Supporting Information

For

Visible light-promoted umpolung coupling of aryl tri-/difluoroethanones with 2-alkenylpyridines

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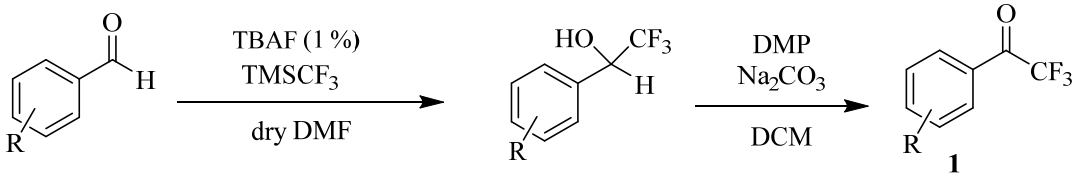
1. General remarks

^{1}H NMR spectra were recorded on 400 or 600 MHz (100 or 150 MHz for ^{13}C NMR, 564 MHz for ^{19}F NMR) agilent NMR spectrometer with $CDCl_3$ as the solvent and tetramethylsilane (TMS) as the internal standard. Chemical shifts were reported in parts per million (ppm, δ scale) downfield from TMS at 0.00 ppm and referenced to the $CDCl_3$ at 7.26 ppm (for ^{1}H NMR) or 77.16 ppm (for ^{13}C NMR). ^{19}F NMR chemical shifts were determined relative to $CFCl_3$ at δ 0.00 ppm. HRMS was recorded on a GCT Premier^{TM} (CI) Mass Spectrometer. Infrared (FT-IR) spectra were recorded on a Varian 1000FT-IR, ν_{max} in cm^{-1}. Melting points were measured using SGW, X-4B and values are uncorrected. All commercially available reagents and solvents were used as received unless otherwise specified.

2. General procedure for synthesis of substrates

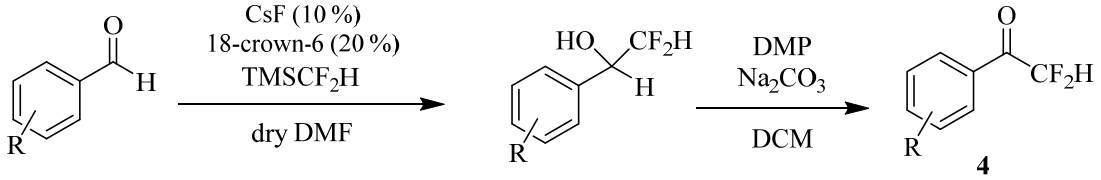
Scheme S1. Synthesis of aryl trifluoroethanones



Step 1: To a solution of aldehyde (5 mmol) in DMF (5 mL) in a 25 mL round-bottom flask equipped, under nitrogen atmosphere, $TMSCF_3$ (6.5 mmol, 1.3 equiv) was added and the mixture was stirred in an ice bath. After approximately 10 min, TBAF (1 M in THF, 0.05 mmol, 0.05 mL, 0.01 equiv) was added dropwise via a syringe. After 10 min, the ice bath was removed and the solution was stirred for approximately 6 h at room temperature. To cleave the silyl ether intermediate, the reaction mixture was cooled to 0 °C in an ice bath and after 10 min; water and TBAF (1 M in THF, 0.5 mL, 0.5 mmol, 0.1 equiv) were added. The ice bath was removed and the reaction mixture was stirred at room temperature. Finally, the mixture was extracted with ethyl acetate (20 mL × 3). The organic phase was washed with brine and then dried over anhydrous Na_2SO_4. After filtration and evaporation under vacuum, the residue was subjected to silica gel column chromatography using hexane/ethyl acetate as eluent to give trifluoromethyl alcohols. (*J. Org. Chem.*, **2012**, *77*, 8131–8141)

Step 2: To a solution of the α-CF_3 alcohol (5 mmol, 1 equiv) in DCM (30 mL), was added DMP (17.5 mmol, 3.5 equiv) and $NaCO_3$ (20 mmol, 4 equiv). The solution was stirred at room temperature for 3 h. Then water was added and the obtained suspension was stirred for an additional hour, the mixture was extracted with DCM (20 mL × 3). The organic phase was washed with brine and then dried over anhydrous Na_2SO_4. The solvent was removed *in vacuo* by rotary evaporation in a room-temperature water bath to give α-CF_3 ketones **1** (yield up to 97 %). (*J. Org. Chem.*, **1989**, *54*, 661–668; *Tetrahedron Lett.,* **2013**, *54*, 4483–4486)

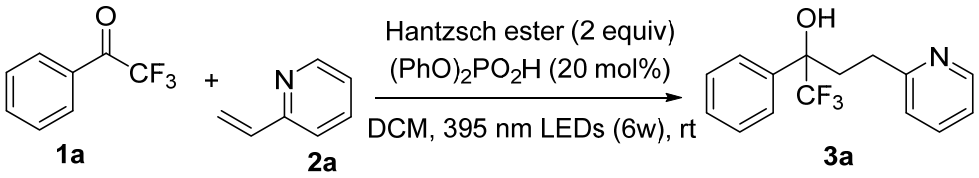
Scheme S2. Synthesis of aryl difluoroethanones



Step 1: Under argon atmosphere, CsF (0.5 mmol, 10 mol %) and 18-crown-6 (1.0 mmol, 20 mol %) were added to a solution of aldehyde (5.0 mmol) in dry DMF (3 mL). $TMSCF_2H$ (6.5 mmol, 1.3 equiv) was added, and the mixture was stirred at room temperature overnight. Subsequently, HCl aq. (1.0 M, 3.5 mL) was added and the solution was stirred for another 1 h. Finally, the mixture was extracted with ethyl acetate (20 mL × 3). The organic phase was washed with brine and then dried over anhydrous Na_2SO_4. After filtration and evaporation under vacuum, the residue was subjected to silica gel column chromatography using hexane/ethyl acetate as eluent to give difluoromethyl alcohols (yield up to 97 %). (*Angew. Chem. Int. Ed.,* **2016**, *55,* 12632–12636)

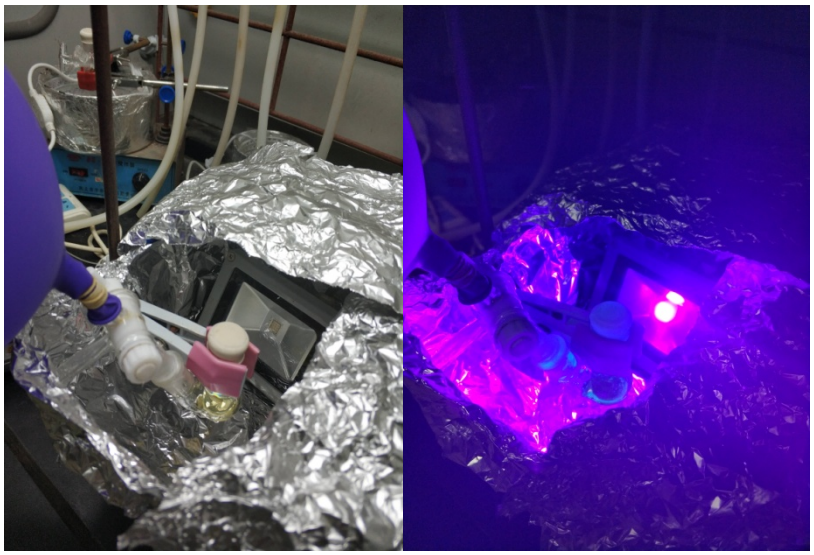
Step 2: Same as **scheme 1- step 2**.

3. Typical experimental procedure



To a suspension of **1a** (52.2 mg, 0.30 mmol), Hantzsch ester (101mg, 0.40 mmol) and $(PhO)_2PO_2H$ (10 mg, 20 mol%) in DCM (2 mL) was added **2a** (21 mg, 0.20 mmol) at rt. The resulting mixture was stirred upon 6W 395 nm LEDs irradiation under argon balloon. After the reaction was finished, the solvent was removed under reduced pressure and the residue was purified by flash column chromatography on silica gel to give **3a** as a white solid (53.0 mg, 95% yield).

Reaction Setup:



Photographs of the 6w 395 nm LEDs and reaction vessel.

4. UV-vis absorption spectra

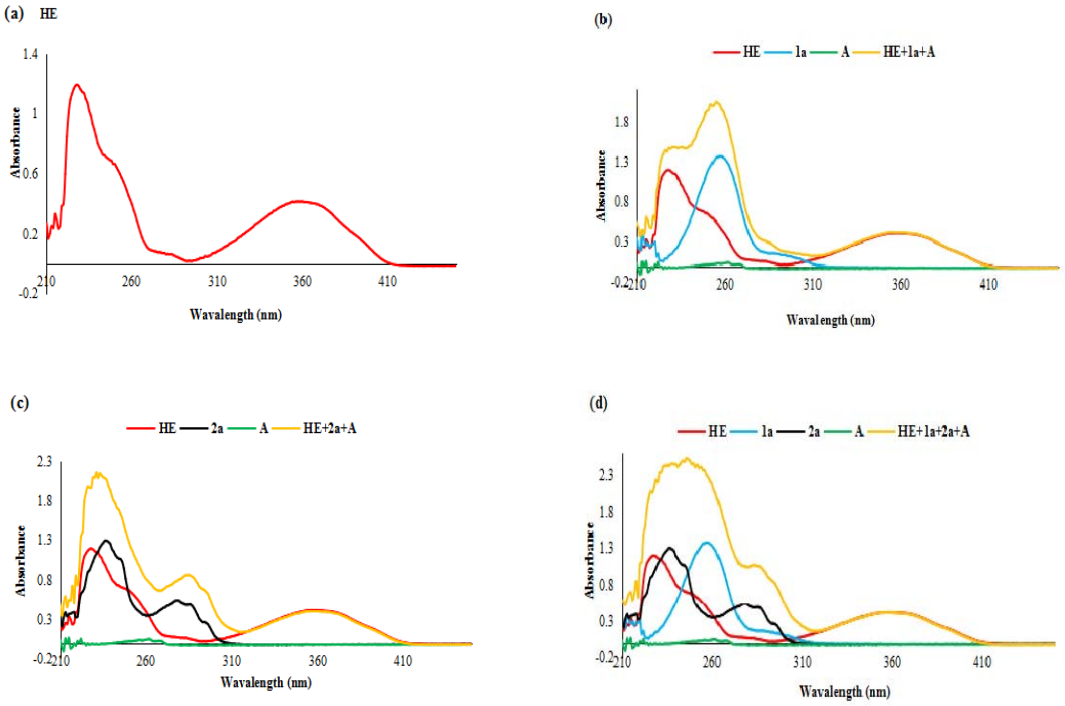


Figure S1. Optical absorption spectra recorded in DCE in 1 cm path quartz cuvettes using a Shimadzu UV-2600 UV-vis spectrophotometer. a) UV-vis absorption spectrum of HE, [HE] = 0.1 μM. b) UV-vis absorption spectra of HE, *α, α, α*-trifluoro-1-phenylethan-1-one (**1a**), $(PhO)_2PO_2H$ (**A**), and the mixture of HE, **1a** and **A**, [HE] = 0.1 μM, [**1a**] = 0.1 μM, [**A**] = 0.02 μM. c) UV-vis absorption spectra of HE, 2-vinylpyridine (**2a**), $(PhO)_2PO_2H$ (**A**), and the mixture of HE, **2a** and **A**, [HE] = 0.1 μM, [**2a**] = 0.1 μM, [**A**] = 0.02 μM. d) UV-vis absorption spectra of HE, *α, α,*

α-trifluoro-1-phenylethan-1-one (**1a**), 2-vinylpyridine (**2a**), $(PhO)_2PO_2H$ (**A**), and the mixture of HE, **1a**, **2a** and **A**, [HE] = 0.1 μM, [**1a**] = 0.1 μM, [**2a**] = 0.1 μM, [**A**] = 0.02 μM.

5. Luminescence quenching experiments

Emission intensities were recorded using LS55 Luminescence Spectrometer for all experiments. All HE solutions were excited at 390 nm and the emission intensity was collected at 440-460nm. In a typical experiment, the DCE solution of HE (0.1 μM) and $(PhO)_2POOH$ (0.02 μM) was added the appropriate amount of *α, α, α*-trifluoro-1-phenylethan-1-one (**1a**) or 2-vinylpyridine (**2a**) in a screw-top 1.0 cm quartz cuvette. After degassing with nitrogen for 10 min, the emission spectra of the samples were collected. The results showed that *α, α, α*-trifluoro-1-phenylethan-1-one (**1a**) quenched the photoexcited HE* effectively but 2-vinylpyridine (**2a**) did not.

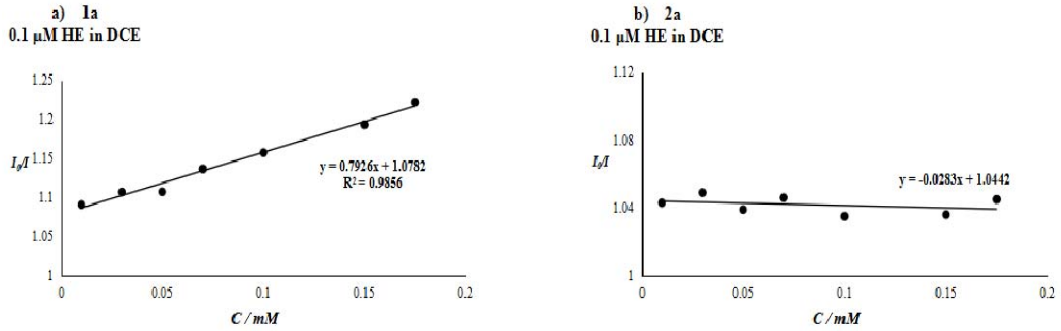
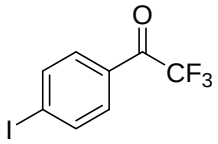


Figure S2. a) HE emission quenching by *α, α, α*-trifluoro-1-phenylethan-1-one (**1a**). b) HE emission quenching by 2-vinylpyridine (**2a**).

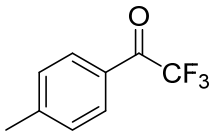
6. References for known substrates

Entry	References	Compounds
1	W. Wu, et al. *Chem. Eur. J.*, **2016**, 22, 16455-16458.	**1e, 1f, 1g**
2	D. J. Leng, et al. *Org. Biomol. Chem.*, **2016**, 14, 1531-1535.	**4a, 4b, 4c, 4d, 4f**
3	E. Schmitt, et al. *Org. Lett.*, **2015**, 17, 4510-4513.	**4e**

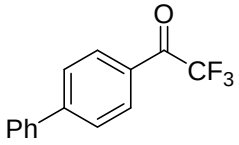
7. Characterization of the substrates and products



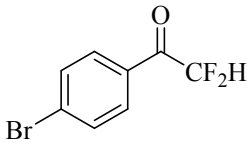
2,2,2-Trifluoro-1-(4-iodophenyl)ethan-1-one (1e): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.3 Hz, 2H), 7.76 (d, *J* = 8.1 Hz, 2H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -71.61 (s, 3F).



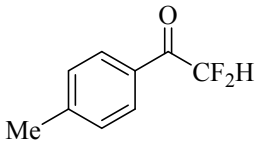
2,2,2-Trifluoro-1-(p-tolyl)ethan-1-one (1f): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.97 (d, *J* = 7.8 Hz, 2H), 7.34 (d, *J* = 8.0 Hz, 2H), 2.46 (s, 3H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -71.38 (s, 3F).



1-([1,1'-Biphenyl]-4-yl)-2,2,2-trifluoroethan-1-one (1g): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, *J* = 8.0 Hz, 2H), 7.77 (d, *J* = 8.2 Hz, 2H), 7.65 (d, *J* = 7.4 Hz, 2H), 7.51 (t, *J* = 7.3 Hz, 2H), 7.48 – 7.42 (t, 1H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -71.36 (s, 3F).

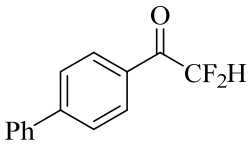


1-(4-Bromophenyl)-2,2-difluoroethan-1-one (4a): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.2 Hz, 2H), 7.65 (d, *J* = 8.4 Hz, 2H), 6.24 (t, *J* = 53.4 Hz, 1H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -122.02 (d, $J_{H\text{-}F}$ = 53.3, 2F).

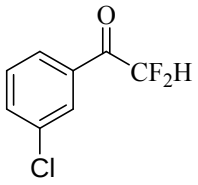


2,2-Difluoro-1-(p-tolyl)ethan-1-one (4b): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (d, *J* =

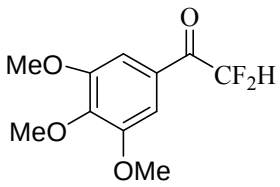
7.9 Hz, 2H), 7.31 (d, J = 7.9 Hz, 2H), 6.28 (t, J = 53.6 Hz, 1H), 2.43 (s, 3H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -122.10 (d, $J_{H\text{-}F}$ = 53.6 Hz, 2F).



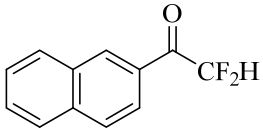
1-([1,1'-Biphenyl]-4-yl)-2,2-difluoroethan-1-one (4c): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 (d, J = 8.1 Hz, 2H), 7.75 (d, J = 8.2 Hz, 2H), 7.65 (d, J = 7.4 Hz, 2H), 7.50 (t, J = 7.3 Hz, 2H), 7.47 – 7.41 (m, 1H), 6.33 (t, J = 53.5 Hz, 1H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -121.77 (d, $J_{H\text{-}F}$ = 53.6 Hz, 2F).



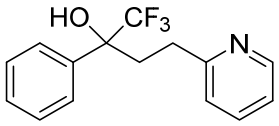
1-(3-Chlorophenyl)-2,2-difluoroethan-1-one (4d): ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.03 (s, 1H), 7.96 (d, J = 7.8 Hz, 1H), 7.64 (m, 1H), 7.48 (t, J = 7.9 Hz, 1H), 6.25 (t, J = 53.4 Hz, 1H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -121.85 (d, $J_{H\text{-}F}$ = 53.3 Hz, 2F).



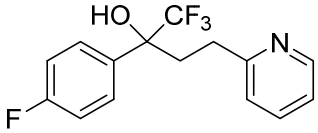
2,2-Difluoro-1-(3,4,5-trimethoxyphenyl) ethan-1-one (4e): ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (s, 2H), 6.26 (t, J = 53.6 Hz, 1H), 3.95 (s, 3H), 3.92 (s, 6H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -120.71 (d, $J_{H\text{-}F}$ = 53.6 Hz, 2F).



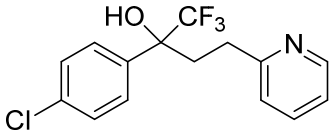
2,2-Difluoro-1-(naphthalen-2-yl) ethan-1-one (4f): ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.62 (s, 1H), 8.04 (t, J = 10. 8 Hz, 1H), 7.97 (d, J = 8.0 Hz, 1H), 7.89 (dd, J = 15.4, 8.4 Hz, 2H), 7.64 (dd, J = 14.9, 7.2 Hz, 1H), 7.58 (t, J = 7.4 Hz, 1H), 6.43 (t, J = 53.5 Hz, 1H); ^{19}F NMR (564 MHz, $CDCl_3$) δ -121.43 (d, $J_{H\text{-}F}$ = 53.5 Hz, 2F).



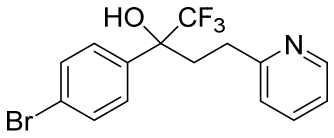
1,1,1-Trifluoro-2-phenyl-4-(pyridin-2-yl)butan-2-ol (3a): White solid; m.p. 115-117 ℃; 95% yield (53 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.38 (s, 1H), 8.48 (d, *J* = 4.7 Hz, 1H), 7.73 (d, *J* = 7.8 Hz, 2H), 7.60 (t, *J* = 7.6 Hz, 1H), 7.40 (t, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.2 Hz, 1H), 7.19 – 7.14 (m, 1H), 7.12 (d, *J* = 7.8 Hz, 1H), 2.94 (dd, *J* = 16.8, 8.8 Hz, 1H), 2.78 – 2.67 (m, 2H), 2.59 (dd, *J* = 14.9, 9.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.1, 147.7, 139.0, 137.6, 128.20, 128.1, 127.3, 124.4 (q, J_{C-F} = 285.9 Hz), 123.6, 121.60, 76.5 (q, J_{C-F} = 27.4 Hz), 32.2, 31.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.68 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3061, 1481, 1450, 702; HRMS (CI) calcd $C_{15}H_{15}NOF_3$ $[M + H]^+$: 282.1106, found: 282.1113.



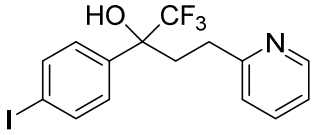
1,1,1-Trifluoro-2-(4-fluorophenyl)-4-(pyridin-2-yl)butan-2-ol (3b): White solid; m.p. 107-109 ℃; 54% yield (32 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.49 (s, 1H), 8.49 (d, *J* = 4.9 Hz, 1H), 7.68 (dd, *J* = 8.4, 5.6 Hz, 2H), 7.65 – 7.60 (m, 1H), 7.21 – 7.17 (m, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 7.07 (t, *J* = 8.7 Hz, 2H), 2.97 (dd, *J* = 16.9, 8.8 Hz, 1H), 2.79 – 2.63 (m, 2H), 2.58 (dd, *J* = 14.9, 9.7 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 162.7 (d, J_{C-F} = 246.7 Hz), 160.1, 147.8, 137.7, 134.9 (d, J_{C-F} = 2.9 Hz), 129.3 (d, J_{C-F} = 8.1 Hz), 126.2 (q, J_{C-F} = 285.7 Hz), 123.6, 121.8, 115.1 (d, J_{C-F} = 21.3 Hz), 76.3 (q, J_{C-F} = 27.7 Hz), 32.1, 31.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ -79.95 (s, 3F), -114.75 – -114.86 (m, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 3062, 2920, 1600, 1509, 828; HRMS (CI) calcd $C_{15}H_{14}NOF_4$ $[M + H]^+$: 300.1012, found: 300.1020.



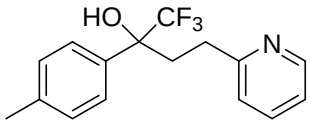
2-(4-Chlorophenyl)-1,1,1-trifluoro-4-(pyridin-2-yl)butan-2-ol (3c): White solid; m.p. 105-106 ℃; 94% yield (59 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 3.9 Hz, 1H), 7.74 – 7.54 (m, 3H), 7.36 (d, *J* = 8.3 Hz, 2H), 7.24 – 7.00 (m, 2H), 2.95 (dd, *J* = 16.5, 7.7 Hz, 1H), 2.82 – 2.47 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.8, 147.3, 138.2, 137.6, 134.3, 128.9, 128.5, 126.1 (q, J_{C-F} = 285.9 Hz), 123.9, 122.0, 76.3 (q, J_{C-F} = 27.7 Hz), 32.3, 30.9; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.85 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3097, 2924, 1597, 1458, 821; HRMS (CI) calcd $C_{15}H_{14}NOF_3{}^{35}Cl$ $[M + H]^+$: 316.0716, found: 316.0727.



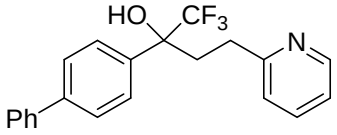
2-(4-Bromophenyl)-1,1,1-trifluoro-4-(pyridin-2-yl)butan-2-ol (3d): White solid; m.p. 137-139 ℃; 70% yiled (50 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.59 (s, 1H), 8.48 (d, *J* = 4.4 Hz, 1H), 7.63 (t, *J* = 7.7 Hz, 1H), 7.58 (d, *J* = 8.4 Hz, 2H), 7.51 (d, *J* = 8.4 Hz, 2H), 7.23 – 7.16 (m, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 2.96 (dd, *J* = 16.8, 8.4 Hz, 1H), 2.79 – 2.50 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.9, 147.7, 138.3, 137.7, 131.4, 129.3, 126.1 (q, J_{C-F} = 285.9 Hz), 123.7, 122.5, 121.7, 76.4 (q, J_{C-F} = 27.6 Hz), 32.1, 31.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.82 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3081, 1489, 1437, 838, 725; HRMS (CI) calcd $C_{15}H_{14}NOF_3{}^{79}Br$ $[M + H]^+$: 360.0211, found: 360.0221.



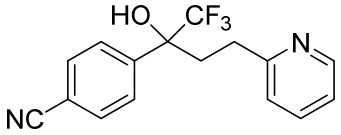
1,1,1-Trifluoro-2-(4-iodophenyl)-4-(pyridin-2-yl)butan-2-ol (3e): White solid; m.p. 150-152 ℃; 99% yield (81 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.52 (s, 1H), 8.47 (d, *J* = 4.7 Hz, 1H), 7.72 (d, *J* = 8.5 Hz, 2H), 7.66 – 7.56 (m, 1H), 7.45 (d, *J* = 8.3 Hz, 2H), 7.22 – 7.15 (m, 1H), 7.13 (d, *J* = 7.8 Hz, 1H), 2.95 (dd, *J* = 16.8, 8.4 Hz, 1H), 2.71 (dd, *J* = 16.9, 9.5 Hz, 1H), 2.67 – 2.60 (m, 1H), 2.61 – 2.51 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.9, 147.7, 139.0, 137.7, 137.4, 129.5, 126.0 (q, J_{C-F} = 285.9 Hz), 123.7, 121.8, 94.4, 76.4 (q, J_{C-F} = 27.6 Hz), 32.0, 31.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.76 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3090, 2922, 1596, 1457, 723; HRMS (CI) calcd $C_{15}H_{14}NOF_3I$ $[M + H]^+$: 408.0072, found: 408.0085.



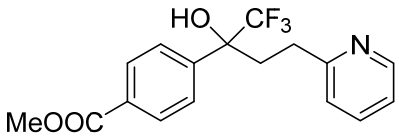
1,1,1-Trifluoro-4-(pyridin-2-yl)-2-(p-tolyl)butan-2-ol (3f): White solid; m.p. 120-122 ℃; 83% yield (49 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.27 (s, 1H), 8.49 (d, *J* = 4.4 Hz, 1H), 7.68 – 7.50 (m, 3H), 7.23 – 7.08 (m, 4H), 2.94 (dd, *J* = 16.7, 8.6 Hz, 1H), 2.84 – 2.63 (m, 2H), 2.56 (dd, *J* = 13.9, 9.9 Hz, 1H), 2.36 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.3, 147.8, 137.8, 137.6, 136.0, 129.0, 127.3, 126.7 (q, J_{C-F} = 285.8 Hz), 123.6, 121.6, 76.5 (q, J_{C-F} = 27.4 Hz), 32.1, 31.2, 21.2; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.90 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3107, 2928, 1596, 1435, 727; HRMS (CI) calcd $C_{16}H_{17}NOF_3$ $[M + H]^+$: 296.1262, found: 296.1271.



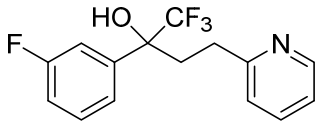
2-([1,1'-Biphenyl]-4-yl)-1,1,1-trifluoro-4-(pyridin-2-yl)butan-2-ol (3g): White solid; m.p. 188-190 ℃; 94% yield (67 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.45 (s, 1H), 8.51 (d, *J* = 4.3 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 2H), 7.69 – 7.54 (m, 5H), 7.44 (t, *J* = 7.4 Hz, 2H), 7.35 (t, *J* = 7.2 Hz, 1H), 7.22 – 7.10 (m, 2H), 3.00 (dd, *J* = 16.8, 8.7 Hz, 1H), 2.90 – 2.69 (m, 2H), 2.62 (dd, *J* = 14.3, 10.0 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.2, 147.8, 140.9, 140.8, 138.1, 137.6, 128.9, 127.9, 127.5, 127.2, 127.0, 126.2 (q, J_{C-F} = 285.9 Hz), 123.6, 121.7, 76.5 (q, J_{C-F} = 27.5 Hz), 32.1, 31.2; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.69 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3099, 2852, 1599, 1488, 761; HRMS (CI) calcd $C_{21}H_{19}NOF_3$ $[M + H]^+$: 358.1419, found: 358.1430.



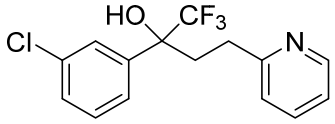
4-(1,1,1-Trifluoro-2-hydroxy-4-(pyridin-2-yl)butan-2-yl)benzonitrile (3h): White solid; m.p. 132-134 ℃; 60% yield (37 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.84 (s, 1H), 8.48 (d, *J* = 4.8 Hz, 1H), 7.84 (d, *J* = 8.3 Hz, 2H), 7.68 (d, *J* = 8.5 Hz, 2H), 7.65 – 7.62 (m, 1H), 7.21 (dd, *J* = 7.1, 5.4 Hz, 1H), 7.16 (d, *J* = 7.8 Hz, 1H), 3.02 – 2.93 (m, 1H), 2.70 – 2.58 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.5, 147.6, 144.7, 137.9, 132.1, 128.5, 125.8 (q, *J* = 286.1 Hz), 123.7, 121.9, 118.75, 112.1, 76.4 (q, *J* = 27.8 Hz), 32.1, 30.9; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.38 (s, 3F). FT-IR (thin film, KBr): ν (cm^{-1}) 3073, 2921, 2232, 1600, 669; HRMS(CI) calcd $C_{16}H_{14}F_3N_2O$ $[M + H]^+$: 307.1058, found: 307.1059.



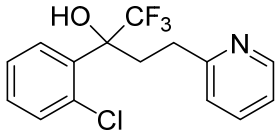
Methyl-4-(1,1,1-trifluoro-2-hydroxy-4-(pyridin-2-yl)butan-2-yl)benzoate (3i): White solid; m.p. 137-138 ℃; 55% yield (37 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.64 (s, 1H), 8.49 (s, 1H), 8.05 (d, *J* = 7.8 Hz, 2H), 7.79 (d, *J* = 7.6 Hz, 2H), 7.63 (t, *J* = 7.1 Hz, 1H), 7.23 – 7.07 (m, 2H), 3.91 (s, 3H), 3.11 – 2.82 (m, 1H), 2.79 – 2.45 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.0, 159.9, 147.8, 144.4, 137.7, 130.0, 129.5, 127.6, 126.1 (q, J_{C-F} = 286.0 Hz), 123.7, 121.8, 76.6 (q, J_{C-F} = 27.6 Hz), 52.3, 32.2, 31.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.47 (s, 3F); FT-IR (thin film, KBr): ν(cm^{-1}) 3100, 1712, 1598, 1435, 713; HRMS (CI) calcd $C_{17}H_{17}NO_3F_3$ $[M + H]^+$: 340.1161, found: 340.1163.



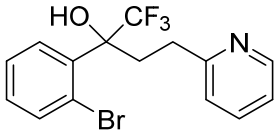
1,1,1-Trifluoro-2-(3-fluorophenyl)-4-(pyridin-2-yl)butan-2-ol (3j): White solid; m.p. 108-111 ℃; 95% yield (57 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (s, 1H), 7.64 (t, *J* = 6.9 Hz, 1H), 7.53 – 7.39 (m, 2H), 7.40 – 7.29 (m, 1H), 7.24 – 7.08 (m, 2H), 7.07 – 6.95 (m, 1H), 2.96 (dd, *J* = 16.3, 7.8 Hz, 1H), 2.82 – 2.50 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 163.0 (d, J_{C-F} = 245.2 Hz), 159.9, 147.6, 142.0 (d, J_{C-F} = 6.9 Hz), 137.9, 129.7 (d, J_{C-F} = 8.0 Hz), 126.1 (q, J_{C-F} = 285.9 Hz), 123.7, 122.9, 121.8, 115.1 (d, J_{C-F} = 20.9 Hz), 114.9 (d, J_{C-F} = 20.3 Hz), 76.3 (d, J_{C-F} = 27.9 Hz), 32.3, 31.0; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.67 (s, 3F), -112.96 – -113.07 (m, 1F); FT-IR (thin film, KBr): ν(cm^{-1}) 3064, 1482, 1477, 788, 705; HRMS (CI) calcd $C_{15}H_{14}NOF_4$ $[M + H]^+$: 300.1012, found: 300.1021.



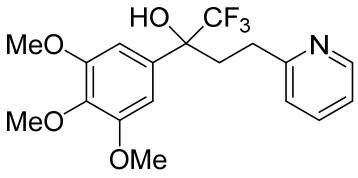
2-(3-Chlorophenyl)-1,1,1-trifluoro-4-(pyridin-2-yl)butan-2-ol (3k): White solid; m.p. 154-155 ℃; 95% yield (60 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 3.8 Hz, 1H), 7.74 (s, 1H), 7.65 (t, *J* = 7.4 Hz, 1H), 7.56 (d, *J* = 4.9 Hz, 1H), 7.38 – 7.27 (m, 2H), 7.24 – 7.09 (m, 2H), 2.97 (dd, *J* = 16.7, 8.2 Hz, 1H), 2.81 – 2.48 (m, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.8, 147.5, 141.4, 138.0, 134.5, 129.5, 128.4, 127.9, 126.1 (q, J_{C-F} = 285.9 Hz), 125.5, 123.8, 121.9, 76.3 (q, J_{C-F} = 27.7 Hz), 32.2, 31.0; ^{19}F NMR (564MHz,$CDCl_3$) δ -79.64(s, 3F); FT-IR(thin film,KBr): ν (cm^{-1}) 3078, 1598, 1478, 790, 713; HRMS (CI) calcd $C_{15}H_{14}NOF_3{}^{35}Cl$ $[M + H]^+$: 316.0716, found: 316.0726.



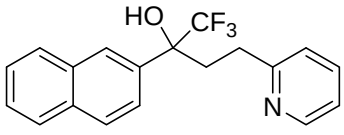
2-(2-Chlorophenyl)-1,1,1-trifluoro-4-(pyridin-2-yl)butan-2-ol (3l): Yellow solid; m.p. 117-118 ℃; 33% (21 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.82 (s, 1H), 8.47 (d, *J* = 4.7 Hz, 1H), 8.28 (d, *J* = 8.0 Hz, 1H), 7.63 (t, *J* = 7.7 Hz, 1H), 7.41 (d, *J* = 7.8 Hz, 1H), 7.33 (t, *J* = 7.6 Hz, 1H), 7.30 – 7.26 (m, 1H), 7.21 – 7.15 (m, 2H), 3.66 (dd, *J* = 15.3, 8.8 Hz, 1H), 3.20 (dd, *J* = 17.3, 8.8 Hz, 1H), 2.83 (dd, *J* = 17.3, 10.1 Hz, 1H), 2.53 (dd, *J* = 15.3, 10.1 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.1, 147.6, 137.7, 136.0, 133.0, 132.3, 131.6, 129.9, 127.0, 126.2 (q, J_{C-F} = 286.1 Hz), 123.6, 121.7, 77.9 (q, J_{C-F} = 28.4 Hz), 31.9, 30.5; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.11 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 2920, 1597, 1459, 764; HRMS(CI) calcd $C_{15}H_{14}F_3NO^{35}Cl$ $[M + H]^+$: 316.0716, found: 316.0713.



2-(2-Bromophenyl)-1,1,1-trifluoro-4-(pyridin-2-yl)butan-2-ol (3m): White solid; m.p. 99-100 ℃; 49% (35 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.82 (s, 1H), 8.45 (d, *J* = 4.4 Hz, 1H), 8.27 (d, *J* = 7.8 Hz, 1H), 7.71 – 7.52 (m, 2H), 7.36 (t, *J* = 7.6 Hz, 1H), 7.24 – 7.06 (m, 3H), 3.79 (dd, *J* = 15.0, 8.9 Hz, 1H), 3.19 (dd, *J* = 17.2, 8.8 Hz, 1H), 2.82 (dd, *J* = 17.2, 10.0 Hz, 1H), 2.47 (dd, *J* = 15.2, 10.1 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$, overlapping peaks) δ 160.1, 147.5, 137.7, 135.5, 133.3, 130.0, 127.5, 126.2 (q, J_{C-F} = 286.5 Hz), 123.6, 121.7, 121.3, 78.0 (q, J_{C-F} = 28.6 Hz), 31.9, 30.4; ^{19}F NMR (564 MHz, $CDCl_3$) δ -78.49 (s,3F); FT-IR (thin film, KBr): ν (cm^{-1}) 2923, 2853, 1602, 1437, 760; HRMS (CI) calcd $C_{15}H_{14}NOF_3{}^{79}Br$ $[M + H]^+$: 360.0211, found: 360.0220.

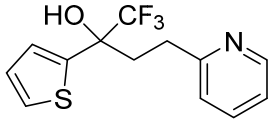


1,1,1-Trifluoro-4-(pyridin-2-yl)-2-(3,4,5-trimethoxyphenyl)butan-2-ol (3n): oil; 92% yield (68 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.42 (s, 1H), 8.48 (d, *J* = 4.9 Hz, 1H), 7.65 – 7.59 (m, 1H), 7.19 – 7.15 (m, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 6.92 (s, 2H), 3.86 (s, 6H), 3.84 (s, 3H), 2.95 (dd, *J* = 16.8, 8.6 Hz, 1H), 2.77 (dd, *J* = 16.8, 9.4 Hz, 1H), 2.63 (dd, *J* = 14.5, 8.7 Hz, 1H), 2.54 (dd, *J* = 14.7, 9.5 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.2, 153.0, 147.7, 137.8, 137.7, 134.7, 126.3 (q, J_{C-F} = 285.8 Hz), 123.7, 121.7, 104.7, 76.5 (q, J_{C-F} = 27.4 Hz), 60.9, 56.3, 32.4, 31.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.53 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 2939, 1591, 1455, 756, 711; HRMS (CI) calcd $C_{18}H_{21}NO_4F_3$ $[M + H]^+$: 372.1423, found: 372.1422.

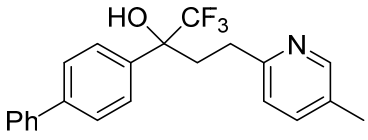


1,1,1-Trifluoro-2-(naphthalen-2-yl)-4-(pyridin-2-yl)butan-2-ol (3o): White solid; m.p. 130-131 ℃; 82% yield (54 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53 (d, *J* = 4.1 Hz, 1H), 8.28 (s, 1H), 7.95 – 7.81 (m, 3H), 7.73 (d, *J* = 8.5 Hz, 1H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.55 – 7.41 (m, 2H), 7.23 – 7.15 (m, 1H), 7.12 (d, *J* = 7.7 Hz, 1H), 2.96 (dd, *J* = 16.4, 8.5 Hz, 1H), 2.88 – 2.73 (m, 2H), 2.67 (dd, *J* = 13.7, 9.9 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.1, 147.6, 138.0, 136.4, 133.2, 133.1, 128.7, 127.9, 127.6, 127.4, 126.5, 126.4 (q, J_{C-F} = 286.1 Hz), 126.2, 124.6, 123.8, 121.8, 76.7 (q, J_{C-F} = 27.5 Hz), 32.3, 31.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.43 (s, 3F); FT-IR (thin film,

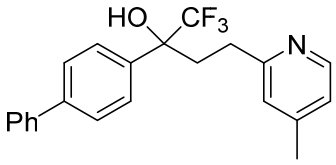
KBr): ν (cm^{-1}) 3064, 2923, 1595, 1459, 753; HRMS (CI) calcd $C_{19}H_{17}NOF_3$ $[M + H]^+$: 332.1262, found: 332.1272.



