Supporting Information

Catalytic asymmetric synthesis of enantioenriched β-nitronitrile bearing a C-CF_3 stereogenic center

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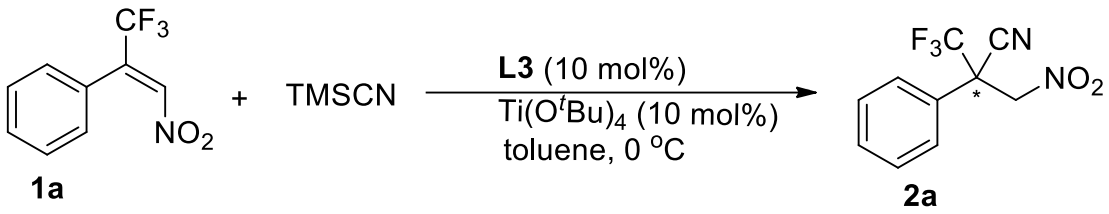
Contents

1. Effect of additives on asymmetric hydrocyanation reaction of β-CF_3-β-nitroolefins

Table S1. Effect of additives on asymmetric hydrocyanation reaction using the L3: Ti(O*t*Bu)$_4$ catalyst [a]

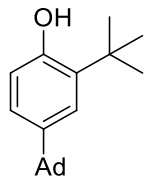


Entry	additive loading (mol%)	temp (°C)	time (h)	yield[b] (%)	*ee*[c] (%)
1	4-phenylpyridine-*N*-oxide (20 mol%)	0	20	90	83
2	*t*-BuOH (20 mol%)	0	20	92	84
3	2-*tert*-butylphenol (20 mol%)	0	16	93	87
4	4-*tert*-butylphenol (20 mol%)	0	16	93	87
5	2,4-di-*tert*-butylphenol (20 mol%)	0	16	93	87
6	4-nitrophenol (20 mol%)	0	16	94	88
7	4-admantyl-2-*tert*-butylphenol (20 mol%)	0	24	89	87
8	4Å molecular sieves (100mg)	0	20	92	87
9	*t*-BuOK (20 mol %)	0	20	92	85

[a] Enantioselective hydrocyanation reaction of **1a** (0.1 mmol) was carried out with **L3**: Ti(O^{t}Bu)$_4$ catalyst (10 mol%) in toluene (1 mL) using TMSCN (0.20 mmol) as a source of cyanide. [b] Isolated yield. [c] *ee* were determined by chiral HPLC using OD-H column.

2. Characterization data of the products

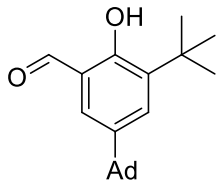
4-(Adamantan-1-yl)-2-(*tert*-butyl)phenol (A1):



White solid; m.p. = 95-97 °C; ^{1}H NMR (200 MHz, $CDCl_3$) δ = 7.27-7.21 (m,1H), 7.07-7.01 (m, 1H), 6.62-6.56 (m, 1H), 4.64 (s, 1H), 2.13-1.75 (m, br, 15H), 1.41(s, 9H) ppm; ^{13}C NMR (50 MHz,

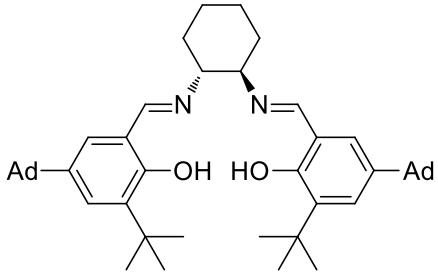
$CDCl_3$) δ = 151.8, 143.3, 135.1, 123.5, 123.1, 116.0, 43.4, 36.8, 35.7, 34.7, 29.6, 29.0 ppm; HRMS (ESI+): m/z Calcd. for $C_{20}H_{29}O$ $[M+H]^+$ 285.2218, Found: 285.2213.

5-(Adamantan-1-yl)-3-(*tert*-butyl)-2-hydroxybenzaldehyde (A2):



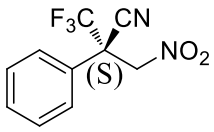
White solid; m.p. = 103-105 °C; ^{1}H NMR (200 MHz, $CDCl_3$) δ = 11.63 (s, 1H), 9.86 (s, 1H), 7.57-7.56 (m,1H), 7.32-7.30 (m,1H), 2.14-1.78 (m, br, 15H), 1.43 (s, 9H) ppm; ^{13}C NMR (50 MHz, $CDCl_3$) δ = 197.3, 159.0, 141.9, 137.4, 131.3, 127.8, 120.1, 43.2, 36.6, 35.6, 35.0, 29.3, 28.8 ppm; HRMS (ESI+): m/z Calcd. for $C_{21}H_{29}O_2$ $[M+H]^+$ 313.2168, Found: 313.2158.

(*R, R*)-(-)*N,N*-Bis(5-Adamantyl-3-*tert*-butylsalicylidene)-1,2-cyclohexanediamine (L5):



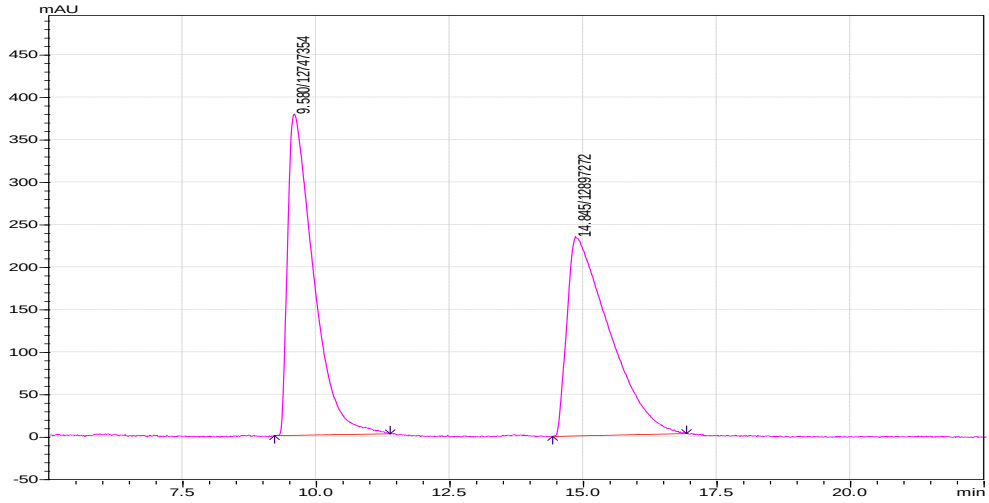
Yellow solid; m.p. = 150-152 °C; $[\alpha]_D^{29}$ = -155.7 (c 1.0, $CHCl_3$); ^{1}H NMR (200 MHz, $CDCl_3$) δ = 13.67 (s, 2H), 8.27 (s, 2H), 7.27-7.20 (m, 2H), 6.97-6.92 (m, 2H), 3.32-3.28 (m, br, 1H), 2.15-1.72(m, br, 38H), 1.41(s,18H) ppm; ^{13}C NMR (50 MHz, $CDCl_3$) δ = 166.0, 157.9, 140.3, 136.2, 126.1, 125.9, 117.9, 72.3, 43.2, 36.7, 35.4, 34.9, 33.2, 29.4, 28.9, 24.3 ppm; HRMS (ESI+): m/z Calcd. for $C_{48}H_{67}N_2O_2$ $[M+H]^+$ 703.5203, Found: 703.5214.

(*S*)-3,3,3-Trifluoro-2-(nitromethyl)-2-phenylpropanenitrile (2a):

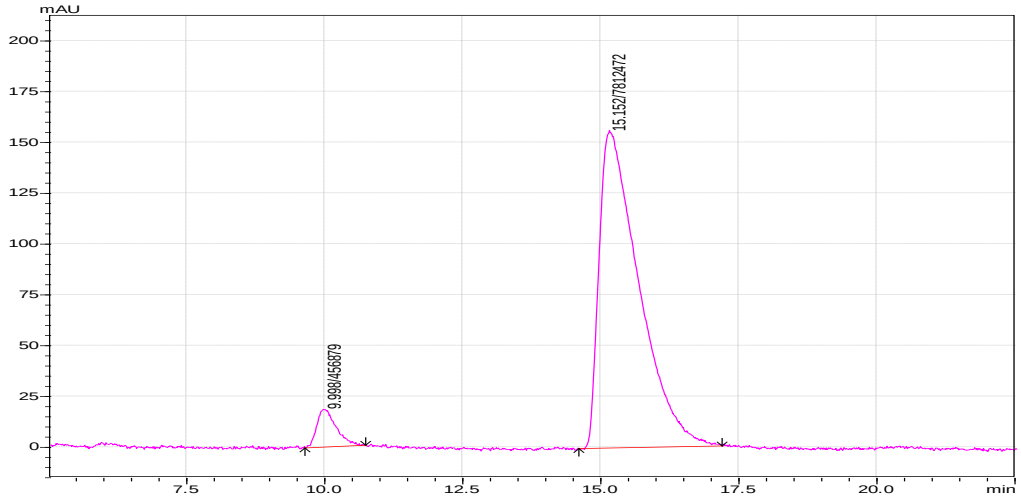


White solid; m.p. = 96-98 °C; $[\alpha]_D^{27}$ = +47.4 (c 1.0, $CHCl_3$); **After Crystallization**: $[\alpha]_D^{27}$ = +59.3 (c 1.0, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.62-7.51 (m, 5H), 5.28-5.20 (dd, *J* = 26, 14.5 Hz, 2H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.56 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 131.0, 129.7, 127.1, 125.7, 123.3, 121.0, 113.3, 73.8, 52.0 (q, *J* = 28.7 ppm; HRMS (ESI+): m/z Calcd. for $C_{10}H_8F_3N_2O_2$ $[M+H]^+$ 245.0538, Found: 245.0549; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 9.99 min, t_{r2} (major) = 15.15 min.

HPLC Chromatograms

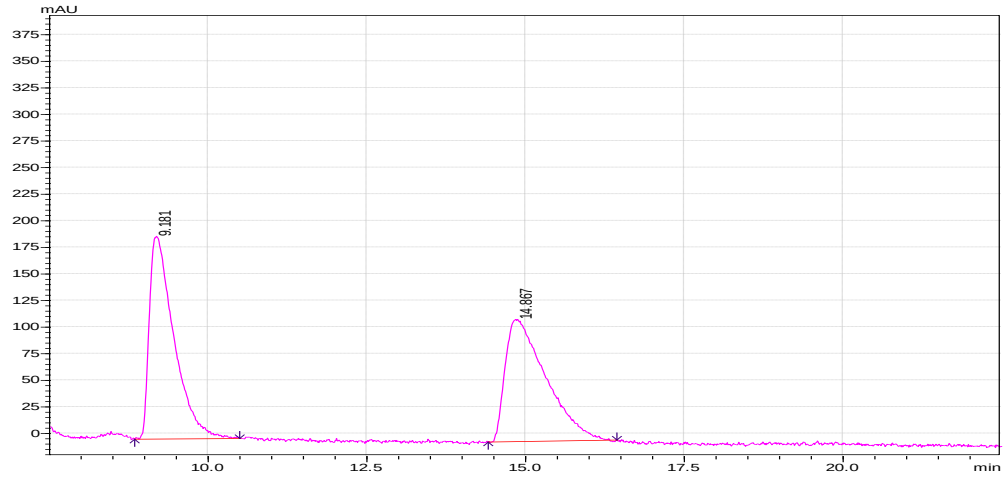


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.580	12747354	9.216	11.381	49.7077
2	14.845	12897272	14.421	16.928	50.2923

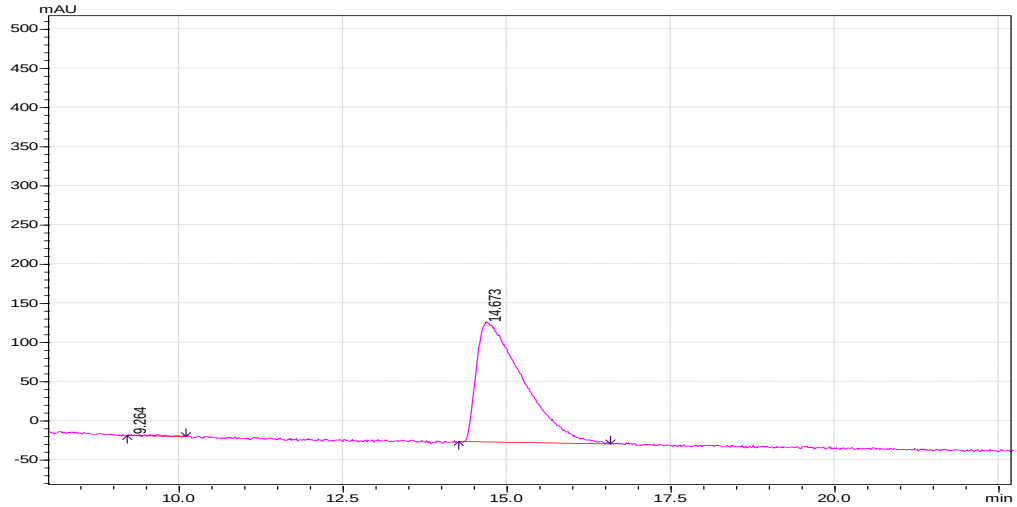


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.998	456879	9.643	10.741	5.5250
2	15.152	7812472	14.603	17.195	94.4750

After Crystallization

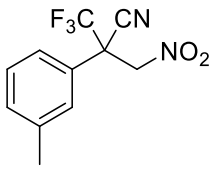


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.181	5150880	8.843	10.496	50.2092
2	14.867	5107967	14.411	16.437	49.7908



Peak	**Ret. Time**	**Area**	**Peak Start**	**Peak End**	**Area%**
1	9.264	19694	9.205	10.101	0.2604
2	14.673	7544724	14.261	16.576	99.7396

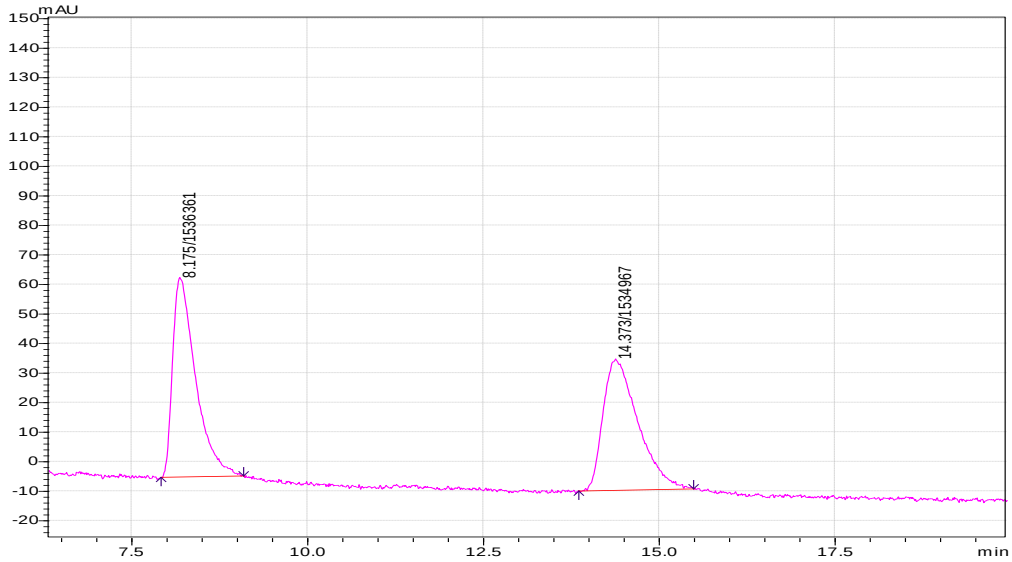
3,3,3-Trifluoro-2-(nitromethyl)-2-(*m*-tolyl)propanenitrile (2b):



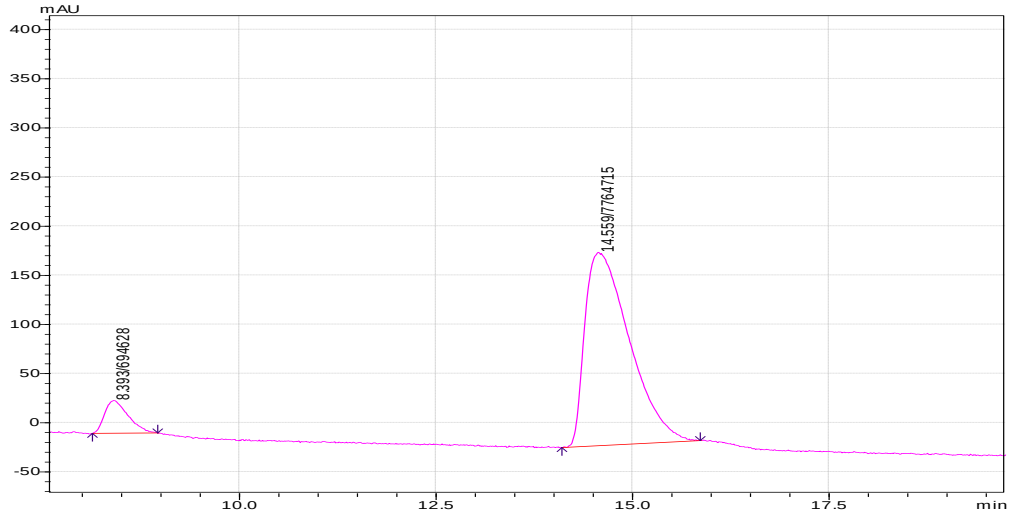
Colorless liquid; $[\alpha]_D^{27}$ = +16.5 (c = 0.2, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$) δ = 7.41-7.32 (m, 3H), 5.26-5.18 (dd, *J* = 26.5, 14 Hz, 2H), 2.42 (s, 3H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.52 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 139.9, 131.8, 129.5, 127.8, 125.5, 123.9,

123.3, 121.1, 113.4, 73.9, 52 (q, J = 28.8 Hz), 21.4 ppm; TOF–MS (ESI+) Anal. Calcd. for ($C_{11}H_9F_3N_2O_2$+Na) 281.06, Found: 281.08; CHIRALCEL OD-H column, hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 8.39 min, t_{r2} (major) = 14.55 min.

HPLC Chromatograms

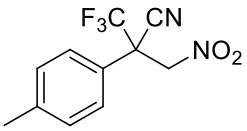


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	8.175	1536361	7.915	9.088	50.0227
2	14.373	1534967	13.856	15.488	49.9773



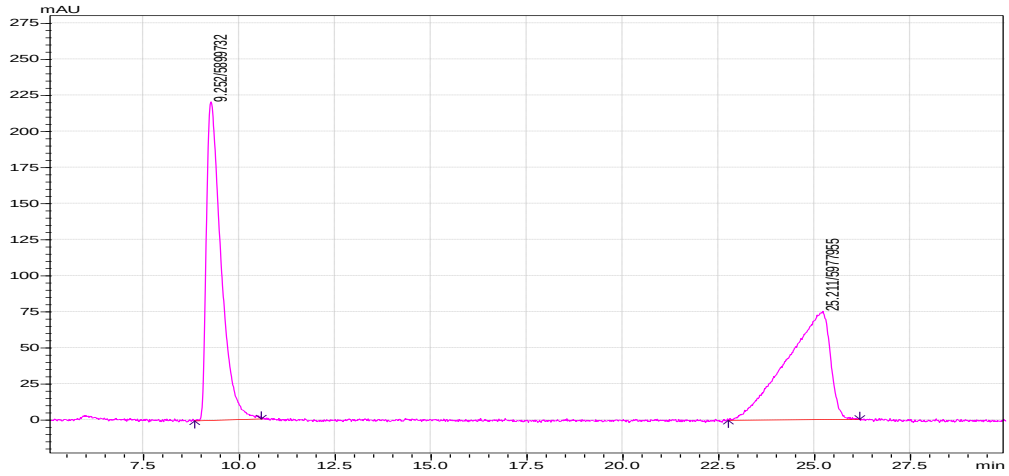
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	8.393	694628	8.128	8.960	8.2114
2	14.559	7764715	14.101	15.861	91.7886

3,3,3-Trifluoro-2-(nitromethyl)-2-(*p*-tolyl)propanenitrile (2c):

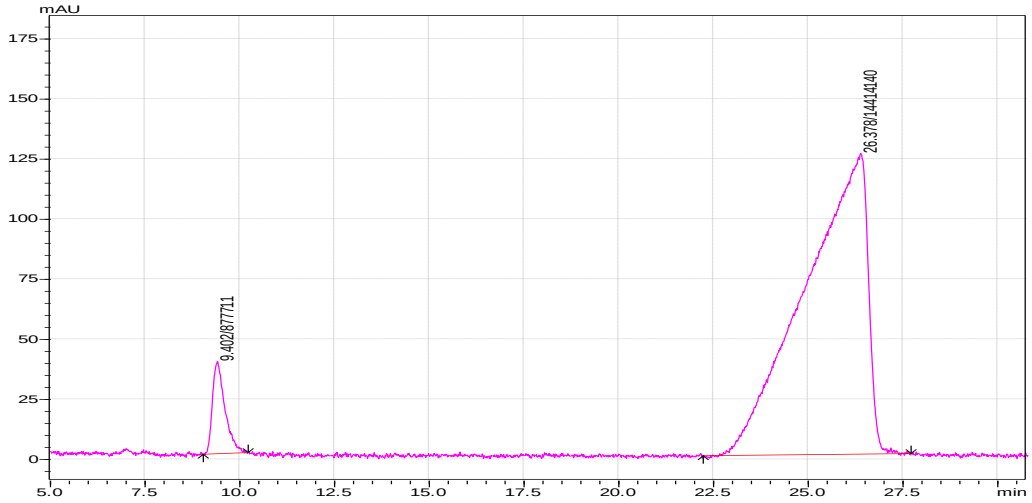


Colorless liquid; $[\alpha]_D^{27}$ = +59.5 (c 1.1, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$) δ = 7.49-7.47 (m, 2H), 7.31-7.30 (m, 2H), 5.24-5.17 (dd, *J* = 22.5, 14 Hz, 2H), 2.39 (s, 3H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.78 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 141.4, 130.4, 126.9, 123.3, 122.5, 121.1, 113.4, 73.9, 51.9, 51.6, 21.0 ppm; HRMS (ESI+): m/z Calcd. for $C_{11}H_{10}F_3N_2O_2$ $[M+H]^+$ 259.0694, Found: 259.0680; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 9.40 min, t_{r2} (major) = 26.37 min.

HPLC Chromatograms

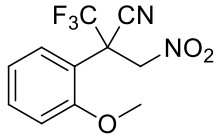


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.252	5899732	8.832	10.571	49.6707
2	25.211	5977955	22.752	26.176	50.3293



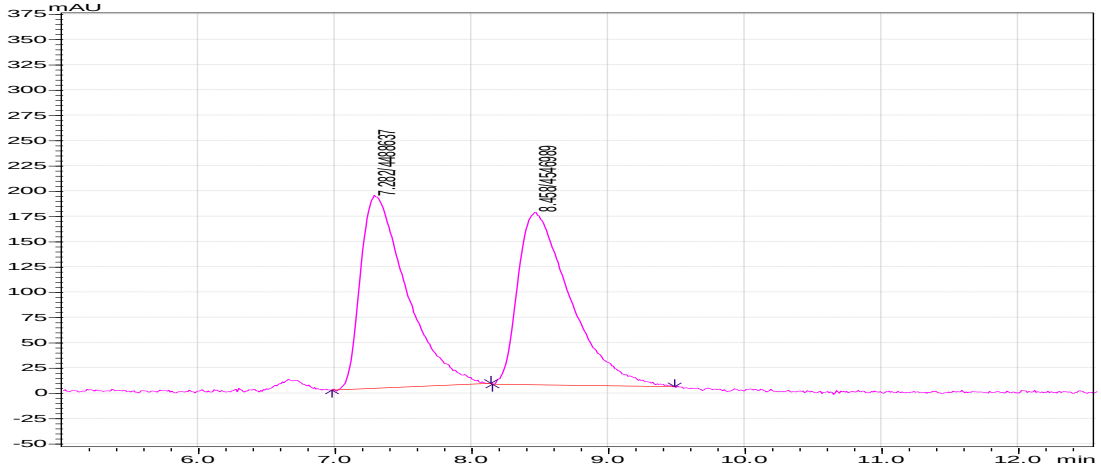
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.402	877711	9.035	10.219	5.7397
2	26.378	14414140	22.229	27.712	94.2603

3,3,3-Trifluoro-2-(2-methoxyphenyl)-2-(nitromethyl)propanenitrile (2d):

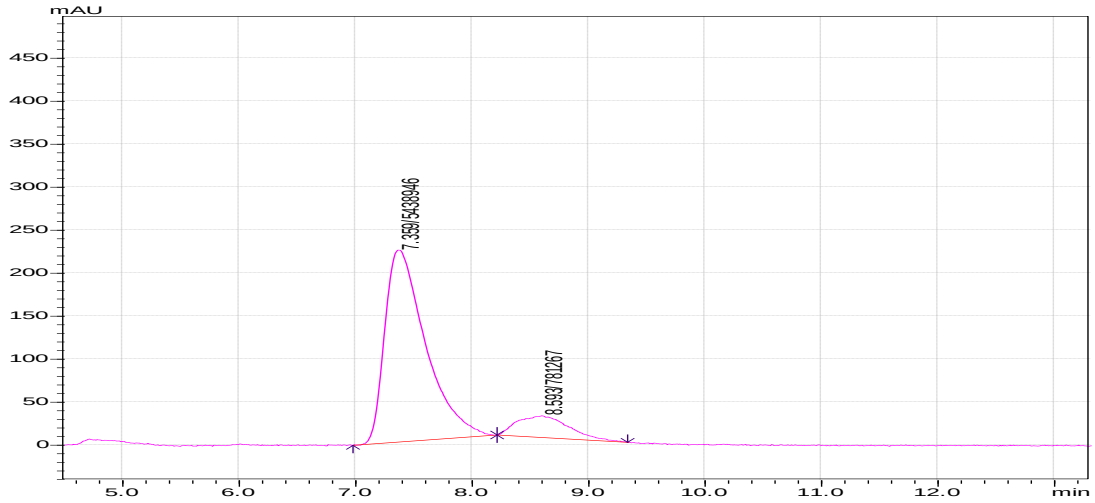


White solid; $[\alpha]_D^{27}$ = +21.7 (c 0.2, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$) δ = 7.75-7.73 (d, *J* = 8 Hz, 1H), 7.48-7.45 (m, 1H), 7.12-7.09 (t, *J* = 15.5, 7.5 Hz, 1H), 6.99-6.97 (d, *J* = 8 Hz, 1H) 5.92-5.89 (d, *J* = 14.5 Hz, 1H), 5.11-5.08 (d, *J* = 14.5 Hz, 1H), 3.83 (s, 3H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.11 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 157.2, 132.3, 131.8, 123.7, 121.8, 121.4, 114.8, 113.8, 112.6, 73.4, 55.7, 51.7 ppm; HRMS (ESI+): m/z Calcd. for $C_{11}H_{10}F_3N_2O_3$ $[M+H]^+$ 275.0644, Found: 275.0644; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (major) = 7.35 min, t_{r2} (minor) = 8.59 min.

HPLC Chromatograms

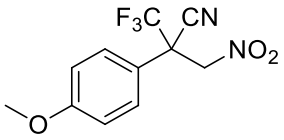


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	7.282	4488637	6.976	8.139	49.6771
2	8.458	4546989	8.149	9.483	50.3229



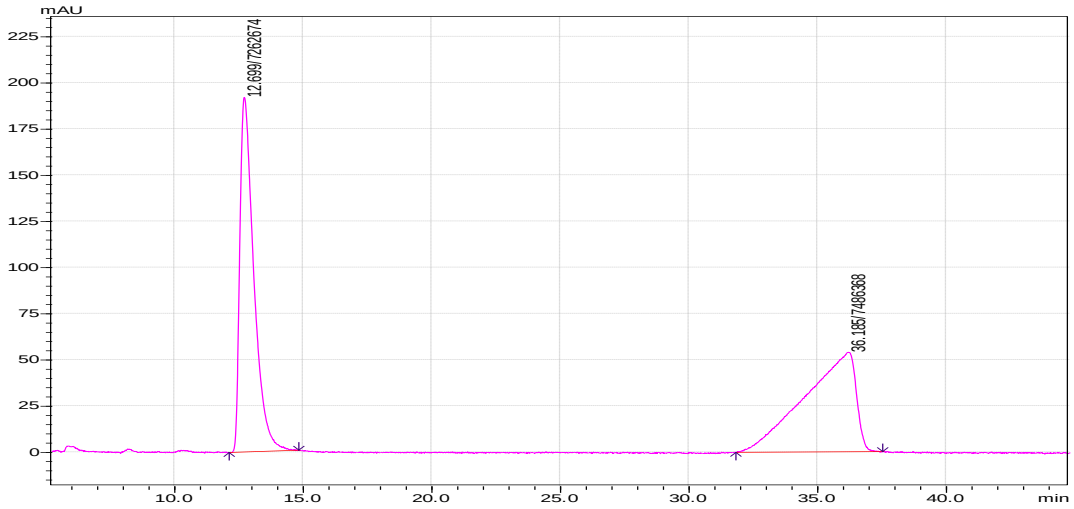
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	7.359	5438946	6.976	8.213	87.4399
2	8.593	781267	8.213	9.333	12.5601

3,3,3-Trifluoro-2-(4-methoxyphenyl)-2-(nitromethyl)propanenitrile (2e):

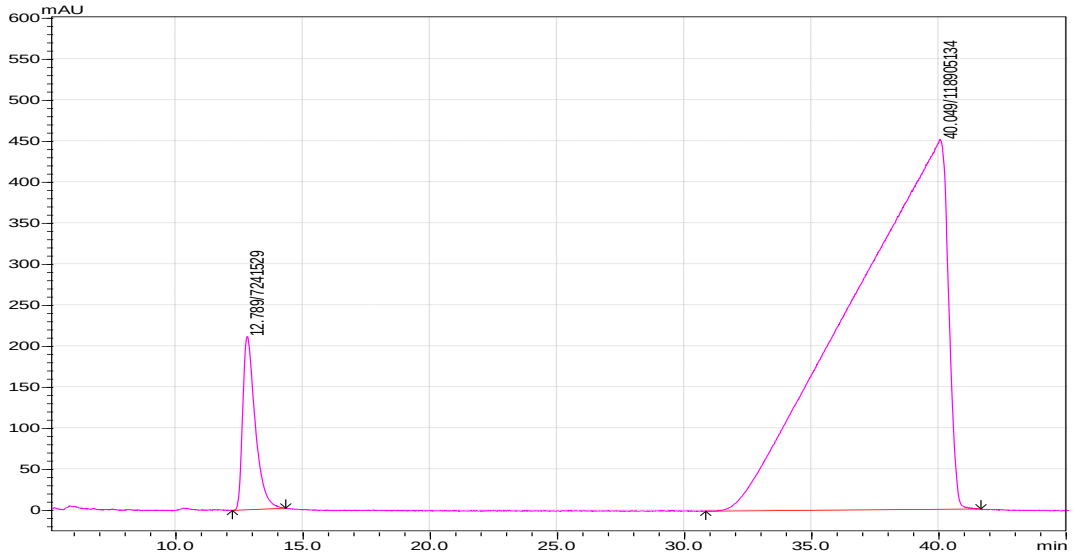


Colorless liquid; $[\alpha]_D^{27}$ = +46.7 (c 1.0, $CHCl_3$); ^1H NMR (200 MHz, $CDCl_3$) δ = 7.54-7.49 (m, 2H), 7.02-6.97 (m, 2H), 5.18 (s, 2H), 3.84 (s, 3H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -71.03 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 161.4, 128.5, 123.4, 121.1, 117.0, 115.0, 113.5, 74.0, 55.4, 51.5(q, *J* = 29.3 Hz) ppm; HRMS (ESI+): m/z Calcd. for $C_{11}H_{10}F_3N_2O_3$ $[M+H]^+$ 275.0644, Found: 275.0652; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 12.78 min, t_{r2} (major) = 40.04 min.

