Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Copper(I)-Catalyzed asymmetric [3+2] cycloaddition of *N*-ester acylhydrazones and β-trifluoromethyl-α,β-unsaturated ketones

Bo Zhu,* Huihui Fan, Yanan Ding, Yubing Zhai, Le Wang, Mengqi Wang, Gongming Zhu, and Junbiao Chang*

NMPA Key Laboratory for Research and Evaluation of Innovative Drug, Henan Key Laboratory of Organic Functional Molecule and Drug Innovation, School of Chemistry and Chemical Engineering, Henan Normal University, Henan, 453007, P. R. China

E-mail: zbtiantang@126.com; cjb@htu.edu.cn

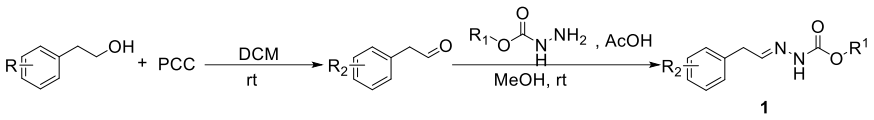
content

1. General information

All solvents and reagents were purchased from commercial sources and purified according to established procedures before use. ^{1}H NMR spectra were recorded on Bruker Avance III HD 600 or Avance 400 MHz spectrometer. Chemical shifts are recorded in ppm relative to tetramethylsilane and with the solvent resonance as the internal standard. Data are reported as follows: chemical shift, multiplicity (s = singlet, d = doublet, dd = doublet of doublets, t = triplet, q = quaternary, m = multiplet), coupling constants (Hz), integration. $^{13}C\{^{1}H\}$ NMR data were collected on Bruker Avance III HD 150 or Avance 100 MHz spectrometer. Chemical shifts are reported in ppm from the tetramethylsilane with the solvent resonance as internal standard. Enantiomer excesses were determined by chiral HPLC analysis on Chiralcel IA/IB/IC/ID/IF/IG/IH/MD/OD–H/OJ–H in comparison with the authentic racemates. Chiral HPLC analysis was operated at Thermo scientific Dionex Ultimate 3000. Optical rotations were reported as follows: $[\alpha]_D^T$ (c: g/100 mL, in solvent). Optical rotations recorded on Autopol Automatic Polarimeter. HRMS was obtained by an ABI/Sciex QStar Mass Spectrometer (ESI). All melting points were conducted on a digital melting point apparatus and were uncorrected. TLC was performed on glass-backed silica plate.

2. Synthesis of substrates

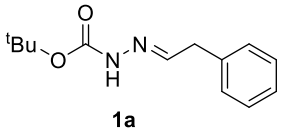
2.1 General procedure for the synthesis of substrates **1**



Pyridinium chlorochromate (7.5 mmol, 1.5 eq) and respective phenylethanol (5 mmol, 1.0 eq) dissolved in 25 mL dichloromethane, the resultant mixture was stirred for 5 h. Following this, the reaction was filtered through a silica plug and washed through with diethyl ether, and the solvent was removed to give the crude phenylacetaldehyde product (Colorless oil, 40-60% yields).

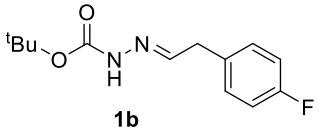
To a solution of *tert*-butyl carbazate (10 mmol, 1.0 eq) in MeOH (30 mL) was added the respective phenylacetaldehyde (10 mmol, 1.0 eq) and glacial aceticacid (0.3 mL). The mixture was stirred at room temperature for 30 min and then concentrated. The resulting white solid obtained was dried in a vacuum oven and used without further purification.

2.2 Characterization data of starting materials not previously reported



1a

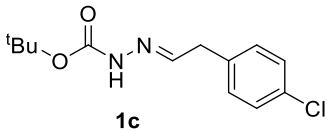
(*E*)-*tert*-butyl 2-(2-phenylethylidene)hydrazinecarboxylate (1a): White solid; 60% yield, m.p.: 77.6 – 77.9 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.69 (s, 1H), 7.34 – 7.28 (m, 2H), 7.26 – 7.16 (m, 4H), 3.63 (d, *J* = 5.8 Hz, 2H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.6, 145.5, 136.7, 129.1, 128.9, 127.0, 81.3, 38.9, 28.4; **HRMS** (ESI) calcd. for $C_{13}H_{18}N_2O_2Na$ ($[M+Na]^+$): 257.1260, found: 257.1257.



1b

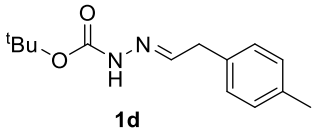
(*E*)-*tert*-butyl 2-(2-(4-fluorophenyl)ethylidene)hydrazinecarboxylate (1b): White

solid; 64% yield, m.p.: 99.9 – 100.1 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.25 – 7.09 (m, 3H), 7.08 – 6.86 (m, 2H), 3.59 (d, *J* = 5.8 Hz, 2H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 162.0 (d, *J* =243.5 Hz), 152.6, 145.2, 132.3 (d, *J* =3.5 Hz) 130.5 (d, *J* =8.0 Hz), 115.7 (d, *J* =21.6 Hz), 81.4, 38.1, 32.5, 28.4; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -116.13; **HRMS** (ESI) calcd. for $C_{13}H_{17}FN_2O_2Na$ ($[M+Na]^+$): 275.1166, found: 275.1167.



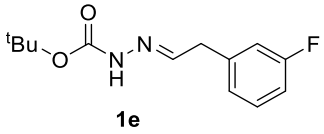
1c

(*E*)-*tert*-butyl 2-(2-(4-chlorophenyl)ethylidene)hydrazinecarboxylate (1c): White solid; 78% yield, m.p.: 119.8 − 120.3 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.71 (s, 1H), 7.31 – 7.24 (m, 3H), 7.21 – 7.10 (m, 3H), 3.59 (d, *J* = 5.8 Hz, 2H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.6, 144.8, 135.1, 132.9, 130.4, 129.0, 81.7, 38.3, 28.4; **HRMS** (ESI) calcd. for $C_{13}H_{17}ClN_2O_2Na$ ($[M+Na]^+$): 291.0871, found: 291.0866.



1d

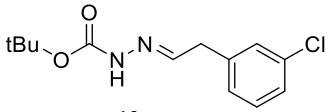
(*E*)-*tert*-butyl 2-(2-(p-tolyl)ethylidene)hydrazinecarboxylate (1d): White solid; 67% yield, m.p.: 80.3 − 80.9 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62 (s, 1H), 7.21 – 6.98 (m, 5H), 3.59 (d, *J* = 5.8 Hz, 2H), 2.32 (s, 3H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.6, 145.8, 136.6, 133.5, 129.6, 129.0, 81.3, 38.5, 28.4, 21.1; **HRMS** (ESI) calcd. for $C_{14}H_{20}N_2O_2Na$ ($[M+Na]^+$): 271.1417, found: 271.1414.



1e

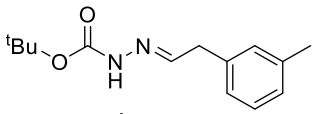
(*E*)-*tert*-butyl 2-(2-(3-fluorophenyl)ethylidene)hydrazinecarboxylate (1e): White solid; 80% yield, m.p.: 87.2 − 87.5 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.73 (s, 1H), 7.32 – 7.17 (m, 2H), 7.01 – 6.96 (m, 1H), 6.96 – 6.89 (m, 2H), 3.62 (d, *J* = 5.8 Hz, 2H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 163.2 (d, *J* =244.8 Hz), 152.6, 144.6, 139.2 (d, *J* =7.6 Hz), 130.3 (d, *J* =8.2 Hz), 124.7 (d, *J* =2.9 Hz), 116.0 (d, *J*

=21.5 Hz), 113.9 (d, *J* =20.9 Hz), 81.5, 38.6, 28.4; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -112.90; **HRMS** (ESI) calcd. for $C_{13}H_{17}FN_2O_2Na$ ($[M+Na]^+$): 275.1166, found: 275.1165.



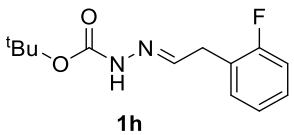
1f

(*E*)-*tert*-butyl 2-(2-(3-chlorophenyl)ethylidene)hydrazinecarboxylate (1f): White solid; 77% yield, m.p.: 104.6 − 105.0 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.78 (s, 1H), 7.36 – 7.15 (m, 4H), 7.14 – 6.94 (m, 1H), 3.59 (d, *J* = 5.8 Hz, 2H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.6, 144.4, 138.7, 134.7, 130.1, 129.1, 127.3, 127.2, 81.5, 38.5, 28.4; **HRMS** (ESI) calcd. for $C_{13}H_{17}ClN_2O_2Na$ ($[M+Na]^+$): 291.0871, found: 291.0865.



1g

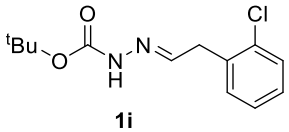
(*E*)-*tert*-butyl 2-(2-(*m*-tolyl)ethylidene)hydrazinecarboxylate (1g): White solid; 75% yield, m.p.: 71.4 − 71.9 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.65 (s, 1H), 7.24 – 7.15 (m, 2H), 7.09 – 6.96 (m, 3H), 3.59 (d, *J* = 5.8 Hz, 2H), 2.33 (s, 3H), 1.51 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.6, 145.7, 138.6, 136.6, 129.9, 128.9, 127.719, 126.1, 81.3, 38.9, 28.4, 21.5; **HRMS** (ESI) calcd. for $C_{14}H_{20}N_2O_2Na$ ($[M+Na]^+$): 271.1417, found: 271.1413.



1h

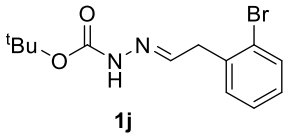
(*E*)-*tert*-butyl 2-(2-(2-fluorophenyl)ethylidene)hydrazinecarboxylate (1h): White solid; 80% yield, m.p.: 70.4 − 70.9 °C; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.05 (s, 1H), 7.33 – 7.23 (m, 1H), 7.24 – 7.16 (m, 2H), 7.10 – 6.97 (m, 2H), 3.63 (d, *J* = 5.7 Hz, 2H), 1.48 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 161.0 (d, *J* =244.1 Hz), 152.7, 144.1, 131.1(d, *J* =4.4 Hz), 128.7 (d, *J* =8.0 Hz), 124.4 (d, *J* =3.6 Hz), 123.7 (d, *J* =15.8 Hz), 115.4 (d, *J* =21.6Hz), 81.1, 32.1 (d, *J* =2.4 Hz), 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -117.84; **HRMS** (ESI) calcd. for $C_{13}H_{17}FN_2O_2Na$ ($[M+Na]^+$):

275.1166, found: 275.1167.



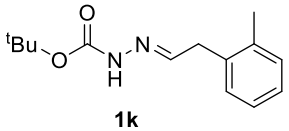
1i

(*E*)-*tert*-butyl 2-(2-(2-chlorophenyl)ethylidene)hydrazinecarboxylate (1i): White solid; 82% yield, m.p.: 102.4 − 102.8 ºC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 (s, 1H), 7.41 – 7.33 (m, 1H), 7.33 – 7.22 (m, 2H), 7.22 – 7.14 (m, 2H), 3.76 (d, *J* = 5.7 Hz, 2H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.6, 144.0, 134.7, 134.1, 131.1, 129.7, 128.5, 127.2, 81.3, 36.6, 28.4; **HRMS** (ESI) calcd. for $C_{13}H_{17}ClN_2O_2Na$ ($[M+Na]^+$): 291.0871, found: 291.0861.



1j

(*E*)-*tert*-butyl 2-(2-(2-bromophenyl)ethylidene)hydrazinecarboxylate (4j): White solid; 65% yield, m.p.: 109.6 − 110.0 ºC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.65 (s, 1H), 7.58 – 7.51 (m, 1H), 7.33 – 7.19 (m, 3H), 7.16 – 7.03 (m, 1H), 3.79 (d, *J* = 5.7 Hz, 2H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.5, 144.1, 136.6, 133.1, 131.3, 128.8, 128.0, 124.6, 81.4, 39.1, 28.4; **HRMS** (ESI) calcd. for $C_{13}H_{17}BrN_2O_2Na$ ($[M+Na]^+$): 335.0366, found: 335.0356.

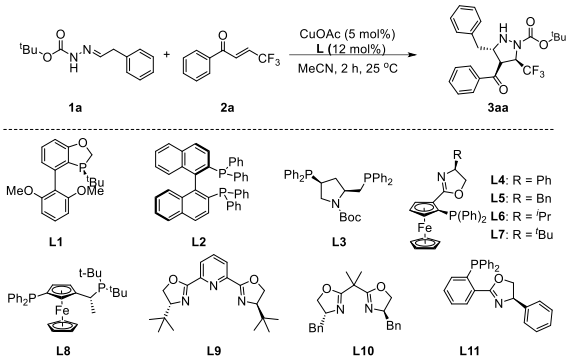


1k

(*E*)-*tert*-butyl 2-(2-(o-tolyl)ethylidene)hydrazinecarboxylate (4k): White solid; 65% yield, m.p.: 107.9 − 108.3 ºC; **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.61 (s, 1H), 7.35 – 7.08 (m, 5H), 3.63 (d, *J* = 5.4 Hz, 2H), 2.32 (s, 3H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 152.6, 145.3, 136.9, 135.0, 130.6, 129.6, 127.2, 126.4, 81.3, 36.6, 28.4, 19.8; **HRMS** (ESI) calcd. for $C_{14}H_{20}N_2O_2Na$ ($[M+Na]^+$): 271.1417, found: 271.1412.

3. Optimization of Asymmetric Reaction Conditions

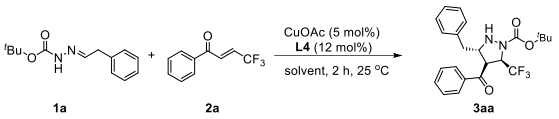
Table S1 The Effect of Ligands[a]



entry	ligand	yield (%)[b]	ee (%)[c]	dr[d]
1	**L1**	84	40	>20:1
2	**L2**	83	13	>20:1
3	**L3**	72	44	>20:1
4	**L4**	84	84	>20:1
5	**L5**	87	79	>20:1
6	**L6**	75	83	>20:1
7	**L7**	89	52	>20:1
8	**L8**	87	22	>20:1
9	**L9**	88	2	>20:1
10	**L10**	74	8	>20:1
11	**L11**	74	1	>20:1

[a] Reaction conditions: **1a** (0.10 mmol), **2a** (0.12 mmol), CuOAc (5 mol%), and chiral Ligand (12 mol%) in MeCN (1.0 mL) at 25 °C under argon atmosphere. [b] Yields of isolated product. [c] The *ee* values were determined by HPLC analysis on a chiral stationary phase. [d] The dr was determined by ^{1}H NMR analysis of the reaction mixture.

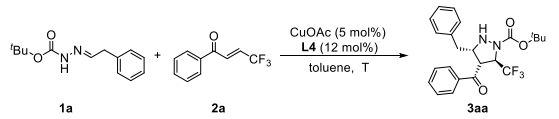
Table S2 The effect of solvents[a]



entry	solvent	yield (%)[b]	ee (%)[c]	dr[d]
1	DCM	84	87	>20:1
2	THF	77	86	>20:1
3	Et_2O	87	87	>20:1
4	toluene	88	90	>20:1
5	PhCl	83	88	>20:1
6[e]	C_6HF_5	30	71	>20:1
7	PhBr	88	90	>20:1
8	$PhCF_3$	88	90	>20:1
9	mesitylene	78	90	>20:1
10	*o*-xylene	90	88	>20:1
11	*m*-xylene	88	90	>20:1

[a] Reaction conditions: **1a** (0.10 mmol), **2a** (0.12 mmol), CuOAc (5 mol%), and **L4** (12 mol%) in solvent (1.0 mL) at 25 °C under argon atmosphere. [b] Yields of isolated product. [c] The *ee* values were determined by HPLC analysis on a chiral stationary phase. [d] The dr was determined by ^{1}H NMR analysis of the reaction mixture.

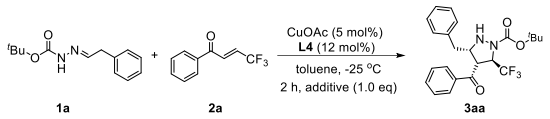
Table S3 The effect of temperature[a]



entry	T (°C)	time (h)	yield (%)[b]	ee (%)[c]	dr[d]
1	0	4	94	92	>20:1
2	-25	10	88	95	>20:1

[a] Reaction conditions: **1a** (0.10 mmol), **2a** (0.12 mmol), CuOAc (5 mol%), and **L4** (12 mol%) in toluene (1.0 mL) under argon atmosphere. [b] Yields of isolated product. [c] The *ee* values were determined by HPLC analysis on a chiral stationary phase. [d] The dr. was determined by ^{1}H NMR analysis of the reaction mixture.

Table S4 The effect of additive[a]

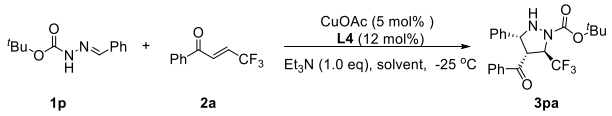


1a 2a 3aa

entry	additive	yield (%)[b]	ee (%)[c]	dr[d]
1	K_2CO_3	78	94	>20:1
2	Cs_2CO_3	86	92	>20:1
3	Et_3N	94	95	>20:1
4	DBU	75	85	>20:1
5	Et_2NH	46	94	>20:1
6	^tBuNH	85	90	>20:1
7	1,2-Ethanediamine	92	94	>20:1

[a] Reaction conditions: **1a** (0.10 mmol), **2a** (0.12 mmol), CuOAc (5 mol%), **L4** (12 mol%) and additive (1.0 eq) in toluene (1.0 mL) at -25 ºC under argon atmosphere. [b] Yields of isolated product. [c] The *ee* values were determined by HPLC analysis on a chiral stationary phase. [d] The dr was determined by ^{1}H NMR analysis of the reaction mixture.

Table S5 The effect of solvent[a]



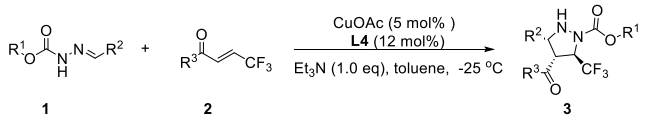
1p 2a 3pa

entry	solvent	time (h)	yield (%)[b]	ee (%)[c]	dr[d]
1	toluene	24	80	73	>20:1
2	THF	17	74	79	>20:1
3	Et_2O	17	82	77	>20:1
4	MeCN	36	67	90	>20:1

[a] Reaction conditions: **1p** (0.10 mmol), **2a** (0.12 mmol), CuOAc (5 mol%), **L4** (12 mol%) and Et_3N (1.0 eq) in solvent (1.0 mL) at -25 ºC under argon atmosphere. [b] Yields of isolated product. [c] The *ee* values were determined by HPLC analysis on a chiral stationary phase. [d] The dr was determined by ^{1}H NMR analysis of the reaction mixture.

4. General procedure for the catalytic asymmetric reaction

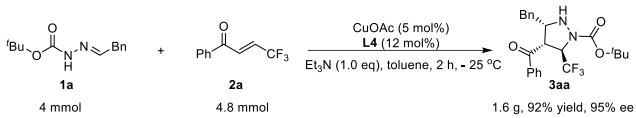
General procedure for the asymmetric [3+2] cycloaition reaction catalytyzed by Cu(I)/Ph-Phosferrox complex



Under argon atmosphere, CuOAc (0.61 mg, 5 mol%) and **L4** (6.18 mg, 12 mol%) were dissolved in 1.0 mL toluene, and stirred at room temperature for 1 h. The reaction temperatue was dropped -25 ºC and then acylhydrazone **1** (0.1 mmol, 1.0 eq), Et_3N (0.1 mmol, 1.0 eq) *β*-trifluoromethyl-*α,β*-unsaturated ketone **2** (0.12 mmol, 1.2 eq) were added sequentially. Once starting material was consumed (monitored by TLC), the organic solvent was removed and the residue was purified by column chromatography to give the product, which was then directly analyzd by HPLC to determine to enantiomeric excess.

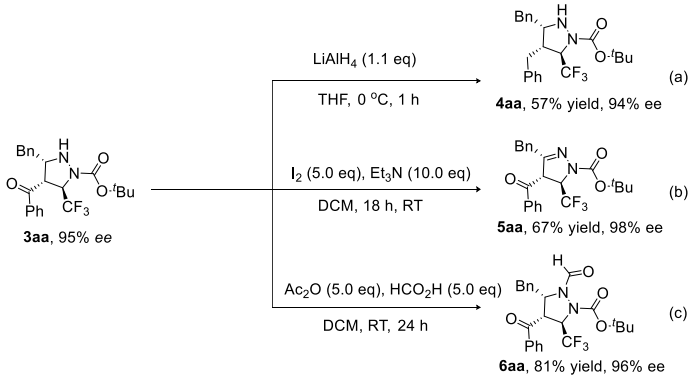
5. Synthetic application of the asymmetric reaction

5.1 Gram-Scale Synthesis of **3aa**



Under argon atmosphere, CuOAc (24 mg, 0.2 mmol) and **L4** (247 mg, 0.48mmol) were dissolved in 40 mL toluene, and stirred at room temperature for 1 h. The reaction temperature was dropped to -25 °C, and then (*E*)-tert-butyl 2-(2-phenylethylidene)hydrazinecarboxylate **1a** (933 mg, 4 mmol), Et_3N (0.5 mL, 4 mmol), (*E*)-4,4,4-trifluoro-1-phenylbut-2-en-1-one **2a** (960 mg, 4.8 mmol) were added sequentially. The mixture was stirred at this temperature for 2 h and detected by TLC, When **1a** was completely consumed, the product **3aa** was separated and purified by column chromatography (PE:EA = 3:1) with 92% yield and 95% ee were obtained.

