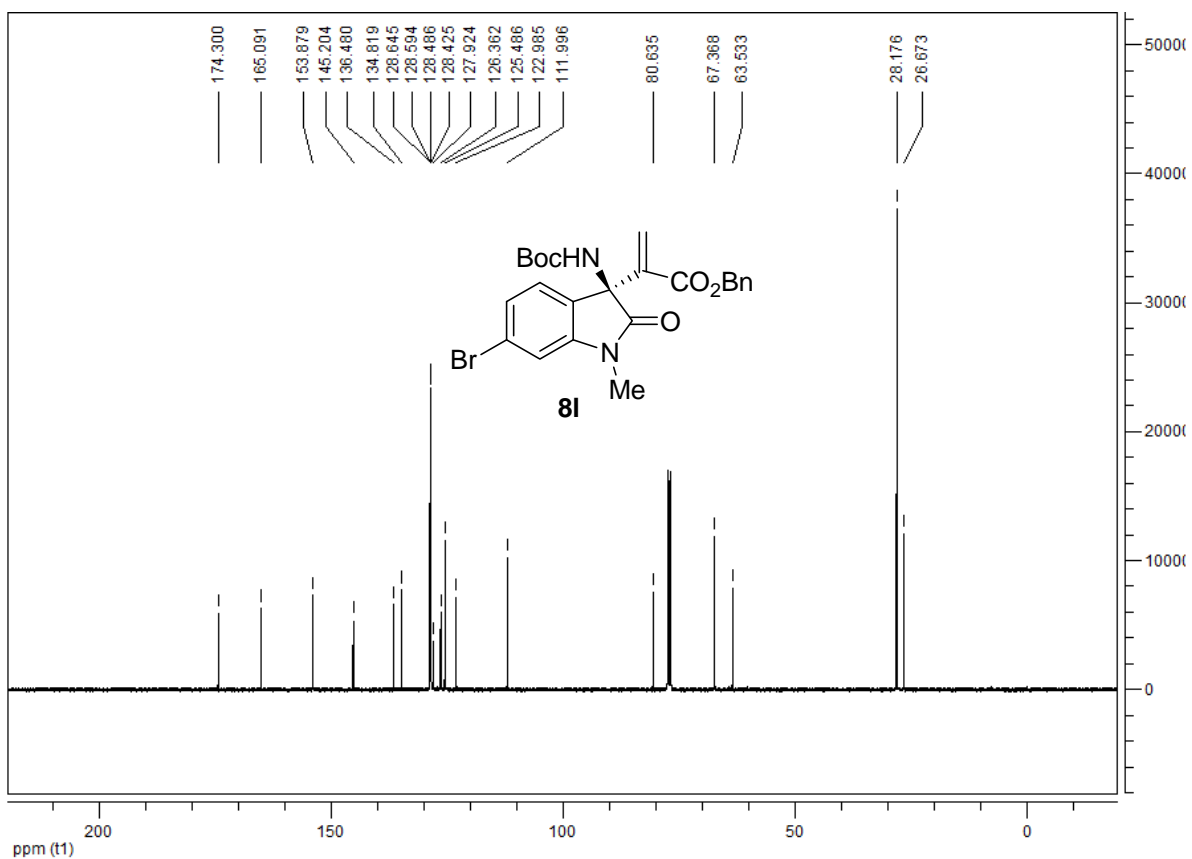
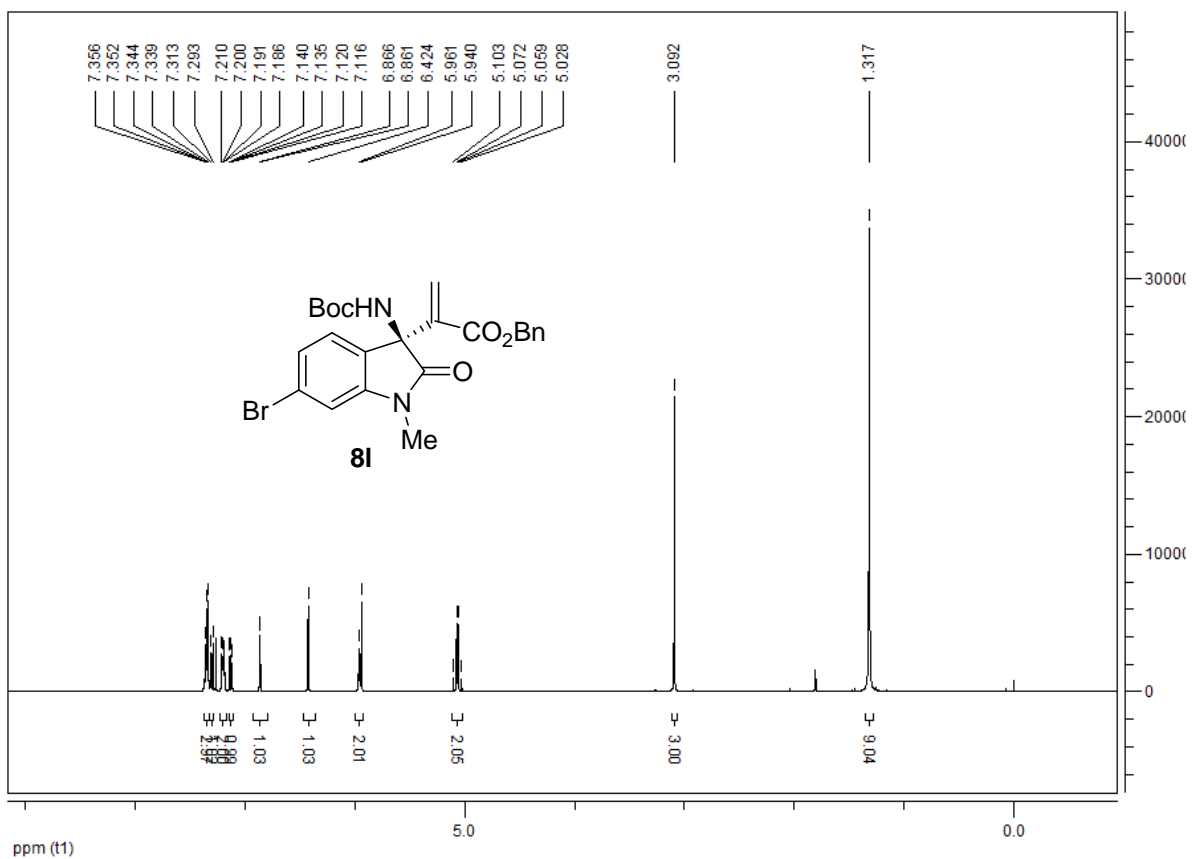


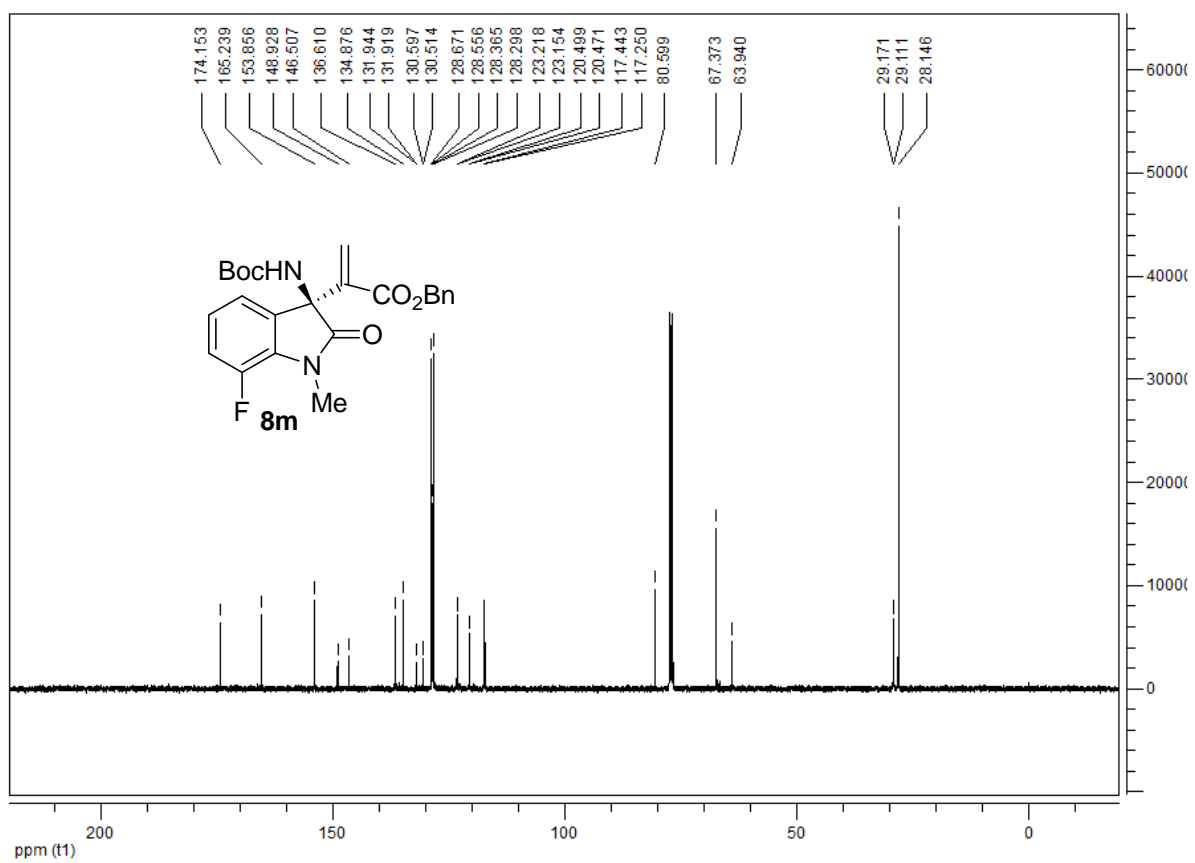
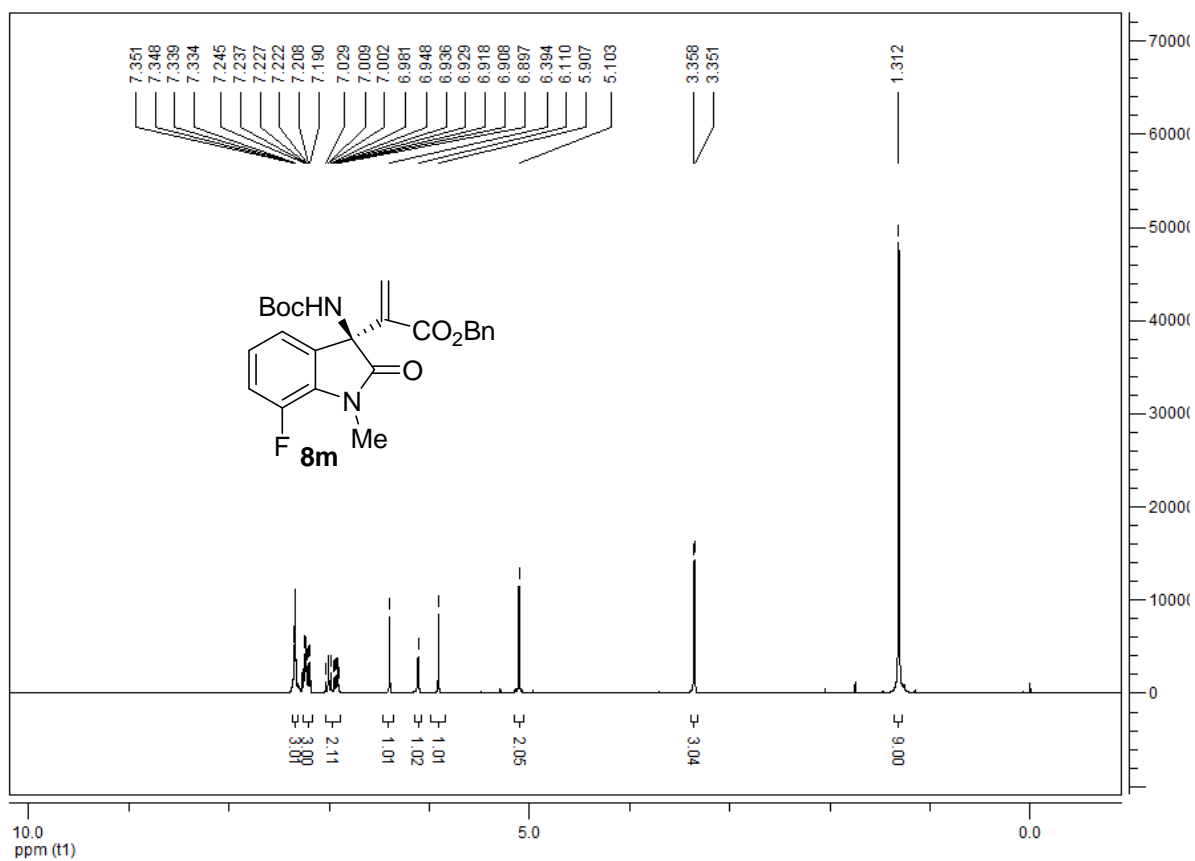


