

SUPPORTING INFORMATION

Organocatalytic asymmetric intramolecular aza-Henry reaction: Facile synthesis of *trans*-2,3-disubstituted tetrahydroquinolines

Rajendra Maity and Subhas Chandra Pan^{*}

Department of Chemistry, Indian Institute of Technology Guwahati, North Guwahati,

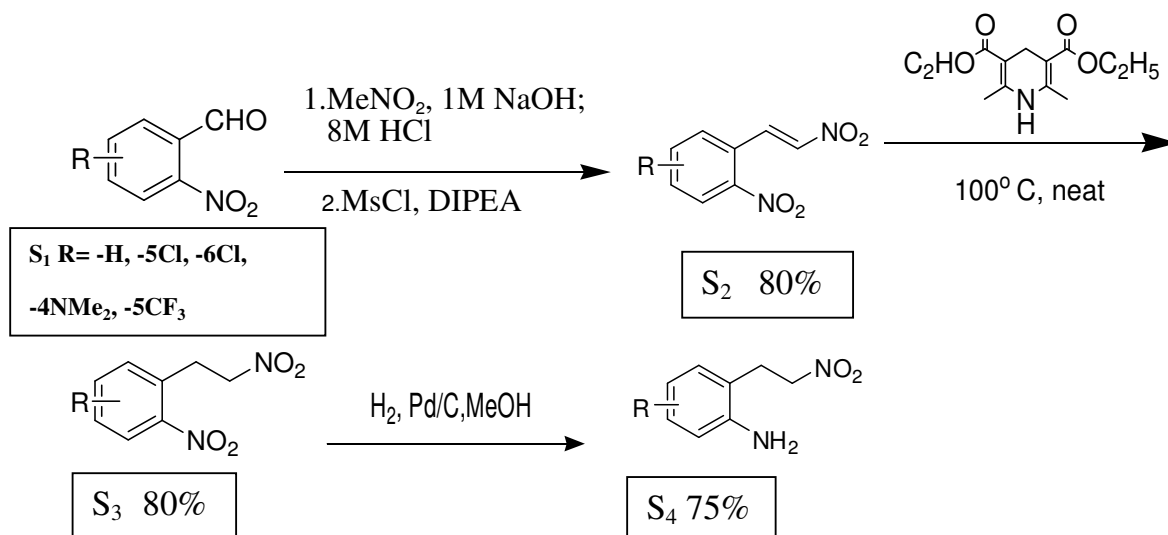
Assam, 781039

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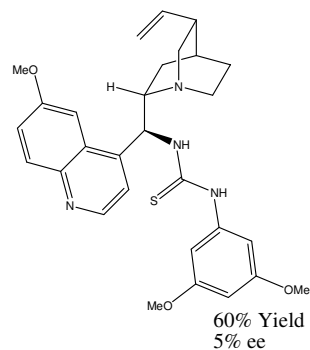
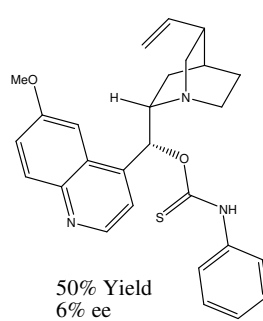
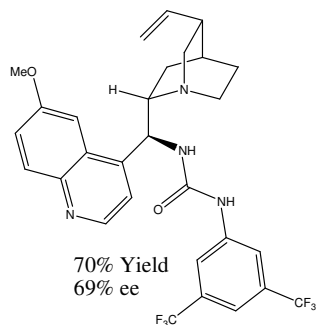
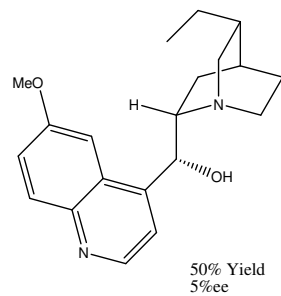
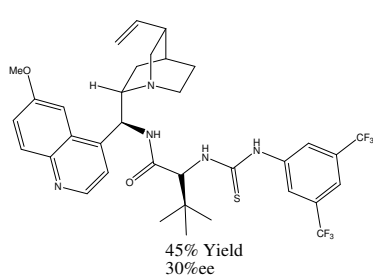
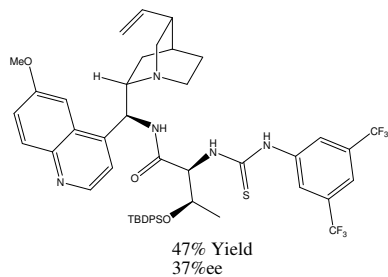
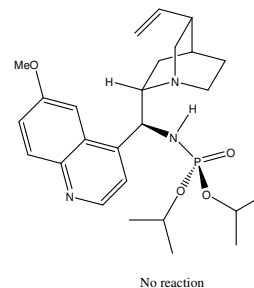
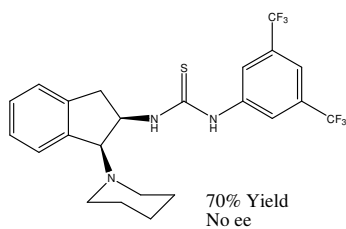
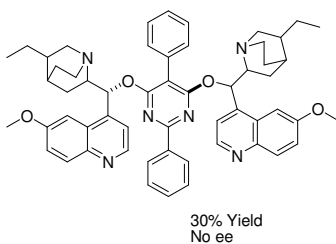
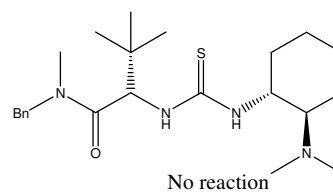
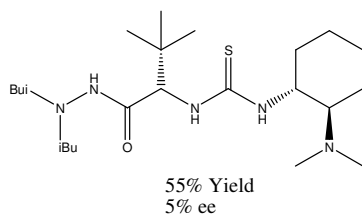
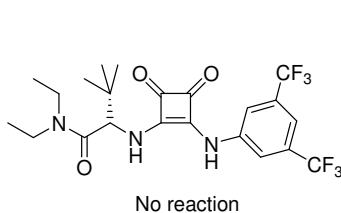
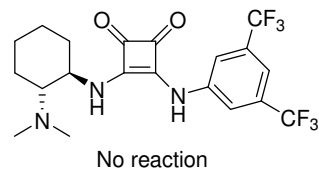
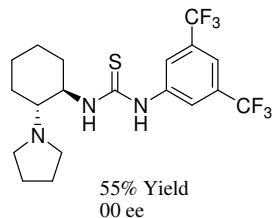
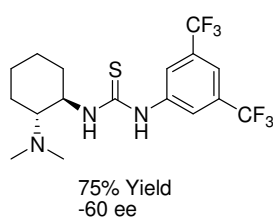
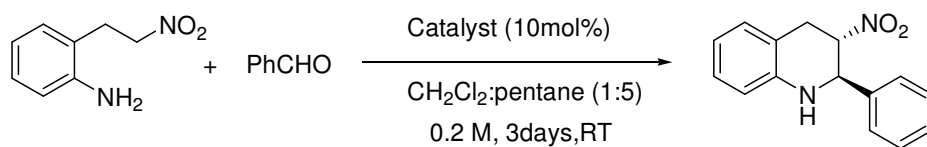
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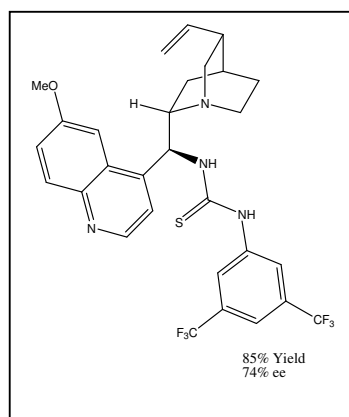
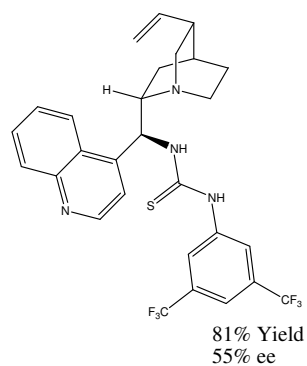
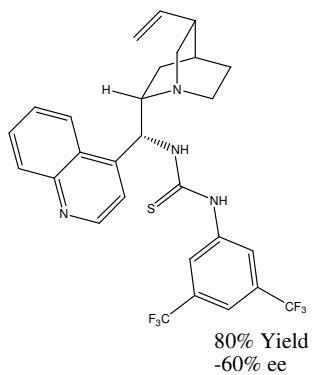
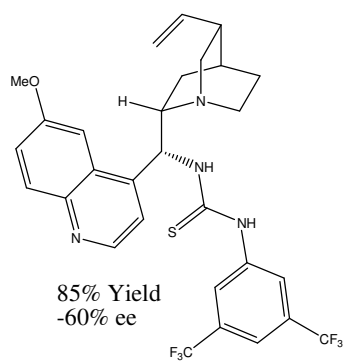
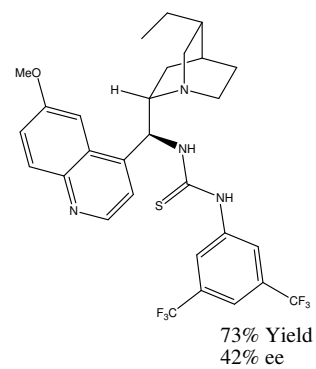
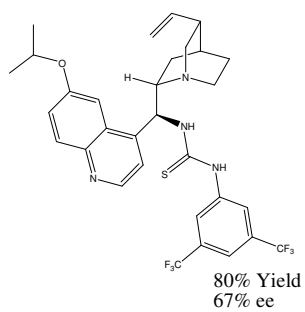
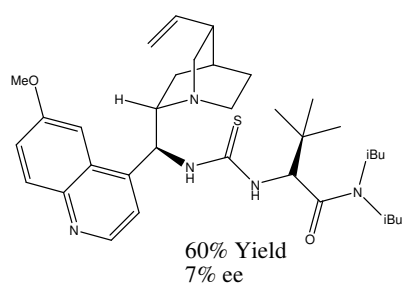
General procedure for the synthesis of nitro-amine:



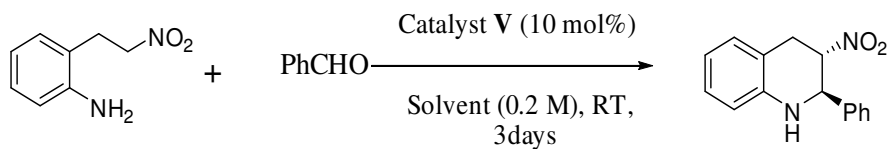
S₂, S₄ were prepared by previously reported procedure¹, S₃ was prepared by previously reported procedure².

Preliminary Catalyst screening:





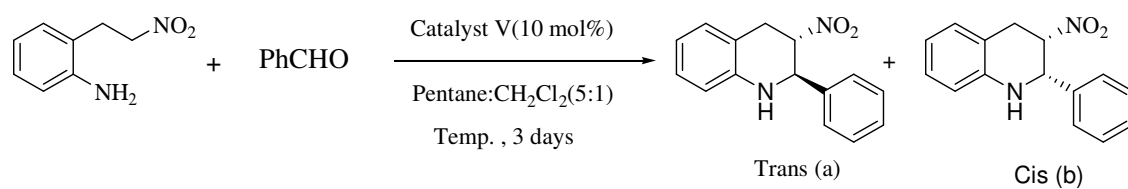
Preliminary solvent screening using catalyst (V):



No.	Solvent	Yield (%) ^a	ee ^b
1.	Ethanol	70	-
2.	Toluene	70	48
3.	CHCl ₃	75	66
4.	CH ₂ Cl ₂	78	58
5.	Benzene	80	67
6.	PhCF ₃	78	60
7.	Chlorobenzene	75	60
8.	Ether	80	70
9.	MTBE	70	70
10.	CCl ₄	80	57
11.	1 2 Dichloroethane	70	52
12.	Cyclohexane:CH ₂ Cl ₂ (5:1)	75	54
13.	n-Hexane:CH ₂ Cl ₂ (5:1)	80	72
14.	Pentane:CH ₂ Cl ₂ (5:1)	85	74
15.	Heptane:CH ₂ Cl ₂ (5:1)	78	69
16.	Hexane:CHCl ₃ (5:1)	75	50
17.	Benzene (MS 4 A ^o)	50	53
18.	Benzene:CHCl ₃ (5:1)	70	66

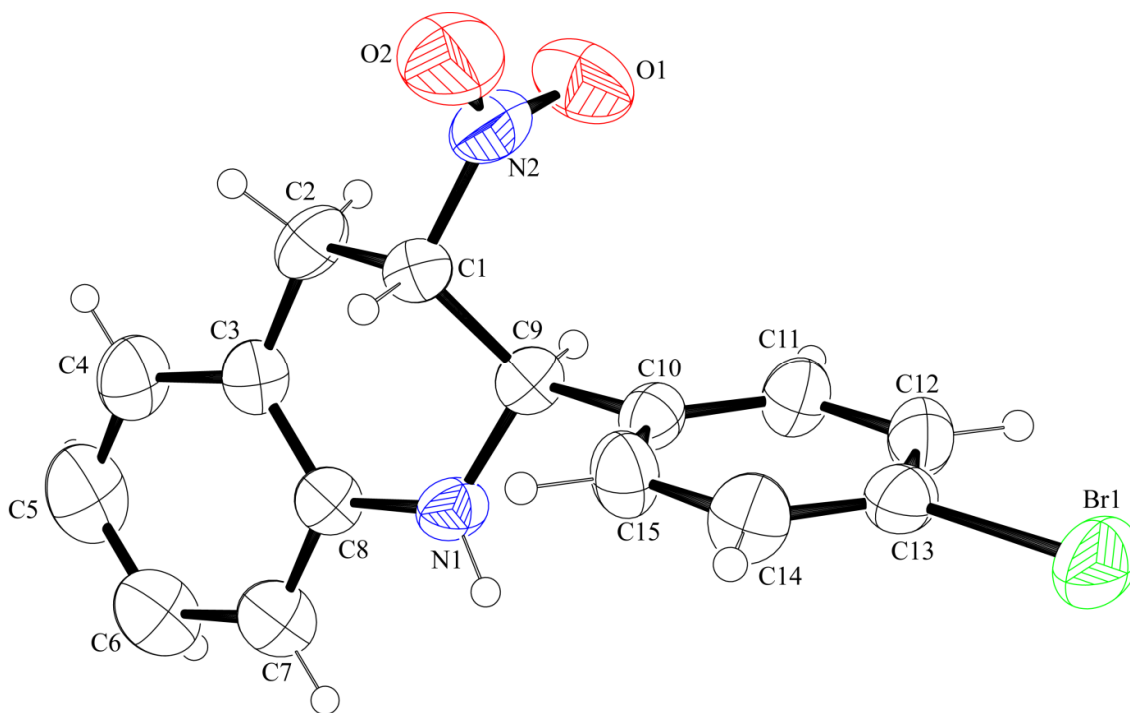
^aIsolated yield after silica gel column chromatography. ^bDetermined by HPLC using stationary phase chiral column.

Preliminary temperature screening using the catalyst V:



No	Temp.	Overall Yield	dr(a:b)	ee (a)
1	RT	85%	100:0	74%
2	0 °C	85%	1:1	80%
3	-20 °C	85%	1:1	80%

CRYSTAL DATA OF COMPOUND (CCDC 1048919) 3f:



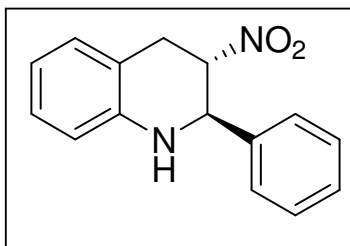
ORTEP STRUCTURE

Crystal data and structure refinement for CHIRAL COMPOUND 3f

Identification code	RM-NO2-4Br-CHIRAL
Empirical formula	C ₁₅ H ₁₃ BrN ₂ O ₂
Formula weight	333.18
Temperature/K	296(2)
Crystal system	orthorhombic
Space group	P2 ₁ 2 ₁ 2 ₁
a/Å	5.947(3)
b/Å	7.118(3)
c/Å	32.870(11)
α/°	90.00
β/°	90.00
γ/°	90.00
Volume/Å ³	1391.4(10)

Z	4
$\rho_{\text{calc}}/\text{mg}/\text{mm}^3$	1.591
m/mm^{-1}	2.957
F(000)	672.0
Crystal size/ mm^3	$0.32 \times 0.28 \times 0.20$
2Θ range for data collection	2.48 to 52.54°
Index ranges	$-7 \leq h \leq 7$, $-8 \leq k \leq 7$, $-36 \leq l \leq 40$
Reflections collected	13277
Independent reflections	2607[R(int) = 0.0576]
Data/restraints/parameters	2607/0/181
Goodness-of-fit on F^2	0.903
Final R indexes [$I \geq 2\sigma(I)$]	$R_1 = 0.0416$, $wR_2 = 0.1129$
Final R indexes [all data]	$R_1 = 0.0824$, $wR_2 = 0.1446$
Largest diff. peak/hole / $e \text{ \AA}^{-3}$	0.51/-0.51
Flack parameter	-0.011(19)

(2*R*, 3*S*)-1,2,3,4-tetrahydro-3-nitro-2-phenylquinoline (3a):

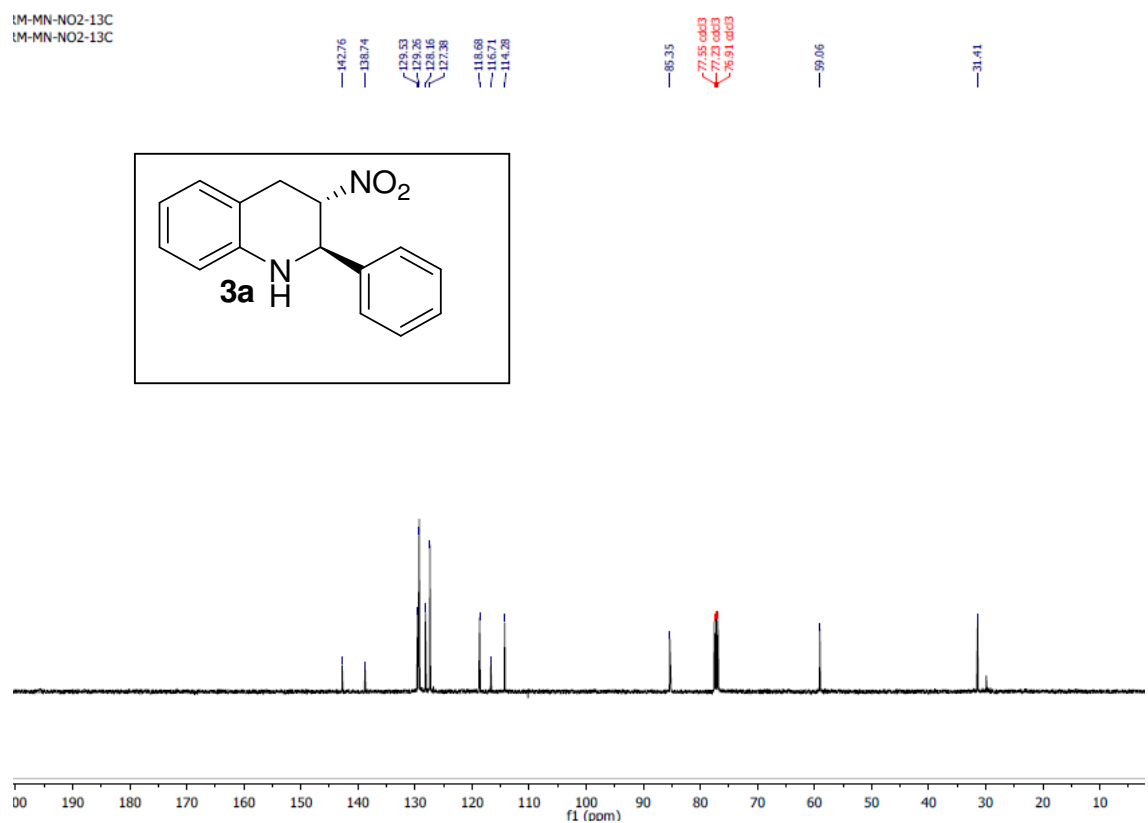
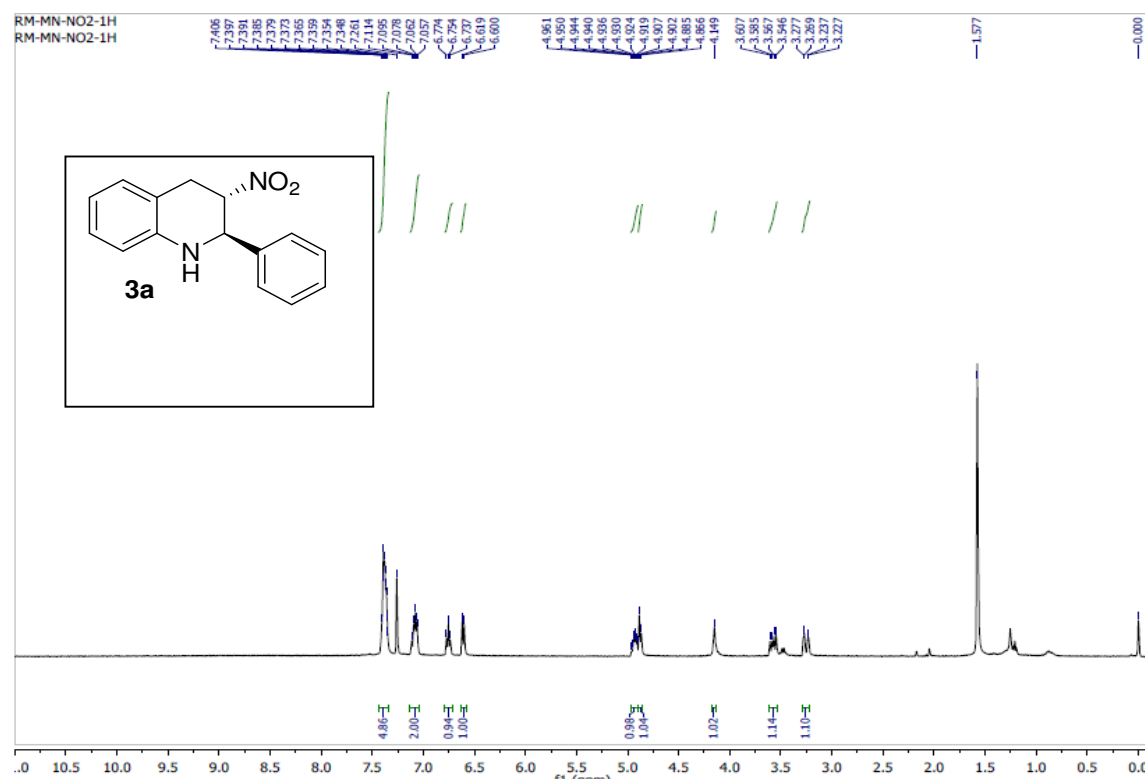


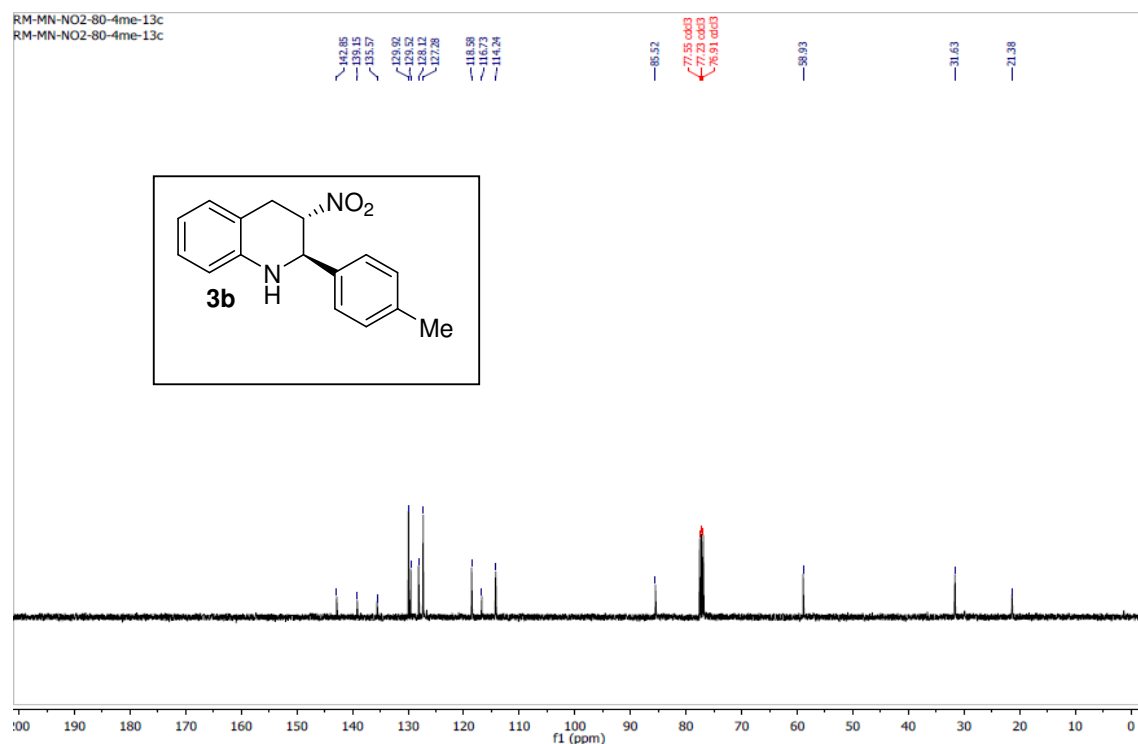
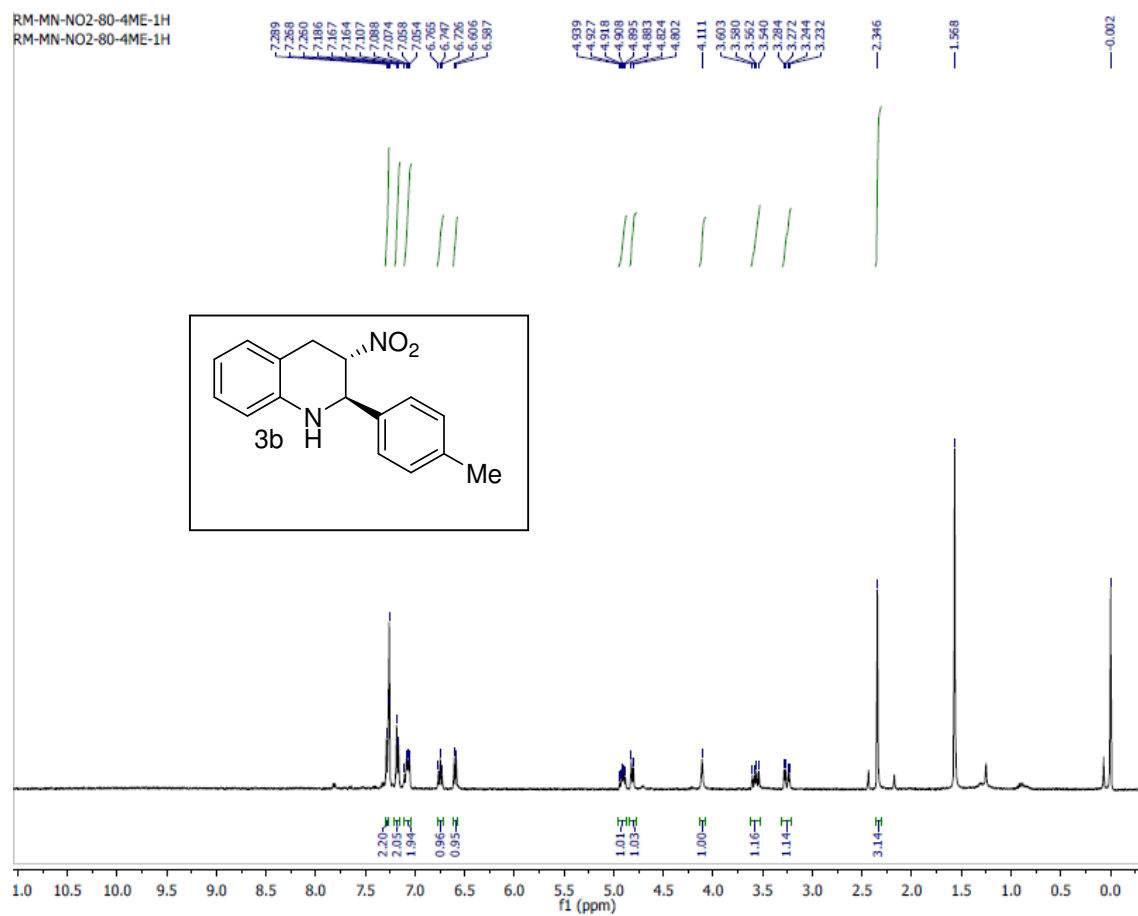
Absolute configuration: The optical rotation of **3a** was $[\alpha]_D^{23} = +42.0$ (c 0.17, CHCl₃). As, it was opposite to the reported compound³, the absolute configuration was determined to be (2*R*, 3*S*).