5.2 General experimental procedure for transforming **3aa** to **4aa, 5aa, 6aa**



a) The compound **3aa** (86.8 mg, 0.2 mmol) was dissolved in THF (1.0 mL), and $LiAlH_4$ (8.3 mg, 0.22 mmol) was added. After the mixture was stirrred at 0 °C for 0.5 h.The mixture was extraced with ethyl acetate and the combined organic layer was washed with brine, drived over anhydrous Na_2SO_4, filtered, and condensed under reduced pressure. The residue was purified by column chromatography (PE:EA = 10:1) to afford **4aa** as a colorless oil in 57% yield and 94% ee.

b) The compound **3aa** (86.8 mg, 0.2 mmol) in 7 mL DCM was added Et_3N (277 μL,

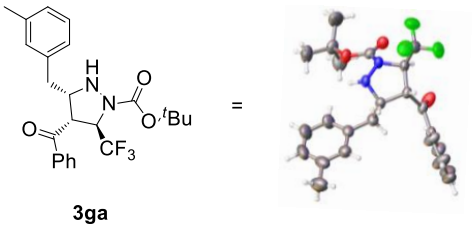
2.0 mmol) followed by I_2 (253 mg, 1.0 mmol) and the reaction mixture was allowed to stir at room temperature for 18 h. The reaction was then washed with 1.0 M $Na_2S_2O_3$, 1.0 M aq HCl, and brine. The organic layer was dried over anhydrous Na_2SO_4, filtered, and concentrated. Purification by flash chromatography over silica gel (PE:EA = 10:1) afford **5aa** as a white solid in 67% yield with 98% ee.

c) To a round bottom flask charged with formic acid (94 μL, 1.0 mmol) was added acetic anhydride (37μL, 1.0 mmol) dropwise and the resulting mixture was stirred for 15 min at 40 °C to give mixed formic-acetic anhydride. To a cooled (0 °C) solution of **3aa** (86.8 mg, 0.2 mmol) in methylene chloride (1.0 mL) was added the mixed anhydride dropwise via syringe and the reaction mixture was stirred at room temperature for 24 h. The reaction was diluted with methylene chloride (10 mL) and quenched by the dropwise addition of saturated aquenous $NaHCO_3$ (20 mL). The layers were separated and the aqueous layer was extracted with methylene chloride (3×20 mL). The combined organic fractions were dried Na_2SO_4, filtered and concentrated under reduced pressure to give the targed compound **6aa** as a white solid in 81% yield and 96% ee.

6. Cell Culture and Cytotoxicity (CCK-8) assay

HepG2, A549 and MCF-7 cells were cultured in DMEM. CFPAC-1 cells were cultured in IMDM. All cells were purchased from American Type Culture Collection (ATCC). Cells were cultured with 10% fetal bovine serum (FBS) at 37 °C in a humidified atmosphere with 5% CO_2. And also added 1% penicillin-streptomycin solution (10 000 U/mL penicillin and 10 000 μg/mL streptomycin) to the culture medium in case of potential contamination. HepG2 (3.0×10^3 cells/well), A549 (3.0×10^3 cells/well), MCF-7 (3.0×10^3 cells/well), CFPAC-1 (5.0×10^3 cells/well) were seeded in 96-well tissue culture plates and cultured under 37 °C in a humidified atmosphere overnight. Cells were treated with various concentrations (3-50 μM) of each compound. After 48 h, cell viability was determined using CCK-8 assay according to the instruction manual. The reaction product of CCK-8 assay was measured at 450 nm and quantified using a Synergy Neo2 Multi-Mode Microplate Reader. Data were analyzed by GraphPad Prism 9.0. and presented as mean ± SD of three independent experiments.

7. Determination of the absolute configuration of products 3ga.



3ga

CCDC 2169814 (**3ga**) contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from The Cambridge Crystallographic Data Centre via https://www.ccdc.cam.ac.uk/structures/.

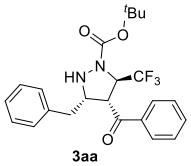
Displacement ellipsoids are drawn at the 50% probability level (solvent: DCM/MeOH =2:1)

Table S1 Crystal data and structure refinement for 3ga

Identification code	3ga
Empirical formula	$C_{48}H_{54}F_6N_4O_6$
Formula weight	896.95
Temperature/K	293
Crystal system	triclinic
Space group	P1
a/Å	5.8241(2)
b/Å	10.8677(3)
c/Å	18.886(2)
α/°	87.135(6)
β/°	89.504(6)
γ/°	79.922(3)
Volume/Å^3	1175.48(14)
Z	1
ρ_{calc}g/cm^3	1.267
μ/mm^{-1}	0.838
F(000)	472.0
Crystal size/mm^3	0.17 × 0.12 × 0.08
Radiation	CuKα (λ = 1.54184)
2Θ range for data collection/°	8.274 to 151.578
Index ranges	$-7 \le h \le 7$, $-13 \le k \le 13$, $-22 \le l \le 22$

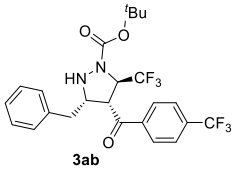
Reflections collected	34215
Independent reflections	7798 [R_{int} = 0.0278, R_{sigma} = 0.0183]
Data/restraints/parameters	7798/3/585
Goodness-of-fit on F^2	1.043
Final R indexes [I>=2σ (I)]	R_1 = 0.0462, wR_2 = 0.1206
Final R indexes [all data]	R_1 = 0.0468, wR_2 = 0.1213
Largest diff. peak/hole / e $Å^{-3}$	0.38/-0.38
Flack parameter	0.02(5)

8. Characterization data of the praducts



3aa

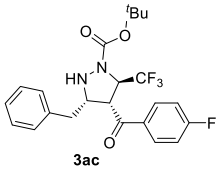
(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-benzyl-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3aa): White solid; 94% yield, 95% ee; >20:1 dr; m.p.: 164.7 − 165.6 ºC; $[\alpha]_D^{17}$ = -43.2 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 95/5, flow rate = 0.5 mL/min, λ = 254 nm, retention time: 17.597 min (major), 11.930 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.08 – 7.95 (m, 2H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.21 – 7.12 (m, 3H), 7.11 – 7.05 (m, 2H), 5.72 – 5.46 (m, 1H), 4.44 (t, *J* = 6.9 Hz, 1H), 4.15 – 3.86 (m, 1H), 2.39 (dd, *J* = 14.2, 10.6 Hz, 1H), 2.15 (dd, *J* = 14.2, 3.2 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.2, 155.9, 138.0, 136.1, 134.4, 129.6, 129.3, 128.5, 128.3, 126.7, 125.8 (q, *J* =279.5 Hz), 82.3, 64.6, 61.4 (q, *J* =31.1 Hz), 55.9, 34.9, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.87; **HRMS** (ESI) calcd. for $C_{23}H_{25}F_3N_2O_3Na$ ($[M+Na]^+$): 457.1709, found: 450.1702.



3ab

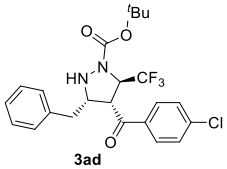
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-5-(trifluoromethyl)-4-(4-(trifluoromethyl)benzoyl)pyrazolidine-1-carboxylate (3ab): White solid; 91% yield, 95% ee; >20:1 dr; m.p.: 147.3 − 147.9 ºC; $[\alpha]_D^{17}$ = -30.5 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IG, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 4.613 min (major), 9.883 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.05 (d, *J* = 8.1 Hz, 2H), 7.77 (d, *J* = 8.2 Hz, 2H), 7.19 – 7.08 (m, 3H), 7.08 – 7.03 (m, 2H), 5.64 – 5.40 (m, 1H), 4.42 (t, *J* = 6.9 Hz, 1H), 4.17 – 3.96 (m, 1H), 2.49 (dd, *J* = 14.3, 9.9 Hz, 1H), 2.13 (dd, *J* = 14.3, 4.4 Hz,

1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.5, 155.9, 138.7, 137.4, 135.5 (q , *J* = 33.0 Hz), 129.6, 128.8, 128.4, 126.9, 126.3 (q, *J* = 3.6 Hz), 125.6 (q, *J* = 279.4 Hz), 124.8, 82.5, 64.4, 61.6 (q, *J* = 31.4 Hz), 56.0 , 35.2, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -63.32, -74.90; **HRMS** (ESI) calcd. for $C_{24}H_{24}F_6N_2O_3Na$ ($[M+Na]^+$): 525.1583, found: 525.1570.



3ac

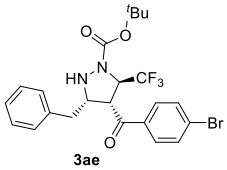
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(4-fluorobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ac): White solid; 87% yield, 94% ee; >20:1 dr; m.p.: 130.8 − 131.7 ºC; $[\alpha]_D^{27}$ = -22.3 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IG, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.810 min (major), 13.238 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.07 – 7.96 (m, 2H), 7.22 – 7.10 (m, 5H), 7.10 – 7.05 (m, 2H), 5.64 – 5.40 (m, 1H), 4.39 (t, *J* = 6.9 Hz, 1H), 4.15 – 3.90 (m, 2H), 2.44 (dd, *J* = 14.2, 10.2 Hz, 1H), 2.14 (dd, *J* = 14.2, 3.9 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 191.7, 166.5 (d, *J* =250 Hz), 155.8, 137.7, 132.5 (d, *J* =3.0 Hz), 131.2 (d, *J* =9.5 Hz), 129.5, 128.3, 126.8, 125.7 (q, *J* =279.4 Hz), 116.5 (d, *J* =22.1 Hz), 82.5, 64.4, 61.5 (q, *J* =31.1 Hz), 55.6, 34.9, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.84, -102.68; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 475.1615, found: 475.1612.



3ad

(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(4-chlorobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ad): White solid; 90% yield, 96% ee; >20:1 dr; m.p.: 155.3 − 155.8 ºC; $[\alpha]_D^{17}$ = -35.4 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.692 min (major), 4.298 min (minor);

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 (d, *J* = 8.3 Hz, 2H), 7.49 (d, *J* = 8.4 Hz, 2H), 7.22 – 7.08 (m, 3H), 7.10 – 7.04 (m, 2H), 5.61 – 5.46 (m, 1H), 4.59 (s, 1H), 4.38 (t, *J* = 6.9 Hz, 1H), 4.10 – 3.94 (m, 1H), 2.43 (dd, *J* = 14.2, 10.3 Hz, 1H), 2.13 (dd, *J* = 14.2, 3.8 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.1, 155.9, 141.0, 137.7, 134.4, 129.8, 129.6 (two peaks), 128.3, 126.8, 125.7 (d, *J* =279.0 Hz), 82.4, 64.4, 61.5 (q, *J* =31.6 Hz), 55.8, 35.0, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.85; **HRMS** (ESI) calcd. for $C_{23}H_{24}ClF_3N_2O_3Na$ ($[M+Na]^+$): 491.1320, found: 491.1317.

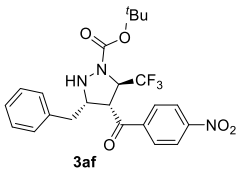


3ae

(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(4-bromobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3ae): White solid; 95% yield, 95% ee; >20:1 dr; m.p.: 155.2 − 155.7 ºC; $[\alpha]_D^{18}$ = -35.3 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.067 min (major), 4.482 min (minor); **^{1}H NMR** (600 MHz, CDCl3) δ 7.87 – 7.81 (m, 2H), 7.70 – 7.63 (m, 2H), 7.22 – 7.11 (m, 3H), 7.10 – 7.05 (m, 2H), 5.61 – 5.48 (m, 1H), 4.57 (s, 1H), 4.36 (t, *J* = 7.0 Hz, 1H), 4.09 – 3.94 (m, 1H), 2.42 (dd, *J* = 14.3, 10.4 Hz, 1H), 2.12 (dd, *J* = 14.3, 3.8 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.3, 155.9, 137.7, 134.8, 132.6, 129.9, 129.8, 129.6, 128.4, 126.8, 125.7 (d, *J* =279.4 Hz), 82.4, 64.5, 61.5 (q, *J* =31.1 Hz), 55.7, 35.0, 28.3; **^{19}F{^{1}H} NMR** (565 MHz, $CDCl_3$) δ -74.86; **HRMS** (ESI) calcd. for $C_{23}H_{24}BrF_3N_2O_3Na$ ($[M+Na]^+$): 535.0815, found: 535.0807.

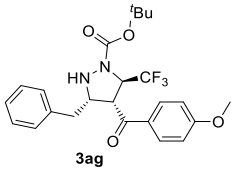


3af

(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(4-nitrobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3af): White solid; 92% yield, 92% ee; >20:1 dr; m.p.: 174.3 − 174.7 ºC; $[\alpha]_D^{17}$ = -32.8 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0

mL/min, λ = 254 nm, retention time: 11.095 min (major), 7.907 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.31 (d, *J* = 8.5 Hz, 2H), 8.07 (d, *J* = 8.5 Hz, 2H), 7.17 – 6.97 (m, 5H), 5.65 – 5.46 (m, 1H), 4.66 (s, 1H), 4.48 – 4.37 (m, 1H), 4.17 – 3.96 (m, 1H), 2.55 (dd, *J* = 14.3, 9.3 Hz, 1H), 2.14 (dd, *J* = 14.3, 4.9 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.0, 155.9, 150.9, 140.3, 137.1, 129.6, 129.4, 128.5, 127.0, 125.6 (d, *J* = 279.5 Hz), 124.3, 82.7, 64.3, 61.7 (q, *J* = 31.3 Hz), 56.1, 35.4, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.88; **HRMS** (ESI) calcd. for $C_{23}H_{24}F_3N_3O_5Na$ ($[M+Na]^+$): 502.1560, found: 502.1556.

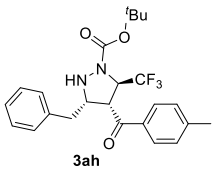


3ag

(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(4-methoxybenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3ag): White solid; 90% yield, 96% ee; >20:1 dr; m.p.: 120.0 − 120.8 ºC; $[\alpha]_D^{17}$ = -26.1 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IG, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 13.190 min (major), 27.453 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.8 Hz, 2H), 7.24 – 7.07 (m, 5H), 7.00 (d, *J* = 8.7 Hz, 2H), 5.66 – 5.38 (m, 1H), 4.54 (s, 1H), 4.38 (t, *J* = 6.8 Hz, 1H), 4.04 – 3.94 (m, 1H), 3.91 (s, 3H), 2.38 (dd, *J* = 14.2, 10.7 Hz, 1H), 2.16 (dd, *J* = 14.2, 3.3 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 191.6, 164.6, 155.9, 138.3, 130.9, 129.6, 129.1, 128.3, 126.63, 125.8 (q, *J* =279.3 Hz), 114.5, 82.2, 64.6, 61.5 (q, *J* =31.0 Hz), 55.8, 55.5, 34.7, 28.3; **^{19}F{^{1}H} NMR** (565 MHz, $CDCl_3$) δ -74.84; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_4Na$ ($[M+Na]^+$): 487.1815, found: 487.1810.



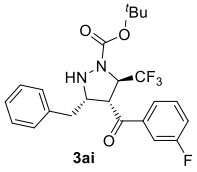
3ah

(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(4-methylbenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

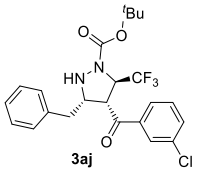
(3ah): White solid; 91% yield, 96% ee; >20:1 dr; m.p.: 121.5 − 121.9 ºC; $[\alpha]_D^{17}$ = -34.8

(c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.322 min (major), 4.172 min (minor); **^{1}H NMR** (400 MHz, CDCl3) δ 7.91 (d, *J* = 8.0 Hz, 2H), 7.33 (d, *J* = 8.0 Hz, 2H), 7.22 – 7.07 (m, 5H), 5.63 – 5.50 (m, 1H), 4.41 (t, *J* = 6.8 Hz, 1H), 4.06 – 3.93 (m, 1H), 2.47 (s, 3H), 2.37 (dd, *J* = 14.2, 10.9 Hz, 1H), 2.15 (dd, *J* = 14.2, 3.2 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.8, 155.9, 145.5, 138.2, 133.6, 130.0, 129.6, 128.6, 128.3, 126.7, 125.8 (q, *J* =279.3 Hz), 82.3, 64.6, 61.4 (q, *J* =31.3 Hz), 55.8, 34.8, 28.3, 21.9; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.86; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 471.1866, found: 471.1857.



3ai

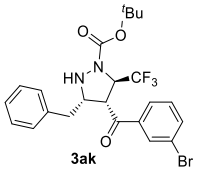
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(3-fluorobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ai): White solid; 90% yield, 94% ee; >20:1 dr; m.p.: 134.9 − 135.6 °C; $[\alpha]_D^{17}$ = -30.8 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.403 min (major), 4.283 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.82 – 7.71 (m, 1H), 7.69 – 7.60 (m, 1H), 7.59 – 7.45 (m, 1H), 7.42 – 7.30 (m, 1H), 7.23 – 7.04 (m, 5H), 5.62 – 5.48 (m, 1H), 4.57 (s, 1H), 4.37 (t, *J* = 6.9 Hz, 1H), 4.09 – 3.95 (m, 1H), 2.44 (dd, *J* = 14.2, 10.3 Hz, 1H), 2.14 (dd, *J* = 14.2, 3.9 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.0, 1643.1 (d, *J* = 250.0 Hz), 155.7, 138.0 (d, *J* = 5.8 Hz), 137.52, 130.9 (d, *J* = 7.8 Hz), 129.4, 128.2, 126.7, 125.5 (q, *J* = 279.4 Hz), 123.9, 121.3 (d, *J* = 21.5 Hz), 115.1 (d, *J* = 22.6 Hz), 82.3, 64.3, 61.4 (q, *J* = 31.1 Hz), 55.9, 34.9, 28.2; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.89, -110.49; **HRMS** (ESI) calcd. for $C_{23}H_{24}F_4N_2O_3Na$ ($[M+Na]^+$): 475.1615, found: 475.1609.



3aj

(3*S*,4*R*,5*R*)-*tert*-butyl

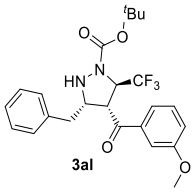
3-benzyl-4-(3-chlorobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3aj): White solid; 88% yield, 94% ee; >20:1 dr; m.p.: 140.4 − 141.0 °C; $[\alpha]_D^{24}$ = -26.3 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IA, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.337 min (major), 13.690 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.92 – 7.89 (m, 1H), 7.83 (d, *J* = 7.8 Hz, 1H), 7.64 – 7.59 (m, 1H), 7.46 (t, *J* = 7.9 Hz, 1H), 7.18 – 7.10 (m, 3H), 7.09 – 7.04 (m, 2H), 5.60 – 5.48 (m, 1H), 4.37 (t, *J* = 7.0 Hz, 1H), 4.10 – 3.98 (m, 1H), 2.44 (dd, *J* = 14.3, 10.1 Hz, 1H), 2.13 (dd, *J* = 14.3, 4.1 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (150 MHz, $CDCl_3$) δ 192.1, 155.9, 137.5 (two peaks), 135.7, 134.3, 130.5, 129.6, 128.5, 128.3, 126.8, 126.4, 125.6 (q, *J* =279.1 Hz), 82.4, 64.4, 61.5 (q, *J* =31.1Hz), 55.9, 35.0, 28.3; **^{19}F{^{1}H} NMR** (565 MHz, $CDCl_3$) δ -74.86; **HRMS** (ESI) calcd. for $C_{23}H_{24}ClF_3N_2O_3Na$ ($[M+Na]^+$): 491.1320, found: 491.1310.



3ak

(3*S*,4*R*,5*R*)-*tert*-butyl

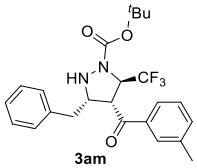
3-benzyl-4-(3-bromobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ak): White solid; 95% yield, 94% ee; >20:1 dr; m.p.: 126.1 − 126.6 °C; $[\alpha]_D^{17}$ = -28.7 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.538 min (major), 4.428 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.05 (t, *J* = 1.8 Hz, 1H), 7.91 – 7.83 (m, 1H), 7.80 – 7.72 (m, 1H), 7.39 (t, *J* = 7.9 Hz, 1H), 7.20 – 7.04 (m, 5H), 5.70 – 5.40 (m, 1H), 4.59 (s, 1H), 4.36 (t, *J* = 6.8 Hz, 1H), 4.19 – 3.96 (m, 1H), 2.46 (dd, *J* = 14.2, 10.0 Hz, 1H), 2.14 (dd, *J* = 14.2, 4.0 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.0, 155.9, 137.8, 137.5, 137.2, 131.5, 130.7, 129.6, 128.3, 126.9, 126.8, 125.6 (q, *J* =279.5 Hz), 123.7, 82.5, 64.4, 61.5 (q, *J* =31.2 Hz), 55.9, 35.1, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.86; **HRMS** (ESI) calcd. for $C_{23}H_{24}BrF_3N_2O_3Na$ ($[M+Na]^+$): 535.0815, found: 535.0810.



(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(3-methoxybenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3al): White solid; 92% yield, 96% ee; >20:1 dr; m.p.: 134.9 − 135.6 ºC; $[\alpha]_D^{17}$ = -23.9 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.490 min (major), 4.768 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.60 – 7.50 (m, 2H), 7.44 (t, *J* = 8.0 Hz, 1H), 7.23 – 7.13 (m, 4H), 7.12 – 7.07 (m, 2H), 5.65 – 5.48 (m, 1H), 4.42 (t, *J* = 6.9 Hz, 1H), 4.08 – 3.96 (m, 1H), 3.88 (s, 3H), 2.38 (dd, *J* = 14.2, 10.7 Hz, 1H), 2.16 (dd, *J* = 14.2, 3.4 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.1, 160.4, 155.9, 138.1, 137.4, 130.3, 129.6, 128.3, 126.7, 125.7 (q, *J* =279.3 Hz), 120.8, 112.9, 82.3, 64.7, 61.4 (q, *J* =31.4 Hz), 56.0, 55.7, 34.9, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.87; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_4Na$ ($[M+Na]^+$): 487.1815, found: 485.1805.

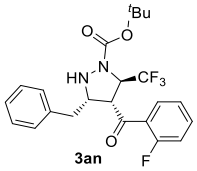


(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(3-methylbenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3am): White solid; 90% yield, 94% ee; >20:1 dr; m.p.: 140.4 − 141.0 ºC; $[\alpha]_D^{22}$ = -26.9 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IG, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 10.513 min (major), 16.738 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.82 – 7.75 (m, 2H), 7.47 (d, *J* = 7.6 Hz, 1H), 7.42 (t, *J* = 8.0 Hz, 1H), 7.21 – 7.11 (m, 3H), 7.11 – 7.07 (m, 2H), 5.67 – 5.41 (m, 1H), 4.54 (s, 1H), 4.43 (t, *J* = 7.0 Hz, 1H), 4.06 – 3.94 (m, 1H), 2.45 (s, 3H), 2.38 (dd, *J* = 14.3, 10.8 Hz, 1H), 2.15 (dd, *J* = 14.3, 3.4 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (150 MHz, $CDCl_3$) δ 193.4, 155.9, 139.3, 138.1, 136.0, 135.2, 129.6, 129.1, 129.0, 128.3,

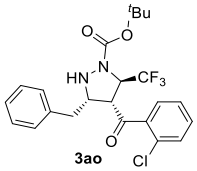
126.7, 125.7 (q, *J* = 279.6 Hz), 125.6, 82.3, 64.5, 61.4 (q, *J* = 31.6 Hz), 55.9, 34.8, 28.3, 21.5; **^{19}F{^{1}H} NMR** (565 MHz, $CDCl_3$) δ -74.84; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 471.1866, found: 471.1856.



