

Supporting Information

Chiral GAP catalysts of phosphonylated imidazolidinones and their applications in asymmetrical Diels-Alder and Friedel-Craft reactions

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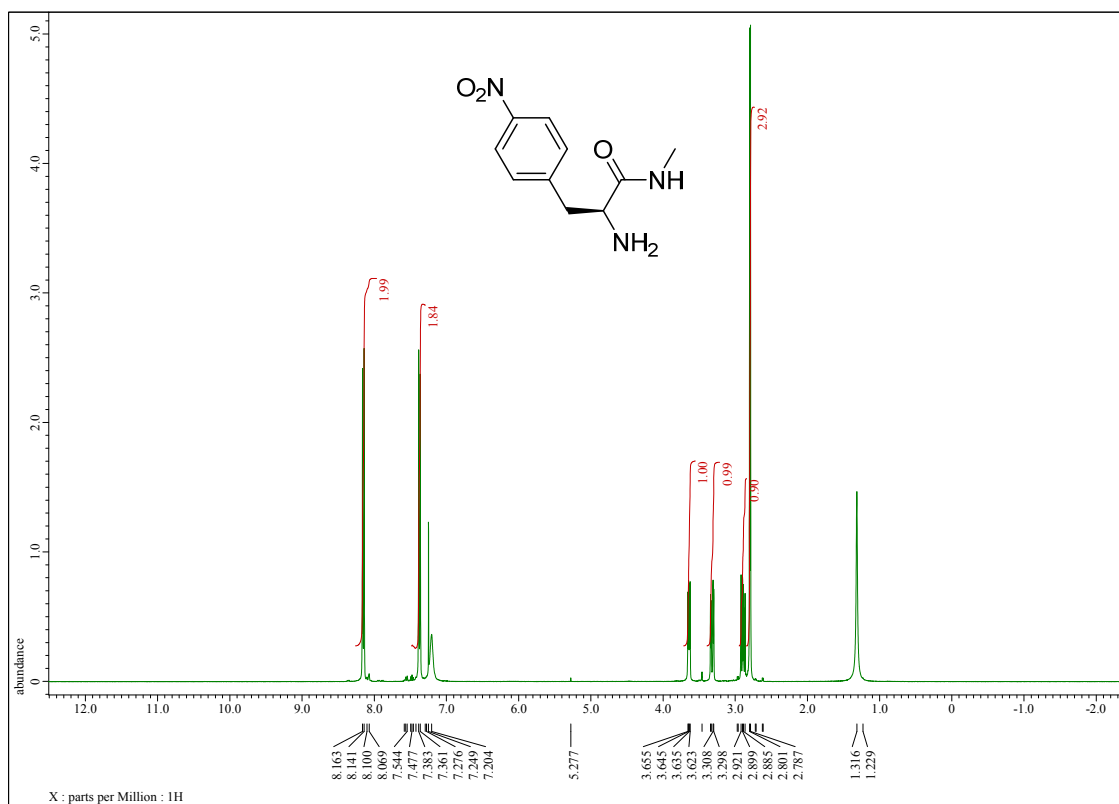
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^cSchool of Chemistry and Materials Science, Jiangsu Key Laboratory of Green Synthetic Chemistry for Functional Materials, Jiangsu Normal University, Xuzhou 221116, P. R. China. Email: jiangchem@jsnu.edu.cn (B.J.).

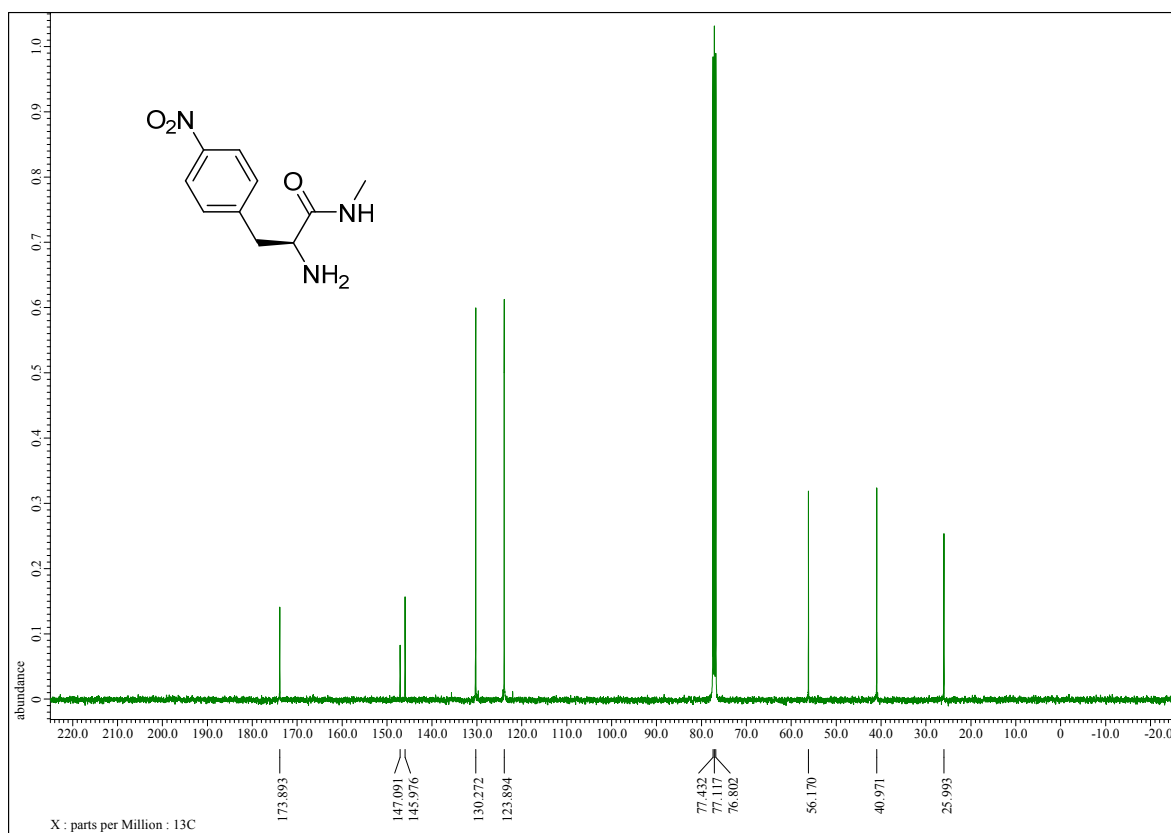
Context

Copies of ¹ H, ¹³ C and ³¹ P NMR Spectra for Catalyst 1a	S1-S6
Copies of ¹ H, ¹³ C NMR Spectra and HPLC for Compounds 4a-4e	S6-S15
Copies of ¹ H, ¹³ C NMR Spectra and HPLC for Compounds 7a-7e	S16-S25

