Electronic Supplementary Information

Visible-light-induced direct C(sp3) -H of tetrahydroisoquinolines with the in-situ generated difluoroenolates

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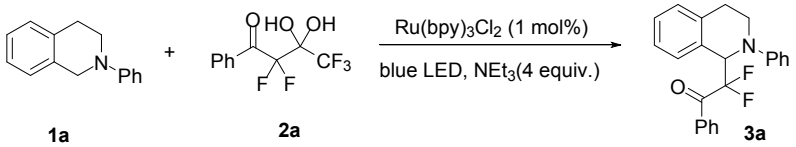
General Information

All reactions were carried out under argon atmosphere unless otherwise noted. CH_3CN was distilled from CaH_2. NEt_3 and CCl_4 were purified according to the procedure from 'Purification of Laboratory Chemicals book'. Reactions were monitored by TLC on silica gel plates (GF254), and the analytical thin-layer chromatography (TLC) was performed on precoated, glass-backed silica gel plates. ^1H NMR, ^{13}C NMR spectra and ^{19}F NMR spectra were recorded on 400 MHz spectrometer at room temperature. $CDCl_3$ was purchased from J&K. Chemical shifts (δ) are reported in ppm downfield from tetramethyl silane. Abbreviations for signal couplings are: s, singlet; d, doublet; t, triplet; m, multiplet. High resolution mass spectra were obtained using an Agilent 6210 Series TOF LC-MS equipped with electrospray ionization (ESI) probe operating in positive ion mode. Melting points (m.p.) were determined with a digital electrothermal apparatus without further correction. The 1,2,3,4-tetrahydroisoquinoline derivatives were prepared according to reported procedures [1]. The gem diol substrates were prepared according to David. A. Colby's reports without modification [2].

General experimental details

Table 1 unsuccessful conditions [a]

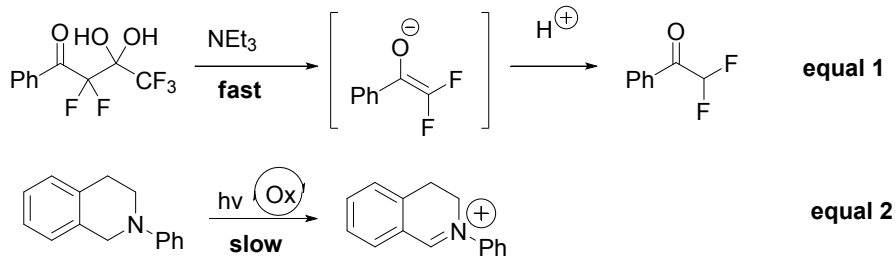


1a **2a** **3a**

Entry	Oxidant	Solvent	additives	Yield[b](%)
1	air	CH_3CN	-	NP
2	air	CH_3CN	LiCl (2 equiv.)	11
3[c]	DNB	CH_3CN	LiCl (2 equiv.)	14
4[c]	CCl_4	CH_3CN	LiCl (2 equiv.)	8
5[c]	CBr_4	CH_3CN	LiCl (2 equiv.)	14
6[c]	$CBrCl_3$	CH_3CN	LiCl (2 equiv.)	28
7[c]	$CBrCl_3$	CH_2Cl_2	LiCl (2 equiv.)	trace
8[c]	$CBrCl_3$	THF	LiCl (2 equiv.)	NR
9[c]	$CBrCl_3$	DMF	LiCl (2 equiv.)	Trace
10[c]	$CBrCl_3$	DMSO	LiCl (2 equiv.)	17
11[c]	$CBrCl_3$	CH_3CN	$LiBF_4$ (2 equiv.)	22
12[c]	$CBrCl_3$	CH_3CN	$LiBr \cdot H_2O$ (2 equiv.)	18
13[c]	$CBrCl_3$	CH_3CN	$Sc(OTf)_3$ (2 equiv.)	NP
14[c]	$CBrCl_3$	CH_3CN	$Cu(NO_3)_2 \cdot 3H_2O$ (2 equiv.)	NR

[a] To a solution of $Ru(bpy)_3Cl_2$ and **1a** (0.2 mmol) in 2 mL solvent was added **2a** (0.4 mmol), oxidant (0.4 mmol), additive (0.4 mmol) and NEt_3 (0.8mmol). The mixture was stirred for 24 h with a 3W blue LED 100 cm trip at room temperarure. [b] Isolated yield. [c] under Ar atmosphere. DNB = 1,3-dinitrobenzene. NR = no reaction. NP = no desired product.

The low yields of above reaction can be rationalized by the mismatch between the reaction rates of the C-C bond cleavage of α, α-difluorinated gem-diol **2a** (Scheme 1, equal 1) and the formation of imine (**Scheme 1**, equal 2). The release of trifluoroacetate occurs rapidly under alkaline condition, which happens in several minutes at room temperature. In contrast, the C-H activation of 1,2,3,4-tetrahydroisoquinoline is sluggish. The active difluoroenolate was soon consumed before it could be trapped by the iminium ion. To solve the problem mentioned above, α, α-difluorinated gem-diol was added to the system after full conversion of the iminiums.



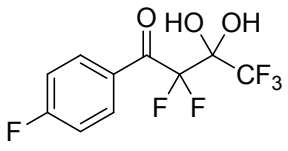
Scheme 1

General procedure for the photoredox catalyzed functionalization of tetrahydroisoquinoline.

A 10 mL Shrek bottle equipped with a magnetic stir bar was added tetrahydroisoquinoline (0.2 mmol), $[Ru(bpy)_3]Cl_2$ (0.002 mmol,1mol%) and acetonitrile (1 mL). The tube was degassed by alternating vacuum evacuation (5 min) and argon backfill three times. CCl_4 (78μL, 0.8 mmol, 4 equiv) was added and the mixture was then irradiated by a 3W blue LED 100 cm trip for 24h at room temperature. After the starting material was consumed as indicated by TLC, the blue LED was removed. Then gem diol (0.4 mmol) was added followed by NEt_3(0.8 mmol, 112 μL), and kept stirring for 30 min. When the reaction finished, the mixture was subjected to flash chromatography (petroleumether 60-90: EtOAc, 15:1) on silica gel to give the desired product.

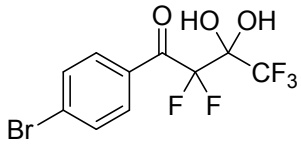
Characterization data of unknown substrates

2,2,4,4,4-pentafluoro-1-(4-fluorophenyl)-3,3-dihydroxybutan-1-one (4b)



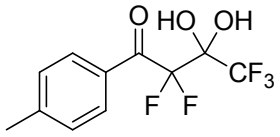
White solid, m.p.: 66-68 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (dd, *J* = 8.8, 5.4 Hz, 2H), 7.24 – 7.14 (m, 2H), 4.79 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.81 (t, *J* = 29.1 Hz), 167.26 (d, *J* = 260.2 Hz), 133.78 (dt, *J* = 10.0, 3.7 Hz), 128.20 (d, *J* = 2.7 Hz), 120.93 (d, *J* = 289.7 Hz), 116.42 (d, *J* = 22.2 Hz), 111.51 (t, *J* = 268.5 Hz), 92.78 (tq, *J* = 33.0, 16.5 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.07 (t, *J* = 11.3 Hz, 3F), -99.38 (s, 1F), -111.88 (q, *J* = 11.5 Hz, 2F).

1-(4-bromophenyl)-2,2,4,4,4-pentafluoro-3,3-dihydroxybutan-1-one (4d)



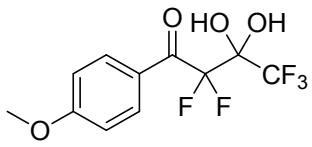
White solid, m.p.: 63-65 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 8.7 Hz, 2H), 7.68 (d, *J* = 8.7 Hz, 2H), 4.71 (s, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.50 (t, *J* = 29.3 Hz), 132.39, 131.92 (t, *J* = 3.6 Hz), 131.59, 130.47, 120.87 (q, *J* = 288.5 Hz), 111.44 (t, *J* = 268.5 Hz), 92.82 (qt, J=33.1, 5.9 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.05 (t, *J* = 11.2 Hz, 3F), -112.10 (q, *J* = 11.3 Hz, 2F).

2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(p-tolyl)butan-1-one (4e)



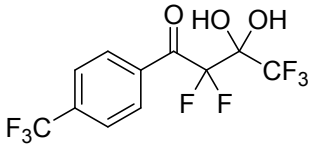
White solid, m.p.: 51-53 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.00 (d, *J* = 8.3 Hz, 2H), 7.32 (d, *J* = 8.2 Hz, 2H), 4.85 (s, 2H), 2.45 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.07 (t, *J* = 29.0 Hz), 147.40, 130.82 (t, *J* = 3.6 Hz), 129.70, 129.19, 120.99 (q, *J* = 288.5 Hz), 111.34 (t, *J* = 268.8 Hz), 92.99 (qt, J= 27.1, 5.81Hz), 21.98. ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.05 (t, *J* = 11.3 Hz, 3F), -111.78 (q, *J* = 11.4 Hz, 2F).

2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(4-methoxyphenyl)butan-1-one (4f)



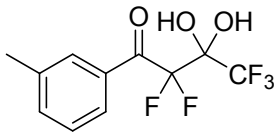
White solid, m.p.: 58-60 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (d, *J* = 9.1 Hz, 2H), 6.98 (d, *J* = 9.1 Hz, 2H), 4.97 (s, 2H), 3.91 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.51(t, *J* = 26.8Hz), 165.73, 133.53(t, 3.8Hz), 124.44, 121.17 (q, *J* =288.5Hz), 114.38, 111.50 (t,J=268.7Hz), 93.09 (qt, *J* = 32.8,5.8), 55.77. ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.04 (t, *J* = 11.3 Hz, 3F), -111.42 (q, *J* = 11.4 Hz, 2F).

2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(4-(trifluoromethyl)phenyl)butan-1-one (4g)



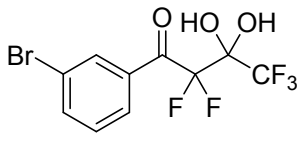
Colorless oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (d, *J* = 8.2 Hz, 2H), 7.79 (d, *J* = 8.4 Hz, 2H), 4.76 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.66 (t, *J* = 29.2 Hz), 136.36 (q, *J* = 33.1 Hz), 134.75, 130.91 (t, *J* = 3.5 Hz), 125.89 (q, *J* = 3.6 Hz), 123.25 (q, *J* = 273.0), 111.66 (t, *J* = 268.1 Hz), 92.79 (qt, *J* =33.1,8.0Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.64 (s, 3F), -81.07 (t, *J* = 11.1 Hz, 3F), -112.56 (q, *J* = 11.2 Hz, 2F).

2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(m-tolyl)butan-1-one (4h)



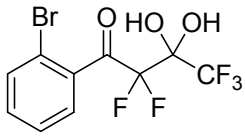
White solid, m.p.: 50-52 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 9.7 Hz, 2H), 7.51 (d, *J* = 7.6 Hz, 1H), 7.40 (t, *J* = 7.7 Hz, 1H), 4.88 (s, 2H), 2.42 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.85 (t, *J* = 29.1 Hz), 138.94, 136.52, 131.79, 130.90 (t, *J* = 3.1 Hz), 128.79, 127.90 (t, *J* = 3.9 Hz), 121.00 (q, *J* = 288.6 Hz), 111.31 (t, *J* = 268.7 Hz), 92.99(qt, *J* = 32.9, 5,8Hz), 21.31. ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.02 (t, *J* = 11.3 Hz, 3F), -111.79 (q, *J* = 11.4 Hz, 2F).

1-(3-bromophenyl)-2,2,4,4,4-pentafluoro-3,3-dihydroxybutan-1-one (4i)



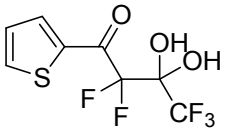
White solid, m.p.: 58-60°C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.19 (s, 1H), 8.03 (d, *J* = 7.9 Hz, 1H), 7.85 – 7.79 (m, 1H), 7.41 (t, *J* = 8.0 Hz, 1H), 4.70 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.20 (t, *J* = 29.3 Hz), 138.36, 133.45, 133.23 (t, *J* = 3.3 Hz), 130.42, 129.09 (t, *J* = 4.0 Hz), 123.10, 121.30 (q, *J* = 288.5 Hz), 111.40 (t, *J* = 268.5 Hz), 92.79 (qt, *J* = 33.1, 6.0 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.02 (t, *J* = 11.2 Hz, 3F), -112.17 (q, *J* = 11.2 Hz, 2F).

1-(2-bromophenyl)-2,2,4,4,4-pentafluoro-3,3-dihydroxybutan-1-one (4j)



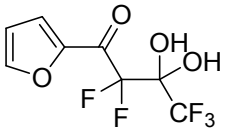
Colorless oil, ^{1}HNMR (400 MHz, $CDCl_3$) δ 7.72 – 7.67 (m, 1H), 7.66 – 7.61 (m, 1H), 7.46 – 7.38 (m, 2H), 4.99 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.32 (t, *J* = 30.2 Hz), 134.48, 134.23, 133.61, 129.97 (t, *J* = 3.6 Hz), 127.10, 120.84 (d, *J* = 286.9 Hz), 120.47, 110.15 (t, *J* = 269.0 Hz), 92.83(qt, J=33.2, 5.7Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -80.98 (t, *J* = 11.1 Hz, 3F), -113.99 (q, *J* = 11.2 Hz, 2F).

2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(thiophen-2-yl)butan-1-one (4k)



Colorless oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.32 – 8.09 (m, 1H), 8.04 – 7.84 (m, 1H), 7.31 – 7.07 (m, 1H), 4.93 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 183.64 (t, *J* = 29.3 Hz), 139.24, 138.21 (t, *J* = 6.2 Hz), 137.46, 129.47, 120.90 (q, *J* = 288.2 Hz), 111.01 (t, *J* = 268.0 Hz), 92.84 (qt, *J* = 33.0, 5.8Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.09 (t, *J* = 11.1 Hz), -113.79 (q, *J* = 11.1 Hz).

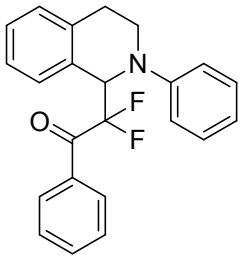
2,2,4,4,4-pentafluoro-1-(furan-2-yl)-3,3-dihydroxybutan-1-one (4l)



Colorless oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 – 7.84 (m, 1H), 7.71 – 7.68 (m, 1H), 6.70 (dd, *J* = 3.8, 1.7 Hz, 1H), 5.13 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 177.84 (t, *J* = 29.1 Hz), 150.87, 147.86, 147.86, 126.67 (t, *J* = 6.9 Hz), 120.95 (q, *J* = 288.5 Hz), 113.67, 111.02 (d, *J* = 266.8 Hz), 92.73 (qt, *J* = 33.1, 6.0 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -81.17 (t, *J* = 10.9 Hz, 3F), -115.99 (q, *J* = 11.0 Hz, 2F).

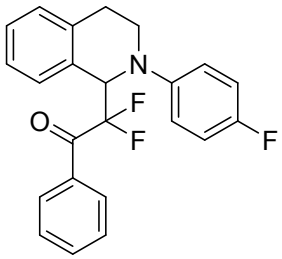
Characterization data of products

2,2-difluoro-1-phenyl-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(3a)



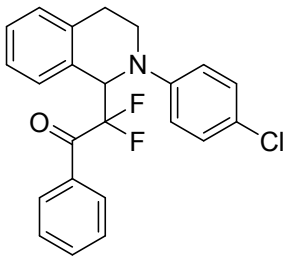
Yield 77%, yellow solid, m.p.: 108-120 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 7.7 Hz, 2H), 7.55 – 7.46 (m, 1H), 7.42 – 7.35 (m, 3H), 7.29 – 7.08 (m, 5H), 6.82 – 6.74 (m, 3H), 5.52 (dd, *J* = 16.6, 13.0 Hz, 1H), 3.79 – 3.68 (m, 1H), 3.47 (dt, *J* = 10.4, 5.0 Hz, 1H), 2.91 (ddd, *J* = 15.3, 9.3, 5.6 Hz, 1H), 2.80 (dt, *J* = 16.4, 4.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.28 (t, *J* = 28.0 Hz), 149.20, 136.83, 133.83, 133.55, 129.31 (t, *J* = 3.5 Hz), 129.11, 129.10, 129.04, 128.99, 128.54, 128.49, 128.46, 128.23, 126.23, 120.03, 116.62, 61.26 (dd, *J* = 26.3, 23.5 Hz), 43.82 (d, *J* = 3.8 Hz), 25.43. ^{19}F NMR (376 MHz, $CDCl_3$) δ -97.45 (d, *J* = 259.4 Hz, 1F), -105.84 (d, *J* = 259.4 Hz, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}F_2NONa$ $[M+Na]^+$ 386.1327, found 386.1330.

2,2-difluoro-2-(2-(4-fluorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(3b)



Yield 72%, white solid, m.p.: 91-92 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 7.7 Hz, 2H), 7.54 – 7.48 (m, 1H), 7.45 – 7.33 (m, 3H), 7.30 – 7.19 (m, 2H), 7.17 (d, *J* = 7.4 Hz, 1H), 6.82 – 6.74 (m, 2H), 6.70 – 6.63 (m, 2H), 5.36 (dd, *J* = 18.0, 11.7 Hz, 1H), 3.75 – 3.64 (m, 1H), 3.34 (dt, *J* = 13.4, 4.7 Hz, 1H), 2.90 – 2.79 (m, 1H), 2.73 (dt, *J* = 16.5, 4.3 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.02(t, 27.8Hz), 157.51(d, 239.85), 145.91, 136.74, 133.85, 133.61, 129.25 (t, *J* = 3.41 Hz), 129.16, 128.84, 128.54, 128.47, 128.32, 126.39, 119.34 (d, *J* = 7.74 Hz), 115.52 (d, *J* = 22.25 Hz), 61.82 (dd, *J* = 26.52, 23.68 Hz), 44.95, 24.96. ^{19}F NMR (376 MHz, $CDCl_3$) δ -96.28 (d, *J* = 259.2 Hz, 1F), -107.51 (dd, *J* = 259.1, 19.7 Hz, 1F), -123.40. HRMS (ESI) m/z calcd for $C_{23}H_{19}F_3NO$ $[M+H]^+$ 382.1413, found 382.1415.

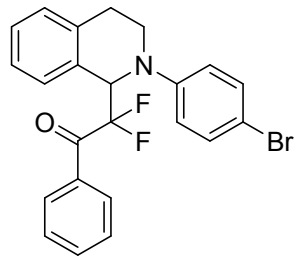
2-(2-(4-chlorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(3c)



Yield 63%, white solid, m.p.: 124-126 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.8 Hz, 2H), 7.56 – 7.50 (m, 1H), 7.38 (t, *J* = 7.8 Hz, 3H), 7.30 – 7.14 (m, 3H), 7.10 – 7.04 (m, 2H), 6.73 – 6.66 (m, 2H), 5.46 (dd, *J* = 15.5, 13.7 Hz, 1H), 3.77 – 3.67 (m, 1H), 3.46 – 3.36 (m, 1H), 2.94 – 2.79 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.15 (t, *J* = 28.0 Hz), 147.85, 136.61, 133.75, 133.66, 129.32 (t, *J* = 3.5 Hz), 128.98, 128.91, 128.82, 128.80, 128.57, 128.53, 128.40, 126.36, 124.88, 117.66, 61.26 (dd, *J* = 26.2, 23.5 Hz), 43.99 (d, *J* = 3.6 Hz), 25.56. ^{19}F NMR (376 MHz, $CDCl_3$) δ -98.22 (d, *J* = 260.9 Hz, 1F), -105.40 (d, *J* = 260.9 Hz, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}F_2ClNO$ $[M+H]^+$ 398.1118,

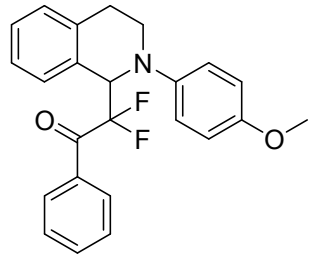
found 398.1120.

2-(2-(4-bromophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(3d)



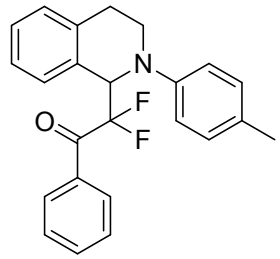
Yield 55%,white solid, m.p.: 124-126 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.8 Hz, 2H), 7.53 (t, *J* = 7.4 Hz, 1H), 7.42-7.33(m,3H), 7.29 – 7.14 (m, 5H), 6.66 (d, *J* = 9.0 Hz, 2H), 5.52 – 5.43 (m, 1H), 3.79 – 3.64 (m, 1H), 3.45 – 3.34 (m, 1H), 2.95 – 2.80 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ191.16 (t, *J* = 28.0 Hz), 148.25, 136.58, 133.77, 133.62, 131.81, 129.33 (t, *J* = 3.5 Hz), 128.95, 128.81, 128.79, 128.58, 128.54, 128.42, 126.35, 117.90, 112.10, 61.17 (dd, *J* = 26.1, 23.5 Hz), 43.71, 25.64. ^{19}F NMR (376 MHz, $CDCl_3$) δ -98.51 (d, *J* = 261.1 Hz, 1F), -105.06 (d, *J* = 261.1 Hz, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{18}F_2BrNO$ $[M+Na]^+$ 464.0432, found 464.0433.

2,2-difluoro-2-(2-(4-methoxyphenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(3e)



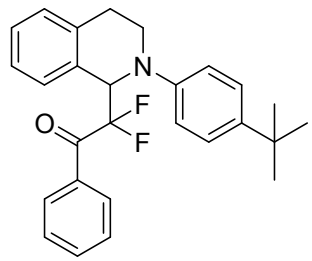
Yield 77%,yellow solid, m.p.: 103-105 °C,^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 7.8 Hz,2H), 7.53 – 7.43 (m, 2H), 7.38 (t, *J* = 7.7 Hz, 2H), 7.30 – 7.20 (m, 2H), 7.15 (d, *J* = 7.4 Hz, 1H), 6.64 (s, 4H), 5.29 (dd, *J* = 19.6, 10.6 Hz, 1H), 3.70 – 3.61 (m, 4H), 3.30 (m, 1H), 2.82 (m, 1H), 2.64 (dt, *J* = 16.5, 3.7 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.97(t, 28.66Hz), 154.36, 143.51, 136.89, 134.02, 133.36, 129.17 (t, *J* = 3.3 Hz), 129.06, 128.44, 128.41, 128.36, 128.08, 126.24, 120.23, 114.26, 62.02 (dd, *J* = 26.6, 23.7 Hz), 55.42, 45.25 (d, *J* = 4.3 Hz), 24.53. ^{19}F NMR (376 MHz, $CDCl_3$) δ -94.92 (d, *J* = 257.1 Hz, 1F), -108.75 (d, *J* = 257.1 Hz, 1F). HRMS (ESI) m/z calcd for $C_{24}H_{21}F_2NNaO_2$ $[M+Na]^+$ 416.1433, found 416.1437.

2,2-difluoro-1-phenyl-2-(2-(p-tolyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(3f)



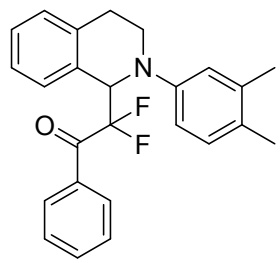
Yield 63%, yellow solid, mp 125-127°C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 7.8 Hz, 2H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.44 – 7.34 (m, 3H), 7.29 – 7.12 (m, 3H), 6.91 (d, *J* = 8.4 Hz, 2H), 6.65 (d, *J* = 8.5 Hz, 2H), 5.43 (dd, *J* = 18.0, 11.9 Hz, 1H), 3.73 – 3.63 (m, 1H), 3.41 (dt, *J* = 13.4, 4.6 Hz, 1H), 2.88 (m, 1H), 2.72 (dt, *J* = 16.4, 4.2 Hz, 1H), 2.18 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.26 (t, 27.28 Hz), 147.07, 136.86, 133.98, 133.44, 129.75, 129.56, 129.28 (t, *J* = 3.7 Hz), 129.12, 129.05, 128.51, 128.47, 128.43, 128.13, 126.18, 117.37, 61.55 (dd, *J* = 26.7, 23.5 Hz), 44.16, 25.04, 20.34. ^{19}F NMR (376 MHz, $CDCl_3$) δ -96.28 (d, *J* = 258.2 Hz, 1F), -107.04 (d, *J* = 258.2, 1F). HRMS (ESI) m/z calcd for $C_{24}H_{21}F_2NNaO$ $[M+Na]^+$ 400.1483, found 400.1487.

2-(2-(4-(tert-butyl)phenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(3g)



Yield 89%, yellow solid, m.p.: 120-122 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, *J* = 7.9 Hz, 2H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.37 (m, 3H), 7.19 (m, 5H), 6.72 (d, *J* = 8.8 Hz, 2H), 5.49 (dd, *J* = 17.0, 12.7 Hz, 1H), 3.78 – 3.67 (m, 1H), 3.49 – 3.41 (m, 1H), 2.98 – 2.87 (m, 1H), 2.79 (dt, *J* = 16.3, 4.5 Hz, 1H), 1.23 (s, 9H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.52(t,J=27.9Hz),146.85,142.75,136.94, 133.99, 133.50, 129.41 (t, *J* = 3.5 Hz),129.27, 129.00, 128.62, 128.57, 128.47, 128.19, 126.18, 125.86, 116.35, 61.62 (dd, *J* = 26.3, 23.5 Hz), 43.78 (d, *J* = 3.8 Hz),33.89, 31.41, 25.48. ^{19}F NMR (376 MHz, $CDCl_3$) δ -97.22 (d, *J* = 259.1 Hz, 1F), -106.13 (d, *J* = 259.1, 1F). HRMS (ESI) m/z calcd for $C_{27}H_{28}F_2NO$ $[M+H]^+$ 420.2133, found 420.2134.

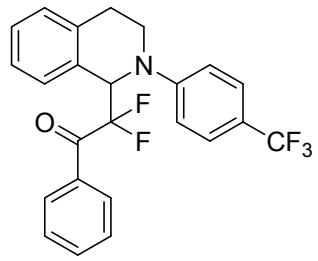
2-(2-(3, 4-dimethylphenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(3h)



Yield 95%, yellow solid, m.p.: 114-116°C , ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.7 Hz, 2H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.45 – 7.34 (m, 3H), 7.27 – 7.11 (m, 3H), 6.85 (d, *J* = 9.0 Hz, 1H), 6.53 – 6.47 (m, 2H), 5.44 (dd, *J* = 18.4, 11.6 Hz, 1H), 3.74 – 3.63 (m, 1H), 3.43 (dt, *J* = 13.5, 4.6 Hz, 1H), 2.90 (m, 1H), 2.71 (dt, *J* = 16.4, 4.1 Hz, 1H), 2.08 (s, 6H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.26(t, 27.7), 147.44, 137.09, 136.92, 134.06, 133.50, 130.11, 129.40 (t, *J* = 3.5 Hz), 129.24, 129.13, 128.58, 128.54, 128.49, 128.16, 126.17, 118.91, 114.68, 61.69 (dd, *J* = 26.5, 23.6 Hz), 43.95 (d, *J* = 4.2 Hz), 25.13, 20.17, 18.74. ^{19}F NMR (376 MHz, $CDCl_3$) δ -95.98 (d, *J* = 258.0 Hz, 1F), -107.10 (d, *J* = 258.0, 1F).

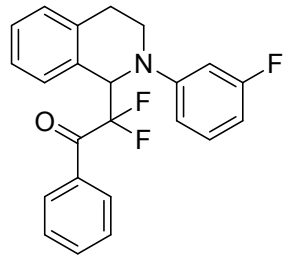
HRMS (ESI) m/z calcd for $C_{25}H_{23}F_2NNaO$ $[M+Na]^+$ 414.1640, found 414.1641.

2,2-difluoro-1-phenyl-2-(2-(4-(trifluoromethyl)phenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(3i)



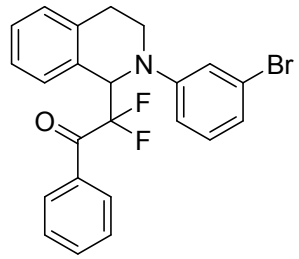
Yield 36%, yellow solid, m.p.: 112-114 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.8 Hz, 2H), 7.55 (t, *J* = 7.4 Hz, 1H), 7.42 – 7.35 (m, 4H), 7.32 – 7.26 (m, 2H), 7.23-7.15 (m 2H), 6.89 (d, *J* = 8.8 Hz,2H), 5.69 (dd, *J* = 15.5, 12.9 Hz, 1H), 3.86 – 3.75 (m, 1H), 3.58 – 3.47 (m, 1H), 3.08 – 2.92(m,2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.33 (t, *J* = 28.3 Hz), 151.40, 136.53, 134.01, 133.39, 129.49 (t, *J* = 3.8Hz), 128.88, 128.86, 128.80, 128.69, 128.66, 128.63, 128.58, 126.46, 126.36 (q, *J* = 3.7 Hz), 114.19 (s), 60.67 (t, *J* = 25.3Hz), 43.35 (d, *J* = 2.5 Hz), 26.46 (d, *J* = 3.0 Hz). ^{19}FNMR (376 MHz, $CDCl_3$) δ -61.41, -101.11 (d, *J* = 264.3 Hz, 1F), -102.55 (d, *J* = 264.3 Hz, 1F). HRMS (ESI) m/z calcd for $C_{24}H_{19}F_5NO$ $[M+H]^+$ 432.1381, found 432.1380.

2,2-difluoro-2-(2-(3-fluorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(3j)



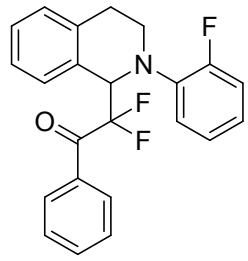
Yield 60%,yellow solid, m.p.: 88-90 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, *J* = 7.8 Hz, 2H), 7.56 – 7.51 (m, 1H), 7.42 – 7.32 (m, 3H), 7.29 – 7.23 (m, 1H), 7.18 (t, *J* = 6.7 Hz, 2H), 7.08 (dd, *J* = 15.3, 8.2 Hz, 1H), 6.59 (dd, *J* = 8.4, 2.3 Hz, 1H), 6.53 – 6.43 (m, 2H), 5.54 (t, *J* = 14.4 Hz, 1H), 3.79 – 3.68 (m, 1H), 3.49 – 3.40 (m, 1H), 2.97 – 2.88 (m,2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 191.20 (t, *J* = 28.1 Hz), 163.66 (d, *J* = 243.3 Hz), 150.88 (d, *J* = 10.2 Hz), 136.62, 133.81, 133.61, 130.09 (d, *J* = 10.1 Hz), 129.41(t,3.5Hz), 128.89, 128.63 (d, *J* = 3.6 Hz), 128.54, 128.46, 126.37, 111.11, 106.03 (d, *J* = 21.4 Hz),, 102.82 (d, *J* = 25.8 Hz), 61.18 (dd, *J* = 26.2, 23.4 Hz), 43.64 (d, *J* = 3.6 Hz), 25.97 (d, *J* = 2.8 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -99.49 (d, *J* = 262.0 Hz, 1F), -104.07 (d, *J* = 262.0 Hz, 1F), -112.11(s, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{18}F_3NNaO$ $[M+Na]^+$ 404.1233, found 404.1235.

2-(2-(3-bromophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(3k)



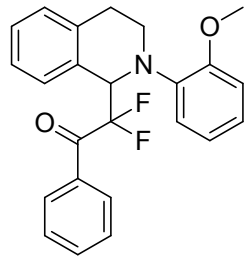
Yield 52%, yellow solid, m.p.: 83-85 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.8 Hz, 2H), 7.57 – 7.51 (m, 1H), 7.42 – 7.32 (m, 3H), 7.29 – 7.23 (m, 1H), 7.22 – 7.15 (m,2H), 7.01 – 6.95 (m, 1H),6.91-6.86(m, 2H), 6.76 – 6.71 (m, 1H), 5.52 (t, *J* = 14.4 Hz, 1H), 3.78-3.67 (m, 1H), 3.50 – 3.40 (m, 1H), 2.99 – 2.84 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.18 (t, *J* = 28.0 Hz), 148.52, 134.67, 132.02, 131.68, 128.42, 127.53 (t, *J* = 3.5 Hz), 127.09, 126.94, 126.72, 126.62, 124.51, 121.24, 120.59, 116.89, 112.51, 59.21 (dd, *J* = 26.1, 23.5 Hz), 41.68 (d, *J* = 3.4 Hz), 24.01 (d, *J* = 2.2 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -98.91 (d, *J* = 261.9 Hz), -104.46 (d, *J* = 261.8 Hz). HRMS (ESI) m/z calcd for $C_{23}H_{18}BrF_2NNaO$ $[M+Na]^+$ 464.0432, found 464.0437.

2,2-difluoro-2-(2-(2-fluorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(3l)



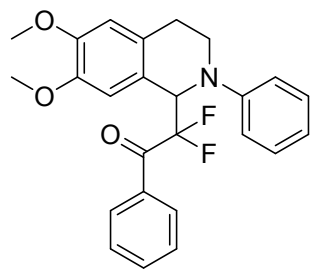
Yield 62%, yellow solid, m.p.: 126-128 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.95 (d, *J* = 7.8 Hz, 2H), 7.57 – 7.45 (m, 2H), 7.39 – 7.28 (m, 4H), 7.20 – 7.15 (m, 1H), 6.87 – 6.76 (m, 3H), 6.65 (m, 1H), 5.25 (dd, *J* = 21.5, 8.4 Hz, 1H), 3.70 – 3.58 (m, 1H), 3.32 (dd, *J* = 13.9, 5.0 Hz, 1H), 2.80 – 2.67 (m, 1H), 2.62 (ddd, *J* = 16.6, 3.9, 2.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ190.57 (dd, *J* = 29.0, 26.1 Hz), 156.13 (d, *J* = 247.4 Hz), 137.81 (d, *J* = 9.4 Hz),136.78, 133.87, 133.28, 129.34, 129.19 (t, *J* = 3.2 Hz), 129.00, 128.91, 128.32, 128.22, 128.16, 126.35, 124.16, 124.11 (d, *J* = 5.5 Hz), 123.33 (d, *J* = 2.1 Hz), 116.18 (t, *J* = 12.9 Hz), 61.53(t,23.8Hz), 45.12 (t, *J* = 4.1 Hz), 25.06. ^{19}F NMR (376 MHz, $CDCl_3$) δ -93.07 (d, *J* = 259.2 Hz, 1F), -110.75 (d, *J* = 259.2 Hz, 1F), -121.95 (s, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{18}F_3NNaO$ $[M+Na]^+$ 404.1233, found 404.1237.

2,2-difluoro-2-(2-(2-methoxyphenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(3m)



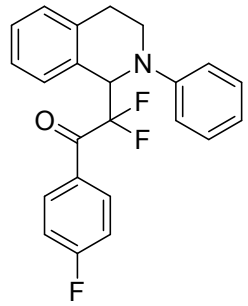
Yield 87%, yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 7.6 Hz, 2H), 7.56-7.50 (m, 1H), 7.48 – 7.42 (m, 1H), 7.36 – 7.26 (m, 4H), 7.20-7.14 (m 1H), 6.90-6.82 (m, 1H), 6.67 – 6.55 (m, 3H), 5.31 (dd, *J* = 22.3, 8.2 Hz, 1H), 3.63 – 3.53 (m, 1H),3.49(s,3H) 3.37 – 3.30 (m, 1H), 2.82-2.70 (m, 1H), 2.67 – 2.58 (m, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ190.56 (dd, *J* = 29.0, 26.3 Hz), 153.03, 138.80, 137.14, 133.91, 132.99, 129.73, 129.31 (t, *J* = 3.2 Hz), 129.18, 128.16, 128.10, 127.95, 127.85, 126.05, 124.20, 123.18, 120.48, 111.36, 54.89, 44.47 (d, *J* = 4.1 Hz), 25.43. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.20 (d, *J* = 256.3 Hz, 1F), -110.78 (d, *J* = 256.3 Hz, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}F_2NO_2$ $[M+H]^+$ 394.1613, found 394.1613.

2-(6,7-dimethoxy-2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(3n)



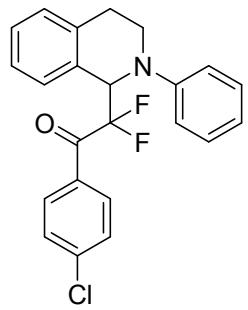
Yield 76%, yellow solid, m.p.: 131-133 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 7.7 Hz, 2H), 7.51 (t, *J* = 7.4 Hz, 1H), 7.37 (t, *J* = 7.8 Hz, 2H), 7.14 – 7.08 (m, 2H), 6.89 (d, *J* = 2.1 Hz, 1H), 6.78 (t, *J* = 7.6 Hz, 3H), 6.64 (s, 1H), 5.41 (dd, *J* = 17.3, 12.2 Hz, 1H), 3.84 (m, 6H), 3.73 – 3.64 (m, 1H), 3.46 (dt, *J* = 13.4, 4.6 Hz, 1H), 2.82 (m, 1H), 2.64 (dt, *J* = 16.2, 4.1 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.39 (t, *J* = 28.4 Hz), 149.32, 148.93, 147.33, 133.92, 133.55, 129.80, 129.25 (t, *J* = 3.4 Hz), 129.16, 129.01, 128.47, 120.53, 120.24, 117.05, 111.54, 111.15 (d, *J* = 4.5 Hz), 61.10 (dd, *J* = 26.6, 23.6 Hz), 55.96, 55.80, 43.93 (d, *J* = 3.9 Hz), 24.68. ^{19}F NMR (376 MHz, $CDCl_3$) δ -96.59 (d, *J* = 257.5 Hz), -106.90 (d, *J* = 257.6 Hz). HRMS (ESI) m/z calcd for $C_{25}H_{23}F_2NO_3$ $[M+H]^+$ 424.1719, found 424.1721.

2,2-difluoro-1-(4-fluorophenyl)-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(4b)



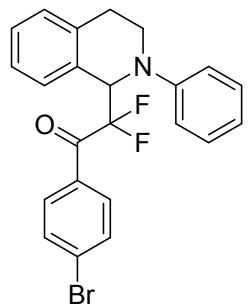
Yield 78%, yellow solid, m.p.: 125-127 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (m, 2H), 7.38 (d, *J* = 7.6 Hz, 1H), 7.28 – 7.09 (m, 5H), 7.08 – 7.00 (m, 2H), 6.79 (m, 3H), 5.50 (dd, *J* = 16.5, 13.1 Hz, 1H), 3.77 – 3.66 (m, 1H), 3.50 – 3.42 (m, 1H), 2.96 – 2.75 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.11, 189.83, 189.55, 167.22, 164.67, 149.22, 136.88, 132.34, 132.30, 132.26, 132.25, 132.21, 132.17, 129.14, 129.03, 128.59, 128.55, 128.34, 126.32, 120.19, 116.65, 115.88, 115.66, 61.56, 61.33, 61.30, 61.07, 44.01, 43.97, 25.60. ^{19}F NMR (376 MHz, $CDCl_3$) δ -97.49 (d, *J* = 259.5 Hz, 1F), -103.34 (s, 1F), -105.73 (d, *J* = 259.5, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}F_3NO$ $[M+H]^+$ 382.1413, found 382.1414.

1-(4-chlorophenyl)-2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(4c)



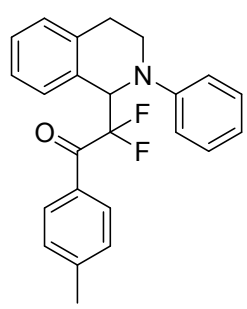
Yield 83%, yellow solid, m.p.: 111-113 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.6 Hz, 1H), 7.40 – 7.31 (m, 3H), 7.29 – 7.10 (m, 5H), 6.83 – 6.75 (m, 3H), 5.49 (dd, *J* = 16.8, 12.8 Hz, 1H), 3.75 – 3.66 (m, 1H), 3.45 (m, 1H), 2.90 (m, 1H), 2.79 (dt, *J* = 16.4, 4.7 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.35 (t, *J* = 28.3 Hz), 149.15, 140.24, 136.87, 132.23, 130.78 (t, *J* = 3.7 Hz), 129.18, 129.07, 128.94, 128.88, 128.57, 128.54, 128.38, 126.36, 120.34, 116.77, 61.33 (dd, *J* = 26.3, 23.6 Hz), 44.08 (d, *J* = 3.6 Hz), 25.52. ^{19}F NMR (376 MHz, $CDCl_3$) δ -97.35 (d, *J* = 259.1 Hz, 1F), -106.12 (d, *J* = 259.1 Hz, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}ClF_2NO$ $[M+H]^+$ 398.1118, found 398.1120.

1-(4-bromophenyl)-2, 2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(4d)



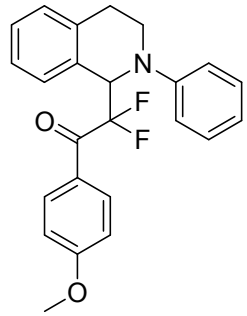
Yield 58%, yellow solid, m.p.: 131-133 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.73 (d, *J* = 8.5 Hz, 2H), 7.52 (d, *J* = 8.6 Hz, 2H), 7.38 (d, *J* = 7.5 Hz, 1H), 7.29 – 7.11 (m, 5H), 6.80 (m, 3H), 5.48 (dd, *J* = 16.8, 12.8 Hz, 1H), 3.74 – 3.65 (m, 1H), 3.50 – 3.41 (m, 1H), 2.91 (m, 1H), 2.79 (dt, *J* = 16.4, 4.7 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.56(t, 28Hz), 149.09, 136.82, 132.63, 131.82, 130.76 (t, *J* = 3.7 Hz), 129.14, 129.03, 129.00, 128.87, 128.52, 128.49, 128.34, 126.32, 120.34, 116.75, 61.28 (dd, *J* = 26.3, 23.6 Hz), 44.06 (d, *J* = 3.7 Hz), 25.47. ^{19}F NMR (376 MHz, $CDCl_3$) δ -97.35 (d, *J* = 258.9 Hz, 1F), -106.31 (d, *J* = 258.9, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}BrF_2NO$ $[M+H]^+$ 442.0613,found 442.0615.

