

## *Supplementary Information*

### **Dinuclear Zinc Cooperative Catalytic Three-Component Reactions for Highly Enantioselective Synthesis of 3,3'-Dihydrofuran Spirooxindoles**

Yu-Hang Miao, Yuan-Zhao Hua, and Min-Can Wang\*

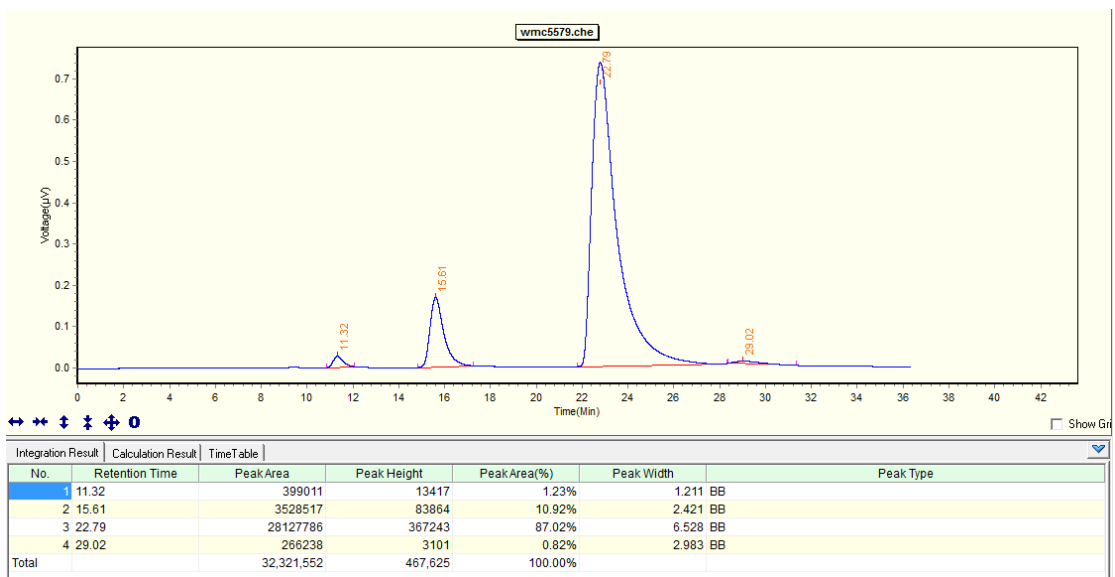
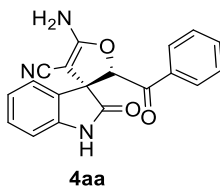
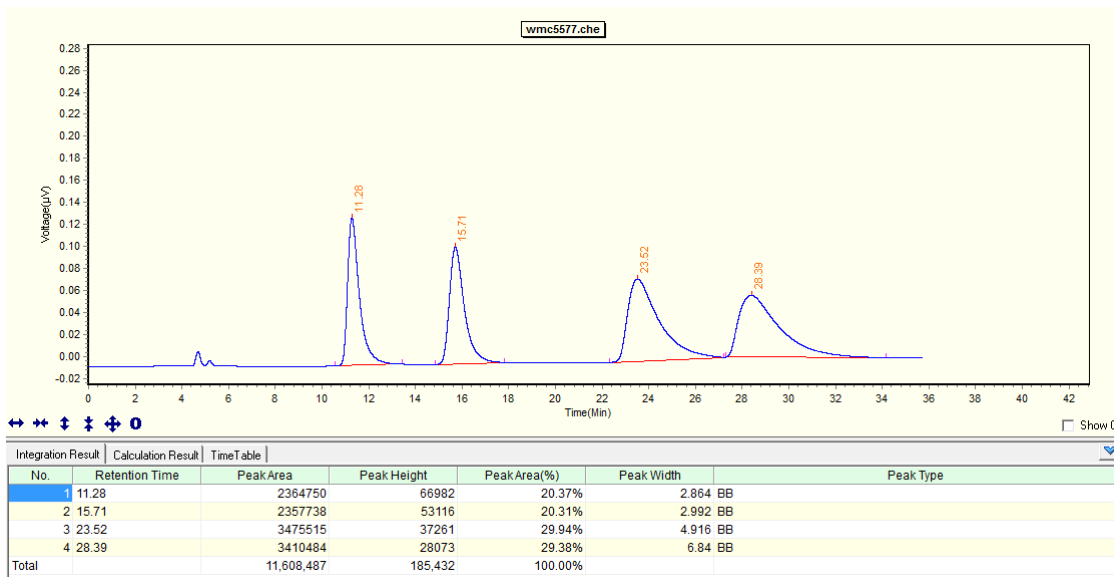
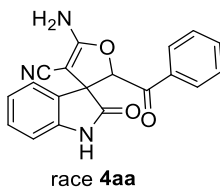
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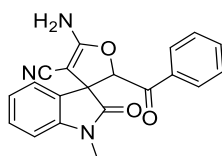
\*E-mail: [wangmincan@zzu.edu.cn](mailto:wangmincan@zzu.edu.cn).

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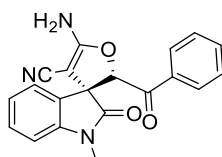
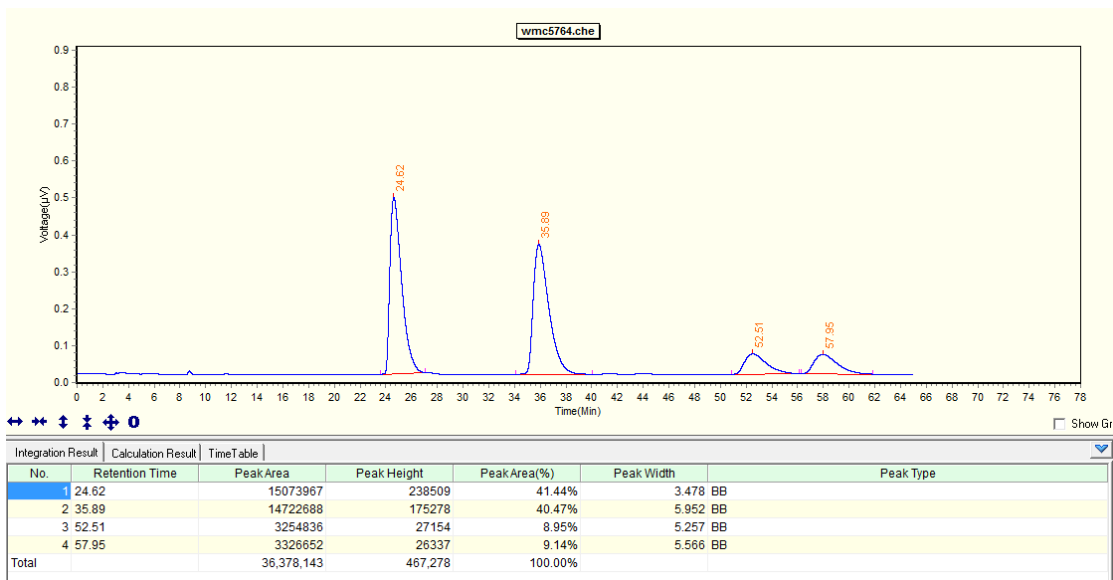
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# 1. HPLC spectra of compounds

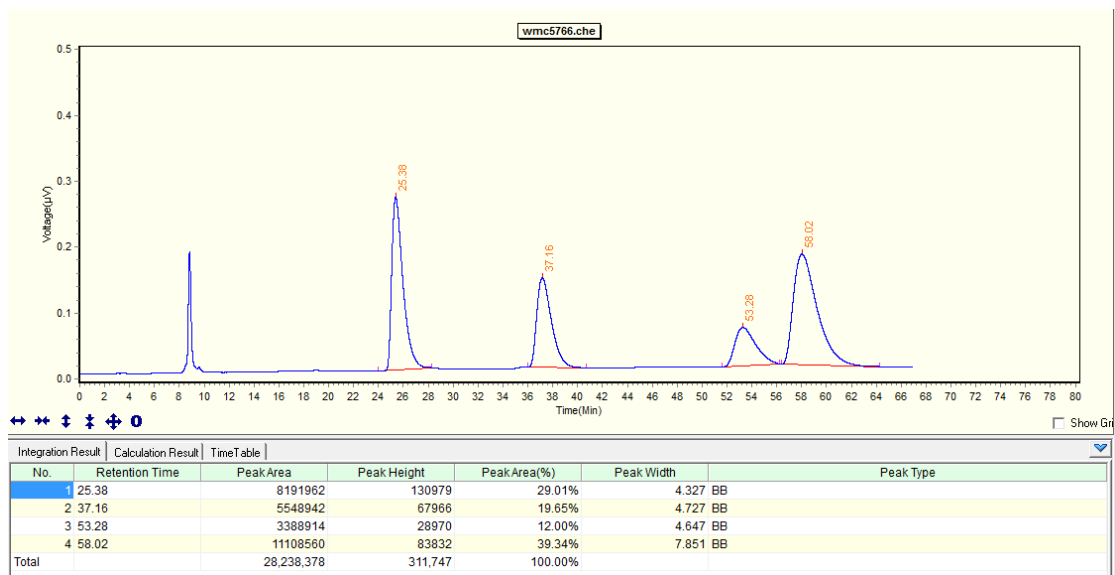


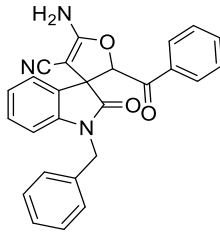


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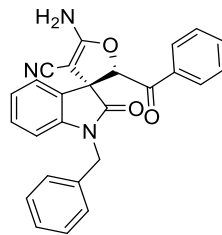
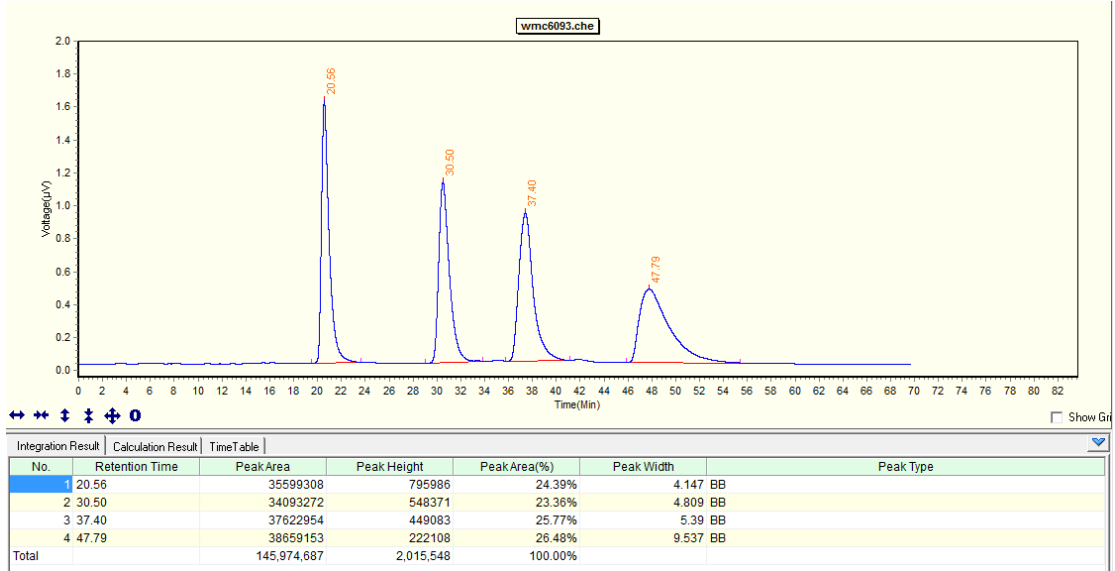


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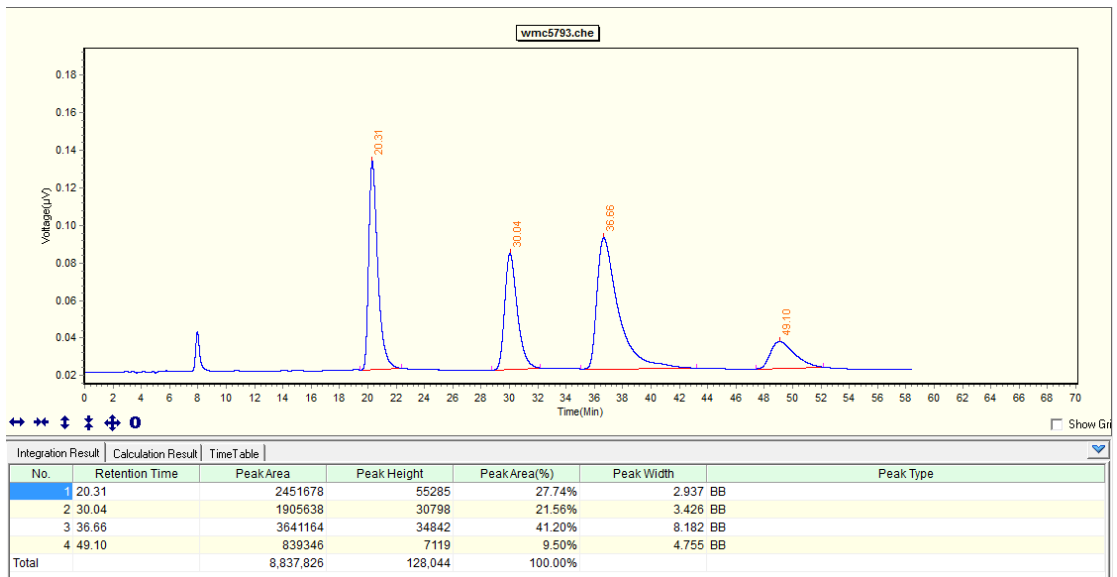


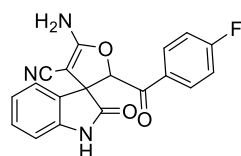


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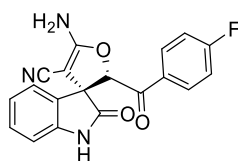
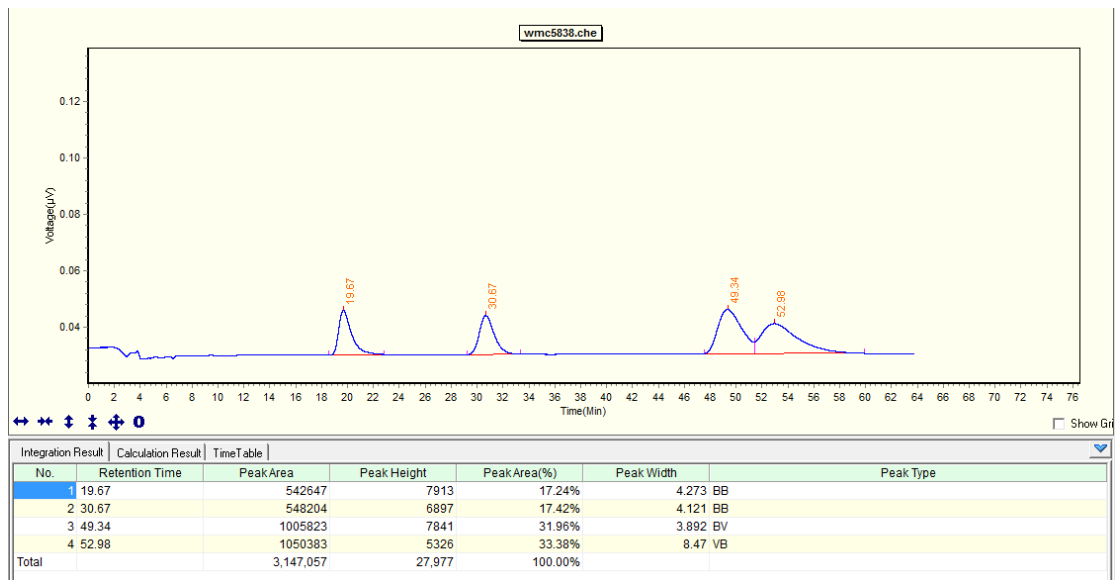


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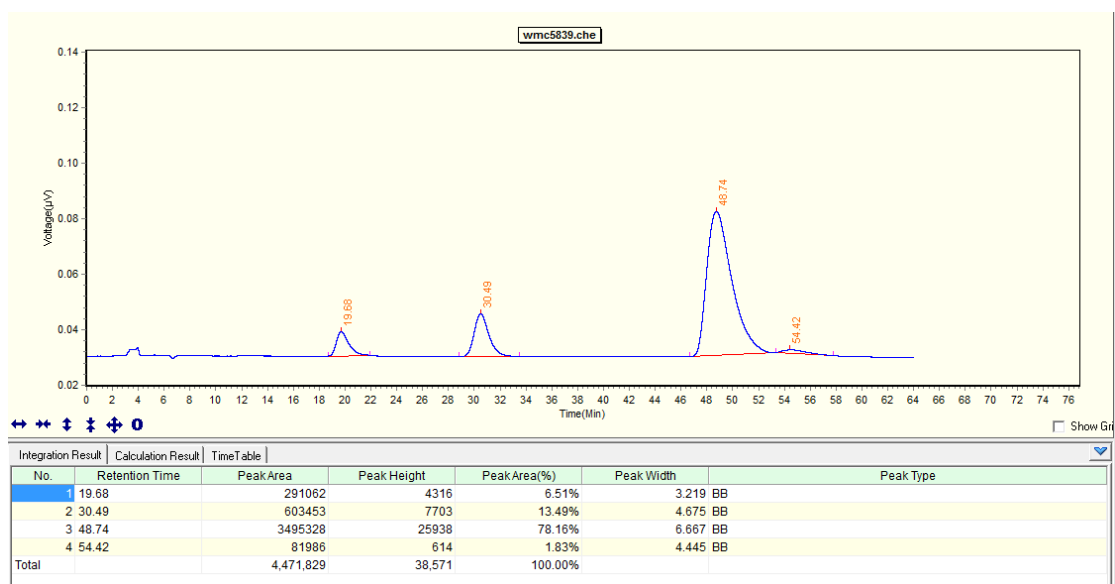


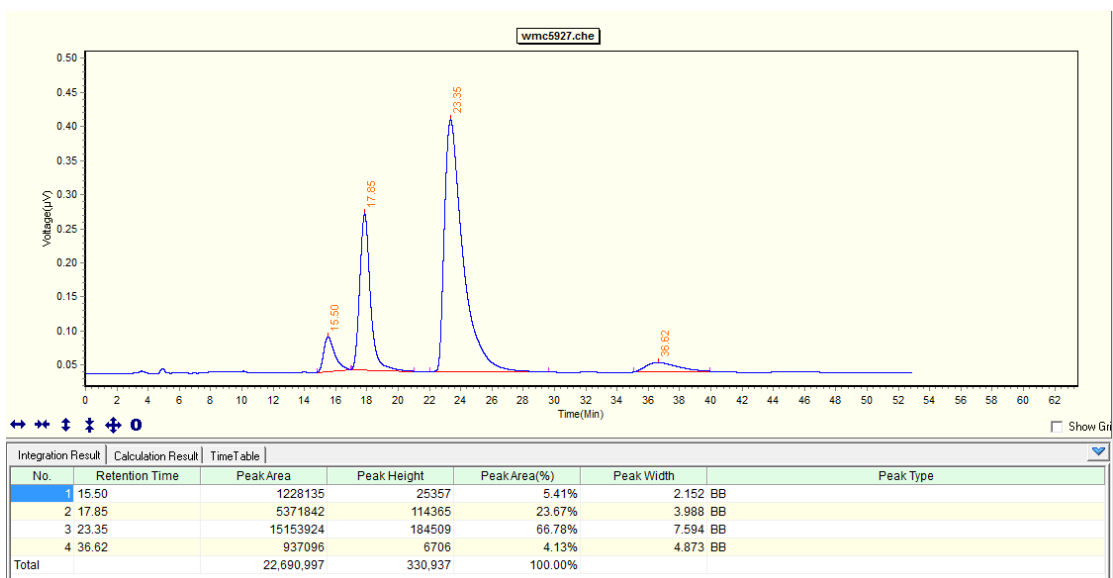
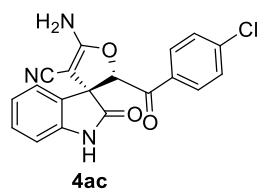
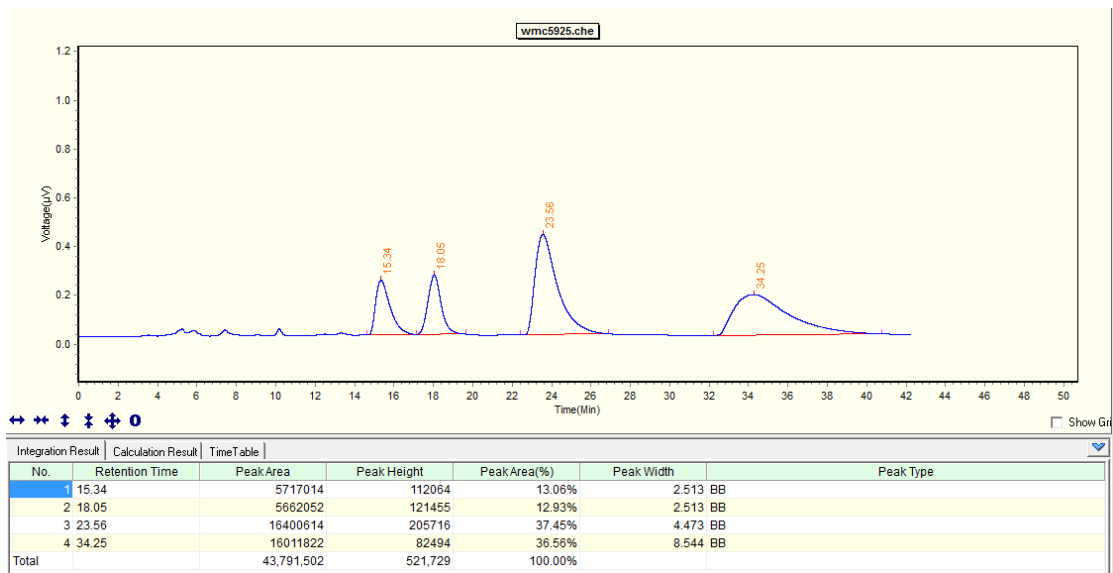
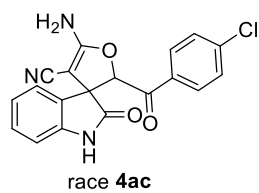


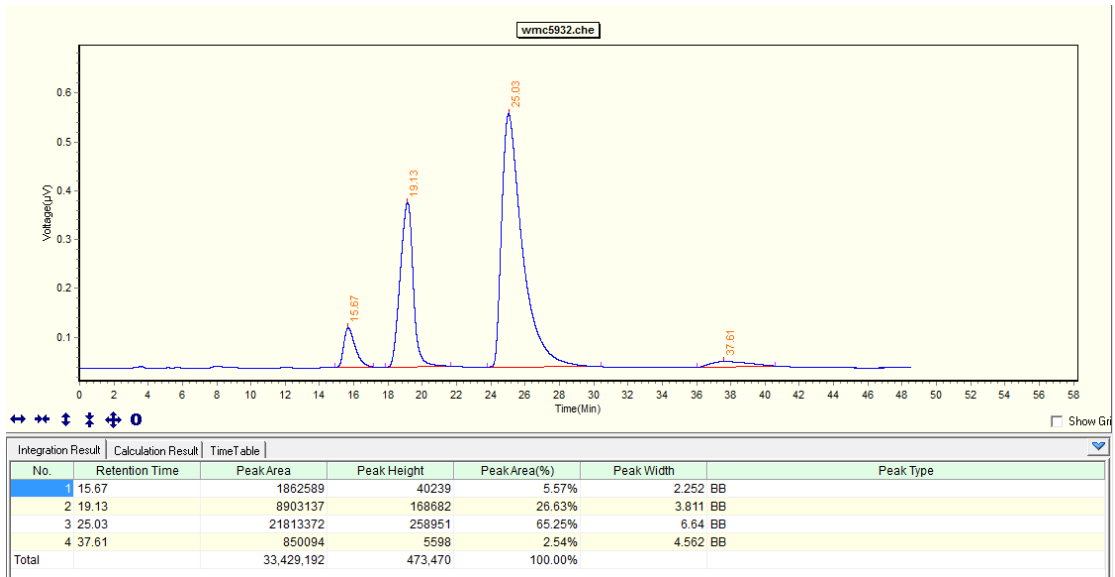
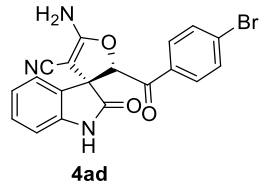
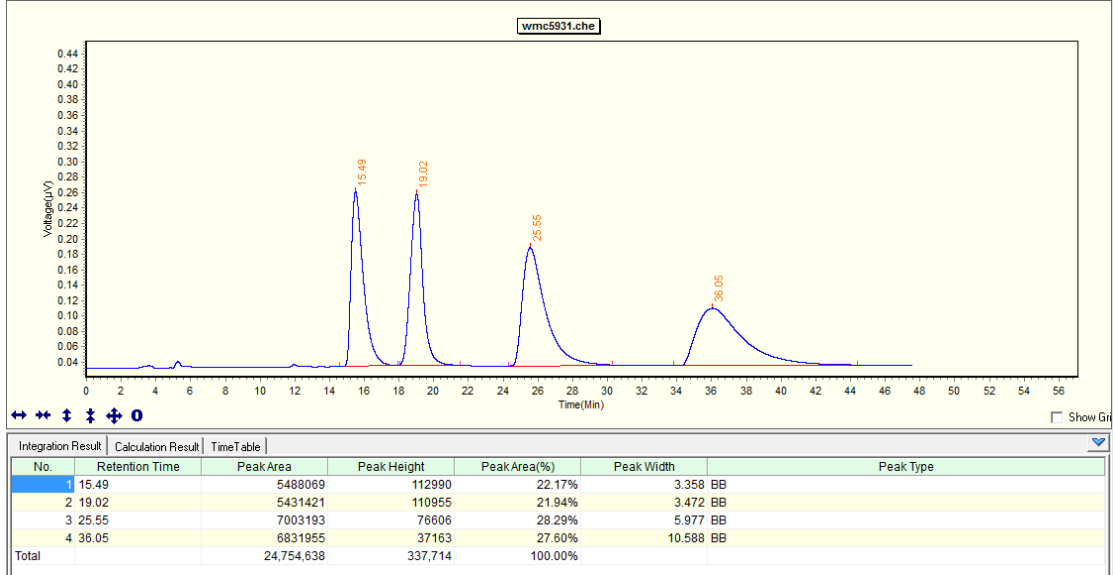
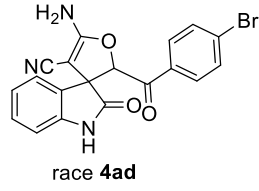
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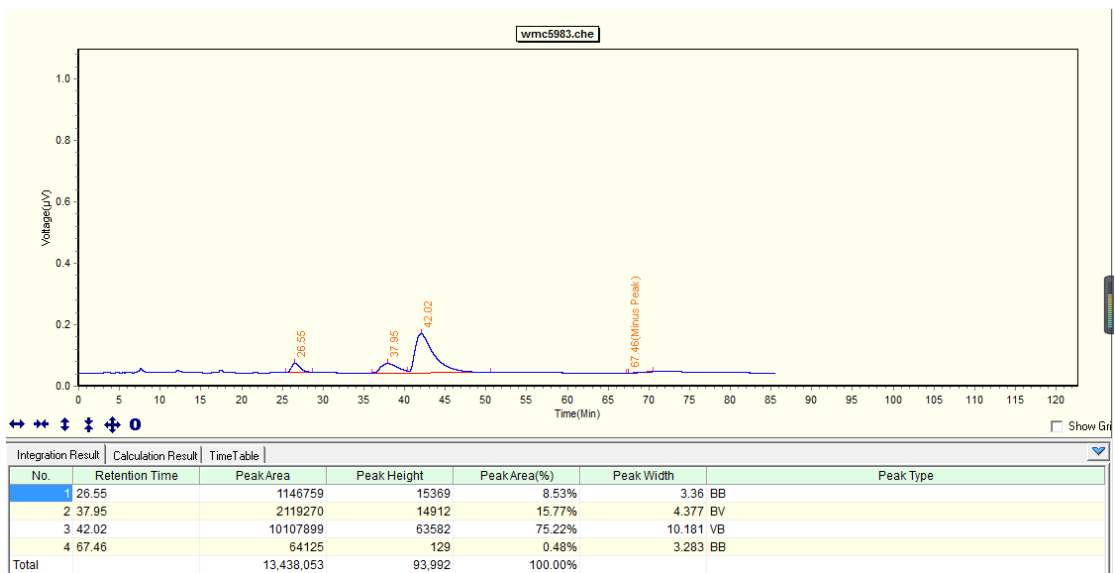
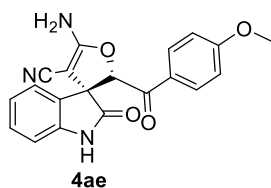
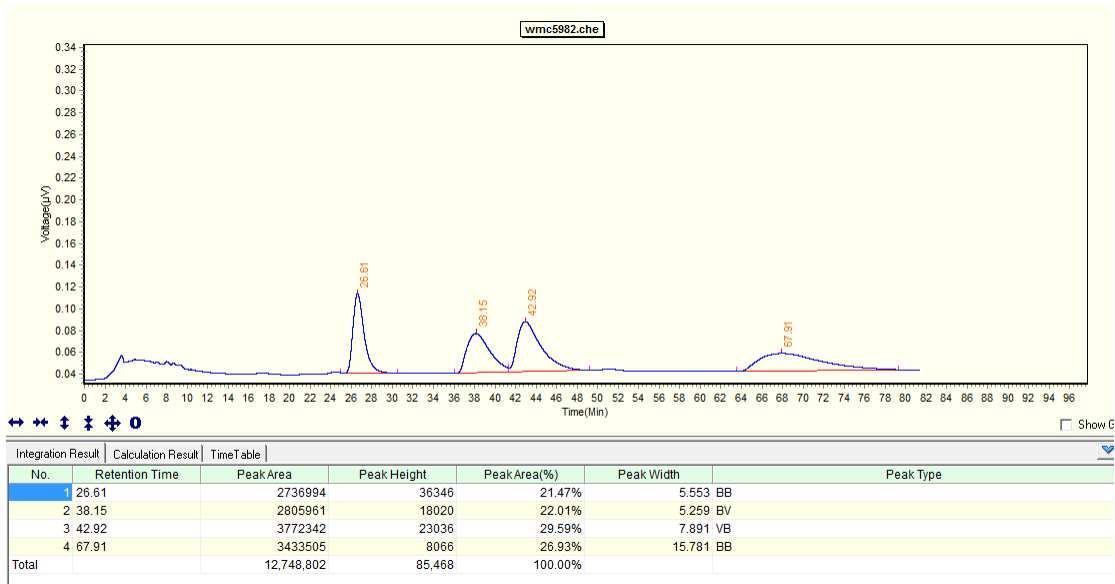
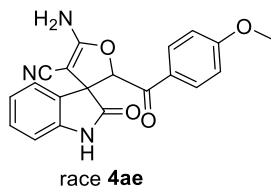


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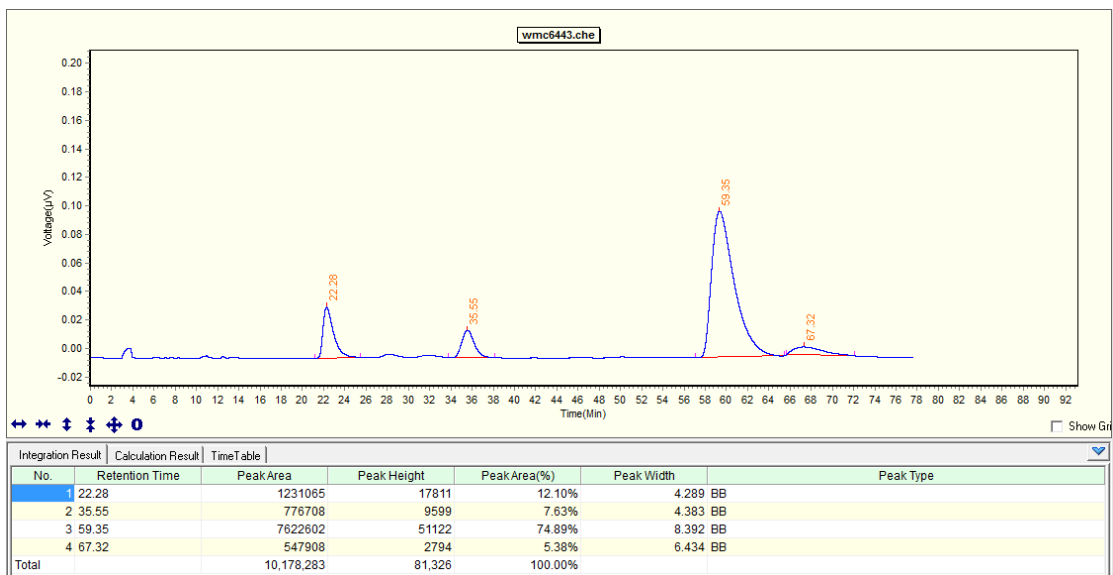
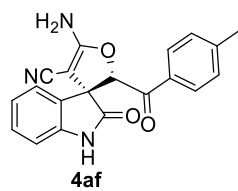
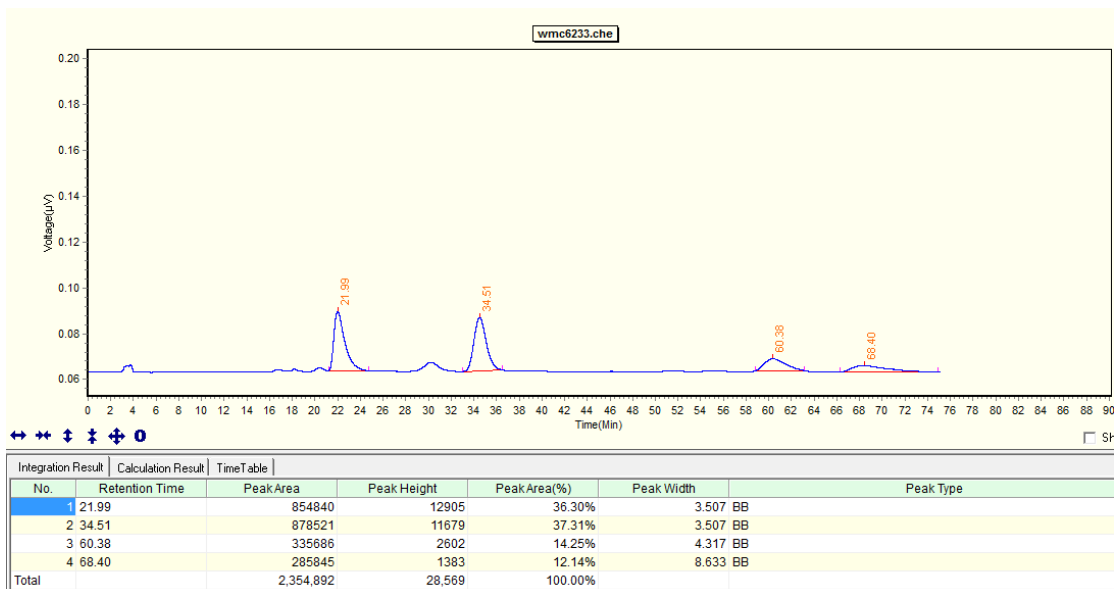
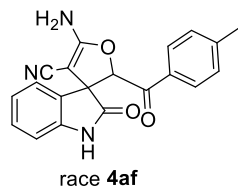