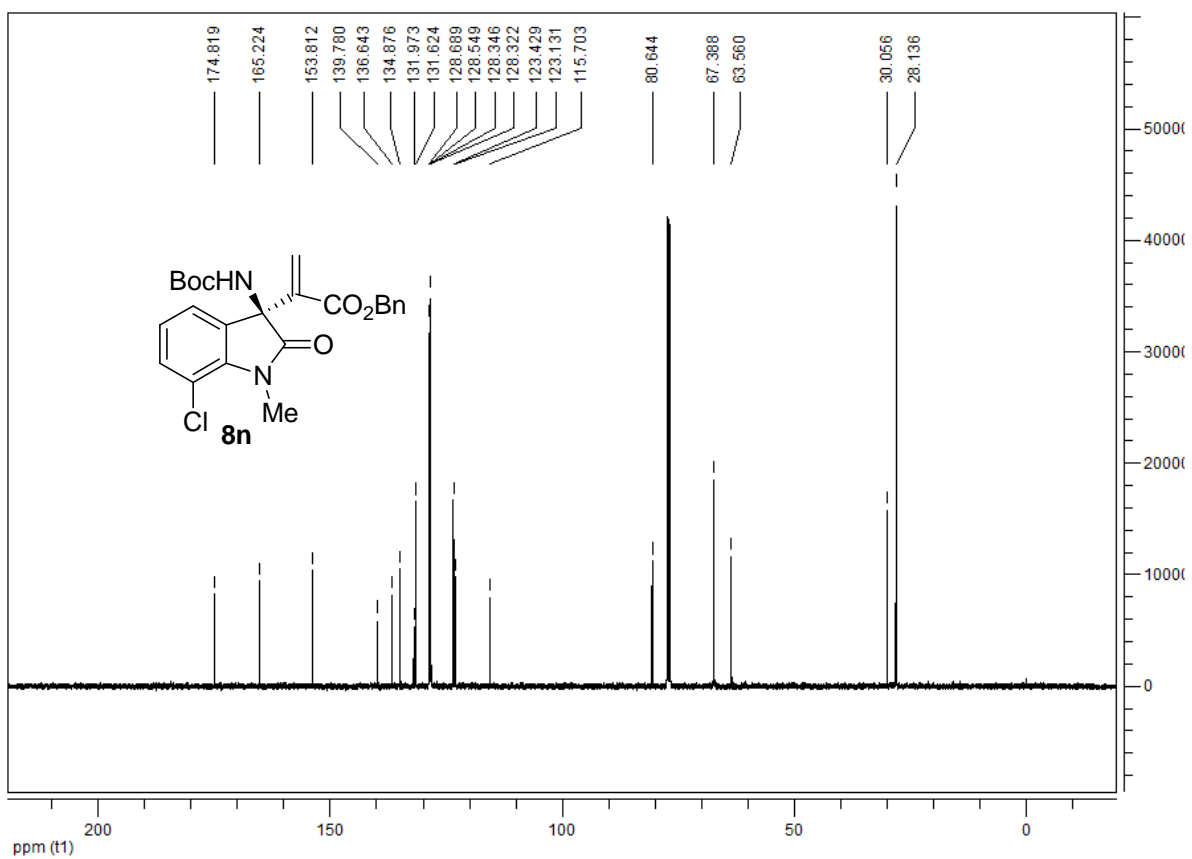
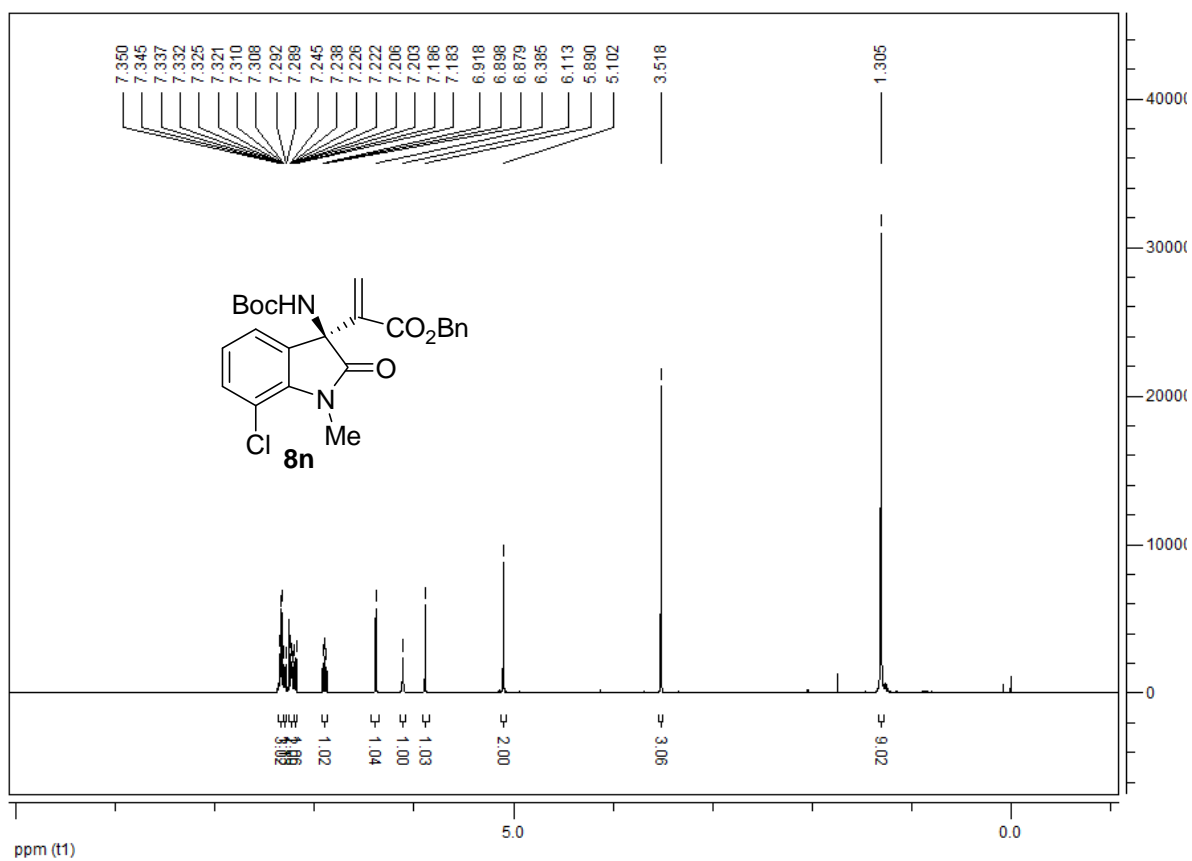


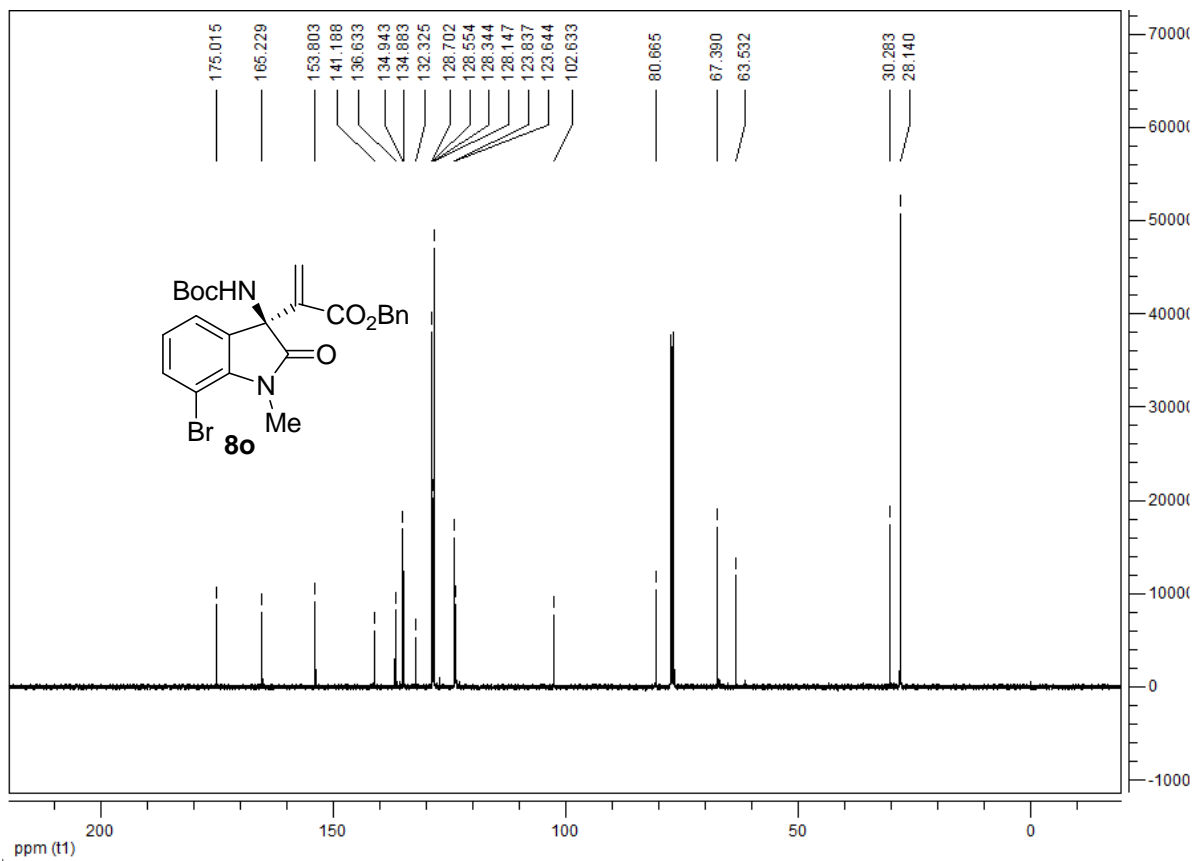
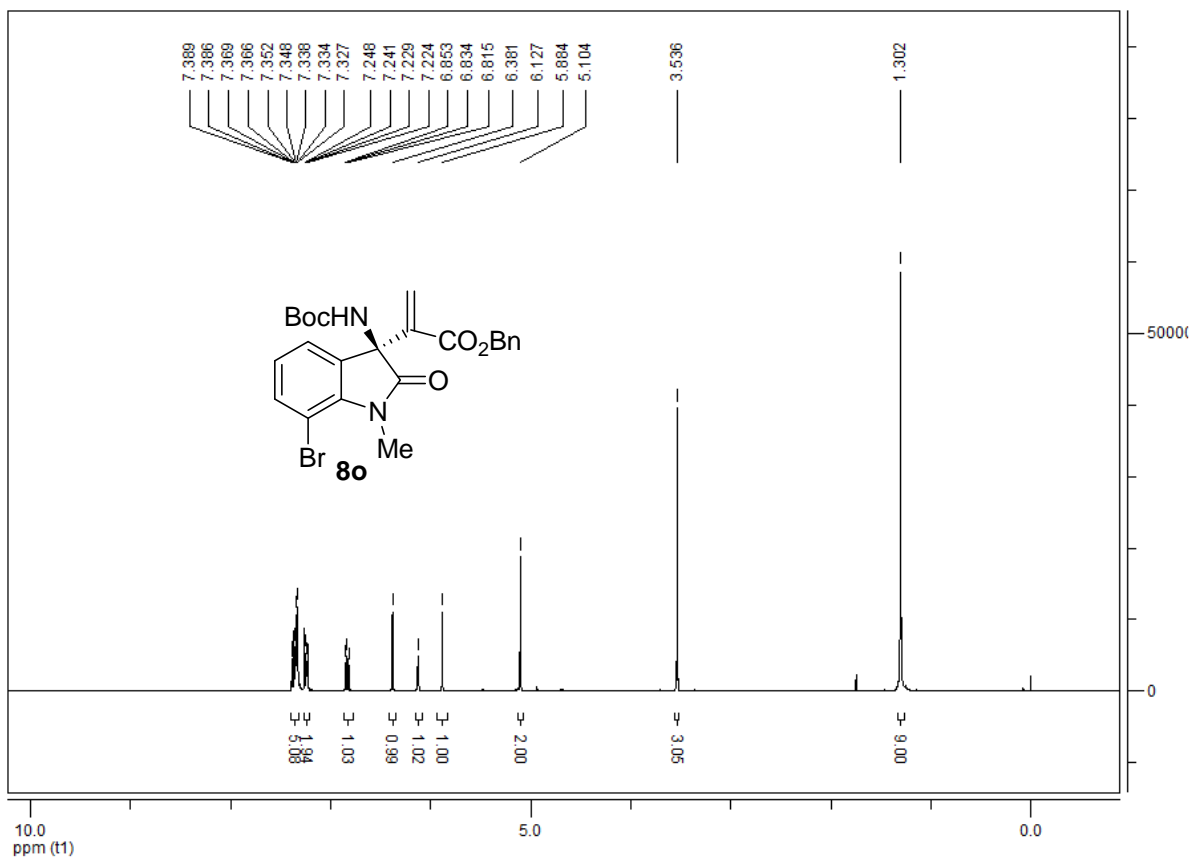