HPLC Chromatograms

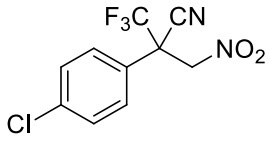


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	12.699	7262674	12.117	14.827	49.2417
2	36.185	7486368	31.819	37.525	50.7583



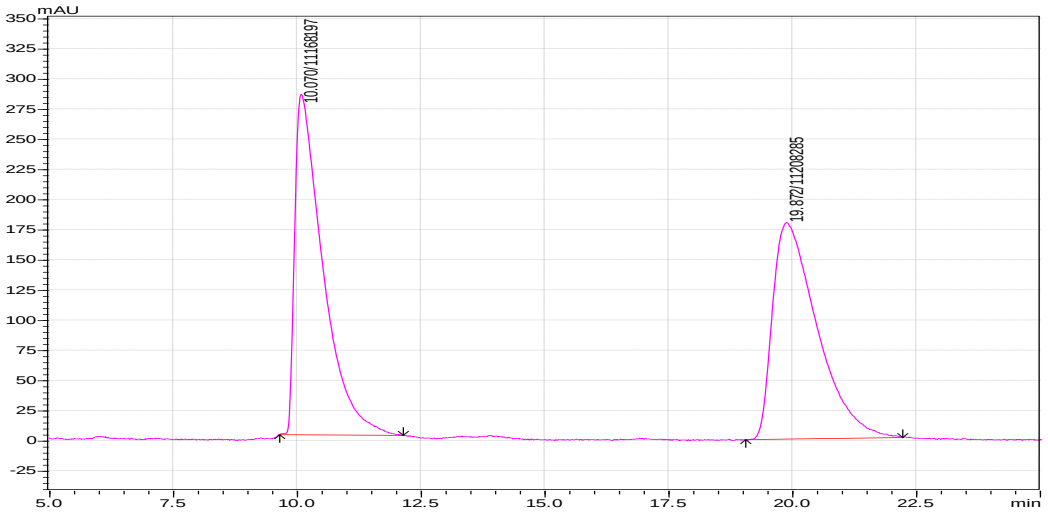
Peak	**Ret. Time**	**Area**	**Peak Start**	**Peak End**	**Area%**
1	12.789	7241529	12.213	14.315	5.7406
2	40.049	118905134	30.827	41.653	94.2594

2-(4-Chlorophenyl)-3,3,3-trifluoro-2-(nitromethyl)propanenitrile (2f):

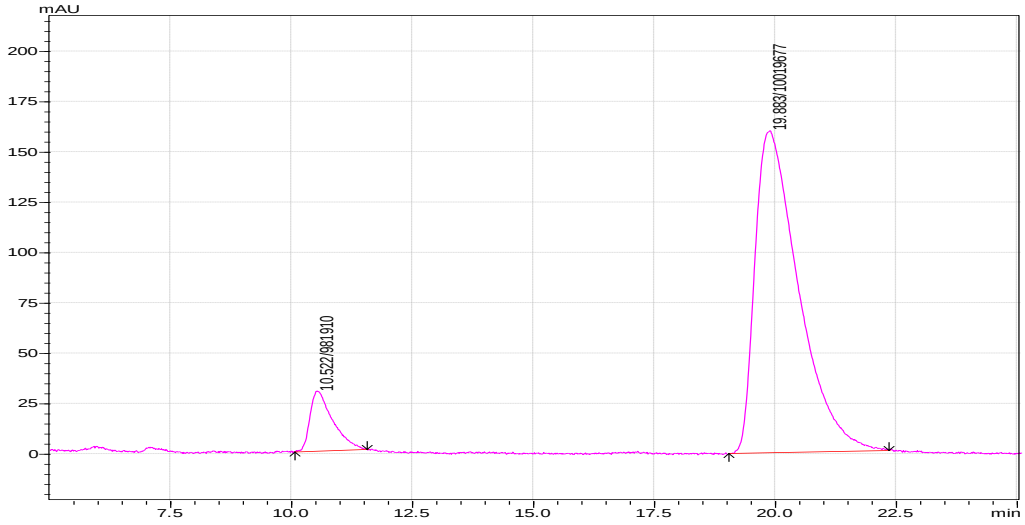


Colorless liquid; $[\alpha]_D^{27}$ = +36.9 (c 0.9, $CHCl_3$); ^1H NMR (200 MHz, $CDCl_3$) δ = 7.58-7.47 (m, 4H), 5.22 (s, 2H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.60 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 137.7, 130.0, 128.5, 124.2, 122.0 (q, *J* = 284.3 Hz), 113.0, 73.7, 51.6 (q, *J* = 29.3 Hz) ppm; HRMS (ESI+): m/z Calcd. for $C_{10}H_7F_3N_2O_2Cl$ $[M+H]^+$ 279.0148, Found: 279.0153; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 10.52 min, t_{r2} (major) = 19.88 min.

HPLC Chromatograms

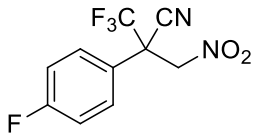


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	10.070	11168197	9.643	12.139	49.9104
2	19.872	11208285	19.051	22.219	50.0896



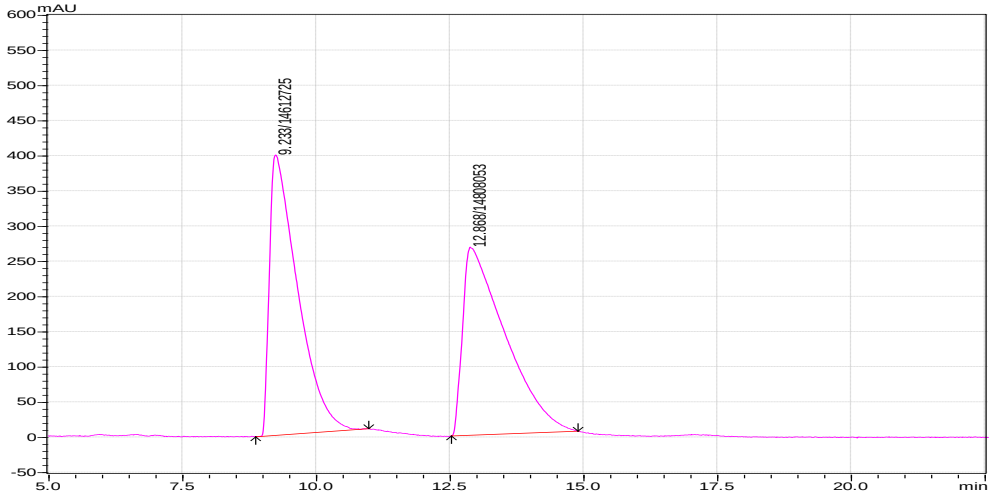
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	10.522	981910	10.069	11.563	8.9252
2	19.883	10019677	19.040	22.347	91.0748

3,3,3-Trifluoro-2-(4-fluorophenyl)-2-(nitromethyl)propanenitrile (2g)

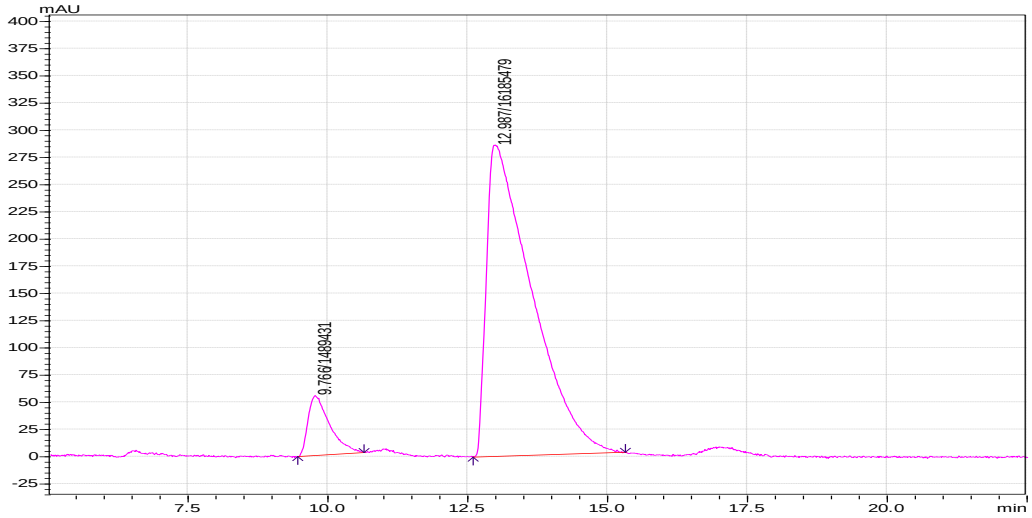


Colorless liquid; $[\alpha]_D^{27}$ = +15.4 (c 0.9, $CHCl_3$); ^1H NMR (200 MHz, $CDCl_3$) δ = 7.65-7.58 (m, 2H), 7.26-7.17 (m, 2H), 5.22 (s, 2H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.78 (s, 3F), -108.43 to -108.48 (m, 1F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 164.0 (d, *J* = 252.5 Hz), 129.4 (d, *J* = 7.5 Hz), 122.1 (q, *J* = 283.7 Hz), 121.5, 117.0 (d, *J* = 22.5 Hz), 113.2, 73.9, 51.5 (q, *J* = 29.3 Hz), ppm; HRMS (ESI+): m/z Calcd. for $C_{10}H_7F_4N_2O_2$ $[M+H]^+$ 263.0444, Found: 263.0442; CHIRALCEL OD-H column, hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 9.76 min, t_{r2} (major) = 12.98 min.

HPLC Chromatograms

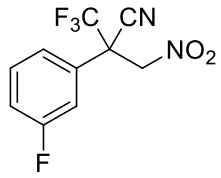


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.233	14612725	8.864	10.976	49.6680
2	12.868	14808053	12.523	14.891	50.3320



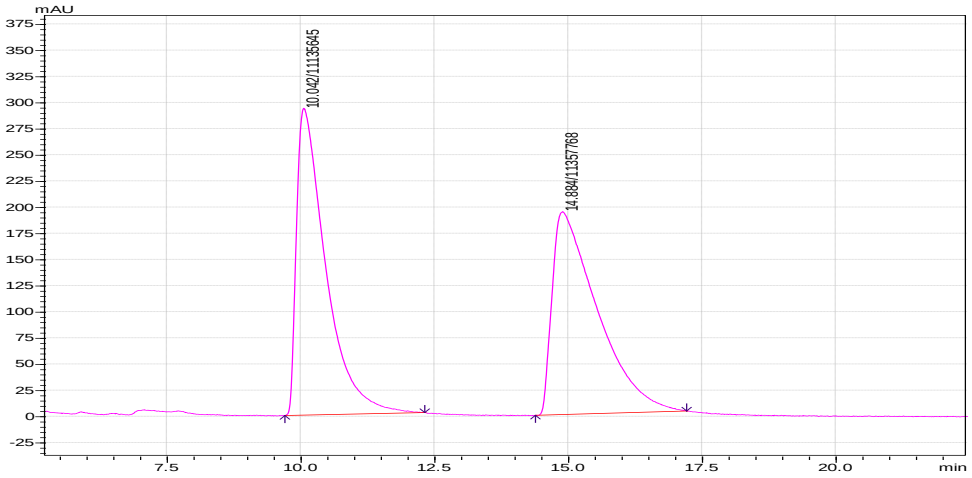
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.766	1489431	9.461	10.645	8.4268
2	12.987	16185479	12.597	15.317	91.5732

3,3,3-Trifluoro-2-(3-fluorophenyl)-2-(nitromethyl)propanenitrile (2h):

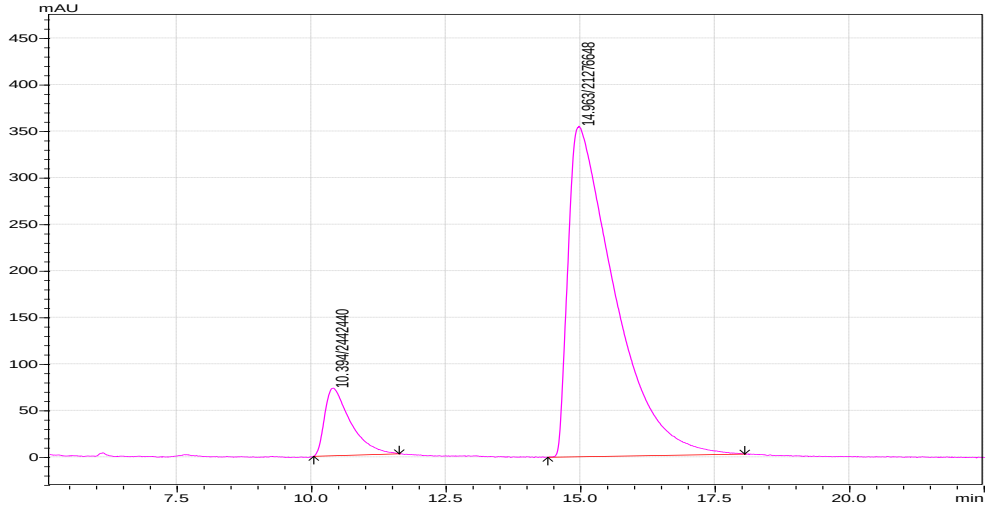


White solid; m.p. = 50-52 ºC; $[\alpha]_D^{27}$ = +18.2 (c 0.4, $CHCl_3$); ^1H NMR (200 MHz, $CDCl_3$) δ = 7.57-7.21 (m, 4H), 5.22 (s, 2H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.37 (s, 3F), -108.86 to -108.92 (m, 1F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 162.9 (d, *J* = 248.7), 131.5(d, *J* = 7.5 Hz), 127.9 (d, *J* = 6.2 Hz), 123.1, 122.9, 120.8 , 118.4 (d, *J* = 20 Hz), 114.9 (d, *J* = 25 Hz), 112.9, 73.7, 51.8, 51.6 ppm; HRMS (ESI+): m/z Calcd. for $C_{10}H_7F_4N_2O_2$ $[M+H]^+$ 263.0444, Found: 263.0435; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 10.39 min, t_{r2} (major) = 14.96 min.

HPLC Chromatograms

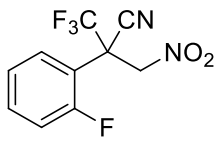


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	10.042	11135645	9.696	12.309	49.5063
2	14.884	11357768	14.379	17.205	50.4937



Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	10.394	2442440	10.037	11.627	10.2974
2	14.963	21276648	14.389	18.048	89.7026

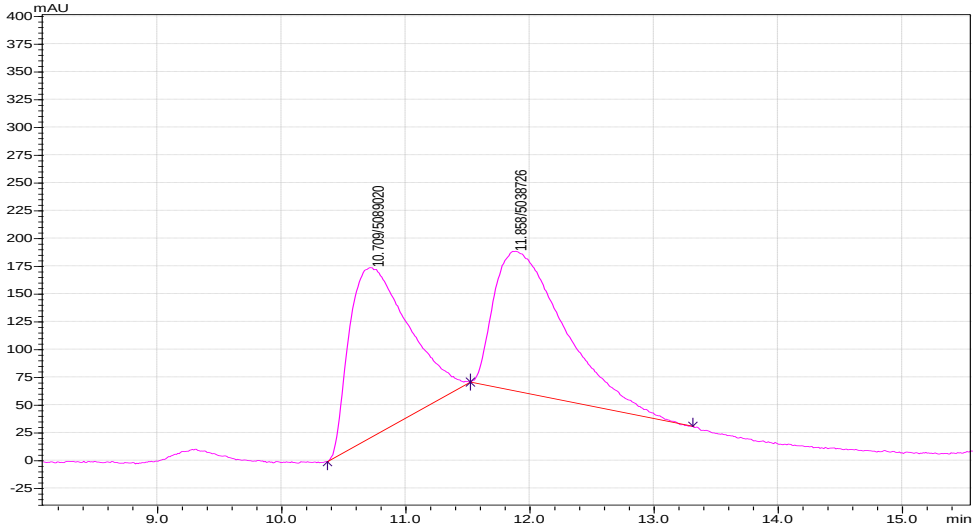
3,3,3-Trifluoro-2-(2-fluorophenyl)-2-(nitromethyl)propanenitrile (2i)



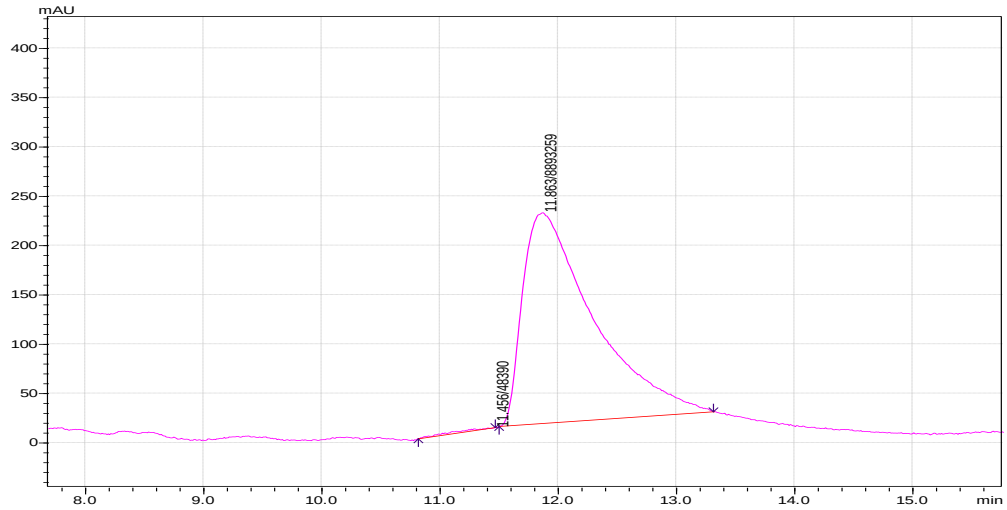
White solid; m.p. = 72-74 ^{o}C; $[\alpha]_D^{27}$ = +15.0 (c 0.2, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.83-7.80 (m, 1H), 7.56-7.52 (m, 1H), 7.36-7.33 (m, 1H), 7.21-7.17 (m, 1H), 5.68-5.65 (d, *J* = 14.5 Hz, 1H), 5.21-5.17 (dd, *J* = 14.5, 2.5 Hz, 1H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.58 (s, 3F), -

106.68 (s, 1F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 160.0 (d, *J* = 249.1 Hz),133.4 (d, *J* = 9 Hz), 131.6, 125.6 (d, *J* = 16.2 Hz), 123.2, 120.9, 117.6 (d, *J* = 23.2 Hz), 113.2, 113.1 (d, *J* = 10.2 Hz), 72.8 (d, *J* = 10.2 Hz), 51.1 ppm; HRMS (ESI+): m/z Calcd. for $C_{10}H_7F_4N_2O_2$ $[M+H]^+$ 263.0444, Found: 263.0445; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 90:10, flow rate 0.8 mL/min, t_{r1} (minor) = 10.39 min, t_{r2} (major) = 14.96 min.

HPLC Chromatograms

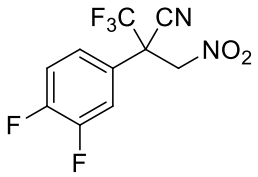


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	10.709	5089020	10.368	11.520	50.2483
2	11.858	5038726	11.520	13.312	49.7517



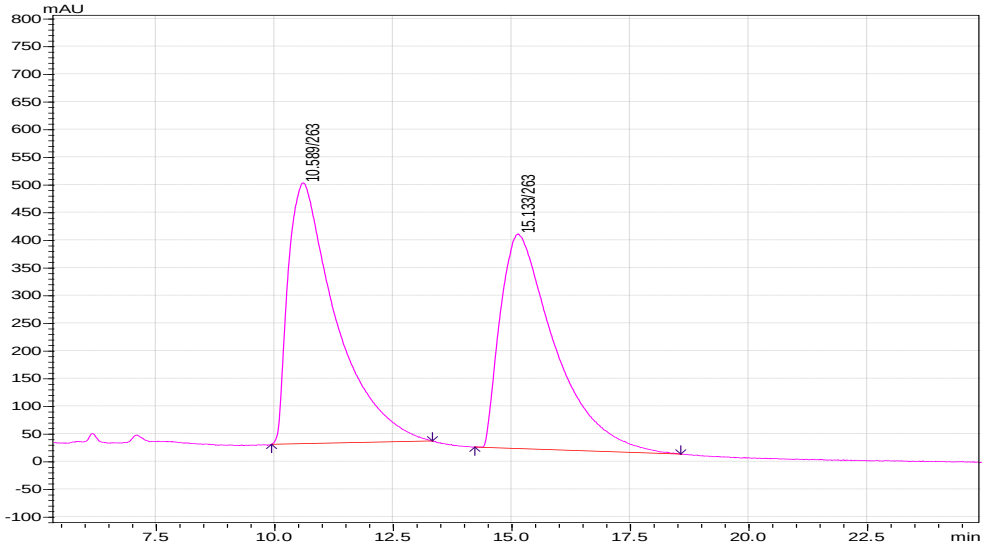
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	11.456	48390	10.816	11.467	0.5412
2	11.863	8893259	11.499	13.312	99.4588

2-(3,4-Difluorophenyl)-3,3,3-trifluoro-2-(nitromethyl)propanenitrile (2j)

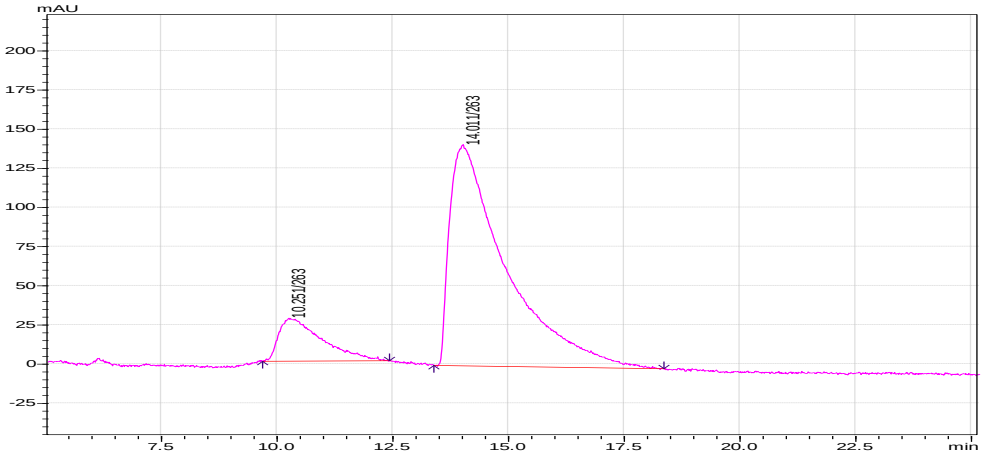


Colorless liquid; $[\alpha]_D^{30}$ = +32.4 (c 0.8, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$) δ = 7.50-7.32 (m, 3H), 5.24-5.16 (dd, *J* = 23.5, 14.5 Hz, 2H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.54 (s, 3F), -131.93 to -132.04 (m, 1F), -132.49 to -132.59 (m, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 152.9 (d, *J* = 11.3 Hz), 151.7 (d, *J* = 12.2 Hz), 150.9 (d, *J* = 11.2 Hz), 149.7 (d, *J* = 12.2 Hz), 123.9, 123.0, 122.5, 120.7, 119.0 (d, *J* = 17.8 Hz), 117.2 (d, *J* = 20.1 Hz), 112.7, 73.6, 51.3 (q, *J* = 29.7 Hz) ppm; HRMS (ESI+): m/z Calcd. for $C_{10}H_6F_5N_2O_2$ $[M+H]^+$ 281.0349, Found: 281.0345; CHIRALCEL OD-H column, hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 10.25 min, t_{r2} (major) = 14.01 min.

HPLC Chromatograms

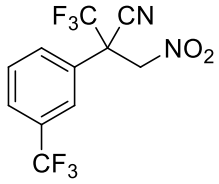


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	10.589	33082550	9.931	13.323	51.6594
2	15.133	30957186	14.219	18.560	48.3406



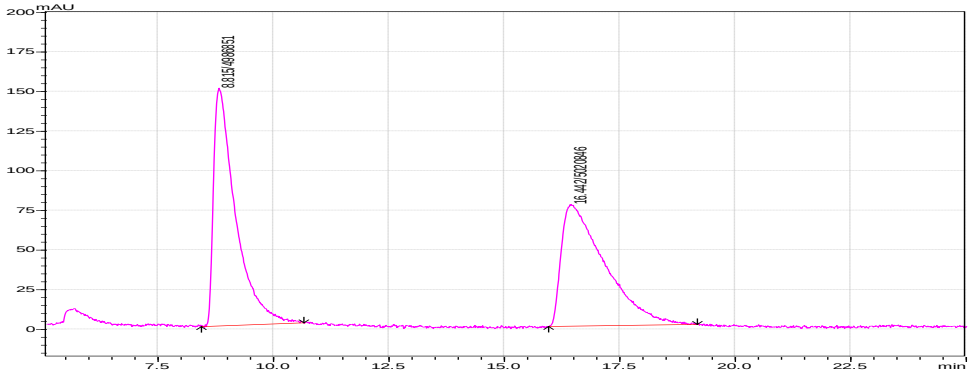
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	10.251	1783763	9.685	12.427	13.0371
2	14.011	11898442	13.387	18.357	86.9629

3,3,3-Trifluoro-2-(nitromethyl)-2-(3-(trifluoromethyl)phenyl)-propanenitrile (2k):

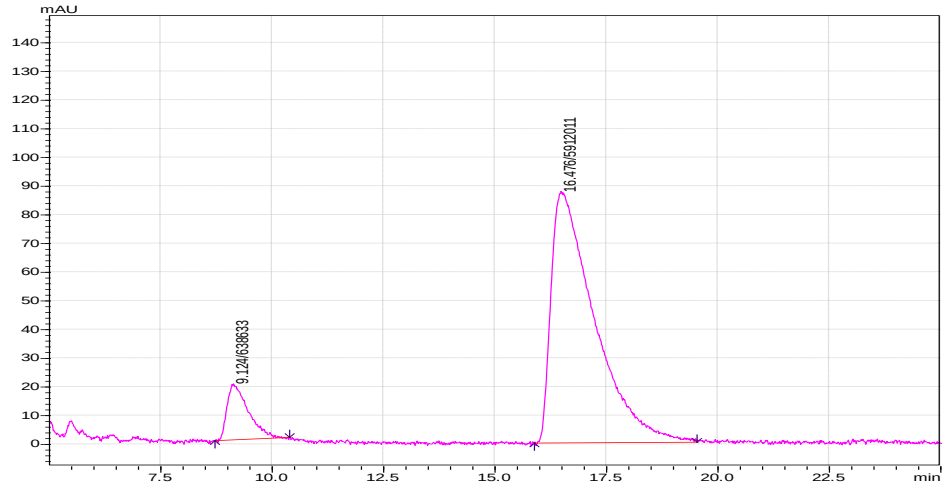


White solid; m.p. = 86-88 °C; $[\alpha]_D^{27}$ = +13.5 (c 0.4, $CHCl_3$); ^1H NMR (500 MHz, $CDCl_3$) δ = 7.85-7.82 (m, 3H), 7.72-7.68(m, 1H), 5.29-5.28 (m, 2H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -62.89 (s, 3F), -70.33 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 132.5(q, *J* = 33.1 Hz), 130.6, 130.5, 128.1, 127.1, 126.3, 124.1, 124.0, 123.0, 122.0, 120.8, 112.7, 73.6, 52.9 (q, *J* = 30.0 Hz), ppm; HRMS (ESI+): m/z Calcd. for $C_{11}H_7F_6N_2O_2$ $[M+H]^+$ 313.0412, Found: 313.0404; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 9.12 min, t_{r2} (major) = 16.47 min.

