Supporting Information

Asymmetric Synthesis of α-Trifluoromethylthio-β-Amino Acids under Phase Transfer Catalysis

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CONTENTS

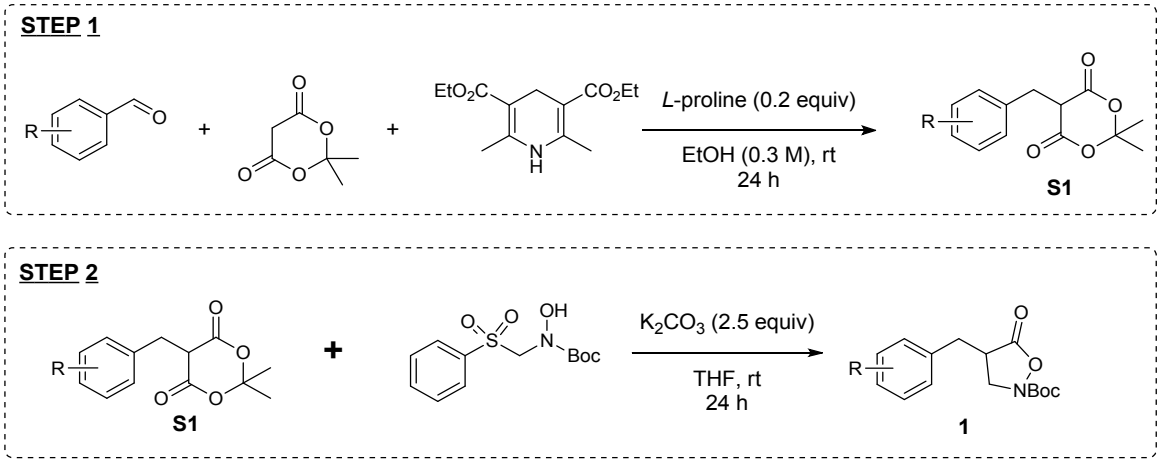
General information

All chemicals and solvents were purchased from Sigma Aldrich and TCI Chemicals, and used without further purification. Substrates *N*-Boc *α*-substituted isoxazolidin-5-one **1a-p**[1,2] and *N*-(trifluoromethylthio)phthalimide **2**[3] were prepared according to the reported procedures. Catalysts **10-11** were commercially available (Fujifilm Wako Chemicals) and catalysts **4-9** were prepared according to the reported procedures.[4] Reactions were monitored by analytical thin layer chromatography (TLC) on precoated silica gel plates (0.25 mm) and visualized by UV light or by $KMnO_4$/ethanol spray test and heating on a hot plate. Flash chromatography was performed on Geduran® Si 60 silica gel. ^{1}H-, ^{13}C- and ^{19}F- NMR spectra were recorded on a Bruker Avance III 300 MHz spectrometer and a Bruker Avance-400 spectrometer at room temperature in $CDCl_3$, CD_3OD or CD_3CN as solvents. All NMR spectra were referenced to residual $CHCl_3$ (7.26 ppm, ^{1}H; 77.16 ppm, ^{13}C), CH_3OH (3.31 ppm, ^{1}H; 49.00 ppm, ^{13}C) and CH_3CN (1.94 ppm, ^{1}H; 1.32 ppm, 118.26 ppm ^{13}C). The following abbreviations are used to indicate the multiplicity in NMR spectra: s = singlet; d = doublet; dd = double doublet; td = triple doublet, dtd = doublet of triplet of doublets, t = triplet; q = quartet; sept = septet, m = multiplet; bs = broad signal. Coupling constants (*J*) are quoted in Hertz. Optical rotations were measured on a Perkin-Elmer 241 MC Polarimeter in cells with 10 cm path length and are reported as follows: $[\alpha]_D^T$ = (c in g/100 mL, solvent). High resolution mass spectra (HRMS) were acquired using a Bruker solariX XR Fourier transform ion cyclotron resonance mass spectrometer (Bruker Daltonik GmbH, Bremen, Germany) equipped with a 7 T refrigerated actively-shielded superconducting magnet. The samples were ionized in positive ion mode using a MALDI ion source. HPLC analyses were performed using CHIRALPAK® AS-H (250 x 4.6 mm, 5 µm) and ID (250 x 4.6 mm, 5 µm) columns.

Synthesis of *N*-Boc α-substituted isoxazolidin-5-ones 1a-p

N-Boc 4-benzylisoxazolidin-5-ones **1a-n** were prepared following the general procedure A,[1] whereas 4-aryl-isoxazolidin-5-ones **1o,p** were prepared following the general procedure B.[2]

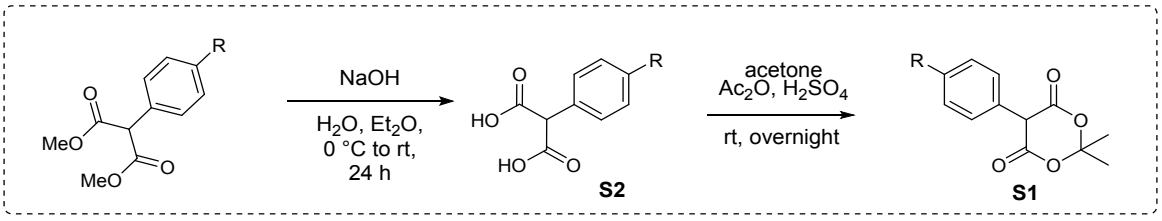
Procedure A:



STEP 1. Meldrum's acid (1.0 equiv), corresponding aldehyde (1.0 equiv), *L*-proline (0.2 equiv) and diethyl 2,6-dimethyl-1,4-dihydropyridine-3,5-dicarboxylate (1.0 equiv) were dissolved in EtOH (0.3 M) and the mixture was stirred for 24 h at room temperature. Then, the solvent was removed in vacuo and the residue dissolved in DCM and washed with water. The organic layer was dried over $MgSO_4$, filtered and concentrated in vacuo to yield crude **S1**, which was used without further purification.

STEP 2. To a solution of crude **S1** in THF (0.1 M), *tert*-butyl hydroxy((phenylsulfonyl)methyl)carbamate (1.0 equiv) and K_2CO_3 (2.5 equiv) were added and the reaction mixture was stirred for 24 hours at room temperature. Next, the reaction mixture was filtered through a plug of Celite®, washed with DCM and the filtrate evaporated under reduced pressure to give the crude residue that was purified by chromatography (silica gel, cyclohexane-ethyl acetate, 25/1 to 15/1) to yield benzyl-substituted isoxazolidin-5-one **1a-n** as an oil or a white/yellow solid.

Procedure B:

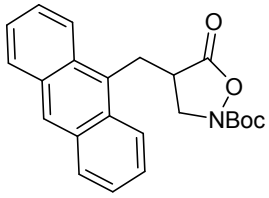


The arylated dimethyl malonate (1.0 equiv, 2.0 mmol) was dissolved in Et_2O (2.0 ml) and the resulting solution was added dropwise to a solution of NaOH (4.00 equiv, 8.0 mmol) in H_2O (7 ml) at 0 °C over 10 min. The resulting mixture was stirred at room temperature for 24 h. Next, the aqueous phase was separated and washed with ethyl acetate (2 x 15 mL), acidified to pH 2 with an aqueous solution of HCl (6 M), and extracted with EtOAc (2 x 30 mL). The combined organic phases were washed with brine (50 mL) and dried over anhydrous $MgSO_4$. The solvent was removed under vacuum affording the corresponding arylated malonic acid **S2**, which was used without further purification.

To a suspension of arylmalonic acid **S2** (1.00 equiv, 3.90 mmol) in Ac_2O (5.0 equiv, 19.5 mmol), concentrated H_2SO_4 (0.40 equiv, 1.56 mmol) was added dropwise. After complete dissolution of the arylmalonic acid, acetone (1.60 equiv, 6.24 mmol) was added and the reaction mixture stirred for the indicated time (10 min. for 2-phenylmalonic acid, 12 hours for 2-(4-methoxyphenyl)malonic acid)). Then, the crude was dissolved in DCM and washed with saturated aqueous $NaHCO_3$. 1 M aqueous HCl was added dropwise to the aqueous phase until pH 4-5. Next, the aqueous phase

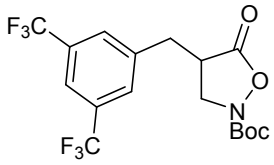
was extracted three times with DCM, the organic phases collected and washed with brine, dried on magnesium sulfate and evaporated under vacuum. The solid product was washed several times with cyclohexane, affording crude **S1**, which was used without further purification.

The characterization data of compounds **1a**,[5] **1d**,[6] **1h**,[7] **1i**,[7] **1k**,[5] **1m**,[5] **1o**,[8] **1p**[8] matched those previously reported. The spectral data of the other compounds are reported below.



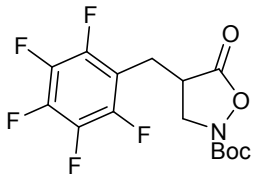
***tert*-butyl 4-(anthracen-9-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (1b)**

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.44 (s, 1H), 8.24 (d, *J* = 8.9 Hz, 2H), 8.05 (d, *J* = 8.9 Hz, 2H), 7.62 – 7.45 (m, 4H), 4.23 (dd, *J* = 14.8, 4.1 Hz, 1H), 3.94 (dd, *J* = 14.8, 10.6 Hz, 1H), 3.91 – 3.81 (m, 2H), 3.41 (dtd, *J* = 10.6, 8.7, 4.1 Hz, 1H), 1.49 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 174.4, 155.7, 131.6, 129.8, 129.6, 129.0, 127.5, 126.7, 125.2, 123.4, 84.2, 53.5, 42.5, 28.0, 26.1. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{23}H_{23}NNaO_4$ 400.1519, found 400.1505.



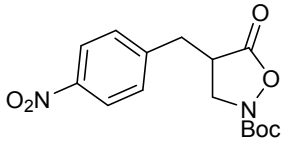
***tert*-butyl 4-(3,5-bis(trifluoromethyl)benzyl)-5-oxoisoxazolidine-2-carboxylate (1c)**

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.81 (s, 1H), 7.68 (s, 2H), 4.24 (dd, *J* = 11.0, 8.4 Hz, 1H), 3.68 (dd, *J* = 11.0, 9.5 Hz, 1H), 3.36 (dd, *J* = 14.2, 5.1 Hz, 1H), 3.29 – 3.15 (m, 1H), 2.97 (dd, *J* = 14.2, 8.9 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 172.2, 154.7, 138.4, 131.3 (q, *J* = 33.4 Hz), 128.0 (q, *J* = 4.0 Hz), 122.0 (q, *J* = 273.0 Hz), 120.5 (sept, *J* = 3.8 Hz), 83.6, 51.8, 40.6, 33.0, 27.0. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -62.9. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{17}H_{17}F_6NNaO_4$ 436.0954, found 436.0969.



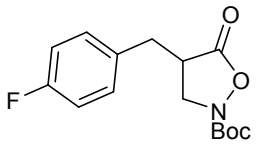
***tert*-butyl 5-oxo-4-((perfluorophenyl)methyl)isoxazolidine-2-carboxylate (1e)**

^{1}H NMR (300 MHz, $CDCl_3$) δ 4.26 (dd, *J* = 11.2, 8.3 Hz, 1H), 3.78 – 3.67 (m, 1H), 3.33 – 3.08 (m, 2H), 2.95 (dd, *J* = 13.8, 8.9 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 171.8, 154.7, 83.6, 52.3, 38.9, 26.9, 20.5. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -142.2 – -142.6 (m), -154.6 (tt, *J* = 20.7 , 1.1 Hz), -161.2 – -161.4 (m). **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{15}H_{14}F_5NNaO_4$ 390.0736, found 390.0731.



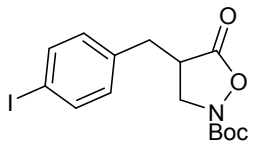
***tert*-butyl 4-(4-nitrobenzyl)-5-oxoisoxazolidine-2-carboxylate (1f)**

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.14 (d, *J* = 8.8 Hz, 2H), 7.39 (d, *J* = 8.8 Hz, 2H), 4.19 (dd, *J* = 11.1, 8.5 Hz, 1H), 3.67 (dd, *J* = 11.1, 9.4 Hz, 1H), 3.35 – 3.16 (m, 2H), 2.95 (dd, *J* = 13.3, 8.5 Hz, 1H), 1.46 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 172.6, 154.7, 146.2, 143.5, 128.8, 123.1, 83.4, 51.8, 40.5, 33.0, 27.0. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{15}H_{18}N_2NaO_6$ 345.1057, found 345.1049.



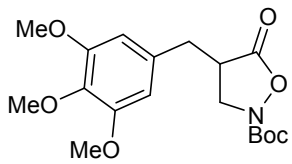
***tert*-butyl 4-(4-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (1g)**

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.20 – 7.10 (m, 2H), 7.04 – 6.94 (m, 2H), 4.13 (dd, *J* = 11.3, 8.4 Hz, 1H), 3.68 (dd, *J* = 10.9, 9.1 Hz, 1H), 3.24 – 3.06 (m, 2H), 2.86 – 2.71 (m, 1H), 1.48 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 173.0 , 161.0 (d, *J* = 245.7 Hz), 154.8 , 131.6 (d, *J* = 3.3 Hz), 129.3 (d, *J* = 8.0 Hz), 114.8 (d, *J* = 21.5 Hz), 83.2 , 51.7 , 41.1 , 32.5 , 27.0 . **^{19}F NMR** (282 MHz, $CDCl_3$) δ -115.3. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{15}H_{18}FNNaO_4$ 318.1112, found 318.1118.



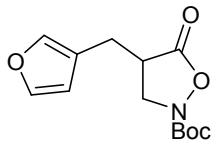
***tert*-butyl 4-(4-iodobenzyl)-5-oxoisoxazolidine-2-carboxylate (1j)**

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.64 (d, *J* = 8.4 Hz, 2H), 6.94 (d, *J* = 8.4 Hz, 2H), 4.14 (dd, *J* = 11.1, 8.3 Hz, 1H), 3.66 (dd, *J* = 11.1, 9.1 Hz, 1H), 3.20 – 3.07 (m, 2H), 2.76 (dd, *J* = 15.3, 10.5 Hz, 1H), 1.49 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 172.9, 154.8, 137.0, 135.5, 129.8, 91.7, 83.2, 51.8, 40.9, 32.9, 27.0. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{15}H_{18}INNaO_4$ 426.0173, found 426.0182.



***tert*-butyl 5-oxo-4-(3,4,5-trimethoxybenzyl)isoxazolidine-2-carboxylate (1l)**

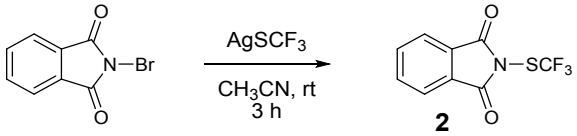
^{1}H NMR (300 MHz, $CDCl_3$) δ 6.39 (s, 2H), 4.26 – 4.04 (m, 1H), 3.85 (s, 6H), 3.83 (s, 3H), 3.74 (dd, *J* = 11.3, 8.9 Hz, 1H), 3.24 – 3.07 (m, 2H), 2.76 (dd, *J* = 15.1, 10.4 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 174.2, 155.9, 153.6, 137.2, 132.4, 105.8, 84.2, 60.8, 56.2, 52.7, 42.3, 34.8, 28.0. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{18}H_{25}NNaO_7$: 390.1524, found 390.1518.



***tert*-butyl 4-(furan-3-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (1n)**

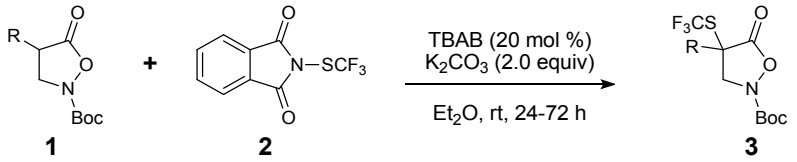
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.38 – 7.33 (m, 1H), 7.30 – 7.27 (m, 1H), 6.29 – 6.23 (m, 1H), 4.20 (dd, *J* = 11.0, 8.7 Hz, 1H), 3.66 (dd, *J* = 11.0, 9.4 Hz, 1H), 3.11 (qd, *J* = 9.4, 8.7, 4.6 Hz, 1H), 2.95 (dd, *J* = 14.9, 4.6 Hz, 1H), 2.72 (dd, *J* = 14.9, 8.7 Hz, 1H), 1.48 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 174.2, 155.8, 143.6, 140.2, 119.9, 110.7, 84.1, 52.7, 41.1, 28.0, 23.7. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{13}H_{17}NNaO_5$ 290.0099, found 290.0108.

Synthesis of *N*-(trifluoromethylthio)phthalimide 2



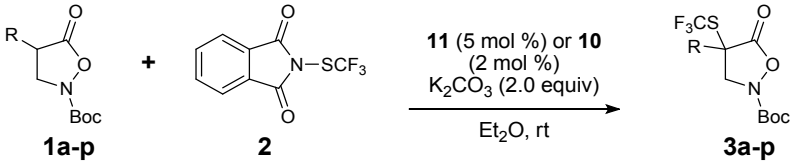
The procedure previously reported was used.[3] In a 100 ml round bottom flask, *N*-bromophthalimide (1.0 equiv, 23.0 mmol, 5.20 g), $AgSCF_3$ (1.1 equiv, 25.3 mmol, 5.28 g) and anhydrous CH_3CN (40 mL) were added under inert atmosphere and the mixture was stirred at room temperature for 3 h. Next, the solvent was removed in vacuo and the residue was dissolved in DCM (20 ml), filtered through a short plug of Celite®. The filtrate was concentrated again under vacuum to yield the title compound as a white solid (5.11 g, 90%).

Typical procedure for the synthesis of racemic compounds 3



A mixture of isoxazolidin-5-one **1** (1.0 equiv, 0.20 mmol), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.40 mmol, 99.0 mg), TBAB (0.2 equiv, 0.040 mmol, 12.9 mg) and K_2CO_3 (2.0 equiv, 0.40 mmol, 55.3 mg) in diethyl ether (2.0 mL) was stirred for 24-72 hours. Then, the reaction mixture was filtered over a pad of Na_2SO_4, the solvent evaporated and the residue thoroughly dried under reduced pressure. The resulting crude product was purified by chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1) to afford racemic products **3.**

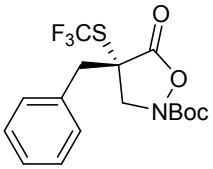
General procedure for the asymmetric trifluoromethylthiolation of isoxazolidin-5-one (3a-p)



A mixture of isoxazolidinone **1** (1.0 equiv, 0.10 mmol), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg), catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) (or **10** (0.02 equiv, 0.002 mmol, 1.8 mg) where indicated) and K_2CO_3 (2.0 equiv, 0.20 mmol, 27.6 mg) in diethyl ether (1.0 mL) was stirred for the indicated time. Then, the mixture was filtered over a pad of Na_2SO_4, the solvent evaporated and the residue thoroughly dried under reduced pressure. The resulting crude product was purified by chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1 (or cyclohexane/DCM 1/3 where indicated) to yield the desired products **3a-p.**

Reaction between 1a and 2 performed at 1.0 mmol scale

A mixture of isoxazolidinone **1a** (1.0 equiv, 1.00 mmol, 277.3 mg), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 2.00 mmol, 494.4 mg), catalyst **11** (0.05 equiv, 0.05 mmol, 53.9 mg) and K_2CO_3 (2.0 equiv, 2.00 mmol, 364.2 mg) in diethyl ether (10.0 mL) was stirred for 48 h. Then, the mixture was filtered over a pad of Na_2SO_4, the solvent was evaporated and the residue thoroughly dried under reduced pressure. The resulting crude product was purified by chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1, affording the **3a** (181.1 mg, 48%, 92:8 e.r.).

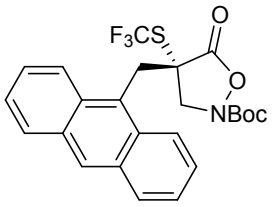


***tert*-butyl (*S*)-4-benzyl-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3a)**

Following the general procedure with *tert*-butyl 4-benzyl-5-oxoisoxazolidine-2-carboxylate **1a** (27.7 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 48 hours, the title compound **3a** (18.9 mg, 50%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.42 – 7.30 (m, 3H), 7.25 – 7.17 (m, 2H), 4.24 (d, *J* = 13.1 Hz, 1H), 4.11 (d, *J* = 13.1 Hz, 1H), 3.48 (d, *J* = 14.4 Hz, 1H), 3.35 (d, *J* = 14.4 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.5, 154.6, 131.9, 129.4, 128.0, 127.8 (q, *J* = 310.6 Hz), 127.3, 84.0, 55.9 (q, *J* = 1.4 Hz), 53.3, 39.6 (q, *J* = 1.1 Hz), 26.9.

^{19}F NMR (282 MHz, $CDCl_3$) δ -35.6. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{16}H_{18}F_3NNaO_4S$ 400.0801, found 400.0801. $[\alpha]_D^{20}$= +55.8° (c = 0.80, $CHCl_3$). Enantiomeric ratio = 93:7 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 99:1, 0.5 mL/min, t_{major} = 12.9 min, t_{minor} = 14.6 min).

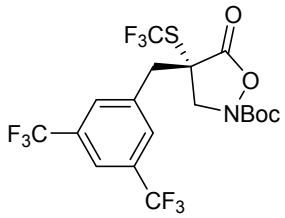


***tert*-butyl (*S*)-4-(anthracen-9-ylmethyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3b)**

Following the general procedure with *tert*-butyl 4-(anthracen-9-ylmethyl)-5-oxoisoxazolidine-2-carboxylate **1b** (37.7 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3b** (28.2 mg, 59%) was obtained as a pale yellow oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

^{1}H NMR (300 MHz, $CDCl_3$) δ 8.48 (s, 1H), 8.21 (bs, 2H), 8.09 – 8.00 (m, 2H), 7.67 – 7.54 (m, 2H), 7.56 – 7.46 (m, 2H), 4.97 (d, *J* = 15.8 Hz, 1H), 4.46 (d, *J* = 15.8 Hz, 1H), 4.16 (d, *J* = 13.5 Hz, 1H), 3.39 (d, *J* = 13.5 Hz, 1H), 1.45 (s, 9H).

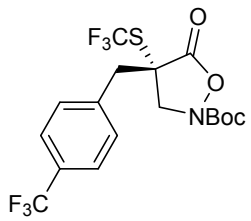
^{13}C NMR (75 MHz, $CDCl_3$) δ 170.2, 154.5, 130.5, 130.0, 128.5, 128.0 (q, 311.0 Hz), 127.8, 126.2, 124.5, 124.3, 123.0, 83.8, 55.2 (q, 1.1 Hz), 52.6, 32.3 (q, 1.1 Hz), 26.8. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.5. **HRMS** (MALDI) [M+H$^+$] calcd for $C_{24}H_{23}F_3NO_4S$ 478.1294, found 478.1299. $[\alpha]_D^{20}$= +50.0° (c = 0.80, $CHCl_3$). Enantiomeric ratio = 89:11 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 0.5 mL/min, t_{major} = 9.9 min, t_{minor} = 10.9 min).



***tert*-butyl (*S*)-4-(3,5-bis(trifluoromethyl)benzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3c)**

Following the general procedure with *tert*-butyl 4-(3,5-bis(trifluoromethyl)benzyl)-5-oxoisoxazolidine-2-carboxylate **1c** (41.3 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 48 hours, the title compound **3c** (24.6 mg, 48%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.89 (s, 1H), 7.70 (s, 2H), 4.29 (d, *J* = 12.9 Hz, 1H), 4.07 (d, *J* = 12.9 Hz, 1H), 3.55 (s, 2H), 1.53 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.6, 155.4, 135.4, 132.4 (q, $J_{C\text{-}F}$ = 33.7 Hz), 130.6 (q, $J_{C\text{-}F}$ = 4.0 Hz), 128.6 (q, $J_{C\text{-}F}$ = 310.0 Hz), 122.9 (q, $J_{C\text{-}F}$ = 273.0 Hz), 122.5 (sept, $J_{C\text{-}F}$ = 3.8 Hz), 85.56, 57.4 (q, $J_{C\text{-}F}$ = 1.6 Hz), 53.87, 39.98, 27.89. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.5, -63.0. **HRMS** (MALDI) [M+H$^+$] calcd for $C_{18}H_{17}F_9NO_4S$ 514.0729, found 514.0734. $[\alpha]_D^{20}$= +68.1° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 98:2 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 98:2, 0.5 mL/min, t_{minor} = 8.6 min, t_{major} = 12.4 min).

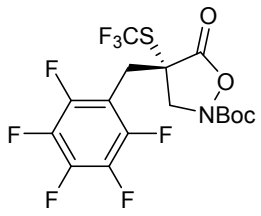


***tert*-butyl (*S*)-5-oxo-4-(4-(trifluoromethyl)benzyl)-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3d)**

Following the general procedure with *tert*-butyl 5-oxo-4-(4-(trifluoromethyl)benzyl)isoxazolidine-2-carboxylate **1d** (34.5 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 48 hours, the title compound **3d** (38.7 mg, 87%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.63 (d, J = 8.0 Hz, 2H), 7.36 (d, J = 8.0 Hz, 2H), 4.26 (d, J = 13.0 Hz, 1H), 4.07 (d, J = 13.0 Hz, 1H), 3.52 (d, J = 14.4 Hz, 1H), 3.43 (d, J = 14.4 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 170.1, 155.6 , 136.9 (q, $J_{C\text{-}F}$ = 1.4 Hz), 130.8, 130.7 (q, $J_{C\text{-}F}$ = 32.0 Hz), 128.6 (q, $J_{C\text{-}F}$ = 310.0 Hz), 126.0 (q, $J_{C\text{-}F}$ = 3.8 Hz), 123.8 (q, $J_{C\text{-}F}$ = 272.1 Hz), 85.3, 57.1 (q, $J_{C\text{-}F}$ = 1.2 Hz), 54.1, 40.2, 27.9.

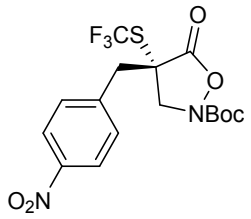
^{19}F NMR (376 MHz, $CDCl_3$) δ -35.7, -62.9. **HRMS** (MALDI) [M+K$^+$] calcd for $C_{17}H_{17}F_6KNO_4S$ 484.0414, found 484.0404. $[\alpha]_D^{20}$= +48.0° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 90:10 determined by **HPLC** analysis (CHIRALPAK® ID column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 98:2, 1.0 mL/min, t_{minor} = 4.7 min, t_{major} = 6.3 min).



***tert*-butyl (*S*)-5-oxo-4-((perfluorophenyl)methyl)-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3e)**

Following the general procedure with *tert*-butyl 5-oxo-4-((perfluorophenyl)methyl)isoxazolidine-2-carboxylate **1e** (36.7 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 48 hours, the title compound **3e** (35.0 mg, 75%) was obtained as a waxy white solid after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

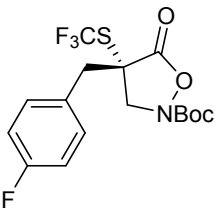
^{1}H NMR (300 MHz, $CDCl_3$) δ 4.34 (d, J = 13.1 Hz, 1H), 4.22 (d, J = 13.1 Hz, 1H), 3.70 (d, J = 15.0 Hz, 1H), 3.35 (d, J = 15.0 Hz, 1H), 1.53 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 168.5 , 154.6 , 146.6 – 146.1 (m), 143.3 – 142.8 (m), 138.7 – 138.1 (m), 135.4 – 134.7 (m), 127.4 (q, $J_{C\text{-}F}$ = 311.2 Hz), 106.3 (td, $J_{C\text{-}F}$ = 18.0, 4.1 Hz), 84.4 , 57.8 (q, $J_{C\text{-}F}$ = 1.8 Hz), 52.3 , 27.3 , 26.8. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -36.3 (t, J = 4.3 Hz), -138.5 – -138.8 (m), -152.0 (tt, J = 21.0, 2.3 Hz), -160.3 – -160.5 (m). **HRMS** (MALDI) [M+H$^+$] calcd for $C_{16}H_{14}F_8NO_4S$ 468.0510, found 468.0511. $[\alpha]_D^{20}$= +86.6° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 89:11 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 0.5 mL/min, t_{major} = 9.3 min, t_{minor} = 10.1 min).



***tert*-butyl (*S*)-4-(4-nitrobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3f)**

Following the general procedure with *tert*-butyl 4-(4-nitrobenzyl)-5-oxoisoxazolidine-2-carboxylate **1f** (32.2 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3f** (22.0 mg, 52%) was obtained as a colorless oil solid after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

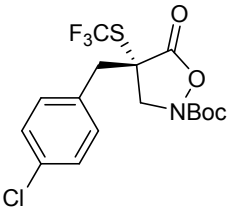
^{1}H NMR (300 MHz, $CDCl_3$) δ 8.23 (d, J = 8.8 Hz, 2H), 7.42 (d, J = 8.8 Hz, 2H), 4.28 (d, J = 13.0 Hz, 1H), 4.07 (d, J = 13.0 Hz, 1H), 3.65 – 3.40 (m, 2H), 1.52 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.8, 155.5, 148.0, 140.2, 131.4, 128.6 (q, 310.7 Hz), 124.1, 85.4, 57.3 (q, 1.2 Hz), 54.0, 40.2, 27.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.5. **HRMS** (MALDI) [M+H$^+$] calcd for $C_{16}H_{18}F_3N_2O_6S$ 423.0832, found 423.0834. $[\alpha]_D^{20}$= +30.0° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 82:18 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 70:30, 1.0 mL/min, t_{major} = 7.0 min, t_{minor} = 7.8 min).



***tert*-butyl (*S*)-4-(4-fluorobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3g)**

Following the general procedure with *tert*-butyl 4-(4-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate **1g** (29.5 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3g** (21.0 mg, 53%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

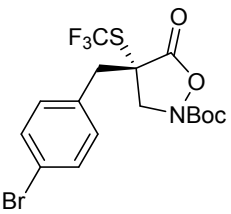
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.24 – 7.12 (m, 2H), 7.12 – 6.94 (m, 2H), 4.24 (d, *J* = 13.0 Hz, 1H), 4.09 (d, *J* = 13.0 Hz, 1H), 3.45 (d, *J* = 14.4 Hz, 1H), 3.32 (d, *J* = 14.4 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 170.3, 162.7 (d, *J* = 248.1 Hz), 155.6, 132.1 (d, *J* = 8.2 Hz), 128.8 (q, *J* = 310.8 Hz), 128.6 (d, *J* = 3.6 Hz), 116.0 (d, *J* = 21.7 Hz), 85.1, 56.9 (q, *J* = 1.9 Hz), 54.4, 39.8, 27.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.6, -113.4. **HRMS** (MALDI) [M^+] calcd for $C_{16}H_{17}F_4NO_4S$ 395.0809, found 395.0818. $[\alpha]_D^{20}$= +57.0° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 89:11 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 96/4, 0.5 mL/min, t_{major} = 10.5 min, t_{minor} = 11.1 min).



***tert*-butyl (*S*)-4-(4-chlorobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3h)**

Following the general procedure with *tert*-butyl 4-(4-chlorobenzyl)-5-oxoisoxazolidine-2-carboxylate **1h** (31.2 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3h** (23.9 mg, 58%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

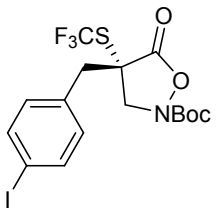
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.7 Hz, 2H), 7.16 (d, *J* = 8.7 Hz, 2H), 4.24 (d, *J* = 13.0 Hz, 1H), 4.08 (d, *J* = 13.0 Hz, 1H), 3.45 (d, *J* = 14.5 Hz, 1H), 3.32 (d, *J* = 14.5 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.7, 155.0, 134.0, 131.2, 130.8, 128.7, 128.2 (q, J = 310.7 Hz), 84.6, 56.4 (q, J = 1.2 Hz), 53.7, 39.4 (q, J = 1.2 Hz), 27.4. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.6. **HRMS** (MALDI) [$M+K^+$] calcd for $C_{16}H_{17}ClF_3KNO_4S$ 450.0150, found 450.0155. [$\alpha]_D^{20}$= +65.4° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 89:11 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 96:4, 0.5 mL/min, t_{major} = 11.5 min, t_{minor} = 12.3 min).



***tert*-butyl (*S*)-4-(4-bromobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3i)**

Following the general procedure with *tert*-butyl 4-(4-bromobenzyl)-5-oxoisoxazolidine-2-carboxylate **1i** (35.6 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 48 hours, the title compound **3i** (36.0 mg, 79%) was obtained a pale yellow oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

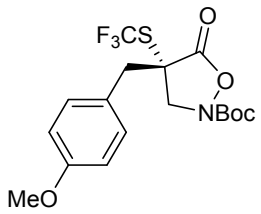
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.49 (d, *J* = 8.4 Hz, 2H), 7.10 (d, *J* = 8.4 Hz, 2H), 4.24 (d, *J* = 13.0 Hz, 1H), 4.07 (d, *J* = 13.0 Hz, 1H), 3.43 (d, *J* = 14.5 Hz, 1H), 3.31 (d, *J* = 14.5 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.2, 154.5, 131.2, 131.0, 130.8, 127.7 (q, J_{C-F} = 310.5 Hz), 121.6, 84.1, 55.9 (q, J_{C-F} = 1.2 Hz), 53.1, 39.0 (q, J_{C-F} = 1.3 Hz), 26.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.6. **HRMS** (MALDI) [$M+K^+$] calcd for $C_{16}H_{17}BrF_3KNO_4S$ 493.9645, found 493.9651. $[\alpha]_D^{20}$= +54.7° (c = 0.30, $CHCl_3$). Enantiomeric ratio = 88:12 determined by **HPLC** analysis (CHIRALPAK® ID column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 1.0 mL/min, t_{minor} = 8.0 min, t_{major} = 11.2 min).



***tert*-butyl (*S*)-4-(4-iodobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3j)**

Following the general procedure with *tert*-butyl 4-(4-iodobenzyl)-5-oxoisoxazolidine-2-carboxylate **1j** (40.3 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3j** (32.6 mg, 65%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

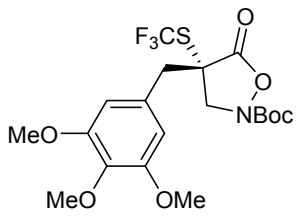
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.4 Hz, 2H), 6.96 (d, *J* = 8.4 Hz, 2H), 4.23 (d, *J* = 13.0 Hz, 1H), 4.07 (d, *J* = 13.0 Hz, 1H), 3.41 (d, *J* = 14.4 Hz, 1H), 3.29 (d, *J* = 14.4 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.2, 154.5, 137.2, 131.5, 131.21, 127.7 (q, 310.4 Hz), 93.2, 84.1, 55.9 (q, 1.1 Hz), 53.0, 39.1, 26.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.6. **HRMS** (MALDI) [M+K$^+$] calcd for $C_{16}H_{17}F_3IKNO_4S$ 541.9512, found 541.9526. $[\boldsymbol{\alpha}]_{\boldsymbol{D}}^{\boldsymbol{20}}$= +65.8° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 90:10 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 0.5 mL/min, t_{major} = 16.6 min, t_{minor} = 19.6 min).



***tert*-butyl (*S*)-4-(4-methoxybenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3k)**

Following the general procedure with *tert*-butyl 4-(4-methoxybenzyl)-5-oxoisoxazolidine-2-carboxylate **1k** (30.7 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3k** (8.1 mg, 20%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-DCM, 1/1 to 4/1).

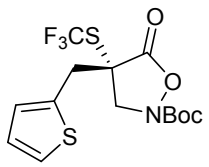
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.13 (d, *J* = 8.7 Hz, 2H), 6.87 (d, *J* = 8.7 Hz, 2H), 4.23 (d, *J* = 13.0 Hz, 1H), 4.12 (d, *J* = 13.0 Hz, 1H), 3.80 (s, 3H), 3.43 (d, *J* = 14.5 Hz, 1H), 3.27 (d, *J* = 14.5 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.6, 158.5, 154.6, 130.5, 127.8 (q, $J_{C\text{-}F}$ = 310.4 Hz), 123.7 , 113.4 , 83.9 , 55.8 (q, $J_{C\text{-}F}$ = 1.3 Hz), 54.3, 53.5, 38.8 (q, $J_{C\text{-}F}$ = 1.3 Hz), 26.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.6. **HRMS** (MALDI) [M+K$^+$] calcd for $C_{17}H_{20}F_3KNO_5S$ 446.0646, found 446.0648. $[\boldsymbol{\alpha}]_{\boldsymbol{D}}^{\boldsymbol{20}}$= +9.7° (c = 0.30, $CHCl_3$). Enantiomeric ratio = 94:6 determined by **HPLC** analysis (CHIRALPAK® ID column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 1.0 mL/min, t_{major} = 7.9 min, t_{minor} = 10.4 min).



***tert*-butyl (*S*)-5-oxo-4-((trifluoromethyl)thio)-4-(3,4,5-trimethoxybenzyl)isoxazolidine-2-carboxylate (3l)**

Following the general procedure with *tert*-butyl 5-oxo-4-(3,4,5-trimethoxybenzyl)isoxazolidine-2-carboxylate **1l** (36.7 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3l** (14.5 mg, 31%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-DCM, 1/1 to 4/1).

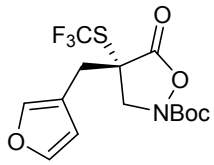
^{1}H NMR (300 MHz, $CDCl_3$) δ 6.40 (s, 2H), 4.28 (d, *J* = 13.0 Hz, 1H), 4.13 (d, *J* = 13.0 Hz, 1H), 3.85 (s, 9H), 3.51 (d, *J* = 14.3 Hz, 1H), 3.23 (d, *J* = 14.3 Hz, 1H), 1.51 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.7, 154.6, 152.5, 137.0, 127.8 (q, $J_{C\text{-}F}$ = 310.8 Hz), 127.3, 106.4, 84.0, 59.8, 55.4 (q, $J_{C\text{-}F}$ = 1.3 Hz), 55.20, 53.4, 40.1 (q, $J_{C\text{-}F}$ = 1.1 Hz), 26.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.5. **HRMS** (MALDI) [M+K$^+$] calcd for $C_{19}H_{24}F_3KNO_7S$ 506.0857, found 506.0861. $[\boldsymbol{\alpha}]_{\boldsymbol{D}}^{\boldsymbol{20}}$= +60.3° (c = 0.3, $CHCl_3$). Enantiomeric ratio = 85:15 determined by **HPLC** analysis (CHIRALPAK® ID column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 80:20, 1.0 mL/min, t_{minor} = 9.0 min, t_{major} = 15.6 min).



***tert*-butyl (*S*)-5-oxo-4-(thiophen-2-ylmethyl)-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3m)**

Following the general procedure with *tert*-butyl 5-oxo-4-(thiophen-2-ylmethyl)isoxazolidine-2-carboxylate **1m** (28.3 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3m** (29.9 mg, 78%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

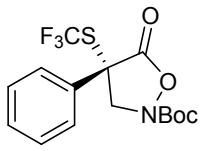
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.30 – 7.25 (m, 1H), 7.03 – 6.98 (m, 1H), 7.00 – 6.92 (m, 1H), 4.30 (d, *J* = 13.2 Hz, 1H), 4.12 (d, *J* = 13.2 Hz, 1H), 3.71 – 3.54 (m, 2H), 1.52 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.3, 154.6, 132.9, 128.1, 127.6 (q, J = 310.9 Hz), 126.5, 125.3, 84.0, 56.2 (q, J = 1.3 Hz), 52.9, 33.9 (q, J = 1.3 Hz), 26.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.7. **HRMS** (MALDI) [M+K$^+$] calcd for $C_{14}H_{16}F_3KNO_4S_2$ 422.0104, found 422.0111. $[\alpha]_D^{20}$= +56.0° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 92:8 determined by **HPLC** analysis (CHIRALPAK® ID column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 1.0 mL/min, t_{minor} = 6.5 min, t_{major} = 9.2 min).



***tert*-butyl (*S*)-4-(furan-3-ylmethyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3n)**

Following the general procedure with *tert*-butyl 4-(furan-3-ylmethyl)-5-oxoisoxazolidine-2-carboxylate **1n** (26.7 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **11** (0.05 equiv, 0.005 mmol, 5.4 mg) for 72 hours, the title compound **3n** (12.1 mg, 33%) was obtained as a colorless oil after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

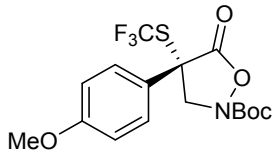
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.48 – 7.38 (m, 1H), 7.37 (s, 1H), 6.30 (s, 1H), 4.29 (d, *J* = 13.1 Hz, 1H), 4.08 (d, *J* = 13.1 Hz, 1H), 3.30 (d, *J* = 15.2 Hz, 1H), 3.20 (d, *J* = 15.2 Hz, 1H), 1.52 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.5, 154.6, 142.8, 140.9, 127.7 (q, 310.1 Hz), 115.6, 110.4, 84.0, 56.0 (q, 1.6 Hz), 52.7, 29.6 (q, 1.2 Hz), 26.9. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -35.7. **HRMS** (MALDI) [M+K$^+$] calcd for $C_{14}H_{16}F_3KNO_5S$ 406.03333, found 406.0333. $[\alpha]_D^{20}$= +24.3° (c = 0.30, $CHCl_3$). Enantiomeric ratio = 83:17 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 0.5 mL/min, t_{major} = 11.2 min, t_{minor} = 11.9 min).



***tert*-butyl (*S*)-5-oxo-4-phenyl-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3o)**

Following the general procedure with *tert*-butyl 5-oxo-4-phenylisoxazolidine-2-carboxylate **1o** (26.3 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2** (2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **10** (0.02 equiv, 0.002 mmol, 1.8 mg) for 10 min, the title compound **3o** (30.2 mg, 83%) was obtained as a waxy white solid after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.68 – 7.57 (m, 2H), 7.50 – 7.36 (m, 3H), 4.95 (d, J = 12.8 Hz, 1H), 4.59 (d, J = 12.8 Hz, 1H), 1.35 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 170.4, 155.4, 131.7, 130.0, 129.4, 128.5 (q, 310.7 Hz), 127.4, 85.0, 59.6 (q, 1.7 Hz), 56.6, 27.7. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -36.8. **HRMS** (MALDI) [M+K$^+$] calcd for $C_{15}H_{16}F_3KNO_4S$ 402.0384, found 402.0397. $[\alpha]_D^{20}$= -25.0° (c = 0.50, $CHCl_3$). Enantiomeric ratio = 84:16 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 99:1, 0.5 mL/min, t_{minor} = 19.5 min, t_{major} = 21.5 min).



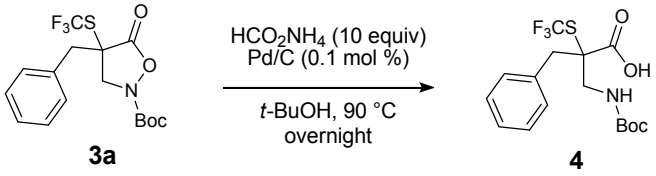
***tert*-butyl (*S*)-4-(4-methoxyphenyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3p)**

Following the general procedure with *tert*-butyl 4-(4-methoxyphenyl)-5-oxoisoxazolidine-2-carboxylate **1p** (29.3 mg, 0.10 mmol, 1.0 equiv), *N*-(trifluoromethylthio)phthalimide **2**

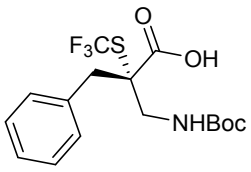
(2.0 equiv, 0.20 mmol, 49.4 mg) and catalyst **10** (0.02 equiv, 0.002 mmol, 1.8 mg) for 10 min, the title compound **3p** (33. mg, 84%) was obtained as a waxy white solid after column chromatography (silica gel, cyclohexane-ethyl acetate, 20/1 to 10/1).