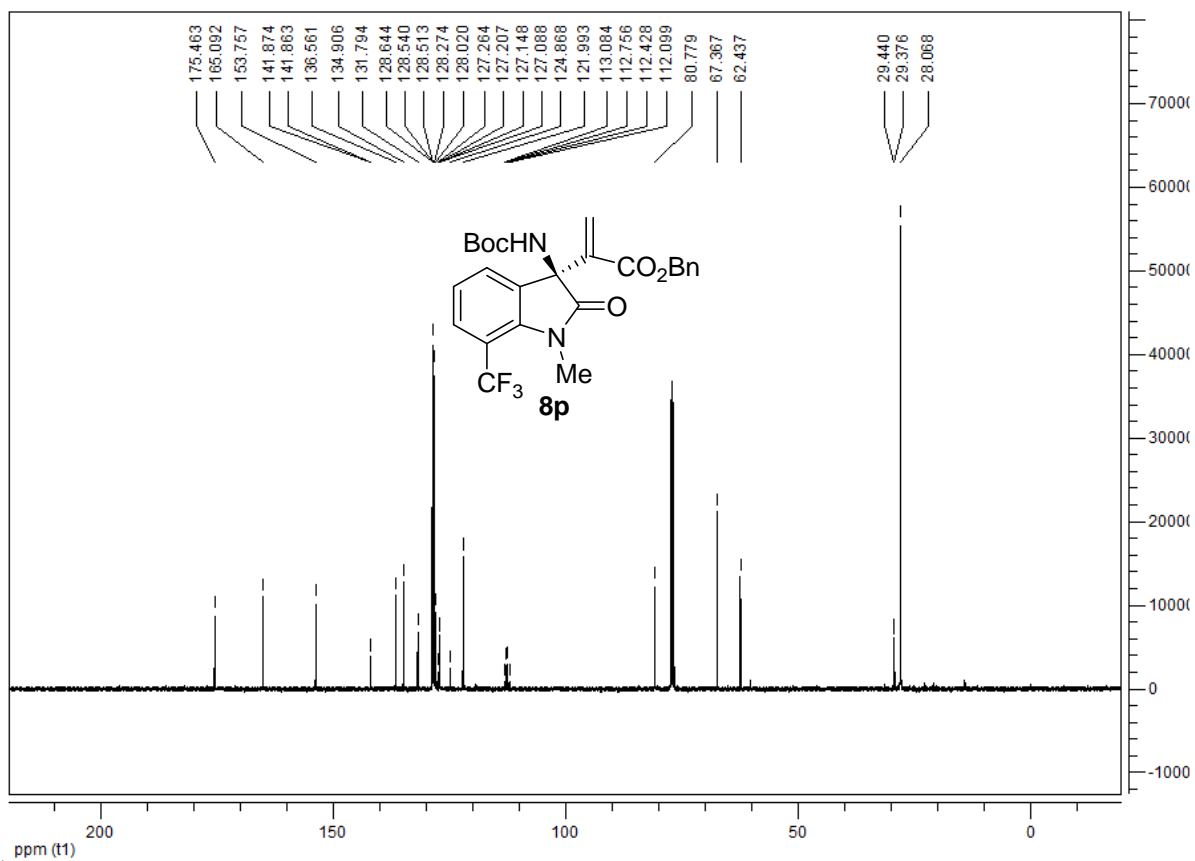
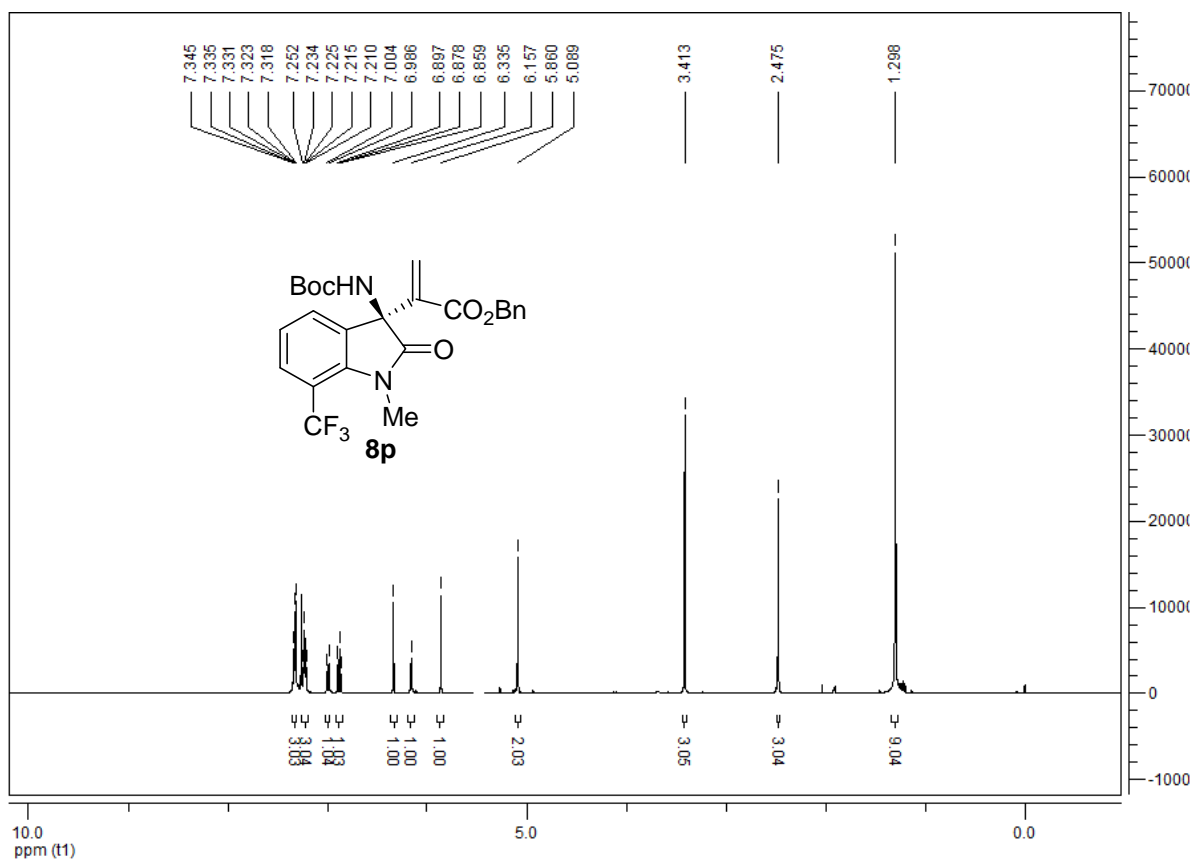


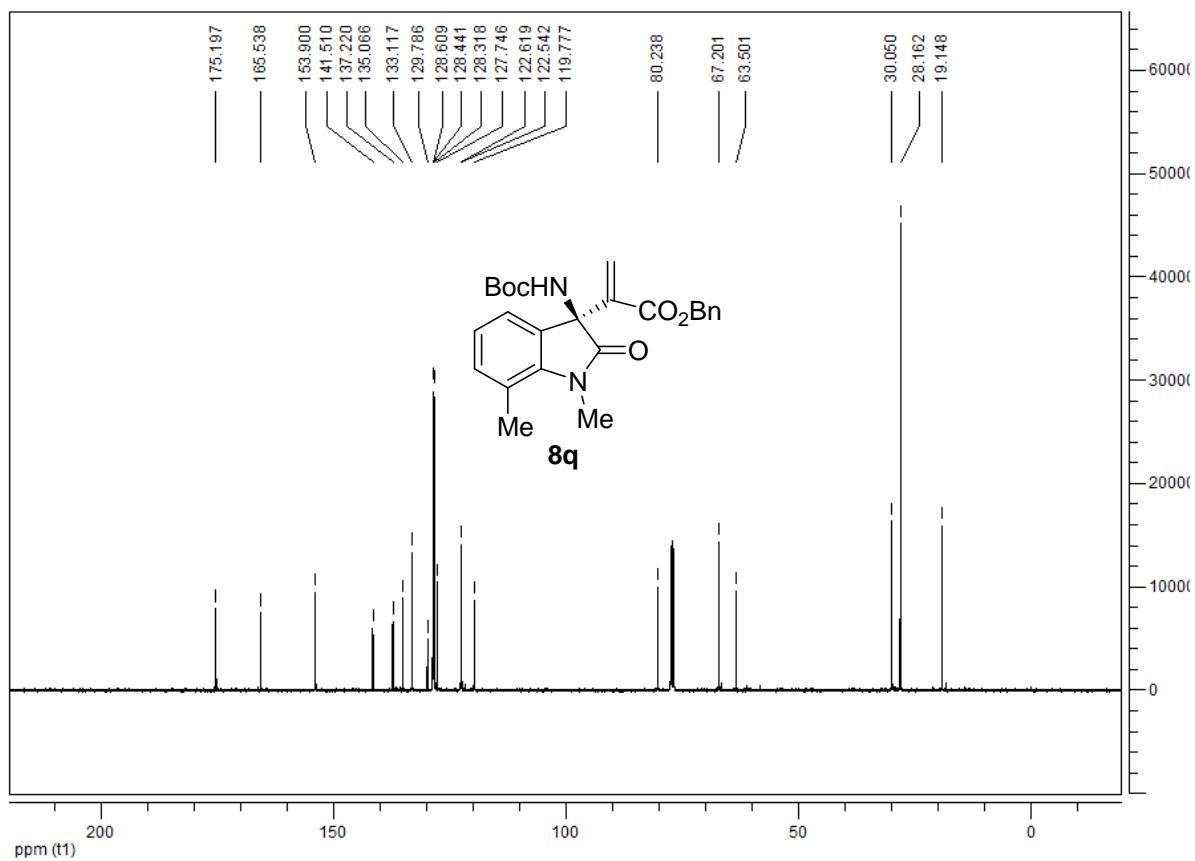
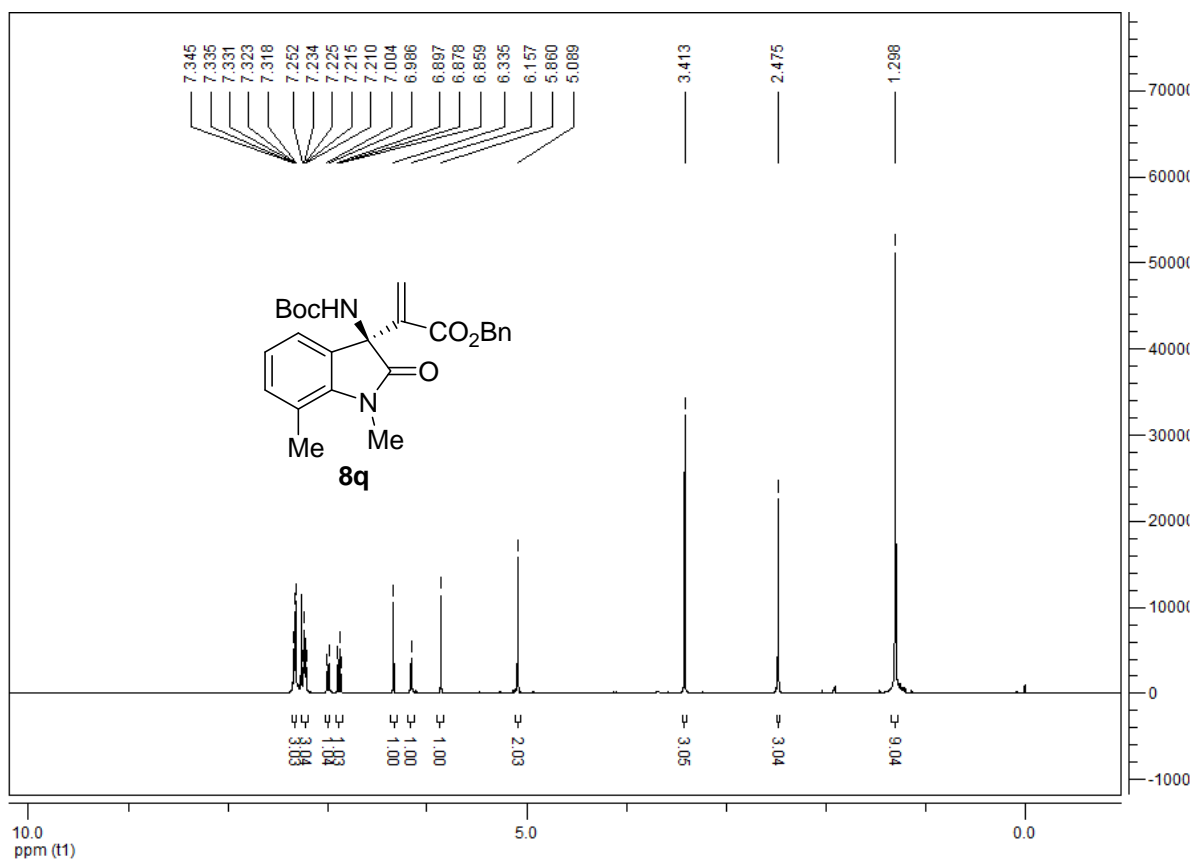