HPLC Chromatograms

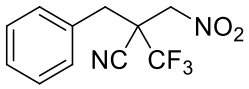


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	8.815	4986851	8.437	10.656	49.8302
2	16.442	5020846	15.957	19.179	50.1698



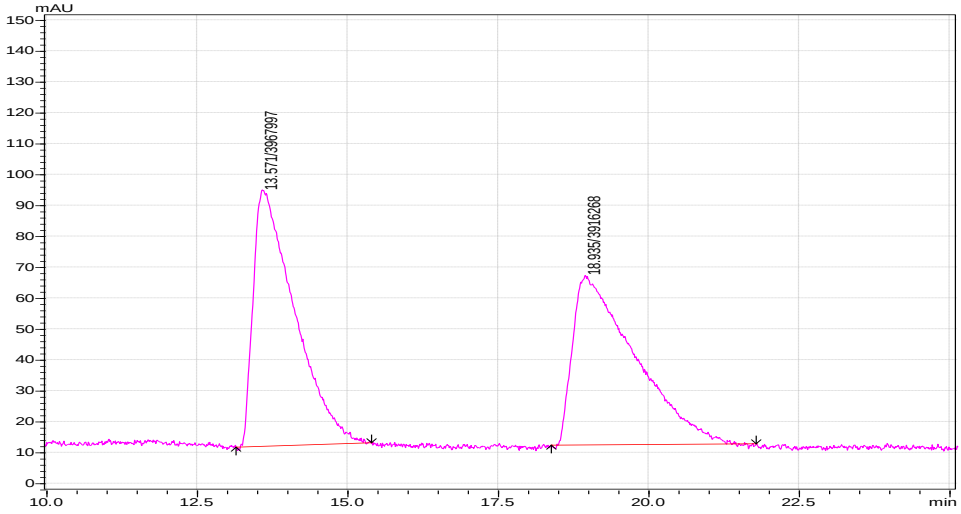
Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	9.124	638633	8.715	10.389	9.7492
2	16.476	5912011	15.883	19.531	90.2508

2-Benzyl-3,3,3-trifluoro-2-(nitromethyl)propanenitrile (2l):

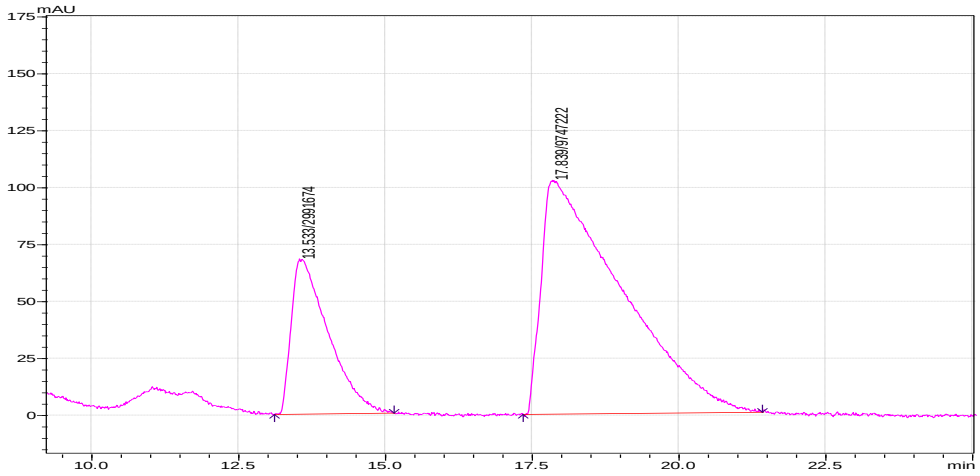


White solid; m.p. = 56-58 ^{o}C; $[\alpha]_D^{27}$ = +2.6 (c 0.5, $CHCl_3$); ^{1}H NMR (500 MHz, $CDCl_3$) δ = 7.42-7.36 (m, 5H), 4.72-4.69 (d, *J* = 13.5 Hz, 1H), 4.58-4.55 (d, *J* = 13.5 Hz, 1H),3.47-3.44 (d, *J* = 14.5, 1H), 3.30-3.27 (d, *J* = 14 Hz, 1H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -70.37 (s, 3F) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ = 130.5, 130.0, 129.3, 129.1, 123.9, 121.6, 112.8, 72.8, 48.1, 47.9, 36.3 ppm; HRMS (ESI+): m/z Calcd. for $C_{11}H_{10}F_3N_2O_2$ $[M+H]^+$ 259.0694, Found: 259.0701; CHIRALCEL OD-H column, *n*-hexane/2-propanol = 80:20, flow rate 1 mL/min, t_{r1} (minor) = 13.53 min, t_{r2} (major) = 17.83 min.

HPLC Chromatograms

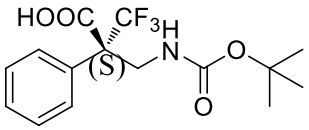


Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	13.571	3967997	13.141	15.392	50.3281
2	18.935	3916268	18.379	21.781	49.6719



Peak	Ret. Time	Area	Peak Start	Peak End	Area%
1	13.533	2991674	13.109	15.147	23.4846
2	17.839	9747222	17.344	21.419	76.5154

3. Synthesis of (*S*)-2-(((*tert*-Butoxycarbonyl)amino)methyl)-3,3,3-trifluoro-2-phenylpropanoic acid (5a):[1]



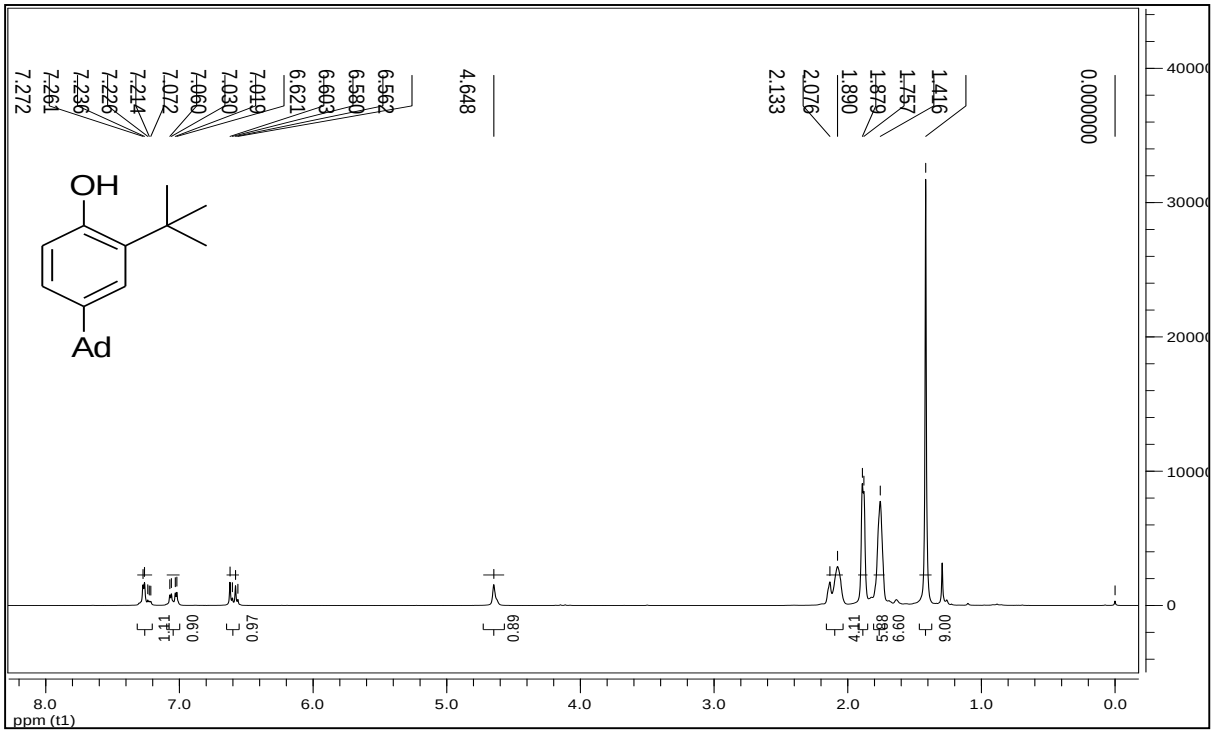
Zinc powder (15eq.) and 3 mL of 6 M HCl (aq.) were added to a stirring solution of (*S*)-3,3,3-trifluoro-2-(nitromethyl)-2-phenylpropanenitrile (**2a**) (0.5 mmol) in ethanol (5ml). After 1 h excess Zinc powder removed by filtration and ethanol was removed in vacuo. NaOH (10%) was added to the above mixture until pH 10. The aqueous layer was extracted with DCM (15 mL x 3). The organic layer was washed with brine, dried over anhydrous Na_2SO_4 and concentrated to give amine (**3a)** which was used for next step without purification.

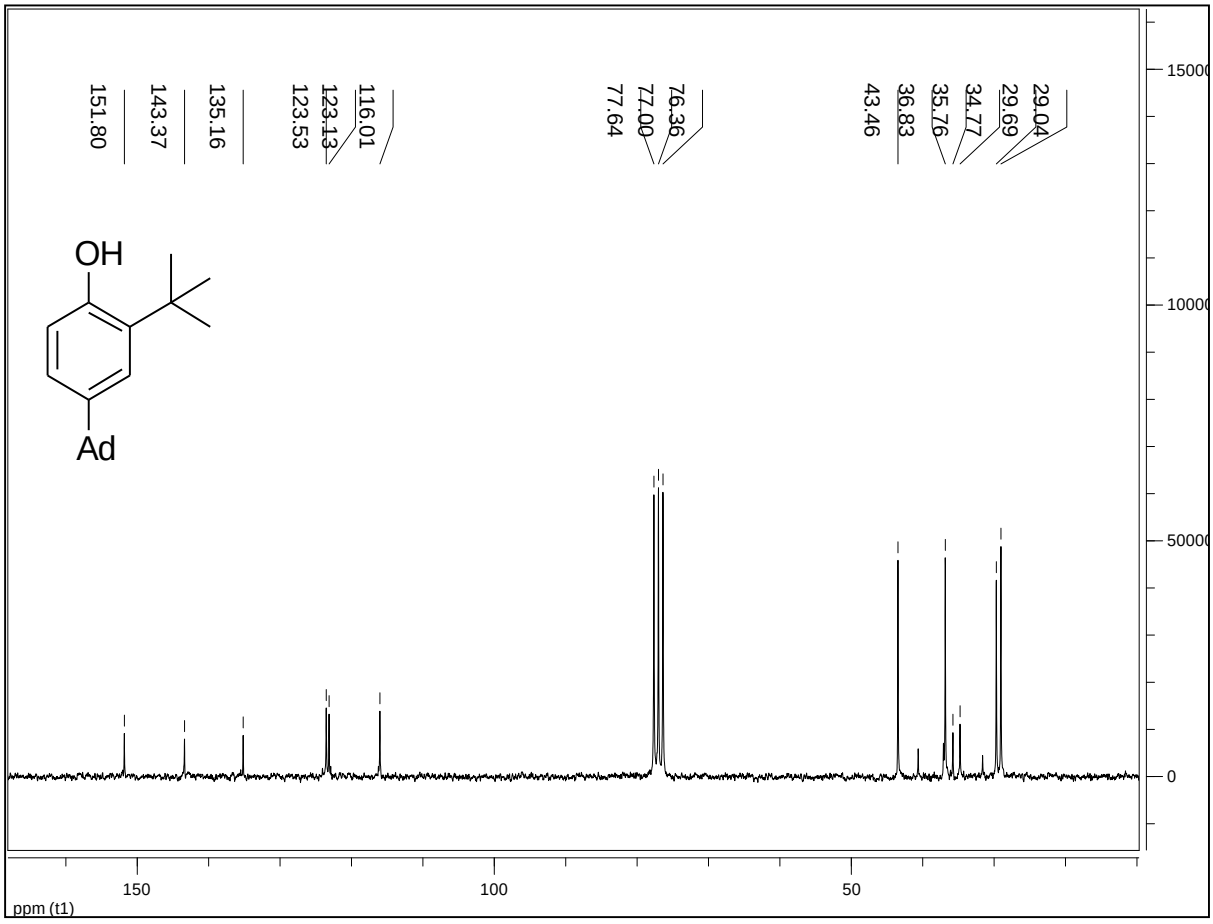
To the above crude amine was added 3 mL H_2SO_4 (75%) and heated under reflux for 2 h. The reaction mixture was allowed to cool to 0 ^oC and carefully maintain to pH 10 with 40% NaOH. Dioxane (3 mL) was added to above reaction mixture followed by $(Boc)_2O$ (1.1 eq. to **2a**). The solution was allowed to attain to room temperature and stirred for further one . The dioxane was removed in vacuo, the aqueous layer was acidified (pH 2) with 1 M $NaHSO_4$ and extracted with ethyl acetate (3 x 15 mL). The organic layer was dried and concentrated in vacuo. The residue was purified by silica gel chromatography using EtOAc/hexane to afford as a white solid (**5a)** (36% yield from **2a**).

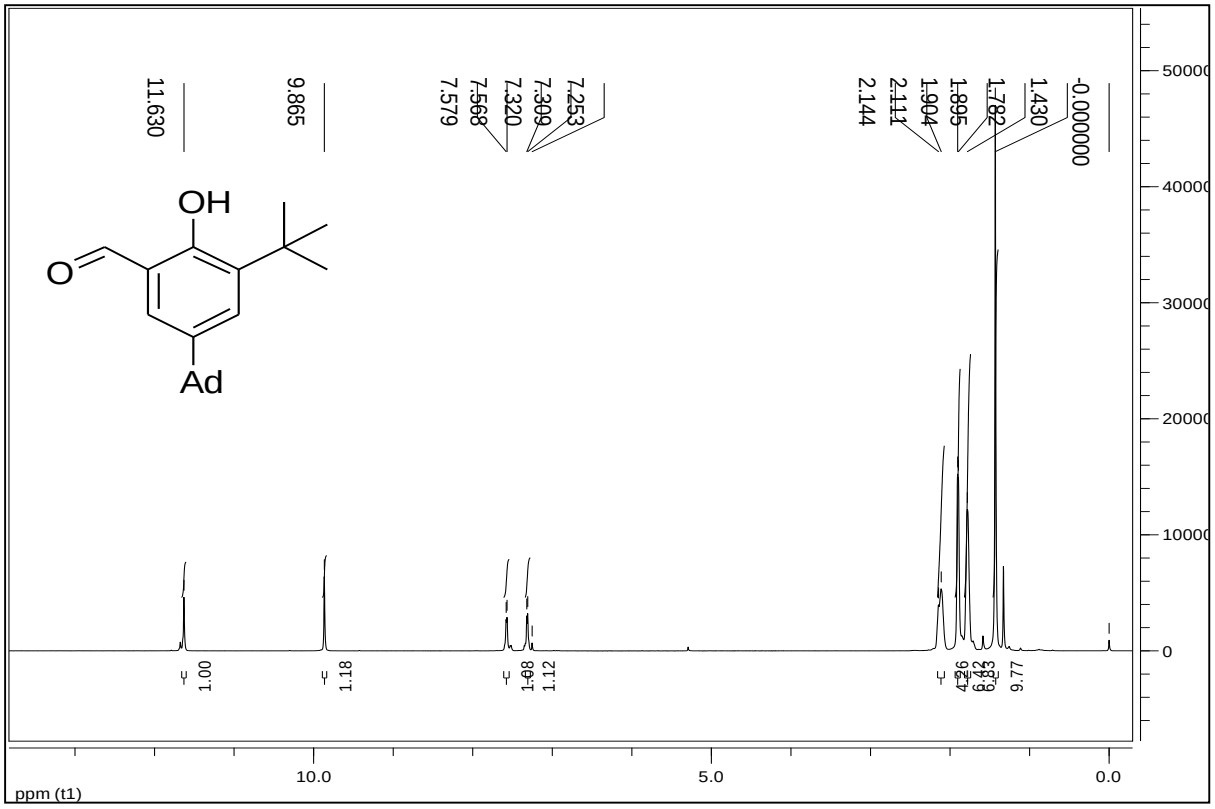
White solid; m.p. = 122-124 ^oC; $[\alpha]_D^{27}$ = +5.6 (c 0.9, CHCl3); ^1H NMR (200 MHz, CDCl3) δ = 7.39-7.35 (m, 5H), 5.32-5.26 (br, 1H), 3.94-3.91 (d, *J* = 6.2 Hz, 2H),1.32 (s, 9H) ppm; ^{19}F NMR (376 MHz, $CDCl_3$) δ = -65.23 (s, 3F); 13C NMR (125 MHz, CDCl3) δ = 170.1, 155.4, 132.6, 128.7, 128.5, 128.3, 127.9, 124.4, 79.5, 61.9 (q, *J* = 23.1 Hz), 43.6, 28.1 ppm; HRMS (ESI+) m/z Calcd. for $C_{15}H_{19}F_3NO_4$ $[M+H]^+$ 334.1266, Found: 334.1262.

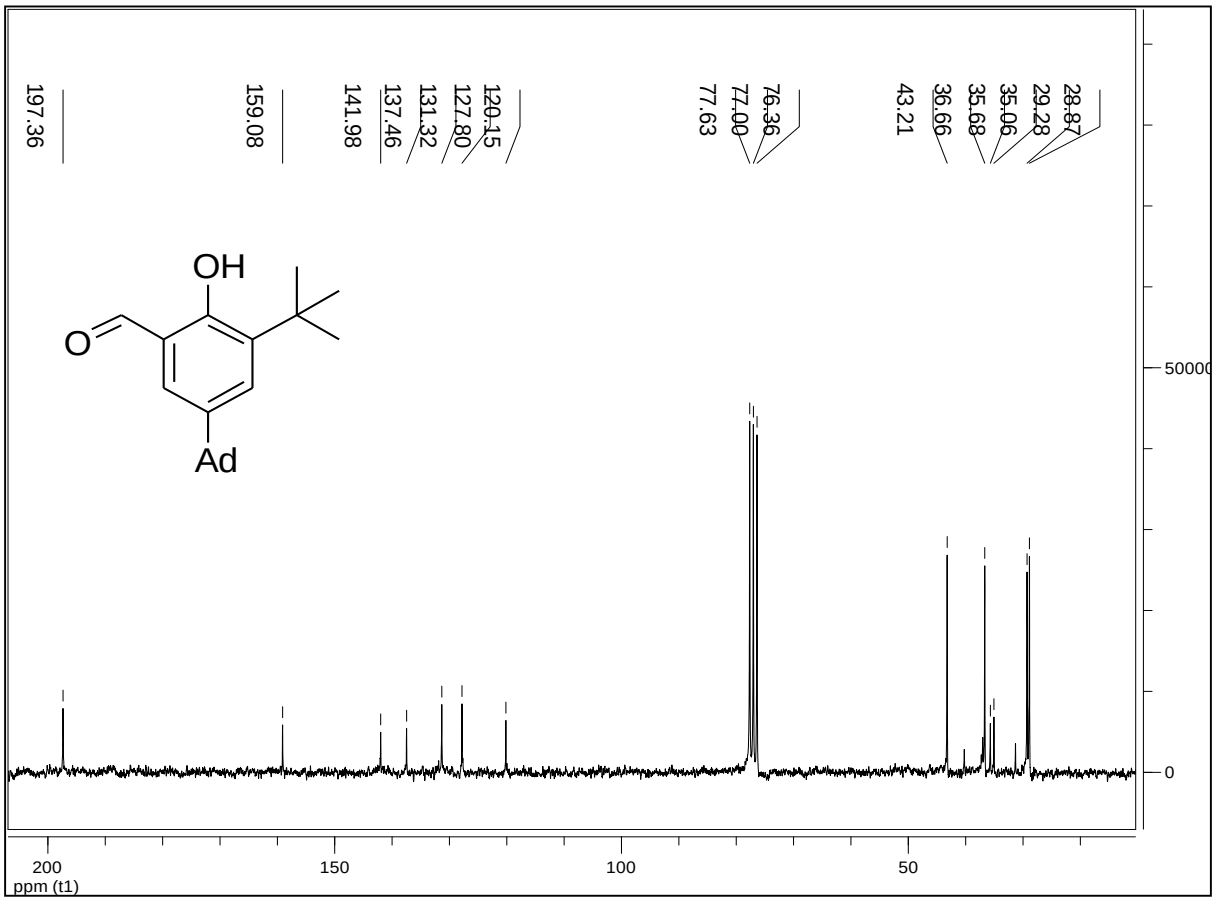
1.(a) J. X. Qiu, E. J. Petersson, E. E. Matthews and A. Schepartz, *J. Am. Chem. Soc.*, 2006, **128**, 11338; (b) L. Lin, W. Yin, X. Fu, J. Zhang, X. Ma and R. Wang, *Org. Biomol. Chem*., 2012, **10**, 83.

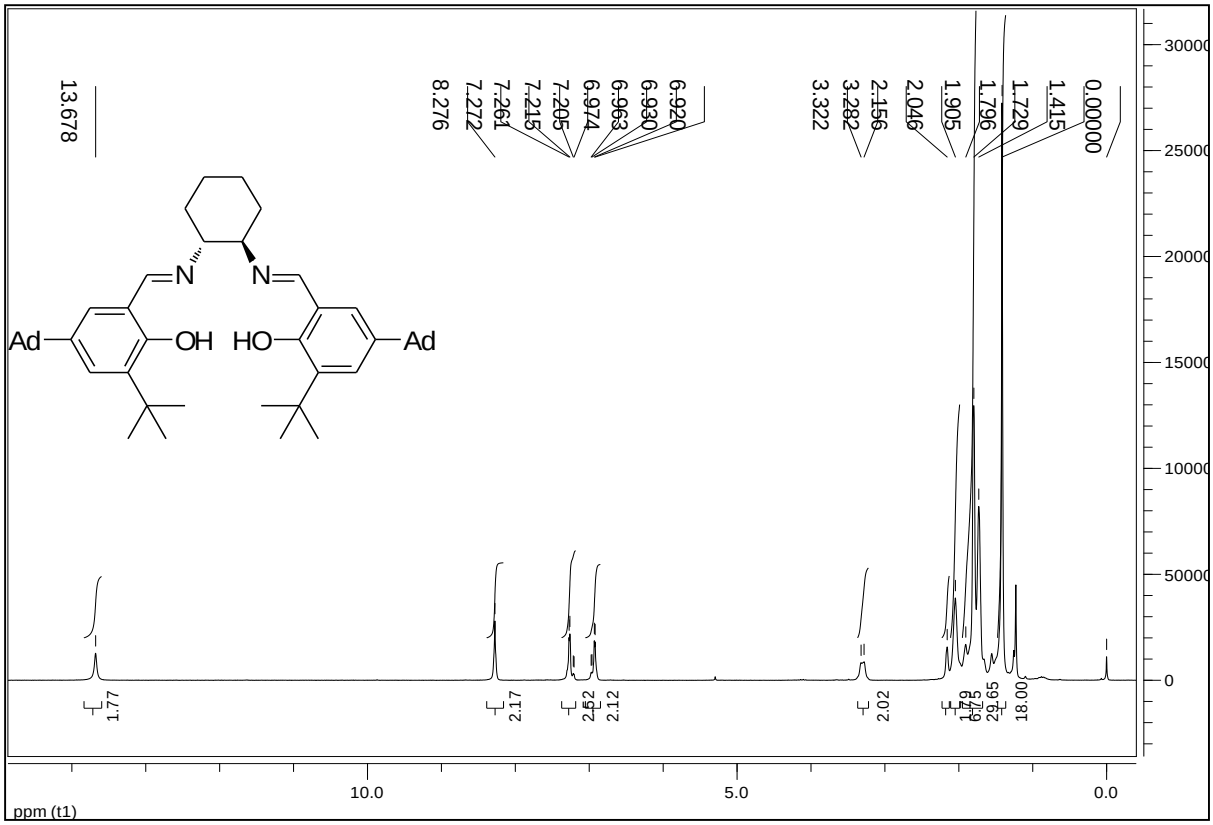
4. Copy of ^{1}H and ^{13}C NMR Spectra for product

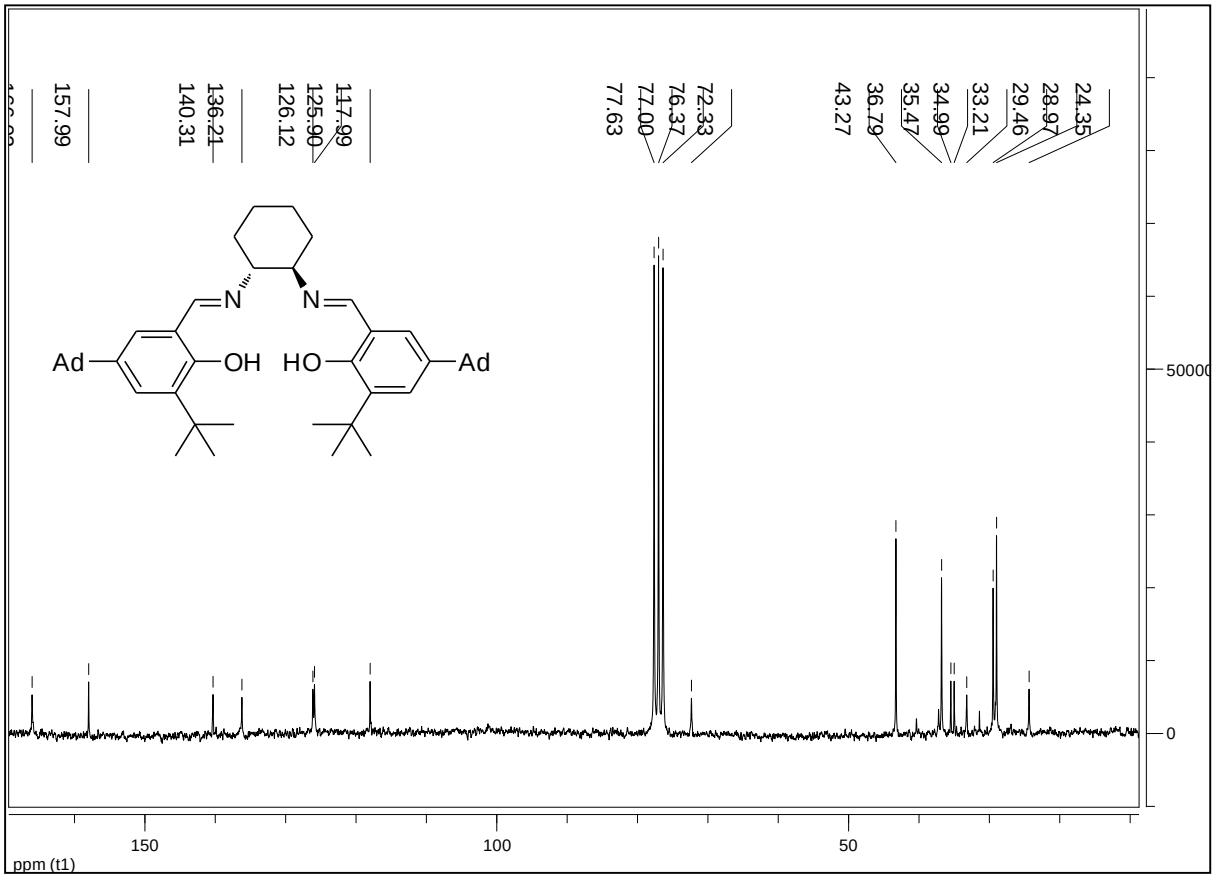


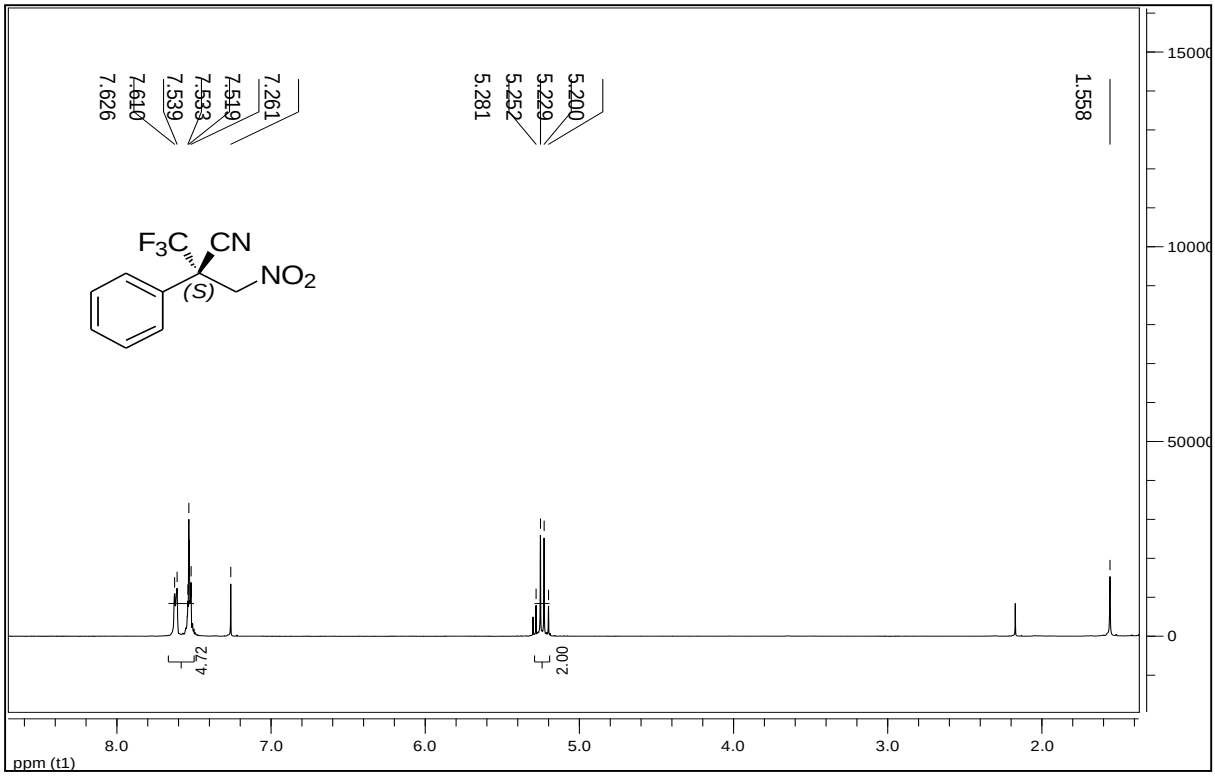


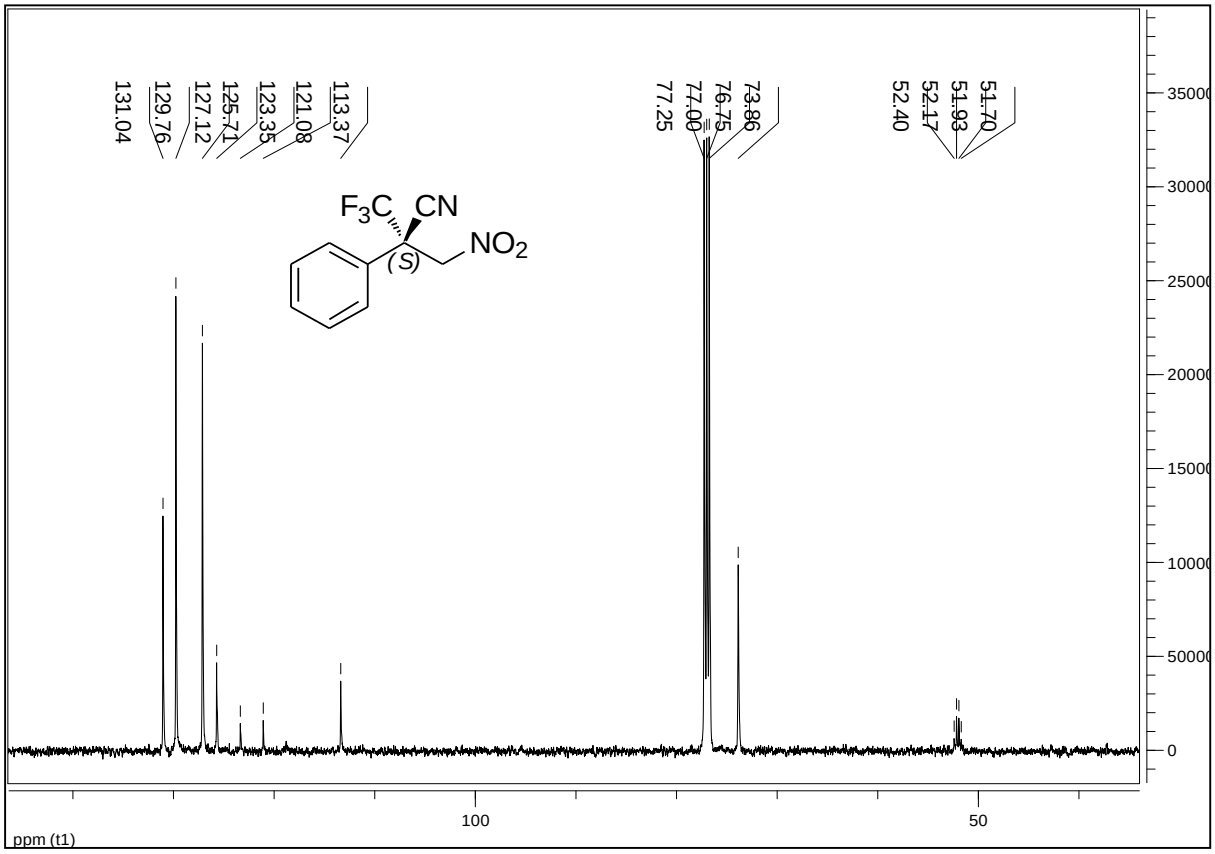

11.630
9.865
7.579
7.568
7.320
7.309
7.253
2.144
2.111
1.904
1.895
1.782
1.430
-0.000000
OH
O
Ad
1.00
1.18
1.08
1.12
4.26
4.42
9.43
6.77
10.0
5.0
0.0
ppm (t1)