3an

(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(2-fluorobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3an): White solid; 86% yield, 95% ee; >20:1 dr; m.p.: 135.6 − 136.5 °C; $[\alpha]_D^{23}$ = -26.4 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 95/5, flow rate = 0.5 mL/min, λ = 254 nm, retention time: 11.677 min (major), 13.037 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.96 – 7.89 (m, 1H), 7.66 – 7.56 (m, 1H), 7.33 – 7.26 (m, 1H), 7.23 – 7.08 (m, 6H), 5.64 – 5.51 (m, 1H), 4.51 (s, 1H), 4.44 (t, *J* = 6.9 Hz, 1H), 4.18 – 4.07 (m, 1H), 2.46 (dd, *J* = 14.2, 10.4 Hz, 1H), 2.21 (dd, *J* = 14.2, 3.8 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 191.2, 161.9 (d, *J* =252.3 Hz), 156.0, 138.0, 136.0 (d, *J* =9.0 Hz), 131.5 (d, *J* =2.1 Hz), 129.6, 128.3, 126.7, 125.7 (q, *J* =279.4 Hz), 125.2 (d, *J* =3.4 Hz), 124.6 (d, *J* =11.6Hz), 117.1 (d, *J* =24.1 Hz), 82.2, 63.6 (d, *J* =4.5Hz), 61.4 (d, *J* =31.4 Hz), 60.2 (d, *J* =7.0 Hz), 35.6, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.99, -110.56; **HRMS** (ESI) calcd. for $C_{23}H_{24}F_4N_2O_3Na$ ($[M+Na]^+$): 475.1615, found: 475.1608.

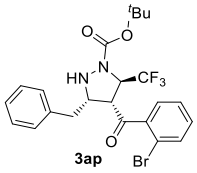


3ao

(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(2-chlorobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ao): White solid; 86% yield, 91% ee; >20:1 dr; m.p.: 134.7 − 135.6 °C; $[\alpha]_D^{24}$ = -20.9 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IA, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 7.720 min (major), 30.207 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.65 – 7.59 (m, 1H), 7.54 – 7.48 (m, 2H), 7.44 – 7.38 (m,

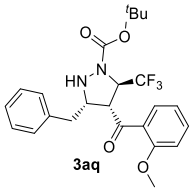
1H), 7.24 – 7.13 (m, 5H), 5.46 – 5.33 (m, 1H), 4.57 (t, *J* = 6.8 Hz, 1H), 4.47 (s, 1H), 3.97 – 3.83 (m, 1H), 2.47 (dd, *J* = 14.2, 10.6 Hz, 1H), 2.38 (dd, *J* = 14.2, 3.4 Hz, 1H), 1.56 (s, 9H); **$^{13}C\{^{1}H\}$ NMR** (100 MHz, $CDCl_3$) δ 195.7, 155.7, 138.2, 137.3, 133.4, 132.2, 131.7, 130.2, 129.5, 128.4, 127.5, 126.8, 125.5 (q, *J* = 281.4 Hz), 82.4, 64.2, 61.9 (q, *J* = 31.6 Hz), 58.7, 34.9, 28.3; **$^{19}F\{^{1}H\}$ NMR** (376 MHz, $CDCl_3$) δ -74.81; **HRMS** (ESI) calcd. for $C_{23}H_{24}ClF_3N_2O_3Na$ ($[M+Na]^+$): 491.1320, found: 491.1311.



(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(2-bromobenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3ap): White solid; 94% yield, 93% ee; >20:1 dr; m.p.: 162.4 − 162.8 ºC; $[\alpha]_D^{17}$ = -65.3 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 7.633 min (major), 10.602 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.74 (d, *J* = 7.7 Hz, 1H), 7.59 (dd, *J* = 7.5, 2.0 Hz, 1H), 7.53 – 7.35 (m, 2H), 7.25 – 7.13 (m, 5H), 5.50 – 5.21 (m, 1H), 4.54 (t, *J* = 6.8 Hz, 1H), 4.48 (s, 1H), 3.93 – 3.79 (m, 1H), 2.51 – 2.40 (m, 2H), 1.57 (s, 9H); **$^{13}C\{^{1}H\}$ NMR** (150 MHz, $CDCl_3$) δ 196.0, 155.9, 138.9, 138.2, 135.2, 133.4, 130.1, 129.5, 128.4, 128.0, 126.8, 125.5 (q, *J* =279.2 Hz), 120.5, 82.5, 64.2, 61.8 (q, *J* =31.5 Hz), 58.28, 34.8, 28.3; **$^{19}F\{^{1}H\}$ NMR** (376 MHz, $CDCl_3$) δ -74.39; **HRMS** (ESI) calcd. for $C_{23}H_{24}BrF_3N_2O_3Na$ ($[M+Na]^+$): 535.0815, found: 535.0808.

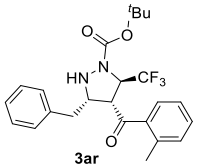


(3*S*,4*R*,5*R*)-*tert*-butyl

3-benzyl-4-(2-methoxybenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

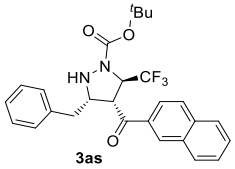
(3aq): White solid; 91% yield, 93% ee; >20:1 dr; m.p.: 140.4 − 141.0 ºC; $[\alpha]_D^{22}$ = -50.7 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 9.080 min (major), 5.680 min (minor);

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 – 7.73 (m, 1H), 7.61 – 7.46 (m, 1H), 7.24 – 7.11 (m, 5H), 7.11 – 6.99 (m, 2H), 5.58 – 5.26 (m, 1H), 4.65 (t, *J* = 6.6 Hz, 1H), 4.02 – 3.95 (m, 1H), 3.93 (s, 3H), 2.45 (dd, *J* = 14.2, 10.7 Hz, 1H), 2.27 (dd, *J* = 14.2, 3.4 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 195.4, 158.9, 155.9, 138.8, 135.0, 131.4, 129.6, 128.2, 127.1, 126.5, 125.8 (q , *J* = 279.1 Hz), 121.4, 112.0, 82.1, 64.2, 62.1 (q , *J* = 30.9 Hz), 59.6, 55.8, 35.5, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.85; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_4Na$ ($[M+Na]^+$): 487.1815, found: 487.1810.



3ar

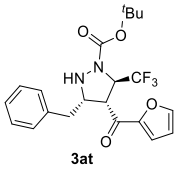
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(2-methylbenzoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ar): White solid; 88% yield, 94% ee; >20:1 dr; m.p.: 149.8 − 150.3 ºC; $[\alpha]_D^{22}$ = -22.7 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK MD, *n*−Hexane/2−propanol = 95/5, flow rate = 0.5 mL/min, λ = 254 nm, retention time: 13.428 min (major), 17.955 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.78 (d, *J* = 7.9 Hz, 1H), 7.50 (t, *J* = 7.3 Hz, 1H), 7.41 – 7.31 (m, 2H), 7.23 – 7.13 (m, 3H), 7.12 – 7.07 (m, 2H), 5.67 – 5.37 (m, 1H), 4.50 (s, 1H), 4.42 (t, *J* = 7.0 Hz, 1H), 3.99 – 3.75 (m, 1H), 2.61 (s, 3H), 2.39 (dd, *J* = 14.1, 11.4 Hz, 1H), 2.18 (dd, *J* = 14.1, 3.0 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 195.74, 155.9, 140.4, 138.2, 135.7, 133.1, 133.0, 129.5, 128.9, 128.3, 126.7, 126.4, 125.8 (d, *J* = 279.5 Hz), 82.3, 64.6, 61.4 (q, *J* = 31.1 Hz), 57.8, 34.7, 28.3, 22.1; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.78; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 471.1866, found: 471.1859.



3as

(3*S*,4*R*,5*R*)-*tert*-butyl 4-(2-naphthoyl)-3-benzyl-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3as):

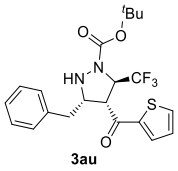
White solid; 90% yield, 95% ee; >20:1 dr; m.p.: 113.5 − 114.1 °C; $[\alpha]_D^{17}$ = -63.0 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.238 min (major), 5.030 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.49 (d, *J* = 1.7 Hz, 1H), 8.06 (dd, *J* = 8.6, 1.8 Hz, 1H), 8.03 – 7.87 (m, 3H), 7.72 – 7.57 (m, 2H), 7.17 – 7.03 (m, 5H), 5.72 – 5.46 (m, 1H), 4.61 (t, *J* = 6.8 Hz, 1H), 4.17 – 4.06 (m, 1H), 2.45 (dd, *J* = 14.3, 10.5 Hz, 1H), 2.21 (dd, *J* = 14.2, 3.5 Hz, 1H), 1.59 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.3, 155.9, 138.0, 136.2, 133.4, 132.6, 130.4, 129.9, 129.5, 129.4, 129.3, 128.3, 128.1, 127.4, 126.7, 125.8 (q, *J* = 279.4 Hz), 123.7, 82.4, 64.6, 61.6 (q, *J* = 31.1 Hz), 55.8, 34.9, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.73; **HRMS** (ESI) calcd. for $C_{27}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 507.1866, found: 507.1868.



3at

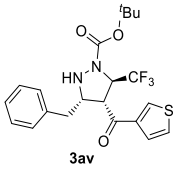
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(furan-2-carbonyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3at): White solid; 86% yield, 90% ee; >20:1 dr; m.p.: 166.1 − 166.5 °C; $[\alpha]_D^{18}$ = -37.8 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 95/5, flow rate = 0.5 mL/min, λ = 254 nm, retention time: 7.012 min (major), 5.192 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 1.8 Hz, 1H), 7.28 (d, *J* = 3.6 Hz, 1H), 7.24 – 7.09 (m, 5H), 6.60 (dd, *J* = 3.6, 1.8 Hz, 1H), 5.54 – 5.31 (m, 1H), 4.53 (s, 1H), 4.28 (t, *J* = 6.9 Hz, 1H), 4.21 – 4.04 (m, 1H), 2.45 (dd, *J* = 14.2, 10.2 Hz, 1H), 2.21 (dd, *J* = 14.2, 4.0 Hz, 1H), 1.55 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 182.2, 155.9, 152.3, 147.1, 138.0, 129.6, 128.3, 126.7, 125.6 (q, *J* = 279.2 Hz), 118.4, 113.3, 82.3, 64.0, 60.5 (q, *J* = 31.2 Hz), 56.2, 35.1, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.95; **HRMS** (ESI) calcd. for $C_{21}H_{23}F_3N_2O_4Na$ ($[M+Na]^+$): 447.1502, found: 447.1500.



3au

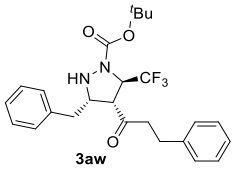
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(thiophene-2-carbonyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3au): White solid; 78% yield, 95% ee; >20:1 dr; m.p.: 193.4 − 193.9 °C; $[\alpha]_D^{18}$ = -9.1 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 95/5, flow rate = 0.5 mL/min, λ = 254 nm, retention time: 26.205 min (major), 14.663 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.76 (d, *J* = 4.4 Hz, 2H), 7.23 – 7.11 (m, 6H), 5.58 – 5.32 (m, 1H), 4.55 (s, 1H), 4.27 (t, *J* = 7.0 Hz, 1H), 4.08 – 3.96 (m, 1H), 2.46 (dd, *J* = 14.2, 10.4 Hz, 1H), 2.29 (dd, *J* = 14.2, 3.8 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 186.1, 155.8, 143.2, 138.0, 135.6, 132.8, 129.5, 128.8, 128.3, 126.7, 125.6 (q, *J* = 279.3 Hz), 82.4, 64.7, 61.4 (q, *J* = 31.1 Hz), 56.6, 34.7, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.81; **HRMS** (ESI) calcd. for $C_{21}H_{23}F_3N_2O_3SNa$ ($[M+Na]^+$): 463.1274, found: 463.1267.



3av

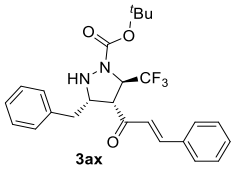
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(thiophene-3-carbonyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3av): White solid; 87% yield, 96% ee; >20:1 dr; m.p.: 165.5 − 166.2 °C; $[\alpha]_D^{18}$ = -38.4 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.992 min (major), 4.670 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.11 (dd, *J* =2.9, 1.2 Hz, 1H), 7.58 (dd, *J* = 5.1, 1.2 Hz, 1H), 7.41 (dd, *J* = 5.1, 2.8 Hz, 1H), 7.22 – 7.09 (m, 5H), 5.60 – 5.33 (m, 1H), 4.24 (t, *J* = 6.9 Hz, 1H), 4.12 – 3.92 (m, 1H), 2.44 (dd, *J* = 14.2, 10.3 Hz, 1H), 2.22 (dd, *J* = 14.2, 3.8 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 187.4, 155.8, 141.5, 138.0, 133.3, 129.5, 128.3, 127.6, 126.9, 126.7, 125.7 (q, *J* = 279.4 Hz), 82.3, 64.5, 61.3 (q, *J* = 31.2 Hz), 57.0, 34.8, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ

-74.84; **HRMS** (ESI) calcd. for $C_{21}H_{23}F_3N_2O_3SNa$ ([M+Na]$^+$): 463.1274, found: 463.1269.



3aw

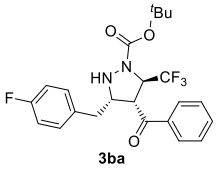
(3*S*,4*R*,5*R*)-*tert*-butyl 3-benzyl-4-(3-phenylpropanoyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3aw): White solid; 74% yield, 97% ee; >20:1 dr; m.p.: 118.7 − 119.3 ºC; $[\alpha]_D^{17}$ = -8.6 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD-H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 210 nm, retention time: 9.337 min (major), 10.990 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.26 – 7.12 (m, 5H), 7.17 – 7.04 (m, 5H), 5.27 – 5.05 (m, 1H), 3.84 – 3.66 (m, 1H), 3.53 (t, *J* = 7.0 Hz, 1H), 2.93 – 2.53 (m, 4H), 2.35 (dd, *J* = 14.3, 9.4 Hz, 1H), 1.96 (dd, *J* = 14.3, 4.6 Hz, 1H), 1.47 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 202.6, 155.9, 140.4, 137.7, 134.0, 129.7, 128.8, 128.5, 126.9, 126.6, 125.5 (q , *J* = 279.2 Hz), 82.4, 63.3, 60.8 (q , *J* = 31.4 Hz), 59.5, 45.8, 35.1, 29.3, 28.2; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.98; **HRMS** (ESI) calcd. for $C_{25}H_{29}F_3N_2O_3Na$ ([M+Na]$^+$): 485.2022, found: 485.2024.



3ax

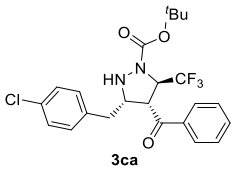
(3*S*,4*R*,5*R*)-*tert*-butyl-3-benzyl-4-cinnamoyl-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ax): White solid; 89% yield, 90% ee; >20:1 dr; m.p.: 136.9 − 137.3 ºC; $[\alpha]_D^{18}$ = -31.4 (c 1.0, $CHCl_3$); HPLC CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.190 min (major), 7.083 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.65 (d, *J* = 16.0 Hz, 1H), 7.58 – 7.51 (m, 2H), 7.49 – 7.38 (m, 3H), 7.29 – 7.21 (m, 4H), 7.20 – 7.11 (m, 1H), 6.76 (d, *J* = 16.0 Hz, 1H), 5.50 – 5.26 (m, 1H), 4.52 (s, 1H), 4.10 – 3.86 (m, 2H), 2.50 (dd, *J* = 14.2, 9.3 Hz, 1H), 2.34 (dd, *J* = 14.2, 3.8 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.8, 155.8, 145.0, 138.0, 133.9, 131.5, 129.7, 129.3, 128.8, 128.4, 126.8,

125.6 (q, *J* =279.5Hz), 125.0, 82.3, 63.7, 61.2 (q, *J* =31.1 Hz), 57.9, 35.0, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.80; **HRMS** (ESI) calcd. for $C_{25}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 483.1866, found: 583.1857.



3ba

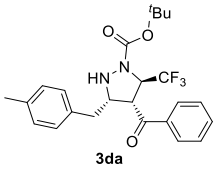
(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(4-fluorobenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ba): White solid; 92% yield, 92% ee; >20:1 dr; m.p.: 153.6 − 154.1 ºC; $[\alpha]_D^{18}$ = -24.5 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD-H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 15.745 min (major), 19.530 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.05 – 7.92 (m, 2H), 7.74 – 7.60 (m, 1H), 7.59 – 7.49 (m, 2H), 7.09 – 6.96 (m, 2H), 6.94 – 6.78 (m, 2H), 5.68 – 5.43 (m, 1H), 4.53 – 4.35 (m, 1H), 4.04 – 3.90 (m, 1H), 3.61 (s, 1H), 2.35 (dd, *J* = 14.2, 10.6 Hz, 1H), 2.11 (dd, *J* = 14.2, 3.0 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.0, 161.8 (d, *J* =243.1 Hz), 155.8, 135.9, 134.5, 133.6 (d, *J* =3.1 Hz), 131.1(d, *J* =7.9 Hz), 129.4, 128.4, 125.7 (q, *J* =279.5 Hz), 115.0 (d, *J* =21.1 Hz), 82.5, 64.6, 61.4 (q, *J* =32.1 Hz), 55.9, 34.1, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.91, -116.55; **HRMS** (ESI) calcd. for $C_{23}H_{24}F_4N_2O_3Na$ ($[M+Na]^+$): 475.1615, found: 475.1606.



3ca

(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(4-chlorobenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ca): White solid; 92% yield, 91% ee; >20:1 dr; m.p.: 155.8 − 156.4 ºC; $[\alpha]_D^{22}$ = -33.6 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IH, *n*−Hexane/2−propanol = 95/5, flow rate = 0.5 mL/min, λ = 254 nm, retention time: 15.745 min (major), 19.530 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.03 – 7.95 (m, 2H), 7.72 – 7.65 (m, 1H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.13 (d, *J* = 8.3 Hz, 2H), 7.03 (d, *J* = 8.2 Hz, 2H), 5.63 – 5.51 (m, 1H), 4.45

(t, *J* = 7.0 Hz, 1H), 4.02 – 3.92 (m, 1H), 2.35 (dd, *J* = 14.3, 10.7 Hz, 1H), 2.10 (dd, *J* = 14.2, 3.5 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (150 MHz, $CDCl_3$) δ 193.0, 155.7, 136.4, 135.9, 134.5, 132.6, 131.0, 129.4, 128.4 (two peaks), 125.7 (q, *J* = 278.9 Hz), 82.5, 64.4 , 61.4 (q, *J* = 30.9 Hz), 56.0, 34.3, 28.3; **^{19}F{^{1}H} NMR** (565 MHz, $CDCl_3$) δ -74.91; **HRMS** (ESI) calcd. for $C_{23}H_{24}ClF_3N_2O_3Na$ ($[M+Na]^+$): 491.1320, found: 491.1310.

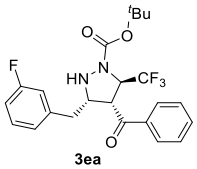


3da

(3*S*,4*R*,5*R*)-*tert*-butyl

4-benzoyl-3-(4-methylbenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3da): White solid; 89% yield, 95% ee; >20:1 dr; m.p.: 155.8 − 156.4 °C; $[\alpha]_D^{22}$ = -33.6 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 95/5, flow rate = 0.5 mL/min, λ = 254 nm, retention time: 12.520 min (major), 11.060 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.04 – 7.93 (m, 2H), 7.66 (t, J = 7.4 Hz, 1H), 7.53 (t, J = 7.6 Hz, 2H), 7.01 – 6.93 (m, 4H), 5.64 – 5.46 (m, 1H), 4.56 (s, 1H), 4.43 (t, J = 6.9 Hz, 1H), 4.10 – 3.93 (m, 1H), 2.36 (dd, J = 14.3, 10.6 Hz, 1H), 2.24 (s, 3H), 2.11 (dd, J = 14.3, 3.4 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.2, 156.0, 136.3, 136.0, 134.8, 134.4, 129.4, 129.3, 129.0, 128.5, 125.7 (q, *J* =279.3 Hz), 82.4, 64.9, 61.2 (d, *J* =30.8 Hz), 55.7, 34.4, 28.3, 21.1; **^{19}F{^{1}H} NMR** (565 MHz, $CDCl_3$) δ -74.85; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 471.1866, found: 471.1862.

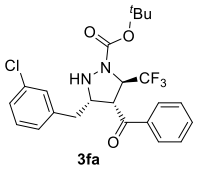


3ea

(3*S*,4*R*,5*R*)-*tert*-butyl

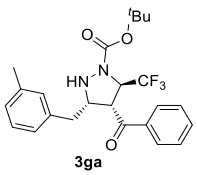
4-benzoyl-3-(3-fluorobenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ea): White solid; 94% yield, 92% ee; >20:1 dr; m.p.: 172.3 − 172.8 °C; $[\alpha]_D^{24}$ = -31.5 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0

mL/min, λ = 254 nm, retention time: 5.587 min (major), 7.888 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.01 (dd, *J* =8.2, 2.6 Hz, 2H), 7.72 – 7.63 (m, 1H), 7.55 (t, *J* = 7.8 Hz, 2H), 7.18 – 7.06 (m, 1H), 6.94 – 6.76 (m, 3H), 5.63 – 5.50 (m, 1H), 4.56 (s, 1H), 4.46 (t, *J* = 7.0 Hz, 1H), 4.06 – 3.91 (m, 1H), 2.36 (dd, *J* = 14.2, 11.0 Hz, 1H), 2.12 (dd, *J* = 14.2, 3.2 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.0, 162.8 (d, *J* = 250.0 Hz), 155.9, 140.5 (d, *J* = 7.8 Hz), 136.0, 134.5, 129.7 (d, *J* = 8.4 Hz), 129.4, 128.4, 125.7 (q, *J* = 279.0 Hz), 125.2 (d, *J* = 2.9 Hz), 116.6 (d, *J* = 21.5 Hz), 113.6 (d, *J* = 21.0 Hz), 82.5, 64.3, 61.4 (q, *J* = 31.0 Hz), 56.0, 34.6, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.92, -113.63; **HRMS** (ESI) calcd. for $C_{23}H_{24}F_4N_2O_3Na$ ($[M+Na]^+$): 475.1615, found: 475.1609.