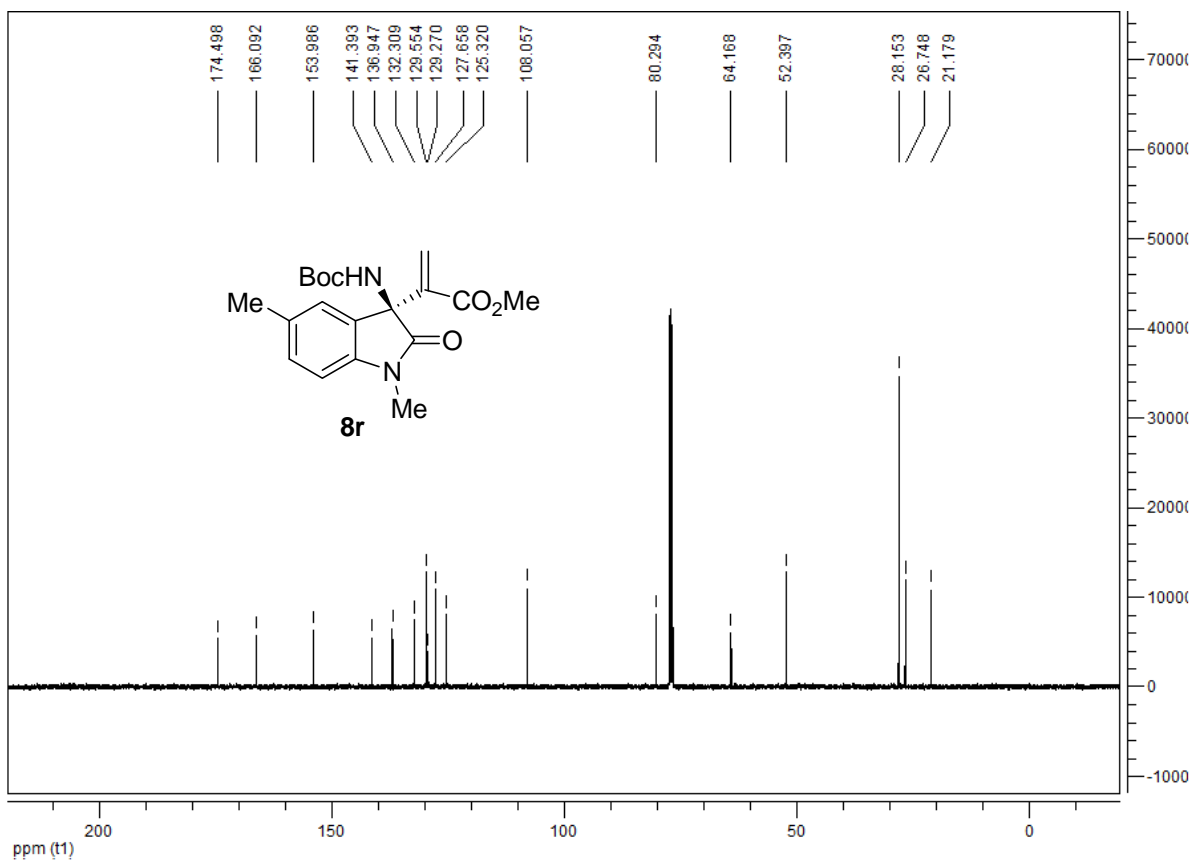
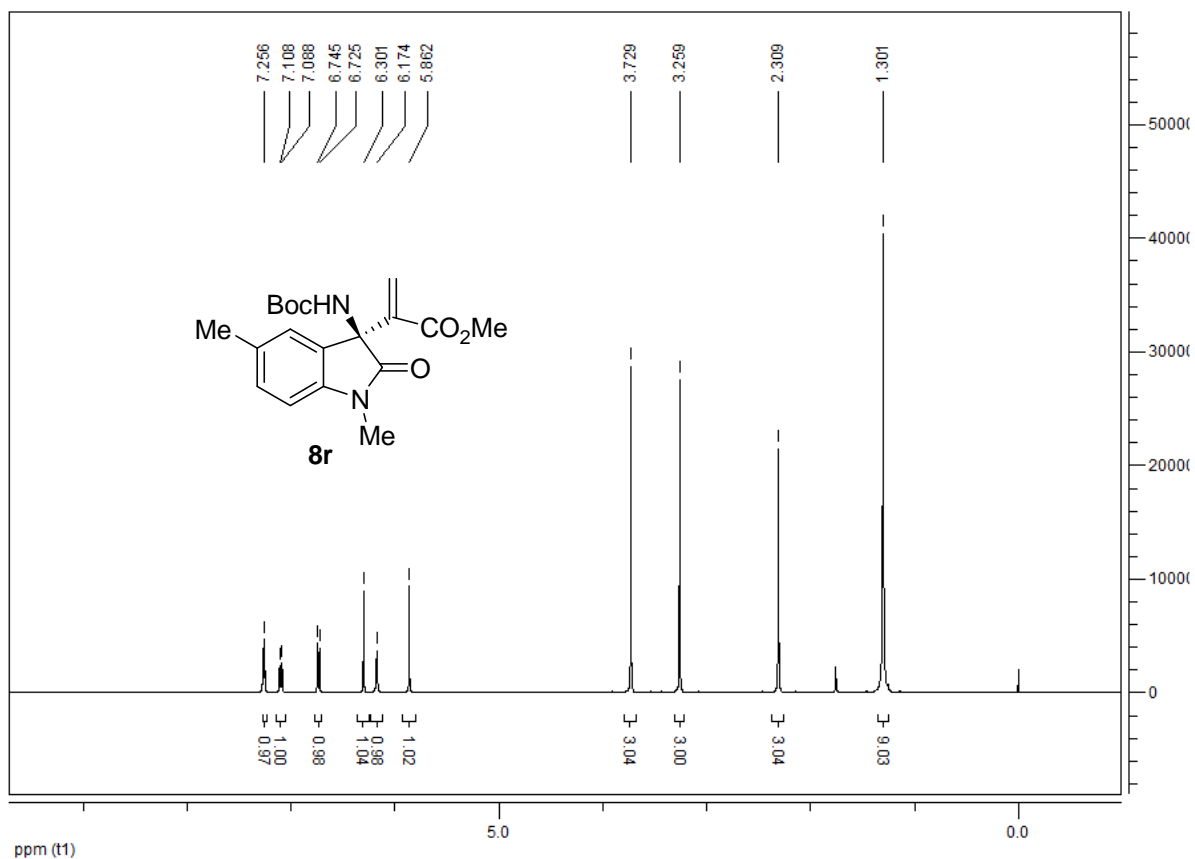




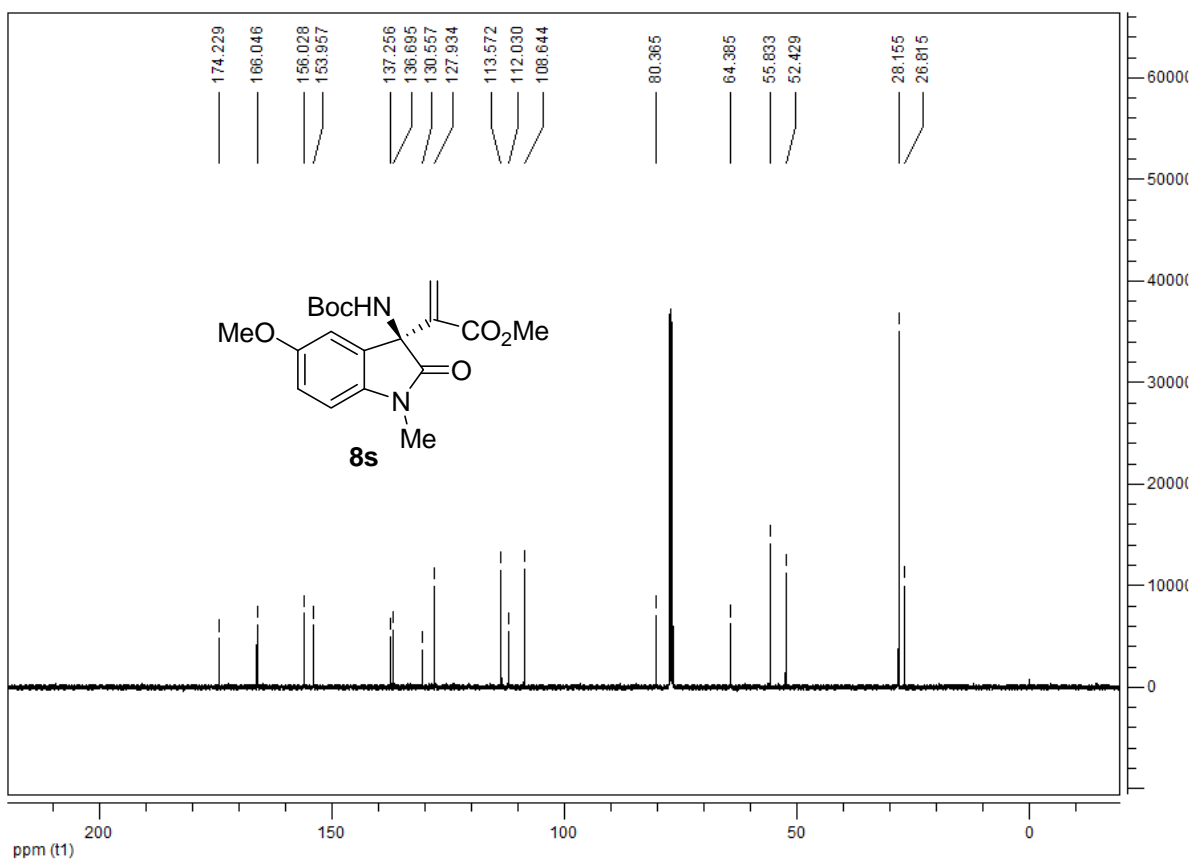
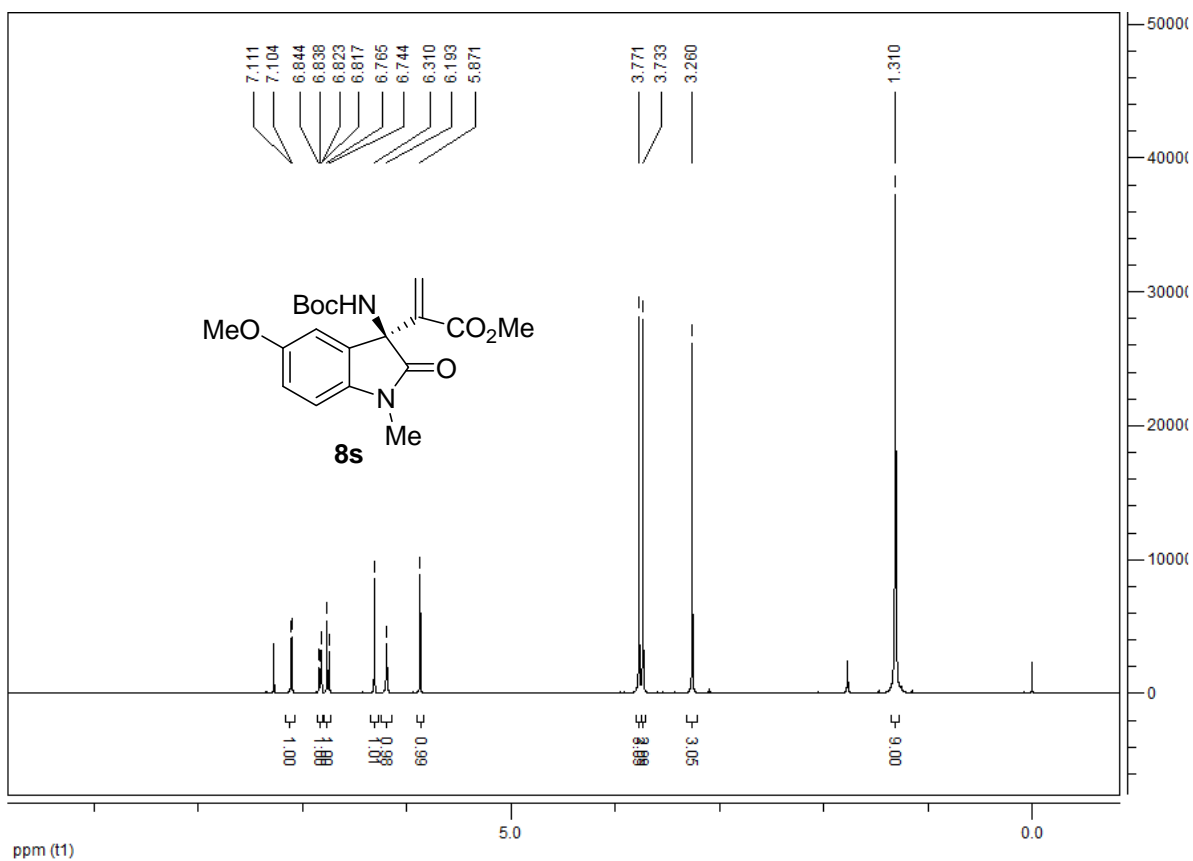




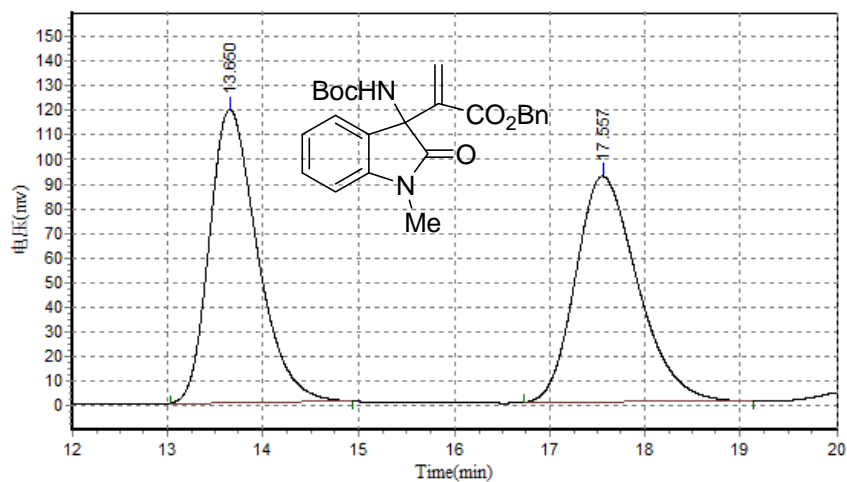






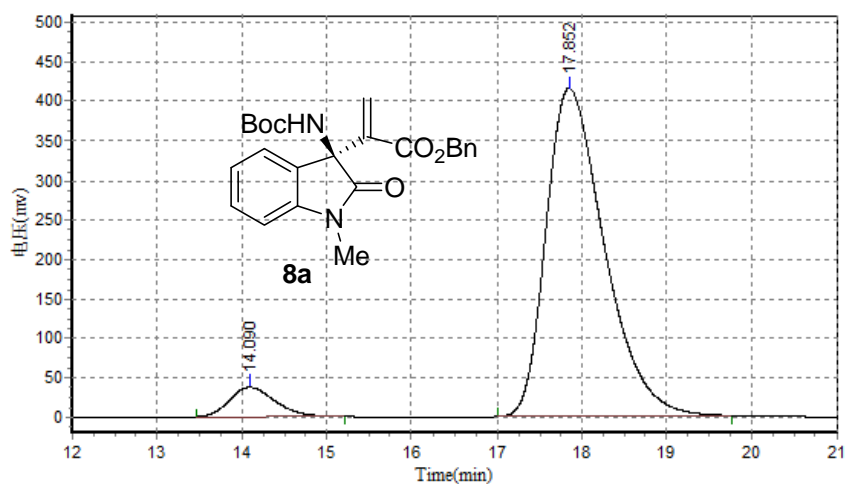


## 5. Copies of HPLC Spectra of Products 8a-s



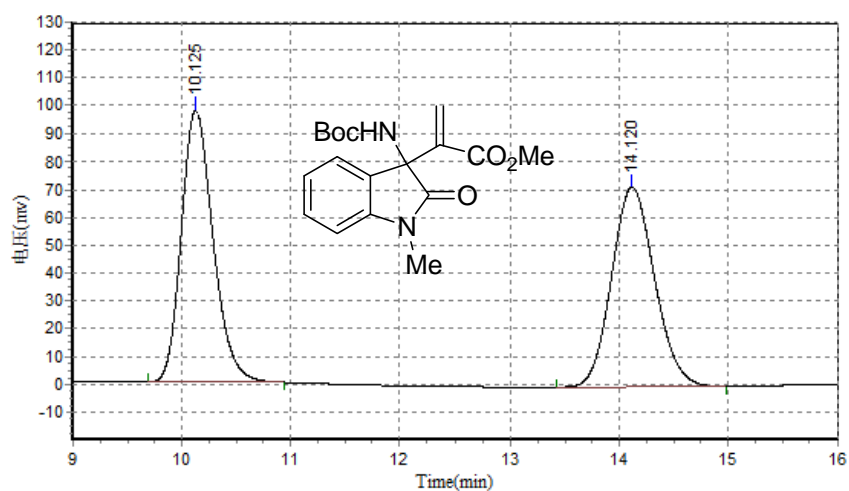
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		13.650	119009.625	4158799.750	49.9616
2		17.557	91948.547	4165188.500	50.0384
<b>Total</b>			210958.172	8323988.250	100.0000