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.53 (d, *J* = 8.9 Hz, 2H), 6.93 (d, *J* = 8.9 Hz, 2H), 4.94 (d, *J* = 12.7 Hz, 1H), 4.55 (d, *J* = 12.7 Hz, 1H), 3.81 (s, 3H), 1.35 (s, 9H). **^{13}C NMR** (75 MHz, $CDCl_3$) δ 169.6, 159.8, 154.4, 127.9, 127.6 (q, 310.8 Hz), 121.8, 113.7, 83.8, 58.5 (q, 1.7 Hz), 55.42, 54.4, 26.7. **^{19}F NMR** (282 MHz, $CDCl_3$) δ -36.9. **HRMS** (MALDI) [M+Na^+] calcd for $C_{16}H_{18}F_3NNaO_5S$ 416.0750, found 416.0753. $[\boldsymbol{\alpha}]_{\boldsymbol{D}}^{\boldsymbol{20}}$= -31.4° (c = 1.00, $CHCl_3$). Enantiomeric ratio = 88:12 determined by **HPLC** analysis (CHIRALPAK® AS-H column (ϕ 0.46 cm x 25 cm), *n*-hexane:*i*-PrOH = 95:5, 0.5 mL/min, t_{minor} = 10.6 min, t_{major} = 11.6 min).

Synthesis of the 2-trifluoromethylthio-β^{2,2}-amino acid 4



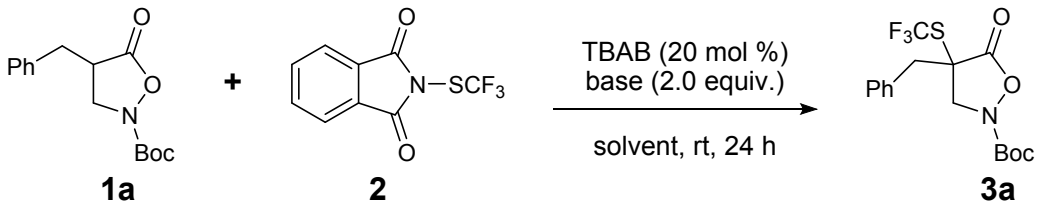
In a Schlenk tube, ammonium formate (10 equiv, 1.5 mmol) and Pd/C (10% w/w) (0.10 equiv, 0.015 mmol, 16.0 mg) were added to a solution of *tert*-butyl 4-benzyl-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate **3a** (1.0 equiv, 0.15 mmol, 56.6 mg) in *tert*-Butanol (1.5 ml). The mixture was degassed through 3 freeze-pump-thaw cycles, the tube sealed and the reaction mixture was heated at 90 °C overnight. Next, the reaction mixture was filtered through a plug of Celite® washing with ethyl acetate (2 x 10 mL). Then, the filtrate was washed with brine (3 x 10 mL) and the organic phase dried over $MgSO_4$, filtered and concentrated under vacuum, affording product **4** (51.2 mg, 90%) as a waxy solid.



2-benzyl-3-((*tert*-butoxycarbonyl)amino)-2-((trifluoromethyl)thio)propanoic acid (4)

^{1}H NMR (300 MHz, Methanol-d_4) δ 7.25 (s, 5H), 3.65 (d, J = 14.5 Hz, 1H), 3.55 (d, J = 14.5 Hz, 1H), 3.28 – 3.17 (m, 2H), 1.44 (s, 9H). **^{13}C NMR** (75 MHz, CD_3CN) δ 170.6, 155.6, 134.2, 130.5, 130.0 (q, 307.9 Hz), 128.3, 127.1, 79.1, 62.0, 44.3, 39.5, 27.5. **^{19}F NMR** (282 MHz, Methanol-d_4) δ -39.2. **HRMS** (MALDI) [M+Na$^+$] calcd for $C_{16}H_{20}F_3NNaO_4S$ 402.0957, found 402.0972. $[\alpha]_D^{20}$= +19.4° (c = 0.50, $CHCl_3$)

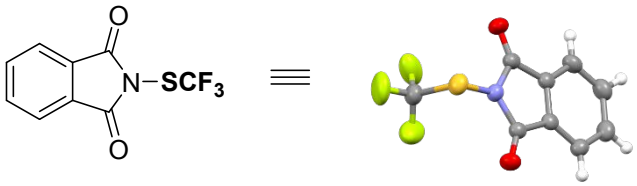
Optimization of reaction conditions of trifluoromethylthiolation catalyzed by tetrabutylammonium bromide



Entry	Base	Solvent	NMR yield (%)[a]
1	Na_2CO_3	Et_2O	<2
2	K_2CO_3	Et_2O	36
3	Cs_2CO_3	Et_2O	<2
4	K_3PO_4	Et_2O	15
5	NaH_2PO_4	Et_2O	<2
6	KF	Et_2O	8
7	NaOH	Et_2O	<2
8	KOH	Et_2O	<2
9	K_2CO_3 20% aq.	Et_2O	<2
10	K_2CO_3	Toluene	9
11	K_2CO_3	CH_2Cl_2	<2
12	K_2CO_3	THF	8

[a] Terephthalaldehyde was used as an internal standard.

X-Ray data



Atom types: C grey, N blue, O red, S yellow, F green.

Compound **2**

A clear colourless prismatic-like specimen of $C_{18}H_8F_6N_2O_4S_2$, approximate dimensions 0.170 mm x 0.297 mm x 0.308 mm, was used for the X-ray crystallographic analysis. The X-ray intensity data were measured. The total exposure time was 8.69 hours. The frames were integrated with the Bruker SAINT software package using a narrow-frame algorithm. The integration of the data using an orthorhombic unit cell yielded a total of 30632 reflections to a maximum θ angle of 25.34° (0.83 Å resolution), of which 1762 were independent (average redundancy 17.385, completeness = 100.0%, R_{int} = 2.31%, R_{sig} = 0.72%) and 1731 (98.24%) were greater than $2\sigma(F^2)$. The final cell constants of a = 5.17410(10) Å, b = 9.2140(3) Å, c = 20.1869(5) Å, volume = 962.39(4) $Å^3$, are based upon the refinement of the XYZ-centroids of 81 reflections above 20 σ(I) with 6.886° < 2θ < 49.18°. Data were corrected for absorption effects using the multi-scan method (SADABS). The ratio of minimum to maximum apparent transmission was 0.963. The calculated minimum and maximum transmission coefficients (based on crystal size) are 0.8960 and 0.9410. The final anisotropic full-matrix least-squares refinement on F^2 with 145 variables converged at R1 = 2.60%, for the observed data and wR2 = 9.81% for all data. The goodness-of-fit was 1.059. The largest peak in the final difference electron density synthesis was 0.224 $e^-/Å^3$ and the largest hole was -0.215 $e^-/Å^3$ with an RMS deviation of 0.084 $e^-/Å^3$. On the basis of the final model, the calculated density was 1.706 g/cm^3 and F(000), 496 e^-.

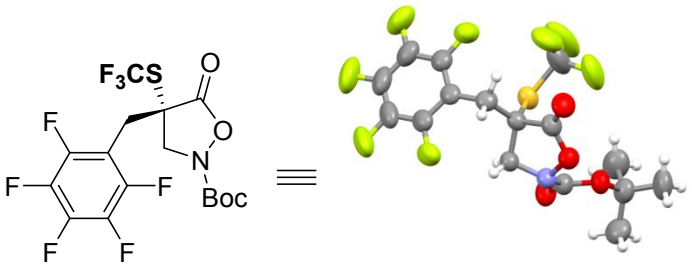
Table S1. Sample and crystal data for Compound 2

Chemical formula	$C_{18}H_8F_6N_2O_4S_2$	
Formula weight	494.38 g/mol	
Temperature	250(2) K	
Wavelength	0.71073 Å	
Crystal size	0.170 x 0.297 x 0.308 mm	
Crystal habit	clear colourless prismatic	
Crystal system	orthorhombic	
Space group	P 21 21 21	
Unit cell dimensions	a = 5.17410(10) Å	α = 90°
	b = 9.2140(3) Å	β = 90°
	c = 20.1869(5) Å	γ = 90°
Volume	962.39(4) $Å^3$	
Z	2	
Density (calculated)	1.706 g/cm^3	
Absorption coefficient	0.365 mm^{-1}	
F(000)	496	

Table S2. Data collection and structure refinement for Compound 2.

Theta range for data collection	2.02 to 25.34°
Index ranges	-6<=h<=6, -11<=k<=11, -24<=l<=24
Reflections collected	30632
Independent reflections	1762 [R(int) = 0.0231]
Coverage of independent reflections	100.0%
Absorption correction	multi-scan
Max. and min. transmission	0.9410 and 0.8960
Refinement method	Full-matrix least-squares on F^2
Refinement program	SHELXL-2014/7 (Sheldrick, 2014)
Function minimized	$\Sigma\ w(F_o^2 - F_c^2)^2$
Data / restraints / parameters	1762 / 0 / 145
Goodness-of-fit on F^2	1.059
Δ/σ_{max}	0.001
Final R indices	1731 data; $I>2\sigma(I)$ R1 = 0.0260, wR2 = 0.0742
	all data R1 = 0.0293, wR2 = 0.0981
Weighting scheme	$w=1/[\sigma^2(F_o^2)+(0.0584P)^2+0.4730P]$ where $P=(F_o^2+2F_c^2)/3$
Absolute structure parameter	0.0(0)
Largest diff. peak and hole	0.224 and -0.215 eÅ^{-3}
R.M.S. deviation from mean	0.084 eÅ^{-3}

Compound **3e**



Atom types: C grey, N blue, O red, S yellow, F green.

A clear colourless prismatic-like specimen of $C_{16}H_{13}F_8NO_4S$, approximate dimensions 0.085 mm x 0.262 mm x 0.430 mm, was used for the X-ray crystallographic analysis. The *X*-ray intensity data were measured. The total exposure time was 1.96 hours. The frames were integrated with the Bruker SAINT software package using a narrow-frame algorithm. The integration of the data using an orthorhombic unit cell yielded a total of 23930 reflections to a maximum θ angle of 25.35° (0.83 Å resolution), of which 3592 were independent (average redundancy 6.662, completeness = 99.7%, R_{int} = 3.62%, R_{sig} = 2.12%) and 3006 (83.69%) were greater than $2\sigma(F^2)$. The final cell constants of a = 11.5372(5) Å, b = 11.7999(5) Å, c = 14.4627(6) Å, volume = 1968.92(14) $Å^3$, are based upon the refinement of the XYZ-centroids of 5731 reflections above 20 σ(I) with 5.685° < 2θ < 41.06°. Data were corrected for absorption effects using the multi-scan method (SADABS). The ratio of minimum to maximum apparent transmission was 0.922. The calculated minimum and maximum transmission coefficients (based on crystal size) are 0.8960 and 0.9780. The final anisotropic full-matrix least-squares refinement on F^2 with 274 variables converged at R1 = 3.60%, for the observed data and wR2 = 13.05% for all data. The goodness-of-fit was 1.018. The largest peak in the final difference electron density synthesis was 0.317 $e^-/Å^3$ and the largest hole was -0.387 $e^-/Å^3$ with an RMS deviation of 0.122 $e^-/Å^3$. On the basis of the final model, the calculated density was 1.577 g/cm^3 and F(000), 944 e^-.

Table S3. Sample and crystal data for Compound 3e.

Chemical formula	$C_{16}H_{13}F_8NO_4S$	
Formula weight	467.33 g/mol	
Temperature	270(2) K	
Wavelength	0.71073 Å	
Crystal size	0.085 x 0.262 x 0.430 mm	
Crystal habit	clear colourless prismatic	
Crystal system	orthorhombic	
Space group	P 21 21 21	
Unit cell dimensions	a = 11.5372(5) Å	α = 90°
	b = 11.7999(5) Å	β = 90°
	c = 14.4627(6) Å	γ = 90°
Volume	1968.92(14) $Å^3$	
Z	4	
Density (calculated)	1.577 g/cm^3	
Absorption coefficient	0.261 mm^{-1}	
F(000)	944	

Table S4. Data collection and structure refinement for Compound 3e.

Theta range for data collection	2.23 to 25.35°
Index ranges	-13<=h<=13, -14<=k<=14, -17<=l<=17
Reflections collected	23930
Independent reflections	3592 [R(int) = 0.0362]
Coverage of independent reflections	99.7%
Absorption correction	multi-scan
Max. and min. transmission	0.9780 and 0.8960
Refinement method	Full-matrix least-squares on F^2
Refinement program	SHELXL-2014/7 (Sheldrick, 2014)
Function minimized	$\Sigma\ w(F_o^2 - F_c^2)^2$
Data / restraints / parameters	3592 / 0 / 274
Goodness-of-fit on F^2	1.018
Final R indices	3006 data; I>2σ(I) R1 = 0.0360, wR2 = 0.0950 all data R1 = 0.0506, wR2 = 0.1305
Weighting scheme	$w=1/[\sigma^2(F_o^2)+(0.0757P)^2+0.5583P]$ where $P=(F_o^2+2F_c^2)/3$
Absolute structure parameter	-0.0(0)
Largest diff. peak and hole	0.317 and -0.387 eÅ^{-3}
R.M.S. deviation from mean	0.122 eÅ^{-3}

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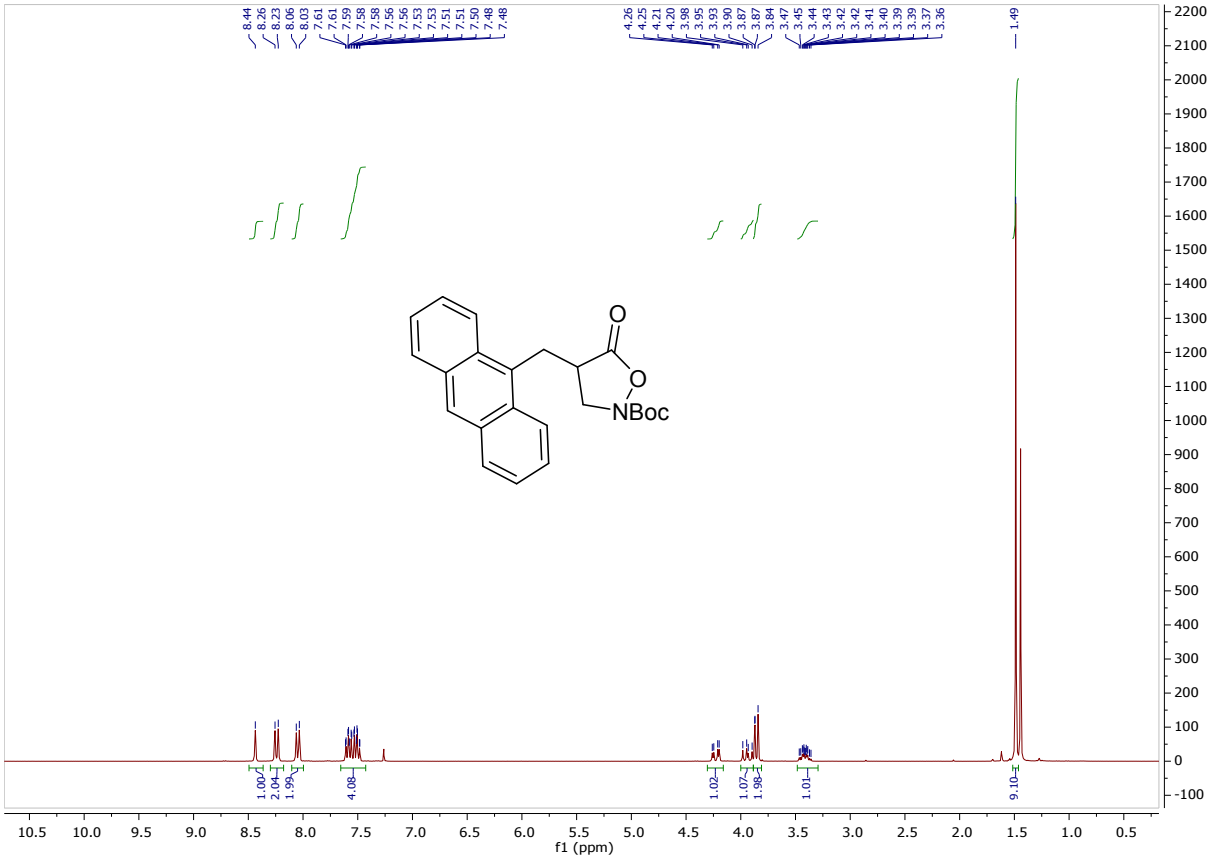
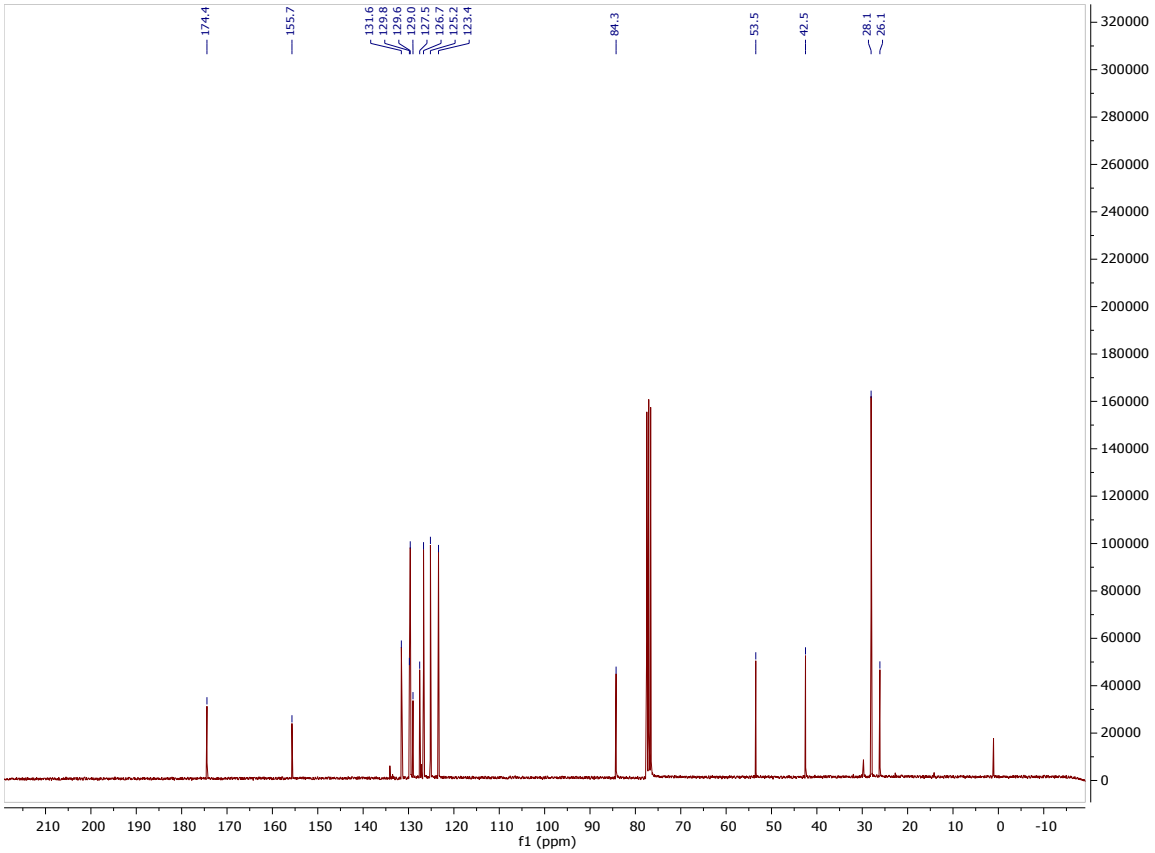
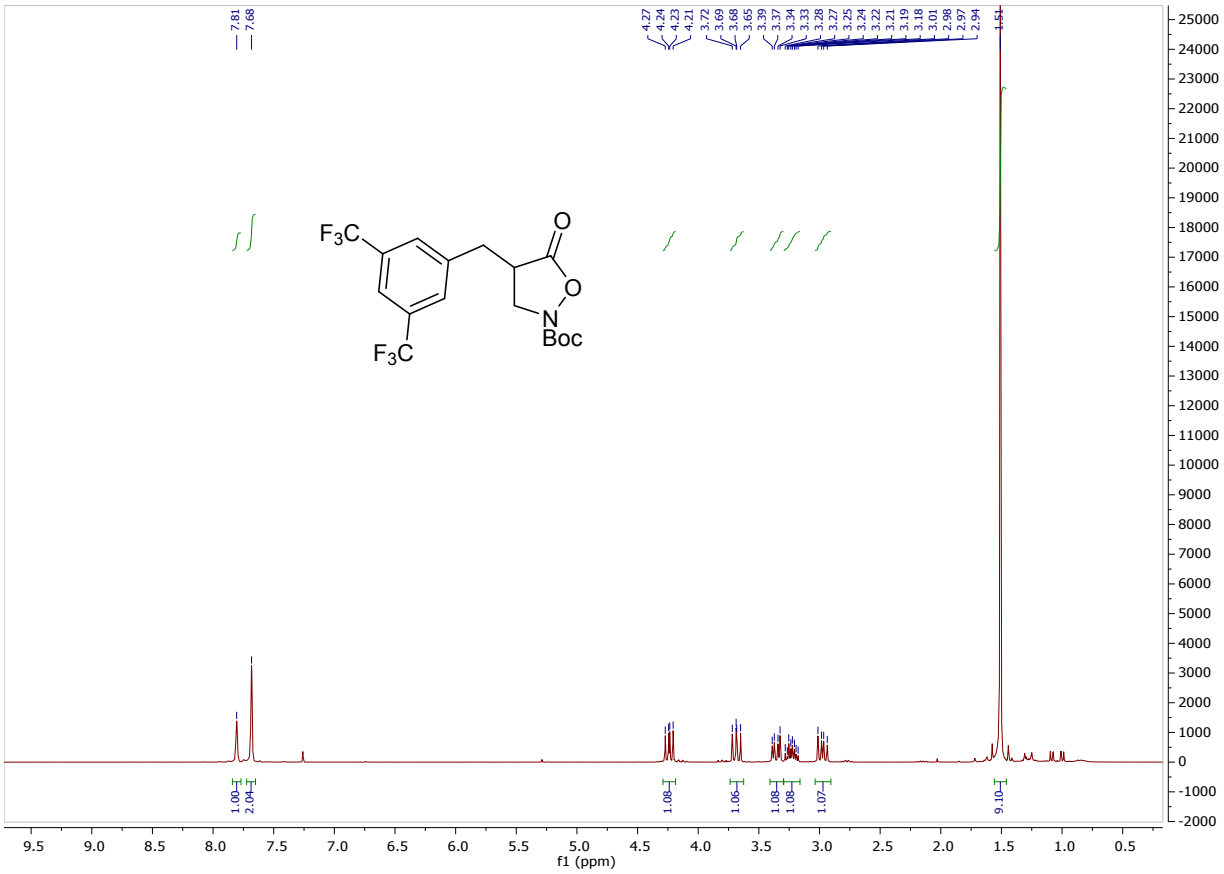
NMR Spectra

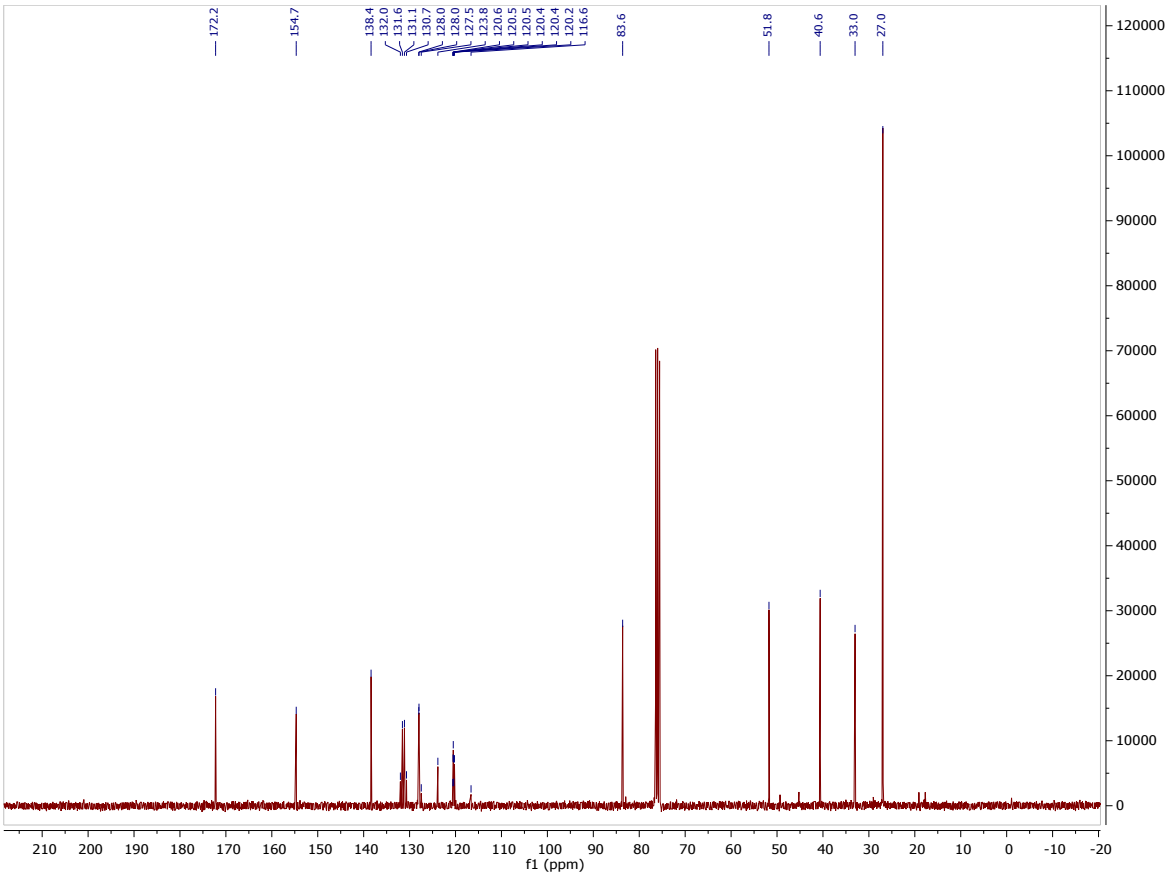
tert-butyl 4-(anthracen-9-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (1b)

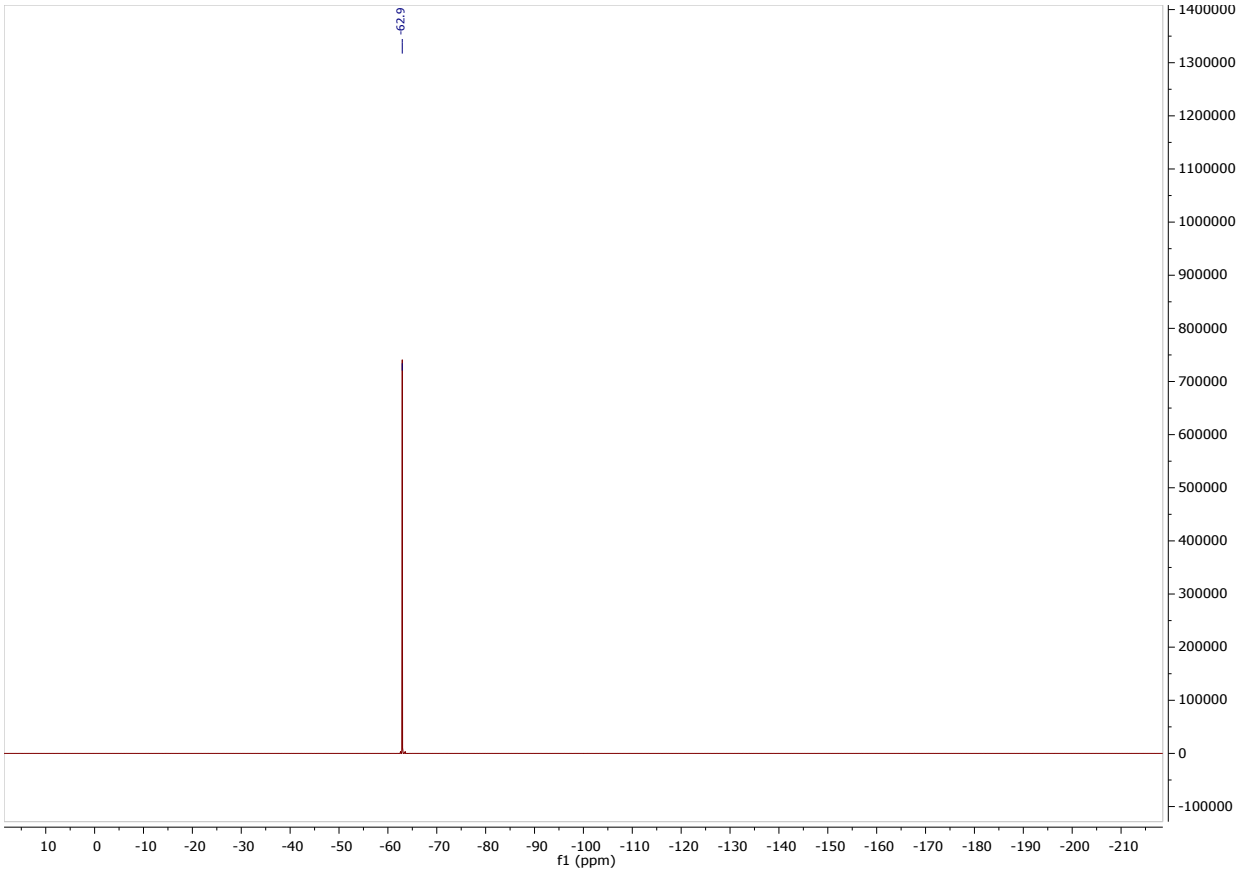




tert-butyl 4-(3,5-bis(trifluoromethyl)benzyl)-5-oxoisoxazolidine-2-carboxylate (1c)



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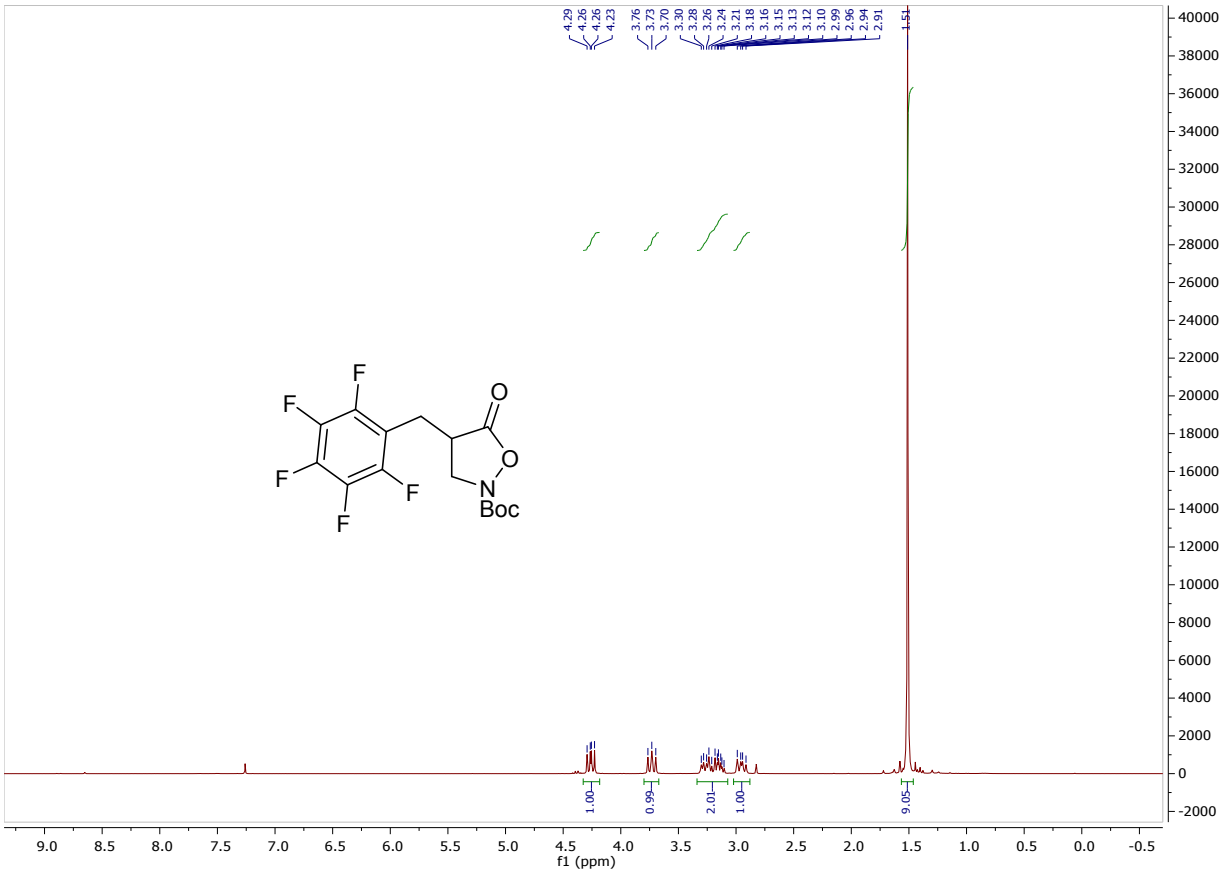
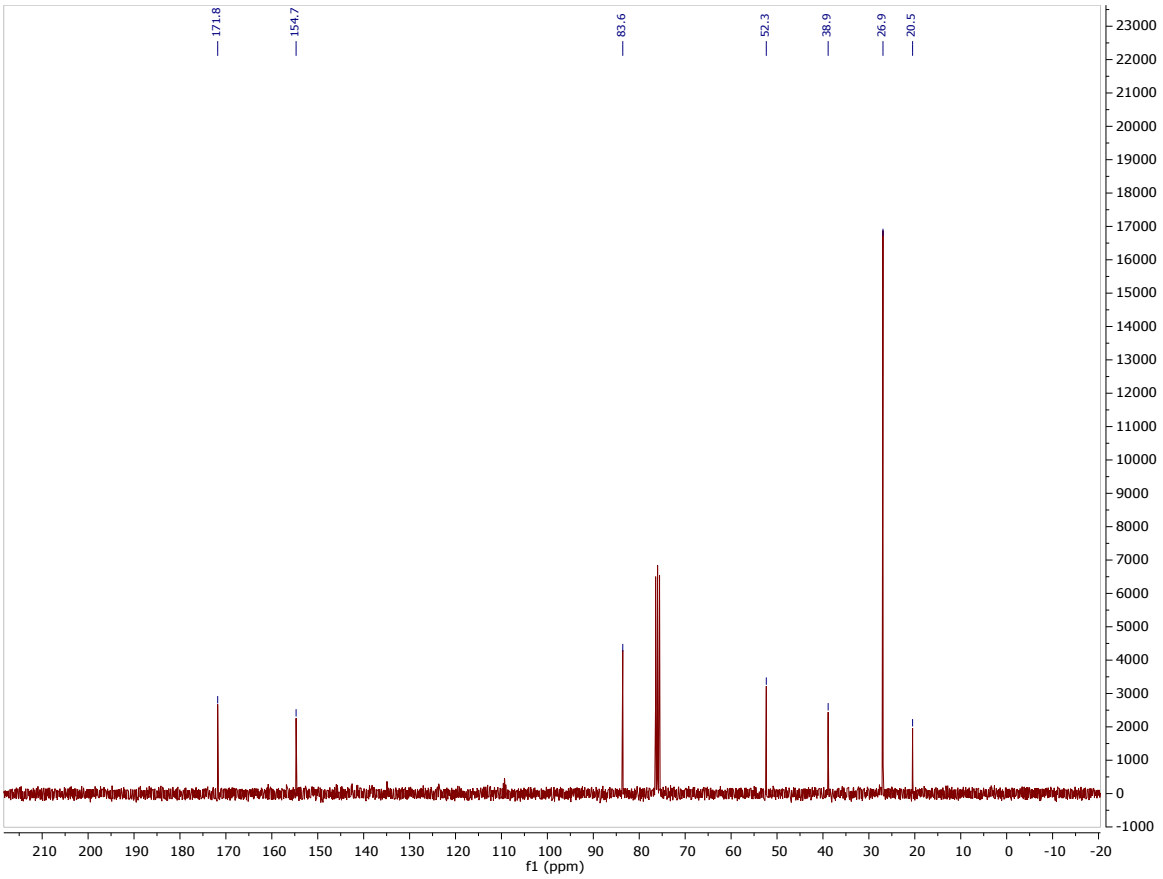
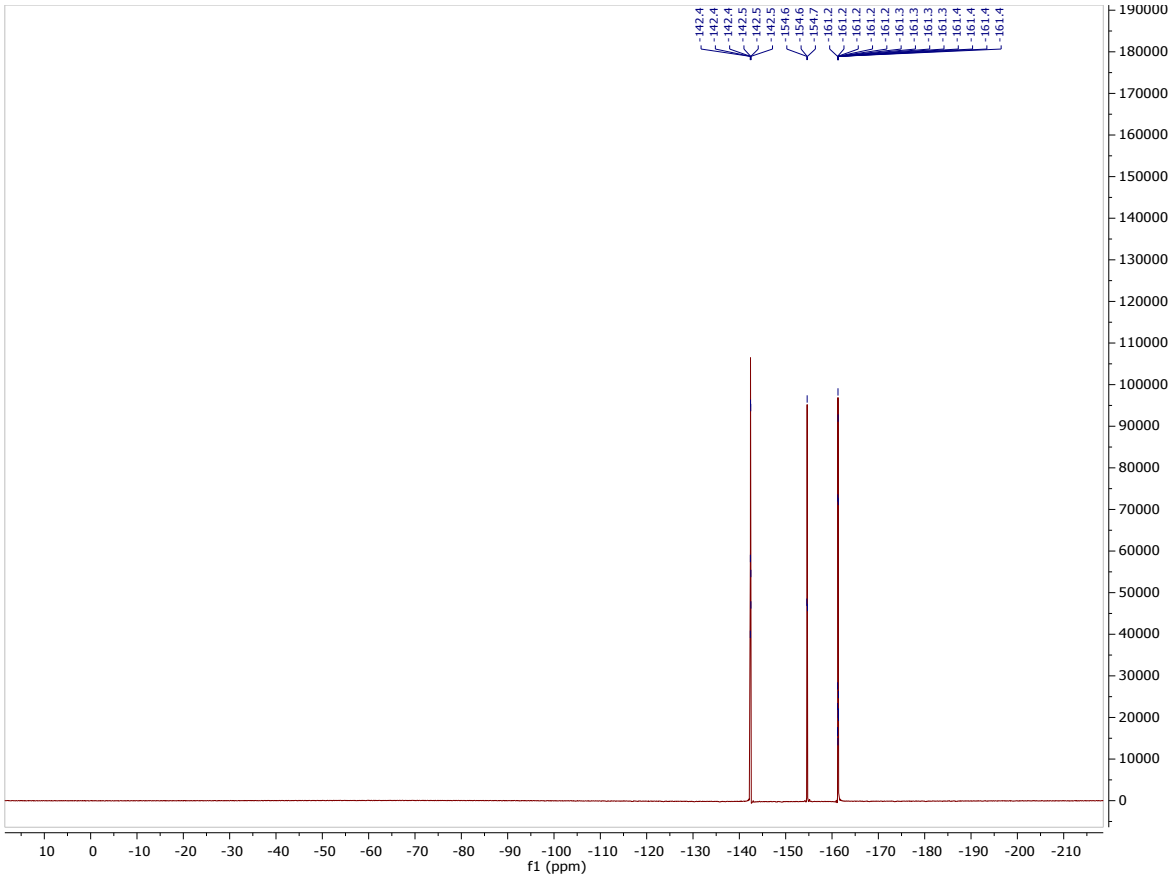
100000
0
-100000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 5-oxo-4-((perfluorophenyl)methyl)isoxazolidine-2-carboxylate (1e)**



