Electronic Supplementary Material (ESI) for Organic & Biomolecular Chemistry
This journal is © The Royal Society of Chemistry 2012

Supporting Information

Highly Enantioselective Michael Addition of 3-Aryloxindoles with Vinyl Phosphates Catalyzed by Cinchona Alkaloid Derived Thiourea Catalysts

Mei-Xin Zhao,*[a] Tong-Lei Dai,[a] Ran Liu,[a] Deng-Ke Wei,[a] Hao Zhou,[a] Fei-Hu Ji[a] and Min Shi*[a,b]

[a] *Laboratory for Advanced Materials and Institute of Fine Chemicals, School of Chemistry & Molecular Engineering, East China University of Science and Technology, 130 Mei Long Road, Shanghai, 200237, P. R. China.*

[b] *State Key Laboratory of Organometallic Chemistry, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, 354 Fenglin Road, Shanghai 200032, P. R. China.*

mxzhao@ecust.edu.edu and Mshi@mail.sioc.ac.cn

* To whom correspondence should be addressed. Tel: 86-21-64252995. Fax: 86-21-34201699

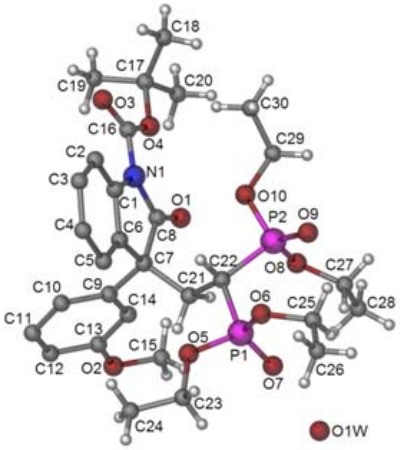
Table of Contents

This journal is © The Royal Society of Chemistry 2012

1. X-Ray Diffraction data of comopound 3u

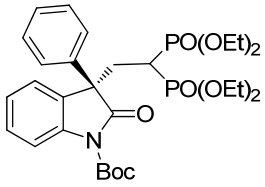
Table 1. Crystal data and structure refinement for 1683.

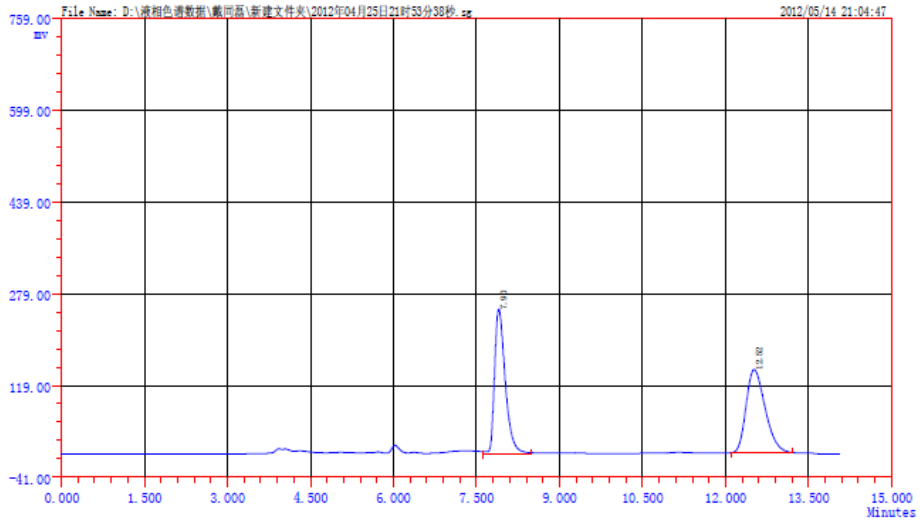
Identification code	1683	
Empirical formula	$C_{30}H_{43}NO_{11}P_2$	
Formula weight	655.59	
Temperature	296(2)	
Wavelength	0.71073 Å	
Crystal system	Orthorhombic	
Space group	P2(1)2(1)2(1)	
Unit cell dimensions	a = 8.8403(5) Å	α = 90°.
	b = 11.1099(7) Å	β = 90°.
	c = 35.459(2) Å	γ = 90°.
Volume	3482.6(4) $Å^3$	
Z	4	
Density (calculated)	1.250 Mg/m^3	
Absorption coefficient	0.180 mm^{-1}	
F(000)	1392	
Crystal size	0.36 x 0.28 x 0.22 mm^3	
Theta range for data collection	1.92 to 25.01°.	
Index ranges	-10<=h<=10, -11<=k<=13, -42<=l<=42	
Reflections collected	40524	
Independent reflections	6107 [R(int) = 0.0337]	
Data / restraints / parameters	6107 / 5 / 397	
Goodness-of-fit on F^2	1.058	
Final R indices [I>2sigma(I)]	R1 = 0.0540, wR2 = 0.1483	
R indices (all data)	R1 = 0.0632, wR2 = 0.1578	
Largest diff. peak and hole	0.312 and -0.337 $e.Å^{-3}$	



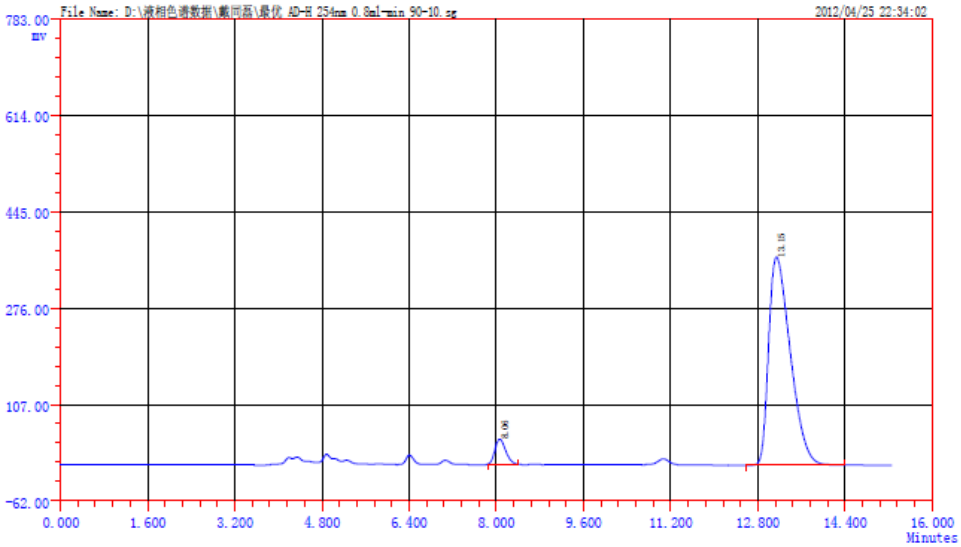
2. HPLC data for the determination of the ee's of adducts 3 and 5

3a (Table 3, entry 1)



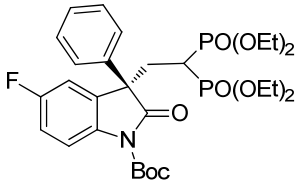


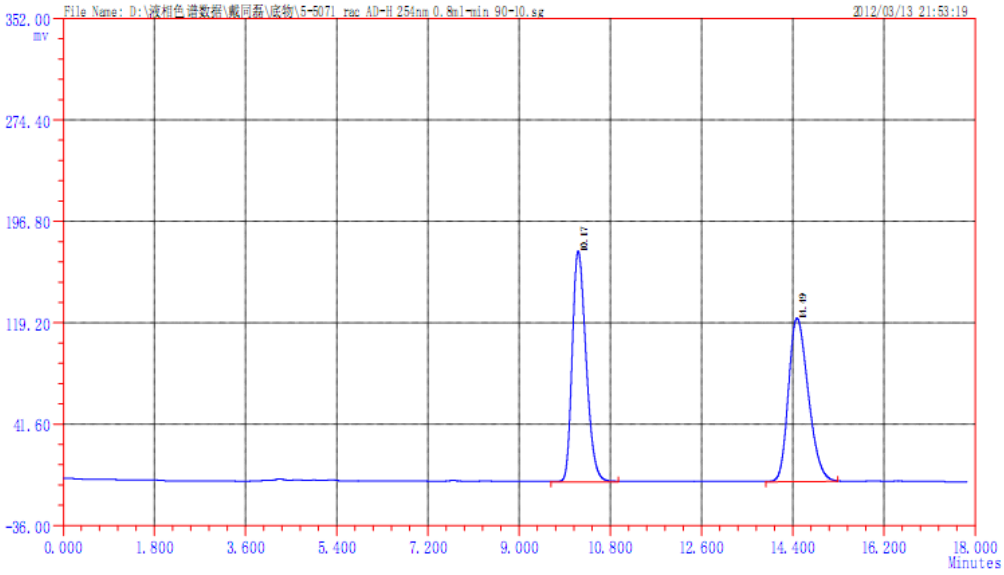
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.903	252203	3418598.6	49.7178	1.53	6776
2		12.520	144737	3457411.0	50.2822	1.32	5475
	Σ:		396940	6876009.6	100.0000		



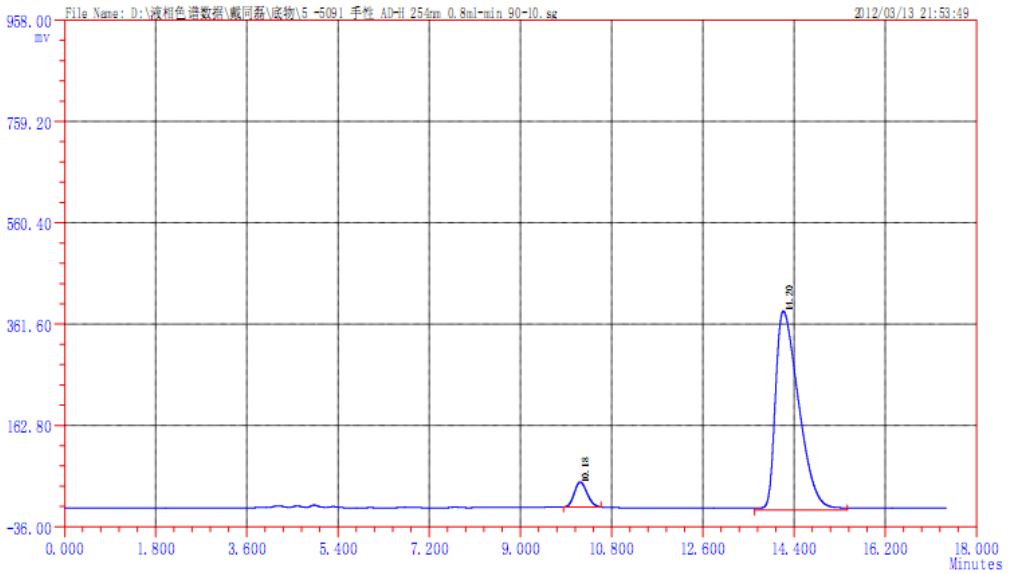
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.065	43907	600967.4	5.5919	1.21	6920
2		13.145	365017	10146085.7	94.4081	1.59	4457
	Σ:		408924	10747053.1	100.0000		

3b (Table 3, entry 2)



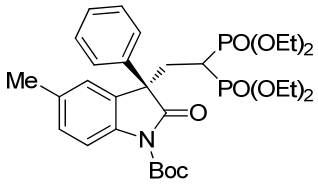


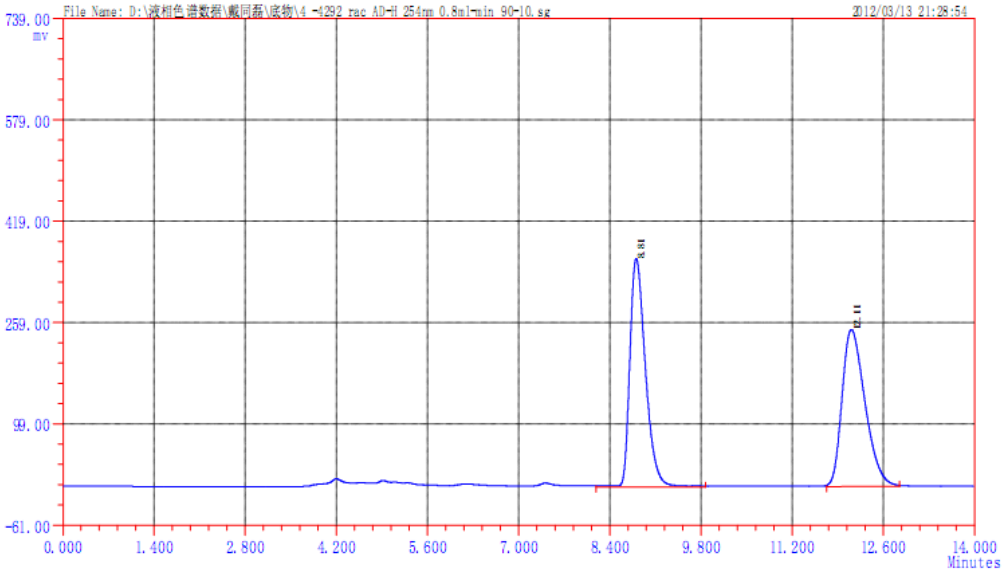
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.168	176744	3376315.7	49.7011	1.28	5647
2		14.488	125217	3416931.4	50.2989	1.26	5618
	Σ:		301961	6793247.2	100.0000		



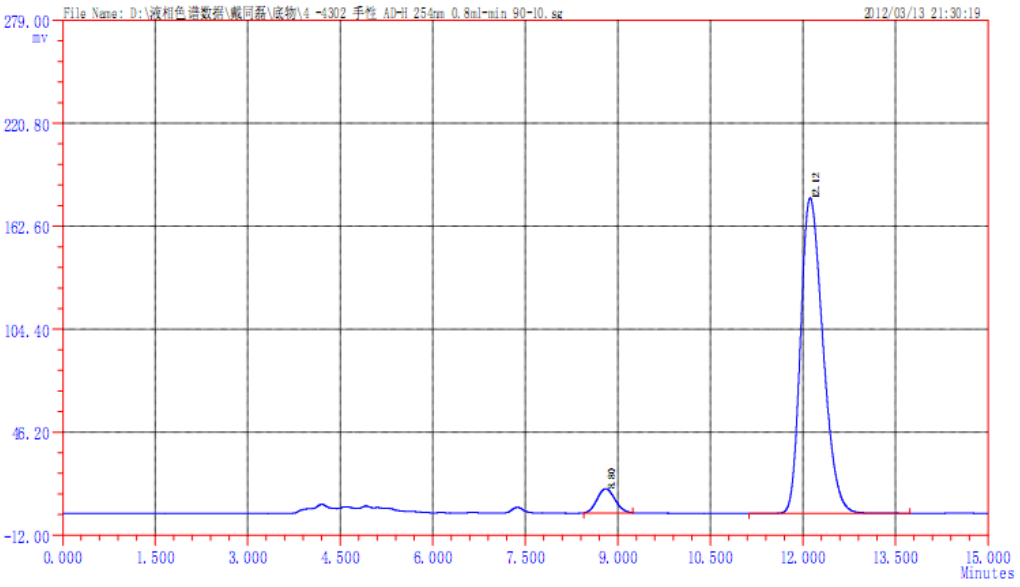
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.182	49191	865893.3	6.4756	1.15	6668
2		14.195	390331	12505790.9	93.5244	1.69	3912
	Σ:		439522	13371684.2	100.0000		

3c (Table 3, entry 3)



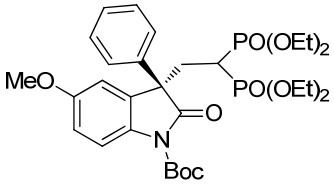


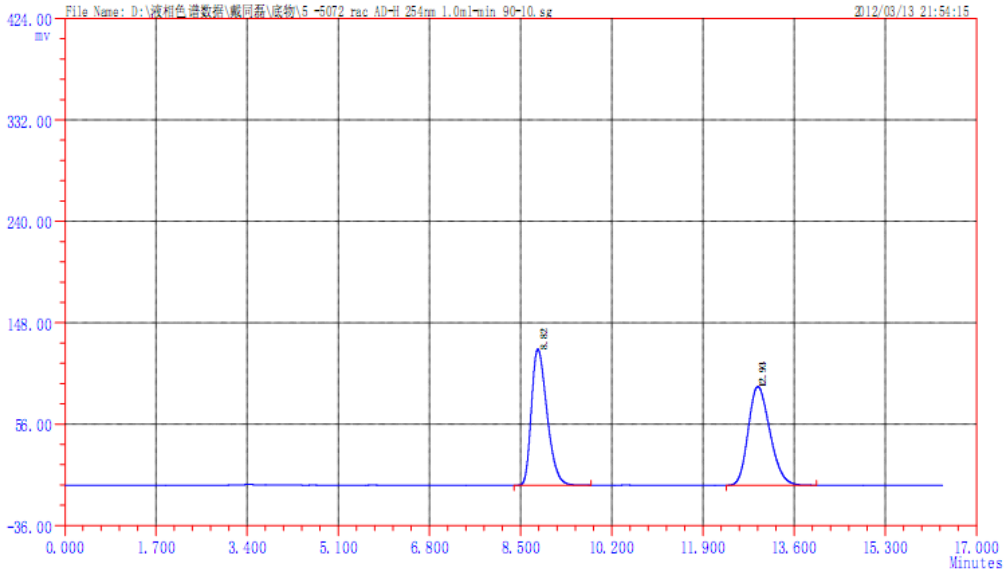
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.807	361039	6071429.8	49.9837	1.43	5466
2		12.113	247801	6075391.7	50.0163	1.37	4865
	Σ:		608840	12146821.5	100.0000		



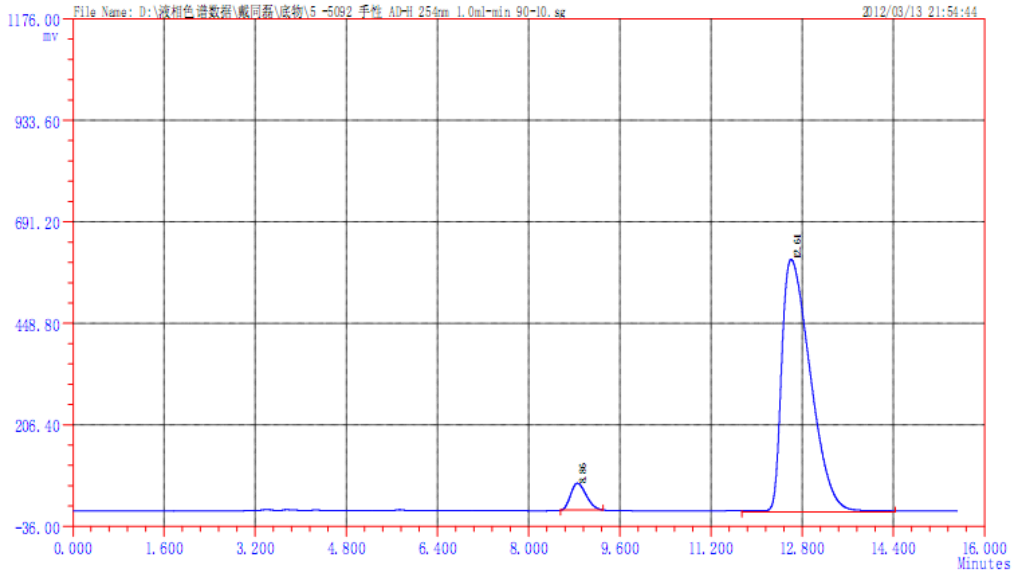
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.805	13650	274370.3	5.7210	1.10	3824
2		12.122	178369	4521471.4	94.2790	1.28	4558
	Σ:		192019	4795841.7	100.0000		

3d (Table 3, entry 4)



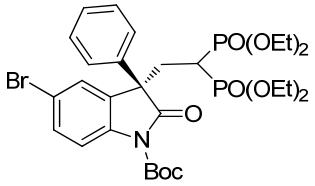


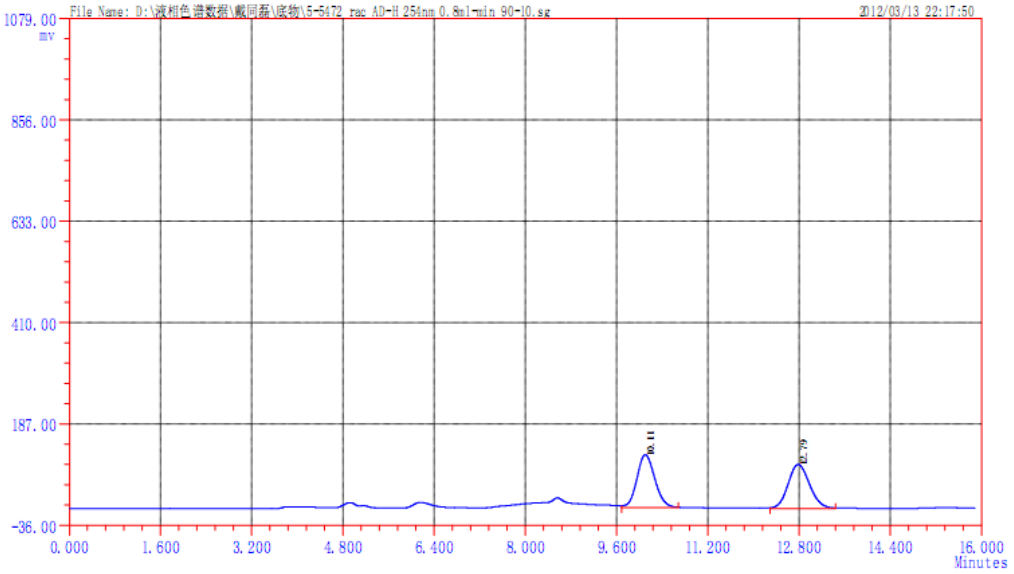
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.823	123753	2513396.6	49.6702	1.36	3762
2		12.927	89924	2546774.4	50.3298	1.22	4152
	Σ:		213677	5060171.0	100.0000		



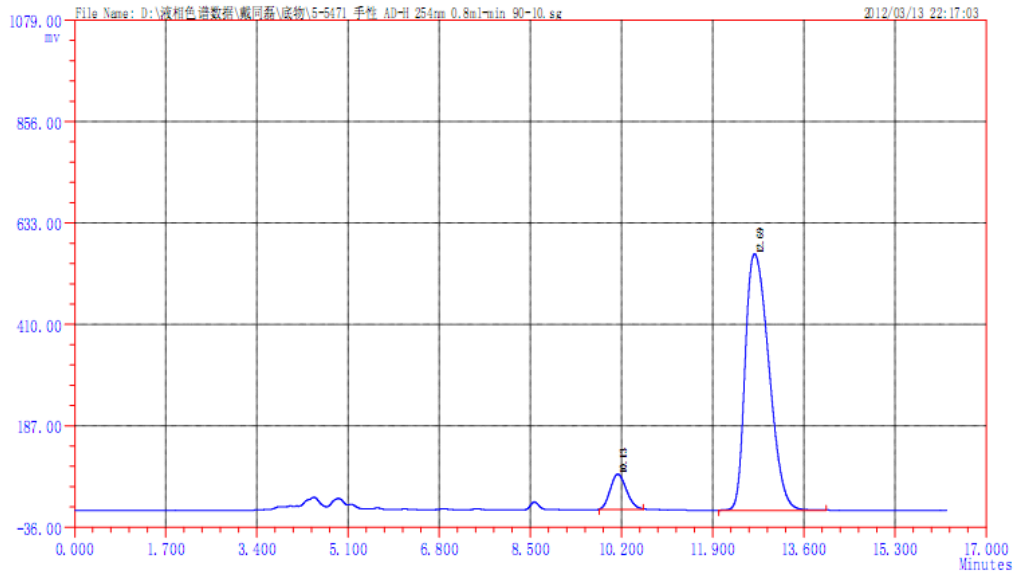
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.858	64458	1236953.0	5.5222	1.25	4247
2		12.612	603004	21162611.8	94.4778	1.78	2574
	Σ:		667462	22399564.9	100.0000		

3e (Table 3, entry 5)





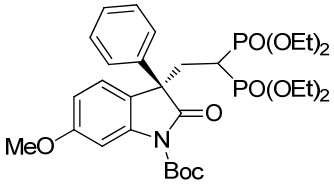
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.107	116600	2570195.9	50.0218	1.09	4190
2		12.792	97146	2567957.8	49.9782	1.11	4667
	Σ:		213746	5138153.7	100.0000		

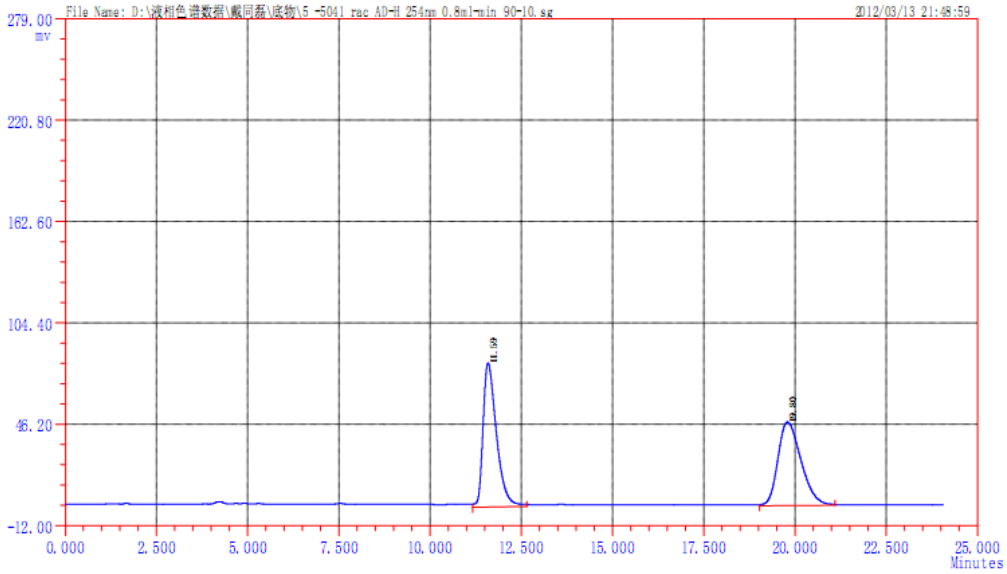


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.133	77096	1610979.9	8.4781	1.15	4687
2		12.685	564342	17390689.9	91.5219	1.38	3377
	Σ:		641438	19001669.8	100.0000		

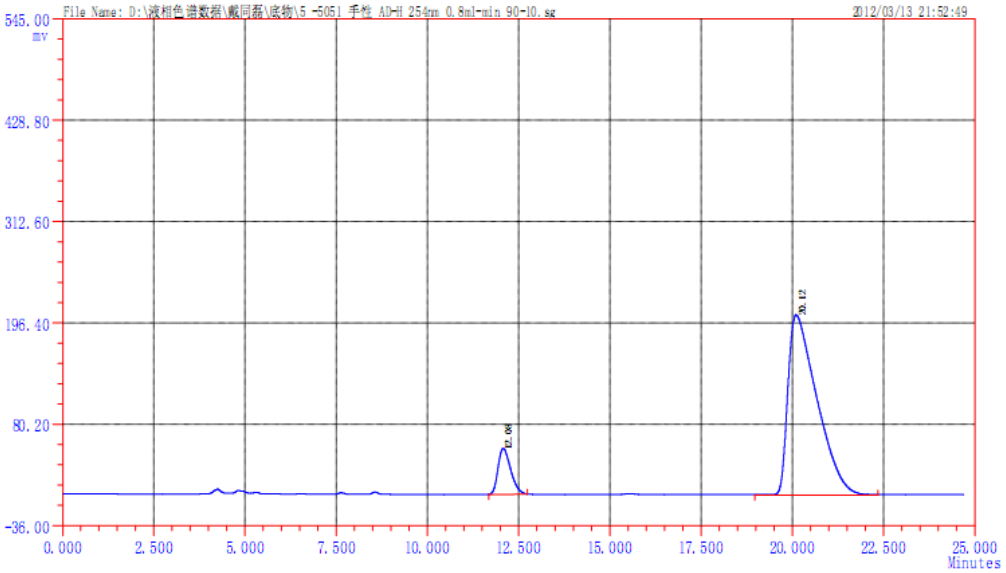
This journal is © The Royal Society of Chemistry 2012

3f (Table 3, entry 6)



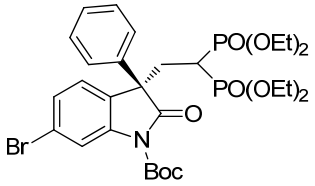


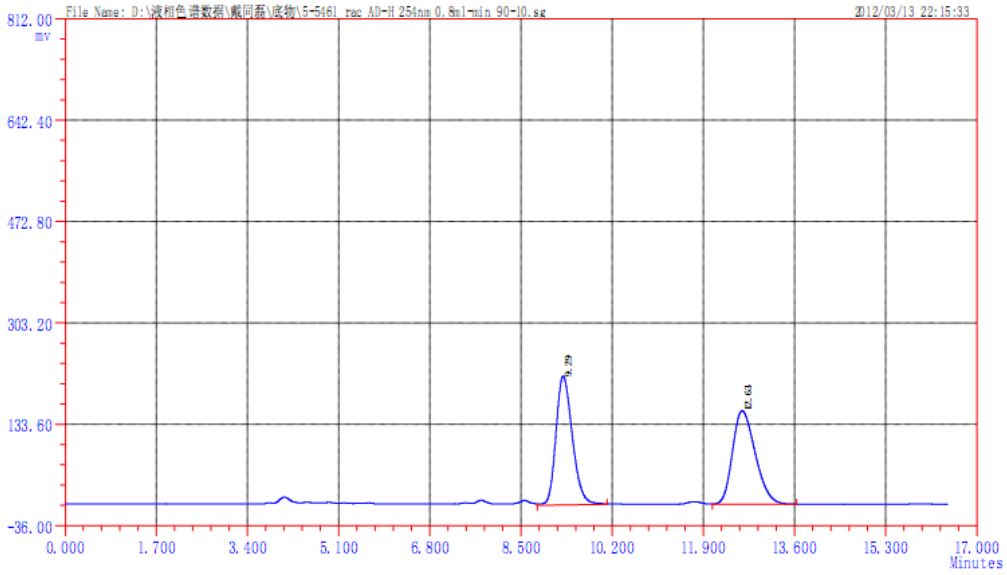
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		11.592	82651	2123044.9	49.9369	1.58	4059
2		19.798	48097	2128411.8	50.0631	1.33	3989
	Σ:		130748	4251456.7	100.0000		



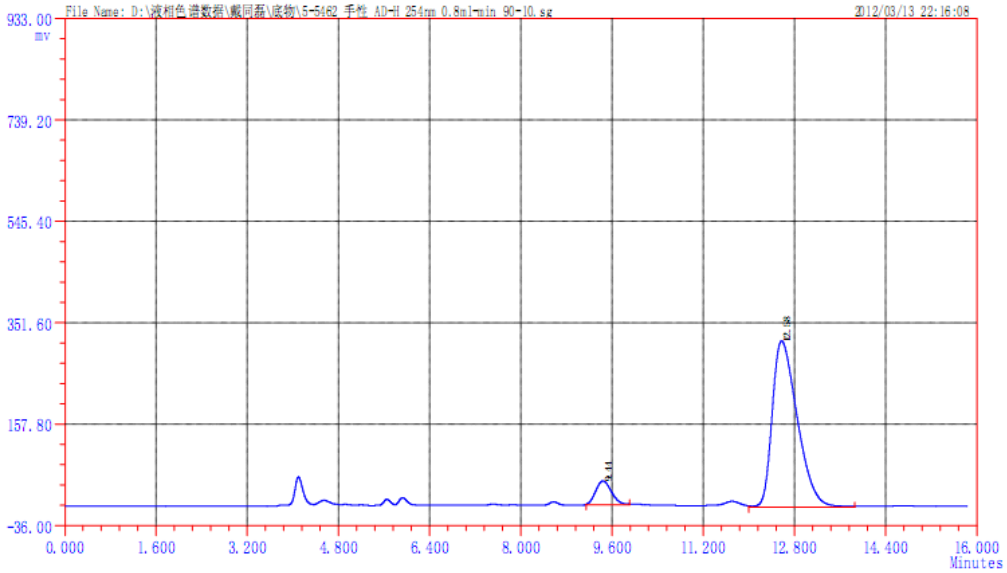
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		12.083	52656	1266062.0	10.0128	1.34	5034
2		20.115	206345	11378314.4	89.9872	2.06	2652
	Σ:		259001	12644376.4	100.0000		

3g (Table 3, entry 7)



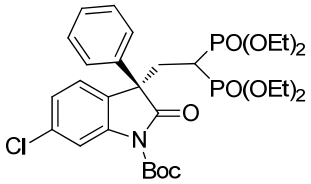


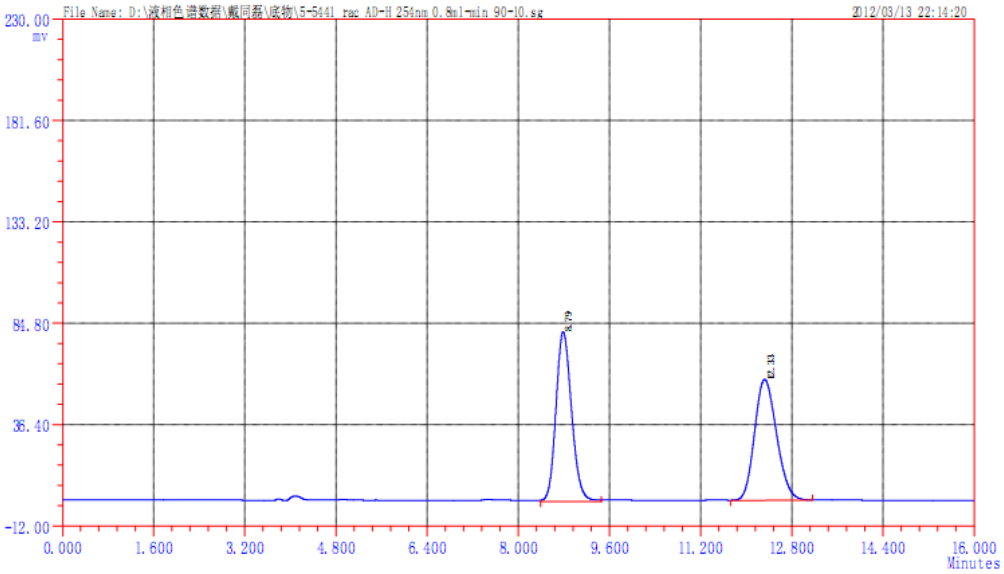
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.288	215060	4578868.7	49.8672	1.24	3793
2		12.630	156178	4603260.8	50.1328	1.27	3660
	Σ:		371238	9182129.5	100.0000		



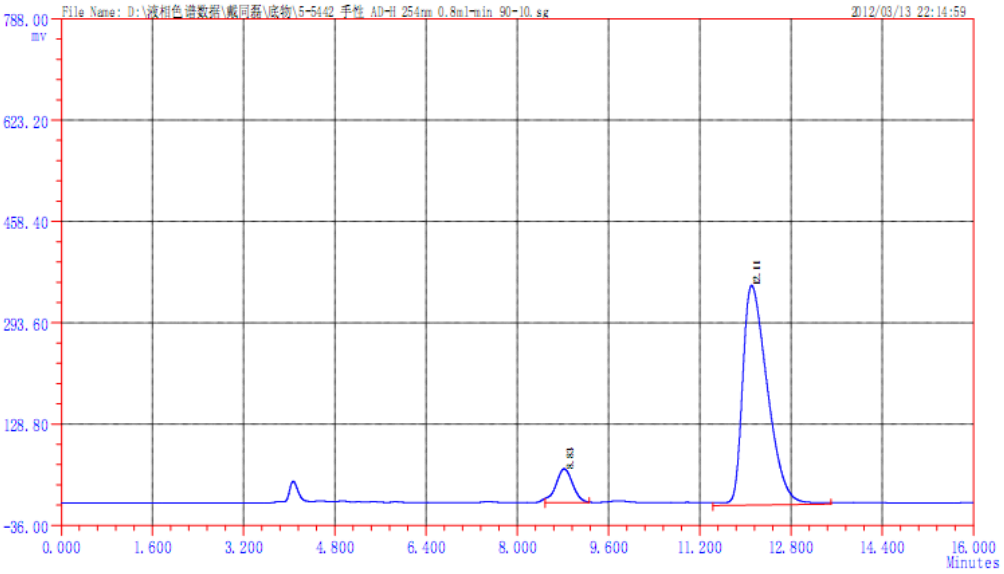
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.443	45490	875963.2	8.1962	1.19	4793
2		12.578	318420	9811440.0	91.8038	1.49	3321
	Σ:		363910	10687403.2	100.0000		

3h (Table 3, entry 8)



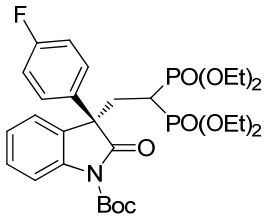


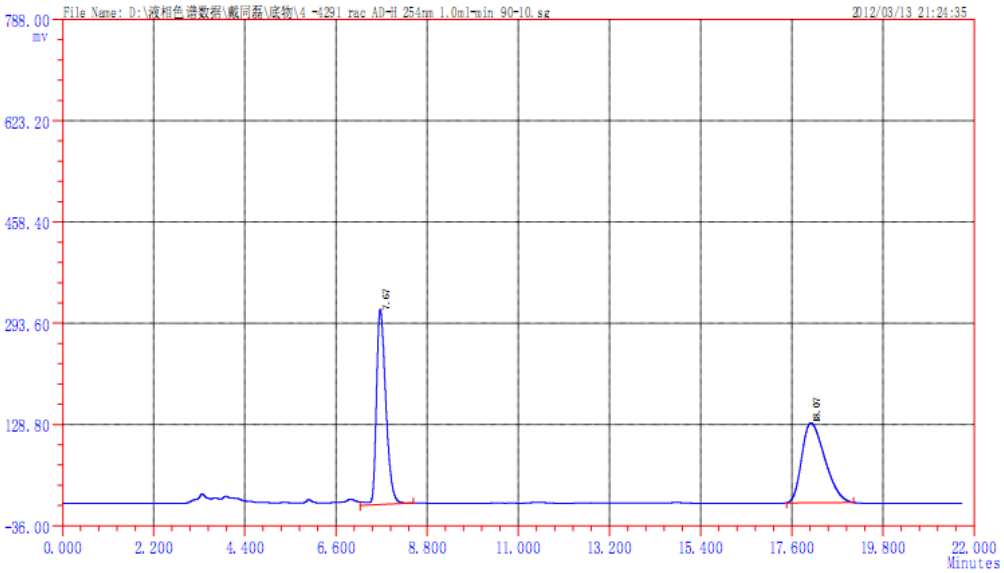
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.790	81047	1547046.8	49.9153	1.15	4226
2		12.328	57712	1552299.9	50.0847	1.16	4187
	Σ:		138759	3099346.7	100.0000		



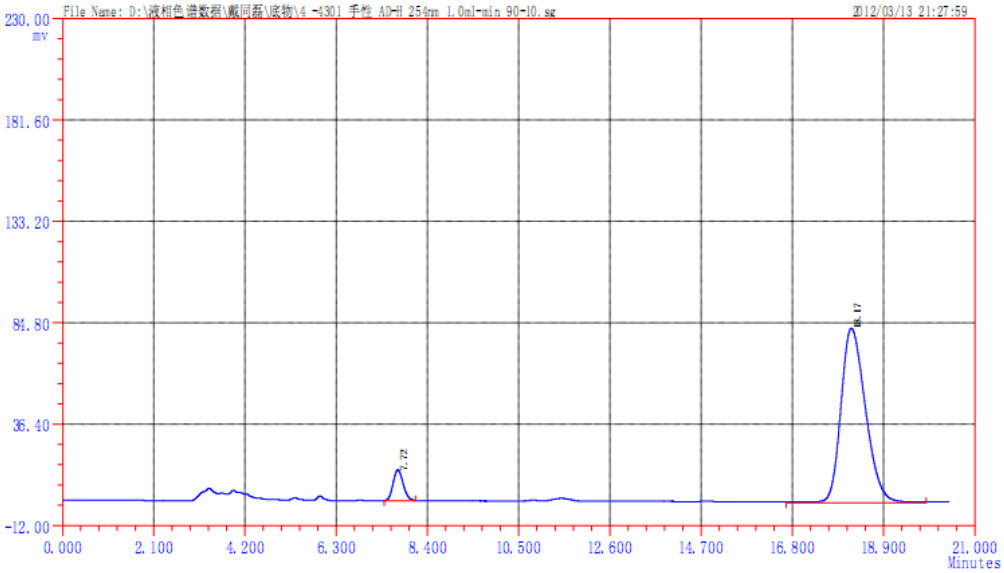
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.827	54783	1120139.3	9.3020	1.02	3714
2		12.112	357731	10921832.0	90.6980	1.59	3137
	Σ:		412514	12041971.2	100.0000		

3i (Table 3, entry 9)



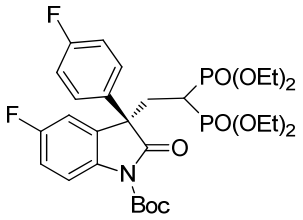


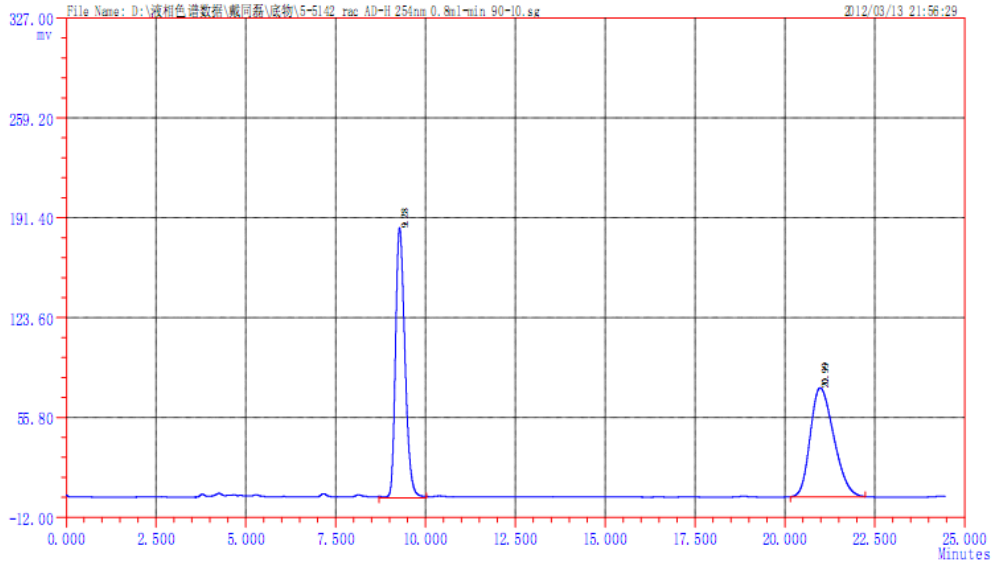
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.670	317287	5029339.0	49.9280	1.41	4667
2		18.068	130009	5043852.8	50.0720	1.38	4323
	Σ:		447296	10073191.8	100.0000		