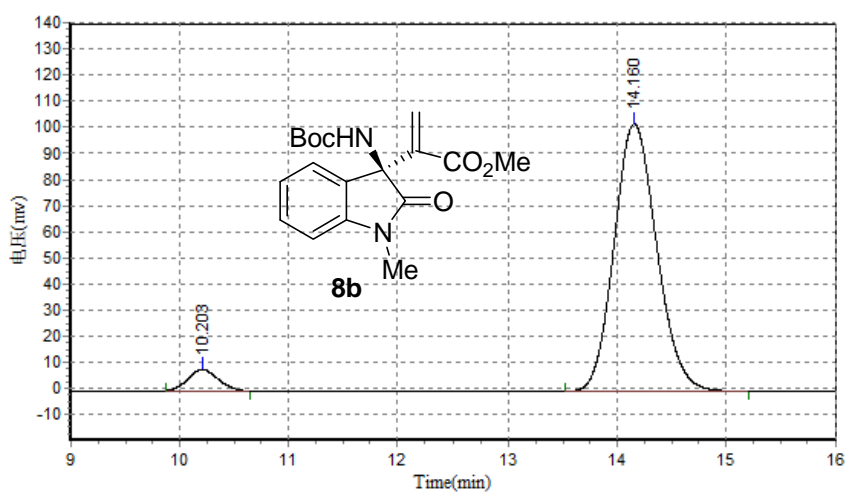
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		14.090	37352.832	1400715.625	6.5764
2		17.852	416034.594	19898408.000	93.4236
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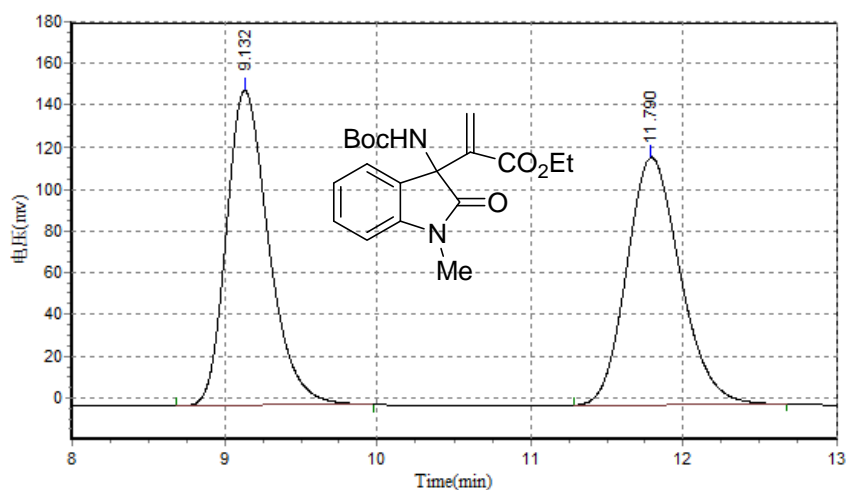
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.125	97625.555	1981271.375	50.0572
2		14.120	71869.734	1976740.500	49.9428
<b>Total</b>			169495.289	3958011.875	100.0000



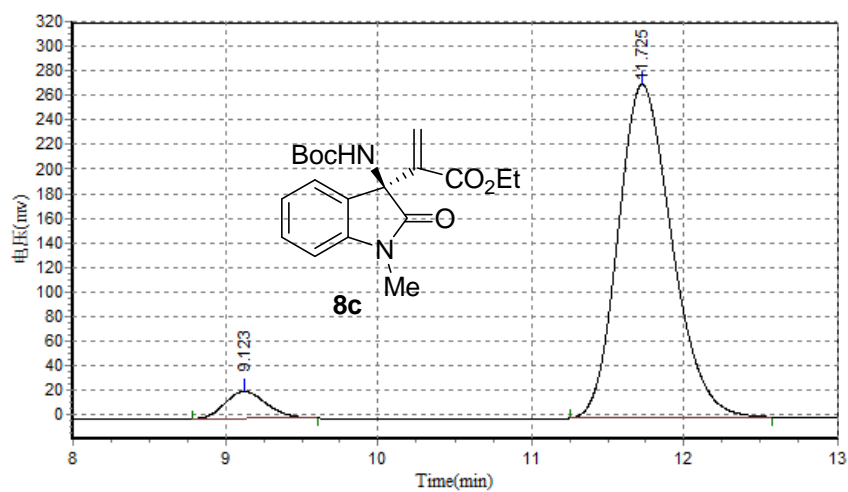
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.203	8267.000	161453.297	5.4560
2		14.180	102575.133	2797747.500	94.5440
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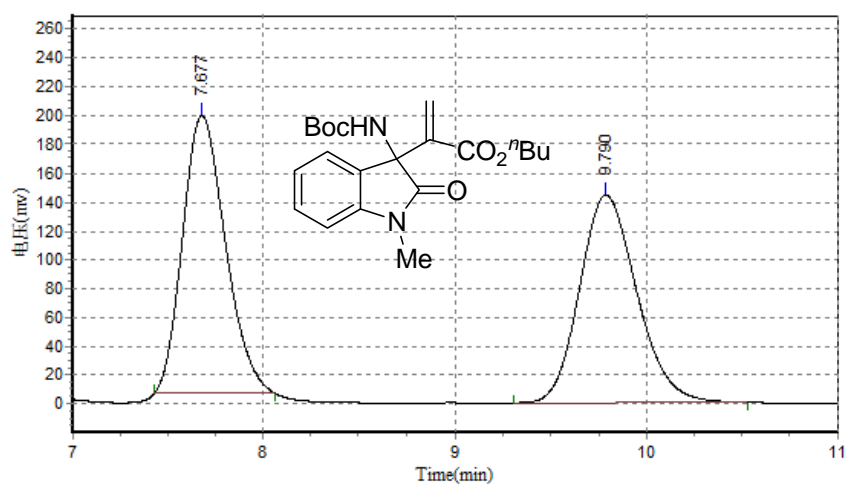
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		9.132	150702.031	2906426.500	50.0907
2		11.790	118525.938	2895904.250	49.9093
<b>Total</b>			269227.969	5802330.750	100.0000



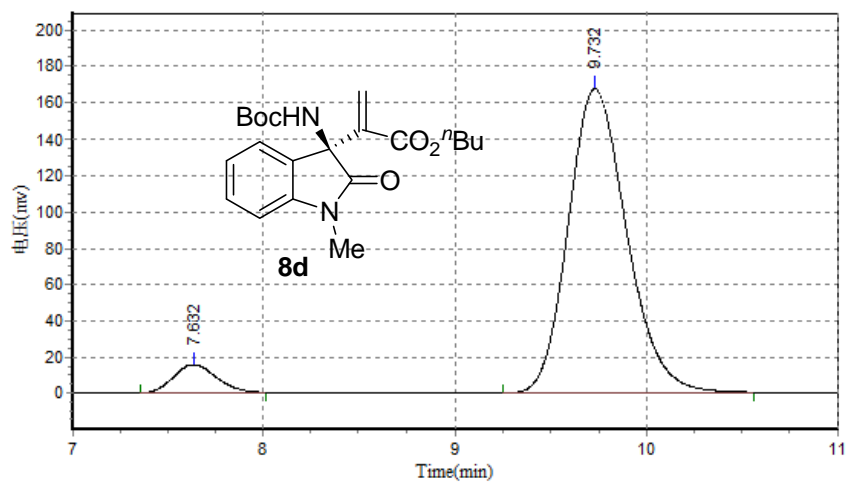
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		9.123	22212.529	421884.938	5.9837
2		11.725	271179.063	6628733.000	94.0163
<b>Total</b>			293391.592	7050617.938	100.0000



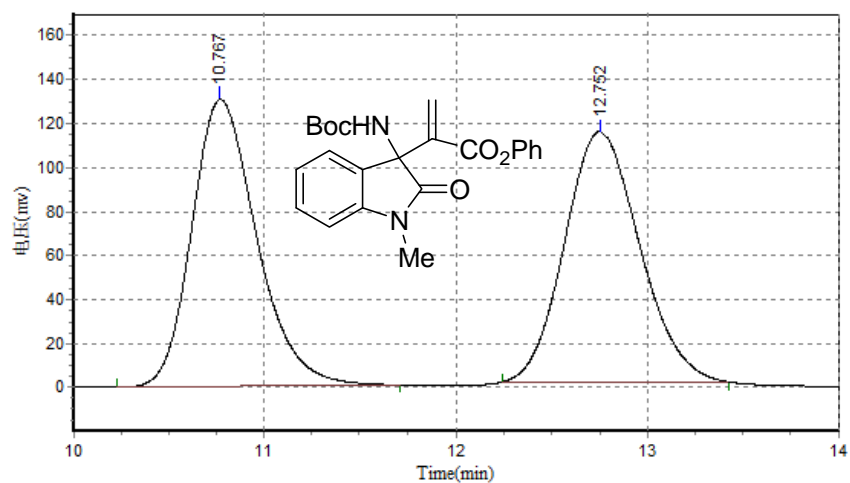
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		7.677	192476.484	3005153.250	49.9404
2		9.790	144448.516	3012326.250	50.0596
<b>Total</b>			336925.000	6017479.500	100.0000



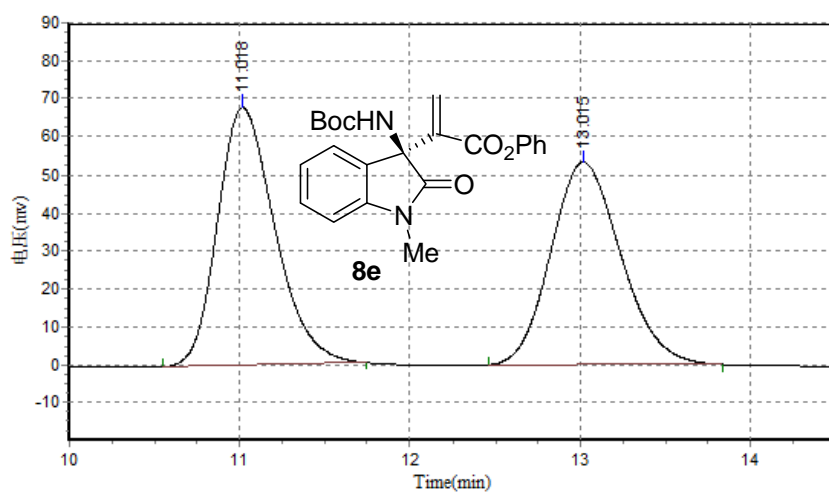
### Results

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1		7.632	15661.421	246720.734	6.4624
2		9.732	167491.563	3571046.250	93.5376
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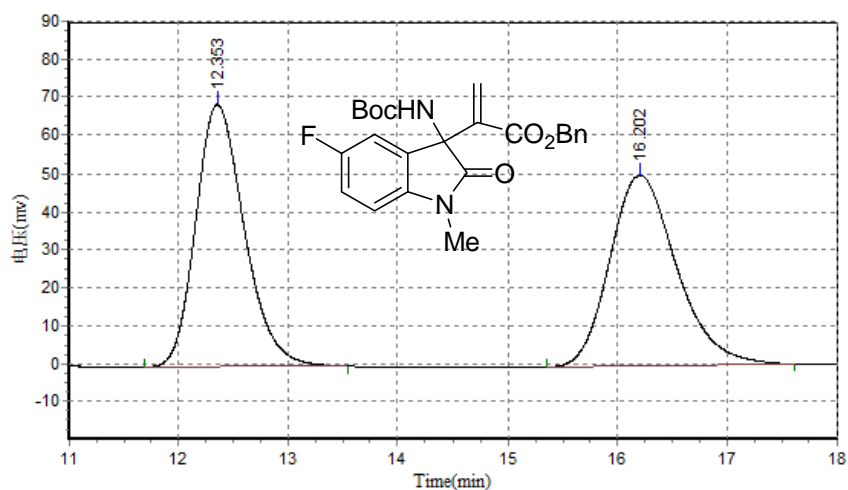
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.767	130340.523	3091748.000	49.8179
2		12.752	113606.156	3114346.500	50.1821
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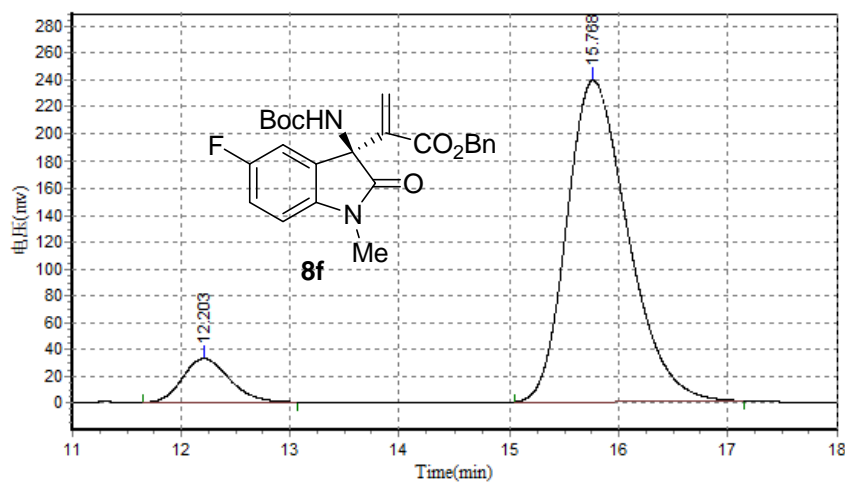
### Results