2, 2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(p-tolyl)ethanone(4e)



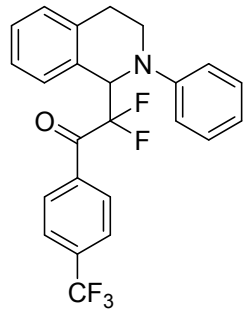
Yield 78%, yellow solid, m.p.: 125-127 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 8.1 Hz, 2H), 7.37 (d, *J* = 7.5 Hz, 1H), 7.25 – 7.10 (m, 7H), 6.78 (m, 3H), 5.54 (t, *J* = 14.6 Hz, 1H), 3.80 – 3.70 (m, 1H), 3.51 – 3.42 (m, 1H), 2.97 – 2.76 (m, 2H), 2.36(s,3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.26(t, 27.28Hz), 147.07, 136.86, 133.98, 133.44, 129.75, 129.56, 129.28 (t, *J* = 3.7 Hz), 129.12, 129.05, 128.51, 128.47, 128.43, 128.13, 126.18, 117.37, 61.55 (dd, *J* = 26.7, 23.5 Hz), 44.16, 25.04, 20.34. ^{19}F NMR (376 MHz, $CDCl_3$) δ -98.00 (d, *J* = 259.8Hz, 1F), -105.15 (d, *J* =259.8Hz, 1F). HRMS (ESI) m/z calcd for $C_{24}H_{22}F_2NO$ $[M+H]^+$ 378.1664, found 378.1667.

2, 2-difluoro-1-(4-methoxyphenyl)-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(4f)



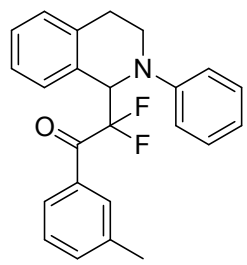
Yield 89%, yellow solid, m.p.: 118-120°C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, *J* = 8.9 Hz, 2H), 7.38 – 7.33 (m, 1H), 7.25 – 7.21 (m, 1H), 7.20 – 7.11 (m, 4H), 6.88 – 6.75 (m, 5H), 5.56 (t, *J* = 14.6 Hz, 1H), 3.83 – 3.73 (m, 4H), 3.52 – 3.43 (m, 1H), 3.00 – 2.82 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.49 (t, *J* = 27.8 Hz), 164.07, 149.37, 136.91, 132.15 (t, *J* = 3.8 Hz), 129.44, 129.11, 128.88, 128.74, 128.70, 128.24, 126.59, 126.21, 119.77, 116.22, 113.84, 61.50 (dd, *J* = 26.0, 23.4 Hz), 55.52, 43.89 (d, *J* = 3.2 Hz), 25.90 (d, *J* = 1.9 Hz). ^{19}F NMR (376 MHz, $CDCl_3$) δ -98.33 (d, *J* = 260.1 Hz, 1F), -104.32 (d, *J* = 260.1 Hz, 1F). HRMS (ESI) m/z calcd for $C_{24}H_{22}F_2NO_2$ $[M+H]^+$ 394.1613, found 394.1615.

2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(4-(trifluoromethyl)phenyl)ethanone(4g)



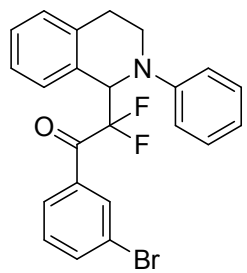
Yield 71%, yellow solid, 129-131 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.2 Hz, 2H), 7.62 (d, *J* = 8.3 Hz, 2H), 7.41 (d, *J* = 7.4 Hz, 1H), 7.31 – 7.08 (m, 5H), 6.84 – 6.70 (m, 3H), 5.47 (dd, *J* = 17.8, 12.1 Hz, 1H), 3.72 – 3.61 (m, 1H), 3.45 (dt, *J* = 13.3, 4.8 Hz, 1H), 2.89 (m, 1H), 2.75 (dt, *J* = 16.4, 4.4 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.80(t, 28.3Hz), 148.95, 136.86, 136.82, 134.54 (q, *J* = 32.8 Hz), 129.47 (t, *J* = 3.4 Hz), 129.16, 128.63, 128.44, 128.41, 126.43, 125.47 (q, *J* = 3.6 Hz), 120.66, 117.06, 61.15 (dd, *J* = 26.5, 23.6 Hz), 44.17 (d, *J* = 3.9 Hz), 25.26. ^{19}F NMR (376 MHz, $CDCl_3$) δ -63.31 (s, 3F), -96.54 (d, *J* = 258.8 Hz,1F), -107.39 (d, *J* = 258.8 Hz,1F). HRMS (ESI) m/z calcd for C24H19F5NO $[M+H]^+$ 432.1381, found 432.1383.

2, 2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(m-tolyl)ethanone(4h)



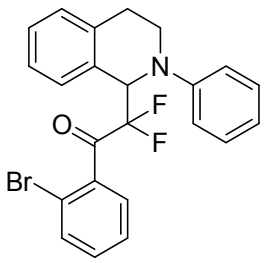
Yield 64%, white solid, m.p.: 134-136 °C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 – 7.62 (m, 2H), 7.22 (m, 8H), 6.78 (m, 3H), 5.52 (dd, *J* = 16.1, 13.4 Hz, 1H), 3.78 – 3.69 (m, 1H), 3.52 – 3.44 (m, 1H), 2.96 – 2.77 (m, 2H), 2.32 (s,3H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 189.59 (t, *J* = 27.8 Hz), 147.38, 136.45, 135.01, 132.49, 131.98, 128.08 (t, *J* = 2.9 Hz), 127.34 (d, *J* = 1.8 Hz), 127.18, 127.11, 126.72 (d, *J* = 3.9 Hz), 126.44, 126.38, 124.60 (t, *J* = 3.9 Hz), 124.37, 118.13, 114.73, 59.41 (dd, *J* = 26.3, 23.5 Hz), 42.05 (d, *J* = 3.6 Hz), 23.74 (d, *J* = 1.7 Hz), 19.46. ^{19}F NMR (376 MHz, $CDCl_3$) δ -97.67 (d, *J* = 259.6 Hz, 1F), -105.55 (d, *J* = 259.6 Hz, 1F). HRMS (ESI) m/z calcd for $C_{24}H_{22}F_2NO$ $[M+H]^+$ 378.1664, found 378.1664.

2,2-difluoro-1-phenyl-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone (4i)



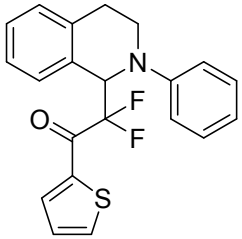
Yield 52%, yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (s, 1H), 7.79 (d, *J* = 7.9 Hz, 1H), 7.61 (m, 1H), 7.39 (d, *J* = 7.4 Hz, 1H), 7.30 – 7.11 (m, 6H), 6.83 – 6.75 (m, 3H), 5.46 (dd, *J* = 17.3, 12.5 Hz, 1H), 3.74 – 3.64 (m, 1H), 3.46 (m, 1H), 2.89 (m, 1H), 2.78 (dt, *J* = 16.4, 4.6 Hz, 1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 190.12(t, 28.1Hz), 149.06, 136.86, 136.32, 135.59, 132.25 (t, *J* = 3.4 Hz), 130.02, 129.16, 129.10, 128.77, 128.51, 128.48, 128.42, 127.64 (t, *J* = 3.7 Hz), 126.39, 122.72, 120.50, 117.01, 61.20 (dd, *J* = 26.4, 23.6 Hz), 44.19 (d, *J* = 3.7 Hz), 25.45. ^{19}F NMR (376 MHz, $CDCl_3$) δ -96.83 (d, *J* = 259.1 Hz, 1F), -106.66 (d, *J* = 259.1 Hz, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}BrF_2NO$ $[M+H]^+$ 442.0613, found 442.0616.

1-(2-bromophenyl)-2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(4j)



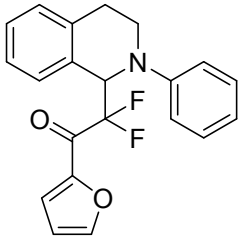
Yield 61%, yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 – 7.54 (m, 1H), 7.44 – 7.40 (m, 1H), 7.33 – 7.17 (m, 8H), 7.14 – 7.10 (m, 1H), 6.93 (d, *J* = 8.1 Hz, 2H), 6.85 (t, *J* = 7.3 Hz, 1H), 5.49 (dd, *J* = 19.2, 11.3 Hz, 1H), 3.61 (dd, *J* = 8.0, 3.5 Hz, 2H), 2.93 (m, 1H), 2.67 (dt, *J* = 16.6, 3.8Hz,1H). ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.71 (dd, *J* = 34.7, 26.7 Hz), 148.86, 137.02, 136.68, 133.68, 132.07, 129.27, 129.18, 128.70, 128.64, 128.44 (t, *J* = 2.5Hz), 128.31, 126.94, 126.31, 120.46, 120.25, 116.67, 60.62 (dd, *J* = 27.5, 23.1 Hz), 43.47 (d, *J* = 5.5 Hz), 24.72. ^{19}F NMR (376 MHz, $CDCl_3$) δ -95.10 (d, *J* = 260.2 Hz, 1F), -108.96 (d, *J* = 260.2 Hz, 1F). HRMS (ESI) m/z calcd for $C_{23}H_{19}BrF_2NO$ $[M+H]^+$ 442.0613, found 442.0614.

2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(thiophen-2-yl)ethanone(4k)



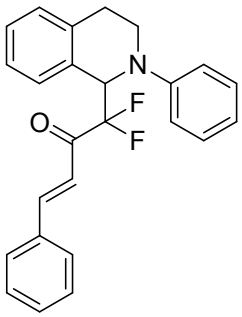
Yield 59%, yellow solid, m.p.: 125-127 ^{0}C, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 – 7.78 (m, 1H), 7.60 (m, 1H), 7.28 (m, 1H), 7.20 – 6.98 (m, 6H), 6.81 – 6.69 (m, 3H), 5.43 (dd, *J* = 16.7, 13.0 Hz, 1H), 3.77 – 3.68 (m, 1H), 3.45 – 3.37 (m, 1H), 2.89 (m, 1H), 2.78 (dt, *J* = 16.3, 4.9 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 182.83 (dd, *J* = 30.4, 28.7 Hz), 148.28, 138.31, 135.81, 134.98, 133.92 (t, *J* = 5.3 Hz), 128.08, 127.88, 127.66, 127.61, 127.45, 127.24, 125.15, 118.87, 115.33, 60.45 (dd, *J* = 26.5, 23.3 Hz), 42.66 (d, *J* = 3.6 Hz), 24.70. ^{19}F NMR (376 MHz, $CDCl_3$) δ -99.22 (d, *J* = 255.9 Hz, 1F), -107.71 (d, *J* = 255.9 Hz, 1F). HRMS (ESI) m/z calcd for $C_{21}H_{17}F_2NOS$ $[M+Na]^+$ 392.0891, found 392.0897.

2,2-difluoro-1-(furan-2-yl)-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(4l)



Yield 86%, yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 1.1 Hz, 1H), 7.39 – 7.31 (m, 2H), 7.28 – 7.13 (m,5H), 6.89 – 6.77 (m, 3H), 6.49 (dd, *J* = 3.7, 1.7 Hz, 1H), 5.55 (dd, *J* = 17.3, 12.9 Hz, 1H), 3.81 – 3.70 (m, 1H), 3.52 (dt, *J* = 13.3, 5.0 Hz, 1H), 2.96 (m, 1H), 2.81 (dt, *J* = 16.4, 4.5 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 178.60(t, *J* =29Hz), 149.26, 149.22, 148.28, 136.71, 129.10, 128.99, 128.51, 128.48, 128.25, 126.19, 121.90 (dd, *J* = 6.3, 4.4 Hz), 120.05, 116.58, 112.61, 61.30 (dd, *J* = 26.9, 23.4 Hz), 43.56 (d, *J* = 3.9 Hz), 25.38. ^{19}F NMR (376 MHz, $CDCl_3$) δ -99.85 (d, *J* = 257.7 Hz, 1F), -109.84 (d, *J* = 257.7 Hz, 1F). HRMS (ESI) m/z calcd for $C_{21}H_{17}F_2NNaO_2$ $[M+Na]^+$ 376.1120, found 376.1123.

(E)-1,1-difluoro-4-phenyl-1-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)but-3-en-2-one(4m)



Yield 55%, yellow oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 15.8 Hz, 1H), 7.53 – 7.48 (m, 2H), 7.41 – 7.33 (m, 4H), 7.29 – 7.15 (m, 5H), 7.05 (dt, *J* = 6.8, 3.4 Hz, 1H), 6.93 (d, *J* = 8.2 Hz, 2H), 6.81 (t, *J* = 7.3 Hz, 1H), 5.42 (dd, *J* = 17.7, 12.3 Hz, 1H), 3.88 – 3.79 (m, 1H), 3.60 (m, 1H), 3.03 – 2.93 (m, 1H), 2.88 – 2.80 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 190.44 (dd, *J* = 30.3, 26.7 Hz), 149.35, 146.33, 136.78, 134.10, 131.31, 129.19, 128.97, 128.88, 128.60, 128.55, 128.19, 126.22, 120.01, 118.44, 116.44, 60.93 (dd, *J* = 27.1, 23.4 Hz), 43.68 (d, *J* = 4.1 Hz), 25.56. ^{19}F NMR (376 MHz, $CDCl_3$) δ -103.57 (d, *J* = 252.0 Hz), -112.83 (d, *J* = 252.0 Hz). HRMS (ESI) m/z calcd for $C_{25}H_{21}F_2NNaO$ $[M+H]^+$ 412.1483, found 412.1489.

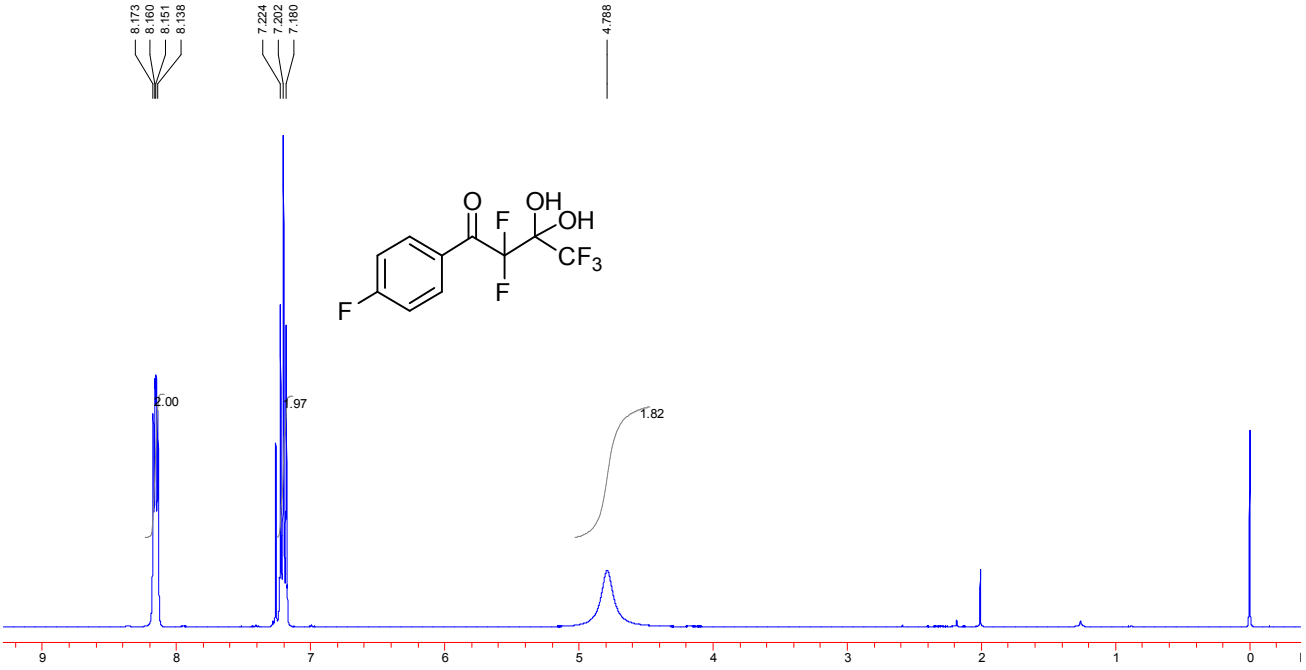
References:

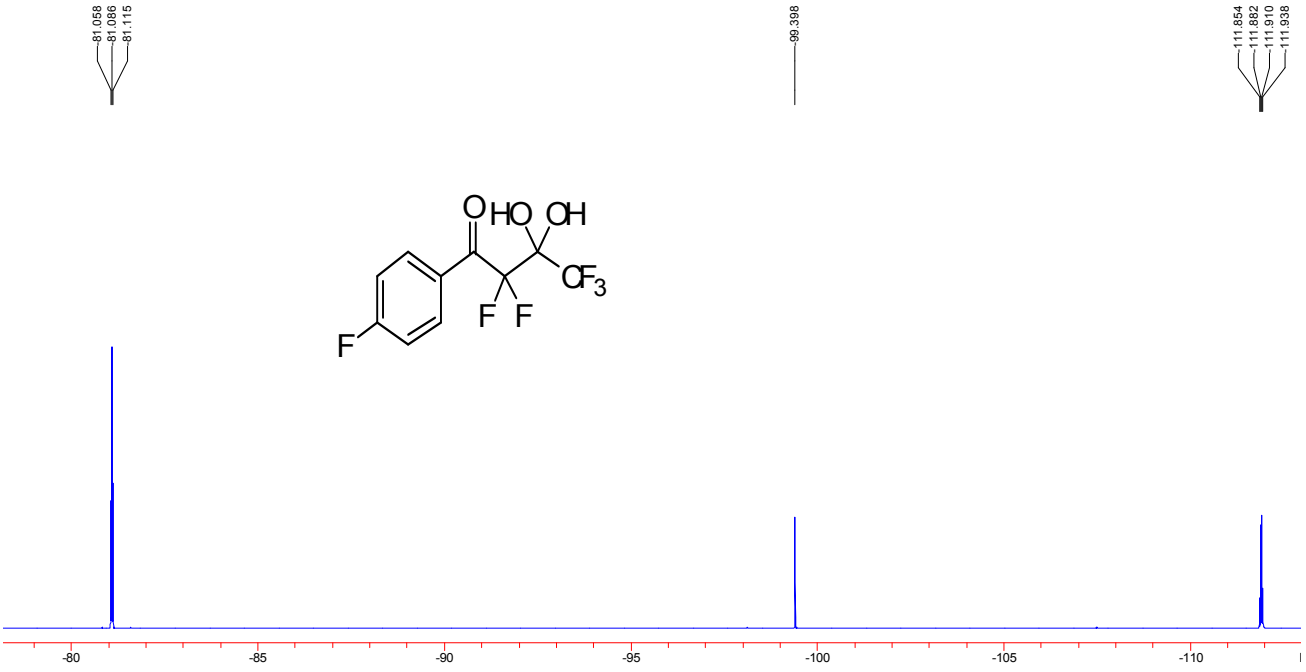
(1) Z. Li, C.-J. Li, *J. Am. Chem. Soc.,* 2005, **127**, 6968.

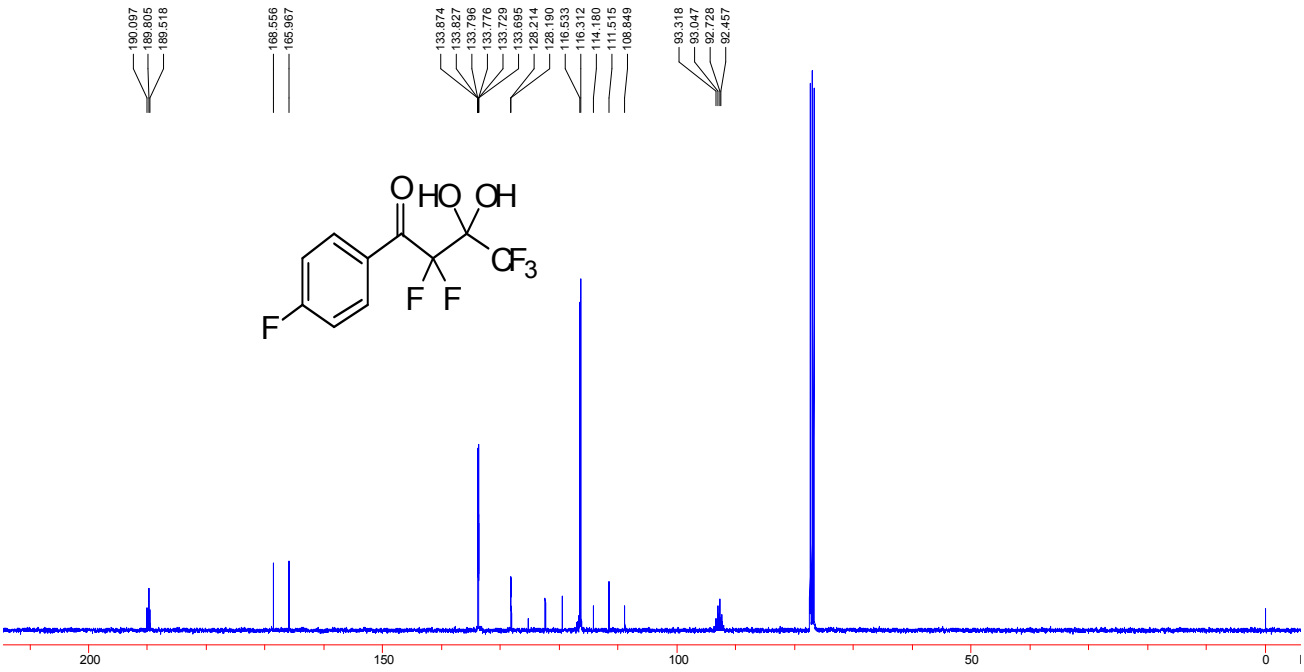
(2) (a) C. Han, E. H. Kim and D. A. Colby, *J. Am. Chem. Soc.,* 2011, **133**, 5802; (b) J. P. John and D. A. Colby, *J. Org. Chem.*, 2011, **76**, 9163.

Copies of ^{1}H NMR, ^{13}C NMR, ^{19}F NMR

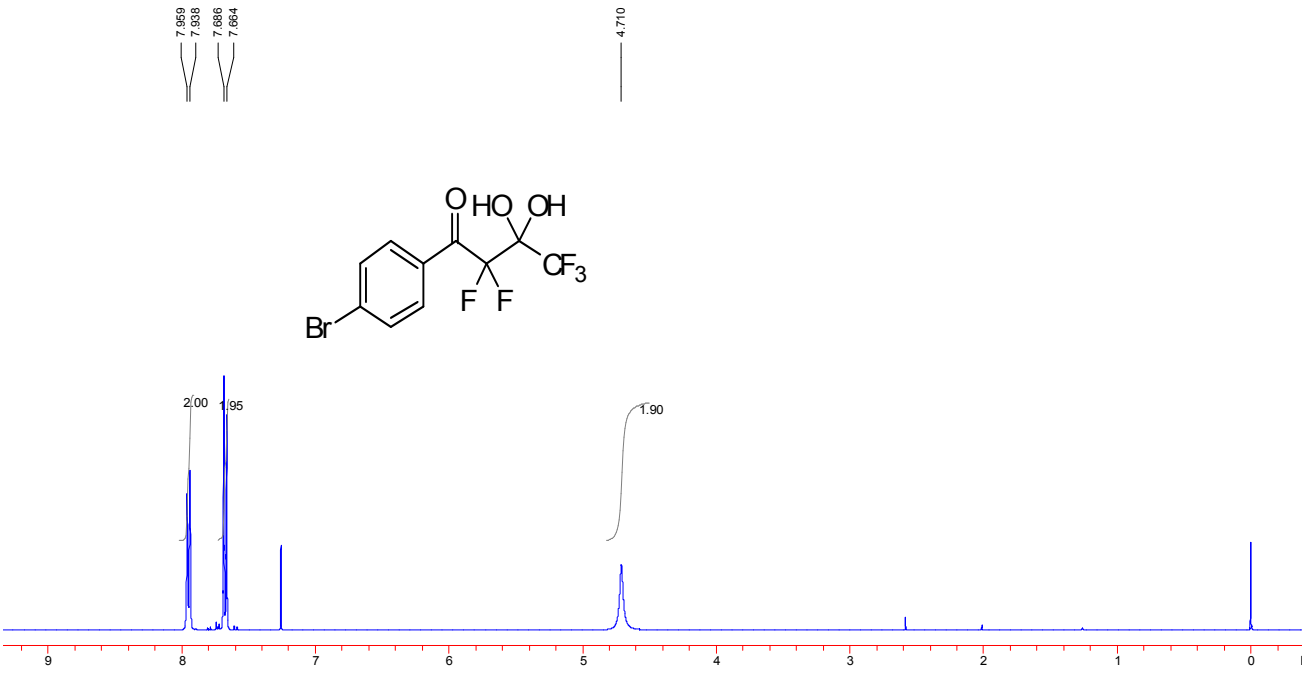
2,2,4,4,4-pentafluoro-1-(4-fluorophenyl)-3,3-dihydroxybutan-1-one **(2b)**

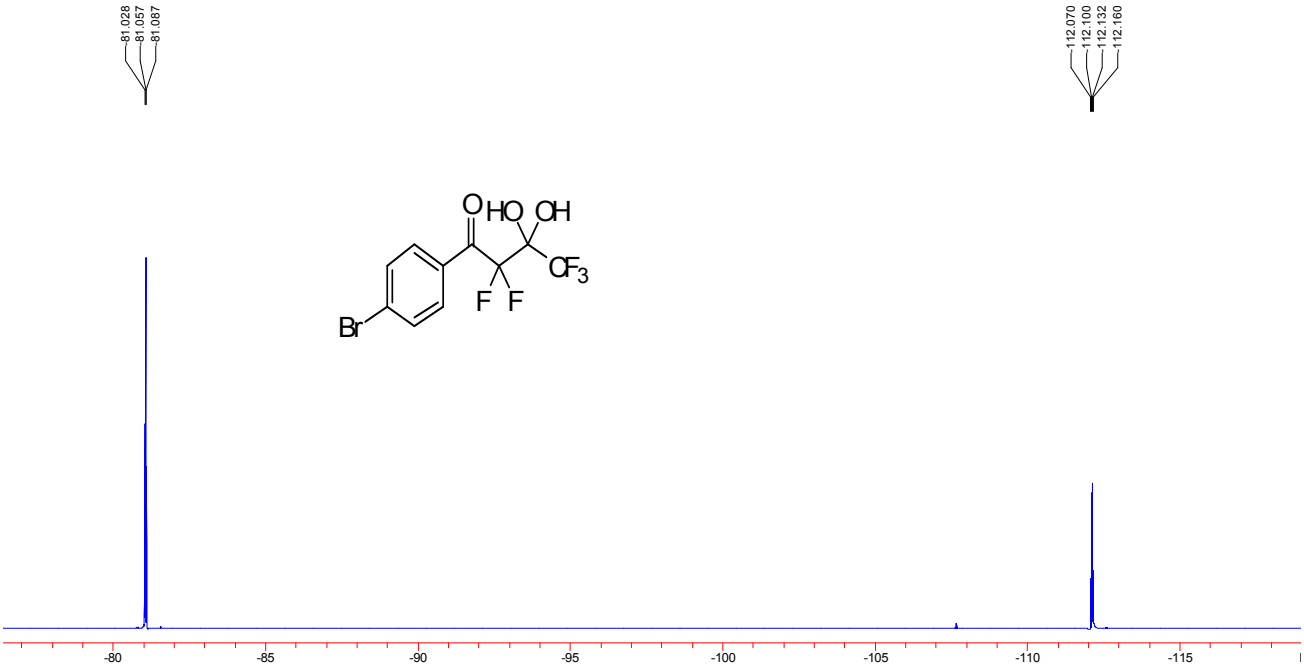






1-(4-bromophenyl)-2,2,4,4,4-pentafluoro-3,3-dihydroxybutan-1-one **(2d)**

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F F
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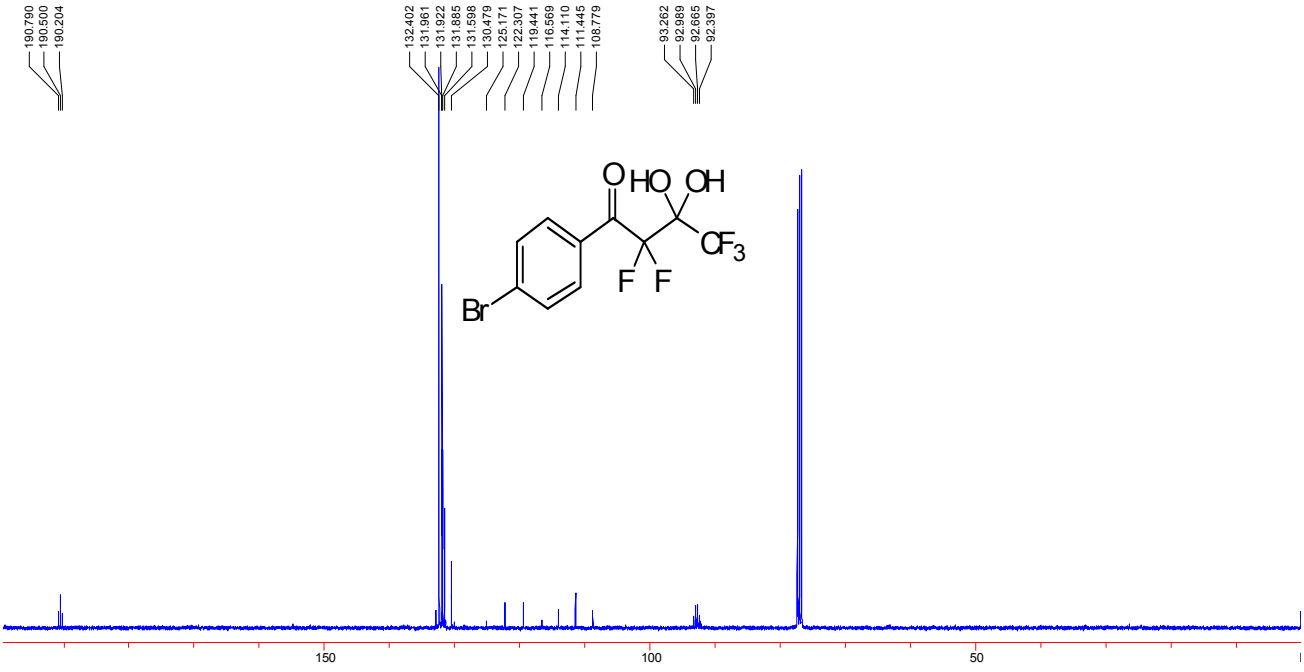
-110
-115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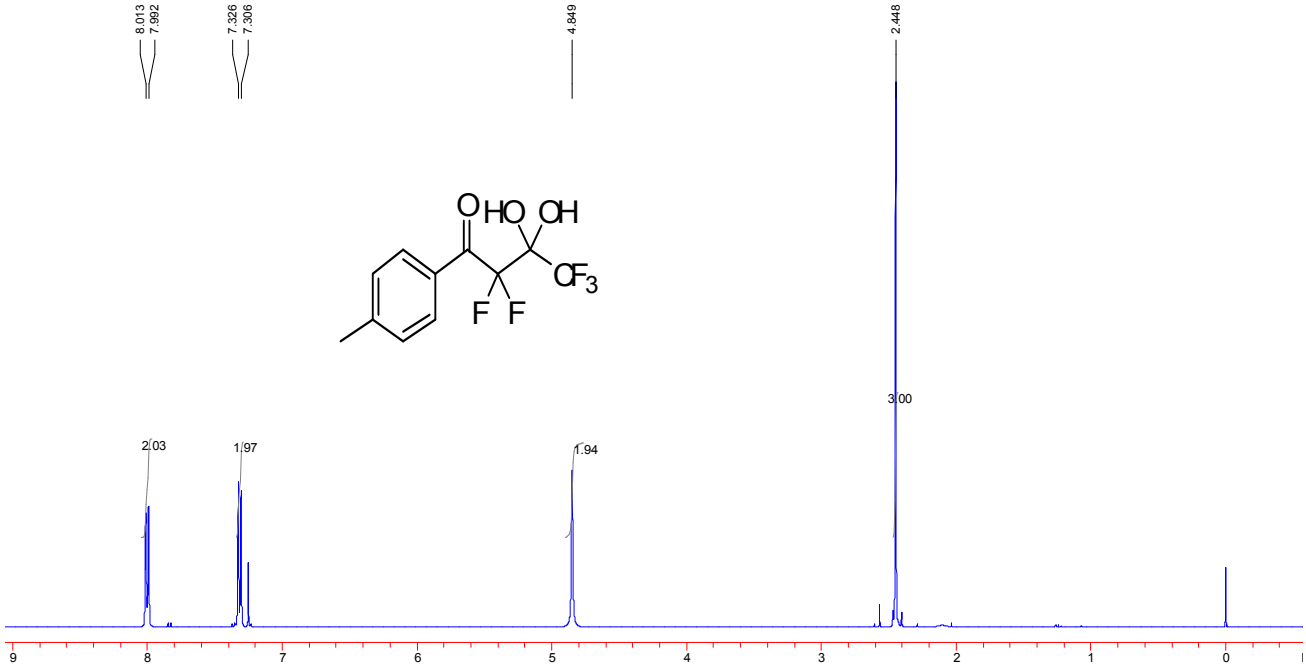
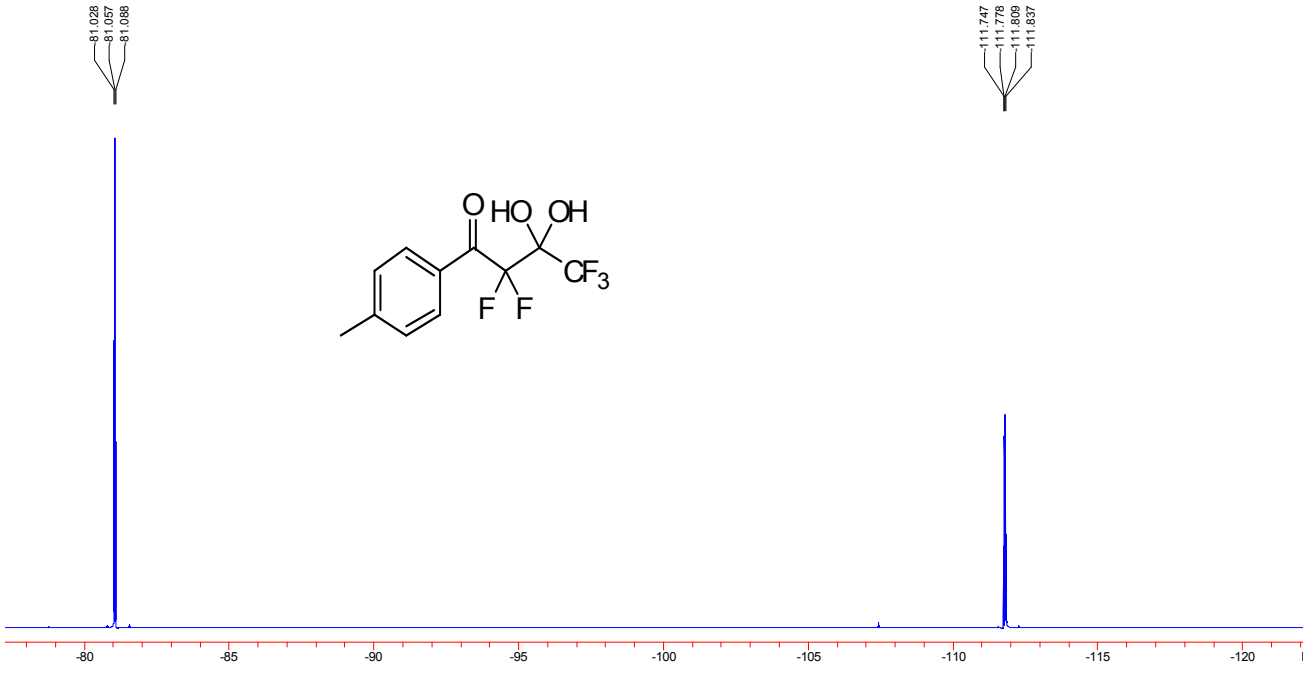
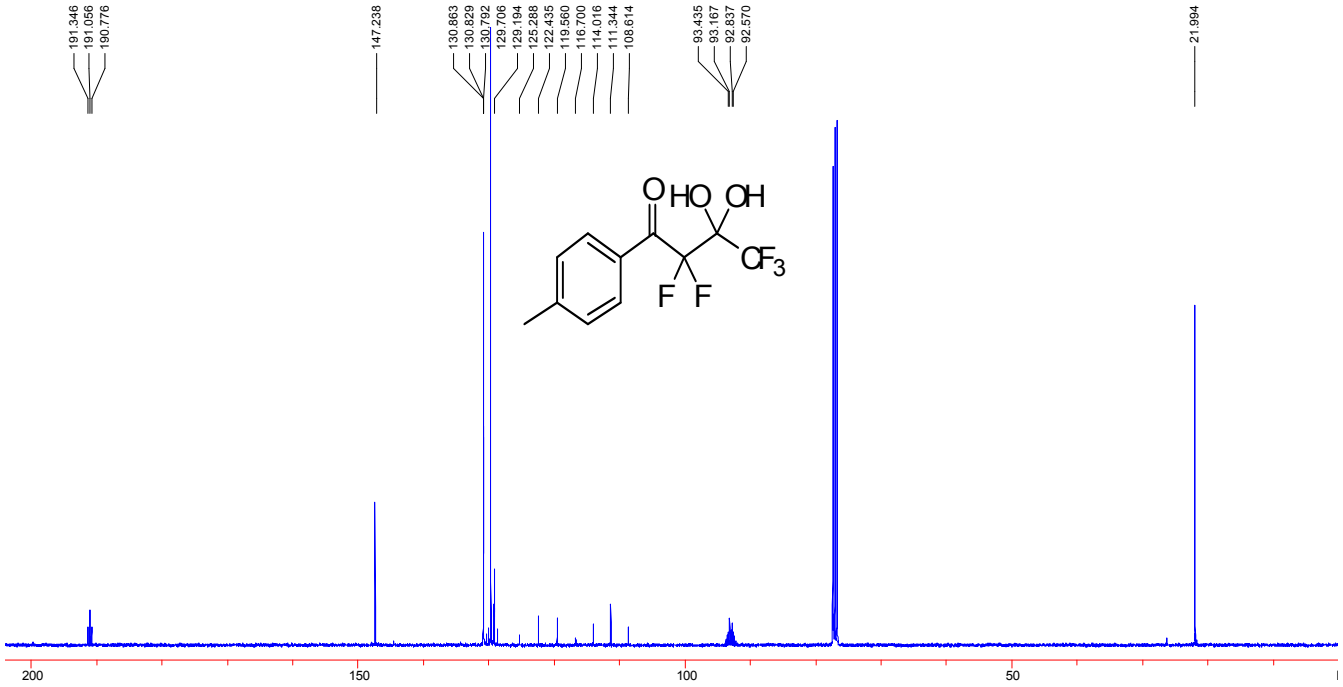
114.110
111.445
108.779
93.262
92.989
92.665
92.397
O
HO
OH
CF3
F F
Br
150
100
50

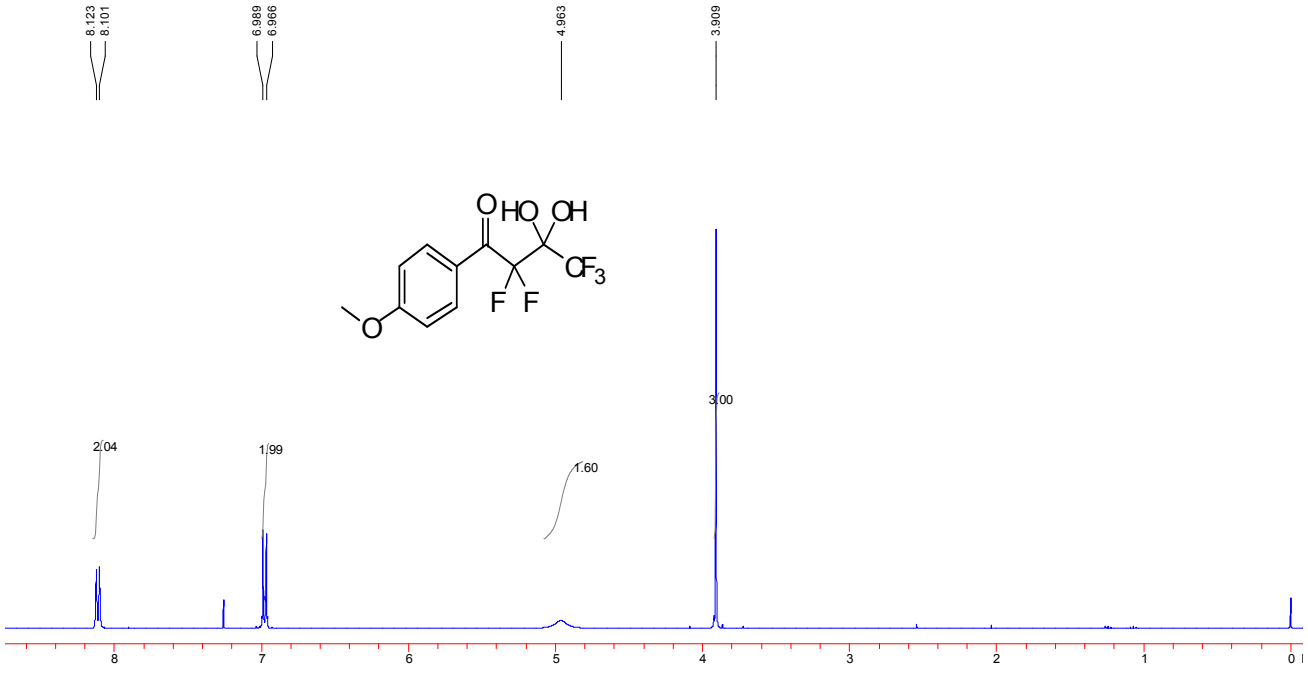
2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(p-tolyl)butan-1-one **(2e)**