1,1,1-Trifluoro-4-(pyridin-2-yl)-2-(thiophen-2-yl)butan-2-ol (3p): Yellow oil; 33% yield (19 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 10.15 (s, 1H), 8.48 (d, *J* = 4.9 Hz, 1H), 7.64 (t, *J* = 7.7 Hz, 1H), 7.30 (d, *J* = 5.0 Hz, 1H), 7.22 – 7.14 (m, 2H), 7.11 (d, *J* = 2.9 Hz, 1H), 7.07 – 7.02 (m, 1H), 3.06 – 2.97 (m, 1H), 2.96 – 2.86 (m, 1H), 2.72 – 2.31 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.0, 147.7, 144.9, 137.8, 127.4, 126.0, 125.7 (q, J_{C-F} = 285.6 Hz), 125.1, 123.7, 121.8, 76.2 (q, J_{C-F} = 29.3 Hz), 33.6, 31.2; ^{19}F NMR (564 MHz, $CDCl_3$) δ -81.00 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3082, 2920, 1597, 1437, 707; HRMS (CI) calcd $C_{13}H_{13}F_3NOS$ $[M + H]^+$: 288.0670, found: 288.0668.

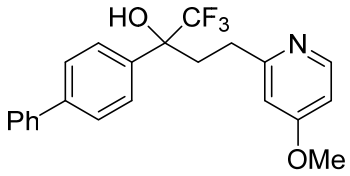


2-([1,1'-Biphenyl]-4-yl)-1,1,1-trifluoro-4-(5-methylpyridin-2-yl)butan-2-ol (3q): White solid; m.p. 167-169 ℃; 60% yield (44 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 9.61 (s, 1H), 8.33 (s, 1H), 7.78 (d, *J* = 8.1 Hz, 2H), 7.62 (t, *J* = 7.5 Hz, 4H), 7.48 – 7.39 (m, 3H), 7.35 (t, *J* = 7.3 Hz, 1H), 7.03 (d, *J* = 7.9 Hz, 1H), 2.95 (dd, *J* = 16.8, 8.9 Hz, 1H), 2.81 – 2.67 (m, 2H), 2.59 (dd, *J* = 14.9, 9.9 Hz, 1H), 2.31 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 157.1, 147.9, 140.9, 140.8, 138.3, 138.2, 131.2, 128.9, 127.9, 127.5, 127.2, 126.9, 126.4 (q, J_{C-F} = 285.9 Hz), 123.1, 76.5 (q, J_{C-F} = 27.4 Hz), 32.3, 30.7, 18.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.68 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3100, 2857, 1609, 1496, 763; HRMS (CI) calcd $C_{22}H_{21}F_3NO$ $[M + H]^+$: 372.1575, found: 372.1571.

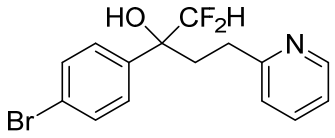


2-([1,1'-Biphenyl]-4-yl)-1,1,1-trifluoro-4-(4-methylpyridin-2-yl)butan-2-ol (3r): White solid; m.p. 130-131 ℃; 57% yield (42 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ δ 8.35 (d, *J* = 5.2 Hz, 1H), 7.78 (d, *J* = 8.1 Hz, 2H), 7.62 (t, *J* = 7.5 Hz, 4H), 7.44 (t, *J* = 7.6 Hz, 2H), 7.35 (t, *J* = 7.3 Hz, 1H), 7.00 (d, *J* = 5.1 Hz, 1H), 6.96 (s, 1H), 2.92 (dd, *J* = 16.8, 8.8 Hz, 1H), 2.82 – 2.66 (m, 2H), 2.60 (dd, *J* = 14.8, 9.7 Hz, 1H), 2.31 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 159.8, 149.2, 147.3, 140.9, 140.7, 138.2, 128.9, 127.9, 127.5, 127.2, 127.0, 126.4 (q, J_{C-F} = 286.0 Hz), 124.4, 122.7, 76.5 (q, J_{C-F} =

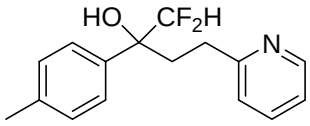
27.5 Hz), 32.2, 31.0, 21.2; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.66 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 3065, 2923, 1612, 1487, 732; HRMS (CI) calcd $C_{22}H_{21}F_3NO$ [M + H]$^+$: 372.1575, found: 375.1580.



2-([1,1'-Biphenyl]-4-yl)-1,1,1-trifluoro-4-(4-methoxypyridin-2-yl)butan-2-ol (3s): White solid; m.p. 107-109 ℃; 72% yield (56 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.32 (d, *J* = 5.9 Hz, 1H), 7.79 (d, *J* = 8.1 Hz, 2H), 7.62 (t, *J* = 8.1 Hz, 4H), 7.44 (t, *J* = 7.5 Hz, 2H), 7.35 (t, *J* = 7.3 Hz, 1H), 6.70 (d, *J* = 5.5 Hz, 1H), 6.63 (s, 1H), 3.81 (s, 3H), 2.90 (dd, *J* = 16.7, 8.8 Hz, 1H), 2.81 – 2.67 (m, 2H), 2.60 (dd, *J* = 14.7, 9.9 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 166.7, 161.8, 148.9, 140.8, 140.7, 138.2, 128.9, 127.9, 127.5, 127.2, 126.9, 126.4 (q, J_{C-F} = 285.8 Hz), 109.1, 108.1, 76.4 (q, J_{C-F} = 27.6 Hz), 55.3, 32.1, 31.4; ^{19}F NMR (564 MHz, $CDCl_3$) δ -79.64 (s, 3F); FT-IR (thin film, KBr): ν (cm^{-1}) 2922, 2851, 1609, 1486, 692; HRMS(CI) calcd $C_{22}H_{21}F_3NO_2$ [M + H]$^+$: 388.1524, found: 388.1523.

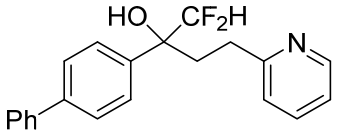


2-(4-Bromophenyl)-1,1-difluoro-4-(pyridin-2-yl)butan-2-ol (5a): White solid; m.p. 112-113 ℃; 63% yield (43mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.87 (s, 1H), 8.48 (d, *J* = 4.8 Hz, 1H), 7.62 (t, *J* = 7.7 Hz, 1H), 7.52 (d, *J* = 8.7 Hz, 2H), 7.50 (d, *J* = 8.7 Hz, 2H), 7.19 – 7.15 (m, 1H), 7.13 (d, *J* = 7.8 Hz, 1H), 5.70 (t, *J* = 56.5 Hz, 1H), 2.95 (dd, *J* = 16.8, 8.6 Hz, 1H), 2.74 (dd, *J* = 16.7, 9.7 Hz, 1H), 2.55 (dd, *J* = 14.8, 8.6 Hz, 1H), 2.43 (dd, *J* = 14.9, 9.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.3, 147.8, 139.7, 137.6, 131.4, 129.2, 123.7, 122.0, 121.7, 117.6 (t, J_{C-F} = 250.5 Hz), 75.6 (t, J_{C-F} = 20.8 Hz), 31.4, 31.3; ^{19}F NMR (564 MHz,$CDCl_3$) δ -128.22 (dd, *J* = 273.5, 56.8 Hz, 1F), -129.52 (dd, *J* = 273.5, 56.3 Hz, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 3184, 2925, 1596, 1434, 809; HRMS (CI) calcd $C_{15}H_{15}{}^{79}BrF_2NO$ [M + H]$^+$: 342.0305, found: 342.0310.

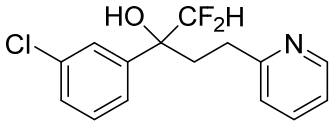


1,1-Difluoro-4-(pyridin-2-yl)-2-(p-tolyl)butan-2-ol (5b): White solid; m.p. 114-116℃; 60% yield (33 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.48 (d, *J* = 3.8 Hz, 1H), 7.60 (t, *J* = 7.4 Hz, 1H), 7.52 (d, *J* = 7.8 Hz, 2H), 7.20 (d, *J* = 7.8 Hz, 2H), 7.18 –

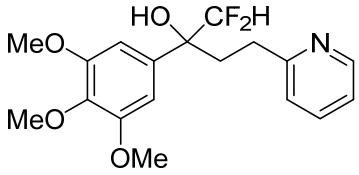
7.03 (m, 2H), 5.72 (t, J = 56.6 Hz, 1H), 3.00 – 2.86 (m, 1H), 2.88 – 2.72 (m, 1H), 2.65 – 2.52 (m, 1H), 2.50 – 2.38 (m, 1H), 2.35 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.7, 147.8, 137.5, 137.4, 137.3, 129.0, 127.1, 123.6, 121.5, 117.9 (t, J_{C-F} = 250.1 Hz), 75.7 (t, J_{C-F} = 20.5 Hz), 31.5, 31.3, 21.1; ^{19}F NMR (564 MHz, $CDCl_3$) δ -128.66 (dd, J = 272.1, 56.9 Hz, 1F), -129.65 (dd, J = 272.1, 56.3 Hz, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 3180, 2926, 1593, 1434, 743; HRMS (CI) calcd $C_{16}H_{18}NOF_2$ $[M + H]^+$: 278.1356, found: 278.1368.



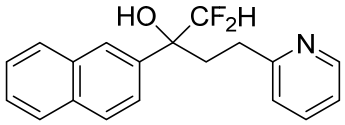
2-([1,1'-Biphenyl]-4-yl)-1,1-difluoro-4-(pyridin-2-yl)butan-2-ol (5c): White solid; m.p. 159-161 ℃; 62% yield (42 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.77 (s, 1H), 8.51 (s, 1H), 7.72 (d, J = 7.5 Hz, 2H), 7.68 – 7.54 (m, 5H), 7.48 – 7.38 (m, 2H), 7.38 – 7.29 (m, 1H), 7.18 – 7.08 (m, 2H), 5.79 (t, J = 56.6 Hz, 1H), 3.09 – 2.92 (m, 1H), 2.93 – 2.74 (m, 1H), 2.75 – 2.56 (m, 1H), 2.56 – 2.35 (m, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.6, 147.9, 140.9, 140.5, 139.6, 137.4, 128.9, 127.7, 127.4, 127.2, 127.0, 123.6, 121.5, 117.8 (t, J_{C-F} = 250.3 Hz), 75.8 (t, J_{C-F} = 20.6 Hz), 31.5, 31.4; ^{19}F NMR (564 MHz, $CDCl_3$) δ -128.40 (dd, J = 272.5, 56.9 Hz, 1F), -129.45 (dd, J = 272.5, 56.3 Hz, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 3120, 2874, 1596,1437, 759; HRMS (CI) calcd $C_{21}H_{20}NOF_2$ $[M + H]^+$: 340.1513, found: 340.1519.



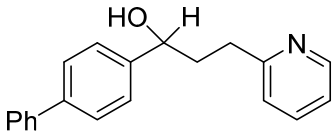
2-(3-Chlorophenyl)-1,1-difluoro-4-(pyridin-2-yl)butan-2-ol (5d): oil; 72% yield (43 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.95 (s, 1H), 8.48 (d, J = 4.8 Hz, 1H), 7.68 (s, 1H), 7.62 (t, J = 7.7 Hz, 1H), 7.50 (d, J = 7.5 Hz, 1H), 7.33 – 7.26 (m, 2H), 7.19 – 7.15 (m, 1H), 7.14 (d, J = 7.8 Hz, 1H), 5.71 (t, J = 56.5 Hz, 1H), 2.96 (dd, J = 16.7, 8.6 Hz, 1H), 2.75 (dd, J = 16.7, 9.6 Hz, 1H), 2.56 (dd, J = 14.9, 8.7 Hz, 1H), 2.44 (dd, J = 14.9, 9.8 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.3, 147.8, 142.9, 137.6, 134.4, 129.5, 127.9, 127.7, 125.4, 123.6, 121.6, 117.6 (t, J_{C-F} = 250.6 Hz), 75.61 (t, J_{C-F} = 20.9 Hz), 31.5, 31.3; ^{19}F NMR (564 MHz,$CDCl_3$) δ -128.22 (dd, J = 273.6, 56.8 Hz, 1F), -129.46 (dd, J = 273.6, 56.2 Hz, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 3169, 1597, 1435, 736, 696; HRMS (CI) calcd $C_{15}H_{15}{}^{35}ClF_2NO$ $[M + H]^+$: 298.0810, found 298.0809.



1, 1-Difluoro-4-(pyridin-2-yl)-2-(3, 4, 5-trimethoxyphenyl) butan-2-ol (5e): oil; 65% yield (46 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.77 (s, 1H), 8.49 (d, *J* = 4.9 Hz, 1H), 7.62 (t, *J* = 7.6 Hz, 1H), 7.19 – 7.16 (m, 1H), 7.14 (d, *J* = 7.8 Hz, 1H), 6.86 (s, 2H), 5.72 (t, *J* = 56.6 Hz, 1H), 3.87 (s, 6H), 3.85 (s, 3H), 2.95 (dd, *J* = 16.5, 8.1 Hz, 1H), 2.81 (dd, *J* = 16.6, 9.2 Hz, 1H), 2.54 (dd, *J* = 14.5, 8.4 Hz, 1H), 2.42 (dd, *J* = 14.7, 9.4 Hz, 1H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 160.6, 153.0, 147.9, 137.5, 137.4, 136.3, 123.67, 121.6, 117.8 (t, J_{C-F} = 250.3 Hz), 104.4, 75.8 (t, J_{C-F} = 20.6 Hz), 60.9, 56.3, 31.6, 31.3; ^{19}F NMR(564 MHz, $CDCl_3$) δ -128.12 (dd, *J* = 272.0, 57.0 Hz, 1F), -129.18 (dd, *J* = 272.0, 56.3 Hz, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 2922, 1590, 1508, 759, 707; HRMS (CI) calcd $C_{18}H_{22}F_2NO_4$ $[M + H]^+$: 354.1517, found: 354.1521.

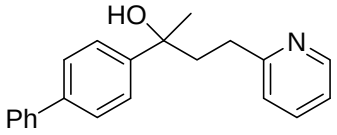


1,1-Difluoro-2-(naphthalen-2-yl)-4-(pyridin-2-yl)butan-2-ol (5f): White solid; m.p. 142-143 ℃; 64% yield (40 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.91 (s, 1H), 8.52 (d, *J* = 4.1 Hz, 1H), 8.22 (s, 1H), 7.95 – 7.78 (m, 3H), 7.69 (d, *J* = 8.5 Hz, 1H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.48 (dd, *J* = 5.8, 3.0 Hz, 2H), 7.21 – 7.13 (m, 1H), 7.10 (d, *J* = 7.7 Hz, 1H), 5.82 (t, *J* = 56.5 Hz, 1H), 2.96 (dd, *J* = 16.5, 8.5 Hz, 1H), 2.85 – 2.66 (m, 2H), 2.52 (dd, *J* = 14.0, 10.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 160.6, 147.9, 138.1, 137.4, 133.3, 132.9, 128.5, 127.9, 127.6, 127.0, 126.2, 126.1, 124.8, 123.6, 121.5, 118.0 (q, J_{C-F} = 250.7 Hz), 76.0 (t, J_{C-F} = 20.6 Hz), 31.4, 31.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ -128.08 (d, *J* = 272.9 Hz, 1F), -129.21 (d, *J* = 272.9 Hz, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 3147, 1595, 1435, 750, 670; HRMS (CI) calcd $C_{19}H_{18}NOF_2$ $[M + H]^+$: 314.1356, found: 314.1364.

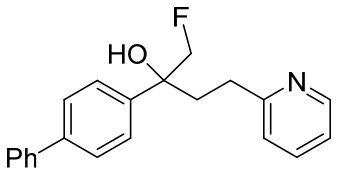


1-([1,1'-Biphenyl]-4-yl)-3-(pyridin-2-yl)propan-1-ol (7a): White solid; m.p. 88-92 ℃; 60% yield (35 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.52 (d, *J* = 4.4 Hz, 1H), 7.62 (t, *J* = 7.8 Hz, 1H), 7.59 (d, *J* = 7.8 Hz, 2H), 7.57 (d, *J* = 8.1 Hz, 2H), 7.47 (d, *J* = 8.1 Hz, 2H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.34 (t, *J* = 7.3 Hz, 1H), 7.19 (d, *J* = 7.8 Hz, 1H), 7.17 – 7.10 (m, 1H), 4.88 (dd, *J* = 8.0, 4.1 Hz, 1H), 3.07 – 2.98 (m, 2H), 2.30 – 2.17 (m, 2H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 161.4, 148.5, 144.4, 141.1, 140.0, 137.1, 128.8, 127.22, 127.16, 127.13, 126.4, 123.5, 121.4, 73.5, 38.1, 34.5; FT-IR (thin film, KBr): ν (cm^{-1}) 3197, 2922, 1593, 1447, 759; HRMS (ESI) calcd $C_{20}H_{20}NO$ $[M + H]^+$:

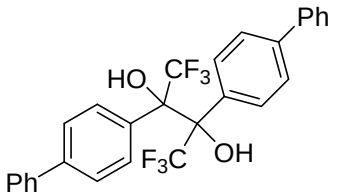
290.1539, found: 290.1539.



2-([1,1'-Biphenyl]-4-yl)-4-(pyridin-2-yl)butan-2-ol (7b): oil; 19% yield (11 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 3.3 Hz, 1H), 7.61 (d, *J* = 7.0 Hz, 4H), 7.59 – 7.55 (m, 3H), 7.43 (t, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 7.3 Hz, 1H), 7.14 – 7.07 (m, 2H), 2.83 (t, *J* = 6.6 Hz, 2H), 2.42 – 2.36 (m, 1H), 2.33 – 2.28 (m, 1H), 1.66 (s, 3H); ^{13}C NMR (150 MHz, $CDCl_3$) δ 161.7, 148.3, 147.9, 141.1, 139.1, 137.0, 128.8, 127.14, 127.13, 126.8, 125.8, 123.41, 121.2, 73.8, 42.2, 32.9, 31.5; FT-IR (thin film, KBr): ν (cm^{-1}) 2960, 2923, 1596, 1457, 760; HRMS (ESI) calcd $C_{21}H_{22}NO$ $[M + H]^+$: 304.1696, found: 304.1696.



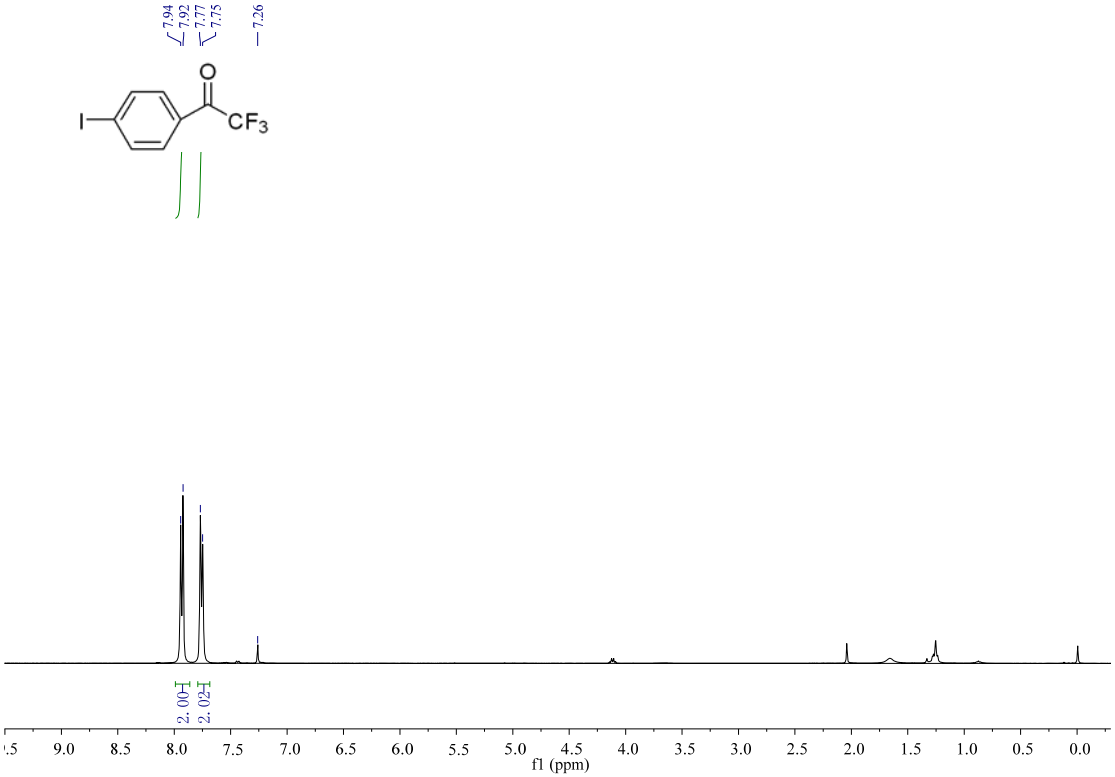
2-([1,1'-Biphenyl]-4-yl)-1-fluoro-4-(pyridin-2-yl)butan-2-ol (7c): oil; 18% yield (12 mg); ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.51 (d, *J* = 4.6 Hz, 1H), 7.65 (d, *J* = 8.3 Hz, 2H), 7.62 – 7.57 (m, 5H), 7.43 (t, *J* = 7.7 Hz, 2H), 7.34 (t, *J* = 7.4 Hz, 1H), 7.16 – 7.11 (m, 2H), 4.50 (d, *J* = 47.9 Hz, 2H), 2.95 – 2.80 (m, 2H), 2.56 – 2.45 (m, 2H); ^{13}C NMR (150 MHz,$CDCl_3$) δ 161.2, 148.18, 142.55, 140.97, 140.04, 137.24, 128.8, 127.3, 127.2, 127.1, 126.7, 123.5, 121.4, 89.9 (d, $J_{C\text{-}F}$ = 179.8 Hz), 75.1 (d, $J_{C\text{-}F}$ = 17.7 Hz), 35.1, 32.0; ^{19}F NMR (564 MHz, $CDCl_3$) δ -222.10 (t, *J* = 47.9 Hz, 1F); FT-IR (thin film, KBr): ν (cm^{-1}) 3167, 2923, 1597, 1436, 759; HRMS (CI) calcd $C_{21}H_{21}FNO$ $[M + H]^+$: 322.1607, found: 322.1611.



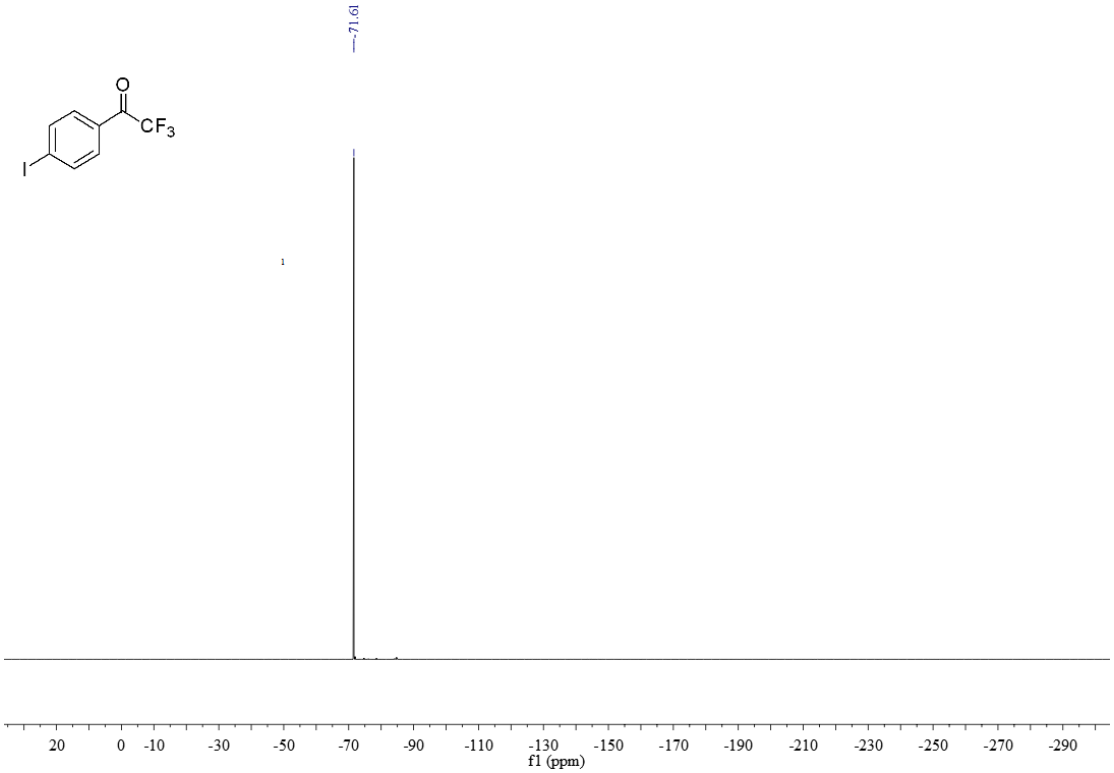
2,3-Bi([1,1'-biphenyl]-4-yl)-1,1,1,4,4,4-hexafluorobutane-2,3-diol (9): White solid; m.p. 308-310 ℃; 32% yield (32 mg); ^{1}H NMR (600 MHz,$(CD_3)_2CO$) δ 7.91 (d, *J* = 8.4 Hz, 4H), 7.71 (d, *J* = 7.4 Hz, 4H), 7.68 (d, *J* = 8.5 Hz, 4H), 7.48 (t, *J* = 7.7 Hz, 4H), 7.38 (t, *J* = 7.4 Hz, 2H), 6.42 (s, 2H); ^{13}C NMR (150 MHz, $(CD_3)_2CO$) δ 141.8, 141.0, 135.9, 129.7, 129.3, 128.4, 127.7, 126.5, 126.1 (q, $J_{C\text{-}F}$ = 289.4 Hz), 81.2 (q, $J_{C\text{-}F}$ = 26.4 Hz); ^{19}F NMR (564 MHz, $(CD_3)_2CO$) δ -74.81 (s, 6F); FT-IR (thin film, KBr): ν (cm^{-1}) 3546, 1488, 1407, 721, 693; HRMS (ESI) calcd $C_{28}H_{21}F_6O_2$ $[M + H]^+$: 503.1440, found: 503.1443.