3fa

(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(3-chlorobenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3fa): White solid; 91% yield, 95% ee; >20:1 dr; m.p.: 172.1 − 172.7 °C; $[\alpha]_D^{24}$ = -31.3 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.423 min (major), 8.070 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.08 – 7.93 (m, 2H), 7.68 (t, J = 7.4 Hz, 1H), 7.55 (t, J = 7.6 Hz, 2H), 7.17 – 7.04 (m, 3H), 7.02 – 6.94 (m, 1H), 5.71 – 5.40 (m, 1H), 4.55 (s, 1H), 4.46 (t, J = 7.0 Hz, 1H), 4.08 – 3.85 (m, 1H), 2.35 (dd, J = 14.2, 10.8 Hz, 1H), 2.10 (dd, J = 14.3, 3.3 Hz, 1H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.0, 155.9, 140.1, 135.9, 134.6, 134.0, 129.6, 129.5, 129.4, 128.4, 127.9, 127.0, 125.7 (q, *J* =279.4 Hz), 82.5, 64.3, 61.4 (d, *J* =32.1 Hz), 56.0, 34.6, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.92; **HRMS** (ESI) calcd. for $C_{23}H_{24}ClF_3N_2O_3Na$ ($[M+Na]^+$): 491.1320, found: 491.1312.

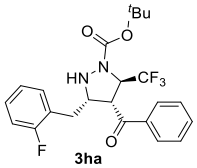


3ga

(3*S*,4*R*,5*R*)-*tert*-butyl

4-benzoyl-3-(3-methylbenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate

(3ga): White solid; 96% yield, 96% ee; >20:1 dr; m.p.: 160.9 − 161.4 ºC; $[\alpha]_D^{18}$ = -30.4 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.127 min (major), 4.210 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.09 – 7.82 (m, 2H), 7.79 – 7.58 (m, 1H), 7.52 (t, J = 7.7 Hz, 2H), 7.05 (t, J = 7.6 Hz, 1H), 6.98 – 6.76 (m, 3H), 5.68 – 5.42 (m, 1H), 4.57 (s, 1H), 4.48 – 4.37 (m, 1H), 4.09 – 3.93 (m, 1H), 2.39 (dd, J = 14.2, 10.3 Hz, 1H), 2.21 (s, 3H), 2.13 (dd, J = 14.2, 3.8 Hz, 1H), 1.56 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.4, 155.9, 137.9, 137.8, 136.1, 134.3, 130.2, 129.2, 128.5, 128.2, 127.5, 126.6, 125.7 (q, *J* =279.0 Hz), 82.3, 64.6, 61.5 (q, *J* =31.0 Hz), 55.7, 34.8, 28.3, 21.4; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.84; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 471.1866, found: 471.1866.

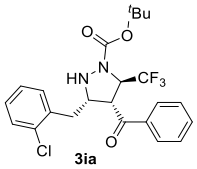


3ha

(3*S*,4*R*,5*R*)-*tert*-butyl

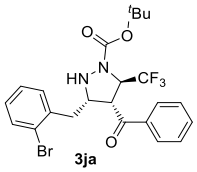
4-benzoyl-3-(2-fluorobenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ha): White solid; 90% yield, 93% ee; >20:1 dr; m.p.: 183.9 − 184.5 ºC; $[\alpha]_D^{24}$ = -31.3 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IA, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.413 min (major), 27.283 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.10 – 7.96 (m, 2H), 7.66 (t, *J* = 7.3 Hz, 1H), 7.54 (t, *J* = 7.7 Hz, 2H), 7.33 (t, *J* = 7.8 Hz, 1H), 7.15 – 7.08 (m, 1H), 7.01 (t, *J* = 7.5 Hz, 2H), 6.86 – 6.78 (m, 1H), 5.77 – 5.52 (m, 1H), 4.47 (t, *J* = 7.0 Hz, 1H), 4.28 – 4.05 (m, 1H), 2.40 (dd, *J* = 14.2, 3.2 Hz, 1H), 2.18 (dd, *J* = 14.2, 11.1 Hz, 1H), 1.58 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.1, 161.1 (d, *J* =250.0 Hz), 155.7, 135.9, 134.4, 132.9 (d, *J* =3.7 Hz), 129.2, 128.6 (d, *J* =8.2 Hz), 128.5, 125.8 (q, *J* =279.3 Hz), 124.9 (d, *J* =14.6 Hz), 124.0 (d, *J* =3.2 Hz), 114.9 (d, *J* =21.3 Hz), 82.3, 62.8, 61.4 (q, *J* =30.9

Hz), 56.1, 28.9, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.93, -118.77; **HRMS** (ESI) calcd. for $C_{23}H_{24}F_4N_2O_3Na$ ($[M+Na]^+$): 475.1615, found: 475.1609.



3ia

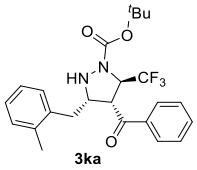
(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(2-chlorobenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ia): White solid; 89% yield, 95% ee; >20:1 dr; m.p.: 179.2 − 179.8 °C; $[\alpha]_D^{24}$ = -38.2 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK ID, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.423 min (major), 8.070 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.07 (dd, *J* = 7.9, 1.2 Hz, 2H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.58 – 7.46 (m, 3H), 7.21 – 7.06 (m, 3H), 5.68 – 5.56 (m, 1H), 4.52 (t, *J* = 7.2 Hz, 1H), 4.21 – 4.08 (m, 1H), 2.49 (dd, *J* = 13.9, 2.5 Hz, 1H), 2.18 (dd, *J* = 13.9, 11.7 Hz, 1H), 1.59 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.1, 155.7, 135.9, 135.6, 134.5, 133.6 (two peaks), 129.2, 129.1, 128.9, 128.4, 126.7, 125.8 (q, *J* = 279.5 Hz), 82.4, 62.1, 61.3 (q, *J* = 31.1 Hz), 56.3, 33.0, 28.4; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.93; **HRMS** (ESI) calcd. for $C_{23}H_{24}ClF_3N_2O_3Na$ ($[M+Na]^+$): 491.1320, found: 491.1314.



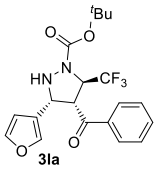
3ja

(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(2-bromobenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ja): White solid; 90% yield, 96% ee; >20:1 dr; m.p.: 206.9 − 207.5 °C; $[\alpha]_D^{17}$ = -35.5 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 5.118 min (major), 7.947 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 – 8.04 (m, 2H), 7.66 (t, *J* = 7.4 Hz, 1H), 7.59 – 7.48 (m, 3H), 7.35 (d, *J* = 7.9 Hz, 1H), 7.22 (t, *J* = 7.4 Hz, 1H), 7.07 – 6.97 (m, 1H), 5.66 – 5.55 (m, 1H), 4.55 (t, *J* = 7.1 Hz, 1H), 4.19 – 4.10 (m, 1H), 2.46 (dd, *J* = 13.9, 2.2 Hz, 1H), 2.22 (dd, *J* = 13.9, 11.9 Hz, 1H), 1.59 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$)

δ 193.1, 155.6, 137.1, 135.8, 134.5, 133.7, 132.5, 129.2, 129.1, 128.6, 127.3, 125.7 (q, *J* =279.5 Hz), 82.4, 62.0, 61.3 (d, *J* =31.8 Hz), 56.0, 35.3, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.90; **HRMS** (ESI) calcd. for $C_{23}H_{24}BrF_3N_2O_3Na$ ($[M+Na]^+$): 535.0815, found: 535.0812.

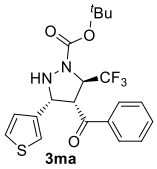


(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(2-methylbenzyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ka): White solid; 85% yield, 95% ee; >20:1 dr; m.p.: 184.3 − 184.6 ºC; $[\alpha]_D^{24}$ = -31.5 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IH, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 10.005 min (major), 6.557 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$）δ 8.07 – 8.01 (m, 2H), 7.67 (t, *J* = 7.4 Hz, 1H), 7.54 (t, *J* = 7.6 Hz, 2H), 7.39 – 7.32 (m, 1H), 7.11 – 7.01 (m, 2H), 6.99 – 6.93 (m, 1H), 5.70 – 5.42 (m, 1H), 4.57 – 4.46 (m, 2H), 4.00 – 3.86 (m, 1H), 2.23 (d, *J* = 6.8 Hz, 2H), 1.69 (s, 3H), 1.57 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.1, 155.7, 136.0 (two peaks) , 135.7, 134.5, 131.3, 130.1, 129.3, 128.6, 126.9, 125.8, 125.7 (q, *J* =279.8 Hz), 82.3, 62.8, 60.9 (q, *J* =30.9 Hz), 56.1, 31.7, 28.3, 18.9; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.82; **HRMS** (ESI) calcd. for $C_{24}H_{27}F_3N_2O_3Na$ ($[M+Na]^+$): 471.1866, found: 471.1863.



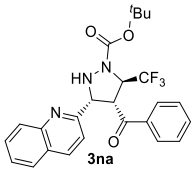
(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(furan-3-yl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3la): White solid; 76% yield, 56% ee; 3:1 dr; m.p.: 137.3 − 137.9 ºC; $[\alpha]_D^{27}$ = -8.9 (c 1.0, CHCl3); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 7.488 min (major), 9.987 min (minor); **^{1}H NMR** (400 MHz, CDCl3) δ 7.98 – 7.78 (m, 2H), 7.66 – 7.53 (m, 1H), 7.51 – 7.41 (m, 2H),

7.21 – 7.09 (m, 1H), 7.06 – 6.87 (m, 1H), 5.94 – 5.79 (m, 1H), 5.54 (m, 1H), 4.98 – 4.82 (m, 1H), 4.73 – 4.54 (m, 1H), 1.51 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, CDCl3) δ 192.7, 155.4, 143.2, 140.7, 136.2, 134.1, 129.1, 128.4, 125.6 (q, *J* =279.6 Hz), 120.6, 109.3, 82.5, 60.9 (q, *J* =31.3 Hz), 58.5, 57.1, 28.2; **^{19}F{^{1}H} NMR** (376MHz, CDCl3) δ -74.66; **HRMS** (ESI) calcd. for $C_{20}H_{21}F_3N_2O_4Na$ ($[M+Na]^+$): 433.1346, found: 449.1339.



3ma

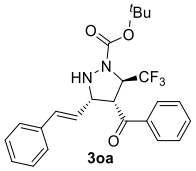
(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(thiophen-3-yl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ma): White solid; 90% yield, 80% ee; 5:1 dr; m.p.: 154.6 − 155.2 °C; $[\alpha]_D^{18}$ = -24.0 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IG, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 17.287 min (major), 19.927 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.85 – 7.66 (m, 2H), 7.60 – 7.48 (m, 1H), 7.47 – 7.36 (m, 2H), 7.04 – 6.96 (m, 1H), 6.73 – 6.63 (m, 1H), 6.52 – 6.46 (m, 1H), 5.64 – 5.46 (m, 1H), 5.09 – 4.98 (m, 1H), 4.84 – 4.69 (m, 1H), 1.52 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.4, 155.3, 136.5, 133.8, 128.9, 128.3, 136.9, 126.6, 126.0 ,125.7 (q, *J* =279.9 Hz), 123.4, 82.4, 61.8, 61.2 (q, *J* =31.2 Hz), 56.9, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.32; **HRMS** (ESI) calcd. for $C_{20}H_{21}F_3N_2O_4Na$ ($[M+Na]^+$): 449.1117, found: 449.1107.



3na

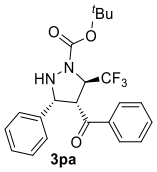
(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(quinolin-2-yl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3na): White solid; 61% yield, 81% ee; >20:1 dr; m.p.: 152.6 − 153.0 °C; $[\alpha]_D^{21}$ = -24.8 (c 0.1, $CHCl_3$); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 10.188 min (major), 11.890 min (minor); **^{1}H**

NMR (600 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.5 Hz, 1H), 7.76 – 7.68 (m, 3H), 7.70 – 7.58 (m, 1H), 7.63 – 7.55 (m, 1H), 7.49 – 7.35 (m, 3H), 7.34 – 7.22 (m, 2H), 5.80 – 5.59 (m, 1H), 5.27 (d, *J* = 7.4 Hz, 1H), 4.58 (t, *J* = 6.5 Hz, 1H), 1.27 (s, 9H); **$^{13}C\{^1H\}$ NMR** (150 MHz, $CDCl_3$) δ 193.9, 155.6, 146.6, 138.0, 136.9, 132.7, 129.6, 128.8, 128.5, 127.6, 127.4, 127.2, 126.8, 125.9 (q, *J* =279.0 Hz), 120.4, 81.9, 67.0, 62.3 (q, *J* =30.9 Hz), 56.5, 28.1; **$^{19}F\{^1H\}$ NMR** (565 MHz, $CDCl_3$) δ -74.64; **HRMS** (ESI) calcd. for $C_{25}H_{24}F_3N_3O_3Na$ ($[M+Na]^+$): 494.1662, found: 494.1653.



3oa

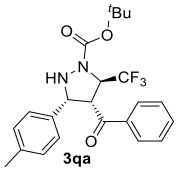
(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-((*E*)-styryl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3oa): White solid; 50% yield, 90% ee; >20:1 dr; m.p.: 158.2 − 159.0 °C; $[\alpha]_D^{18}$ = -52.7 (c 0.5, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 4.973 min (major), 7.700 min (minor); **^1H NMR** (400 MHz, $CDCl_3$) δ 7.96 (d, *J* = 7.7 Hz, 2H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.51 (t, *J* = 7.6 Hz, 2H), 7.23 – 7.16 (m, 3H), 7.09 – 7.03 (m, 2H), 6.42 (d, *J* = 15.7 Hz, 1H), 5.63 – 5.40 (m, 2H), 4.68 – 4.52 (m, 2H), 1.52 (s, 9H); **$^{13}C\{^1H\}$ NMR** (100 MHz, $CDCl_3$) δ 193.0, 155.6, 136.4, 136.1, 134.2, 134.1, 129.2, 128.6, 128.1, 126.6, 125.7 (q, *J* =278.8 Hz), 122.1, 82.4, 64.2, 61.0 (q, *J* =31.2 Hz), 56.6, 28.3; **$^{19}F\{^1H\}$ NMR** (376 MHz, $CDCl_3$) δ -74.57; **HRMS** (ESI) calcd. for $C_{24}H_{25}F_3N_2O_3Na$ ($[M+Na]^+$): 469.1709, found: 469.1700.



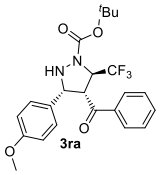
3pa

(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-phenyl-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3pa): White solid; 67% yield, 90% ee; >20:1 dr; m.p.: 158.4 − 159.3 °C; $[\alpha]_D^{24}$ = -20.2 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IH, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0

mL/min, λ = 254 nm, retention time: 7.627 min (major), 9.723 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.67 (d, *J* = 7.7 Hz, 2H), 7.50 (t, *J* = 7.4 Hz, 1H), 7.35 (t, *J* = 7.6 Hz, 2H), 7.12 – 6.97 (m, 3H), 6.91 – 6.77 (m, 2H), 5.60 – 5.45 (m, 1H), 5.17 (s, 1H), 4.93 (d, *J* = 8.1 Hz, 1H), 4.81 – 4.65 (m, 1H), 1.52 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 194.2, 155.1, 136.6, 136.2, 133.7, 128.8, 128.4, 128.2, 128.1, 127.5, 125.6 (q, *J* = 279.5 Hz), 82.40, 66.1, 61.7 (q, *J* = 31.2 Hz), 56.3, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.43; **HRMS** (ESI) calcd. for $C_{22}H_{23}F_3N_2O_3Na$ ($[M+Na]^+$): 443.1553, found: 443.1544.

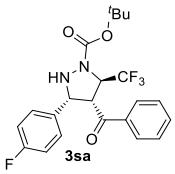


(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(p-tolyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3qa): White solid; 67% yield, 85% ee; >20:1 dr; m.p.: 89.7 − 90.5 °C; $[\alpha]_D^{18}$ = -11.2 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IG, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 14.867 min (major), 23.757 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.69 (d, *J* = 8.0 Hz, 2H), 7.57 – 7.45 (m, 1H), 7.36 (t, *J* = 7.6 Hz, 2H), 6.85 (d, *J* = 7.7 Hz, 2H), 6.72 (d, *J* = 7.9 Hz, 2H), 5.60 – 5.40 (m, 1H), 4.91 (d, *J* = 7.8 Hz, 1H), 4.76 – 4.64 (m, 1H), 2.16 (s, 3H), 1.52 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 194.2, 155.1, 137.8, 136.6, 133.7, 133.0, 129.1, 128.8, 128.3, 127.3, 125.6 (q, *J* = 279.5 Hz), 82.3, 65.9, 61.7 (q, *J* = 31.0 Hz), 56.4, 28.3, 21.1; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.45; **HRMS** (ESI) calcd. for $C_{23}H_{25}F_3N_2O_3Na$ ($[M+Na]^+$): 457.1709, found: 457.1702.

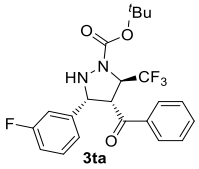


(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(4-methoxyphenyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ra): White solid; 69% yield, 90% ee; >20:1 dr; m.p.: 126.7 − 127.4 °C; $[\alpha]_D^{19}$ = -8.9

(c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 12.005 min (major), 18.835 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 – 7.57 (m, 2H), 7.59 – 7.38 (m, 1H), 7.40 – 7.31 (m, 2H), 6.92 – 6.71 (m, 2H), 6.62 – 6.43 (m, 2H), 5.80 – 5.35 (m, 1H), 4.95 – 4.84 (m, 1H), 4.78 – 4.56 (m, 1H), 3.65 (s, 3H), 1.52 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 194.1, 159.3, 155.1, 136.6, 133.7, 128.8, 128.7, 128.3 (two peaks), 125.6 (q, *J* =278.7 Hz), 113.8, 82.3, 65.6, 61.6 (q, *J* =31.1 Hz), 56.5, 55.2, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.49; **HRMS** (ESI) calcd. for $C_{23}H_{25}F_3N_2O_4Na$ ($[M+Na]^+$): 473.1658, found: 473.1655.

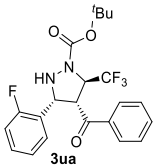


(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(4-fluorophenyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3sa): White solid; 68% yield, 91% ee; >20:1 dr; m.p.: 94.7 − 95.5 °C; $[\alpha]_D^{18}$ = -13.7 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IG, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 13.473 min (major), 20.077 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.76 – 7.65 (m, 2H), 7.52 (t, *J* = 7.4 Hz, 1H), 7.37 (t, *J* = 7.7 Hz, 2H), 6.88 – 6.67 (m, 4H), 5.67 – 5.41 (m, 1H), 5.13 (s, 1H), 4.94 (d, *J* = 8.2 Hz, 1H), 4.78 – 4.66 (m, 1H), 1.52 (s, 9H); **^{13}C{^{1}H} NMR** (150 MHz, $CDCl_3$) δ 193.8 , 162.3 (d, *J* = 240.0 Hz), 155.03 , 136.4 , 133.9 , 132.3 , 129.2 (d, *J* = 8.0 Hz), 128.9 , 128.2 , 125.6 (q, *J* = 279.7 Hz), 115.3 (d, *J* = 57.5 Hz), 82.5 , 65.4 , 61.5 (q, *J* = 31.5 Hz), 56.4 , 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.53, -113.72; **HRMS** (ESI) calcd. for $C_{22}H_{22}F_4N_2O_3Na$ ($[M+Na]^+$): 461.1459, found: 461.1455.



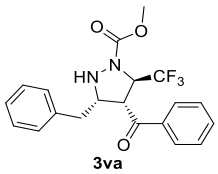
(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(3-fluorophenyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ta):

White solid; 46% yield, 78% ee; >20:1 dr; m.p.: 182.4 − 183.2 °C; $[\alpha]_D^{21}$ = -17.0 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.945 min (major), 10.490 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89 – 7.60 (m, 2H), 7.58 – 7.43 (m, 1H), 7.47 – 7.30 (m, 2H), 7.13 – 6.91 (m, 1H), 6.89 – 6.69 (m, 1H), 6.71 – 6.54 (m, 2H), 5.71 – 5.39 (m, 1H), 4.94 (d, *J* = 7.7 Hz, 1H), 4.86 – 4.59 (m, 1H), 1.54 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 193.7, 162.6 (d, *J* =245.4 Hz), 155.0, 138.88 (d, *J* =6.8 Hz), 136.5, 134.0, 130.0 (d, *J* =8.0 Hz), 129.0, 128.3, 125.6 (q, *J* =279.9 Hz), 123.1, (q, *J* =3.1 Hz), 115.1 (d, *J* =20.9 Hz), 114.7, (d, *J* =22.6 Hz), 82.7, 65.5, 61.7, (q, *J* =31.3 Hz), 56.3, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.51, -112.35; **HRMS** (ESI) calcd. for $C_{22}H_{22}F_4N_2O_3Na$ ($[M+Na]^+$): 461.1459, found: 461.1451.



3ua

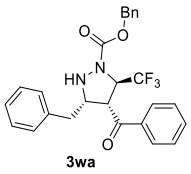
(3*R*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-(2-fluorophenyl)-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3ua): White solid; 50% yield, 93% ee; >20:1 dr; m.p.: 126.2 − 127.0 °C; $[\alpha]_D^{19}$ = -21.2 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 7.890 min (major), 10.212 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.75 – 7.55 (m, 2H), 7.54 – 7.45 (m, 1H), 7.40 – 7.30 (m, 2H), 7.12 – 6.99 (m, 2H), 6.99 – 6.89 (m, 1H), 6.75 – 6.59 (m, 1H), 5.53 – 5.38 (m, 1H), 5.33 (d, *J* = 8.1 Hz, 1H), 5.07 (s, 1H), 4.79 (dd, *J* = 8.1, 4.2 Hz, 1H), 1.54 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 194.8, 159.8 (d, *J* =244.6 Hz), 155.1, 136.2, 133.8, 129.9 (d, *J* =8.6 Hz), 128.7, 128.2, 128.1, 125.5 (q, *J* =279.6Hz), 124.4 (d, *J* =3.6 Hz), 123.9 (d, *J* =13.4 Hz), 115.0 (d, *J* =22.3 Hz), 82.5, 62.5 (q, *J* =31.4 Hz), 58.6, 58.5 (d, *J* =4.3 Hz), 54.5, 28.3; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.49, -116.23; **HRMS** (ESI) calcd. for $C_{22}H_{22}F_4N_2O_3Na$ ($[M+Na]^+$): 461.1459, found: 461.1459.