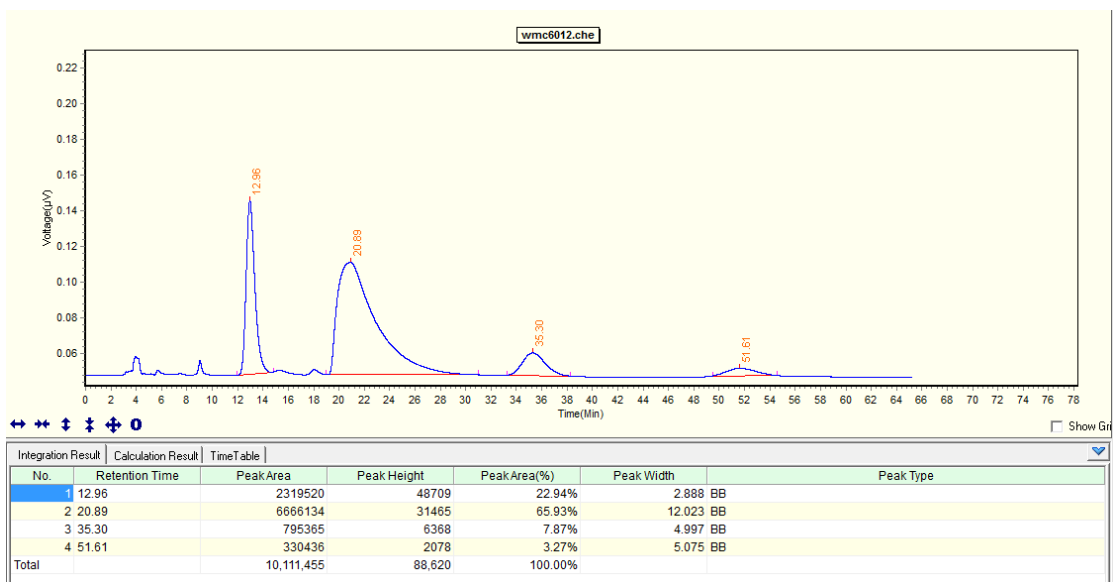
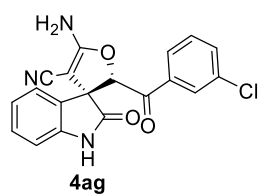
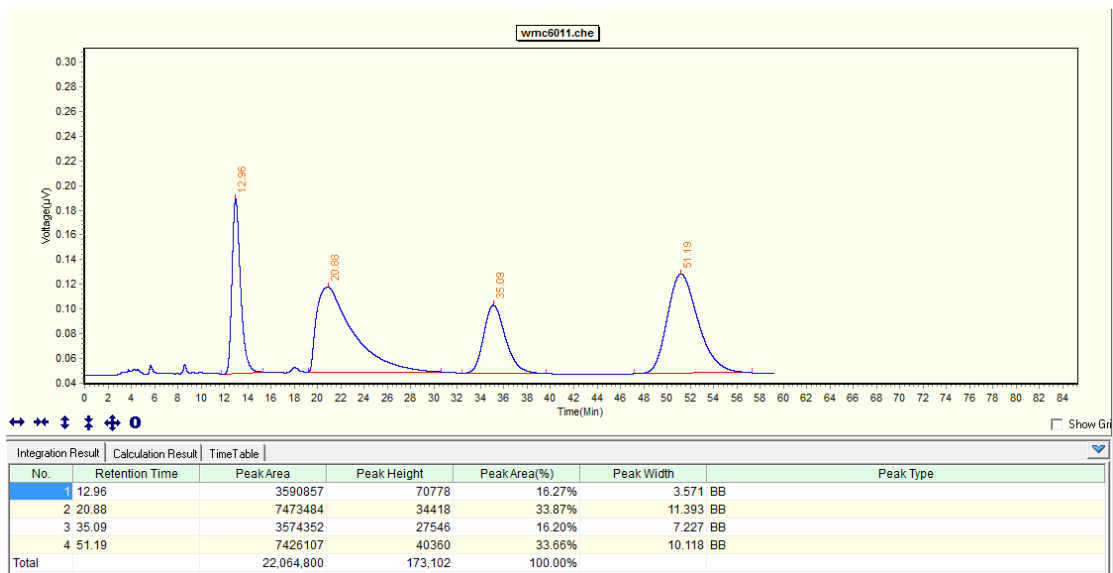
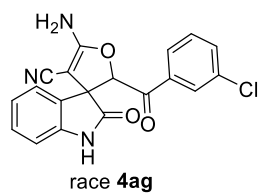


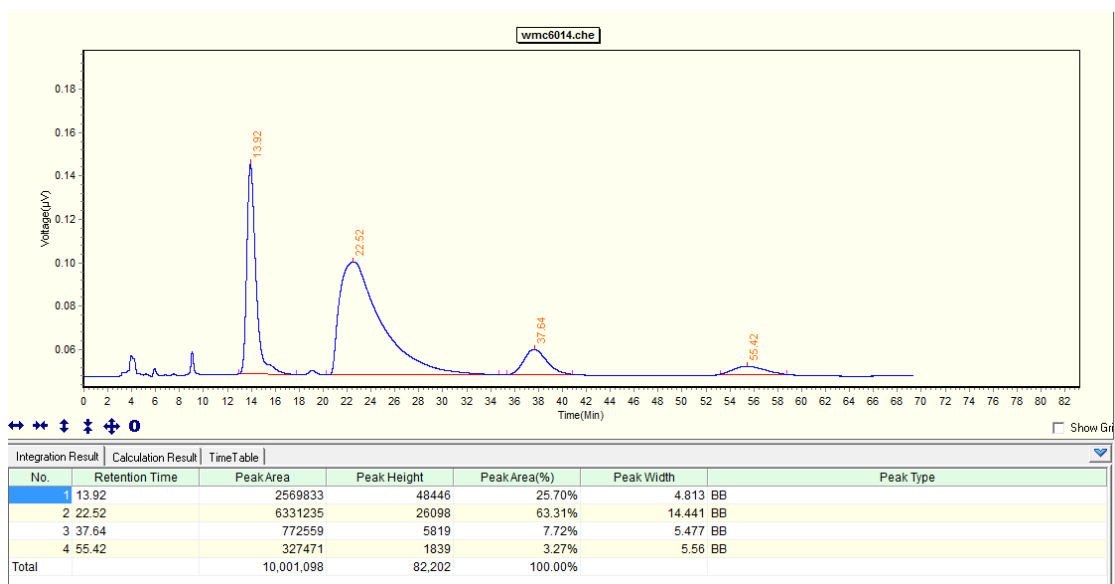
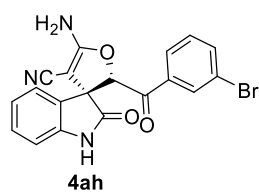
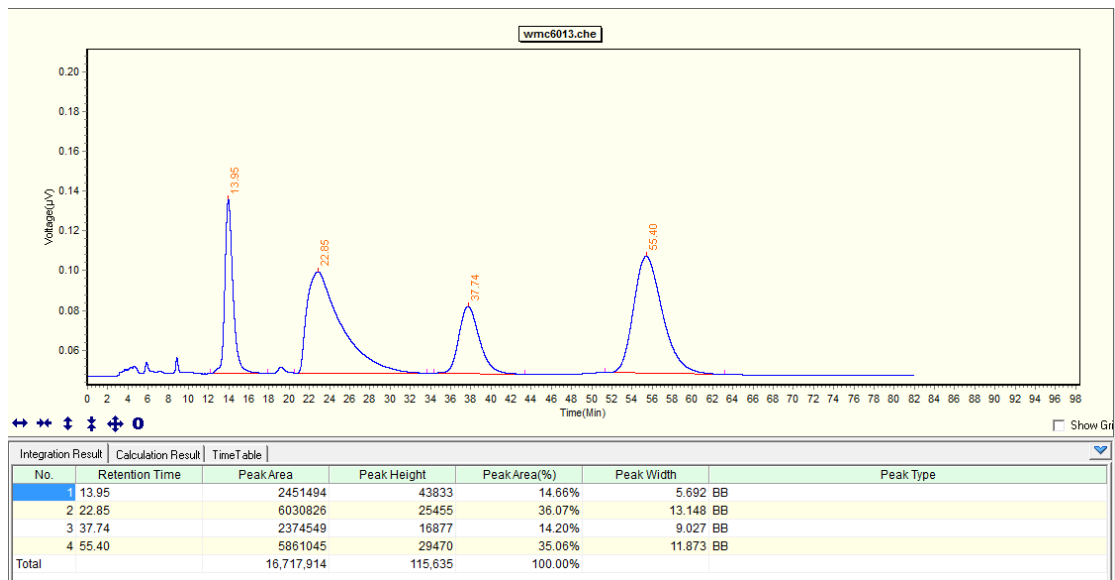
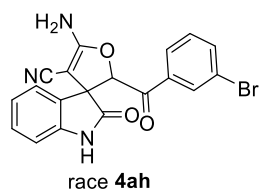


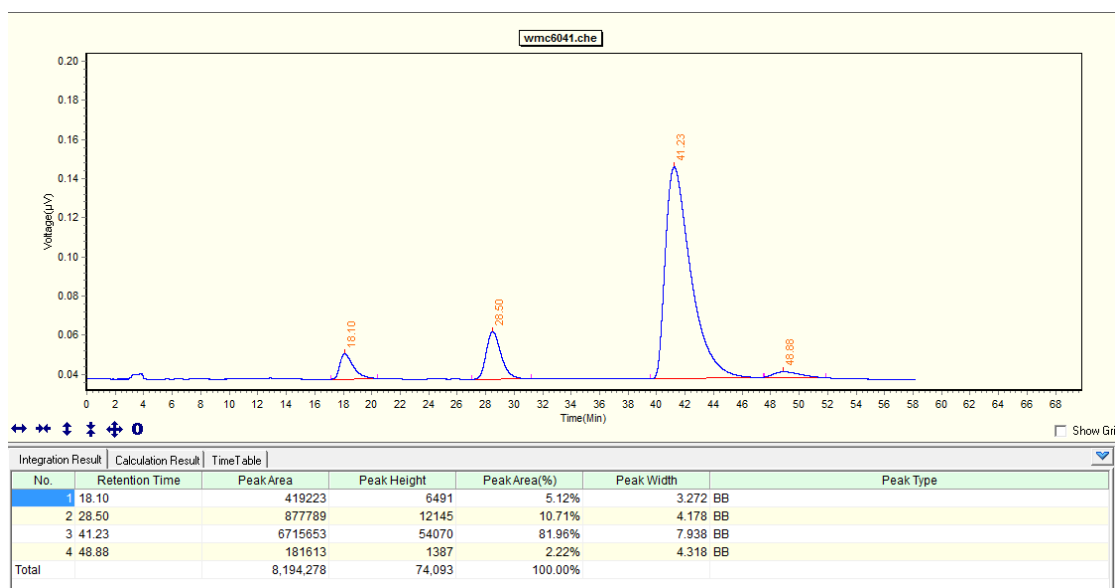
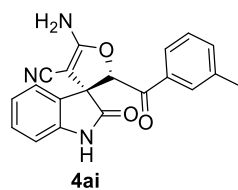
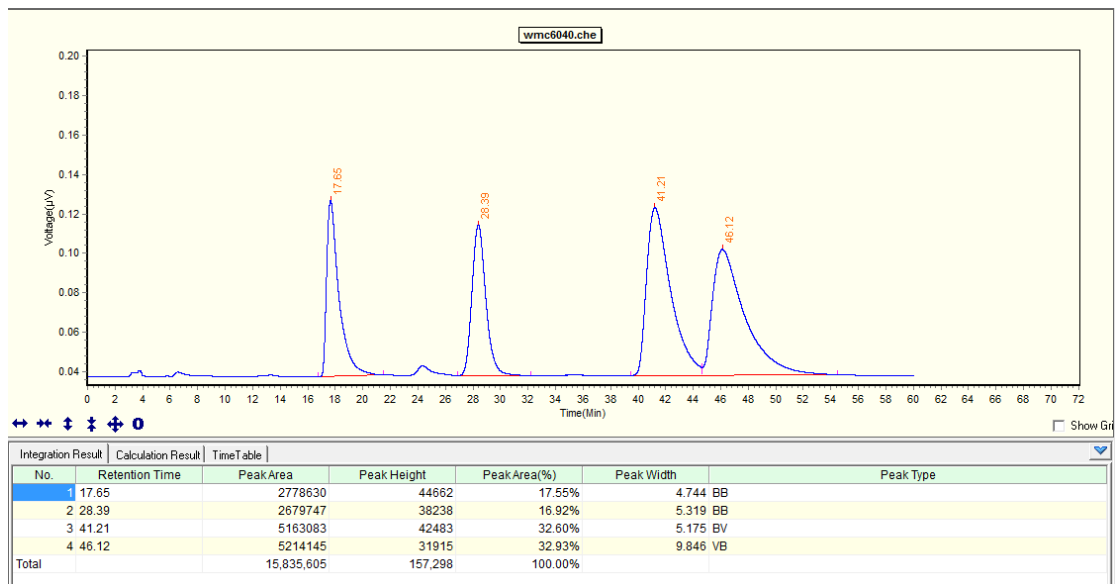
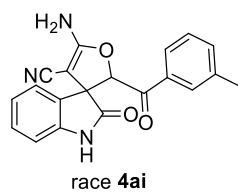


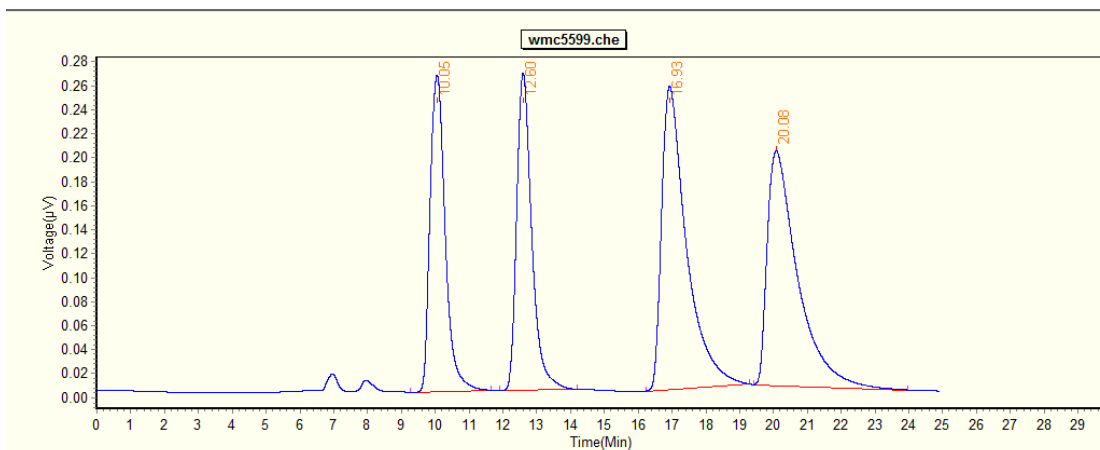
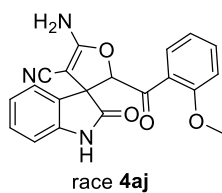




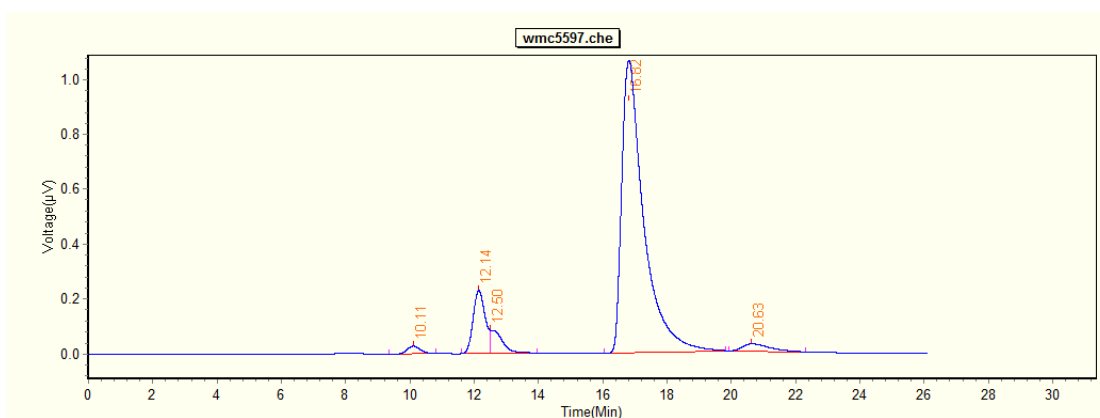
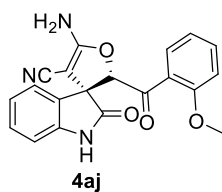




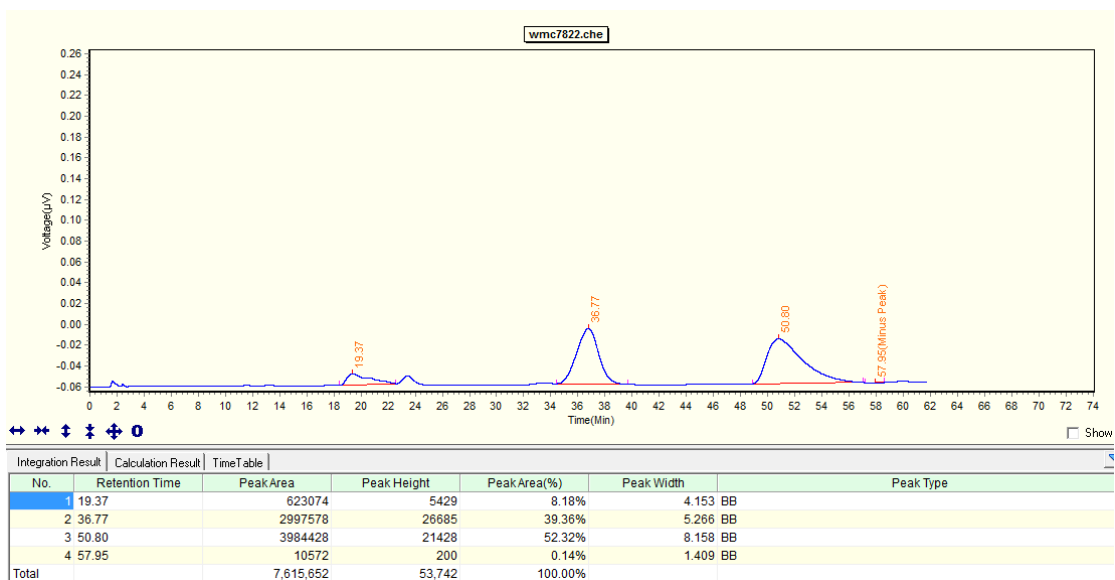
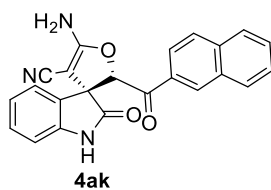
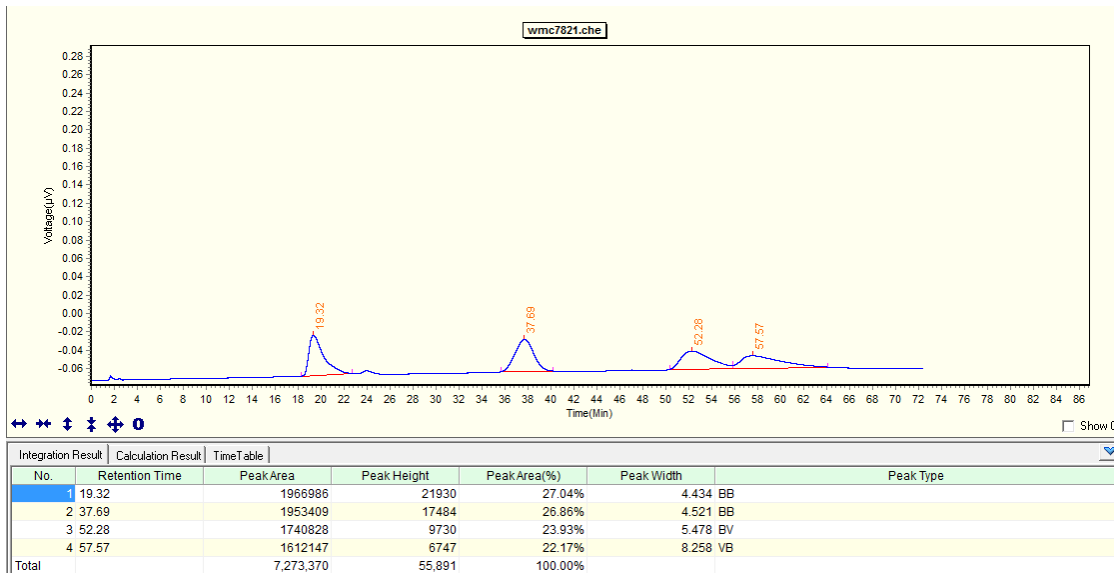
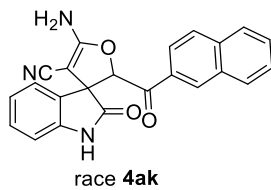


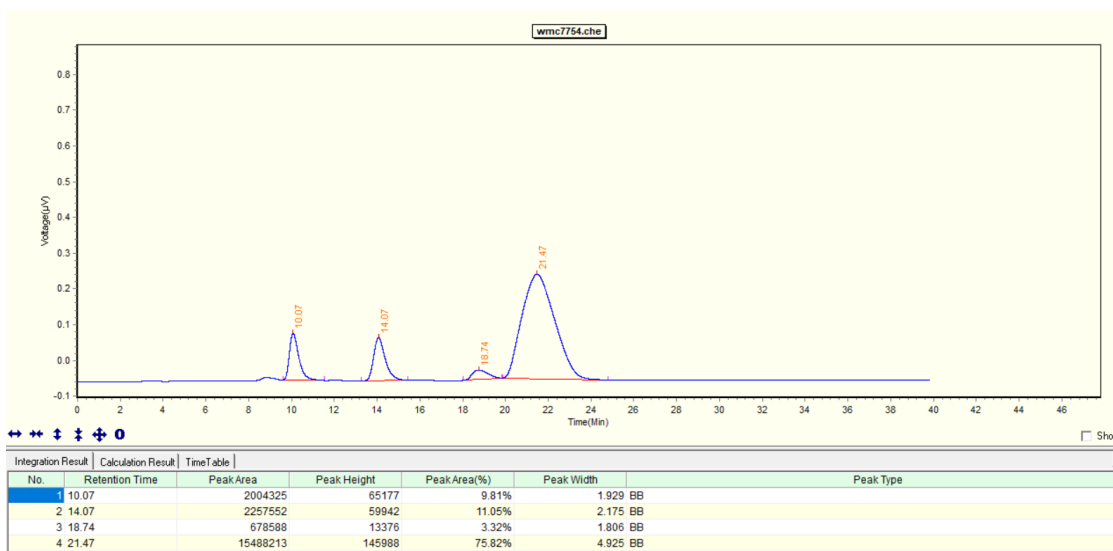
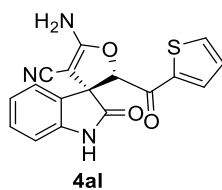
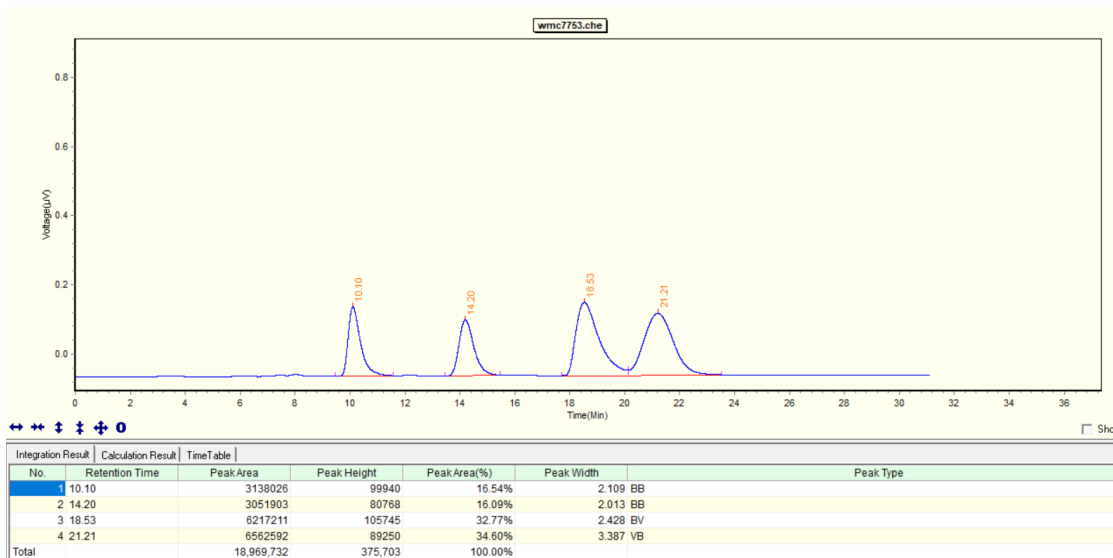
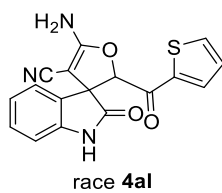


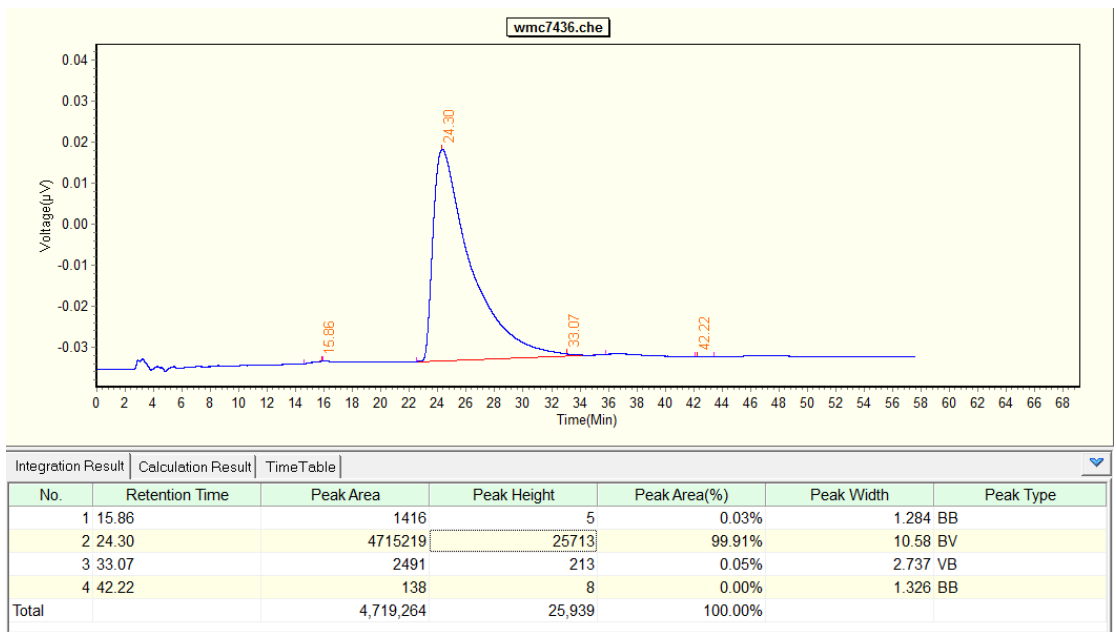
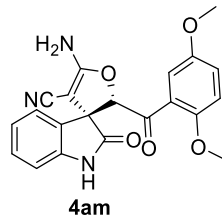
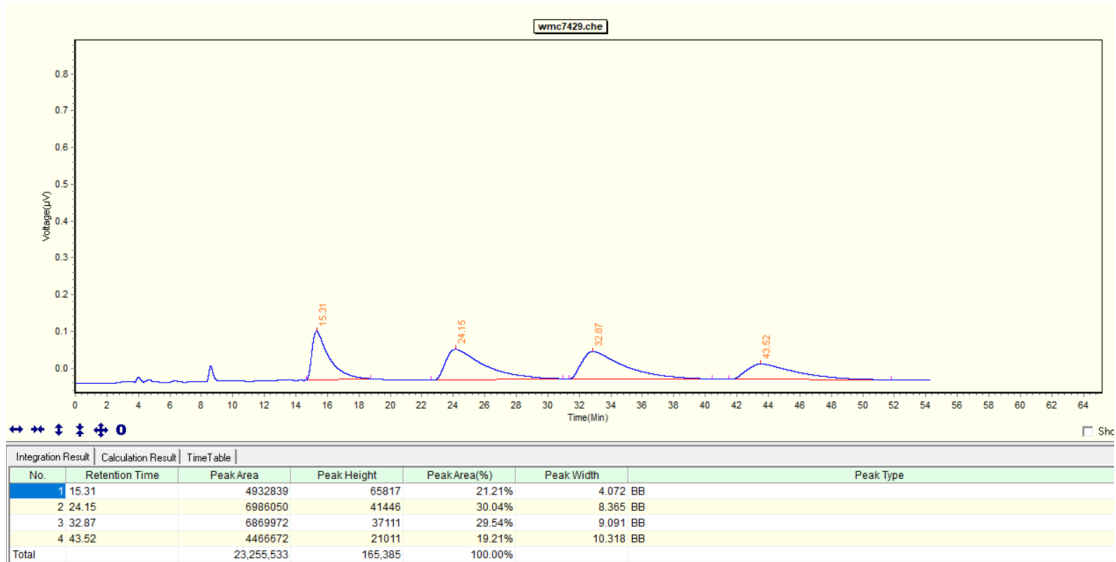
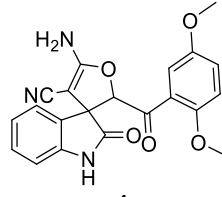
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2	12.60	4090441	132161	19.73%	2.292	BB
3	16.93	6447855	126412	31.10%	3.056	BB
4	20.08	6086048	97951	29.36%	4.551	BB
Total		20,732,341	488,410	100.00%		



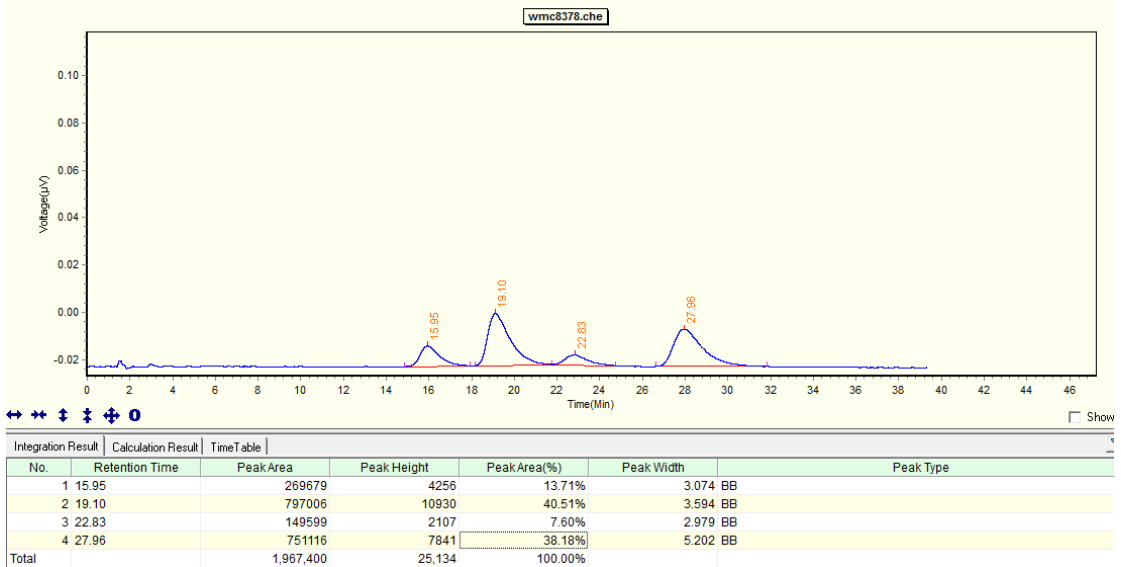
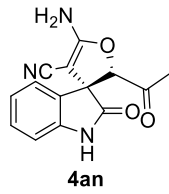
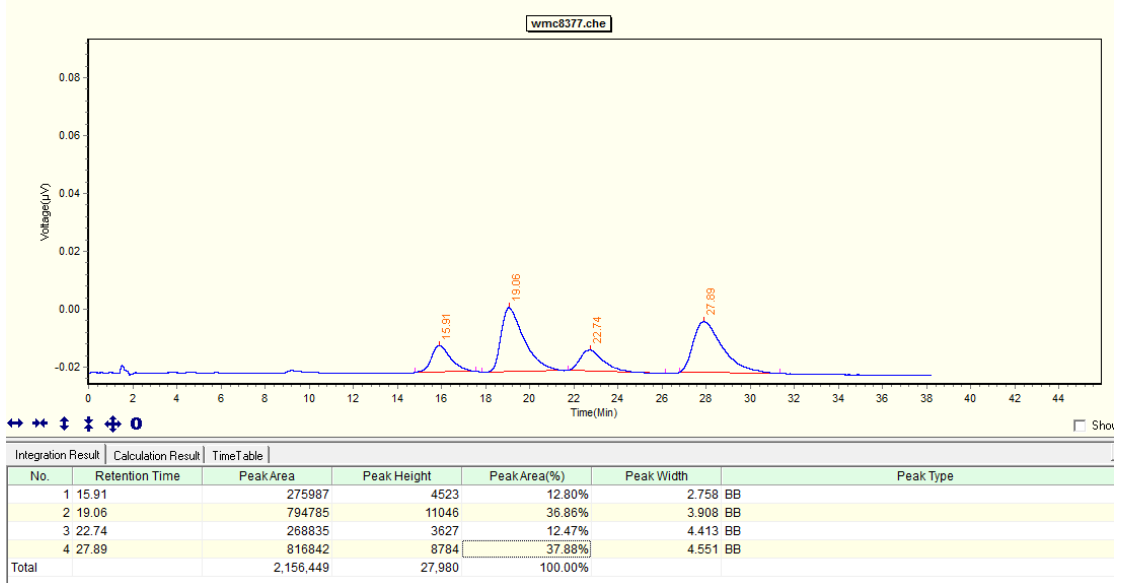
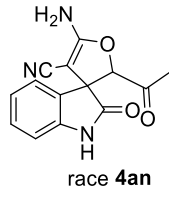
No.	Retention Time	Peak Area	Peak Height	Peak Area(%)	Peak Width	Peak Type
1	10.11	379790	13697	1.25%	1.458	BB
2	12.14	2996084	114961	9.83%	0.895	BV
3	12.50	1097125	42371	3.60%	1.458	VB
4	16.82	25244149	532564	82.81%	3.778	BB
5	20.63	766125	13243	2.51%	2.386	BB
Total		30,483,273	716,836	100.00%		