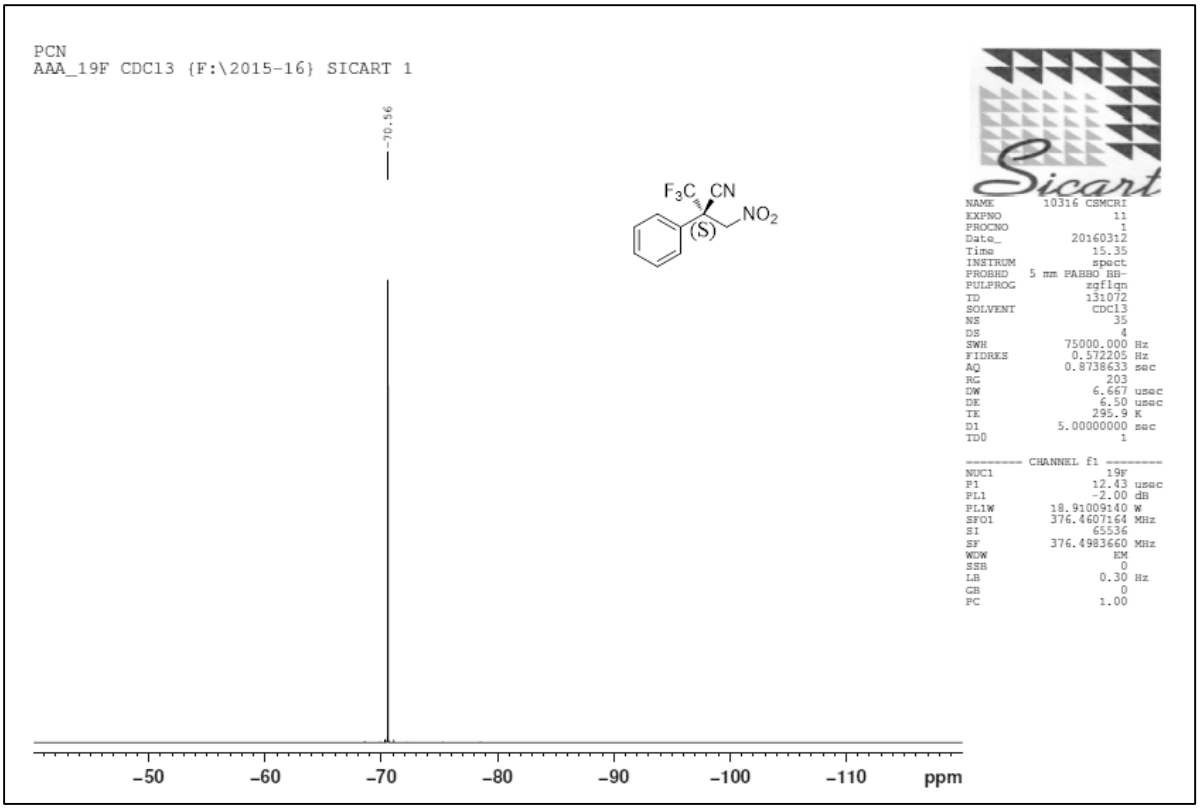

197.36
159.08
141.98
137.46
131.32
127.80
120.15
77.63
77.00
76.36
43.21
36.66
35.68
35.06
29.28
28.87
OH
O
Ad
200
150
100
50
ppm (t1)

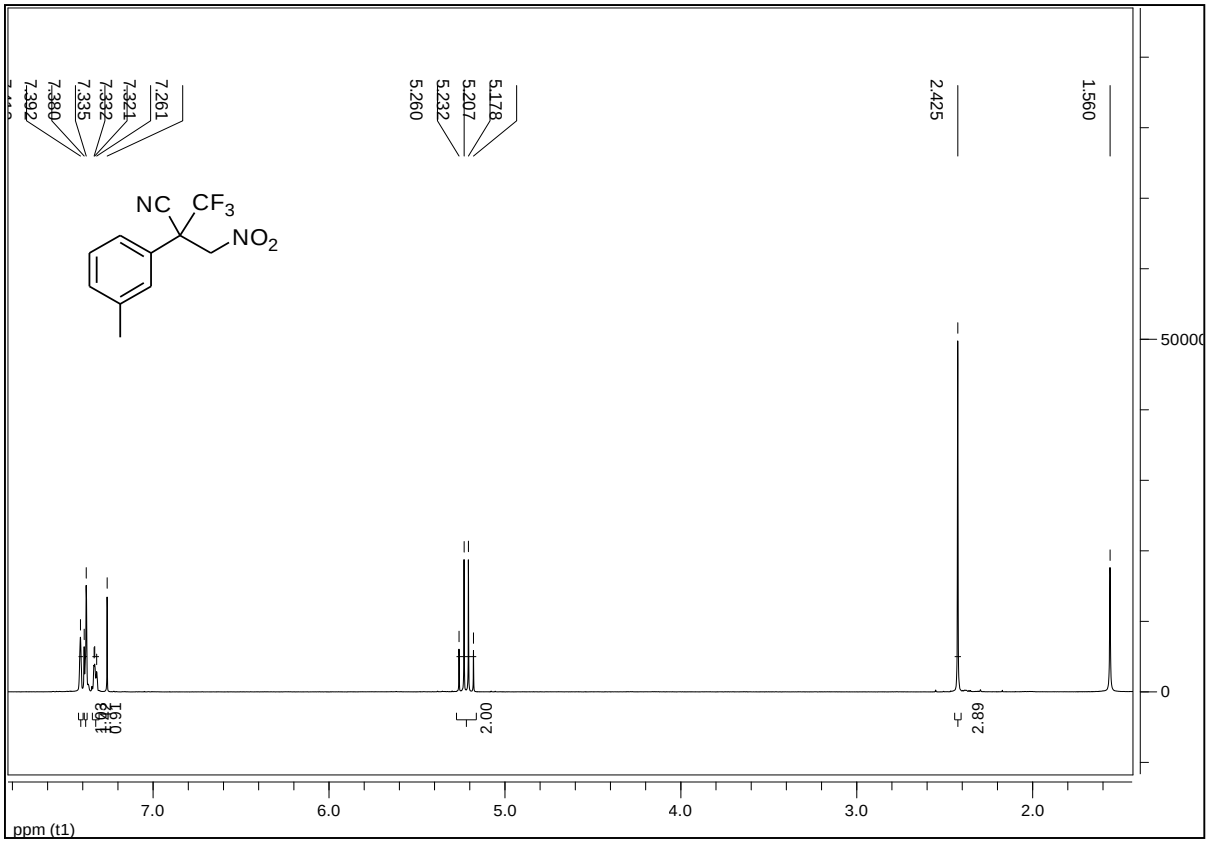

13.678
8.276
7.272
7.261
7.215
7.205
6.974
6.963
6.930
6.920
3.322
3.282
2.156
2.046
1.905
1.796
1.729
1.415
0.00000
Ad
OH
HO
Ad
N
N
1.77
2.17
2.52
2.12
2.02
1.79
6.77
2.95
18.00
10.0
5.0
0.0
ppm (t1)

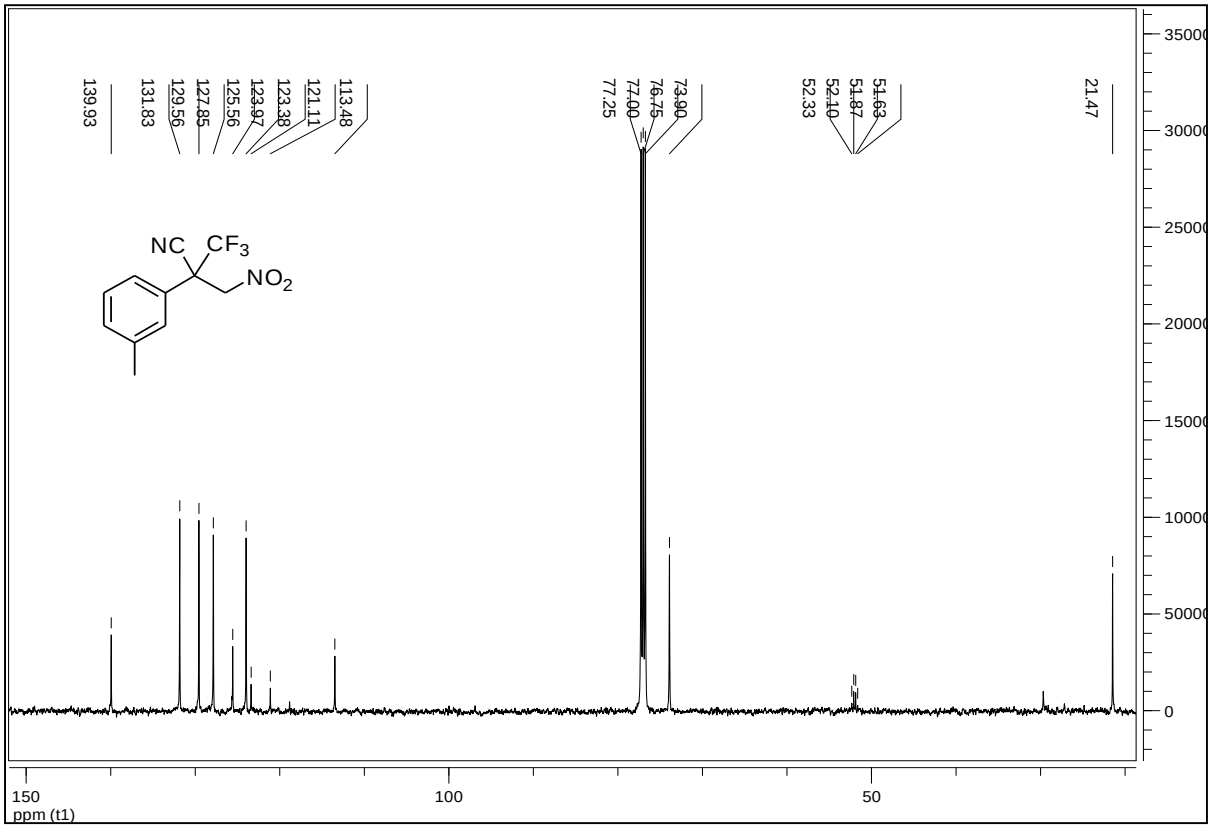

157.99
140.31
136.21
126.12
125.90
117.99
77.63
77.00
76.37
72.33
43.27
36.79
35.47
34.99
33.21
29.46
28.97
24.35
Ad
OH
HO
Ad
N
N
150
100
50
ppm (t1)

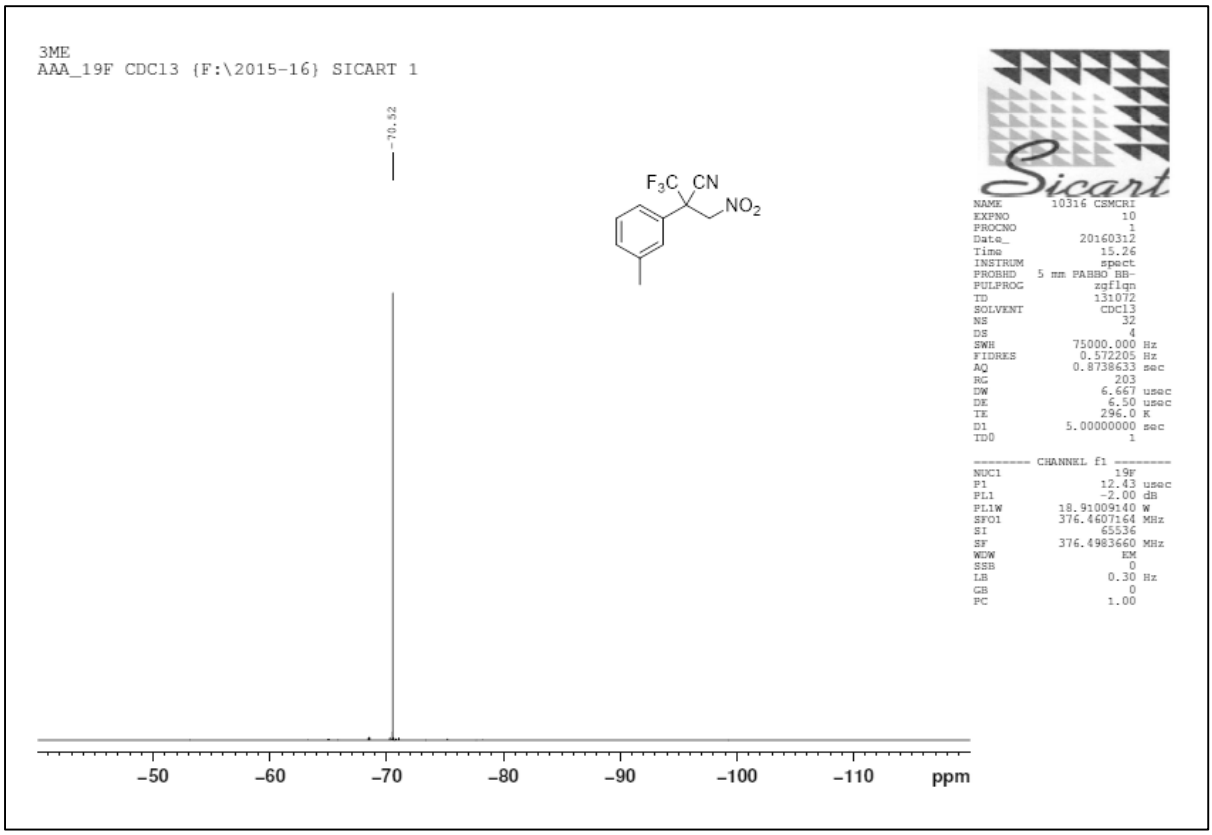

7.626
7.610
7.539
7.533
7.519
7.261
5.281
5.252
5.229
5.200
1.558
F3C
CN
NO2
(S)
4.72
2.00
15000
10000
50000
0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)

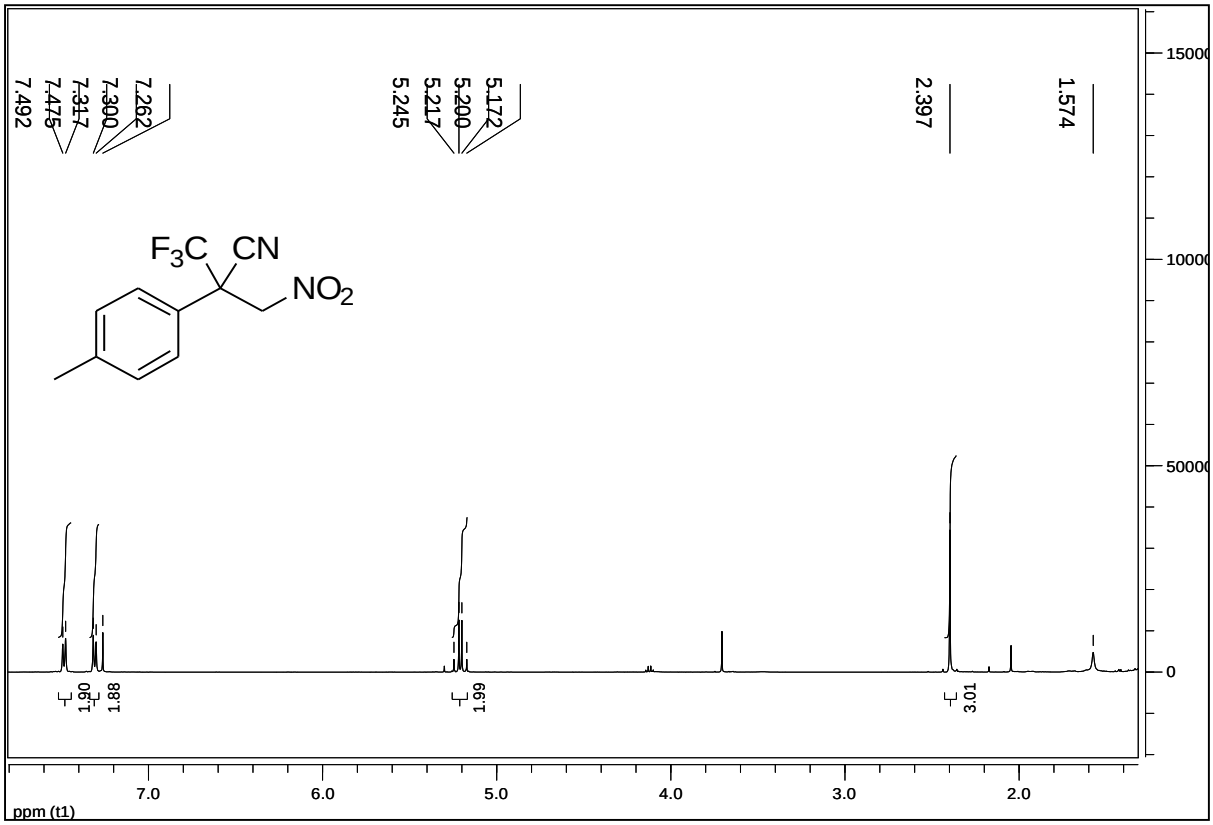

131.04
129.76
127.12
125.71
123.35
121.08
113.37
77.25
77.00
76.75
73.86
52.40
52.17
51.93
51.70
F3C
CN
NO2
(S)
35000
30000
25000
20000
15000
10000
50000
0
100
50
ppm (t1)

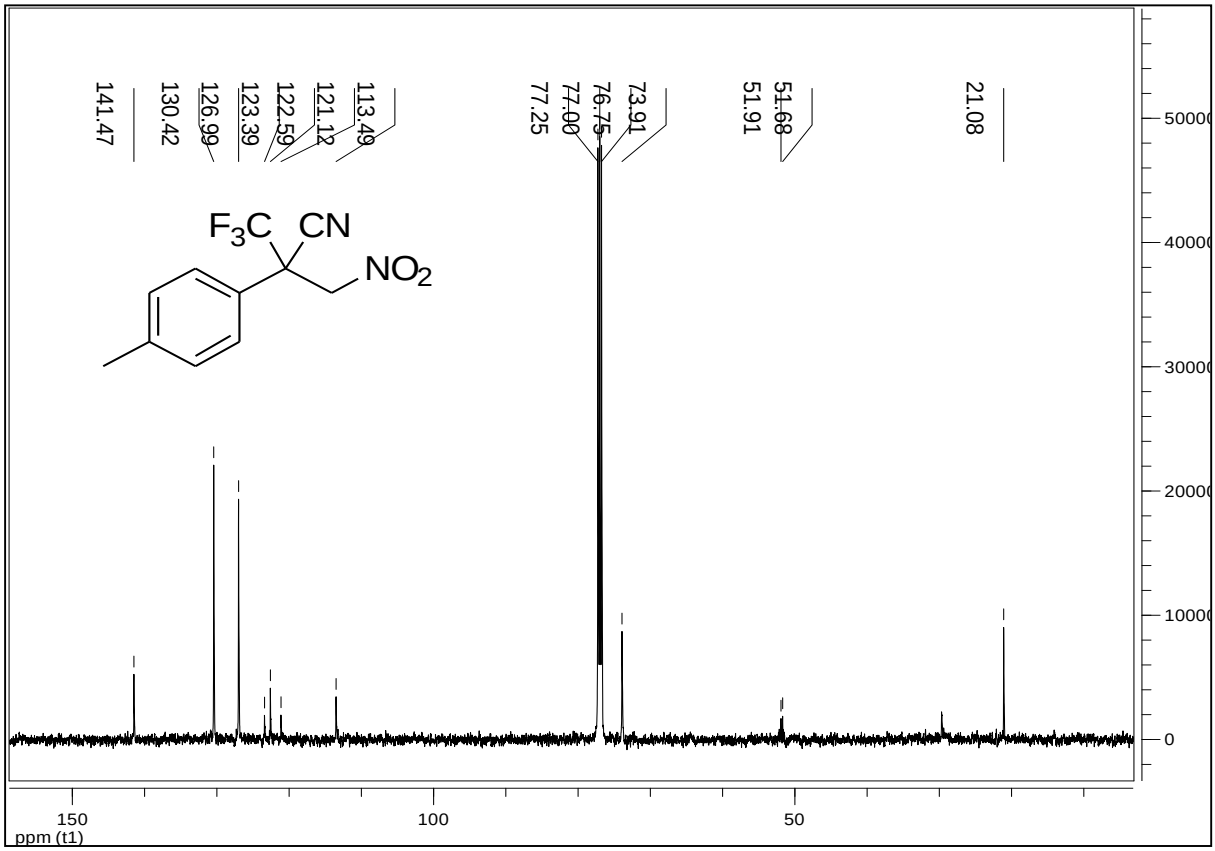

PCN
AAA_19F CDC13 {F:\2015-16} SICART 1
-70.56
F3C
CN
NO2
(S)
Sicart
NAME 10316 CSMCRI
EXPNO 11
PROCNO 1
Date_ 20160312
Time 15.35
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDC13
NS 35
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 295.9 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-50
-60
-70
-80
-90
-100
-110
ppm

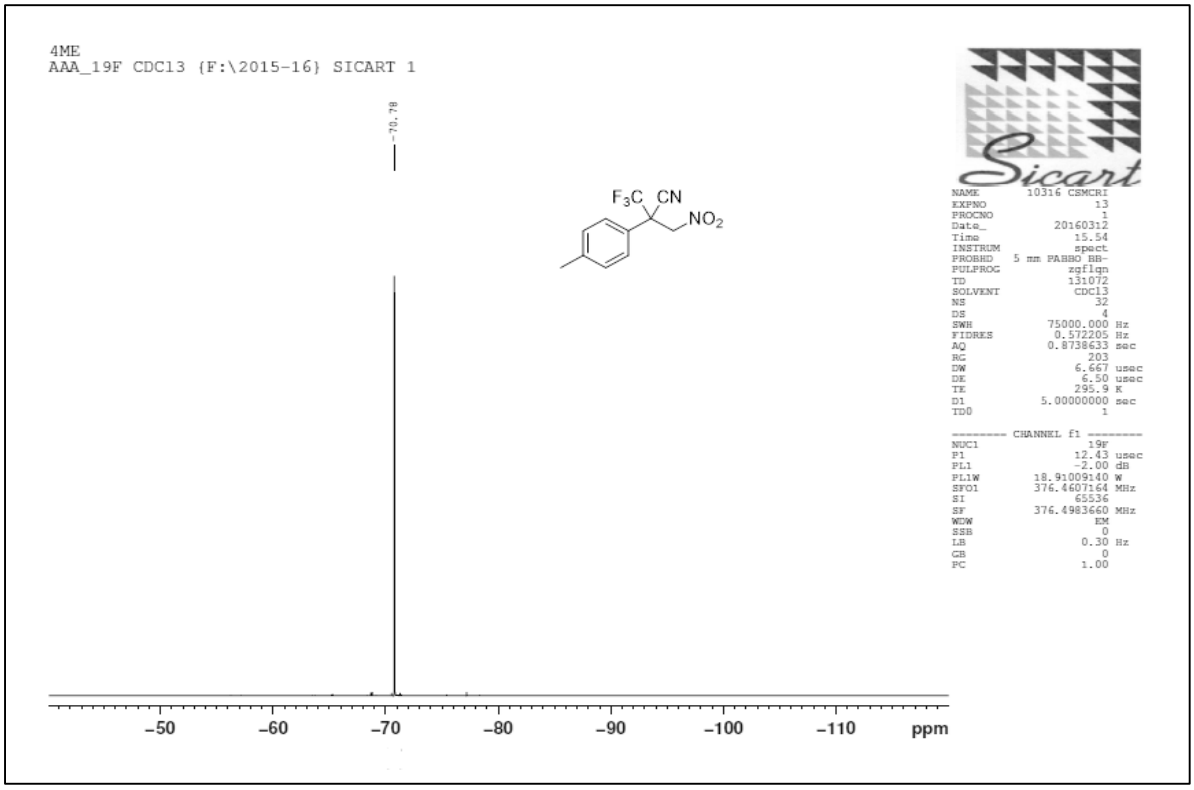

7.392
7.380
7.335
7.332
7.321
7.261
5.260
5.232
5.207
5.178
2.425
1.560
NC
CF3
NO2
50000
0
1.91
1.88
1.87
1.00
2.00
2.89
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)

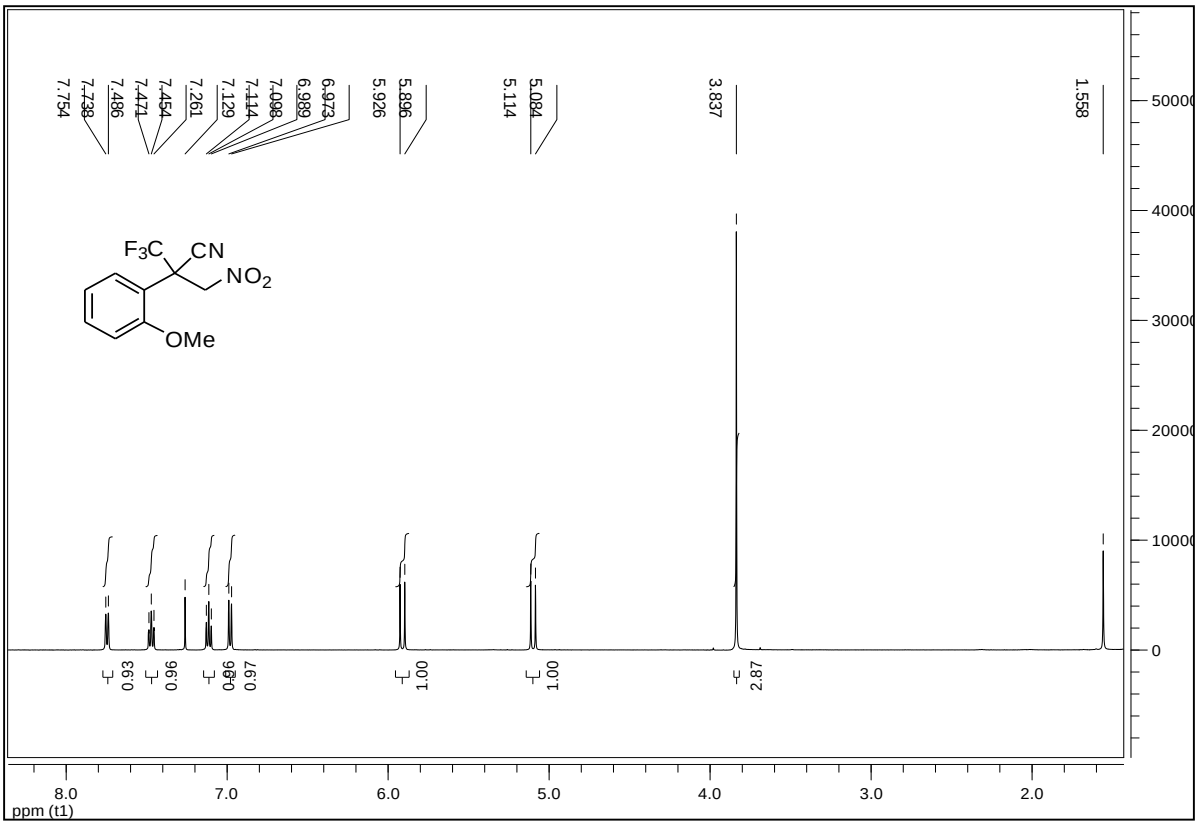

139.93
131.83
129.56
127.85
125.56
123.97
123.38
121.11
113.48
77.25
77.00
76.75
73.90
52.33
52.10
51.87
51.63
21.47
NC
CF3
NO2
150
100
50
ppm (t1)

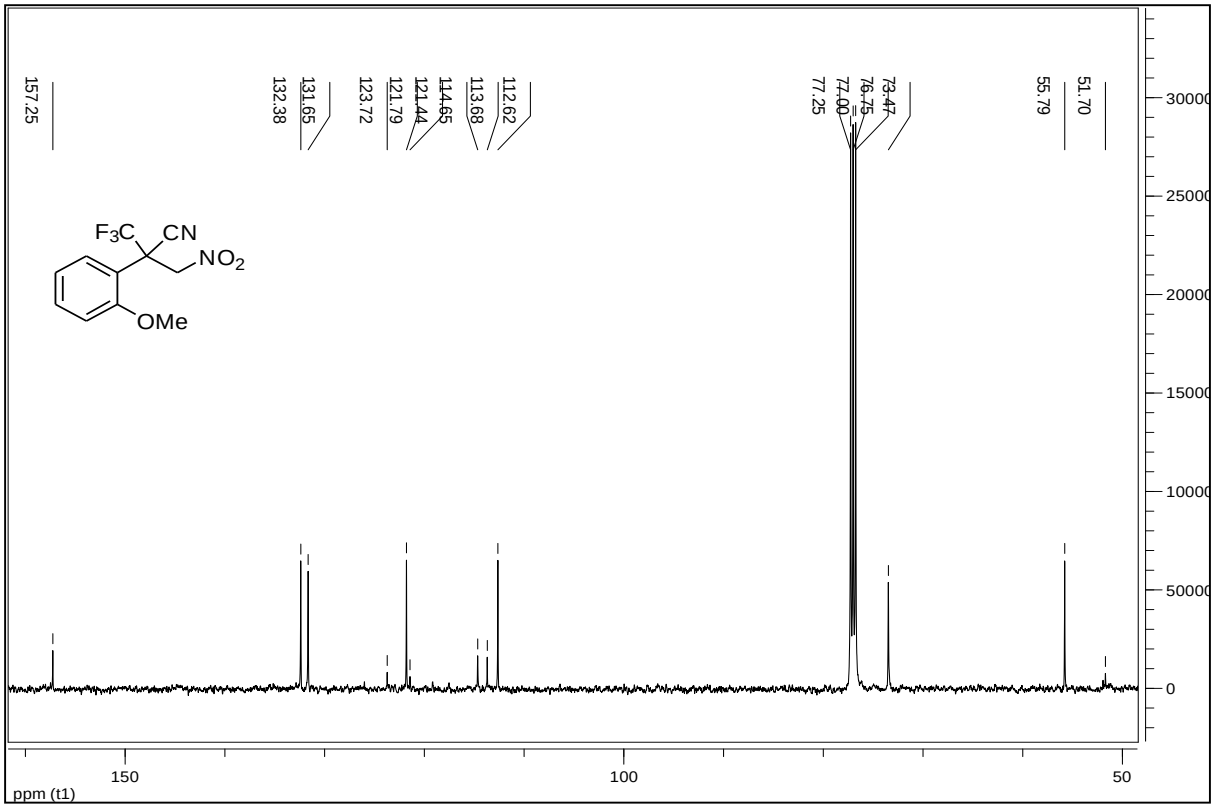

3ME
AAA_19F CDCl3 {F:\2015-16} SICART 1
-70.52
F3C
CN
NO2
Sicart
NAME 10316 CSMCRI
EXPNO 10
PROCNO 1
Date_ 20160312
Time 15.26
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 32
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 296.0 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-50
-60
-70
-80
-90
-100
-110
ppm