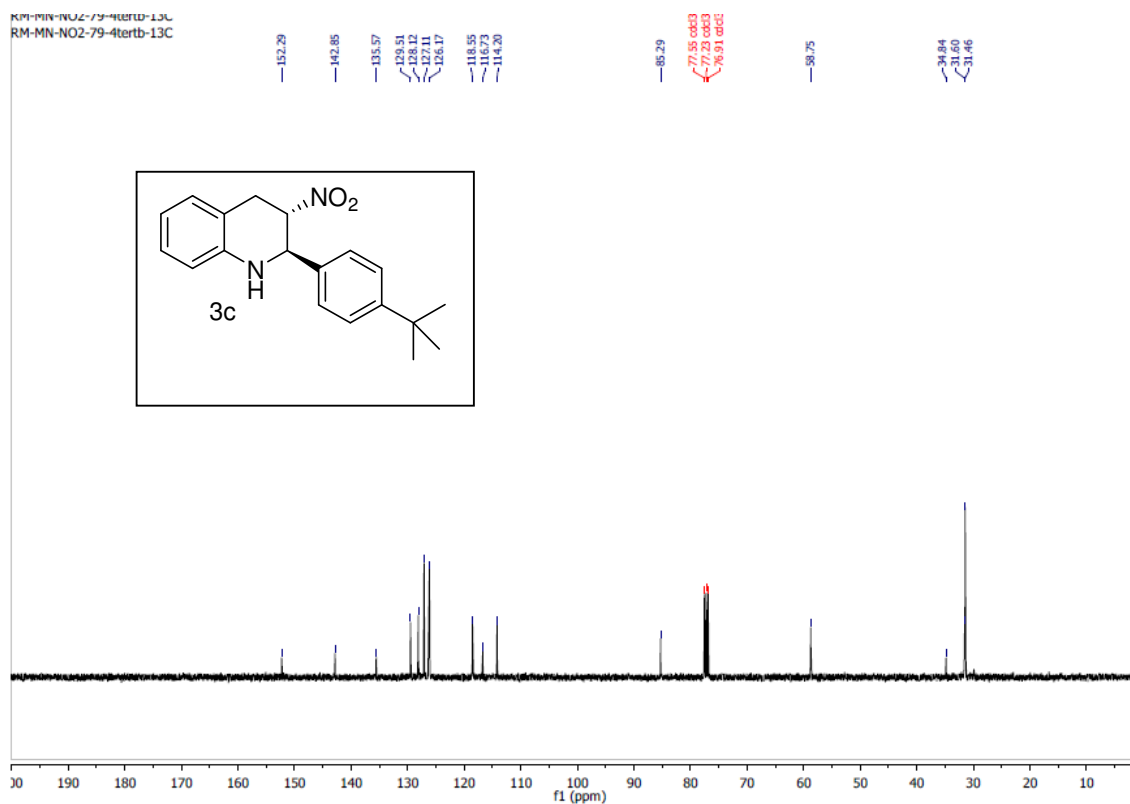
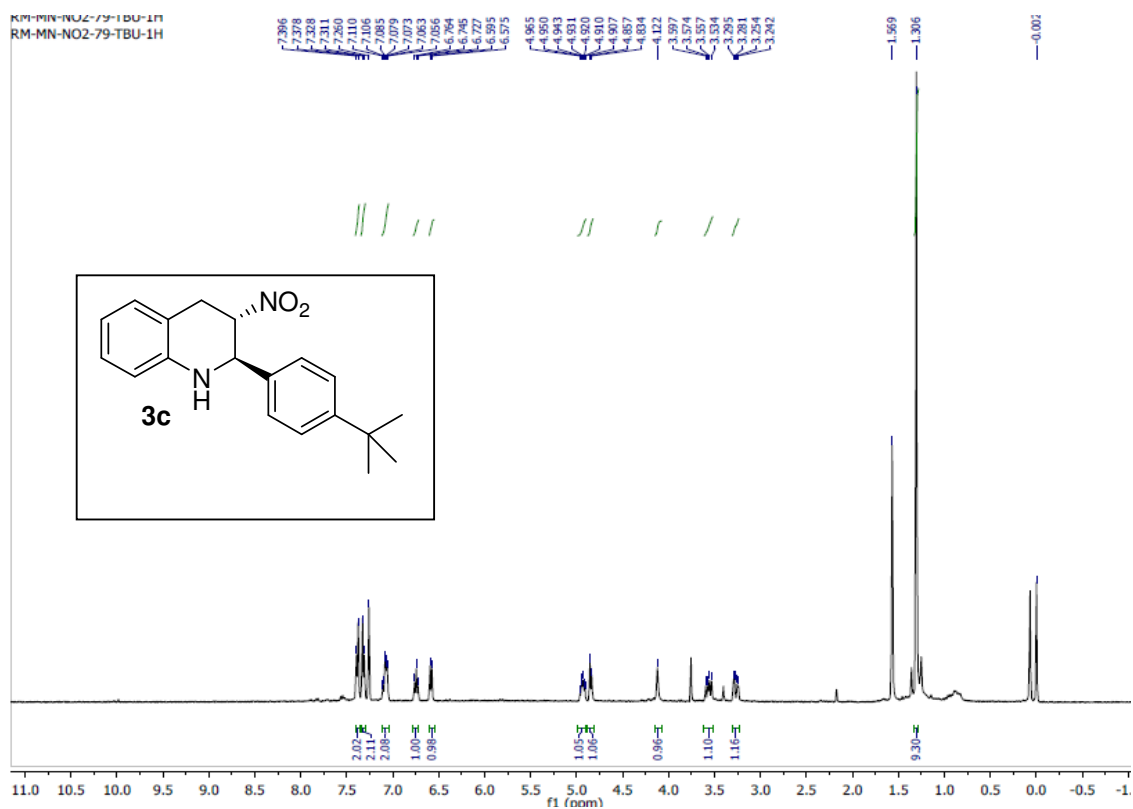
References:

1. J. C. Anderson, A. Noble, P. R. Torres, *Tetrahedron Lett.*, 2012, **53**, 5707.
2. P. Chauhan, K. Kaur, N. Bala, V. Kumar, S. S. Chimni, *Indian J. Chem., Sect B*, 2011, **50B**, 304.
3. X.-F. Cai, M.-W. Chen, Z.-S. Ye, R.-N. Guo, L. Shi, Y.-Q. Li, Y.-G. Zhou, *Chem. Asian J.*, 2013, **8**, 1381.

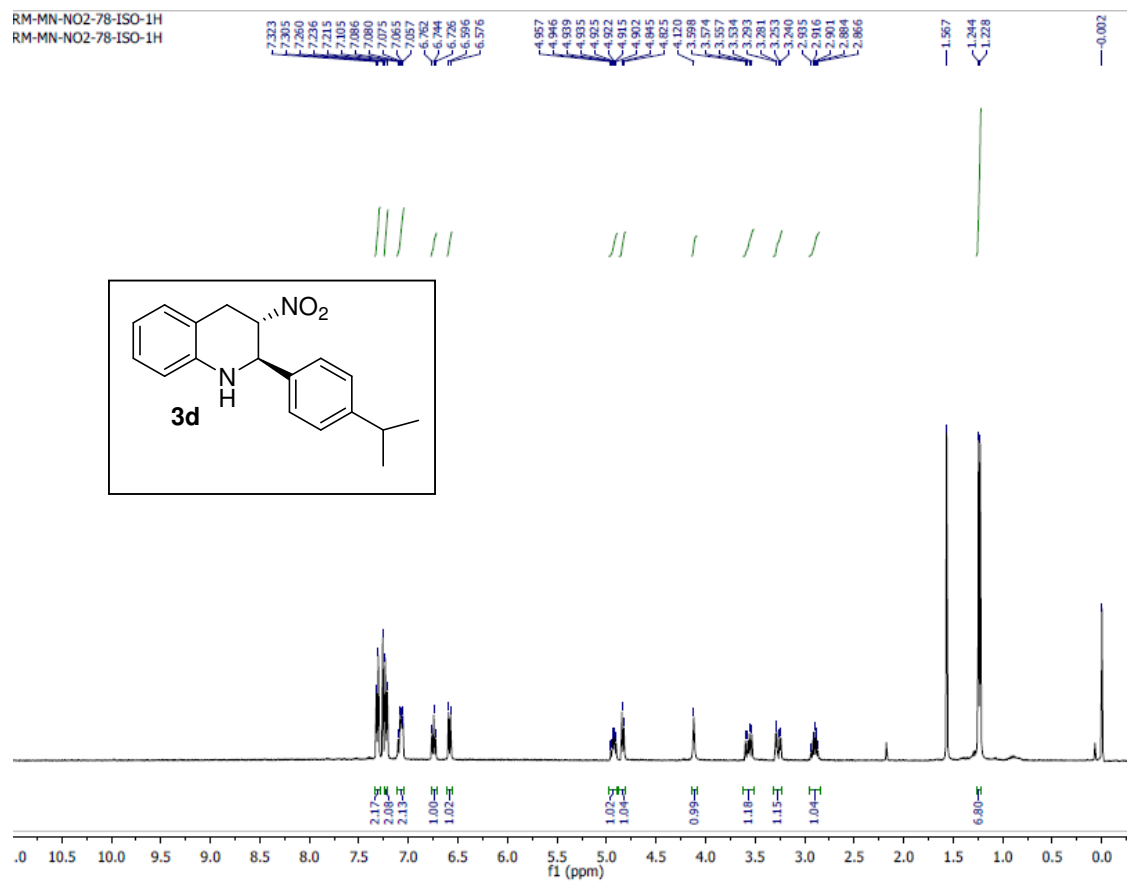
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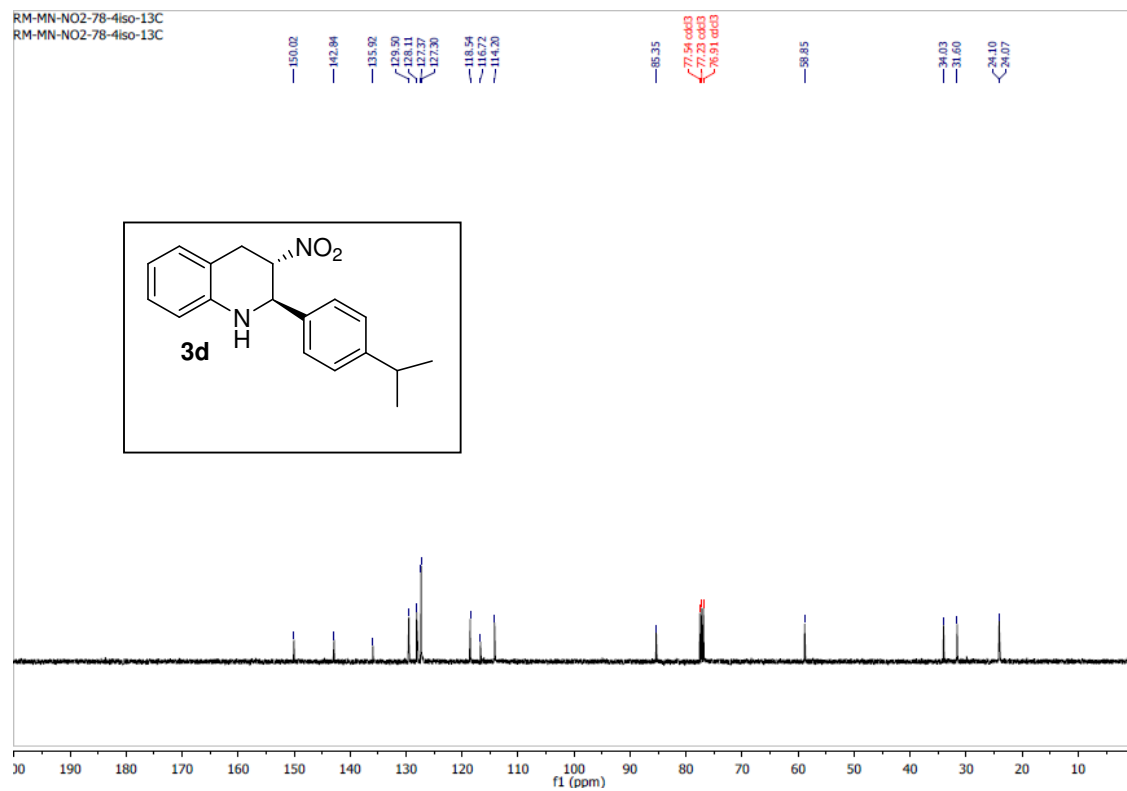


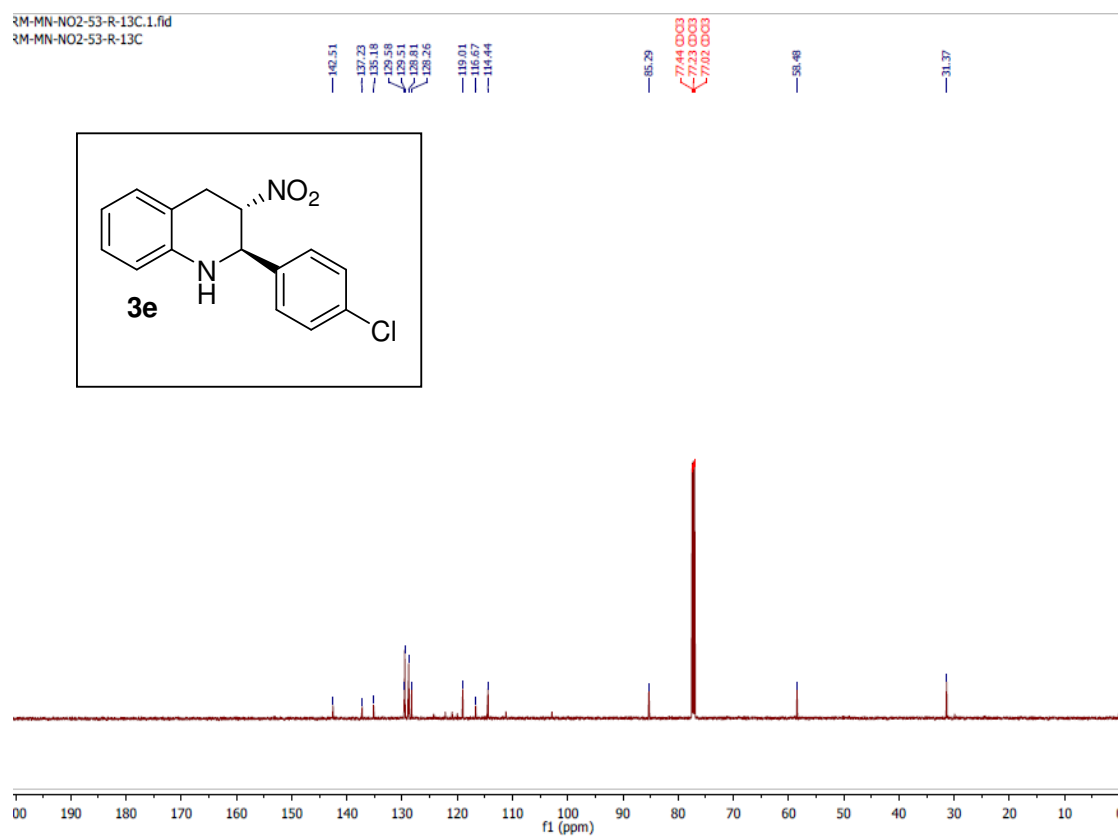
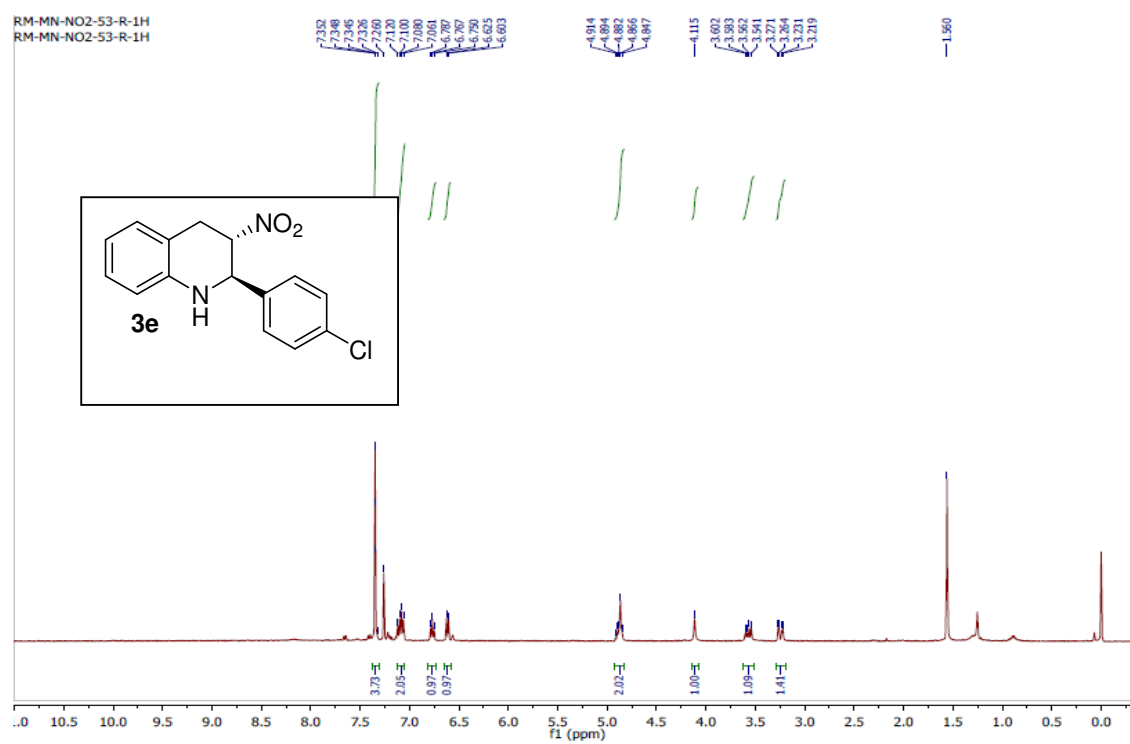


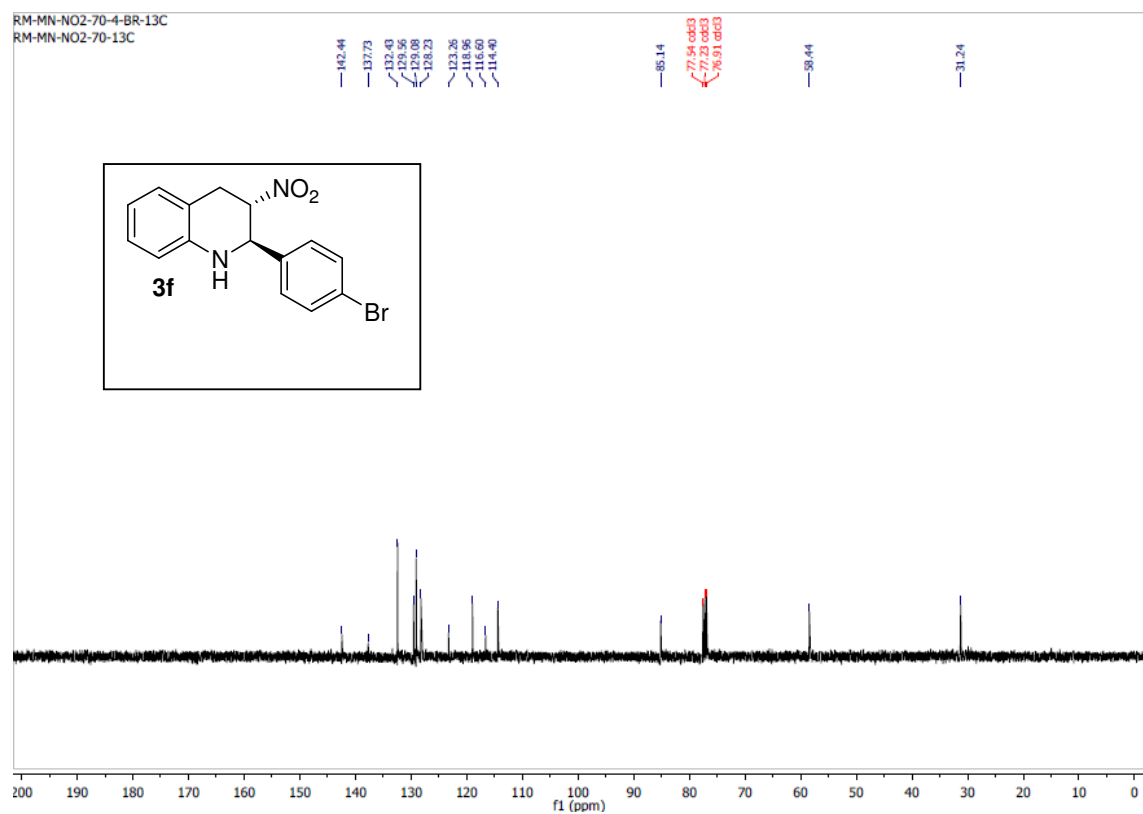
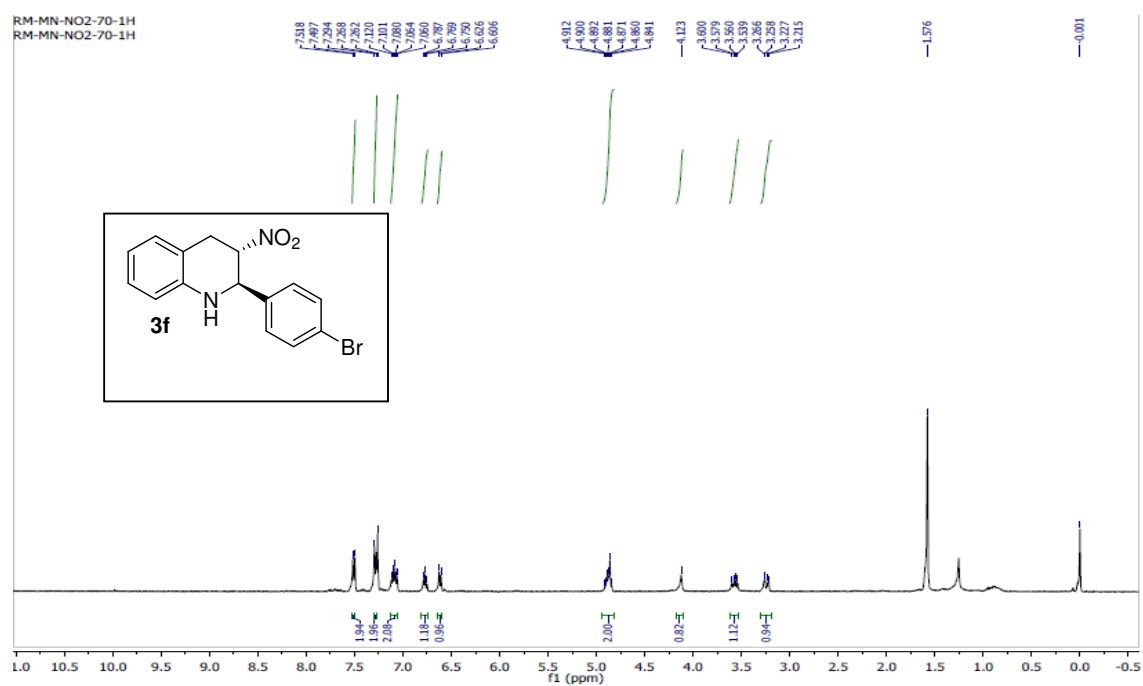
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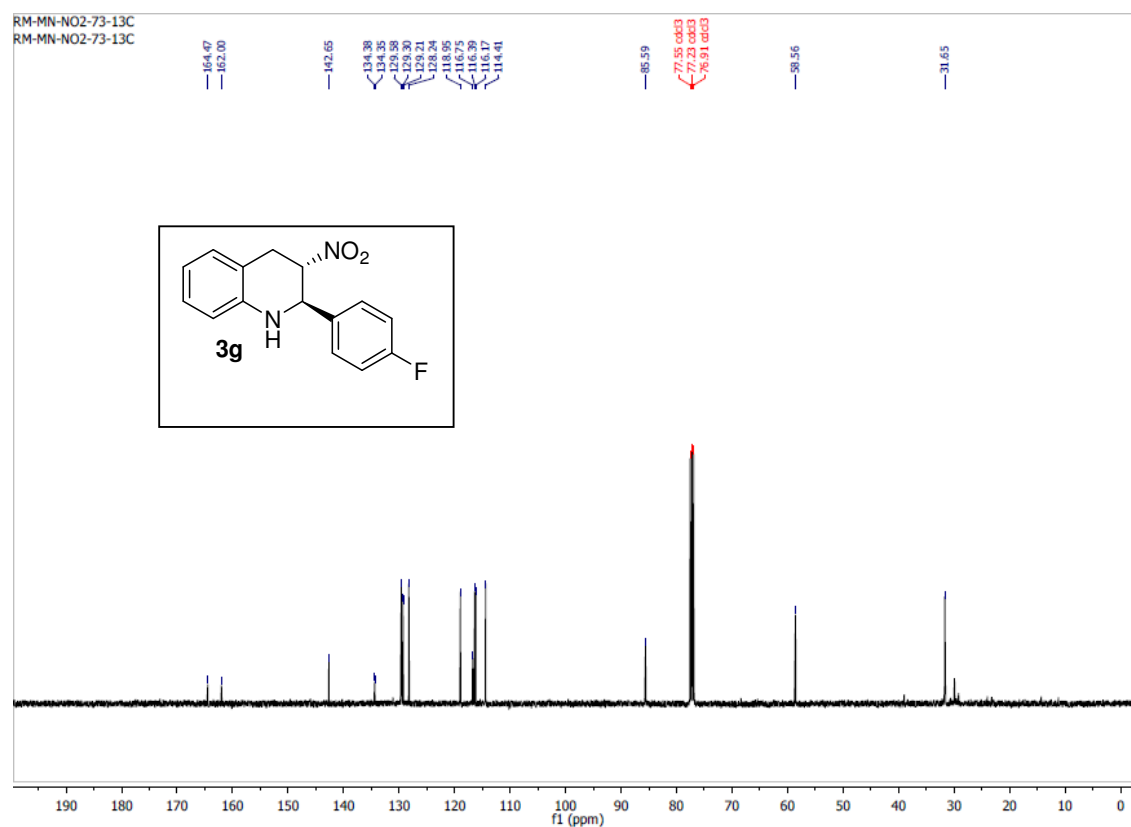
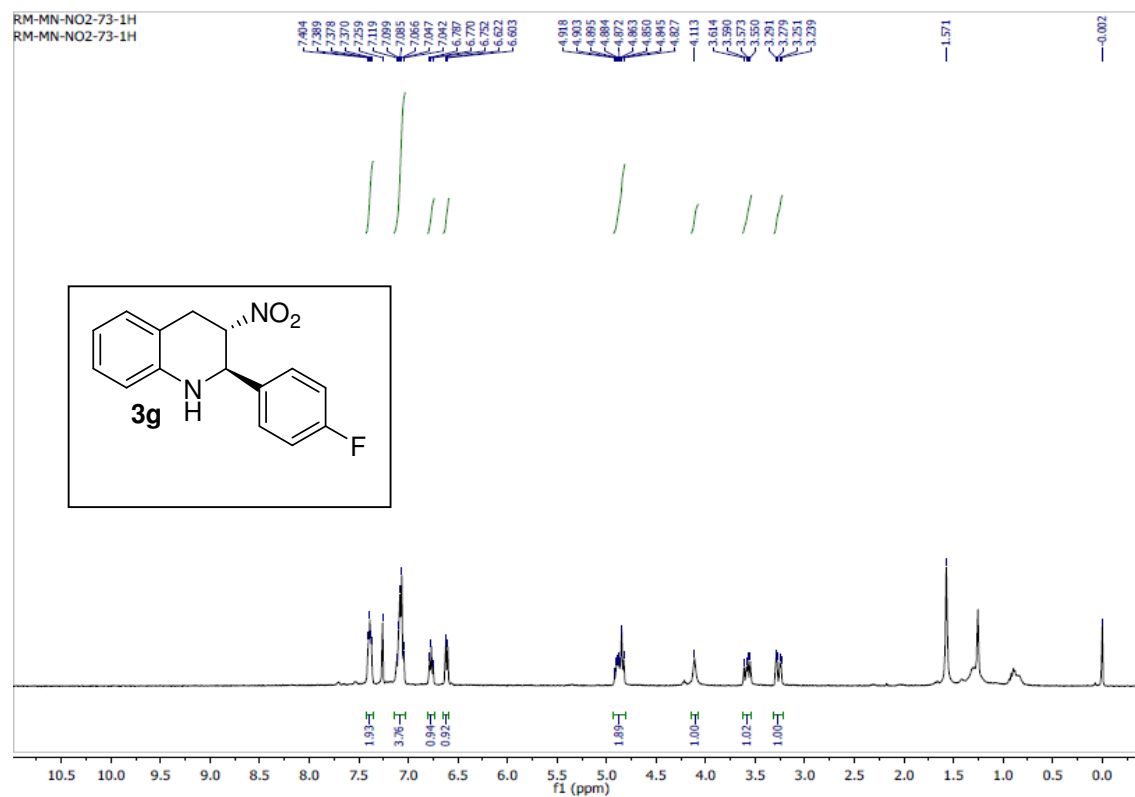