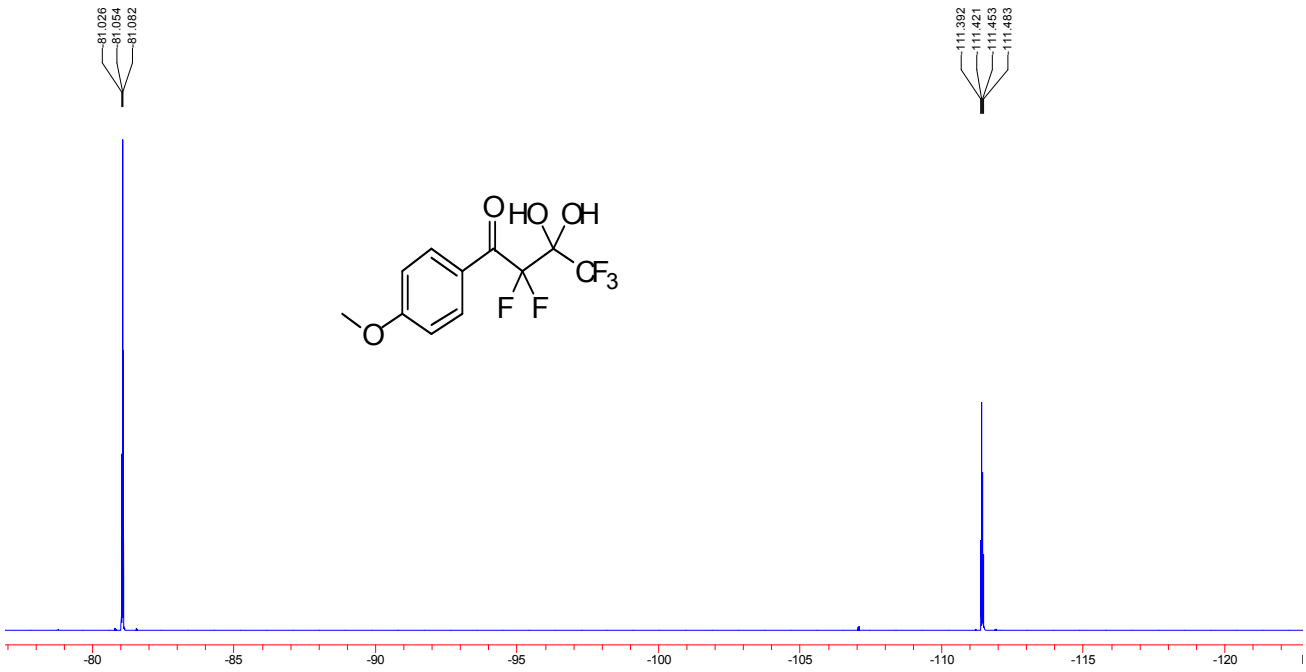






2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(4-methoxyphenyl)butan-1-one **(2f)**

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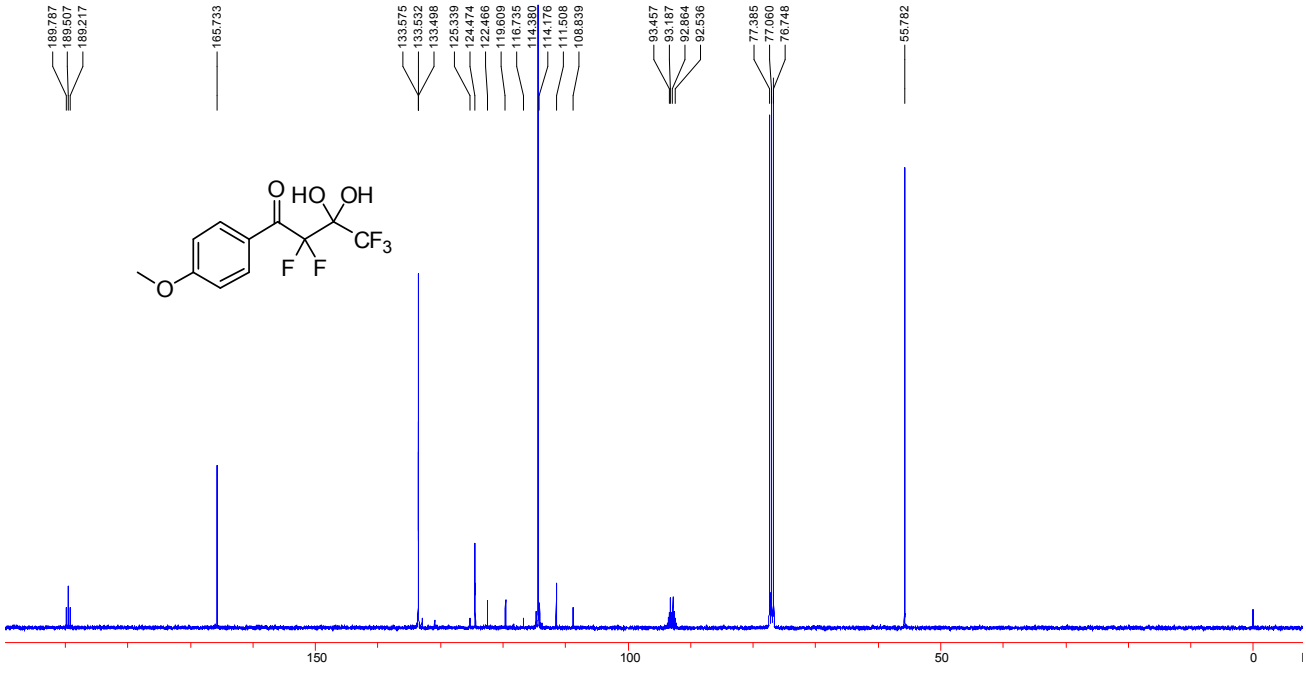
-81.054
-81.082
-111.392
-111.421
-111.453
-111.483
O
HO
OH
CF3
F
F
O
-80
-85
-90
-95
-100
-105
-110
-115
-120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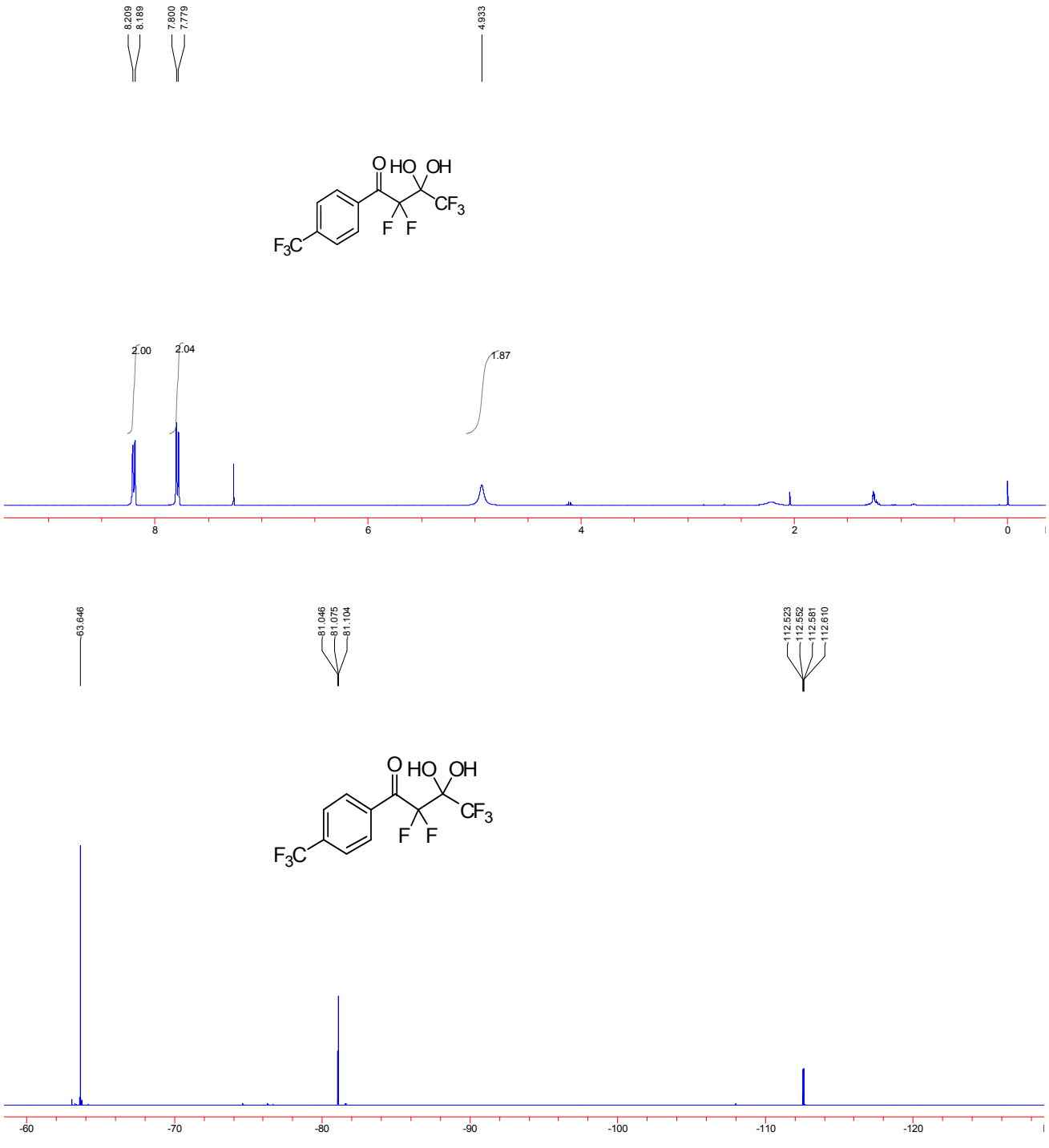
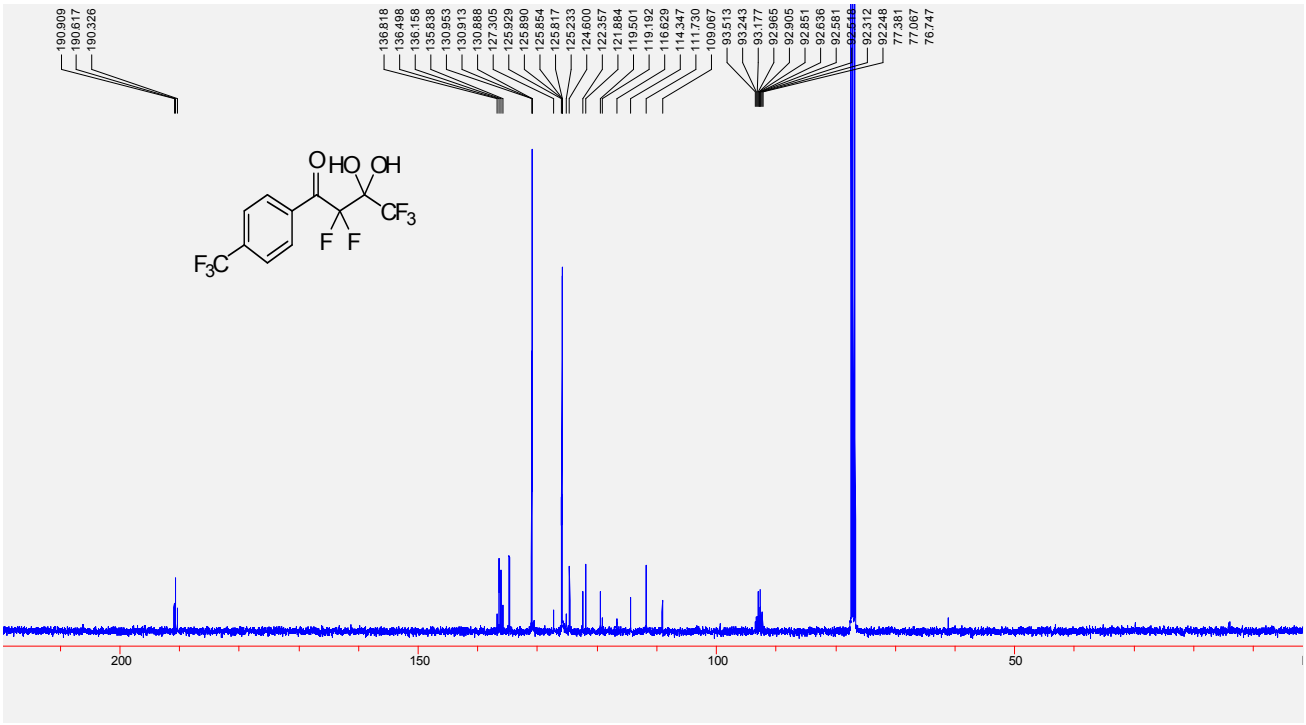
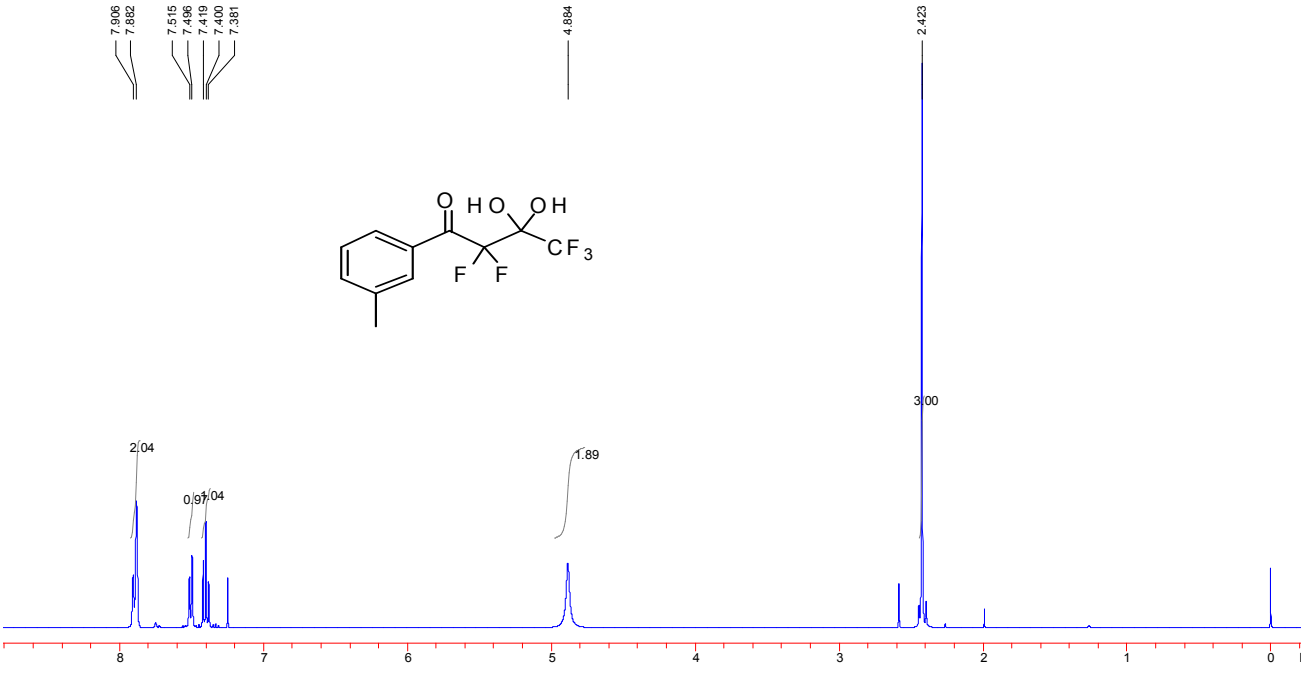
189.217
165.733
133.575
133.532
133.498
125.339
124.474
122.466
119.609
116.735
114.380
114.176
111.508
108.839
93.457
93.187
92.864
92.536
77.385
77.060
76.748
55.782
O
HO
OH
CF3
F
F
O
150
100
50
0

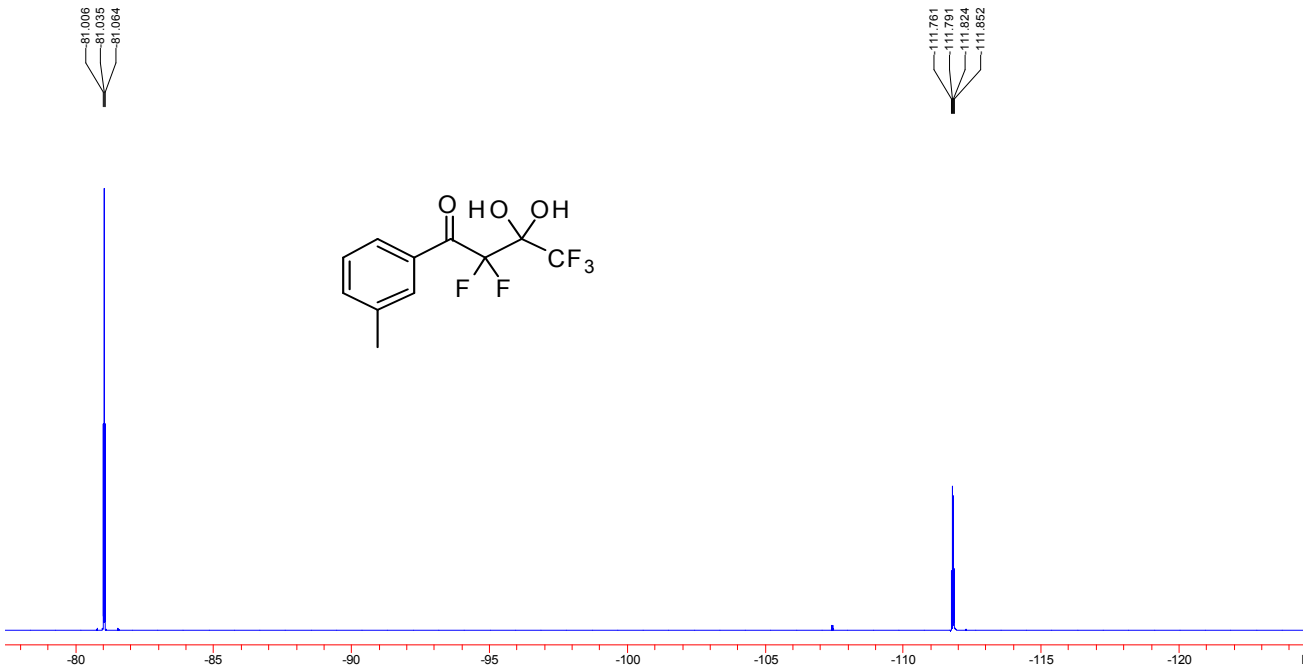
2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(4-(trifluoromethyl)phenyl)butan-1-one **(2g)**





2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(m-tolyl)butan-1-one **(2h)**

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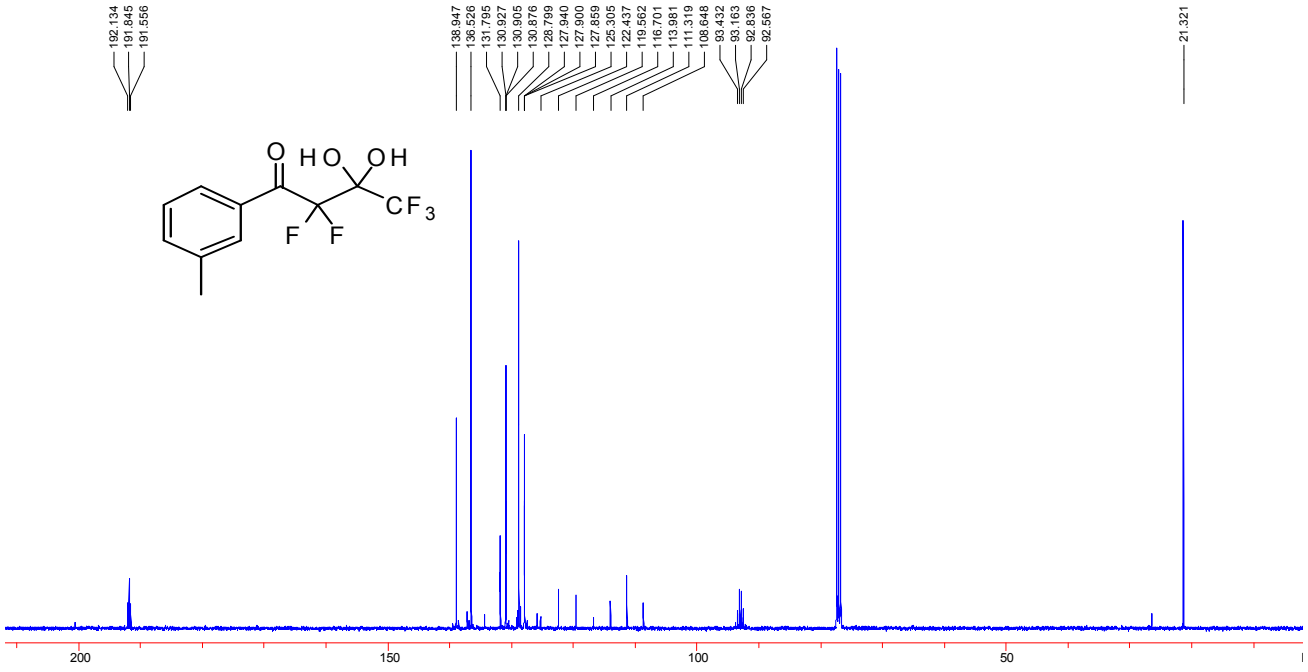
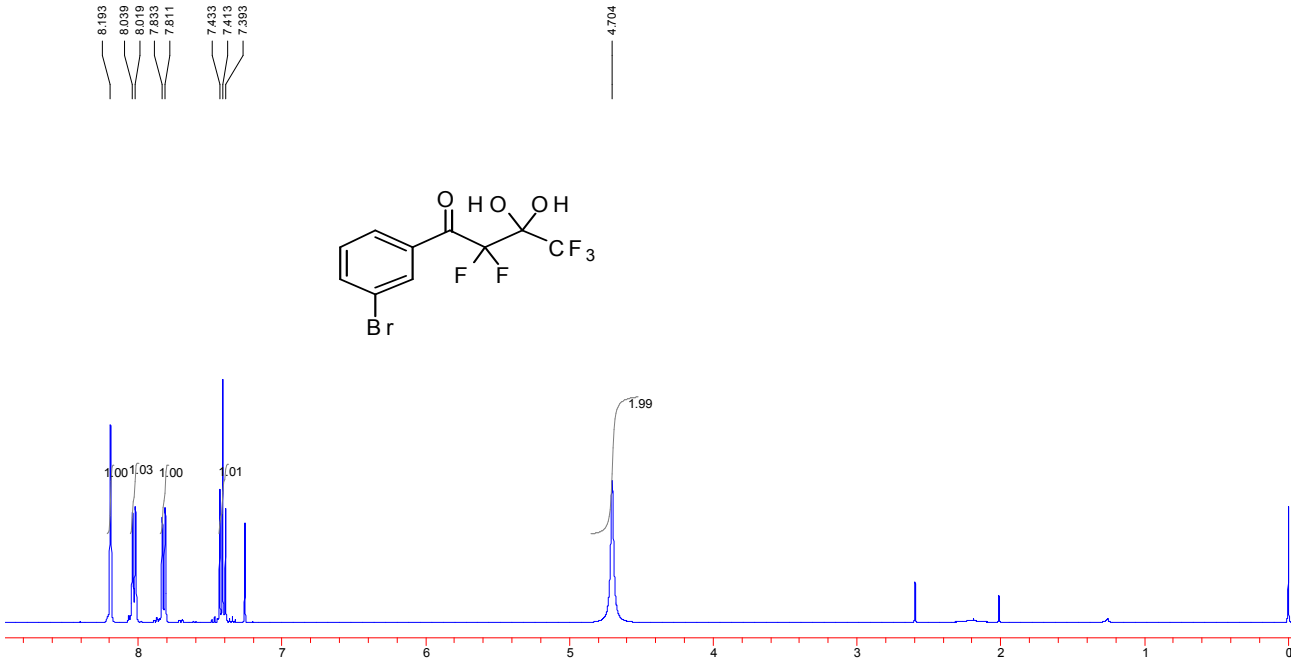
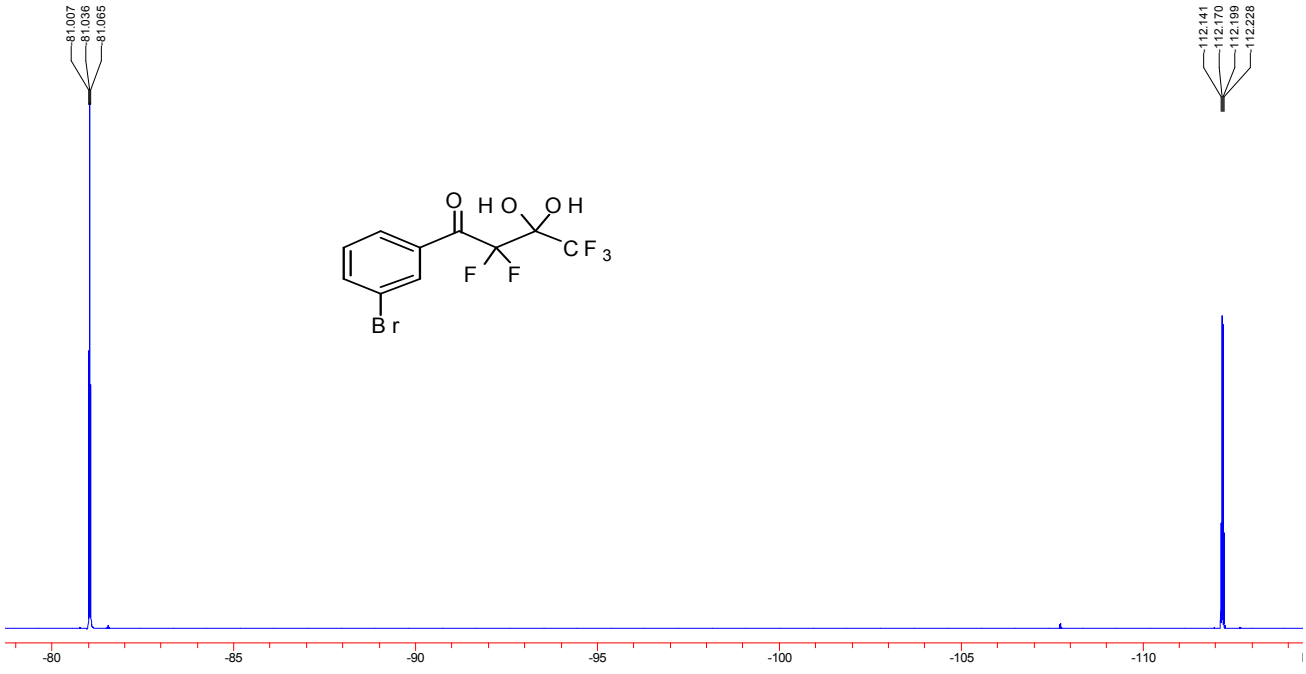
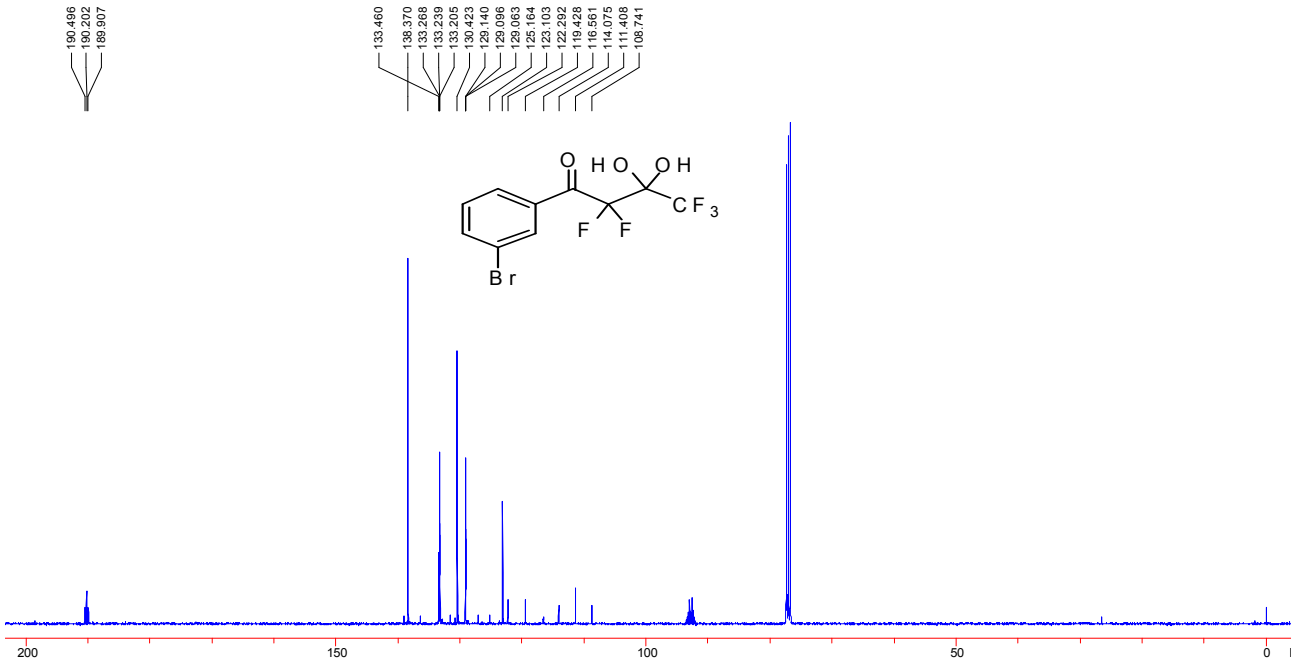
-81.064
-111.761
-111.791
-111.824
-111.852
O
HO
OH
CF3
F
F
-80
-85
-90
-95
-100
-105
-110
-115
-120


192.134
191.845
191.556
138.947
136.526
131.795
130.927
130.905
130.876
128.799
127.940
127.900
127.859
125.305
122.437
119.562
116.701
113.981
111.319
108.648
93.432
93.163
92.836
92.567
21.321
O
HO
OH
CF3
F
F
200
150
100
50

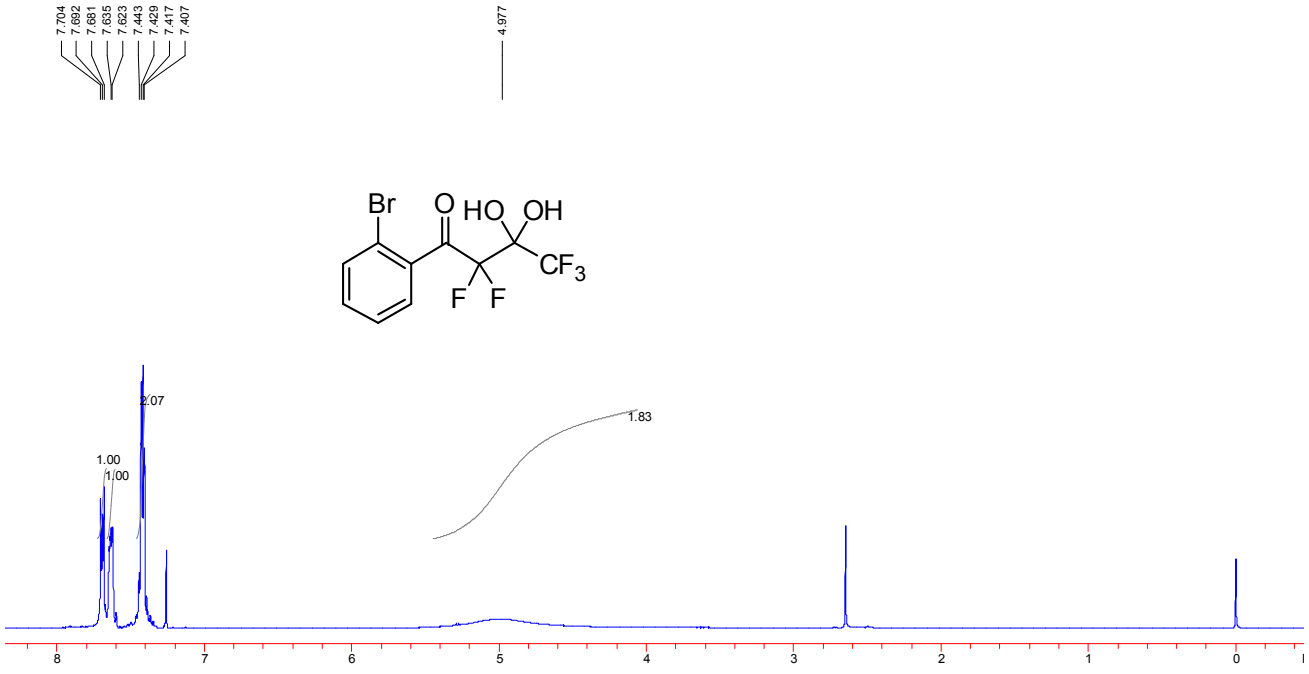
1-(3-bromophenyl)-2,2,4,4,4-pentafluoro-3,3-dihydroxybutan-1-one **(2i)**

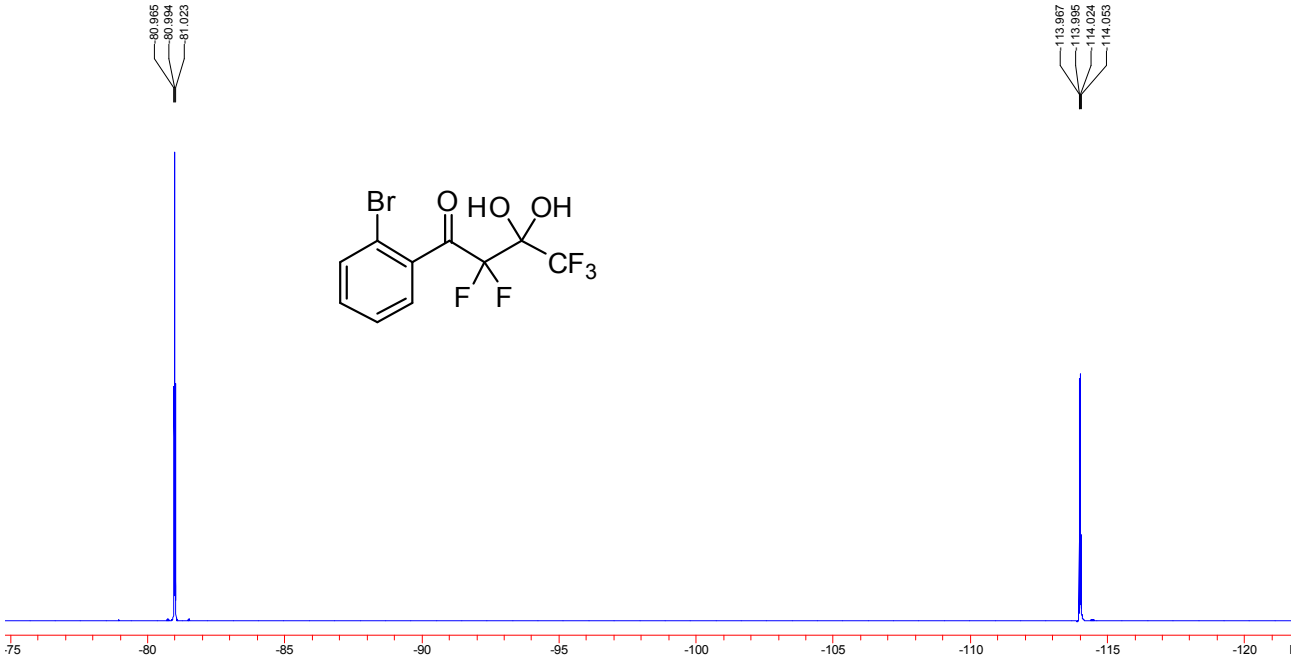


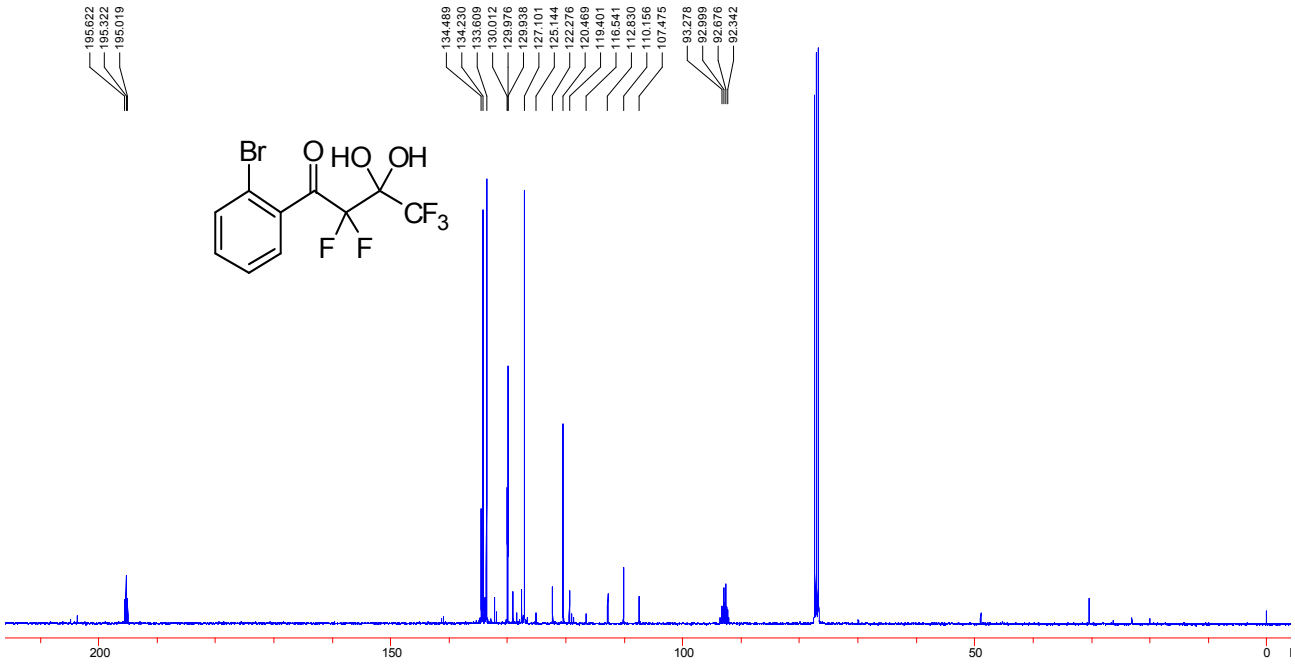




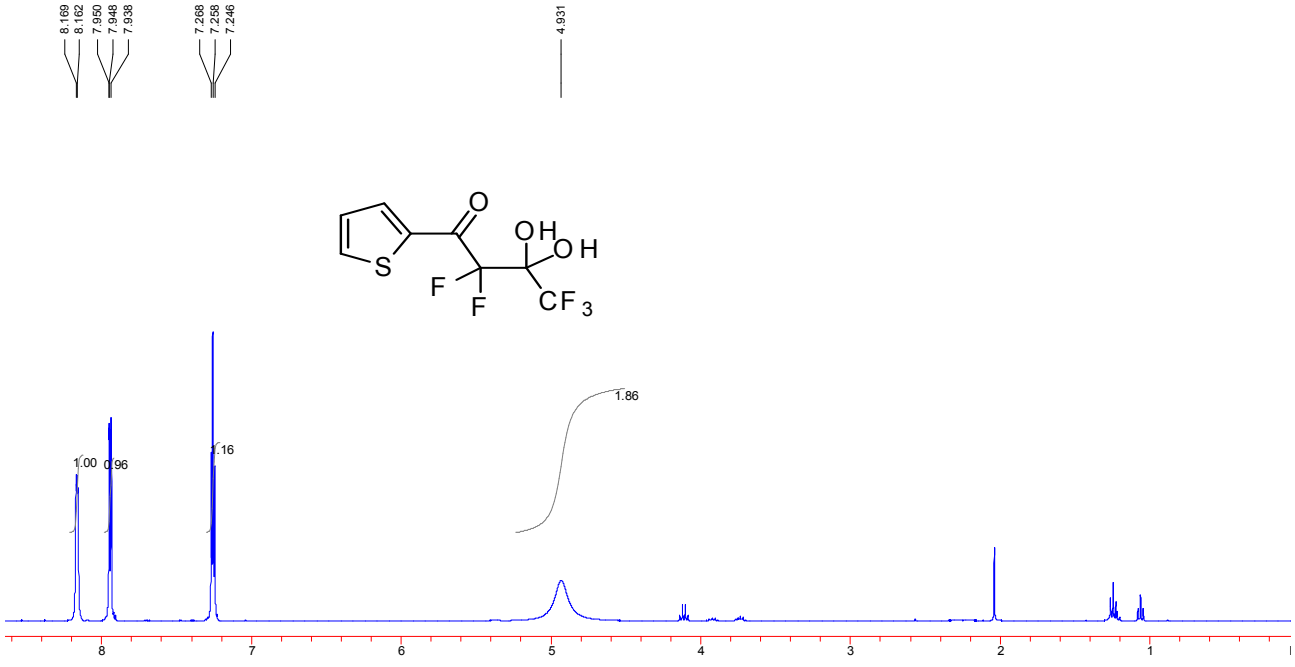
1-(2-bromophenyl)-2,2,4,4,4-pentafluoro-3,3-dihydroxybutan-1-one **(2j)**