3va

(3*S*,4*R*,5*R*)-methy

4-benzoyl-3-benzyl-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3va): Colorless oil; 60% yield, 90% ee; >20:1 dr; $[\alpha]_D^{24}$ = -31.3 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IH, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 18.763 min (major), 60.243 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.14 – 7.87 (m, 2H), 7.67 (t, *J* = 7.4 Hz, 1H), 7.54 (t, *J* = 7.7 Hz, 1H), 7.22 – 7.10 (m, 3H), 6.99 (d, *J* = 7.5 Hz, 2H), 5.71 – 5.56 (m, 1H), 4.47 (t, *J* = 6.9 Hz, 1H), 4.15 – 4.02 (m, 1H), 3.89 (s, 3H), 2.36 (dd, *J* = 14.3, 10.7 Hz, 1H), 2.19 (dd, *J* = 14.3, 3.7 Hz, 1H); **^{13}C{^{1}H} NMR** (150 MHz, $CDCl_3$) δ 192.8, 157.7, 137.7, 135.9, 134.5, 129.4, 129.3, 128.4 (two peaks), 126.8, 125.6 (q, *J* =279.7 Hz), 64.7, 61.5 (q, *J* =31.5 Hz), 55.8, 53.9, 35.0; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.85; **HRMS** (ESI) calcd. for $C_{20}H_{19}F_3N_2O_3Na$ ($[M+Na]^+$): 415.1240, found: 415.1231.

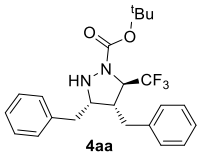


3wa

(3*S*,4*R*,5*R*)-benzyl

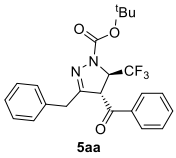
4-benzoyl-3-benzyl-5-(trifluoromethyl)pyrazolidine-1-carboxylate (3wa): White solid; 64% yield, 90% ee; >20:1 dr; m.p.: 37.4 − 38.2 °C; $[\alpha]_D^{18}$ = -27.7 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK OD−H, *n*−Hexane/2−propanol = 80/20, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 7.410 min (major), 6.107 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.05 – 7.96 (m, 2H), 7.72 – 7.62 (m, 1H), 7.54 (t, *J* = 7.8 Hz, 2H), 7.49 – 7.41 (m, 2H), 7.41 – 7.31 (m, 3H), 7.14 – 7.02 (m, 3H), 6.97 – 6.85 (m, 2H), 5.76 – 5.63 (m, 1H), 5.38 (d, *J* = 12.1 Hz, 1H), 5.24 (d, *J* = 12.1 Hz, 1H), 4.63 (s, 1H), 4.54 – 4.41 (m, 1H), 4.15 – 3.93 (m, 1H), 2.33 (dd, *J* = 14.2, 10.8 Hz, 1H), 2.14 (dd, *J* = 14.2, 3.4 Hz, 1H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.8, 157.2, 137.7, 135.9, 135.7, 134.4, 129.4, 129.3, 128.7, 128.6 (two peaks), 128.4, 128.3, 126.7, 125.6 (q, *J*

=279.0 Hz), 68.8, 64.7, 61.5 (q, *J* =31.2 Hz), 55.9, 35.0; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.71; **HRMS** (ESI) calcd. for $C_{26}H_{23}F_3N_2O_3Na$ ($[M+Na]^+$): 491.1553, found: 491.1549.



4aa

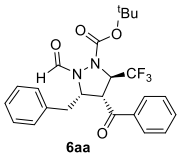
(3*S*,4*R*,5*R*)-*tert*-butyl 3,4-dibenzyl-5-(trifluoromethyl)pyrazolidine-1-carboxylate (4aa): Colorless oil; 57% yield, 94% ee; >20:1 dr; $[\alpha]_D^{21}$ = -27.9 (c 1.0, CHCl3); **HPLC** CHIRALPAK IF, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 220 nm, retention time: 6.110 min (major), 8.650 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.46 – 7.30 (m, 7H), 7.27 – 7.17 (m, 3H), 5.03 – 4.88 (m, 1H), 4.73 – 4.45 (m, 1H), 4.21 (s, 1H), 3.71 – 3.52 (m, 1H), 3.23 – 3.11 (m, 1H), 3.06 – 2.93 (m, 1H), 2.44 – 2.27 (m, 2H), 1.53 (s, 9H);**^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 156.6, 142.2, 140.2, 129.8, 129.0, 128.7, 128.2, 126.4, 126.3, 125.6 (q, *J* =280.0 Hz), 82.0, 72.8, 64.1, 60.8 (q, *J* =30.7 Hz), 54.3, 34.1, 28.4; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -74.52; **HRMS** (ESI) calcd. for $C_{23}H_{27}F_3N_2O_2Na$ ($[M+Na]^+$): 443.1917, found: 443.1913.



5aa

(4*S*,5*R*)-*tert*-butyl 4-benzoyl-3-benzyl-5-(trifluoromethyl)-4,5-dihydro-1*H*-pyrazole-1-carboxylate (5aa): White solid; 67% yield, 98% ee; >20:1 dr; m.p.: 152.6 − 153.0 ºC; $[\alpha]_D^{21}$ = -33.4 (c 1.0, CHCl3); **HPLC** CHIRALPAK OJ–H, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 6.053 min (major), 8.917 min (minor); **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.77 – 7.68 (m, 2H), 7.67 – 7.62 (m, 1H), 7.45 (t, *J* = 7.8 Hz, 2H), 7.29 – 7.16 (m, 3H), 7.07 – 6.94 (m, 2H), 5.29 – 5.11 (m, 1H), 4.75 (d, *J* = 3.6 Hz, 1H), 3.97 (d, *J* = 15.6 Hz, 1H), 3.26 (d, *J* = 15.6 Hz, 1H), 1.58 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 192.8, 153.3, 151.6, 135.0, 134.8, 134.7, 129.2, 129.1, 129.0, 127.5, 124.3 (q, *J* =280.6 Hz), 83.2, 62.16 (q, *J* =32.3 Hz), 55.3, 35.5,

28.3; **^{19}F{^{1}H} NMR** (565 MHz, $CDCl_3$) δ -75.68; **HRMS** (ESI) calcd. for $C_{23}H_{23}F_3N_2O_3Na$ ([M+Na]$^+$): 455.1553, found: 455.1548.

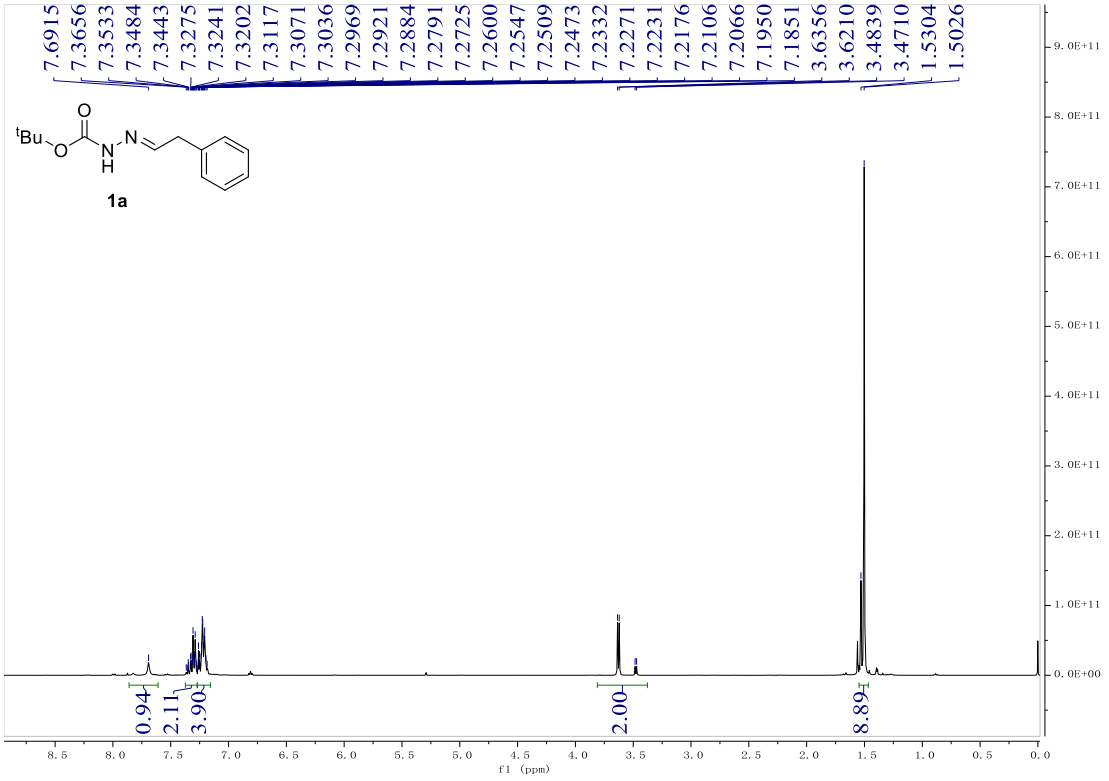


6aa

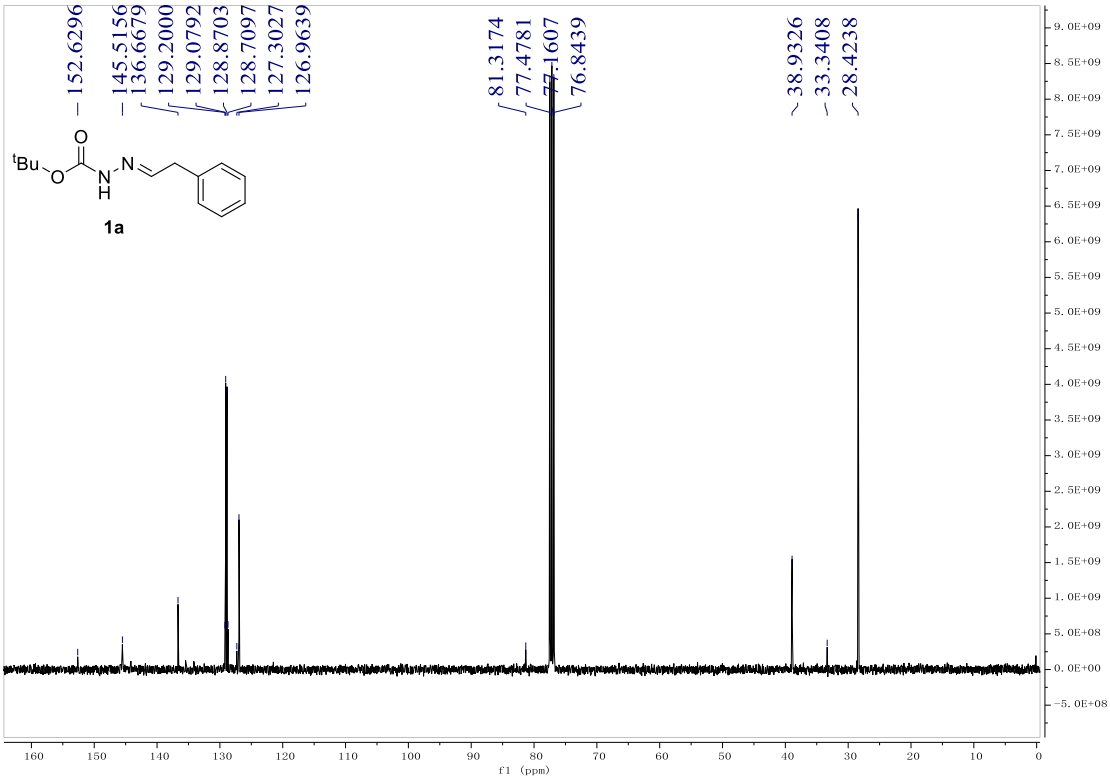
(3*S*,4*R*,5*R*)-*tert*-butyl 4-benzoyl-3-benzyl-2-formyl-5-(trifluoromethyl)pyrazolidine-1-car (6aa): White solid; 81% yield, 96% ee; >20:1 dr; m.p.: 88.9 − 89.5 °C; $[\alpha]_D^{21}$ = 1.2 (c 1.0, $CHCl_3$); **HPLC** CHIRALPAK IE, *n*−Hexane/2−propanol = 90/10, flow rate = 1.0 mL/min, λ = 254 nm, retention time: 11.657 min (major), 6.183 min (minor); **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.28 (s, 1H), 8.05 – 7.94 (m, 2H), 7.71 – 7.62 (m, 1H), 7.58 – 7.49 (m, 2H), 7.22 – 7.02 (m, 5H), 5.76 – 5.59 (m, 1H), 5.45 – 5.29 (m, 1H), 4.50 – 4.37 (m, 1H), 2.47 (dd, *J* = 15.0, 11.0 Hz, 1H), 2.36 (dd, *J* = 14.9, 4.2 Hz, 1H), 1.50 (s, 9H); **^{13}C{^{1}H} NMR** (100 MHz, $CDCl_3$) δ 191.7, 165.8, 156.0, 135.9, 135.4, 134.8, 129.5, 128.9, 128.6, 128.5, 127.1, 125.0 (q, *J* = 278.43 Hz), 84.6, 60.8 (q, *J* = 29.9 Hz), 58.1, 53.1, 34.3, 28.0; **^{19}F{^{1}H} NMR** (376 MHz, $CDCl_3$) δ -75.46; **HRMS** (ESI) calcd. for $C_{24}H_{25}F_3N_2O_4Na$ ([M+Na]$^+$): 485.1658, found: 485.1653.

9. Copies of NMR Spectra

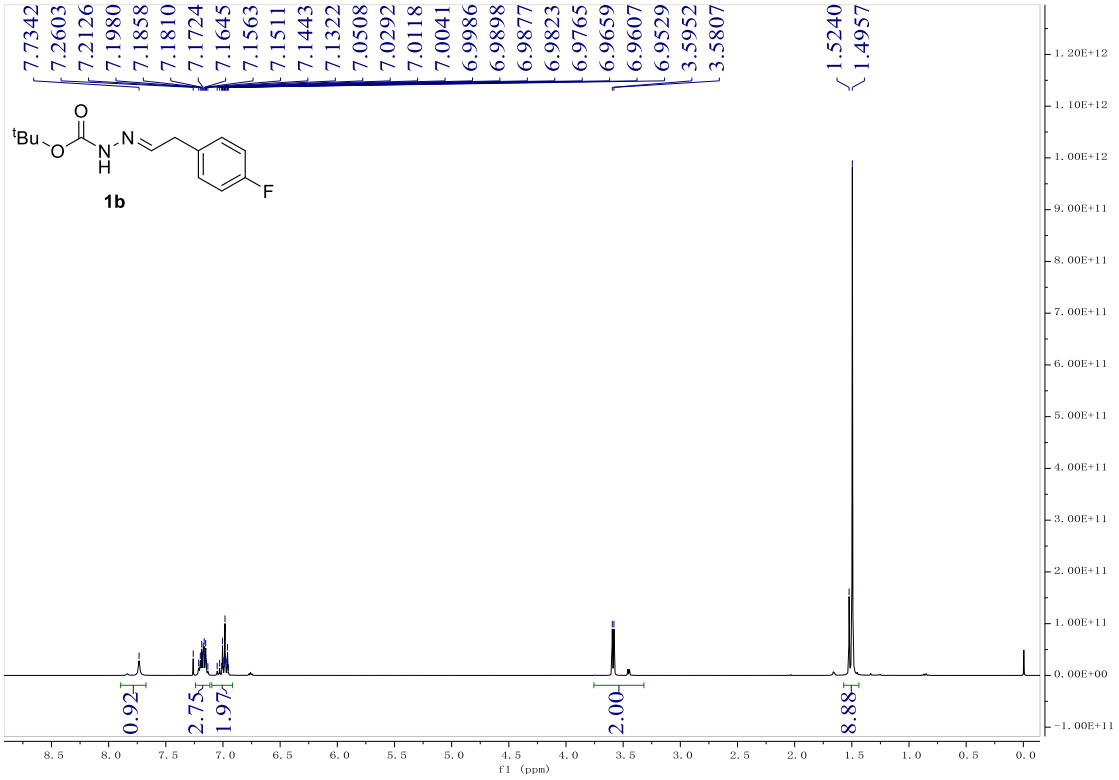
^{1}H NMR of 1a (400 MHz, $CDCl_3$)



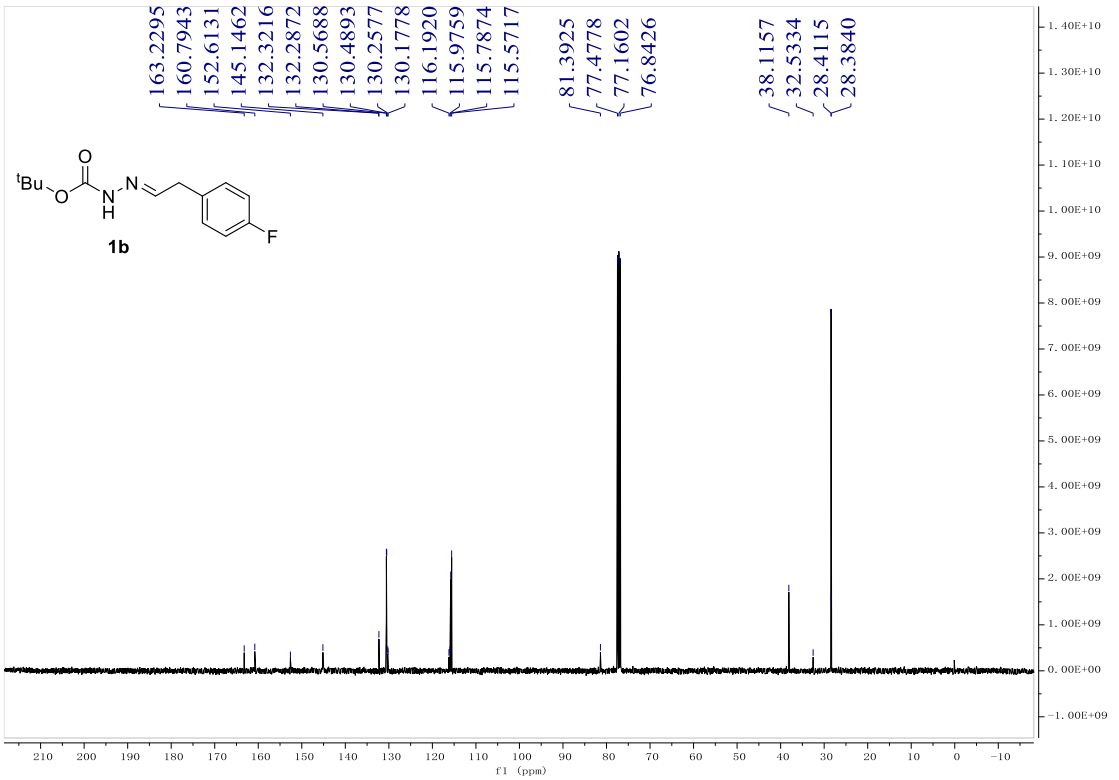
^{13}C{^{1}H} NMR of 1a (100 MHz, $CDCl_3$)



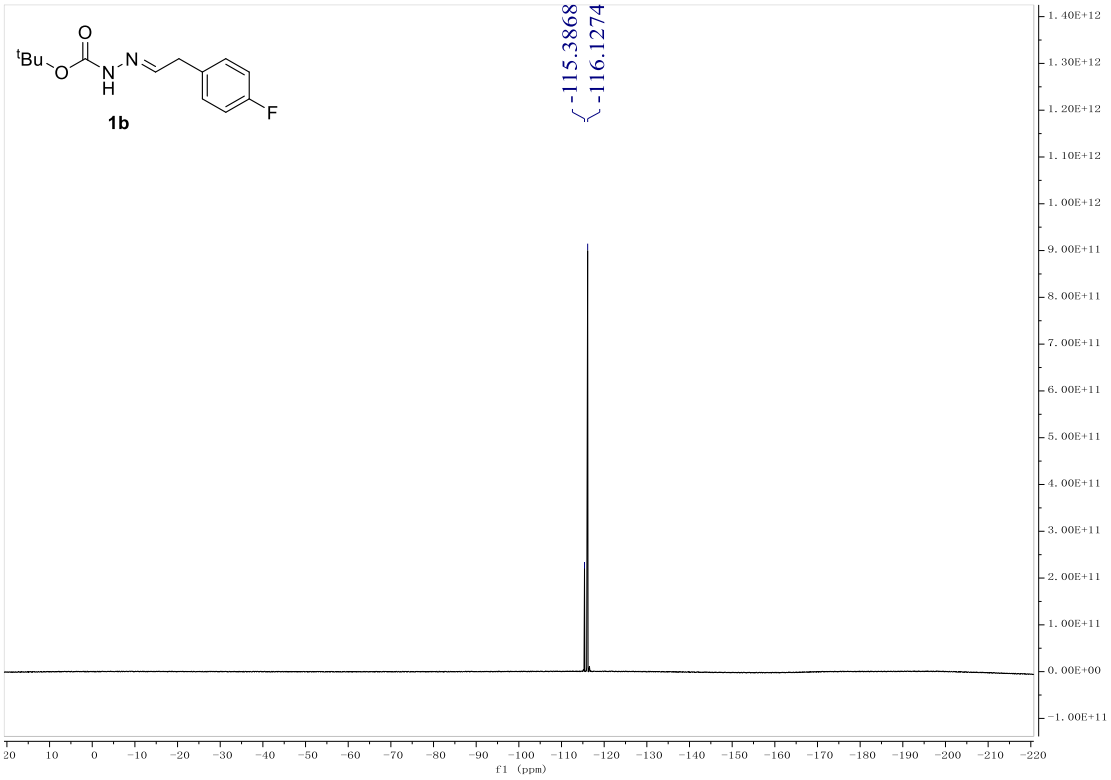
^{1}H NMR of 1b (400 MHz, $CDCl_3$)