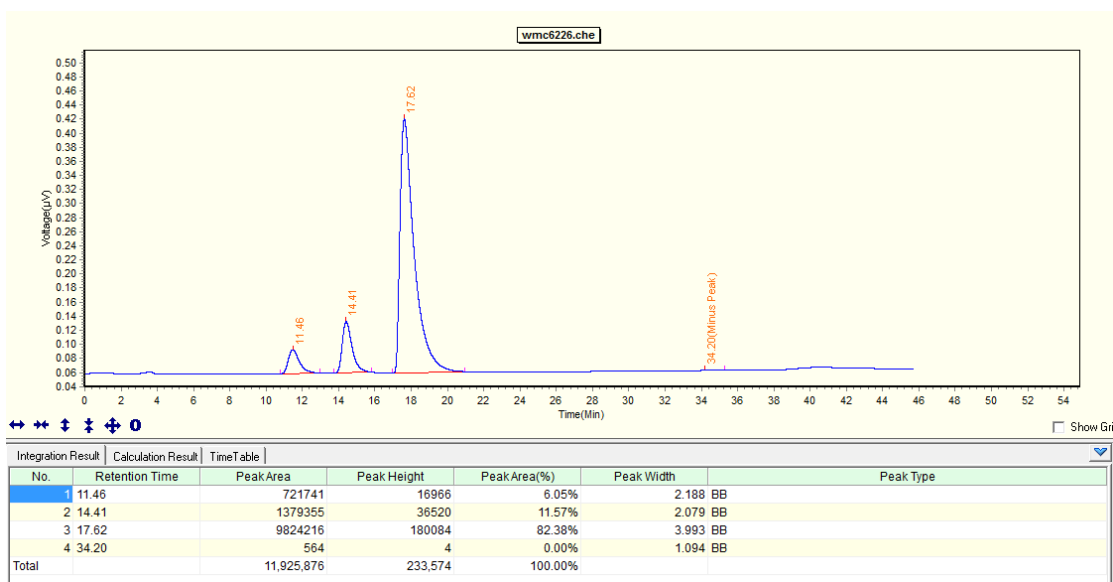
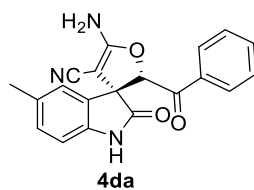
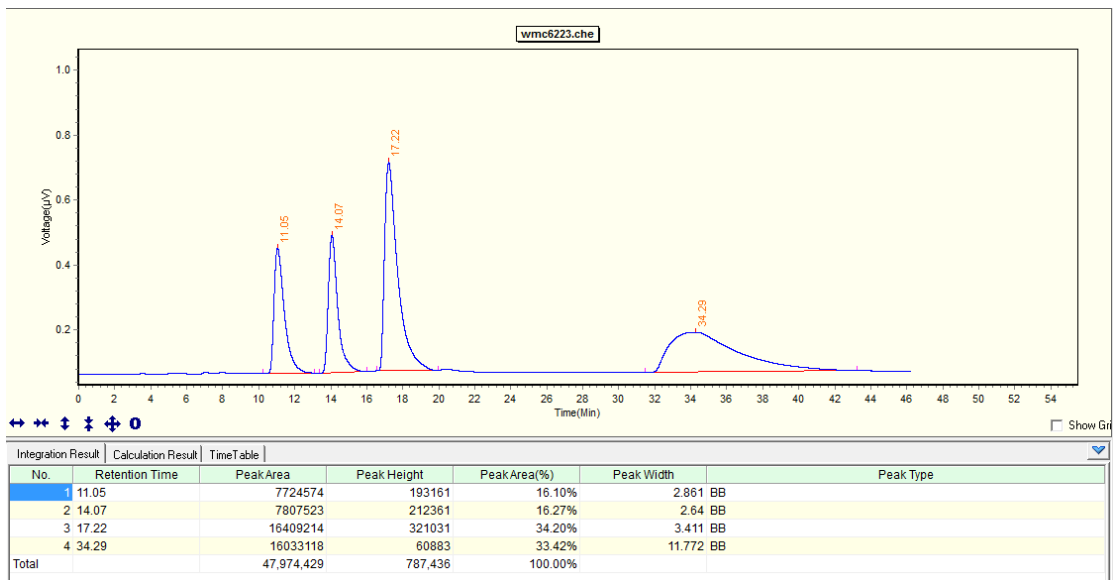
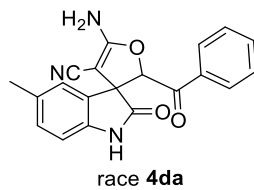


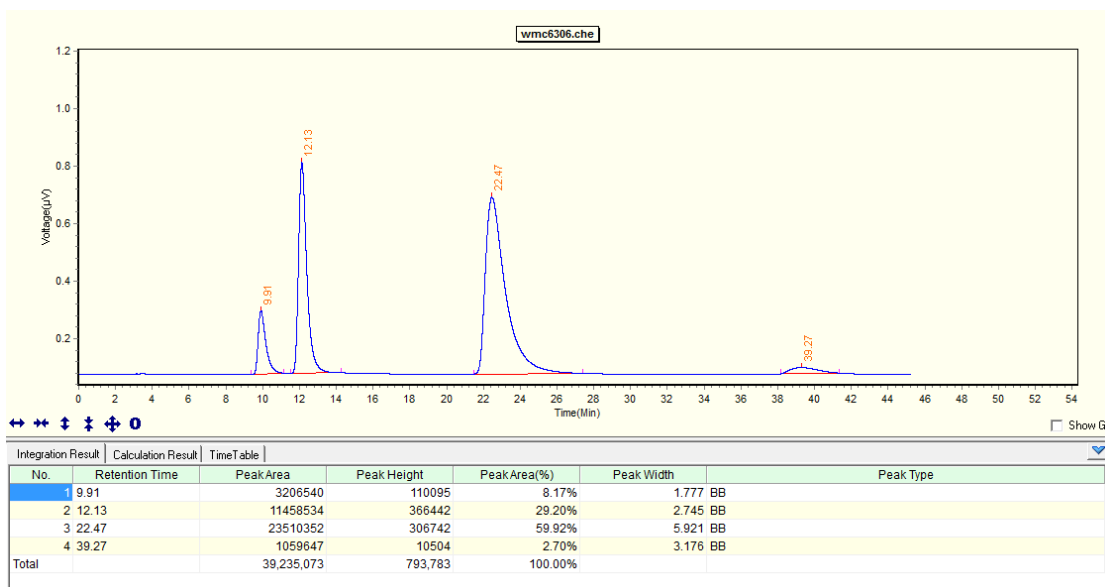
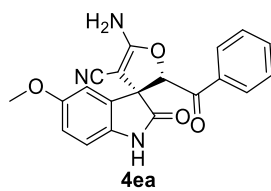
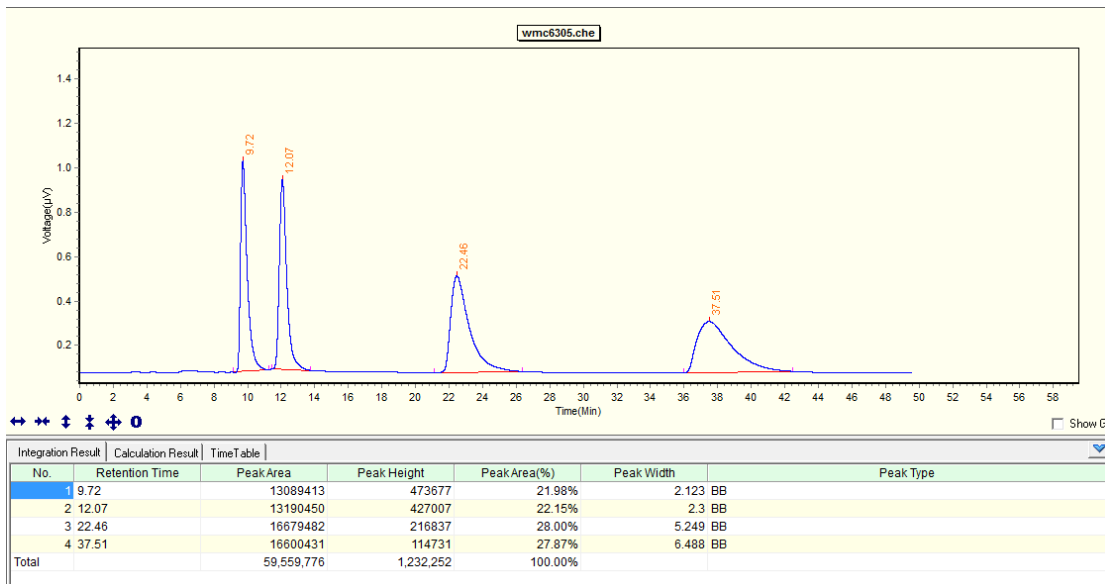
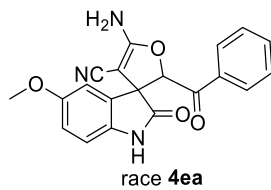


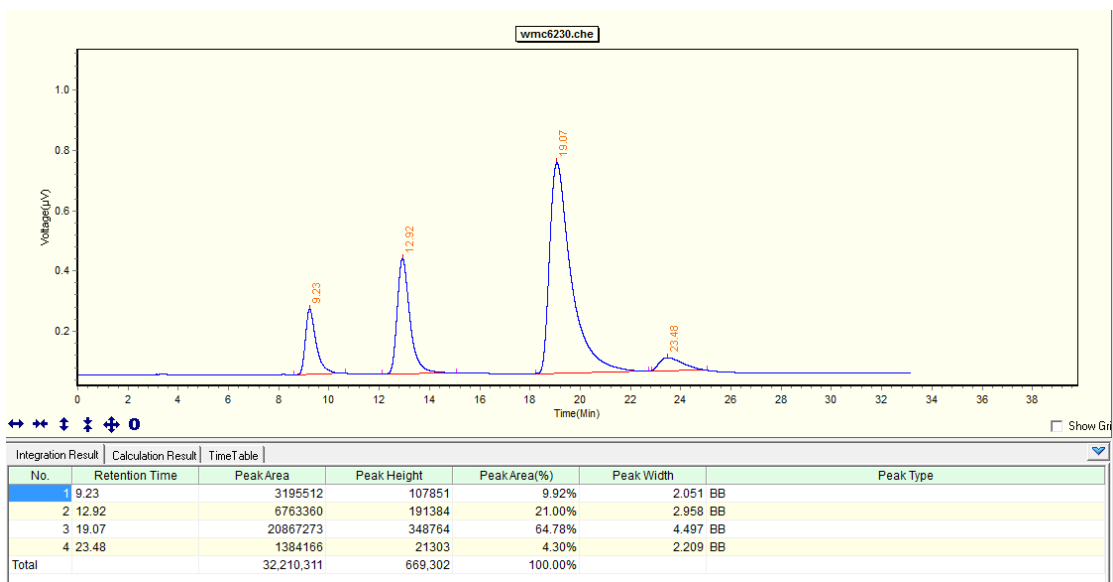
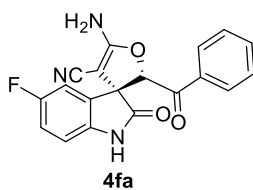
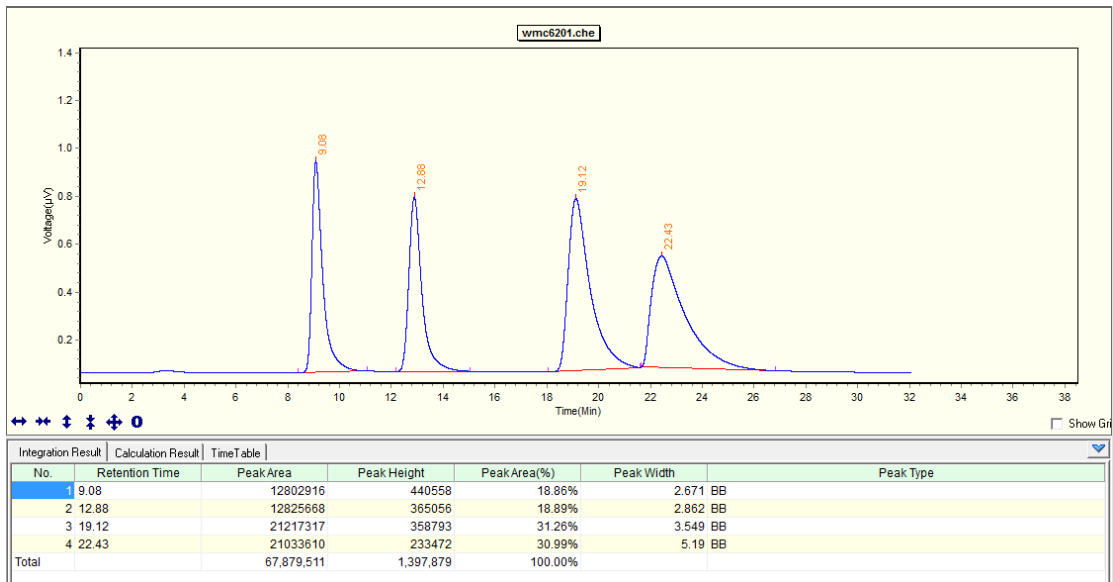
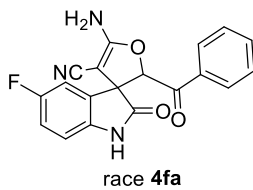


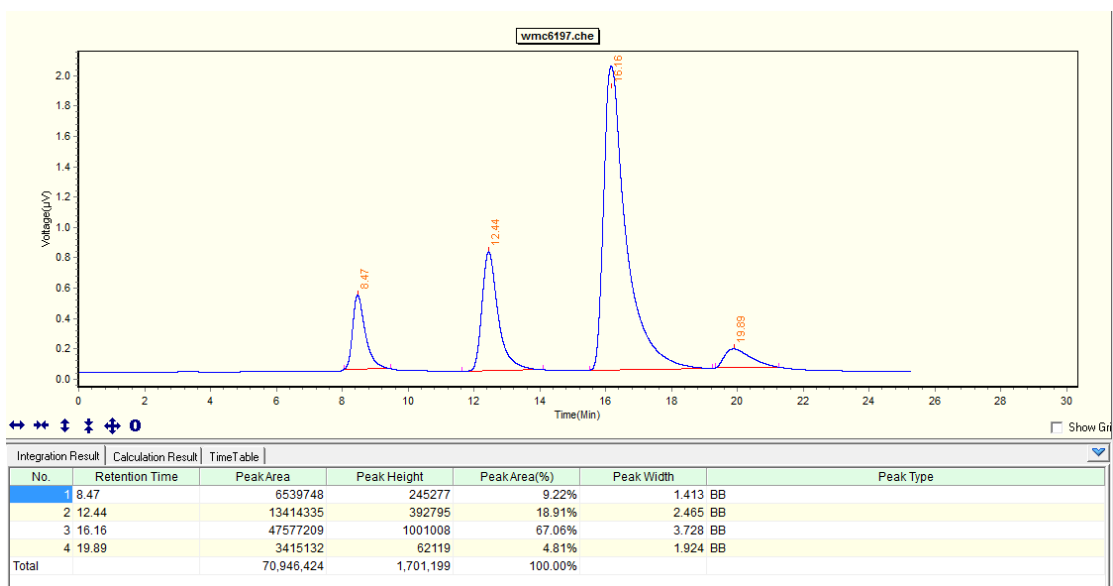
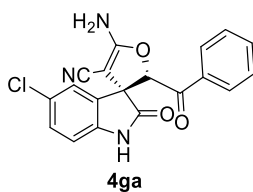
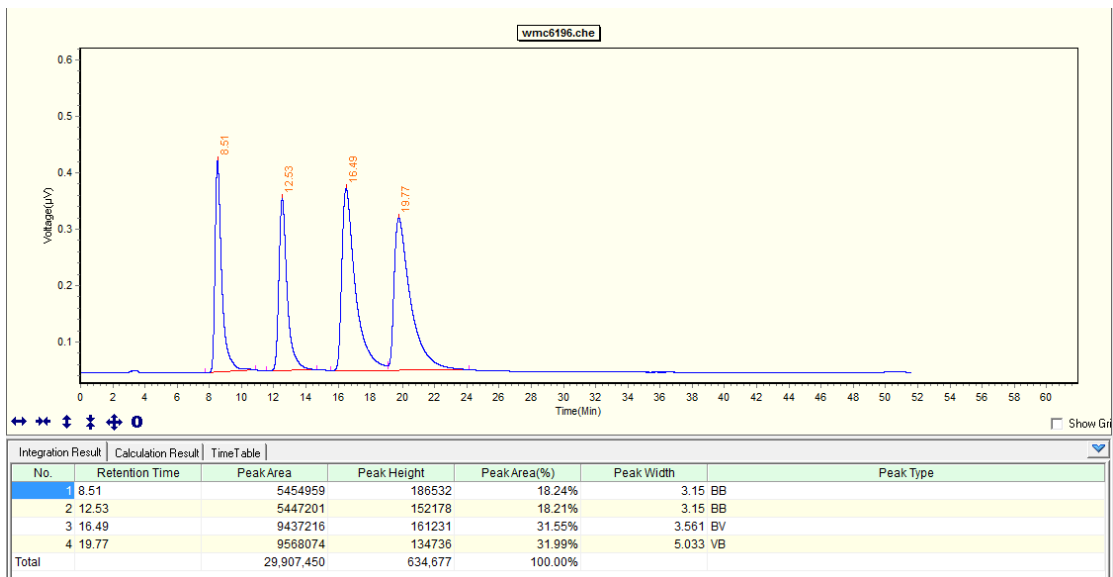
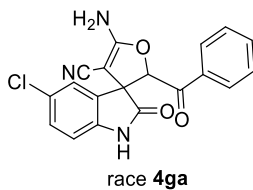


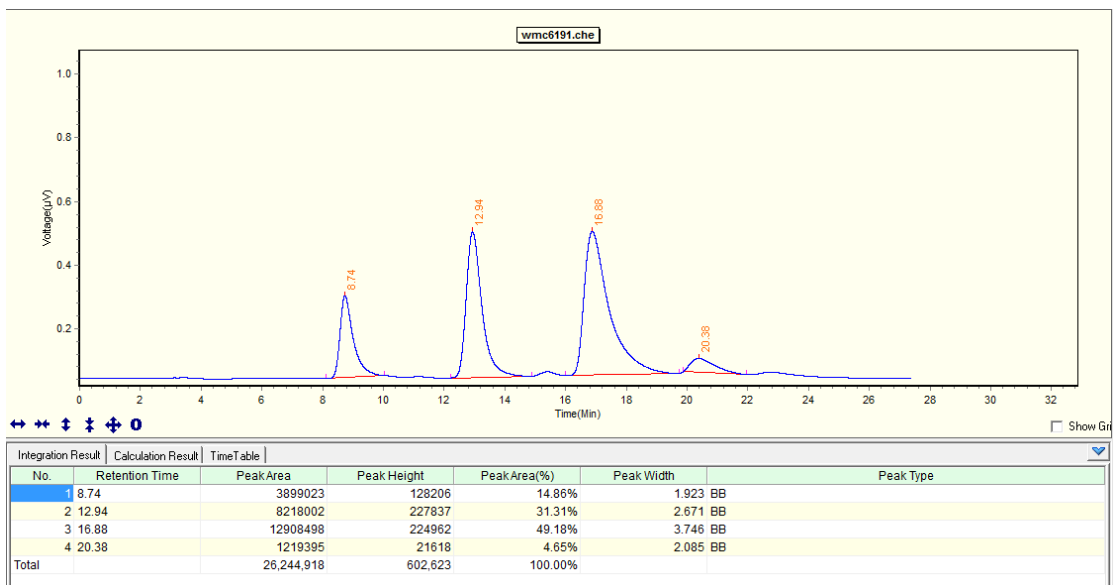
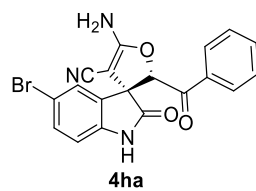
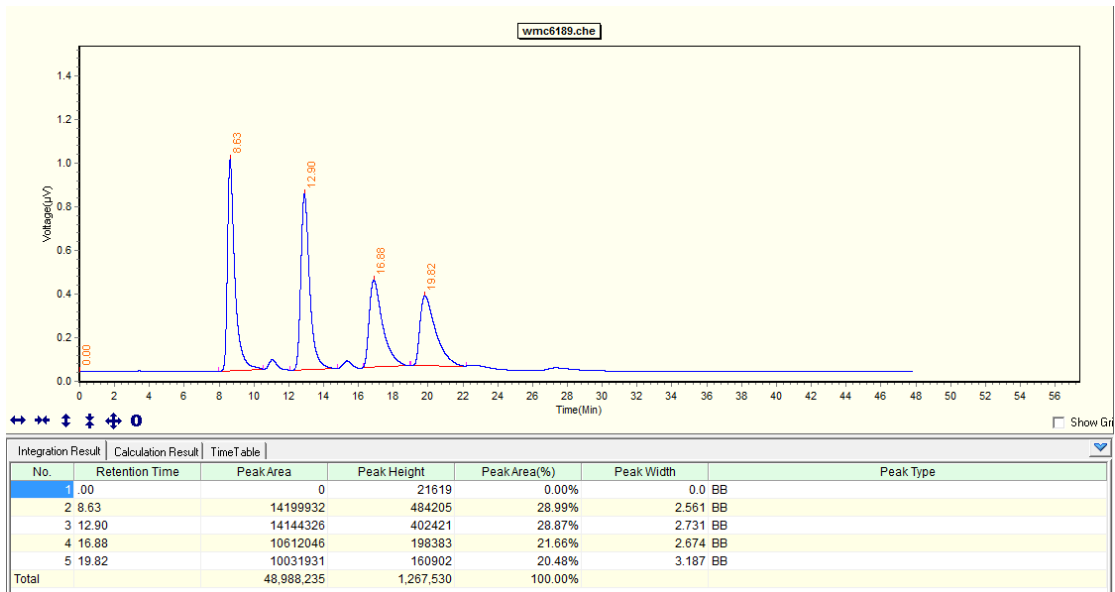
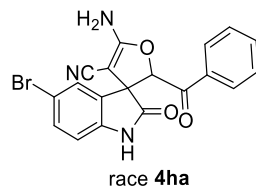


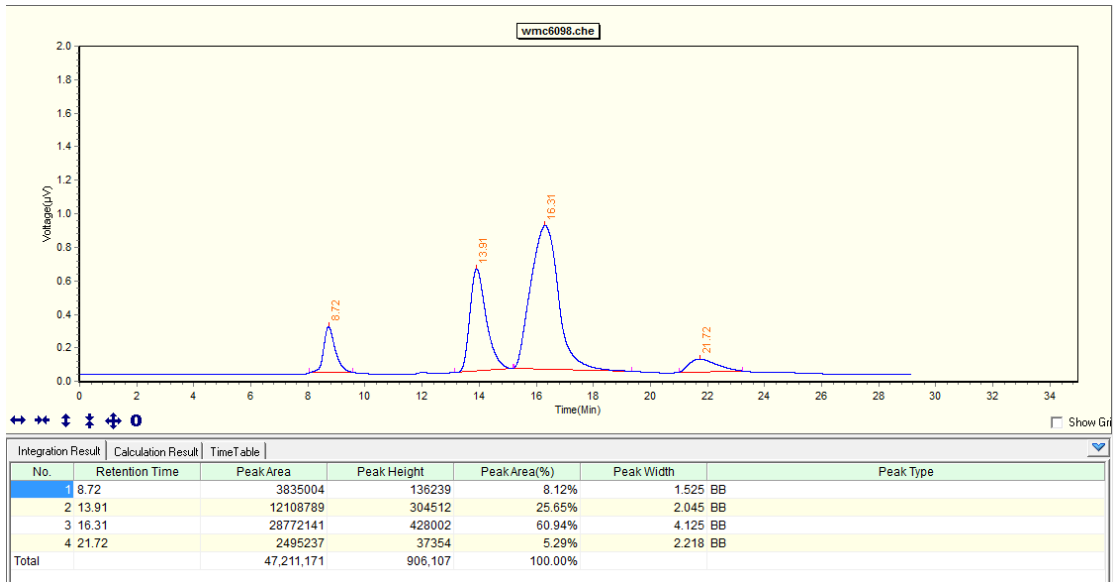
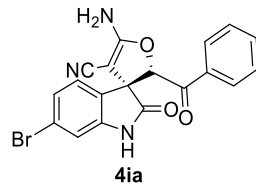
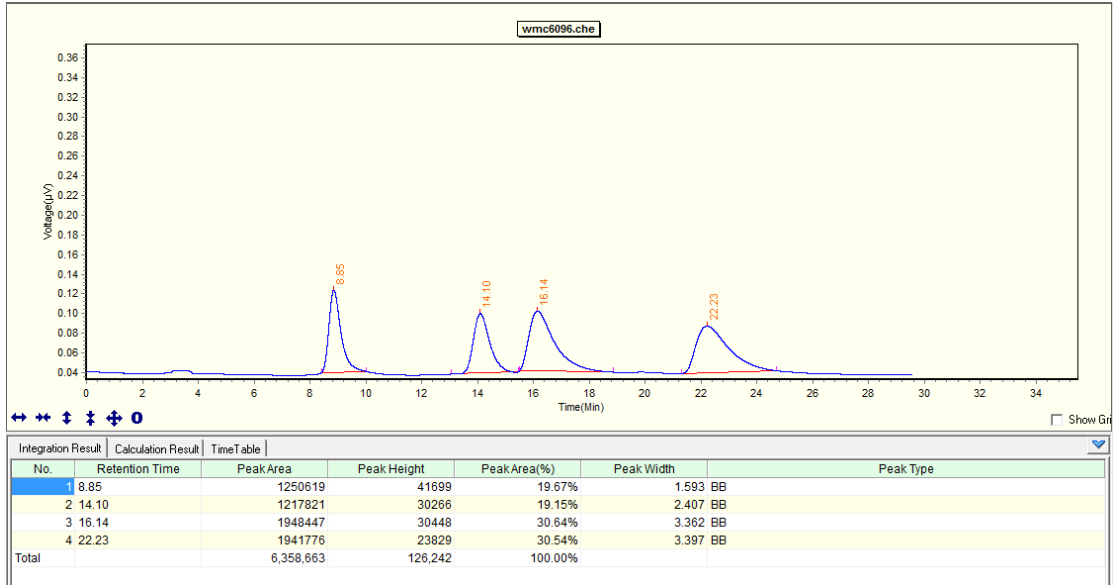
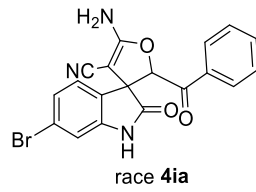


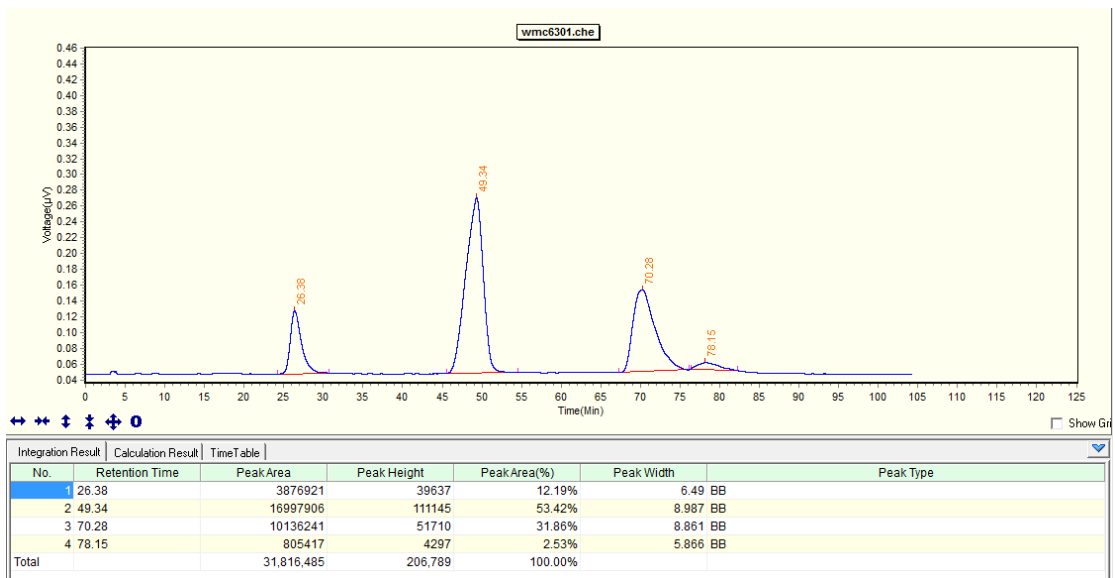
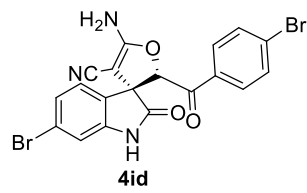
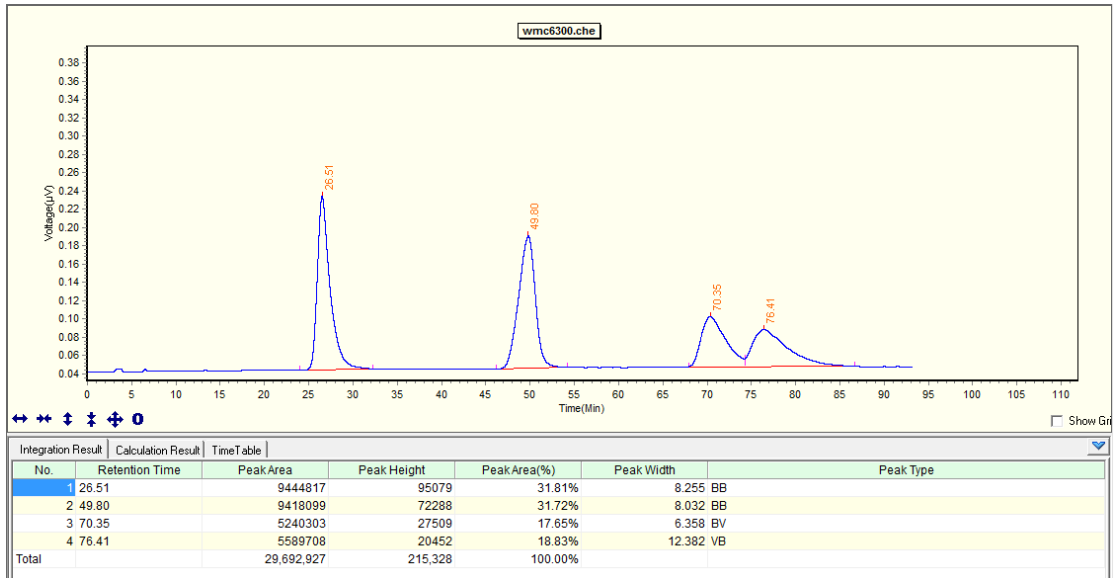
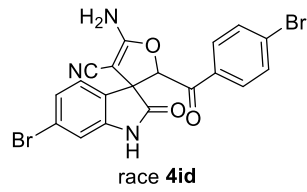








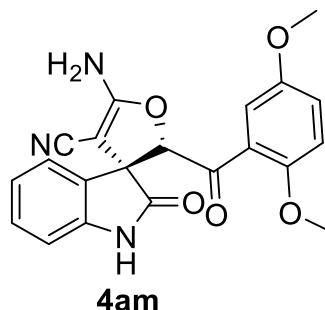
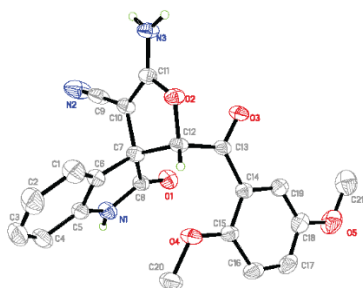






## 2. X-ray crystal structure of 4am

CCDC 1866997



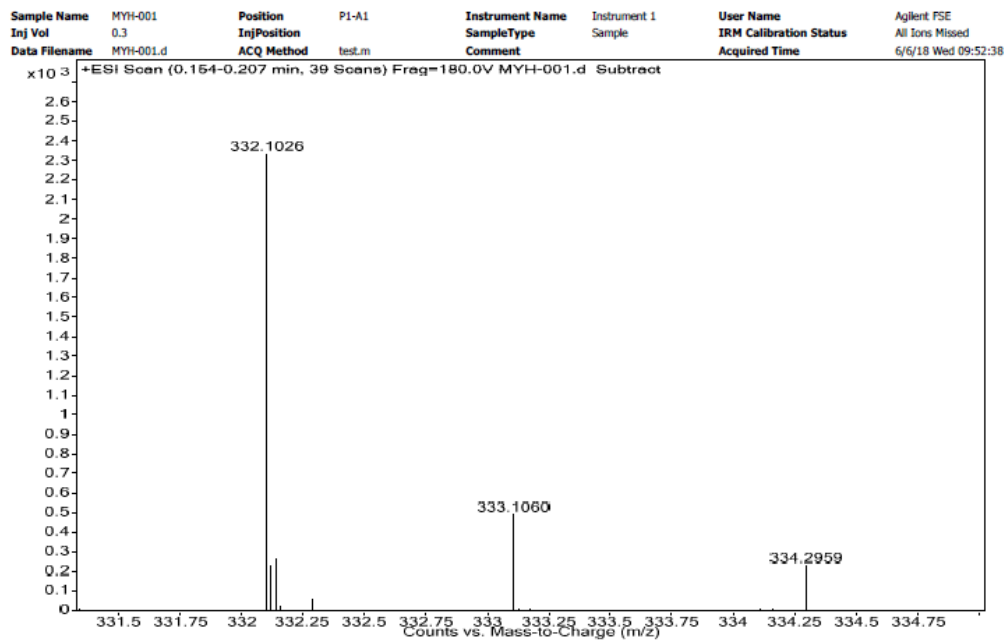
**Table 1 Crystal data and structure refinement for 201807329.**

Identification code	201807329
Empirical formula	C <sub>46</sub> H <sub>42</sub> N <sub>6</sub> O <sub>11</sub>
Formula weight	854.85
Temperature/K	293(2)
Crystal system	orthorhombic
Space group	P2 <sub>1</sub> 2 <sub>1</sub> 2 <sub>1</sub>
a/Å	14.1242(3)
b/Å	14.3980(3)
c/Å	20.2906(6)
α/°	90
β/°	90
γ/°	90
Volume/Å <sup>3</sup>	4126.30(18)
Z	4

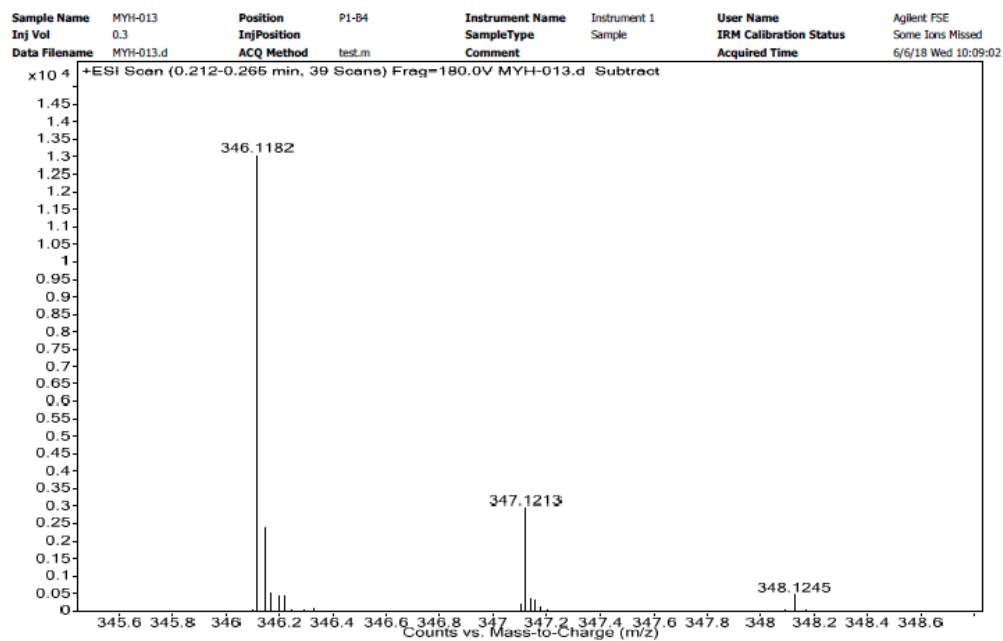
$\rho_{\text{calc}}/\text{cm}^3$	1.376
$\mu/\text{mm}^{-1}$	0.828
F(000)	1792.0
Crystal size/ $\text{mm}^3$	0.19 × 0.15 × 0.13
Radiation	CuK $\alpha$ ( $\lambda$ = 1.54184)
2 $\theta$ range for data collection/ $^\circ$	7.528 to 134.082
Index ranges	-14 ≤ h ≤ 16, -16 ≤ k ≤ 17, -18 ≤ l ≤ 24
Reflections collected	15987
Independent reflections	7264 [R <sub>int</sub> = 0.0282, R <sub>sigma</sub> = 0.0380]
Data/restraints/parameters	7264/0/573
Goodness-of-fit on F <sup>2</sup>	1.046
Final R indexes [I ≥ 2 $\sigma$ (I)]	R <sub>1</sub> = 0.0522, wR <sub>2</sub> = 0.1394
Final R indexes [all data]	R <sub>1</sub> = 0.0613, wR <sub>2</sub> = 0.1481
Largest diff. peak/hole / e Å <sup>-3</sup>	0.38/-0.22
Flack parameter	-0.06(12)