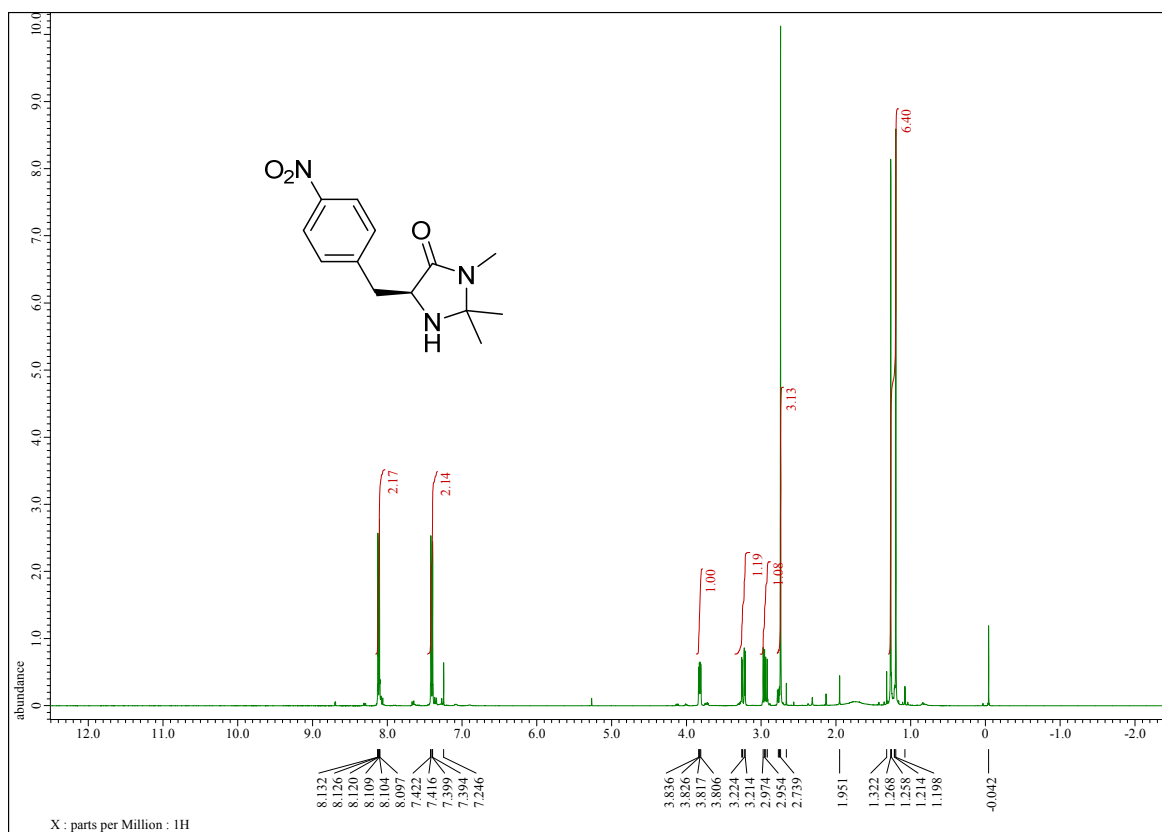
Copies of NMR and HPLC of Products



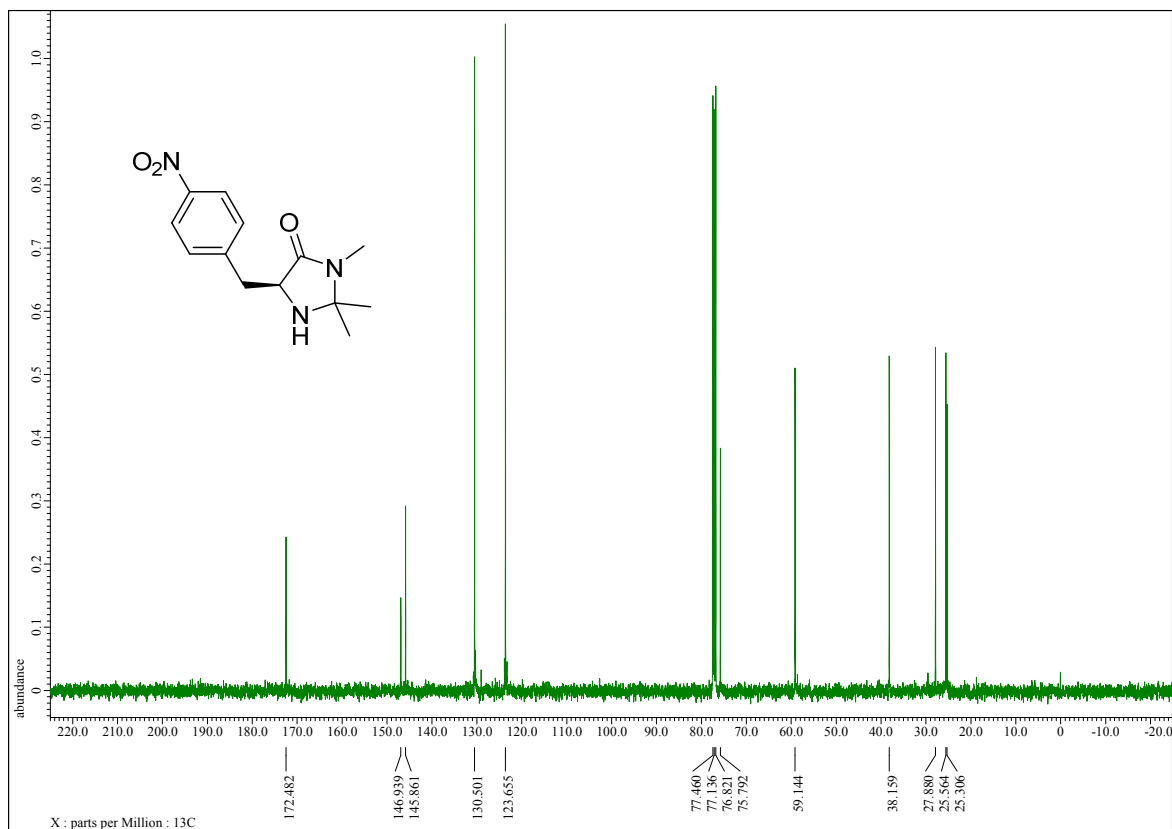
¹H NMR Spectrum of Compound 1-2



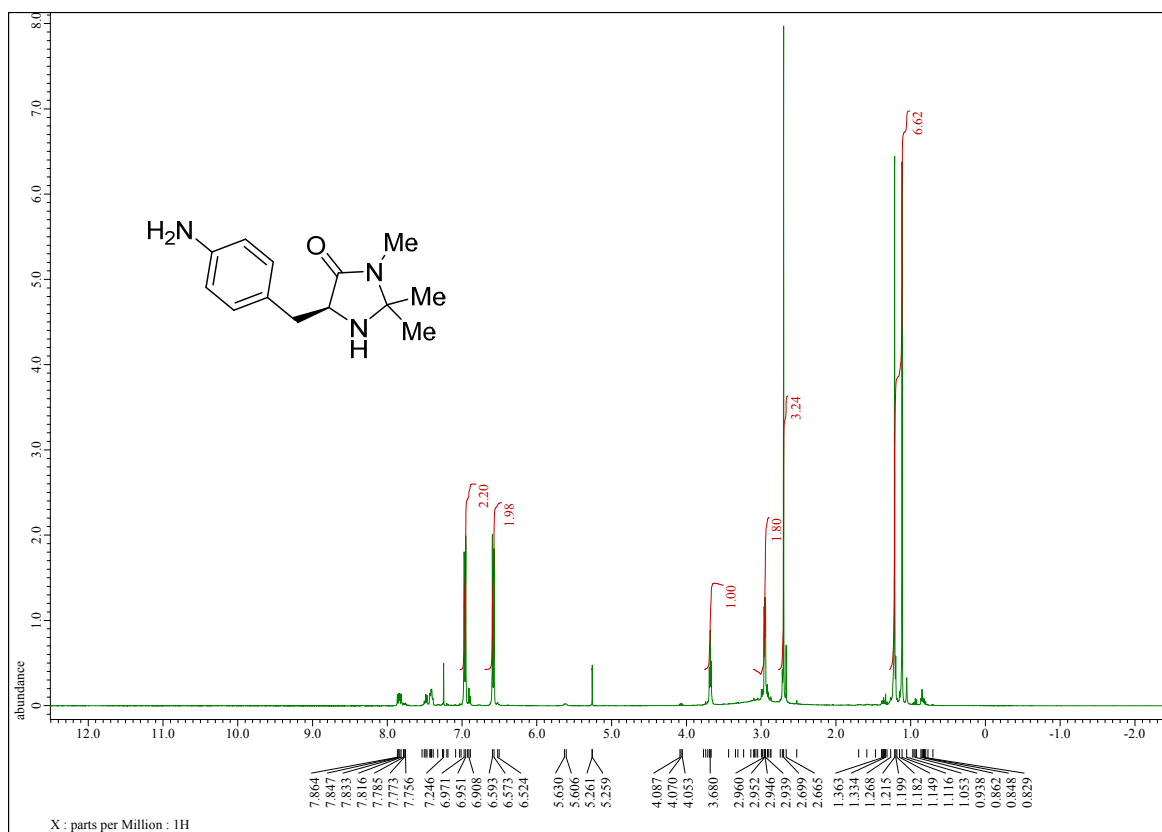
¹³C NMR Spectrum of Compound 1-2



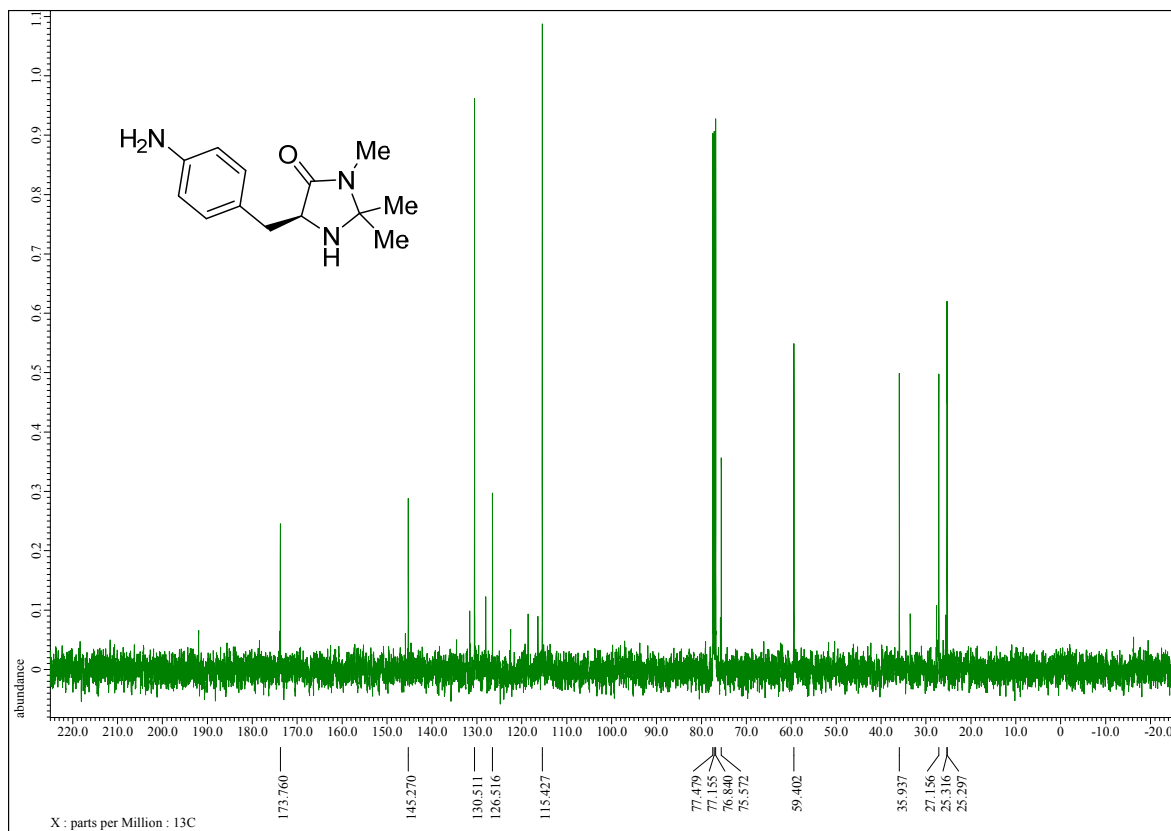
¹H NMR Spectrum of Compound 1-3



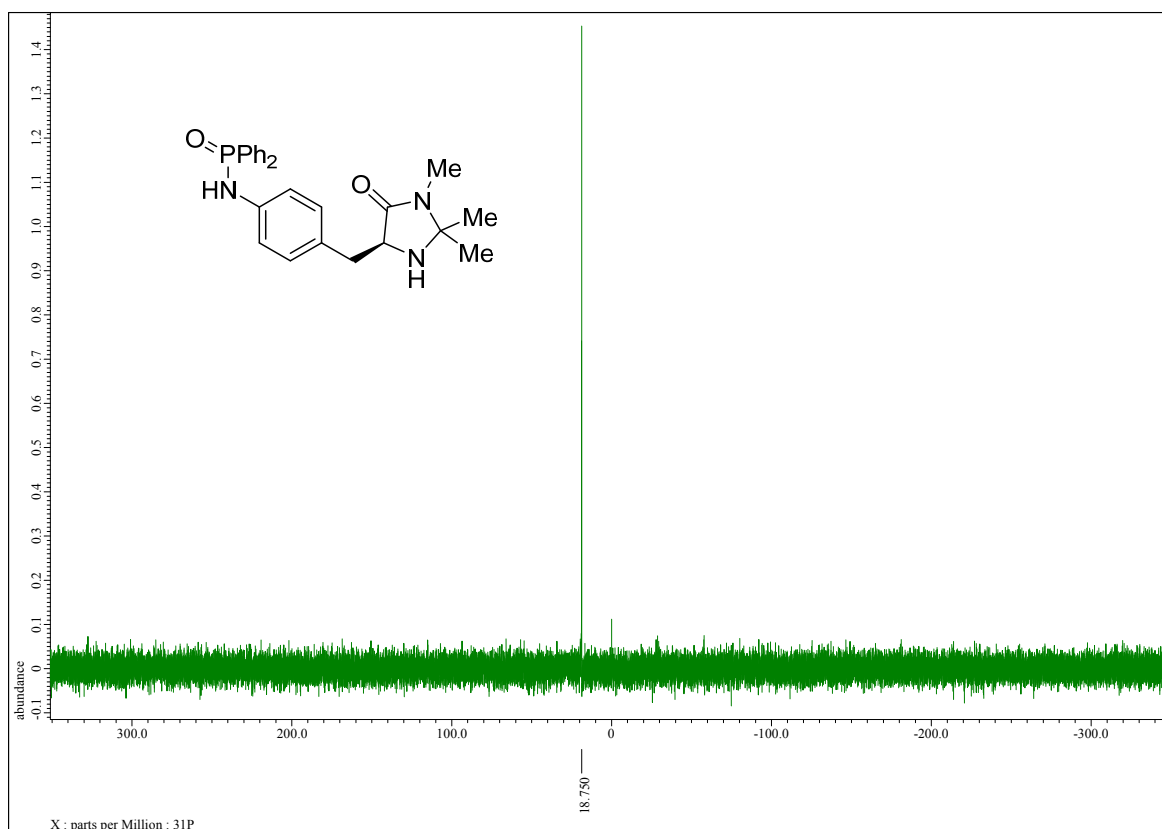
¹³C NMR Spectrum of Compound 1-3



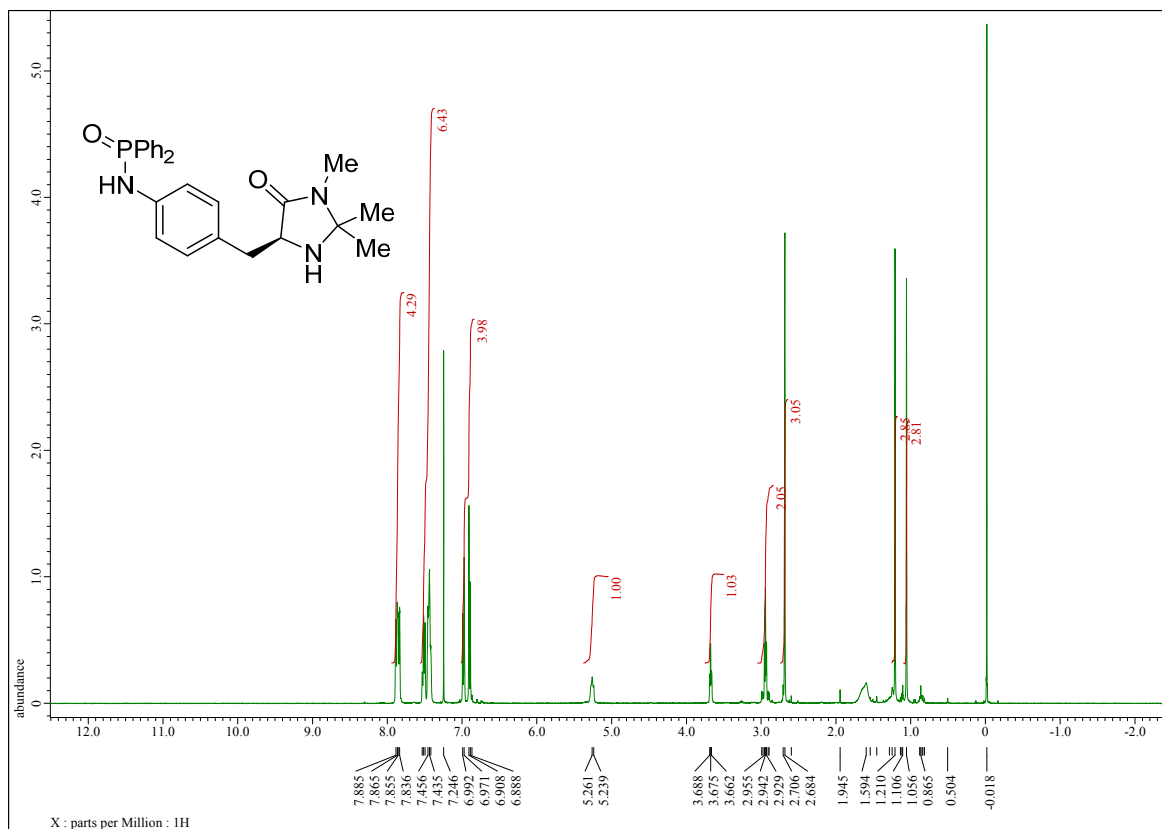
¹H NMR Spectrum of Compound 1-4



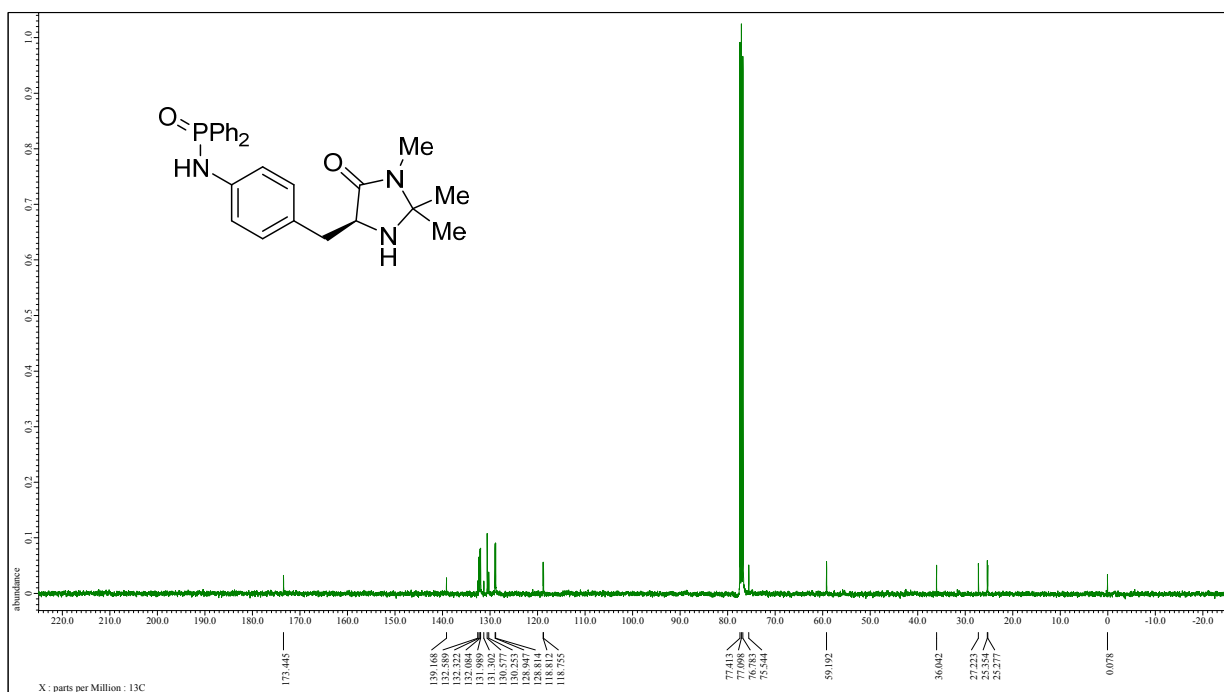
¹³C NMR Spectrum of Compound 1-4



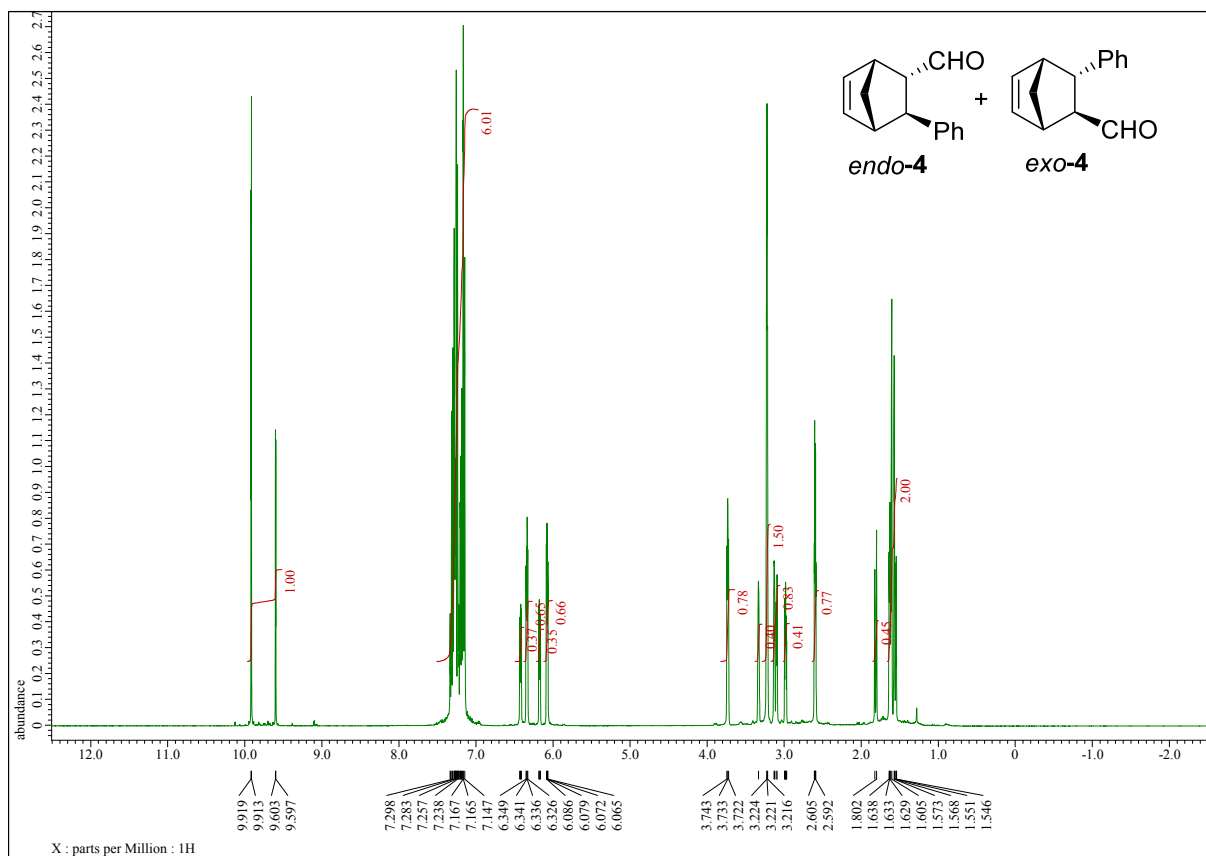
³¹P NMR Spectrum of Catalyst 1a



