Supporting Information for:

Enantioselective Synthesis of Chiral 2,2,2-Trifluoroethyl Lactams *via* Asymmetric Hydrogenation

Chaochao Xie,[a] Qianling Guo,[a] Zhihong Yang,[a] Guofu Zi, [a] Yuping Huang*[b] and Guohua Hou*[a]

[a] Key Laboratory of Radiopharmaceuticals, College of Chemistry, Beijing Normal University, Beijing 100875, China

[b] Research Institute of Petroleum Processing, SINOPEC, Beijing 100083, China

CONTENTS

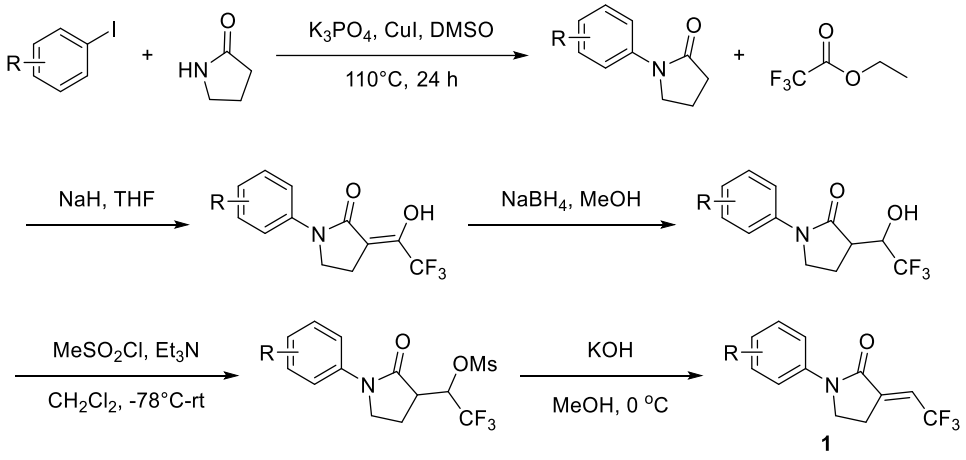
1. Experimental section

General Information:

All the air or moisture sensitive reactions and manipulations were performed by using standard Schlenk techniques and in a nitrogen-filled glovebox. ^{1}H NMR,^{13}C NMR and ^{19}F NMR spectra were recorded on Bruker AV (400 MHz) spectrometers and JEOL JNM-ECX600P and JNM-ECS600 (400 MHz or 600 MHz) spectrometers. $CDC1_3$ was the solvent used for the NMR analysis, with TMS as the internal standard. Chemical shifts were reported upfield to TMS (0.00 ppm) for ^{1}H NMR. Data is represented as follows: chemical shift, integration, multiplicity (s = singlet, d = doublet, dd = double of doublets, t = triplet, q = quartet, m = multiplet) and coupling constants (*J*) in Hertz (Hz). Optical rotation was determined using Autopol III Automatic polarimeter (Rudolph research Analyical). GC analysis was conducted on an Agilent 7890A series instrument. HPLC analysis was conducted on Agilent 1260 series instrument. SFC analysis was conducted on Agilent 1260 series instrument. HRMS were recorded on a Waters LCT Premier XE mass spectrometer with APCI or ESI.

2. General procedure for synthesis of substrates 1, 3 and compounds 5 - 8.

Method A: 1a-1r were prepared by the following protocol.[1, 2]



The 2-pyrrolidinone (30 mmol), iodoarenes (20 mmol), potassium phosphate (60 mmol), CuI (2 mmol) were placed in a three-neck round bottom flask equipped with a stir bar. DMSO (24 mL) was added under nitrogen. The reaction mixture was heated to

110 °C. After 24 h, the reaction mixture was diluted with ethyl acetate, washed with saturated brine, dried over Na_2SO_4 and concentrated in vacuo. The residue was purified by column chromatography over silica gel to give product in 55-87% yield.

Sodium hydride (20 mmol) was placed in a three-neck round bottom flask. THF (20 mL) was added under nitrogen. Then a solution of trifluoromethyl ethyl acetate (12 mmol) and the pyrrolidones derivatives (10 mmol) in THF (20 mL) was added dropwise. The mixture was stirred for 24 h at room temperature and adjusted PH to 3 with 1M HCl solution. The organic phase was extracted with ethyl acetate, washed with saturated brine, dried over Na_2SO_4 and concentrated in vacuo. The crude product was purified with column chromatography to give 3-(2,2,2-trifluoro-1-hydroxyethylidene) pyrrolidin-2-one in 50-90% yield.

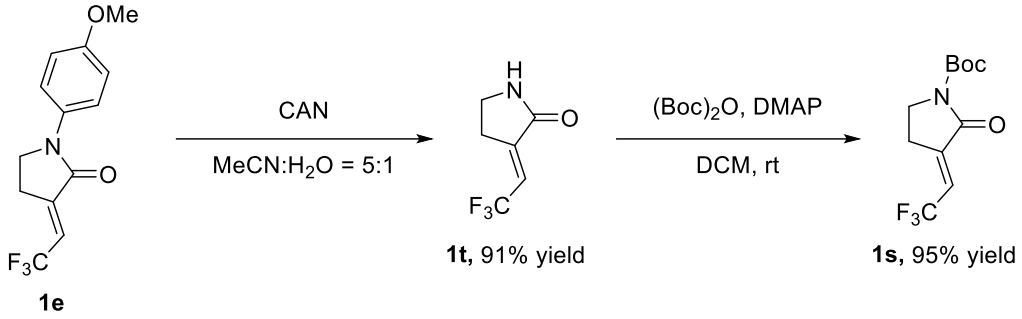
The 3-(2,2,2-trifluoro-1-hydroxyethylidene)pyrrolidin-2-one (10 mmol) was dissolved in methanol (60 mL), $NaBH_4$ was added (15 mmol) at 0 °C and the reaction mixture was stirred at room temperature for 2 h. The organic phase was extracted with ethyl acetate, then washed with saturated brine, and dried over Na_2SO_4, concentrated in vacuo to give crude product 3-(2,2,2-trifluoro-1-hydroxyethyl) pyrrolidin-2-one without purification.

To a solution of 3-(2,2,2-trifluoro-1-hydroxyethyl) pyrrolidin-2-one (10 mmol) in CH_2Cl_2 (27 mL) was added Et_3N (10 mmol) under nitrogen. The solution was stirred for 30 min at room temperature. Then methanesulfonyl chloride (15 mmol) was added dropwise to the solution at -78 °C. After stirred at -78 °C for 30 min, the reaction mixture was warmed to room temperature. Then Et_3N (15 mmol) was added, followed by stirring at room temperature for 3 h. The solution was stirred overnight and extracted with CH_2Cl_2. The organic phase was washed with saturated brine, and dried over Na_2SO_4, concentrated in vacuo. The residue was purified by chromatography over silica gel.

To a solution of 2,2,2-trifluoro-1-(2-oxopyrrolidin-3-yl)ethylmethanesulfonate (10 mmol) in methanol (30 mL) was added KOH (10 mmol) at 0 ºC for 1 h. The organic phase was extracted with ethyl acetate, then washed with saturated brine, and dried over

Na_2SO_4, concentrated in vacuo. The residue was purified by chromatography over silica gel to give compound **1** in 64-87% yield.

General Procedure for Synthesis of Product 1s and 1t

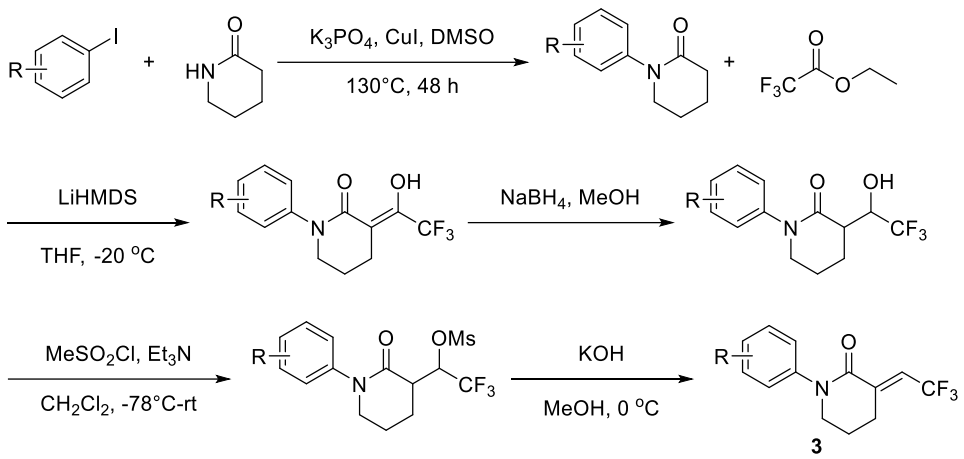


To a cold solution (0 °C) of **1e** in CH_3CN/H_2O (5:1) was added CAN (ceric ammonium nitrate, 4.4 equiv.). The reaction was stirred for 30 min at 0 °C and then 12 h at room temperature. The reaction mixture was diluted with EtOAc, washed with saturated aqueous $NaHCO_3$, brine, dried (Na_2SO_4), and then concentrated. Purification of the crude product by flash chromatography afforded the desired product **1t**.

The compound **1t** (4.0 mmol), DMAP (0.1 equiv.), and triethylamine (1.5 equiv.) were dissolved in dichloromethane (8.0 mL), followed by slow addition of $(Boc)_2O$ (2.0 equiv.). The mixture was stirred further for 5 h at room temperature. The reaction mixture was concentrated under vacuum, and the residue was purified by chromatography on silica gel to afforded the desired product **1s**.

Method C: 3a-3m were prepared by the following protocol.

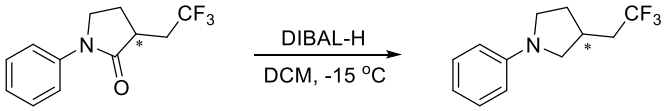
The 2-Piperidone (30 mmol), iodoarenes (20 mmol), potassium phosphate (60 mmol), CuI (2 mmol) were placed in a three-neck round bottom flask equipped with a stir bar. DMSO (24 mL) was added under nitrogen. The reaction mixture was heated to 130 ° C. After 48 h, the reaction mixture was diluted with ethyl acetate, washed with saturated brine, dried over Na_2SO_4 and concentrated in vacuo. The residue was purified by column chromatography over silica gel to give product in 50-75% yield.



The piperidone s derivatives (10 mmol) was placed in a three-neck round bottom flask. THF (20 mL) was added under nitrogen. Then slowly add tetrahydrofuran solution of LiHMDS (Lithium bis(trimethylsilyl)amide, 15 mmol). Next, a solution of trifluoromethyl ethyl acetate (12 mmol) in THF (20 mL) was added dropwise. The mixture was stirred for 6 h at -20 °C and adjusted PH to 3 with 1M HCl solution. The organic phase was extracted with ethyl acetate, washed with saturated brine, dried over Na_2SO_4 and concentrated in vacuo. The crude product was purified with column chromatography to give 3-(2,2,2-trifluoro-1-hydroxyethylidene)piperidin-2-one in 60-88% yield..

The next synthesis method refers to the synthesis of substrate **1a**.

General Procedure for Synthesis of Product 5

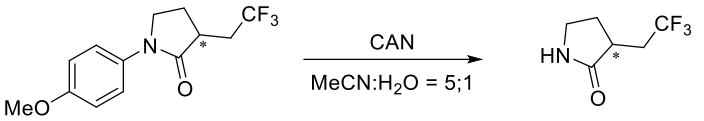


2a, 97% ee　　**5**, 90% yield; 94% ee

To a flame-dried round bottom flask charged with a magnetic stir and substrate **2a** was added CH_2Cl_2 and cooled to -15 °C. Following, a freshly prepared 1M solution of DIBAL-H (Diisobutylaluminium hydride) in toluene (1.2 equiv.) was added dropwise to and the reaction was stirred at -15 °C until completion was observed by TLC analysis. Upon completion the reaction was cooled to 0 °C and few milliliters of water are added to quench the reaction. The reaction was transferred to a separatory funnel and the milky aqueous layer was extracted twice with CH_2Cl_2. The combined organic layer was dried over $MgSO_4$ and concentrated. The crude product was purified by column

chromatography to give product **5** in 90% yield.

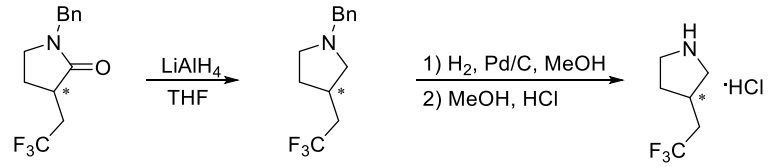
General Procedure for Synthesis of Product 6



2e, 96% ee **6**, 92% yield; 92% ee

To a cold solution (0 °C) of **2e** in CH_3CN/H_2O (5:1) was added CAN (ceric ammonium nitrate, 4.4 equiv.). The reaction was stirred for 30 min at 0 °C and then 12 h at room temperature. The reaction mixture was diluted with EtOAc, washed with saturated aqueous $NaHCO_3$, brine, dried (Na_2SO_4), and then concentrated. Purification of the crude product by flash chromatography afforded the desired product **6** in 92% yield.

General Procedure for Synthesis of Product 8



2r, 99.9% ee **7**, 88% yield, 99% ee **8**, 73% yield

$LiAlH_4$ (2.5 equiv.) was added to a solution of **2r** in THF. The resulting mixture was refluxed for 10 h and quenched at 0°C with 25 wt.% NaOH. The formed precipitate was filtered off on a plug of celite and the filter cake washed with Et_2O. The filtrate was washed with brine, dried (Na_2SO_4) and concentrated under reduced pressure affording the crude amine. Purification of the crude product by flash chromatography afforded the desired product **7** in 88% yield.

A solution of **7** in methanol was charged with palladium on carbon (2.5 equiv.), then hydrogen gas (1 atm), and the mixture was stirred for 24 h. Then filter the reaction solution and collect the filtrate, added 4 mol/L hydrochloric acid in methanol to the filtrate. The reaction mixture was vigorously stirred at 45 °C in an oil bath for 16 h. The mixture was concentrated under reduced pressure, washed with Et_2O, and dried under reduced pressure to give **8** as a brown oil in 73% yield.

3. General procedure for asymmetric hydrogenation of compounds 1 and 3

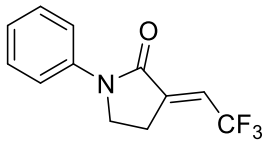
At room temperature, $[Rh(COD)Cl]_2$ and (*R, R*)-f-spirophos were mixed in methanol at a molar ratio of 0.5:1.1 for 20 minutes in a nitrogen-filled glove box to prepare a stock solution. An aliquot of the catalyst solution (1.0 mL, 0.00125 mmol)) was transferred by syringe into the vials charged with different substrates **1** (0.125 mmol for each) in anhydrous MeOH (2.0 ml). The vials were then placed into a steel autoclave which hydrogen gas was charged. The reaction mixture was stirred under H_2 (10 atm) at room temperature for 1 h for the substrates. The hydrogen gas was released slowly and carefully. The solution was passed through a short column of silica gel to remove the metal complex. The conversion of products was determined by GC or ^{1}H NMR analysis. The crude products were concentrated and purified by column chromatography and the ee values were determined by HPLC or SFC analysis on a chiral stationary phase.

4. Procedure for asymmetric hydrogenation of 1a on gram-scale.

At room temperature, $[Rh(COD)Cl]_2$ and (*R, R*)-f-spirophos were mixed in methanol at a molar ratio of 0.5:1.1 for 20 minutes in a nitrogen-filled glove box to prepare a stock solution. An aliquot of the catalyst solution (1.0 mL, 0.00125 mmol)) was transferred by syringe into the vials charged with substrate **1a** (13.2 mmol) in anhydrous MeOH (5.0 ml). The vials were then placed into a steel autoclave which hydrogen gas was charged. The reaction mixture was stirred under H_2 (80 atm) at 40 ^{o}C for 5 days. The hydrogen gas was released slowly and carefully. The solid was washed with CH_2Cl_2, and filtered to give the product **2a** as a white solid (3.05 g, 96% yield) with 98% ee determined by HPLC with a chiral column.

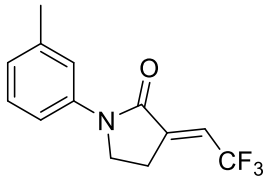
5. The characterization data for substrates 1 and 3

(*E*)-1-phenyl-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1a**)



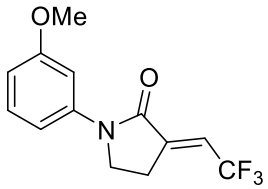
White solid; Yield: 82%; (PE/EA = 12/1); ^{1}H NMR ($CDCl_3$, 600 MHz) δ: 7.71 (t, *J* = 6.5 Hz, 2H), 7. 42 –7.39 (m, 2H), 7.24 – 7.20 (m, 1H), 6.64 – 6.56 (m, 1H), 3.98 – 3.93 (m, 2H), 3.13 – 3.10 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.9, 142.8, 138.9, 129.2, 125.8, 123.5 (q, *J* = 270.2 Hz), 120.1, 118.7 (q, *J* = 35.6 Hz), 45.5, 22.2; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, *J* = 3.4 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_{11}NOF_3$ [M+H$^+$]: 242.0787, found 242.0790.

(*E*)-1-(*m*-tolyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1b**)



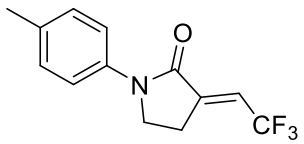
White solid; Yield: 85%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.55 (s, 1H), 7.49 – 7.46 (m, 1H), 7.28 (t, *J* = 7.9 Hz, 1H), 7.04 – 7.02 (m, 1H), 6.62 – 6.55 (m, 1H), 3.94 (t, *J* = 6.3Hz, 2H), 3.12– 3.06 (m, 2H), 2.38 (s, 3H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.8, 142.9 (d, *J* = 5.1 Hz), 139.1, 138.8, 129.0, 126.7, 123.6 (q, *J* =271.7 Hz), 118.6 (q, *J* = 35.4 Hz), 117.2, 45.7, 22.2, 21.7; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, *J* = 3.8 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{13}NOF_3$ [M+H$^+$]: 256.0943, found 256.0940.

(*E*)-1-(3-methoxyphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1c**)



White solid; Yield:87%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.47 (s, 1H), 7.30 (t, *J* = 8.2 Hz, 1H), 7.19 (d, *J* = 8.2 Hz, 1H), 6.77 (d, *J* = 8.2, 1H), 6.63– 6.55 (m, 1H), 3.93 (t, *J* = 6.5 Hz, 2H), 3.82 (s, 3H), 3.12 –3.07 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.9, 160.19, 142.89 (q, *J* = 5.0 Hz), 140.09, 129.8, 123.5 (q, *J* = 270.3 Hz), 118.6 (q, *J* = 35.6 Hz), 111.9, 111.4, 106.1, 55.4, 45.6, 22.0; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, *J* = 3.8 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{13}NO_2F_3$ [M+H$^+$]: 272.0892, found 272.0890.

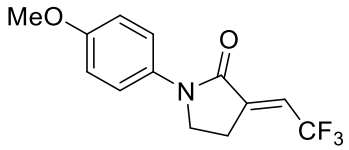
(*E*)-1-(*p*-tolyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1d**)



White solid; Yield: 75%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.59 (d, *J* = 8.6 Hz, 2H), 7.20 (d, *J* = 8.2 Hz, 2H), 6.62 – 6.55 (m, 1H), 3.93 (t, *J* = 6.4 Hz, 2H) 3.13 –3.08

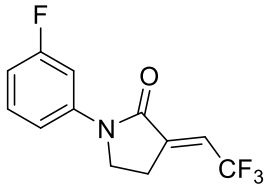
(m, 2H); 2.34 (s, 3H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.7, 142.9 (q, J = 4.6 Hz), 136.4, 135.6, 129.7, 123.6 (q, J = 270.3 Hz), 120.1, 118.4 (q, J = 35.5 Hz), 45.6 (d, J = 0.9 Hz), 22.2 (d, J = 0.8 Hz), 21.0; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, J = 3.4 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{13}NOF_3$ [M+H$^+$]: 256.0943, found 256.0940.

(*E*)-1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1e**)



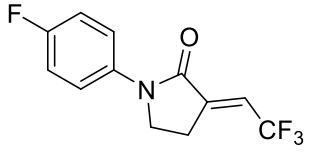
White solid; Yield: 73%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.62 (d, J = 9.2 Hz, 2H), 6.93 (d, J = 9.2 Hz, 2H), 6.62 – 6.54 (m, 1H), 3.92 (t, J = 6.2 Hz, 2H), 3.81 (s, 3H), 3.13 –3.08 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.6, 157.4, 142.8 (d, J = 5.2 Hz), 132.1, 123.6 (q, J = 270.2 Hz), 121.7, 118.3 (q, J = 35.5 Hz), 114.3, 55. 6, 45.9 (t, J = 1.0 Hz), 22. 2 (t, J = 1.0 Hz); ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.7 (t, J = 3.4 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{13}NO_2F_3$ [M+H$^+$]: 272.0892, found 272.0890.

(*E*)-1-(3-fluorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1f**)



White solid; Yield: 68%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.64 (dt, J = 11.2, 2.3 Hz, 1H), 7.44 (dd, J = 8.3, 2.1 Hz, 1H), 7.36 (td, J = 8.2, 6.4 Hz, 1H), 6.92 (td, J = 8.2, 2.4 Hz, 1H), 6.66 – 6.58 (m, 1H), 3.94 (t, J = 6.6 Hz, 2H), 3.15 –3.10 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.9, 162.9 (d, J = 245.5 Hz), 142.2 (q, J = 4.9 Hz), 140.3(d, J = 10.5 Hz), 130.2 (d, J = 9.2 Hz), 123.3 (q, J = 271.7 Hz), 119.2 (q, J = 35.7 Hz), 114.9 (d, J = 3.0 Hz), 112.4 (d, J = 21.3 Hz), 107.4 (d, J = 26.6 Hz), 45.4, 21.9; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.9 (t, J = 3.8 Hz, 3F), -110.7 – -110.8 (m, 1F); TOF-HRMS Calcd. for $C_{12}H_{10}NOF_4$ [M+H$^+$]: 260.0693, found 260.0690.

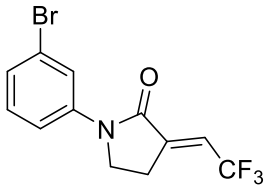
(*E*)-1-(4-fluorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1g**)



White solid; Yield: 65%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.73 – 7.64 (m, 2H), 7.15 – 7.03 (m, 2H), 6.69 – 6.51 (m, 1H), 4.02 – 3.79 (m, 2H), 3.15 –3,10 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.8, 160.2 (d, J = 246.1 Hz), 142.4 (q, J = 5.1 Hz), 135.0 (d, J = 2.9 Hz), 123.5 (q, J = 270.3 Hz), 121.8 (q, J = 8.1 Hz), 118.9 (q, J = 35.6 Hz),

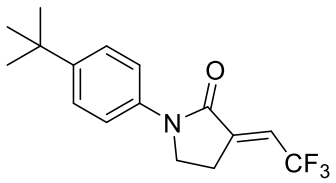
116.0 (d, J = 22.6 Hz), 45.8, 22.1; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, J = 3.8 Hz, 3F), -115.7 – -110.8 (m, 1F); TOF-HRMS Calcd. for $C_{12}H_{10}NOF_4$ [M+H$^+$]: 260.0693, found 260.0690.

(*E*)-1-(3-bromophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1h**)



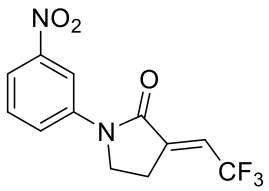
Yellow solid; Yield: 87%; (PE/EA = 20/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.91 (t, J = 2.0 Hz, 1H), 7.71 (ddd, J = 8.1, 2.0, 0.9 Hz, 1H), 7.35 (ddd, J = 8.0, 1.6, 1.0 Hz, 1H), 7.28 (d, J = 8.1 Hz, 1H), 6.65 – 6.57 (m, 1H), 3.93 (t, J = 6.4 Hz, 2H), 3.15 –3.10 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 165.0, 142.2 (q, J = 5.1 Hz), 140.1, 130.4, 128.7, 122.9, 122.8, 122.4 (q, J = 268.9 Hz), 119.3 (q, J = 35.7 Hz), 118.3, 45.4 (q, J = 1.2 Hz), 22.1 (q, J =0.9 Hz); ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -61.0 (t, J = 3.4 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_{10}NOF_3Br$ [M+H$^+$]: 319.9892, found 319.9890.

(*E*)-1-(4-(tert-butyl)phenyl)-3-(2,2-trifluoroethylidene) pyrrolidin-2-one (**1i**)



White solid; Yield: 78%; (PE/EA = 20/1); ^{1}H NMR ($CDCl_3$, 600 MHz) δ: 7.62 (d, J = 8.7 Hz, 2H), 7.42 (d, J = 8.9 Hz, 2H), 6.62 – 6.57 (m, 1H), 3.94 (t, J = 6.5 Hz, 2H), 3.12 – 3.09 (m, 2H), 1.31(s, 9H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.8, 148.9, 142.9 (q, J = 4.9 Hz), 136.3, 126.0, 123.6 (q, J = 270.3 Hz), 119.8, 118.5 (q, J = 35.5 Hz), 45.6 (d, J = 0.9 Hz), 34.6, 31.4, 22.2 (d, J = 0.8 Hz); ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, J = 3.8 Hz, 3F); TOF-HRMS Calcd. for $C_{16}H_{19}NOF_3$ [M+H$^+$]: 298.1413, found 298.1410.

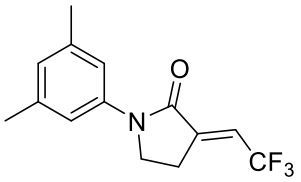
(*E*)-1-(3-nitrophenyl)-3-(2,2,2-trifluoroethylidenepyrrolidin-2-one (**1j**)



Yellow solid; Yield: 77%; (PE/EA = 6/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 8.48 (t, J = 2.2 Hz, 1H), 8.29 (ddd, J = 8.3, 2.2, 0.7 Hz, 1H), 8.06 (ddd, J = 8.2, 2.1, 0.7 Hz, 1H), 7.59 (t, J = 8.3 Hz, 1H), 6.67– 6.51 (m, 1H), 4.03 (t, J = 6.5 Hz, 2H), 3.21–3.16 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 165.3, 148.6, 141.6, 139.8, 130.0, 125.4, 123.2 (q, J = 271.9 Hz), 120.0, 119.9 (q, J = 36.0 Hz), 114.0, 45.3, 21.9; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -61.0 (t, J = 3.4 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_8N_2O_3F_3$ [M-H$^+$]: 285.0492,

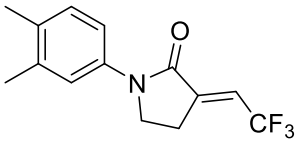
found 285.0490.

(*E*)-1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1k**)



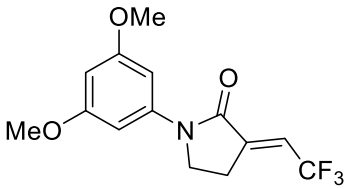
White solid; Yield: 66%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.34 – 7.29 (m, 2H), 6.89 – 6.84 (m, 1H), 6.62 – 6.54 (m, 1H), 3.92 ((t, *J* = 6.9 Hz, 2H), 3.12 –3.05 (m, 2H), 2.33 (s, 6H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.8, 143.0 (q, *J* =5.0 Hz), 138.9, 138.7, 127.7, 123.6 (q, *J* = 270.3 Hz), 118.4 (q, *J* = 35.6 Hz), 118.1, 45.8, 22.2, 21.6; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, *J* = 4.1 Hz, 3F); TOF-HRMS Calcd. for $C_{14}H_{15}NOF_3$ [M+H$^+$]: 270.1100, found 270.1198.

(*E*)-1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-onee (**1l**)



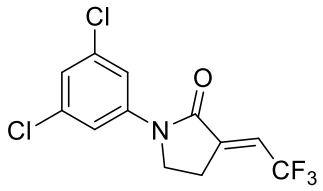
White solid; Yield: 80%; (PE/EA = 20/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.50 (s, 1H), 7.38 (d, *J* = 8.2 Hz, 1H), 7.15 (d, *J* = 8.2 Hz, 1H), 6.61 – 6.54 (m, 1H), 3.92 (t, *J* = 6.7 Hz, 2H), 3.11 –3.07 (m, 2H); 2.26 (d, *J* = 12.8 Hz, 6H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.7, 143.1 (q, *J* = 5.1 Hz), 137.5, 136.6, 134.4, 130.1, 123.6 (q, *J* = 270.3 Hz), 121.4, 118.2 (q, *J* = 35.5 Hz), 117.6 , 45.7 (d, *J* = 1.01 Hz), 22.2 (d, *J* = 1.0 Hz), 20.1, 19.3; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.8 (t, *J* = 3.8 Hz, 3F); TOF-HRMS Calcd. for $C_{14}H_{15}NOF_3$ [M+H$^+$]: 270.1100, found 270.1198.

(*E*)-1-(3,5-dimethoxyphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1m**)



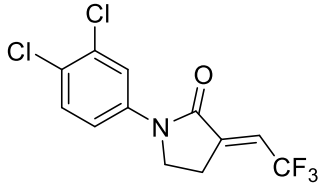
Yellow solid; Yield: 82%; (PE/EA = 4/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.70 (d, *J* = 2.5 Hz, 1H), 6.93 (dd, *J* = 8.7, 2.5 Hz, 1H), 6.86 (d, *J* = 8.7 Hz, 1H), 6.61 – 6.53 (m, 1H), 3.93 (t, *J* =6.2 Hz, 2H), 3.90 (s, 3H), 3.88 (s, 3H), 3.13 –3.08 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 164.7, 149.1, 147.0, 142.9 (d, *J* = 5.1 Hz), 132.5, 123.6 (q, *J* = 270.2 Hz), 118.3 (q, *J* = 35.6 Hz), 111.7, 111.0, 104.9, 56.1(d, *J* = 5.05 Hz), 45.9, 22. 1; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.6 – -61.2 (m, 3F); TOF-HRMS Calcd. for $C_{14}H_{15}NO_3F_3$ [M+H$^+$]: 302.0998, found 302.1001.

(*E*)-1-(3,5-dichlorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1n**)



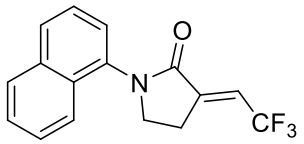
White solid; Yield: 64%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 600 MHz) δ: 7.71 (d, *J* = 1.7 Hz, 2H), 7.21 (t, *J* = 1.6 Hz, 1H), 6.65 – 6.60(m, 1H),, 3.91 (t, *J* = 6.6 Hz, 2H), 3.15 – 3.12 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 165.1 , 141.8 (d, *J* = 5.1 Hz), 140.6, 135.5, 125.5, 123.3 (q, *J* = 270.5 Hz), 119. 8 (q, *J* = 35.8 Hz), 117. 9, 45.3, 21.9; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -61.0 (t, *J* = 3.8 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_9NOF_3Cl_2$ [M+H$^+$]: 310.0007, found 310.0005.

(*E*)-1-(3,4-dichlorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1o**)



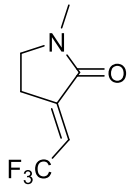
White solid; Yield: 65 %; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.90 (d, *J* = 2.6 Hz, 1H), 7.64 (dd, *J* = 8.9, 2.6 Hz, 1H), 7.45 (d, *J* = 8.9 Hz, 1H), 6.64 – 6.57 (m, 1H), 3.91 (t, *J* = 6.9 Hz, 2H), 3.15 –3.10 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 165.0, 141.8 (q, *J* = 5.0 Hz), 138.2, 133.0, 130.6, 129.0, 123.2 (q, *J* = 270.7 Hz), 121.3, 119.4 (q, *J* = 35.9 Hz), 118.7, 45.2, 21.9; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -61.0 (t, *J* = 3.4 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_9NOF_3Cl_2$ [M+H$^+$]: 310.0007, found 310.0005.

(*E*)-1-(naphthalen-1-yl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1p**)



White solid; Yield: 66%; (PE/EA = 10/1); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.94 – 7.85 (m, 2H), 7.70 – 7.63 (m, 1H), 7.57 – 7.48 (m, 3H), 7.41 (dd, *J* = 7.3, 1.2 Hz, 1H), 6.71 – 6.23 (m, 1H), 3.97 (t, *J* = 6.2 Hz, 2H), 3.31 –3.26 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 166.0, 142.0 (q, *J* = 5.1 Hz), 134.8, 134. 7, 129.2, 129.2, 128.8, 127.2, 126.7, 125. 7, 124.9, 124.5, 123.6 (q, *J* = 274.4 Hz) 122.5, 119.0 (q, *J* = 35.6 Hz), 48.8, 23.4; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.9 (t, *J* = 3.8 Hz, 3F); TOF-HRMS Calcd. for $C_{16}H_{13}NOF_3$ [M+H$^+$]: 292.0943, found 292.0946.

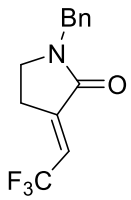
(*E*)-1-methyl-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1q**)



Colorless oil; Yield: 74% (PE/EA = 5/1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.36 (qt, *J* = 8.44, 3.06 Hz, 1H), 3.42 (t, *J* = 6.24 Hz, 2H), 2.93 (s, 3H), 2.92 – 2.87 (m, 2H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 166.0, 142.3 –

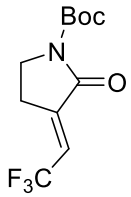
142.0 (m), 123.6 (q, J = 270.17 Hz), 117.3 (q, J = 35.46 Hz), 46.5, 22.4. ^{19}F NMR ($CDCl_3$, 376 MHz) δ: -61.1 (s, 3F); TOF-HRMS Calcd. for $C_7H_9F_3NO$ [M+H^+]: 180.0631, found 180.0626.

(*E*)-1-benzyl-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1r**)



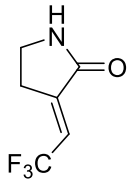
Colorless oil; Yield: 68% (PE/EA = 10/1); 1H NMR (600 MHz, Chloroform-d) δ 7.33 (t, J = 7.25 Hz, 2H), 7.29 (t, J = 7.25 Hz, 1H), 7.24 (d, J = 6.89 Hz, 2H), 6.52 (dtd, J = 11.60, 8.37, 3.20 Hz, 1H), 4.57 (s, 2H), 3.41 – 3.26 (m, 2H), 2.92 (tt, J = 6.78, 3.44 Hz, 2H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 165.8, 142.3 (t, J = 5.48 Hz), 135.5, 128.9, 128.4, 128.1, 123.5 (q, J = 270.44 Hz), 118.0 (q, J = 35.78 Hz), 47.6, 43.8, 22.4. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -60.7 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{13}F_3NO$ [M+H^+]: 256.0944, found 256.0946.

tert-butyl (*E*)-2-oxo-3-(2,2,2-trifluoroethylidene)pyrrolidine-1-carboxylate (**1s**)



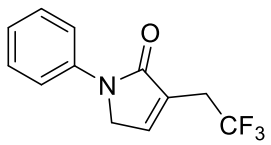
White solid; Yield: 80% (PE/EA = 20/1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.64 – 6.56 (m, 1H), 3.89 – 3.63 (m, 2H), 2.94 (tt, J = 6.92, 3.44 Hz, 2H), 1.53 (s, 9H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 164.5, 123.0 (d, J = 270.63 Hz), 120.9 (q, J = 35.81 Hz), 43.2, 28.0, 21.4. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -60.9 (t, J = 3.8 Hz, 3F); ^{19}F NMR (565 MHz, Chloroform-*d*) δ: -61.1 (s, 3F); TOF-HRMS Calcd. for $C_7H_7F_3NO_3$ [M+H^+]: 210.0373, found 210.0365.

(*E*)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1t**)



Brown solid; Yield: 69% (PE/EA = 3/1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 8.32 (s, 1H), 6.41 (qt, J = 8.30, 3.12 Hz, 1H), 3.50 (t, J = 6.27 Hz, 2H), 3.02 (tp, J = 6.88, 3.45 Hz, 2H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 169.8, 142.2 (q, J = 5.03 Hz), 123.4 (q, J = 270.29 Hz), 117.8 (q, J = 35.63 Hz), 39.7, 24.3. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -61.1 (s, 3F); TOF-HRMS Calcd. for $C_6H_7F_3NO$ [M+H^+]: 166.0474, found 166.0476.

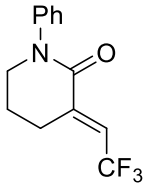
1-phenyl-3-(2,2,2-trifluoroethyl)-1,5-dihydro-2H-pyrrol-2-one (**1u**)



White solid; NMR ($CDCl_3$, 400 MHz) δ: 7.73 – 7.70 (m, 2H), 7.40 – 7.36 (m, 2H), 7.17 – 7.13 (m, 2H), 4.43– 4.41 (m, 2H), 3.24 –3.18 (m, 2H); ^{13}C{^{1}H}NMR ($CDCl_3$, 151 MHz) δ: 168.8,

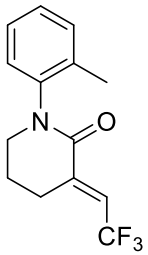
139.0, 138.76, 130.7, 129.3, 125.6 (q, J = 277.8 Hz), 124.6, 118.8, 51.56, 30.4 (q, J = 31.7 Hz); ^{19}F NMR ($CDCl_3$, 565 MHz) δ: 64.9 (t, J = 5.6 Hz, 3F); TOF-HRMS Calcd. for $C_{16}H_{13}NOF_3$ [M+H$^+$]: 292.0943, found 292.0946.

(*E*)-1-phenyl-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3a**)



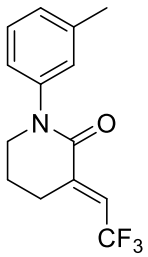
White solid; Yield: 77%; (PE/EA = 12/1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.45 – 7.37 (m, 2H), 7.32 – 7.24 (m, 3H), 6.96 – 6.87 (m, 1H), 3.76 (td, J = 5.52, 0.98 Hz, 2H), 2.97 – 2.84 (m, 2H), 2.14 – 1.99 (m, 2H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 162.0, 143.0, 140.8 (d, J = 5.11 Hz), 129.3, 127.3, 125.8, 126.8 (q, J = 34.7 Hz) 125.9 (d, J = 271.8 Hz), 25.6, 22.5. ^{19}F NMR (565 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{13}F_3NO$ [M+H$^+$]: 256.0944, found 256.0947.

(*E*)-1-(*o*-tolyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3b**)



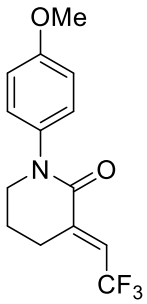
White solid; Yield: 83%; (PE/EA = 20/1); ^{1}H NMR (400 MHz, Chloroform-d) δ 7.32 – 7.20 (m, 3H), 7.17 – 7.06 (m, 1H), 6.91 (qt, J = 8.9, 2.2 Hz, 1H), 3.71 (ddd, J = 12.4, 7.3, 4.7 Hz, 1H), 3.60 – 3.47 (m, 1H), 3.04 – 2.81 (m, 2H), 2.20 (s, 3H), 2.07 (ddt, J = 9.8, 7.5, 5.1 Hz, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 161.5, 141.8, 140.6 (d, J = 5.07 Hz), 134.8, 131.3, 128.2, 127.4, 126.5, 124.8, 123.6 (q, J = 34.3 Hz), 123.4 (d, J = 272.7 Hz), 51.1, 25.7, 22.6, 17.6. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.5 (s, 3F); TOF-HRMS Calcd. for $C_{14}H_{15}F_3NO$ [M+H$^+$]: 270.1100, found 270.1096.

(*E*)-1-(*m*-tolyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3c**)



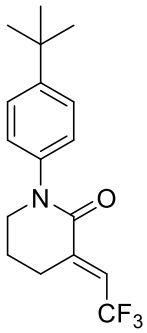
White solid; Yield: 82%; (PE/EA = 12/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.29 (t, J = 7.73 Hz, 1H), 7.16 – 7.01 (m, 3H), 6.97 – 6.86 (m, 1H), 3.80 – 3.65 (m, 2H), 2.89 (ddt, J = 8.98, 4.70, 2.35 Hz, 2H), 2.36 (s, 3H), 2.05 (dq, J = 7.60, 6.04 Hz, 2H). ^{13}C NMR (101 MHz, Chloroform-d) δ 162.0, 142.9, 140.8 (q, J = 5.0 Hz), 139.3, 129.2, 128.2, 126.6, 123.7 (q, J = 35.3 Hz) 123.5 (d, J = 272.7 Hz), 122.8, 51.5, 25.6, 21.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{14}H_{15}F_3NO$ [M+H$^+$]: 270.1100, found 270.1096.

(*E*)-1-(3-bromophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3d**)



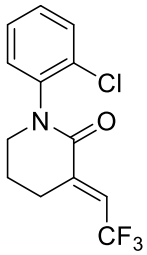
White solid; Yield: 79%; (PE/EA = 15/1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.20 – 7.12 (m, 2H), 6.95 – 6.83 (m, 3H), 3.80 (d, *J* = 1.23 Hz, 3H), 3.72 (dd, *J* = 6.52, 4.98 Hz, 2H), 2.89 (ddt, *J* = 9.09, 4.91, 2.37 Hz, 2H), 2.09 – 1.98 (m, 2H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 162.2, 158.5, 140.8, 135.8, 127.0, 123.7 (q, *J* = 34.6 Hz), 123.5 (d, *J* = 270.3 Hz) 114.6, 55.5, 51.7, 25.6, 22.5. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{14}H_{15}F_3NO_2$ [M+H$^+$]: 286.1049, found 286.1046.

(*E)*-1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3e**)



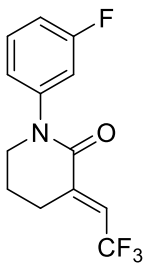
White solid; Yield: 81%; (PE/EA = 15/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.49 – 7.35 (m, 2H), 7.19 (d, *J* = 8.62 Hz, 2H), 6.97 – 6.85 (m, 1H), 3.75 (t, *J* = 5.61 Hz, 2H), 2.89 (ddt, *J* = 6.77, 4.62, 2.46 Hz, 2H), 2.17 – 1.96 (m, 2H), 1.31 (s, 9H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.0, 150.1, 140.9 (d, *J* = 5.1 Hz), 140.3, 126.3, 125.2, 123.7 (q, *J* = 34.3 Hz), 123.5 (d, *J* = 272.7 Hz), 51.4, 34.6, 31.4, 25.6, 22.5. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{17}H_{21}F_3NO$ [M+H$^+$]: 312.1570, found 312.1570.

(*E*)-1-(2-chlorophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3f**)



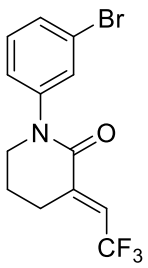
White solid; Yield: 70%; (PE/EA = 15/1); ^{1}H NMR (400 MHz, Chloroform-d) δ 7.49 (dd, *J* = 7.32, 2.10 Hz, 1H), 7.37 – 7.27 (m, 2H), 7.27 – 7.24 (m, 1H), 6.91 (qt, *J* = 8.80, 2.16 Hz, 1H), 3.82 – 3.50 (m, 2H), 2.92 (dddt, *J* = 11.20, 7.17, 4.75, 2.31 Hz, 2H), 2.30 – 1.92 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 161.9, 140.1, 131.9, 130.6, 129.5, 129.0, 128.2, 124.0 (q, *J* = 34.66 Hz), 122.0, 50.8, 25.6, 22.3. ^{19}F NMR (565 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{12}ClF_3NO$ [M+H$^+$]: 290.0554, found 290.0556.

(*E*)-1-(3-fluorophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3g**)



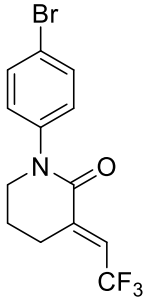
White solid; Yield: 80%; (PE/EA = 15/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.36 (td, *J* = 8.15, 6.32 Hz, 1H), 7.11 – 6.96 (m, 3H), 6.92 (qt, *J* = 8.84, 2.28 Hz, 1H), 3.84 – 3.64 (m, 2H), 2.90 (ddq, *J* = 9.38, 4.77, 2.38 Hz, 2H), 2.16 – 1.98 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 164.1, 162.0, 161.6, 144.2 (d, *J* = 9.5 Hz), 140.5 (d, *J* = 5.1 Hz), 130.4 (d, *J* = 9.1 Hz), 124.4 (q, *J* = 35.3 Hz), 123.4 (d, *J* = 281.7 Hz), 121.4 (d, *J* = 3.3 Hz), 113.9 (dd, *J* = 80.4, 22.2 Hz), 51.2, 25.5, 22.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.7 (s, 3F), -111.25 (s, F); TOF-HRMS Calcd. for $C_{13}H_{12}F_4NO$ [M+H$^+$]: 274.0850, found 274.0855.

(*E*)-1-(3-bromophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3h**)



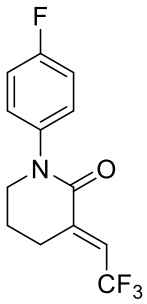
White solid; Yield: 56%; (PE/EA = 15/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.67 – 7.44 (m, 1H), 7.44 – 7.38 (m, 1H), 7.28 (t, *J* = 7.89 Hz, 1H), 7.25 – 7.20 (m, 1H), 7.17 – 6.85 (m, 1H), 3.86 – 3.59 (m, 2H), 2.90 (tq, *J* = 7.08, 2.39 Hz, 2H), 2.17 – 1.97 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.0, 144.1, 140.4, 136.3, 134.91, 130.5 (d, *J* = 14.02 Hz), 129.1, 124.7 (d, *J* = 120.1 Hz) 124.5 (d, *J* = 11.0 Hz), 122.6, 51.3, 25.5, 22.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.7 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{12}BrF_3NO$ [M+H$^+$]: 334.0049, found 334.0051.

(*E*)-1-(4-bromophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3i**)



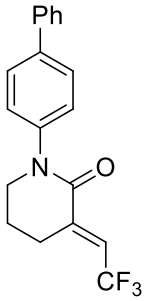
White solid; Yield: 51%; (PE/EA = 20/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.76 – 7.47 (m, 2H), 7.20 – 7.00 (m, 2H), 6.91 (qt, *J* = 8.87, 2.27 Hz, 1H), 3.82 – 3.66 (m, 2H), 3.05 – 2.63 (m, 2H), 2.18 – 1.93 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.0, 141.9, 140.5 (d, *J* = 5.0 Hz), 138.4, 132.4, 127.5, 124.2 (q, *J* = 34.4, 33.2 Hz), 120.7, 51.2, 25.5, 22.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.7 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{12}BrF_3NO$ [M+H$^+$]: 334.0049, found 334.0051.

(*E*)-1-(4-fluorophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3j**)



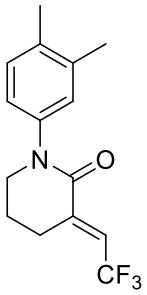
White solid; Yield: 84%; (PE/EA = 15/1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.27 – 7.21 (m, 2H), 7.12 – 7.06 (m, 2H), 6.91 (qt, *J* = 8.85, 2.19 Hz, 1H), 3.80 – 3.66 (m, 2H), 2.95 – 2.84 (m, 2H), 2.12 – 1.95 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.3 (d, *J* = 39.5 Hz), 160.1, 140.6, 138.9, 127.6 (d, *J* = 8.5 Hz), 124.0 (q, *J* = 35.3 Hz), 123.4 (d, *J* = 272.7 Hz), 116.2 (d, *J* = 22.7 Hz), 51.5, 25.5, 22.5. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.7 (s, 3F), -114.2 (s, F). TOF-HRMS Calcd. for $C_{13}H_{15}F_4NO_2$ [M+H$^+$]: 274.0850, found 274.0855.

(*E*)-1-([1,1'-biphenyl]-4-yl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3k**)



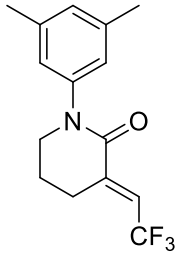
White solid; Yield: 69%; (PE/EA = 20/1); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.62 (dd, *J* = 8.52, 2.52 Hz, 2H), 7.57 (dd, *J* = 7.49, 2.34 Hz, 2H), 7.44 (td, *J* = 7.76, 2.47 Hz, 2H), 7.35 (tq, *J* = 5.20, 2.64, 2.06 Hz, 3H), 6.94 (qt, *J* = 8.83, 2.35 Hz, 1H), 3.81 (dq, *J* = 5.85, 2.69 Hz, 2H), 2.93 (ddq, *J* = 7.50, 5.07, 2.43 Hz, 2H), 2.09 (dqd, *J* = 8.47, 6.10, 2.61 Hz, 2H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 162.1, 142.1, 140.7, 140.4, 140.2, 128.9, 128.0, 127.6, 127.2, 126.0, 124.9 – 123.3 (m), 51.3, 25.6, 22.5. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{19}H_{17}F_3NO$ [M+H$^+$]: 332.1257, found 334.1418.

(*E*)-1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3l**)



White solid; Yield: 85%; (PE/EA = 12/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.16 (d, *J* = 7.98 Hz, 1H), 7.04 (d, *J* = 2.28 Hz, 1H), 6.97 (dd, *J* = 7.96, 2.34 Hz, 1H), 6.91 (qt, *J* = 8.90, 2.19 Hz, 1H), 3.80 – 3.64 (m, 2H), 2.89 (ddt, *J* = 8.95, 4.87, 2.34 Hz, 2H), 2.25 (t, *J* = 1.19 Hz, 6H), 2.05 (dq, *J* = 7.63, 6.03 Hz, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.0, 140.9 (d, *J* = 5.30 Hz), 140.7, 137.8, 136.0, 130.5, 127.0, 123.6 (q, *J* = 34.3 Hz), 123.5 (d, *J* = 272.7 Hz), 123.0, 51.6, 25.6, 22.5, 19.9, 19.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{15}H_{17}F_3NO$ [M+H$^+$]: 284.1257, found 284.1253.

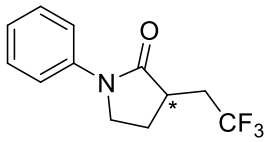
(*E*)-1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3m**)



White solid; Yield: 85%; (PE/EA = 10/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.95 – 6.88 (m, 2H), 6.88 – 6.84 (m, 2H), 3.80 – 3.64 (m, 2H), 2.95 – 2.82 (m, 2H), 2.31 (d, *J* = 0.72 Hz, 6H), 2.04 (dq, *J* = 7.63, 5.80 Hz, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.0, 142.9, 140.8 (d, *J* = 5.0 Hz), 139.2, 129.2, 123.7 (q, *J* = 34.3 Hz), 123.6, 123.5 (d, *J* = 272.7 Hz), 51.6, 25.6, 22.5, 21.3. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.6 (s, 3F); TOF-HRMS Calcd. for $C_{15}H_{17}F_3NO$ [M+H$^+$]: 284.1257, found 284.1253.

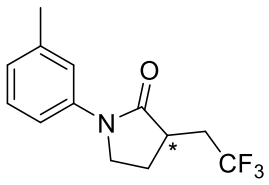
6. NMR, GC or SFC and HPLC, optical rotation and HRMS data of compounds 2, and 4 – 8

1-phenyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2a**)



White solid; 96% yield; 97% ee; $[\alpha]_D^{25}$ = +28.4 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 3:97, 2.0 mL/min, 230 nm; t_R = 6.5 min (minor), t_R = 7.1 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.51 (d, *J* = 8.3 Hz, 2H), 7.28 (t, *J* = 7.8 Hz, 2H), 7.07 (t, *J* = 7.5Hz, 1H), 3.79 – 3.67(m, 2H), 2.91 –2.78 (m, 2H), 2.48 – 2.42 (m, 1H), 2.12 – 2.00 (m, 1H), 1.91 – 1.81(m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.7, 139.1, 128.9, 126.9 (d, *J* = 276.5 Hz), 124.9, 119.8, 46. 7, 38.3 (d, *J* = 2.5 Hz), 35.6 (q, *J* = 29.3 Hz), 25.8; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, *J* = 10.8 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_{13}NOF_3$ [M+H$^+$]: 244.0943, found 244.0941.

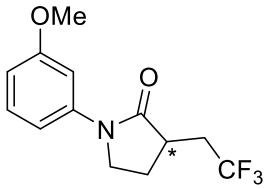
1-(*m*-tolyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2b**)



White solid; 95% yield; 99.9% ee; $[\alpha]_D^{25}$ = +26.4 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 230 nm; t_R = 2.2 min (minor), t_R = 2.4 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.44 (s, 1H), 7.36 (d, *J* = 8.0 Hz, 1H), 7.28 – 7.23 (m, 1H), 6.98 (d, *J* = 7.5 Hz, 1H), 3.86 – 3.75 (m, 2H), 3.03 – 2.85 (m, 2H), 2.56 – 2.49 (m, 1H), 2.36 (s, 3H), 2.20 – 2.08 (m, 1H), 1.98 – 1.86 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.8, 139.1 138.9, 128.8, 127.2

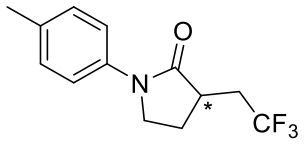
(q, J = 275 Hz), 125.7, 120.76, 117.1, 46.9, 38.4 (q, J = 2.7 Hz), 35.6 (q, J = 29.0 Hz), 25.9, 21.7; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, J = 10.7 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{14}NOF_3Na$ [M+Na^+]: 280.0919, found 280.0918.

1-(3-methoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2c**)



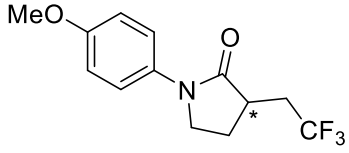
White solid; 94% yield; 99.9% ee; $[\alpha]_D^{25}$ = +20.6 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 5:95, 3.0 mL/min, 230 nm; t_R = 4.4 min (minor), t_R = 4.6 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.35 (t, J = 2.3 Hz, 1H), 7.27 (d, J = 8.2 Hz, 1H), 7.10 (ddd, J = 8.2, 2.1, 0.9 Hz, 1H), 6.72 (ddd, J = 8.3, 2.5, 0.8 Hz, 1H), 3.85 – 3.79 (m, 5H), 3.00 – 2.86 (m, 2H), 2.56 – 2.49 (m, 1H), 2.20 – 2.06 (m, 1H), 2.00 – 1.88 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.9, 160.0, 140.3, 129.6, 126.9 (q, J = 276.6 Hz), 111. 8, 110. 6, 105.9, 55.4, 46.8, 35.5 (q, J = 28.9 Hz), 25.8; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, J = 10.6 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{15}NO_2F_3$ [M+H^+]: 274.1049, found 274.1052.

1-(*p*-tolyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2d**)



White solid; 96% yield; 99.5% ee; $[\alpha]_D^{25}$ = +27.6 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 254 nm; t_R = 2.2 min (minor), t_R = 2.4 min (major);^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.47 (d, J = 8.4 Hz, 2H), 7.17 (d, J = 8.3 Hz, 2H), 3.85 – 3.74(m, 2H), 3.04 – 2.84 (m, 2H), 2.60– 2.49(m, 1H), 2.32 (s, 3H), 2.17 – 2.08 (m, 1H), 1.99 – 1.88 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.7, 136.6, 134.7, 129. 6, 127.0 (q, J = 276.3 Hz), 112.0, 46.9, 38.3 ,35.7 (q, J = 29.1 Hz), 25.9, 21.0; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, J = 10.8 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{14}NOF_3Na$ [M+Na^+]: 280.0919, found 280.0918.

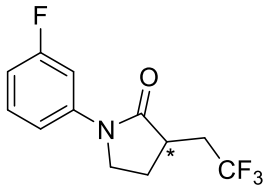
1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2e**)



White solid; 97% yield; 99.9% ee; $[\alpha]_D^{25}$ = +11.1 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 ×4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 254 nm; t_R = 2.8 min (minor), t_R = 3.0 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.48 (d, J = 8.5 Hz,

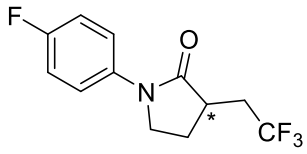
2H), 6.90 (d, *J* = 8.7 Hz, 2H), 3.84– 3.71 (m, 2H), 3.79 (s, 3H), 3.03 – 2.84 (m, 2H), 2.55 – 2.48 (m, 1H), 2.19 – 2.08 (m, 1H), 1.99 – 1.89 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.5, 156.9, 132.4, 127.0 (q, *J* = 279.6 Hz), 121.7, 114.2 ,55. 6, 47.2, 38.2, 35.7 (q, *J* = 29.0 Hz), 26.0; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, *J* = 10.7 Hz, 3F); TOF-HRMS Calcd. for $C_{13}H_{15}NO_2F_3$ [M+H$^+$]: 274.1049, found 274.1052.

1-(3-fluorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2f**)



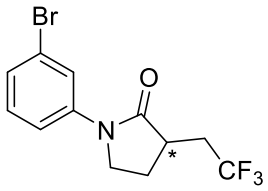
White solid; 94% yield; 99.9% ee; $[\alpha]_D^{25}$ = +15.9 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 210 nm; t_R = 2.6 min (major), t_R = 2.8 min (minor); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.51(dt, *J* = 11.3, 2.3 Hz, 1H), 7.35 – 7.31 (m, 2H), 6.89 – 6.84 (m, 1H), 3.85 – 3.77 (m, 2H), 3.03 – 2.87 (m, 2H), 2.58 – 2.51 (m, 1H), 2.21 – 2.09 (m, 1H), 2.01 – 1.90 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 173.0, 163.0 (d, *J* = 245.1 Hz), 140.6 (d, *J* = 10.5 Hz), 130.1 (d, *J* = 9.3 Hz), 126.9 (q, *J* = 276.5 Hz), 114.8 (d, *J* = 3.1 Hz), 111.6 (d, *J* = 21.2 Hz), 107.2 (d, *J* = 26.3 Hz), 46.7, 38.5 (q, *J* = 2.7 Hz), 35.5 (q, *J* = 29.2 Hz), 25.7; ^{19}F NMR ($CDCl_3$, 376 MHz) δ: -64. 9 (t, *J* = 11.3 Hz, 3F), -111.16 (s, 1F); TOF-HRMS Calcd. for $C_{12}H_{12}NOF_4$ [M+H$^+$]: 262.0849, found 262.0847.

1-(4-fluorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2g**)



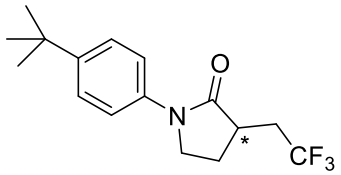
White solid; 96% yield; 96% ee; $[\alpha]_D^{25}$ = +25.2 (c = 0.5, CH_2Cl_2); HPLC condition: Lux 5u Cellulose-2 (250 × 4.60 mm), ipa:hex = 10:90, 1.0 mL/min, 210 nm; t_R = 8.5 min (major), t_R = 8.9 min (minor); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.56 (dd, *J* = 9.0, 4.8 Hz, 2H), 7.06 (t, *J* = 8.6 Hz, 2H), 3.86– 3.78 (m, 2H), 3.03 – 2.85 (m, 2H), 2.57 – 2.50 (m, 1H), 2.20 – 2.06 (m, 1H), 2.00 – 1.90 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 171.8, 158.8 (q, *J* = 245.4 Hz), 134.3 (d, *J* = 2.9 Hz), 125.9 (q, *J* = 276.4 Hz), 120.7 (d, *J* = 7.9 Hz), 114.7 (d, *J* = 22.4 Hz), 46.0 , 37.2 (q, *J* = 2.6 Hz), 34.6 (q, *J* = 29.0 Hz), 24.8; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, *J* = 10.6 Hz, 3F), -113.28 – -126.39 (m, 1F); TOF-HRMS Calcd. for $C_{12}H_{12}NOF_4$ [M+H$^+$]: 262.0849, found 262.0847.

1-(3-bromophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2h**)



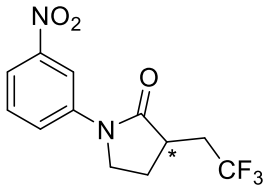
White solid; 95% yield; 99.9% ee; $[\alpha]_D^{25}$ = +21.7(c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 230 nm; t_R = 2.9 min (minor), t_R = 3.1 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.80 (t, *J* = 2.0 Hz, 1H), 7.58 (ddd, *J* = 8.1, 2.1, 1.1 Hz, 1H), 7.31 – 7.27 (ddd, *J* = 8.0, 1.7, 1.2 Hz, 1H), 7.22 (t, *J* = 8.0 Hz, 1H), 3.85 – 3.74 (m, 2H), 3.02 – 2.86(m, 2H), 2.58 – 2.51 (m, 1H), 2.20 – 2.06 (m, 1H), 2.00 – 1.89 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.9, 140.3, 130.2, 126.8 (q, *J* = 277.8 Hz), 127.8, 122.7, 122.5, 118.1, 46.6, 38.3 (q, *J* = 2.6 Hz), 35.4 (q, *J* = 29.1 Hz), 25. 7; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, *J* = 10.6 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_{12}NOF_3Br$ [M+H$^+$]: 322.0048, found 322.0046.

1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2i**)



White solid; 93% yield; 99% ee; $[\alpha]_D^{25}$ = +15.7 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 254 nm; t_R = 2.0 min (minor), t_R = 2.1 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.46 (d, *J* = 8.6 Hz, 2H), 7.33 (d, *J* = 8.5 Hz, 2H), 3.81 – 3.70 (m, 2H), 2.94 – 2.79 (m, 2H), 2.48 – 2.45(m, 1H), 2.11–2.03 (m, 1H), 1.93 – 1.83 (m, 1H), 1.25 (s, 9H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ:172.6, 147.9, 136.4, 127.0 (q, *J* = 278.8 Hz), 125.8, 119.6, 46.7, 38.2 (q, *J* = 3.0 Hz), 35.5 (q, *J* = 28.9 Hz), 34.4, 31.3, 25.8; ^{19}F NMR ($CDCl_3$, 376 MHz) δ: -64.9 (t, *J* = 10.7 Hz, 3F); TOF-HRMS Calcd. for $C_{16}H_{21}NOF_3$ [M+H$^+$]: 300.1569, found 300.1564.

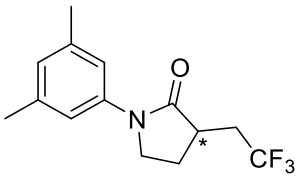
1-(3-nitrophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2j**)



Yellow solid; 90% yield; 99.7% ee; $[\alpha]_D^{25}$ = +20.3 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 254 nm; t_R = 5.0 min (major), t_R = 6.5 min (minor); ^{1}H NMR ($CDCl_3$, 400 MHz) δ:8.38 (t, *J* = 2.0 Hz, 1H), 8.17 (d, *J* = 8.2 Hz, 1H), 8.02 (d, *J* = 8.2 Hz, 1H),7.55 (t, *J* = 8.2 Hz, 1H), 3.93 – 3.85 (m, 1H), 3.01 – 2.92 (m, 2H), 2.65 – 2.58 (dt, *J* = 14.1, 7.2 Hz), 2.24 – 2.09

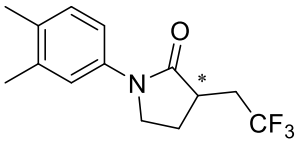
(m, 1H), 2.06 – 1,96 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 173.4, 148.6, 140.2, 129.9, 126.8 (q, *J* = 277.8 Hz), 125.3, 119.3, 113.9, 38.4 (q, *J* = 2.9 Hz), 35.4 (q, *J* = 29.5 Hz), 25.6; ^{19}F NMR ($CDCl_3$, 376 MHz) δ: -64. 7 (t, *J* = 10.2 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_{12}N_2O_3F_4$ [M+H$^+$]: 289.0794, found 289.0798.

1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2k**)



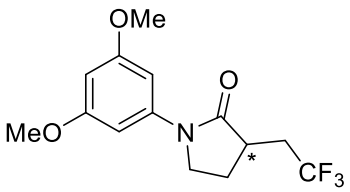
White solid; 92% yield; 99.9% ee; $[\alpha]_D^{25}$ = +21.2 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 ×4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 254 nm; t_R = 2.0 min (minor), t_R = 2.5 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.20 (s, 2H), 6.81 (s, 1H), 3.85 – 3.73 (m, 2H), 3.06 – 2.74 (m, 2H), 2.54 – 2.47 (m, 1H), 2.31 (s, 6H), 2.19 – 2.05 (m, 2H) 1.97 – 1.87 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172. 8, 139.1, 138.7, 127.0 (q, *J* = 277.8 Hz), 126.8, 118.0, 47.1, 38.4 (q, *J* = 3.0 Hz), 35.6(q, *J* = 29.3 Hz), 26.0, 21.5; ^{19}F NMR ($CDCl_3$, 376 MHz) δ: -64. 9 (t, *J* = 10.7 Hz, 3F); TOF-HRMS Calcd. for $C_{14}H_{17}NOF_3$ [M+H$^+$]: 272.1256, found 272.1262.

1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2l**)



White solid; 92% yield; 99% ee; $[\alpha]_D^{25}$ = +22.4 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 ×4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 254 nm; t_R = 2.2 min (minor), t_R = 2.5 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.38 (s, 1H), 7.27 (d, *J* = 8.2 Hz, 1H), 7.11 (d, *J* = 8.2 Hz, 1H), 3.84 – 3.72 (m, 2H), 3.03 – 2.83 (m, 2H), 2.54 – 2.48 (m, 1H), 2.26 (s, 3H), 2.23 (s, 3H), 2.16 – 2.07 (m, 1H), 1.98 – 1.87 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.7, 137.3, 136. 9, 133.6, 130.0, 127.0 (q, *J* = 276.6 Hz), 121.5, 117.6, 47.1, 38.3 (q, *J* = 2.1 Hz), 35.7 (q, *J* = 29.0 Hz), 26.0, 20.1, 19.3; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, *J* = 10.8 Hz, 3F); TOF-HRMS Calcd. for $C_{14}H_{17}NOF_3$ [M+H$^+$]: 272.1256, found 272.1262.

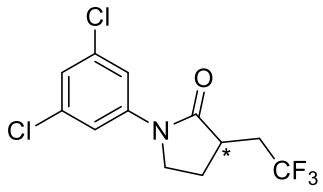
1-(3,5-dimethoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2m**)



White solid; 93% yield; 99.9% ee; $[\alpha]_D^{25}$ = +3.5 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 ×4.60 mm), MeOH : CO_2 = 5:95, 2.0 mL/min, 254 nm; t_R

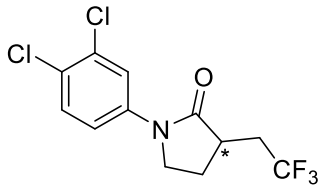
=9.7min (minor), t_R = 10.1 min (major);^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.53 (t, *J* = 1.3 Hz, 1H), 6.84 (d, *J* = 1.3 Hz, 2H), 3.89 (s, 3H), 3.86 (s, 3H), 3.89 – 3.74 (m, 2H), 3.03–2.86 (m, 2H), 2.56 – 2.49 (m, 1H), 2.18– 2.08 (m, 1H), 2.00 – 1.89 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 172.6, 149.1, 146.5, 132.9, 127.0 (q, *J* = 282.7 Hz), 111.6, 111.1, 105.1, 56.2, 56.1, 47.2, 38.4, 35.7 (q, *J* = 29.0 Hz), 25.8; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, *J* = 10.6 Hz, 3F). TOF-HRMS Calcd. for $C_{14}H_{17}F_3NO_3$ [M+H$^+$]: 304.1155, found 304.1157.

1-(3,5-dichlorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2n**)



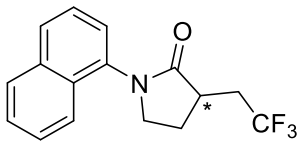
White solid; 94% yield; 97% ee; $[\alpha]_D^{25}$ = +18.3 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 230 nm; t_R = 2.9 min (minor), t_R = 3.0 min (major); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.59 (s, 2H), 7.15 (s, 1H), 3.81 – 3.76 (m, 2H), 2.98– 2.90 (m, 2H), 2.60 – 2.52 (m,1H), 2.20 – 2.10 (m, 1H), 2.06 – 1.93 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 173.2, 140.9, 135.4, 126.8 (d, *J* = 276.4 Hz), 124.7, 117.8, 46.6, 38.4 (q, *J* = 2.7 Hz), 35.4 (q, *J* = 29.3 Hz), 25.6; ^{19}F NMR ($CDCl_3$, 376 MHz) δ: -64.7 – -64.9 (m, 3F); TOF-HRMS Calcd. for $C_{12}H_{11}NOF_3Cl_2$ [M+H$^+$]: 312.0164, found 312.0165.

1-(3,4-dichlorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2o**)



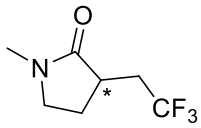
White solid; 95% yield; 98% ee; $[\alpha]_D^{25}$ = +20.4 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 254 nm; t_R = 4.7 min (major), t_R = 5.7 min (minor); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.78 (s, 1H), 7.52 (d, *J* = 8.9 Hz, 1H), 7.42 (d, *J* = 8.9 Hz, 1H) 3.81–3.76 (m, 2H), 3.03 – 2.81 (m,2H), 2.67 – 2.46 (m, 1H), 2.21 – 2.05 (m, 1H), 2.04 – 1.87 (m, 1H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 173.1, 138.6, 132.9, 130.5, 128.2, 126.8 (q, *J* = 277.8 Hz), 121.2, 118.8, 46.6, 38.4 (q, *J* = 2.0 Hz), 35.5 (q, *J* = 29.3 Hz), 25.6; ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.9 (t, *J* = 10.5 Hz, 3F); TOF-HRMS Calcd. for $C_{12}H_{11}NOF_3Cl_2$ [M+H$^+$]: 312.0164, found 312.0165.

1-(naphthalen-1-yl)-3-(2,2,2-trifluoroethyl) pyrrolidin-2-one (**2p**)



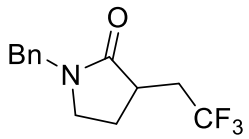
White solid; 91% yield; 99.9% ee; $[\alpha]_D^{25}$ = +23.4 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 230 nm; t_R = 4.6 min (major), t_R =5.8 min (minor); ^{1}H NMR ($CDCl_3$, 400 MHz) δ: 7.91 – 7.84 (m, 2H), 7.66 – 7.63 (m, 1H), 7.54 – 7.47(m, 3H), 7.36 (dd, *J* = 7.3, 1.0 Hz, 1H), 3.94– 3.87 (m, 1H), 3.80 – 3.74 (m, 1H), 3.10 – 2.97 (m, 2H), 2.70 – 2.62 (m, 1H), 2.32 – 2.14 (m, 2H); ^{13}C NMR ($CDCl_3$, 101 MHz) δ: 174.0, 135.2, 134.7, 129.6, 129.2 (q, *J* = 157.6 Hz), 128.8, 128.8, 127,0, 126.6, 125.7, 124.7, 122.4, 49.9, 37.4 (q, *J* = 2.2 Hz), 35.8 (q, *J* = 29.3 Hz), 27.2; ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -64.7 (s, 3F); TOF-HRMS Calcd. for $C_{16}H_{15}NOF_3$ [M+H$^+$]: 294.1100, found 294.1103.

1-methyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2q**)



Colorless oil; 94% yield; 99.9% ee; $[\alpha]_D^{25}$ = 2.4 (c = 0.3, CH_2Cl_2); GC conditions: Supelco Alpha DexTM 120 column (30 m × 0.25 mm × 0.25 μm), N_2 1.0 mL/min, programmed 70 ºC - 0.6 ºC/min - 190 ºC (hold 50 min); t_R = 31.1 min (minor), t_R = 31.9 (major); ^{1}HNMR (600 MHz, Chloroform-*d*) δ 3.32 (dt, *J* = 19.89, 9.11 Hz, 2H), 2.86 (d, *J* = 3.10 Hz, 4H), 2.66 (q, *J* = 10.73 Hz, 1H), 2.38 (dd, *J* = 13.22, 7.42 Hz, 1H), 1.98 (dt, *J* = 15.68, 10.57 Hz, 1H), 1.80 (p, *J* = 10.31 Hz, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 173.7, 127.0 (d, *J* = 276.2 Hz), 47.5, 36.6, 35.7 (q, *J* = 28.8 Hz), 30.0, 25.8. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -78.4 (s, 3F); TOF-HRMS Calcd. for $C_7H_{11}F_3NO$ [M+H$^+$]: 182.0787, found 182.0789.

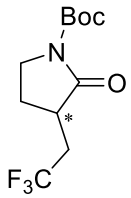
1-benzyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2r**)



Colorless oil; 96% yield; 99.9% ee; $[\alpha]_D^{25}$ = 4.6 (c = 0.5 , CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 210 nm; t_R = 3.5 min (major), t_R = 3.7 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.34 – 7.30 (m, 2H), 7.30 – 7.25 (m, 1H), 7.23 – 7.18 (m, 2H), 4.46 (s, 2H), 3.28 – 3.14 (m, 2H), 2.97 – 2.88 (m, 1H), 2.76 – 2.70 (m, 1H), 2.40 – 2.30 (m, 1H), 2.09 – 1.99 (m, 1H), 1.81 – 1.74 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 173.6, 136.2, 128.8, 128.2, 127.8, 127.0 (q, *J* = 276.3 Hz), 47.1,

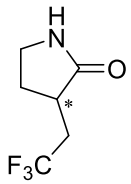
44.8, 36.9 (d, J = 2.9 Hz), 35.7 (q, J = 29.0 Hz), 25.9. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.8 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{15}F_3NO$ [M+H$^+$]: 258.1100, found 258.1103.

tert-butyl-2-oxo-3-(2,2,2-trifluoroethyl)pyrrolidine-1-carboxylate (**2s**)



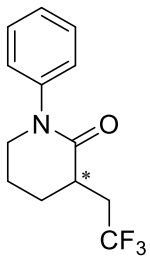
White solid; 93% yield; 93% ee; $[\alpha]_D^{25}$ = 40.7 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 1.4 min (major), t_R = 1.5 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 3.82 (t, J = 9.99 Hz, 1H), 3.57 (td, J = 11.11, 6.67 Hz, 1H), 2.96 – 2.83 (m, 1H), 2.83 – 2.73 (m, 1H), 2.37 (dt, J = 14.15, 7.48 Hz, 1H), 2.04 (dp, J = 15.19, 10.39 Hz, 1H), 1.76 (p, J = 11.41 Hz, 1H), 1.51 (d, J = 2.44 Hz, 9H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 173.0, 150.0, 126.7 (d, J = 276.2 Hz), 83.4, 44.5, 38.7, 34.9 (q, J = 29.4 Hz), 28.0, 25.2. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.8 (s, 3F); TOF-HRMS Calcd. for $C_7H_9F_3NO_3$ [M+H$^+$]: 212.0529, found 212.0532.

3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2t**)



White solid; 92% yield; 94% ee; $[\alpha]_D^{25}$ = 11.8 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 2.7 min (major), t_R = 2.2 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.28 (d, J = 32.24 Hz, 1H), 3.41 – 3.27 (m, 2H), 2.83 (dqd, J = 14.47, 11.72, 2.63 Hz, 1H), 2.64 (tdd, J = 11.14, 8.26, 2.62 Hz, 1H), 2.47 (dt, J = 13.96, 7.21 Hz, 1H), 2.06 – 1.97 (m, 1H), 1.96 – 1.85 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 177.5, 126.9 (d, J = 276.22 Hz), 40.3, 35.9, 35.2 (q, J = 29.17 Hz), 28.4. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -65.0 (s, 3F); TOF-HRMS Calcd. for $C_6H_9F_3NO$ [M+H$^+$]: 168.0631, found 168.0632.

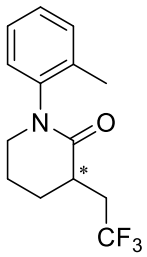
1-phenyl-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4a**)



Colorless oil; 93% yield; 96% ee; $[\alpha]_D^{25}$ = -26.7 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 2.4 min (major), t_R = 3.2 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.38 (tt, J = 7.49, 1.15 Hz, 2H), 7.25 (ddq, J = 7.06, 5.93, 1.18 Hz, 1H), 7.21 (dt, J = 8.46, 1.18 Hz, 2H), 3.76 – 3.67 (m, 1H), 3.63 (dddt, J = 12.17, 5.44, 4.19, 1.27 Hz, 1H), 3.22 – 3.07 (m, 1H), 2.84 –

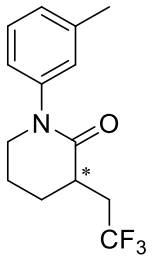
2.70 (m, 1H), 2.38 – 2.29 (m, 1H), 2.28 – 2.17 (m, 1H), 2.09 – 1.92 (m, 2H), 1.75 (qd, *J* = 11.59, 4.31 Hz, 1H). ^{13}C NMR (151 MHz, Chloroform-d) δ 170.0, 143.2, 129.3, 127.3 (q, *J* = 276.3 Hz), 127.0, 126.1, 51.4, 37.4, 35.2 (q, *J* = 28.4 Hz), 26.9, 22.5. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -63.3 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{15}F_3NO$ [M+H$^+$]: 258.1100, found 258.0947.

1-(*o*-tolyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4b**)



Colorless oil; 92% yield; 93% ee; $[\alpha]_D^{25}$ = -36.1 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-2 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 210 nm; t_R = 2.8 min (major), t_R = 3.1 min (minor); (PE/EA = 15/1); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.23 (ddd, *J* = 12.82, 5.84, 4.00 Hz, 3H), 7.08 (td, *J* = 5.17, 2.31 Hz, 1H), 3.69 – 3.54 (m, 1H), 3.53 – 3.35 (m, 1H), 3.24 – 3.00 (m, 1H), 2.77 (tdd, *J* = 9.82, 5.90, 2.72 Hz, 1H), 2.30 (ddq, *J* = 26.75, 16.42, 5.53 Hz, 2H), 2.17 (d, *J* = 10.04 Hz, 3H), 2.10 – 1.89 (m, 2H), 1.86 – 1.70 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 169.3 (d, *J* = 5.7 Hz), 142.0, 134.9 (d, *J* = 24.7 Hz), 131.2 (d, *J* = 13.7 Hz), 127.9 (d, *J* = 4.3 Hz), 127.5, 127.2 (d, *J* = 11.2 Hz), 126.5, 51.2 (d, *J* = 25.5 Hz), 37.3 (d, *J* = 8.1 Hz), 35.3 (q, *J* = 28.6 Hz), 26.9 (d, *J* = 80.4 Hz), 22.6 (d, *J* = 60.3 Hz), 17.4 (d, *J* = 8.6 Hz). ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -63.3 (s, 3F); TOF-HRMS Calcd. for $C_{14}H_{17}F_3NO$ [M+H$^+$]: 272.1257, found 272.1257.

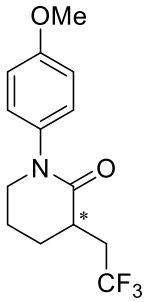
1-(*m*-tolyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4c**)



White solid; 94% yield; 94% ee; $[\alpha]_D^{25}$ = -33.6 (c =1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 1.7 min (major), t_R = 1.9 min (minor);^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.29 – 7.24 (m, 1H), 7.07 (ddt, *J* = 7.68, 1.81, 0.93 Hz, 1H), 7.03 (d, *J* = 1.87 Hz, 1H), 7.02 – 6.98 (m, 1H), 3.69 (ddd, *J* = 12.29, 9.94, 4.91 Hz, 1H), 3.61 (dddt, *J* = 12.09, 5.33, 4.16, 1.20 Hz, 1H), 3.22 – 3.06 (m, 1H), 2.77 (tdd, *J* = 9.78, 5.99, 3.03 Hz, 1H), 2.34 (s, 3H), 2.33 – 2.27 (m, 1H), 2.27 – 2.17 (m, 1H), 2.09 – 2.01 (m, 1H), 2.00 – 1.92 (m, 1H), 1.80 – 1.72 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 170.0, 143.2, 139.2, 129.1, 127.8, 127.3 (q, *J* = 28.4 Hz), 126.9, 123.0, 51.5, 37.4, 35.2 (q, *J* = 28.4 Hz), 26.9, 22.5, 21.4. ^{19}F NMR ($CDCl_3$,

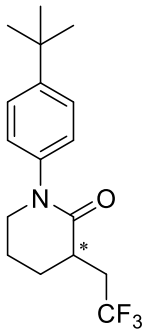
377 MHz) δ: -63.3 (s, 3F); TOF-HRMS Calcd. for $C_{14}H_{17}F_3NO$ [M+H$^+$]: 272.1257, found 272.1257.

1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4d**)



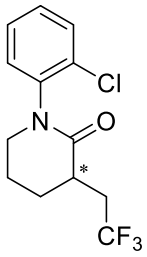
White solid; 90% yield; 93% ee; $[\alpha]_D^{25}$ = -36.3 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 210 nm; t_R = 5.2 min (major), t_R = 7.5 min (minor); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.16 – 7.07 (m, 2H), 6.96 – 6.83 (m, 2H), 3.78 (s, 3H), 3.71 – 3.54 (m, 2H), 3.11 (dtd, *J* = 15.29, 12.27, 3.01 Hz, 1H), 2.75 (tdd, *J* = 9.71, 5.99, 3.02 Hz, 1H), 2.38 – 2.13 (m, 2H), 2.08 – 1.88 (m, 2H), 1.73 (dtd, *J* = 13.34, 11.23, 4.27 Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.1, 158.3, 136.1, 127.3 (q, *J* = 277.7 Hz), 127.2, 114.5, 55.5, 51.7, 37.4 (d, *J* = 2.6 Hz), 35.2 (q, *J* = 28.5 Hz), 26.9, 22.5. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -63.3 (s, 3F); TOF-HRMS Calcd. for $C_{14}H_{17}F_3NO_2$ [M+H$^+$]: 288.1206, found 288.1213.

1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4e**)



White solid; 95% yield; 95% ee; $[\alpha]_D^{25}$ = -15.4 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 3.1 min (major), t_R = 4.1 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.43 – 7.35 (m, 2H), 7.17 – 7.09 (m, 2H), 3.70 (ddd, *J* = 12.21, 9.91, 4.94 Hz, 1H), 3.62 (dddd, *J* = 12.26, 5.49, 4.21, 1.38 Hz, 1H), 3.13 (dqd, *J* = 15.33, 12.27, 3.06 Hz, 1H), 2.83 – 2.72 (m, 1H), 2.31 (dq, *J* = 10.49, 5.06 Hz, 1H), 2.22 (dp, *J* = 15.26, 10.52 Hz, 1H), 2.07 – 1.92 (m, 2H), 1.74 (dtd, *J* = 13.46, 11.33, 4.34 Hz, 1H), 1.31 (s, 9H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 170.0, 149.8, 140.5, 127.3 (q, *J* = 276.3 Hz), 126.2, 125.4, 51.3, 37.4, 35.3 (q, *J* = 28.4 Hz), 34.6, 31.3, 26.9, 22.5. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -63.3 (s, 3F); TOF-HRMS Calcd. for $C_{17}H_{23}F_3NO$ [M+H$^+$]: 314.1726, found 314.1723.

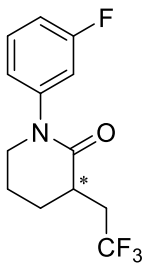
1-(2-chlorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4f**)



White solid; 91% yield; 95% ee; $[\alpha]_D^{25}$ = -19.2 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 210 nm; t_R = 5.2 min (major), t_R = 5.7 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.46 (td, *J* = 8.04, 1.57 Hz, 1H), 7.34 – 7.25 (m, 2H), 7.22 (ddd, *J* = 12.20, 7.63, 1.78 Hz, 1H), 3.69 – 3.45 (m, 2H), 3.12 (ddqd, *J* = 21.62, 15.30, 12.23, 3.08 Hz, 1H), 2.88 – 2.71 (m, 1H), 2.40 – 2.17 (m, 2H), 2.16 – 1.92 (m, 2H), 1.86 – 1.72 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 169.8 (d, *J* = 21.8 Hz), 140.4 (d, *J* = 16.0 Hz), 132.1 (d, *J* = 18.8 Hz), 130.5 (d, *J* = 14.0 Hz), 129.5, 129.3 – 128.8 (m), 128.1 (d, *J* = 48.9 Hz), 127.2 (q, *J* = 127.2 Hz), 50.8 (d, *J* = 36.9 Hz), 37.3 (d, *J* = 18.1 Hz), 35.9 – 33.9 (m), 26.8 (d, *J* = 34.1 Hz), 22.4 (d, *J* = 37.5 Hz).

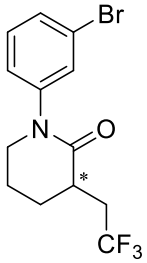
^{19}F NMR (565 MHz, Chloroform-*d*) δ -63.37 (d, *J* = 172.13 Hz, CF_3); TOF-HRMS Calcd. for $C_{13}H_{14}ClF_3NO$ [M+H$^+$]: 292.0711, found 292.0729.

1-(3-fluorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4g**)



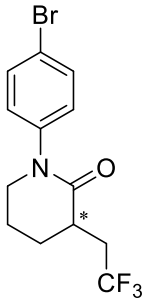
White solid; 94% yield; 98% ee; $[\alpha]_D^{25}$ = -24.8 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 2.5 min (major), t_R = 3.2 min (minor); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.33 (td, *J* = 8.05, 6.39 Hz, 1H), 7.08 – 6.90 (m, 3H), 3.79 – 3.54 (m, 2H), 3.11 (dqd, *J* = 15.18, 12.15, 3.07 Hz, 1H), 2.77 (dddd, *J* = 12.27, 9.61, 6.06, 3.13 Hz, 1H), 2.41 – 2.14 (m, 2H), 2.01 (dtq, *J* = 29.69, 9.35, 4.86 Hz, 2H), 1.74 (qd, *J* = 11.49, 4.61 Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.1, 162.9 (d, *J* = 247.0 Hz), 144.6 (d, *J* = 9.6 Hz), 130.2 (d, *J* = 9.1 Hz), 128.5, 125.8, 121.6 (d, *J* = 3.2 Hz), 113.7 (dd, *J* = 29.2, 22.0 Hz), 51.2, 37.5 (d, *J* = 2.8 Hz), 35.1 (q, *J* = 28.5 Hz), 26.8, 22.5. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -63.4 (s, 3F), -111.5 (s, F); TOF-HRMS Calcd. for $C_{13}H_{14}F_4NO$ [M+H$^+$]: 276.1006, found 276.1000.

1-(3-bromophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4h**)



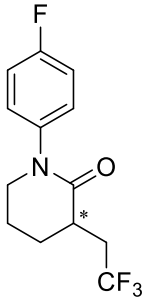
White solid; 93% yield; 99% ee; $[\alpha]_D^{25}$ = -15.9 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 15:85, 3.0 mL/min, 210 nm; t_R = 5.3 min (major), t_R = 5.7 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.61 – 7.35 (m, 2H), 7.25 (d, *J* = 15.83 Hz, 1H), 7.20 – 7.07 (m, 1H), 3.70 (ddd, *J* = 12.14, 10.05, 4.96 Hz, 1H), 3.62 (dddd, *J* = 12.03, 5.42, 4.24, 1.39 Hz, 1H), 3.10 (dqd, *J* = 15.29, 12.18, 3.12 Hz, 1H), 2.82 – 2.72 (m, 1H), 2.32 (dd, *J* = 13.93, 5.36 Hz, 1H), 2.28 – 2.14 (m, 1H), 2.10 – 1.91 (m, 2H), 1.74 (dtd, *J* = 13.16, 11.37, 4.24 Hz, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 170.1, 144.4, 135.5 (d, *J* = 137.6 Hz), 130.4, 129.7 (q, *J* = 111.7 Hz), 125.9 (d, *J* = 100.4 Hz), 124.8, 122.5, 51.3, 37.4, 35.1 (q, *J* = 28.6 Hz), 26.8, 22.5. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -63.4 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{14}BrF_3NO$ [M+H$^+$]: 336.0205, found 336.0211.

1-(4-bromophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4i**)



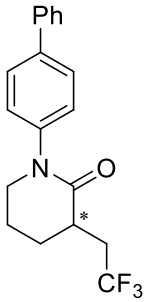
White solid; 95% yield; 96% ee; $[\alpha]_D^{25}$ = -29.9 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 210 nm; t_R = 4.7 min (major), t_R = 5.2 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.49 (ddt, *J* = 8.13, 2.99, 1.22 Hz, 2H), 7.15 – 6.94 (m, 2H), 3.69 (ddd, *J* = 12.73, 9.75, 4.89 Hz, 1H), 3.61 (dddt, *J* = 12.03, 5.35, 4.12, 1.22 Hz, 1H), 3.24 – 3.02 (m, 1H), 2.76 (ddt, *J* = 12.99, 9.57, 3.04 Hz, 1H), 2.32 (dd, *J* = 13.61, 5.69 Hz, 1H), 2.22 (dp, *J* = 15.15, 10.45 Hz, 1H), 2.10 – 1.90 (m, 2H), 1.83 – 1.68 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 170.1, 142.2, 132.3, 127.7, 127.1 (q, *J* = 276.3 Hz), 120.3, 51.2, 37.4, 35.1 (q, *J* = 28.6 Hz), 26.8, 22.5. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -63.3 (s, 3F); TOF-HRMS Calcd. for $C_{13}H_{14}BrF_3NO$ [M+H$^+$]: 336.0205, found 336.0211.

1-(4-fluorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4j**)



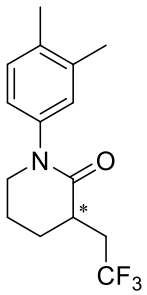
White solid; 94% yield; 98% ee; $[\alpha]_D^{25}$ = -37.0 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO2 = 20:80, 3.0 mL/min, 210 nm; t_R = 2.3 min (major), t_R = 2.9 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.22 – 7.13 (m, 2H), 7.11 – 6.99 (m, 2H), 3.68 (ddd, *J* = 11.86, 10.10, 4.84 Hz, 1H), 3.60 (dtd, *J* = 12.25, 5.37, 4.74, 2.75 Hz, 1H), 3.10 (dqd, *J* = 15.24, 12.22, 3.07 Hz, 1H), 2.84 – 2.70 (m, 1H), 2.32 (dq, *J* = 14.77, 5.05 Hz, 1H), 2.23 (dp, *J* = 15.07, 10.50 Hz, 1H), 2.08 – 1.91 (m, 2H), 1.75 (dtd, *J* = 13.03, 11.43, 4.14 Hz, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 170.2, 161.2 (d, *J* = 246.3 Hz), 139.1 (d, *J* = 3.3 Hz), 127.9, 127.8, 127.2 (q, *J* = 276.3 Hz), 116.2, 116.0, 51.6, 37.4, 35.2 (q, *J* = 28.7 Hz), 26.8, 22.5. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -63.3 (s, 3F), -114.8 (s, F); TOF-HRMS Calcd. for $C_{13}H_{14}F_4NO$ [M+H$^+$]: 276.1006, found 276.1000.

1-([1,1'-biphenyl]-4-yl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4k**)



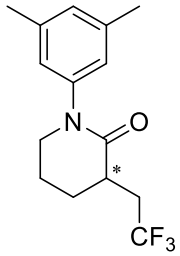
White solid; 90% yield; 95% ee; $[\alpha]_D^{25}$ = -38.5 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Cellulose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 3.9 min (major), t_R = 4.5 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.62 – 7.58 (m, 2H), 7.58 – 7.53 (m, 2H), 7.43 (dd, *J* = 8.43, 6.97 Hz, 2H), 7.37 – 7.32 (m, 1H), 7.32 – 7.27 (m, 2H), 3.76 (ddd, *J* = 12.19, 9.92, 4.91 Hz, 1H), 3.68 (dddd, *J* = 12.19, 5.48, 4.19, 1.37 Hz, 1H), 3.15 (dqd, *J* = 15.28, 12.23, 3.07 Hz, 1H), 2.85 – 2.76 (m, 1H), 2.34 (dq, *J* = 10.46, 5.05 Hz, 1H), 2.25 (dp, *J* = 15.27, 10.49 Hz, 1H), 2.13 – 1.94 (m, 2H), 1.77 (dtd, *J* = 13.52, 11.41, 4.36 Hz, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 170.1, 142.3, 140.5, 139.9, 128.8, 128.0, 127.5, 127.2, 126.3, 51.3, 37.5, 35.2 (q, *J* = 28.2 Hz), 26.9, 22.5. ^{19}F NMR ($CDCl_3$, 565 MHz) δ: -63.3 (s, 3F); TOF-HRMS Calcd. for $C_{19}H_{19}F_3NO$ [M+H$^+$]: 334.1413, found 334.1418.

1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4l**)



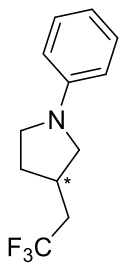
White solid; 93% yield; 92% ee; $[\alpha]_D^{25}$ = -36.6 (c = 1.0, CH_2Cl_2); HPLC condition: Lux 5u Cellulose-2 (250 × 4.60 mm), MeOH : CO_2 = 10:90, 3.0 mL/min, 210 nm; t_R = 13.3 min (major), t_R = 12.0 min (minor); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 7.14 (d, *J* = 7.95 Hz, 1H), 6.98 (d, *J* = 2.23 Hz, 1H), 6.92 (dd, *J* = 7.99, 2.30 Hz, 1H), 3.67 (ddd, *J* = 12.22, 9.76, 5.12 Hz, 1H), 3.59 (dddd, *J* = 12.24, 5.49, 4.14, 1.37 Hz, 1H), 3.14 (dqd, *J* = 15.29, 12.31, 3.01 Hz, 1H), 2.84 – 2.60 (m, 1H), 2.35 – 2.26 (m, 1H), 2.24 (t, *J* = 1.17 Hz, 6H), 2.23 – 2.15 (m, 1H), 2.09 – 1.88 (m, 2H), 1.73 (dtd, *J* = 13.32, 11.21, 4.48 Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.0, 141.0, 137.7, 135.6, 130.4, 127.4 (d, *J* = 277.7 Hz), 127.3, 123.3, 51.6, 37.4, 35.2 (q, *J* = 28.4 Hz), 26.9, 22.5, 19.9, 19.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -63.3 (s, CF_3); TOF-HRMS Calcd. for $C_{15}H_{19}F_3NO$ [M+H$^+$]: 286.1413, found 286.1416.

1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4m**)



White solid; 95% yield; 93% ee; $[\alpha]_D^{25}$ = -24.4 (c = 1.0, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 1.7 min (major), t_R = 1.9 min (minor); ^{1}H NMR (400 MHz, Chloroform-*d*) δ 6.90 (s, 1H), 6.82 (s, 2H), 3.75 – 3.50 (m, 2H), 3.14 (tt, *J* = 12.30, 2.99 Hz, 1H), 2.76 (tdd, *J* = 10.00, 5.94, 3.02 Hz, 1H), 2.30 (s, 7H), 2.20 (dq, *J* = 15.25, 10.43 Hz, 1H), 2.08 – 1.88 (m, 2H), 1.81 – 1.66 (m, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 170.0, 143.1, 139.0, 128.8, 127.3 (q, *J* = 278.7 Hz), 123.8, 51.5, 37.4 (d, *J* = 2.5 Hz), 35.2 (q, *J* = 28.4 Hz), 26.9, 22.5, 21.3. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -63.4 (s, CF_3); TOF-HRMS Calcd. for $C_{15}H_{19}F_3NO$ [M+H$^+$]: 286.1413, found 286.1416.

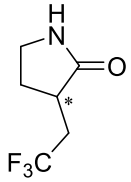
1-phenyl-3-(2,2,2-trifluoroethyl)pyrrolidine (**5**)



White solid; 90% yield; 94% ee; $[\alpha]_D^{25}$ = 3.1 (c = 0.5, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 1.8 min (major), t_R = 1.6 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.28 – 7.18 (m, 2H), 6.69 (td, *J* = 7.28, 1.11 Hz, 1H),

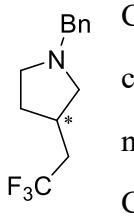
6.58 – 6.49 (m, 2H), 3.55 (t, *J* = 8.33 Hz, 1H), 3.39 (td, *J* = 8.80, 2.83 Hz, 1H), 3.36 – 3.27 (m, 1H), 3.00 (t, *J* = 8.74 Hz, 1H), 2.60 (dq, *J* = 9.57, 7.24 Hz, 1H), 2.36 – 2.22 (m, 3H), 1.76 (dq, *J* = 12.26, 9.06 Hz, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 147.5, 129.4, 129.3, 116.0, 111.6, 53.0, 47.1, 37.5 (q, *J* = 28.1 Hz), 32.8, 31.7. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -64.8 (s, 3F); TOF-HRMS Calcd. for $C_{12}H_{15}F_3N$ [M+H$^+$]: 230.1151, found 230.1154.

3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**6**)



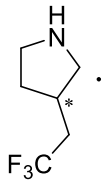
White solid; 92% yield; 92% ee; $[\alpha]_D^{25}$ = 11.8 (c = 1, CH_2Cl_2); SFC condition: Lux 5u Amylose-1 (250 × 4.60 mm), MeOH : CO_2 = 20:80, 3.0 mL/min, 210 nm; t_R = 2.7 min (major), t_R = 2.2 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 6.28 (d, *J* = 32.24 Hz, 1H), 3.41 – 3.27 (m, 2H), 2.83 (dqd, *J* = 14.47, 11.72, 2.63 Hz, 1H), 2.64 (tdd, *J* = 11.14, 8.26, 2.62 Hz, 1H), 2.47 (dt, *J* = 13.96, 7.21 Hz, 1H), 2.06 – 1.97 (m, 1H), 1.96 – 1.85 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 177.5, 126.9 (d, *J* = 276.22 Hz), 40.3, 35.9, 35.2 (q, *J* = 29.17 Hz), 28.4. ^{19}F NMR ($CDCl_3$, 377 MHz) δ: -65.0 (s, 3F); TOF-HRMS Calcd. for $C_6H_9F_3NO$ [M+H$^+$]: 168.0631, found 168.0632.

1-benzyl-3-(2,2,2-trifluoroethyl)pyrrolidine (**7**)



Colorless oil; 88% yield; 99.9% ee; $[\alpha]_D^{25}$ = 1.5 (c = 0.1, CH_2Cl_2); HPLC condition: Chiralpak OD-H (250 × 4.60 mm), hexane: isopropanol = 97:3, 210 nm; t_R = 4.6 min (major), t_R = 4.9 min (minor); ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.33 – 7.29 (m, 4H), 7.27 – 7.22 (m, 1H), 3.66 – 3.55 (m, 2H), 2.84 (dd, *J* = 9.33, 7.44 Hz, 1H), 2.66 (ddd, *J* = 9.31, 8.06, 5.86 Hz, 1H), 2.51 – 2.42 (m, 2H), 2.21 – 2.13 (m, 3H), 2.13 – 2.07 (m, 1H), 1.53 – 1.47 (m, 1H). ^{13}C NMR (151 MHz, Chloroform-*d*) δ 139.0, 128.8, 128.3, 127.0, 126.9 (q, *J* = 276.1 Hz). 60.4, 59.8, 53.4, 38.9 (q, *J* = 27.5 Hz), 31.4, 30.7. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -65.0 (s, CF_3).[3]

3-(2,2,2-trifluoroethyl)pyrrolidine hydrochloride (**8**)



Colorless oil; 73% yield; $[\alpha]_D^{25}$ = 1.8 (c = 0.3, CH_2Cl_2); ^{1}H NMR (400 MHz, D_2O) δ 3.45 (dd, *J* = 11.85, 7.80 Hz, 1H), 3.31 (ddd, *J* = 11.89, 8.79, 3.13 Hz, 1H), 3.13 (td, *J* = 11.62, 11.21, 8.45 Hz, 1H), 2.89 – 2.78 (m, 1H), 2.56 – 2.44 (m, 1H), 2.37 – 2.23 (m, 2H), 2.18 (dtd, *J* = 13.53, 6.66, 2.97 Hz, 1H), 1.70 – 1.54 (m, 1H). ^{13}C NMR (151 MHz, D_2O) δ 126.6 (q, *J* = 276.1 Hz), 49.4, 45.1, 35.1 (q, *J* = 28.5 Hz), 31.9, 29.8. ^{19}F NMR (376 MHz, D_2O) δ -65.1 (s, CF_3).[3]

References

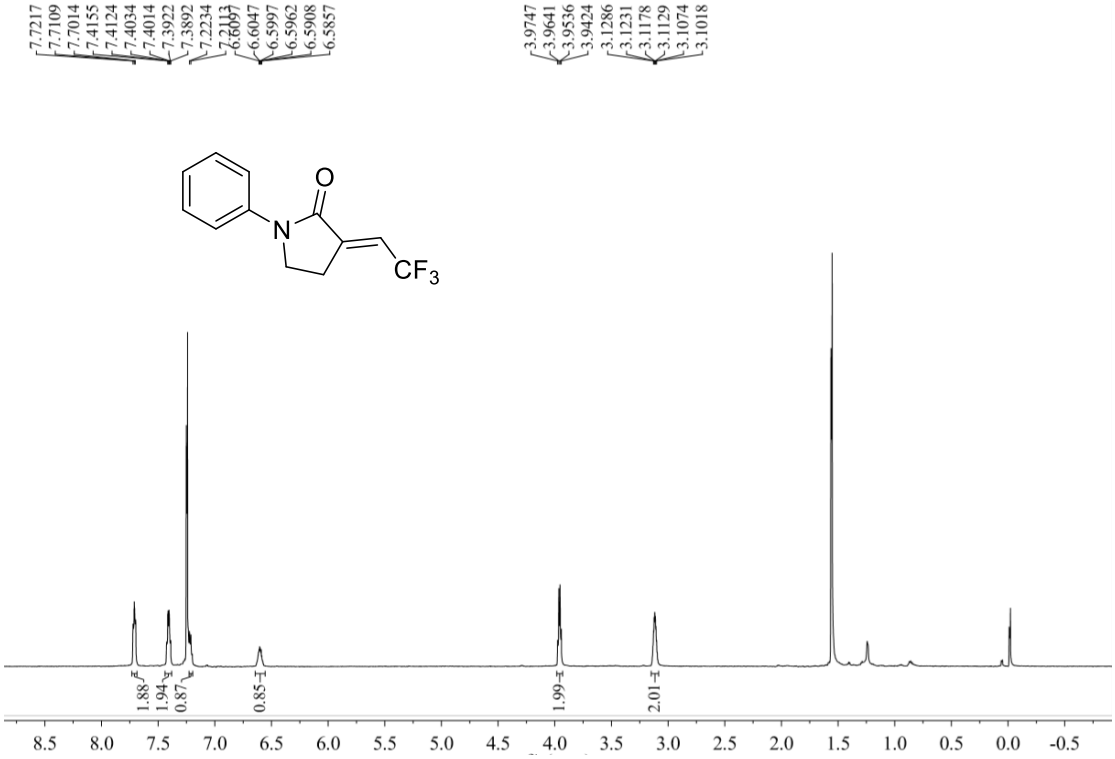
[1] P. Zargaran, T. Wurm, D. Zahner, J. Schießl, M. Rudolph, F. Rominger and A. S. K. Hashmi, Front Cover Picture: A Structure-Based Activity Study of Highly Active Unsymmetrically Substituted NHC Gold(I) Catalysts, *Adv. Synth. Catal.*, 2018, **360**, 1-1.