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40000
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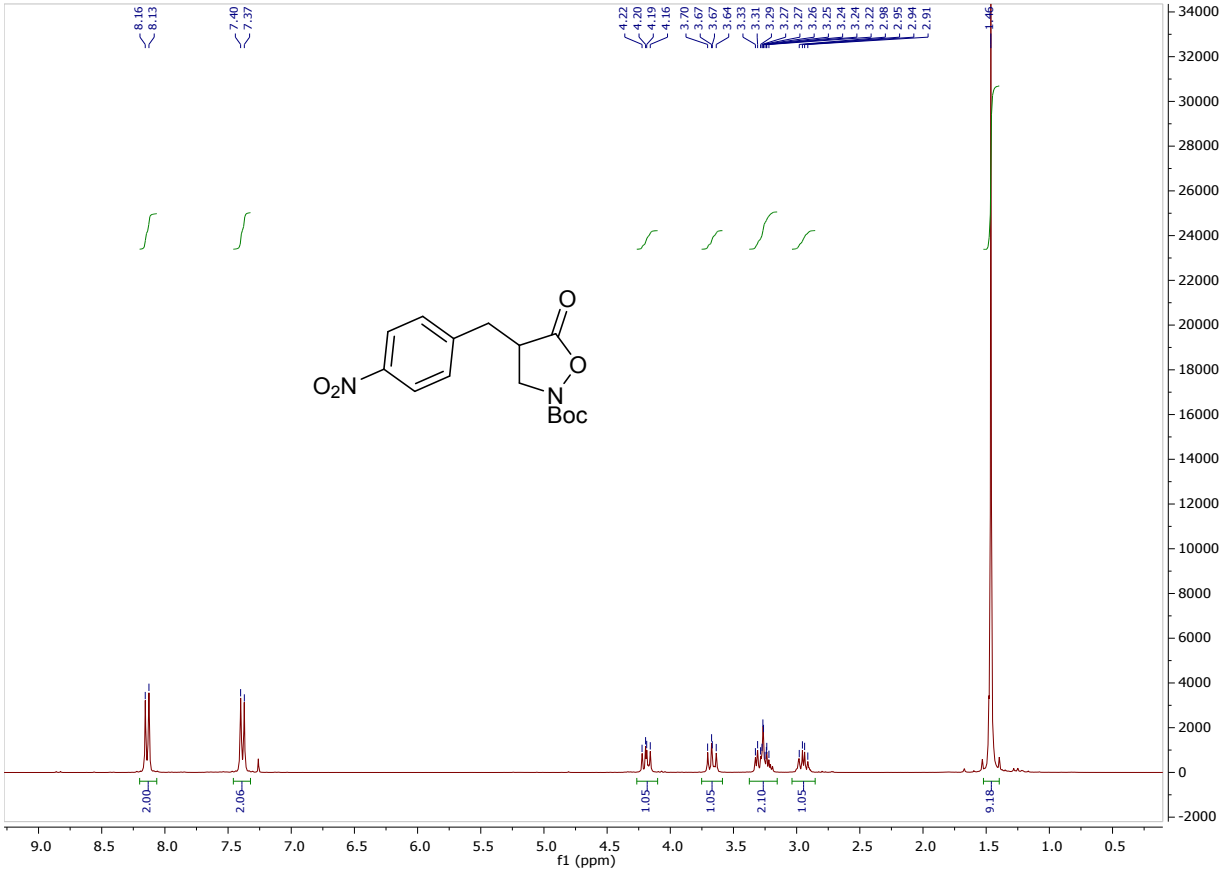
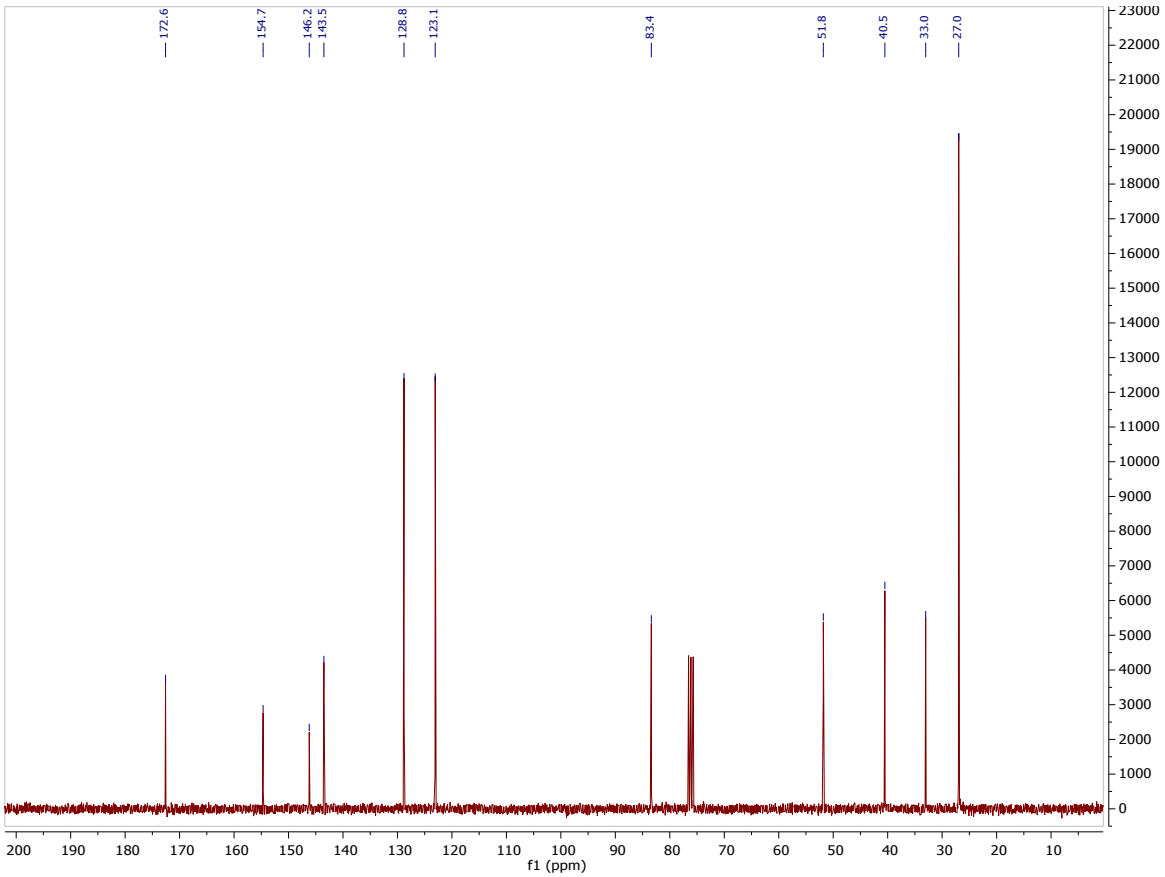
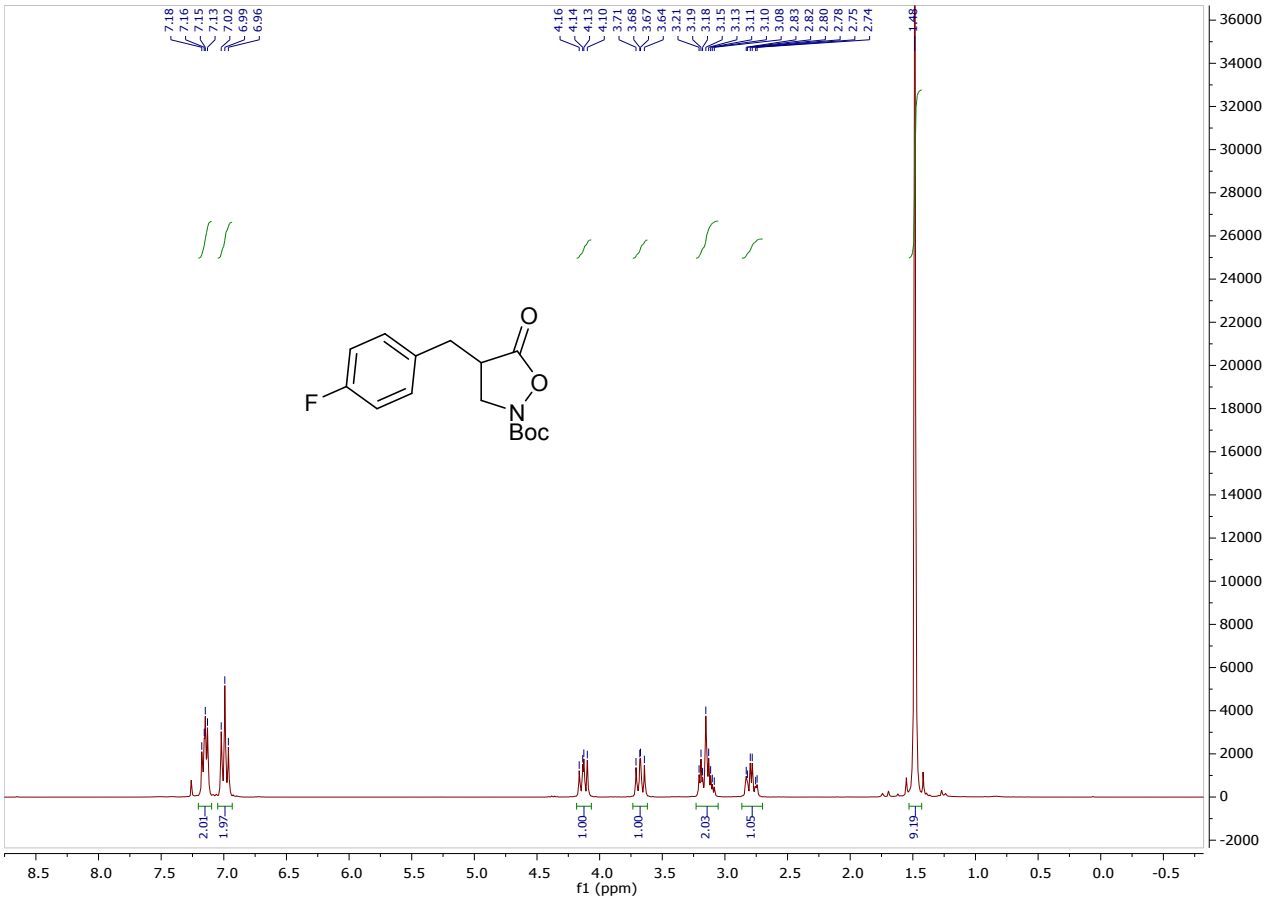
20000
10000
0
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

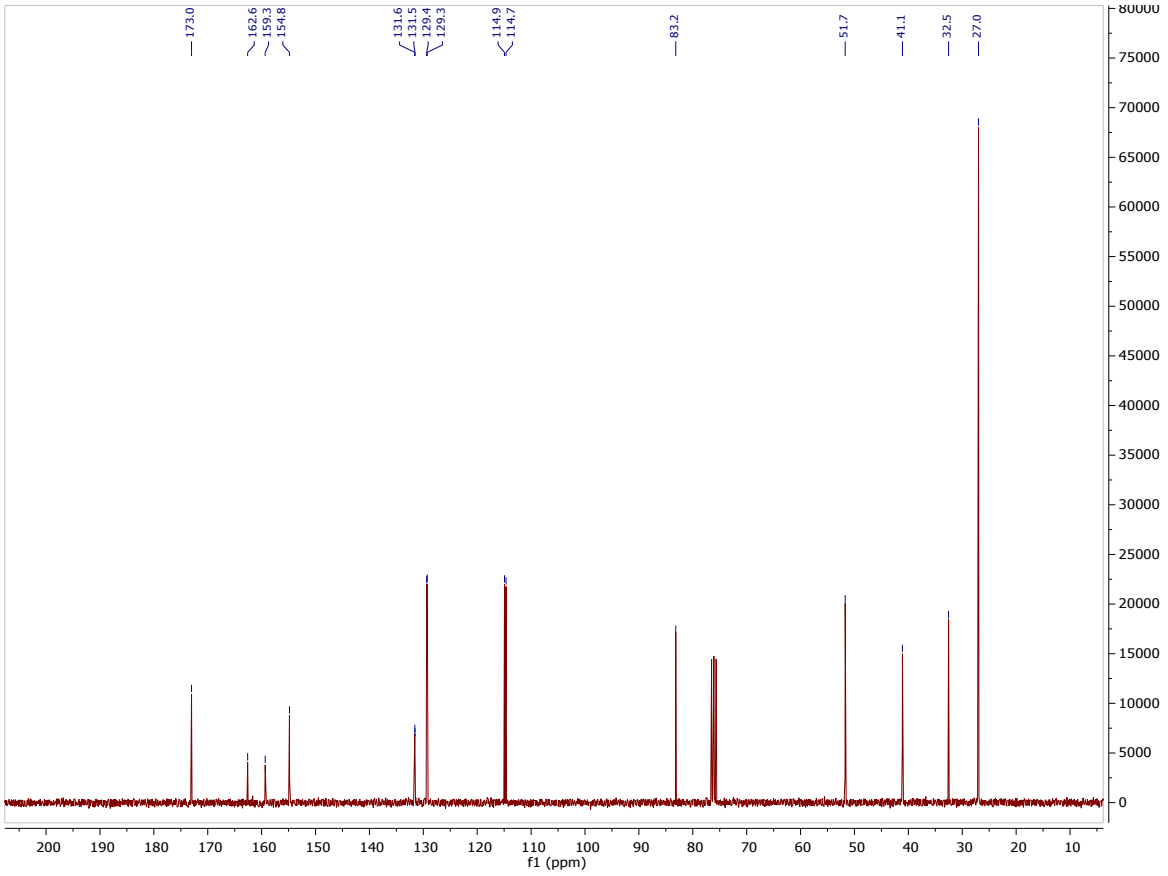
***tert*-butyl 4-(4-nitrobenzyl)-5-oxoisoxazolidine-2-carboxylate (1f)**

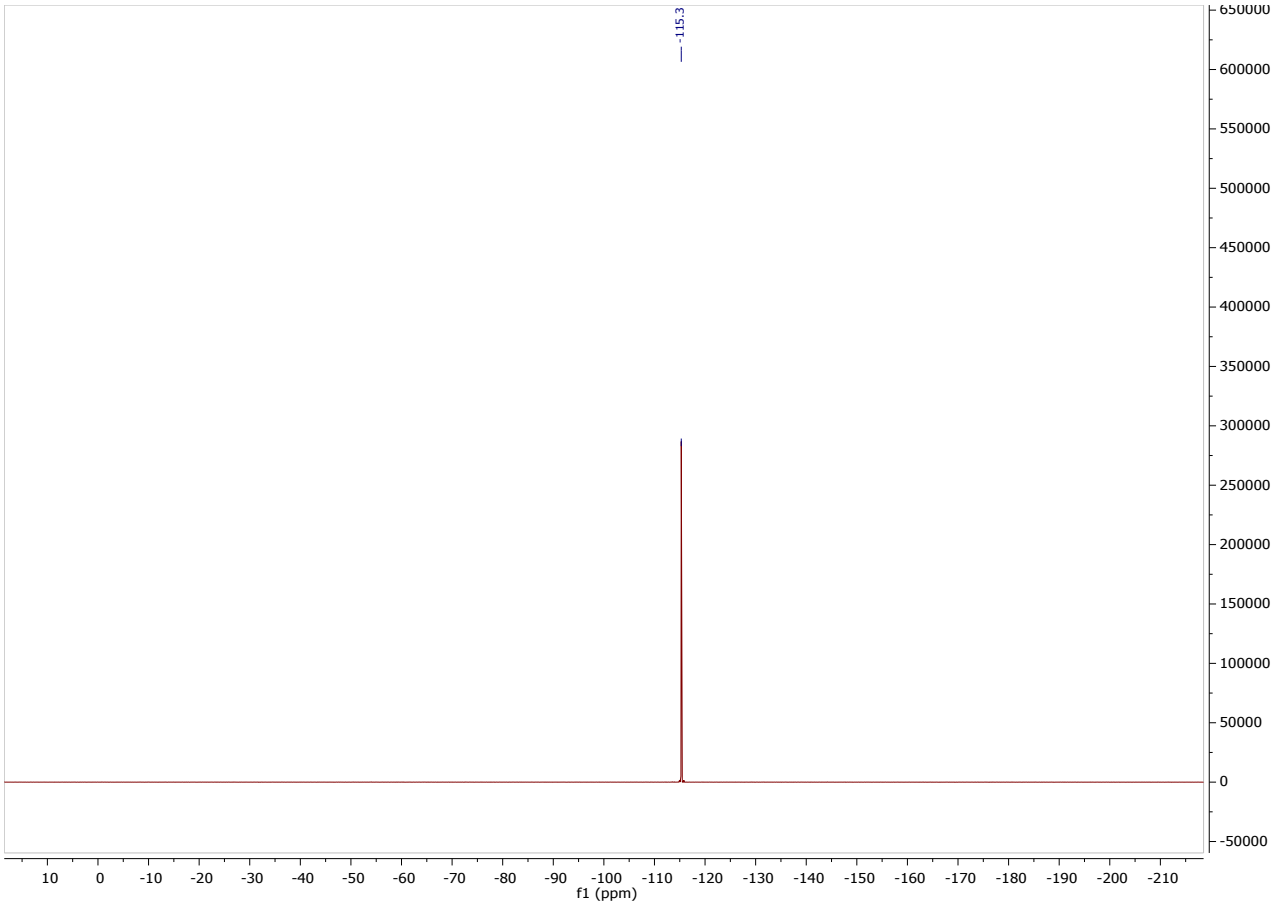




***tert*-butyl 4-(4-fluorobenzyl)-5-oxoisoxazolidine-2-carboxylate (1g)**



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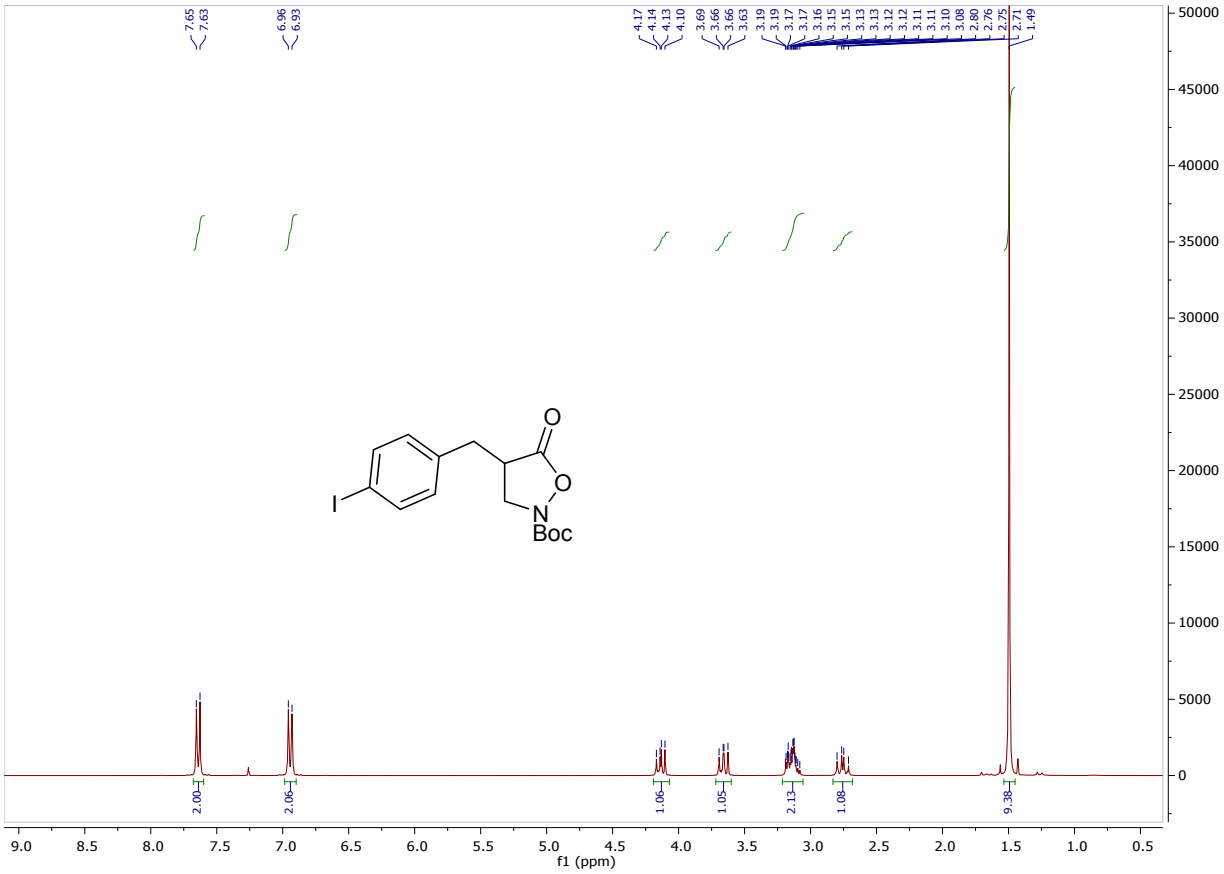
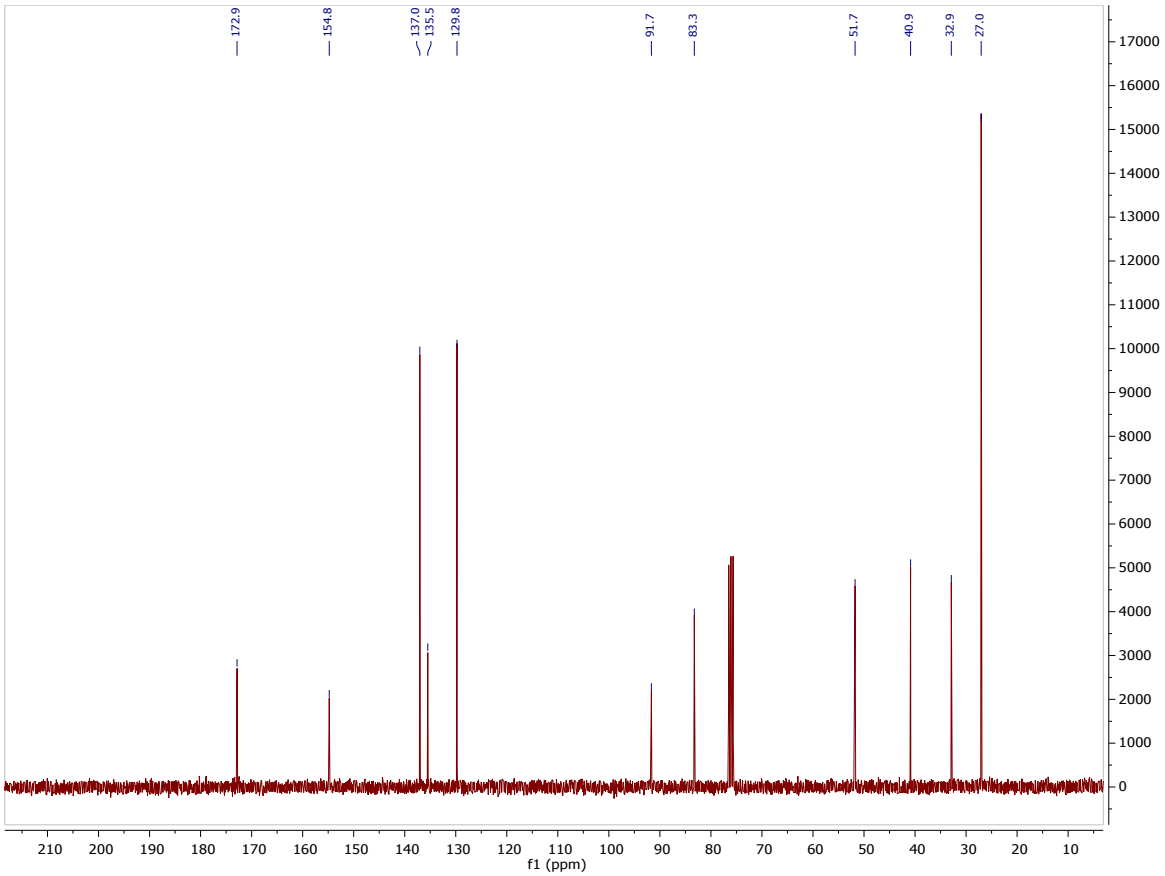
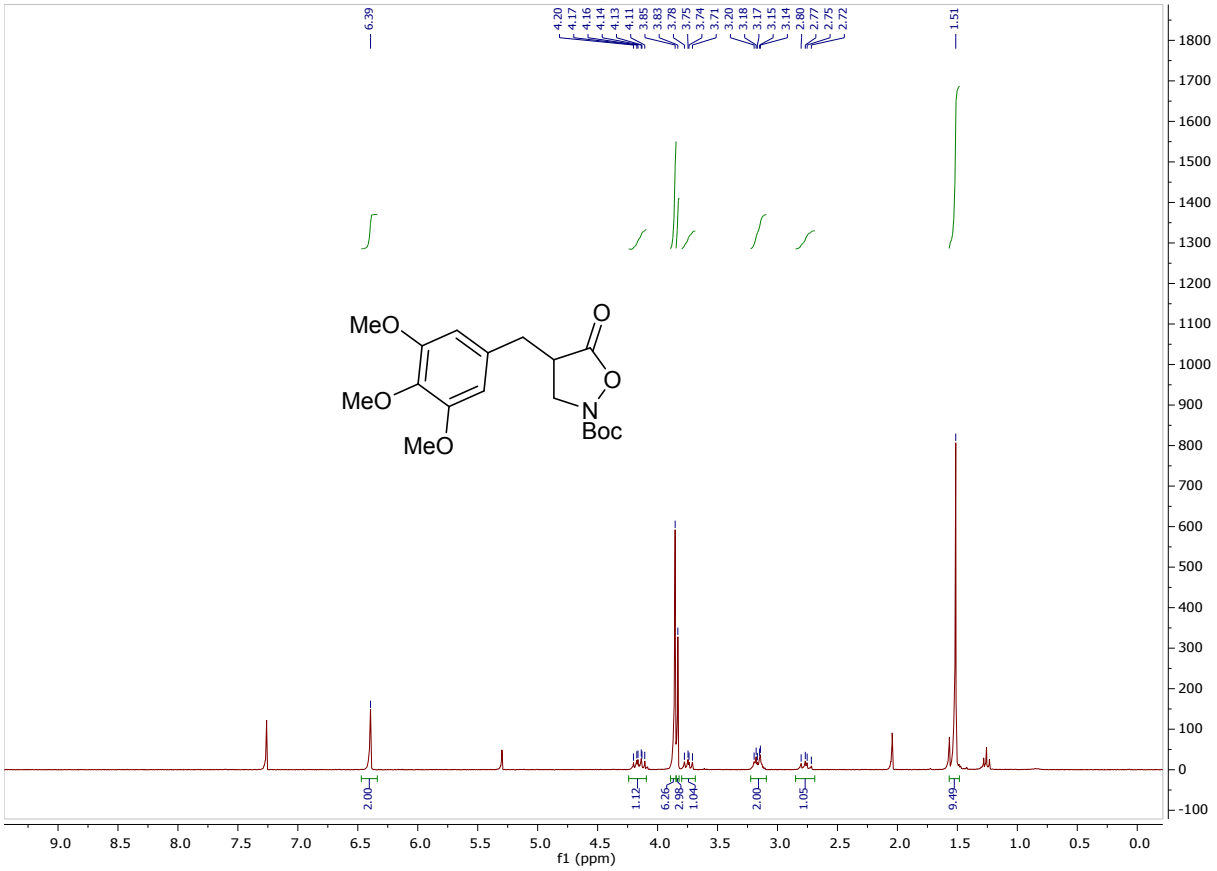
100000
50000
0
-50000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

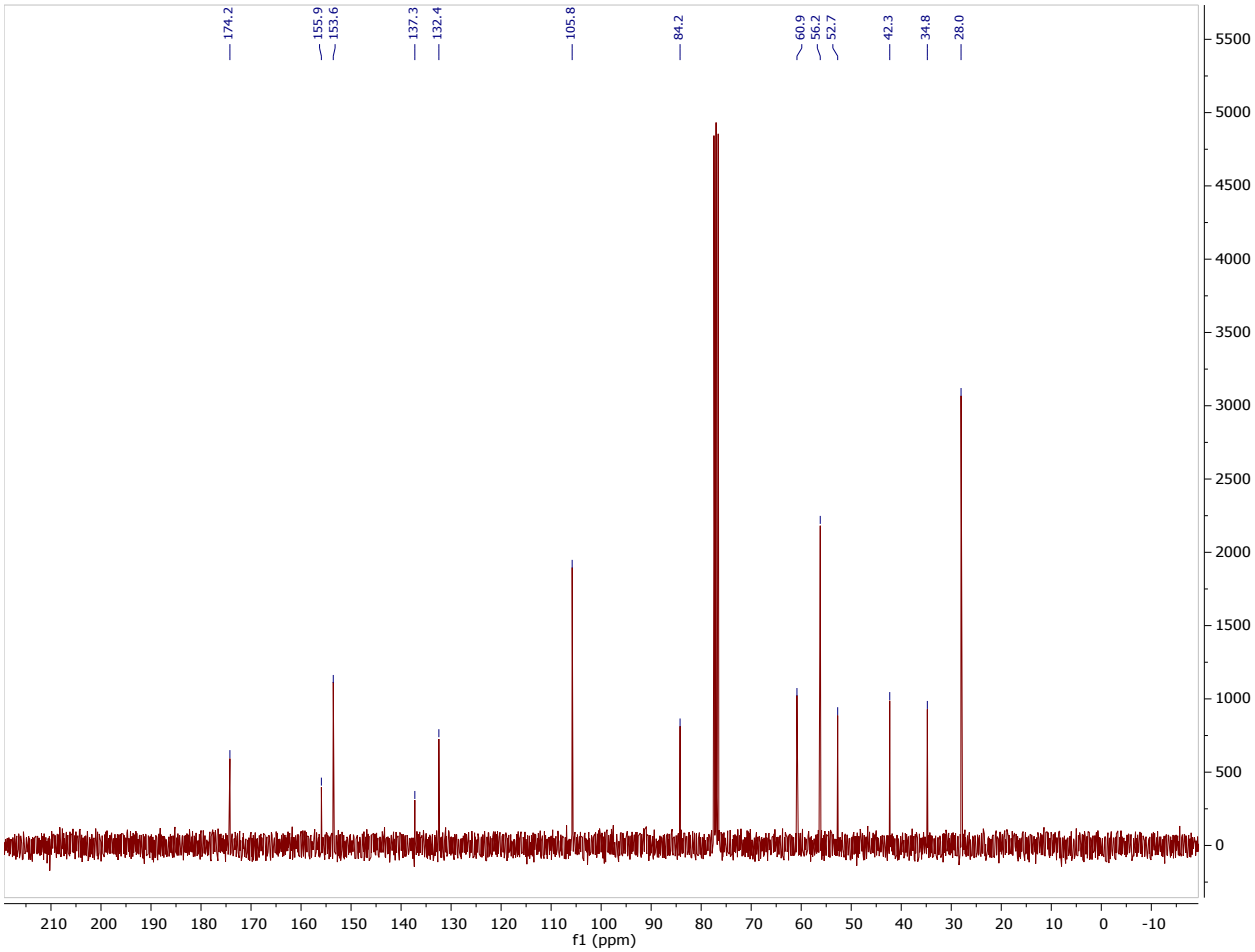
***tert*-butyl 4-(4-iodobenzyl)-5-oxoisoxazolidine-2-carboxylate (1j)**



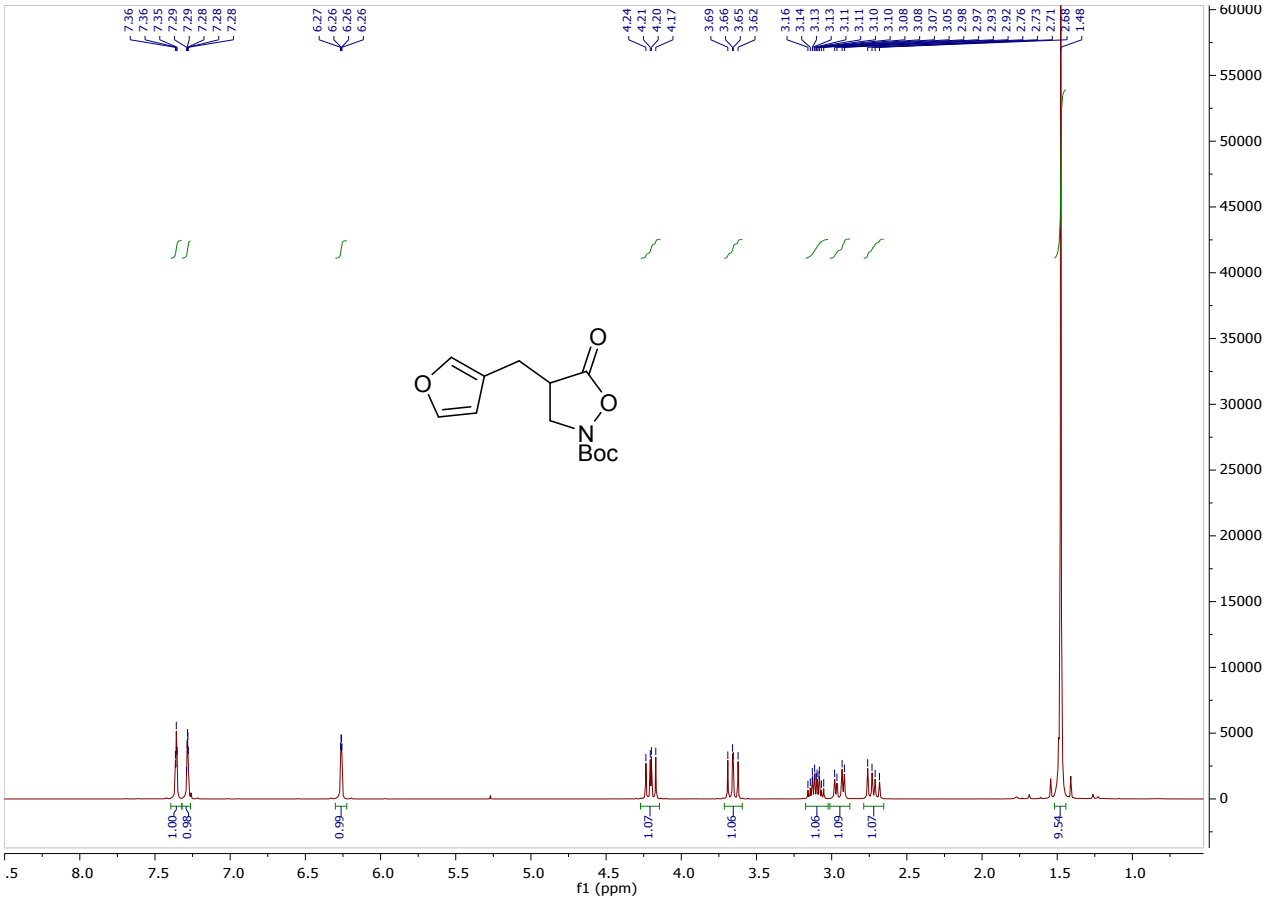


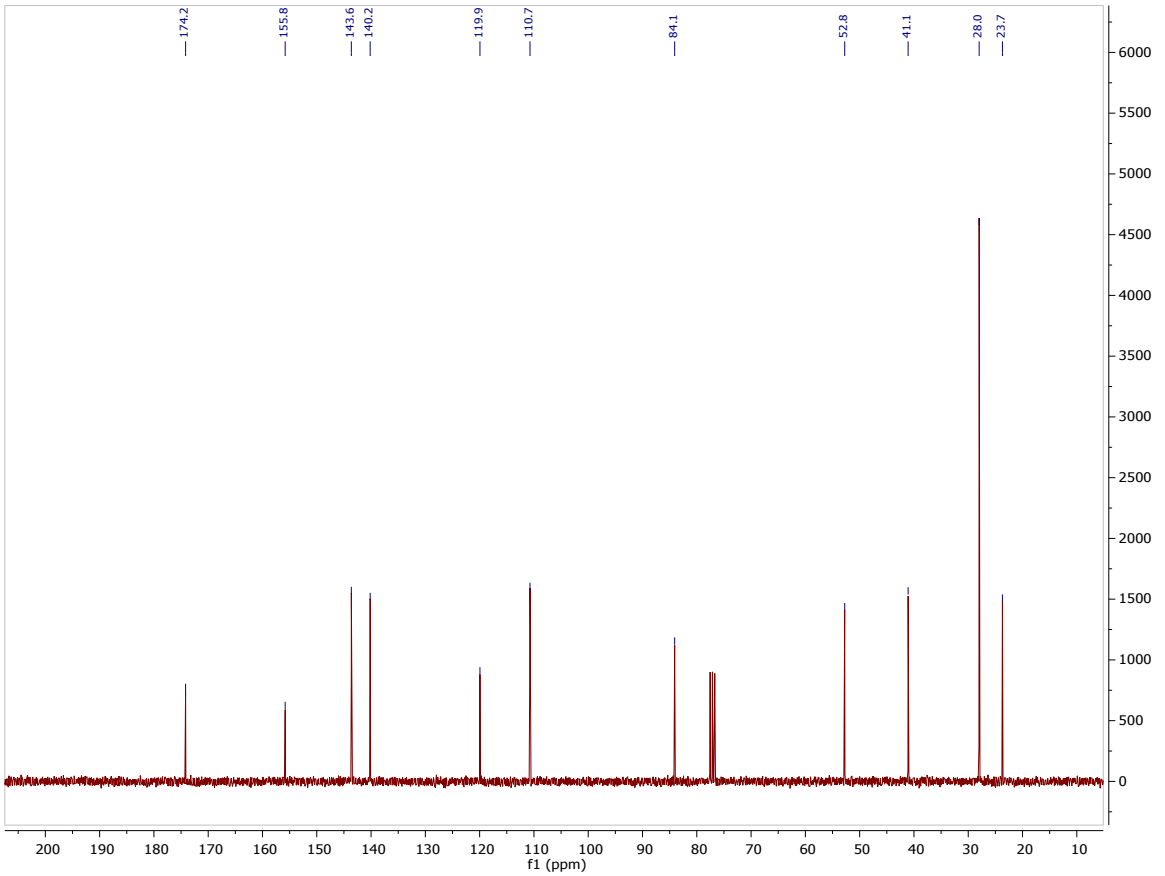
***tert*-butyl 5-oxo-4-(3,4,5-trimethoxybenzyl)isoxazolidine-2-carboxylate (1l)**



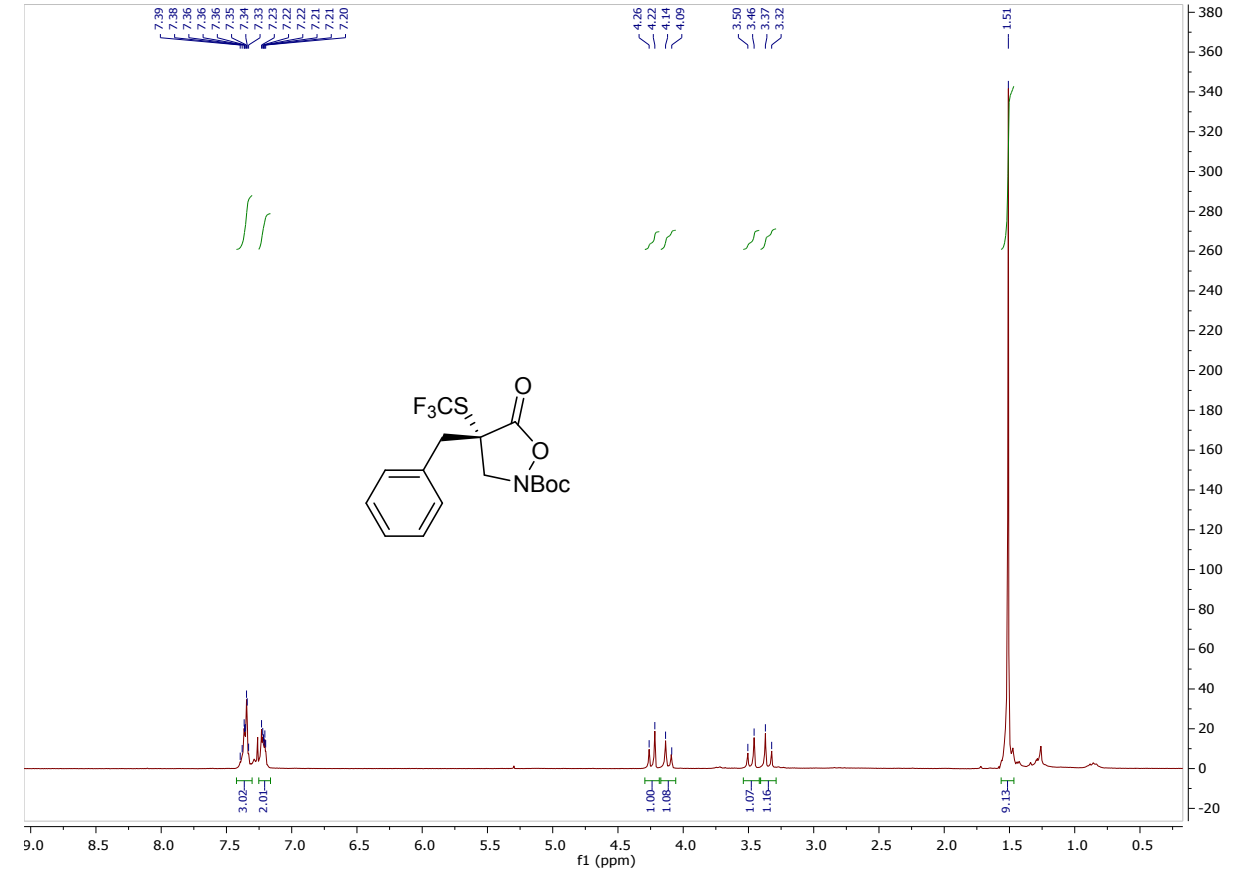


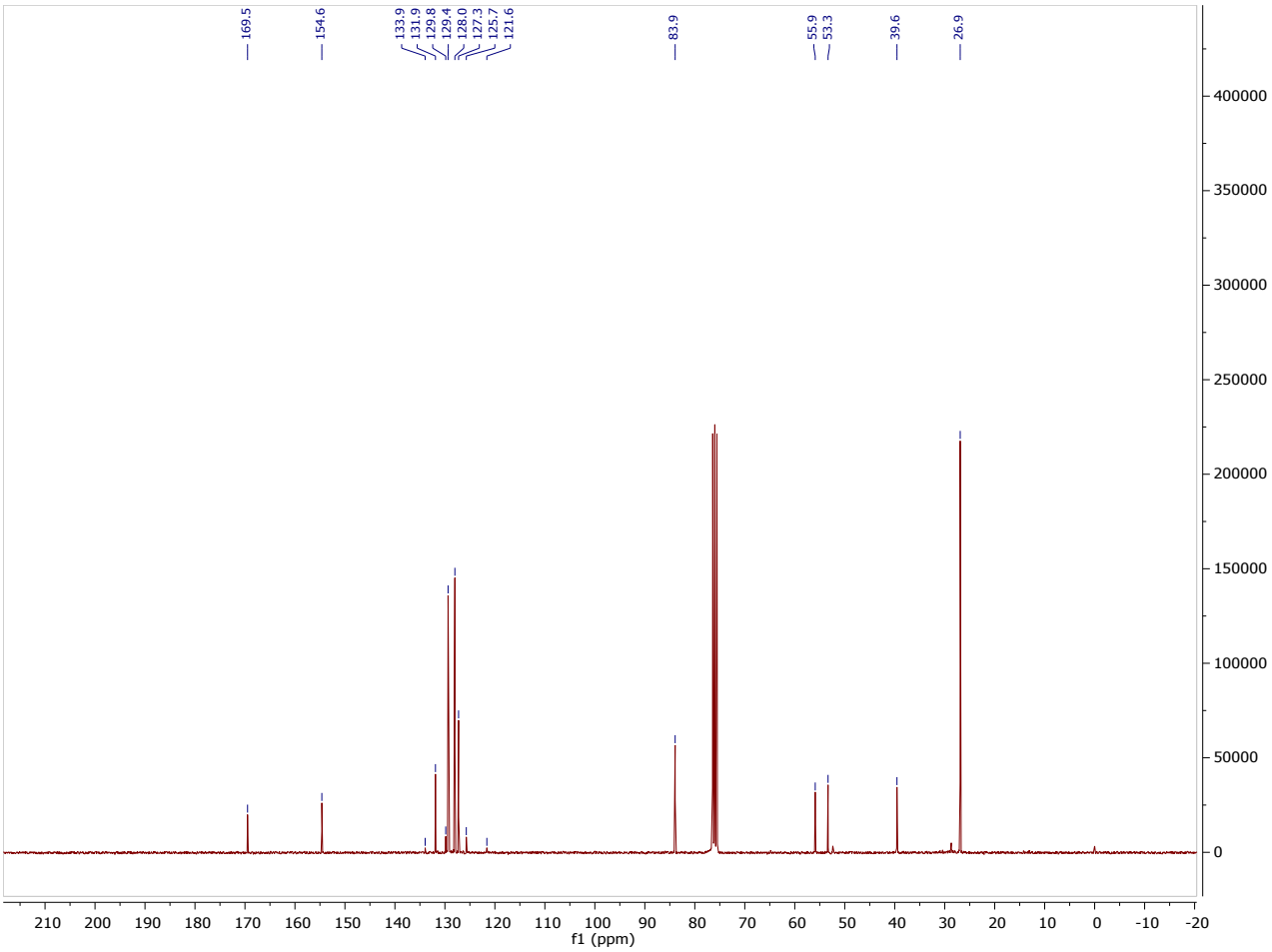
***tert*-butyl 4-(furan-3-ylmethyl)-5-oxoisoxazolidine-2-carboxylate (1n)**