### 3. HRMS spectra of compounds

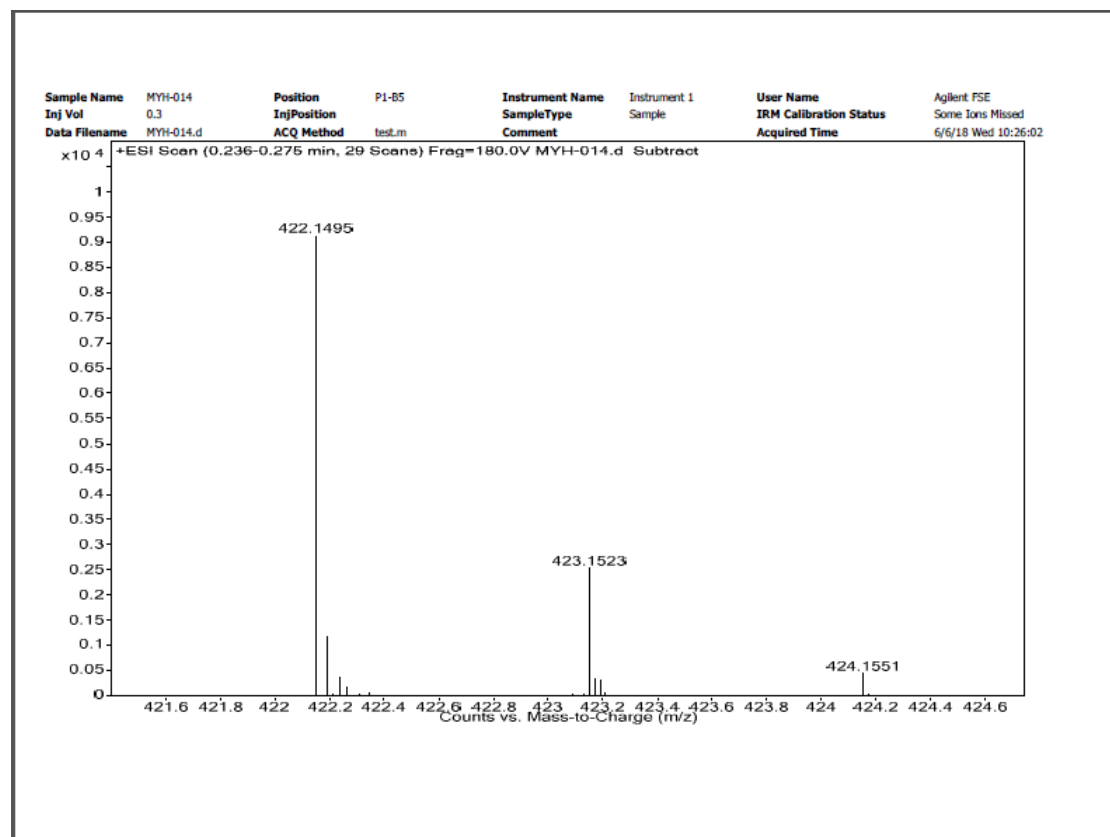
#### HRMS spectra of Compound 4aa



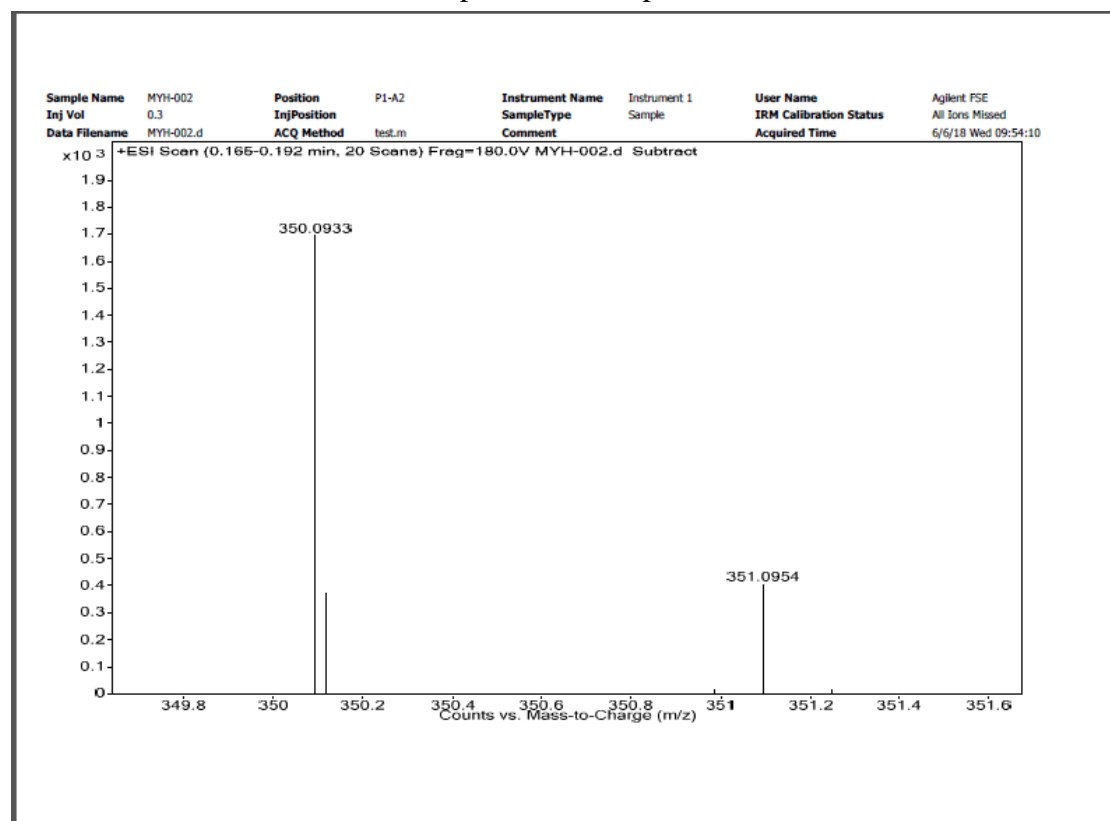
#### HRMS spectra of Compound 4ba



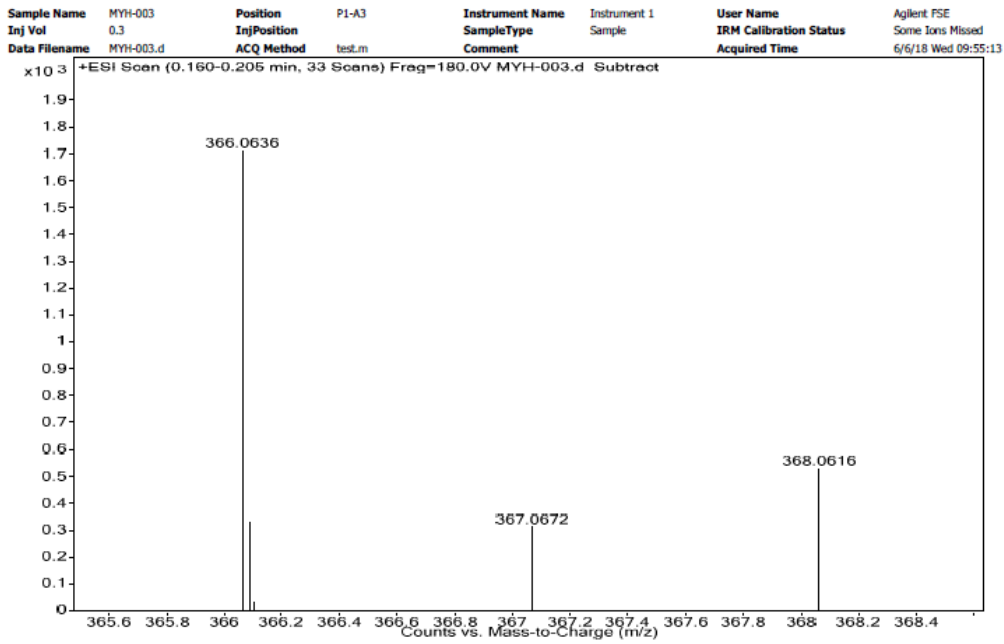
## HRMS spectra of Compound 4ca



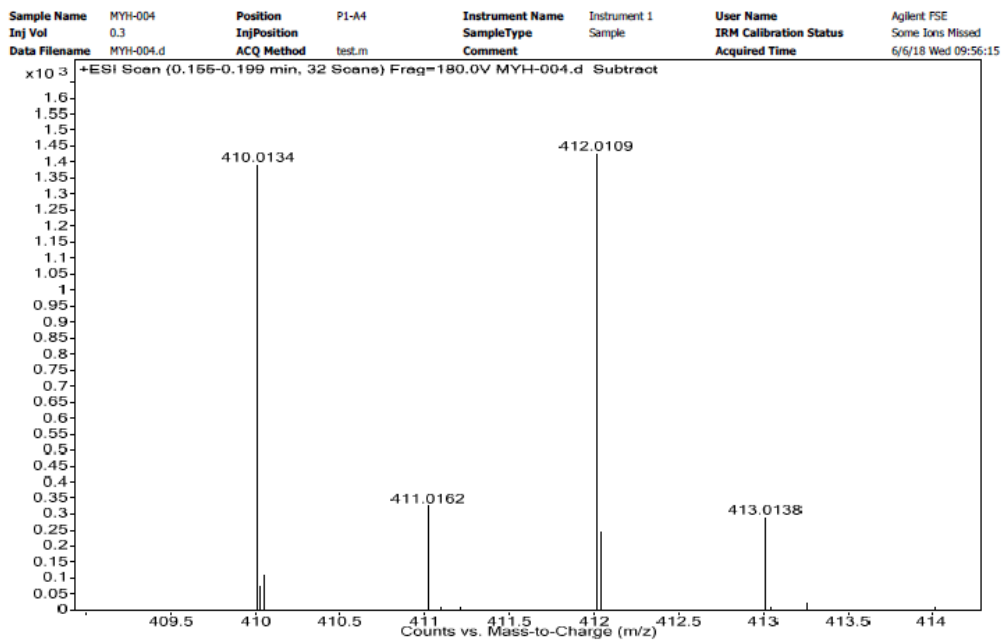
## HRMS spectra of Compound 4ab



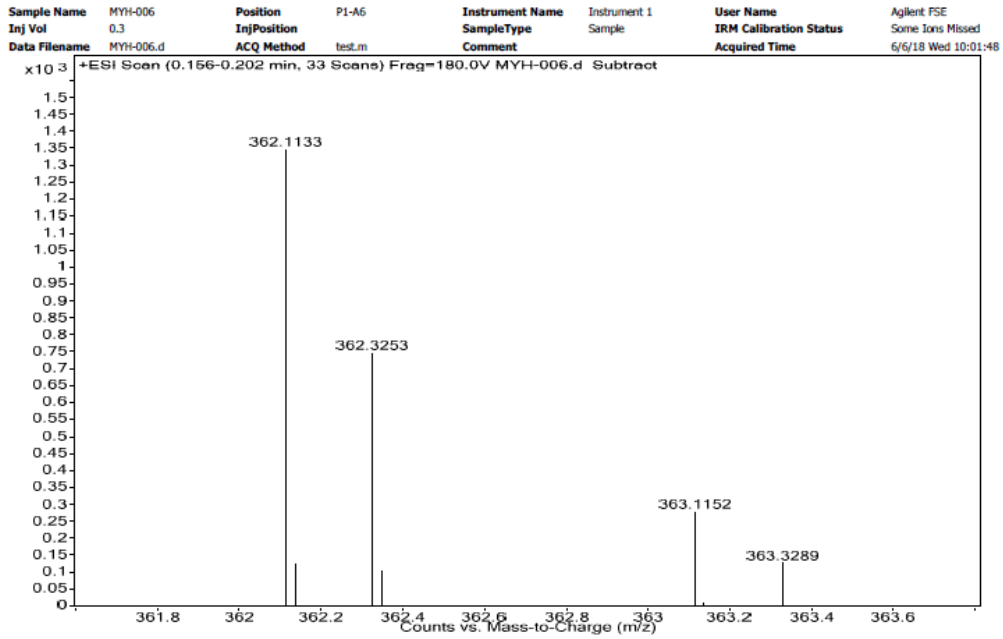
## HRMS spectra of Compound 4ac



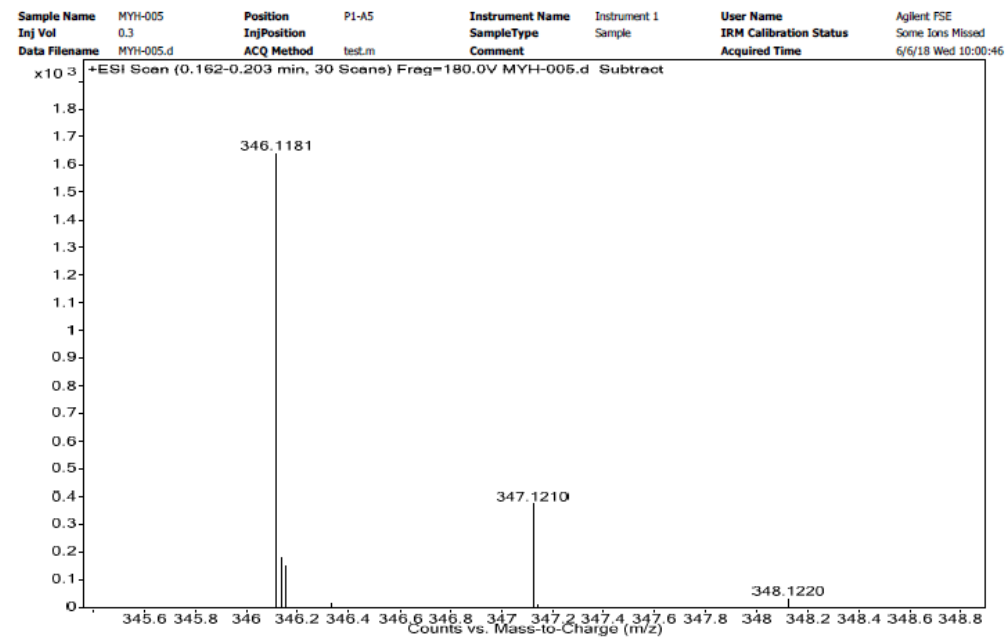
## HRMS spectra of Compound 4ad



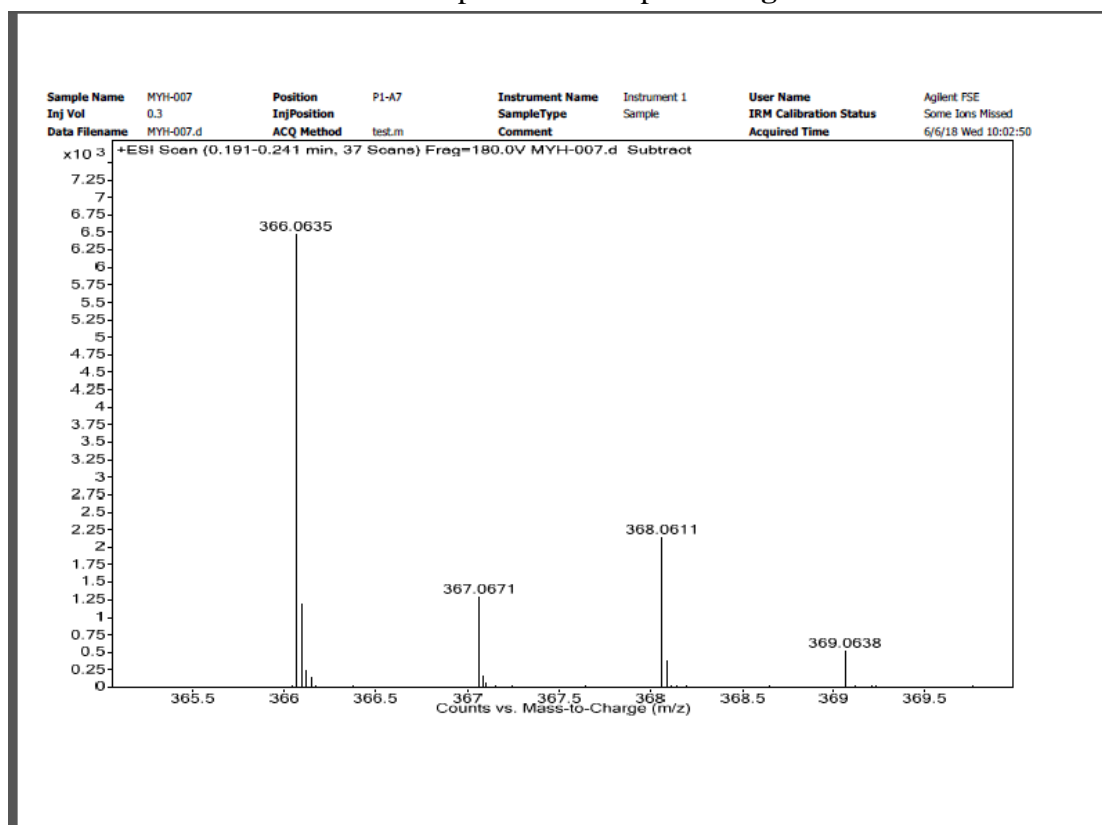
## HRMS spectra of Compound 4ae



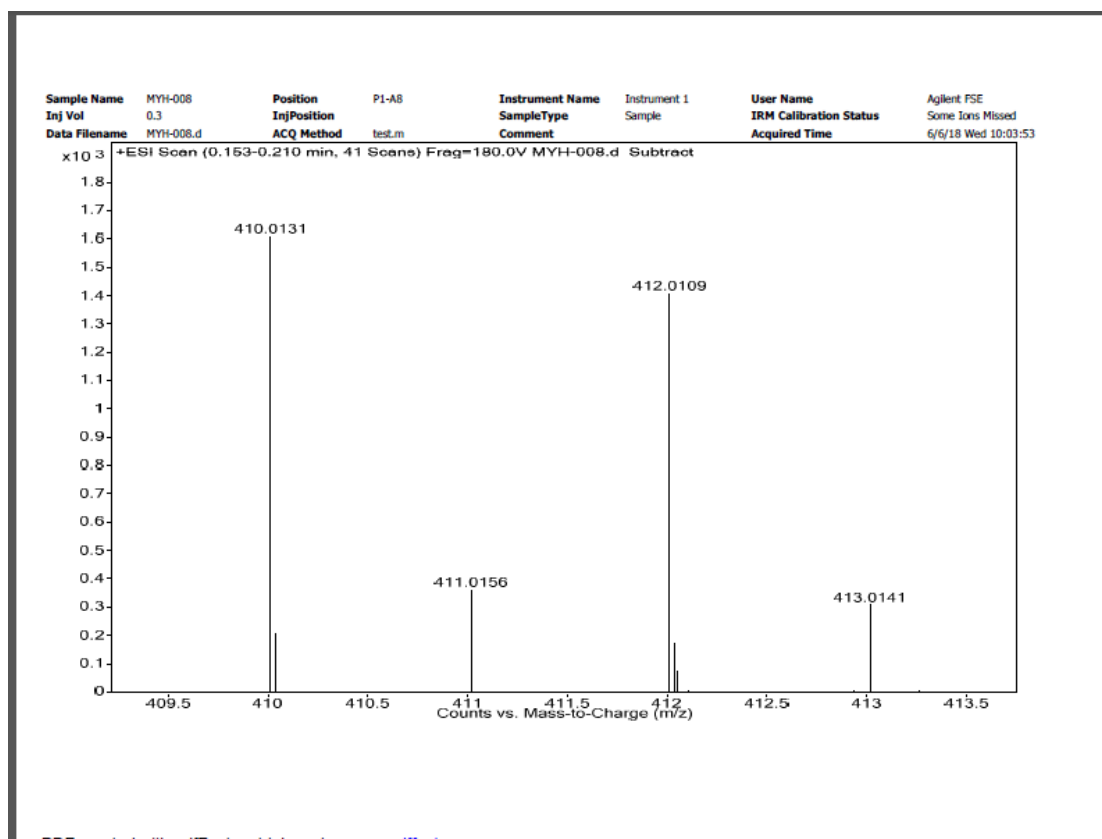
## HRMS spectra of Compound 4af



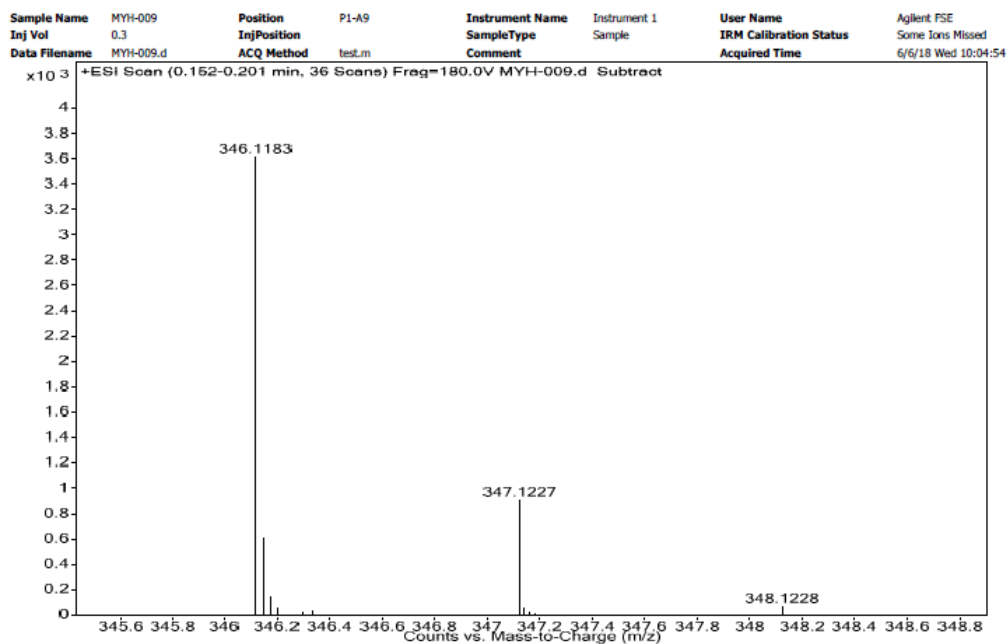
## HRMS spectra of Compound 4ag



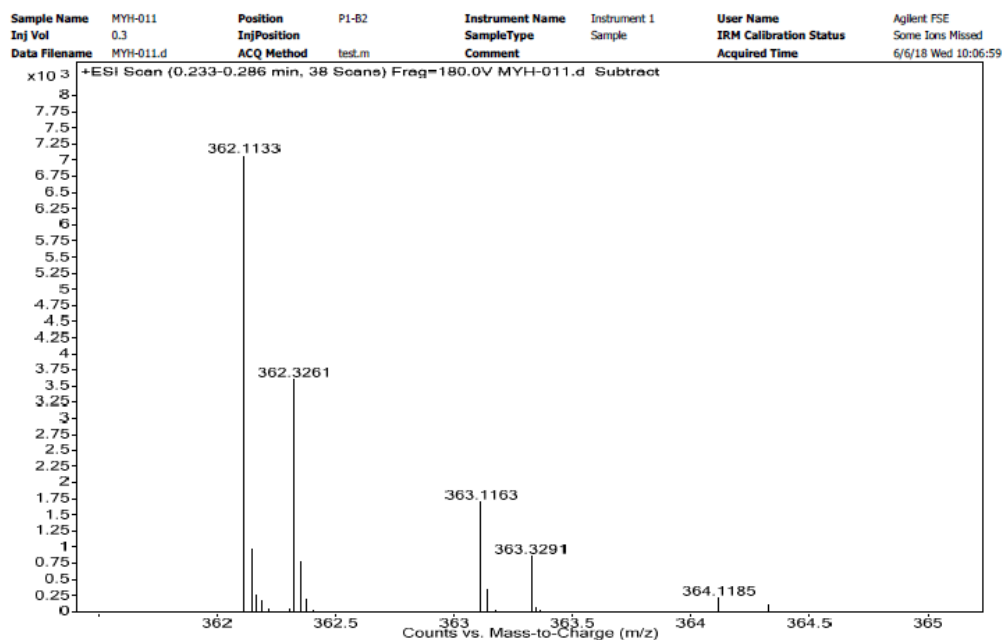
## HRMS spectra of Compound 4ah



## HRMS spectra of Compound 4ai

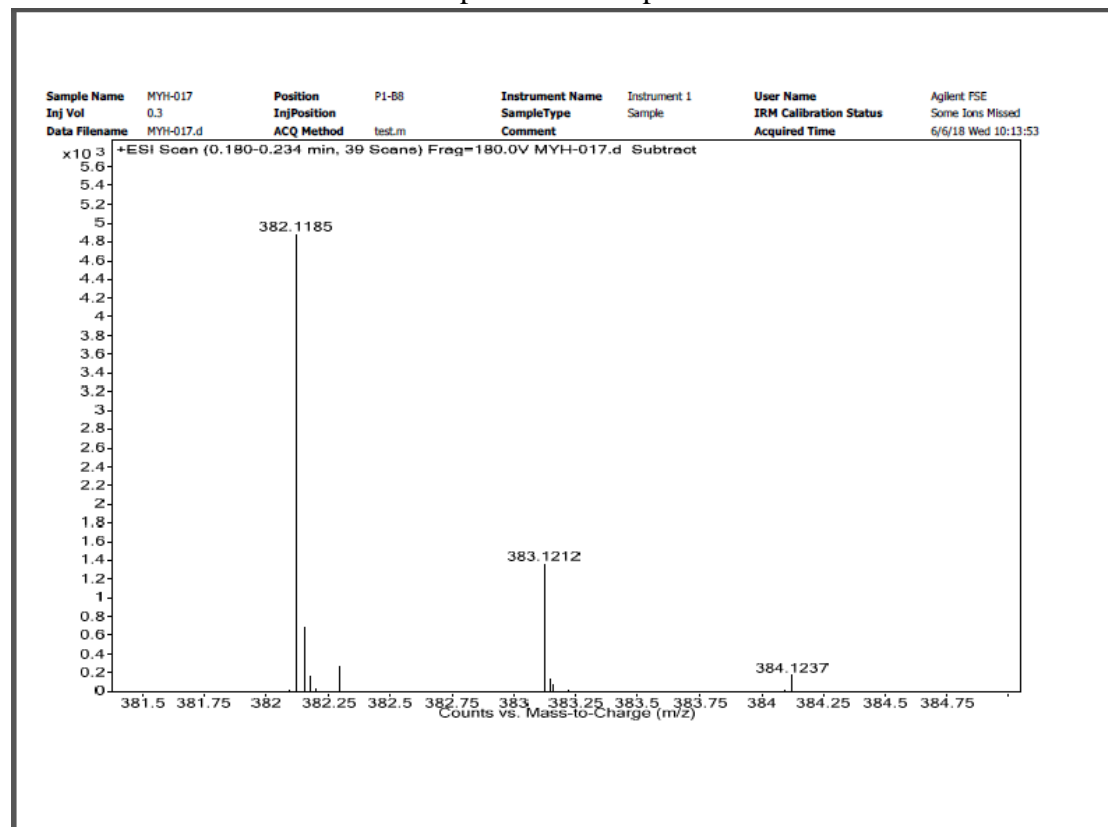


## HRMS spectra of Compound 4aj

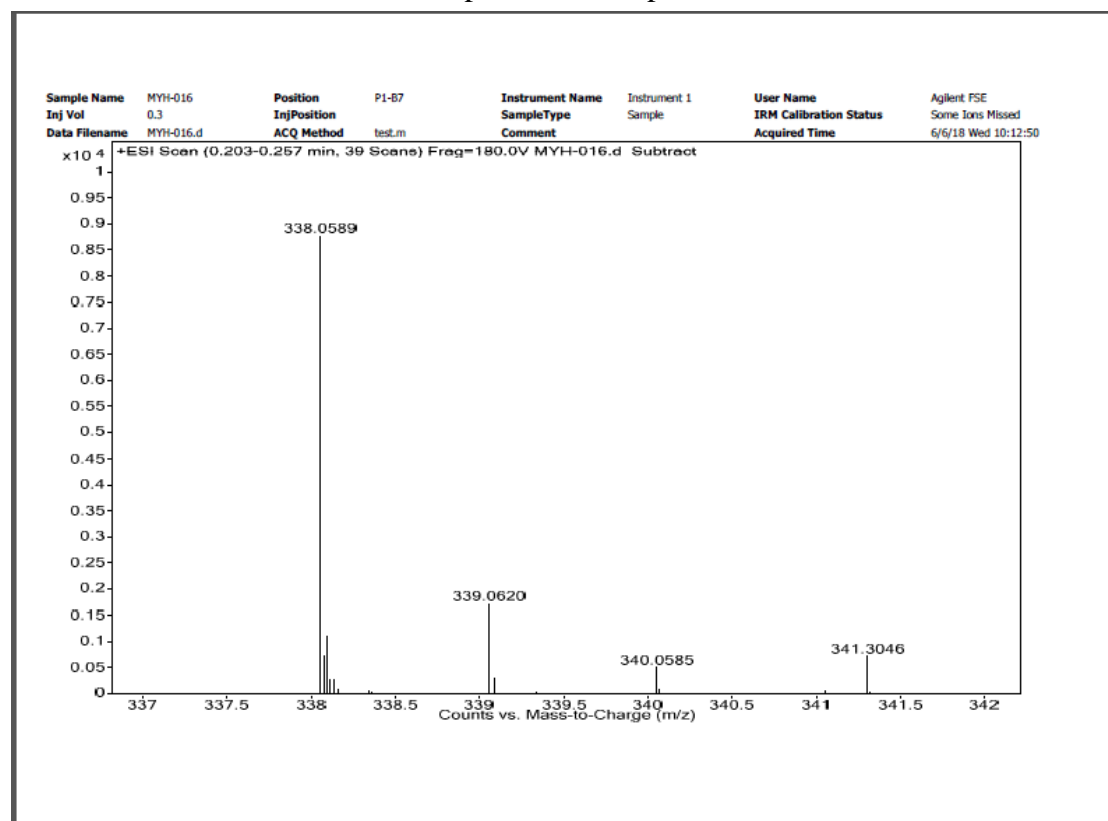




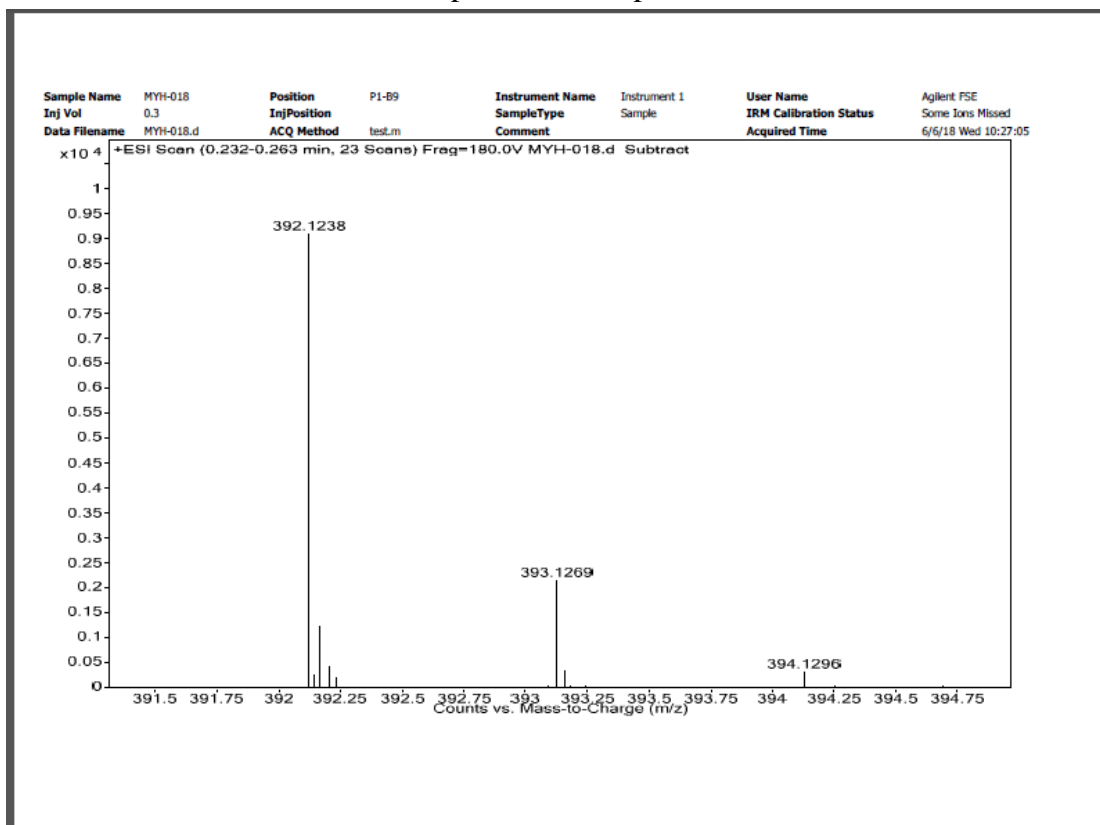
## HRMS spectra of Compound 4ak



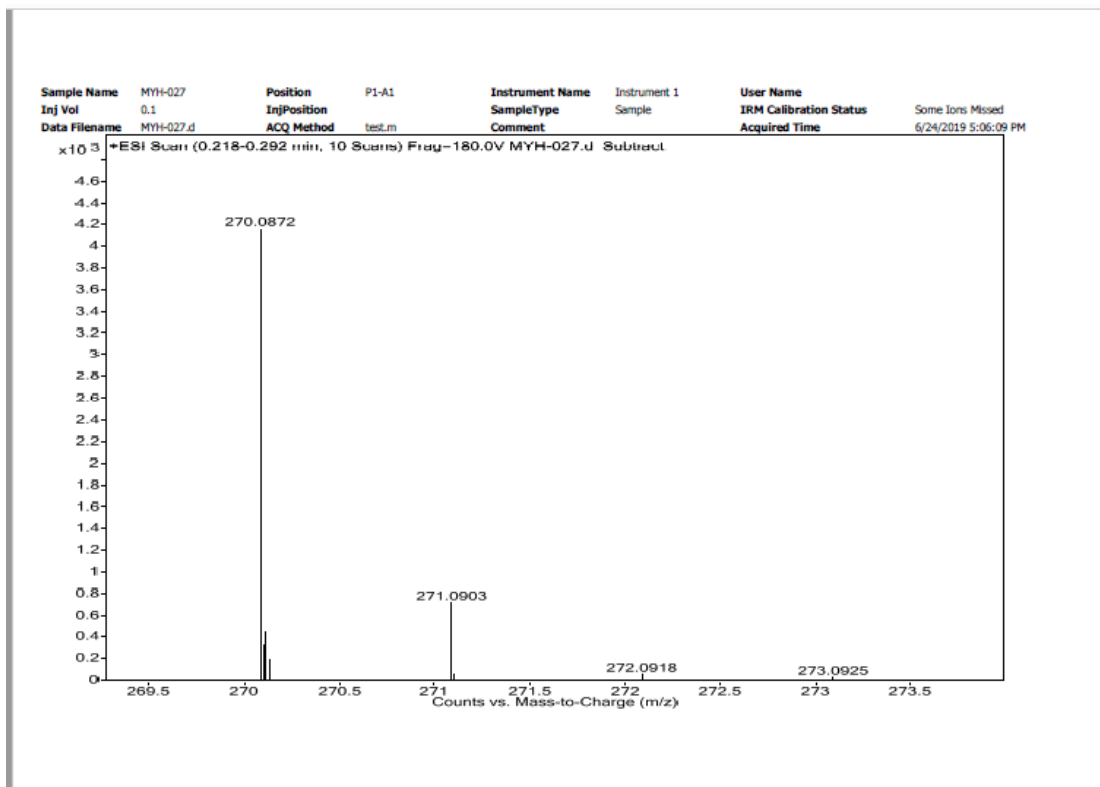
## HRMS spectra of Compound 4al



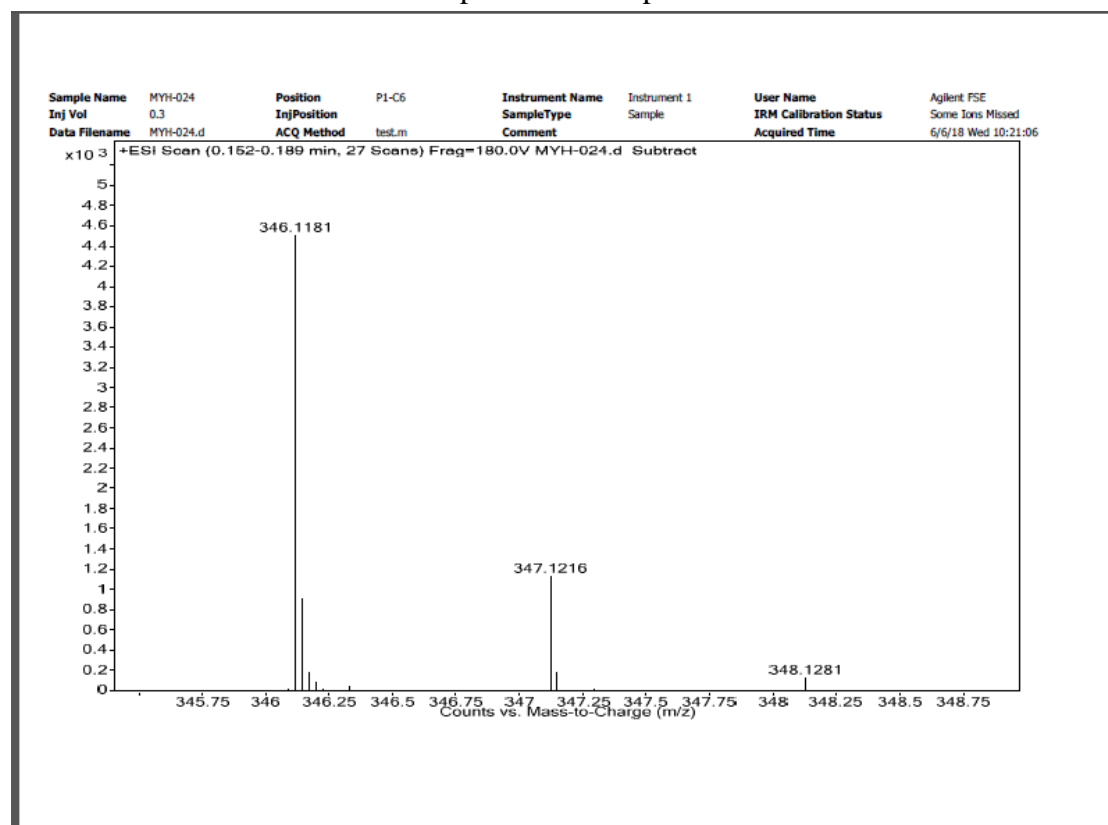
## HRMS spectra of Compound 4am



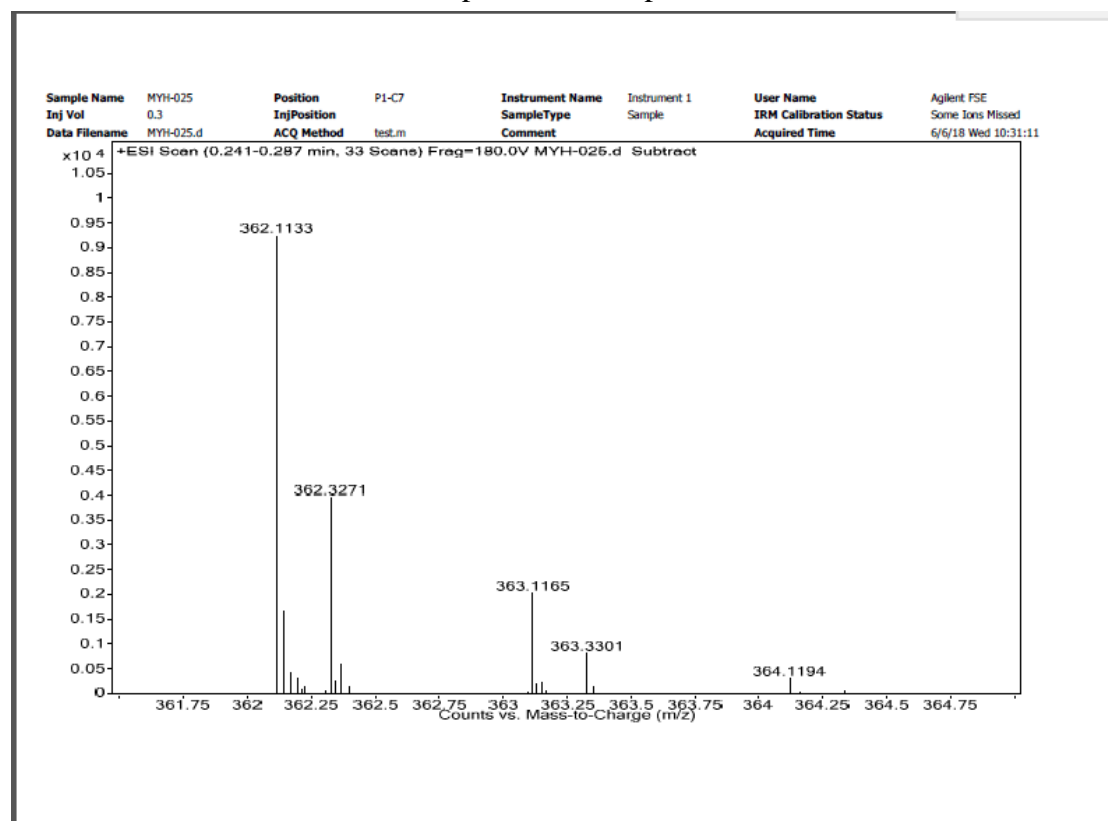
## HRMS spectra of Compound 4an



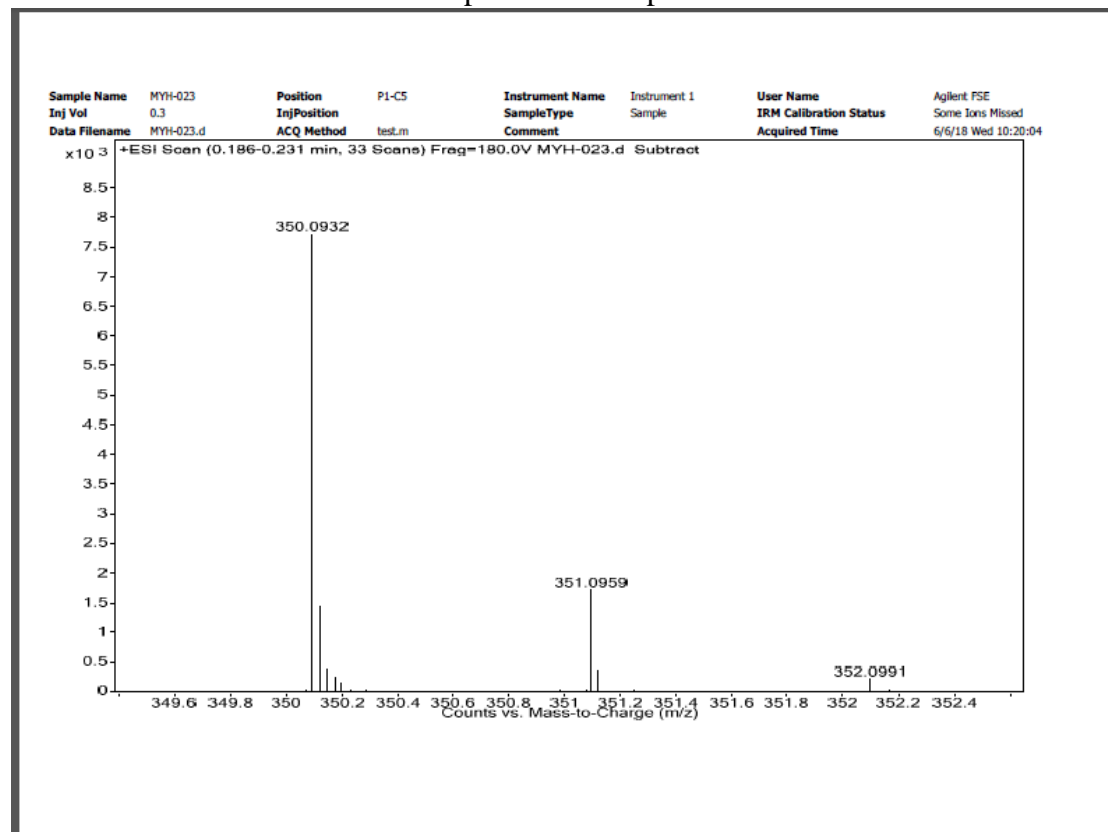