RM-MN-NO2-78-ISO-13C
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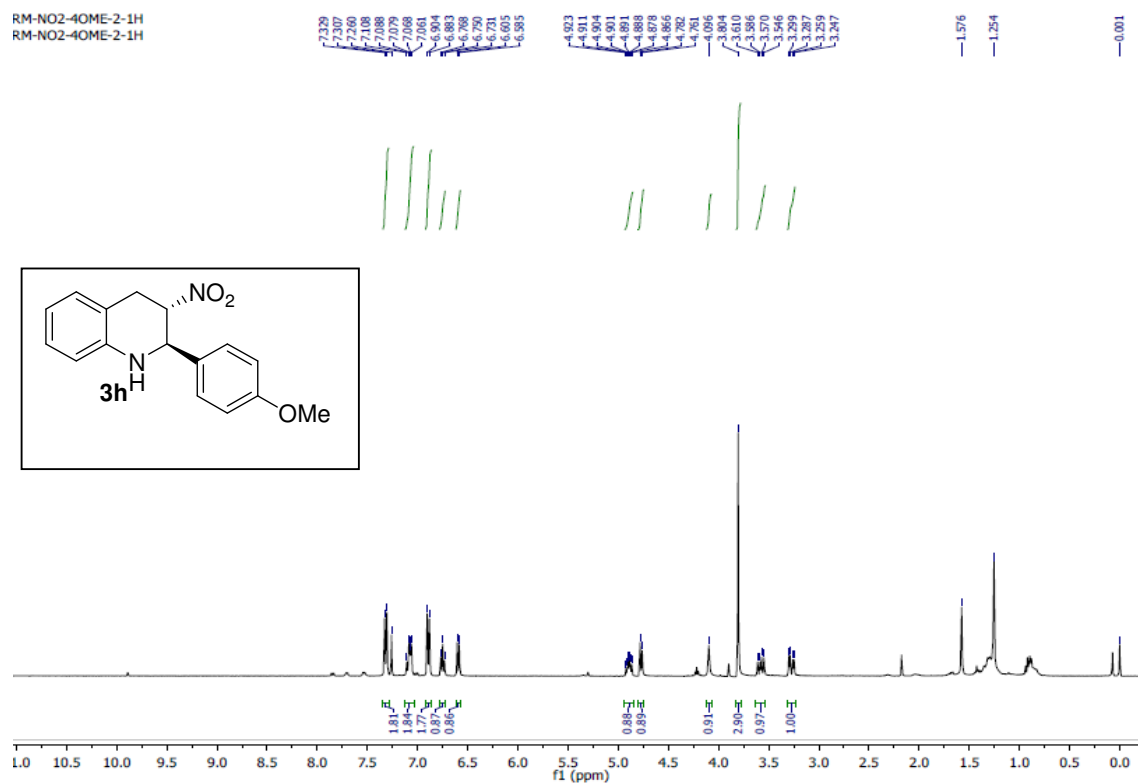




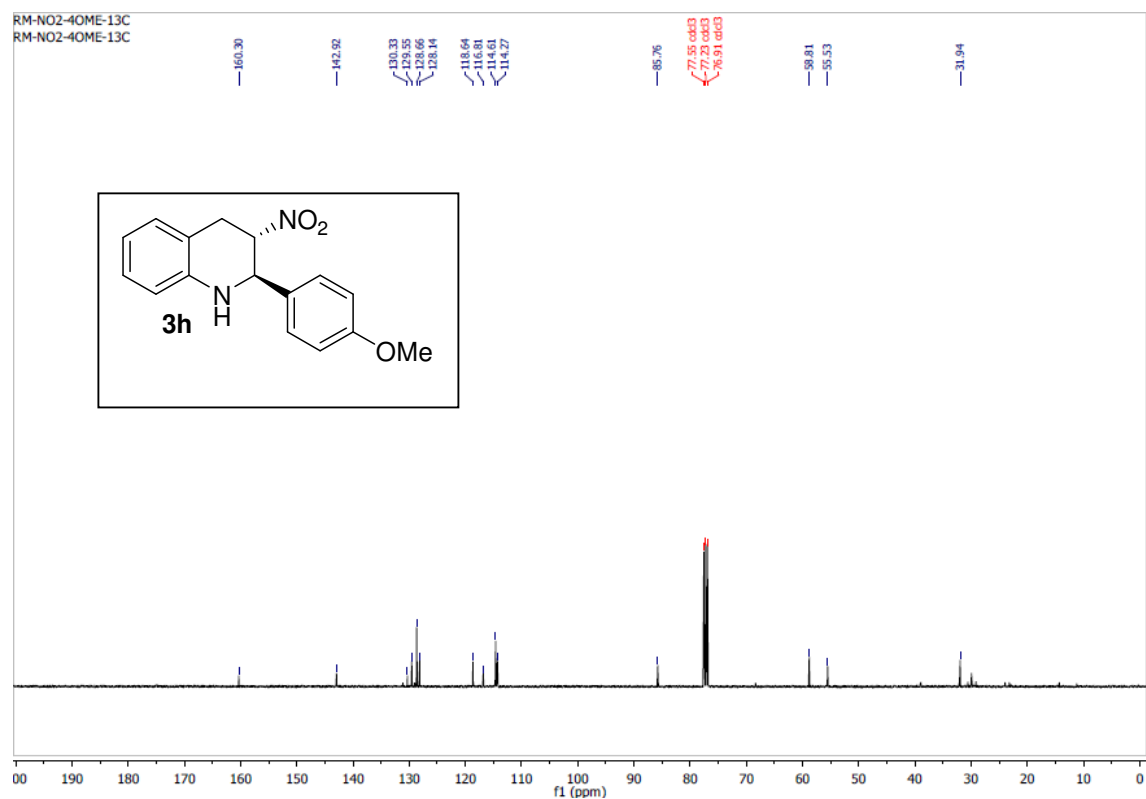


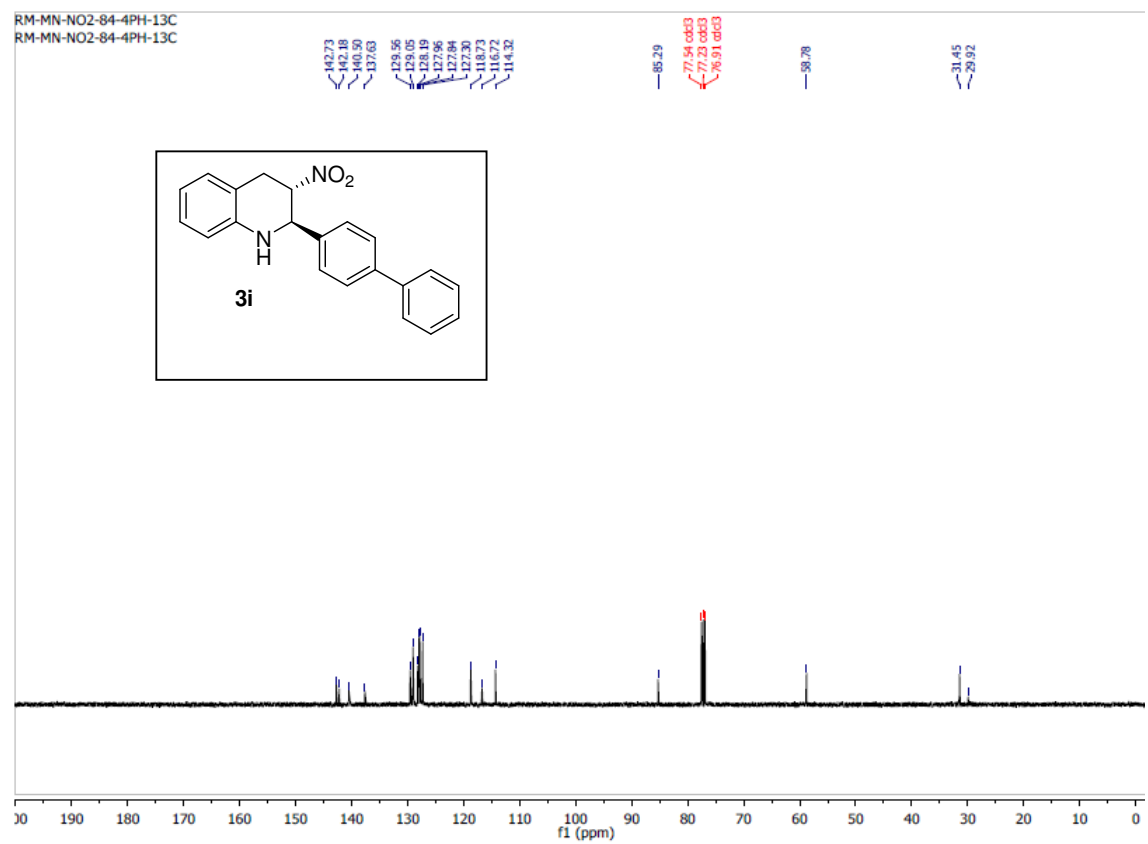
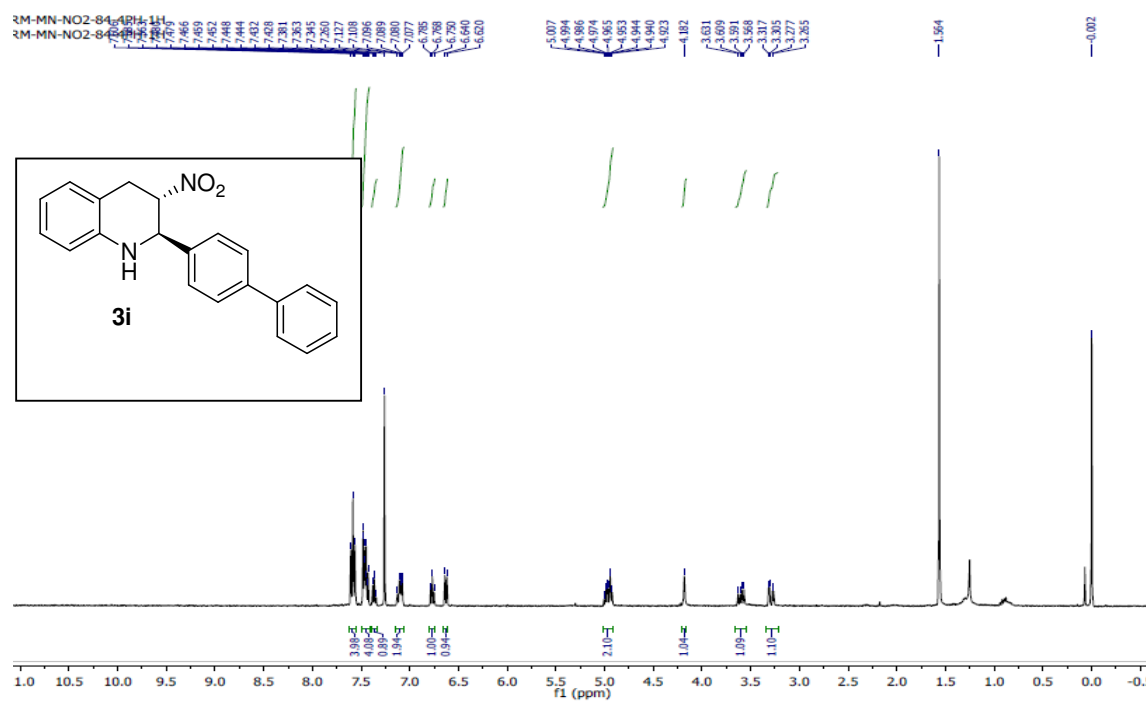


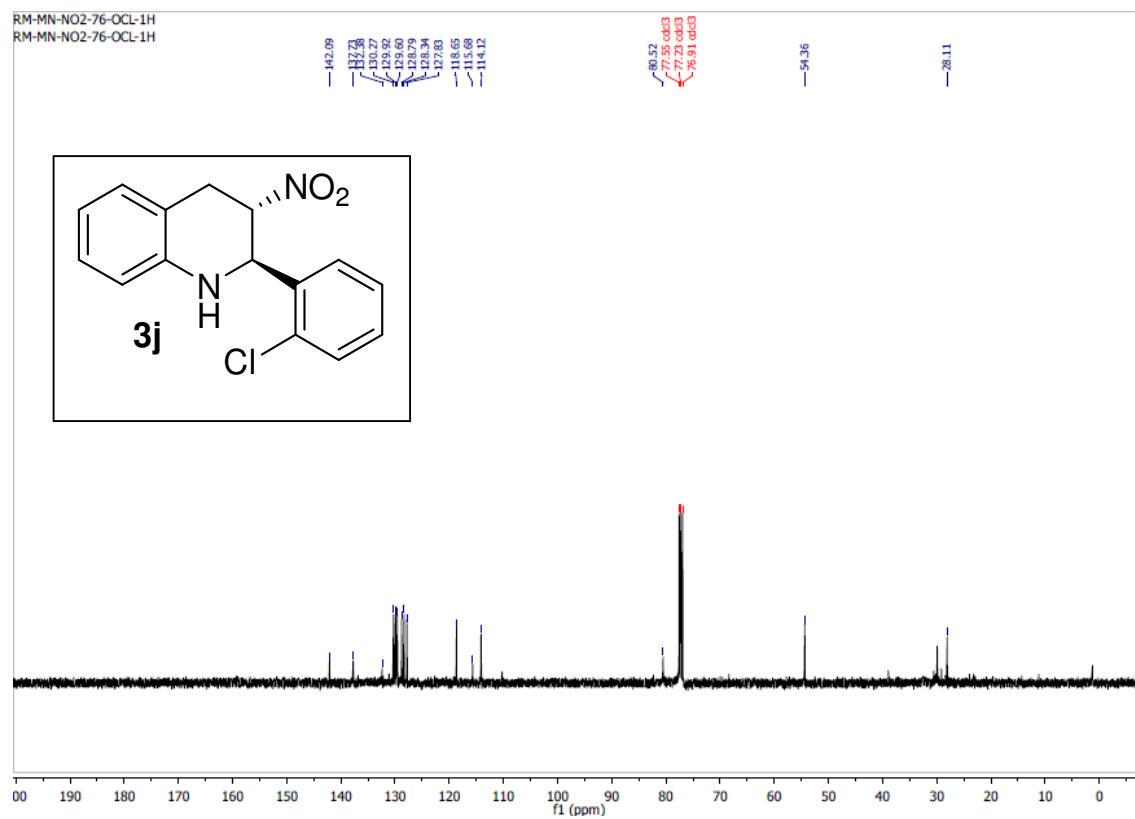
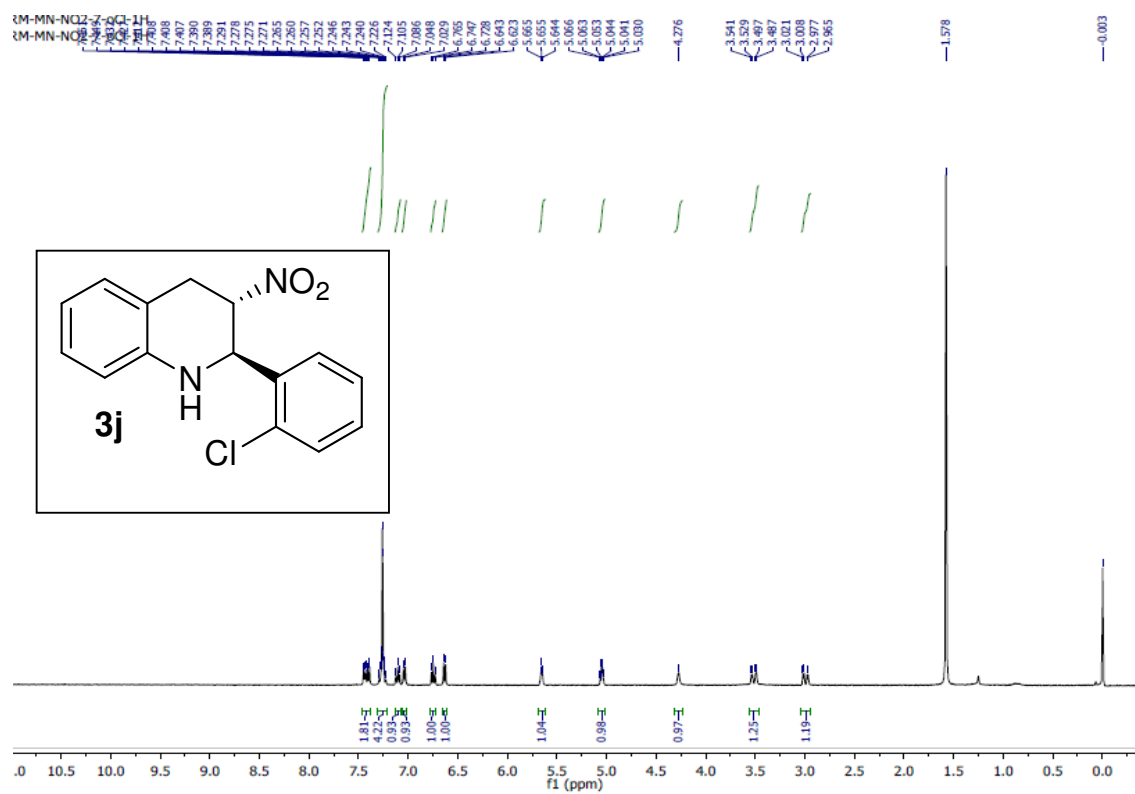
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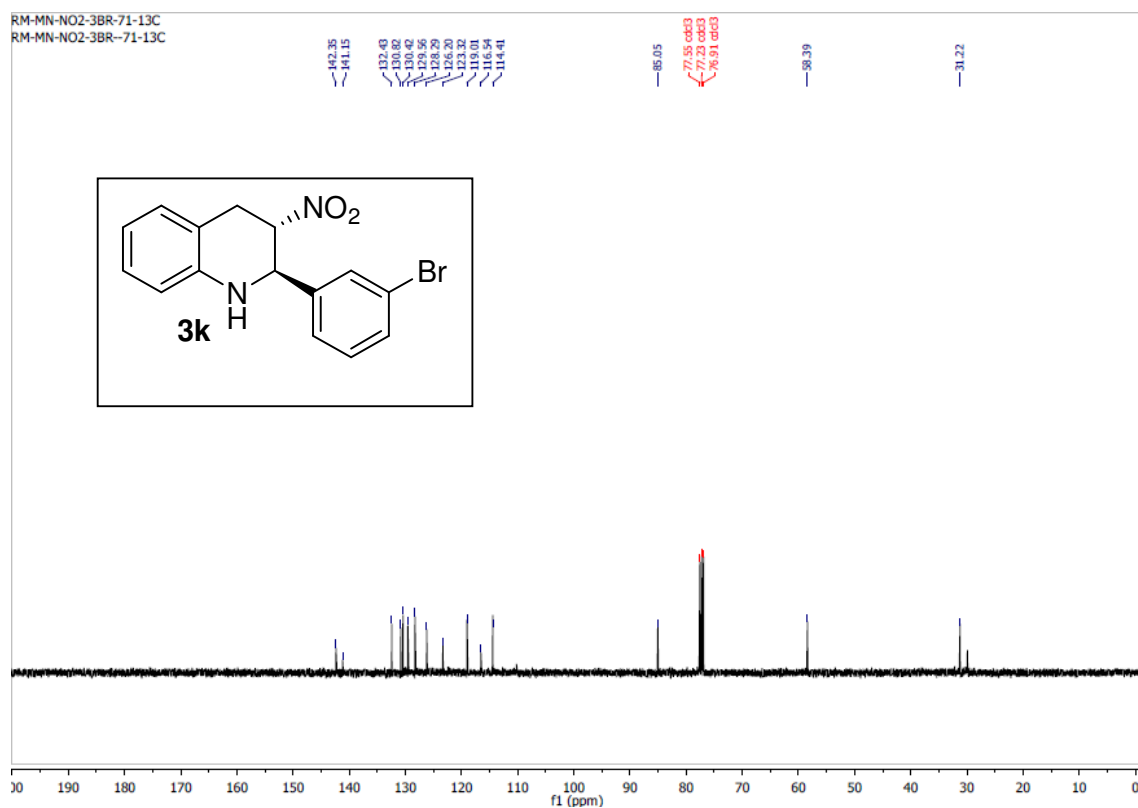
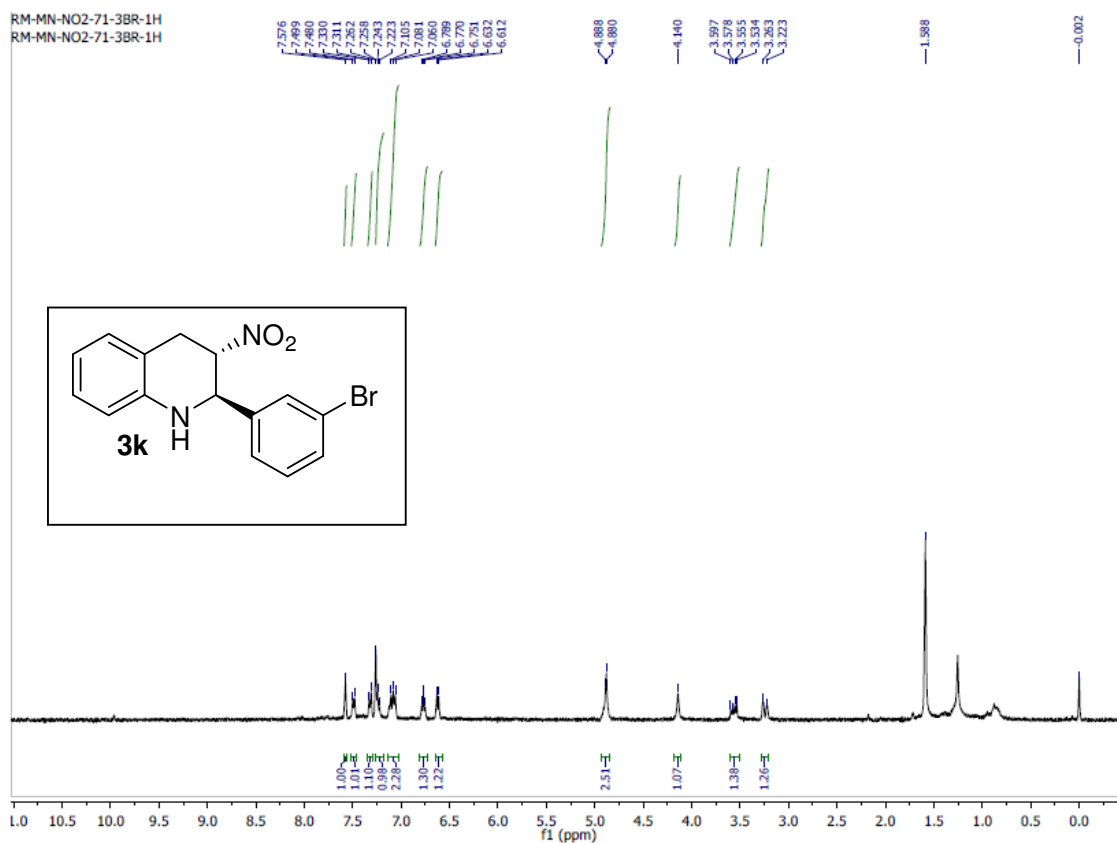


