Catalytic Asymmetric Synthesis of 3-Hydroxy-3-Trifluoromethyl Benzofuranones via Tandem Friedel-Crafts/Lactonization Reaction

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Supporting Information

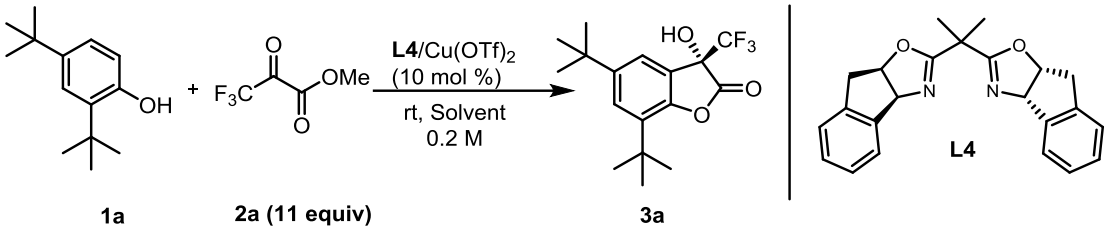
Contents

1. General information

Unless stated, otherwise all reactions were carried out under an atmosphere of nitrogen using standard Schlenk techniques. All solvents and reagents were obtained from commercial sources and were purified according to standard procedures before use. ^{1}H NMR spectra were recorded on a Varian Mercury 400 MHz or Agilent Mercury 400 MHz spectrometer in chloroform-d or acetone-d. All signals were reported in ppm with the internal TMS signal at 0.0 ppm as a standard. Data for ^{1}HNMR were recorded as follows: chemical shift (δ, ppm), multiplicity (s = singlet, d = doublet, t = triplet, m = multiplet or unresolved, coupling constant(s) in Hz, integration). ^{13}C NMR spectra were recorded on a Mercury 100 MHz spectrometer in chloroform-d or acetone-d. All signals are reported in ppm with the internal chloroform signal at 77.0 ppm or 205.87 ppm as a standard. IR spectra were recorded on a Perkin–Elmer 983, Digital FT–IR spectrometer or Bruker–Tensor 27; frequencies are given in reciprocal centimeters (cm^{-1}) and only selected absorbance is reported. High resolution mass spectra were recorded on Waters Micromass GCT Premier (EI) and Bruker Daltonics, Inc. APEXIII 7.0TESLA FTMS (ESI) mass spectrometers. Enantiomeric ratios were obtained using a Shimadzu SPD-M20A equipped with an UV-VIS detector using one of the following chiral HPLC columns: Chiralcel Chiralpak IA-3, AD-3, and IE column. Substrates **1a-1v** are commercially available and were used as purchased.

2. Optimization of the condition

2.1 Screening of solvents [a]

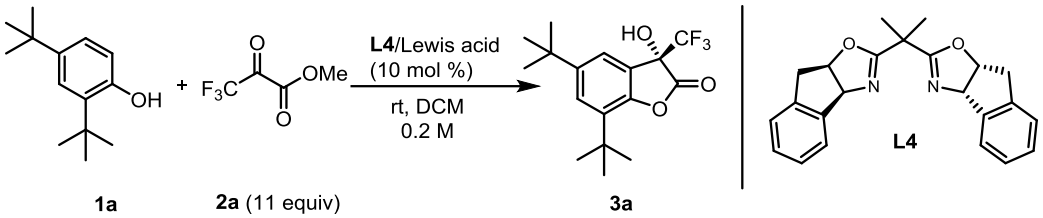


1a 2a (11 equiv) 3a

Entry	Solvent	Time (h)	Yield (%)[b]	Ee (%)[c]
1	DCM	4	93	77
2	DCE	3	85	74
3	$CHCl_3$	3	85	73
4	$PhCH_3$	3	90	74
5	PhF	2	92	74
6	THF	17	55	59
7	DME	17	58	74
8	Et_2O	7	93	79
9	CH_3CN	17	Trace	--

[a]The reactions were carried out under N_2 atmosphere: Lewis acid (0.04 mmol), **L4** (0.048 mmol), 0.2 M, DCM (2.0 mL), **1a** (0.40 mmol), **2a** (4.40 mmol); [b] Isolated yield; [c] Determined by HPLC analysis on chiral stationary phases.

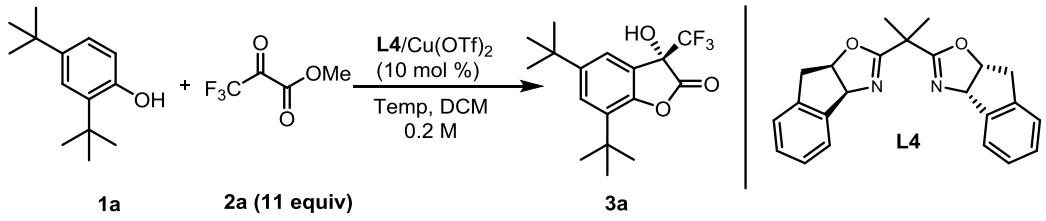
2.2 Screening of Lewis acid [a]



Entry	Lewis acid	Time (h)	Yield (%)[b]	Ee (%)[c]
1	$Cu(OTf)_2$	4	93	77
2	$Cu(ClO_4)_2{\cdot}6H_2O$	2	93	76
3	$Cu(SbF_6)_2$	2	86	56
4	CuOTf· 0.5toluene	4	83	68
5	$Ni(ClO_4)_2{\cdot}6H_2O$	2	93	58
6	$Ni(OTf)_2$	21	Trace	--
7	$Fe(OTf)_3$	2	93	0
8	$Mg(ClO_4)_2{\cdot}6H_2O$	15	75	12

[a]The reactions were carried out under N_2 atmosphere: Lewis acid (0.04 mmol), **L4** (0.048 mmol), 0.2 M, DCM (2.0 mL), **1a** (0.40 mmol), **2a** (4.40 mmol); [b] Isolated yield; [c] Determined by HPLC analysis on chiral stationary phases.

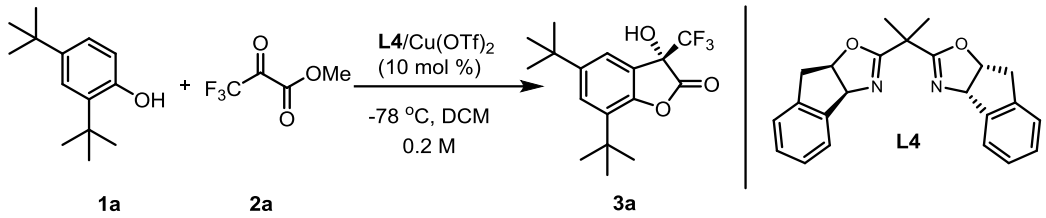
2.3 Screening of the temperature [a]



Entry	Temp. (℃)	Time (h)	Yield (%)[b]	Ee (%)[c]
1	rt	4	93	77
2	-20	10.5	90	84
3	-40	8	90	85
4	-78	8	93	90

[a]The reactions were carried out under N_2 atmosphere: Lewis acid (0.04 mmol), **L4** (0.048 mmol), 0.2 M, DCM (2.0 mL), **1a** (0.40 mmol), **2a** (4.40 mmol); [b] Isolated yield; [c] Determined by HPLC analysis on chiral stationary phases.

2.4 Screening of the ratio of 1a/2a [a]

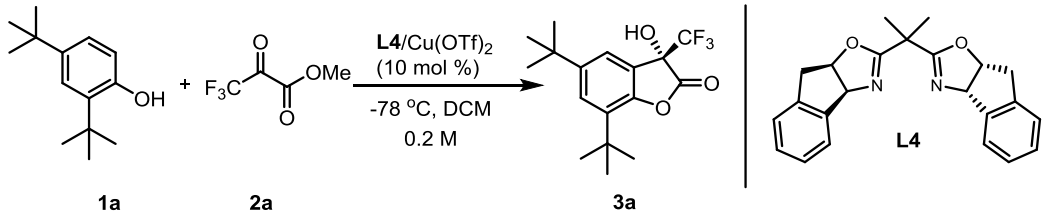


1a 2a 3a

Entry	1a/2a	Time (h)	Yield (%)[b]	Ee (%)[c]
1	1/1.2	16	61	90
2[d]	1/1.5	25	94	94
3[d,e]	1/1.5	25	76	83
4	1/2.5	4	91	90
5	1/5	8	93	90
6	1/11	8	93	89.5
7	1/20	8	95	88

[a]The reactions were carried out under N_2 atmosphere: Lewis acid (0.04 mmol), **L4** (0.048 mmol), 0.2 M, DCM (2.0 mL), **1a** (0.40 mmol); [b] Isolated yield; [c] Determined by HPLC analysis on chiral stationary phases; [d] 0.1 M, DCM (4 mL); [e] at room temperature.

2.5 Screening of the ratio of L4/Cu(OTf)$_2$ [a]

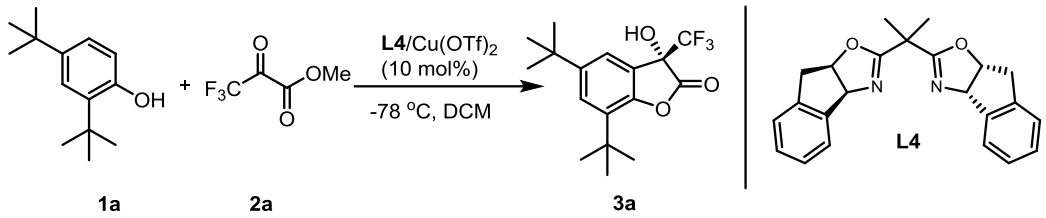


1a 2a 3a

Entry	L4/Cu(OTf)$_2$	Time	Yield (%)[b]	Ee (%)[c]
1	1.5/1	8	NR	--
2	1.2/1	4	93	91
3	1/1	3	94	91
4	1/1.2	3	90	90

[a]The reactions were carried out under N_2 atmosphere: Lewis acid (0.04 mmol), 0.2 M, DCM (2.0 mL), **1a** (0.40 mmol), **2a** (1 mmol); [b] Isolated yield; [c] Determined by HPLC analysis on chiral stationary phases.

2.6 Screening of the concentration of substrate [a]

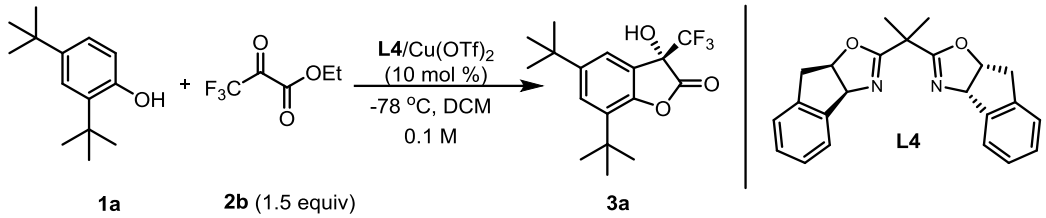


1a 2a 3a

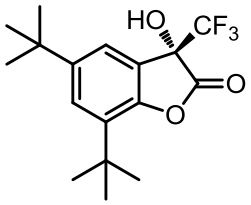
Entry	C (mol / L)	Time	Yield (%)[b]	Ee (%)[c]
1	0.2	4	91	90
2	0.1	5	96	92
3	0.05	8	94	93
4	0.025	22	65	88

[a]The reactions were carried out under N_2 atmosphere: Lewis acid (0.04 mmol), **L4** (0.04 mmol), **1a** (0.4mmol), **2a** (1.0 mmol); [b] Isolated yield; [c] Determined by HPLC analysis on chiral stationary phases.

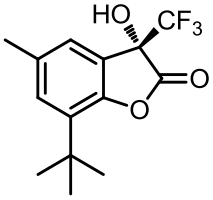
3. General experimental procedure for the reaction



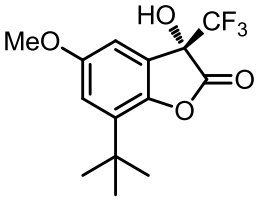
Procedure: A mixture of Cu $(OTf)_2$ (14.5 mg, 0.04 mmol, 0.1 equiv) and **L4** (14.3 mg, 0.04 mmol, 0.1 equiv) in DCM (4 mL) was stirred at room temperature for 3 h under the atmosphere of nitrogen. Substrate **2** (0.6 mmol, 1.5 equiv) was added immediately without interval at room temperature, the reaction mixture was cooled to -78 ℃ for 10 minutes, then substrate **1** (0.4 mmol, 1.0 equiv) was added and stirred at -78 ℃. After the reaction was complete (monitored by TLC), the reaction was filtered through a glass funnel with thin layer (20 mm) of silica gel (100-200 mesh) and eluted with DCM. The filtrate was concentrated under reduced pressure, purified by flash chromatography (hexane/ethyl acetate =40/1-20/1) to afford the product **3**.



3a: white solid (124 mg, 94% yield), melting point: 75-77 ℃; 94% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 232 nm: t_R (minor) = 6.9 min, t_R (major) = 8.4 min.); $[\alpha]_D^{25}$ = -29.5 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.48 (s, 1H), 7.41 (s, 1H), 4.10 (s, 1H), 1.40 (s, 9H), 1.34 (s, 9H); All analytical data are consistent with literature values[1].

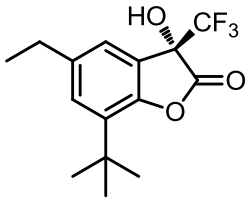


3b: white solid (92.7 mg, 80% yield), melting point: 99-100 ℃; 96% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 97/3, 0.6 mL/min, λ = 254 nm: t_R (minor) = 9.2 min, t_R (major) = 11.1 min.); $[\alpha]_D^{25}$ = -32.0 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.16 (s, 1H), 7.14 (s, 1H), 3.91 (s, 1H), 2.30 (s, 3H), 1.30 (s, 9H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.81; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.5, 150.2, 135.1, 134.8 130.8 123.7, 122.3 (q, $^1J_{CF3}$ = 285.8 Hz), 120.9, 74.3 (q, $^2J_{CF3}$ = 33.0 Hz), 34.2, 29.4, 21.2; IR (KBr):3461, 2973, 2875, 1807, 1618, 1479, 1273, 1203, 1182, 1120, 1094, 985, 930, 868, 716 cm^{-1}; HRMS-ESI: Exact mass calcd. for $C_{14}H_{19}F_3NO_3^+$ $[M+NH_4]^+$: 306.1317; Found: 306.1314.

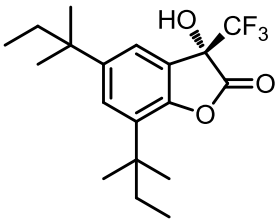


3c: white solid (99 mg, 81% yield), melting point: 99-100 ℃; 95% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 254 nm: t_R (minor) = 13.1 min, t_R (major) = 15.0 min.); $[\alpha]_D^{25}$ = -42.9 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.01 (m, 1H), 6.91 (m, 1H), 4.27 (s, 1H), 3.82 (s, 3H), 1.38 (s, 9H); ^{19}F NMR (376

MHz, $CDCl_3$): δ -79.81; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.5, 156.9, 146.2, 136.7, 122.2 (q, $^1J_{CF3}$ = 284.0 Hz), 121.5, 117.4, 107.1, 74.7 (q, $^2J_{CF3}$ = 32.4 Hz), 55.9, 34.4, 29.3; IR (KBr): 3346, 2972, 2847, 1820, 1485, 1427, 1310, 1171, 1100, 975, 799, 687 cm^{-1}; HRMS-ESI: Exact mass calcd. for $C_{14}H_{19}F_3NO_4^+$ $[M+NH_4]^+$: 322.1266; Found: 322.1264.

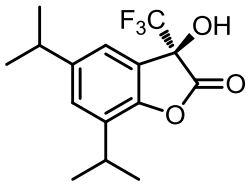


3d: white solid (106 mg, 88% yield), melting point: 72-74 ℃; 95% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 254 nm: t_R (minor) = 7.9 min, t_R (major) = 10.0 min.); $[\alpha]_D^{25}$ = -32.3 (c 0.50, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$): δ 7.18 (s, 1H), 7.16 (s, 1H), 4.00 (s, 1H), 2.59 (q, *J* = 7.6 Hz, 2H), 1.31 (s, 9H), 1.17 (t, *J* =7.4 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.79; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6, 150.3, 141.6, 134.8, 129.8, 122.5, 122.3(q, $^1J_{CF3}$ = 284.0 Hz), 120.9, 74.3 (q, $^2J_{CF3}$ = 33.4 Hz), 34.2, 29.4, 28.7, 15.6; IR (KBr): 3455, 2969, 2874, 1803, 1480, 1367, 1268, 1219, 1096, 987, 870, 671 cm^{-1}; HRMS-ESI: Exact mass calcd. for $C_{15}H_{21}F_3NO_3^+$ $[M+NH_4]^+$: 320.1474; Found: 320.1471.

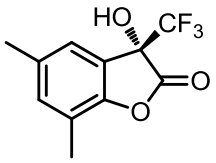


3e: white solid (136 mg, 94% yield), melting point: 56.5-58.5 ℃; 94% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 97/3, 0.6 mL/min, λ = 254 nm: t_R (minor) = 7.7 min, t_R (major) = 9.3 min.); $[\alpha]_D^{25}$ = -22.3 (c 0.50, $CHCl_3$); ^1H NMR (400 MHz, $CDCl_3$): δ 7.27 (s, 2H), 4.16 (s, 1H), 1.73-1.65 (m, 2H), 1.57 (q, *J* =7.3 Hz, 2H), 1.28 (s, 6H), 1.21 (s, 6H), 0.61-0.58(m, 6H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.96; ^{13}C NMR (100 MHz, $CDCl_3$):δ 170.8, 149.9, 146.8, 132.7, 129.0, 122.3 (q, $^1J_{CF3}$ = 285.0 Hz), 120.4, 74.5 (q, $^2J_{CF3}$ = 32.5 Hz), 38.1, 38.0, 36.9, 33.9, 28.43, 28.37, 27.2, 27.1, 9.1,

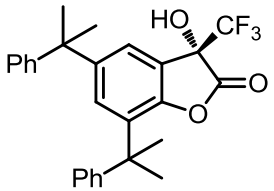
8.9; IR (KBr): 3394, 2965, 2877, 1811, 1619, 1476, 1265, 1177, 1107, 1085, 982, 893, 759, 732, 705, 655 cm^{-1}; HRMS-ESI: Exact mass calcd. for $C_{19}H_{29}F_3NO_3^+$ $[M+NH_4]^+$: 376.2100; Found: 376.2099.



The reaction was carried out at rt. **3f**: oil (90 mg, 75% yield); 99% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 232 nm: t_R (minor) = 7.3 min, t_R (major) = 8.5 min.); $[\alpha]_D^{25}$ = -36.4 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.16 (s, 1H), 7.15 (s, 1H), 4.01 (s, 1H), 3.09-3.05 (m, 1H), 2.86-2.83 (m, 1H), 1.22-1.14 (m, 12H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.76; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.8, 149.9, 146.7, 132.3, 128.7, 122.3 (q, $^1J_{CF3}$ = 283.1 Hz), 121.0, 120.3, 75.0 (q, $^2J_{CF3}$ = 33.6 Hz), 34.0, 28.6, 24.1, 24.0, 22.3, 22.2; IR (KBr): 3439, 2965, 2874, 1810, 1628, 1480, 1272, 1174, 1098, 970, 876, 759, 677 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{15}H_{17}F_3O_3^+$ $[M]^+$: 302.1130; Found: 302.1125.

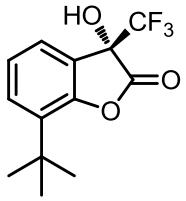


The reaction was carried out at rt**. 3g**: white solid (50.3 mg, 51% yield), melting point: 106-108 ℃; >99% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 254 nm: t_R (minor) = 11.9 min, t_R (major) = 13.6 min.); $[\alpha]_D^{25}$ = -41.8 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.18 (s, 1H), 7.13 (s, 1H), 3.96 (s, 1H), 2.35(s, 3H), 2.30(s, 3H); All analytical data are consistent with literature values[2].

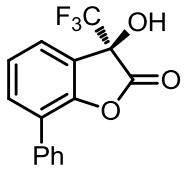


The reaction was carried out at rt**. 3h**: gum (170 mg, 94% yield); 92% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 254 nm: t_R (minor) = 8.5 min, t_R (major) = 10.3 min.); $[\alpha]_D^{25}$ = -2.7 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ

7.24-7.03 (m, 12H), 3.80 (s, 1H), 1.58- 1.56 (m, 12H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.8; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.1, 150.1, 150.0, 148.2, 148.0, 133.8, 130.0, 128.2, 128.1, 126.5, 126.2, 126.0, 125.9, 122.1 (q, $^1J_{CF3}$ = 284.5 Hz), 121.7, 120.6, 74.4 (q, $^2J_{CF3}$ = 32.3 Hz), 43.1, 41.8, 30.81, 30.77, 29.1, 28.9; IR (KBr): 3466, 3026, 2970, 1821, 1602, 1493, 1269, 1082, 1003, 969, 793, 697 cm^{-1}; HRMS-ESI: Exact mass calcd. for $C_{27}H_{29}F_3NO_3^+$ $[M+NH_4]^+$: 472.2100; Found: 473.2097.

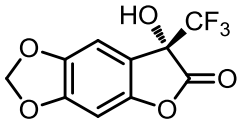


The reaction was carried out at rt**. 3i**: oil (91.1 mg, 83% yield); 85% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 232 nm: t_R (minor) = 11.7 min, t_R (major) = 14.2 min.); $[\alpha]_D^{25}$ = -19.4 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.39 (dd, J_1 = 8.4Hz, J_2 = 1.2Hz, 1H), 7.33 (d, J = 7.6Hz, 1H), 7.17-7.13(m, 1H), 4.00 (s, 1H), 1.32 (s, 9H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.83; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.2, 152.3, 135.2, 130.2, 125.3, 123.6, 122.3(q, $^1J_{CF3}$ = 283.7 Hz), 121.1, 74.2 (q, $^2J_{CF3}$ = 33.1 Hz), 34.3, 29.4; IR (KBr): 3477, 3183, 2966, 2874, 1794, 1430, 1305, 1180, 1102, 990, 796, 714, 637cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{13}H_{17}F_3NO_3^+$ $[M+NH_4]^+$: 292.1155; Found: 292.1155.

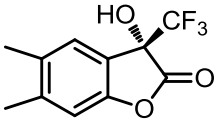


The reaction was carried out at rt**. 3j**: white solid (86.7 mg, 67% yield), melting point: 69-72 ℃; 90% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 95/5, 0.6 mL/min, λ = 232 nm: t_R (major) = 16.1 min, t_R (minor) = 17.9 min.); $[\alpha]_D^{25}$ = +4.3 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.66-7.60 (m, 3H), 7.54 (d, J = 7.2, Hz, 1H), 7.49-7.24 (m, 4H), 3.86 (s, 1H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.64; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.0, 151.2, 134.1, 133.1, 128.8, 128.6, 128.5, 126.1, 125.9, 124.9, 122.2(q, $^1J_{CF3}$ = 283.9 Hz), 121.3, 74.6 (q, $^2J_{CF3}$ = 32.6 Hz); IR (KBr): 3459, 1799,

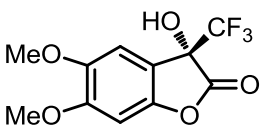
1631, 1595, 1503, 1458, 1271, 1254, 1178, 1109, 1072, 979, 871, 804, 722, 696, 640 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{15}H_{13}F_3NO_3^+$ $[M+NH_4]^+$: 312.0842; Found: 312.0840.



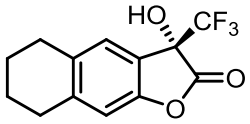
The reaction was carried out at rt**. 3k**: white solid (118 mg, 58% yield), melting point: 115.5-117.5 ℃; 91% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 90/10, 0.6 mL/min, λ = 254 nm: t_R (minor) = 13.1 min, t_R (major) = 15.7 min.); $[\alpha]_D^{25}$ = -37.9 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, Acetone-D_6): δ 7.61 (s, 1H), 7.49(s, 1H), 7.36(s, 1H), 6.57 (d, *J* = 2.4 Hz, 2H); ^{19}F NMR (376 MHz, Acetone-D_6): δ -74.90; ^{13}C NMR (100 MHz, Acetone-D_6): δ 169.9, 151.1, 149.2, 145.4, 122.9(q, $^1J_{CF3}$ = 283.2 Hz), 113.3, 105.2, 102.7, 94.6, 75.3 (q, $^2J_{CF3}$ = 32.5 Hz); IR (KBr): 3458, 3114, 2922, 2558, 2360, 1810, 1644, 1468, 1290, 1183, 1096, 936, 807, 686, 668 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{10}H_5F_3O_5^+$ $[M]^+$: 262.0089; Found: 262.0092.



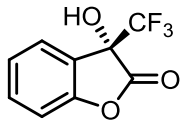
The reaction was carried out at rt**. 3l**: white solid (108 mg, 58% yield), melting point: 60-62 ℃; >99% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 97/3, 0.8 mL/min, λ = 254 nm: t_R (minor) = 14.6 min, t_R (major) = 15.7 min.); $[\alpha]_D^{25}$ = -46.7 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.22 (s, 1H), 6.88(s, 1H), 3.97(s, 1H), 2.23 (s, 3H), 2.19(s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.79; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.78-170.75 (m), 152.5, 142.6, 134.1, 126.5 (q, $^3J_{CF3}$ = 0.7 Hz), 122.2(q, $^1J_{CF3}$ = 283.5 Hz), 117.7, 112.4, 74.8 (q, $^2J_{CF3}$ = 33.4 Hz), 20.6, 19.4; IR (KBr): 3429, 2923, 2852, 2360, 1809, 1795, 1629, 1304, 1108, 1060, 1019, 976, 886, 682 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{11}H_{13}F_3NO_3[M+NH_4]^+$: 264.0842; Found: 264.0841.



The reaction was carried out at rt**. 3m**: yellow solid (136 mg, 61% yield), melting point: 67-70 ℃; 96% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 90/10, 0.6 mL/min, λ = 254 nm: t_R (minor) = 15.0 min, t_R (major) = 16.5 min.); $[\alpha]_D^{25}$ = -36.4 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, Acetone-D_6): δ 7.58 (s, 1H), 7.54(s, 1H), 7.44(s, 1H), 4.36 (s, 3H), 4.29 (s, 3H); ^{19}F NMR (376 MHz, Acetone-D_6): δ -74.90; ^{13}C NMR (100 MHz, Acetone-D_6): δ 170.4, 153.7, 148.9, 147.5, 123.2(q, $^1J_{CF3}$ = 282.5 Hz), 112.0, 108.8, 96.6, 75.5 (q, $^2J_{CF3}$ = 32.9 Hz), 56.3, 56.0; IR (KBr): 3433, 2922, 2850, 2360, 1817, 1629, 1500, 1460, 1344, 1257, 1082, 1001, 947, 793, 697 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{11}H_9F_3O_5^+$ $[M]^+$: 278.0402; Found: 278.0405.

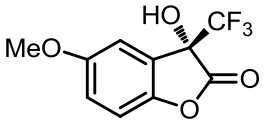


The reaction was carried out at rt**. 3n**: white solid (163 mg, 75% yield), melting point: 125-127 ℃; 99% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 97/3, 0.6 mL/min, λ = 254 nm: t_R (minor) = 19.4 min, t_R (major) = 20.6 min.); $[\alpha]_D^{25}$ = -46.5 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.24 (s, 1H), 6.88 (s, 1H), 3.76 (s, 1H), 2.82-2.78 (m, 4H), 1.81 (t, *J* = 6.4 Hz 4H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.8; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6, 152.0, 143.1, 134.7, 126.5, 122.3 (q, $^1J_{CF3}$ = 283.9 Hz), 117.7, 111.6, 74.7 (q, $^2J_{CF3}$ = 32.6 Hz), 30.2, 29.1, 22.7, 22.4; IR (KBr): 3439, 2950, 2852, 1806, 1793, 1634, 1486, 1440, 1319, 1188, 1069, 977, 676 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{13}H_{11}F_3O_3^+$ $[M]^+$: 272.0660; Found: 272.0663.

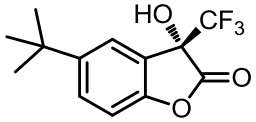


The reaction was carried out at 40 ℃. **3o**: oil (100 mg, 58% yield); 96% ee (Chiralpak IA-3, hexanes / ^{i}PrOH = 97/3, 0.8 mL/min, λ = 254 nm: t_R (minor) = 11.4 min, t_R (major) = 12.5 min.); $[\alpha]_D^{25}$ = -40.3 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57 (d, *J* = 7.6 Hz, 1H), 7.54-7.50 (m, 1H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.18 (d, *J* = 8.0 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.7; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.3 (q, $^3J_{CF3}$ = 1.5 Hz), 154.1, 133.0, 126.2 (q, $^3J_{CF3}$ =1.2 Hz), 125.5,

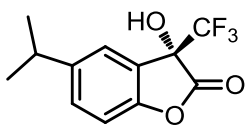
122.2 (q, $^{1}J_{CF3}$ =283.9 Hz), 120.9, 111.6, 74.8 (q, $^{2}J_{CF3}$ =33.1 Hz); IR (KBr): 3454, 2927, 2855, 1813, 1703, 1479, 1177, 1075, 970, 751, 660 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_9H_5F_3O_3^+$ $[M]^+$: 218.0191; Found: 218.0196.



The reaction was carried out at 40 ℃. **3p**: oil (148.8 mg, 74% yield); 95% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 90/10, 0.6 mL/min, λ = 254 nm: t_R (minor) = 10.3 min, t_R (major) = 12.1 min.); $[\alpha]_D^{25}$ = -79.5 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.10-7.00 (m, 3H), 3.82(s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.75; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6, 157.2, 147.9, 122.2(q, $^{1}J_{CF3}$ = 283.9 Hz), 121.5, 118.8, 112.4, 111,2, 75.3 (q, $^{2}J_{CF3}$ = 32.9 Hz), 56.0; IR (KBr): 3452, 2919, 2849, 2361, 1790, 1616, 1490, 1454, 1278, 1163, 1105, 973, 853, 791, 680 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{10}H_7F_3O_4^+$ $[M]^+$: 248.0296; Found: 248.0292.

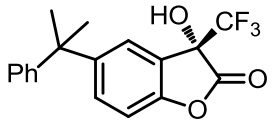


The reaction was carried out at 40 ℃. **3q**: oil (147 mg, 67% yield); 98% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 254 nm: t_R (minor) = 10.6 min, t_R (major) = 12.8 min.); $[\alpha]_D^{25}$ = -46.2 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.57-7.54 (m, 2H), 7.11 (d, J = 8.8 Hz, 1H), 4.00 (s, 1H), 1.34 (s, 9H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.75; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6, 152.1, 149.1, 130.1, 123.0 (q, $^{3}J_{CF3}$ = 1.1 Hz), 122.3(q, $^{1}J_{CF3}$ = 284.2 Hz), 120.2, 111.0, 75.0 (q, $^{2}J_{CF3}$ = 32.6 Hz), 34.9, 31.4; IR (KBr): 3386, 2961, 2922, 2852, 1826, 1623, 1489, 1260, 1183, 1094, 799, 681 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{13}H_{13}F_3O_3^+$ $[M]^+$: 274.0817; Found: 274.0823.

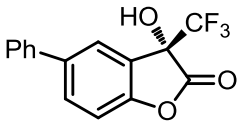


The reaction was carried out at 40 ℃. **3r**: oil (64 mg, 61% yield); 95% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 98/2, 0.8 mL/min, λ = 254 nm: t_R (minor) = 11.2 min, t_R

(major) = 14.3 min.); $[\alpha]_D^{25}$ = -41.7 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.34 (s, 1H), 7.30 (dd, J_1 = 8 Hz, J_2= 1.8 Hz, 1H), 7.04(d, J = 8.4 Hz, 1H), 3.78 (s, 1H), 2.90-2.87 (m, 1H), 1.20 (d, J = 8 Hz, 3H), 1.18 (d, J = 8 Hz, 3H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.8; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.5, 152.3, 146.7, 131.1, 124.0 (q, $^3J_{CF3}$ = 0.7 Hz), 122.2(q, $^1J_{CF3}$ = 283.5 Hz), 120.4, 111.4, 74.9 (q, $^2J_{CF3}$ = 33 Hz), 33.9, 24.0, 23.9; IR (KBr): 3424, 2965, 1815, 1622, 1486, 1273, 1177, 1082, 971, 825, 741, 680 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{12}H_{11}F_3O_3^+$ $[M]^+$: 260.0660; Found: 260.0664.

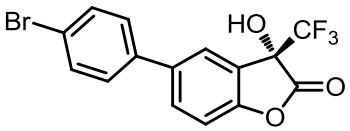


The reaction was carried out at 40 ℃. **3s**: gum (108 mg, 80% yield); 96% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 95/5, 0.6 mL/min, λ = 232 nm: t_R (minor) = 8.9 min, t_R (major) = 10.2 min.); $[\alpha]_D^{25}$ = -38.4 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.40 (s, 1H), 7.23-7.09 (m, 6H), 6.95 (d, J = 8.8 Hz, 1H), 4.03 (s, 1H), 1.60 (s, 6H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.68; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.5, 152.1, 149.5, 148.8, 132.0, 128.2, 126.6, 126.1, 124.0, 122.2(q, $^1J_{CF3}$ = 283.8 Hz), 120.2, 111.1, 74.9 (q, $^2J_{CF3}$ = 33 Hz), 43.0, 30.8, 30.7; IR (KBr): 3458, 2970, 2929, 1821, 1622, 1485, 1387, 1179, 1088, 971, 826, 700 cm^{-1}; HRMS-ESI: Exact mass calcd. for $C_{18}H_{19}F_3NO_3^+$ $[M+NH_4]^+$: 354.1317; Found: 354.1315.

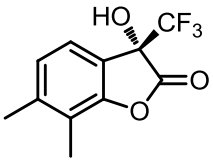


The reaction was carried out at 40 ℃. **3t**: gum (84 mg, 70% yield); 97% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 90/10, 0.6 mL/min, λ = 232 nm: t_R (minor) = 9.0 min, t_R (major) = 11.3 min.); $[\alpha]_D^{25}$ = -56.0 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.70 (s, 1H), 7.66 (dd, J_1 = 8.4 Hz, J_2 = 2 Hz, 1H), 7.50-7.33 (m, 5H), 7.19 (d, J = 3.2 Hz, 1H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.61; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.1, 153.6, 139.40, 139.36, 131.9, 129.0, 128.0, 127.1, 124.9, 122.3 (q, $^1J_{CF3}$ = 283.9 Hz), 121.3, 111.9, 74.9 (q, $^2J_{CF3}$ =3 3.3 Hz); IR (KBr): 3442, 3370, 2924,

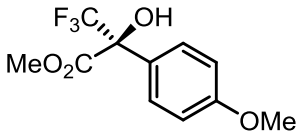
1824, 1619, 1499, 1429, 1293, 1179, 1086, 974, 900, 767, 699 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{15}H_9F_3O_3^+$ $[M]^+$: 294.0504; Found: 294.0508.



The reaction was carried out at 40 ℃. **3u**: white solid (74.5 mg, 50% yield), melting point: 124-126 ℃; 95% ee (Chiralpak AD-3, hexanes / ^{i}PrOH = 90/10, 0.6 mL/min, λ = 232 nm: t_R (minor) = 10.8 min, t_R (major) = 14.6 min.); $[\alpha]_D^{25}$ = -58.3 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.73 (s, 1H), 7.69 (dd, J_1 = 8.4 Hz, J_2 = 2.4 Hz, 1H), 7.60-7.58 (m, 2H), 7.43-7.28 (m, 2H), 7.27 (d, J = 8.4 Hz, 1H), 4.16(s, 1H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.60; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.0, 153.7, 138.2, 138.1, 132.1, 131.7, 128.6, 124.7, 122.3, 122.2(q, $^1J_{CF3}$ =284.3 Hz), 121.4, 112.1, 74.8 (q, $^2J_{CF3}$ =32.7 Hz); IR (KBr): 3428, 2961, 2924, 1805, 1620, 1475, 1316, 1177, 1086, 1006, 957, 811, 680 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{15}H_8F_3O_3Br^+$ $[M]^+$: 371.9609; Found: 371.9613.

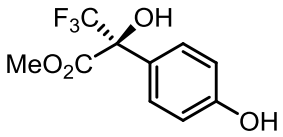


The reaction was carried out at rt. **3v**: white solid (74.5 mg, 76% yield), melting point: 96.5-98.5 ℃; 97% ee (Chiralpak IE, hexanes / ^{i}PrOH = 98/2, 0.6 mL/min, λ = 254 nm: t_R (minor) = 14.2 min, t_R (major) = 14.9 min.); $[\alpha]_D^{25}$ = -22.4 (c 0.50, $CHCl_3$); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.20 (d, J =7.6 Hz, 1H), 6.99 (d, J =7.6 Hz, 1H), 3.79 (s, 1H), 2.26 (s, 3H), 2.16 (s, 3H); ^{19}F NMR (376 MHz, $CDCl_3$): δ -79.83; ^{13}C NMR (100 MHz, $CDCl_3$): δ 170.6, 152.8, 143.0, 126.4, 122.8, 122.3 (q, $^1J_{CF3}$ = 283.8 Hz), 120.8, 117.6, 75.4 (q, $^2J_{CF3}$ = 33.1 Hz), 19.9, 11.7; IR (KBr): 3441, 2958, 2924, 2852, 1807, 1637, 1596, 1457, 1388, 1304, 1173, 1136, 983, 771, 675 cm^{-1}; HRMS-EI: Exact mass calcd. for $C_{11}H_9F_3O_3^+$ $[M]^+$: 246.0504; Found: 246.0497.