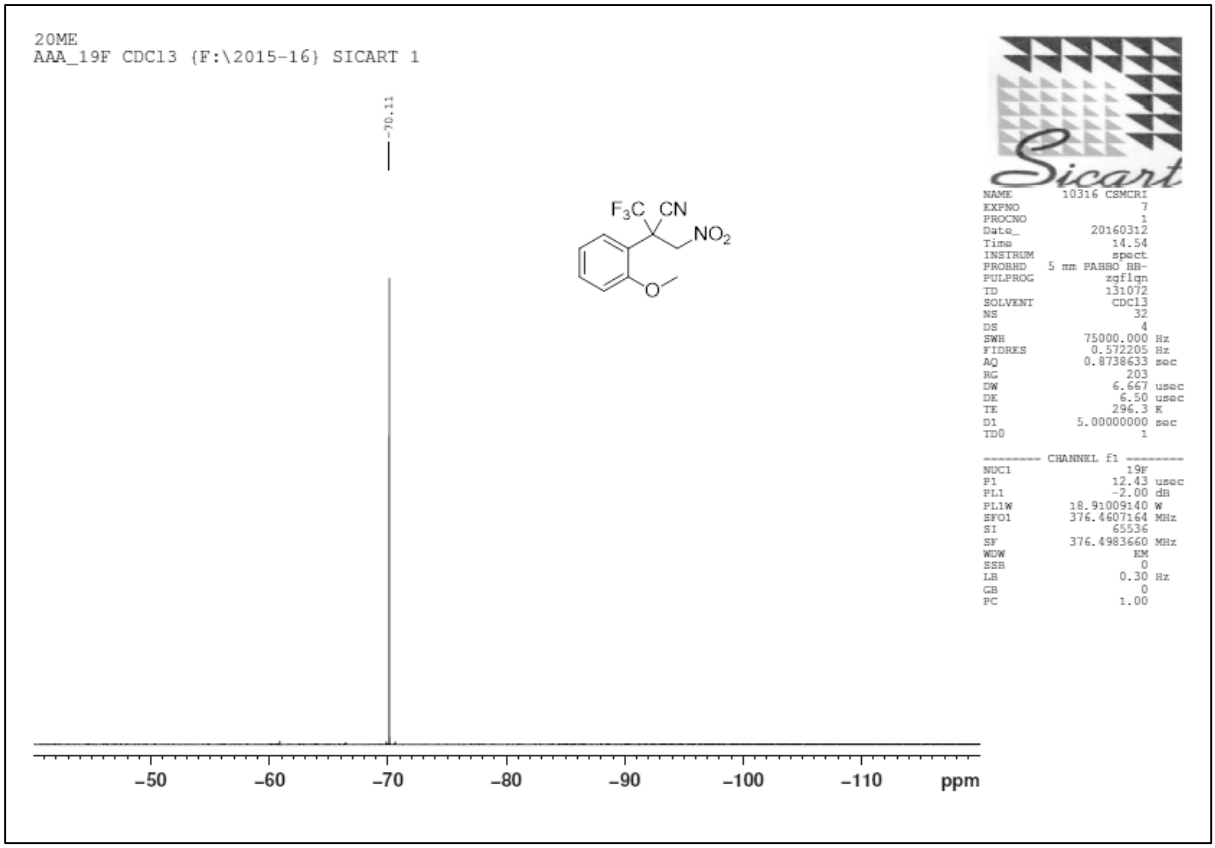

7.492
7.475
7.317
7.300
7.262
5.245
5.217
5.200
5.172
2.397
1.574
F3C CN
NO2
1.90
1.88
1.99
3.01
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)

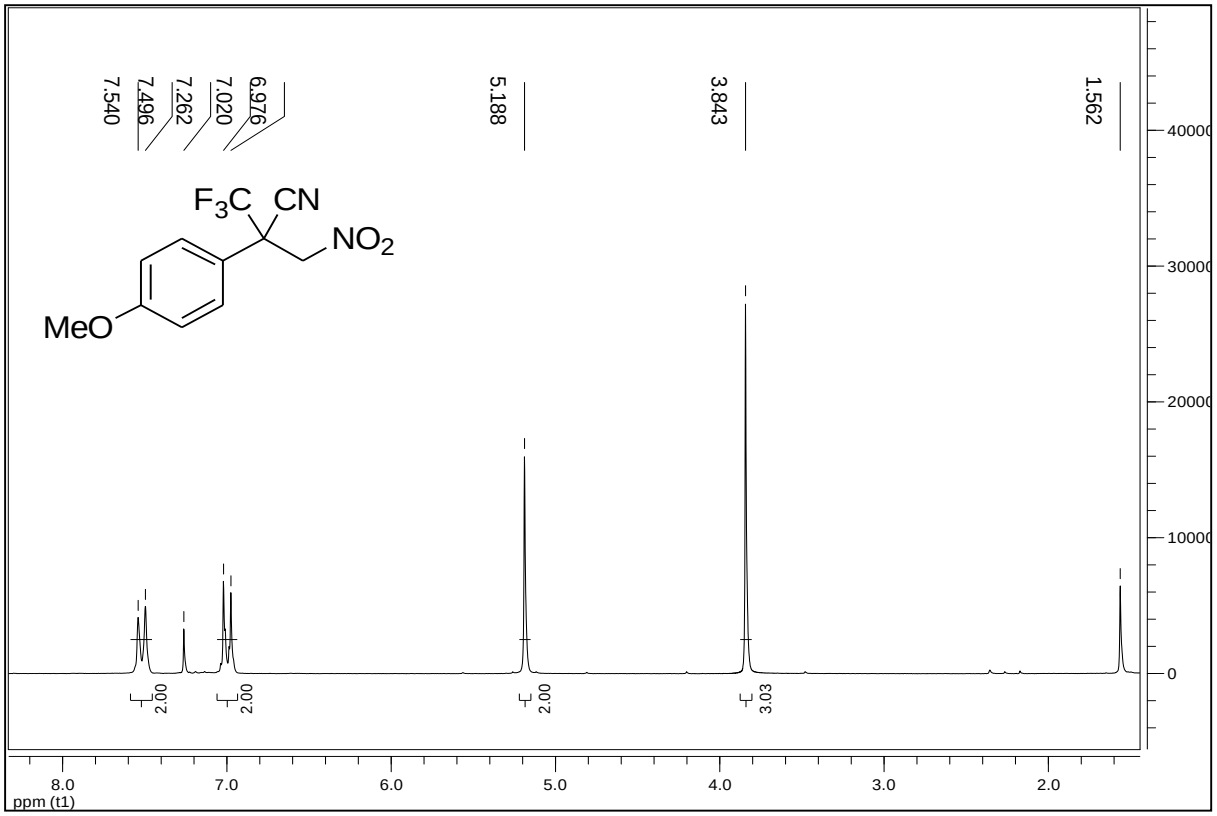

141.47
130.42
126.99
123.39
122.59
121.12
113.49
77.25
77.00
76.75
73.91
51.91
51.68
21.08
F3C CN
NO2
150
100
50
ppm (t1)

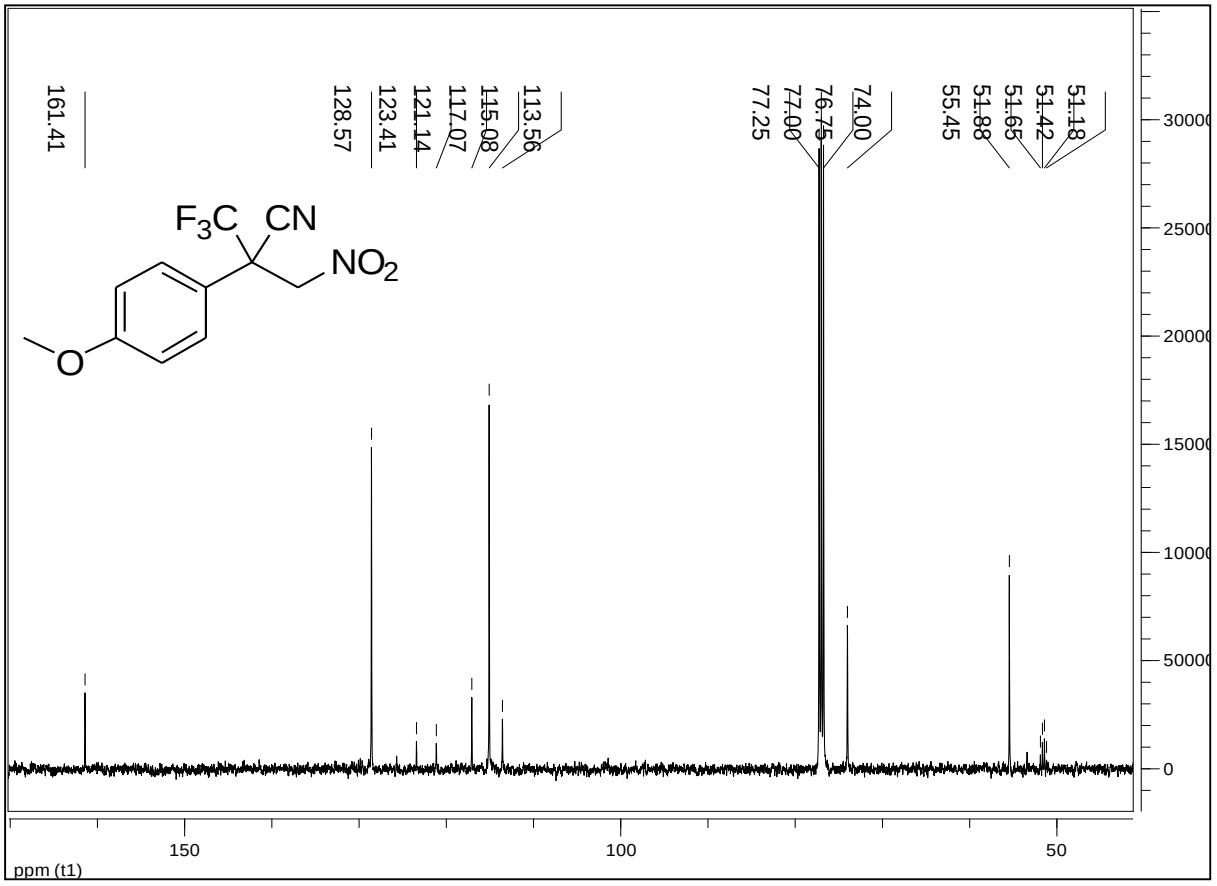

4ME
AAA_19F CDCl3 {F:\2015-16} SICART 1
-70.78
F3C CN
NO2
Sicart
NAME 10316 CSMCRI
EXPNO 13
PROCNO 1
Date_ 20160312
Time 15.54
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 32
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 295.9 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-50
-60
-70
-80
-90
-100
-110
ppm

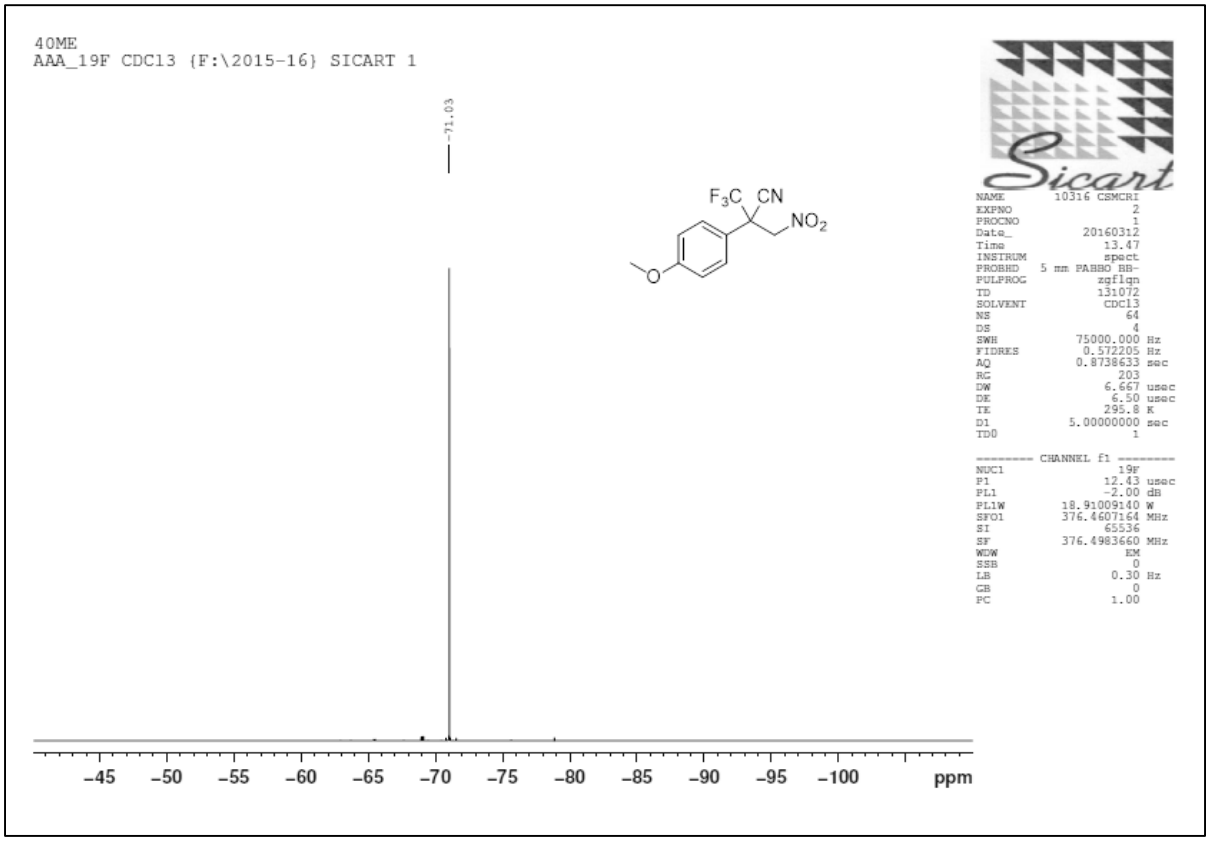

7.754
7.738
7.486
7.471
7.454
7.261
7.129
7.114
7.098
6.989
6.973
5.926
5.896
5.114
5.084
3.837
1.558
F3C CN
NO2
OMe
0.93
0.96
0.90
0.97
1.00
1.00
2.87
8.0
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)


157.25
132.38
131.65
123.72
121.79
121.44
114.65
113.68
112.62
77.25
77.00
76.75
73.47
55.79
51.70
F3C
CN
NO2
OMe
30000
25000
20000
15000
10000
5000
0
150
100
50
ppm (t1)

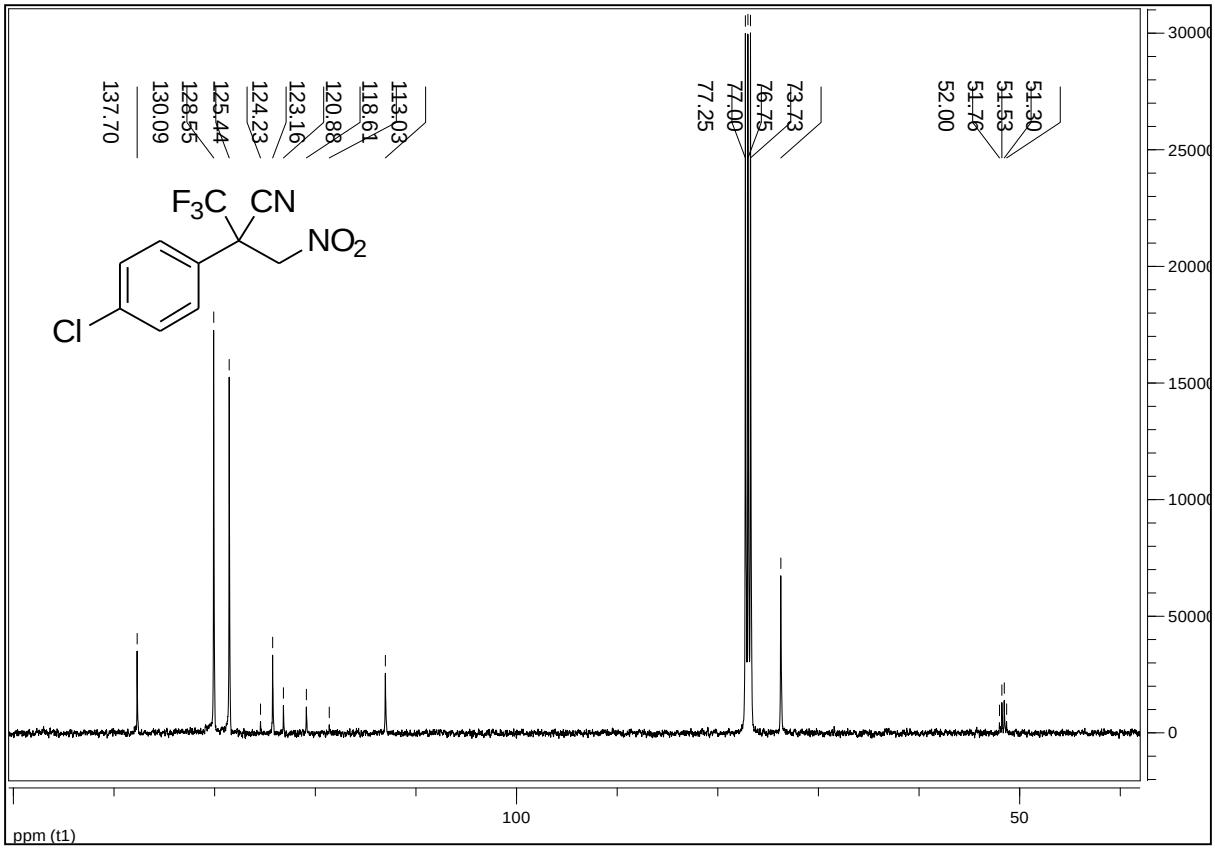

20ME
AAA_19F CDCl3 (F:\2015-16) SICART 1
-70.11
F3C
CN
NO2
O
Sicart
NAME 10316 CSMCRI
EXPNO 7
PROCNO 1
Date_ 20160312
Time 14.54
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 32
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 296.3 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-50
-60
-70
-80
-90
-100
-110
ppm

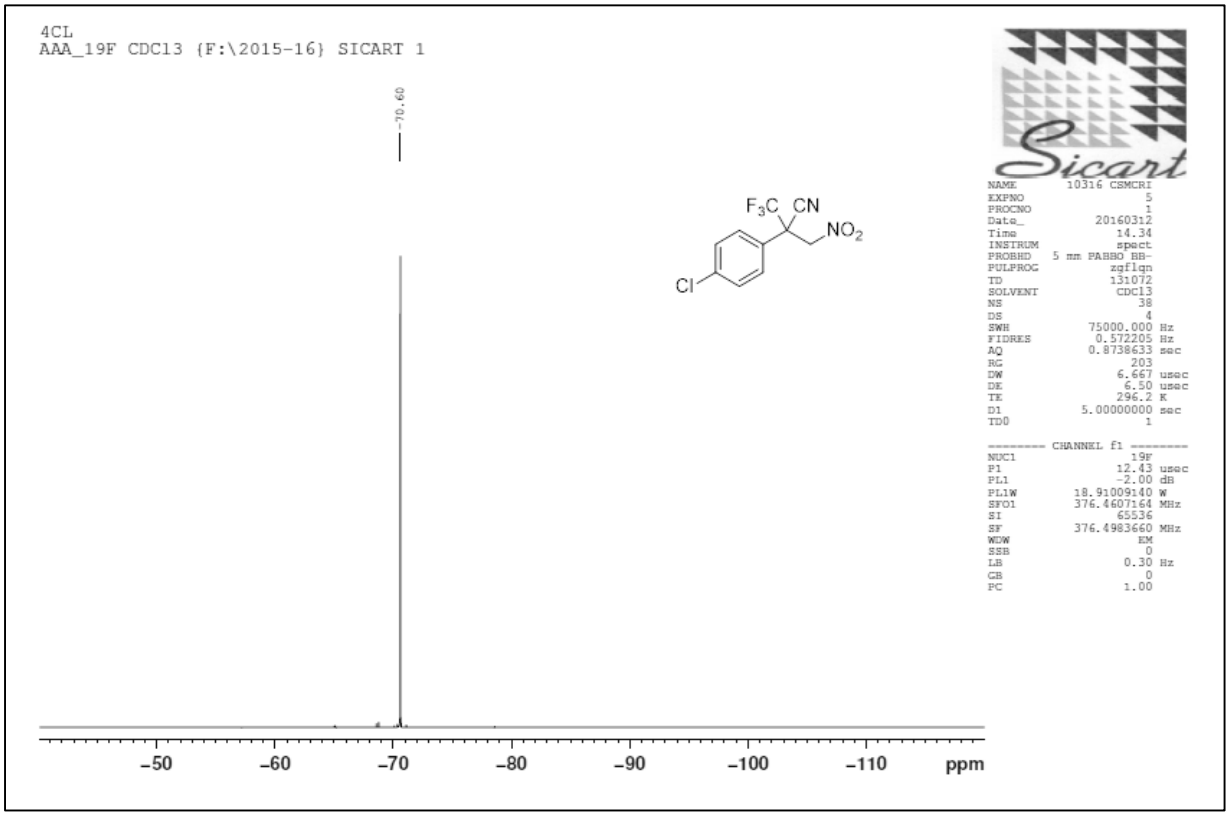

7.540
7.496
7.262
7.020
6.976
5.188
3.843
1.562
F3C CN
NO2
MeO
2.00
2.00
2.00
3.03
8.0
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)

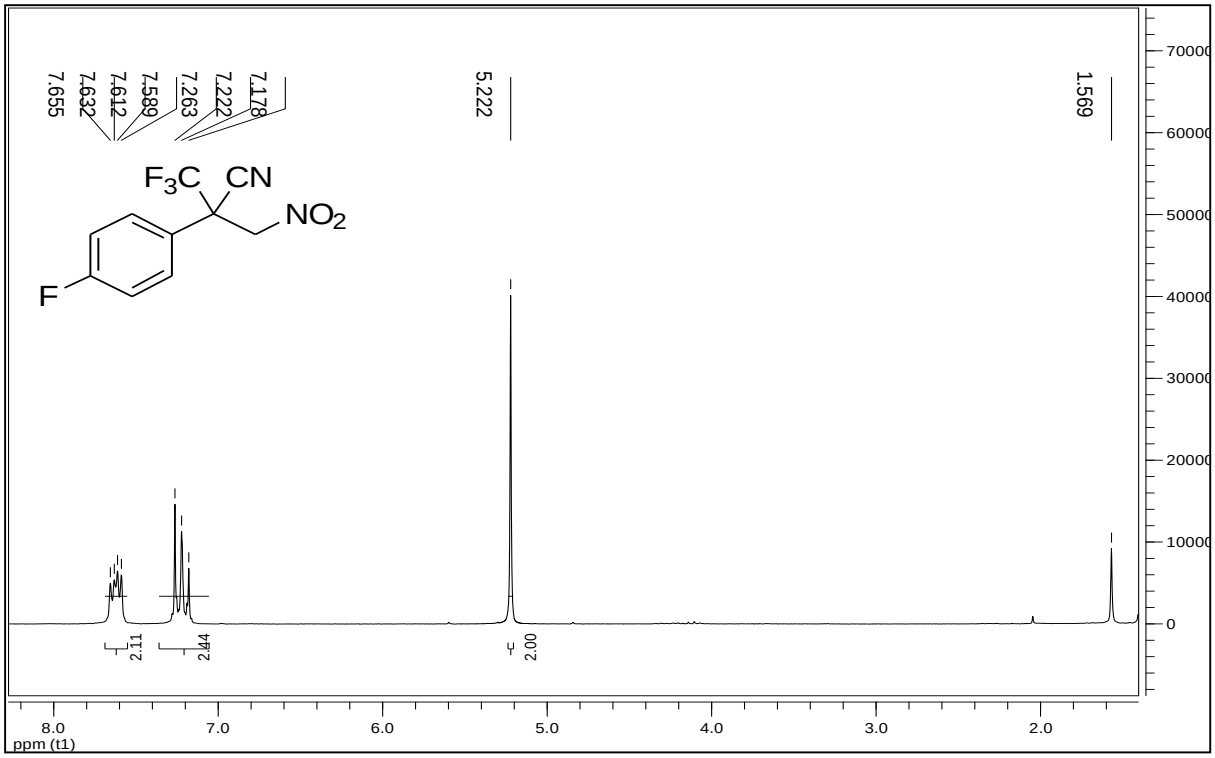

161.41
128.57
123.41
121.14
117.07
115.08
113.56
77.25
77.00
76.75
74.00
55.45
51.88
51.65
51.42
51.18
F3C CN
NO2
O
150
100
50
ppm (t1)

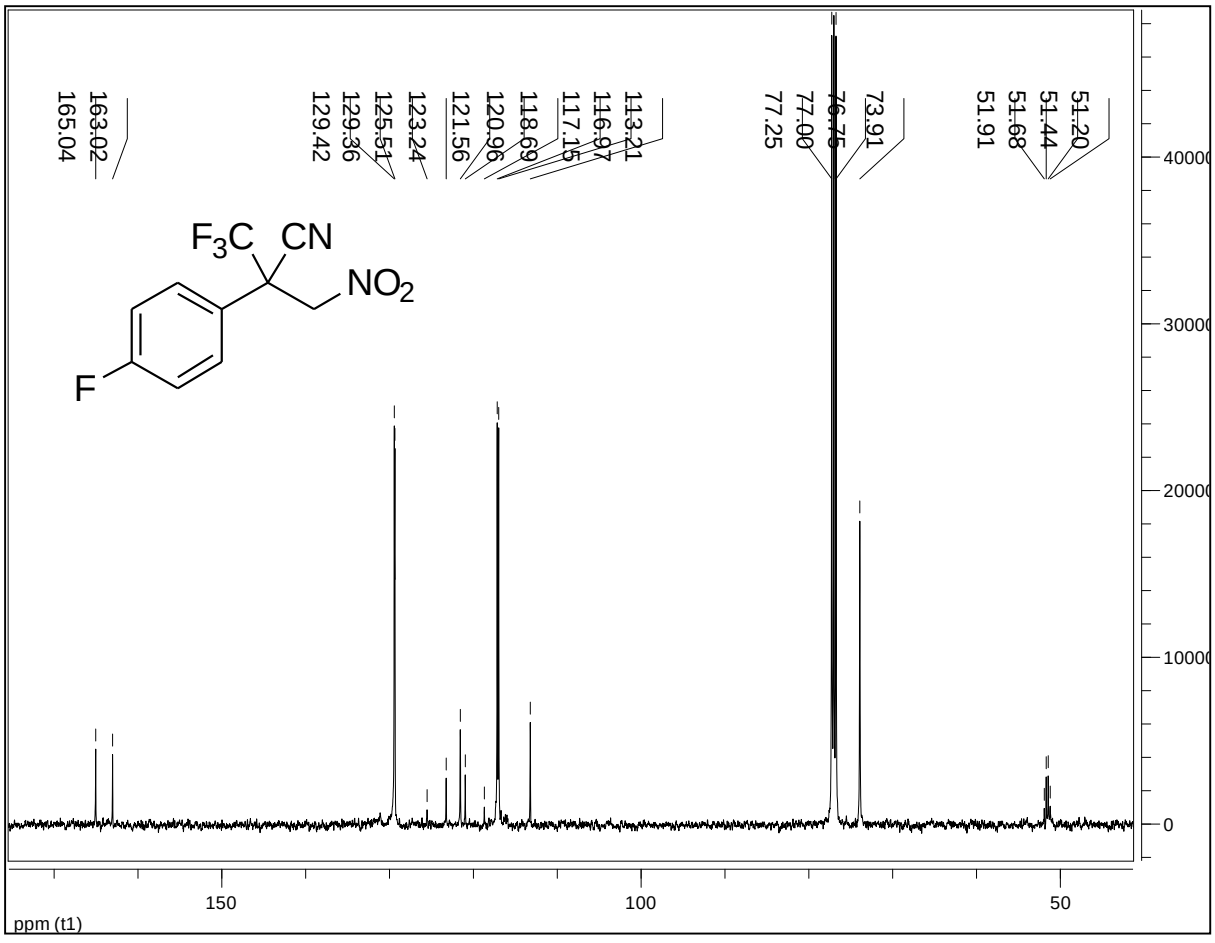

40ME
AAA_19F CDCl3 {F:\2015-16} SICART 1
-71.03
F3C CN
NO2
O
Sicart
NAME 10316 CSMCRI
EXPNO 2
PROCNO 1
Date_ 20160312
Time 13.47
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 64
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 295.8 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100 ppm