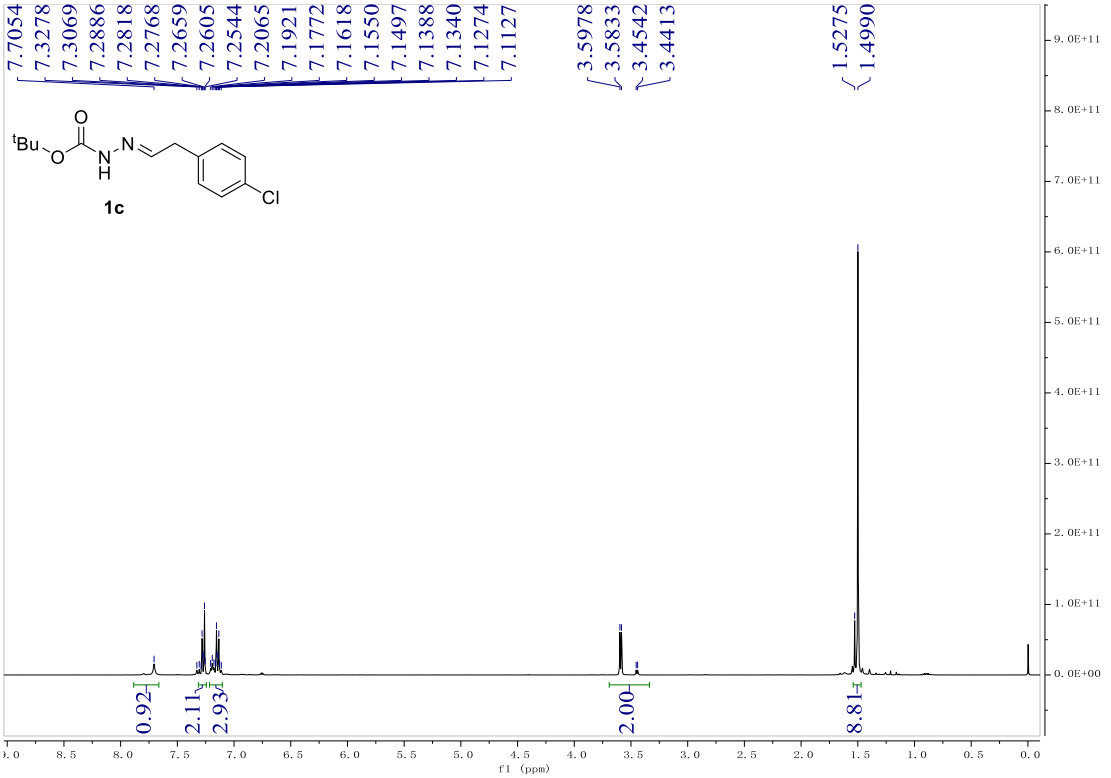
^{13}C{^{1}H} NMR of 1b (100 MHz, $CDCl_3$)



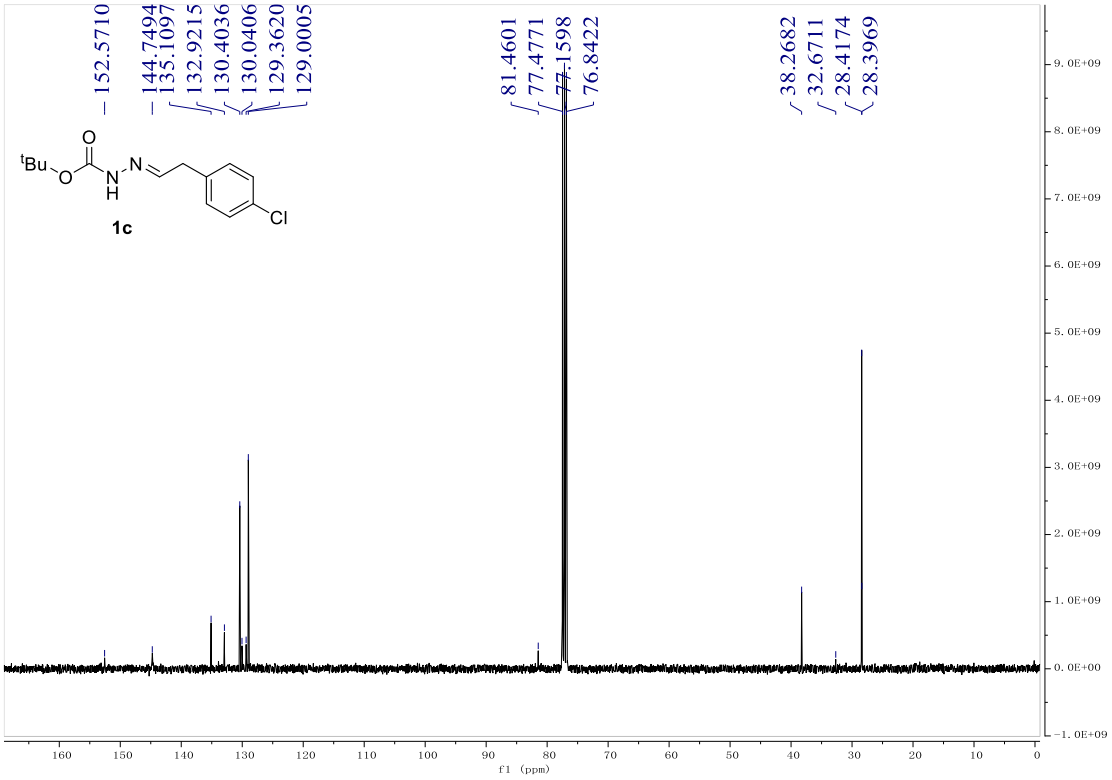
$^{19}F\{^{1}H\}$ NMR of 1b (376 MHz, $CDCl_3$)



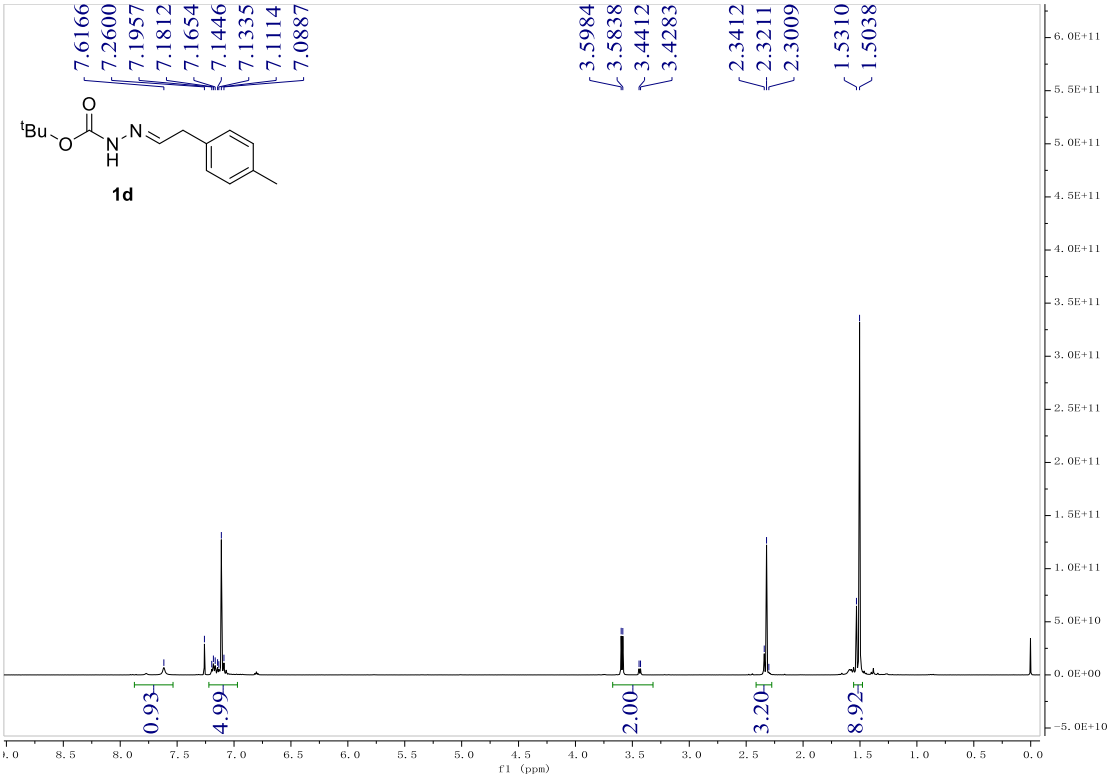
^{1}H NMR of 1c (400 MHz, $CDCl_3$)



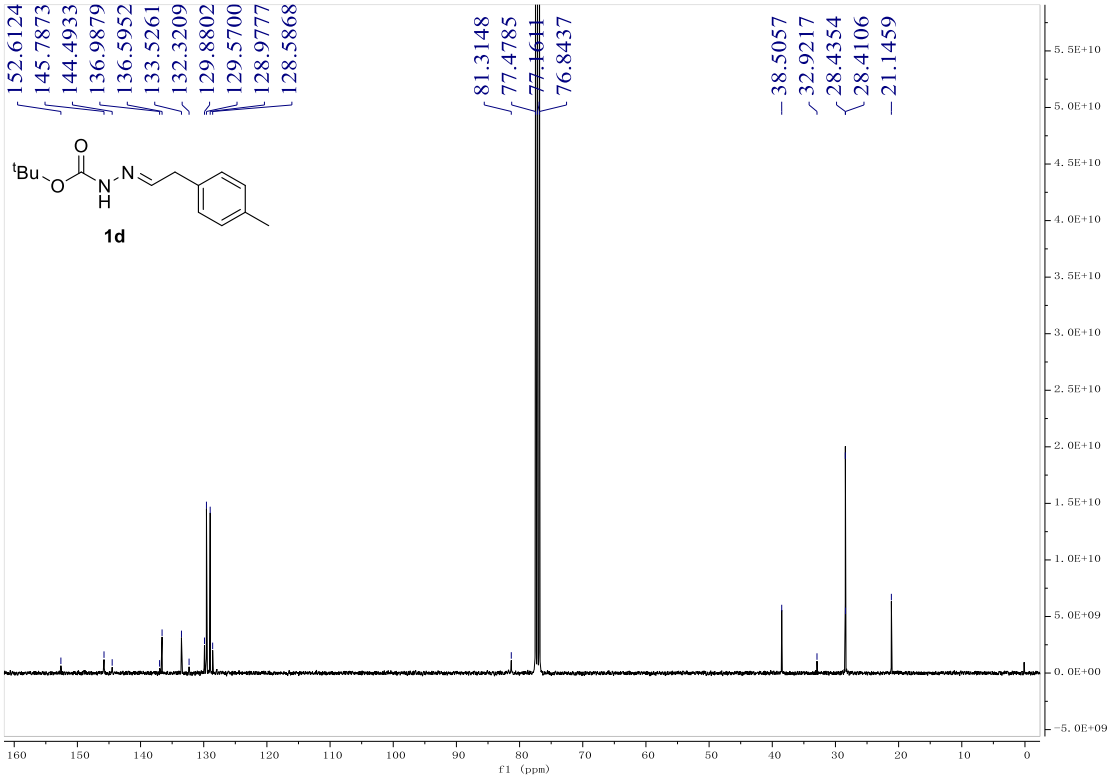
$^{13}C\{^{1}H\}$ NMR of 1c (100 MHz, $CDCl_3$)



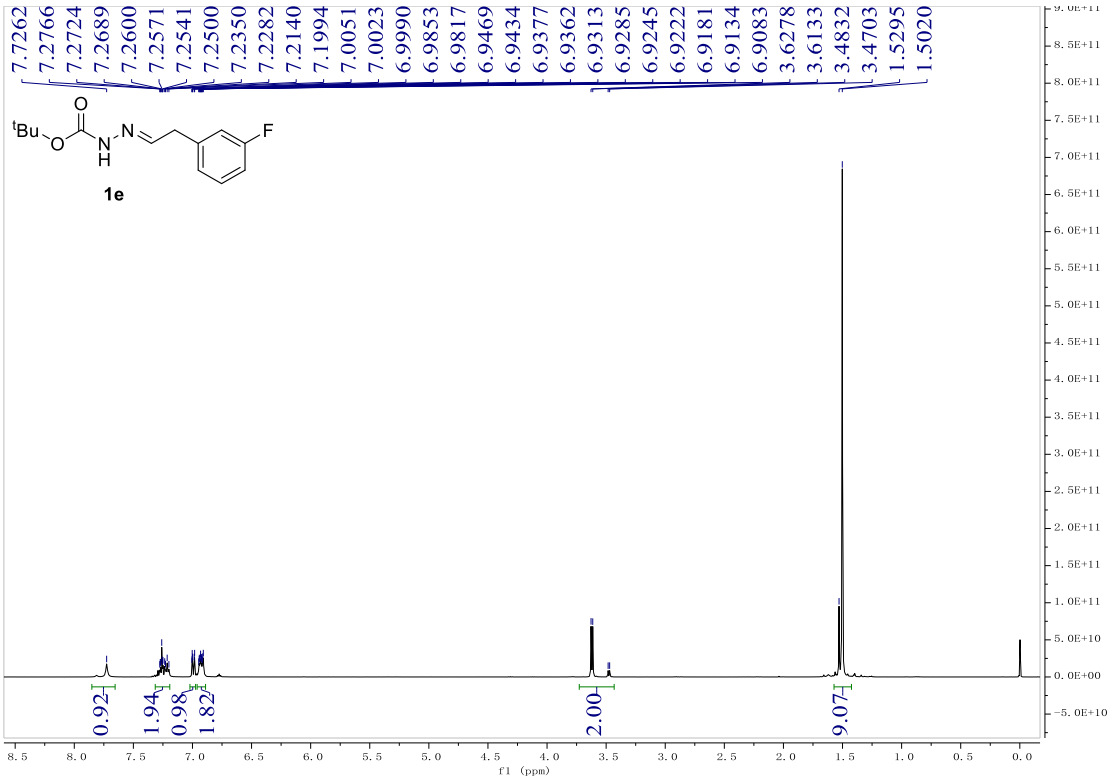
^{1}H NMR of 1d (400 MHz, $CDCl_3$)



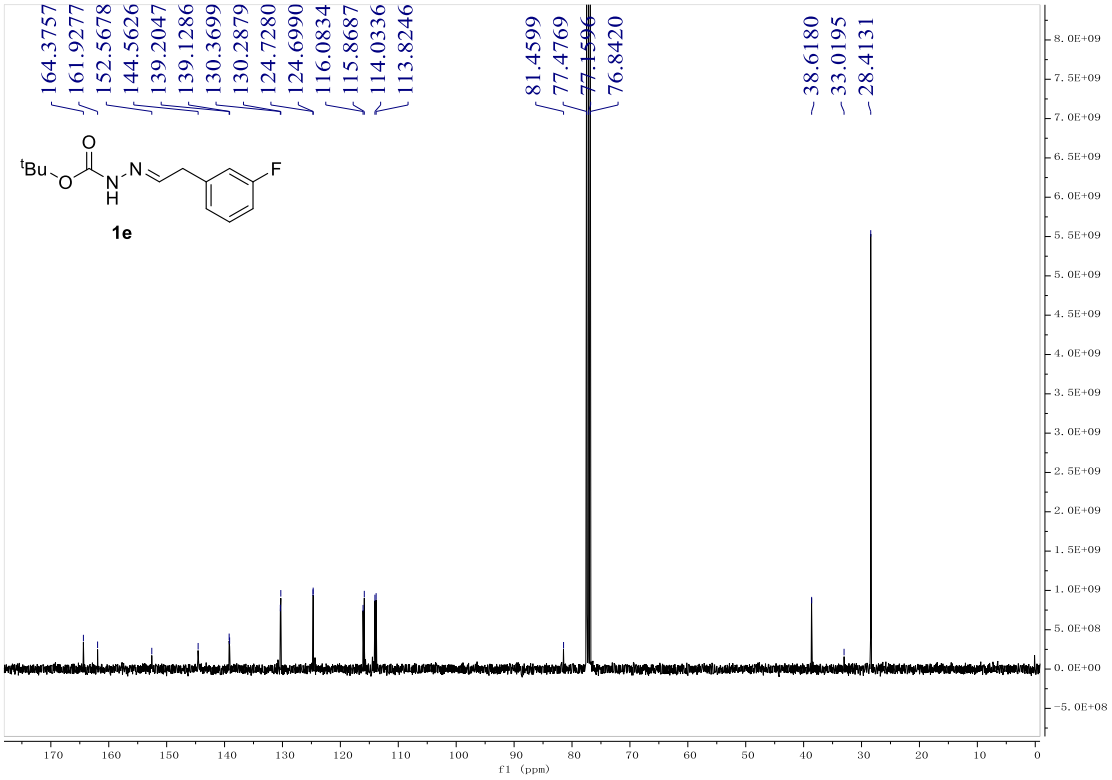
$^{13}C\{^{1}H\}$ NMR of 1d (100 MHz, $CDCl_3$)



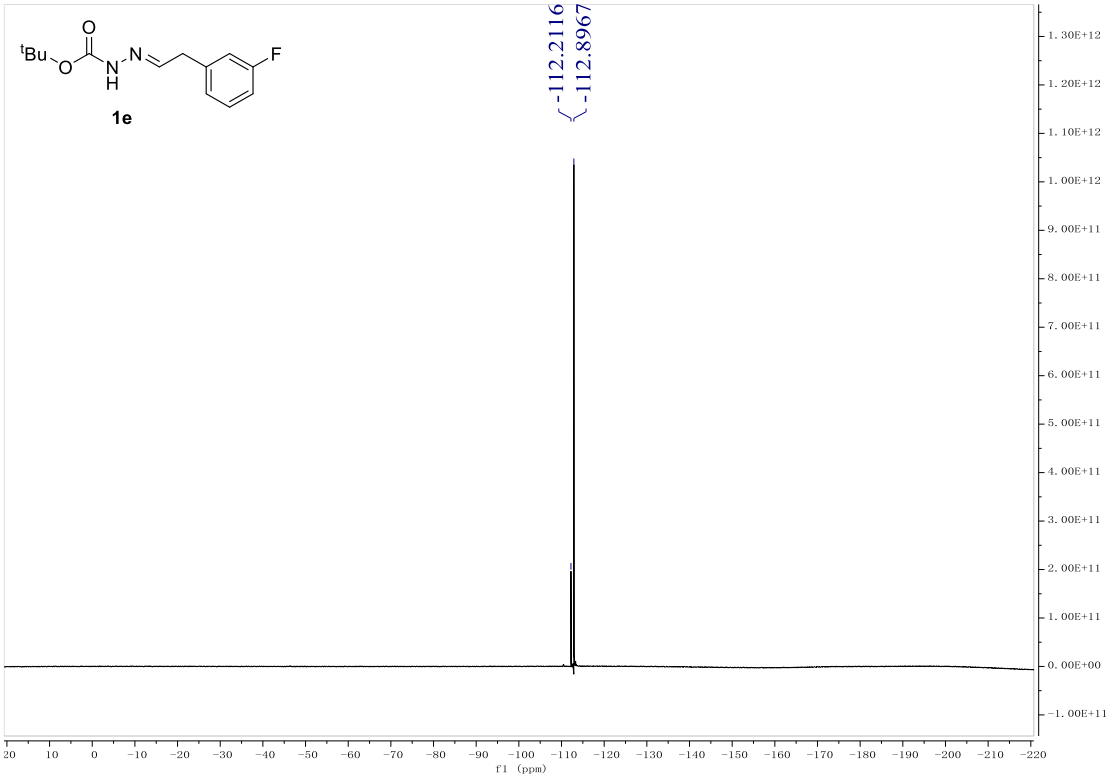
^{1}H NMR of 1e (400 MHz, $CDCl_3$)



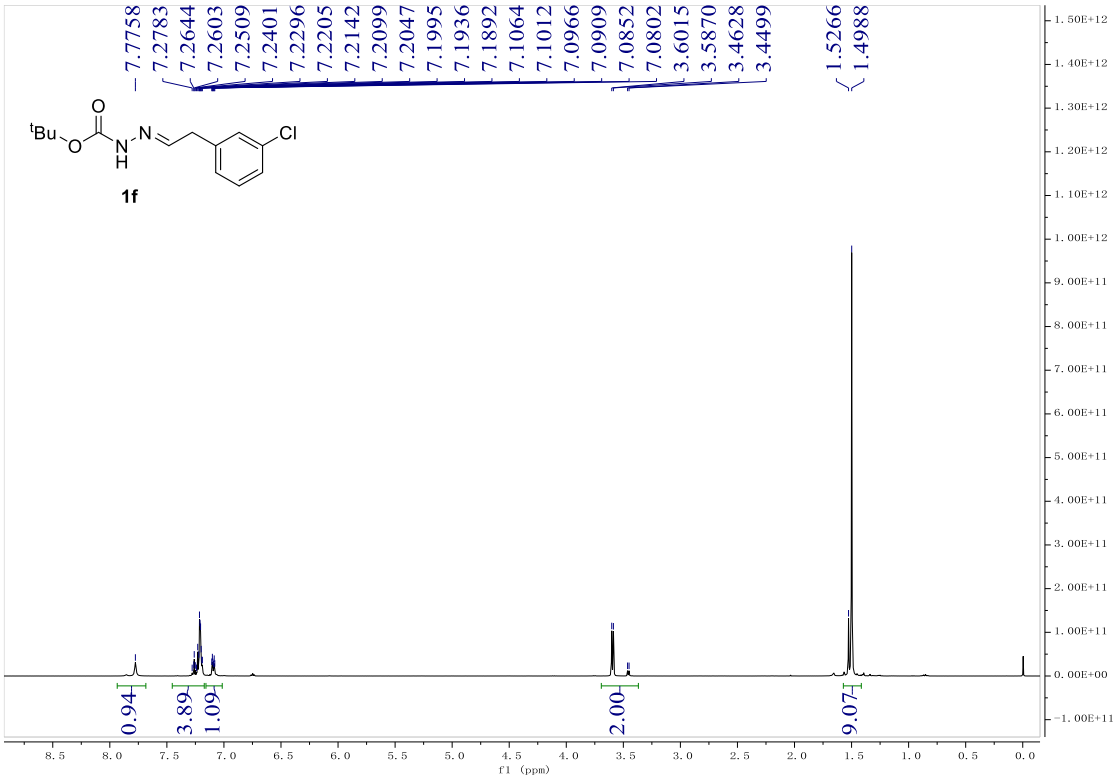
$^{13}C\{^{1}H\}$ NMR of 1e (100 MHz, $CDCl_3$)