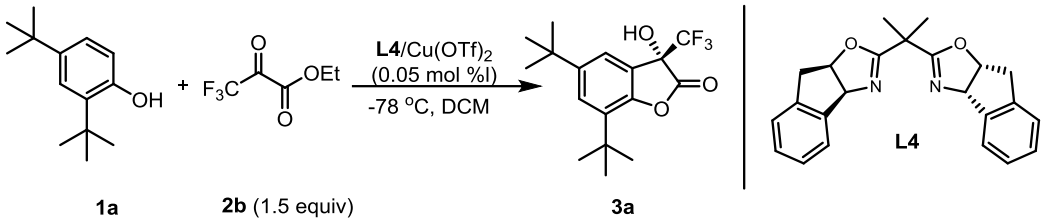
5: oil (18 mg, 17% yield); 51% ee (Chiralpak AD-H, hexanes / ^{i}PrOH= 90/10, 0.6

mL/min, λ = 254 nm: t_R (major) = 12.7 min, t_R (minor) = 20.3 min.); ^{1}H NMR (400 MHz, CDCl3): δ 7.69 (d, *J* = 8.4 Hz, 2H), 6.92 (d, *J* = 8.8 Hz, 2H), 4.26 (s, 1H), 3.96(s, 3H), 3.82 (s, 3H); All analytical data are consistent with literature values[3].



3o': oil (13 mg, 15% yield); 2% ee (Chiralpak IA-3, hexanes / ^{i}PrOH= 90/10, 0.8 mL/min, λ = 254 nm: t_R (minor) = 13.3 min, t_R (major) = 14.2 min.); ^{1}H NMR (400 MHz, CDCl3): δ 7.62 (d, *J* = 8.8 Hz, 2H), 6.84 (d, *J* = 8.4 Hz, 2H), 5.56 (s, 1H), 4.33 (s, 1H), 3.95(s, 3H); All analytical data are consistent with literature values[4].

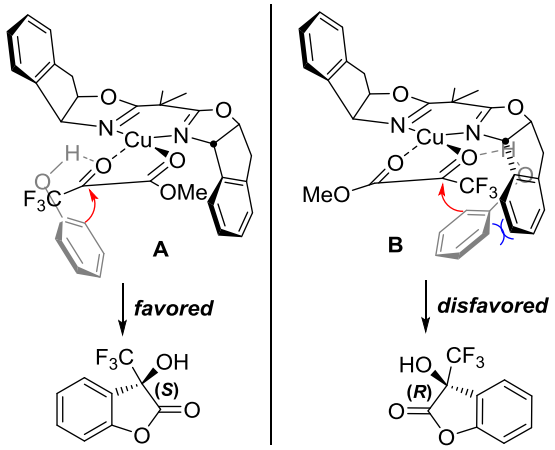
4. Gram-scale experiment



1a **2b** (1.5 equiv) **3a**

The general procedure for Gram-Scale experiment: A mixture of $Cu(OTf)_2$ (14.5 mg, 0.04 mmol) and **L4** (14.3 mg, 0.04 mmol) in DCM (5 mL) was stirred at room temperature for 4 h under the atmosphere of nitrogen (solution A). To a 100 mL Schlenktube which contained **2b** (1.6 mL, 12 mmol) in 20 mL DCM, 0.5 mL of solution A was added. The mixture was stirred at -78 °C for 20 minutes, then **1a** (1.65 g, 8 mmol) was added and stirred at -78 ℃. After the reaction was taken on for 120 h, the reaction was filtered through a glass funnel with thin layer (20 mm) of silica gel (100-200 mesh) and eluted with DCM. The filtrate was concentrated under reduced pressure. The residue was purified by flash chromatography (hexane/ethyl acetate =40/1) to afford the product **3a** (2.16 g). The purified product (2.02 g) was recrystallized from cold hexane, and dried to afford 1.26 g (62% yield) of white crystal **3a** (>99% ee).

5. A proposed working model for the stereoselection



6. References

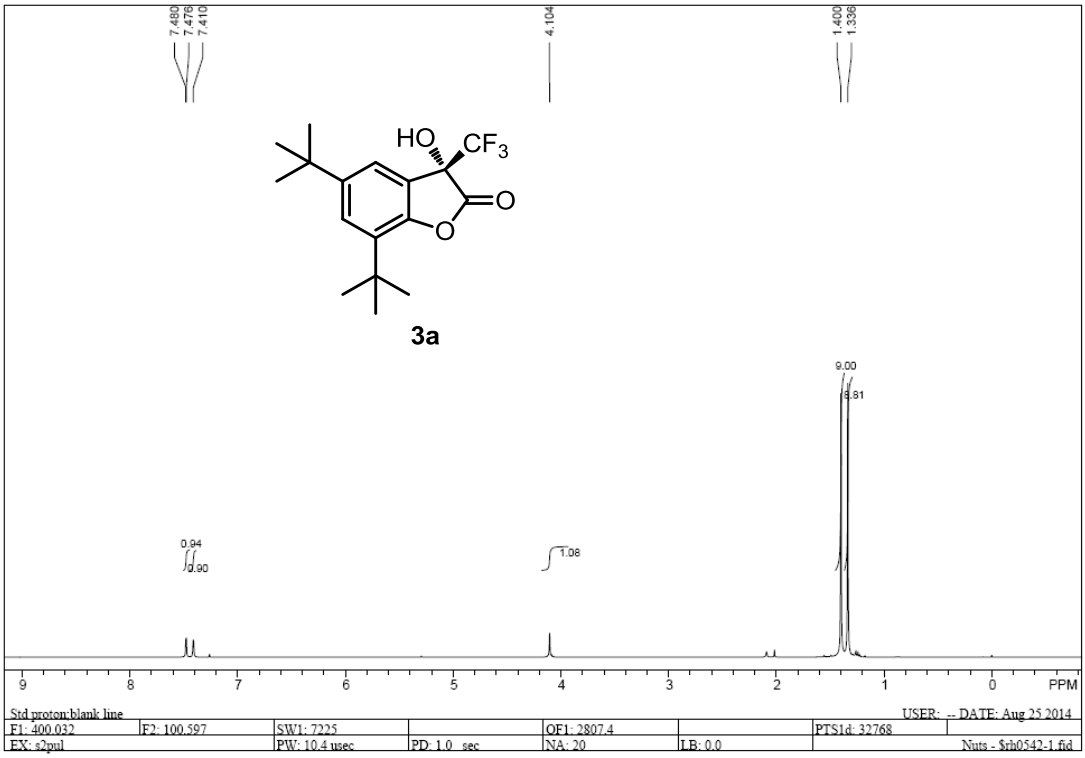
(1) P. Malherbe, R. Masciadri, R. D. Norcross, F. Knoflach, C.Kratzeisen, M. T. Zenner, Y. Kolb, A. Marcuz, J. Huwyler, T. Nakagawa, R. H. P. Porter, A. W. Thomas, J. G.Wettstein, A. J.Sleight, W. Spooren, E. P. Prinssen. *Brit. J. Pharmacol*. **2008,** *154*, 797–811;

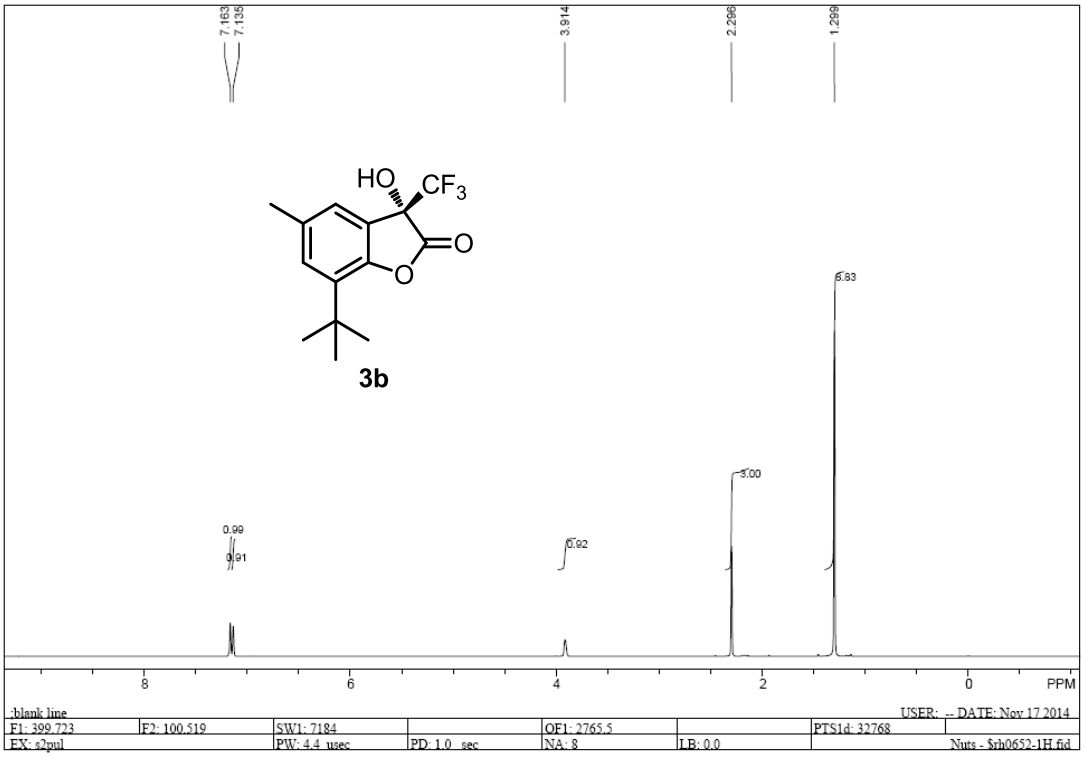
(2) F. Vetica, T. Gasperi,et al. *Eur. J. Org. Chem.* **2014**, 2014, 1899–1906

(3) R. Ding , J. Chao. *Synlett*, **2004**, 3, 555-557.

(4) A. V. Fokin, et al. *Russian Chemical Bulletin.* **1995**, *44*, 511-513.

7. ^{1}H NMR, ^{13}C NMR and ^{19}F NMR spectra

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7.135
3.914
2.296
1.299
HO
CF3
O
O
3b
6.83
3.00
0.99
0.91
0.92
8
6
4
2
0
PPM
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USER: -- DATE: Nov 17 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2765.5
PTS1d: 32768
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PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
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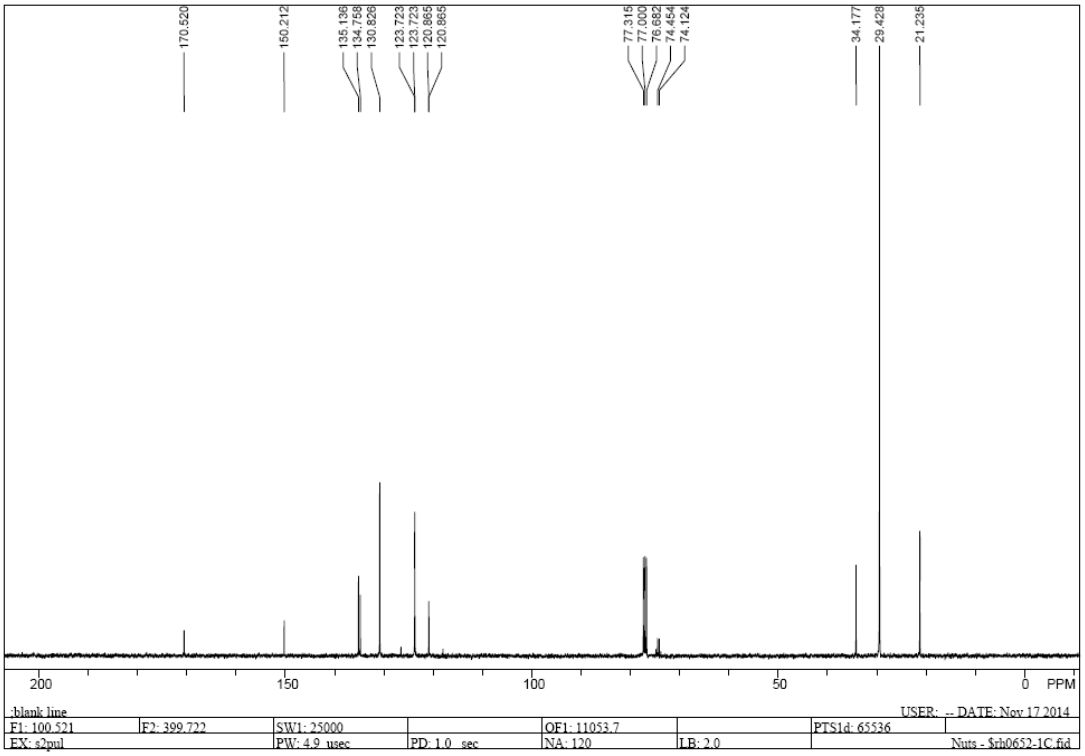
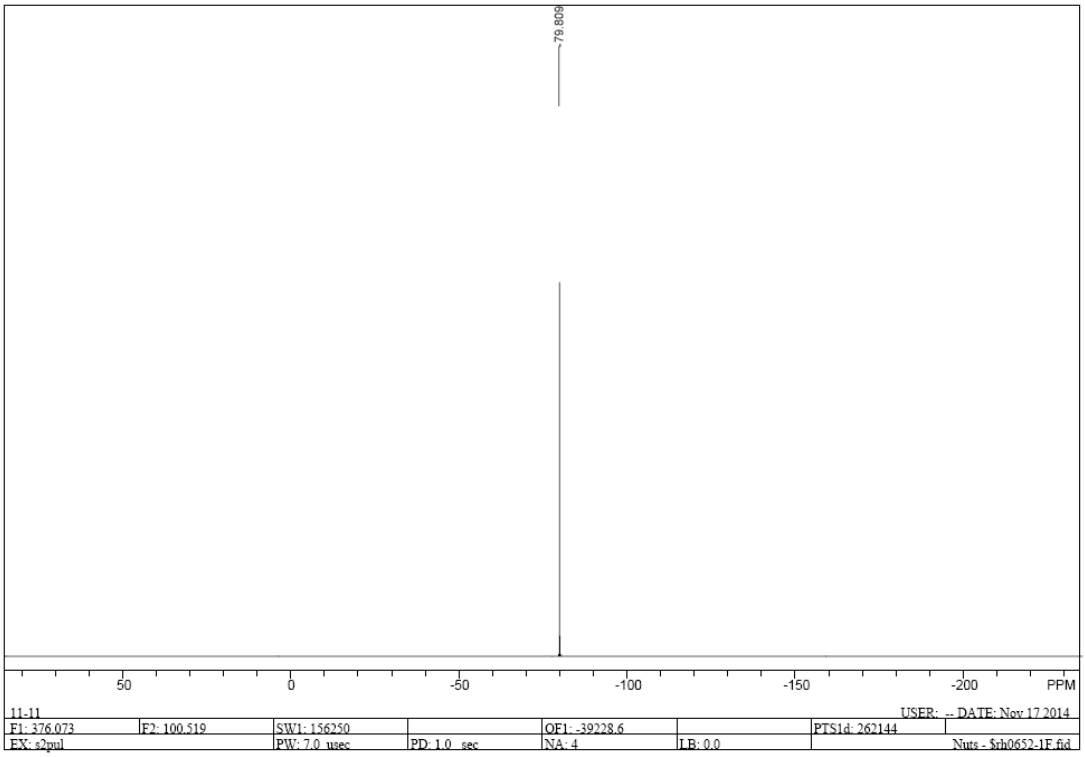

170.520
150.212
135.136
134.758
130.826
123.723
123.723
120.865
120.865
77.315
77.000
76.682
74.454
74.124
34.177
29.428
21.235
200
150
100
50
0
PPM
:blank line
USER: -- DATE: Nov 17 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11053.7
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 120
LB: 2.0
Nuts - $rh0652-1C.fid


79.809
50
0
-50
-100
-150
-200
PPM
11-11
USER: -- DATE: Nov 17 2014
F1: 376.073
F2: 100.519
SW1: 156250
OF1: -39228.6
PTS1d: 262144
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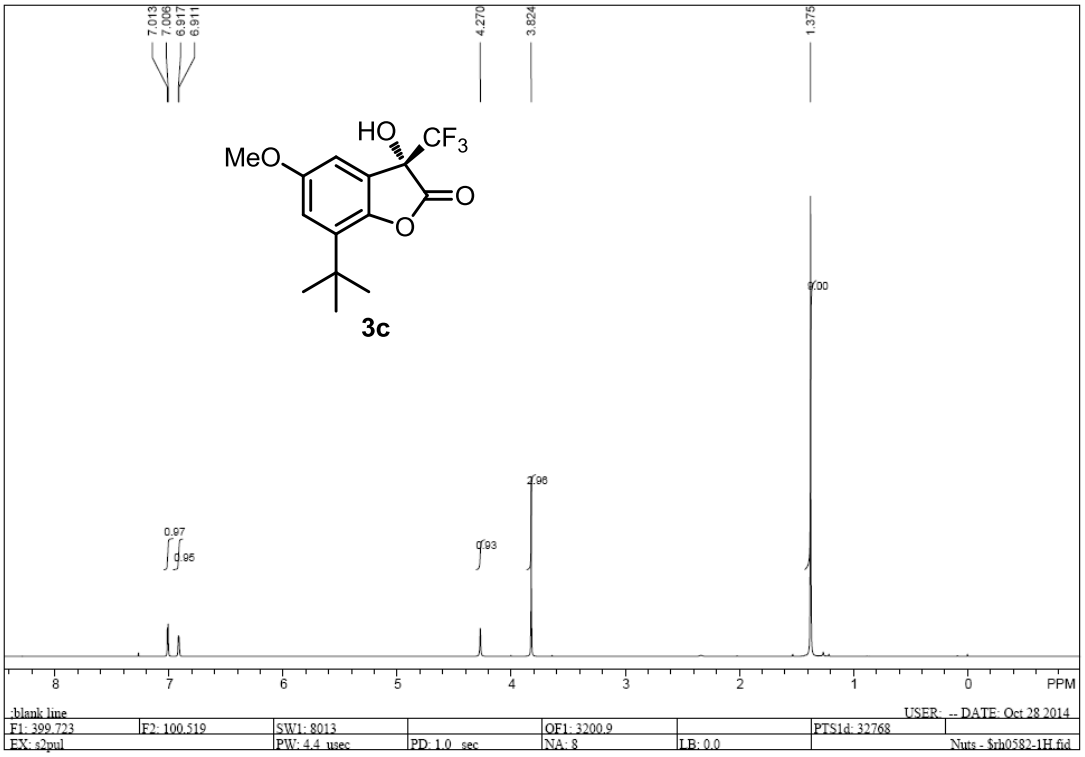
PW: 7.0 usec
PD: 1.0 sec
NA: 4
LB: 0.0
Nuts - $rh0652-1F.fid


7.013
7.006
6.917
6.911
4.270
3.824
1.375
HO
CF3
MeO
O
O
3c
9.00
2.96
0.97
0.95
0.93
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Oct 28 2014
F1: 399.723
F2: 100.519
SW1: 8013
OF1: 3200.9
PTS1d: 32768
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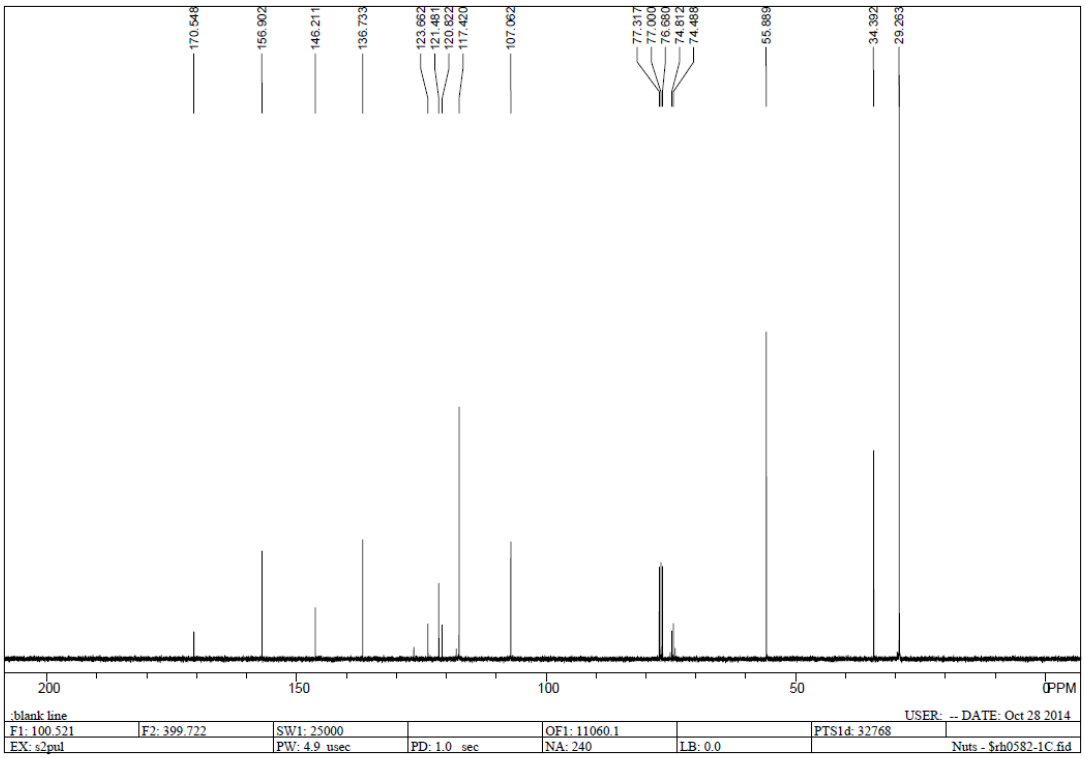
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0582-1H.fid


170.548
156.902
146.211
136.733
123.662
121.481
120.822
117.420
107.062
77.317
77.000
76.680
74.812
74.488
55.889
34.392
29.263
200
150
100
50
0
PPM
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USER: -- DATE: Oct 28 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11060.1
PTS1d: 32768
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PW: 4.9 usec
PD: 1.0 sec
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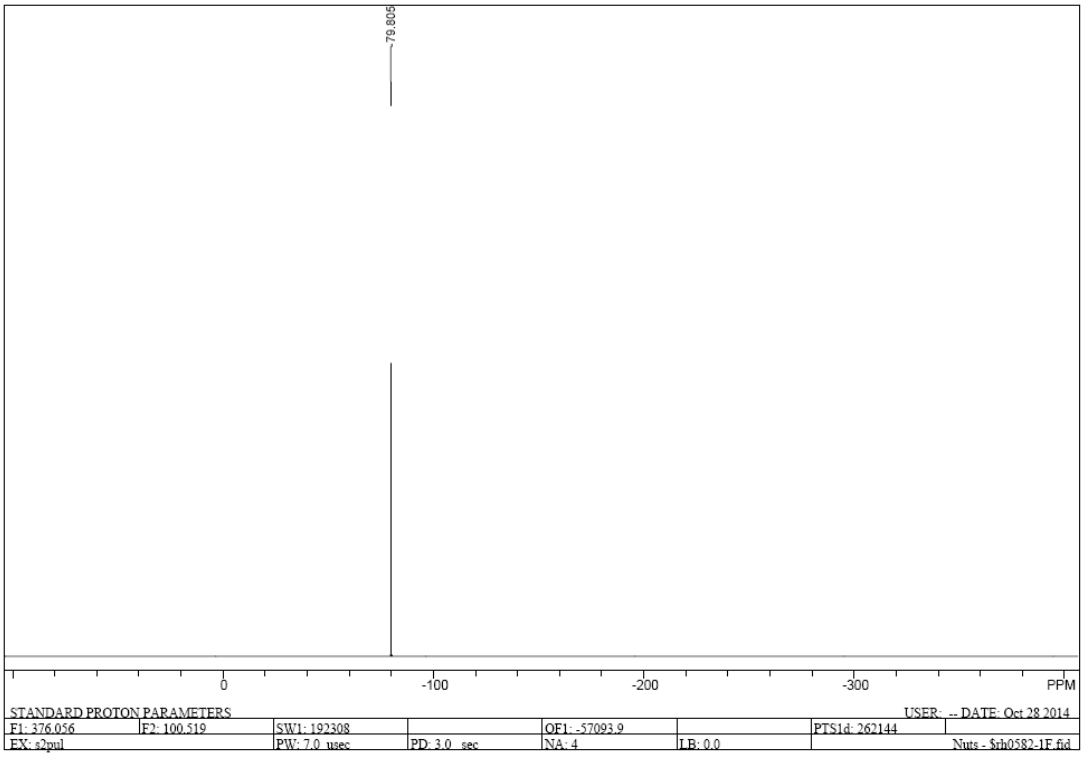
LB: 0.0
Nuts - $rh0582-1C.fid


79.805
0
-100
-200
-300
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Oct 28 2014
F1: 376.056
F2: 100.519
SW1: 192308
OF1: -57093.9
PTS1d: 262144
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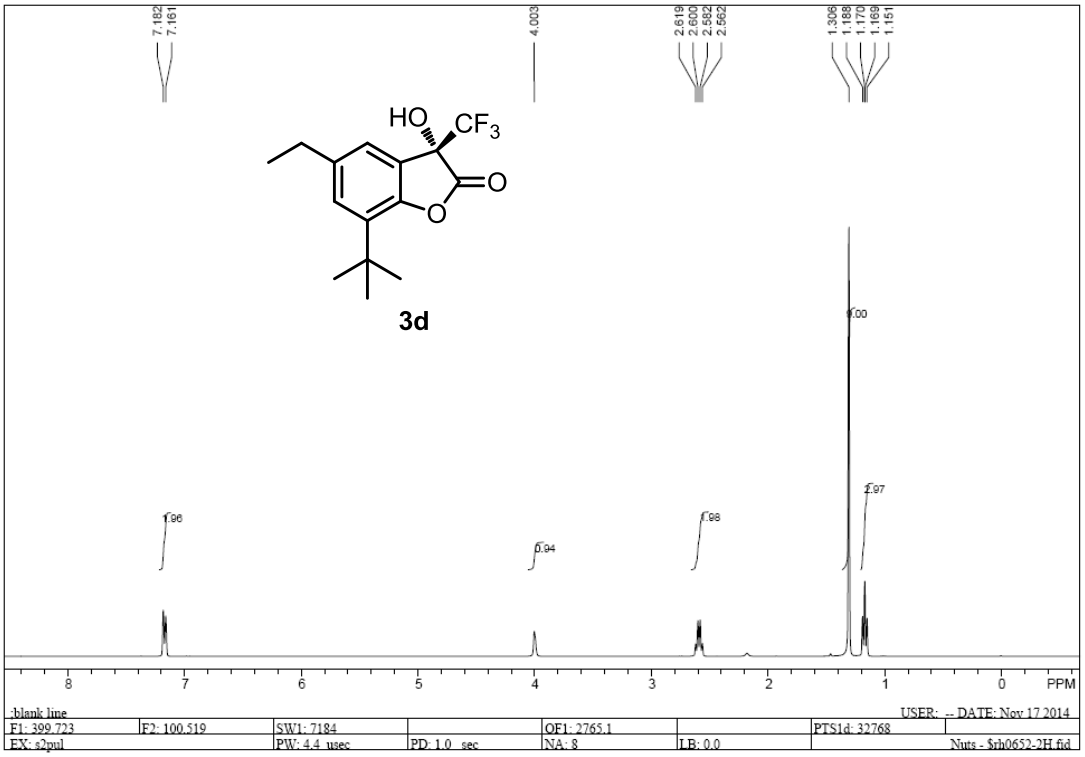
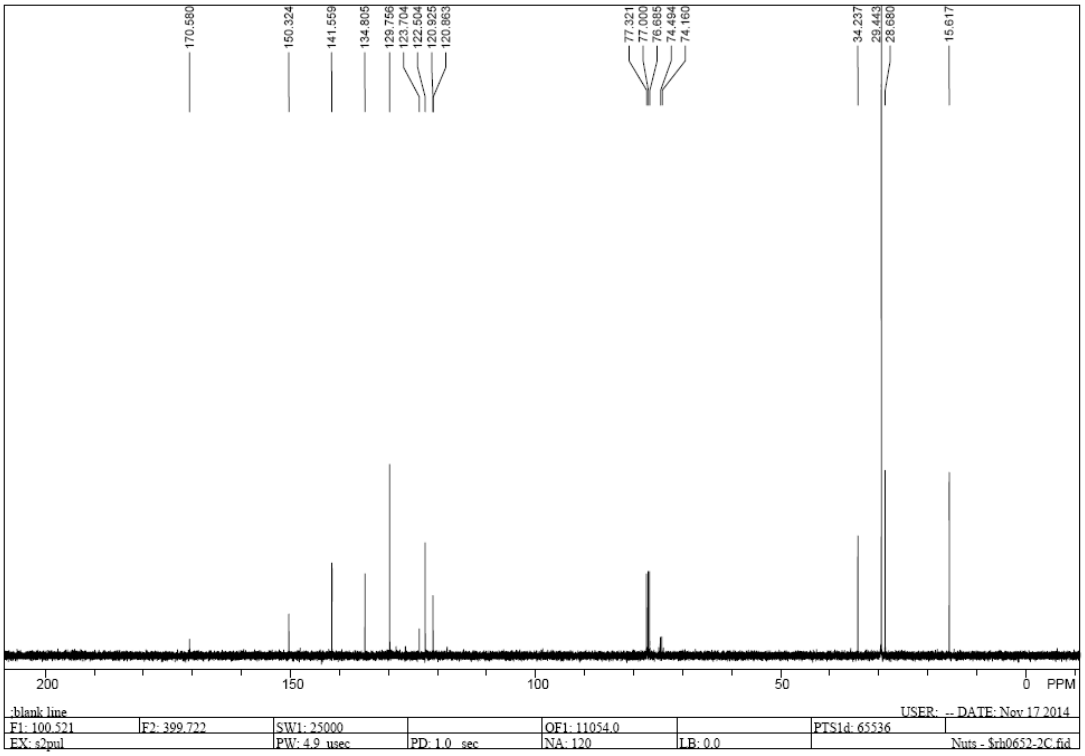
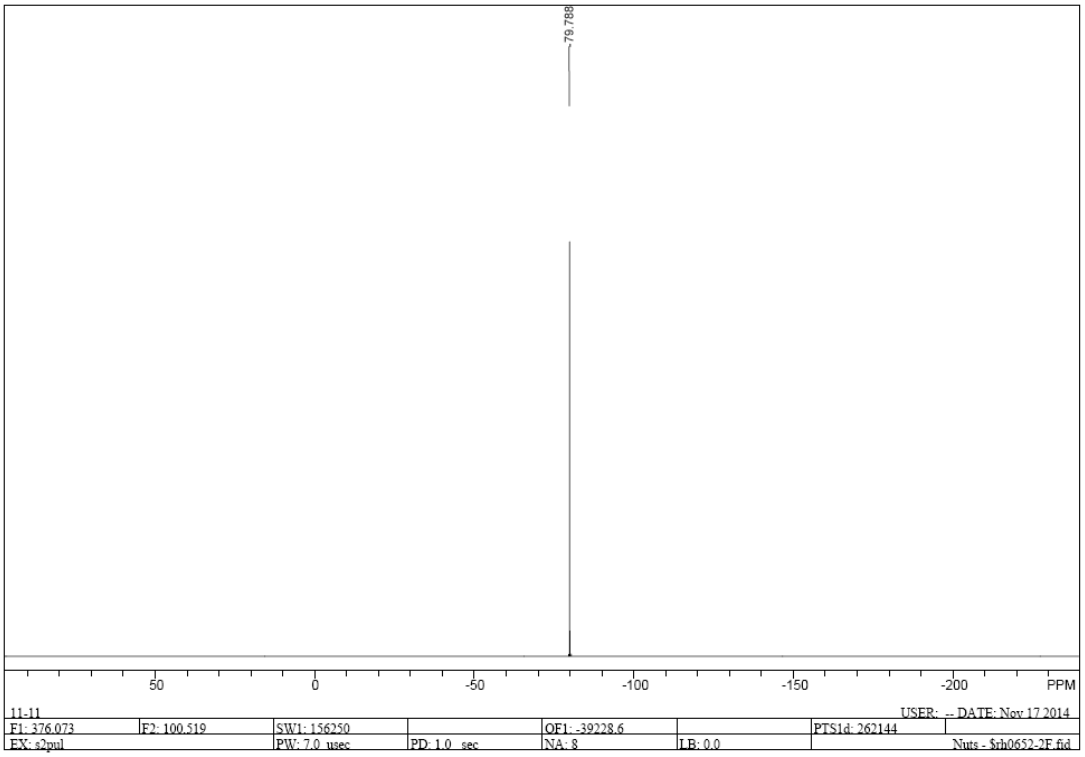
PW: 7.0 usec
PD: 3.0 sec
NA: 4
LB: 0.0
Nuts - $rh0582-1F.fid


7.182
7.161
4.003
2.619
2.600
2.582
2.562
1.306
1.188
1.170
1.169
1.151
HO
CF3
O
O
3d
9.00
2.97
1.96
0.94
1.98
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Nov 17 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2765.1
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0652-2H.fid


170.580
150.324
141.559
134.805
129.756
123.704
122.504
120.925
120.863
77.321
77.000
76.685
74.494
74.160
34.237
29.443
28.680
15.617
200
150
100
50
0
PPM
:blank line
USER: -- DATE: Nov 17 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11054.0
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 120
LB: 0.0
Nuts - $rh0652-2C.fid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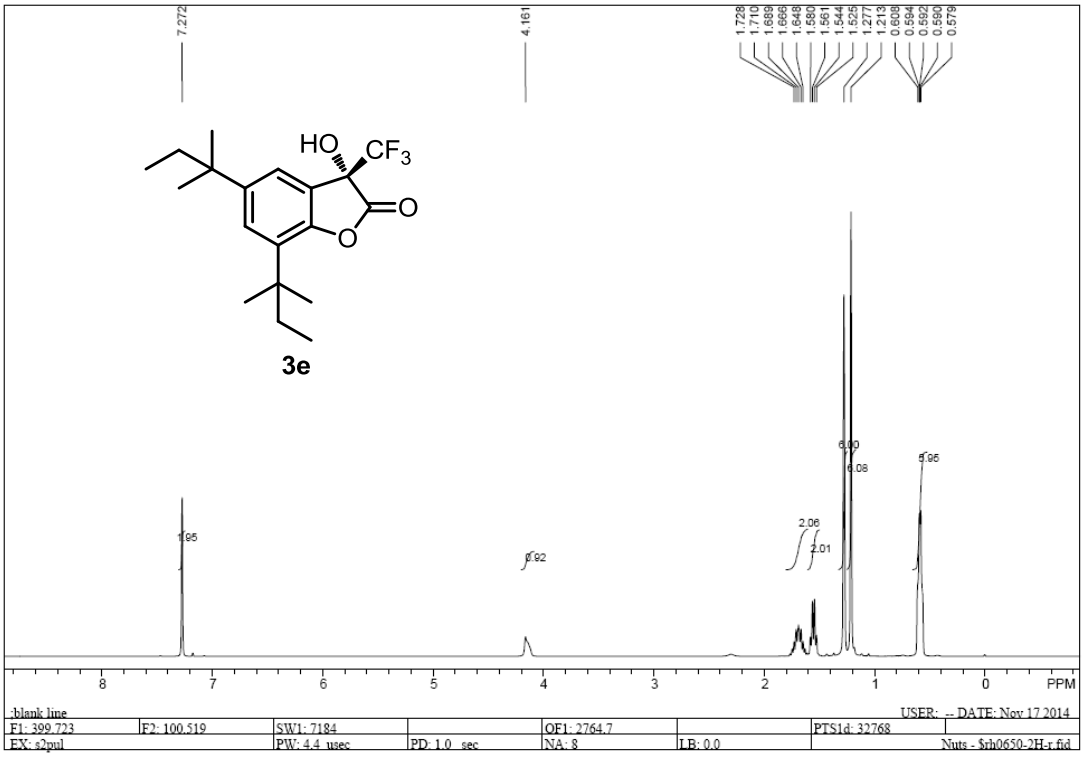
0
-50
-100
-150
-200
PPM
11-11
USER: -- DATE: Nov 17 2014
F1: 376.073
F2: 100.519
SW1: 156250
OF1: -39228.6
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0652-2F.fid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4.161
1.728
1.710
1.689
1.666
1.648
1.580
1.561
1.544
1.525
1.277
1.213
0.608
0.594
0.592
0.590
0.579
HO
CF3
O
O
3e
6.00
6.08
5.96
2.06
2.01
1.95
0.92
8
7
6
5
4
3
2
1
0
PPM
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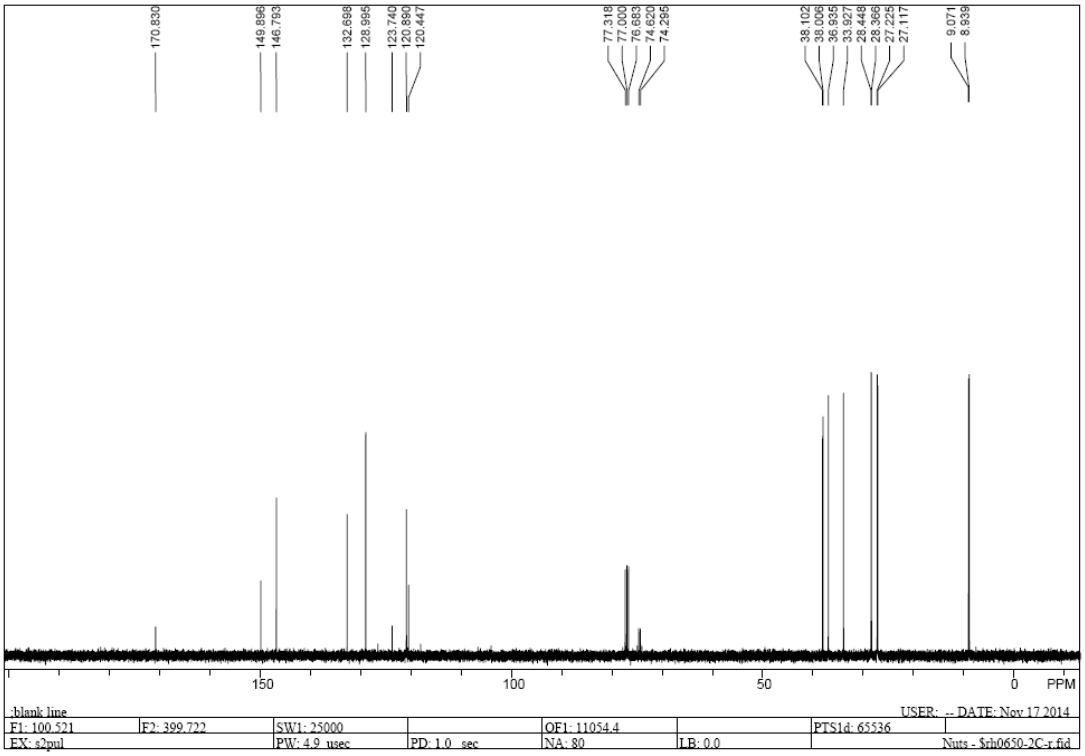
USER: -- DATE: Nov 17 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2764.7
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0650-2H-r.fid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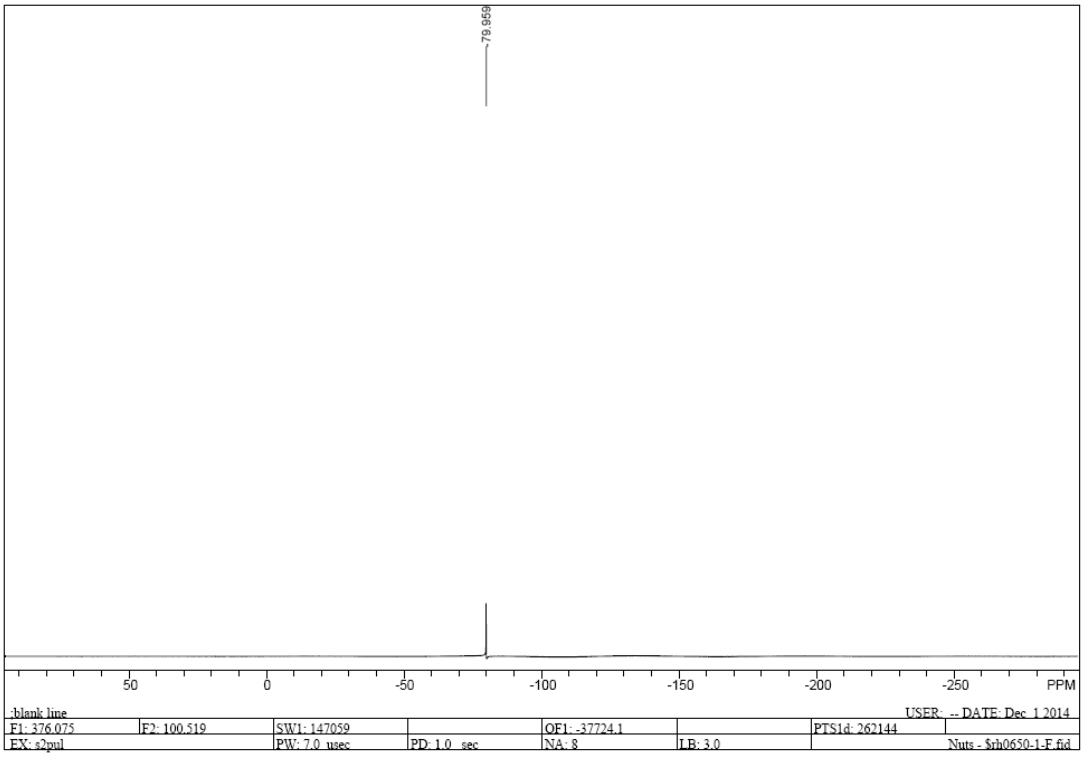
146.793
132.698
128.995
123.740
120.890
120.447
77.318
77.000
76.683
74.620
74.295
38.102
38.006
36.935
33.927
28.448
28.366
27.225
27.117
9.071
8.939
150
100
50
0
PPM
:blank line
USER: -- DATE: Nov 17 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11054.4
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 80
LB: 0.0
Nuts - $rh0650-2C-r.fid