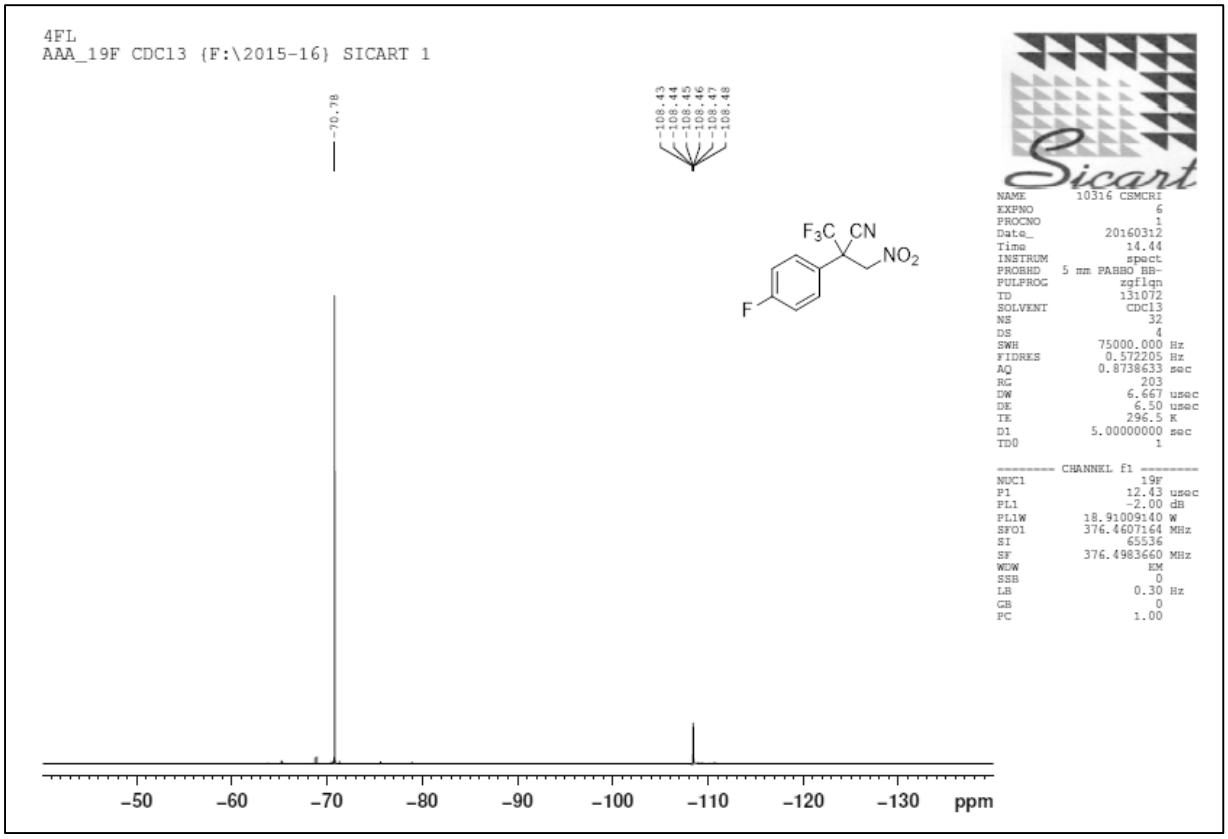

7.589
7.544
7.522
7.489
7.477
7.262
5.222
1.573
F3C CN
NO2
Cl
3.93
2.00
10000
50000
0
8.0 7.0 6.0 5.0 4.0 3.0 2.0
ppm (t1)

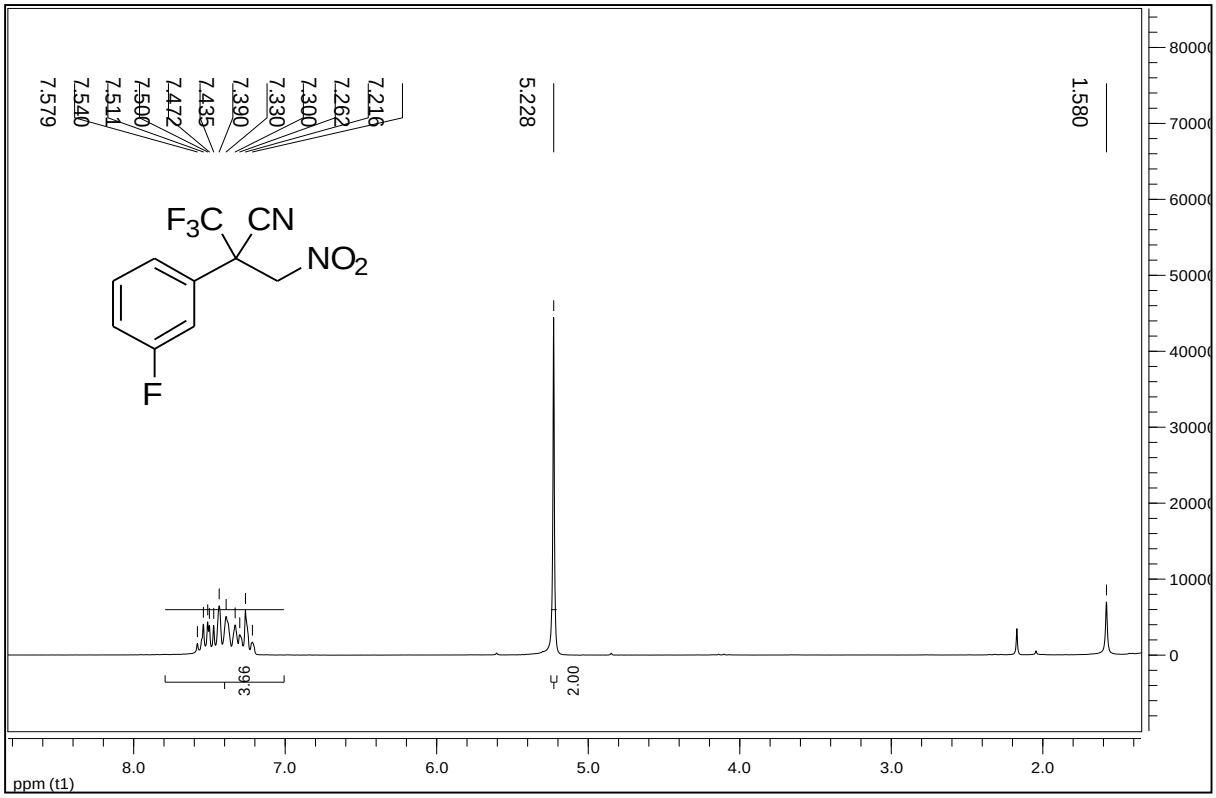

137.70
130.09
128.55
125.44
124.23
123.16
120.88
118.61
113.03
77.25
77.00
76.75
73.73
52.00
51.76
51.53
51.30
F3C CN
NO2
Cl
ppm (t1)

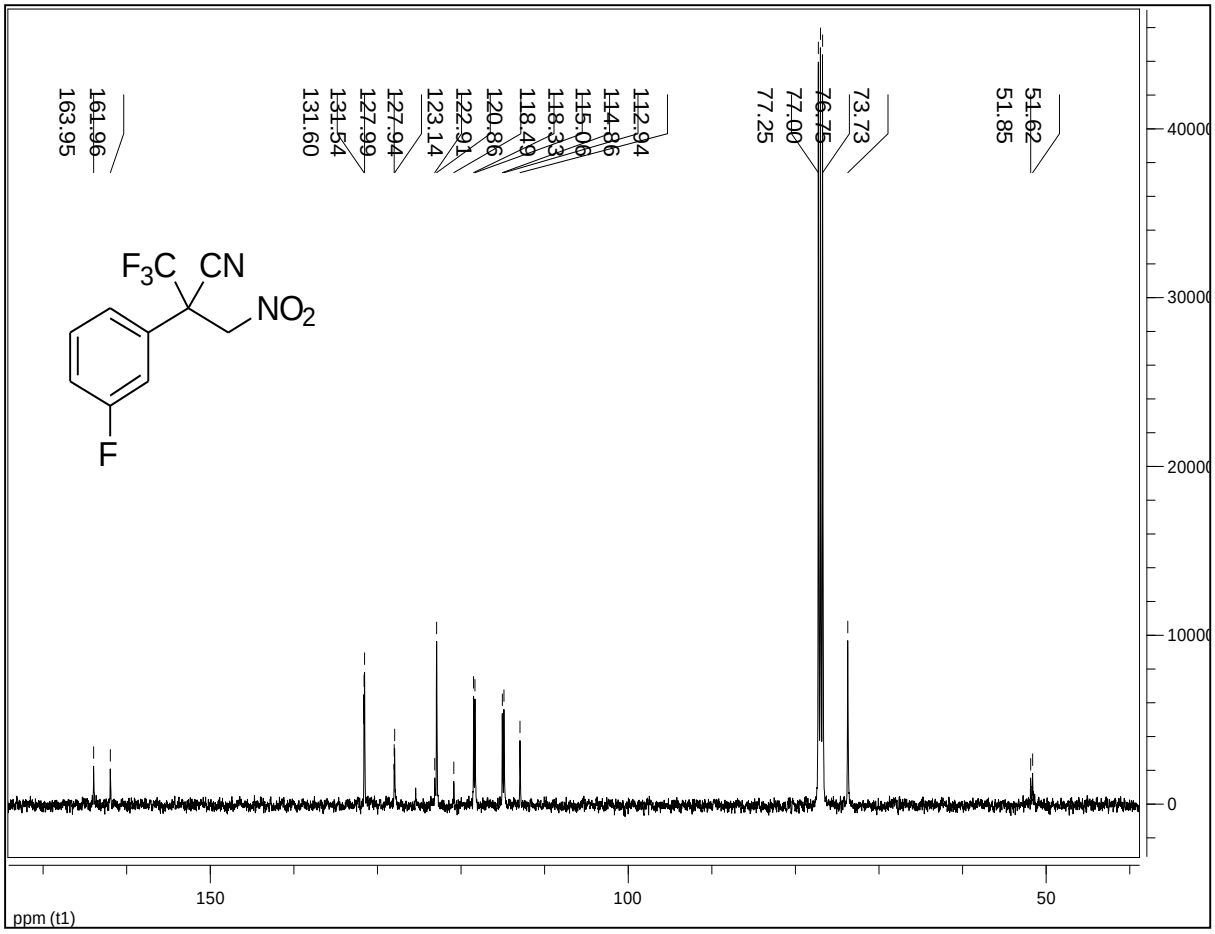

4CL
AAA_19F CDCl3 (F:\2015-16) SICART 1
-70.60
F3C CN
NO2
Cl
Sicart
NAME 10316 CSMCRI
EXPNO 5
PROCNO 1
Data_ 20160312
Time 14.34
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 38
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 296.2 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-50
-60
-70
-80
-90
-100
-110
ppm

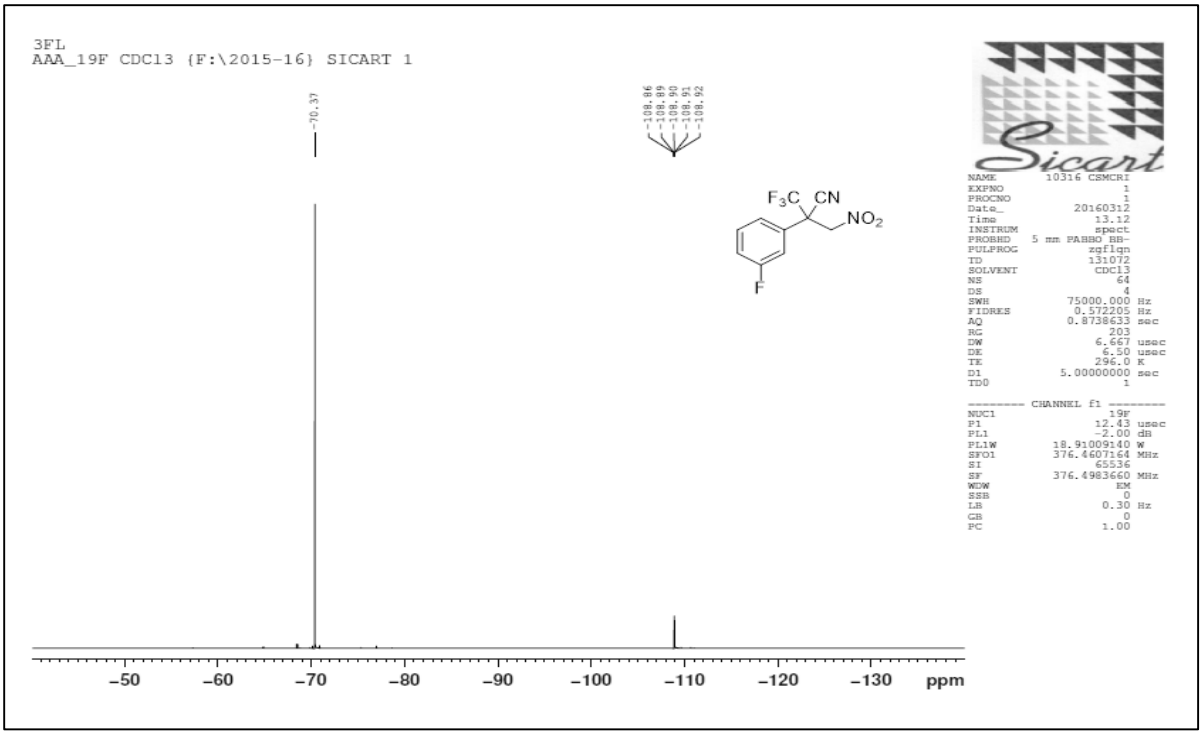

7.655
7.632
7.612
7.589
7.263
7.222
7.178
5.222
1.569
F3C CN
NO2
F
2.11
2.44
2.00
8.0
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)

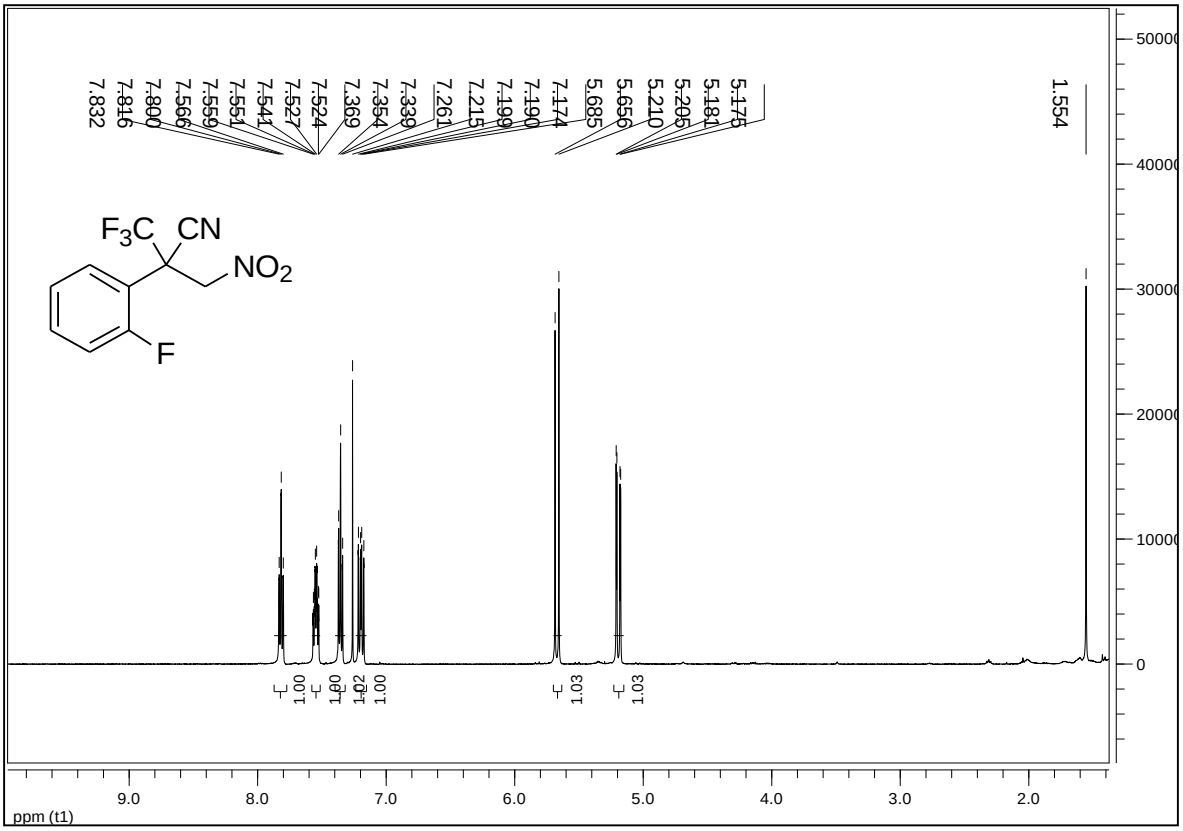

165.04
163.02
129.42
129.36
125.51
123.24
121.56
120.96
118.69
117.15
116.97
113.21
77.25
77.00
76.75
73.91
51.91
51.68
51.44
51.20
F3C CN
NO2
F
150
100
50
ppm (t1)

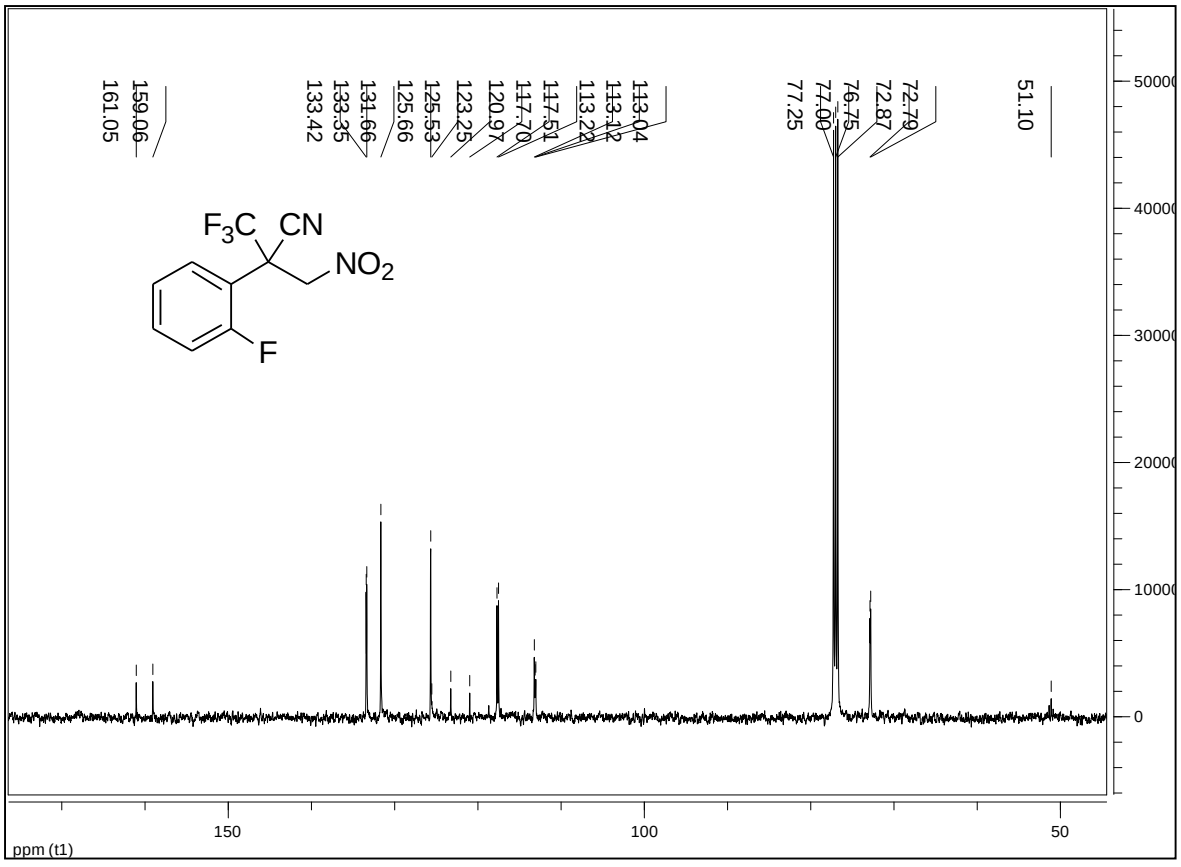

4FL
AAA_19F CDCl3 {F:\2015-16} SICART 1
-70.78
-108.43
-108.44
-108.45
-108.46
-108.47
-108.48
F3C CN
NO2
F
Sicart
NAME 10316 CSMCRI
EXPNO 6
PROCNO 1
Date_ 20160312
Time 14.44
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 32
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 296.5 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-50 -60 -70 -80 -90 -100 -110 -120 -130 ppm

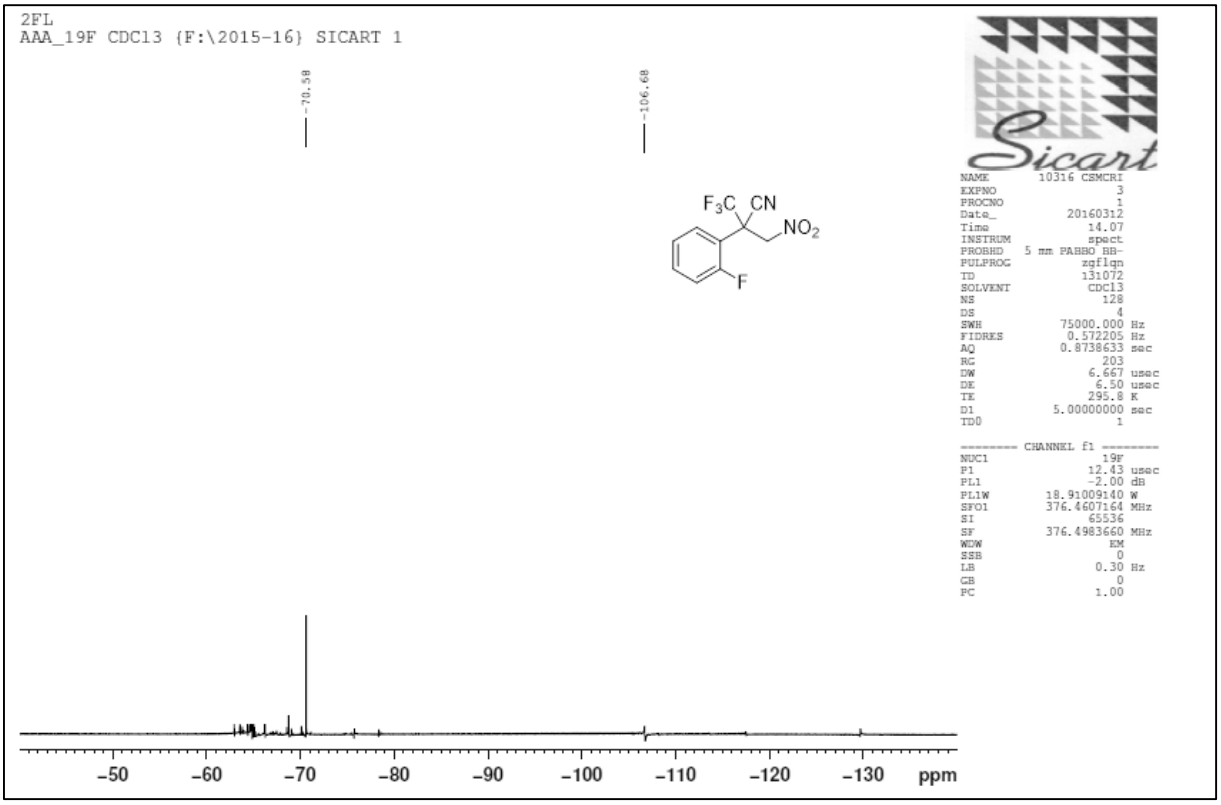

7.579
7.540
7.511
7.500
7.472
7.435
7.390
7.330
7.300
7.262
7.216
5.228
1.580
F3C CN
NO2
F
3.66
2.00
80000
70000
60000
50000
40000
30000
20000
10000
0
8.0 7.0 6.0 5.0 4.0 3.0 2.0
ppm (t1)


163.95
161.96
131.60
131.54
127.99
127.94
123.14
122.91
120.86
118.49
118.33
115.06
114.86
112.94
77.25
77.00
76.75
73.73
51.85
51.62
F3C CN
NO2
F
40000
30000
20000
10000
0
150
100
50
ppm (t1)


3FL
AAA_19F CDCl3 {F:\2015-16} SICART 1
-70.37
-108.86
-108.89
-108.90
-108.91
-108.92
F3C CN
NO2
F
Sicart
NAME 10316 CSMCRI
EXPNO 1
PROCNO 1
Date_ 20160312
Time 13.12
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 64
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 296.0 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-50
-60
-70
-80
-90
-100
-110
-120
-130
ppm


7.832
7.816
7.800
7.566
7.559
7.551
7.541
7.527
7.524
7.369
7.354
7.339
7.261
7.215
7.199
7.190
7.174
5.685
5.656
5.210
5.205
5.181
5.175
1.554
F3C CN
NO2
F
1.00
1.00
2.01
1.00
3.03
3.03
50000
40000
30000
20000
10000
0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)


161.05
159.06
133.42
133.35
131.66
125.66
125.53
123.25
120.97
117.70
117.51
113.22
113.12
113.04
77.25
77.00
76.75
72.87
72.79
51.10
F3C CN
NO2
F
50000
40000
30000
20000
10000
0
150
100
50
ppm (t1)