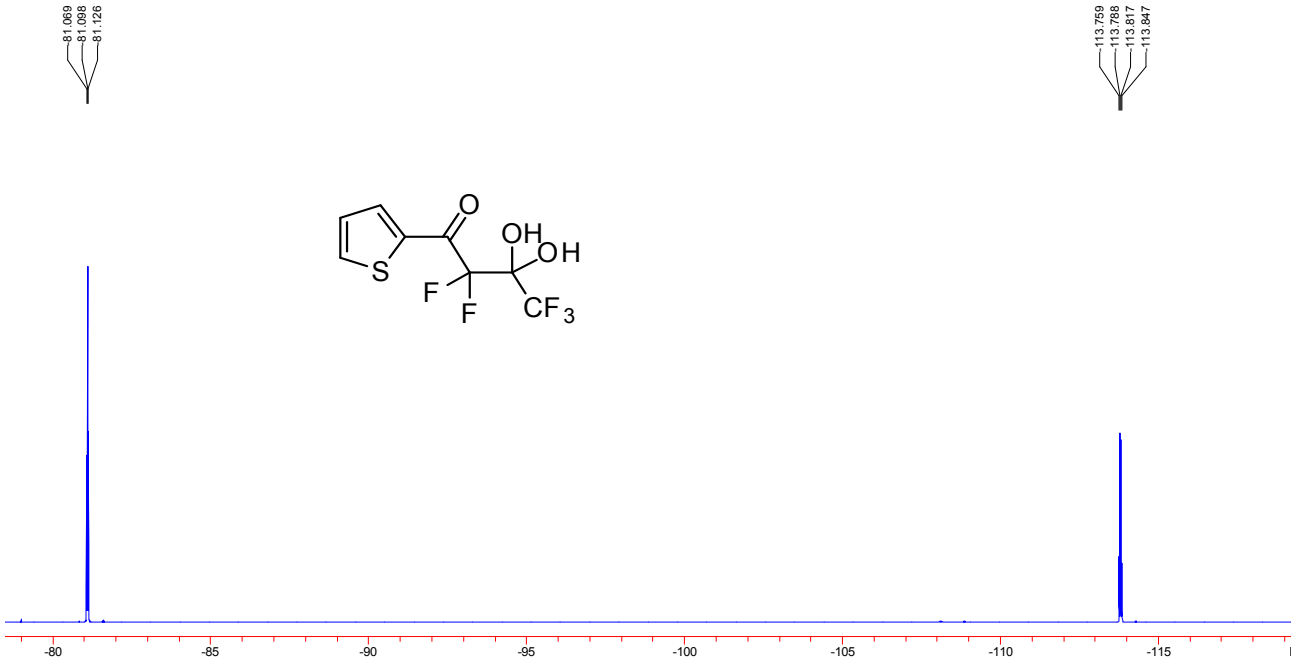


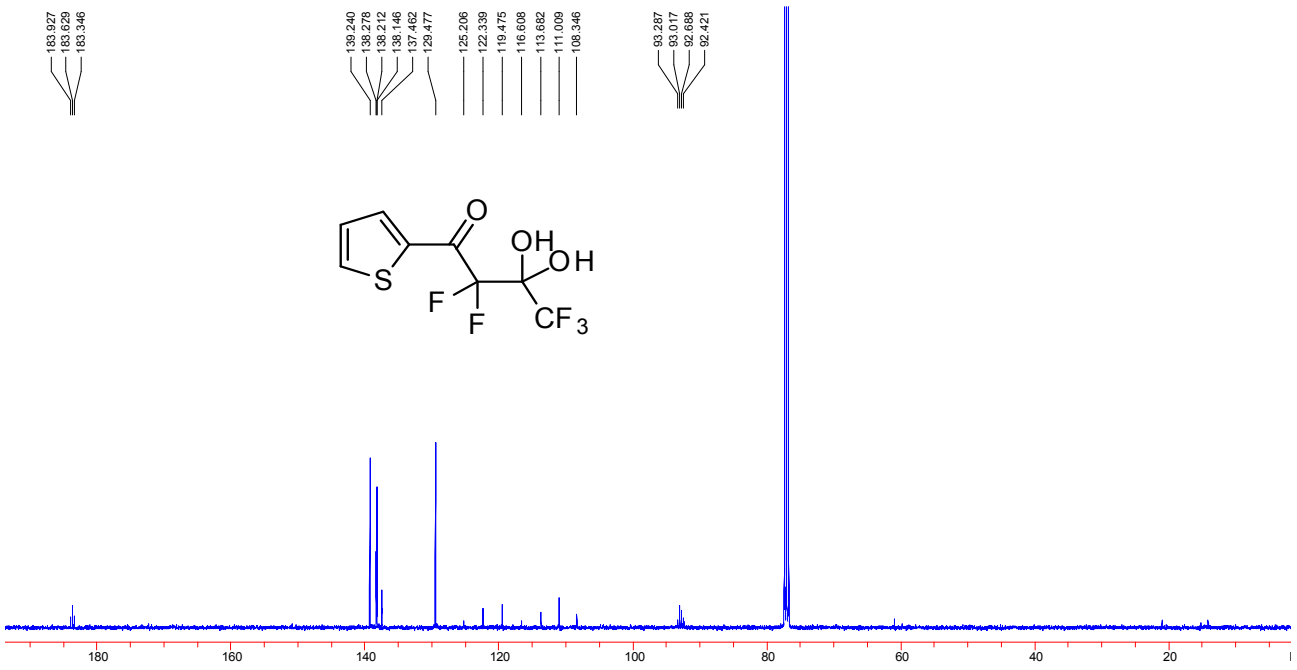

-80.965
-80.994
-81.023
-113.967
-113.995
-114.024
-114.053
Br
O
HO
OH
CF3
F
F
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120


195.622
195.322
195.019
134.489
134.230
133.609
130.012
129.976
129.938
127.101
125.144
122.276
120.469
119.401
116.541
112.830
110.156
107.475
93.278
92.999
92.676
92.342
Br
O
HO
OH
CF3
F
F
200
150
100
50
0

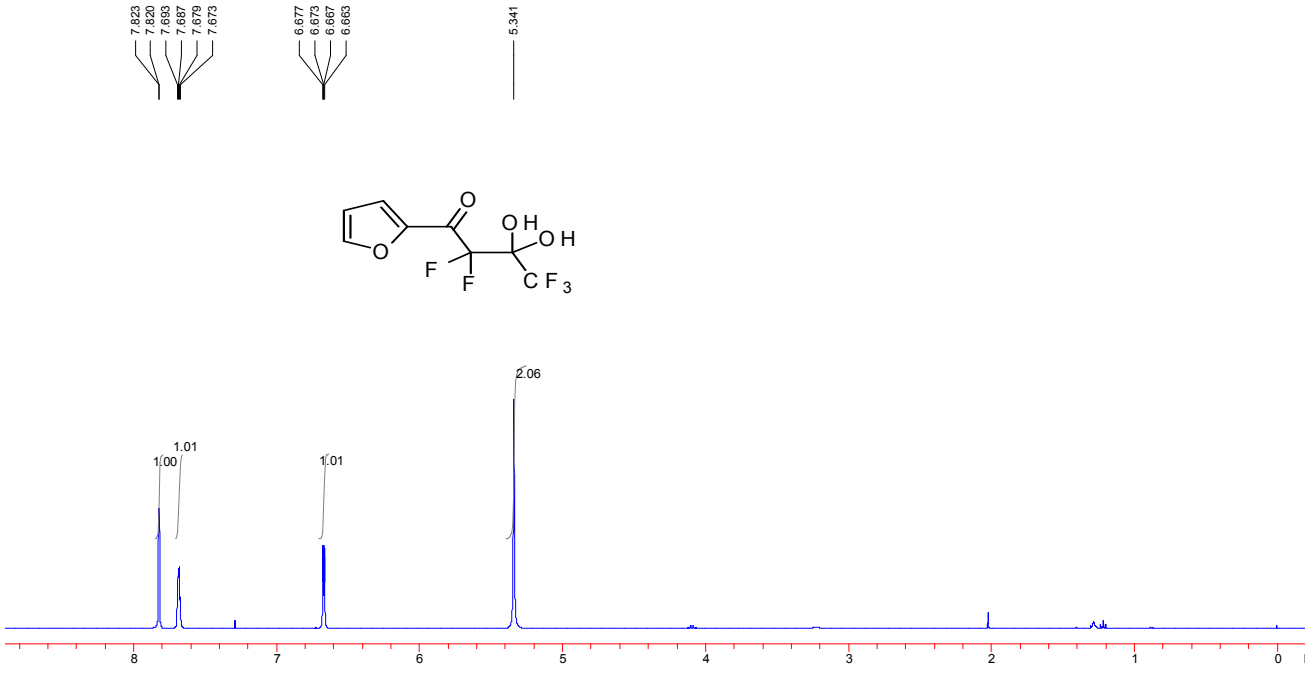
2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(thiophen-2-yl)butan-1-one **(2k)**

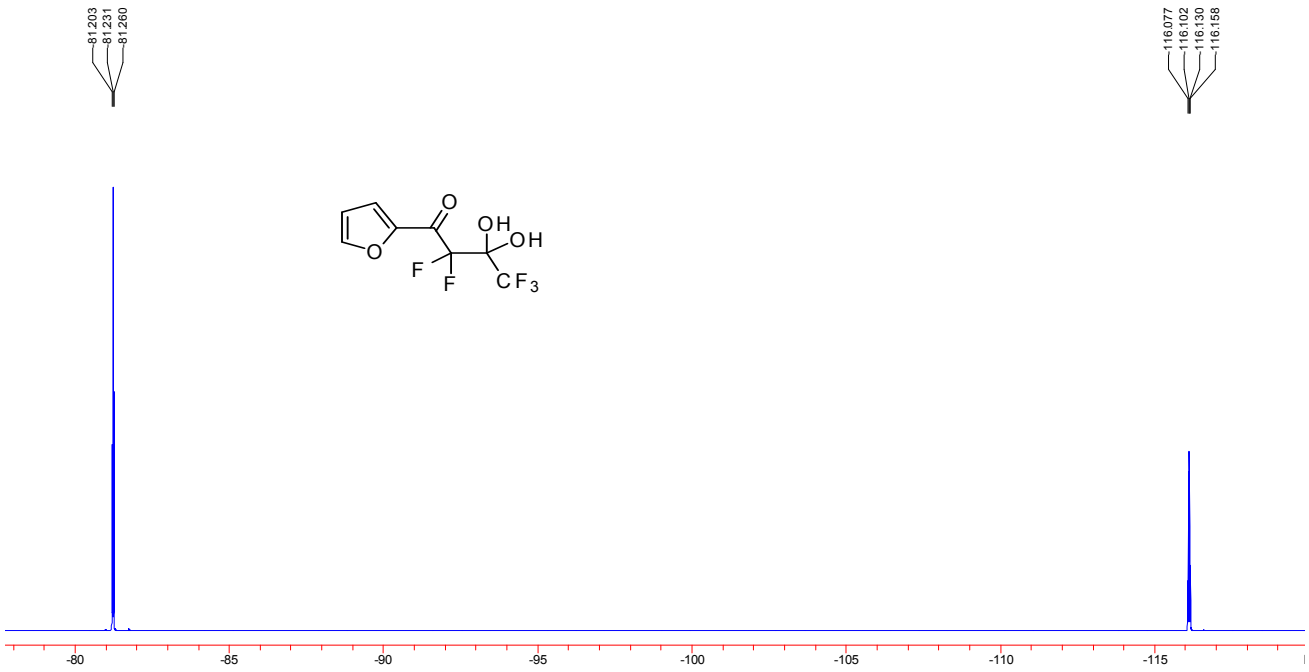


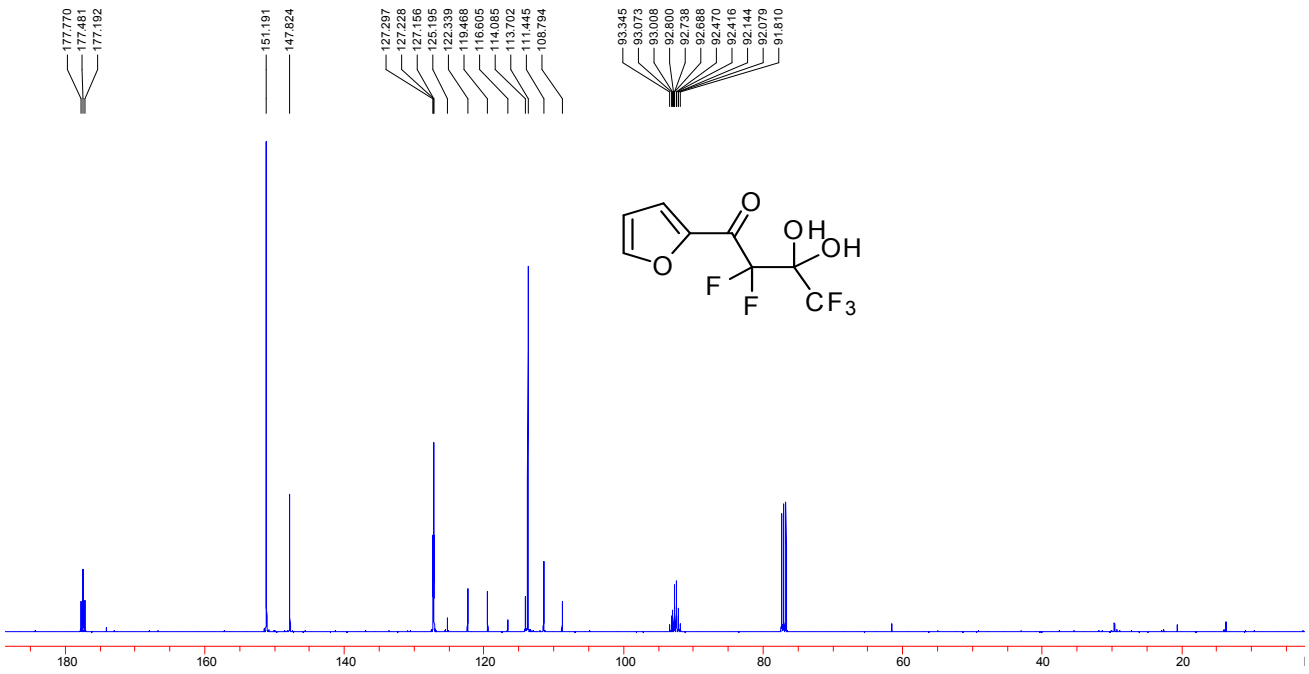




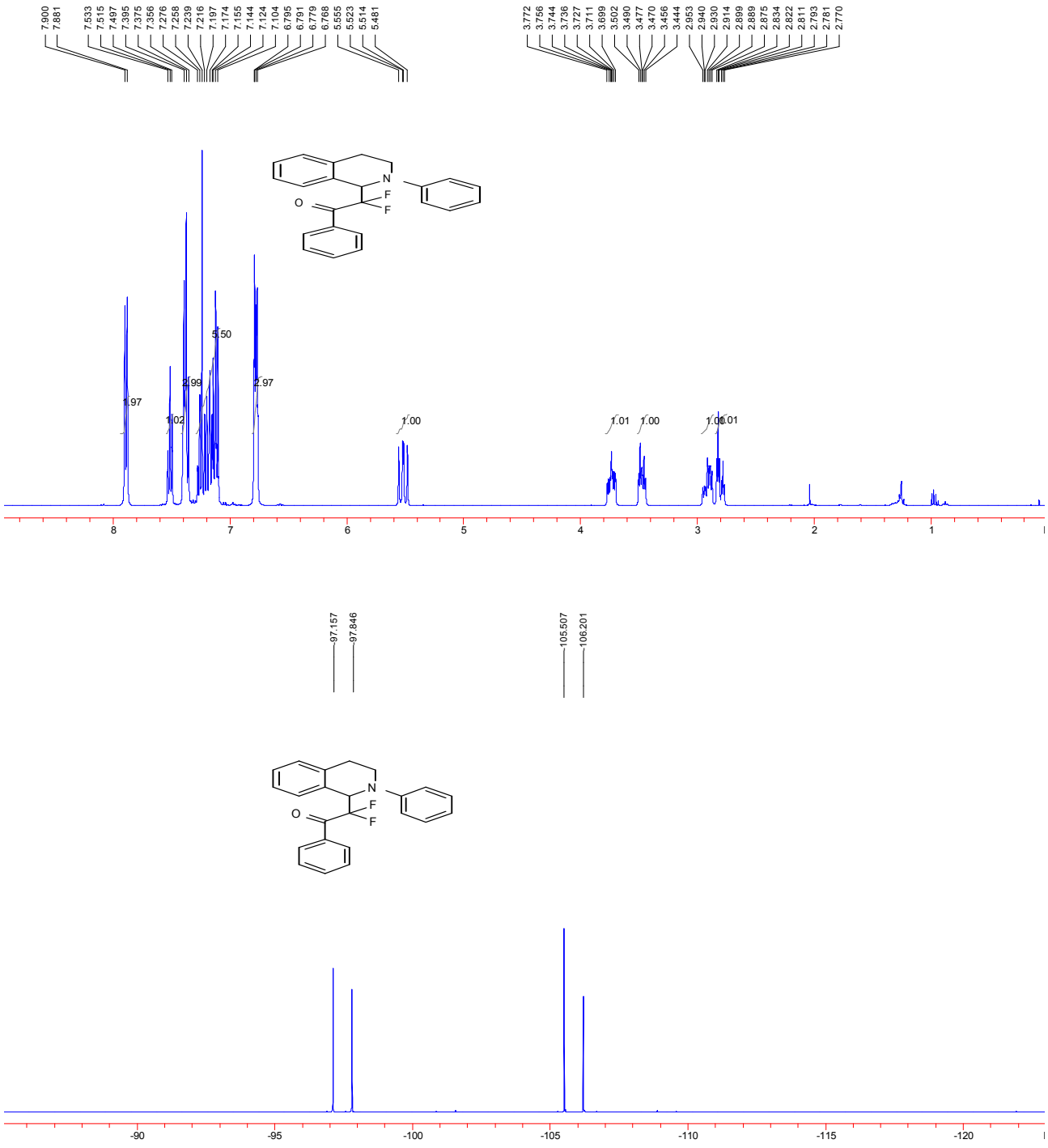
2,2,4,4,4-pentafluoro-3,3-dihydroxy-1-(furan-2-yl)butan-1-one **(2l)**

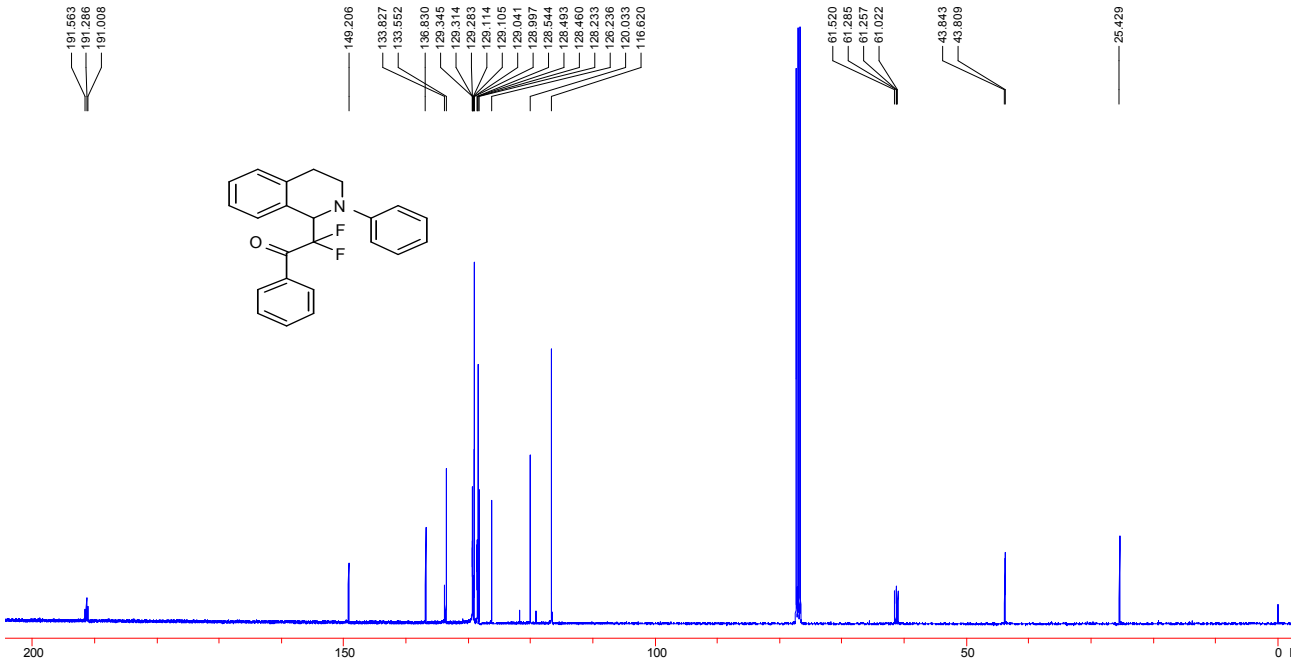



-81.203
-81.231
-81.260
-116.077
-116.102
-116.130
-116.158
O
OH
OH
F
F
CF3
-80
-85
-90
-95
-100
-105
-110
-115

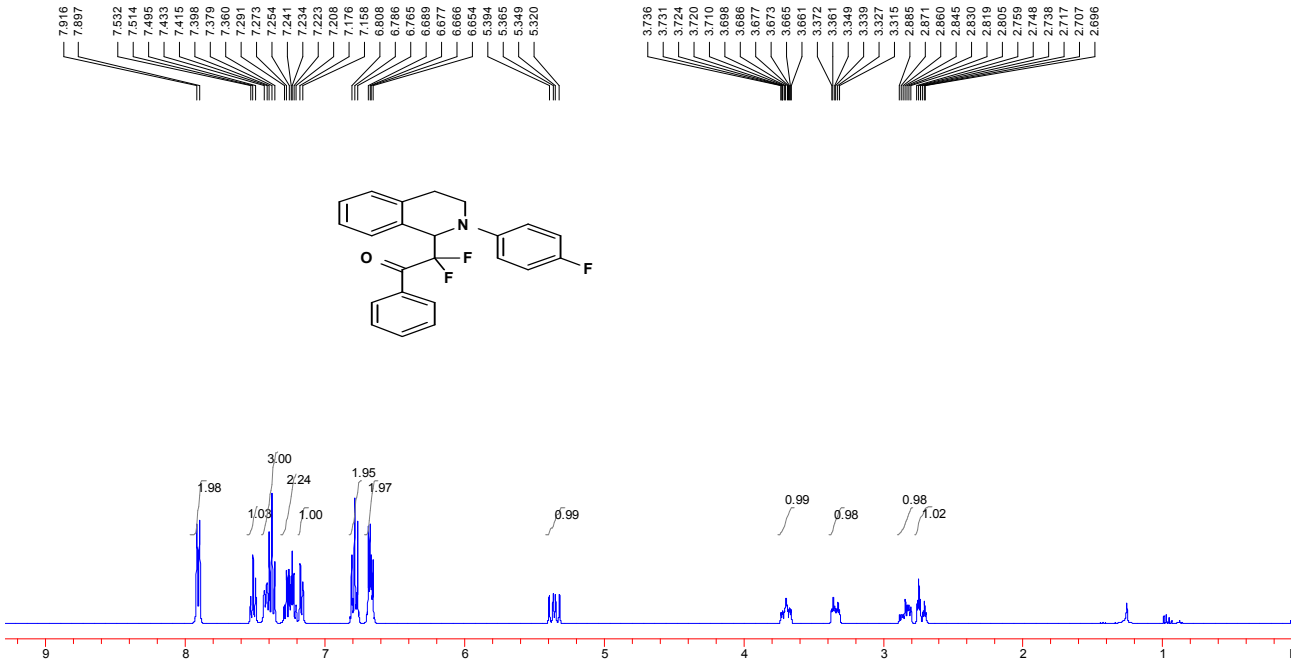

177.770
177.481
177.192
151.191
147.824
127.297
127.228
127.156
125.195
122.339
119.468
116.605
114.085
113.702
111.445
108.794
93.345
93.073
93.008
92.800
92.738
92.688
92.470
92.416
92.144
92.079
91.810
O
OH
OH
F
F
CF3
180
160
140
120
100
80
60
40
20

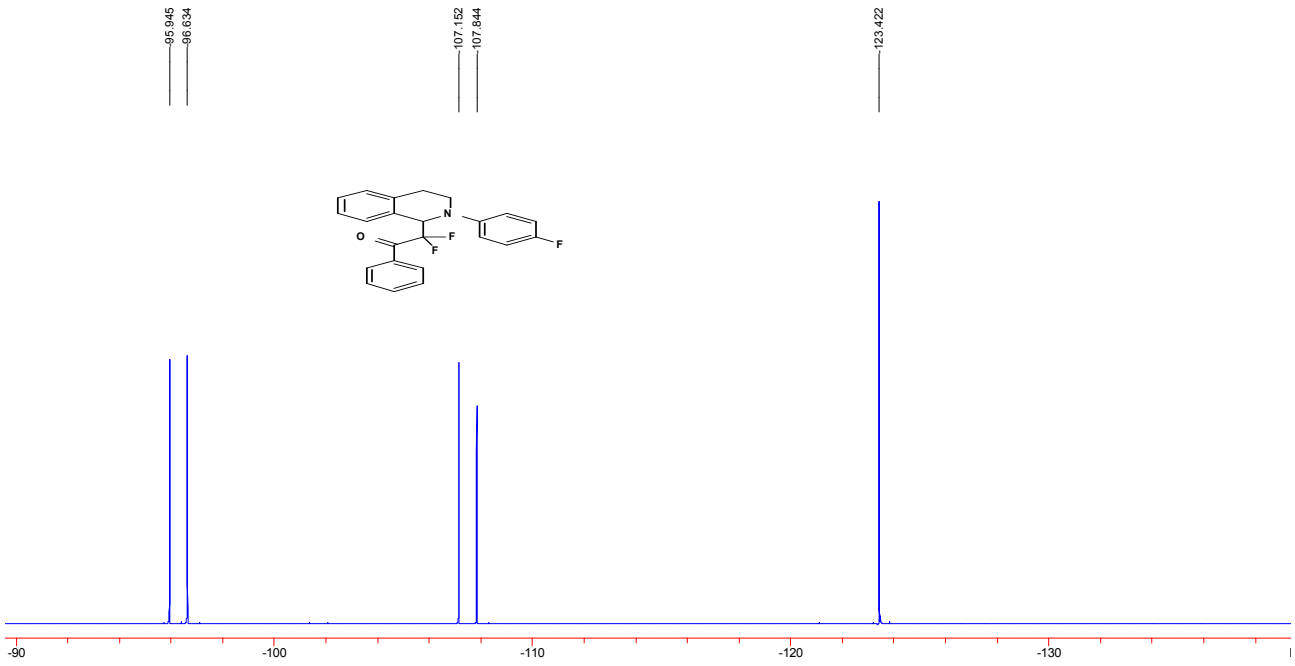
2,2-difluoro-1-phenyl-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone**(3a)**

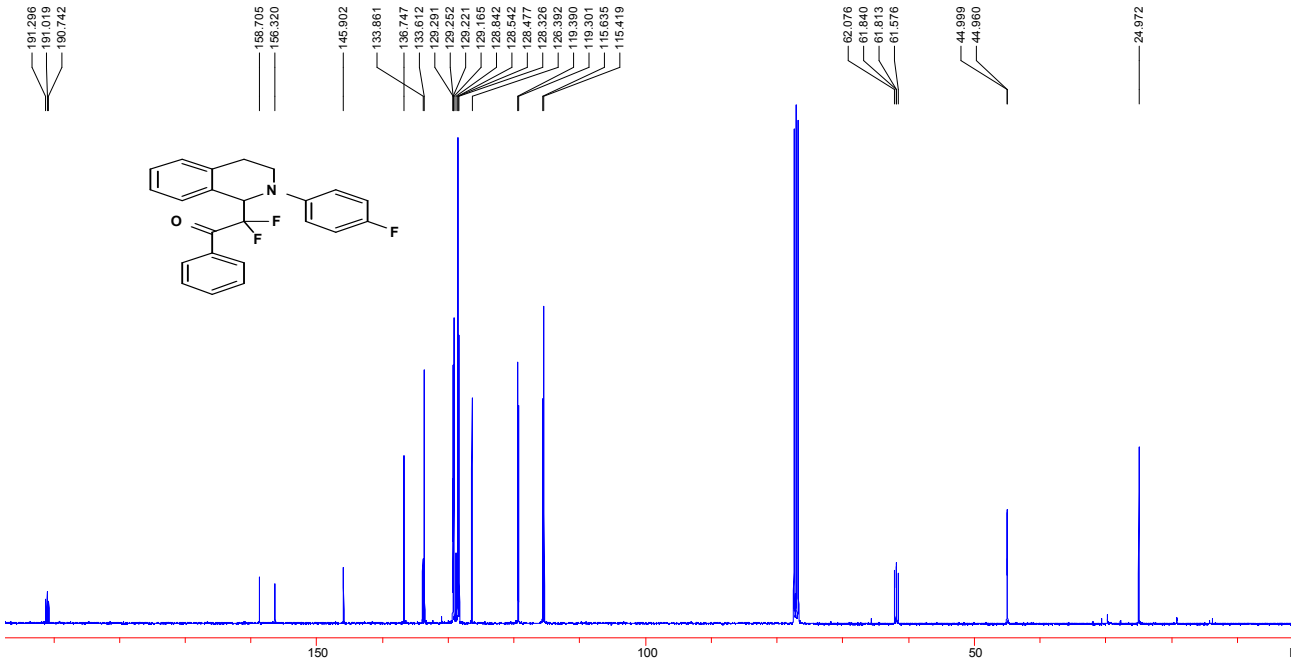




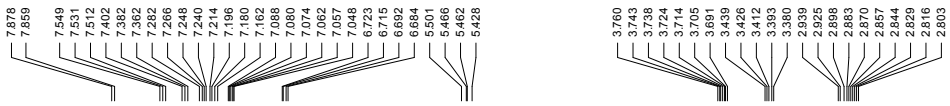
2,2-difluoro-2-(2-(4-fluorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone**(3b)**

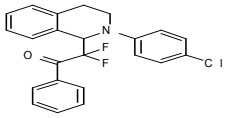


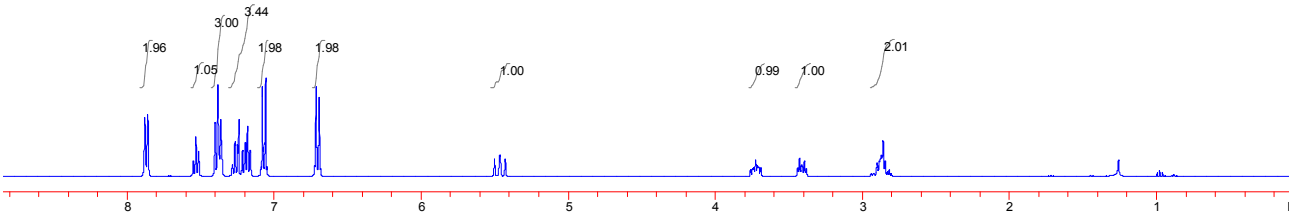

95.945
96.634
107.152
107.844
123.422
N
O
F
F
F
-90
-100
-110
-120
-130

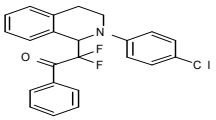

191.296
191.019
190.742
158.705
156.320
145.902
133.861
136.747
133.612
129.291
129.252
129.221
129.165
128.842
128.542
128.477
128.326
128.392
119.390
119.301
115.635
115.419
62.076
61.840
61.813
61.576
44.999
44.960
24.972
N
O
F
F
F
150
100
50

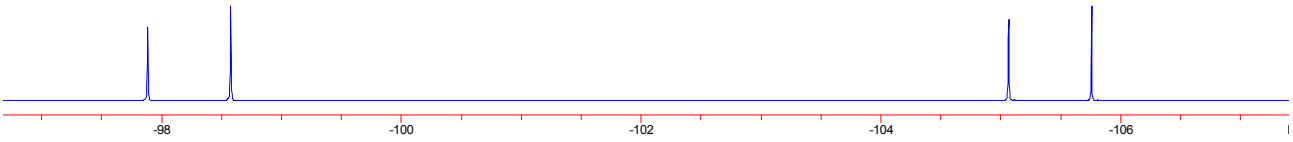
2-(2-(4-chlorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(**3c**)

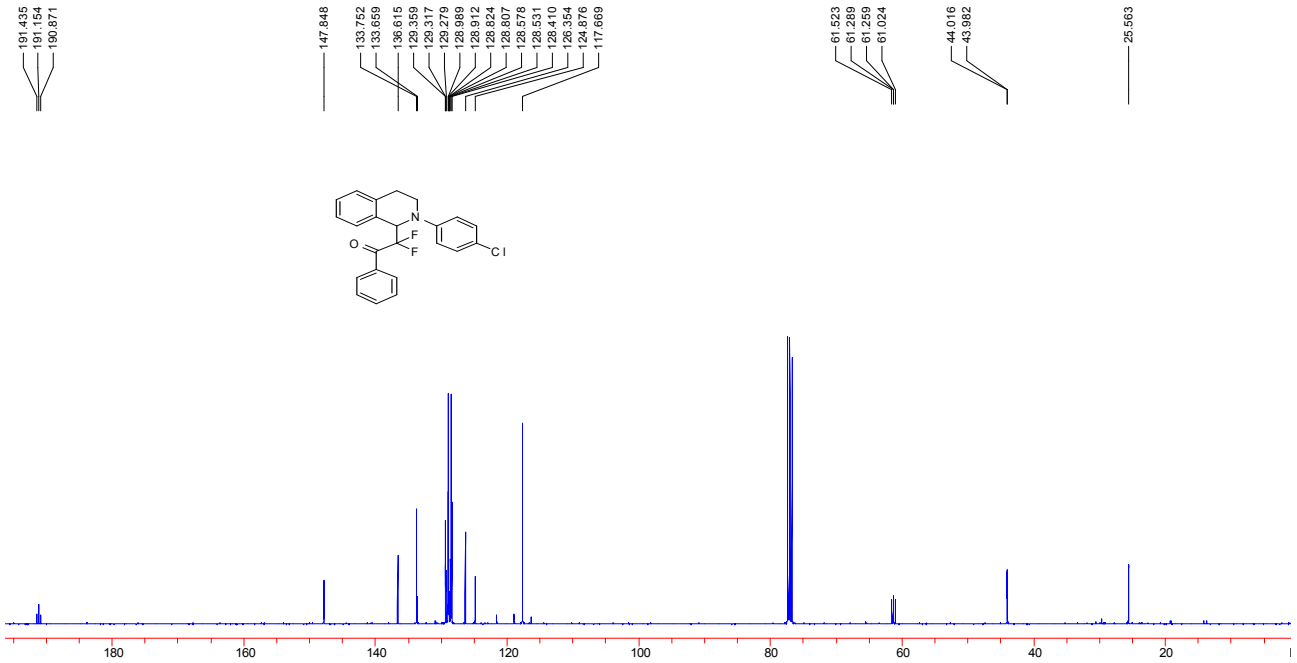




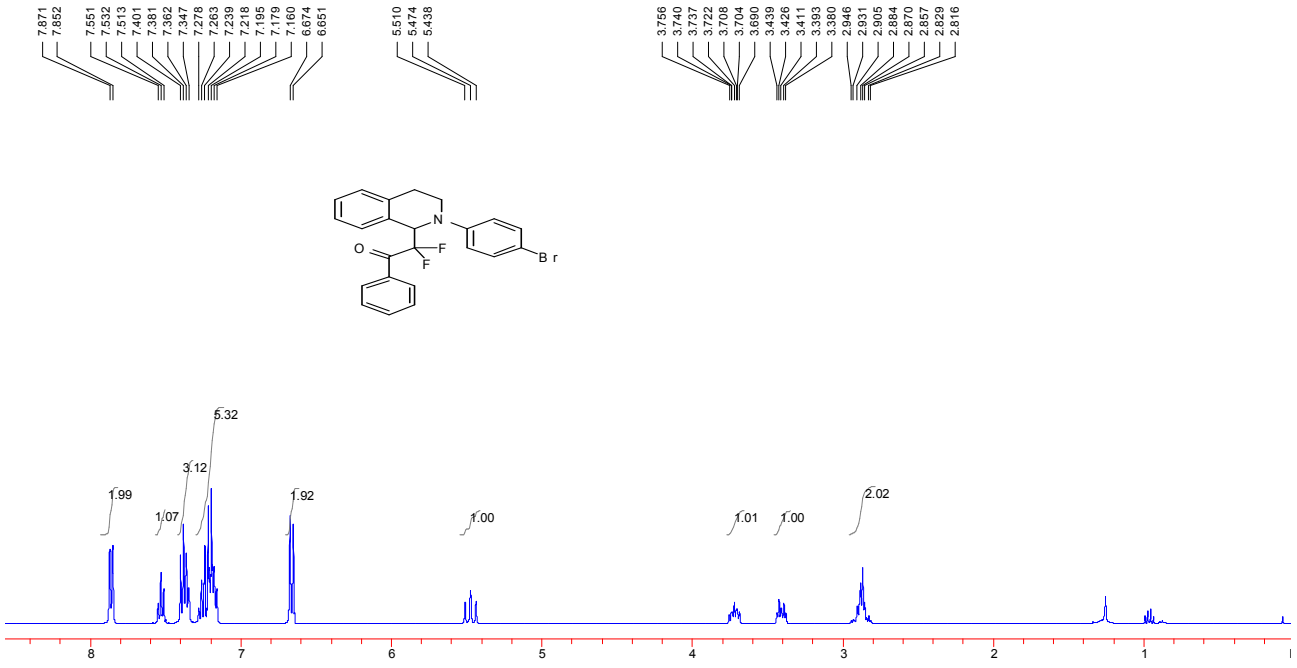


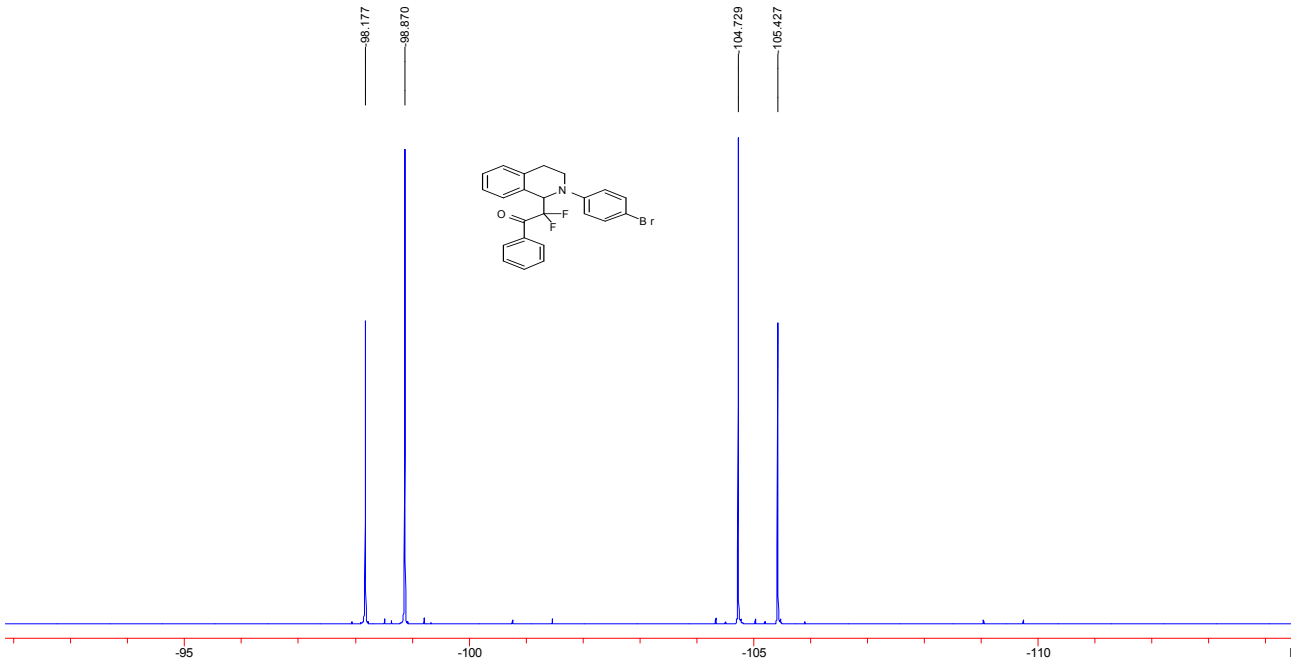


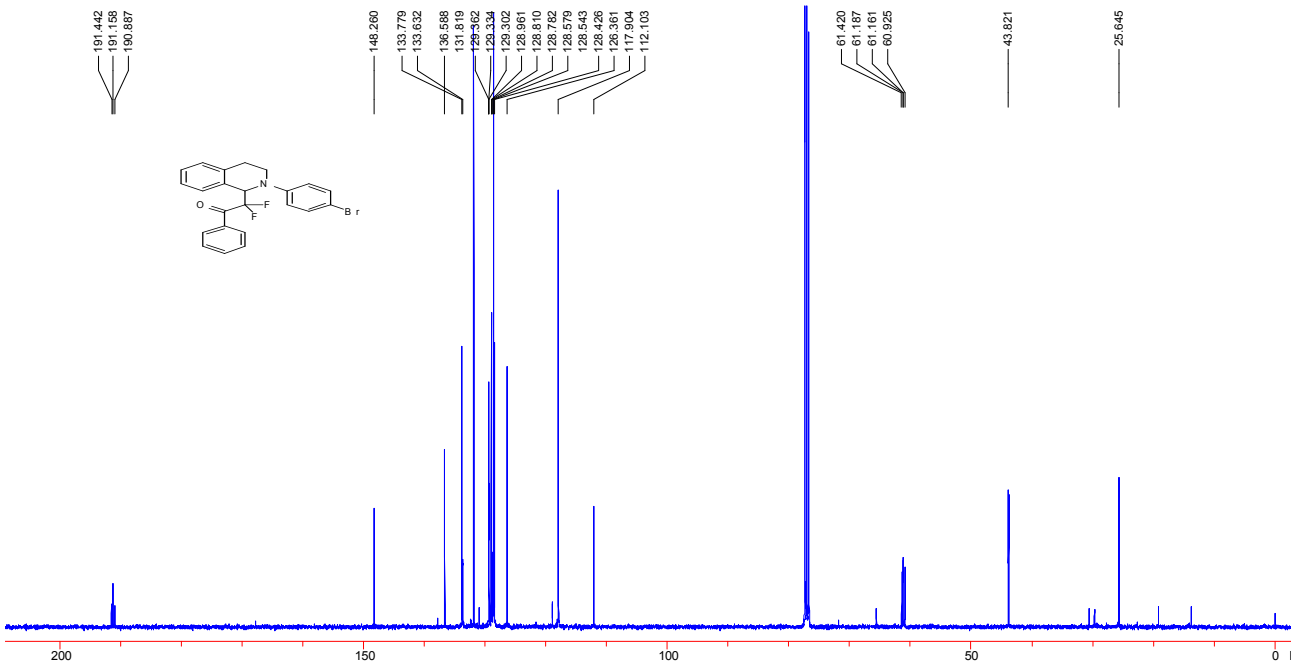




2-(2-(4-bromophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(**3d**)