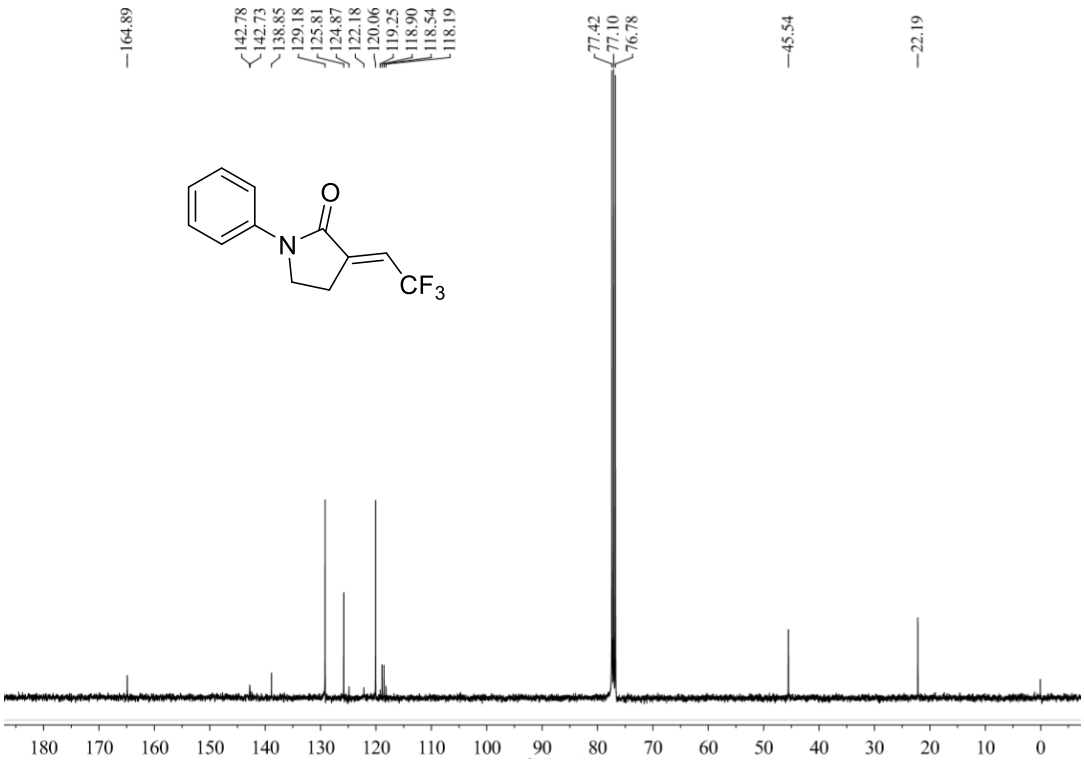
[2] a) C. Xie, L. Zhang, W. Sha, V. A. Soloshonok, J. Han and Y. Pan, Detrifluoroacetylative in Situ Generation of Free 3-Fluoroindolin-2-one-Derived Tertiary Enolates: Design, Synthesis, and Assessment of Reactivity toward Asymmetric Mannich Reactions, *Org. Lett.*, 2016, **18**, 3270-3273. b) O. Marrec, J. Borrini, T. Billard and B. R. Langlois, Synthesis of β-Trifluoromethylated Enones: An Unexpected Reactivity of Trifluoromethylated Weinreb Enamides towards Organolithium Species, *Synlett*, 2009, **2009**, 1241-1244.

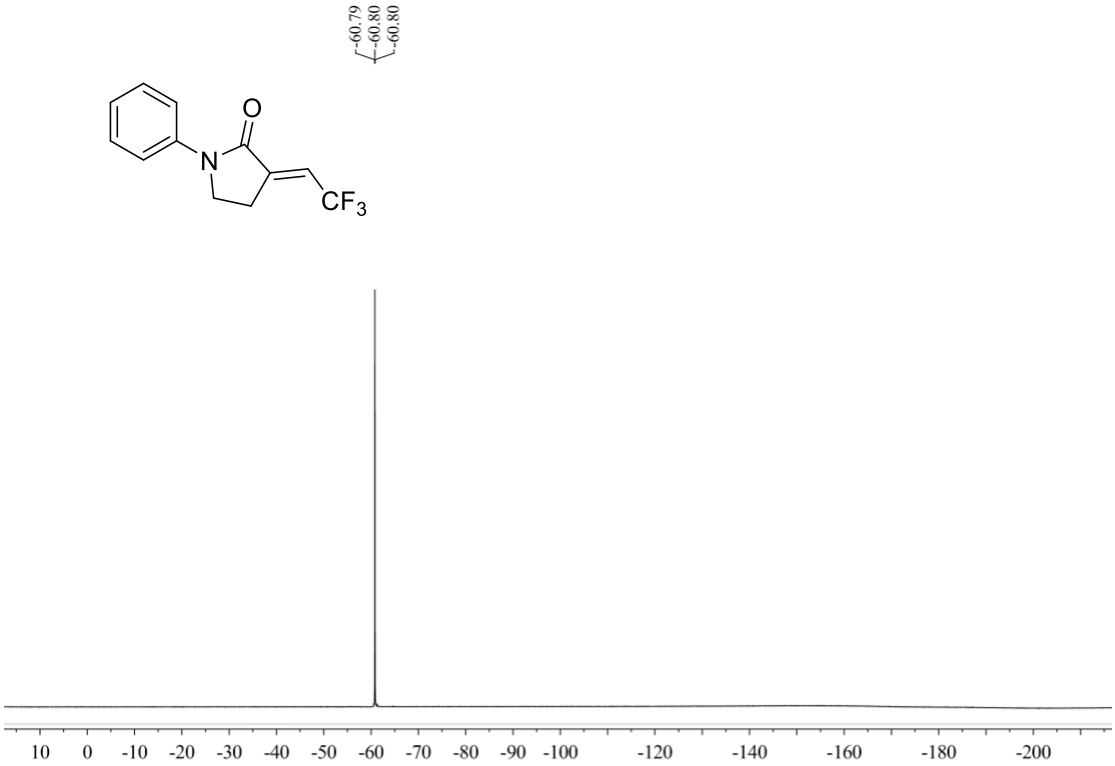
[3] G. Zhang, B. Shuai, Y. Shan, Preparation of 3-(2,2,2-trifluoroethyl)-pyrrolidine hydrochloride. CN113563242A, 2021.

7. NMR, GC and HPLC spectra

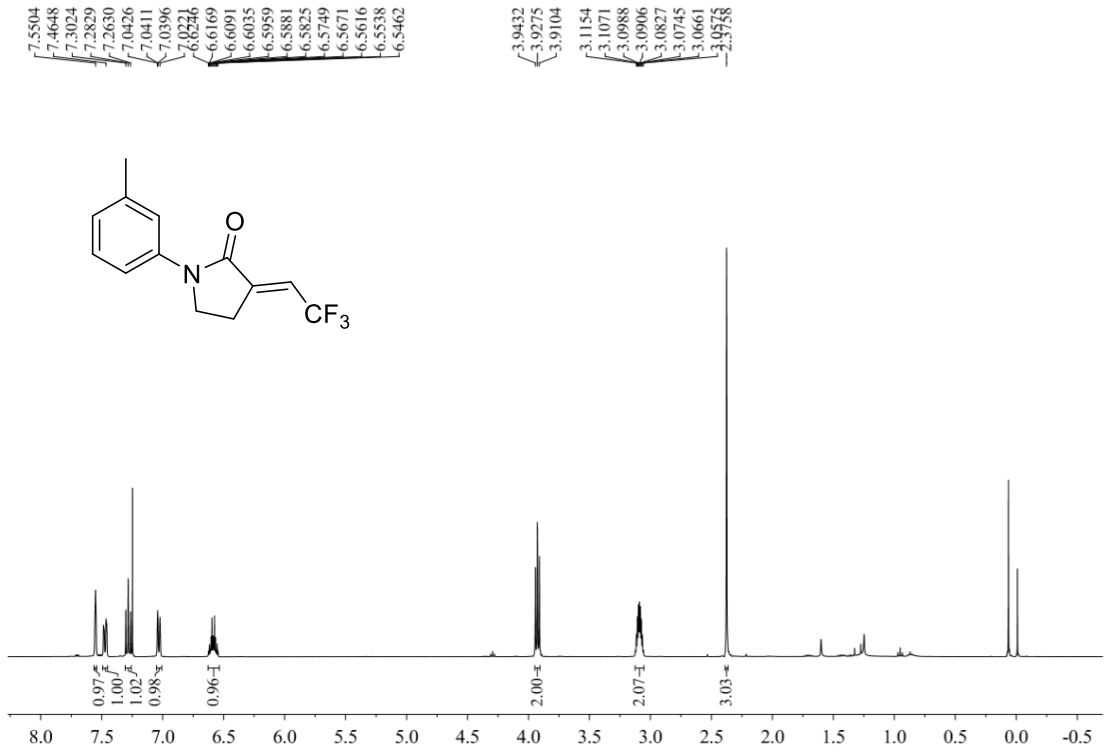
(*E*)-1-phenyl-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1a**)

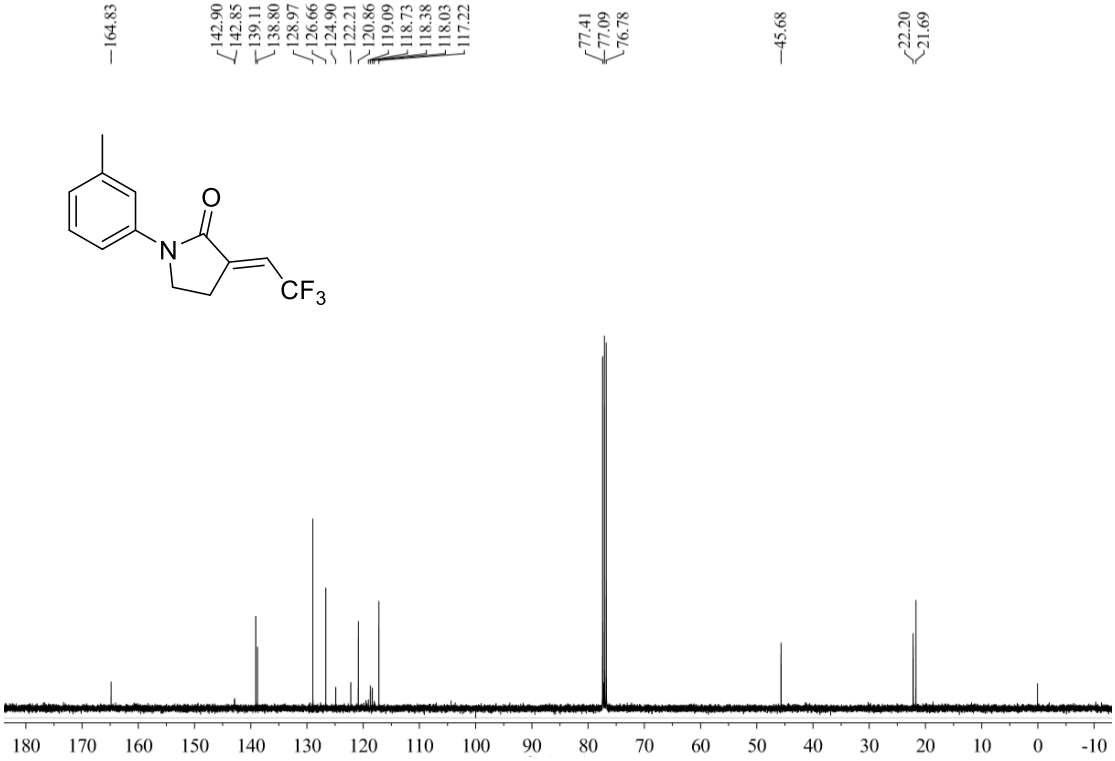


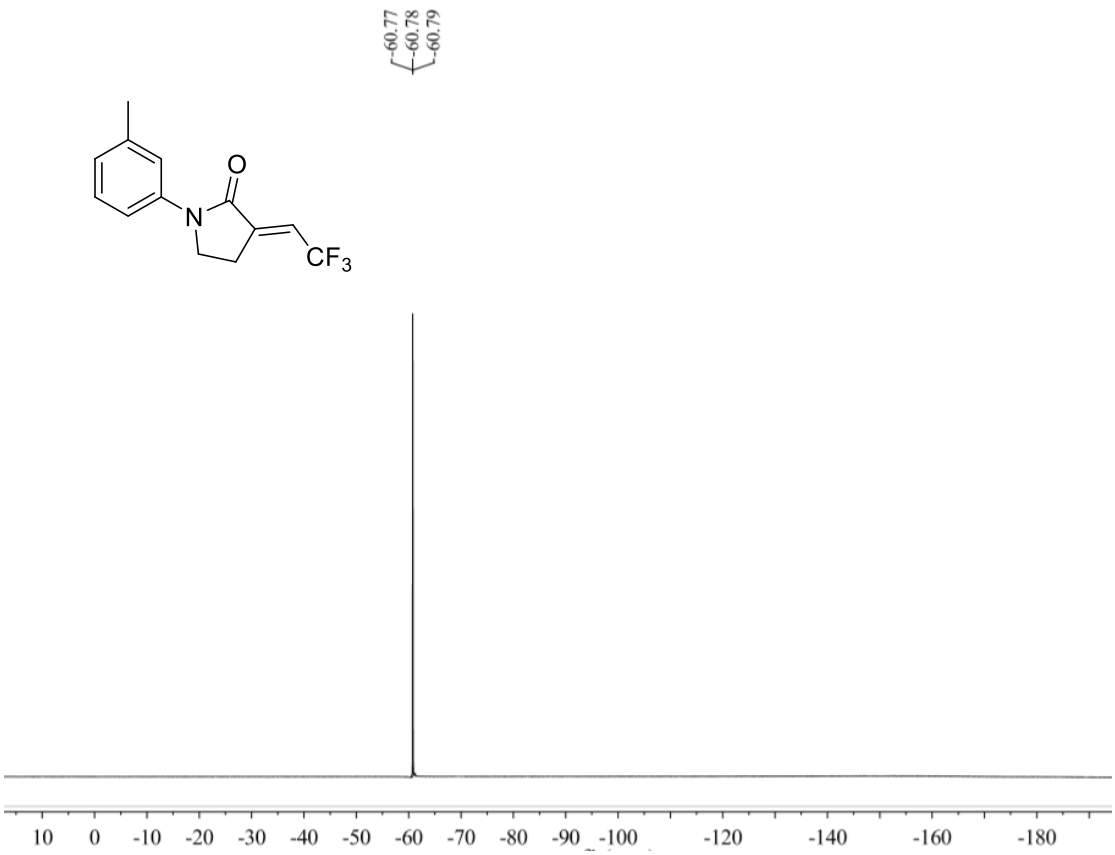



-60.79
-60.80
-60.80
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
-200

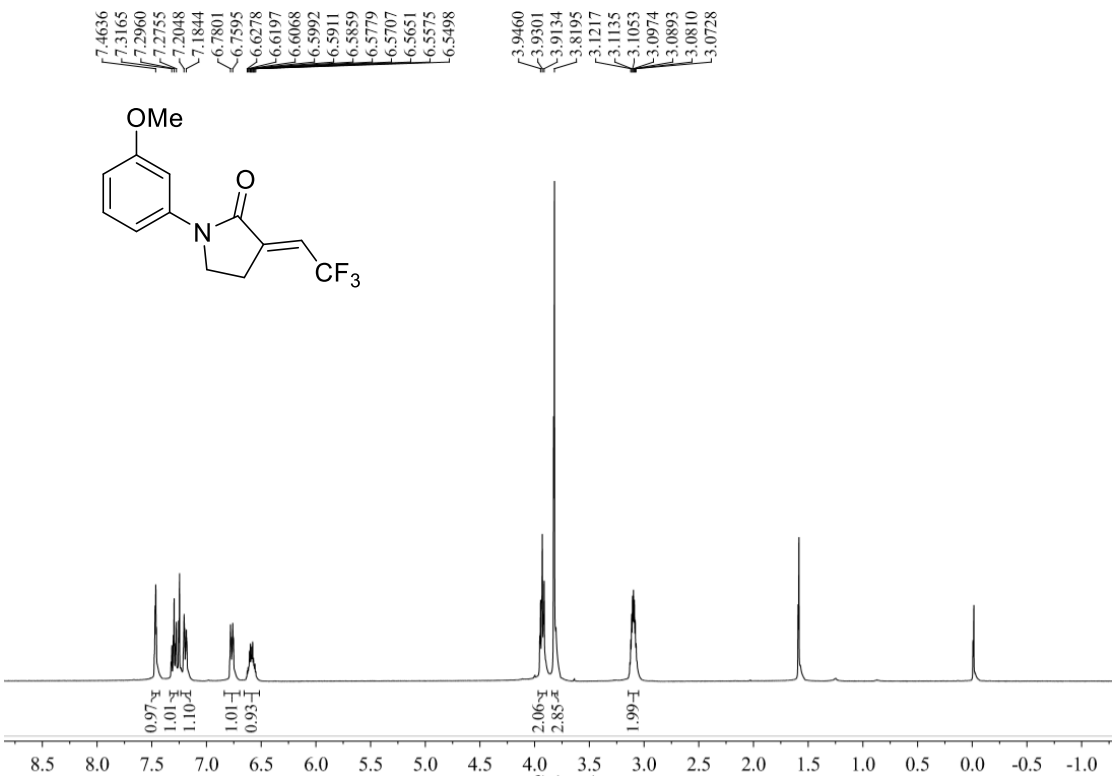
(*E*)-1-(*m*-tolyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1b**)

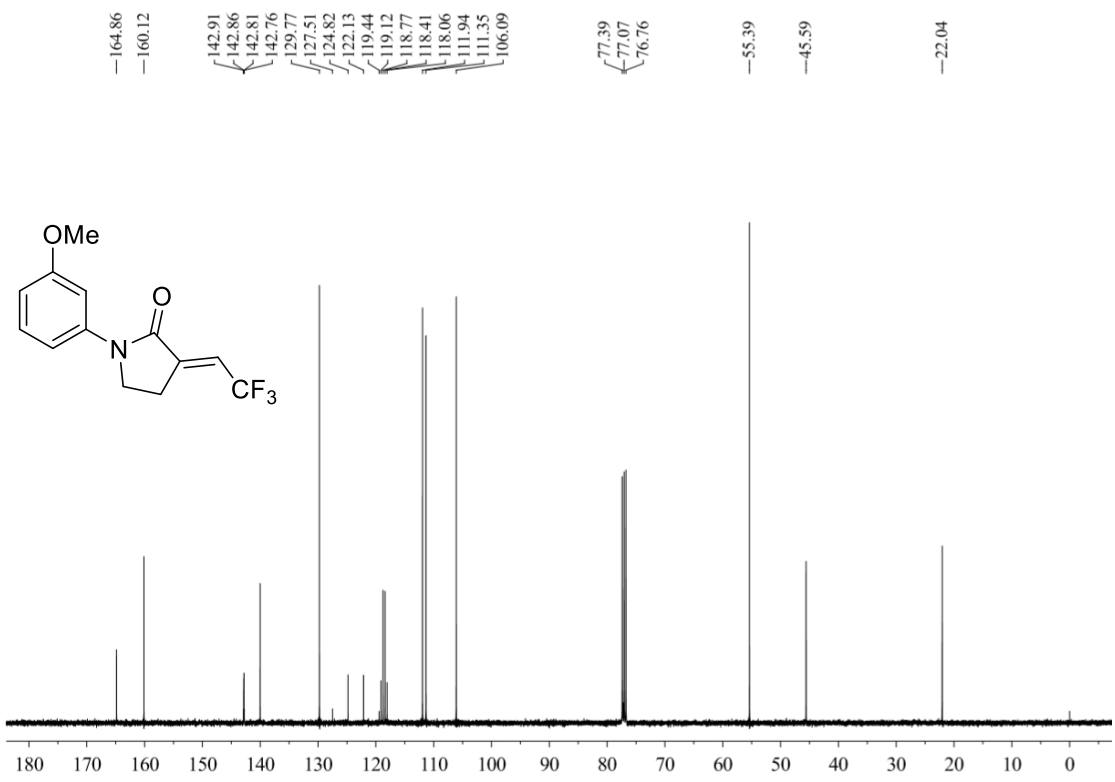


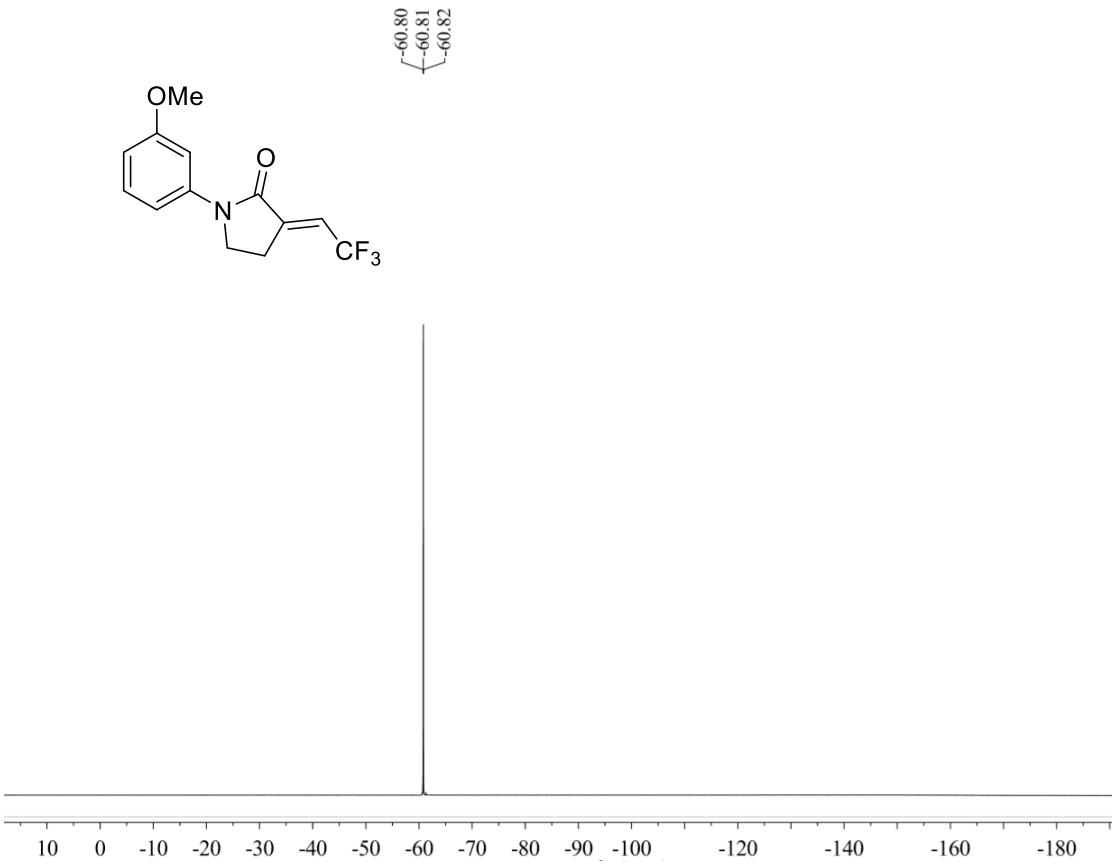



-60.77
-60.78
-60.79
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

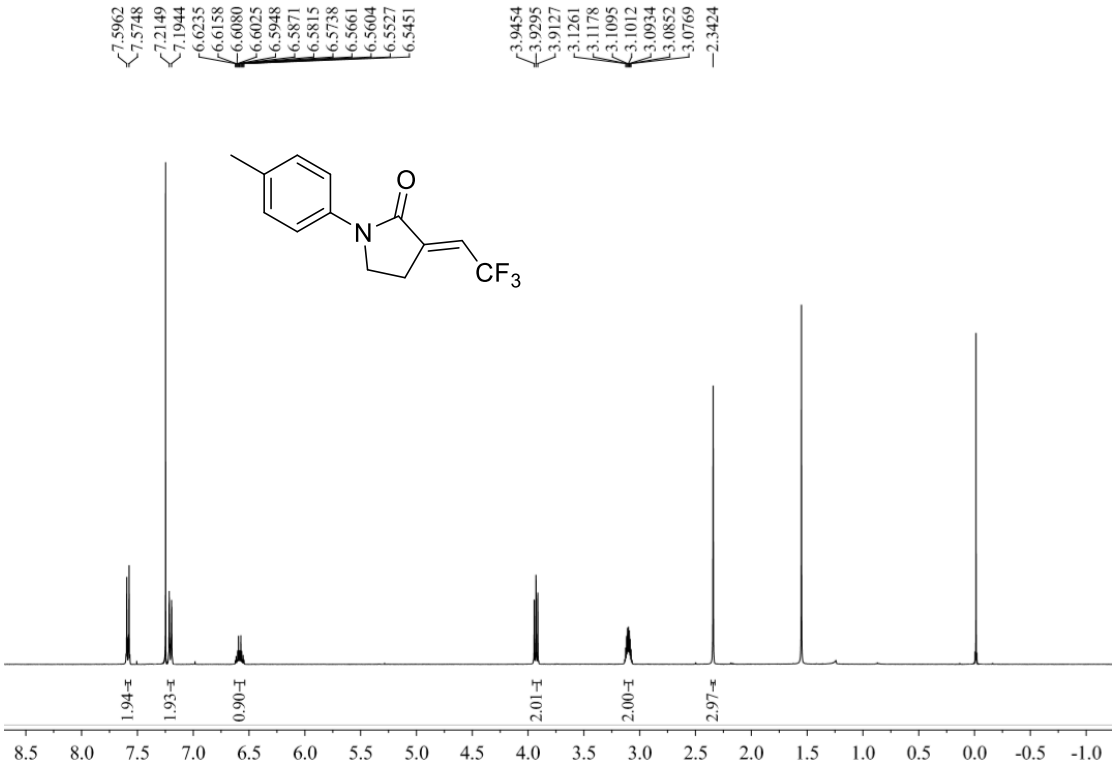
(*E*)-1-(3-methoxyphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1c**)

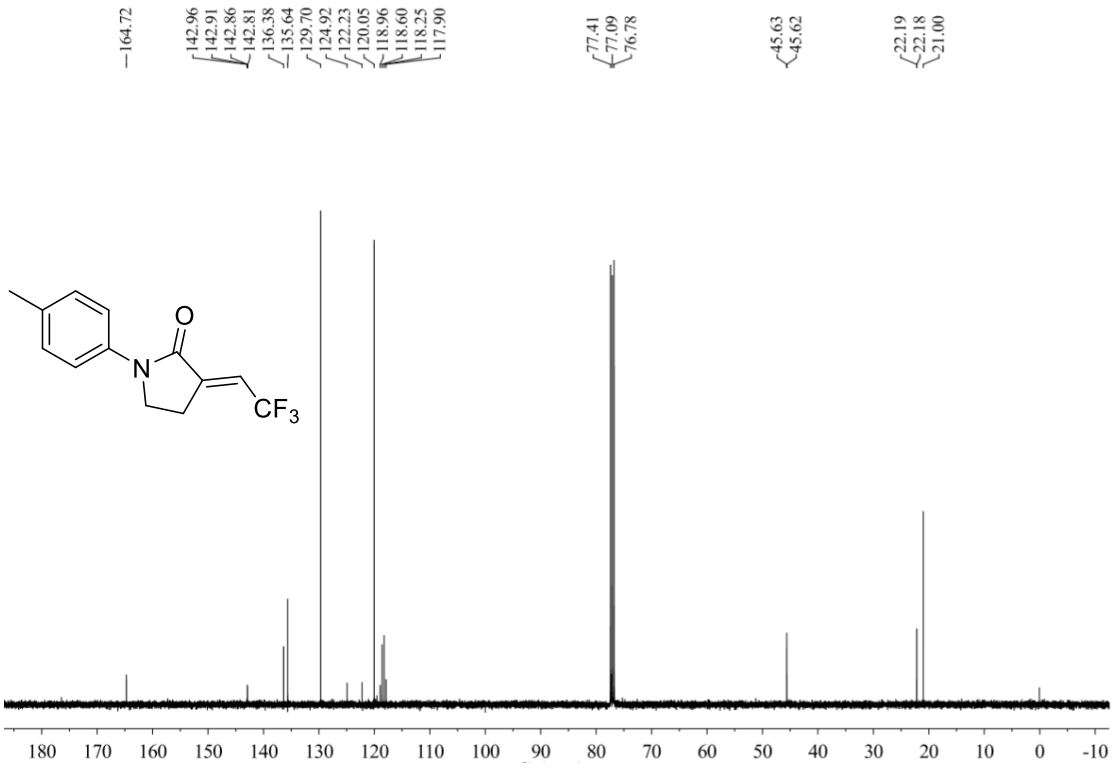


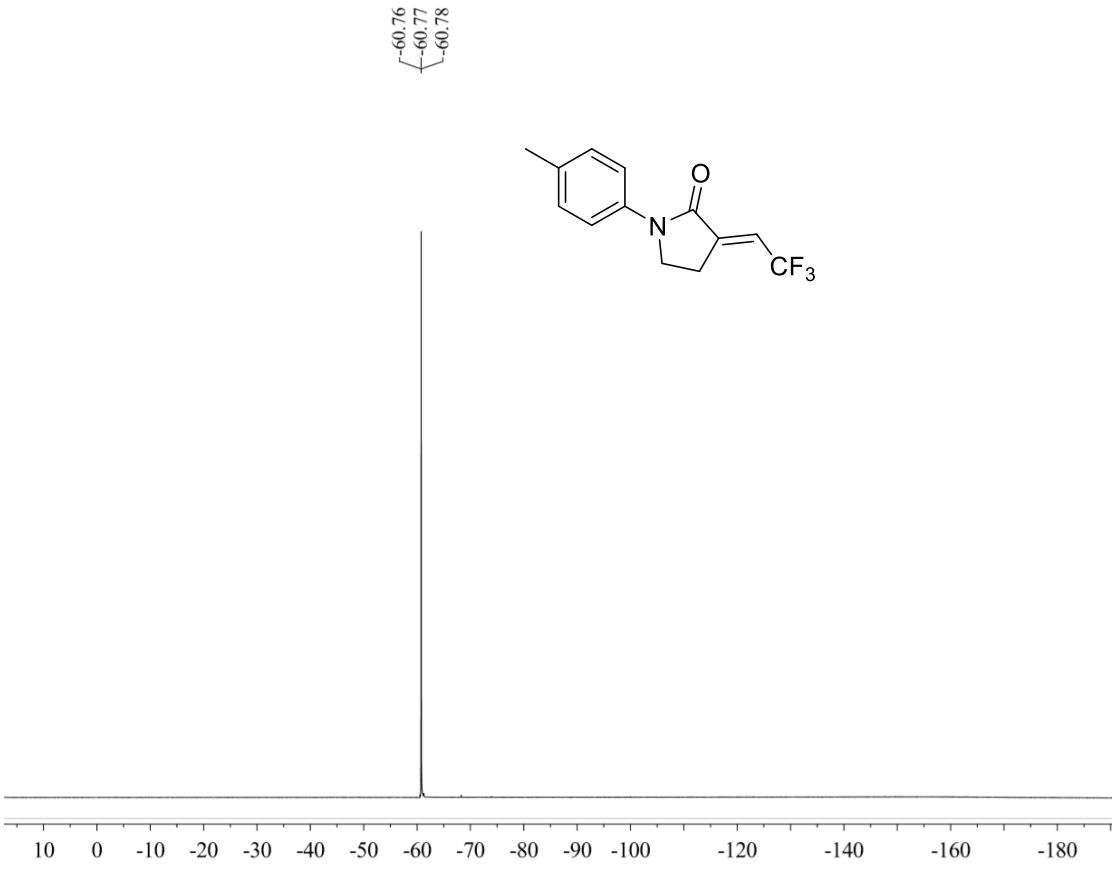



-60.80
-60.81
-60.82
OMe
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

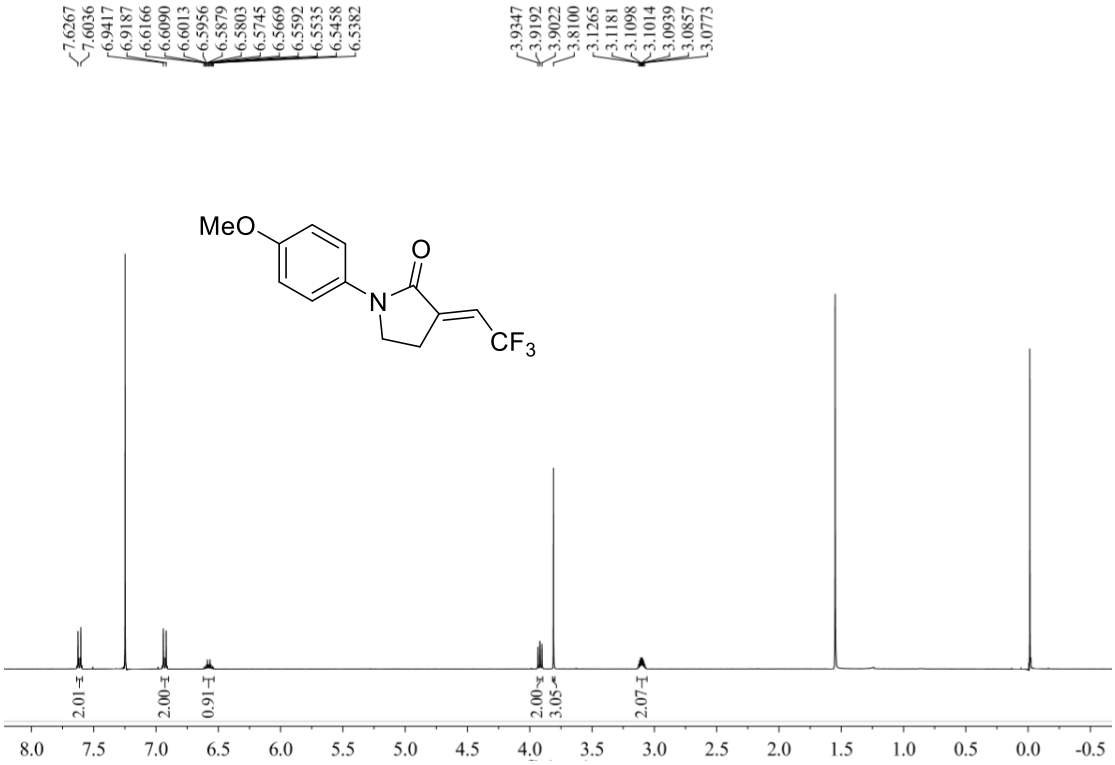
(*E*)-1-(*p*-tolyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1d**)

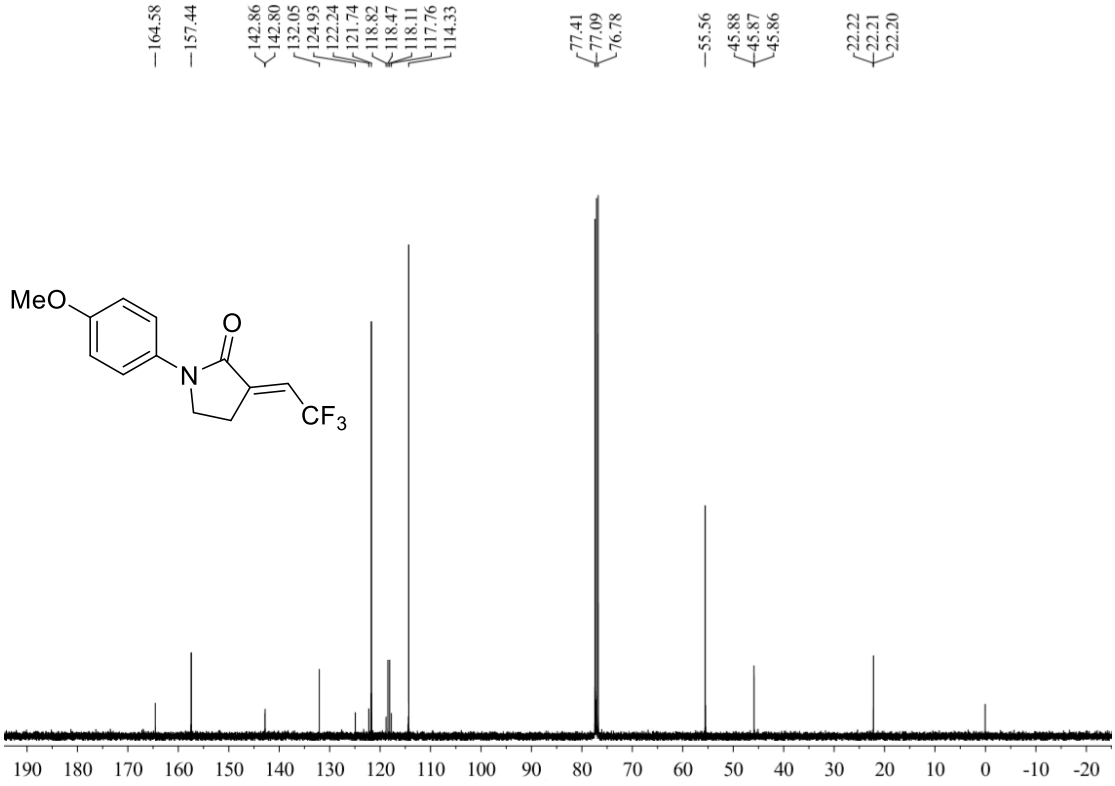


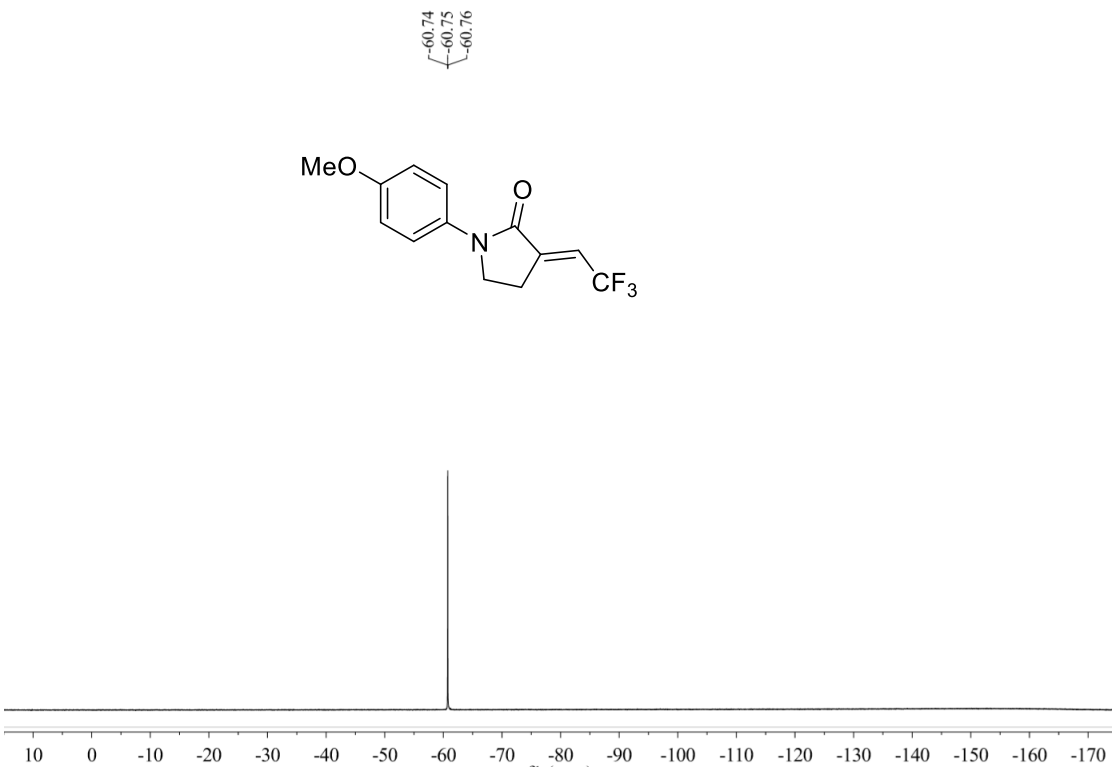



-60.76
-60.77
-60.78
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

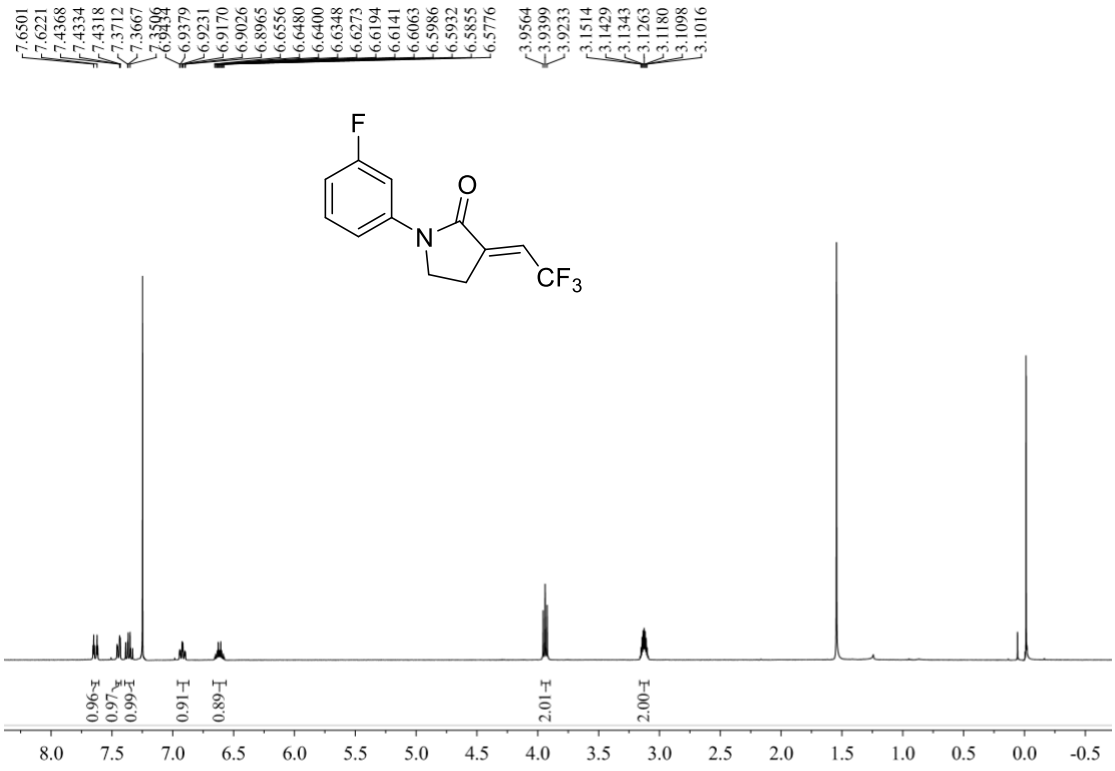
(*E*)-1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1e**)

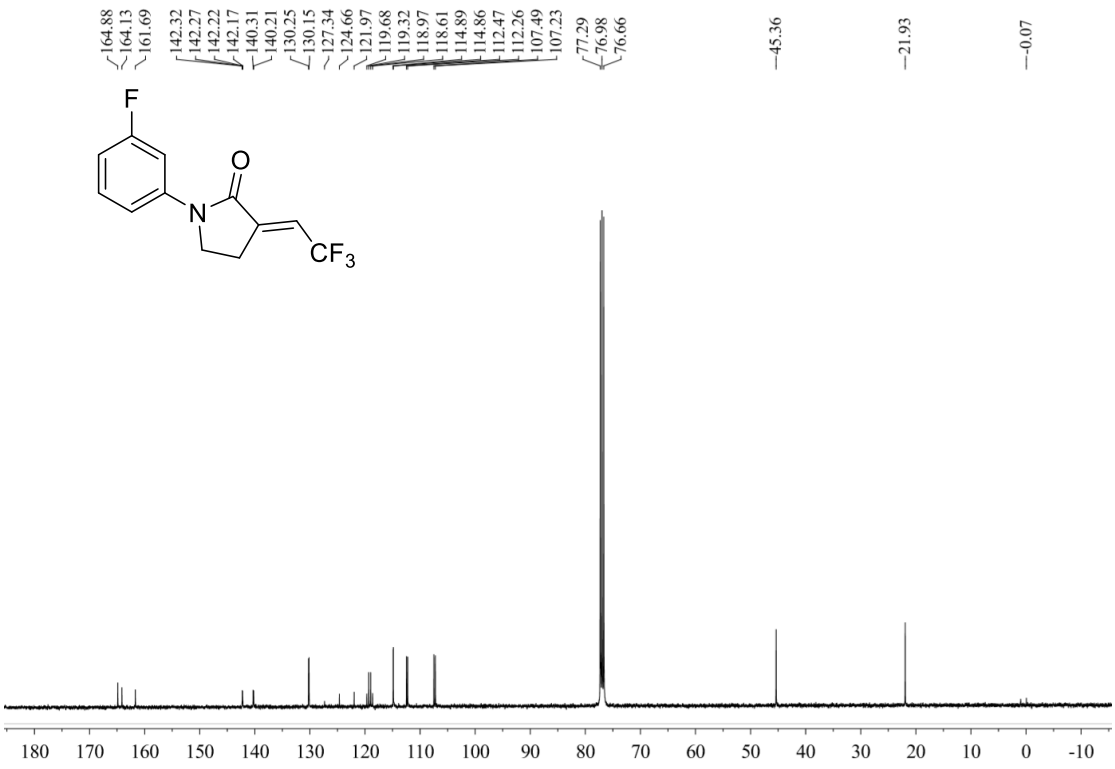


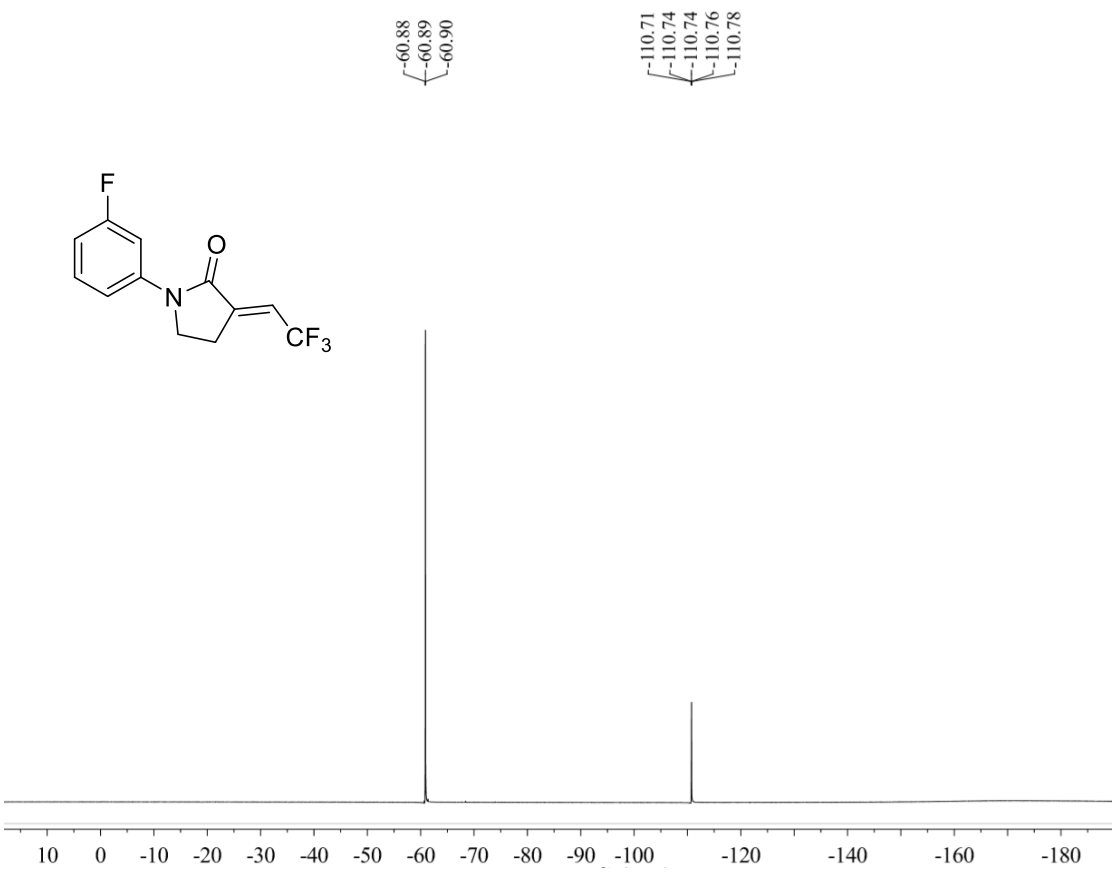



-60.74
-60.75
-60.76
MeO
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170

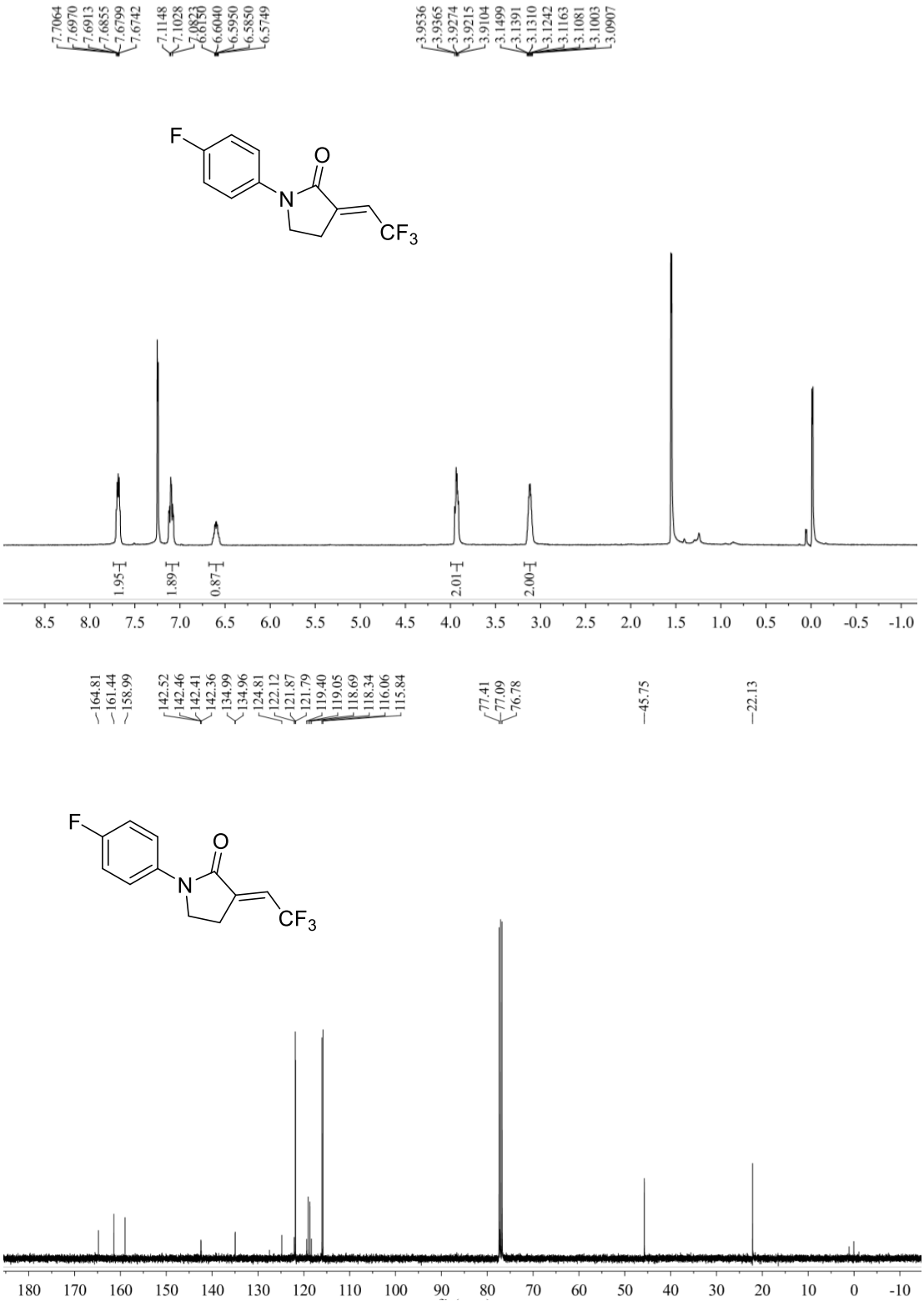
(*E*)-1-(3-fluorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1f**)

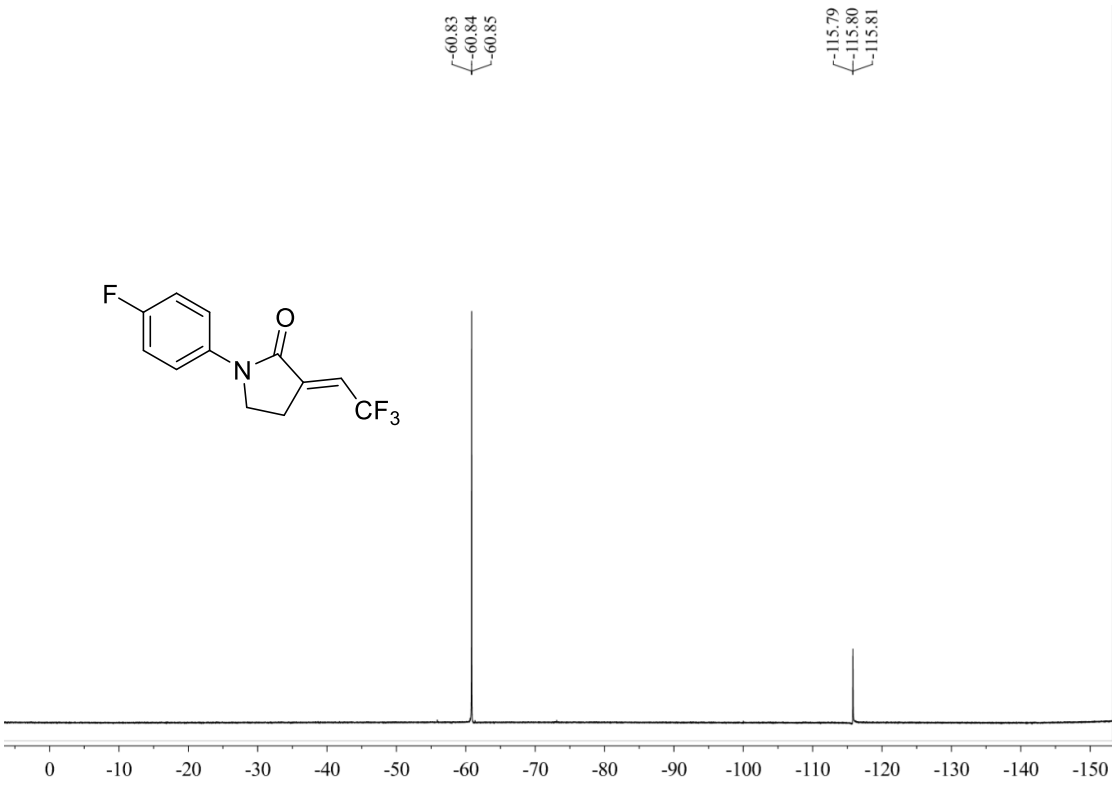




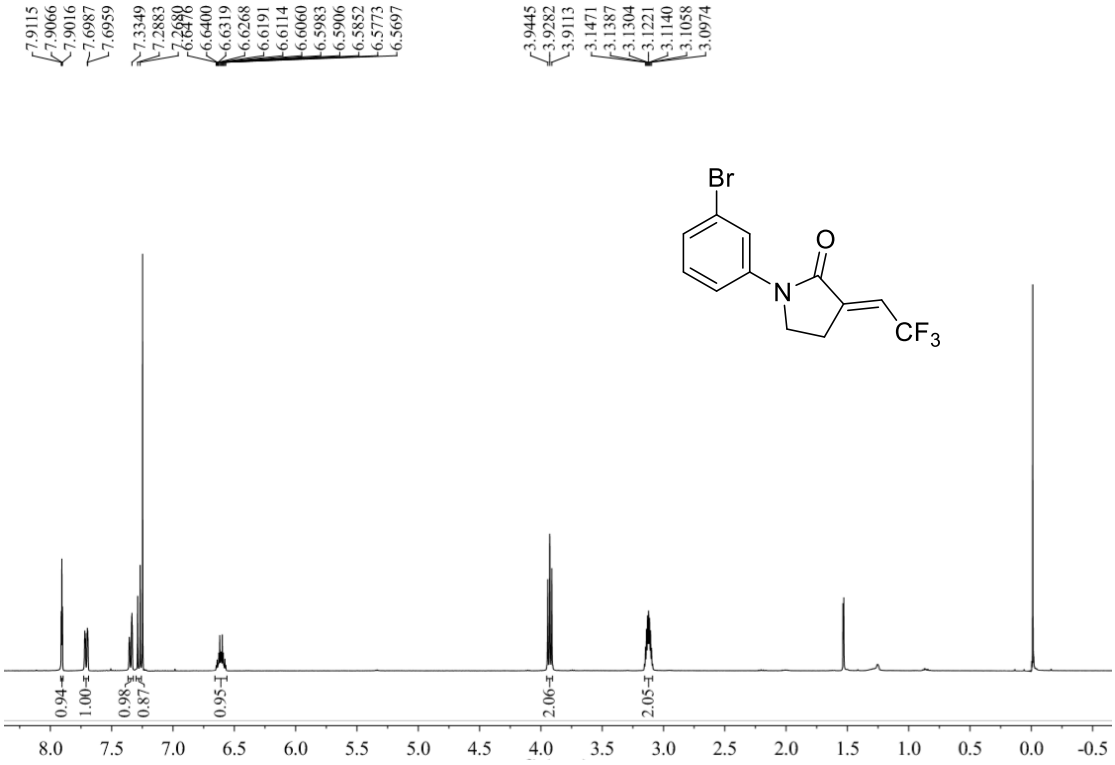

-60.88
-60.89
-60.90
-110.71
-110.74
-110.74
-110.76
-110.78
F
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

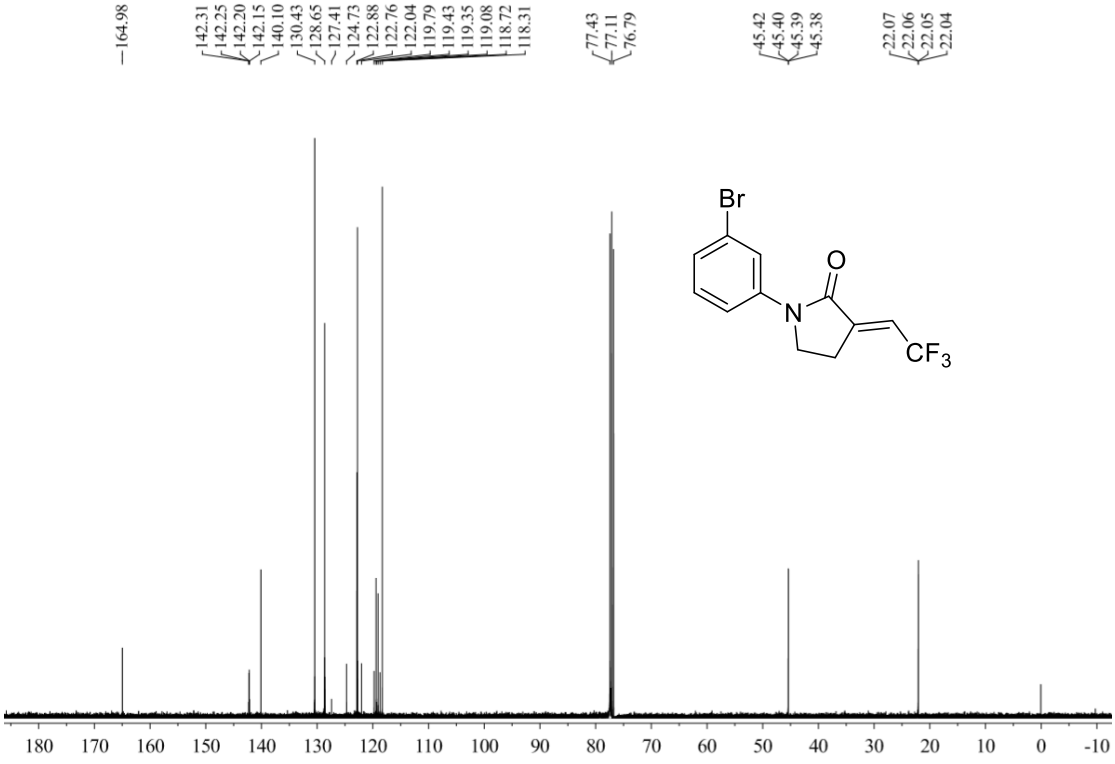
(*E*)-1-(4-fluorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1g**)

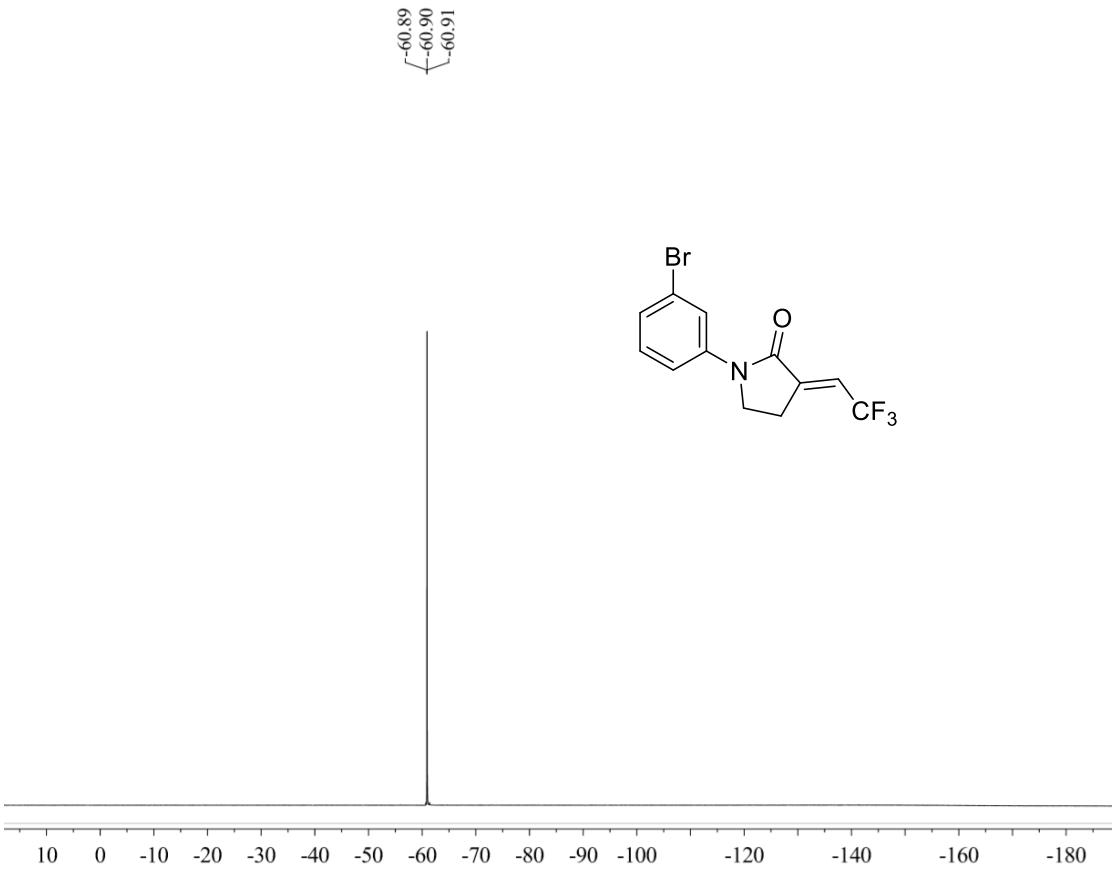



-60.83
-60.84
-60.85
-115.79
-115.80
-115.81
F
O
N
CF3
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150

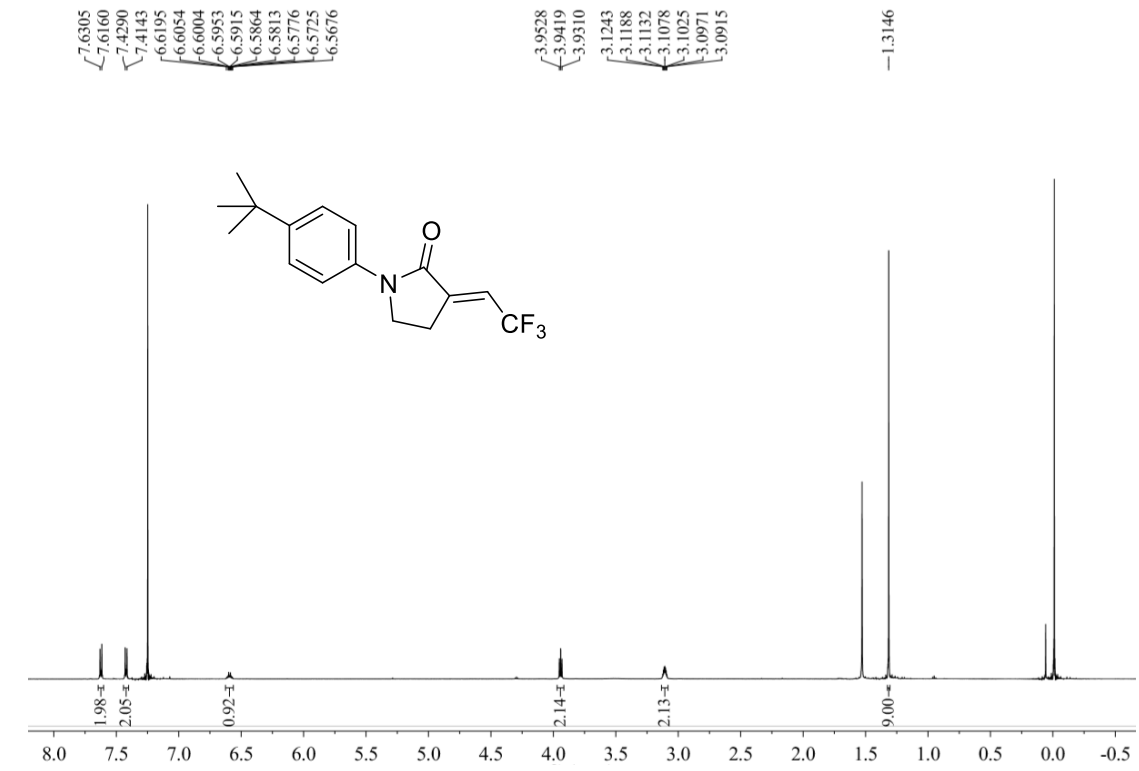
(*E*)-1-(3-bromophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1h**)

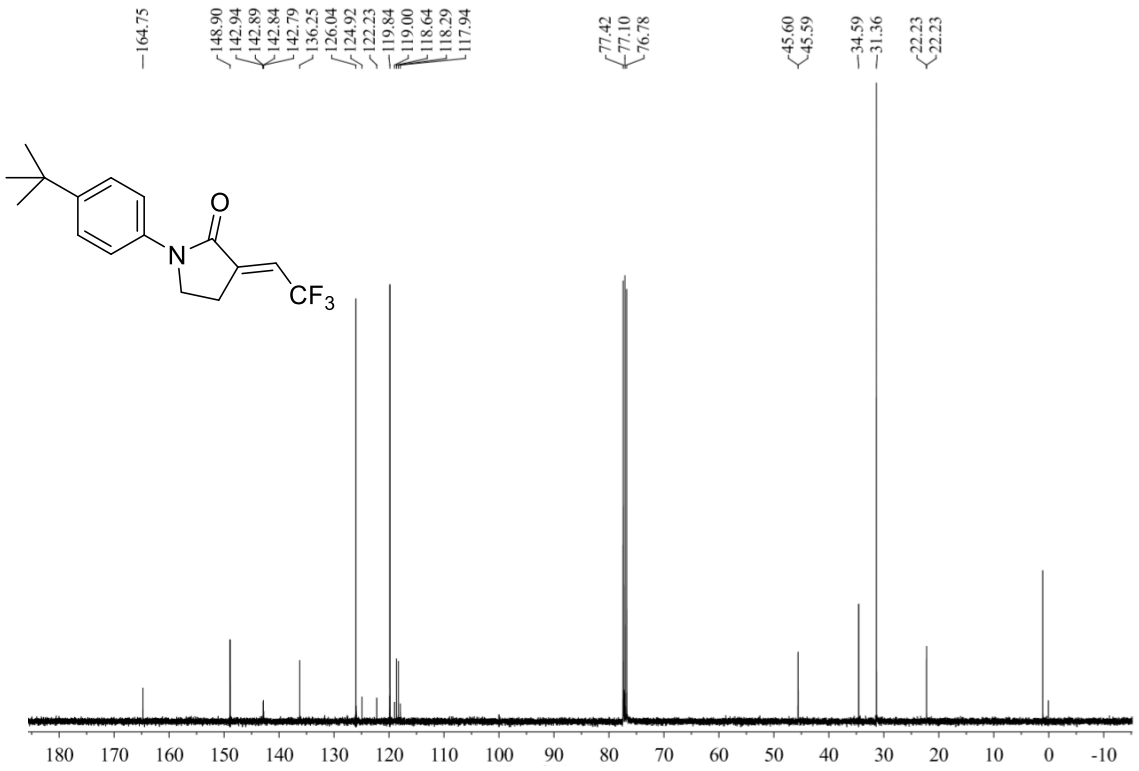


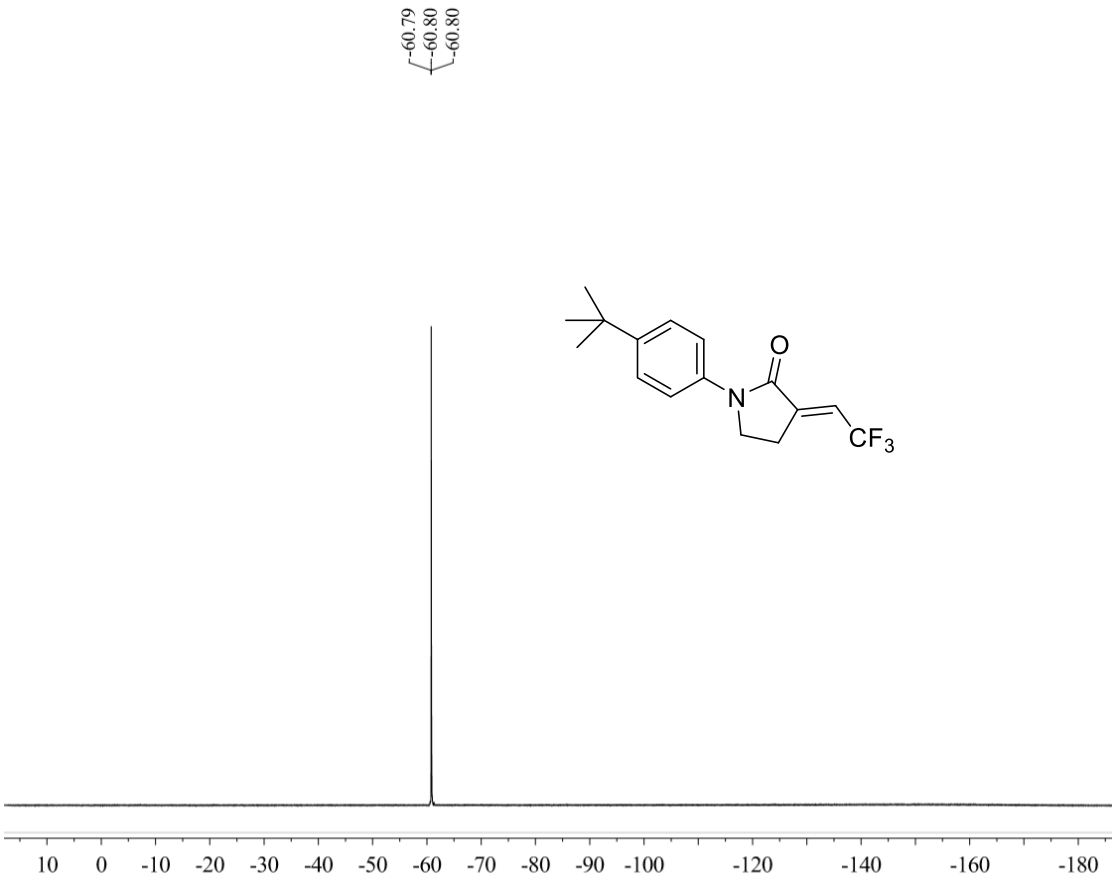



-60.89
-60.90
-60.91
Br
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

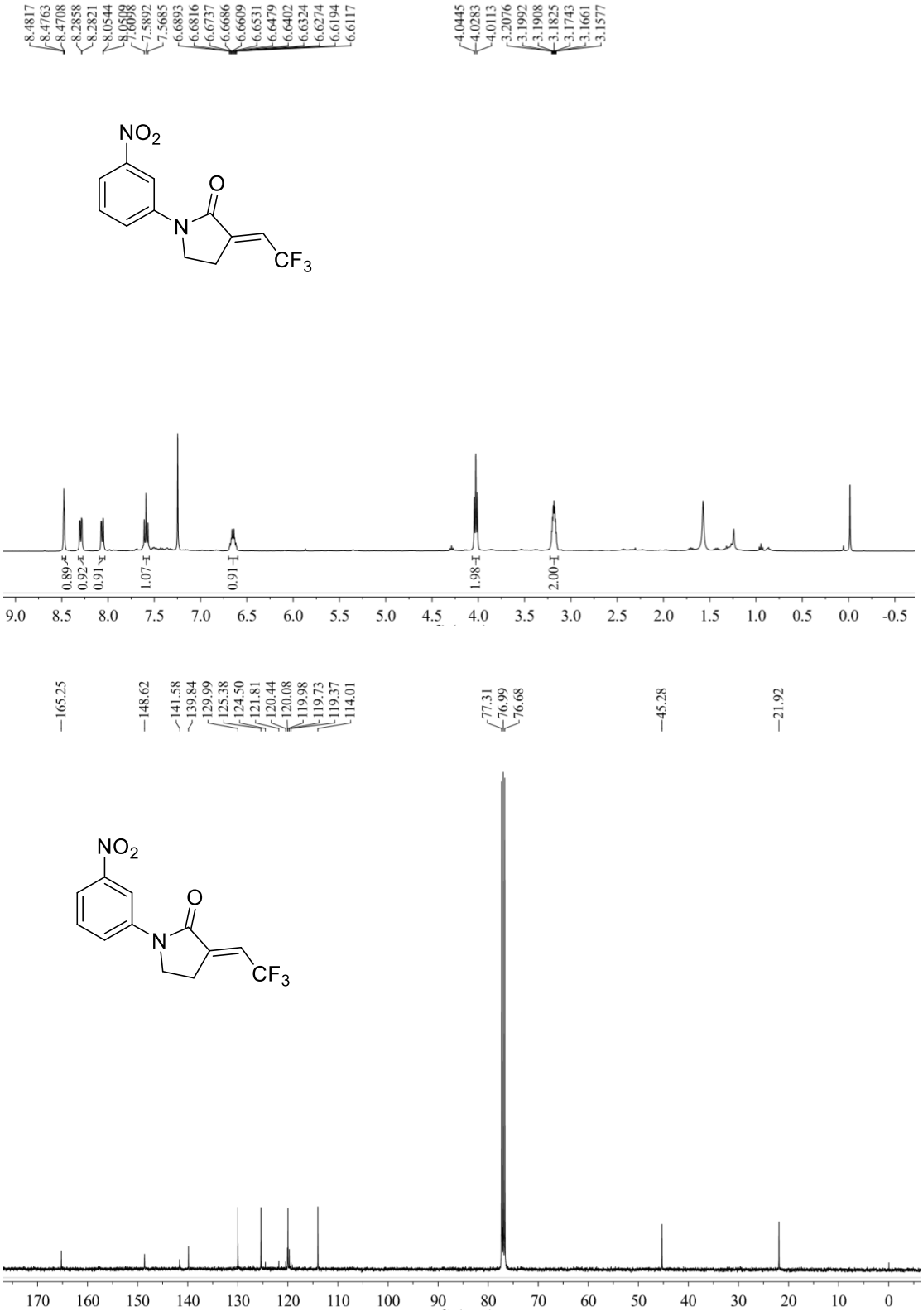
(*E*)-1-(4-(*tert*-butyl)phenyl)-3-(2,2-trifluoroethylidene)pyrrolidin-2-one (**1i**)





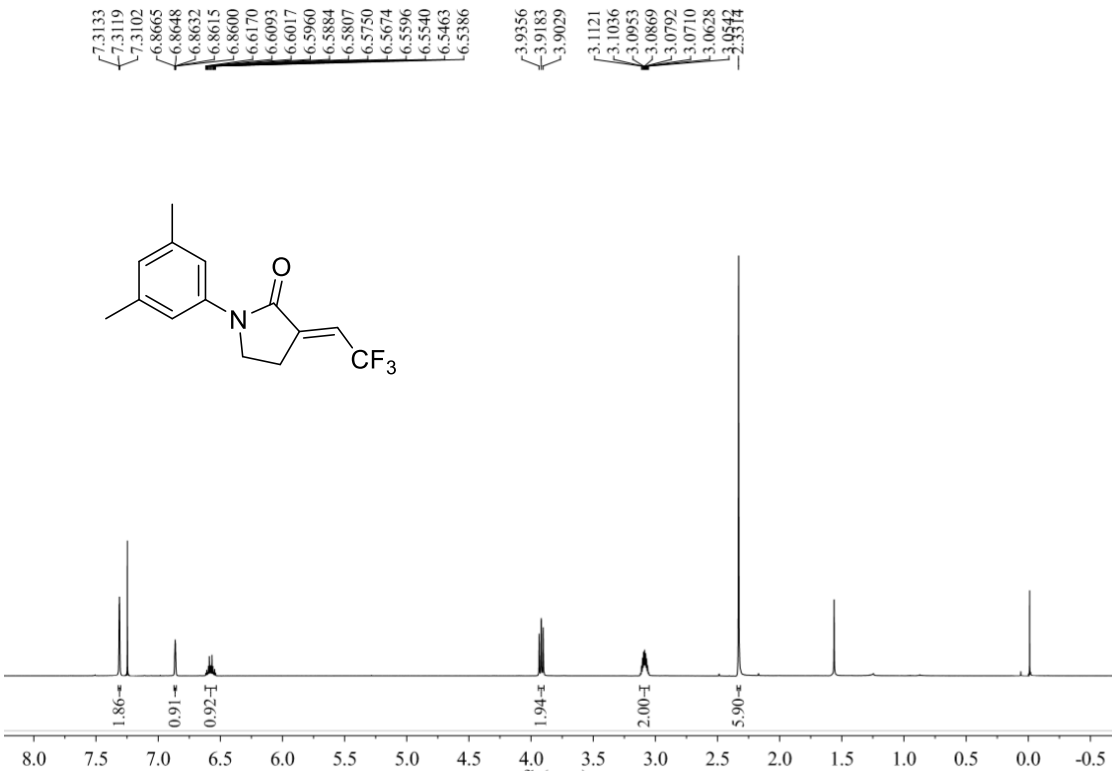

-60.79
-60.80
-60.80
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

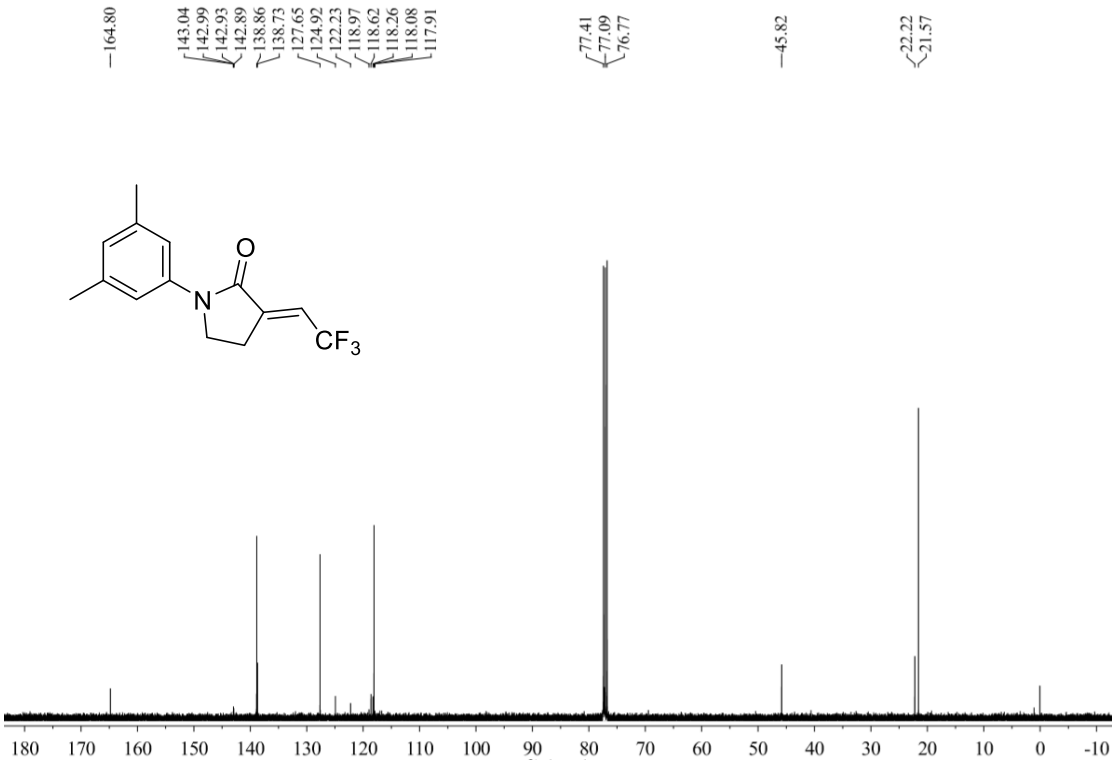
(*E*)-1-(3-nitrophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1j**)

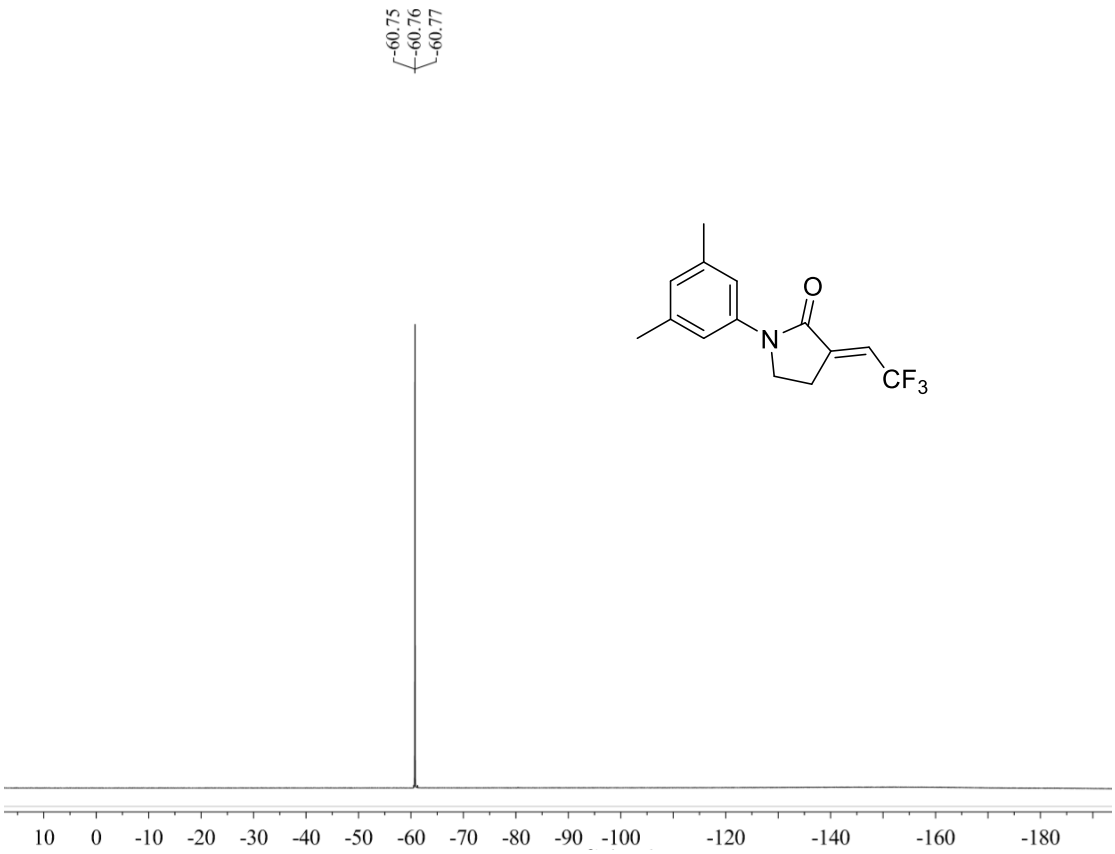



-60.96
-60.97
-60.98
NO2
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140

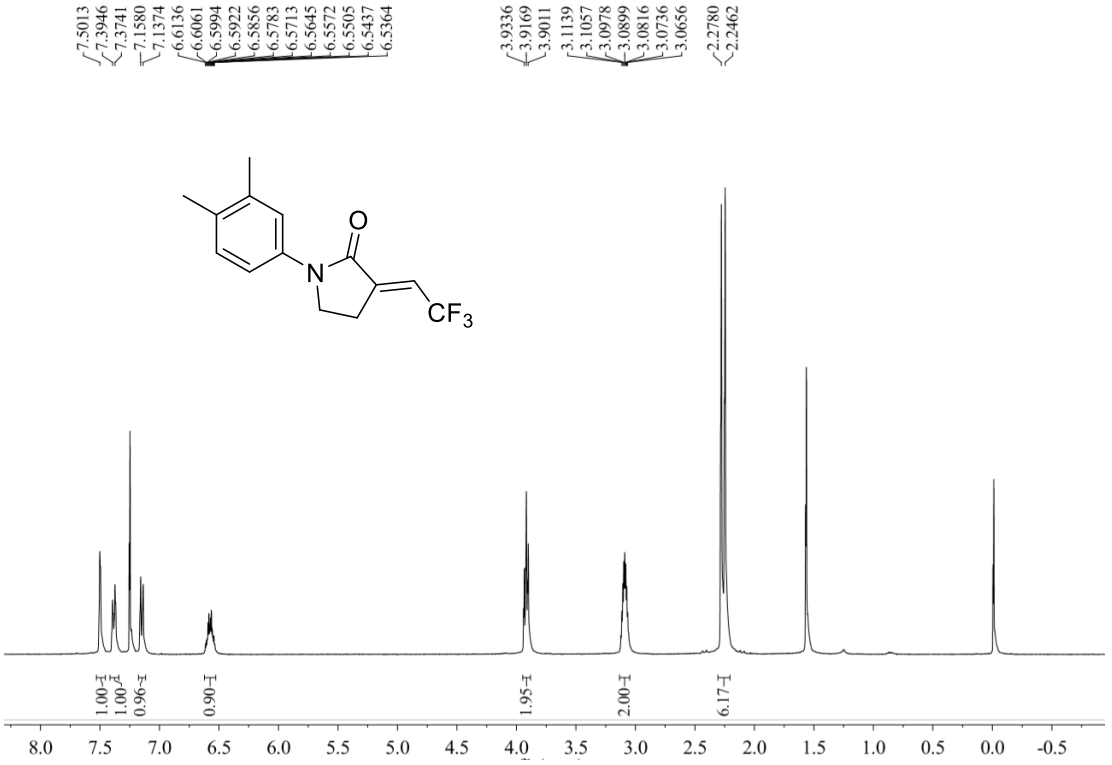
(*E*)-1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1k**)

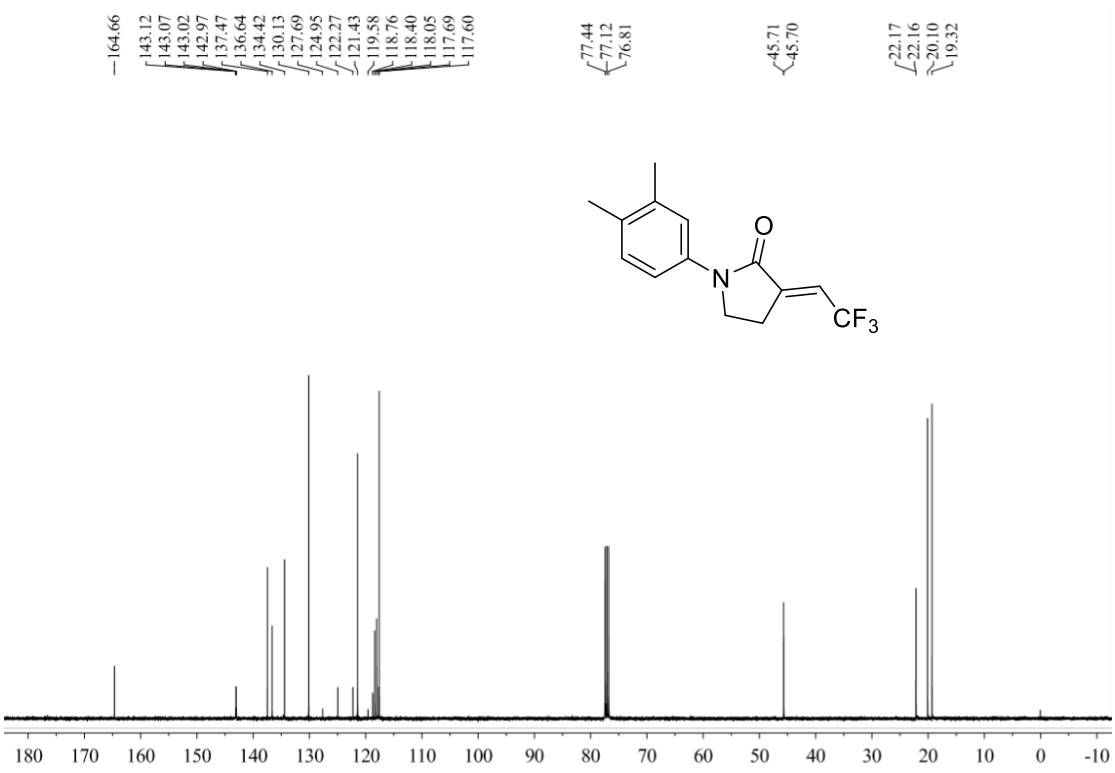


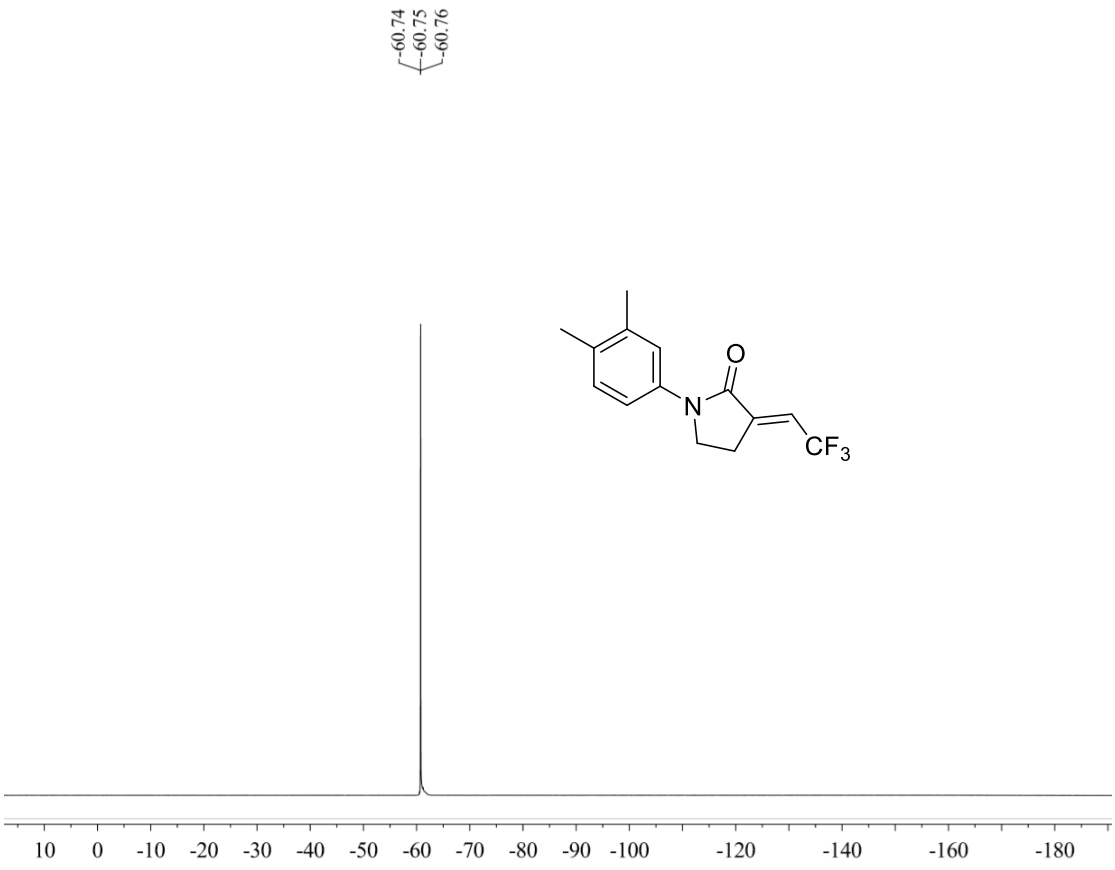



-60.75
-60.76
-60.77
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

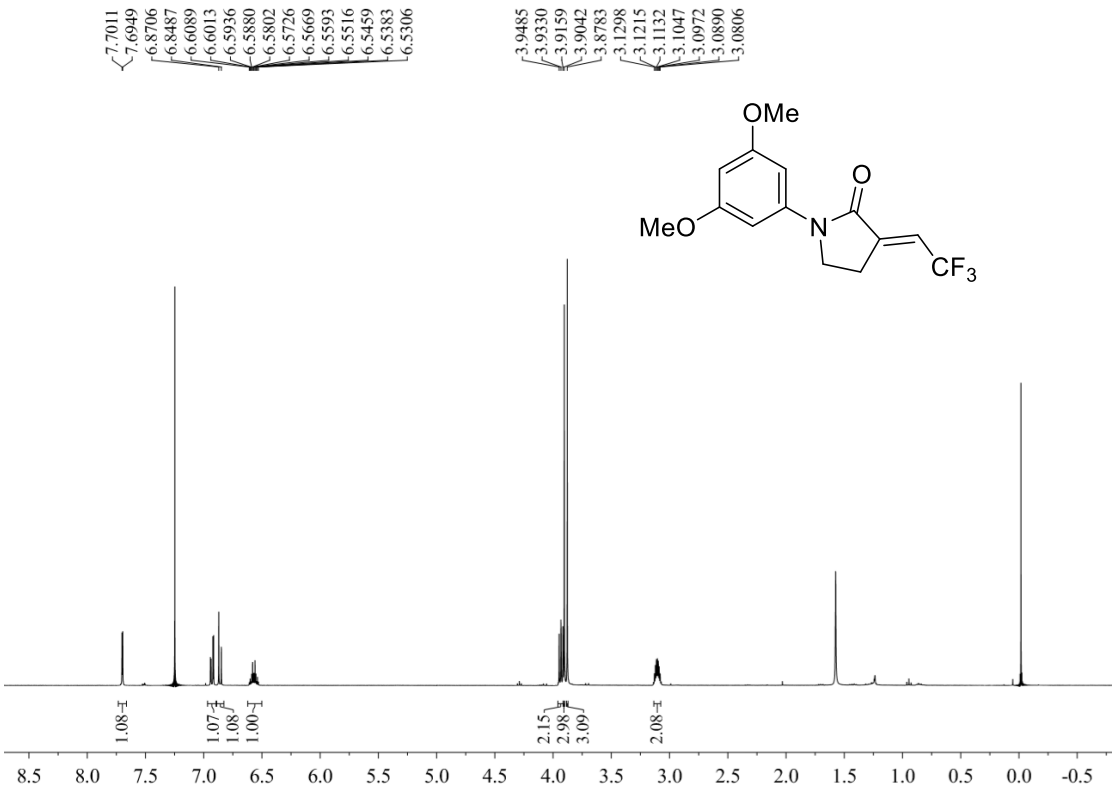
(*E*)-1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1l**)

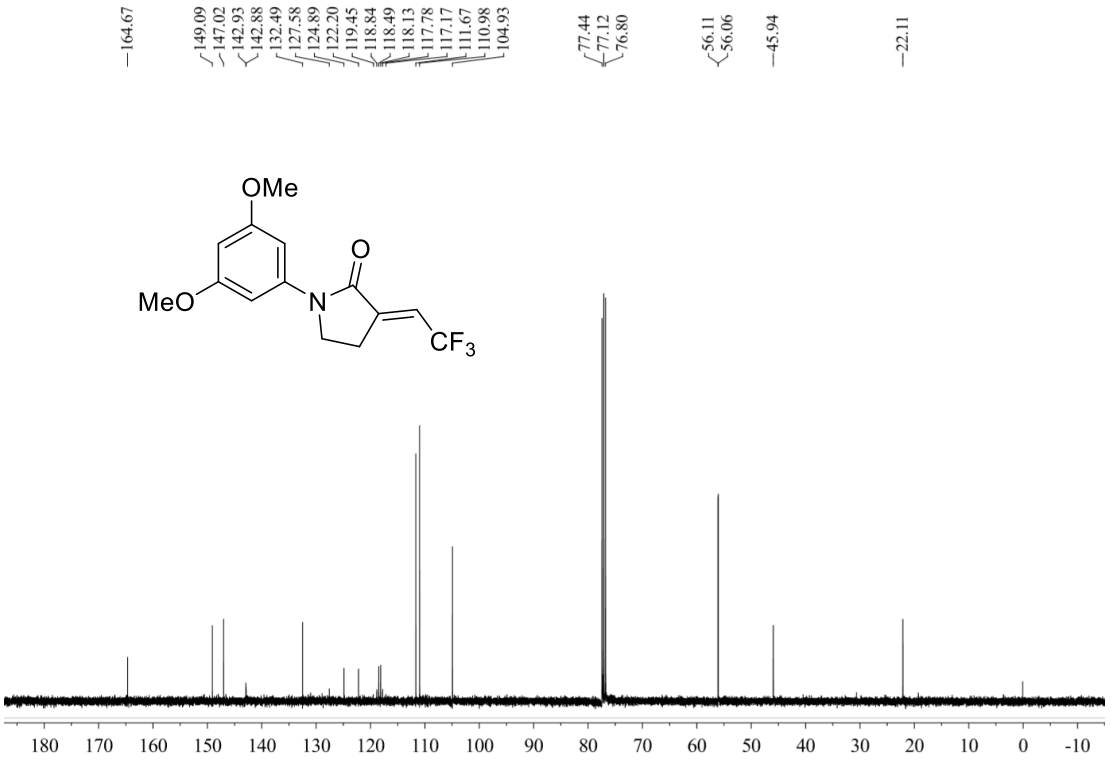


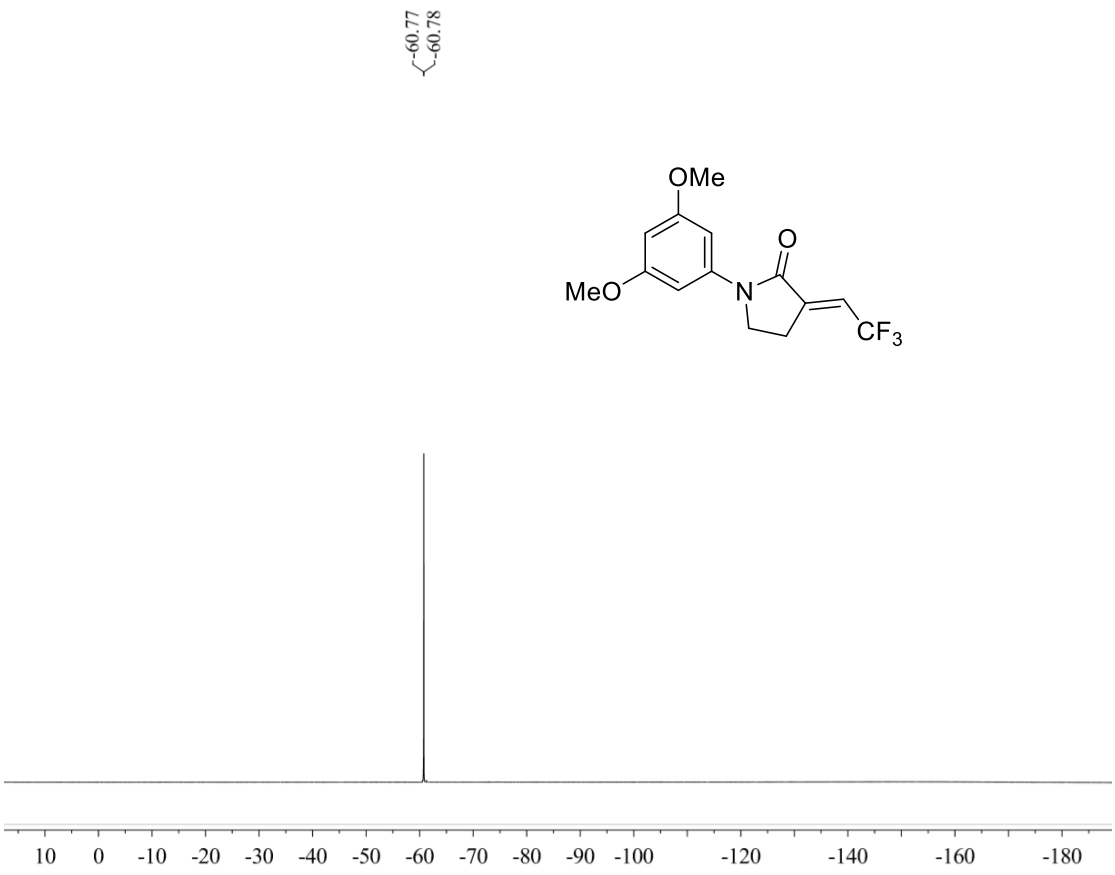



-60.74
-60.75
-60.76
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

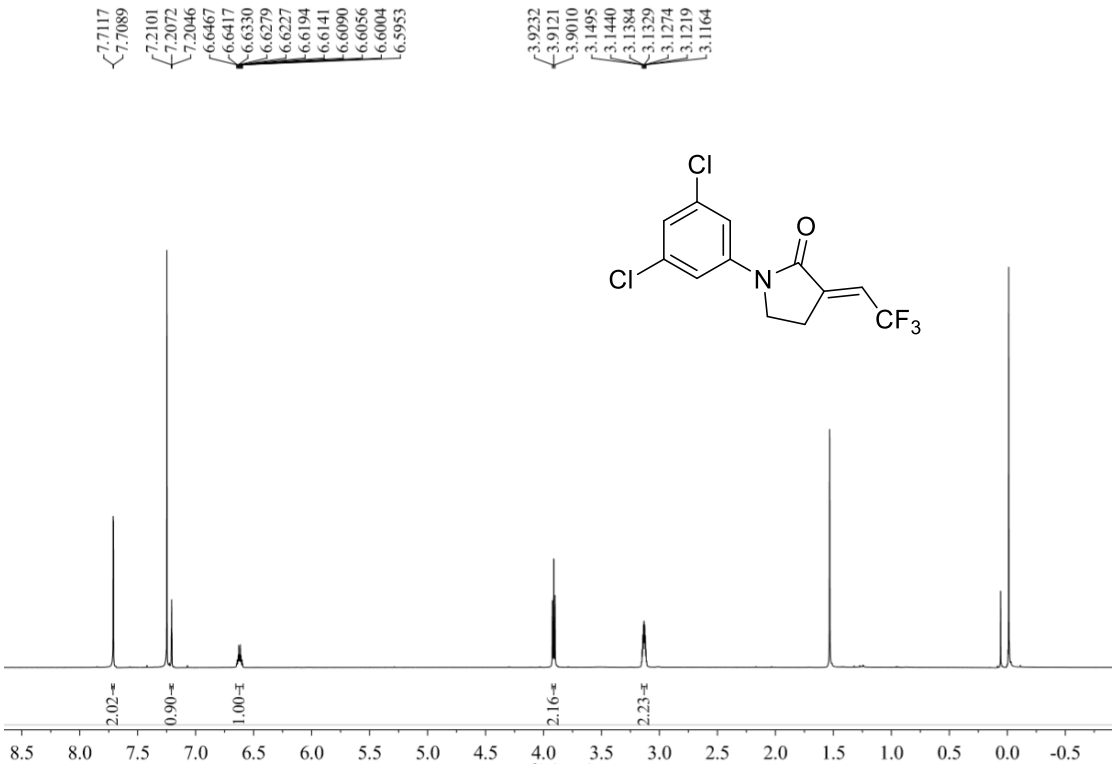
(*E*)-1-(3,5-dimethoxyphenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1m**)