2FL
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-106.68
F3C CN
NO2
F
Sicart
NAME 10316 CSMCRI
EXPNO 3
PROCNO 1
Date_ 20160312
Time 14.07
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDC13
NS 128
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 295.8 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
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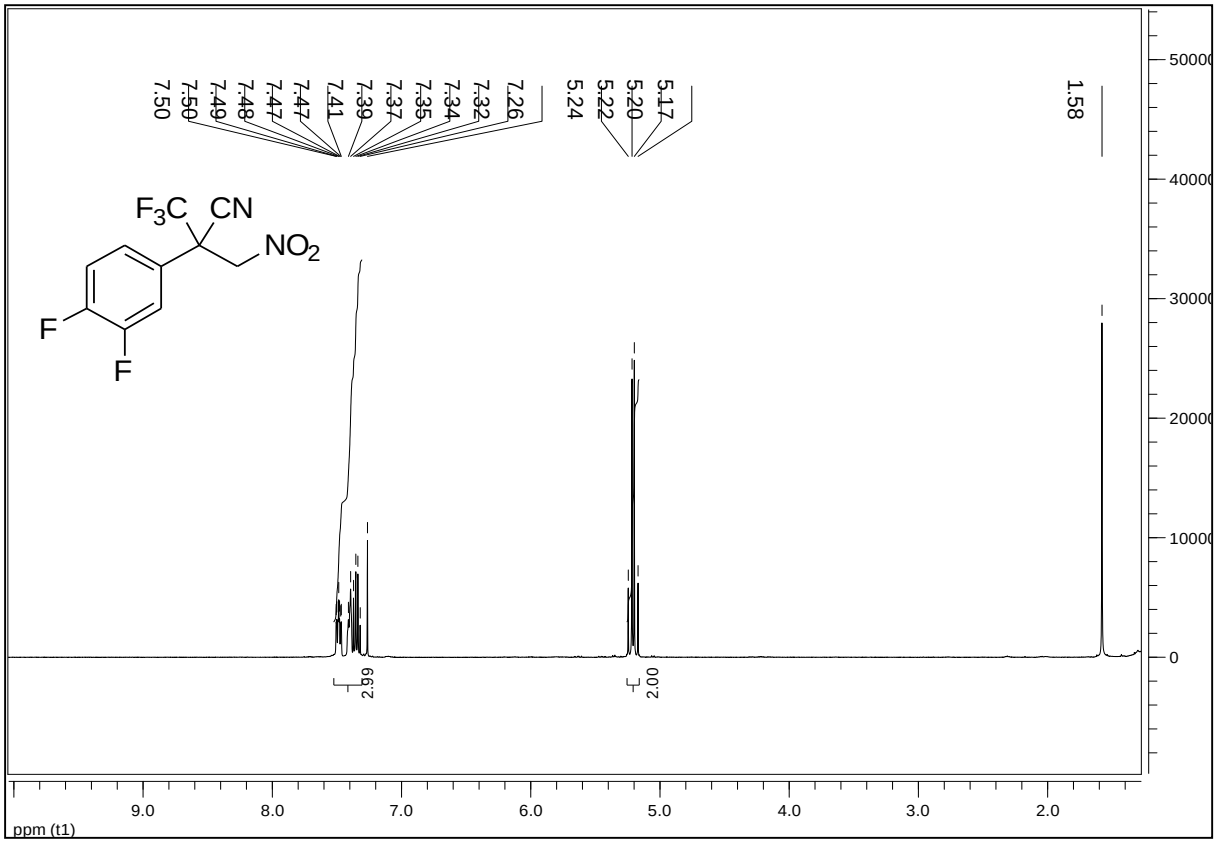
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5.24 5.22 5.20 5.17
1.58
F3C CN
NO2
F
F
2.69
2.00
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30000
20000
10000
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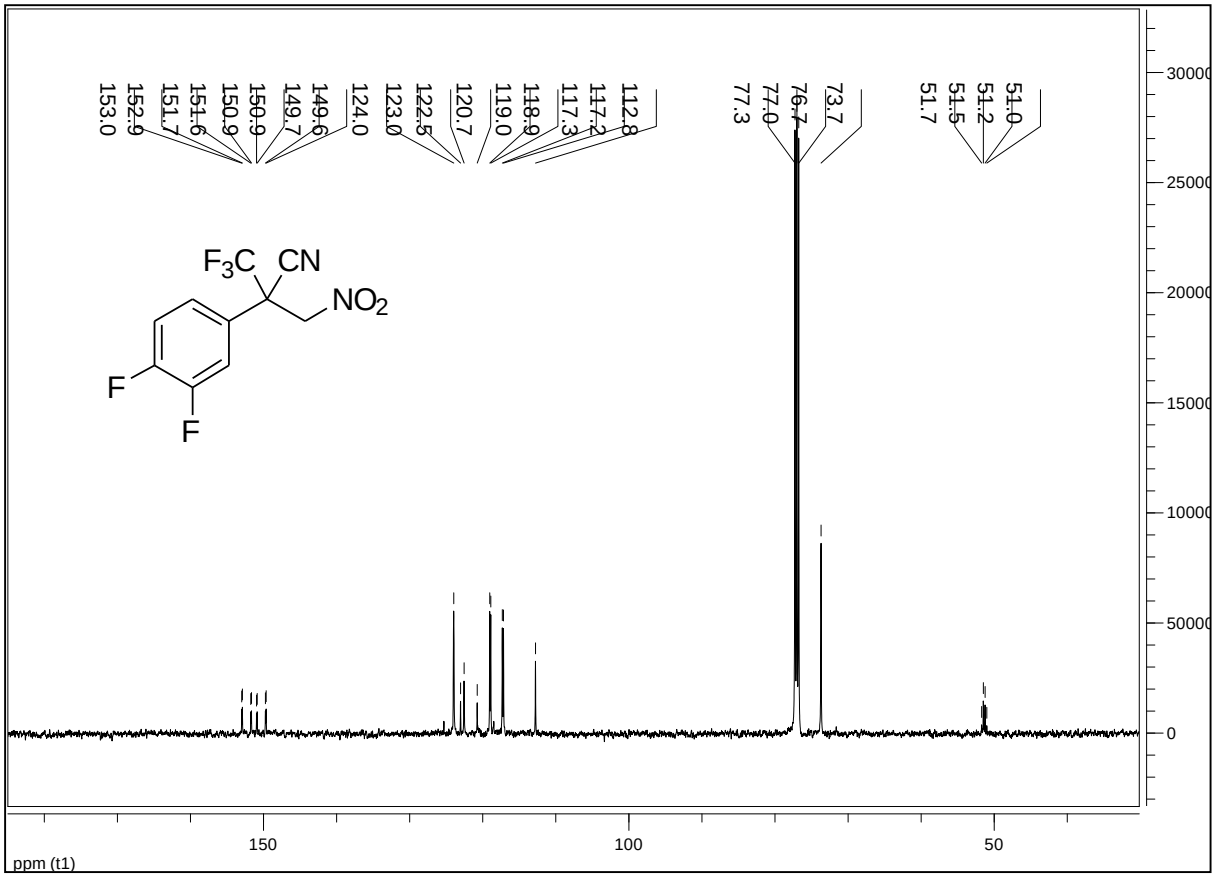
ppm (t1)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149.7
149.6
124.0
123.0
122.5
120.7
119.0
118.9
117.3
117.2
112.8
77.3
77.0
76.7
73.7
51.7
51.5
51.2
51.0
F3C CN
NO2
F
F
30000
25000
20000
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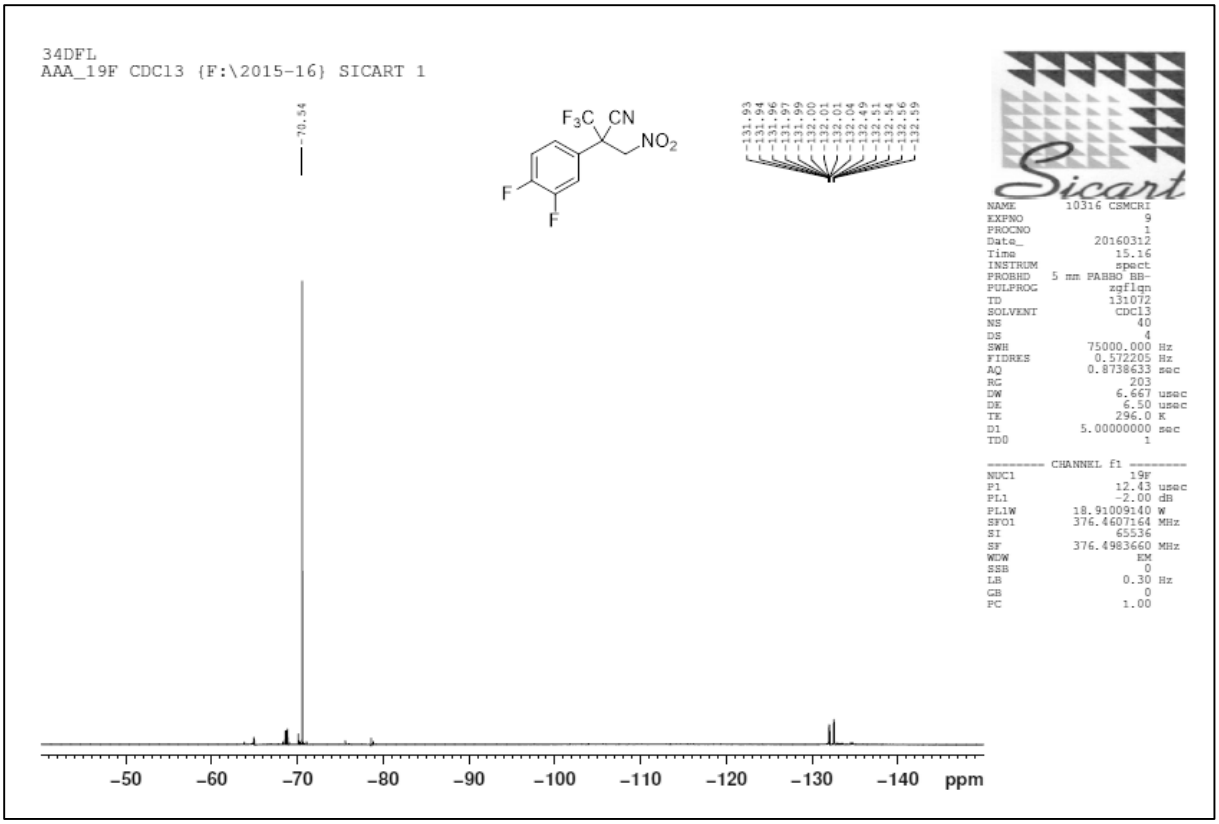
10000
50000
0
150
100
50
ppm (t1)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NO2
F
F
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Sicart
NAME 10316 CSMCRI
EXPNO 9
PROCNO 1
Date_ 20160312
Time 15.16
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zqflqn
TD 131072
SOLVENT CDCl3
NS 40
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 296.0 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
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-120
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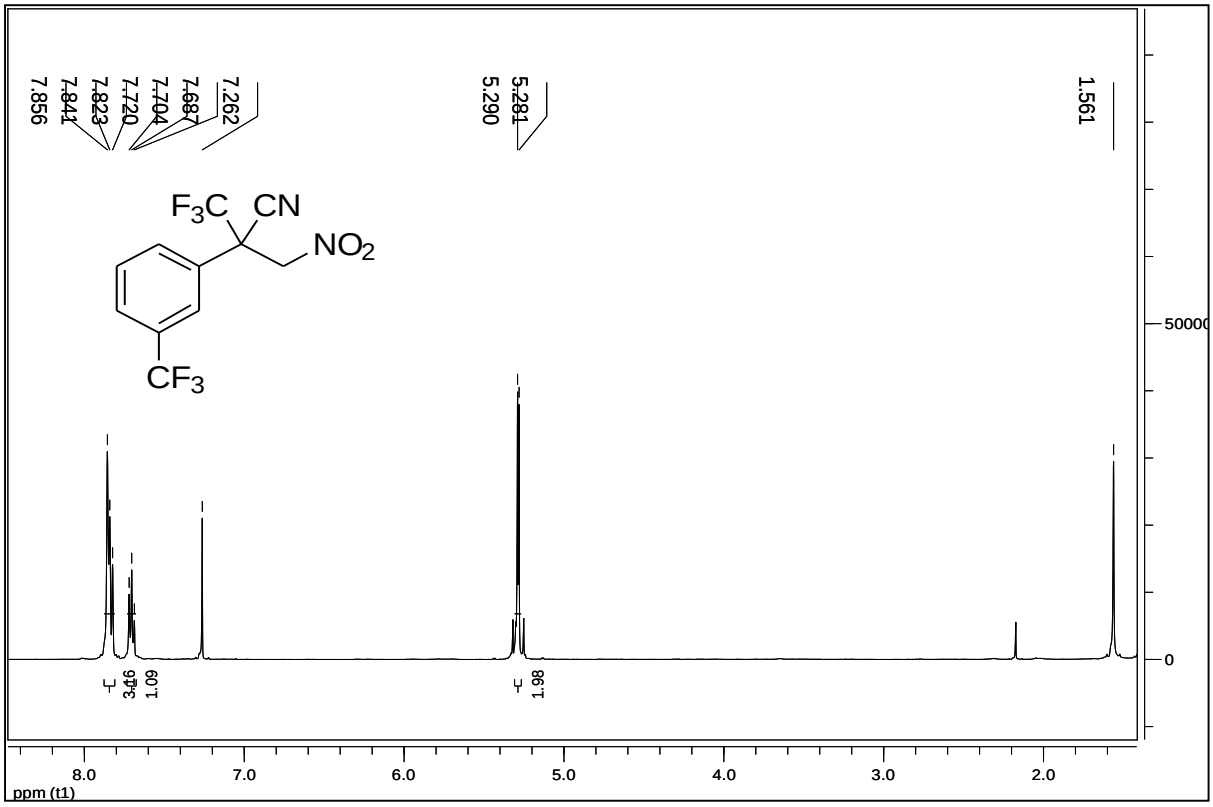
ppm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F3C CN
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CF3
1.09
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8.0
7.0
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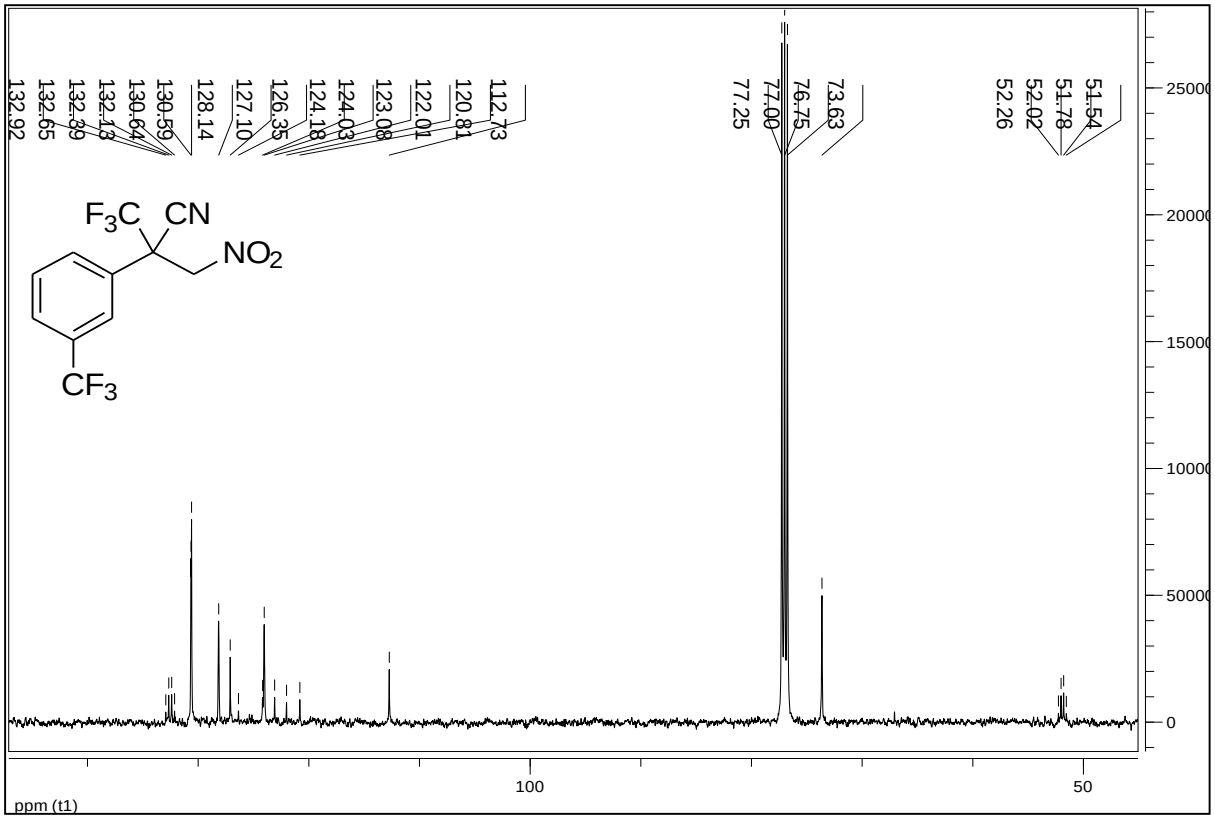
4.0
3.0
2.0
ppm (t1)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132.39
132.13
130.64
130.59
128.14
127.10
126.35
124.18
124.03
123.08
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120.81
112.73
77.25
77.00
76.75
73.63
52.26
52.02
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F3C CN
NO2
CF3
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10000
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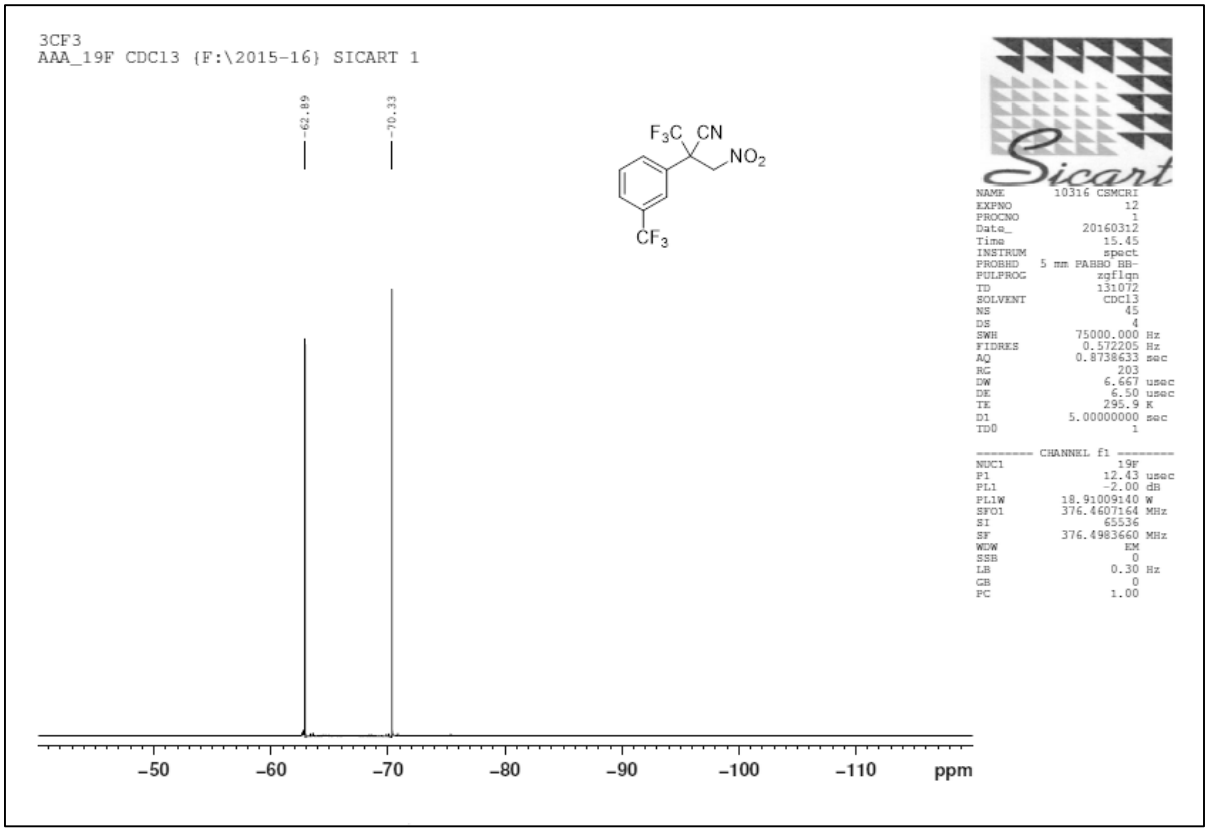
0
100
50
ppm (t1)


3CF3
AAA_19F CDC13 (F:\2015-16) SICART 1
-62.89
-70.33
F3C CN
NO2
CF3
Sicart
NAME 10316 CSMCRI
EXPNO 12
PROCNO 1
Date_ 20160312
Time 15.45
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 45
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SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 295.9 K
D1 5.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
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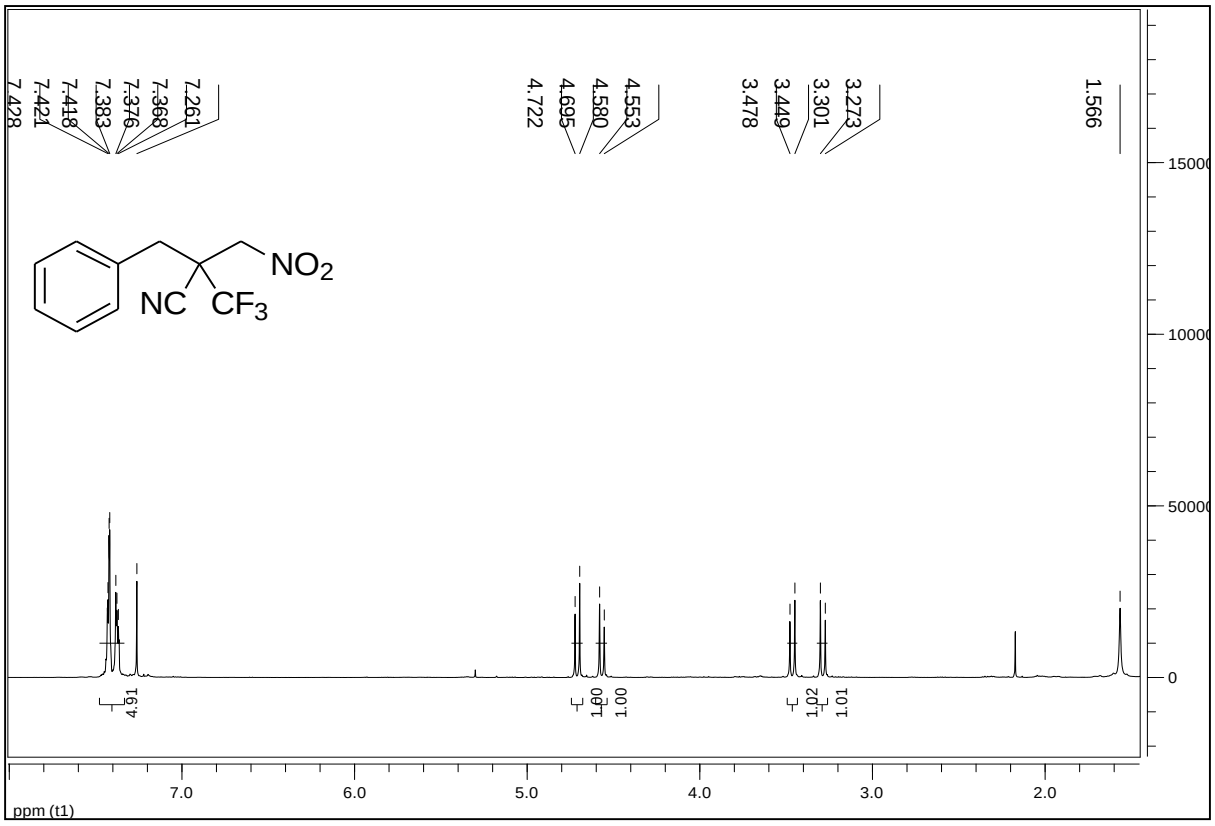
-60
-70
-80
-90
-100
-110
ppm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7.418
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7.376
7.368
7.261
4.722
4.695
4.580
4.553
3.478
3.449
3.301
3.273
1.566
NO2
NC CF3
4.91
1.00
1.00
2.02
1.01
15000
10000
50000
0
7.0
6.0
5.0
4.0
3.0
2.0
ppm (t1)


130.50
130.04
129.32
129.18
123.95
121.67
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77.00
76.75
72.83
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47.94
36.30
NO2
F3C
CN
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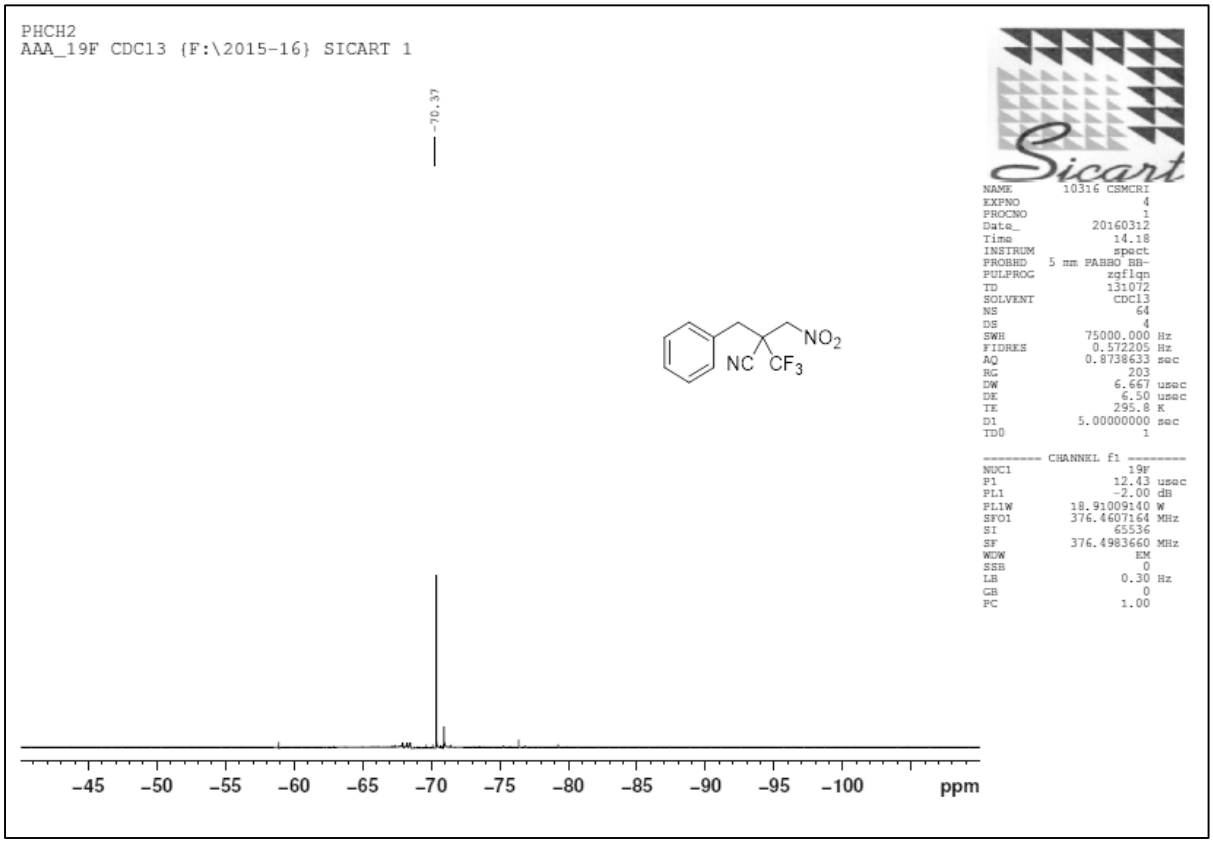
40000
30000
20000
10000
0
100
50
ppm (t1)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AAA_19F CDCl3 (F:\2015-16) SICART 1
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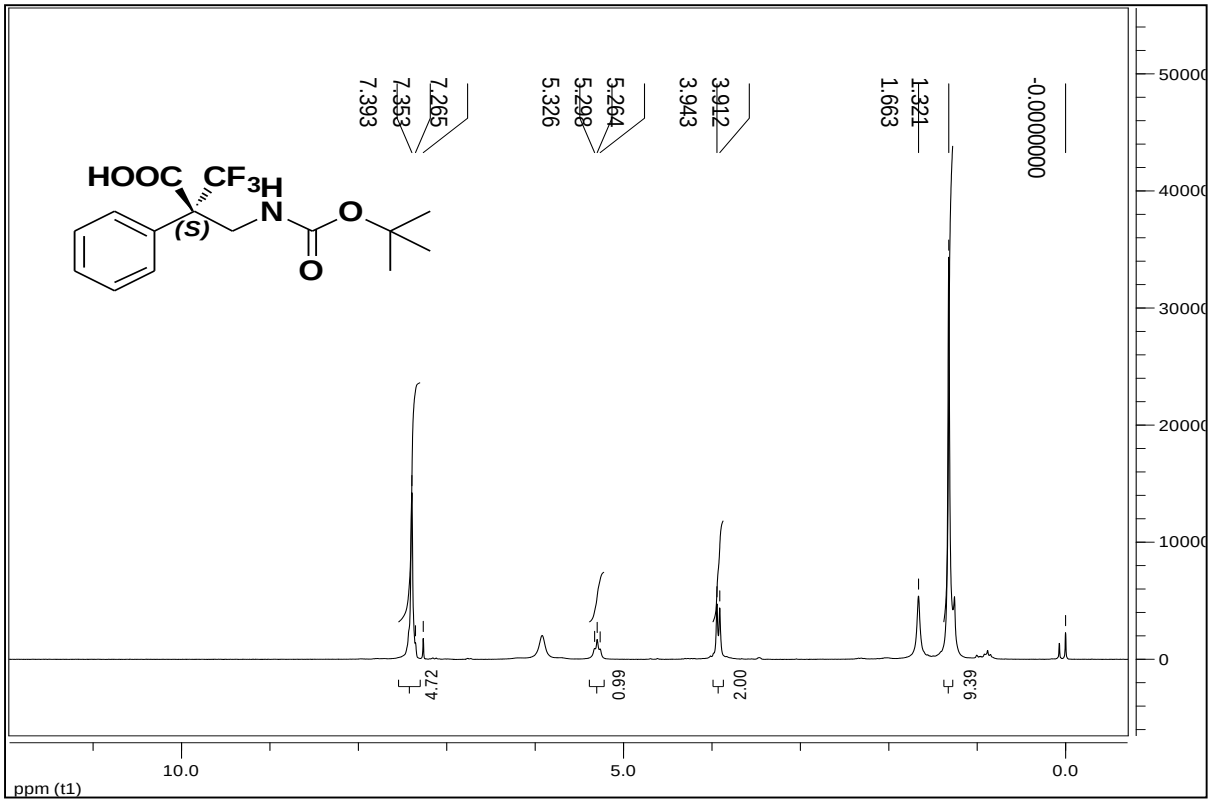
NO2
NC
CF3
Sicart
NAME 10316 CSMCRI
EXPNO 4
PROCNO 1
Date_ 20160312
Time 14.18
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgflqn
TD 131072
SOLVENT CDCl3
NS 64
DS 4
SWH 75000.000 Hz
FIDRES 0.572205 Hz
AQ 0.8738633 sec
RG 203
DW 6.667 usec
DE 6.50 usec
TE 295.8 K
D1 5.00000000 sec
TD0 1
CHANNEL f1
NUC1 19F
P1 12.43 usec
PL1 -2.00 dB
PL1W 18.91009140 W
SFO1 376.4607164 MHz
SI 65536
SF 376.4983660 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
-45 -50 -55 -60 -65 -70 -75 -80 -85 -90 -95 -100
ppm


HOOC
CF3H
N
O
(S)
O
7.393
7.353
7.265
5.326
5.298
5.264
3.943
3.912
1.663
1.321
-0.0000000
2.74
0.99
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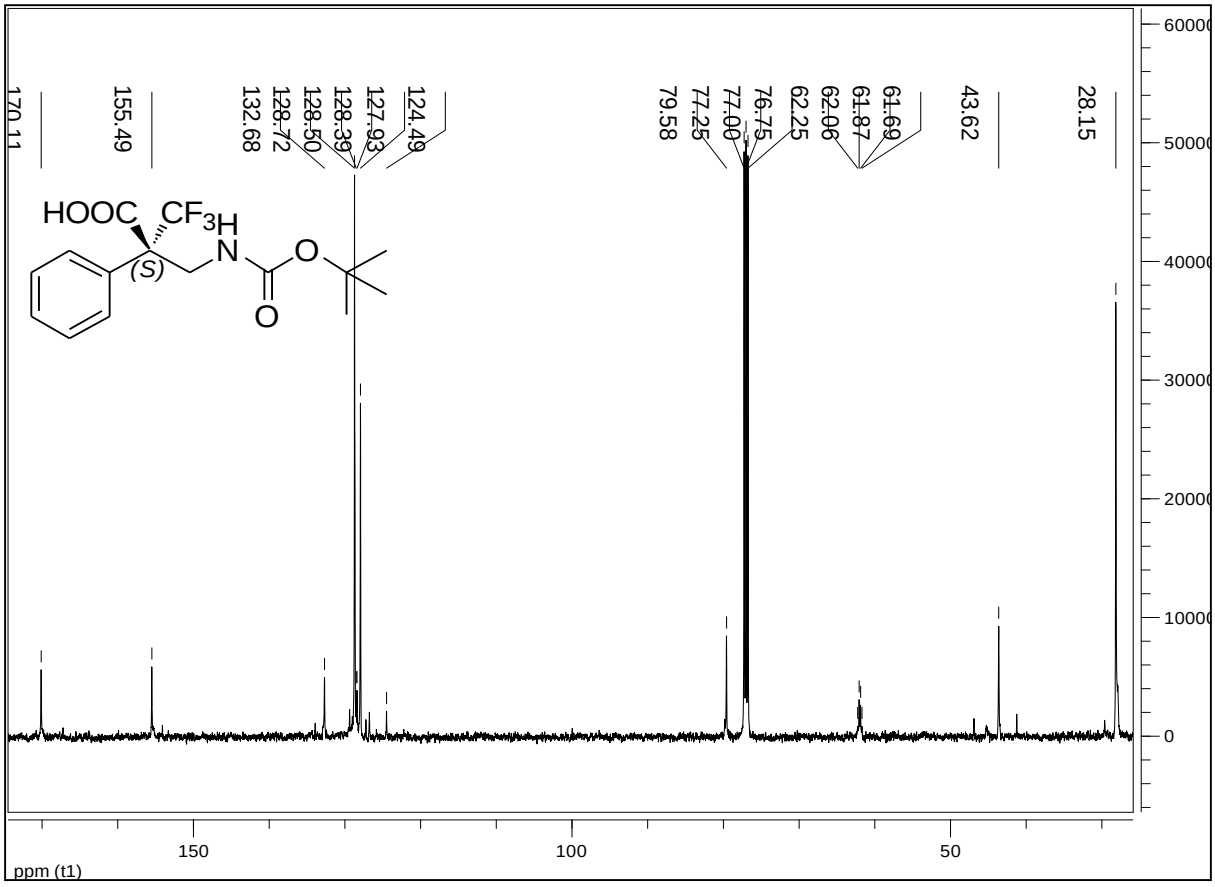
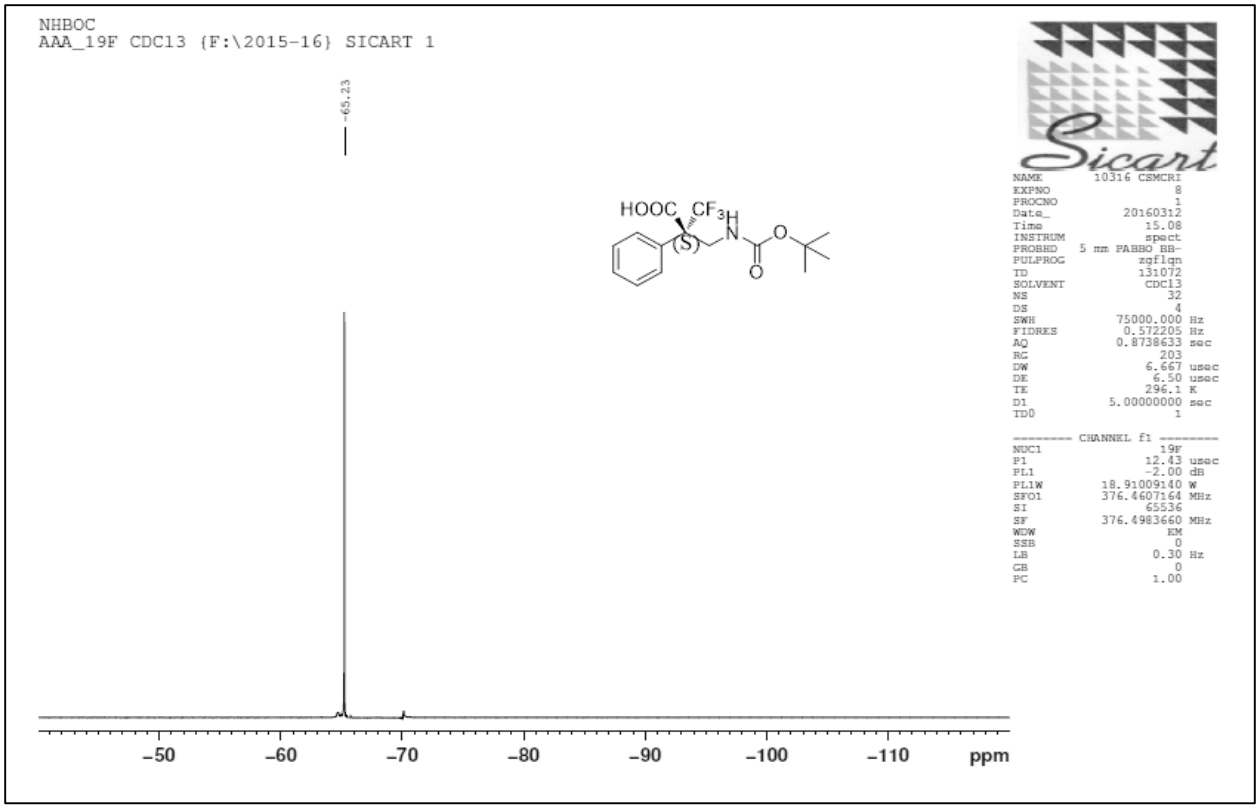
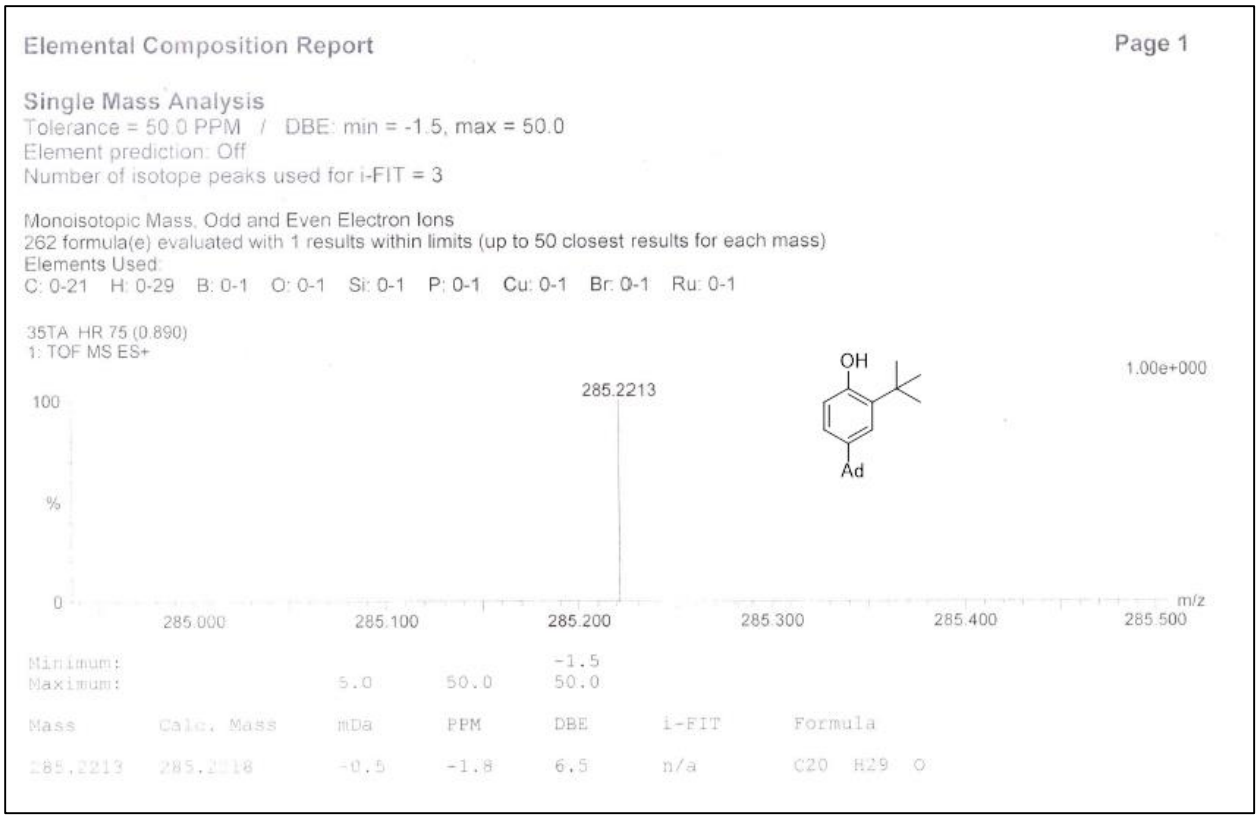
9.39
10.0
5.0
0.0
ppm (t1)