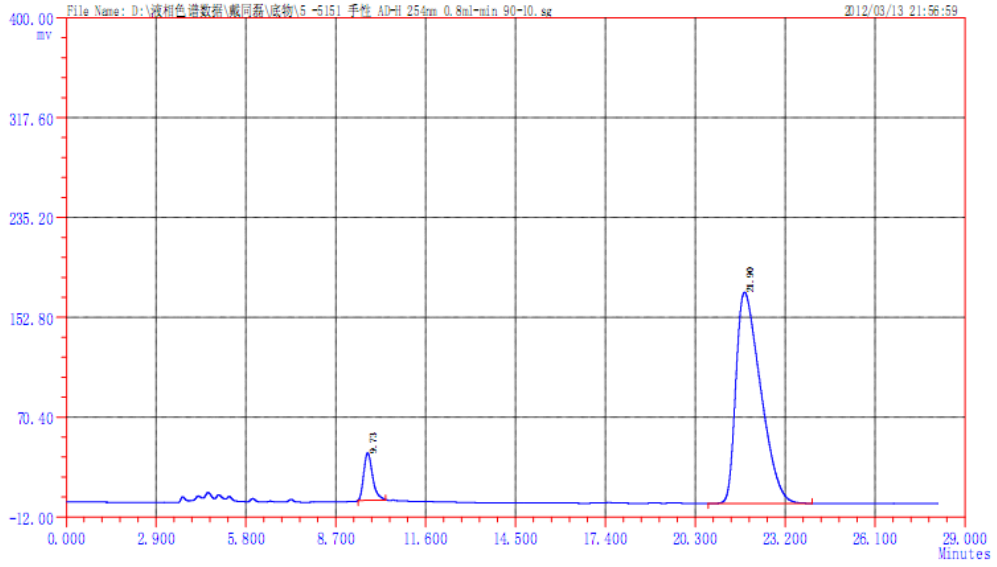
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.720	14739	237994.7	6.7682	1.13	4556
2		18.167	83190	3278360.2	93.2318	1.26	4235
	Σ:		97929	3516354.8	100.0000		

3j (Table 3, entry 10)



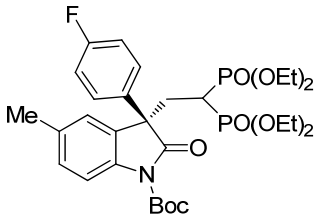


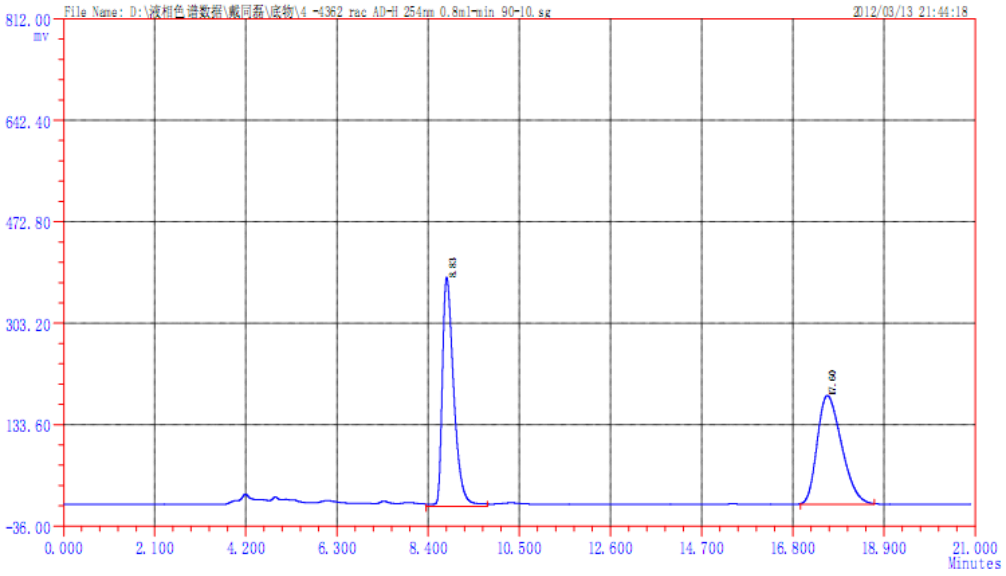
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.280	183227	3350383.1	49.7227	1.27	5133
2		20.993	74160	3387749.6	50.2773	1.26	4209
	Σ:		257387	6738132.7	100.0000		



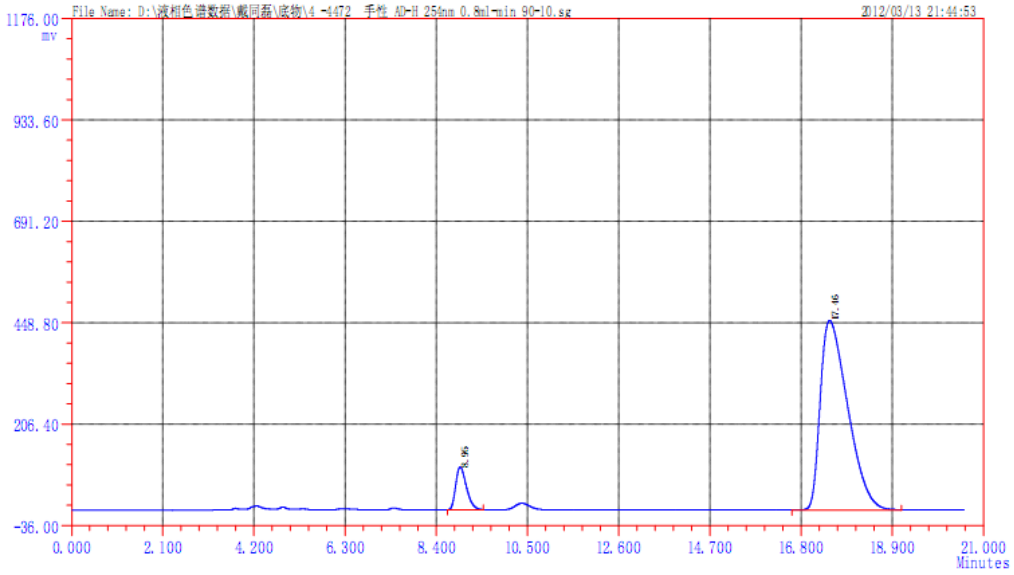
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.727	39211	779343.5	7.4384	1.40	4773
2		21.895	174474	9697897.2	92.5616	1.62	3093
	Σ:		213685	10477240.7	100.0000		

3k (Table 3, entry 11)



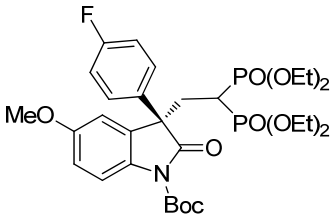


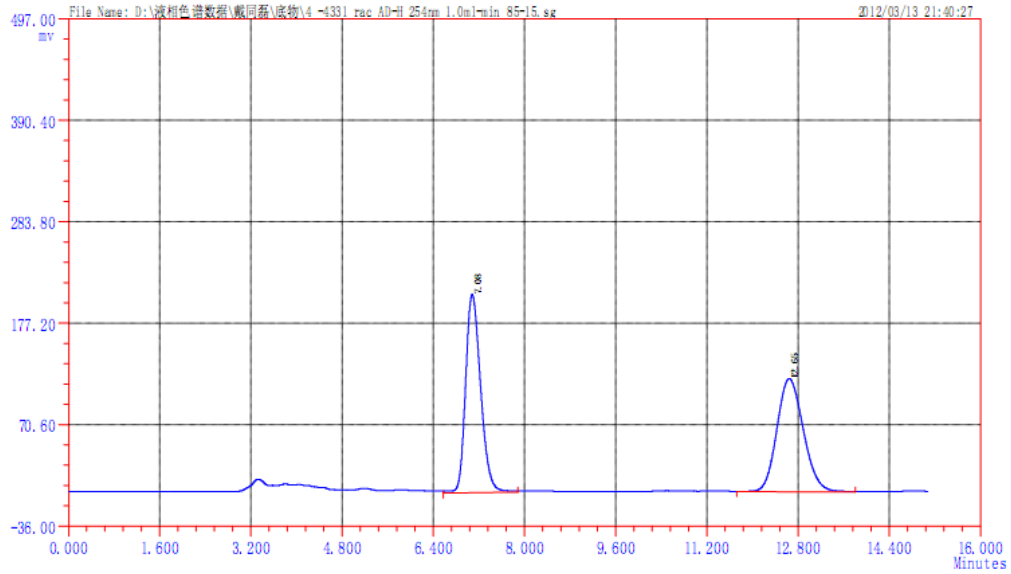
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.828	382505	7065198.6	49.7367	1.57	4553
2		17.600	181940	7140011.4	50.2633	1.32	4009
	Σ:		564445	14205210.0	100.0000		



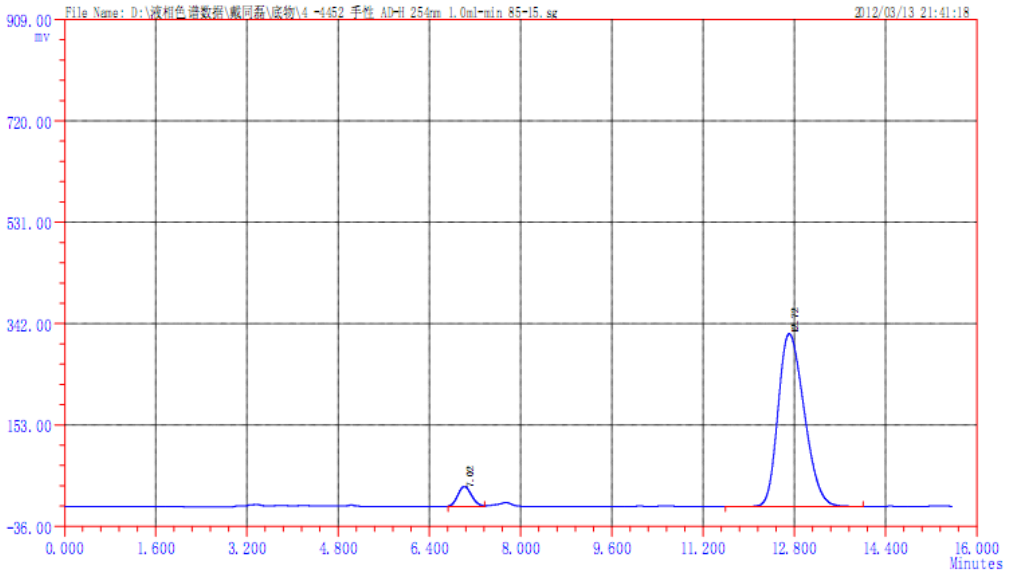
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.952	102515	1782952.7	8.1772	1.35	5280
2		17.462	453007	20021050.6	91.8228	1.69	3111
	Σ:		555522	21804003.3	100.0000		

3l (Table 3, entry 12)



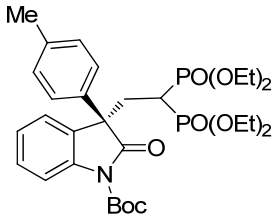


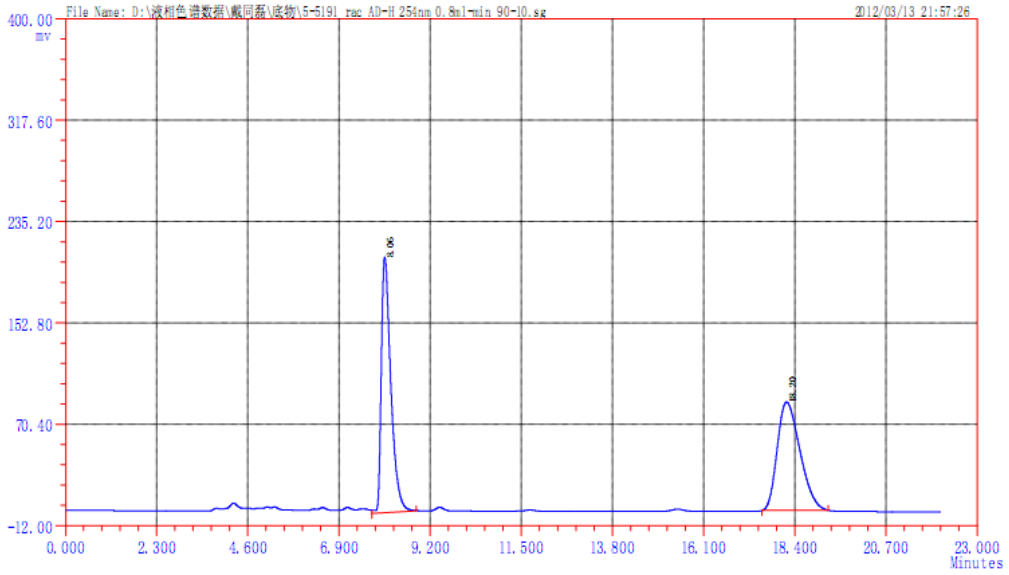
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.083	208375	3845465.6	50.0842	1.25	2936
2		12.648	118610	3832530.7	49.9158	1.13	3054
	Σ:		326985	7677996.3	100.0000		



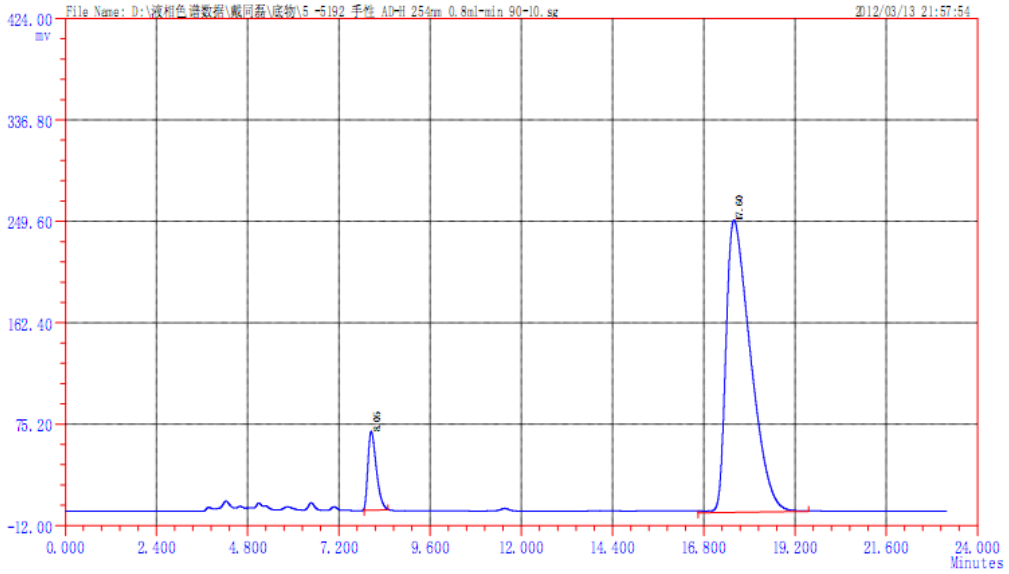
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.017	36829	616699.6	5.6696	1.12	3500
2		12.717	322185	10260621.5	94.3304	1.25	3178
	Σ:		359014	10877321.1	100.0000		

3m (Table 3, entry 13)



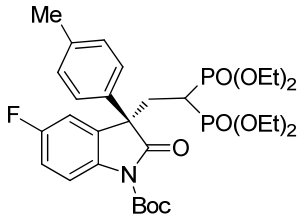


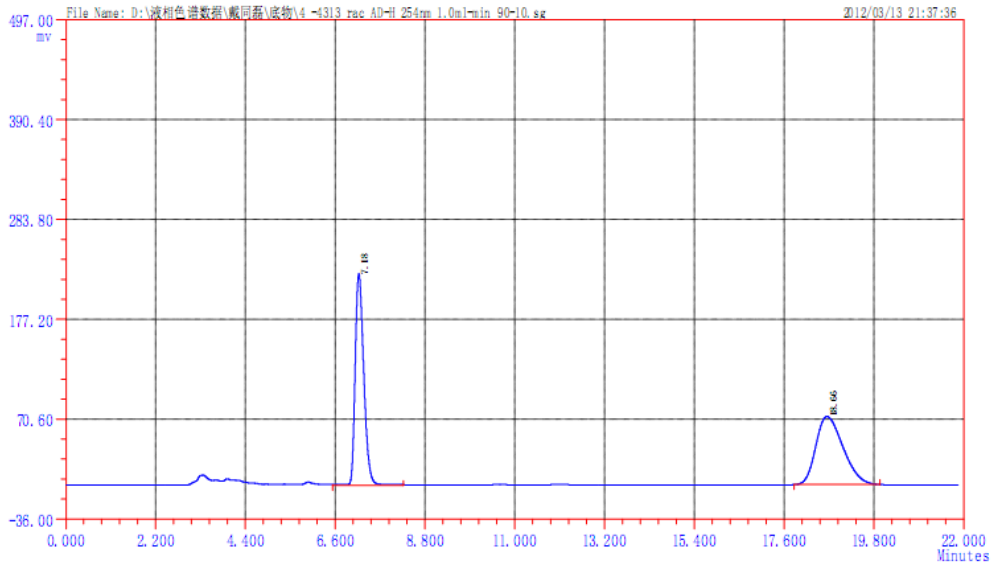
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.057	207642	3469171.6	49.6455	1.74	4635
2		18.202	88033	3518711.7	50.3545	1.32	4133
	Σ:		295675	6987883.2	100.0000		



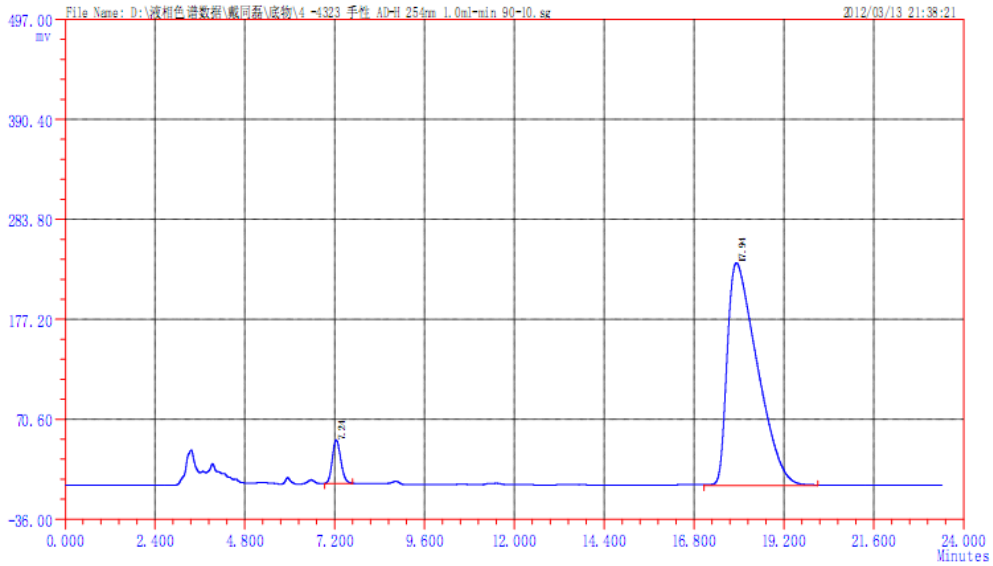
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.048	67737	1040495.7	8.4443	1.54	5472
2		17.598	251044	11281338.1	91.5557	1.81	3057
	Σ:		318781	12321833.9	100.0000		

3n (Table 3, entry 14)



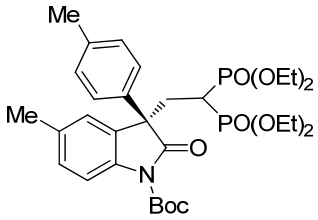


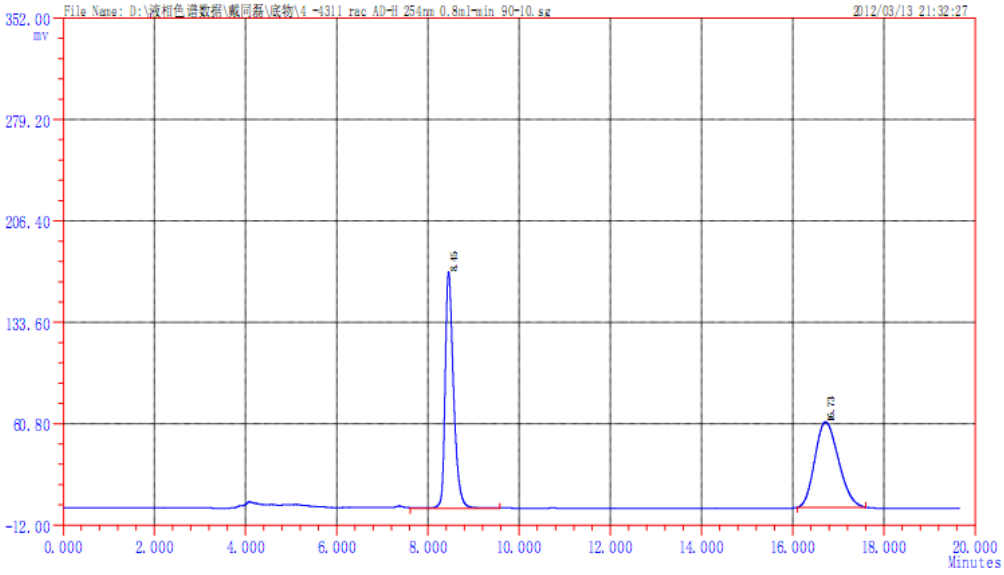
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.180	226185	3354800.7	49.8175	1.33	4671
2		18.663	72937	3379374.6	50.1825	1.30	3234
	Σ:		299122	6734175.3	100.0000		



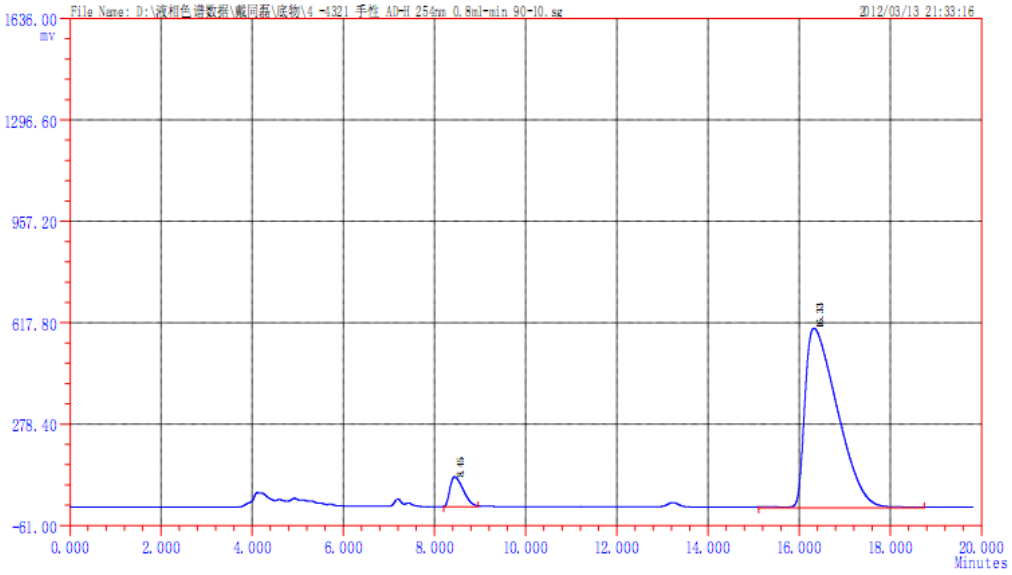
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.240	46644	743523.9	5.3151	1.18	4112
2		17.940	237380	13245343.0	94.6849	1.90	2060
	Σ:		284024	13988866.9	100.0000		

3o (Table 3, entry 15)



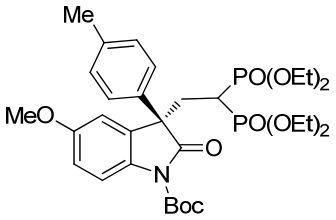


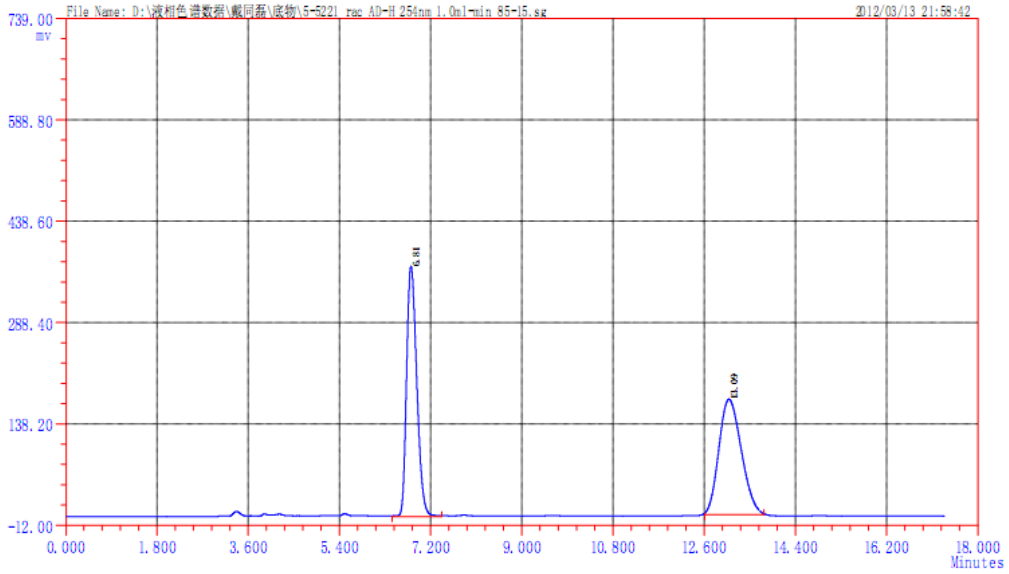
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.453	169740	2189967.2	49.7346	1.40	8556
2		16.725	61411	2213342.9	50.2654	1.18	4292
	Σ:		231151	4403310.1	100.0000		



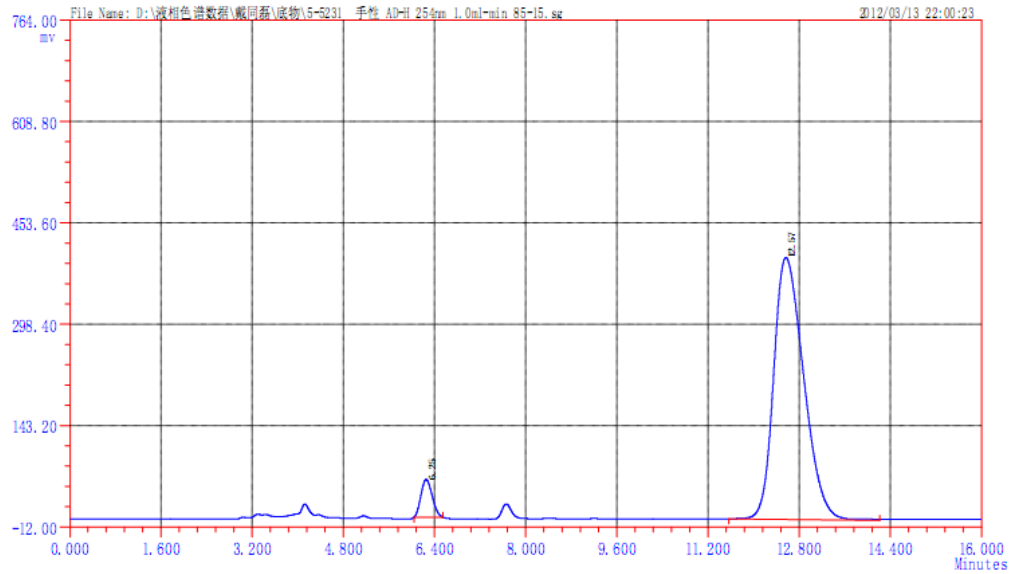
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.445	100278	2050716.5	6.4495	1.61	3399
2		16.328	601369	29745862.5	93.5505	2.13	2172
	Σ:		701647	31796579.0	100.0000		

3p (Table 3, entry 16)



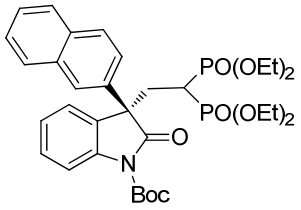


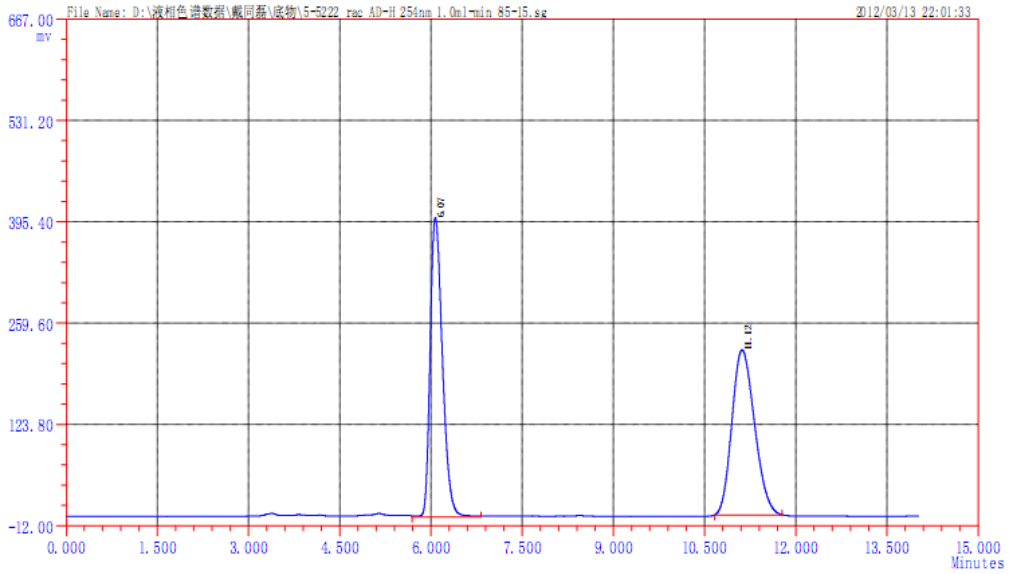
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		6.813	371059	5196007.5	49.7613	1.28	4718
2		13.092	170582	5245856.7	50.2387	1.18	3612
	Σ:		541641	10441864.1	100.0000		



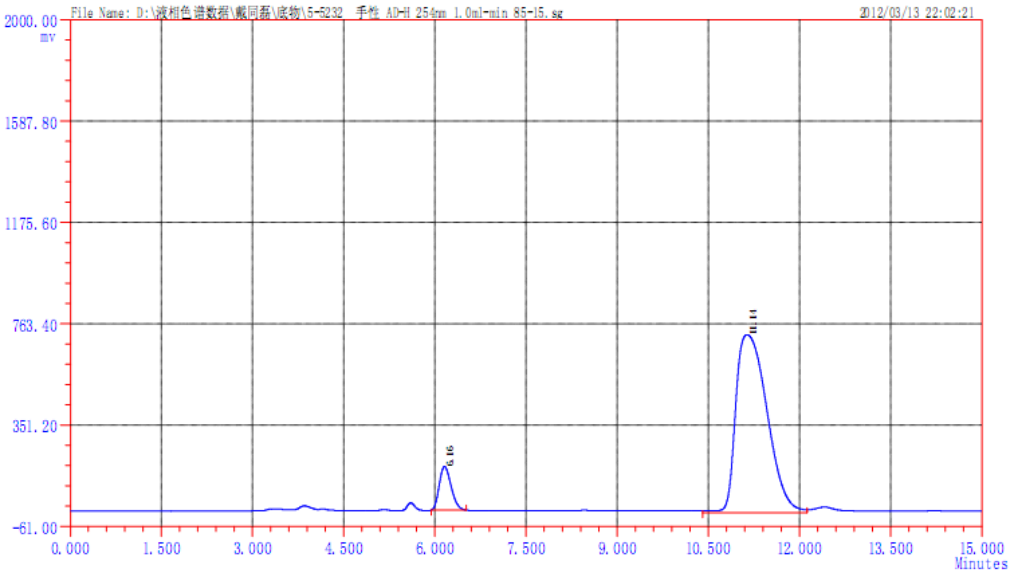
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		6.255	57969	800949.5	5.1747	1.15	4085
2		12.570	401043	14677233.7	94.8253	1.29	2351
	Σ:		459012	15478183.2	100.0000		

3q (Table 3, entry 17)



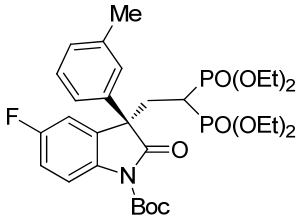


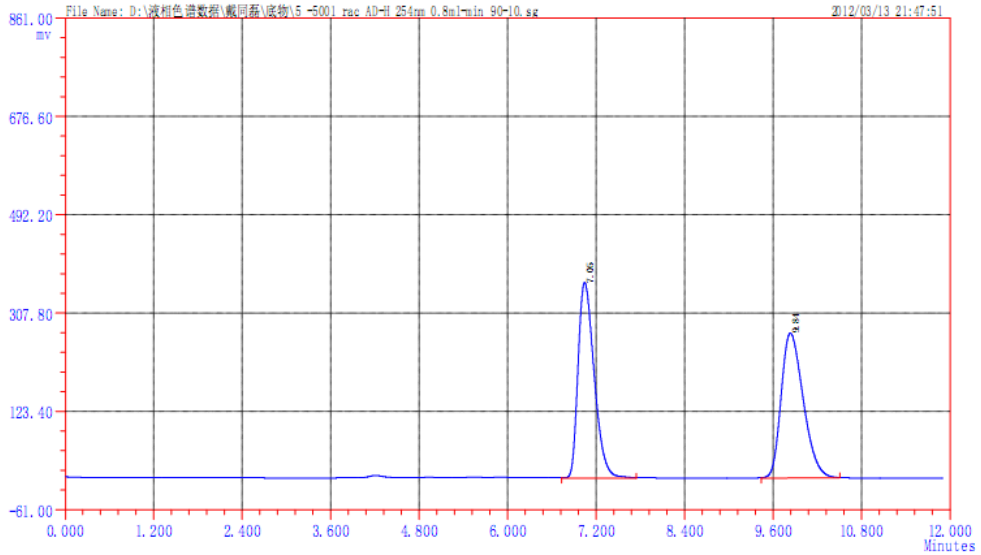
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		6.073	401809	5663678.4	49.6726	1.32	3700
2		11.120	221282	5738348.4	50.3274	1.19	3665
	Σ:		623091	11402026.8	100.0000		



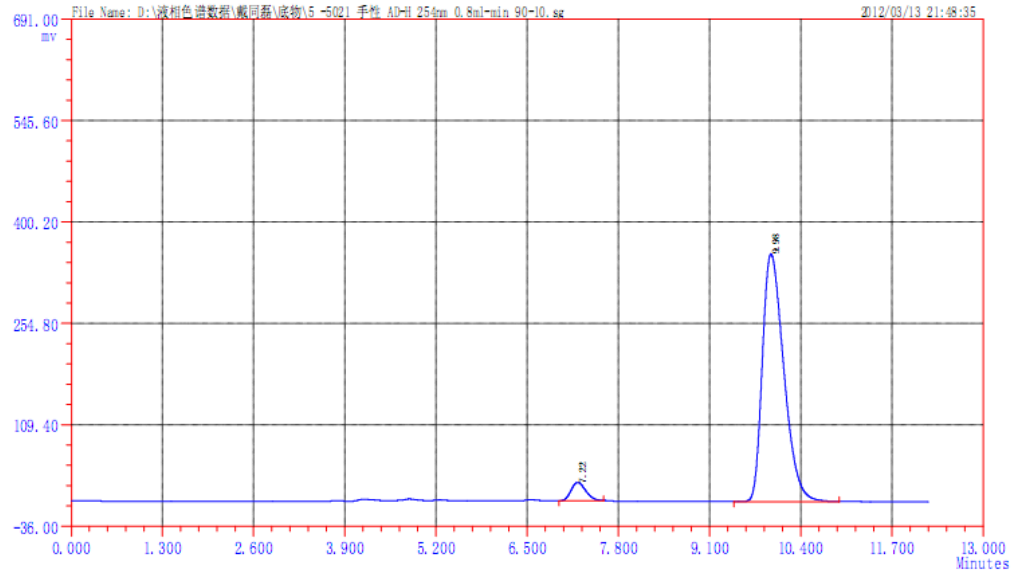
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		6.162	178027	2424318.0	8.5499	1.23	4081
2		11.140	723804	25930745.2	91.4501	1.56	1927
	Σ:		901831	28355063.1	100.0000		

3r (Table 3, entry 18)



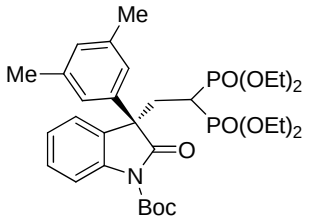


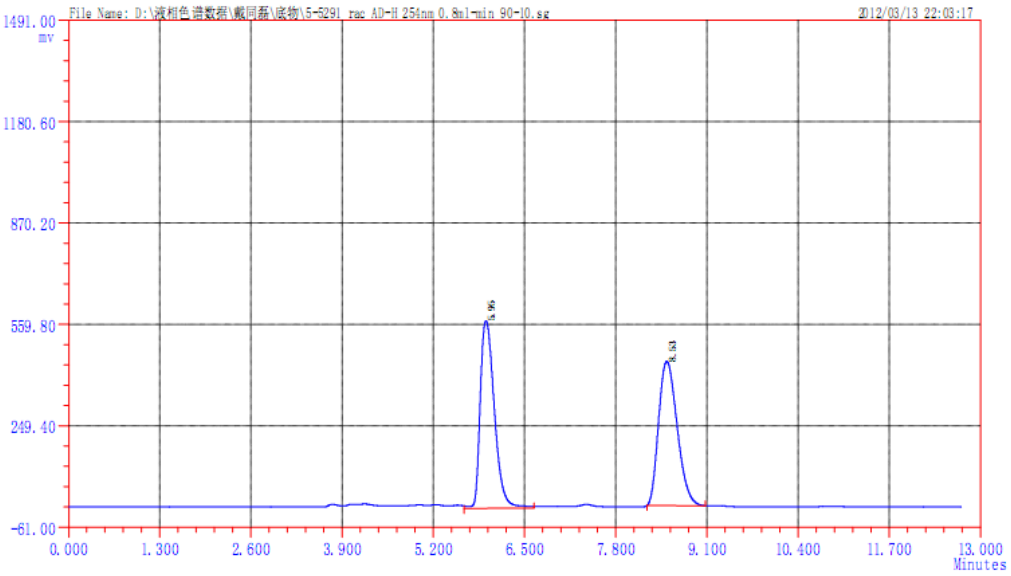
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.047	367151	5595958.3	49.7408	1.40	4260
2		9.838	271509	5654281.6	50.2592	1.32	4448
	Σ:		638660	11250239.8	100.0000		



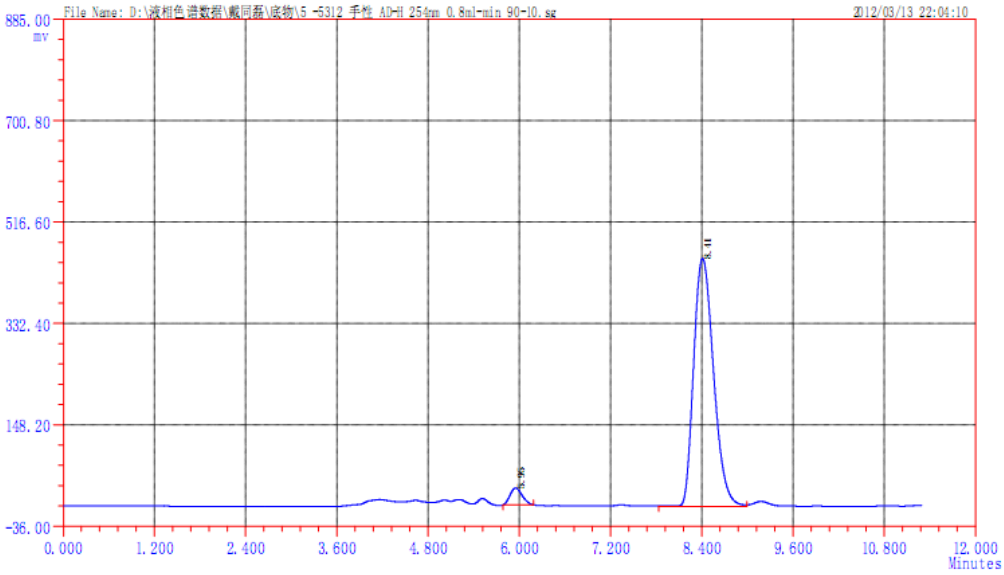
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		7.222	26392	387621.4	4.8590	1.23	4819
2		9.978	355511	7589783.6	95.1410	1.41	4354
	Σ:		381903	7977405.0	100.0000		

3s (Table 3, entry 19)





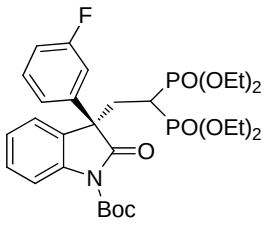
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		5.952	573891	8066362.6	49.7381	1.45	3574
2		8.530	441867	8151303.0	50.2619	1.27	4261
	Σ:		1015758	16217665.6	100.0000		