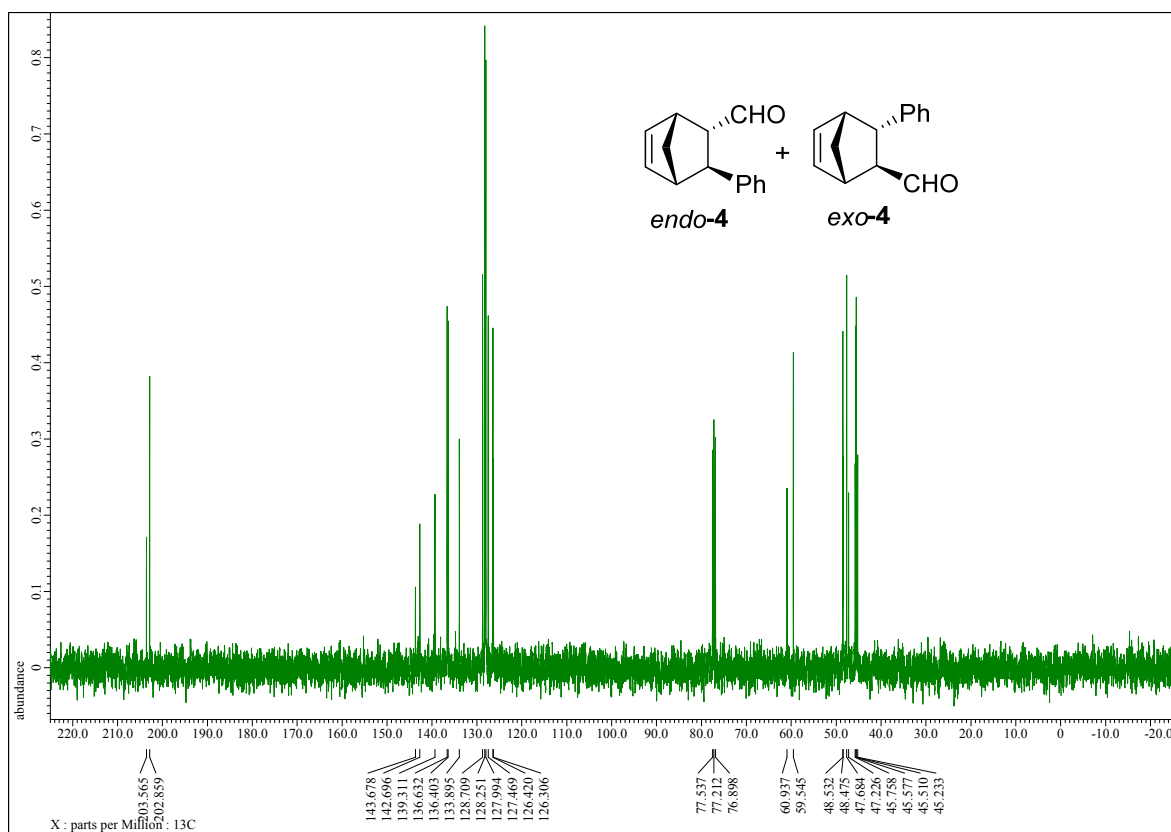
¹H NMR Spectrum of Catalyst 1a



¹³C NMR Spectrum of Catalyst 1a

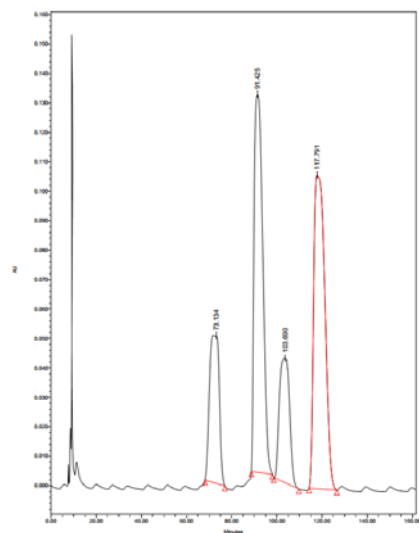


¹H NMR Spectrum of Compound 4a

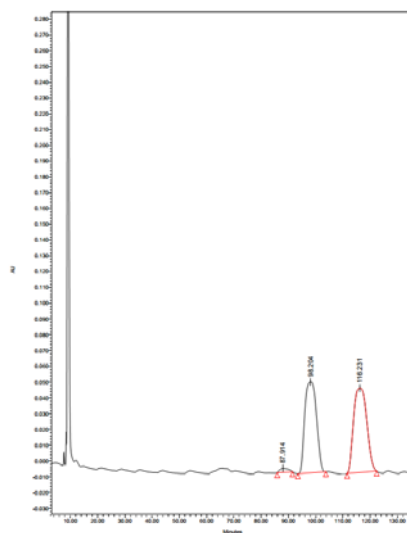


¹³C NMR Spectrum of Compound 4a

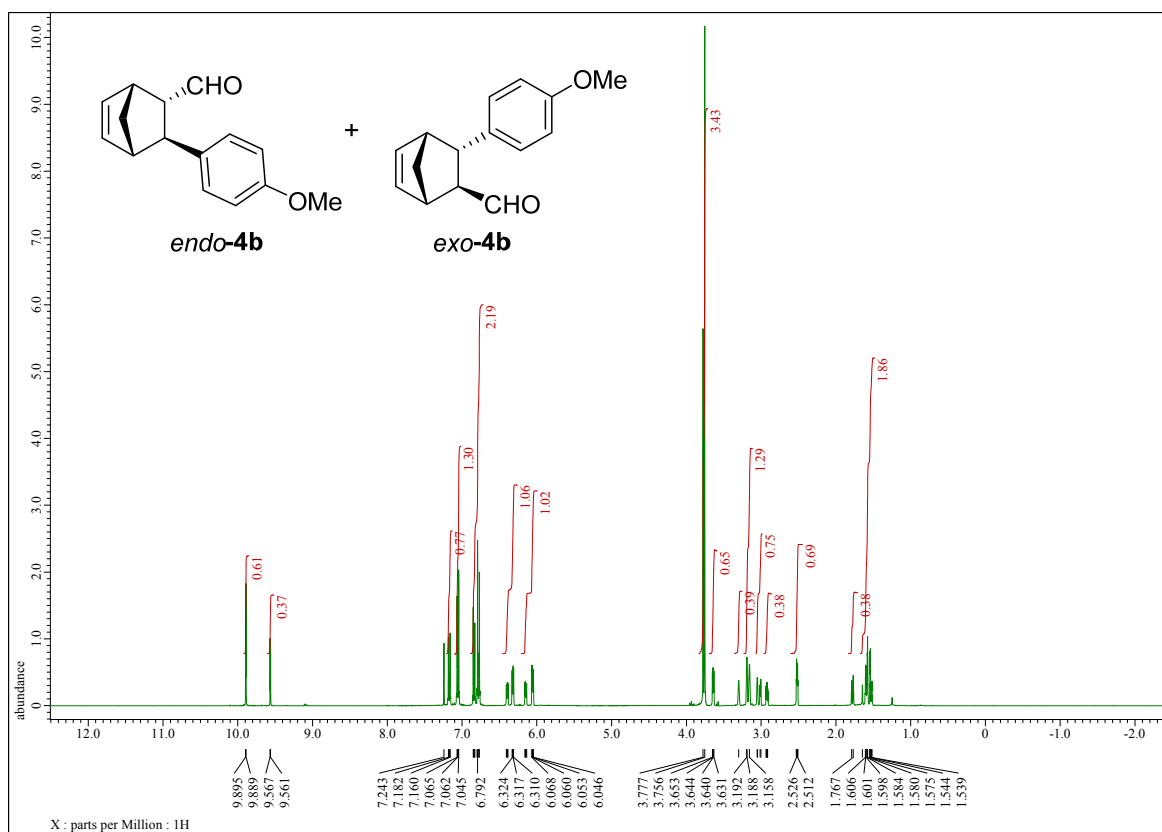
HPLC of Compound 4a



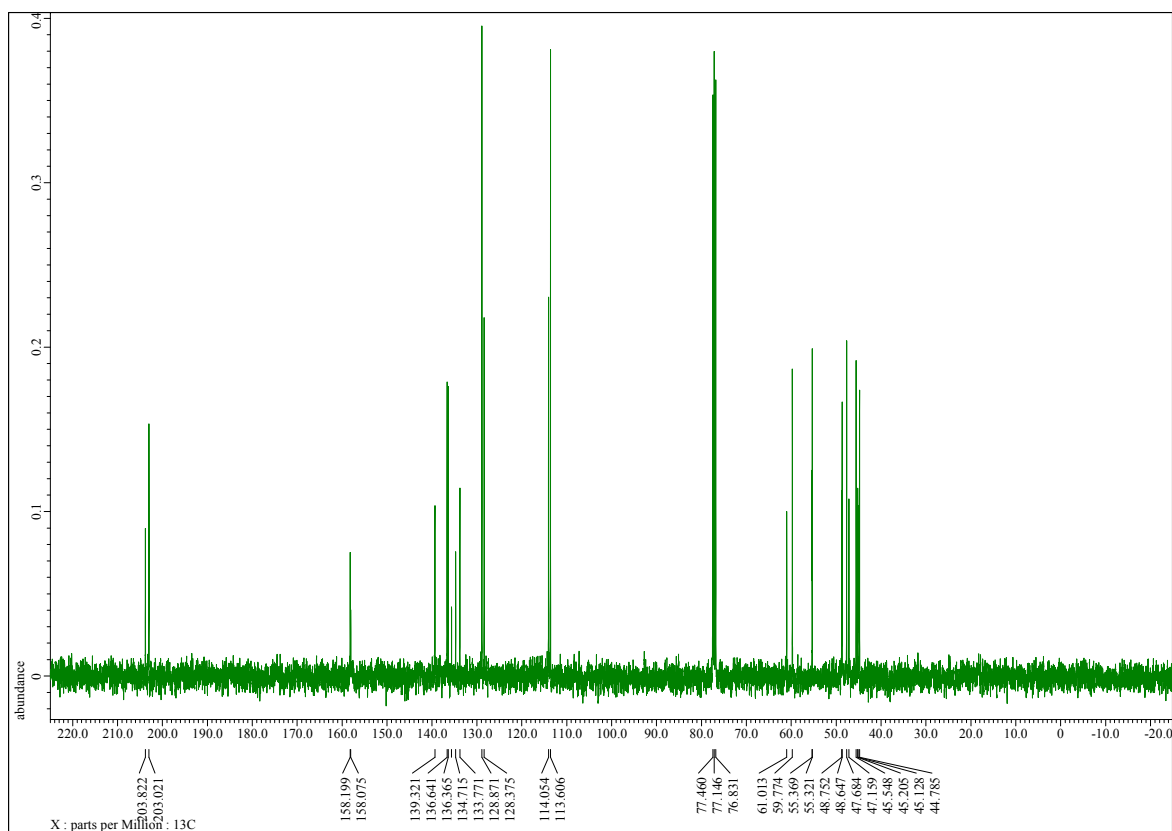
	Retention Time (min)	Area (μV*sec)	% Area	Height (μV)
1	73.134	15008995	15.17	50207
2	91.425	34100933	34.48	128387
3	103.690	13224013	13.37	42385
4	117.791	36574281	36.98	106583



	Name	Retention Time (min)	Area (μV*sec)	% Area	Height (μV)