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1		11.018	67804.352	1591209.375	51.0208
2		13.015	53265.266	1527539.875	48.9792
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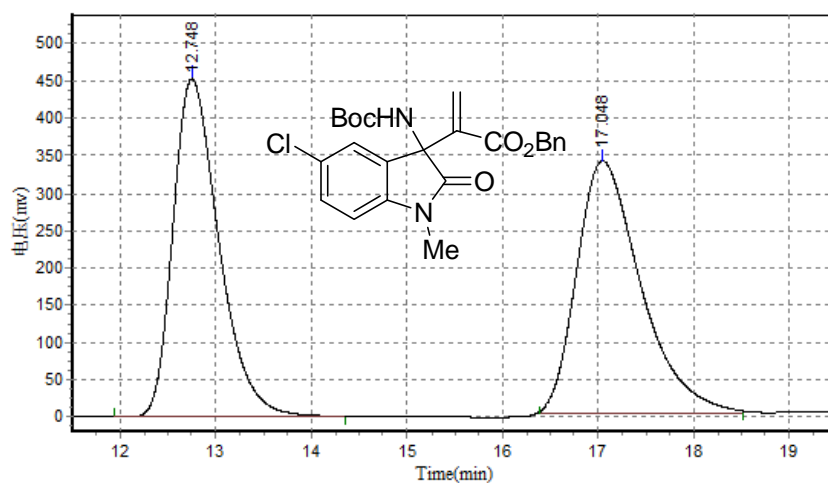
### Results

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1		12.353	68895.383	2130942.250	49.9547
2		16.202	50340.012	2134811.000	50.0453
<b>Total</b>			119235.395	4265753.250	100.0000



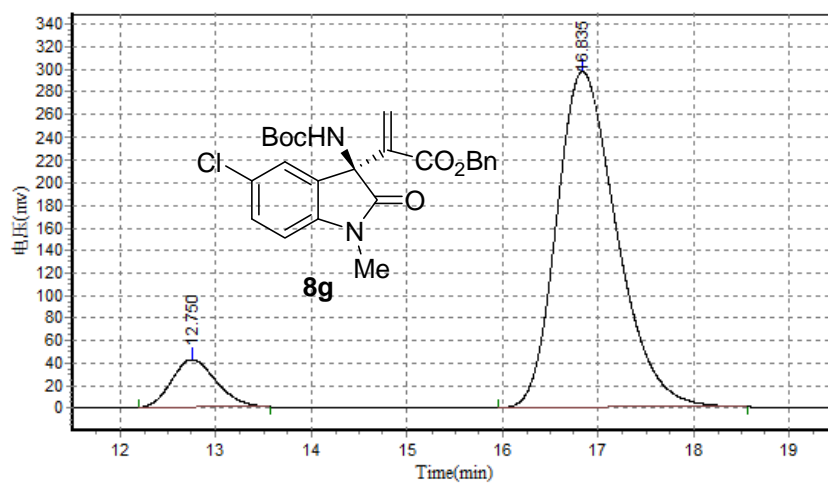
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.203	32564.326	971983.188	9.4743
2		15.768	238440.797	9287163.000	90.5257
<b>Total</b>			271005.123	10259146.188	100.0000



### Results

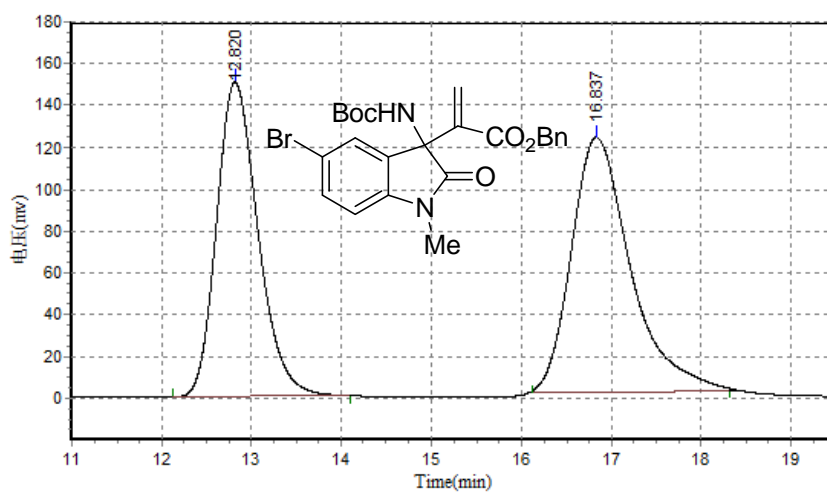
Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.748	452441.156	15179017.000	49.9529
2		17.048	333118.125	15207620.000	50.0471
<b>Total</b>			785559.281	30386637.000	100.0000



### Results

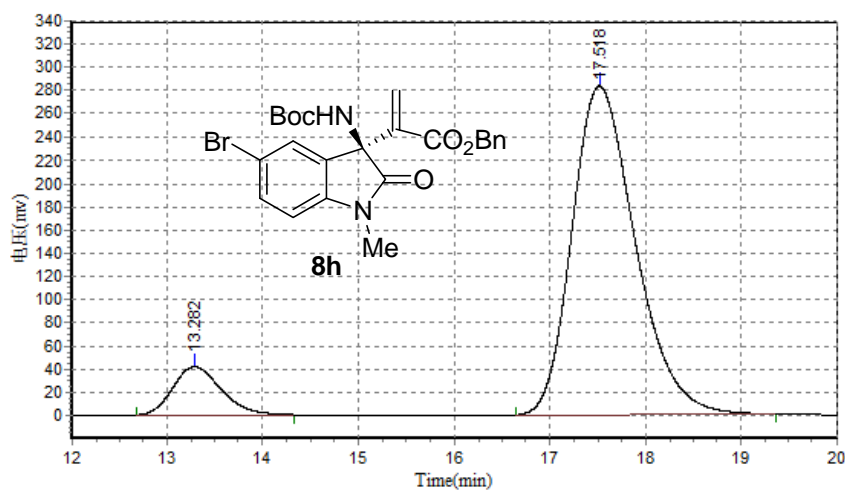
Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.750	42508.176	1383968.625	9.5648
2		16.835	298132.875	13085478.000	90.4352
<b>Total</b>			340641.051	14469446.625	100.0000





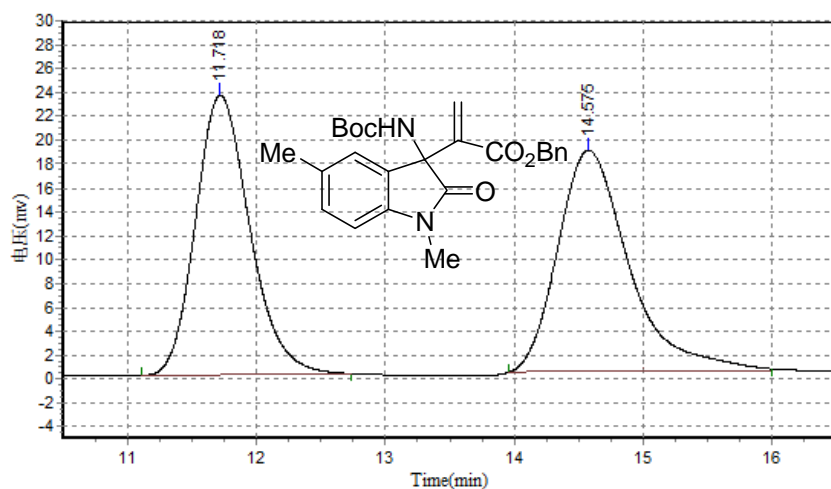
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.820	150352.453	4834646.500	50.0081
2		16.837	114116.117	4833071.500	49.9919
<b>Total</b>			264468.570	9667718.000	100.0000



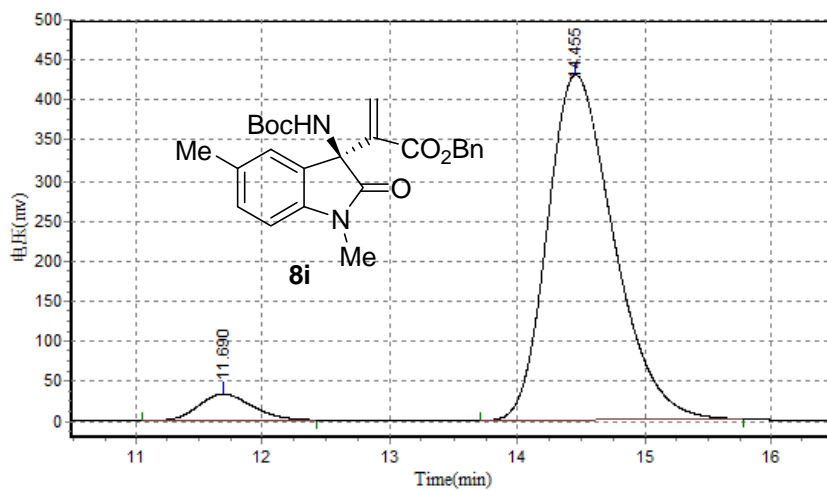
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		13.282	41696.633	1469458.250	10.0800
2		17.518	283274.781	13108515.000	89.9200
<b>Total</b>			324971.414	14577973.250	100.0000



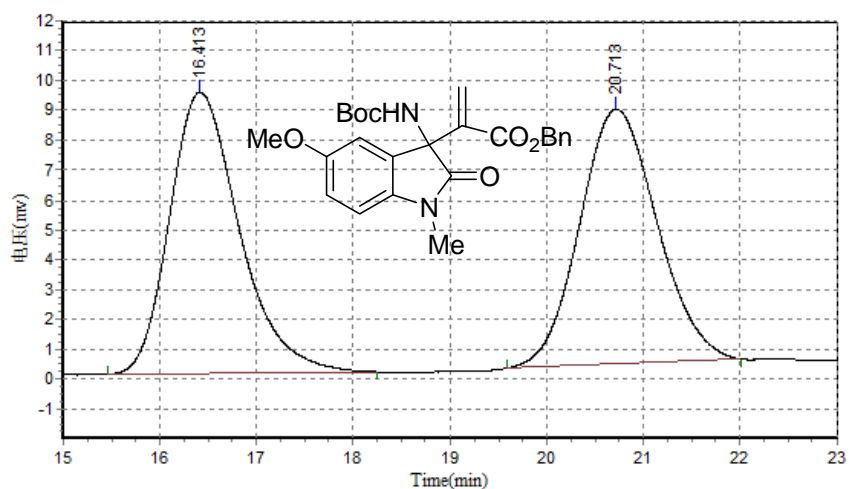
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		11.718	23400.498	686112.188	49.9415
2		14.575	18379.338	687719.875	50.0585
<b>Total</b>			41779.836	1373832.063	100.0000



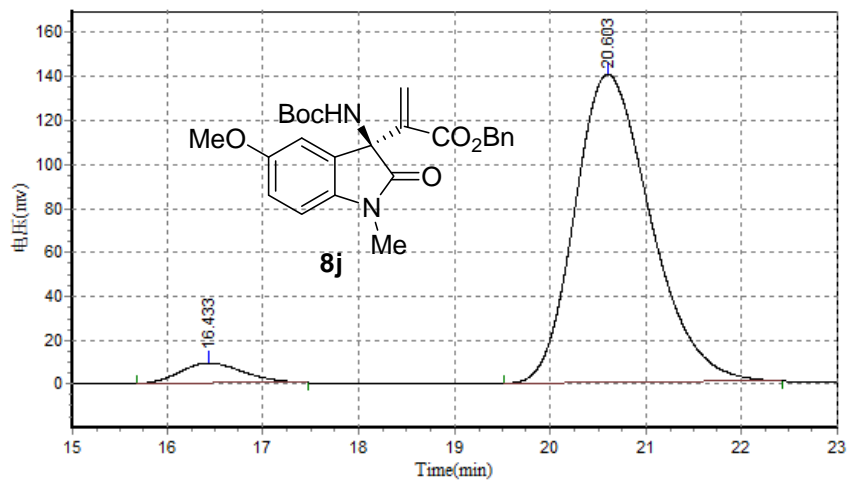
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		11.690	32828.086	967663.250	5.8364
2		14.455	430436.875	15612158.000	94.1636
<b>Total</b>			463264.961	16379821.250	100.0000