8. NMR spectra for the substrates and products

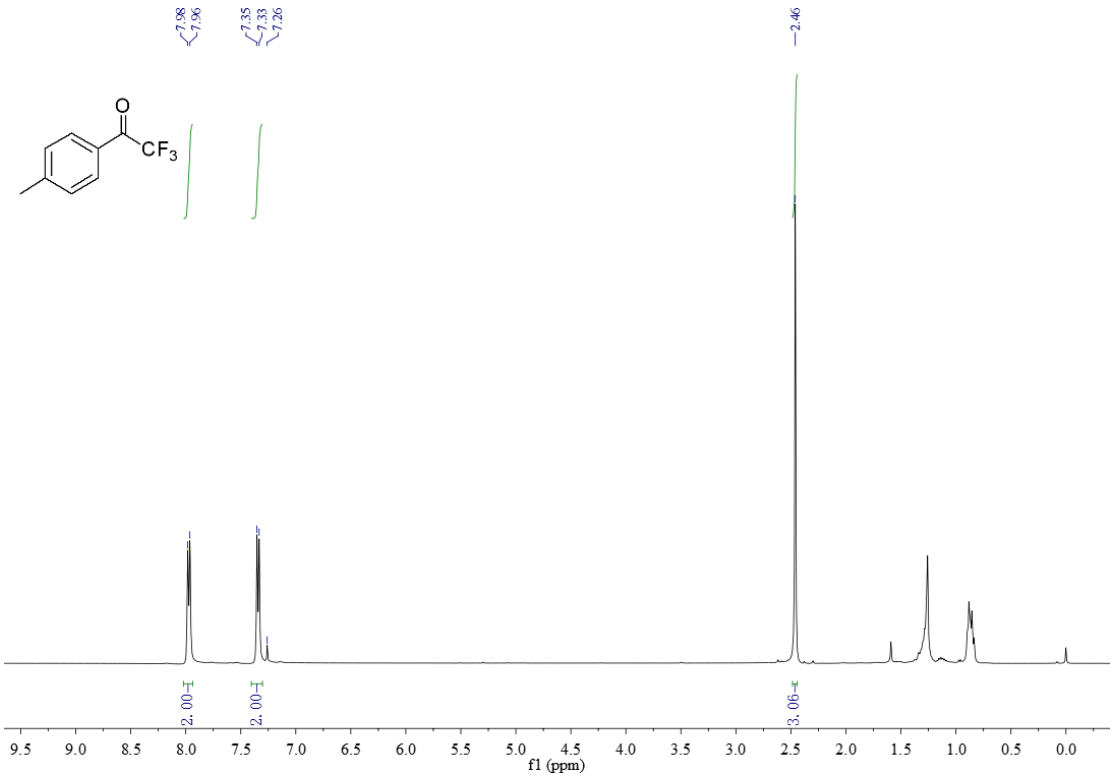
^{1}H NMR of **1e**



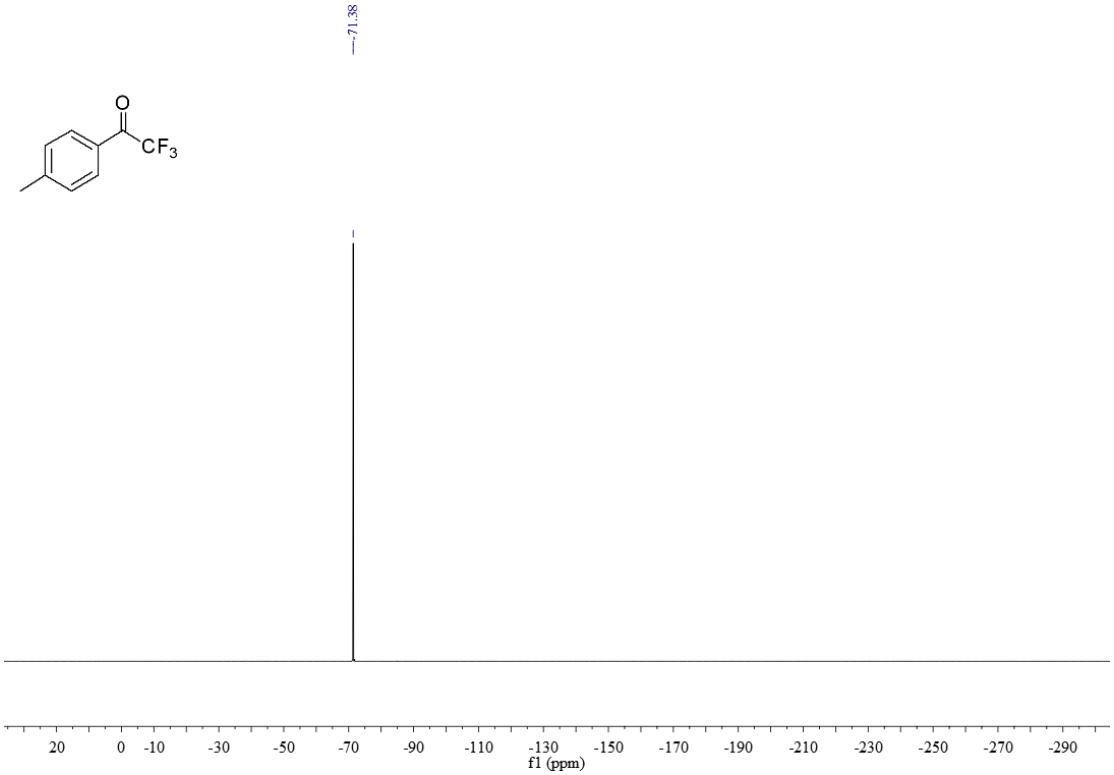
^{19}F NMR of **1e**



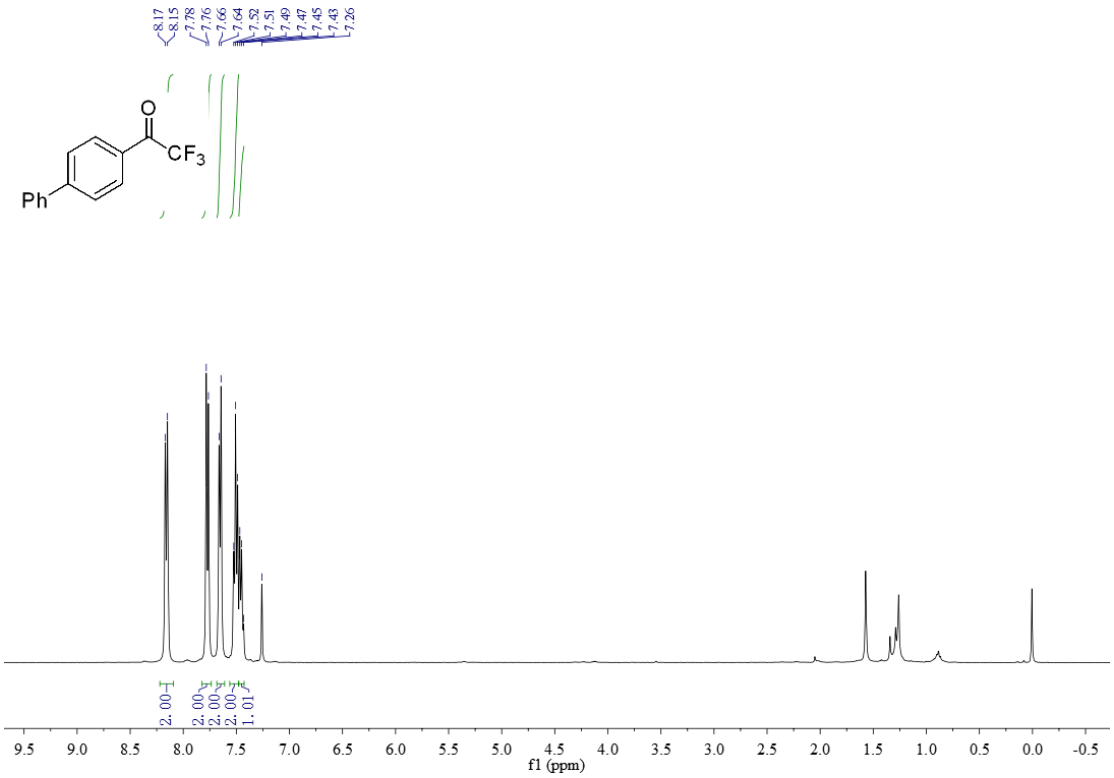
^{1}H NMR of **1f**



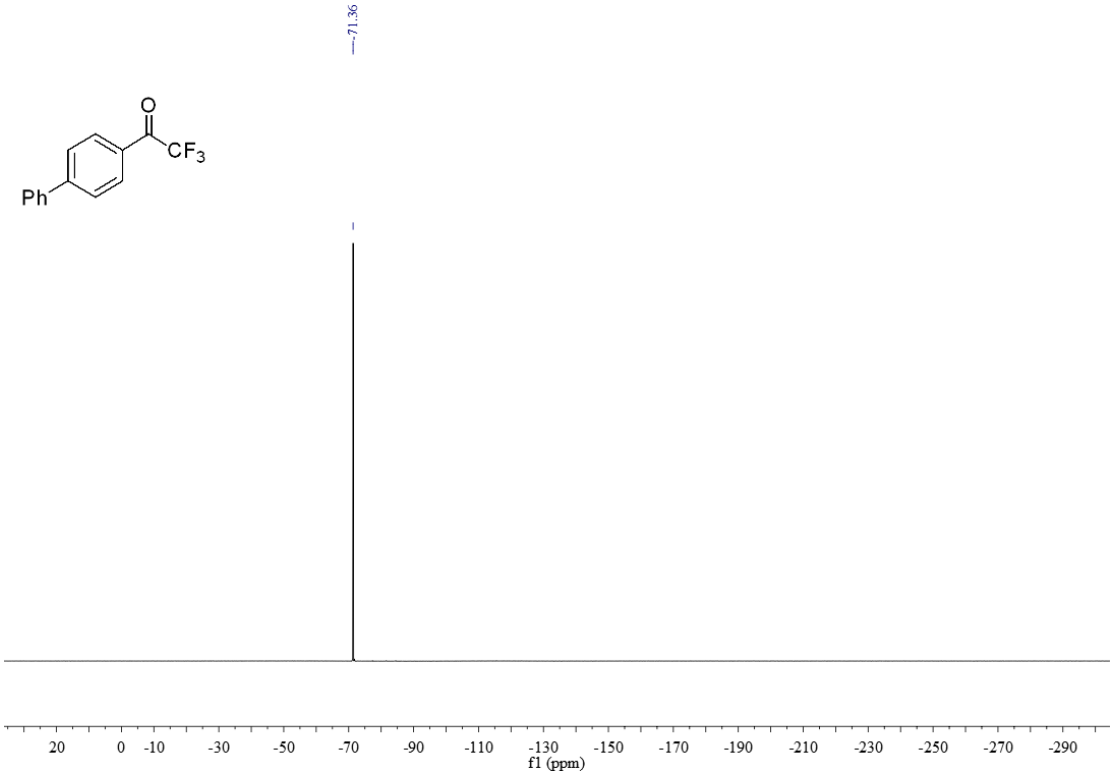
^{19}F NMR of **1f**



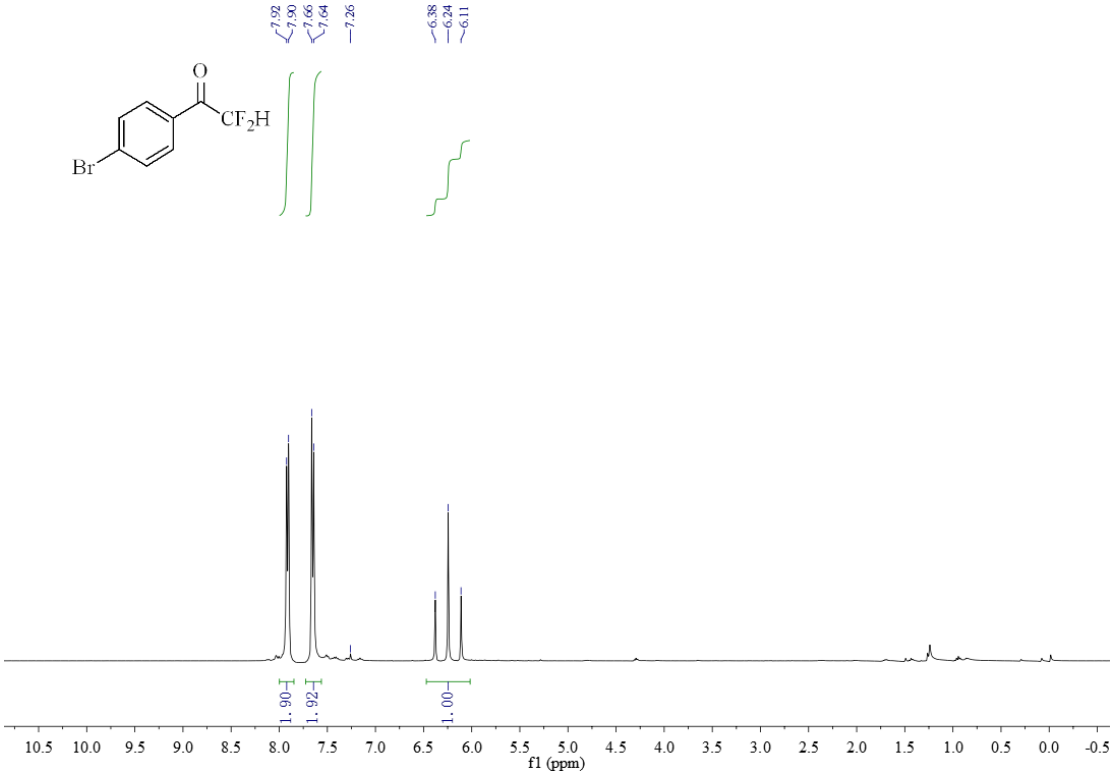
^{1}H NMR of **1g**



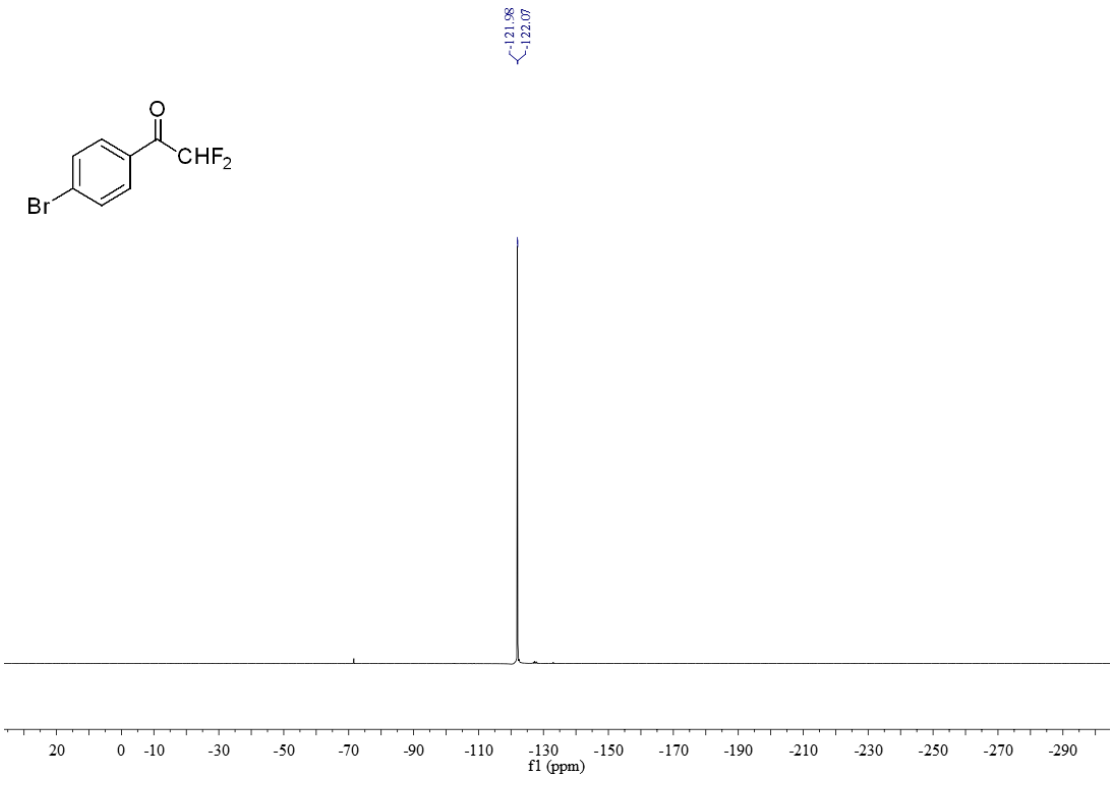
^{19}F NMR of **1g**



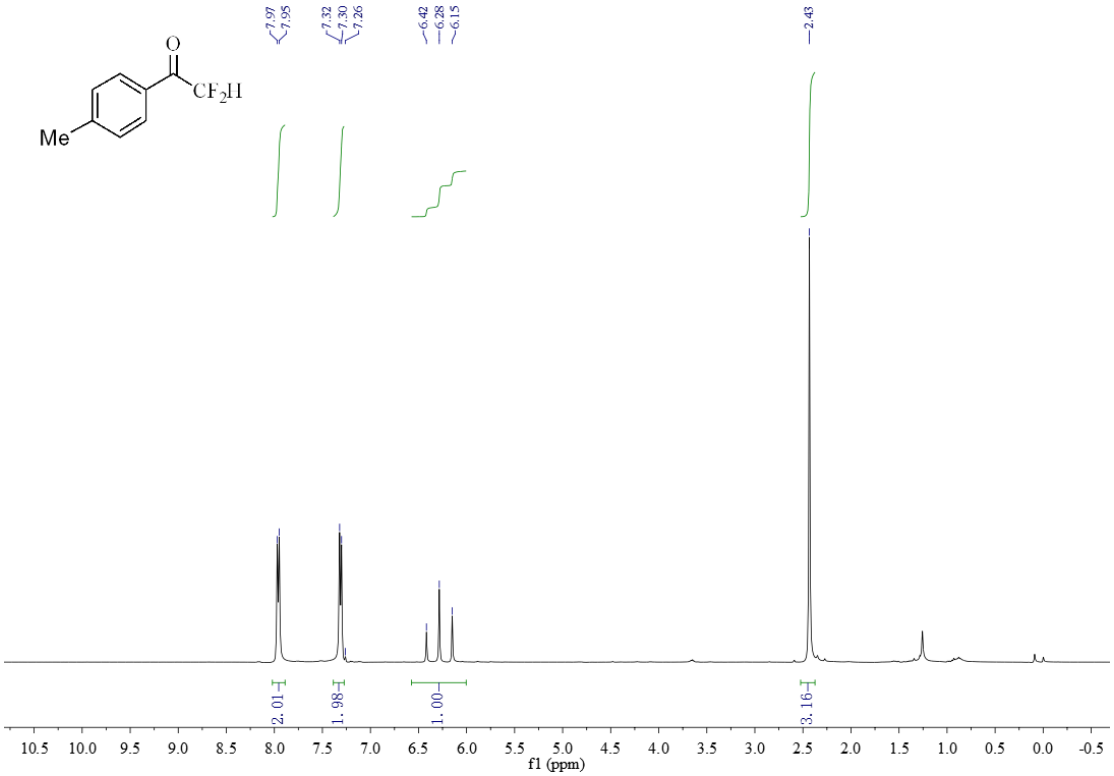
^{1}H NMR of **4a**



^{19}F NMR of **4a**



^{1}H NMR of **4b**



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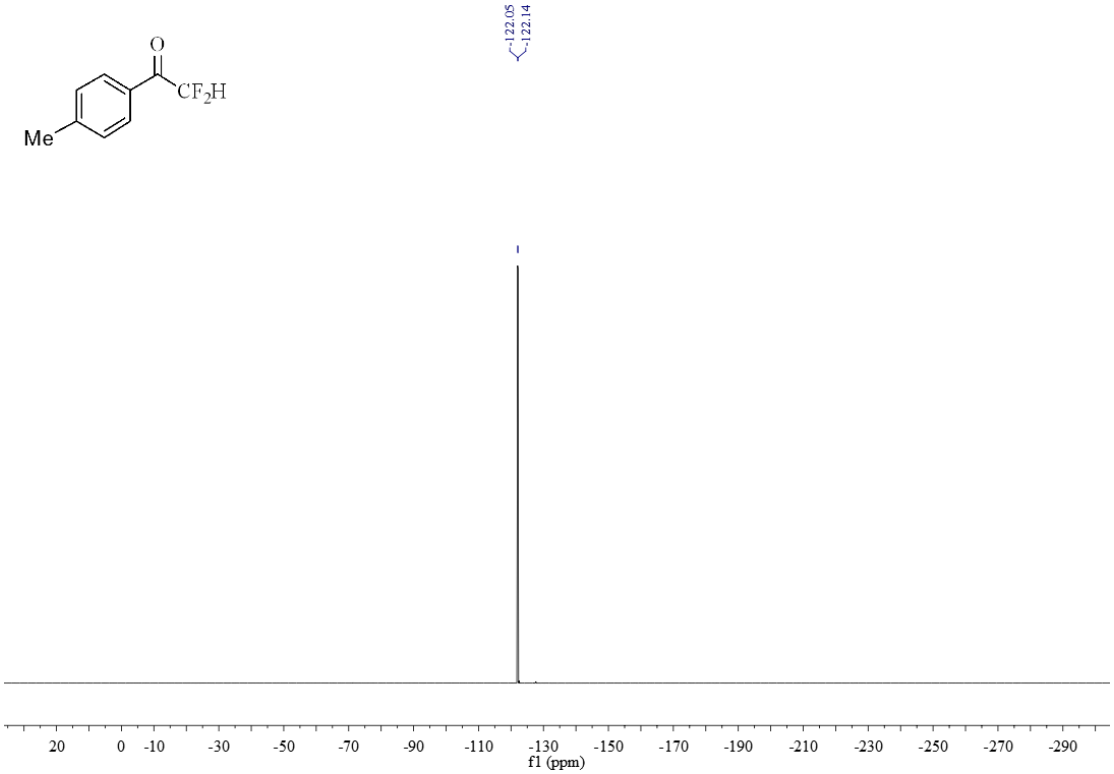
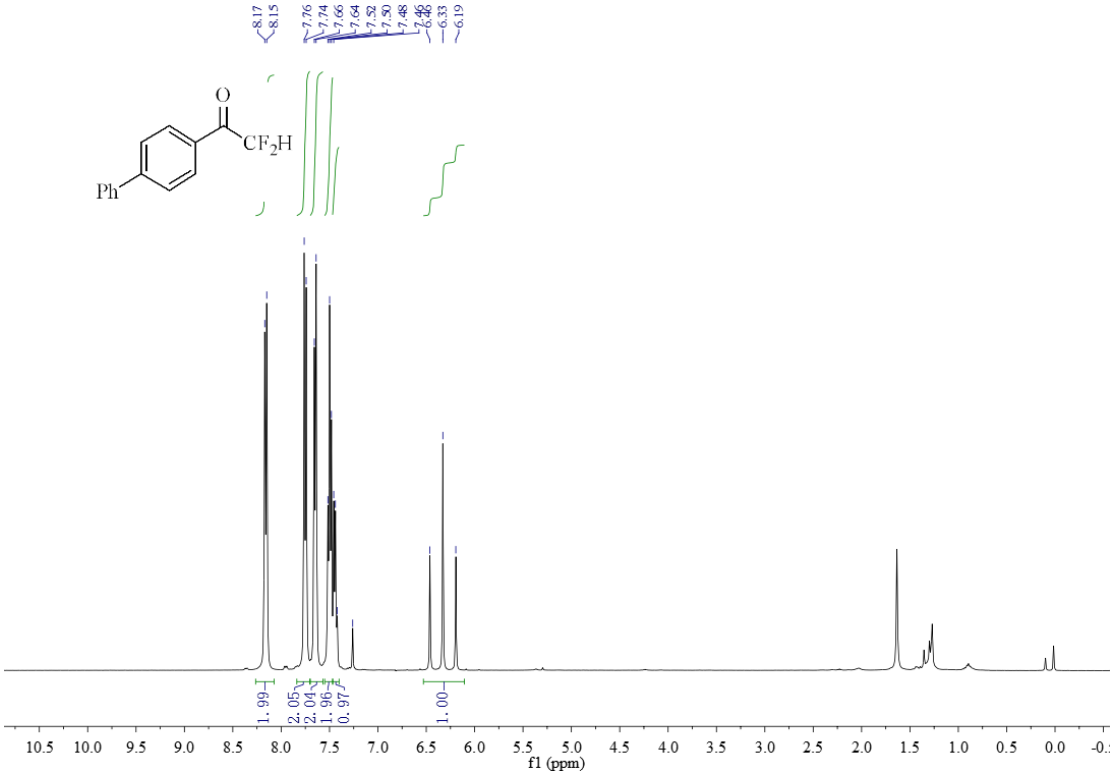
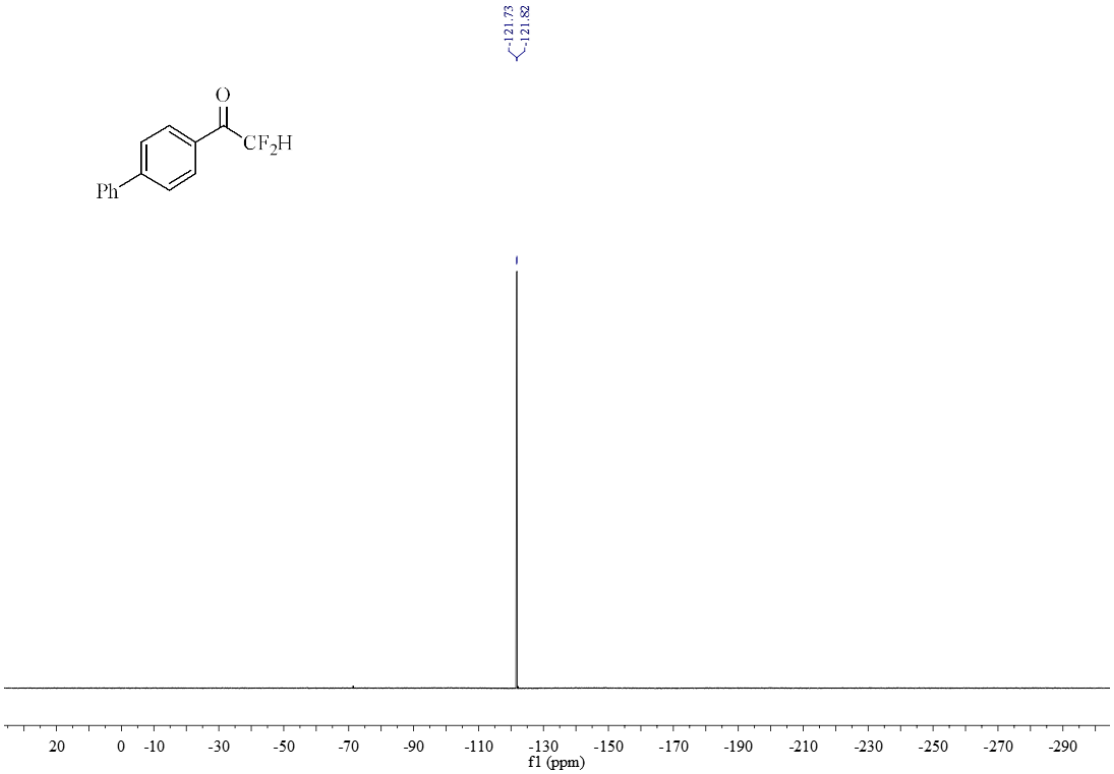


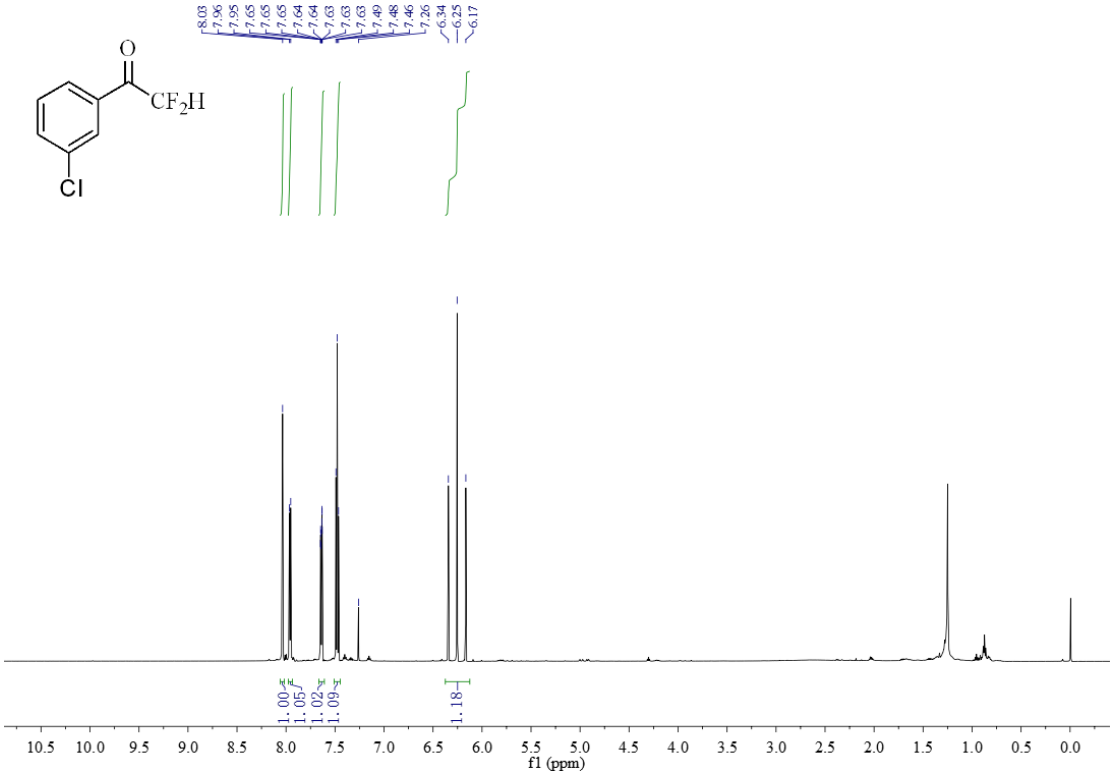
^{1}H NMR of **4c**



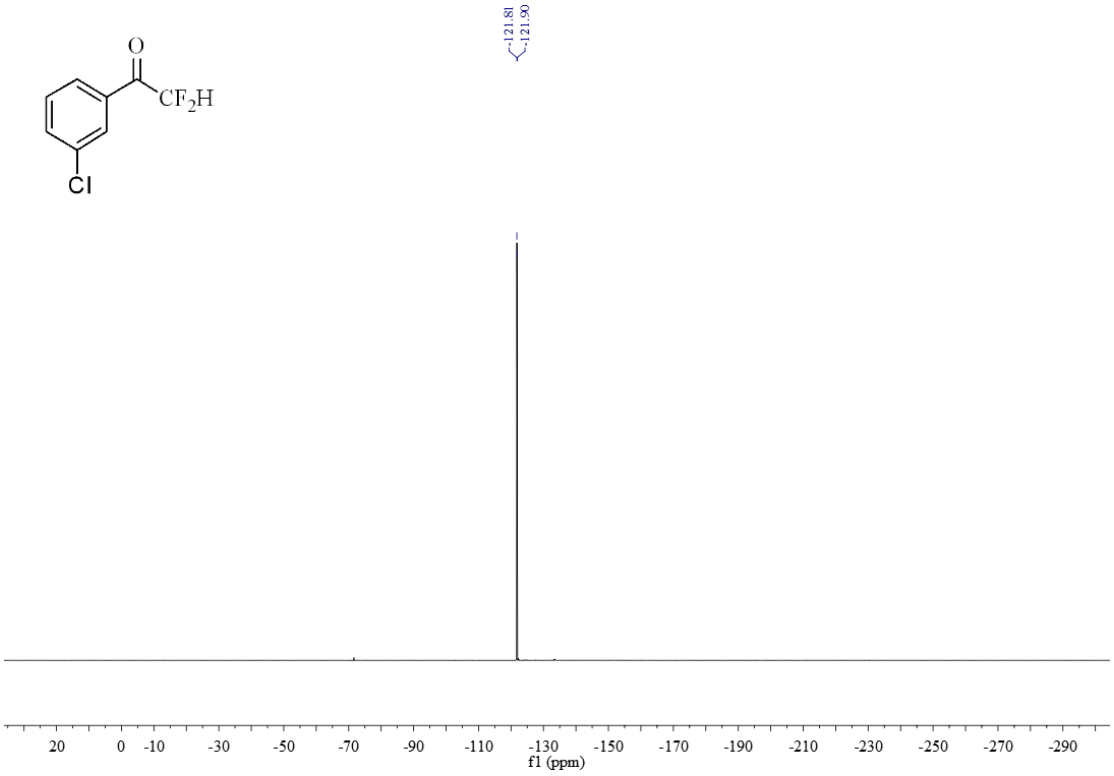
^{19}F NMR of **4c**



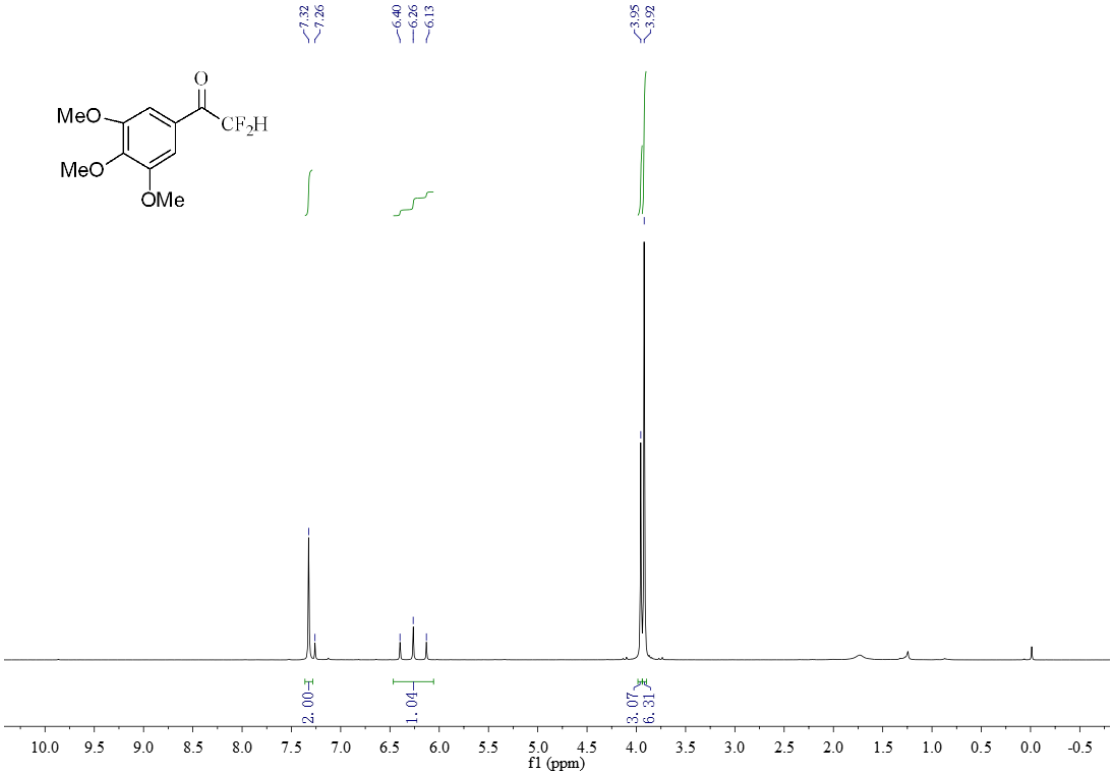
^{1}H NMR of **4d**



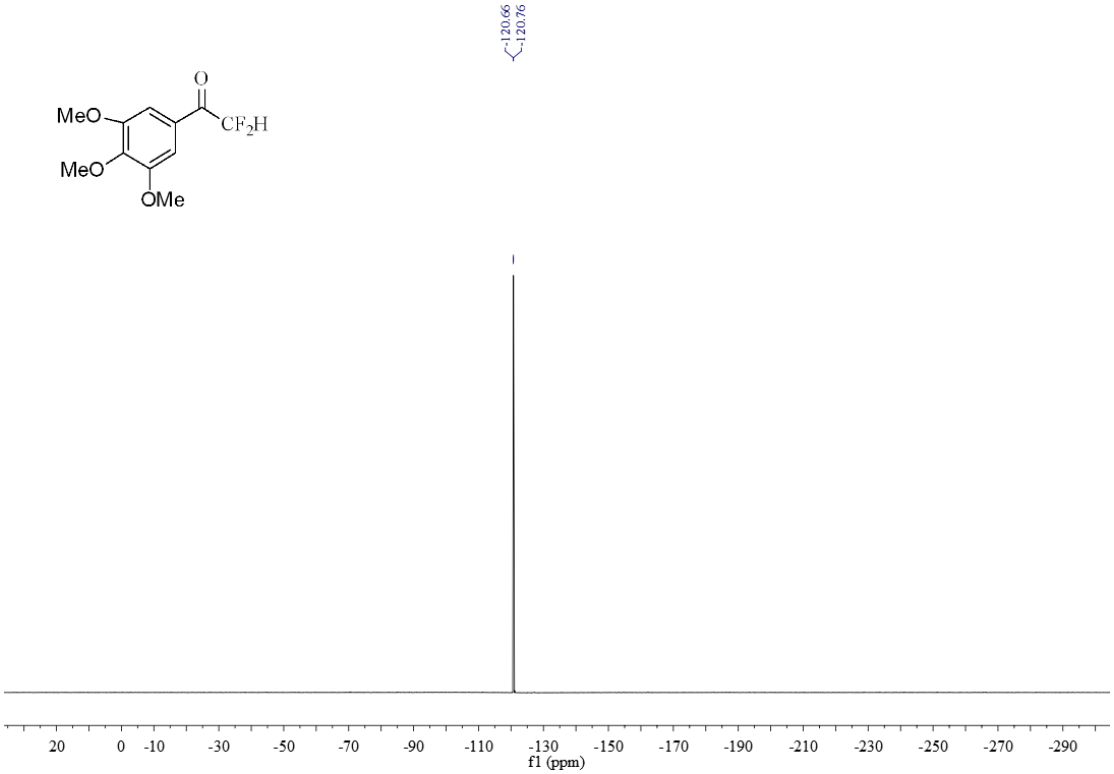
^{19}F NMR of **4d**



^{1}H NMR of **4e**



^{19}F NMR of **4e**



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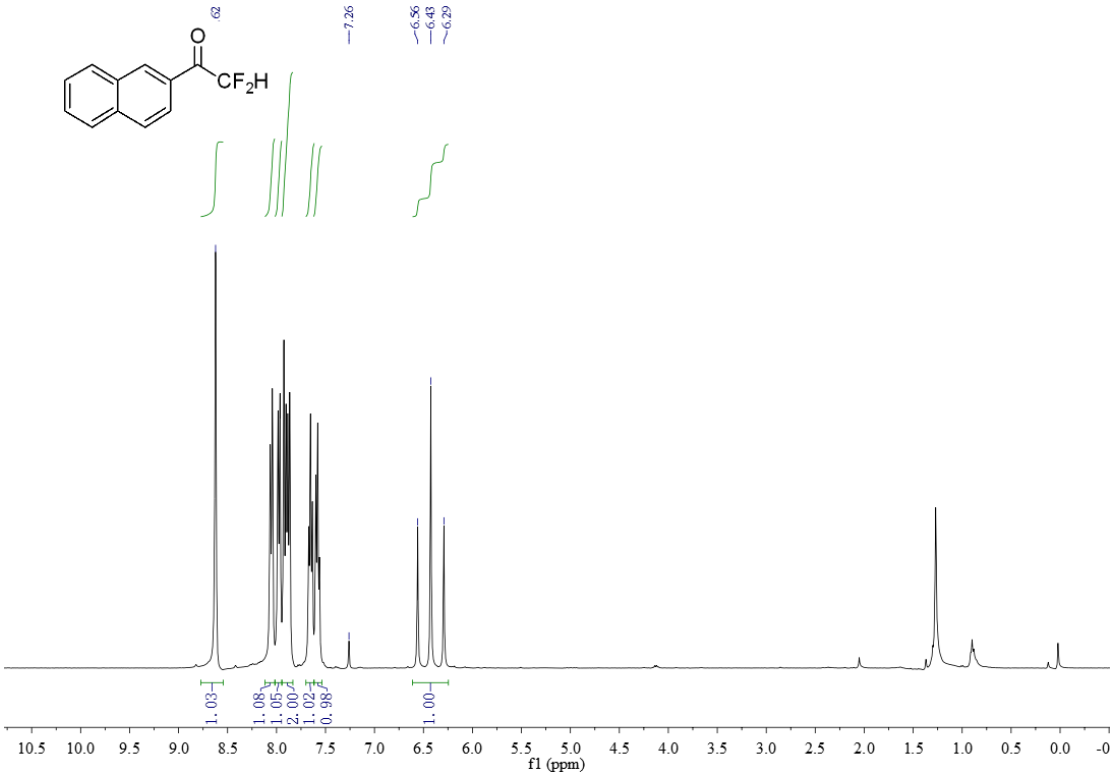
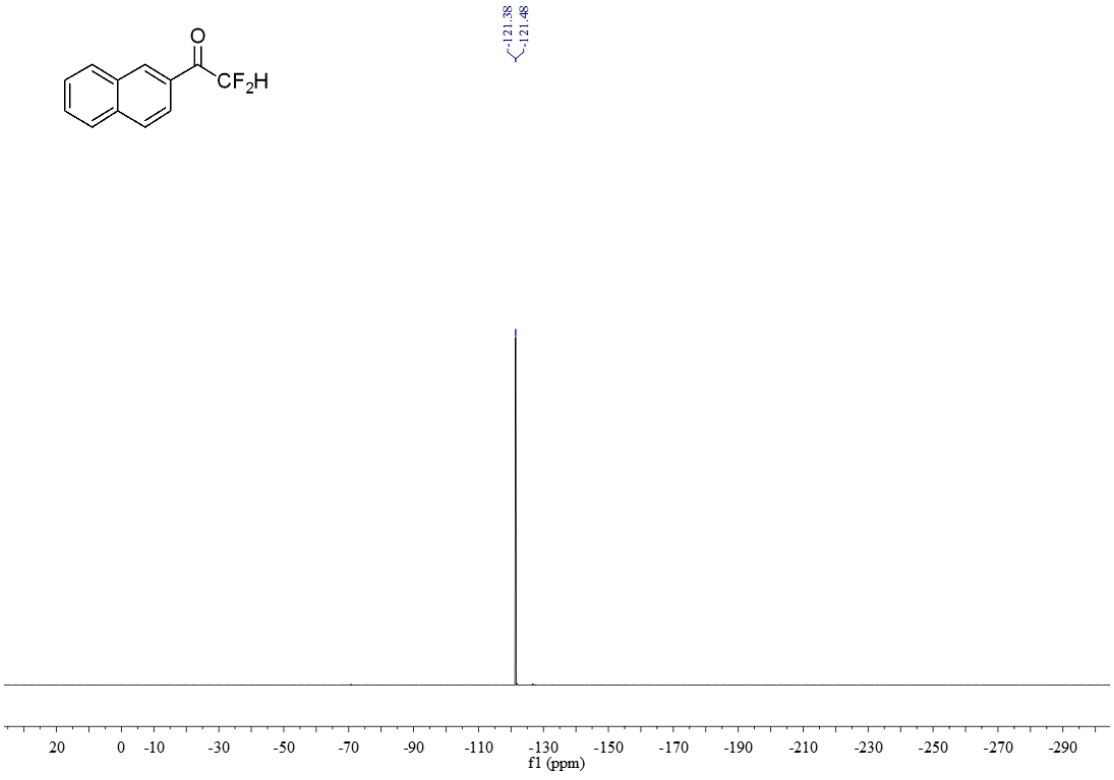
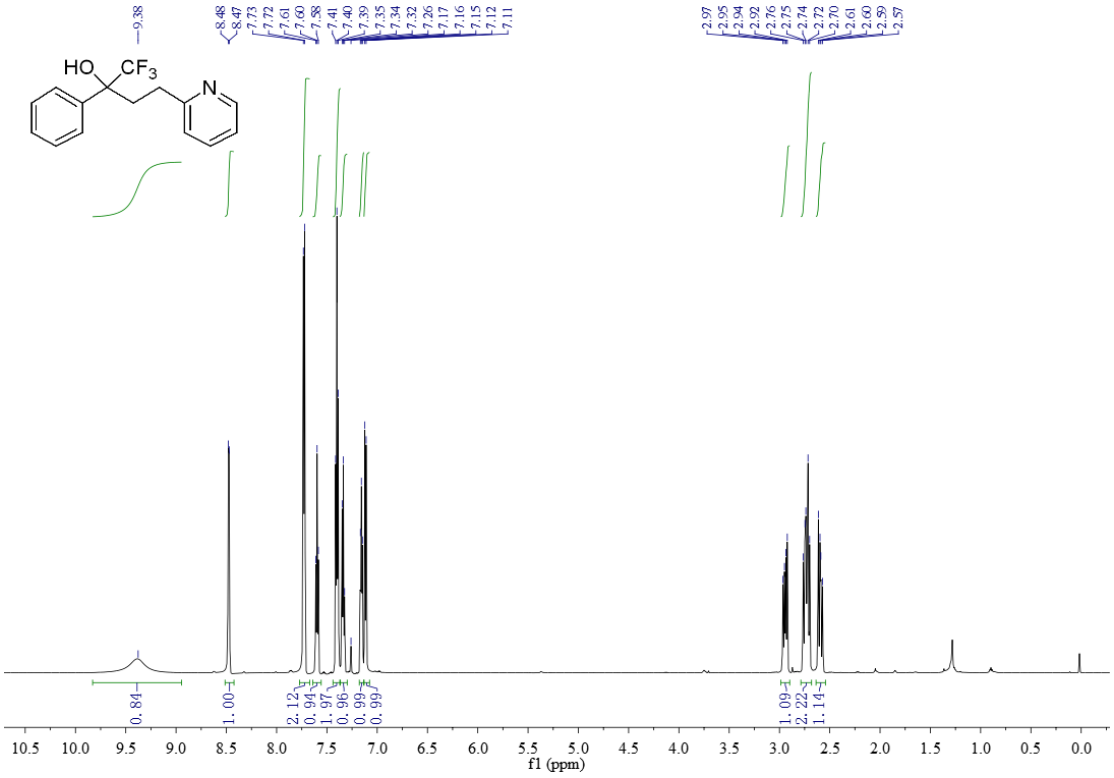