## HRMS spectra of Compound 4da



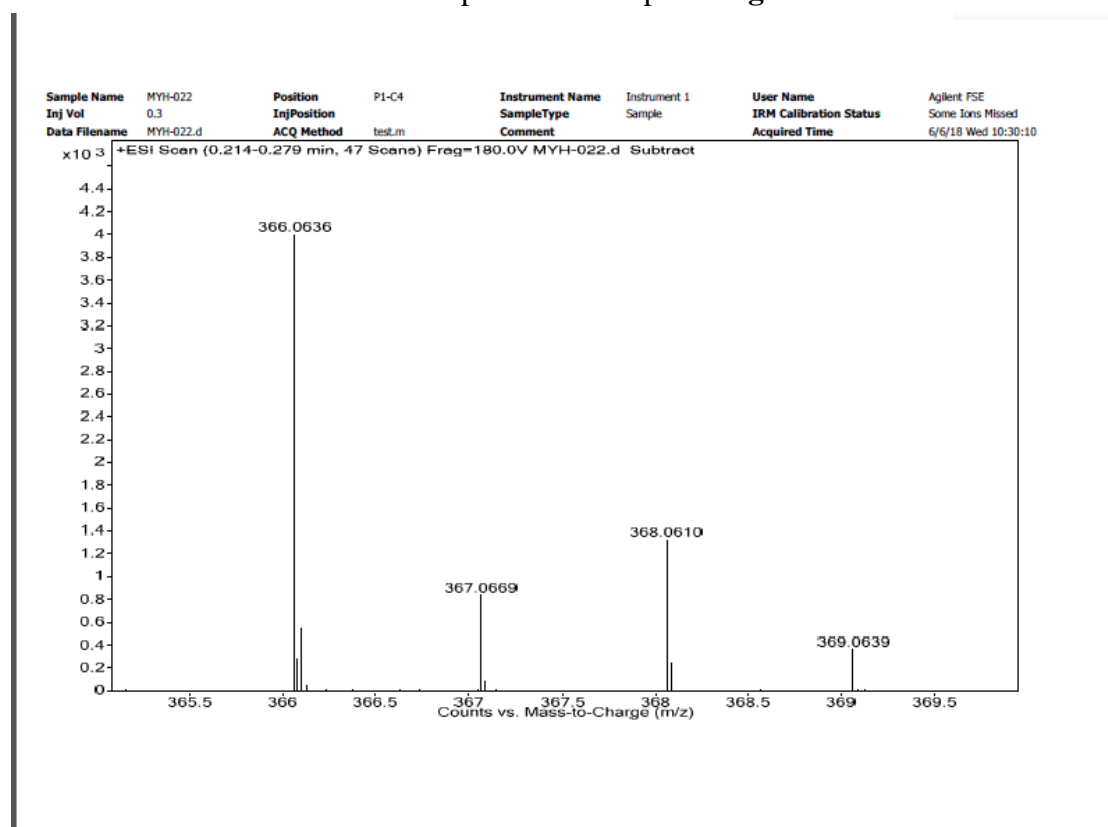
## HRMS spectra of Compound 4ea



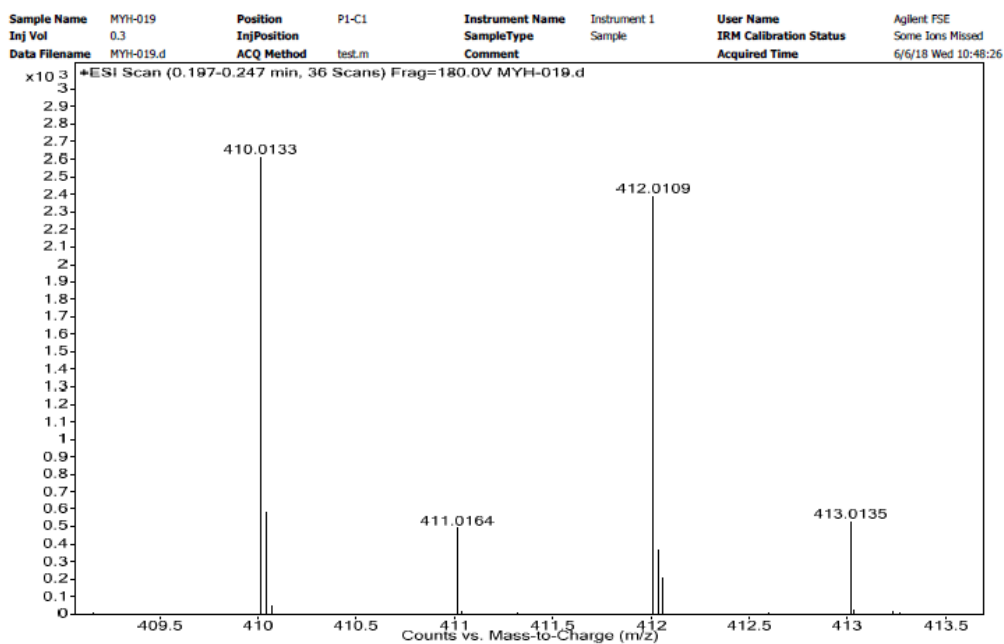
## HRMS spectra of Compound 4fa



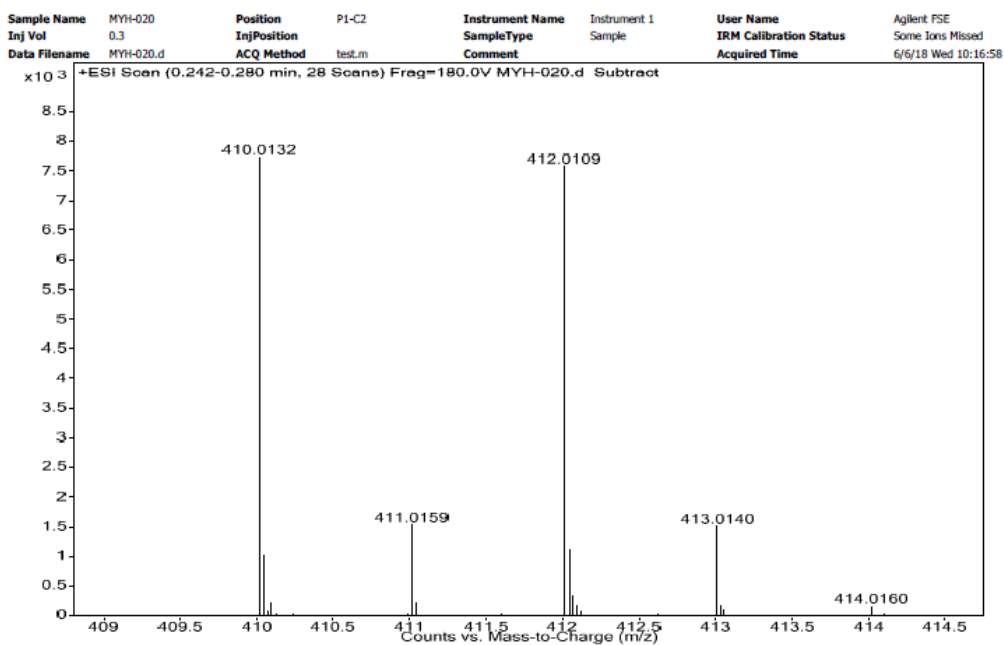
## HRMS spectra of Compound 4ga



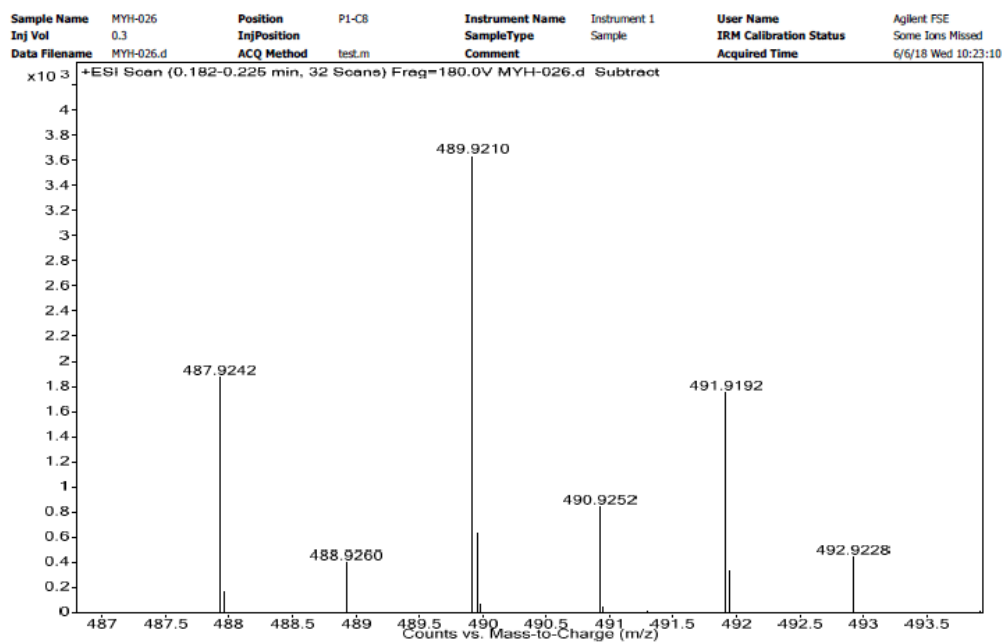
## HRMS spectra of Compound 4ha



## HRMS spectra of Compound 4ia

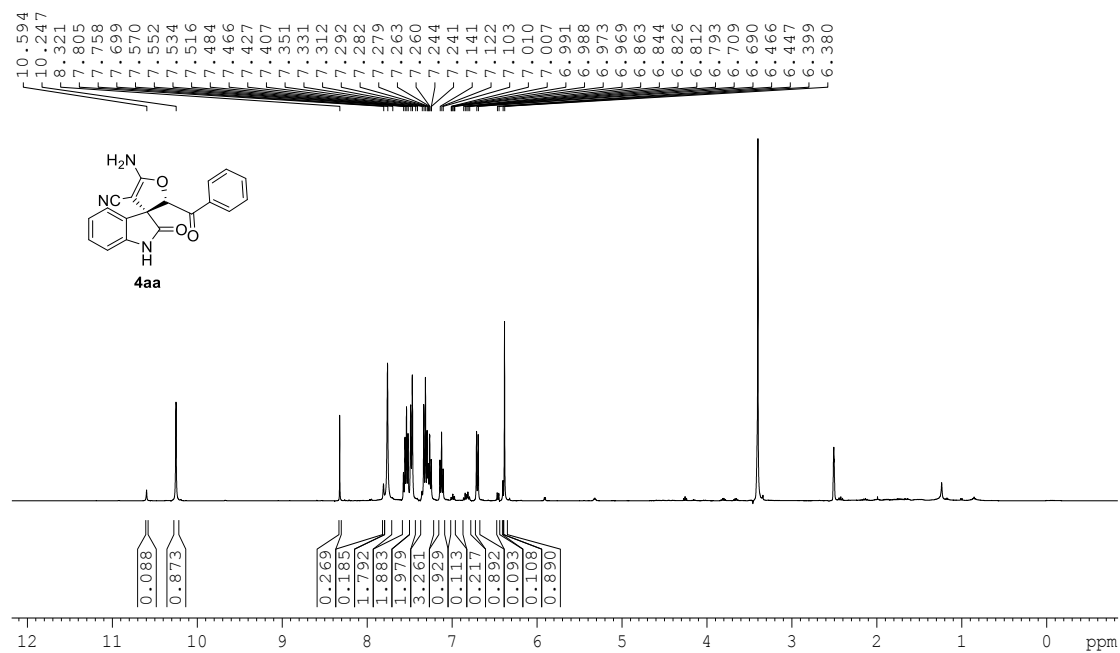


# HRMS spectra of Compound 4id

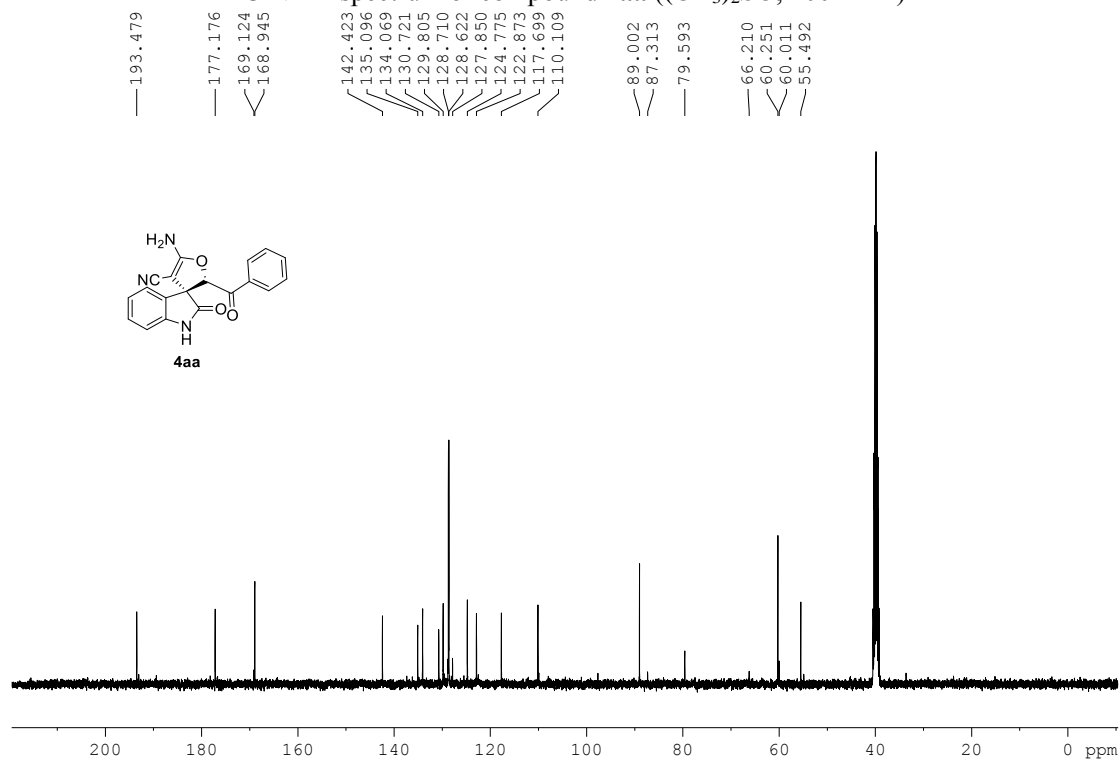


## 4. NMR Spectra of compounds

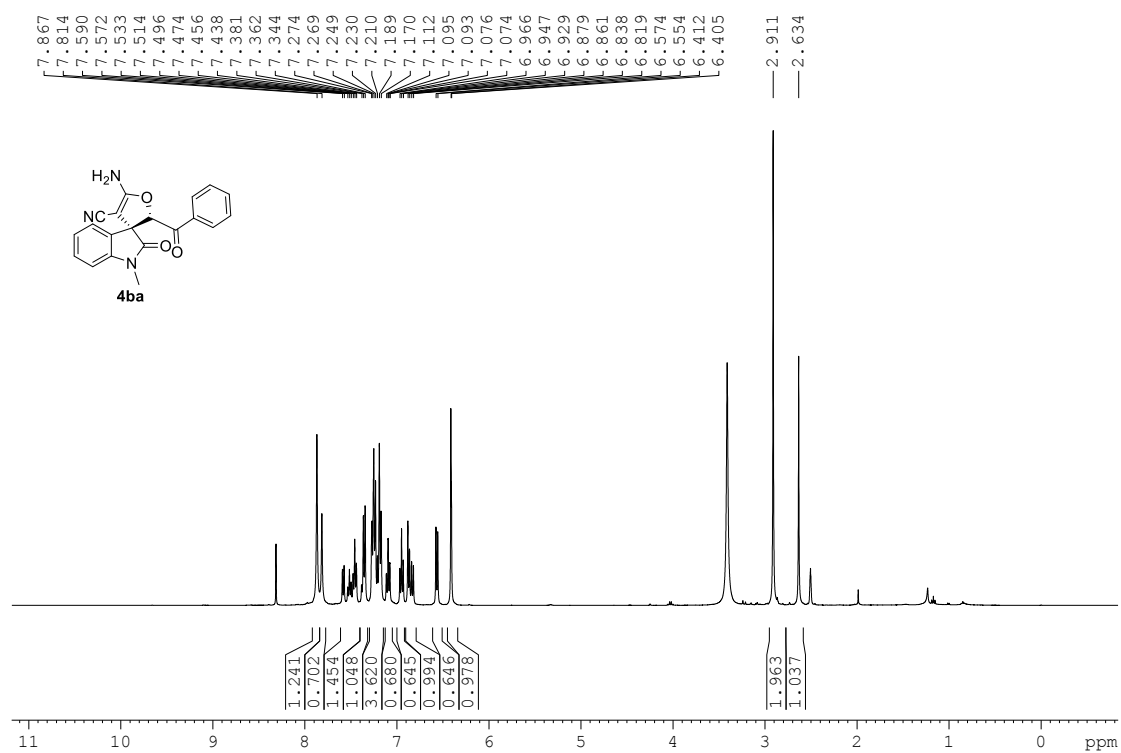
$^1\text{H}$  NMR spectrum of compound **4aa** ( $(\text{CD}_3)_2\text{SO}$ , 400 MHz)



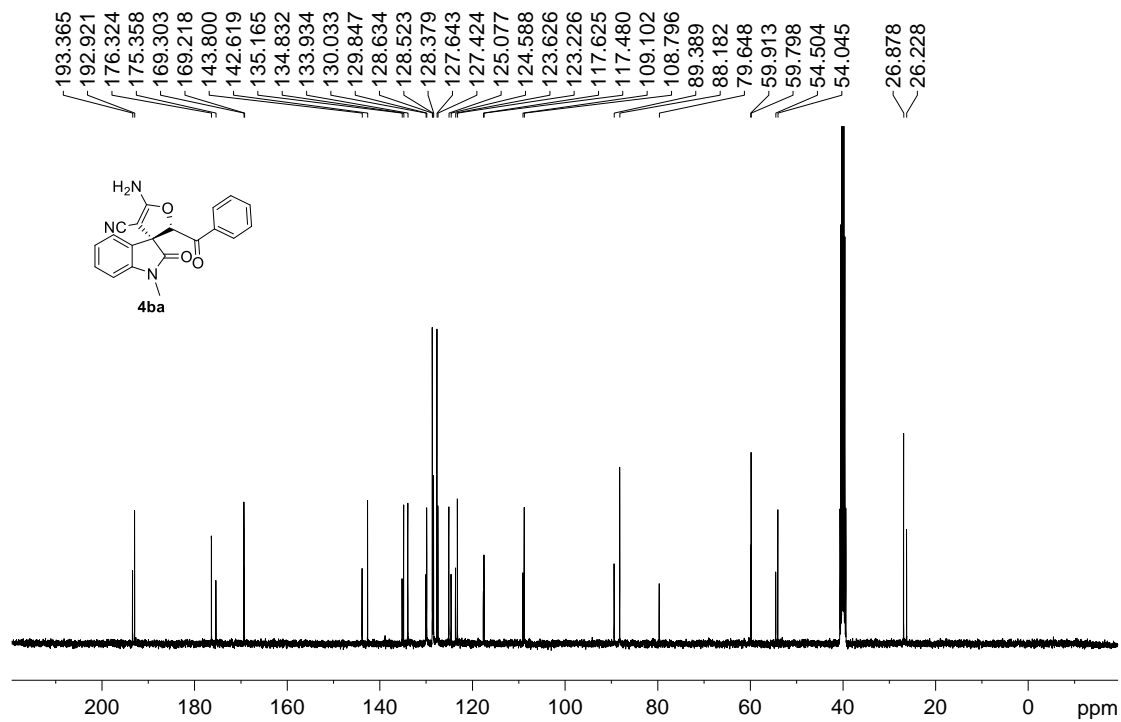
$^{13}\text{C}$  NMR spectrum of compound **4aa** ( $(\text{CD}_3)_2\text{SO}$ , 100 MHz)



<sup>1</sup>H NMR spectrum of compound **4ba** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)

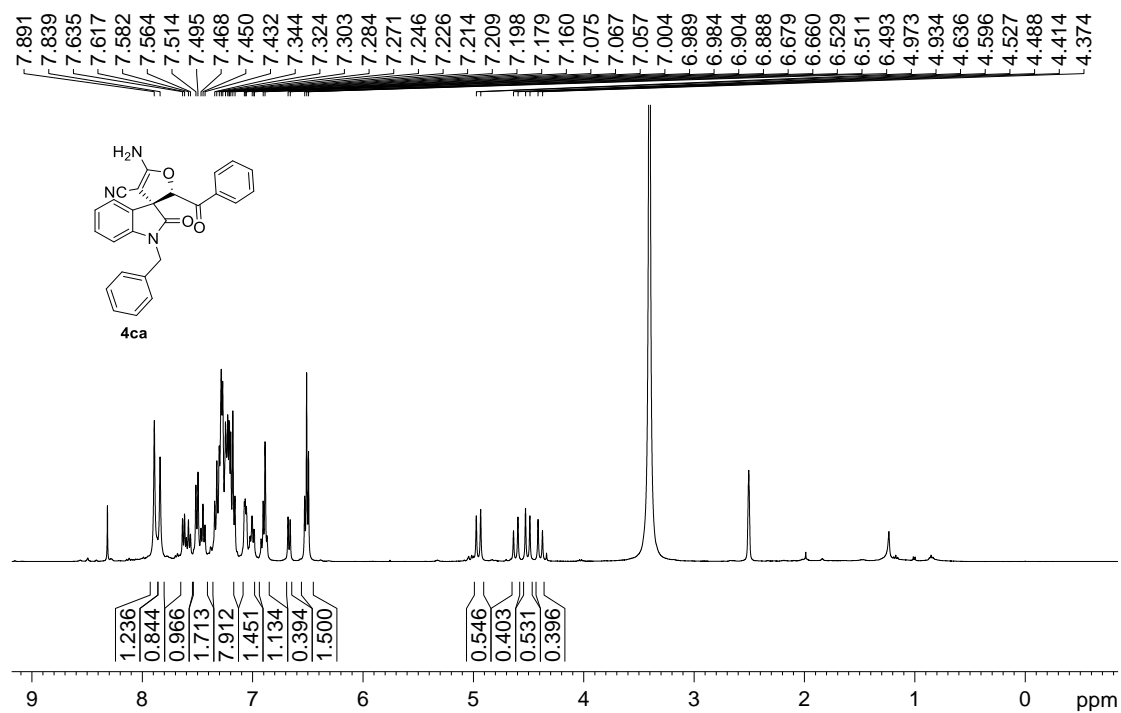


<sup>13</sup>C NMR spectrum of compound **4ba** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)

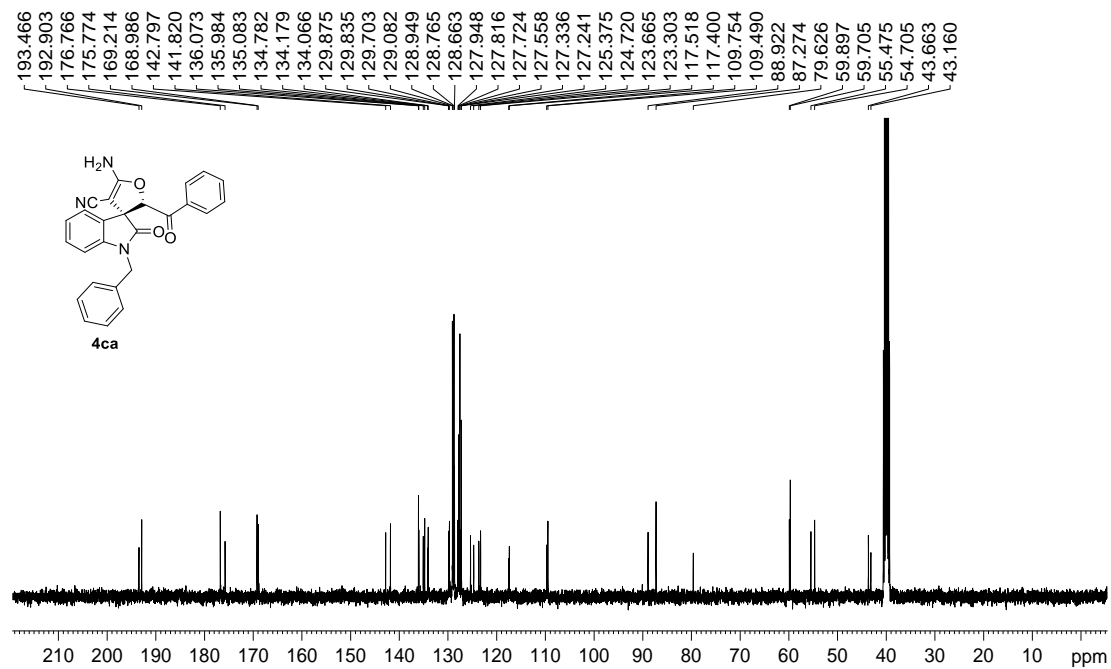




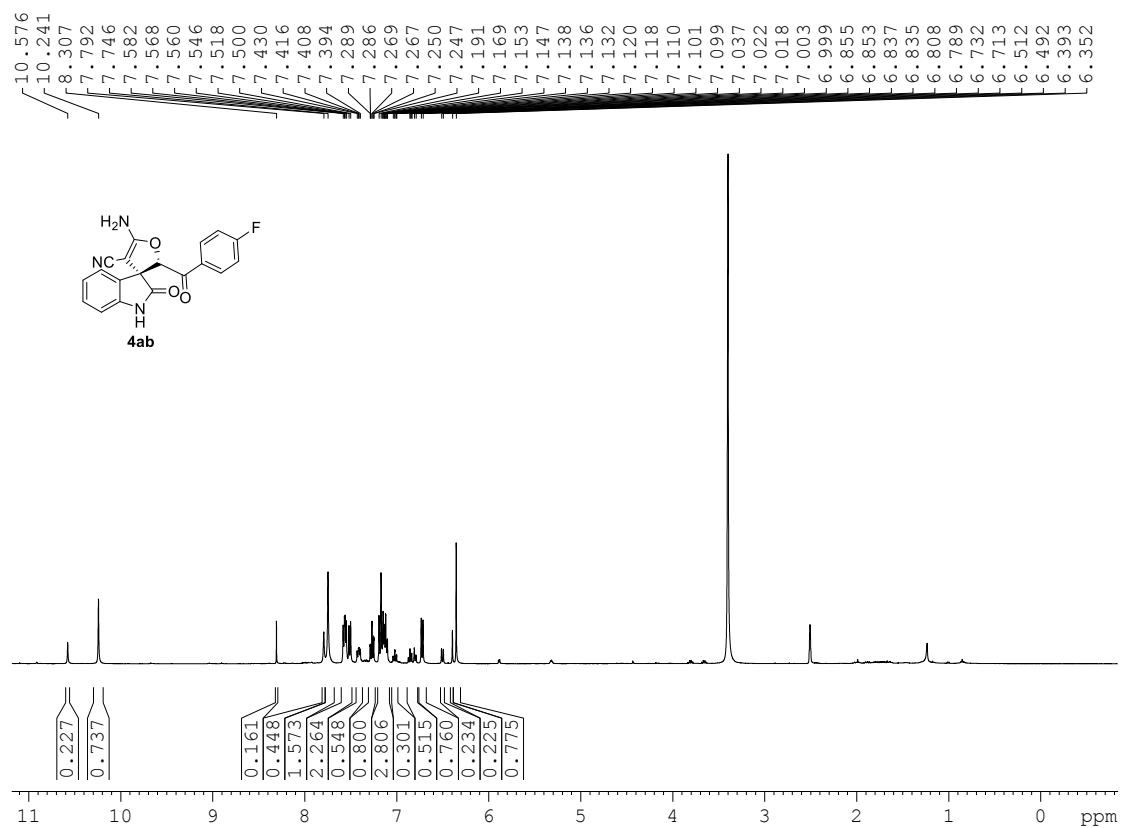
<sup>1</sup>H NMR spectrum of compound **4ca** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