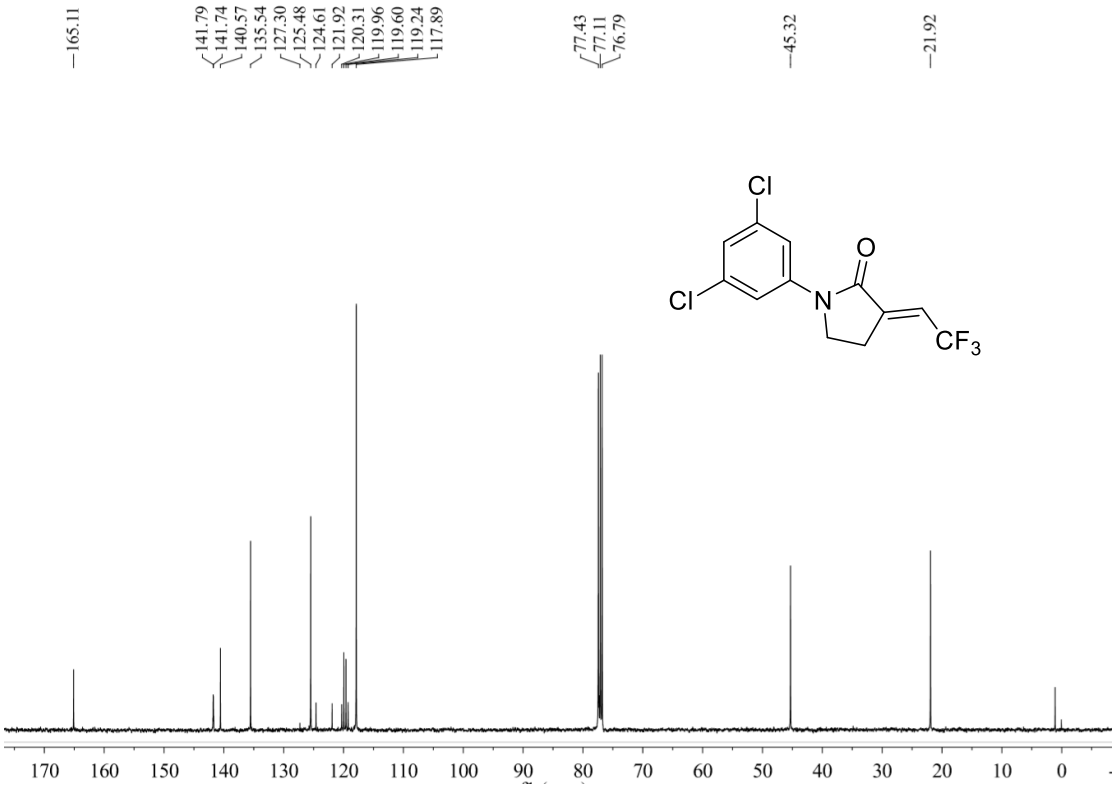


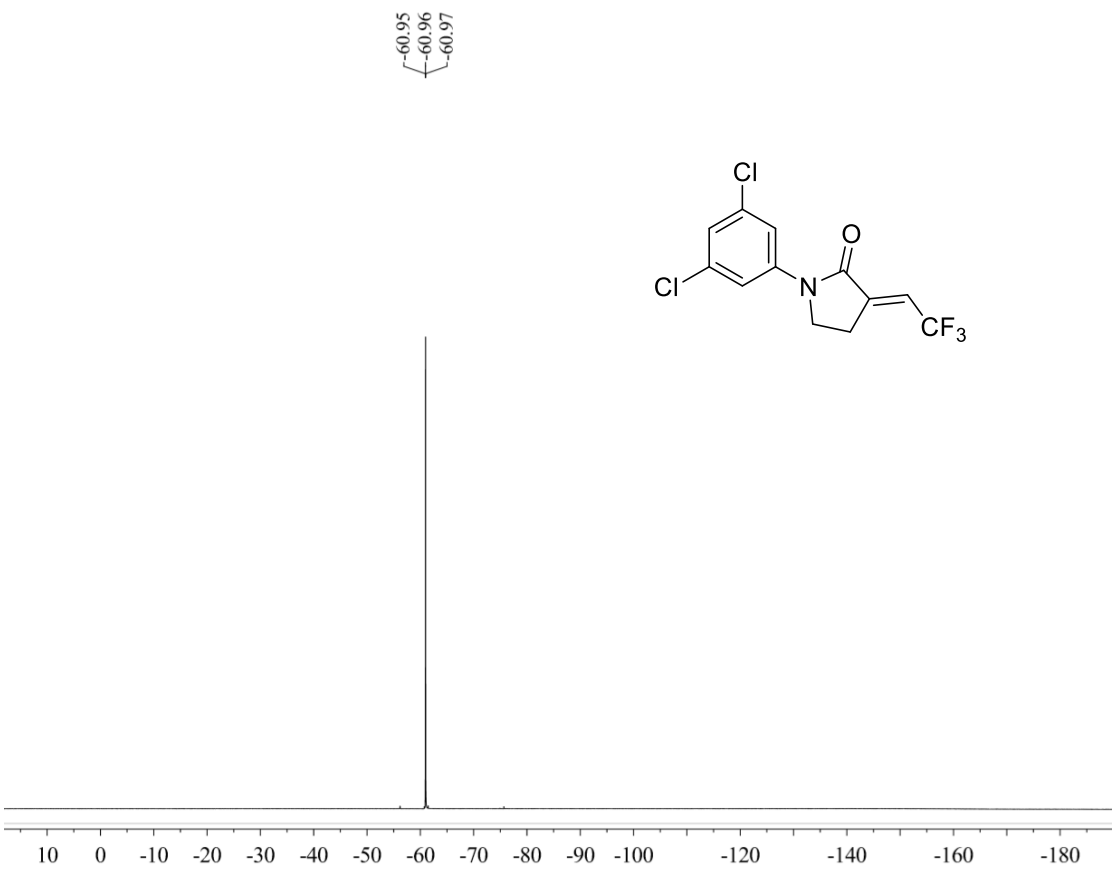



-60.77
-60.78
OMe
MeO
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

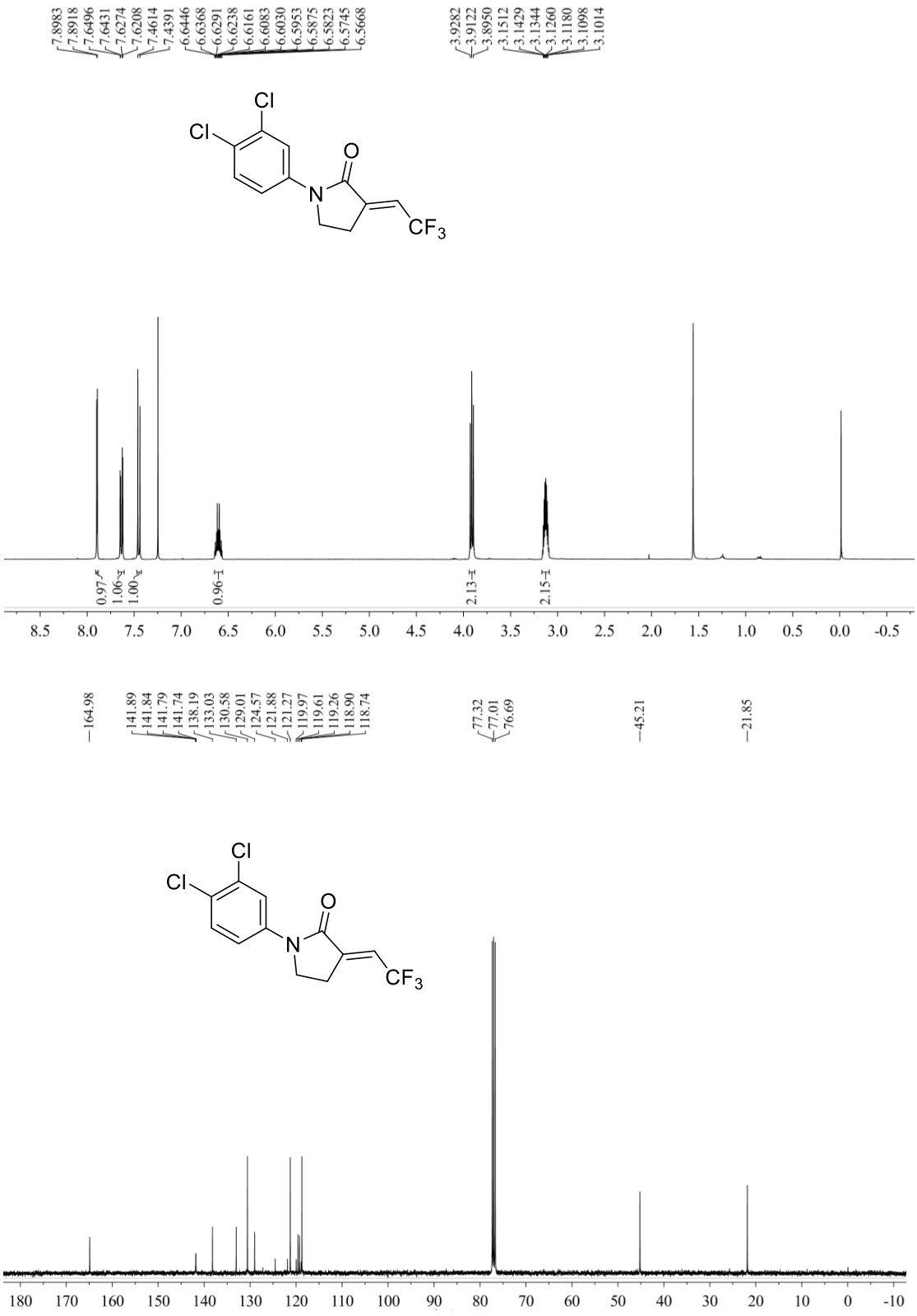
(*E*)-1-(3,5-dichlorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1n**)

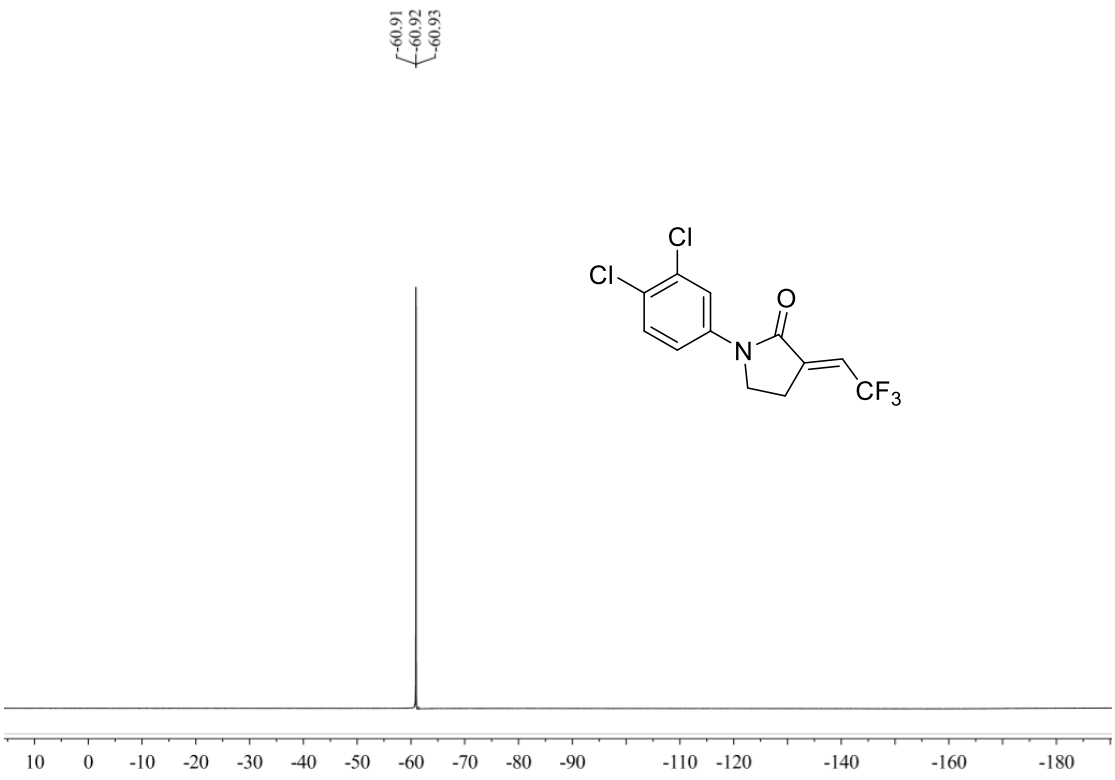




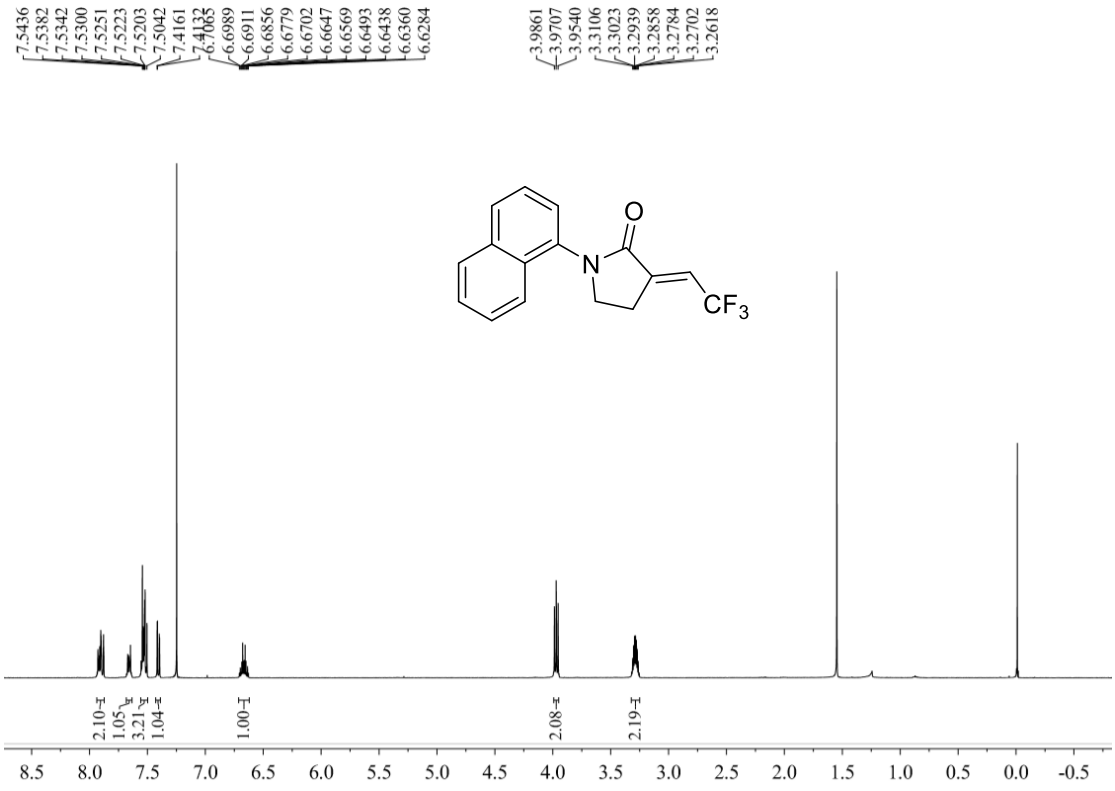

-60.95
-60.96
-60.97
Cl
Cl
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

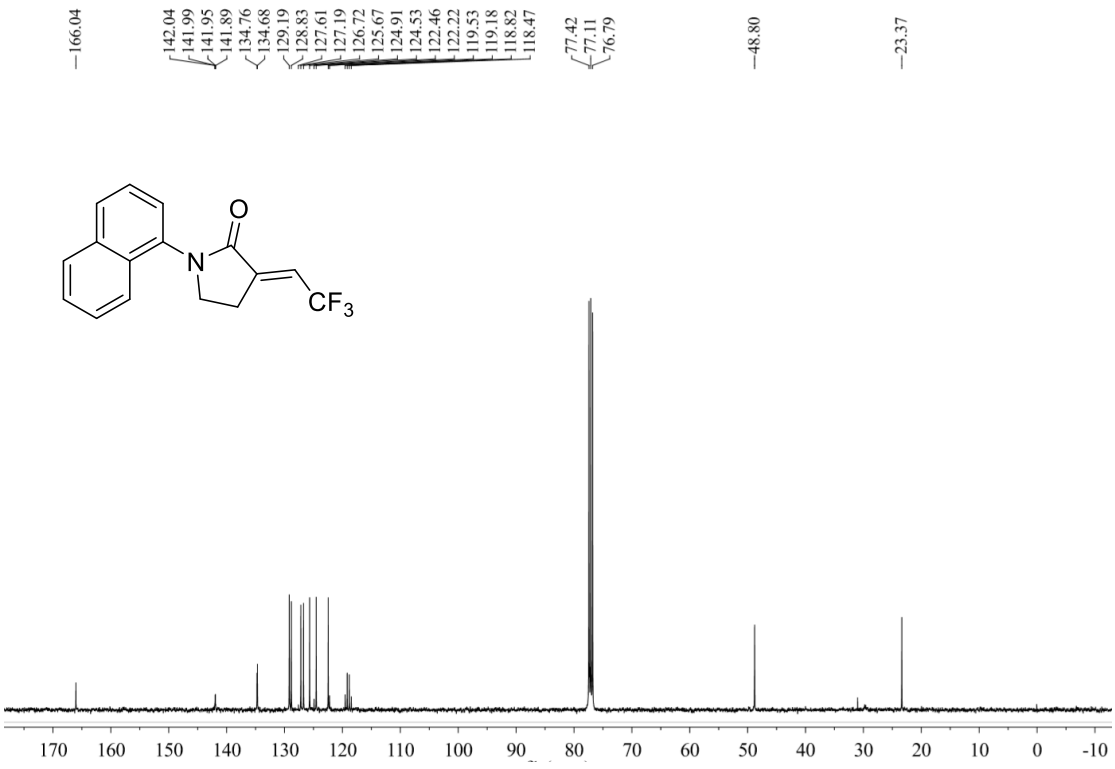
(*E*)-1-(3,4-dichlorophenyl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1o**)

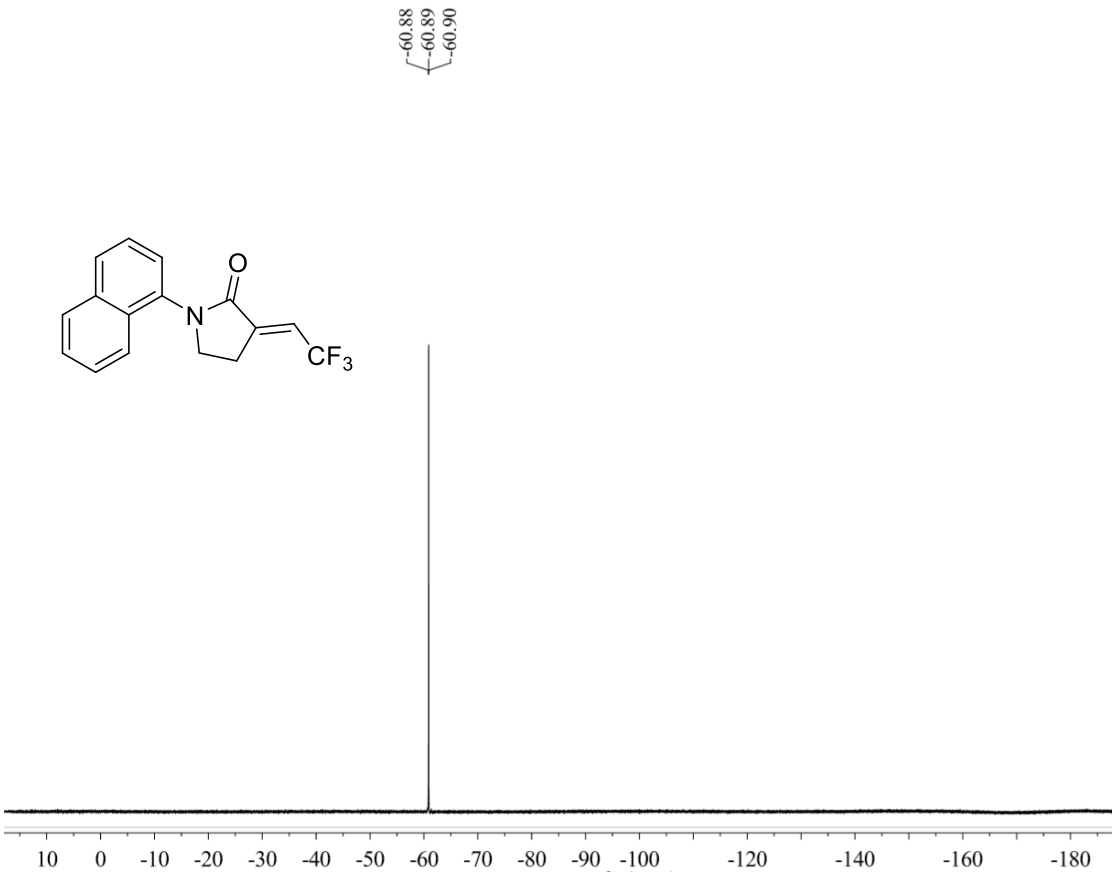



-60.91
-60.92
-60.93
Cl
Cl
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-110
-120
-140
-160
-180

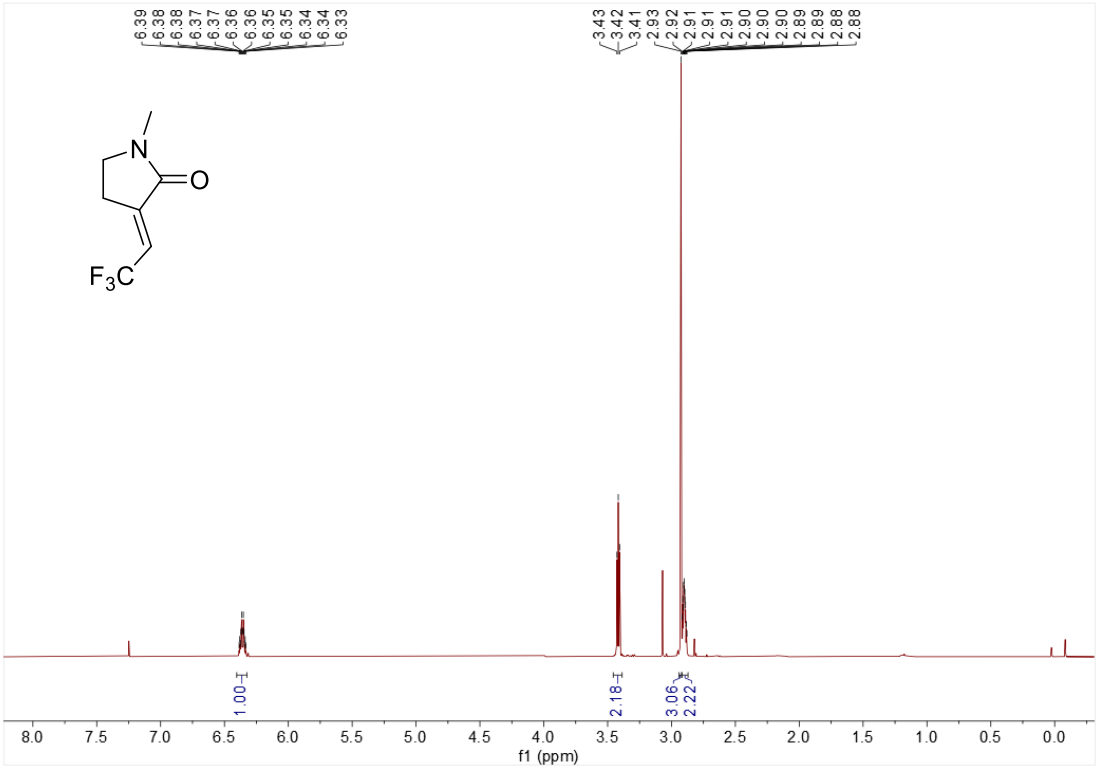
(*E*)-1-(naphthalen-1-yl)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1p**)

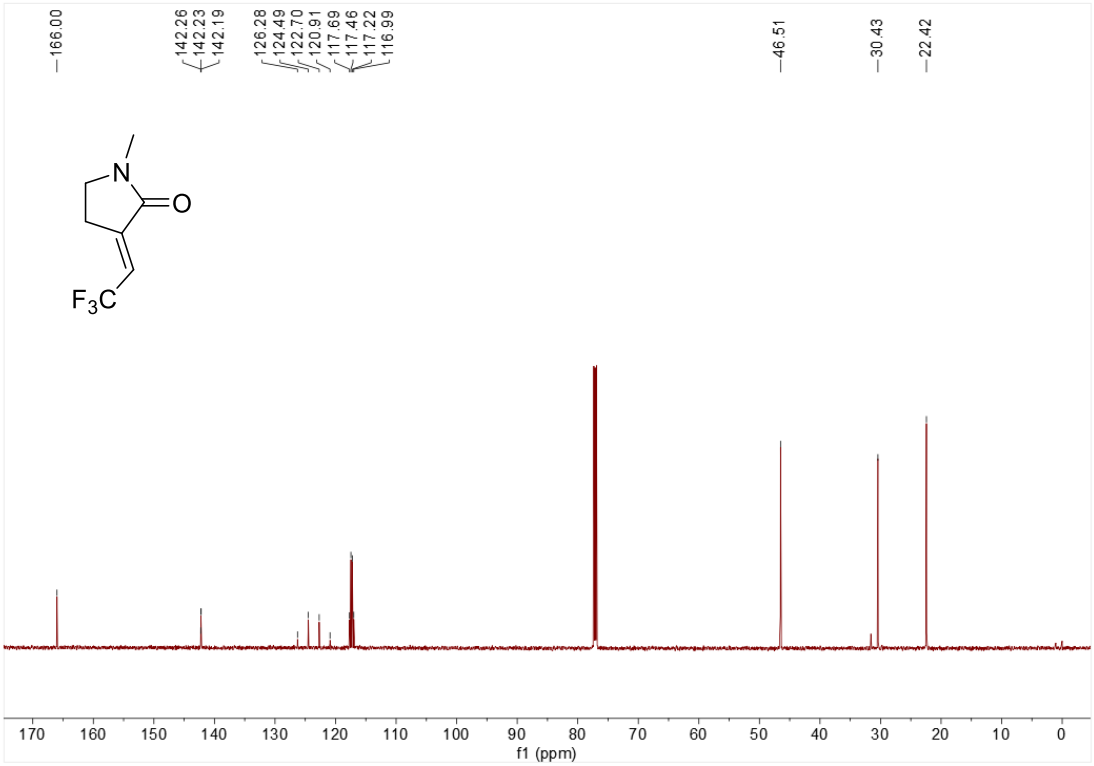




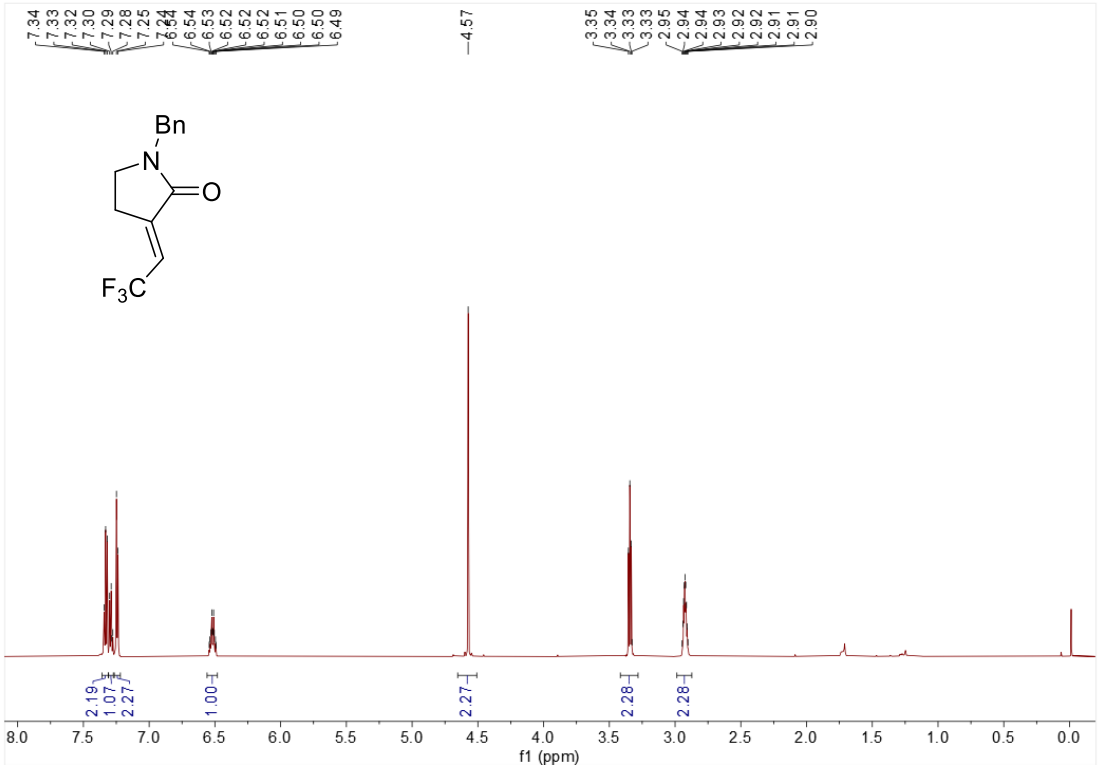

-60.88
-60.89
-60.90
O
N
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

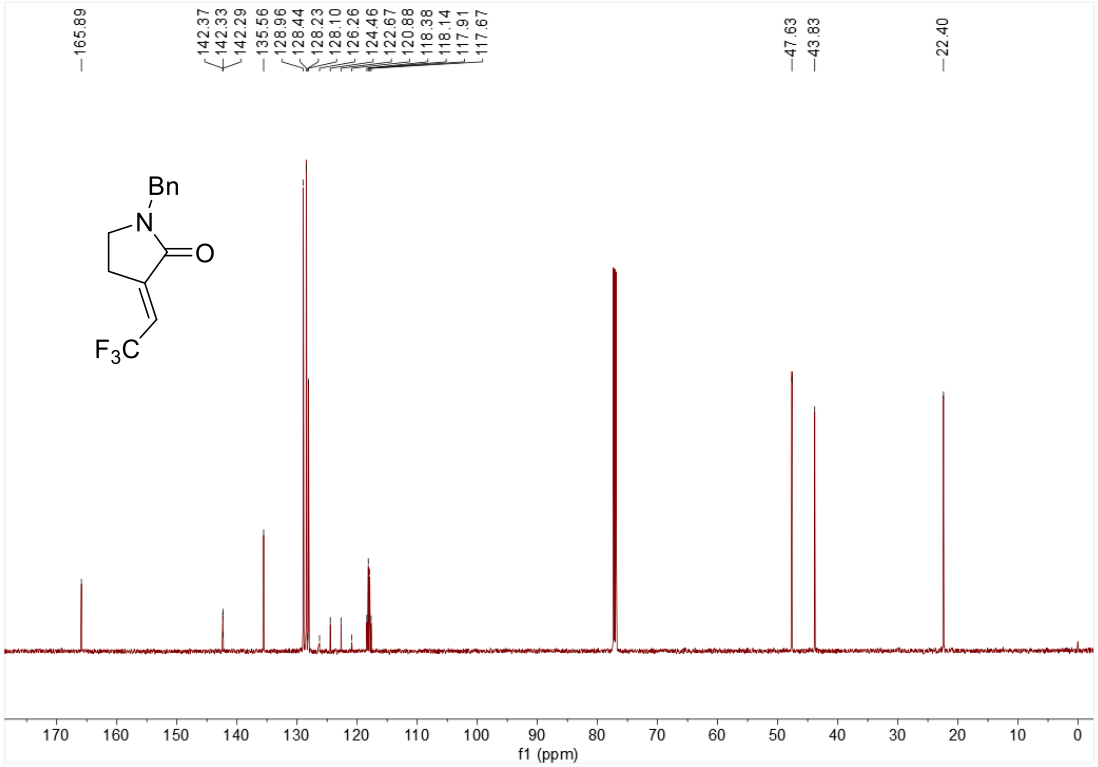
(*E*)-1-methyl-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1q**)

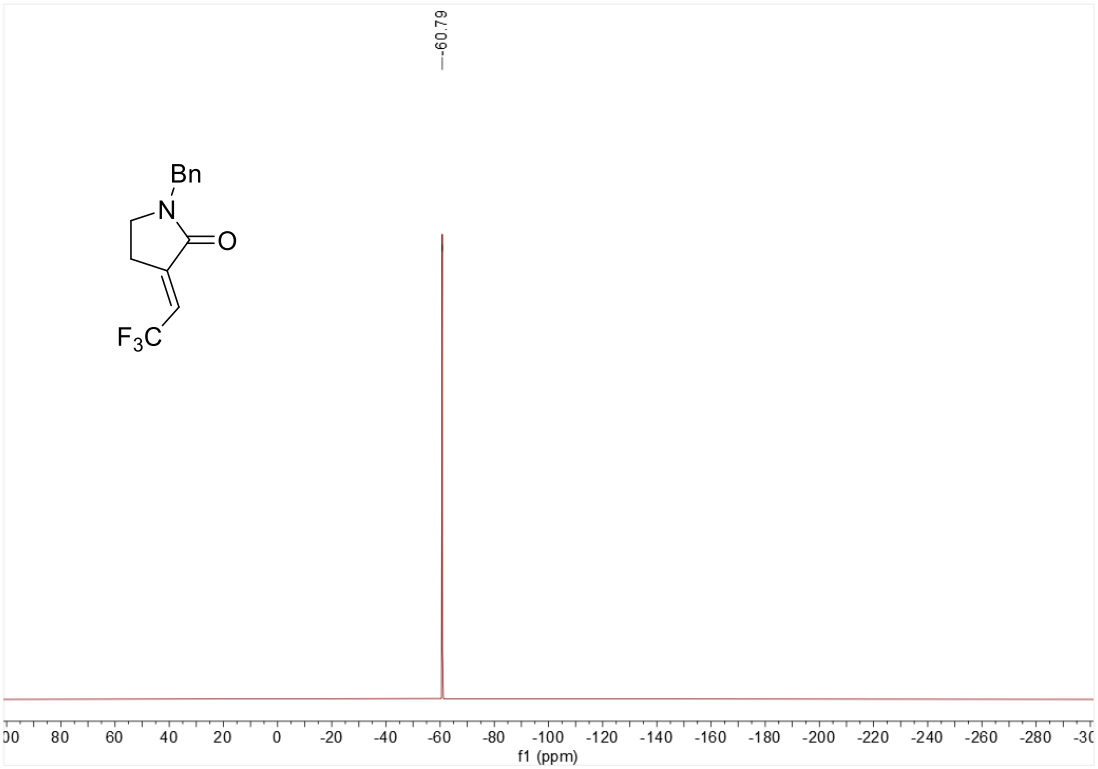




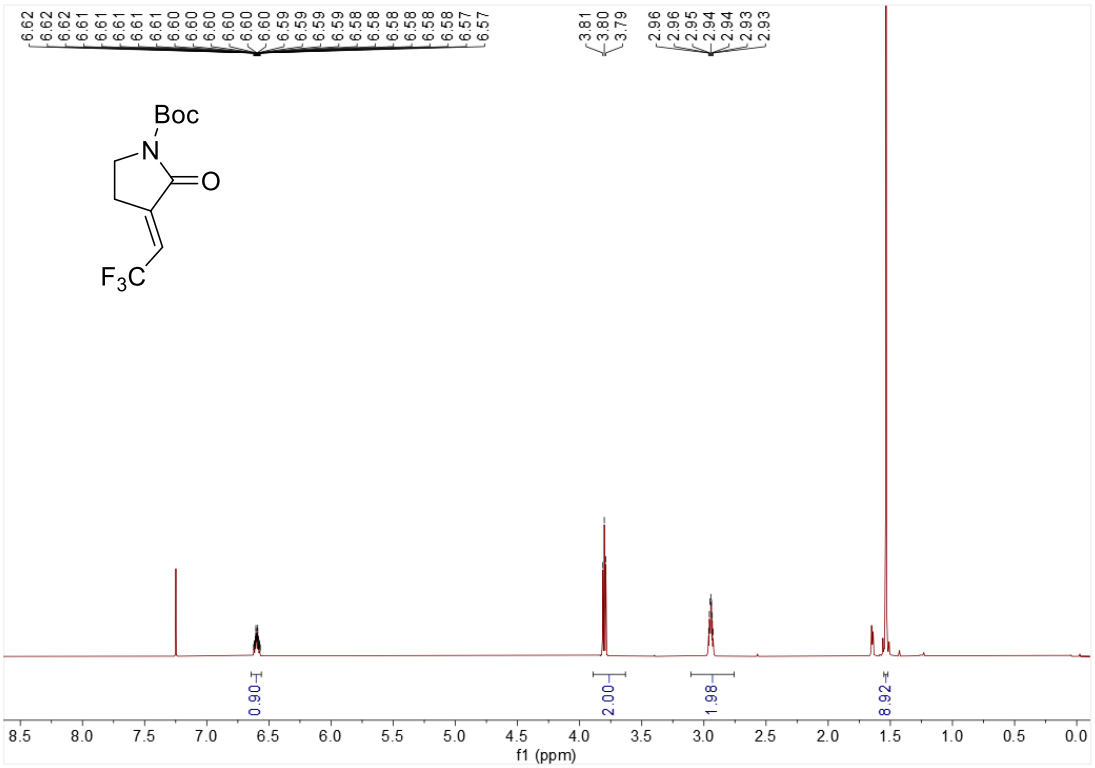
(*E*)-1-benzyl-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1r**)

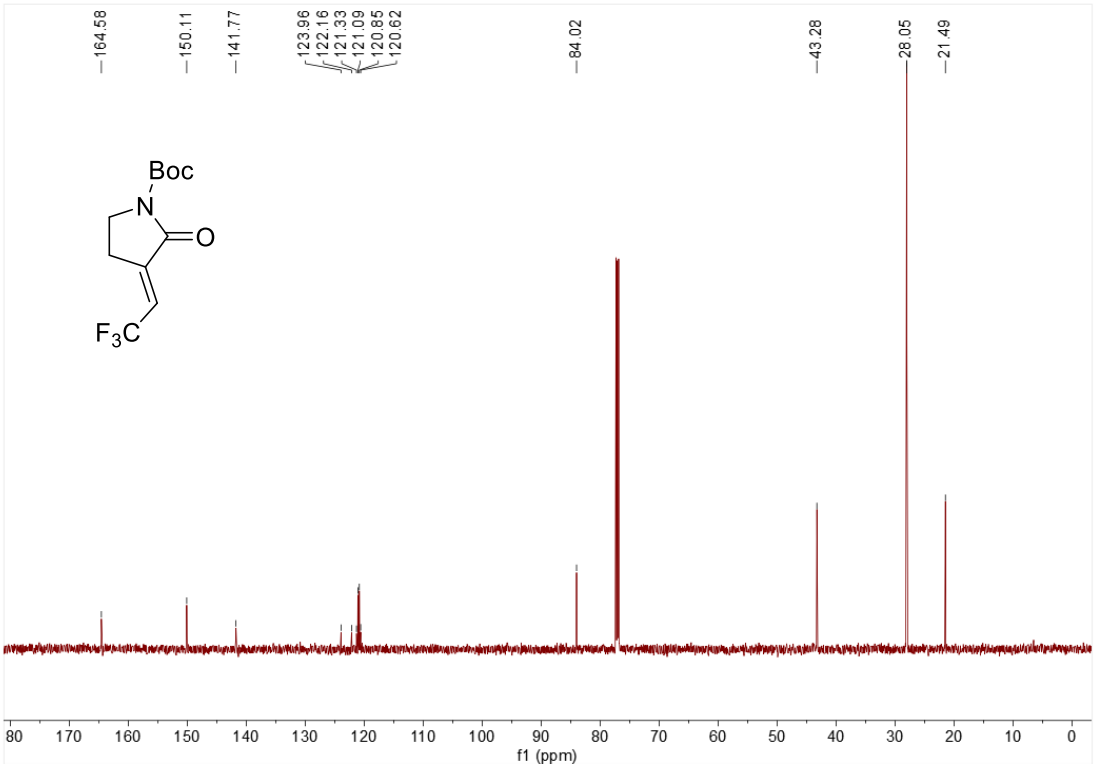


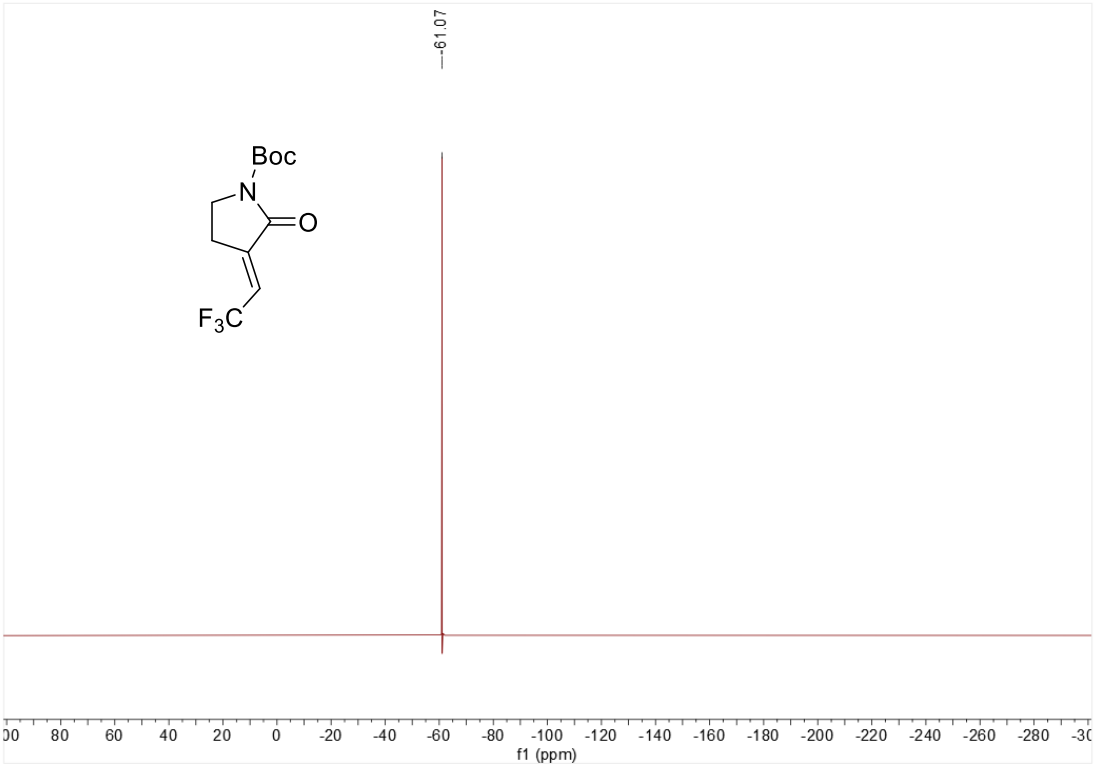



-60.79
Bn
N
O
F3C
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

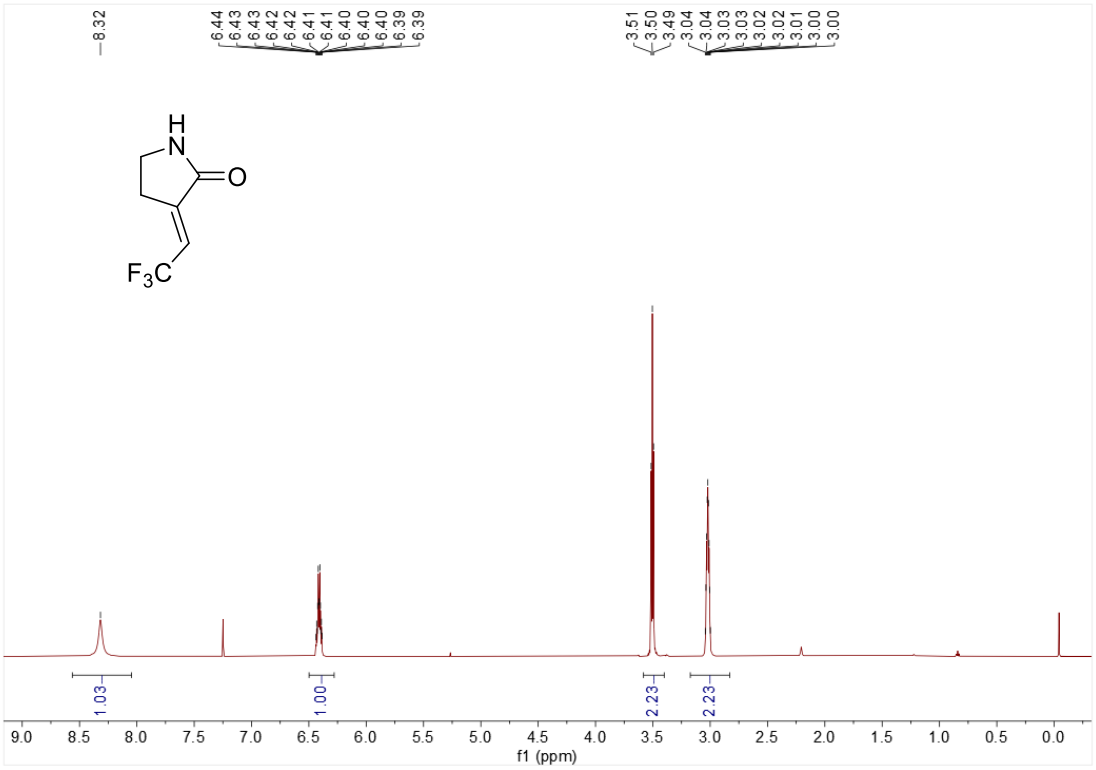
tert-butyl (*E*)-2-oxo-3-(2,2,2-trifluoroethylidene)pyrrolidine-1-carboxylate (**1s**)

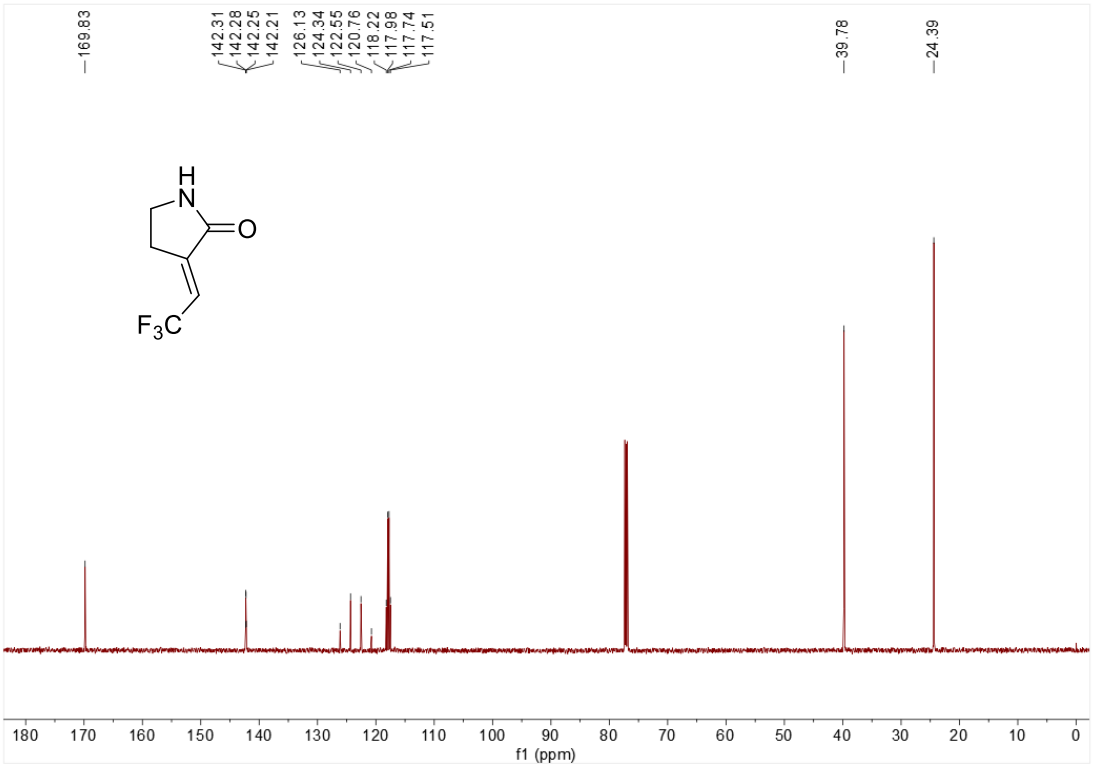


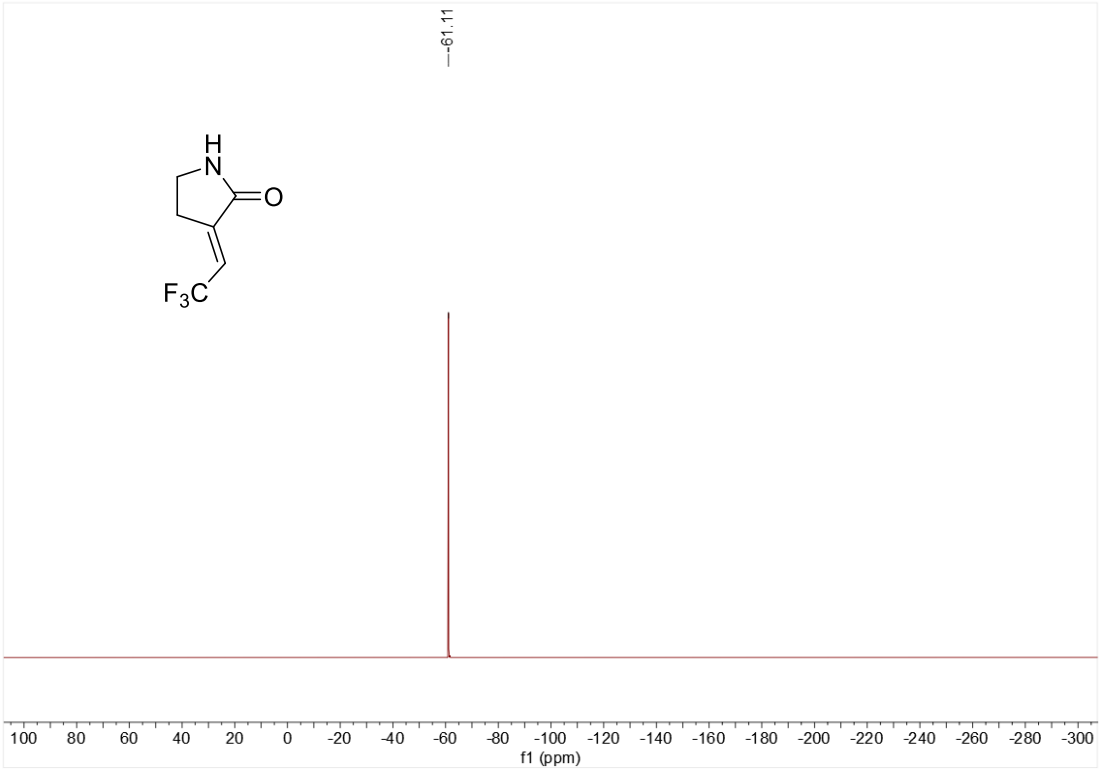



-61.07
Boc
N
O
F3C
f1 (ppm)

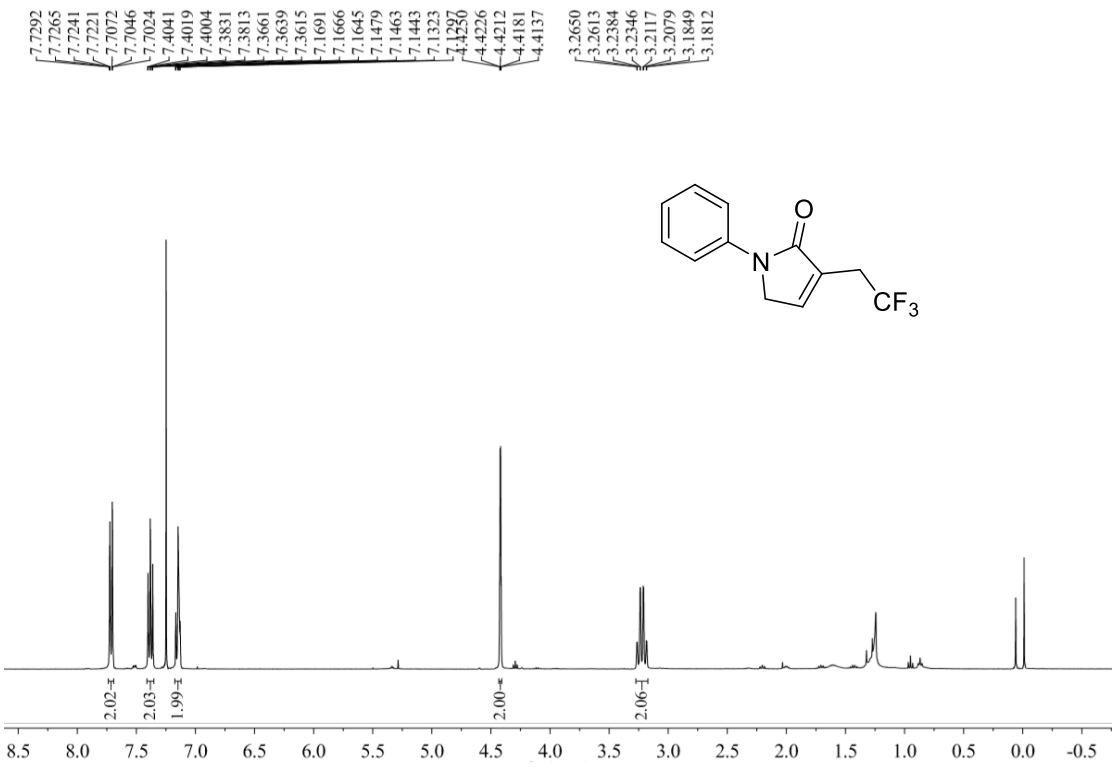
(*E*)-3-(2,2,2-trifluoroethylidene)pyrrolidin-2-one (**1t**)

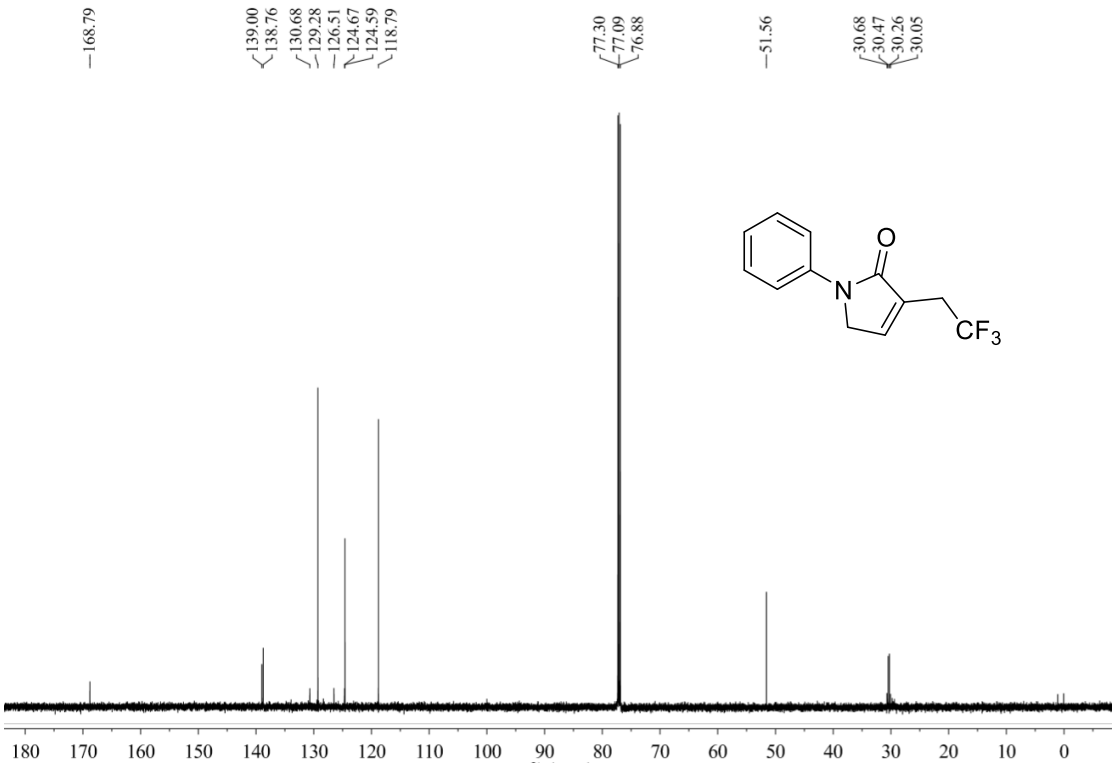


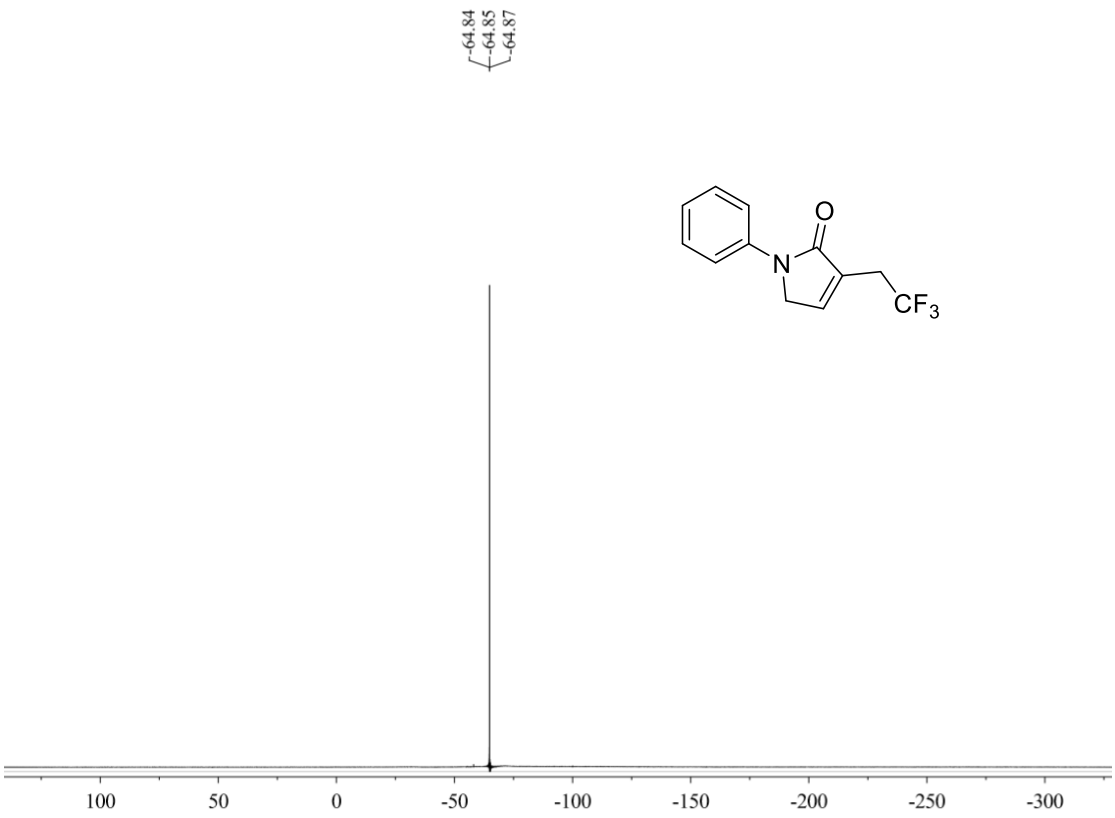



-61.11
H
N
O
F3C
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

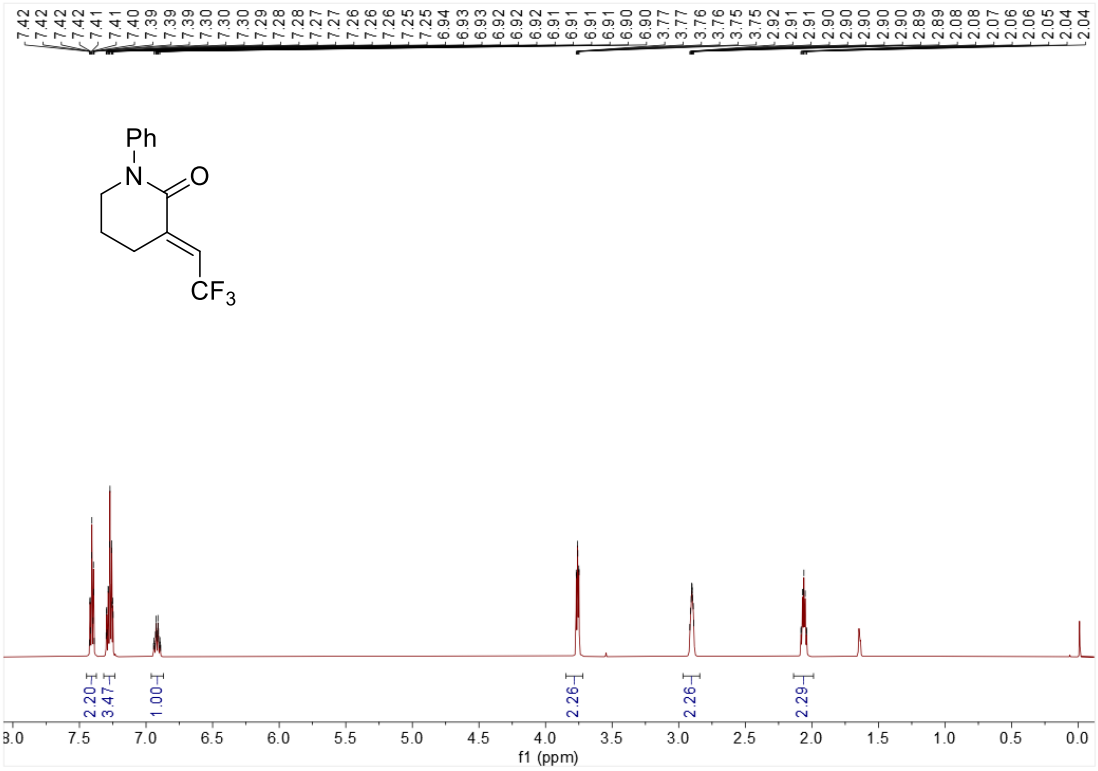
1-phenyl-3-(2,2,2-trifluoroethyl)-1,5-dihydro-2H-pyrrol-2-one (**1u**)

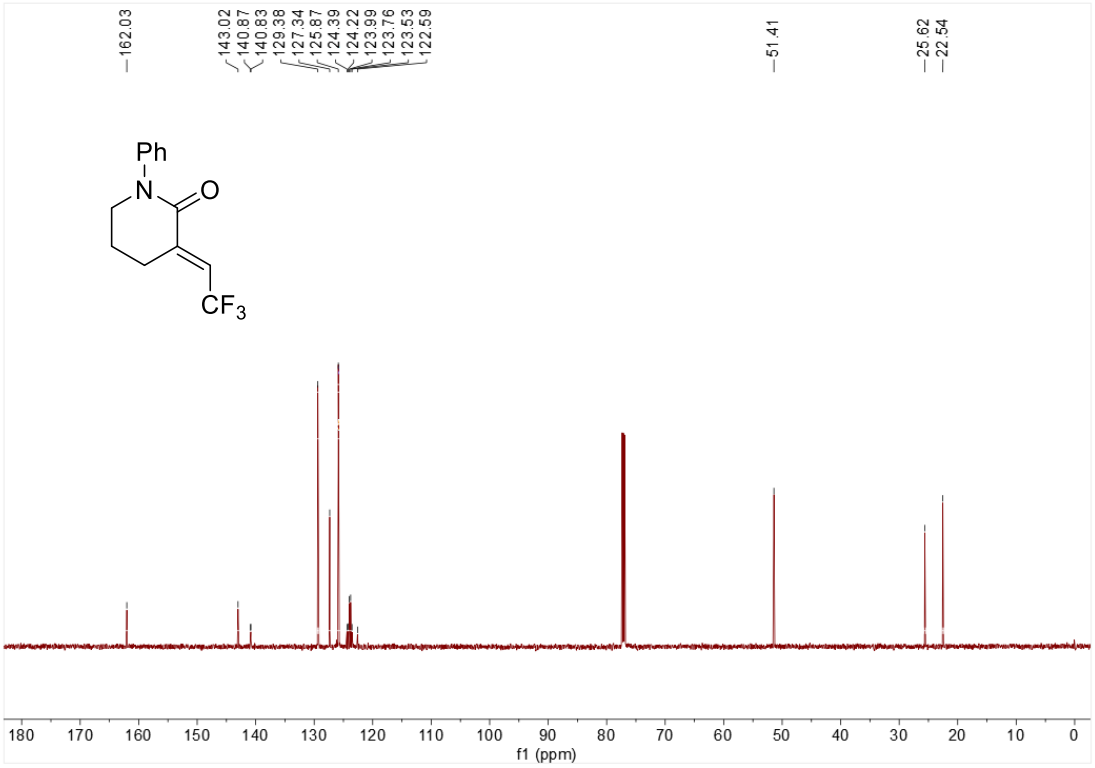


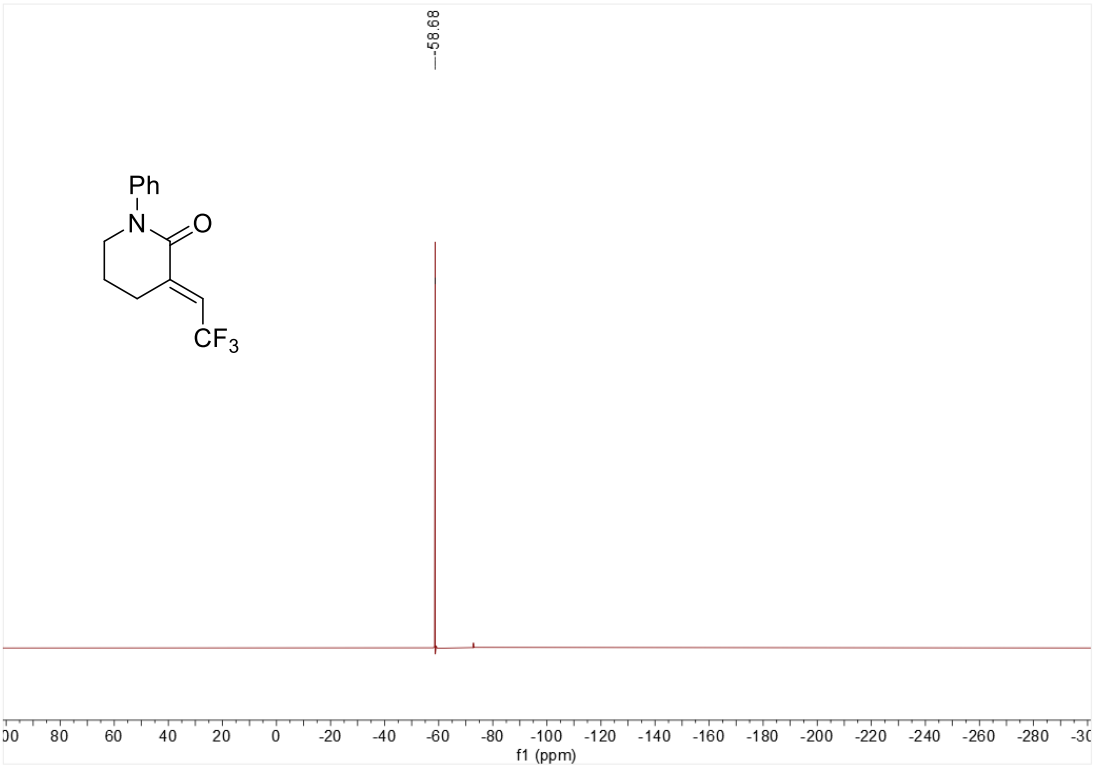



-64.84
-64.85
-64.87
O
N
CF3
100
50
0
-50
-100
-150
-200
-250
-300

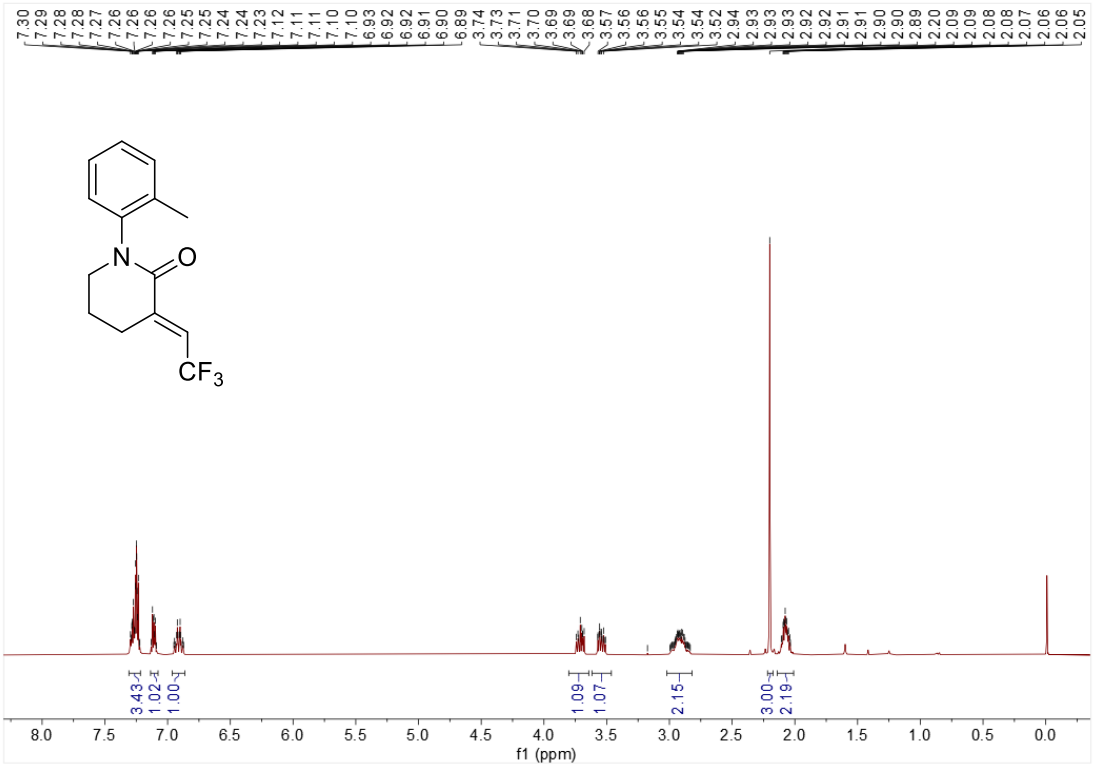
(*E*)-1-phenyl-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3a**)

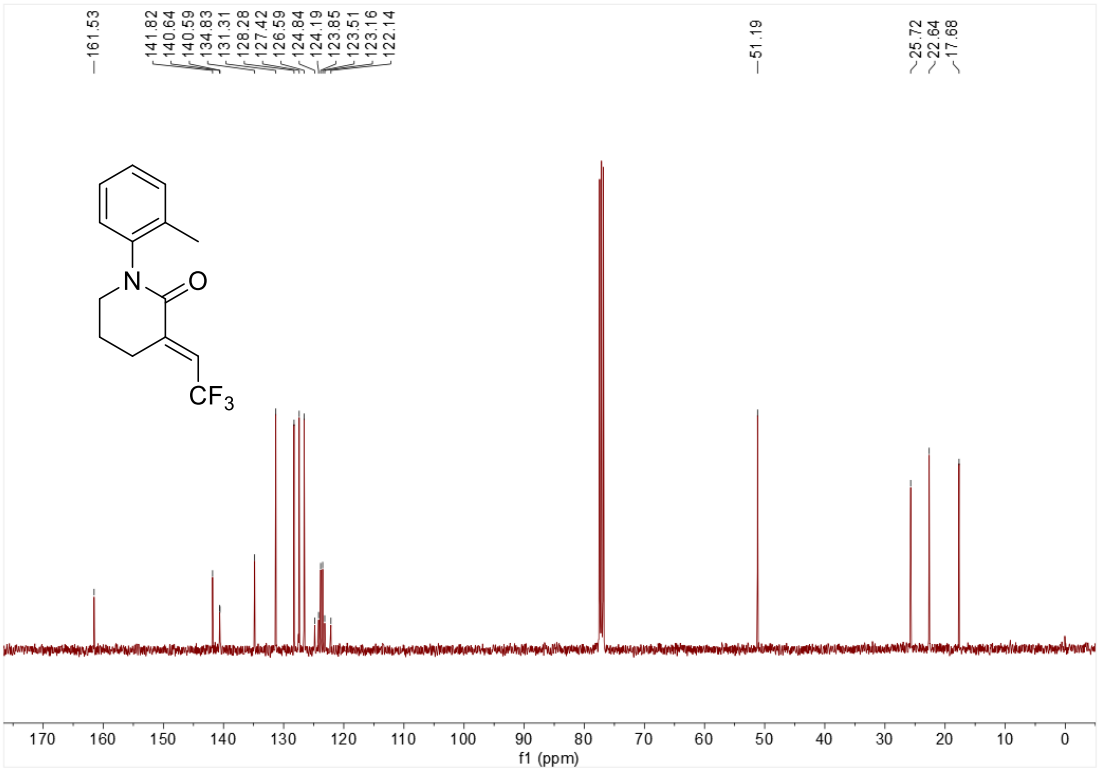


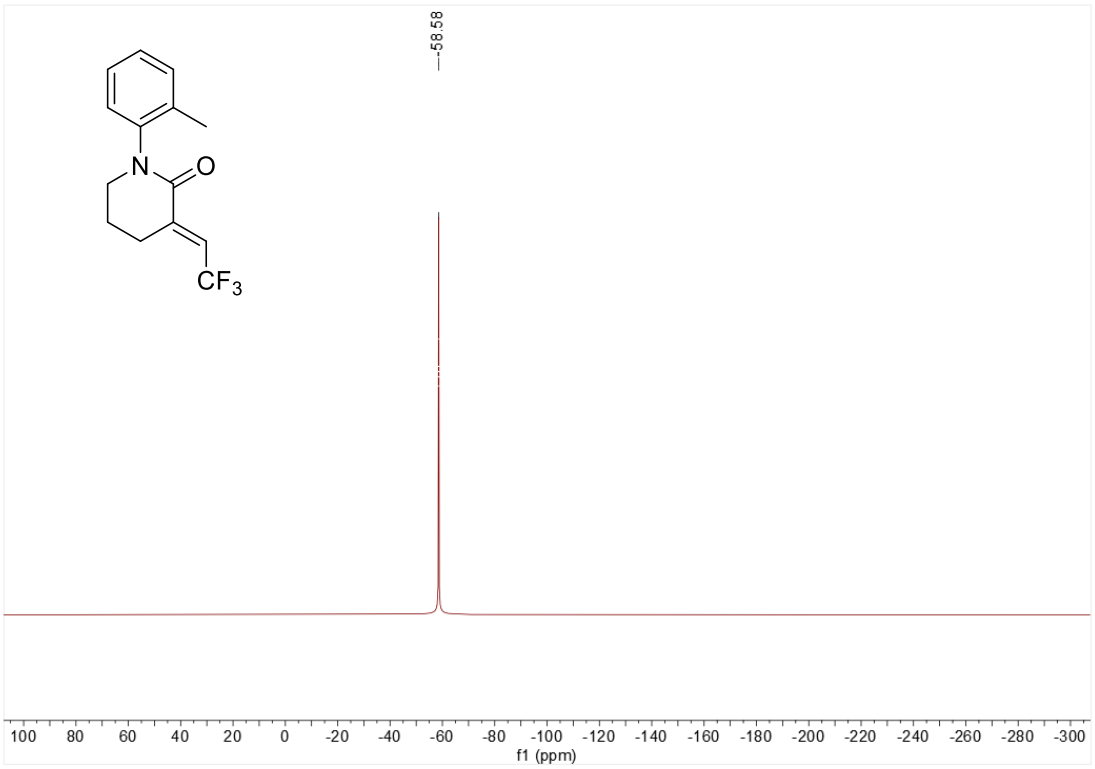



-58.68
Ph
N
O
CF3
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

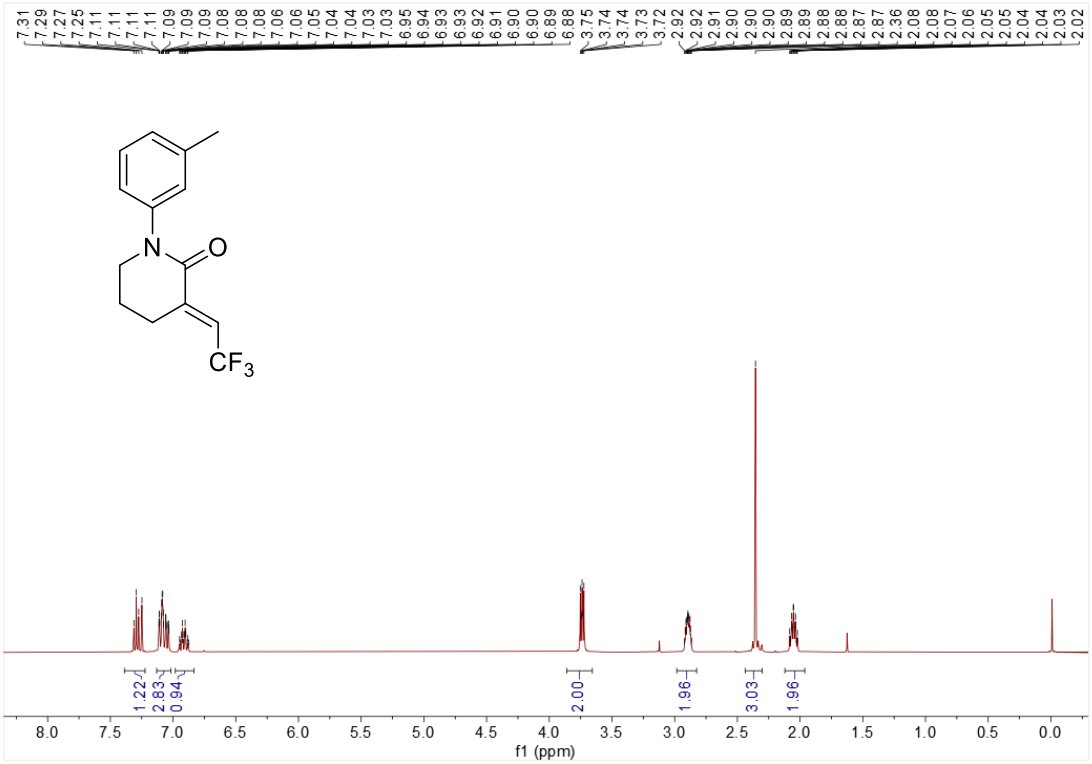
(*E*)-1-(*o*-tolyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3b**)

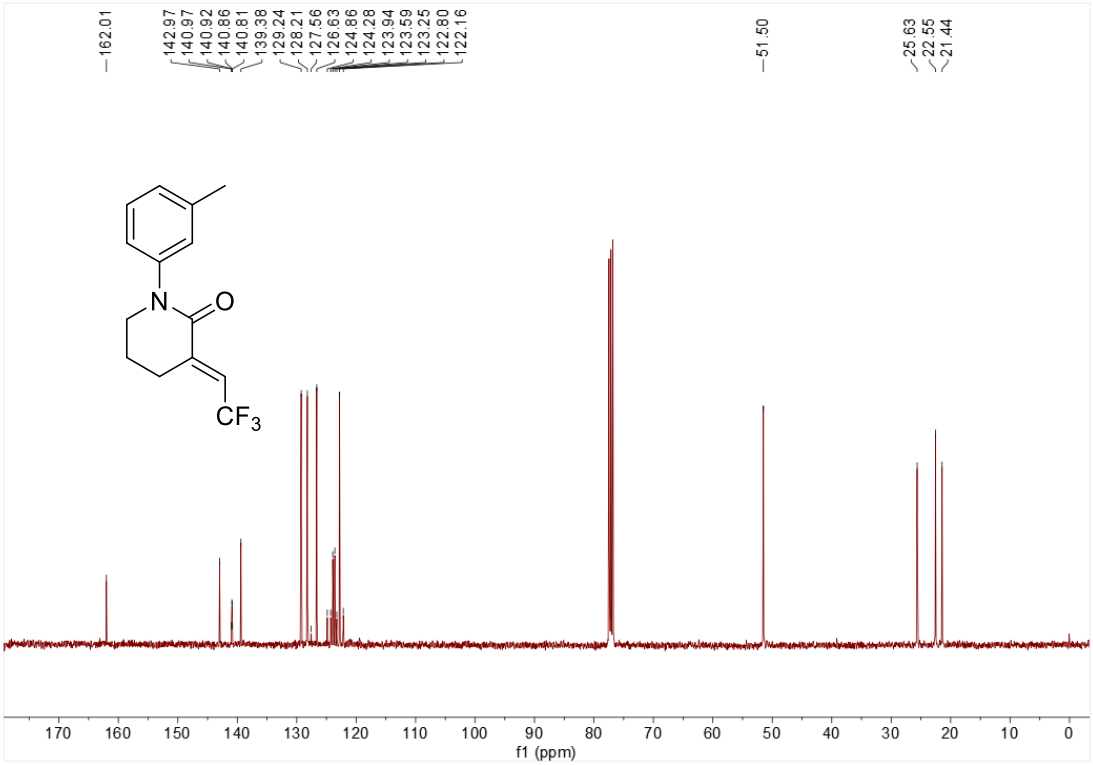


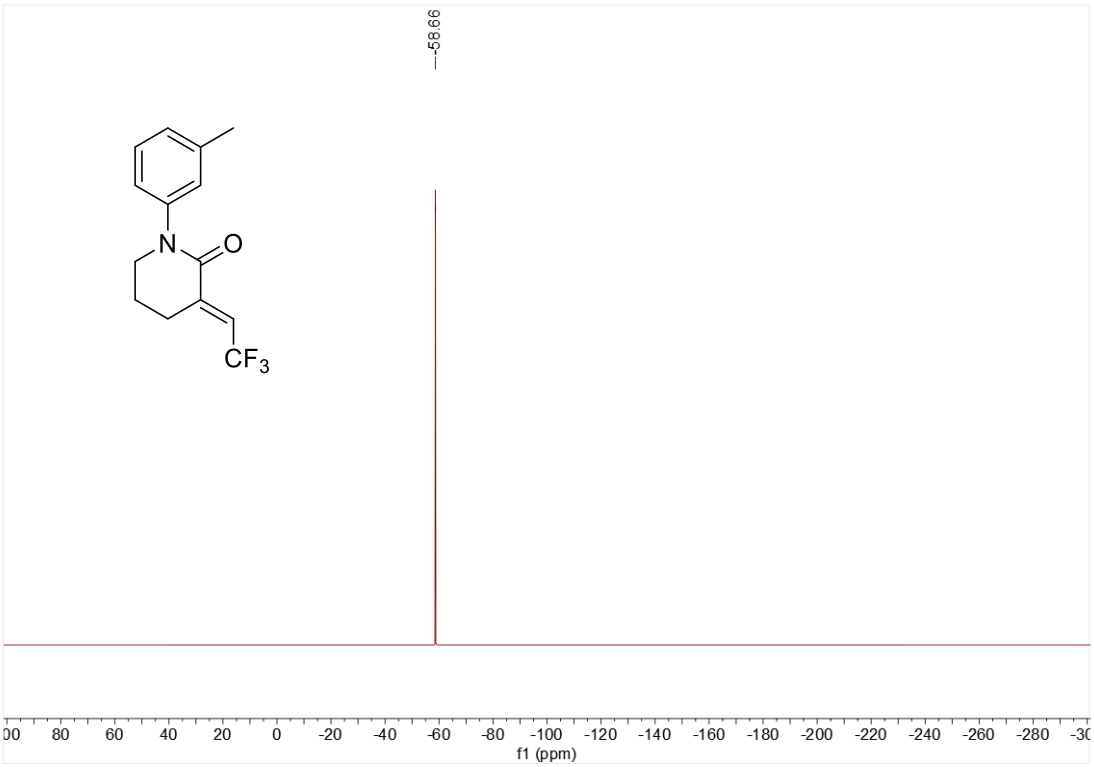



-58.58
N
O
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

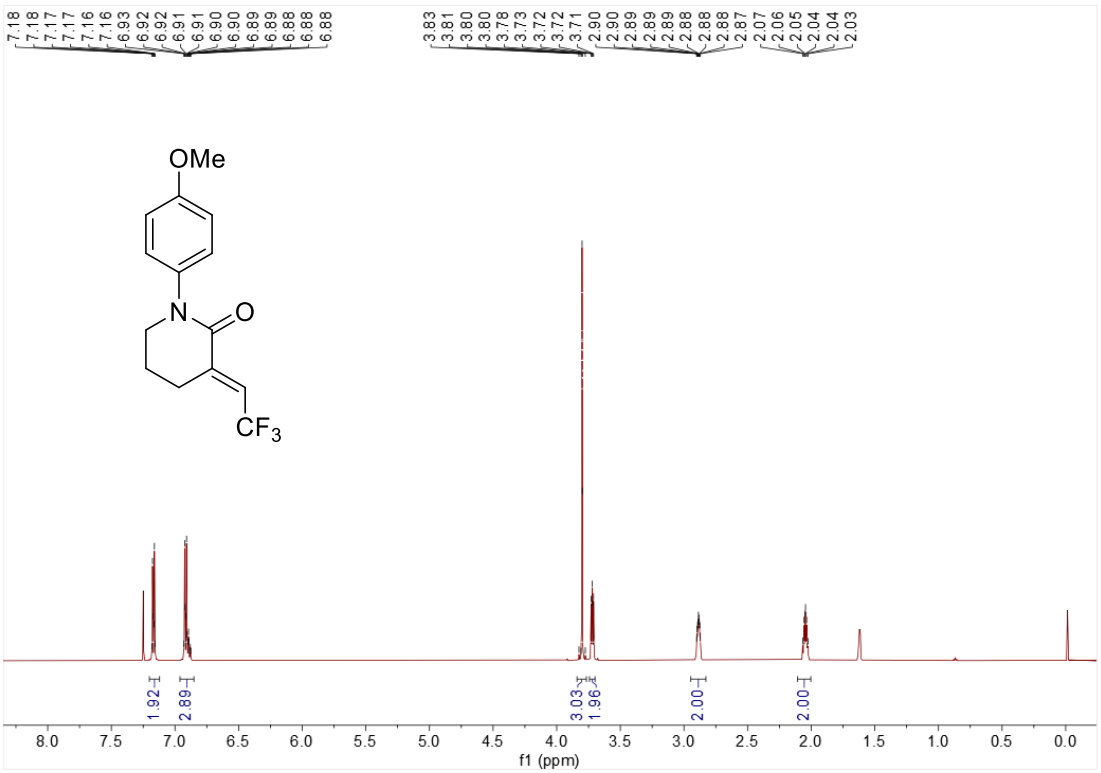
(*E*)-1-(*m*-tolyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3c**)

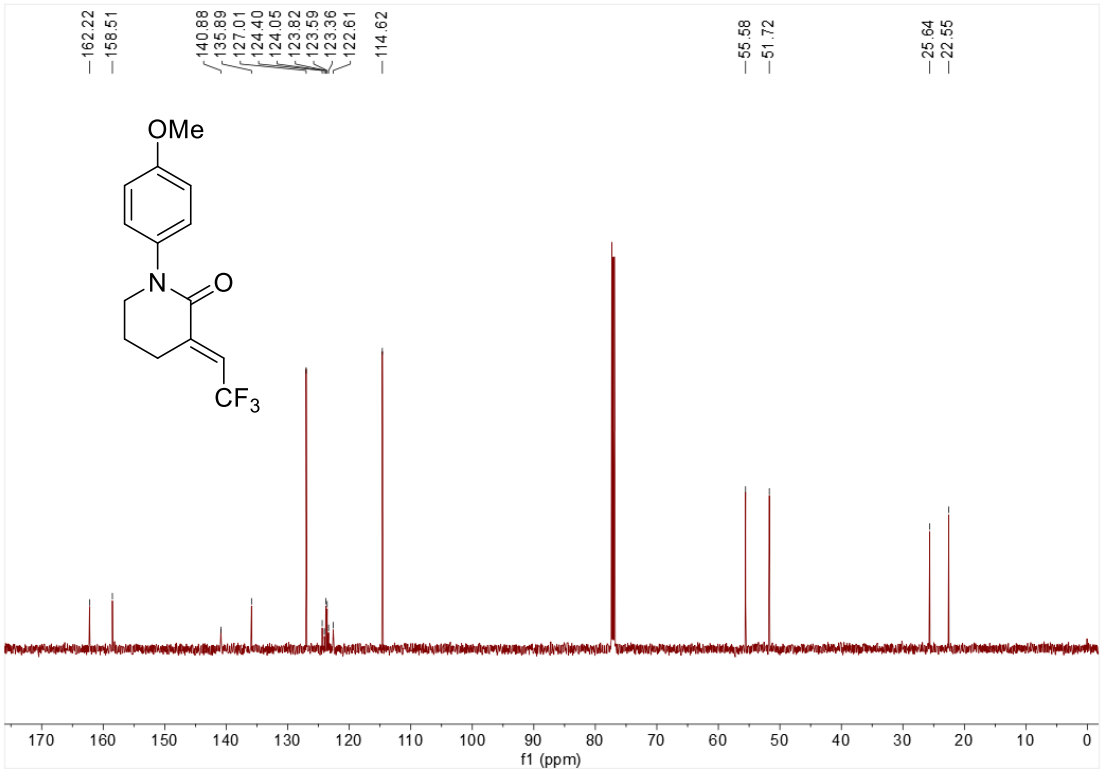


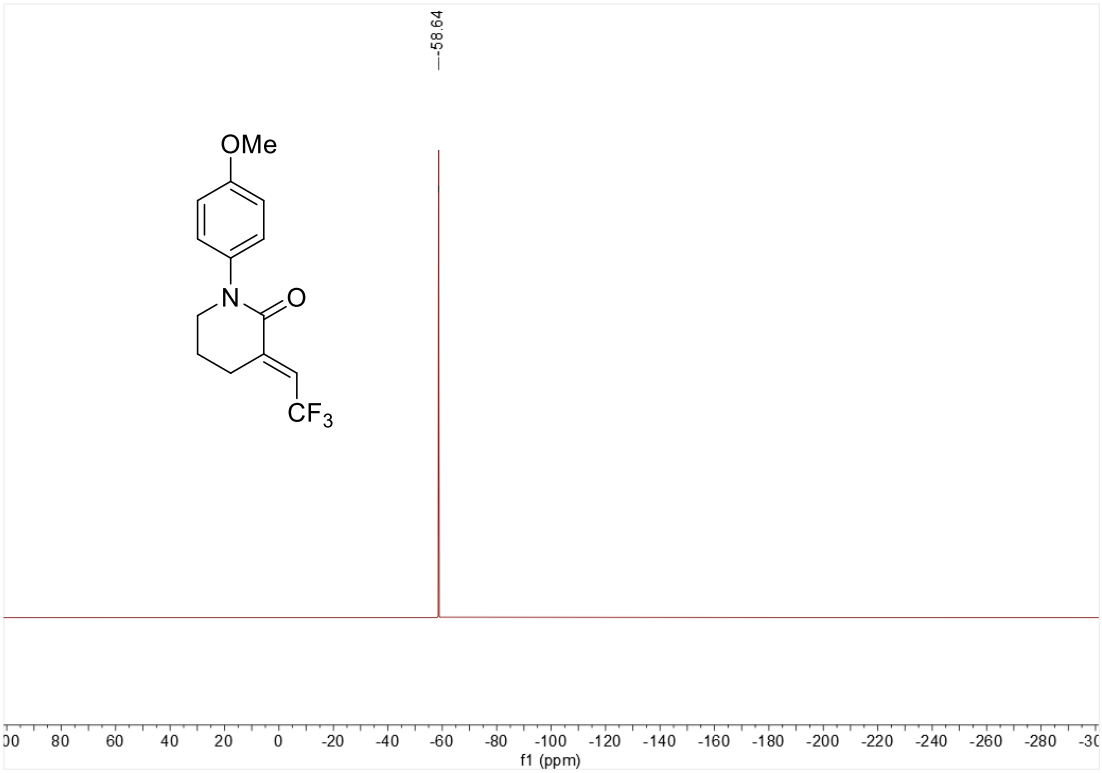



-58.66
N
O
CF3
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -3(
f1 (ppm)

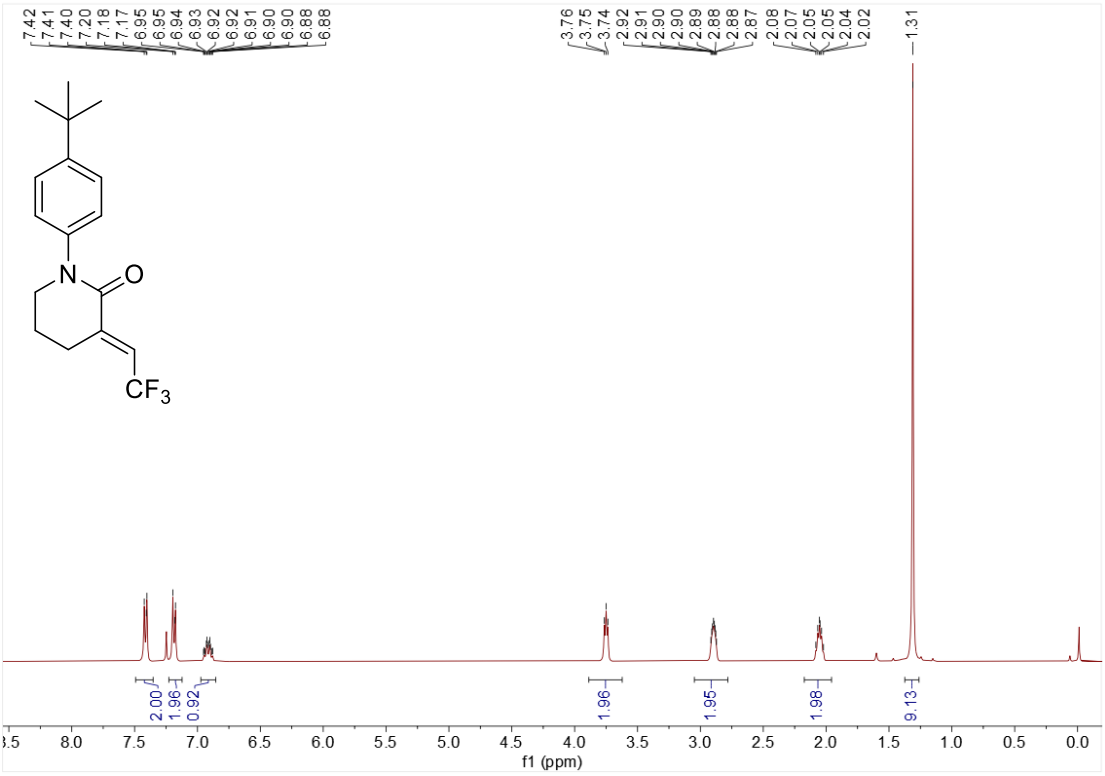
(*E*)-1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3d**)

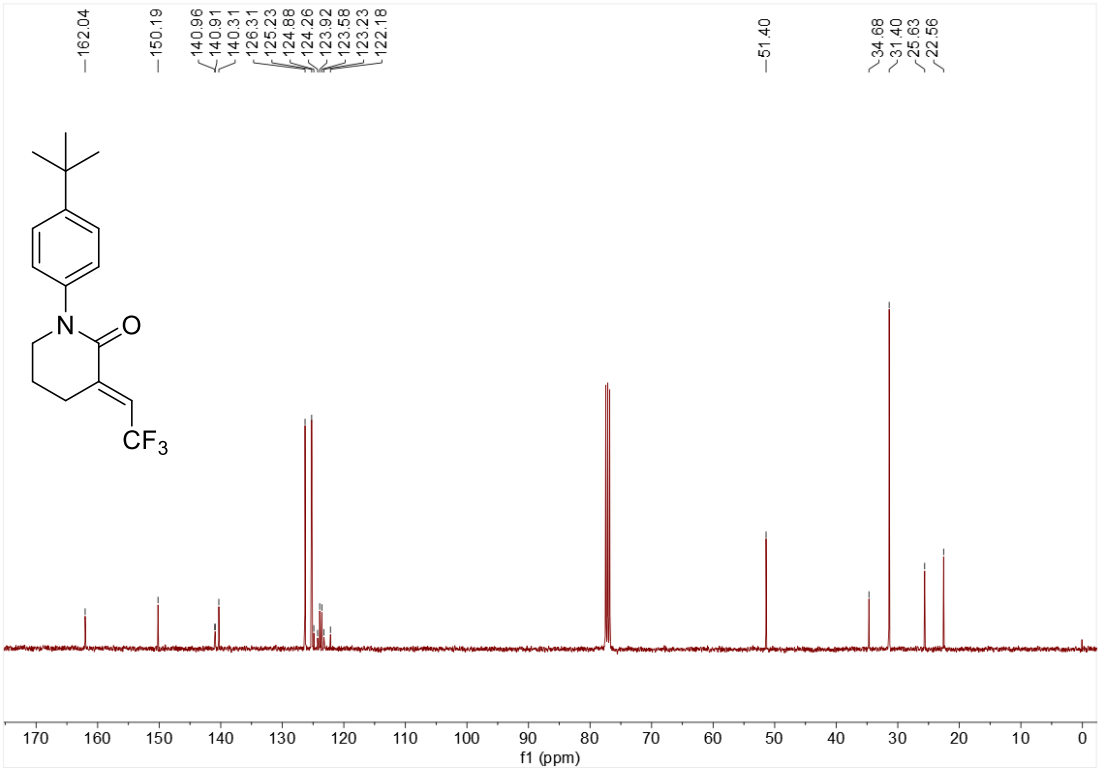


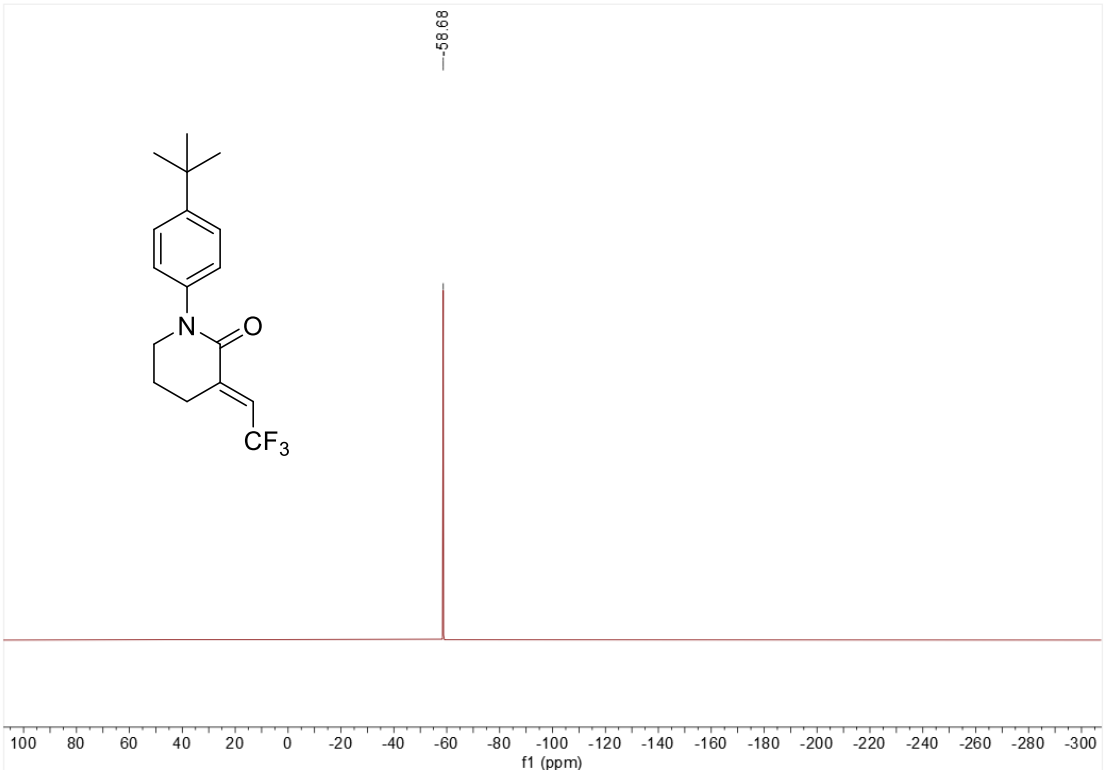



-58.64
OMe
N
O
CF3
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

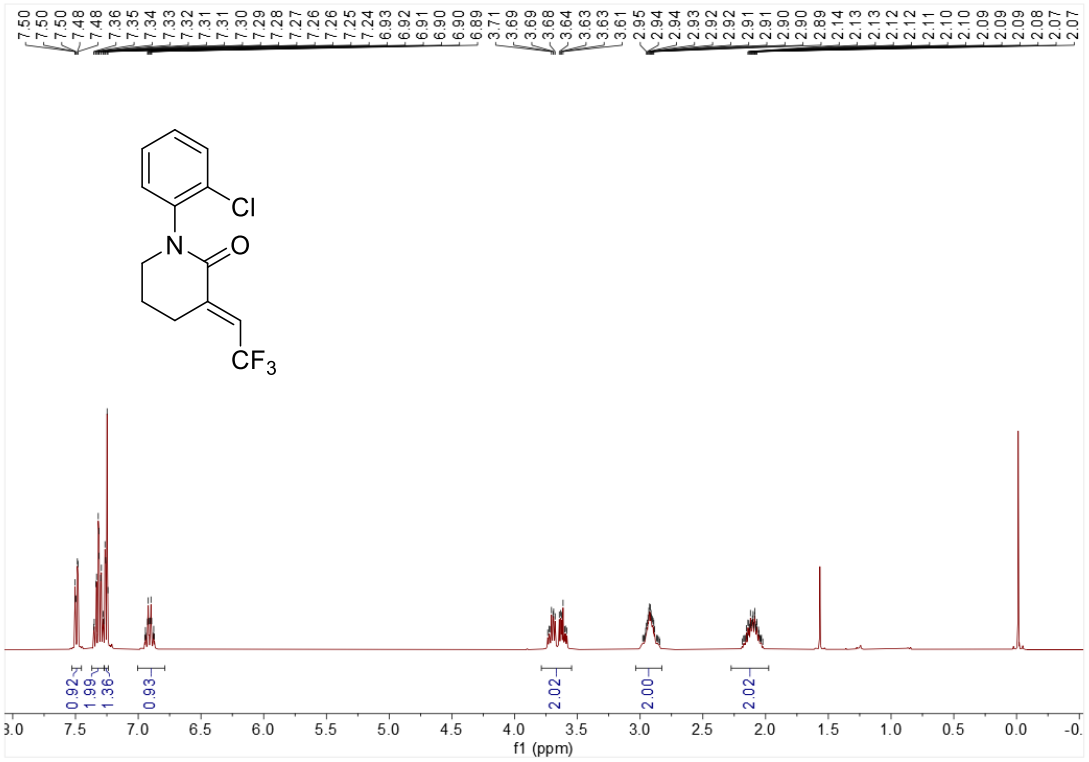
(*E*)-1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3e**)