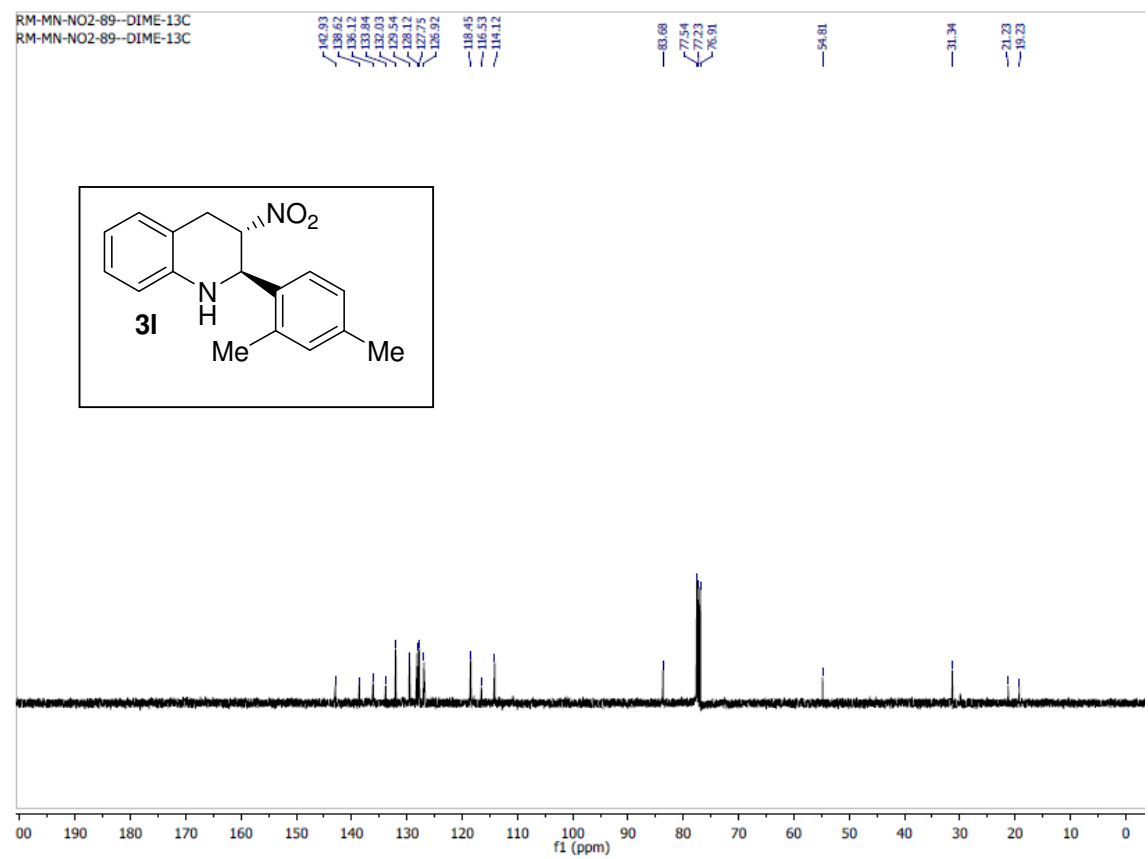
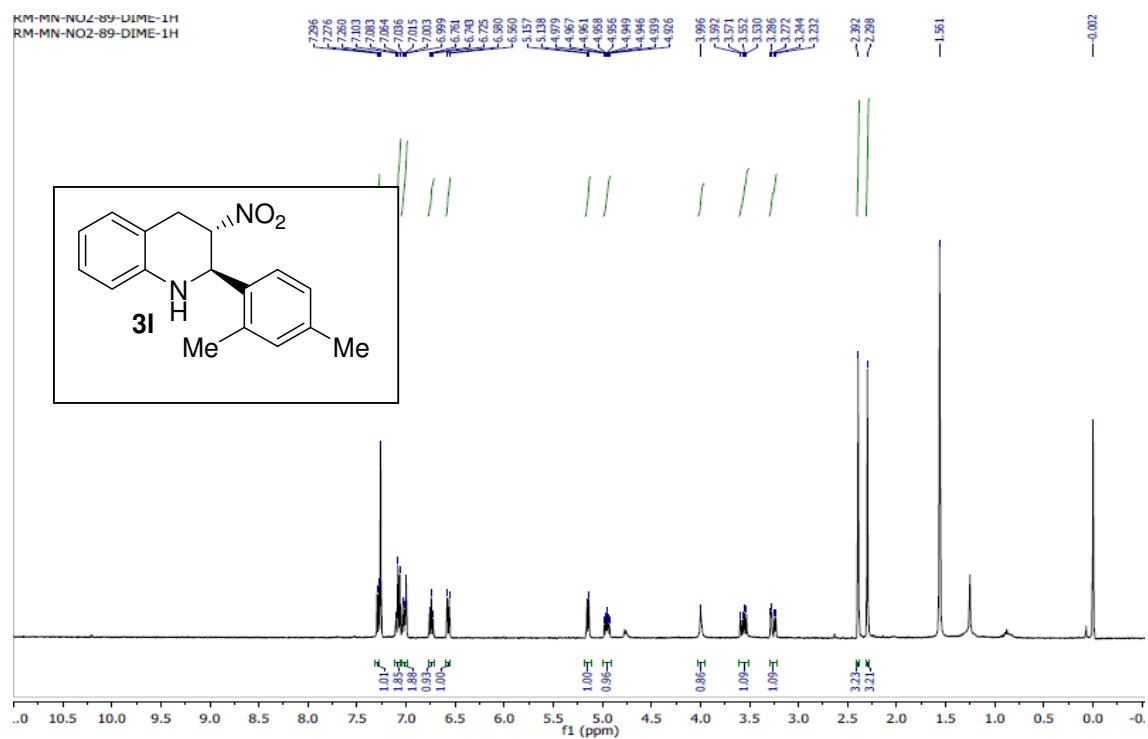
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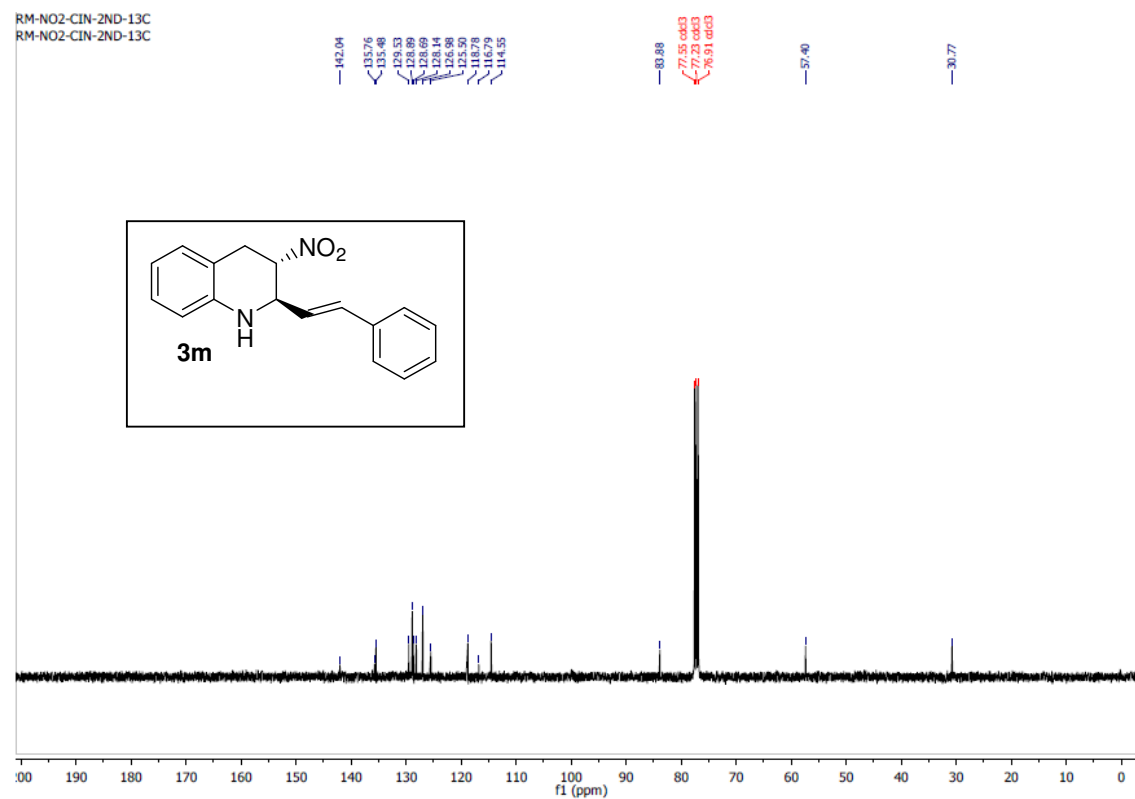
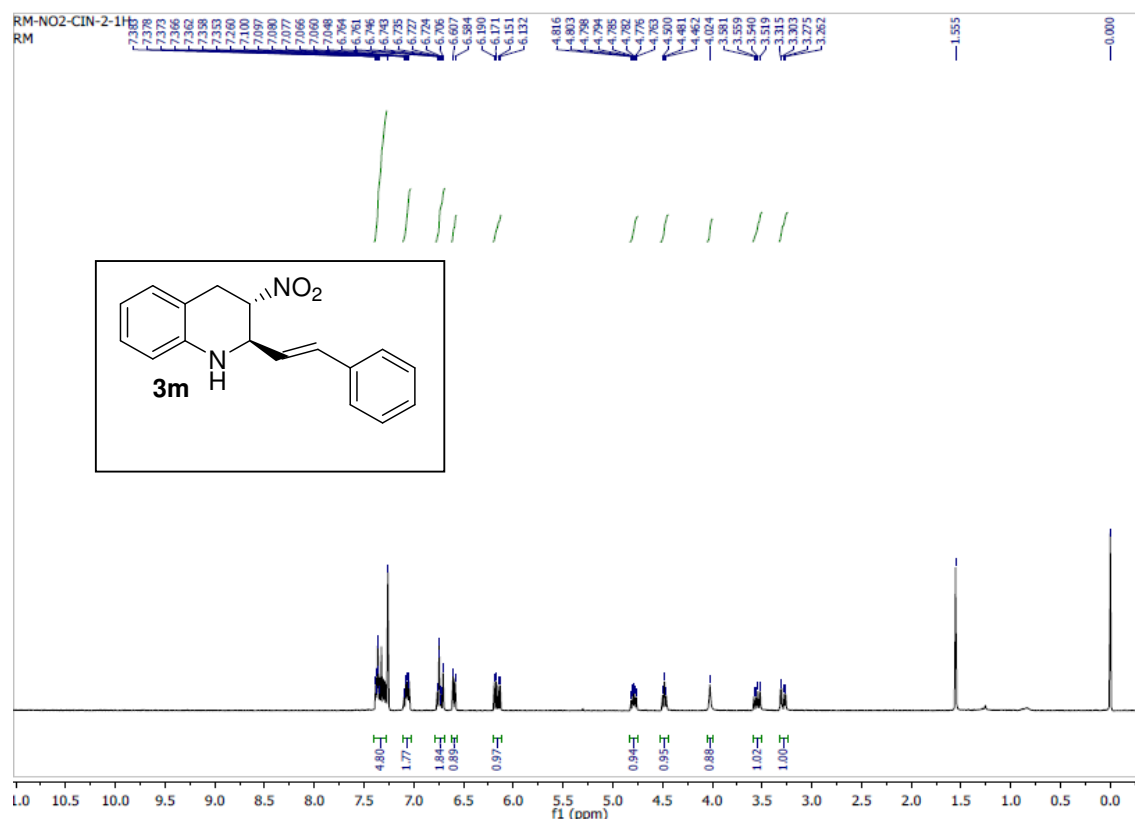


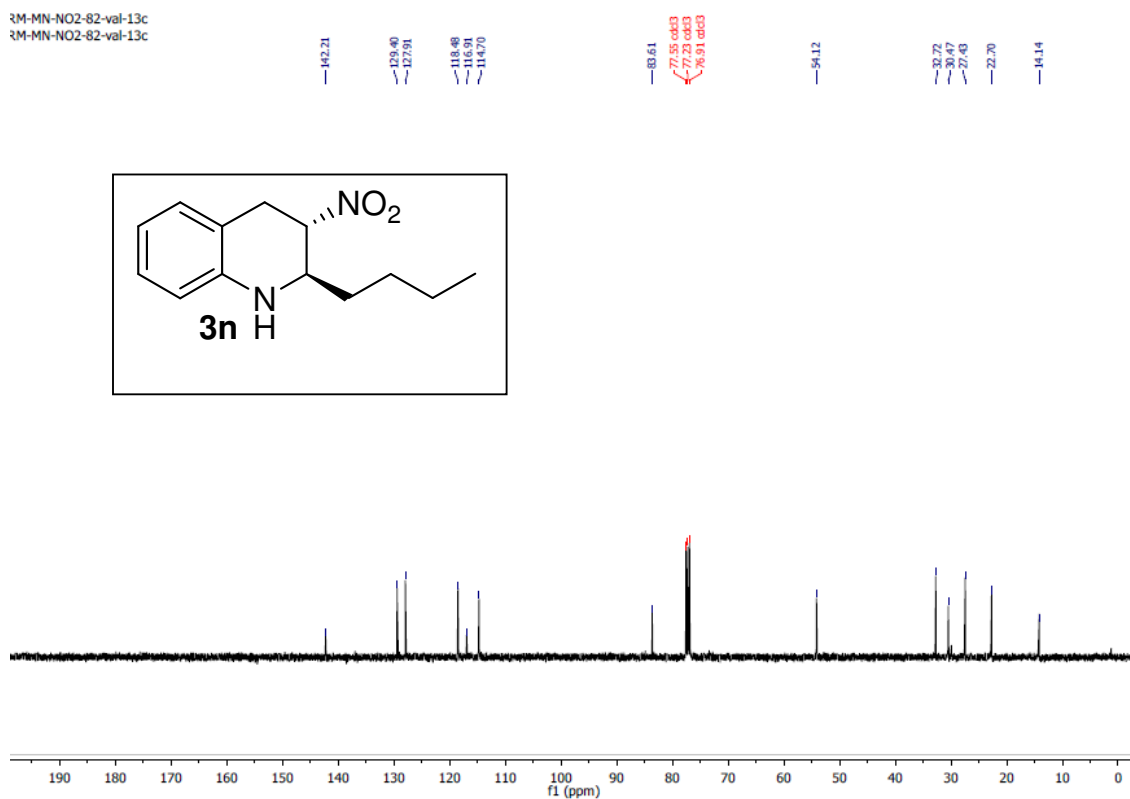
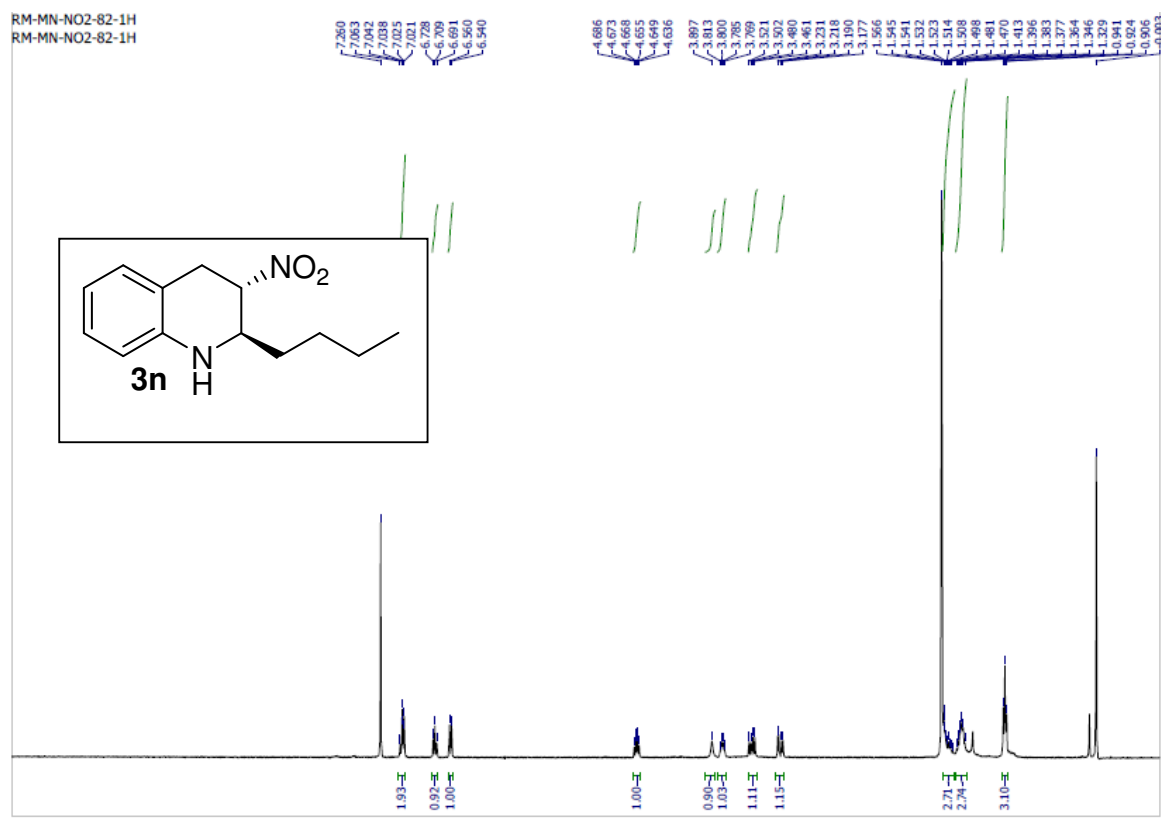


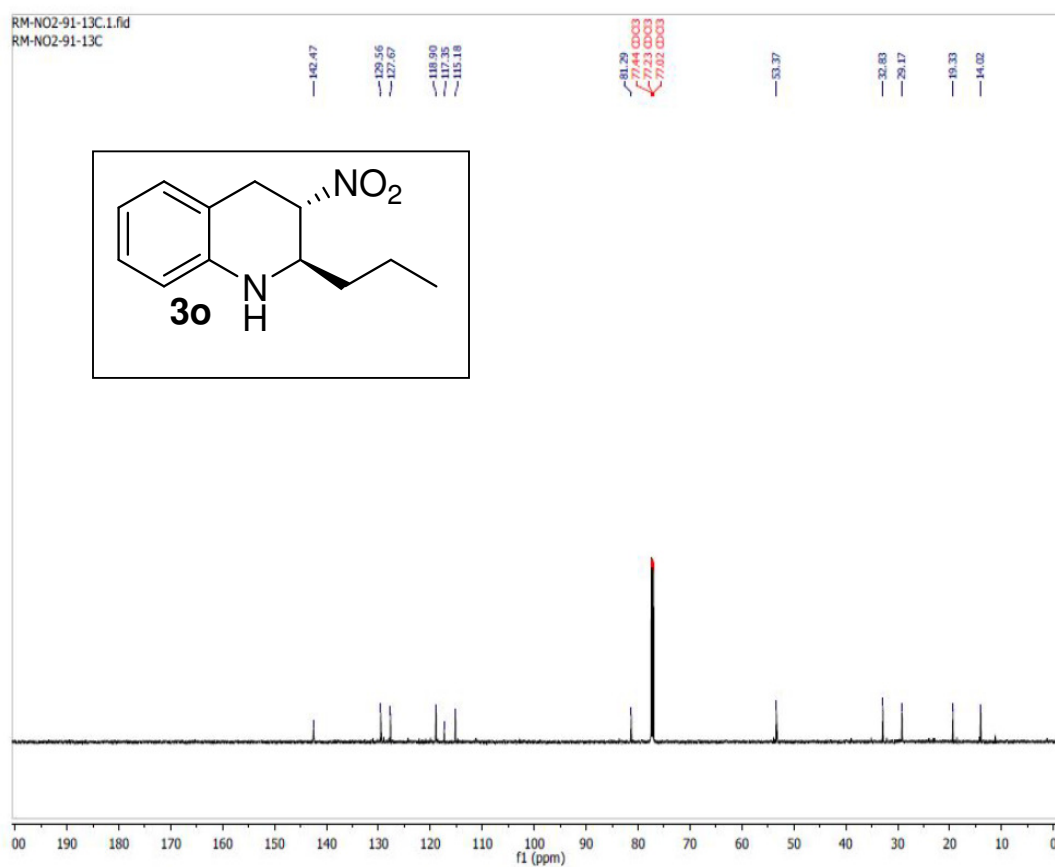
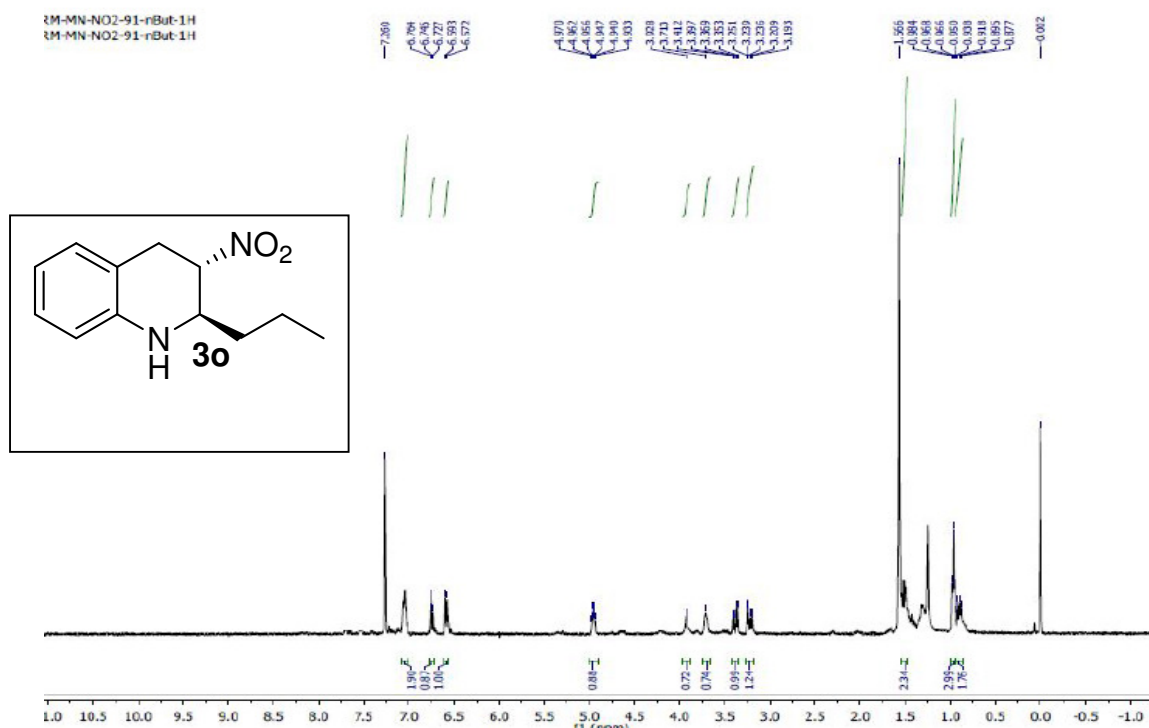


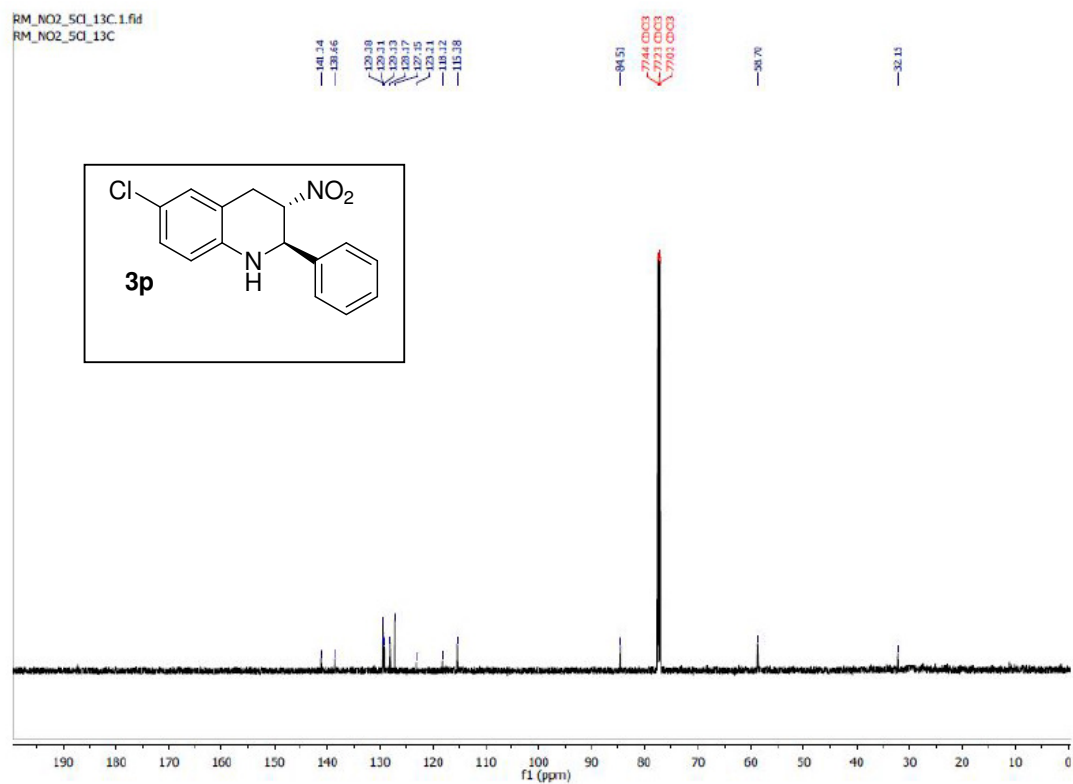
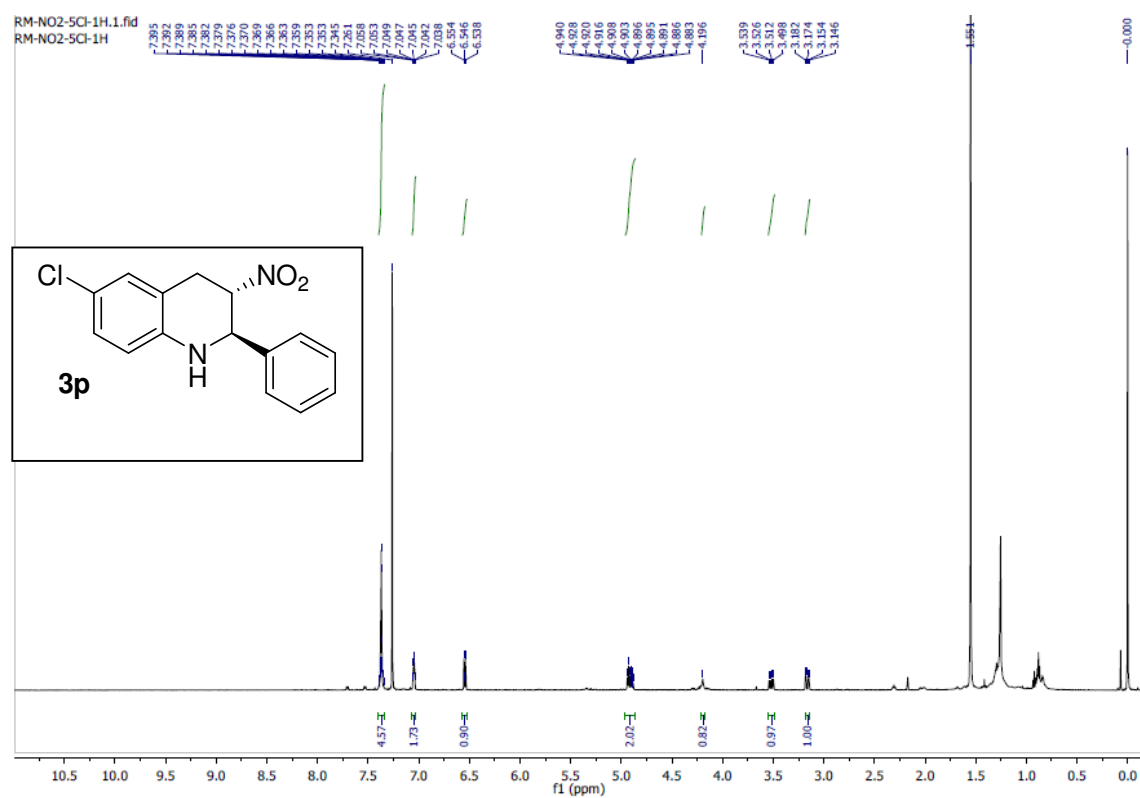