79.959
50
0
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-100
-150
-200
-250
PPM
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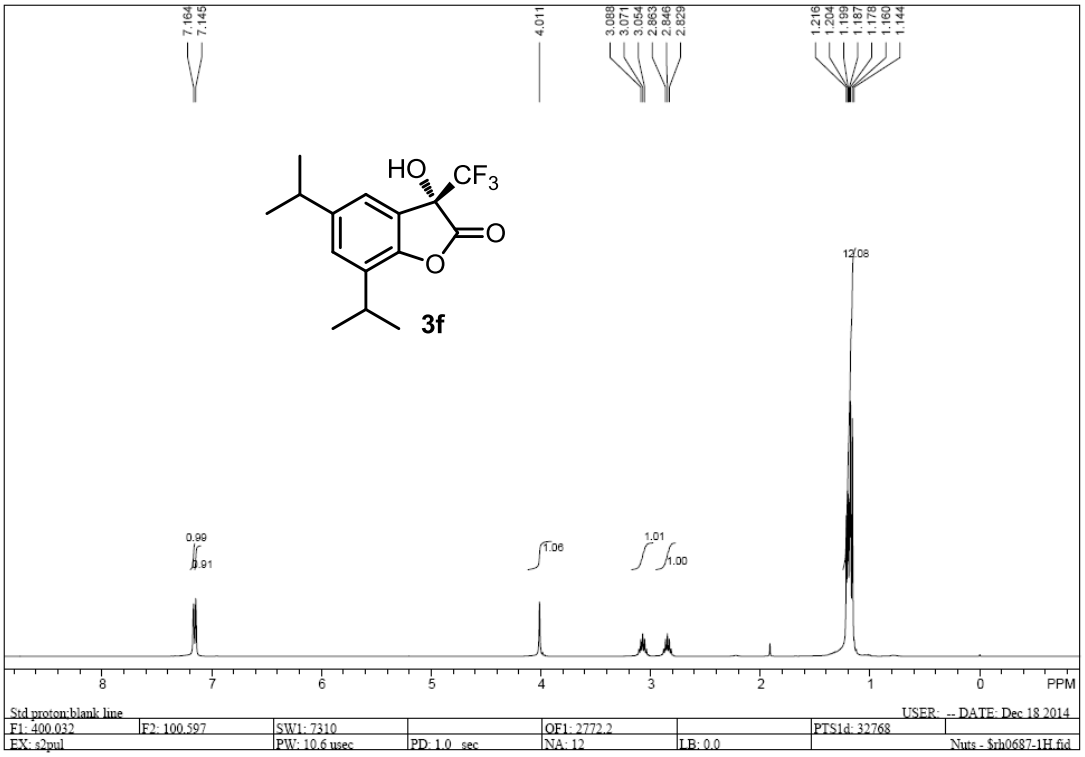
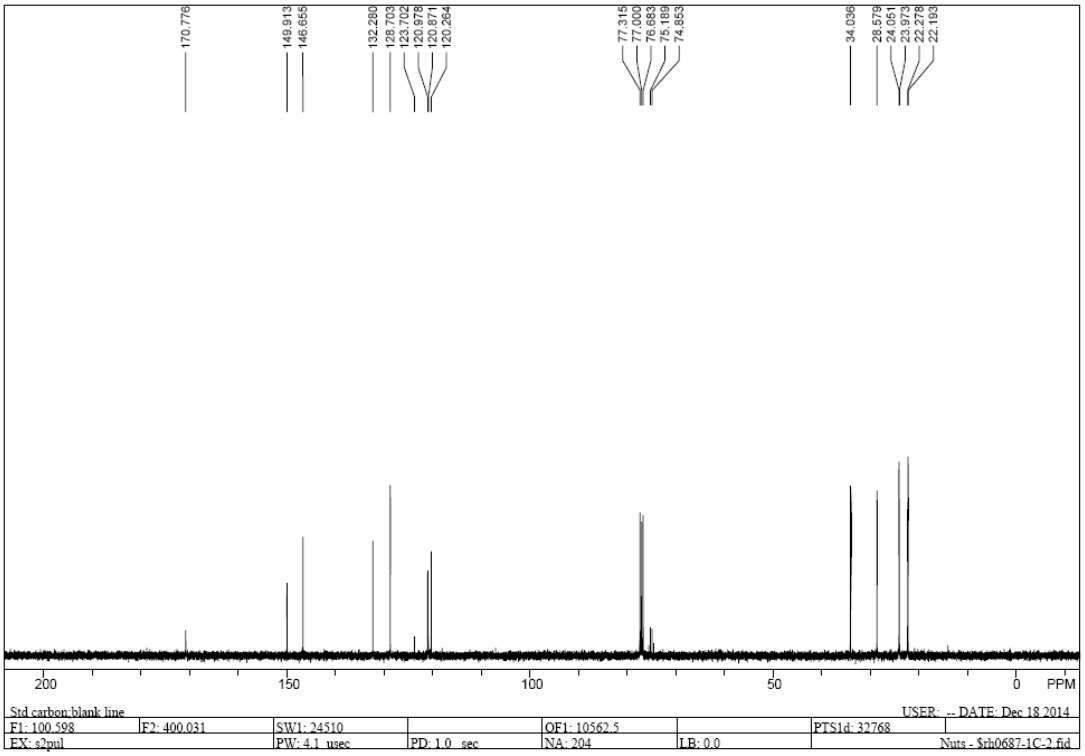
USER: -- DATE: Dec 1 2014
F1: 376.075
F2: 100.519
SW1: 147059
OF1: -37724.1
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 8
LB: 3.0
Nuts - $rh0650-1-F.fid


7.164
7.145
4.011
3.088
3.071
3.054
2.863
2.846
2.829
1.216
1.204
1.189
1.187
1.178
1.160
1.144
HO
CF3
O
O
3f
12.08
0.99
0.91
1.06
1.01
1.00
8
7
6
5
4
3
2
1
0
PPM
Std proton;blank line
USER: -- DATE: Dec 18 2014
F1: 400.032
F2: 100.597
SW1: 7310
OF1: 2772.2
PTS1d: 32768
EX: s2pul
PW: 10.6 usec
PD: 1.0 sec
NA: 12
LB: 0.0
Nuts - $rh0687-1H.fid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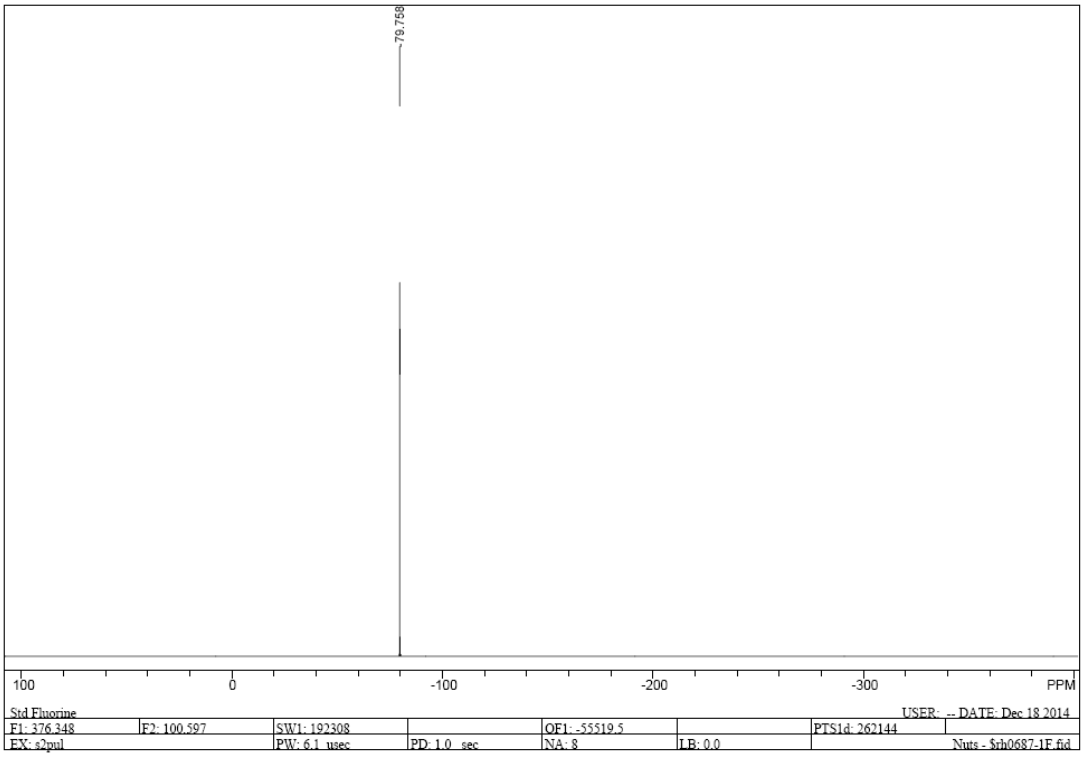
132.280
128.703
123.702
120.978
120.871
120.264
77.315
77.000
76.683
75.189
74.853
34.036
28.579
24.051
23.973
22.278
22.193
200
150
100
50
0
PPM
Std carbon;blank line
USER: -- DATE: Dec 18 2014
F1: 100.598
F2: 400.031
SW1: 24510
OF1: 10562.5
PTS1d: 32768
EX: s2pul
PW: 4.1 usec
PD: 1.0 sec
NA: 204
LB: 0.0
Nuts - $rh0687-1C-2.fid


-79.768
100
0
-100
-200
-300
PPM
Std Fluorine
USER: -- DATE: Dec 18 2014
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F2: 100.597
SW1: 192308
OF1: -55519.5
PTS1d: 262144
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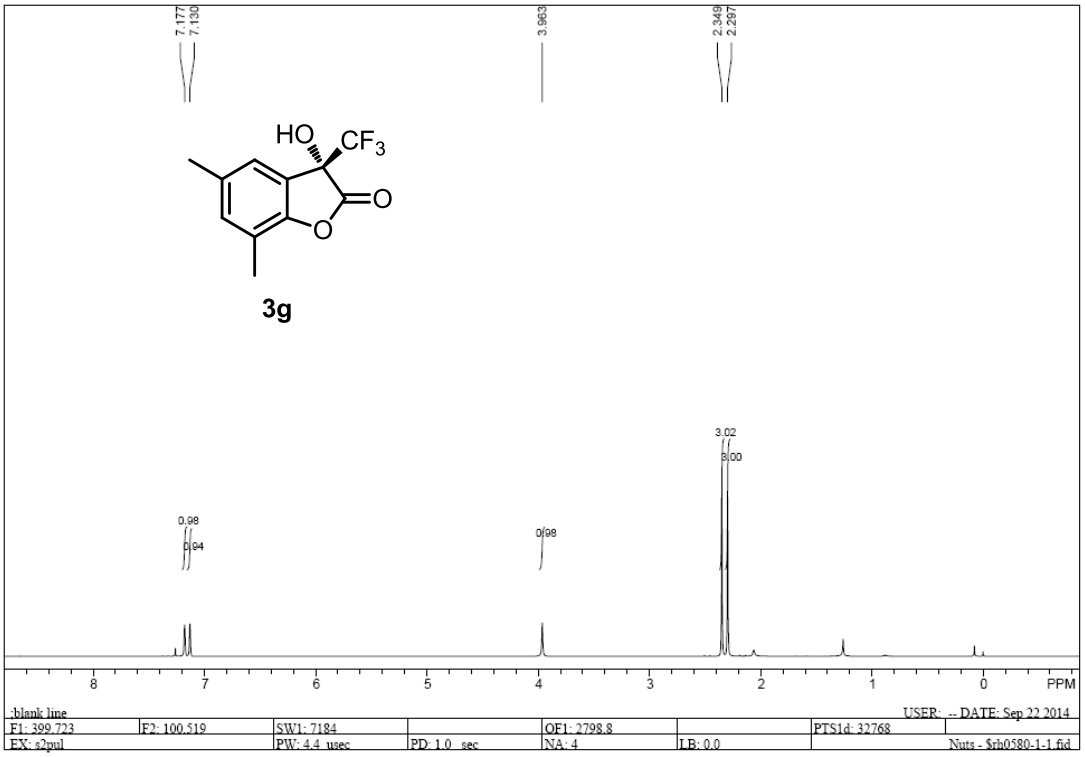
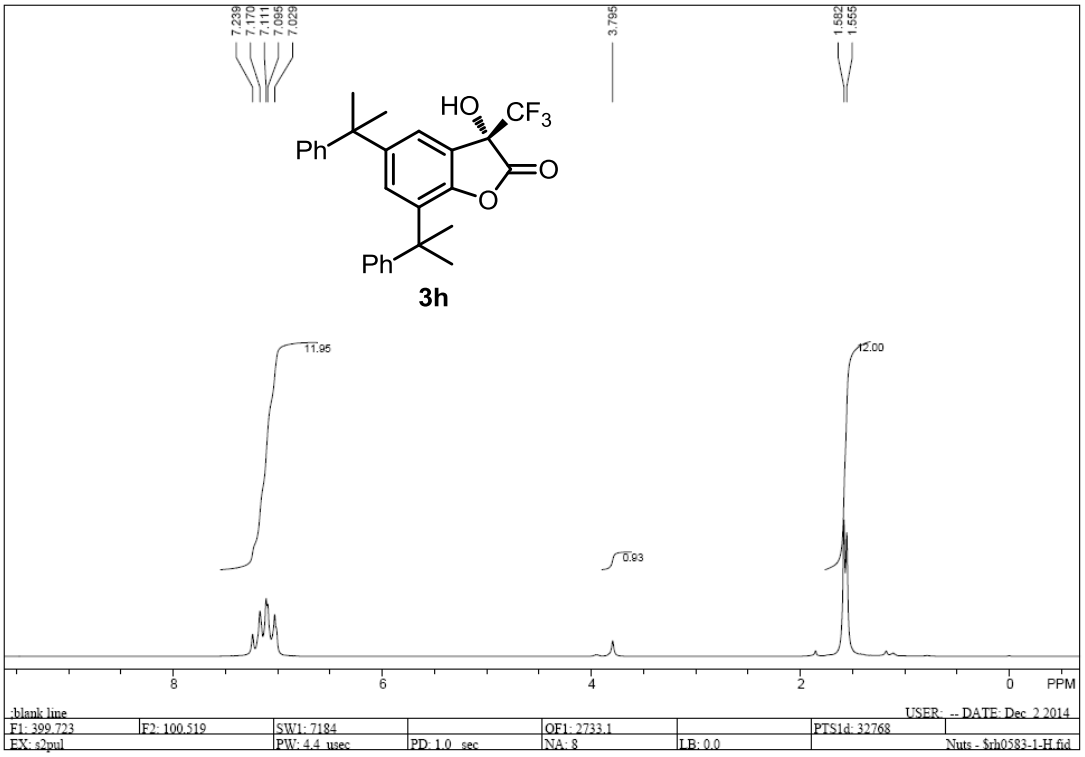
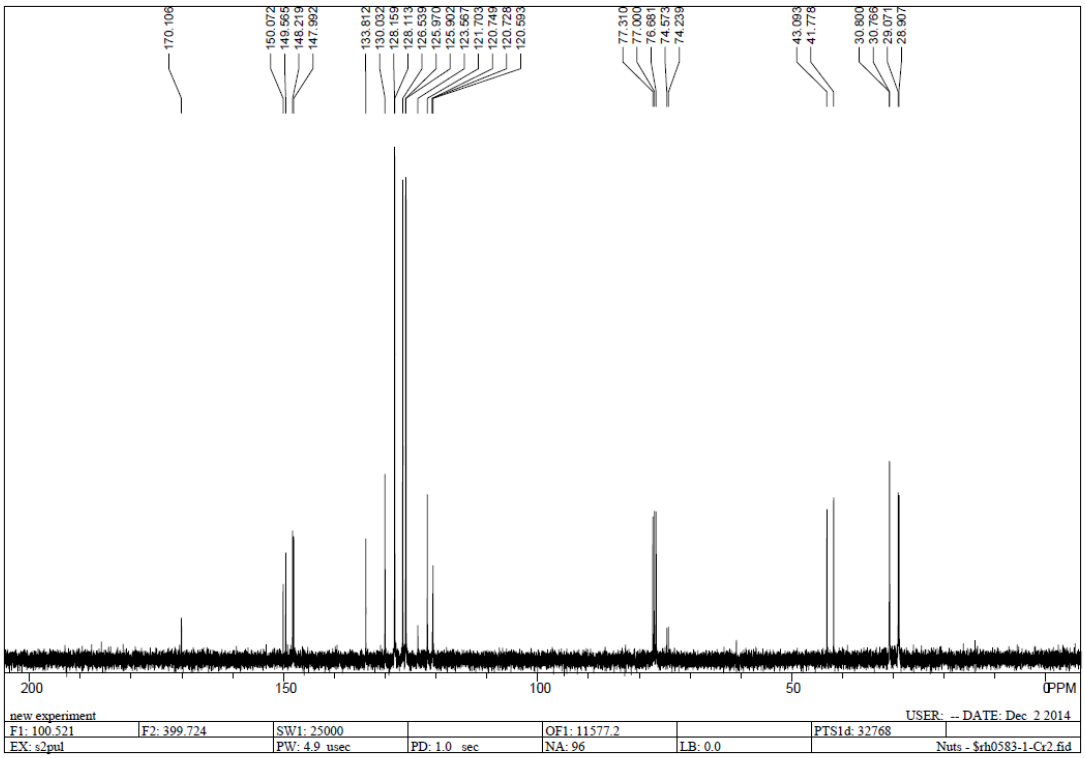
PW: 6.1 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0687-1F.fid


7.177
7.130
3.963
2.349
2.297
HO
CF3
O
O
3g
3.02
3.00
0.98
0.94
0.98
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Sep 22 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2798.8
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 4
LB: 0.0
Nuts - $rh0580-1-1.fid


7.239
7.170
7.111
7.095
7.029
3.795
1.582
1.555
HO
CF3
Ph
O
O
Ph
3h
11.95
0.93
12.00
8
6
4
2
0
PPM
:blank line
USER: -- DATE: Dec 2 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2733.1
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0583-1-H.fid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150.072
149.565
148.219
147.992
133.812
130.032
128.159
128.113
126.539
125.970
125.902
123.567
121.703
120.749
120.728
120.593
77.310
77.000
76.681
74.573
74.239
43.093
41.778
30.800
30.766
29.071
28.907
200
150
100
50
0
PPM
new experiment
USER: -- DATE: Dec 2 2014
F1: 100.521
F2: 399.724
SW1: 25000
OF1: 11577.2
PTS1d: 32768
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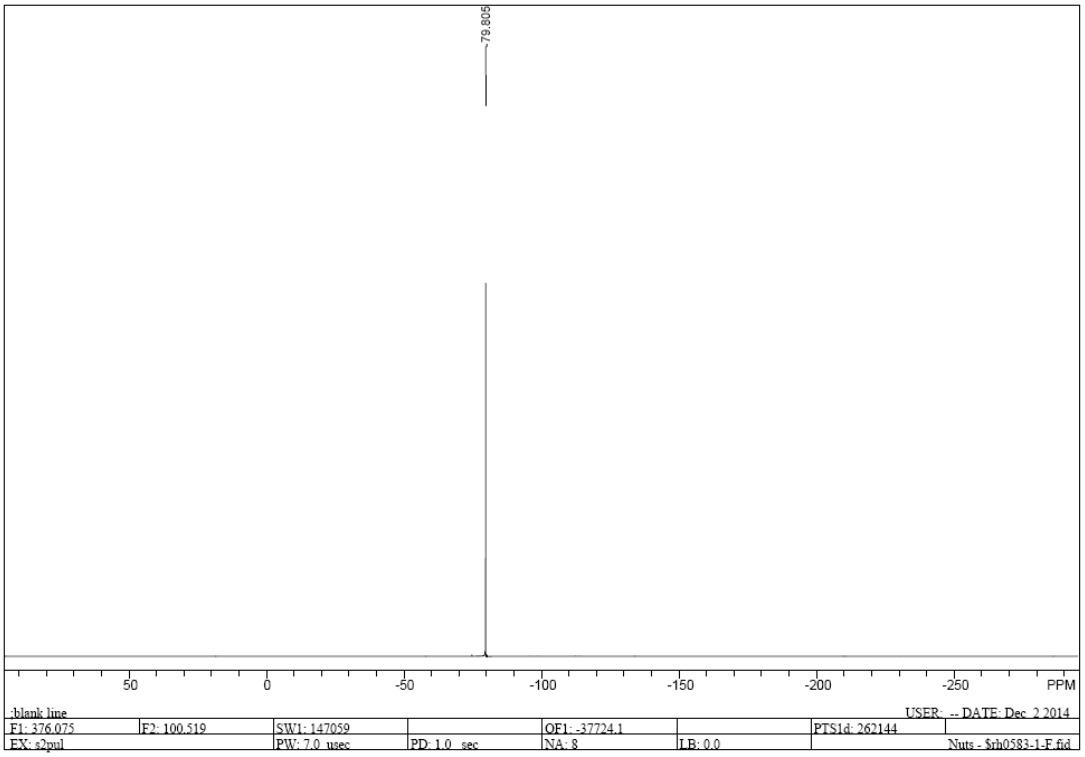
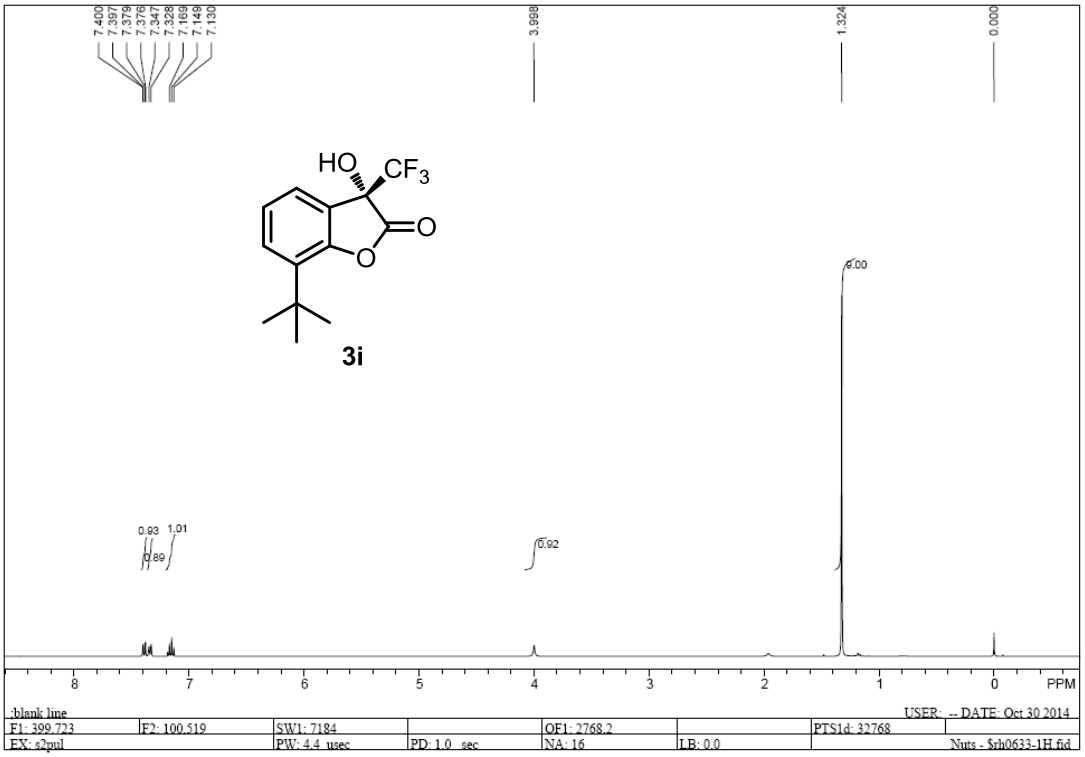
PW: 4.9 usec
PD: 1.0 sec
NA: 96
LB: 0.0
Nuts - $rh0583-1-Cr2.fid


79.805
50
0
-50
-100
-150
-200
-250
PPM
:blank line
USER: -- DATE: Dec 2 2014
F1: 376.075
F2: 100.519
SW1: 147059
OF1: -37724.1
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0583-1-F.fid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7.397
7.379
7.376
7.347
7.328
7.169
7.149
7.130
3.998
1.324
0.000
HO
CF3
O
O
3i
9.00
0.93
1.01
0.89
0.92
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Oct 30 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2768.2
PTS1d: 32768
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PW: 4.4 usec
PD: 1.0 sec
NA: 16
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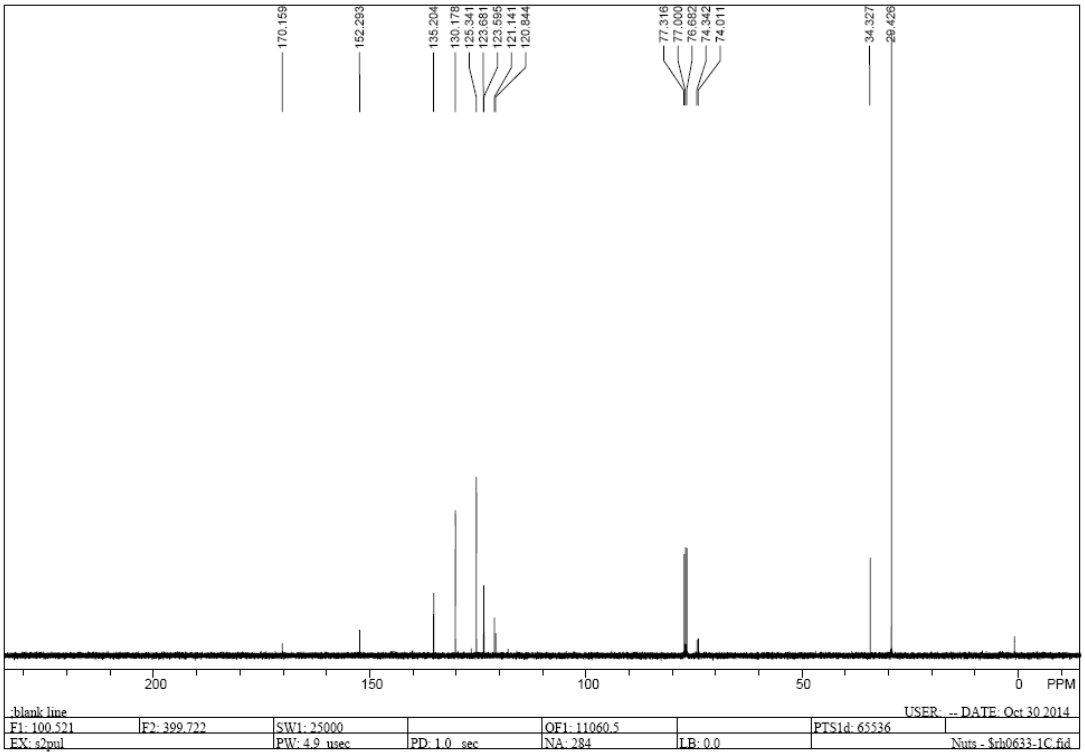
Nuts - $rh0633-1H.fid