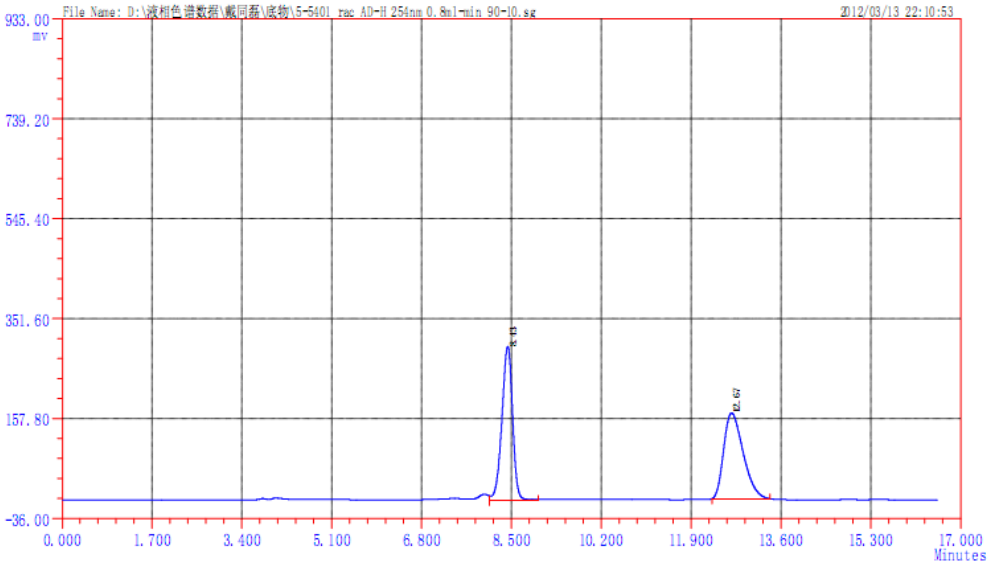


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		5.952	30716	345675.4	4.0539	1.20	5574
2		8.412	450446	8181318.7	95.9461	1.27	4275
	Σ:		481162	8526994.1	100.0000		

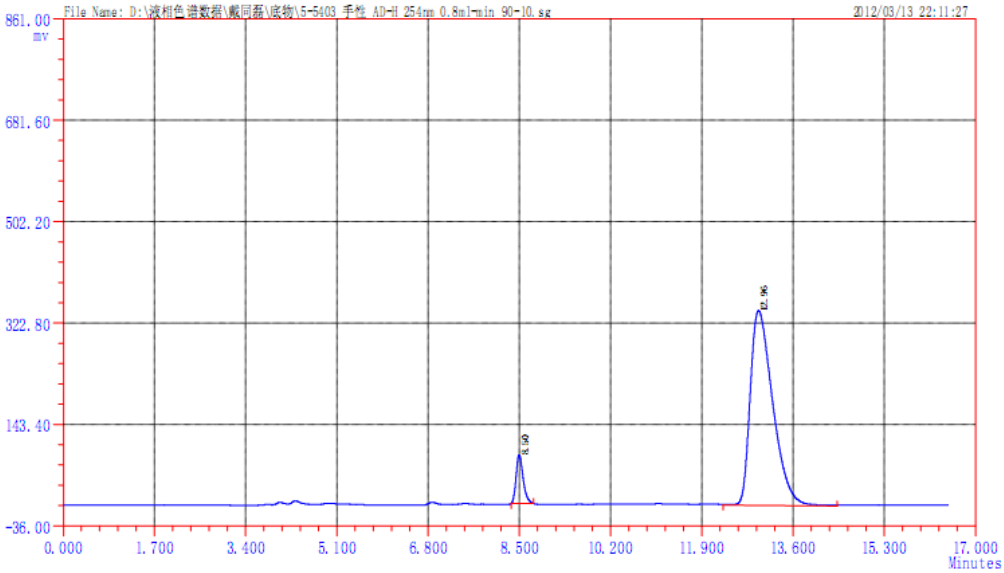
This journal is © The Royal Society of Chemistry 2012

3t (Table 3, entry 20)





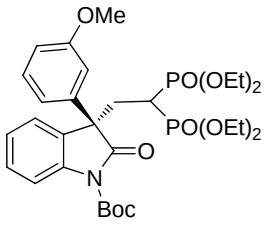
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.432	298321	4237487.2	49.8415	0.91	7023
2		12.668	166669	4264443.7	50.1585	1.39	4886
	Σ:		464990	8501930.9	100.0000		

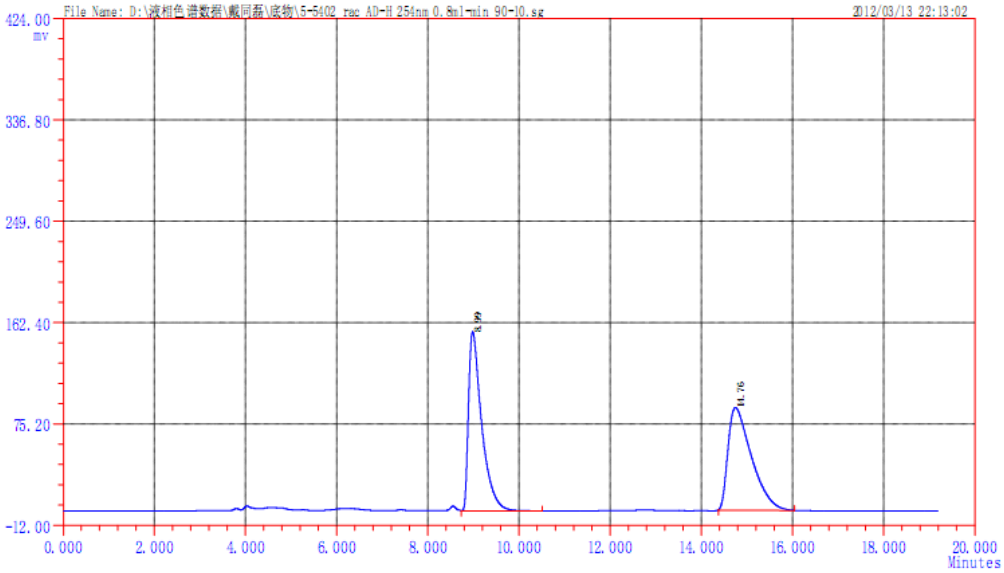


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.497	86730	800596.1	7.3605	1.33	16886
2		12.962	344508	10076321.1	92.6395	1.56	3914
	Σ:		431238	10876917.2	100.0000		

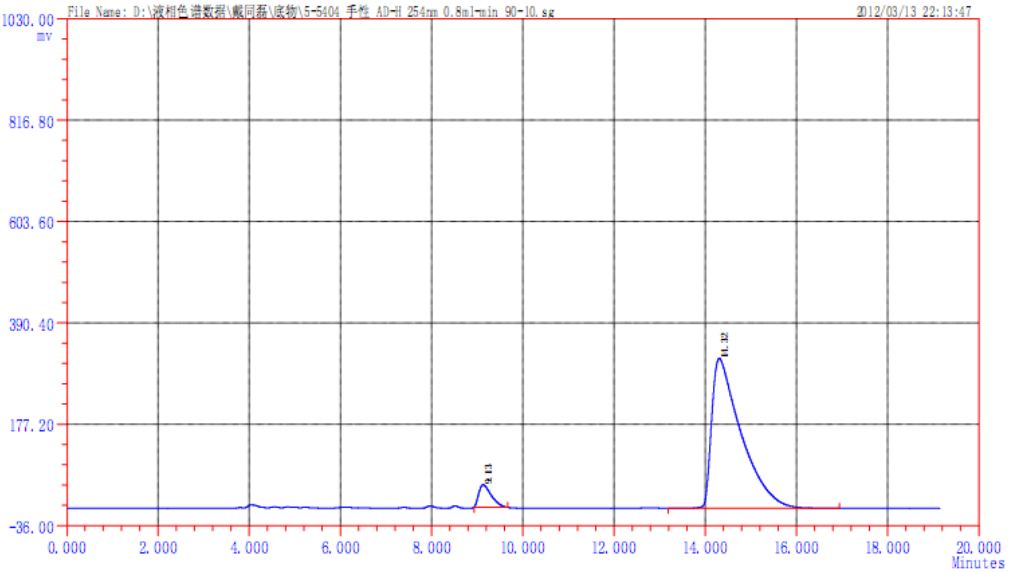
This journal is © The Royal Society of Chemistry 2012

3u (Table 3, entry 21)



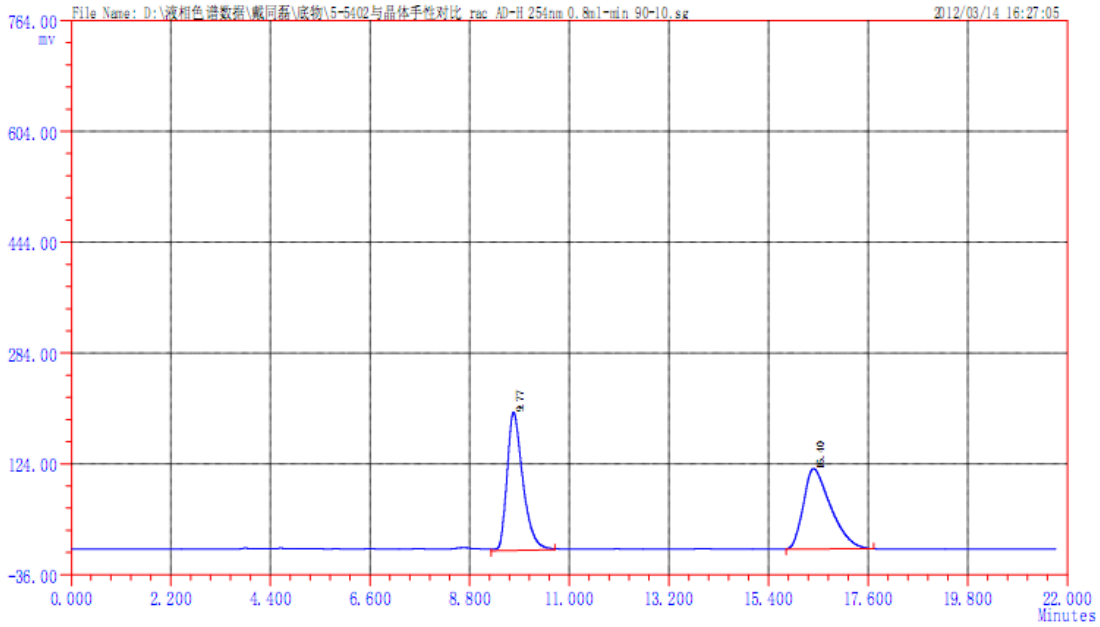


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.987	154447	3130586.7	49.7637	2.08	3918
2		14.757	88383	3160315.9	50.2363	1.89	3395
	Σ:		242830	6290902.6	100.0000		

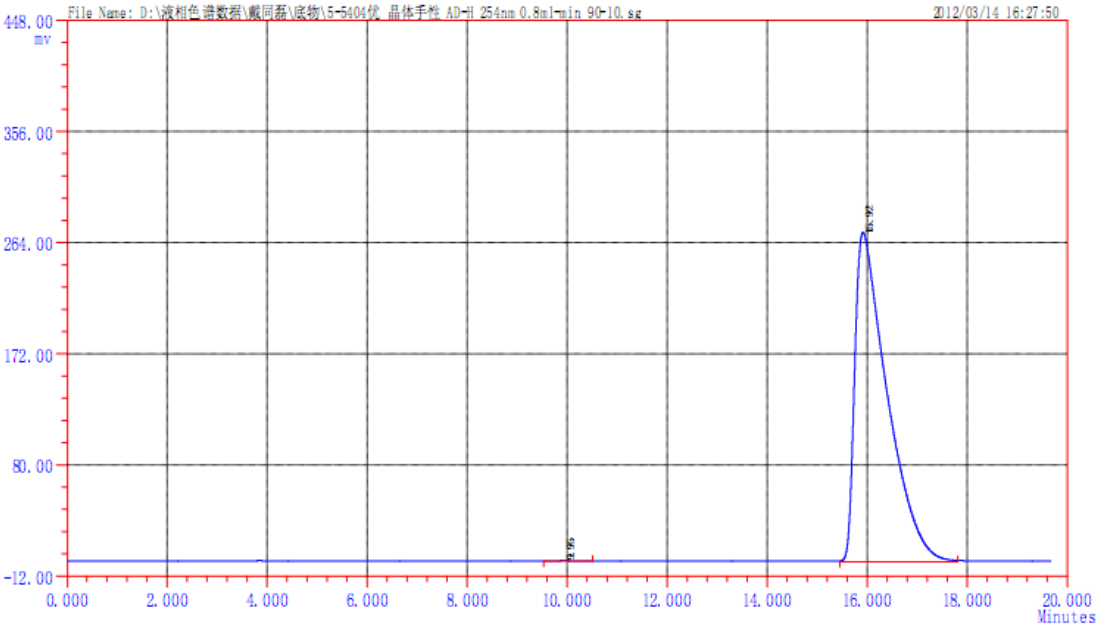


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.133	47914	927132.4	6.1205	1.70	4440
2		14.315	315463	14220834.0	93.8795	2.55	2010
	Σ:		363377	15147966.5	100.0000		

After Recrystallization of 3u:



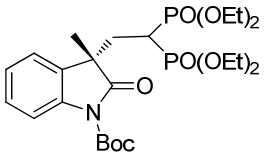
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.772	199394	4866218.5	50.0683	1.43	3195
2		16.400	115988	4852943.1	49.9317	1.51	3062
	Σ:		315382	9719161.7	100.0000		

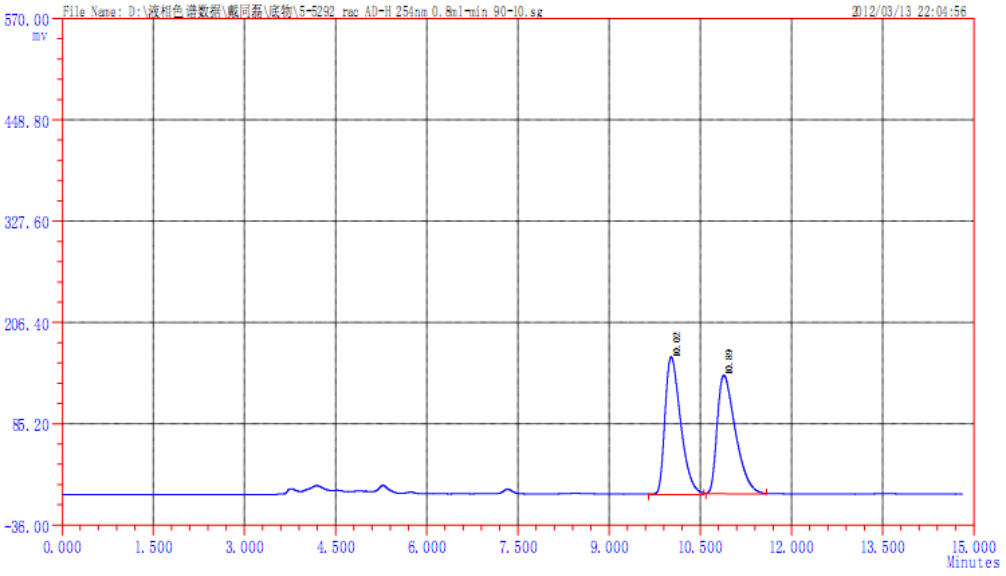


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.952	412	11442.7	0.0936	1.17	2559
2		15.923	272441	12213029.9	99.9064	2.47	2515
	Σ:		272853	12224472.6	100.0000		

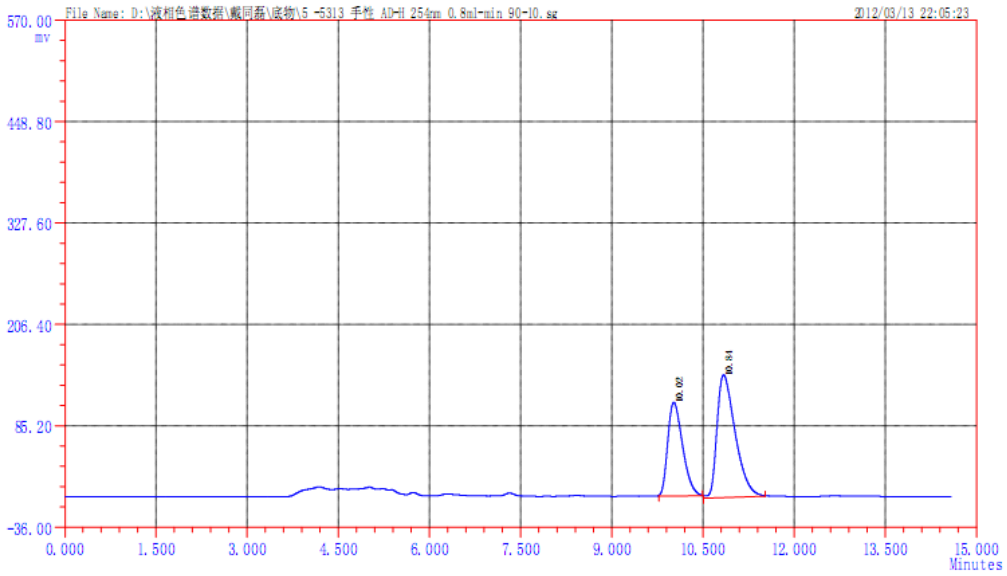
This journal is © The Royal Society of Chemistry 2012

3w (Table 3, entry 23)



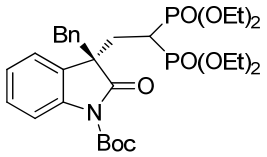


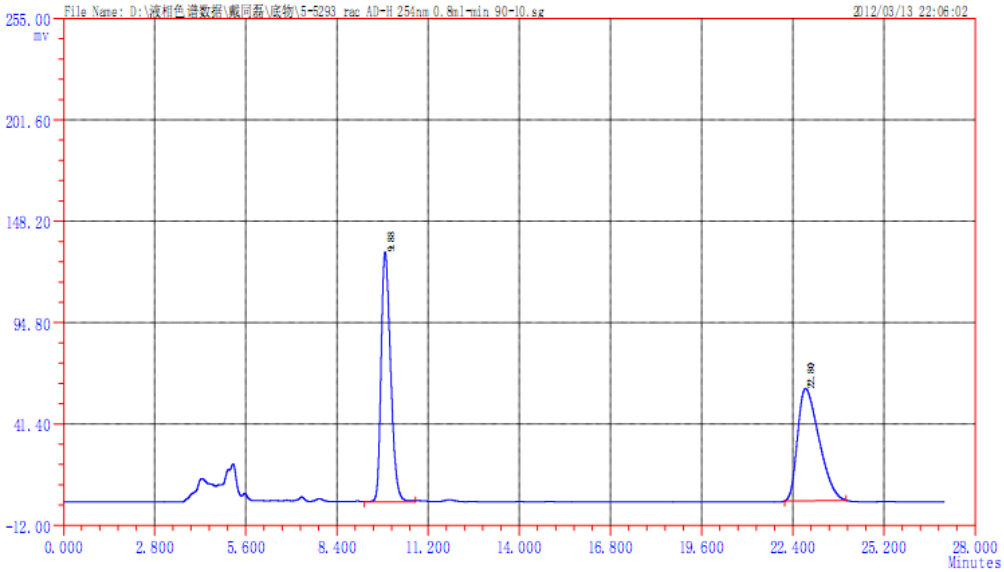
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.023	164508	2942900.4	49.8011	1.48	6257
2		10.890	141658	2966404.0	50.1989	1.61	5390
	Σ:		306166	5909304.4	100.0000		



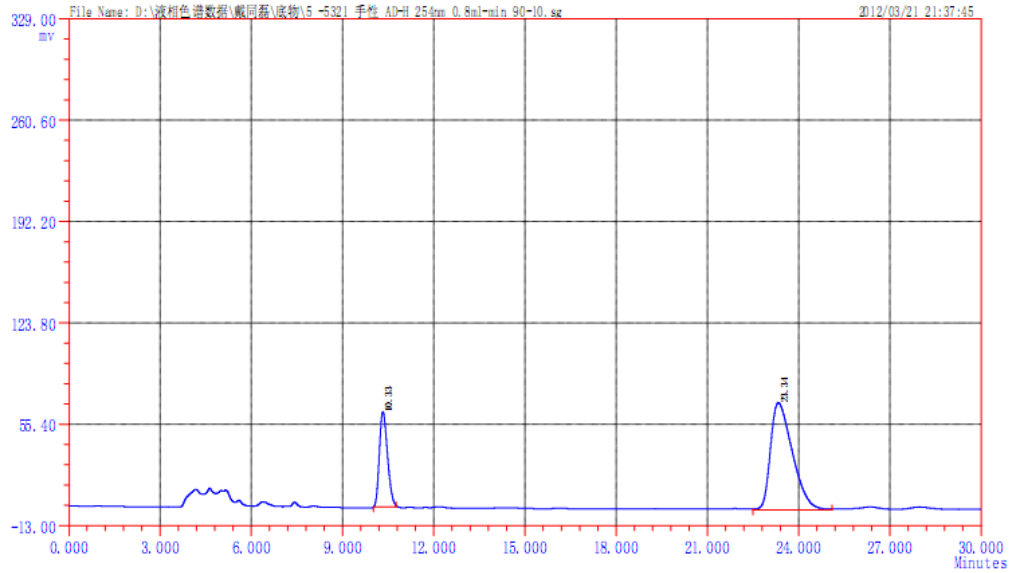
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.023	111994	1901193.0	38.2960	1.39	6948
2		10.843	146693	3063279.0	61.7040	1.65	5374
	Σ:		258687	4964472.0	100.0000		

3x (Table 3, entry 24)



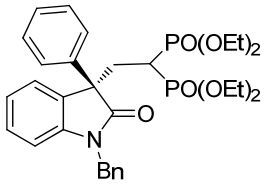


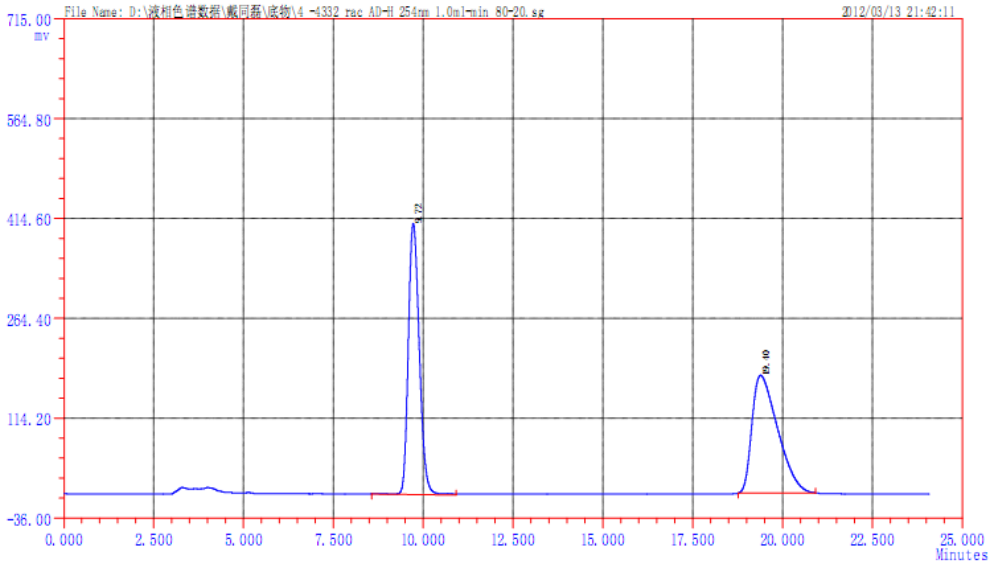
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.880	131868	2697175.3	49.8201	1.31	4650
2		22.802	59196	2716657.7	50.1799	1.49	4920
	Σ:		191064	5413833.0	100.0000		



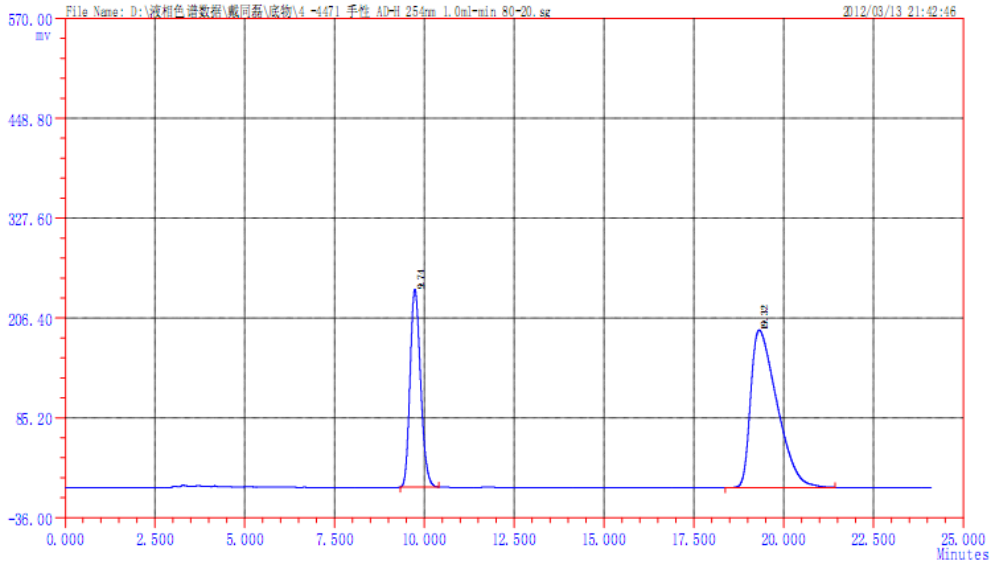
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		10.330	64379	1204491.7	25.0387	1.25	6076
2		23.342	72186	3606030.0	74.9613	1.55	4351
	Σ:		136565	4810521.8	100.0000		

5c (Table 4, entry 4)



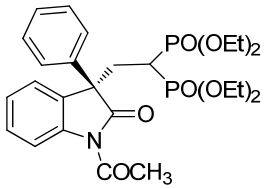


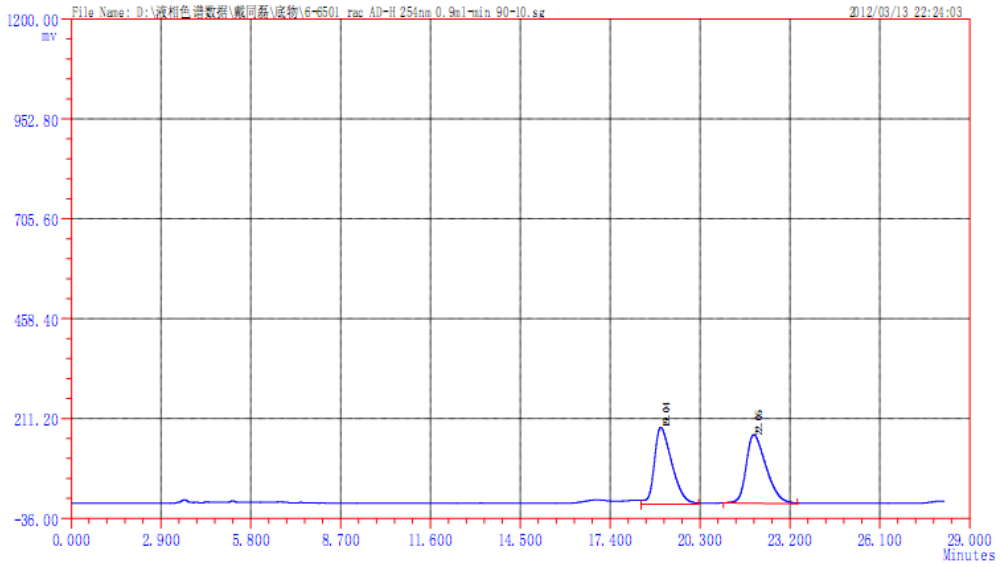
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.722	407405	8696157.8	49.6669	1.22	4134
2		19.395	177036	8812796.2	50.3331	1.68	3026
	Σ:		584441	17508954.0	100.0000		



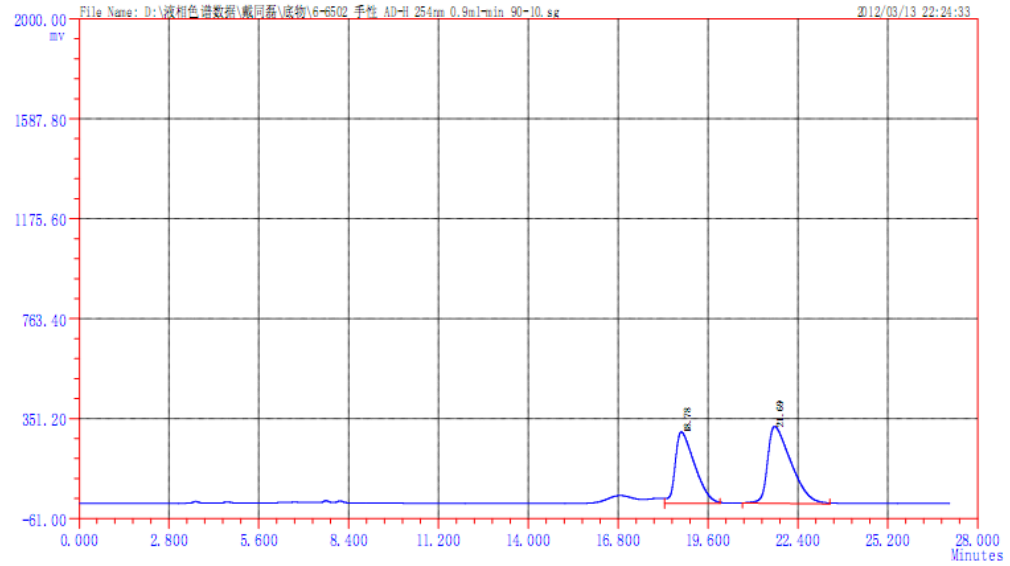
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.735	240257	4915768.0	33.4920	1.20	4512
2		19.325	191301	9761687.1	66.5080	1.76	2859
	Σ:		431558	14677455.1	100.0000		

5d (Table 5, entry 5)



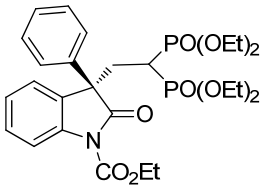


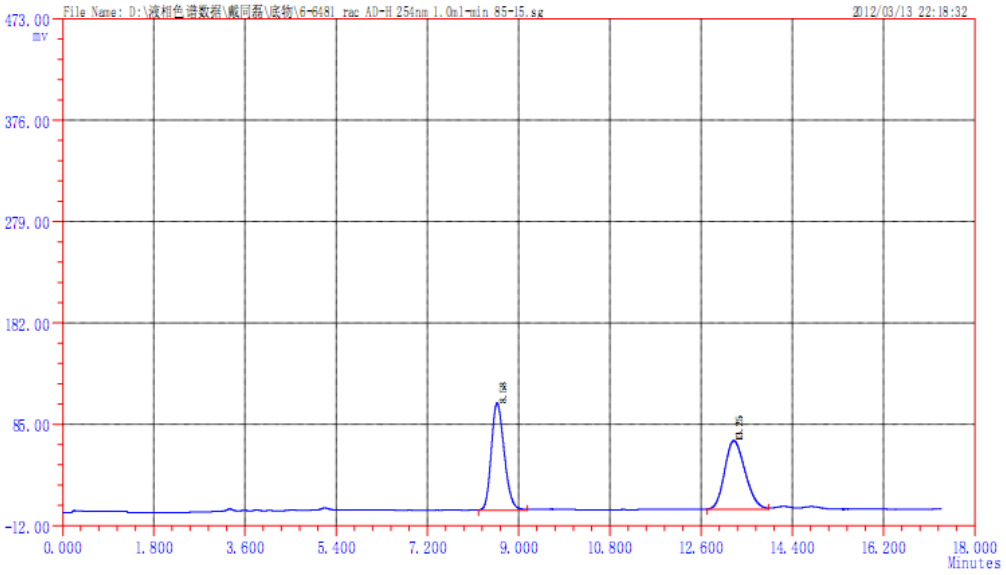
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		19.038	190914	7640594.9	50.0120	1.22	4510
2		22.045	169868	7636921.7	49.9880	1.37	4792
	Σ:		360782	15277516.6	100.0000		



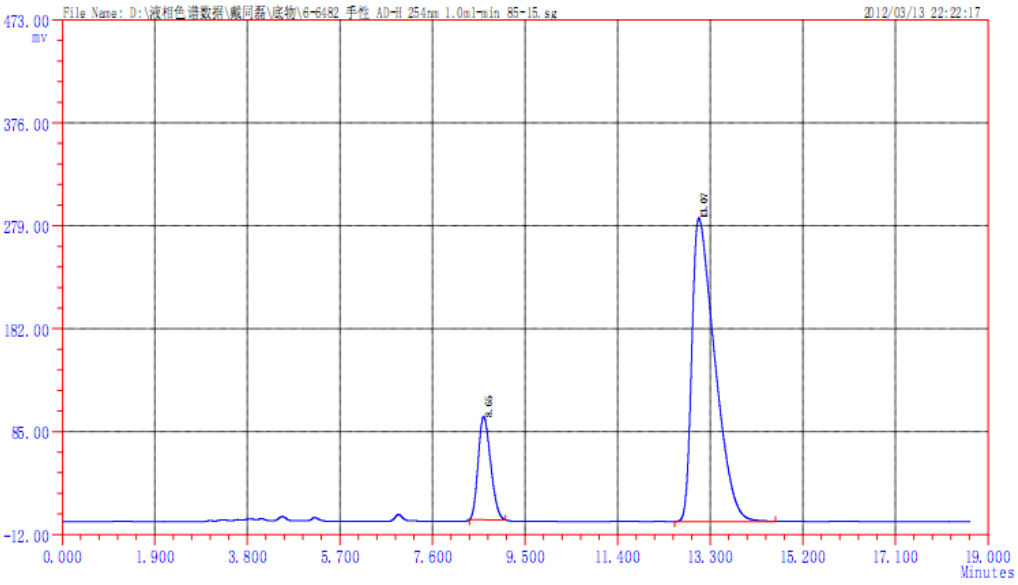
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		18.775	294506	12456805.8	43.5027	1.46	3927
2		21.685	317866	16177730.4	56.4973	1.76	3618
	Σ:		612372	28634536.2	100.0000		

5e (Table 5, entry 6)



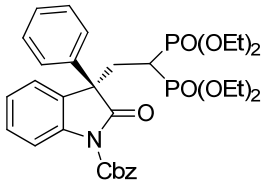


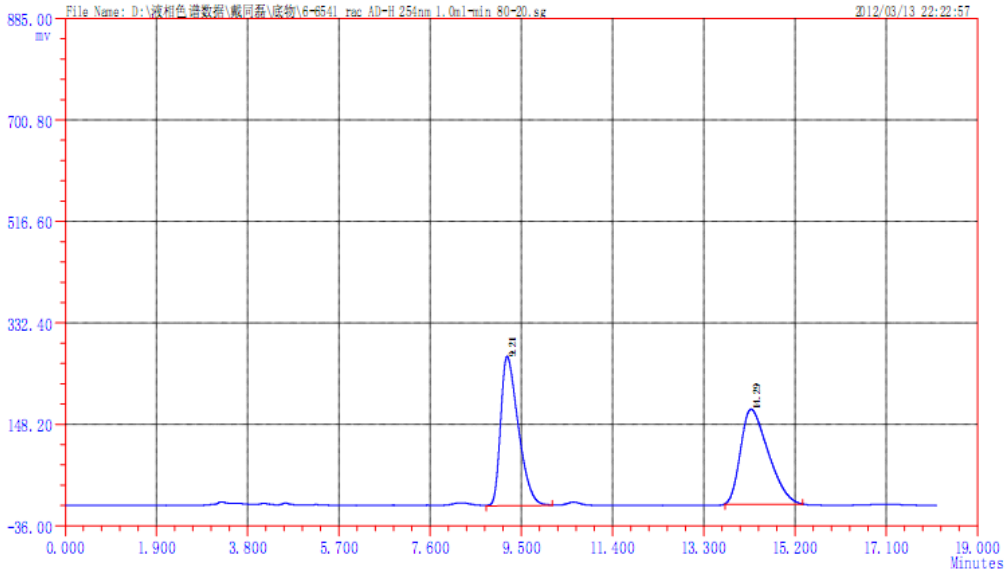
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.577	102538	1831342.7	49.8544	1.20	4596
2		13.252	65587	1842037.2	50.1456	1.18	4437
	Σ:		168125	3673379.8	100.0000		



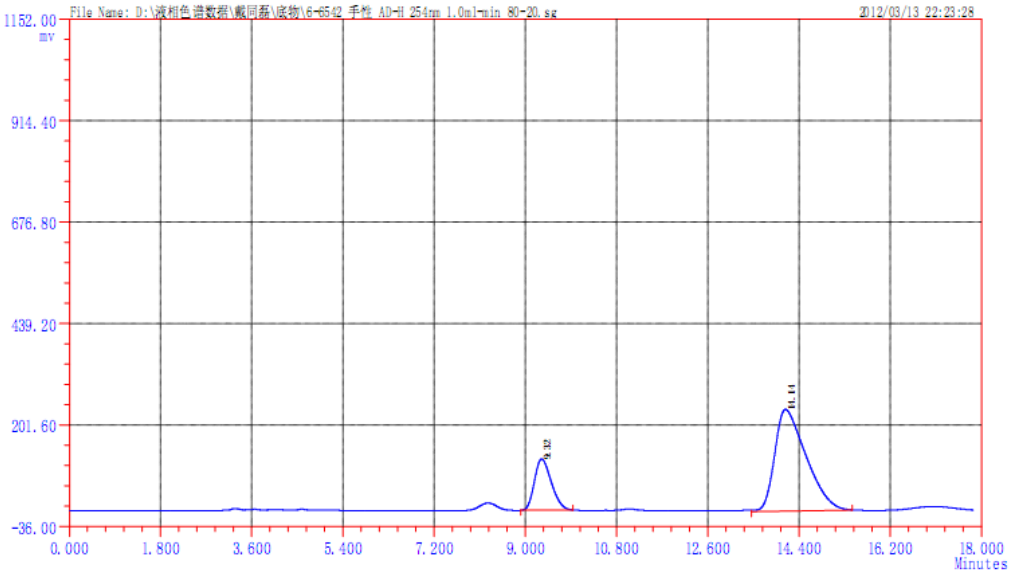
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		8.652	97215	1726201.8	15.5369	1.20	4732
2		13.073	286080	9384127.0	84.4631	1.84	3166
	Σ:		383295	11110328.7	100.0000		

5f (Table 5, entry 7)



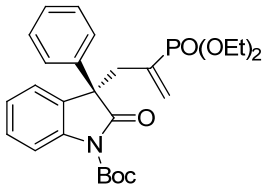


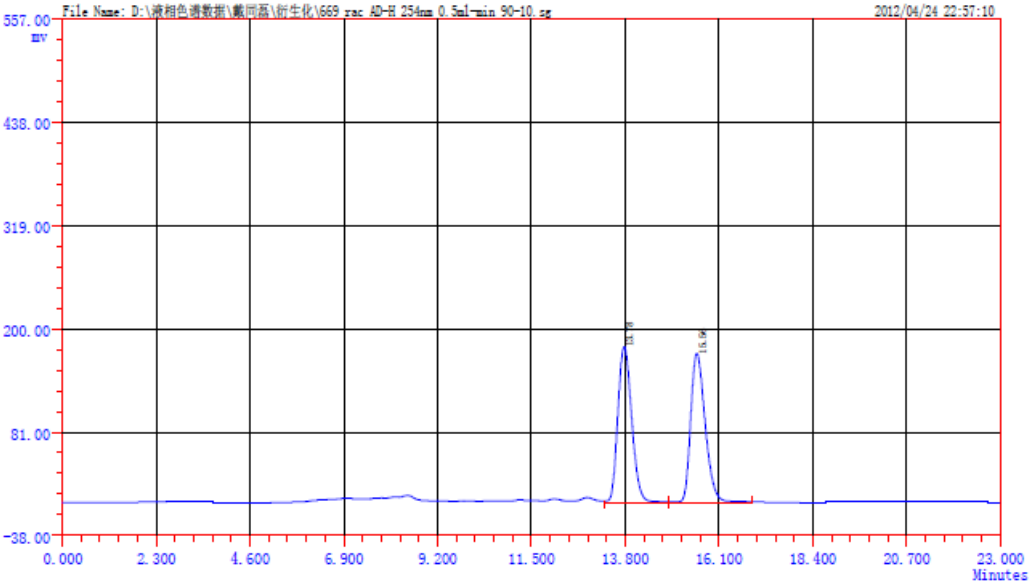
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.208	270825	6923278.9	49.9495	1.52	2586
2		14.292	172628	6937273.7	50.0505	1.43	2521
	Σ:		443453	13860552.6	100.0000		



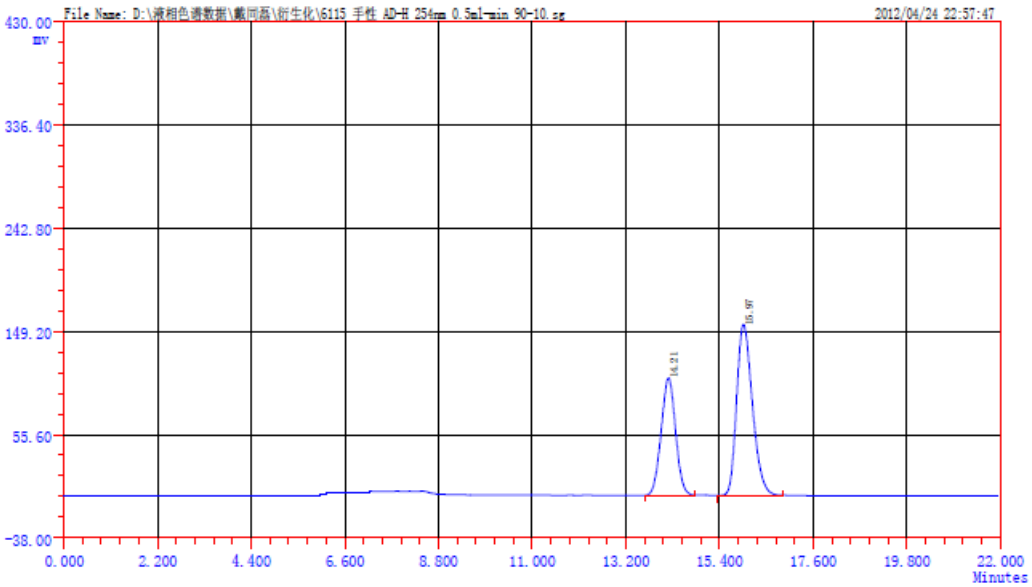
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		9.323	120523	2814085.4	21.4514	1.28	3178
2		14.138	238429	10304348.7	78.5486	1.61	2133
	Σ:		358952	13118434.1	100.0000		