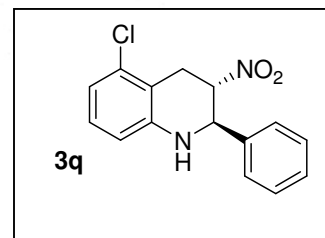
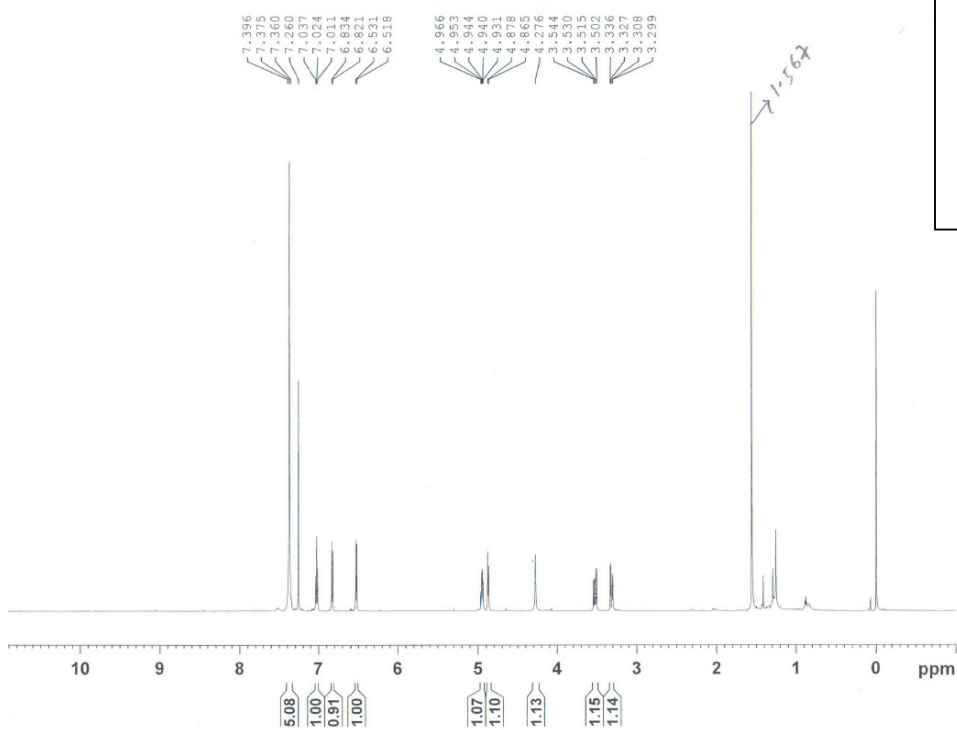






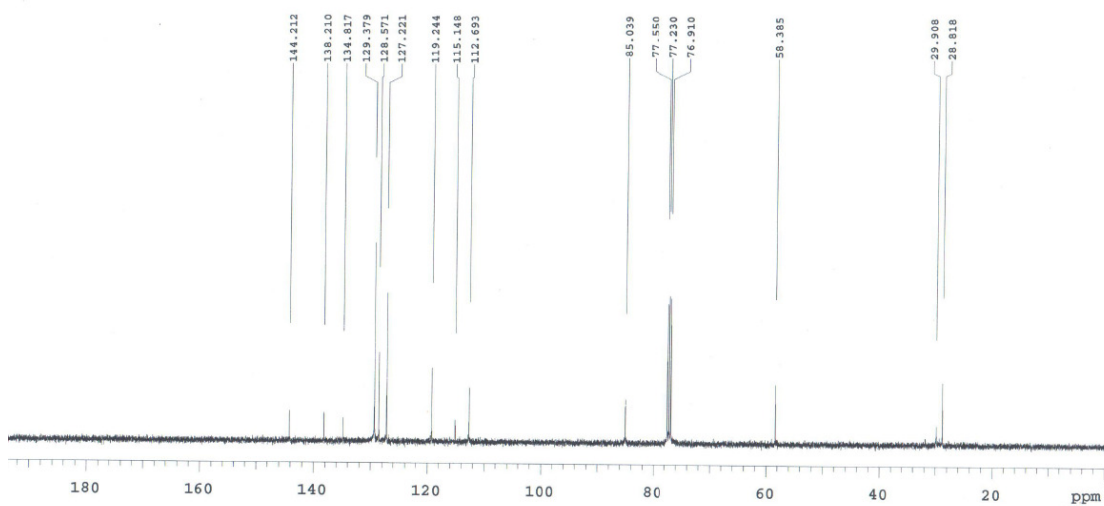
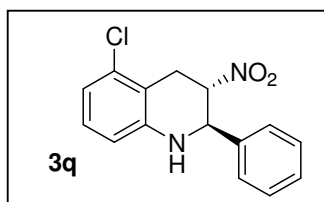


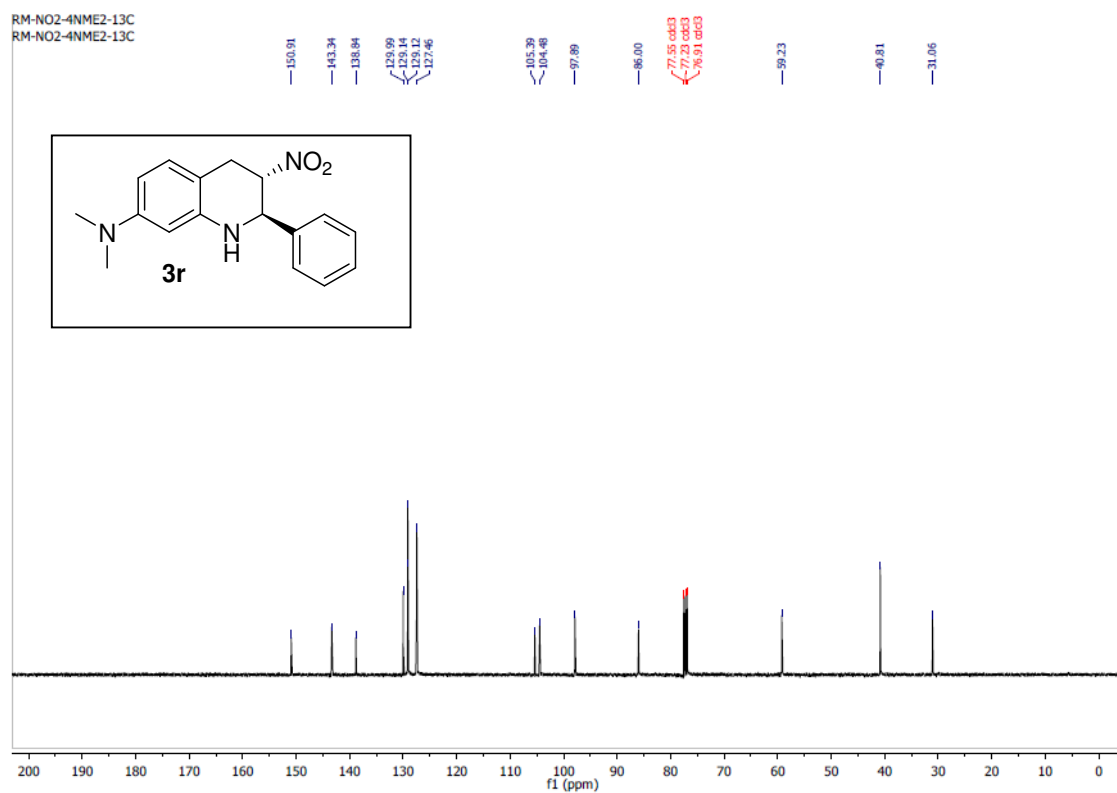
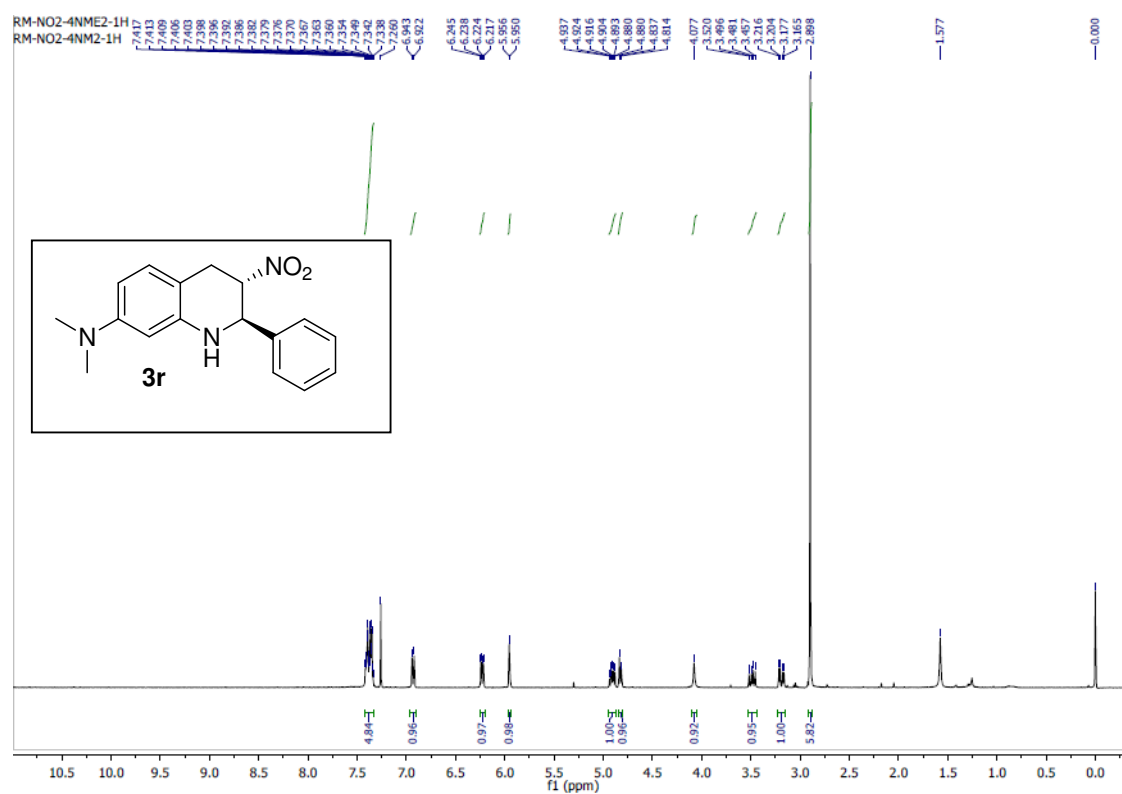
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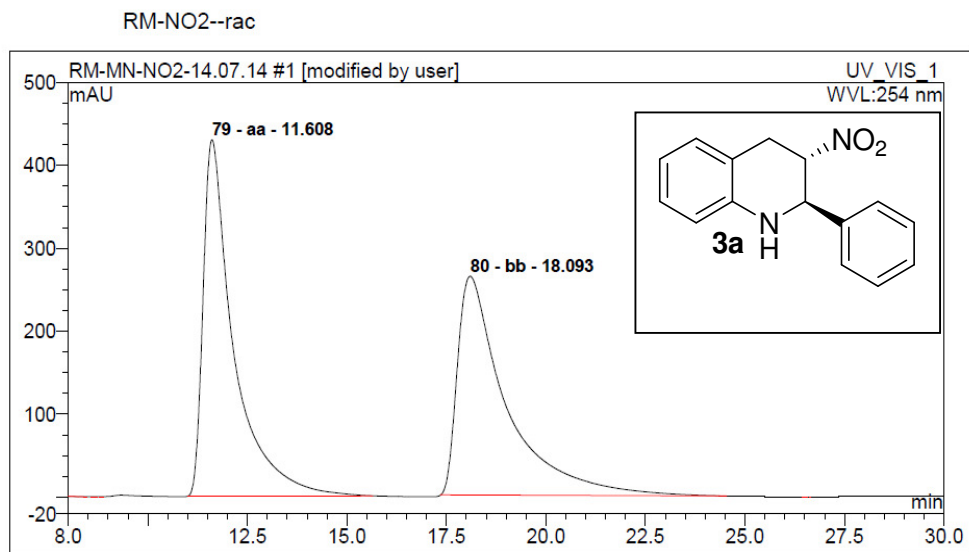
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NUC1 13
P1 12.00 usec
PL1 21.00000000 W
F2 - Processing parameters
S1 16394
SP 600.1700146 MHz
RG 0 RM
LB 0 6.39 Hz
GB 0
PC 0 1.00
  
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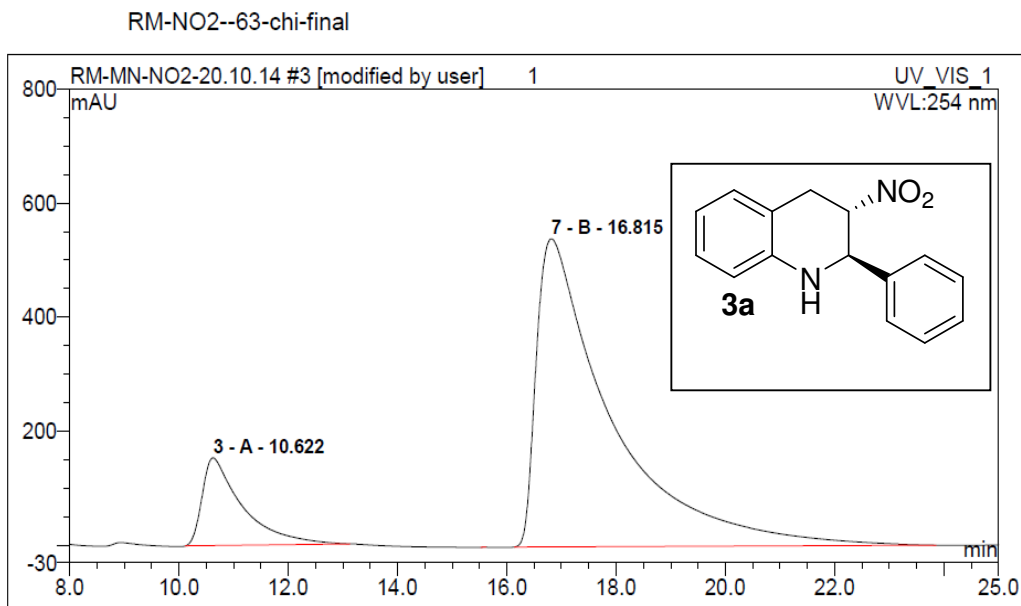




HPLC data of the Products:

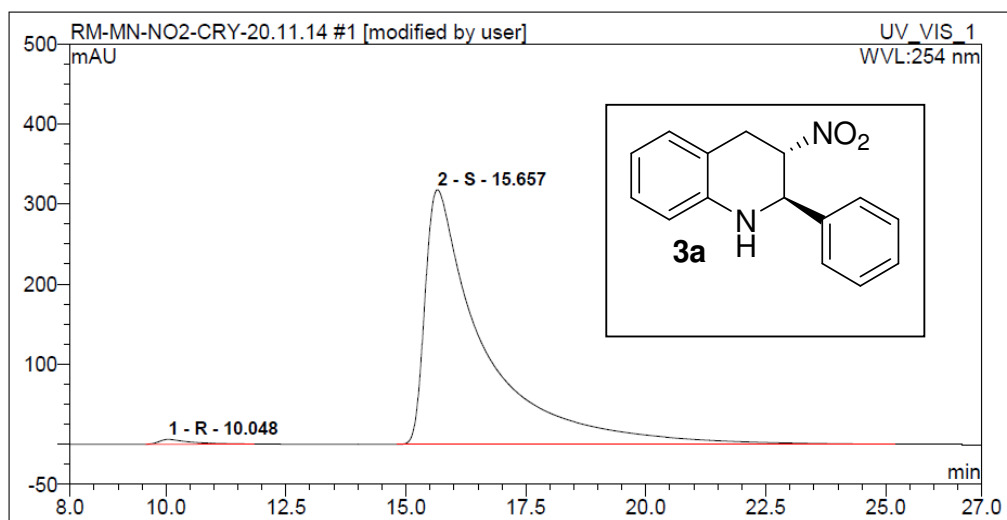


No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
79 aa		11.61	381.3727	50.37396303	429.3288	n.a.
80 bb		18.09	375.710	49.62603697	263.659	n.a.



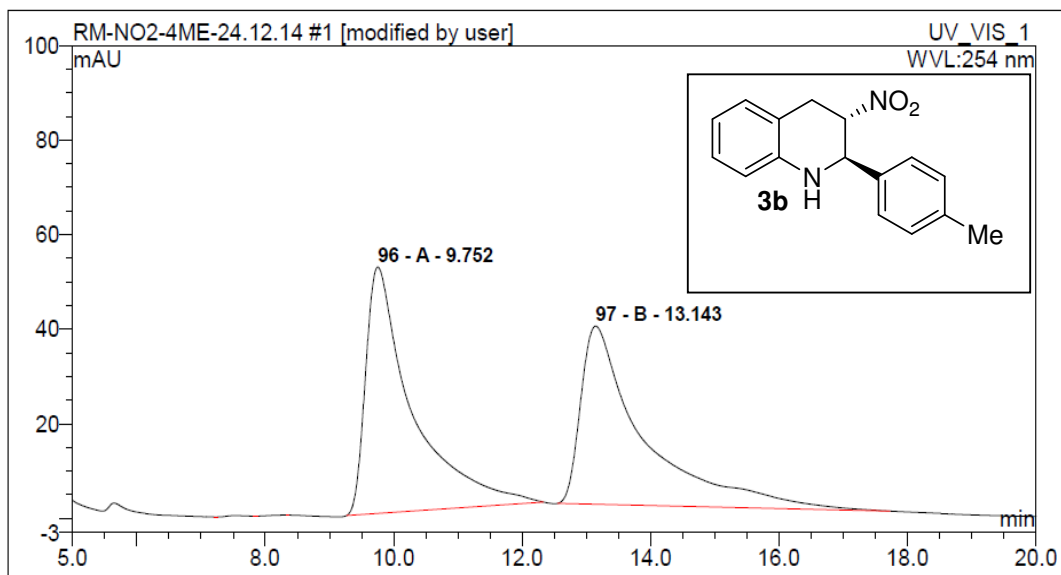
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
3 A		10.62	130.149	13.26822863	153.5928	n.a.
7 B		16.82	850.758	86.73177137	539.395	n.a.

RM-PURE-CRY-2ND



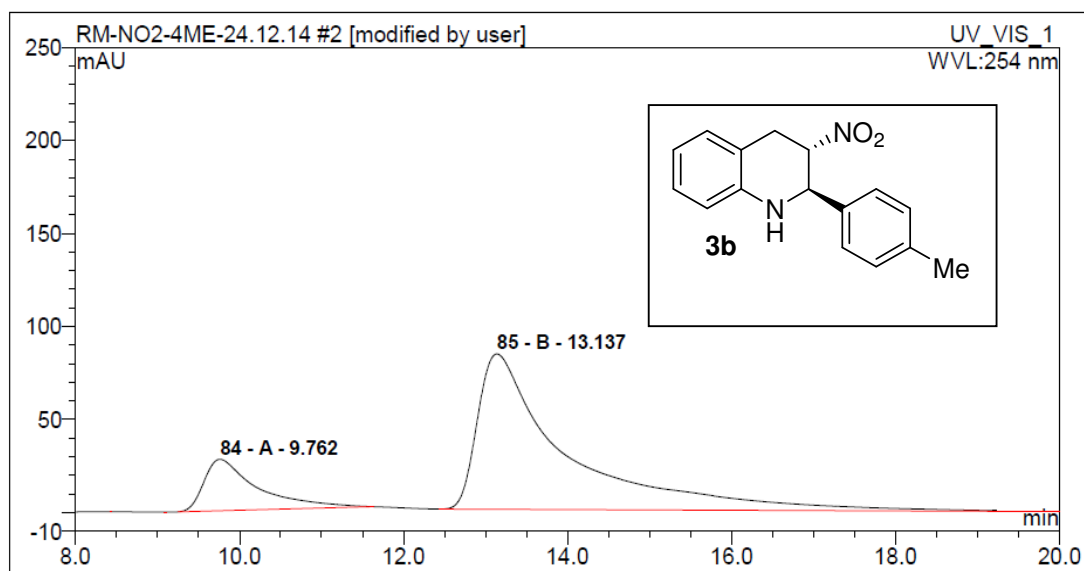
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1 R		10.05	4.555784	0.9905253208	6.17194	n.a.
2 S		15.66	455.380	99.00947468	318.035	n.a.

RM-MN-NO2-4ME-RAC



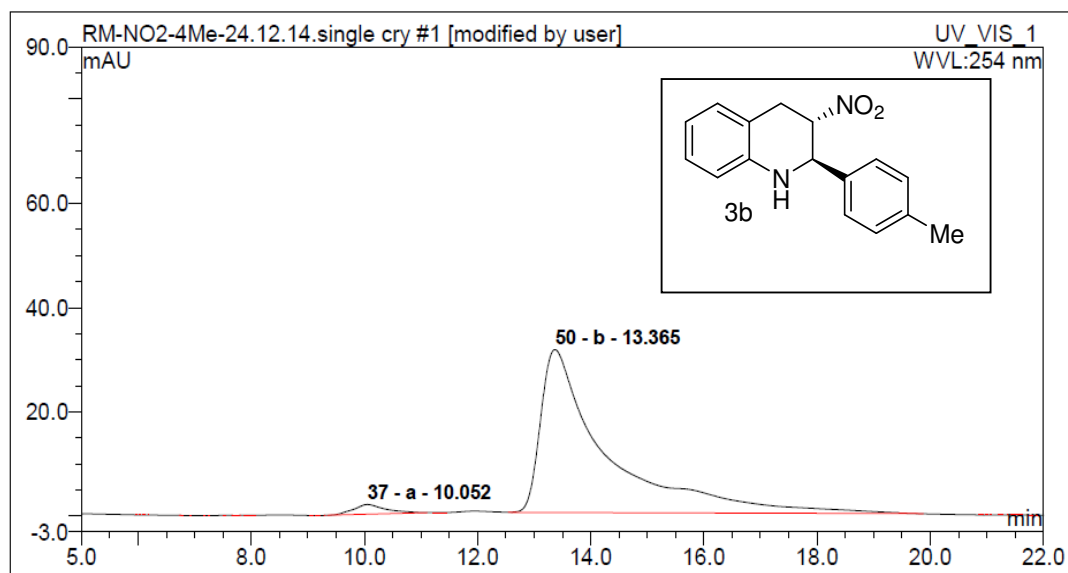
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96 A		9.75	43.74347	50.6765512	52.11201	n.a.
97 B		13.14	42.575	49.3234488	37.664	n.a.

RM-NO2--4ME-CHI



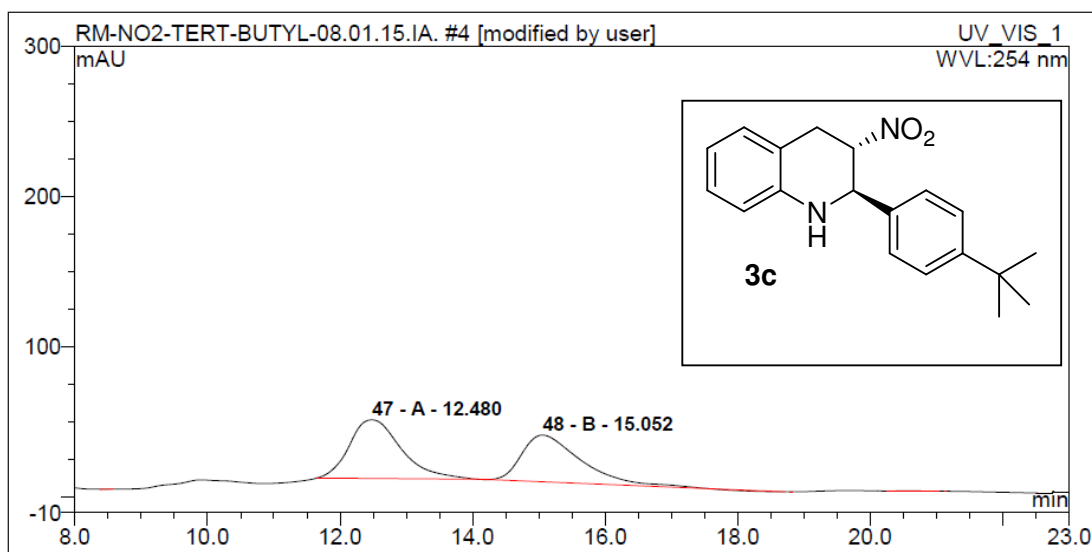
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
84 A		9.76	20.84747	16.66084654	27.67521	n.a.
85 B		13.14	104.281	83.33915346	83.530	n.a.

RM-MN-NO2-4Me-single-cry



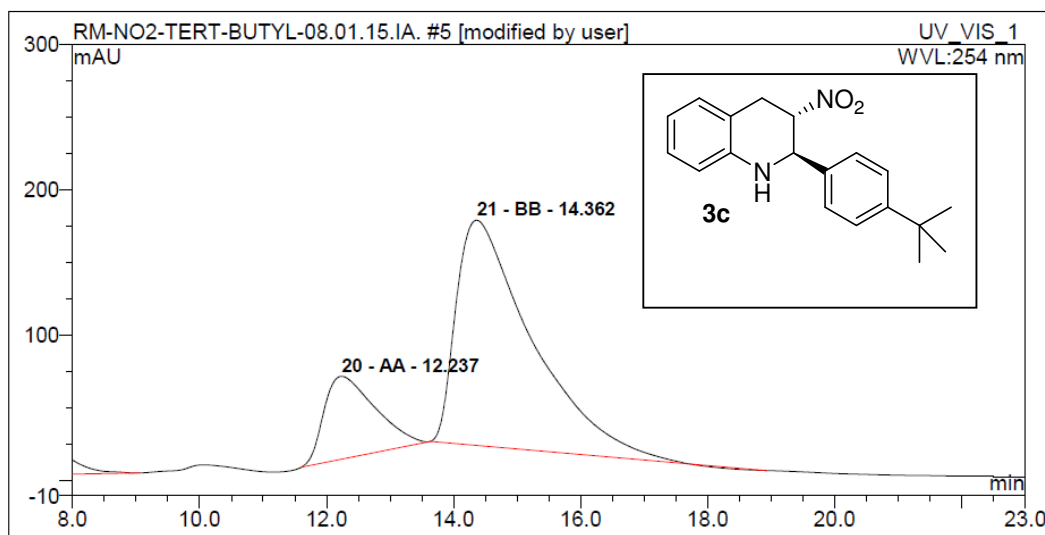
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
37 a		10.05	1.226015	2.822362736	1.8759	n.a.
50 b		13.37	42.213	97.17763726	31.251	n.a.

RM-NO2--4tButyl-rac



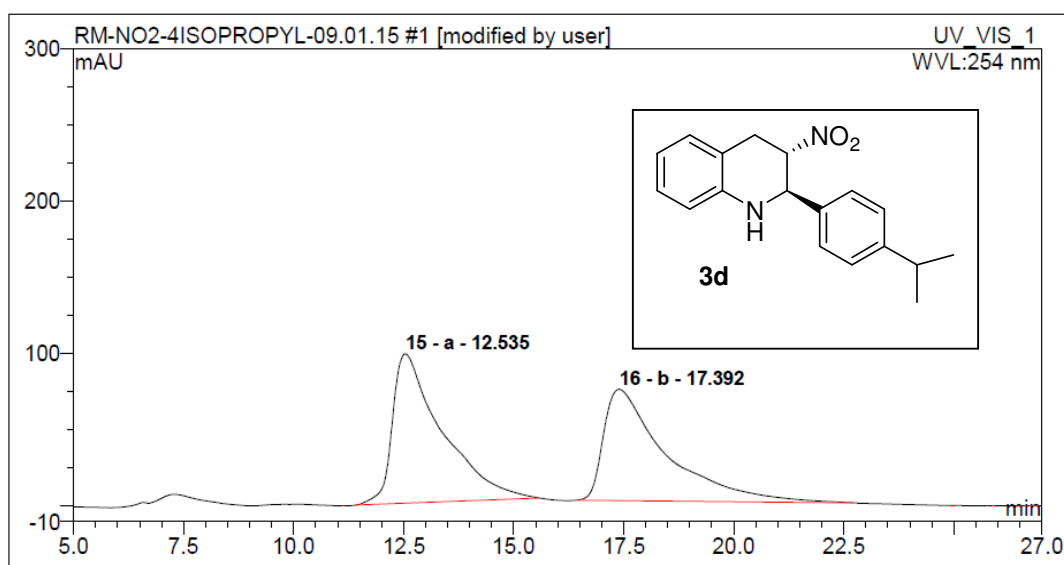
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
47 A		12.48	35.53253	52.53290717	39.02726	n.a.
48 B		15.05	32.106	47.46709283	31.121	n.a.