1		87.914	2550292	0.64	15608
2		98.204	194778549	48.88	704187
3		116.231	201154279	50.48	685404

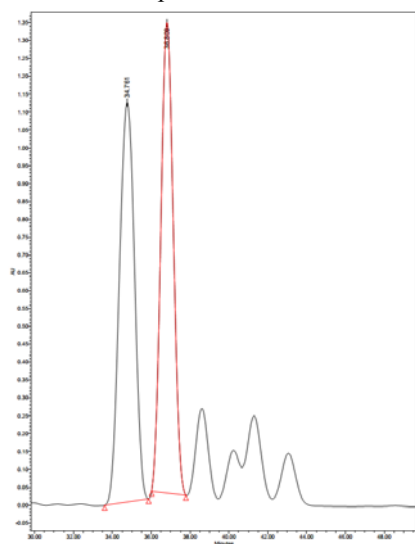


¹H NMR Spectrum of Compound 4b

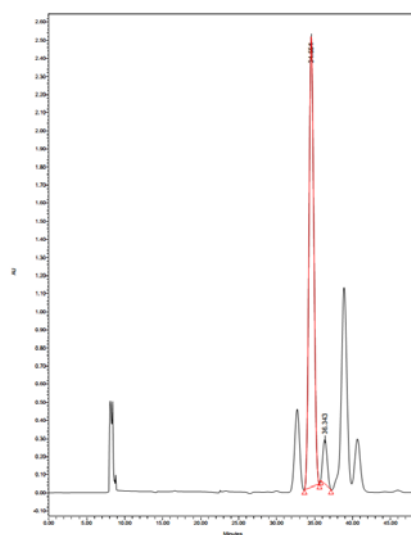


¹³C NMR Spectrum of Compound 4b

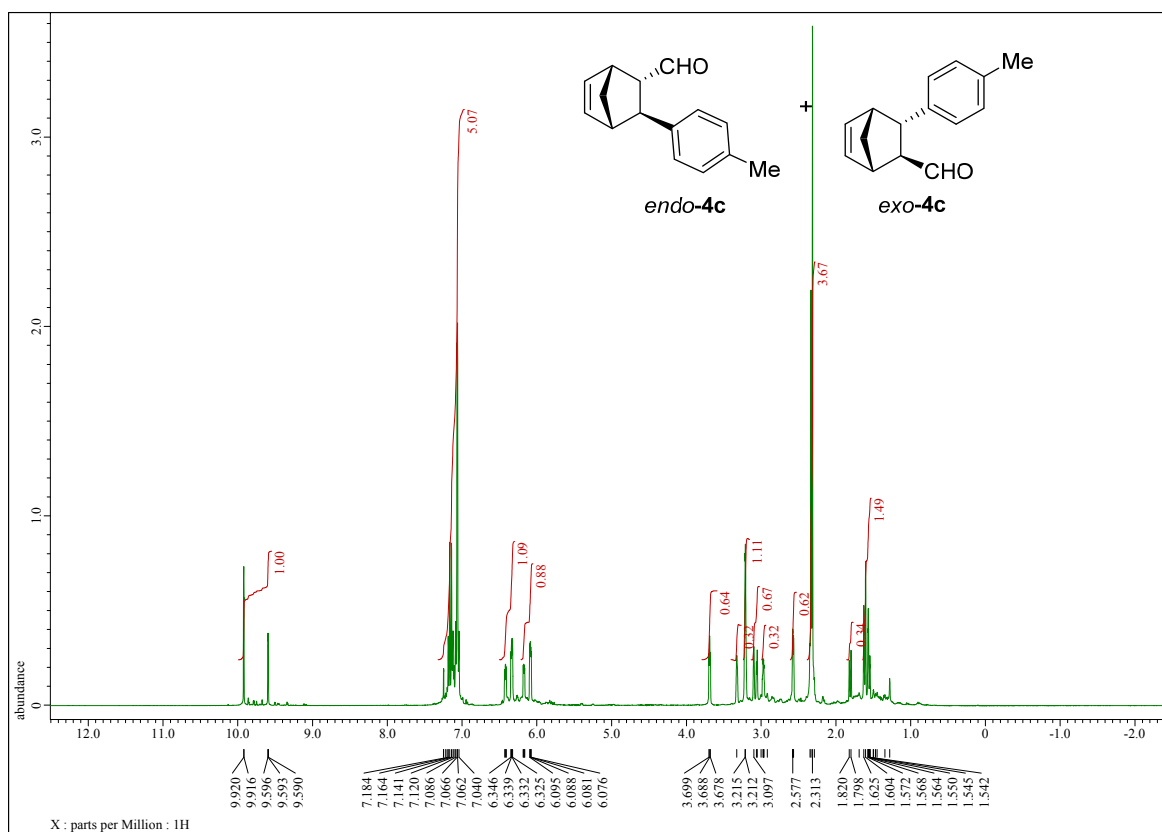
HPLC of Compound **4b**



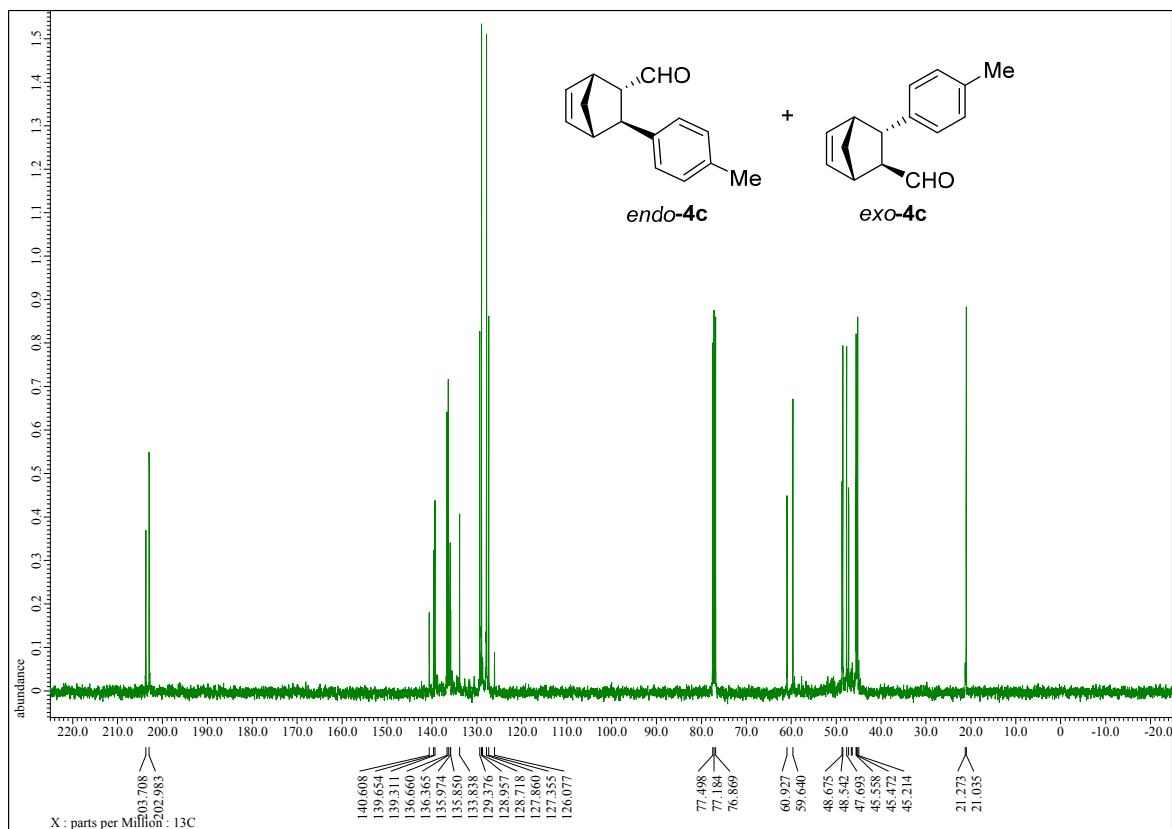
	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	34.761	60174896	50.74	1117525
2	36.809	58424289	49.26	1316152



	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	34.551	110650507	95.82	2488911
2	36.343	4826958	4.18	246239