170.159
152.293
135.204
130.178
125.341
123.681
123.595
121.141
120.844
77.316
77.000
76.682
74.342
74.011
34.327
29.426
200
150
100
50
0
PPM
:blank line
USER: -- DATE: Oct 30 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11060.5
PTS1d: 65536
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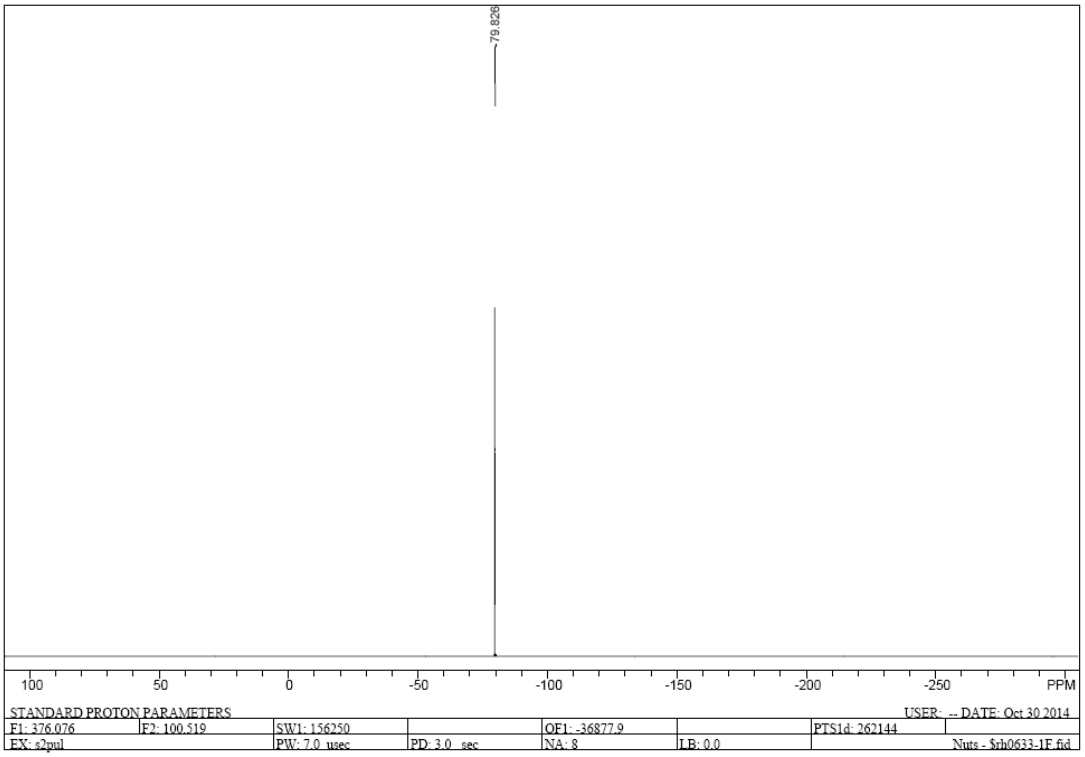
PW: 4.9 usec
PD: 1.0 sec
NA: 284
LB: 0.0
Nuts - $rh0633-1C.fid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50
0
-50
-100
-150
-200
-250
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Oct 30 2014
F1: 376.076
F2: 100.519
SW1: 156250
OF1: -36877.9
PTS1d: 262144
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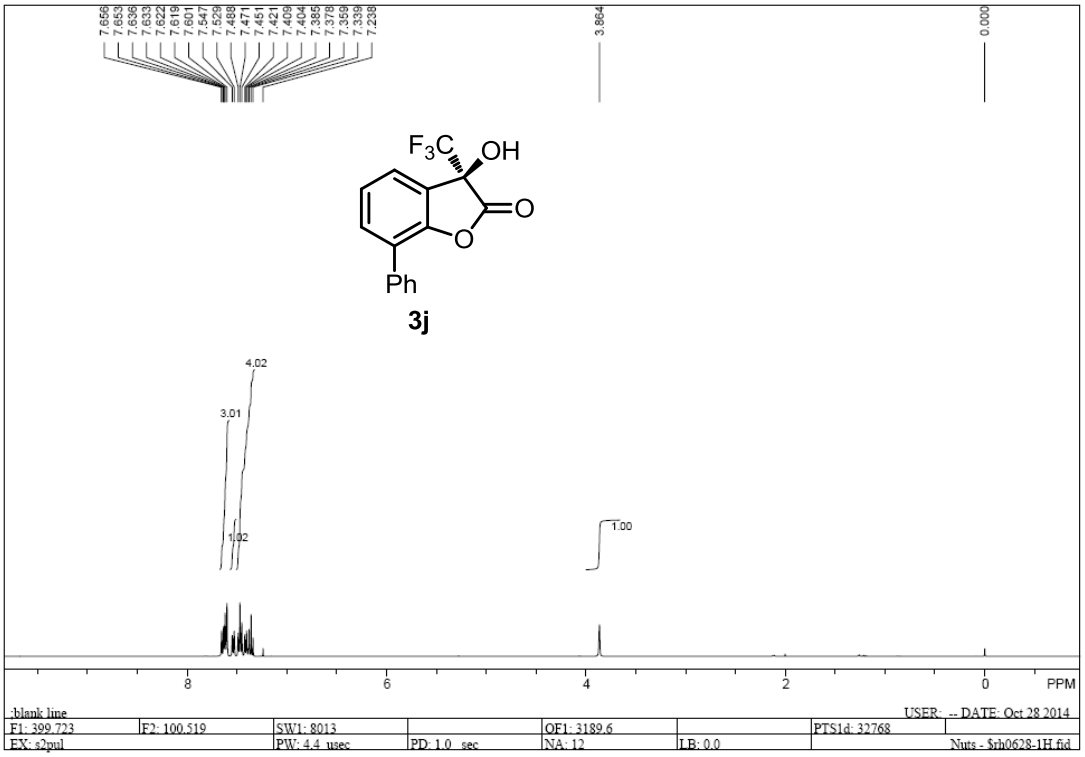
PW: 7.0 usec
PD: 3.0 sec
NA: 8
LB: 0.0
Nuts - $rh0633-1F.fid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7.622
7.619
7.601
7.547
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7.488
7.471
7.451
7.421
7.409
7.404
7.385
7.378
7.359
7.339
7.238
3.864
0.000
F3C
OH
O
O
Ph
3j
4.02
3.01
1.02
1.00
8
6
4
2
0
PPM
:blank line
USER: -- DATE: Oct 28 2014
F1: 399.723
F2: 100.519
SW1: 8013
OF1: 3189.6
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
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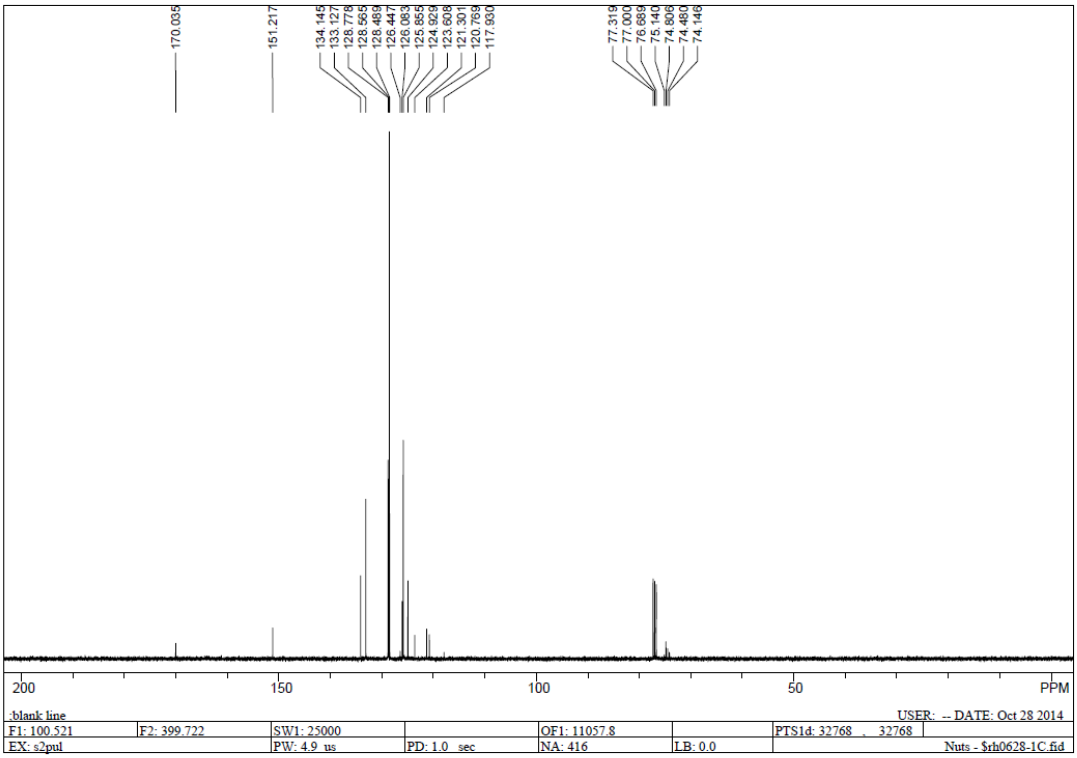
LB: 0.0
Nuts - $rh0628-1H.fid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134.145
133.127
128.778
128.565
128.489
126.447
126.063
125.855
124.929
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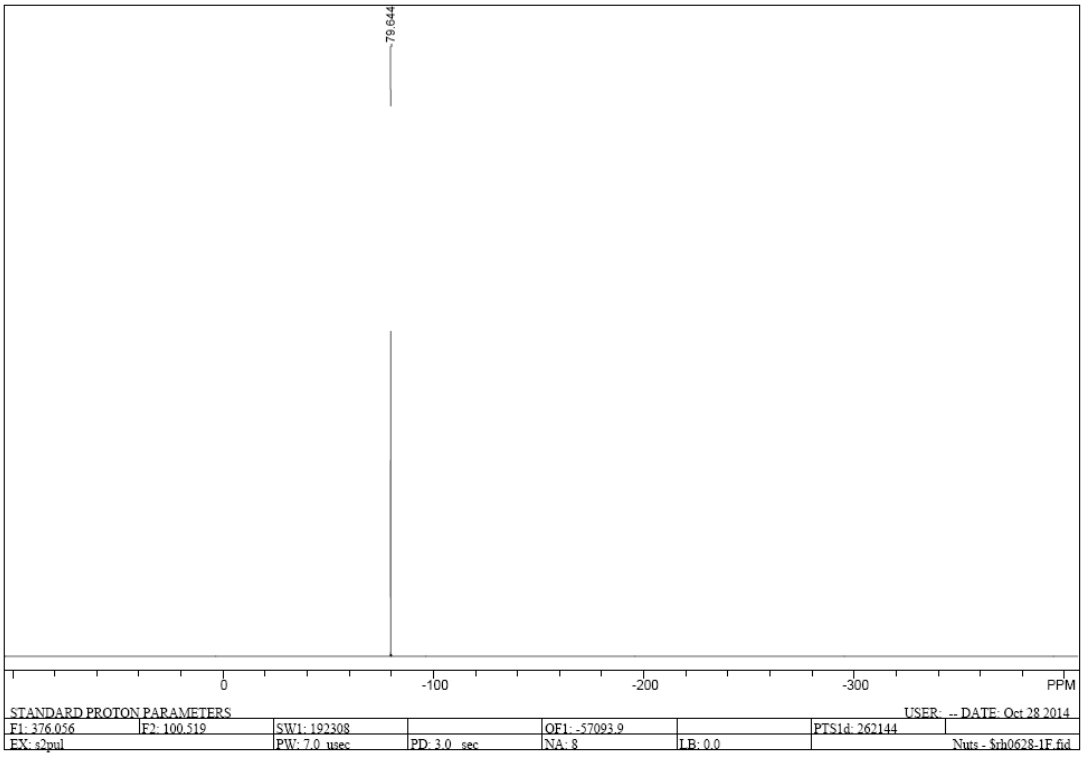
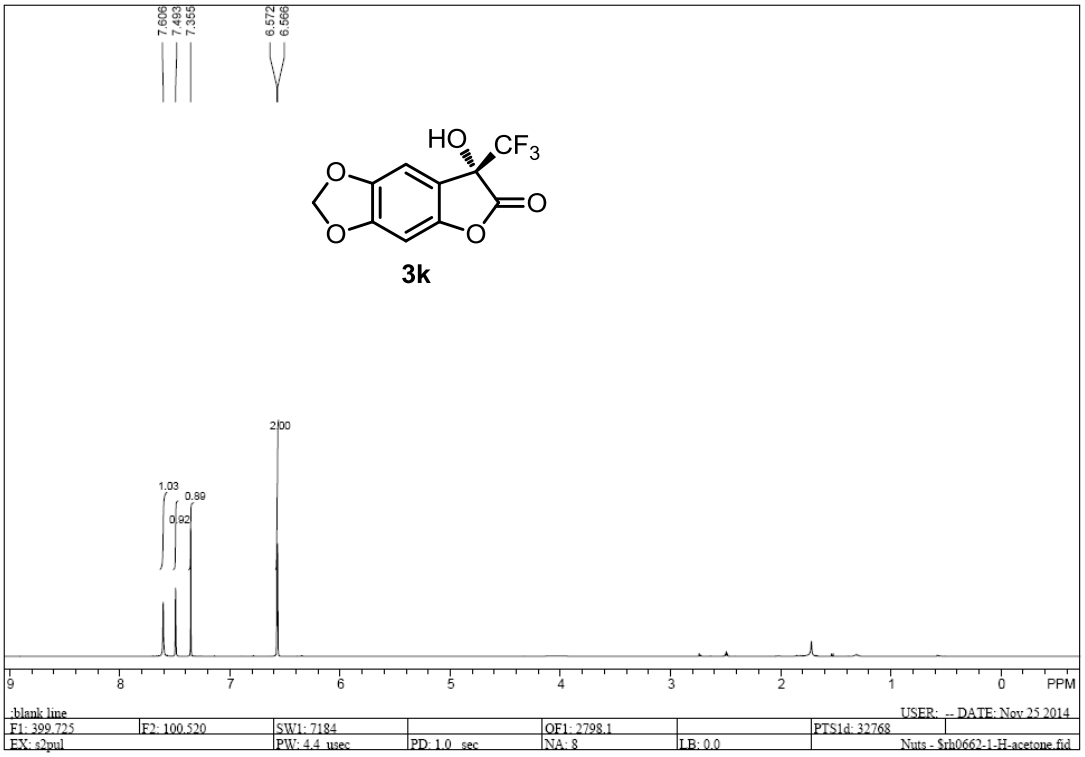
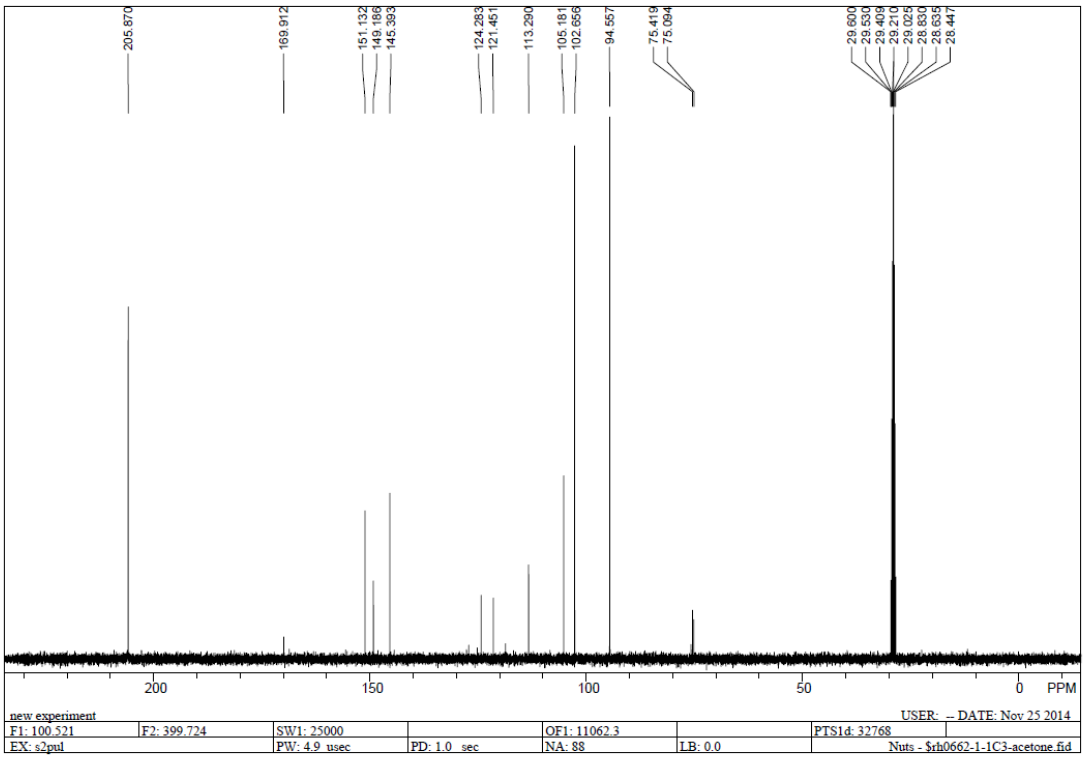
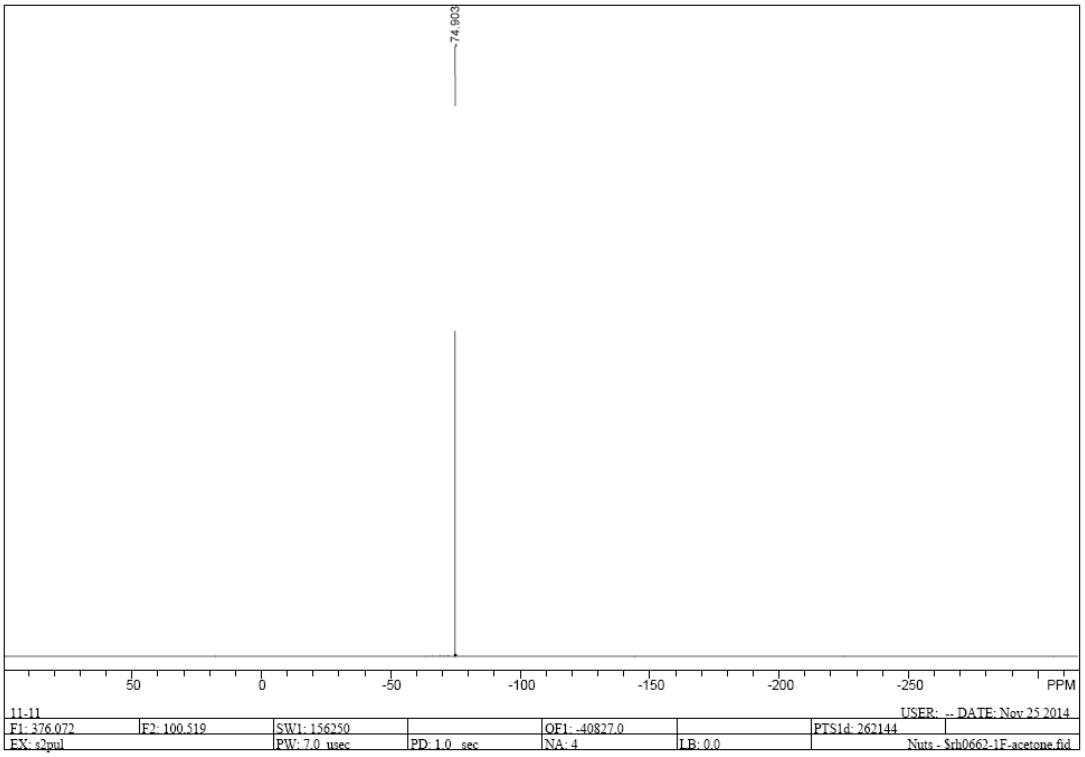
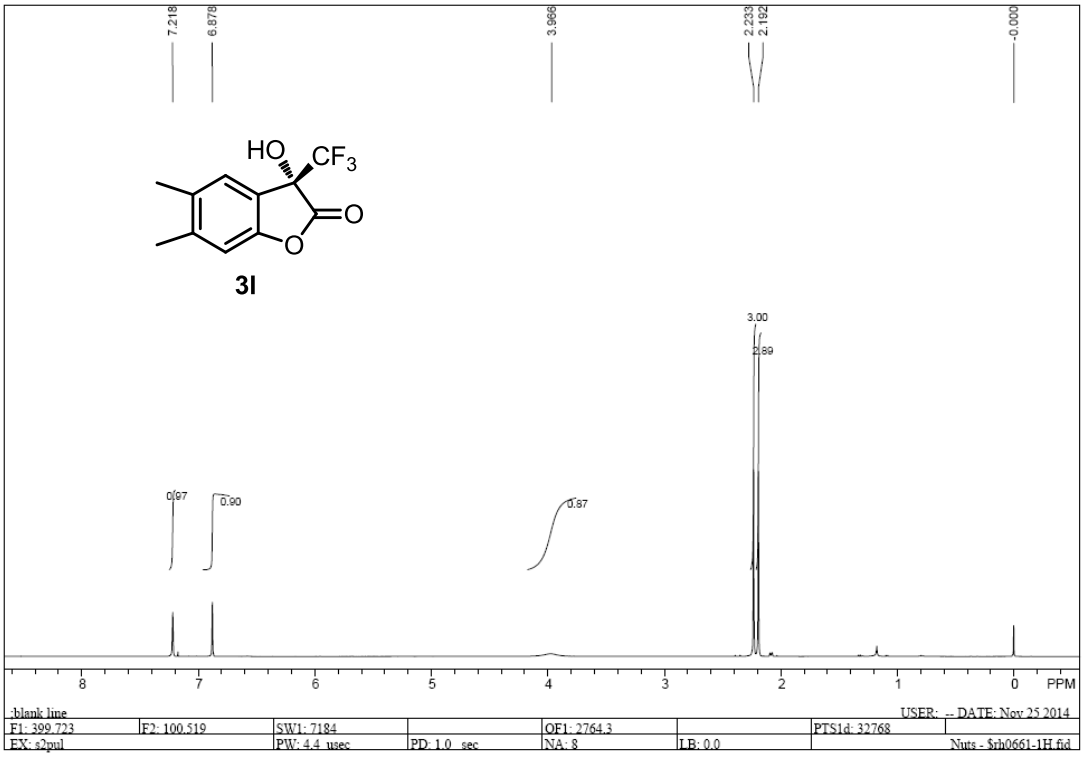
121.301
120.769
117.930
77.319
77.000
76.689
75.140
74.806
74.480
74.146
200
150
100
50
PPM
:blank line
USER: -- DATE: Oct 28 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11057.8
PTS1d: 32768 , 32768
EX: s2pul
PW: 4.9 us
PD: 1.0 sec
NA: 416
LB: 0.0
Nuts - $rh0628-1C.fid

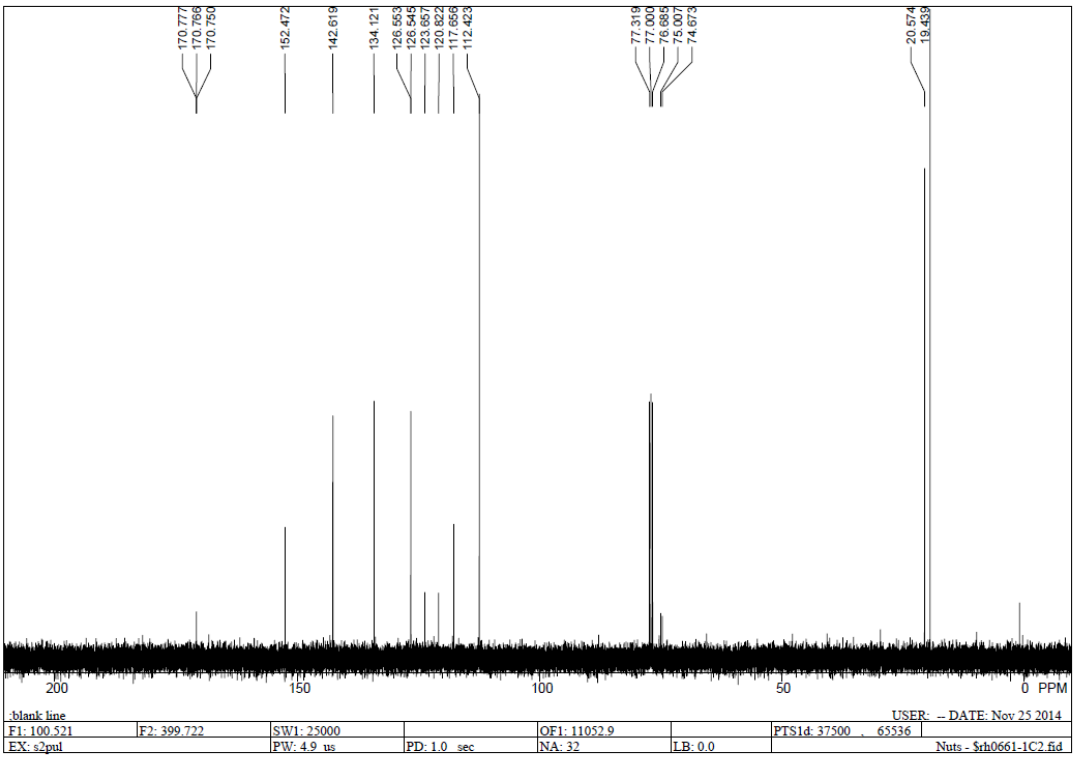

79.644
0
-100
-200
-300
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Oct 28 2014
F1: 376.056
F2: 100.519
SW1: 192308
OF1: -57093.9
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 3.0 sec
NA: 8
LB: 0.0
Nuts - $rh0628-1F.fid

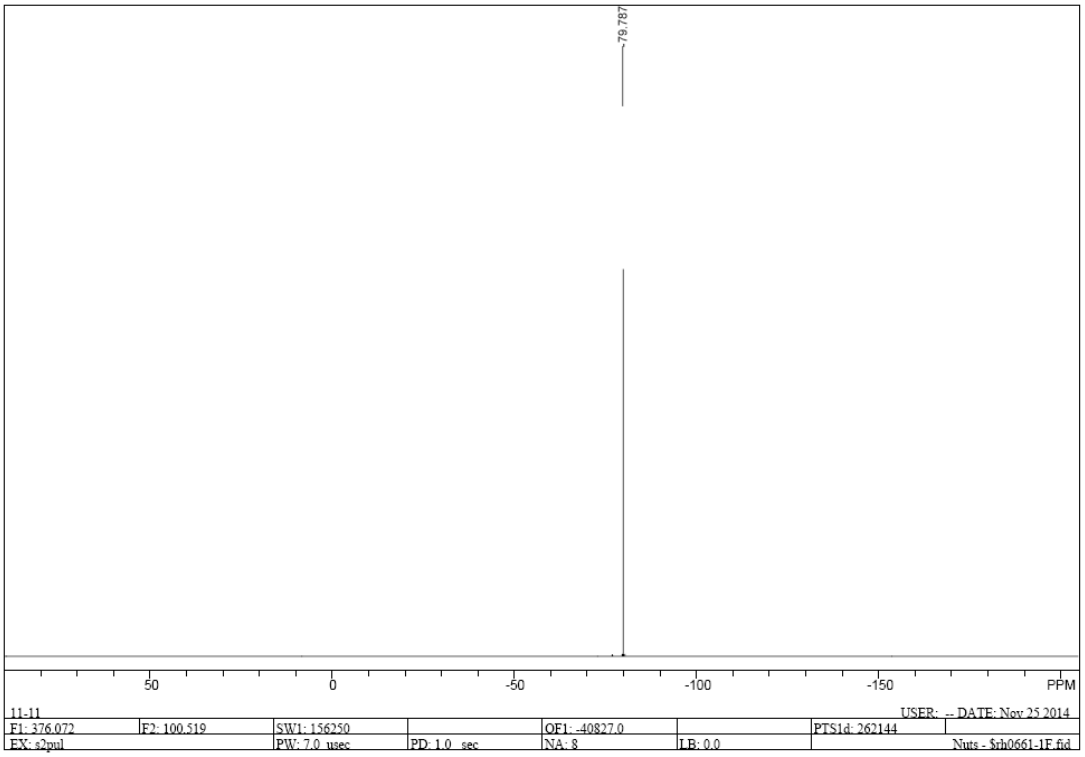

7.606
7.493
7.355
6.572
6.566
HO
CF3
O
O
O
O
O
3k
2.00
1.03
0.92
0.89
9
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Nov 25 2014
F1: 399.725
F2: 100.520
SW1: 7184
OF1: 2798.1
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0662-1-H-acetone.fid

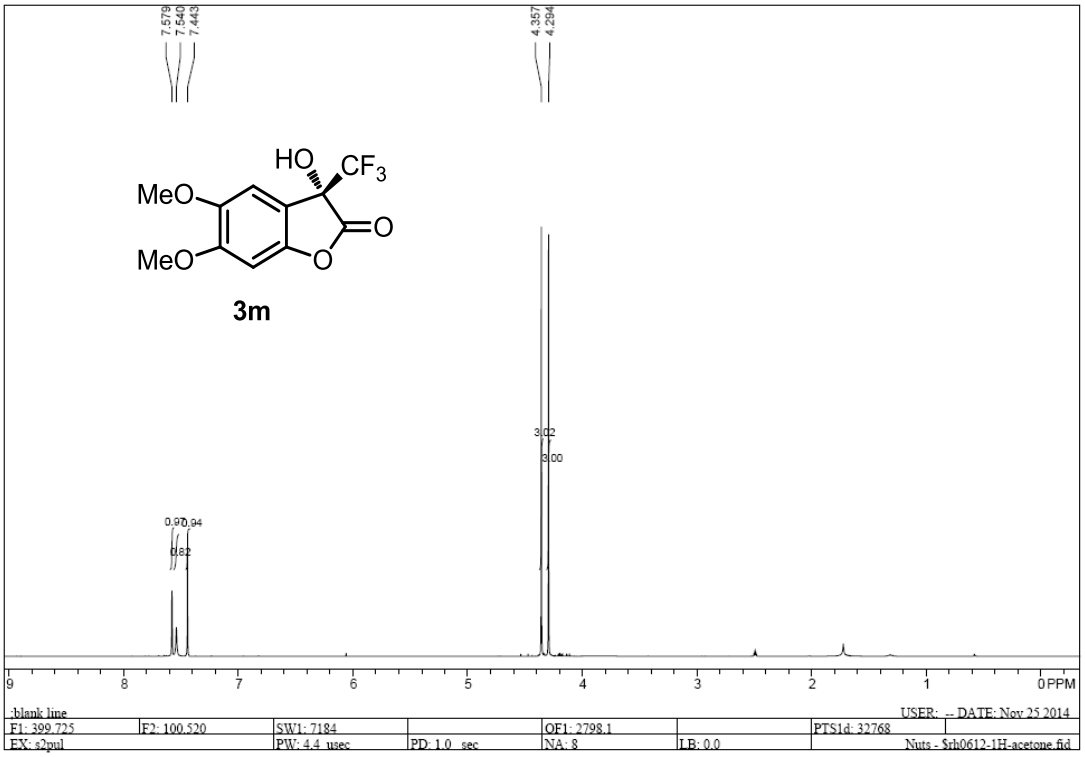

205.870
169.912
151.132
149.186
145.393
124.283
121.451
113.290
105.181
102.656
94.557
75.419
75.094
29.600
29.530
29.409
29.210
29.025
28.830
28.635
28.447
200
150
100
50
0
PPM
new experiment
USER: -- DATE: Nov 25 2014
F1: 100.521
F2: 399.724
SW1: 25000
OF1: 11062.3
PTS1d: 32768
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 88
LB: 0.0
Nuts - $rh0662-1-1C3-acetone.fid

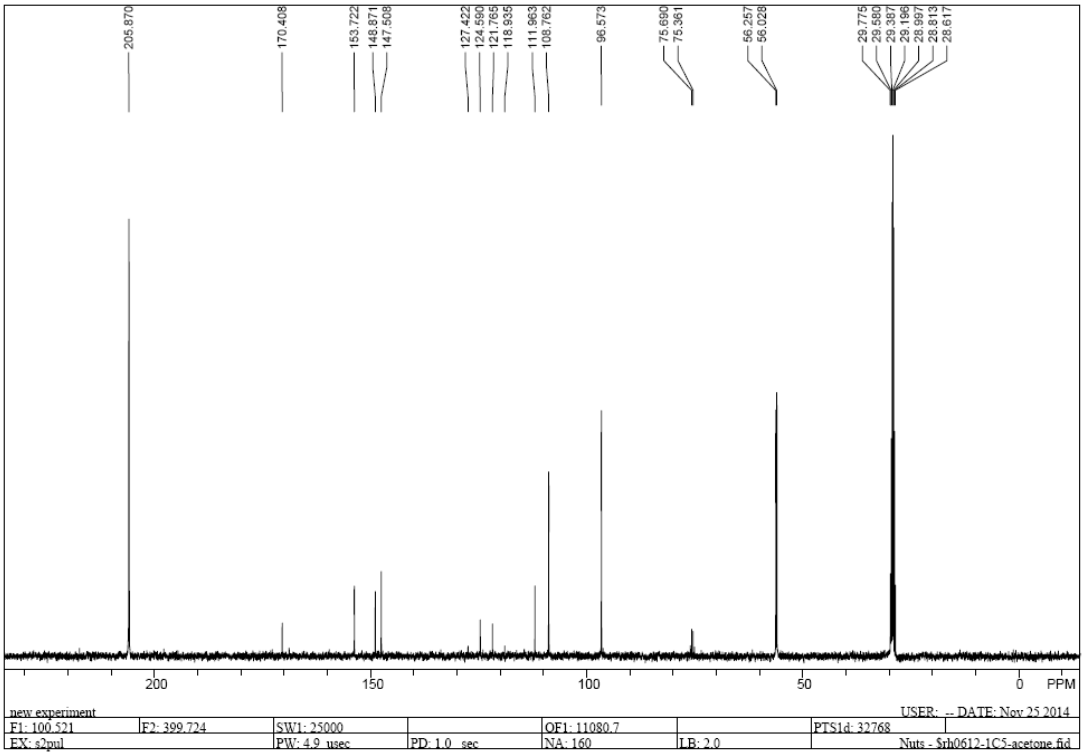

74.903
50
0
-50
-100
-150
-200
-250
PPM
11-11
USER: -- DATE: Nov 25 2014
F1: 376.072
F2: 100.519
SW1: 156250
OF1: -40827.0
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 4
LB: 0.0
Nuts - $rh0662-1F-acetone.fid

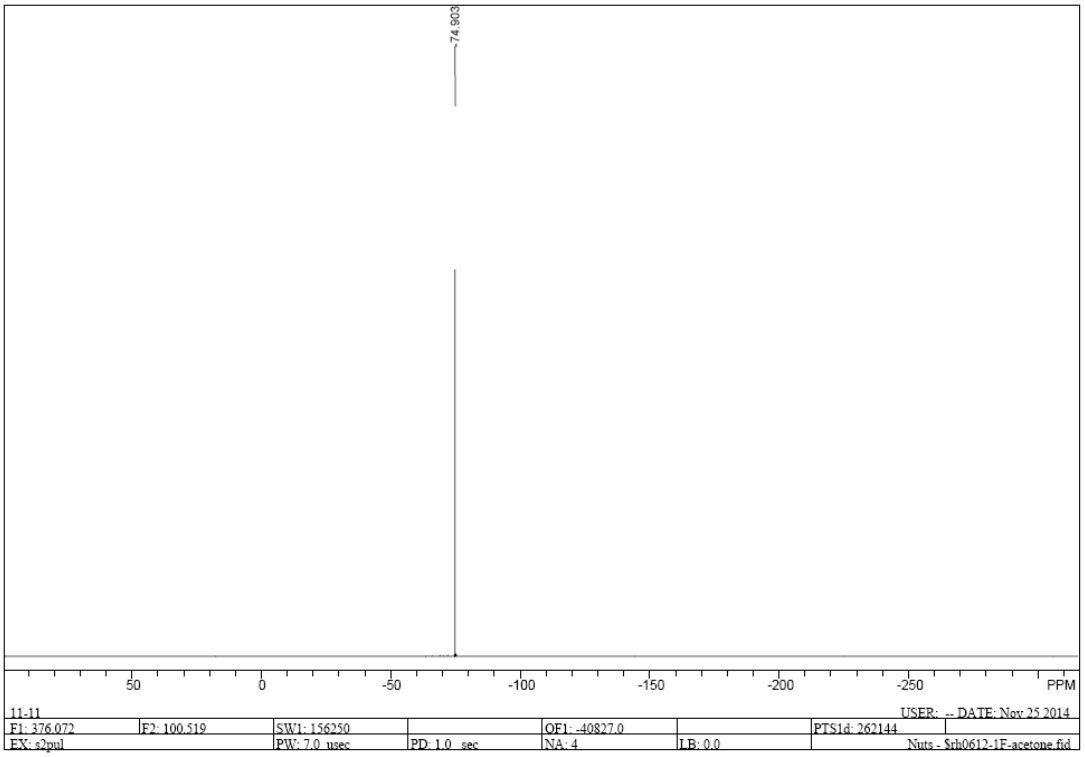

7.218
6.879
3.966
2.233
2.192
-0.000
HO
CF3
O
O
3l
3.00
2.89
0.97
0.90
0.87
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Nov 25 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2764.3
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0661-1H.fid

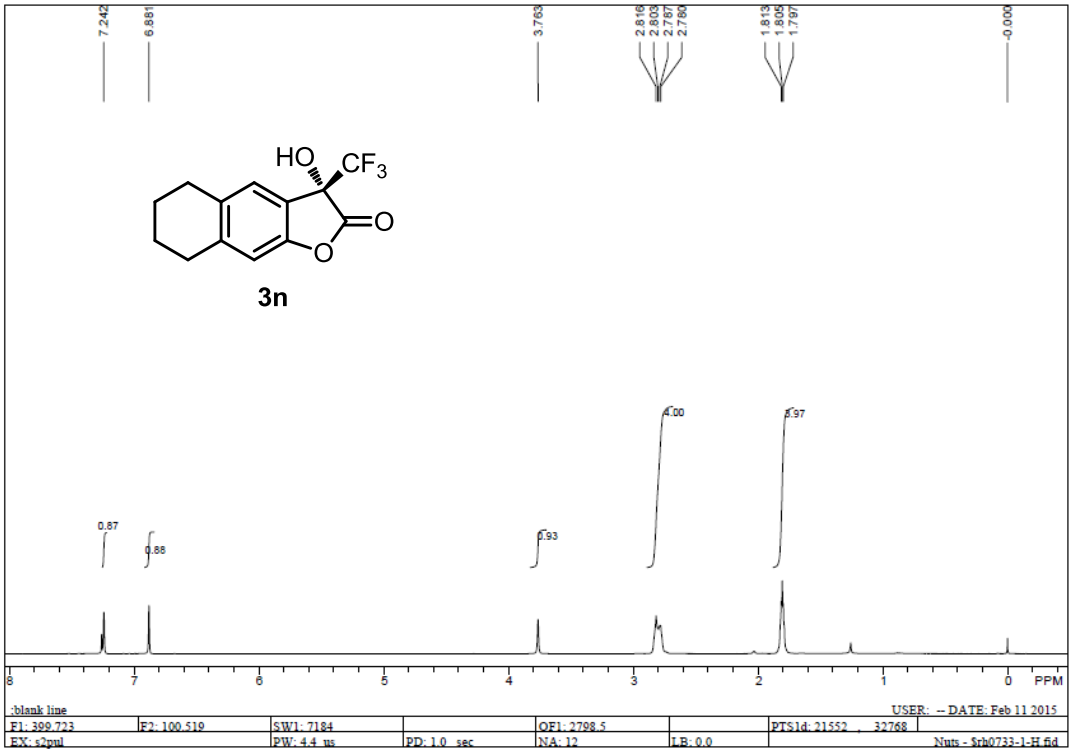

170.777
170.766
170.750
152.472
142.619
134.121
126.553
126.545
123.657
120.822
117.656
112.423
77.319
77.000
76.685
75.007
74.673
20.574
19.439
200
150
100
50
0 PPM
:blank line
USER: -- DATE: Nov 25 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11052.9
PTS1d: 37500 , 65536
EX: s2pul
PW: 4.9 us
PD: 1.0 sec
NA: 32
LB: 0.0
Nuts - $rh0661-1C2.fid

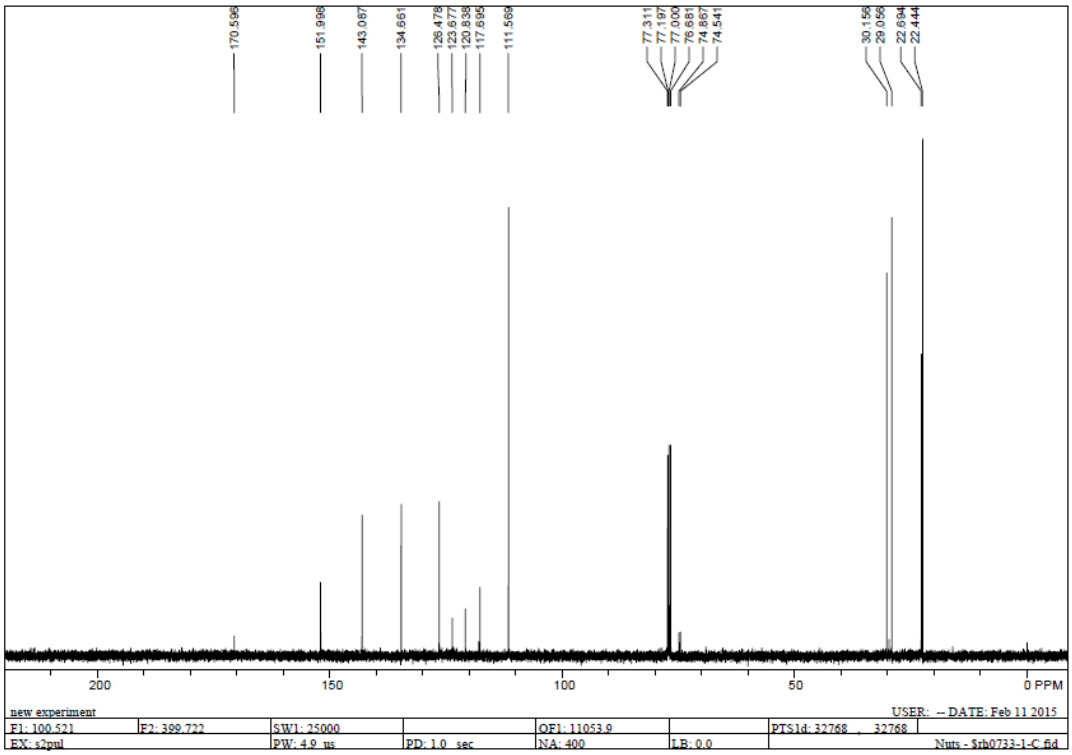

79.787
50
0
-50
-100
-150
PPM
11-11
USER: -- DATE: Nov 25 2014
F1: 376.072
F2: 100.519
SW1: 156250
OF1: -40827.0
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0661-1F.fid

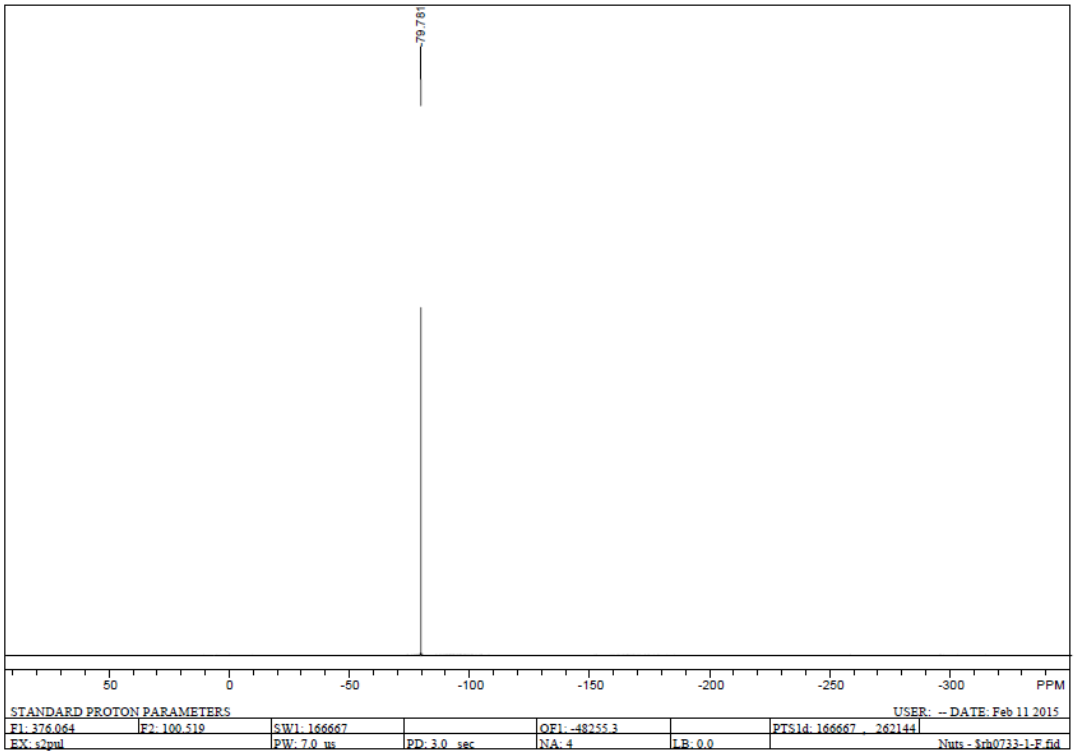

7.579
7.540
7.443
4.357
4.294
HO
CF3
MeO
MeO
O
O
3m
3.02
3.00
0.97
0.94
0.82
9
8
7
6
5
4
3
2
1
0 PPM
:blank line
USER: -- DATE: Nov 25 2014
F1: 399.725
F2: 100.520
SW1: 7184
OF1: 2798.1
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0612-1H-acetone.fid