RM-NO2--4tButyl-chi



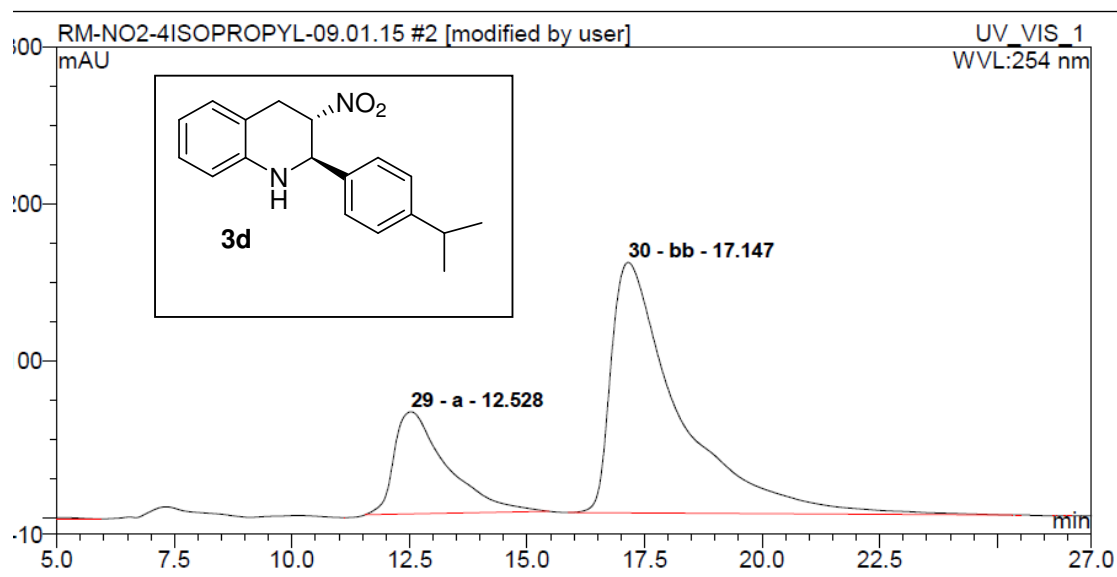
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
20 AA		12.24	52.50979	19.71245215	56.84097	n.a.
21 BB		14.36	213.869	80.28754785	154.614	n.a.

RM-NO2--4Isopropyl-rac



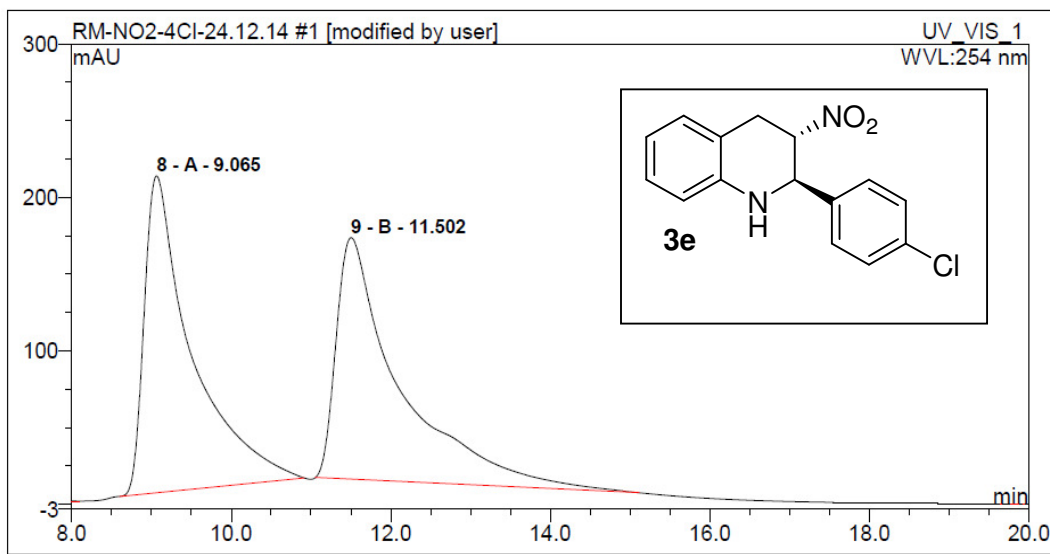
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
15 a		12.54	127.3727	51.78452458	97.78783	n.a.
16 b		17.39	118.594	48.21547542	72.841	n.a.

RM-NO2--4Isopropyl-chi



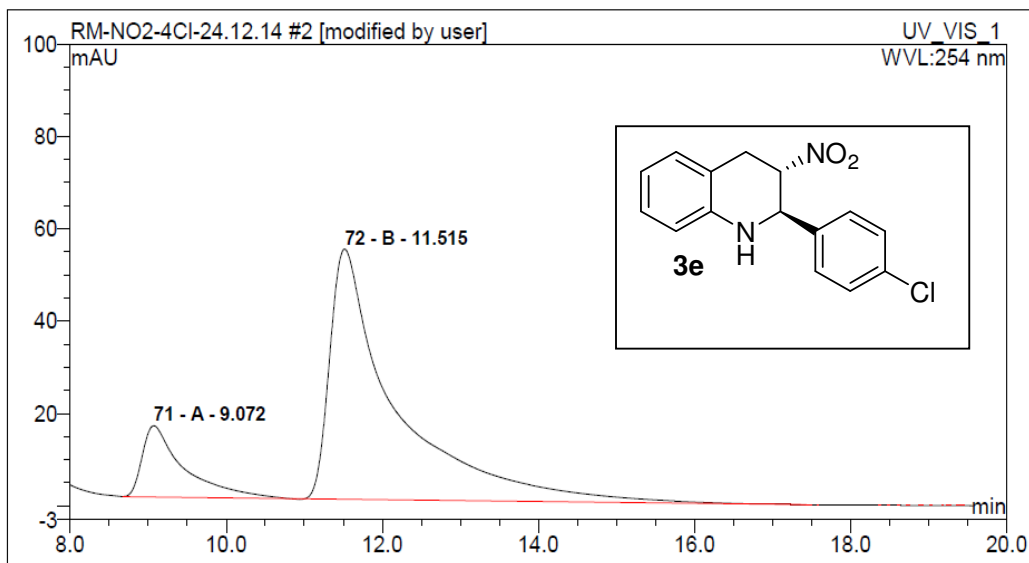
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
29 a		12.53	84.42389	23.97654726	64.91747	n.a.
30 bb		17.15	267.686	76.02345274	159.277	n.a.

RM-NO2-4Cl-RAC



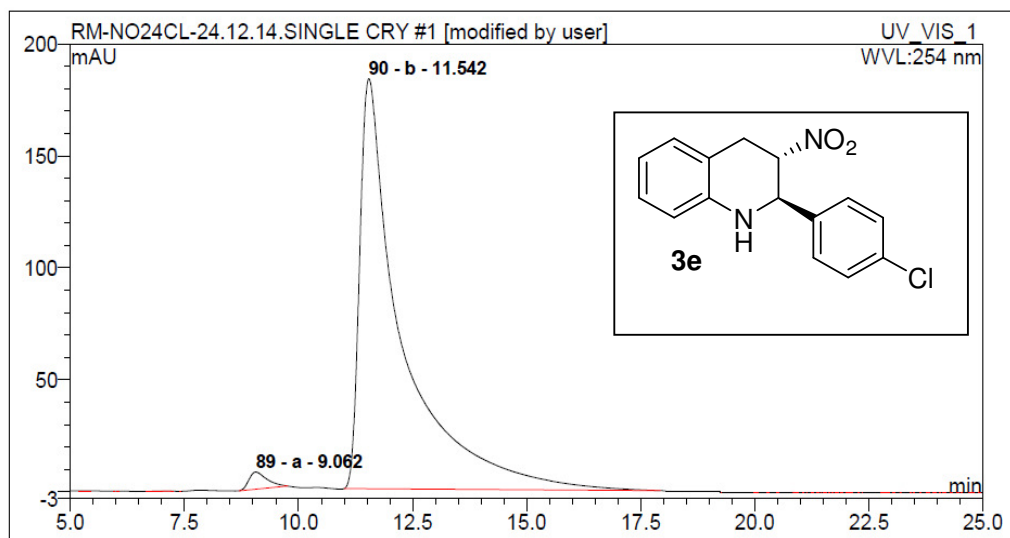
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
8 A		9.07	141.651	49.5703078	206.3158	n.a.
9 B		11.50	144.107	50.4296922	157.334	n.a.

RM-NO2-4Cl-CHI



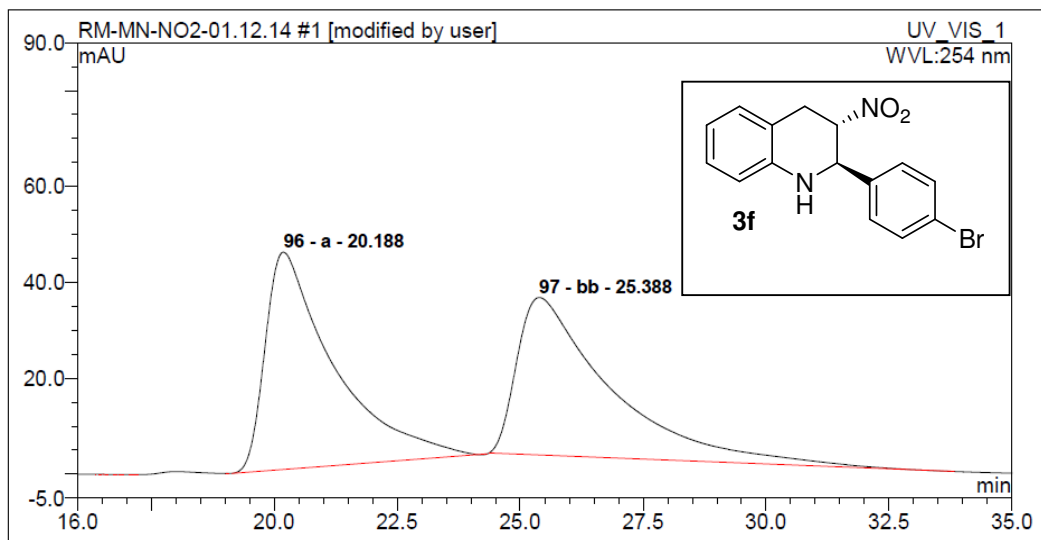
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
71 A		9.07	9.435416	15.09155782	15.41844	n.a.
72 B		11.52	53.086	84.90844218	54.174	n.a.

RM-MN-NO2-4Cl-singl cry



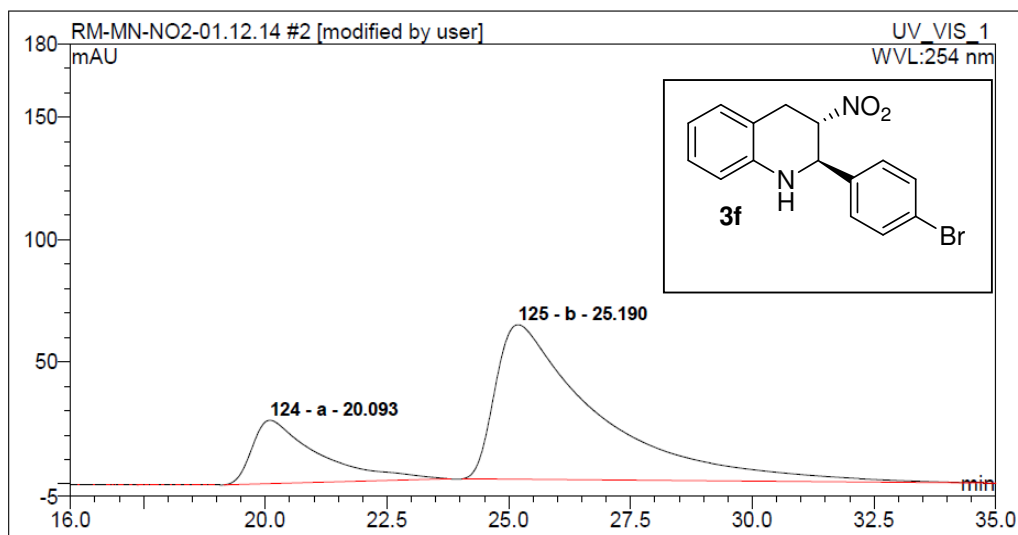
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
89 a		9.06	3.518747	1.766810343	7.65566	n.a.
90 b		11.54	195.639	98.23318966	183.082	n.a.

RM-MN-NO2-4BR-rac-2nd



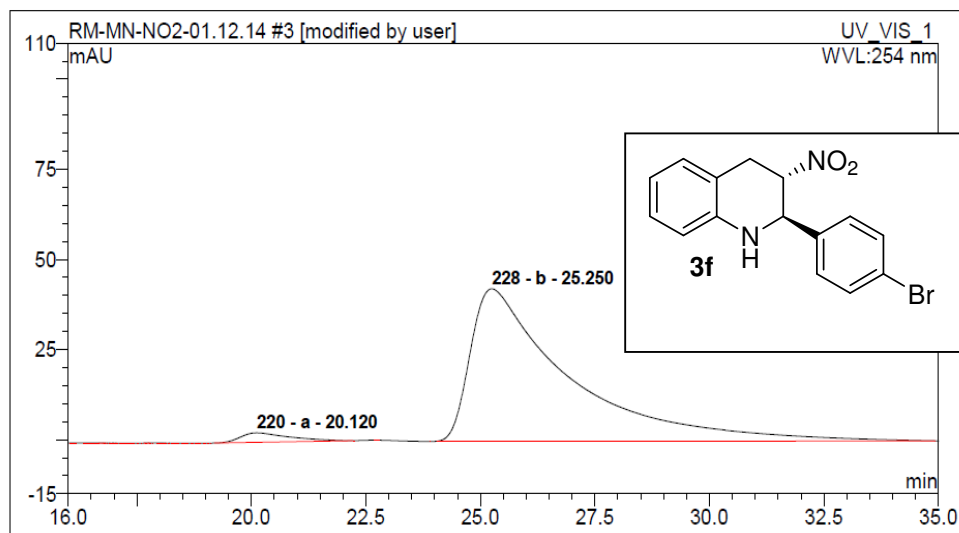
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
96 a		20.19	73.27526	50.4629241	45.32562	n.a.
97 bb		25.39	71.931	49.5370759	32.852	n.a.

RM-MN-NO2-4BR-CHIRAL-2nd

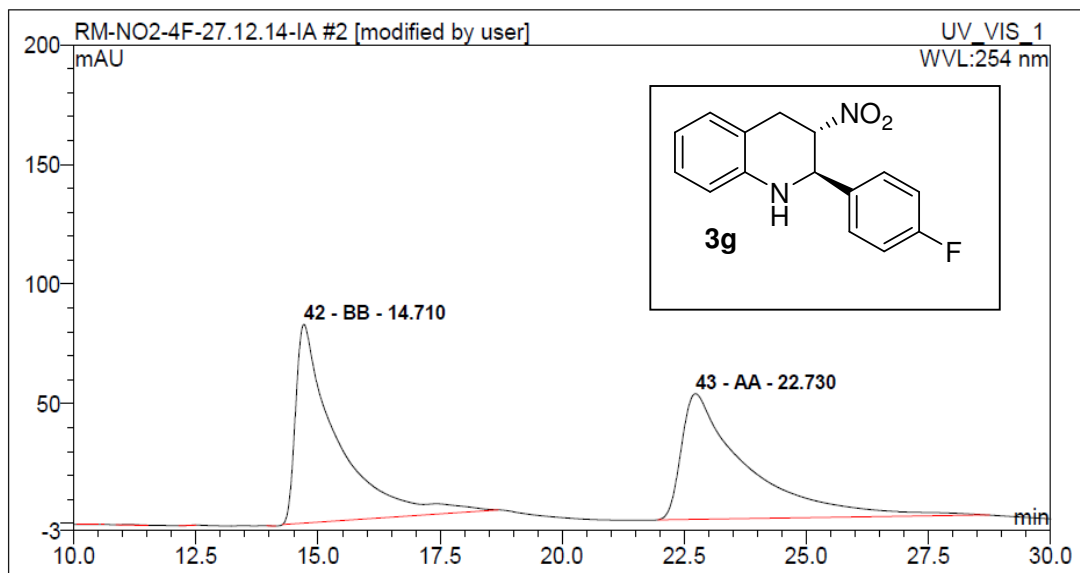


No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
124 a		20.09	40.74264	20.96612444	25.91935	n.a.
125 b		25.19	153.583	79.03387556	63.169	n.a.

RM-MN-NO2-4BR-CHIRAL-single-cry

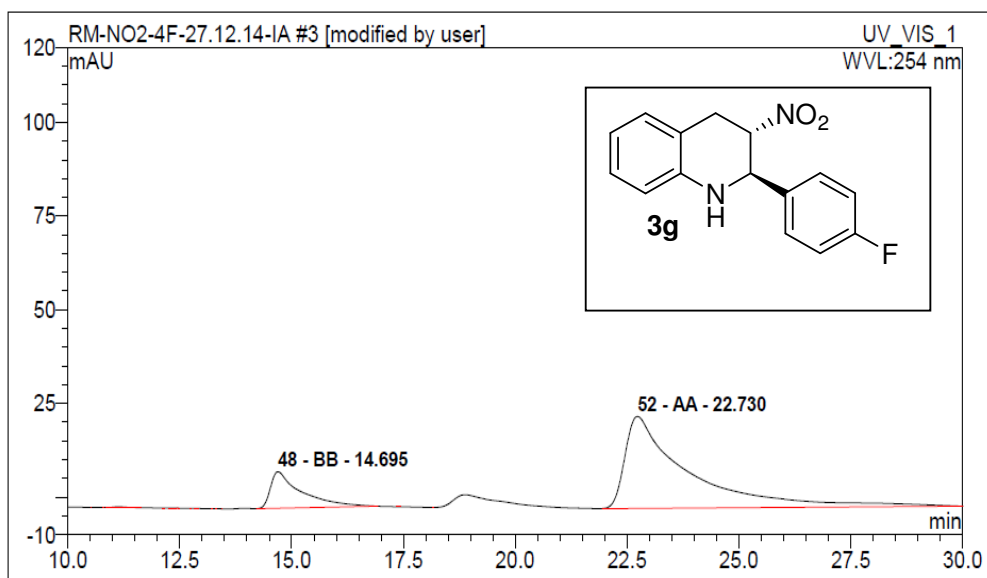


No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
220 a		20.12	3.287854	3.047131871	2.66705	n.a.
228 b		25.25	104.612	96.95286813	42.269	n.a.



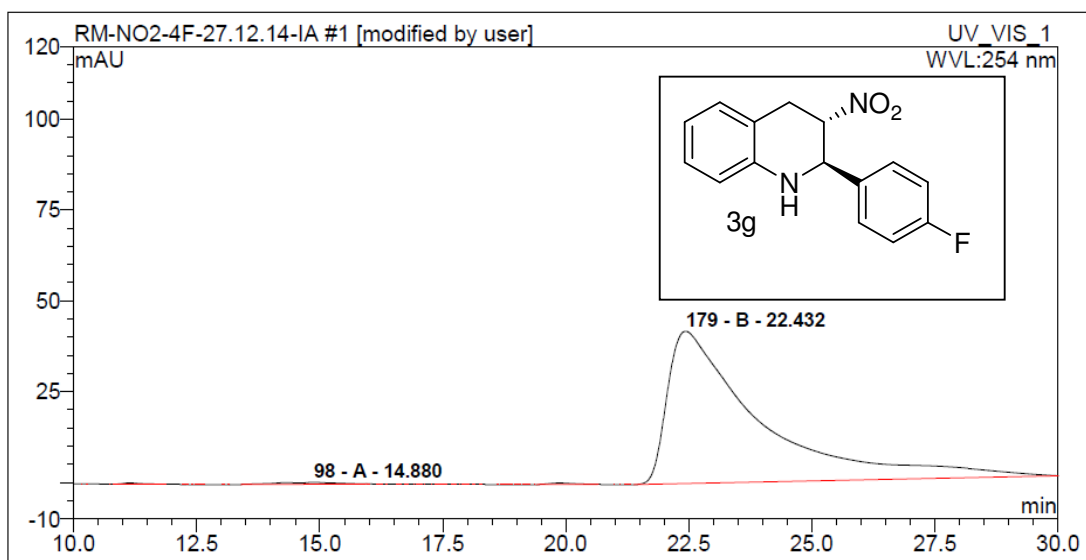
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
42	BB	14.71	81.8511	50.13962177	83.05047	n.a.
43	AA	22.73	81.395	49.86037823	52.427	n.a.

RM-MN-NO2-4F-CHI-IA



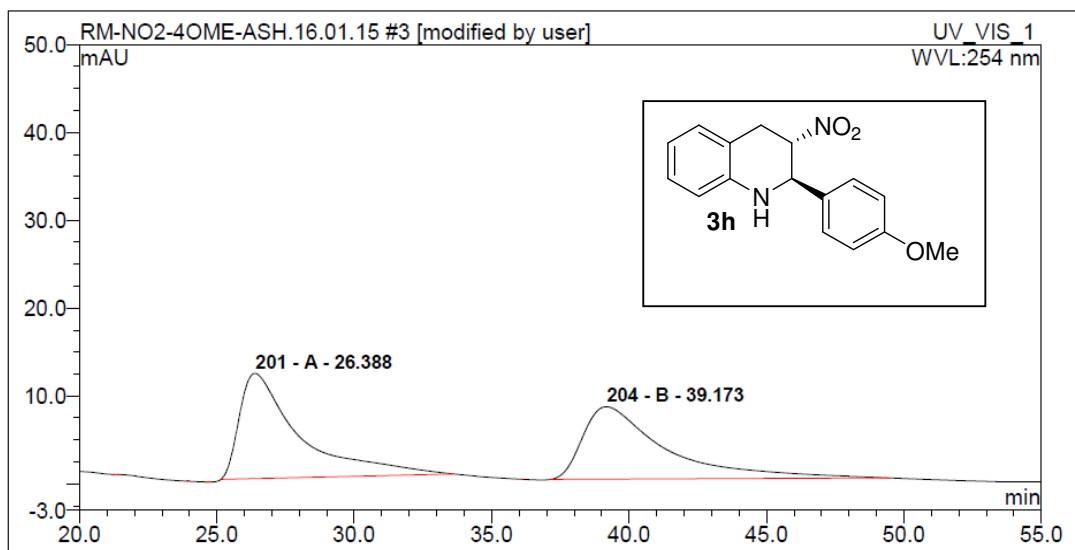
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
48	BB	14.70	7.814515	16.37273527	9.74772	n.a.
52	AA	22.73	39.914	83.62726473	24.524	n.a.

RM-MN-NO2-4F-single-cry



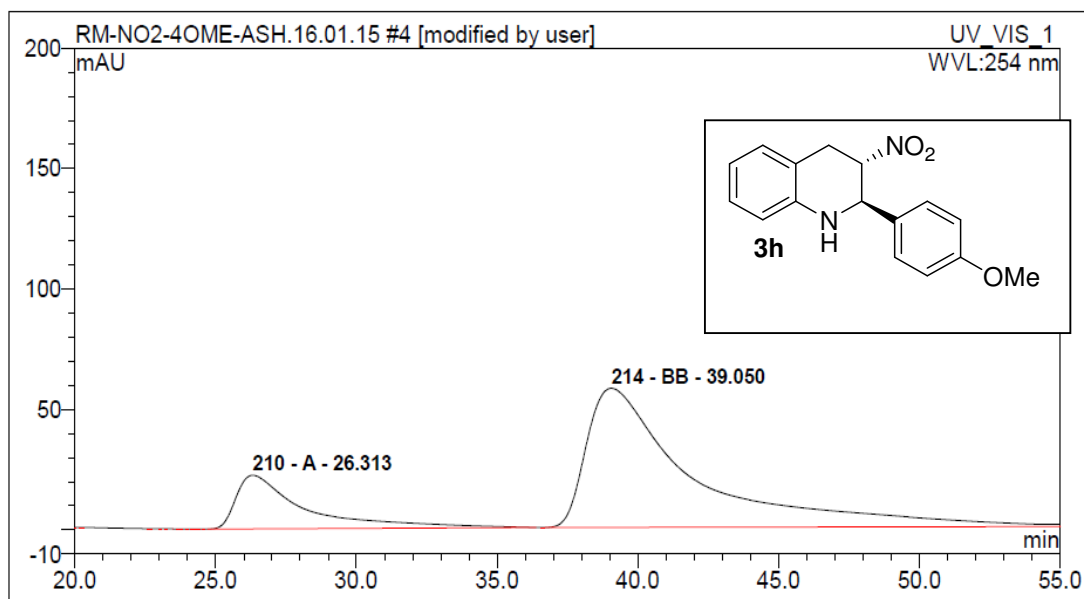
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
	98 A	14.88	0.353333	0.3882099601	0.51336	n.a.
	179 B	22.43	90.663	99.61179004	41.892	n.a.

RM-NO2--4OMe-RAC



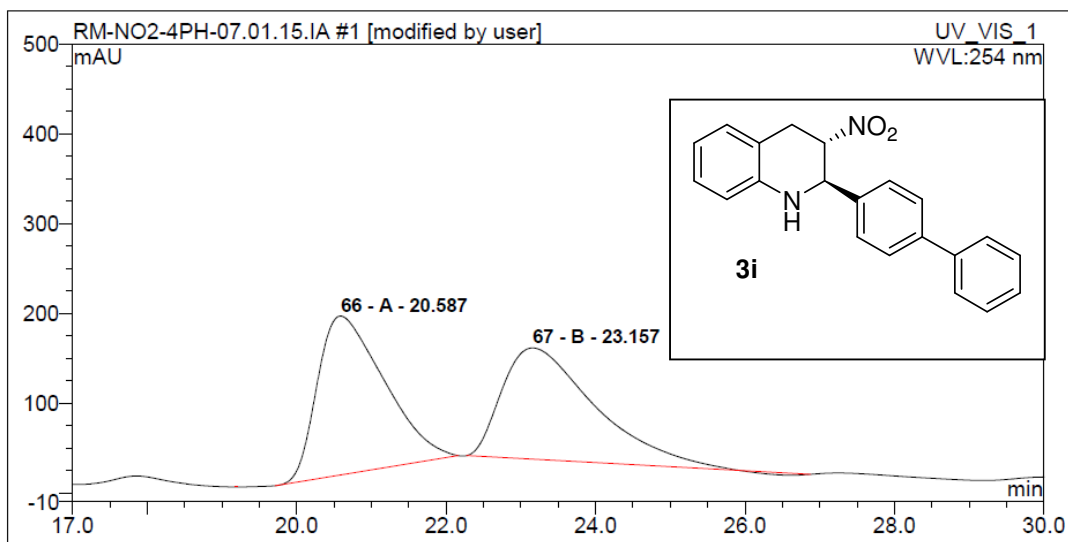
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
	201 A	26.39	30.27649	51.50365255	11.97973	n.a.
	204 B	39.17	28.509	48.49634745	8.248	n.a.