98.177
98.870
104.729
105.427
N
O
F
F
B r
-95
-100
-105
-110


191.442
191.158
190.887
148.260
133.779
133.632
136.588
131.819
129.362
129.334
129.302
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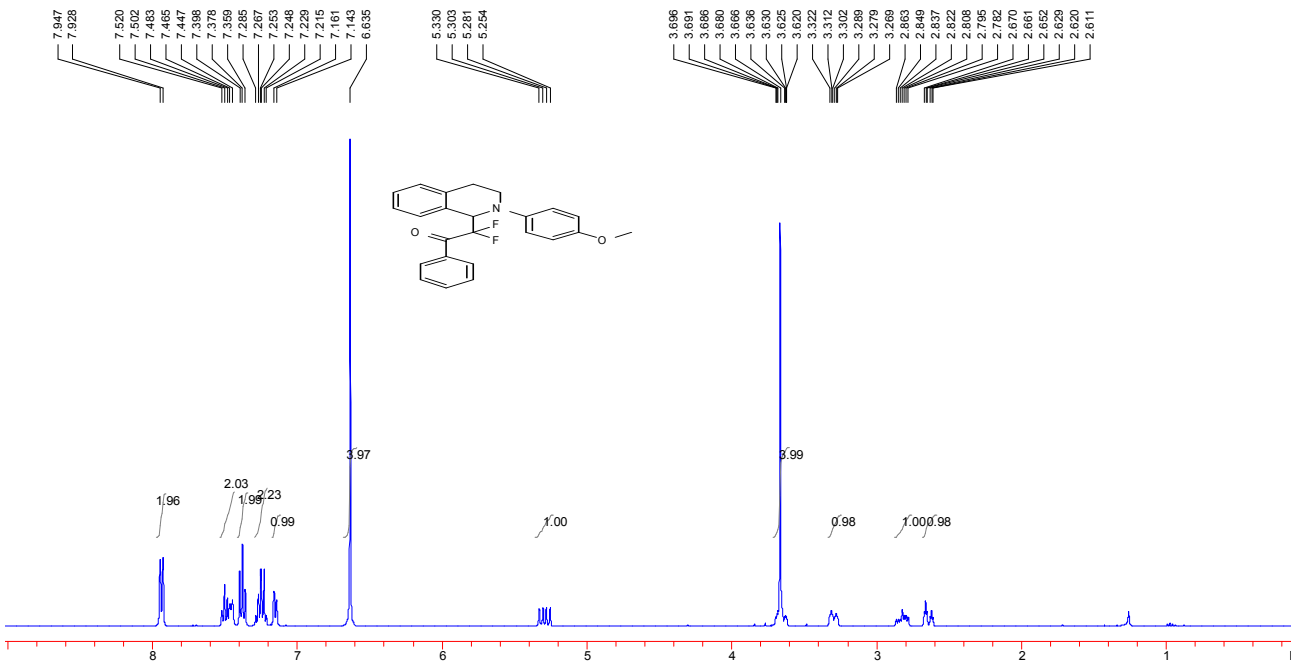
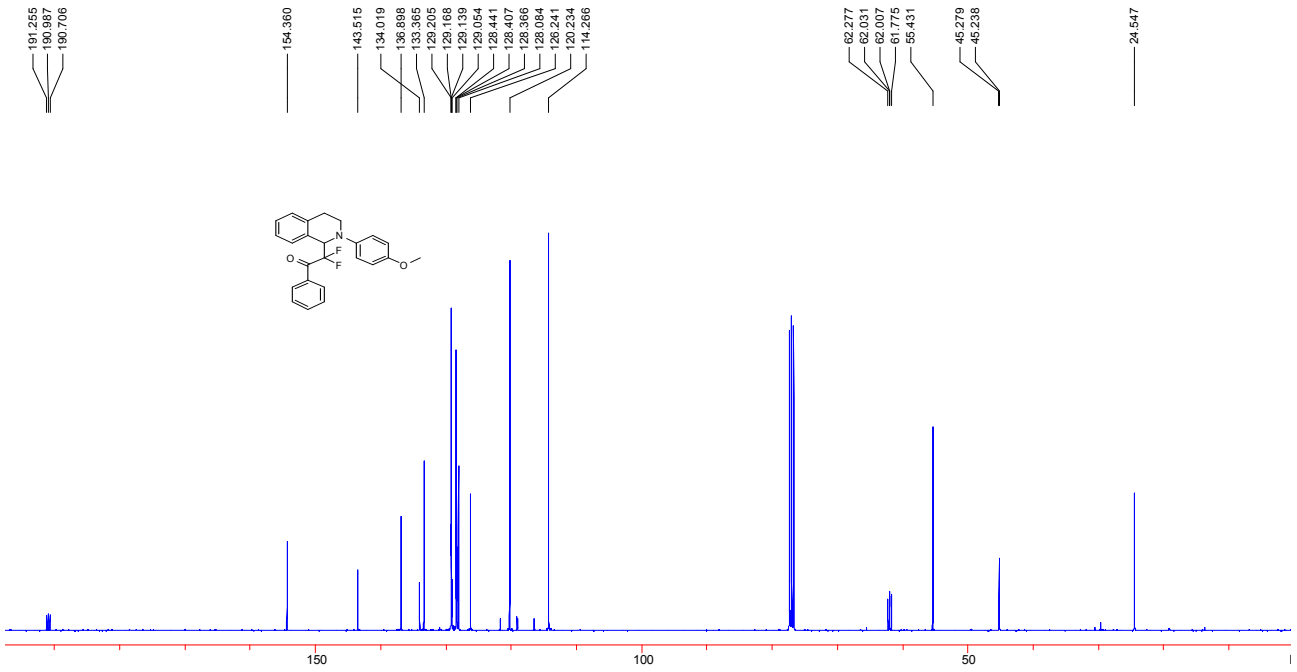
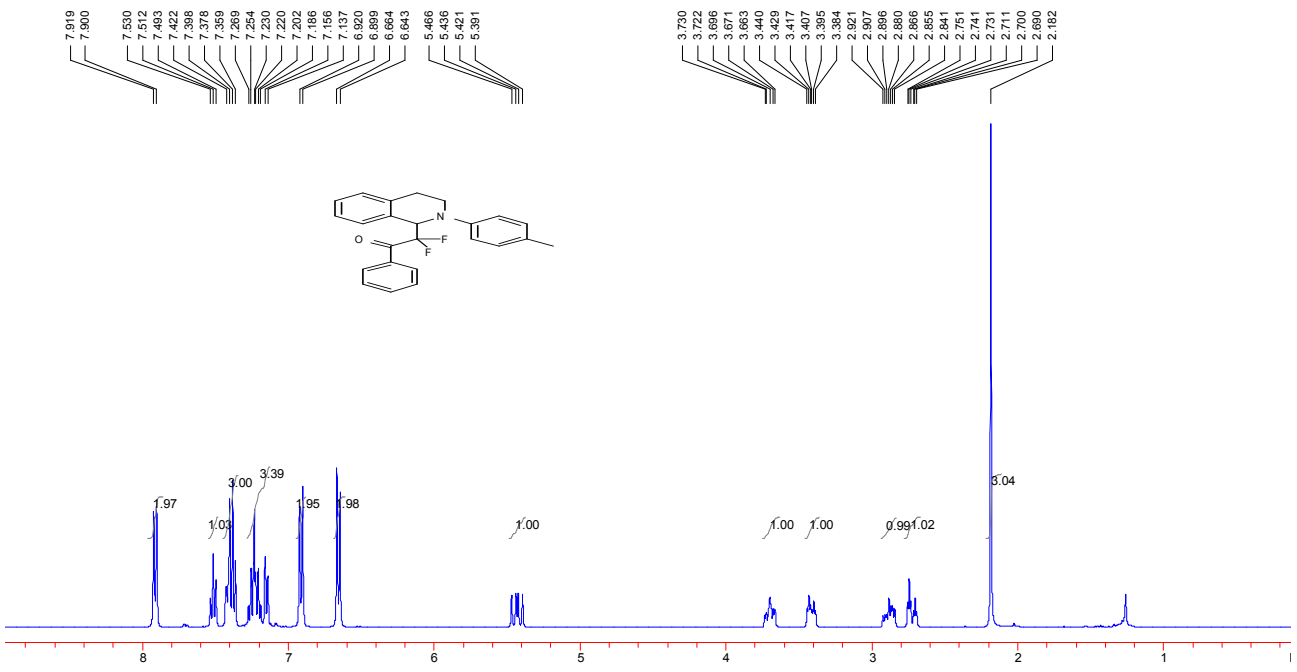
128.810
128.782
128.579
128.543
128.426
128.361
117.904
112.103
61.420
61.187
61.161
60.925
43.821
25.645
N
O
F
F
B r
200
150
100
50
0

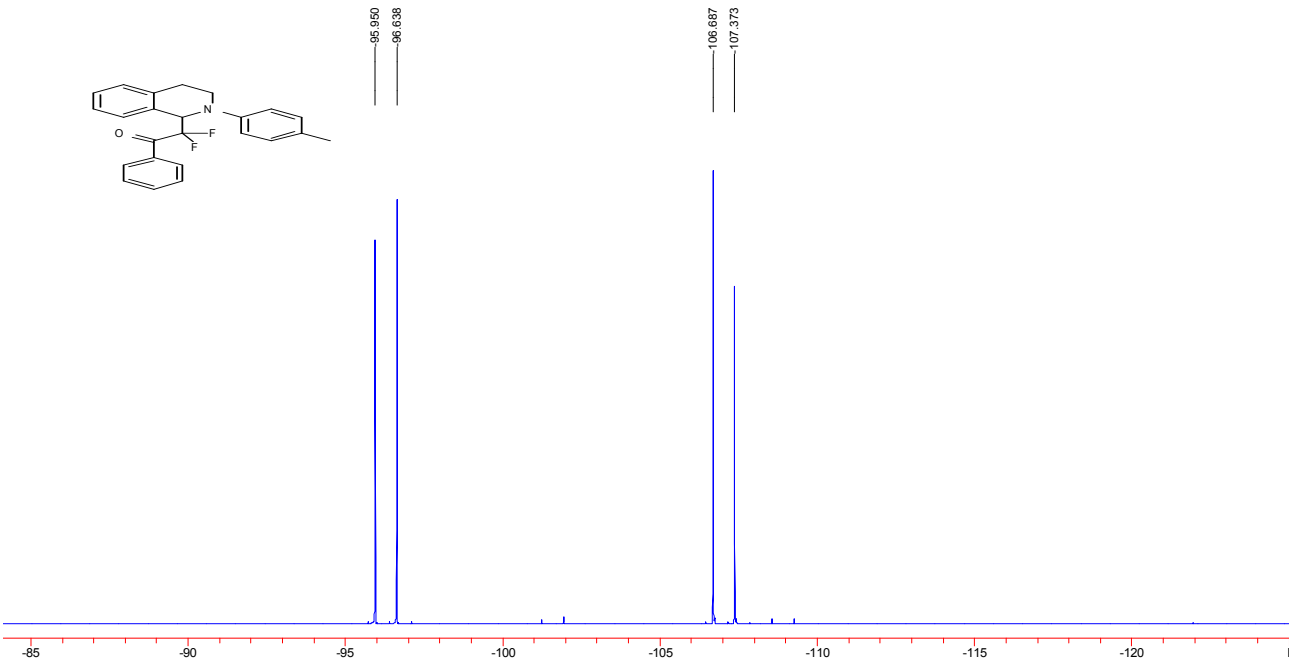
2,2-difluoro-2-(2-(4-methoxyphenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(**3e**)

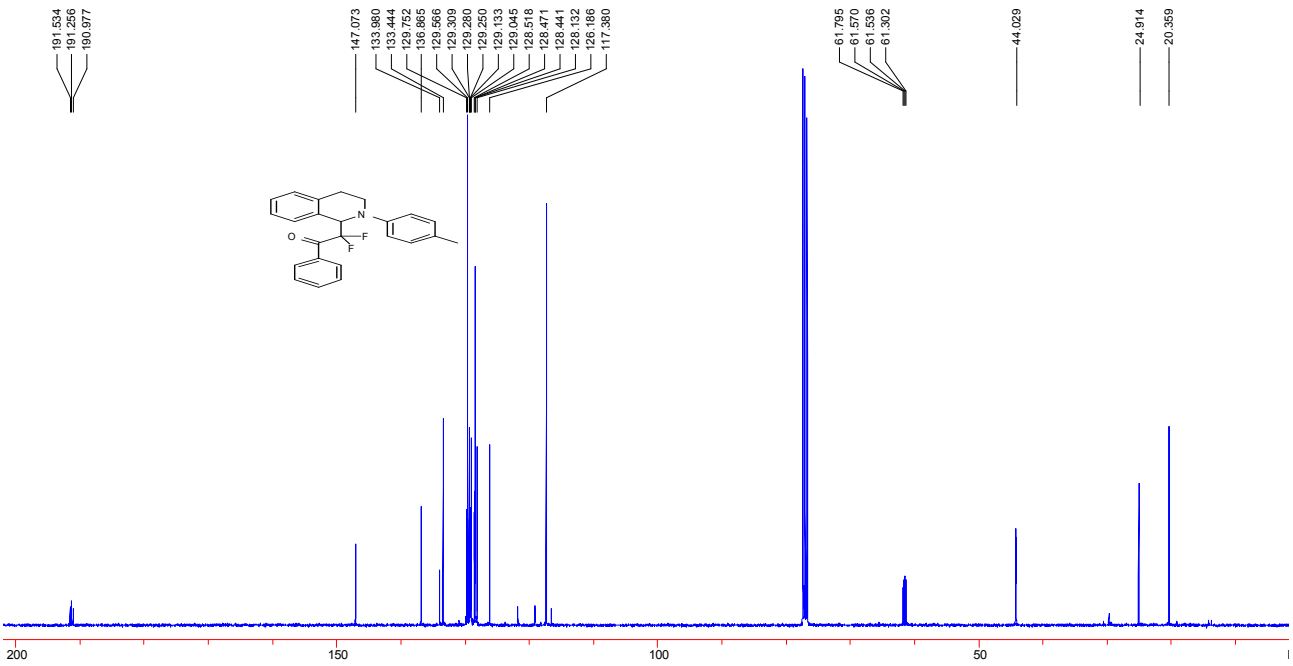




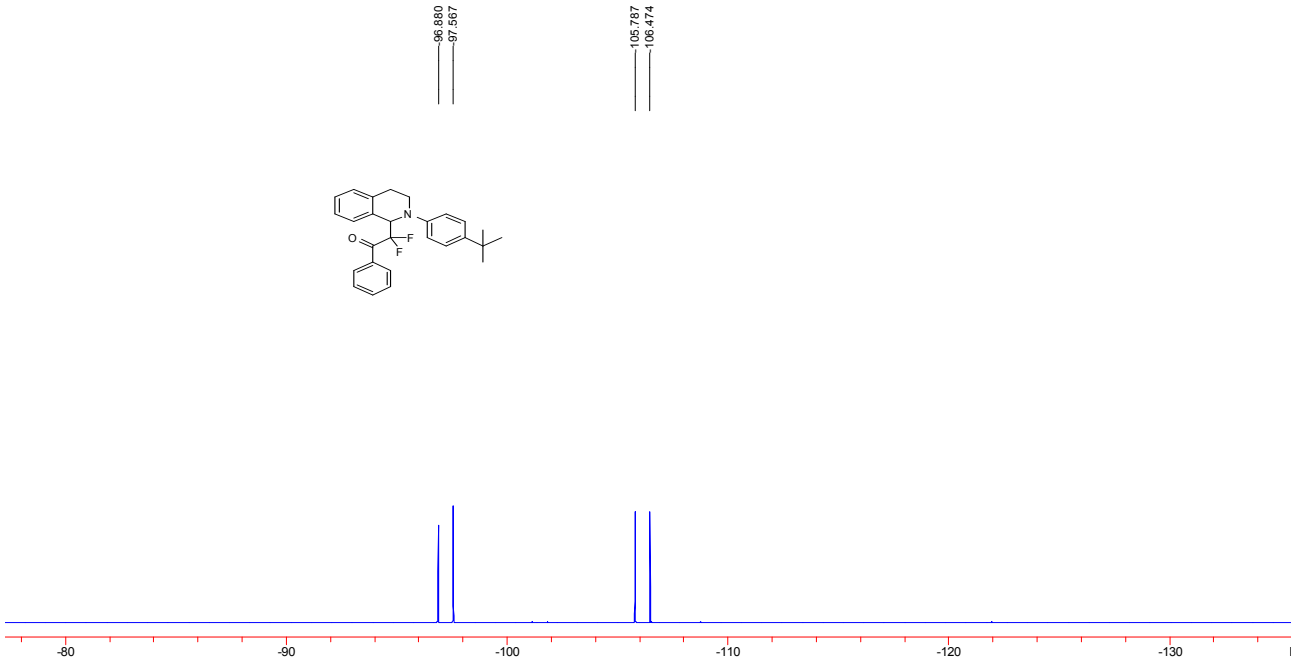
2,2-difluoro-1-phenyl-2-(2-(p-tolyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(**3f**)

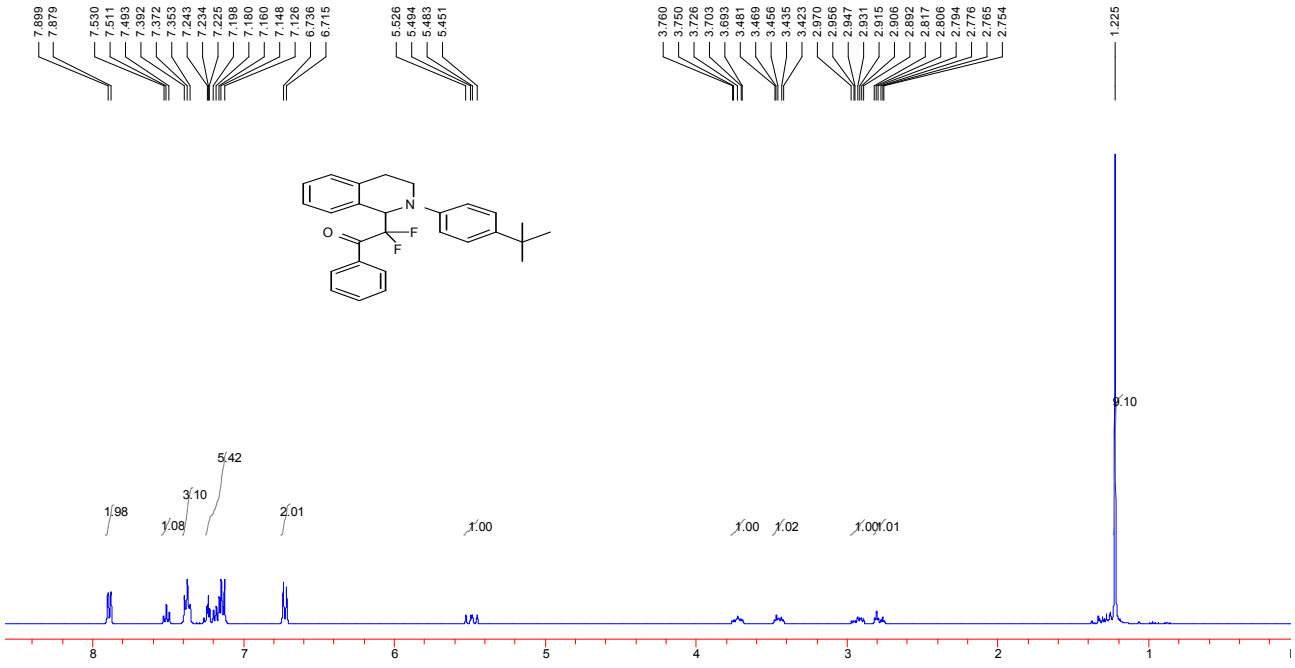


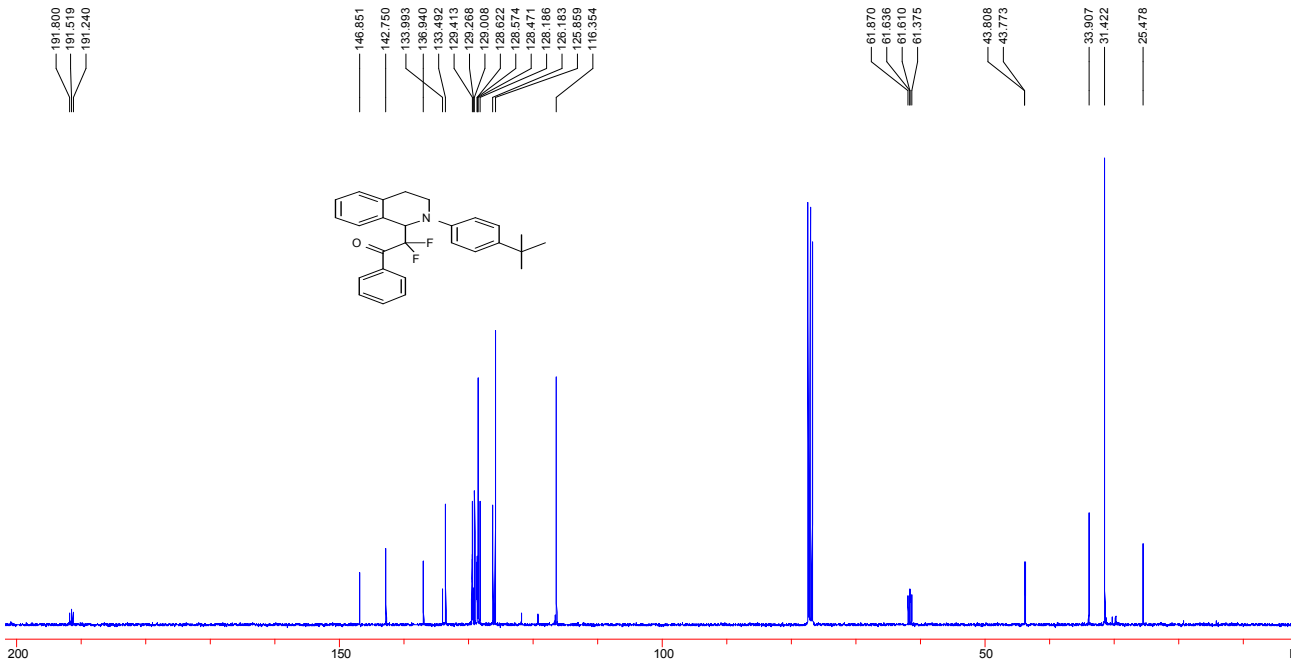

95.950
96.638
106.687
107.373
N
O
F
F
-85
-90
-95
-100
-105
-110
-115
-120


191.534
191.256
190.977
147.073
133.980
133.444
129.752
136.885
129.566
129.309
129.280
129.250
129.133
129.045
128.518
128.471
128.441
128.132
126.186
117.380
61.795
61.570
61.536
61.302
44.029
24.914
20.359
N
O
F
F
200
150
100
50

2-(2-(4-(tert-butyl)phenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(**3g**)

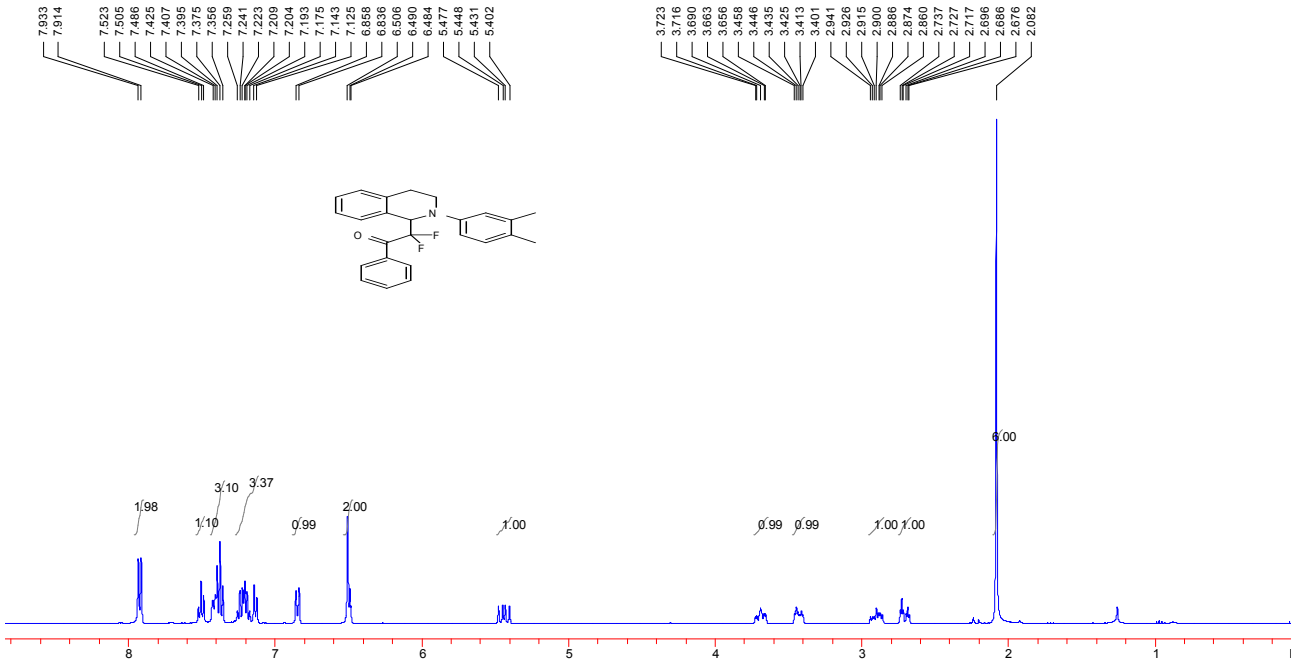


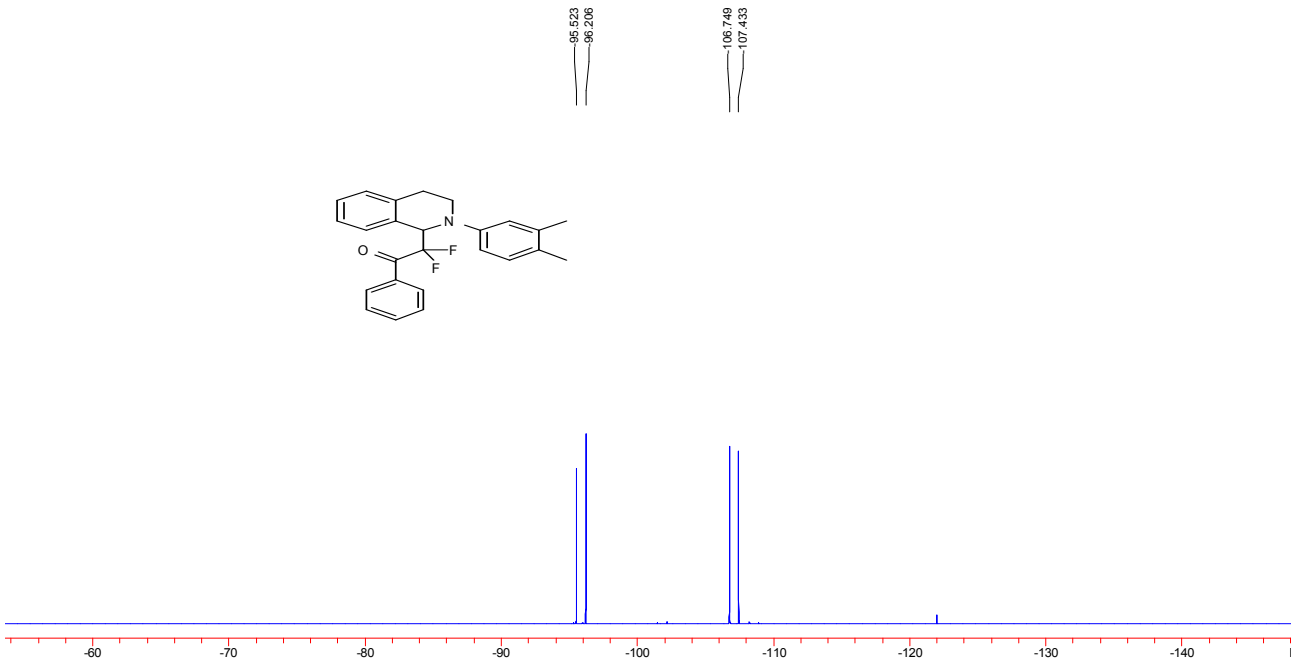


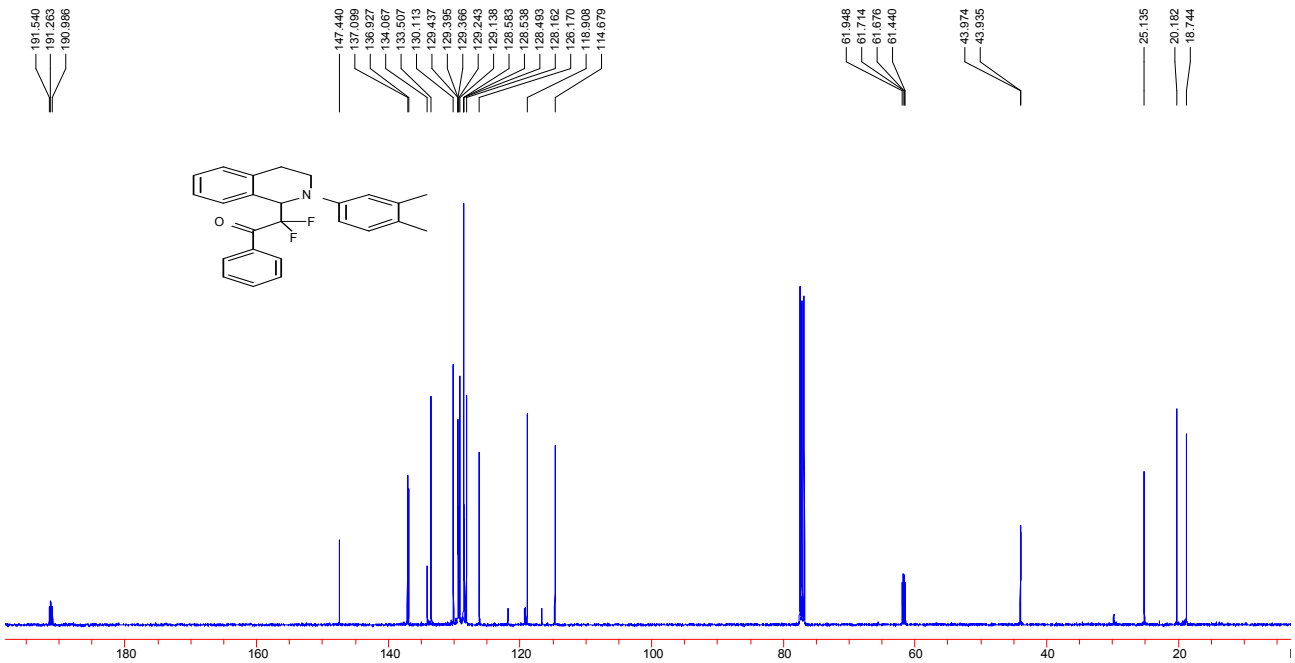


2

-(2-(3, 4-dimethylphenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(**3h**)




95.523
96.206
106.749
107.433
N
O
F
F
-60
-70
-80
-90
-100
-110
-120
-130
-140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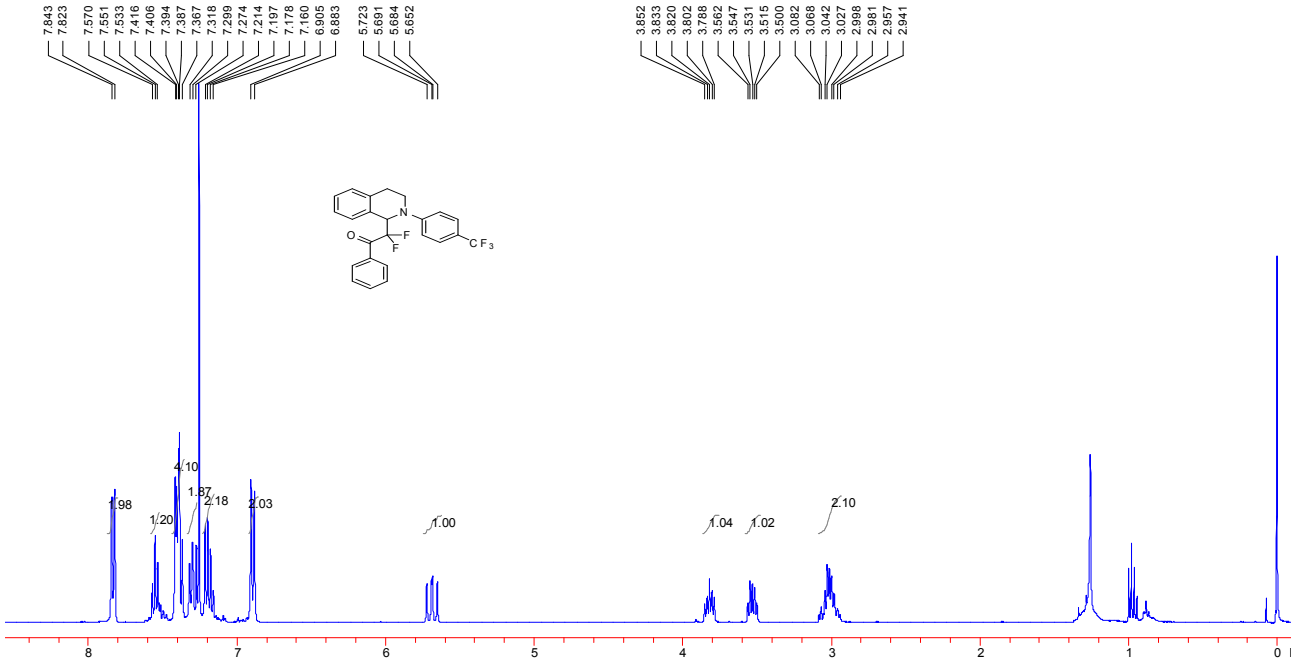
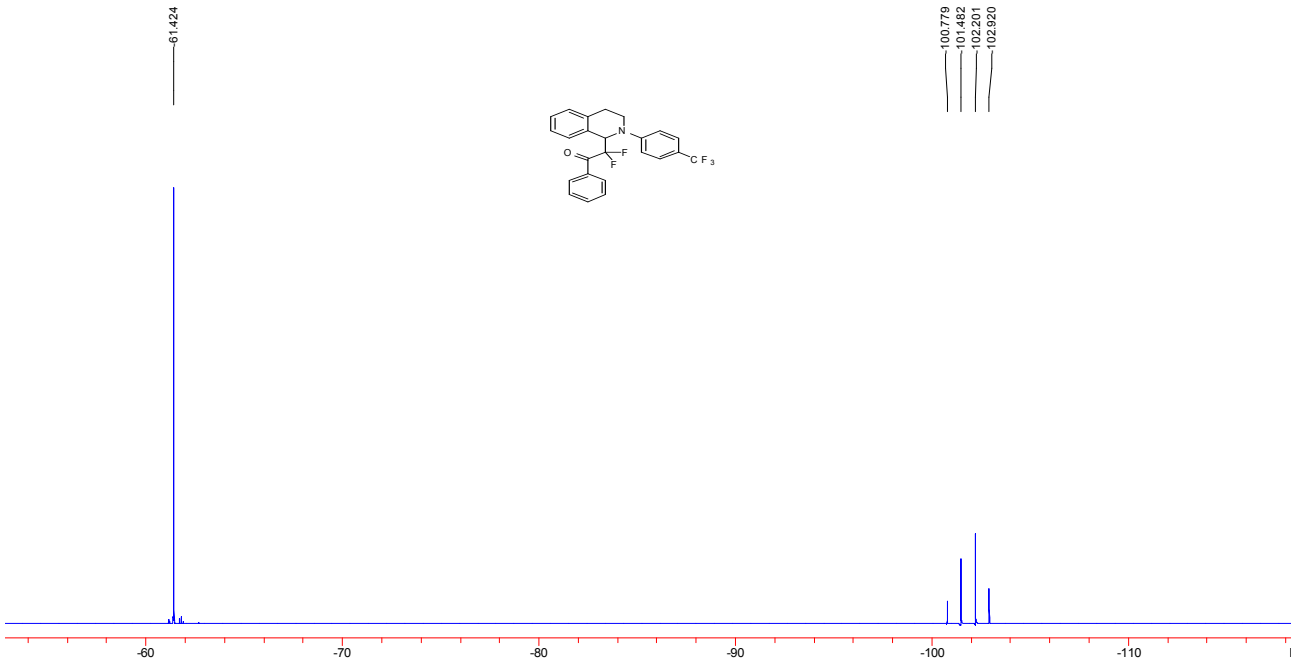
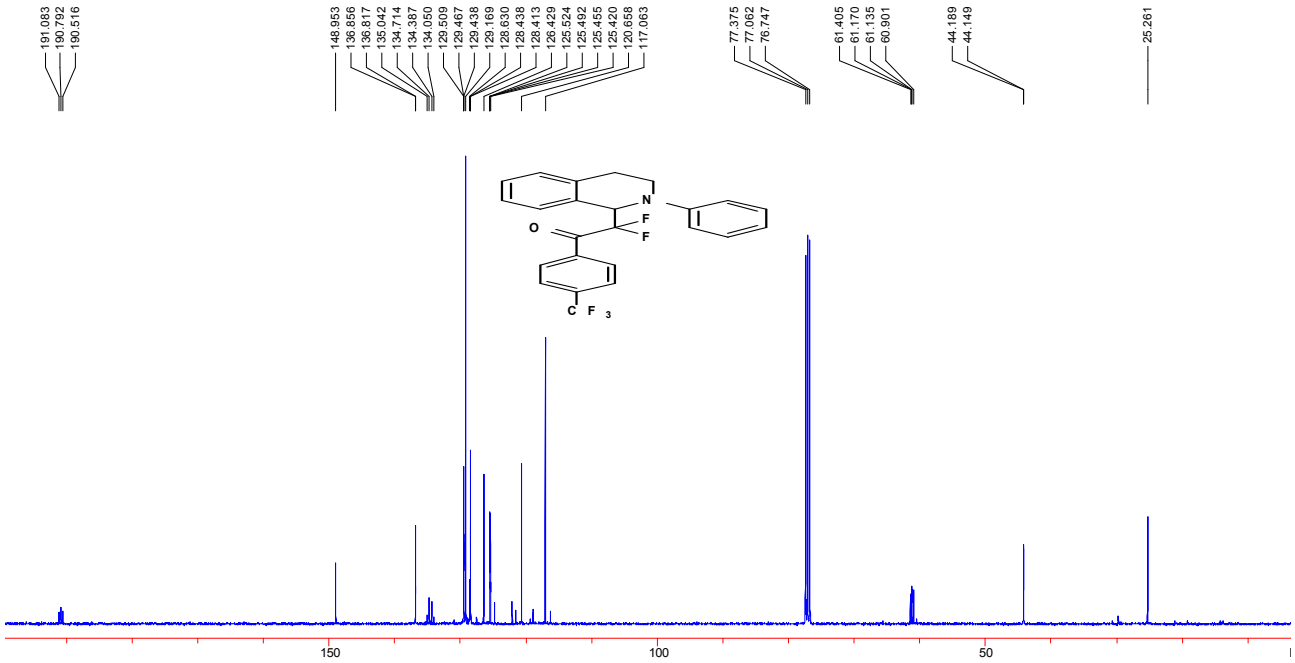
129.243
129.138
128.583
128.538
128.493
128.162
126.170
118.908
114.679
61.948
61.714
61.676
61.440
43.974
43.935
25.135
20.182
18.744
N
O
F
F
180
160
140
120
100
80
60
40
20

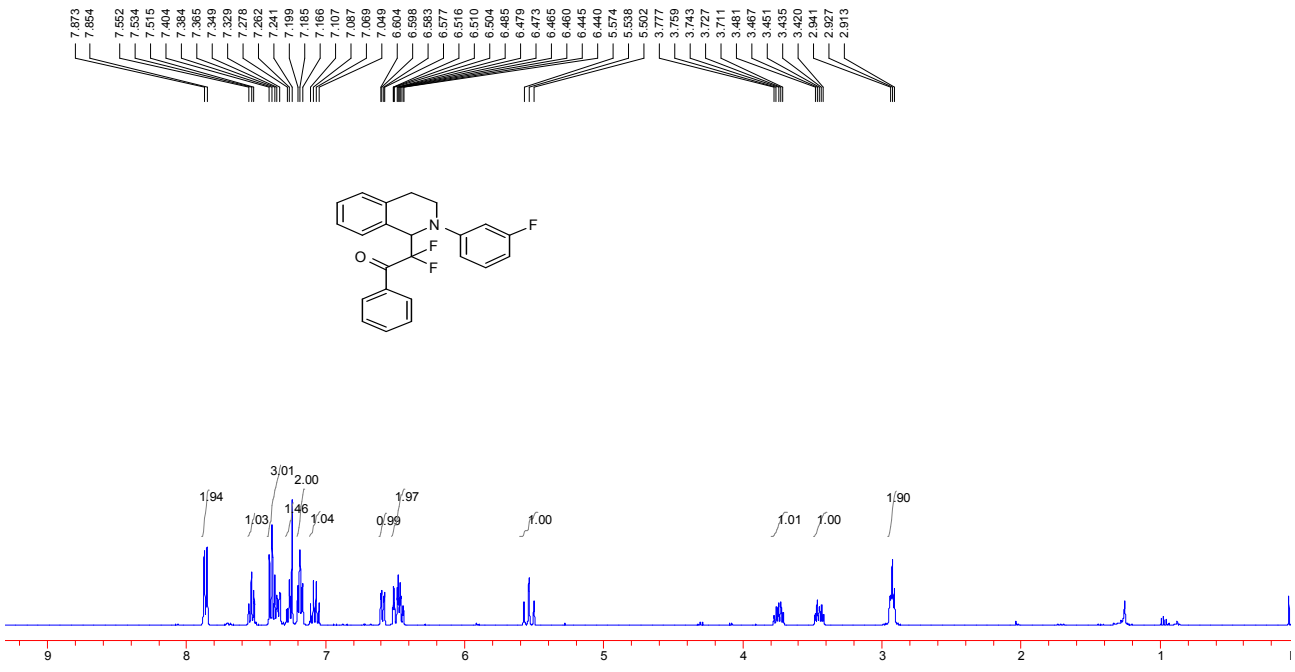
2,2-difluoro-1-phenyl-2-(2-(4-(trifluoromethyl)phenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone**(3i)**

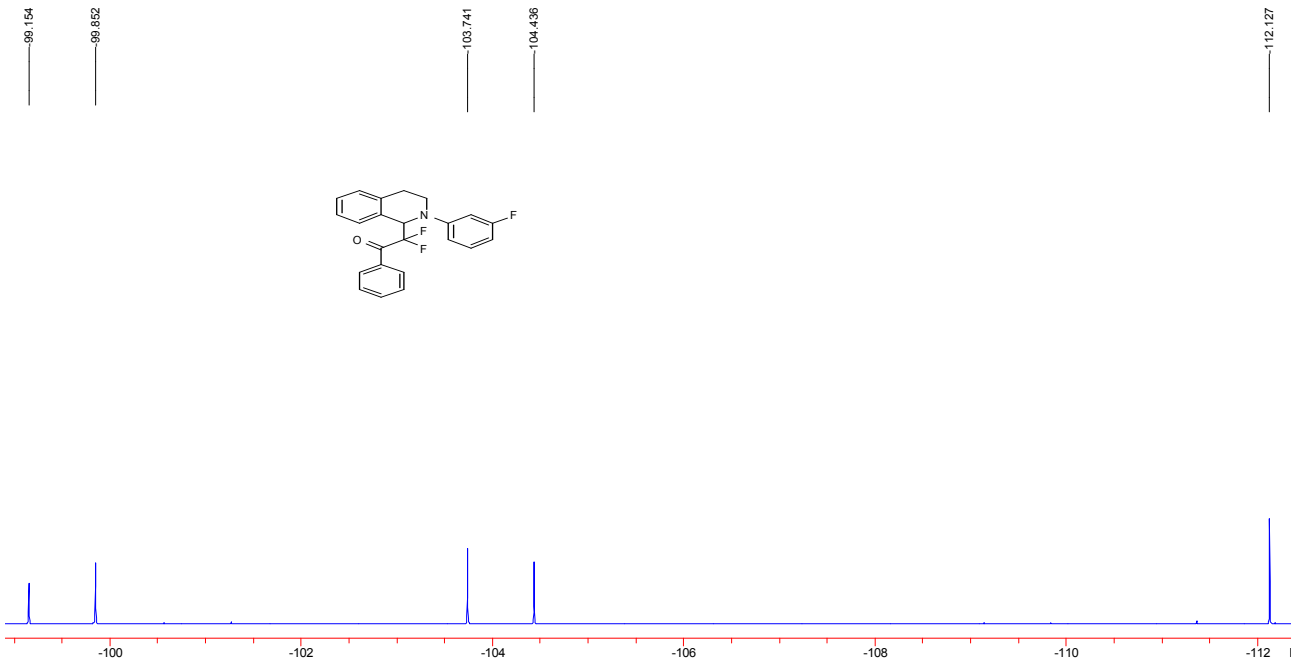






2,2-difluoro-2-(2-(3-fluorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(**3j**)