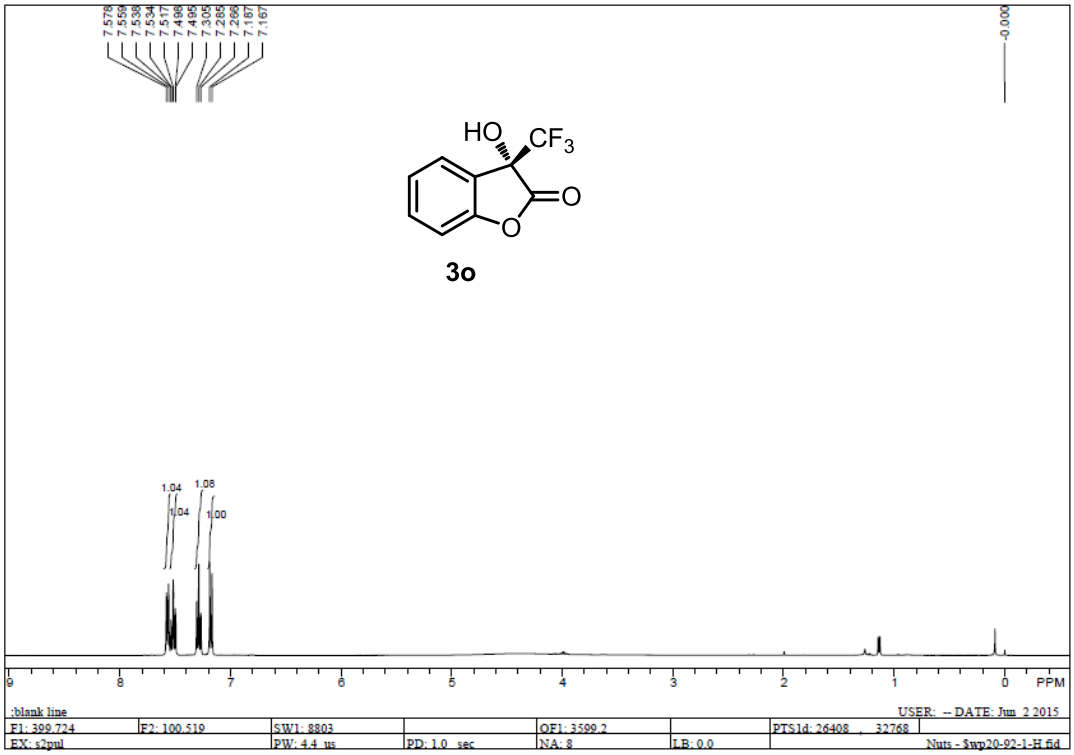

205.870
170.408
153.722
148.871
147.508
127.422
124.560
121.765
118.935
111.963
108.762
96.573
75.690
75.361
56.257
56.028
29.775
29.580
29.387
29.196
28.997
28.813
28.617
200
150
100
50
0 PPM
new experiment
USER: -- DATE: Nov 25 2014
F1: 100.521
F2: 399.724
SW1: 25000
OF1: 11080.7
PTS1d: 32768
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 160
LB: 2.0
Nuts - $rh0612-1C5-acetone.fid

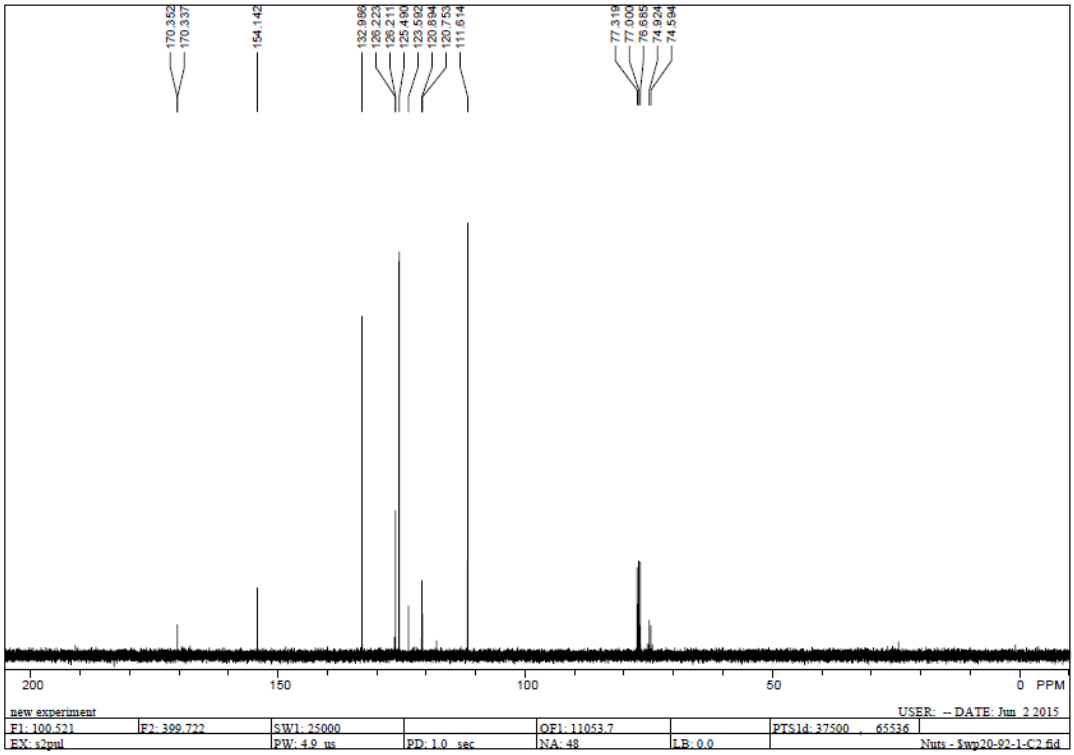

74.903
50
0
-50
-100
-150
-200
-250
PPM
11-11
USER: -- DATE: Nov 25 2014
F1: 376.072
F2: 100.519
SW1: 156250
OF1: -40827.0
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 4
LB: 0.0
Nuts - $rh0612-1F-acetone.fid

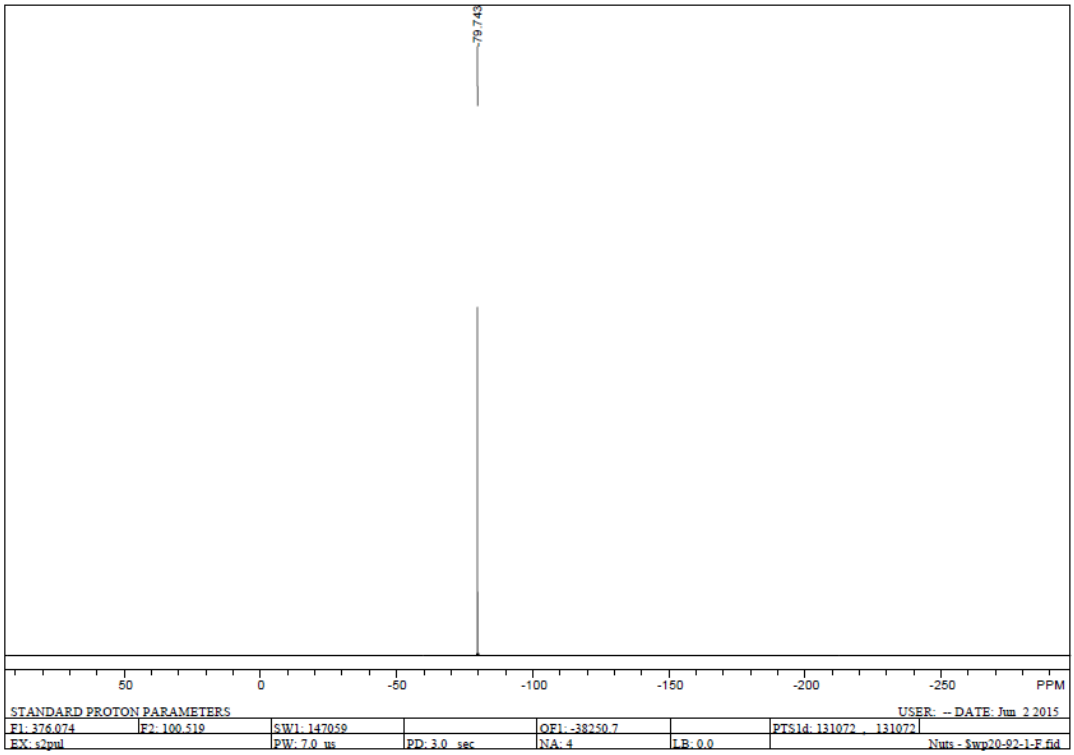

HO
CF3
O
O
3n
7.242
6.881
3.763
2.816
2.803
2.787
2.780
1.813
1.805
1.797
-0.000
4.00
3.97
0.87
0.88
0.93
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Feb 11 2015
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2798.5
PTS1d: 21552 , 32768
EX: s2pul
PW: 4.4 us
PD: 1.0 sec
NA: 12
LB: 0.0
Nuts - $rh0733-1-H.fid

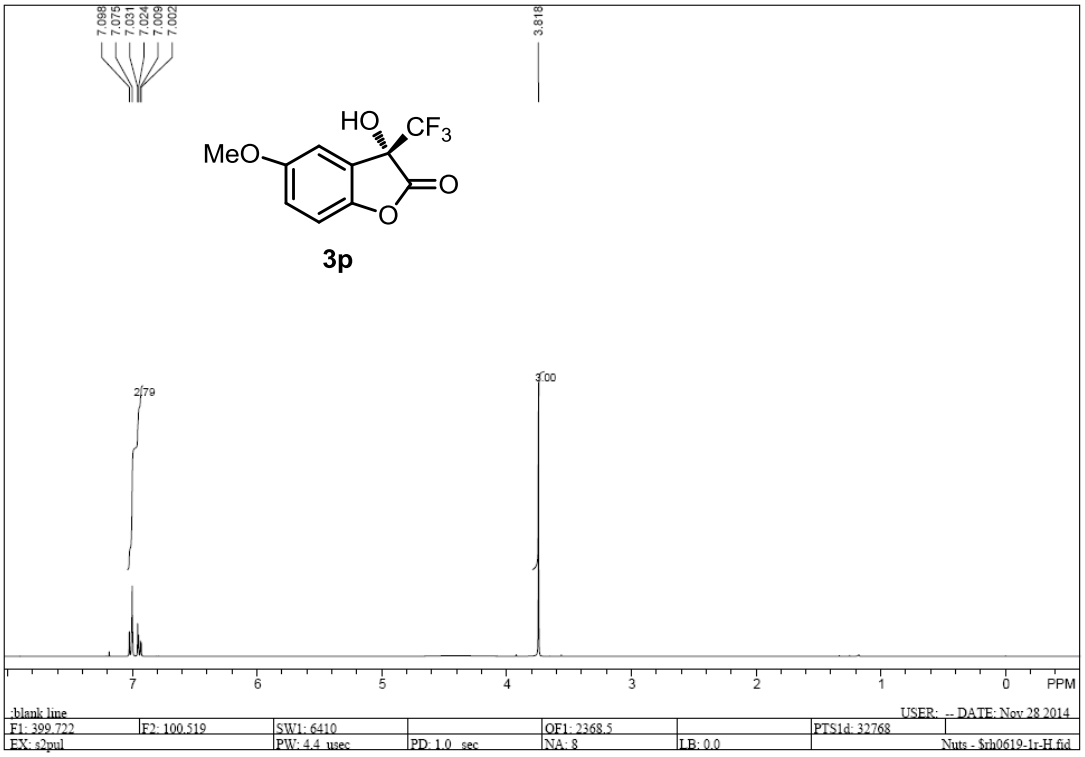

170.596
151.998
143.087
134.661
126.478
123.677
120.838
117.695
111.569
77.311
77.197
77.000
76.681
74.867
74.541
30.158
29.056
22.694
22.444
200
150
100
50
0 PPM
new experiment
USER: -- DATE: Feb 11 2015
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11053.9
PTS1d: 32768 , 32768
EX: s2pul
PW: 4.9 us
PD: 1.0 sec
NA: 400
LB: 0.0
Nuts - $rh0733-1-C.fid

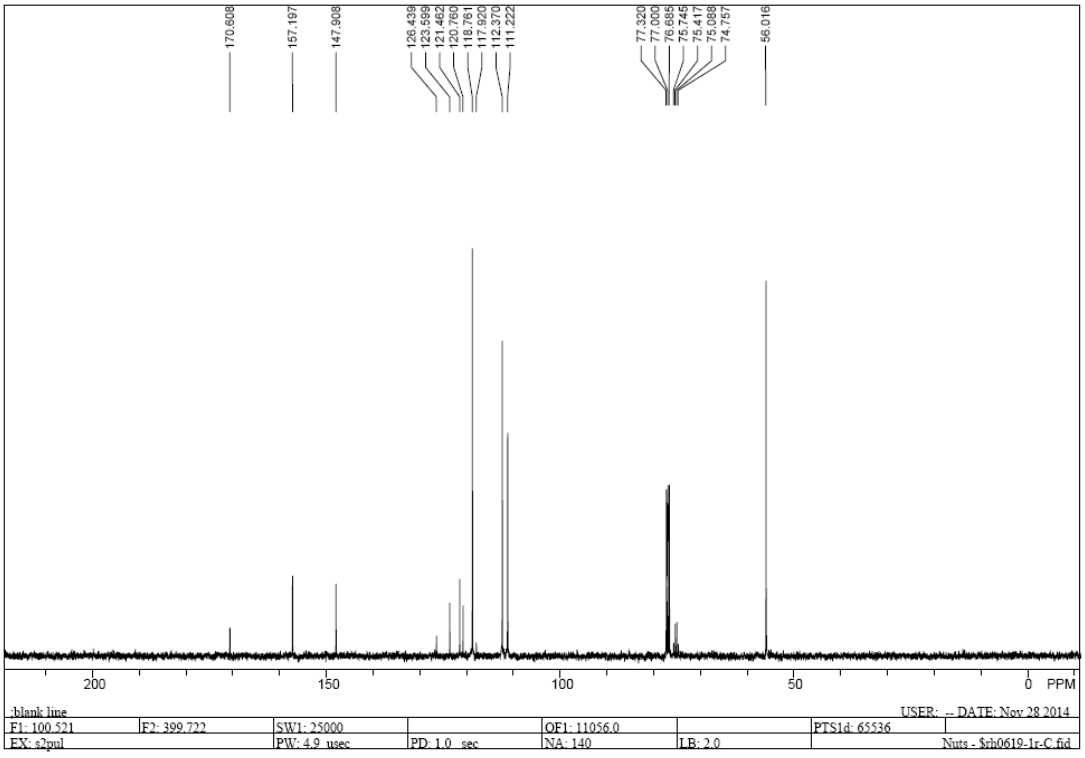

-79.781
50
0
-50
-100
-150
-200
-250
-300
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Feb 11 2015
F1: 376.064
F2: 100.519
SW1: 166667
OF1: -48255.3
PTS1d: 166667 , 262144
EX: s2pul
PW: 7.0 us
PD: 3.0 sec
NA: 4
LB: 0.0
Nuts - $rh0733-1-F.fid

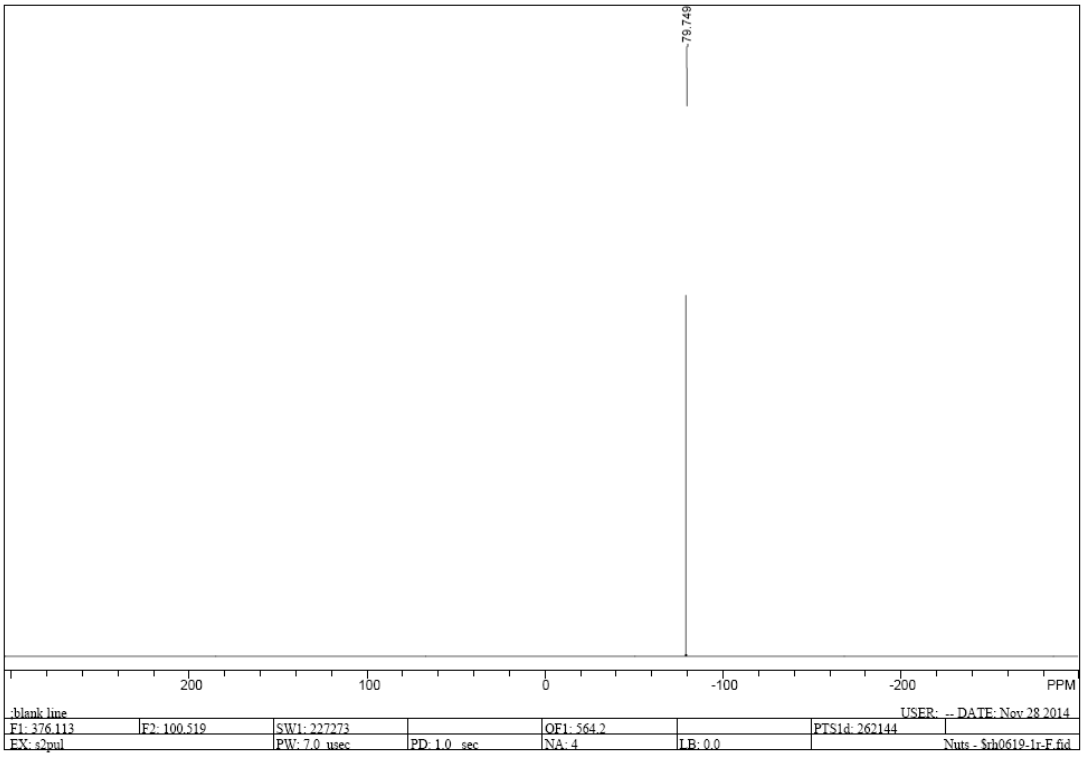

7.578
7.559
7.538
7.534
7.517
7.498
7.495
7.305
7.285
7.266
7.167
7.167
-0.000
HO
CF3
O
O
3o
1.04
1.04
1.08
1.00
9
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Jun 2 2015
F1: 399.724
F2: 100.519
SW1: 8803
OF1: 3599.2
PTS1d: 26408 , 32768
EX: s2pul
PW: 4.4 us
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $wp20-92-1-H.fid

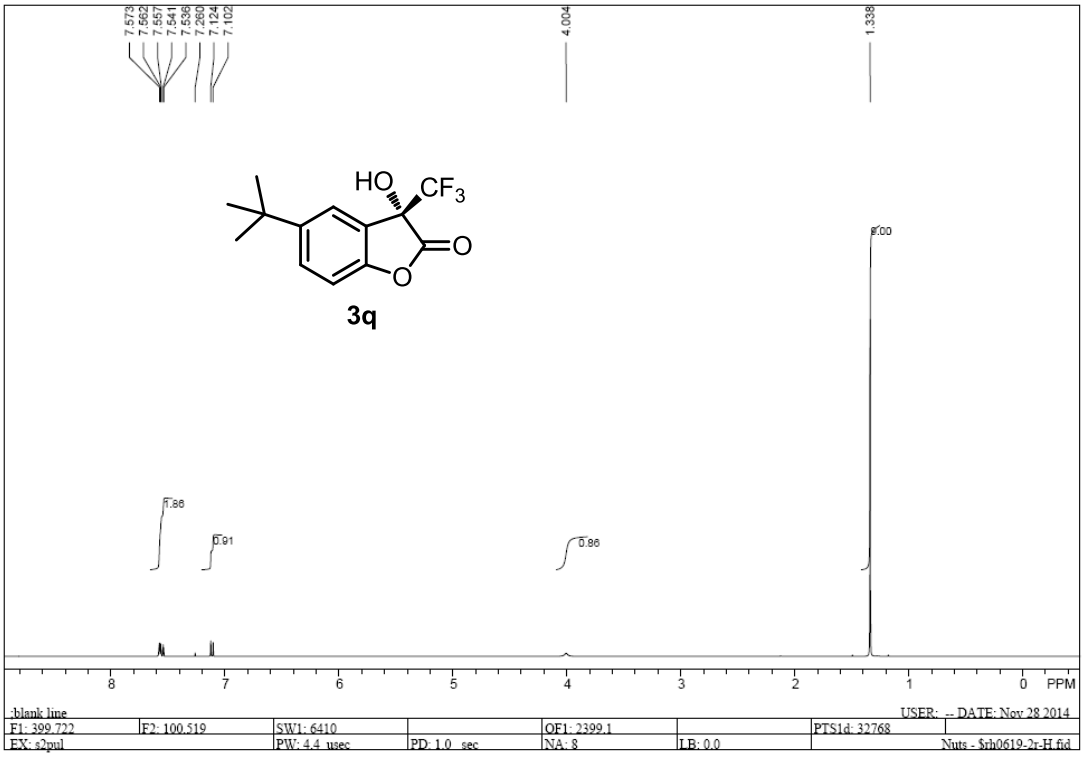

170.352
170.337
154.142
132.986
126.223
126.211
125.480
123.592
120.984
120.753
111.614
77.319
77.000
76.685
74.924
74.594
200
150
100
50
0
PPM
new experiment
USER: -- DATE: Jun 2 2015
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11053.7
PTS1d: 37500 , 65536
EX: s2pul
PW: 4.9 us
PD: 1.0 sec
NA: 48
LB: 0.0
Nuts - $wp20-92-1-C2.fid

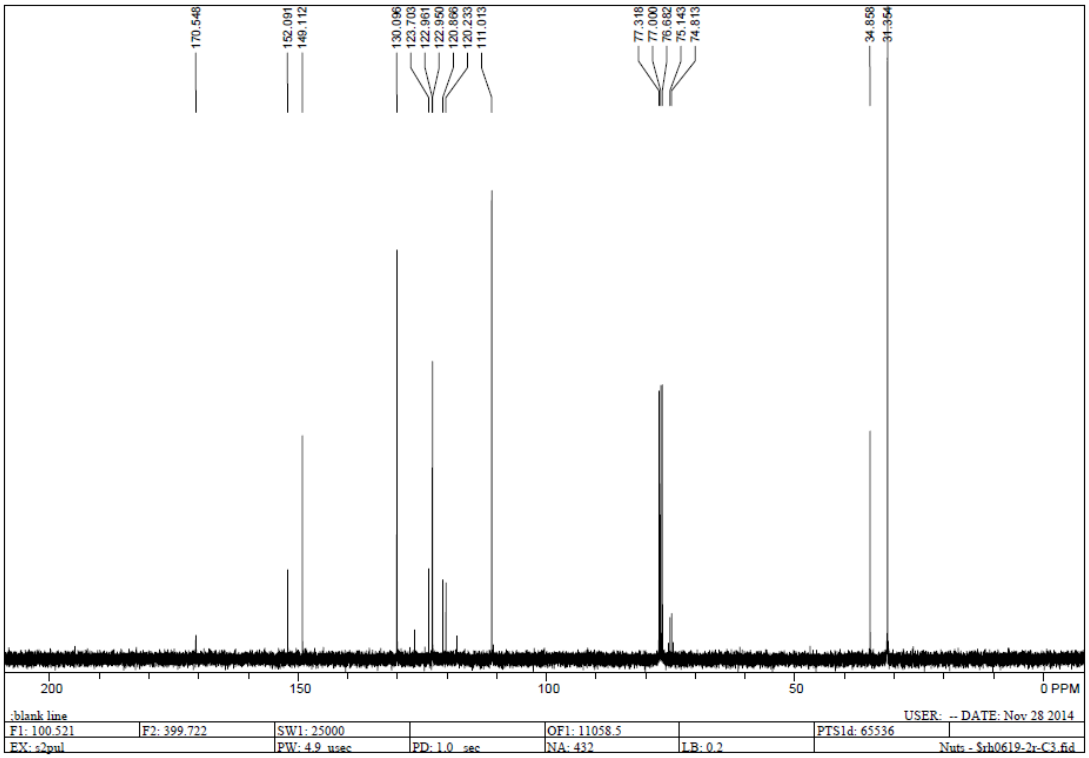

-79.743
50
0
-50
-100
-150
-200
-250
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Jun 2 2015
F1: 376.074
F2: 100.519
SW1: 147059
OF1: -38250.7
PTS1d: 131072 , 131072
EX: s2pul
PW: 7.0 us
PD: 3.0 sec
NA: 4
LB: 0.0
Nuts - $wp20-92-1-F.fid

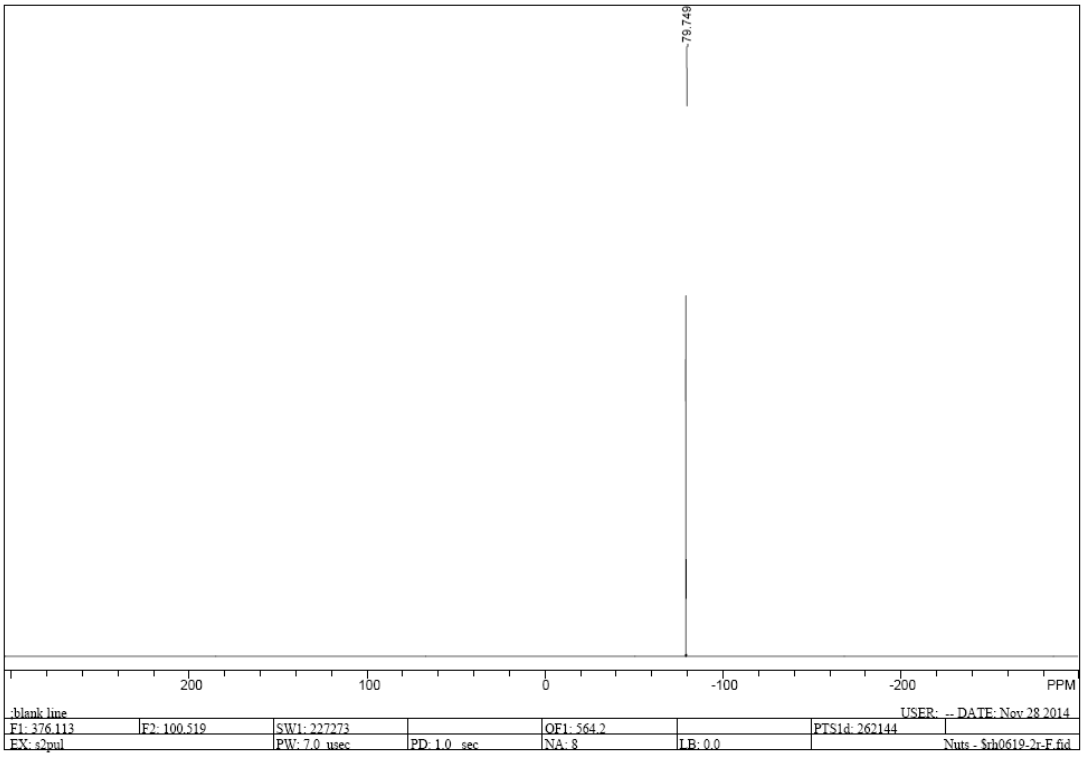

7.098
7.075
7.051
7.024
7.009
7.002
3.818
HO
CF3
MeO
O
O
3p
2.79
3.00
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Nov 28 2014
F1: 399.722
F2: 100.519
SW1: 6410
OF1: 2368.5
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0619-1r-H.fid

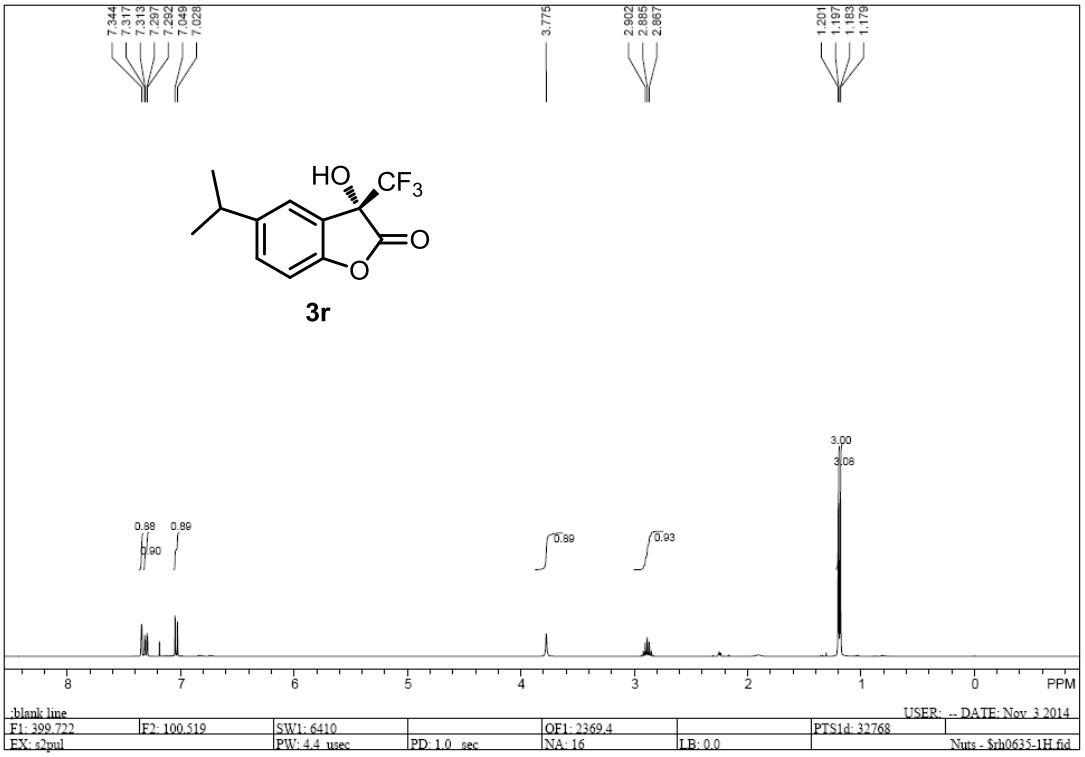

170.608
157.197
147.908
126.439
123.599
121.462
120.760
118.761
117.920
112.370
111.222
77.320
77.000
76.685
75.745
75.417
75.088
74.757
56.016
200
150
100
50
0
PPM
:blank line
USER: -- DATE: Nov 28 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11056.0
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 140
LB: 2.0
Nuts - $rh0619-1r-C.fid

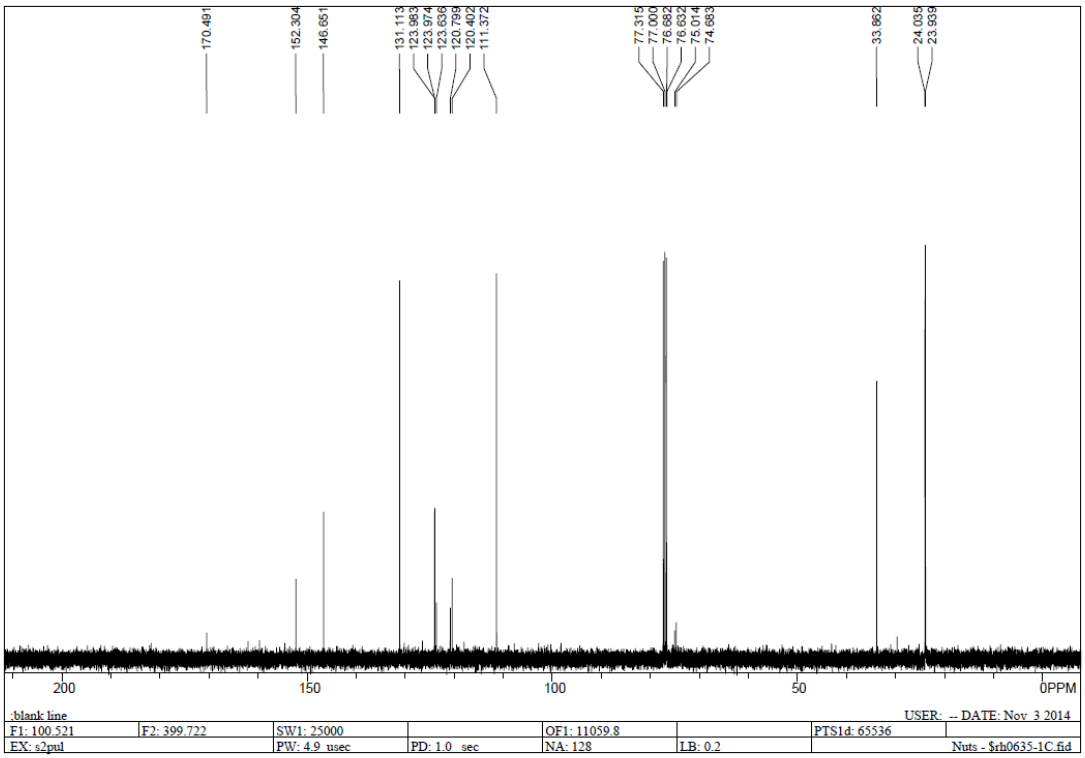

79.749
200
100
0
-100
-200
PPM
:blank line
USER: -- DATE: Nov 28 2014
F1: 376.113
F2: 100.519
SW1: 227273
OF1: 564.2
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 4
LB: 0.0
Nuts - $rh0619-1r-F.fid

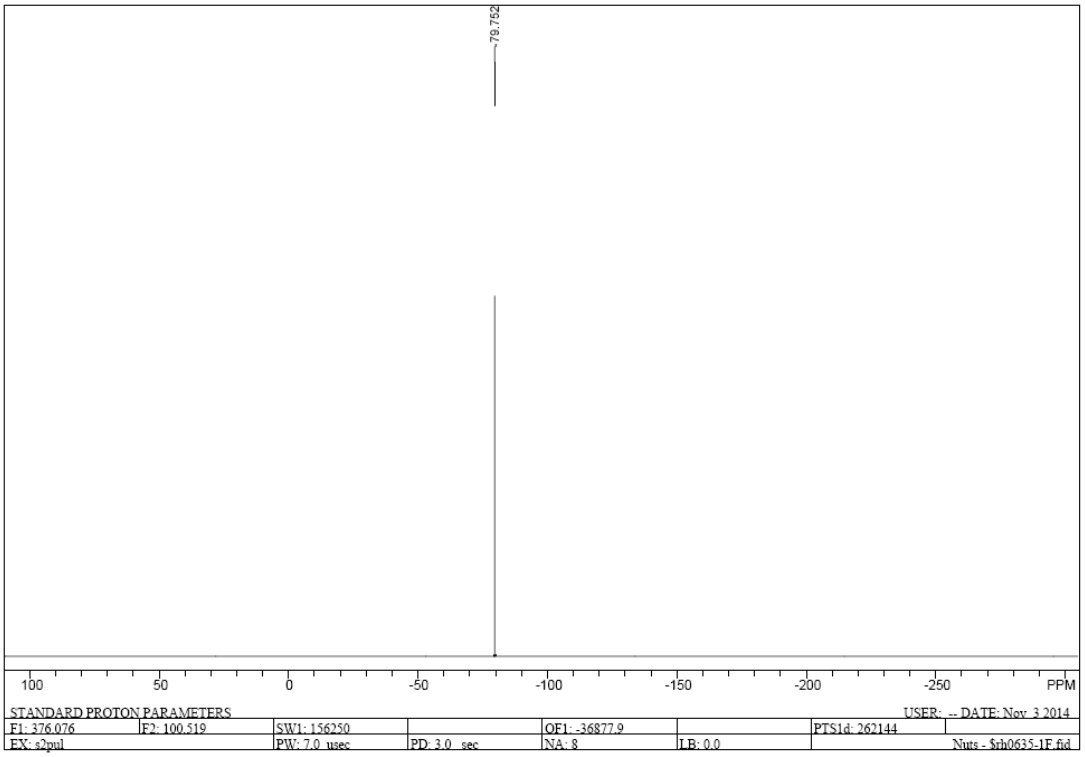

7.573
7.562
7.557
7.541
7.538
7.260
7.124
7.102
4.004
1.338
HO
CF3
O
O
3q
9.00
1.86
0.91
0.96
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Nov 28 2014
F1: 399.722
F2: 100.519
SW1: 6410
OF1: 2399.1
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0619-2r-H.fid

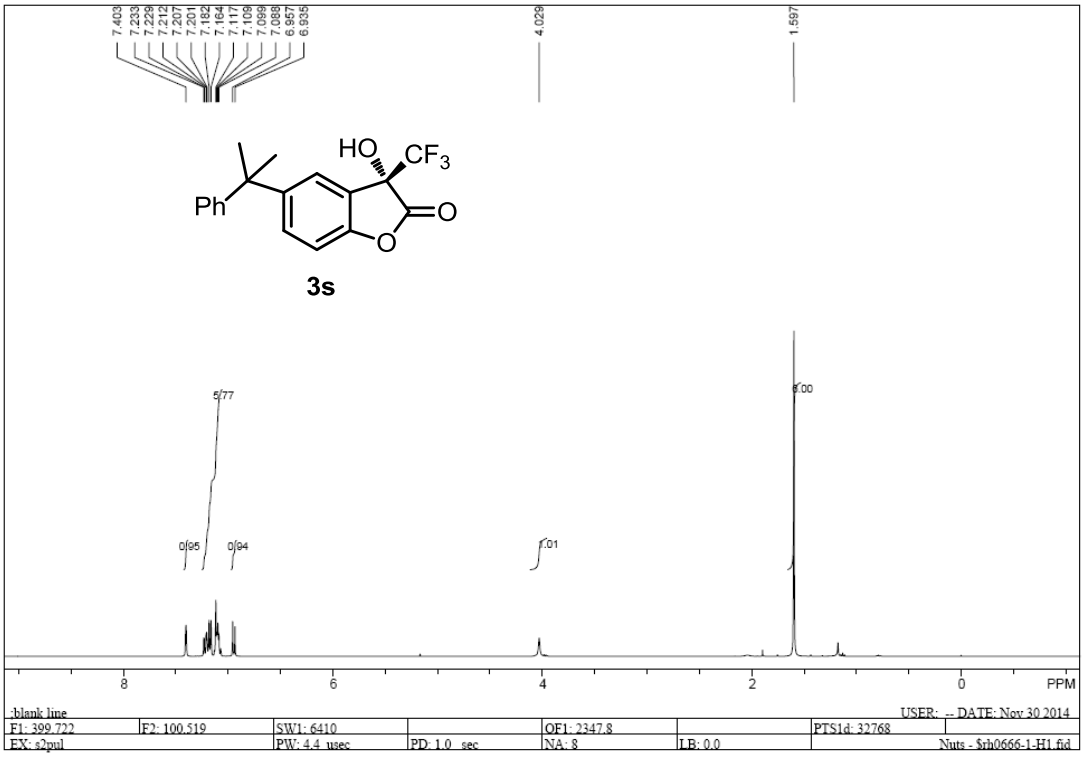

170.548
152.091
149.112
130.096
123.703
122.961
122.950
120.866
120.233
111.013
77.318
77.000
76.682
75.143
74.813
34.858
31.954
200
150
100
50
0 PPM
:blank line
USER: -- DATE: Nov 28 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11058.5
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 432
LB: 0.2
Nuts - $rh0619-2r-C3.fid