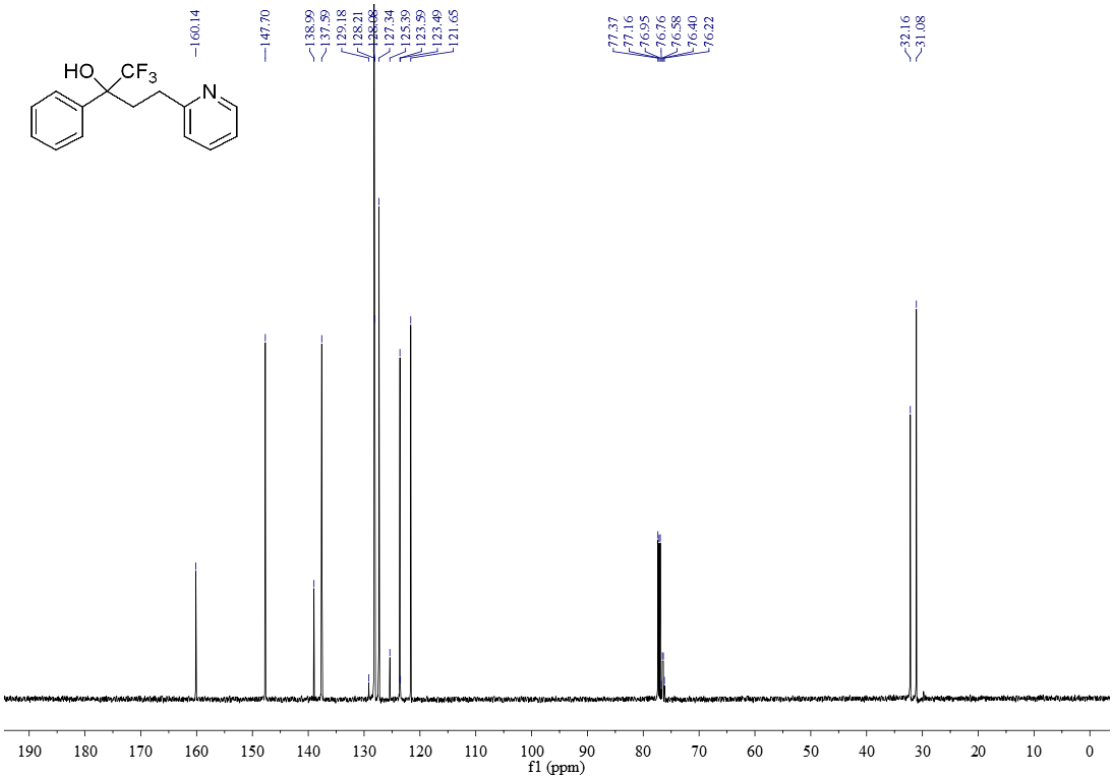
^{19}F NMR of **4f**



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

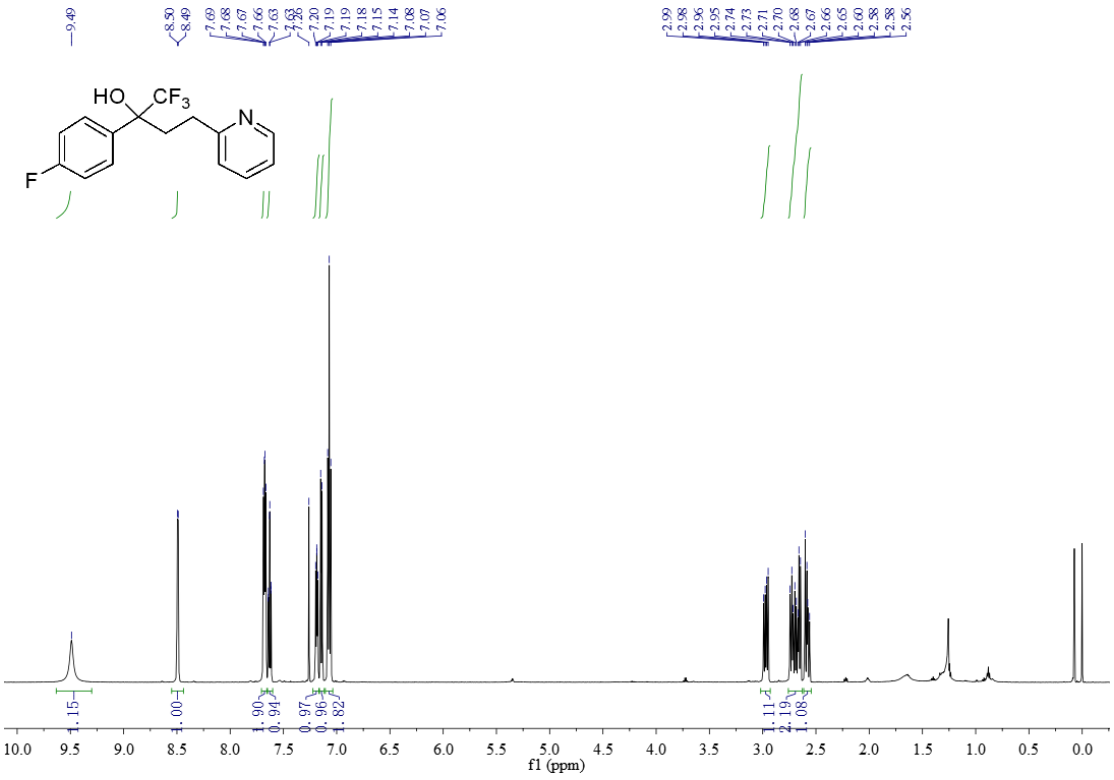


^{13}C NMR of **3a**

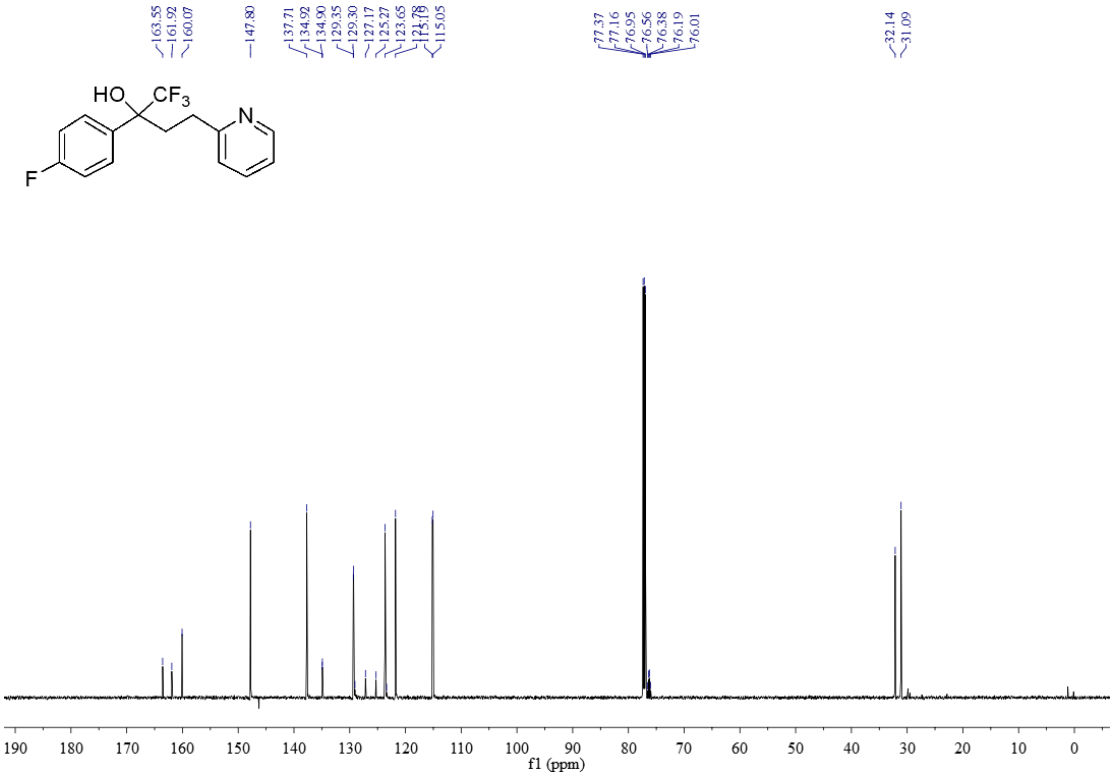


^{19}F NMR of **3a**

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



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



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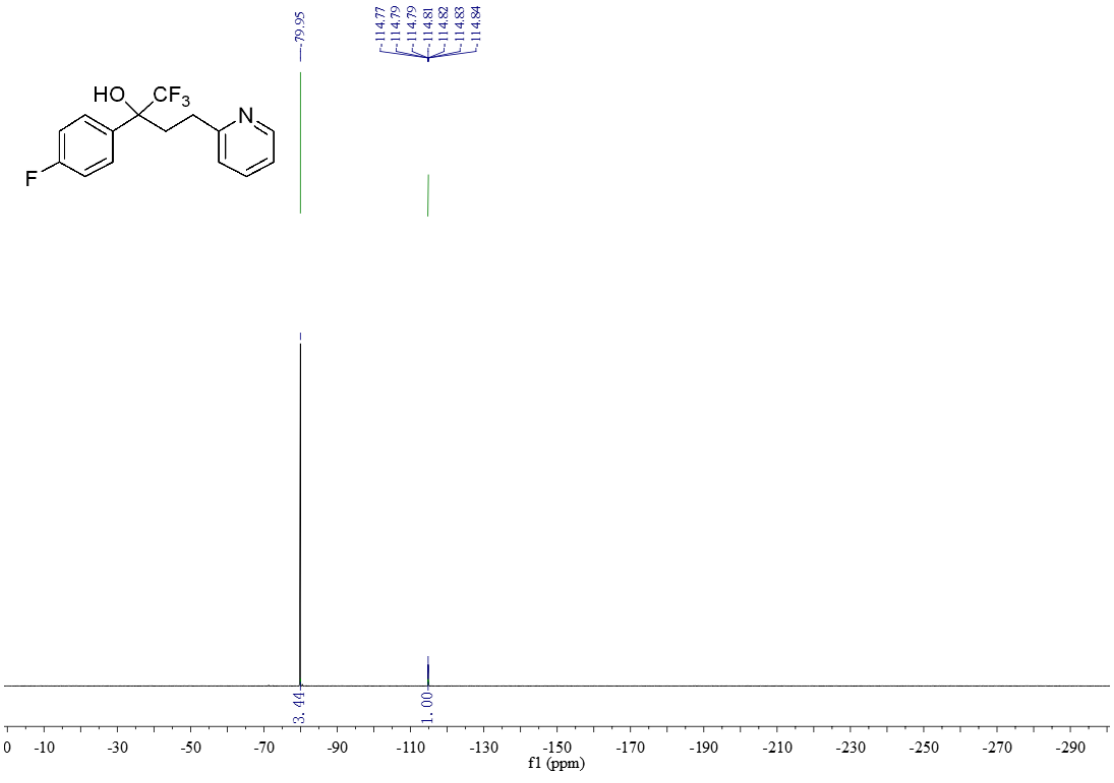
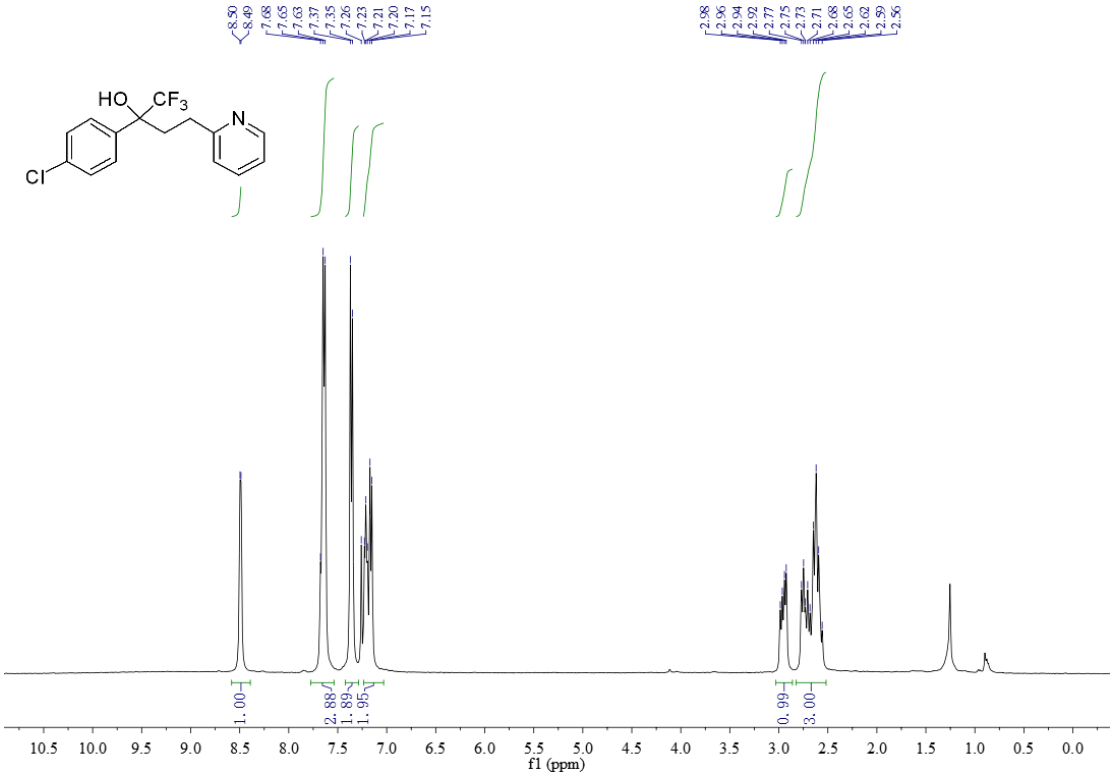
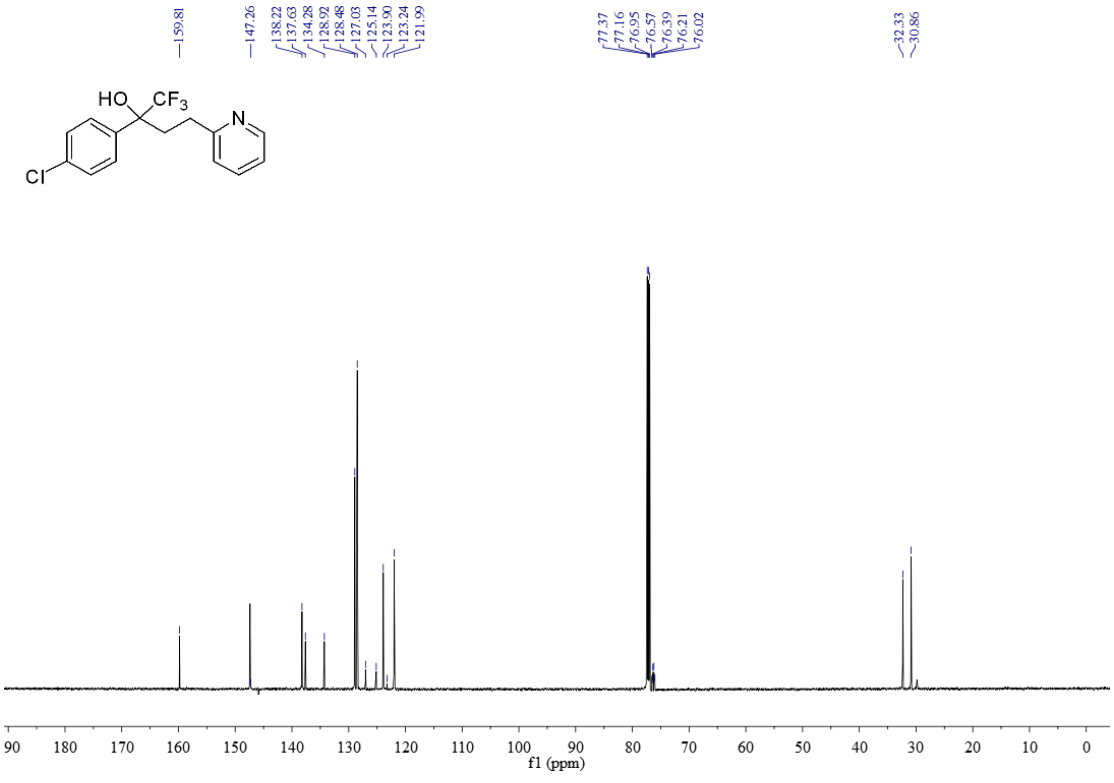