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-108
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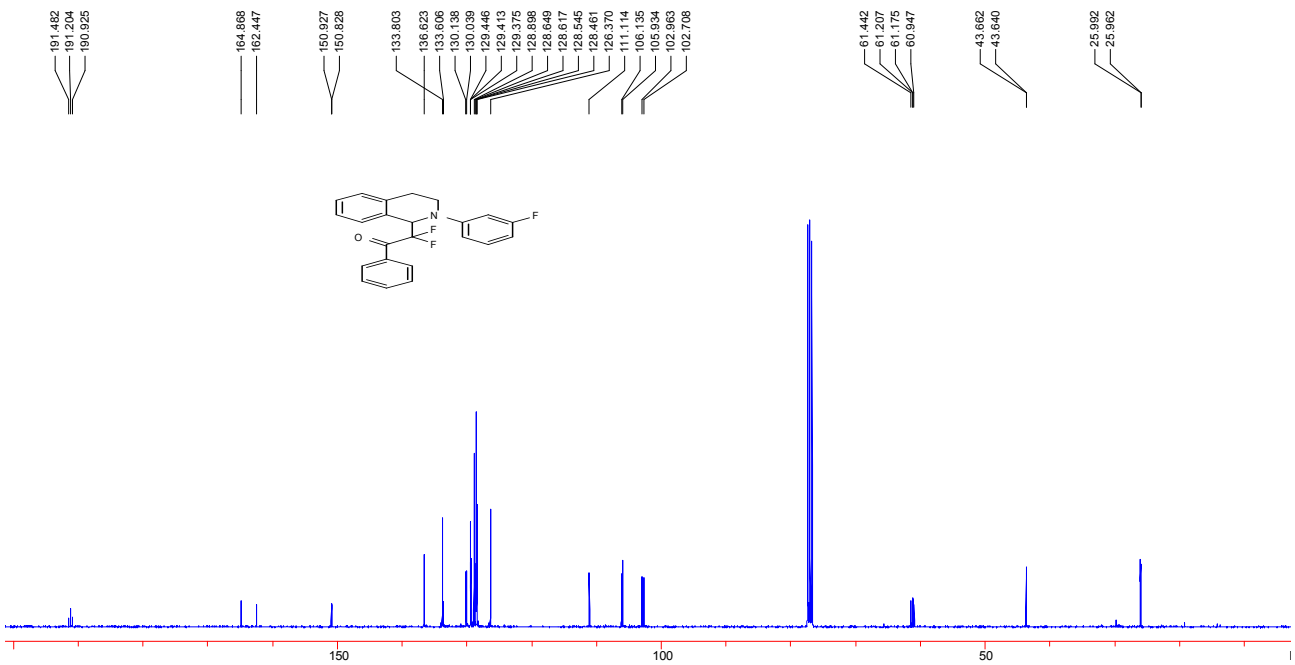
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128.898
128.649
128.617
128.545
128.461
126.370
111.114
106.135
105.934
102.963
102.708
61.442
61.207
61.175
60.947
43.662
43.640
25.992
25.962
N
F
F
F
O
150
100
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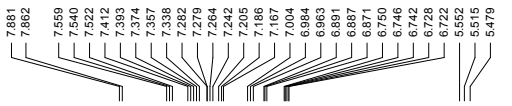
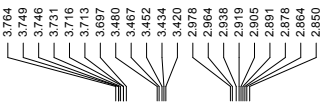
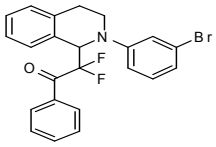
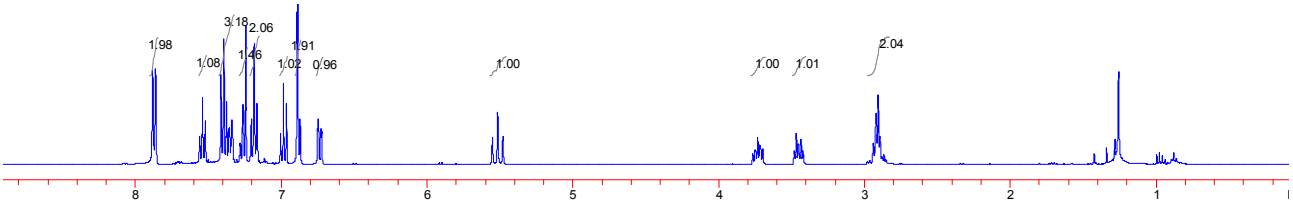
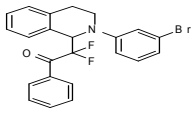
2-(2-(3-bromophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone(**3k**)

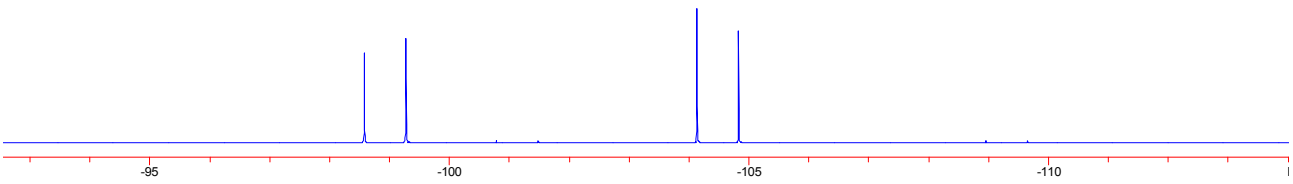


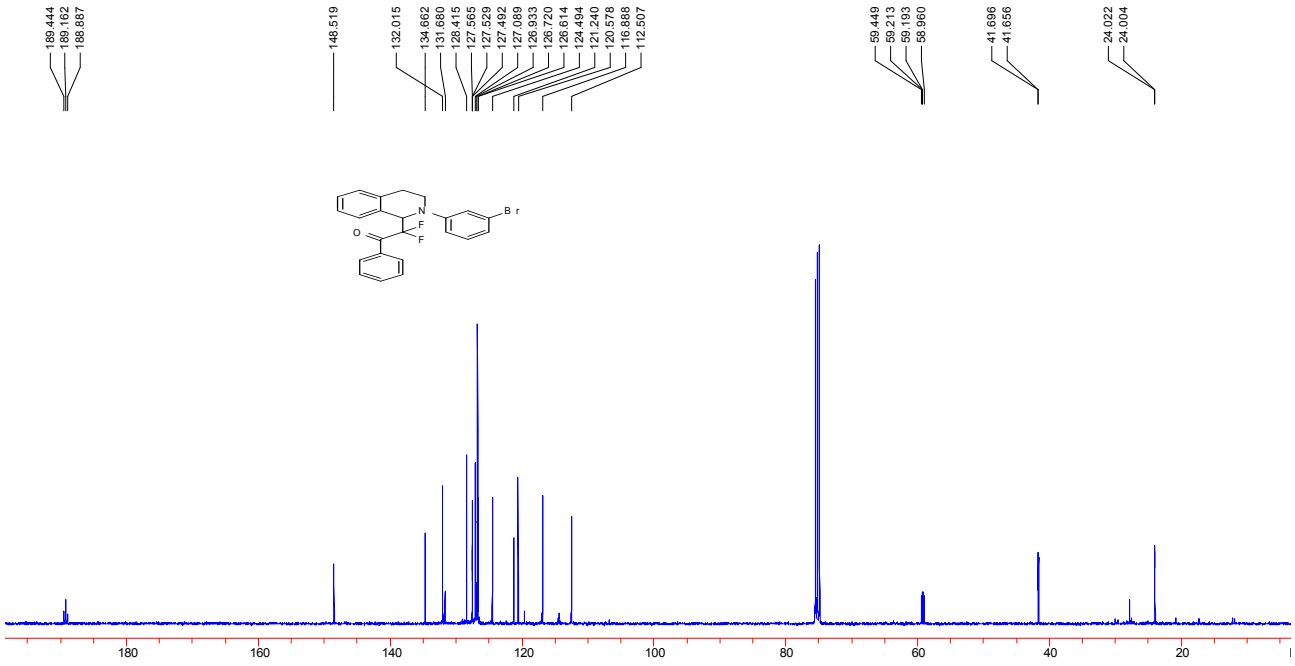




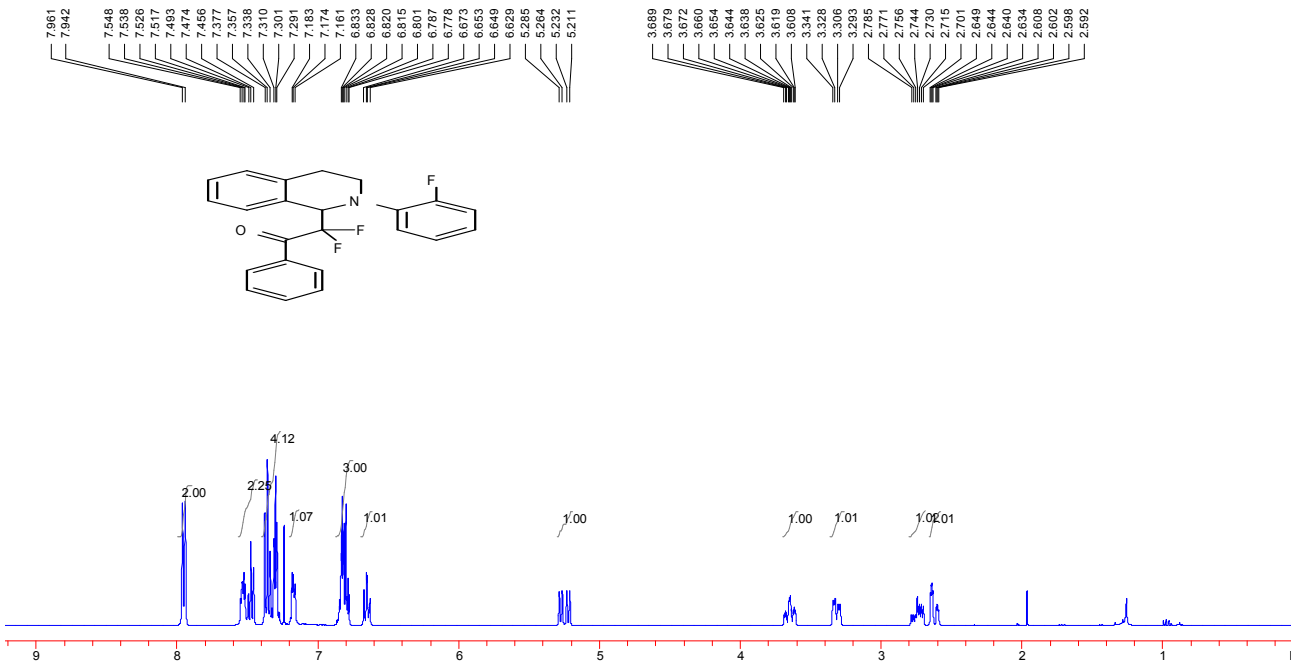


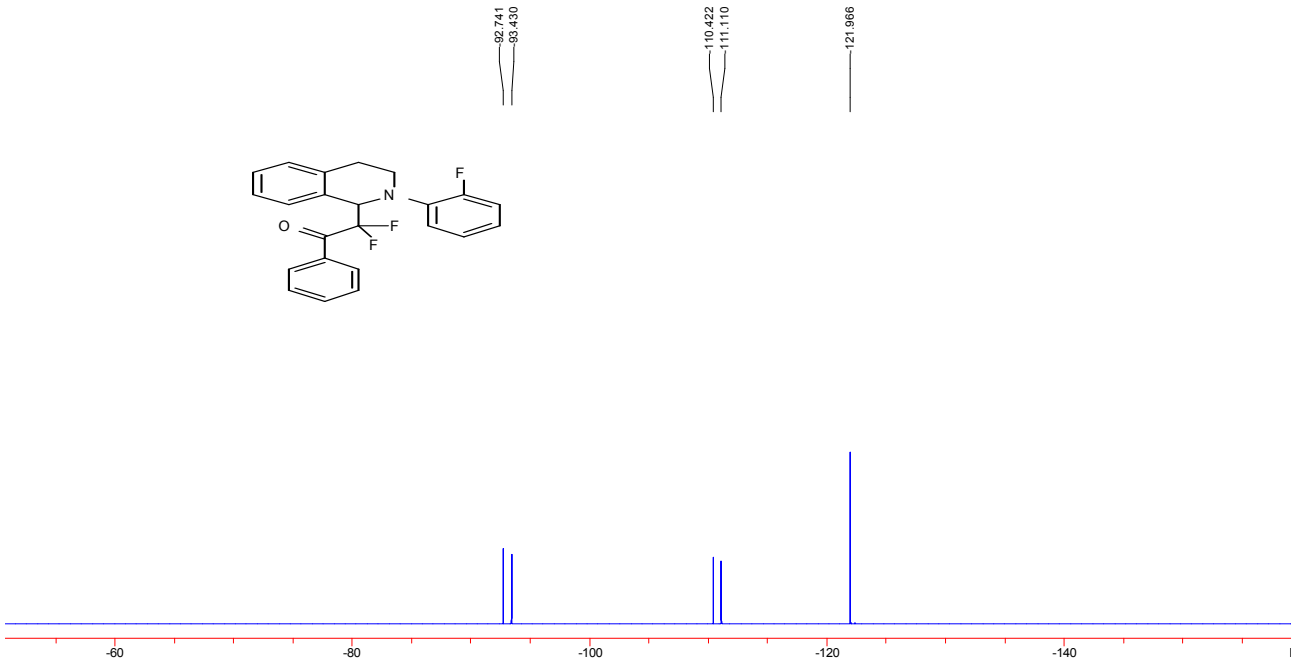






2,2-difluoro-2-(2-(2-fluorophenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(**3l**)

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F
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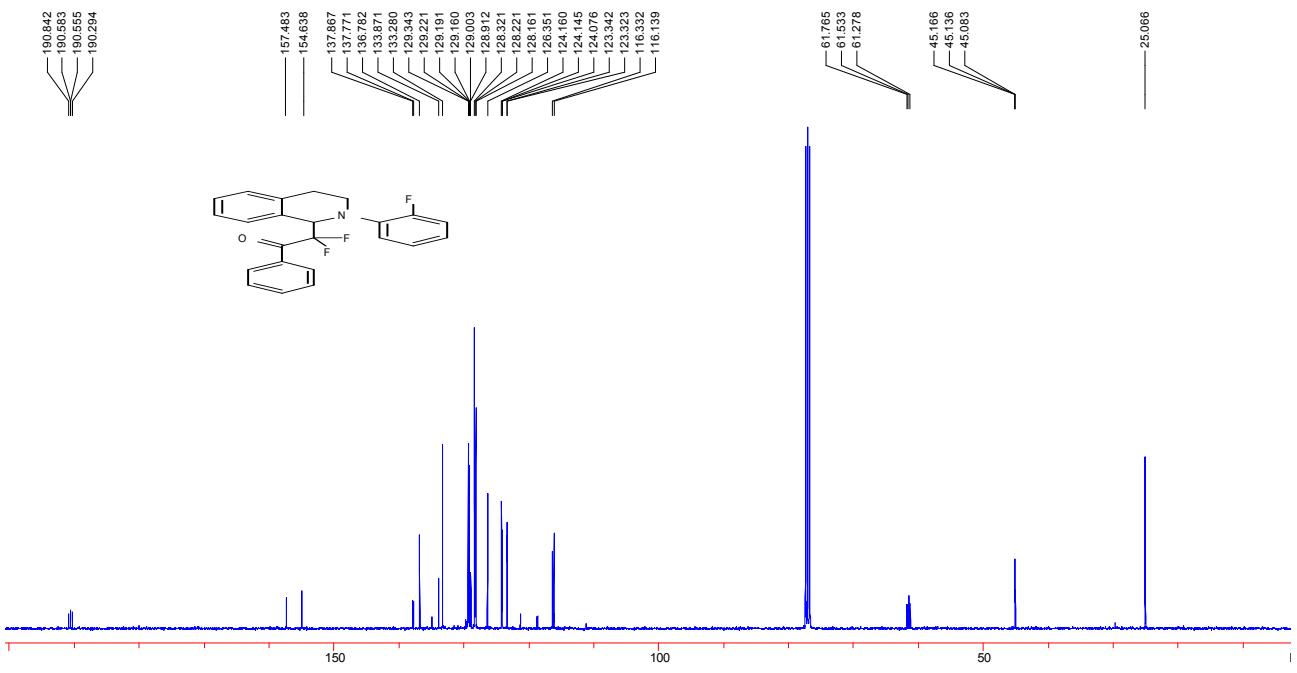
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129.221
129.191
129.160
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128.221
128.161
126.351
124.160
124.145
124.076
123.342
123.323
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116.139
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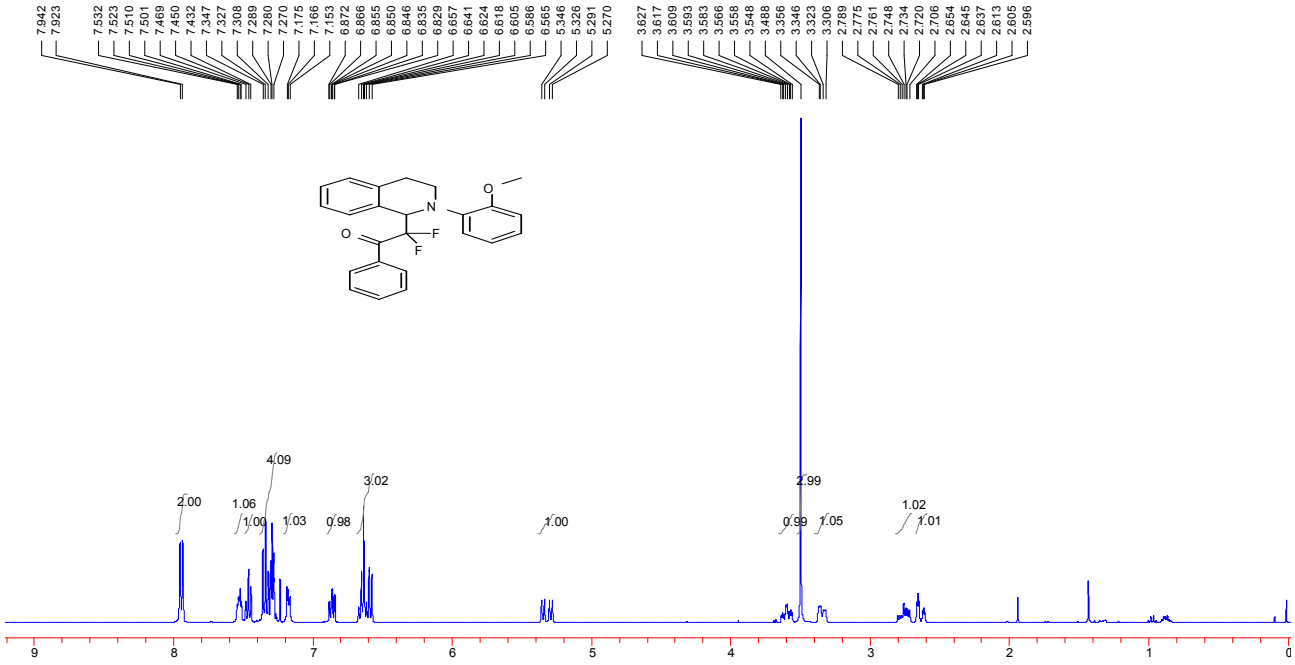
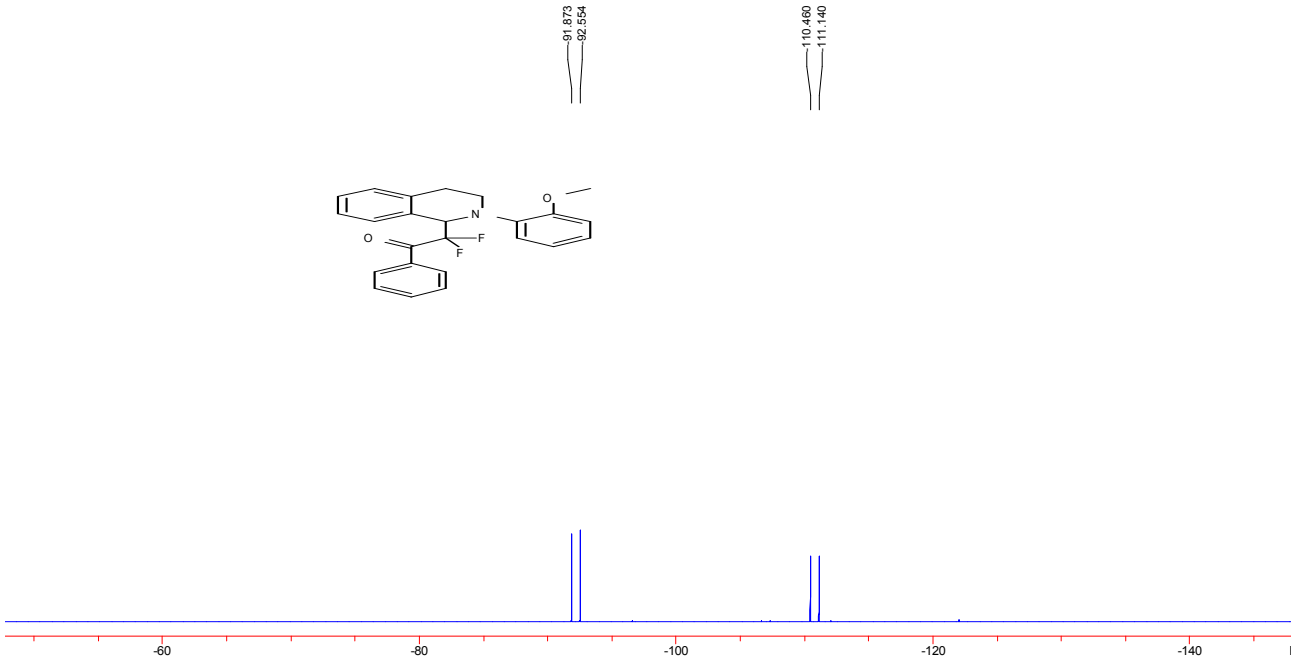
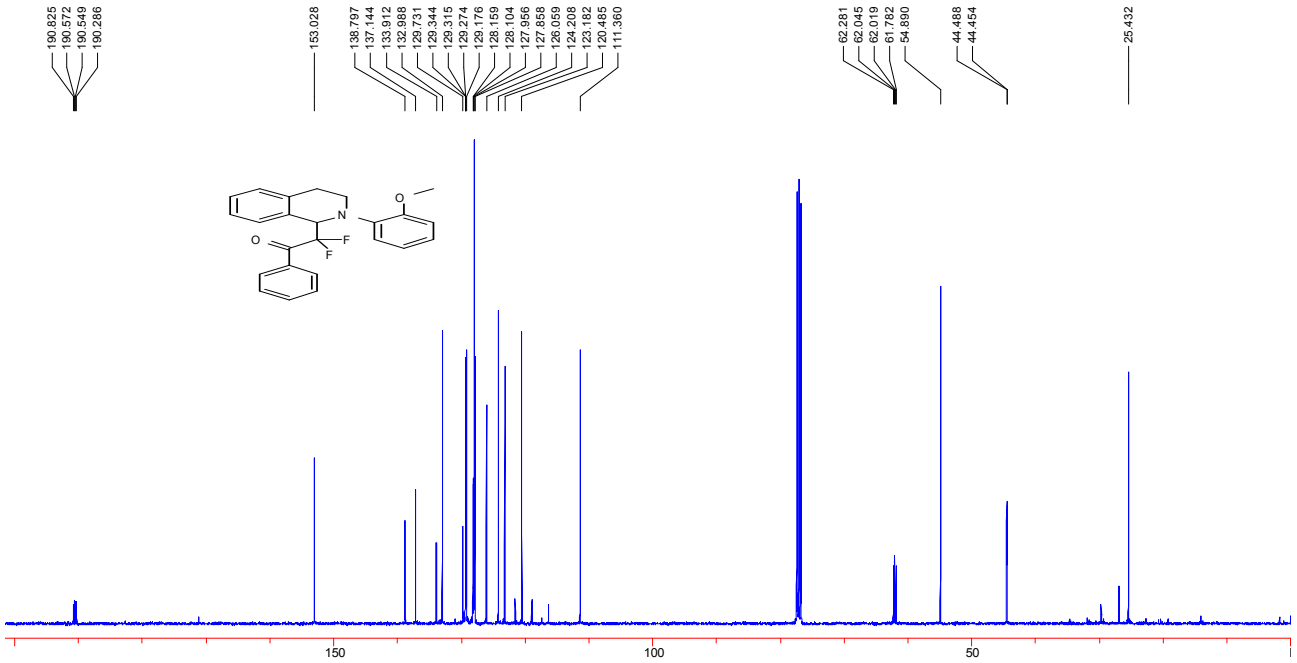
61.533
61.278
45.166
45.136
45.083
25.066
F
N
O
F
F
150
100
50

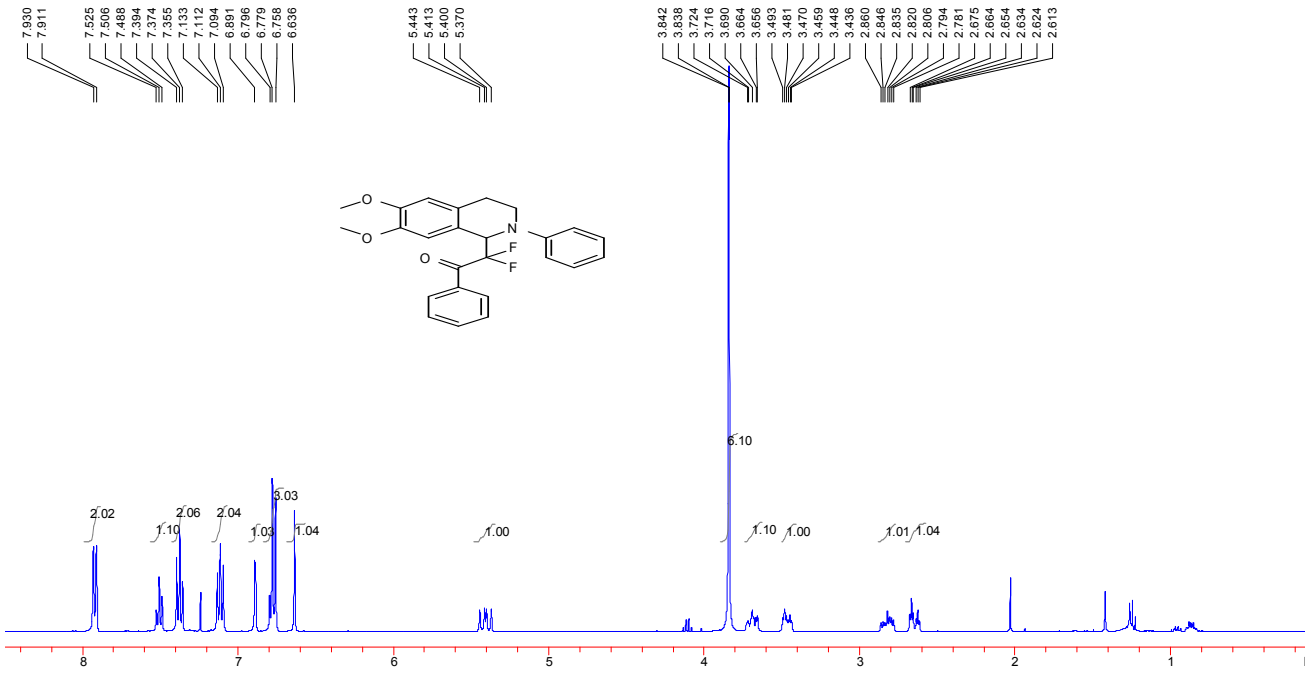
2,2-difluoro-2-(2-(2-methoxyphenyl)-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-phenylethanone(**3m**)

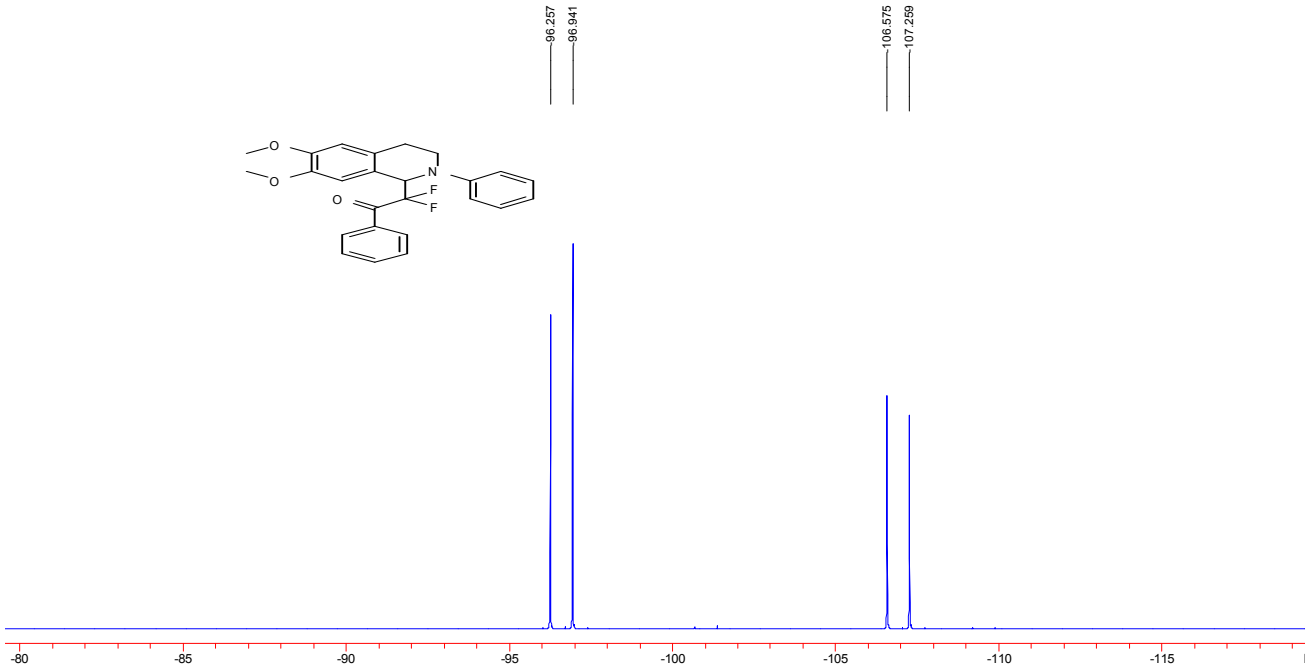






2-(6,7-dimethoxy-2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-2,2-difluoro-1-phenylethanone **(3n)**

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F
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-90
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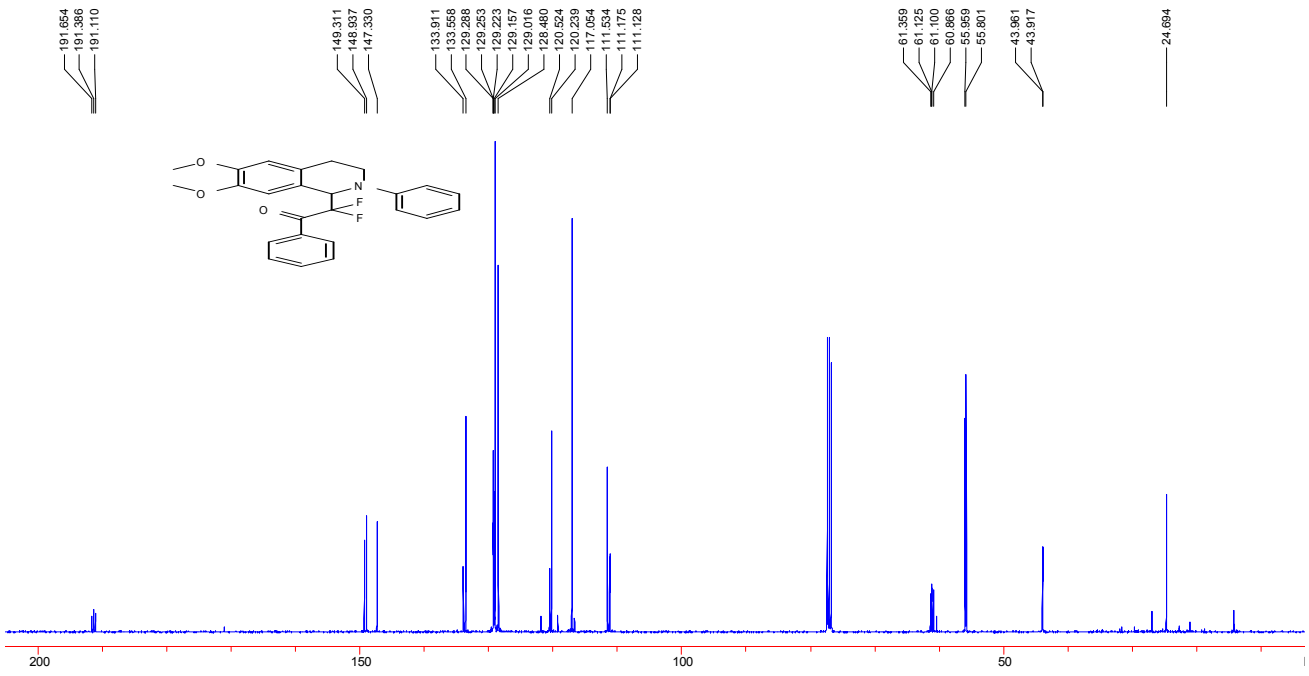
-110
-115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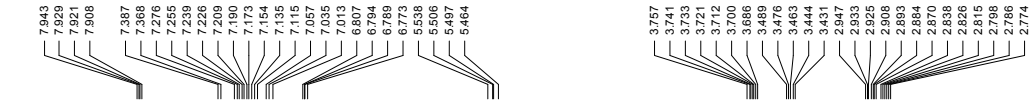
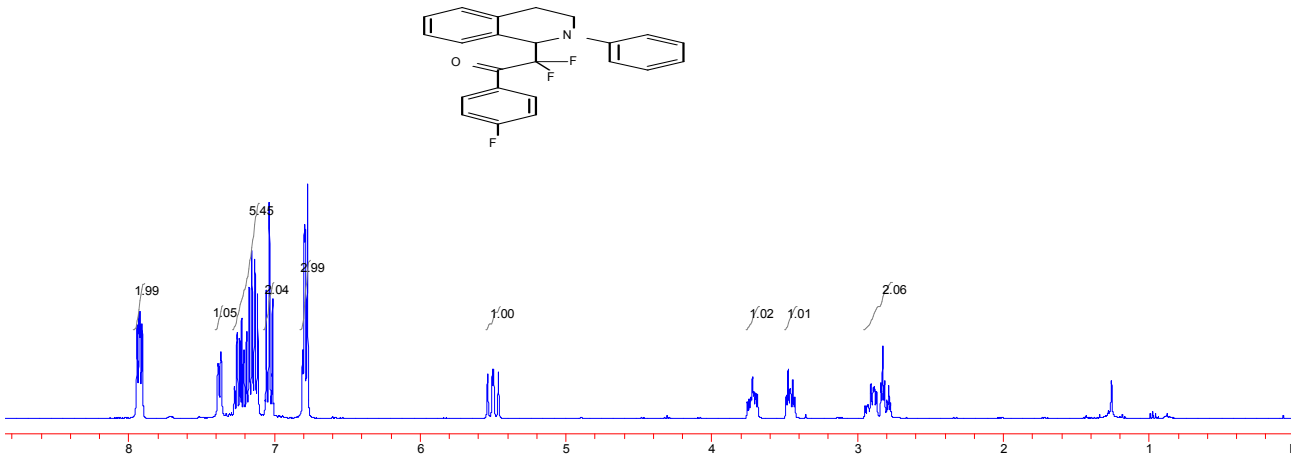
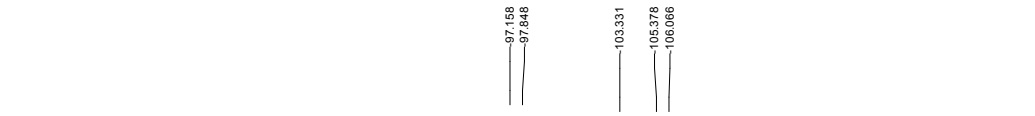
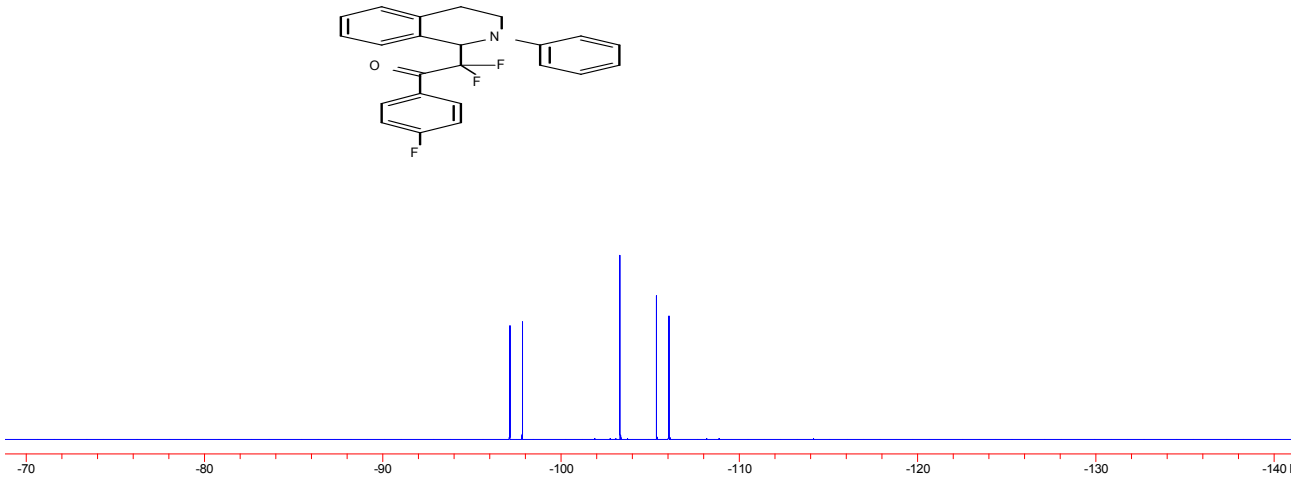
120.524
120.239
117.054
111.534
111.175
111.128
61.359
61.125
61.100
60.866
55.959
55.801
43.961
43.917
24.694
O
O
N
F
F
O
200
150
100
50

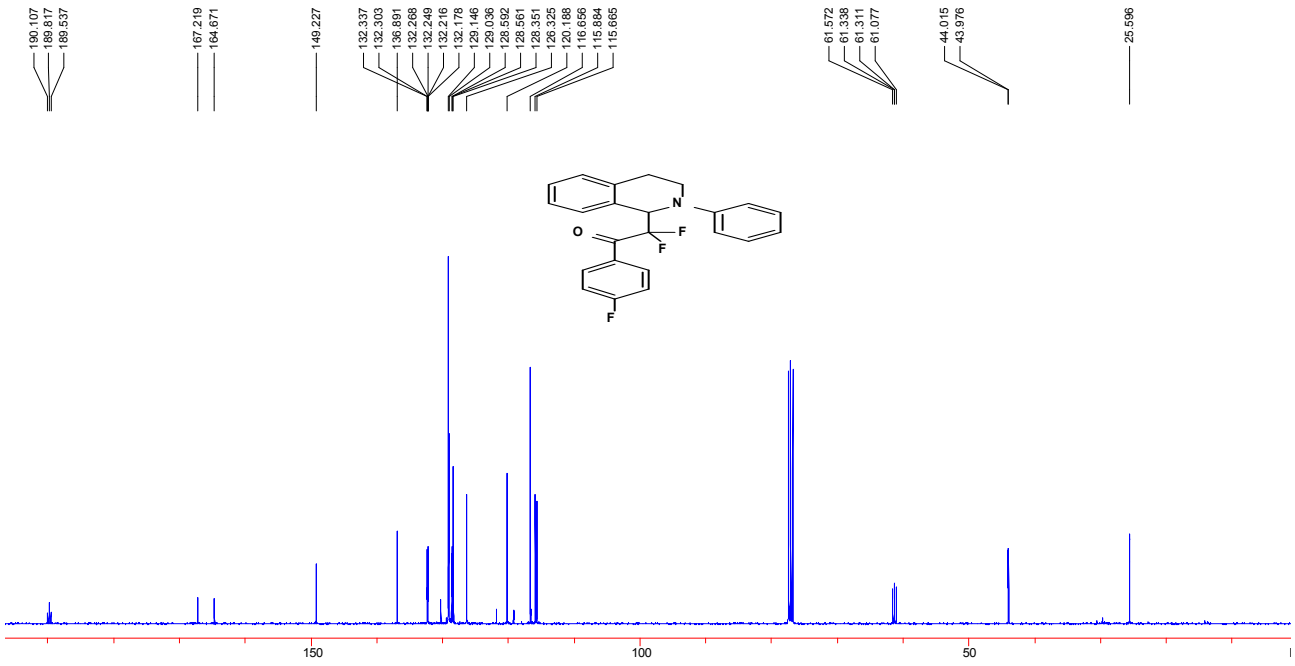
2,2-difluoro-1-(4-fluorophenyl)-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(**4b**)