RM-NO2--4OMe-CHI



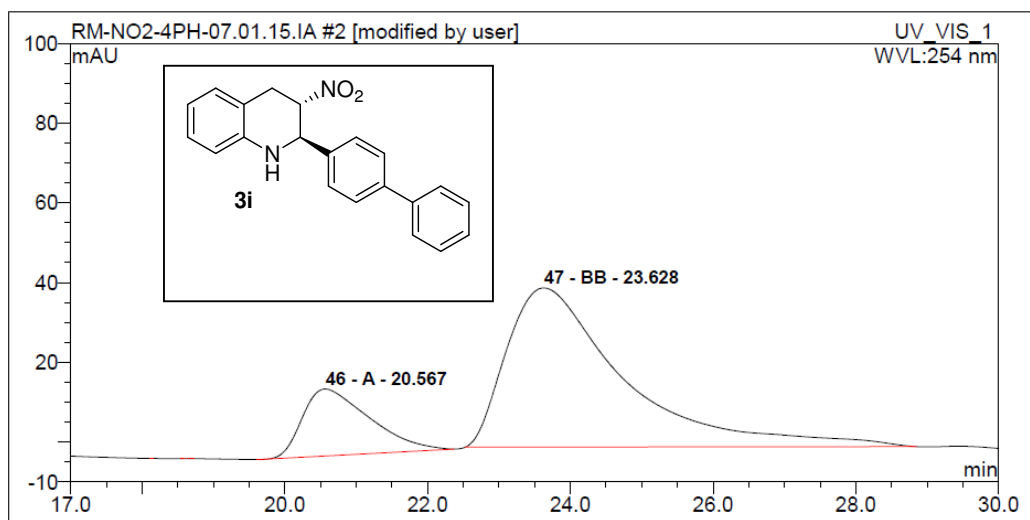
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
	210 A	26.31	62.53129	19.9090604	22.26955	n.a.
	214 BB	39.05	251.553	80.0909396	57.759	n.a.

RM-NO2-4PH



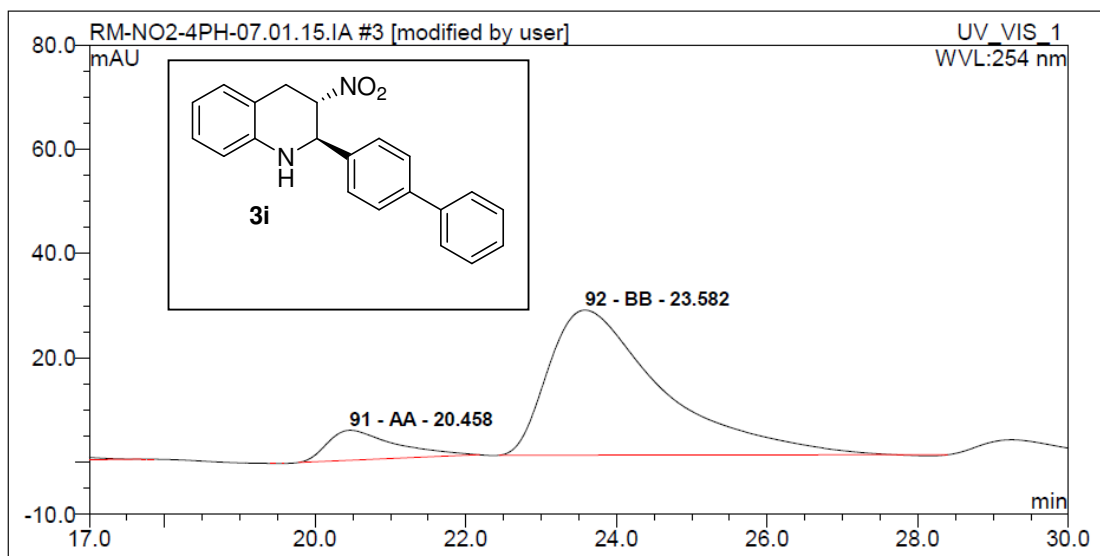
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
	66 A	20.59	182.3403	50.65517068	176.9847	n.a.
	67 B	23.16	177.624	49.34482932	123.915	n.a.

RM-NO2-4PH-CHI



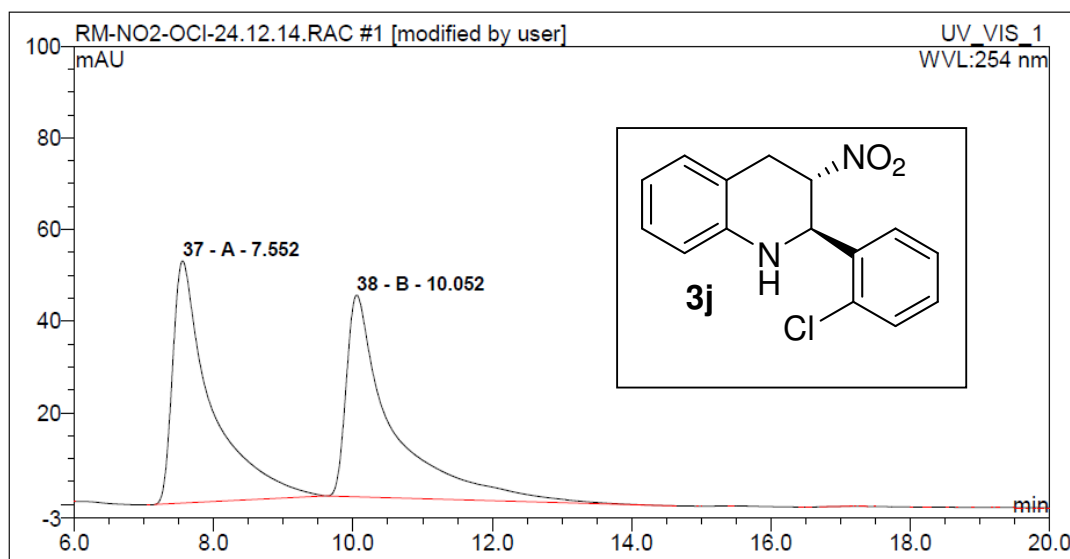
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
46 A		20.57	18.1566	19.34534113	16.79401	n.a.
47 BB		23.63	75.699	80.65465887	39.958	n.a.

RM-NO2-4PH-CRY



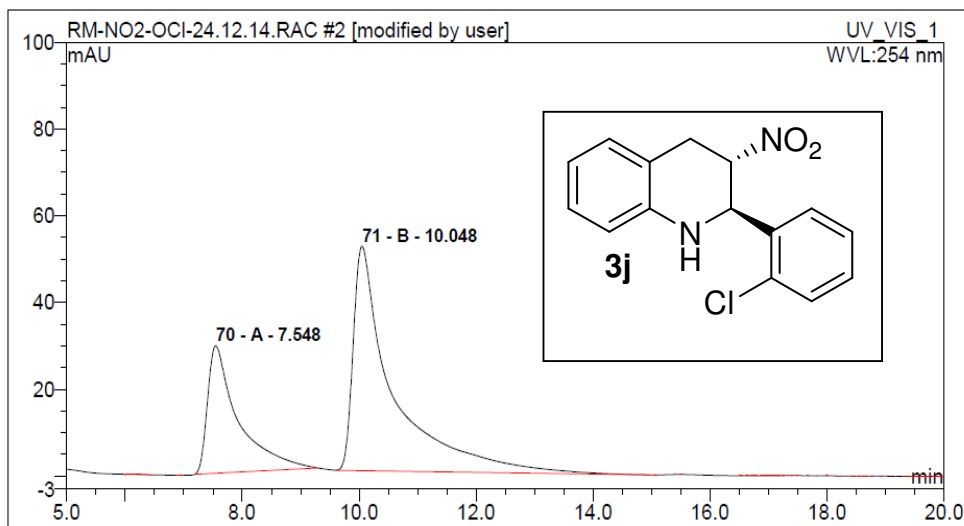
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
91 AA		20.46	5.976195	10.94880955	5.75004	n.a.
92 BB		23.58	48.607	89.05119045	27.825	n.a.

RM-NO2-4CI-RAC



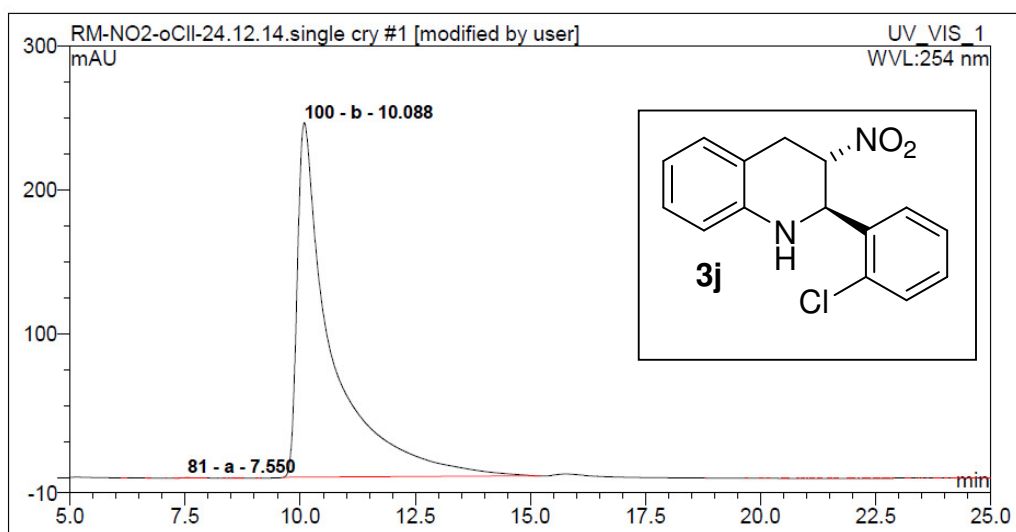
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
37 A		7.55	33.75207	50.32381639	52.85636	n.a.
38 B		10.05	33.318	49.67618361	44.050	n.a.

RM-NO2-OCI-CHI



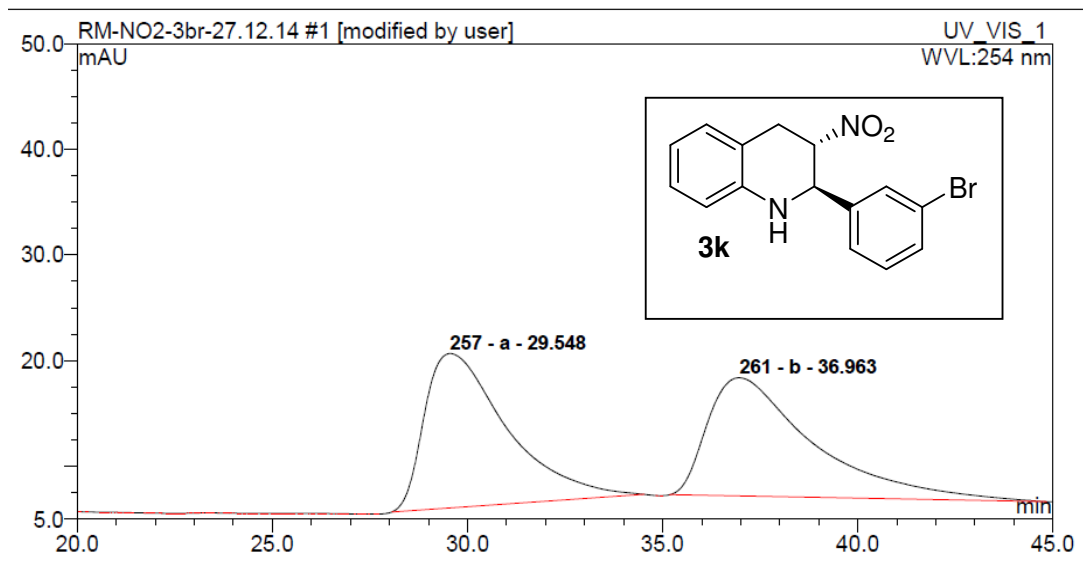
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
70 A		7.55	17.68461	30.25727577	29.35662	n.a.
71 B		10.05	40.763	69.74272423	51.732	n.a.

RM-MN-NO2-2CL-SINGLE cry



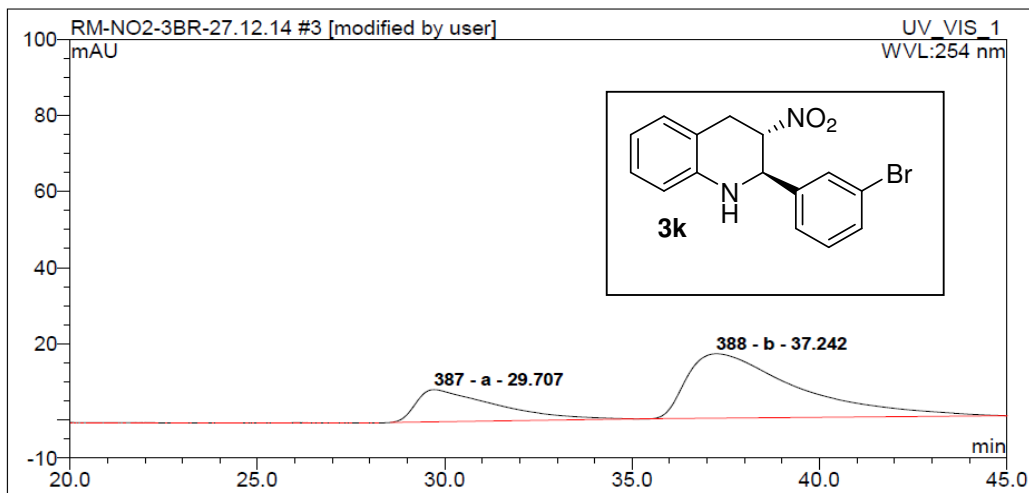
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
81 a		7.55	0.081605	0.03810406846	0.25076	n.a.
100 b		10.09	214.081	99.96189593	245.800	n.a.

RM-NO2-3BR-RAC



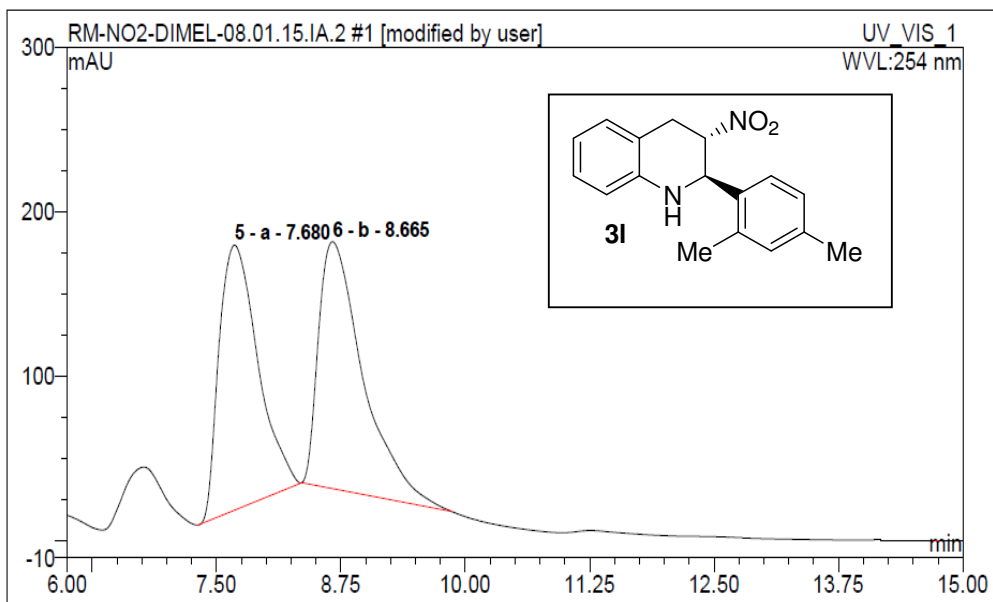
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
257 a		29.55	35.67469	50.54243484	14.60068	n.a.
261 b		36.96	34.909	49.45756516	11.193	n.a.

RM-NO2--3BR-CHI



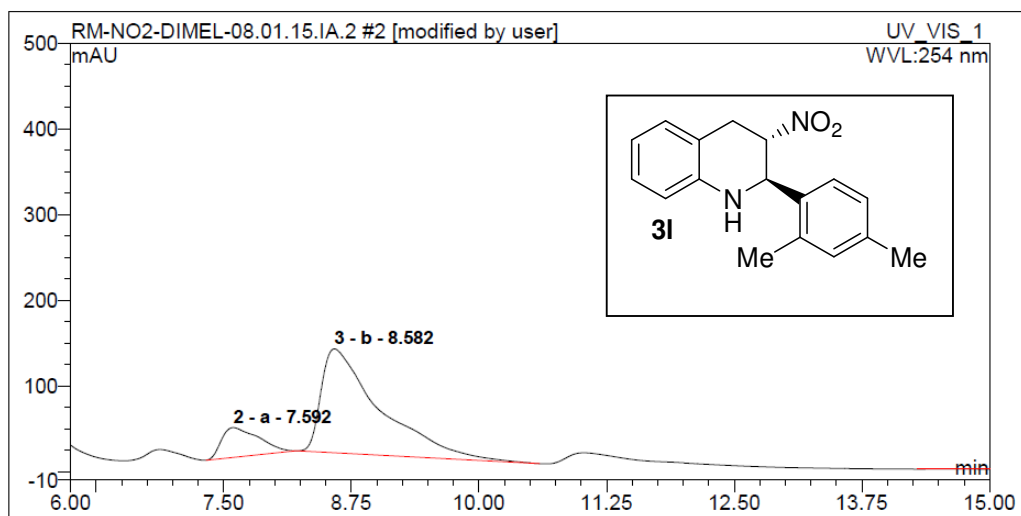
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
387 a		29.71	20.69569	26.46350524	8.48416	n.a.
388 b		37.24	57.509	73.53649476	16.917	n.a.

RM-NO2-DIME-RAC



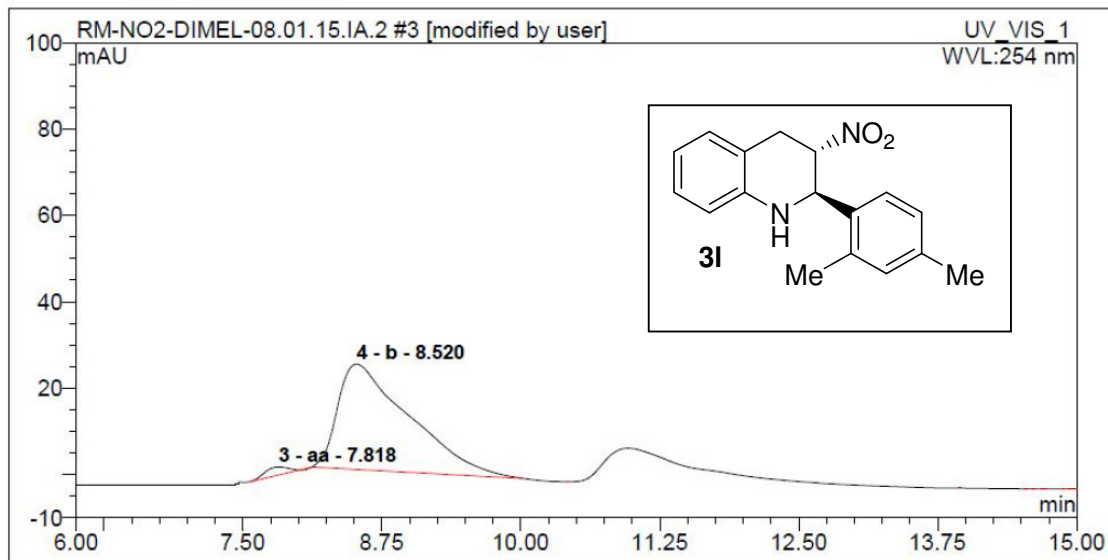
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
5 a		7.68	72.72266	48.32554208	160.8897	n.a.
6 b		8.67	77.762	51.67445792	149.823	n.a.

RM-NO2-DIME-CHI



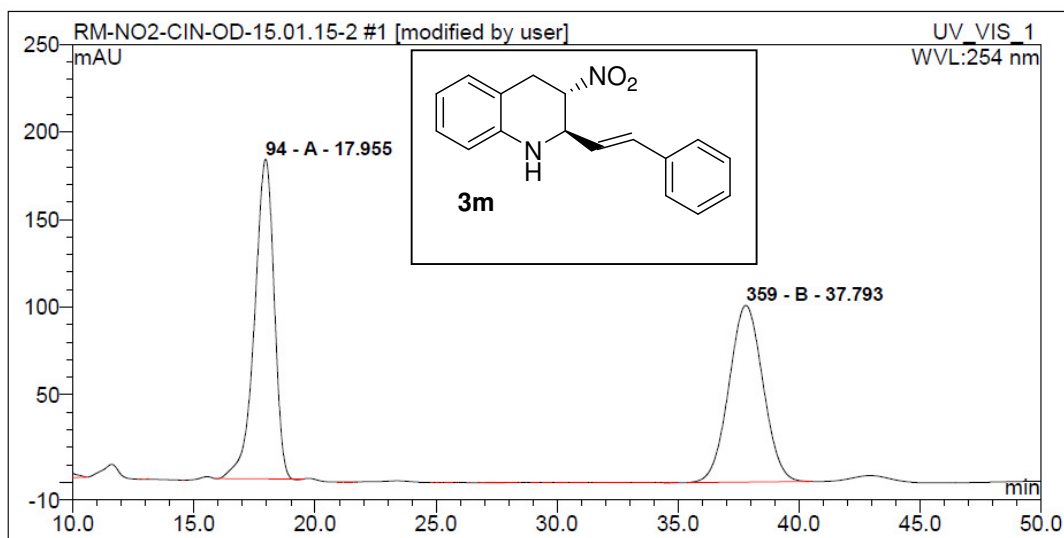
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
2 a		7.59	14.43651	15.17765468	34.72095	n.a.
3 b		8.58	80.680	84.82234532	121.322	n.a.

RM-NO2-DIME-CRY



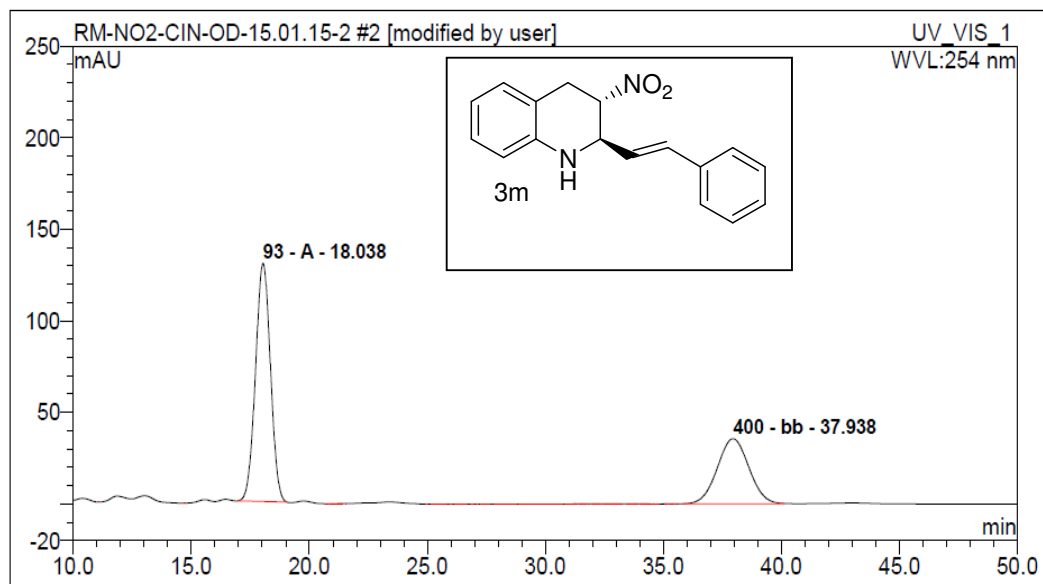
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
3 aa		7.82	0.447183	2.403681203	1.87588	n.a.
4 b		8.52	18.157	97.5963188	24.361	n.a.

RM-NO2--cin-rac



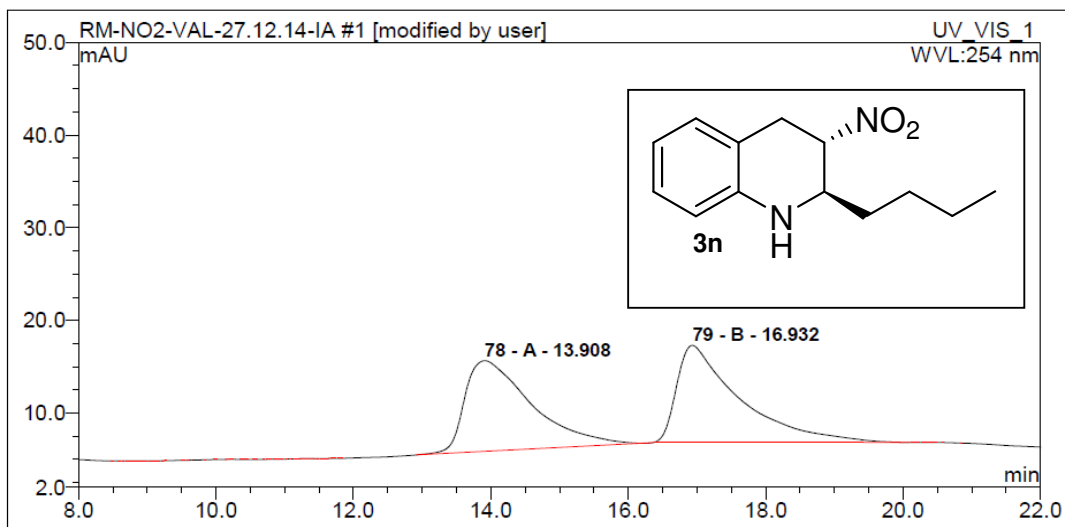
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
94 A		17.96	171.384	50.99830055	182.3699	n.a.
359 B		37.79	164.674	49.00169945	100.750	n.a.

RM-NO2--cin-chi



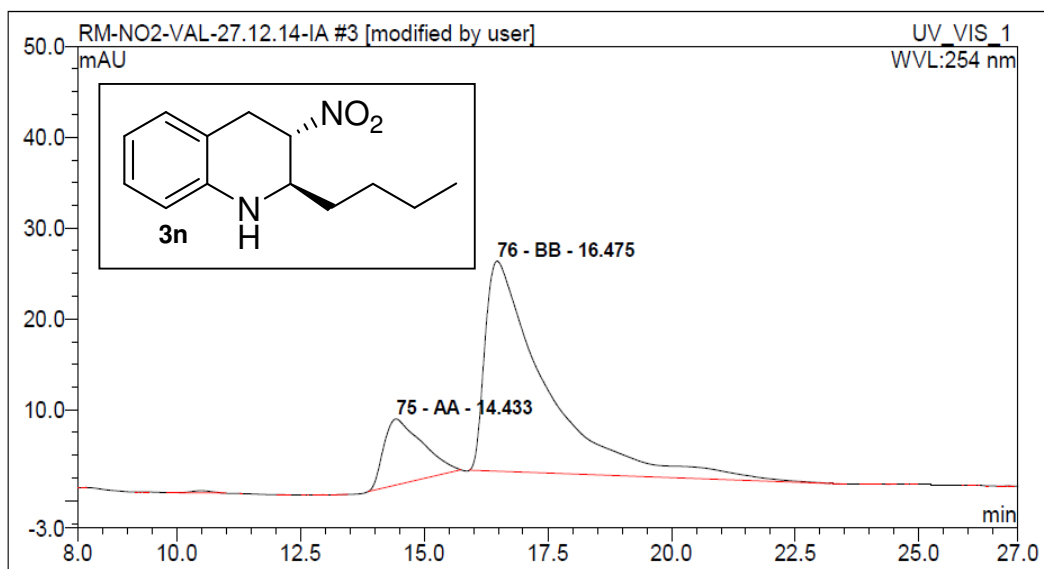
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
93 A		18.04	95.76953	63.51579761	130.0774	n.a.
400 bb		37.94	55.011	36.48420239	35.552	n.a.