6 (Scheme 2)





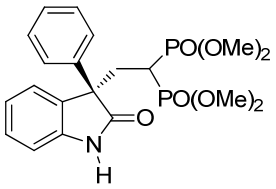
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		13.778	179144	4260893.0	49.9479	1.19	6688
2		15.562	171588	4269774.5	50.0521	1.31	7795
	Σ:		350732	8530667.4	100.0000		

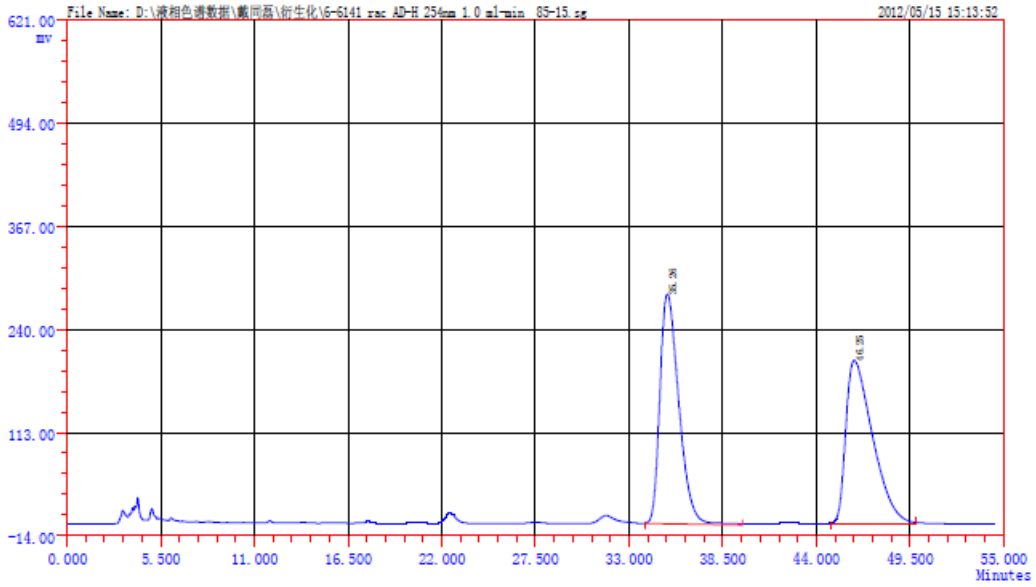


ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		14.208	106878	2546704.5	38.3324	1.01	7086
2		15.965	155903	4097027.8	61.6676	1.29	7356
	Σ:		262781	6643732.3	100.0000		

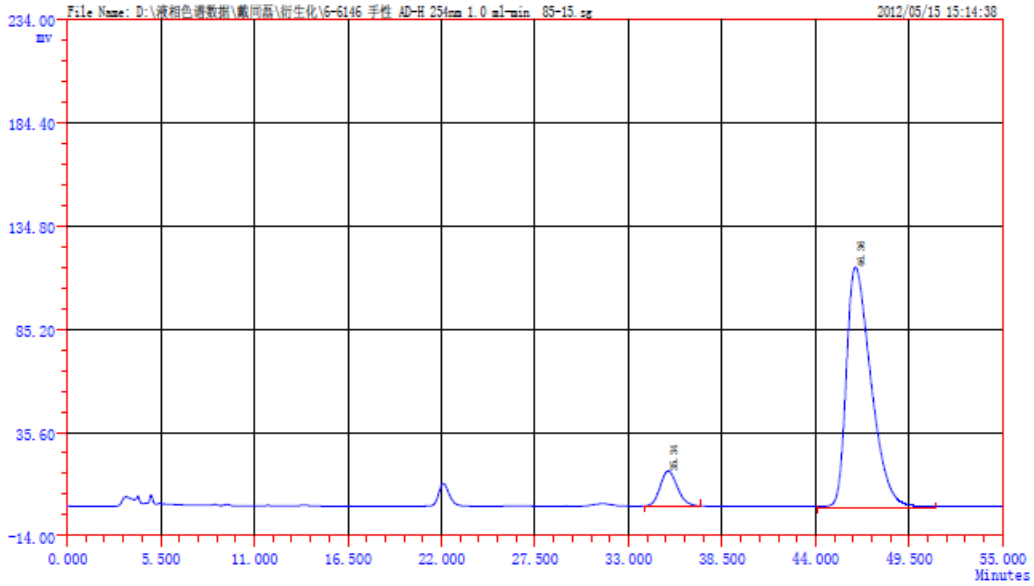
This journal is © The Royal Society of Chemistry 2012

8 (Scheme 2)





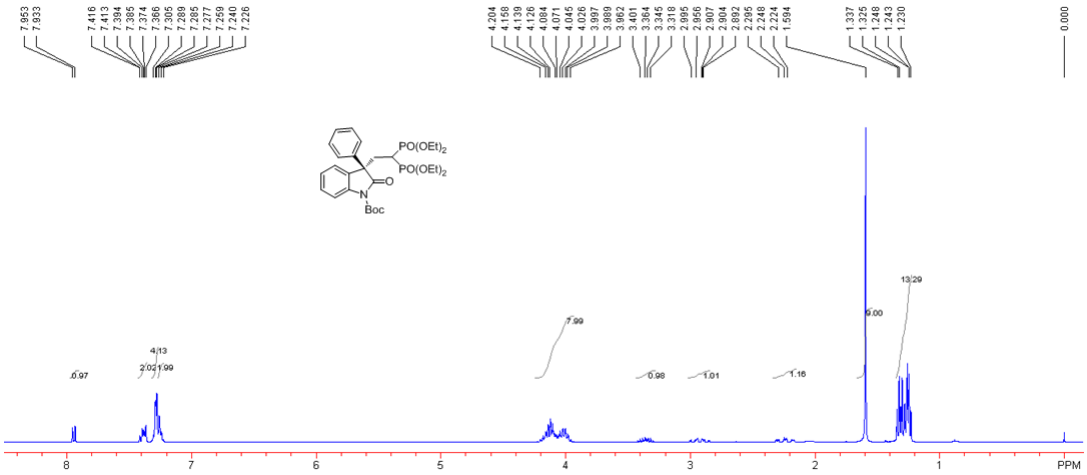
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		35.262	282291	21865464.8	49.9782	1.41	4131
2		46.252	200387	21884559.5	50.0218	1.84	3575
	Σ:		482678	43750024.3	100.0000		



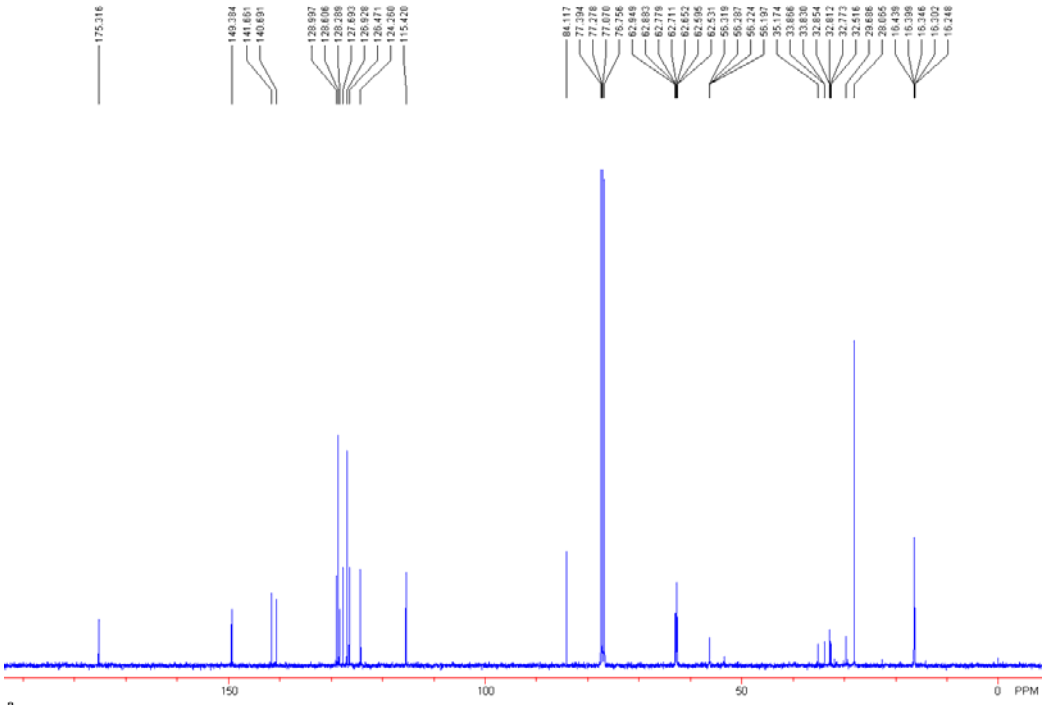
ID	组分名	保留时间	峰高	峰面积	浓度	拖尾因子	理论塔板
1		35.340	16859	1186041.8	9.1230	1.15	5029
2		46.360	115707	11814536.8	90.8770	1.53	4109
	Σ:		132566	13000578.7	100.0000		