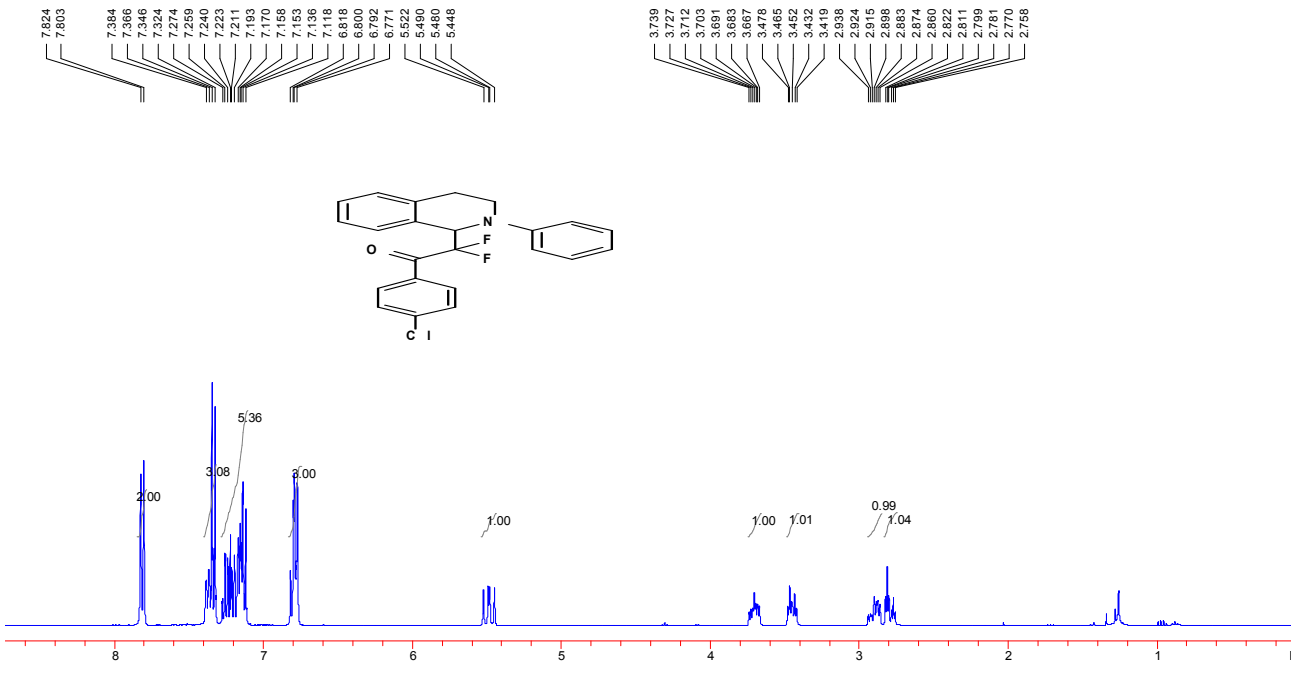


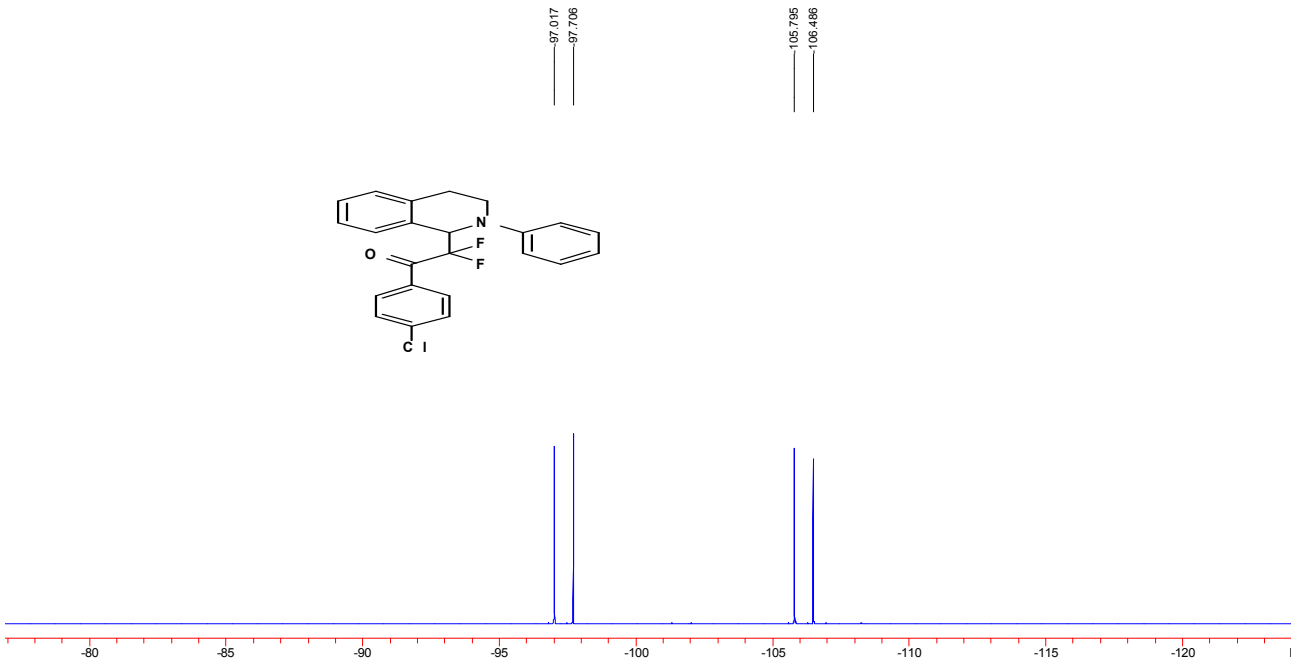


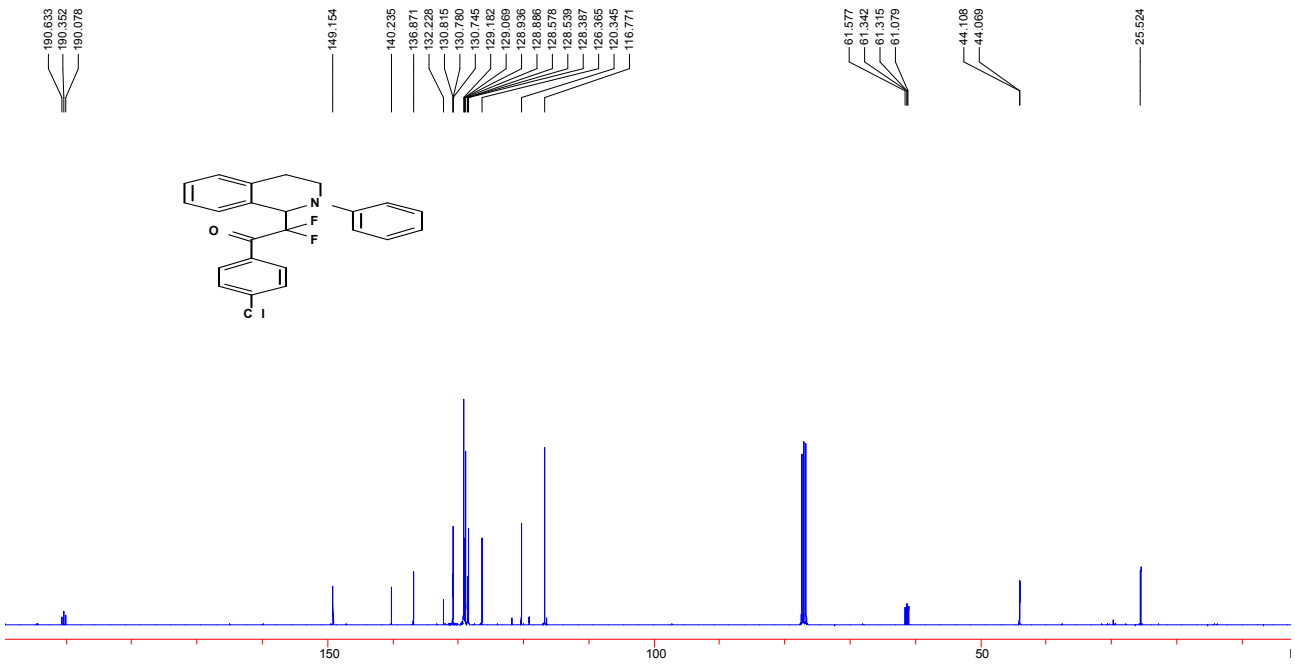




1-(4-chlorophenyl)-2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(**4c**)







1-(4-bromophenyl)-2, 2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(**4d**)


7.744
7.722
7.527
7.506
7.386
7.367
7.284
7.269
7.244
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7.203
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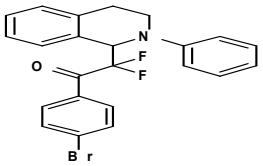
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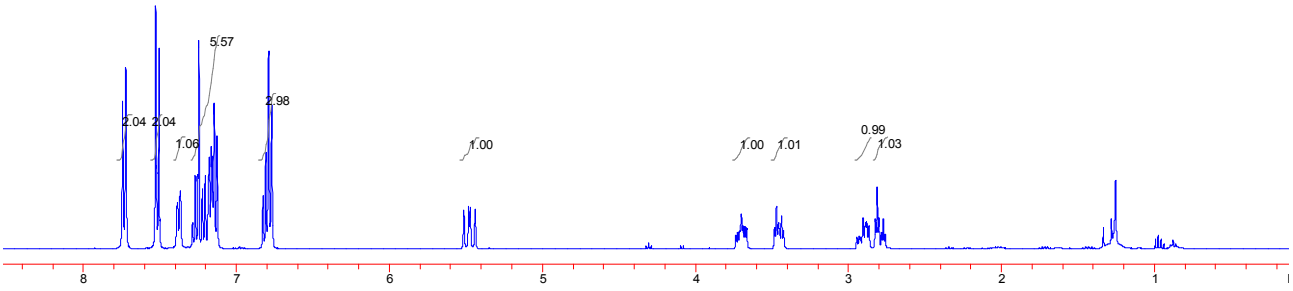
O
B r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1.00
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3
2
1


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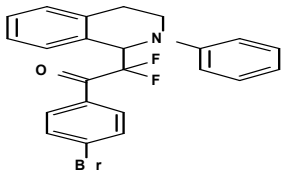
105.920
106.647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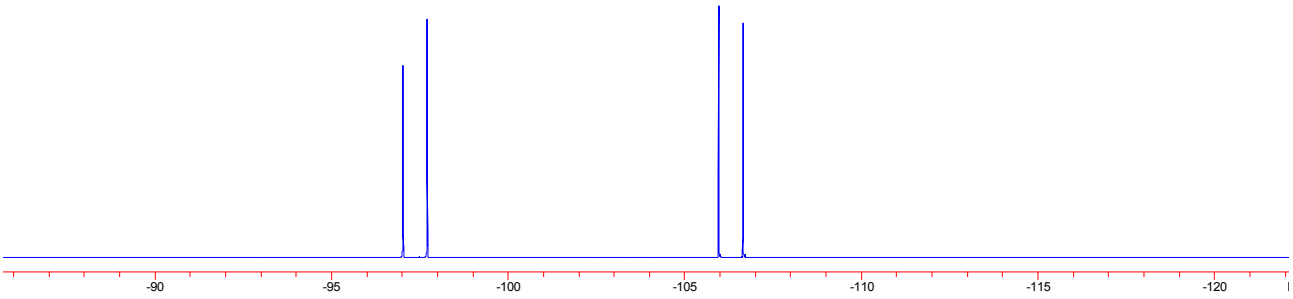
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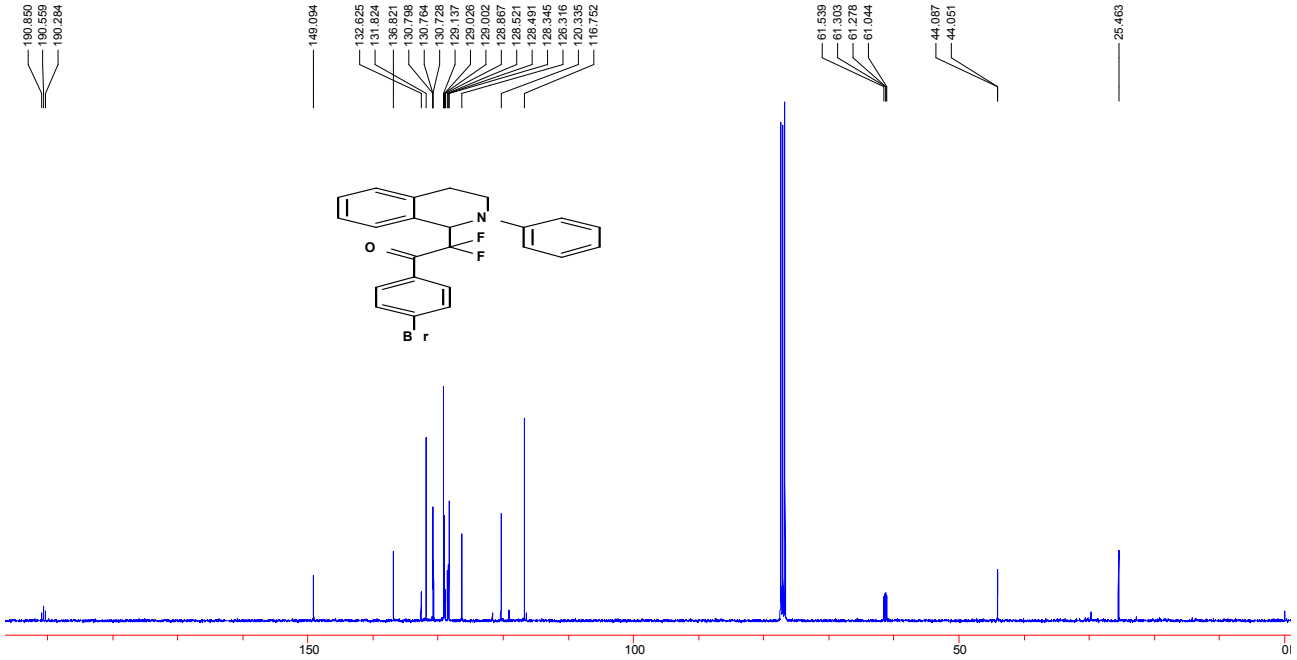
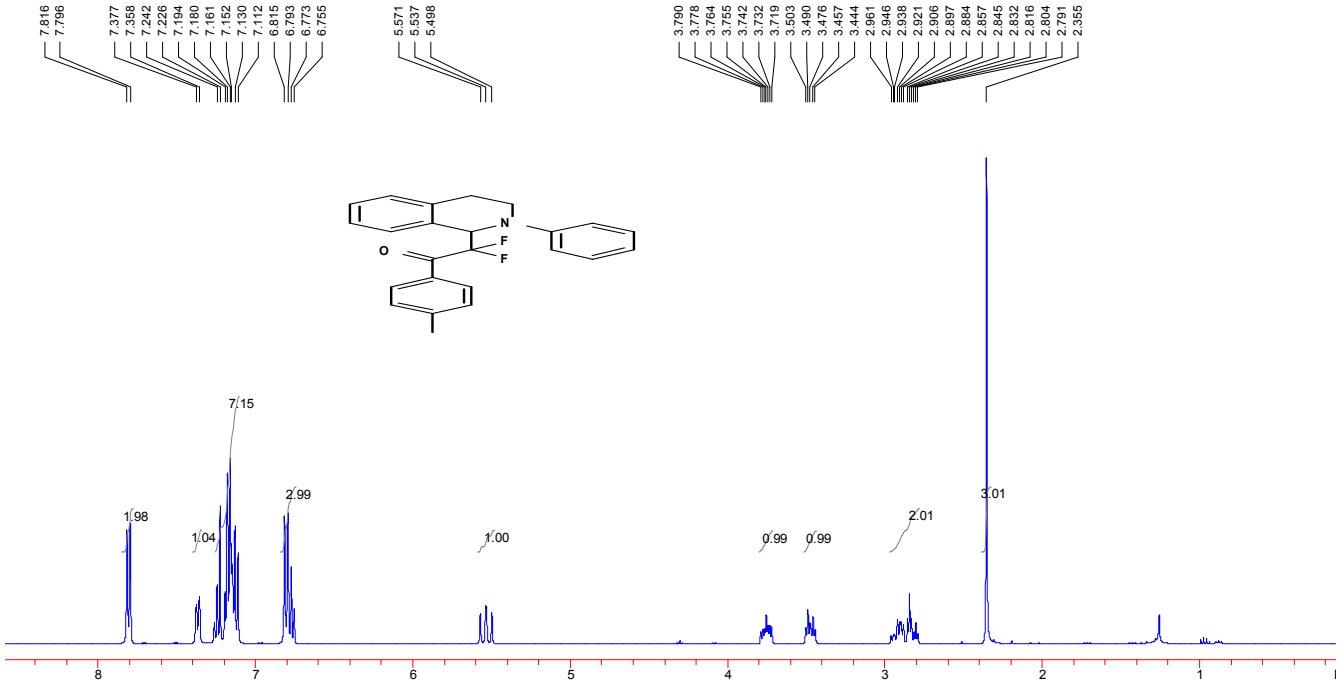
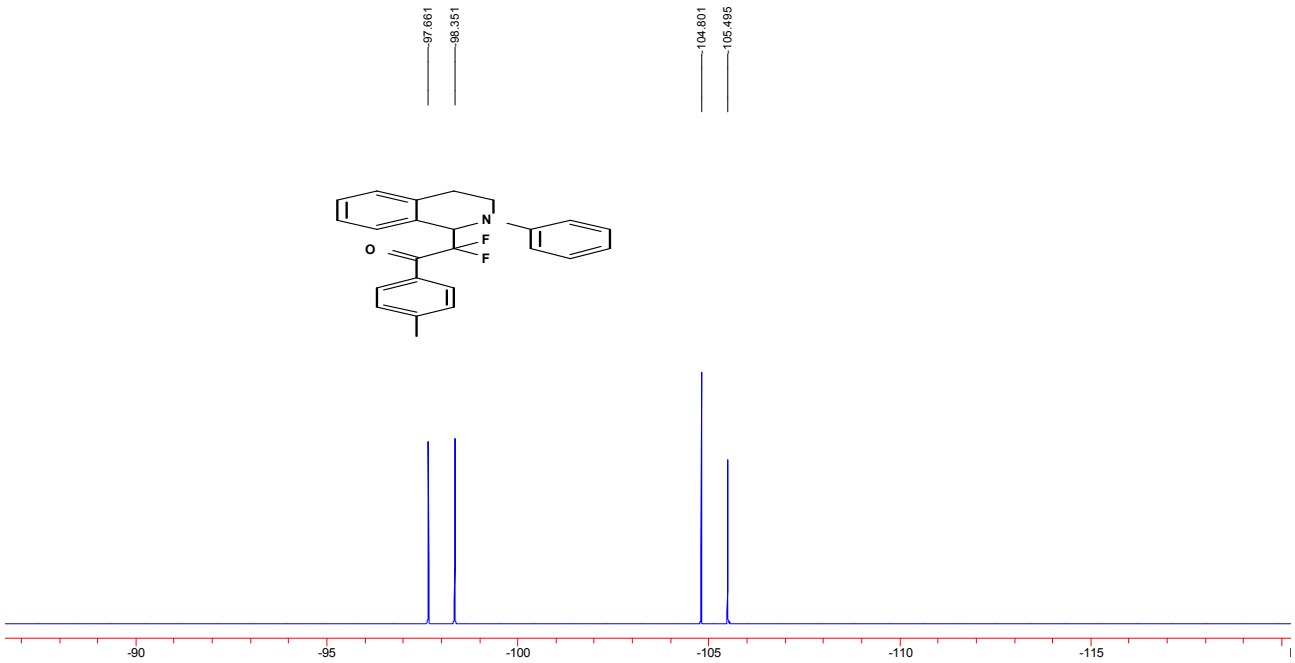


2, 2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(p-tolyl)ethanone(**4e**)

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O
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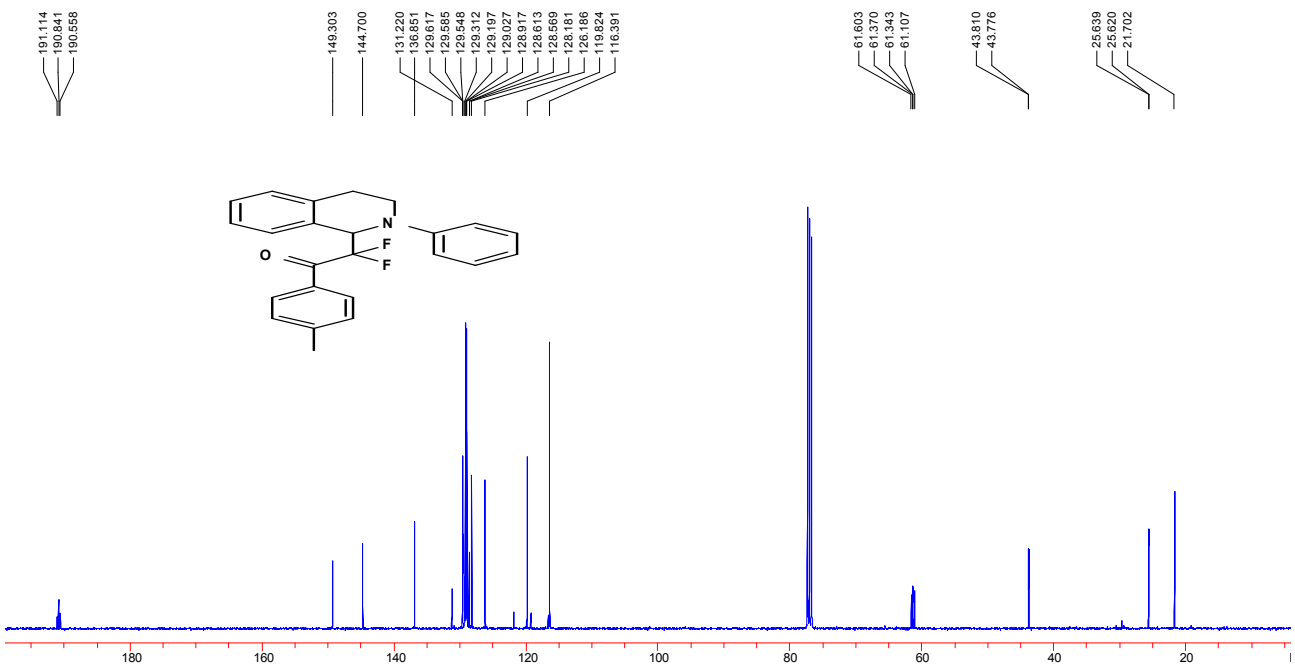
-95
-100
-105
-110
-115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116.391
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61.343
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25.639
25.620
21.702
N
F
F
O
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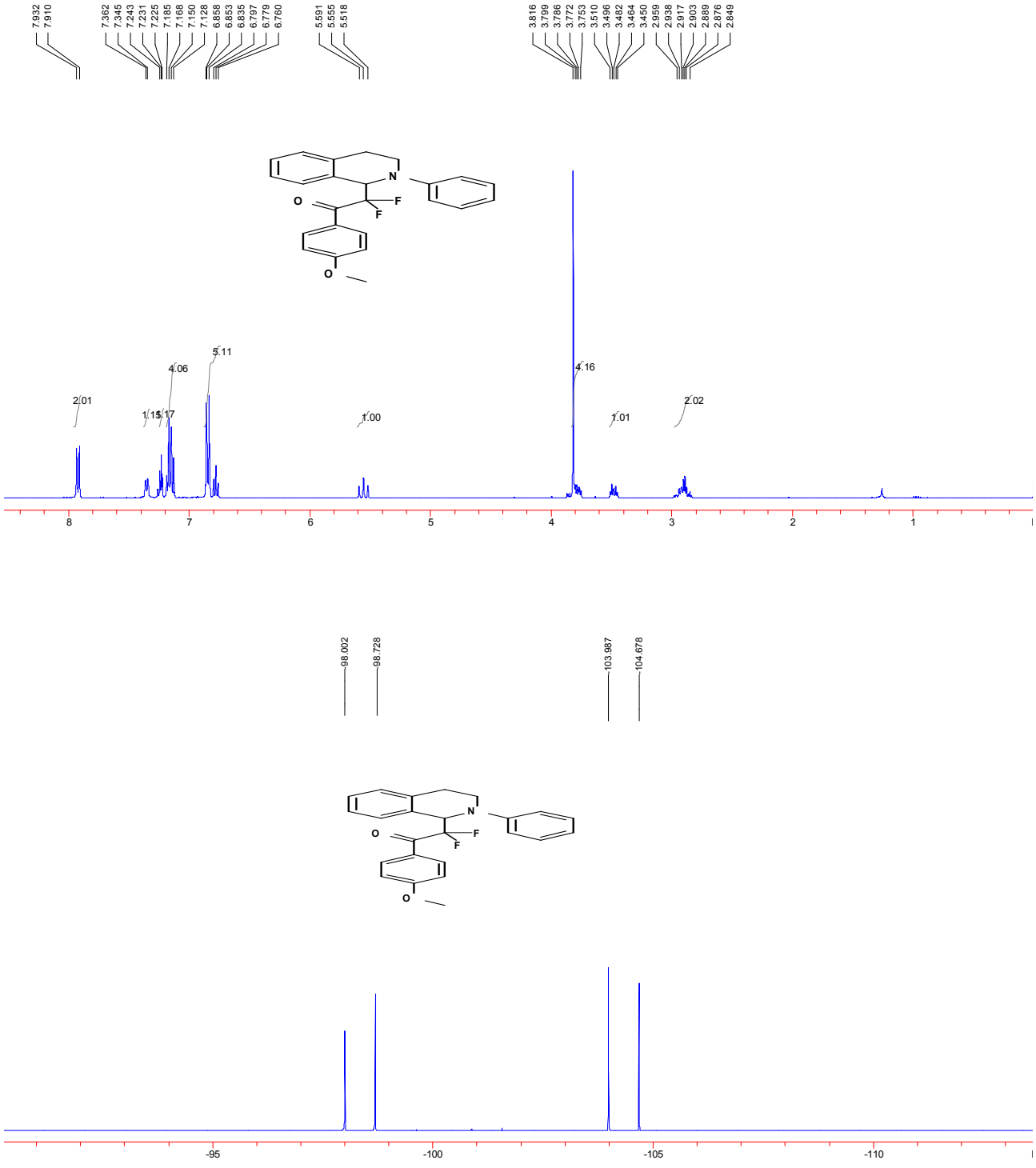
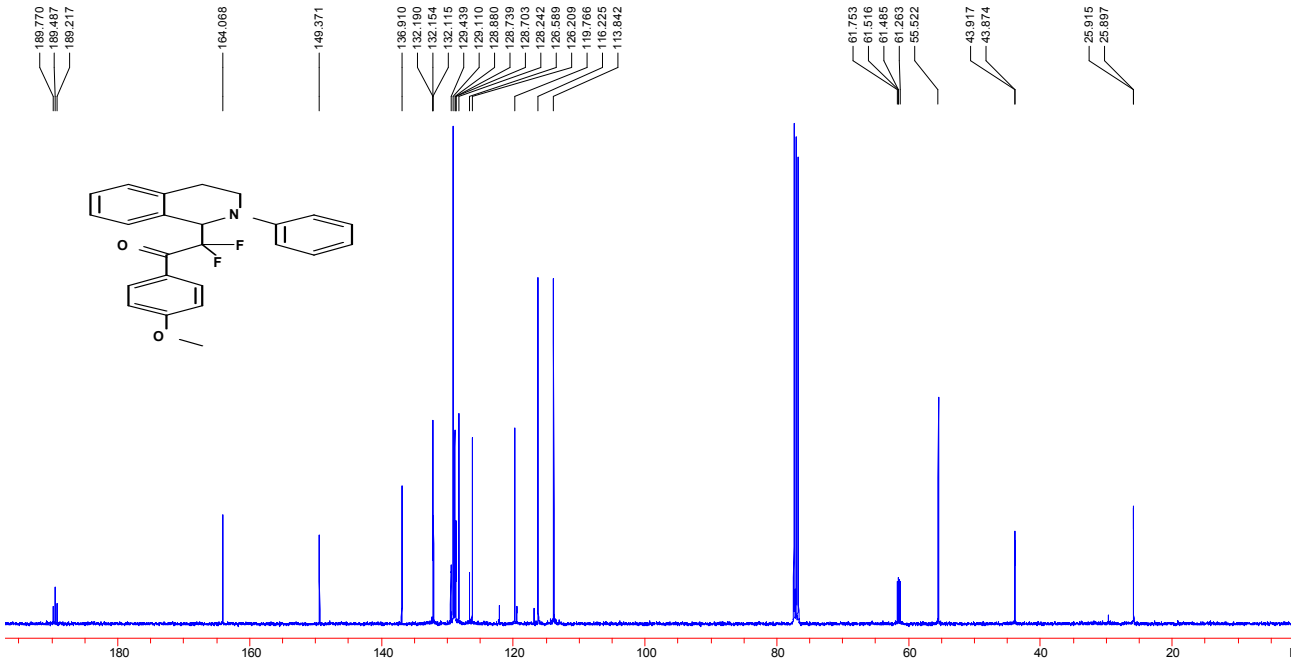
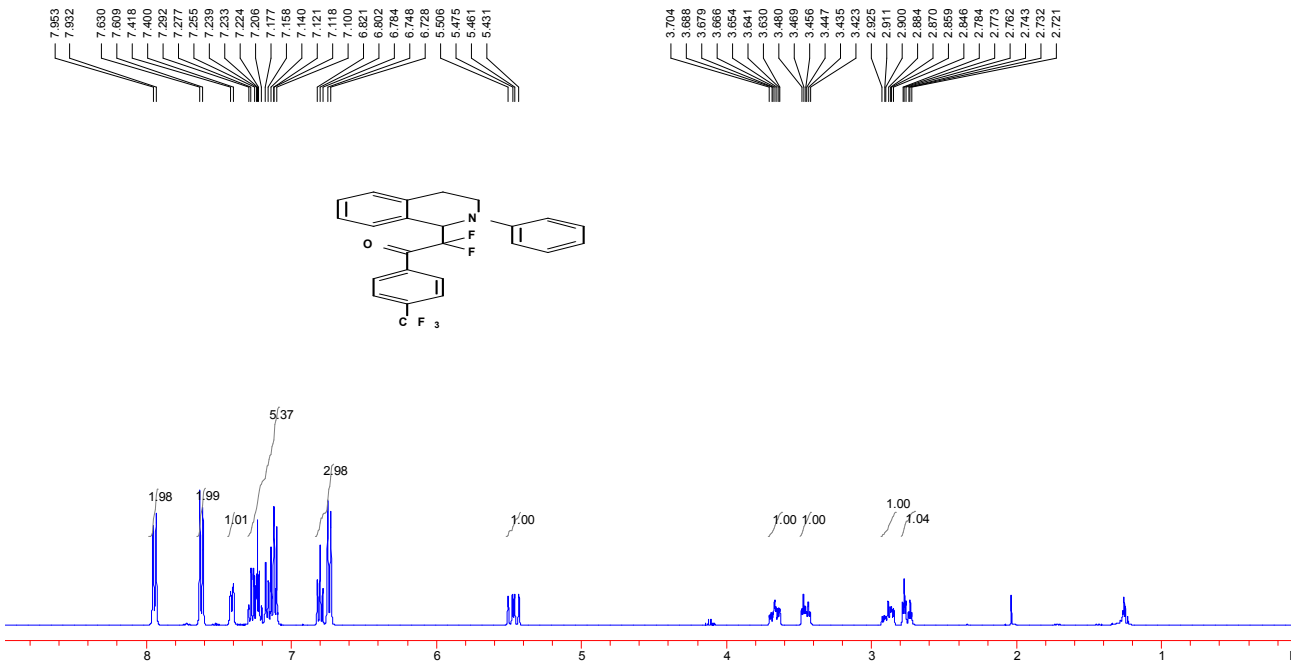
140
120
100
80
60
40
20

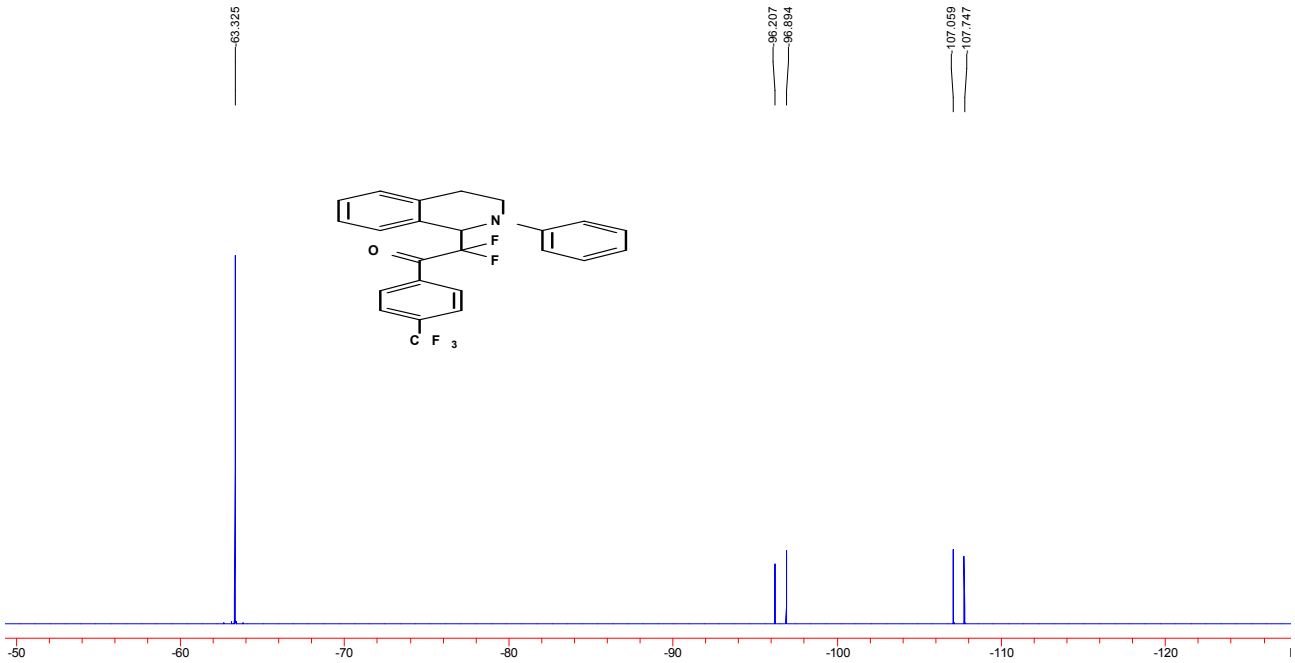
2, 2-difluoro-1-(4-methoxyphenyl)-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(**4f**)





2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(4-(trifluoromethyl)phenyl)ethanone(**4g**)

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O
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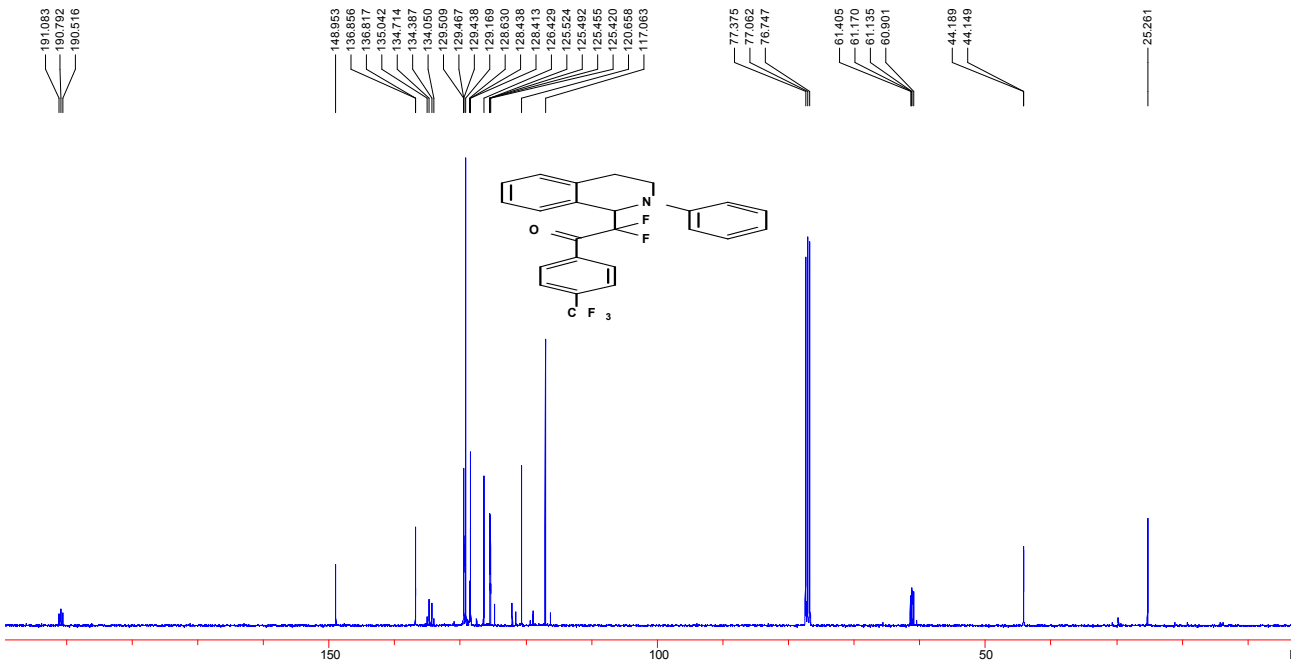
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125.420
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61.135
60.901
44.189
44.149
25.261
N
F
F
O
C F 3
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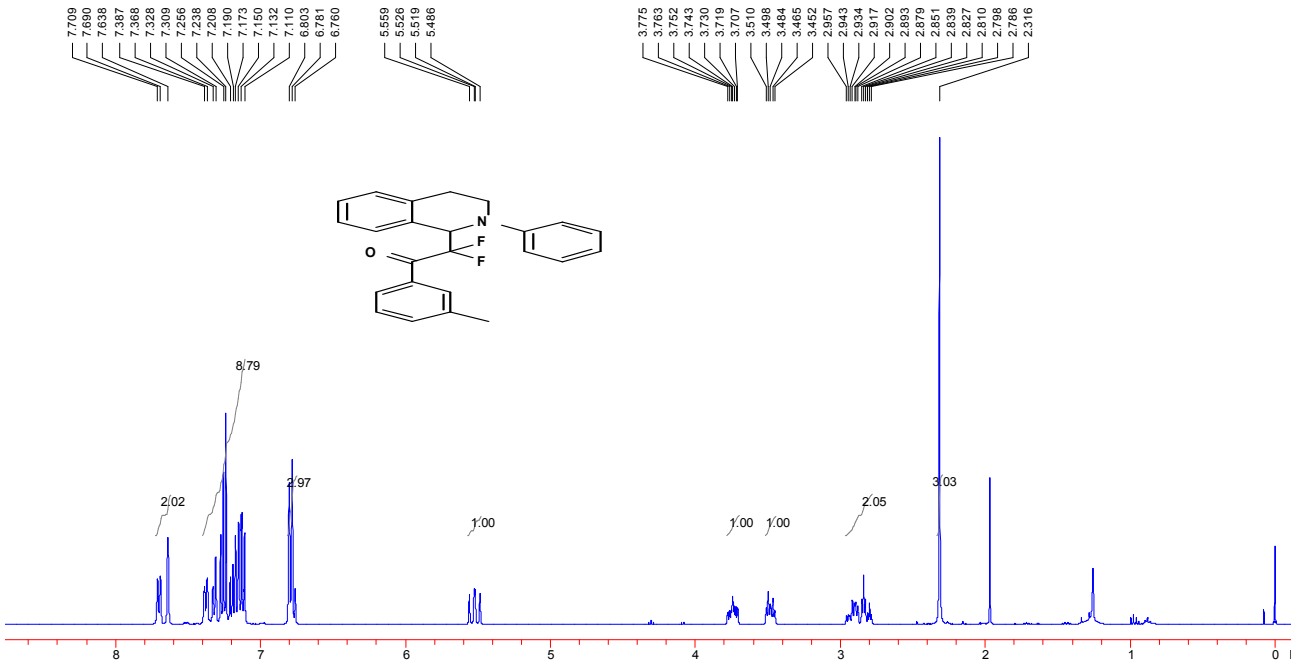
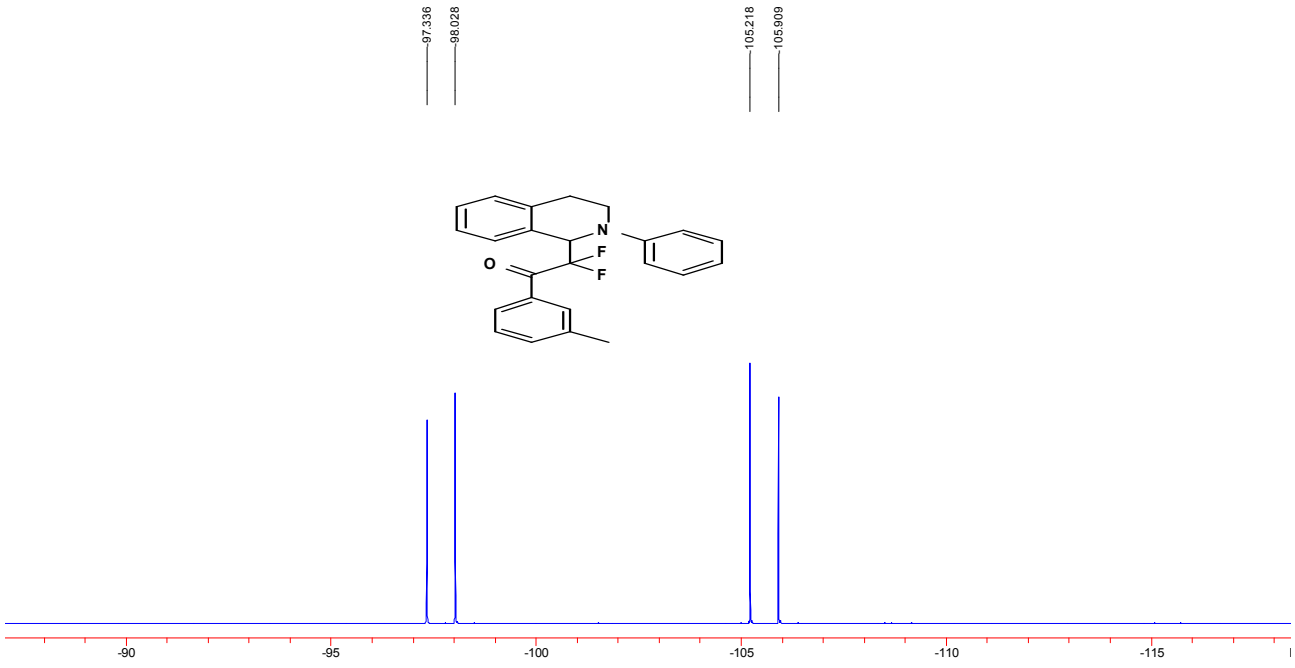
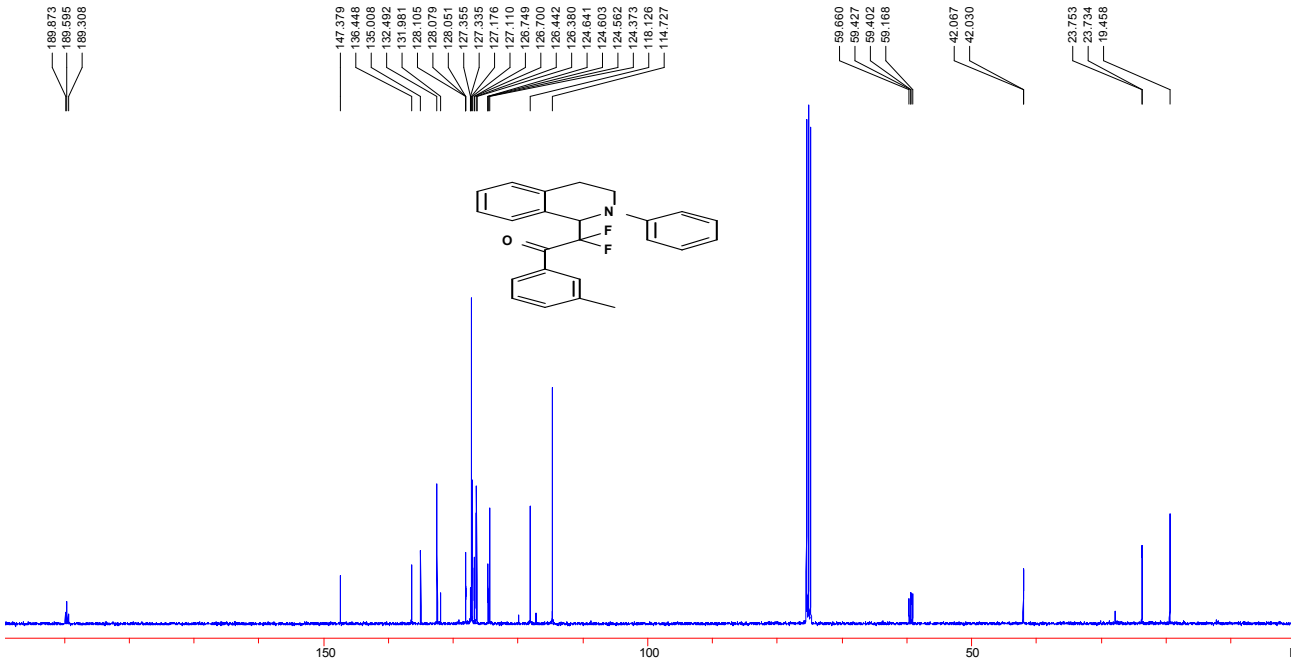
100
50