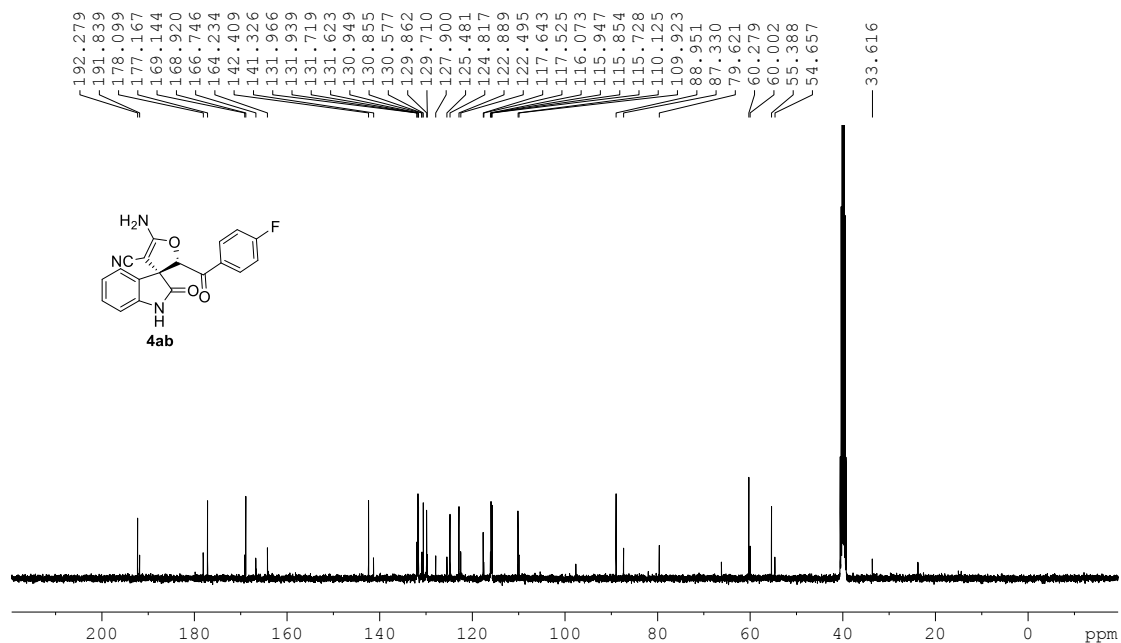
<sup>13</sup>C NMR spectrum of compound **4ca** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



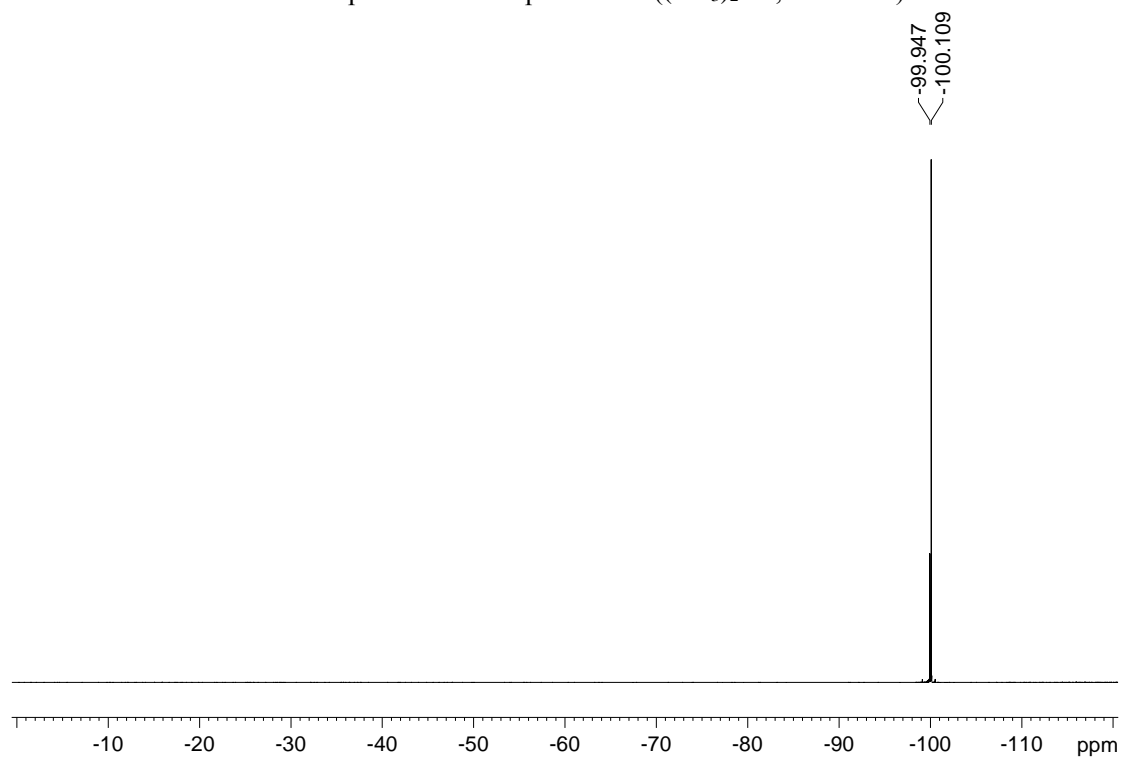
<sup>1</sup>H NMR spectrum of compound **4ab** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



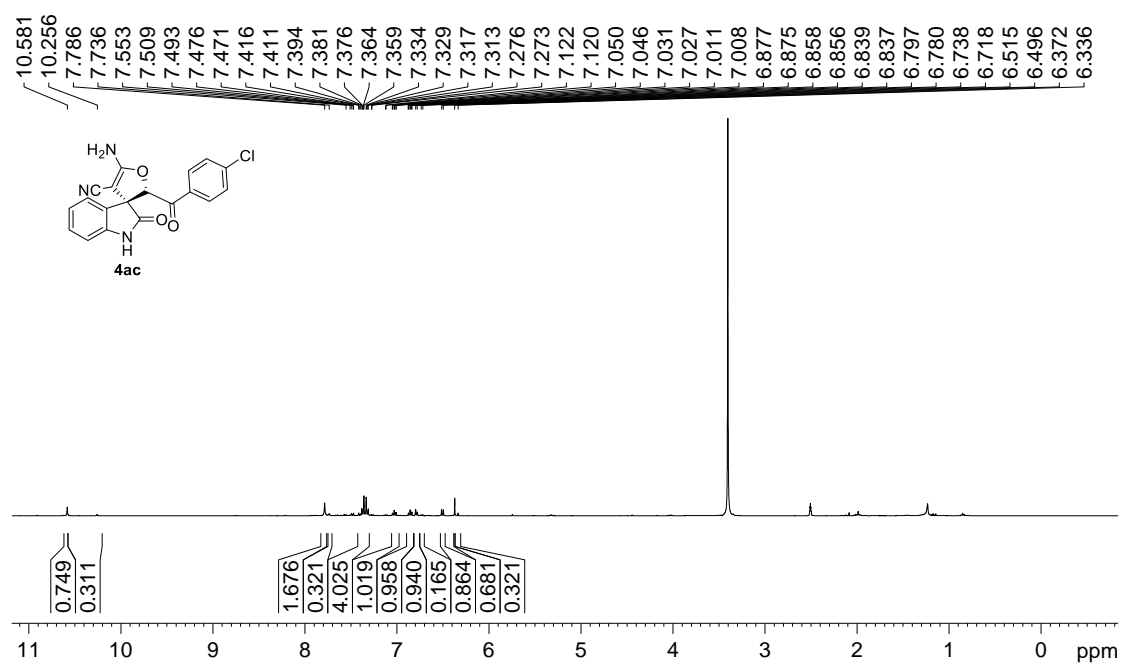
<sup>13</sup>C NMR spectrum of compound **4ab** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



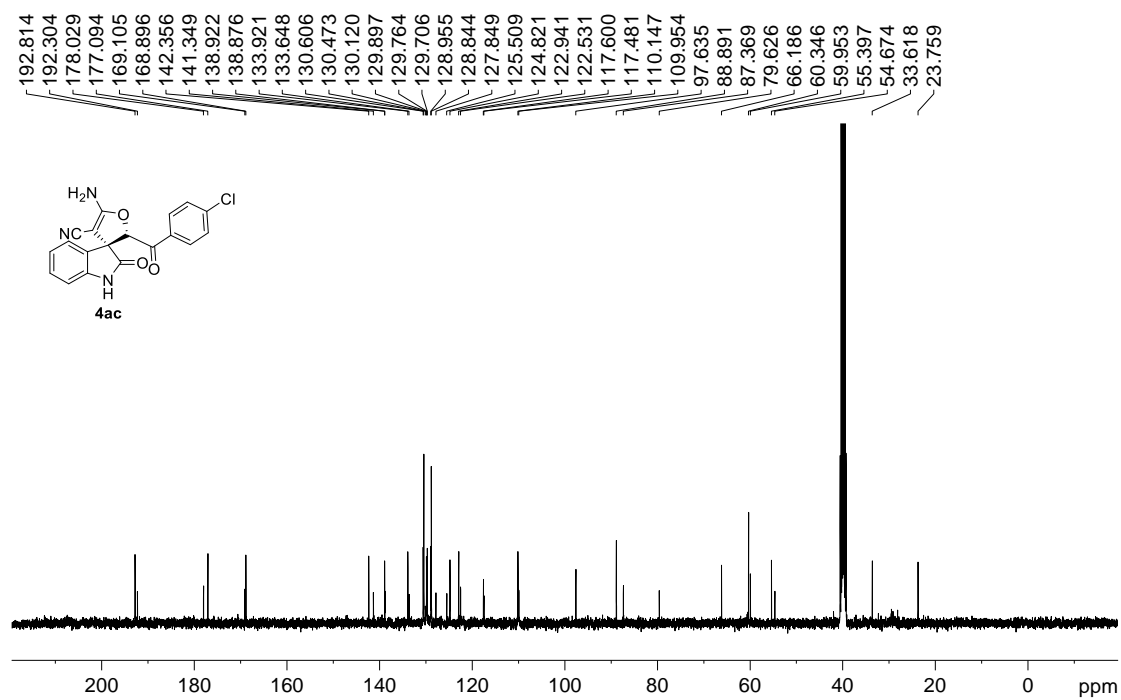
$^{19}\text{F}$  NMR spectrum of compound **4ab** ( $(\text{CD}_3)_2\text{SO}$ , 376 MHz)



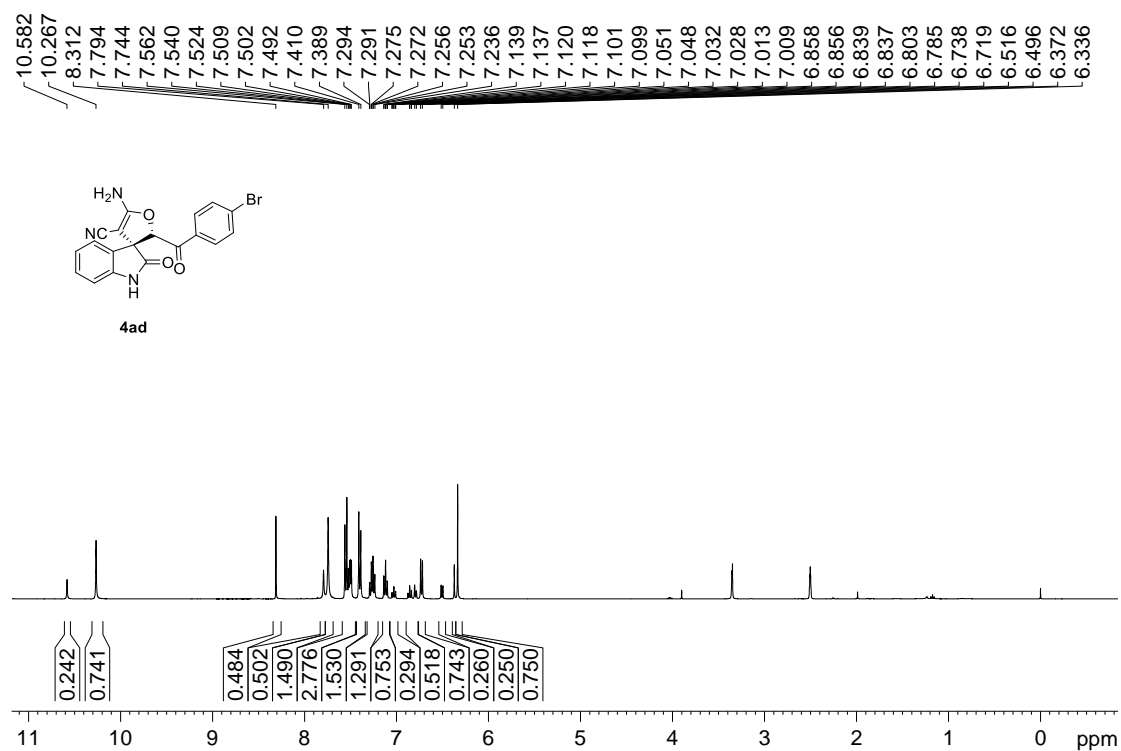
<sup>1</sup>H NMR spectrum of compound **4ac** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



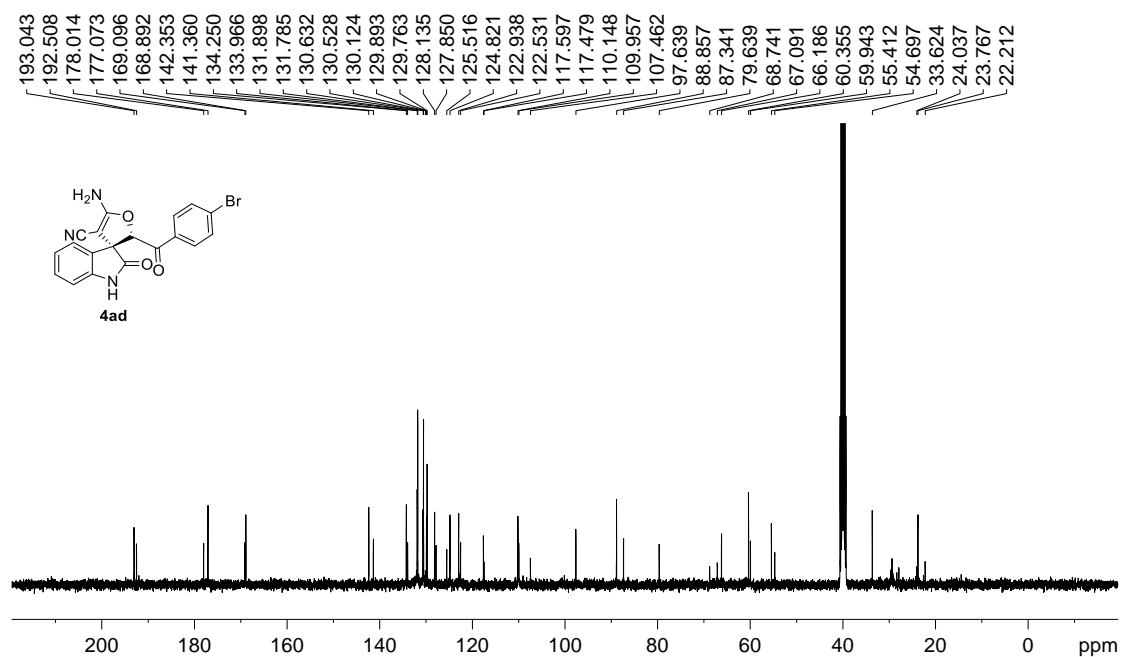
<sup>13</sup>C NMR spectrum of compound **4ac** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



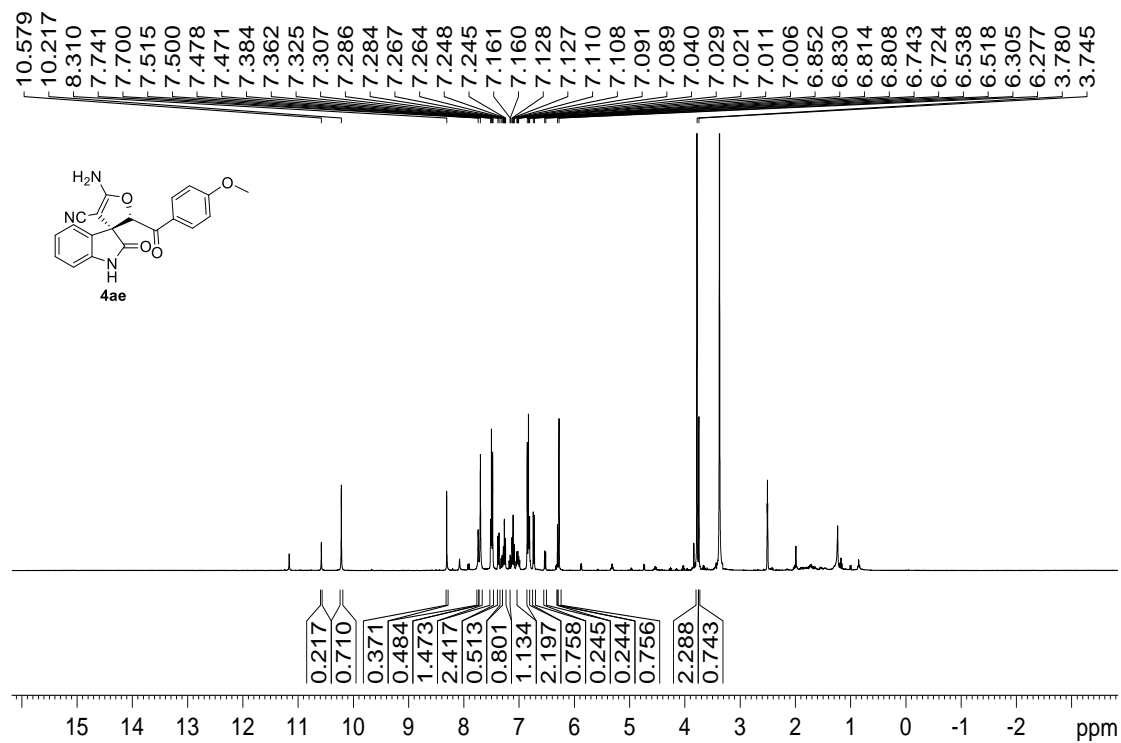
<sup>1</sup>H NMR spectrum of compound **4ad** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



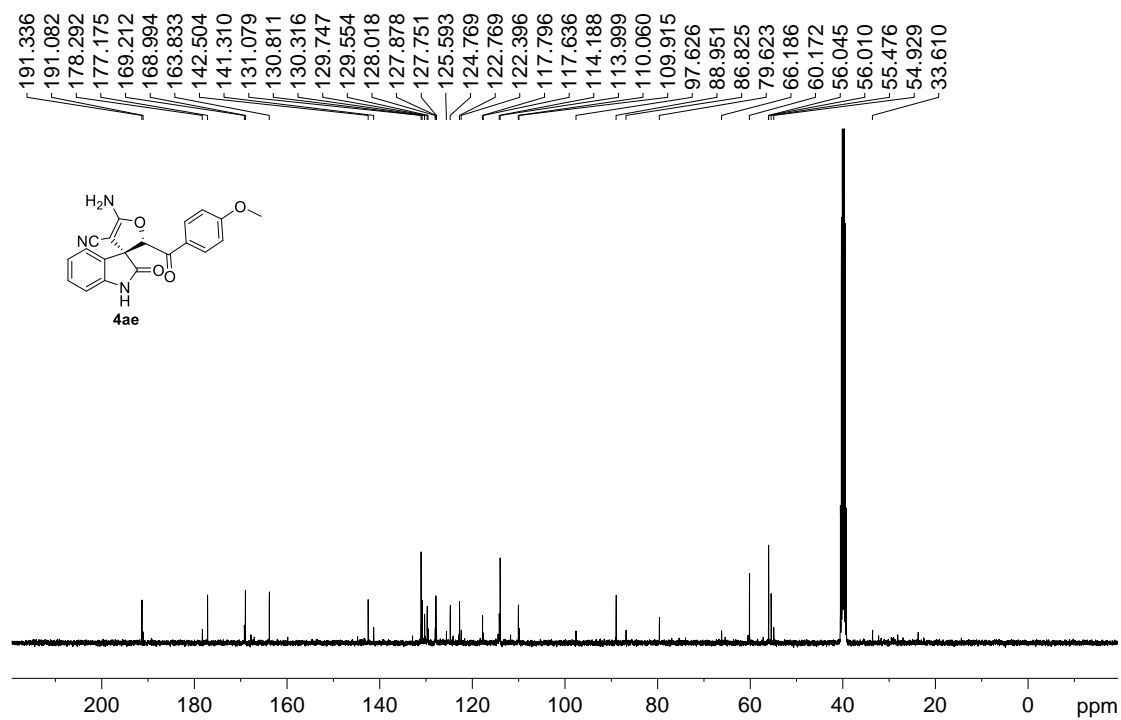
<sup>13</sup>C NMR spectrum of compound **4ad** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



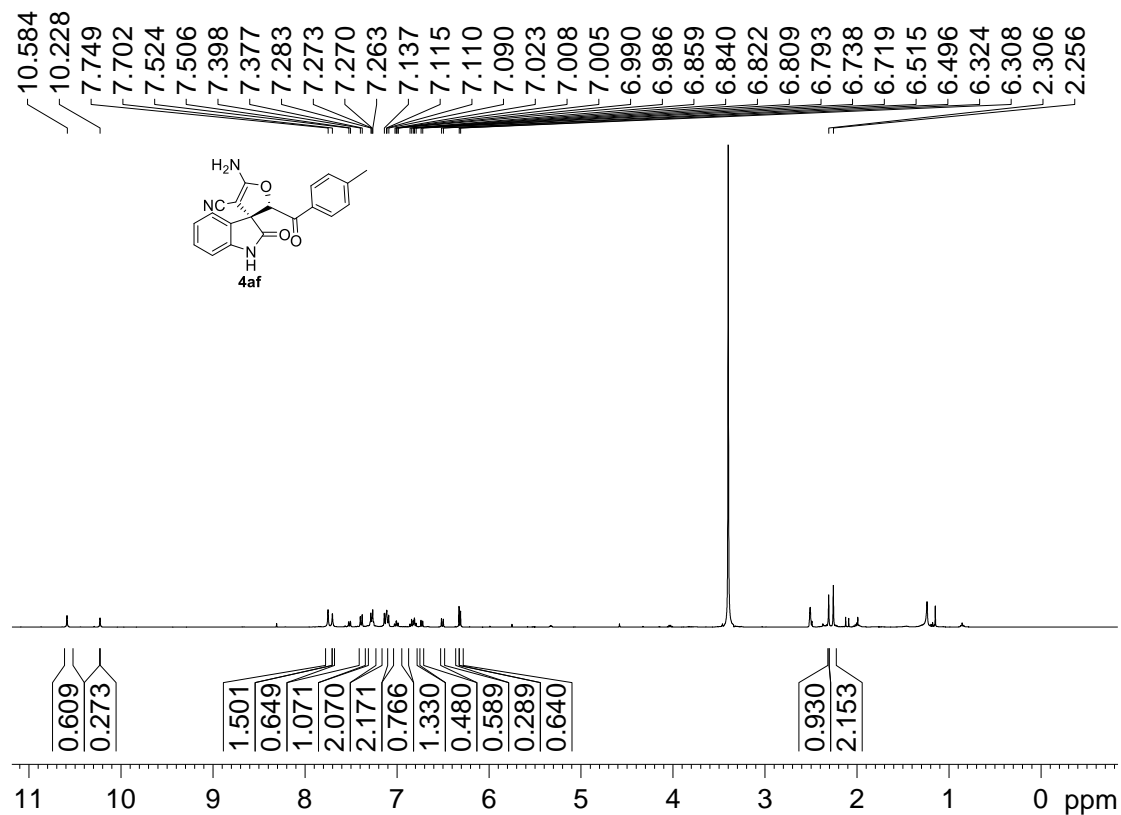
<sup>1</sup>H NMR spectrum of compound **4ae** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



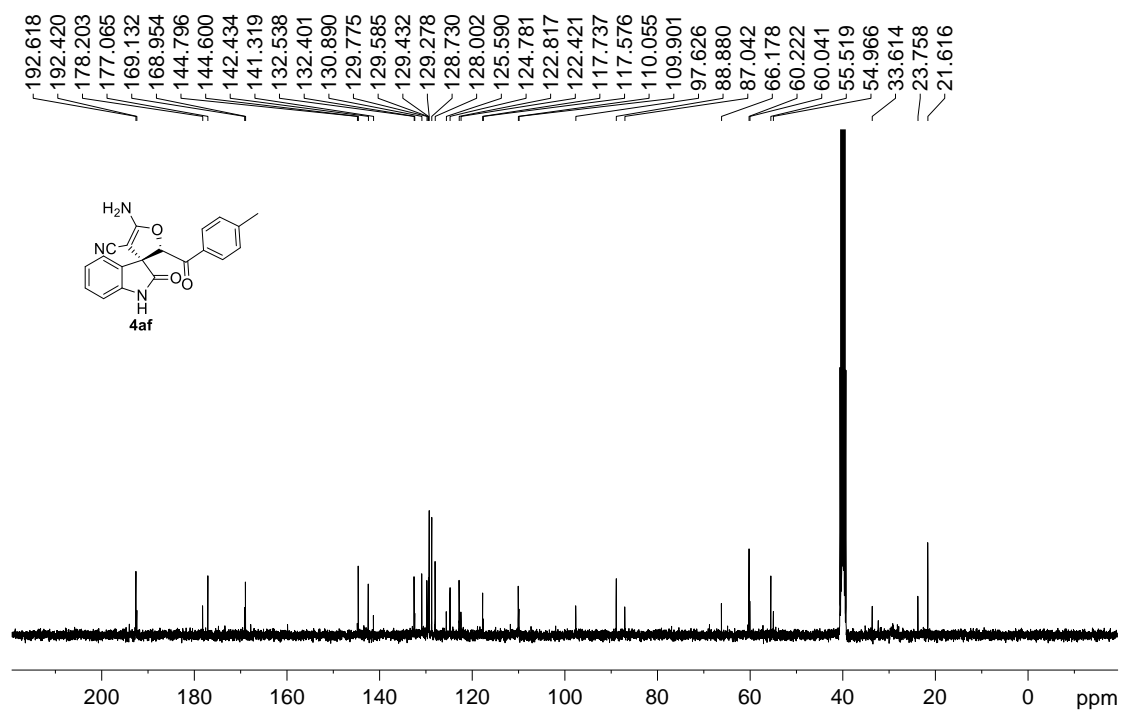
<sup>13</sup>C NMR spectrum of compound **4ae** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



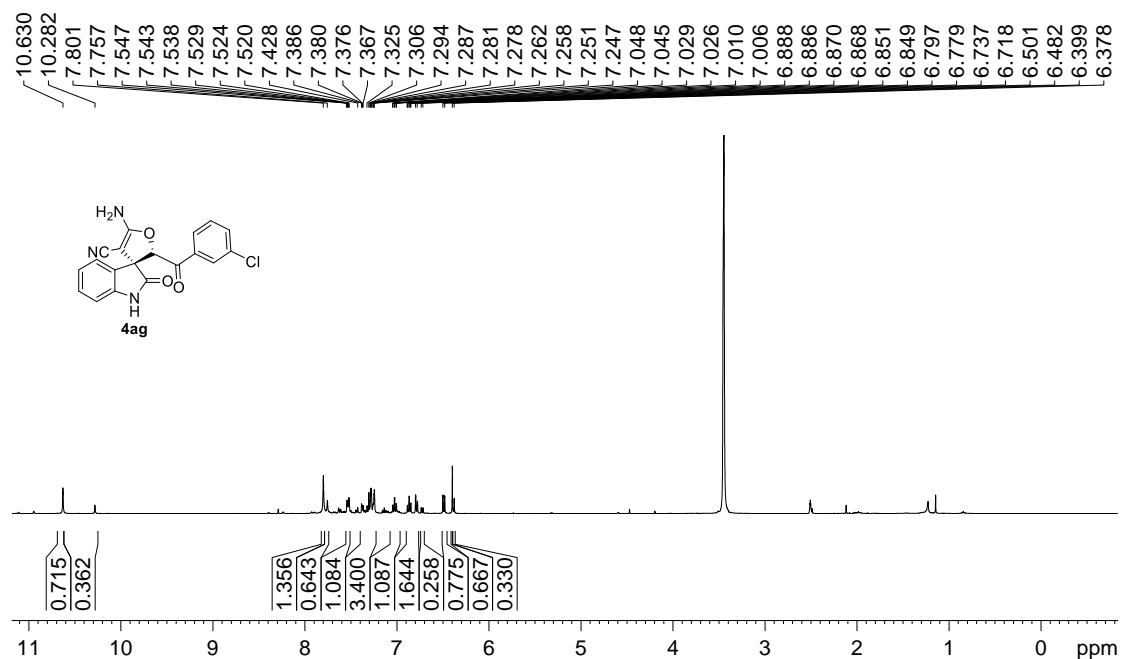
<sup>1</sup>H NMR spectrum of compound **4af** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



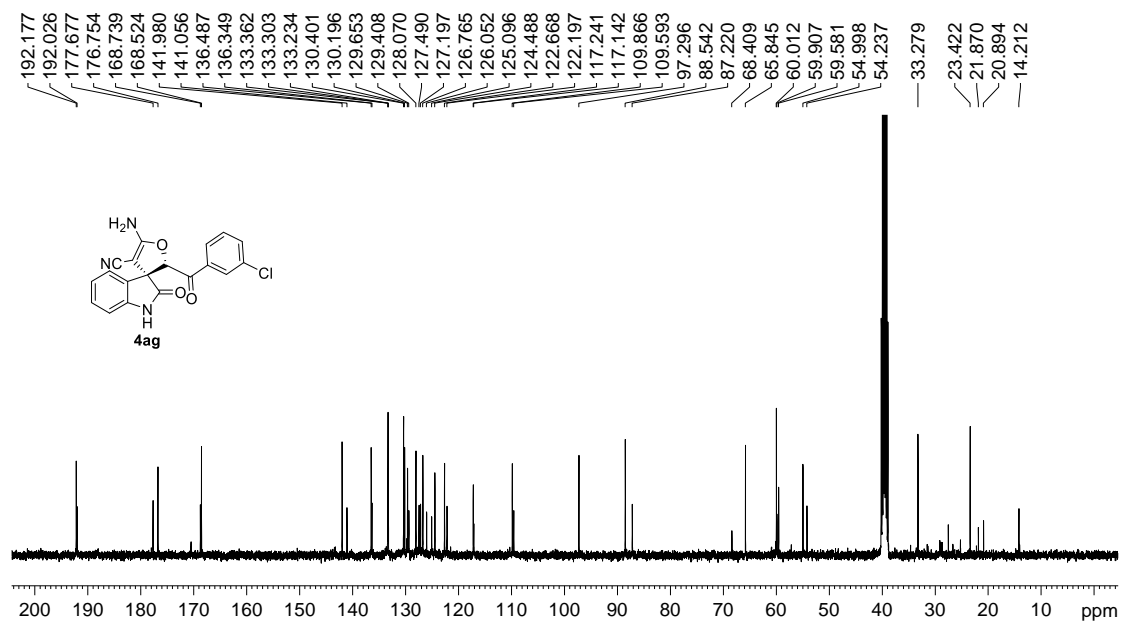
<sup>13</sup>C NMR spectrum of compound **4af** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



<sup>1</sup>H NMR spectrum of compound **4ag** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)

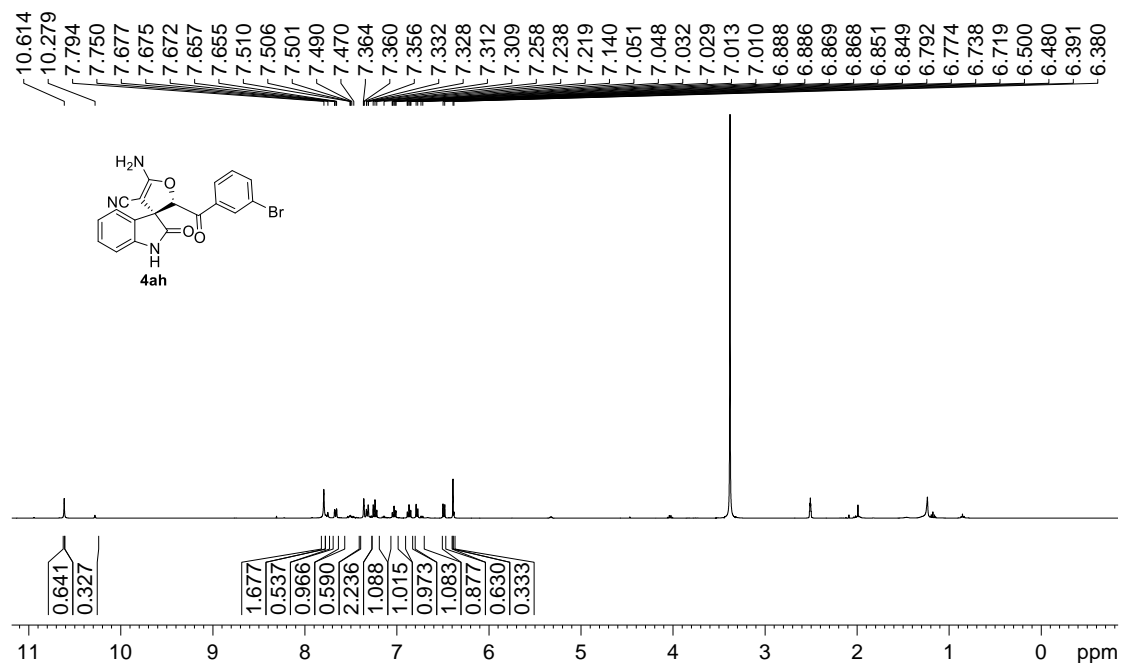


<sup>13</sup>C NMR spectrum of compound **4ag** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)