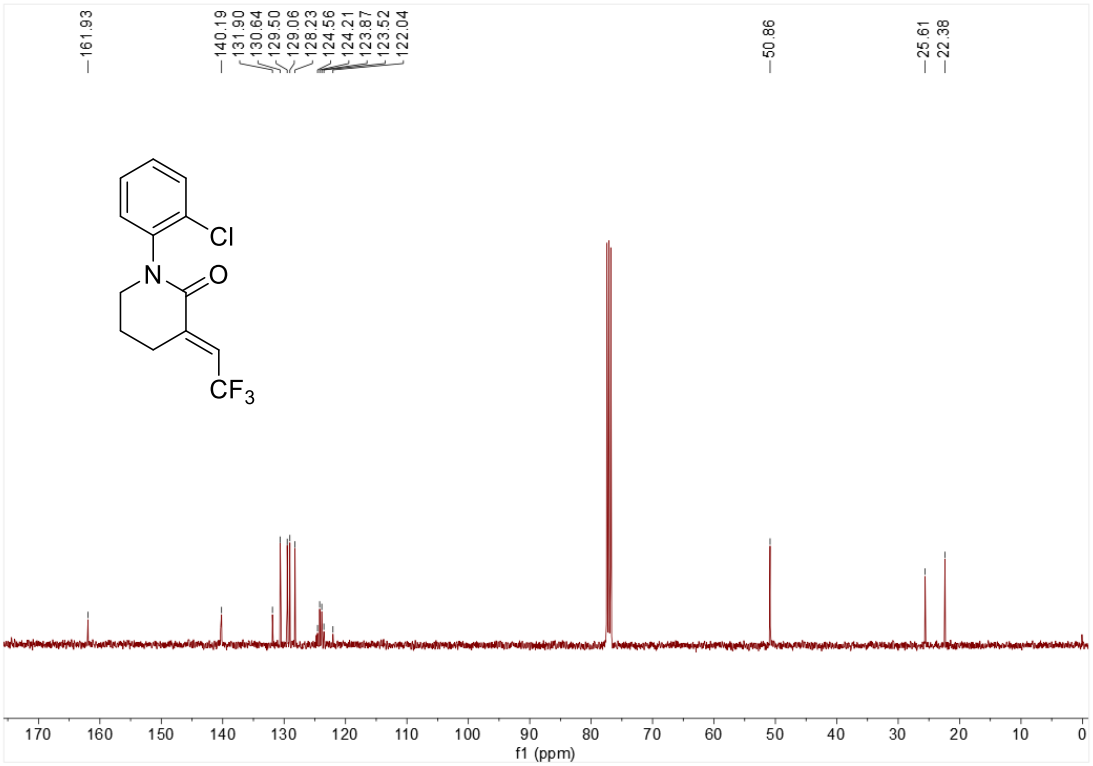


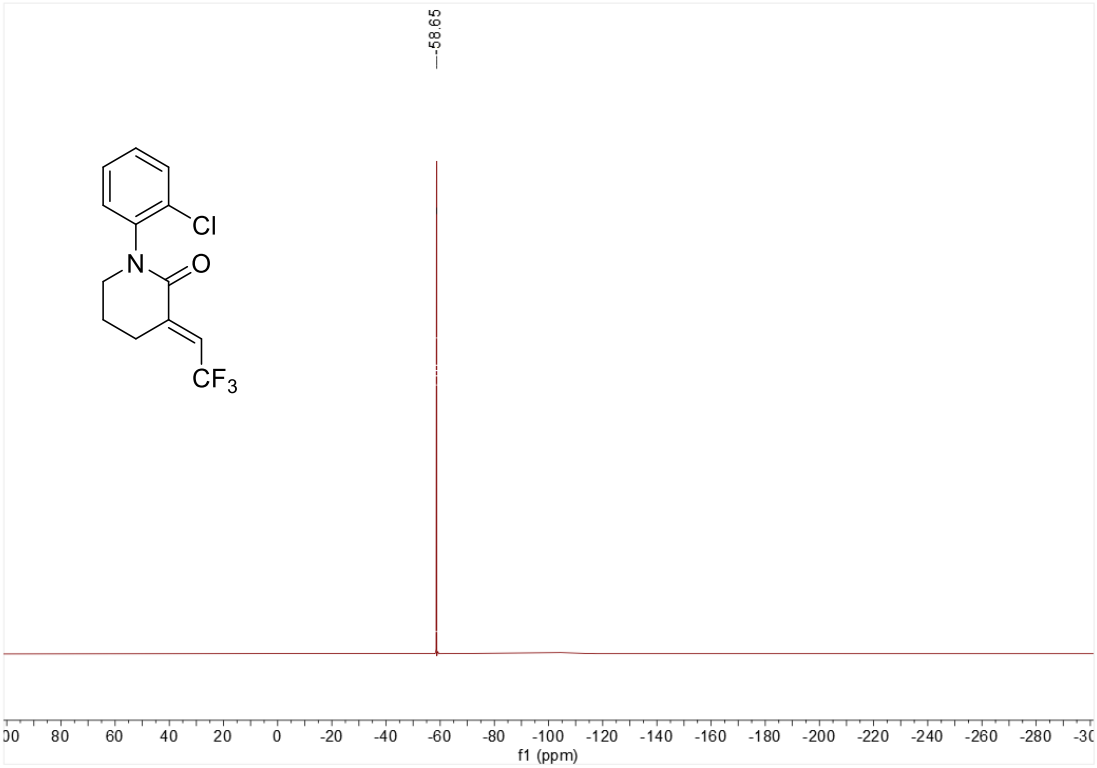



-58.68
N
O
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

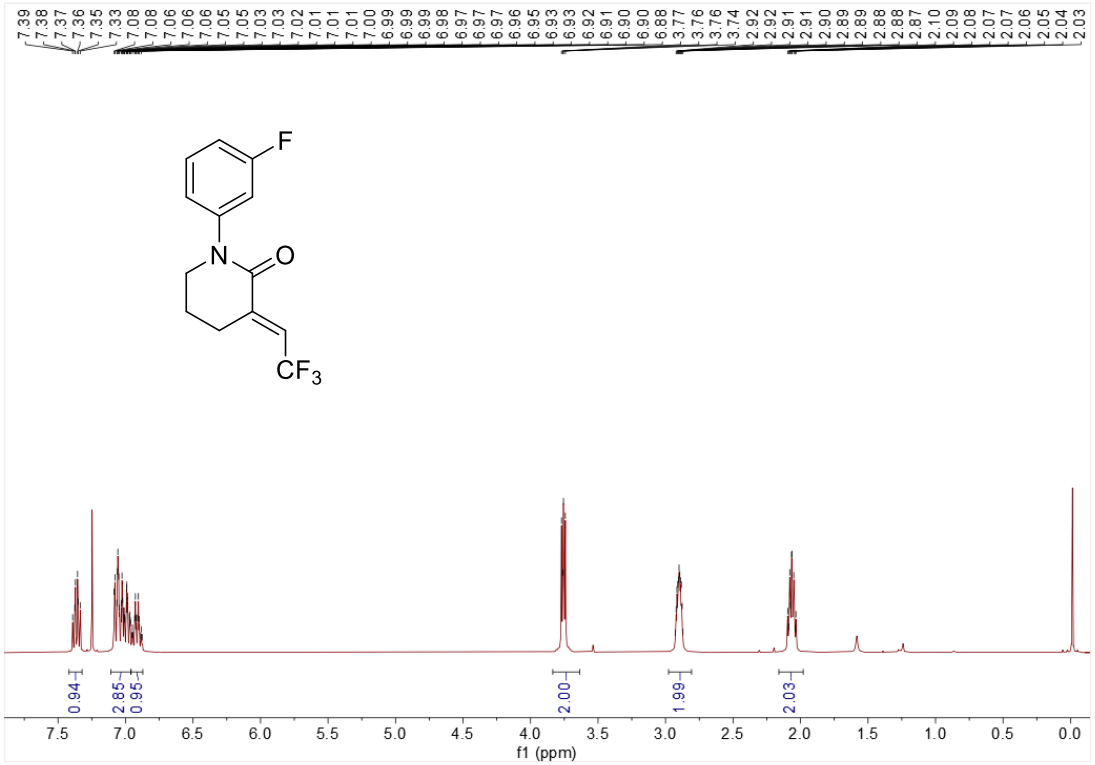
(*E*)-1-(2-chlorophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3f**)

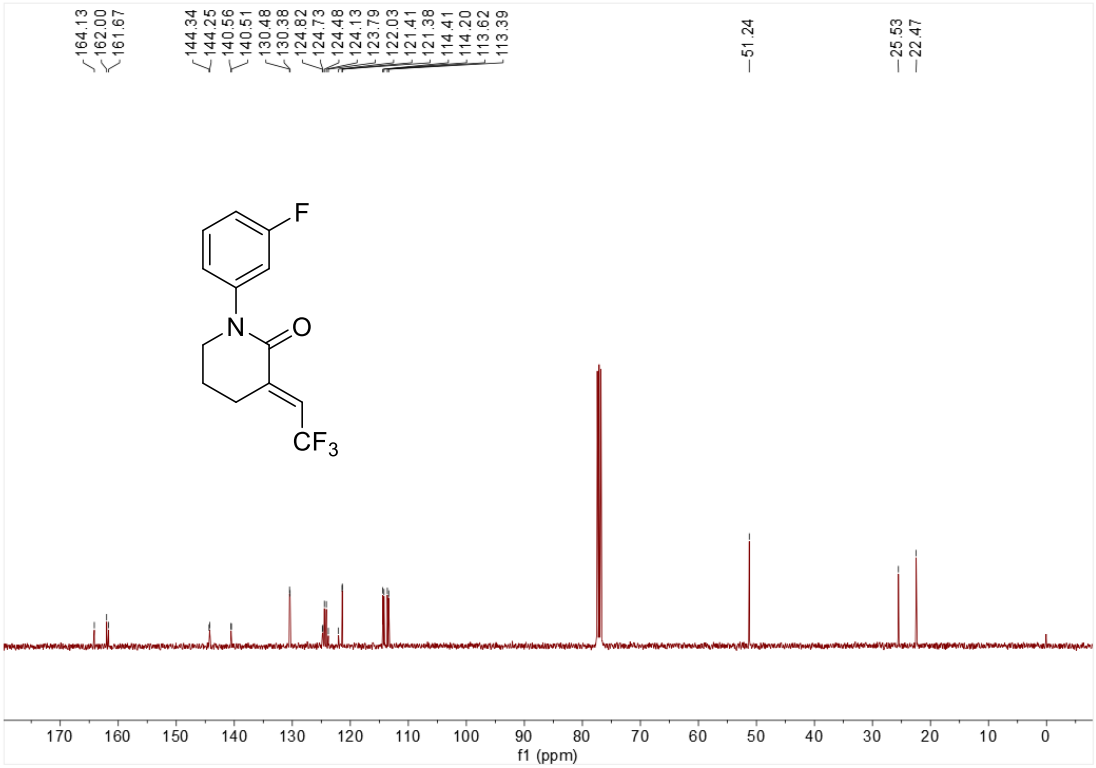


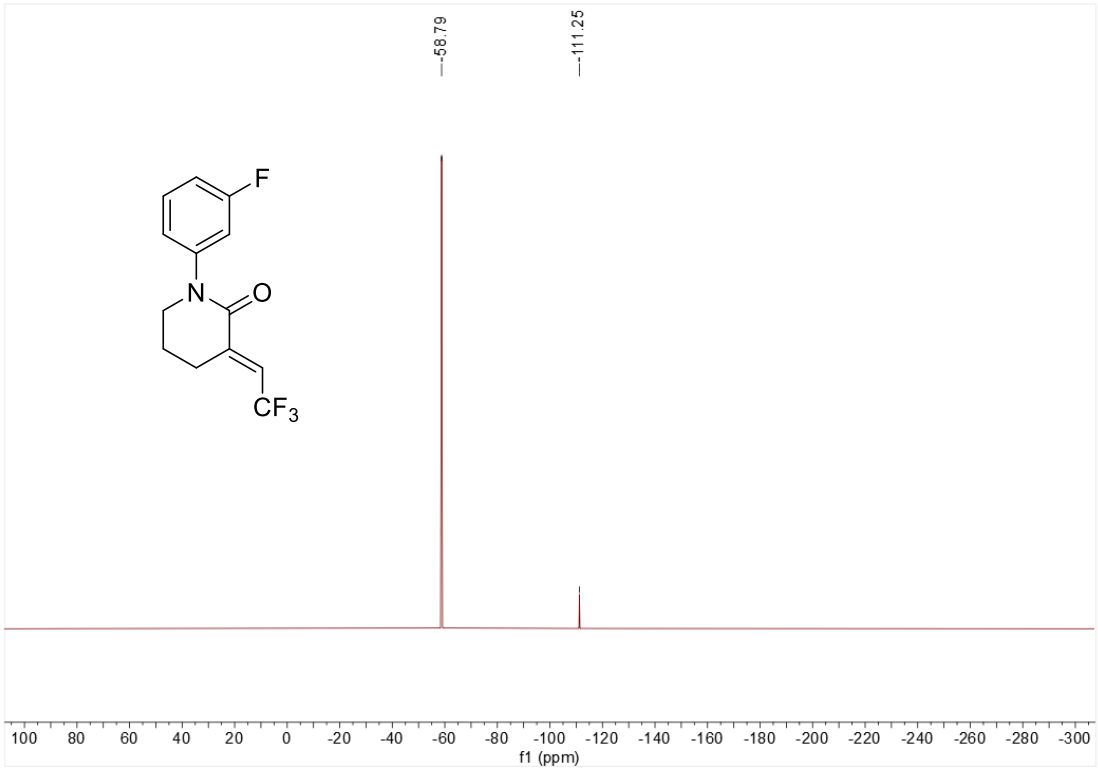



-58.65
Cl
N
O
CF3
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

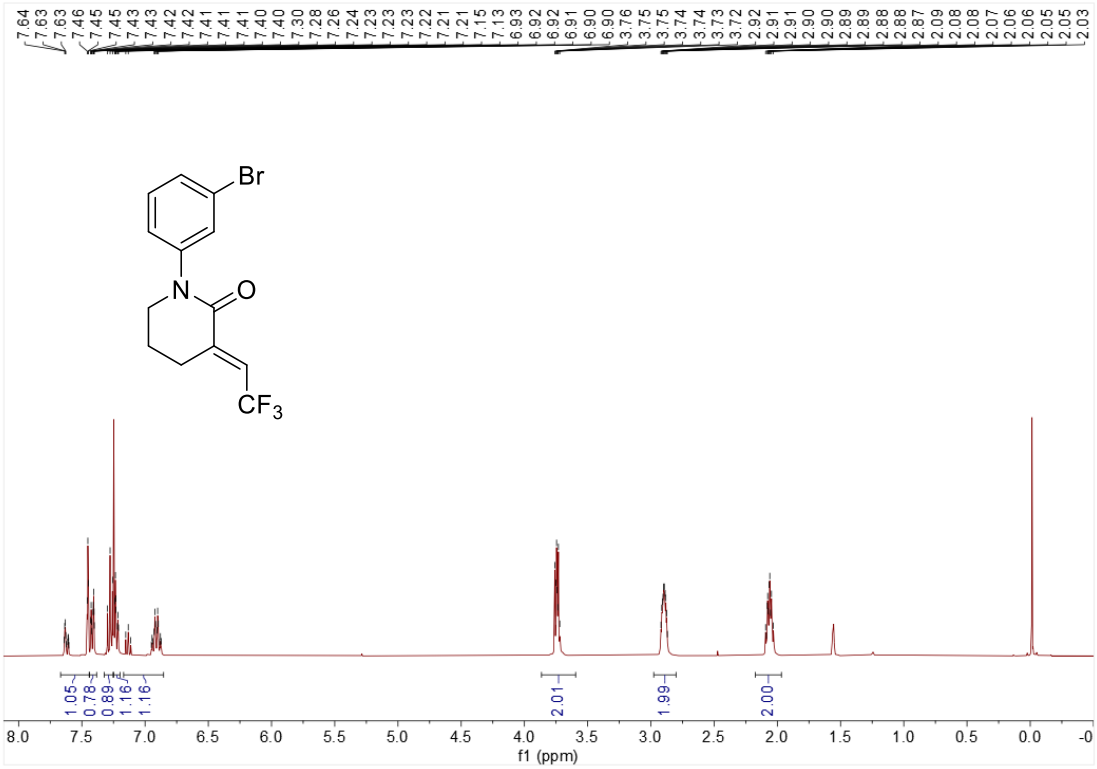
(*E*)-1-(3-fluorophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3g**)

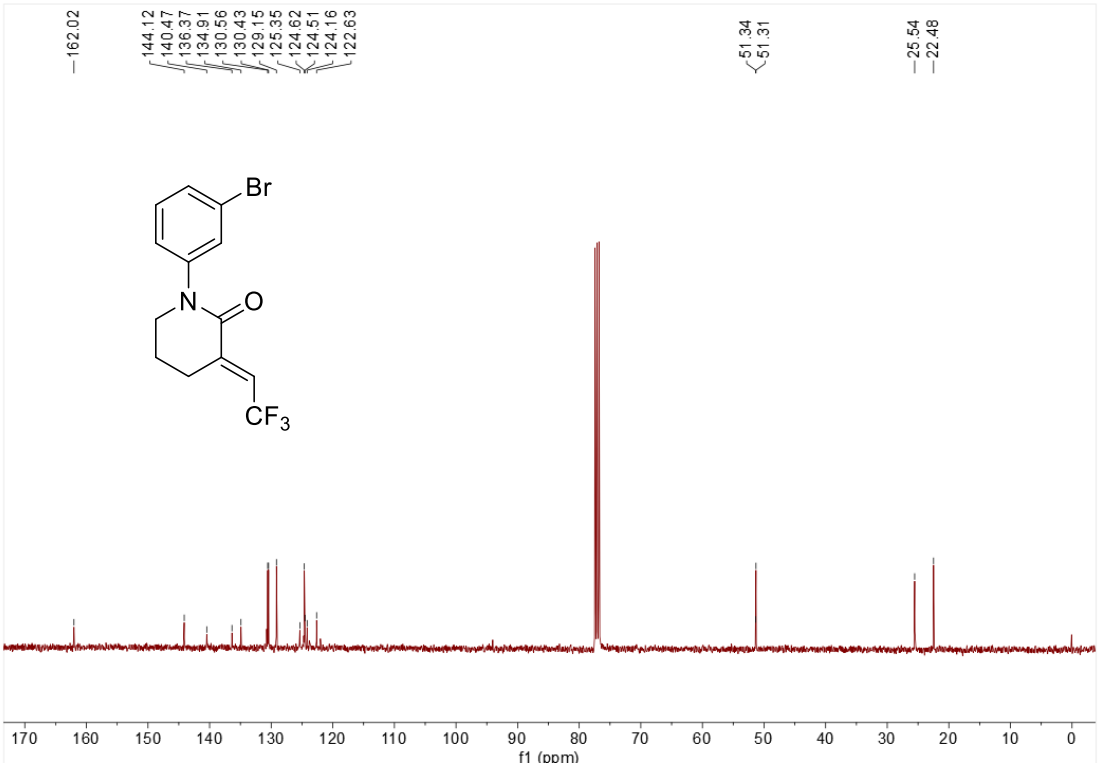


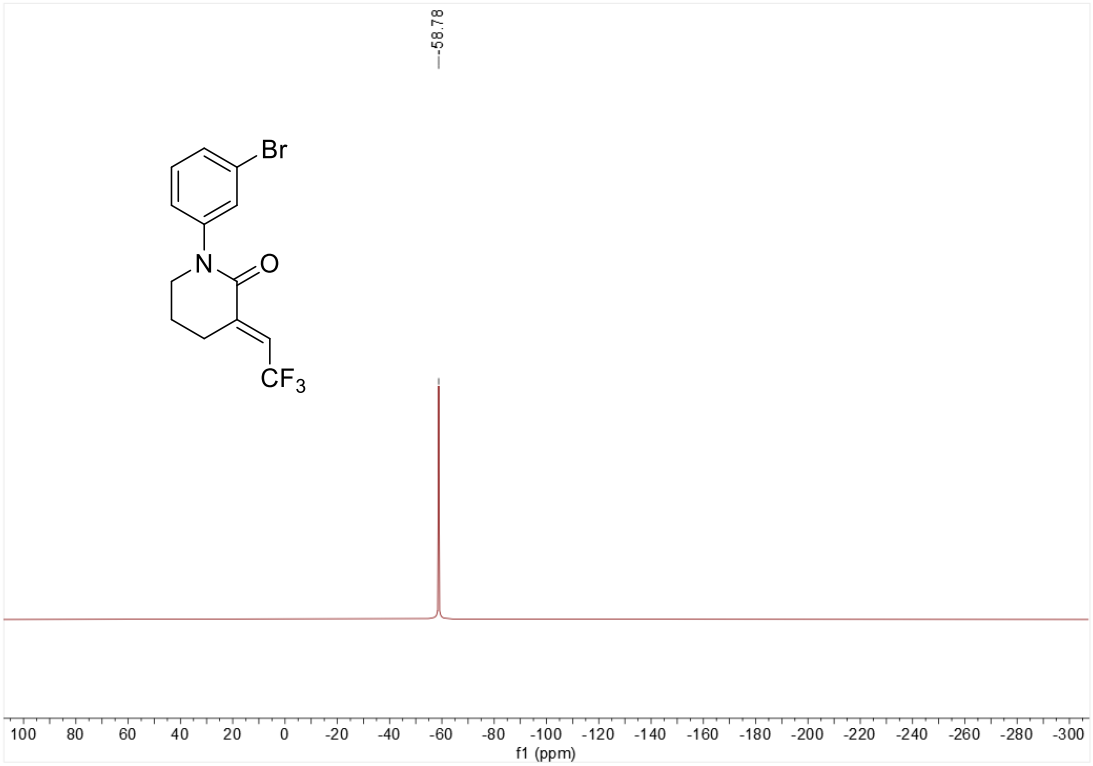



-58.79
-111.25
F
N
O
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

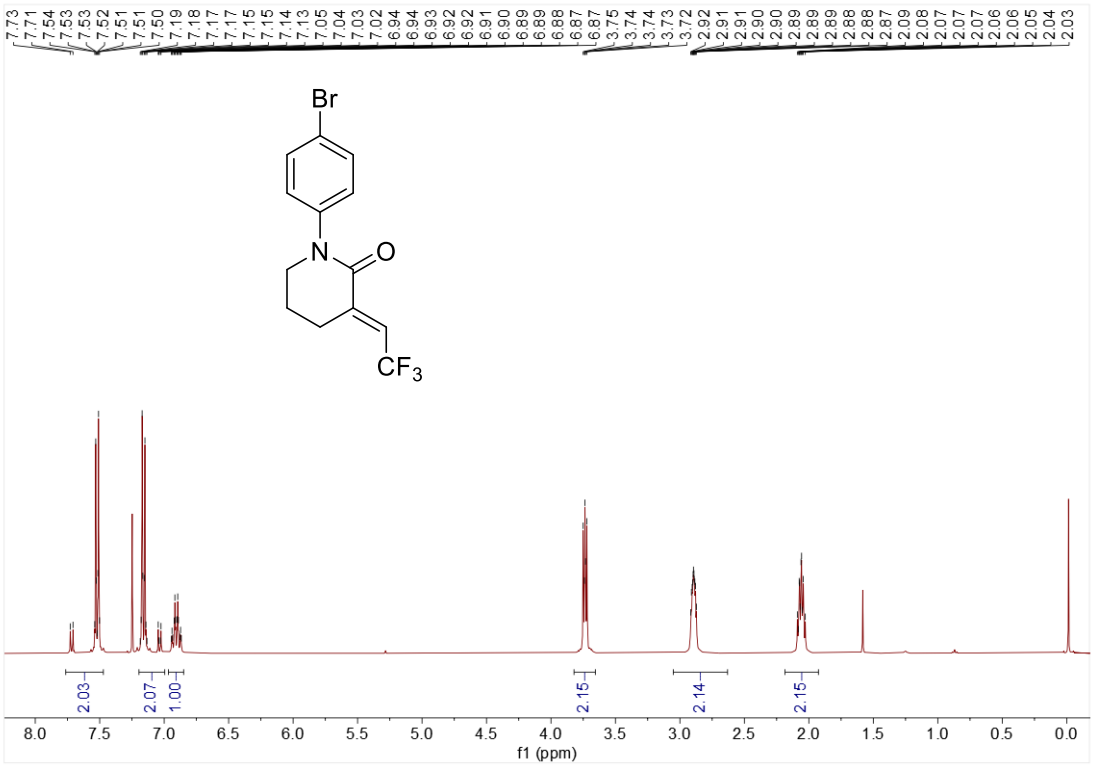
(*E*)-1-(3-bromophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3h**)

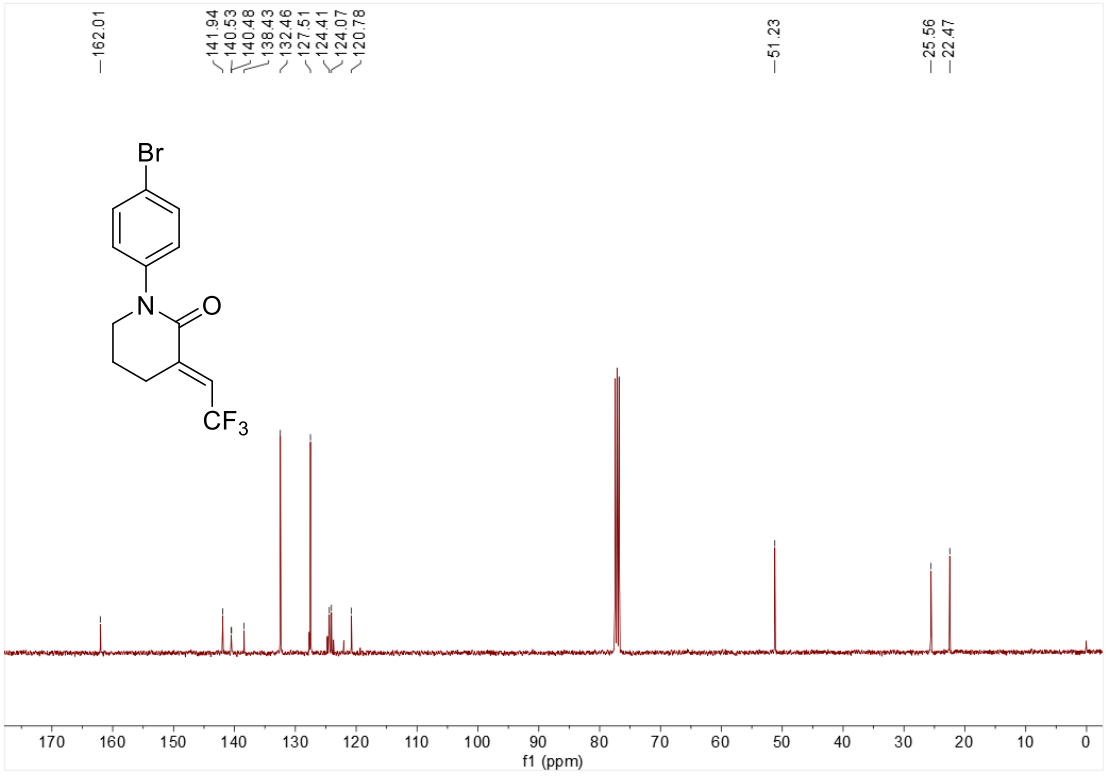


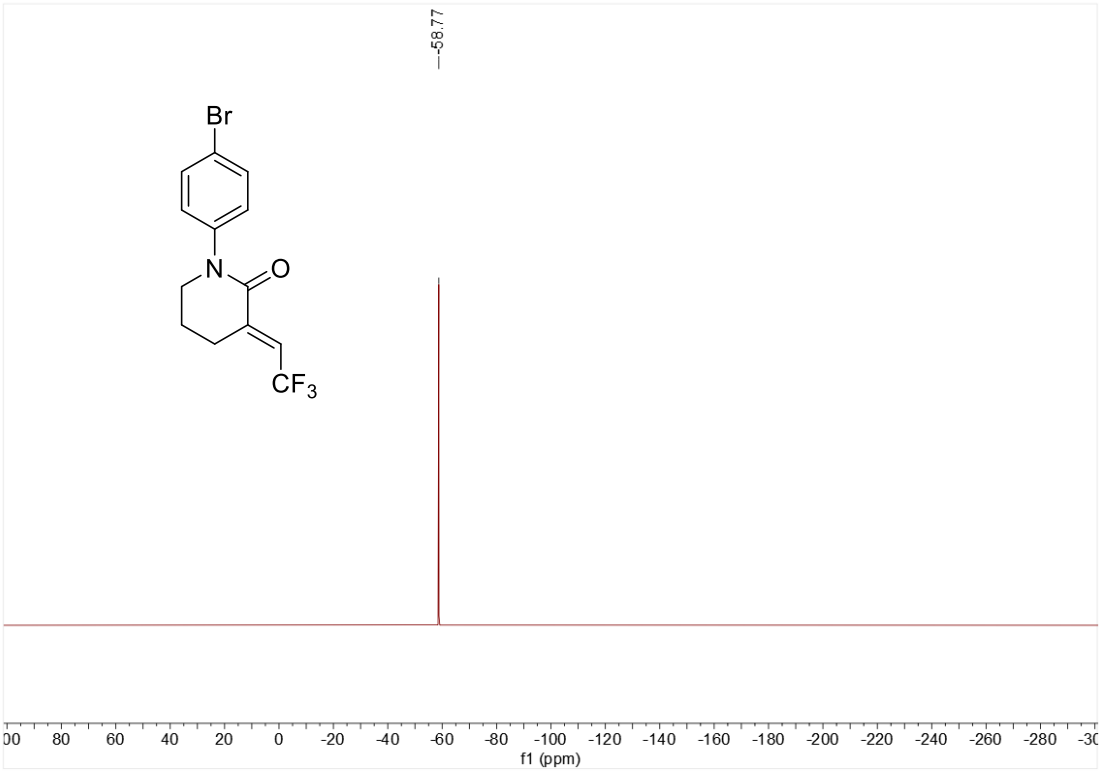



-58.78
Br
N
O
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

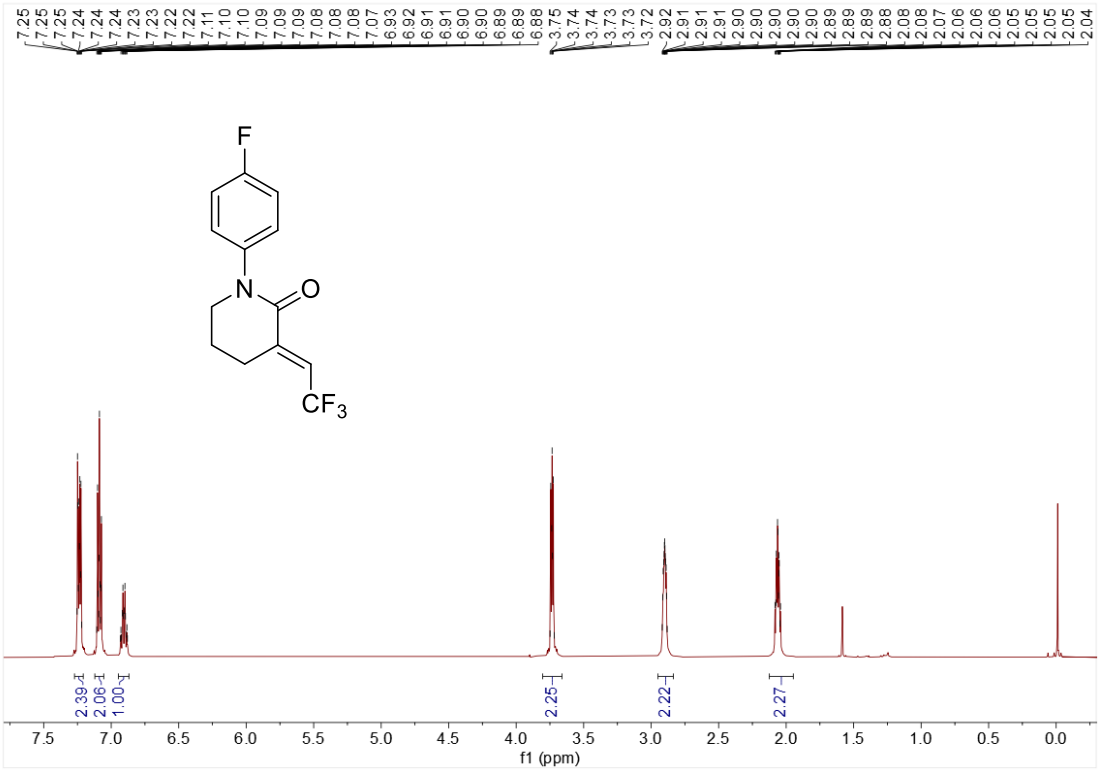
(*E*)-1-(4-bromophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3i**)

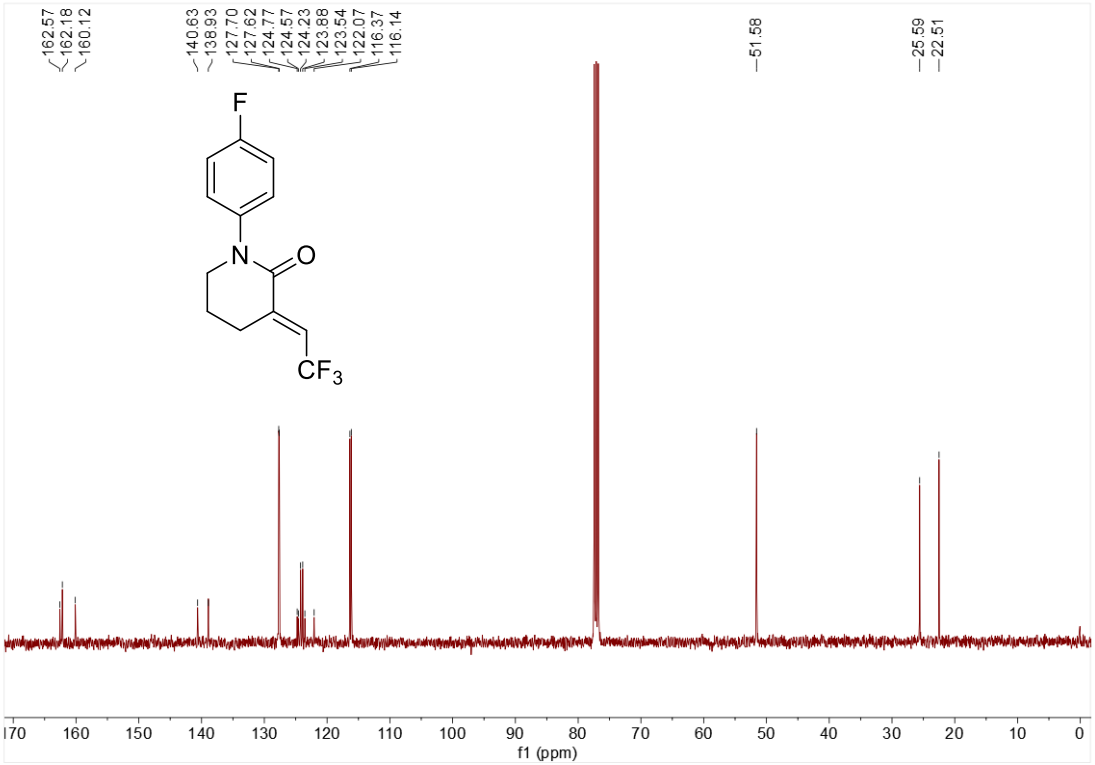


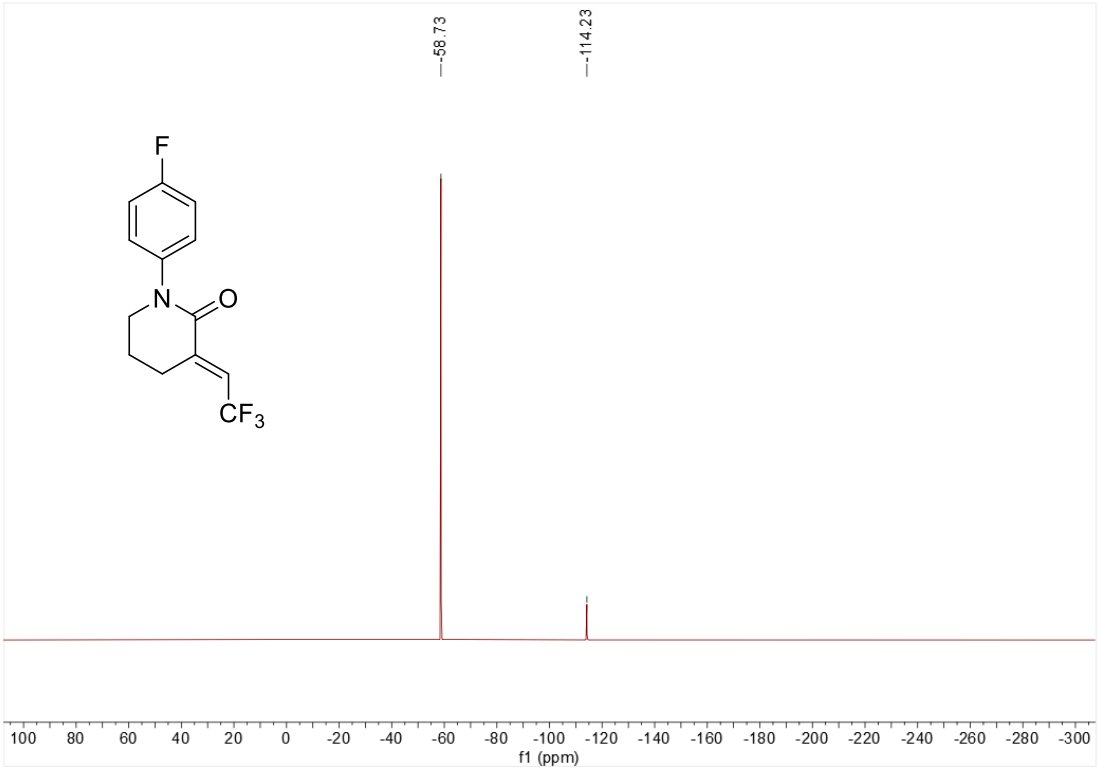



-58.77
Br
N
O
CF3
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -30
f1 (ppm)

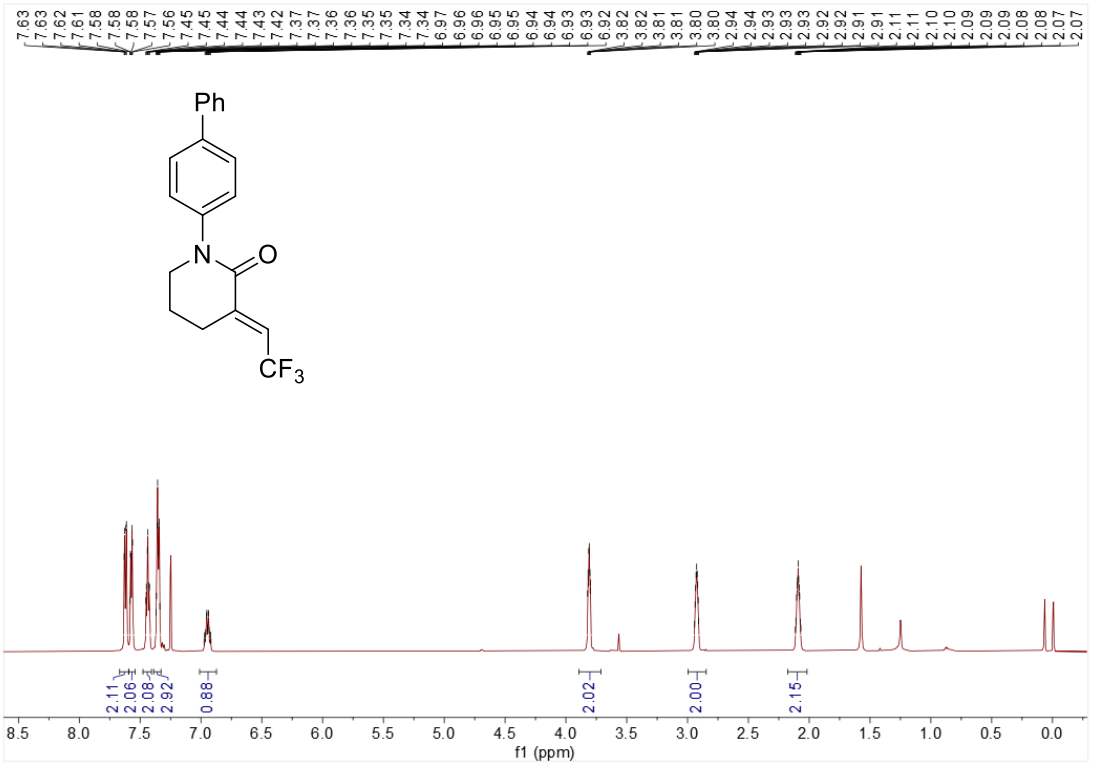
(*E*)-1-(4-fluorophenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3j**)

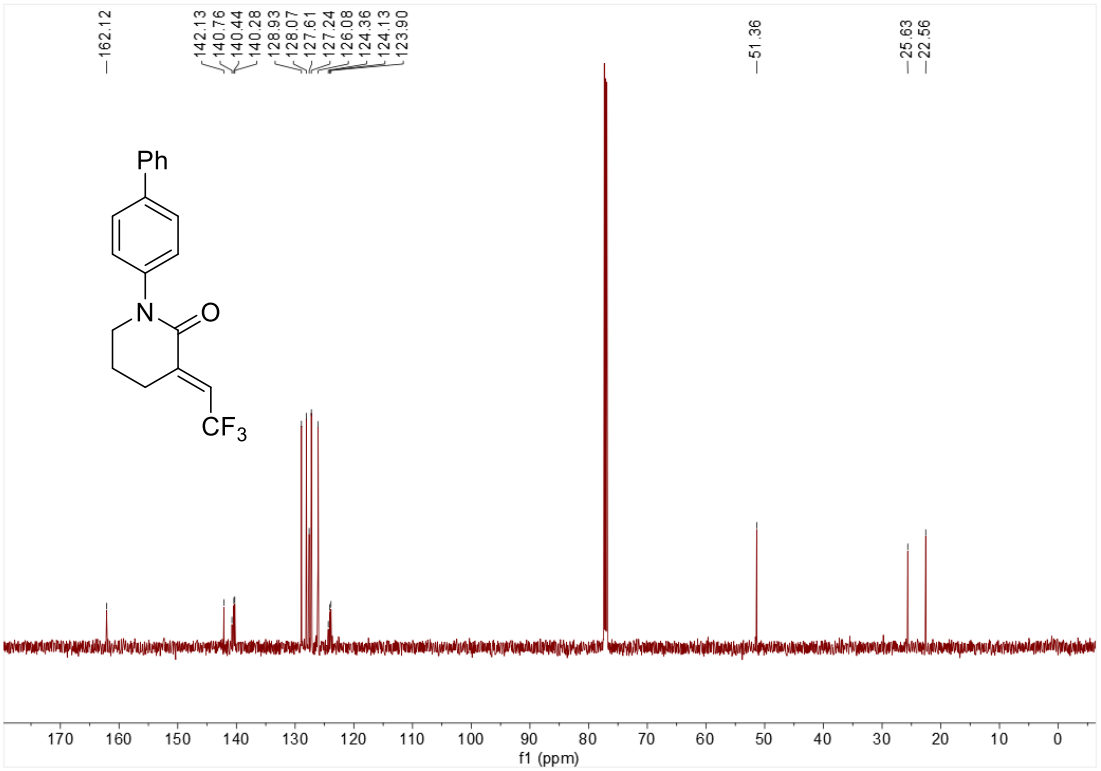


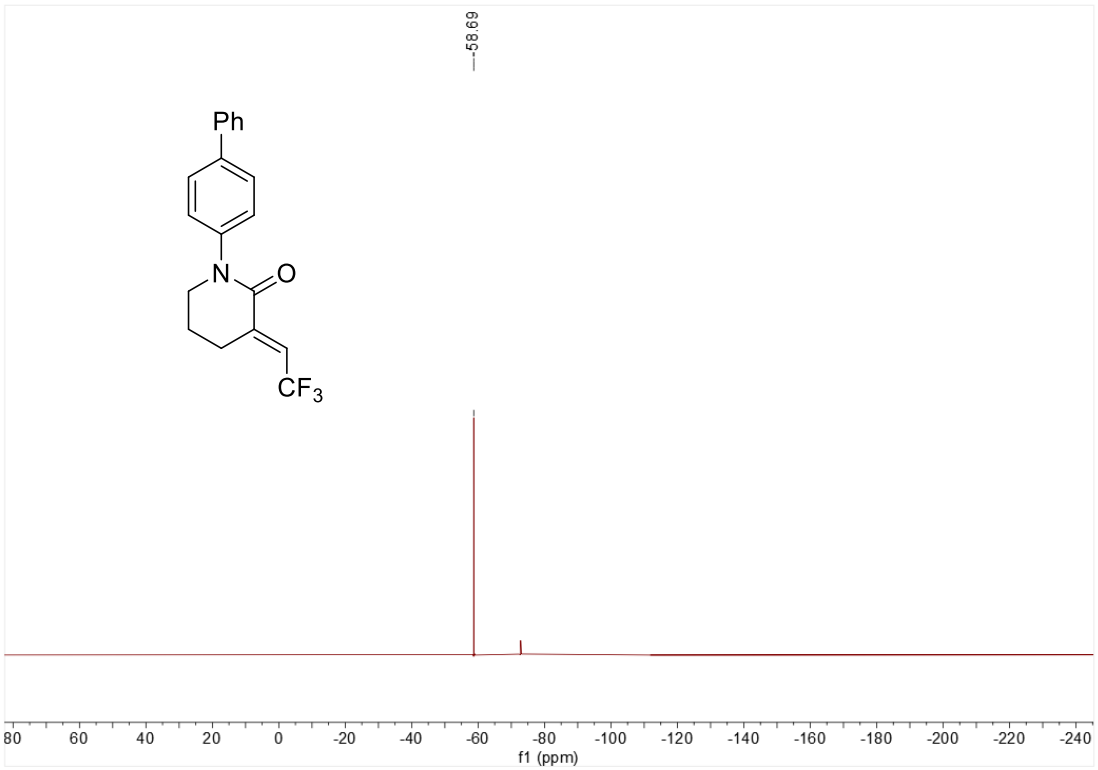



-58.73
-114.23
F
N
O
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

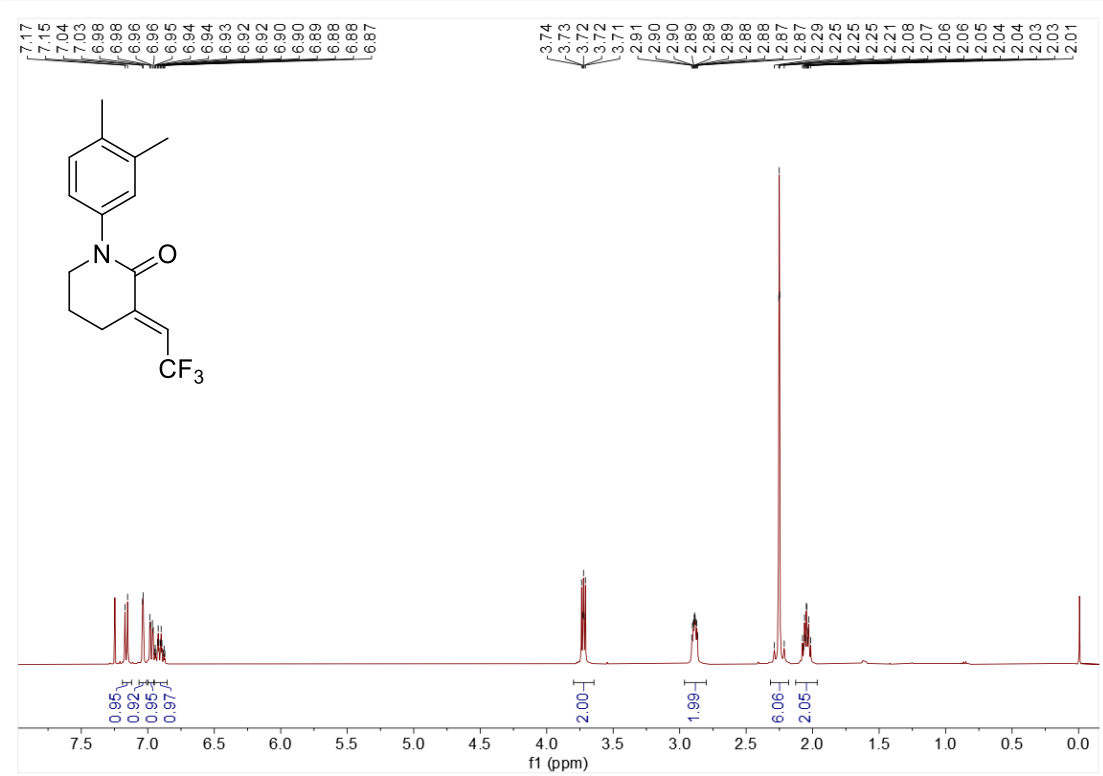
(*E*)-1-([1,1'-biphenyl]-4-yl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3k**)

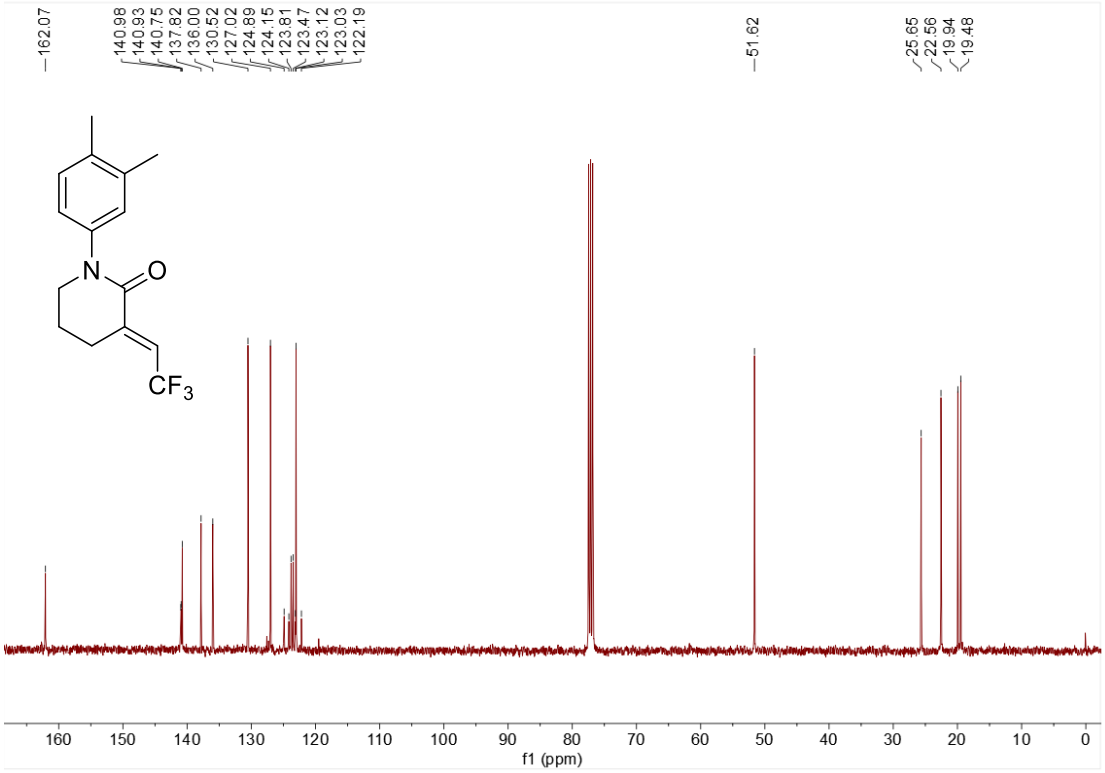


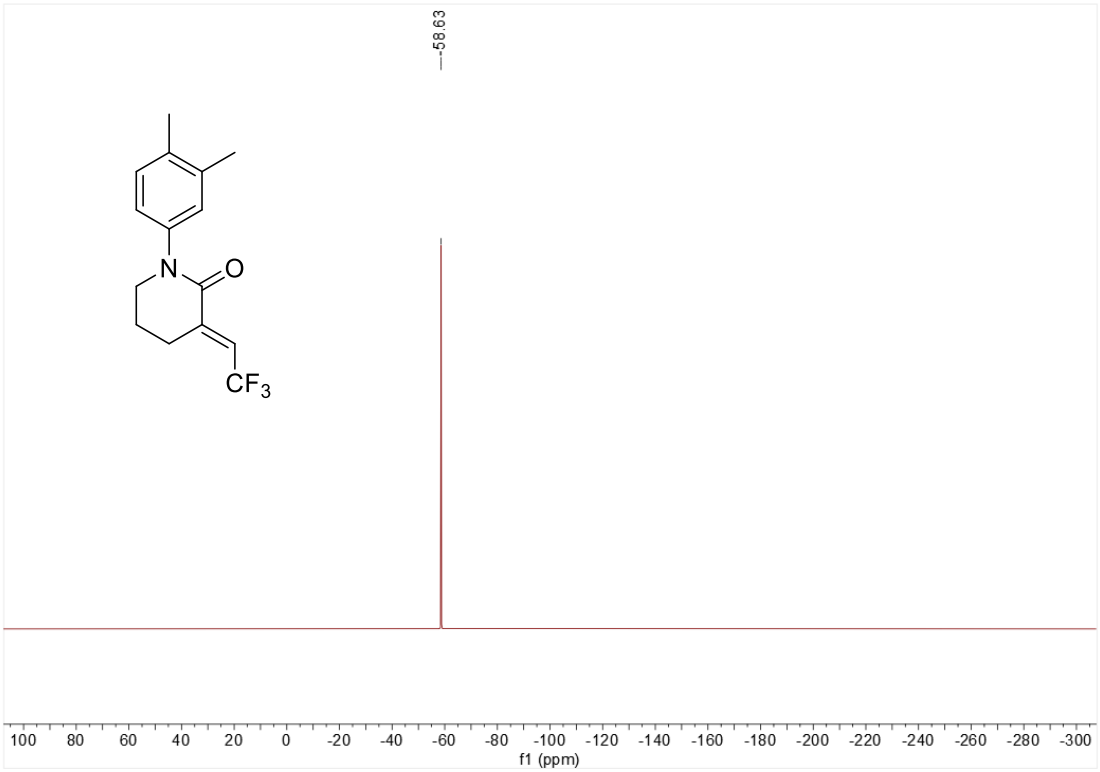



-58.69
Ph
N
O
CF3
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
f1 (ppm)

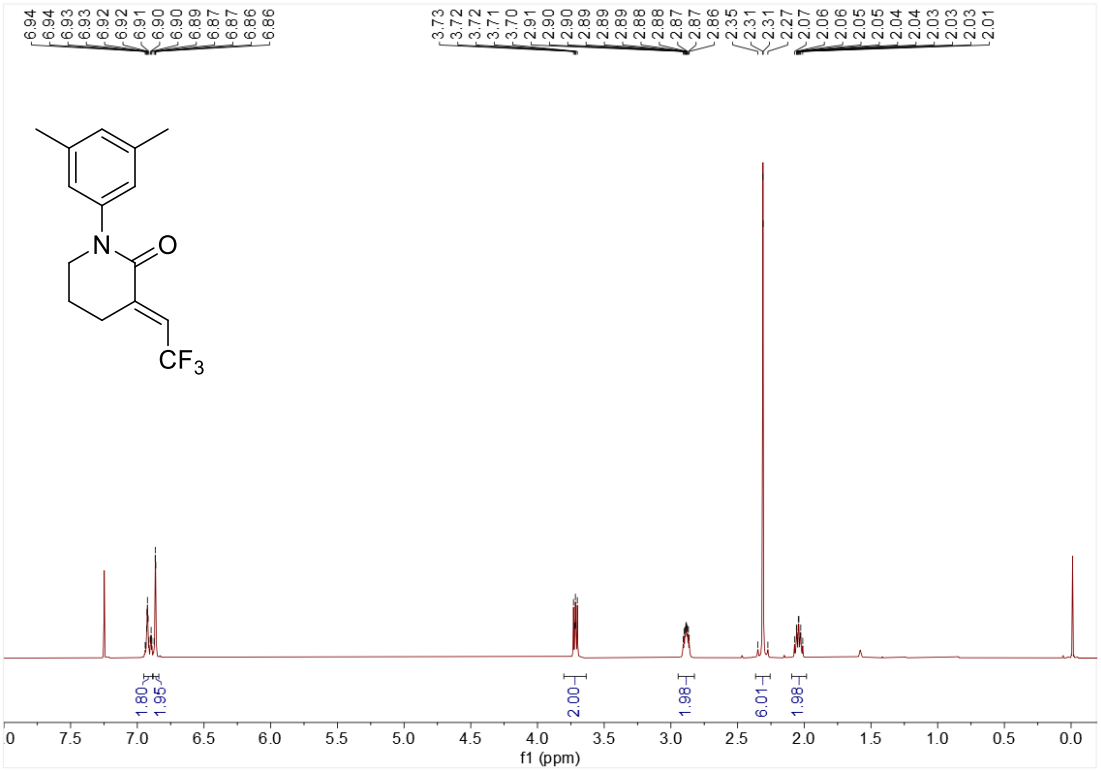
(*E*)-1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3l**)

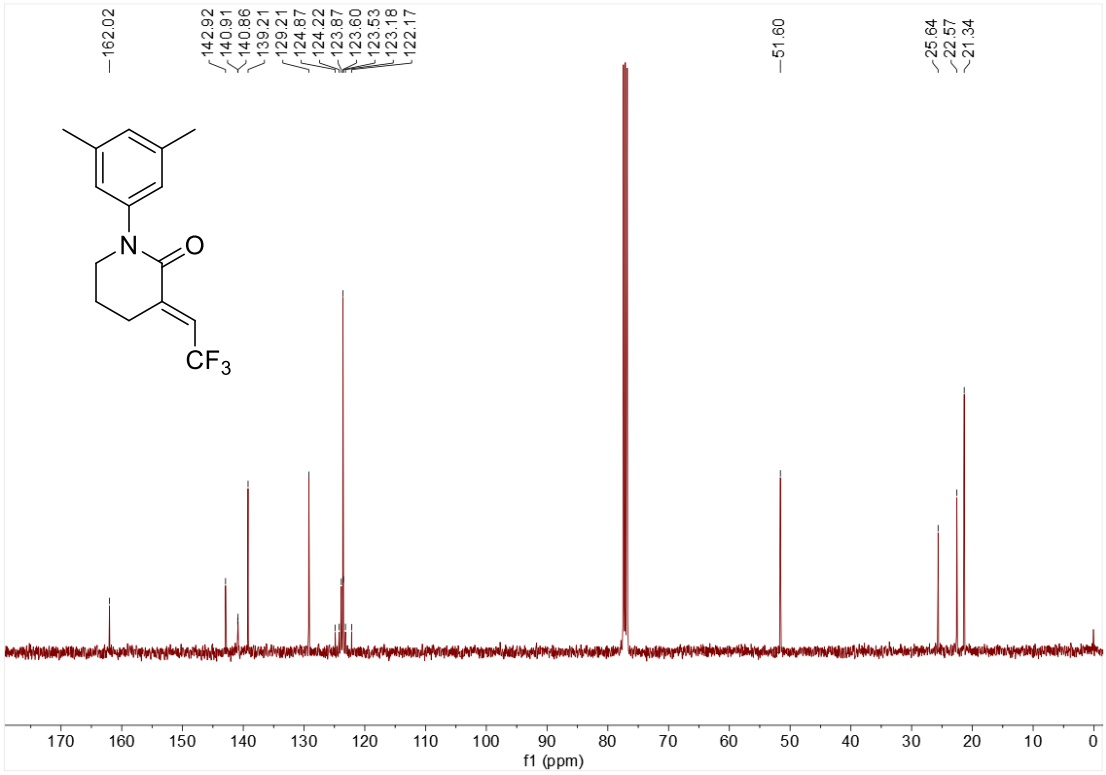


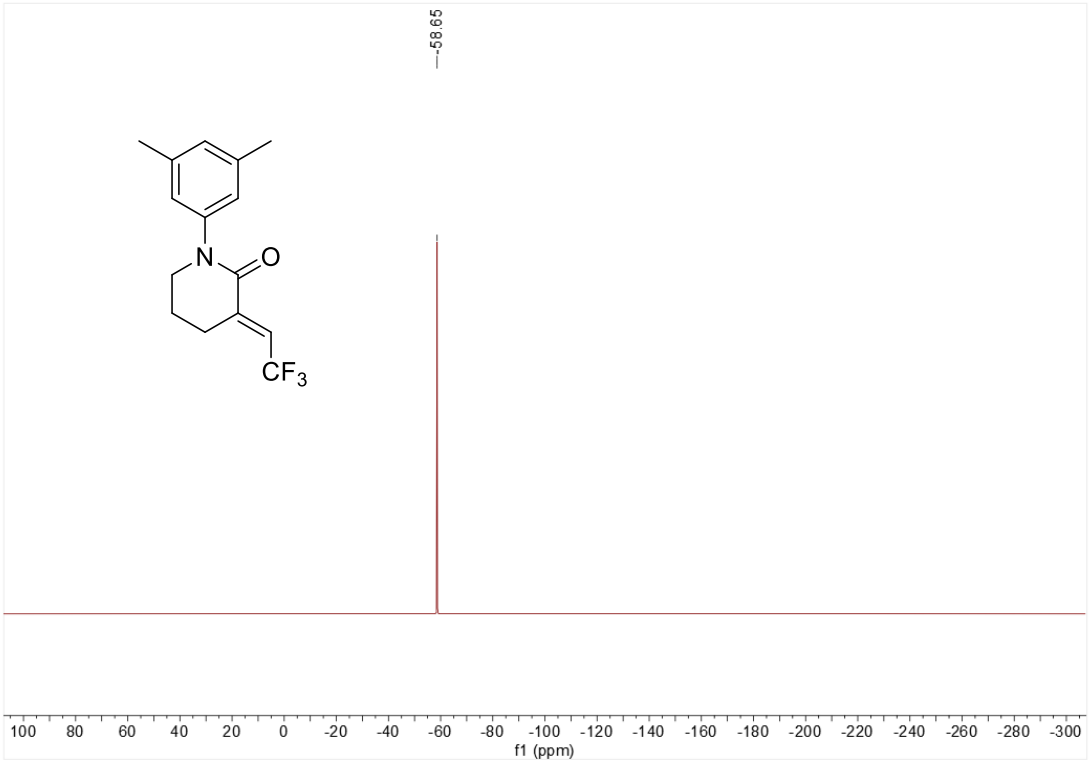



-58.63
N
O
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

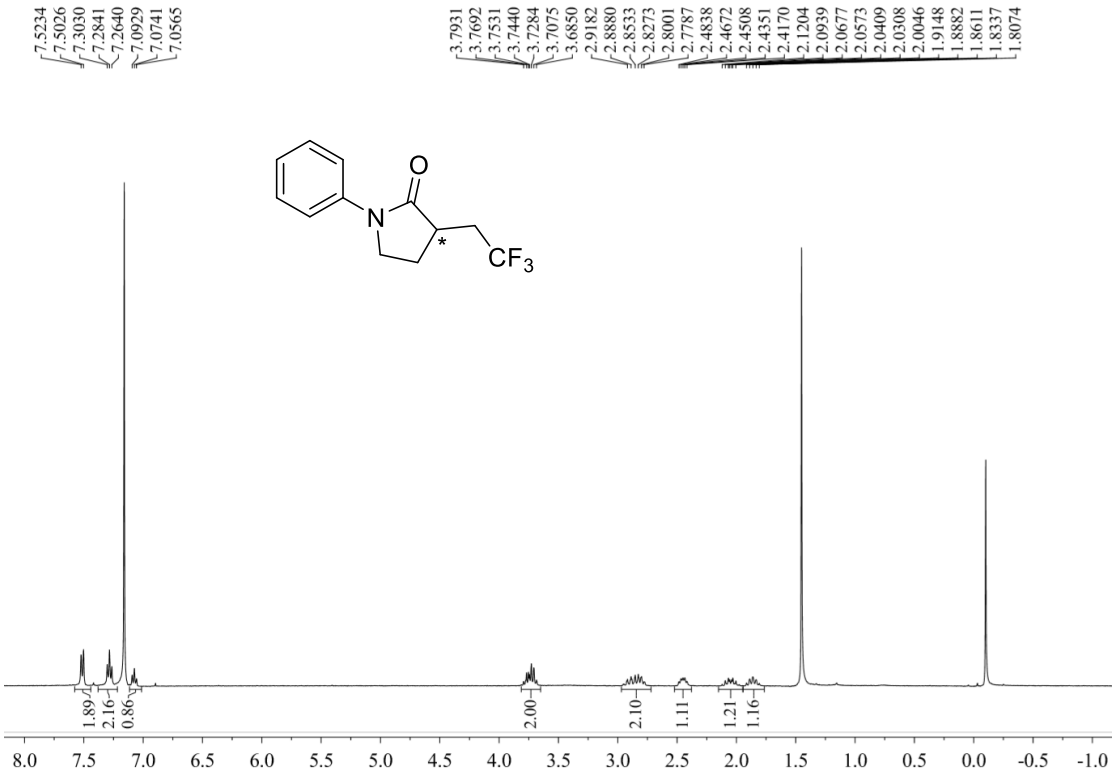
(*E*)-1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethylidene)piperidin-2-one (**3m**)

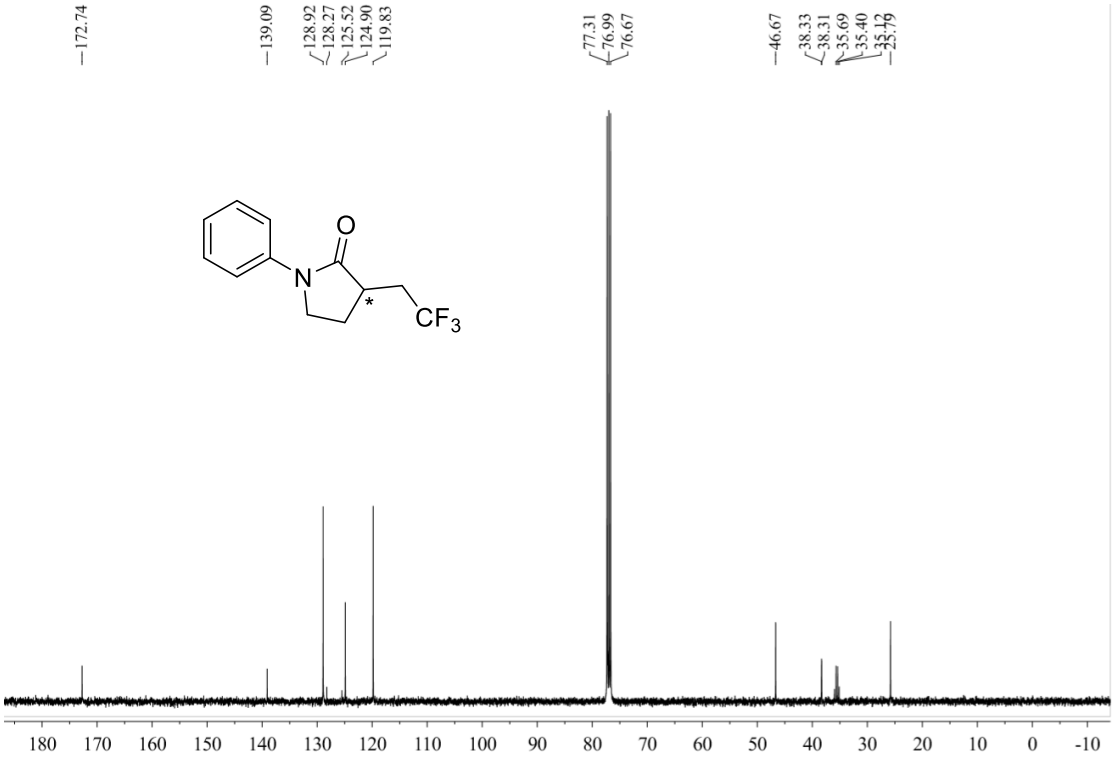


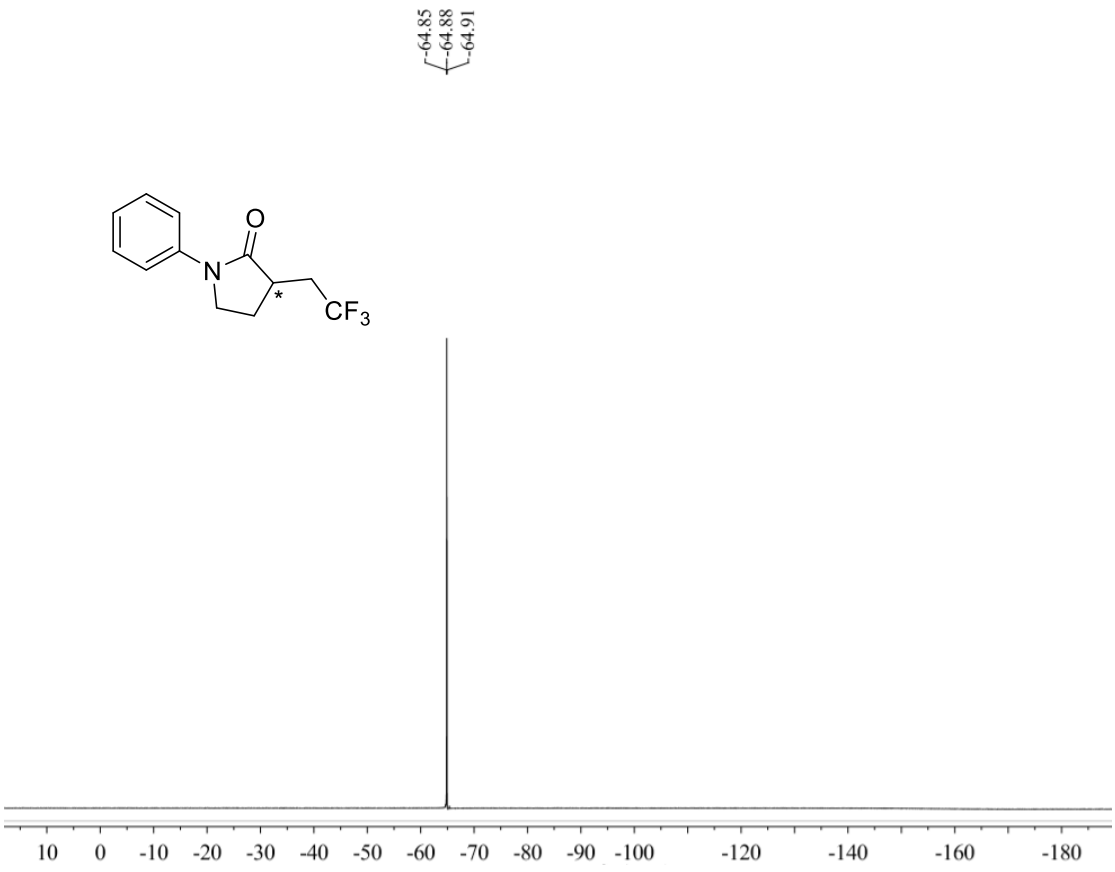



-58.65
N
O
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

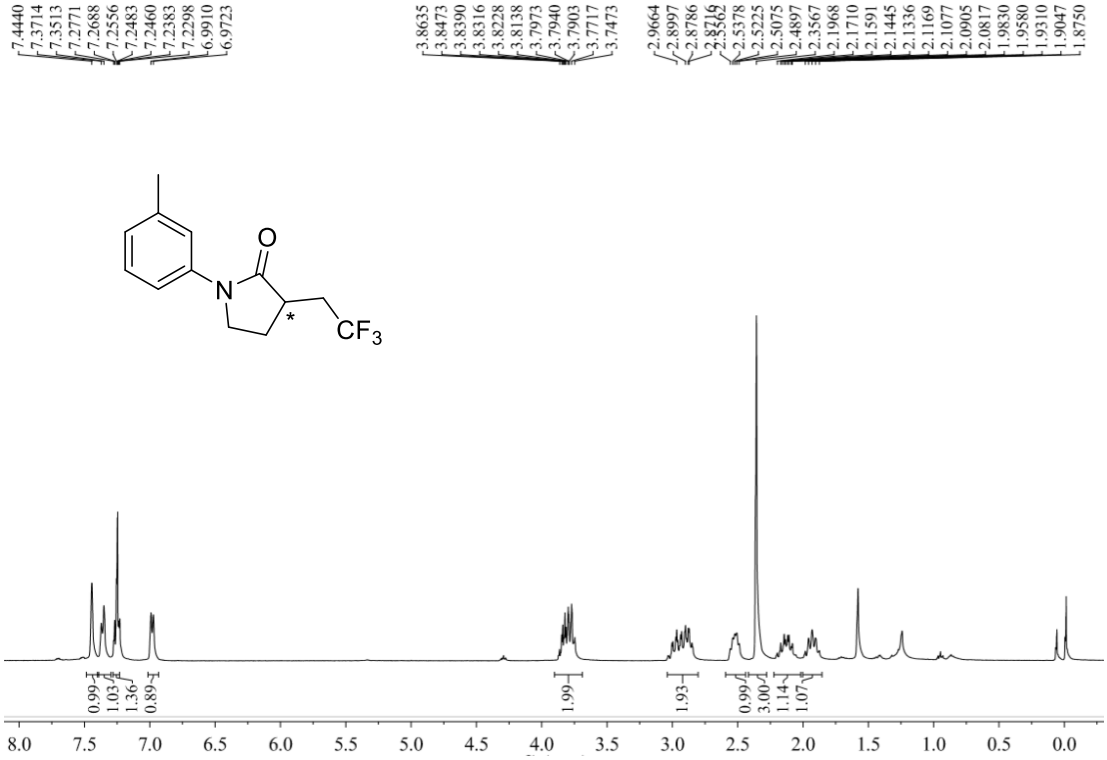
1-phenyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2a**)

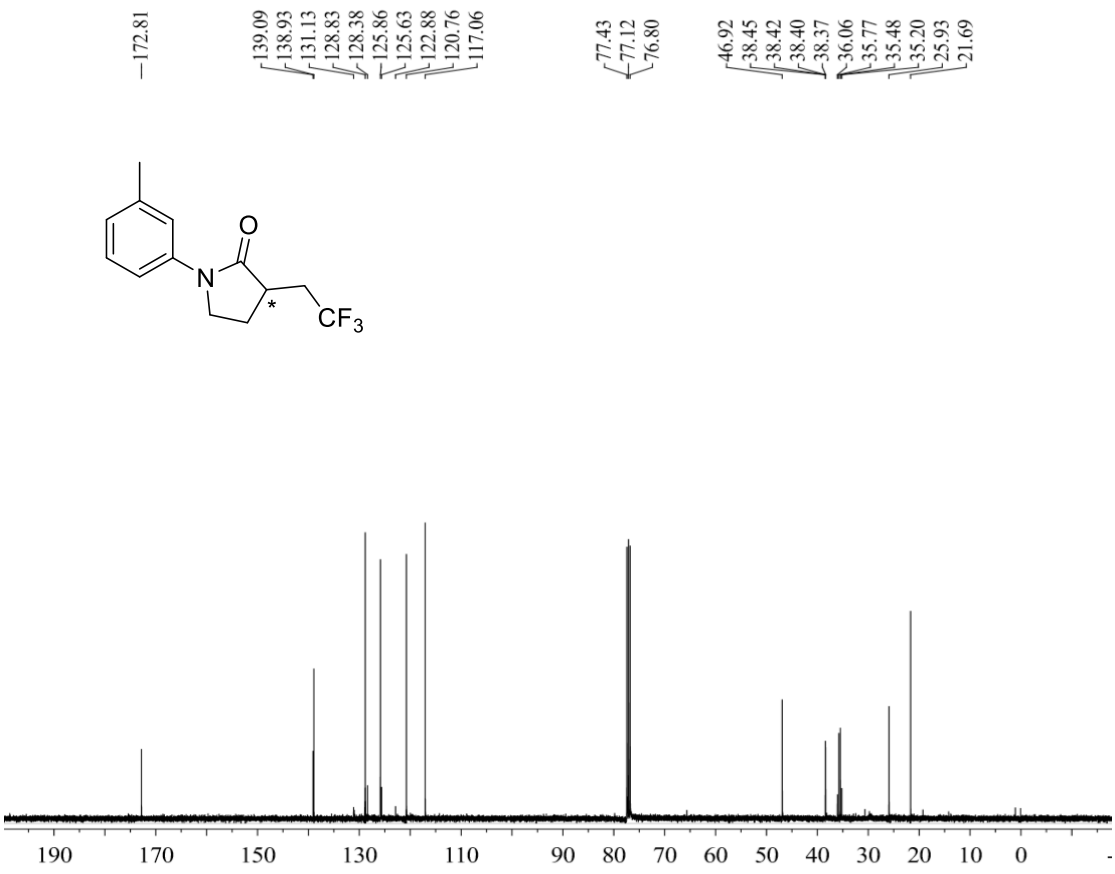


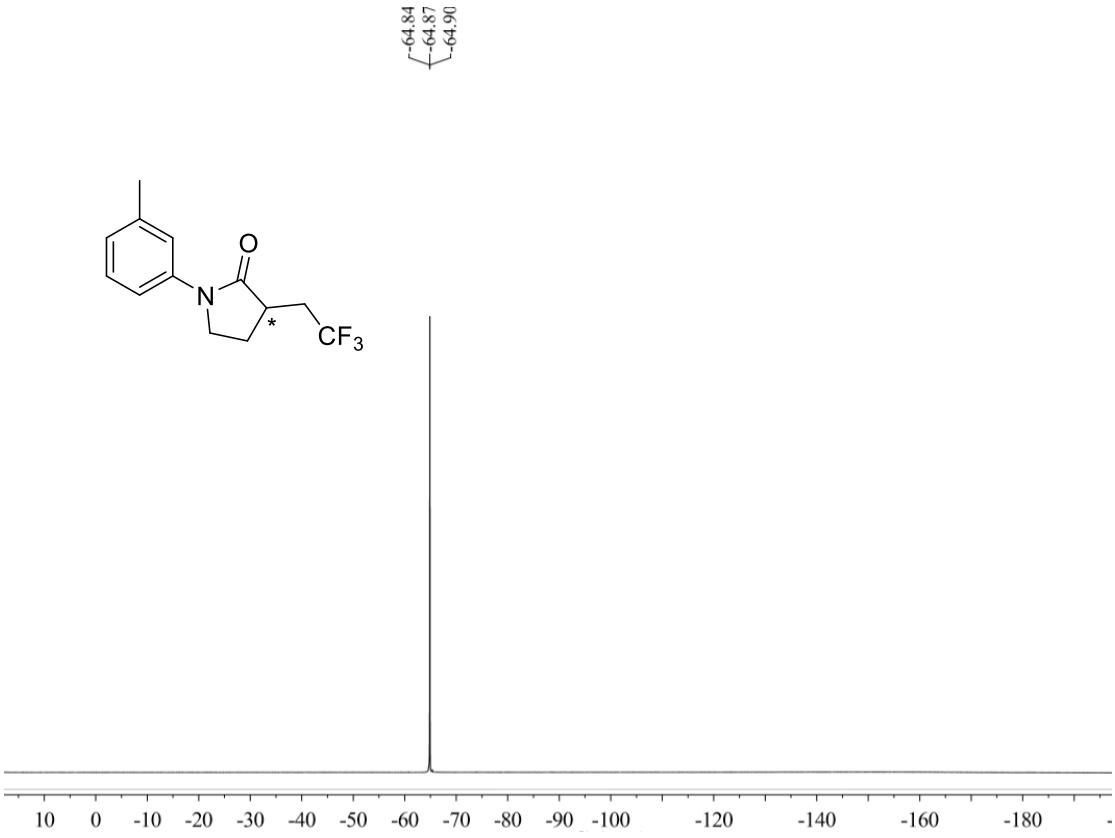



-64.85
-64.88
-64.91
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

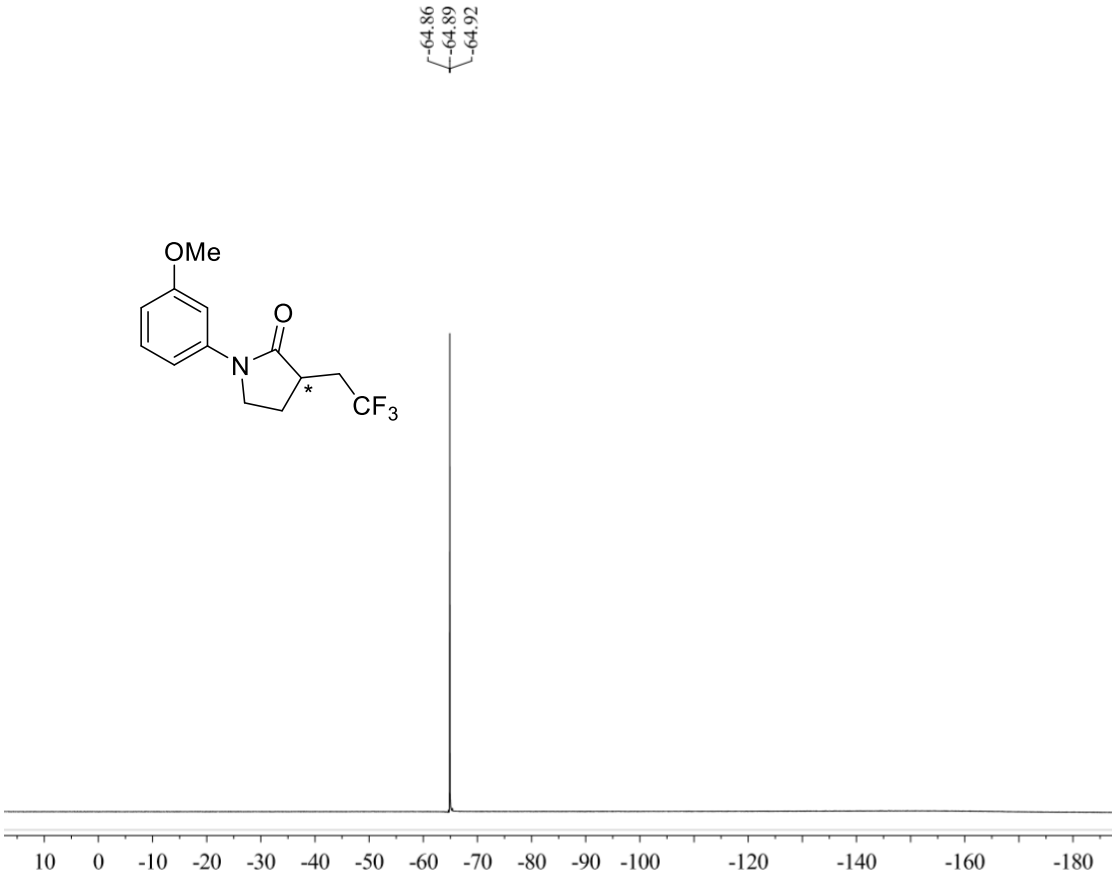
1-(*m*-tolyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2b**)



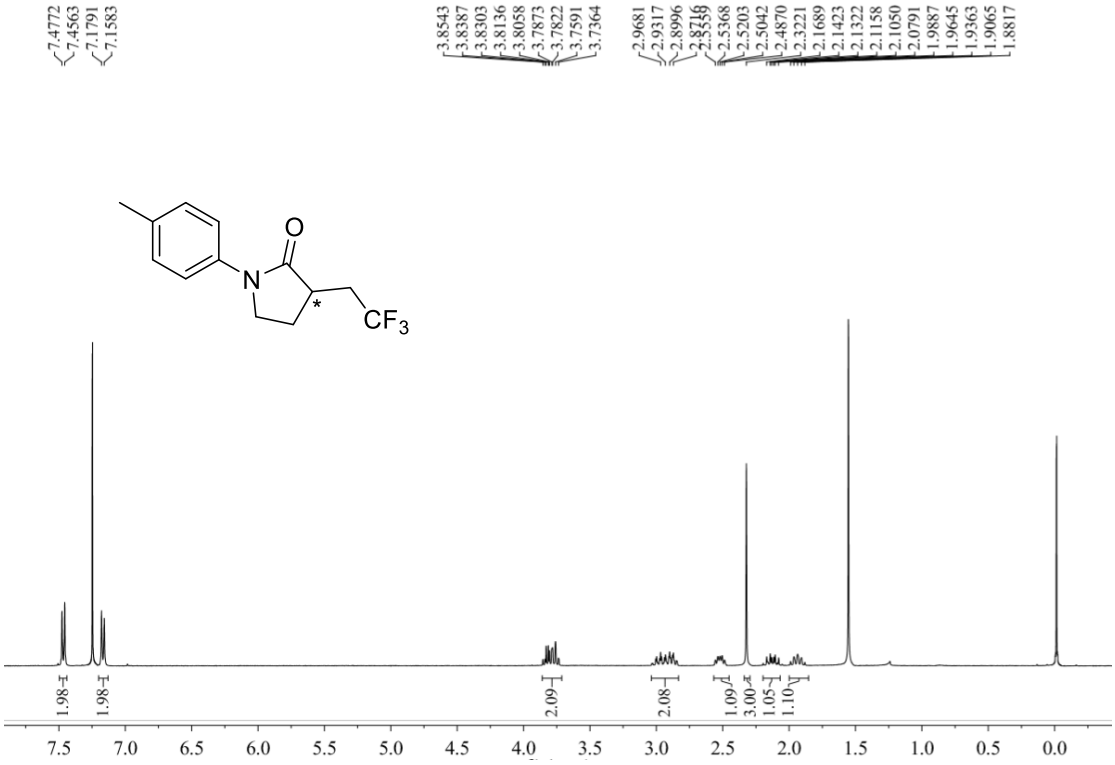


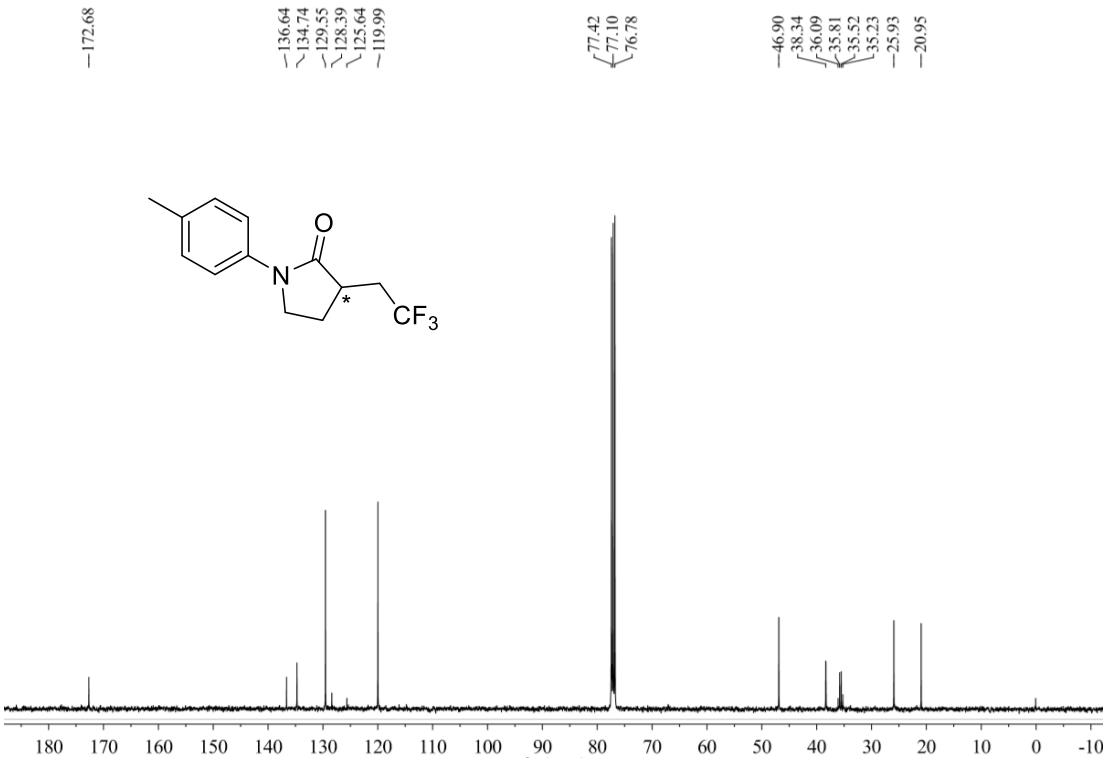

-64.84
-64.87
-64.90
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

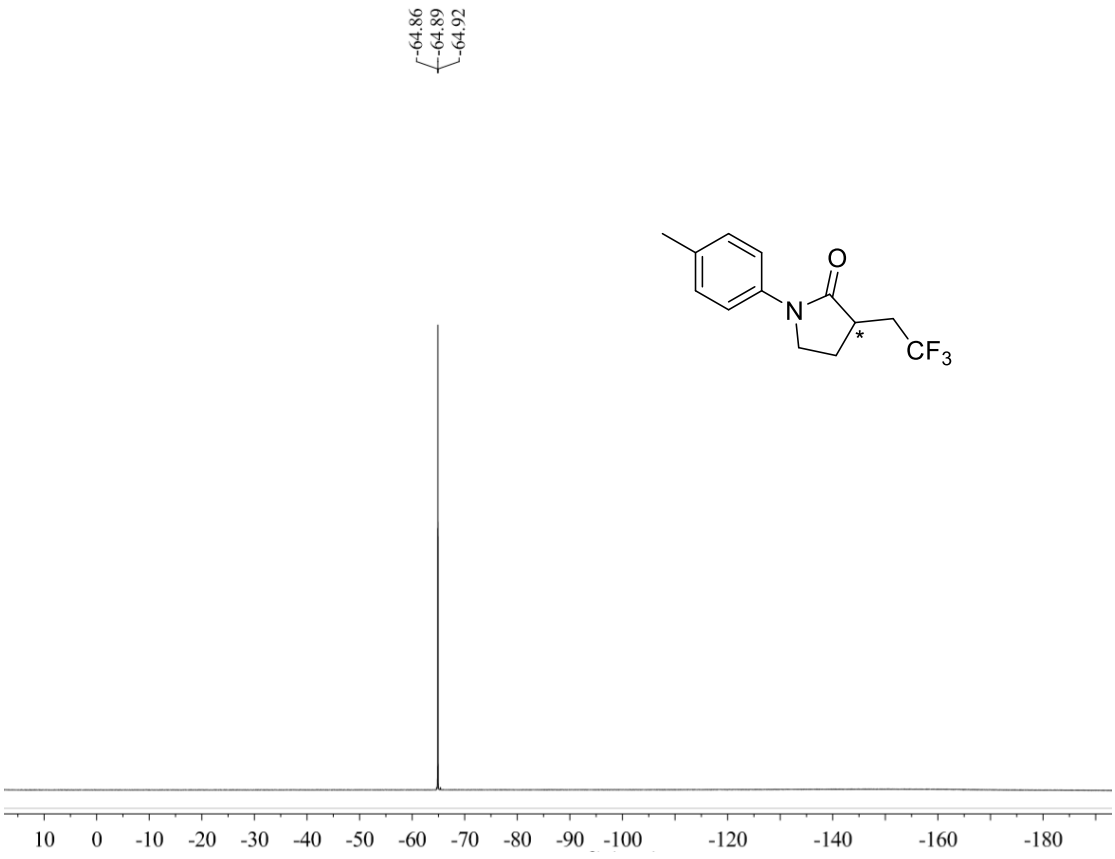
1-(3-methoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2c**)


-64.86
-64.89
-64.92
OMe
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

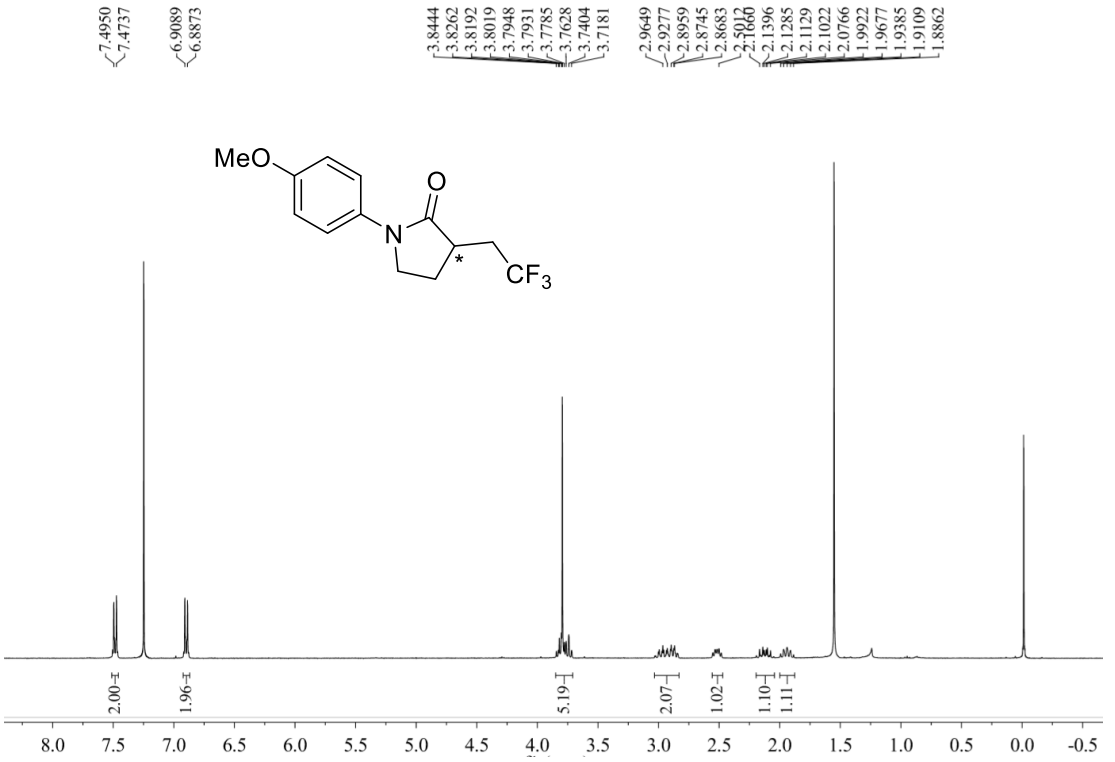
1-(*p*-tolyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2d**)

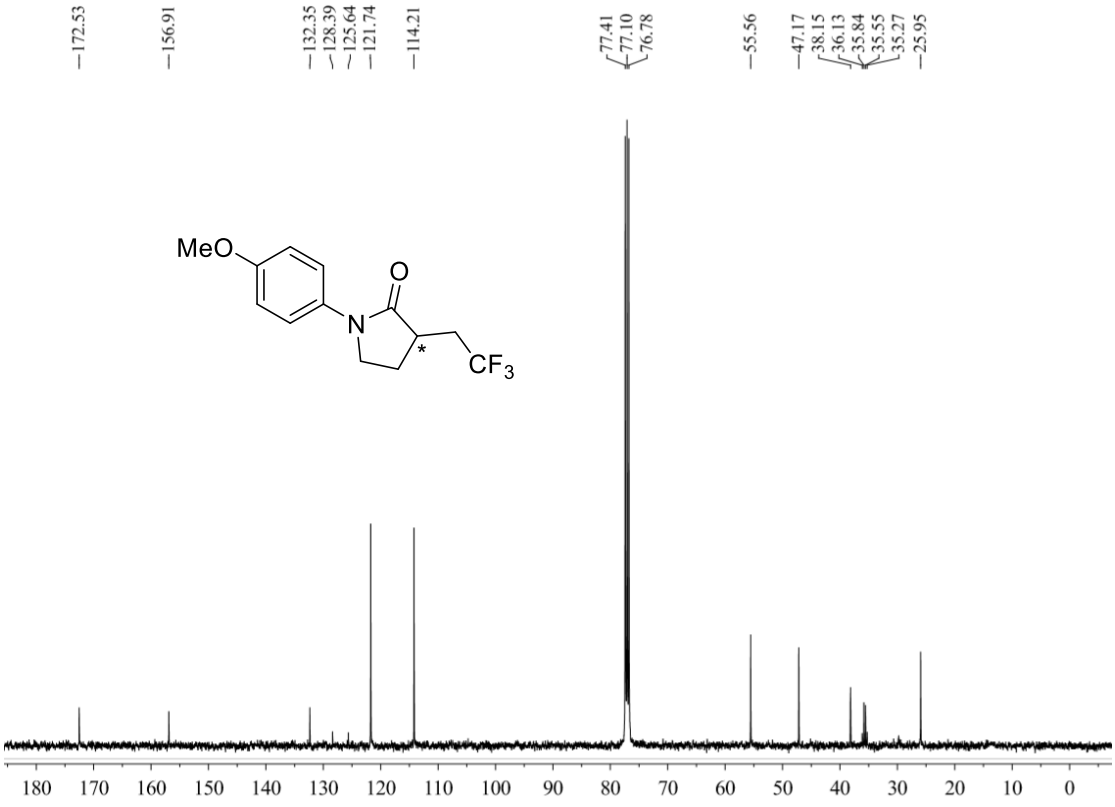


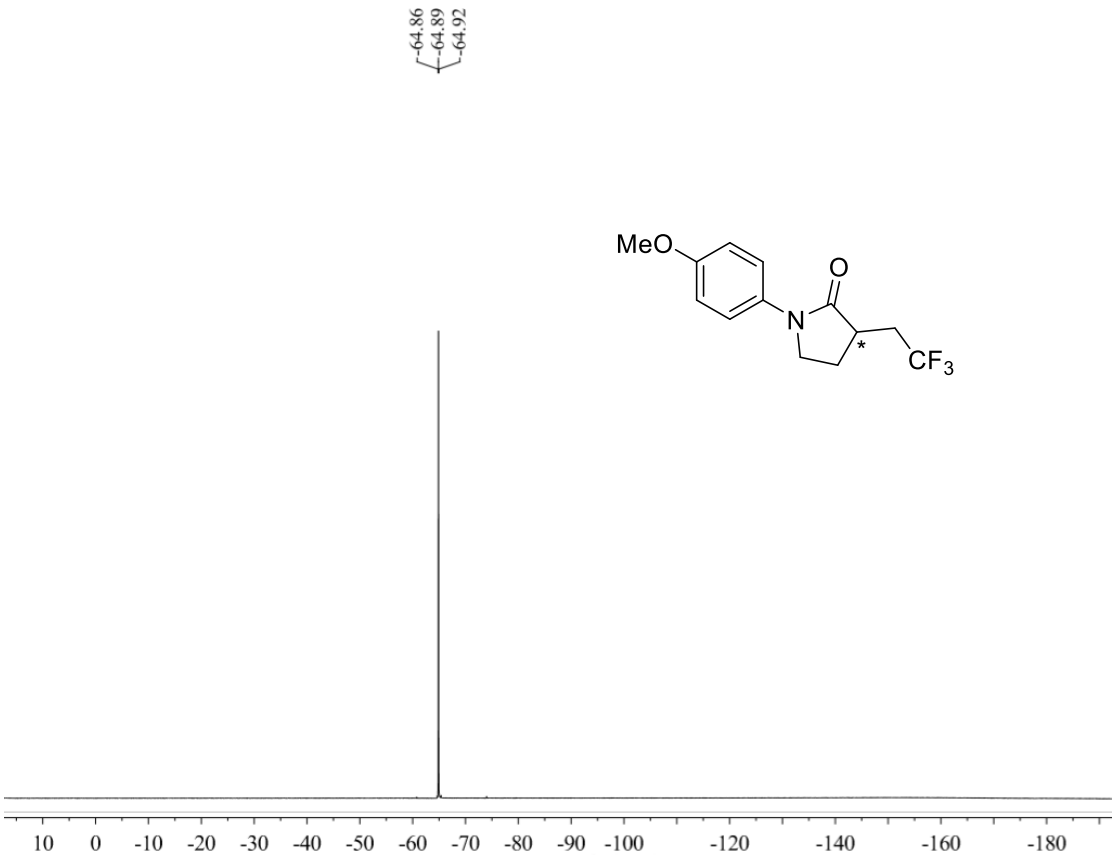



-64.86
-64.89
-64.92
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

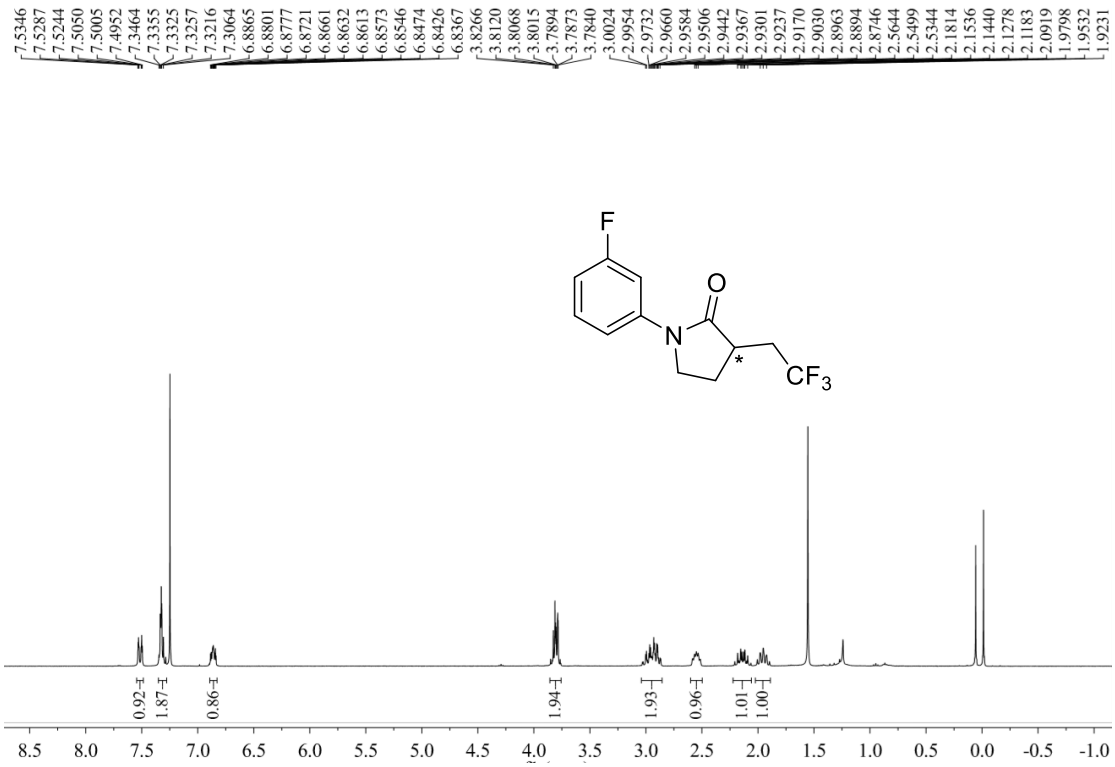
1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2e**)