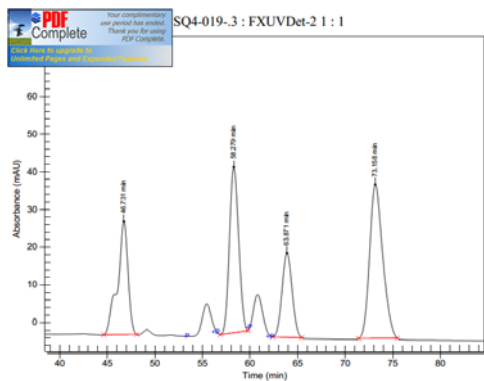


¹H NMR Spectrum of Compound 4c

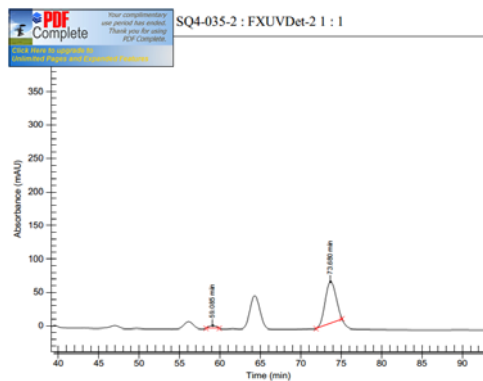


¹³C NMR Spectrum of Compound 4c

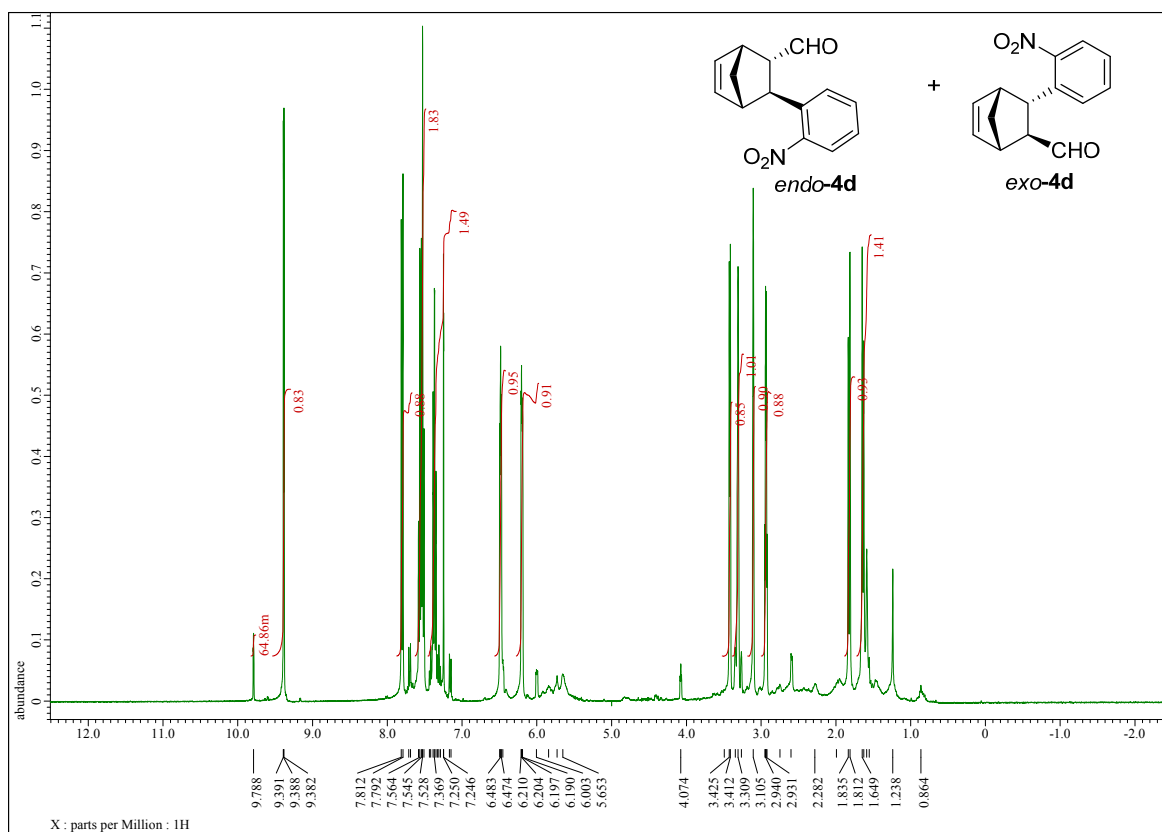
HPLC of Compound **4c**



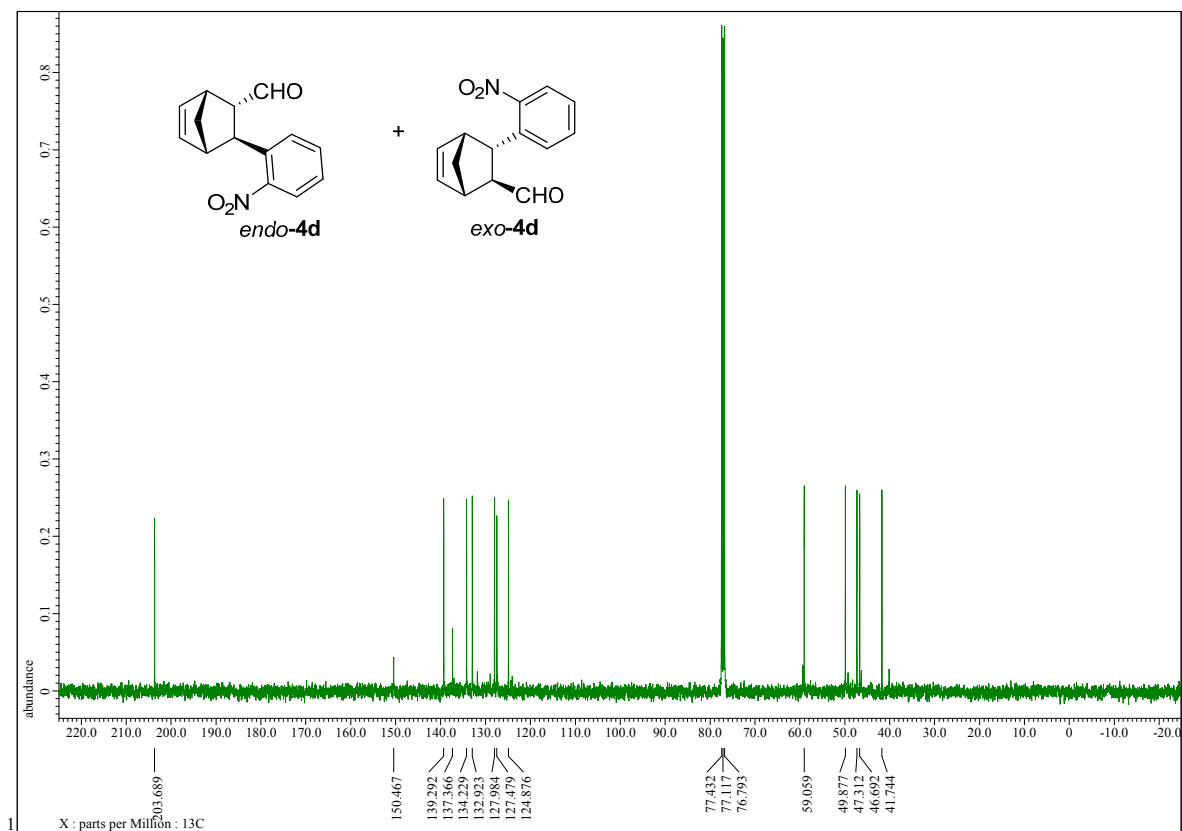
	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	46.731	2293380	21.24	30031
2	58.279	2965716	27.47	43900
3	63.871	1638572	19.18	22327
4	73.158	3899379	32.11	40802



	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	59.163	179800	3.12	3870
2	73.680	5583030	96.88	61370

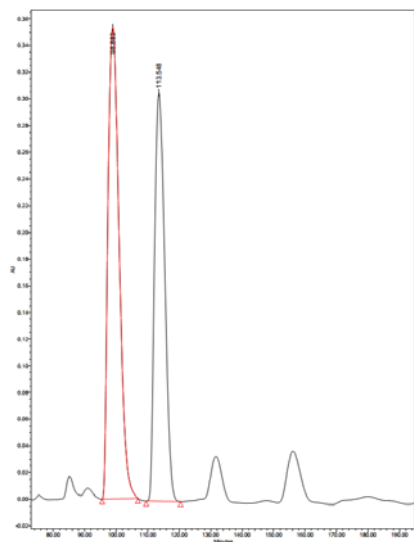


¹H NMR Spectrum of Compound 4d

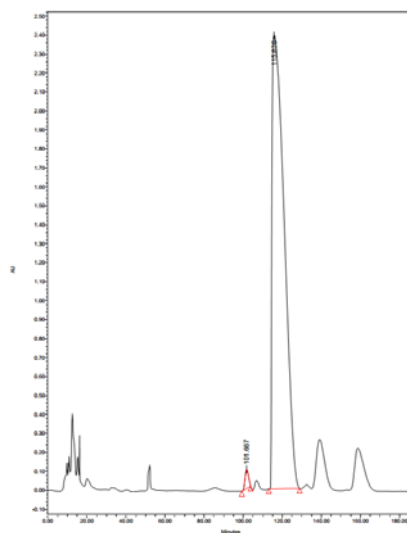


¹³C NMR Spectrum of Compound 4d

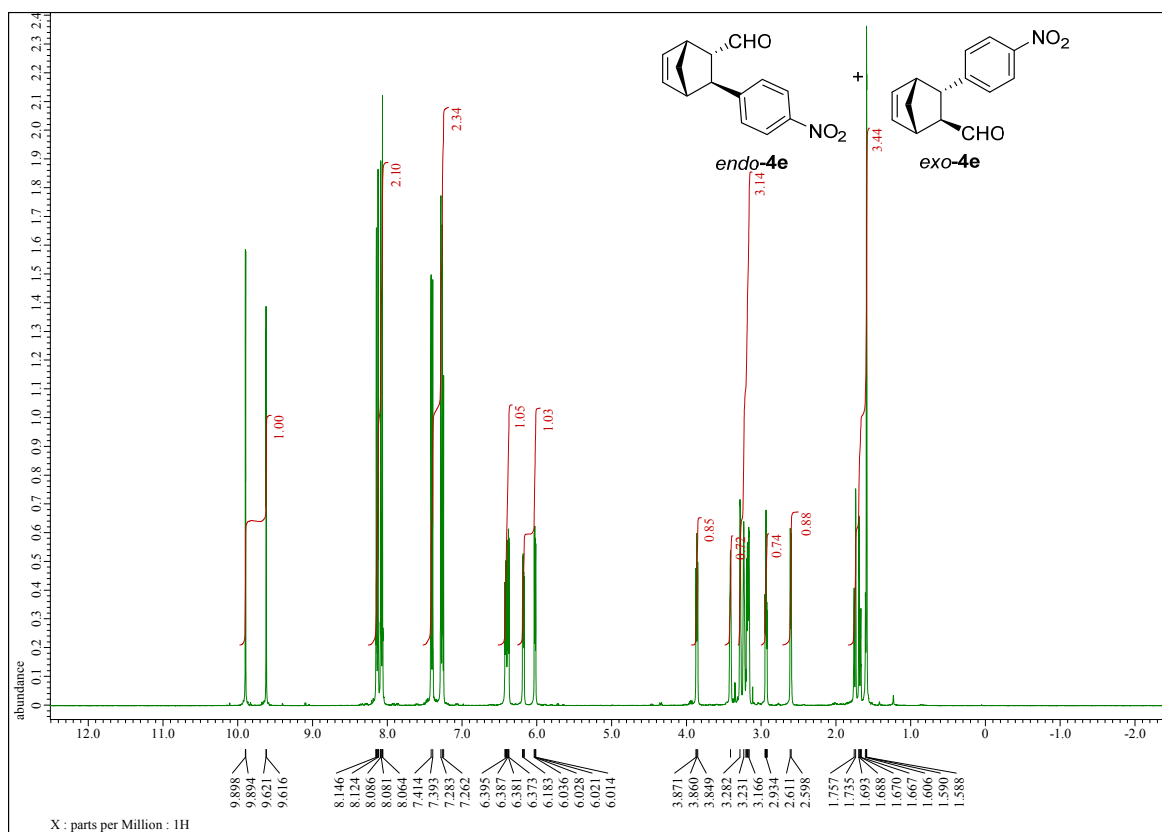
HPLC of Compound **4d**



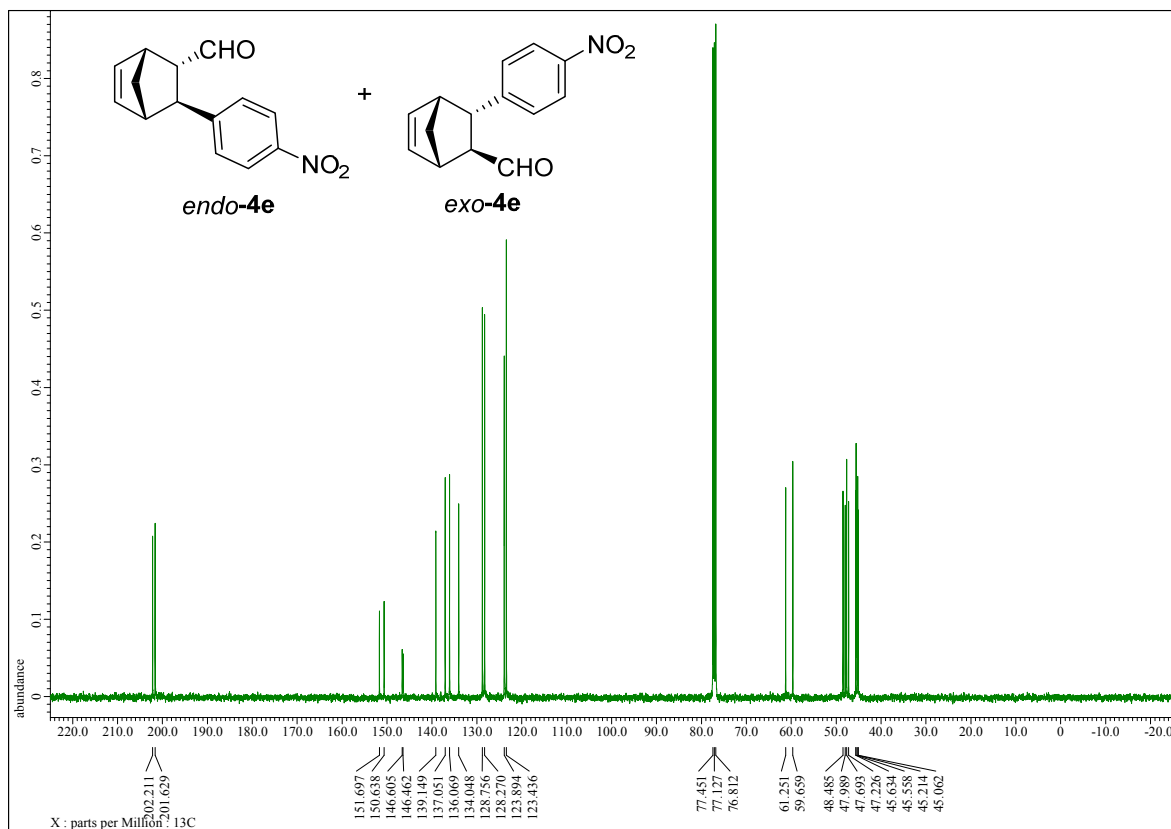
	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	98.883	86731994	55.73	353045
2	113.548	68884964	44.27	305943



	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area
1	101.667	12199215	1.17
2	115.826	1033192227	98.83