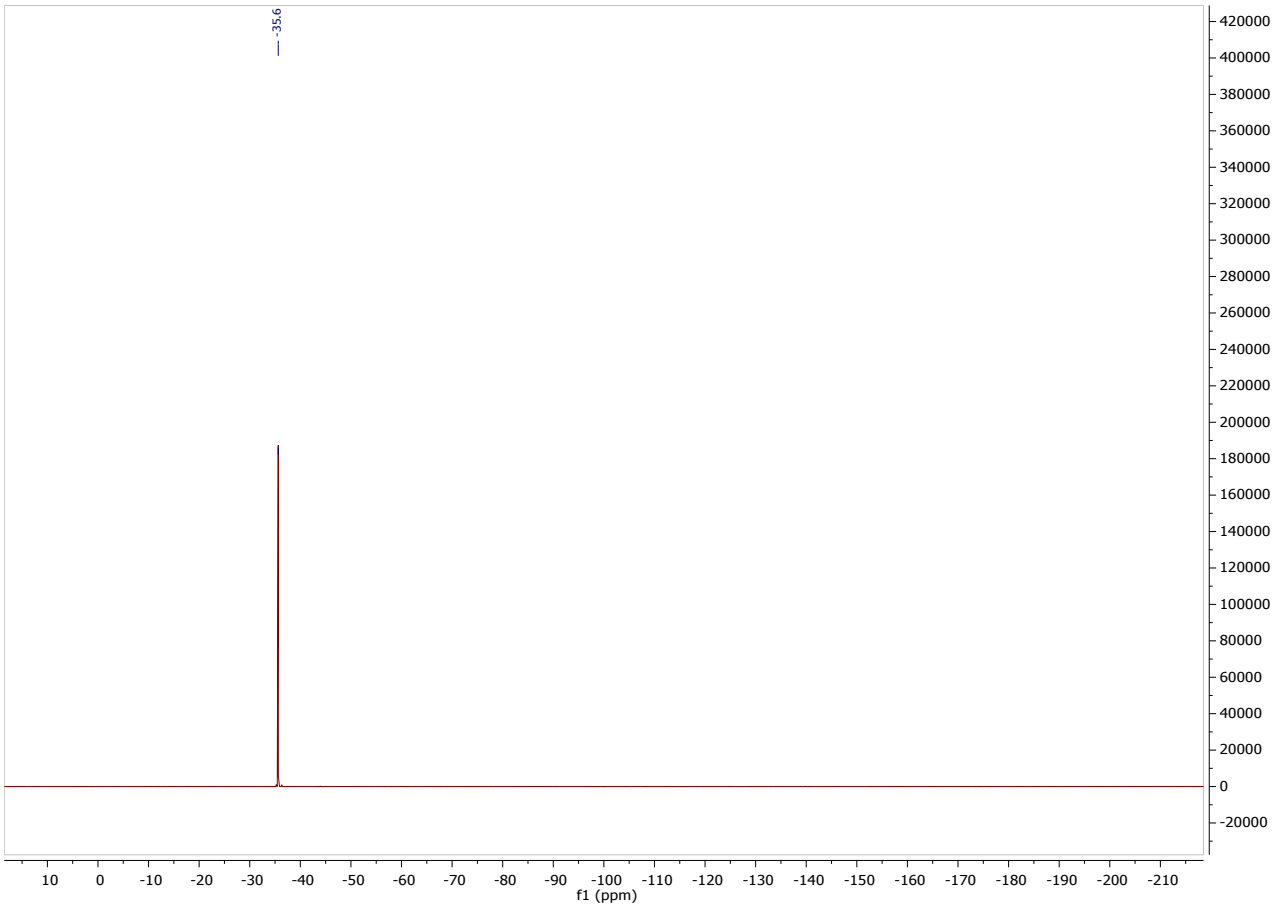




***tert*-butyl 4-benzyl-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3a)**



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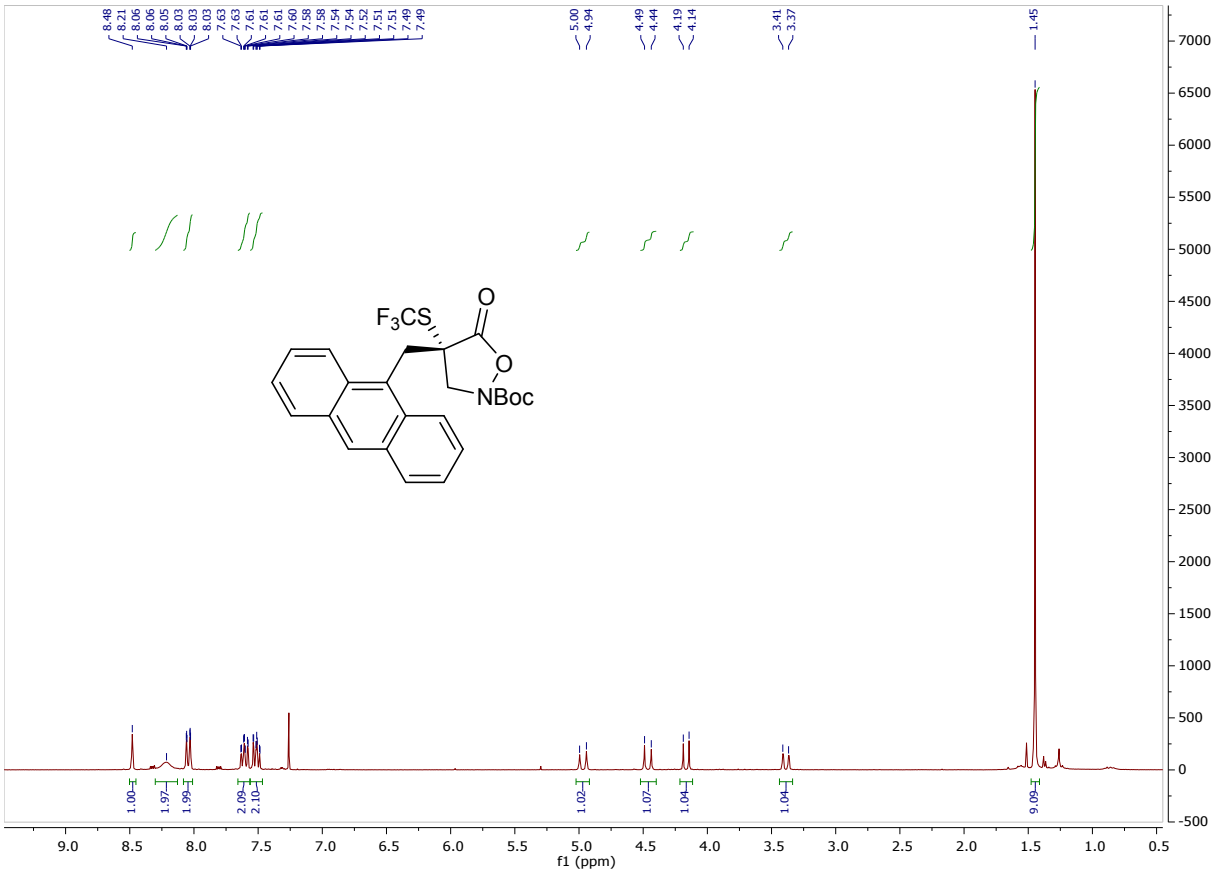
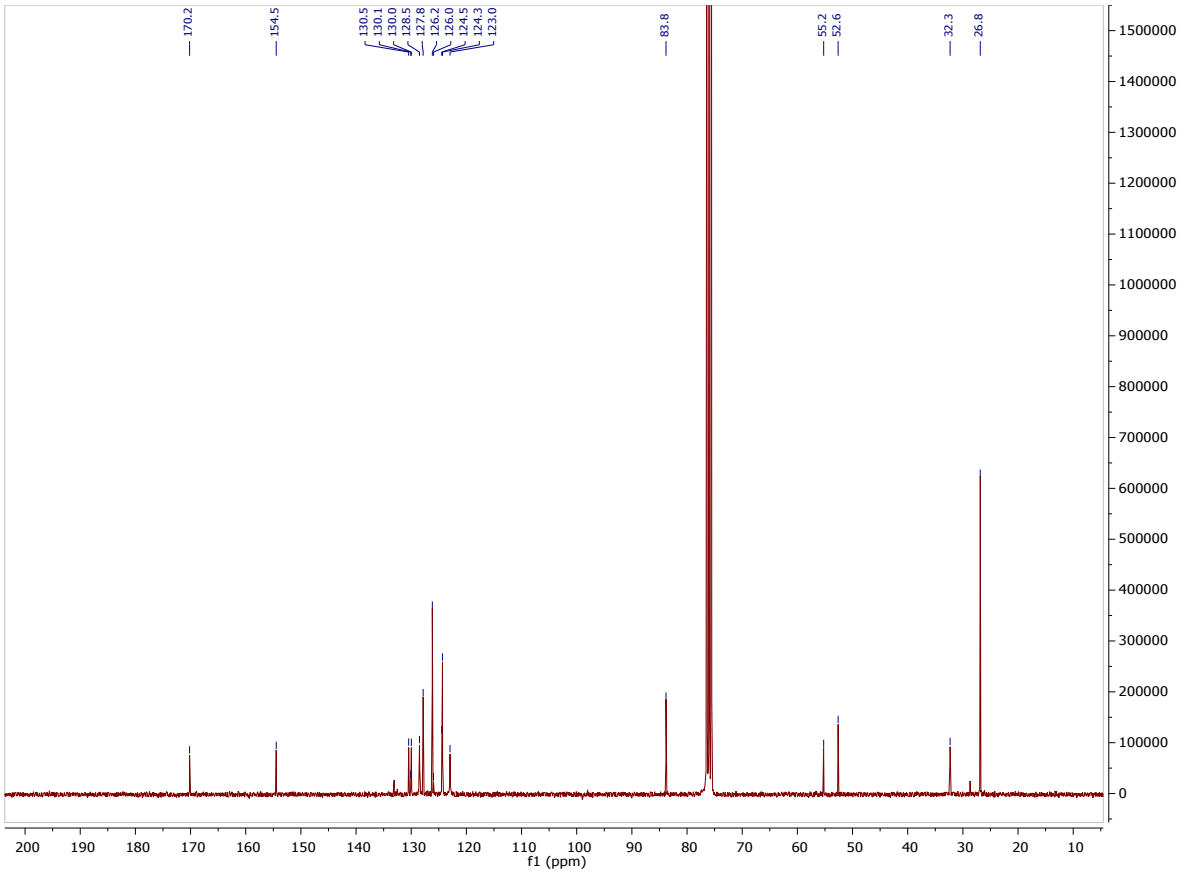
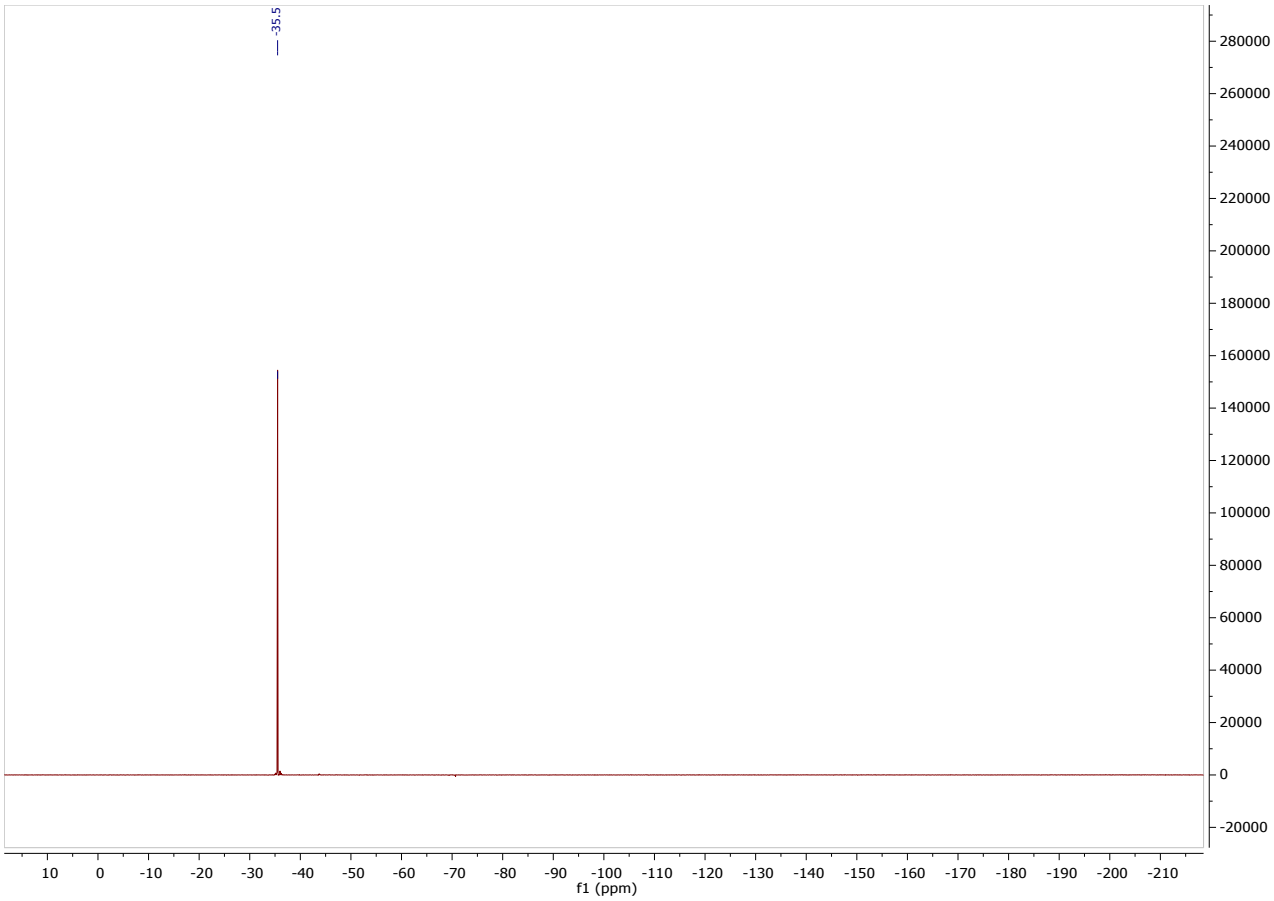
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(anthracen-9-ylmethyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3b)**



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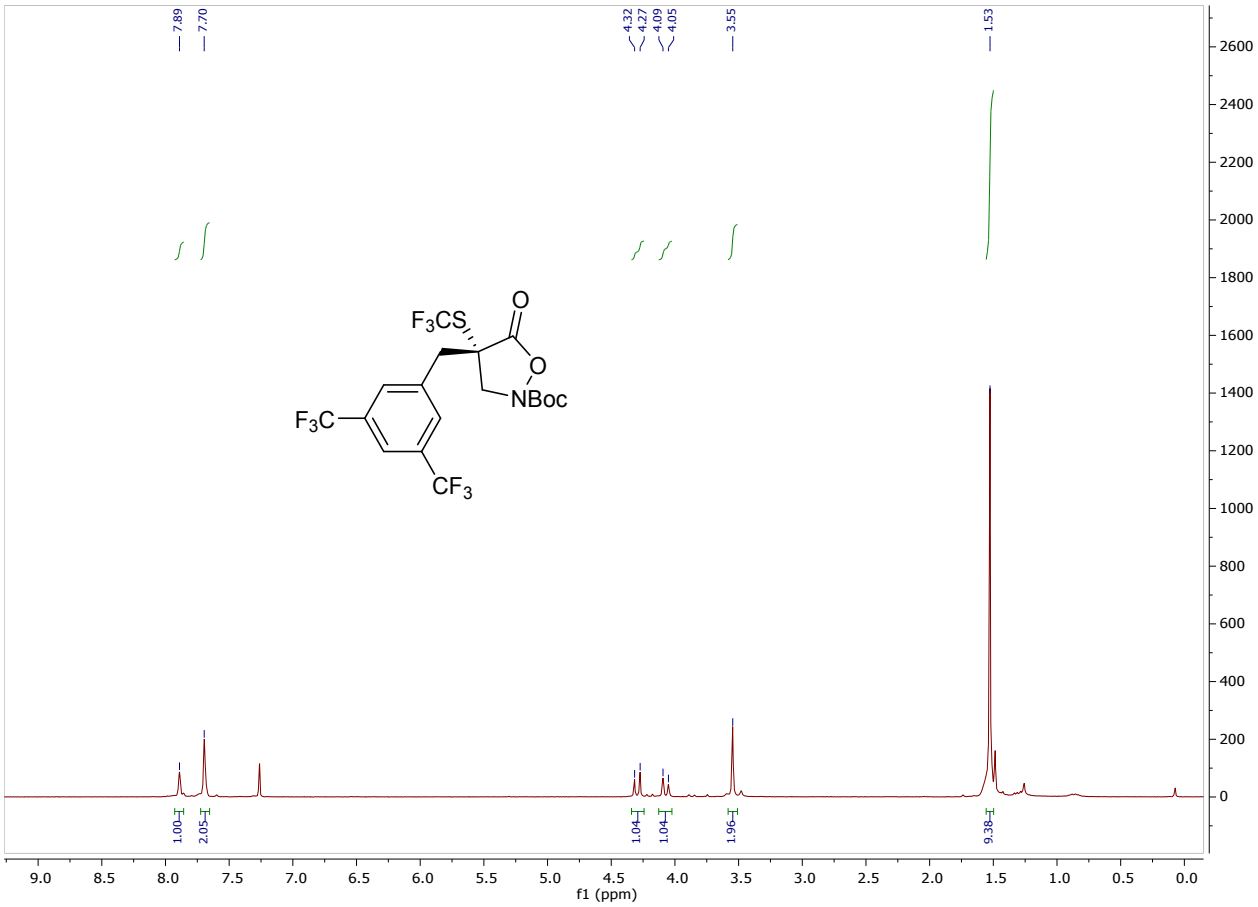
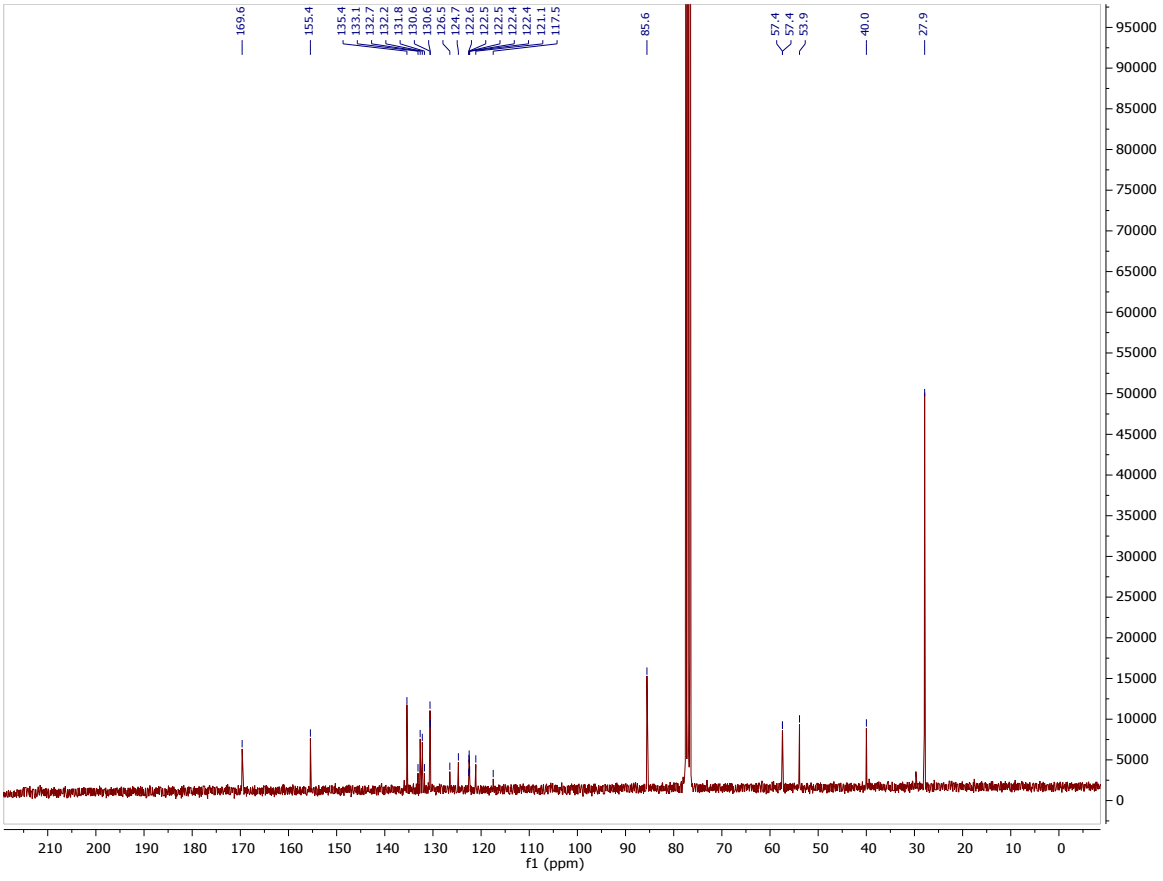
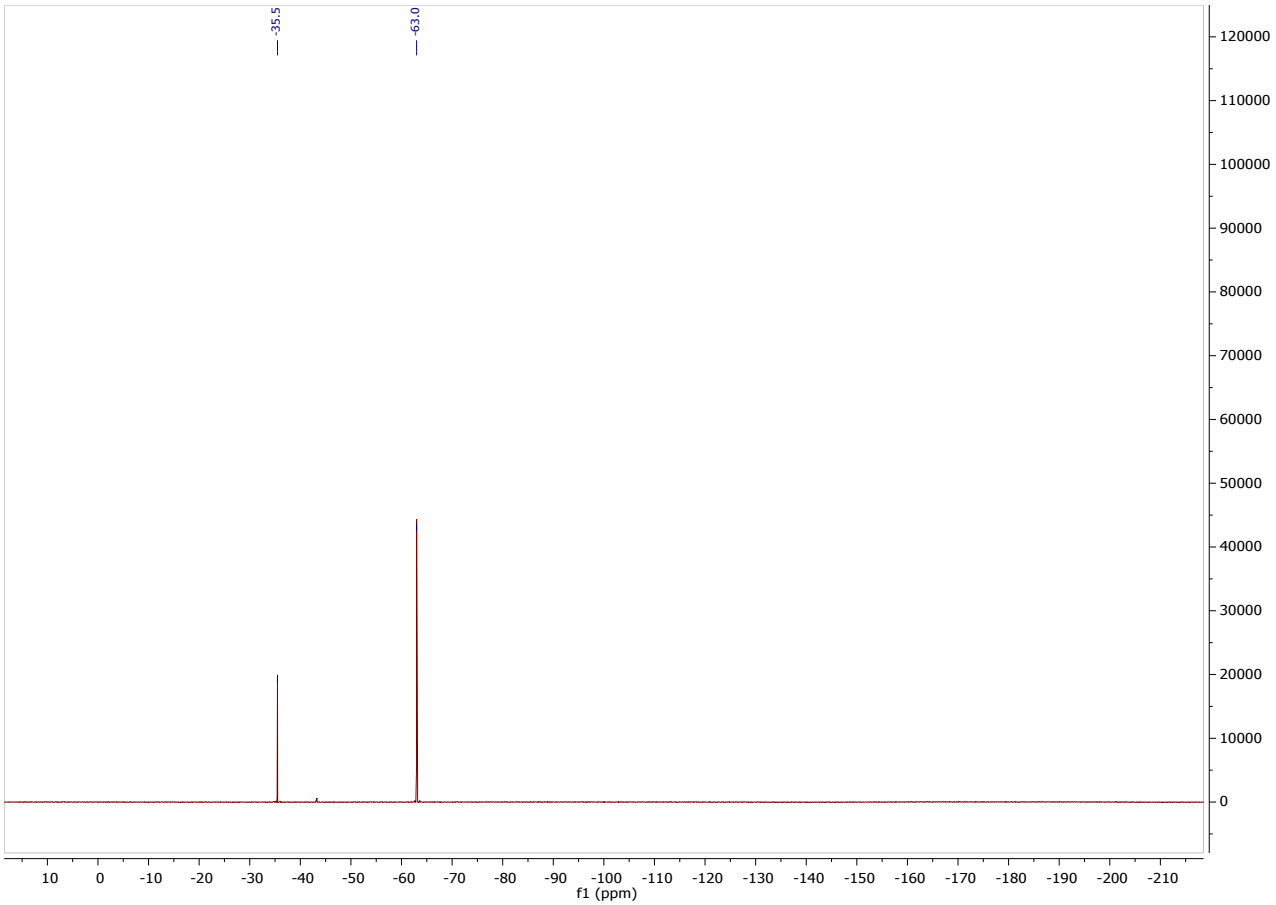
-20000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(3,5-bis(trifluoromethyl)benzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3c)**



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20000
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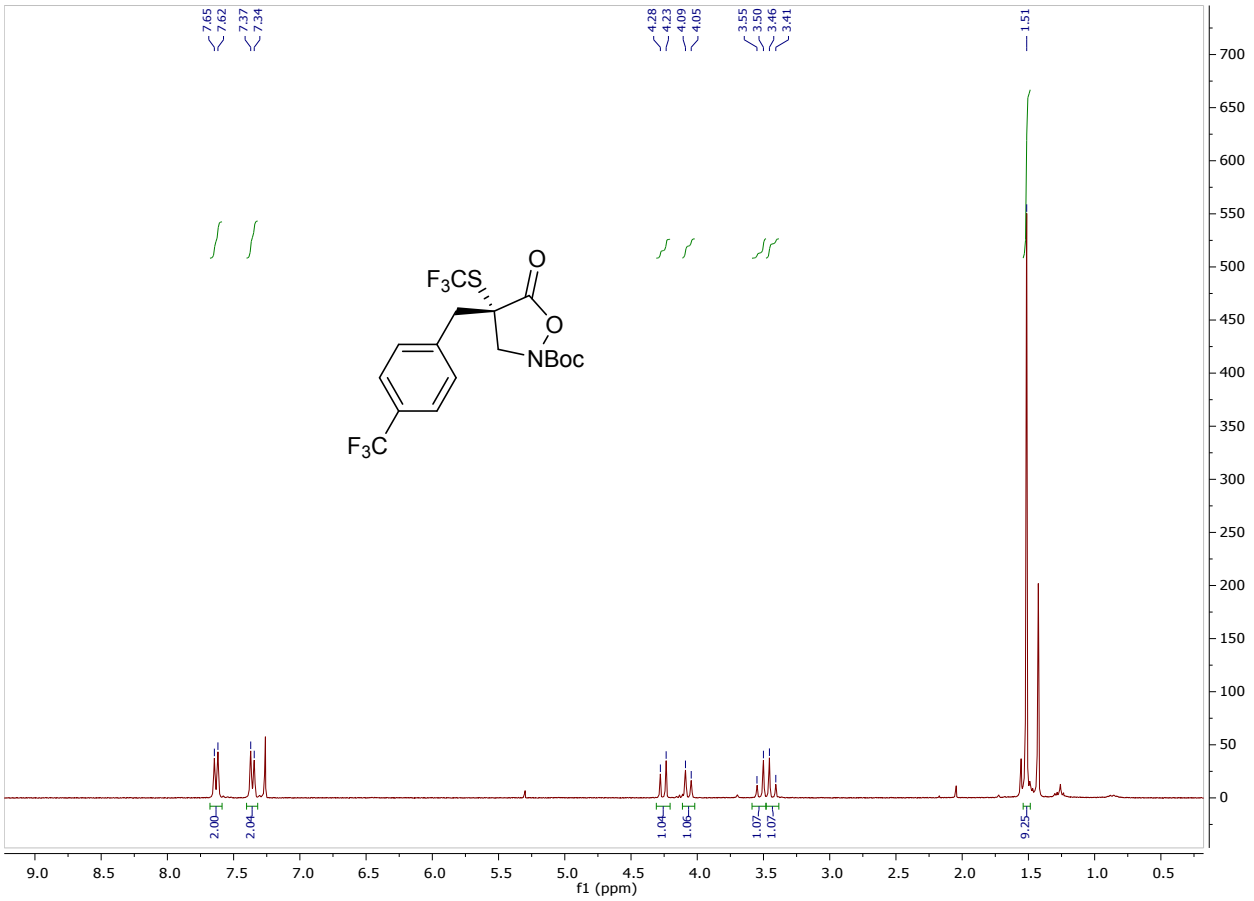
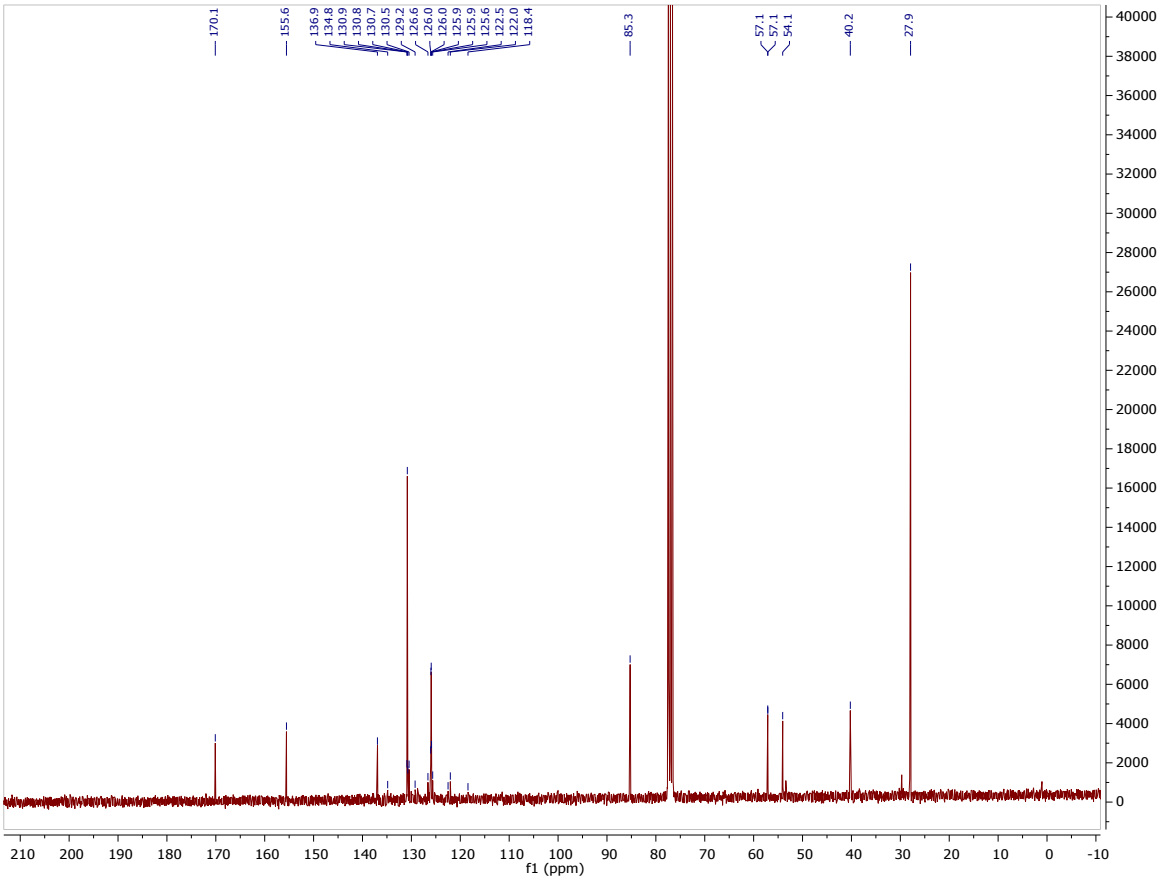
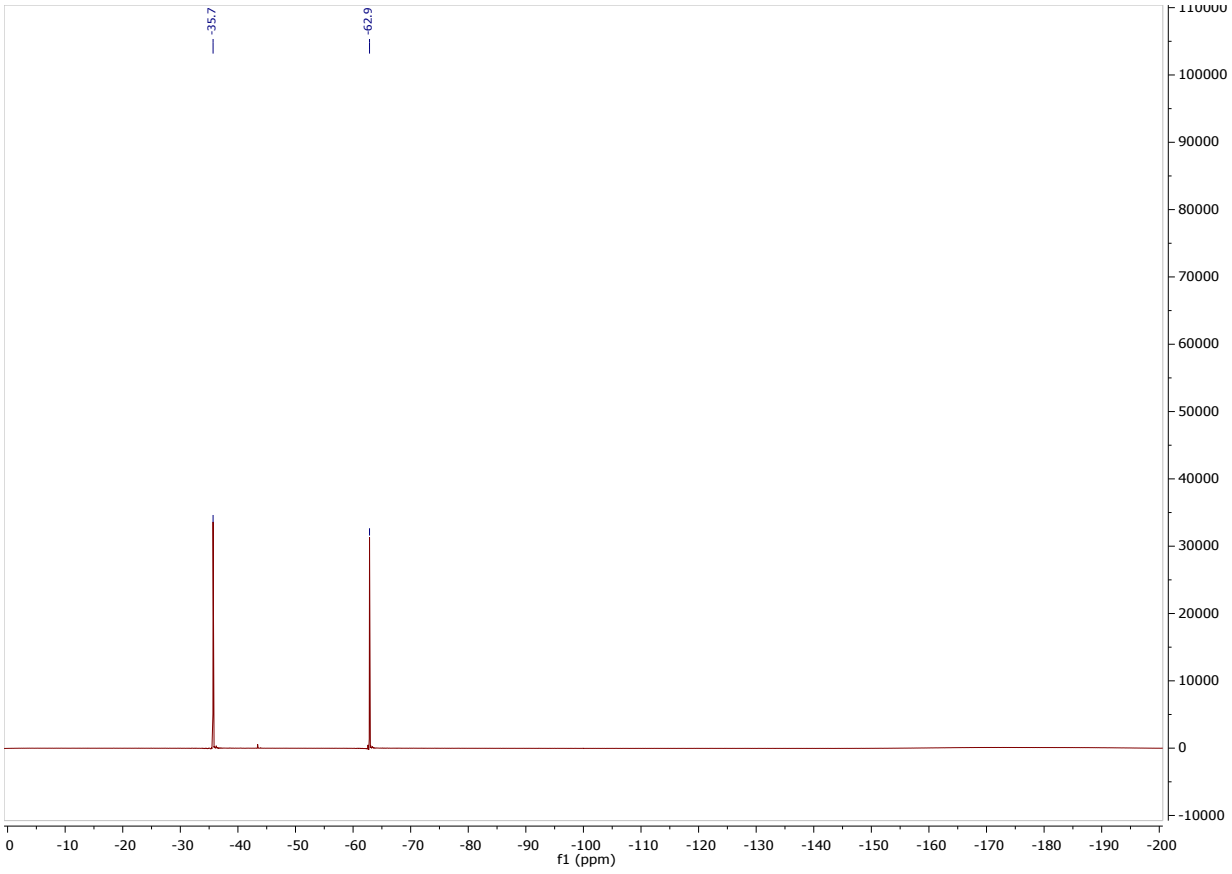
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 5-oxo-4-(4-(trifluoromethyl)benzyl)-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3d)**



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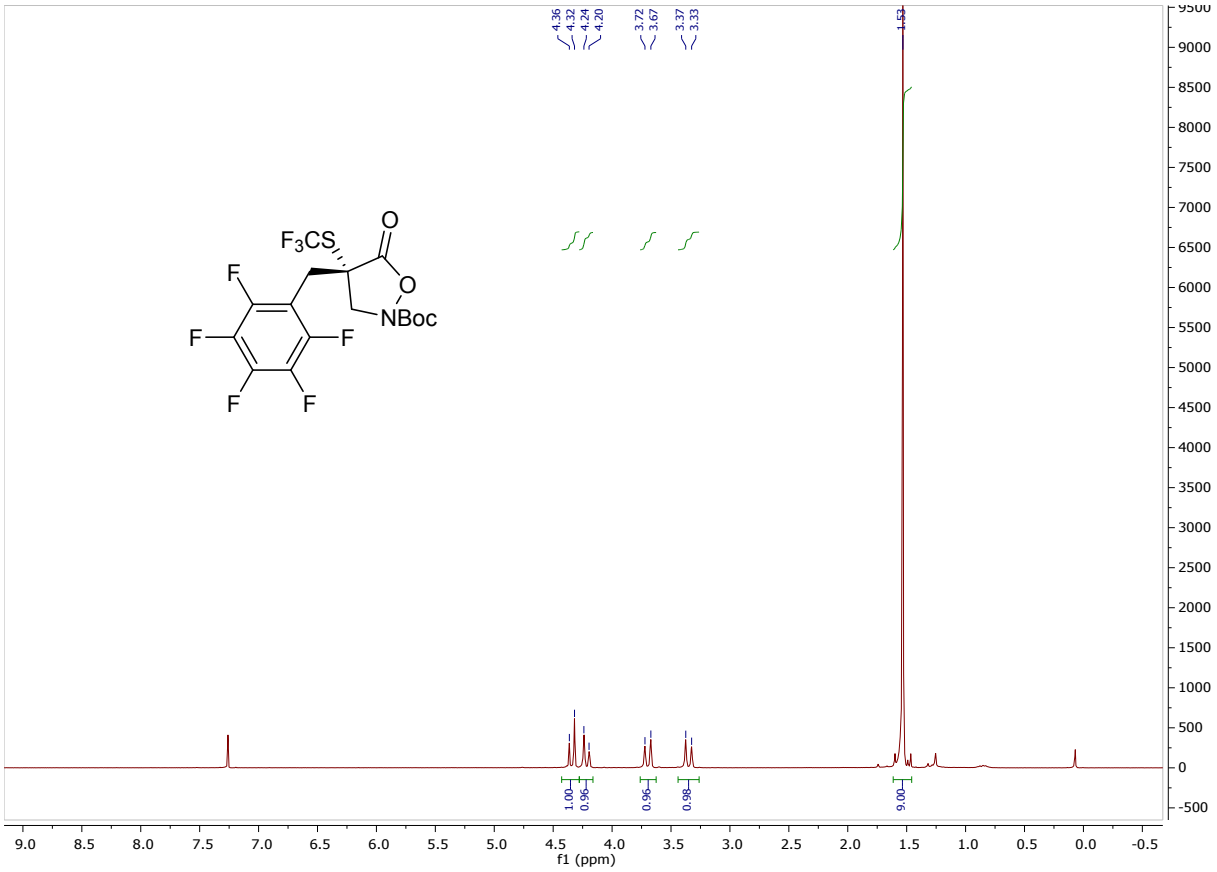
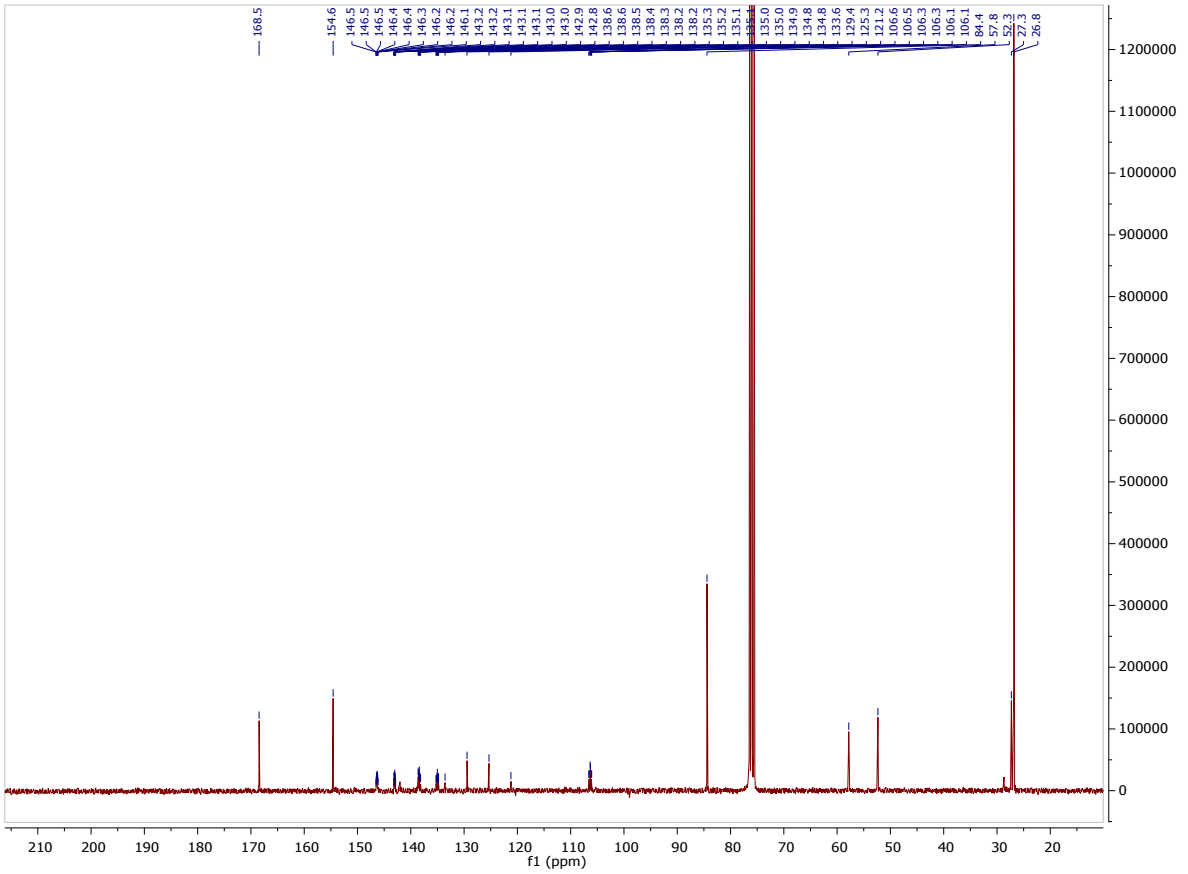
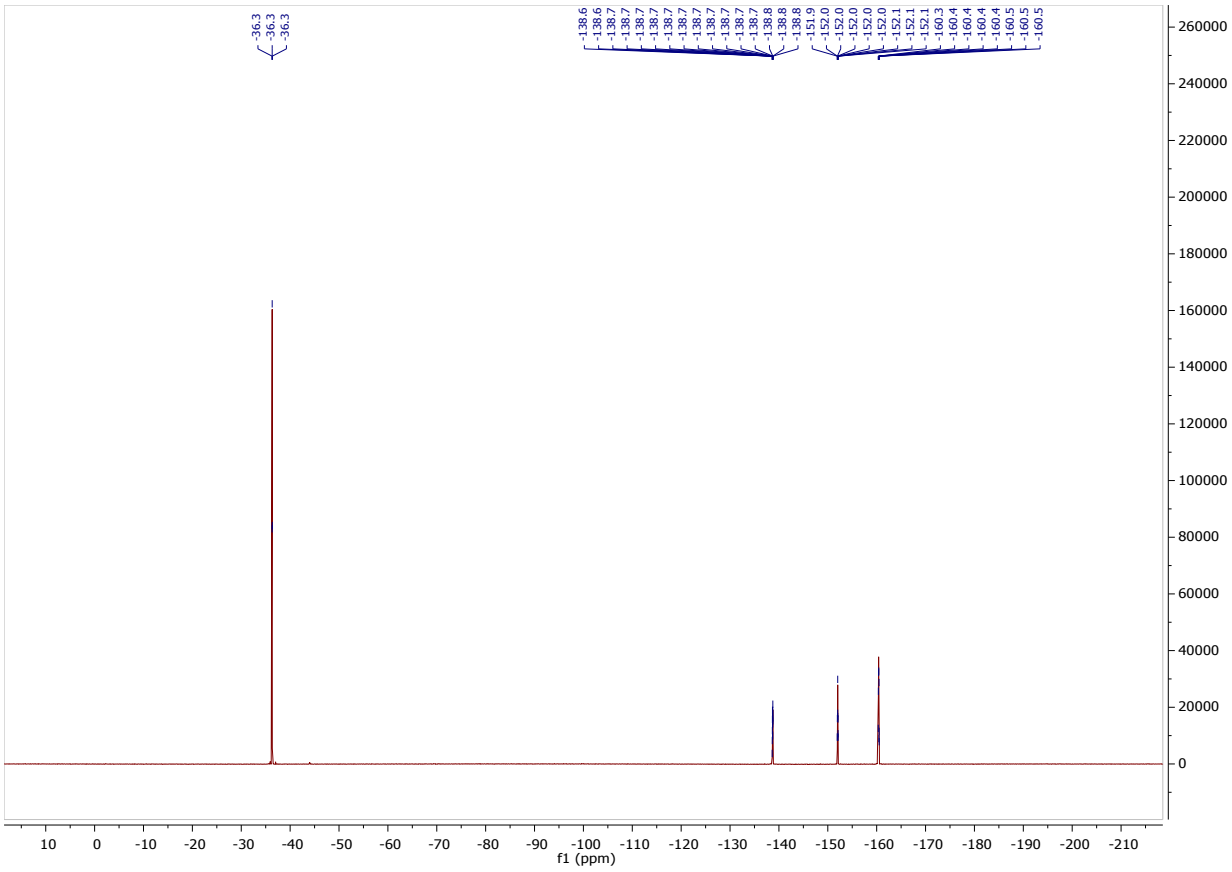
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
f1 (ppm)