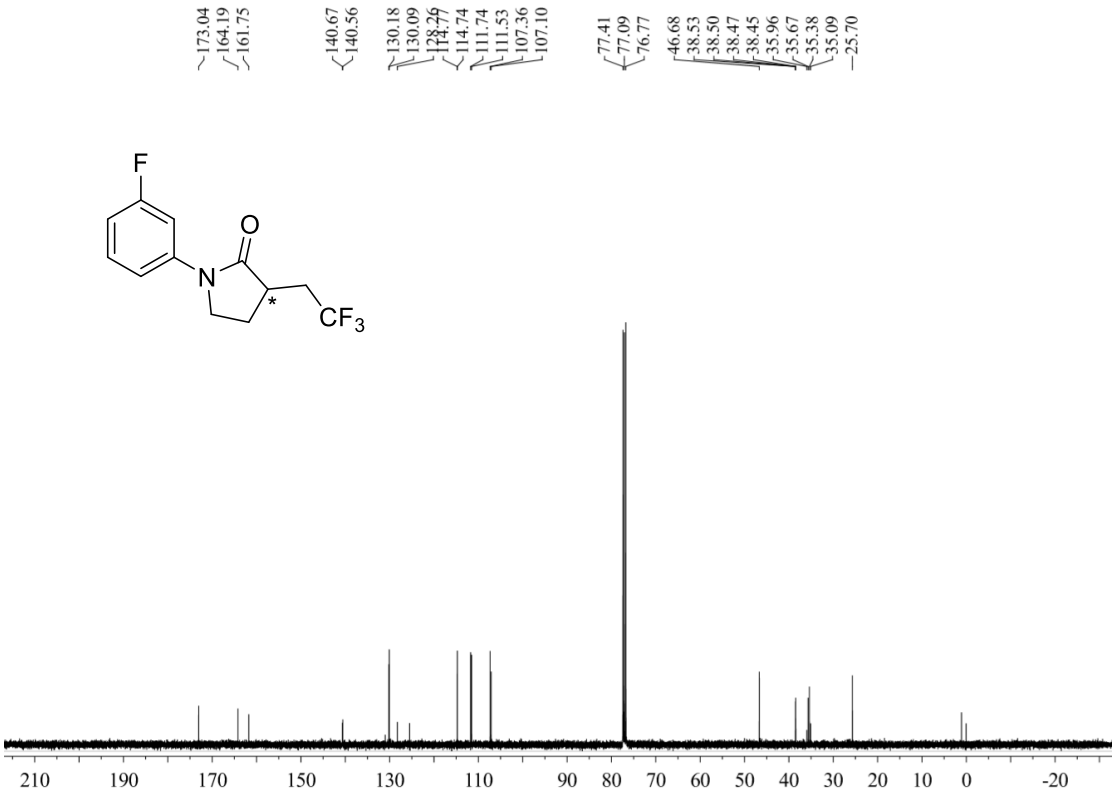


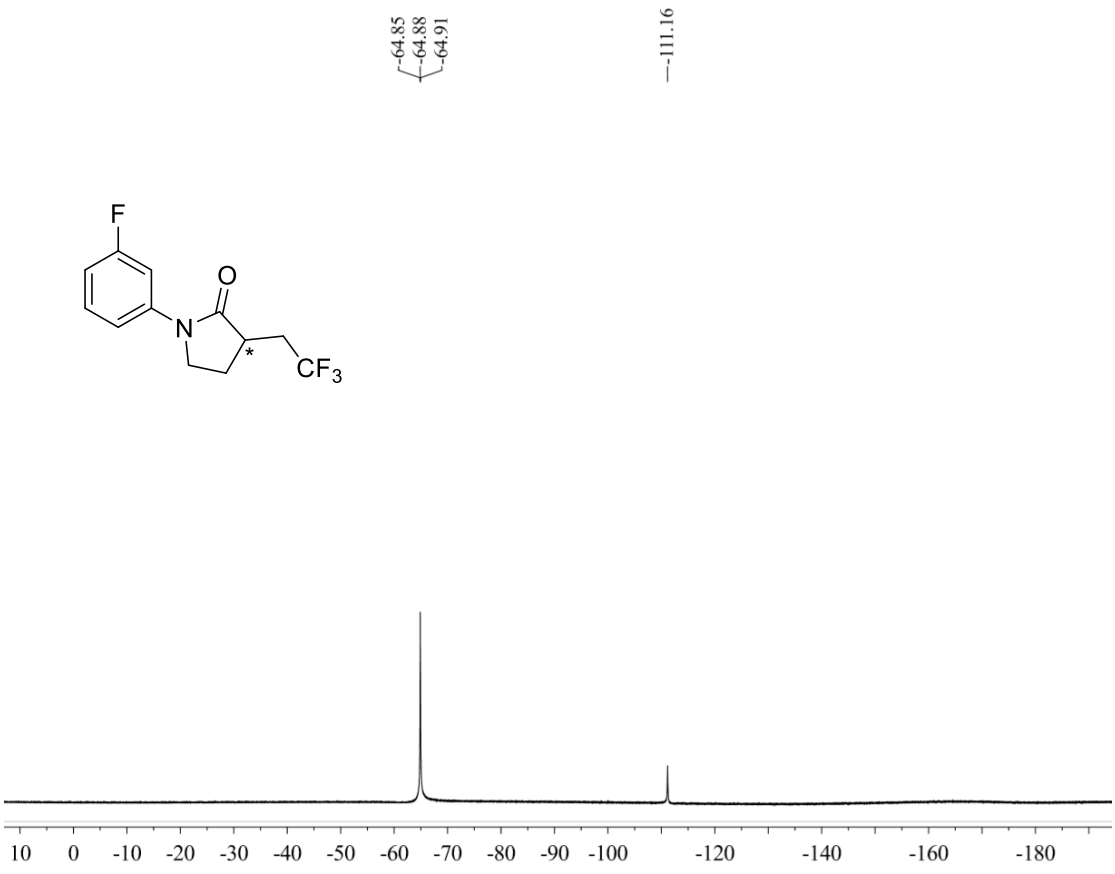



-64.86
-64.89
-64.92
MeO
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

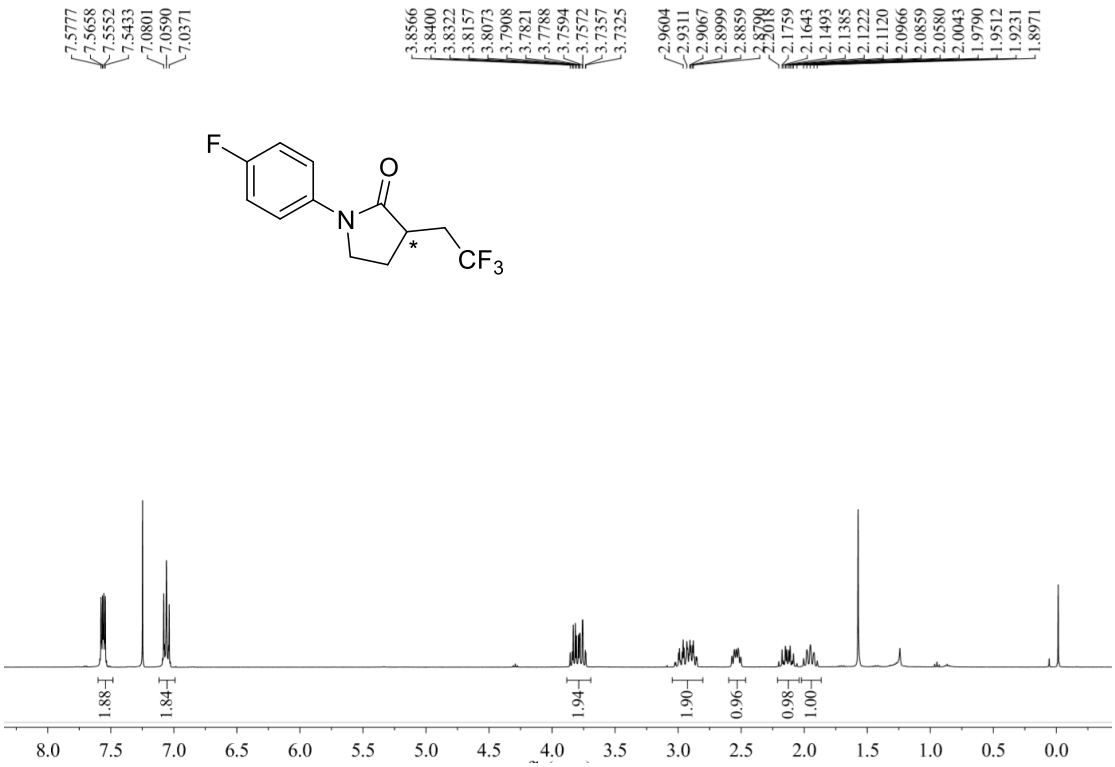
1-(3-fluorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2f**)

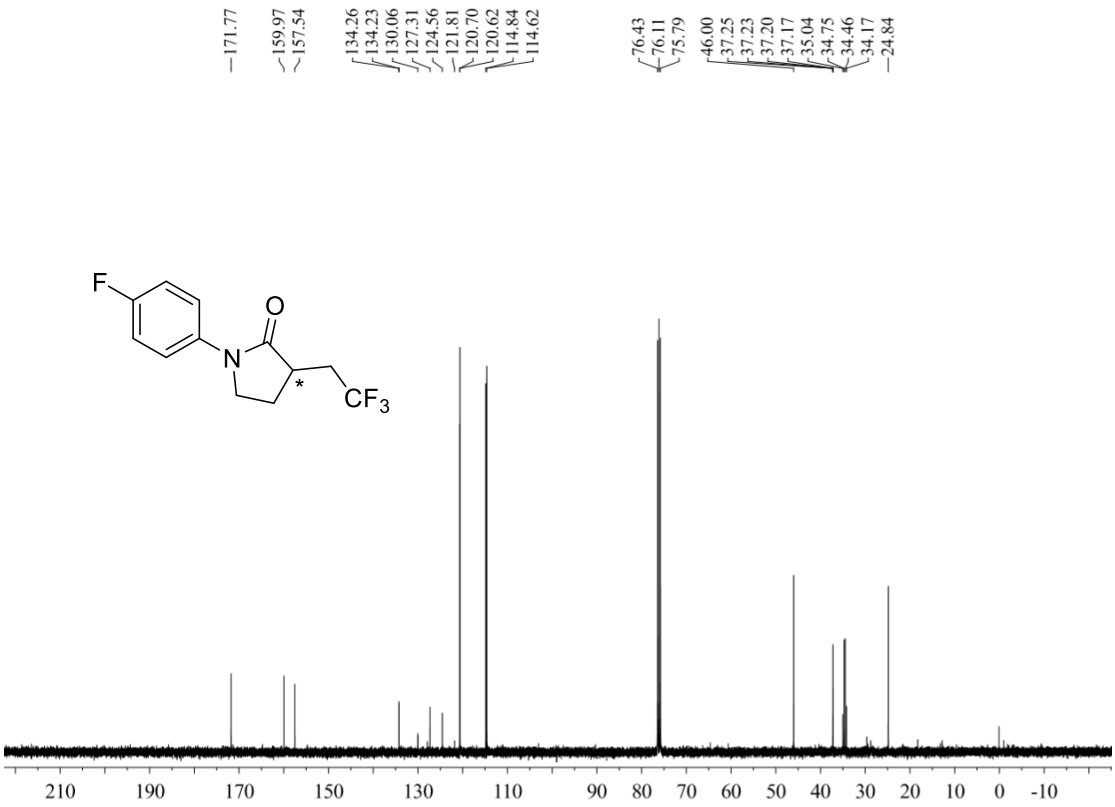


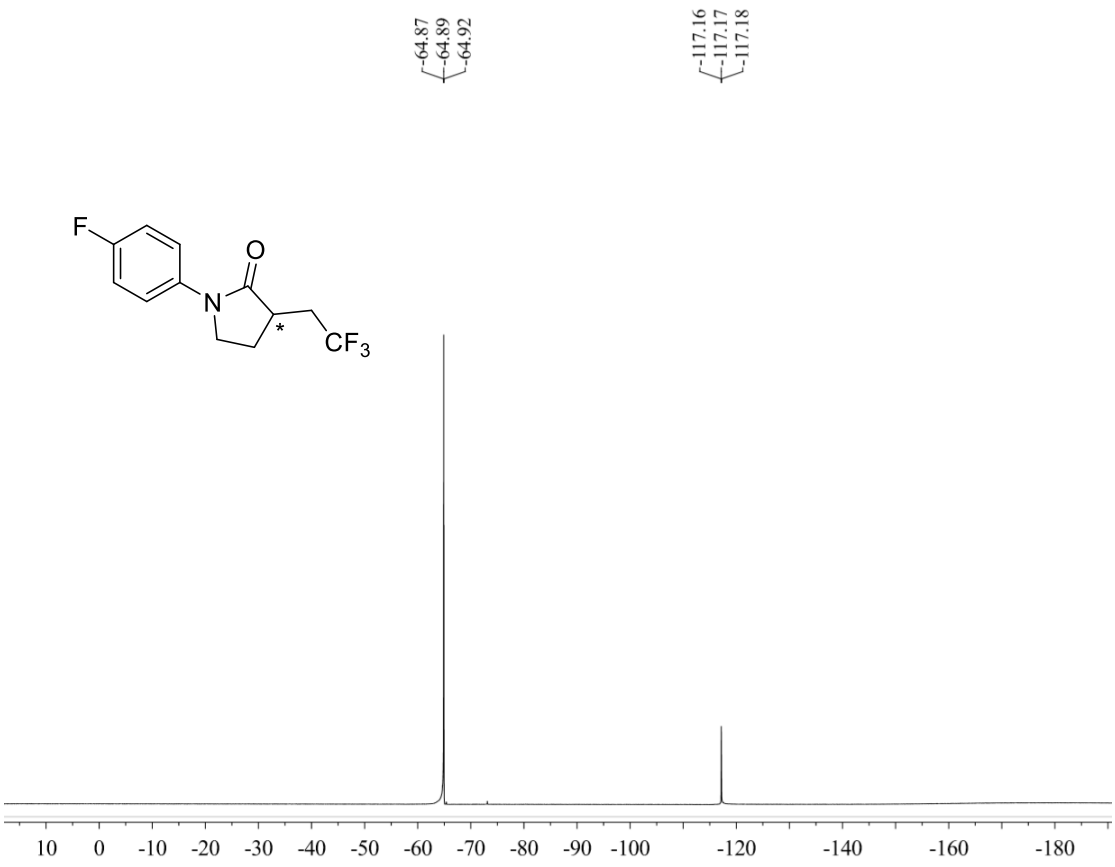



-64.85
-64.88
-64.91
-111.16
F
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

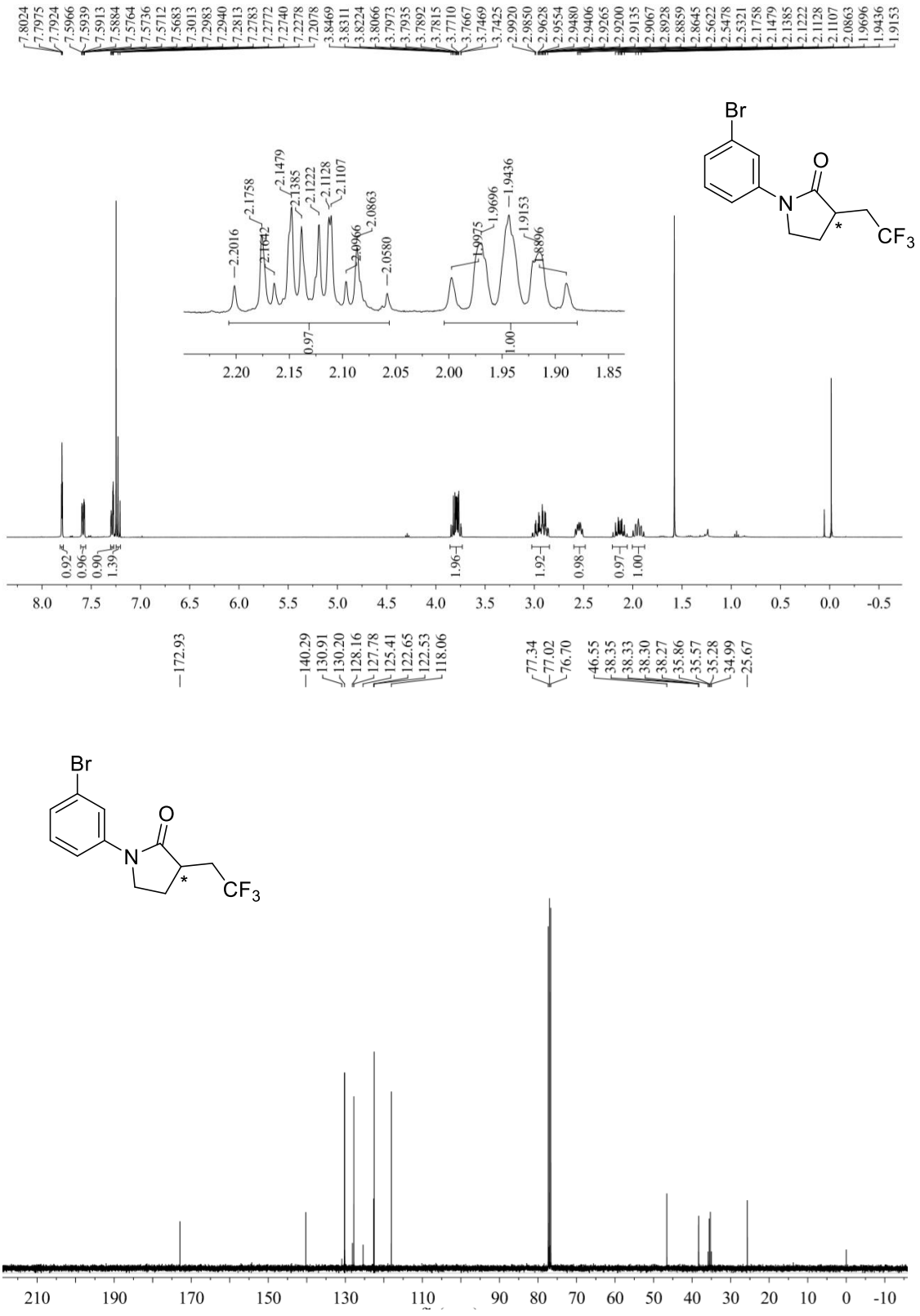
1-(4-fluorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2g**)

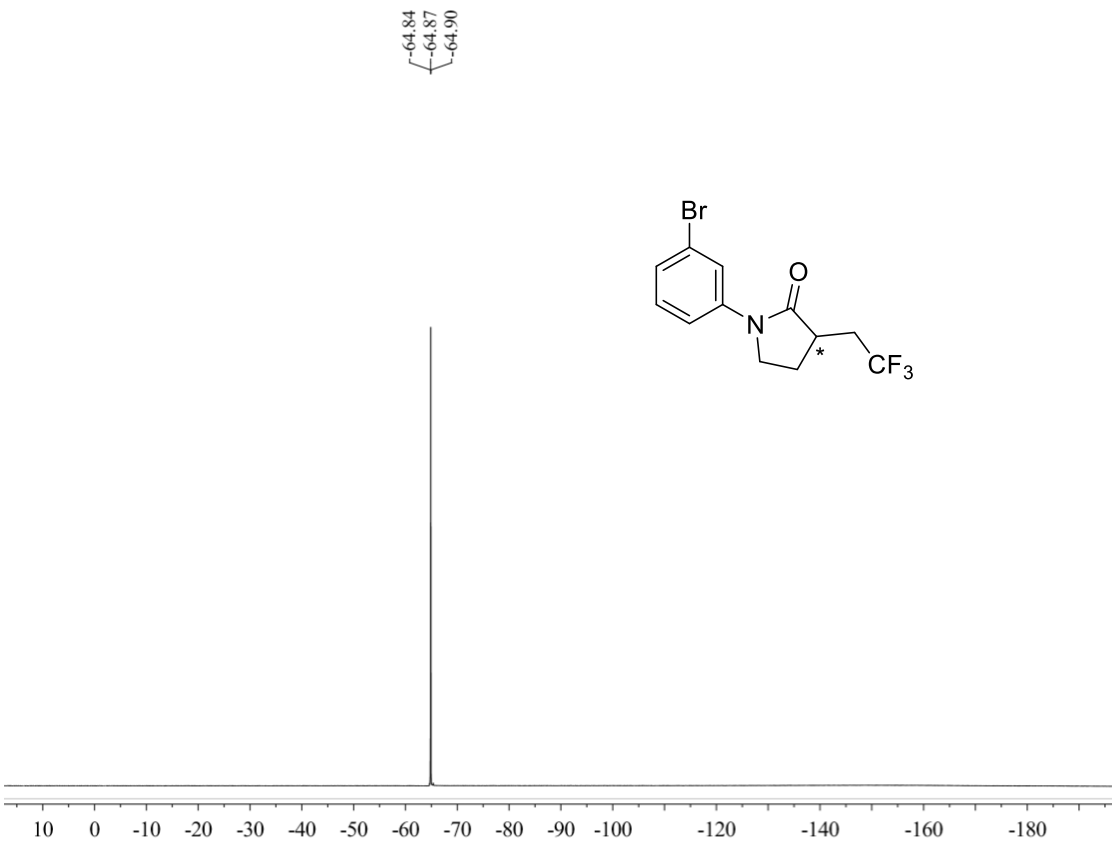




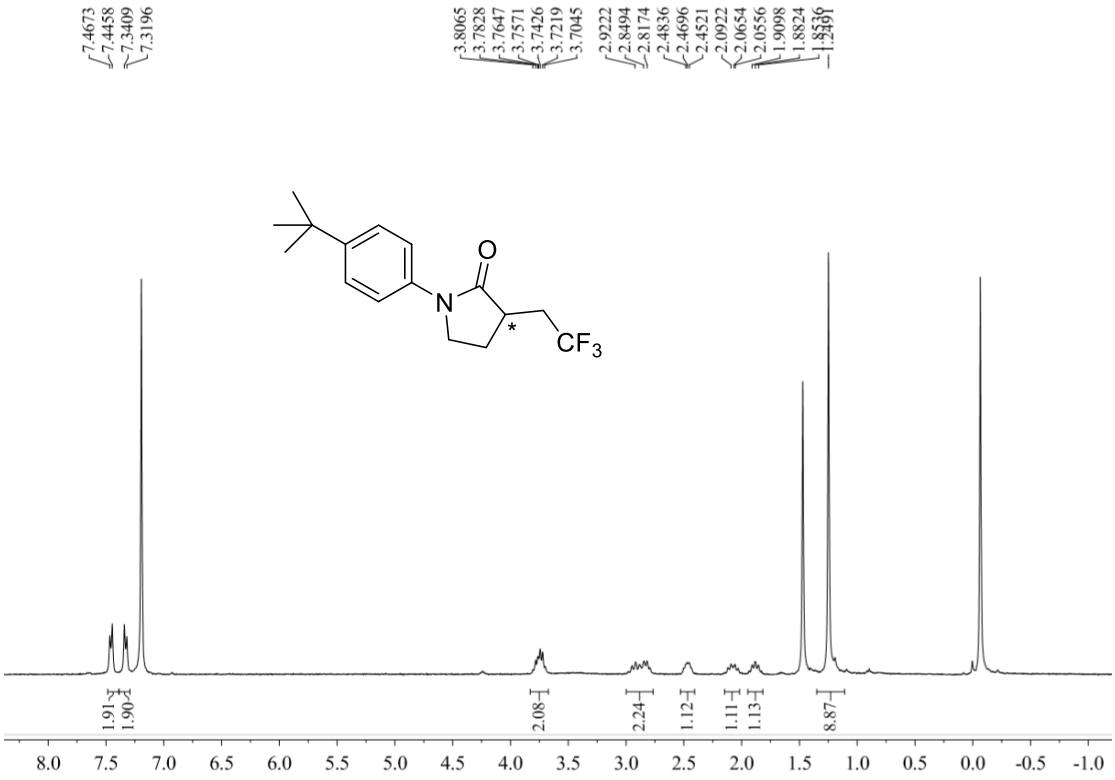

-64.87
-64.89
-64.92
-117.16
-117.17
-117.18
F
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

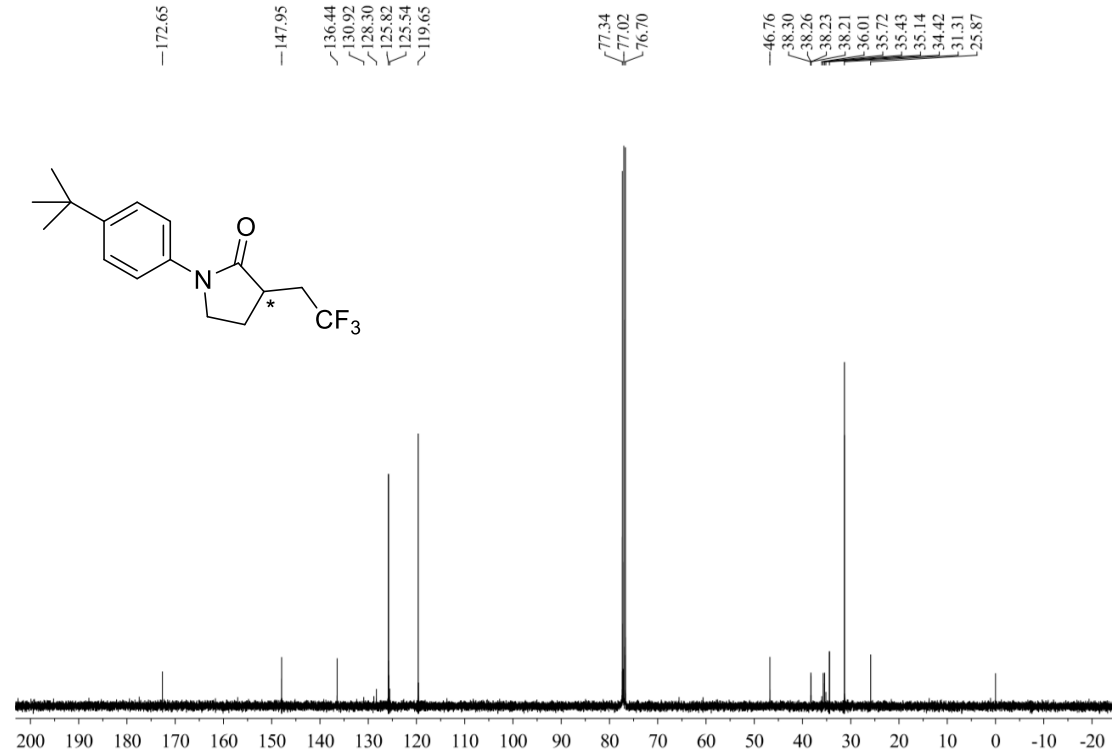
1-(3-bromophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2h**)

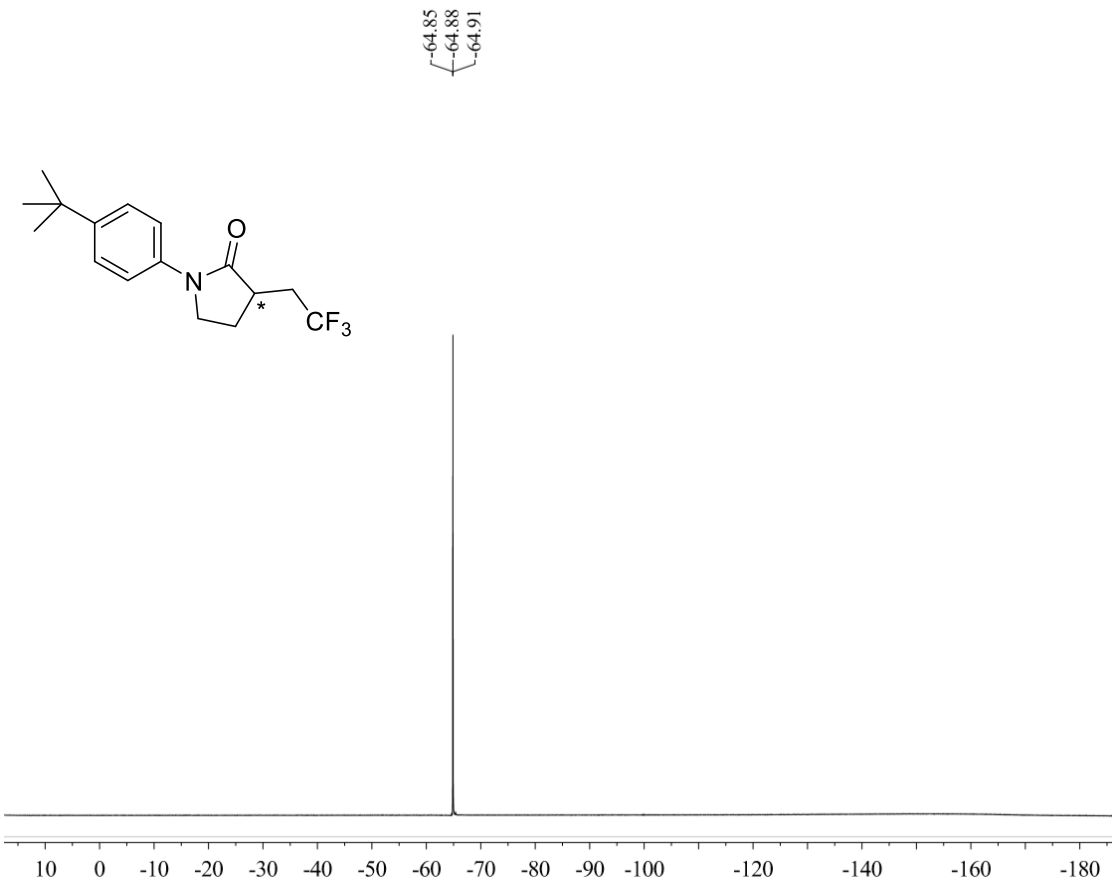



-64.84
-64.87
-64.90
Br
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

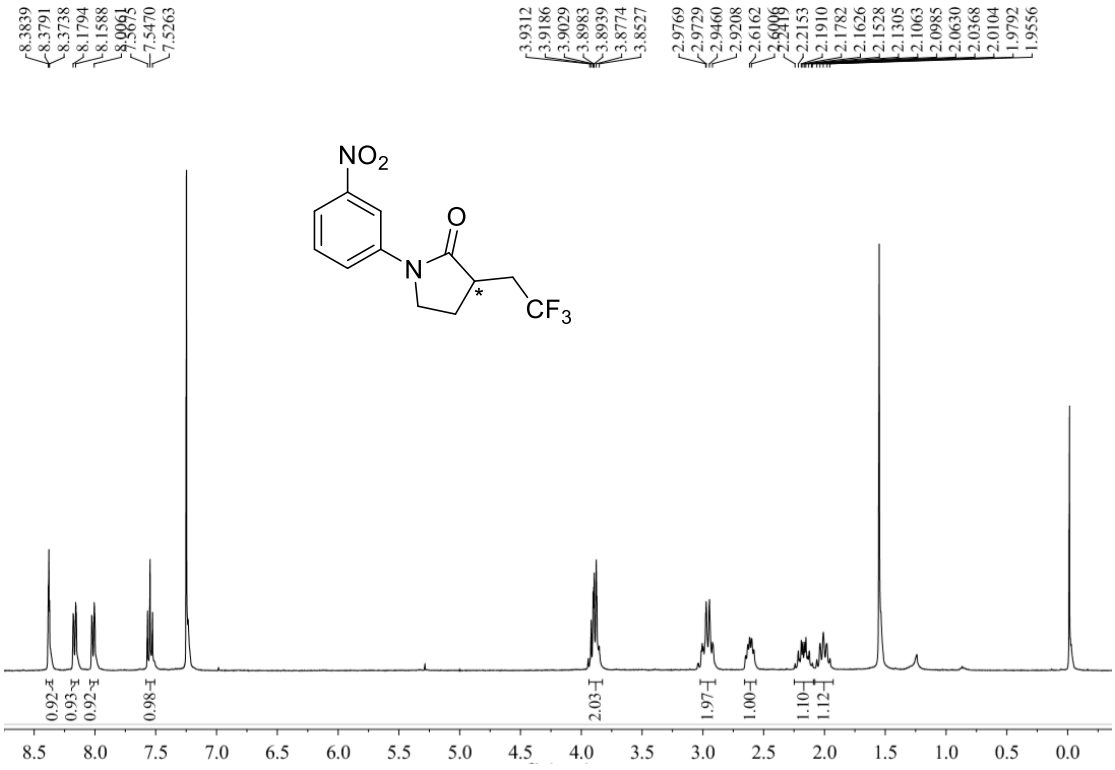
1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2i**)

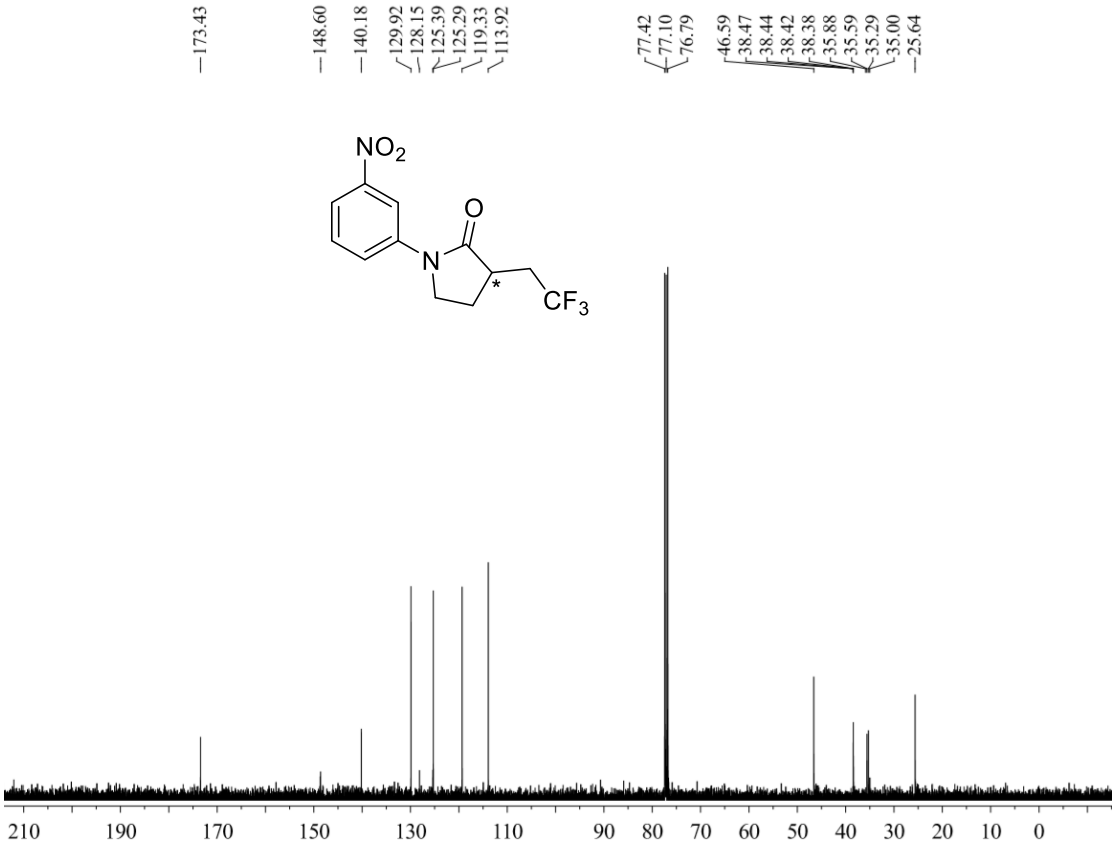


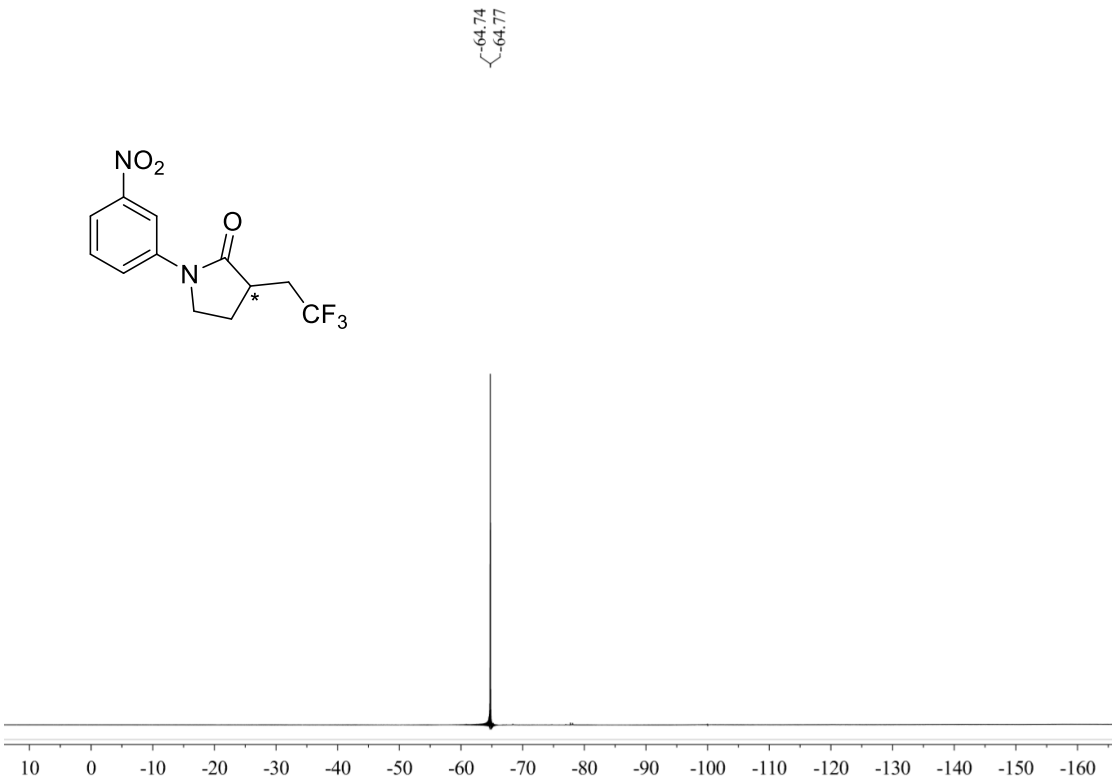



-64.85
-64.88
-64.91
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

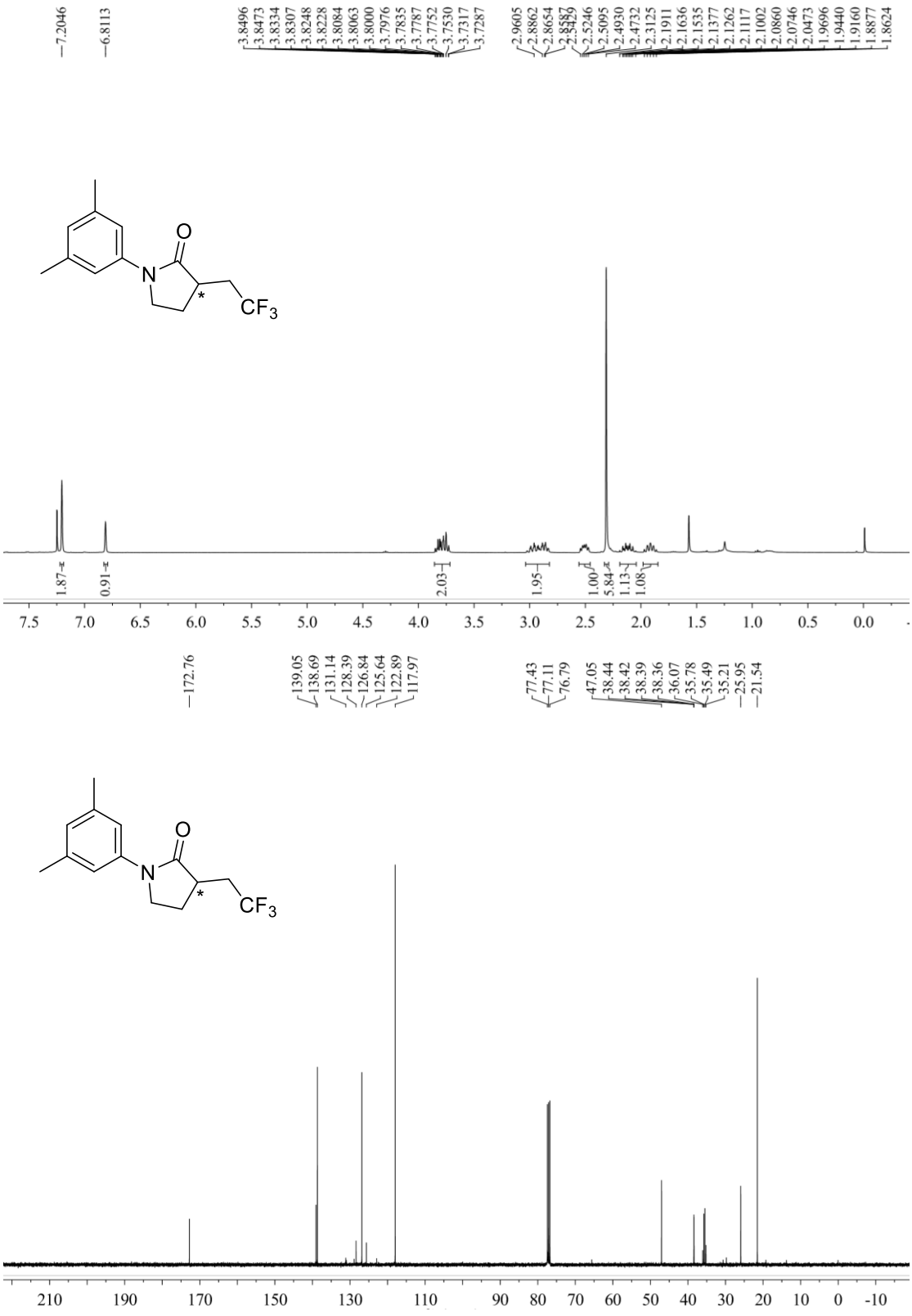
1-(3-nitrophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2j**)

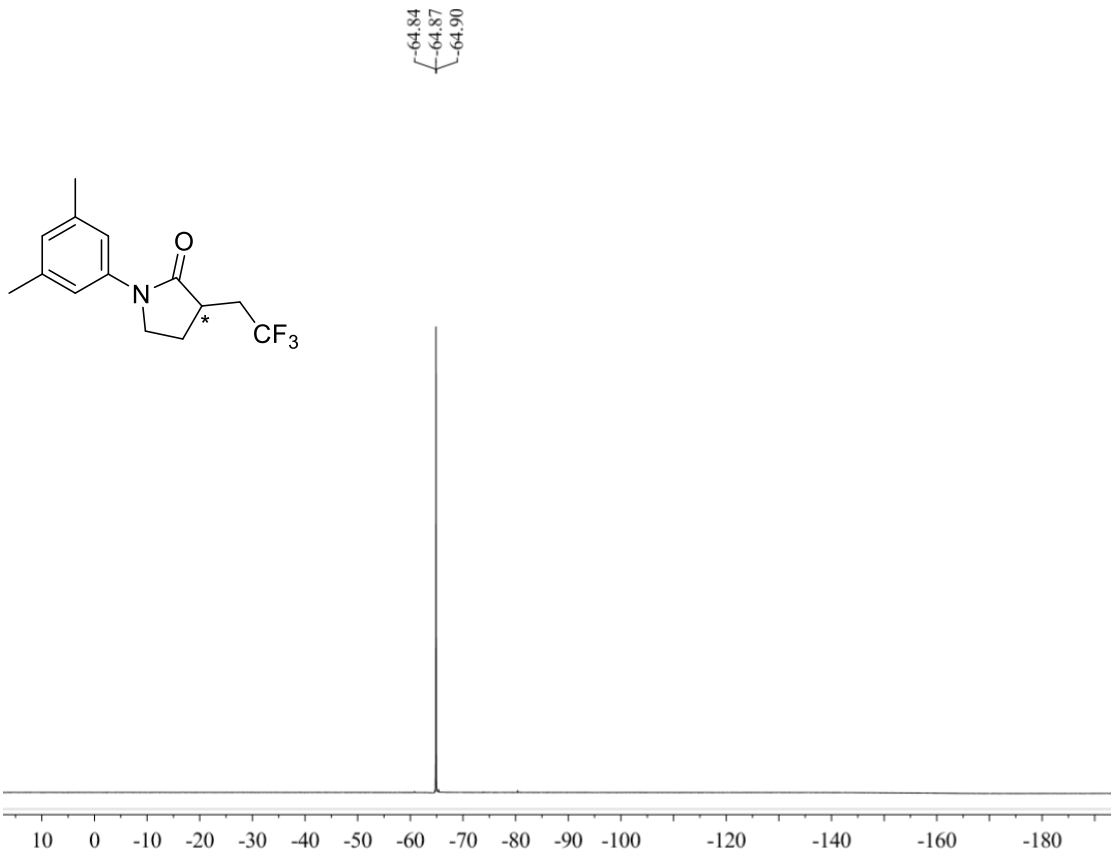




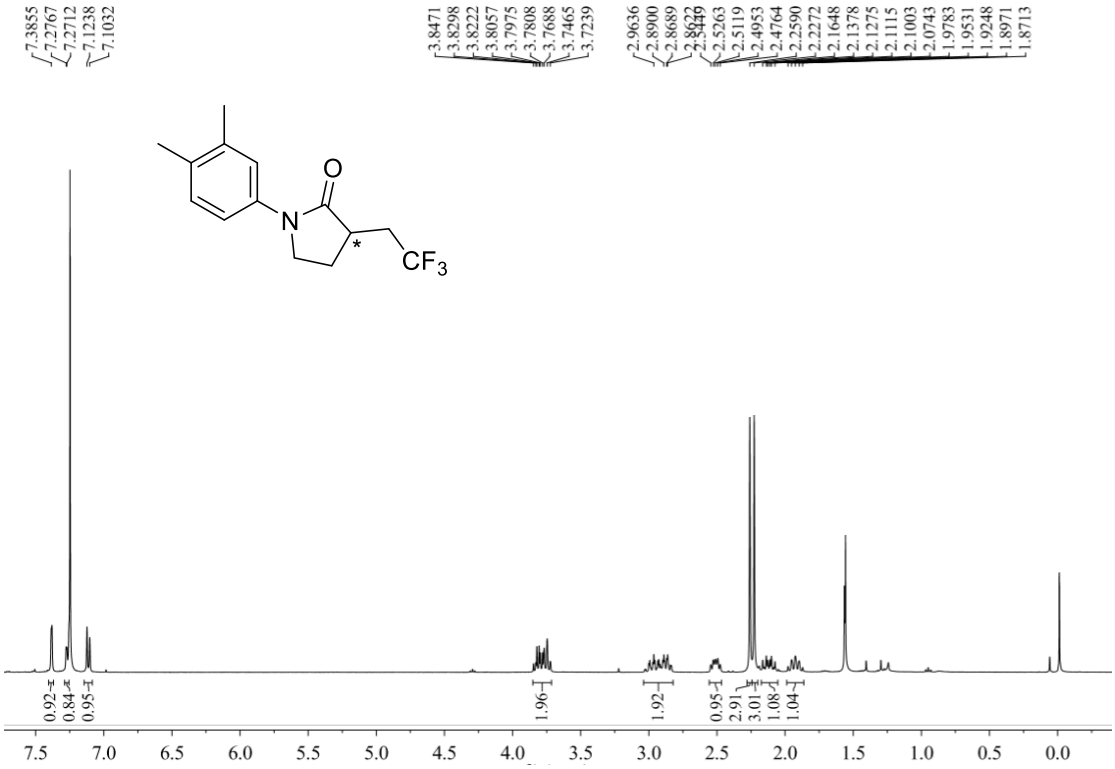

-64.74
-64.77
NO2
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160

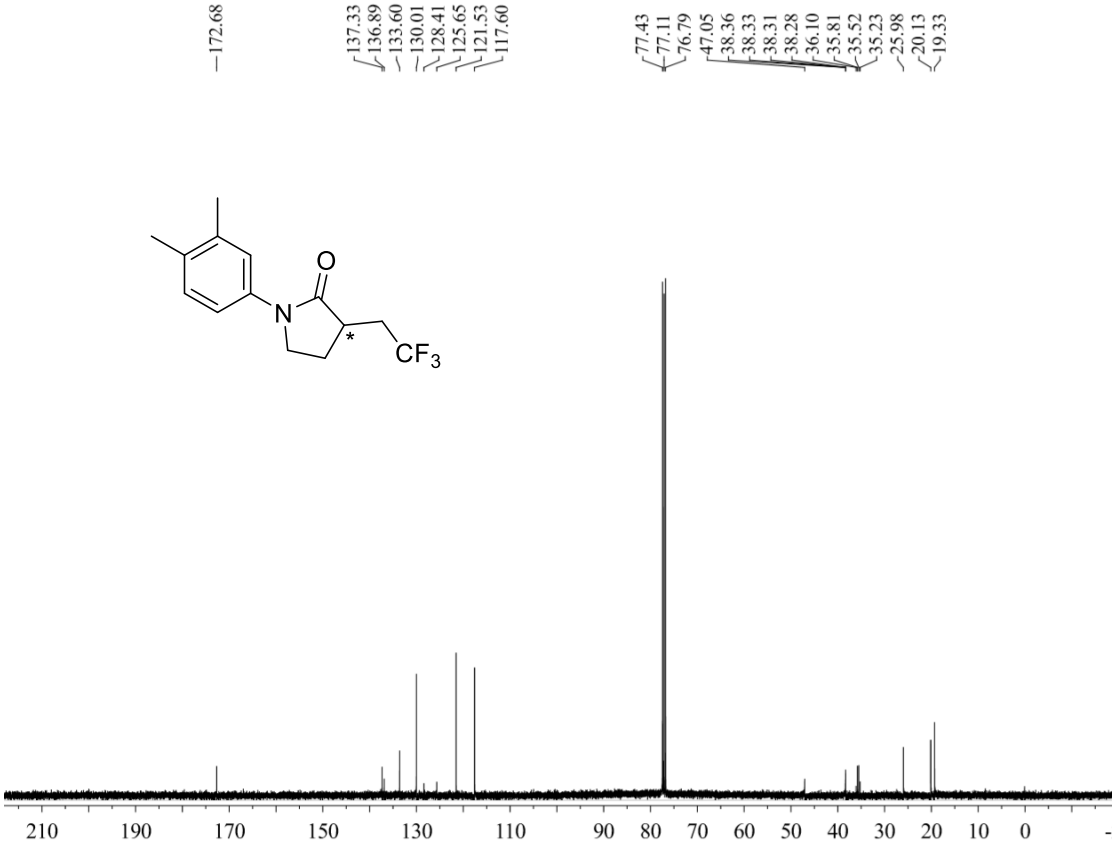
1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2k**)

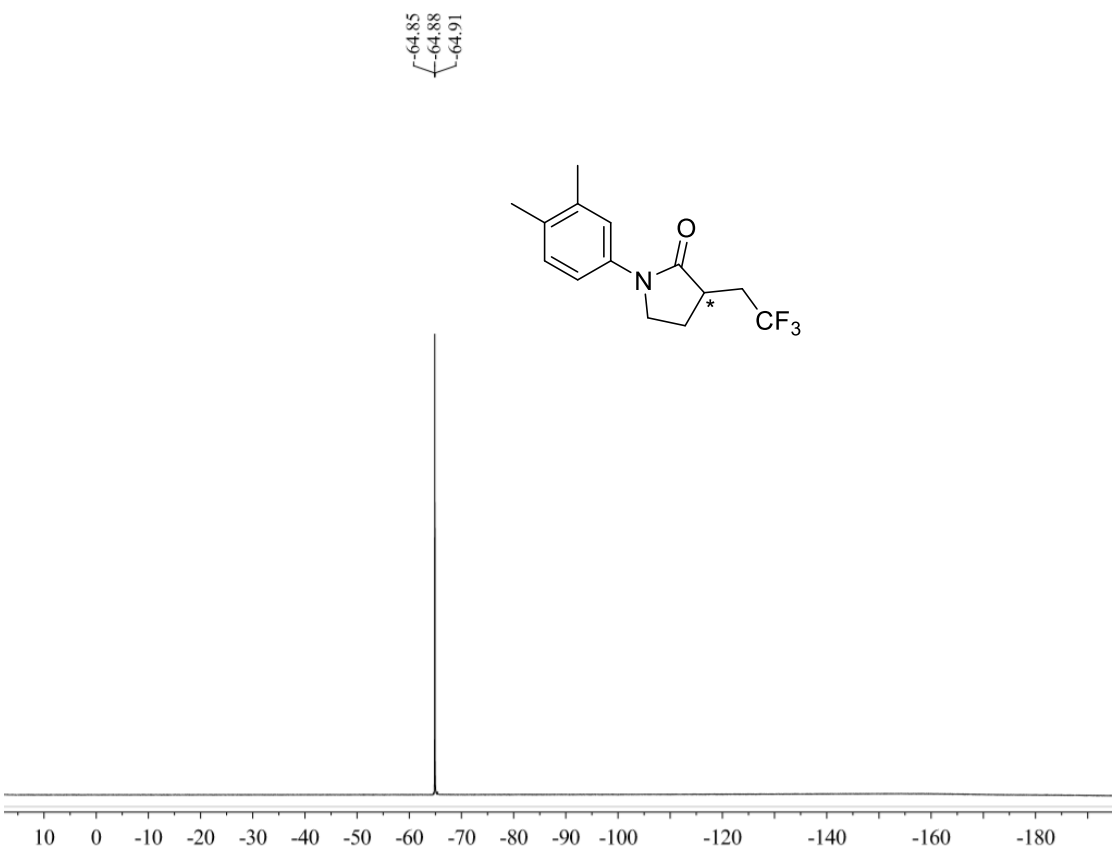



-64.84
-64.87
-64.90
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

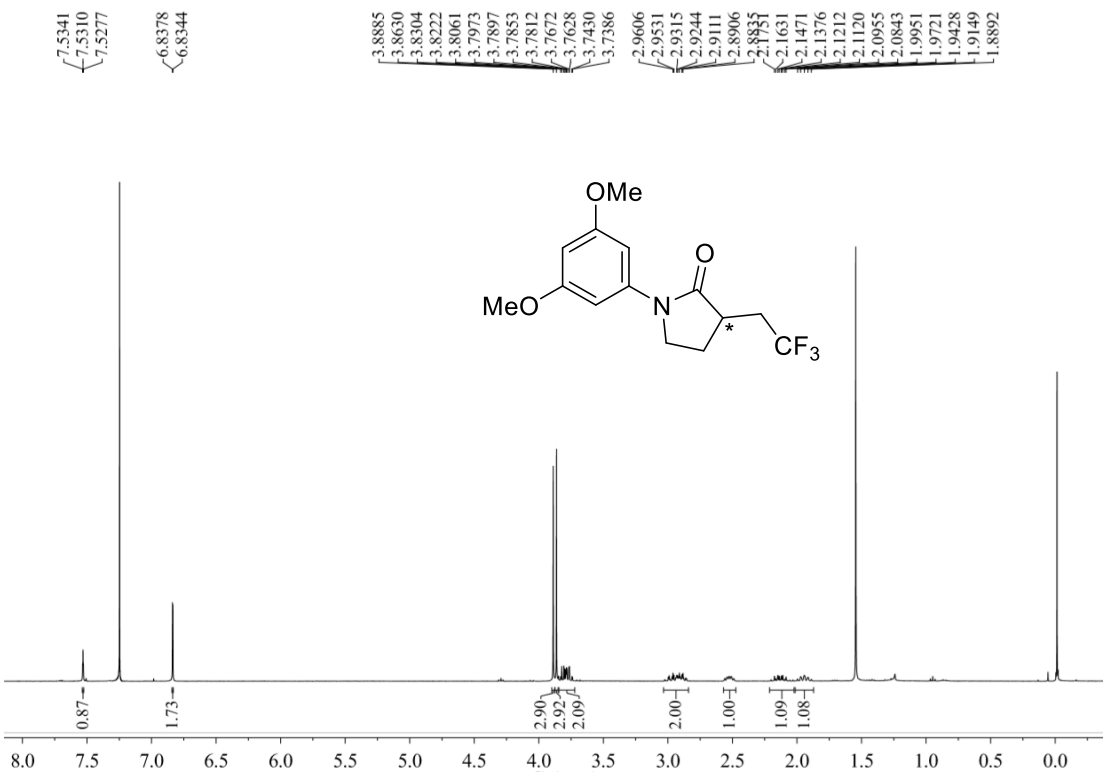
1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2l**)

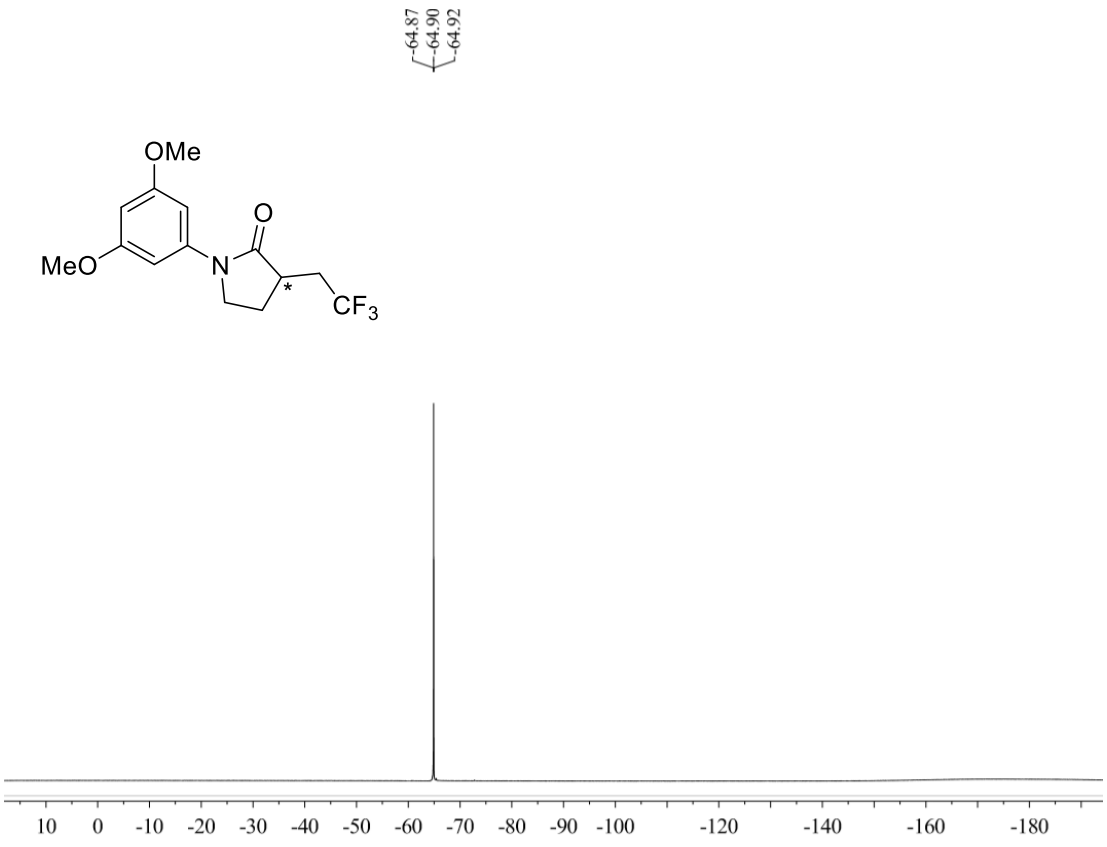




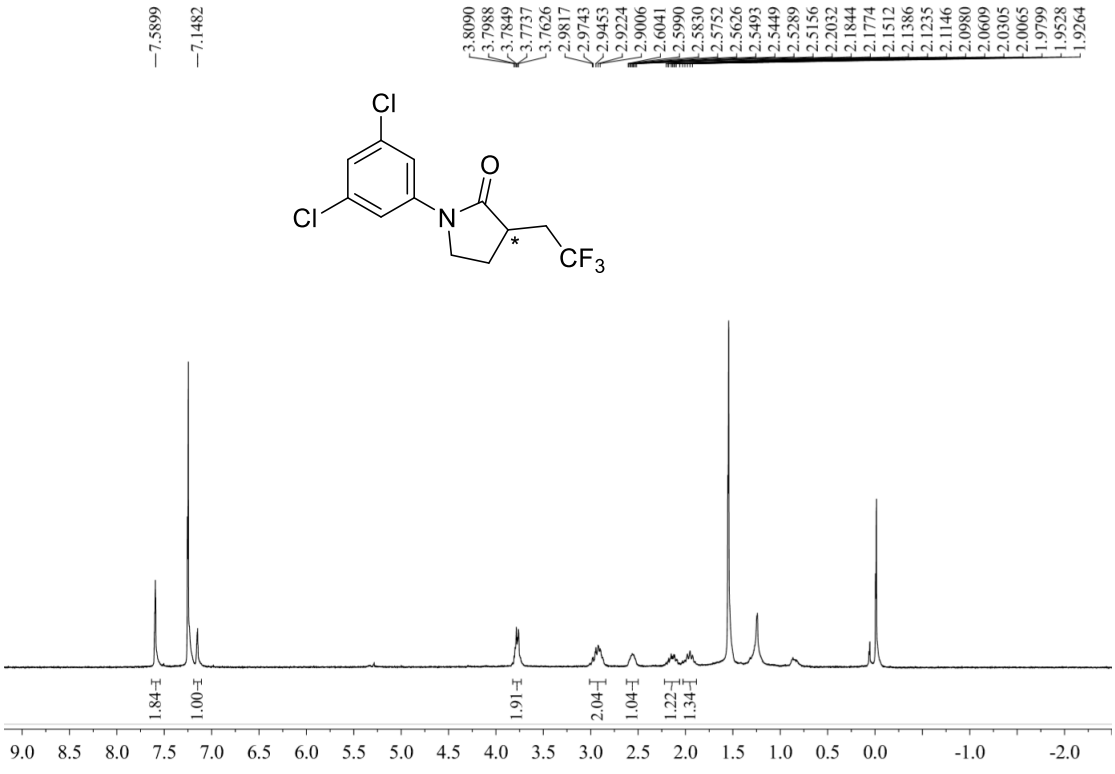

-64.85
-64.88
-64.91
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

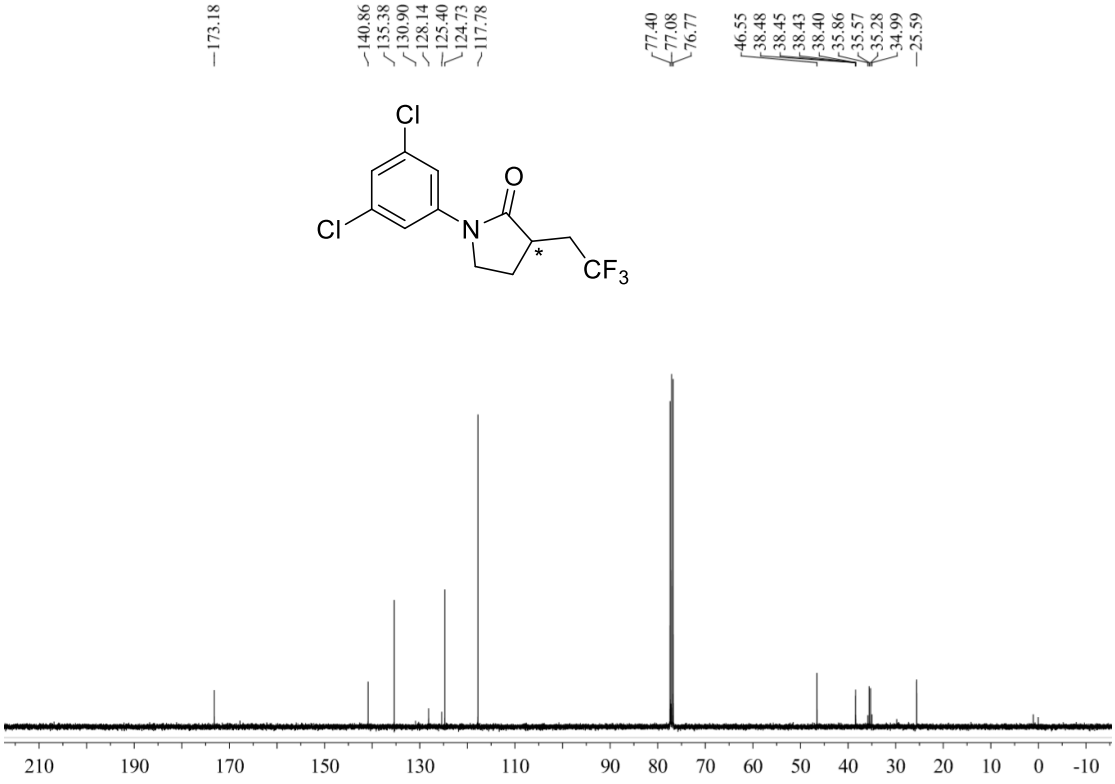
1-(3,5-dimethoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2m**)

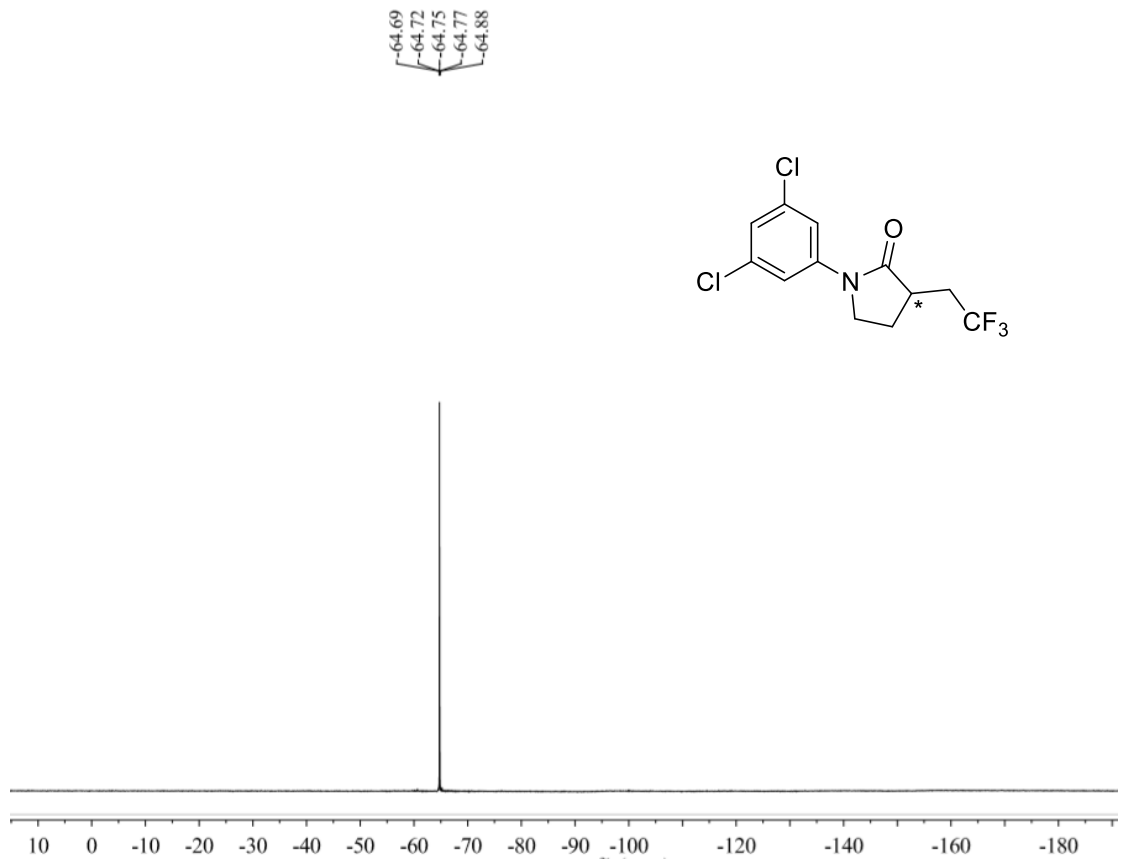



-64.87
-64.90
-64.92
OMe
MeO
N
O
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

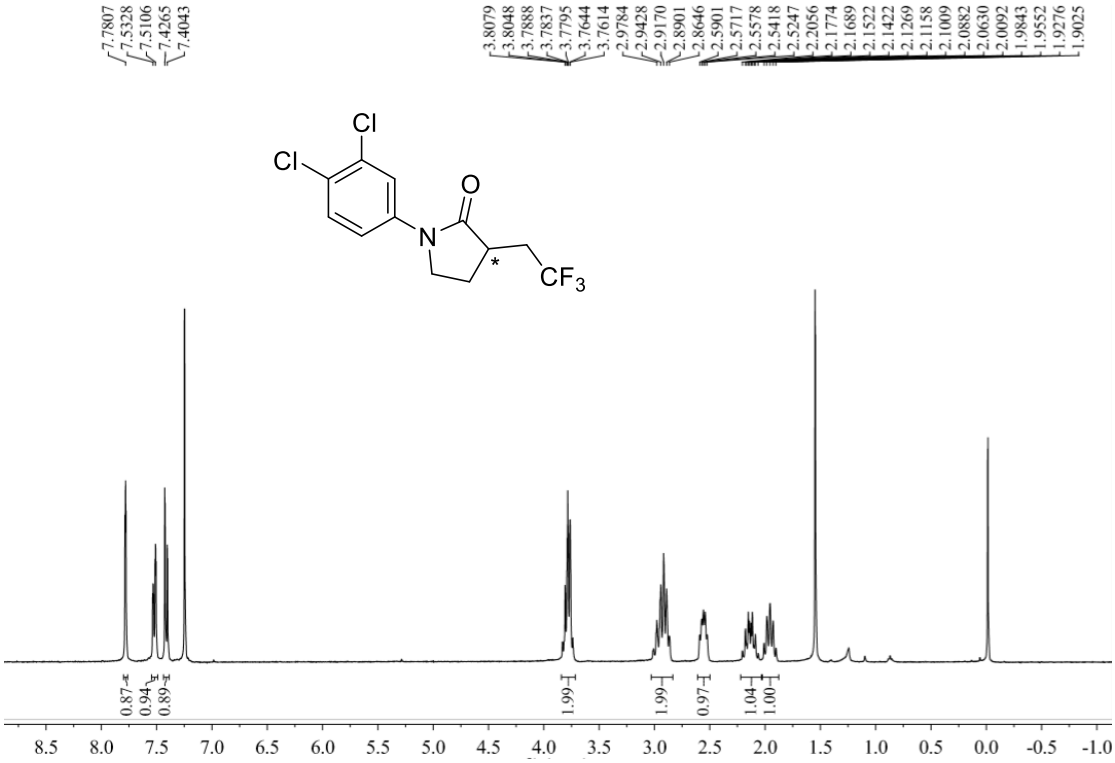
1-(3,5-dichlorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2n**)

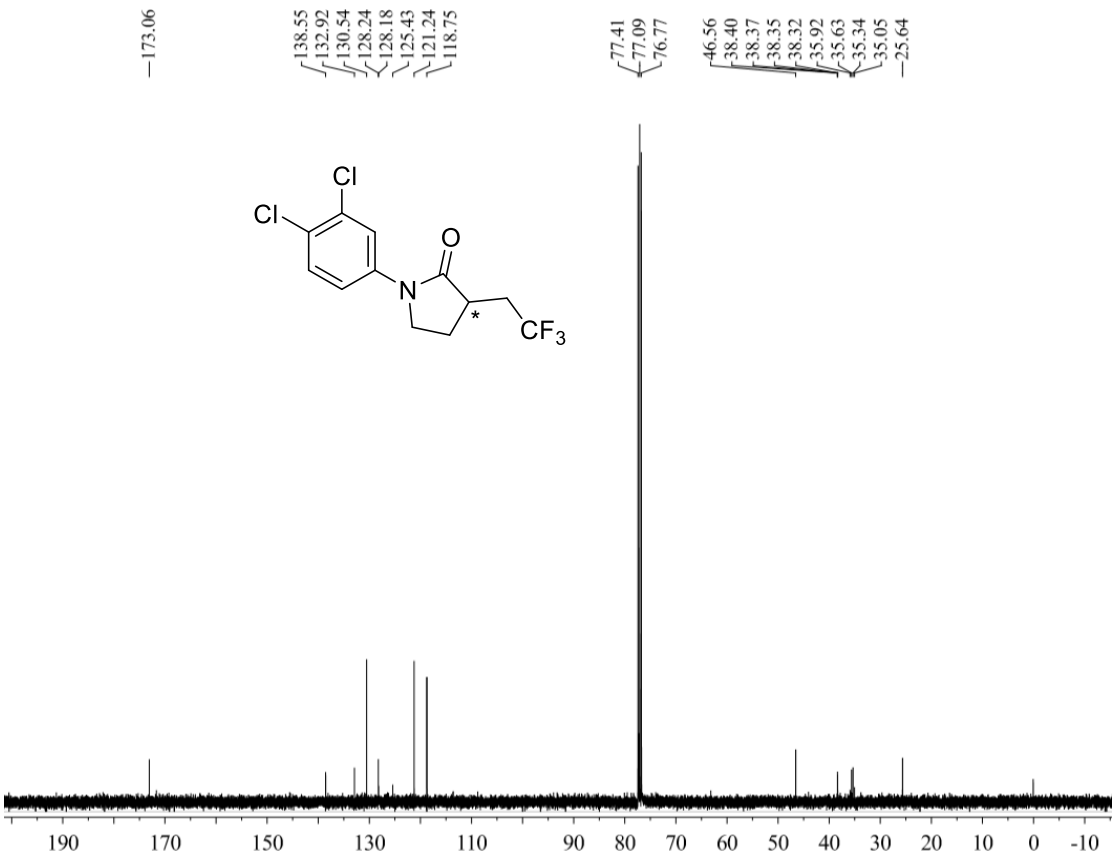


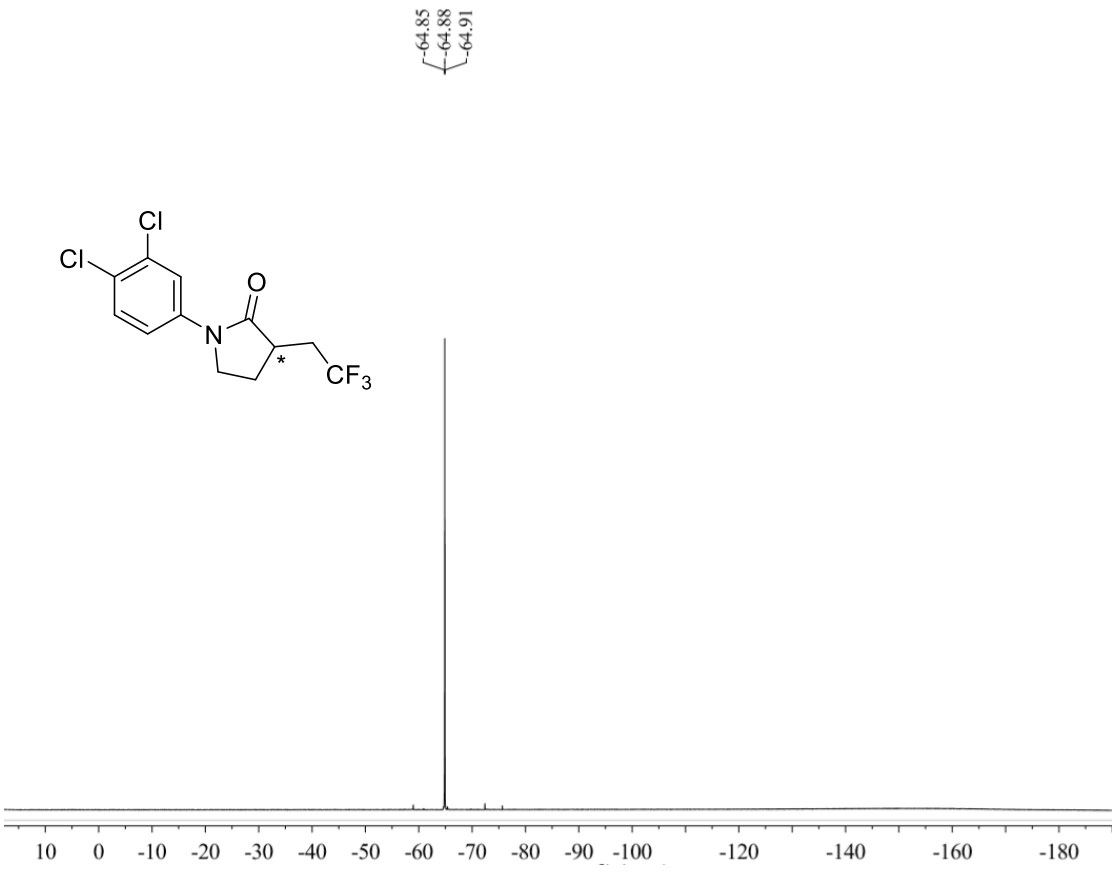



-64.69
-64.72
-64.75
-64.77
-64.88
Cl
Cl
N
O
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

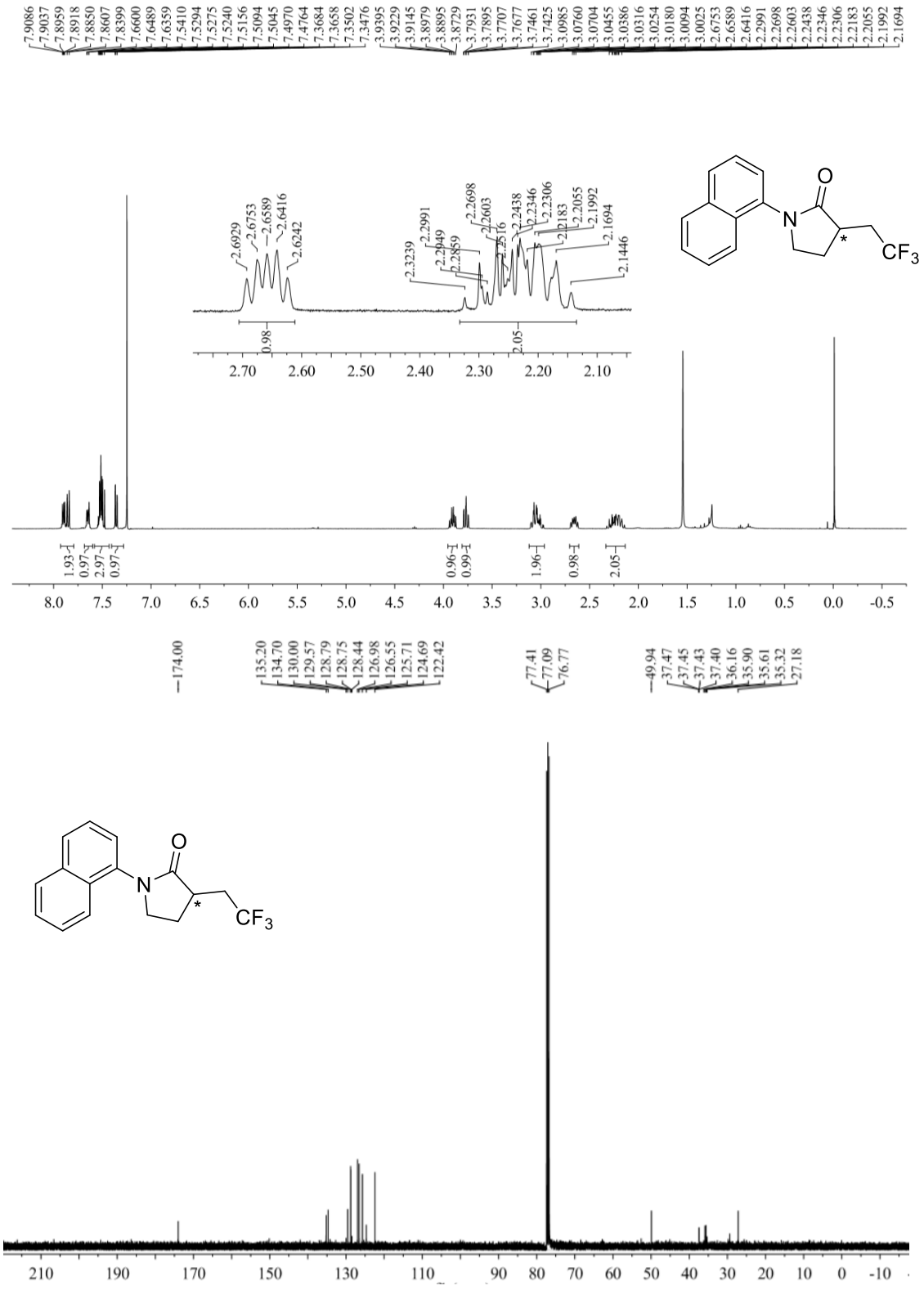
1-(3,4-dichlorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2o**)

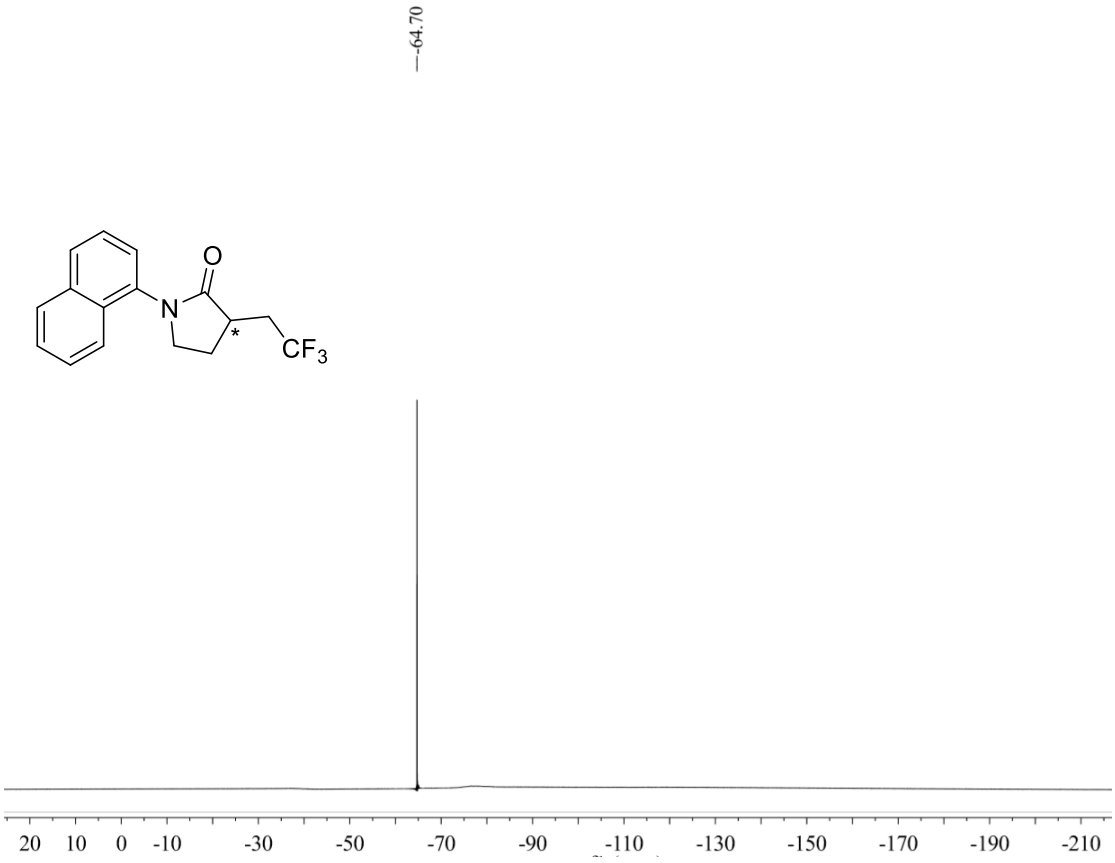




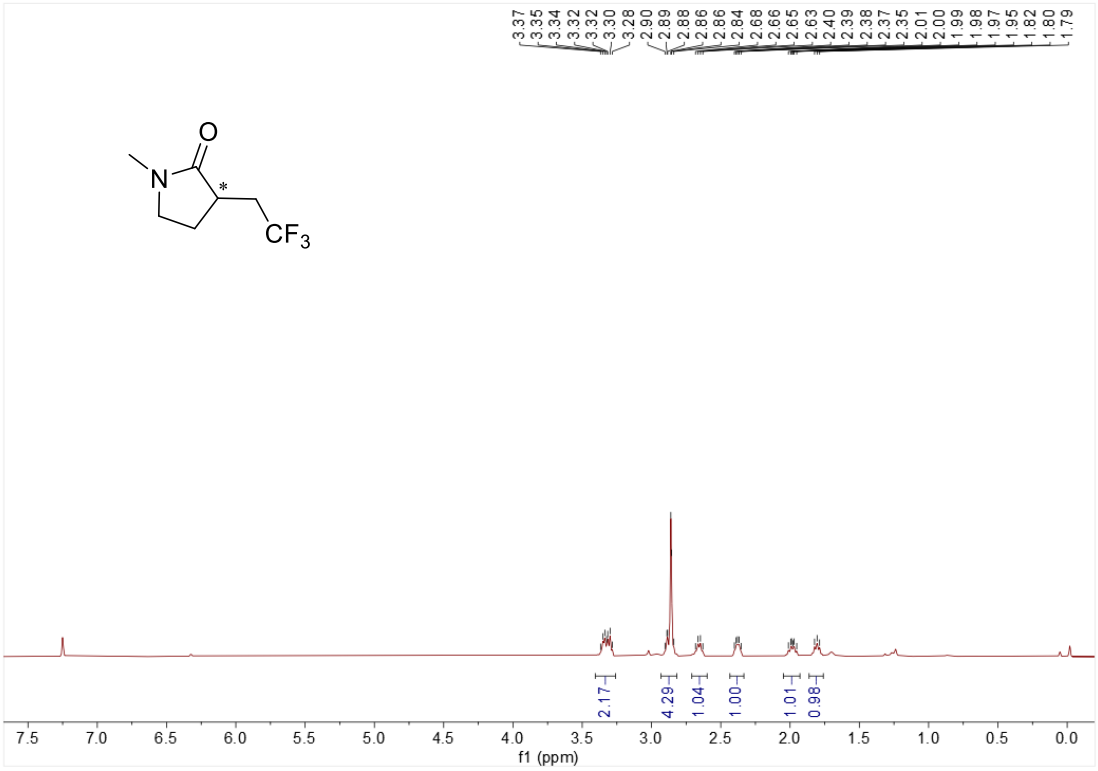

-64.85
-64.88
-64.91
Cl
Cl
O
N
*
CF3
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180

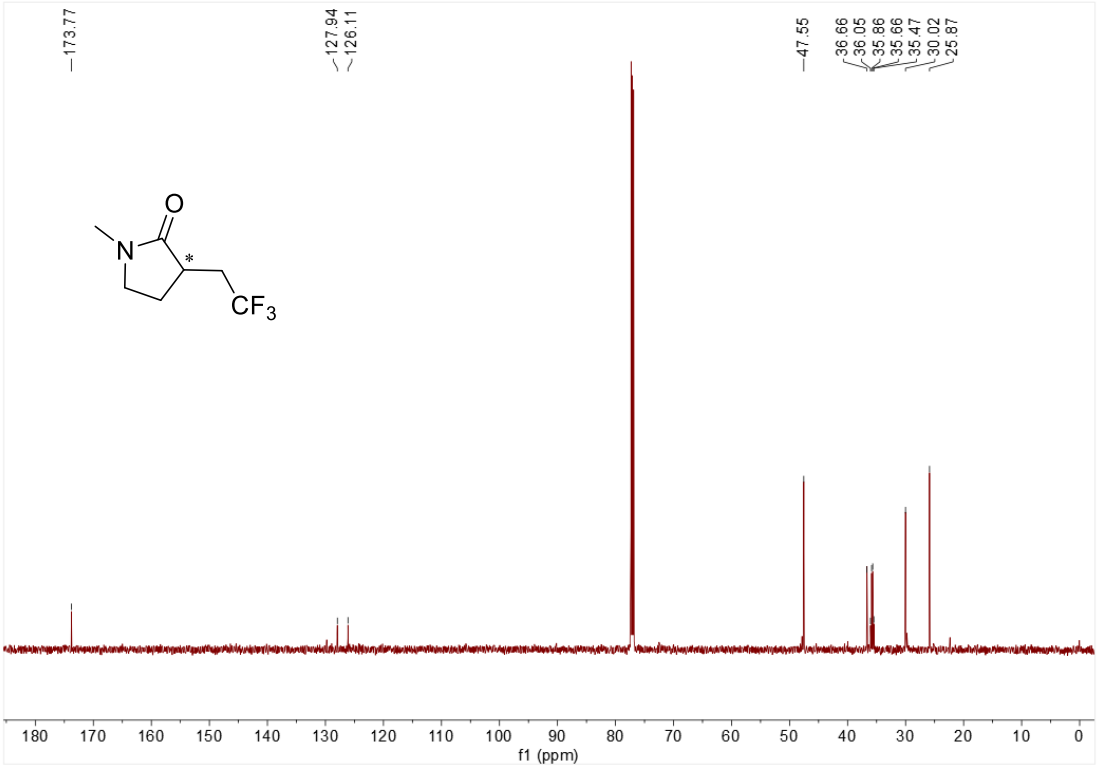
1-(naphthalen-1-yl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2p**)

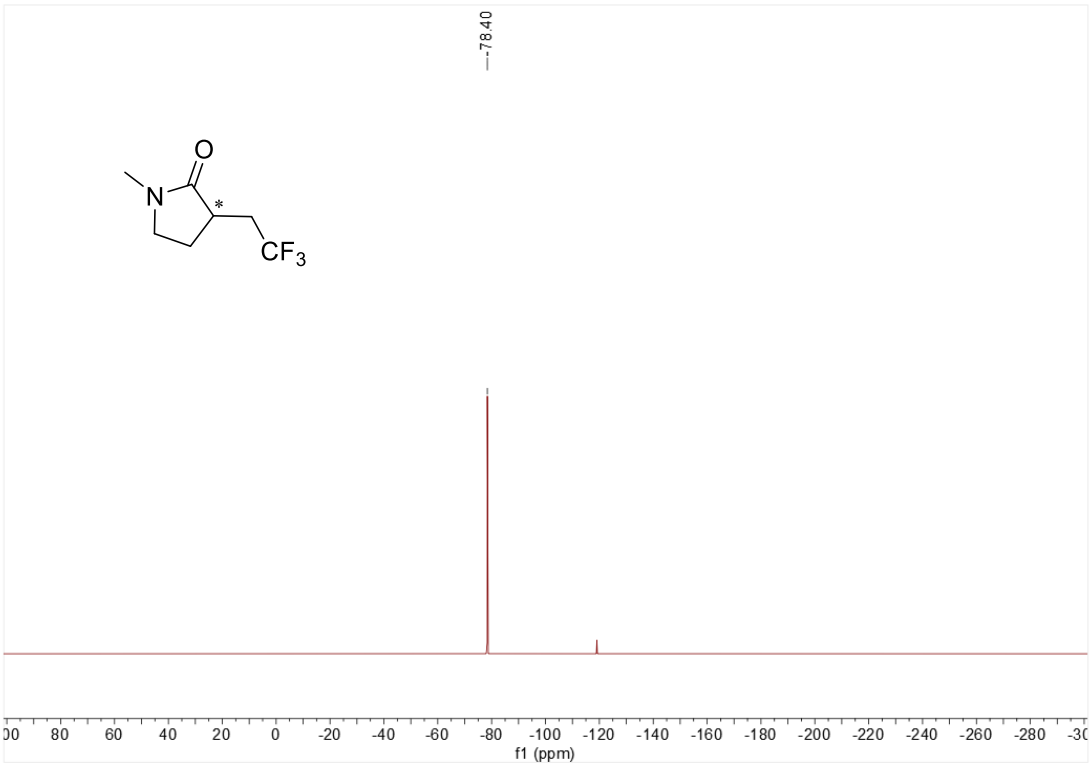



-64.70
O
N
*
CF3
20
10
0
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210

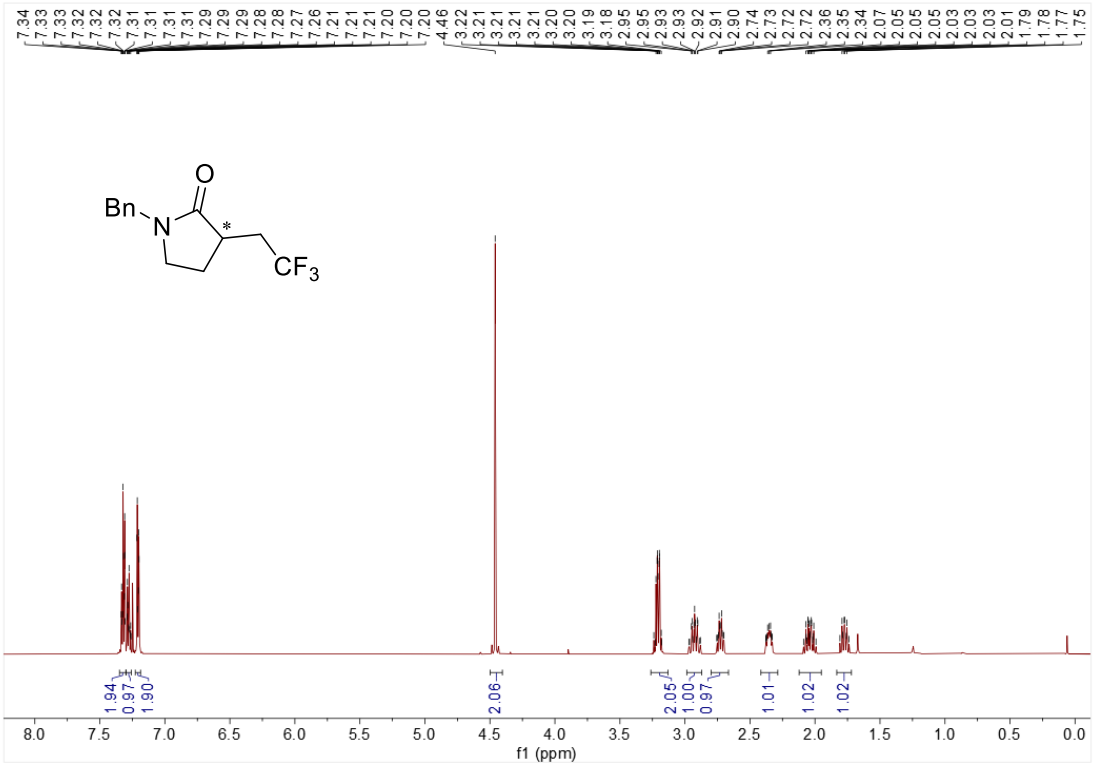
1-methyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2q**)

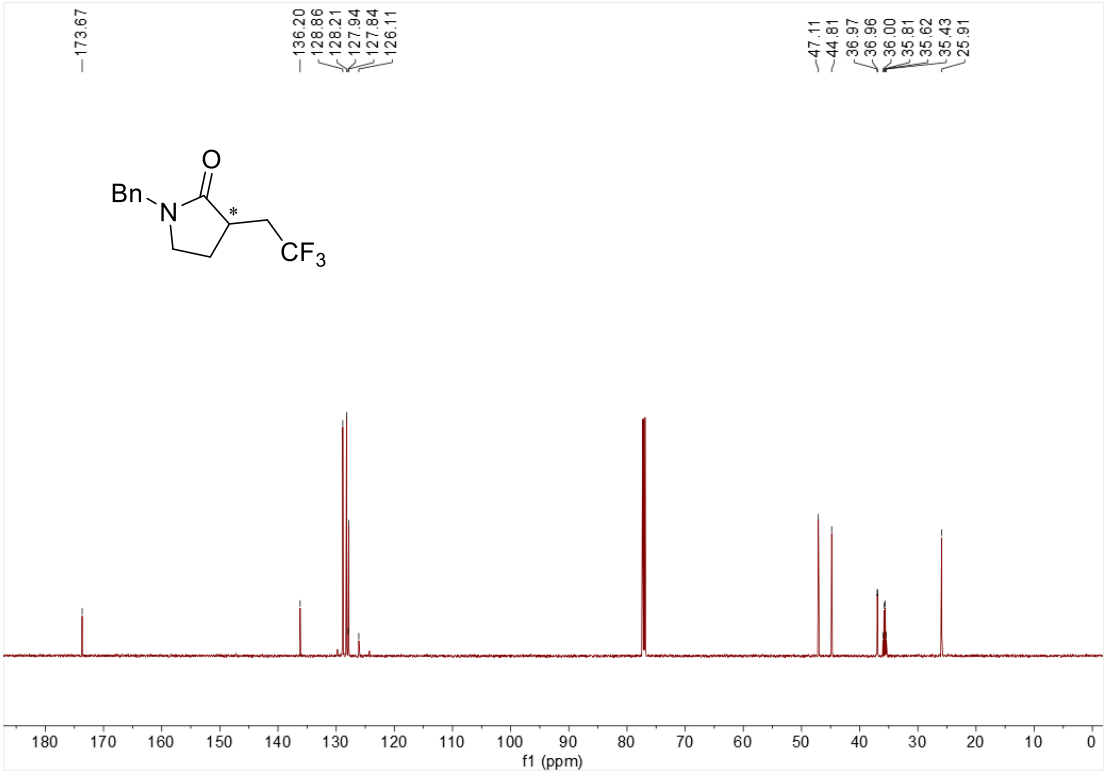


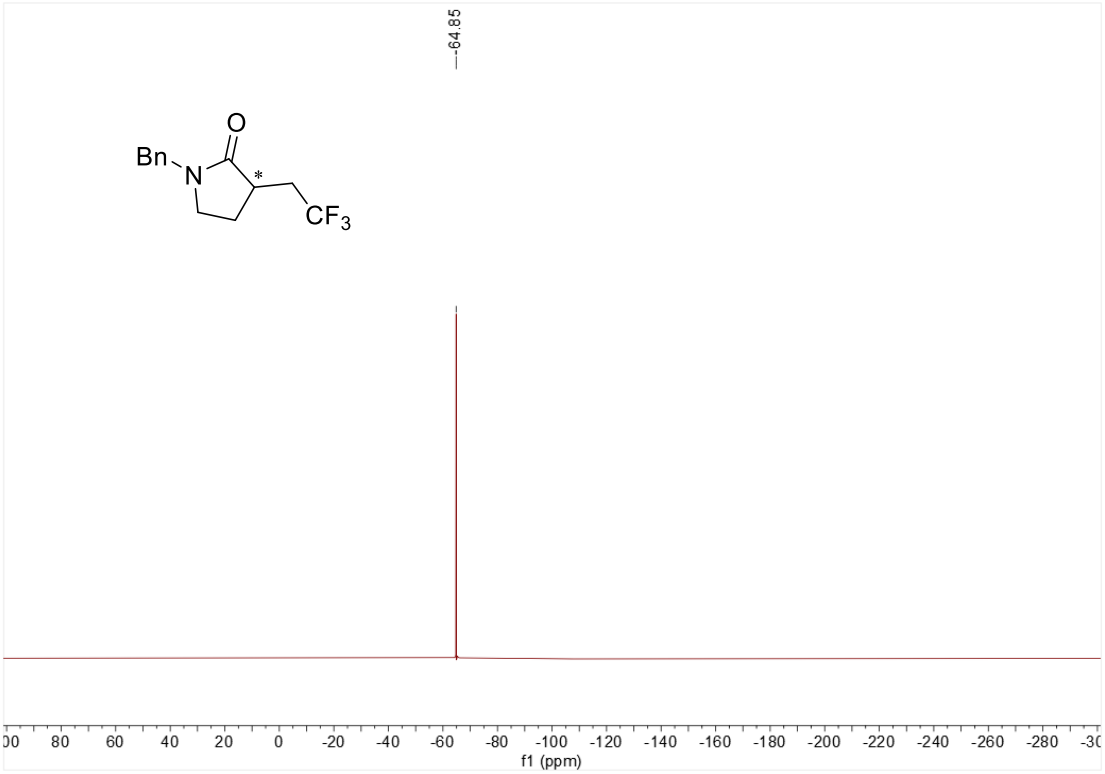



-78.40
O
N
*
CF3
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

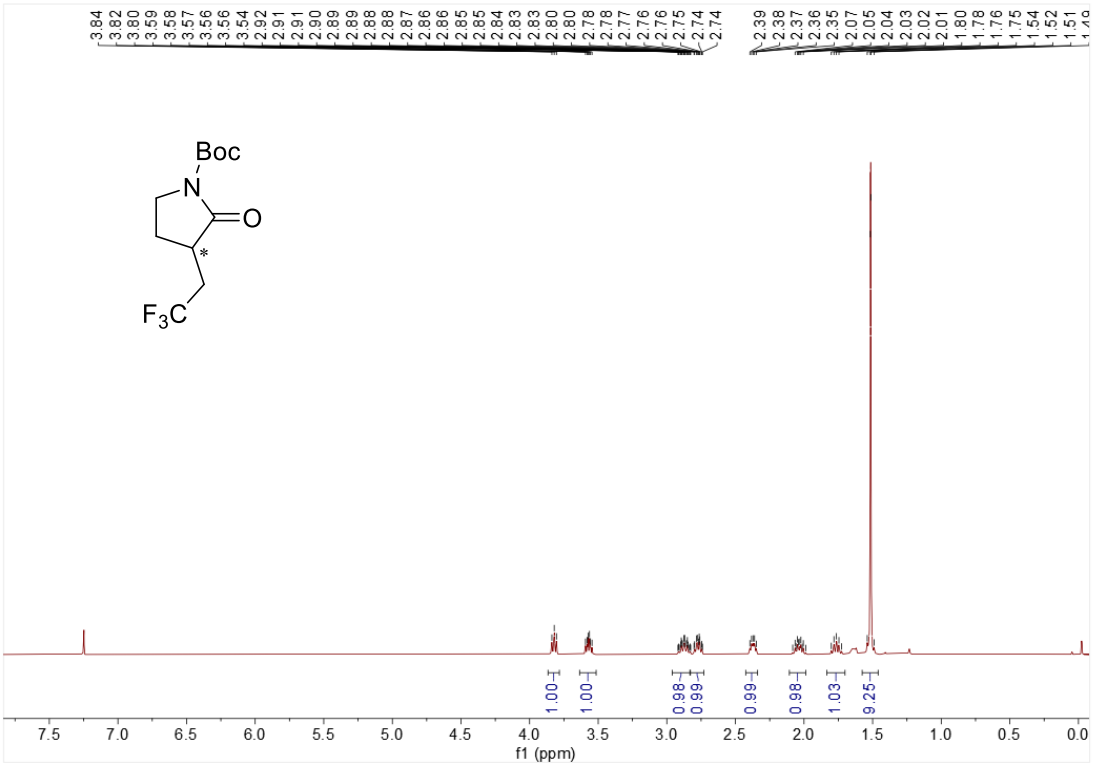
1-benzyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2r**)