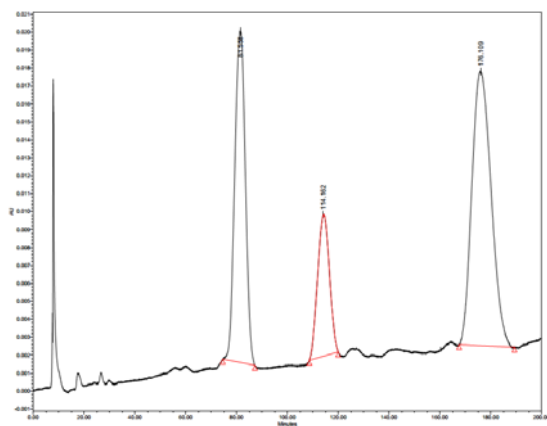


¹H NMR Spectrum of Compound 4e

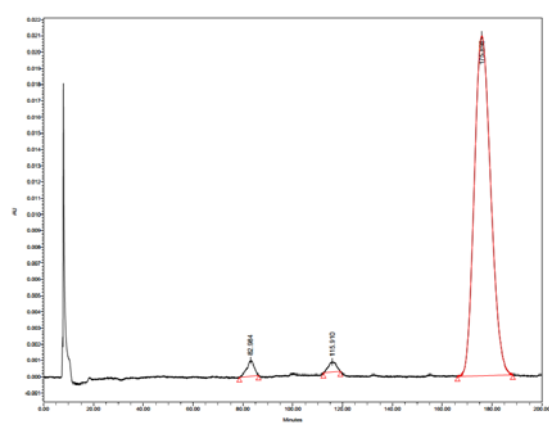


¹³C NMR Spectrum of Compound 4e

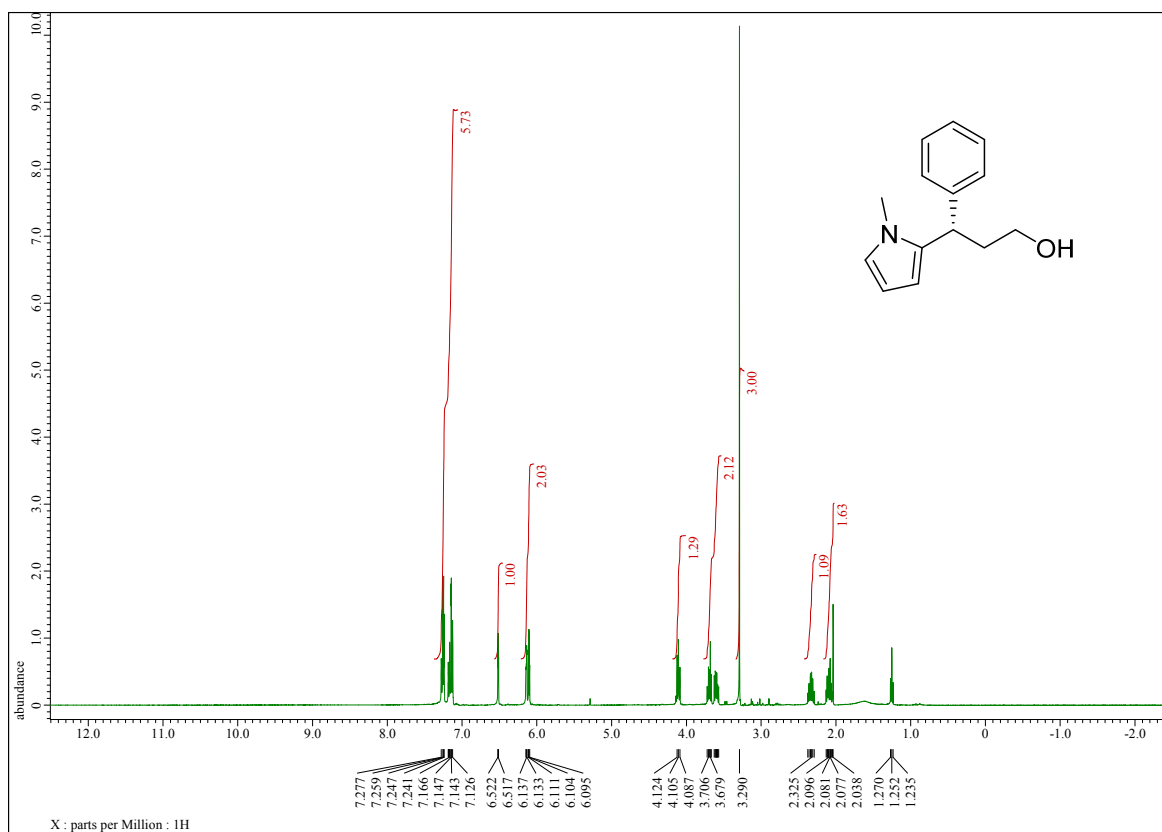
HPLC of Compound 4e



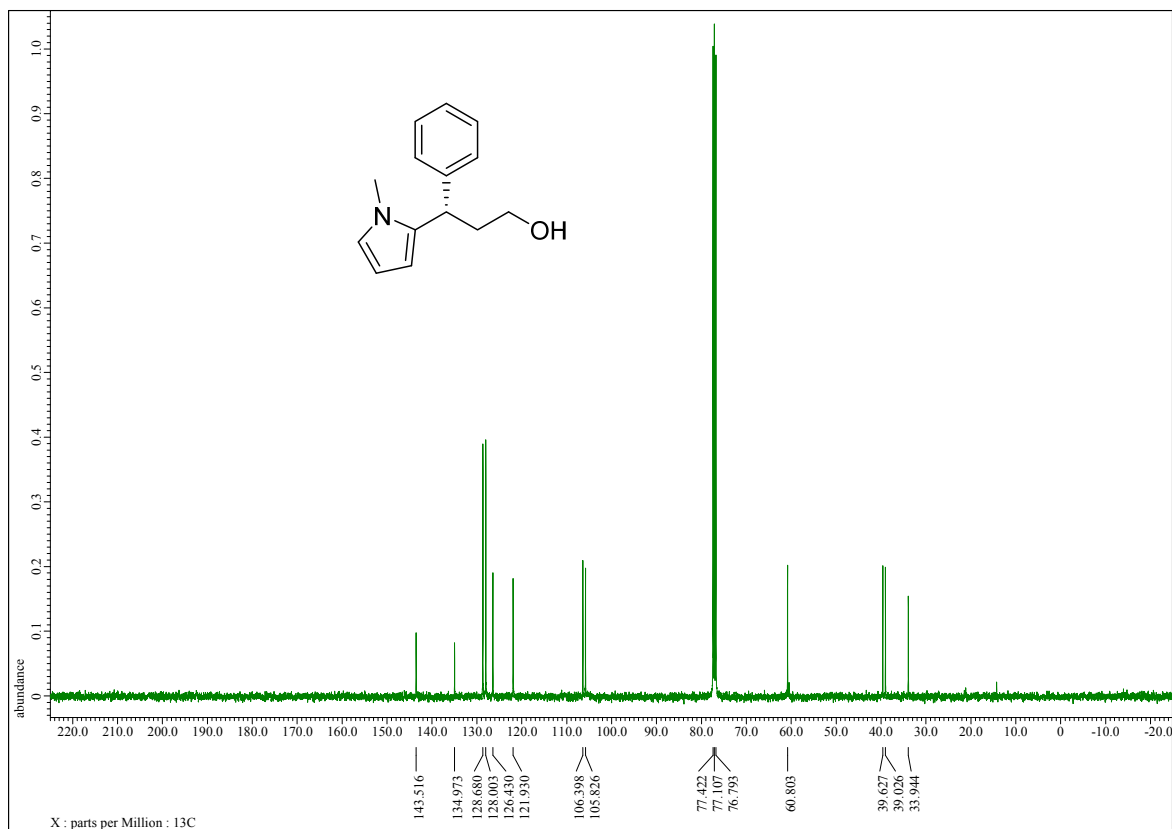
	Retention Time (min)	Area (μV*sec)	% Area	Height (μV)	Int Type
1	81.558	5340037	33.49	18468	bb
2	114.162	2560584	16.06	7893	bb
3	176.109	8046703	50.46	15294	bb



	Retention Time (min)	Area (μV*sec)	% Area	Height (μV)
1	82.984	197950	1.99	953
2	115.910	141005	1.41	623
3	175.898	9633104	96.60	20947

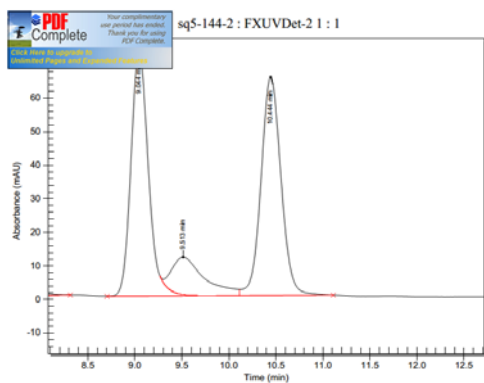


¹H NMR Spectrum of Compound 7a

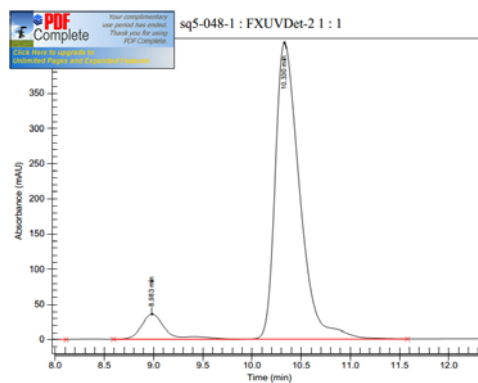


¹³C NMR Spectrum of Compound 7a

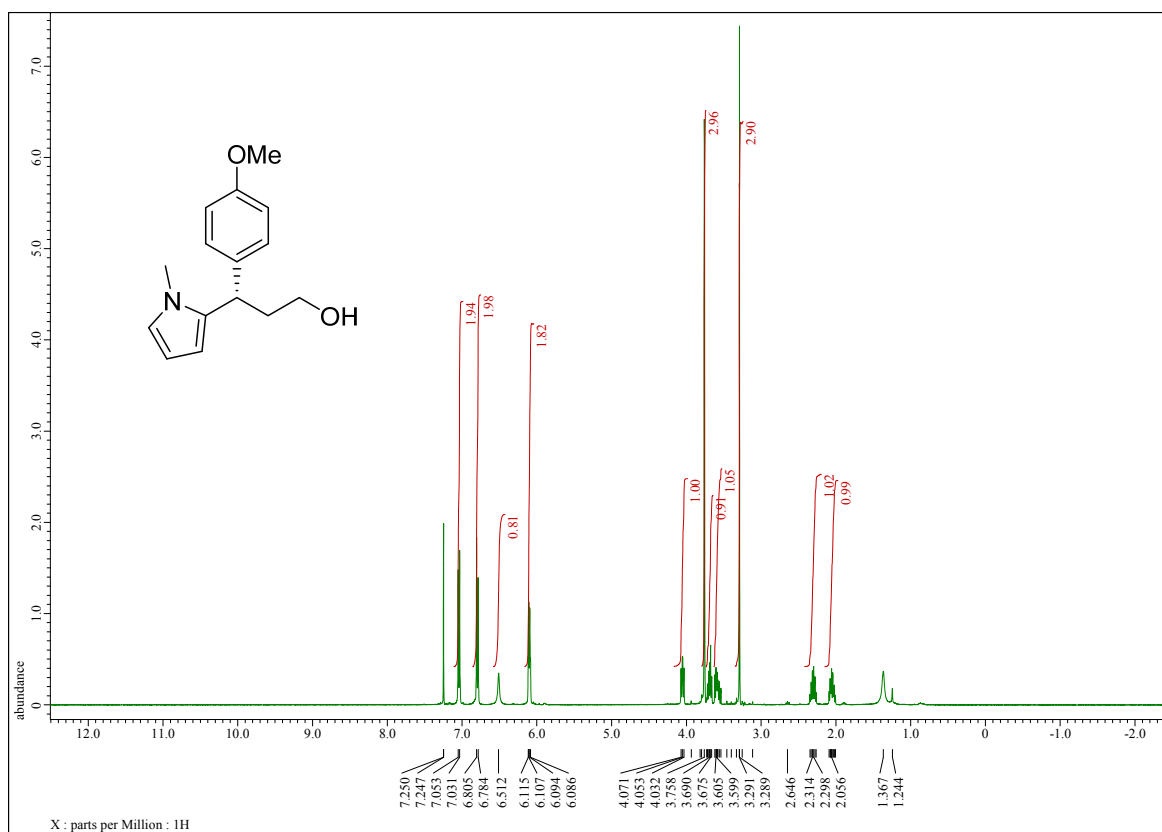
HPLC of Compound **7a**



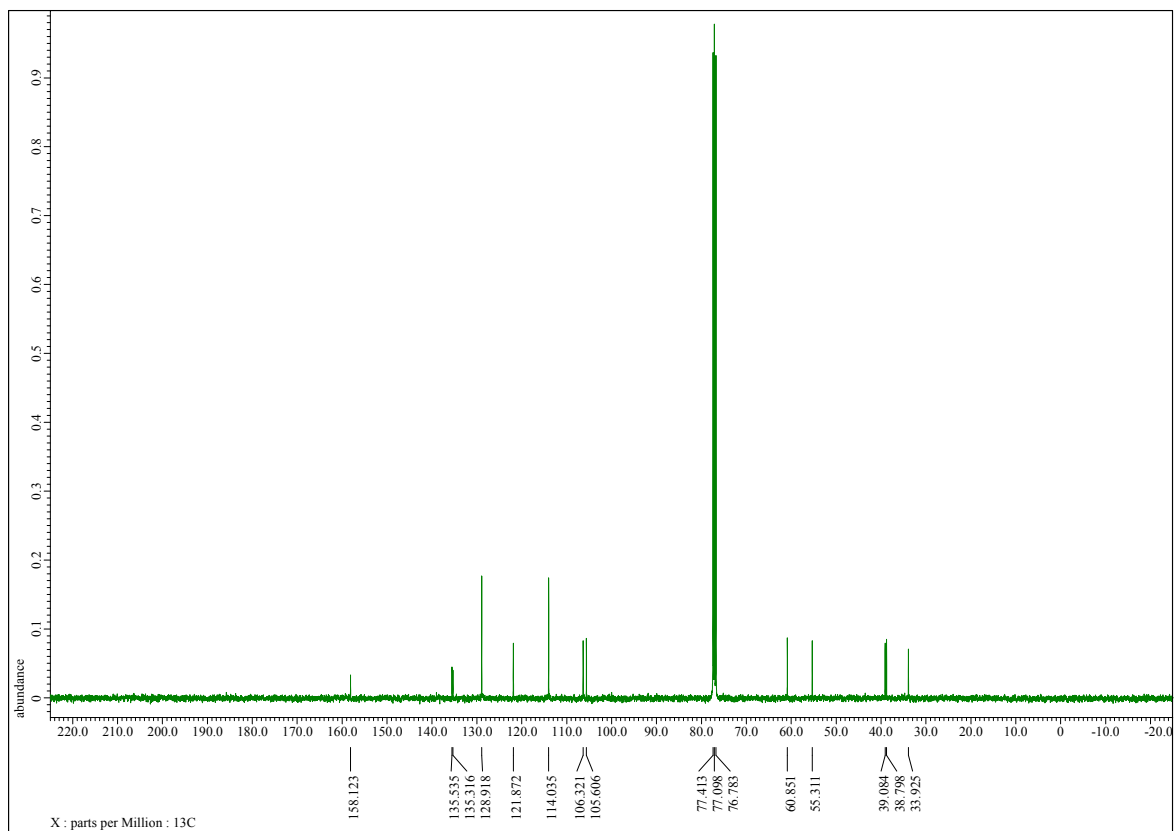
	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	9.044	814931	47.32	69513
2	10.444	907218	52.68	63894