***tert*-butyl 5-oxo-4-((perfluorophenyl)methyl)-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3e)**



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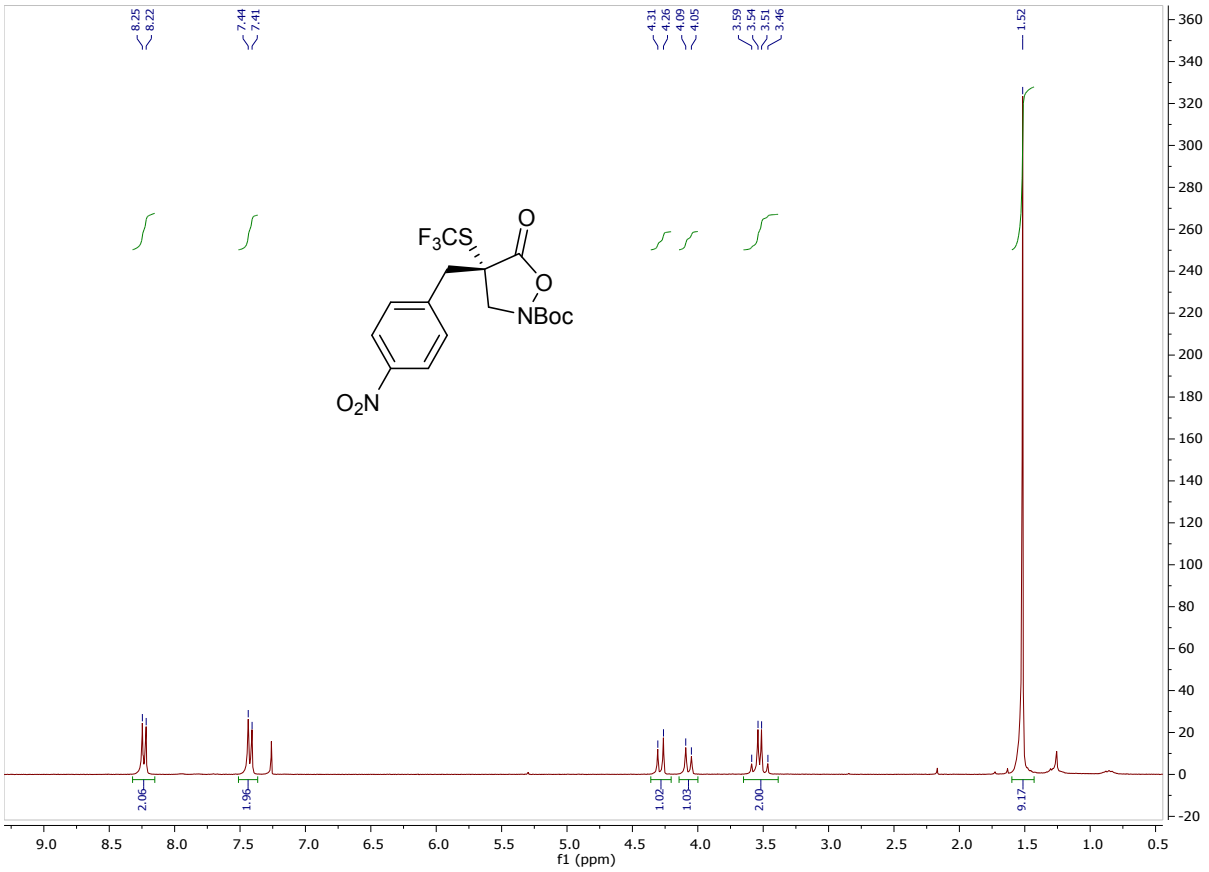
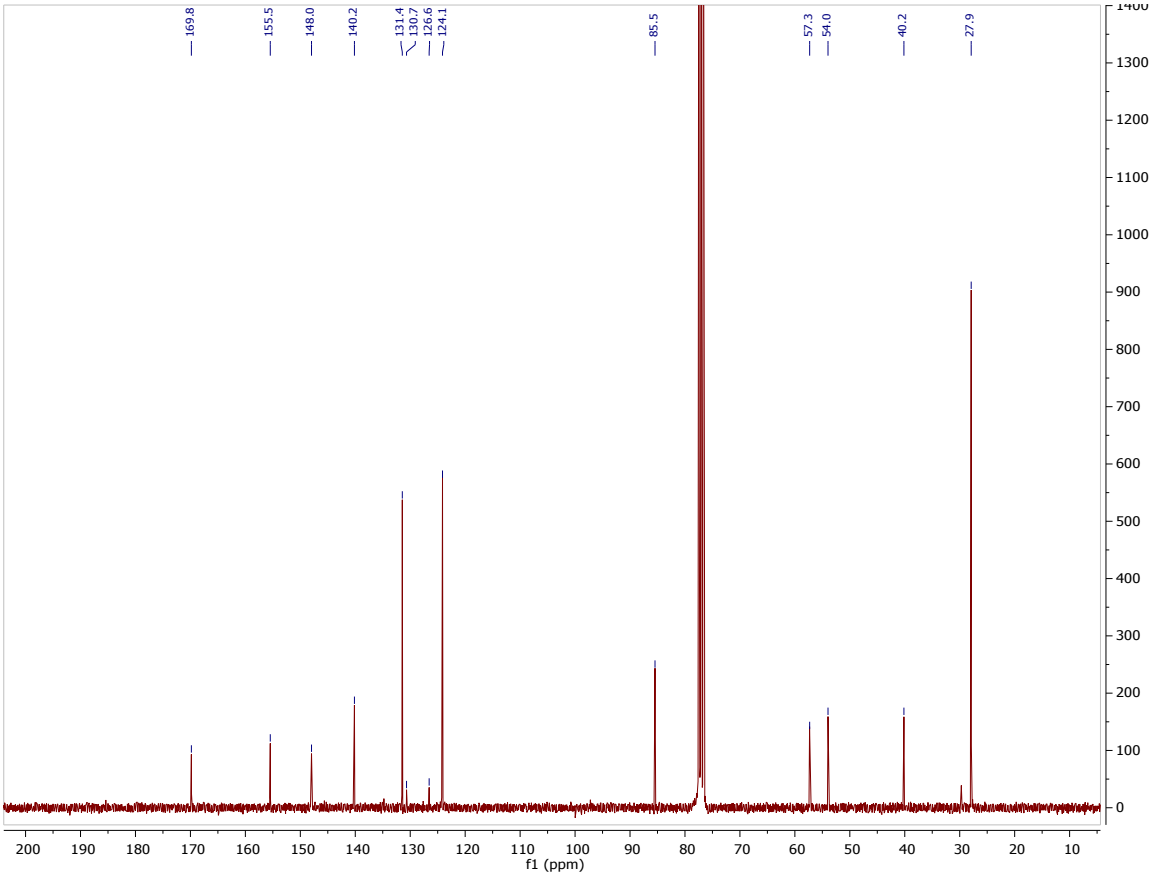
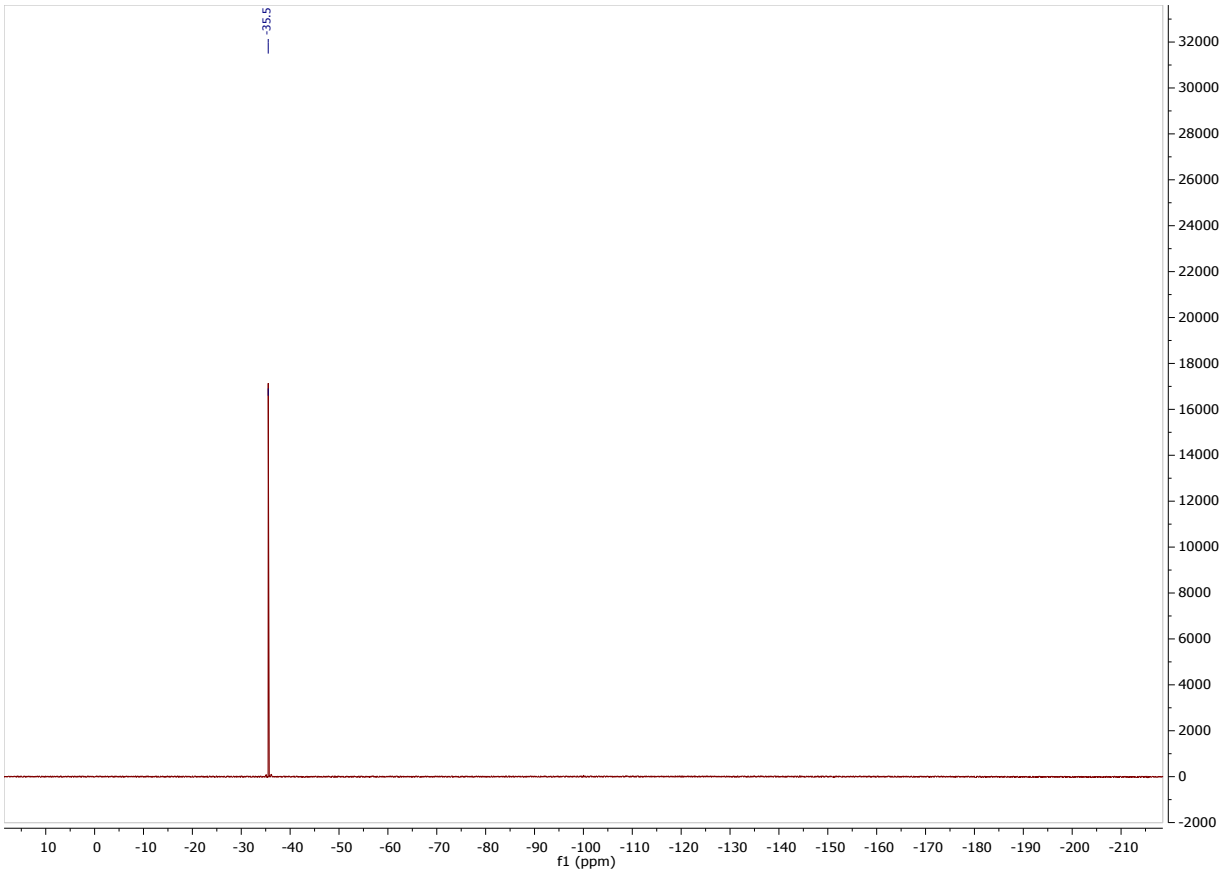
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

***tert*-butyl 4-(4-nitrobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3f)**



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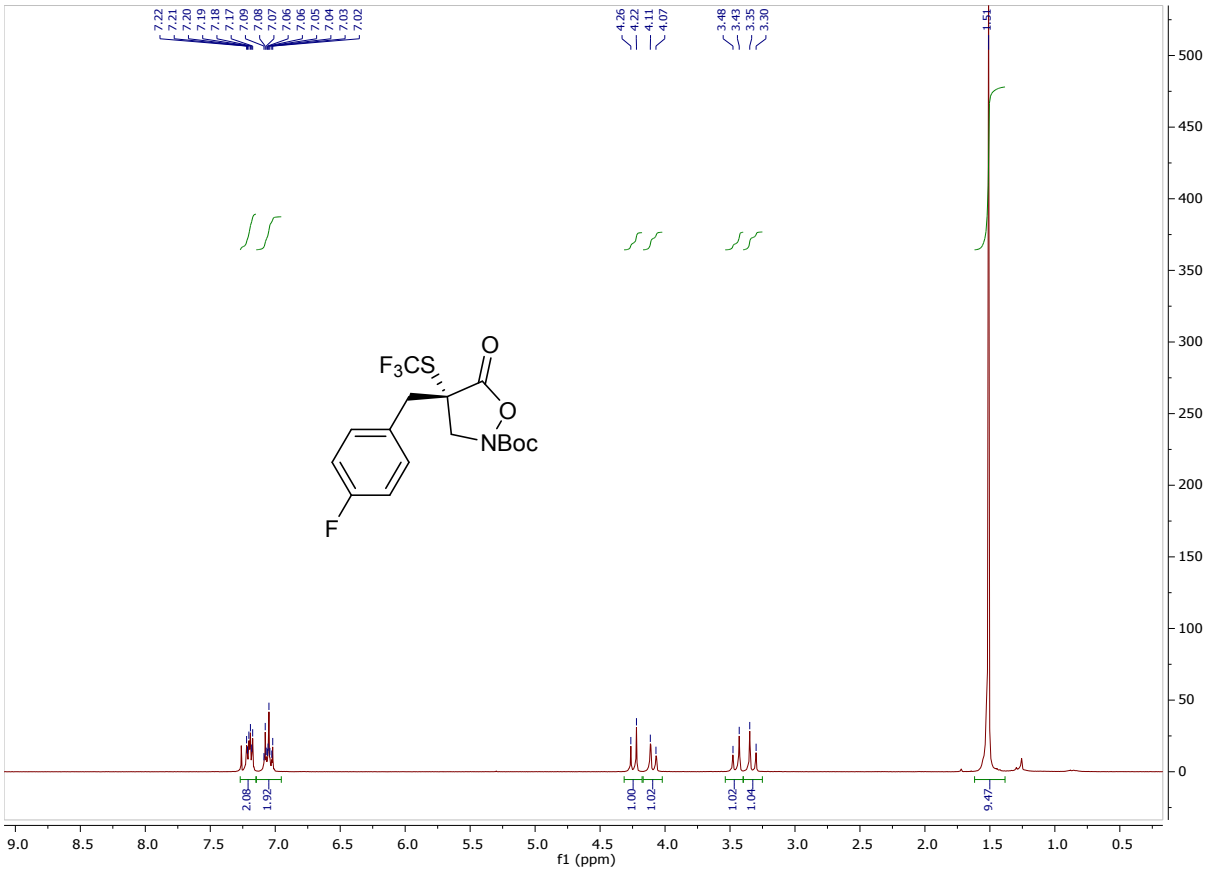
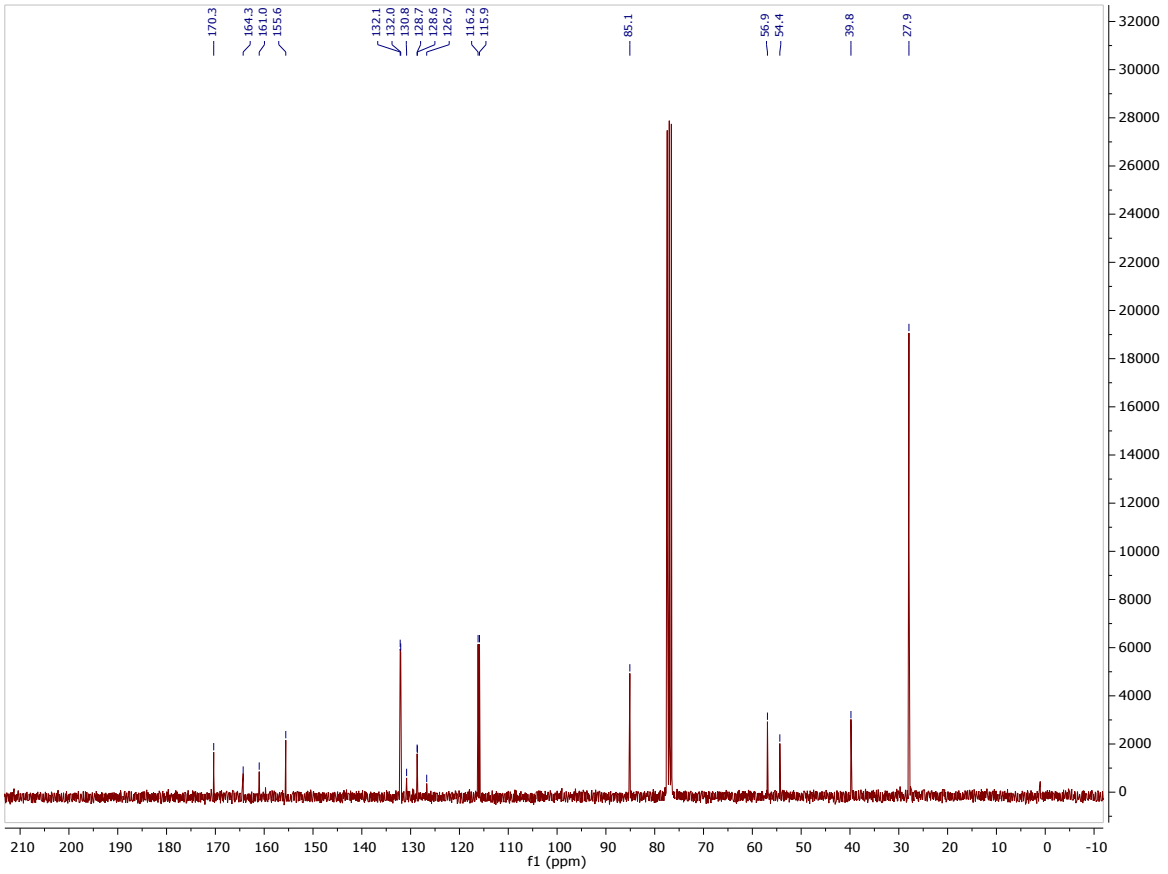
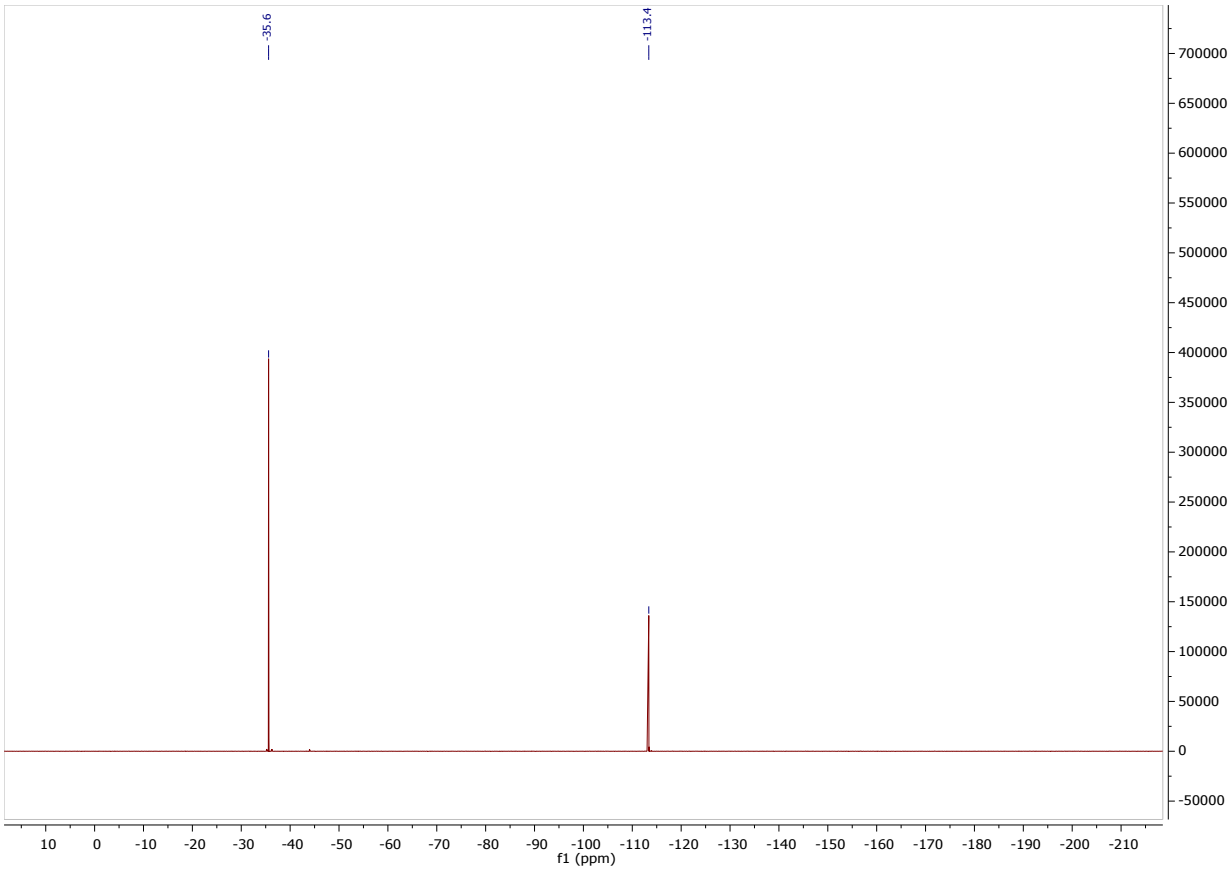
4000
2000
0
-2000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(4-fluorobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3g)**



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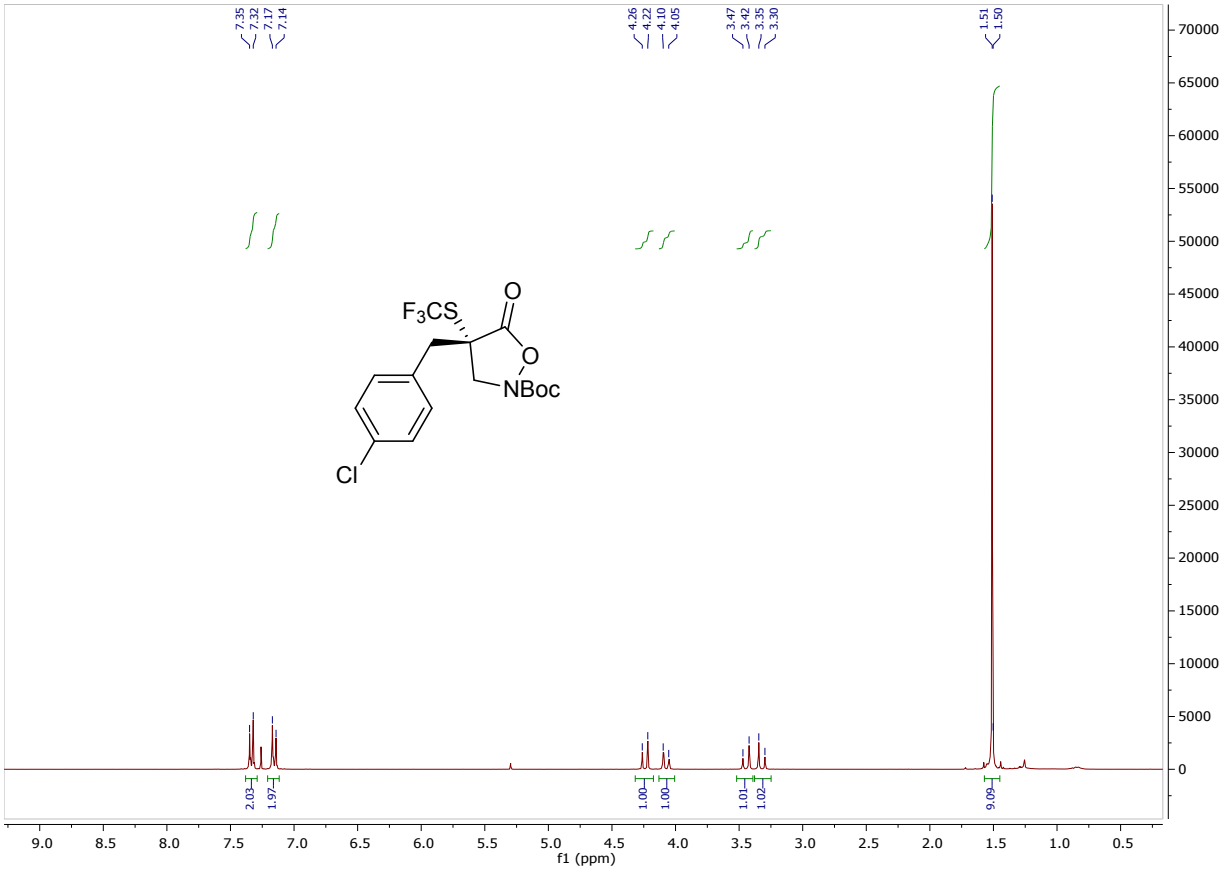
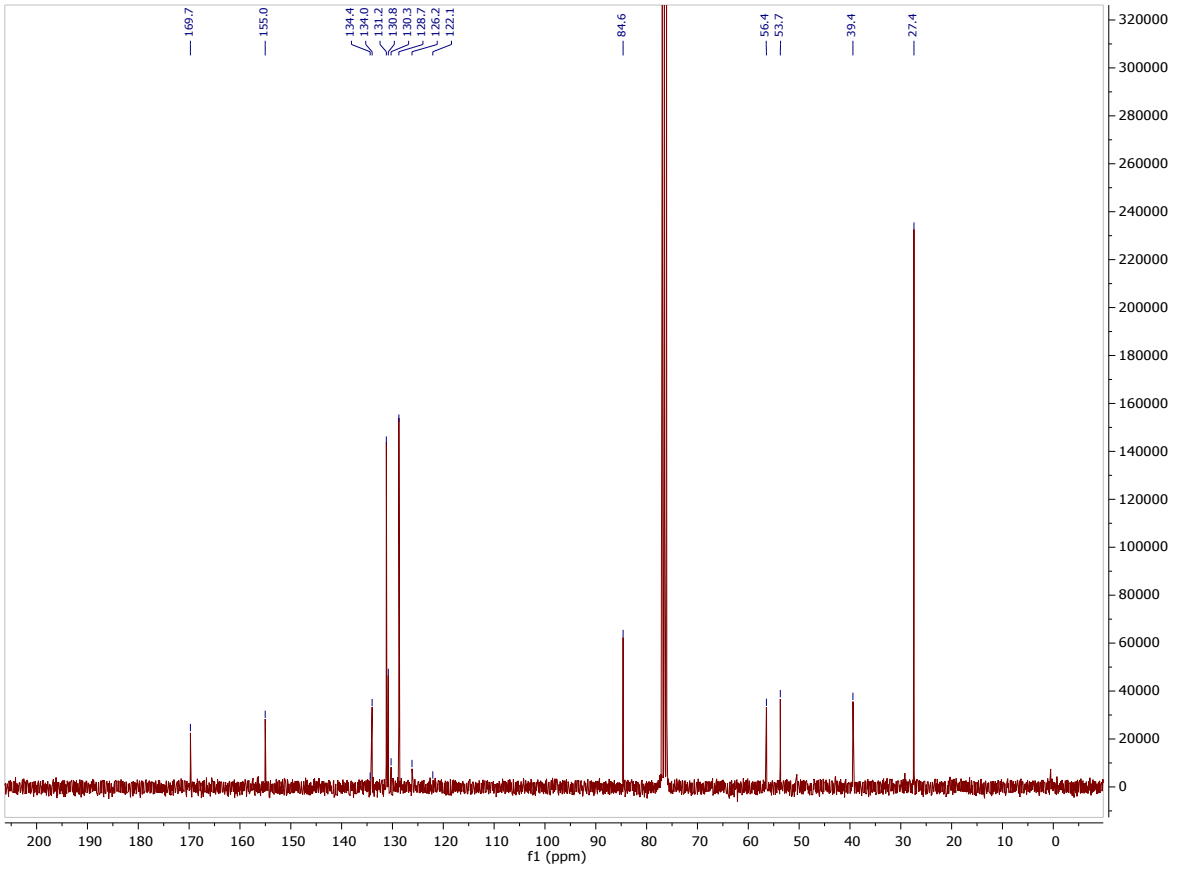
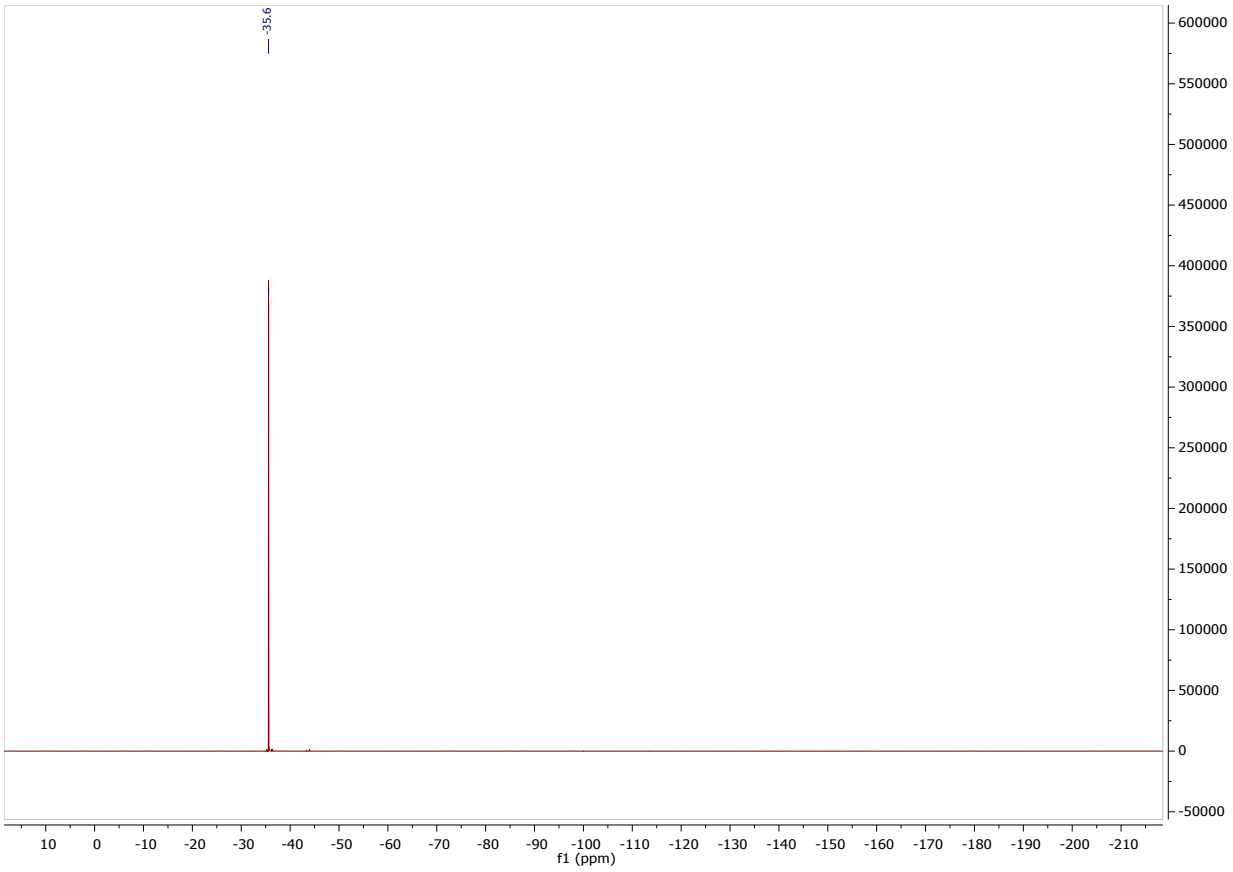
100000
50000
0
-50000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(4-chlorobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3h)**



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100000
50000
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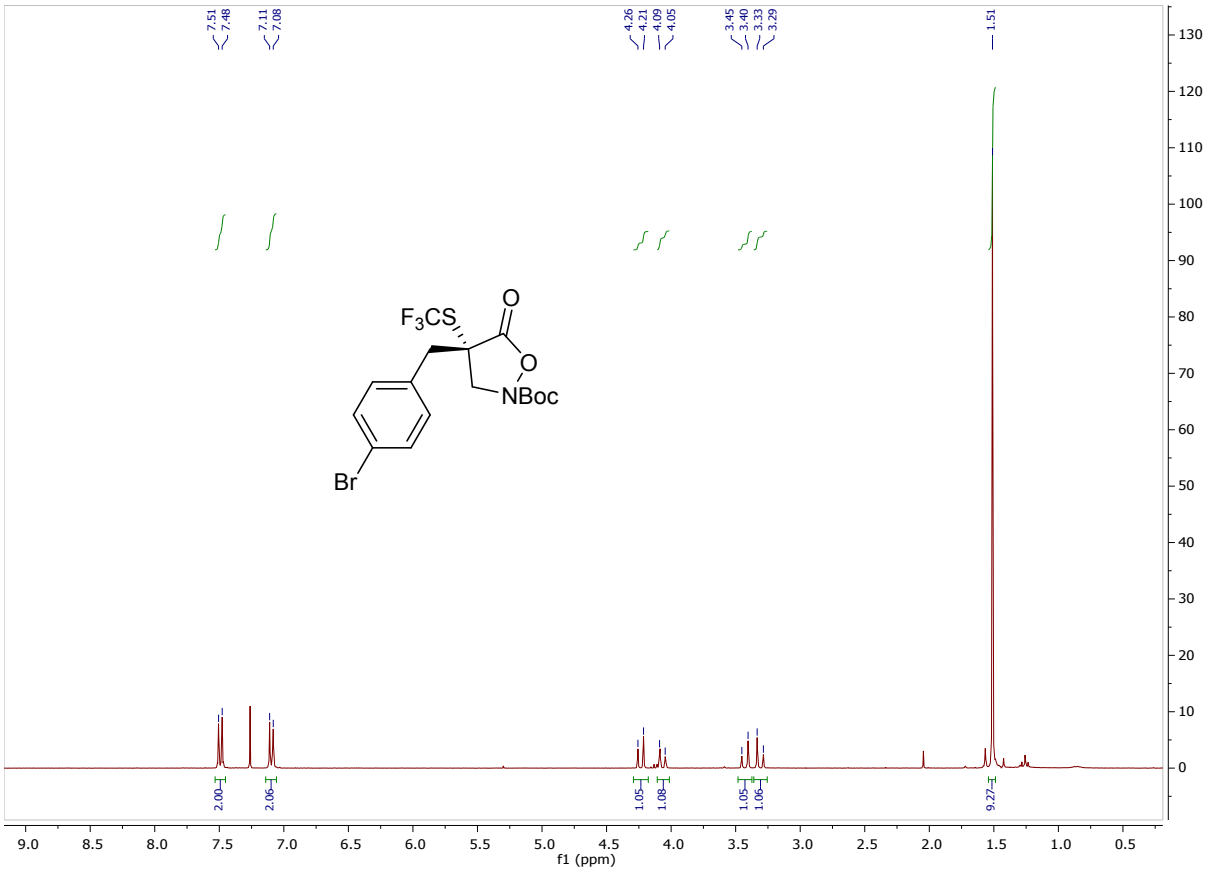
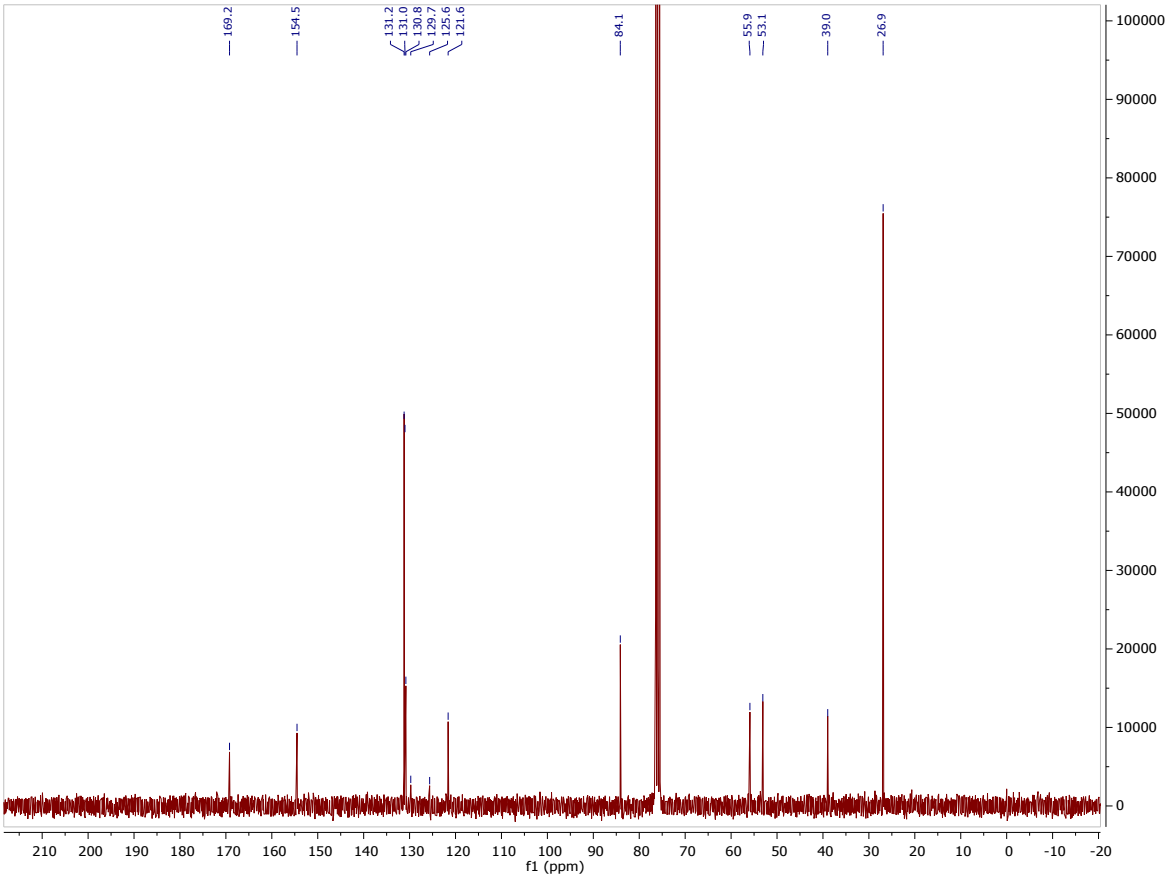
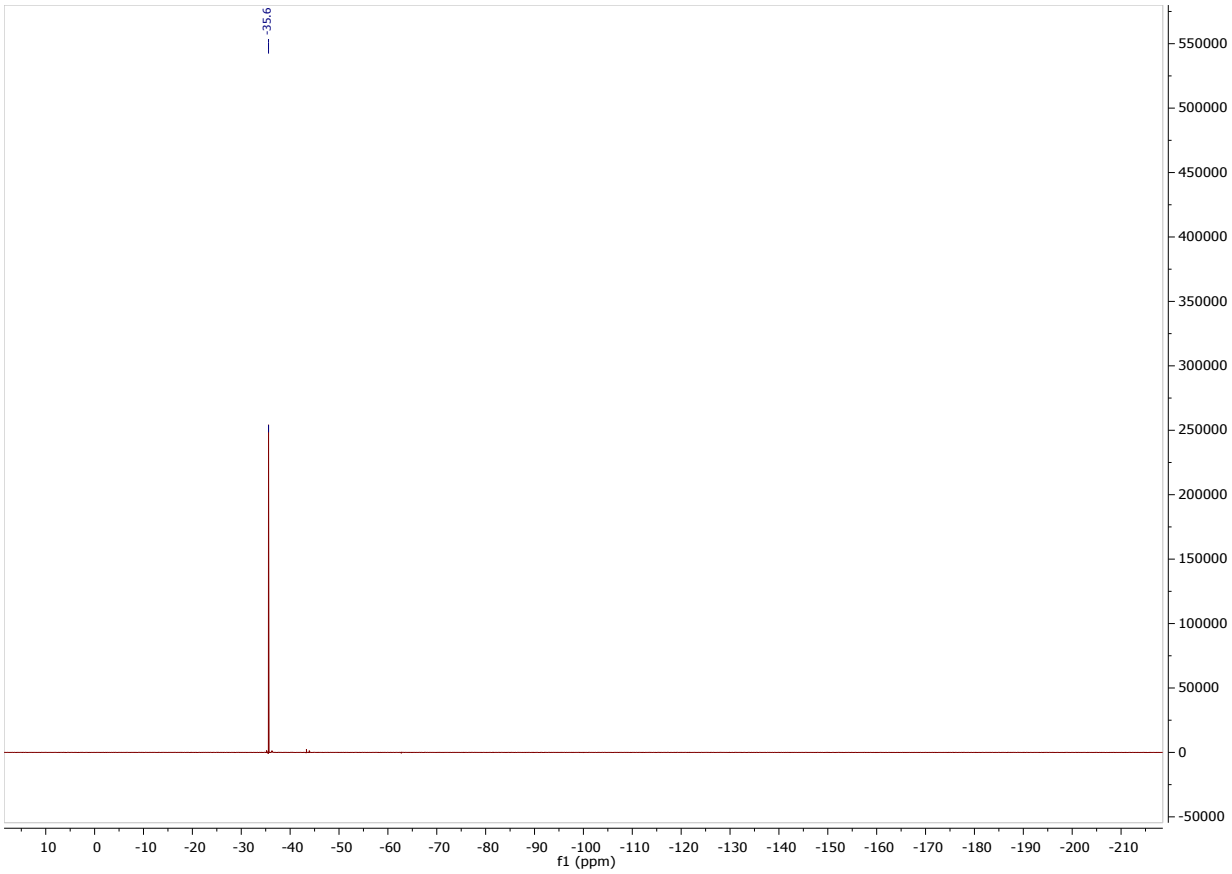
-50000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(4-bromobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3i)**