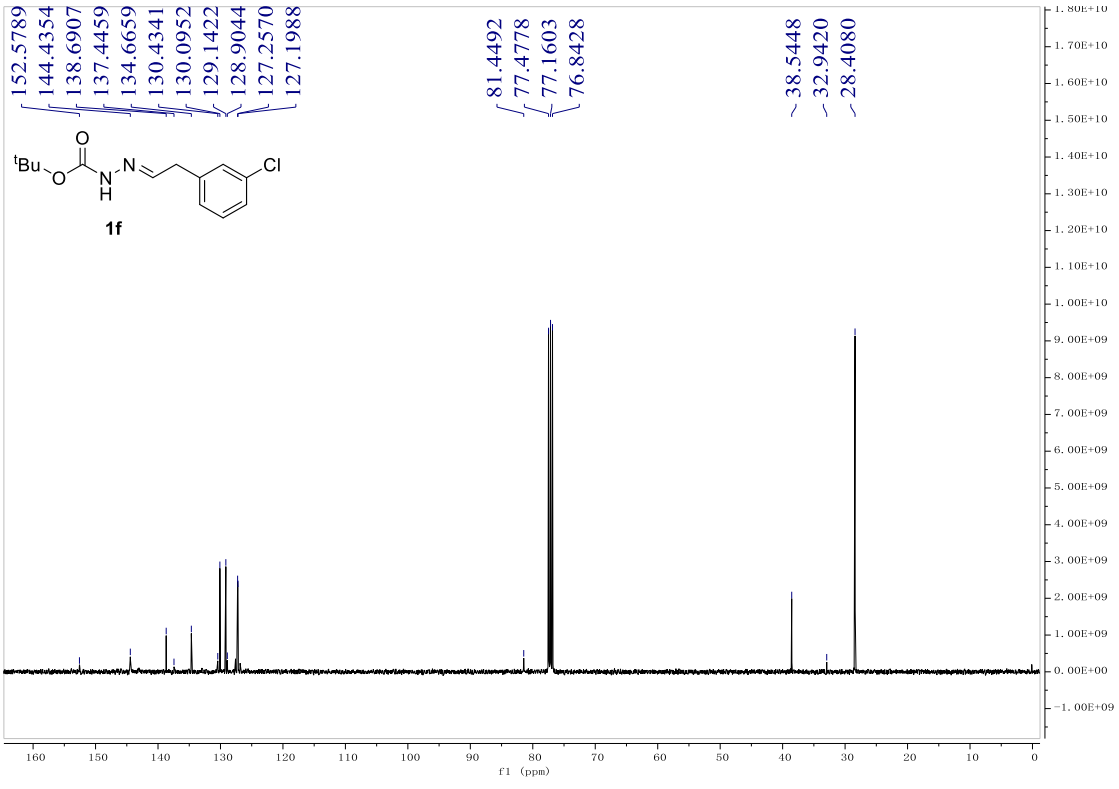
$^{19}F\{^{1}H\}$ NMR of 1e (376 MHz, $CDCl_3$)



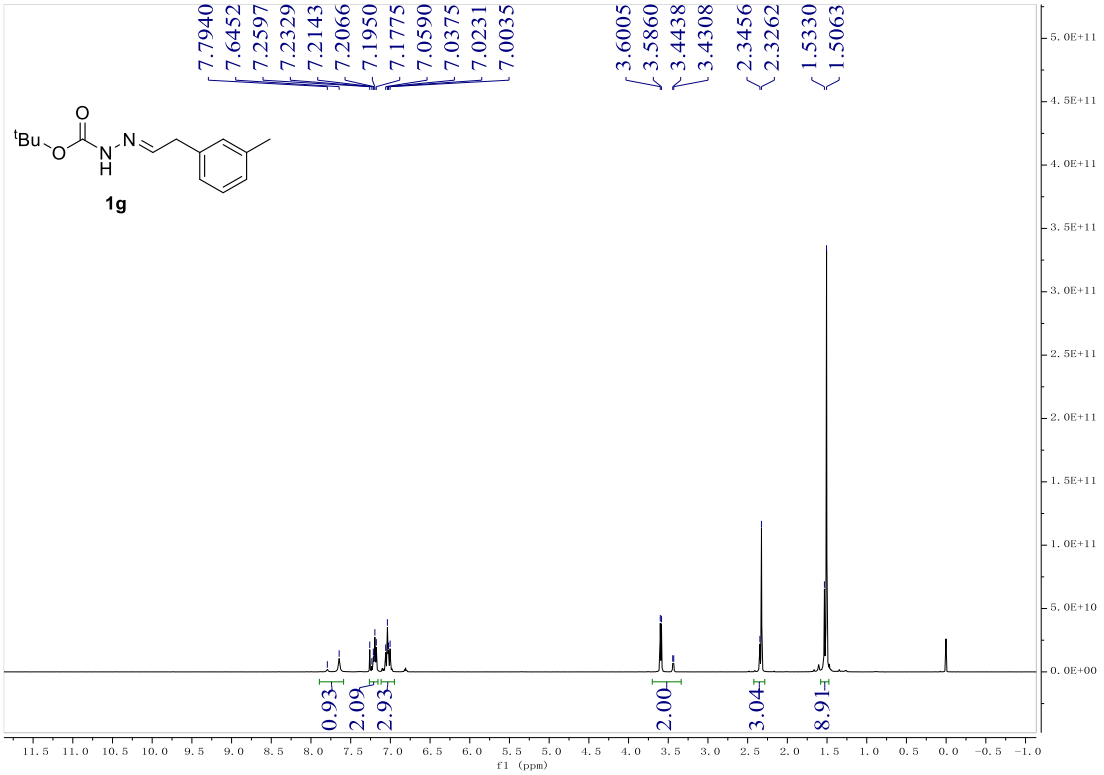
^{1}H NMR of 1f (400 MHz, $CDCl_3$)



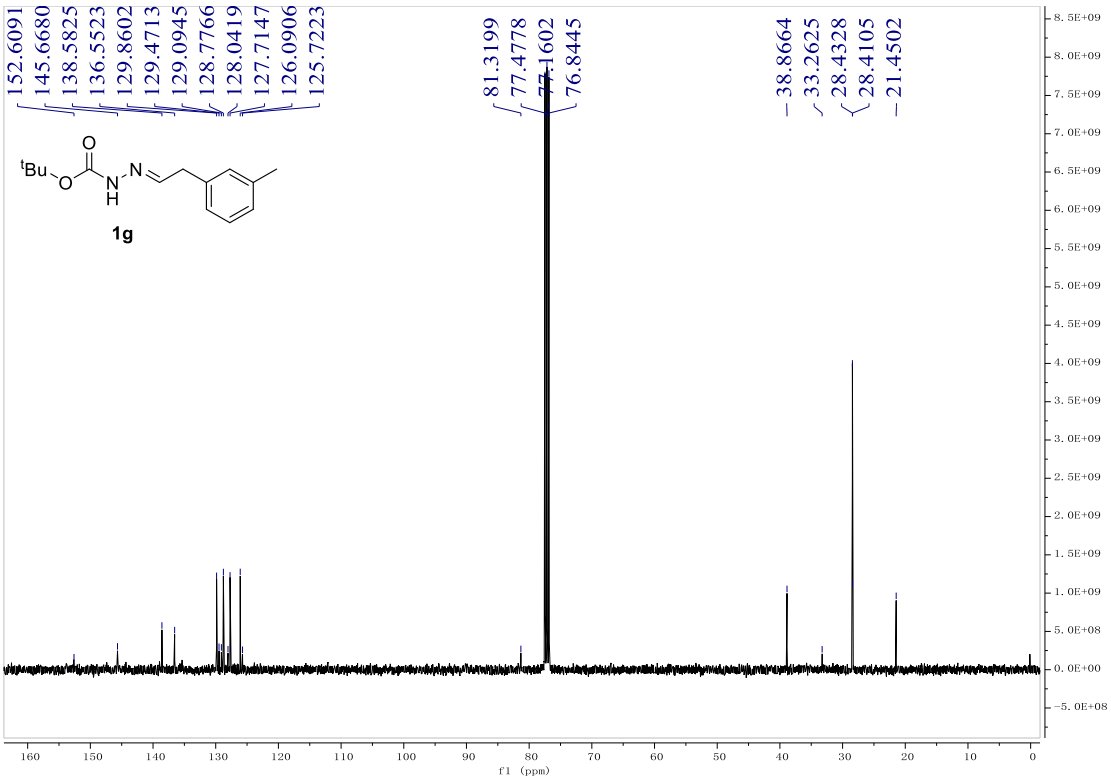
^{13}C{^{1}H} NMR of 1f (100 MHz, $CDCl_3$)



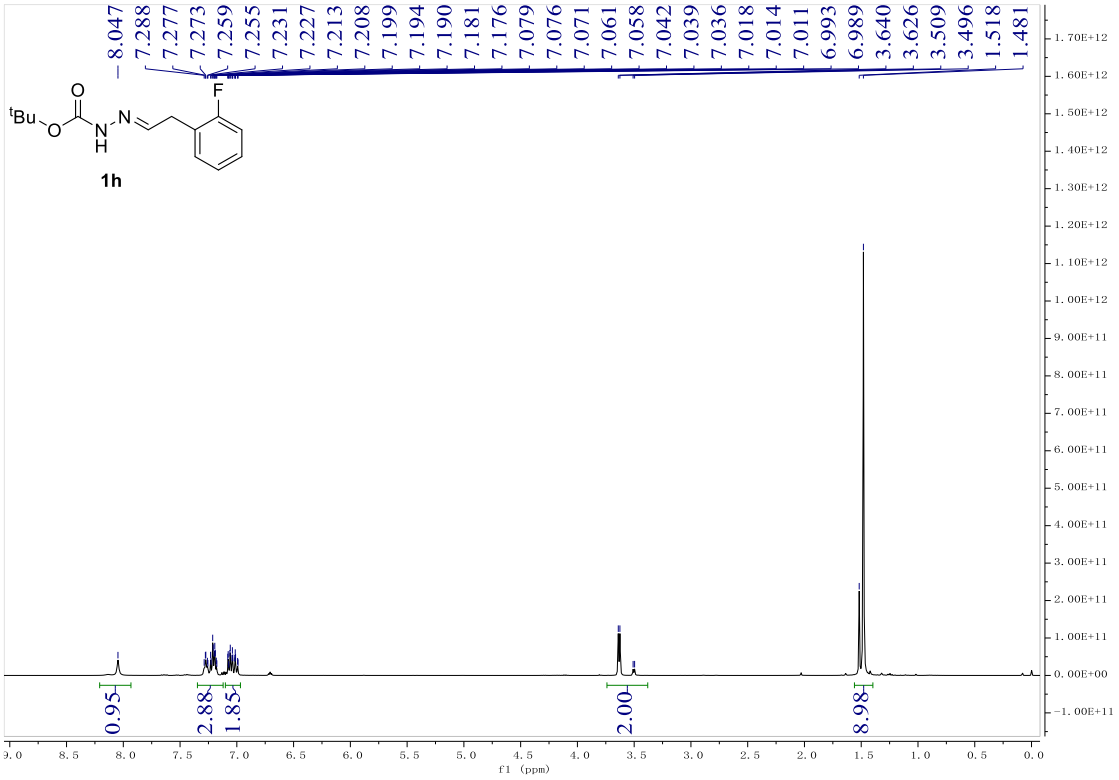
^{1}H NMR of 1g (400 MHz, $CDCl_3$)



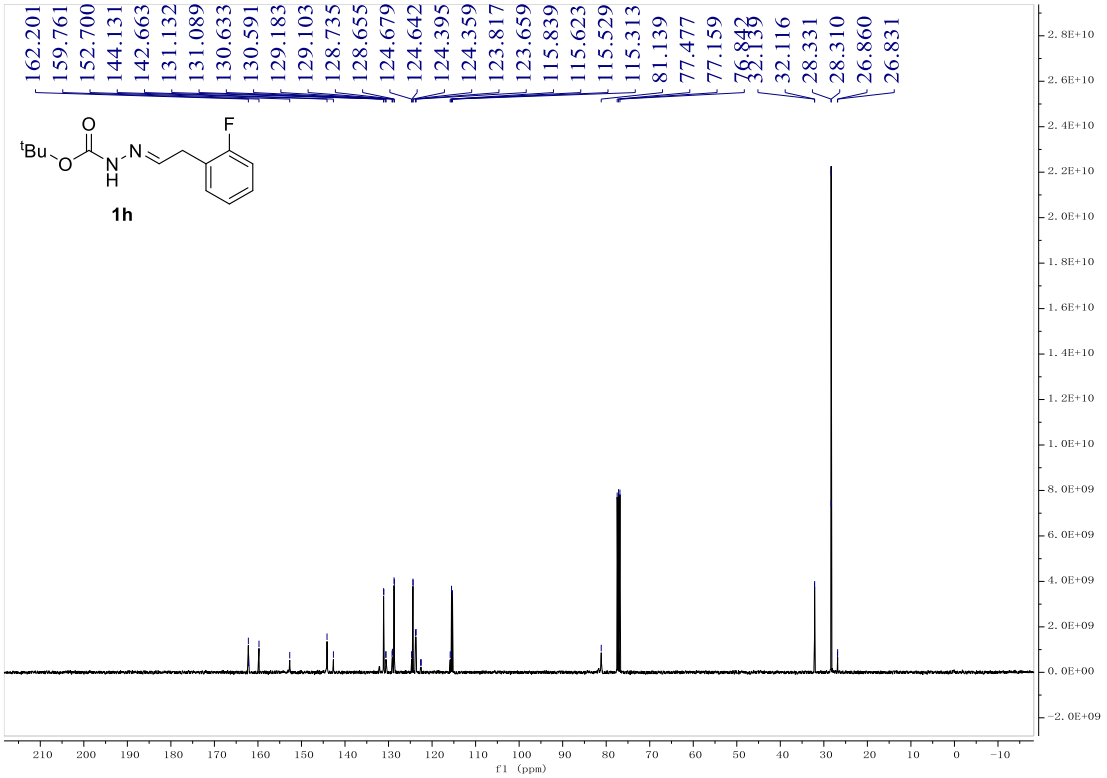
^{13}C{^{1}H} NMR of 1g (100 MHz, $CDCl_3$)



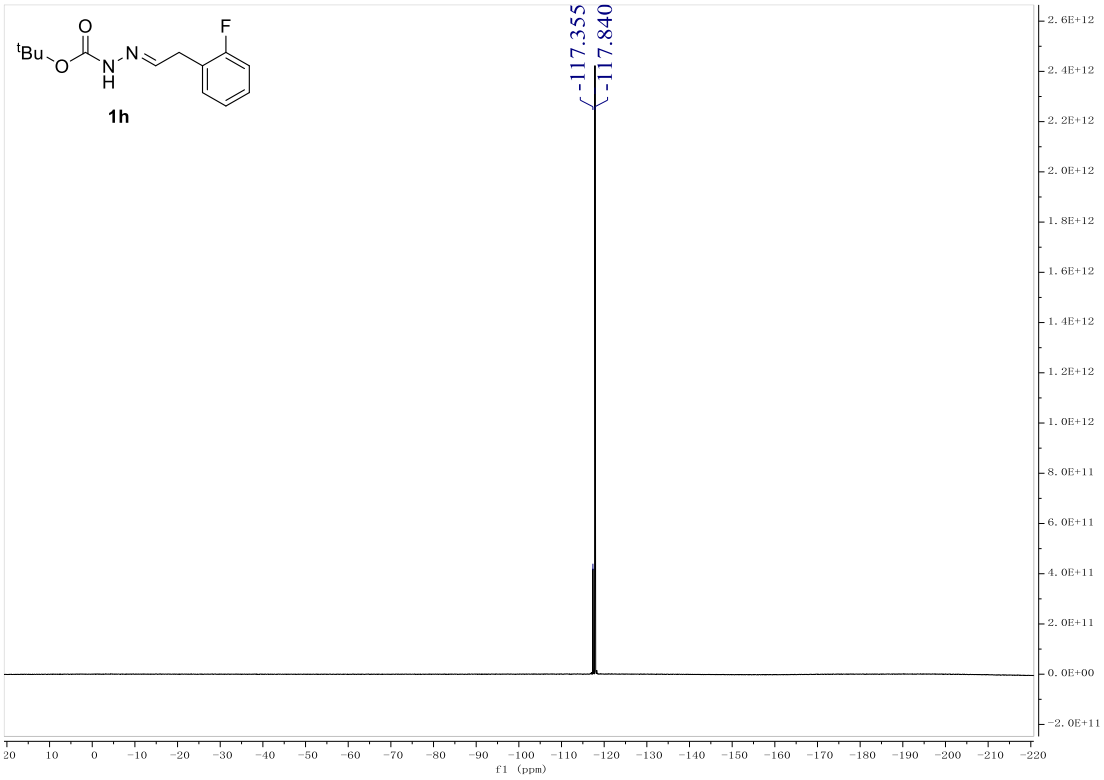
^{1}H NMR of 1h (400 MHz, $CDCl_3$)



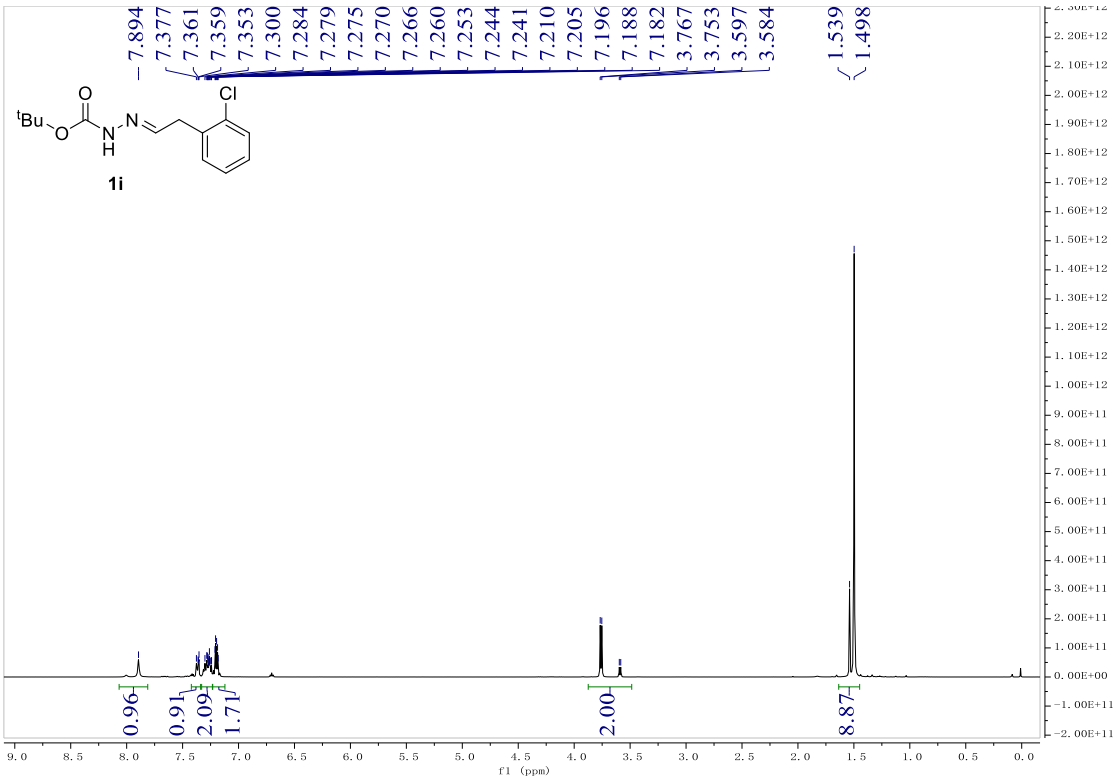
^{13}C{^{1}H} NMR of 1h (100 MHz, $CDCl_3$)



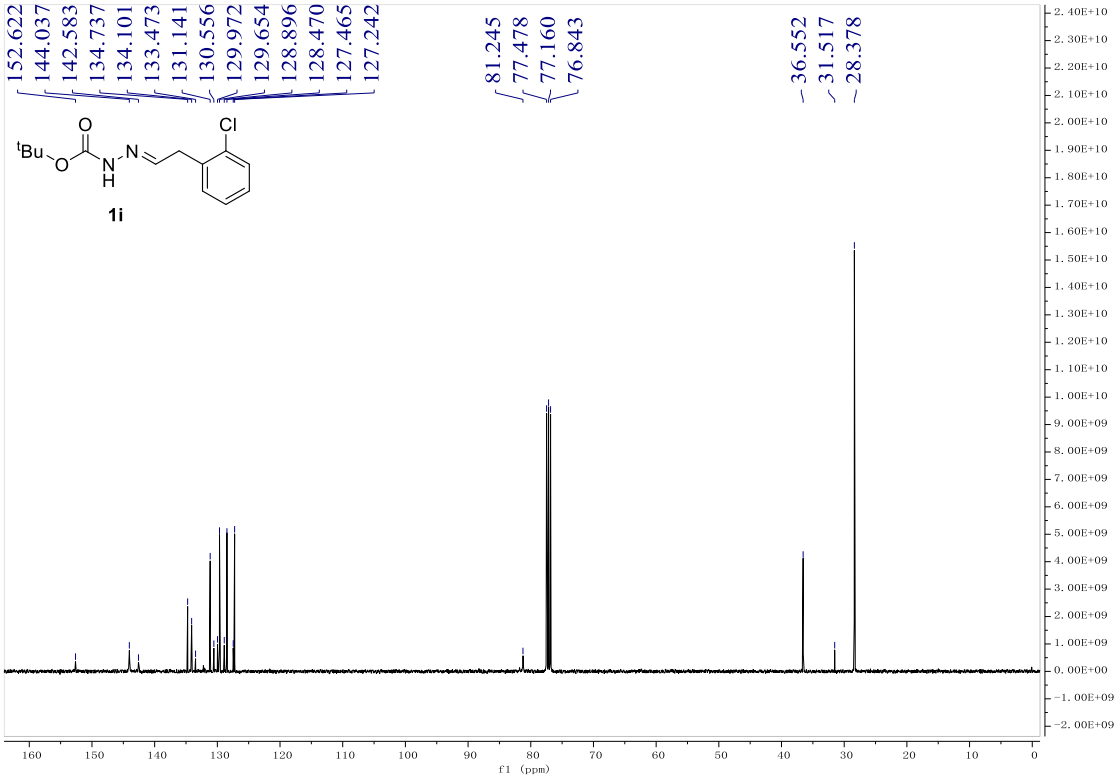
$^{19}F\{^{1}H\}$ NMR of 1h (376 MHz, $CDCl_3$)