3. NMR data for the compounds 3 and 5-8.

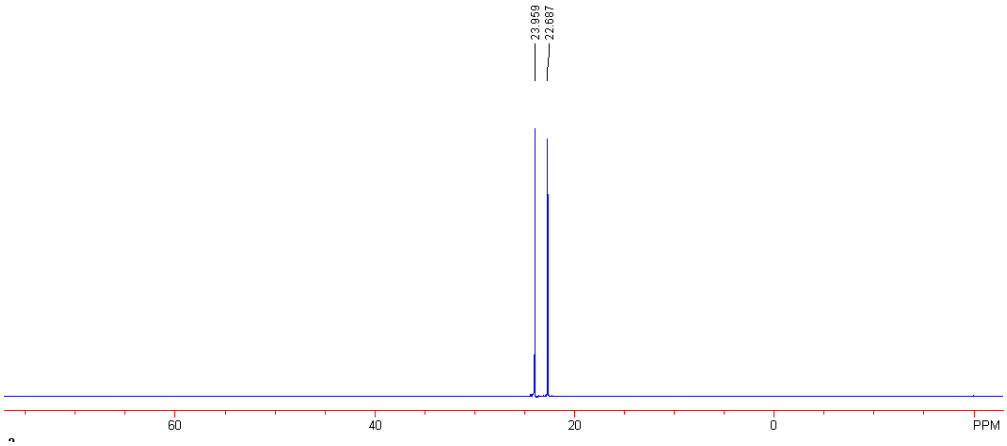
^{1}H NMR of **3a**



^{13}C NMR of **3a**

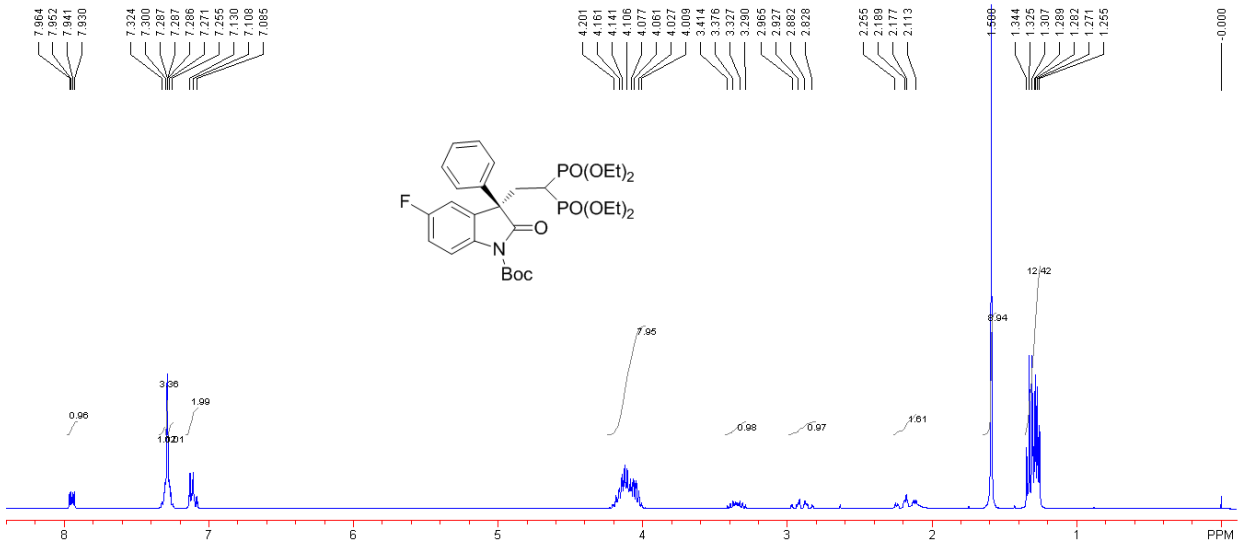


^{31}P NMR of **3a**

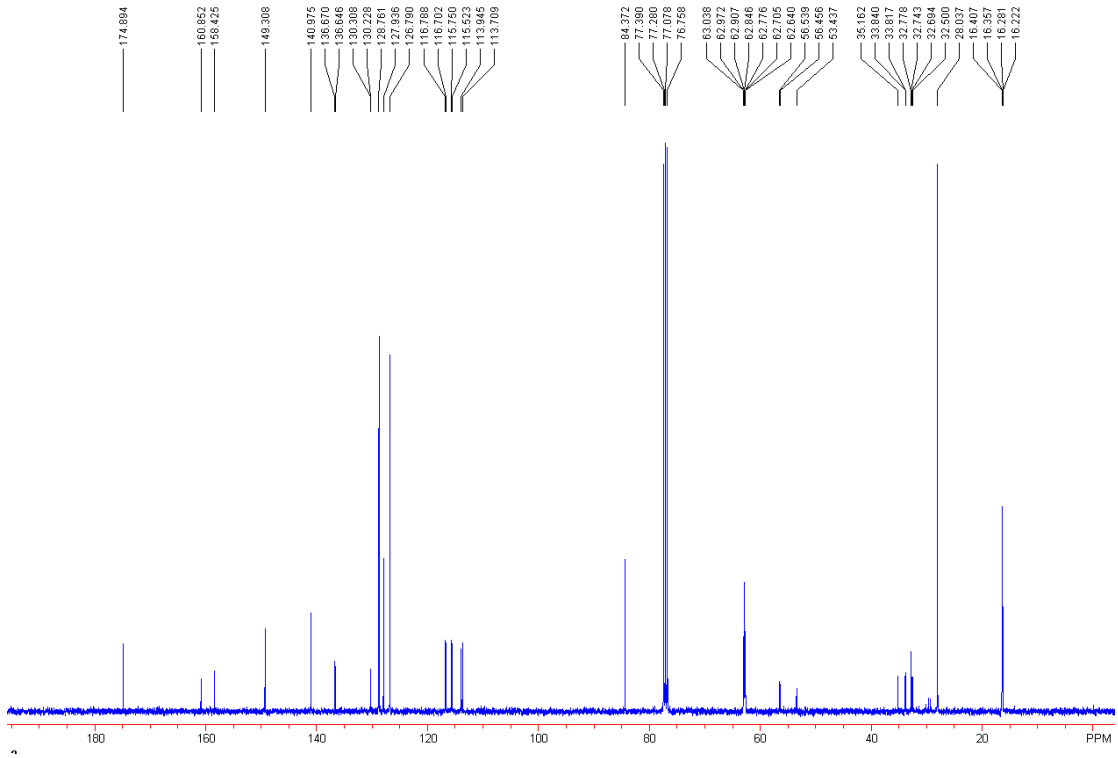


This journal is © The Royal Society of Chemistry 2012

^{1}H NMR of **3b**

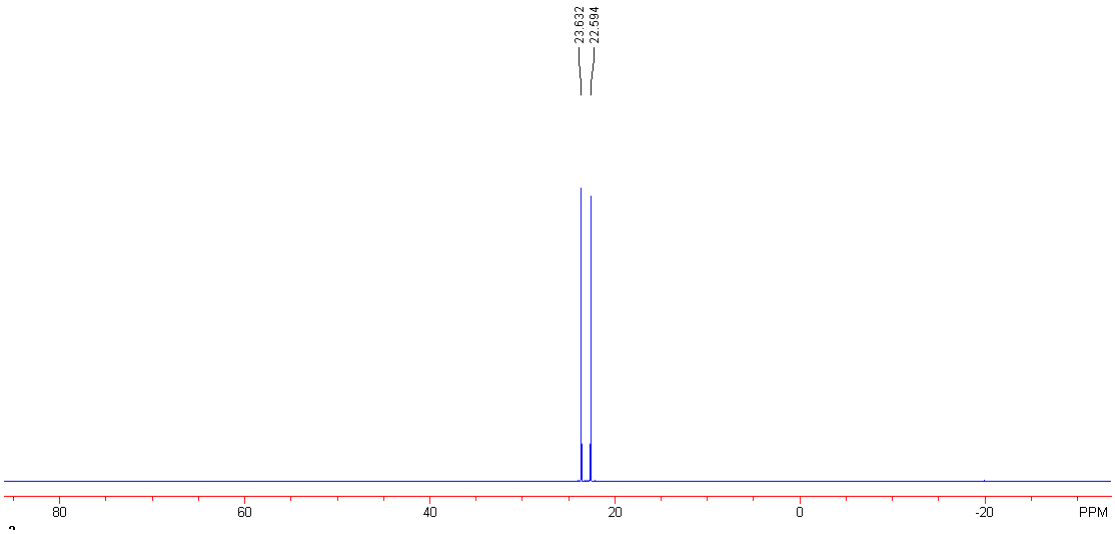


^{13}C NMR of **3b**

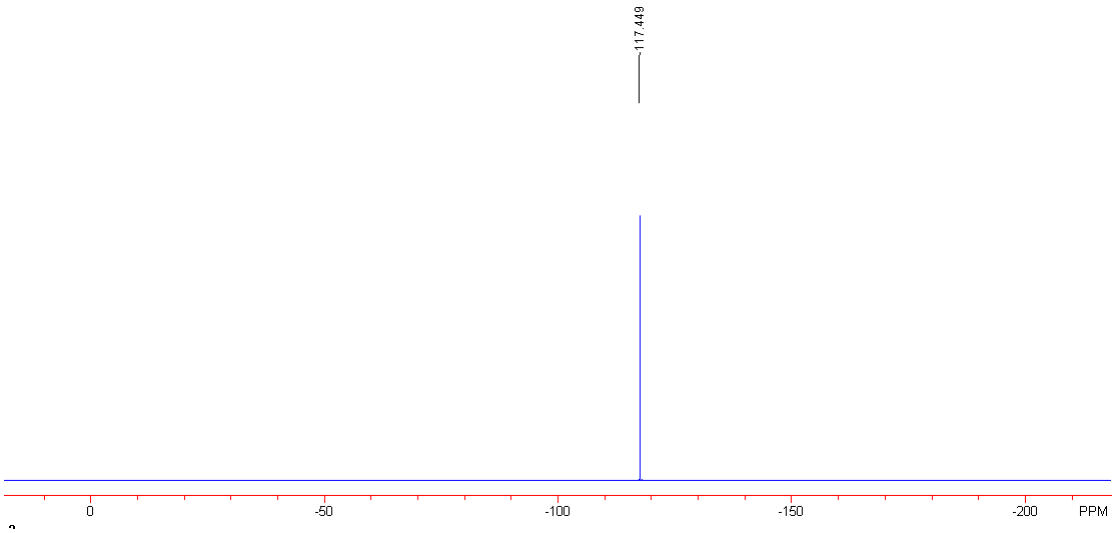


This journal is © The Royal Society of Chemistry 2012

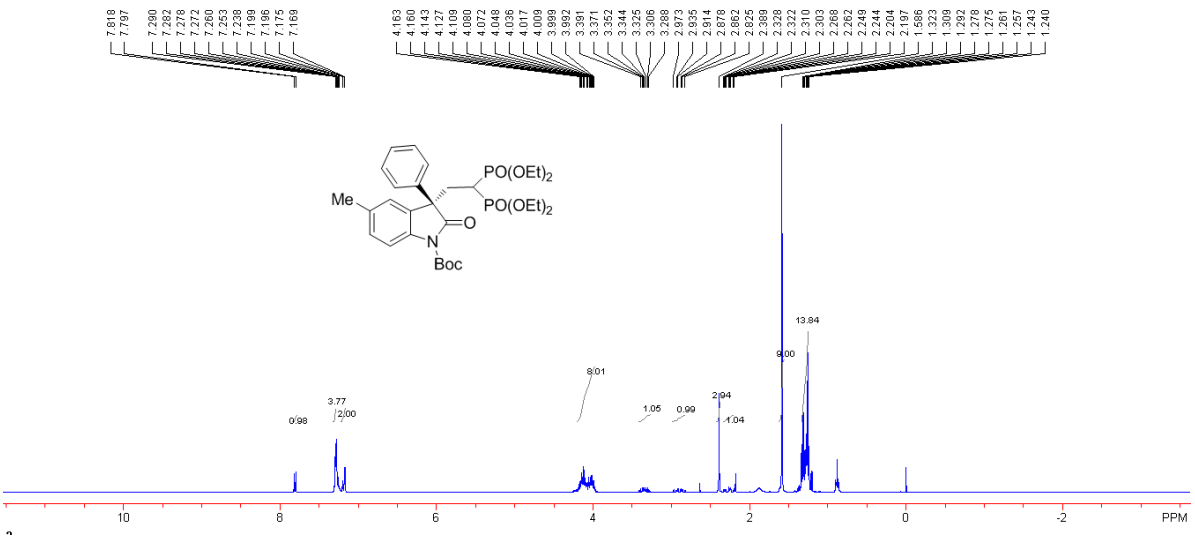
^{31}P NMR of **3b**



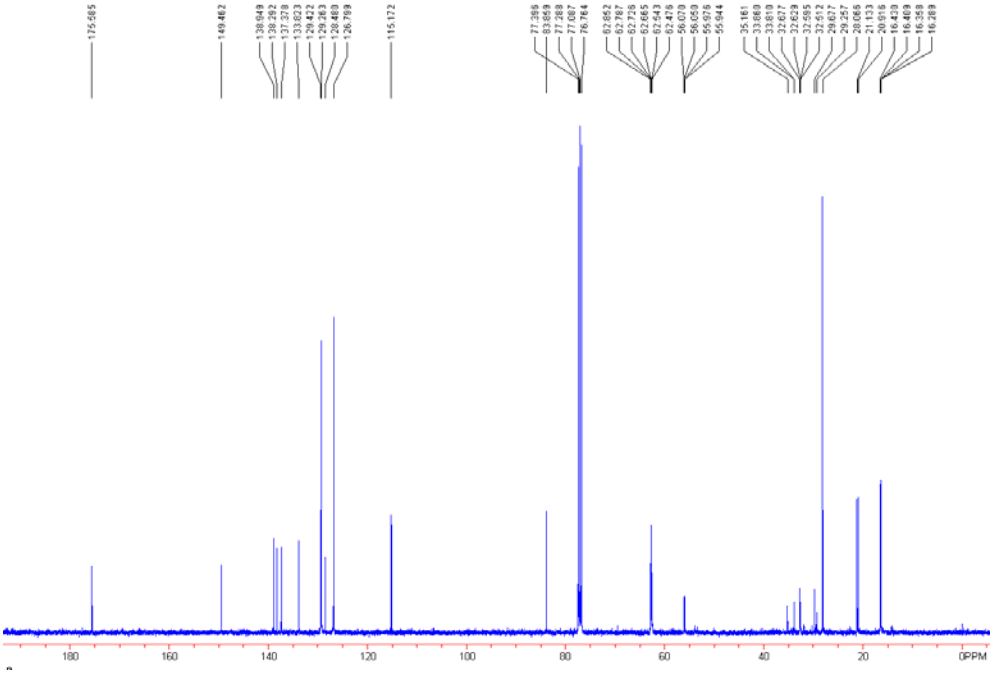
^{19}F NMR of **3b**



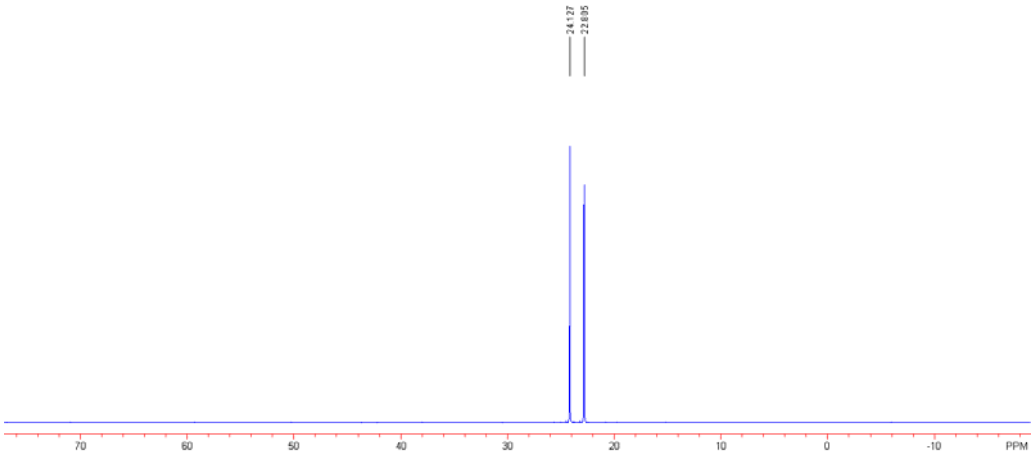
^{1}H NMR of **3c**



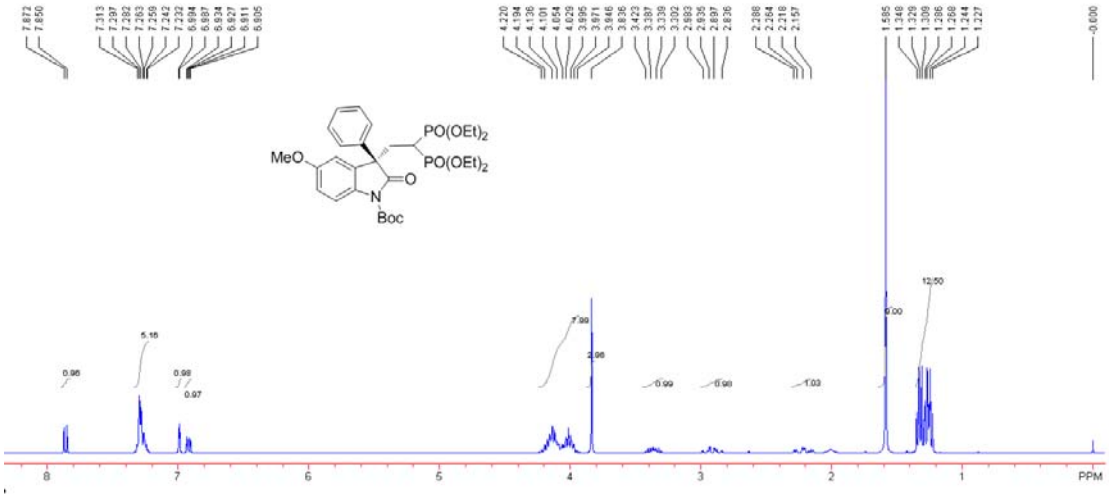
^{13}C NMR of **3c**



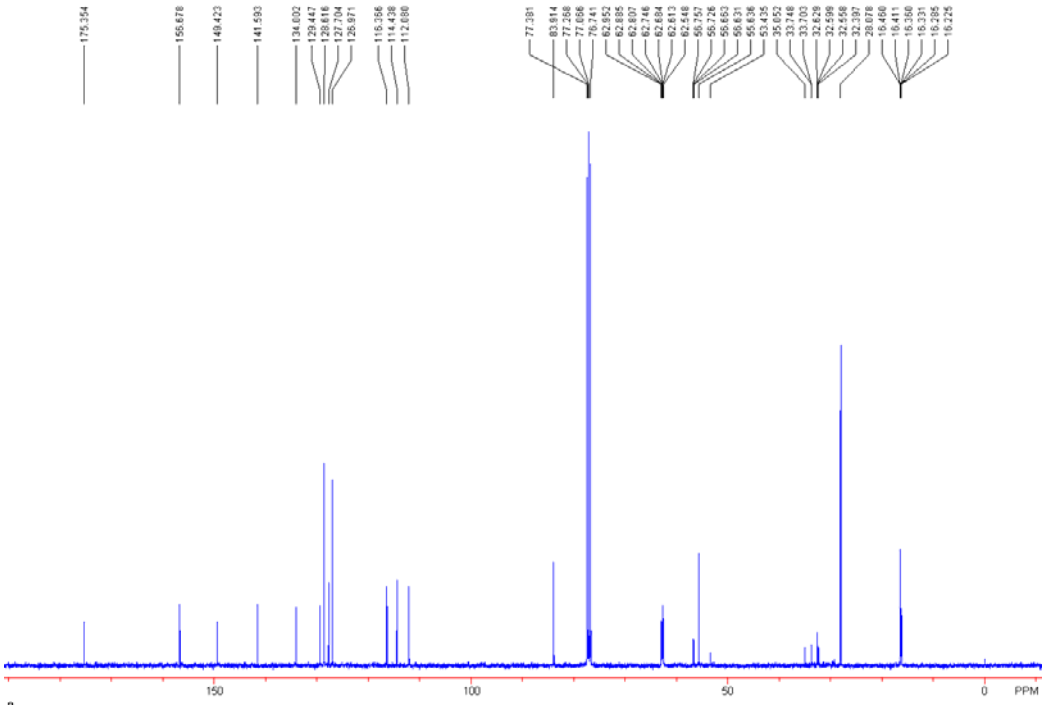
^{31}P NMR of **3c**



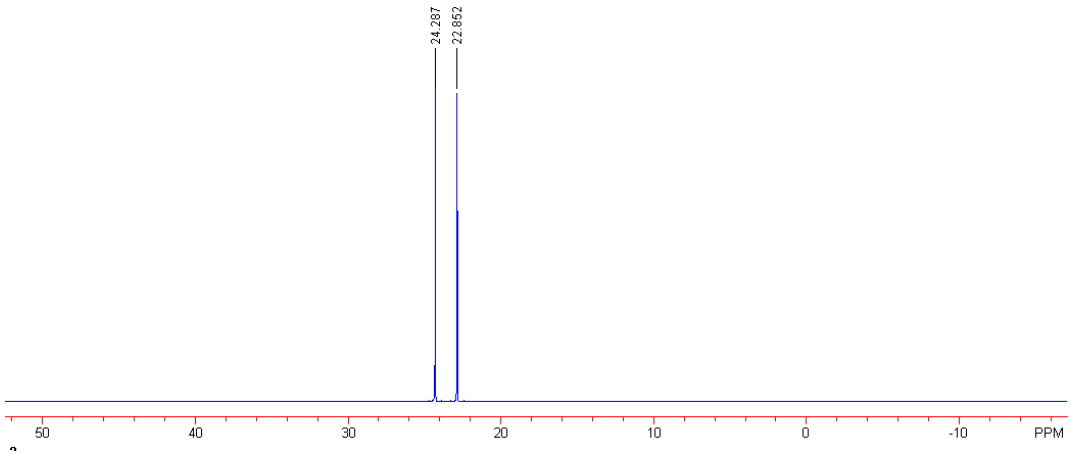
^{1}H NMR of **3d**



^{13}C NMR of **3d**

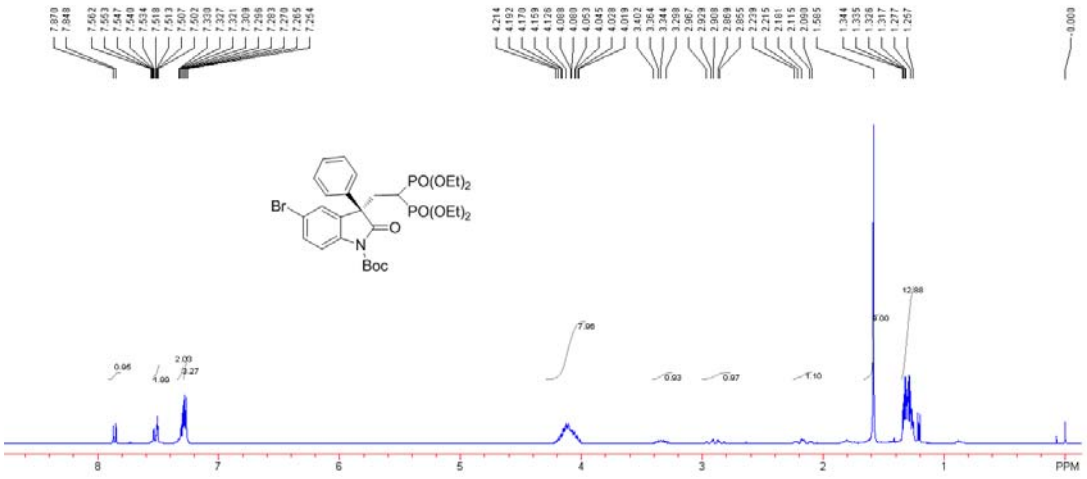


^{31}P NMR of **3d**

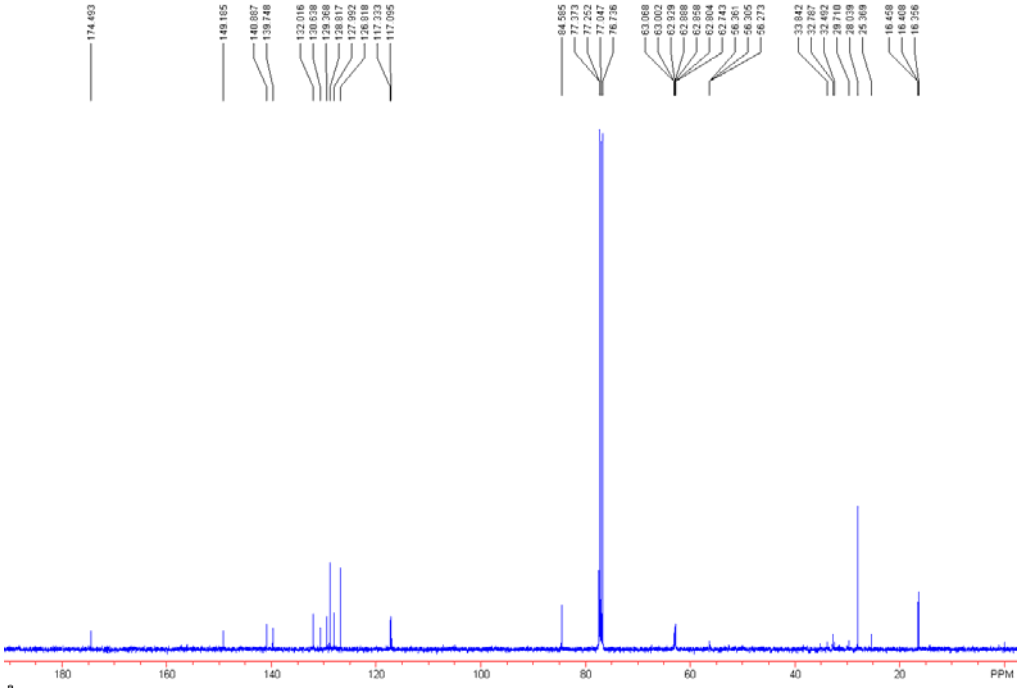


This journal is © The Royal Society of Chemistry 2012

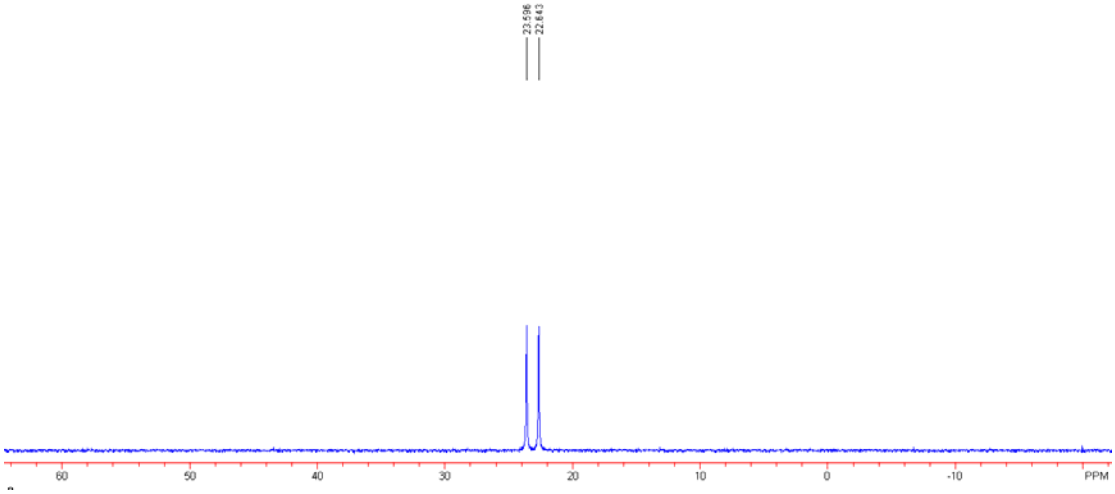
^{1}H NMR of **3e**



^{13}C NMR of **3e**

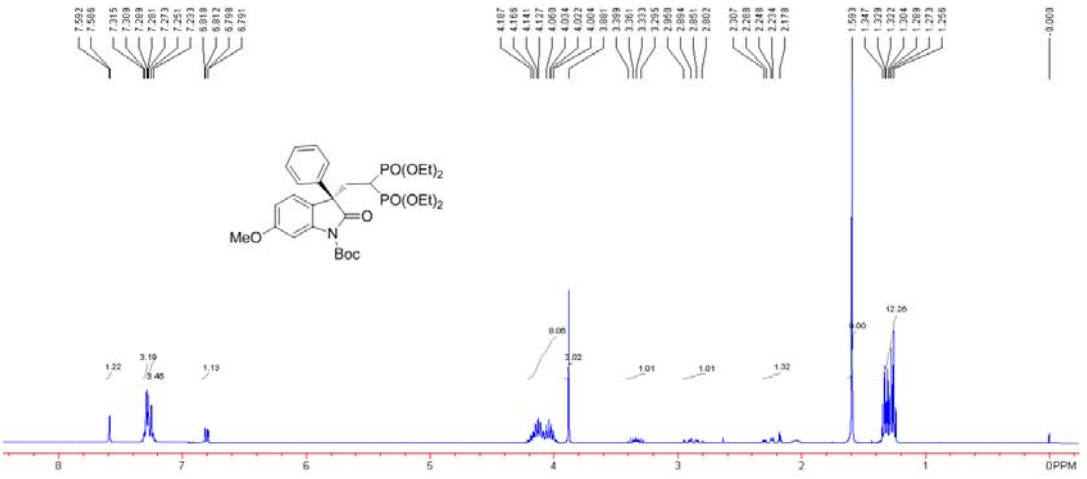


^{31}P NMR of **3e**

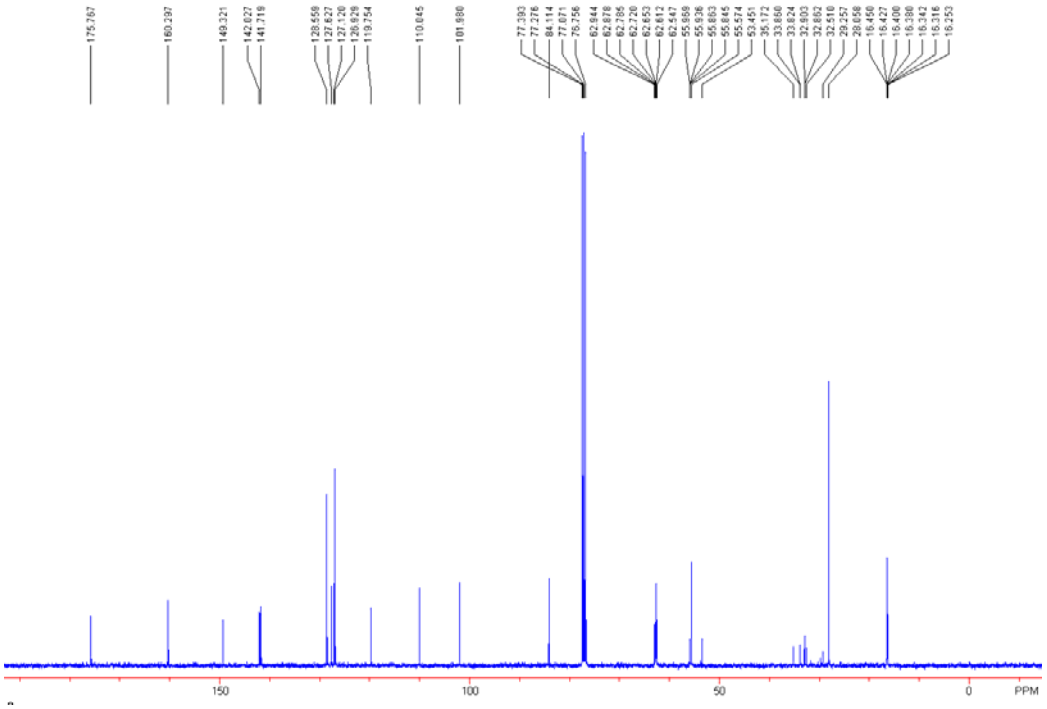


This journal is © The Royal Society of Chemistry 2012

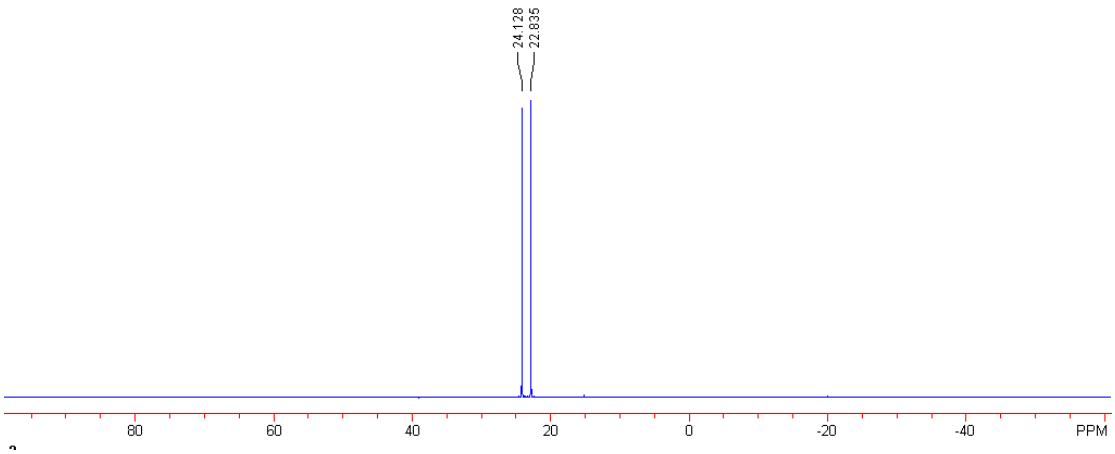
^{1}H NMR of **3f**



^{13}C NMR of **3f**

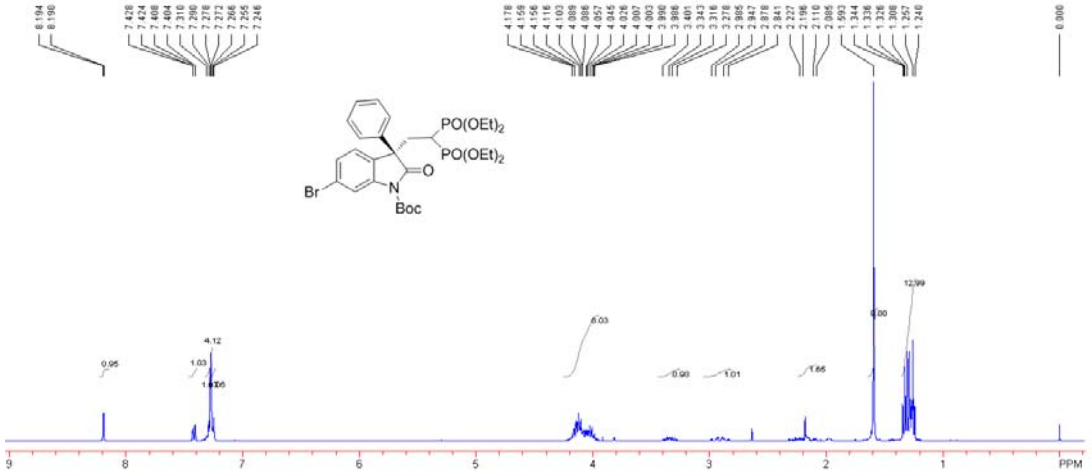


^{31}P NMR of **3f**

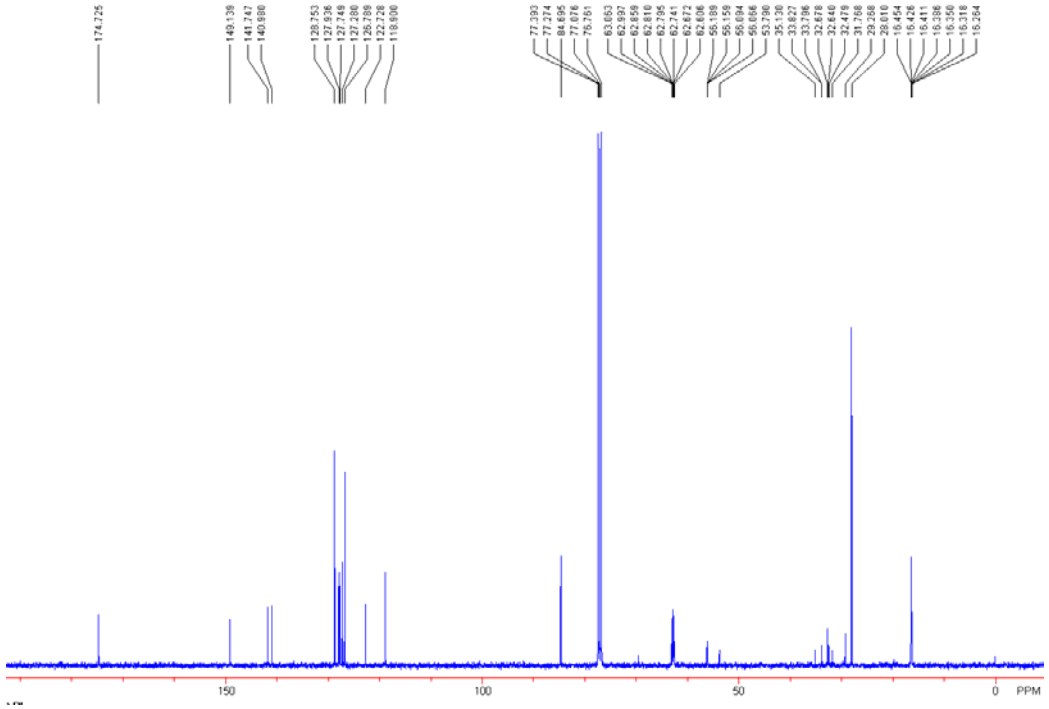


This journal is © The Royal Society of Chemistry 2012

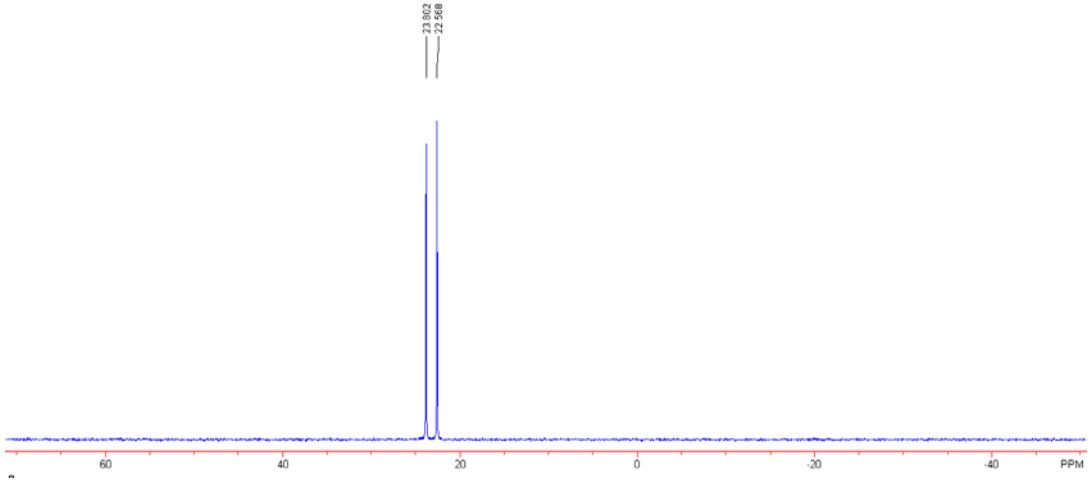
^{1}H NMR of **3g**



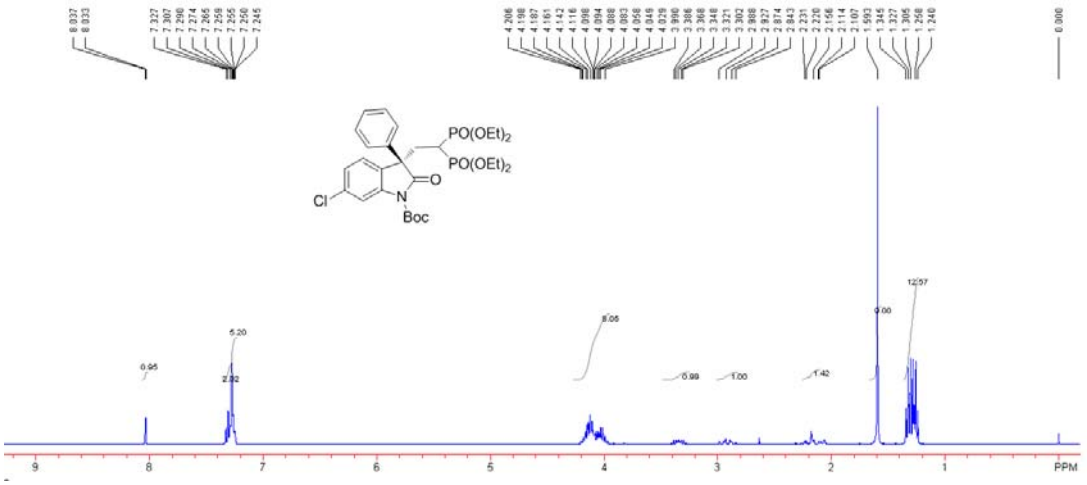
^{13}C NMR of **3g**



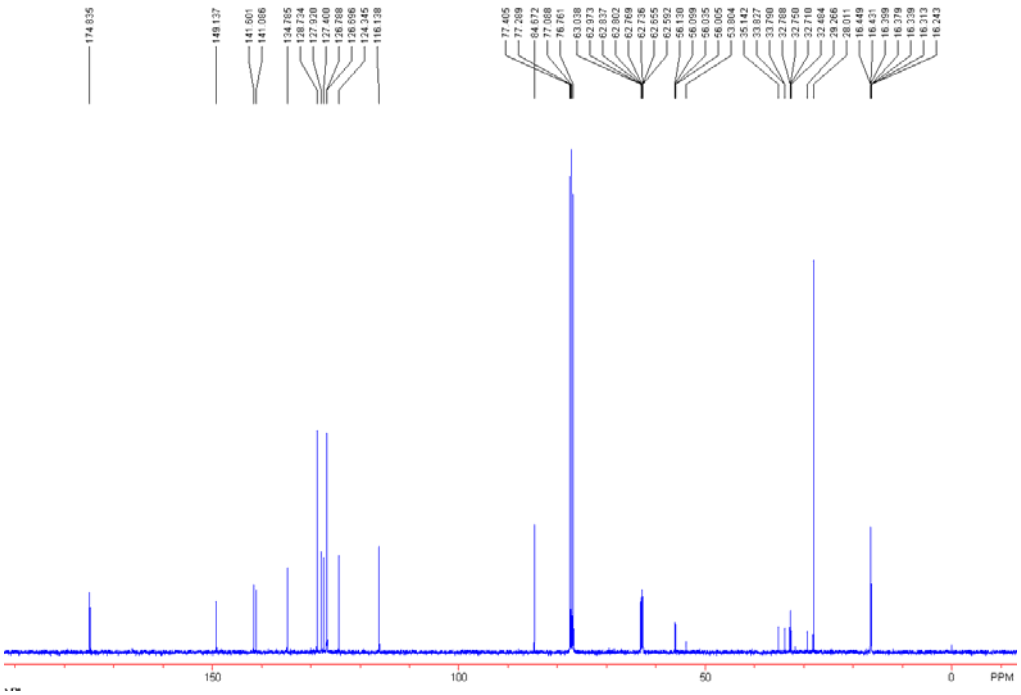
^{31}P NMR of **3g**



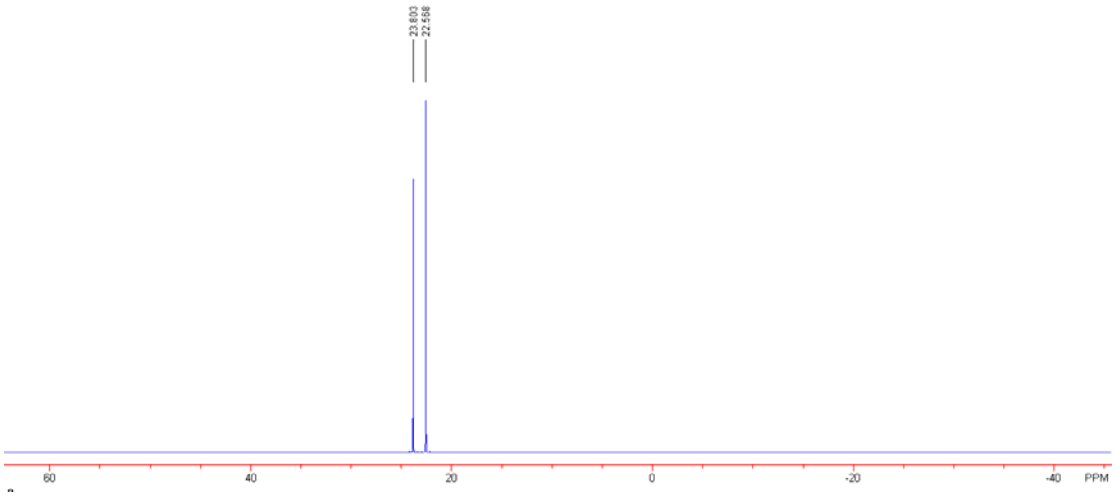
^{1}H NMR of **3h**



^{13}C NMR of **3h**

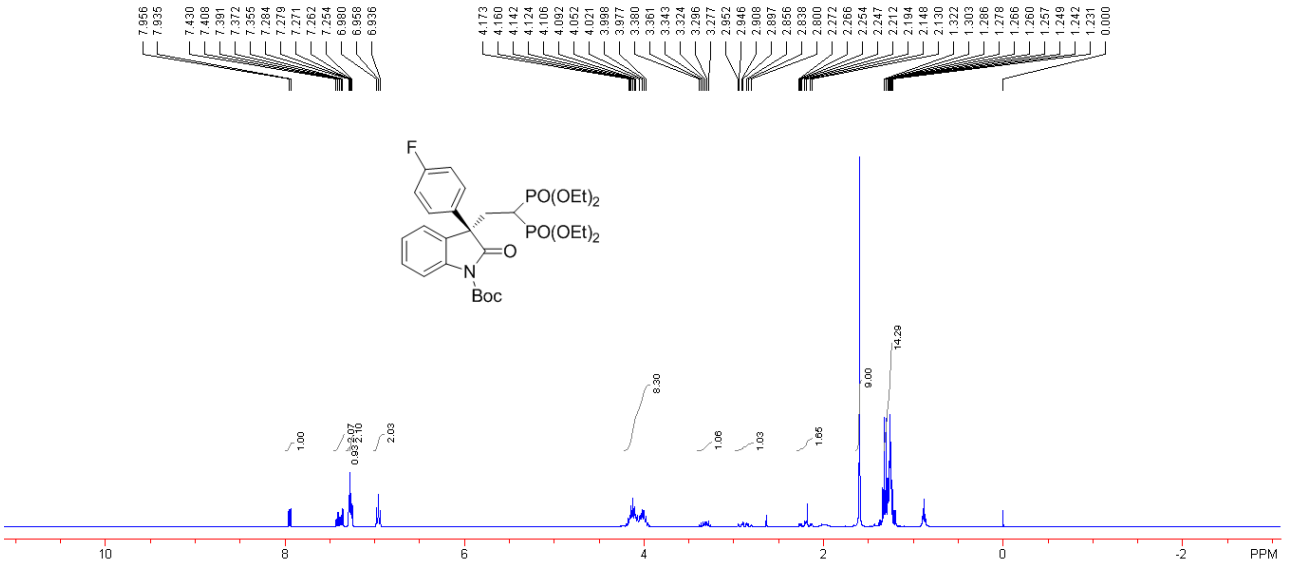