	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	8.983	517478	6.67	36172
2	10.330	7240823	93.33	421829

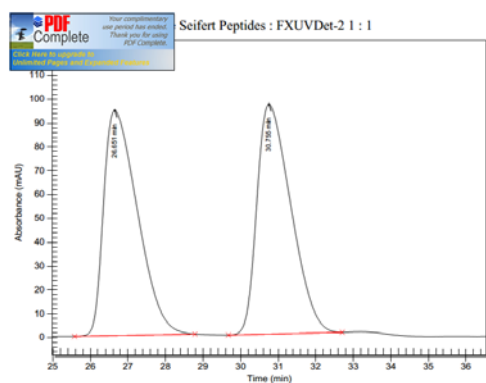


¹H NMR Spectrum of Compound 7b

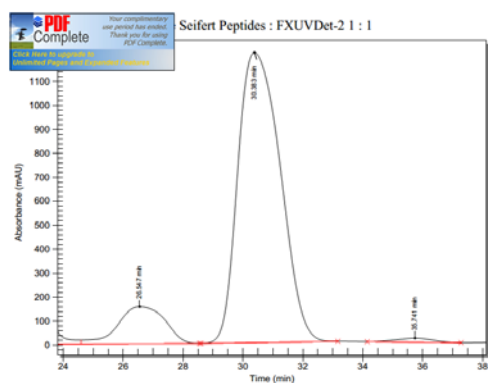


¹³C NMR Spectrum of Compound 7b

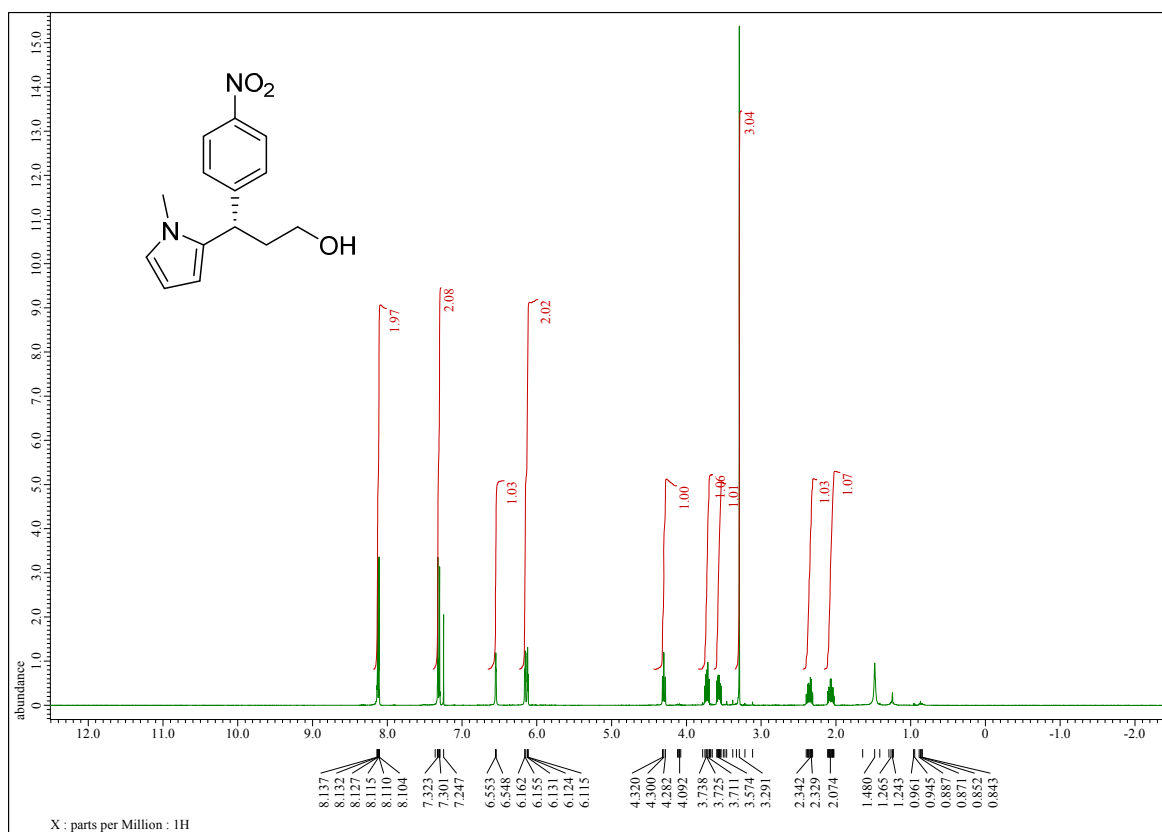
HPLC of Compound 7b



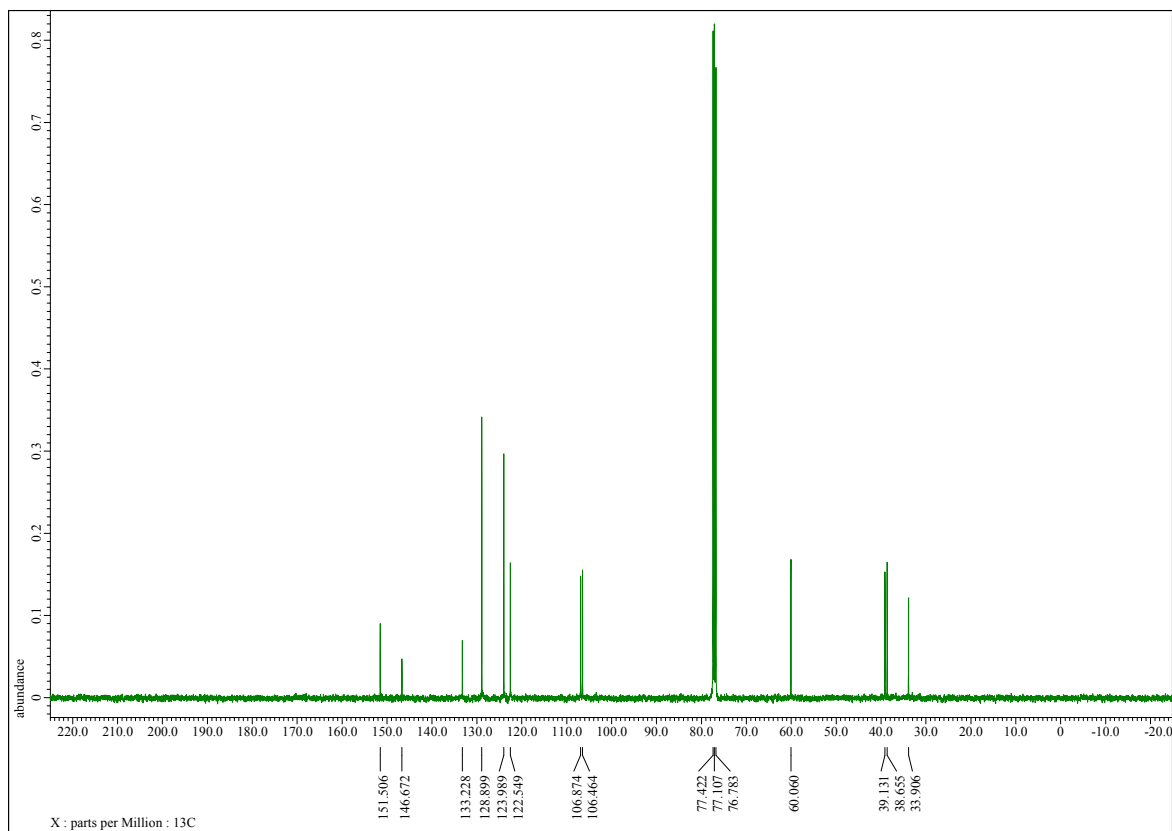
	Retention Time (min)	Area ($\mu V \cdot sec$)	% Area	Height (μV)
1	26.651	5899067	49.44	94374
2	30.755	6033887	50.56	96294



	Retention Time (min)	Area ($\mu V \cdot sec$)	% Area	Height (μV)
1	26.547	13519742	10.21	147396
2	30.383	118896933	89.79	1210602