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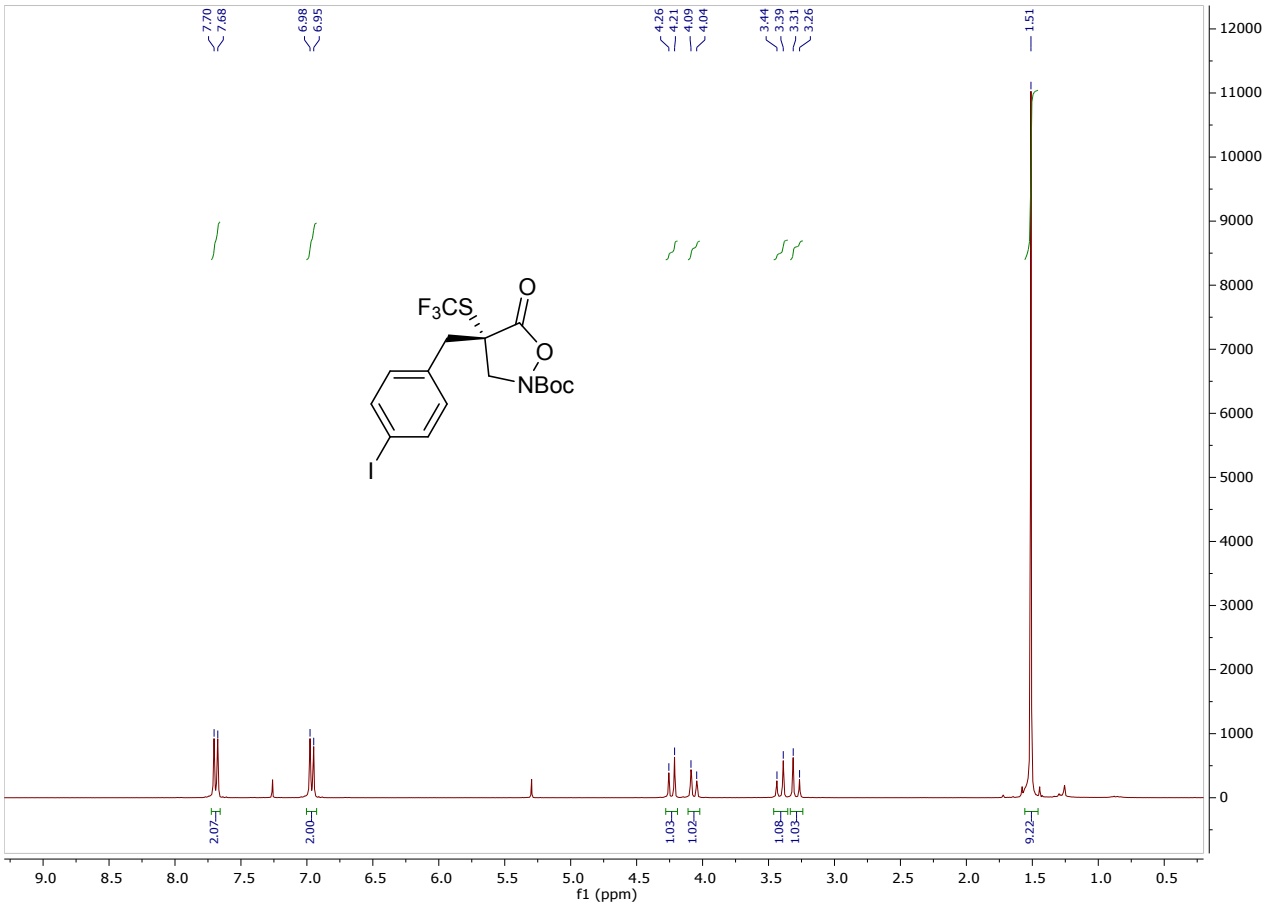
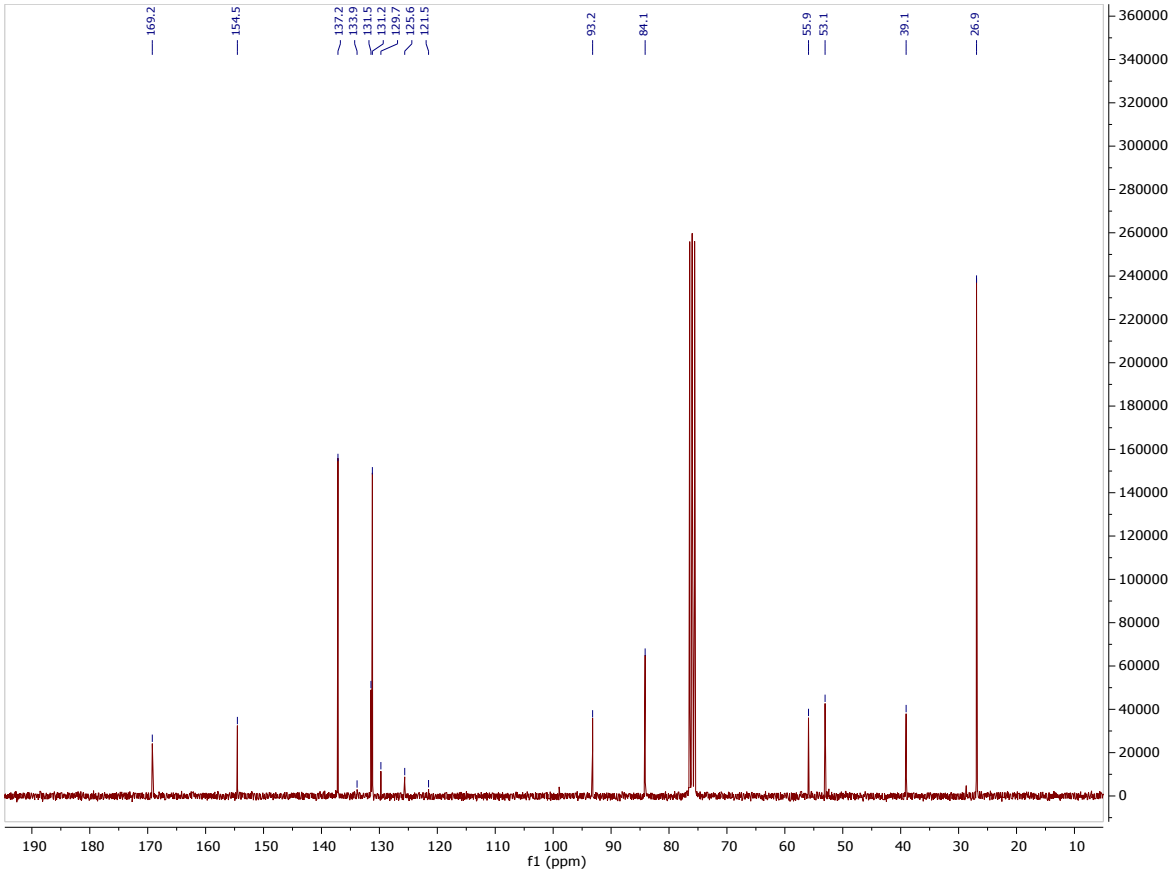
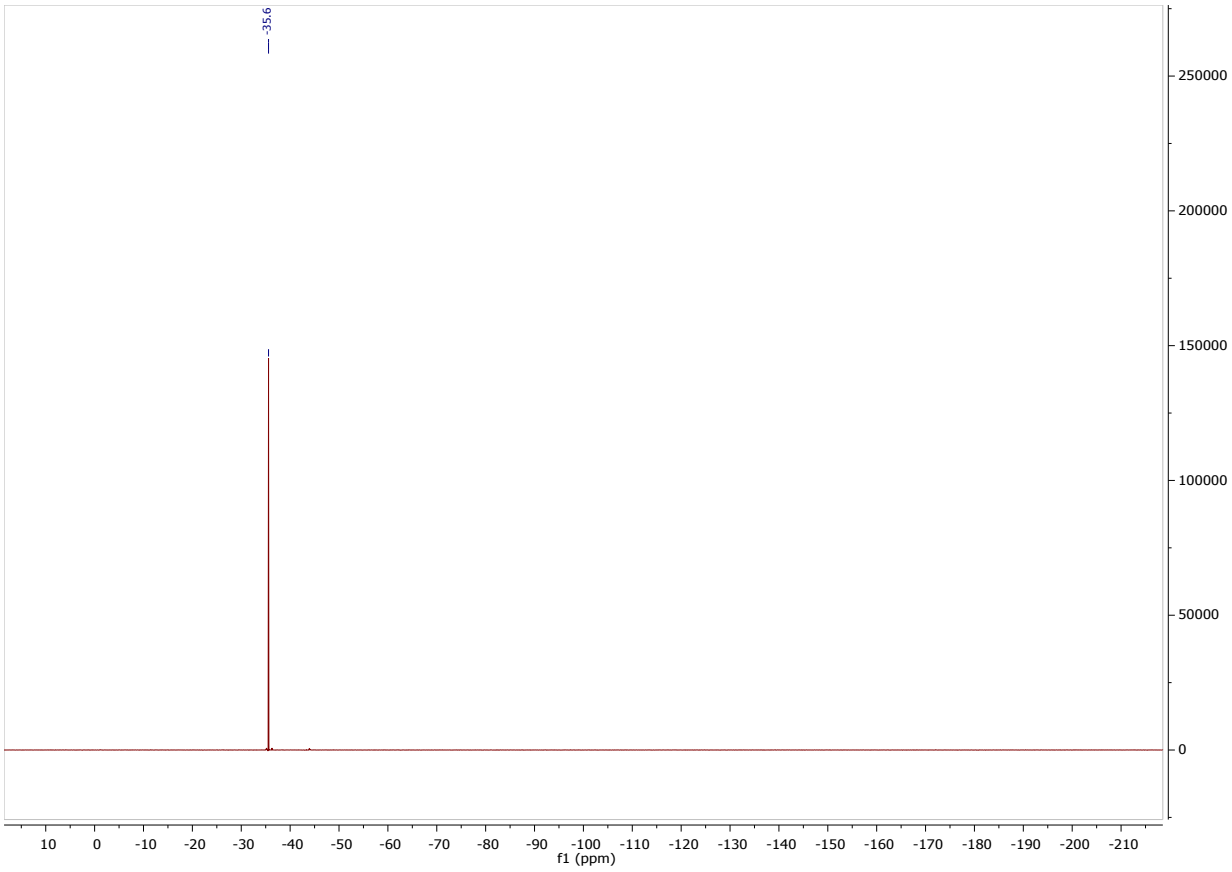
250000
200000
150000
100000
50000
0
-50000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(4-iodobenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3j)**



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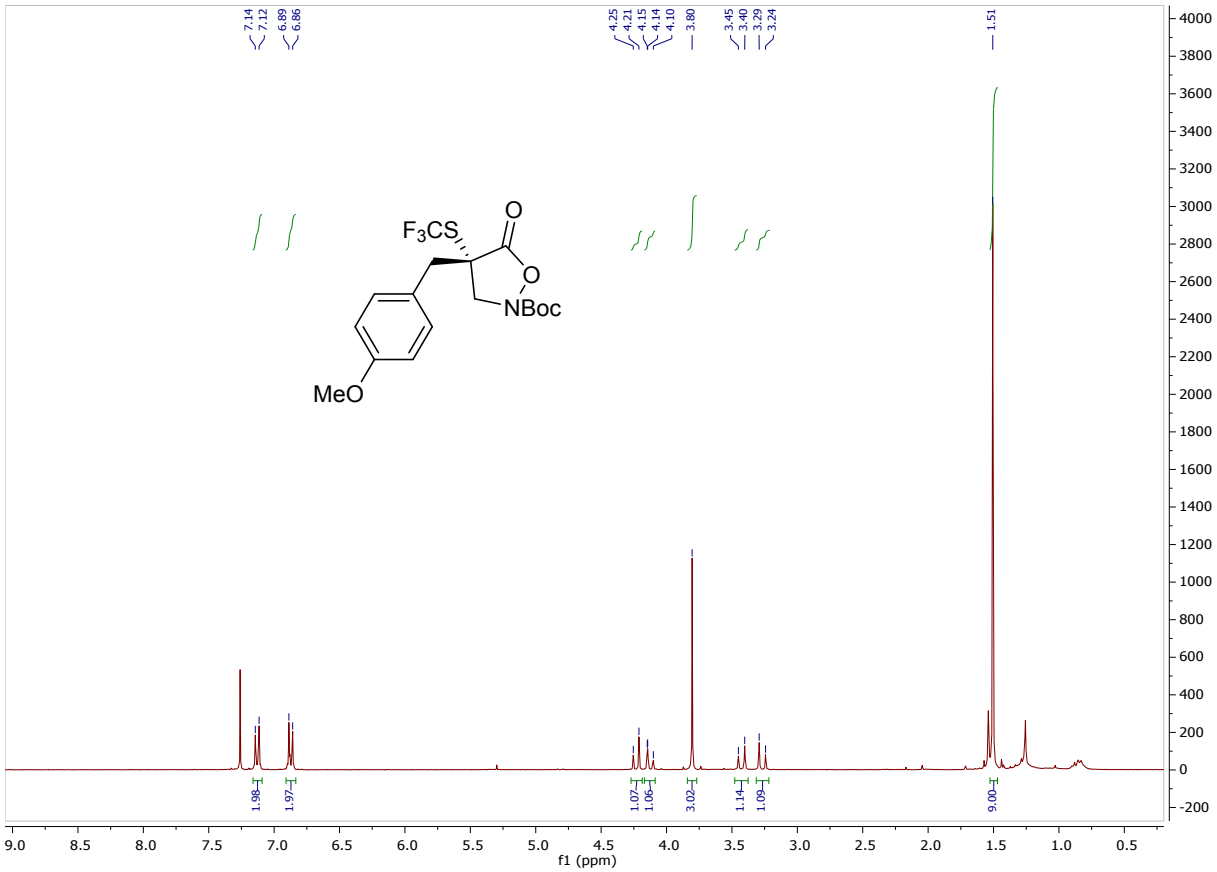
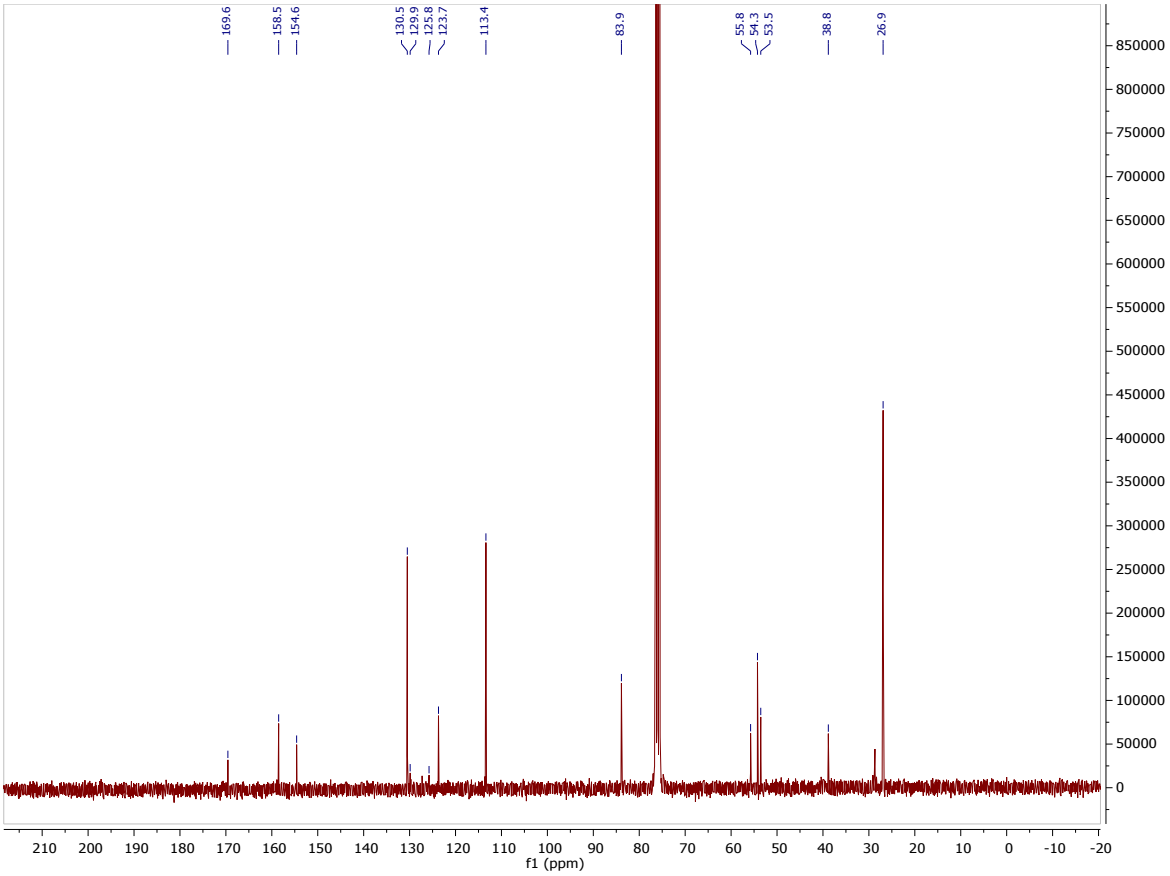
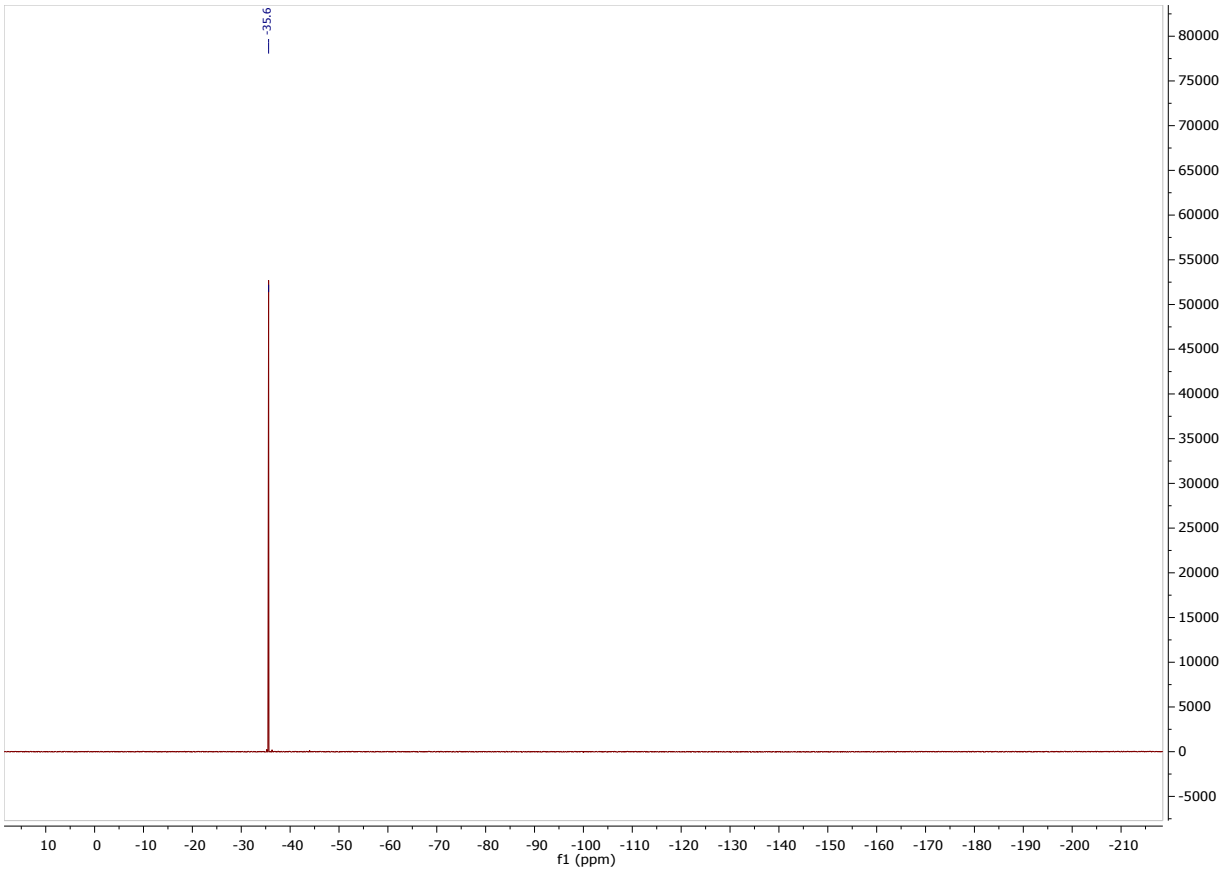
100000
50000
0
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(4-methoxybenzyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3k)**



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40000
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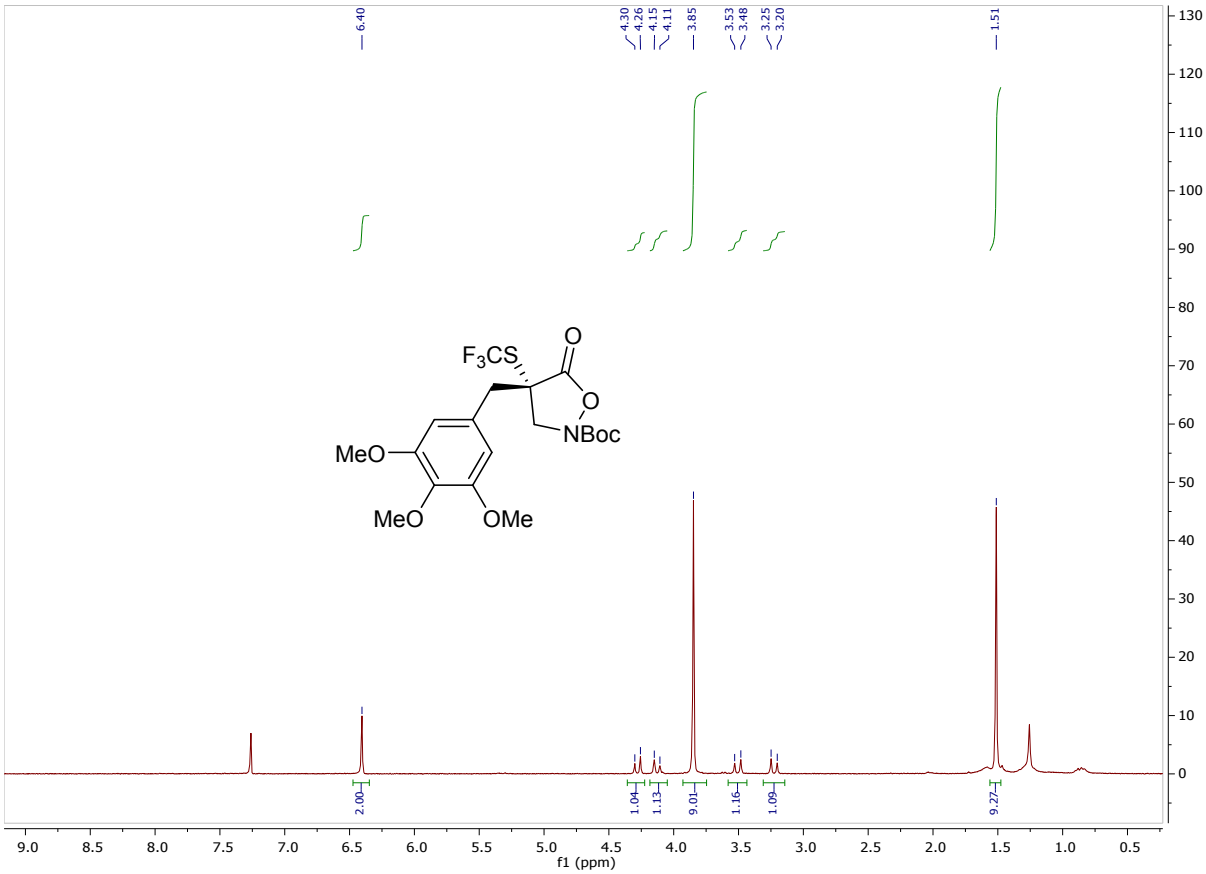
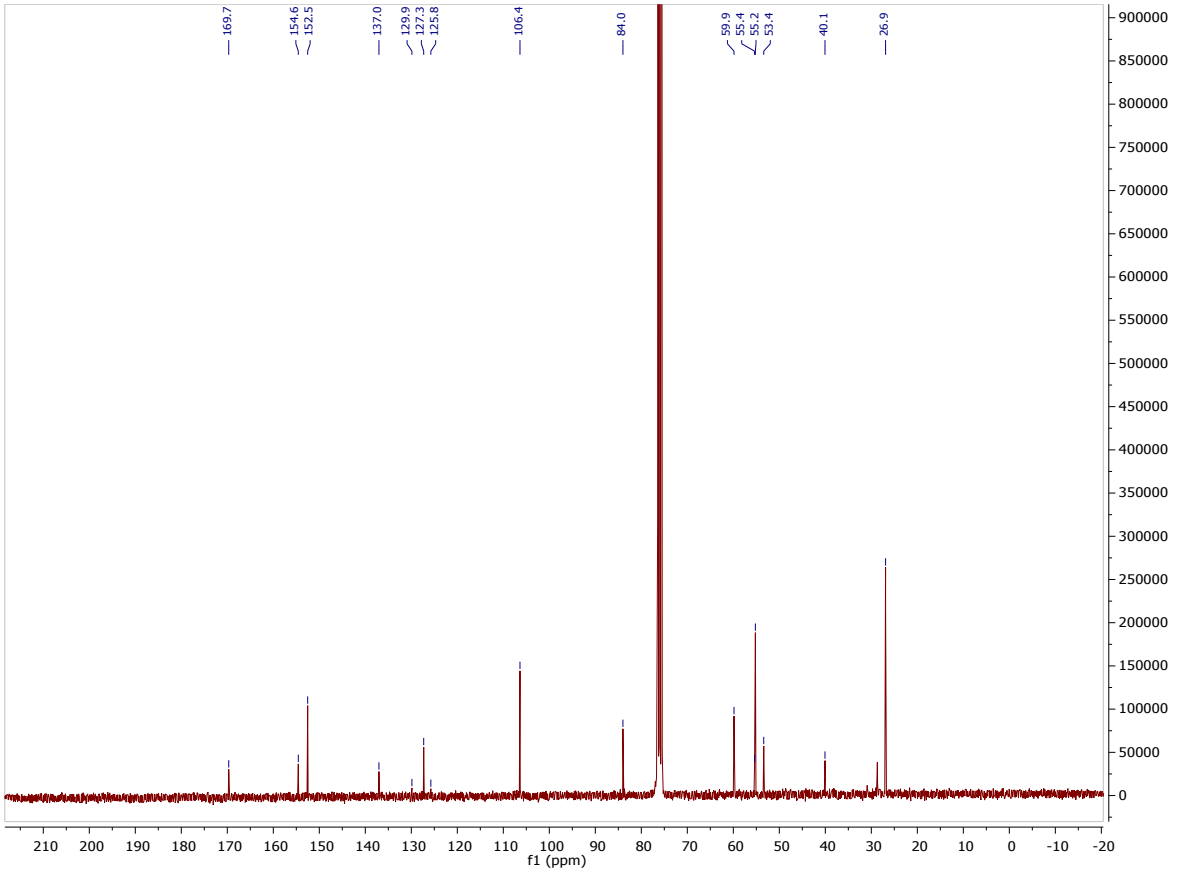
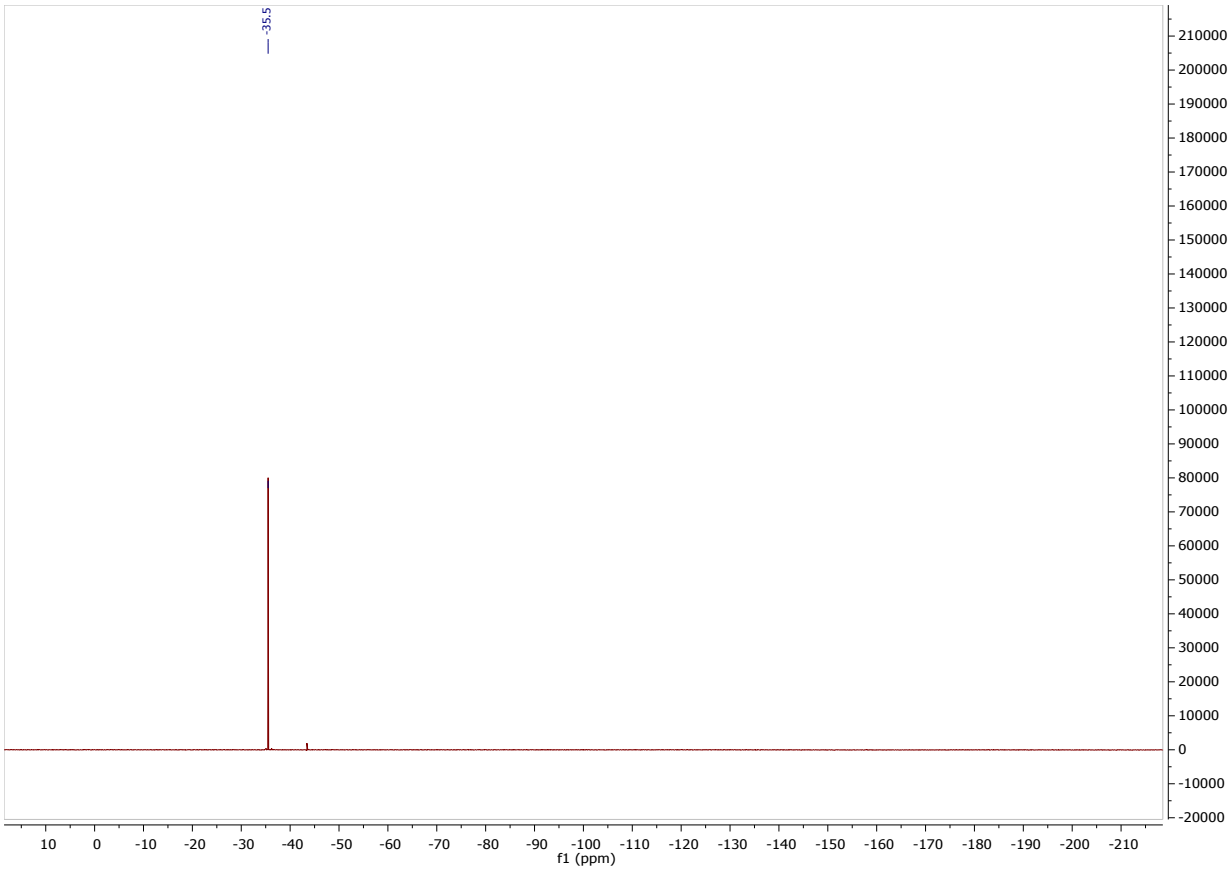
25000
20000
15000
10000
5000
0
-5000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 5-oxo-4-((trifluoromethyl)thio)-4-(3,4,5-trimethoxybenzyl)isoxazolidine-2-carboxylate (3l)**



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60000
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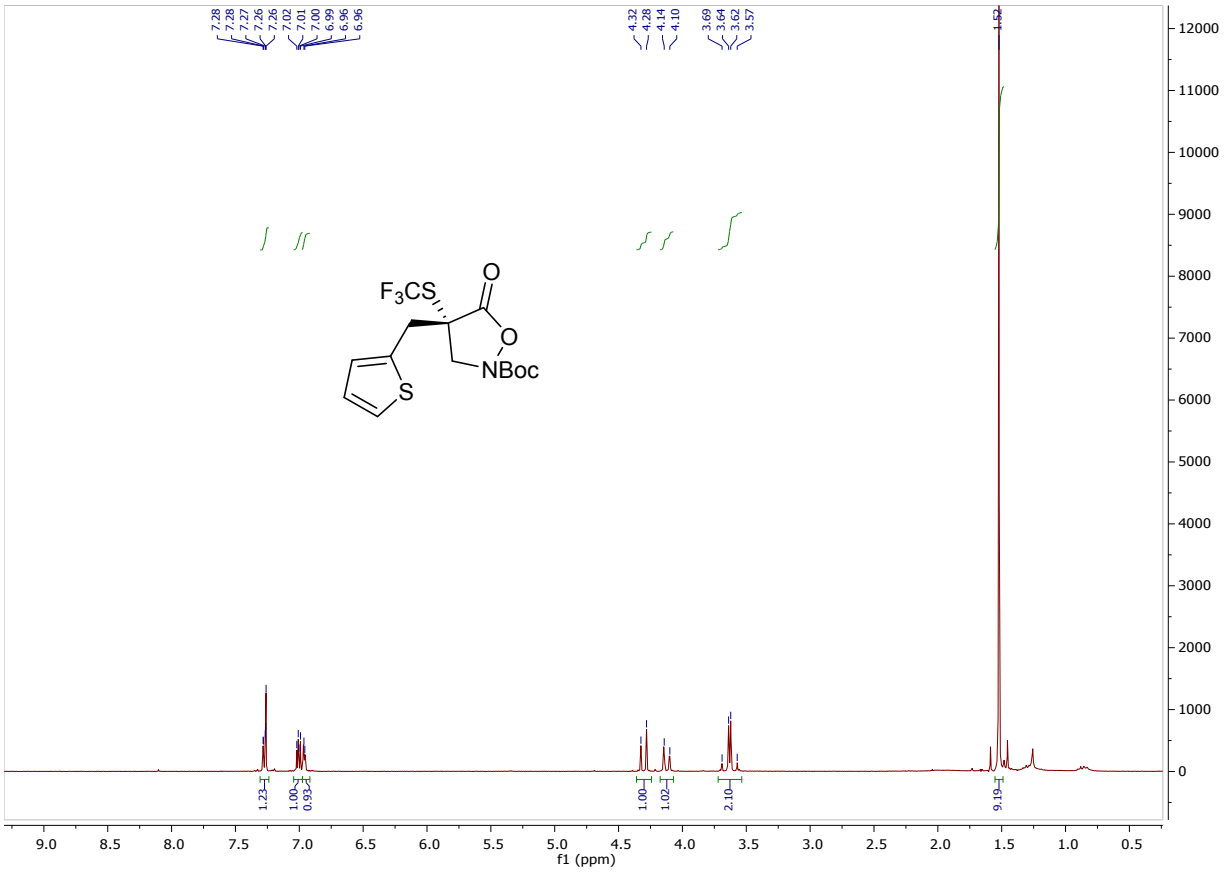
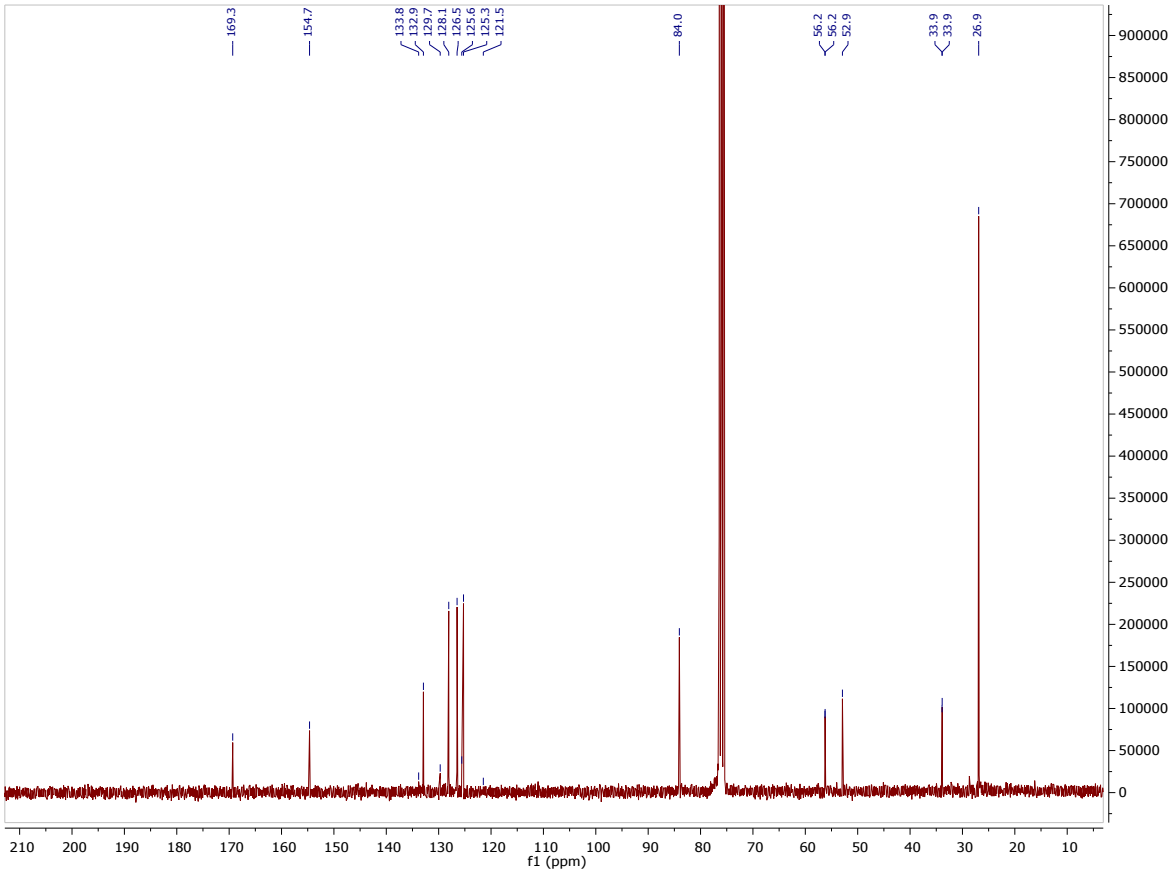
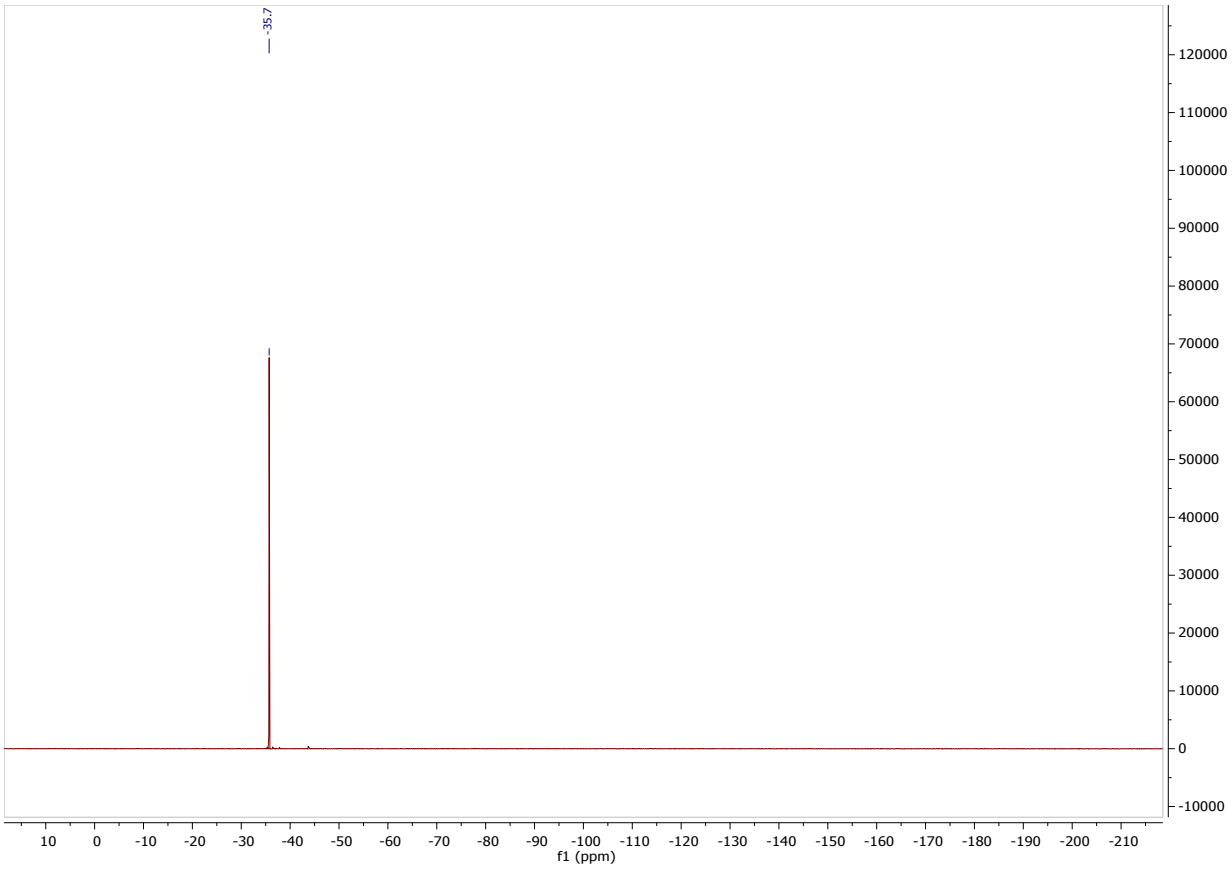
40000
30000
20000
10000
0
-10000
-20000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 5-oxo-4-(thiophen-2-ylmethyl)-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3m)**



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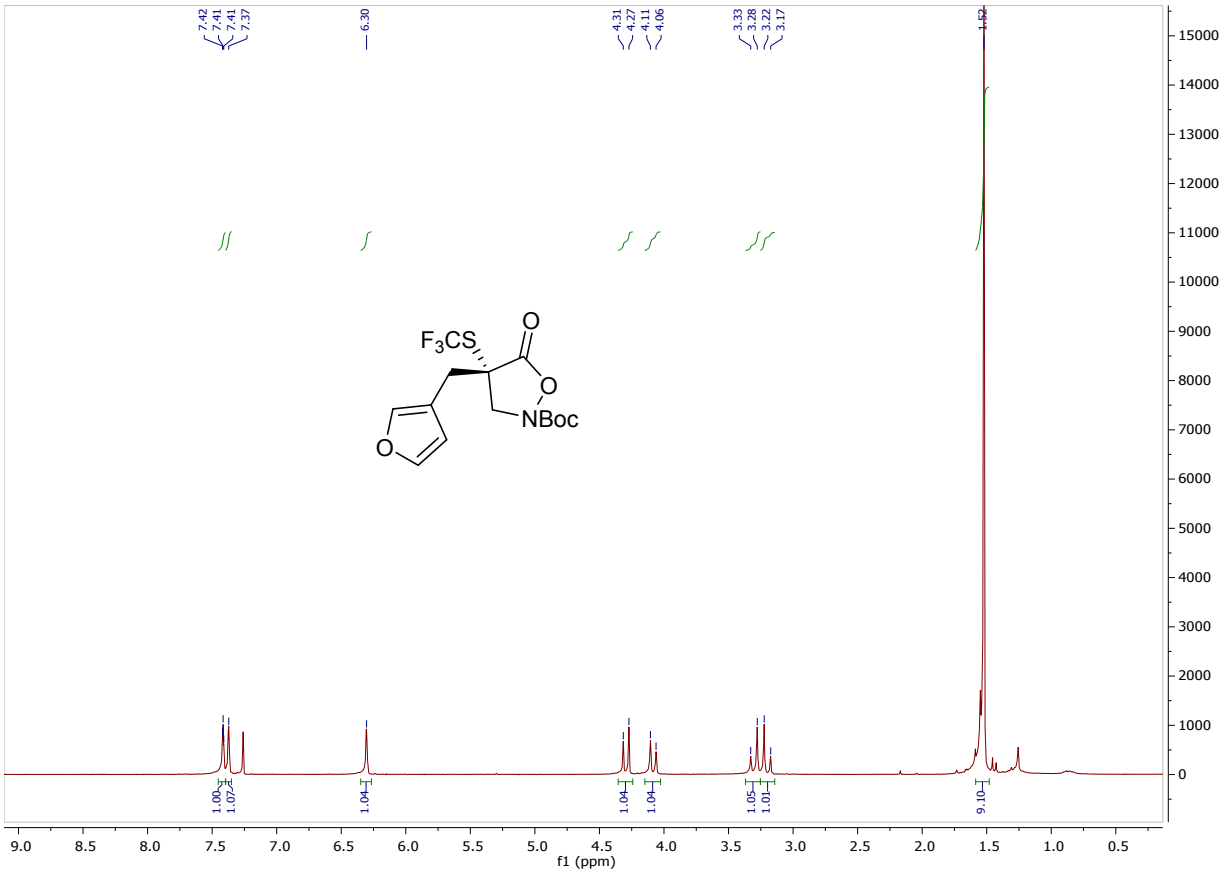
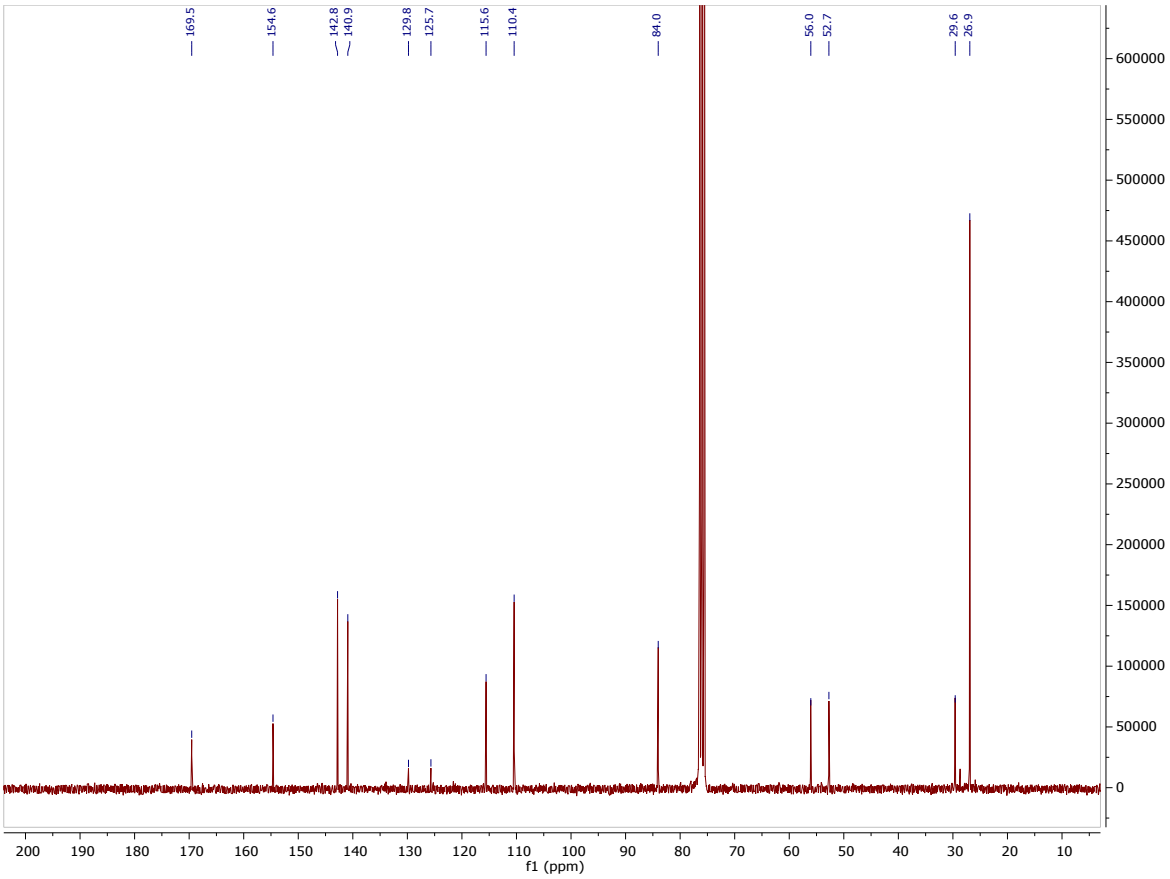
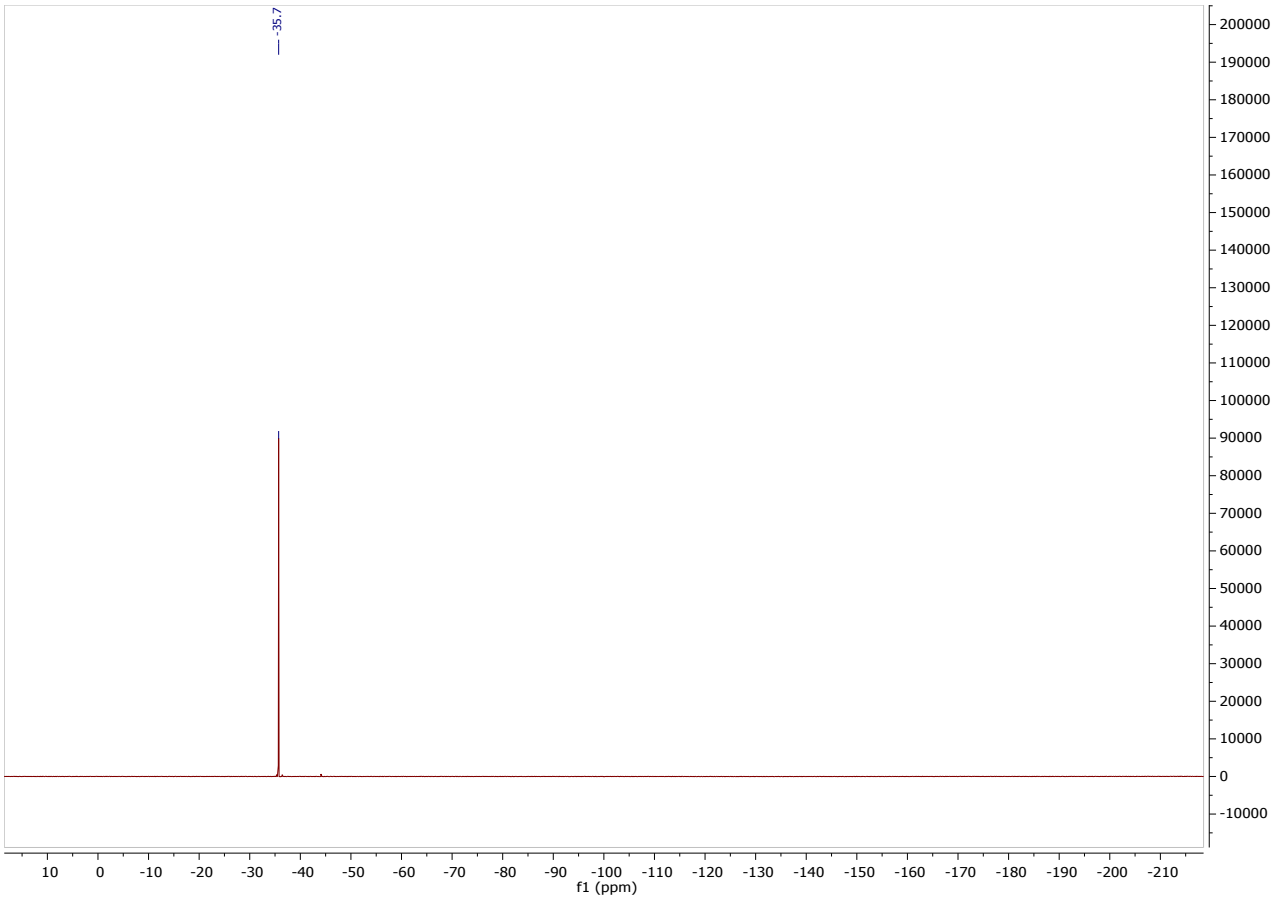
20000
10000
0
-10000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(furan-3-ylmethyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3n)**