^{31}P NMR of **3h**

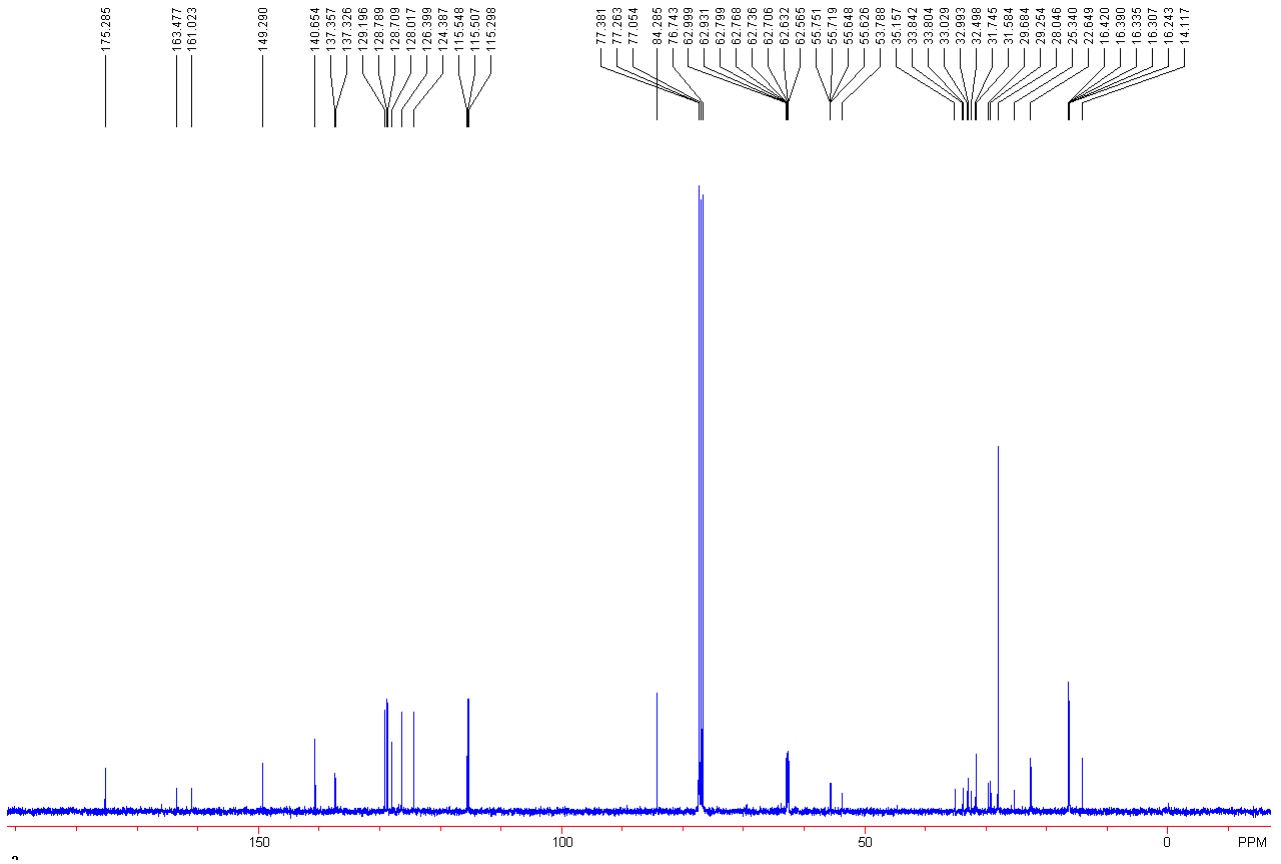


This journal is © The Royal Society of Chemistry 2012

^{1}H NMR of **3i**

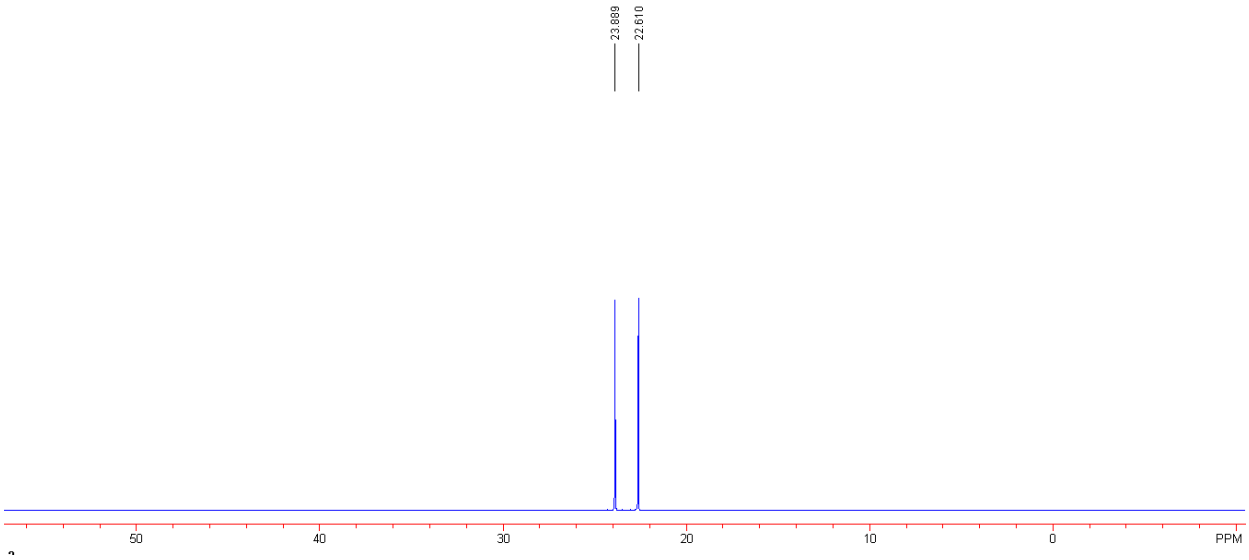


^{13}C NMR of **3i**

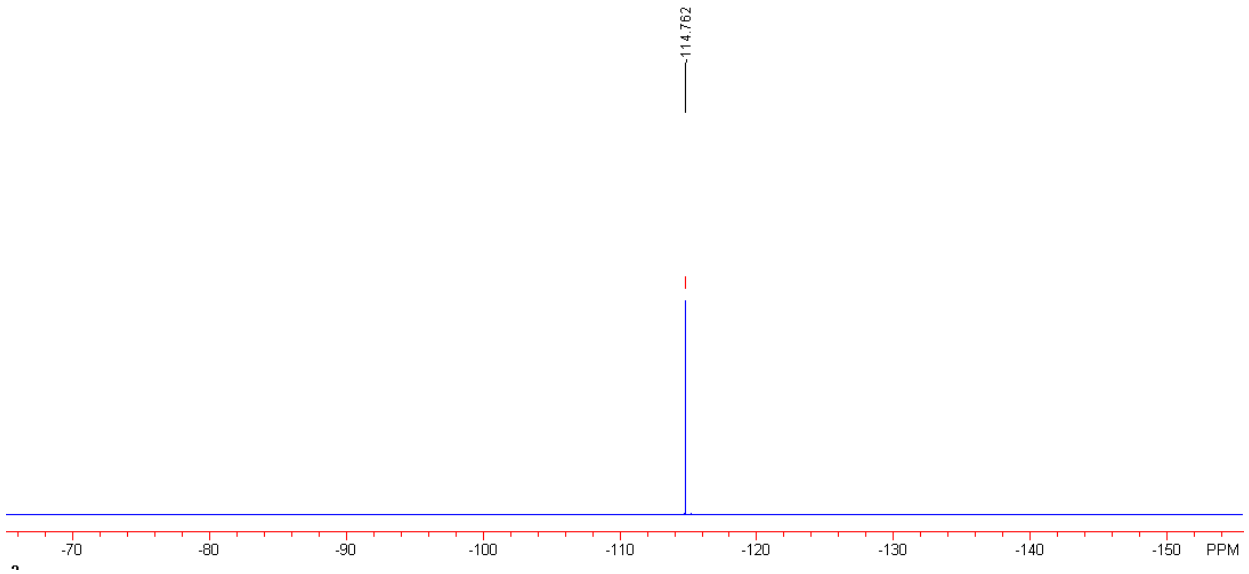


This journal is © The Royal Society of Chemistry 2012

^{31}P NMR of **3i**

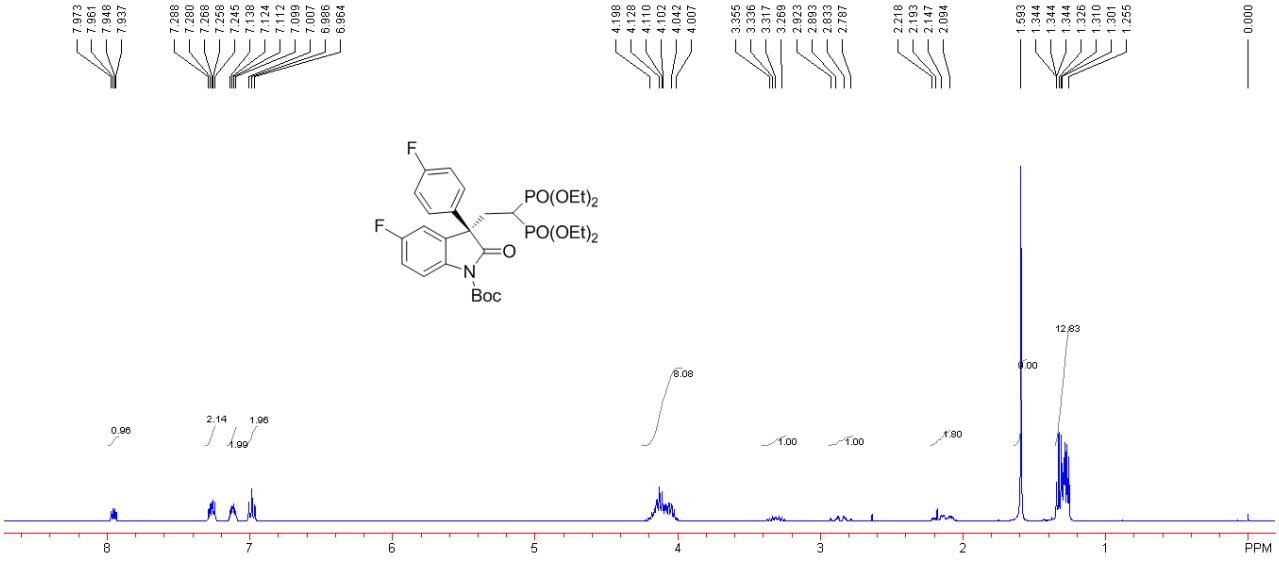


^{19}F NMR of **3i**

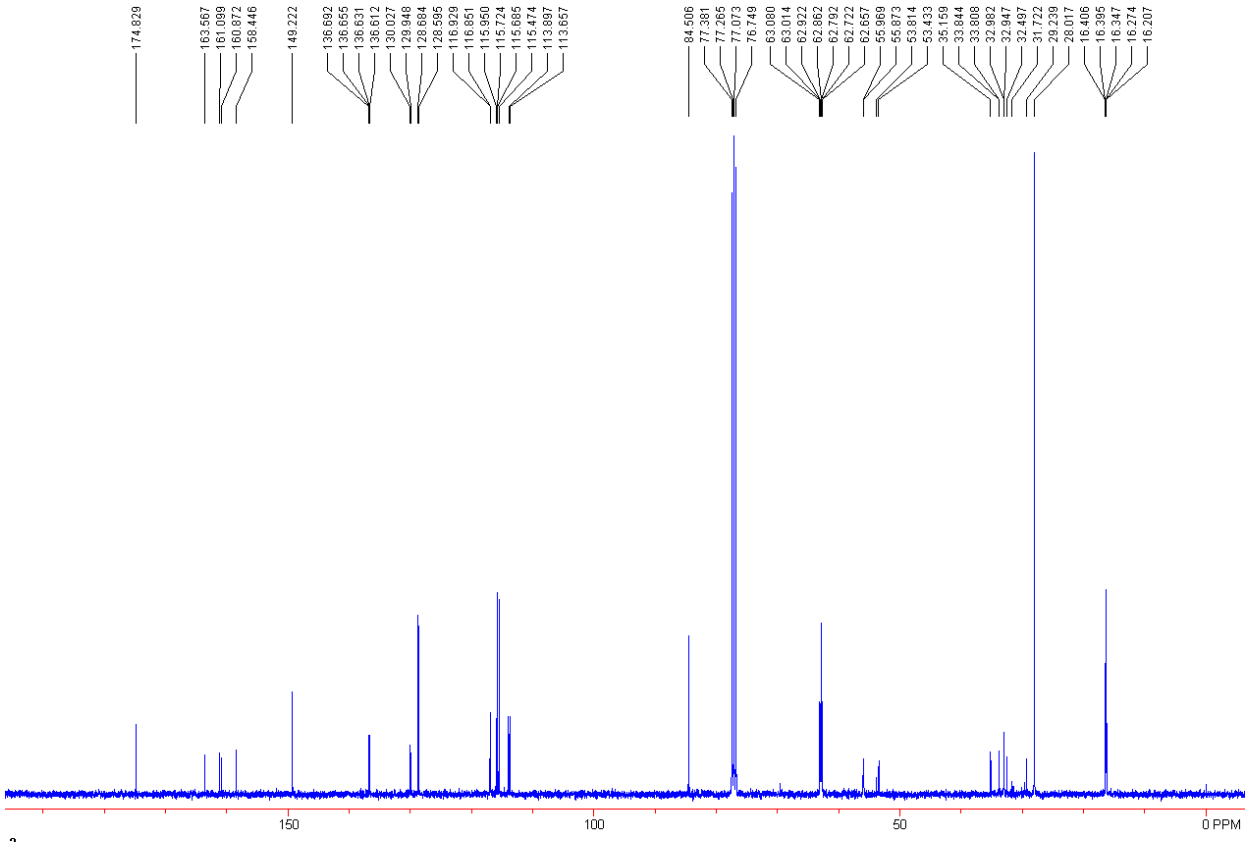


This journal is © The Royal Society of Chemistry 2012

^{1}H NMR of **3j**

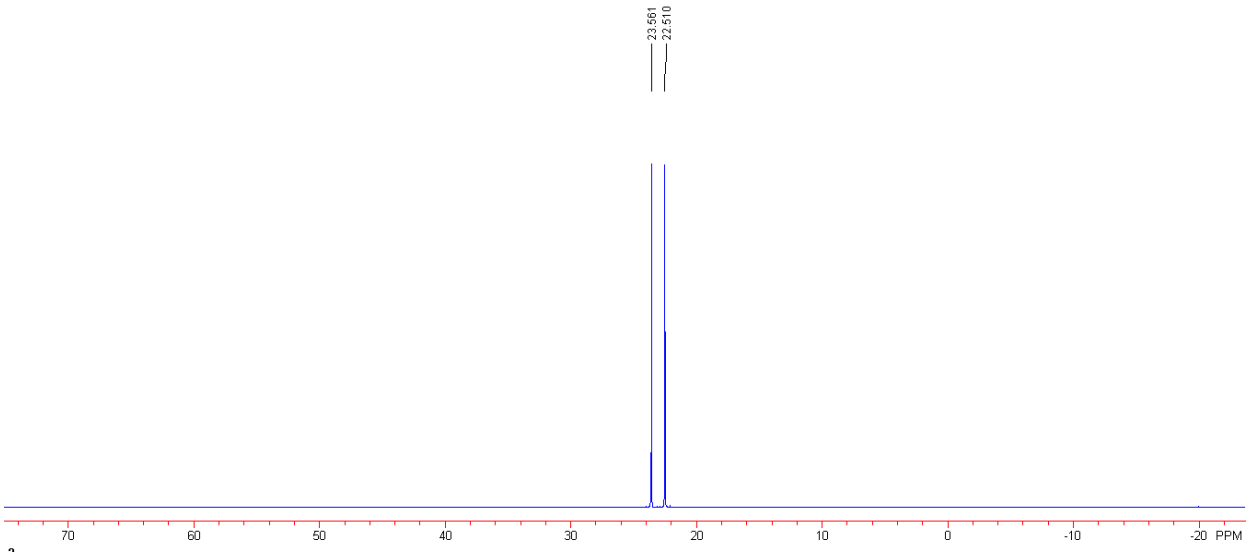


^{13}C NMR of **3j**

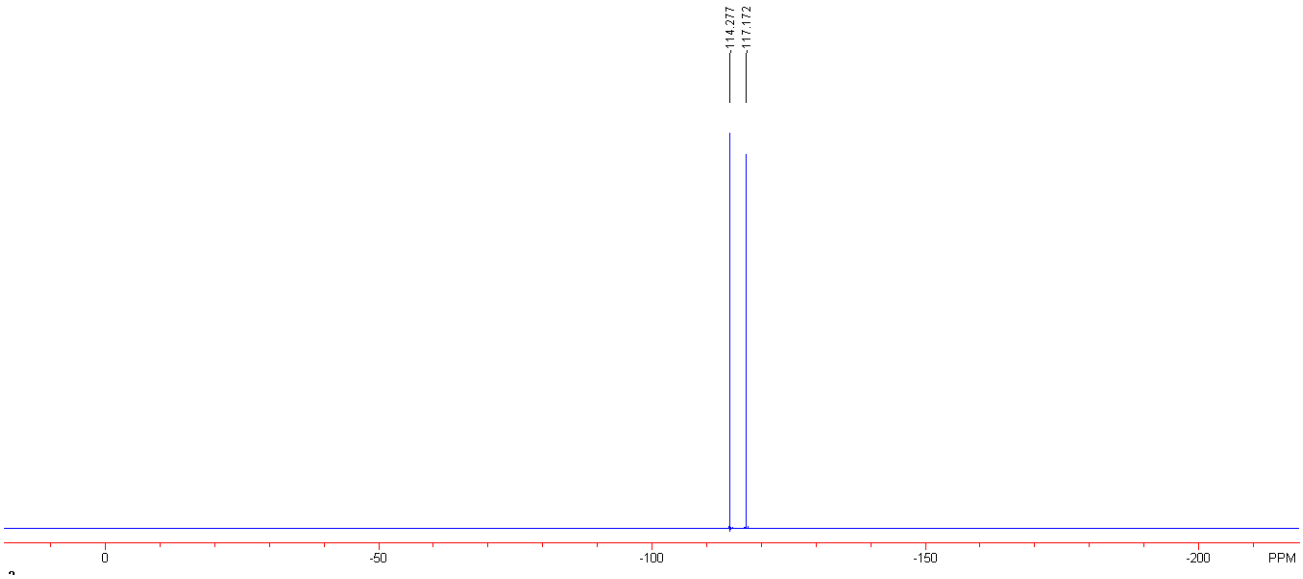


This journal is © The Royal Society of Chemistry 2012

^{31}P NMR of **3j**

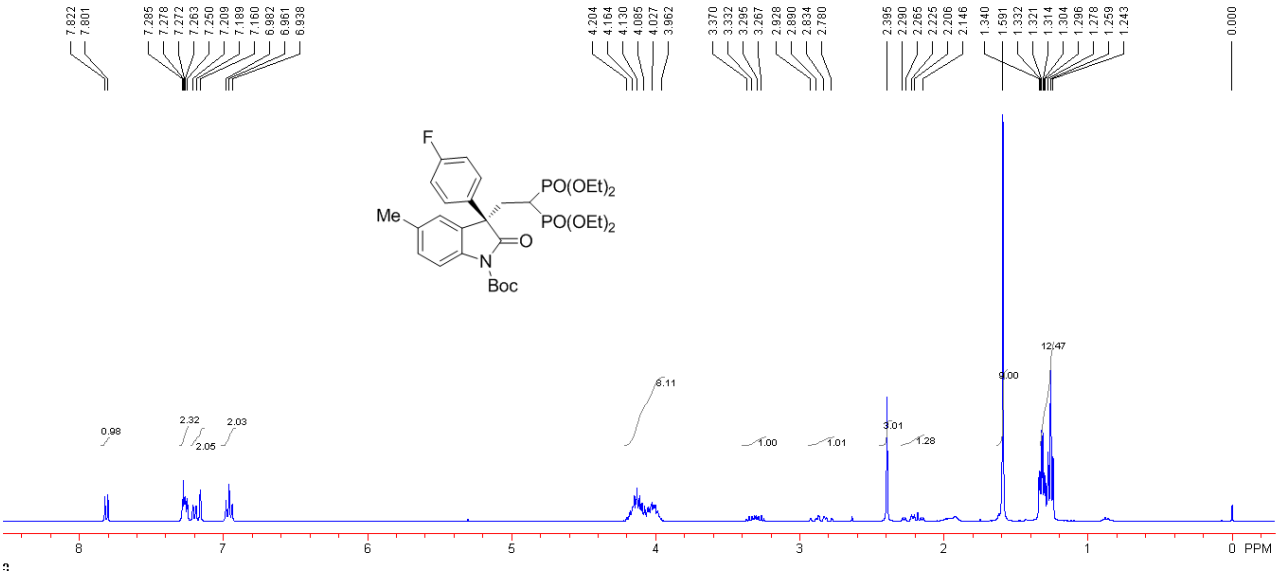


^{19}F NMR of **3j**

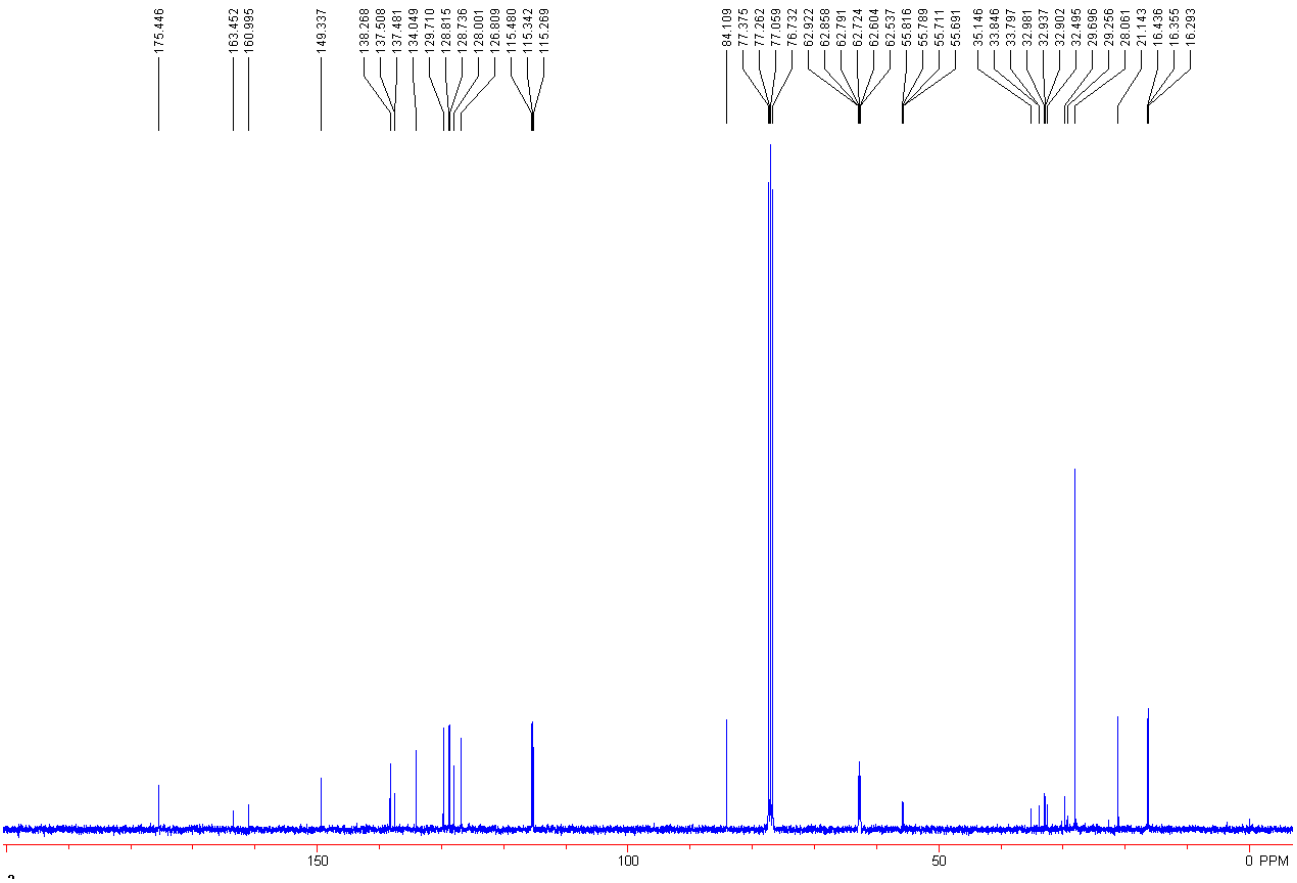


This journal is © The Royal Society of Chemistry 2012

^{1}H NMR of **3k**

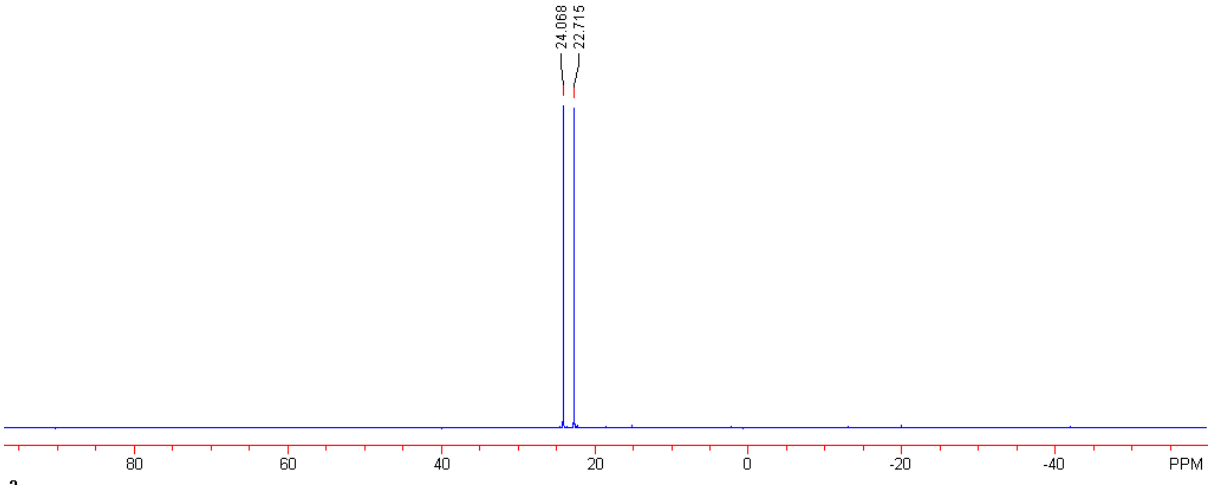


^{13}C NMR of **3k**

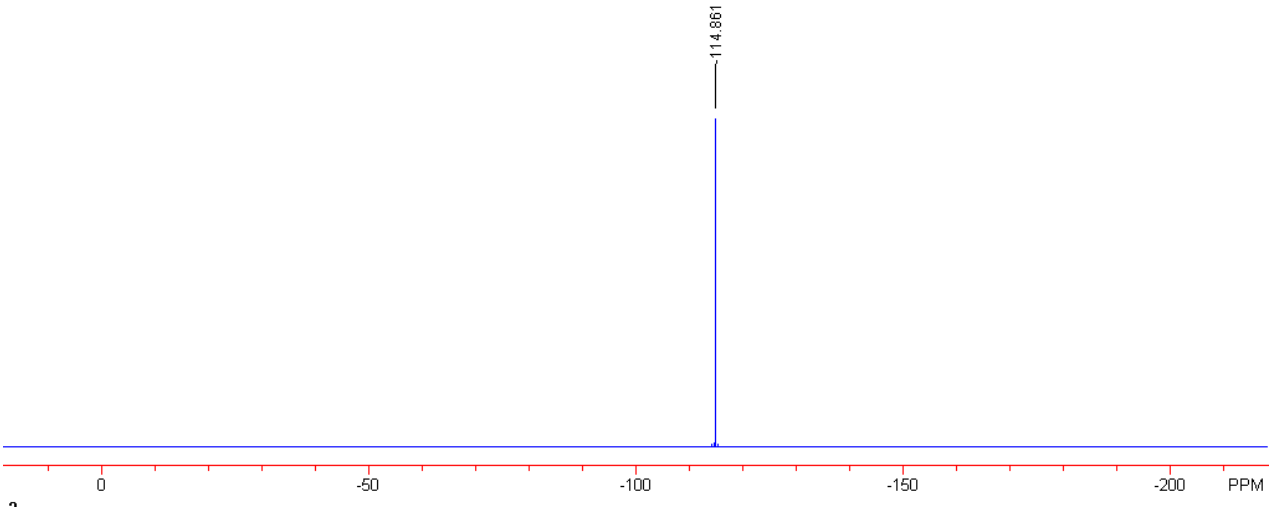


This journal is © The Royal Society of Chemistry 2012

^{31}P NMR of **3k**

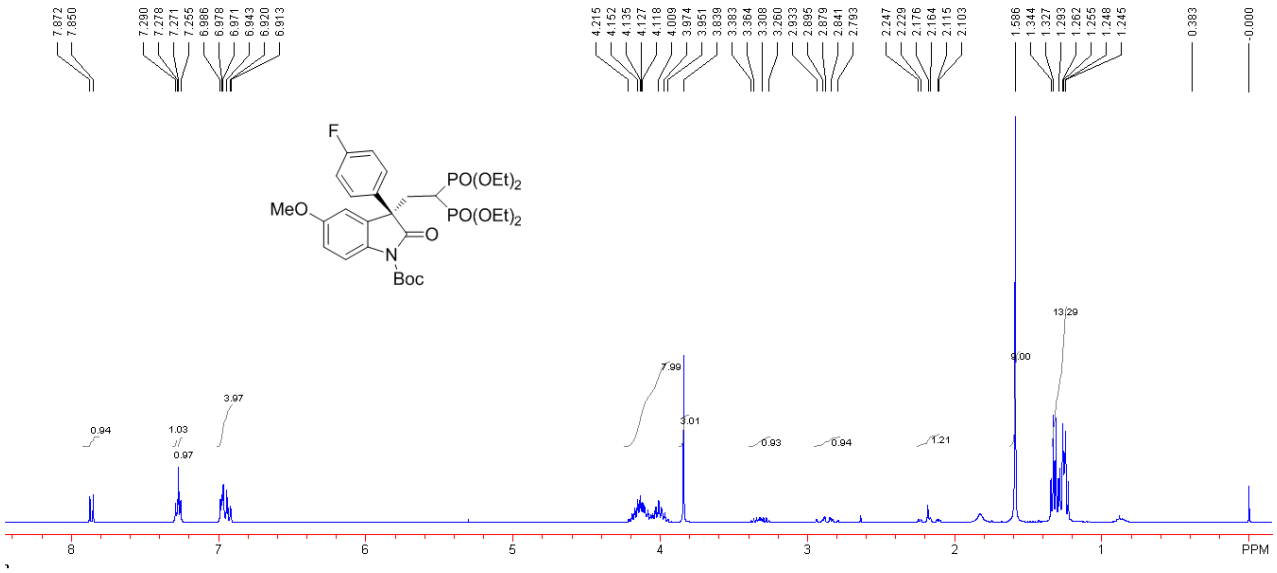


^{19}F NMR of **3k**

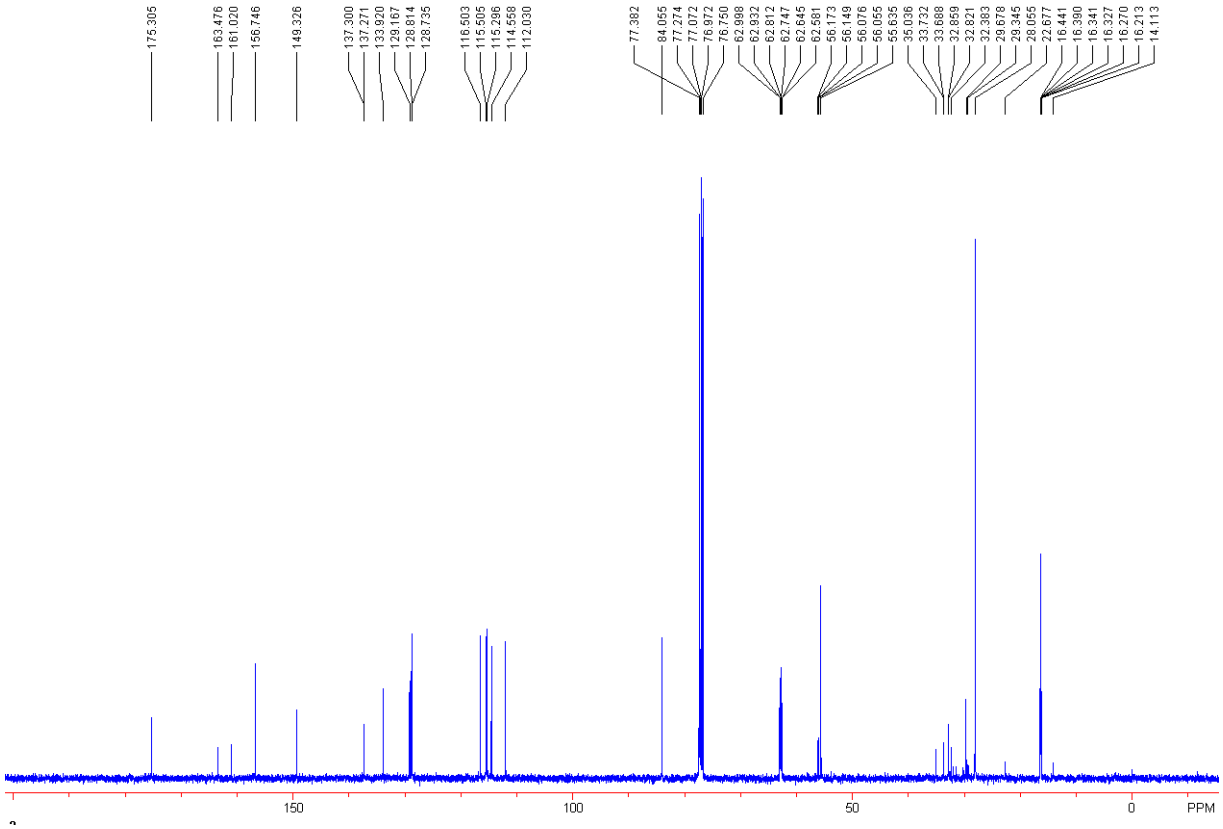


This journal is © The Royal Society of Chemistry 2012

^{1}H NMR of **3l**

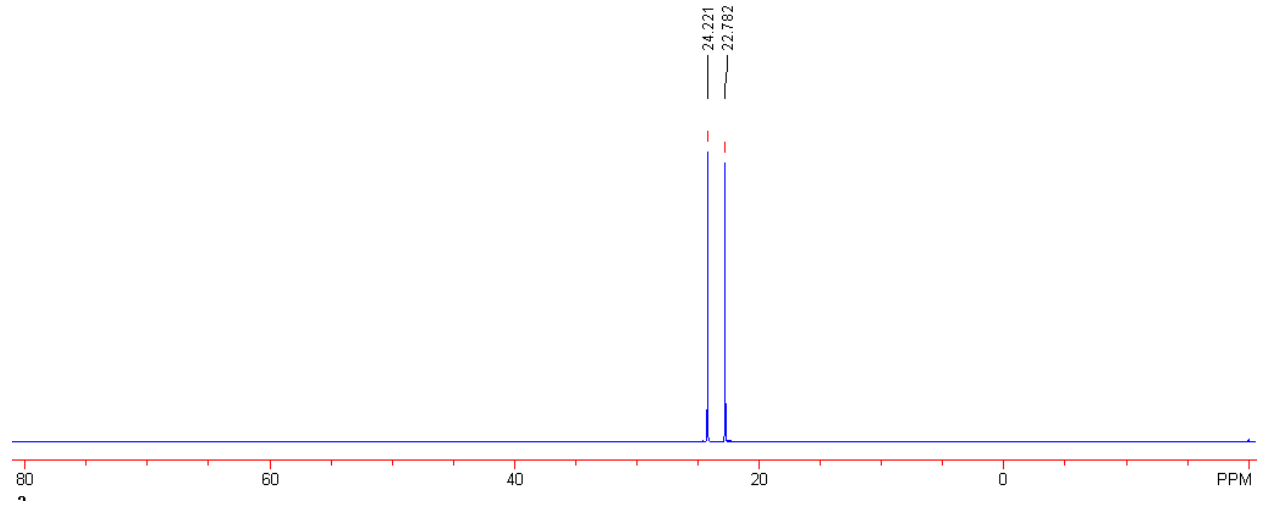


^{13}C NMR of **3l**

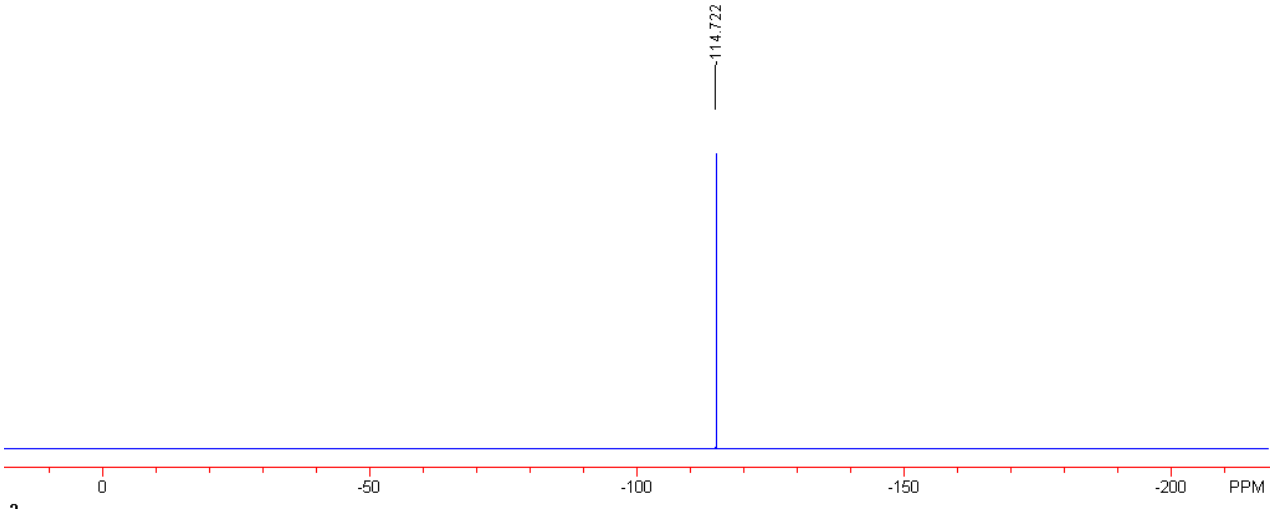


This journal is © The Royal Society of Chemistry 2012

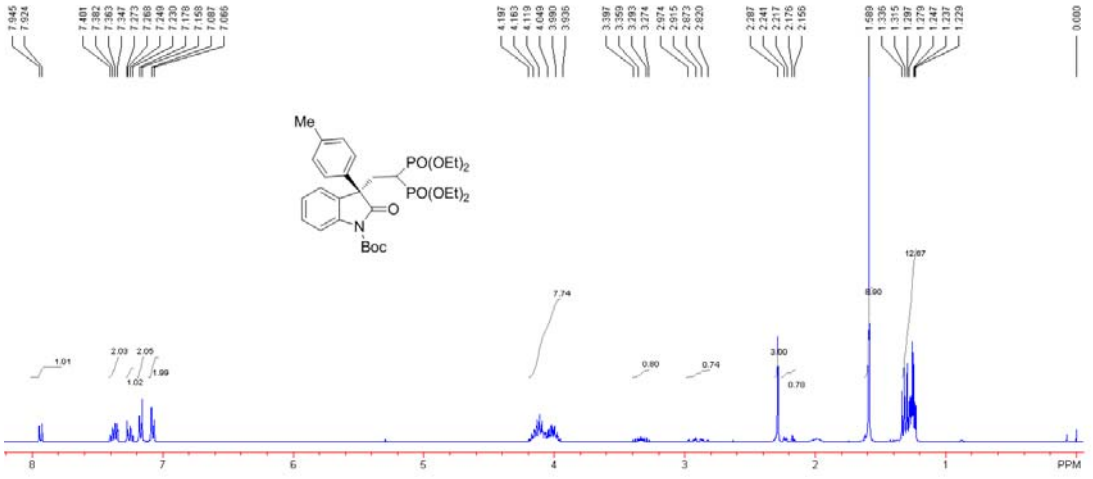
^{31}P NMR of **3l**



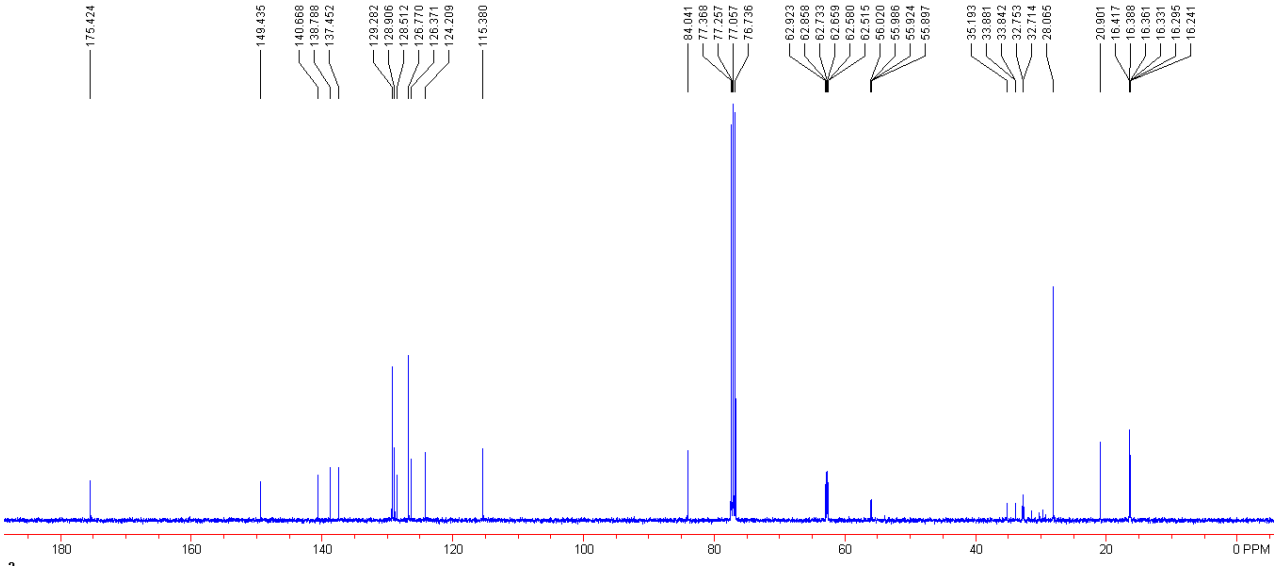
^{19}F NMR of **3l**



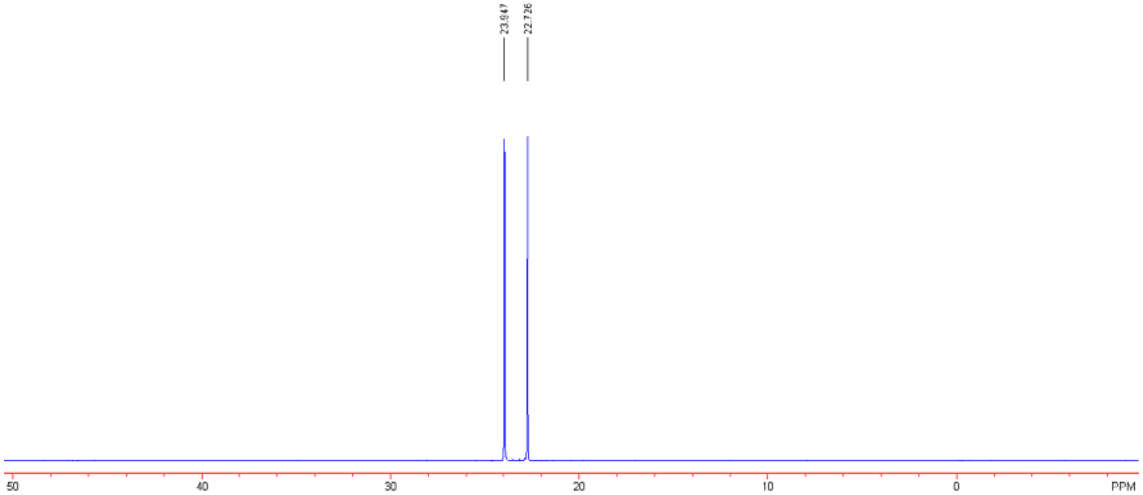
^{1}H NMR of **3m**



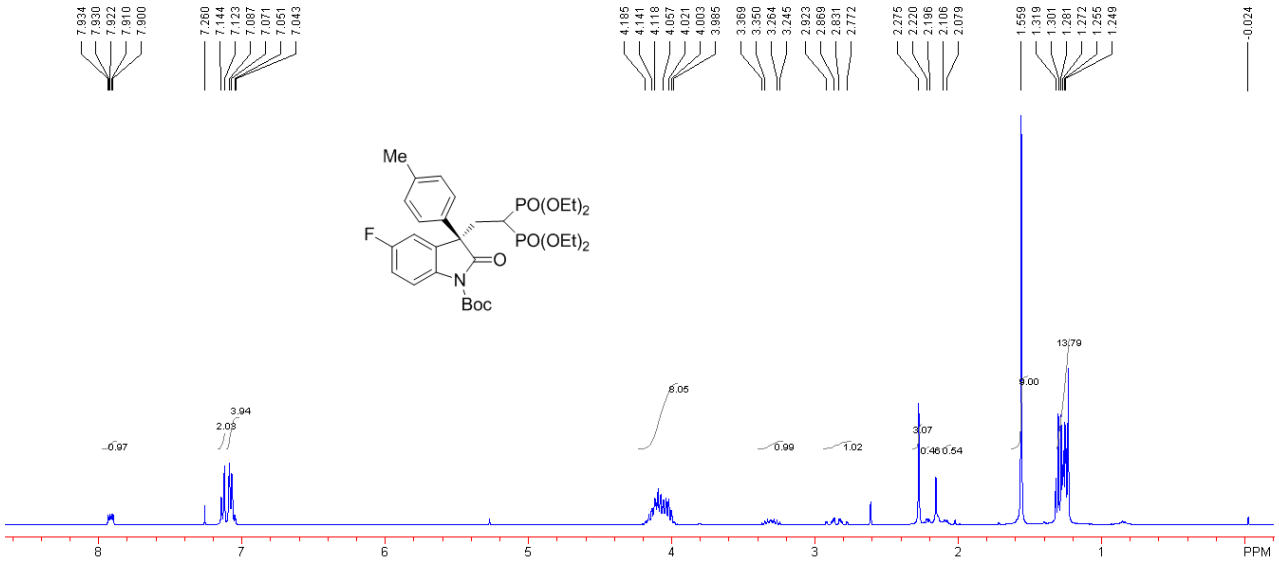
^{13}C NMR of **3m**



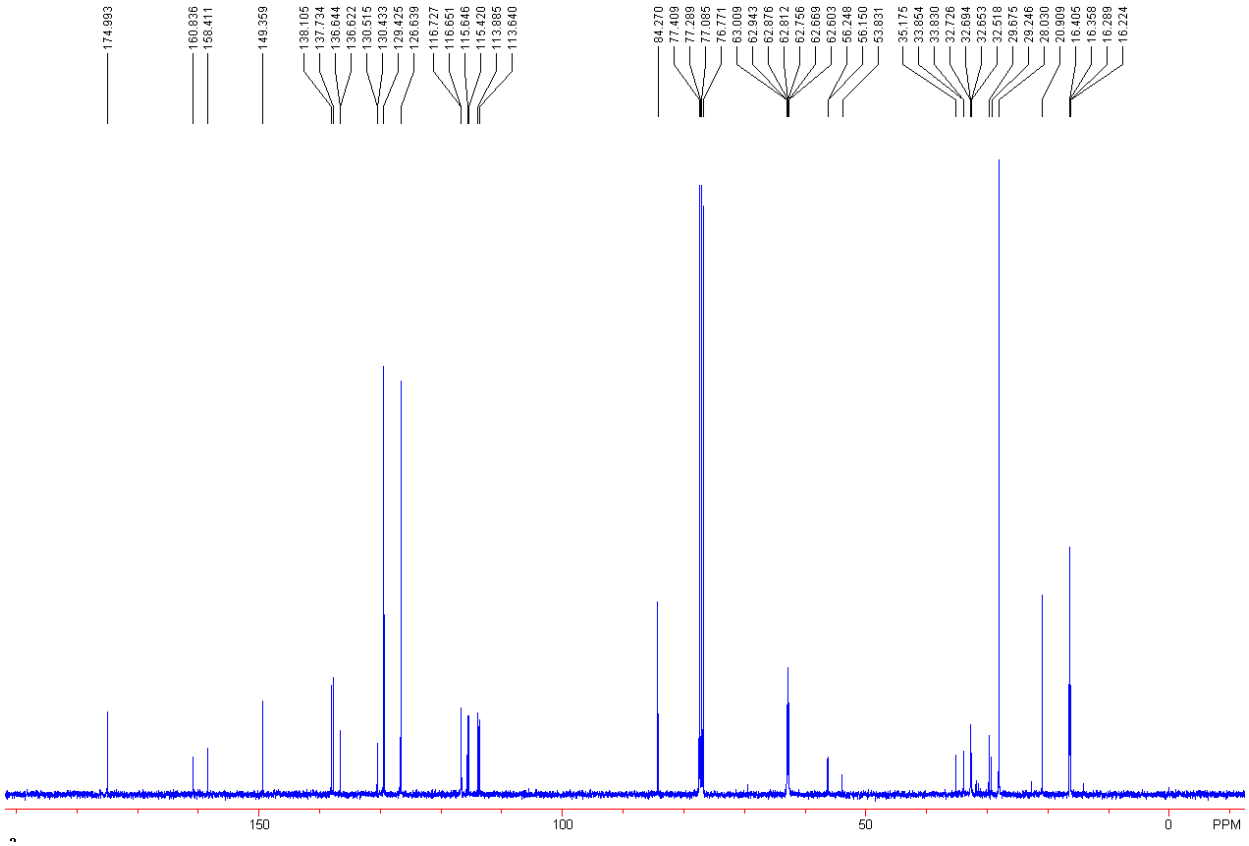
^{31}P NMR of **3m**



^{1}H NMR of **3n**

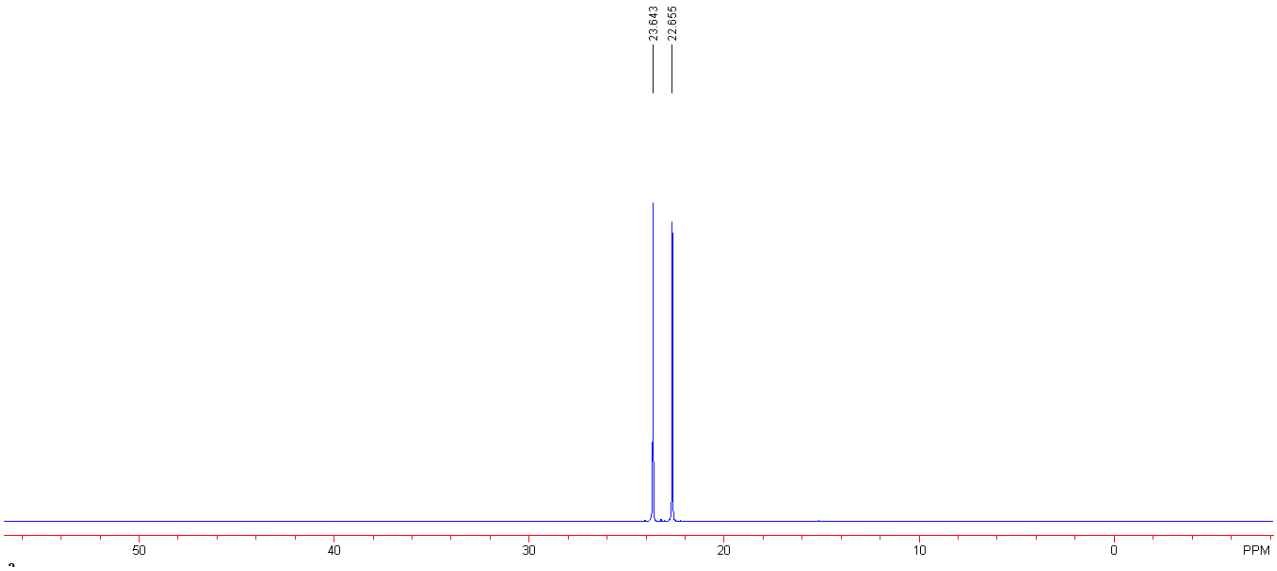


^{13}C NMR of **3n**