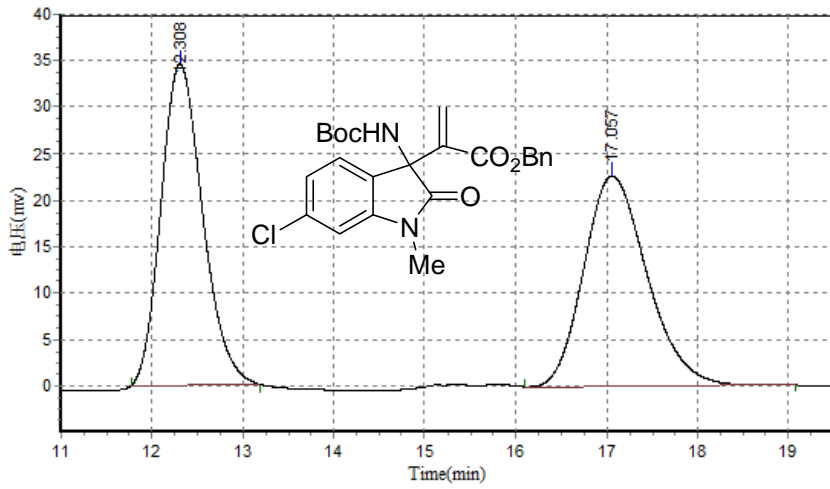
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		16.413	9422.454	474676.406	49.9410
2		20.713	8516.694	475798.563	50.0590
<b>Total</b>			17939.148	950474.969	100.0000



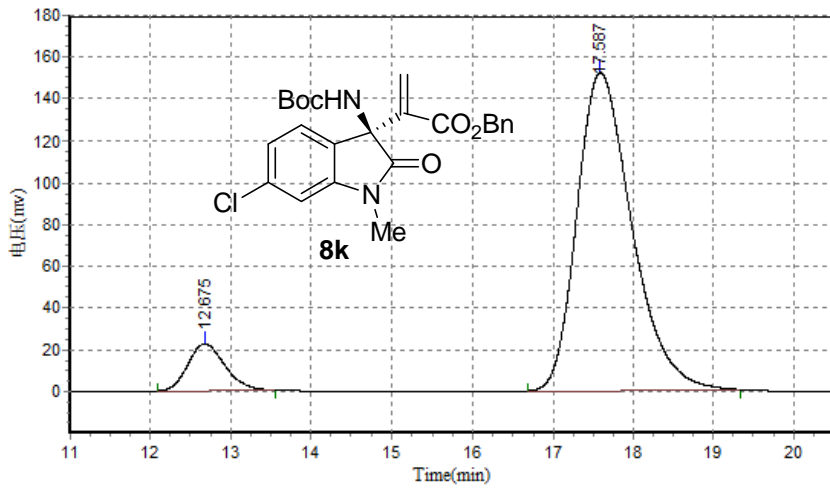
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		16.433	9188.699	429528.719	5.2381
2		20.603	140244.031	7770582.000	94.7619
<b>Total</b>			149432.730	8200110.719	100.0000



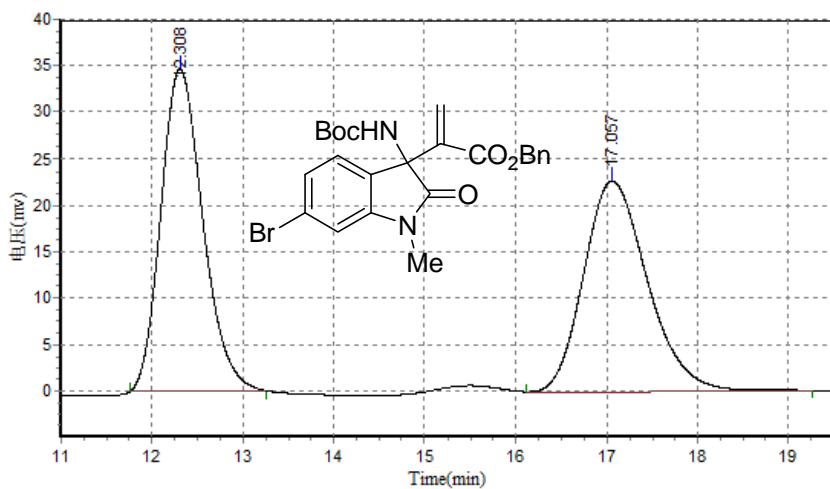
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.308	34612.512	1103508.250	49.9961
2		17.057	22772.836	1103679.375	50.0039
<b>Total</b>			57385.348	2207187.625	100.0000



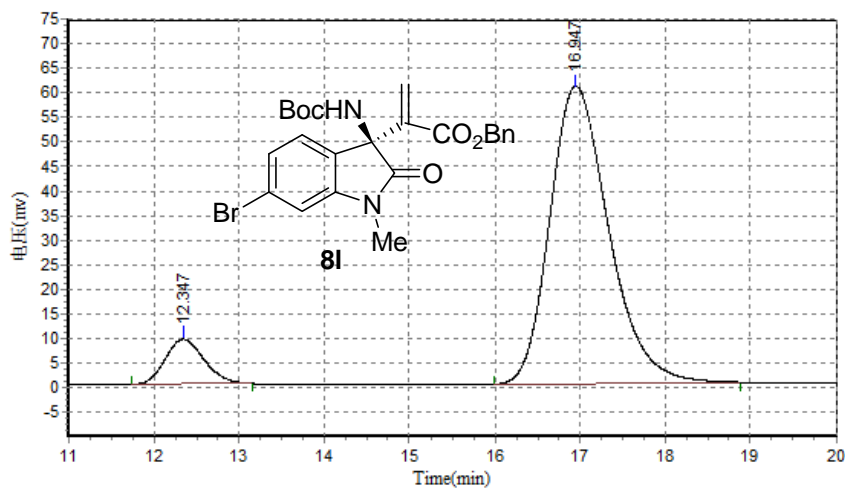
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.675	22477.961	720924.875	9.0537
2		17.587	152102.359	7241861.500	90.9463
<b>Total</b>			174580.320	7962786.375	100.0000



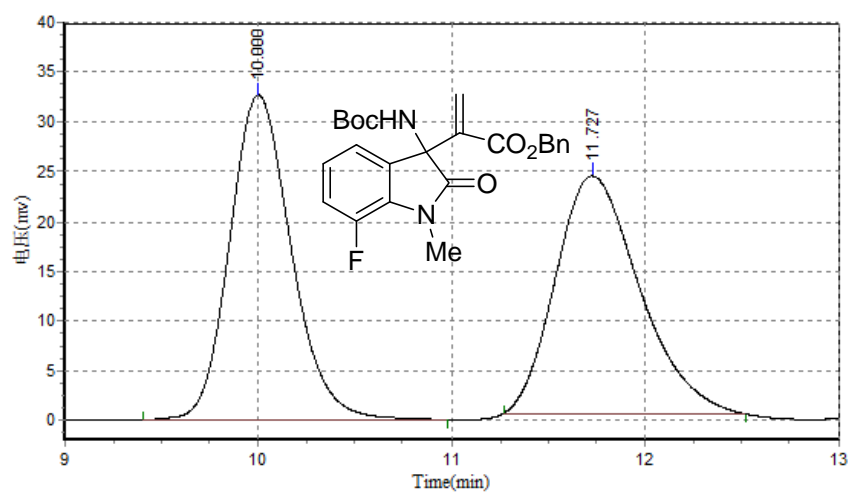
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.308	34729.063	1114175.125	50.1153
2		17.057	22793.830	1109047.250	49.8847
<b>Total</b>			57522.893	2223222.375	100.0000



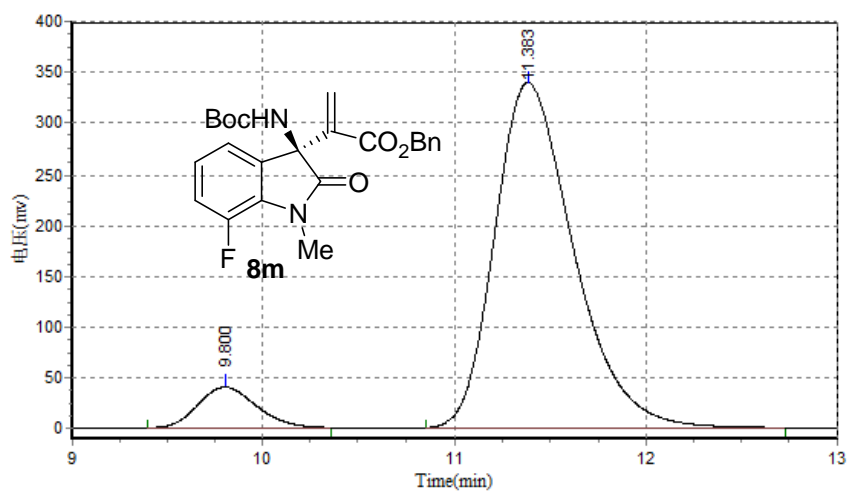
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		12.347	9183.613	293553.906	9.1543
2		16.947	60582.441	2913179.500	90.8457
<b>Total</b>			69766.055	3206733.406	100.0000



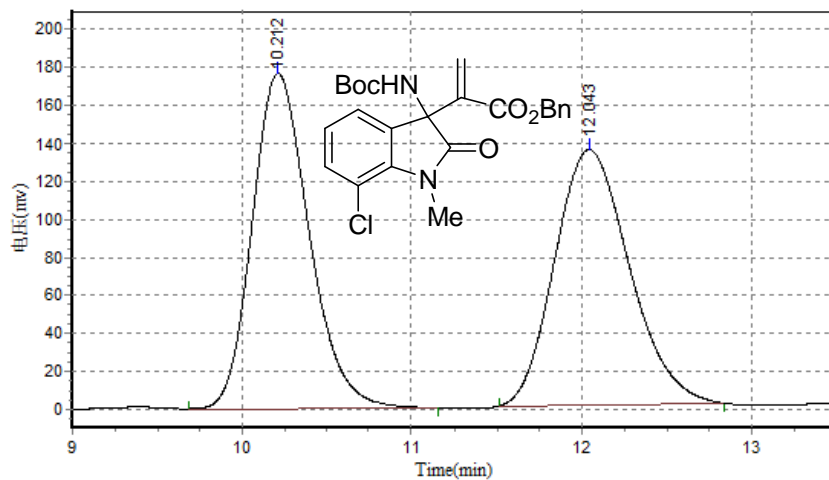
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.000	32711.574	724781.563	49.9716
2		11.727	23980.967	725606.375	50.0284
<b>Total</b>			56692.541	1450387.938	100.0000



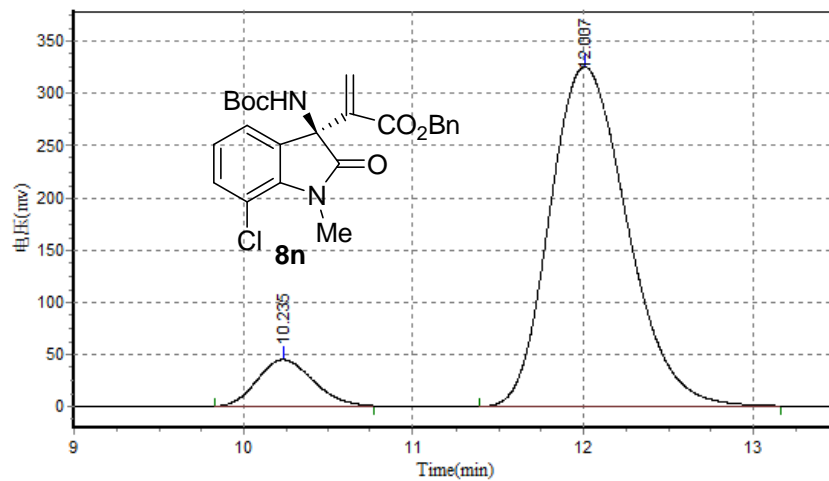
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		9.800	40074.539	854112.125	8.0611
2		11.383	339246.813	9741321.000	91.9389
<b>Total</b>			379321.352	10595433.125	100.0000



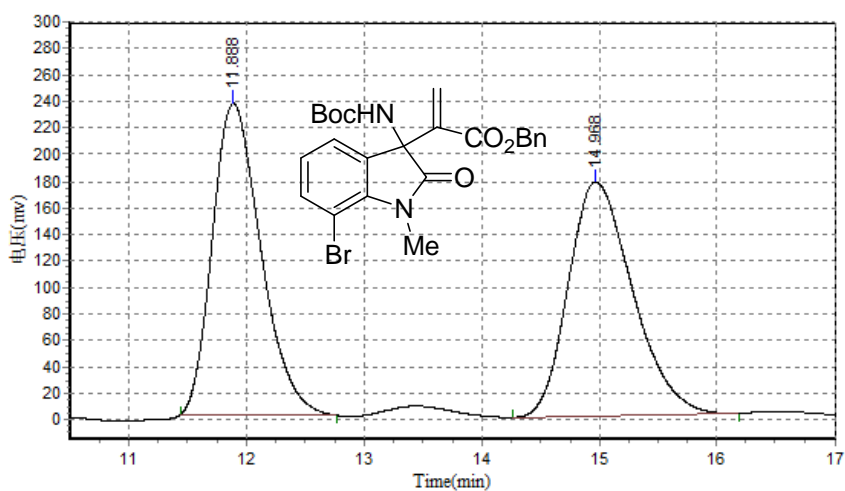
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.212	176676.891	4111445.250	49.9033
2		12.043	134509.859	4127372.750	50.0967
<b>Total</b>			311186.750	8238818.000	100.0000