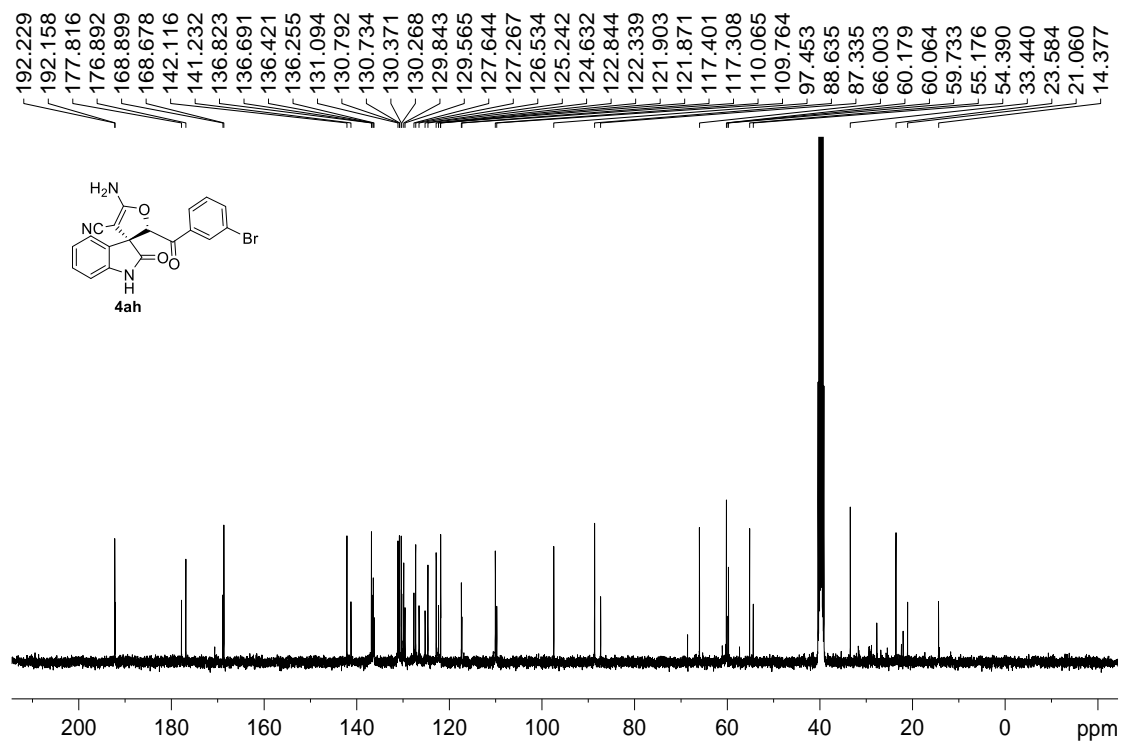




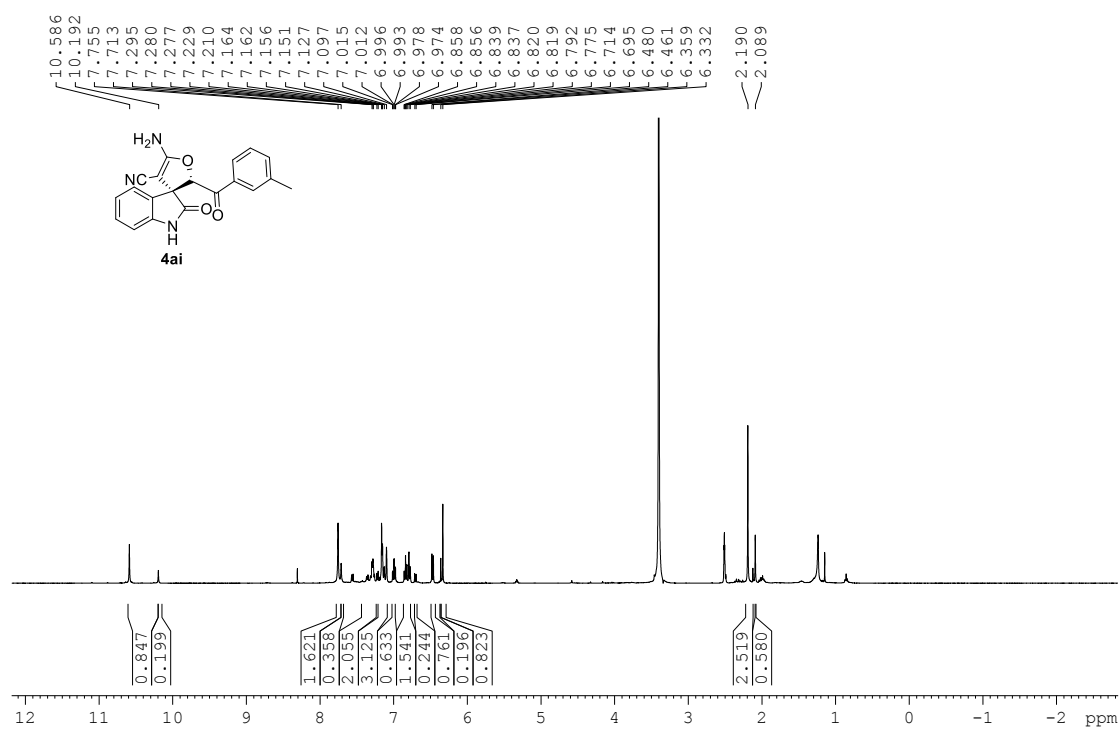
<sup>1</sup>H NMR spectrum of compound **4ah** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



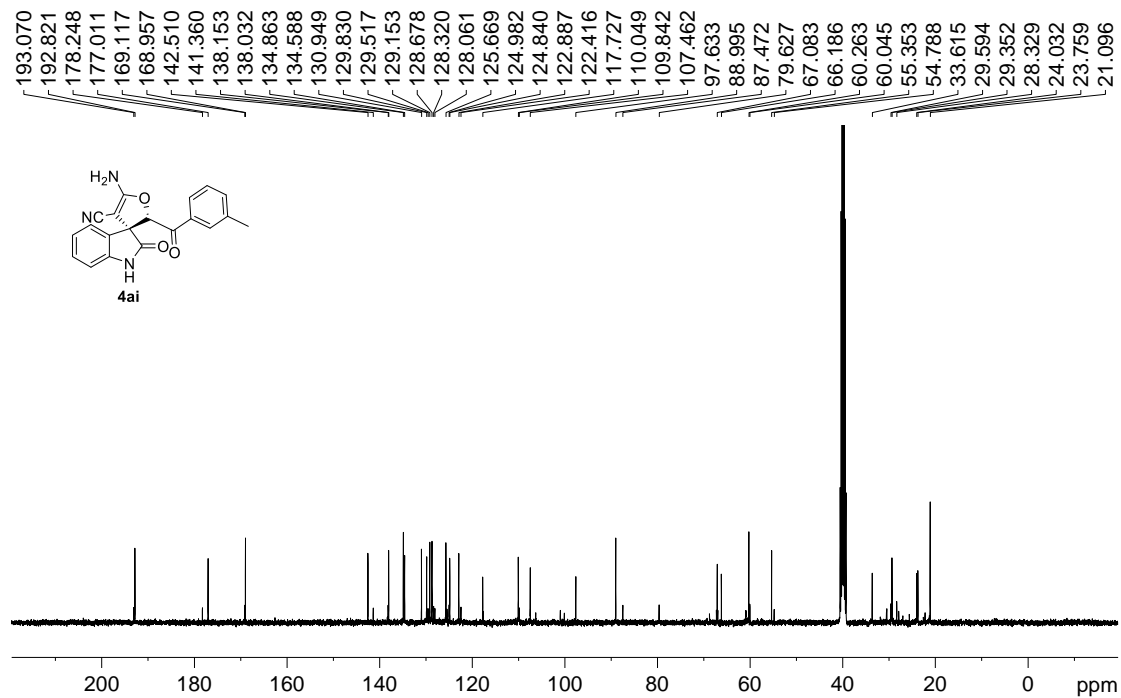
<sup>13</sup>C NMR spectrum of compound **4ah** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



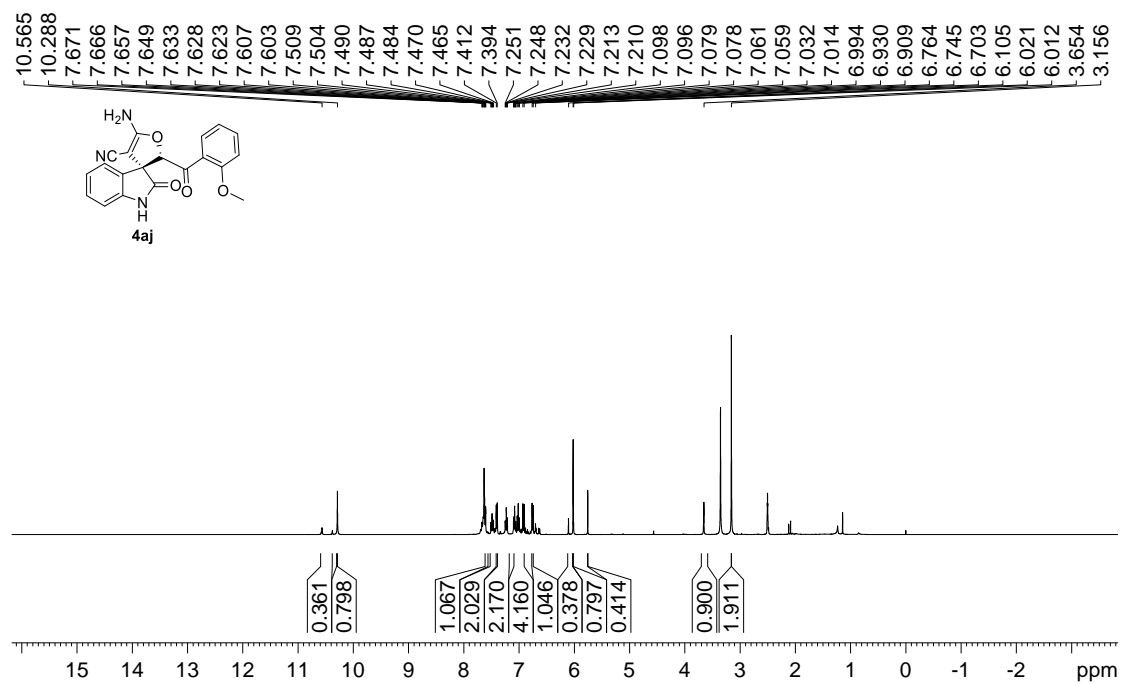
<sup>1</sup>H NMR spectrum of compound **4ai** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



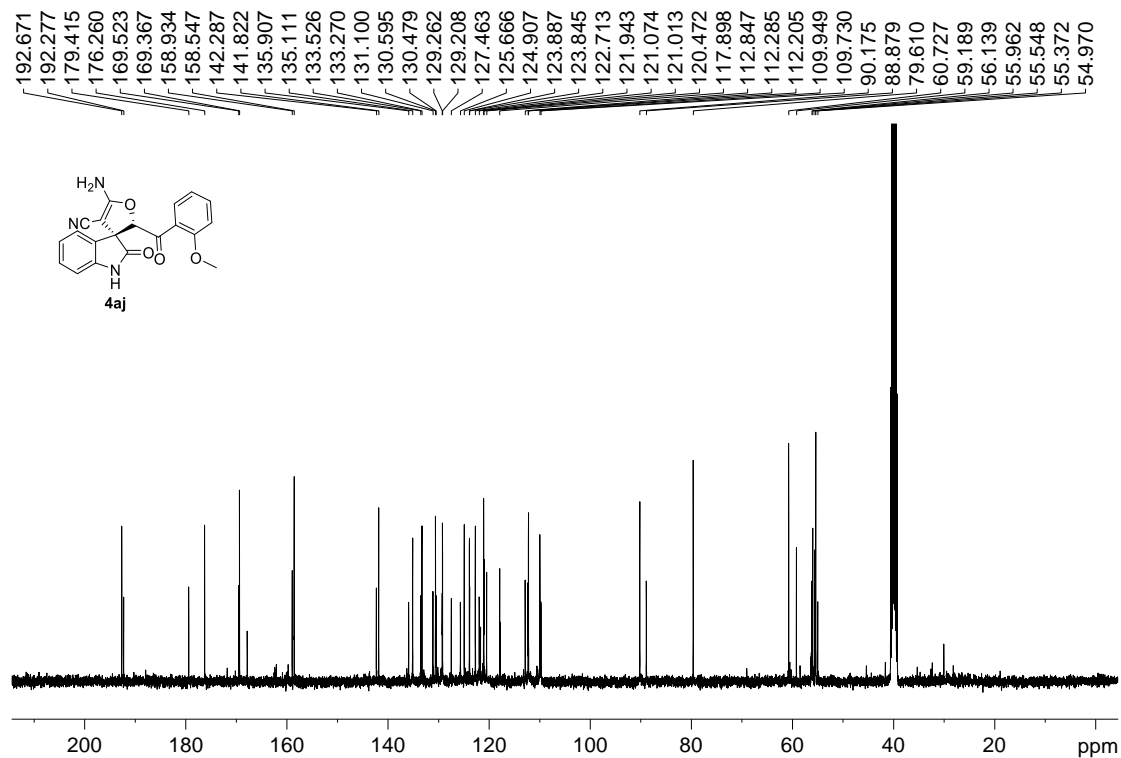
<sup>13</sup>C NMR spectrum of compound **4ai** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



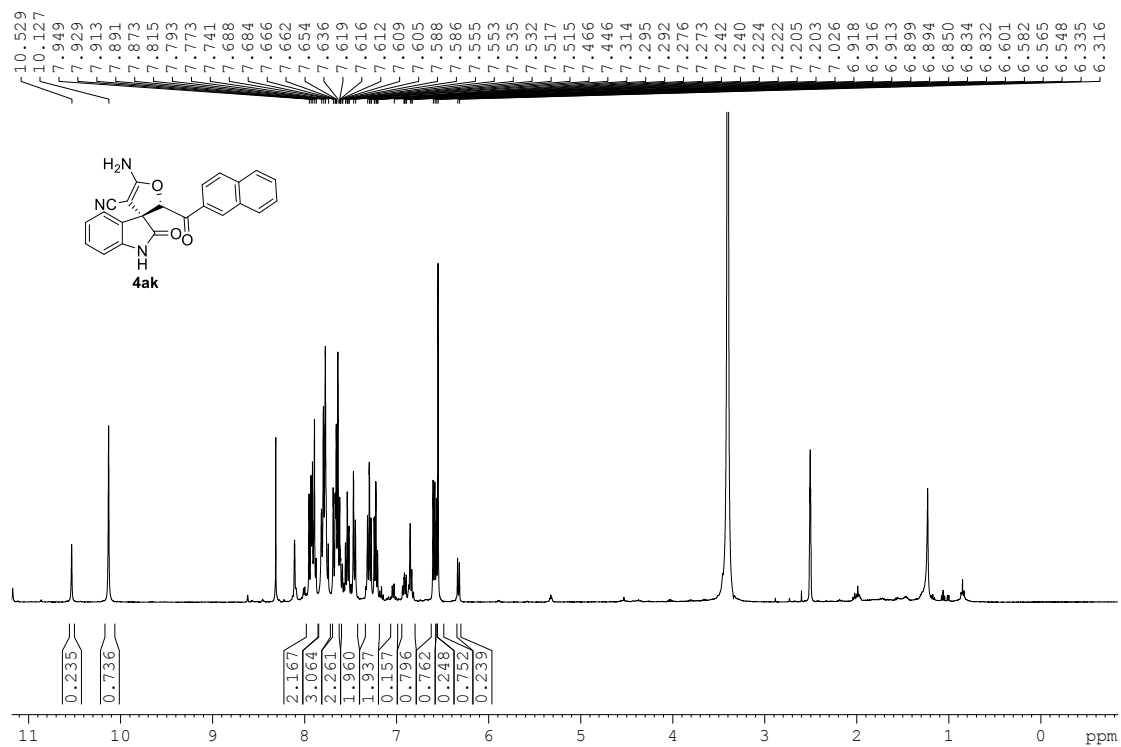
<sup>1</sup>H NMR spectrum of compound **4aj** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



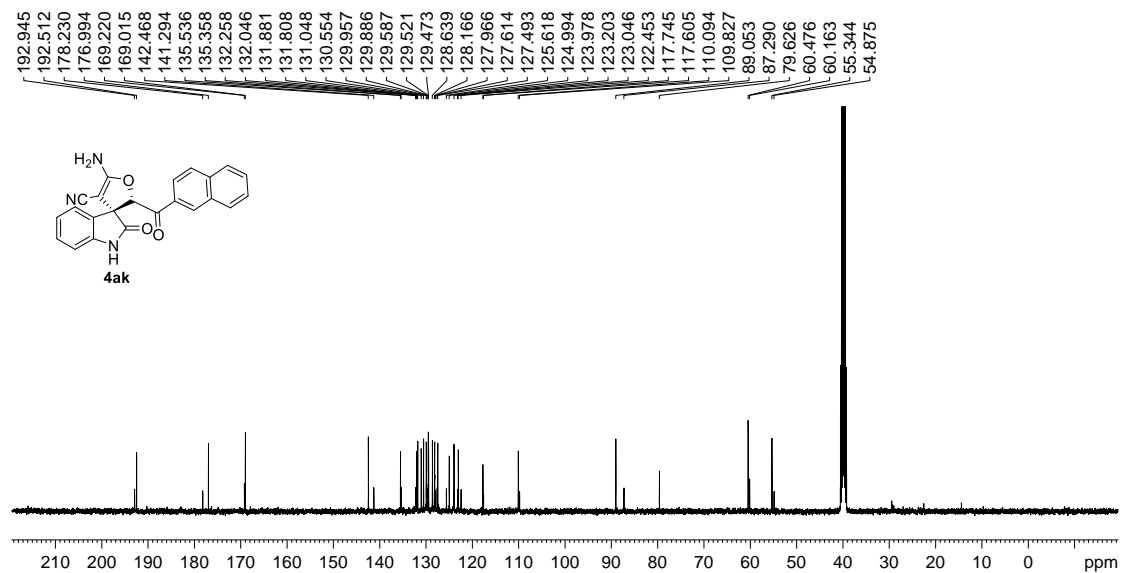
<sup>13</sup>C NMR spectrum of compound **4aj** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



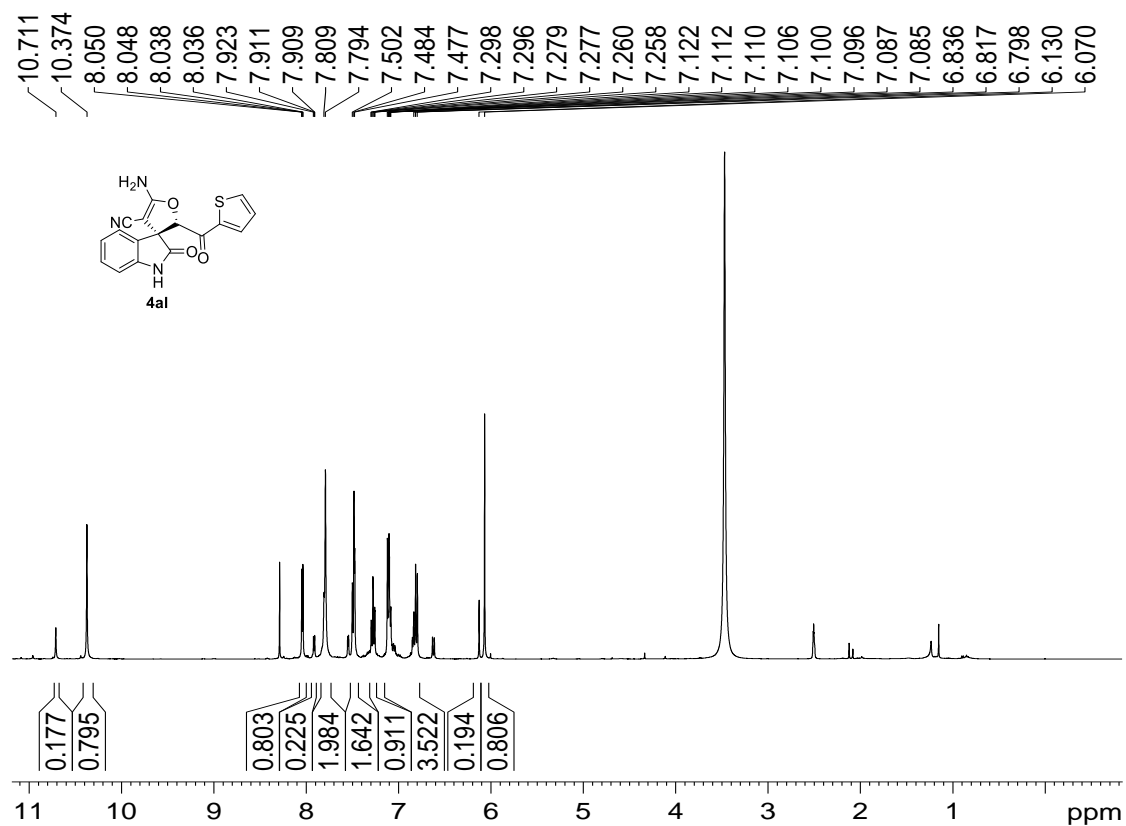
<sup>1</sup>H NMR spectrum of compound **4ak** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



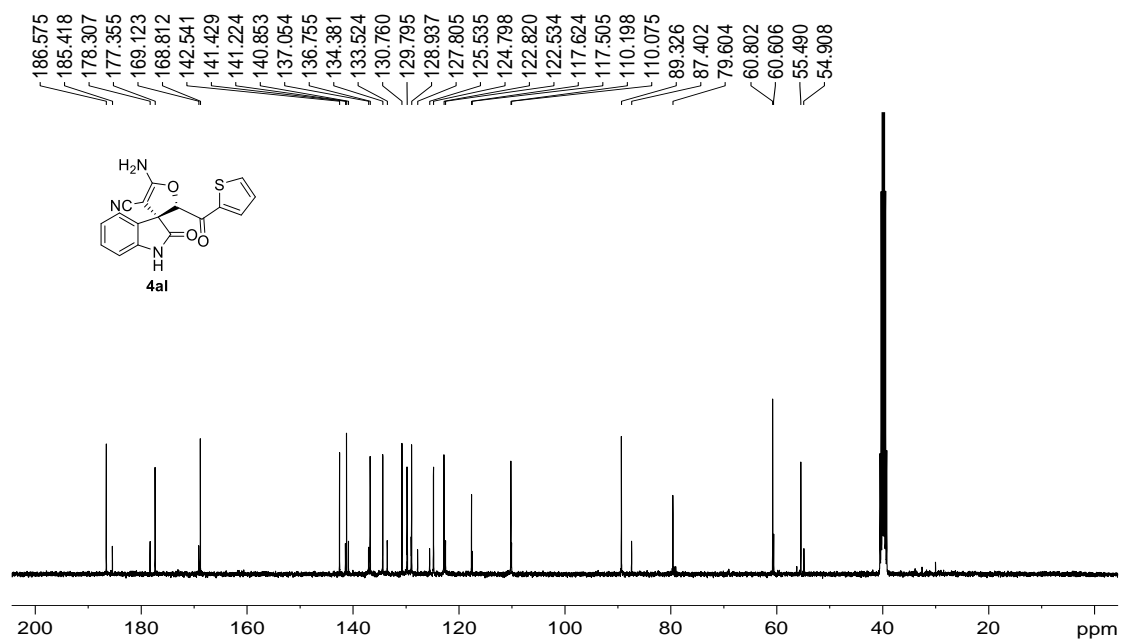
<sup>13</sup>C NMR spectrum of compound **4ak** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



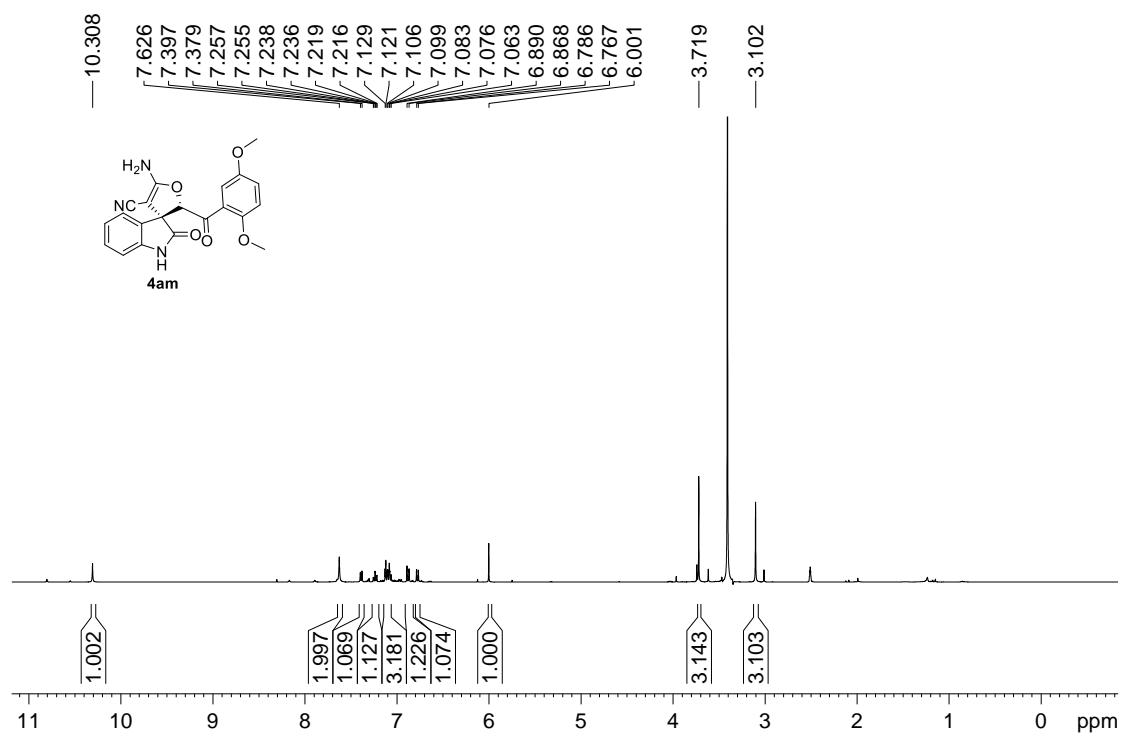
<sup>1</sup>H NMR spectrum of compound **4al** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



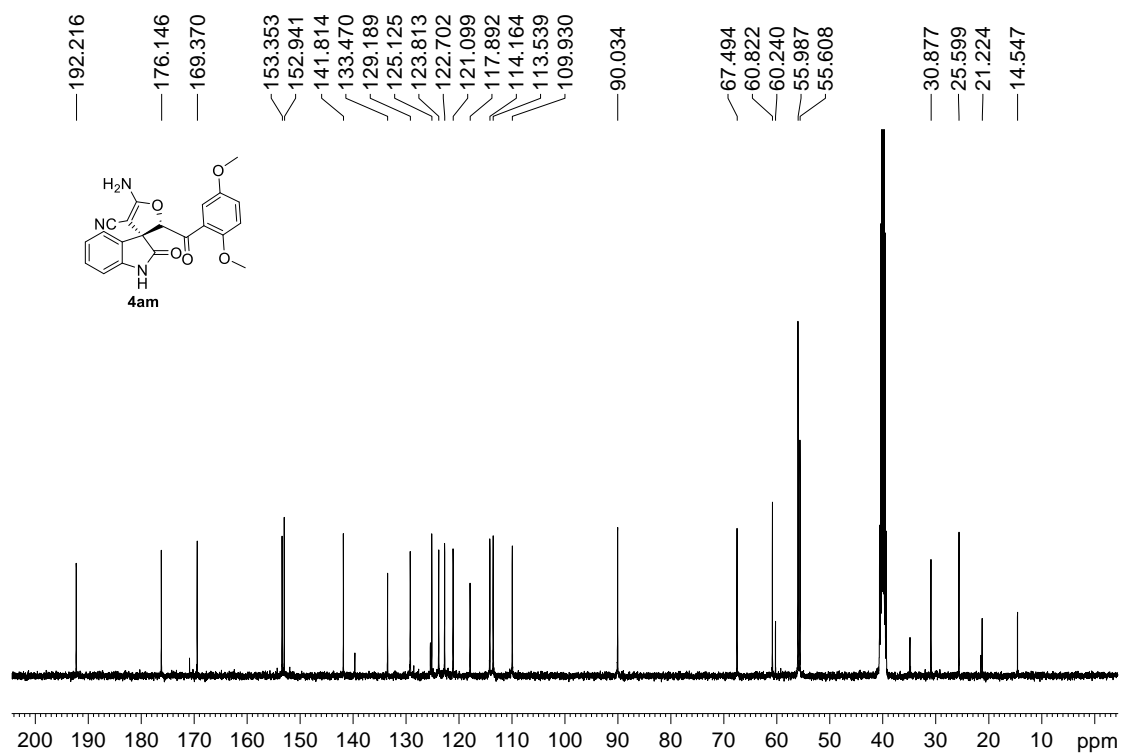
<sup>13</sup>C NMR spectrum of compound **4al** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



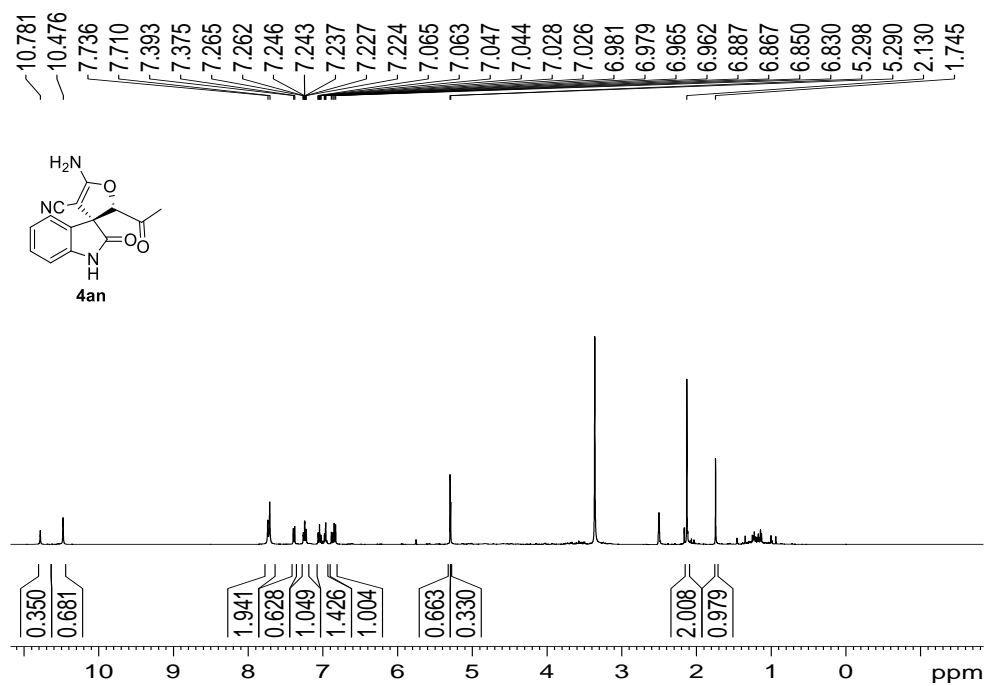
$^1\text{H}$  NMR spectrum of compound **4am** ( $(\text{CD}_3)_2\text{SO}$ , 400 MHz)



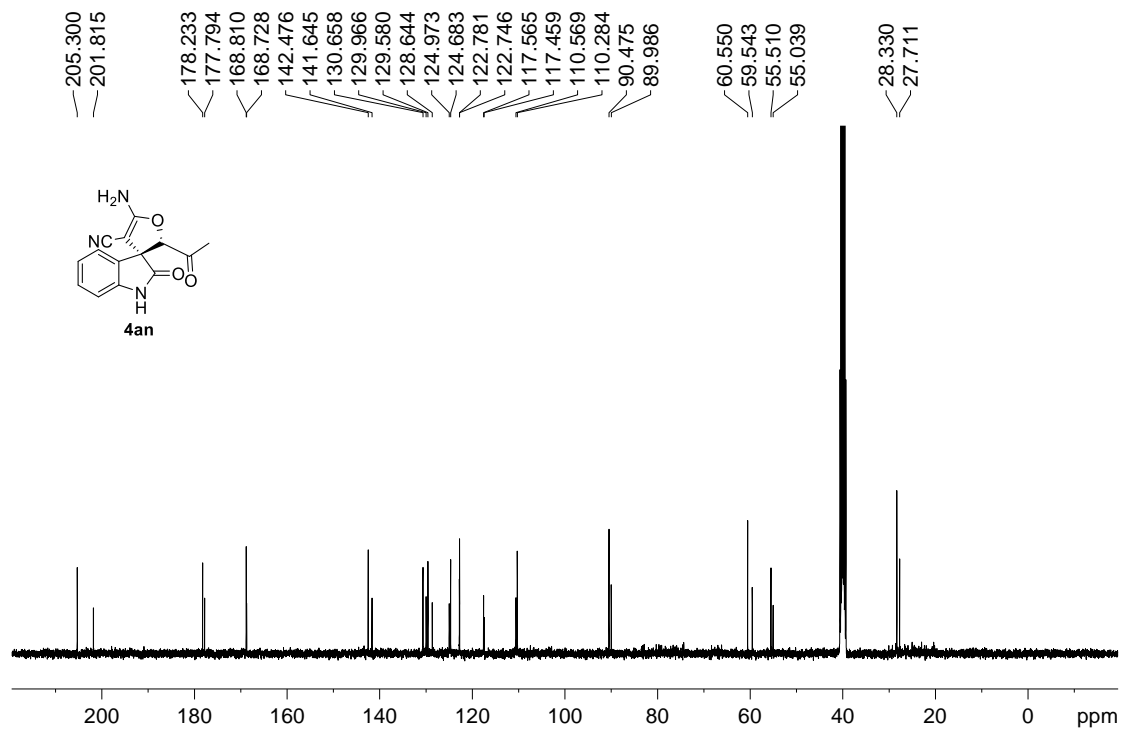
$^{13}\text{C}$  NMR spectrum of compound **4am** ( $(\text{CD}_3)_2\text{SO}$ , 100 MHz)



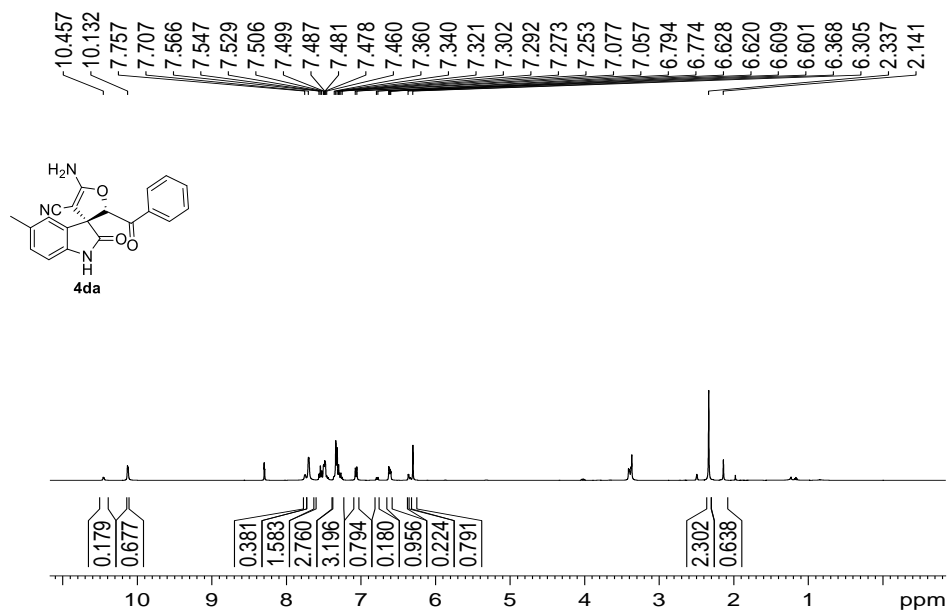
<sup>1</sup>H NMR spectrum of compound **4an** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



<sup>13</sup>C NMR spectrum of compound **4an** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)