HOOC
CF3H
N
O
(S)
O
170.11
155.49
132.68
128.72
128.50
128.39
127.93
124.49
79.58
77.25
77.00
76.75
62.25
62.06
61.87
61.69
43.62
28.15
150
100
50
ppm (t1)



5. Copy of HRMS for product



Elemental Composition Report

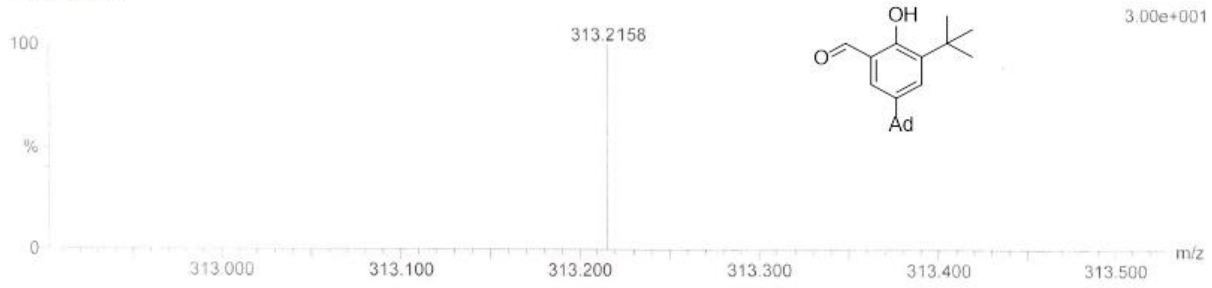
Page 1

Single Mass Analysis

Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Odd and Even Electron Ions
412 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-22 H: 0-29 B: 0-1 O: 0-2 Si: 0-1 P: 0-1 Cu: 0-1 Br: 0-1 Ru: 0-1

5AS HR 42 (0.499)
1: TOF MS ES+



Minimum:		5.0	50.0	-1.5		
Maximum:				50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
313.2158	313.2168	-1.0	-3.2	7.5	n/a	C21 H29 O2

Elemental Composition Report

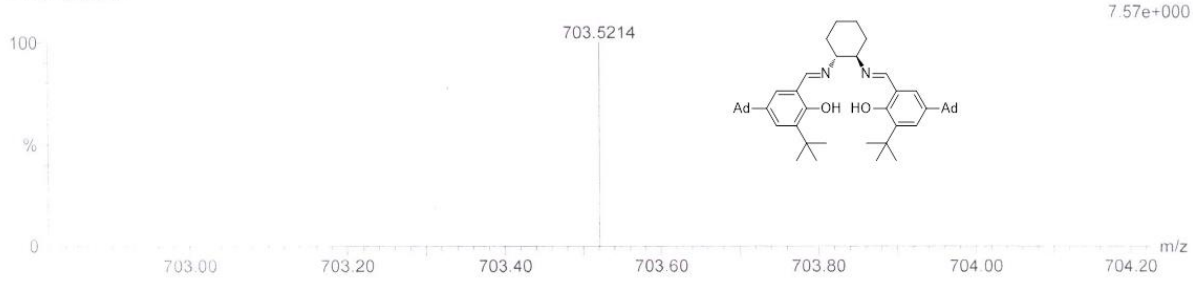
Page 1

Single Mass Analysis

Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Odd and Even Electron Ions
3 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-49 H: 0-67 N: 0-2 O: 0-2

N2 1 HR 57 (0.677)
1: TOF MS ES+

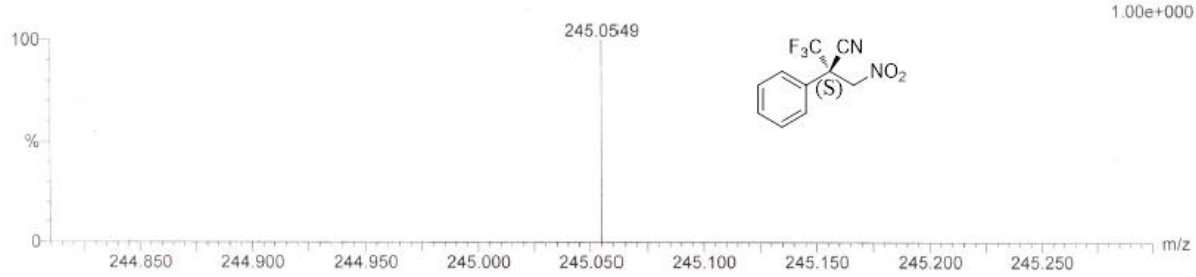


Minimum:		5.0	50.0	-1.5		
Maximum:				50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
703.5214	703.5203	1.1	1.6	16.5	n/a	C48 H67 N2 O2

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
27 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-11 H: 0-8 N: 0-2 O: 0-2 F: 0-3
PCN HR 10 (0.139)
1: TOF MS ES+

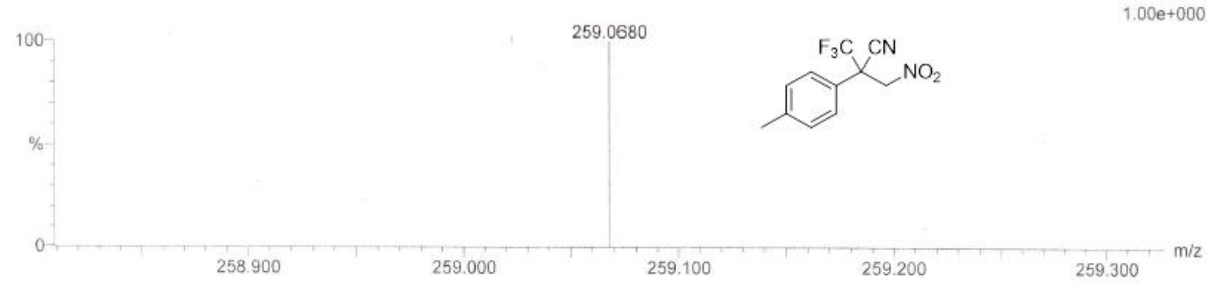


Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
245.0549	245.0538	1.1	4.5	6.5	n/a	C10 H8 N2 O2 F3

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
27 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-12 H: 0-10 N: 0-2 O: 0-2 F: 0-3
MEC HR 3 (0.042)
1: TOF MS ES+



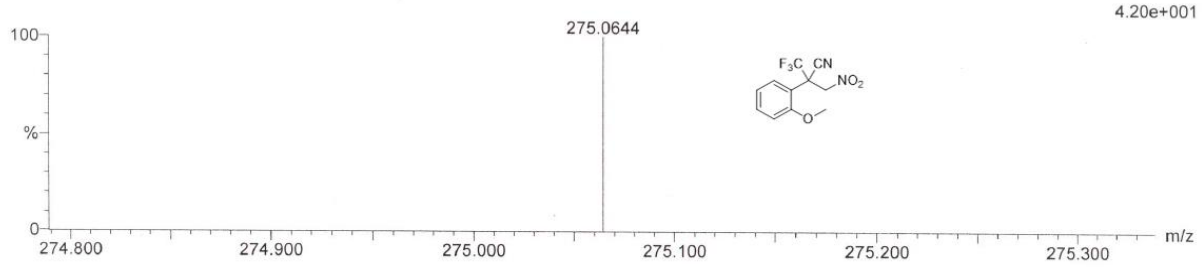
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
259.0680	259.0694	-1.4	-5.4	6.5	n/a	C11 H10 N2 O2 F3

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
973 formula(e) evaluated with 4 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-12 H: 0-10 B: 0-1 N: 0-2 O: 0-3 F: 0-3 Na: 0-1 Si: 0-1 V: 0-2

MEOCN 50 (0.594)
1: TOF MS ES+



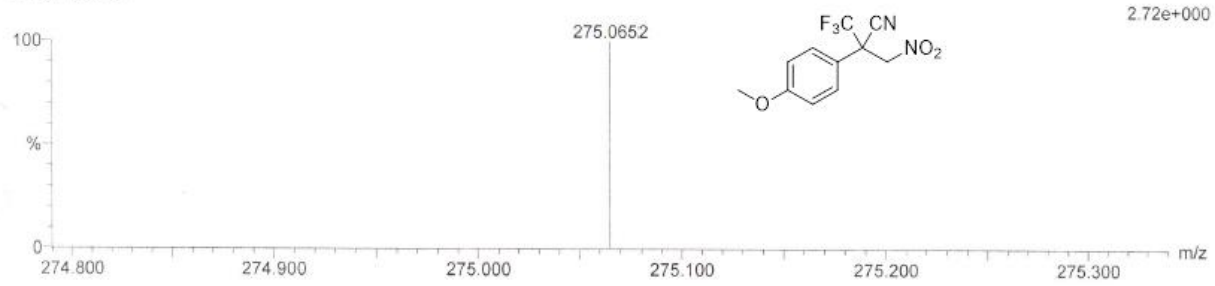
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
275.0644	275.0644	0.0	0.0	6.5	n/a	C11 H10 N2 O3 F3
	275.0624	2.0	7.3	9.5	n/a	C12 H10 B N2 O F2 Si
	275.0608	3.6	13.1	7.5	n/a	C12 H10 N2 O2 F2 Na
	275.0579	6.5	23.6	7.5	n/a	C11 H8 B N2 O F3 Na

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
80 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-12 H: 0-10 N: 0-2 O: 0-3 F: 0-3 Br: 0-1

4MEO HR 6 (0.083)
1: TOF MS ES+



Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
275.0652	275.0644	0.8	2.9	6.5	n/a	C11 H10 N2 O3 F3

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Odd and Even Electron Ions
2352 formula(e) evaluated with 8 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-11 H: 0-7 B: 0-1 N: 0-2 O: 0-2 F: 0-3 Si: 0-1 P: 0-1 Cl: 0-1 Cu: 0-1 Br: 0-1 Ru: 0-1

4CL HR1 20 (0.237)
1: TOF MS ES+

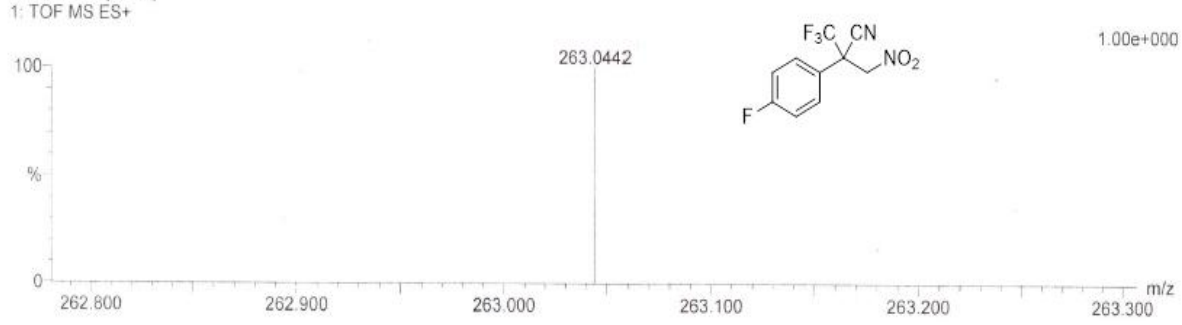
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
279.0153 ✓	279.0148	0.5	1.8	6.5	n/a	C10 H7 N2 O2 F3 Cl
	279.0135	1.8	6.5	10.0	n/a	C11 H5 B N O2 F3 Si
	279.0128	2.5	9.0	9.5	n/a	C11 H7 B N2 F2 Si Cl
	279.0126	2.7	9.7	9.5	n/a	C10 H7 B N2 O F2 Si P
	279.0106	4.7	16.8	10.5	n/a	C11 H4 B N2 O F3 P
	279.0062	9.1	32.6	9.5	n/a	C11 H7 B N2 O F P Cl
	279.0052	10.1	36.2	10.0	n/a	C11 H6 B N F3 Si P
	279.0014	13.9	49.8	9.5	n/a	C11 H7 B O2 F2 Si P

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
66 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-11 H: 0-7 N: 0-2 O: 0-2 F: 0-4 Br: 0-1

4FCN HR 6 (0.083)
1: TOF MS ES+



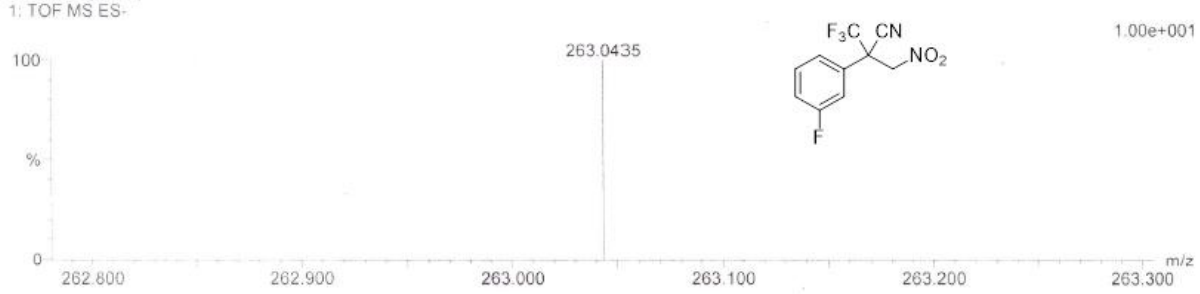
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
263.0442	263.0444	-0.2	-0.8	6.5	n/a	C10 H7 N2 O2 F4

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
1396 formula(e) evaluated with 3 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-11 H: 0-7 B: 0-1 N: 0-2 O: 0-2 F: 0-4 Si: 0-1 P: 0-1 Cu: 0-1 Br: 0-1 Ru: 0-1

3F HR 10 (0.119)
1: TOF MS ES-



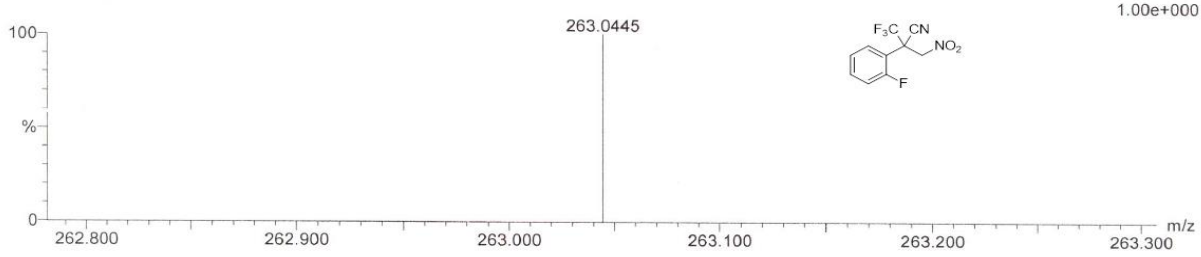
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
263.0435	263.0444	-0.9	-3.4	6.5	n/a	C10 H7 N2 O2 F4
	263.0424	1.1	4.2	9.5	n/a	C11 H7 B N2 F3 Si
	263.0357	7.8	29.7	9.5	n/a	C11 H7 B N2 O F2 P

2FM

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
1417 formula(e) evaluated with 4 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-11 H: 0-7 B: 0-1 N: 0-2 O: 0-2 F: 0-4 Na: 0-1 Si: 0-1 Cl: 0-1 V: 0-2
2FM 82 (0.973)
1: TOF MS ES+



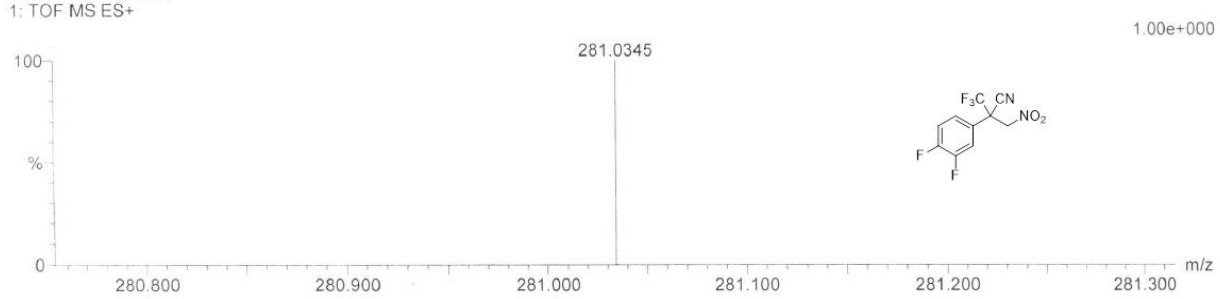
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
263.0445	263.0444	0.1	0.4	6.5	n/a	C10 H7 N2 O2 F4
	263.0424	2.1	8.0	9.5	n/a	C11 H7 B N2 F3 Si
	263.0408	3.7	14.1	7.5	n/a	C11 H7 N2 O F3 Na
	263.0380	6.5	24.7	7.5	n/a	C10 H5 B N2 F4 Na

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
78 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-11 H: 0-6 N: 0-2 O: 0-2 F: 0-5 Br: 0-1

34FCN HR 4 (0.055)
1: TOF MS ES+



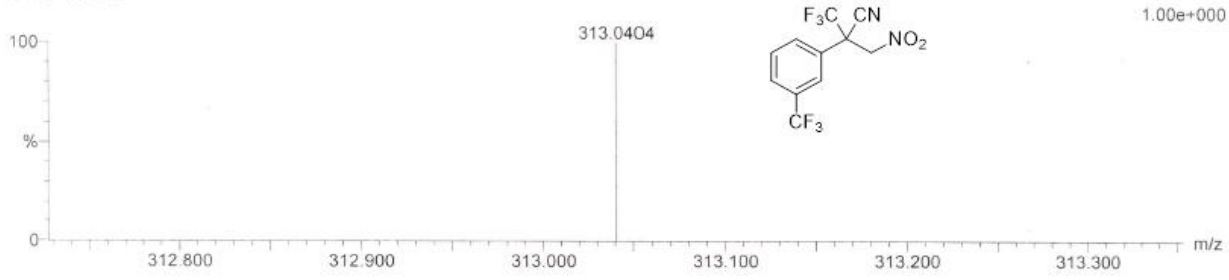
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
281.0345	281.0349	-0.4	-1.4	6.5	n/a	C10 H6 N2 O2 F5

Elemental Composition Report Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
98 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-12 H: 0-7 N: 0-2 O: 0-2 F: 0-6 Br: 0-1

C3 HR 10 (0.139)
1: TOF MS ES+



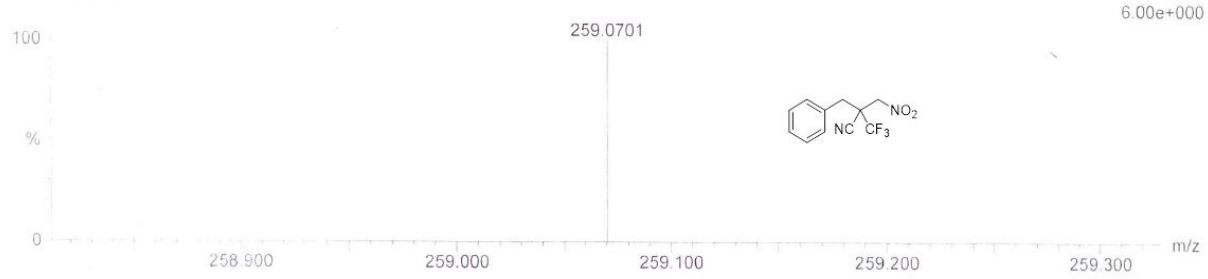
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
313.0404	313.0412	-0.8	-2.6	6.5	n/a	C11 H7 N2 O2 F6

Elemental Composition Report

Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Even Electron Ions
27 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-12 H: 0-10 N: 0-2 O: 0-2 F: 0-3
PHCH HR 74 (0.879)
1: TOF MS ES+



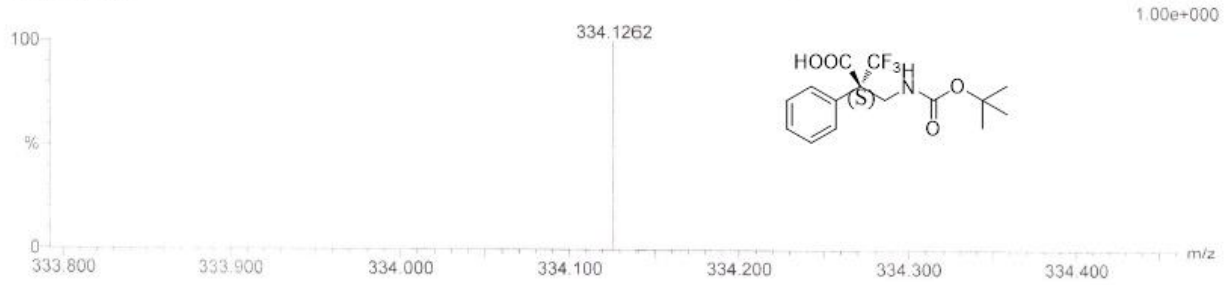
Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
259.0701	259.0694	0.7	2.7	6.5	n/a	C11 H10 N2 O2 F3

Elemental Composition Report

Page 1

Single Mass Analysis
Tolerance = 50.0 PPM / DBE: min = -1.5, max = 50.0
Element prediction: Off
Number of isotope peaks used for i-FIT = 3

Monoisotopic Mass, Odd and Even Electron Ions
34 formula(e) evaluated with 1 results within limits (up to 50 closest results for each mass)
Elements Used:
C: 0-16 H: 0-19 N: 0-1 O: 0-4 F: 0-3
CHRL HR 78 (0.926)
1: TOF MS ES+



Minimum:				-1.5		
Maximum:		5.0	50.0	50.0		
Mass	Calc. Mass	mDa	PPM	DBE	i-FIT	Formula
334.1262	334.1266	-0.4	-1.2	5.5	n/a	C15 H19 N O4 F3

6. Crystal reports for product (2a):

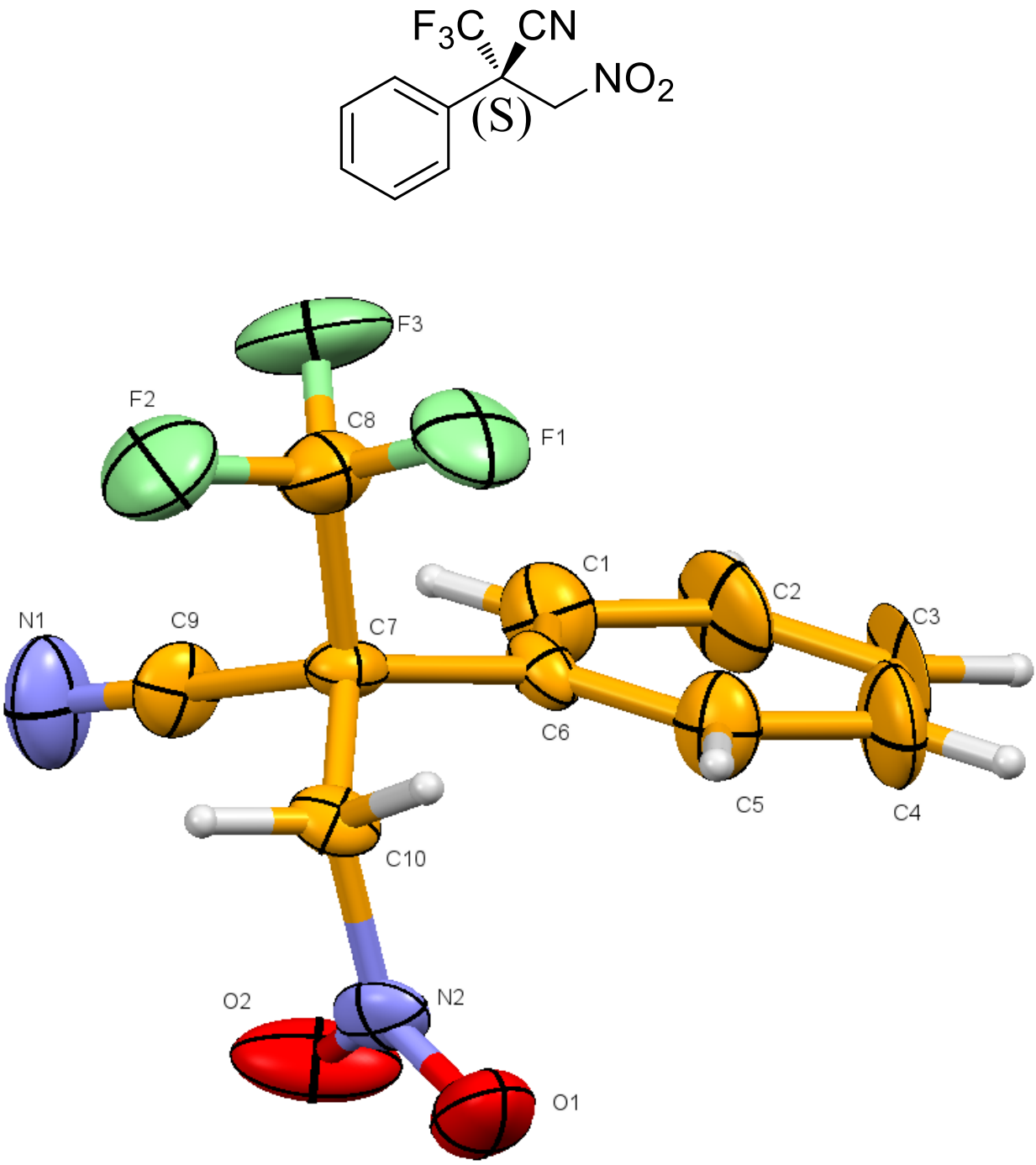


Fig. ORTEP diagram of the chiral organic compound with atom numbering scheme (40% probability factor for the thermal ellipsoids)

Identification code	**AJT1M**
Chemical formula	$C_{10}H_7F_3N_2O_2$
Formula weight	244.18
Crystal Colour	Colourless
Crystal Size (mm)	0.23 x 0.11 x 0.04
Temperature (K)	293(2)
Crystal System	Monoclinic
Space Group	$P2_1$
a(Å)	8.085(5)
b(Å)	6.710(4)
c(Å)	10.341(6)
α(°)	90
β(°)	93.418(9)
γ (°)	90
Z	2
Volume(Å^3)	560.0(5)
Density (Mg/m^3)	1.448
μ (mm^{-1})	0.135
F(000)	248
Reflections Collected	3502
Independent Reflections	1733
R_{int}	0.0475
Number of parameters	154
GOF on F^2	1.187
Final R_1/wR_2 ($I \geq 2\sigma(I)$)	0.0902/0.1719
Weighted R_1/wR_2 (all data)	0.1184/0.1827

$R_1 = \Sigma||Fo| - |Fc||/\Sigma|Fo|$; $wR_2 = [\Sigma w(Fo^2 - Fc^2)^2/\Sigma w(Fo^2)^2]^{1/2}$