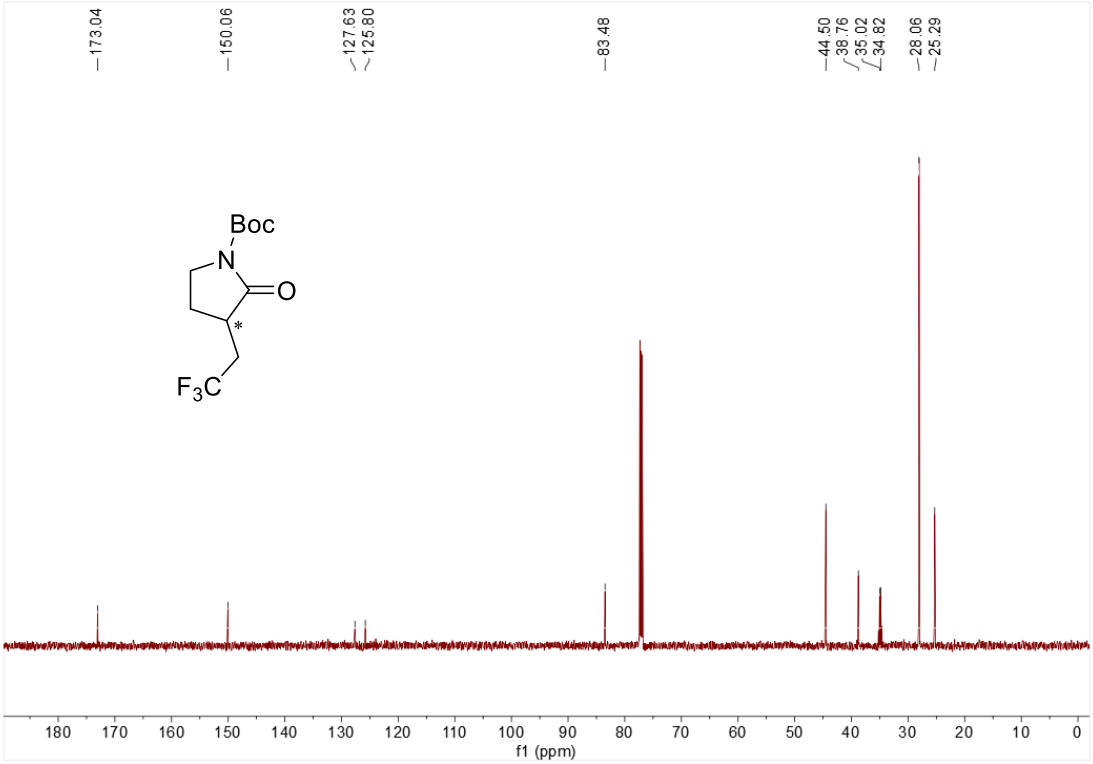


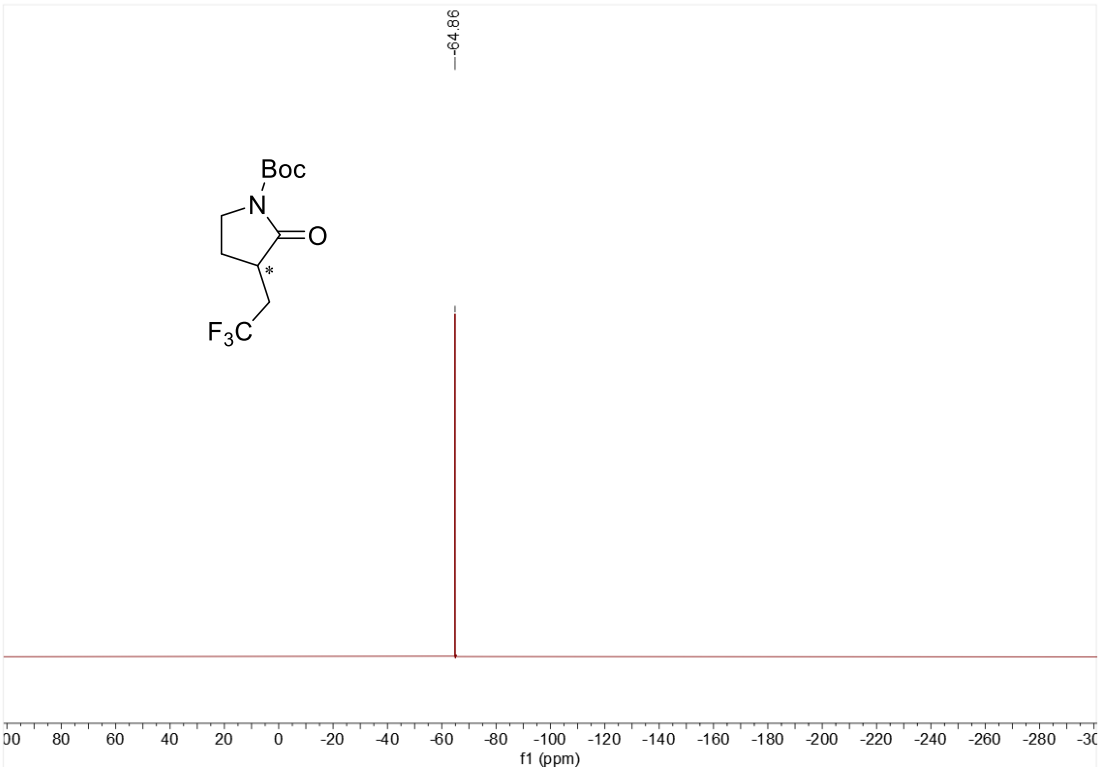



-64.85
O
Bn
N
*
CF3
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

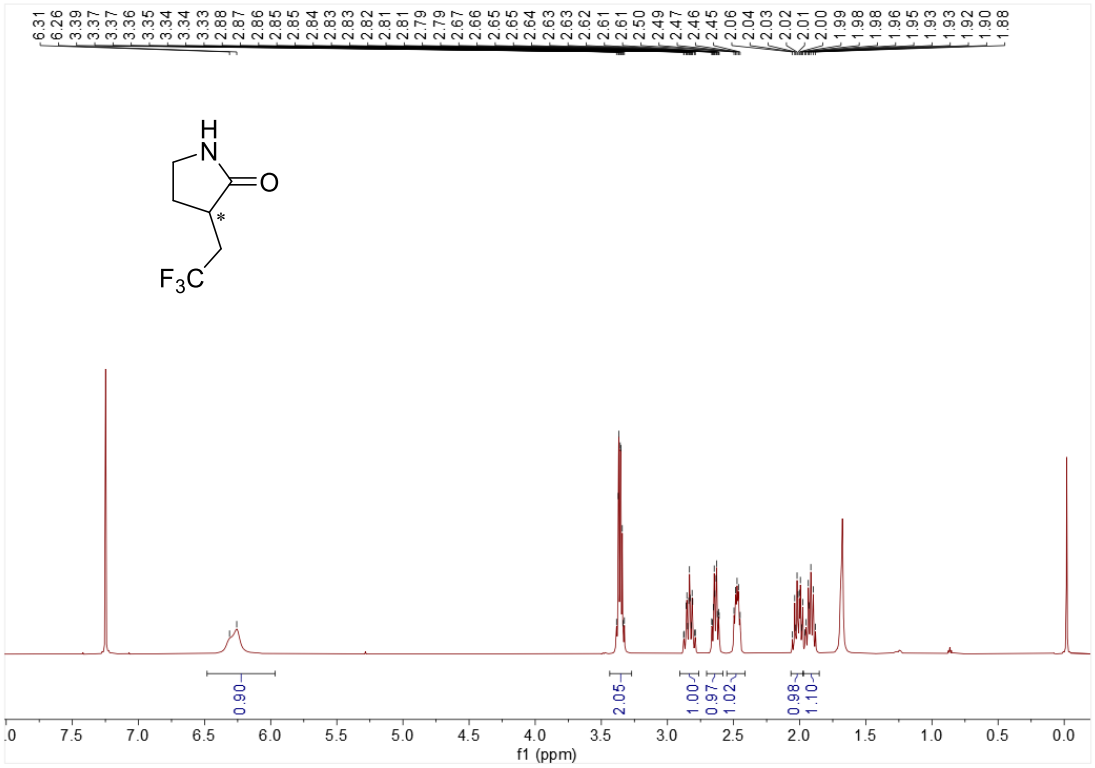
tert-butyl-2-oxo-3-(2,2,2-trifluoroethyl)pyrrolidine-1-carboxylate (**2s**)

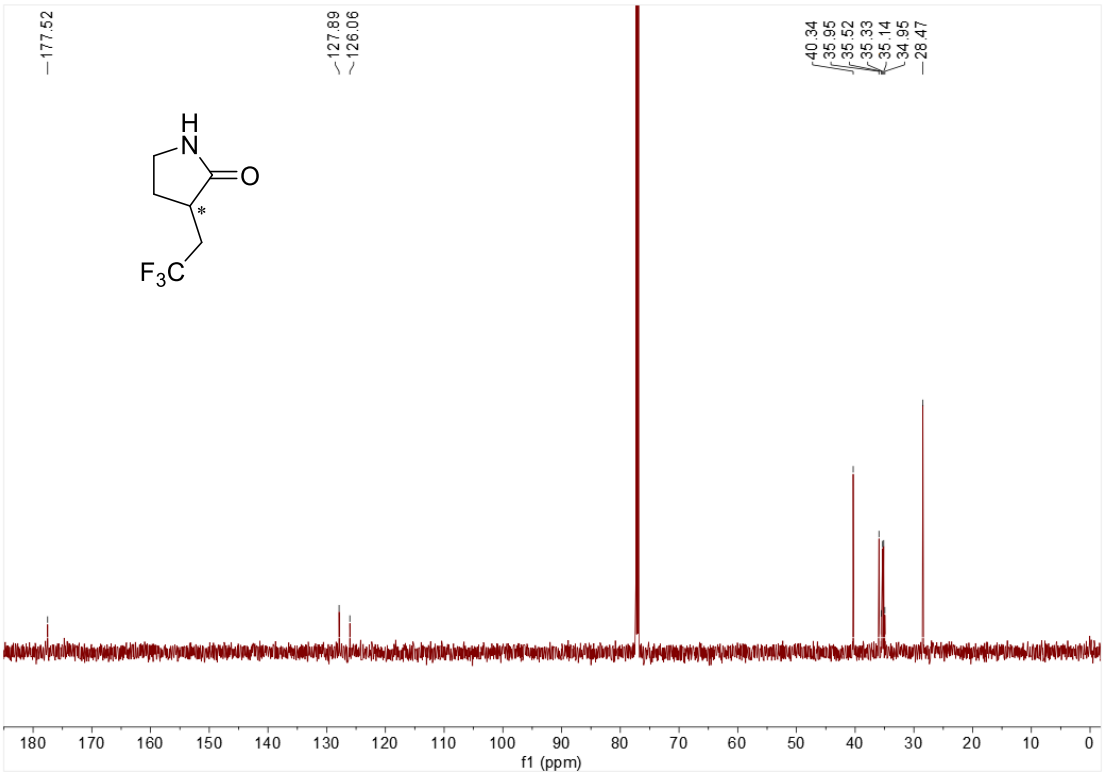


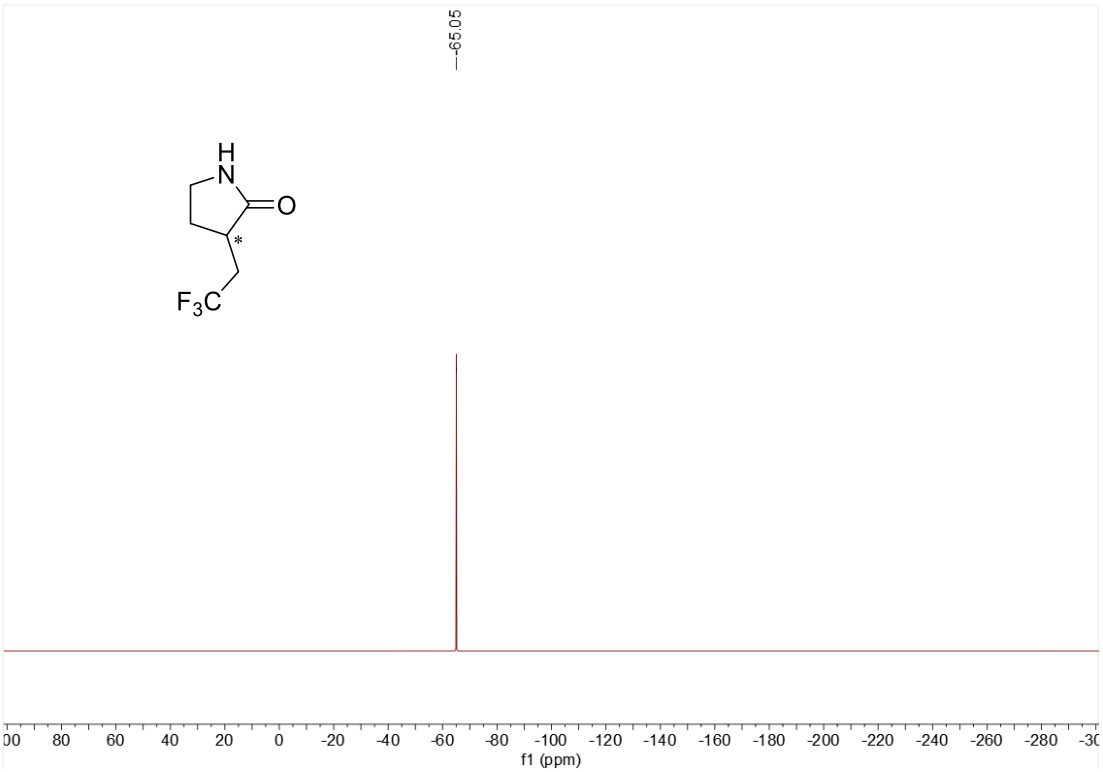



-64.86
Boc
N
O
*
F3C
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -30
f1 (ppm)

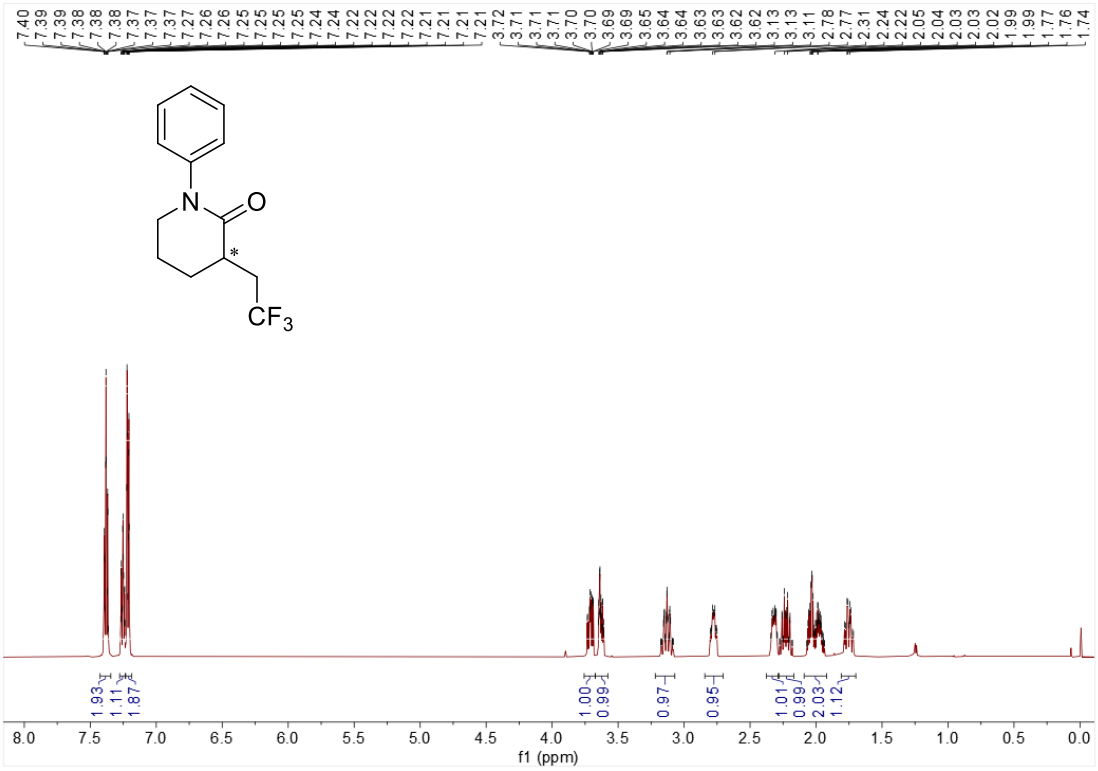
3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2t**)

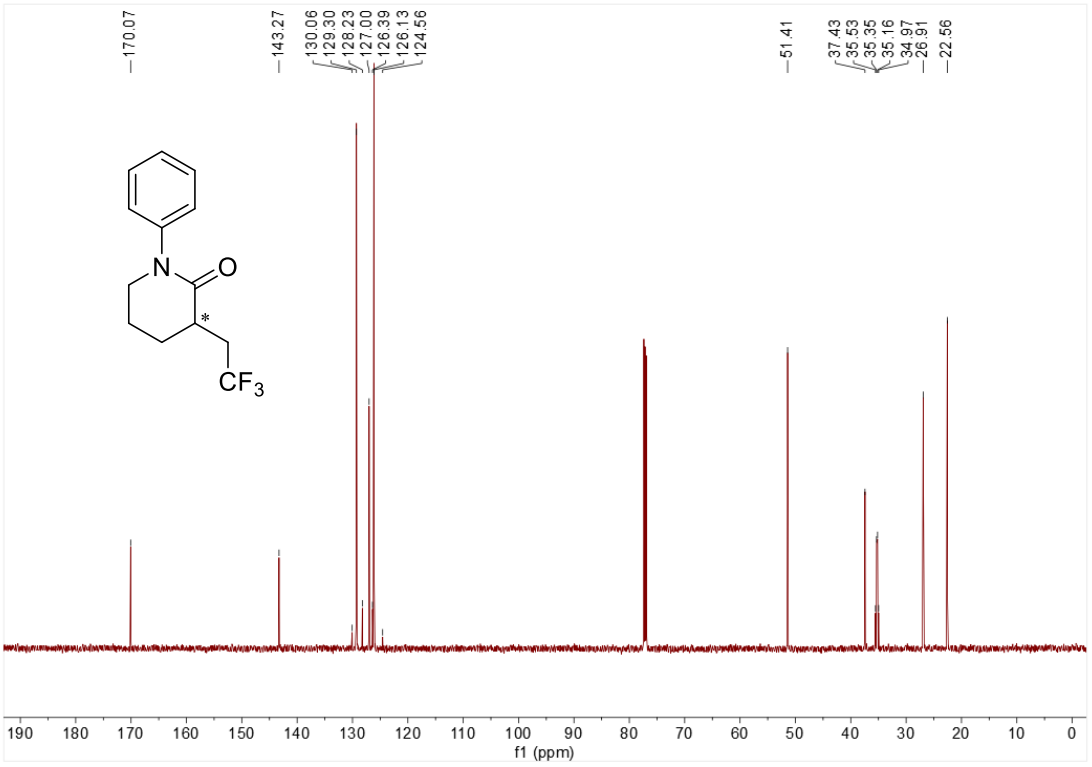


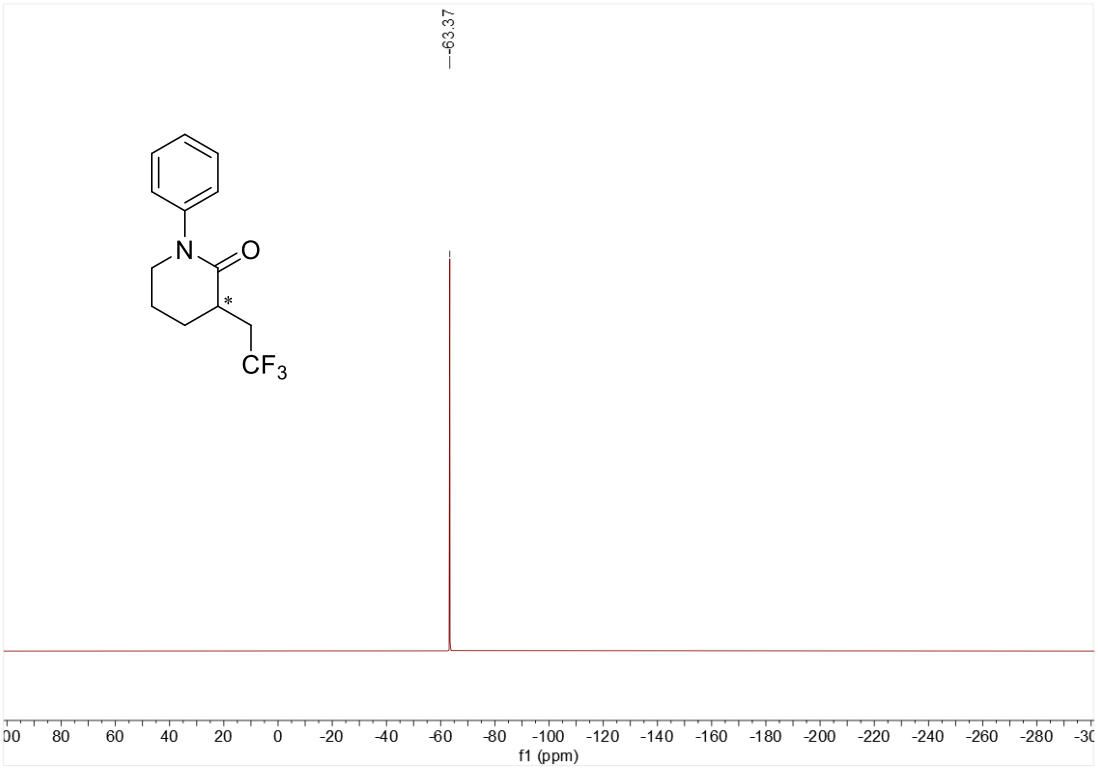



-65.05
H
N
O
*
F3C
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -30
f1 (ppm)

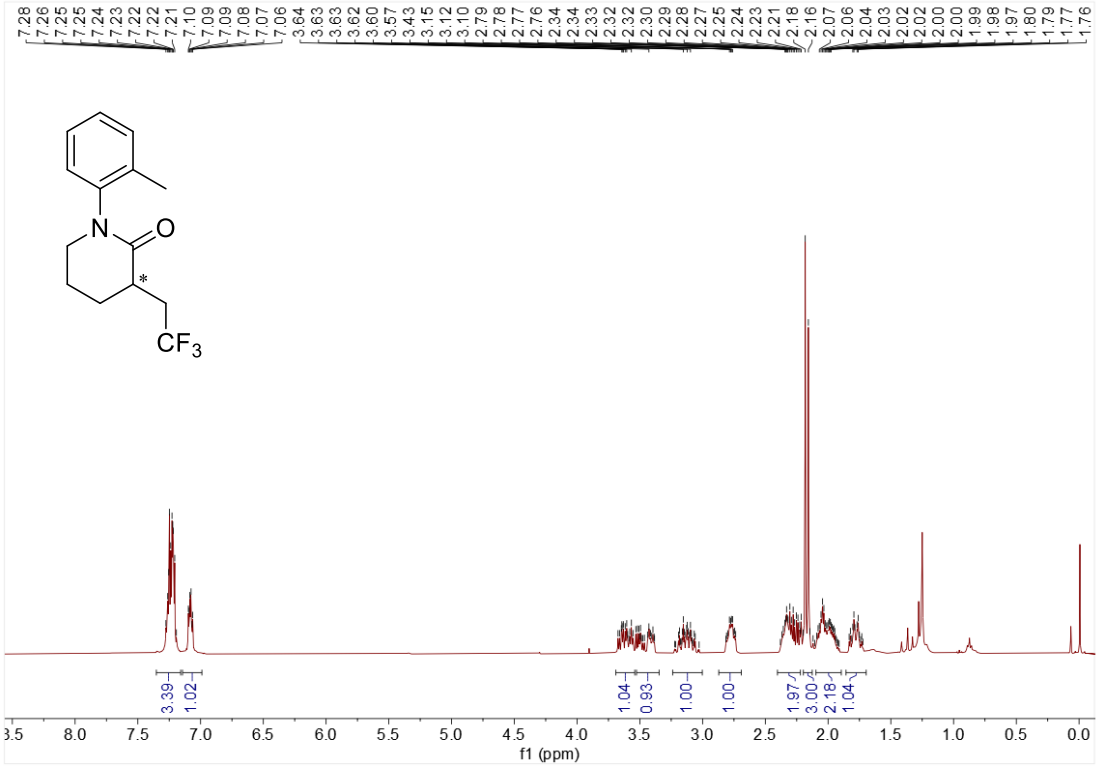
1-phenyl-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4a**)

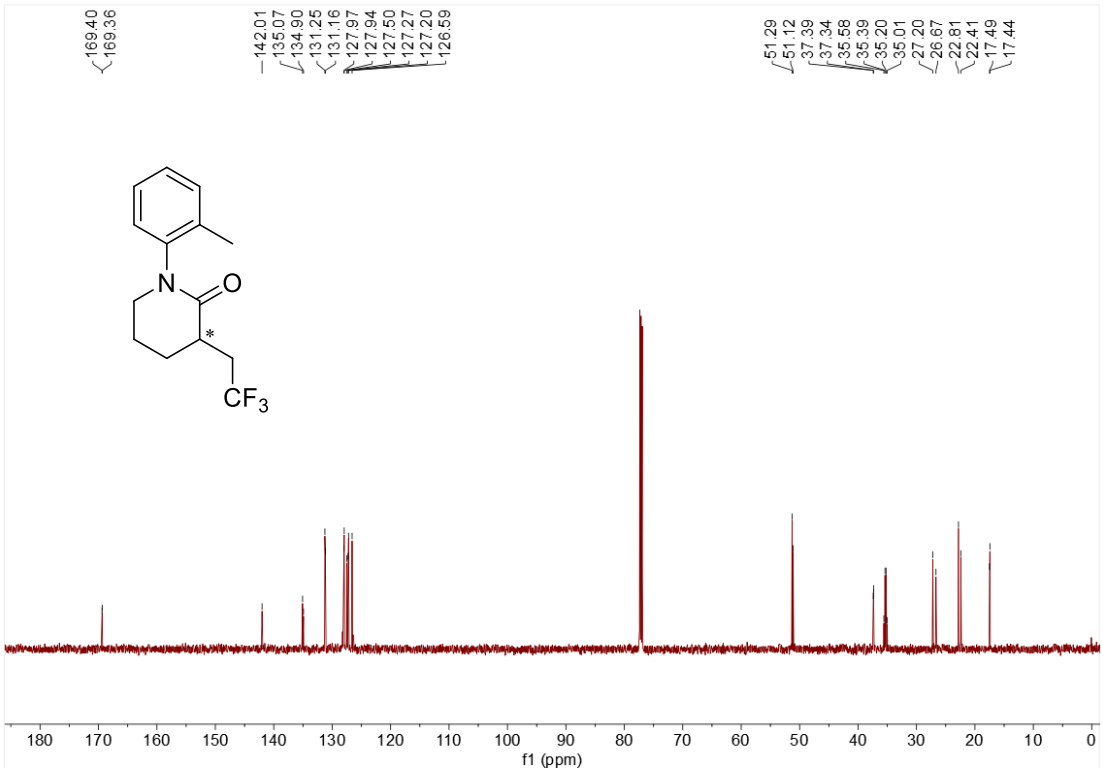


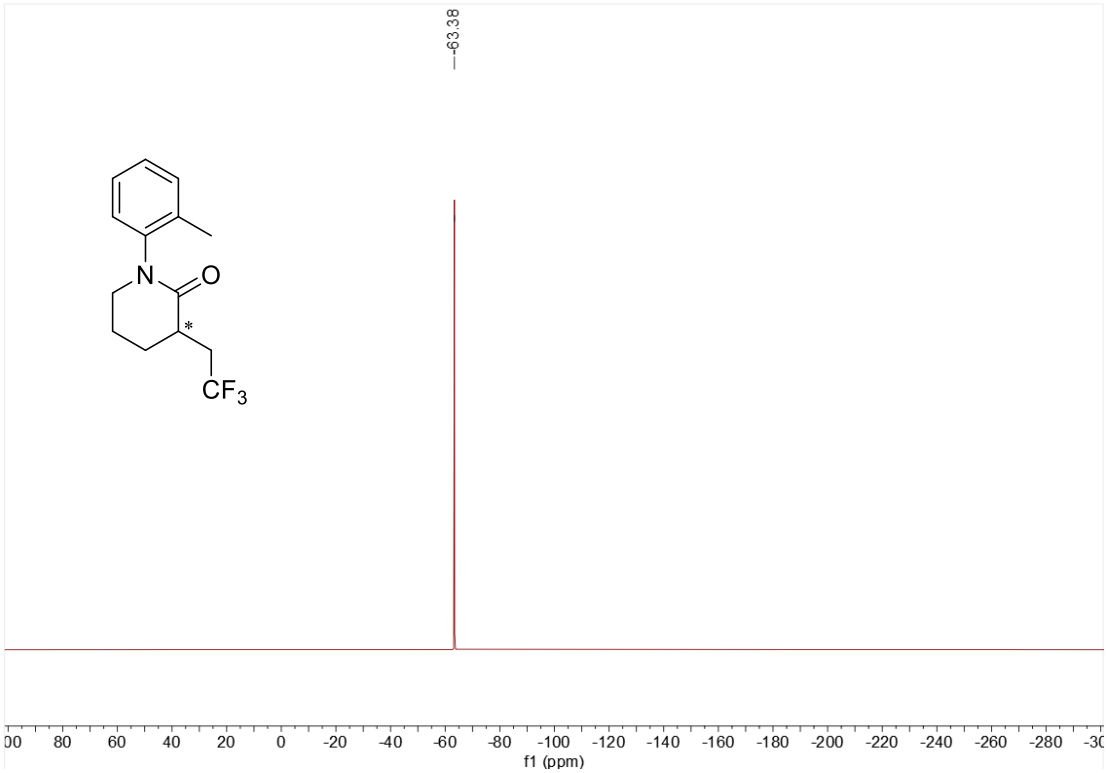



-63.37
N
O
*
CF3
f1 (ppm)

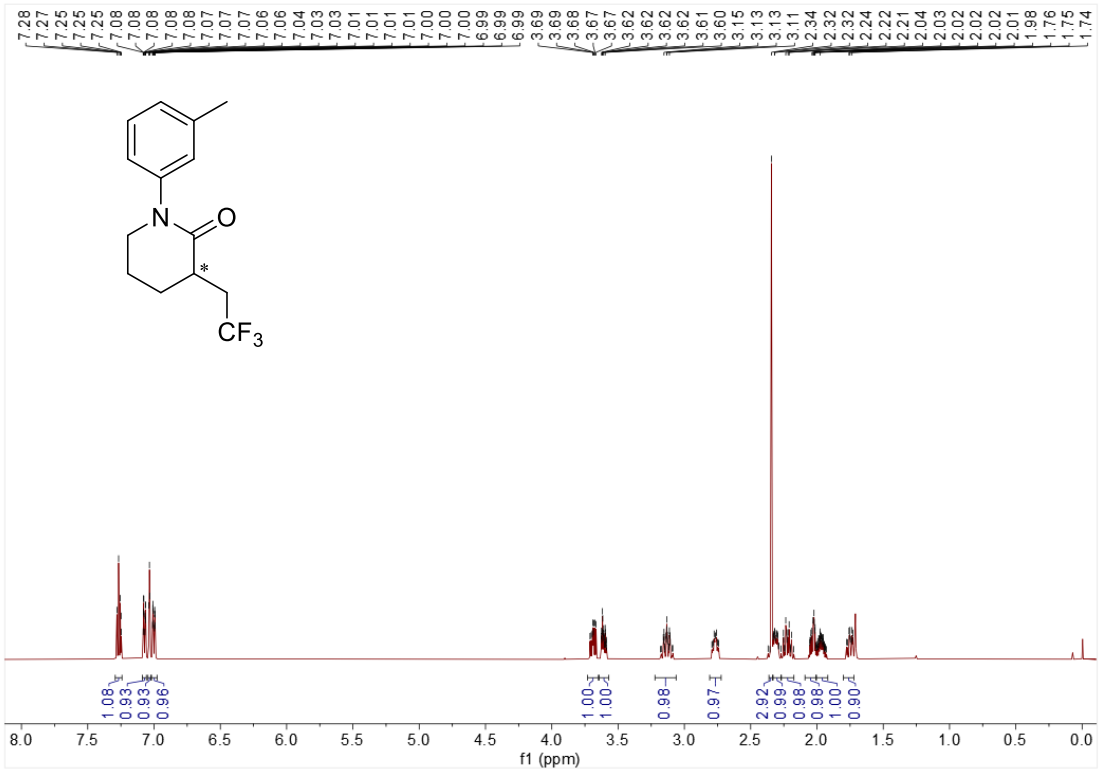
1-(*o*-tolyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4b**)

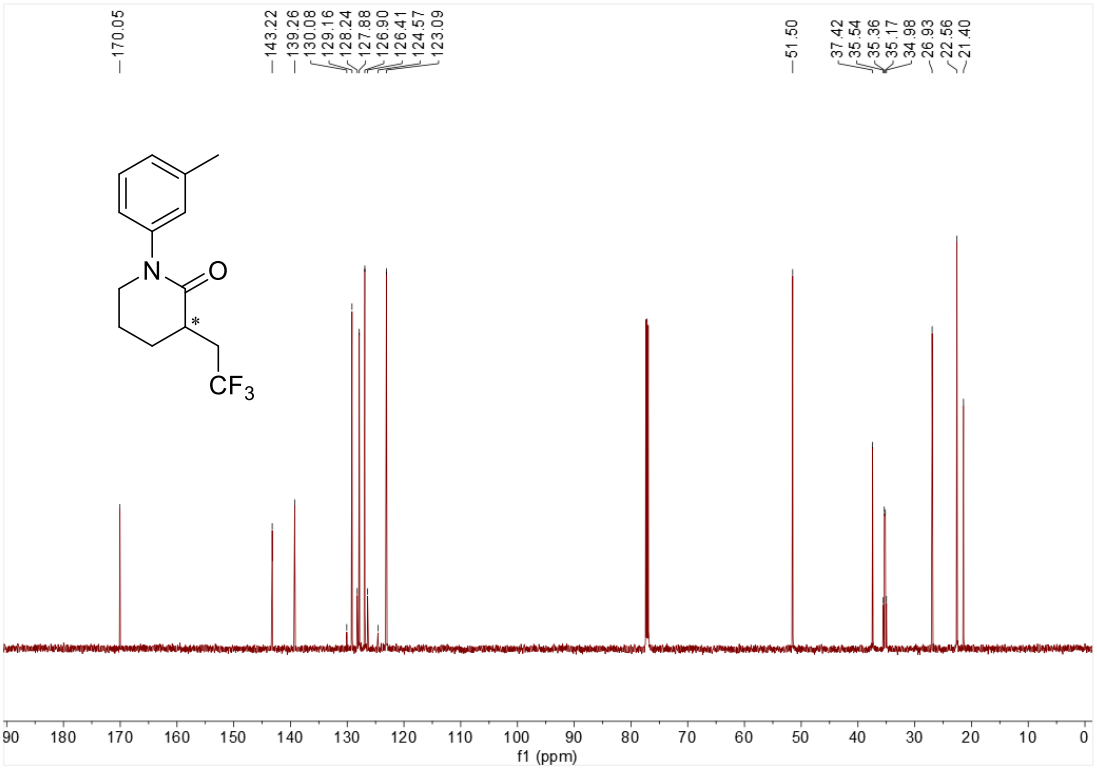


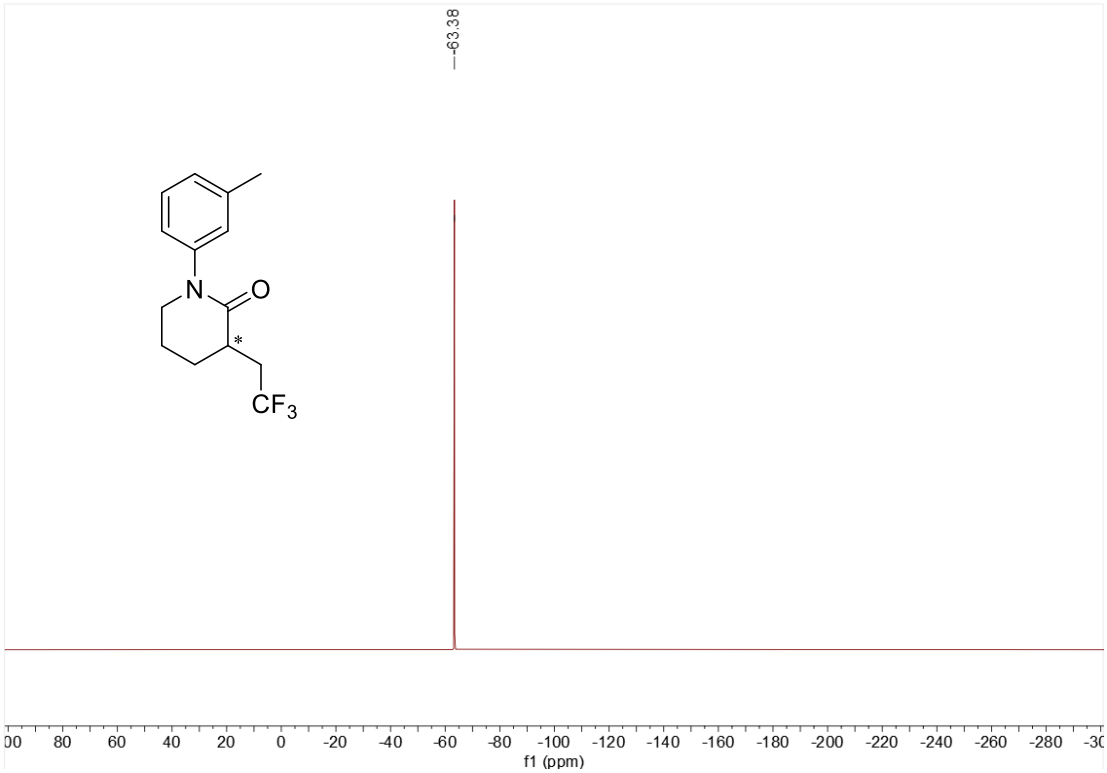



-63.38
N
O
*
CF3
f1 (ppm)

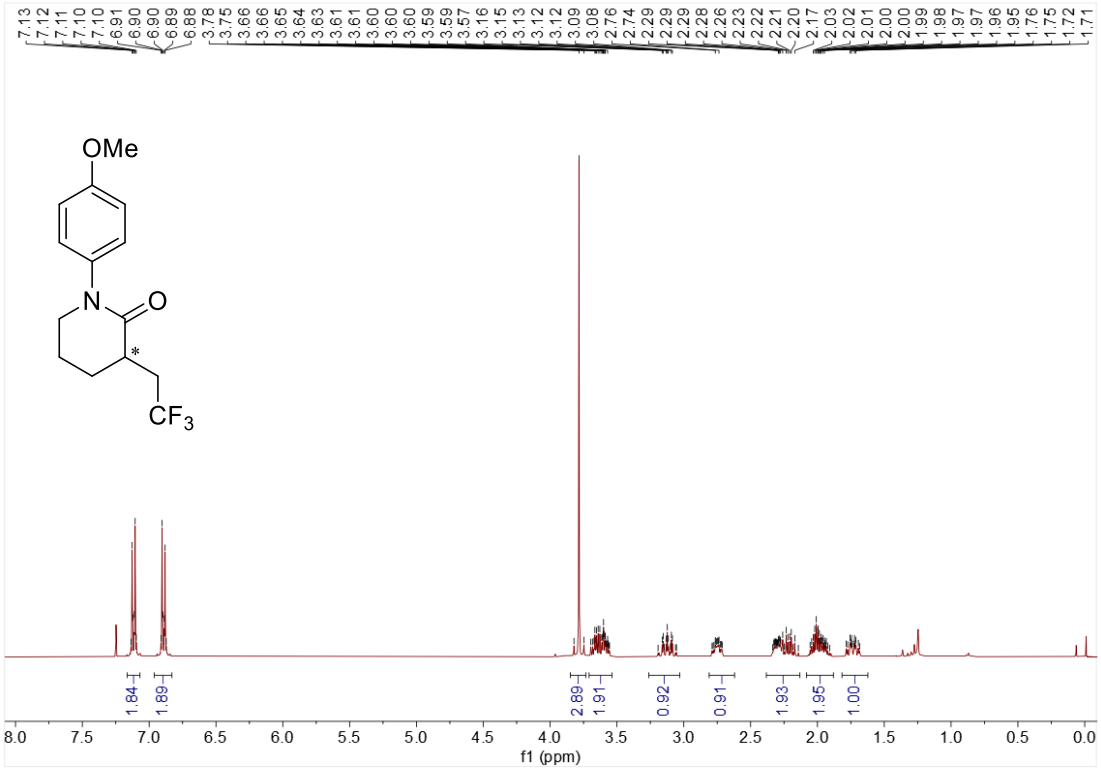
(*S*)-1-(*m*-tolyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4c**)

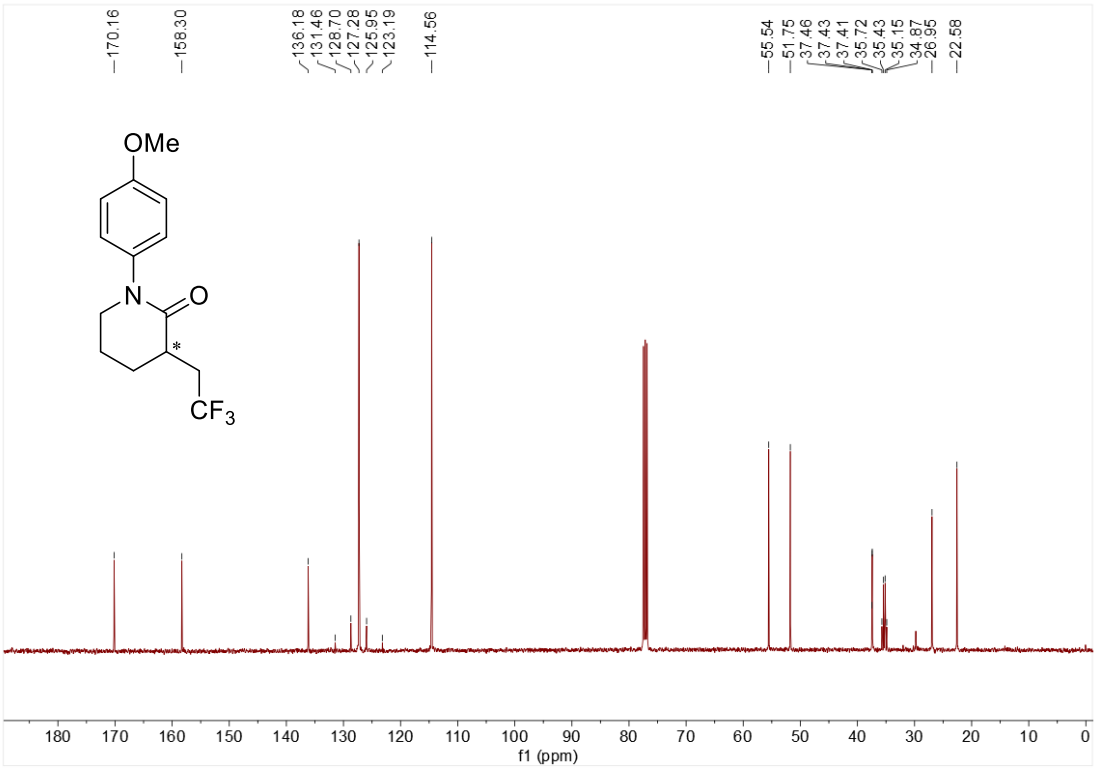


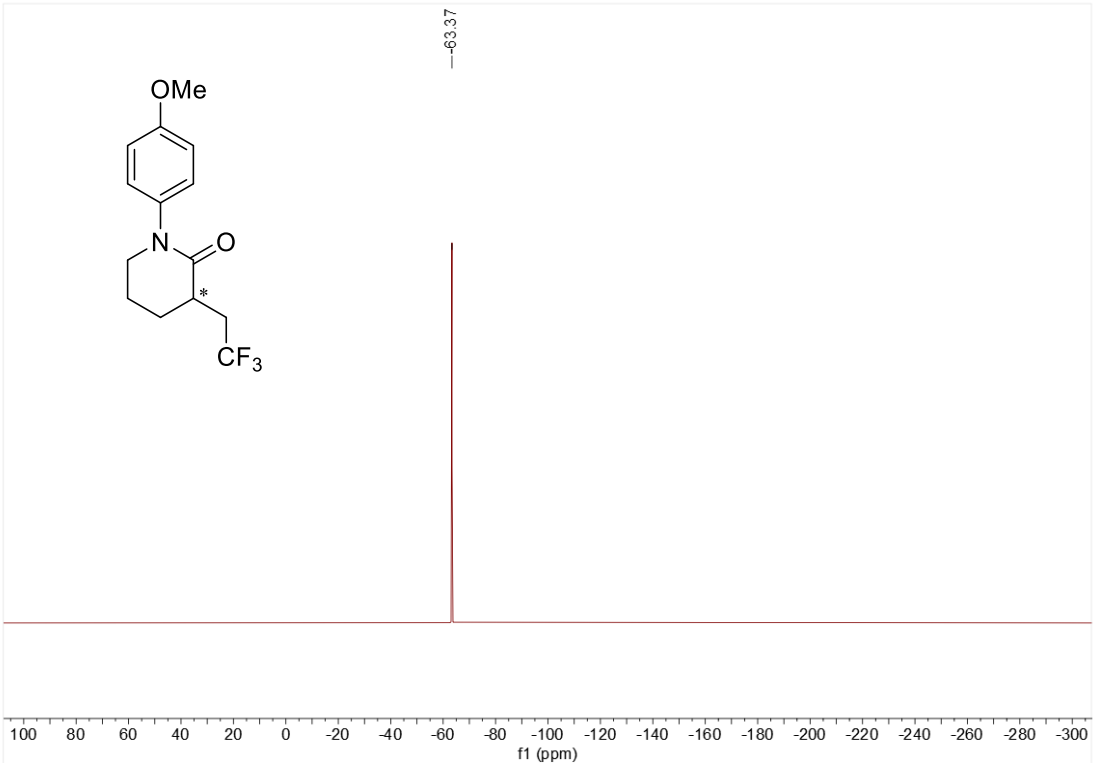



-63.38
N
O
*
CF3
f1 (ppm)

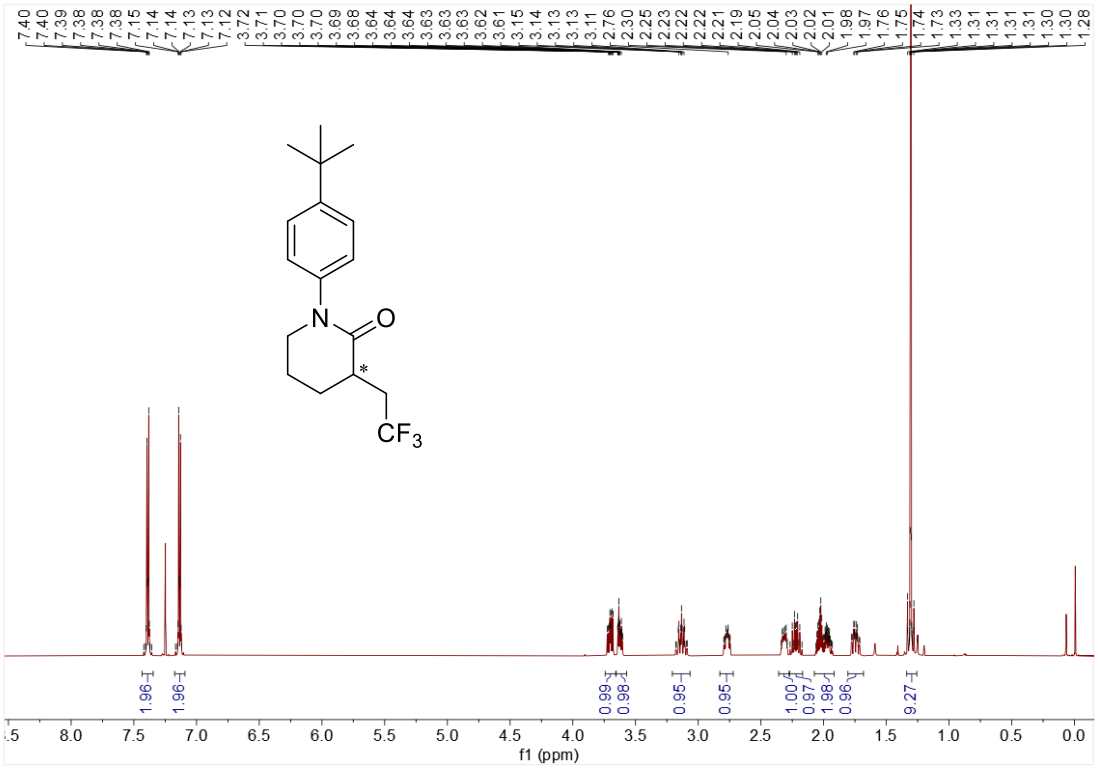
1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4d**)

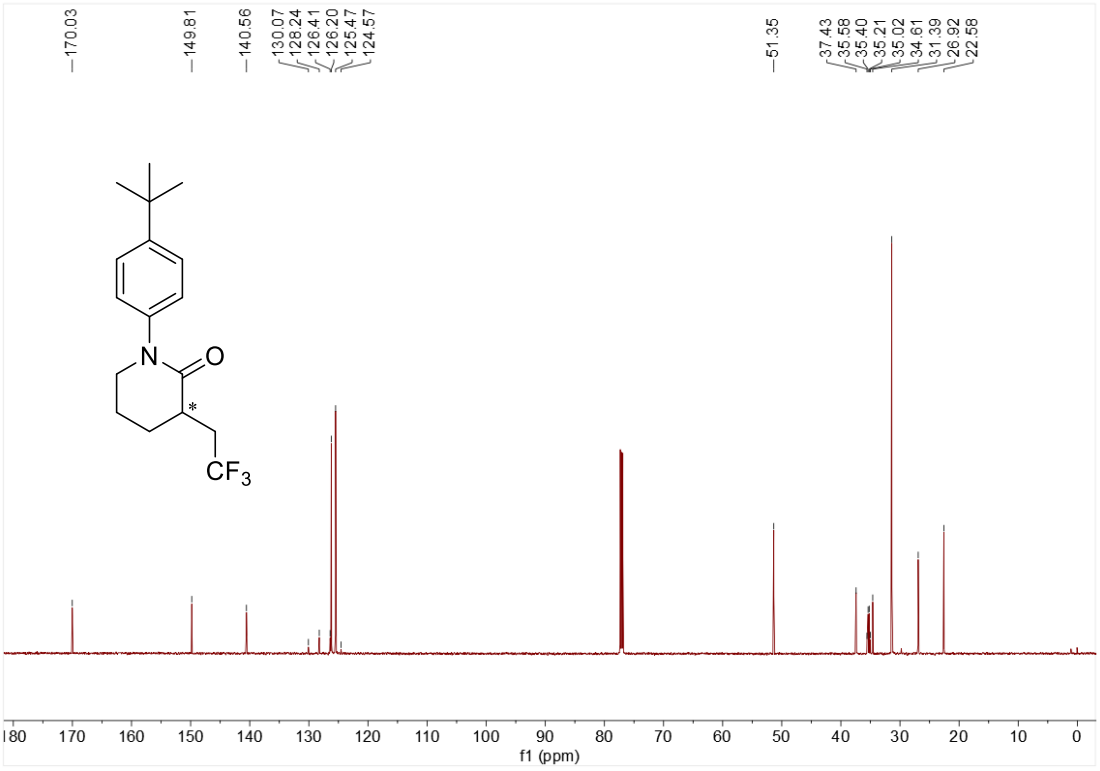


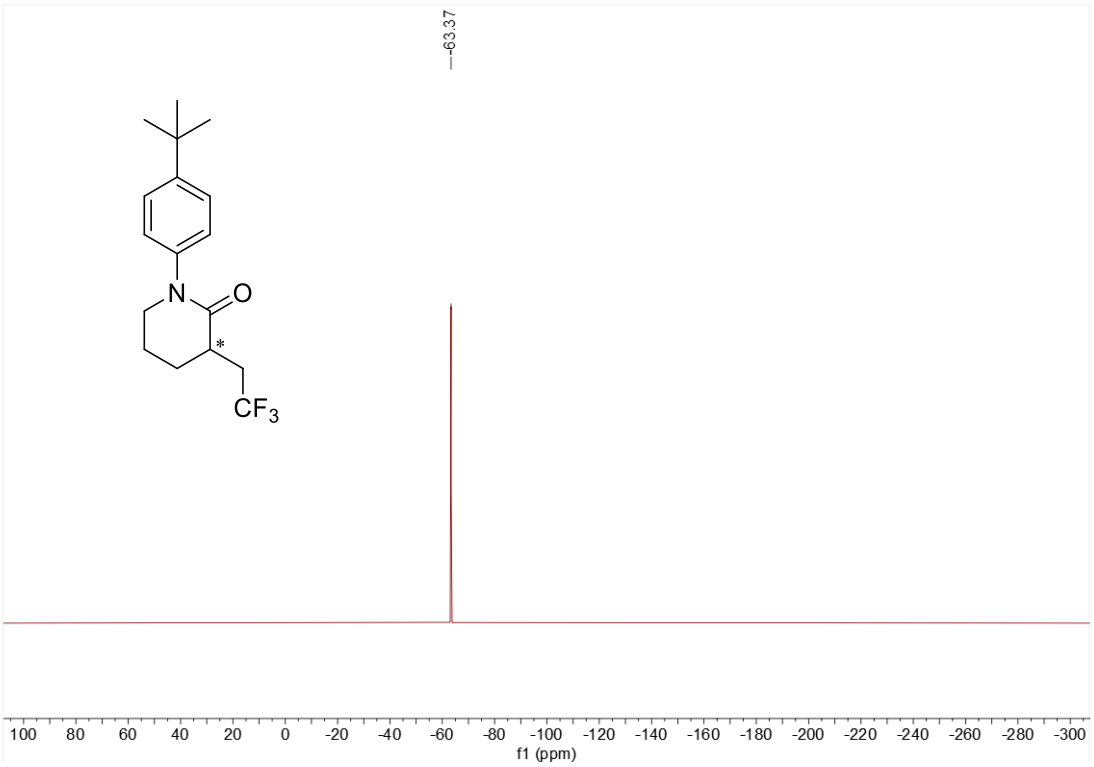



-63.37
OMe
N
O
*
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

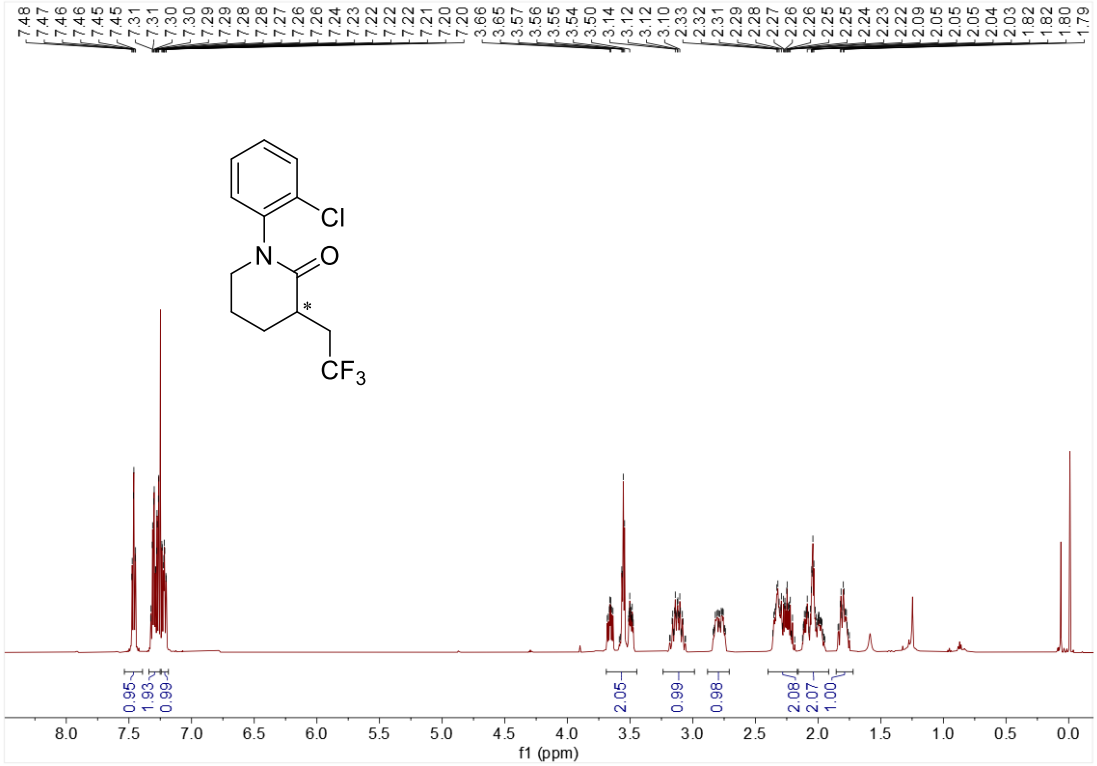
1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4e**)

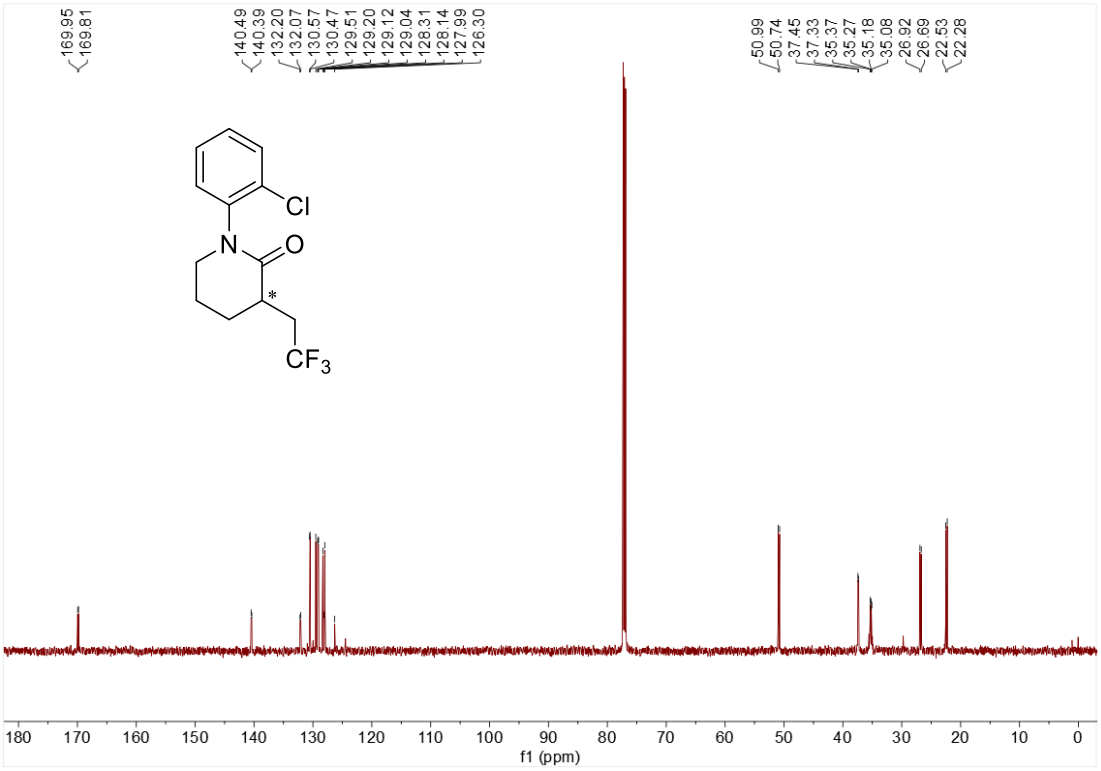


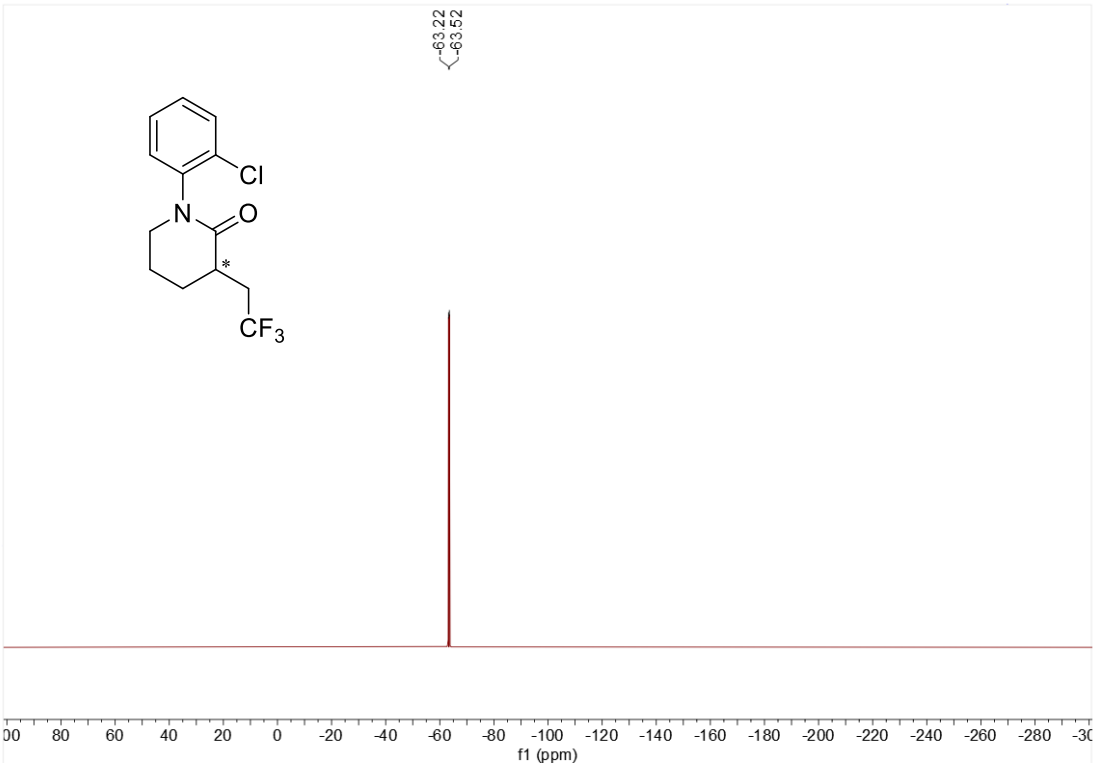



-63.37
N
O
*
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

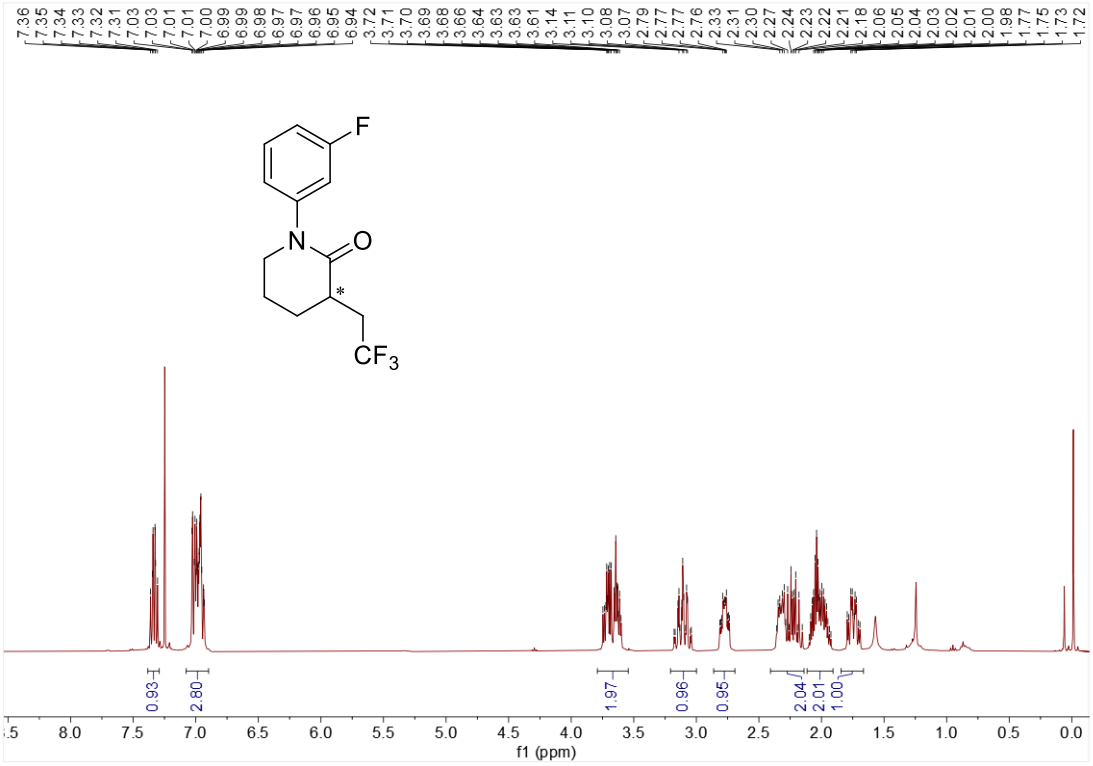
1-(2-chlorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4f**)

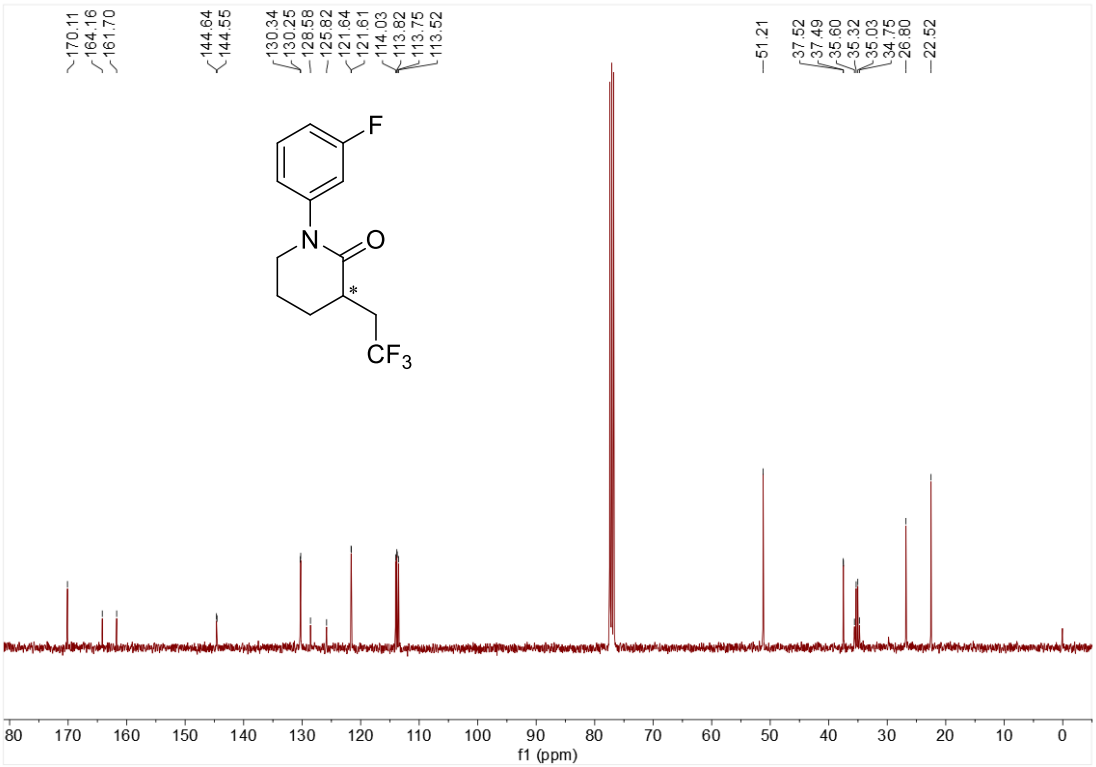


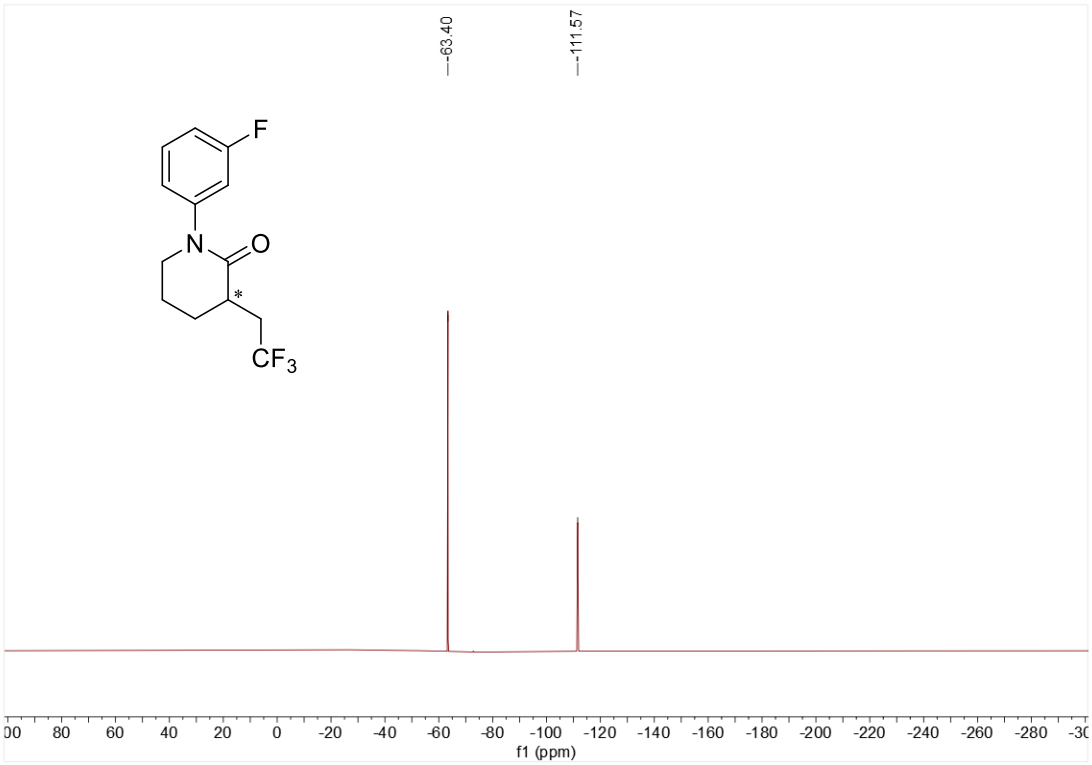



-63.22
-63.52
Cl
N
O
*
CF3
f1 (ppm)

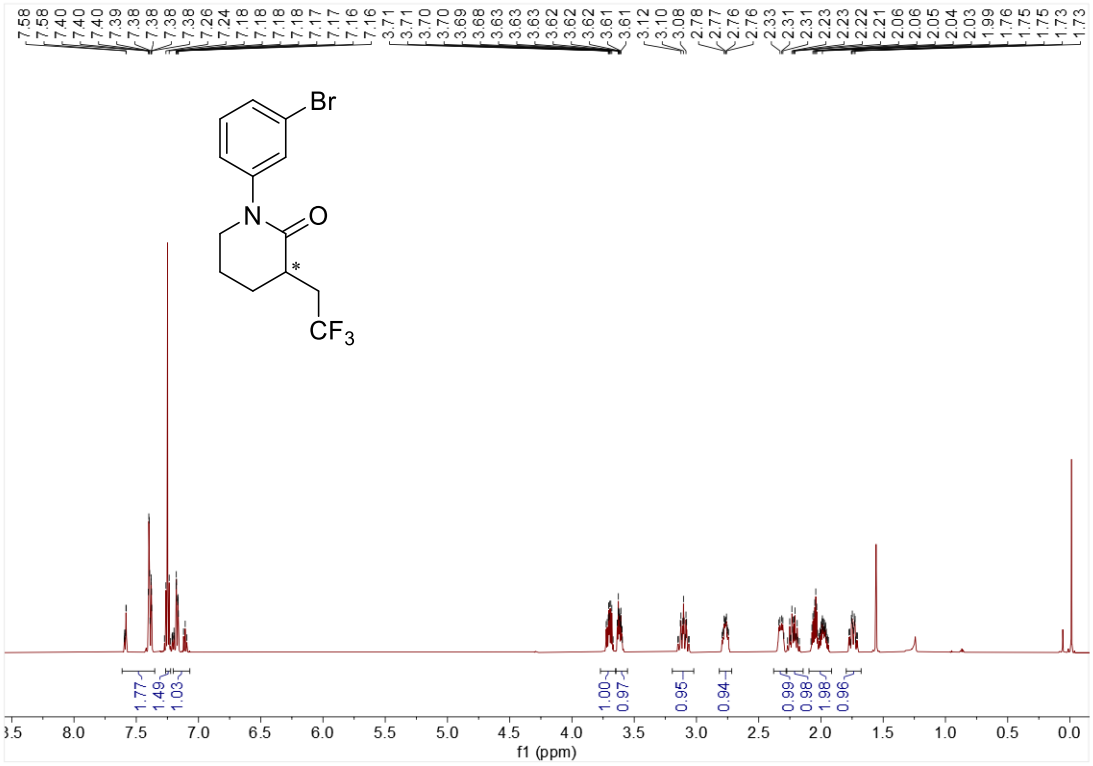
1-(3-fluorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4g**)

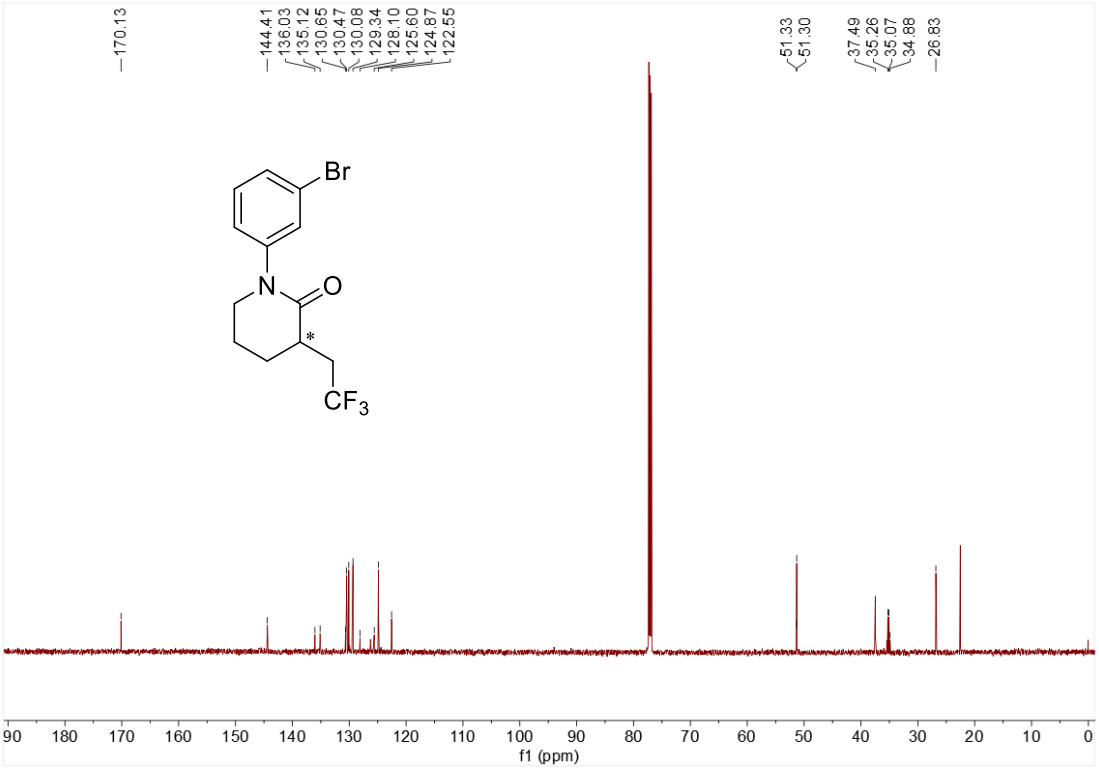


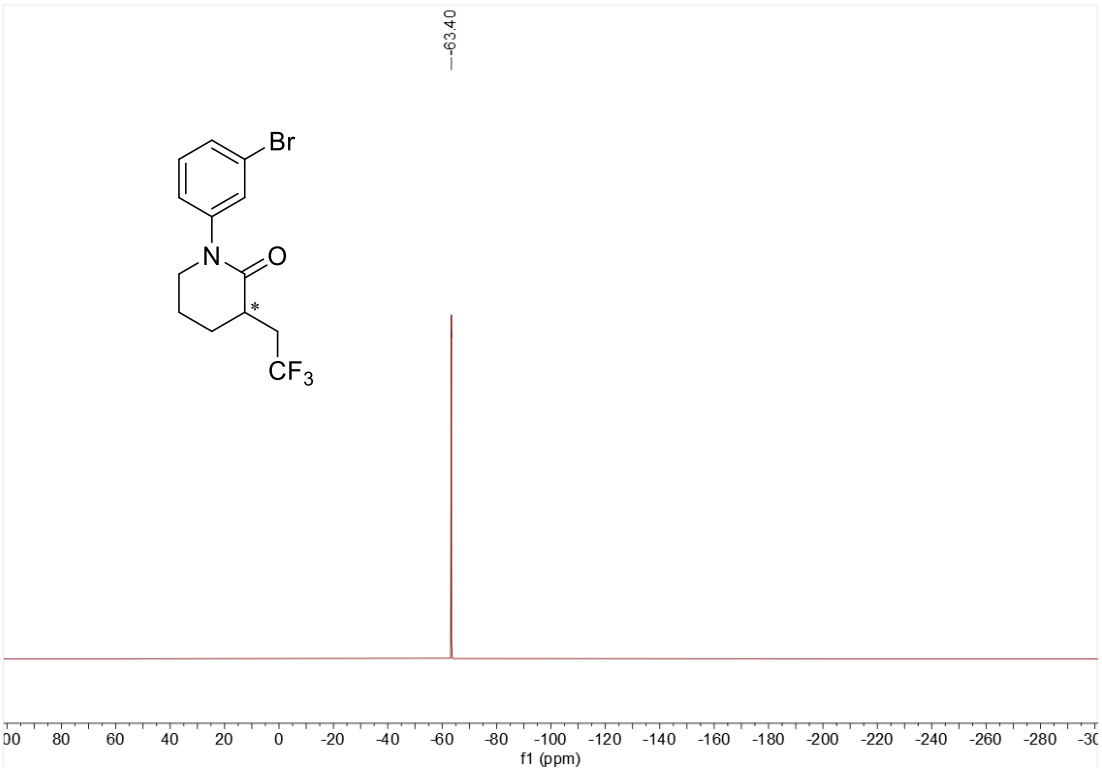



-63.40
-111.57
F
N
O
*
CF3
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -3
f1 (ppm)

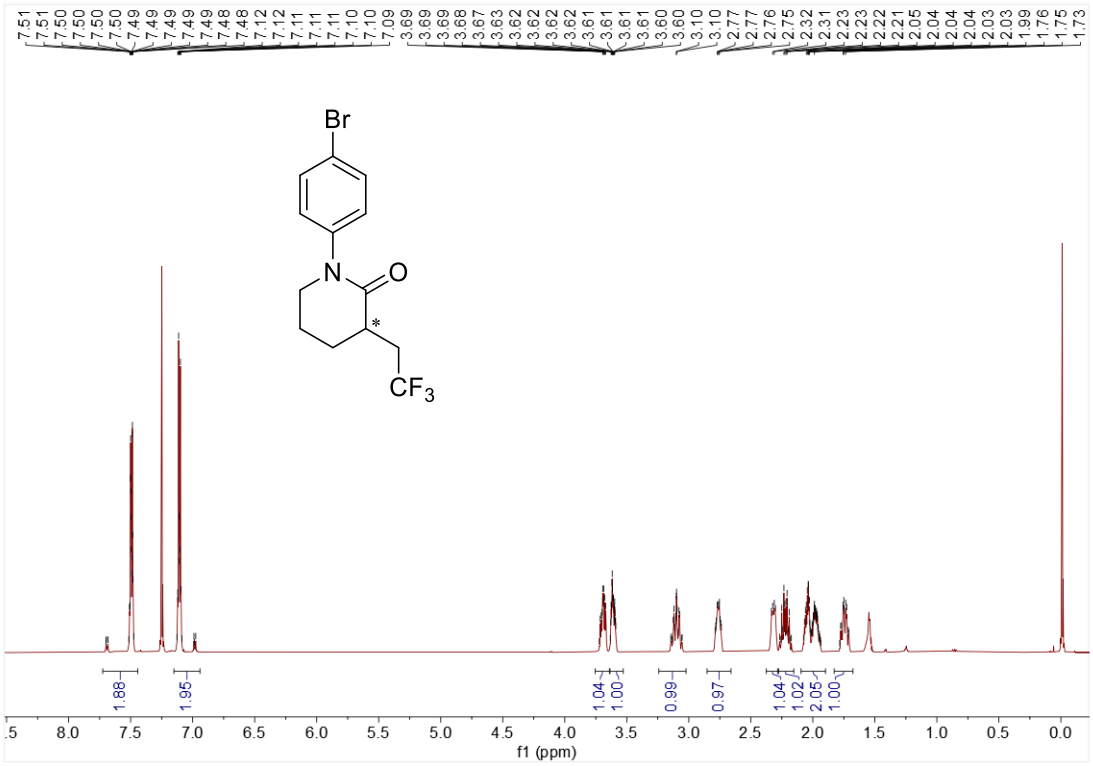
1-(3-bromophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4h**)

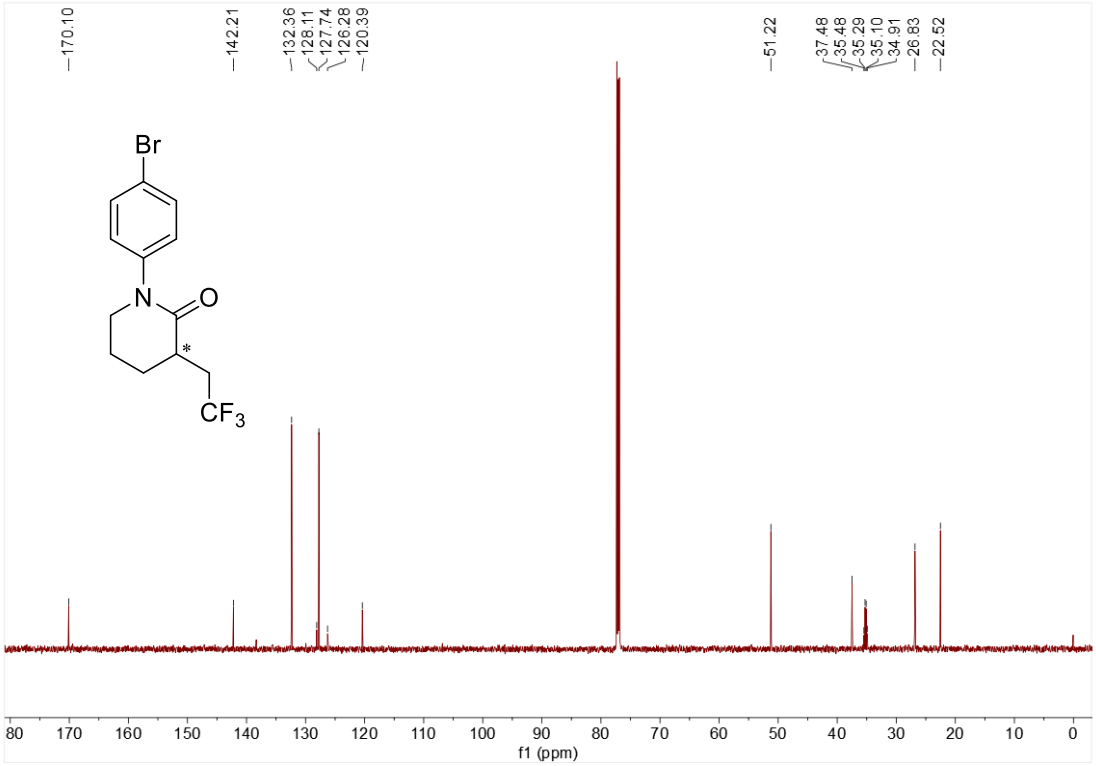


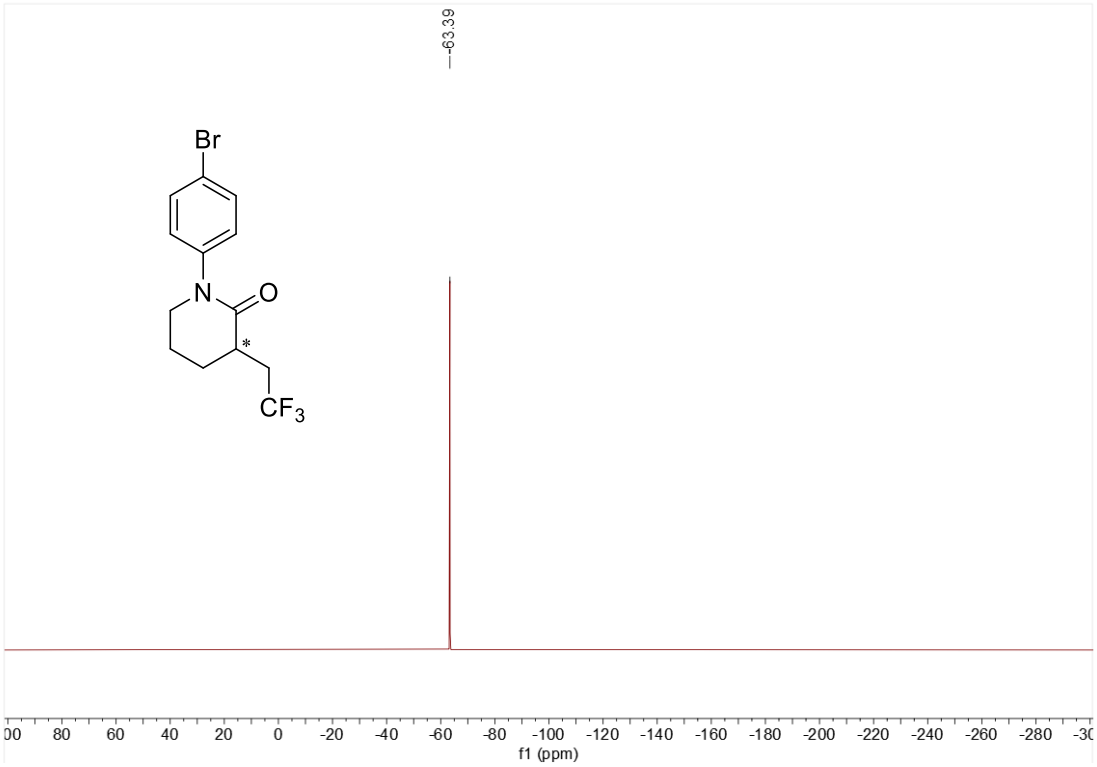



-63.40
Br
N
O
*
CF3
f1 (ppm)

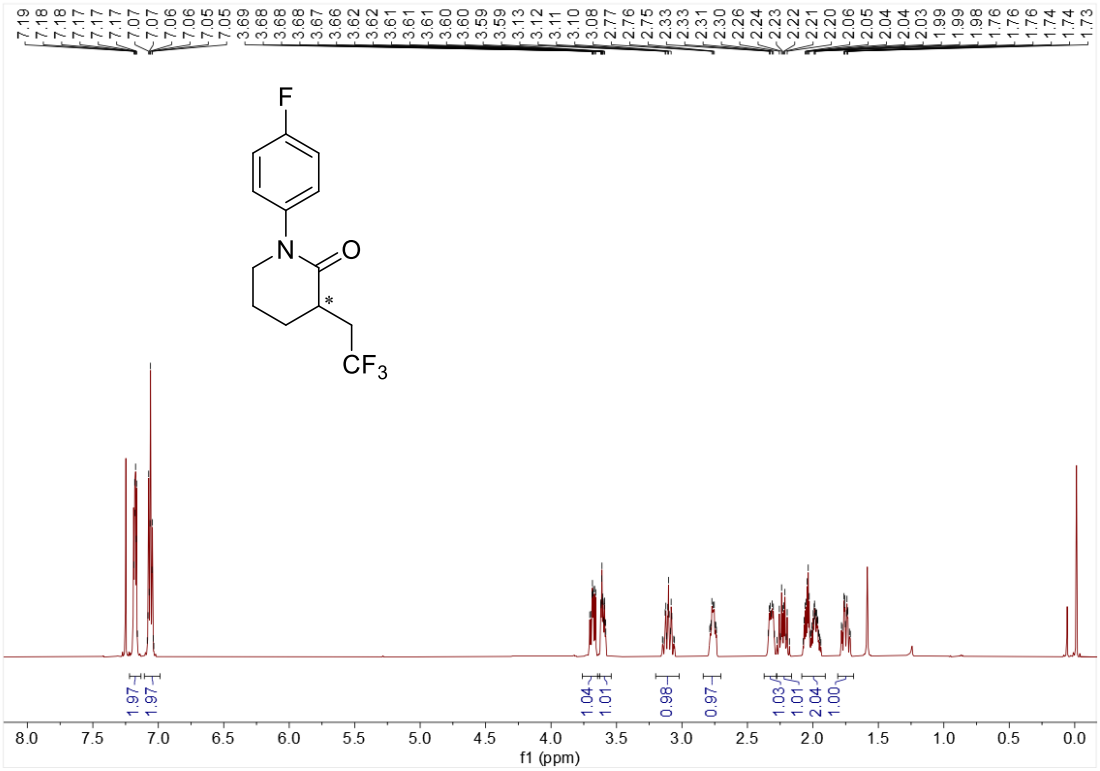
1-(4-bromophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4i**)

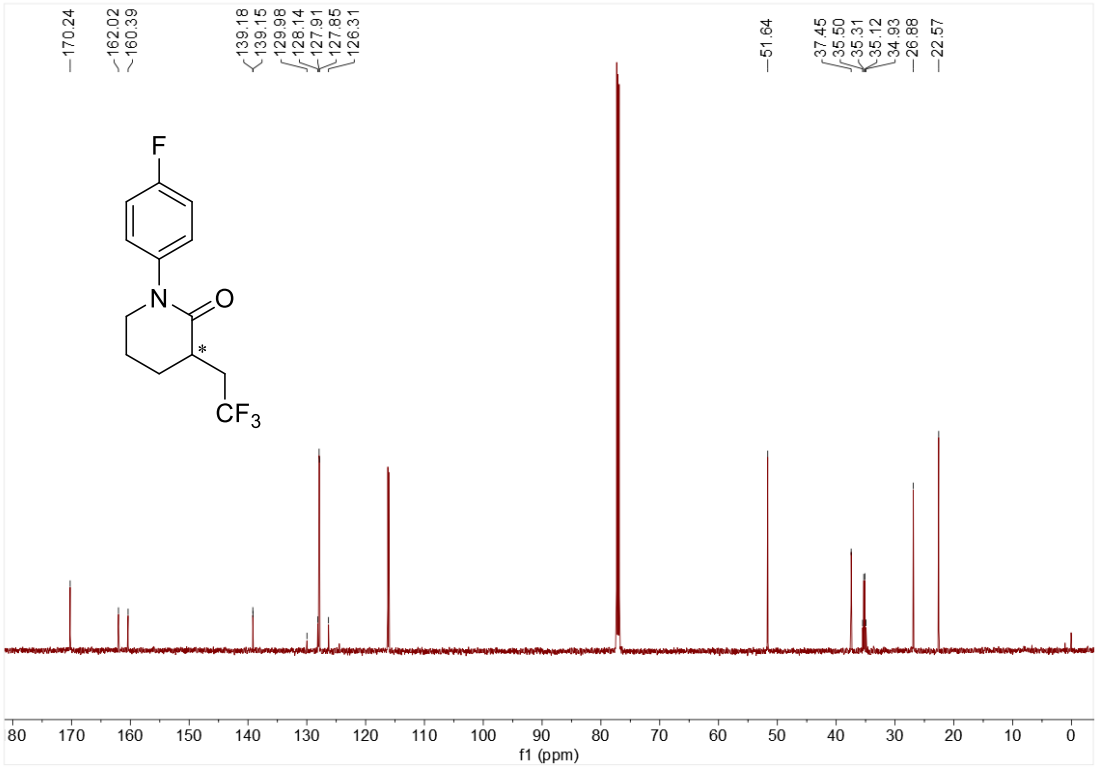


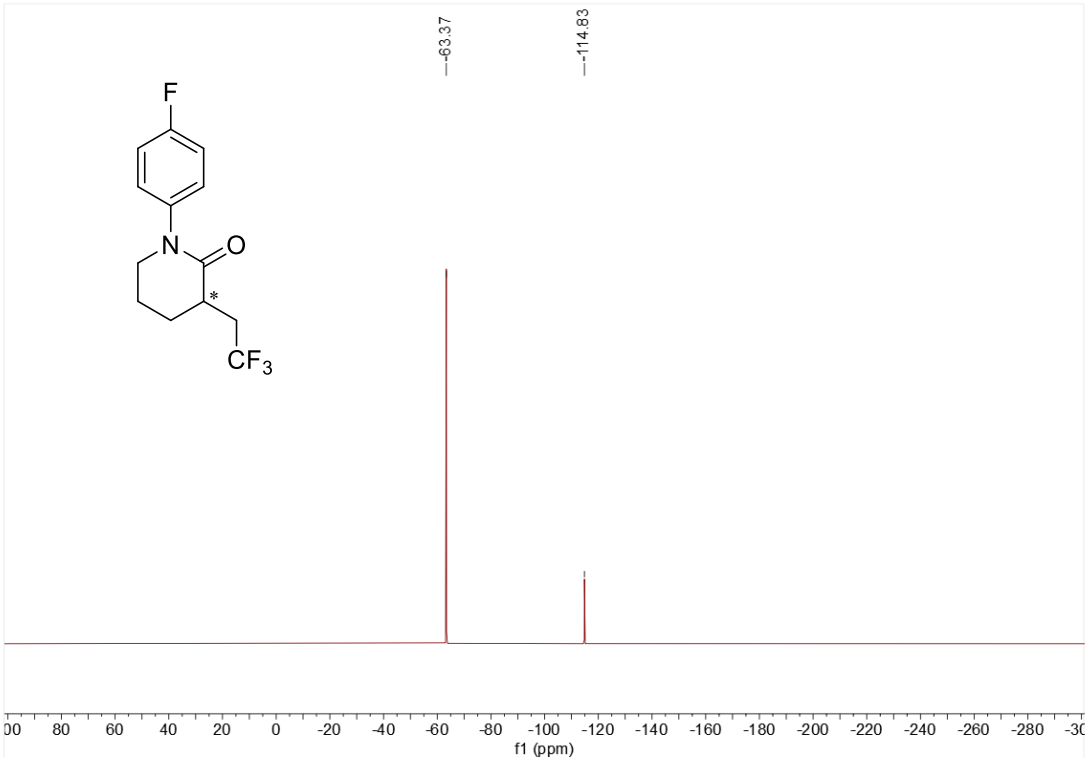



-63.39
Br
N
O
*
CF3
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -30
f1 (ppm)

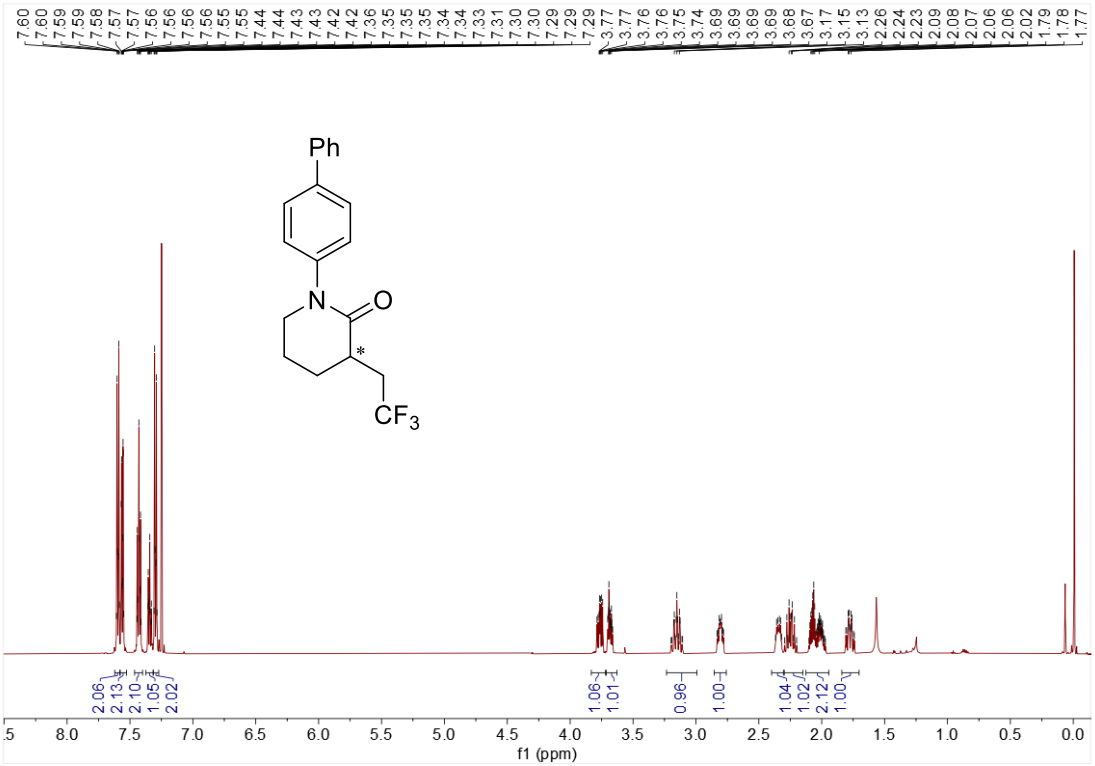
1-(4-fluorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4j**)

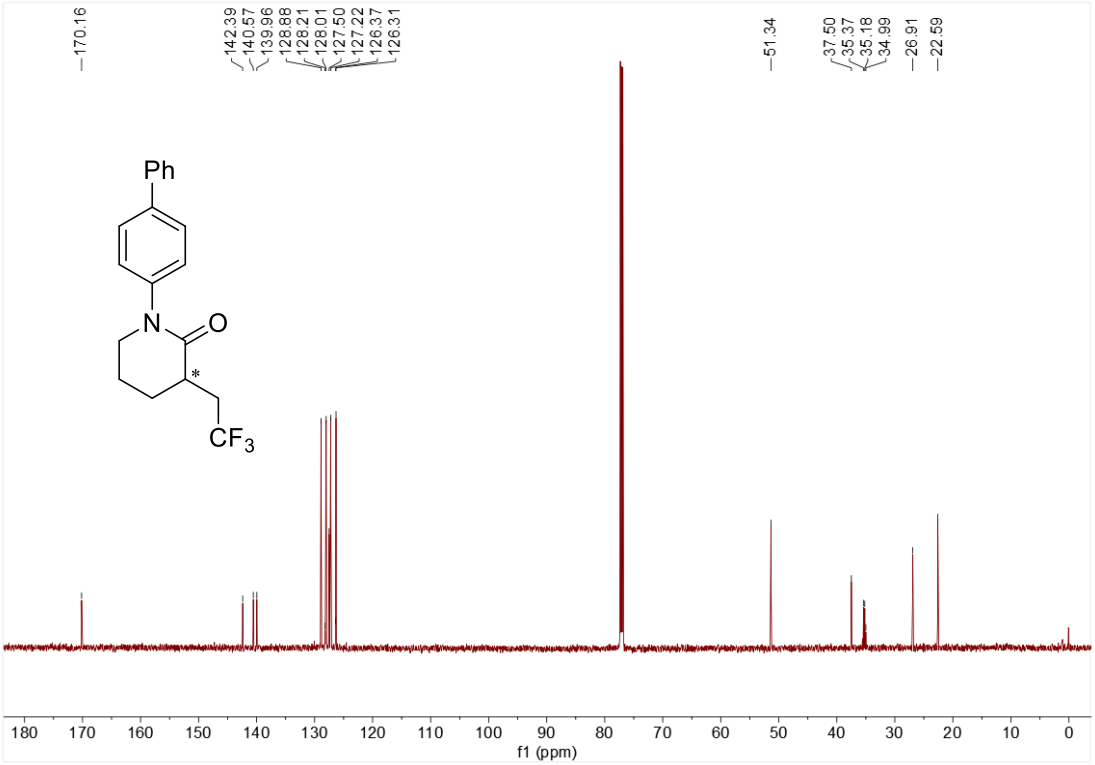


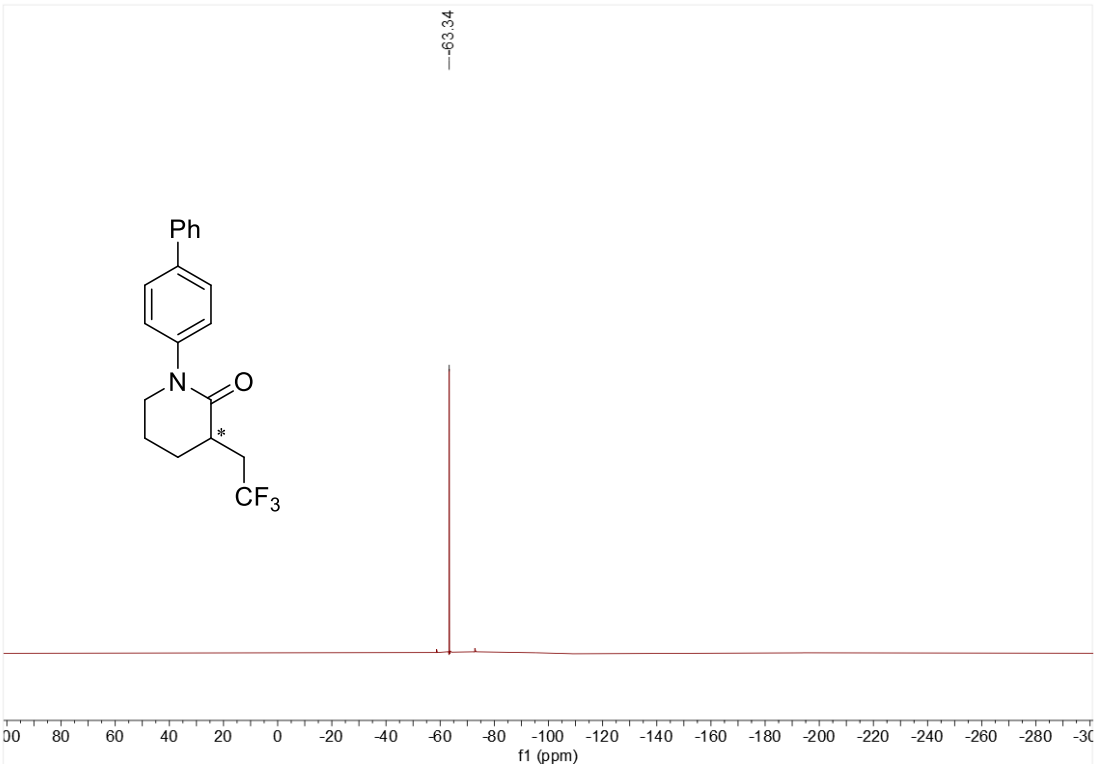



-63.37
-114.83
F
N
O
*
CF3
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -30
f1 (ppm)