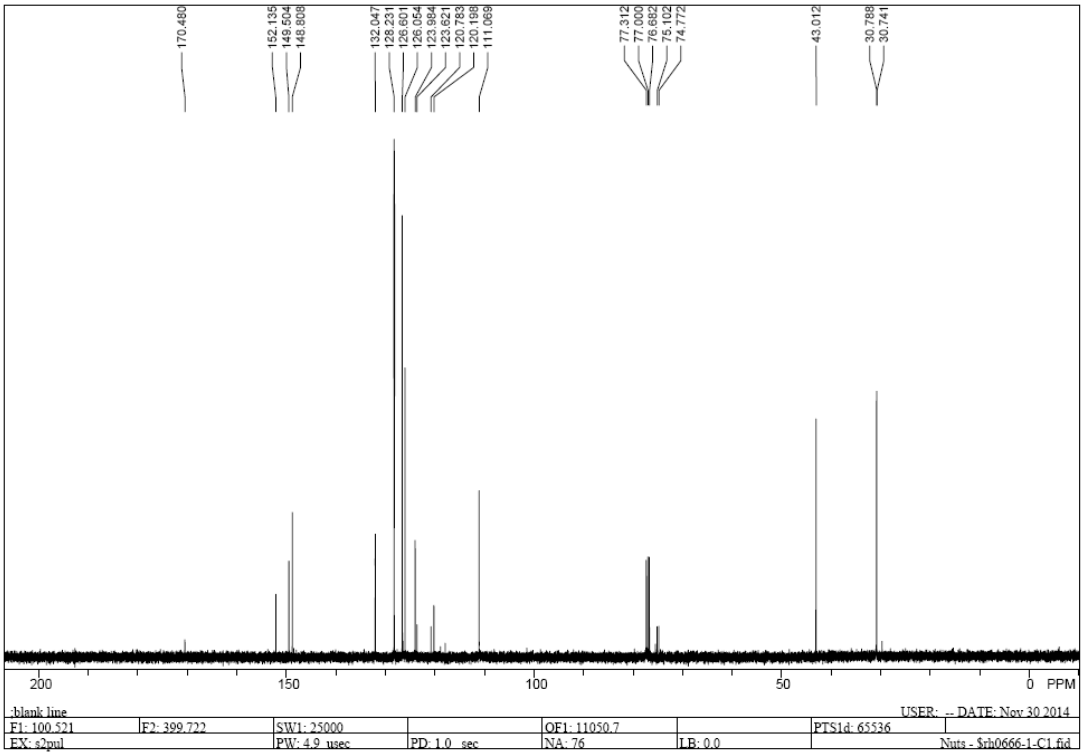

79.749
200
100
0
-100
-200
PPM
:blank line
USER: -- DATE: Nov 28 2014
F1: 376.113
F2: 100.519
SW1: 227273
OF1: 564.2
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0619-2r-F.fid

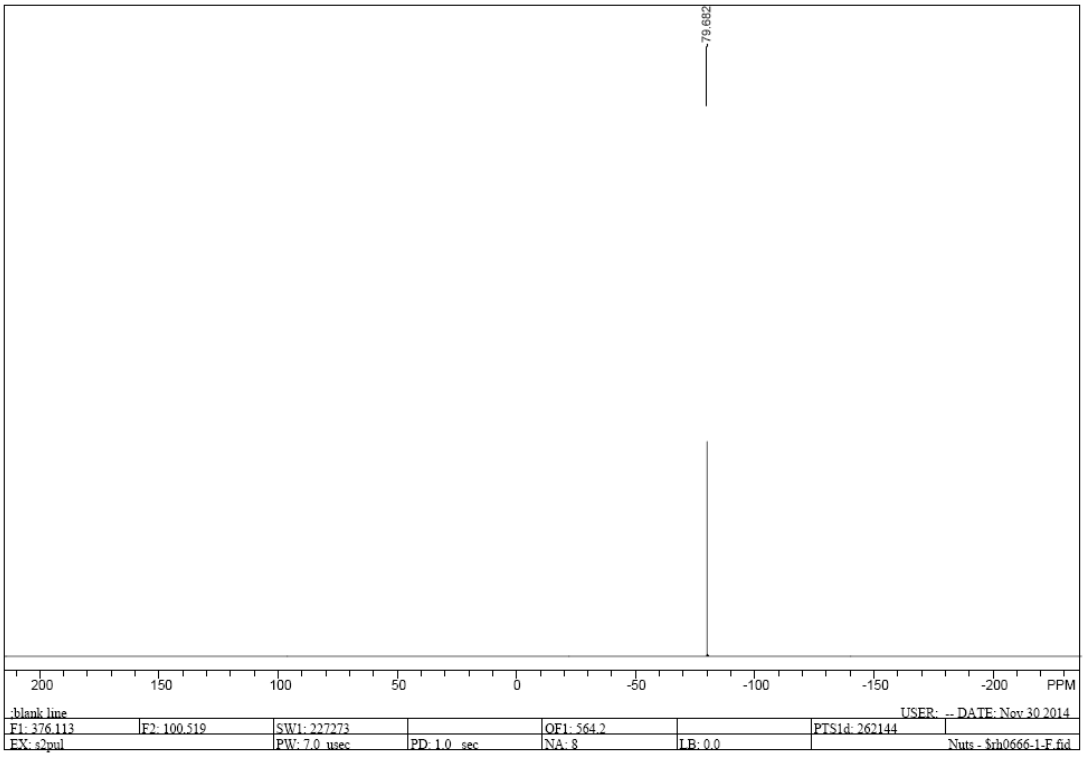

7.344
7.317
7.313
7.297
7.292
7.049
7.028
3.775
2.902
2.885
2.867
1.201
1.197
1.183
1.179
HO
CF3
O
O
3r
3.00
3.08
0.88
0.90
0.89
0.89
0.93
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Nov 3 2014
F1: 399.722
F2: 100.519
SW1: 6410
OF1: 2369.4
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 16
LB: 0.0
Nuts - $rh0635-1H.fid

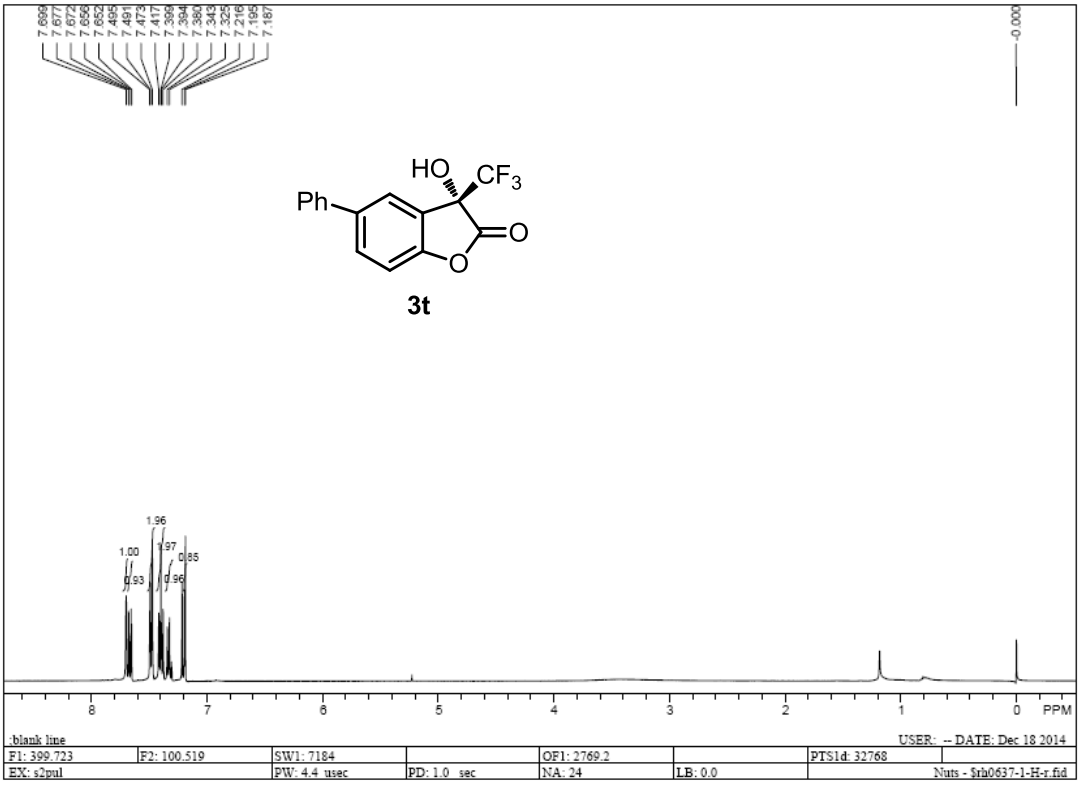

170.491
152.304
146.651
131.113
123.983
123.974
123.636
120.799
120.402
111.372
77.315
77.000
76.682
76.632
75.014
74.683
33.862
24.035
23.939
200
150
100
50
0PPM
:blank line
USER: -- DATE: Nov 3 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11059.8
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 128
LB: 0.2
Nuts - $rh0635-1C.fid

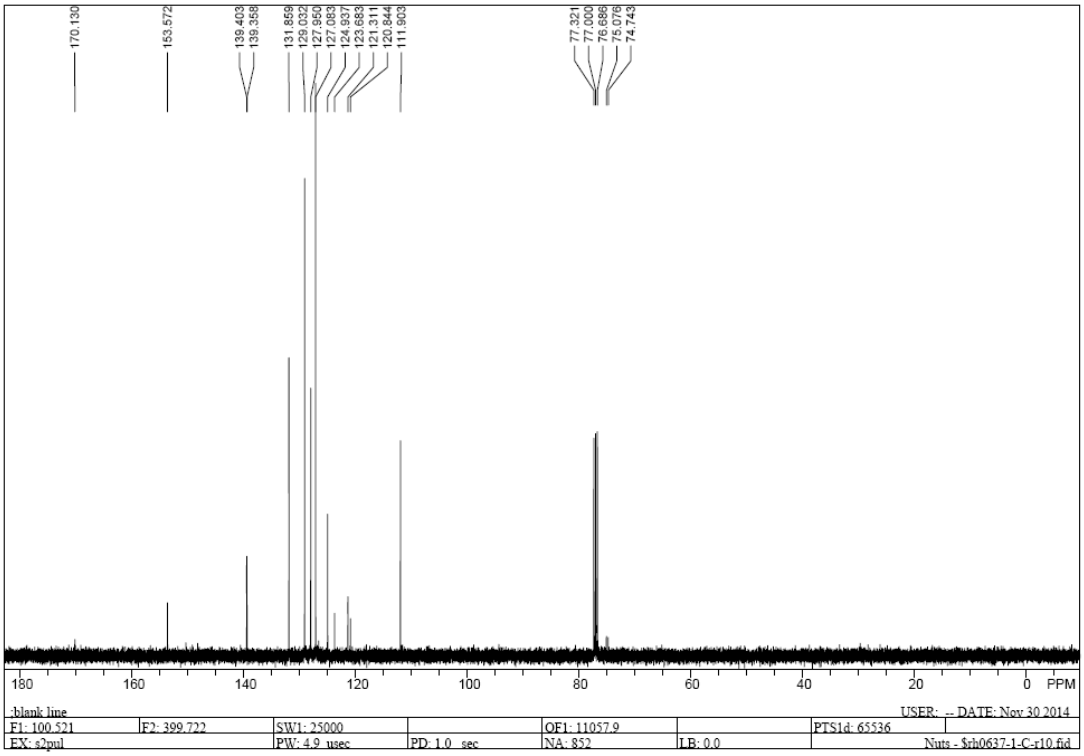

79.752
100
50
0
-50
-100
-150
-200
-250
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Nov 3 2014
F1: 376.076
F2: 100.519
SW1: 156250
OF1: -36877.9
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 3.0 sec
NA: 8
LB: 0.0
Nuts - $rh0635-1F.fid

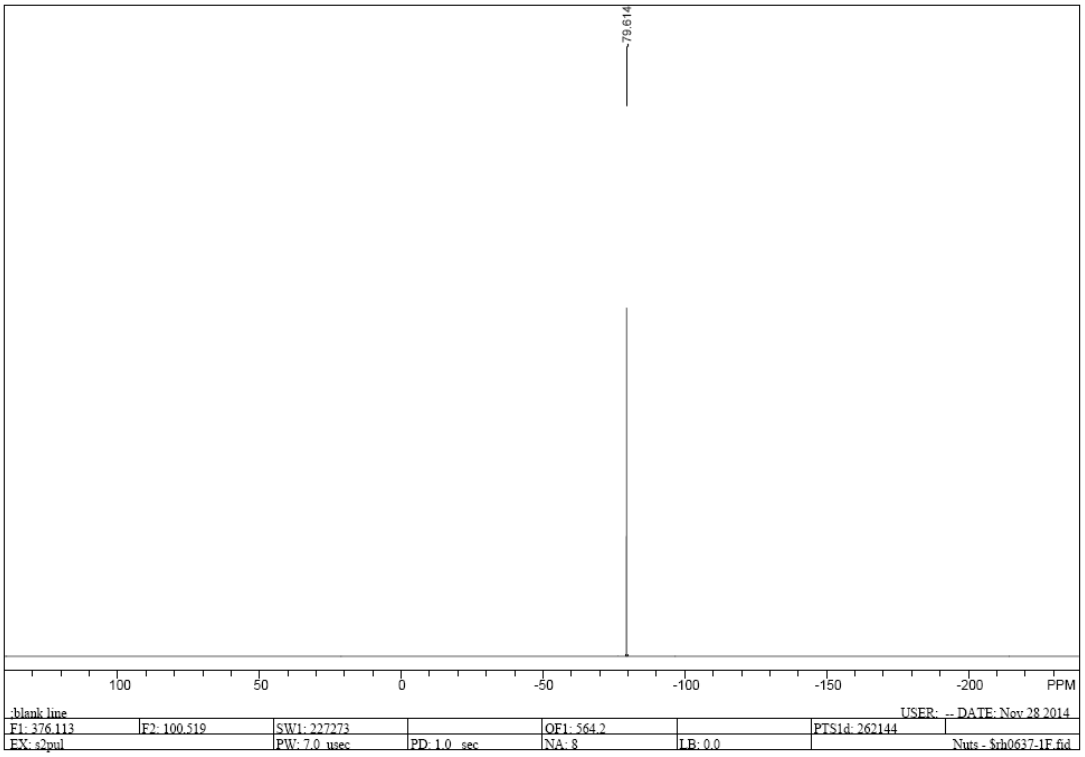

7.403
7.233
7.229
7.212
7.207
7.201
7.182
7.164
7.117
7.109
7.099
7.088
6.957
6.935
4.029
1.597
HO
CF3
Ph
O
O
3s
5.77
9.00
0.95
0.94
1.01
8
6
4
2
0
PPM
:blank line
USER: -- DATE: Nov 30 2014
F1: 399.722
F2: 100.519
SW1: 6410
OF1: 2347.8
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0666-1-H1.fid

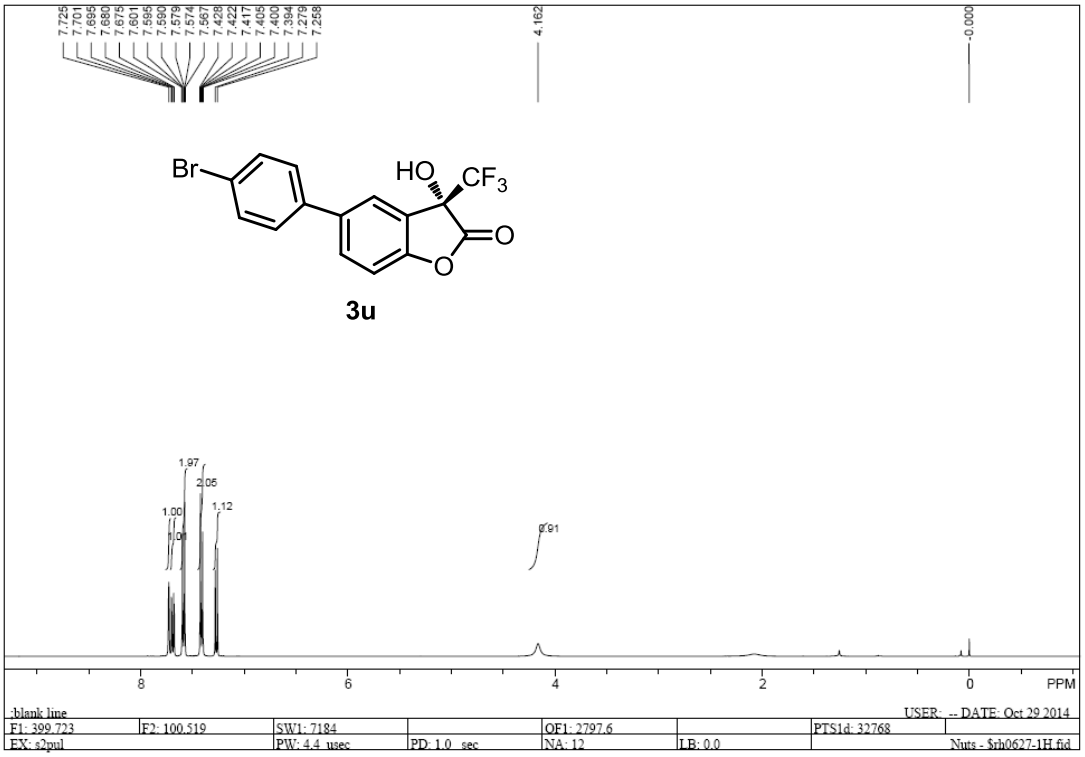

170.480
152.135
149.504
148.808
132.047
128.231
126.601
126.054
123.984
123.621
120.783
120.198
111.069
77.312
77.000
76.682
75.102
74.772
43.012
30.788
30.741
200
150
100
50
0 PPM
:blank line
USER: -- DATE: Nov 30 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11050.7
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 76
LB: 0.0
Nuts - $rh0666-1-C1.fid

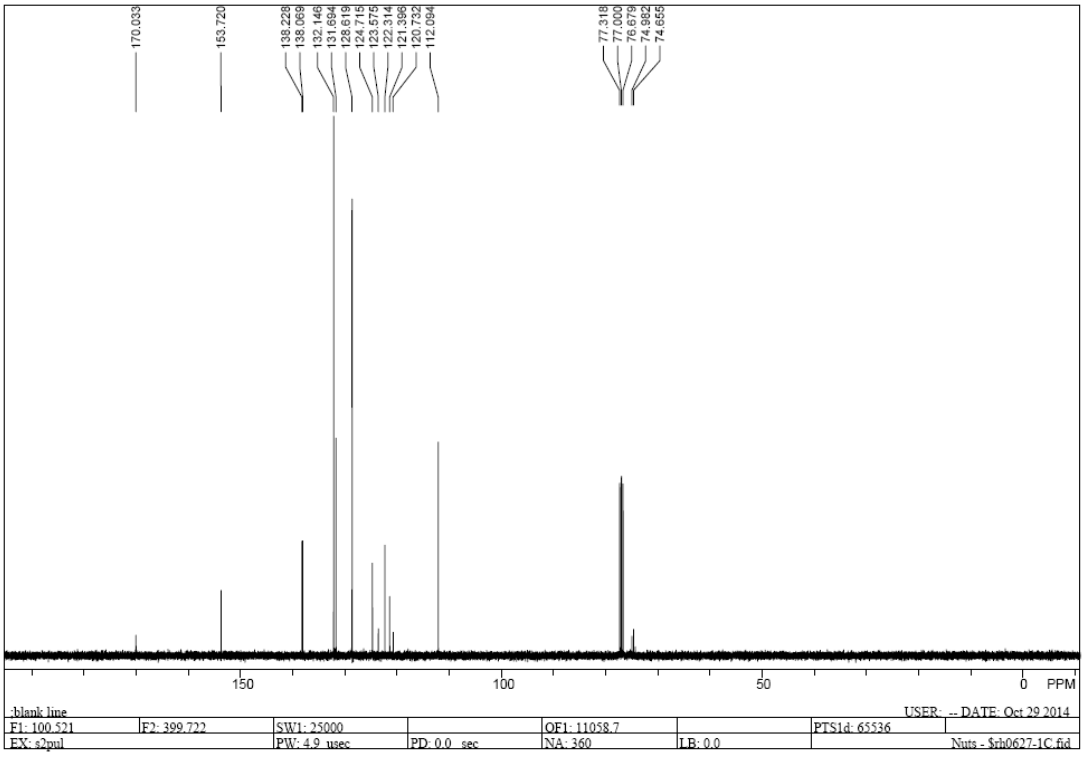

79.682
200
150
100
50
0
-50
-100
-150
-200
PPM
:blank line
USER: -- DATE: Nov 30 2014
F1: 376.113
F2: 100.519
SW1: 227273
OF1: 564.2
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0666-1-F.fid

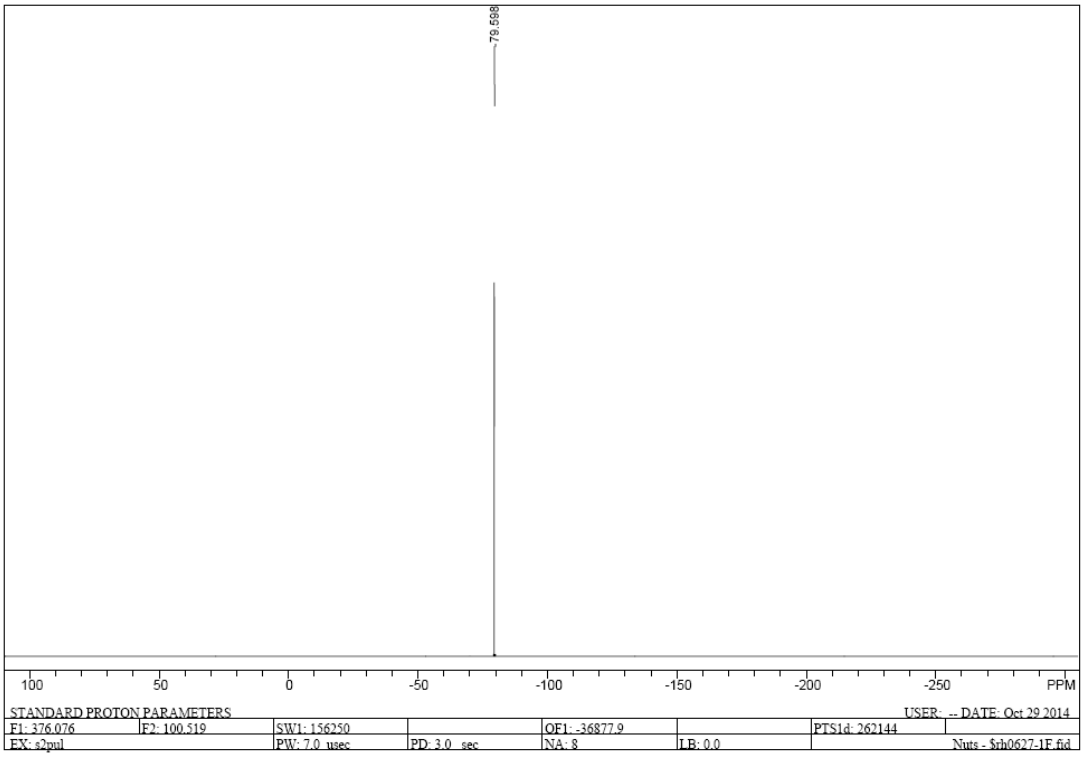

7.699
7.677
7.672
7.656
7.652
7.495
7.491
7.473
7.417
7.399
7.394
7.380
7.343
7.325
7.216
7.195
7.187
0.000
HO
CF3
Ph
O
O
3t
1.96
1.00
1.97
0.85
0.93
0.96
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Dec 18 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2769.2
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 24
LB: 0.0
Nuts - $rh0637-1-H-r.fid

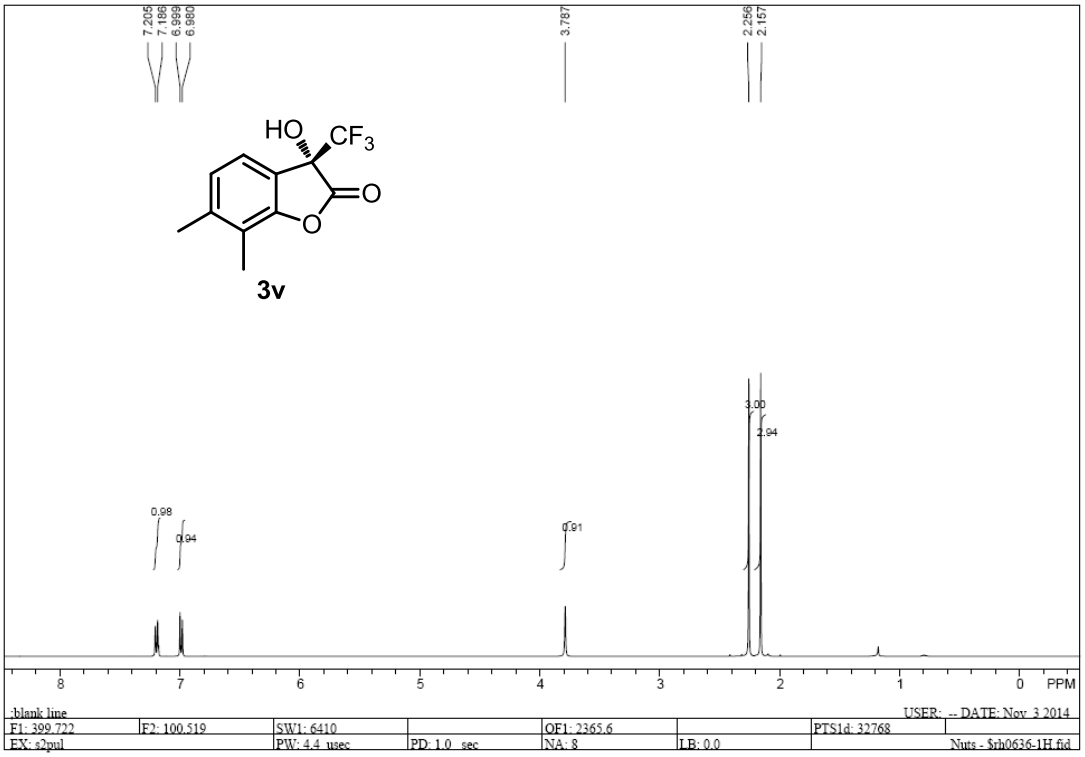

170.130
153.572
139.403
139.358
131.859
129.032
127.950
127.083
124.937
123.683
121.311
120.844
111.903
77.321
77.000
76.686
75.076
74.743
180
160
140
120
100
80
60
40
20
0
PPM
:blank line
USER: -- DATE: Nov 30 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11057.9
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 852
LB: 0.0
Nuts - $rh0637-1-C-r10.fid

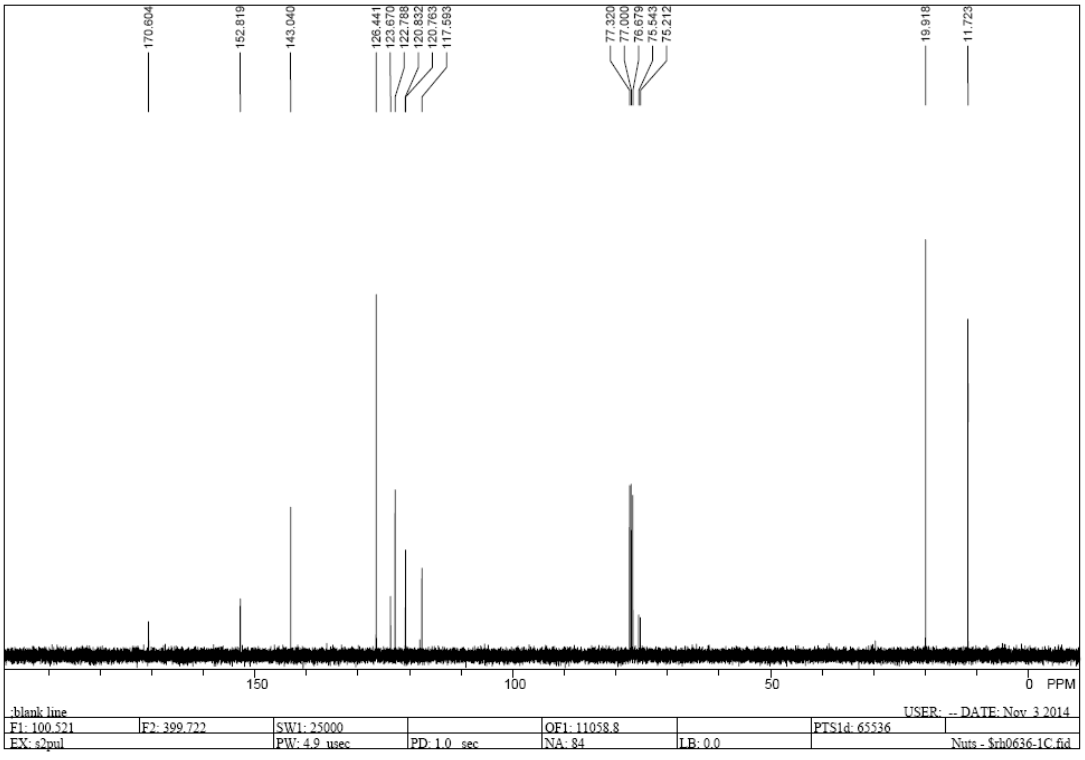

79.614
100
50
0
-50
-100
-150
-200
PPM
:blank line
USER: -- DATE: Nov 28 2014
F1: 376.113
F2: 100.519
SW1: 227273
OF1: 564.2
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0637-1F.fid

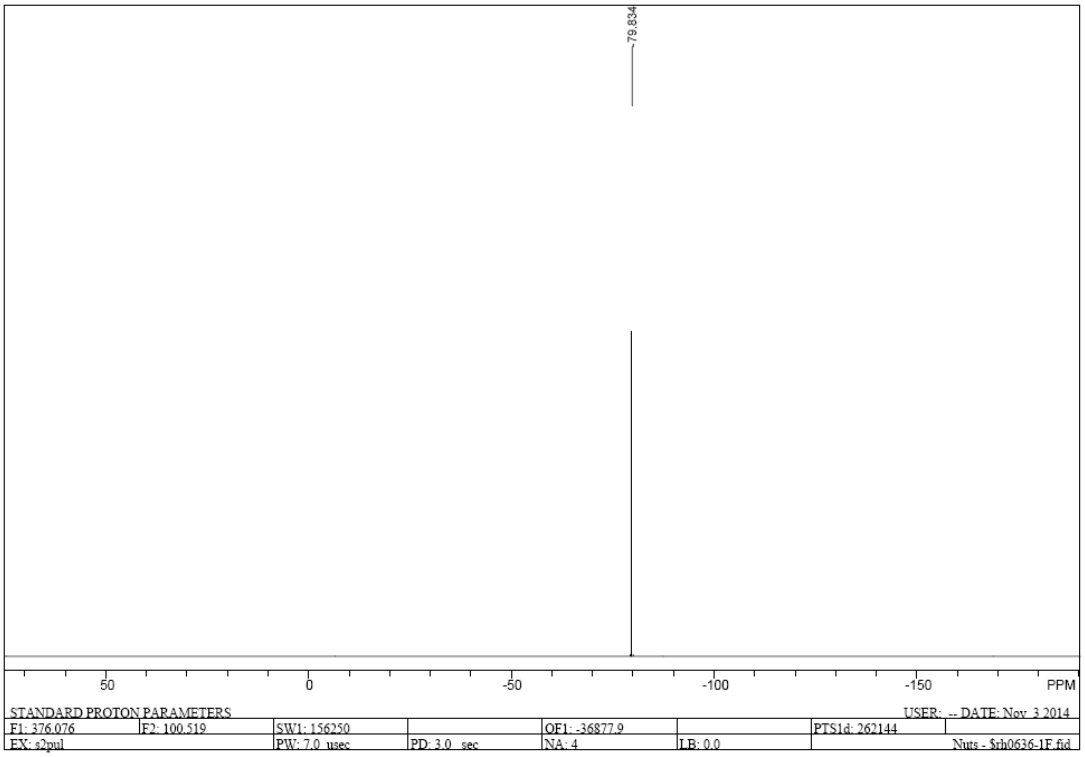

7.725
7.701
7.696
7.680
7.675
7.601
7.595
7.590
7.579
7.574
7.567
7.428
7.422
7.417
7.405
7.400
7.394
7.279
7.258
4.162
0.000
Br
HO
CF3
O
O
3u
1.97
2.05
1.12
1.00
1.00
0.91
8
6
4
2
0
PPM
:blank line
USER: -- DATE: Oct 29 2014
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2797.6
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 12
LB: 0.0
Nuts - $rh0627-1H.fid

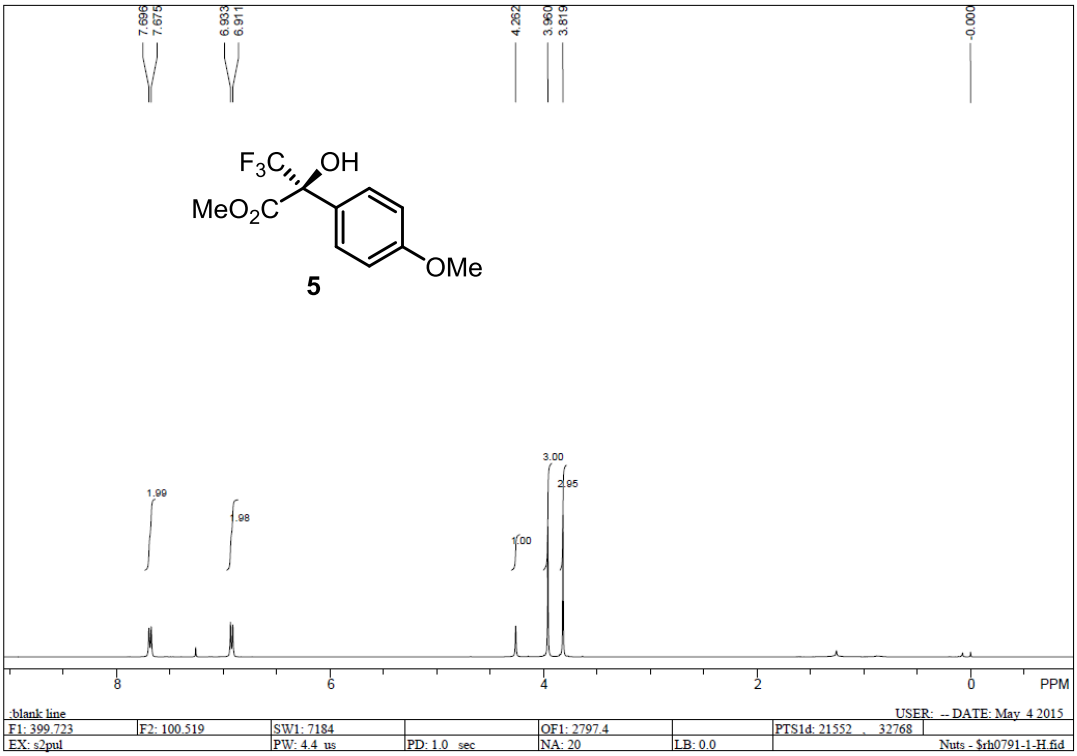

170.033
153.720
138.228
138.069
132.146
131.694
128.619
124.715
123.575
122.314
121.396
120.732
112.094
77.318
77.000
76.679
74.982
74.655
150
100
50
0
PPM
:blank line
USER: -- DATE: Oct 29 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11058.7
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 0.0 sec
NA: 360
LB: 0.0
Nuts - $rh0627-1C.fid

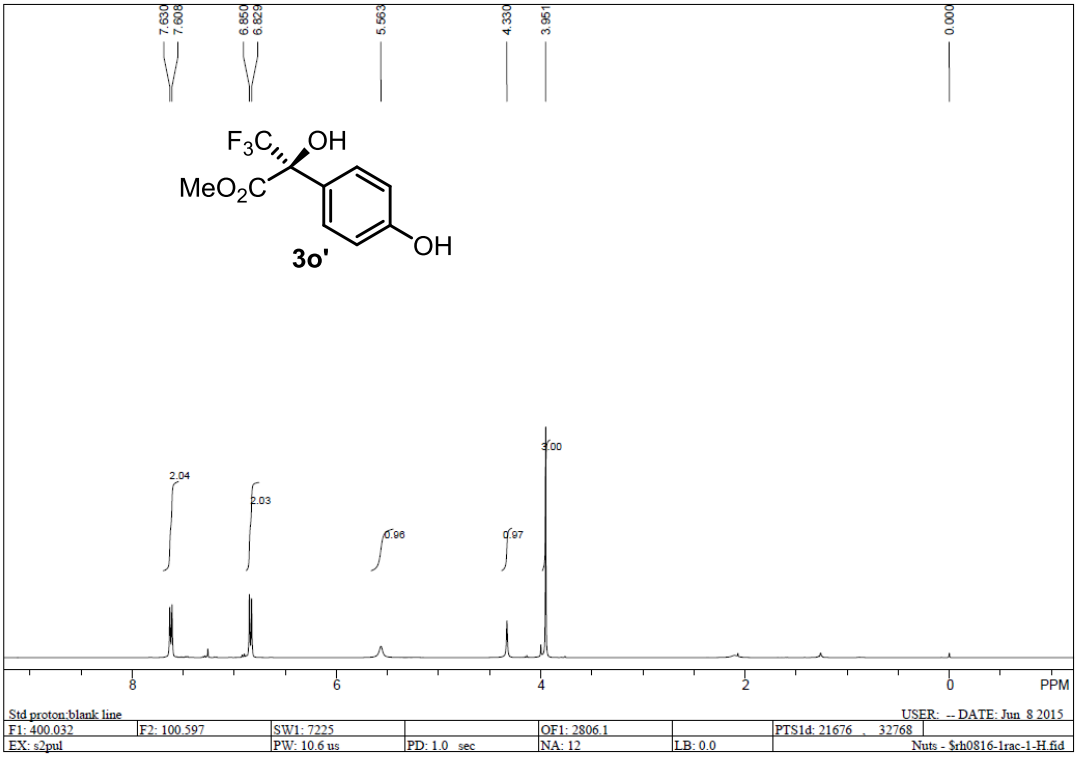

79.598
100
50
0
-50
-100
-150
-200
-250
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Oct 29 2014
F1: 376.076
F2: 100.519
SW1: 156250
OF1: -36877.9
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 3.0 sec
NA: 8
LB: 0.0
Nuts - $rh0627-1F.fid