RM-MN-NO2-VAL-RAC-IA



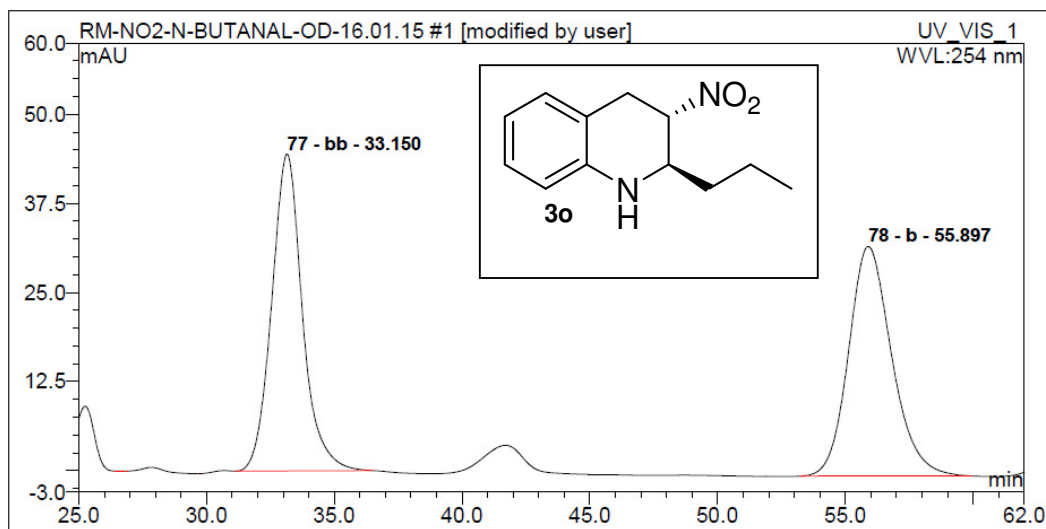
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
78 A		13.91	10.88828	49.77493654	9.77446	n.a.
79 B		16.93	10.987	50.22506346	10.436	n.a.

RM-MN-NO2-VAL-CHI-IA

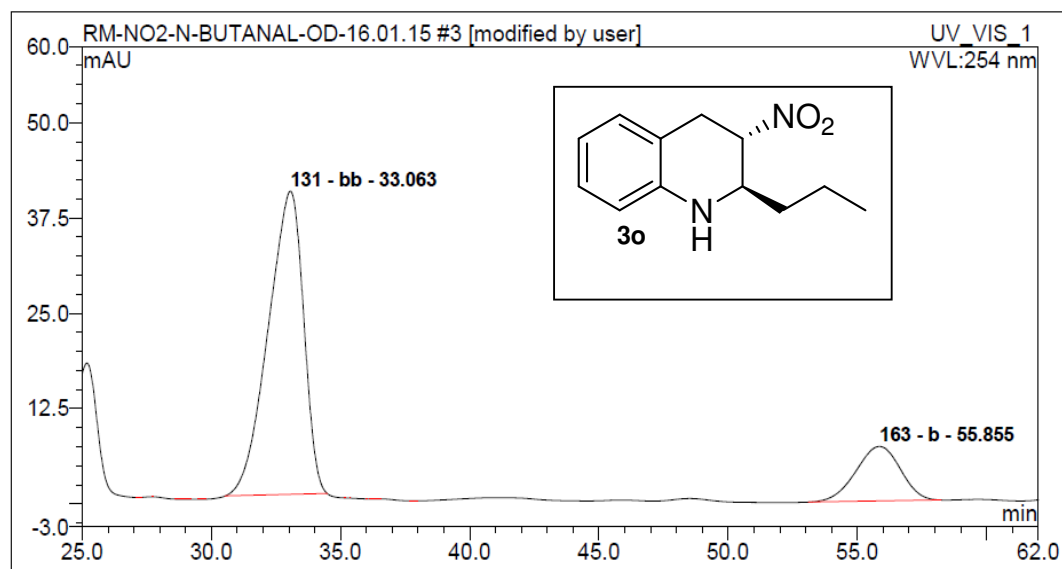


No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
75 AA		14.43	6.434665	16.18448509	7.25302	n.a.
76 BB		16.48	33.324	83.81551491	23.111	n.a.

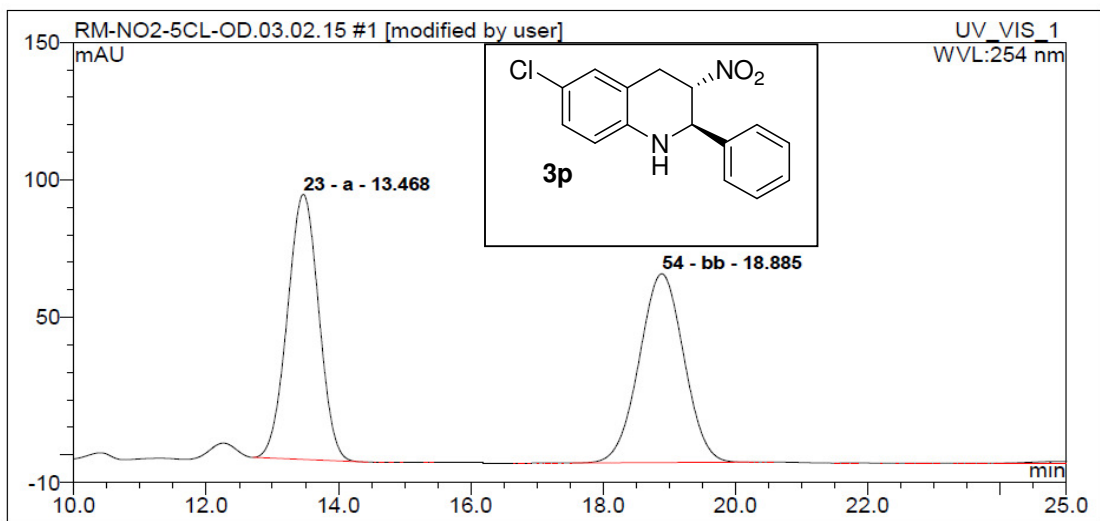
RM-NO2--n-butanal



RM-NO2--n-butanal-chi

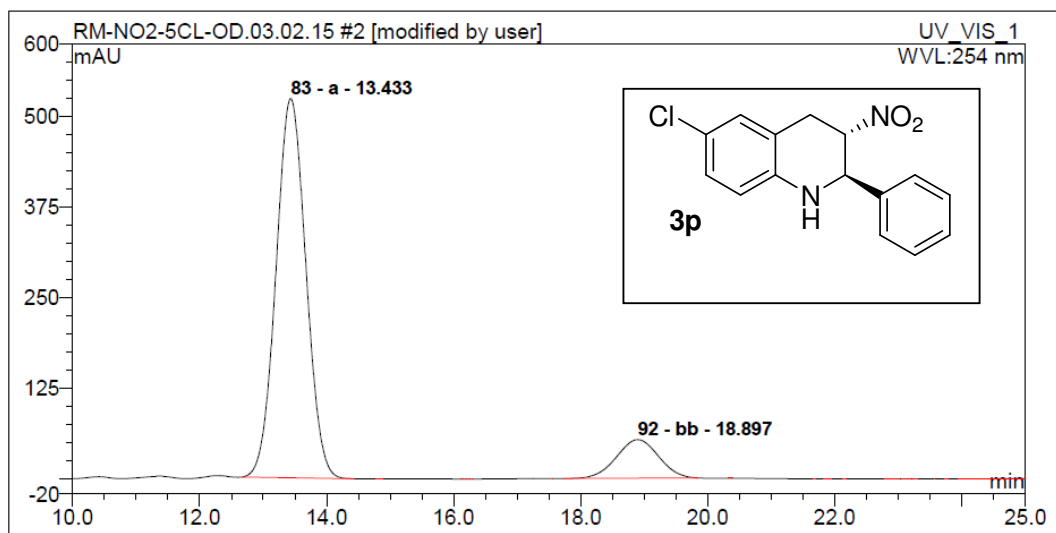


RM-NO2--5cl



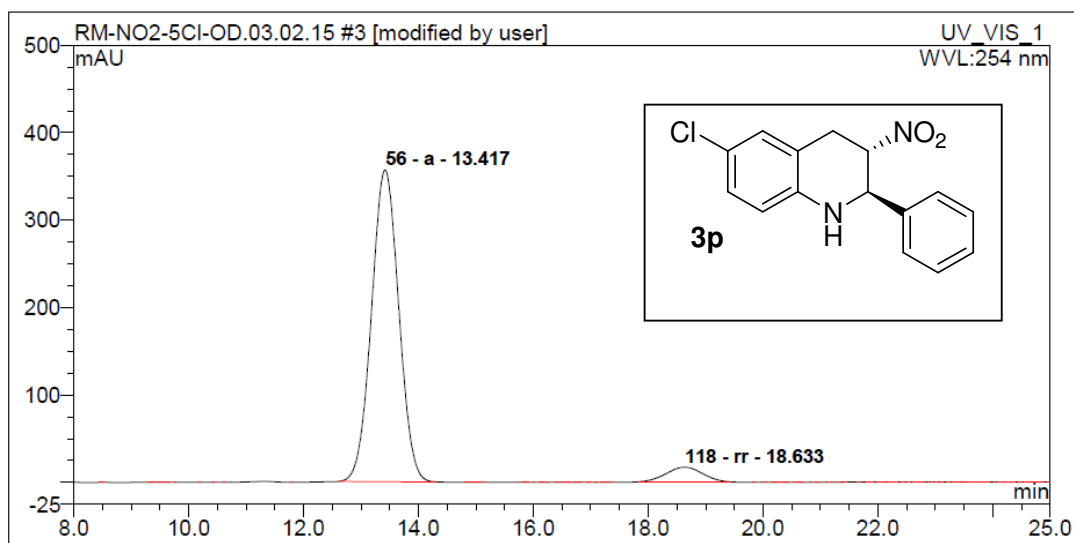
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
23 a		13.47	52.90188	49.6765927	96.35341	n.a.
54 bb		18.89	53.591	50.3234073	68.602	n.a.

RM-NO2--5cl-chi

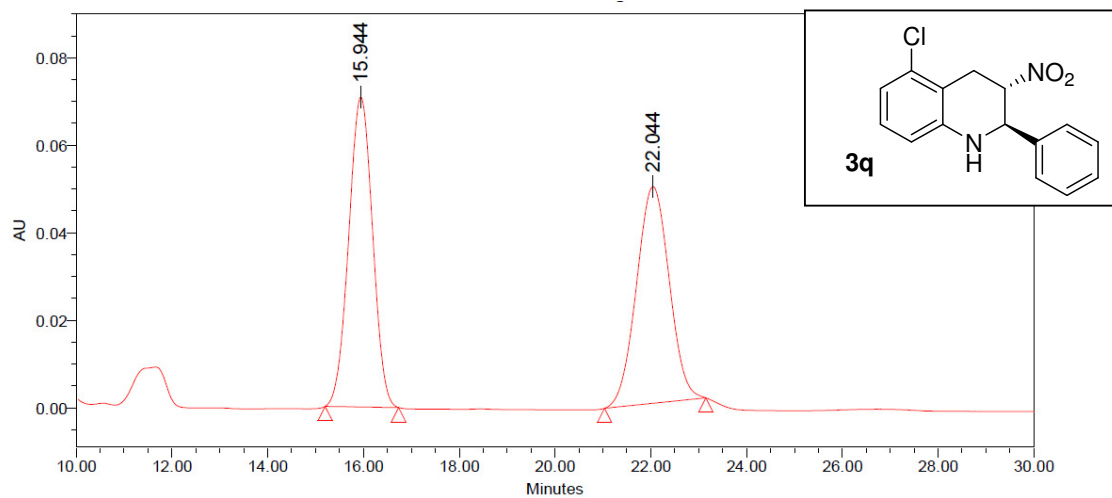


No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
83 a		13.43	284.2532	87.47178967	522.114	n.a.
92 bb		18.90	40.712	12.52821033	52.999	n.a.

RM-NO2-5Cl-Cry

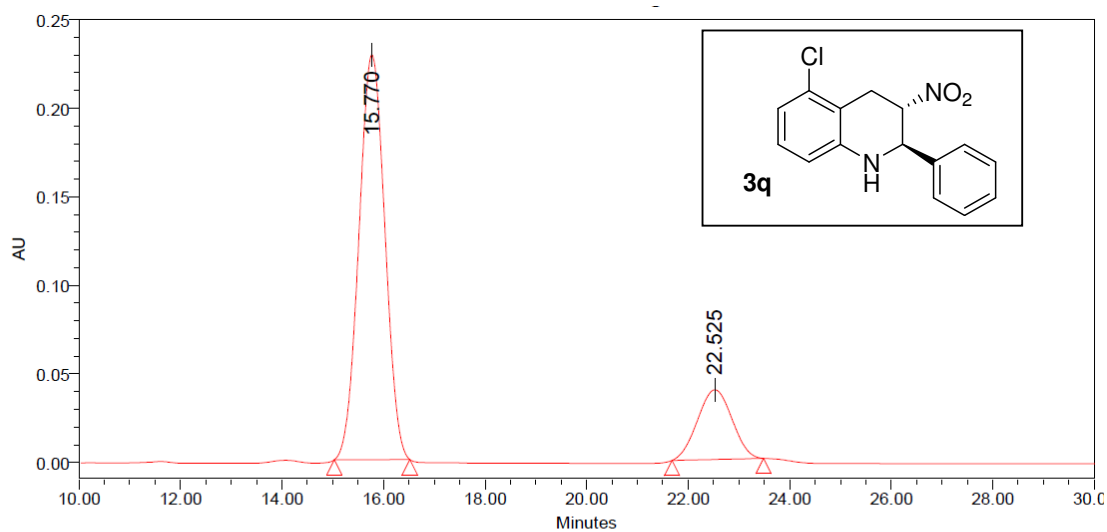


No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
56 a		13.42	195.7353	94.06946113	356.5455	n.a.
118 rr		18.63	12.340	5.930538874	16.776	n.a.



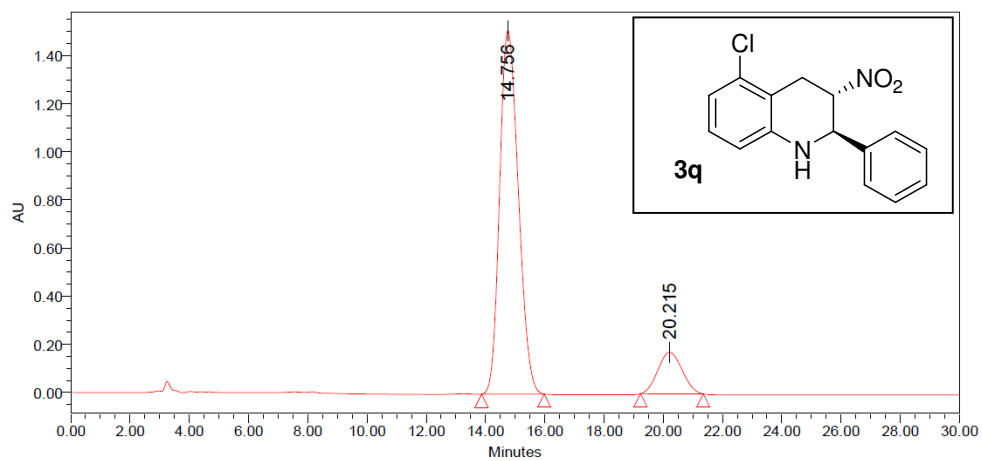
Peak Results

	Name	RT	Area	Height	% Area
1		15.944	2452696	70887	51.02
2		22.044	2355083	49541	48.98



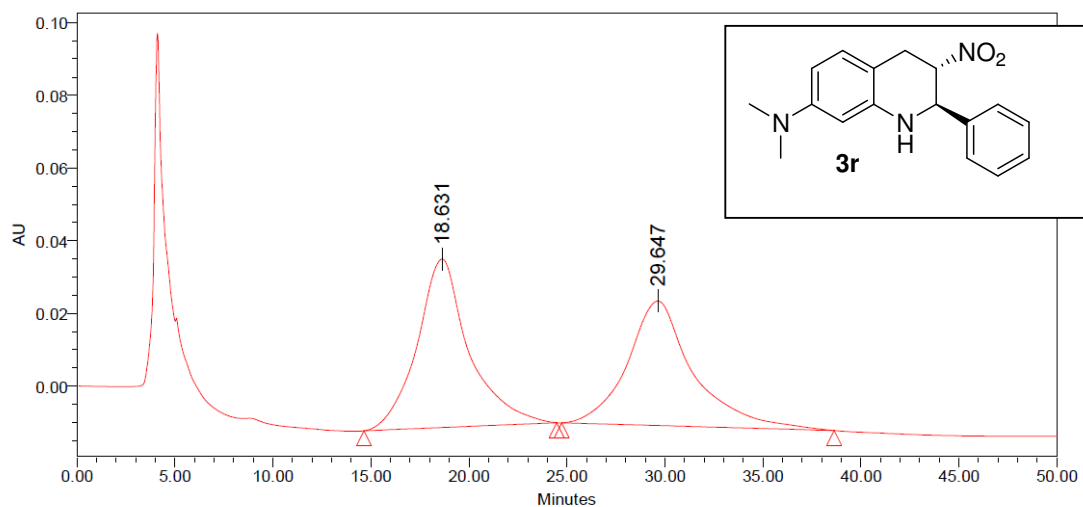
Peak Results

	Name	RT	Area	Height	% Area
1		15.770	8090534	228640	81.34
2		22.525	1855870	39346	18.66



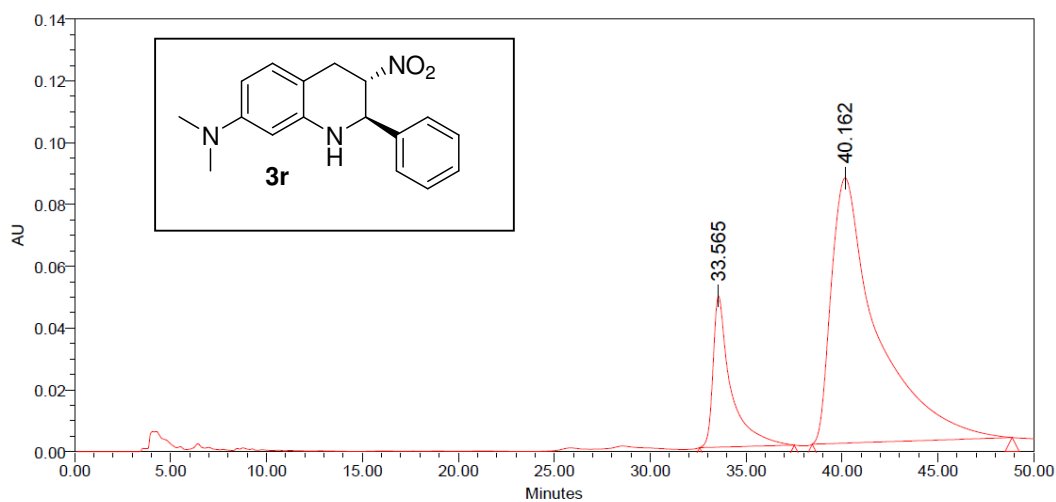
Peak Results

	Name	RT	Area	Height	% Area
1		14.756	66250648	1511202	87.11
2		20.215	9807147	172306	12.89



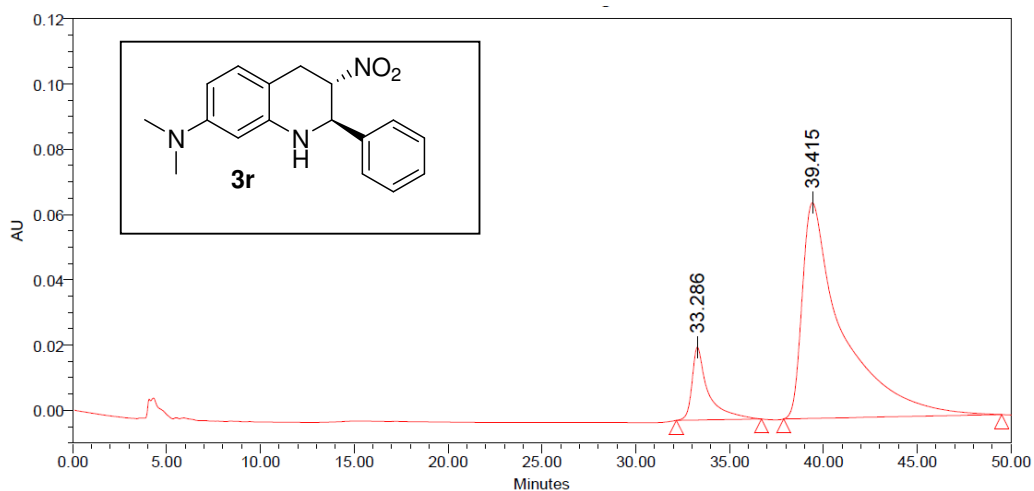
Peak Results

	Name	RT	Area	Height	% Area
1		18.631	8507685	46345	51.65
2		29.647	7963601	34246	48.35



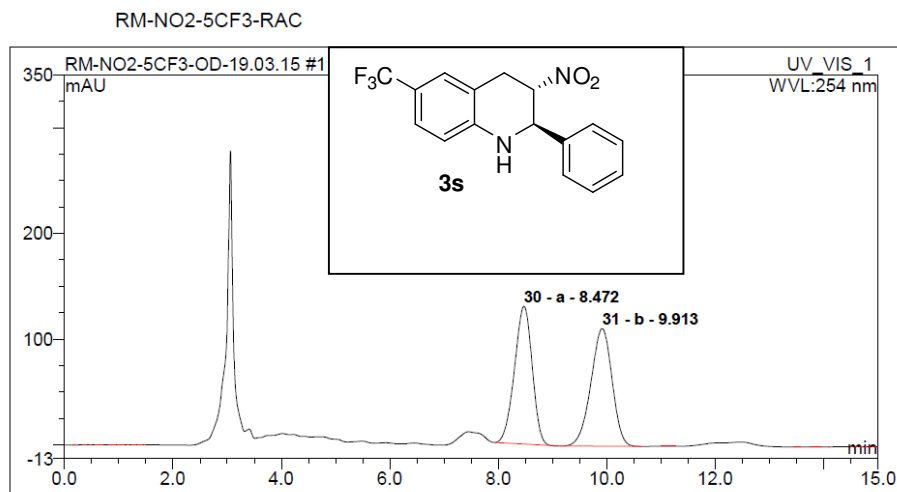
Peak Results

	Name	RT	Area	Height	% Area
1		33.565	3143133	48904	17.98
2		40.162	14341553	85825	82.02



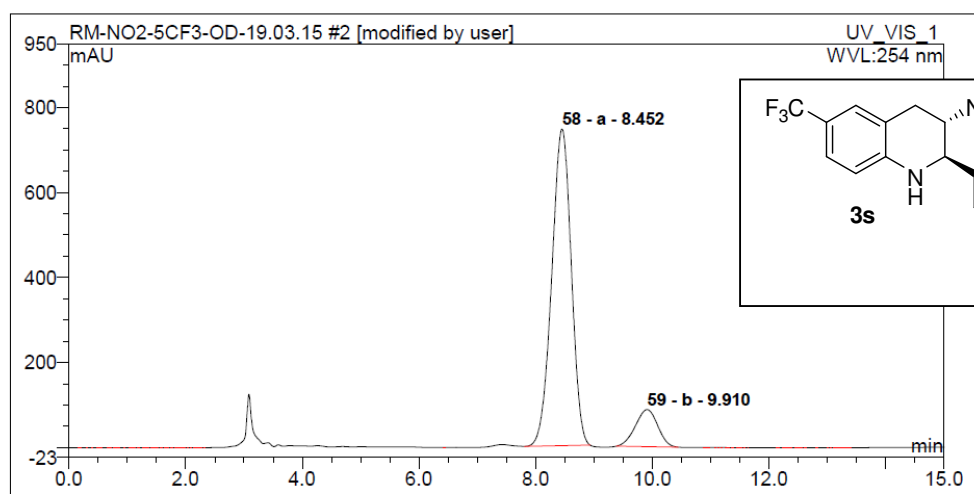
Peak Results

	Name	RT	Area	Height	% Area
1		33.286	1347850	22310	11.95
2		39.415	9934682	66035	88.05



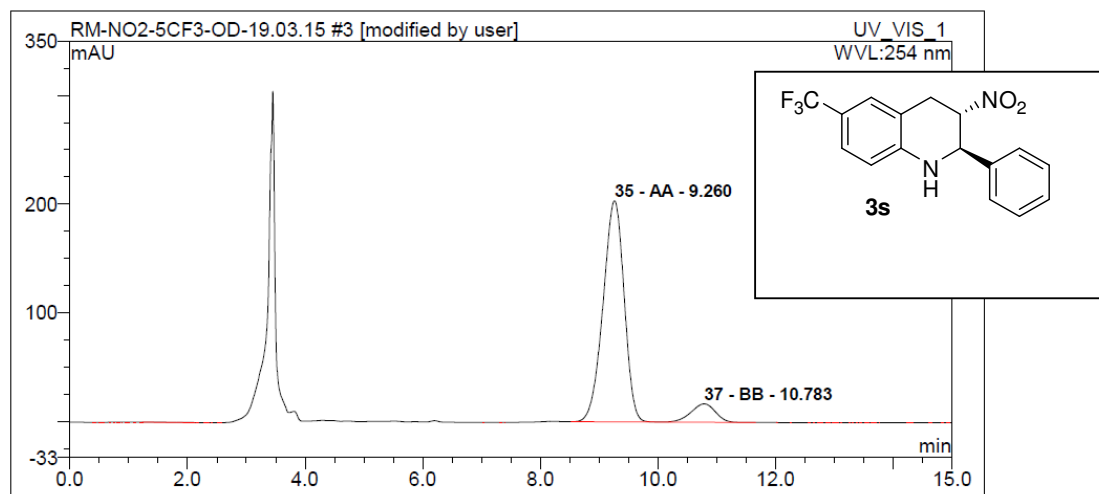
No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
	30 a	8.47	49.42286	49.49053986	130.3515	n.a.
	31 b	9.91	50.440	50.50946014	111.210	n.a.

RM-NO2-5CF3-CHI



No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
58 a		8.45	288.0884	88.17406032	744.5998	n.a.
59 b		9.91	38.639	11.82593968	87.086	n.a.

RM-NO2-5CF3-CRY



No.	Peak Name	Ret.Time (detected) min	Area mAU*min	Rel.Area(ident.) %	Height mAU	Amount
35 AA		9.26	84.49823	91.12835464	203.412	n.a.
37 BB		10.78	8.226	8.871645359	17.015	n.a.