^{1}H NMR of **3c**

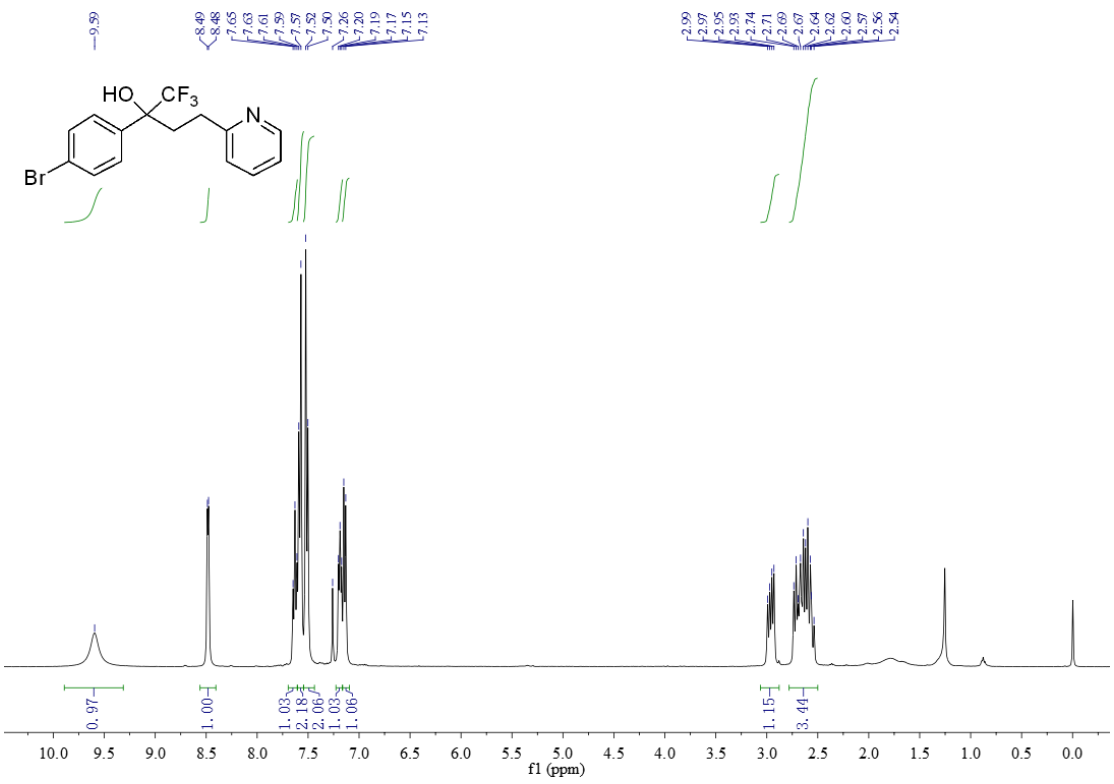


^{13}C NMR of **3c**

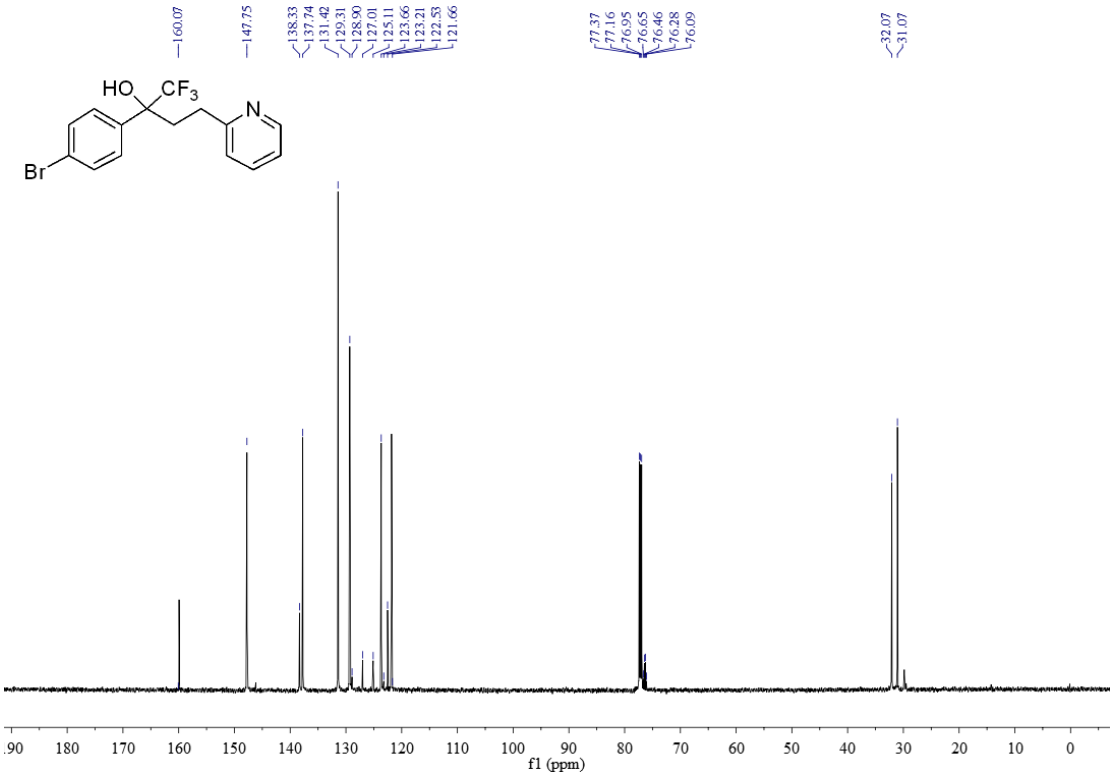


^{19}F NMR of **3c**

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

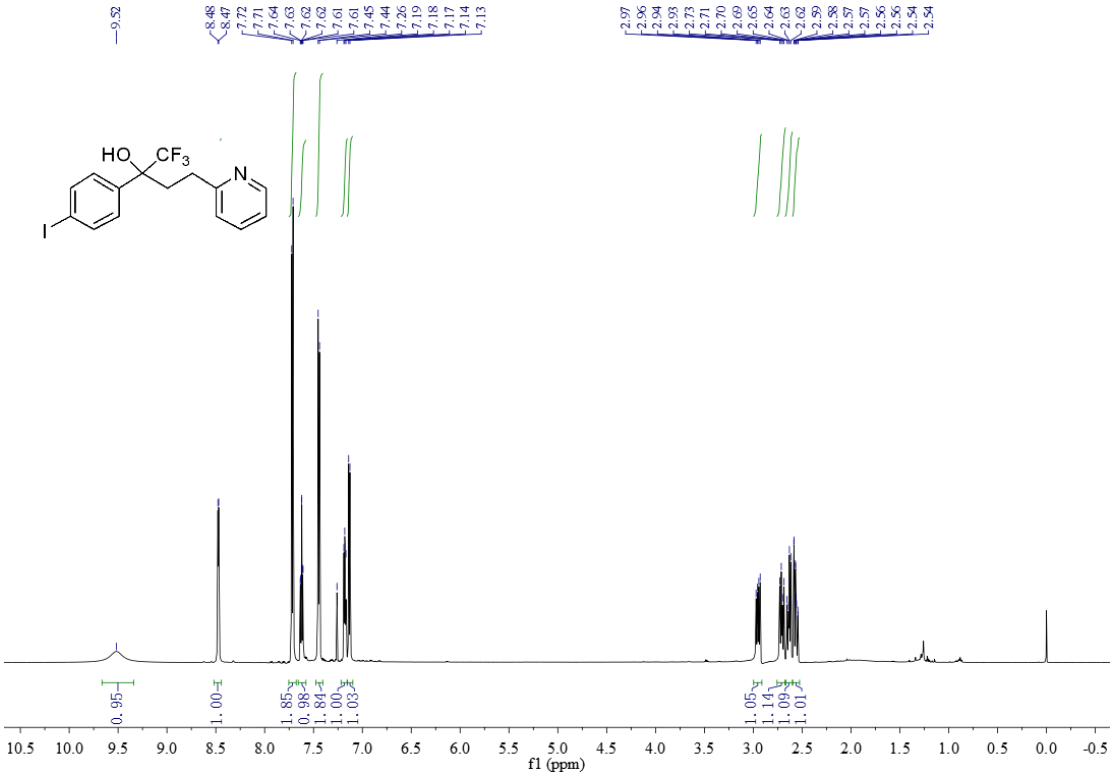


^{13}C NMR of **3d**

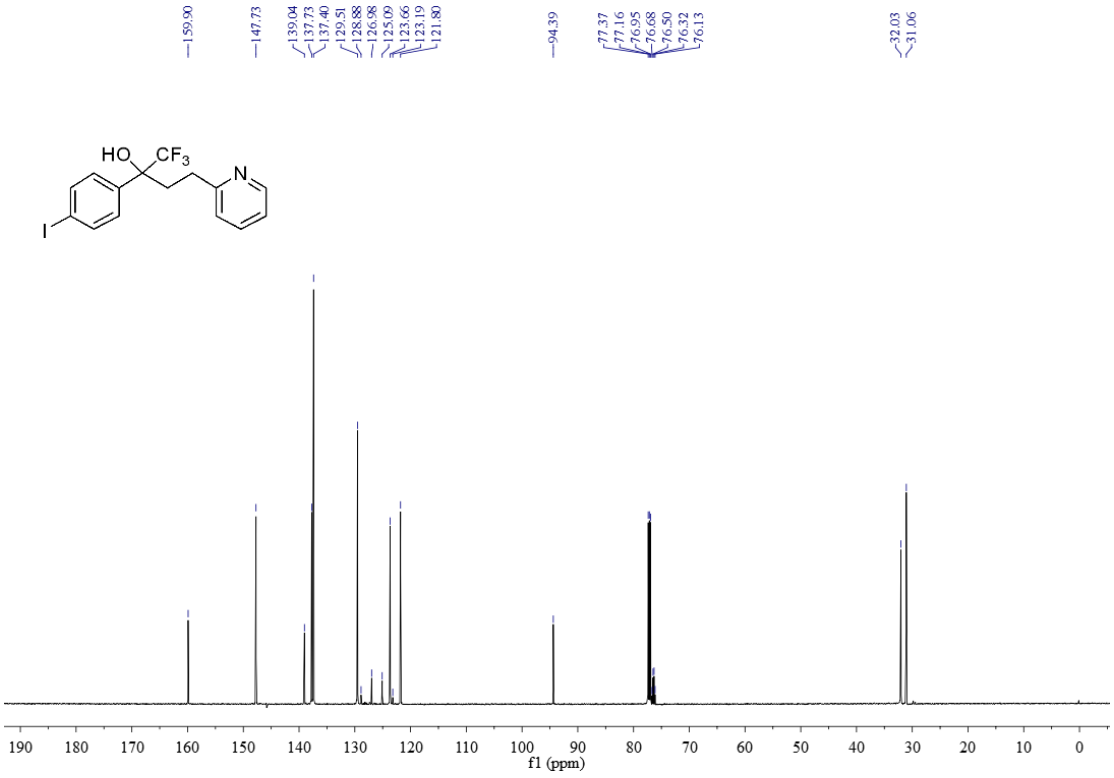


^{19}F NMR of **3d**

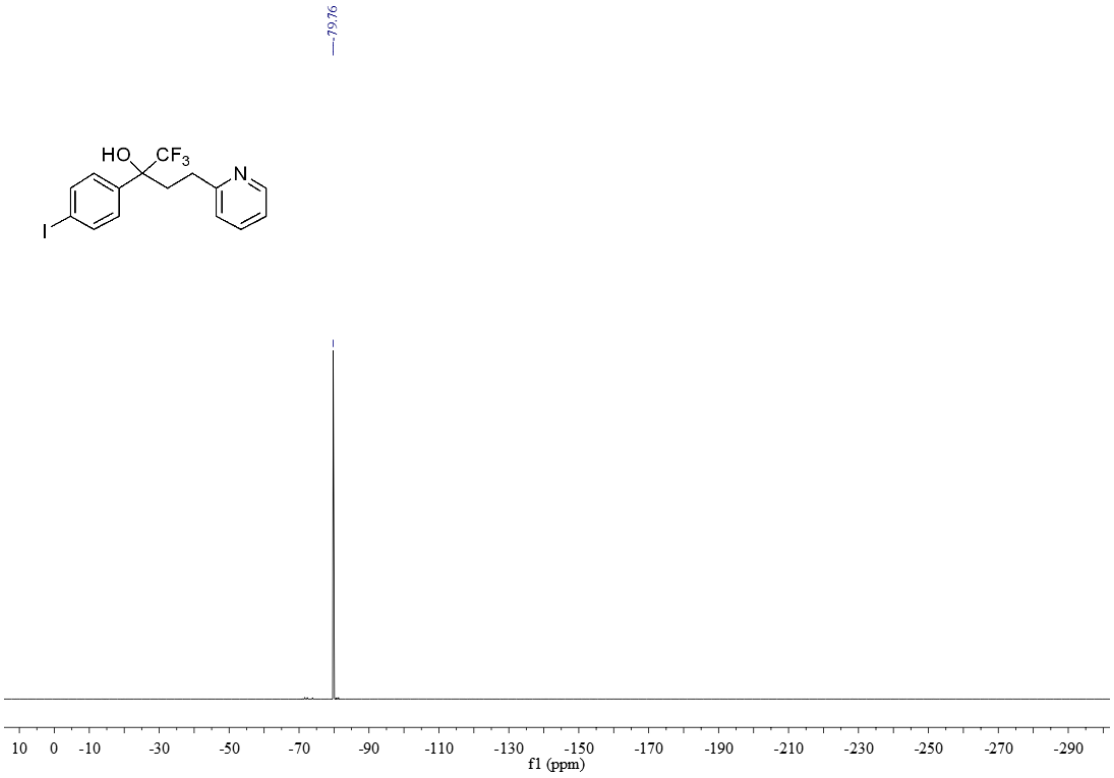
^{1}H NMR of **3e**



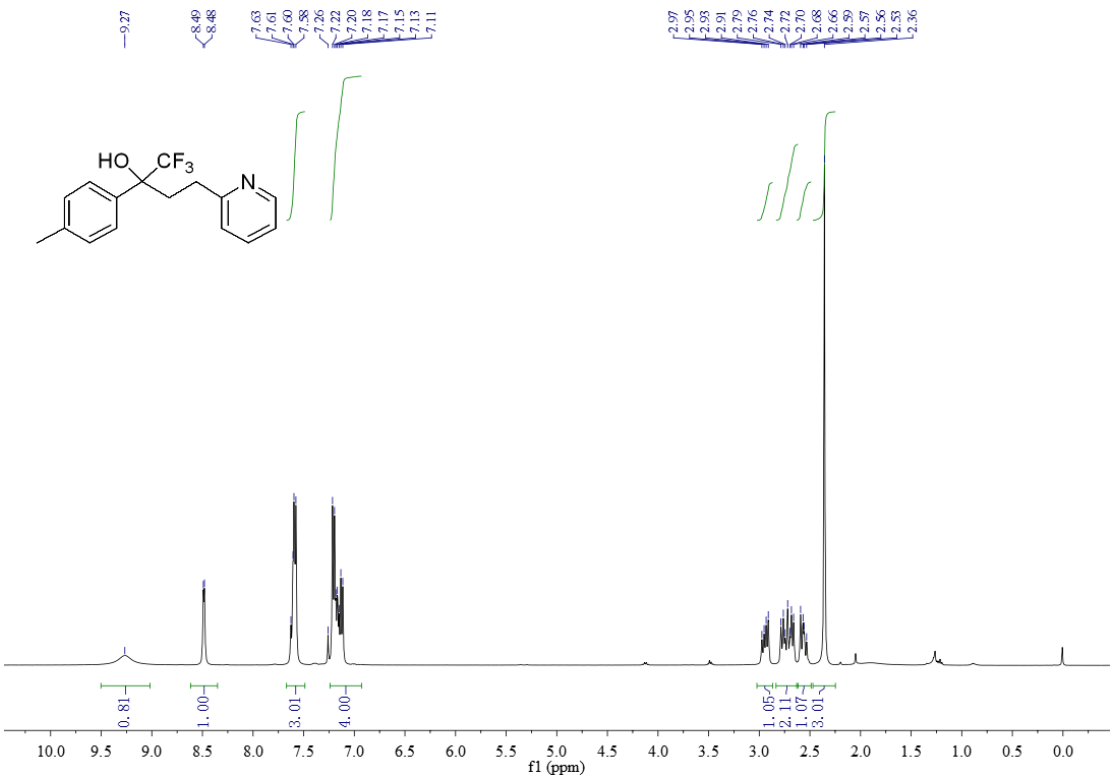
^{13}C NMR of **3e**



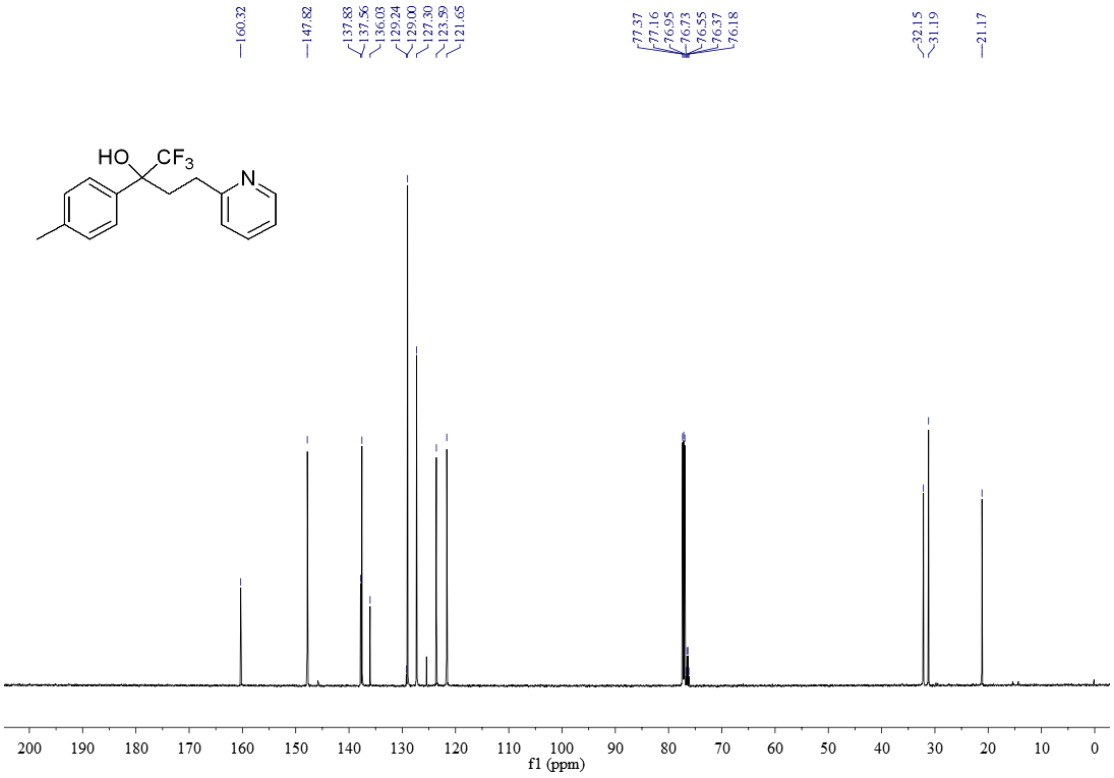
^{19}F NMR of **3e**



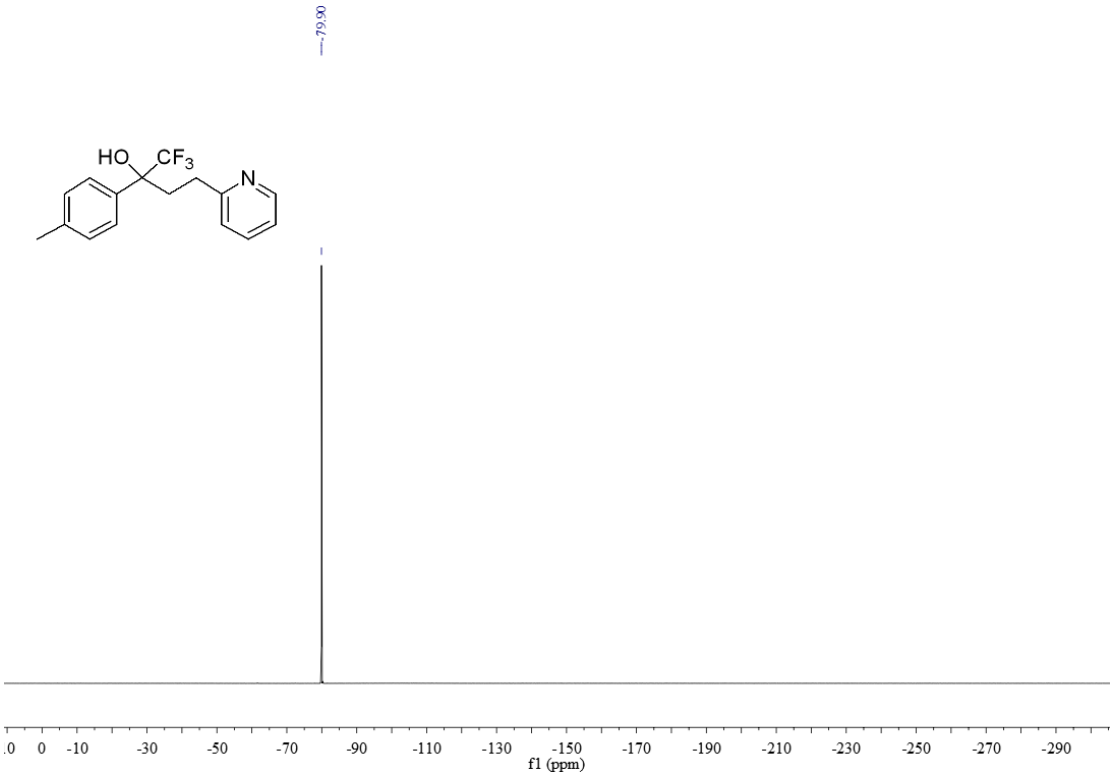
^{1}H NMR of **3f**



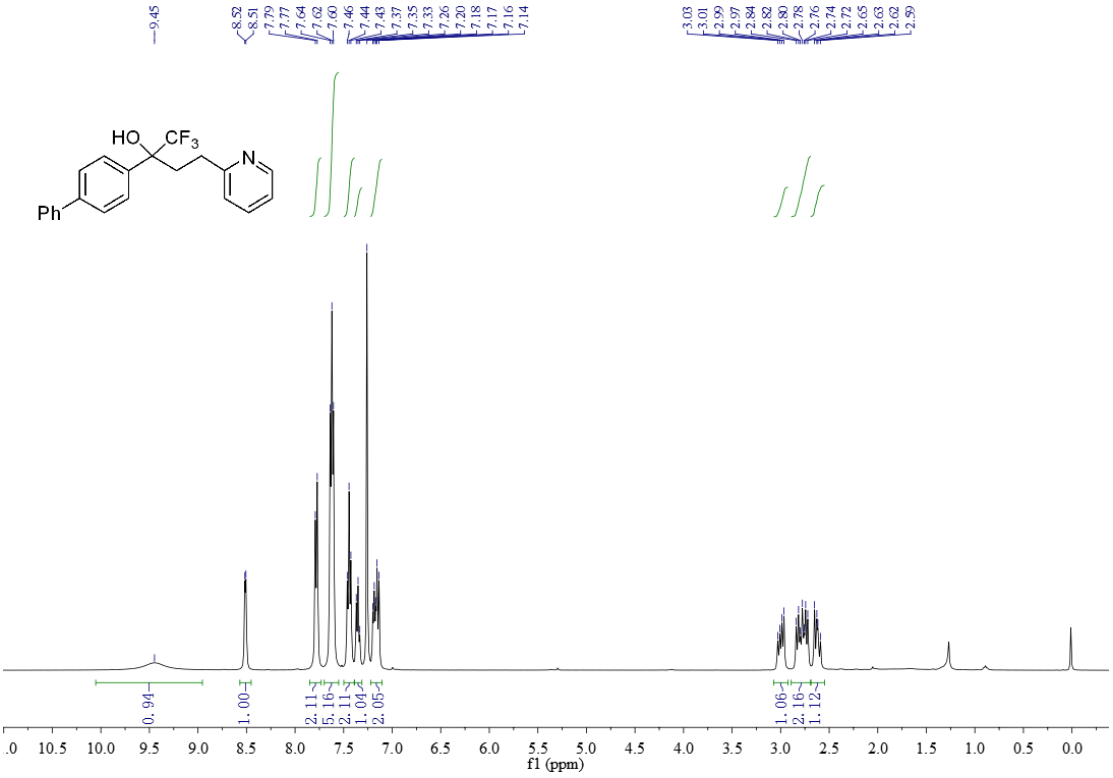
^{13}C NMR of **3f**



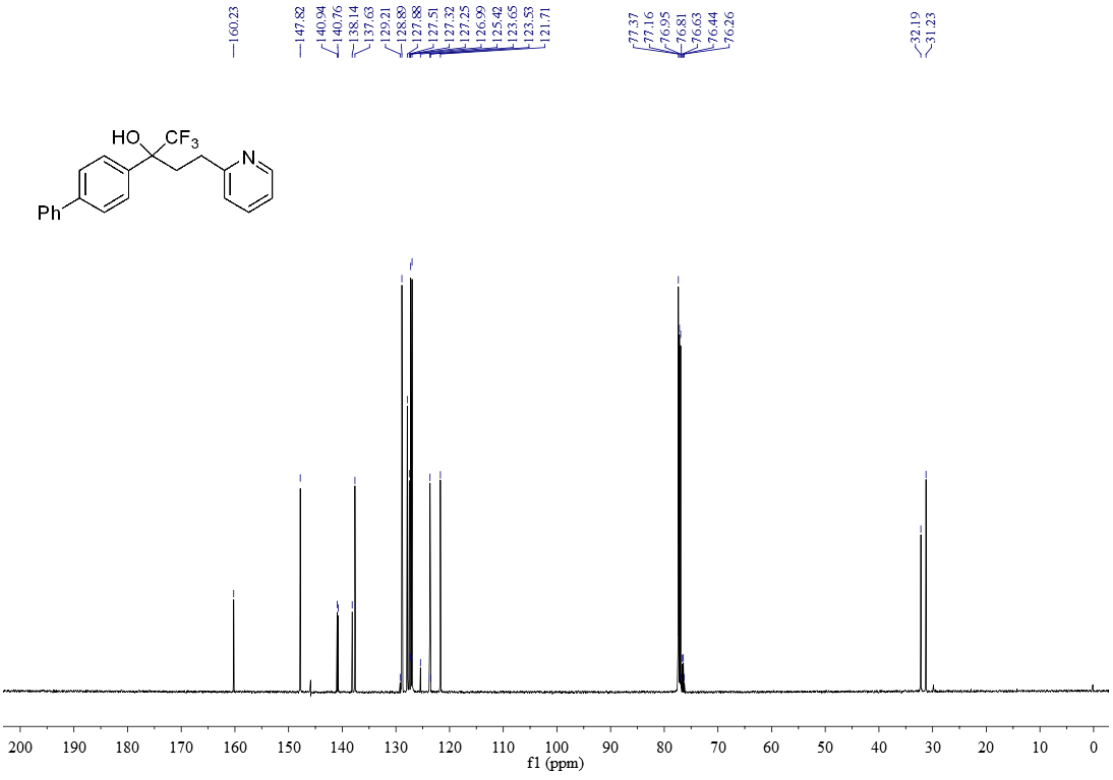
^{19}F NMR of **3f**



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

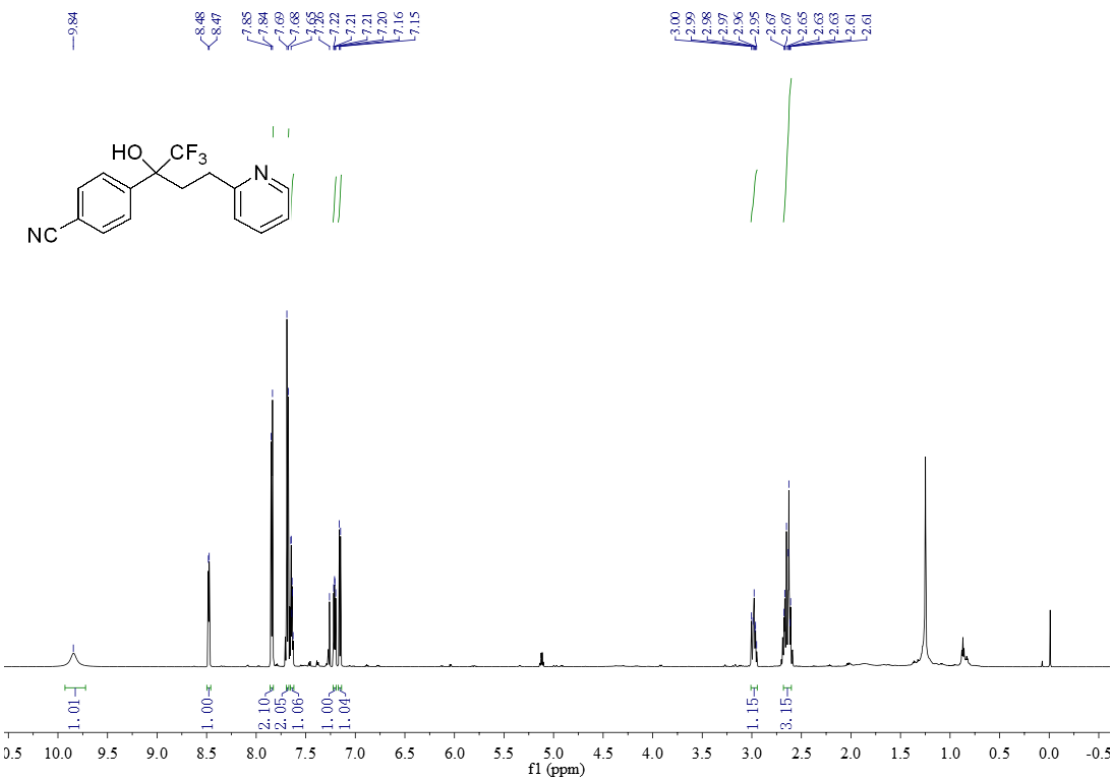


^{13}C NMR of **3g**

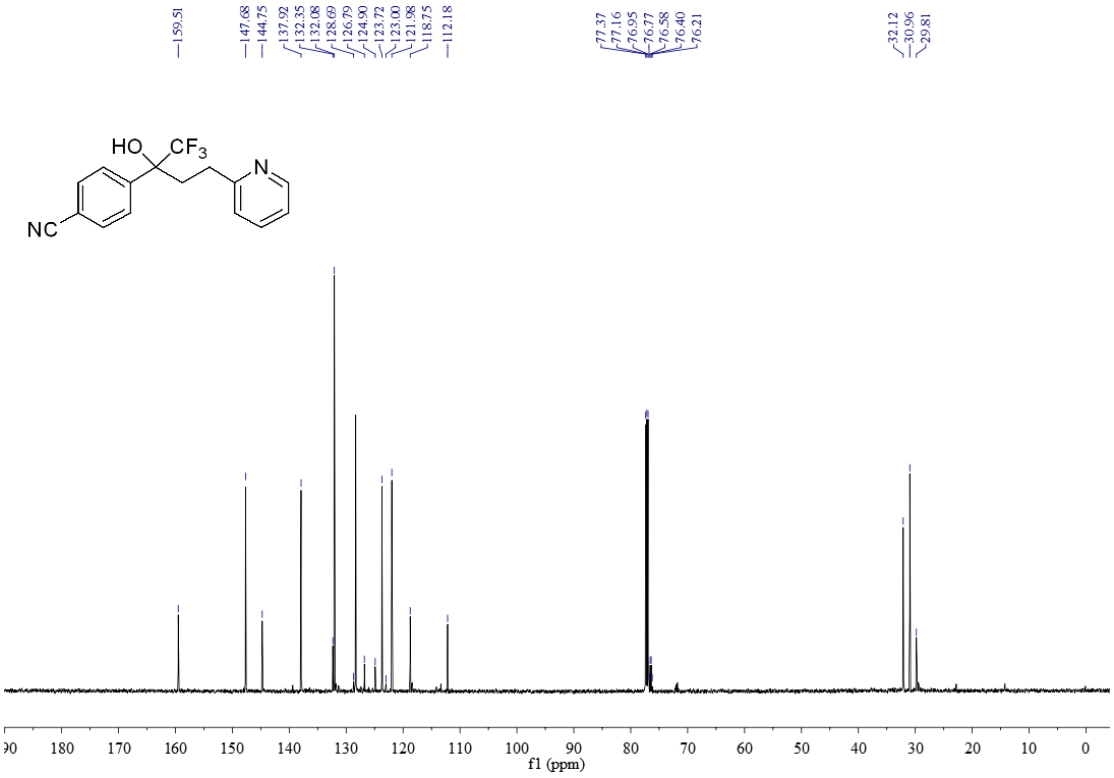


^{19}F NMR of **3g**

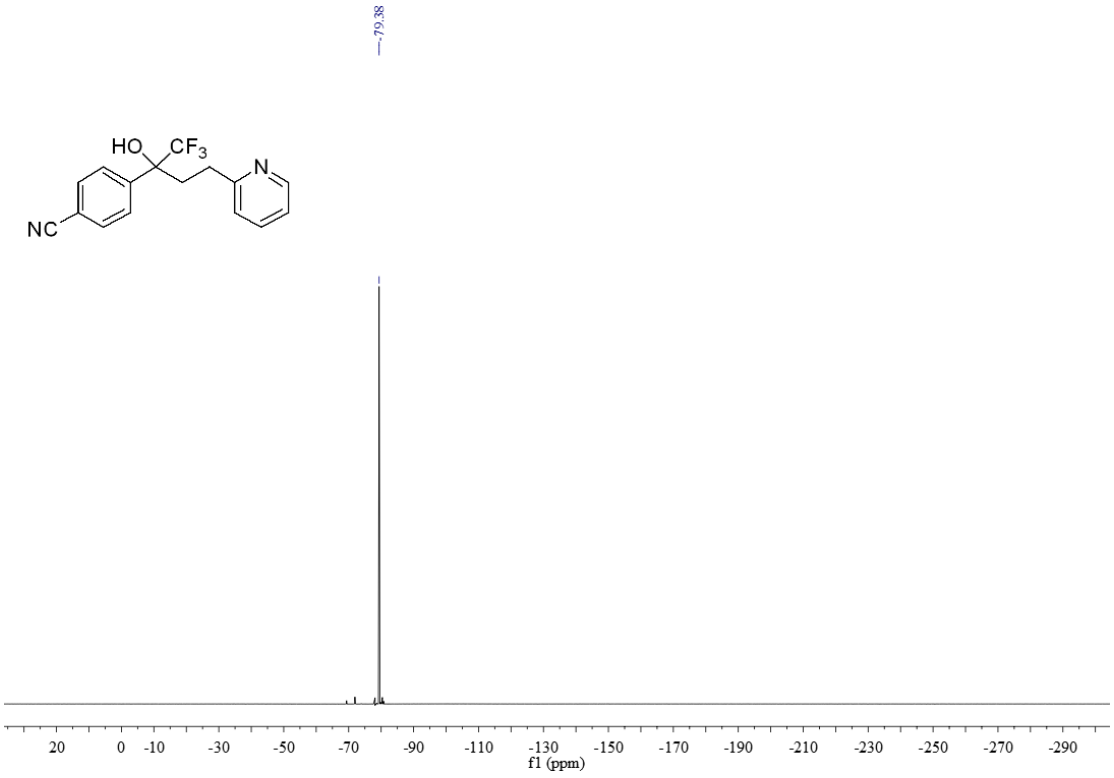
^{1}H NMR of **3h**



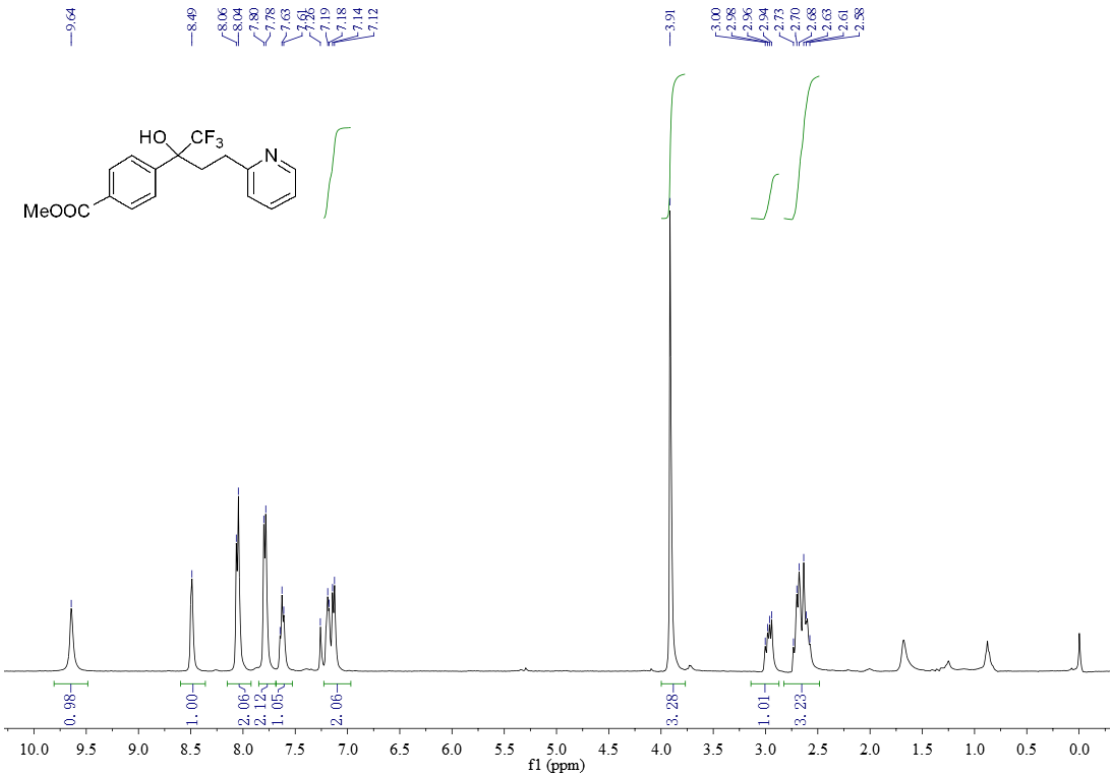
^{13}C NMR of **3h**



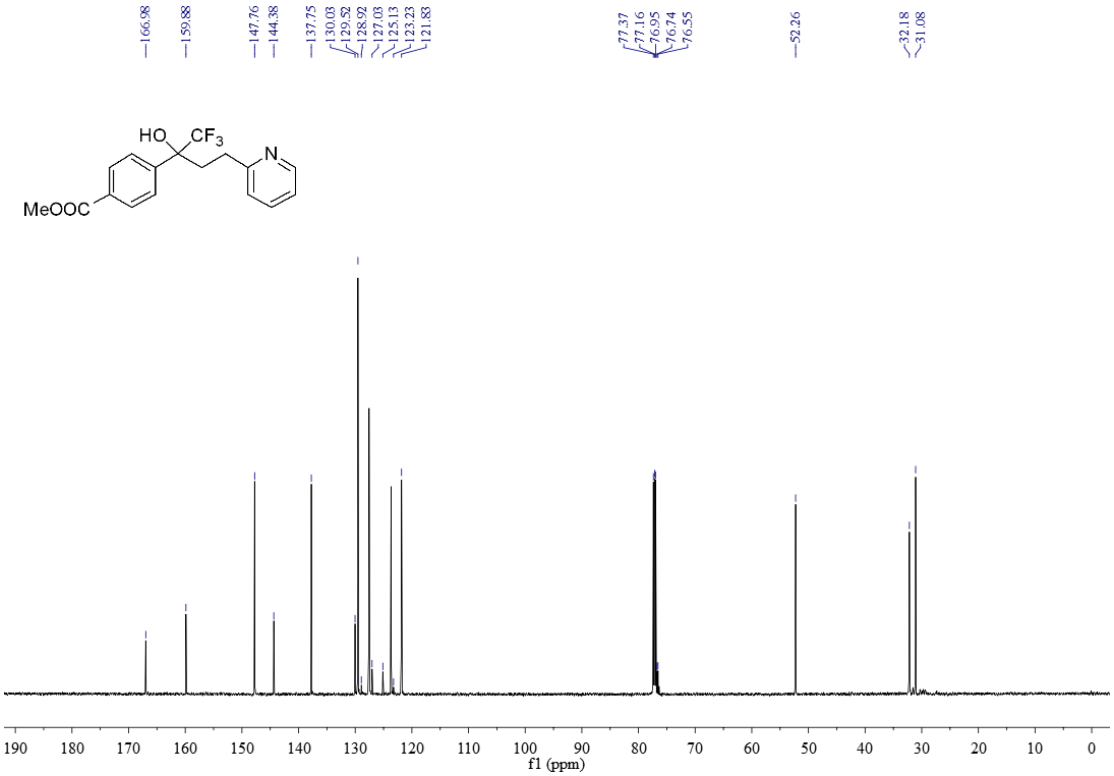
^{19}F NMR of **3h**



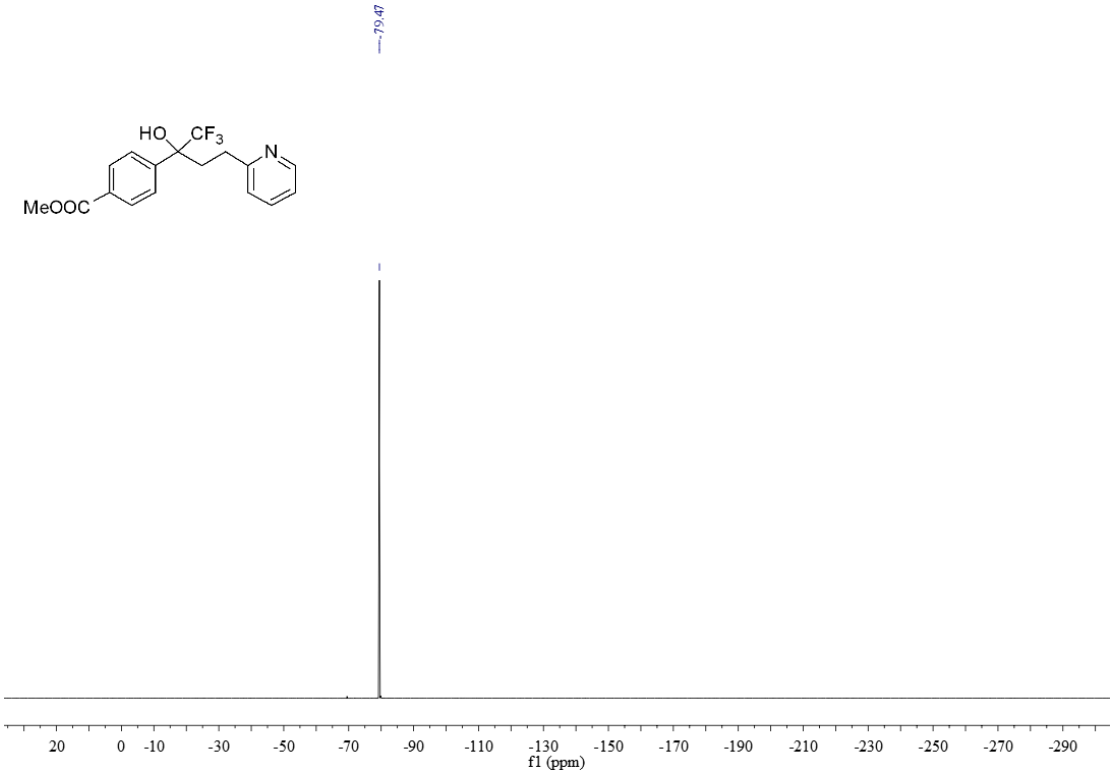
^{1}H NMR of **3i**



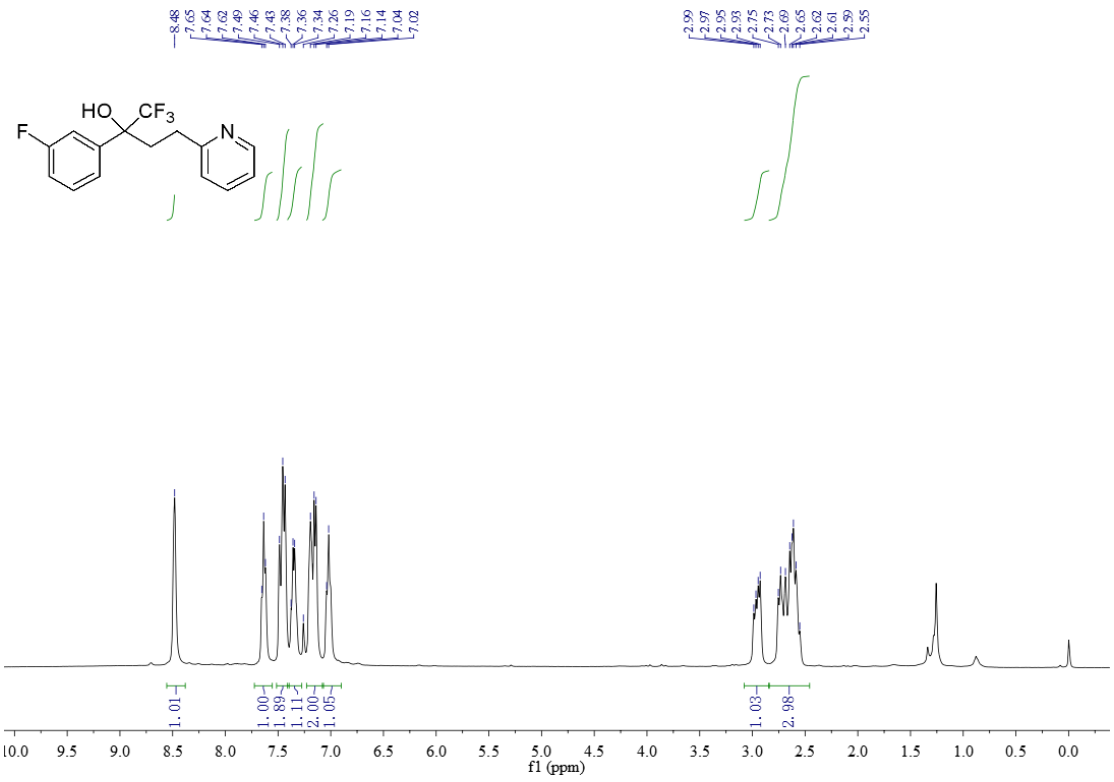
^{13}C NMR of **3i**



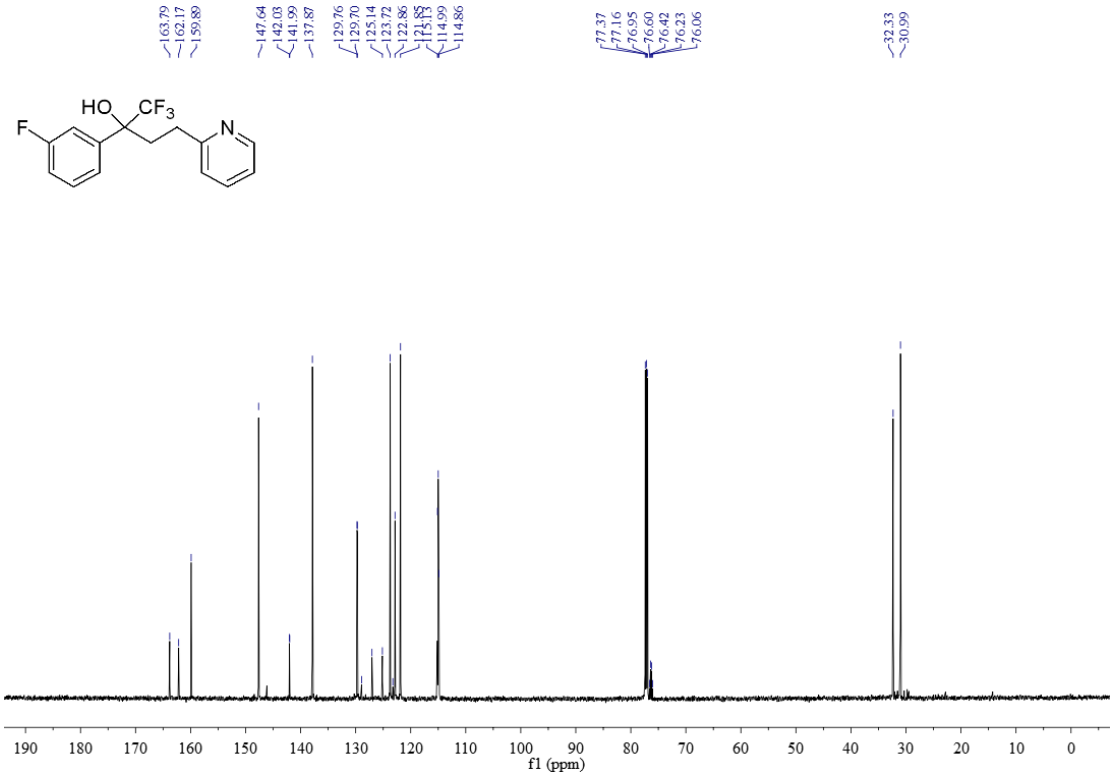
^{19}F NMR of **3i**



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

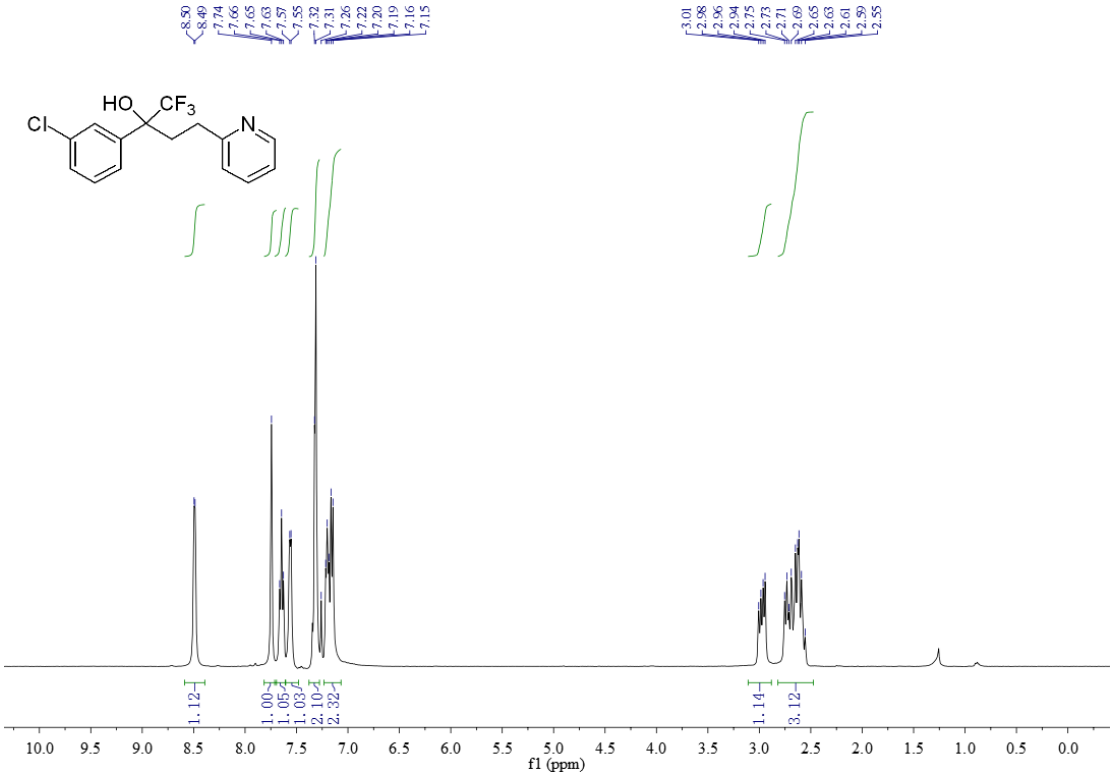


^{13}C NMR of **3j**

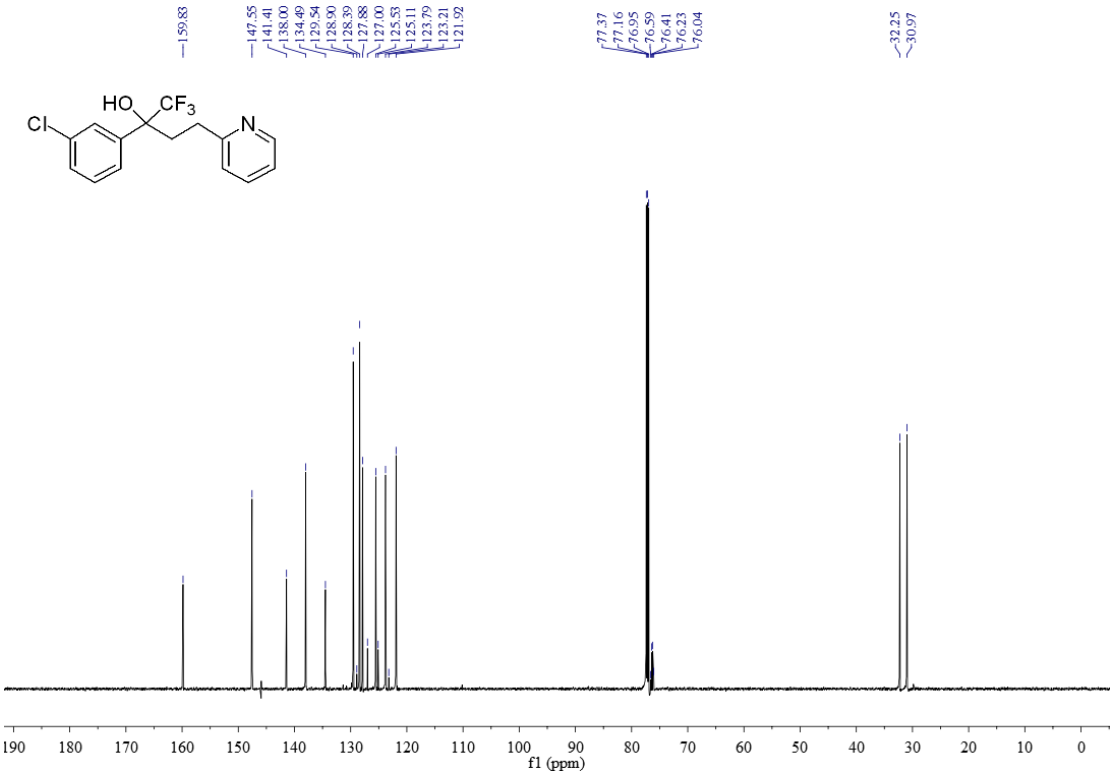


^{19}F NMR of **3j**