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100000
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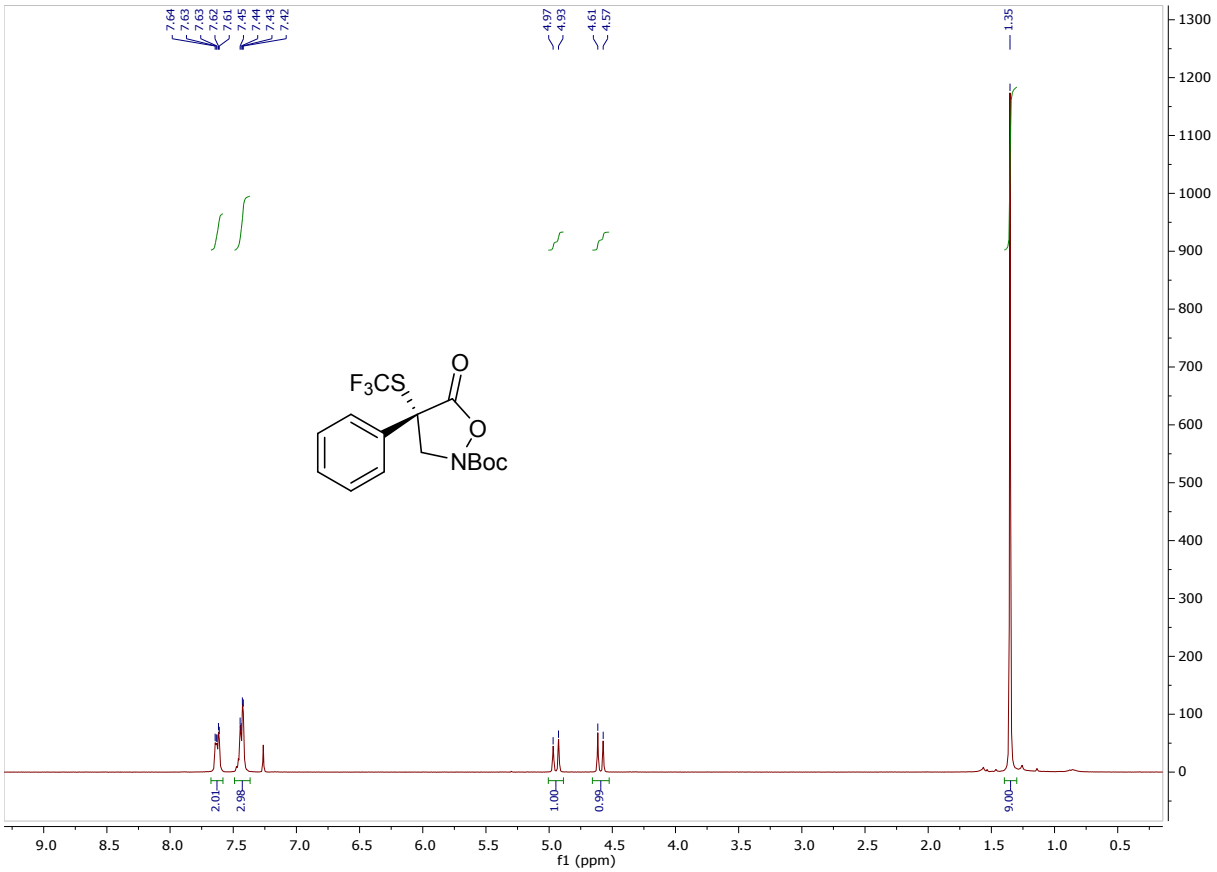
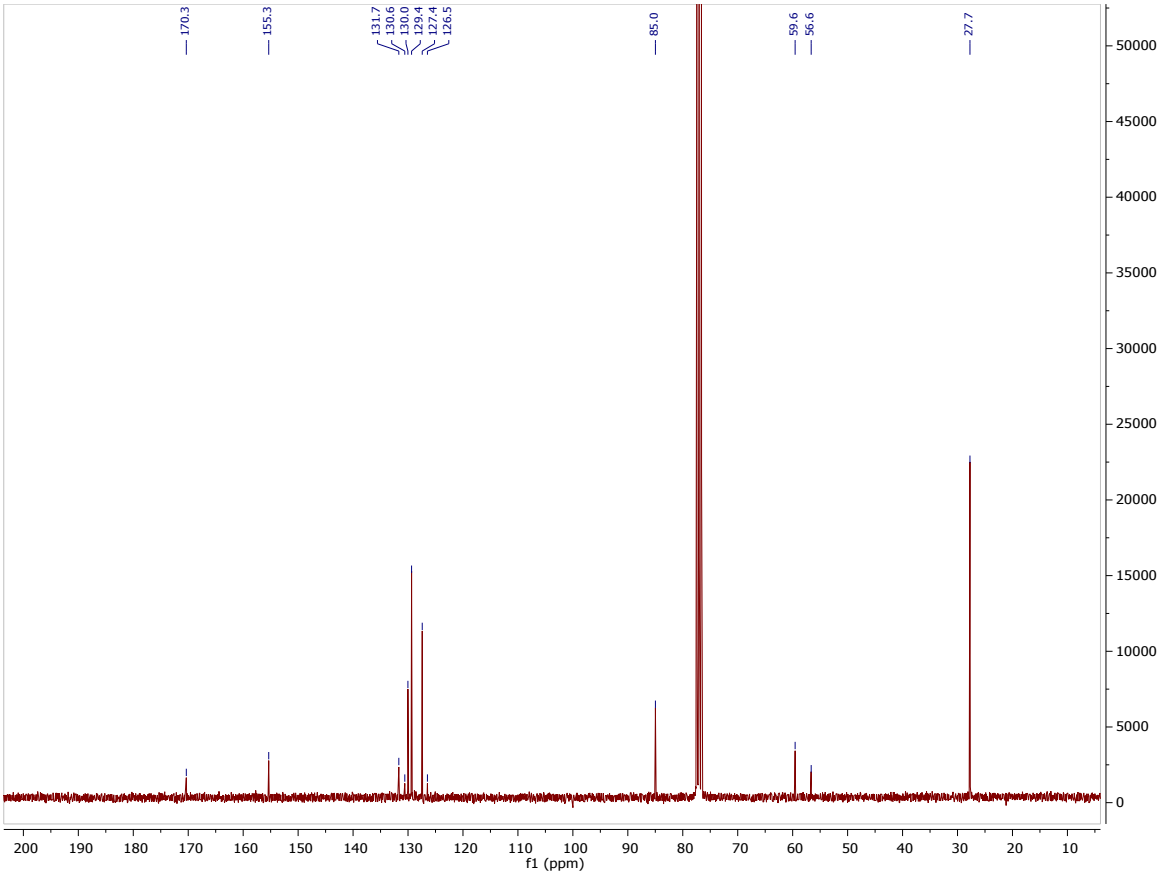
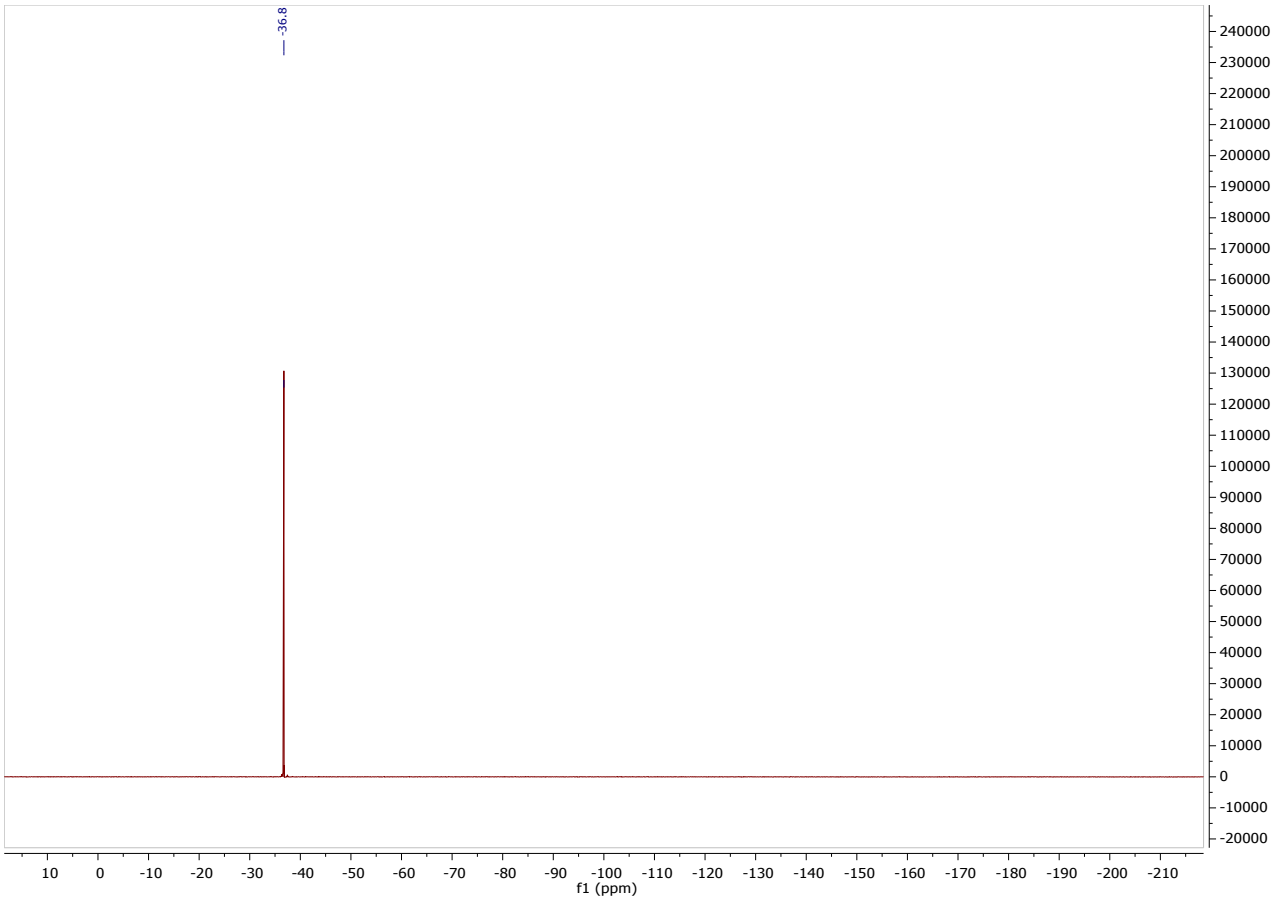
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 5-oxo-4-phenyl-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3o)**



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120000
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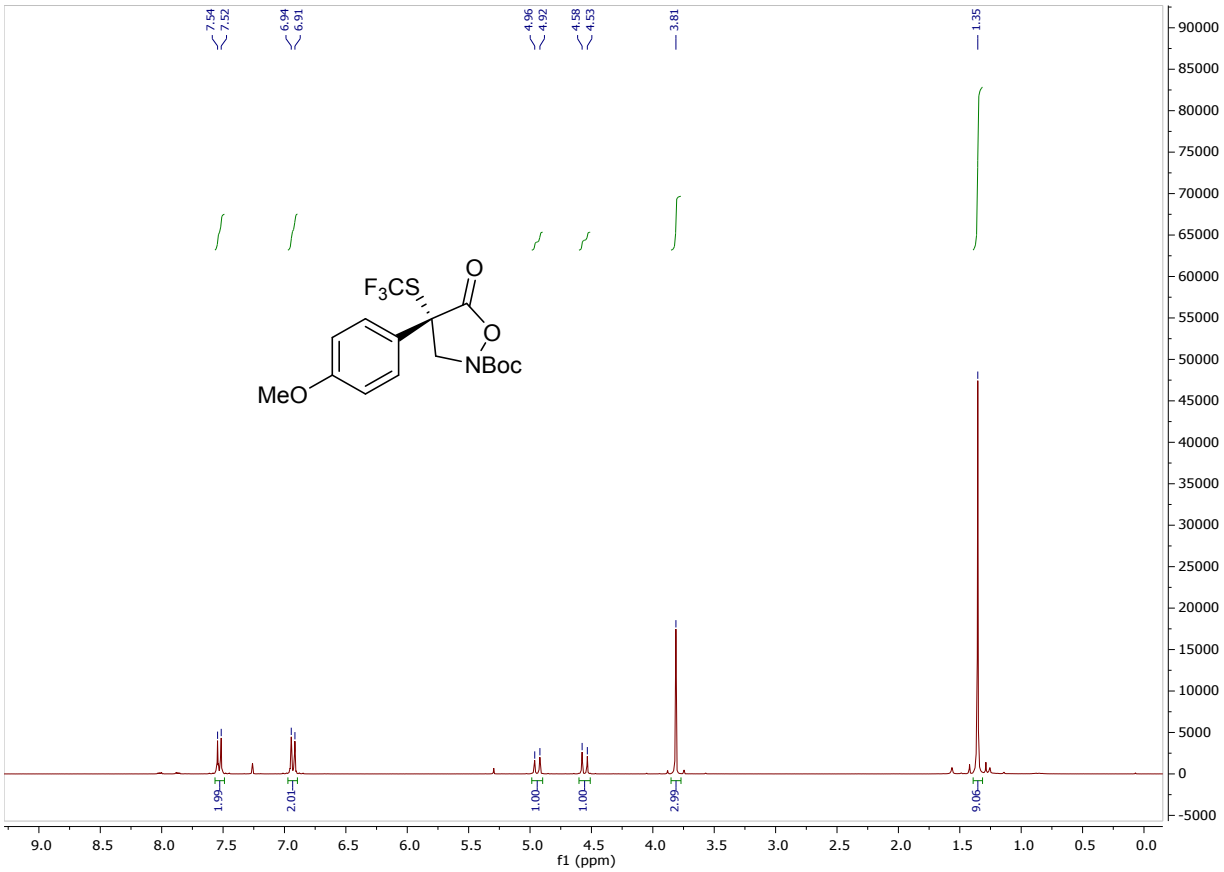
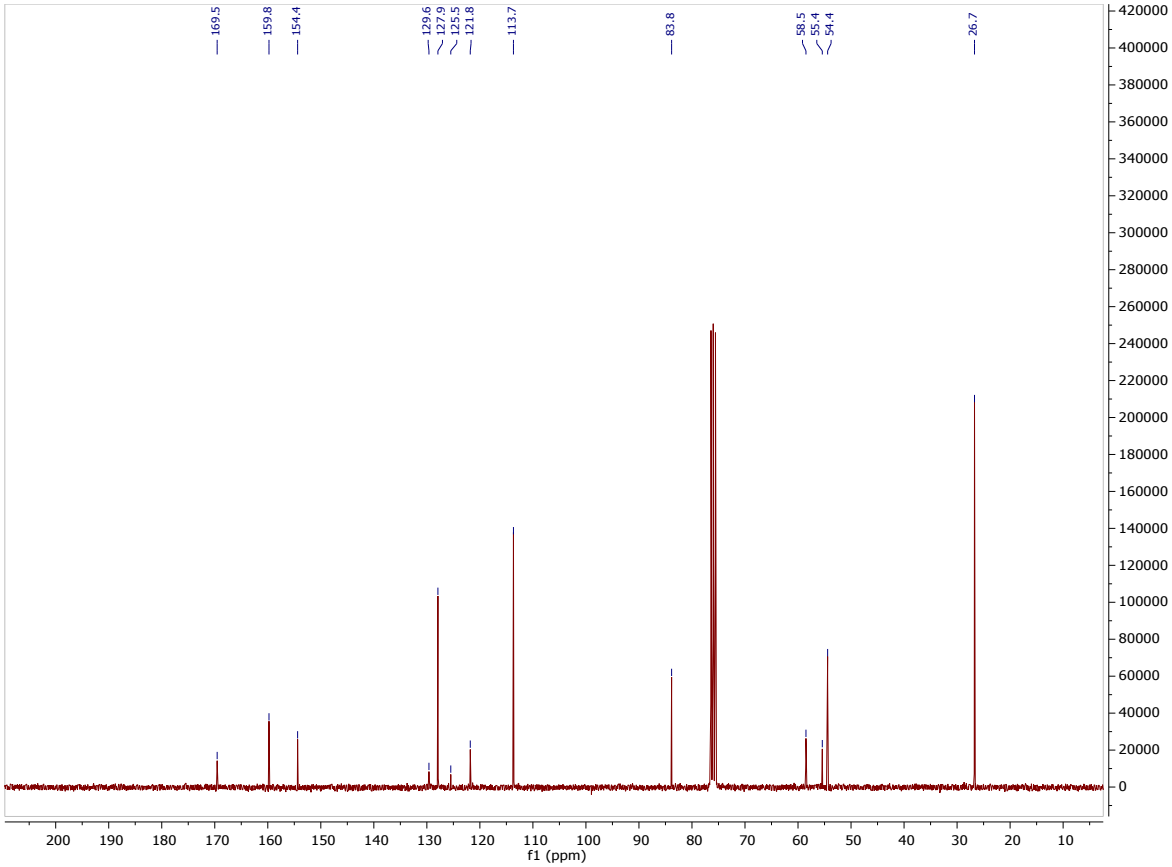
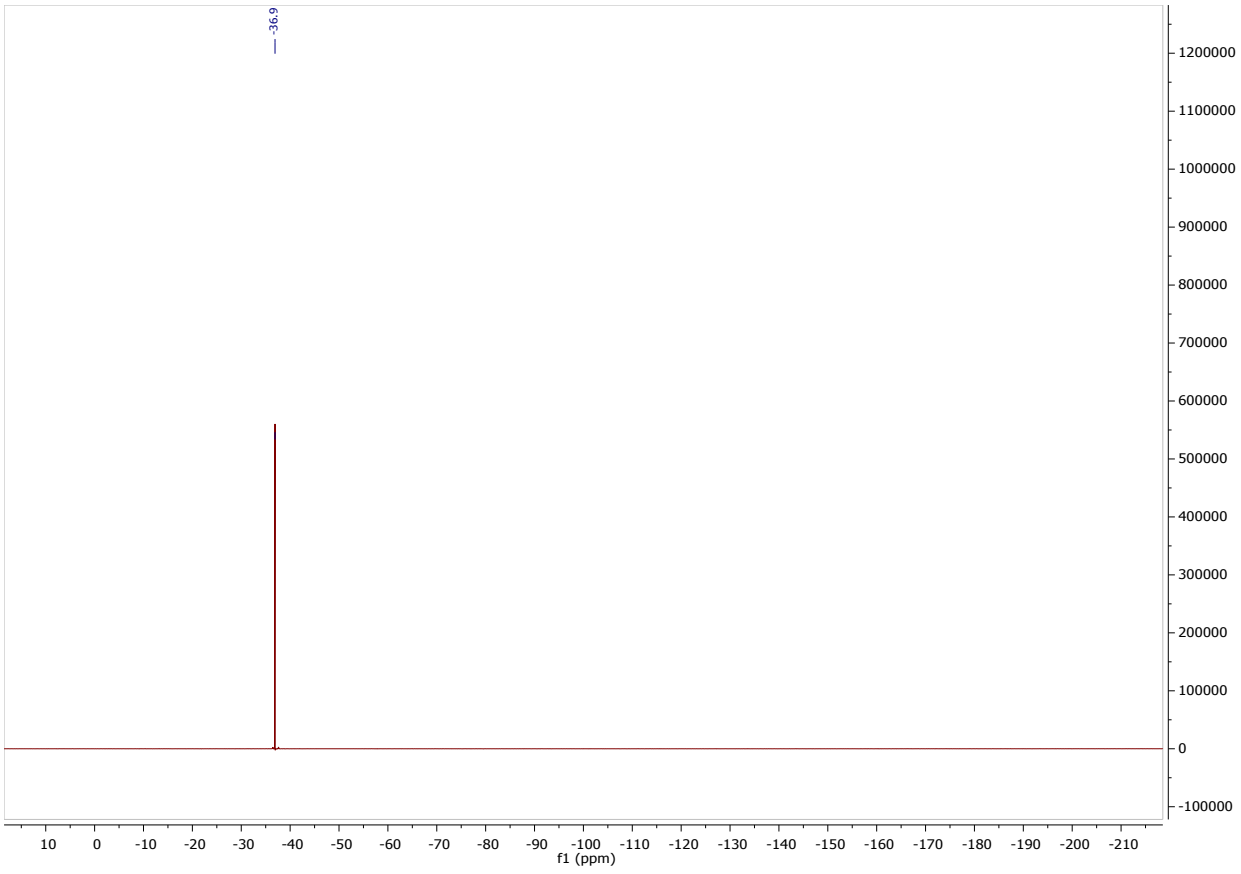
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

***tert*-butyl 4-(4-methoxyphenyl)-5-oxo-4-((trifluoromethyl)thio)isoxazolidine-2-carboxylate (3p)**



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400000
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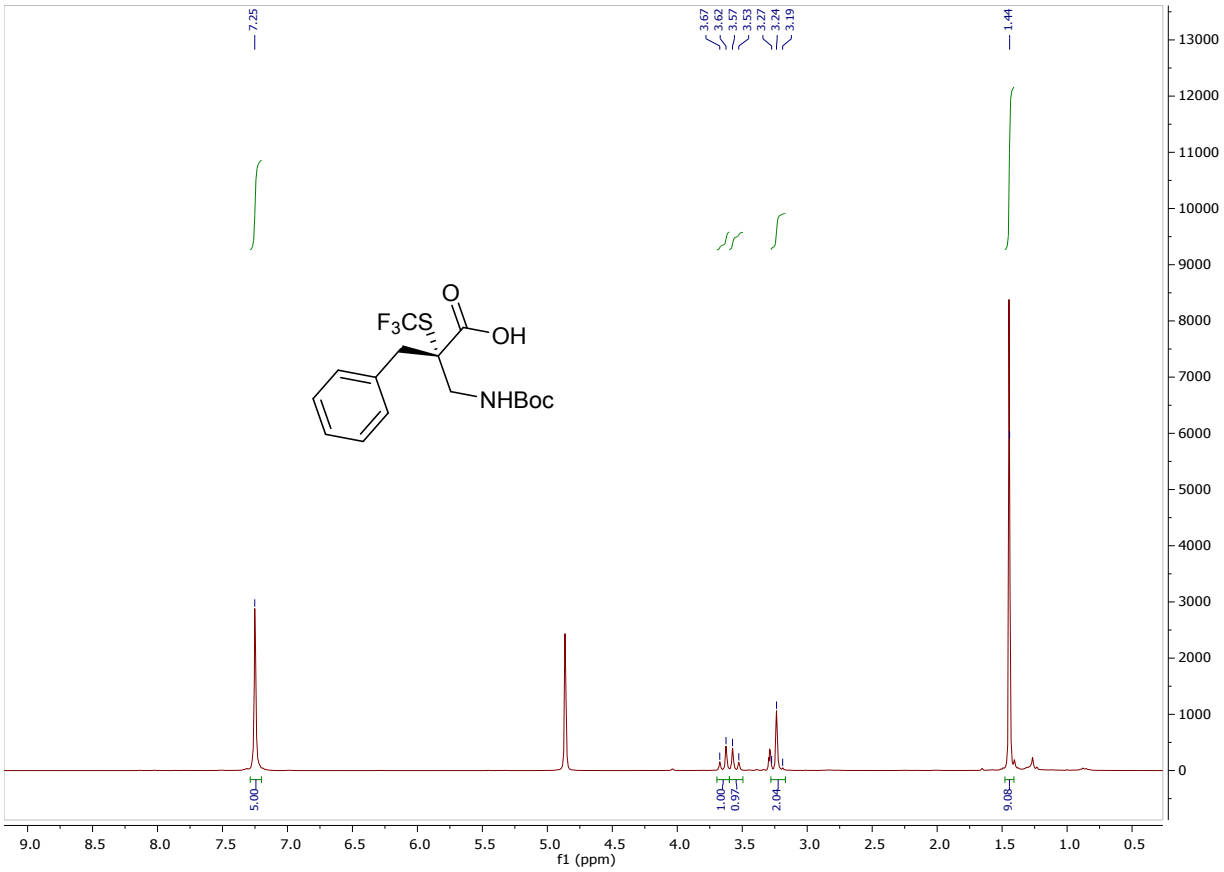
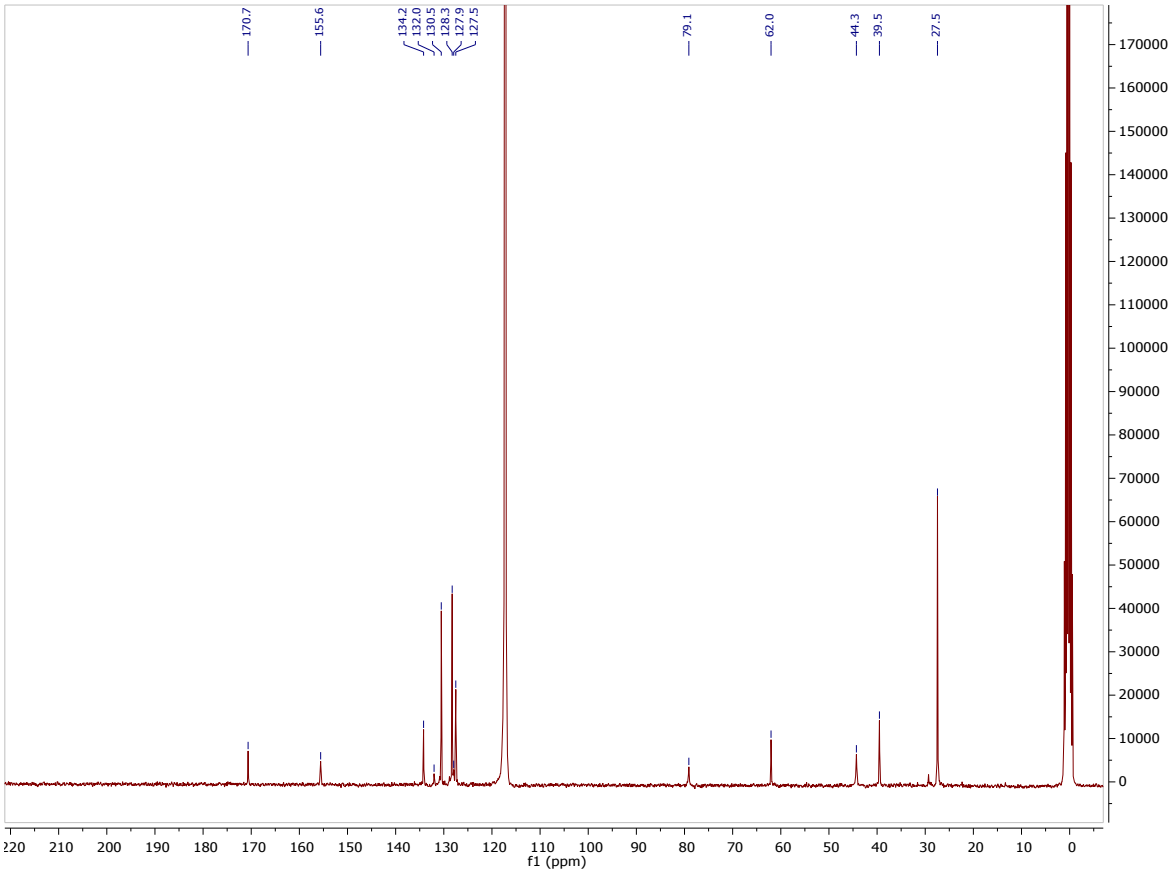
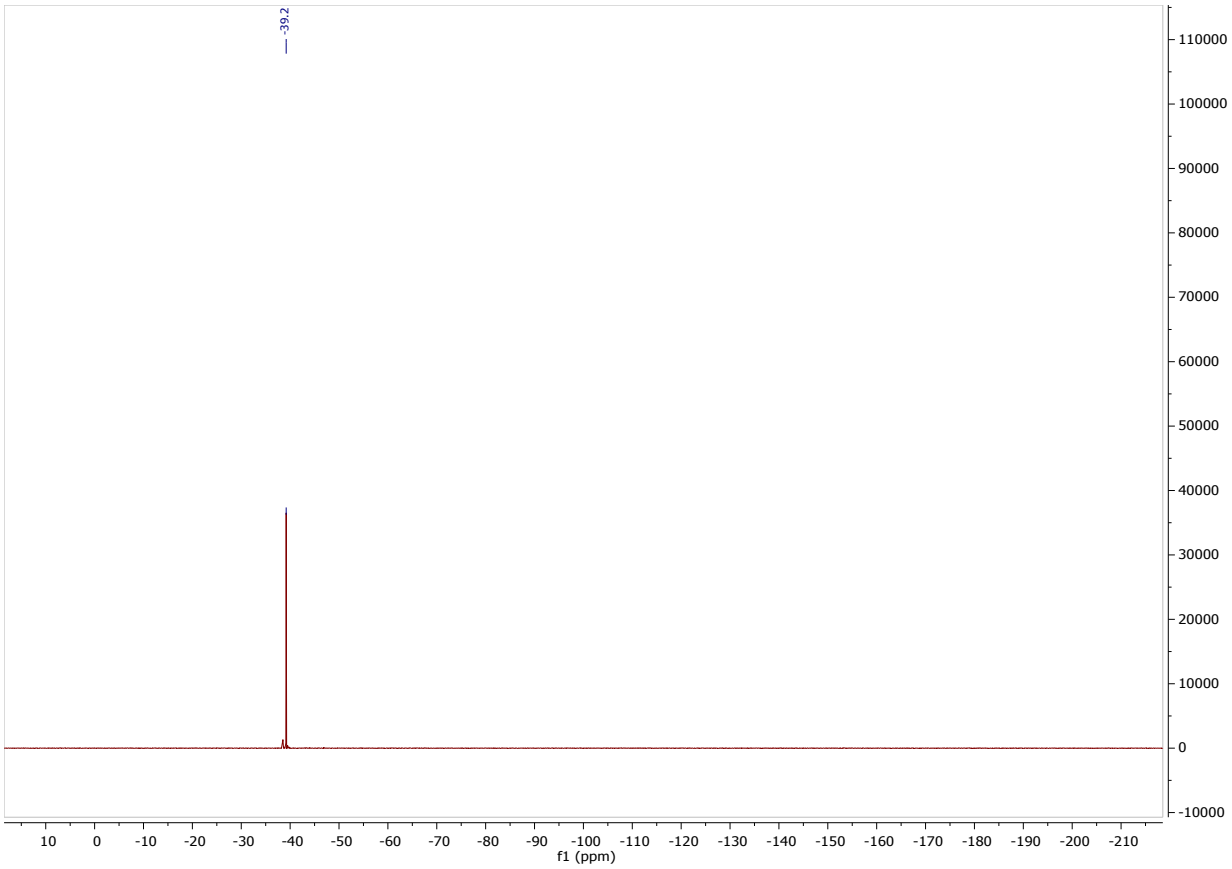
200000
100000
0
-100000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

2-benzyl-3-((*tert*-butoxycarbonyl)amino)-2-((trifluoromethyl)thio)propanoic acid (4)



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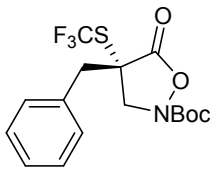
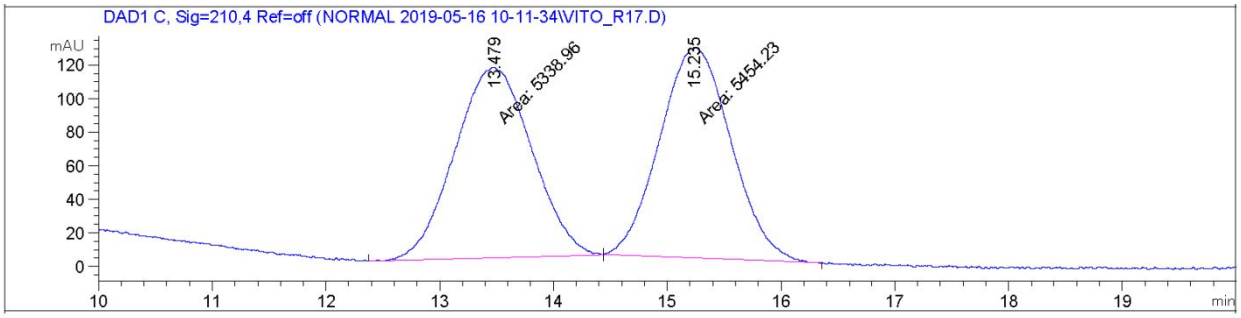
10000
0
-10000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

HPLC Chromatograms

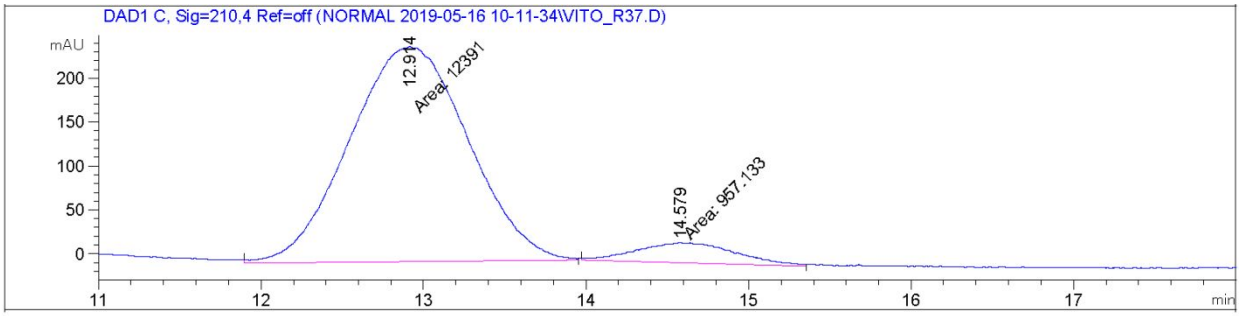
Product **3a**:





Signal 2: DAD1 C, Sig=210,4 Ref=off

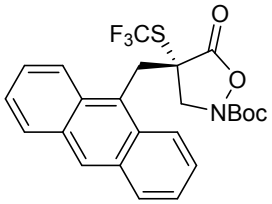
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	13.479	MM	0.7837	5338.95557	113.53867	49.4660
2	15.235	MM	0.7243	5454.23047	125.49737	50.5340
Totals :				1.07932e4	239.03603	

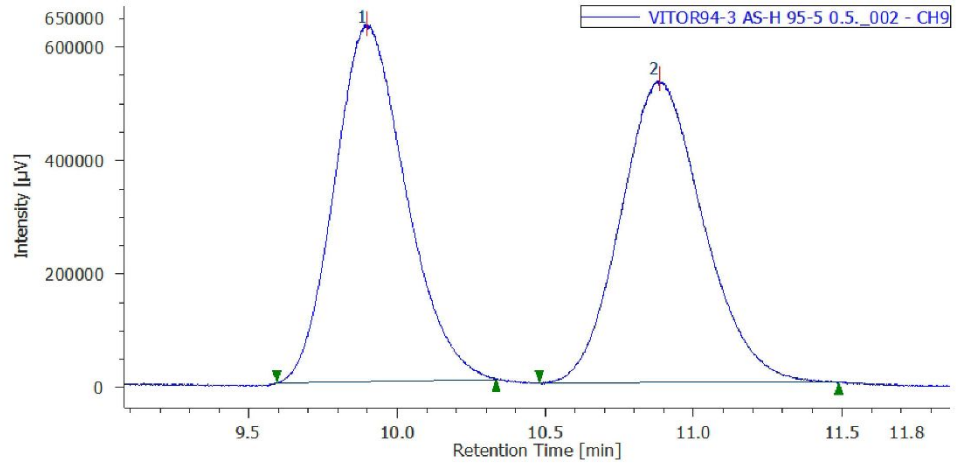


Signal 2: DAD1 C, Sig=210,4 Ref=off

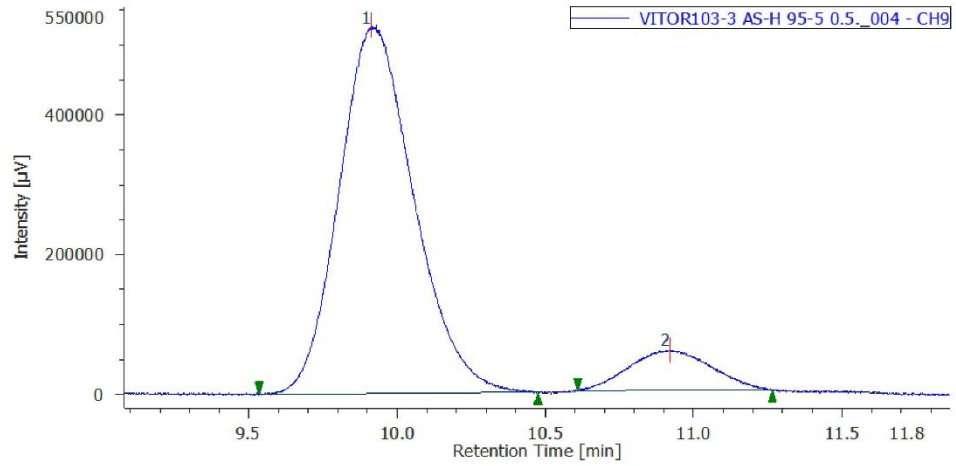
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	12.914	MM	0.8439	1.23910e4	244.70430	92.8295
2	14.579	MM	0.7036	957.13281	22.67181	7.1705
Totals :				1.33481e4	267.37611	

Product **3b**:



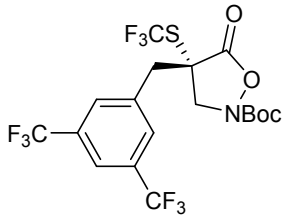


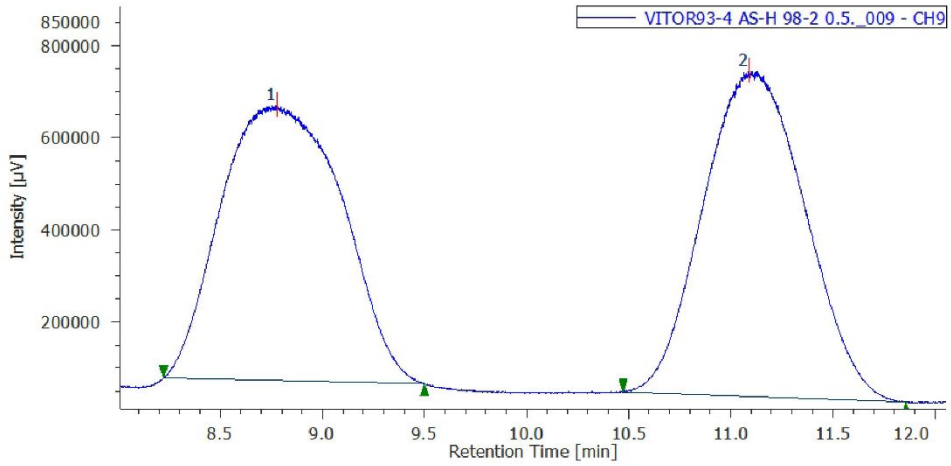
#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	9.899	10498531	630117	50.526	54.129	N/A	8159	2.090	1.183	
2	Unknown	9	10.886	10280075	533995	49.474	45.871	N/A	7342	N/A	1.140	



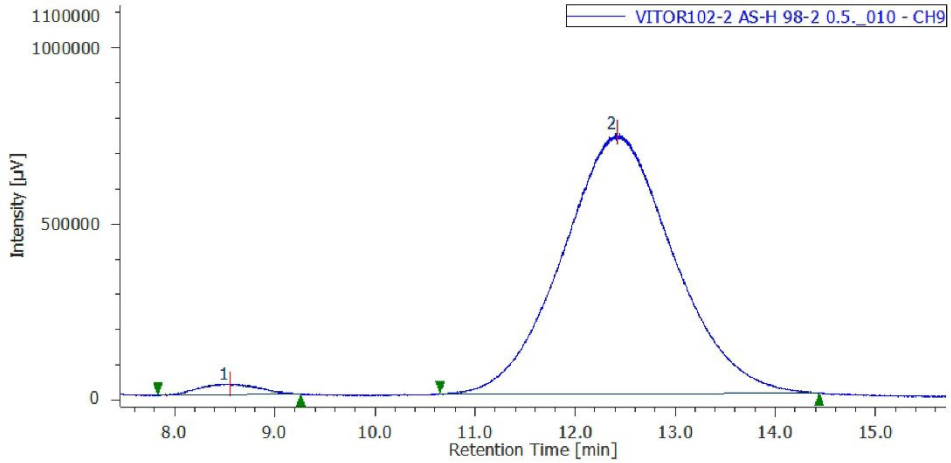
#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	9.913	9210465	526450	89.378	90.182	N/A	7594	2.030	1.209	
2	Unknown	9	10.922	1094566	57314	10.622	9.818	N/A	6519	N/A	1.040	