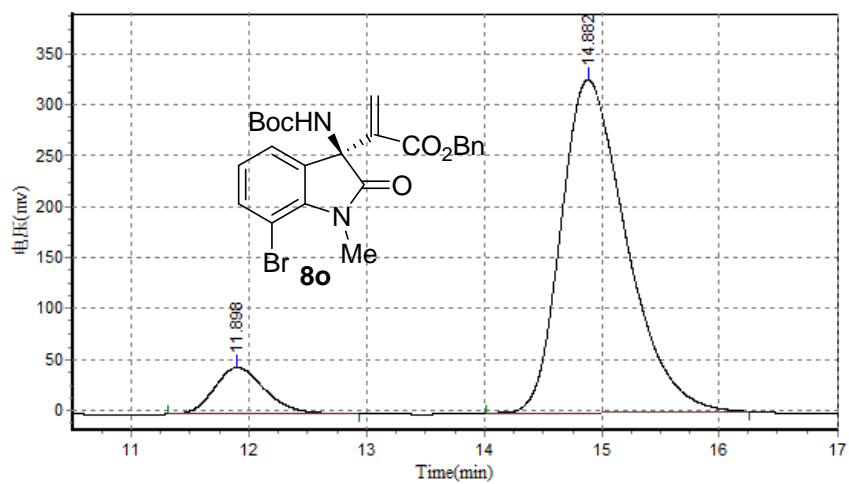
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.235	44801.563	1025175.500	9.0253
2		12.007	325093.594	10333725.000	90.9747
<b>Total</b>			369895.156	11358900.500	100.0000



### Results

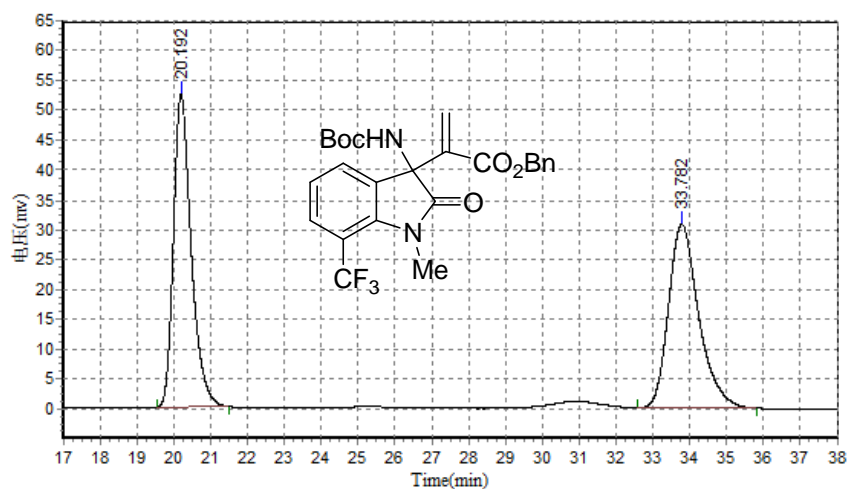
Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		11.888	234842.094	6751176.500	50.0868
2		14.968	177068.109	6727765.500	49.9132
<b>Total</b>			411910.203	13478942.000	100.0000



### Results

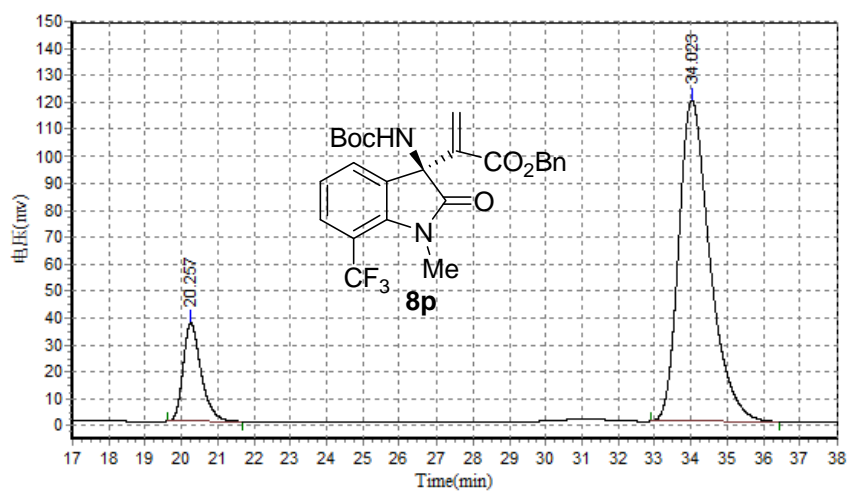
Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		11.898	45806.816	1382501.750	9.8567
2		14.882	326203.219	12643548.000	90.1433
<b>Total</b>			372010.035	14026049.750	100.0000





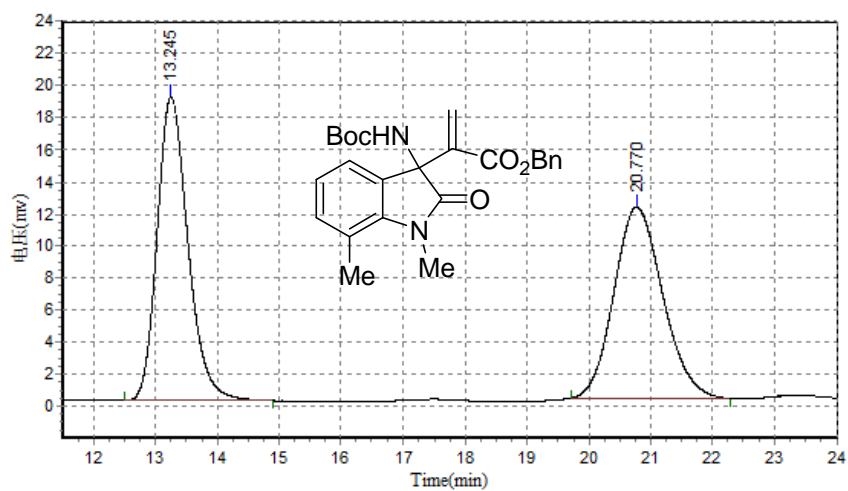
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		20.192	52420.137	1762778.875	49.9432
2		33.782	30903.168	1766787.750	50.0568
<b>Total</b>			83323.305	3529566.625	100.0000



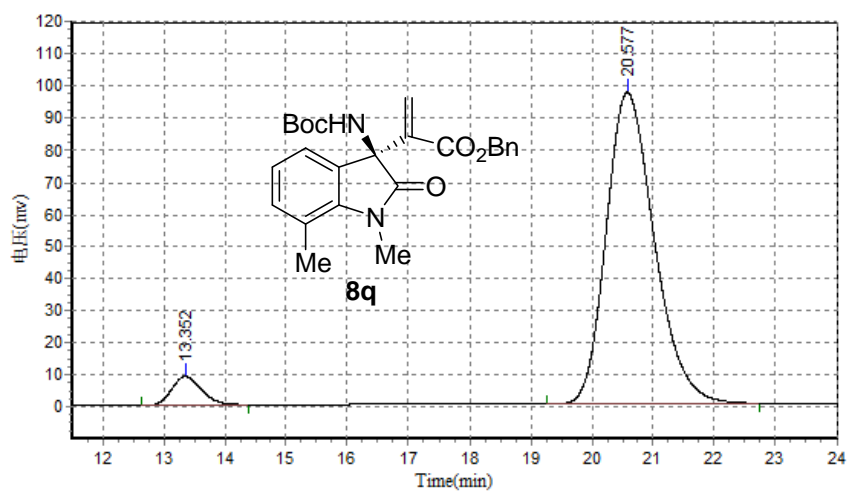
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		20.257	36799.945	1262841.125	15.0880
2		34.023	119315.617	7106994.500	84.9120
<b>Total</b>			156115.563	8369835.625	100.0000



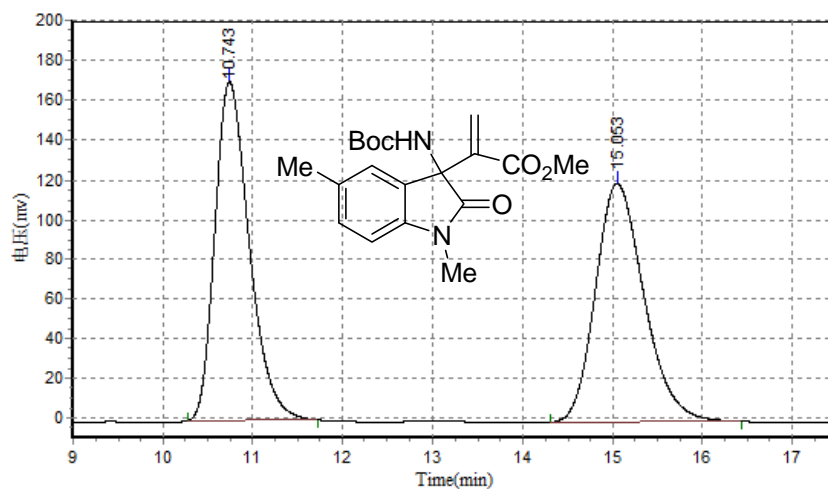
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		13.245	18919.789	656986.750	50.0079
2		20.770	11935.828	656780.188	49.9921
<b>Total</b>			30855.617	1313766.938	100.0000



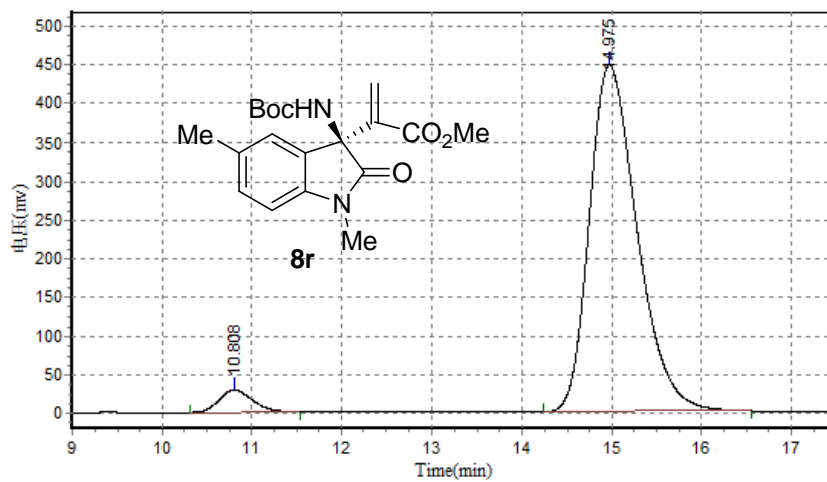
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		13.352	9033.867	307131.500	5.4556
2		20.577	96870.289	5322508.000	94.5444
<b>Total</b>			105904.156	5629639.500	100.0000



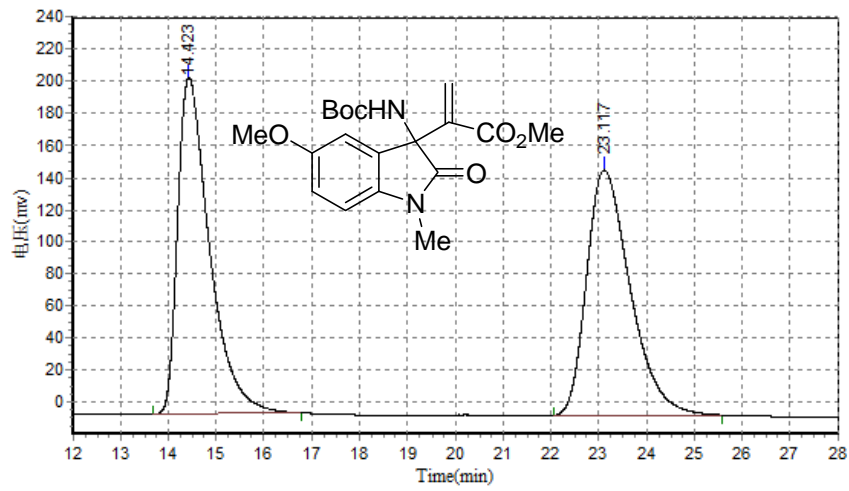
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.743	170222.281	4546736.500	50.0388
2		15.053	120556.211	4539693.500	49.9612
<b>Total</b>			290778.492	9086430.000	100.0000



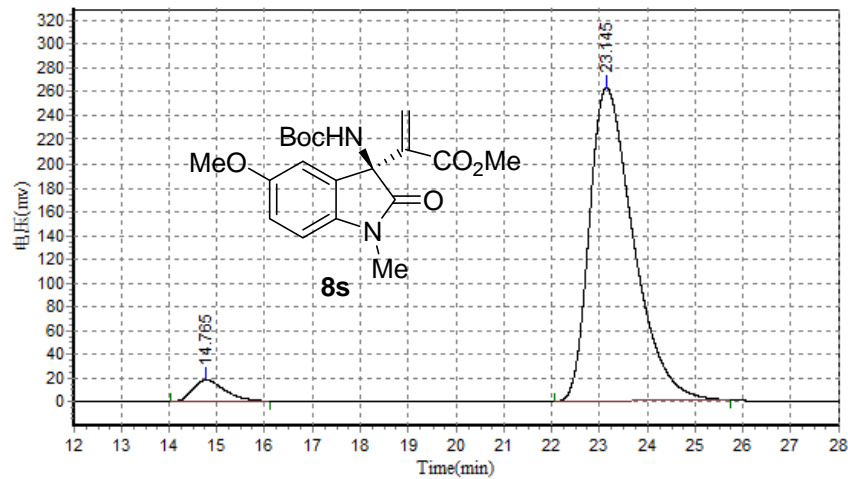
### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		10.808	28815.973	757933.063	4.3670
2		14.975	448139.344	16597805.000	95.6330
<b>Total</b>			476955.316	17355738.063	100.0000



### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		14.423	209580.984	9749123.000	50.0161
2		23.117	153295.516	9742855.000	49.9839
<b>Total</b>			362876.500	19491978.000	100.0000



### Results

Peak No.	Peak ID	Ret Time	Height	Area	Conc.
1		14.765	18296.209	858213.813	4.8310
2		23.145	262781.875	16906578.000	95.1690
<b>Total</b>			281078.084	17764791.813	100.0000