7.205
7.186
6.999
6.980
3.787
2.256
2.157
HO
CF3
O
O
3v
3.00
2.94
0.98
0.94
0.91
8
7
6
5
4
3
2
1
0
PPM
:blank line
USER: -- DATE: Nov 3 2014
F1: 399.722
F2: 100.519
SW1: 6410
OF1: 2365.6
PTS1d: 32768
EX: s2pul
PW: 4.4 usec
PD: 1.0 sec
NA: 8
LB: 0.0
Nuts - $rh0636-1H.fid

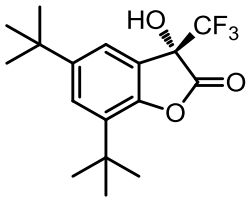

170.604
152.819
143.040
126.441
123.670
122.788
120.832
120.763
117.593
77.320
77.000
76.679
75.543
75.212
19.918
11.723
150
100
50
0
PPM
:blank line
USER: -- DATE: Nov 3 2014
F1: 100.521
F2: 399.722
SW1: 25000
OF1: 11058.8
PTS1d: 65536
EX: s2pul
PW: 4.9 usec
PD: 1.0 sec
NA: 84
LB: 0.0
Nuts - $rh0636-1C.fid


-79.834
50
0
-50
-100
-150
PPM
STANDARD PROTON PARAMETERS
USER: -- DATE: Nov 3 2014
F1: 376.076
F2: 100.519
SW1: 156250
OF1: -36877.9
PTS1d: 262144
EX: s2pul
PW: 7.0 usec
PD: 3.0 sec
NA: 4
LB: 0.0
Nuts - $rh0636-1F.fid


7.696
7.675
6.933
6.911
4.262
3.960
3.819
-0.000
F3C
OH
MeO2C
OMe
5
1.99
1.98
1.00
3.00
2.95
8
6
4
2
0
PPM
:blank line
USER: -- DATE: May 4 2015
F1: 399.723
F2: 100.519
SW1: 7184
OF1: 2797.4
PTS1d: 21552 , 32768
EX: s2pul
PW: 4.4 us
PD: 1.0 sec
NA: 20
LB: 0.0
Nuts - $rh0791-1-H.fid

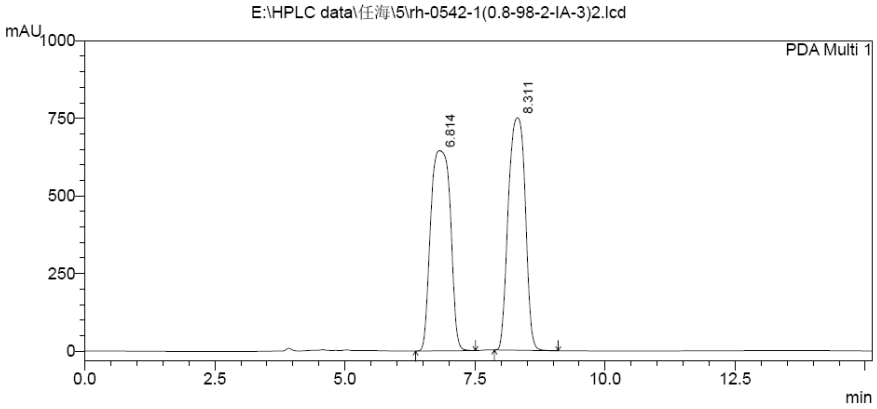

7.630
7.608
6.850
6.829
5.563
4.330
3.951
0.000
F3C
OH
MeO2C
OH
3o'
2.04
2.03
0.96
0.97
3.00
8
6
4
2
0
PPM
Std proton;blank line
USER: -- DATE: Jun 8 2015
F1: 400.032
F2: 100.597
SW1: 7225
OF1: 2806.1
PTS1d: 21676 , 32768
EX: s2pul
PW: 10.6 us
PD: 1.0 sec
NA: 12
LB: 0.0
Nuts - $rh0816-1rac-1-H.fid

8. HPLC traces



3a

<Chromatogram>

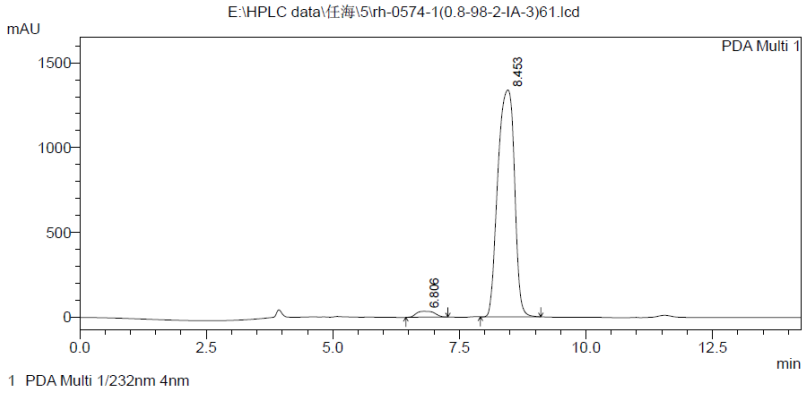


PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.814	17037201	645053	50.162	46.253
2	8.311	16927488	749567	49.838	53.747
Total		33964689	1394621	100.000	100.000

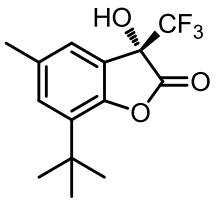
<Chromatogram>



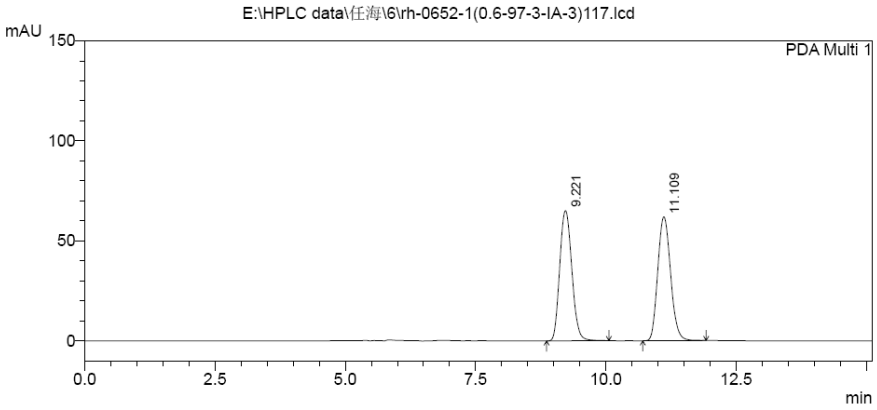
PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.806	860962	34201	2.739	2.497
2	8.453	30577550	1335674	97.261	97.503
Total		31438512	1369875	100.000	100.000



3b



1 PDA Multi 1/254nm 4nm

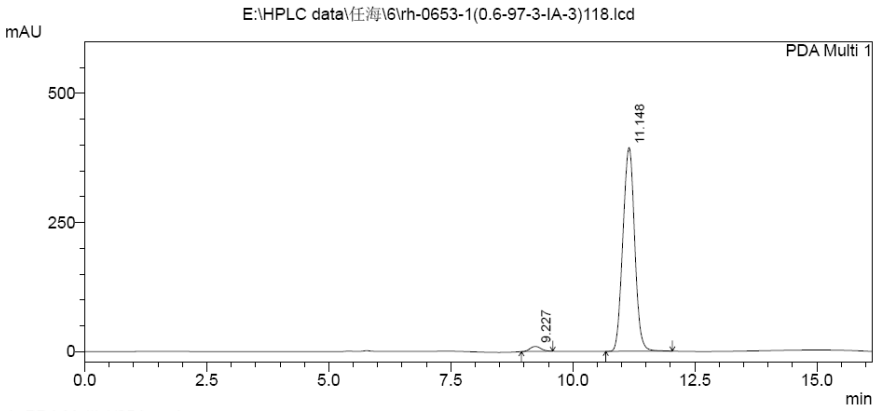
<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.221	1054627	65122	49.905	51.246
2	11.109	1058653	61954	50.095	48.754
Total		2113280	127075	100.000	100.000

<Chromatogram>



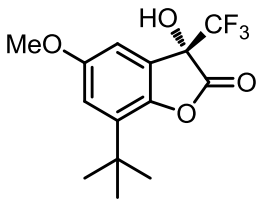
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

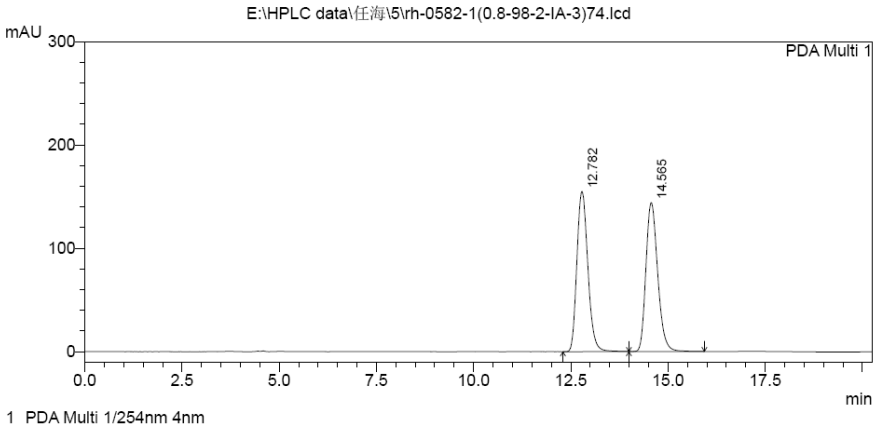
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.227	150661	9585	2.219	2.373
2	11.148	6638481	394360	97.781	97.627
Total		6789142	403945	100.000	100.000



3c

<Chromatogram>



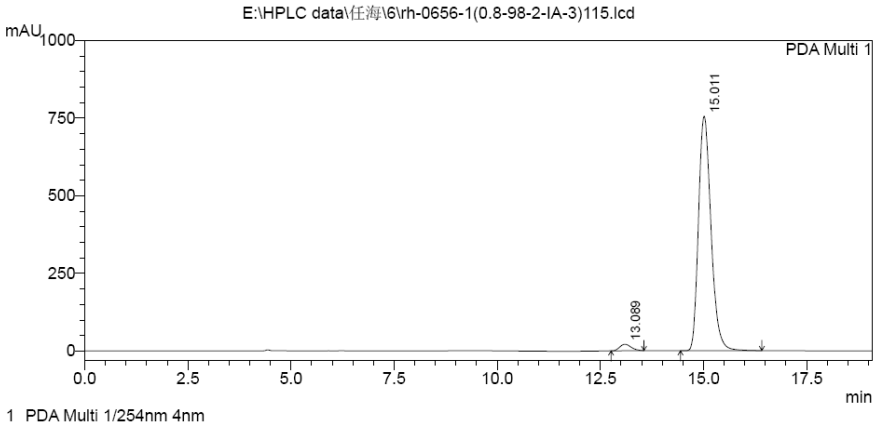
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.782	3050375	155098	50.100	51.814
2	14.565	3038237	144237	49.900	48.186
Total		6088613	299335	100.000	100.000

<Chromatogram>



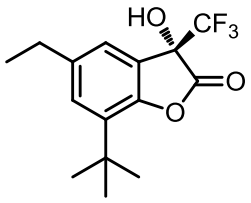
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

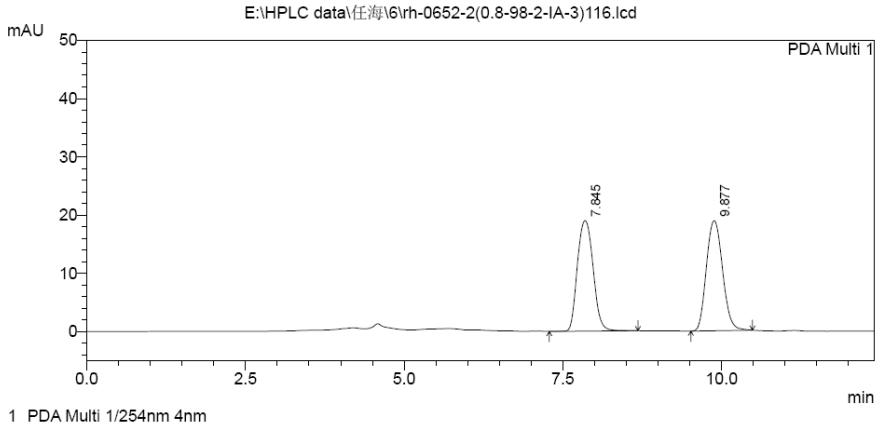
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.089	403320	20857	2.467	2.686
2	15.011	15948085	755526	97.533	97.314
Total		16351404	776383	100.000	100.000



3d

<Chromatogram>



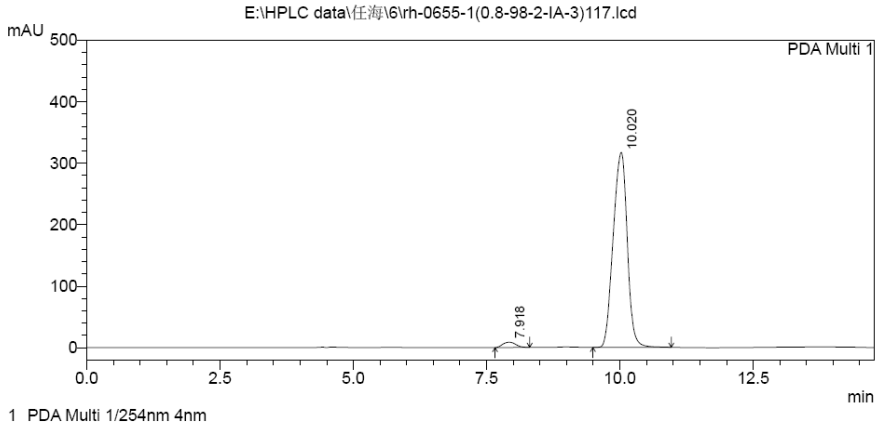
<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.845	328492	19002	49.429	50.140
2	9.877	336086	18897	50.571	49.860
Total		664578	37899	100.000	100.000

<Chromatogram>

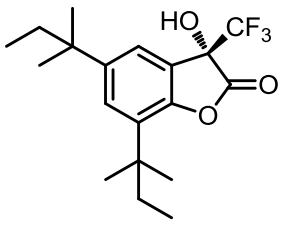


<Results>

PeakTable

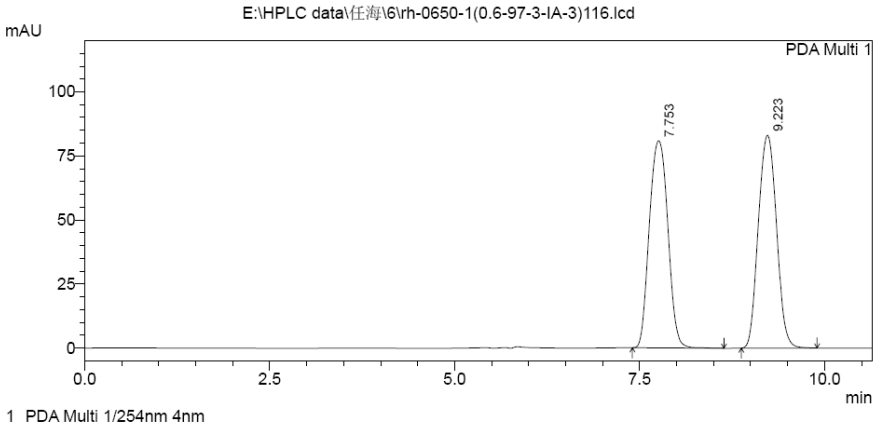
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.918	144552	8519	2.423	2.616
2	10.020	5820048	317179	97.577	97.384
Total		5964600	325698	100.000	100.000



3e

<Chromatogram>



1 PDA Multi 1/254nm 4nm

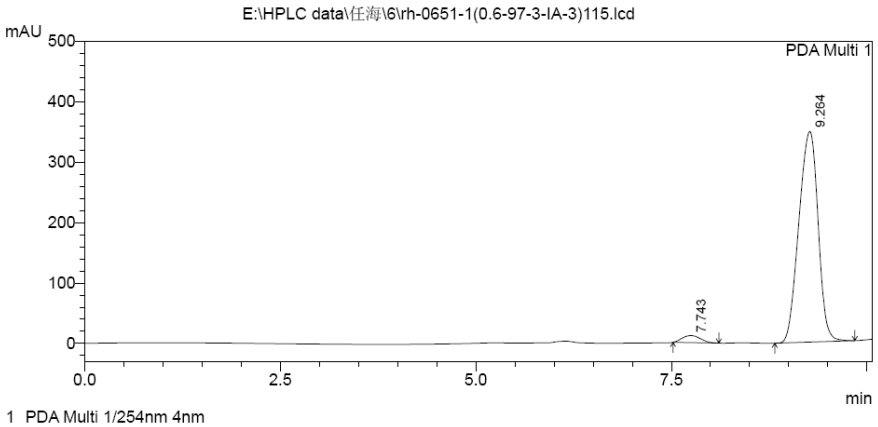
<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.753	1411147	80882	49.817	49.331
2	9.223	1421532	83076	50.183	50.669
Total		2832679	163958	100.000	100.000

<Chromatogram>



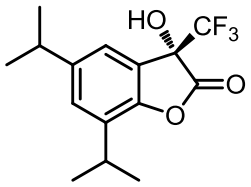
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.743	187002	11442	3.038	3.176
2	9.264	5968066	348887	96.962	96.824
Total		6155069	360330	100.000	100.000



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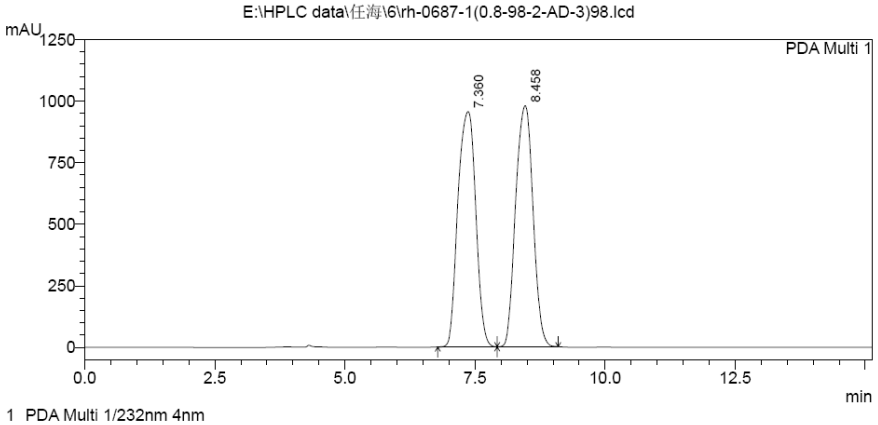
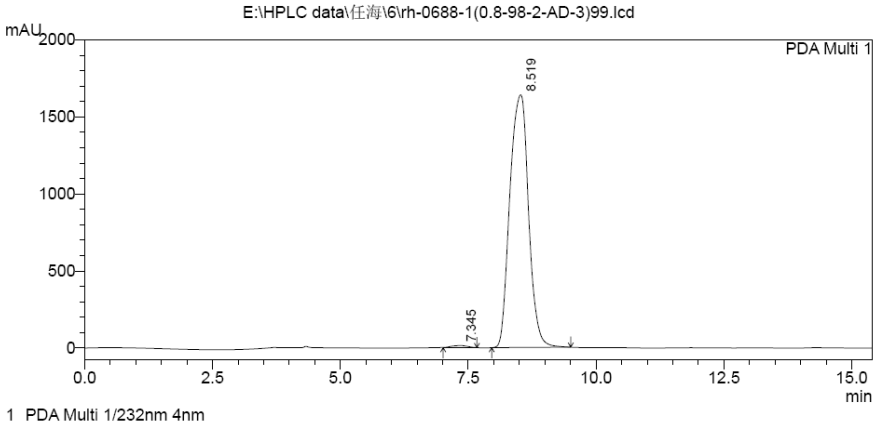


<Results>

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.360	22794998	955143	50.032	49.396
2	8.458	22766210	978488	49.968	50.604
Total		45561207	1933632	100.000	100.000

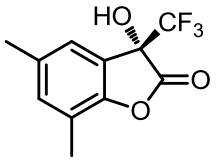


<Results>

PeakTable

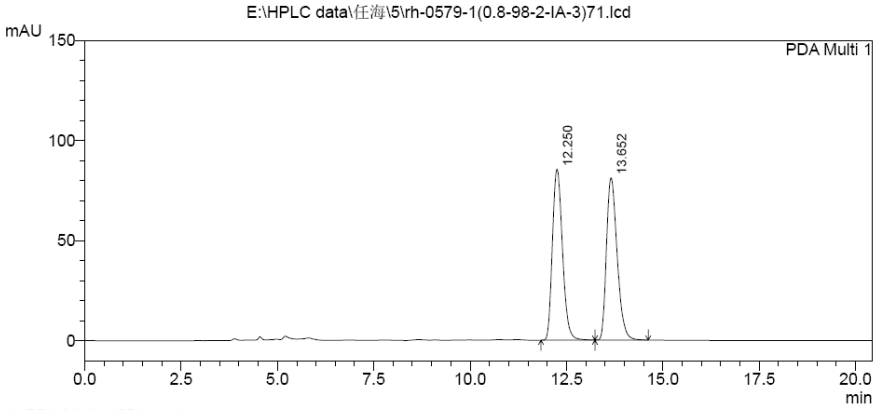
PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.345	283380	12563	0.675	0.760
2	8.519	41670849	1639739	99.325	99.240
Total		41954229	1652302	100.000	100.000



3g

<Chromatogram>



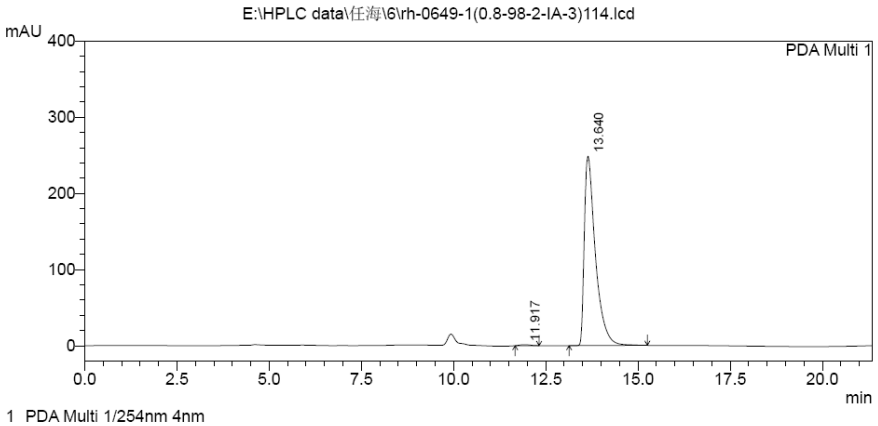
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.250	1552364	85430	49.790	51.302
2	13.652	1565461	81094	50.210	48.698
Total		3117825	166524	100.000	100.000

<Chromatogram>



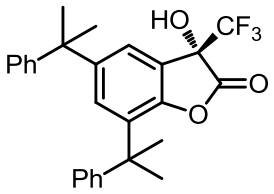
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.917	21383	1208	0.410	0.483
2	13.640	5197843	248734	99.590	99.517
Total		5219226	249942	100.000	100.000



3h

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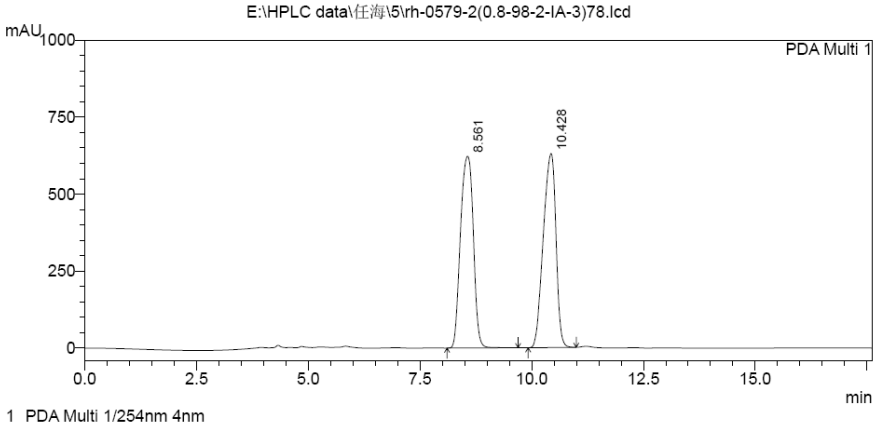
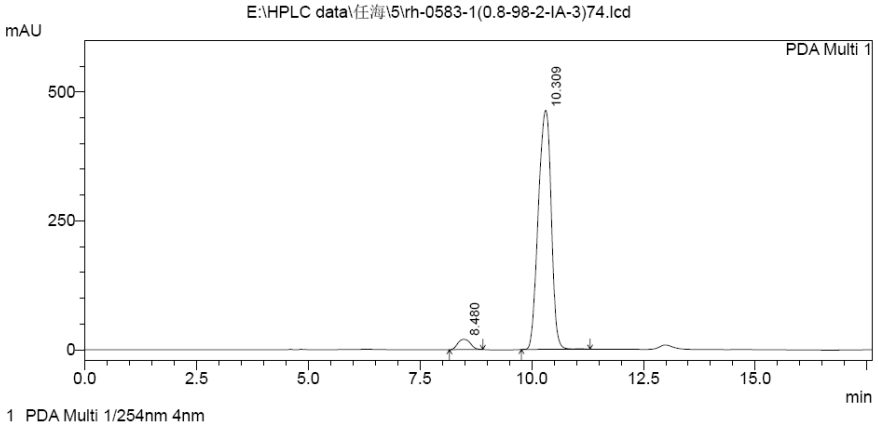


PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.561	12445692	622623	50.109	49.692
2	10.428	12391765	630331	49.891	50.308
Total		24837458	1252954	100.000	100.000

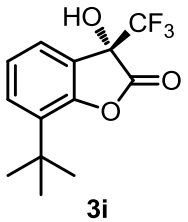
<Chromatogram>



PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.480	390451	19976	4.017	4.131
2	10.309	9329113	463604	95.983	95.869
Total		9719564	483580	100.000	100.000



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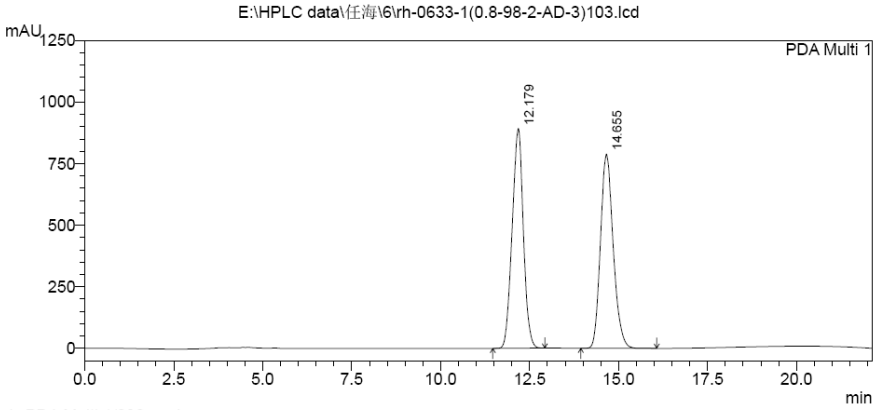


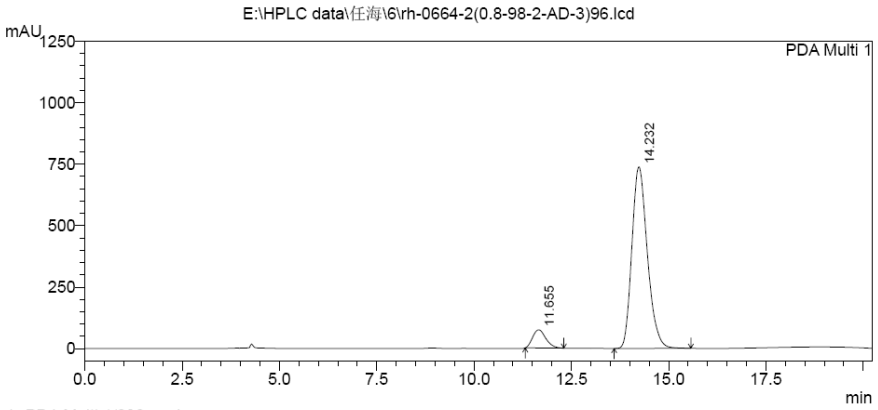
1 PDA Multi 1/232nm 4nm

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.179	19514369	892179	49.847	53.099
2	14.655	19634328	788036	50.153	46.901
Total		39148697	1680214	100.000	100.000

<Chromatogram>



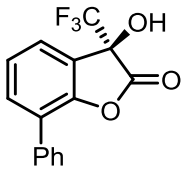
1 PDA Multi 1/232nm 4nm

<Results>

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.655	1727309	73815	7.796	9.087
2	14.232	20429099	738470	92.204	90.913
Total		22156408	812285	100.000	100.000



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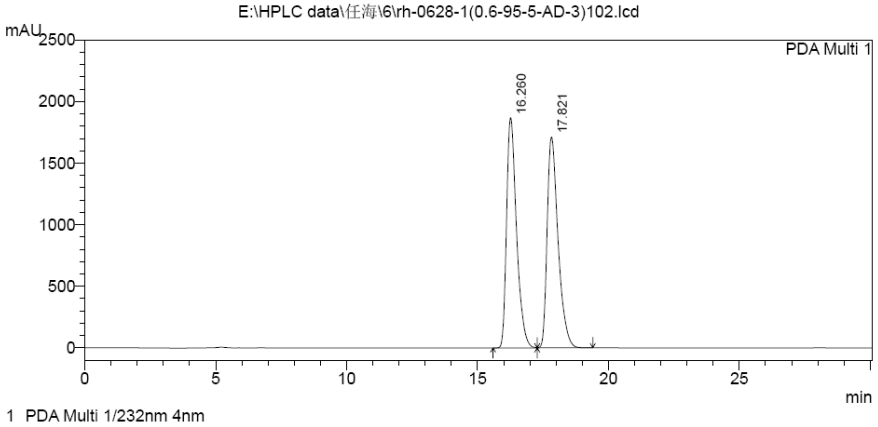
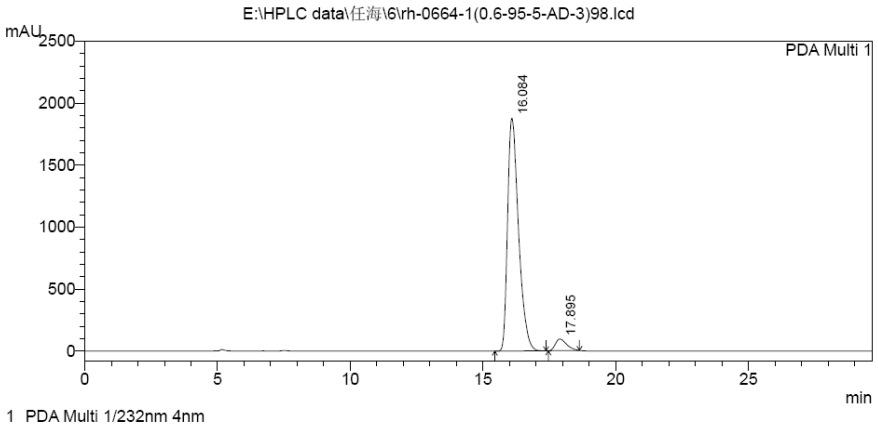


PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.260	49161148	1868907	49.849	52.198
2	17.821	49459655	1711494	50.151	47.802
Total		98620803	3580401	100.000	100.000

<Chromatogram>

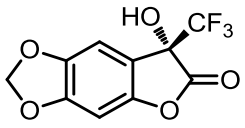


<Results>

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	16.084	53906884	1878410	95.082	95.200
2	17.895	2788191	94709	4.918	4.800
Total		56695075	1973120	100.000	100.000



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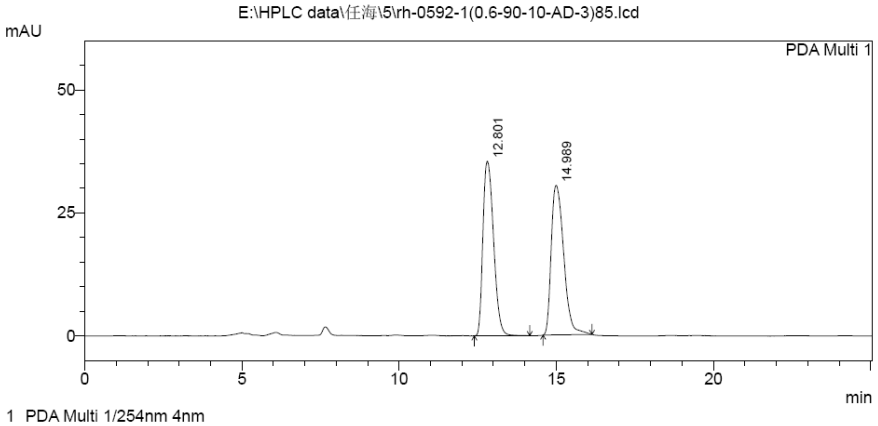


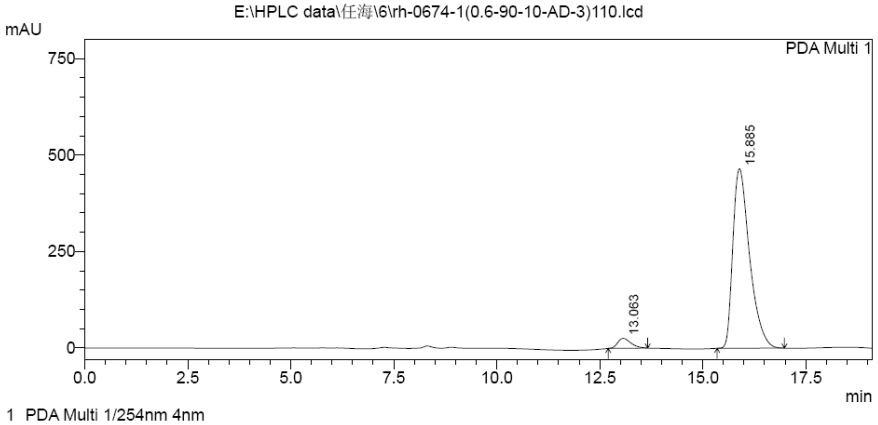
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.801	833365	35481	49.631	53.843
2	14.989	845751	30416	50.369	46.157
Total		1679115	65897	100.000	100.000

<Chromatogram>



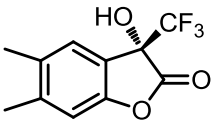
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.063	566998	25686	4.126	5.233
2	15.885	13176340	465144	95.874	94.767
Total		13743338	490830	100.000	100.000



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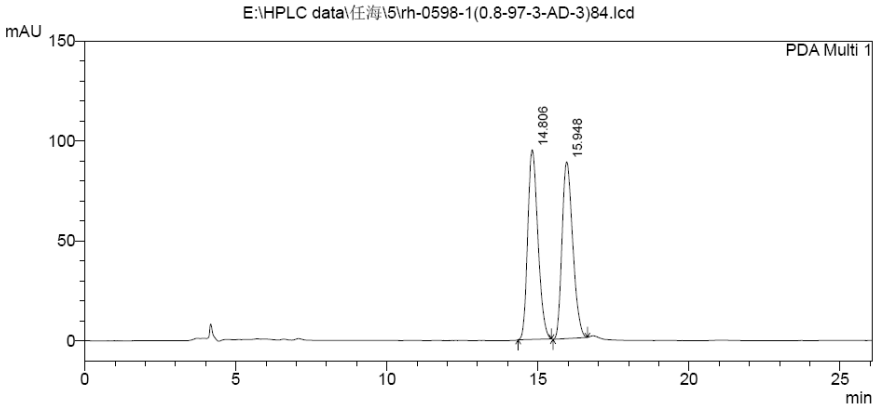


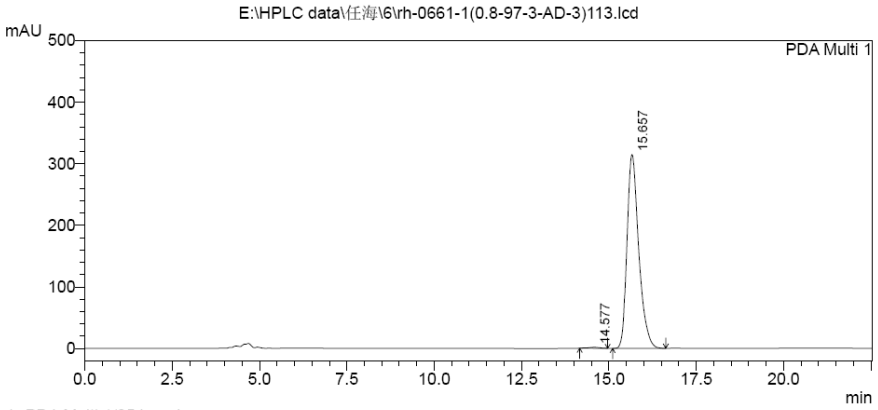
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.806	2222931	94815	50.519	51.757
2	15.948	2177287	88379	49.481	48.243
Total		4400218	183195	100.000	100.000

<Chromatogram>



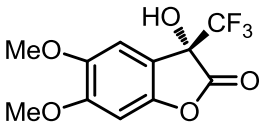
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.577	32843	1561	0.445	0.493
2	15.657	7340661	314770	99.555	99.507
Total		7373504	316331	100.000	100.000