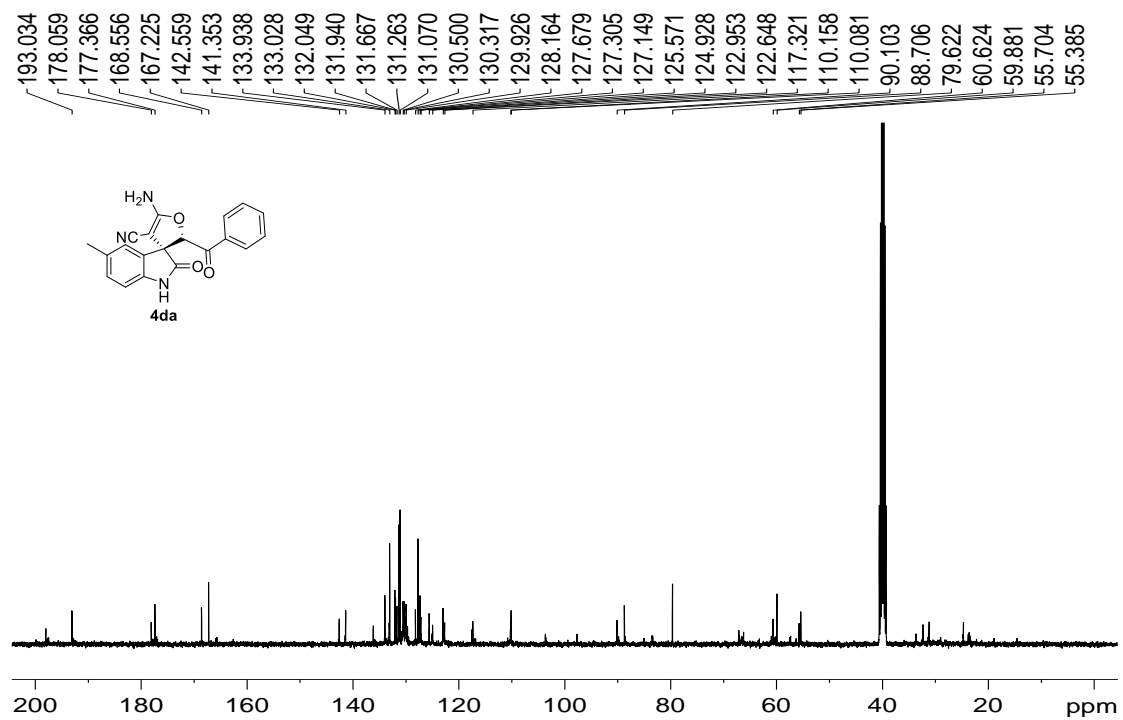


<sup>1</sup>H NMR spectrum of compound **4da** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)

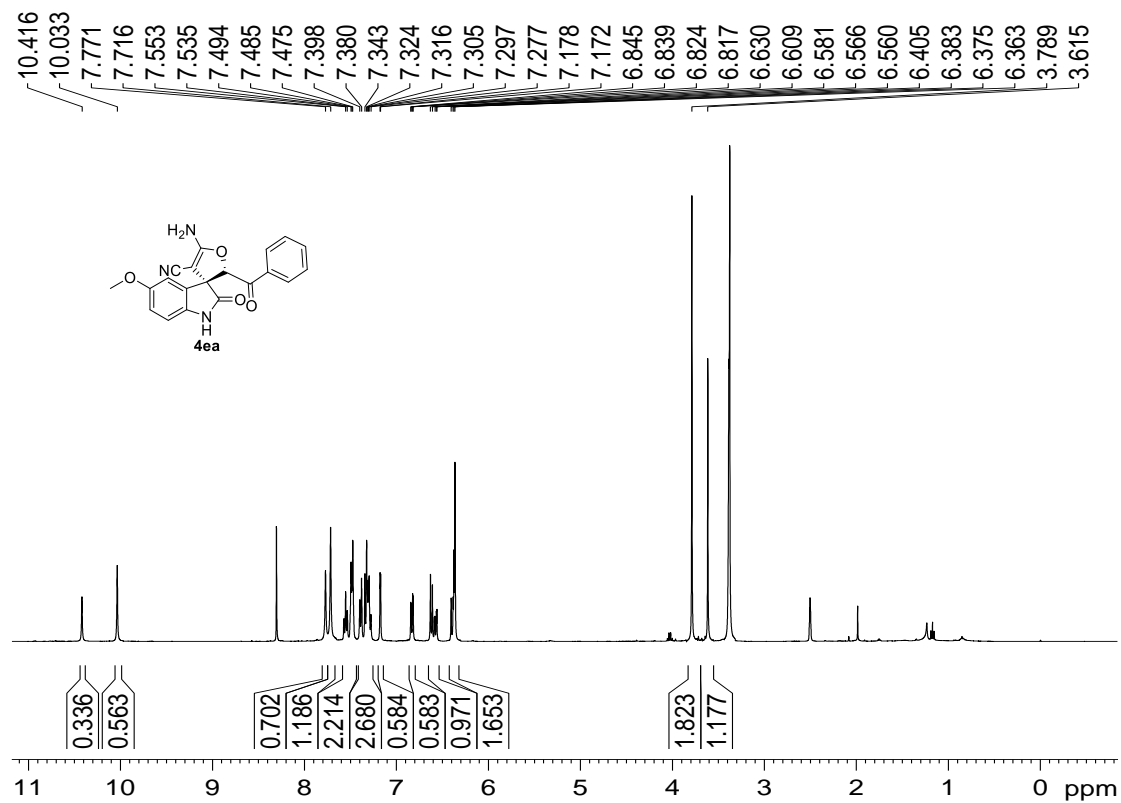


<sup>13</sup>C NMR spectrum of compound **4da** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)

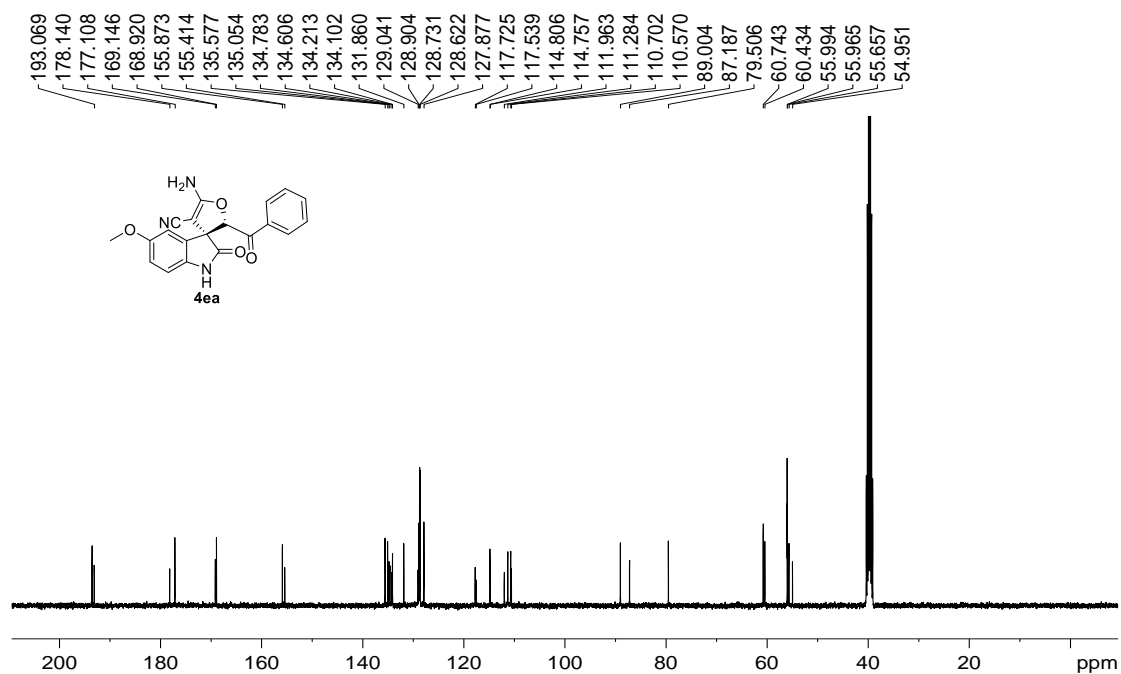




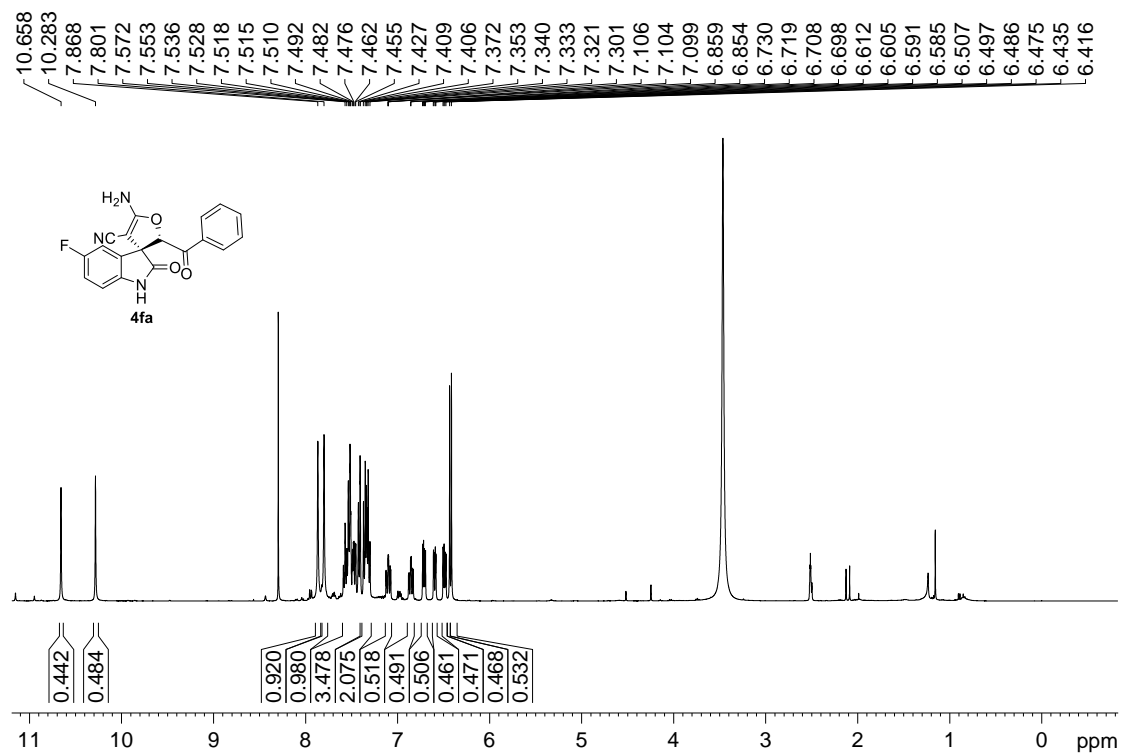
$^{13}\text{C}$  NMR spectrum of compound **4da** ( $(\text{CD}_3)_2\text{SO}$ , 400 MHz)



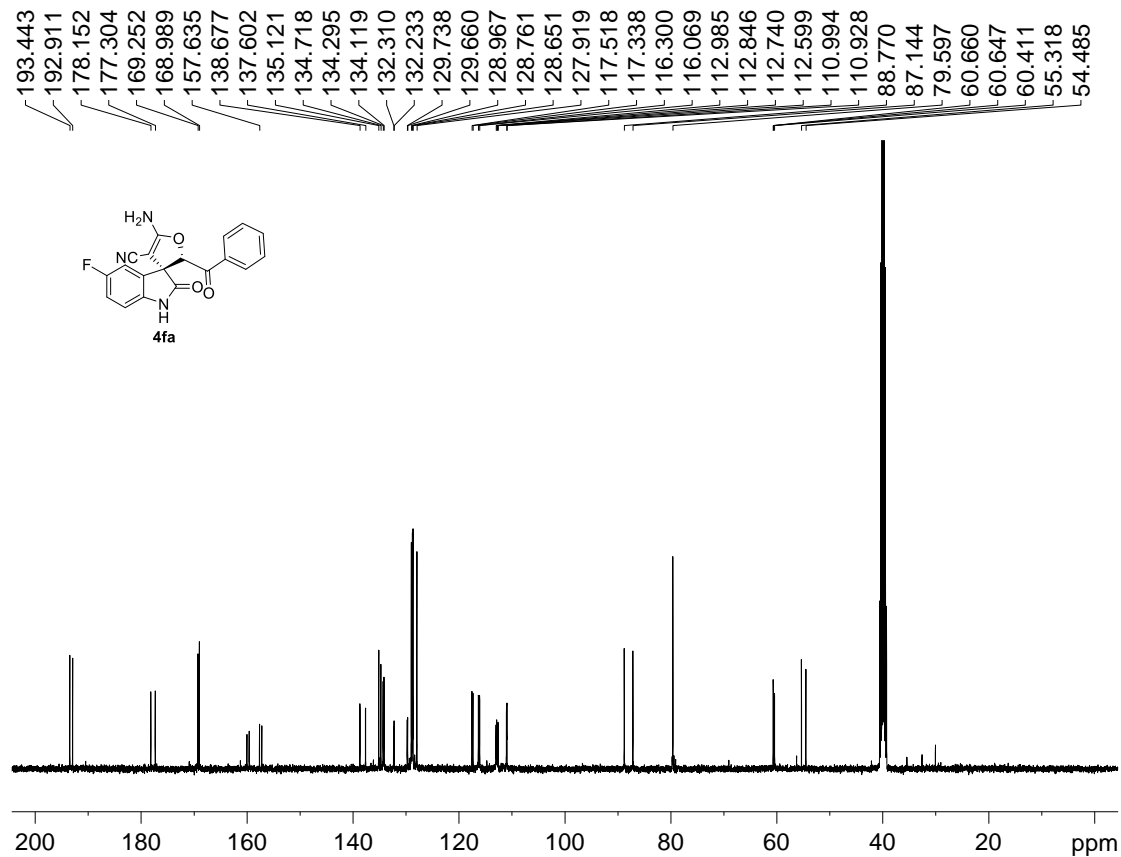
<sup>13</sup>C NMR spectrum of compound 4ea ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



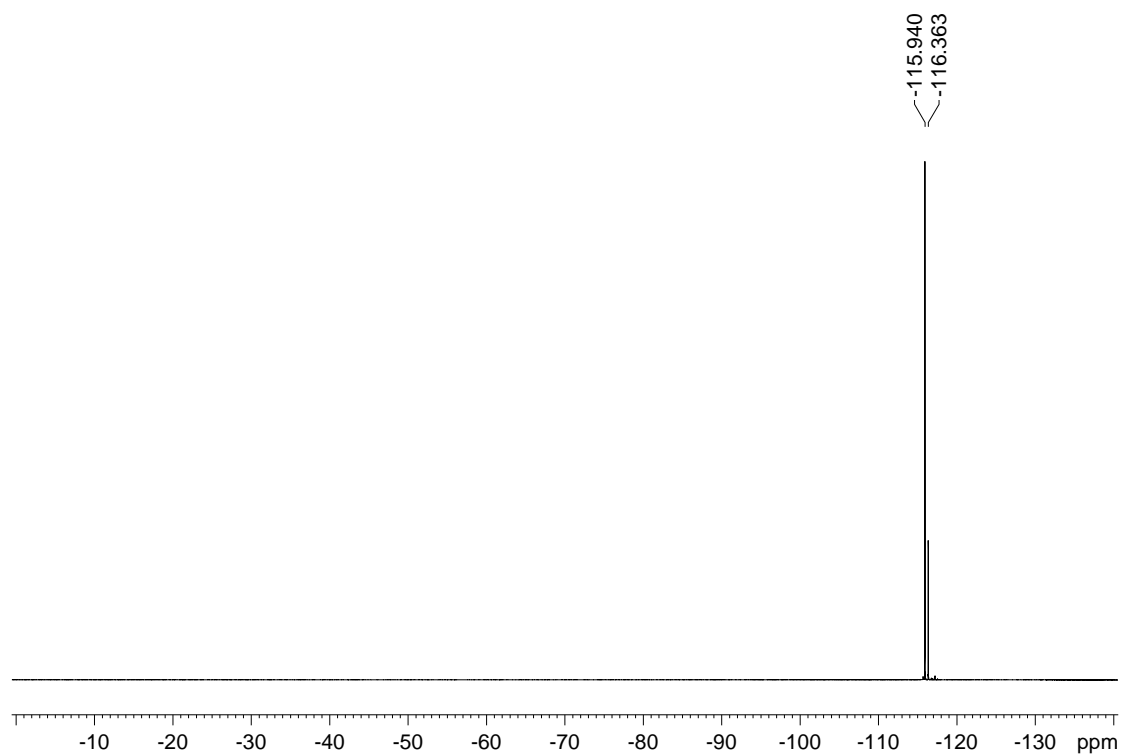
<sup>1</sup>H NMR spectrum of compound 4fa ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



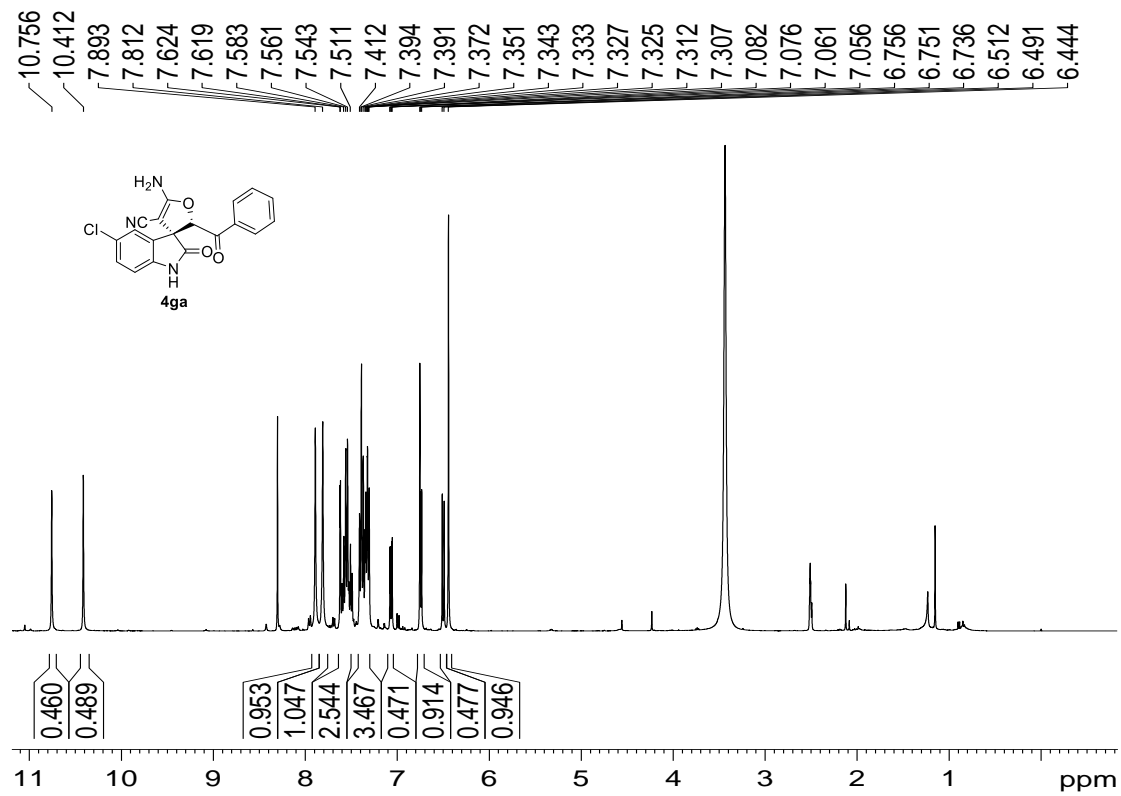
<sup>13</sup>C NMR spectrum of compound 4fa ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



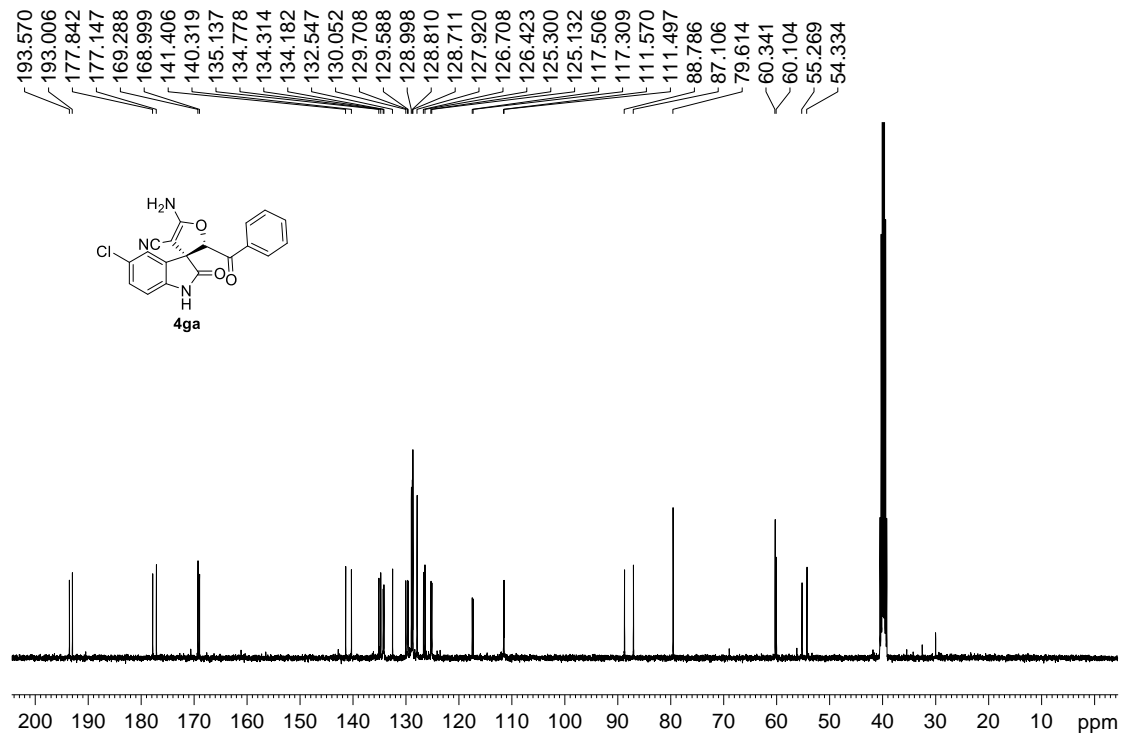
<sup>19</sup>F NMR spectrum of compound 4fa ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



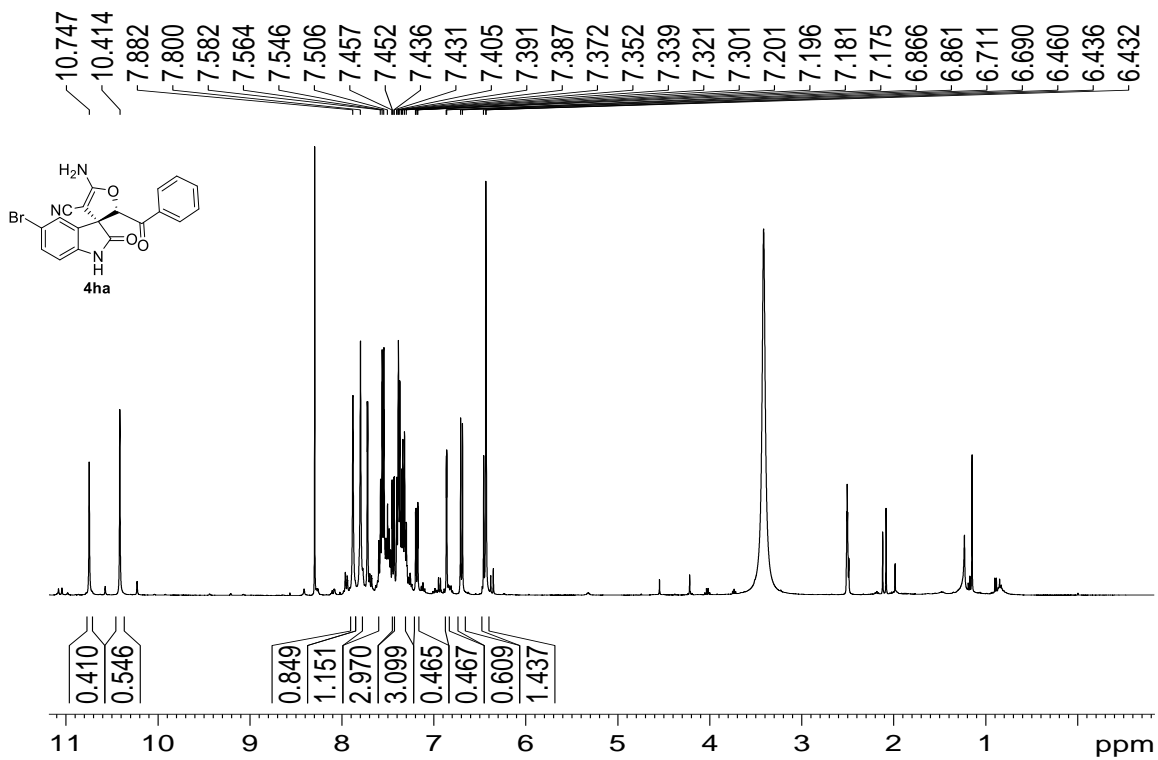
$^1\text{H}$  NMR spectrum of compound **4ga** ( $(\text{CD}_3)_2\text{SO}$ , 400 MHz)



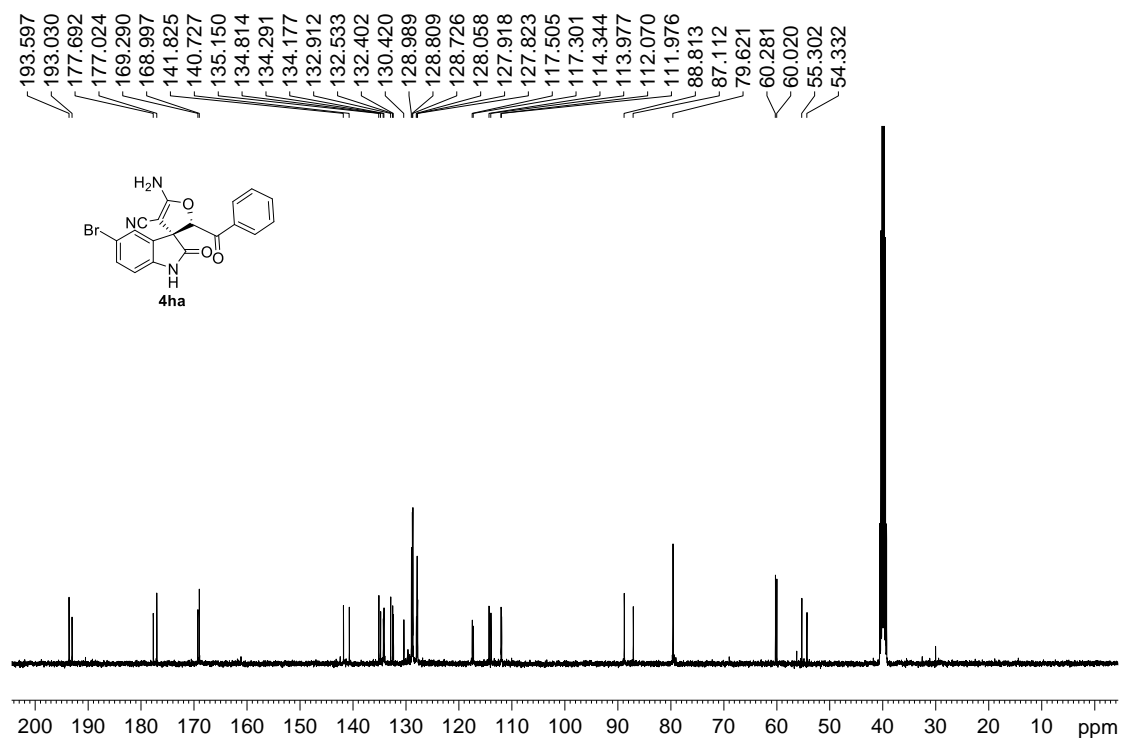
<sup>13</sup>C NMR spectrum of compound 4ga ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



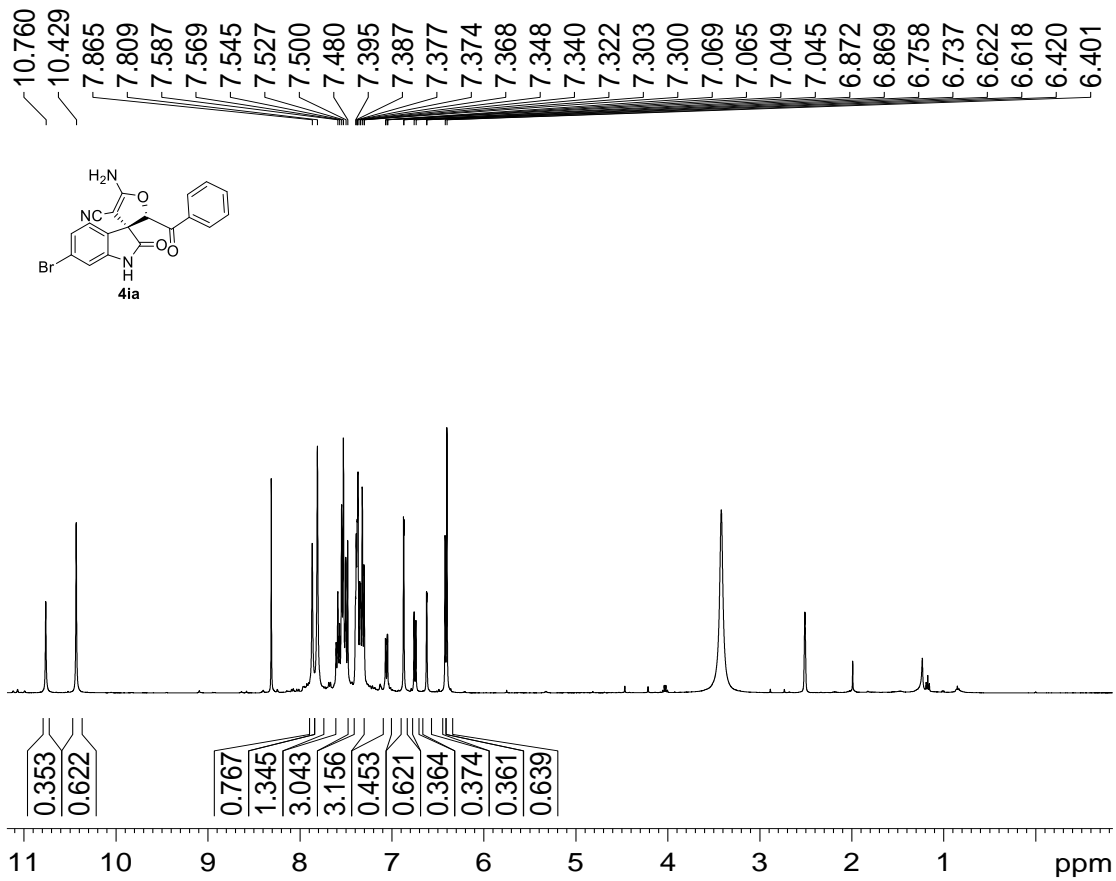
<sup>1</sup>H NMR spectrum of compound 4ha ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



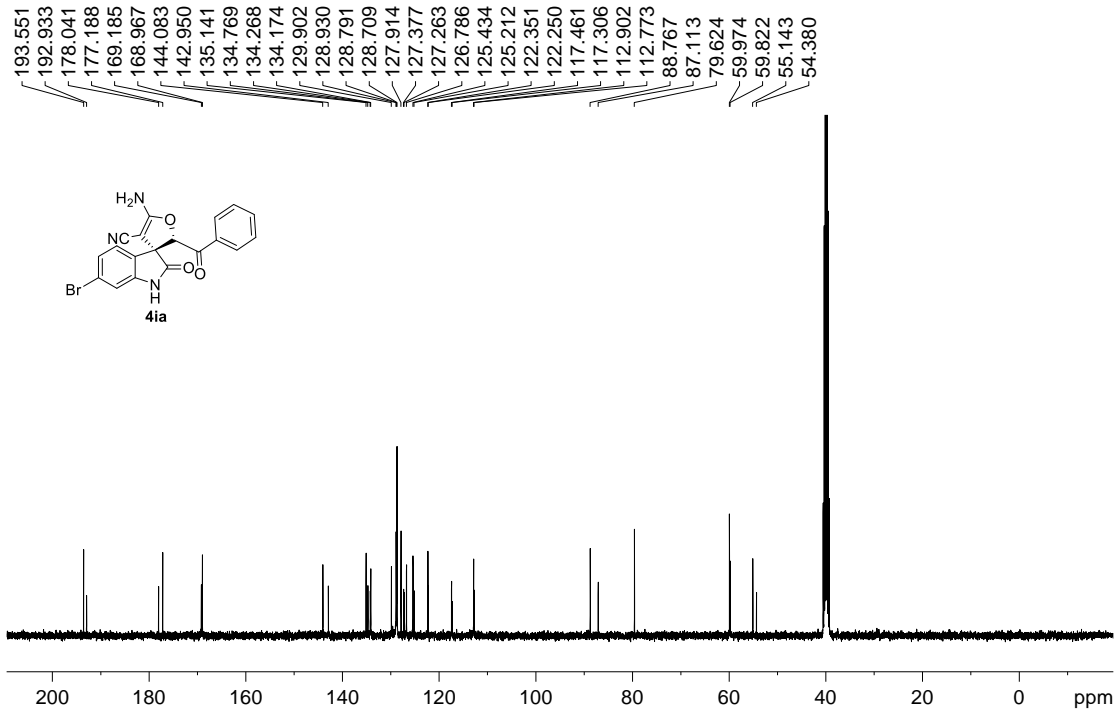
<sup>13</sup>C NMR spectrum of compound **4ha** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



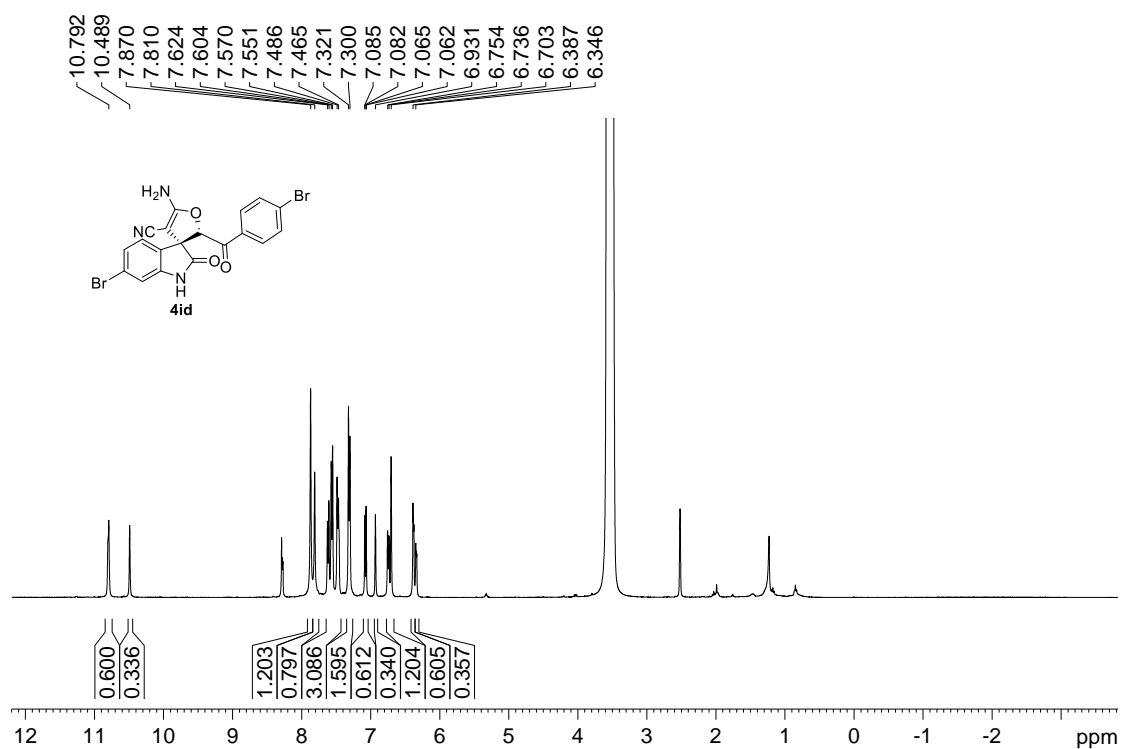
<sup>1</sup>H NMR spectrum of compound **4ia** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



<sup>13</sup>C NMR spectrum of compound 4ia ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)



<sup>1</sup>H NMR spectrum of compound **4id** ((CD<sub>3</sub>)<sub>2</sub>SO, 400 MHz)



<sup>13</sup>C NMR spectrum of compound **4id** ((CD<sub>3</sub>)<sub>2</sub>SO, 100 MHz)