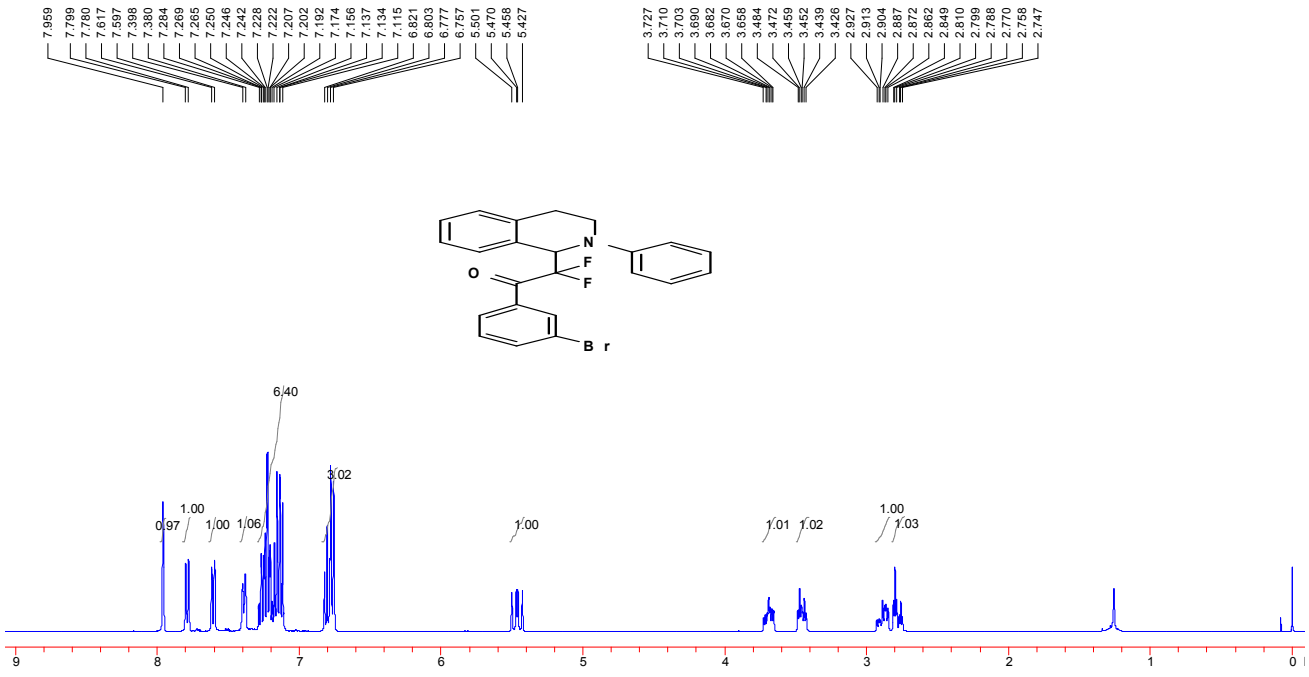
2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(m-tolyl)ethanone(**4h**)

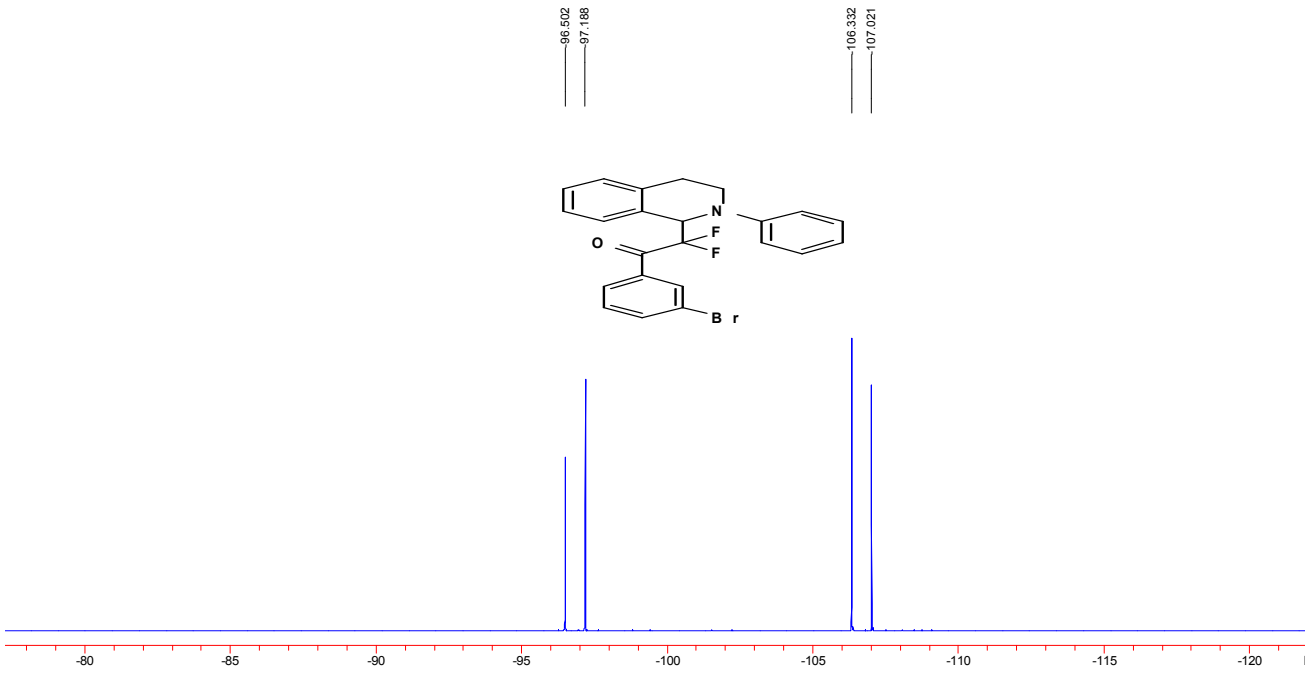


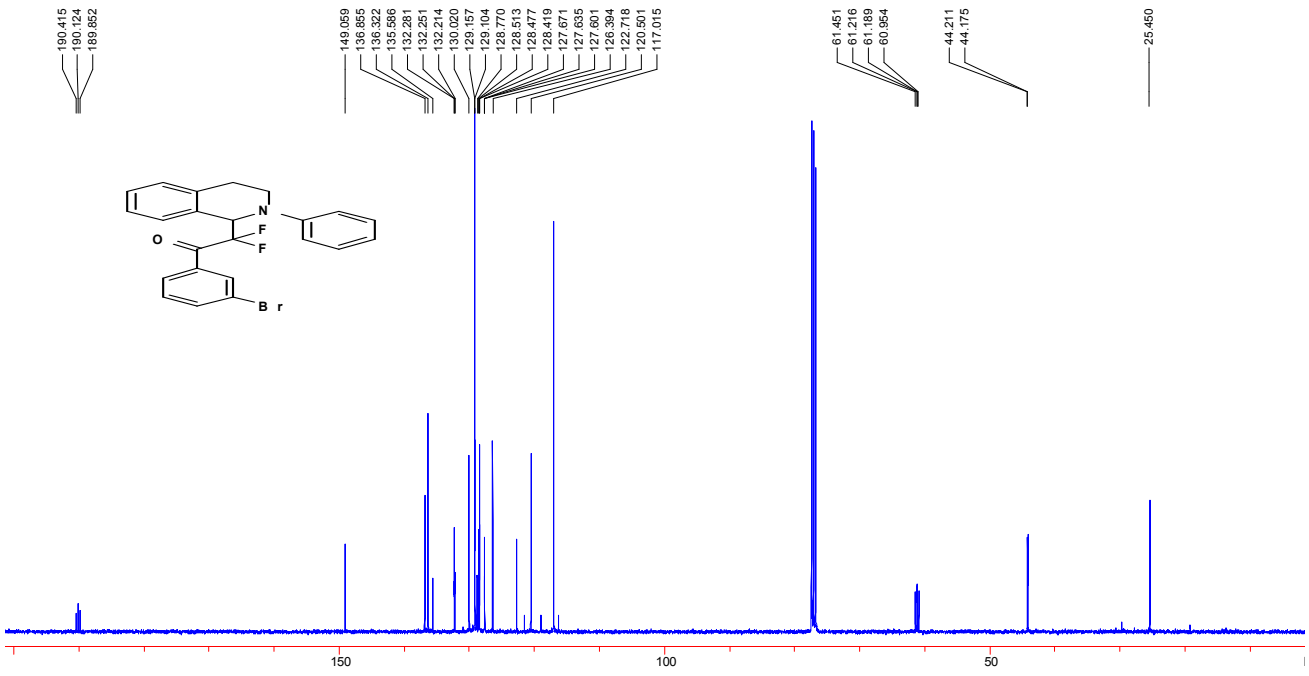




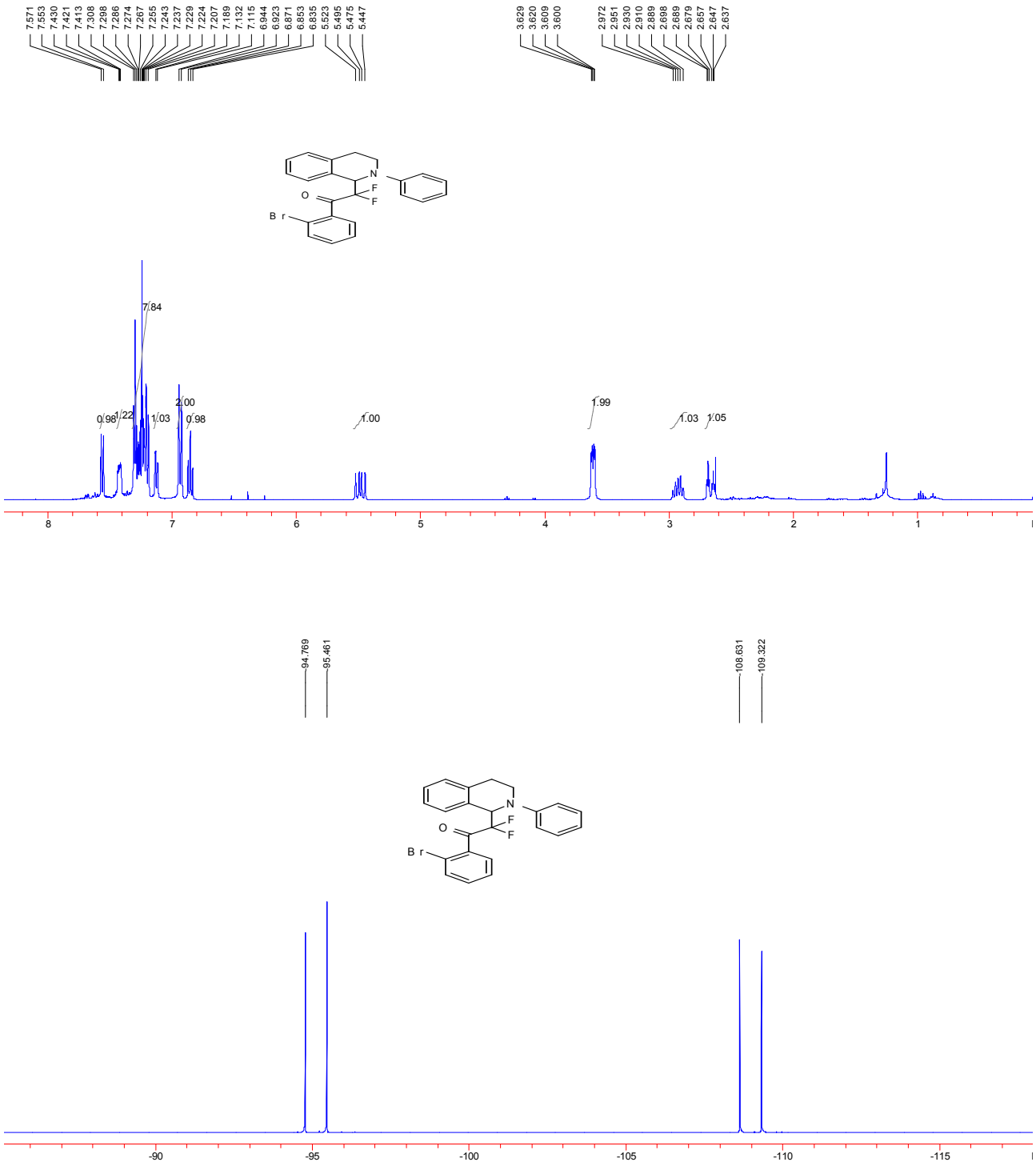
1-(3-bromophenyl)-2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone (**4i**)

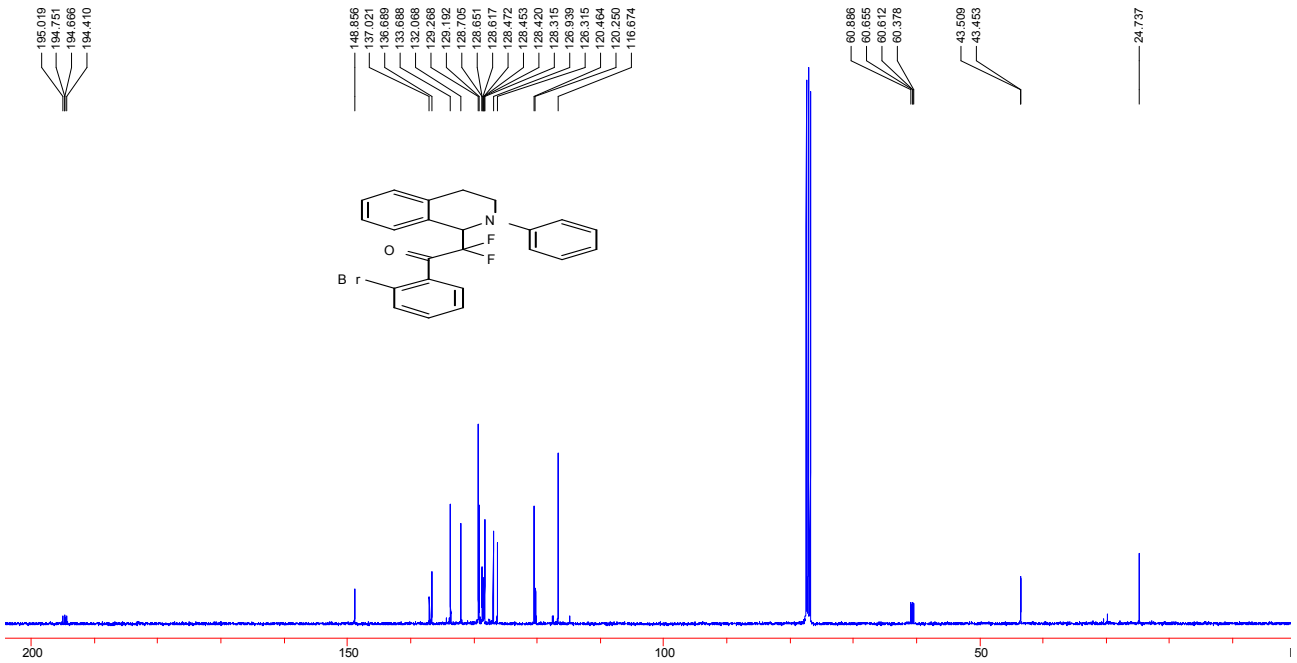



-96.502
-97.188
-106.332
-107.021
N
F
F
O
Br
-80
-85
-90
-95
-100
-105
-110
-115
-120

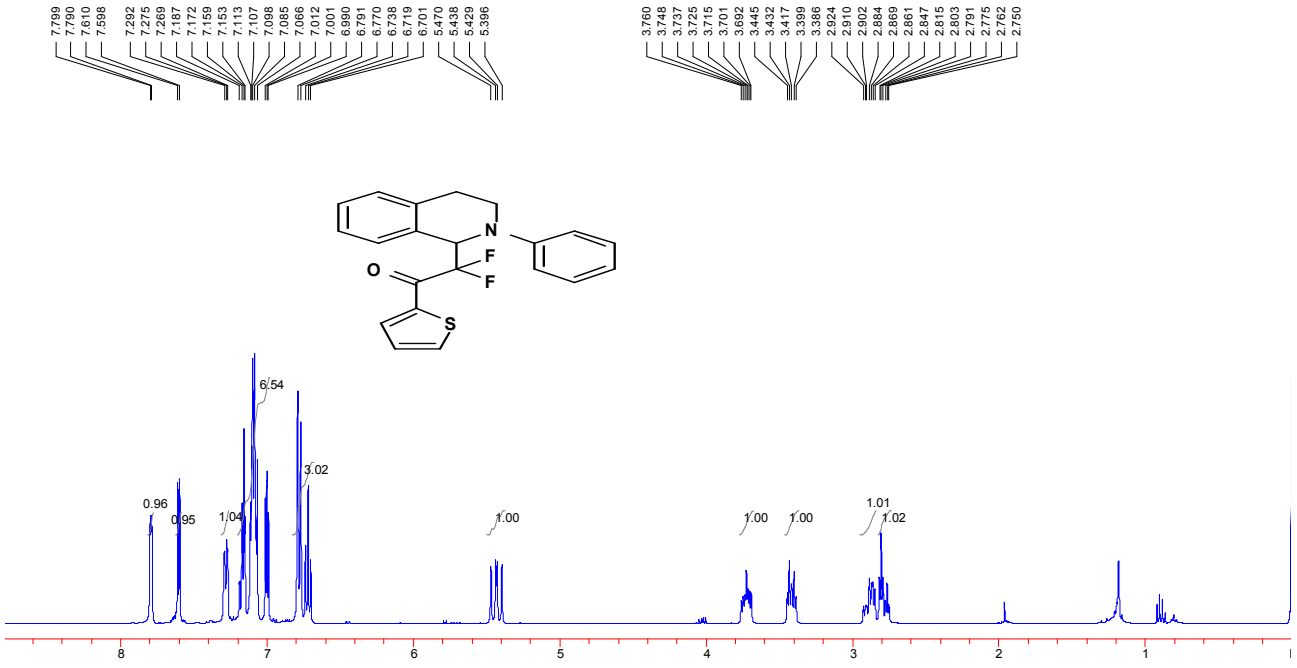

190.415
190.124
189.852
149.059
136.855
136.322
135.586
132.281
132.251
132.214
130.020
129.157
129.104
128.770
128.513
128.477
128.419
127.671
127.635
127.601
126.394
122.718
120.501
117.015
61.451
61.216
61.189
60.954
44.211
44.175
25.450
N
F
F
O
Br
150
100
50

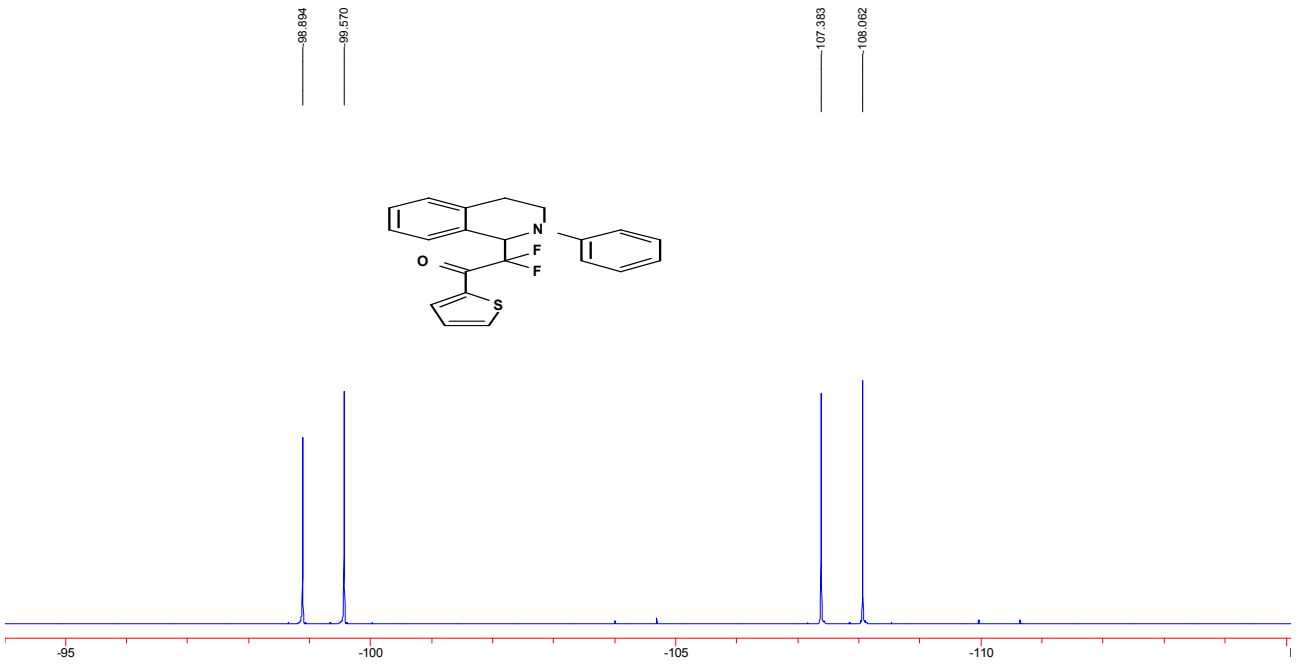
1-(2-bromophenyl)-2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone**(4j)**

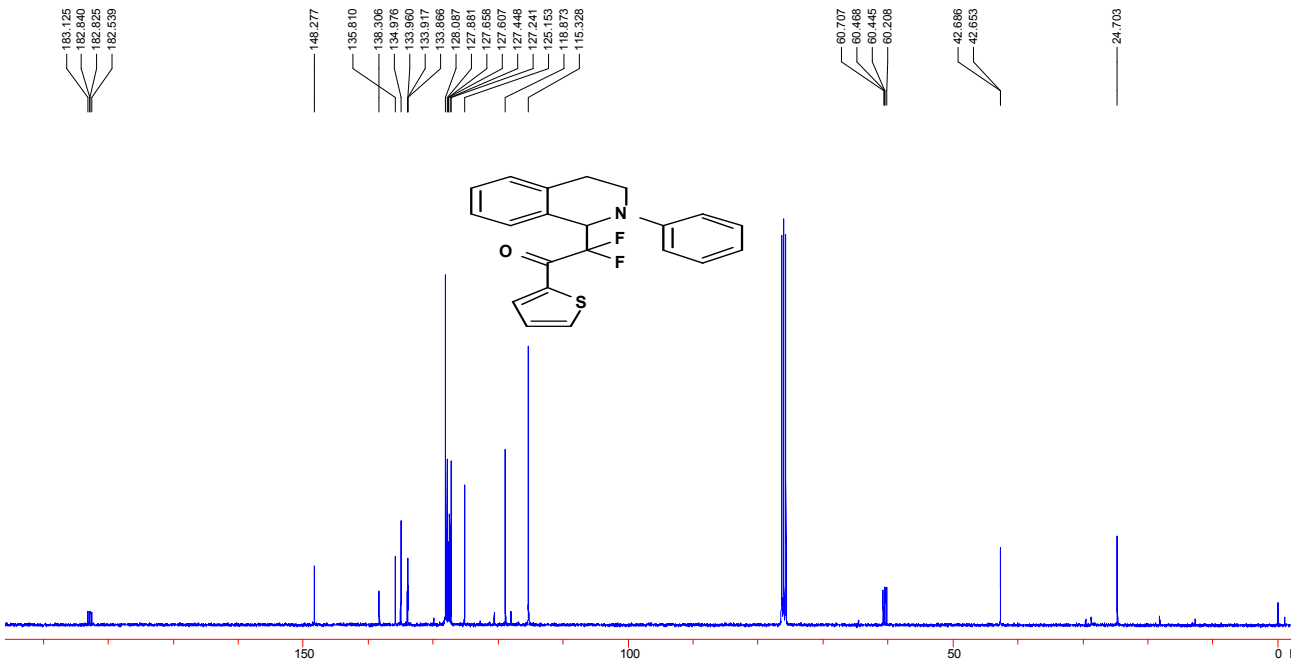




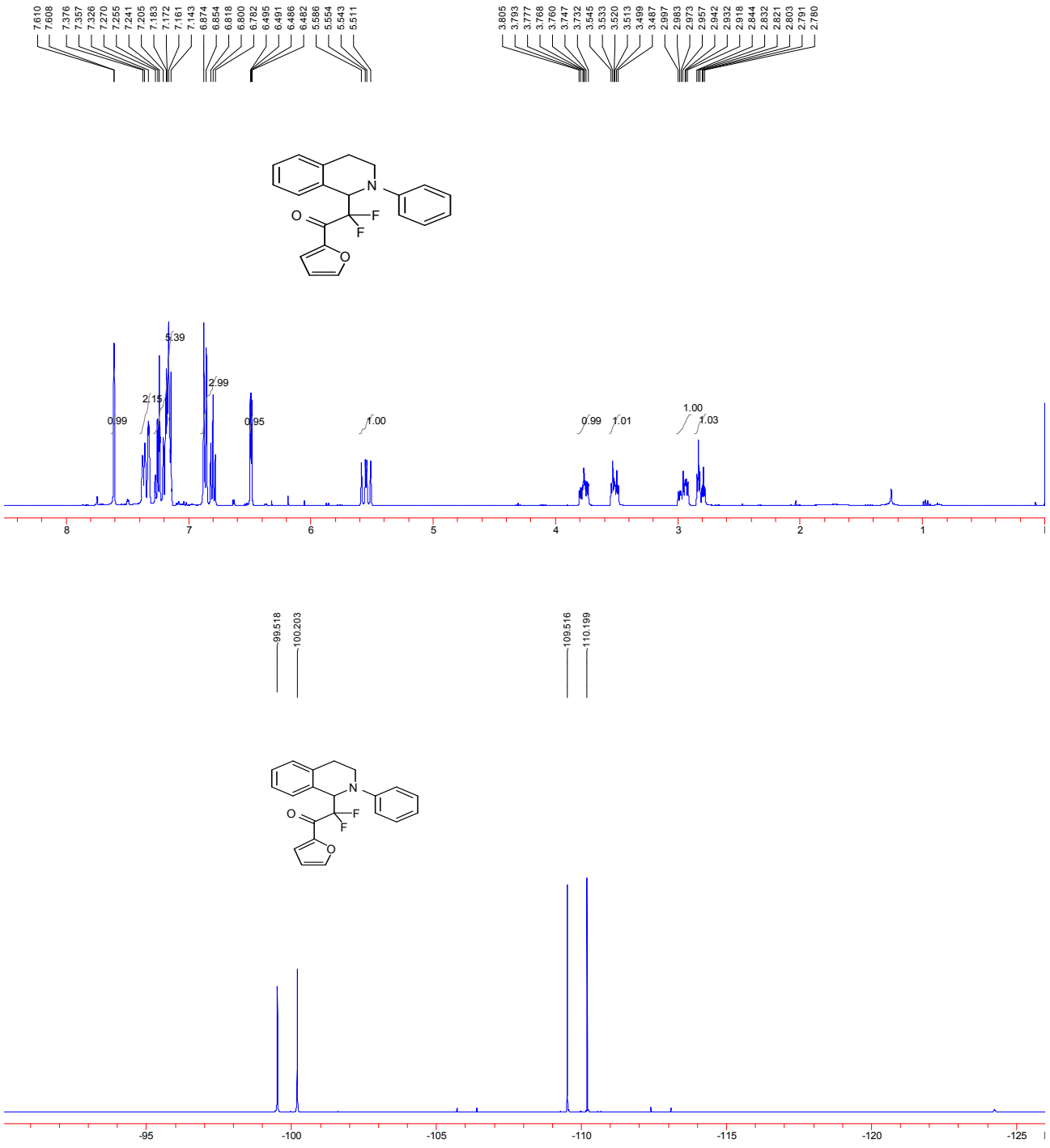
2,2-difluoro-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)-1-(thiophen-2-yl)ethanone(**4k**)

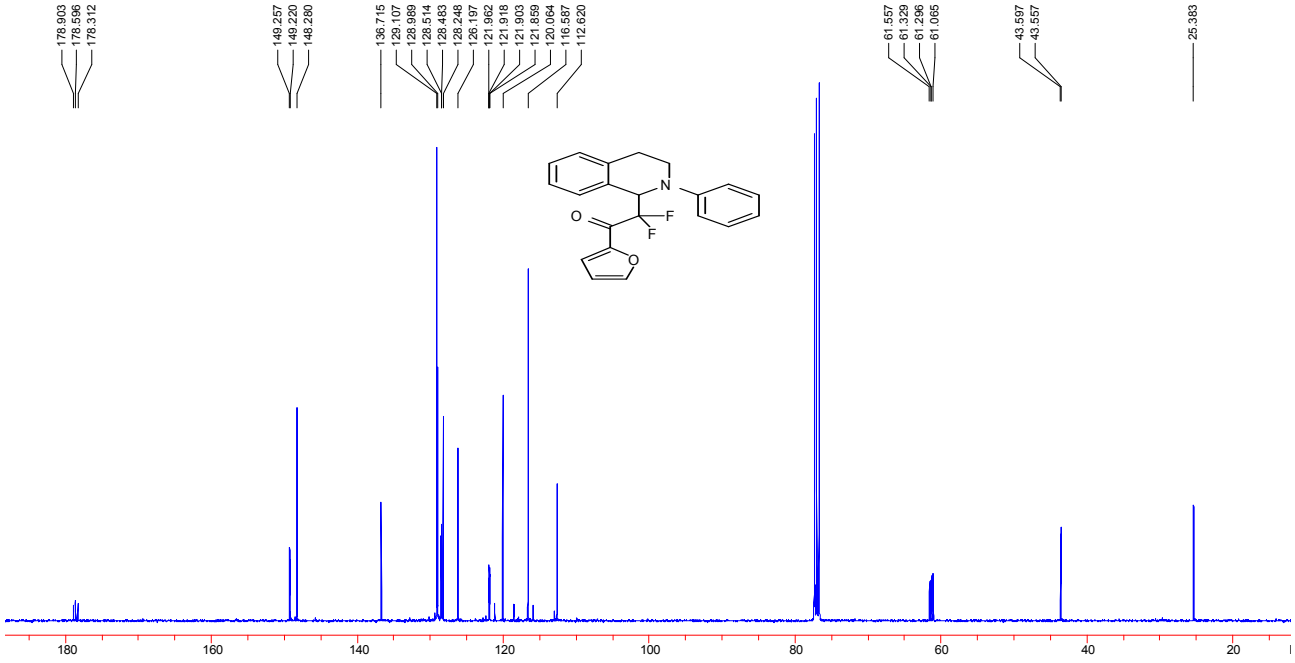



98.894
99.570
107.383
108.062
N
F
F
O
S
-95
-100
-105
-110

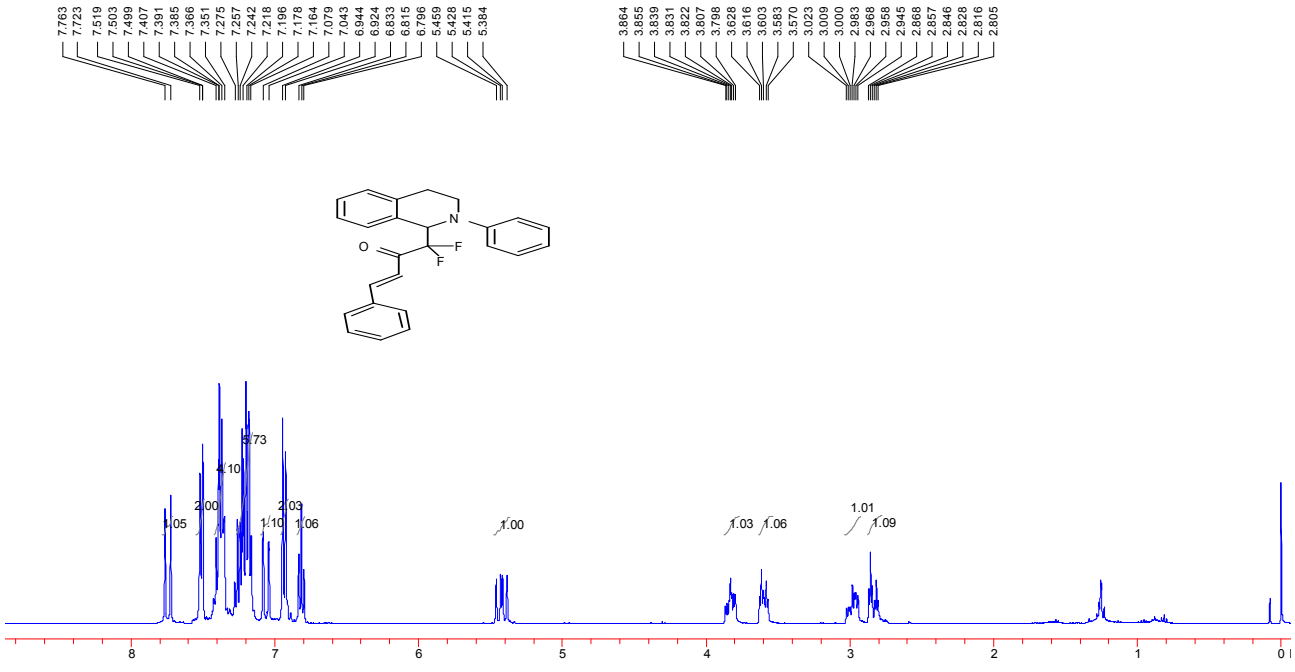

183.125
182.840
182.825
182.539
148.277
135.810
138.306
134.976
133.960
133.917
133.866
128.087
127.881
127.658
127.607
127.448
127.241
125.153
118.873
115.328
60.707
60.468
60.445
60.208
42.686
42.653
24.703
N
F
F
O
S
150
100
50
0

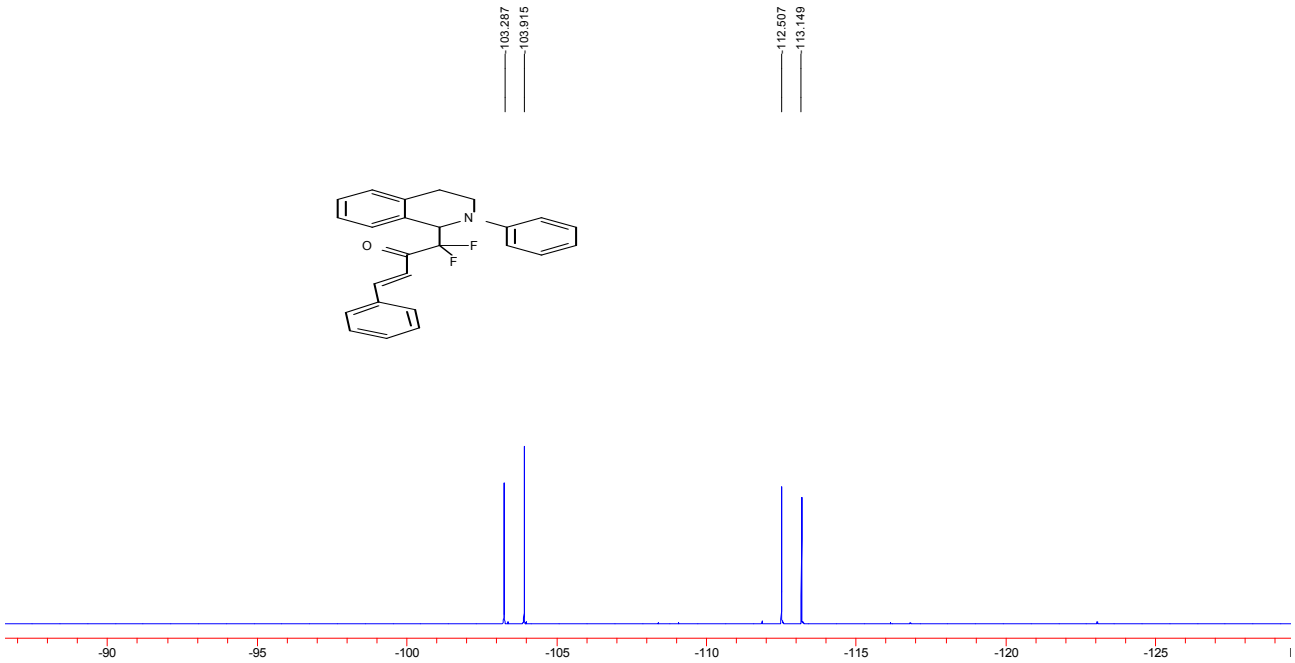
2,2-difluoro-1-(furan-2-yl)-2-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)ethanone(**4l**)

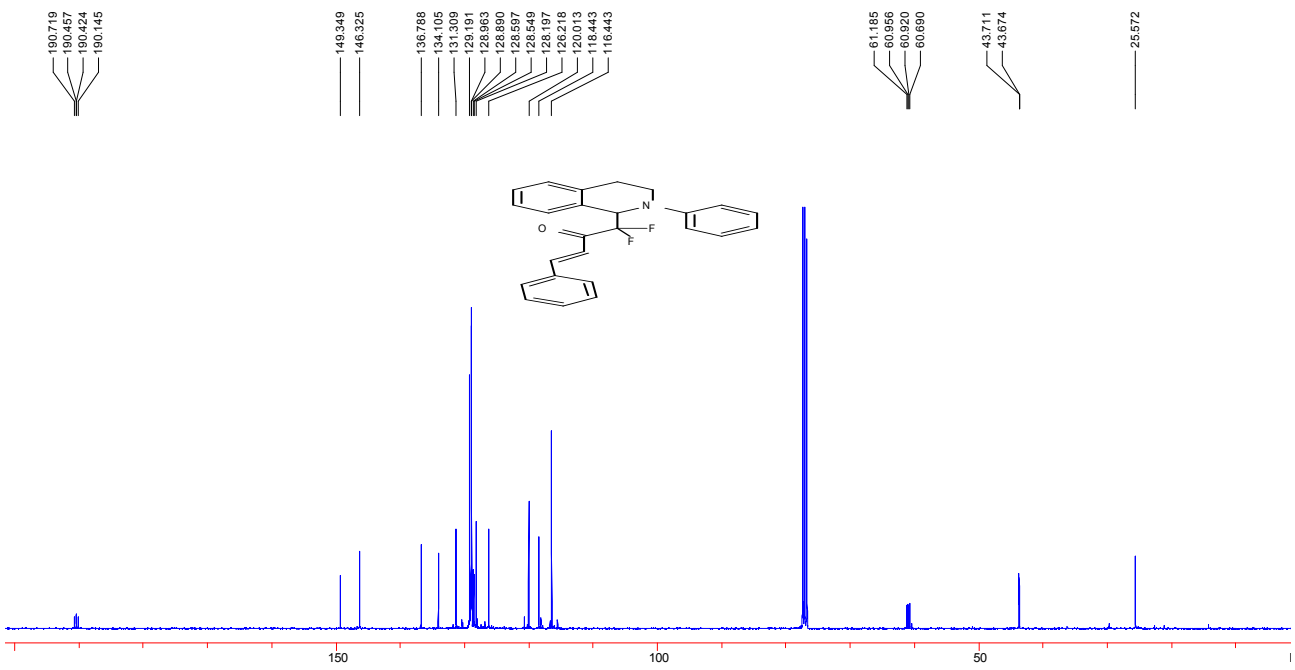




(E)-1,1-difluoro-4-phenyl-1-(2-phenyl-1,2,3,4-tetrahydroisoquinolin-1-yl)but-3-en-2-one(**4m**)




103.287
103.915
112.507
113.149
N
O
F
F
-90
-95
-100
-105
-110
-115
-120
-125


190.719
190.457
190.424
190.145
149.349
146.325
136.788
134.105
131.309
129.191
128.963
128.890
128.597
128.549
128.197
126.218
120.013
118.443
116.443
61.185
60.956
60.920
60.690
43.711
43.674
25.572
N
O
F
F
150
100
50