Product **3c**:



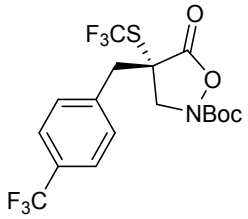


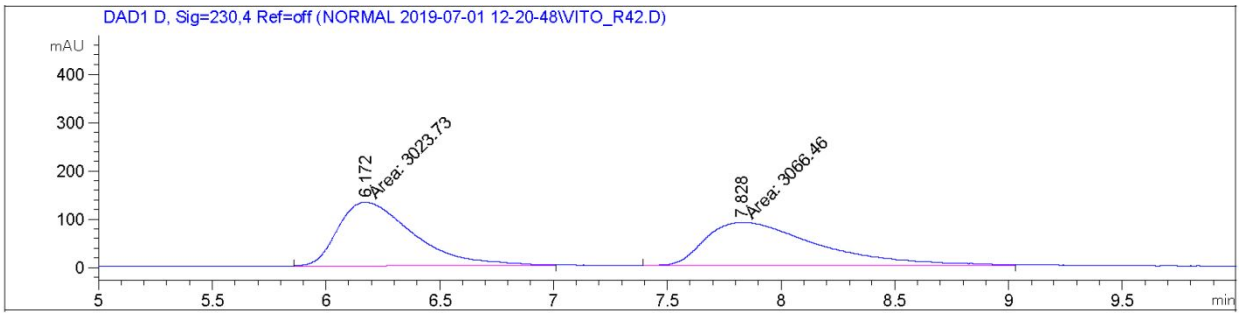
#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	8.777	24603819	596775	50.187	45.765	N/A	868	2.160	1.105	
2	Unknown	9	11.090	24420071	707213	49.813	54.235	N/A	2157	N/A	1.103	



#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	8.552	1232051	30348	2.136	3.951	N/A	817	2.432	0.972	
2	Unknown	9	12.422	56445310	737773	97.864	96.049	N/A	621	N/A	1.063	

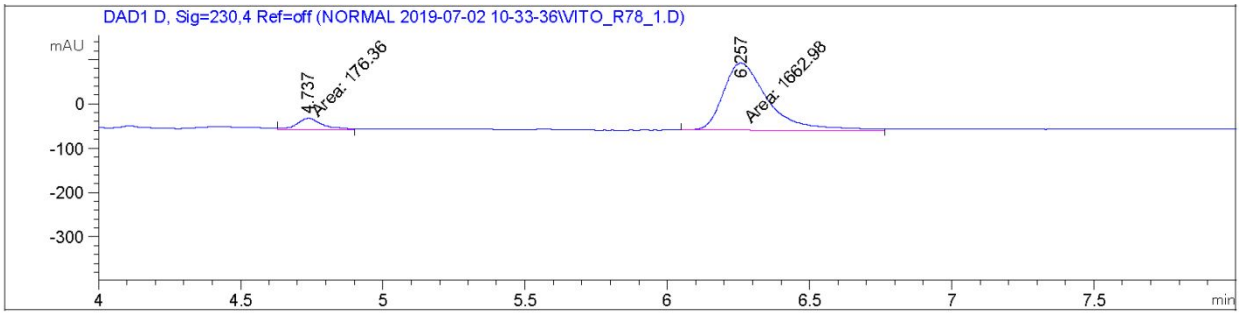
Product **3d**:





Signal 3: DAD1 D, Sig=230,4 Ref=off

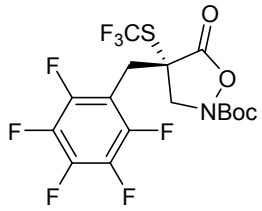
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.172	MM	0.3840	3023.73022	131.25462	49.6492
2	7.828	MM	0.5740	3066.45605	89.04433	50.3508
Totals :				6090.18628	220.29895	

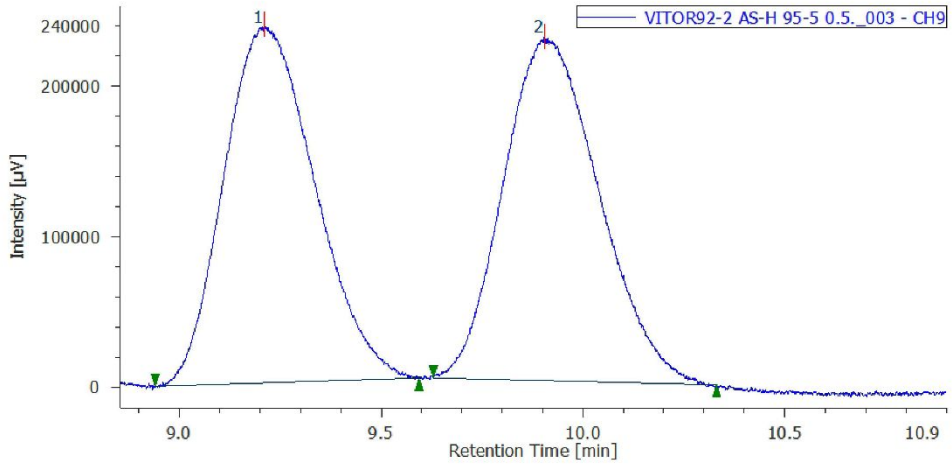


Signal 3: DAD1 D, Sig=230,4 Ref=off

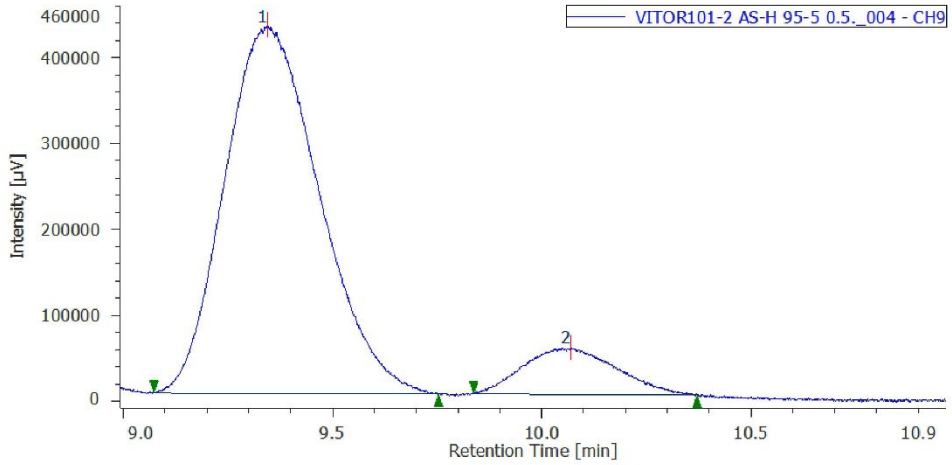
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	4.737	MM	0.1112	176.36011	26.43260	9.5882
2	6.257	MM	0.1826	1662.98303	151.80779	90.4118
Totals :				1839.34314	178.24038	

Product **3e**:



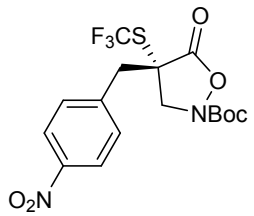


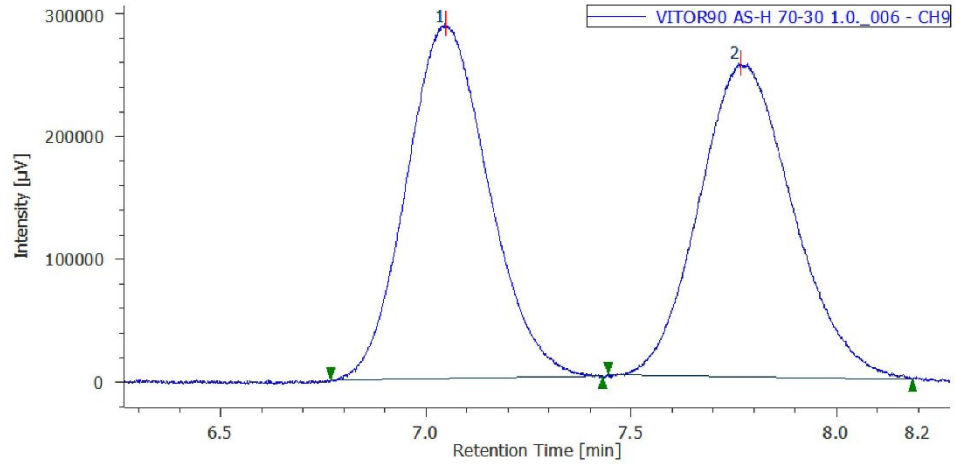
#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	9.210	3696517	237698	49.666	51.007	N/A	7642	1.614	1.205	
2	Unknown	9	9.904	3746216	228308	50.334	48.993	N/A	8104	N/A	1.202	



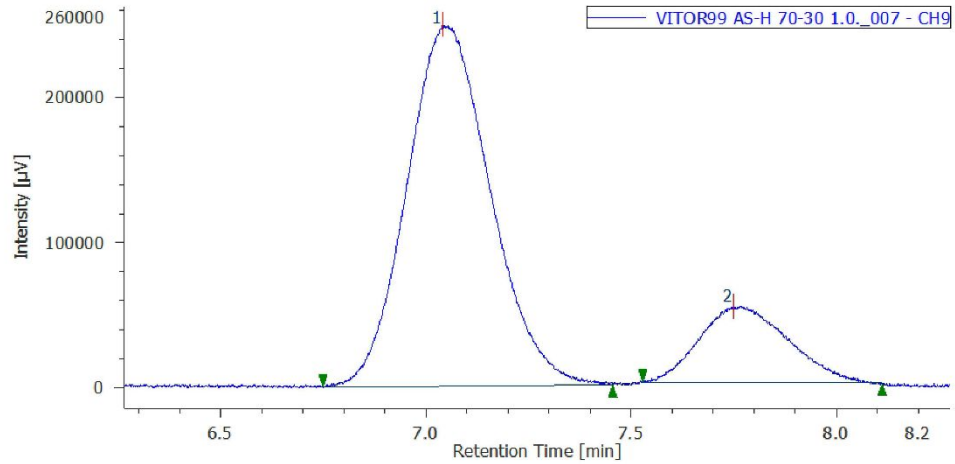
#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	9.345	6717270	429866	88.919	88.770	N/A	7931	1.722	1.209	
2	Unknown	9	10.070	837117	54382	11.081	11.230	N/A	9003	N/A	1.141	

Product **3f**:



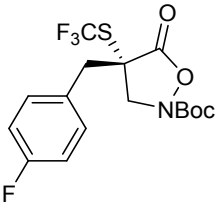


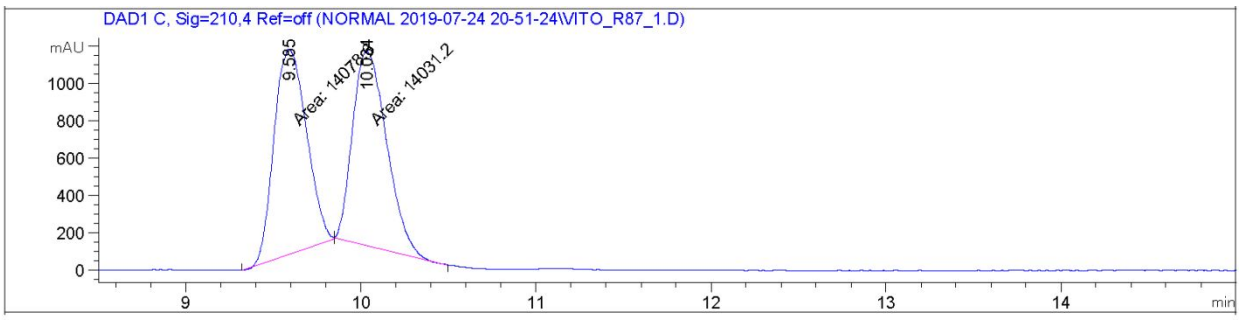
#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	7.048	3998483	288817	49.725	53.104	N/A	5921	1.835	1.118	
2	Unknown	9	7.767	4042639	255050	50.275	46.896	N/A	5496	N/A	1.170	



#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	7.041	3520836	249124	81.768	82.648	N/A	5752	1.809	1.161	
2	Unknown	9	7.750	785053	52305	18.232	17.352	N/A	5616	N/A	1.315	

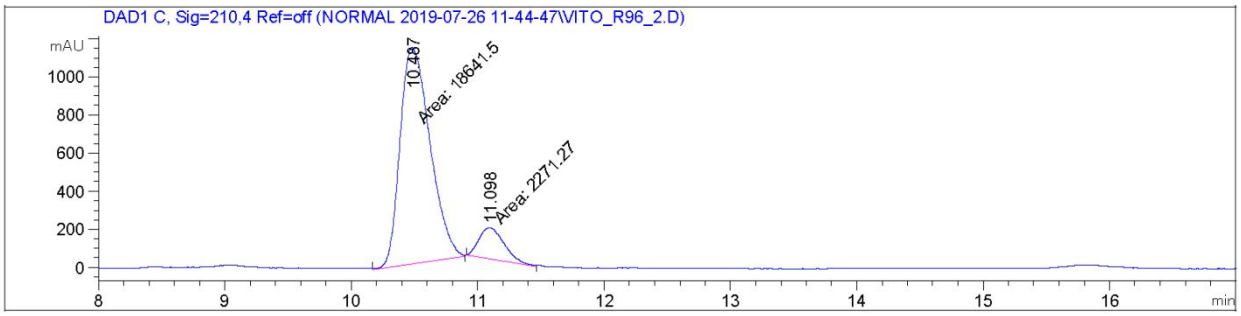
Product **3g**:





Signal 2: DAD1 C, Sig=210,4 Ref=off

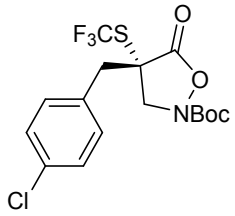
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.585	MM	0.2136	1.40786e4	1098.68665	50.0843
2	10.034	MM	0.2244	1.40312e4	1042.16626	49.9157
Totals :				2.81098e4	2140.85291	

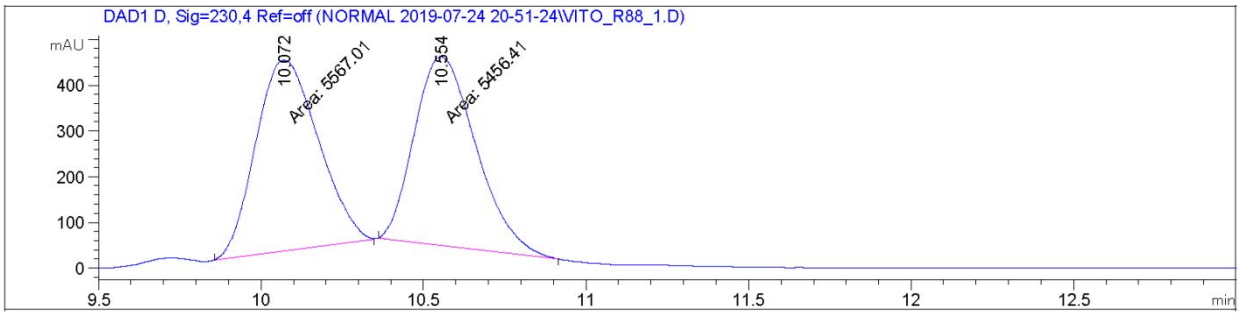


Signal 2: DAD1 C, Sig=210,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.487	MM	0.2739	1.86415e4	1134.33264	89.1393
2	11.098	MM	0.2314	2271.26514	163.56158	10.8607
Totals :				2.09127e4	1297.89423	

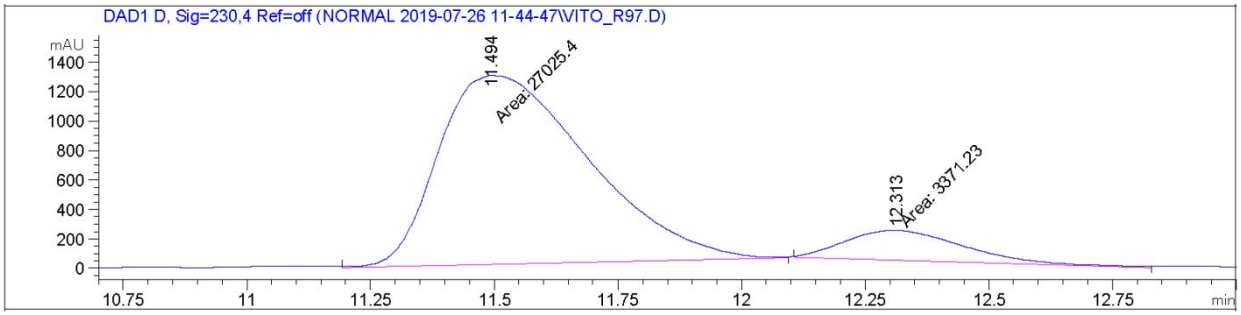
Product **3h**:





Signal 3: DAD1 D, Sig=230,4 Ref=off

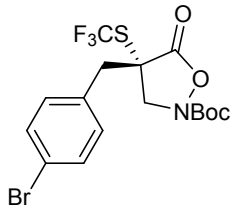
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.072	MM	0.2222	5567.01025	417.65942	50.5017
2	10.554	MM	0.2204	5456.41211	412.55890	49.4983
Totals :				1.10234e4	830.21832	

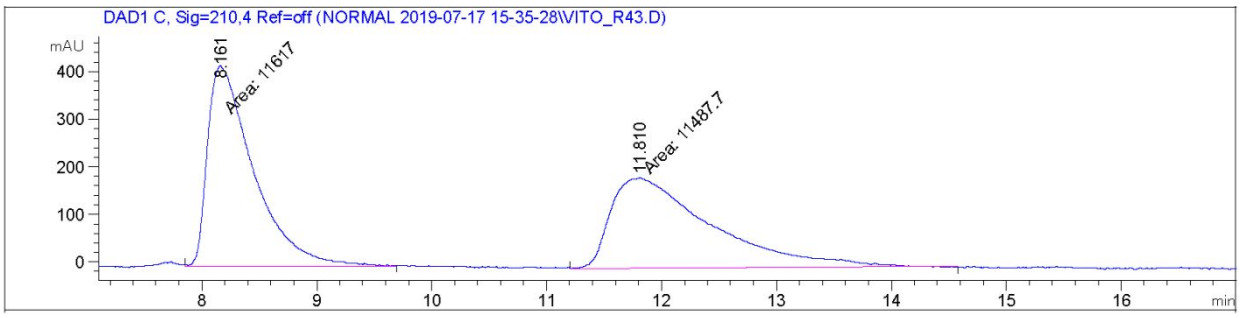


Signal 3: DAD1 D, Sig=230,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.494	MM	0.3505	2.70254e4	1284.96289	88.9092
2	12.313	MM	0.2800	3371.23364	200.69231	11.0908
Totals :				3.03966e4	1485.65520	

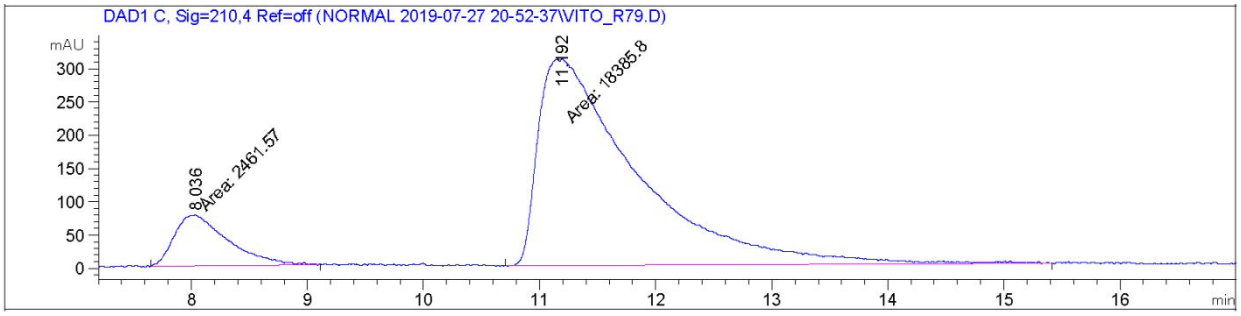
Product **3i**:





Signal 2: DAD1 C, Sig=210,4 Ref=off

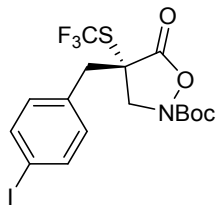
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.161	MM	0.4606	1.16170e4	420.35074	50.2798
2	11.810	MM	1.0066	1.14877e4	190.21274	49.7202
Totals :				2.31047e4	610.56348	

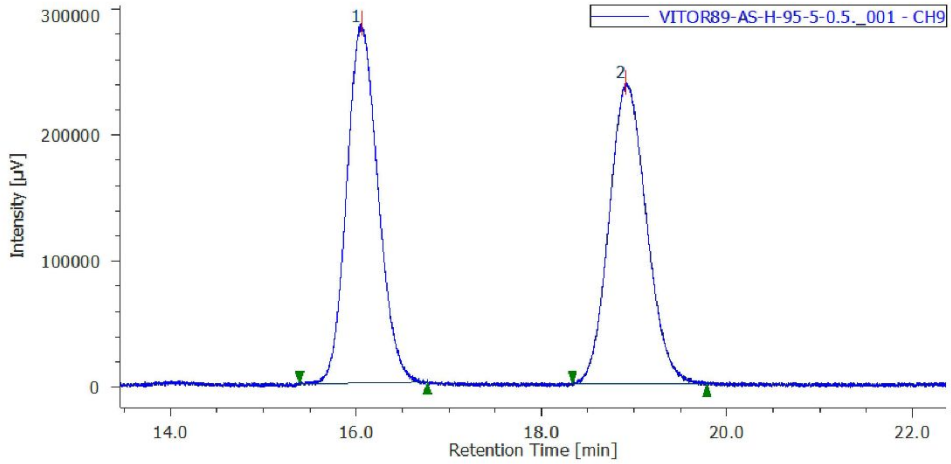


Signal 2: DAD1 C, Sig=210,4 Ref=off

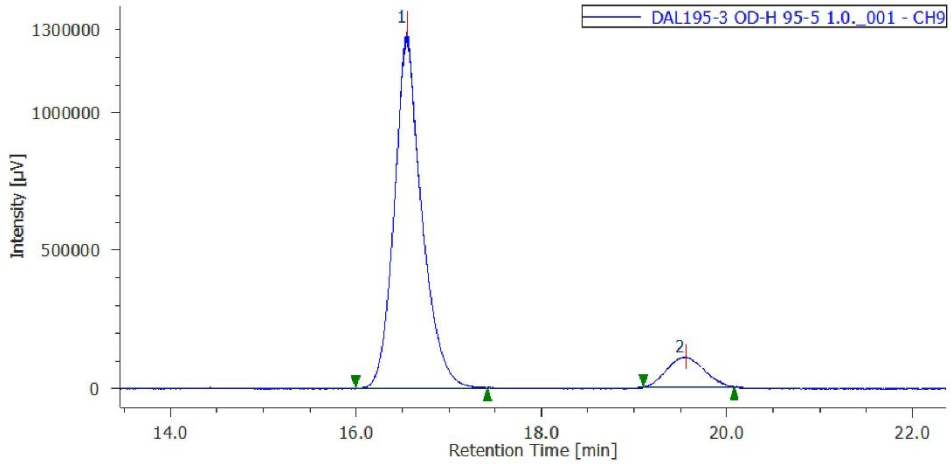
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	8.036	MM	0.5353	2461.57446	76.64464	11.8076
2	11.192	MM	0.9872	1.83858e4	310.39520	88.1924
Totals :				2.08473e4	387.03984	

Product **3j**:



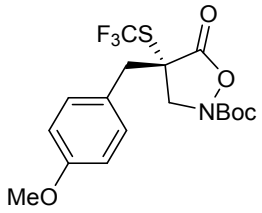


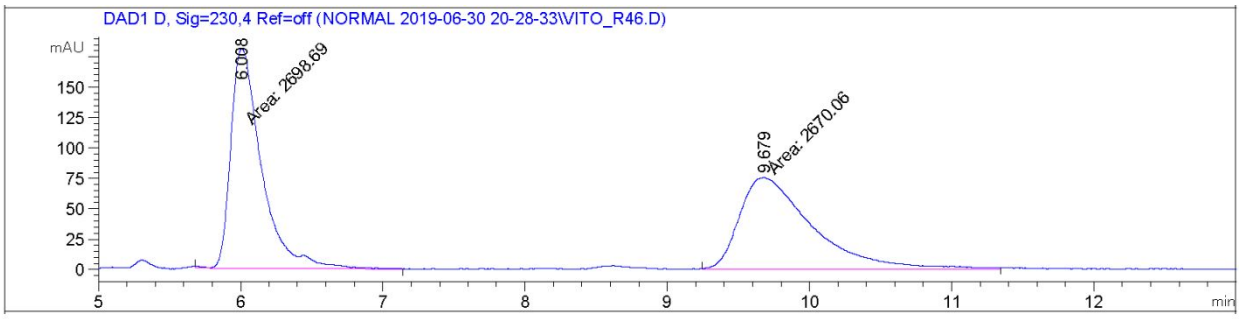
#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	16.058	6663234	285550	49.840	54.432	N/A	10899	4.222	1.125	
2	Unknown	9	18.910	6706049	239053	50.160	45.568	N/A	10466	N/A	1.145	



#	Peak Name	CH	tR [min]	Area [μV·sec]	Height [μV]	Area%	Height%	Quantity	NTP	Resolution	Symmetry Factor	Warning
1	Unknown	9	16.552	26262750	1320255	89.714	92.358	N/A	18011	4.801	1.188	
2	Unknown	9	19.553	3011112	109245	10.286	7.642	N/A	10582	N/A	1.061	

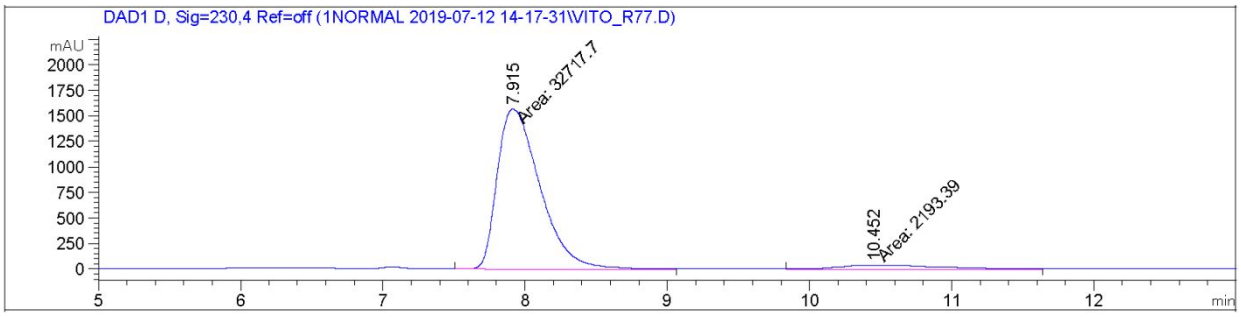
Product **3k**:





Signal 3: DAD1 D, Sig=230,4 Ref=off

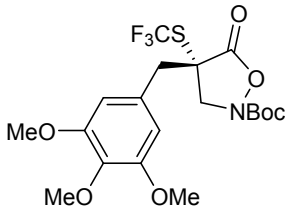
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.008	MM	0.2490	2698.68921	180.60706	50.2666
2	9.679	MM	0.5926	2670.06323	75.08831	49.7334
Totals :				5368.75244	255.69537	

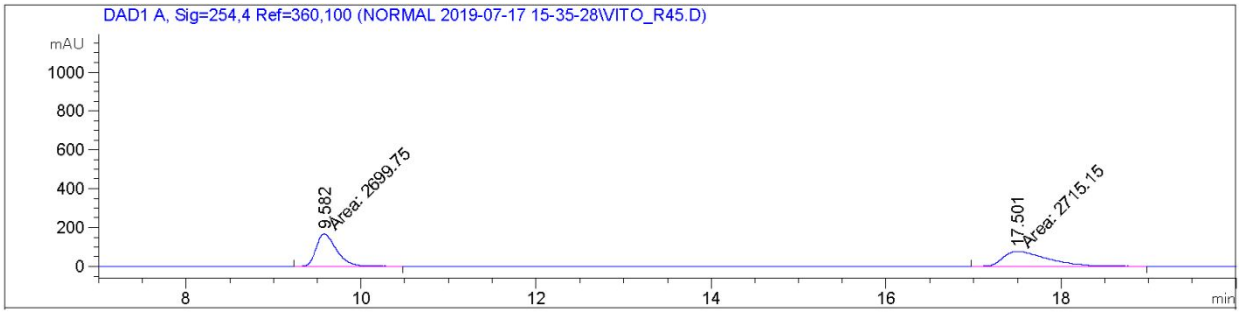


Signal 3: DAD1 D, Sig=230,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	7.915	MM	0.3475	3.27177e4	1569.12622	93.7172
2	10.452	MM	0.8838	2193.38794	41.36155	6.2828
Totals :				3.49111e4	1610.48777	

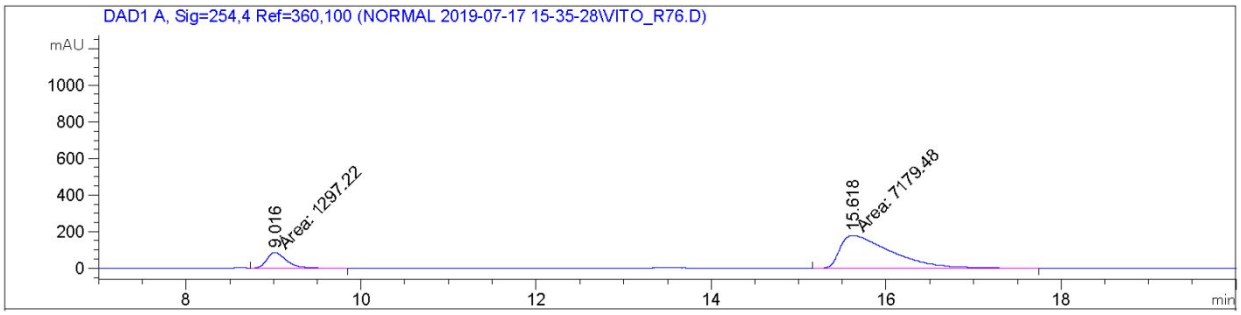
Product **3l**:





Signal 1: DAD1 A, Sig=254,4 Ref=360,100

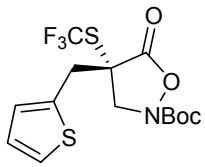
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.582	MM	0.2690	2699.75342	167.25240	49.8578
2	17.501	MM	0.5882	2715.15283	76.92753	50.1422
Totals :				5414.90625	244.17992	

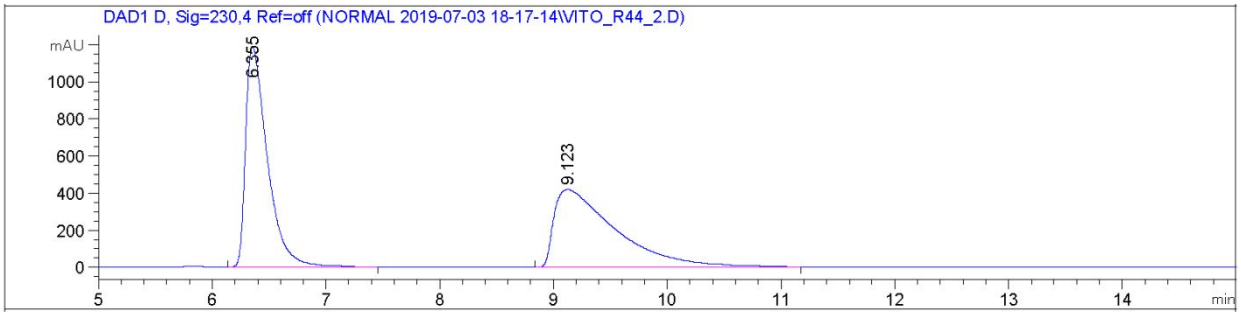


Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	9.016	MM	0.2565	1297.22314	84.29401	15.3034
2	15.618	MM	0.6705	7179.48193	178.45415	84.6966
Totals :				8476.70508	262.74816	

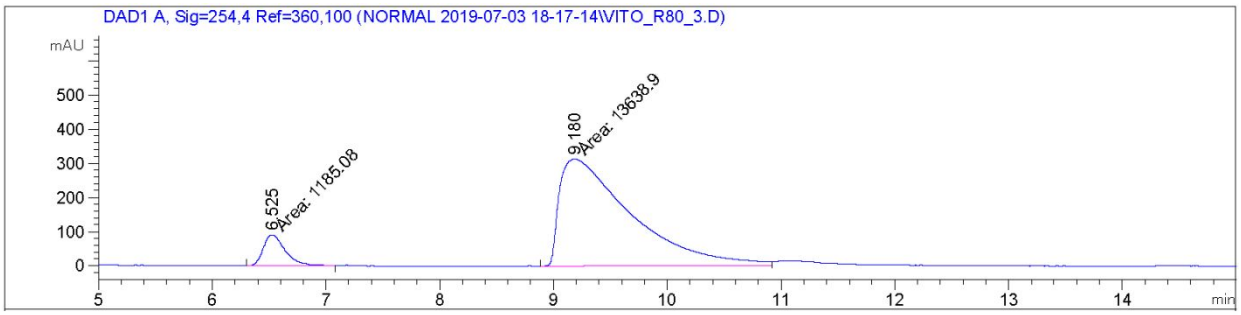
Product **3m**:





Signal 3: DAD1 D, Sig=230,4 Ref=off

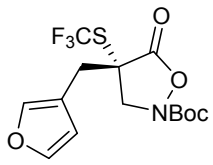
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.355	VB	0.1948	1.58535e4	1187.45618	50.1805
2	9.123	VB	0.5090	1.57394e4	418.27359	49.8195
Totals :				3.15930e4	1605.72977	

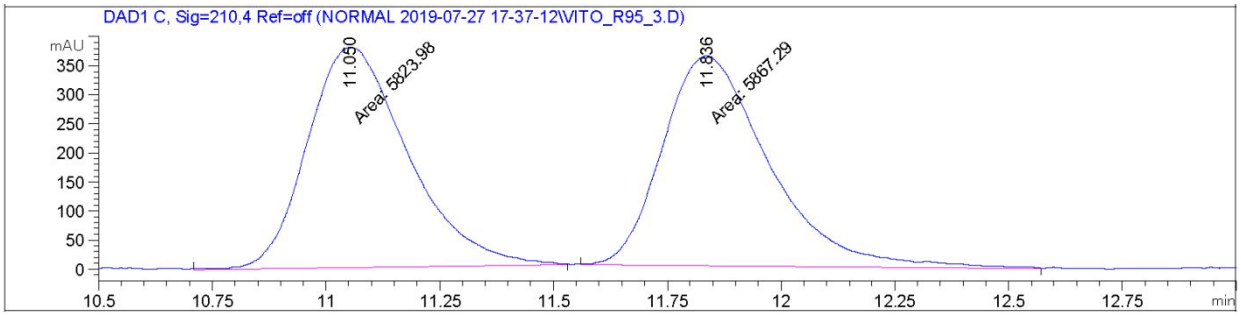


Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	6.525	MM	0.2193	1185.07532	90.07677	7.9943
2	9.180	MM	0.7279	1.36389e4	312.27551	92.0057
Totals :				1.48240e4	402.35229	

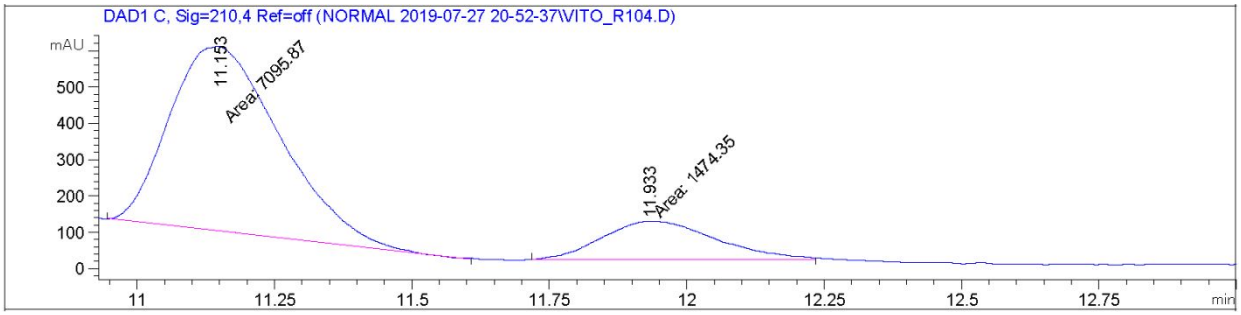
Product **3n**:





Signal 2: DAD1 C, Sig=210,4 Ref=off

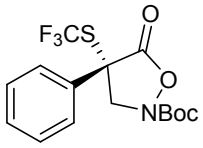
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.050	MM	0.2557	5823.98486	379.58466	49.8148
2	11.836	MM	0.2704	5867.29443	361.67554	50.1852
Totals :				1.16913e4	741.26019	

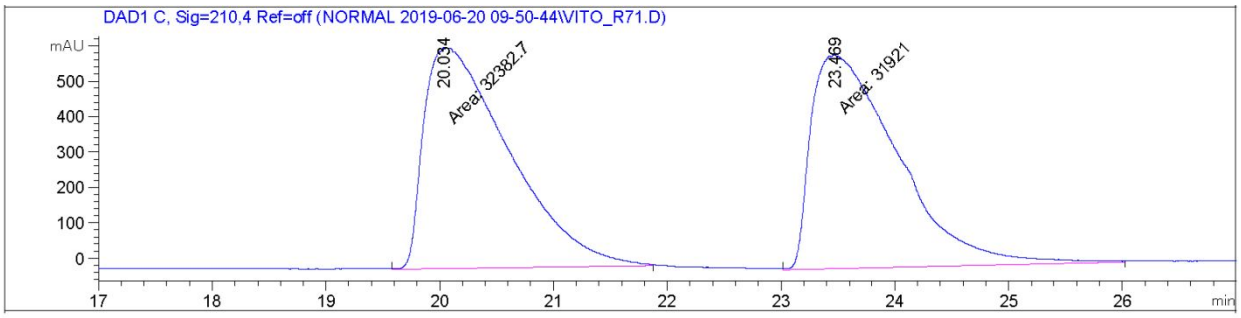


Signal 2: DAD1 C, Sig=210,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	11.153	MM	0.2334	7095.86572	506.65039	82.7968
2	11.933	MM	0.2362	1474.35132	104.02129	17.2032
Totals :				8570.21704	610.67168	

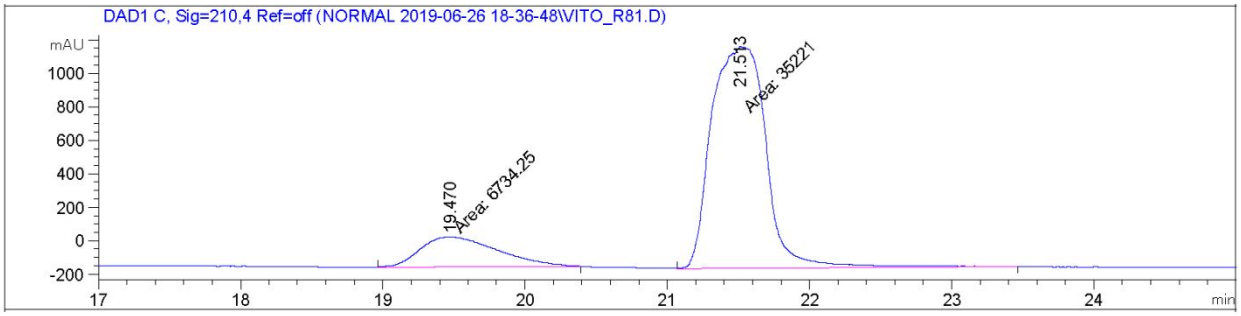
Product **3o**:





Signal 2: DAD1 C, Sig=210,4 Ref=off

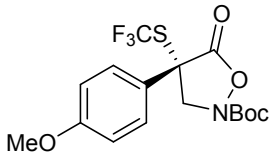
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	20.034	MM	0.8644	3.23827e4	624.34149	50.3590
2	23.469	MM	0.8827	3.19210e4	602.69580	49.6410
Totals :				6.43037e4	1227.03729	

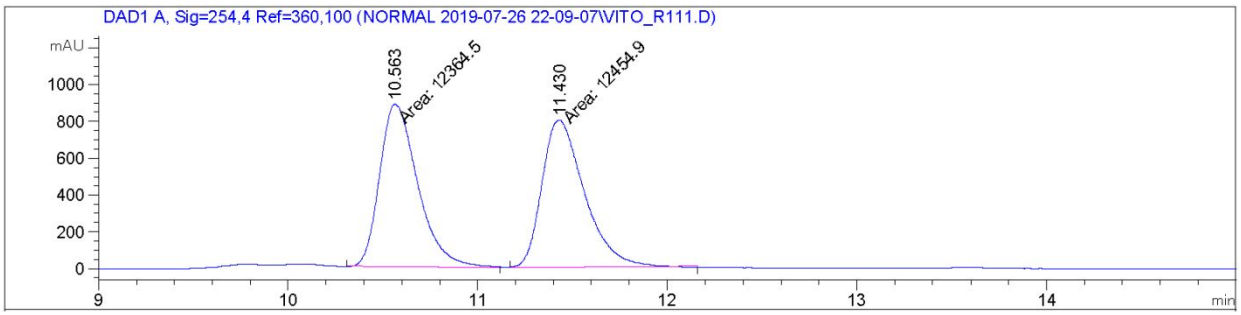


Signal 2: DAD1 C, Sig=210,4 Ref=off

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	19.470	MM	0.6300	6734.24658	178.15094	16.0510
2	21.513	MM	0.4432	3.52210e4	1324.56189	83.9490
Totals :				4.19552e4	1502.71283	

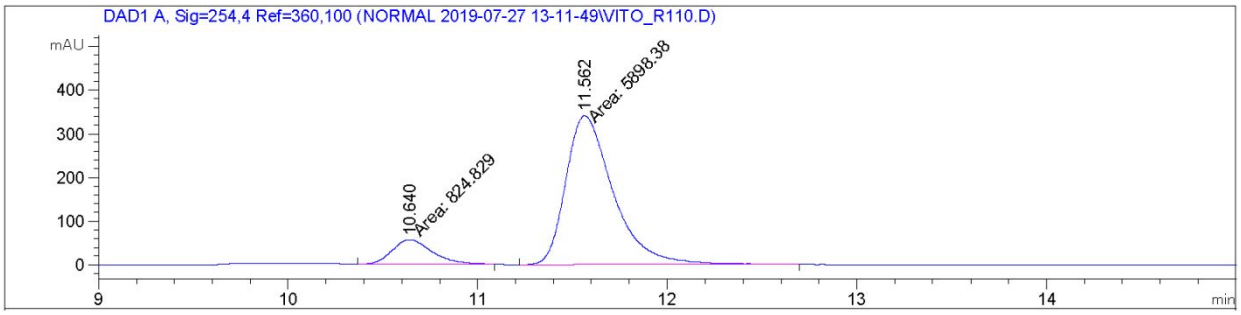
Product **3p**:





Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.563	MM	0.2331	1.23645e4	884.00287	49.8179
2	11.430	MM	0.2592	1.24549e4	800.99219	50.1821
Totals :				2.48193e4	1684.99506	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	10.640	MM	0.2435	824.82928	56.44827	12.2684
2	11.562	MM	0.2882	5898.37891	341.14554	87.7316
Totals :				6723.20819	397.59380	