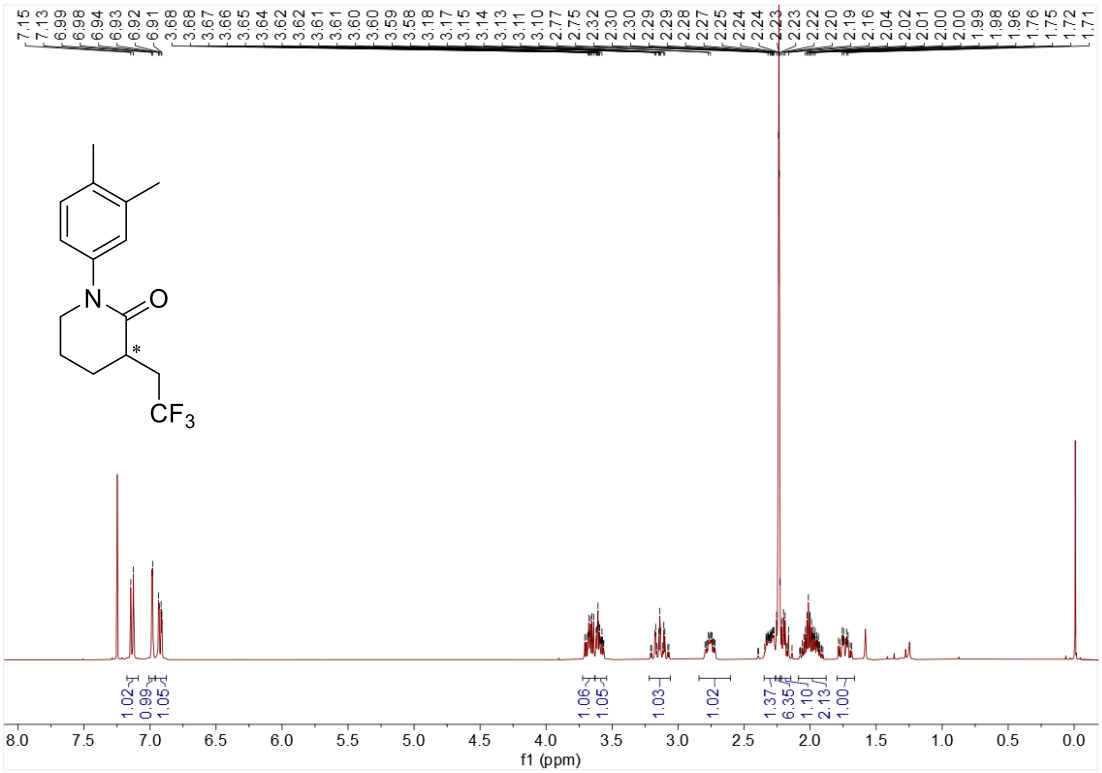
1-([1,1'-biphenyl]-4-yl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4k**)

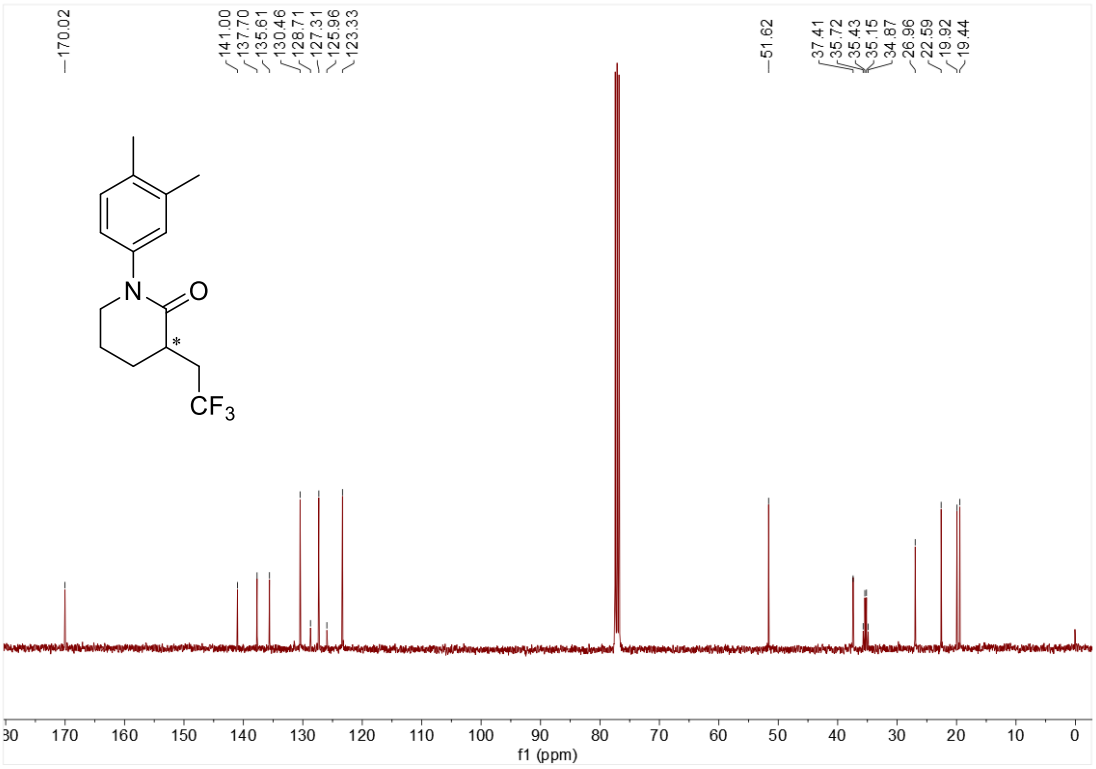


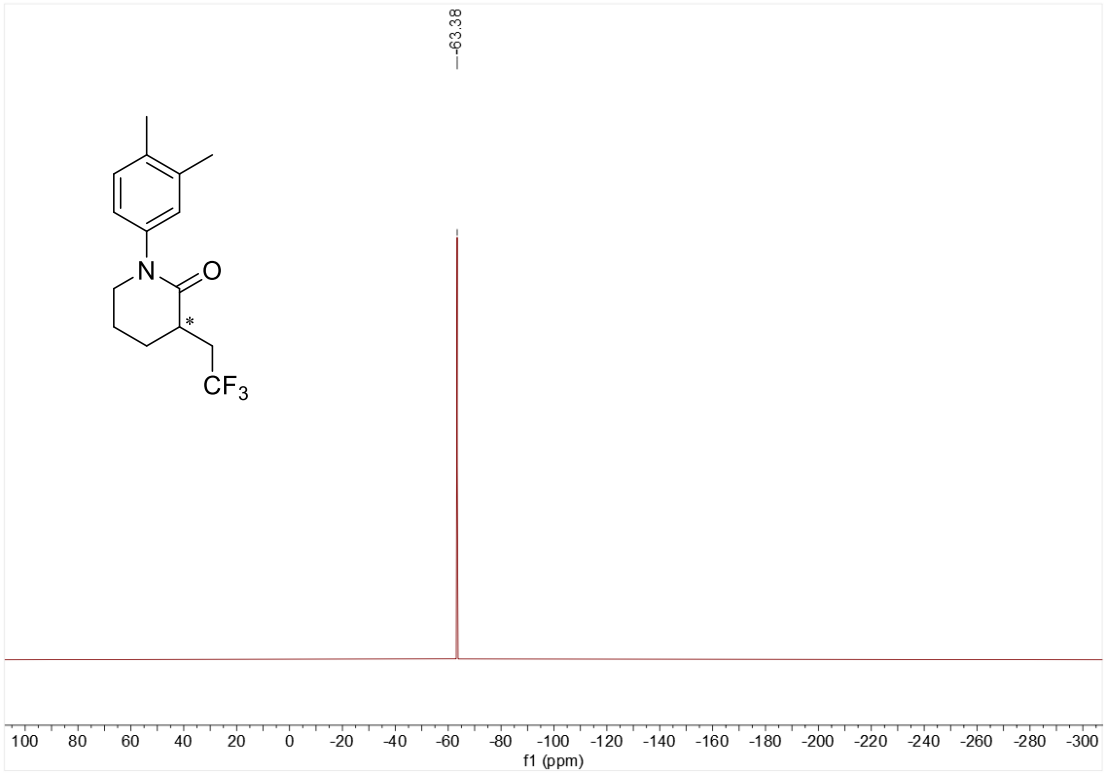



-63.34
Ph
N
O
*
CF3
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -3
f1 (ppm)

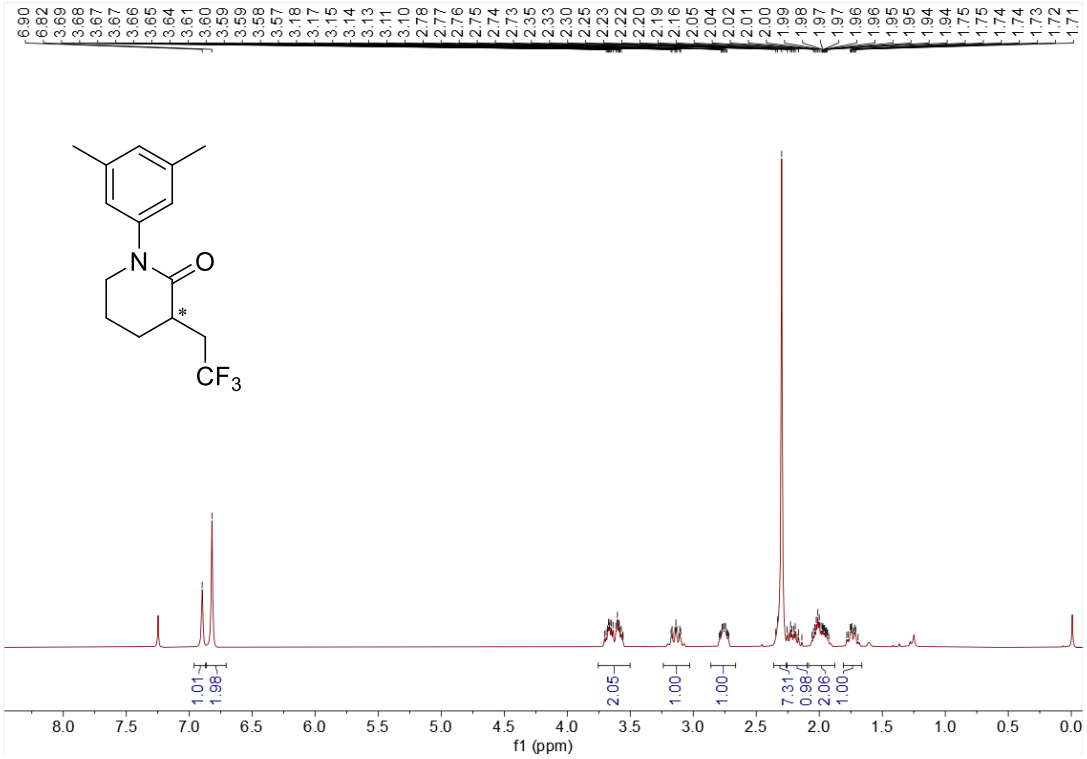
1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4l**)

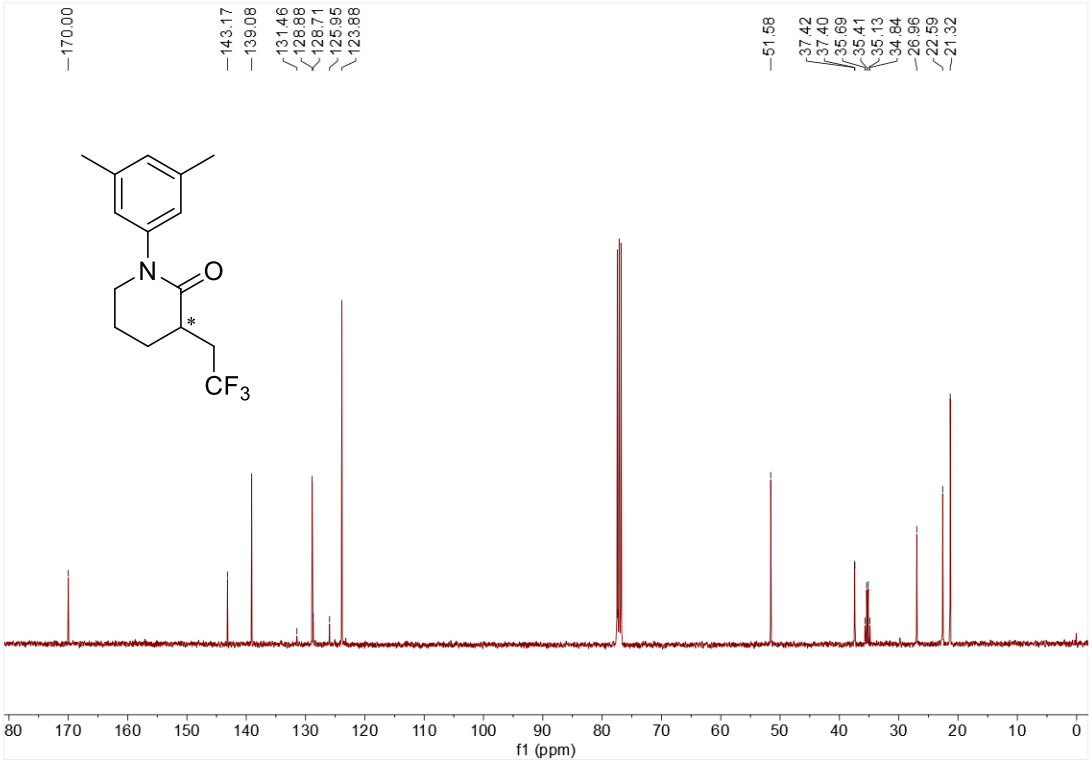


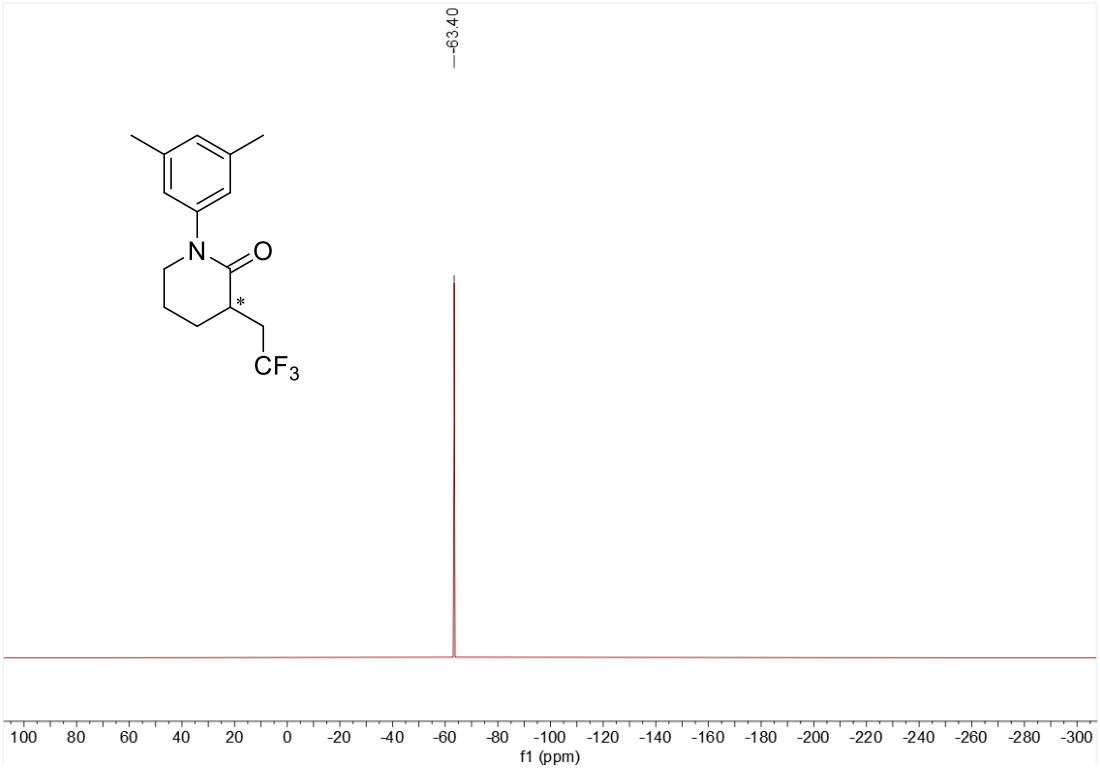



-63.38
N
O
*
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

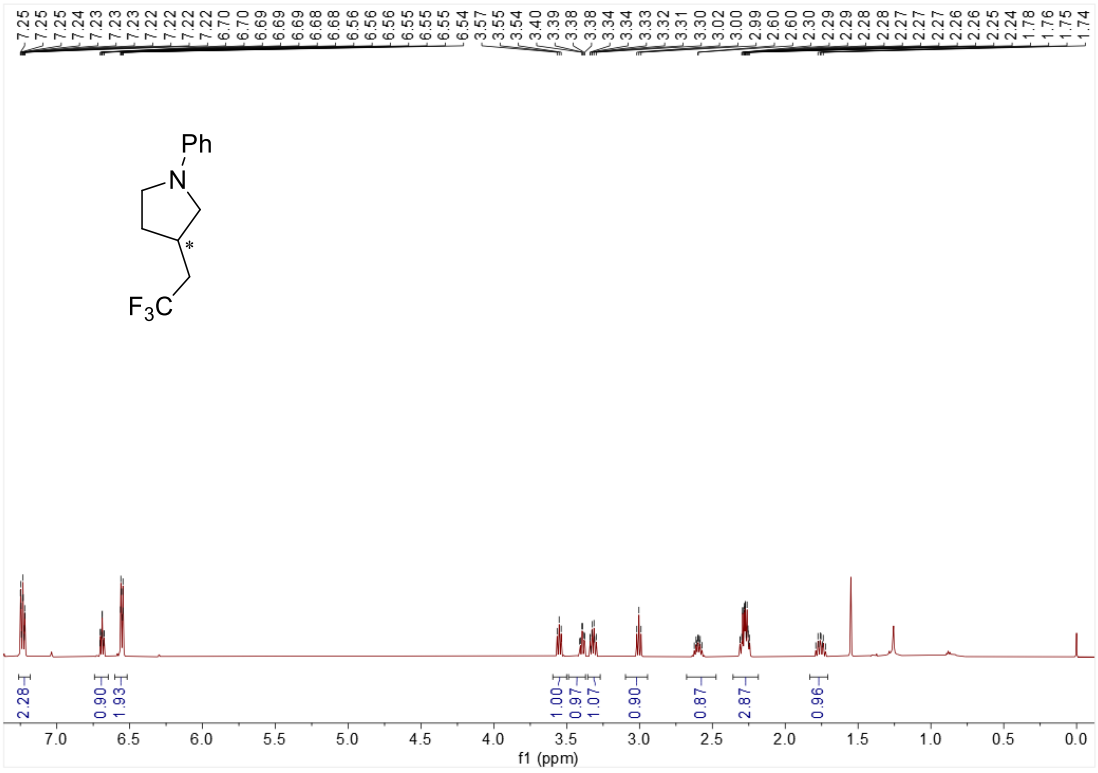
1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4m**)

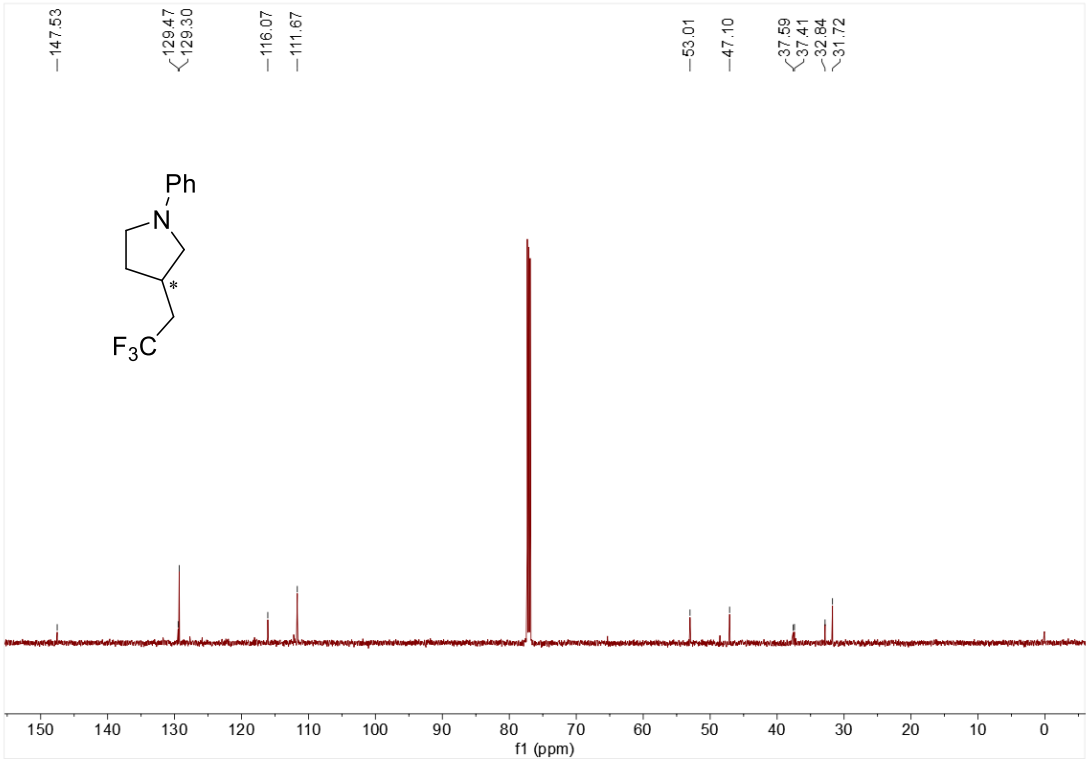


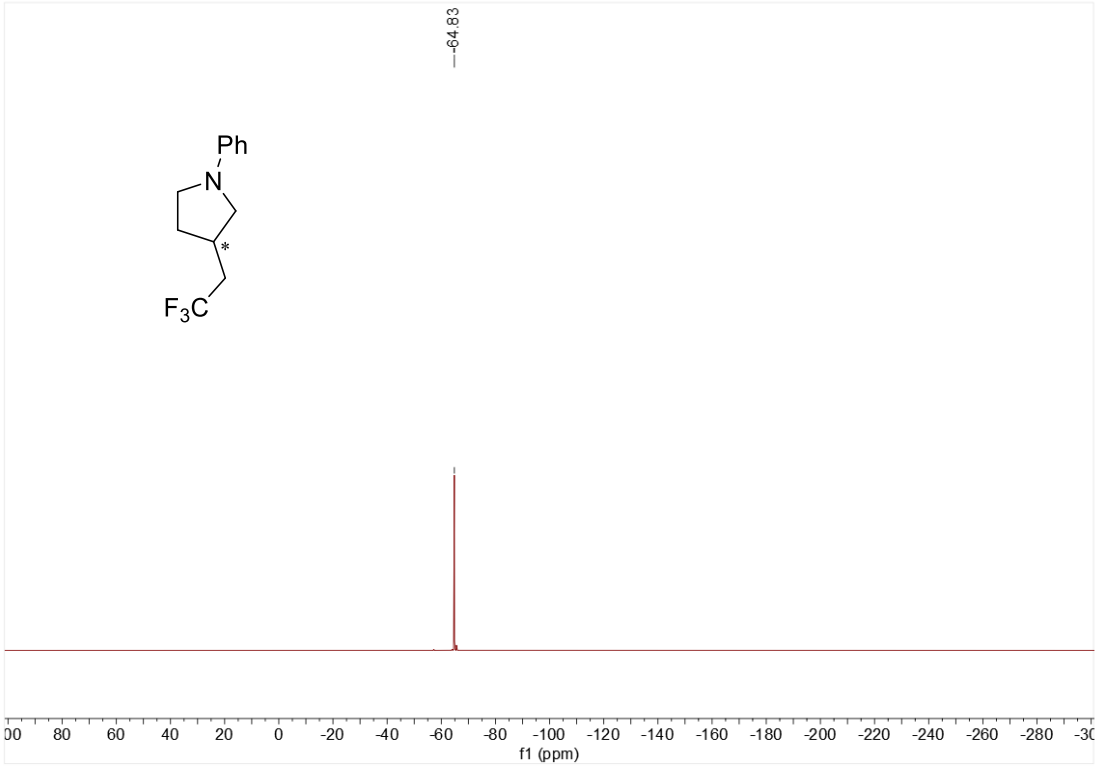



-63.40
N
O
*
CF3
100 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -300
f1 (ppm)

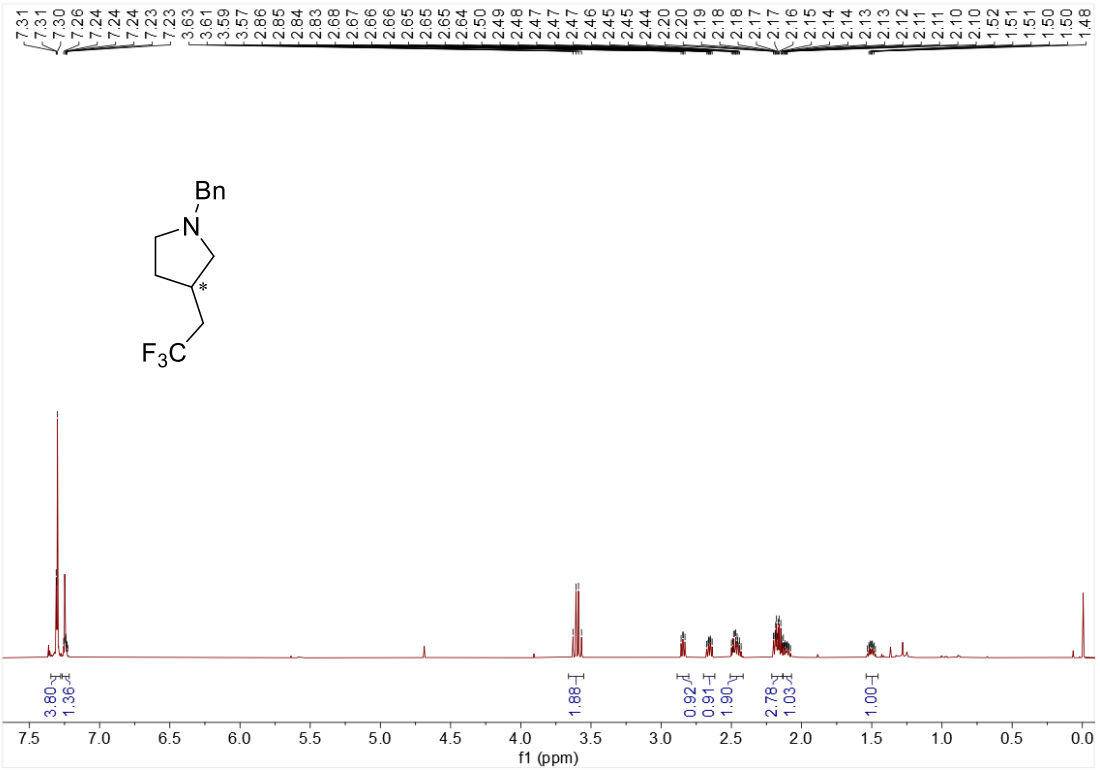
1-phenyl-3-(2,2,2-trifluoroethyl)pyrrolidine (**5**)

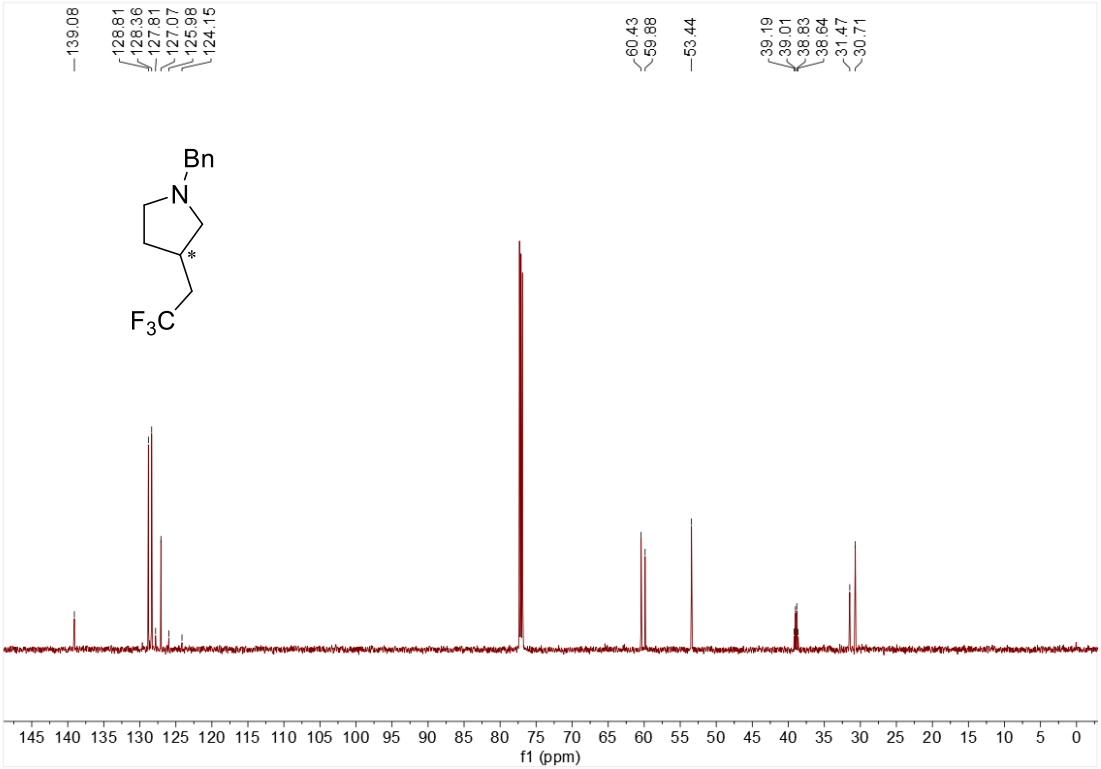


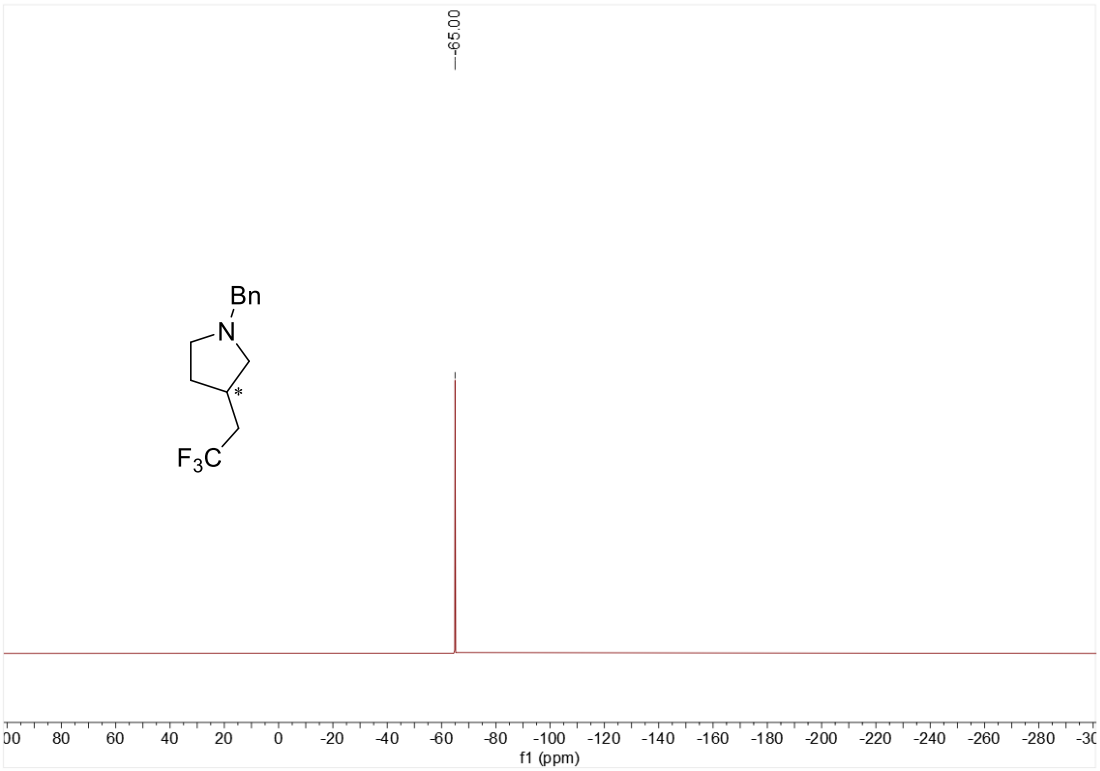



-64.83
Ph
N
*
F3C
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

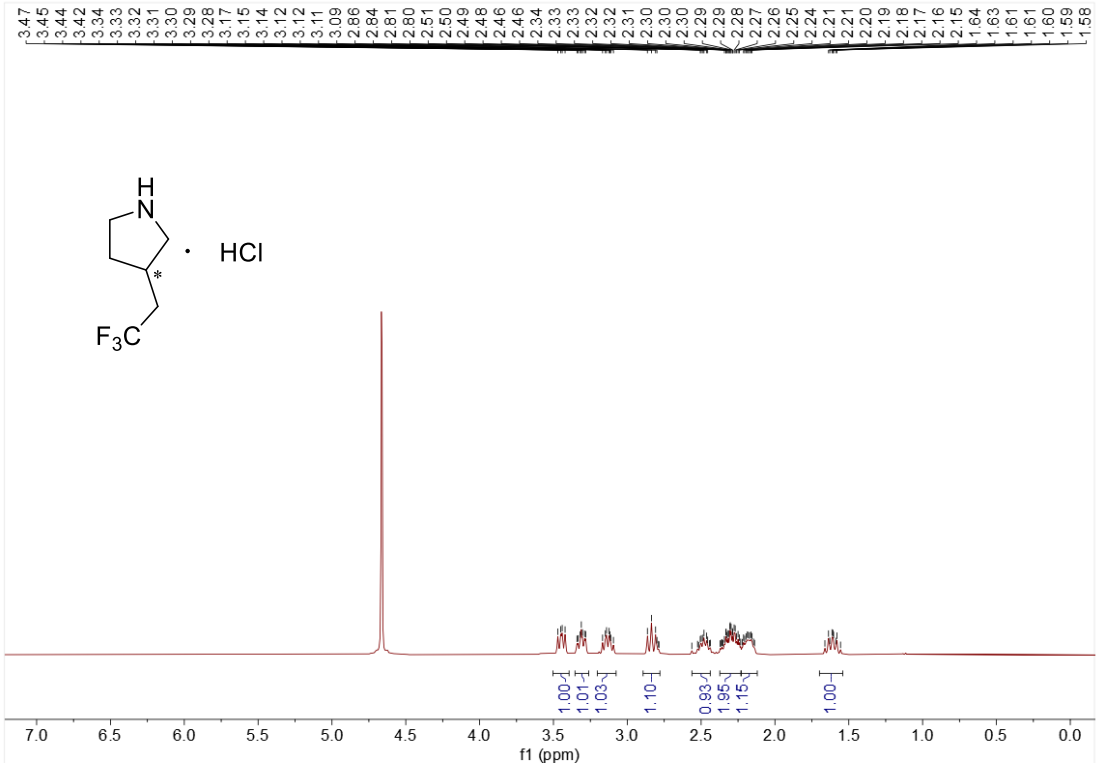
1-benzyl-3-(2,2,2-trifluoroethyl)pyrrolidine (**7**)

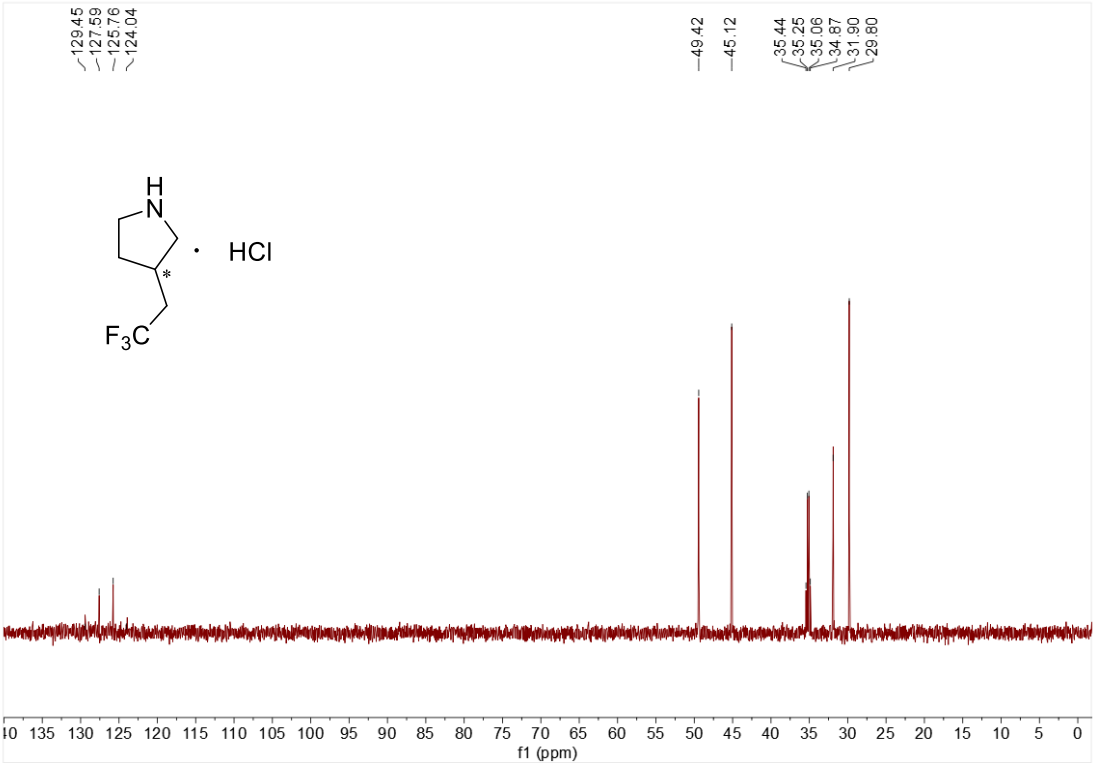


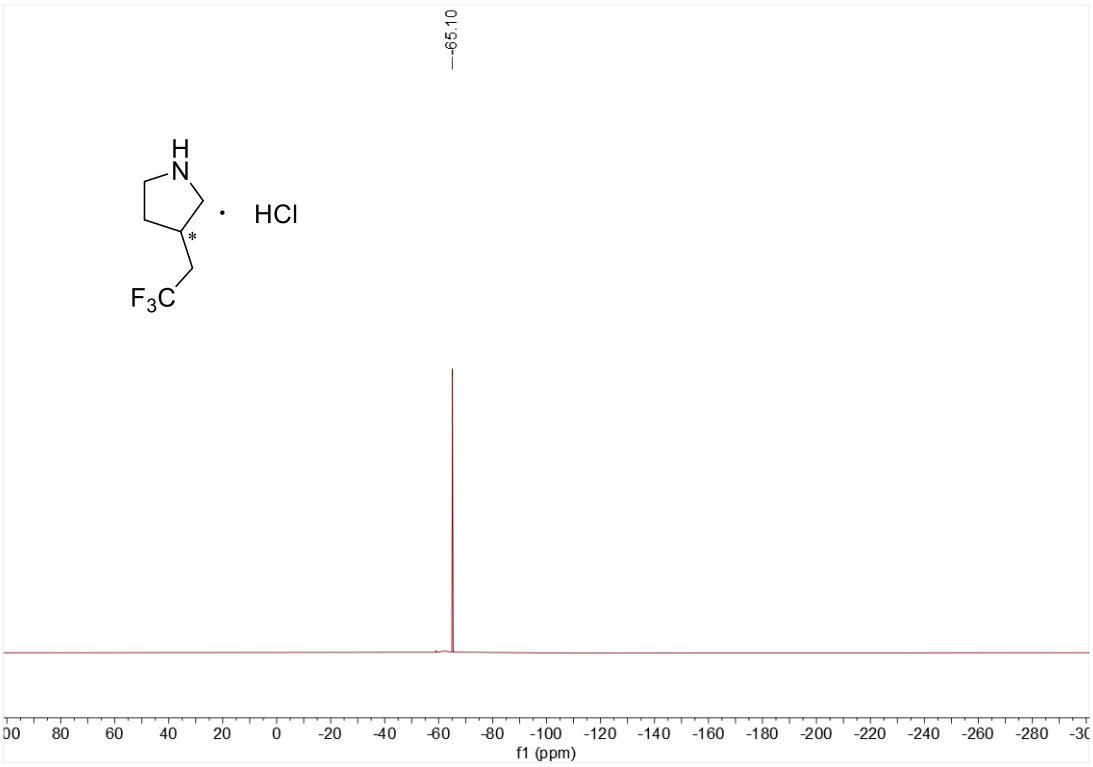



-65.00
Bn
N
*
F3C
80
60
40
20
0
-20
-40
-60
-80
-100
-120
-140
-160
-180
-200
-220
-240
-260
-280
f1 (ppm)

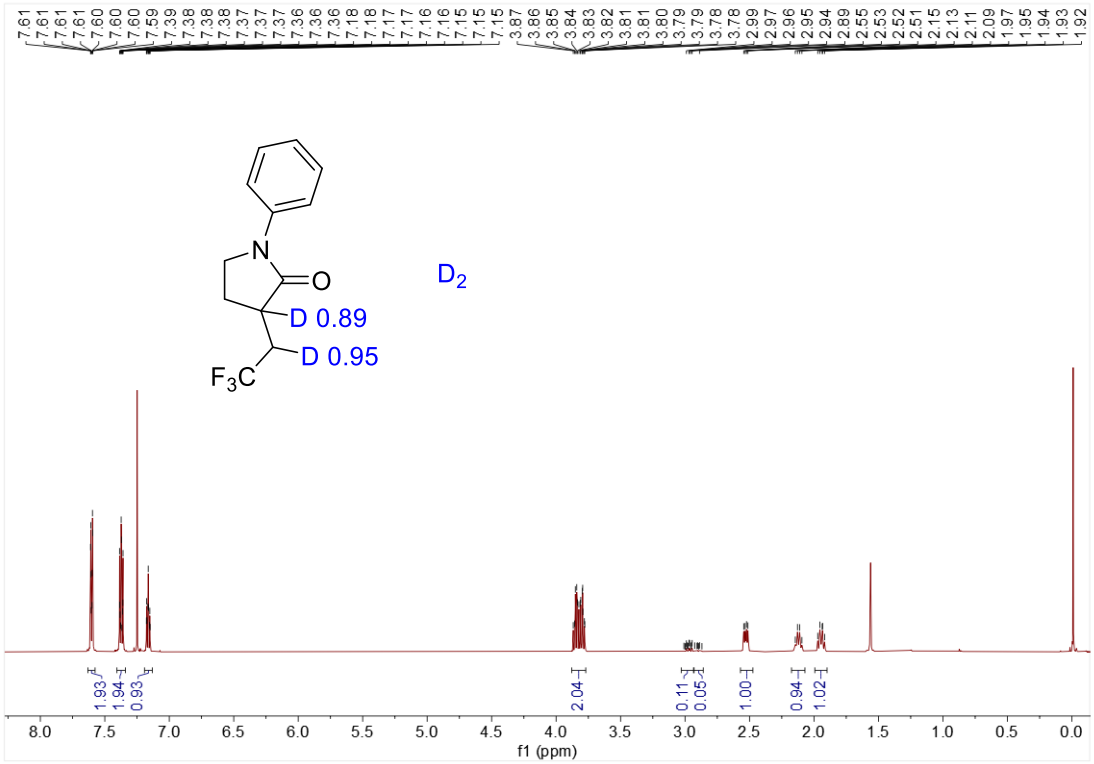
3-(2,2,2-trifluoroethyl)pyrrolidine hydrochloride (**8**)

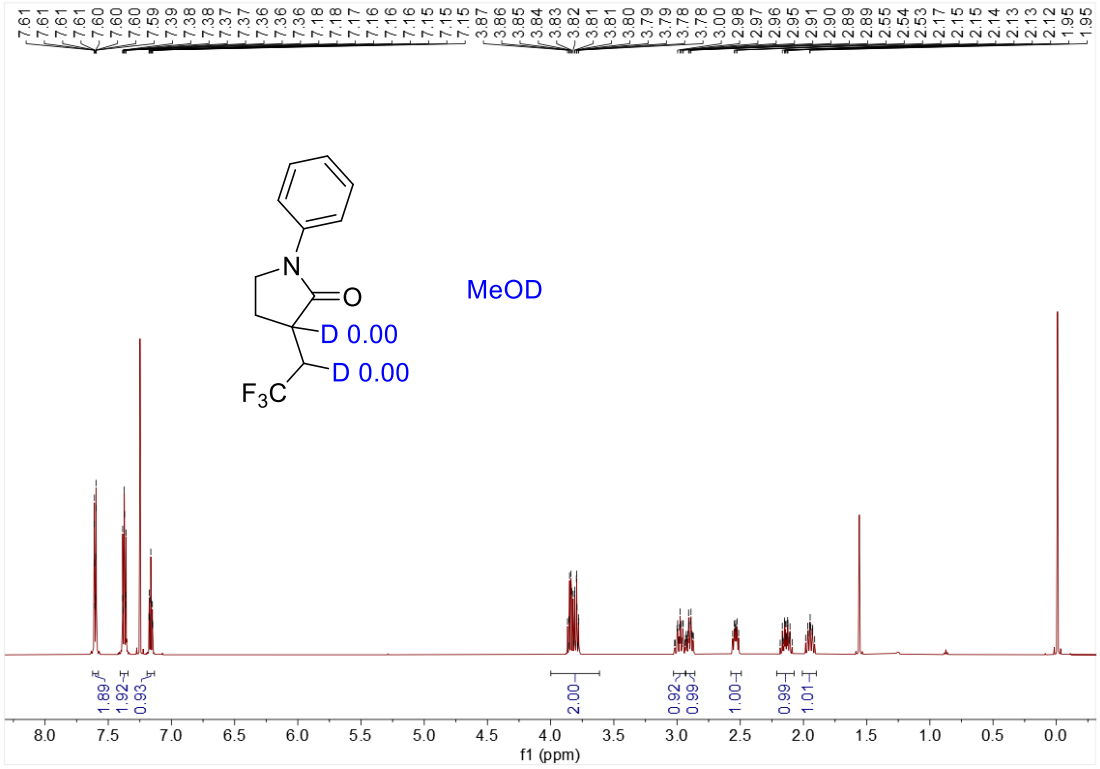




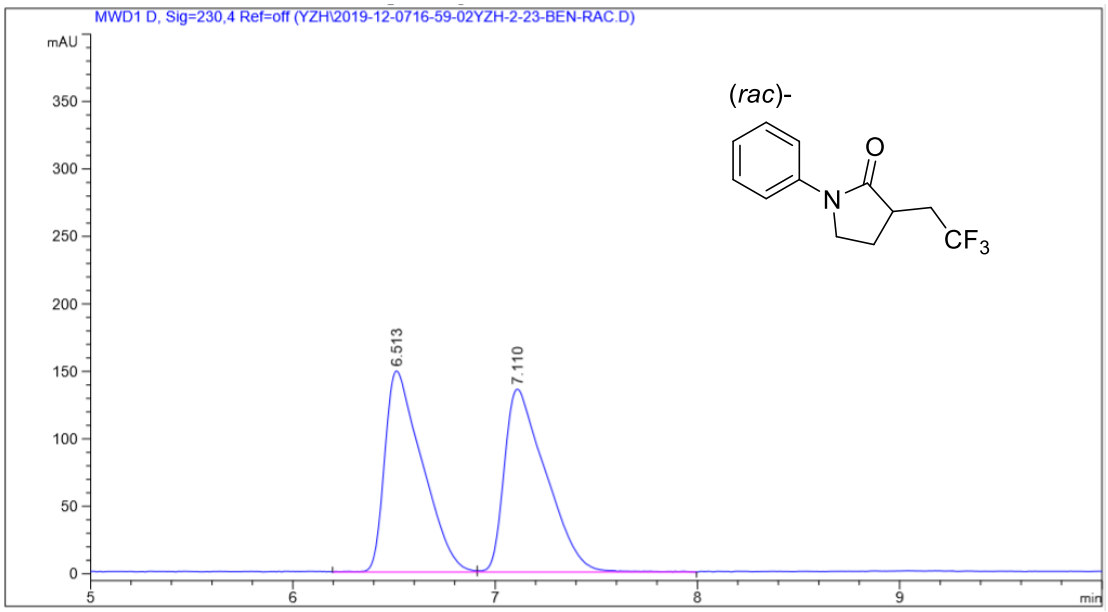

-65.10
H
N
HCl
*
F3C
00 80 60 40 20 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260 -280 -3(
f1 (ppm)

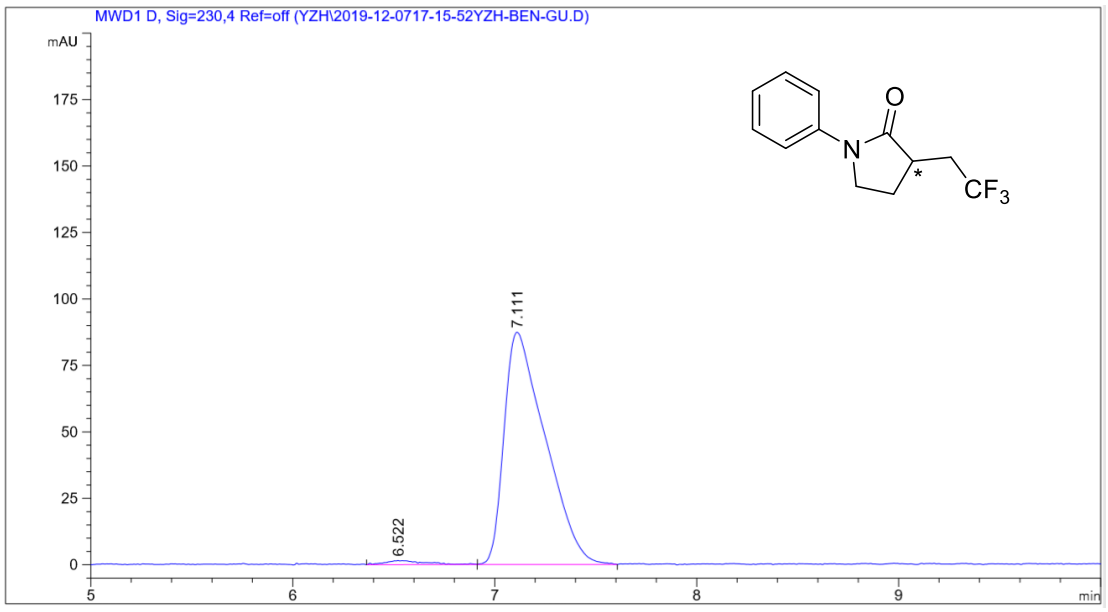
The ^{1}H NMR of deuterium labeling experiments.





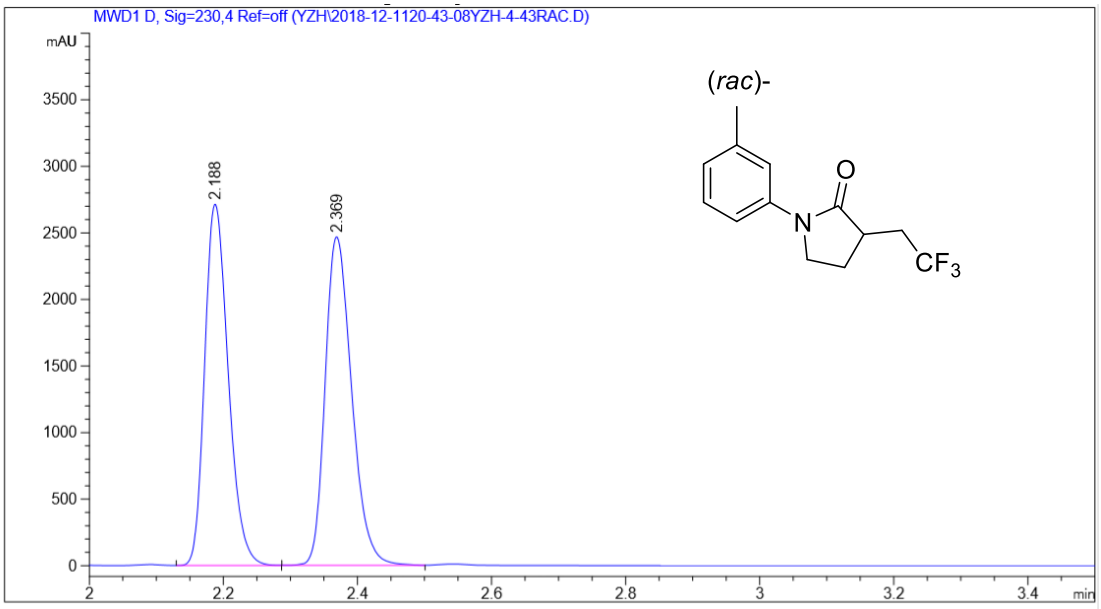
1-phenyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2a**)

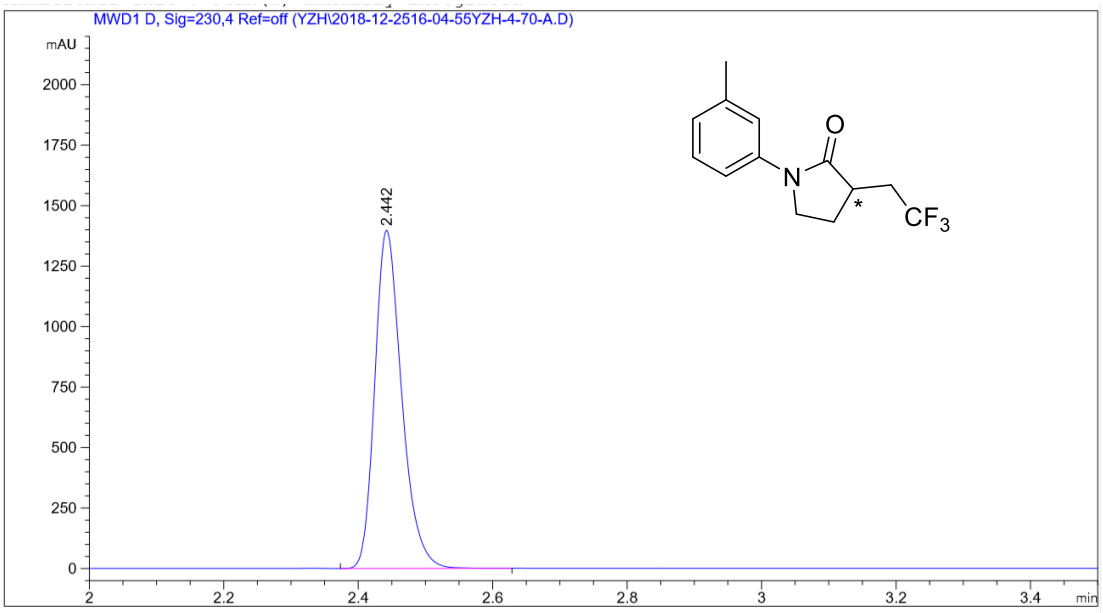




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.948	VV R	0.0425	91.31137	32.78270	1.4353
2	3.073	VV R	0.0489	6270.69873	1980.46948	98.5647
Totals :				6362.01010	2013.25218	

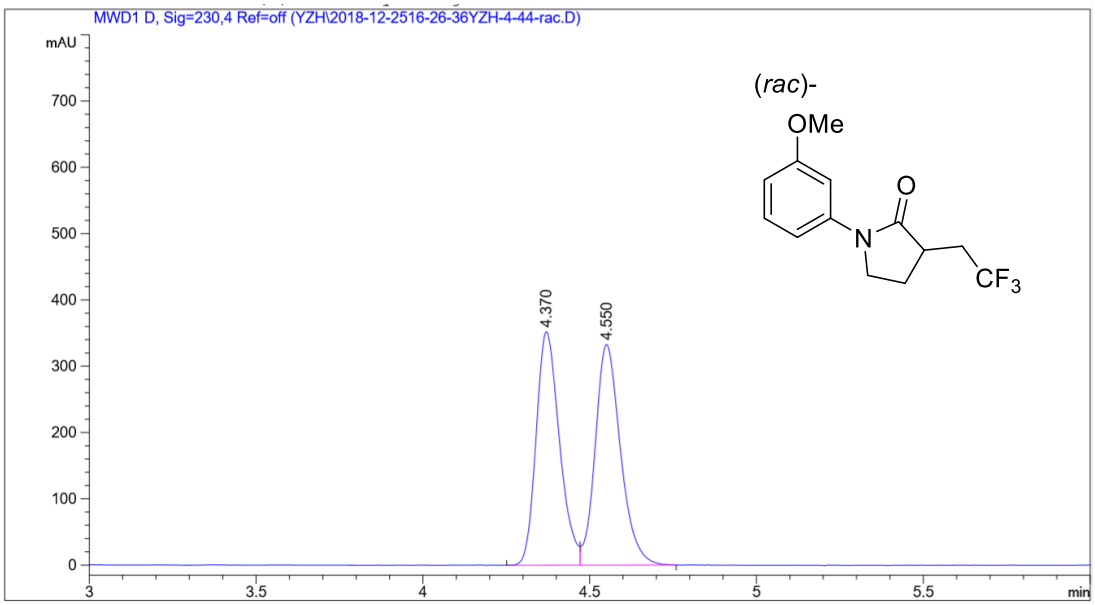
1-(*m*-tolyl)-3-(2,2,2-trifluoroethyl) pyrrolidin-2-one (**2b**)

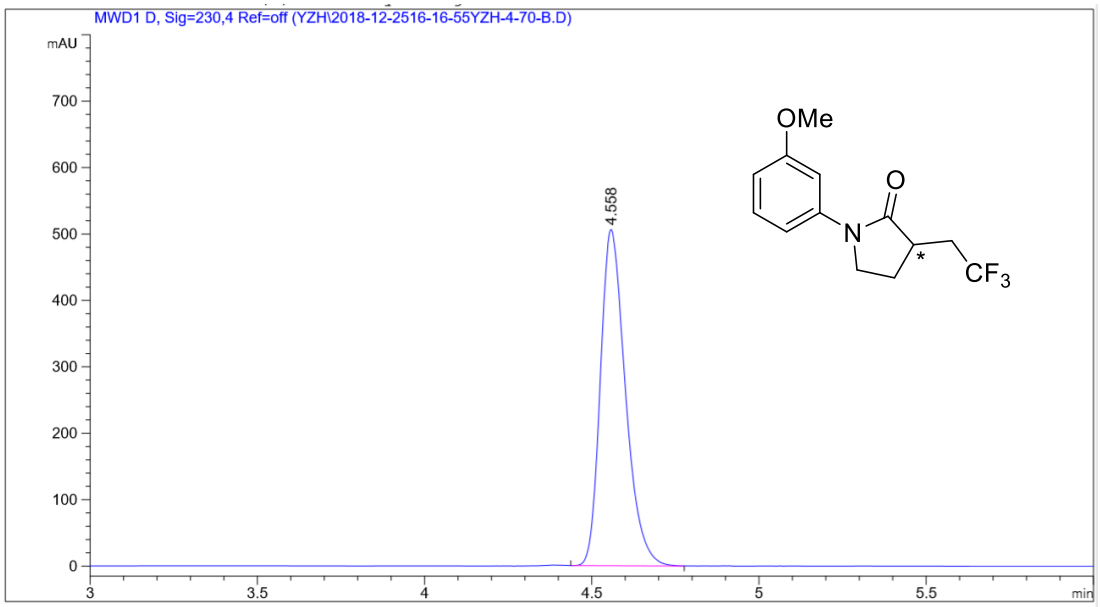




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.442	BV R	0.0424	3883.56323	1398.43164	100.0000
Totals :				3883.56323	1398.43164	

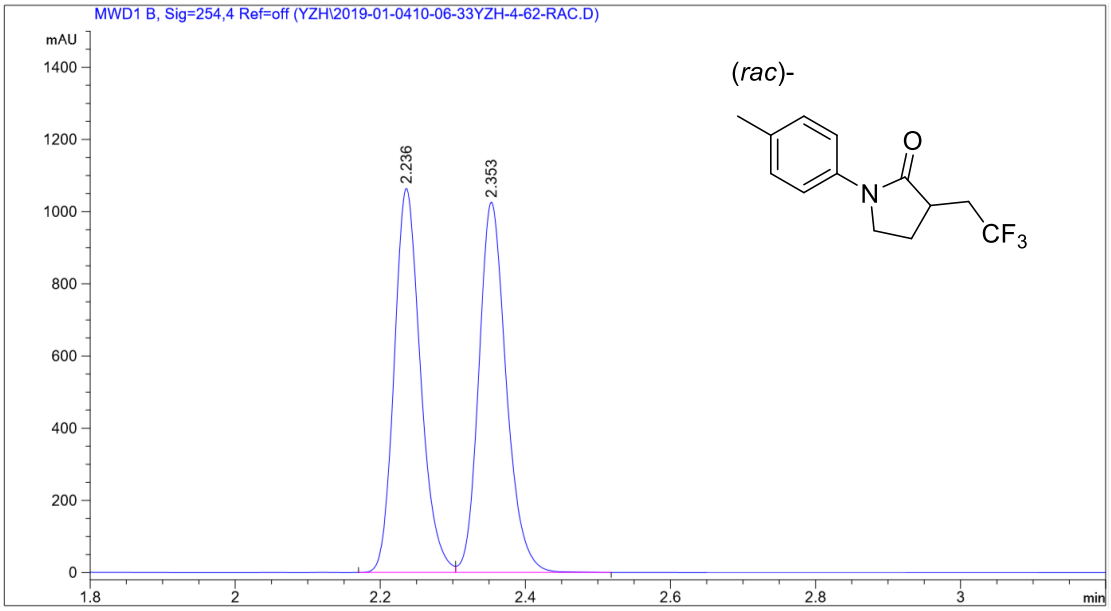
1-(3-methoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2c**)

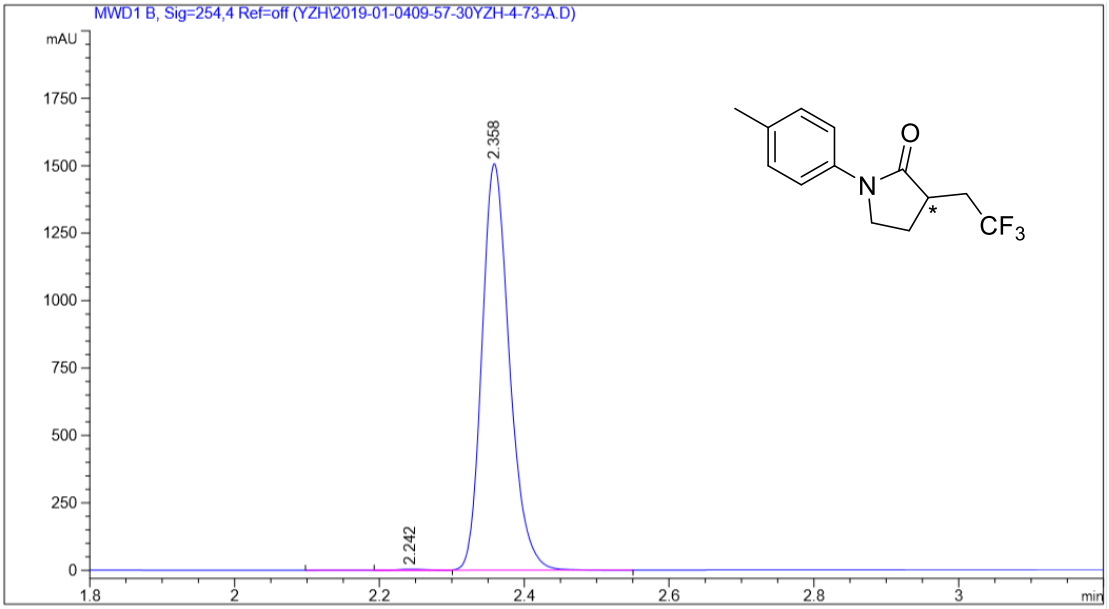




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.558	BB	0.0803	2638.98633	506.16745	100.0000
Totals :				2638.98633	506.16745	

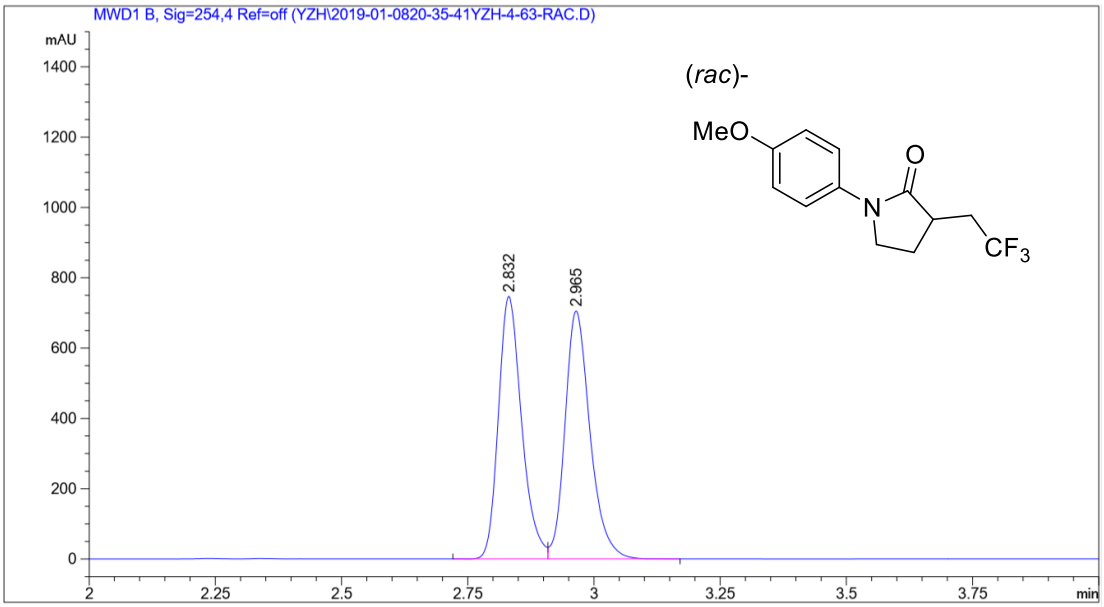
1-(*p*-tolyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2d**)

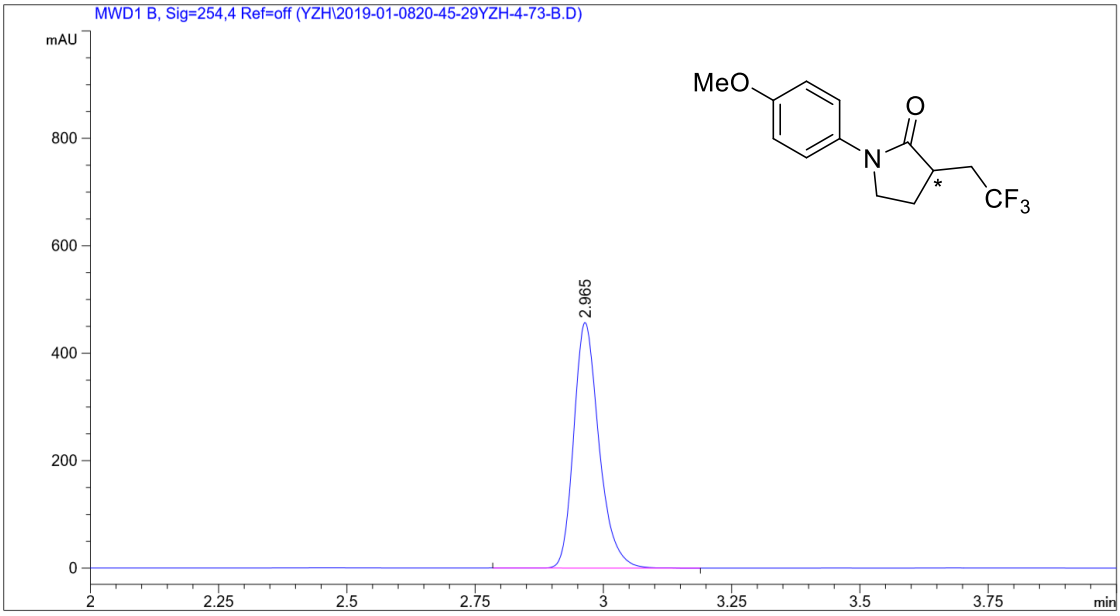




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.242	VV E	0.0351	10.75305	4.24057	0.2694
2	2.358	VV R	0.0403	3980.28394	1507.89783	99.7306
Totals :				3991.03699	1512.13840	

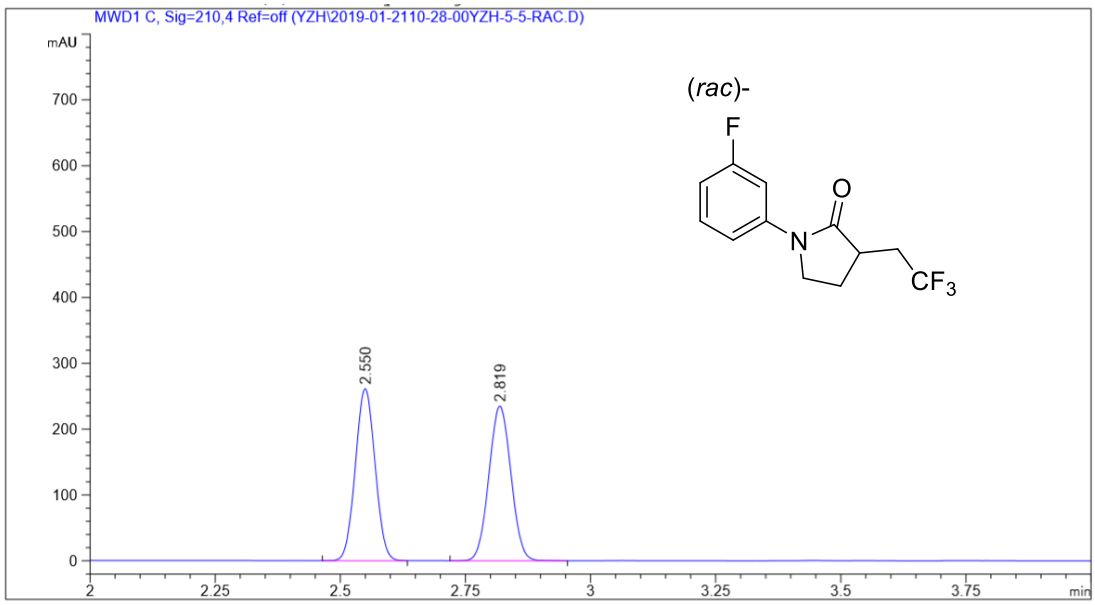
1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2e**)

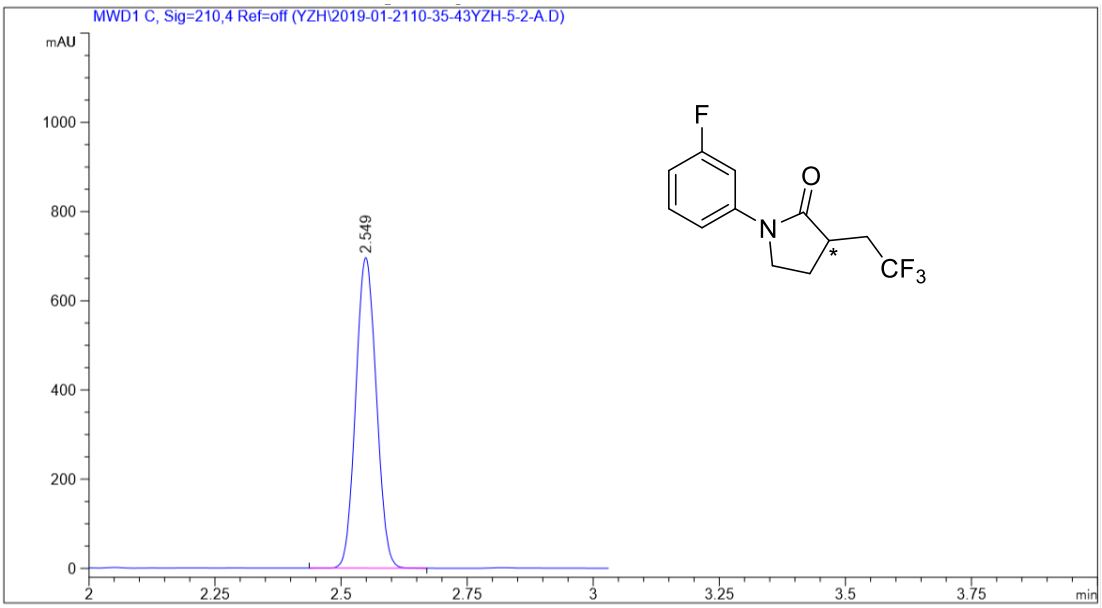




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.965	VV R	0.0524	1564.96265	457.23709	100.0000
Totals :				1564.96265	457.23709	

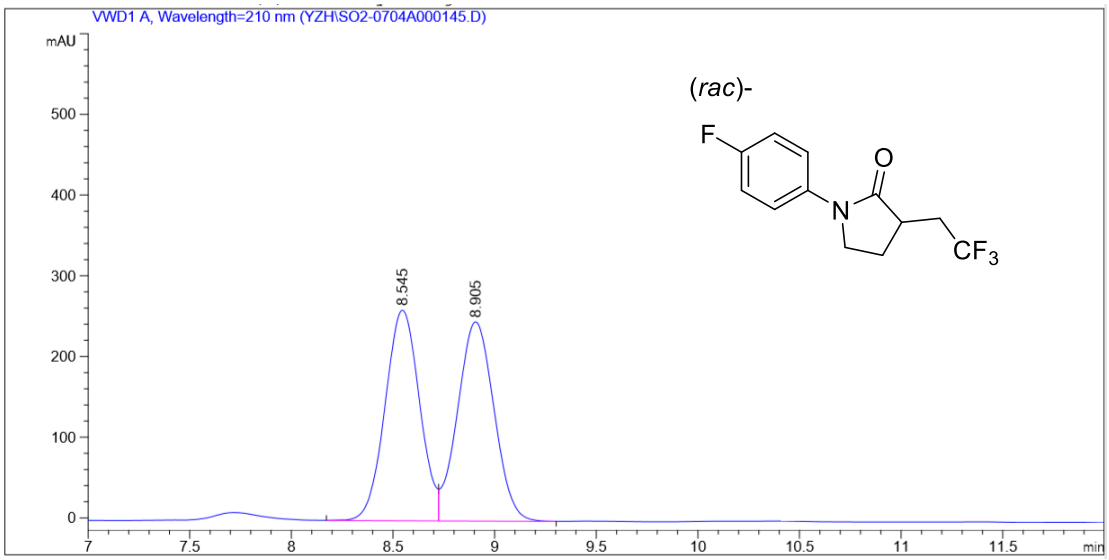
1-(3-fluorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2f**)

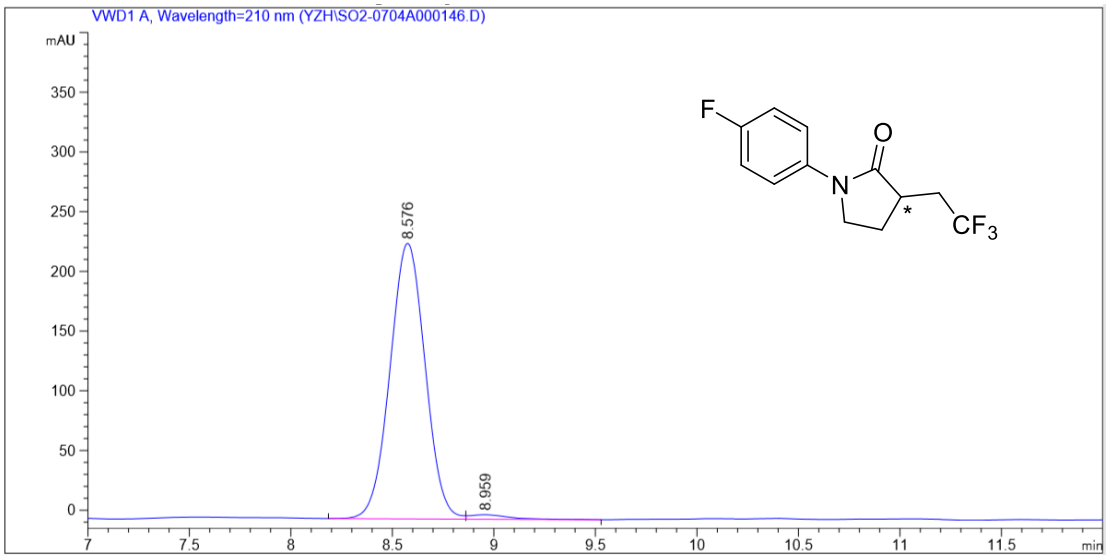




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.549	VV R	0.0450	1971.38428	696.45831	100.0000
Totals :				1971.38428	696.45831	

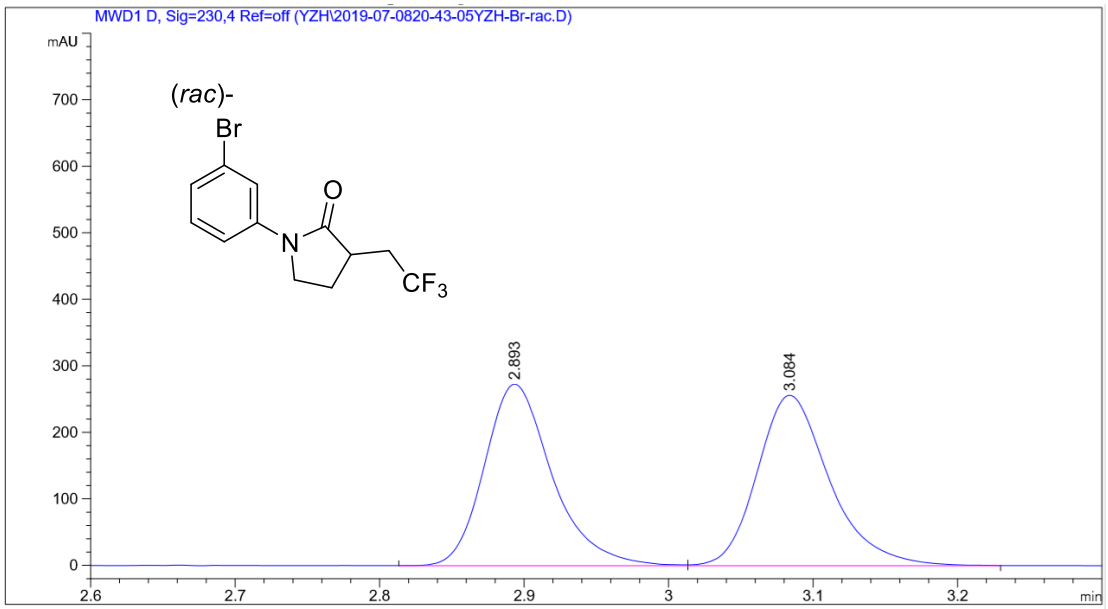
1-(4-fluorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2g**)

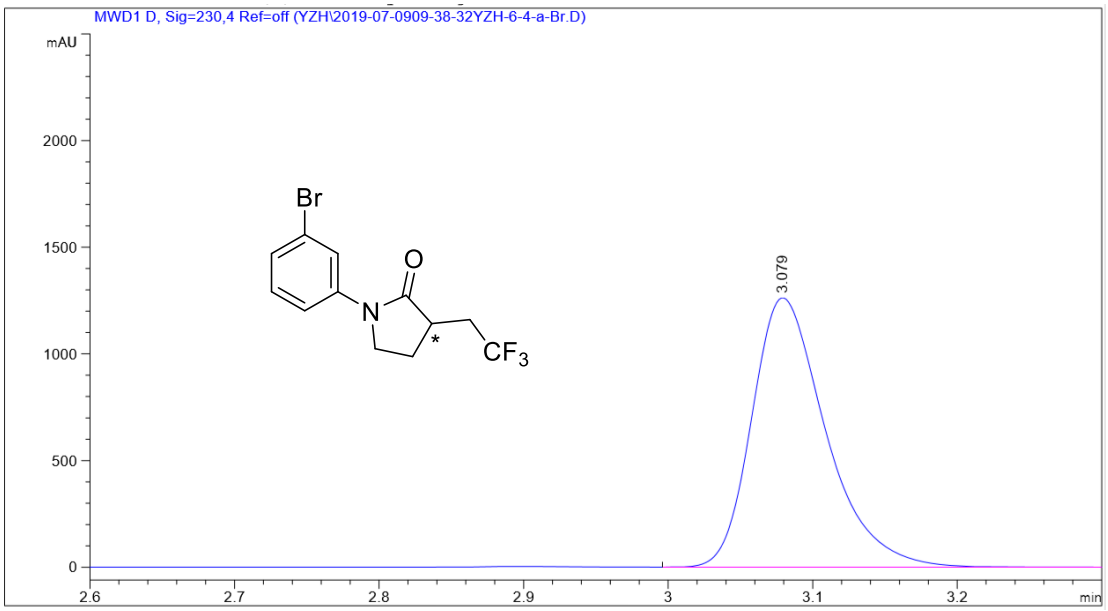




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.576	BV	0.1882	2772.76611	230.71695	98.1103
2	8.959	VB	0.2075	53.40612	3.78834	1.8897
Totals :				2826.17224	234.50529	

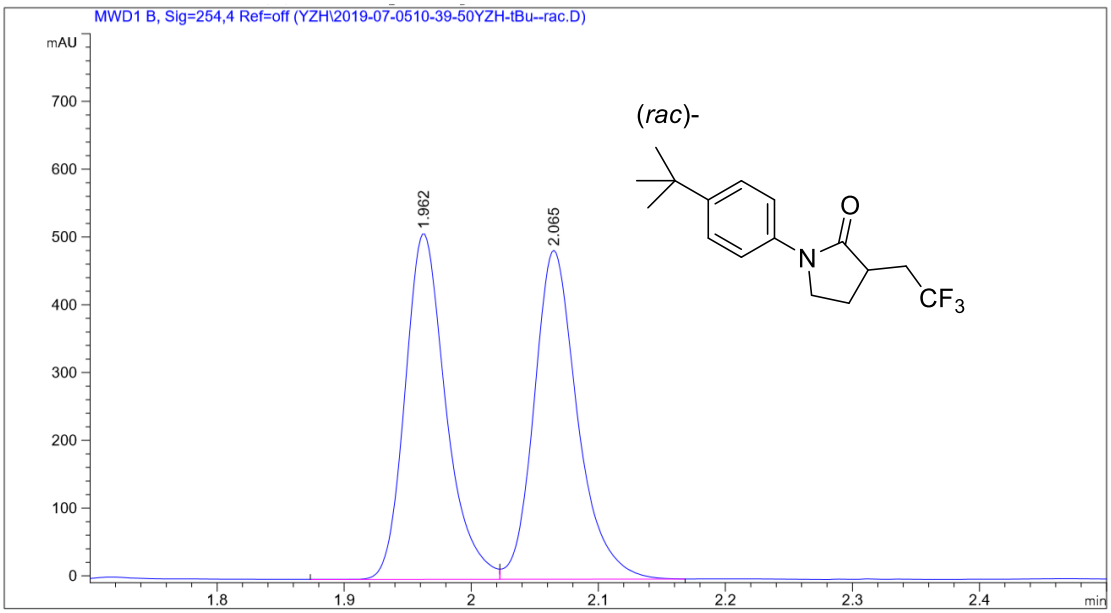
1-(3-bromophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2h**)

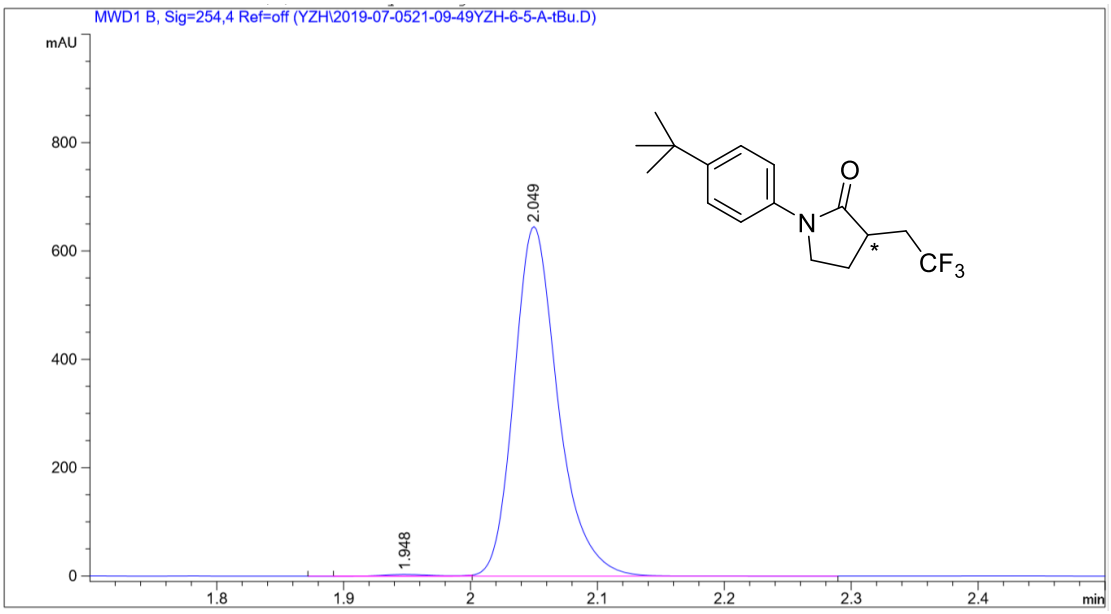




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.079	BV R	0.0539	4476.41650	1262.87476	100.0000
Totals :				4476.41650	1262.87476	

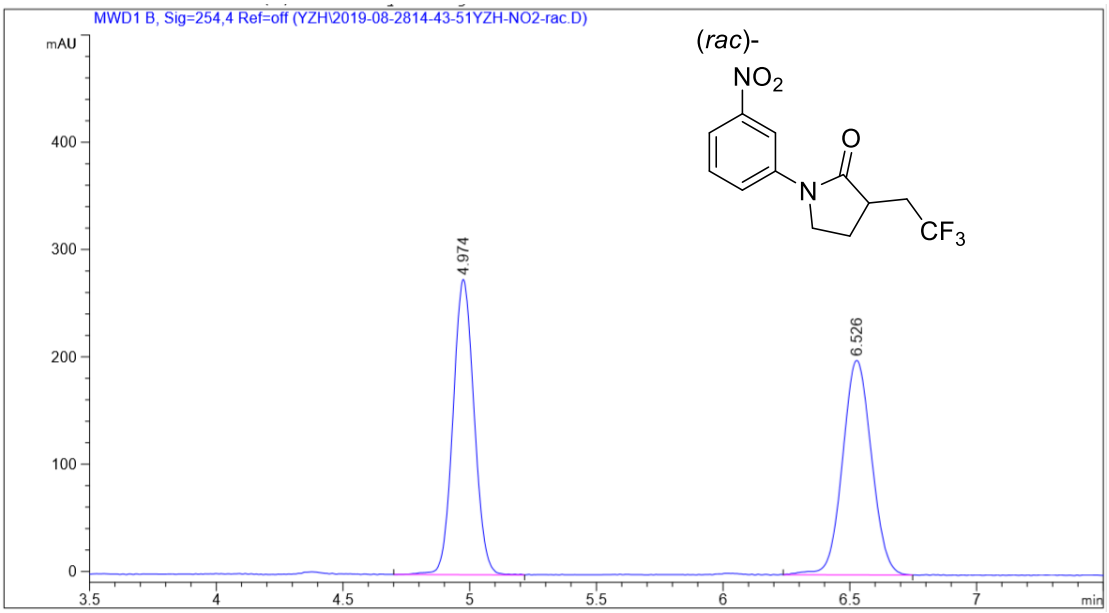
1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2i**)

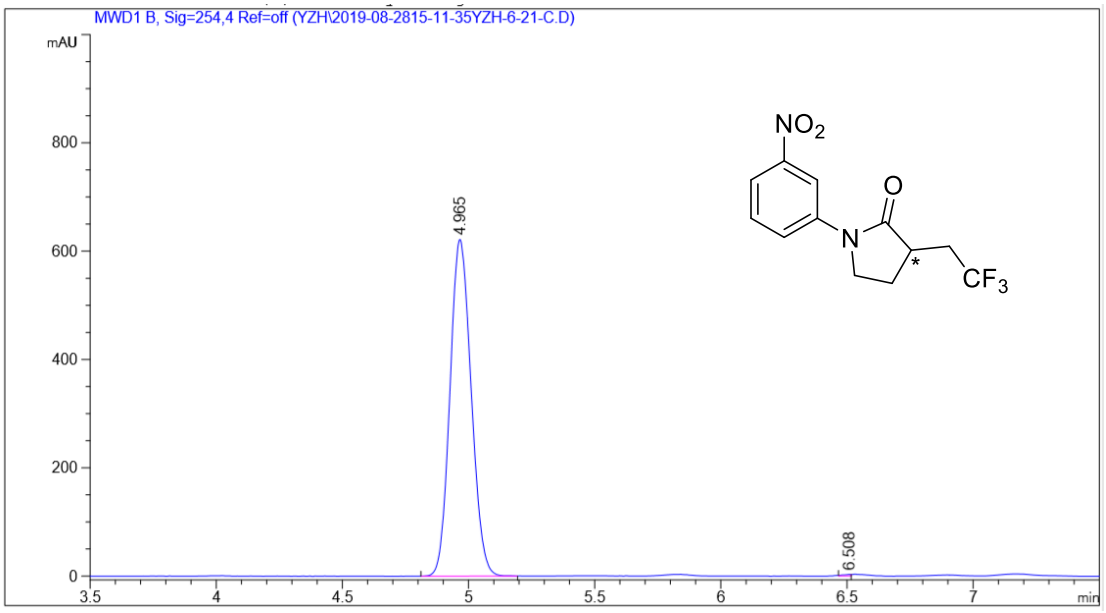




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	1.948	VV E	0.0381	8.32995	3.23315	0.5321
2	2.049	VV R	0.0366	1557.14990	645.38452	99.4679
Totals :				1565.47985	648.61767	

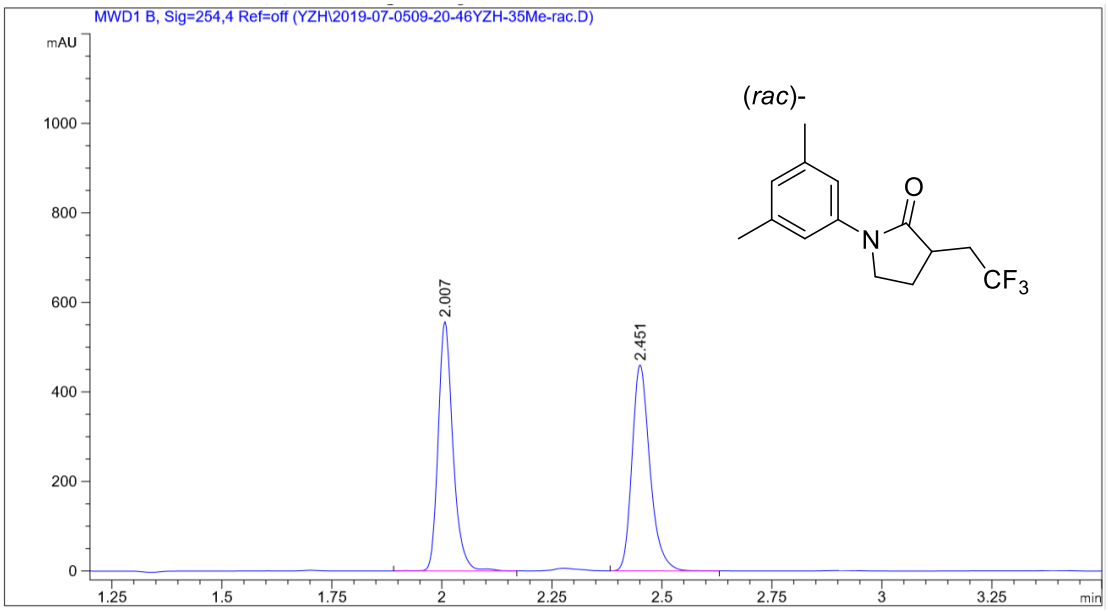
1-(3-nitrophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2j**)

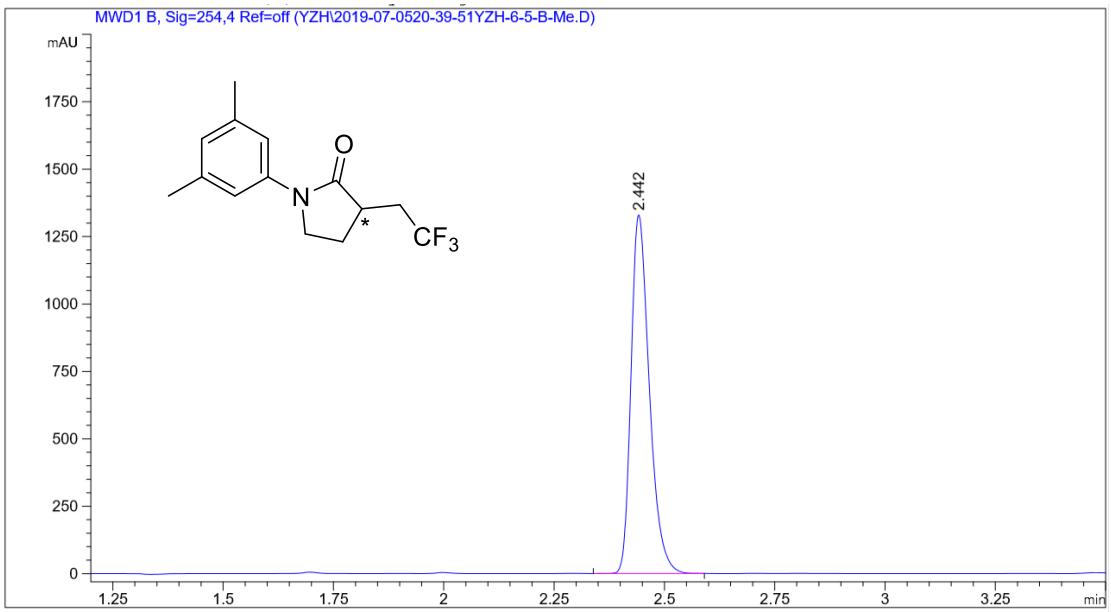




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.965	BV R	0.0917	3632.43018	621.70306	99.8243
2	6.508	VV	0.0294	6.39376	2.93935	0.1757
Totals :				3638.82394	624.64241	

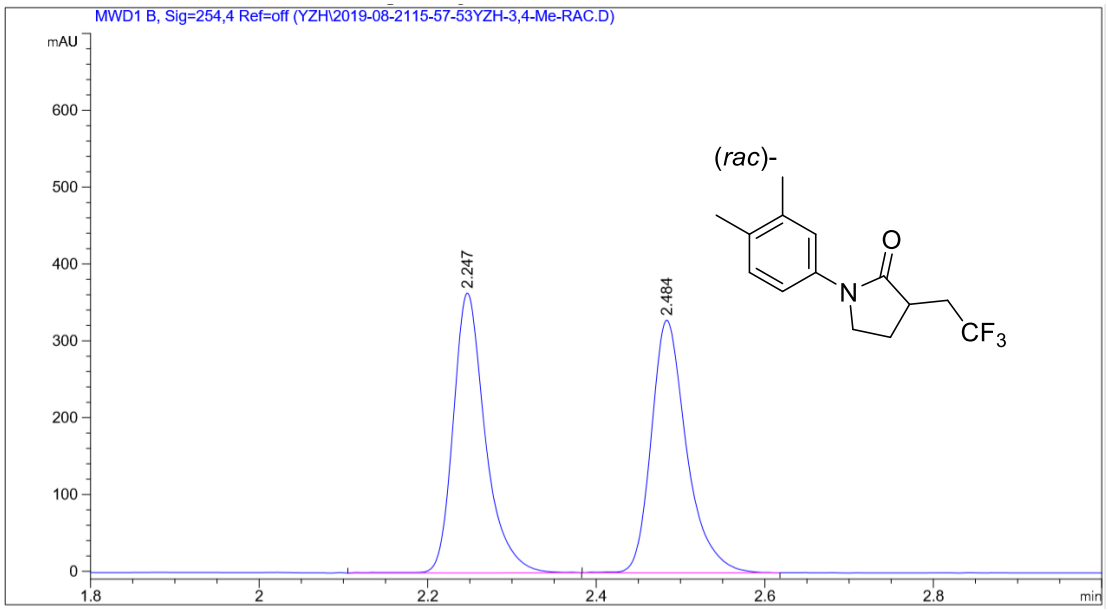
1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2k**)

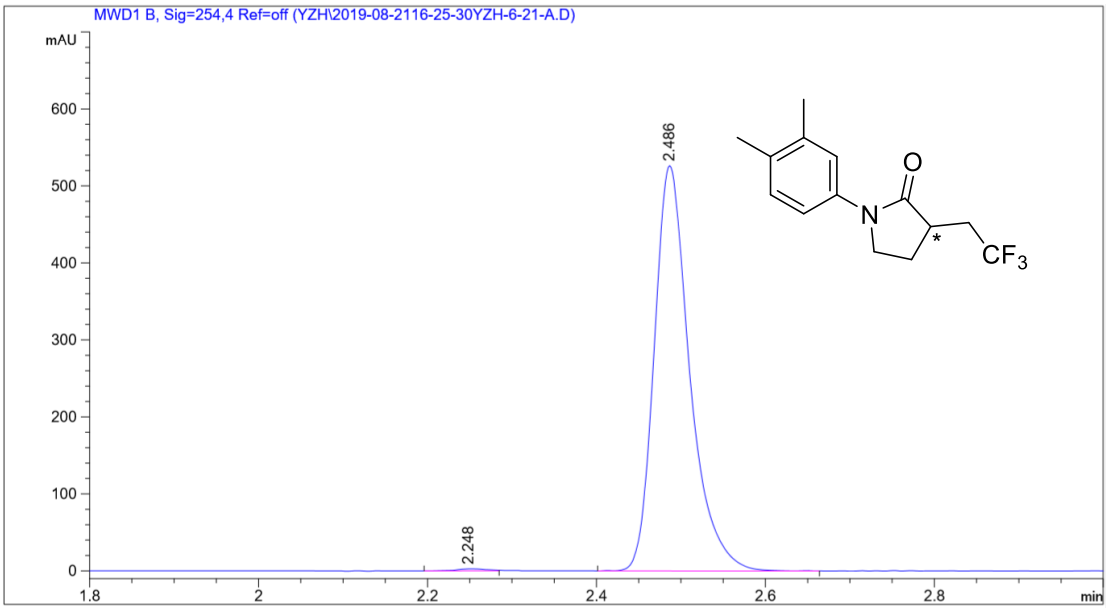




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.442	VV R	0.0446	3834.03589	1330.37695	100.0000
Totals :				3834.03589	1330.37695	

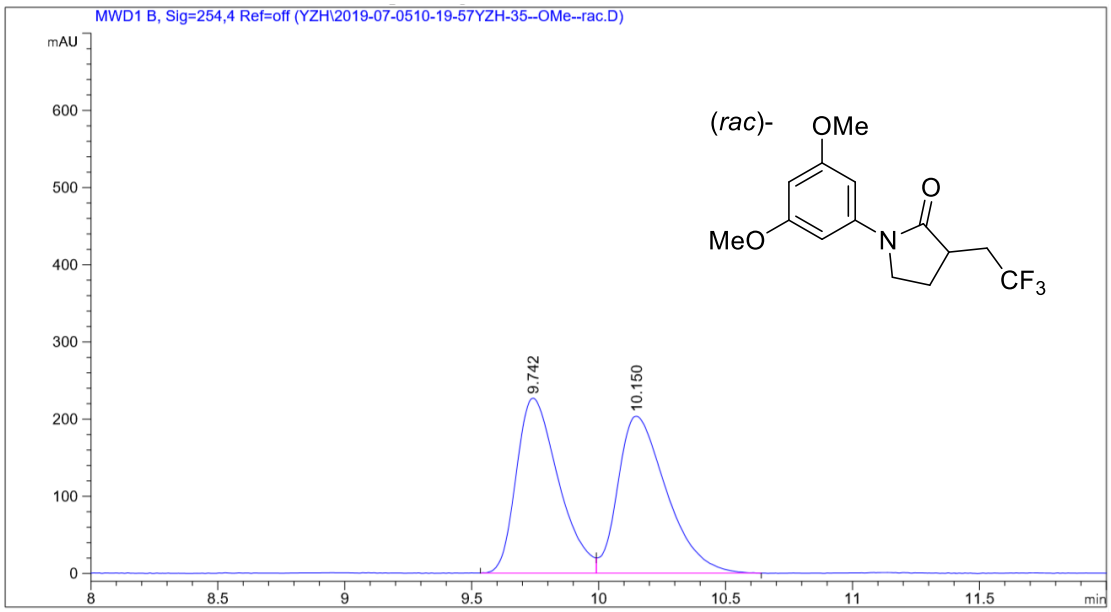
1-(3,4-dimethylphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2l**)

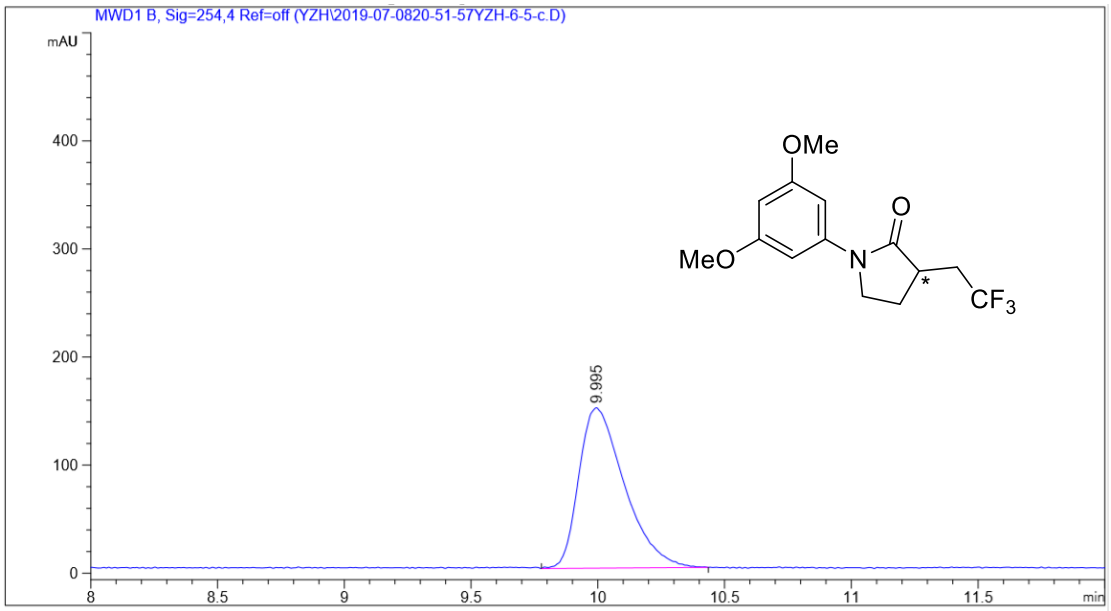




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.248	VV R	0.0306	6.51410	2.75706	0.4218
2	2.486	VV R	0.0441	1537.92639	526.55475	99.5782
Totals :				1544.44049	529.31180	