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

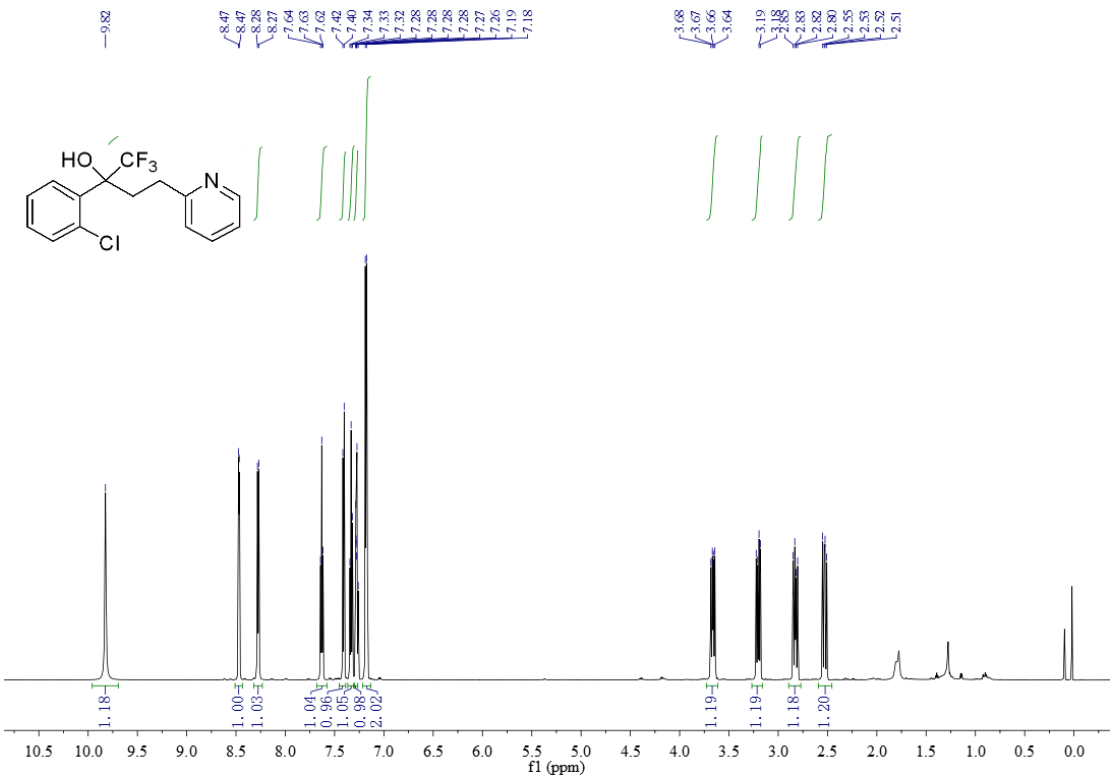


^{13}C NMR of **3k**

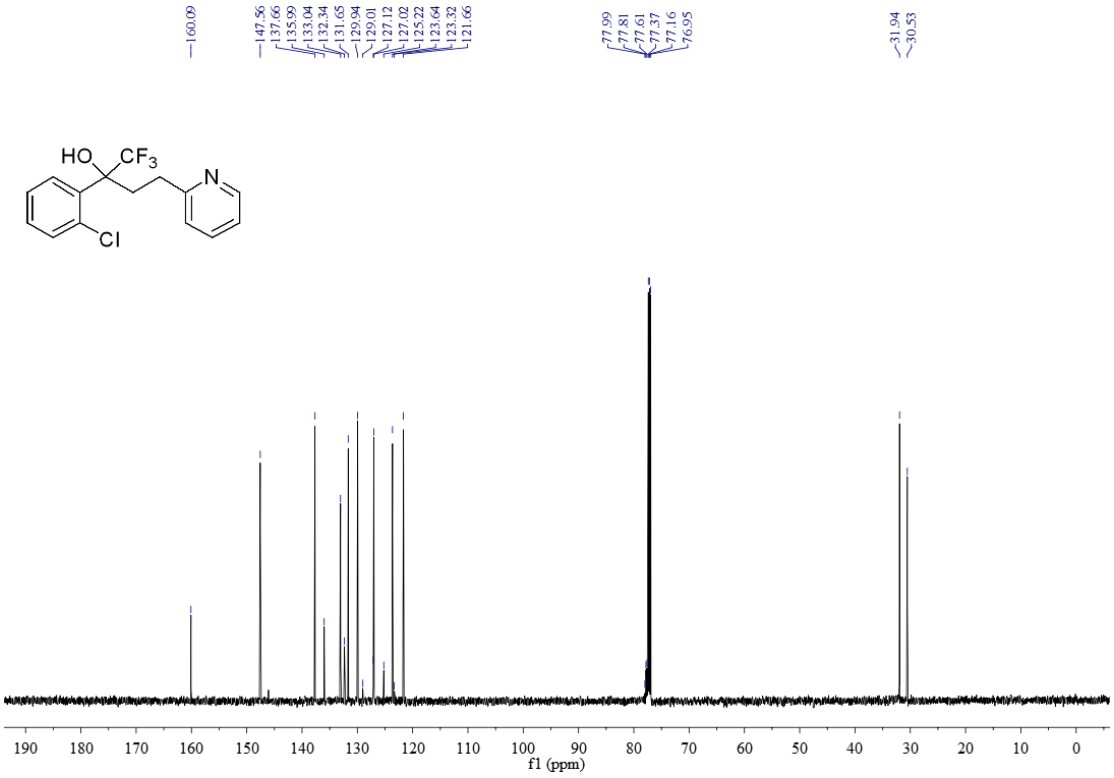


^{19}F NMR of **3k**

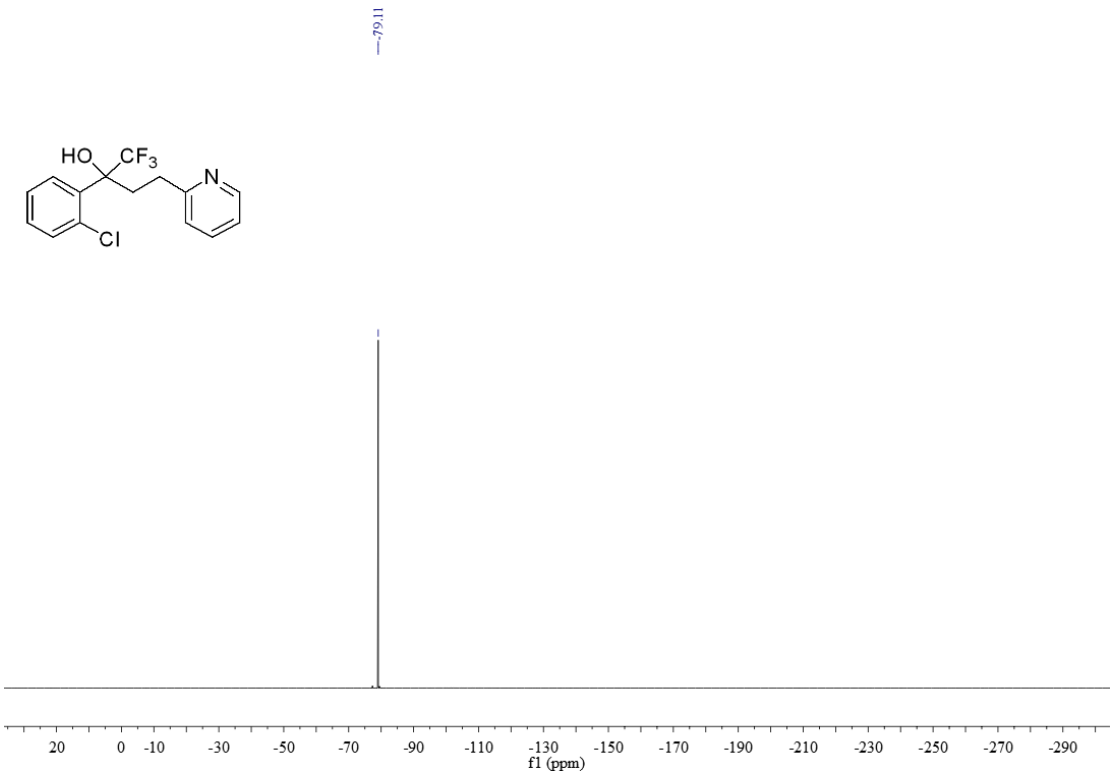
^{1}H NMR of **3l**



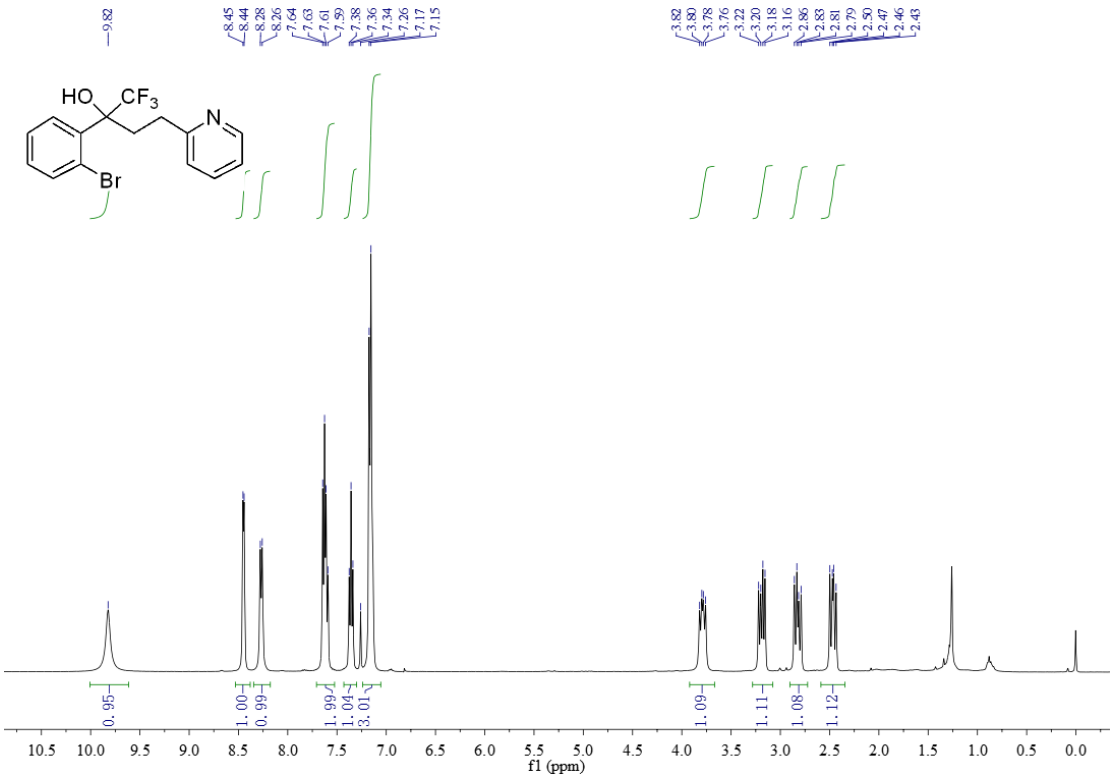
^{13}C NMR of **3l**



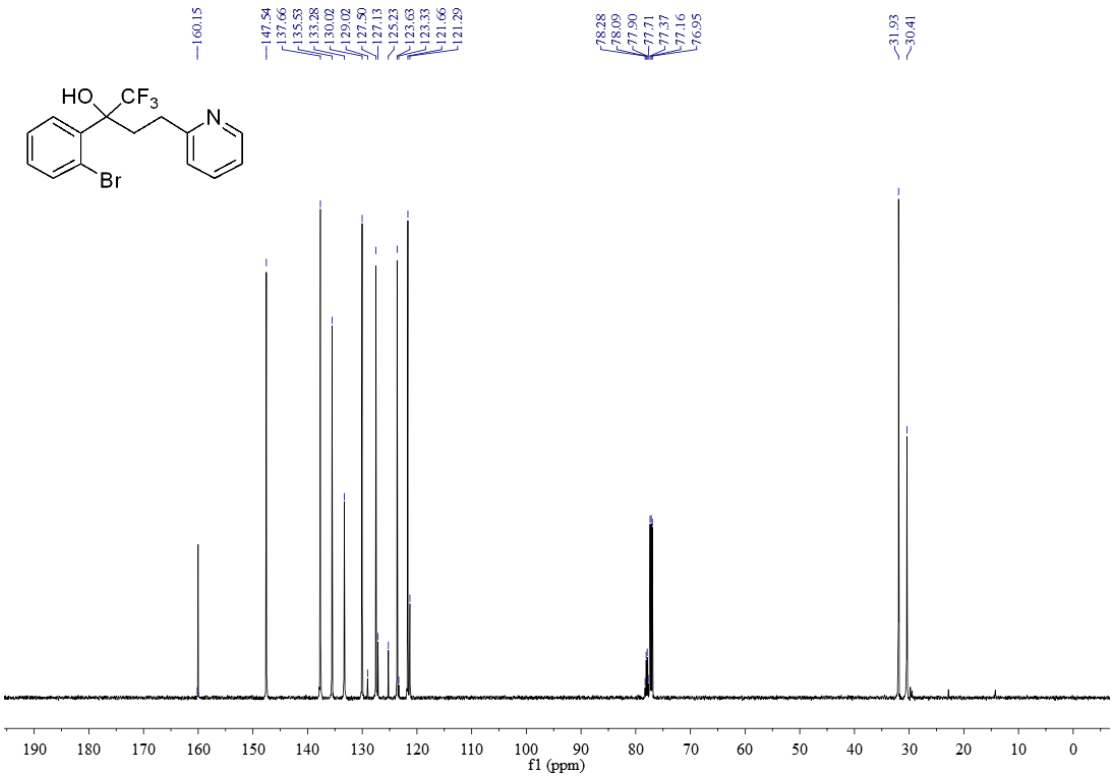
^{19}F NMR of **3l**



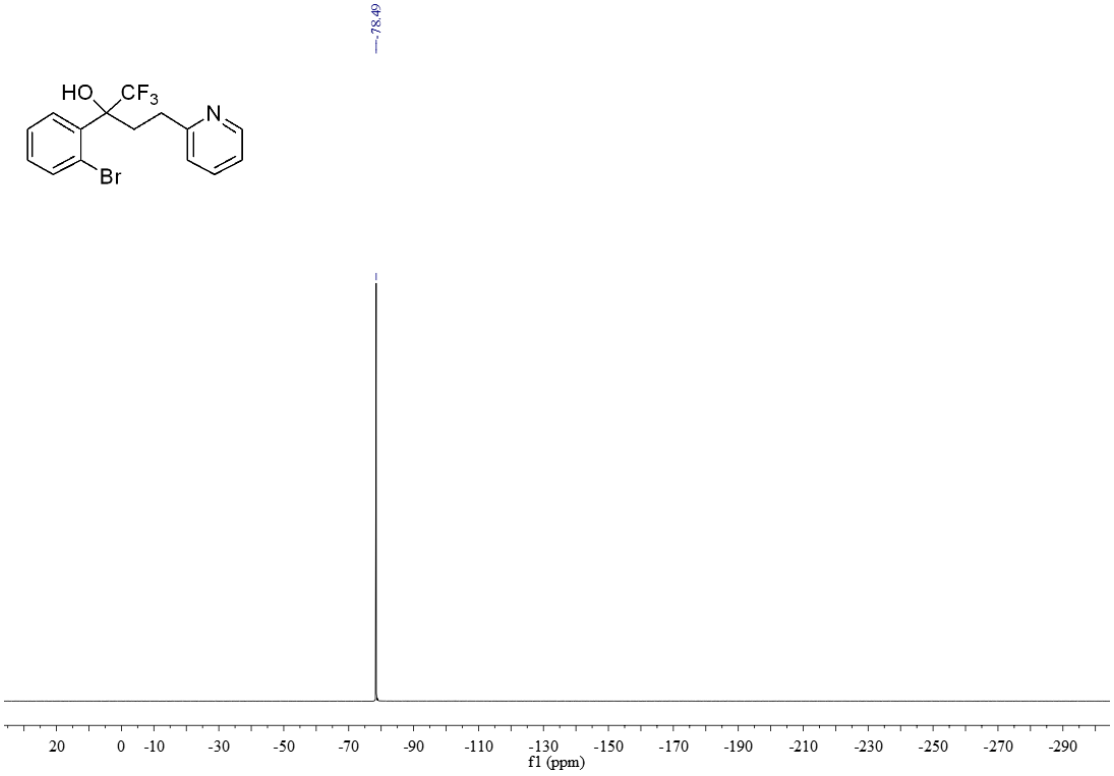
^{1}H NMR of **3m**



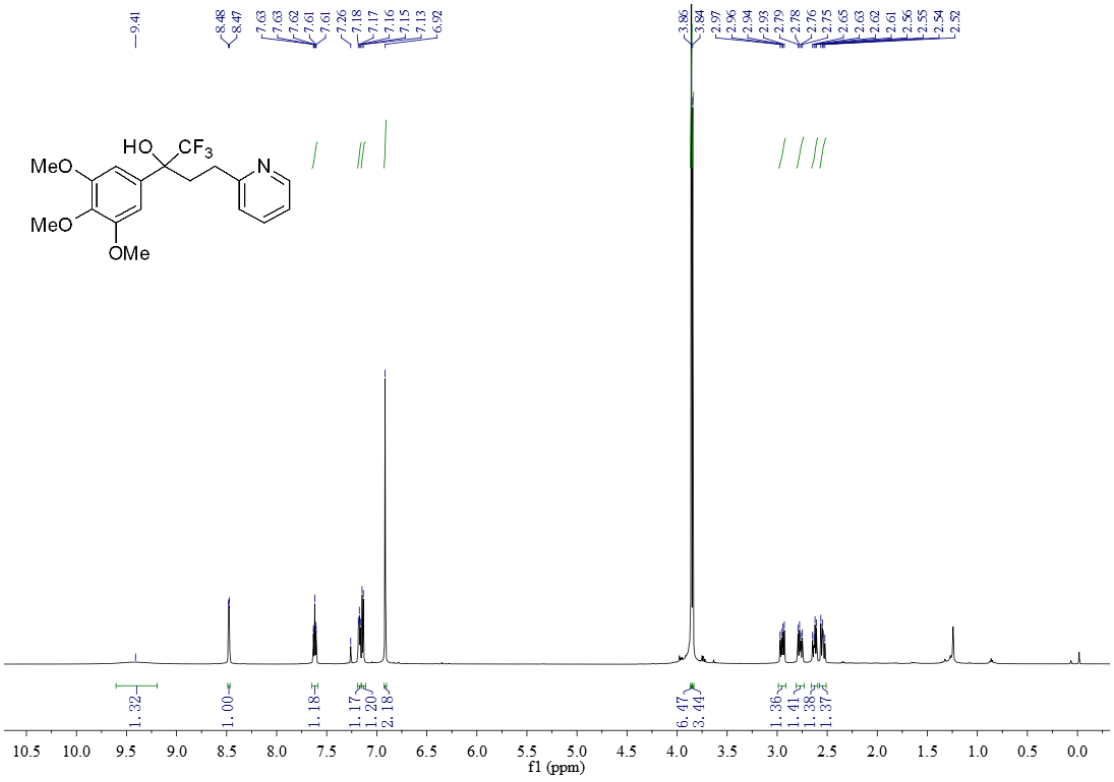
^{13}C NMR of **3m**



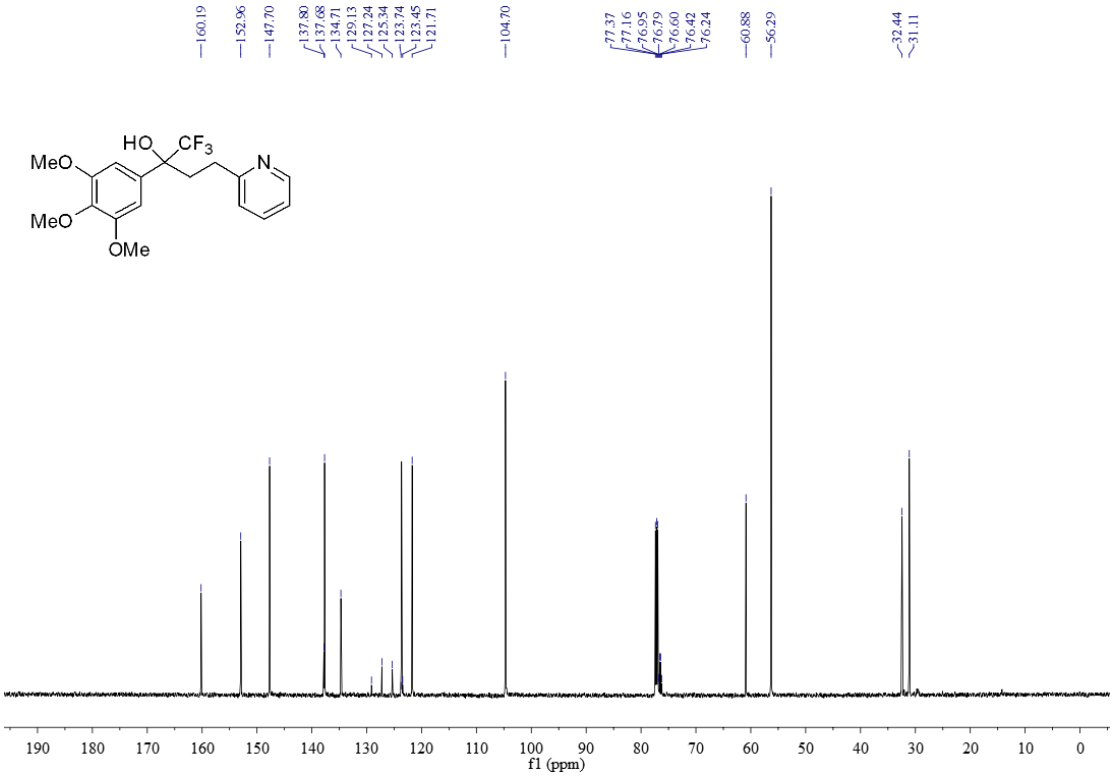
^{19}F NMR of **3m**



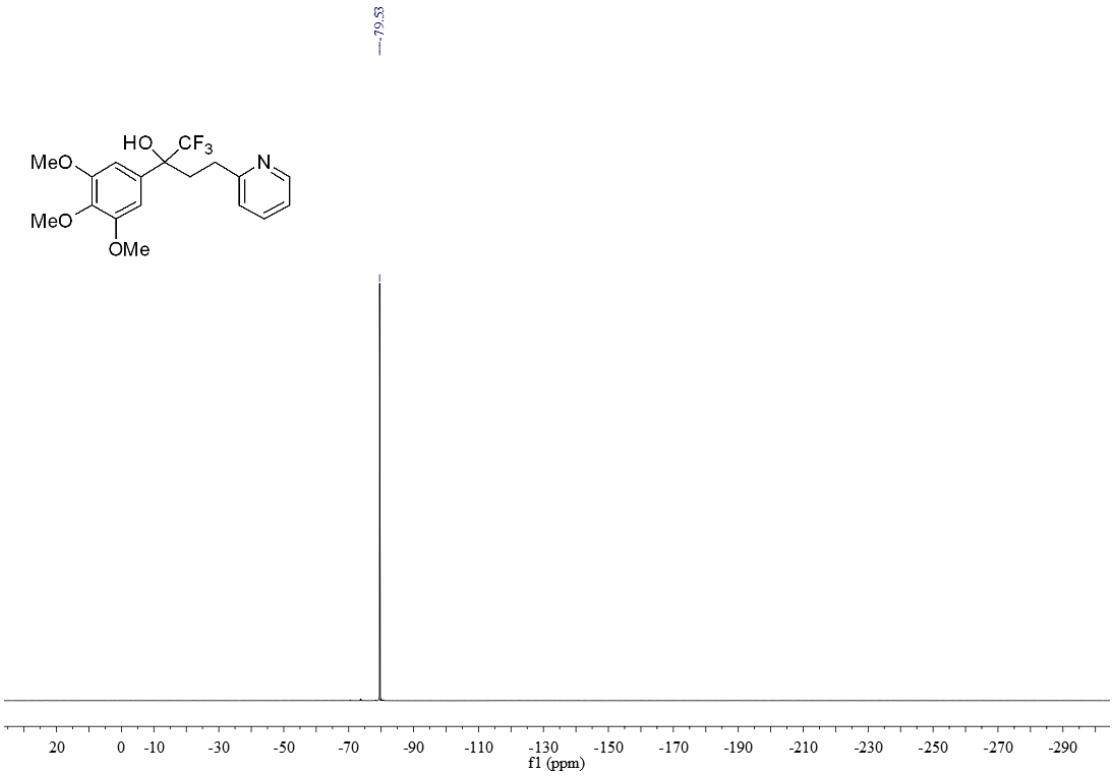
^{1}H NMR of **3n**



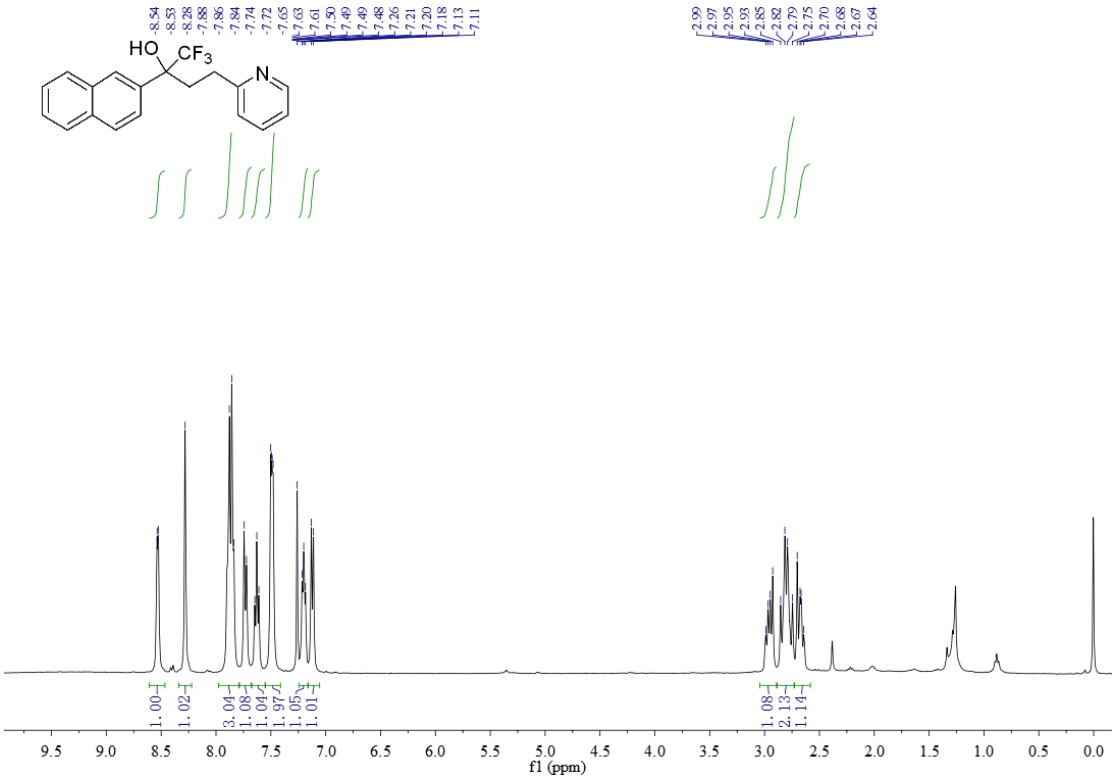
^{13}C NMR of **3n**



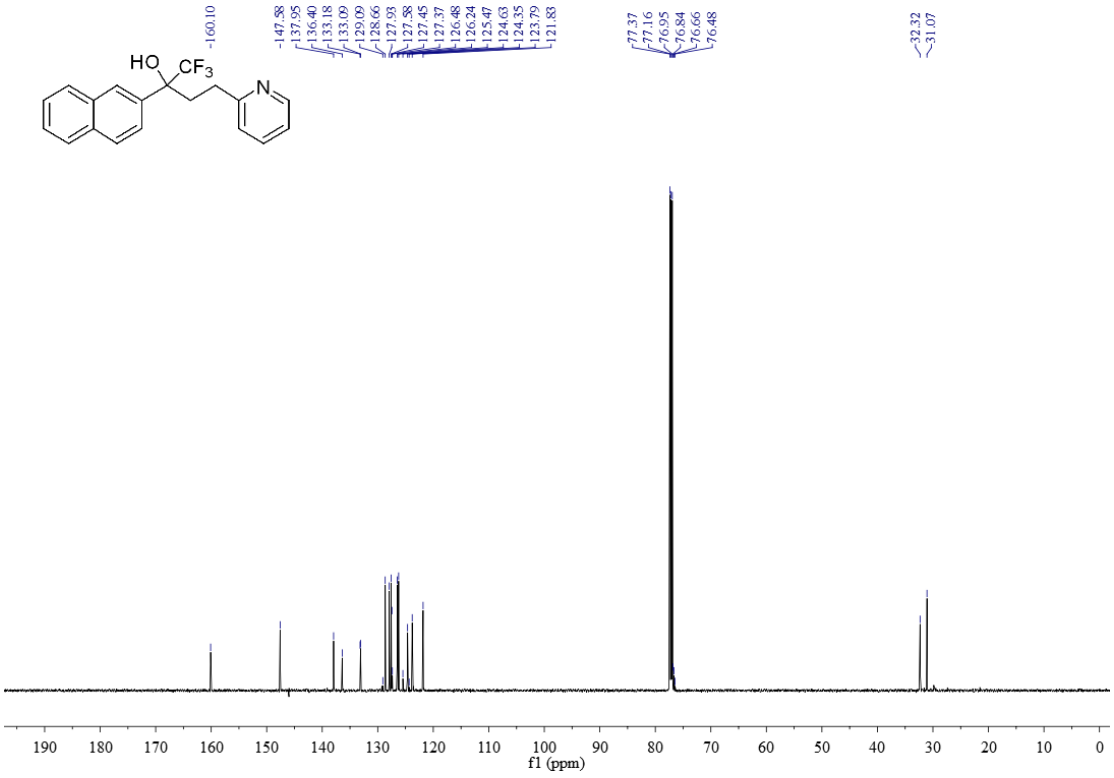
^{19}F NMR of **3n**



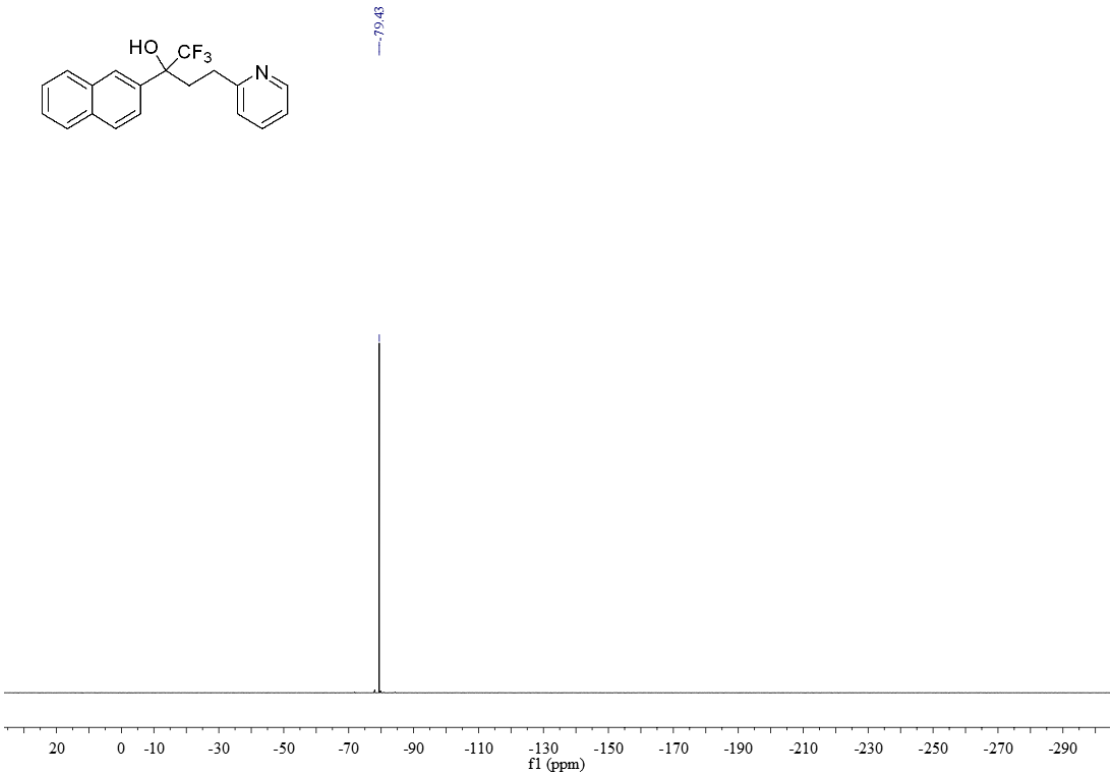
^{1}H NMR of **3o**



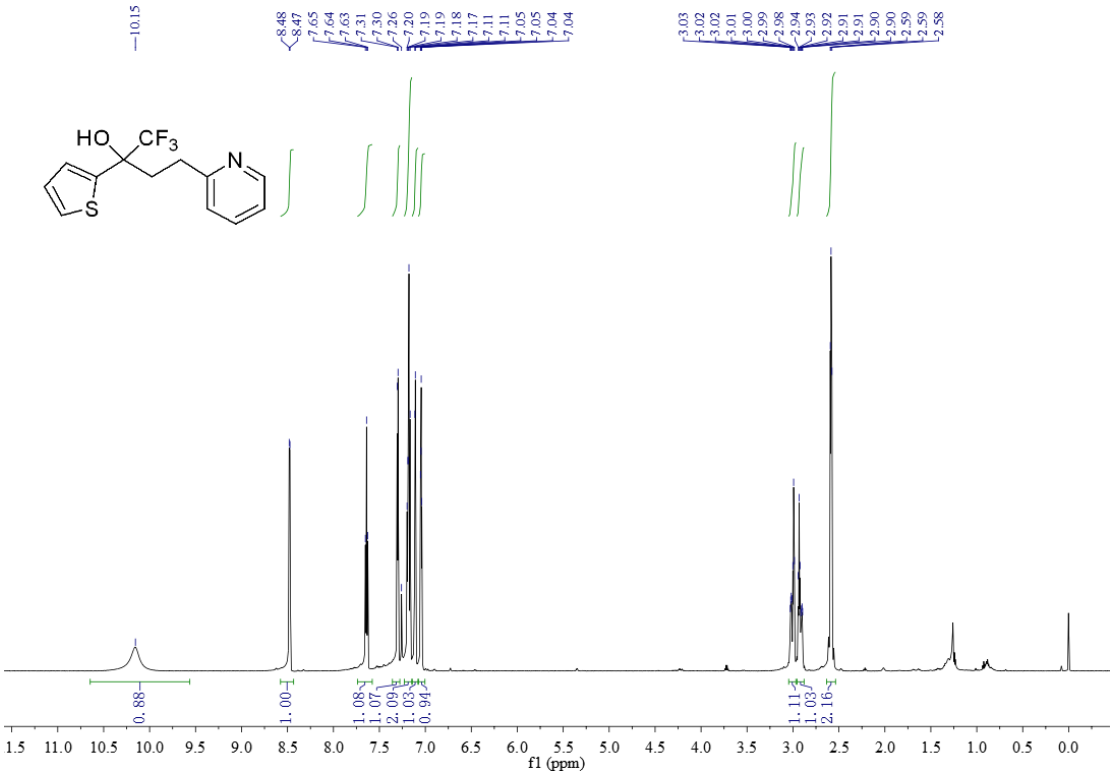
^{13}C NMR of **3o**



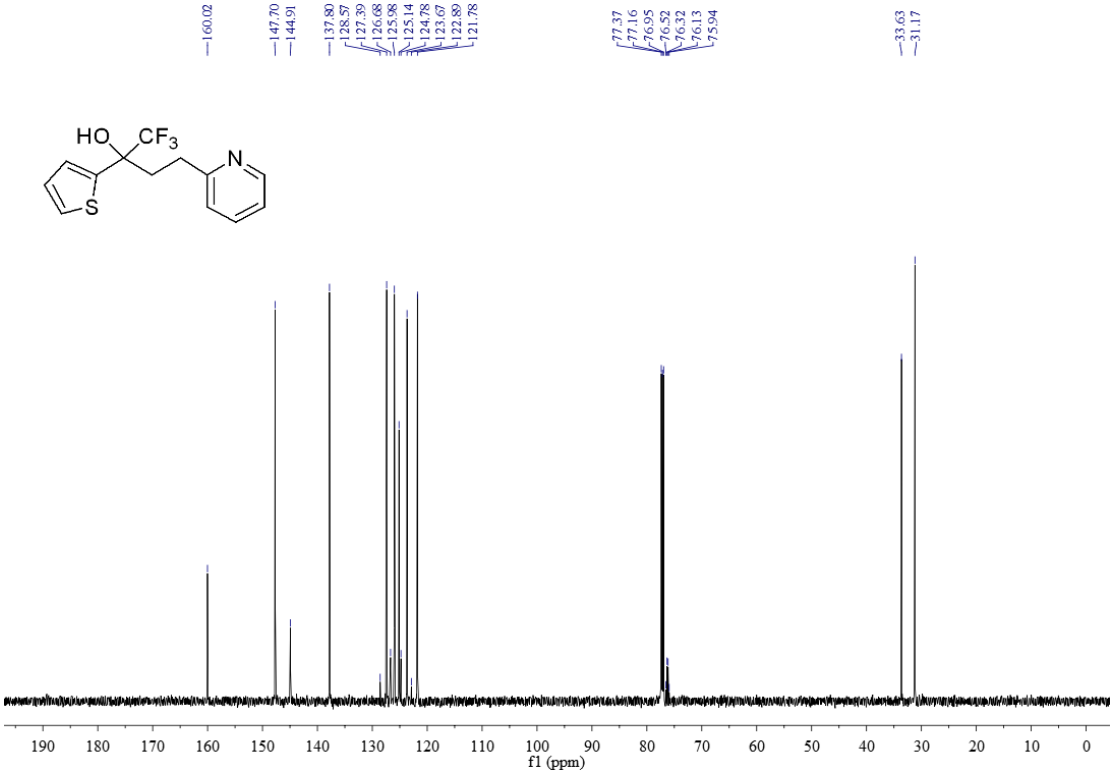
^{19}F NMR of **3o**



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

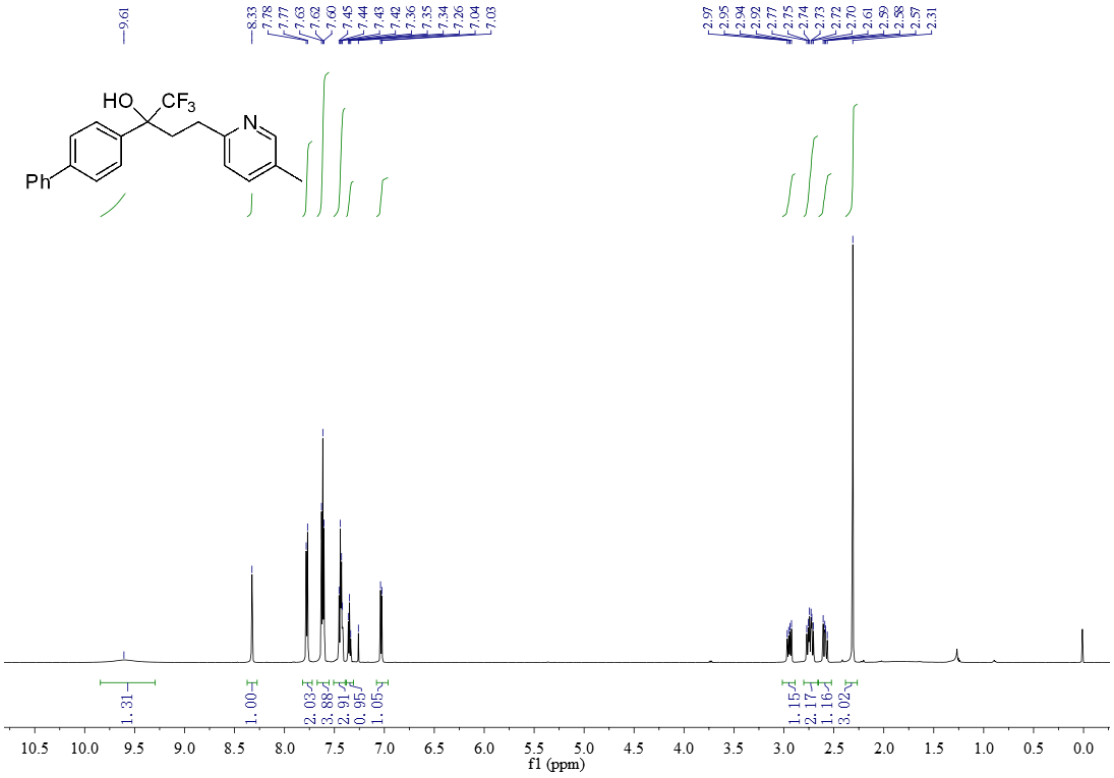


^{13}C NMR of **3p**



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

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



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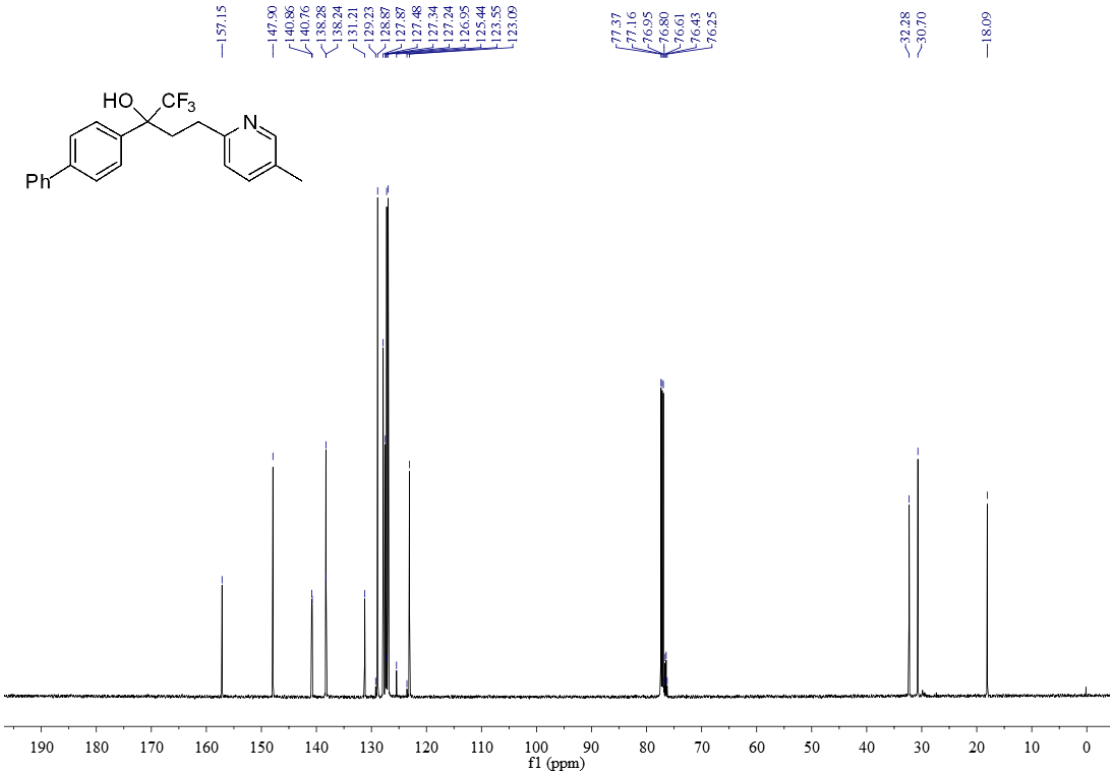

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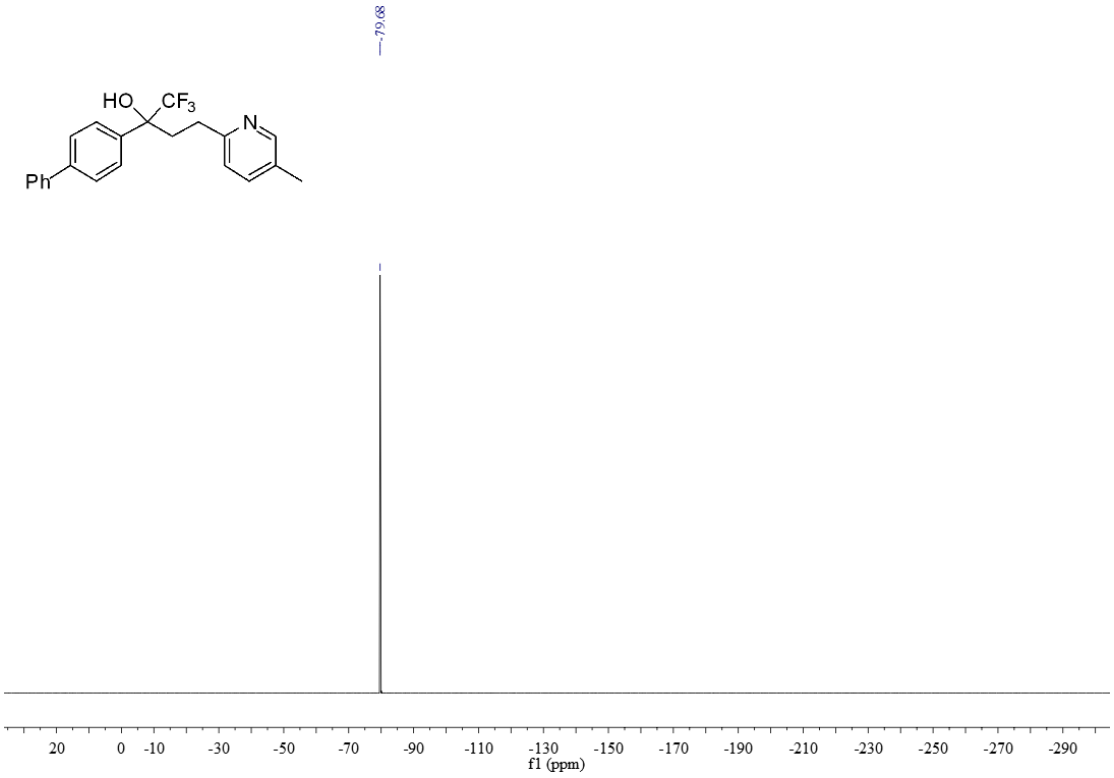
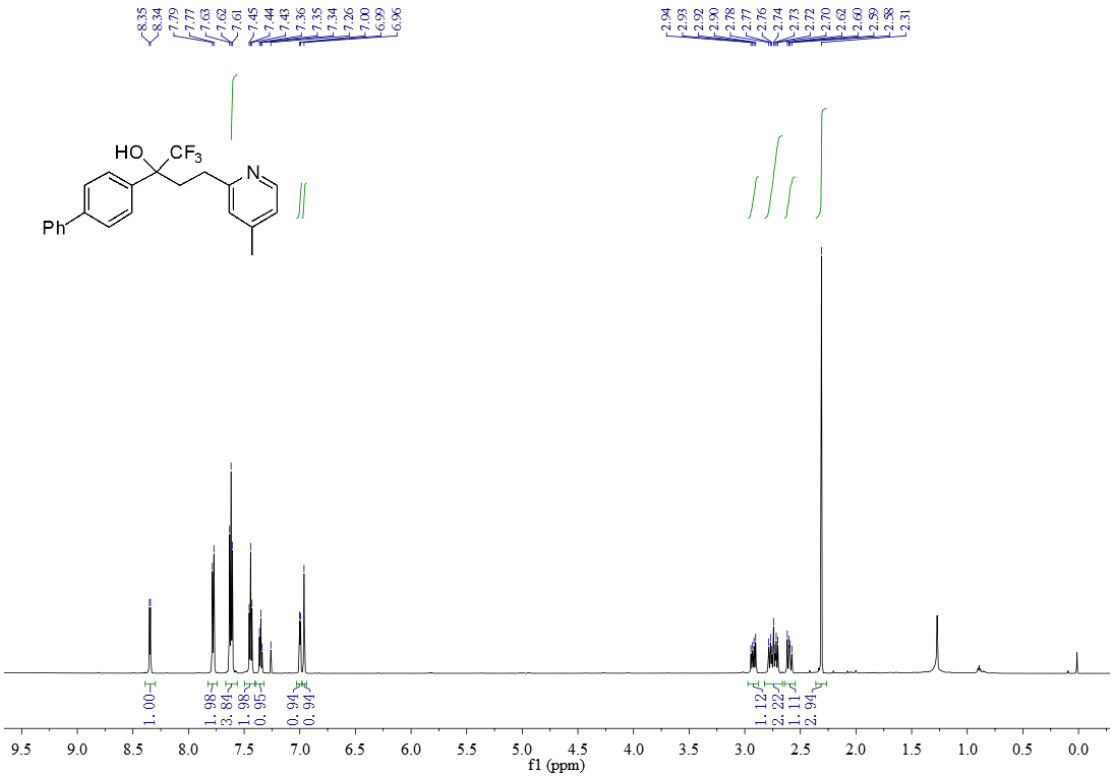
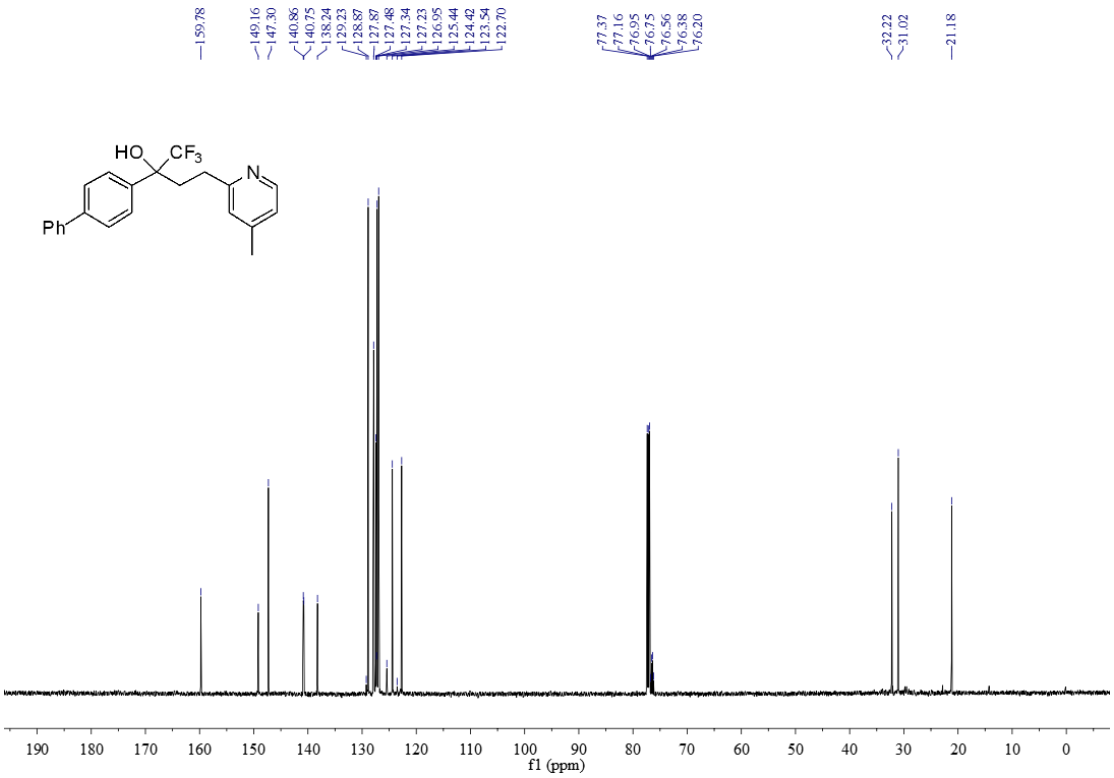