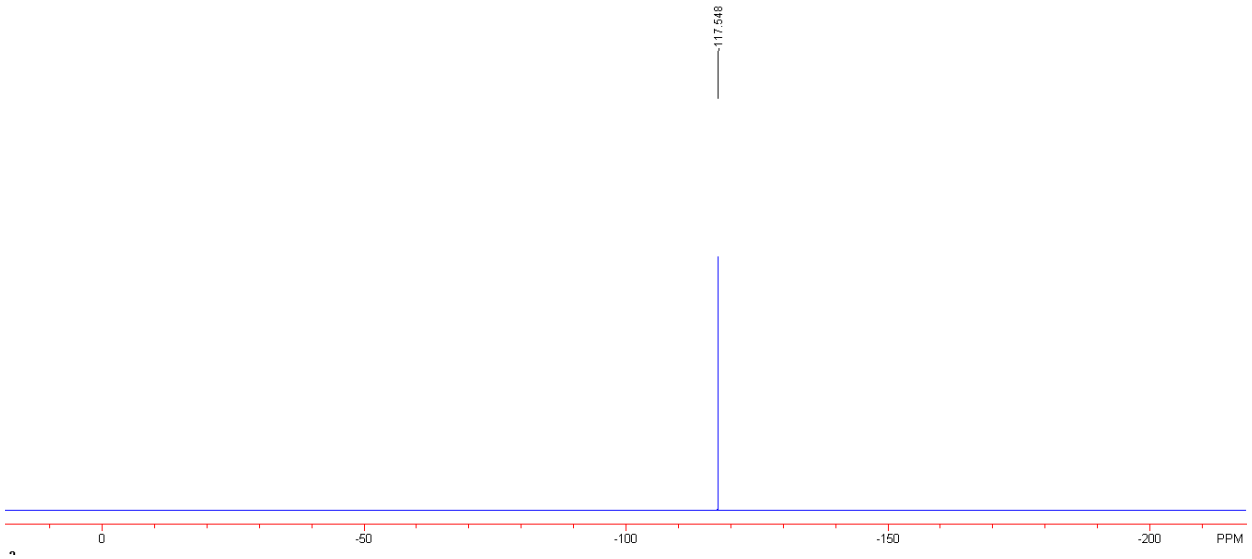


This journal is © The Royal Society of Chemistry 2012

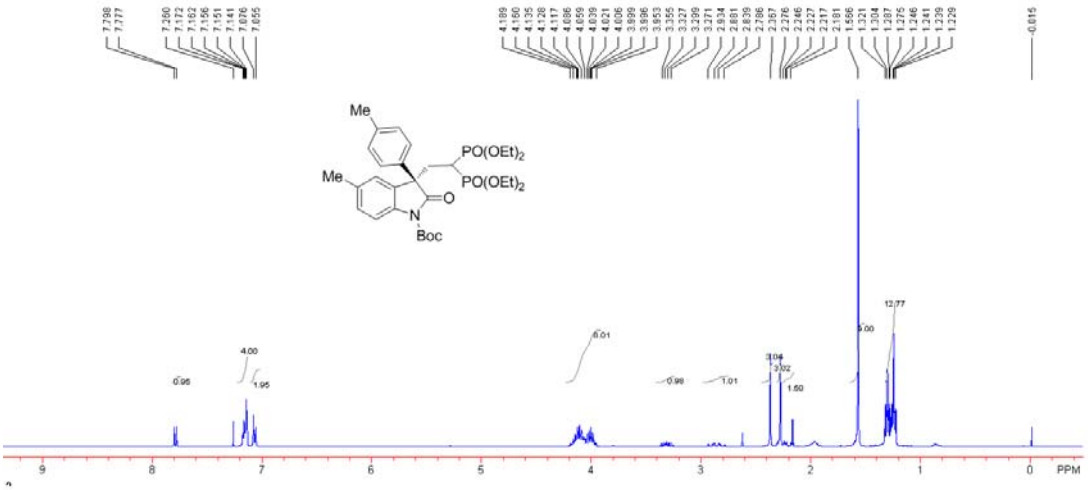
^{31}P NMR of **3n**



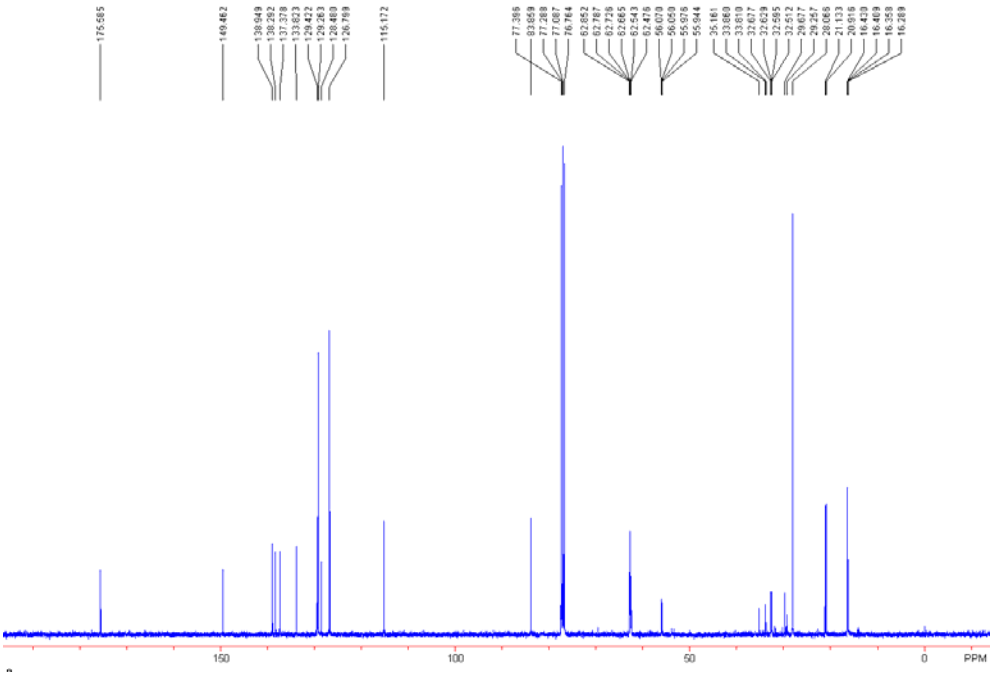
^{19}F NMR of **3n**



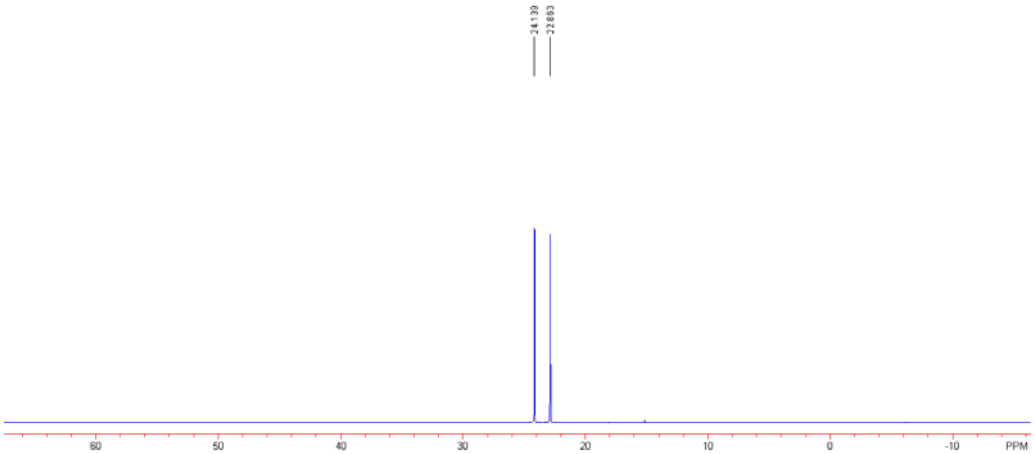
^{1}H NMR of **3o**



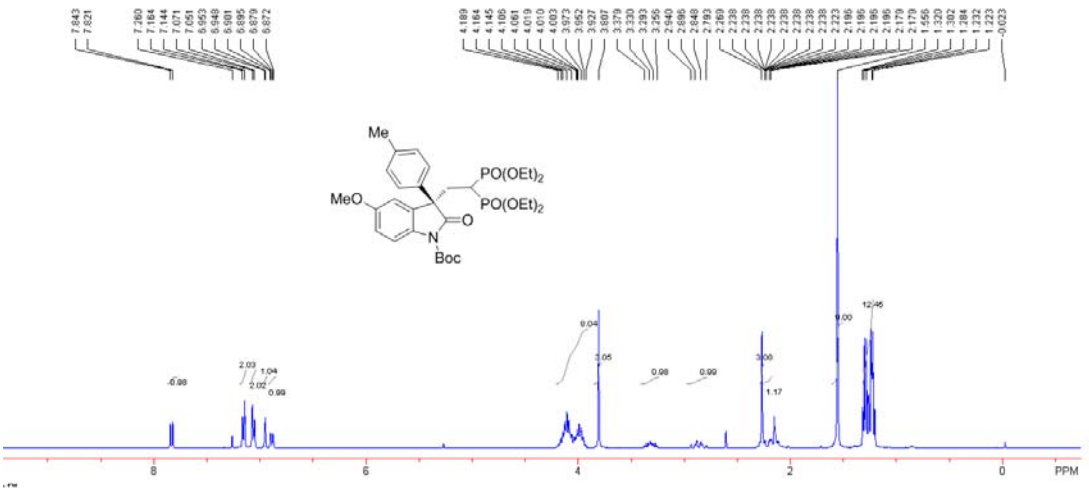
^{13}C NMR of **3o**



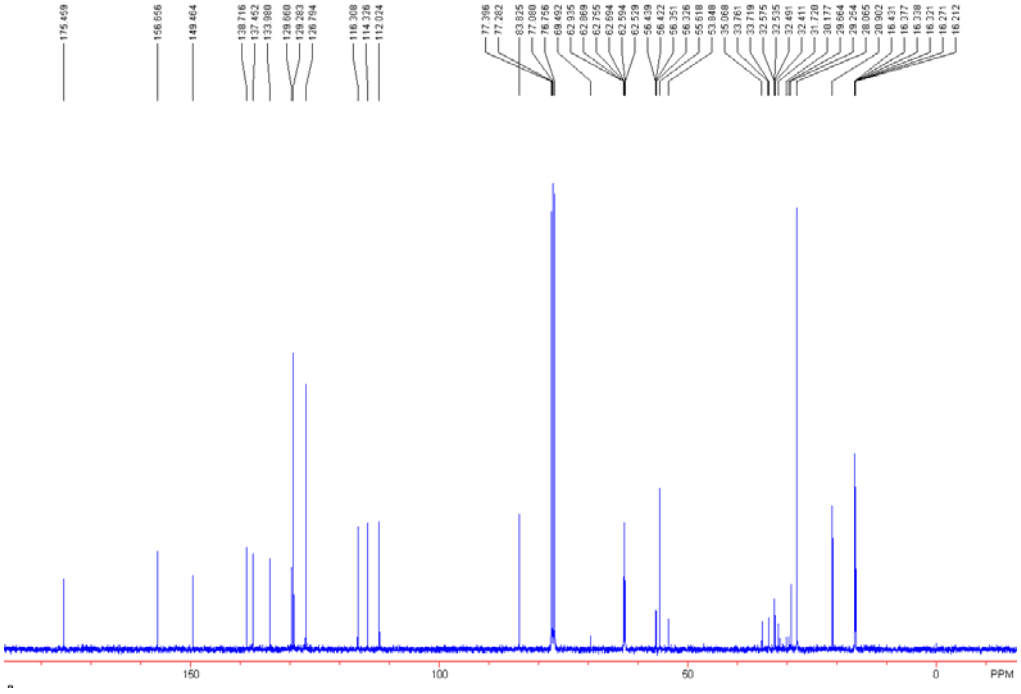
^{31}P NMR of **3o**



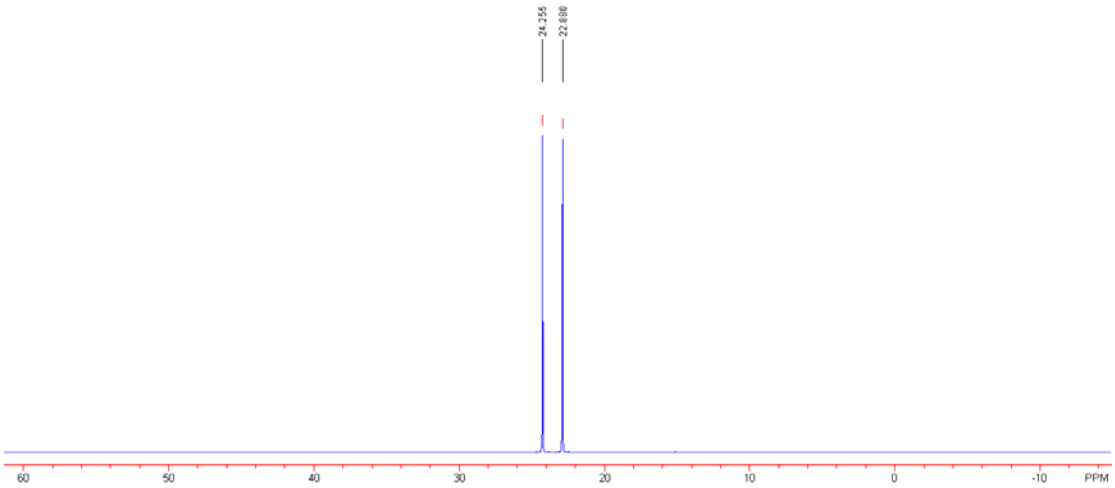
^{1}H NMR of **3p**



^{13}C NMR of **3p**

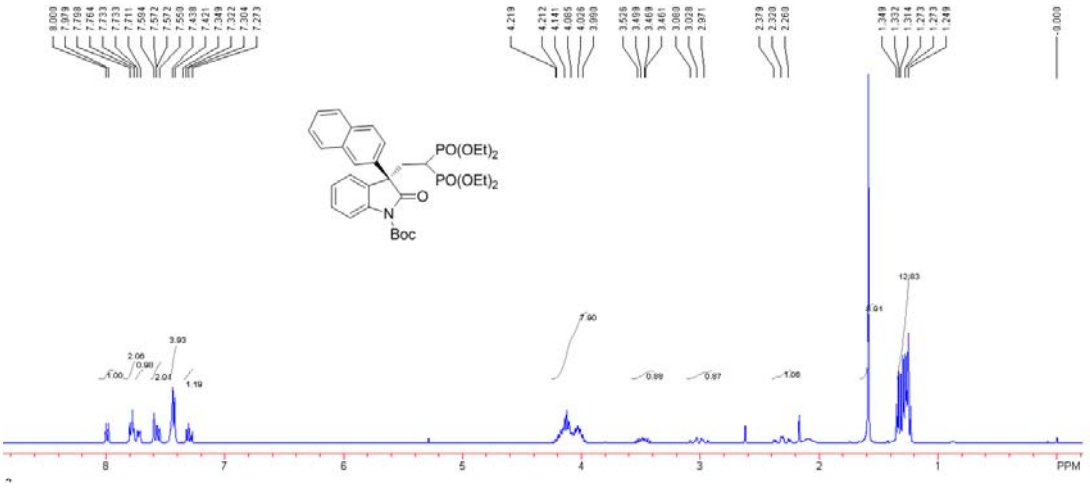


^{31}P NMR of **3p**

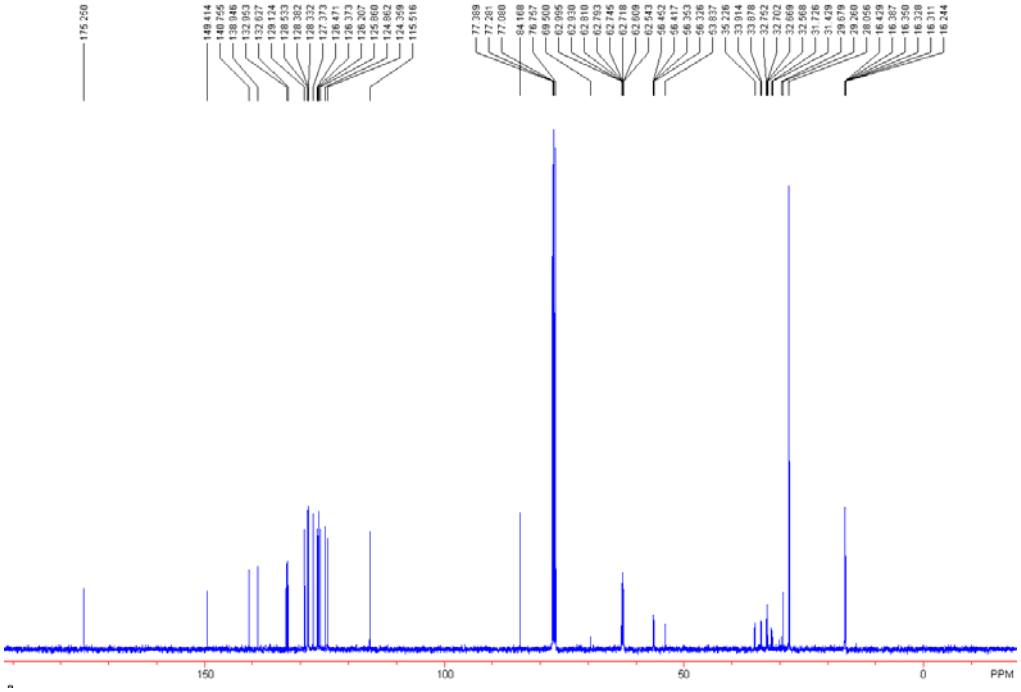


This journal is © The Royal Society of Chemistry 2012

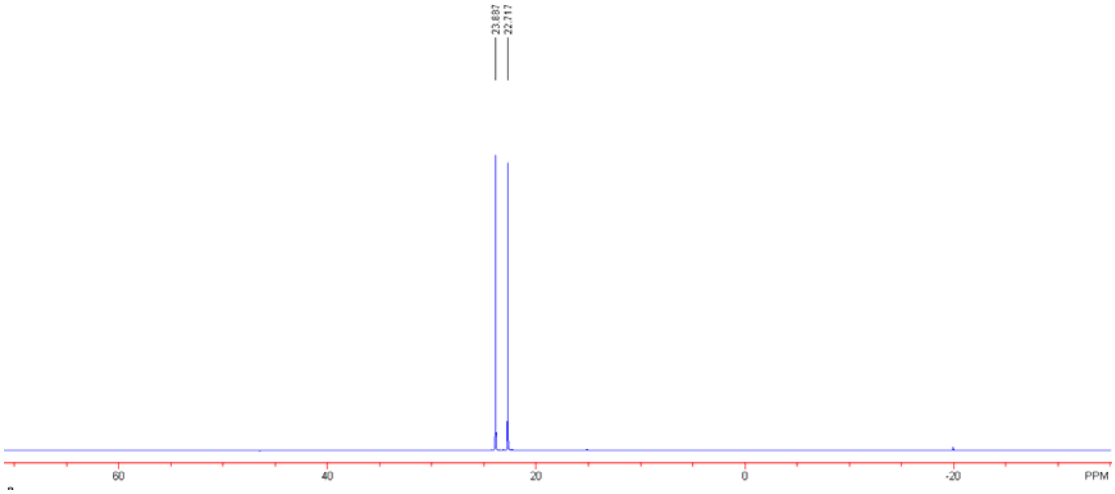
^{1}H NMR of **3q**



^{13}C NMR of **3q**

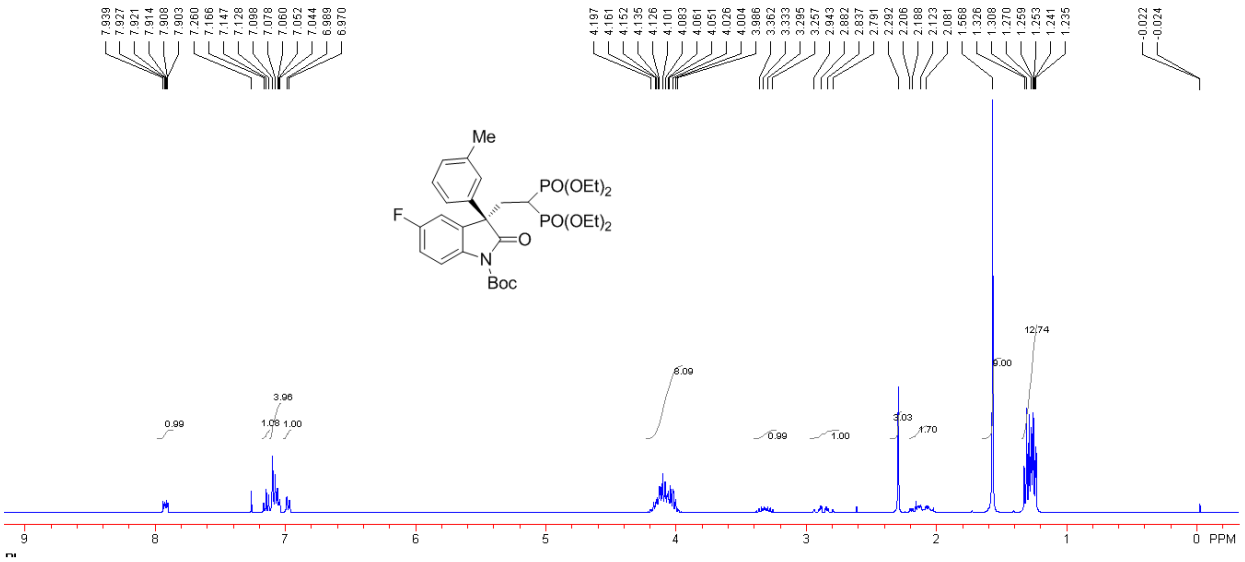


^{31}P NMR of **3q**

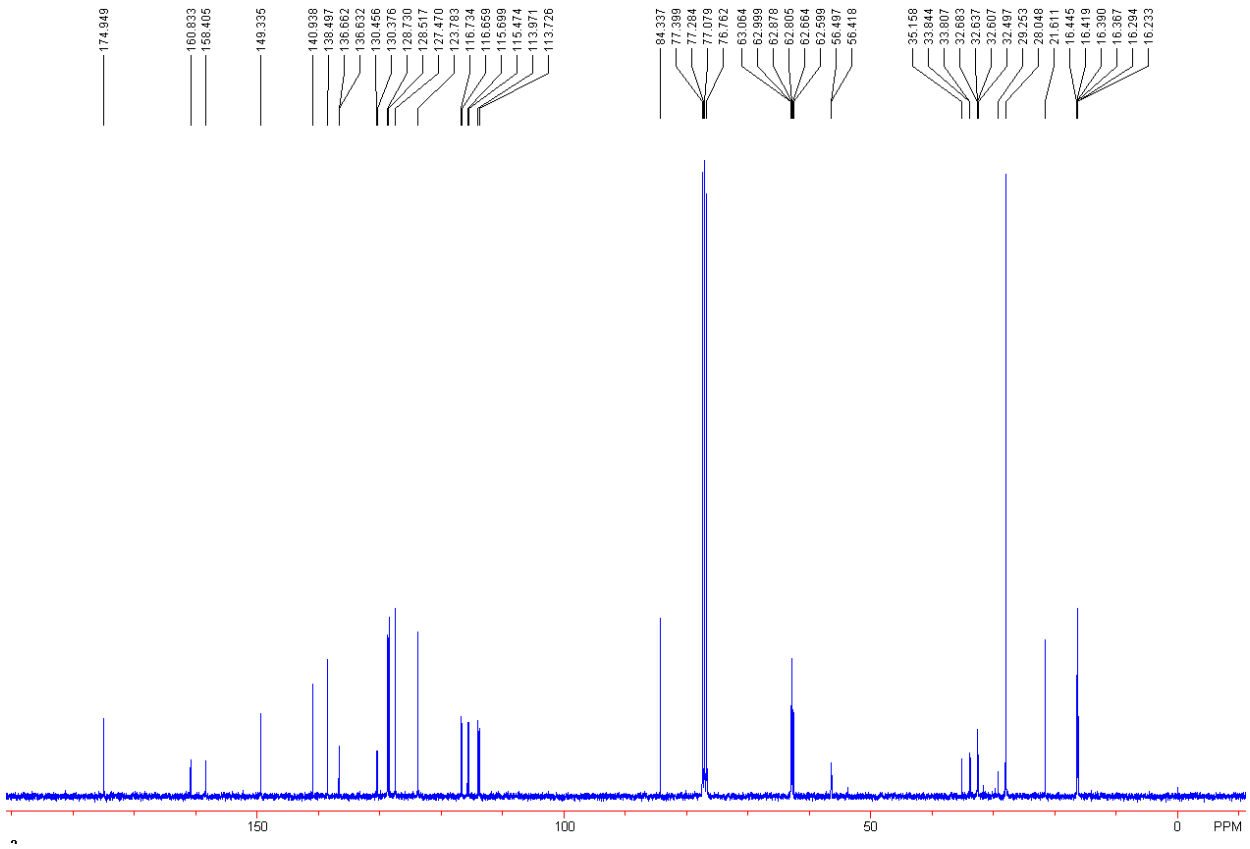


This journal is © The Royal Society of Chemistry 2012

^{1}H NMR of **3r**

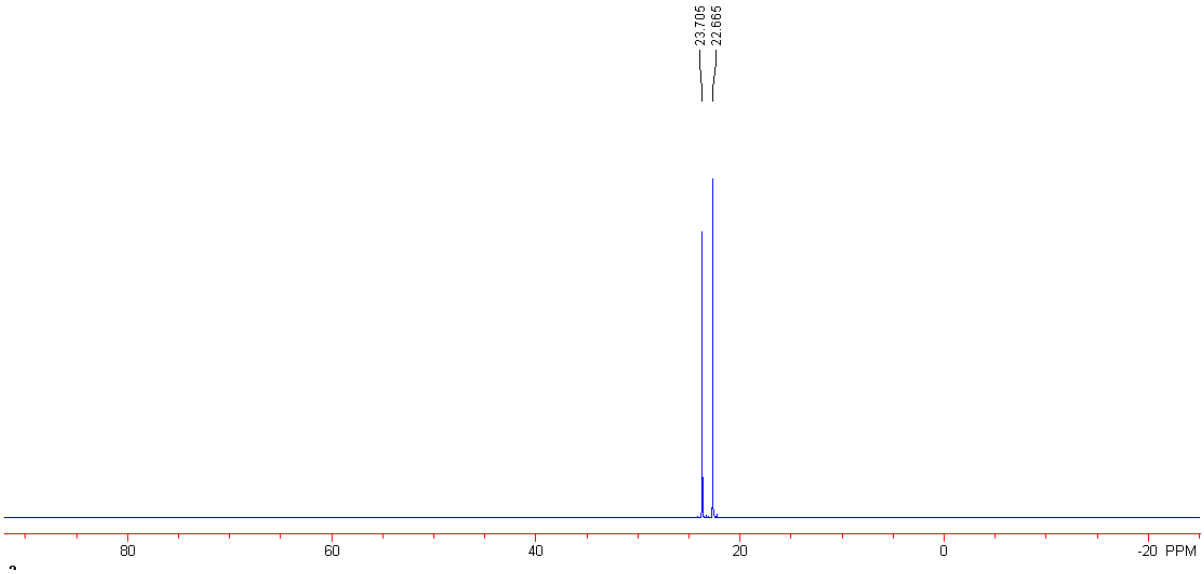


^{13}C NMR of **3r**

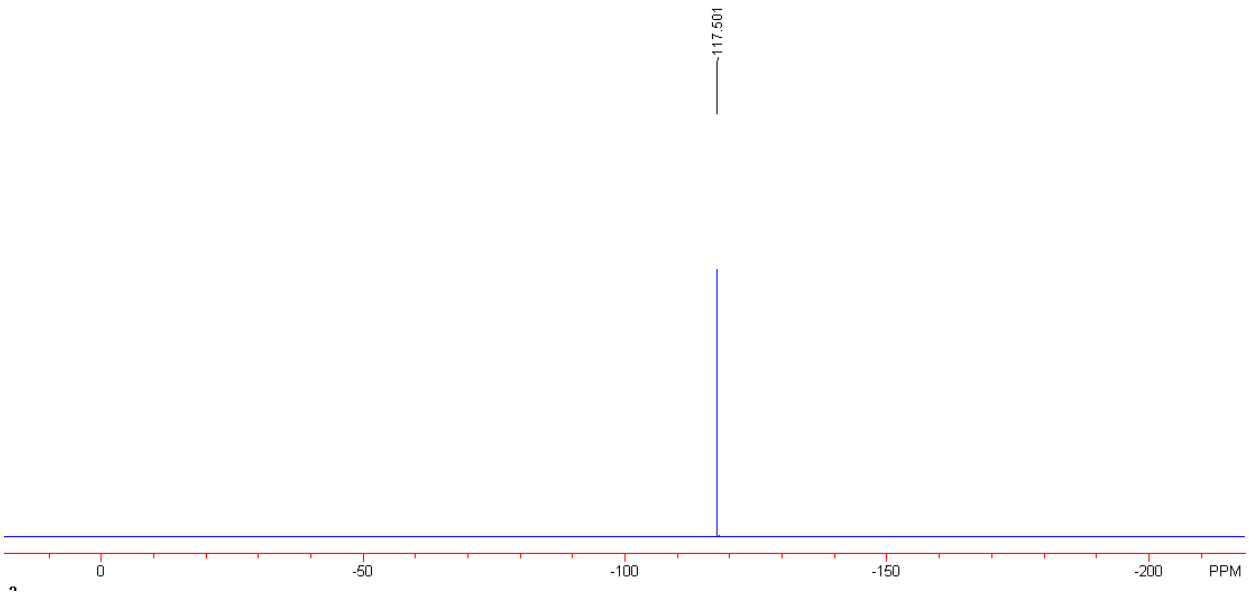


This journal is © The Royal Society of Chemistry 2012

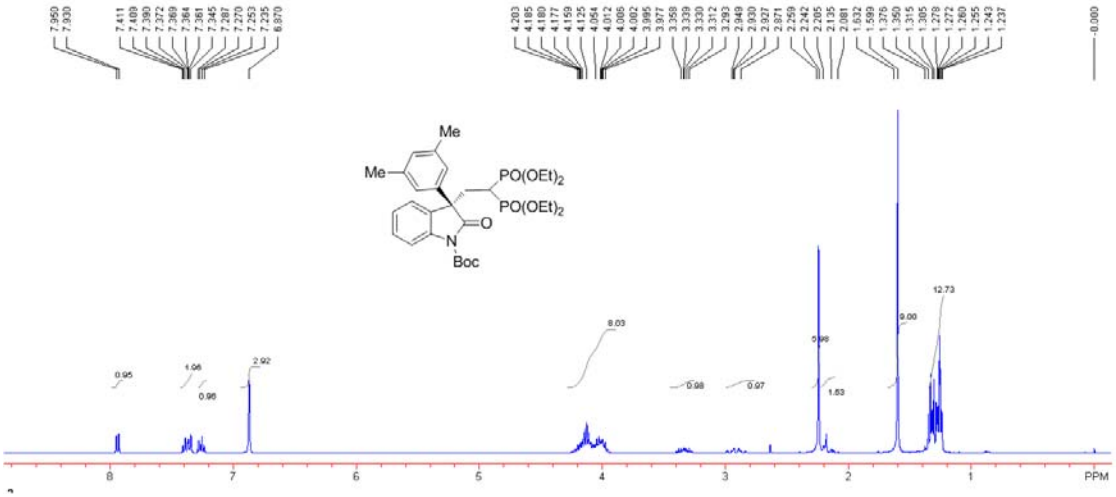
^{31}P NMR of **3r**



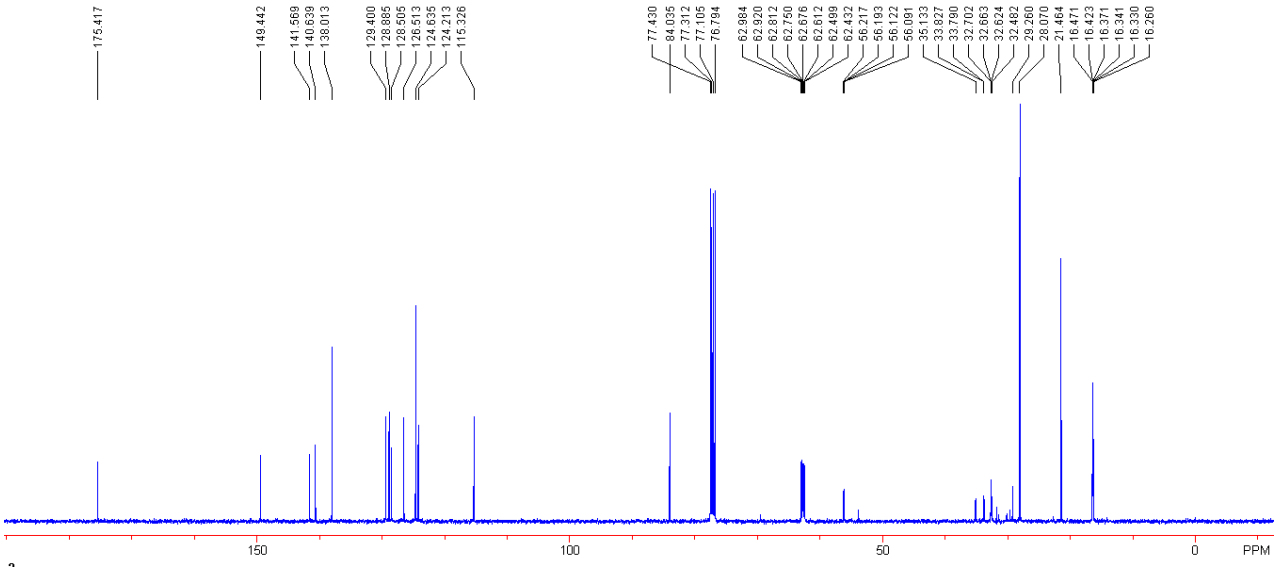
^{19}F NMR of **3r**



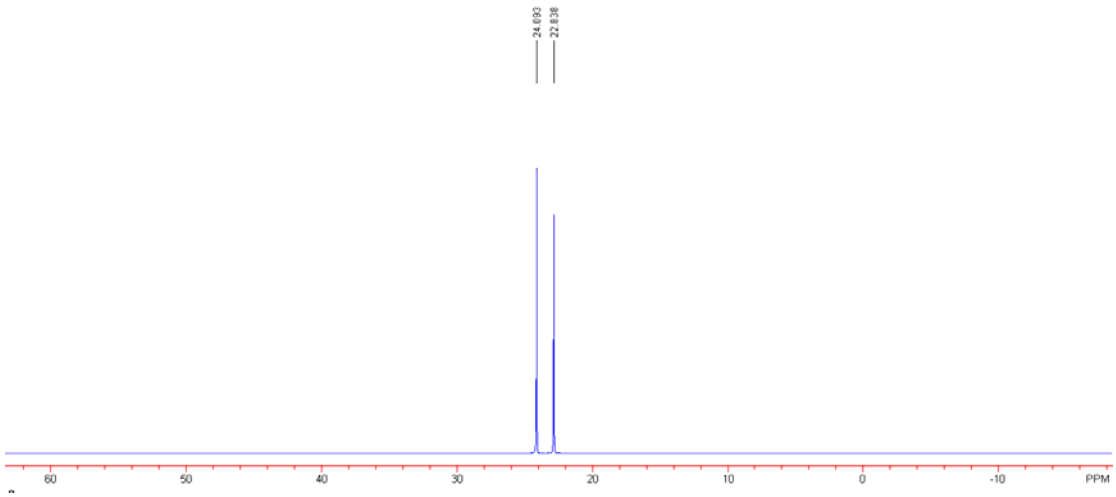
^{1}H NMR of **3s**



^{13}C NMR of **3s**

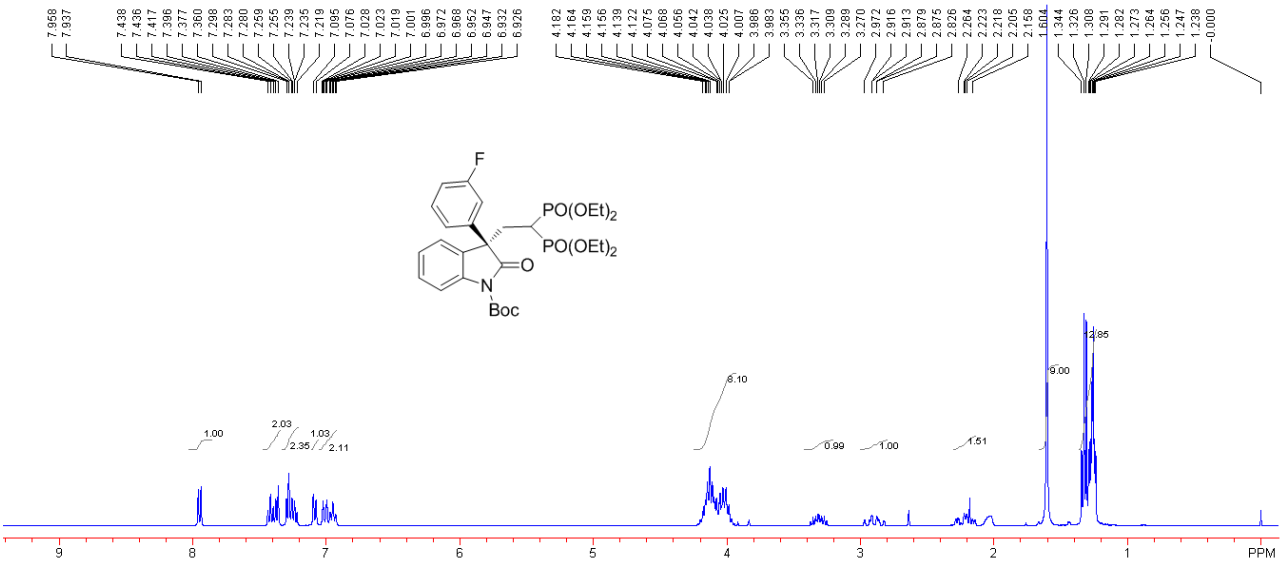


^{31}P NMR of **3s**

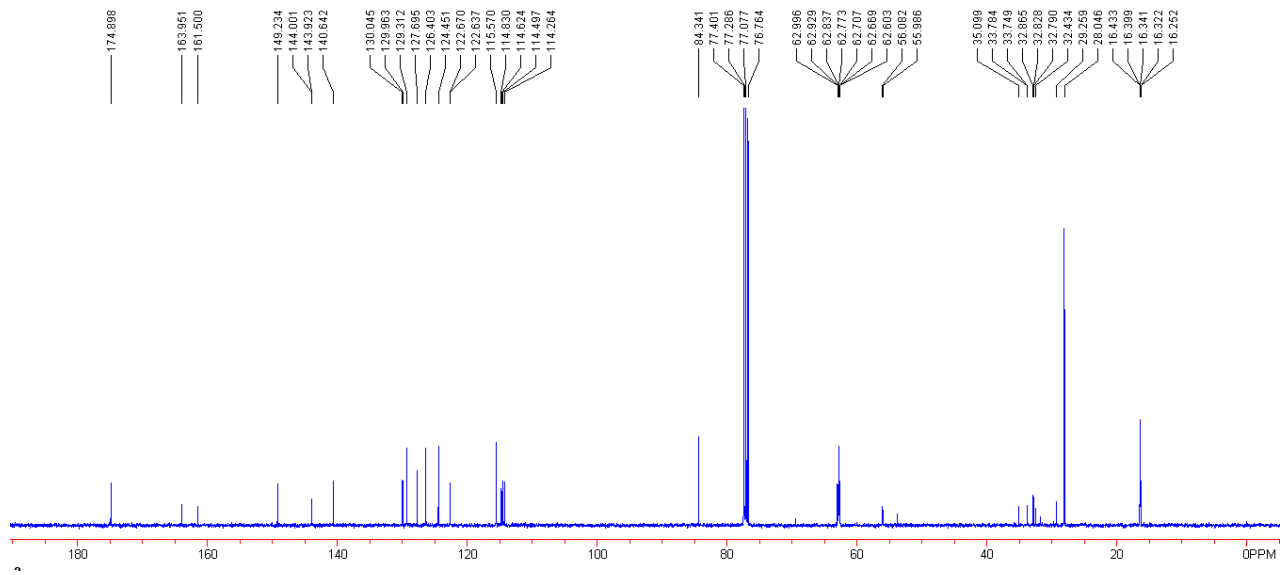


This journal is © The Royal Society of Chemistry 2012

^{1}H NMR of **3t**

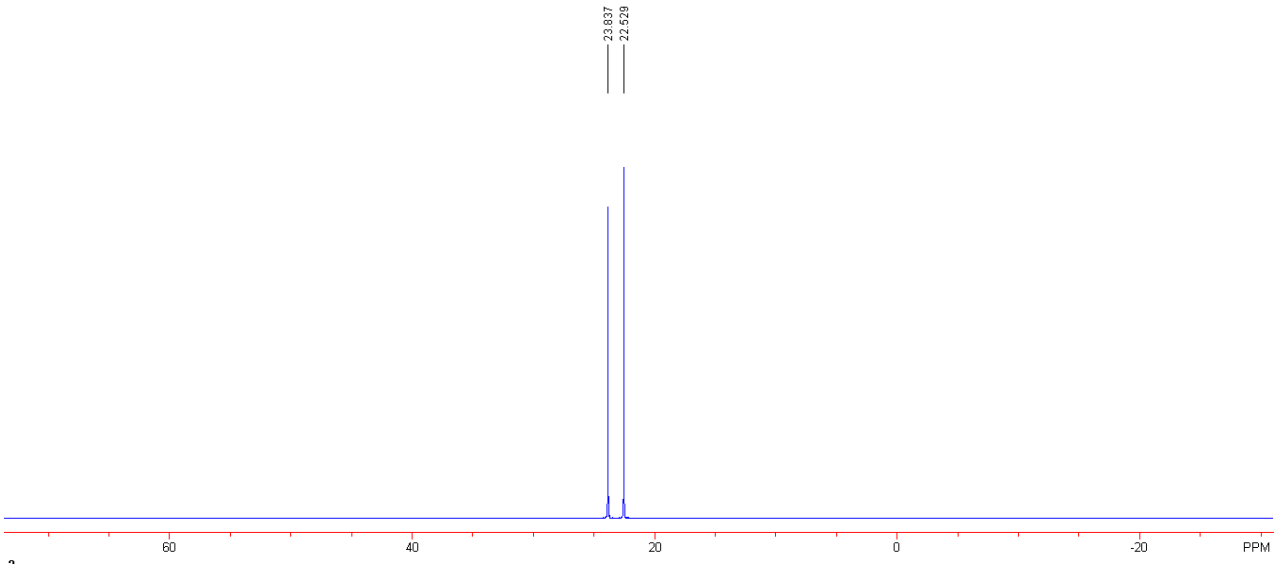


^{13}C NMR of **3t**

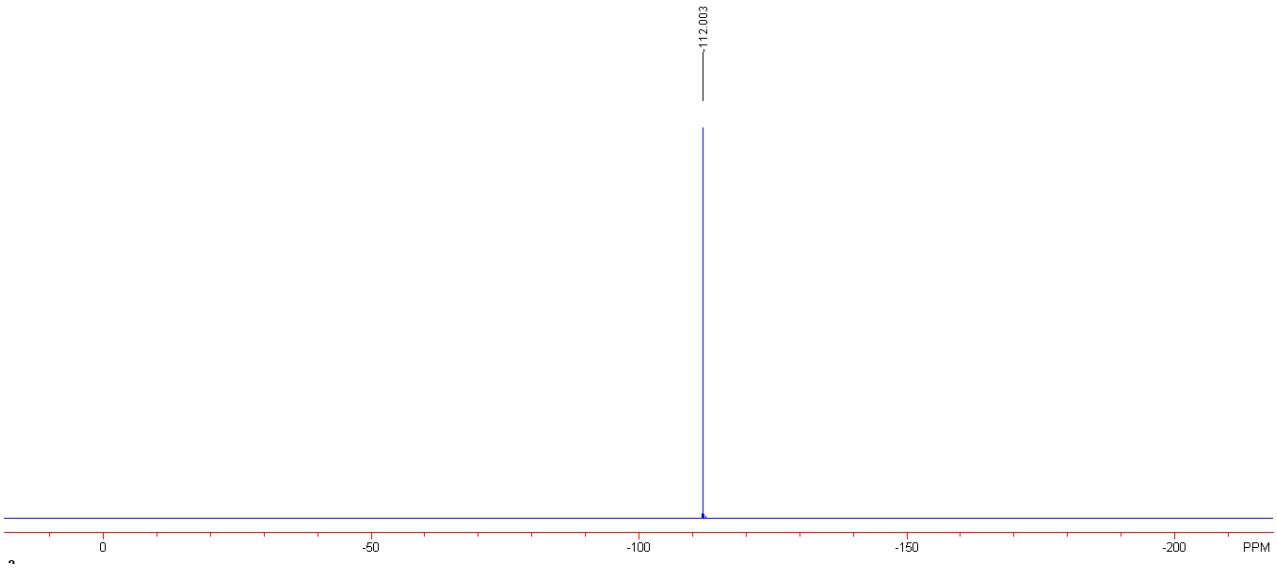


This journal is © The Royal Society of Chemistry 2012

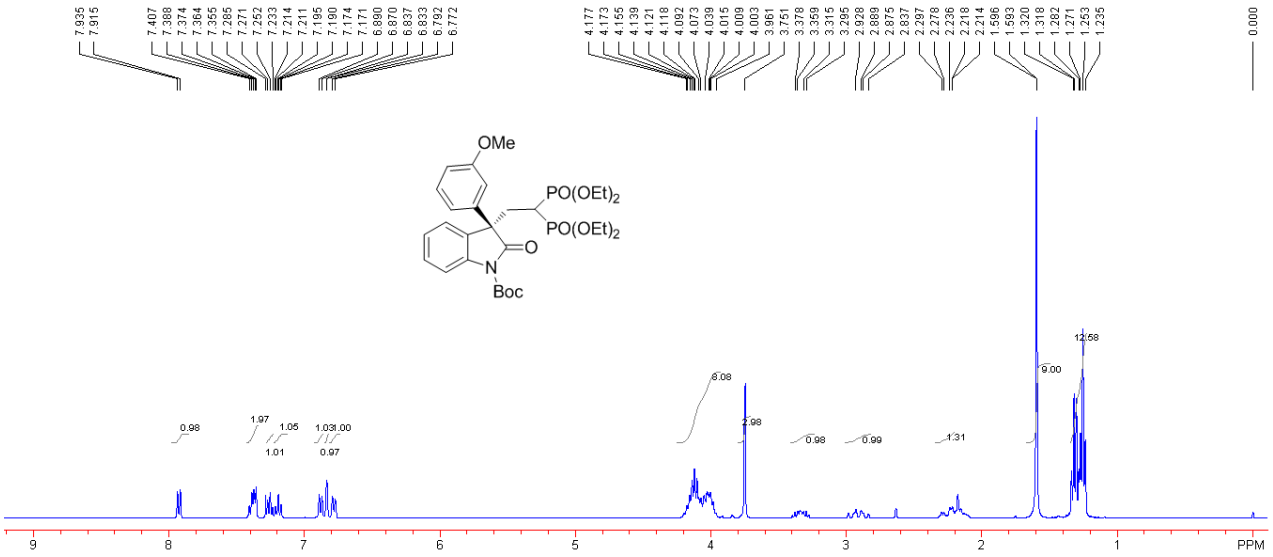
^{31}P NMR of **3t**



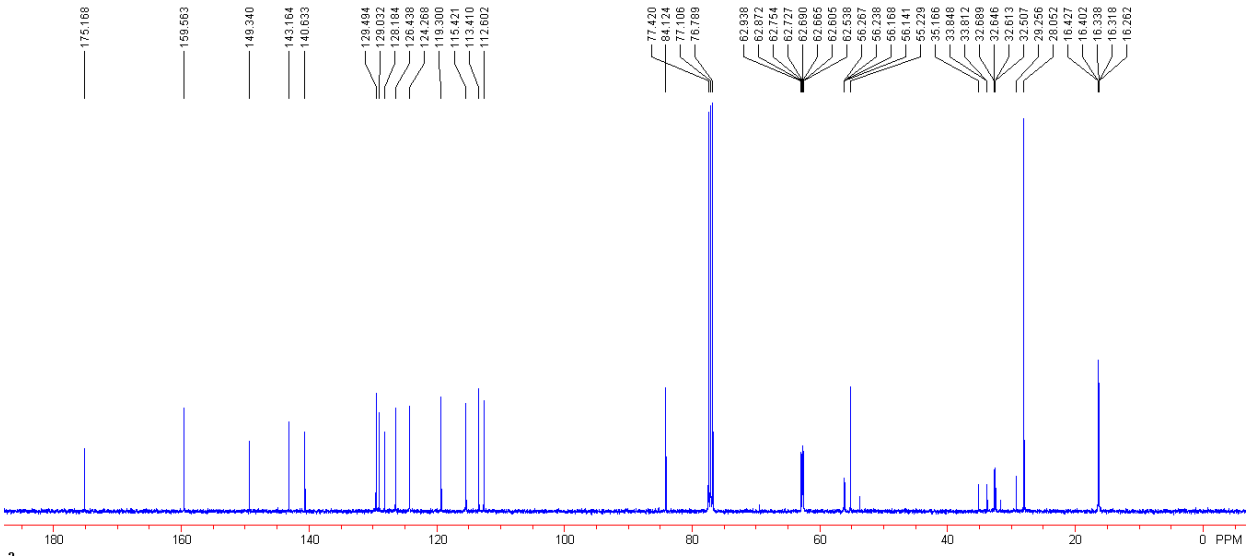
^{19}F NMR of **3t**



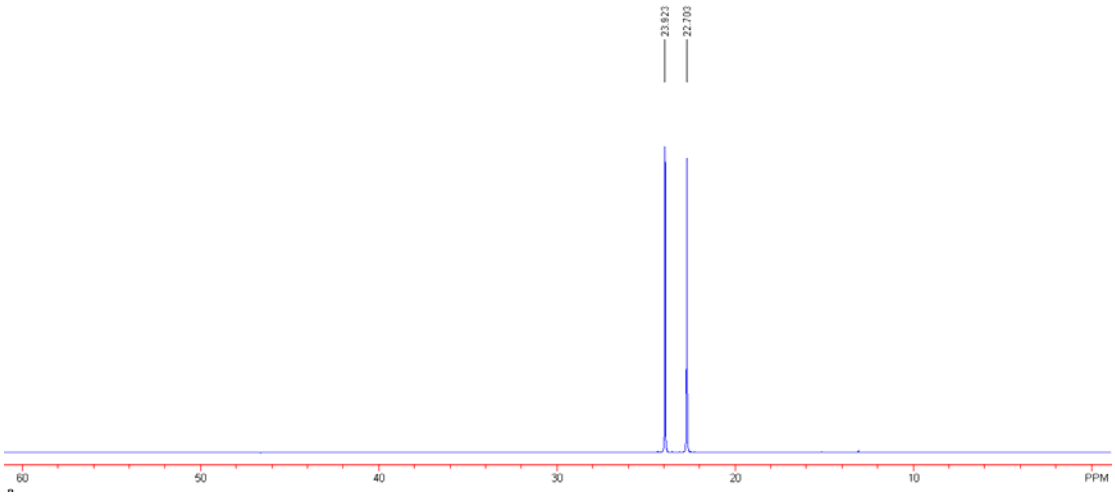
^{1}H NMR of **3u**