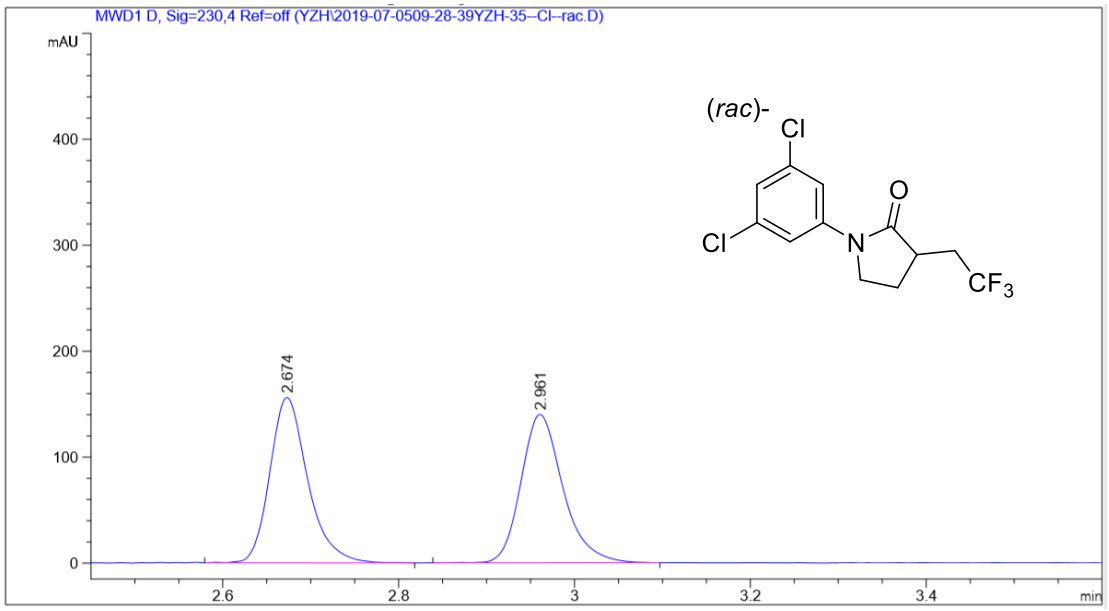
1-(3,5-dimethoxyphenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2m**)

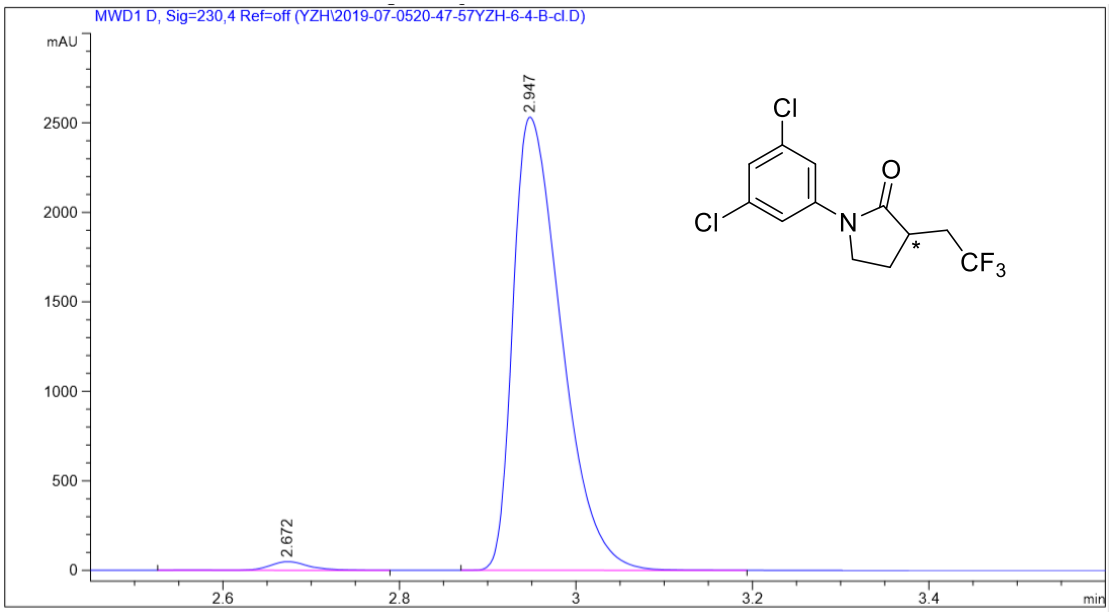




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.995	VV R	0.1524	1857.11304	148.46355	100.0000
Totals :				1857.11304	148.46355	

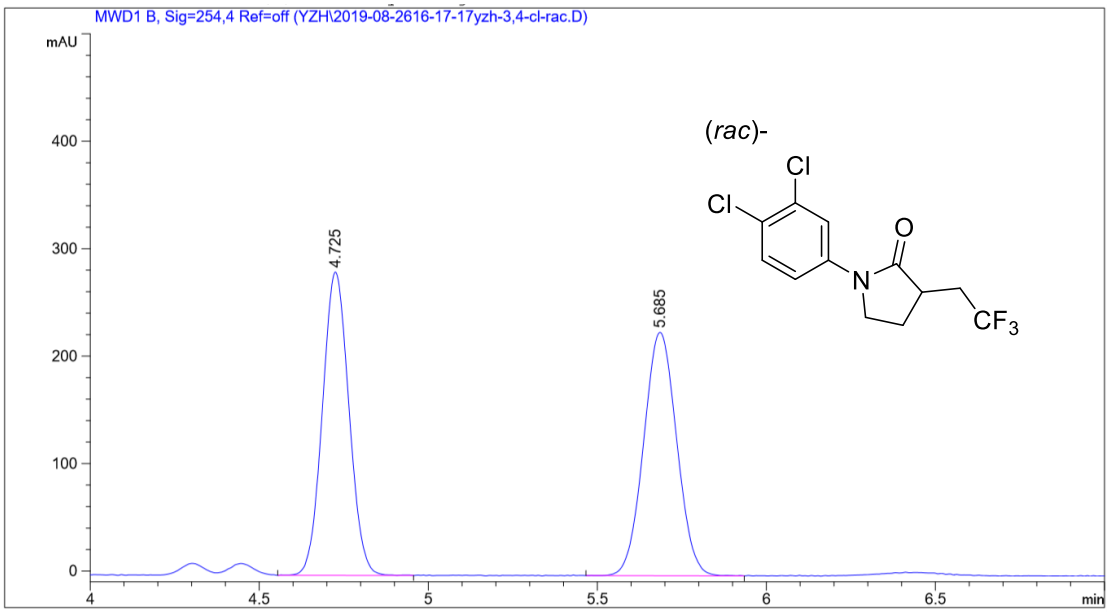
1-(3,5-dichlorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2n**)

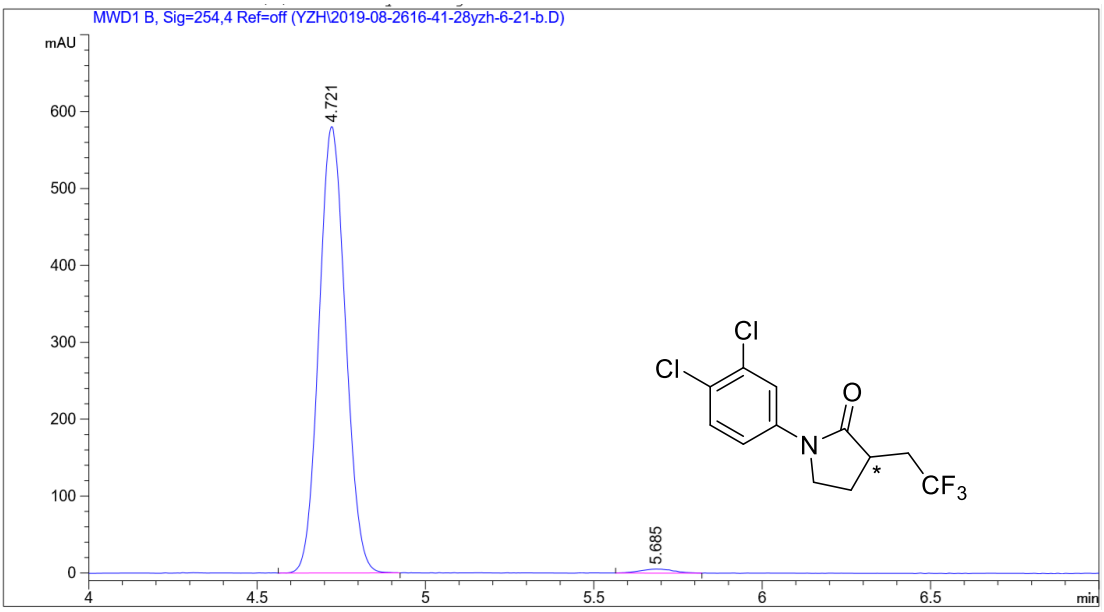




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.672	VV R	0.0462	149.30211	48.76148	1.5341
2	2.947	BV R	0.0586	9583.18945	2532.50488	98.4659
Totals :				9732.49156	2581.26636	

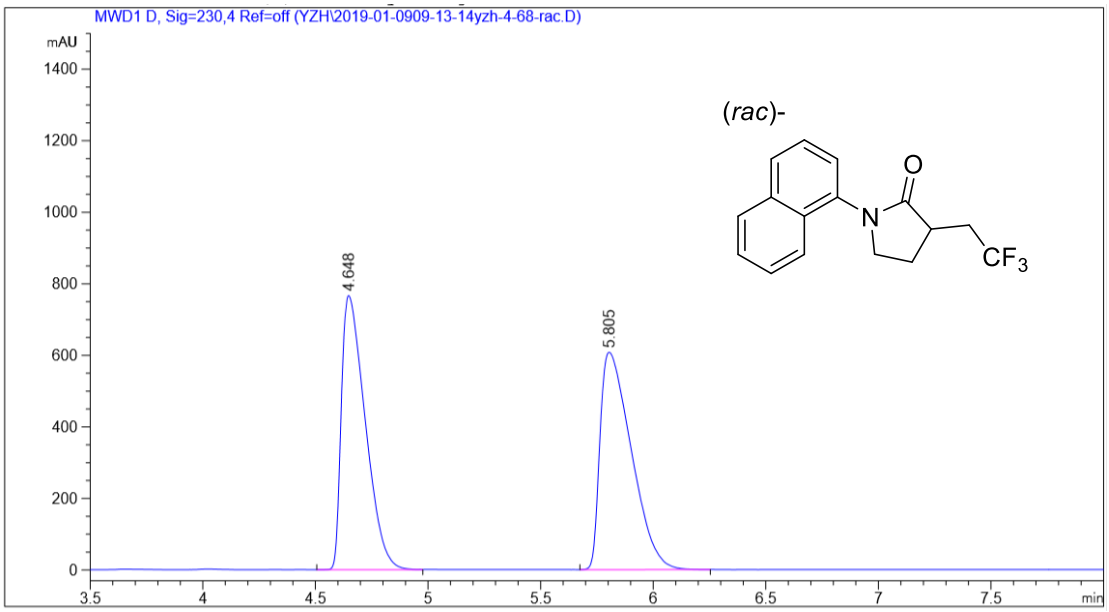
1-(3,4-dichlorophenyl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2o**)

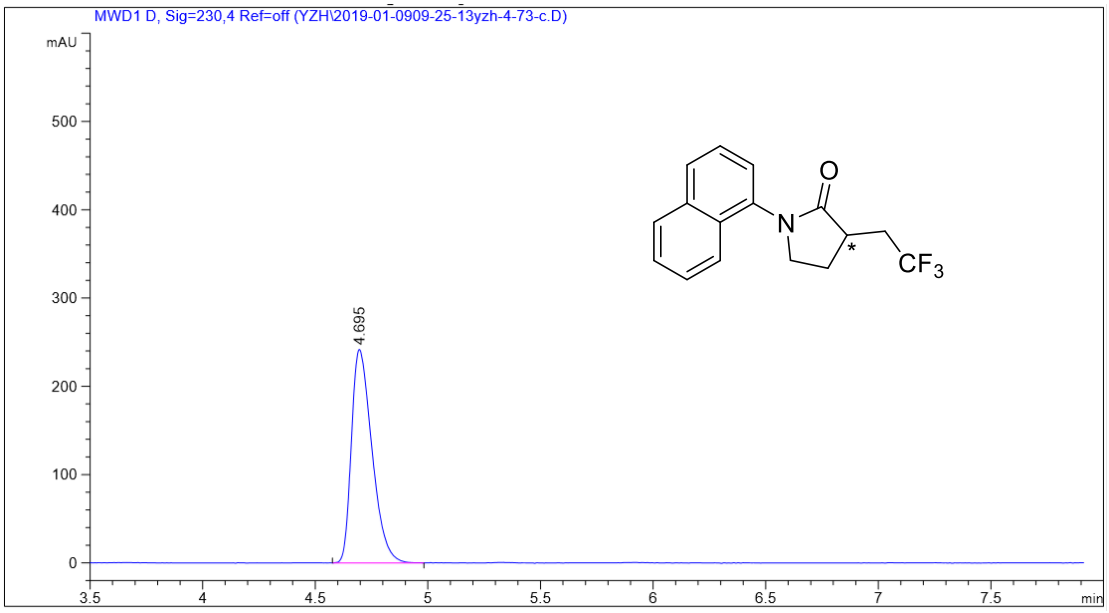




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.721	VV R	0.0854	3179.20581	580.57288	98.8601
2	5.685	BV R	0.0839	36.65637	5.41821	1.1399
Totals :				3215.86218	585.99109	

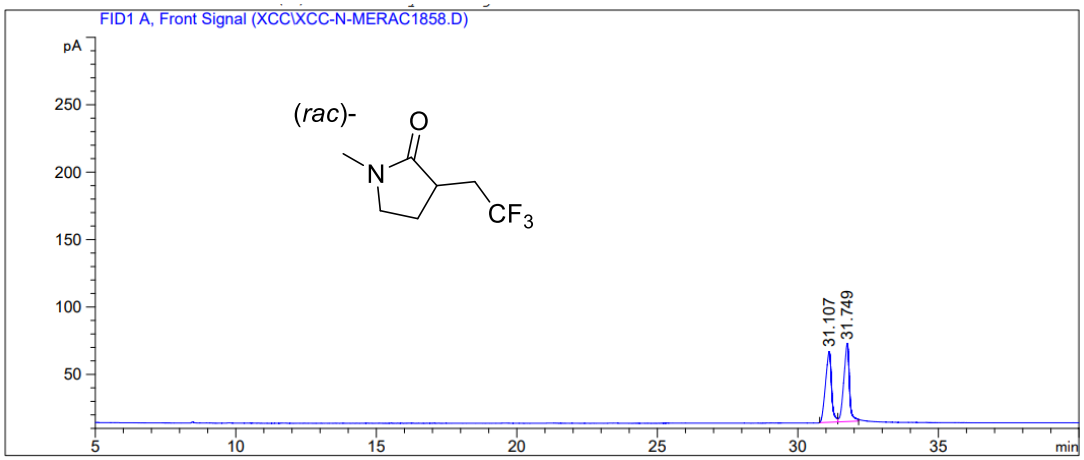
1-(naphthalen-1-yl)-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2p**)

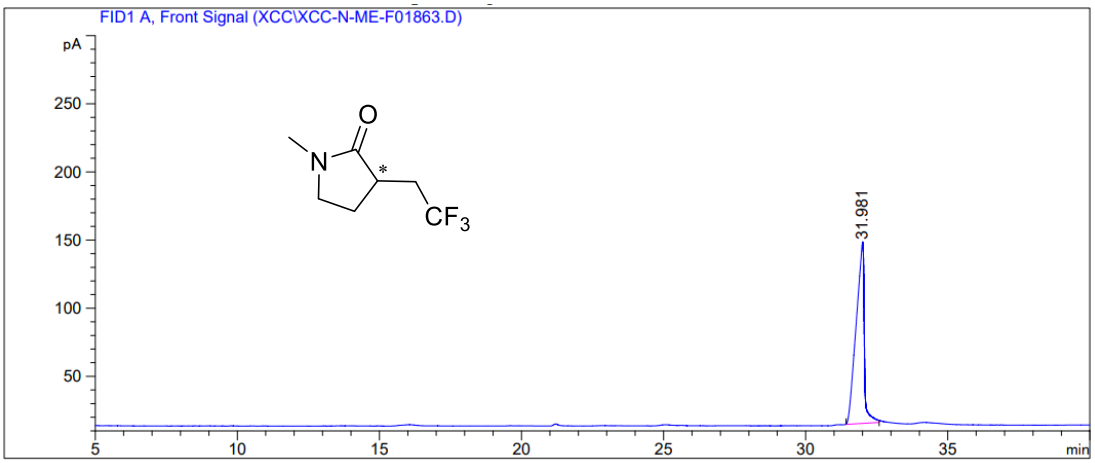




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.695	BV R	0.0987	1537.27405	241.86537	100.0000
Totals :				1537.27405	241.86537	

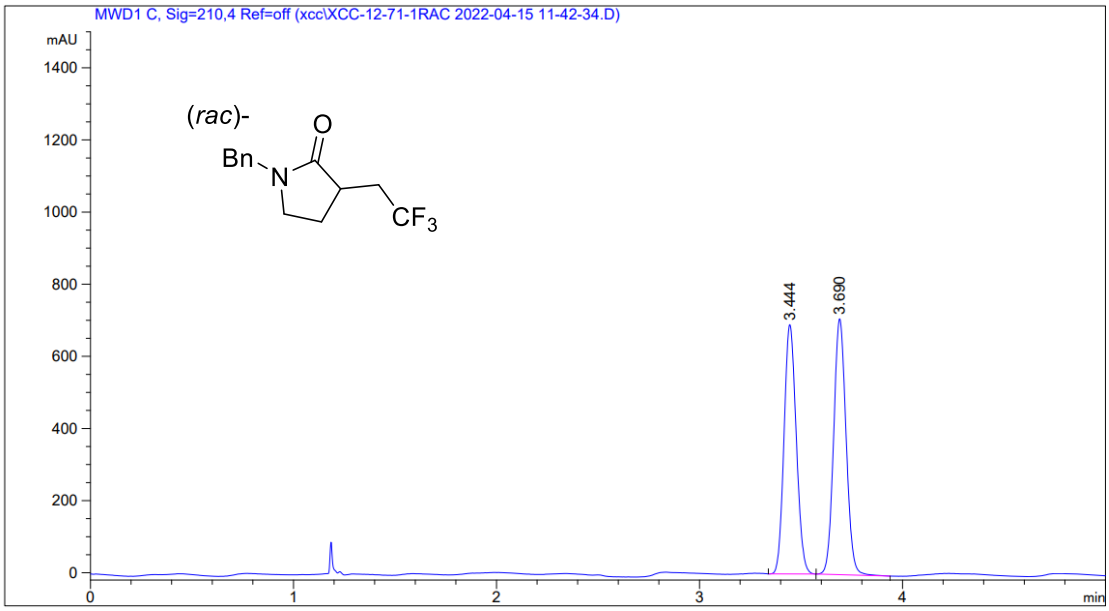
1-methyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2q**)

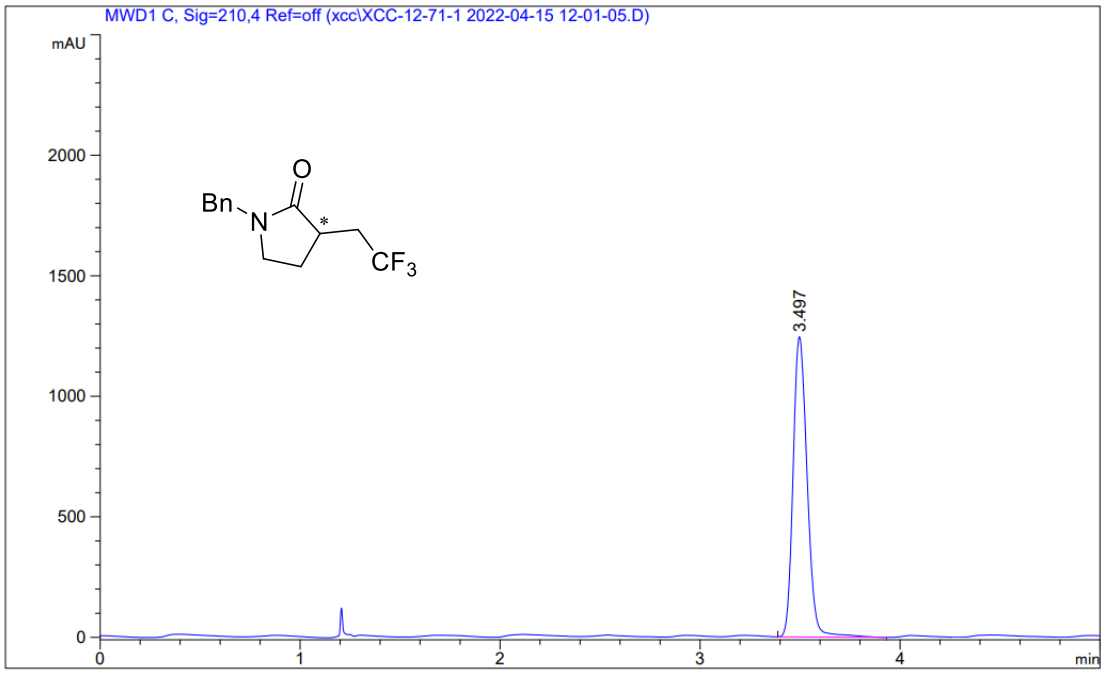




Peak #	RetTime [min]	Type	Width [min]	Area [pA*s]	Height [pA]	Area %
1	31.981	BB	0.3077	2670.02979	131.27904	1.000e2
Totals :				2670.02979	131.27904	

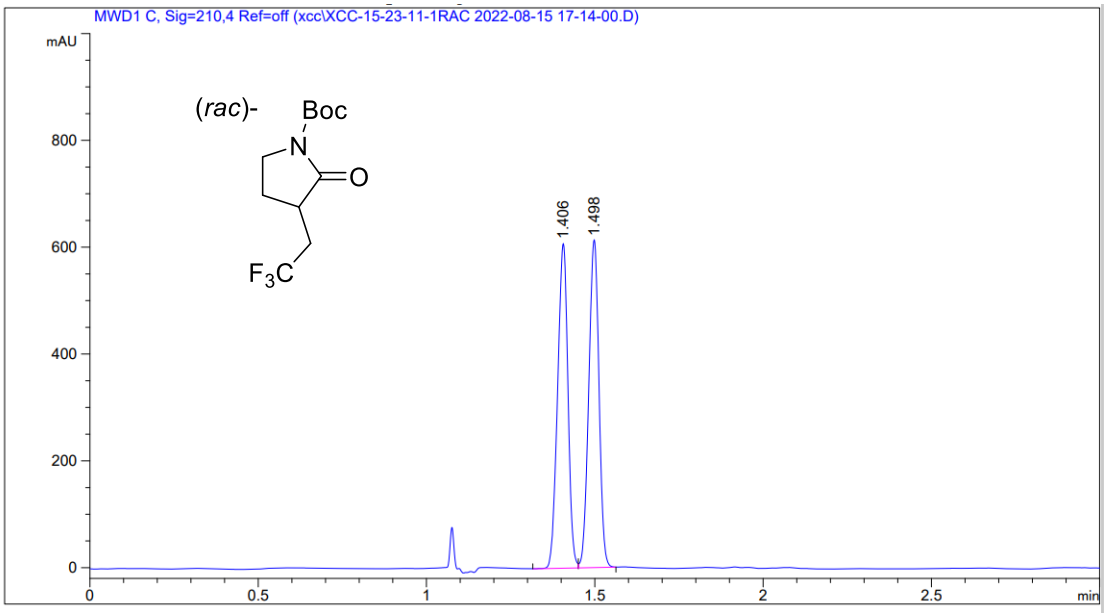
1-benzyl-3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2r**)

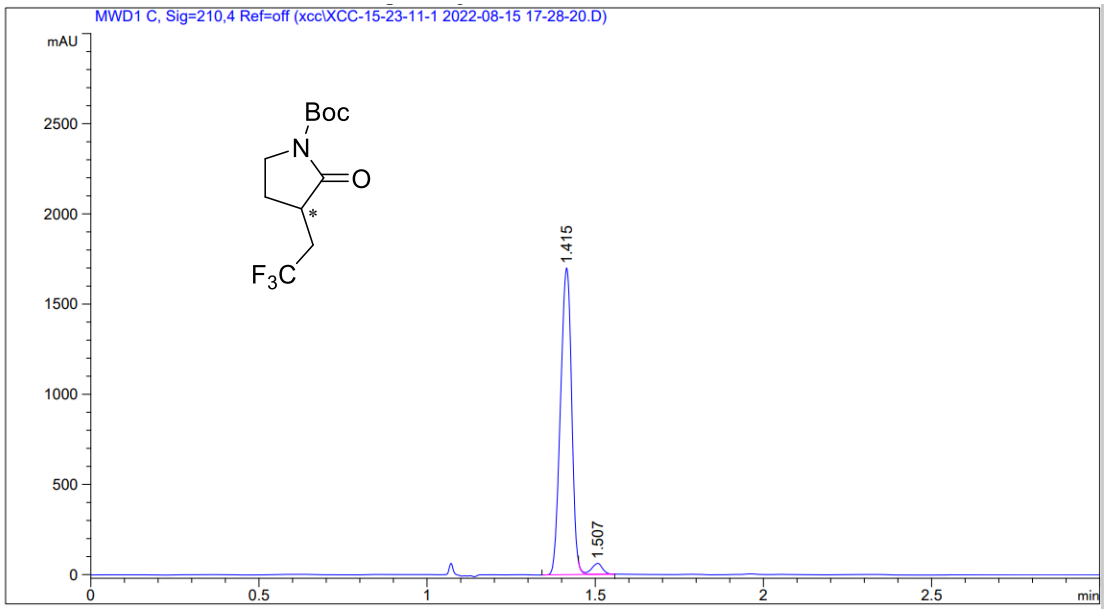




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.497	BB	0.0768	6114.55322	1245.28137	100.0000
Totals :				6114.55322	1245.28137	

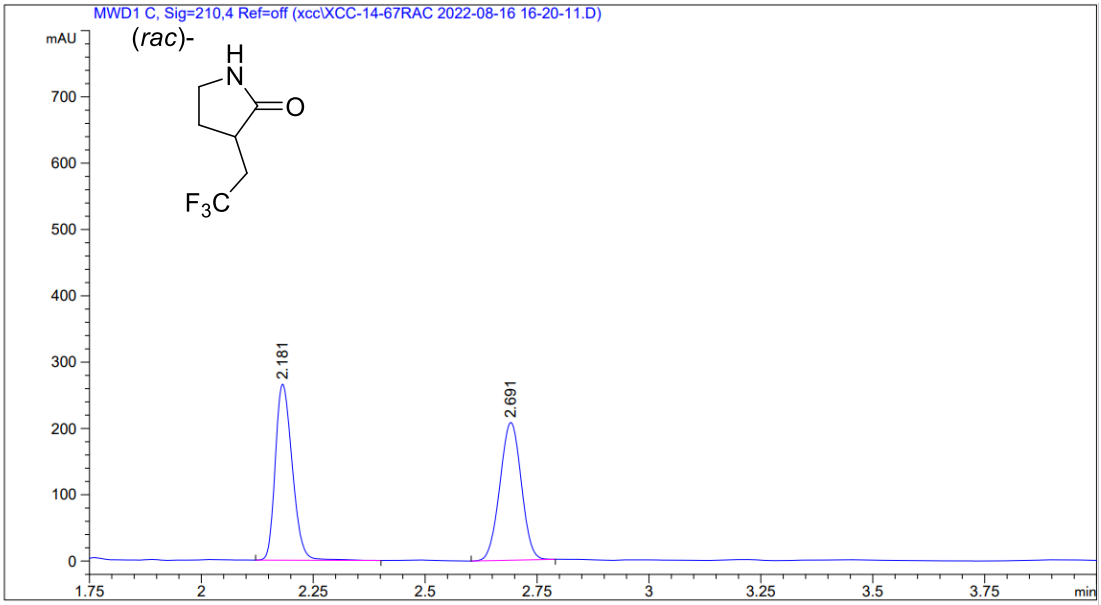
tert-butyl (*S*)-2-oxo-3-(2,2,2-trifluoroethyl)pyrrolidine-1-carboxylate (**2s**)

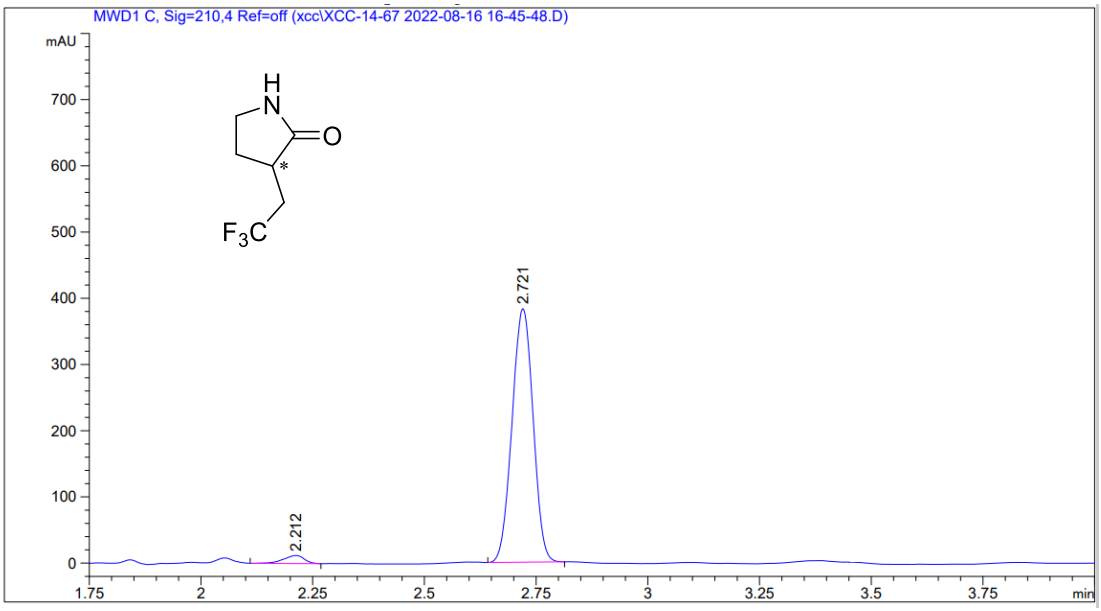




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	1.415	BV R	0.0364	3918.84009	1700.91638	96.6022
2	1.507	VB E	0.0349	137.83948	60.85395	3.3978
Totals :				4056.67957	1761.77033	

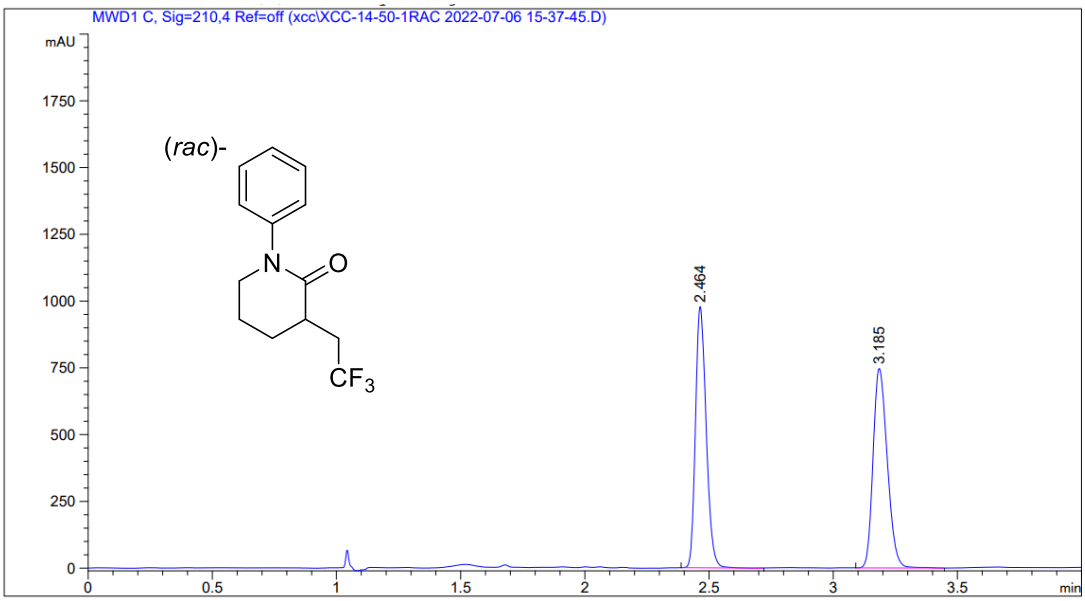
3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**2t**)

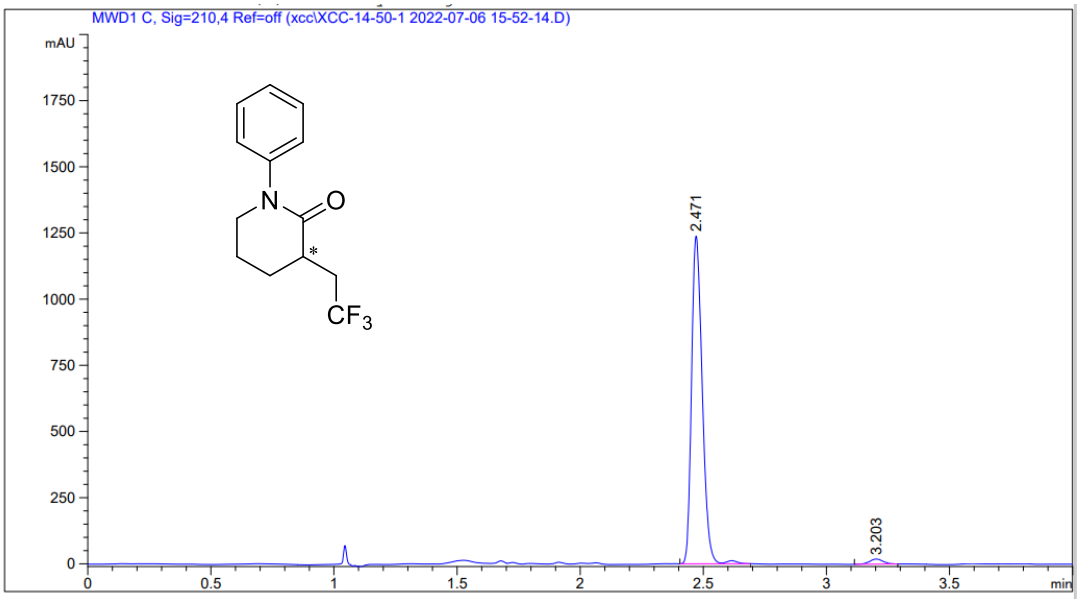




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.212	BB	0.0483	39.66670	12.24830	3.0655
2	2.721	BB	0.0517	1254.29224	382.85352	96.9345
Totals :				1293.95893	395.10182	

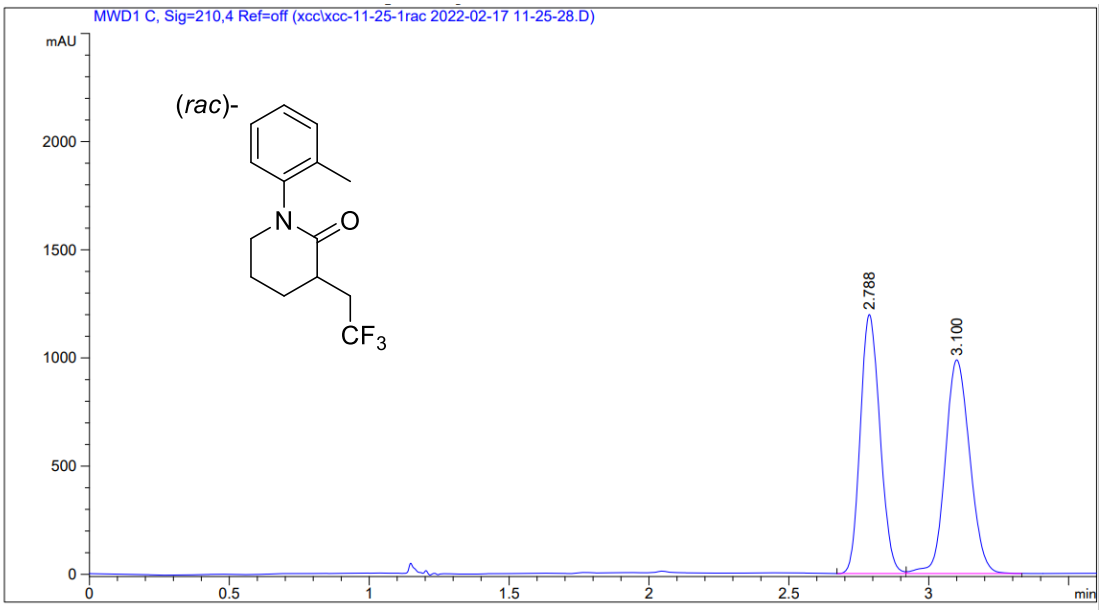
1-phenyl-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4a**)

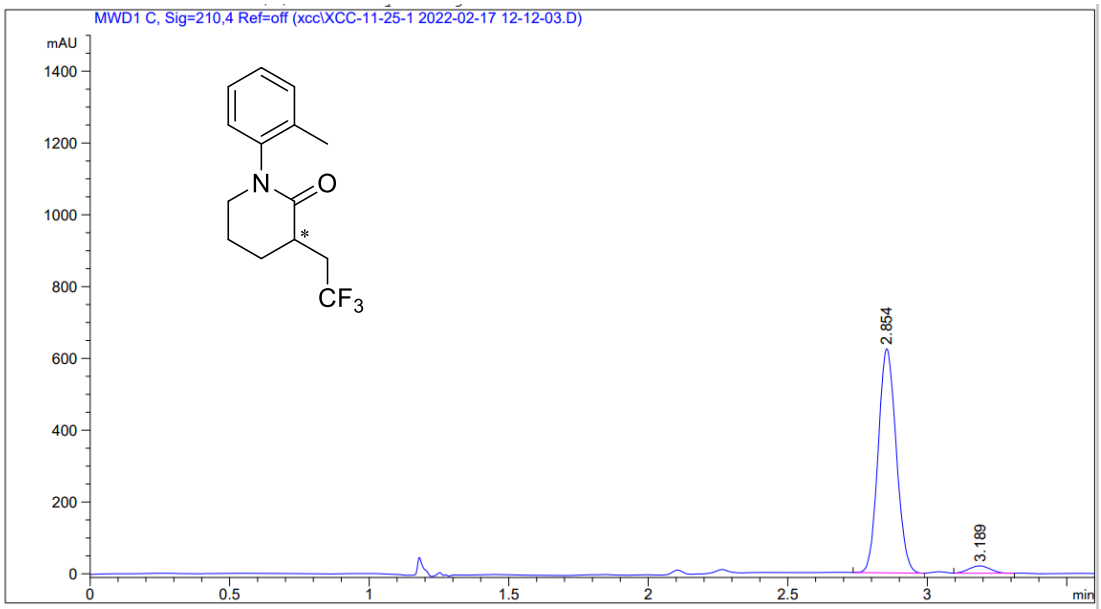




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.471	BV R	0.0470	3746.72314	1238.81628	98.0849
2	3.203	BB	0.0579	73.15430	19.23549	1.9151
Totals :				3819.87744	1258.05177	

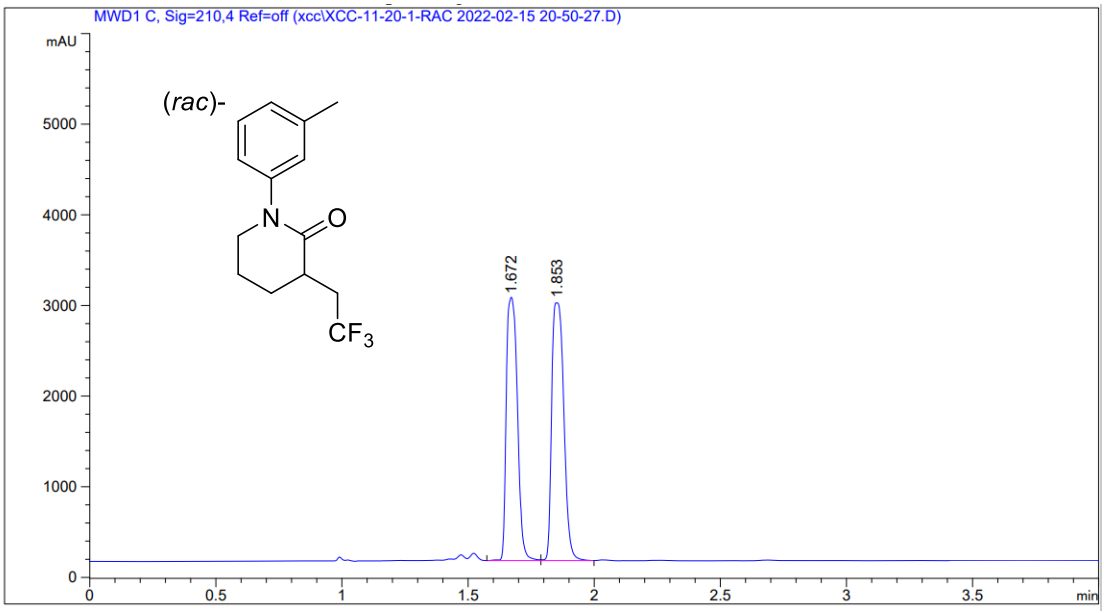
1-(*o*-tolyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4b**)

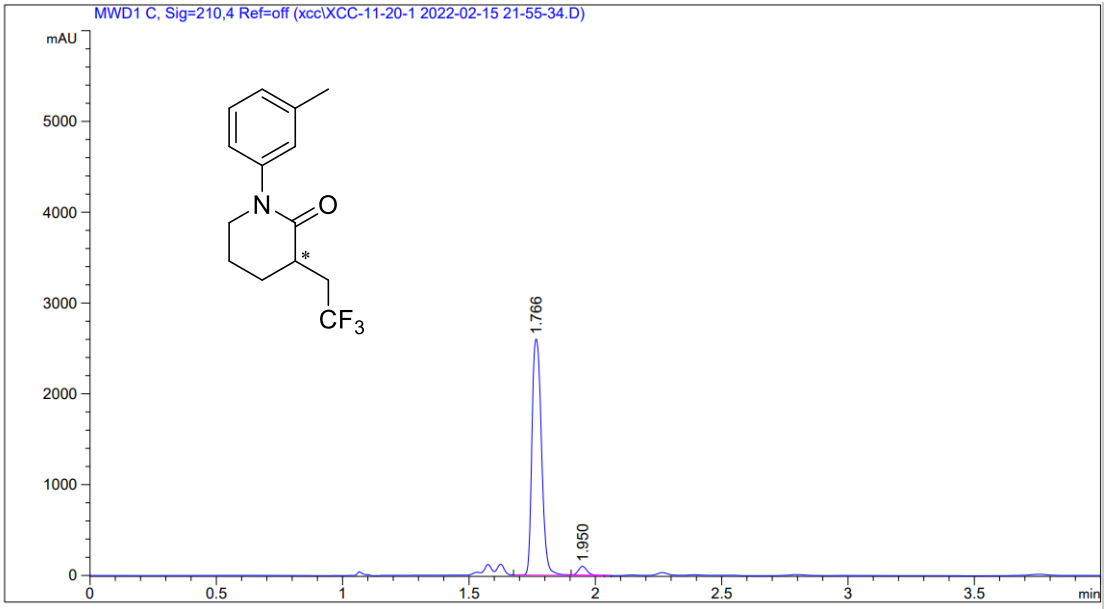




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.854	BB	0.0704	2803.23413	624.26410	96.2786
2	3.189	VB	0.0783	108.35059	20.29696	3.7214
Totals :				2911.58472	644.56106	

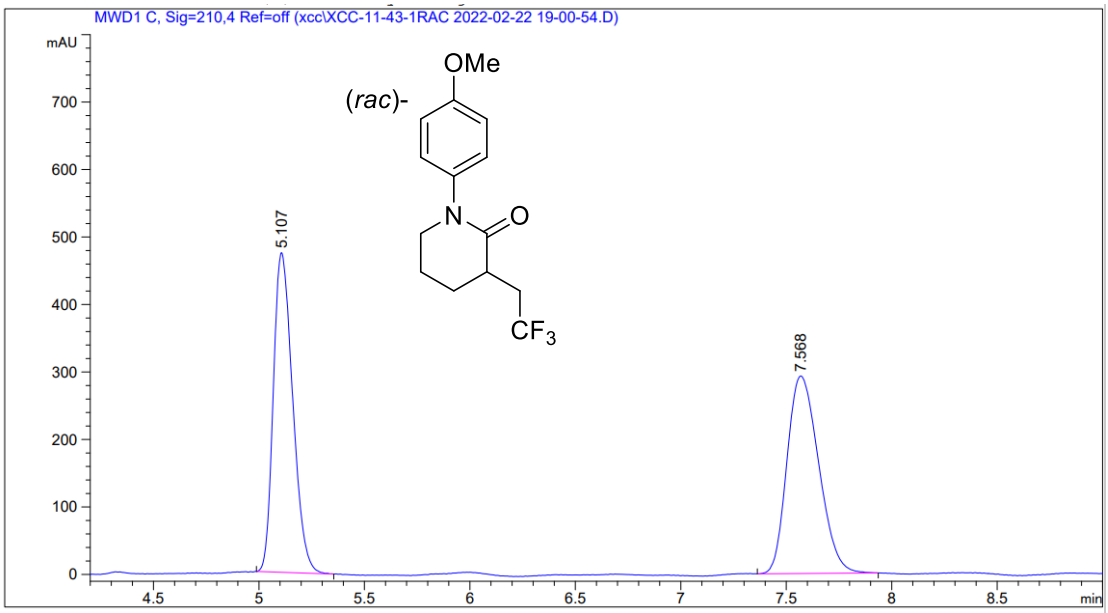
1-(*m*-tolyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4c**)

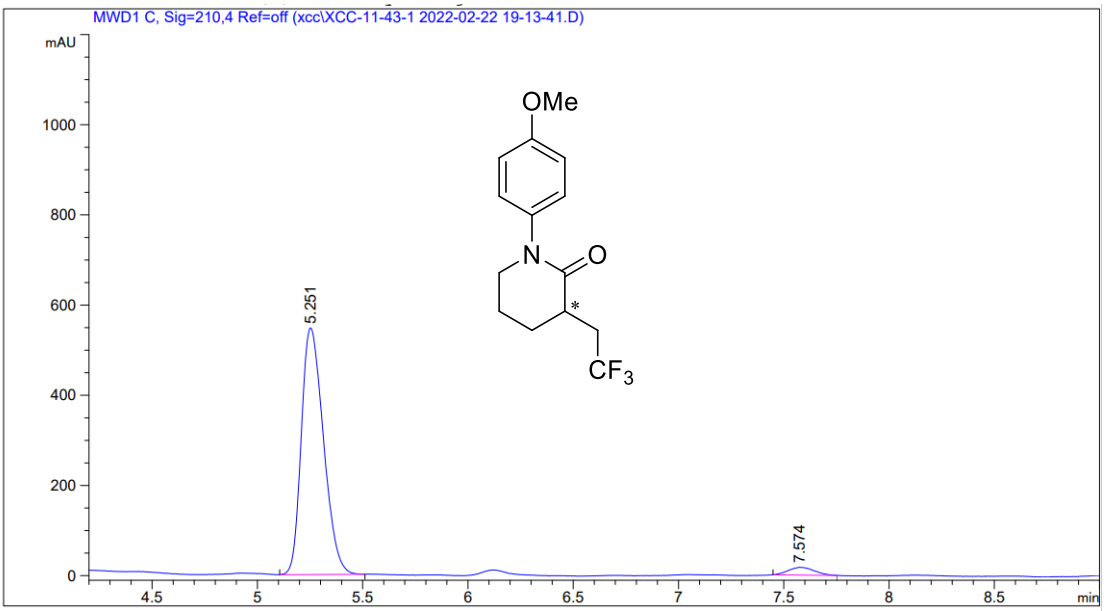




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	1.766	BV R	0.0416	6834.88525	2602.01245	96.8056
2	1.950	VB E	0.0358	225.53506	98.13914	3.1944
Totals :				7060.42032	2700.15160	

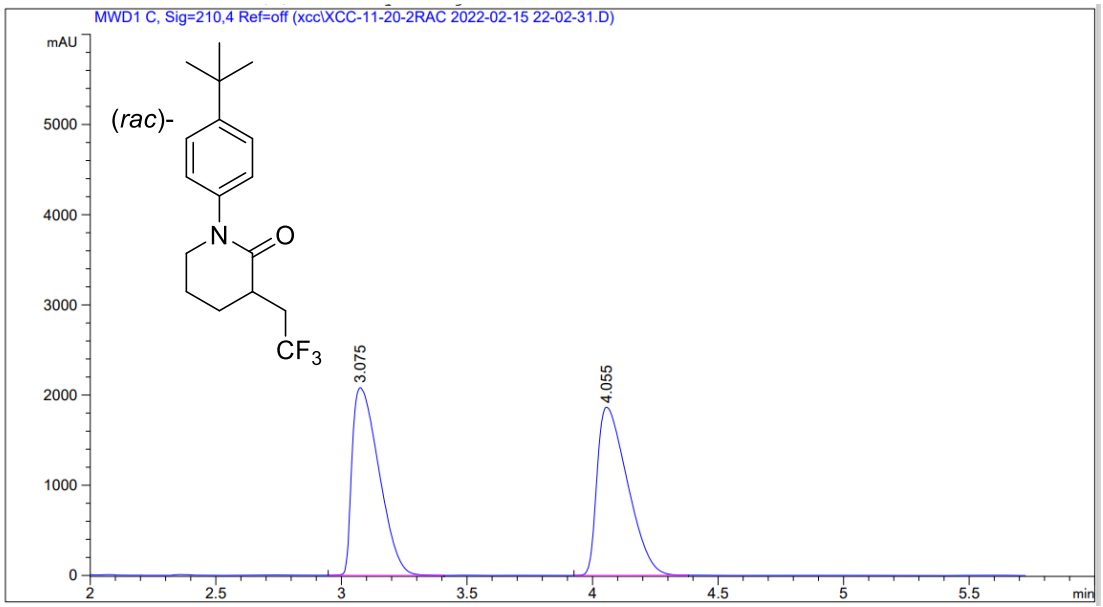
1-(4-methoxyphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4d**)

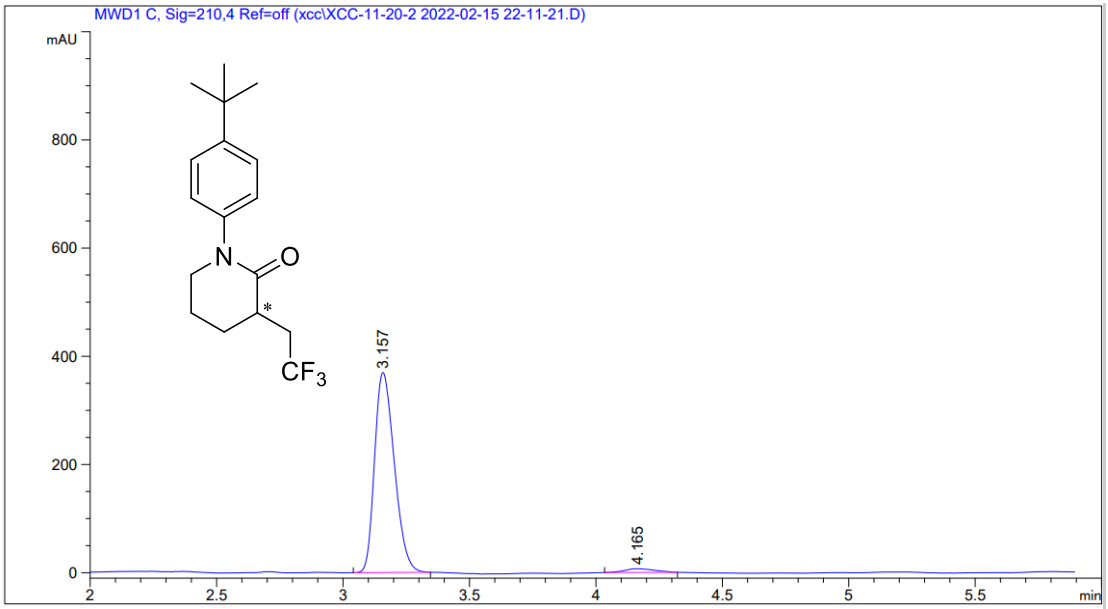




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.251	BB	0.1117	3996.45313	546.96100	96.4394
2	7.574	BB	0.1043	147.55339	17.24218	3.5606
Totals :				4144.00652	564.20317	

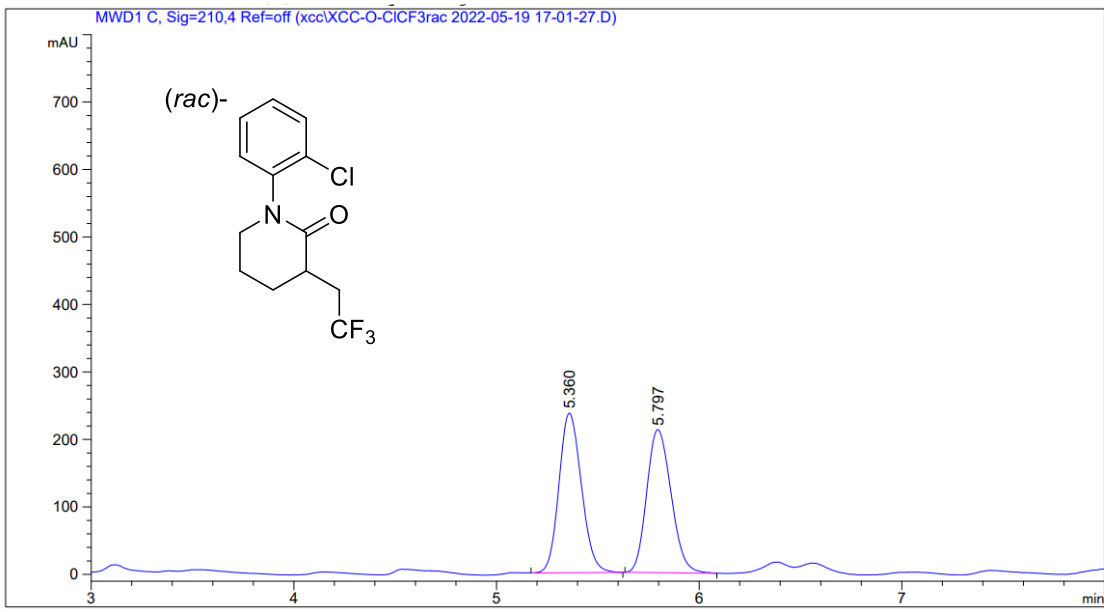
1-(4-(*tert*-butyl)phenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4e**)

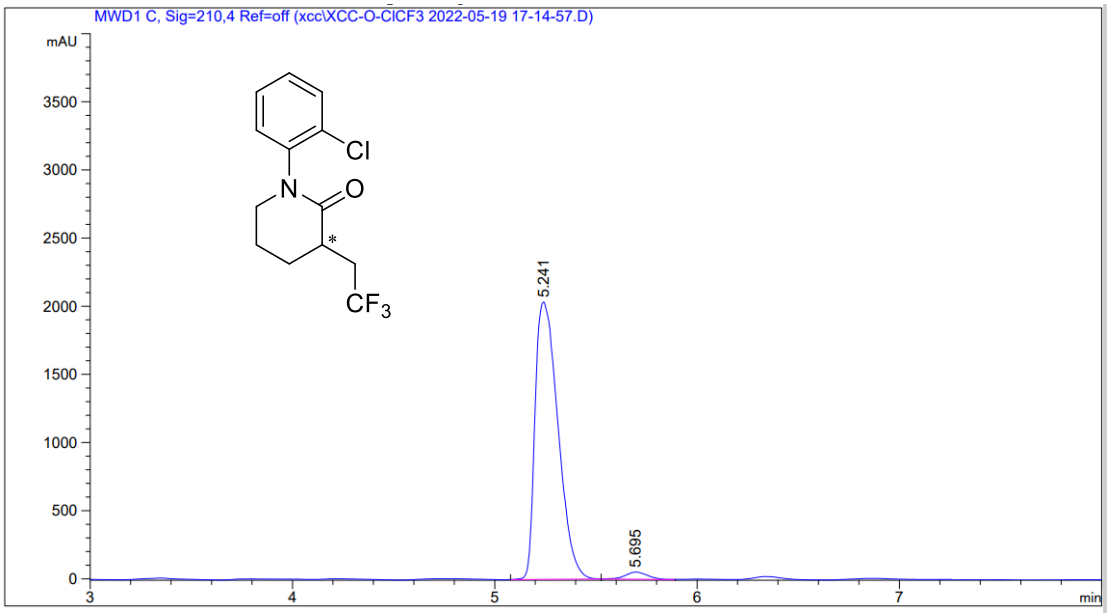




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.157	BB	0.0848	2007.34888	369.72351	97.2234
2	4.165	BB	0.0989	57.32841	6.86928	2.7766
Totals :				2064.67729	376.59279	

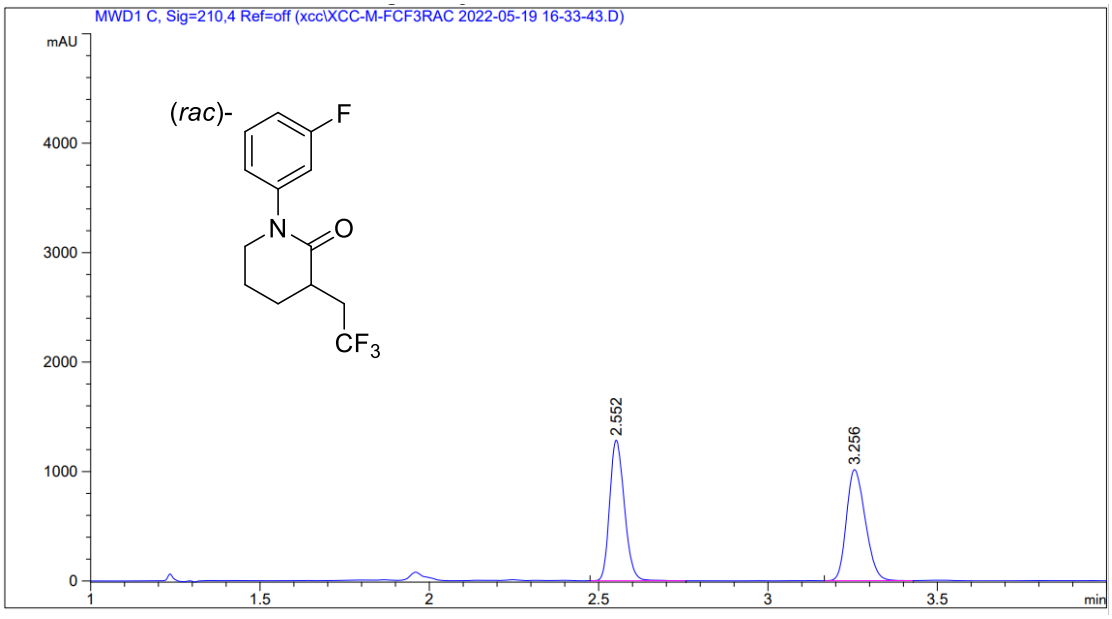
1-(2-chlorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4f**)

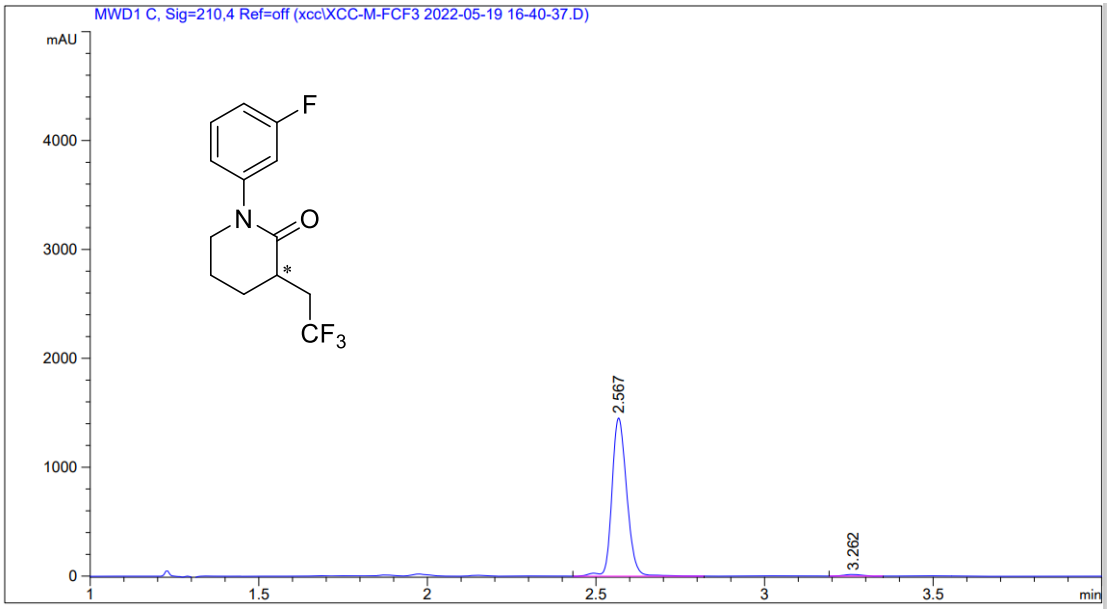




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.241	BB	0.0992	1.59987e4	2034.98645	97.5781
2	5.695	BB	0.1005	397.08264	52.36831	2.4219
Totals :				1.63957e4	2087.35476	

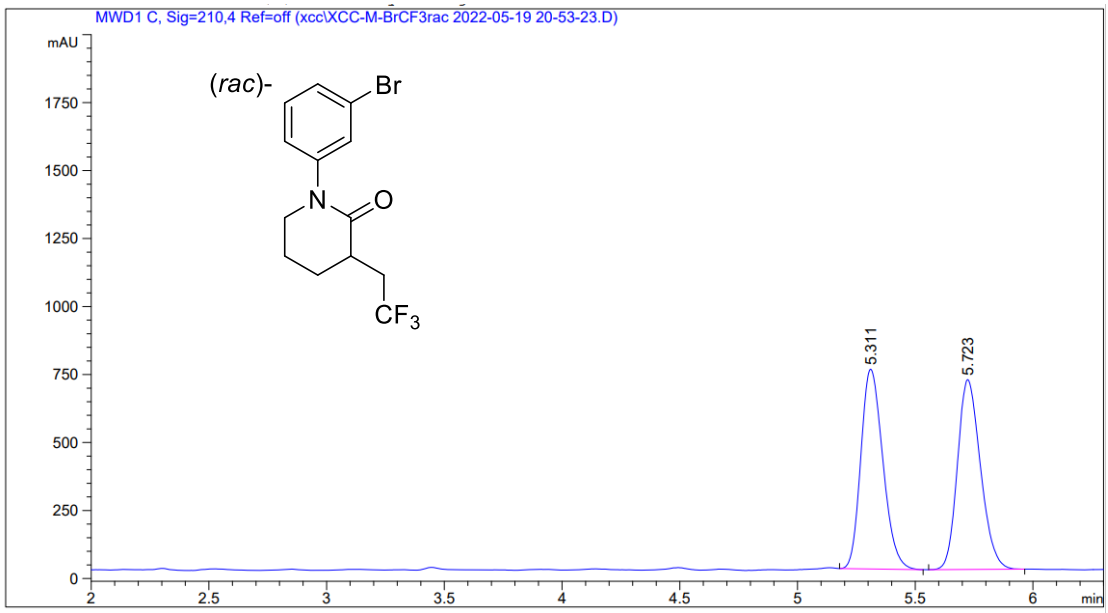
1-(3-fluorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4g**)

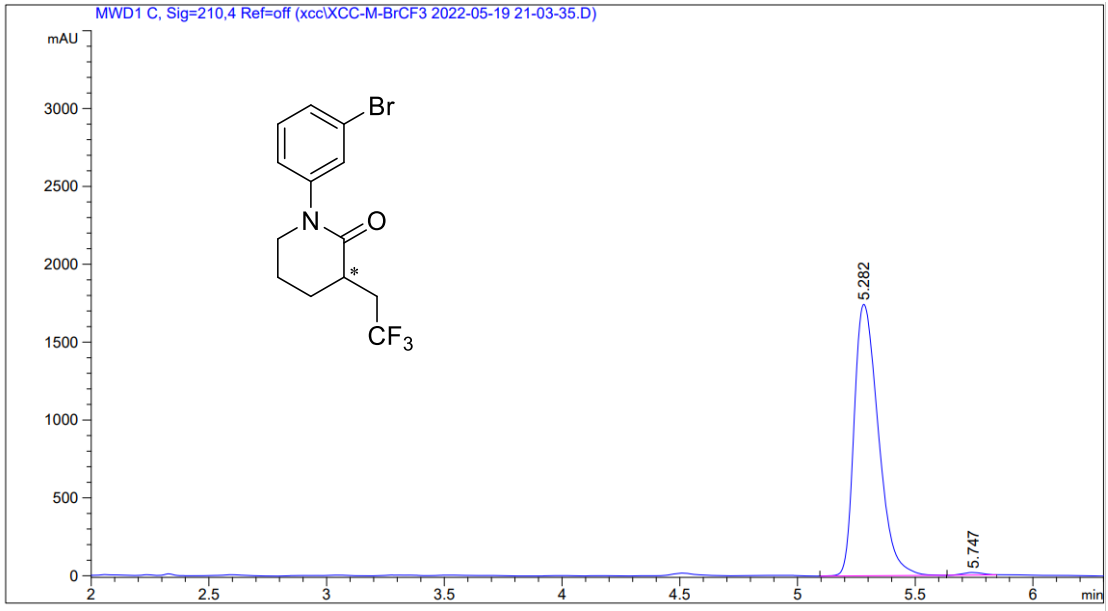




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.567	VB R	0.0477	4447.97949	1452.87524	98.8059
2	3.262	BB	0.0542	53.75637	15.42774	1.1941
Totals :				4501.73586	1468.30299	

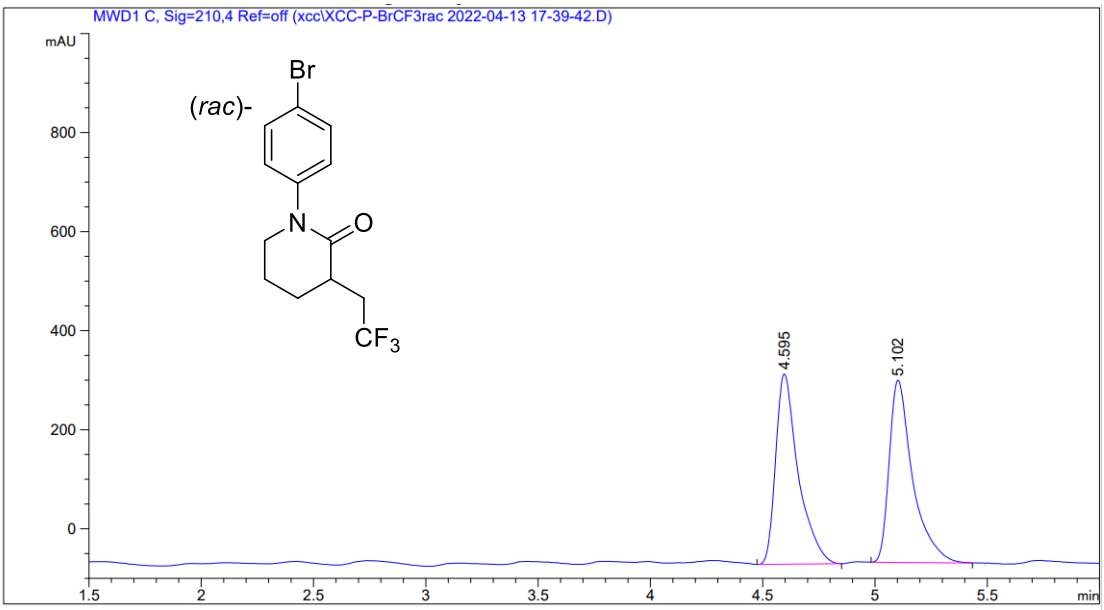
1-(3-bromophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4h**)

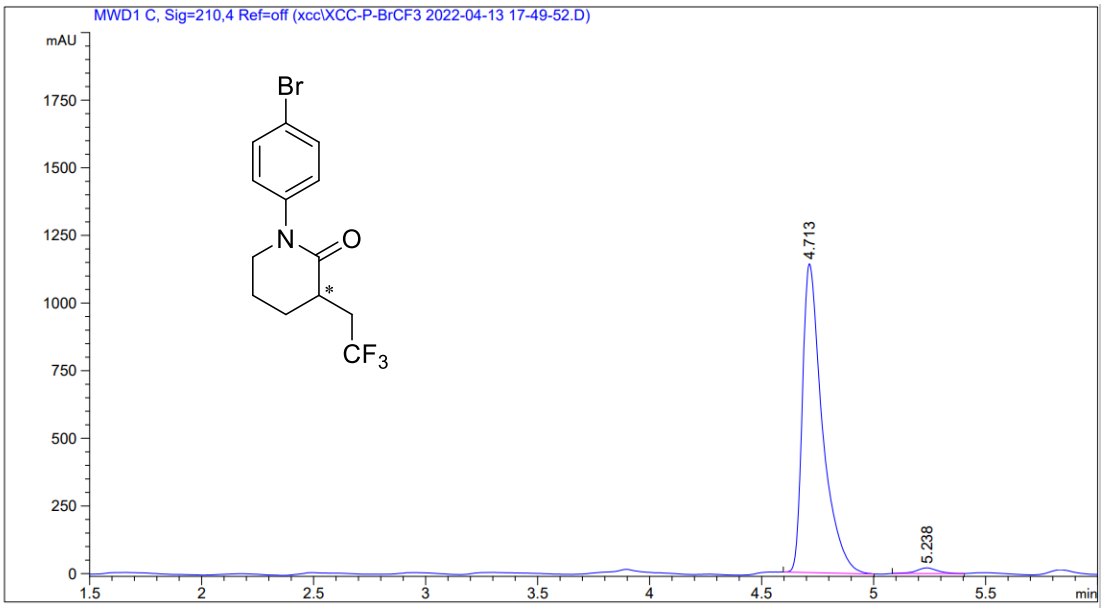




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	5.282	BB	0.1098	1.24385e4	1743.09387	99.2472
2	5.747	BB	0.0724	94.35030	16.21813	0.7528
Totals :				1.25328e4	1759.31200	

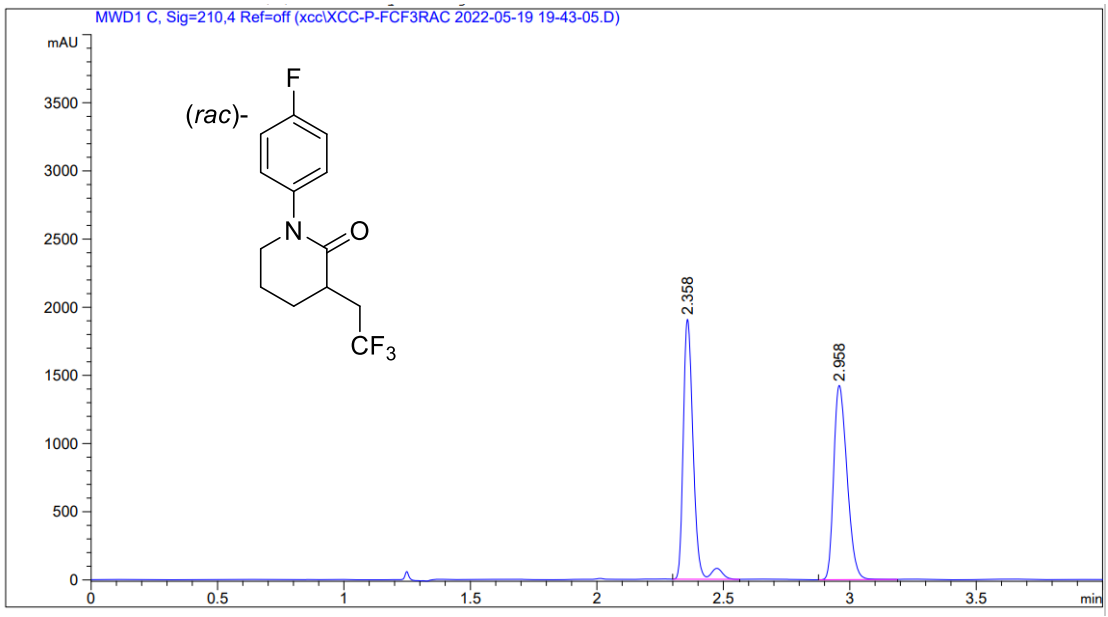
1-(4-bromophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4i**)

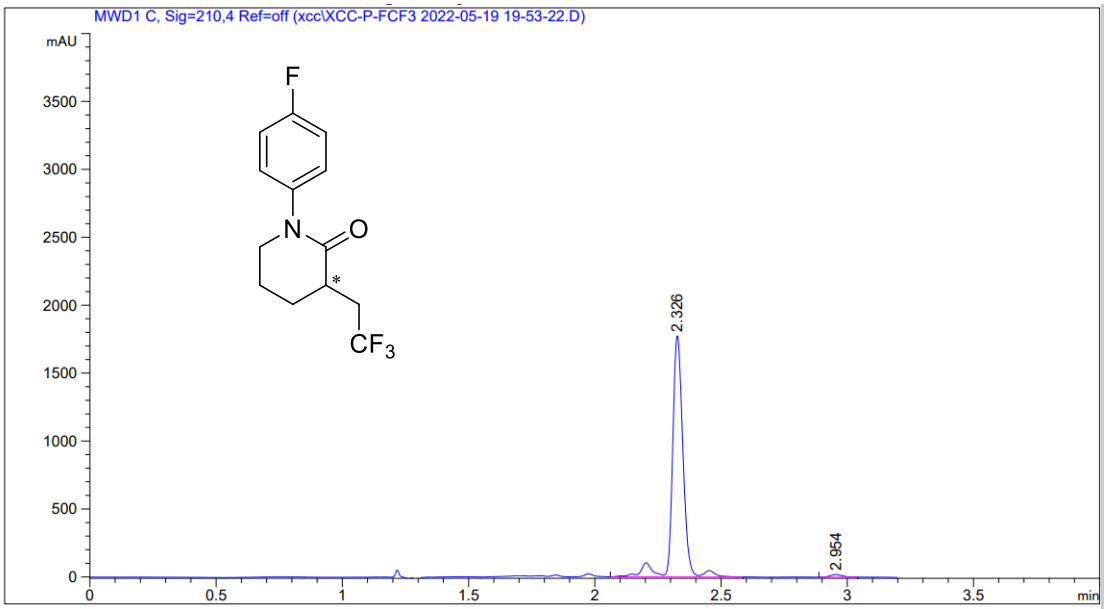




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.713	BB	0.0924	7082.33398	1141.08997	98.0785
2	5.238	BB	0.0883	138.75333	20.94371	1.9215
Totals :				7221.08731	1162.03367	

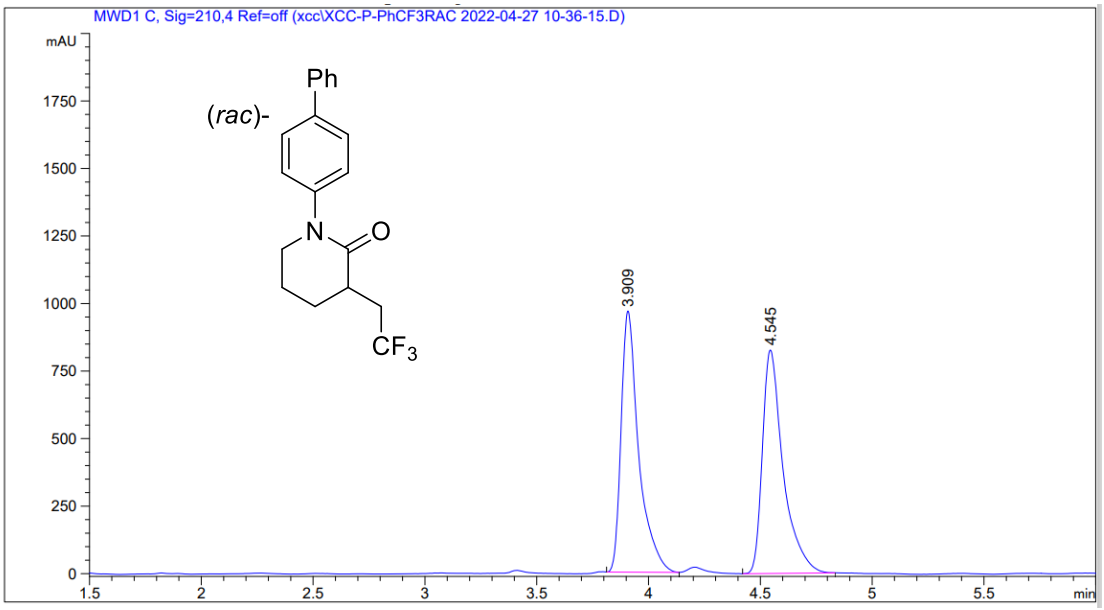
1-(4-fluorophenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4j**)

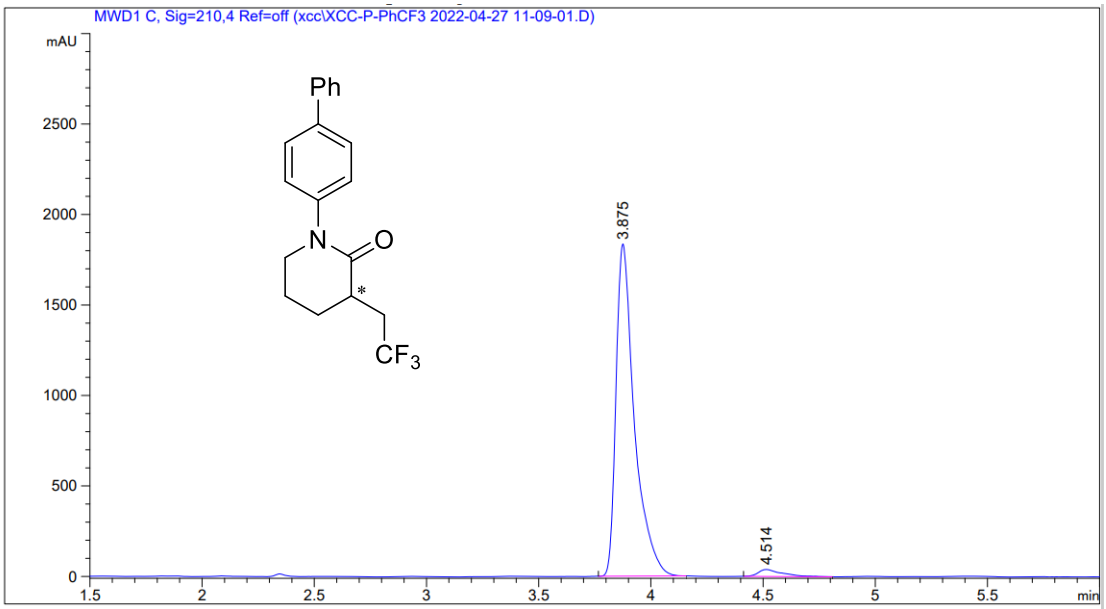




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.326	VV R	0.0429	5375.07373	1774.05896	98.8323
2	2.954	BB	0.0505	63.50900	19.02128	1.1677
Totals :				5438.58273	1793.08024	

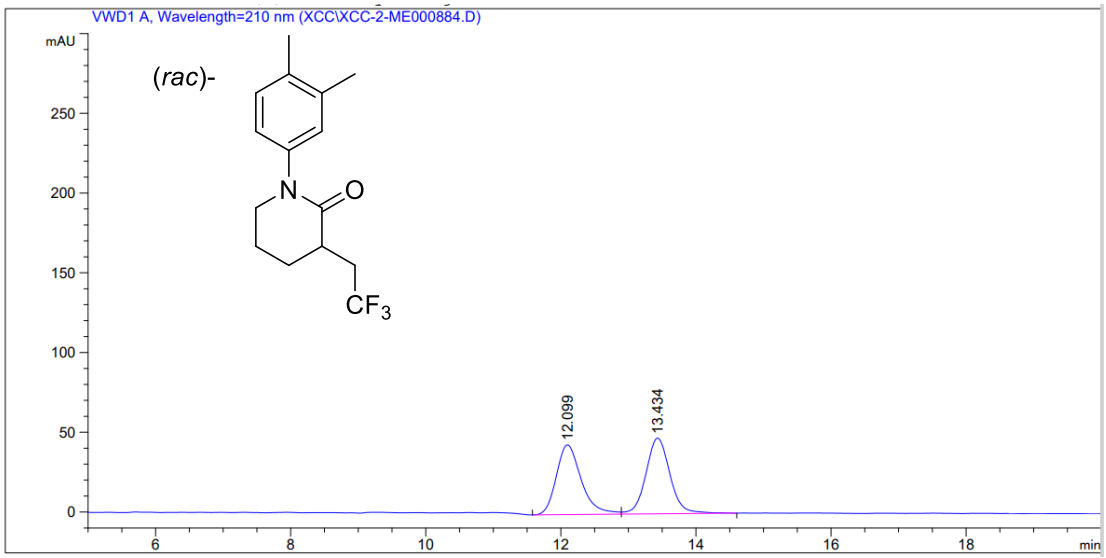
1-([1,1'-biphenyl]-4-yl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4k**)

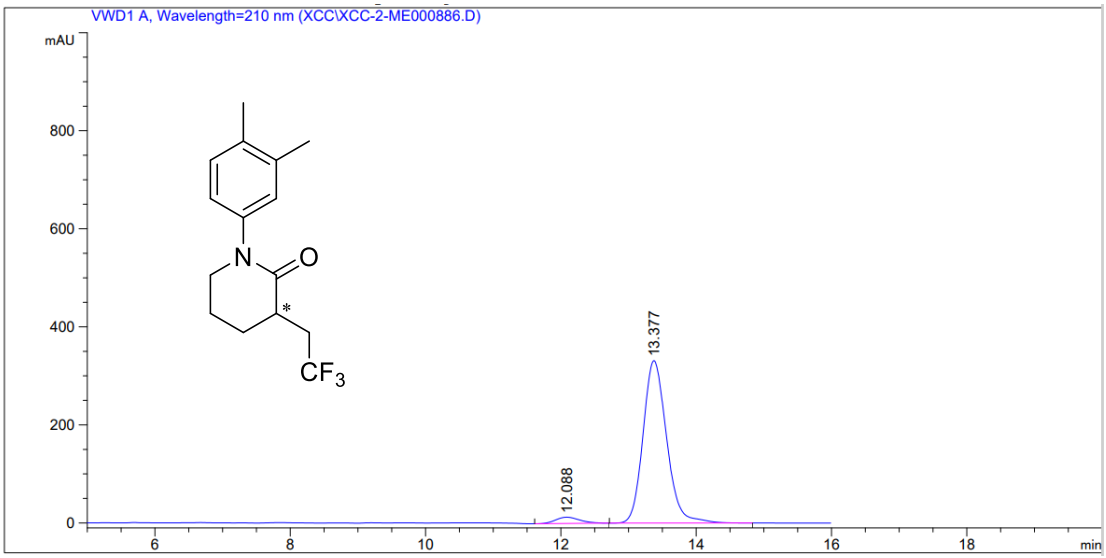




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	3.875	BB	0.0849	1.04525e4	1835.32056	97.2923
2	4.514	BB	0.0990	290.89856	39.24723	2.7077
Totals :				1.07434e4	1874.56779	

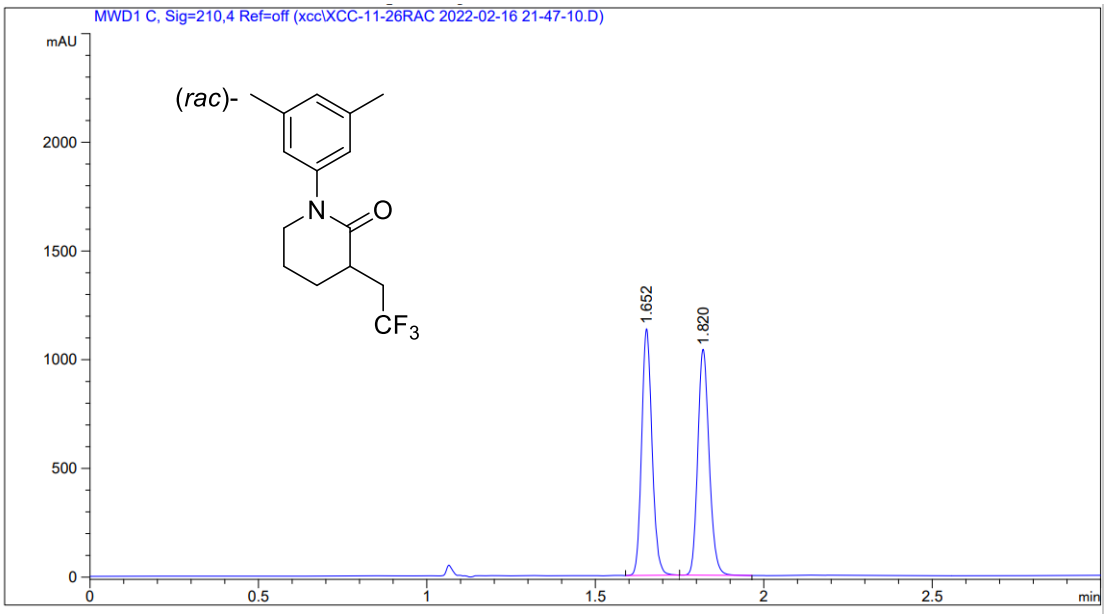
1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4l**)

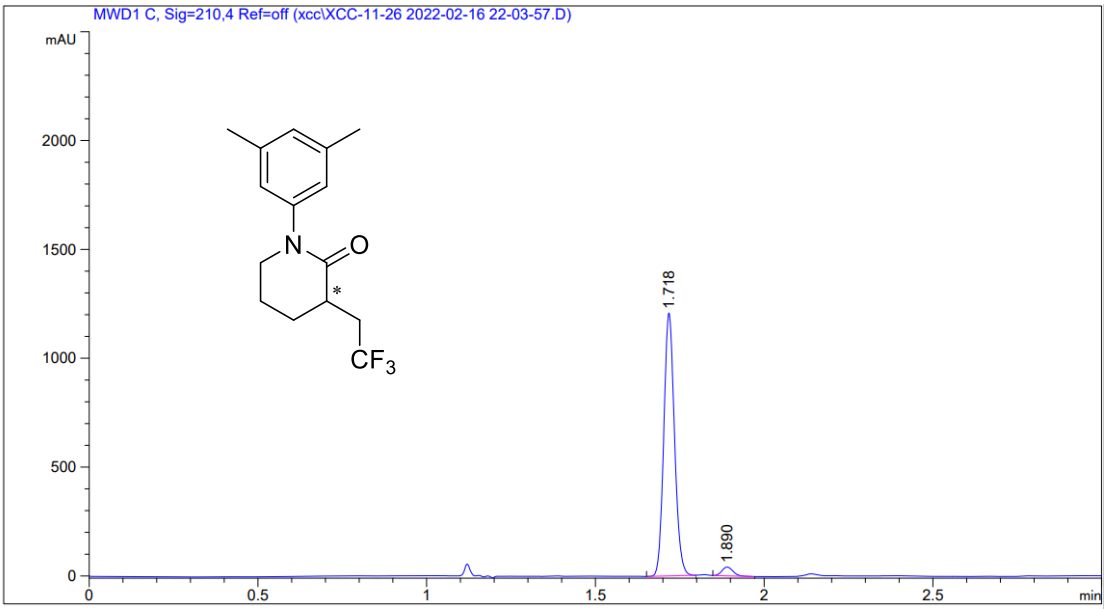




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.088	BB	0.3856	320.26678	12.85644	3.8393
2	13.377	BB	0.3745	8021.53467	331.28864	96.1607
Totals :				8341.80145	344.14508	

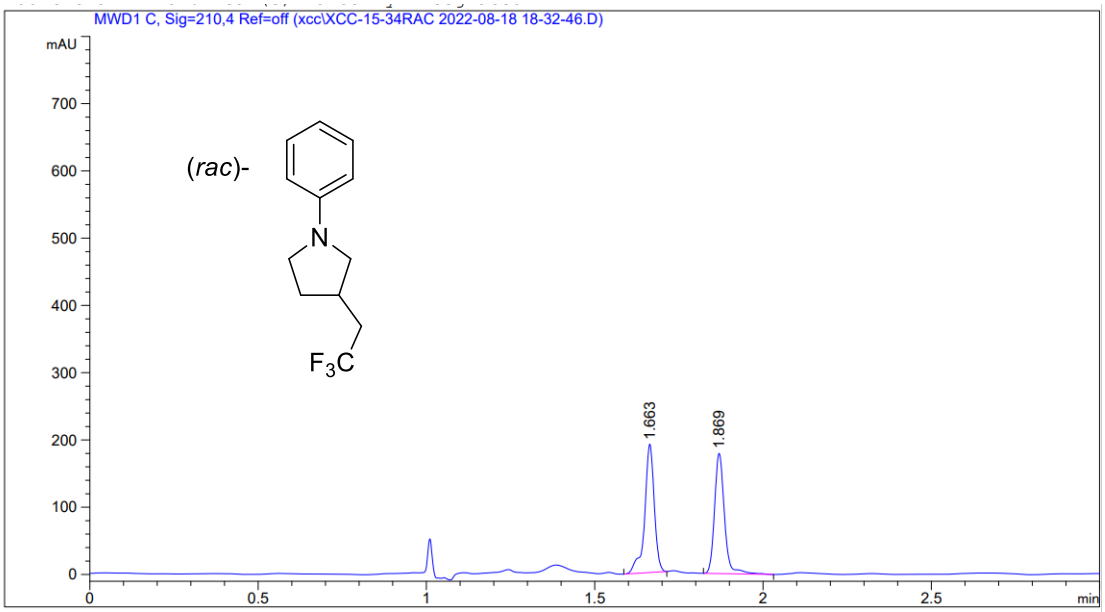
1-(3,5-dimethylphenyl)-3-(2,2,2-trifluoroethyl)piperidin-2-one (**4m**)

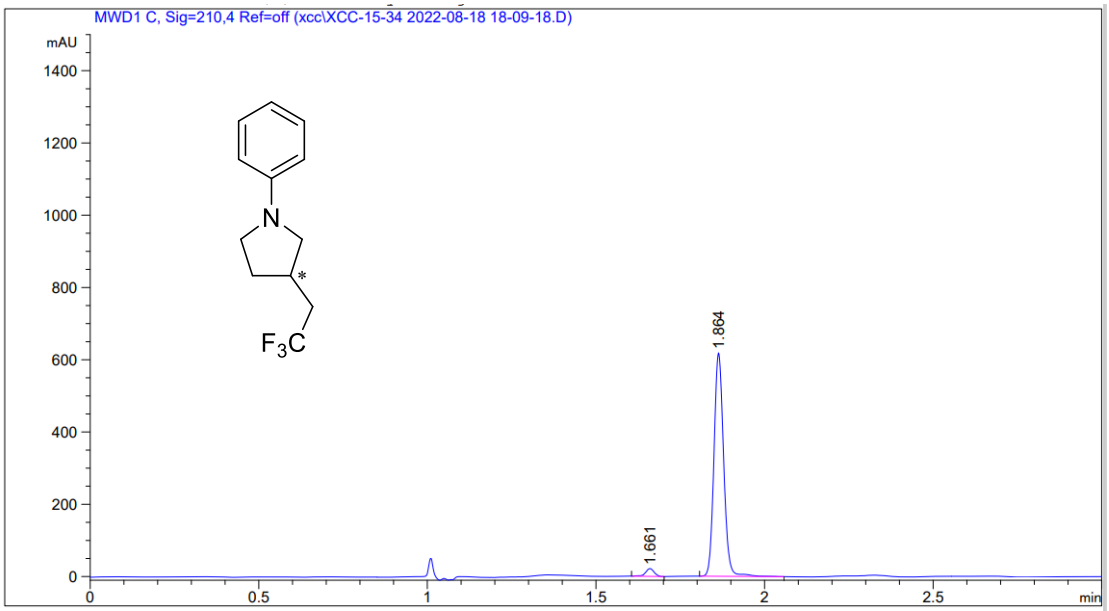




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	1.718	BB	0.0337	2660.83447	1208.53259	96.6183
2	1.890	BB	0.0351	93.13111	40.86246	3.3817
Totals :				2753.96558	1249.39505	

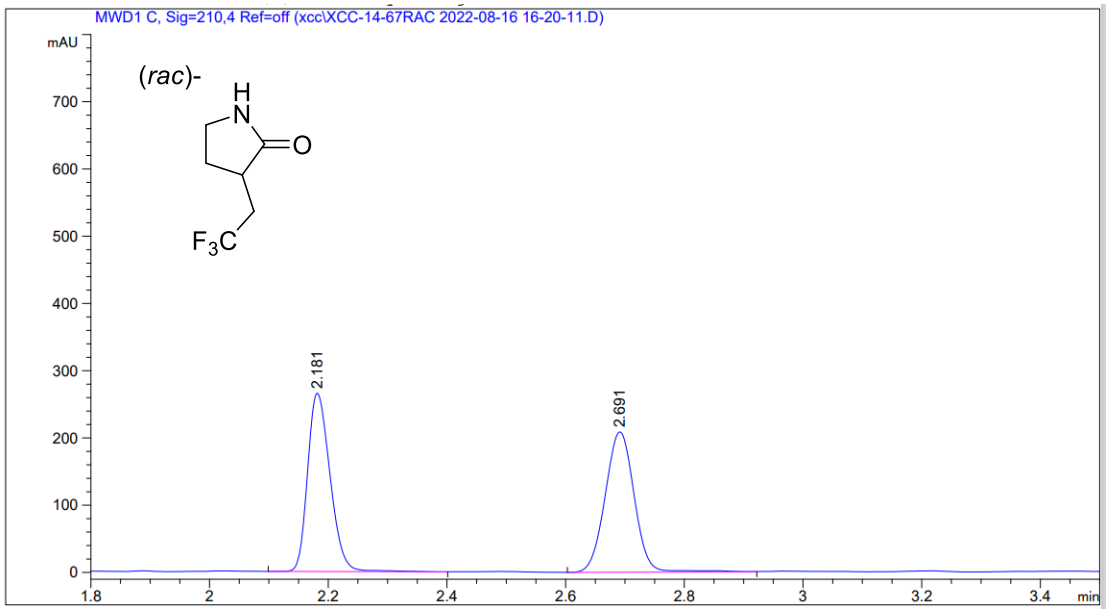
1-phenyl-3-(2,2,2-trifluoroethyl)pyrrolidine (**5**)

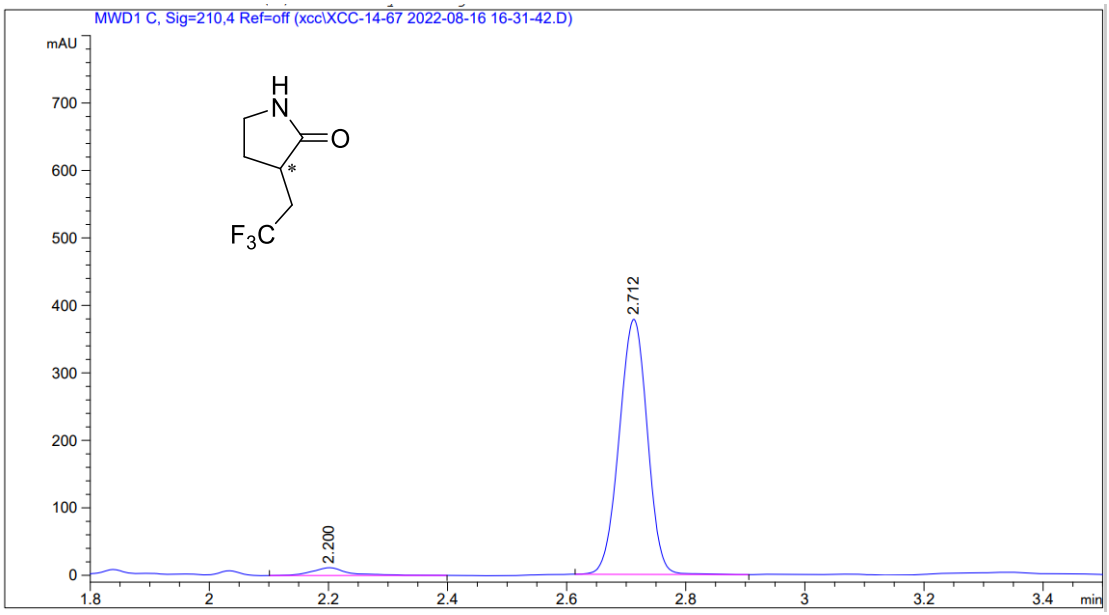




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	1.661	BB	0.0271	38.44345	21.76937	3.0343
2	1.864	BB	0.0307	1228.53015	618.48969	96.9657
Totals :				1266.97360	640.25906	

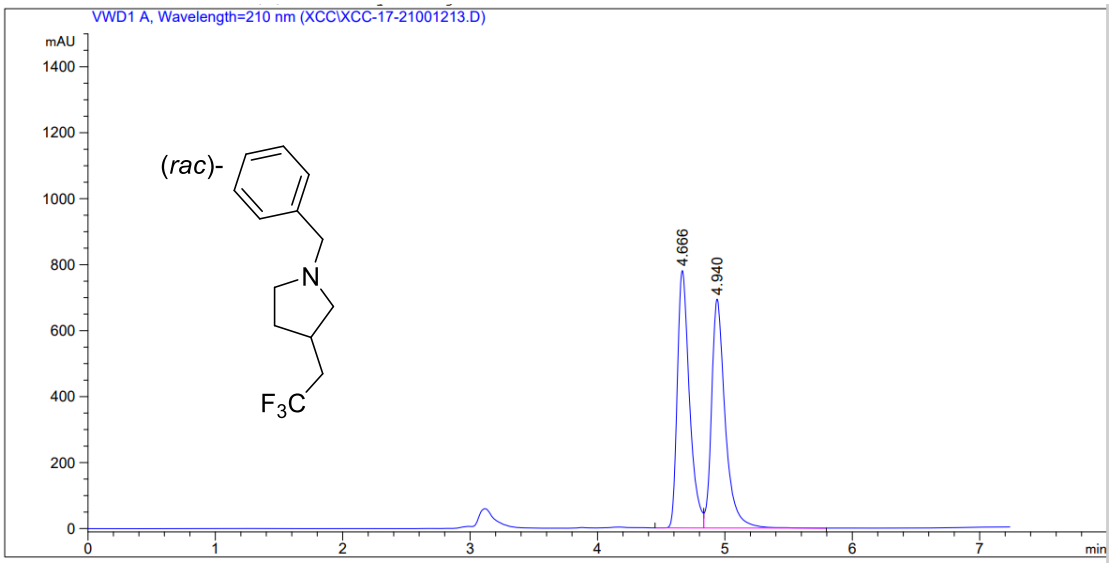
3-(2,2,2-trifluoroethyl)pyrrolidin-2-one (**6**)

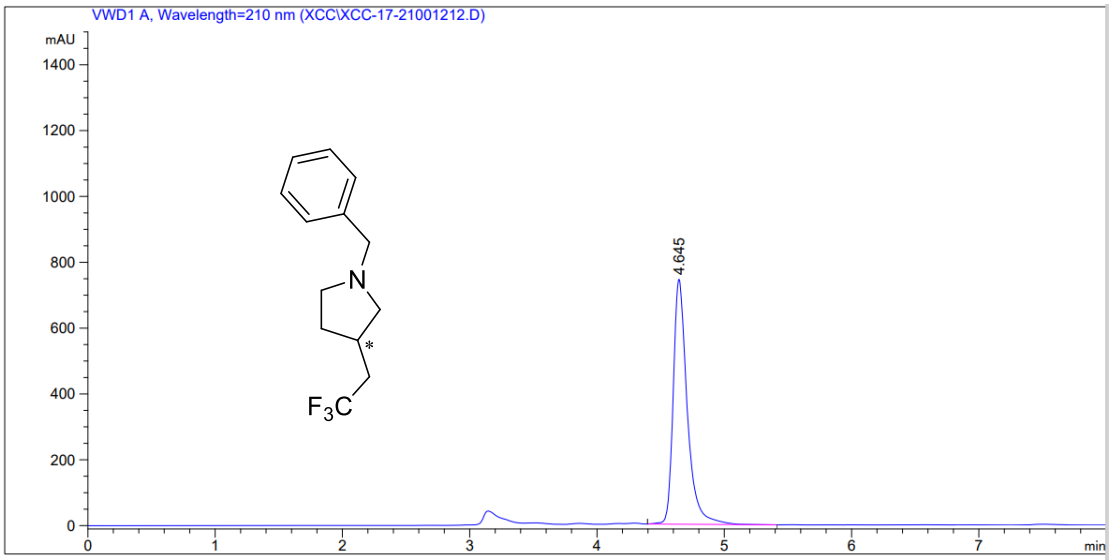




Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	2.200	BB	0.0601	50.74048	11.69973	3.9332
2	2.712	BB	0.0512	1239.32263	378.25339	96.0668
Totals :				1290.06311	389.95311	

1-benzyl-3-(2,2,2-trifluoroethyl)pyrrolidine (**7**)





Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.645	BB	0.1142	5688.37646	743.93665	100.0000
Totals :				5688.37646	743.93665	

8. X-ray crystallographic analysis of compound 2l.

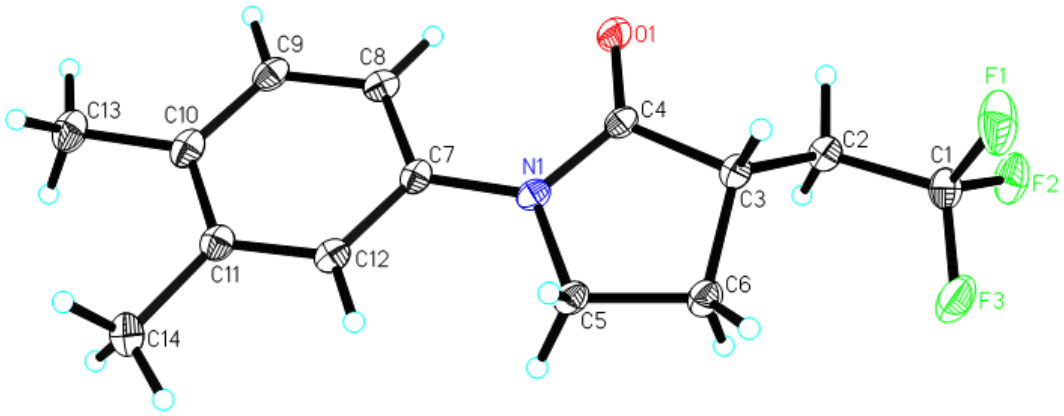


Table S1. Crystal Data and Experimental Parameters for Compound 2l

Compound	**2l**
Formula	$C_{14}H_{16}F_3NO$
Fw	271.28
crystal system	monoclinic
space group	P1211
a (Å)	6.4877(3)
b (Å)	14.6746(8)
c (Å)	13.7914(6)
α (deg)	90
β (deg)	99.427(4)
γ (deg)	90
V (Å^3)	1295.27(11)
Z	4
D_{calc} (g/cm^3)	1.391
μ(Mo/Kα)$_{calc}$ (cm^{-1})	1.001
size (mm)	0.20 × 0.15 × 0.10
F(000)	568
2θ range (deg)	8.864 to 144.996
no. of reflns, collected	11747
no of obsd reflns	4640
no of variables	347

abscorr (T_{max}, T_{min})	1.00, 0.73
R	0.049
R_w	0.117
R_{all}	0.058
Absolute structure parameter	0.01 (13)
Gof	1.01
CCDC	2235529