^{1}H NMR of **3r**

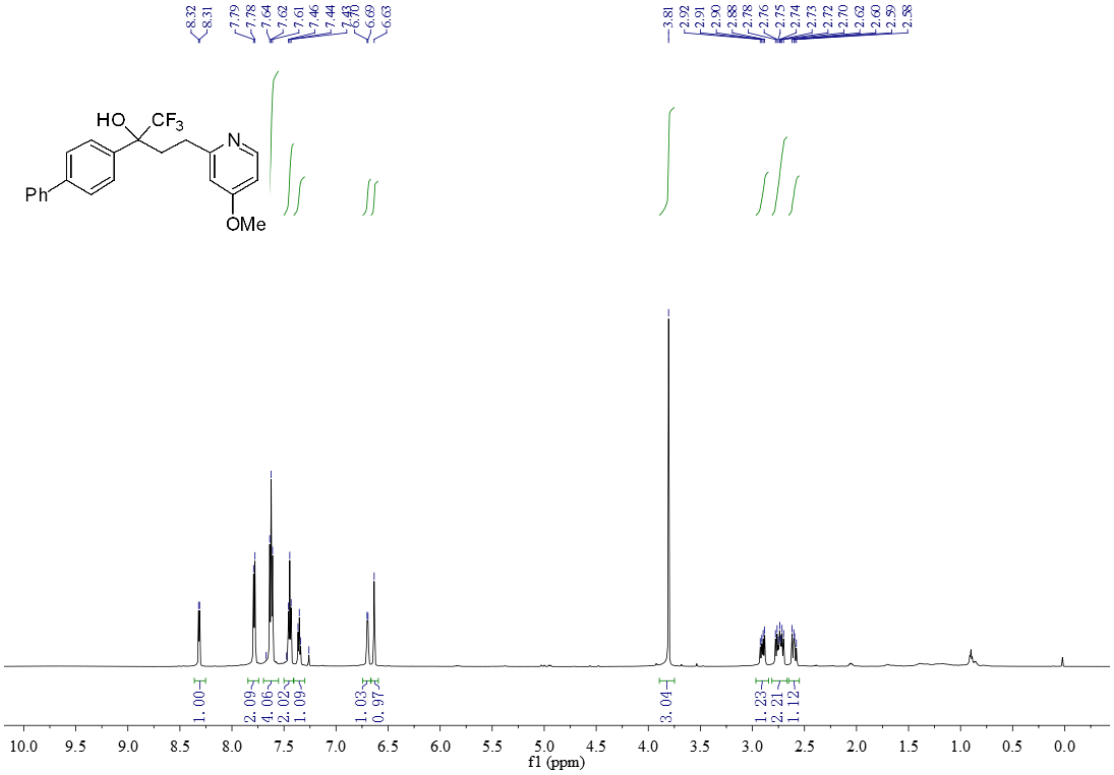


^{13}C NMR of **3r**

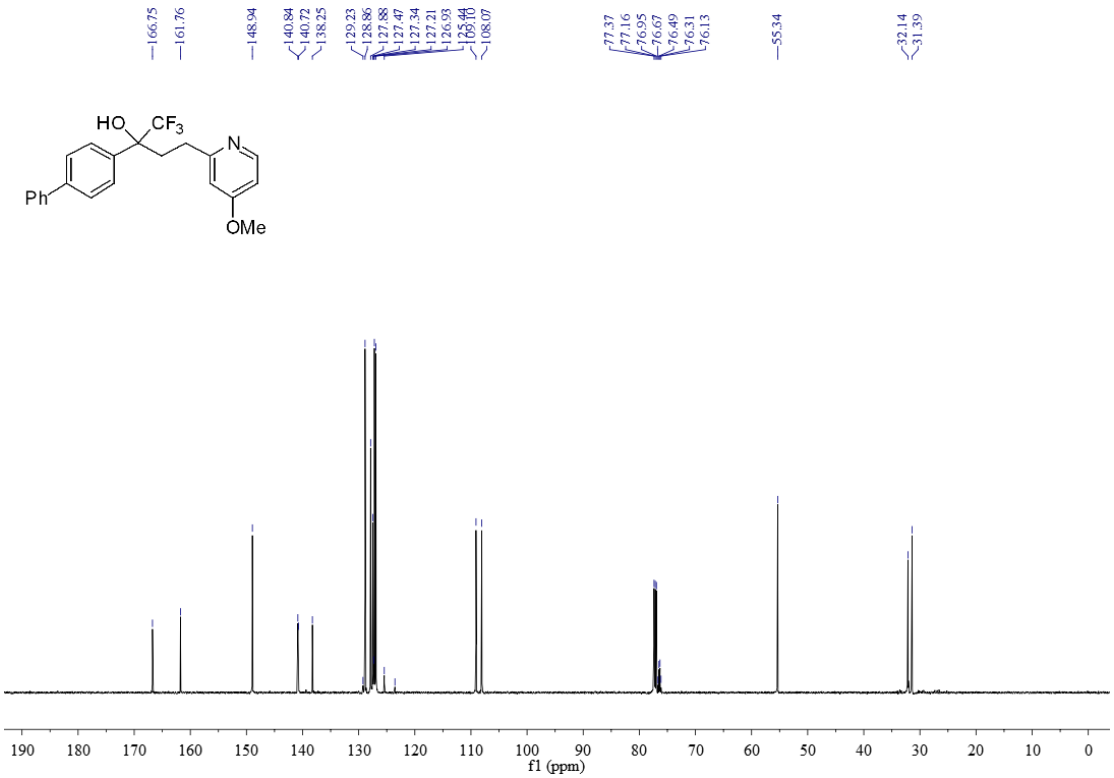


^{19}F NMR of **3r**

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

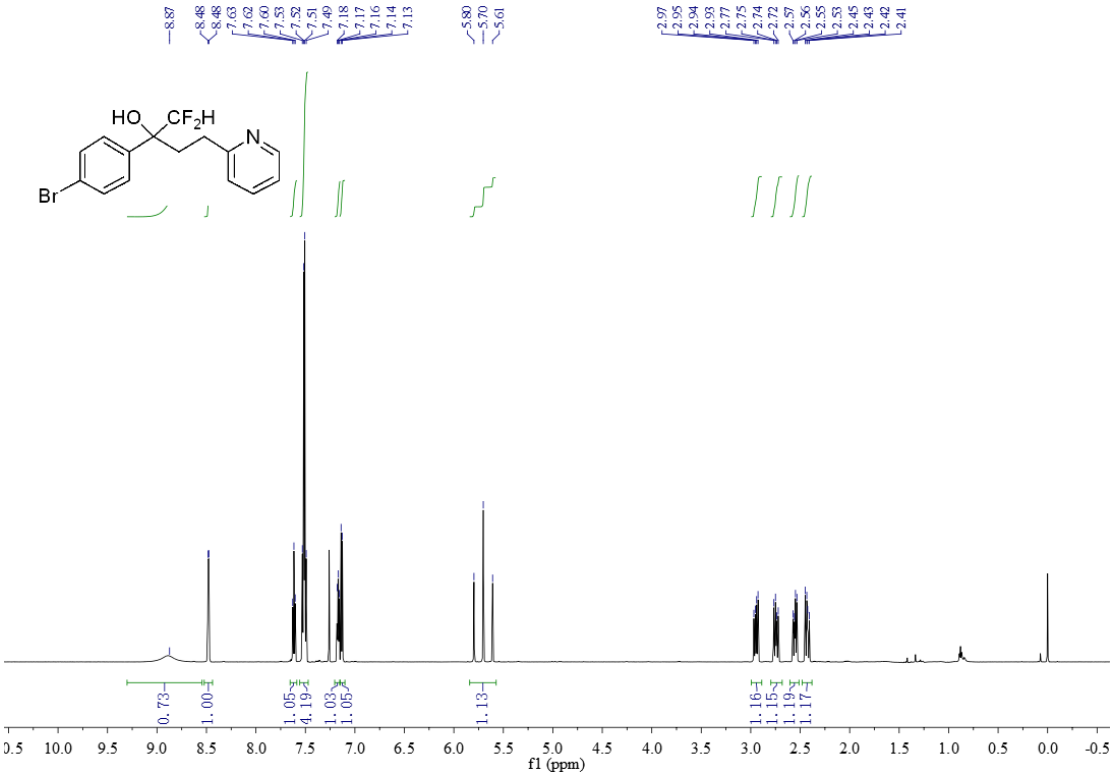


^{13}C NMR of **3s**

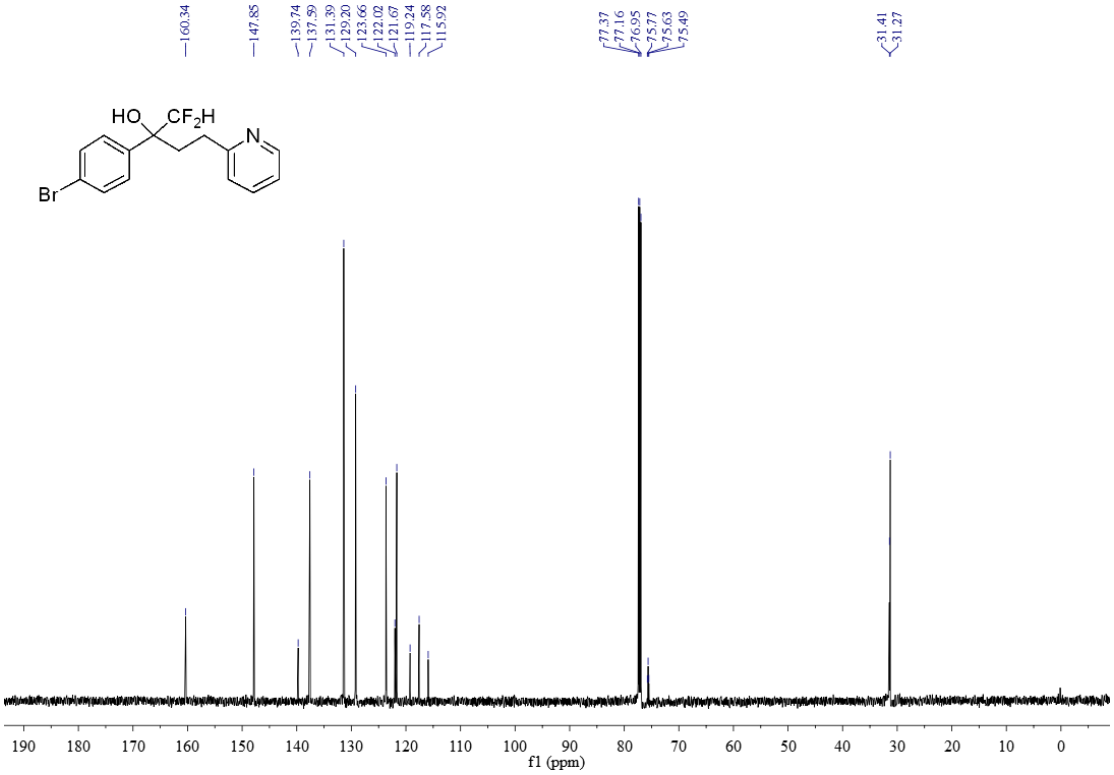


^{19}F NMR of **3s**

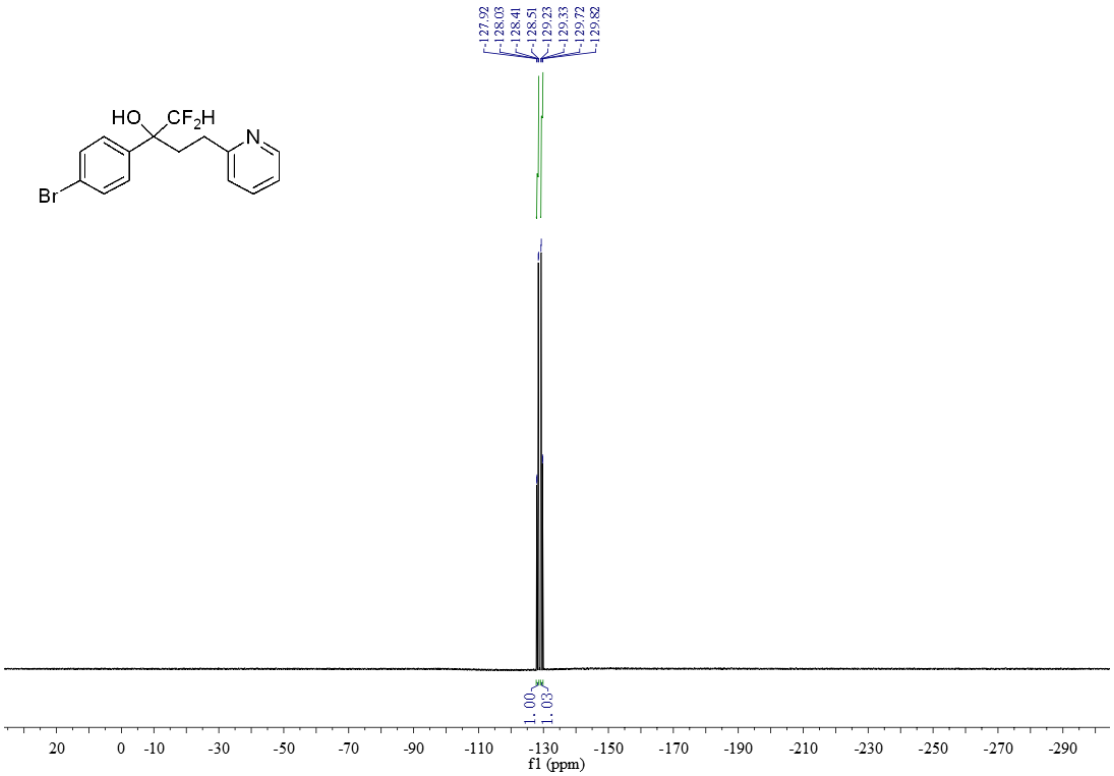
^{1}H NMR of **5a**



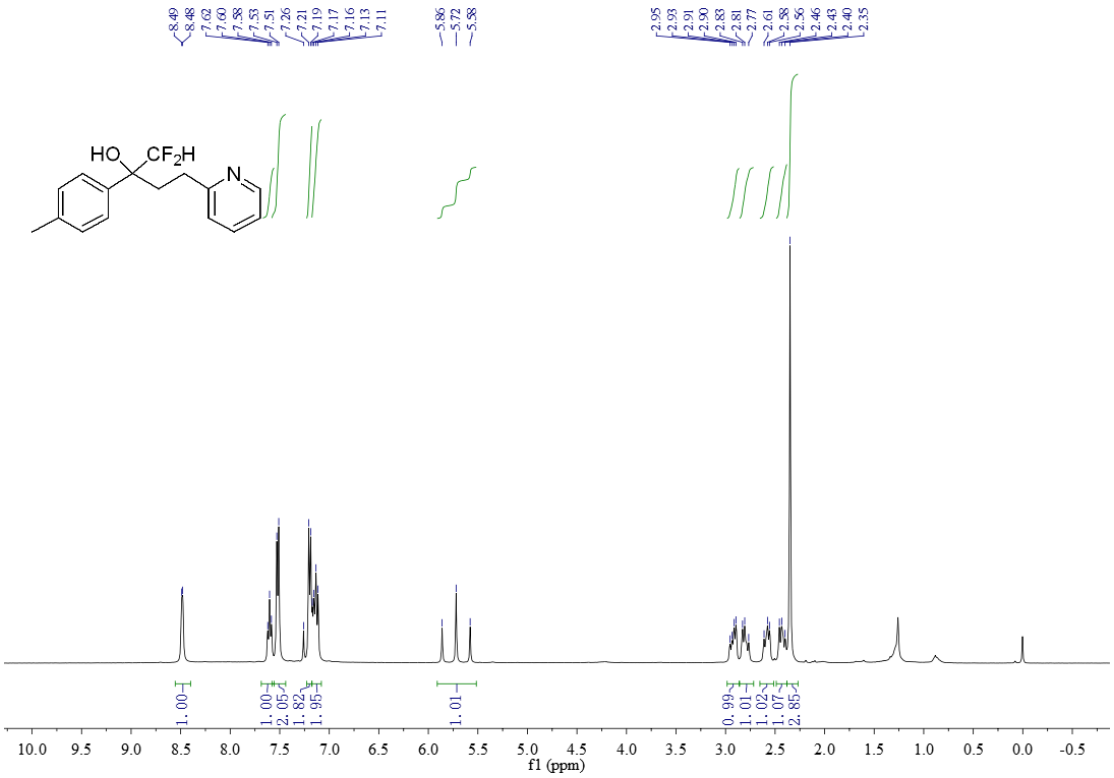
^{13}C NMR of **5a**



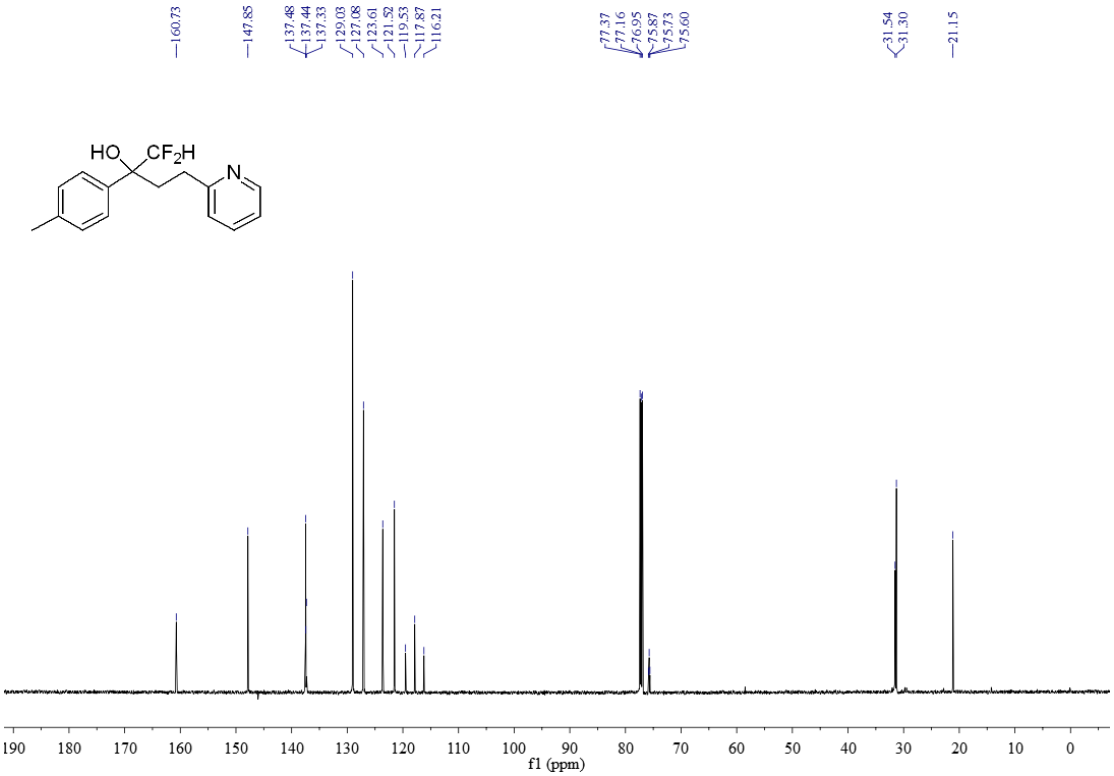
^{19}F NMR of **5a**



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



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



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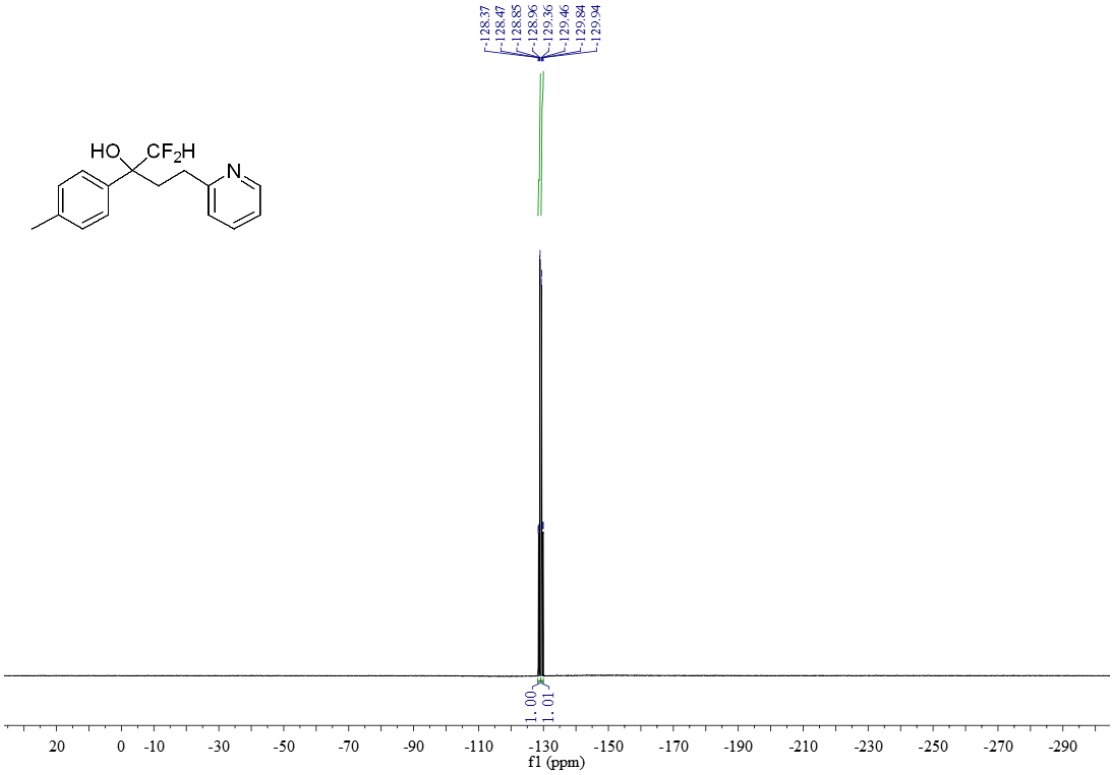
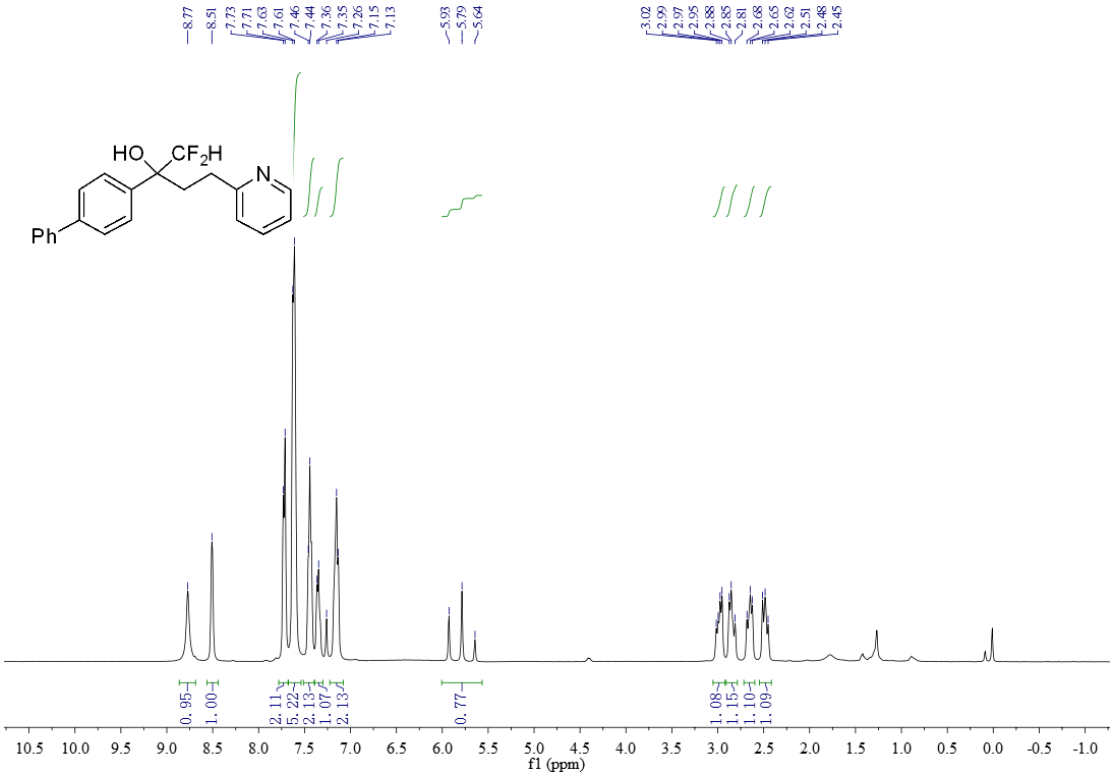
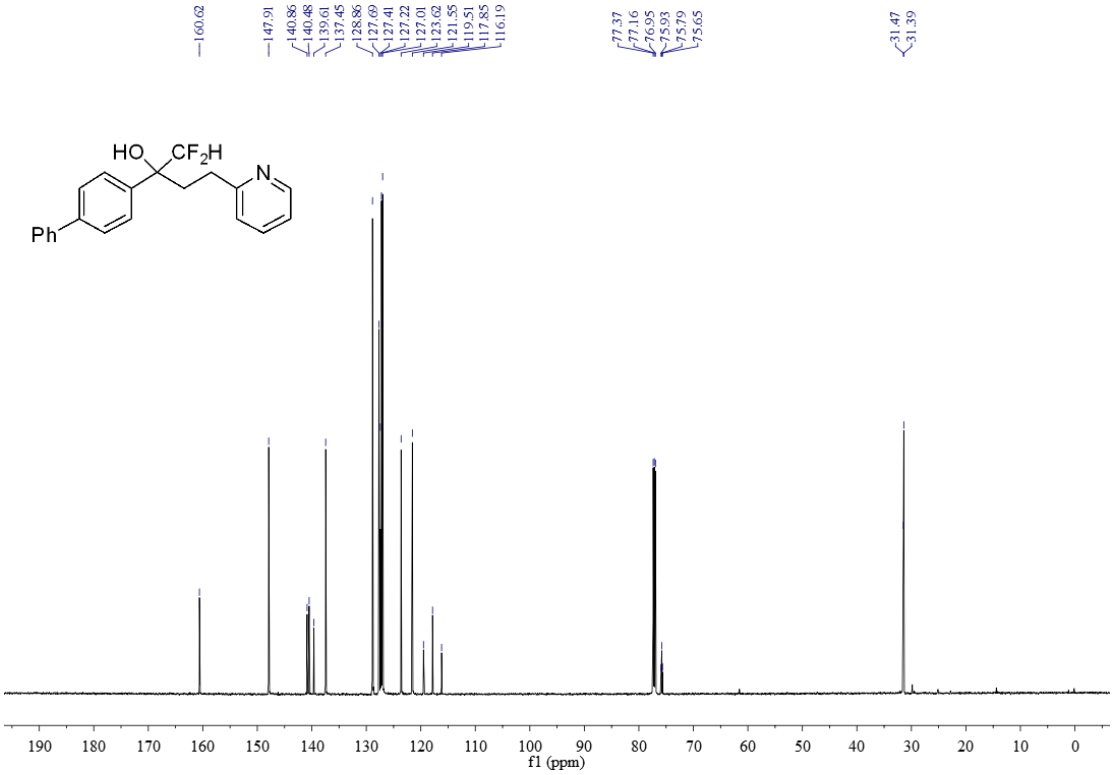


^{1}H NMR of **5c**



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



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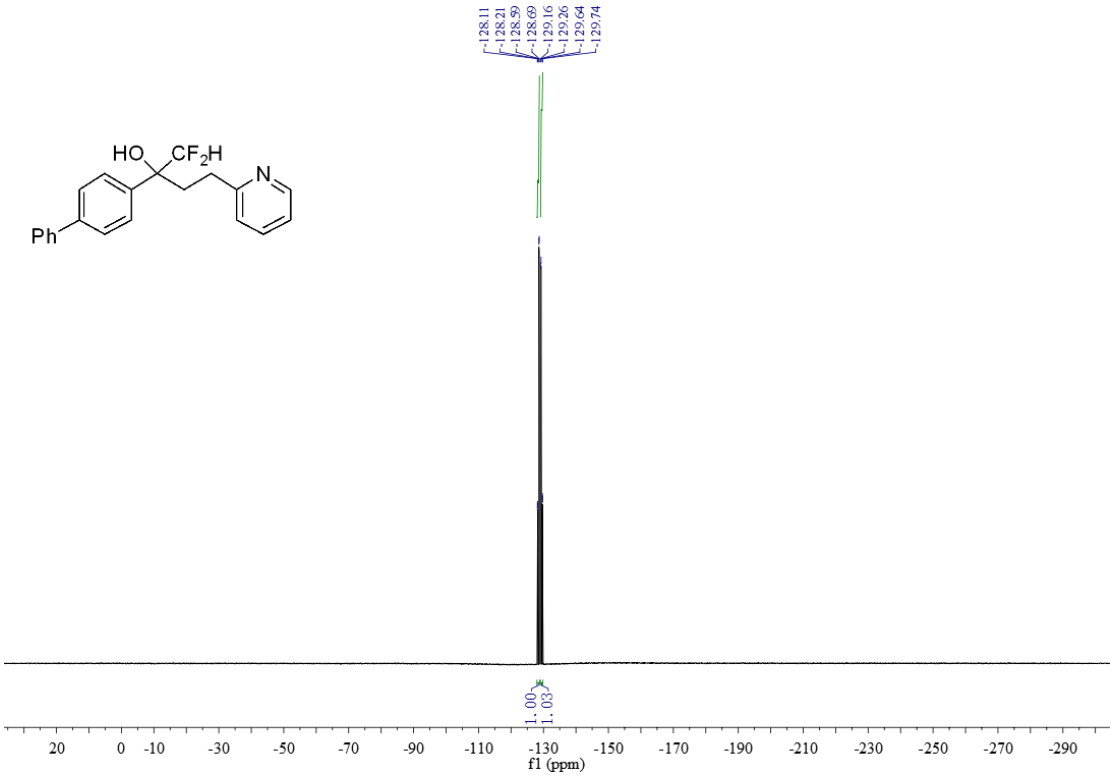

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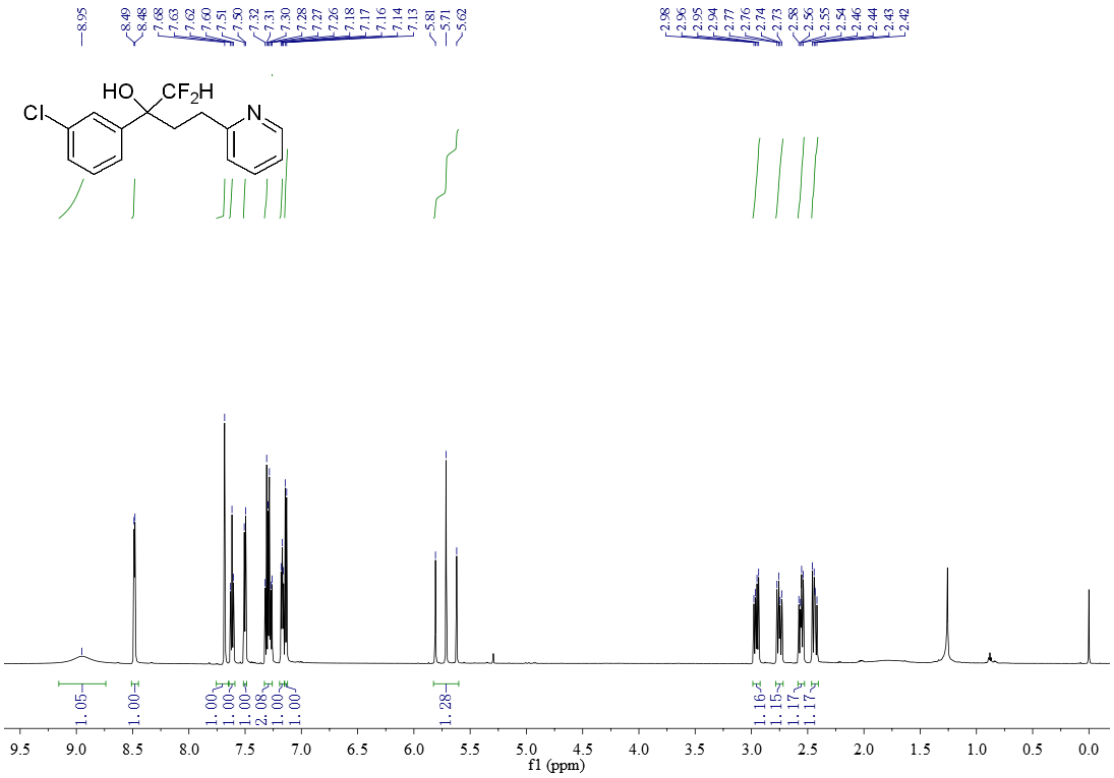

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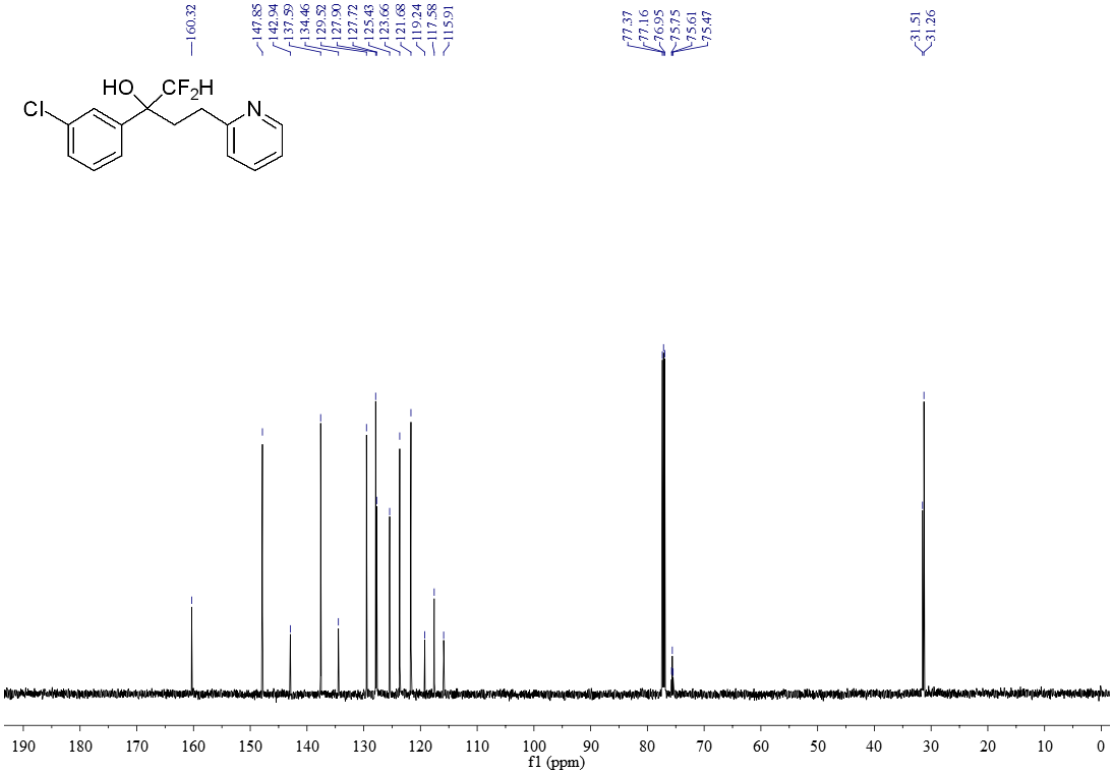

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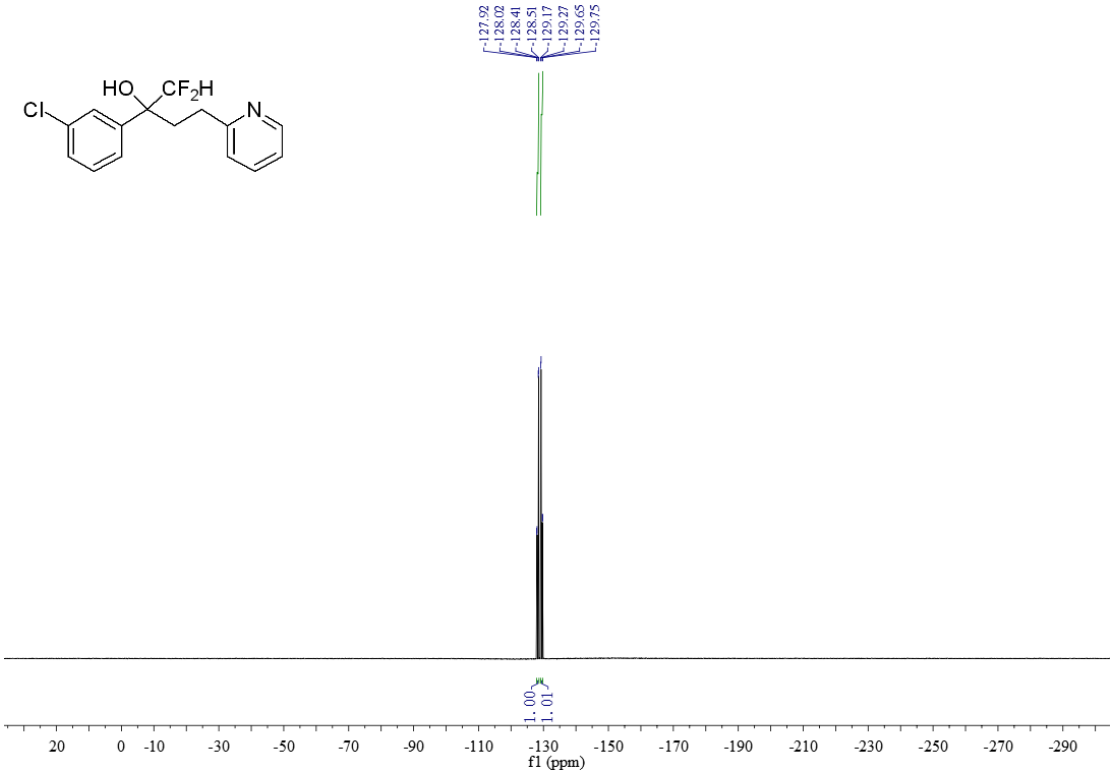
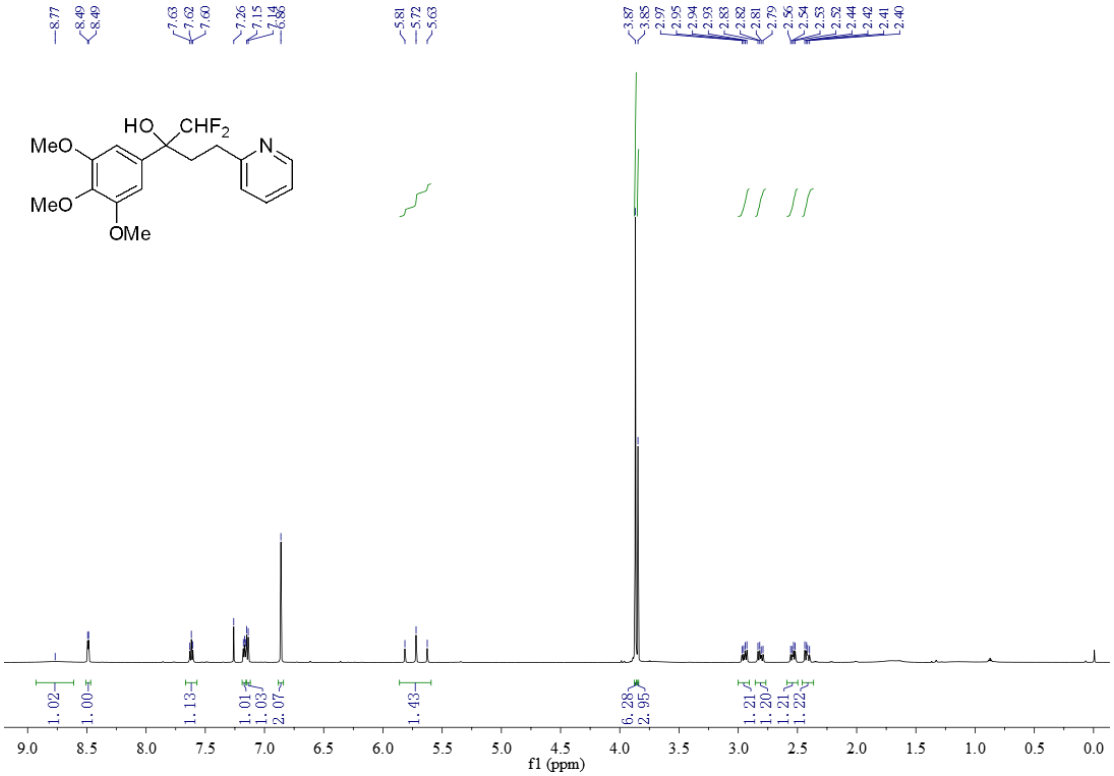