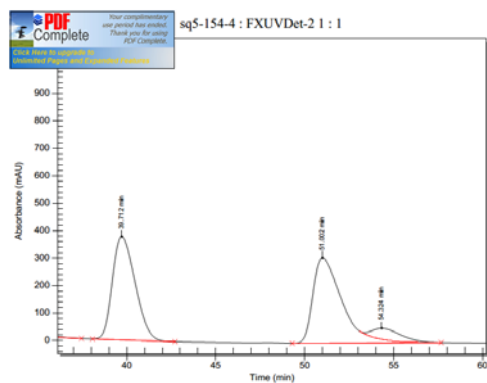


¹H NMR Spectrum of Compound 7c

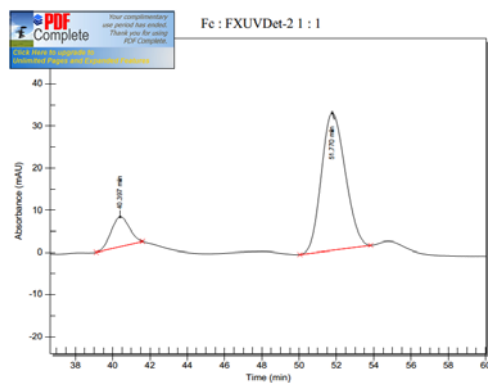


¹³C NMR Spectrum of Compound 7c

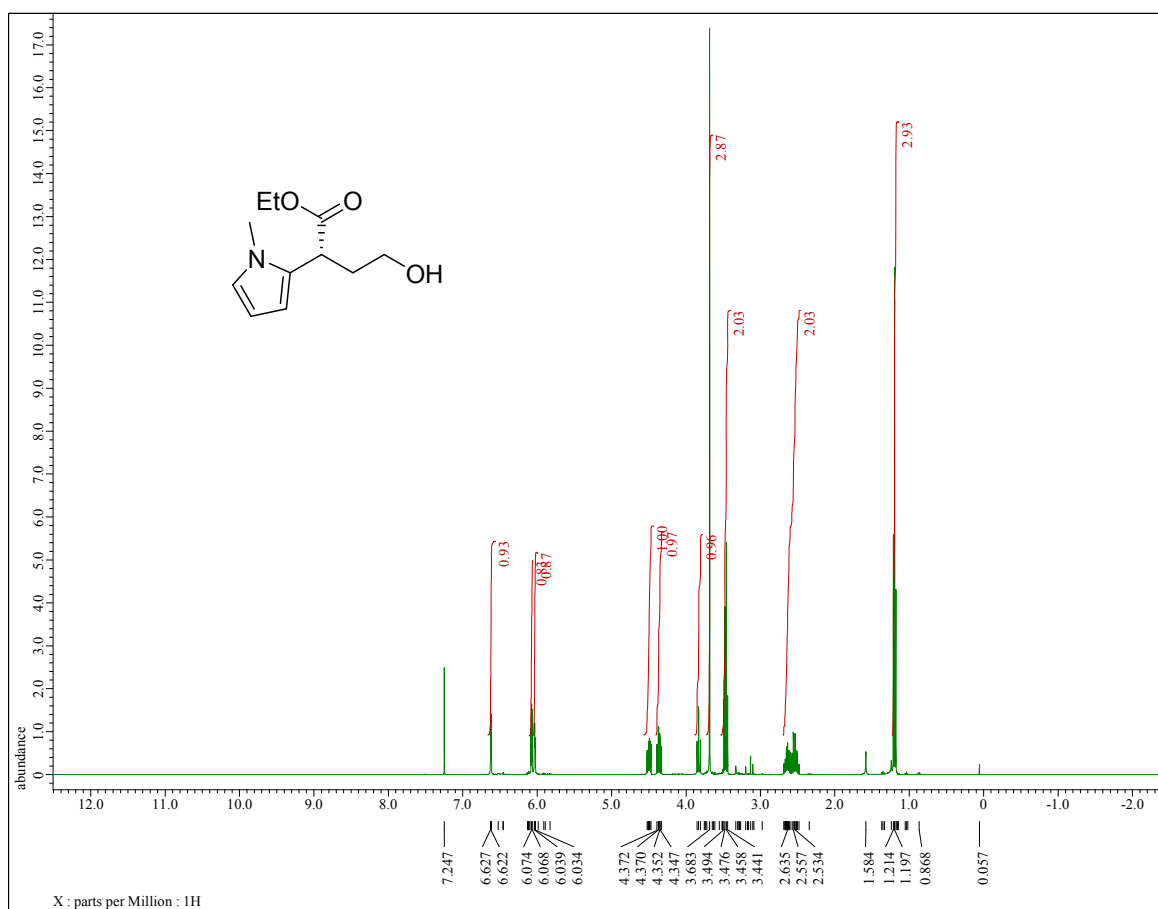
HPLC of compound 7c



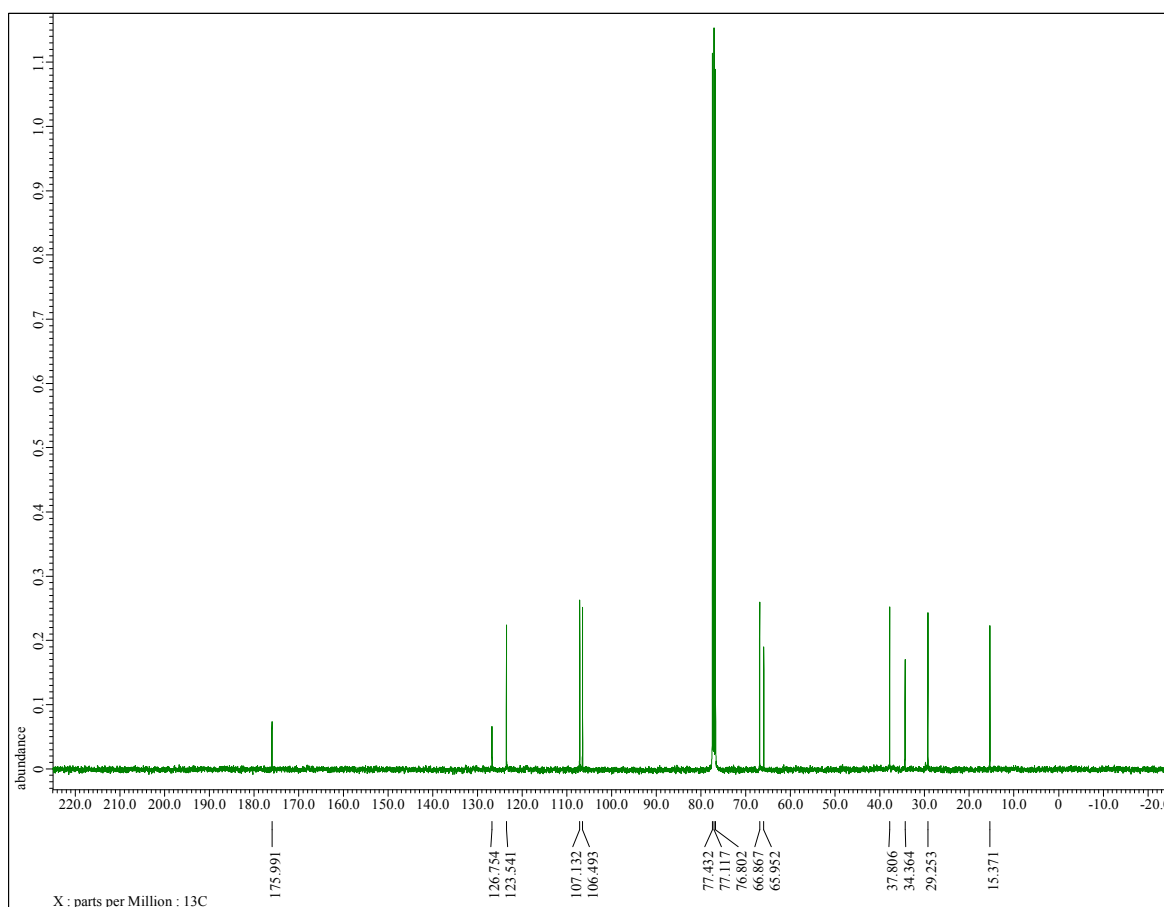
	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	39.712	33356634	53.53	376046
2	51.002	28959707	46.47	295907



	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	40.397	387430	11.79	7059
2	51.770	2898666	88.21	32642

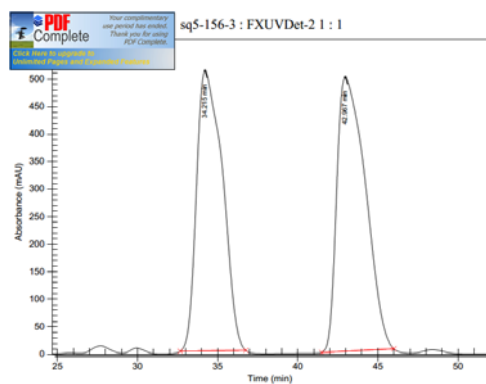


¹H NMR Spectrum of Compound 7d

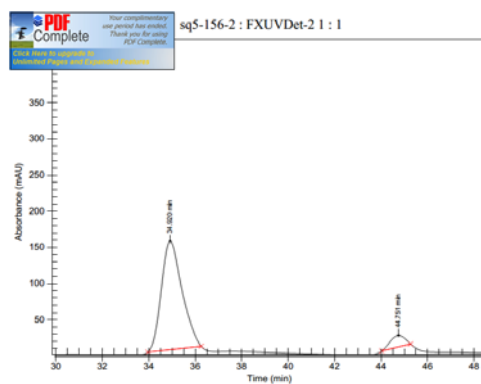


^{13}C NMR Spectrum of Compound **7d**

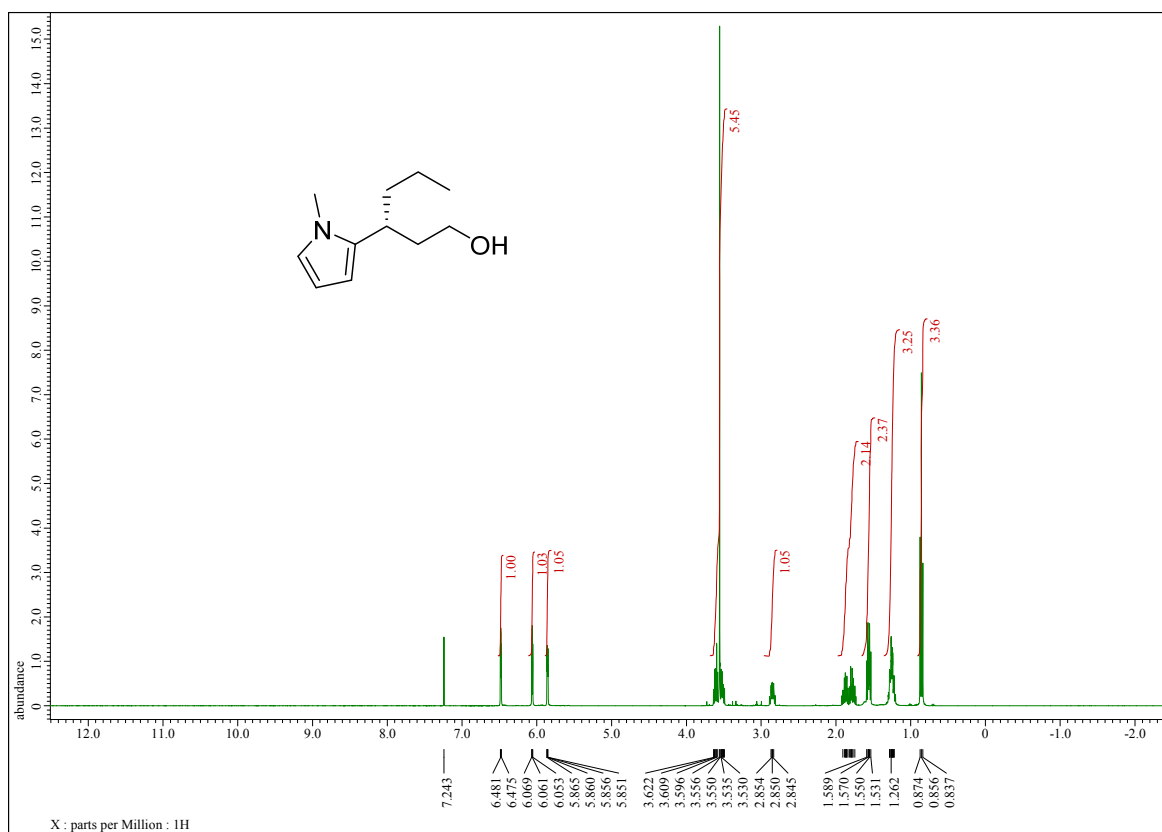
HPLC of Compound **7d**



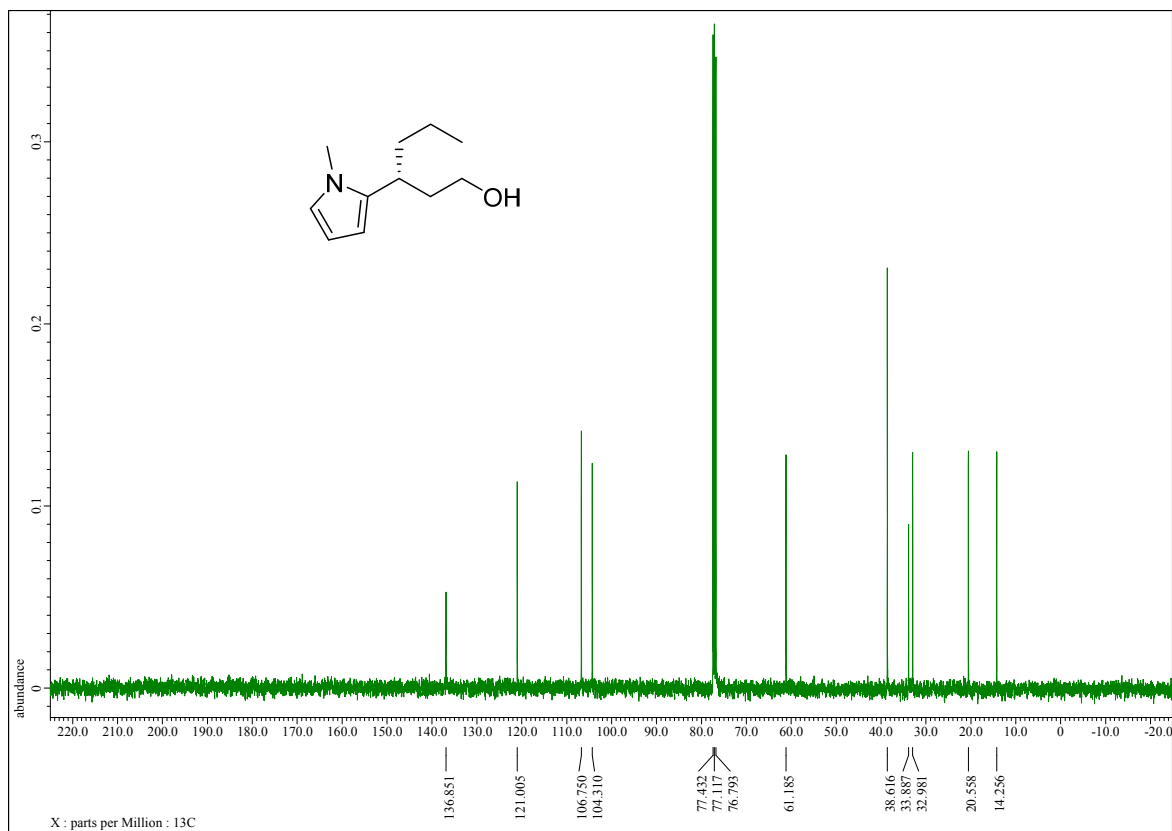
	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	34.215	57016582	48.12	508639
2	42.967	61468342	51.88	497813



	Retention Time (min)	Area ($\mu\text{V}\cdot\text{sec}$)	% Area	Height (μV)
1	34.920	9230975	92.97	150161
2	44.751	698319	7.03	15965

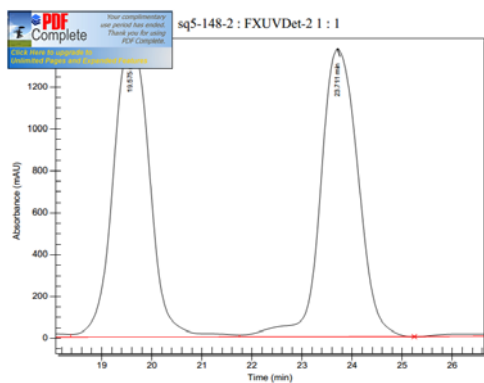


¹H NMR Spectrum of Compound 7e

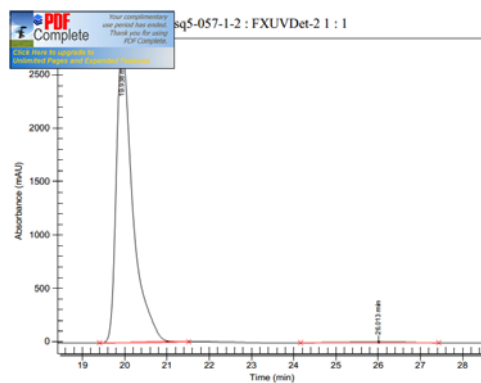


¹³C NMR Spectrum of Compound 7e

HPLC of Compound 7e



	Retention Time (min)	Area (μV*sec)	% Area	Height (μV)
1	19.575	68182017	49.05	1380964
2	23.711	70809815	50.95	1368051



	Retention Time (min)	Area (μV*sec)	% Area	Height (μV)
1	19.938	74711712	100.00	2746225