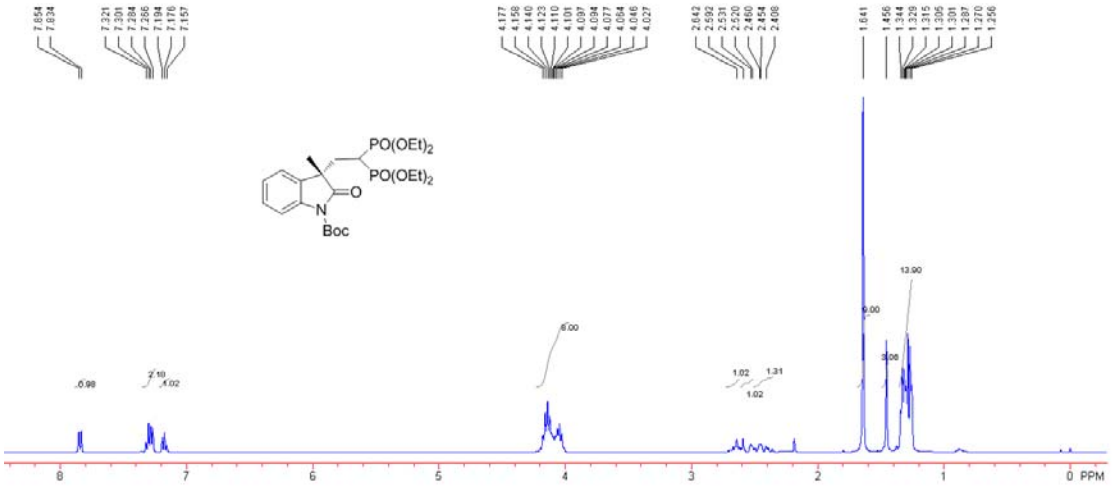
^{13}C NMR of **3u**



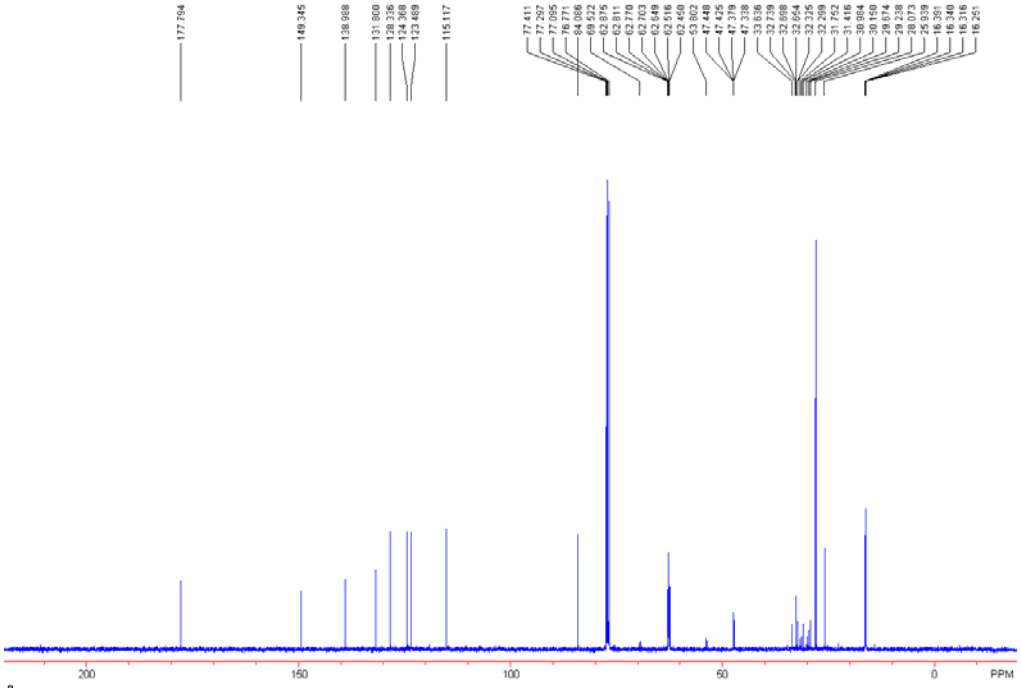
^{31}P NMR of **3u**



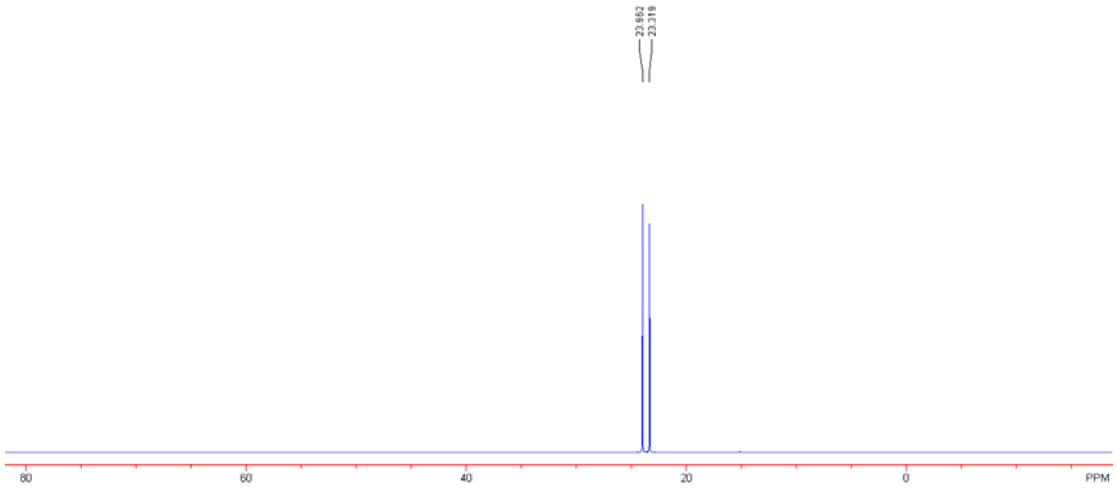
^{1}H NMR of **3w**



^{13}C NMR of **3w**

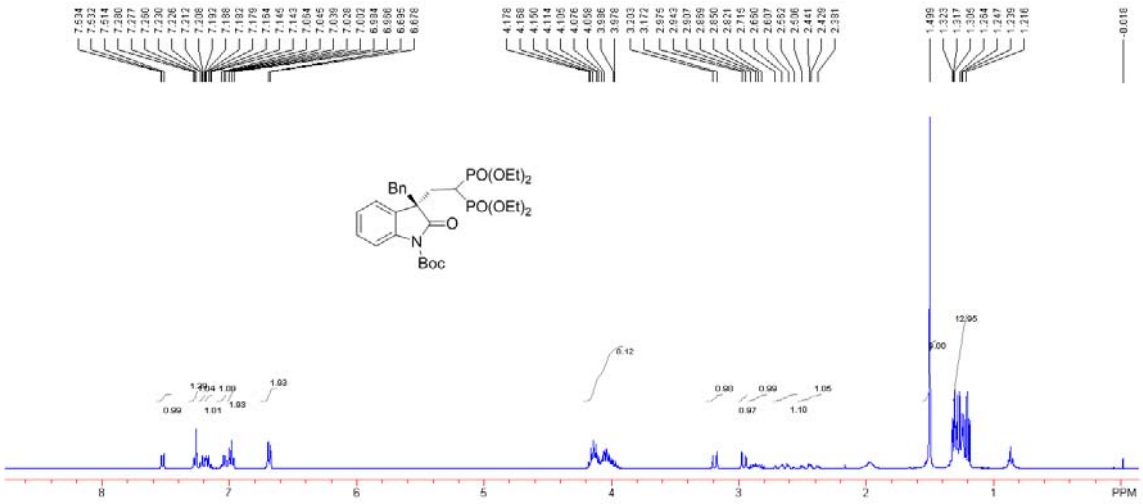


^{31}P NMR of **3w**

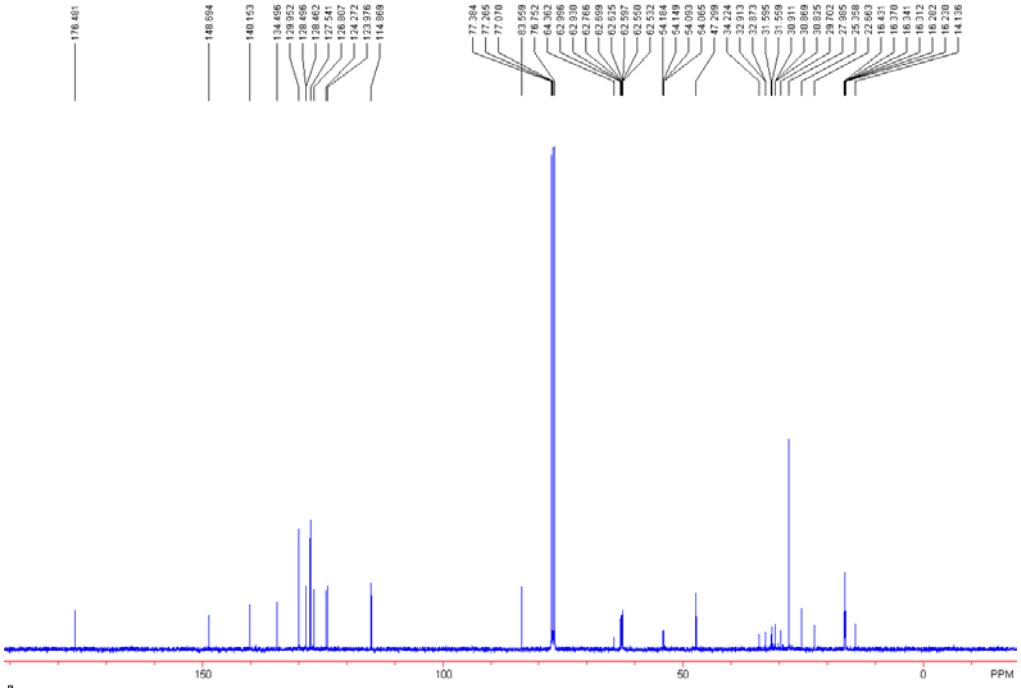


This journal is © The Royal Society of Chemistry 2012

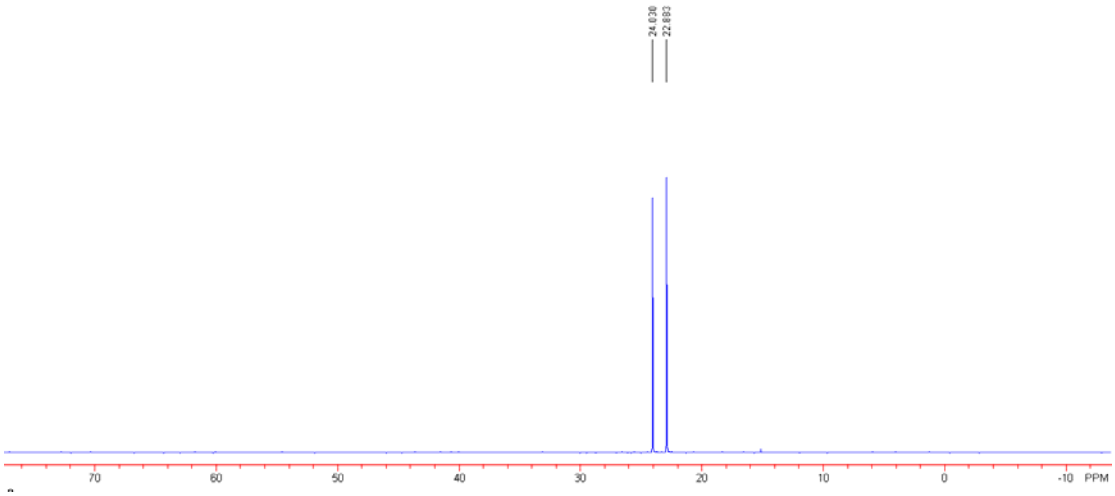
^{1}H NMR of **3x**



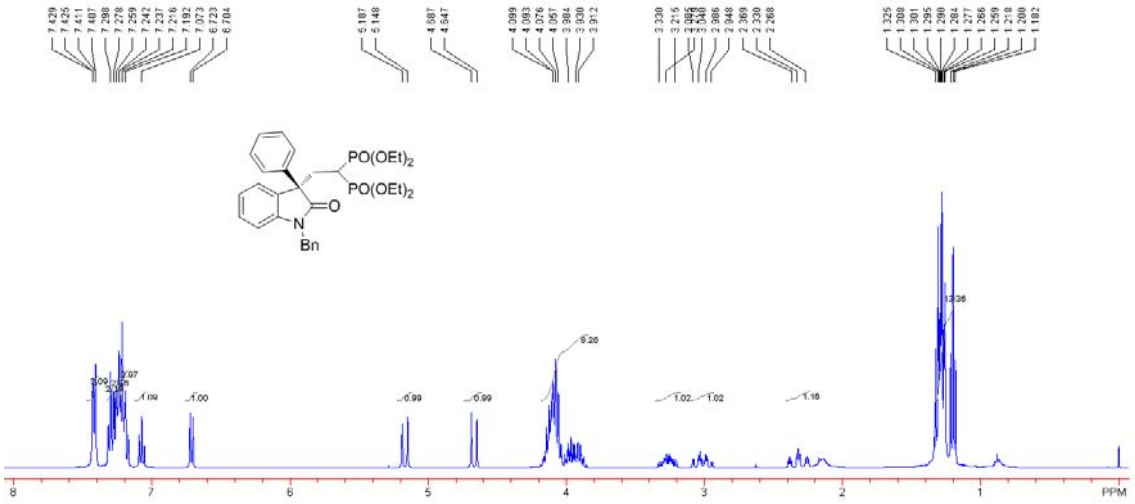
^{13}C NMR of **3x**



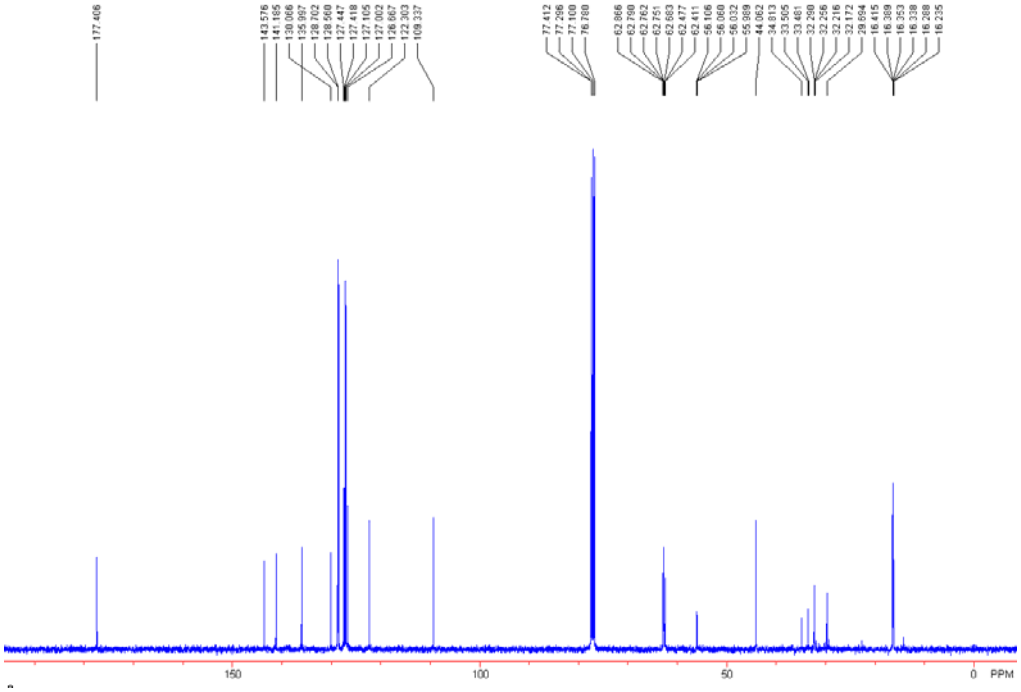
^{31}P NMR of **3x**



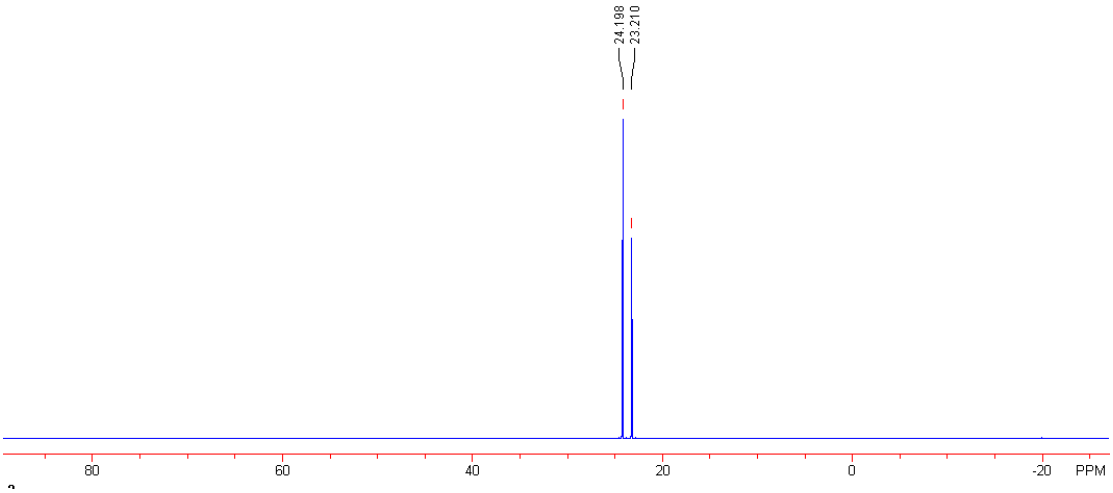
^{1}H NMR of **5c**



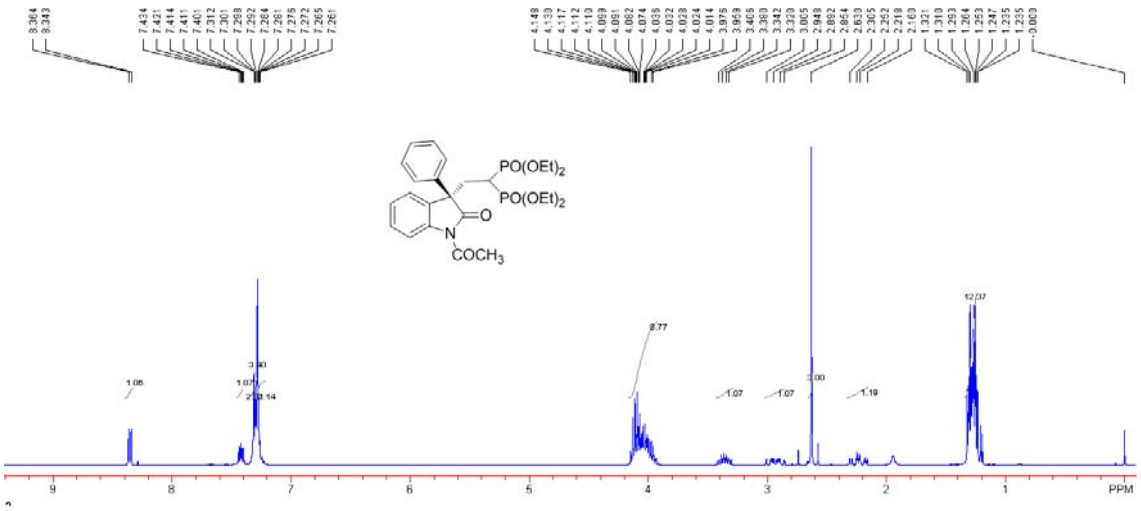
^{13}C NMR of **5c**



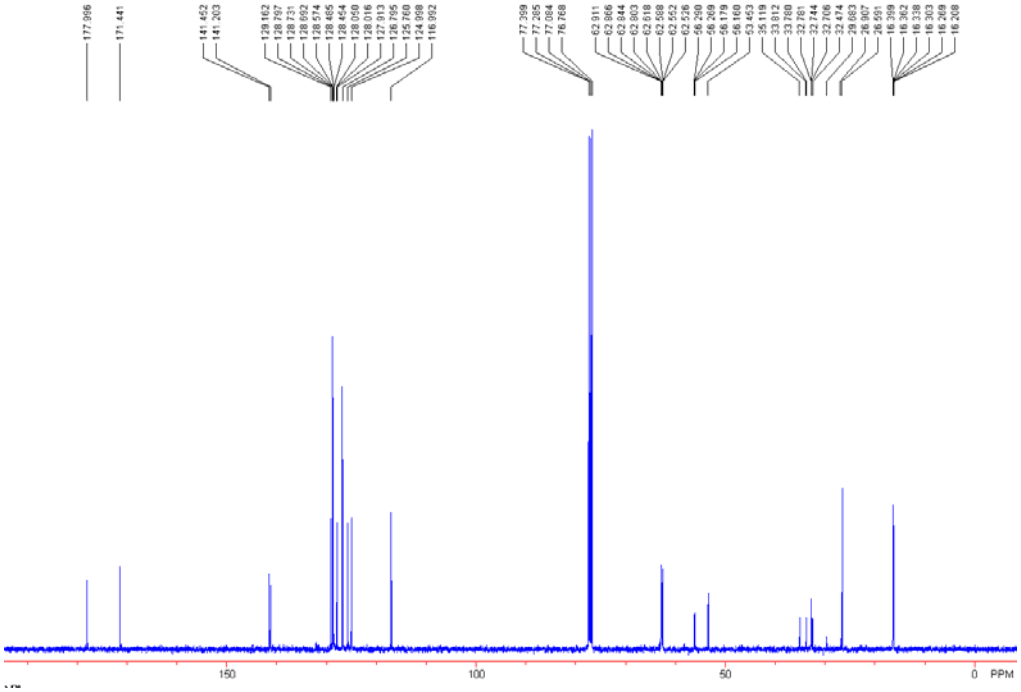
^{31}P NMR of **5c**



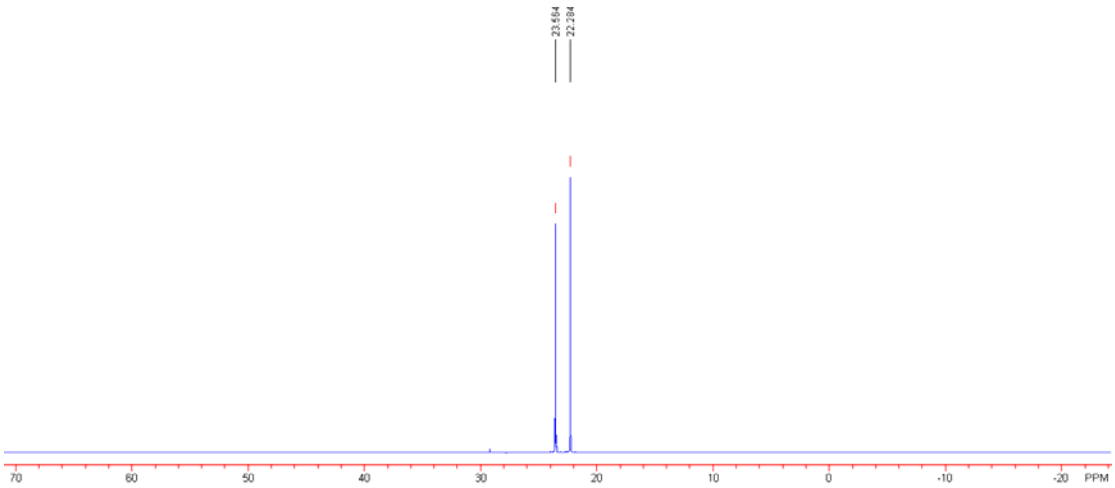
^{1}H NMR of **5d**



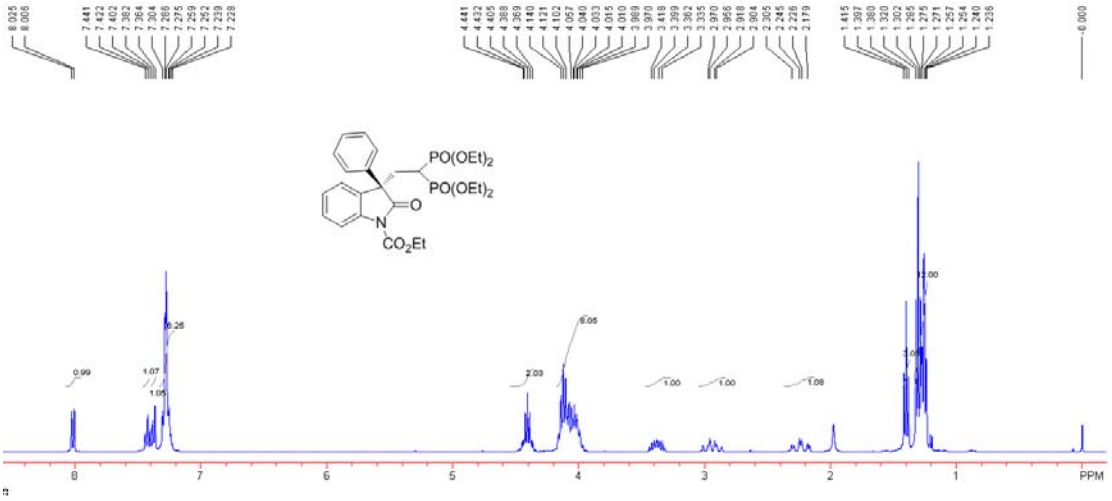
^{13}C NMR of **5d**



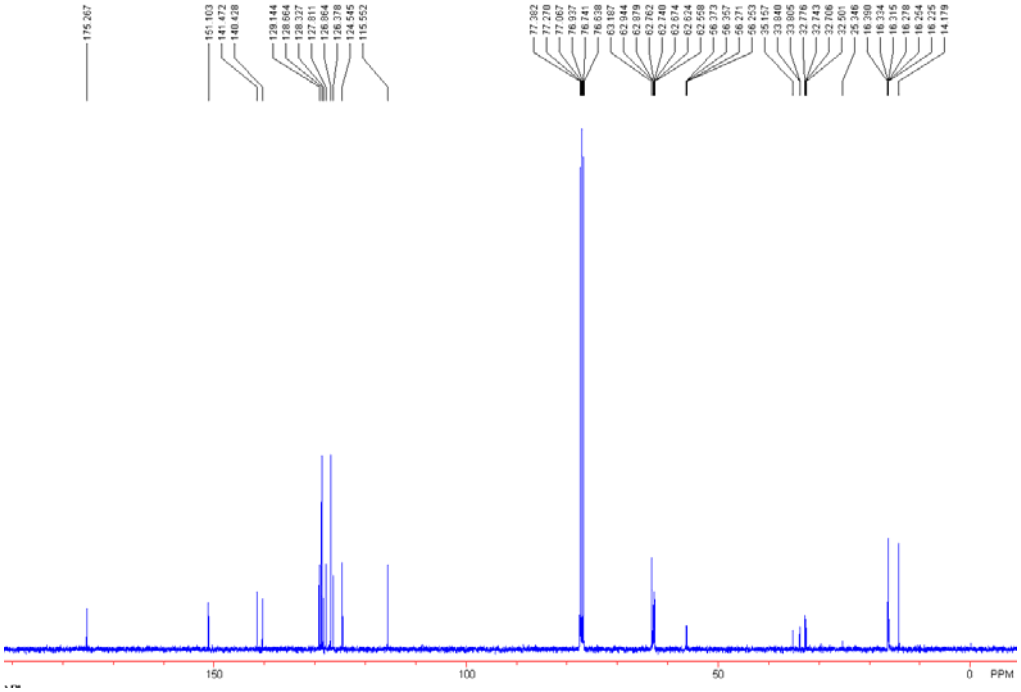
^{31}P NMR of **5d**



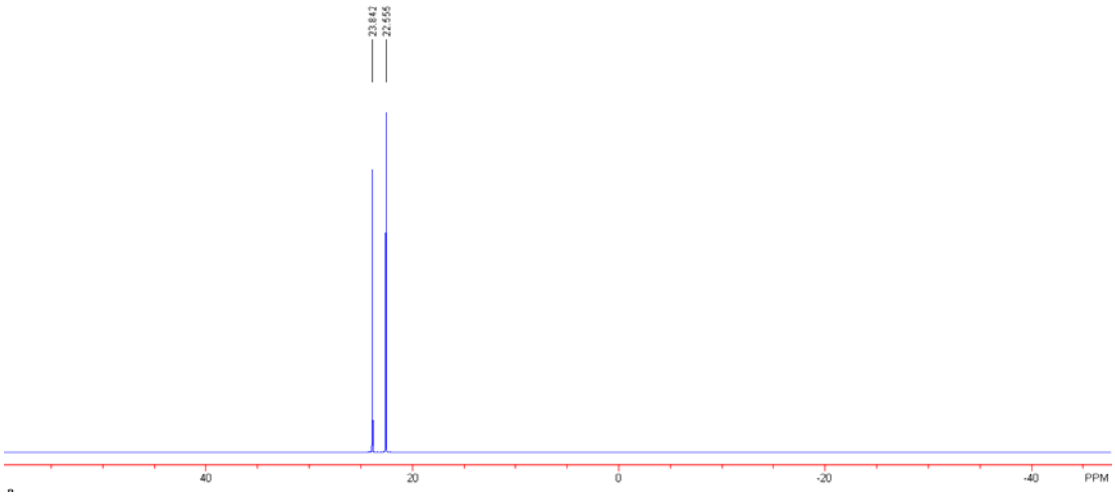
^{1}H NMR of **5e**



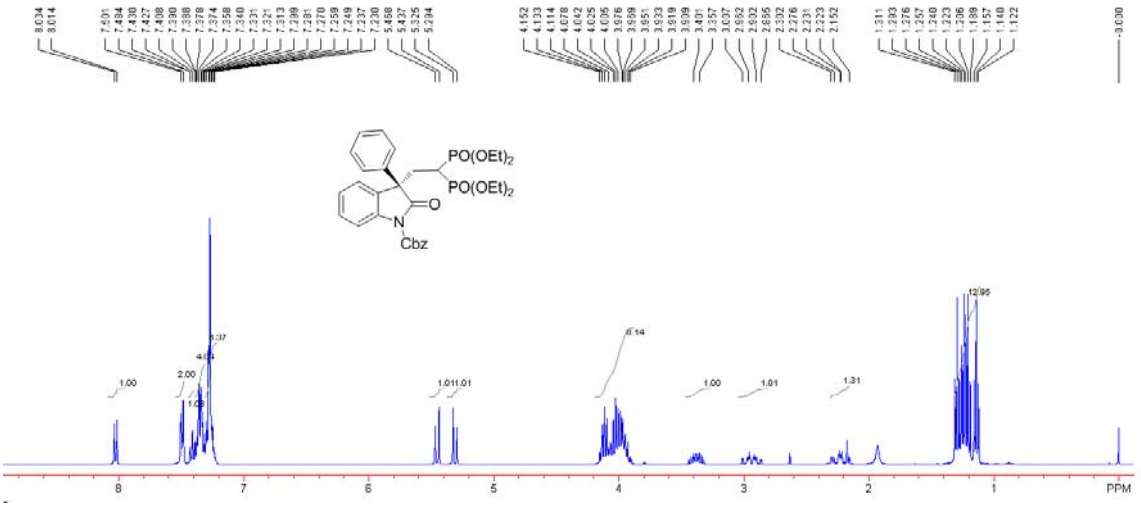
^{13}C NMR of **5e**



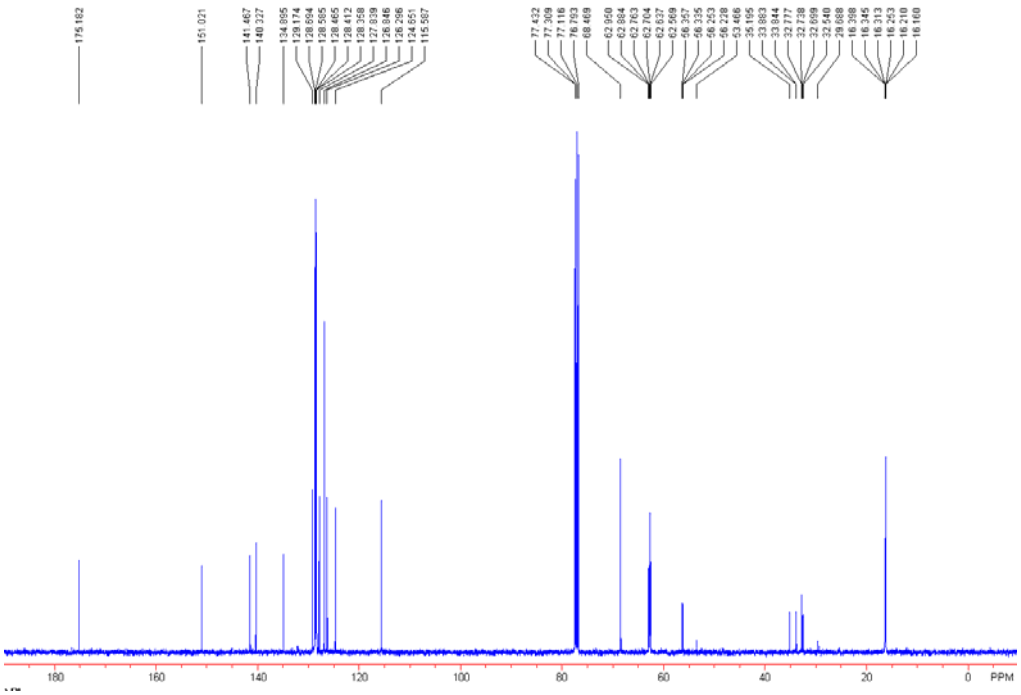
^{31}P NMR of **5e**



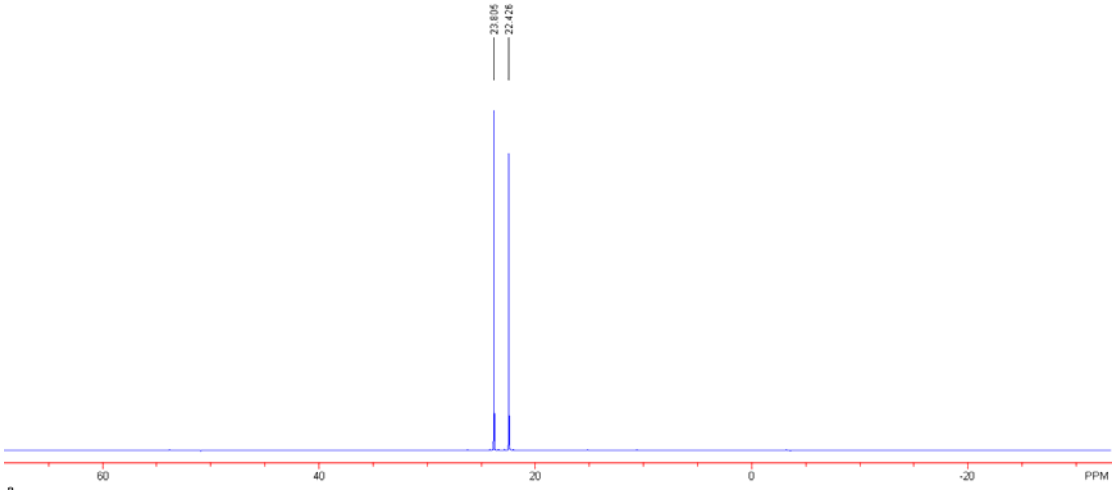
^{1}H NMR of **5f**



^{13}C NMR of **5f**

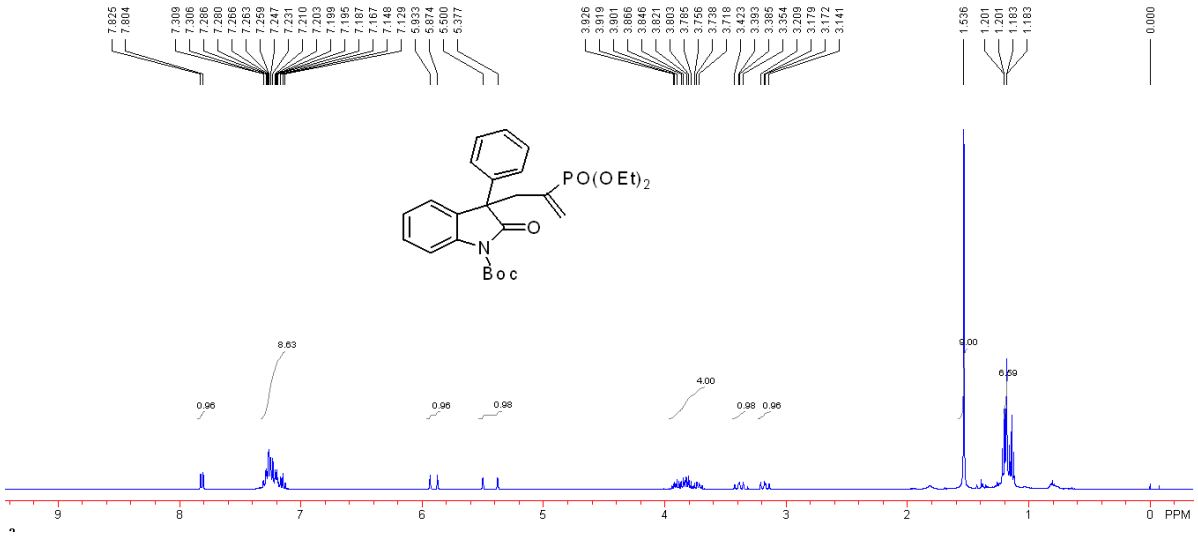


^{31}P NMR of **5f**

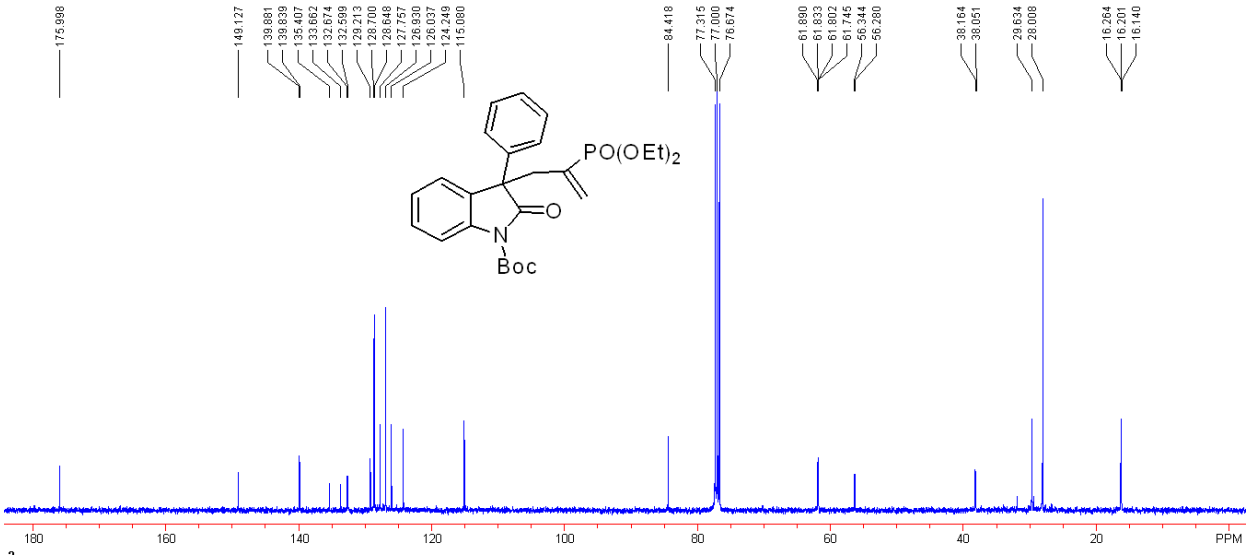


This journal is © The Royal Society of Chemistry 2012

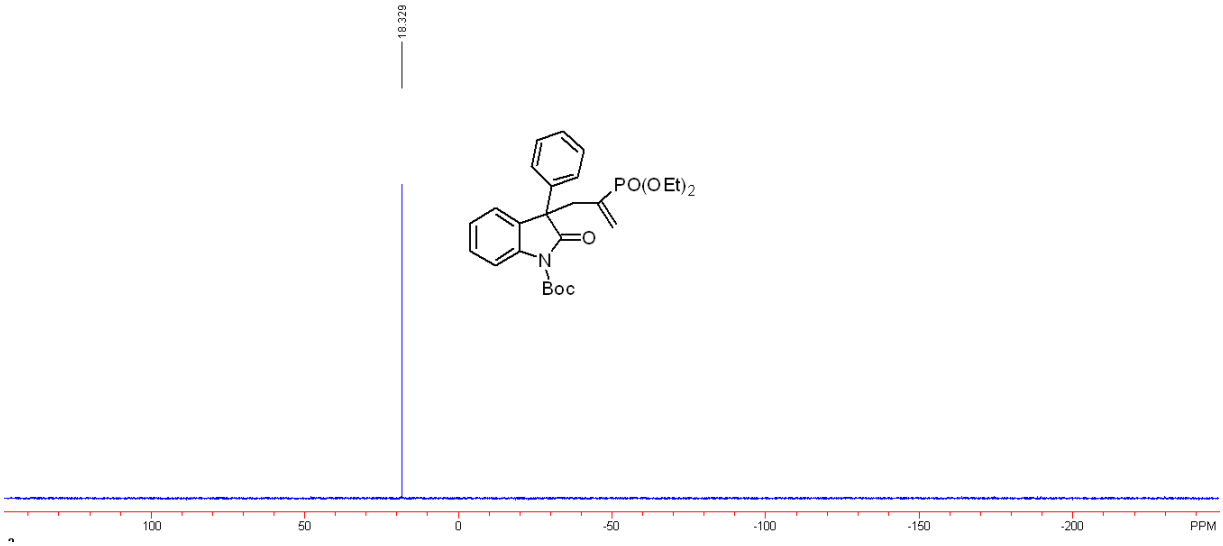
^{1}H NMR of **6**



^{13}C NMR of **6**

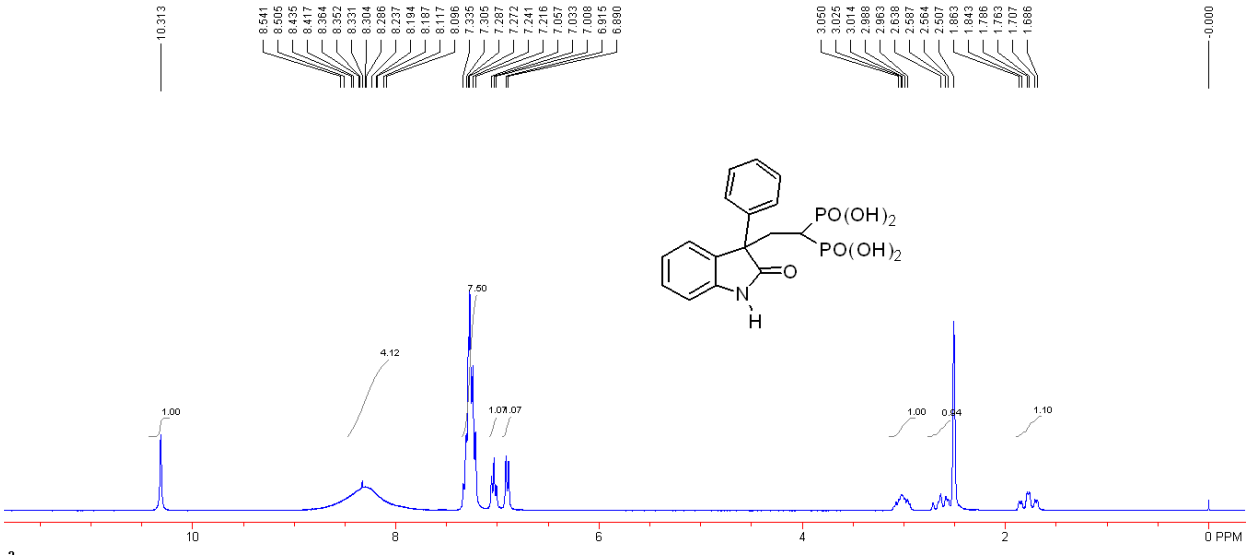


^{31}P NMR of **6**

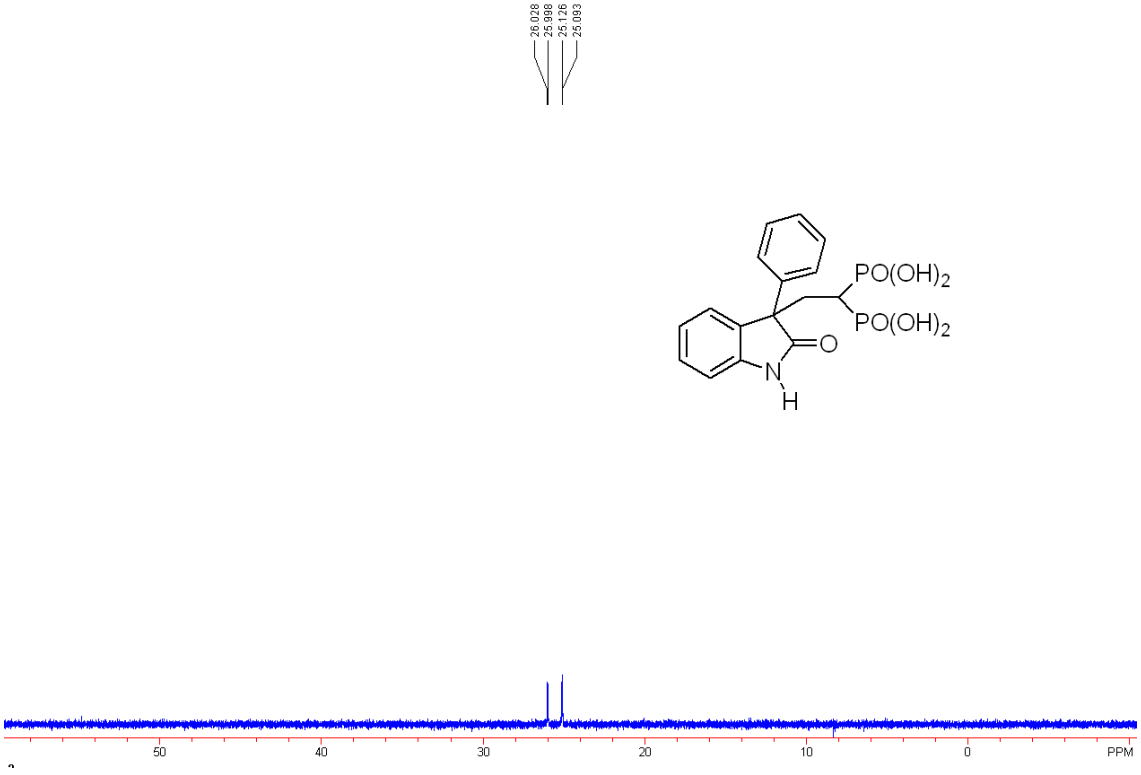


This journal is © The Royal Society of Chemistry 2012

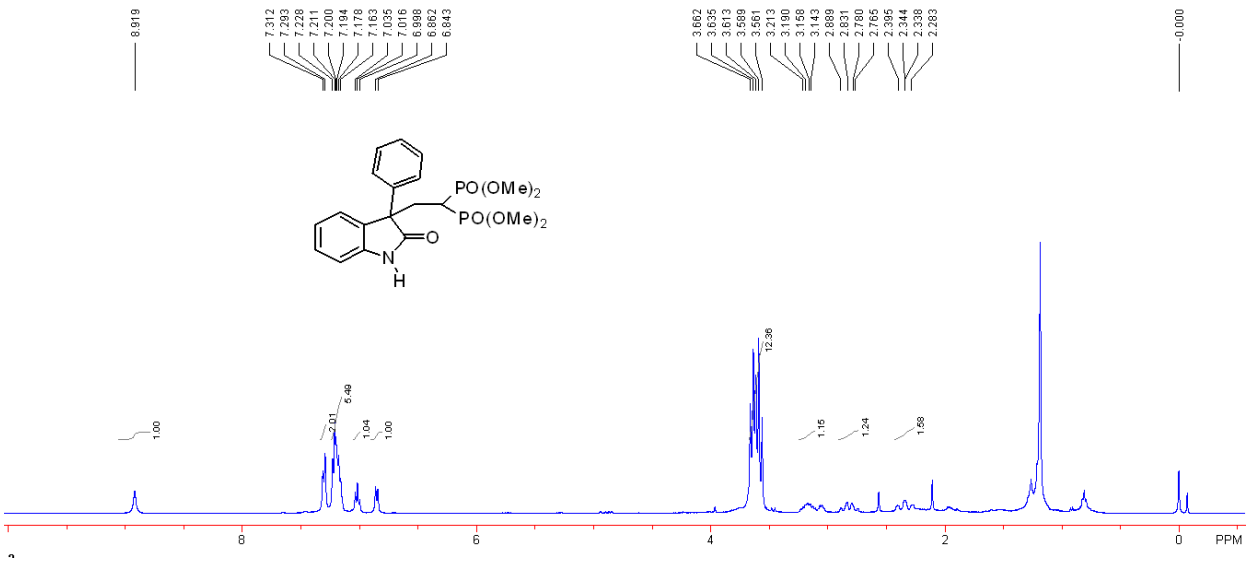
^{1}H NMR of **7**



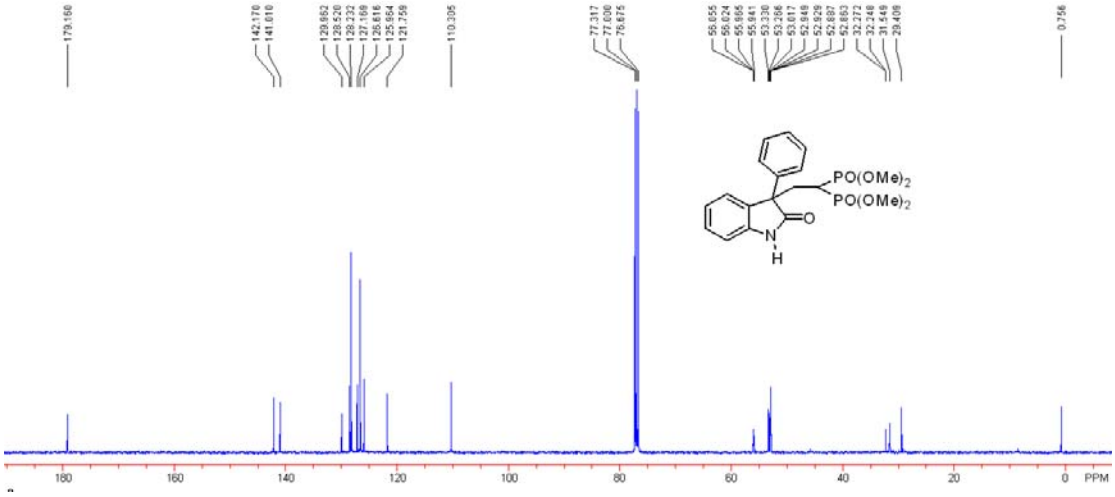
^{31}P NMR of **7**



^{1}H NMR of **8**



^{13}C NMR of **8**



^{31}P NMR of **8**