^{1}H NMR of **5e**



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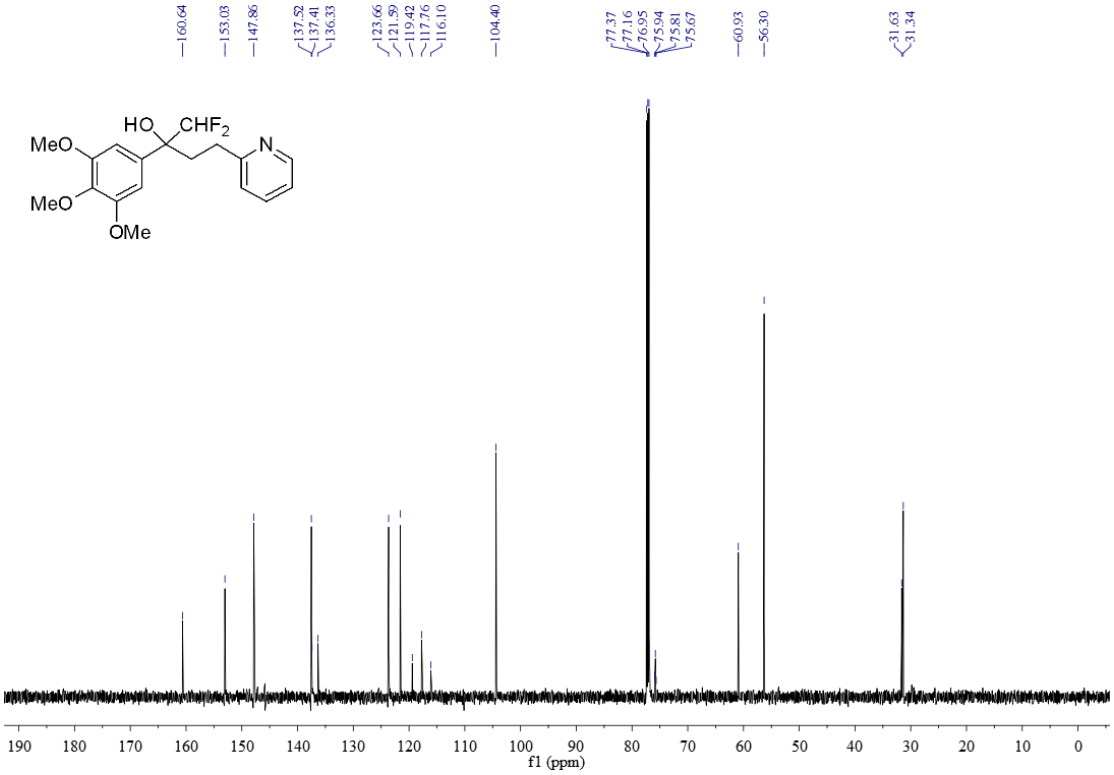

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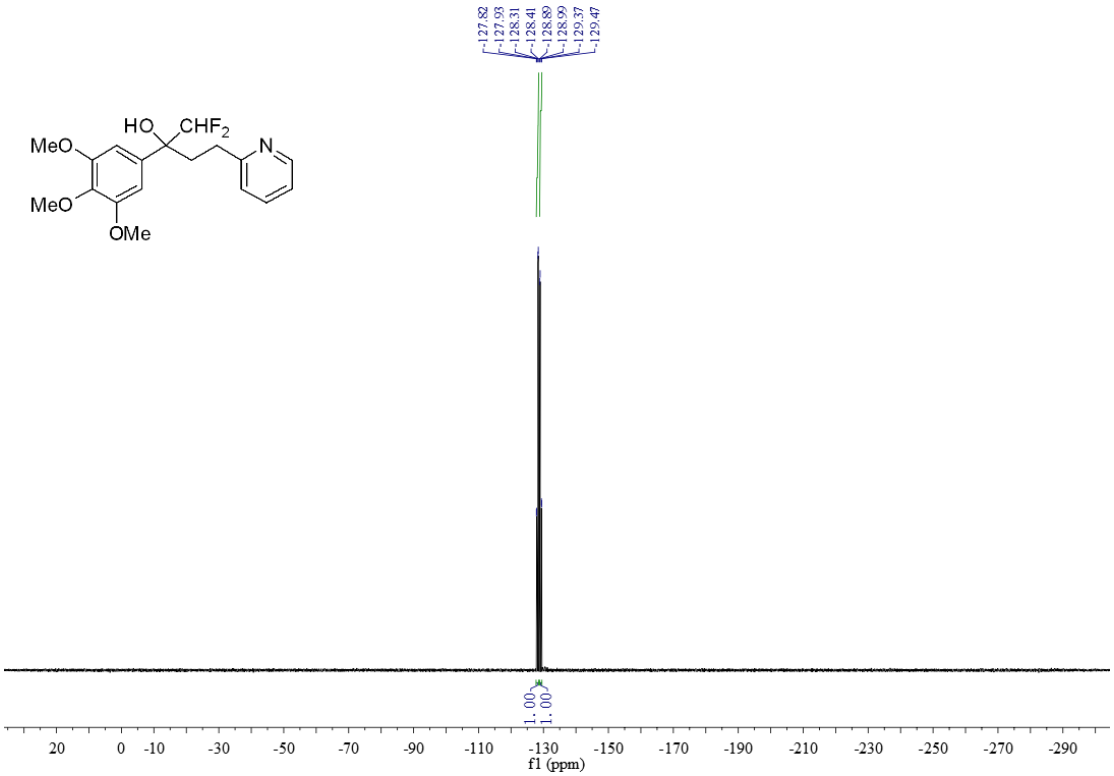

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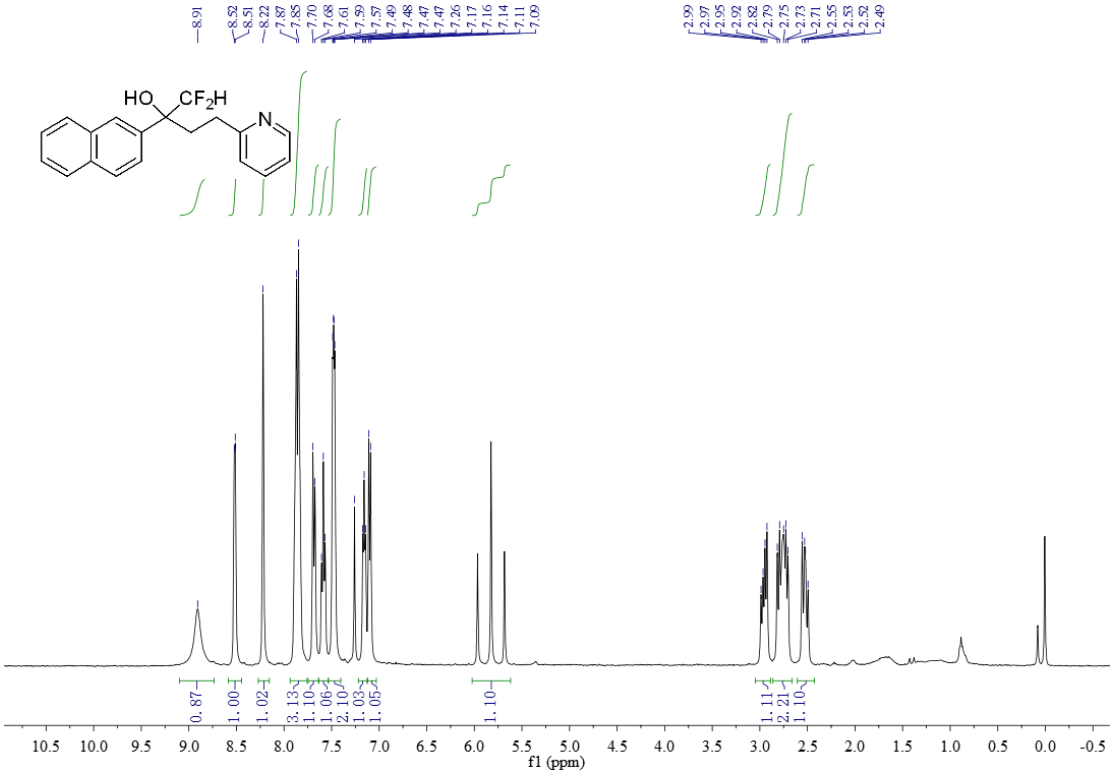

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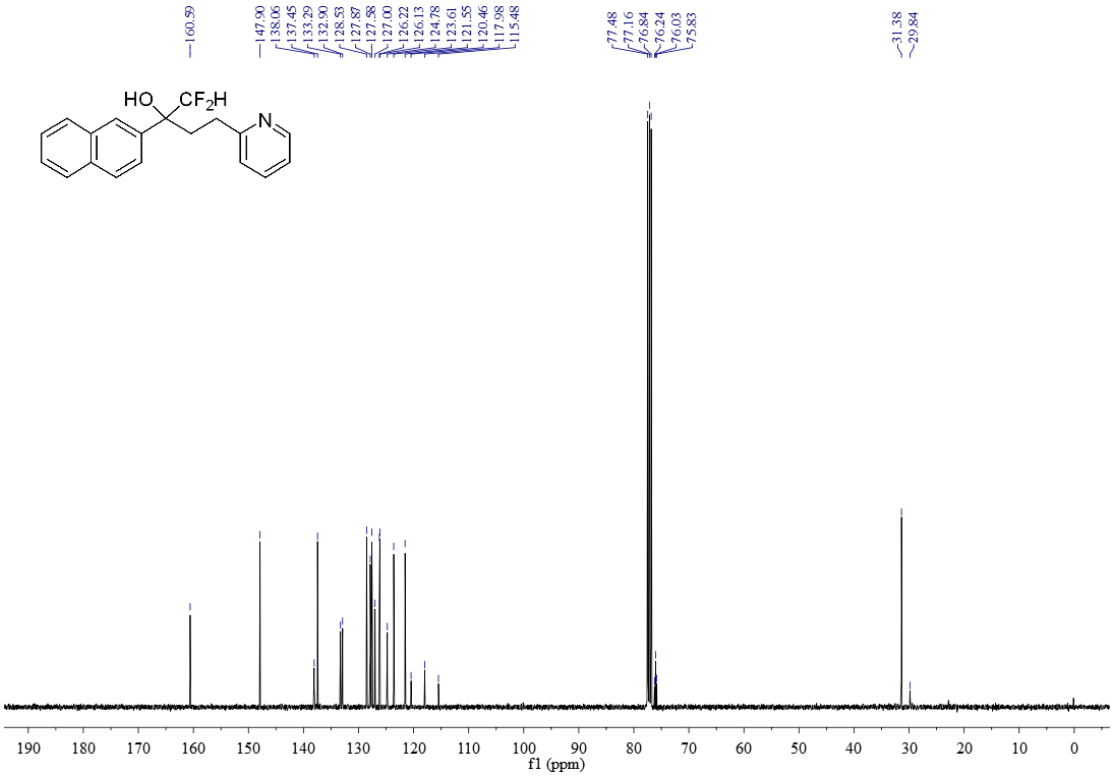

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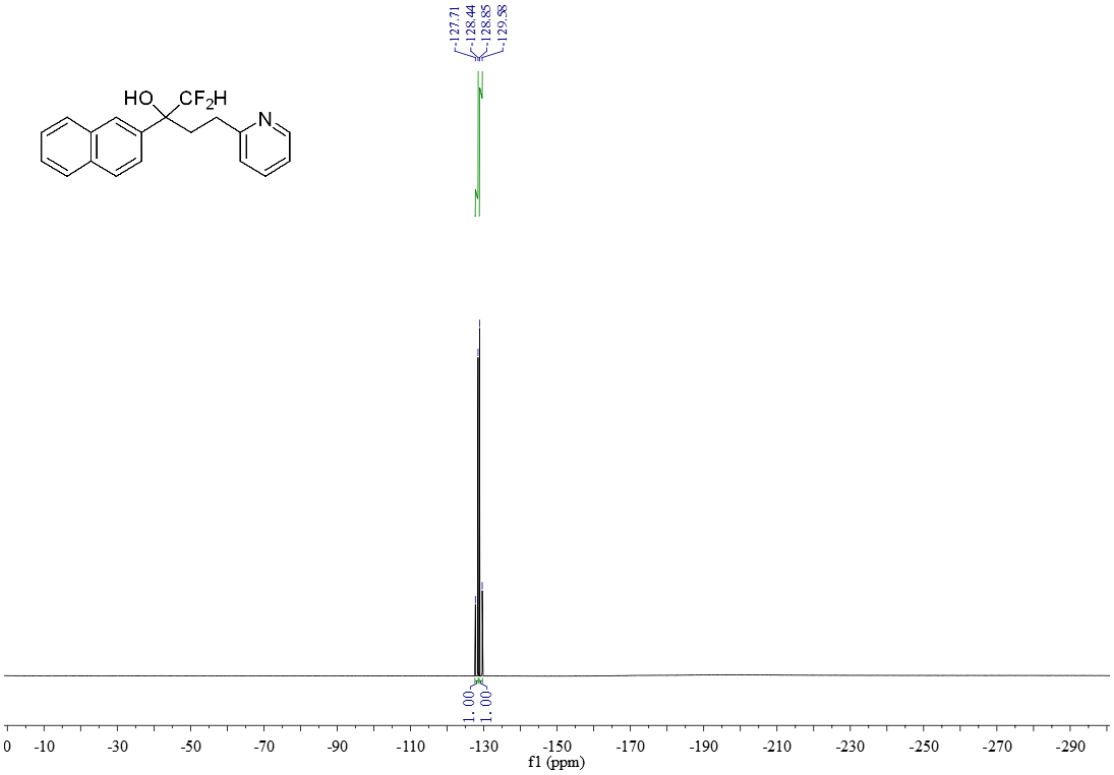

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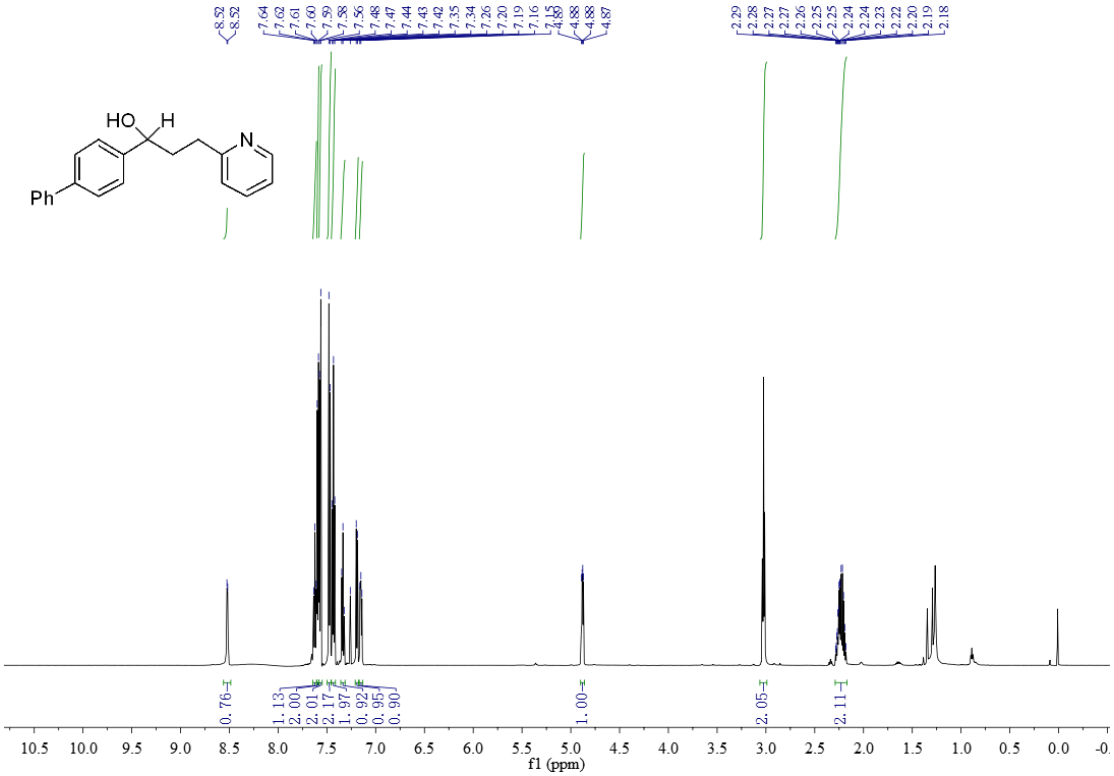

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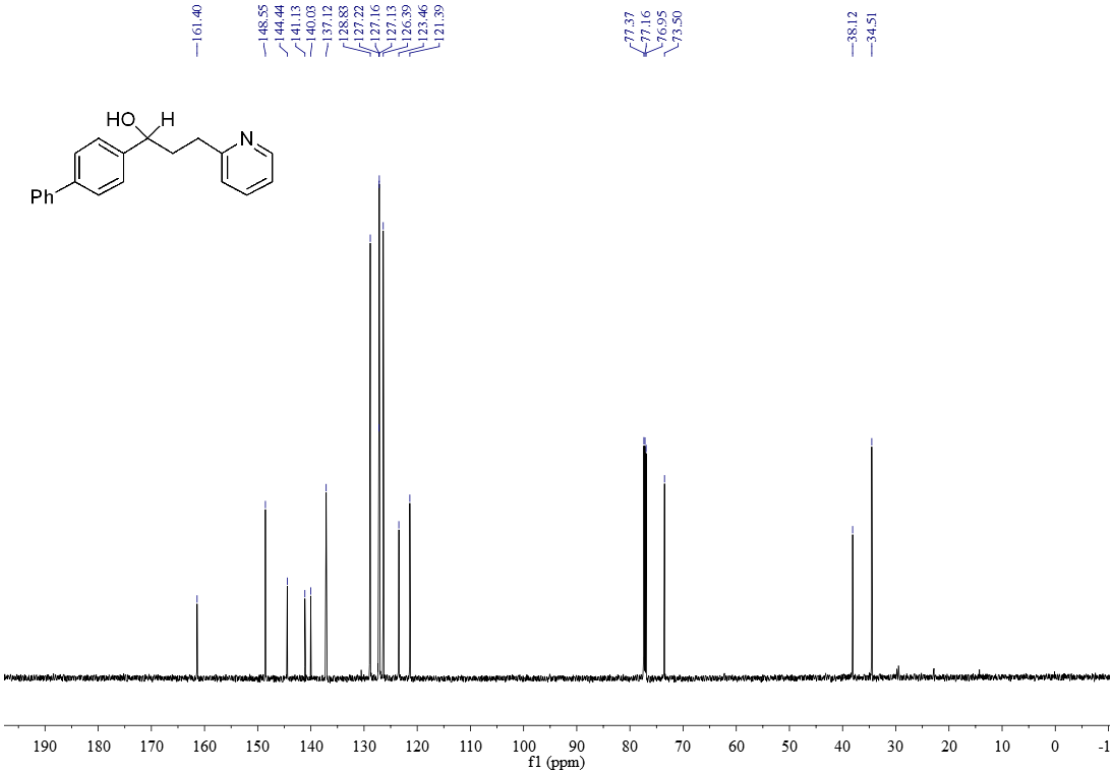

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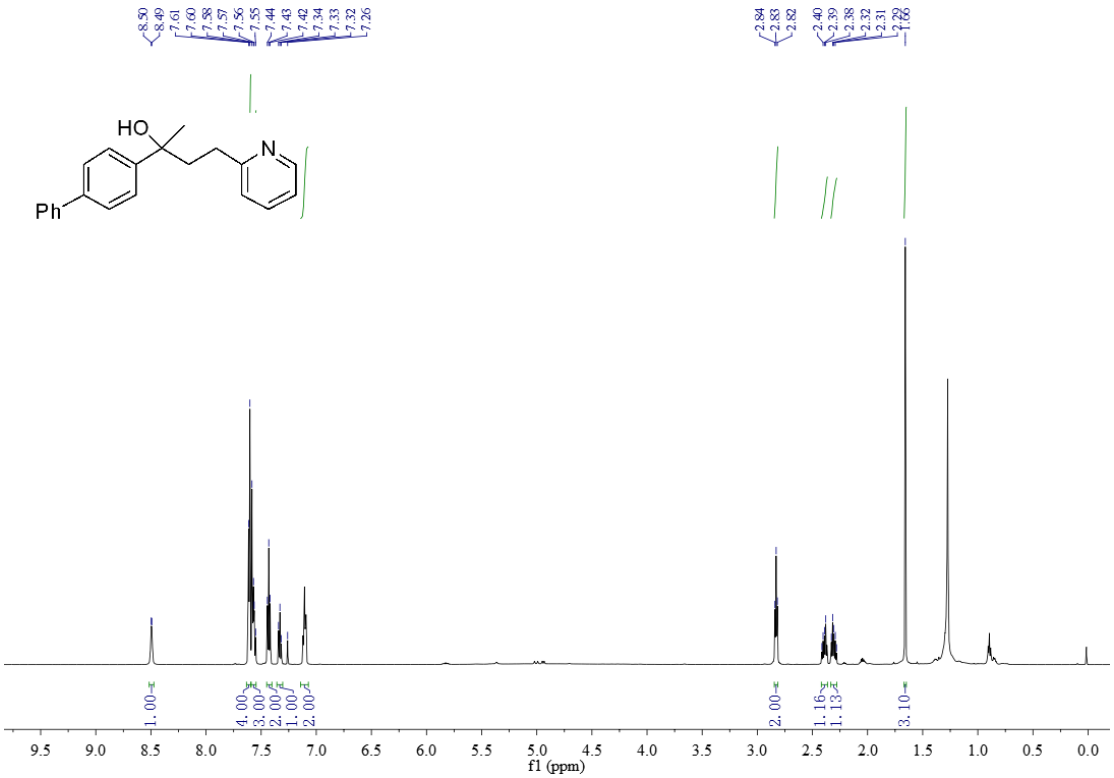

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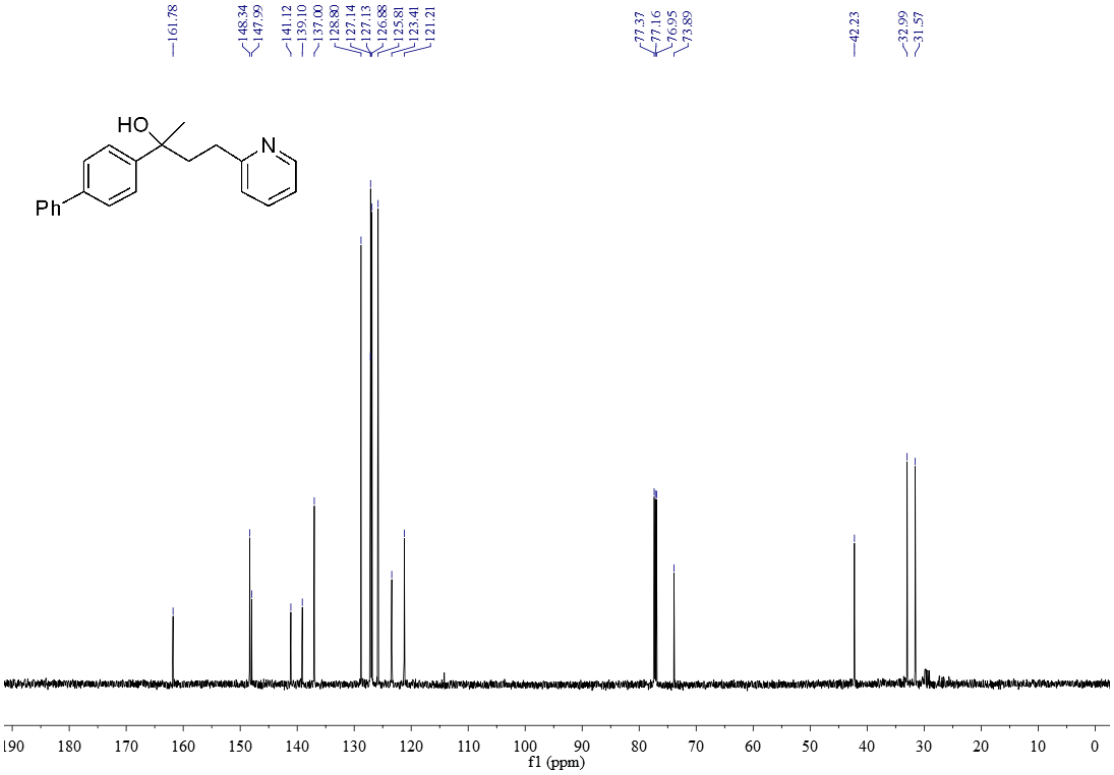

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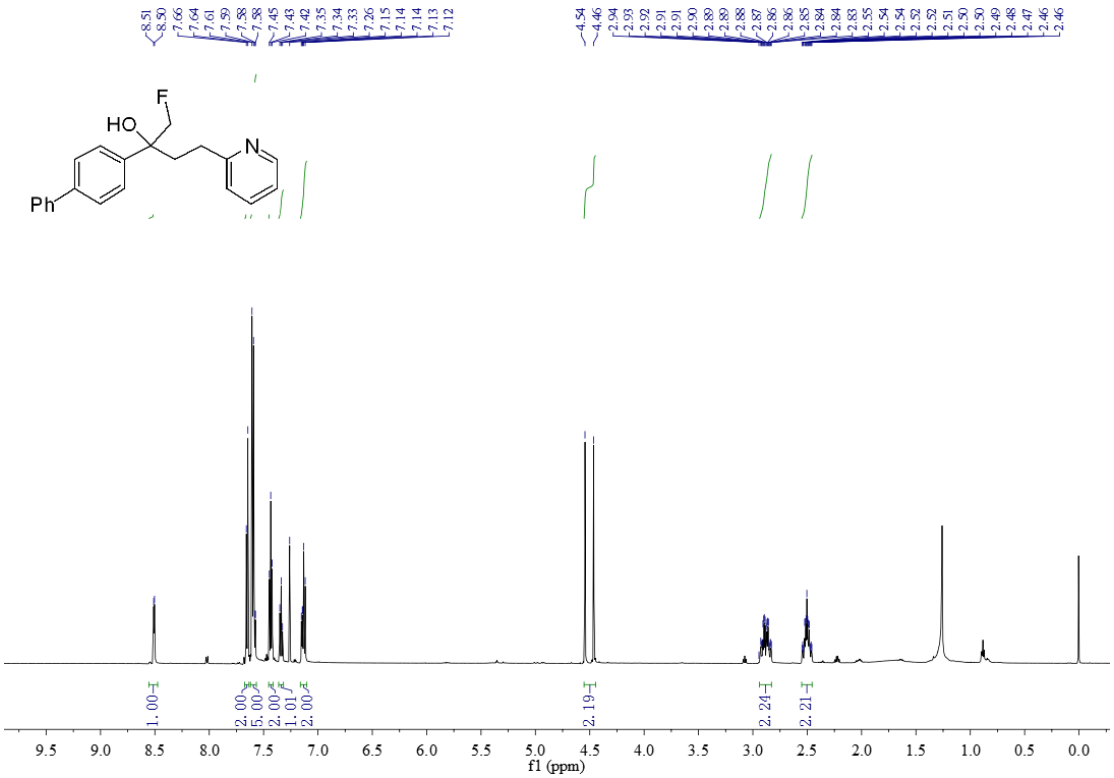

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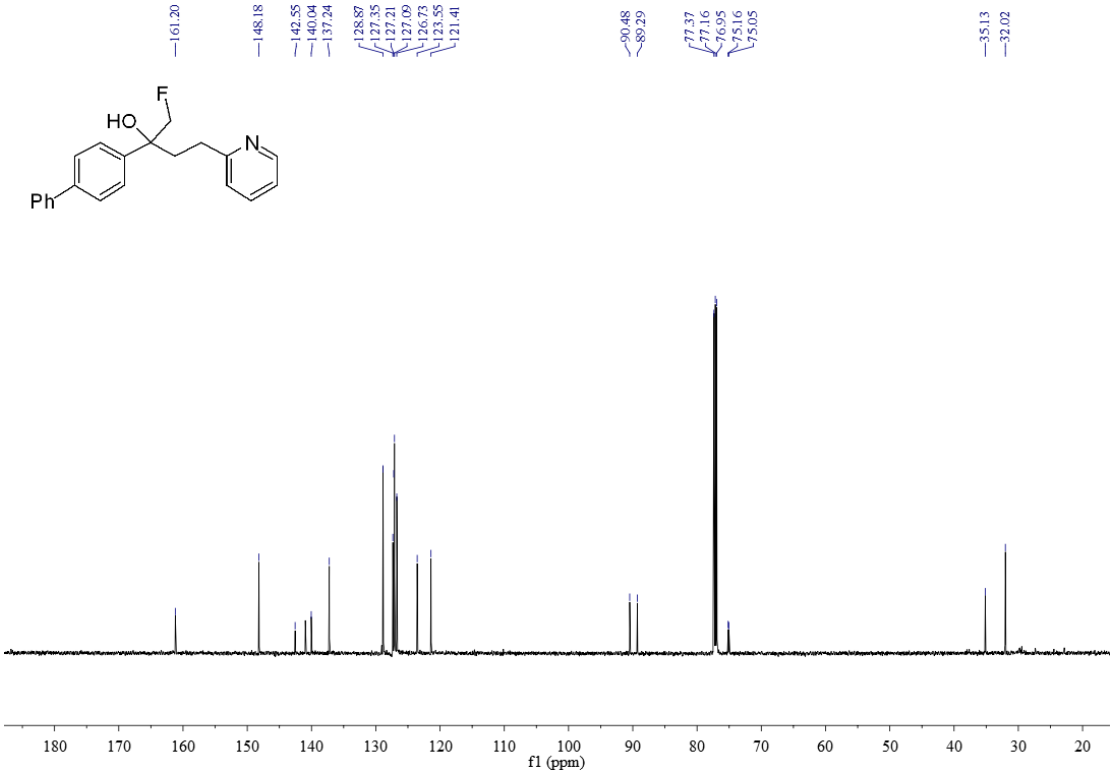

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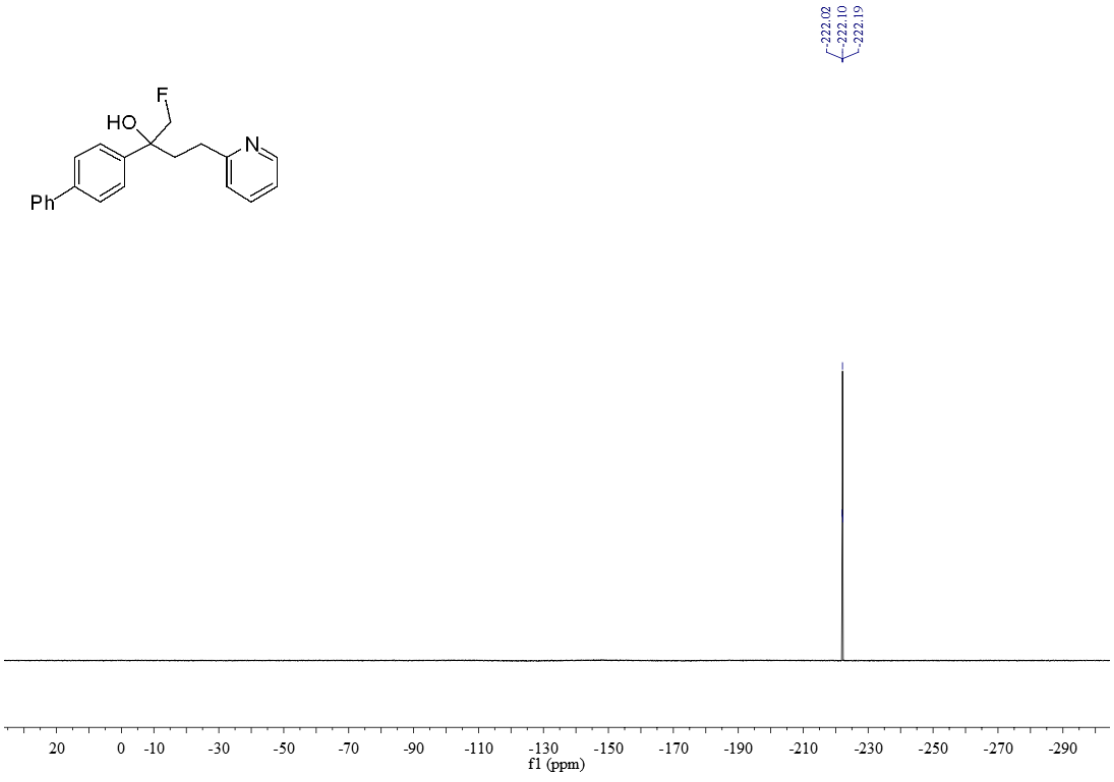

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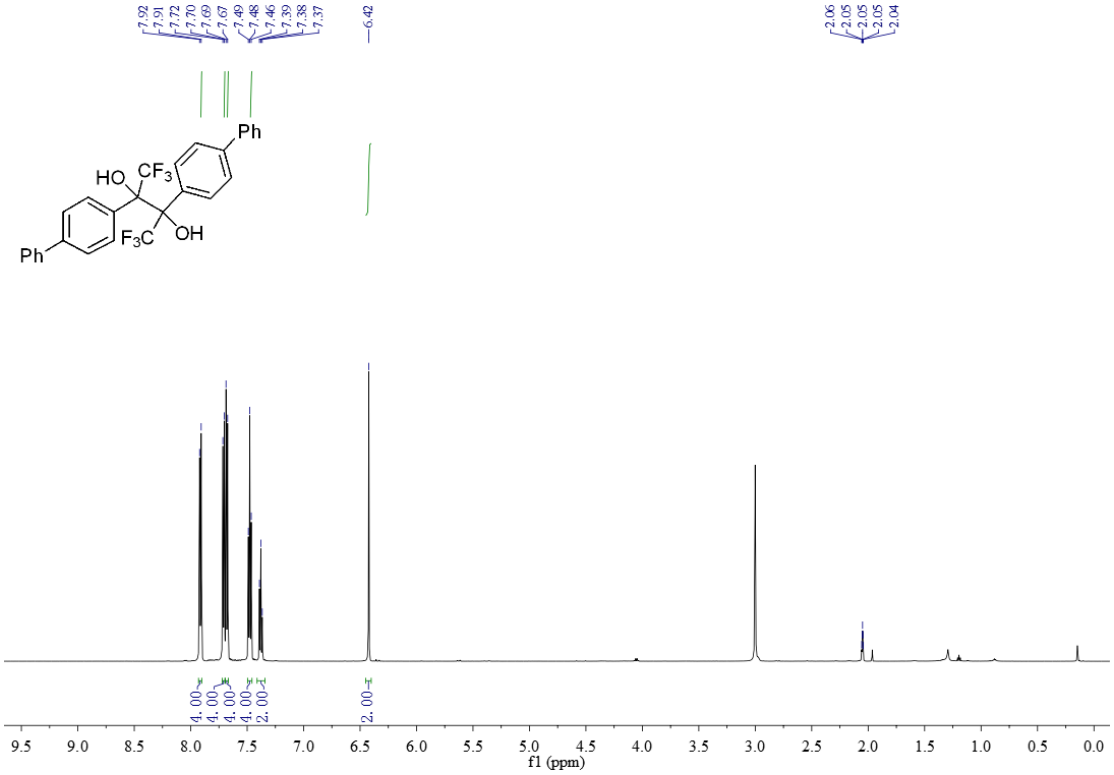
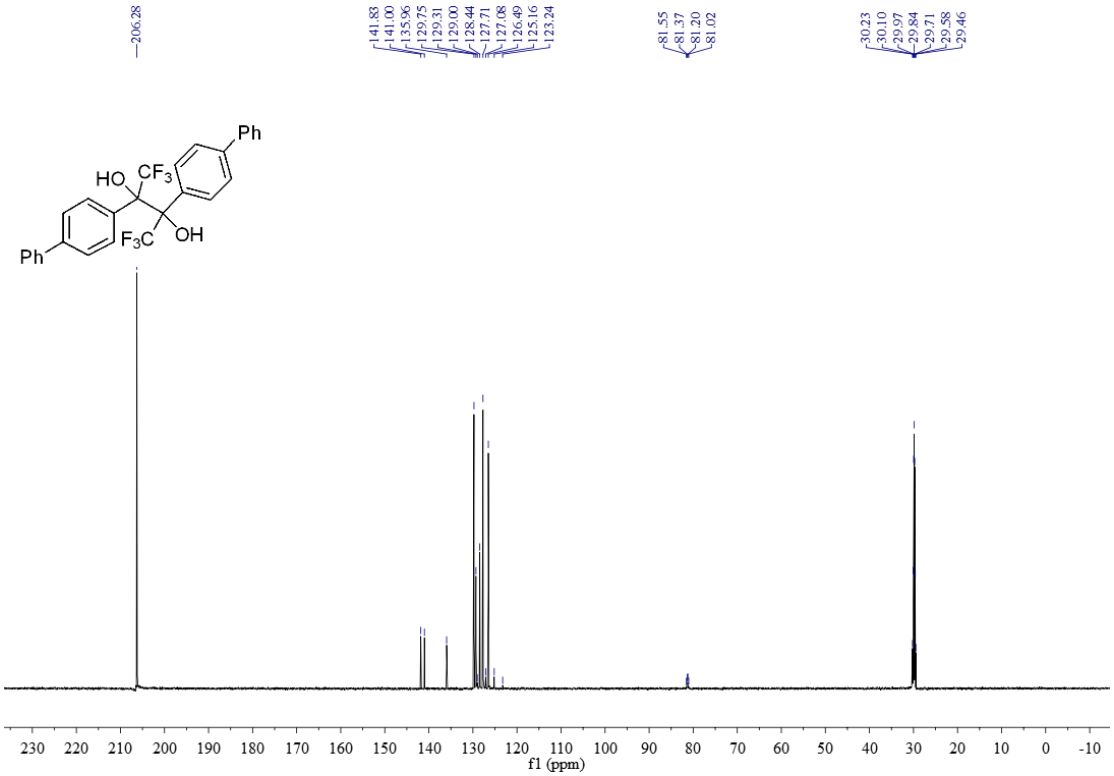


^{13}C NMR of **9**



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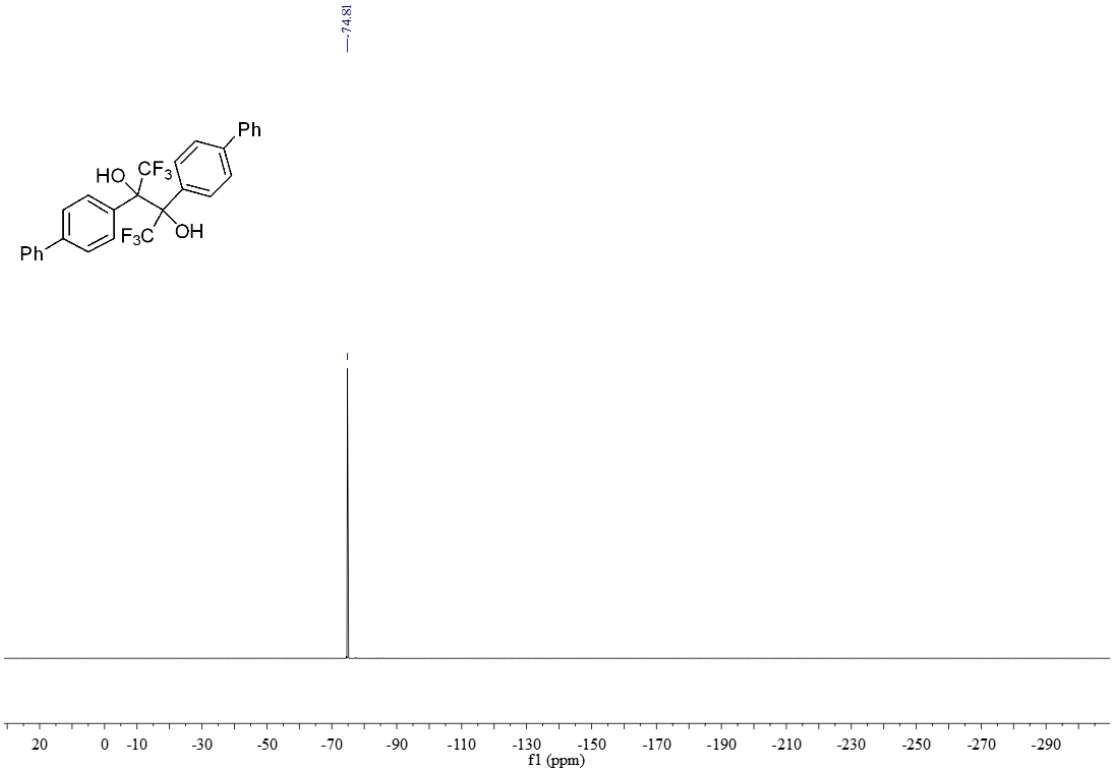
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f1 (ppm)