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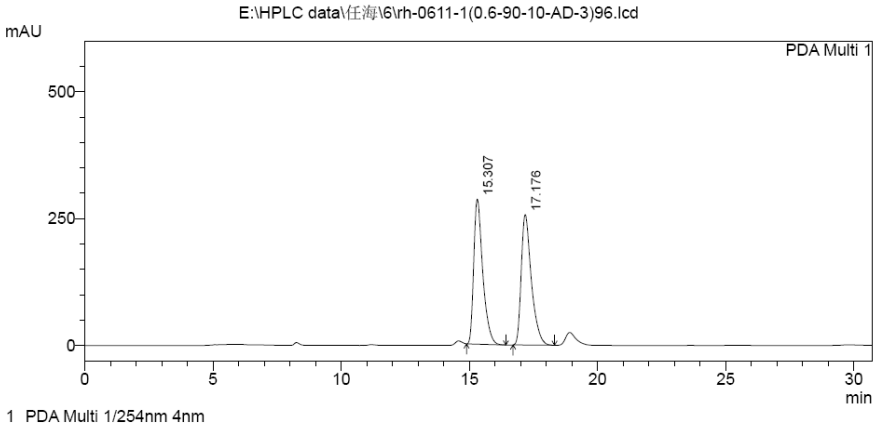

1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	15.307	6984494	285744	49.763	52.654
2	17.176	7051036	256939	50.237	47.346
Total		14035530	542683	100.000	100.000

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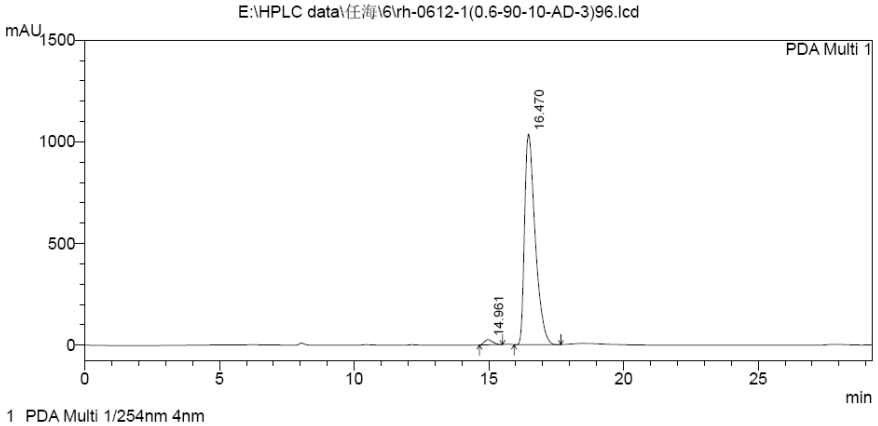
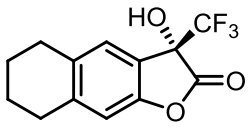


1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.961	539960	25460	1.867	2.398
2	16.470	28388901	1036249	98.133	97.602
Total		28928862	1061710	100.000	100.000



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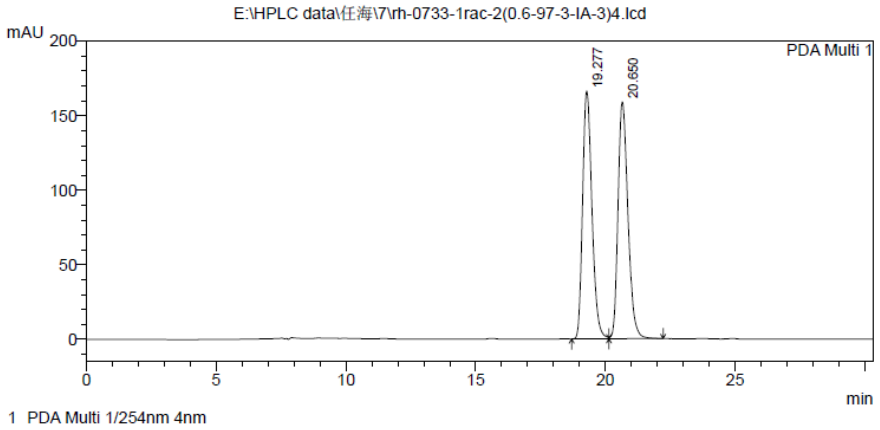


1 PDA Multi 1/254nm 4nm

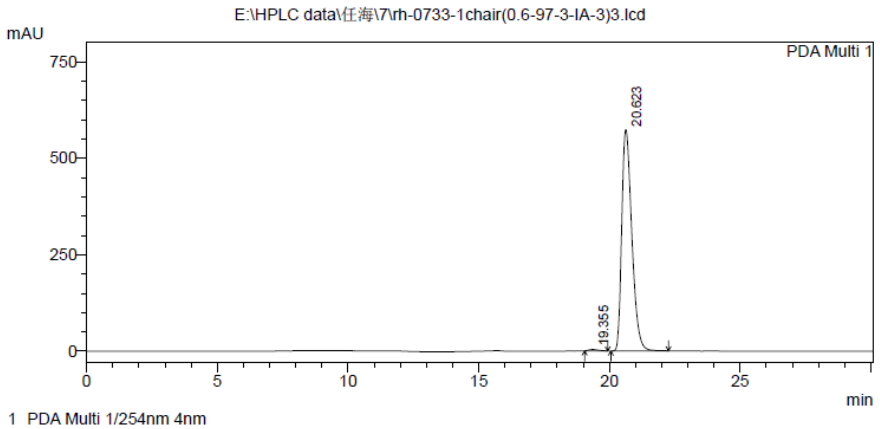
<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.277	4167090	166402	49.613	51.143
2	20.650	4232100	158961	50.387	48.857
Total		8399190	325363	100.000	100.000

<Chromatogram>



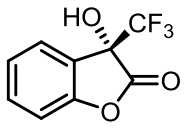
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	19.355	90404	3578	0.586	0.620
2	20.623	15334410	573757	99.414	99.380
Total		15424813	577335	100.000	100.000



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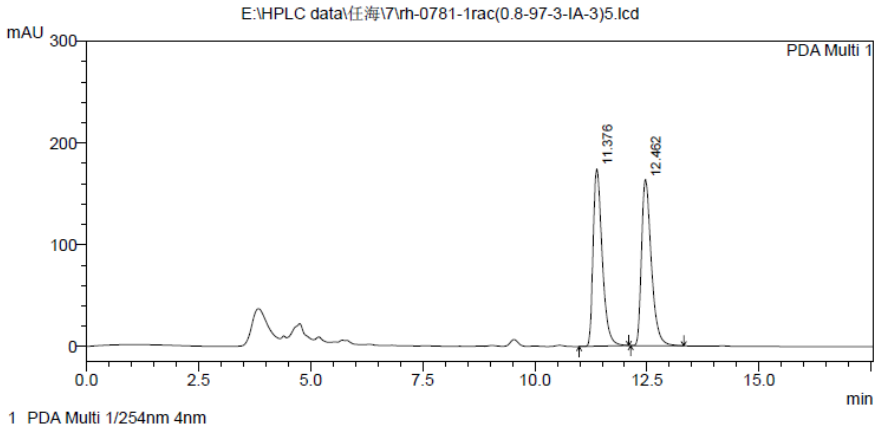


1 PDA Multi 1/254nm 4nm

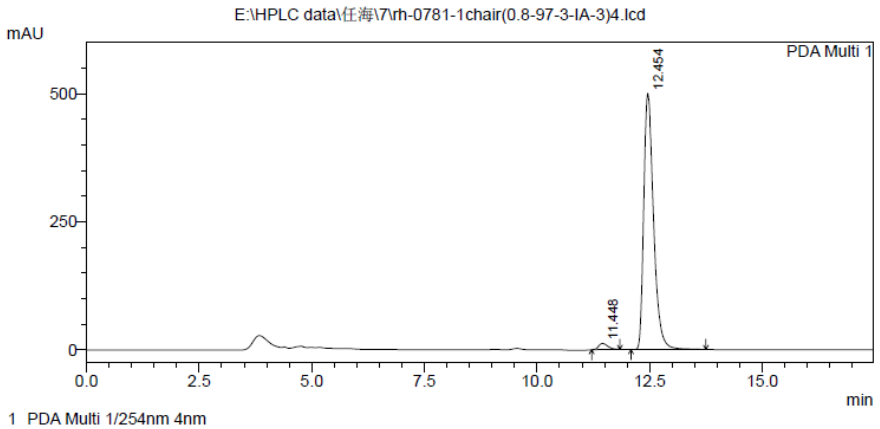
<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.376	2460341	174384	49.758	51.589
2	12.462	2484298	163645	50.242	48.411
Total		4944639	338029	100.000	100.000

<Chromatogram>



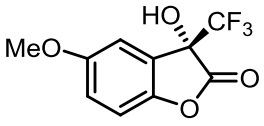
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.448	170440	12059	2.198	2.354
2	12.454	7583750	500148	97.802	97.646
Total		7754190	512207	100.000	100.000



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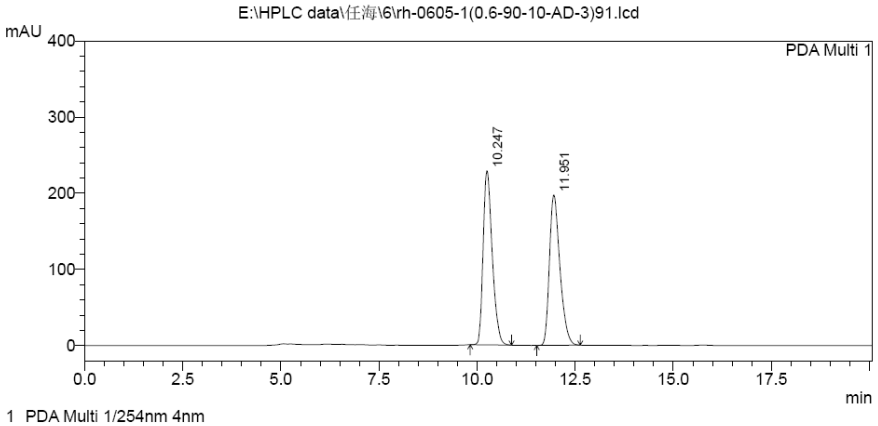

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.247	3693115	228870	50.129	53.676
2	11.951	3674043	197520	49.871	46.324
Total		7367158	426389	100.000	100.000

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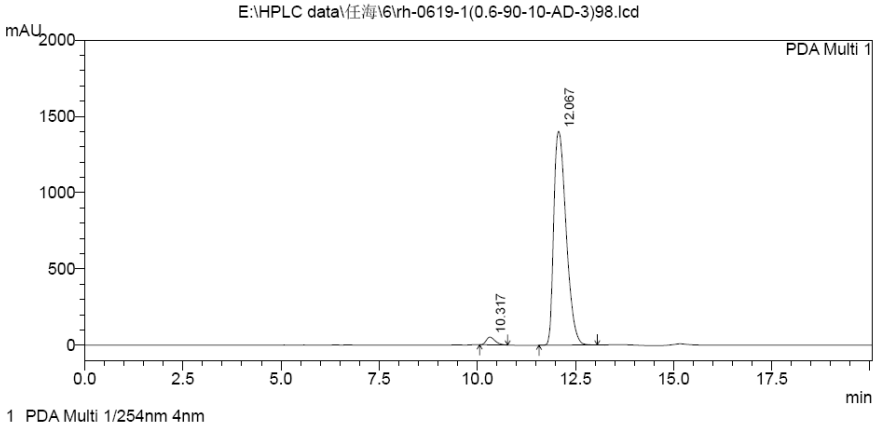
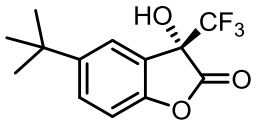


PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.317	800233	50993	2.541	3.510
2	12.067	30698121	1401638	97.459	96.490
Total		31498354	1452631	100.000	100.000



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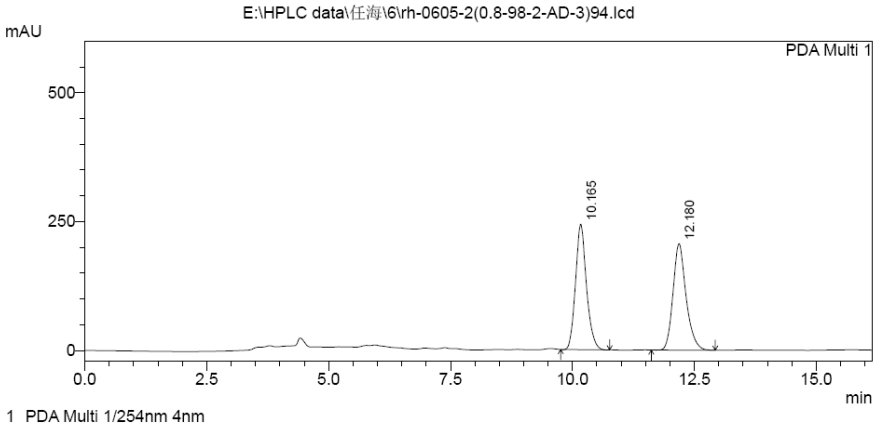
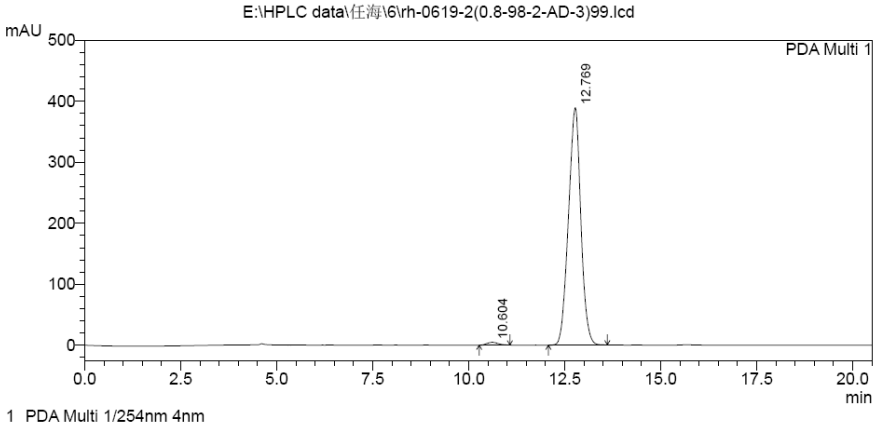


1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.165	3803940	243413	49.717	54.126
2	12.180	3847236	206300	50.283	45.874
Total		7651177	449713	100.000	100.000

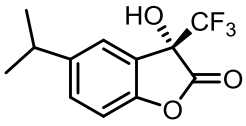


1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.604	92341	4533	1.048	1.151
2	12.769	8722803	389157	98.952	98.849
Total		8815144	393690	100.000	100.000



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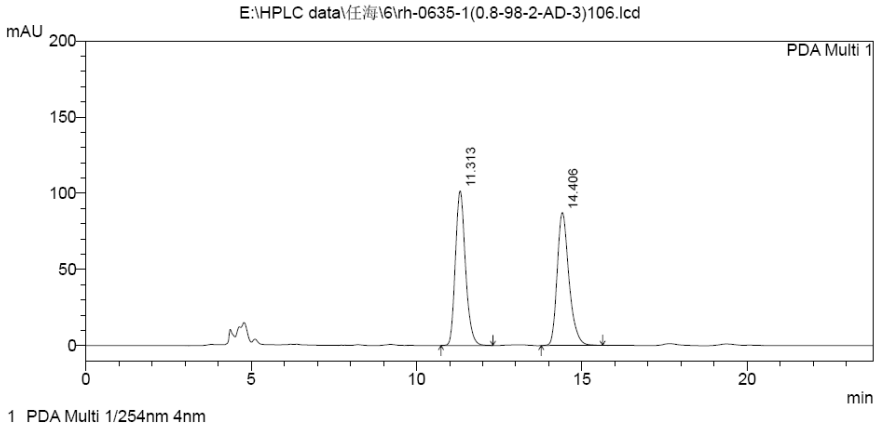


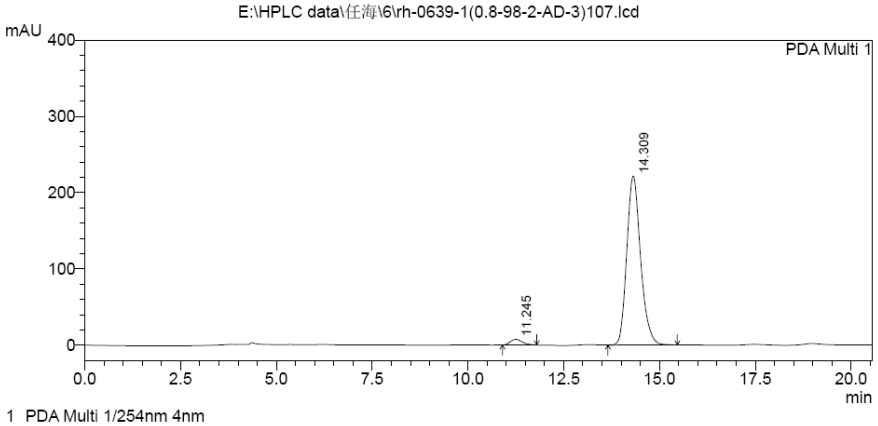
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.313	2151458	101452	49.859	53.732
2	14.406	2163593	87361	50.141	46.268
Total		4315051	188813	100.000	100.000

<Chromatogram>

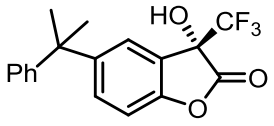


1 PDA Multi 1/254nm 4nm

PeakTable

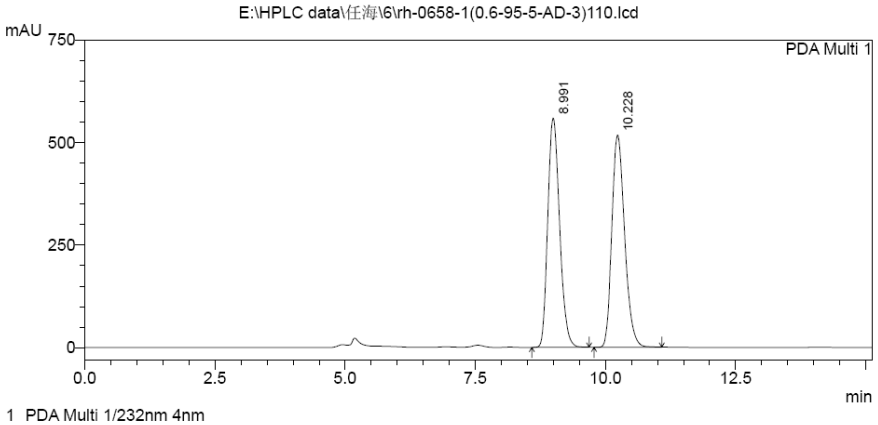
PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.245	158856	7320	2.784	3.199
2	14.309	5547561	221513	97.216	96.801
Total		5706417	228833	100.000	100.000



3s

<Chromatogram>



1 PDA Multi 1/232nm 4nm

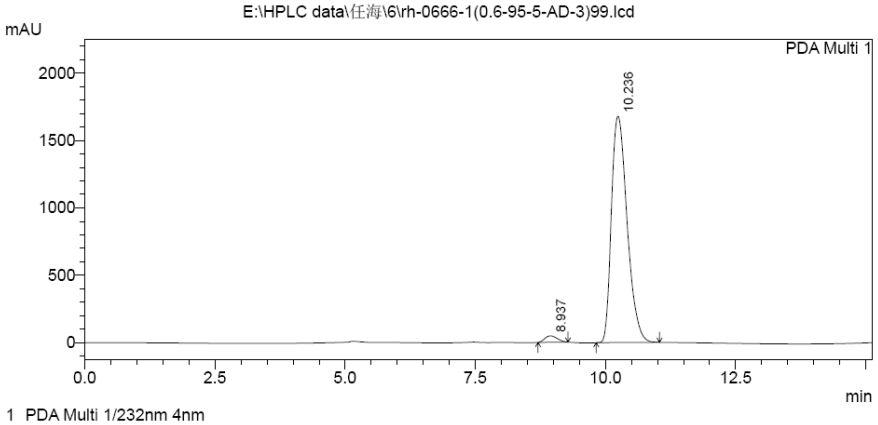
<Results>

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.991	8818215	559371	49.923	51.937
2	10.228	8845458	517649	50.077	48.063
Total		17663673	1077019	100.000	100.000

<Chromatogram>



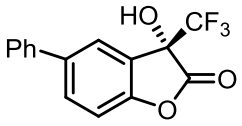
1 PDA Multi 1/232nm 4nm

<Results>

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.937	791202	48115	2.200	2.786
2	10.236	35176761	1679197	97.800	97.214
Total		35967964	1727312	100.000	100.000



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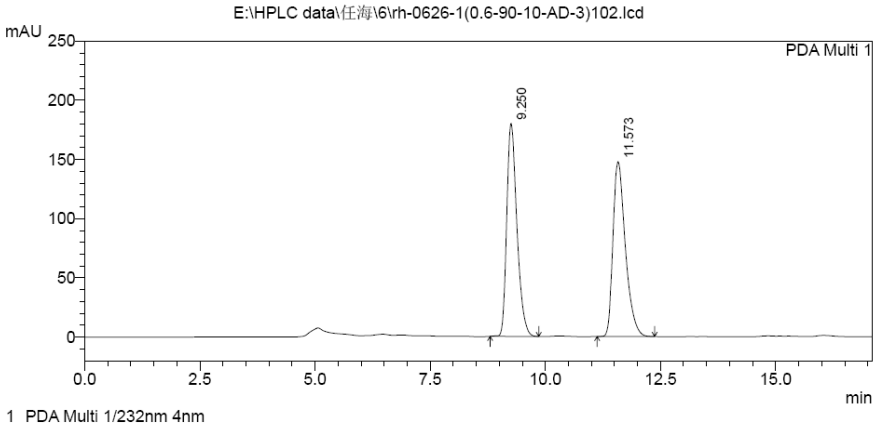
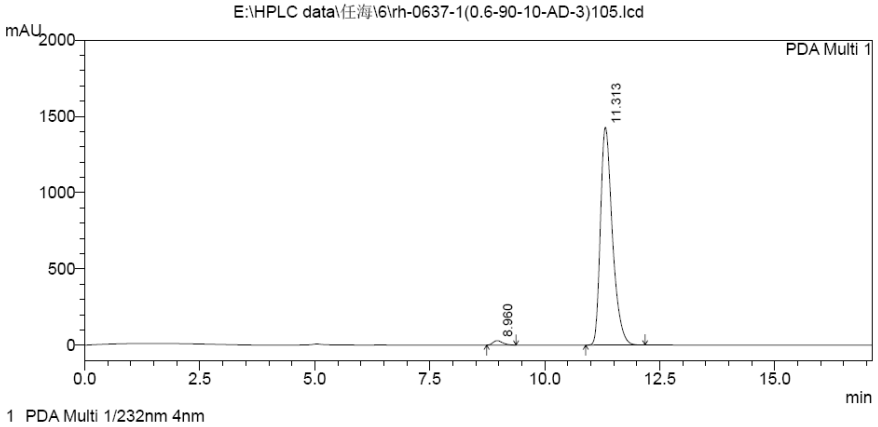


PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	9.250	2766619	179930	50.018	54.932
2	11.573	2764629	147621	49.982	45.068
Total		5531248	327551	100.000	100.000

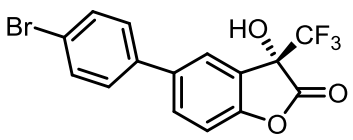
<Chromatogram>



PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	8.960	414918	28844	1.582	1.978
2	11.313	25809893	1429033	98.418	98.022
Total		26224811	1457877	100.000	100.000



3u

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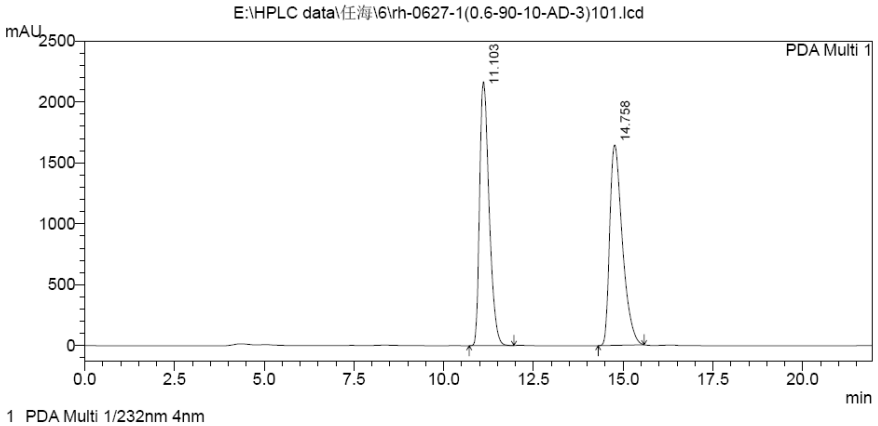


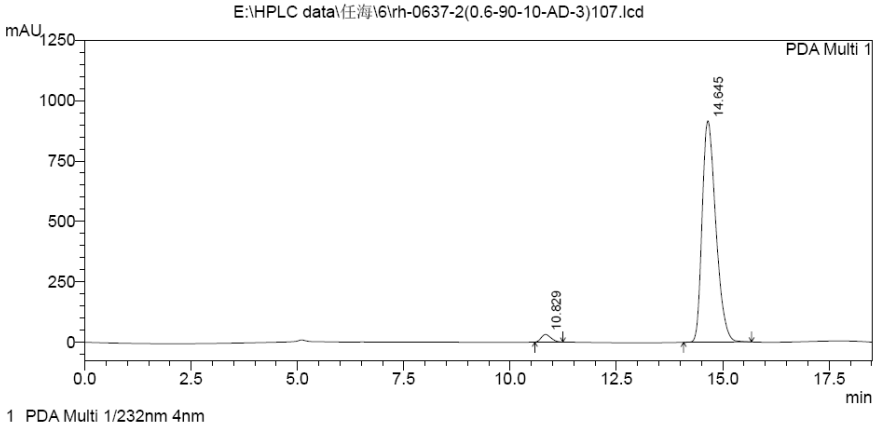
1 PDA Multi 1/232nm 4nm

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.103	39892171	2165513	49.688	56.819
2	14.758	40393747	1645751	50.312	43.181
Total		80285919	3811264	100.000	100.000

<Chromatogram>

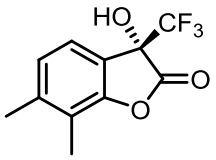


1 PDA Multi 1/232nm 4nm

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	10.829	508071	31610	2.418	3.337
2	14.645	20507939	915720	97.582	96.663
Total		21016010	947330	100.000	100.000



3v

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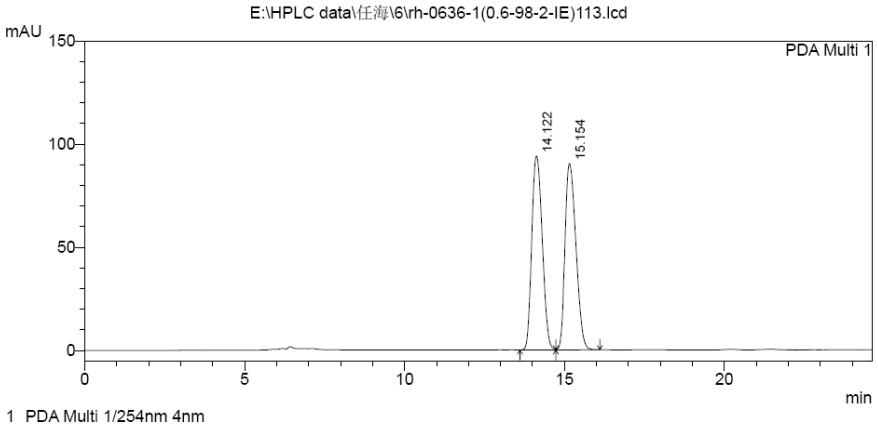


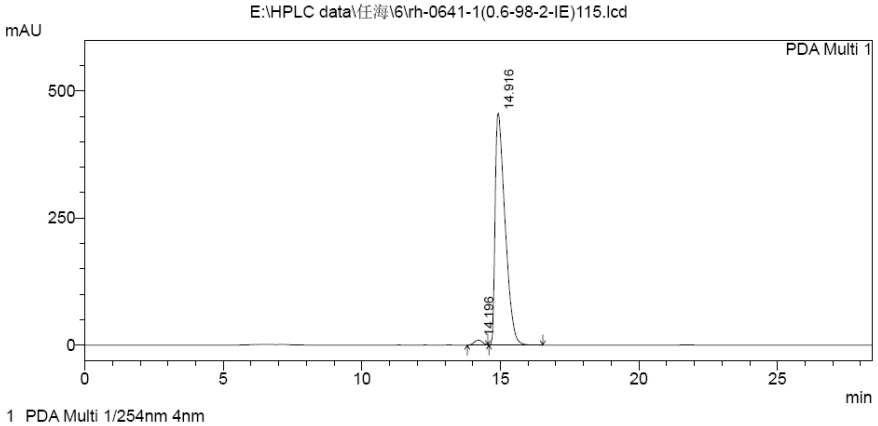
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.122	2143934	94019	49.963	50.977
2	15.154	2147105	90415	50.037	49.023
Total		4291039	184434	100.000	100.000

<Chromatogram>



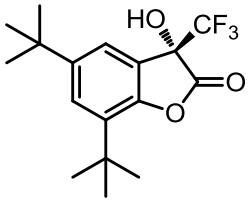
1 PDA Multi 1/254nm 4nm

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	14.196	188831	9329	1.641	2.005
2	14.916	11317367	456074	98.359	97.995
Total		11506198	465403	100.000	100.000

HPLC spectra of the Grame-scale experiment.



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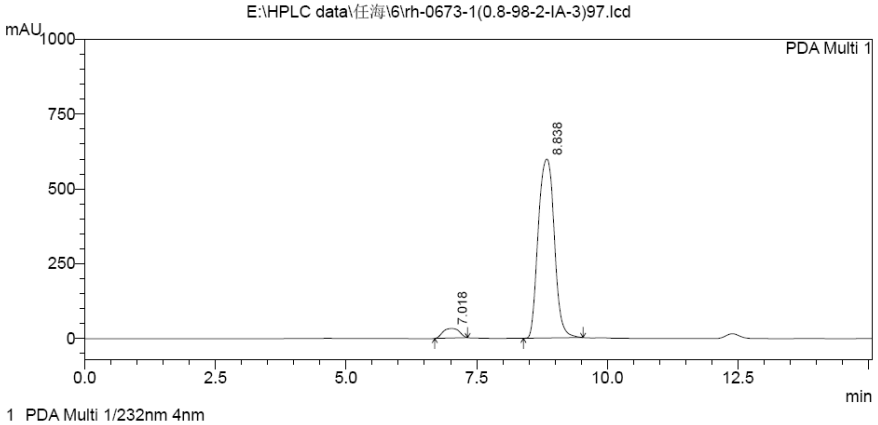


1 PDA Multi 1/232nm 4nm

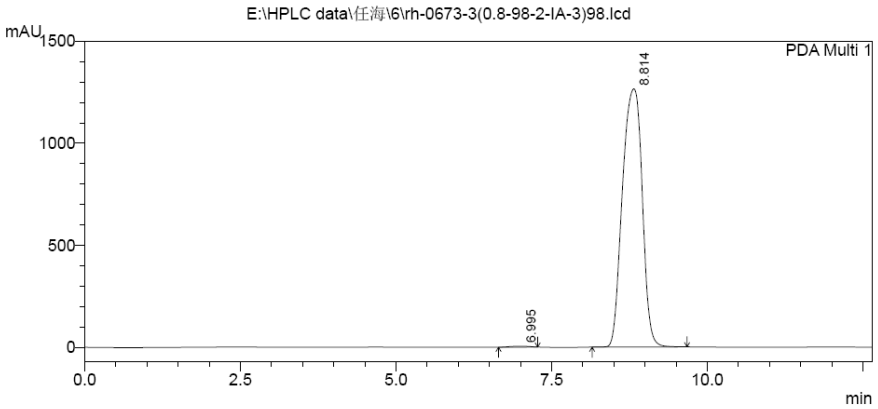
<Results>

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	7.018	694342	31598	5.157	5.020
2	8.838	12769723	597839	94.843	94.980
Total		13464065	629436	100.000	100.000

<Chromatogram>



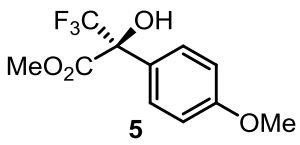
1 PDA Multi 1/232nm 4nm

<Results>

PeakTable

PDA Ch1 232nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	6.995	89626	4013	0.319	0.316
2	8.814	28015716	1265513	99.681	99.684
Total		28105342	1269526	100.000	100.000



5

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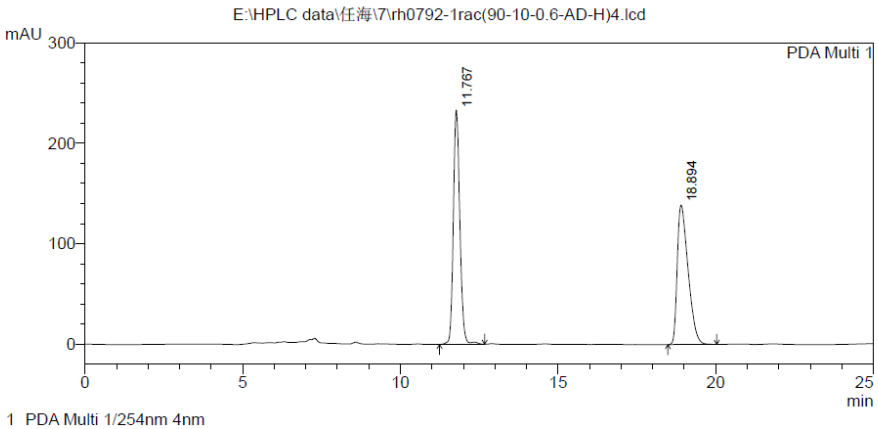

1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	11.767	3340701	233243	50.181	62.668
2	18.894	3316654	138946	49.819	37.332
Total		6657355	372188	100.000	100.000

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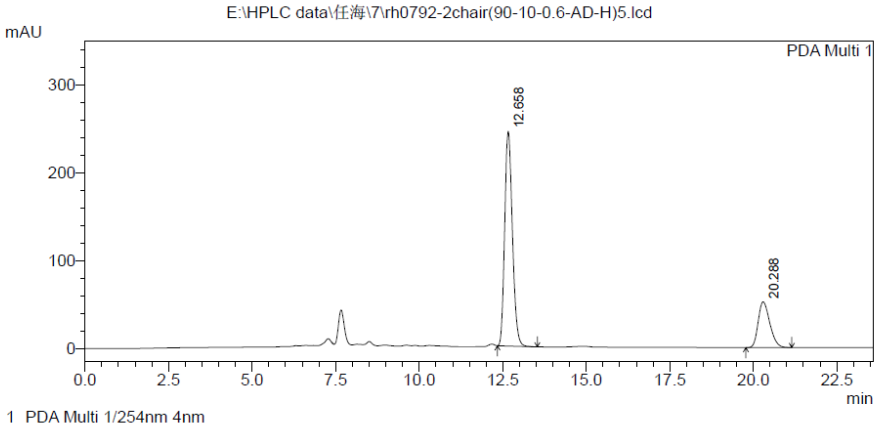


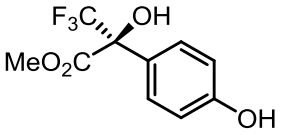
1 PDA Multi 1/254nm 4nm

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	12.658	3918174	244390	75.673	82.433
2	20.288	1259575	52079	24.327	17.567
Total		5177749	296470	100.000	100.000



3o'

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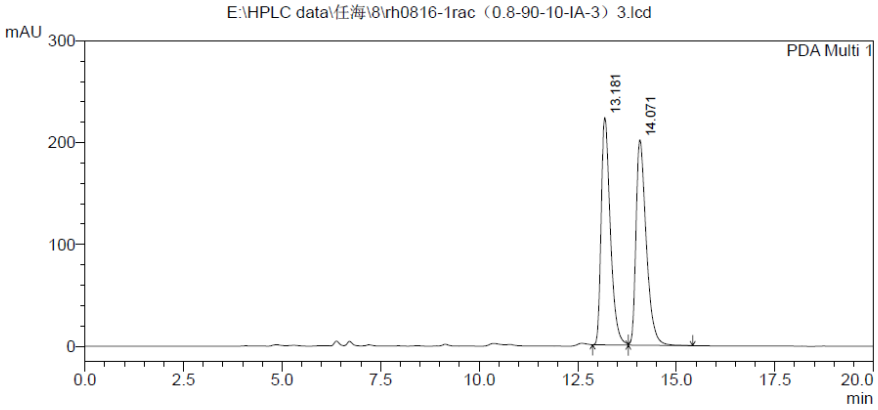

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.181	3602606	223452	49.692	52.565
2	14.071	3647256	201644	50.308	47.435
Total		7249862	425096	100.000	100.000

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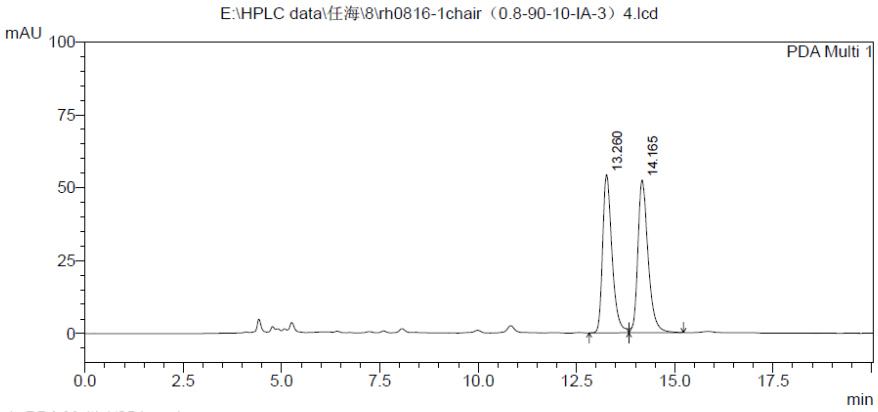

<Results>

PeakTable

PDA Ch1 254nm 4nm

Peak#	Ret. Time	Area	Height	Area %	Height %
1	13.260	902785	54251	48.805	50.909
2	14.165	946978	52315	51.195	49.091
Total		1849763	106566	100.000	100.000