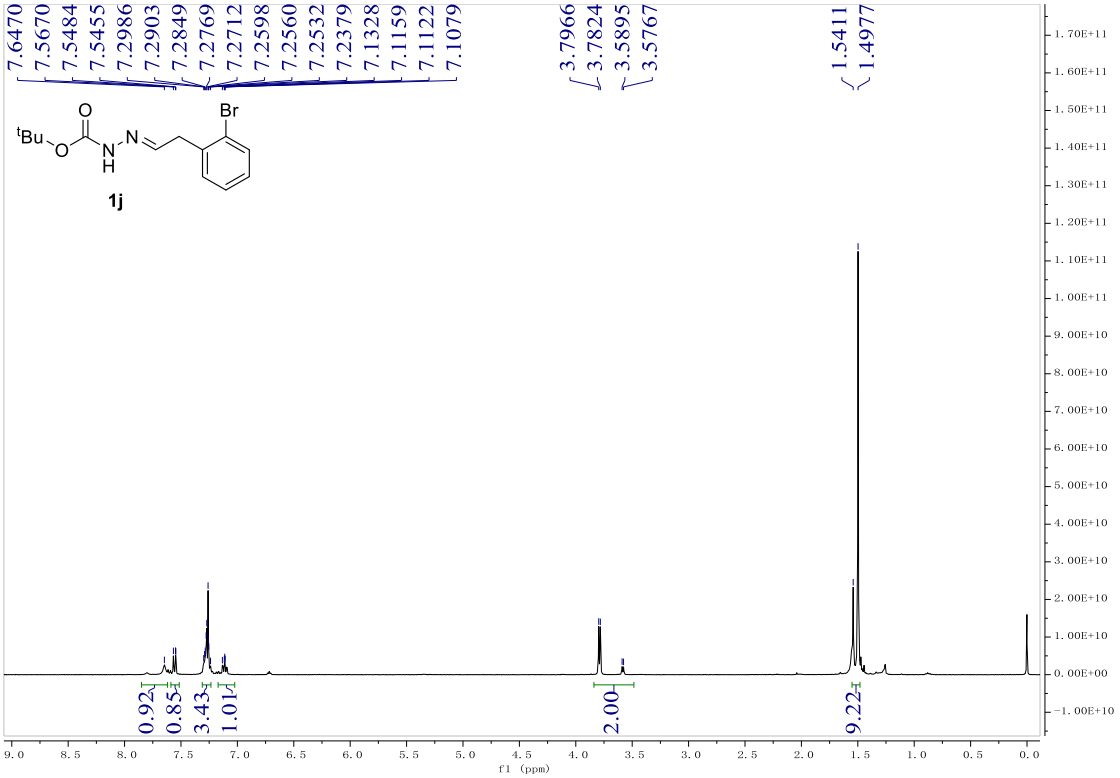
^{1}H NMR of 1i (400 MHz, $CDCl_3$)



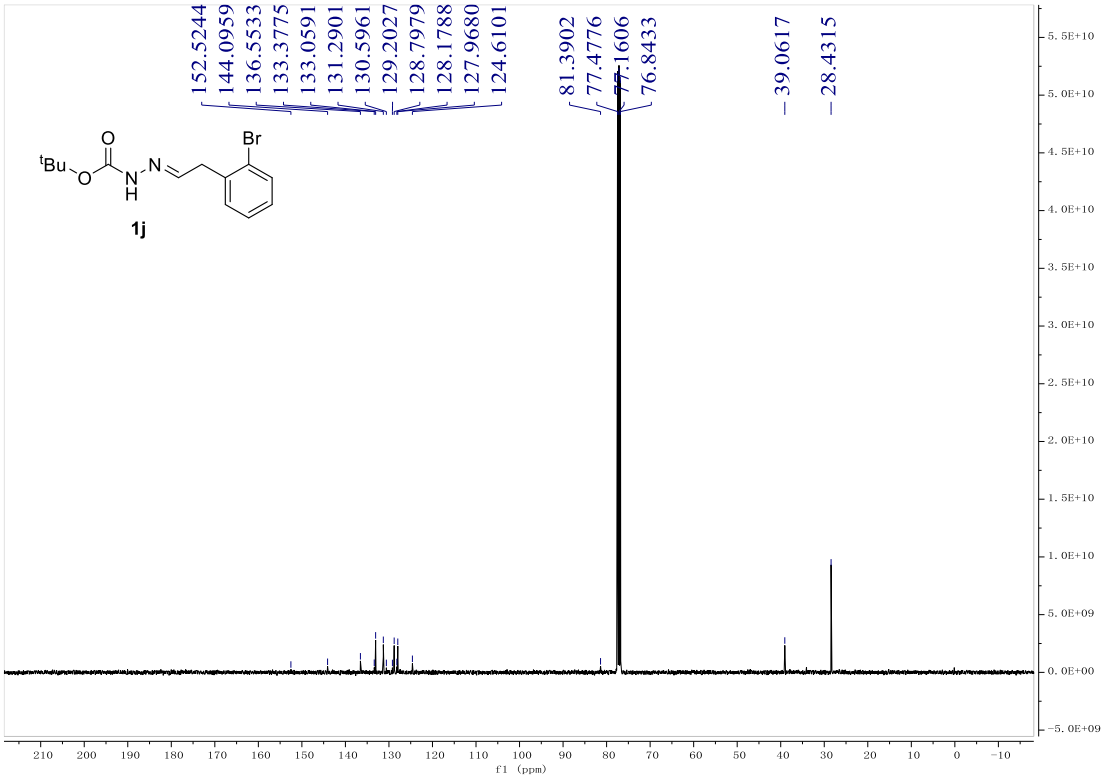
$^{13}C\{^{1}H\}$ NMR of 1i (100 MHz, $CDCl_3$)



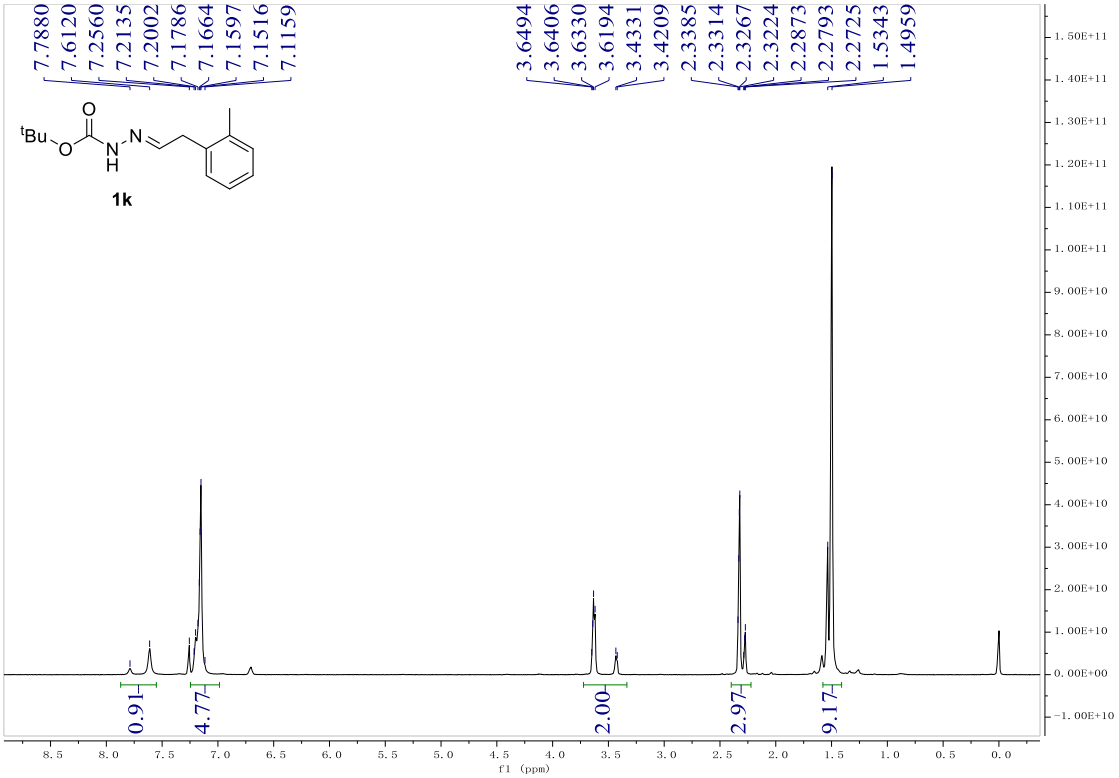
^{1}H NMR of 1*J* (400 MHz, $CDCl_3$)



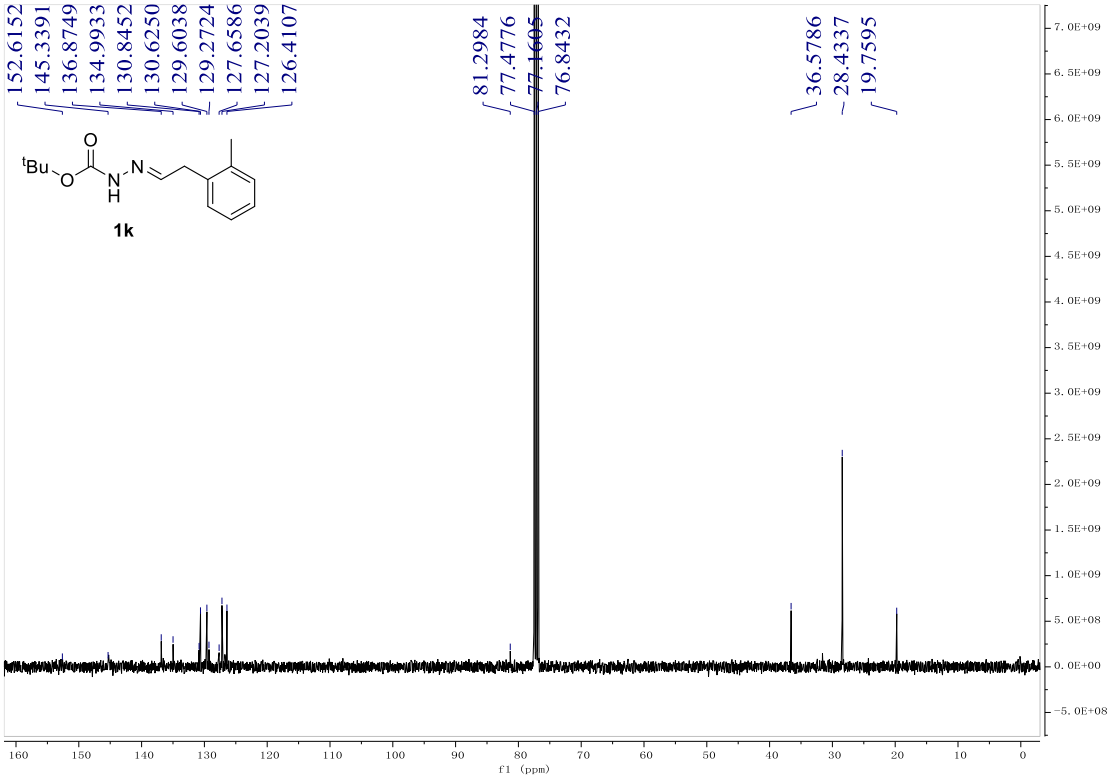
$^{13}C\{^{1}H\}$ NMR of 1*J* (100 MHz, $CDCl_3$)



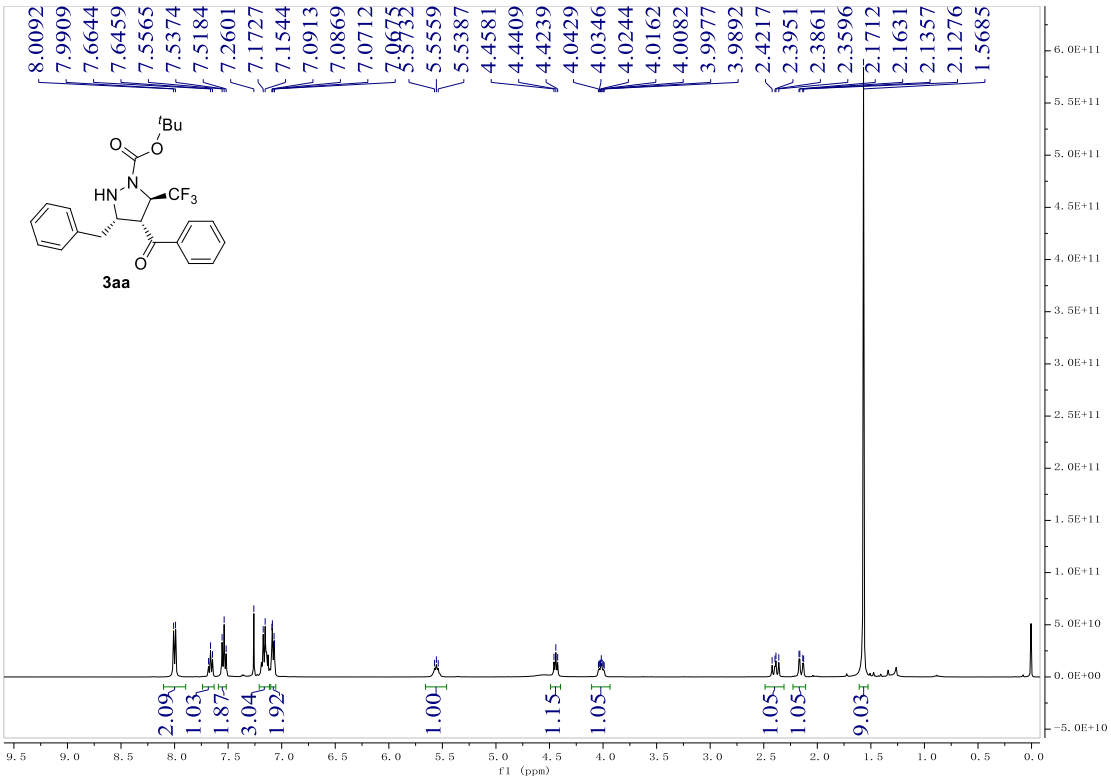
^{1}H NMR of 1k (400 MHz, $CDCl_3$)



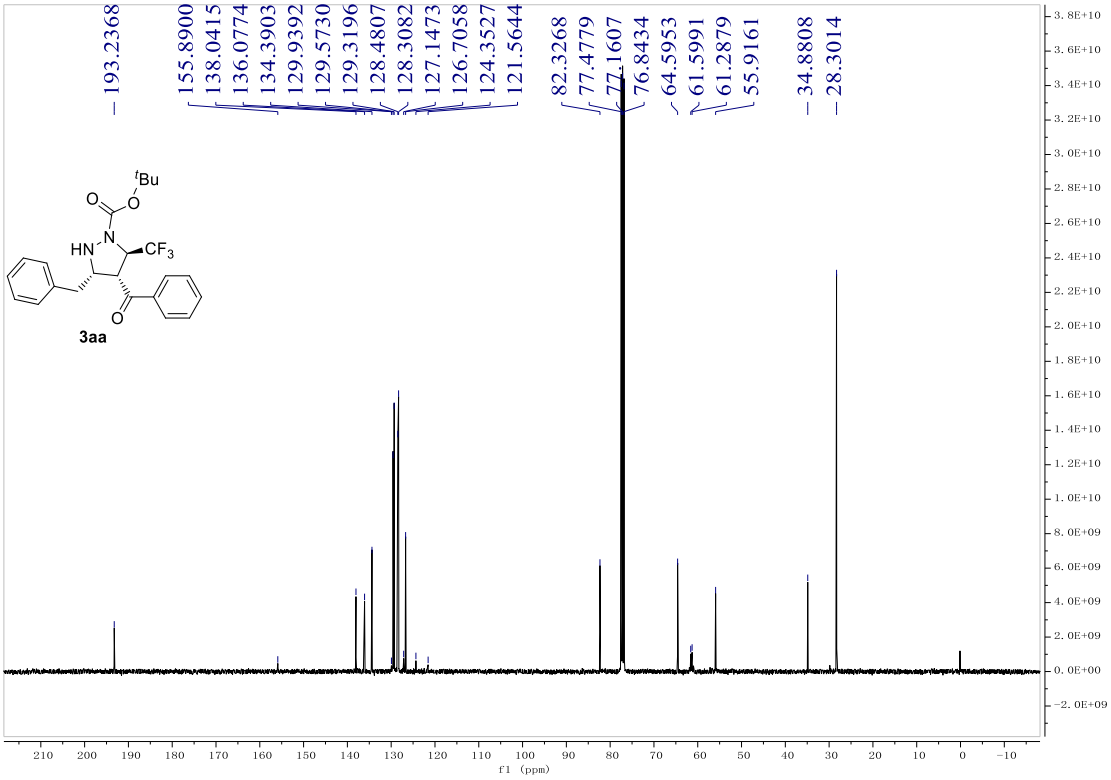
$^{13}C\{^{1}H\}$ NMR of 1k (100 MHz, $CDCl_3$)



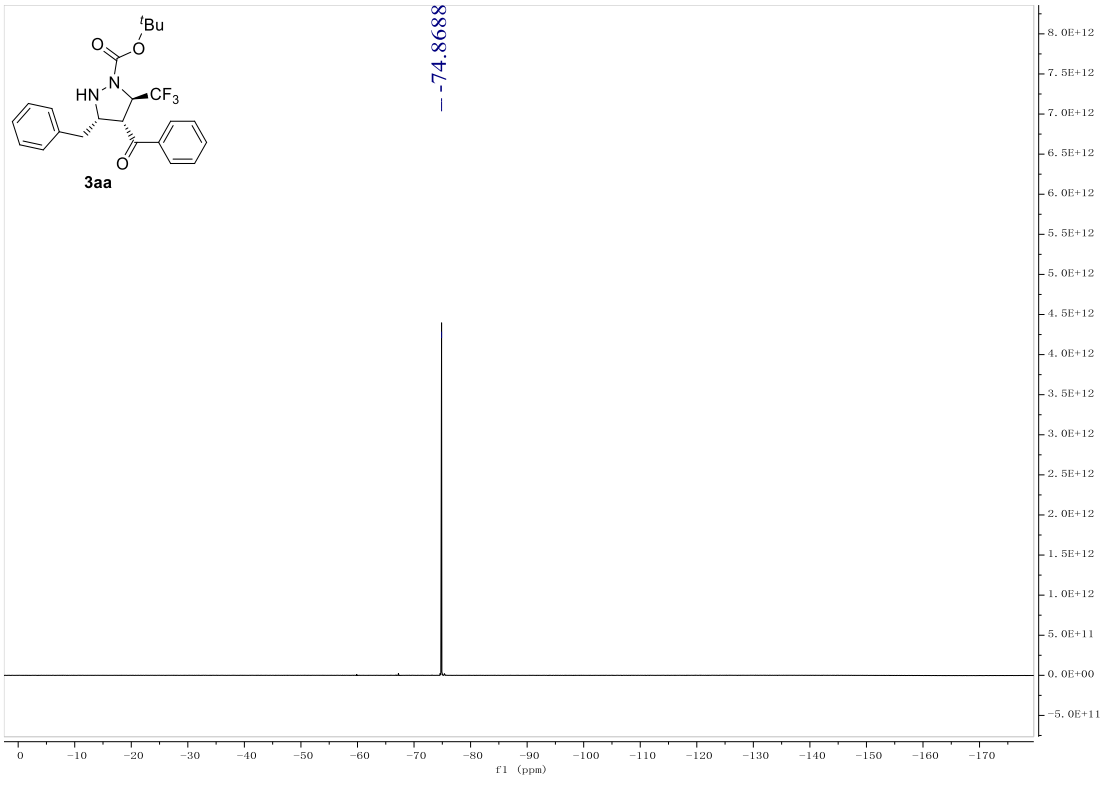
^{1}H NMR of 3aa (400 MHz, $CDCl_3$)



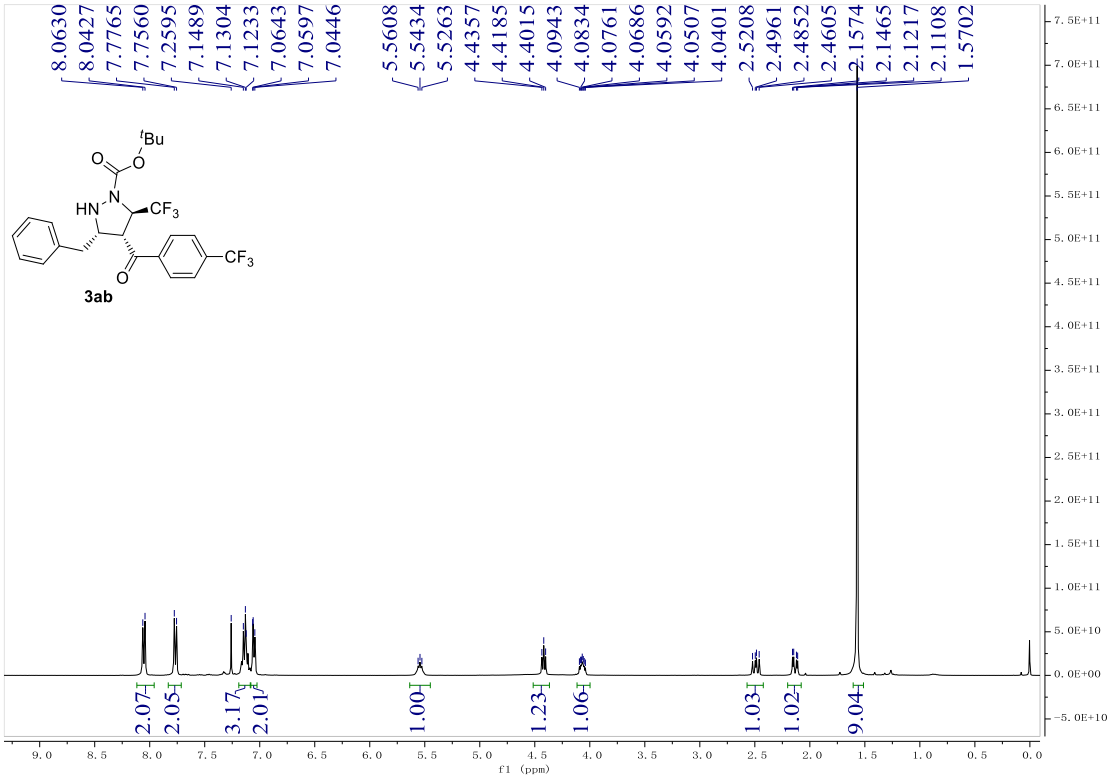
$^{13}C\{^{1}H\}$ NMR of 3aa (100 MHz, $CDCl_3$)



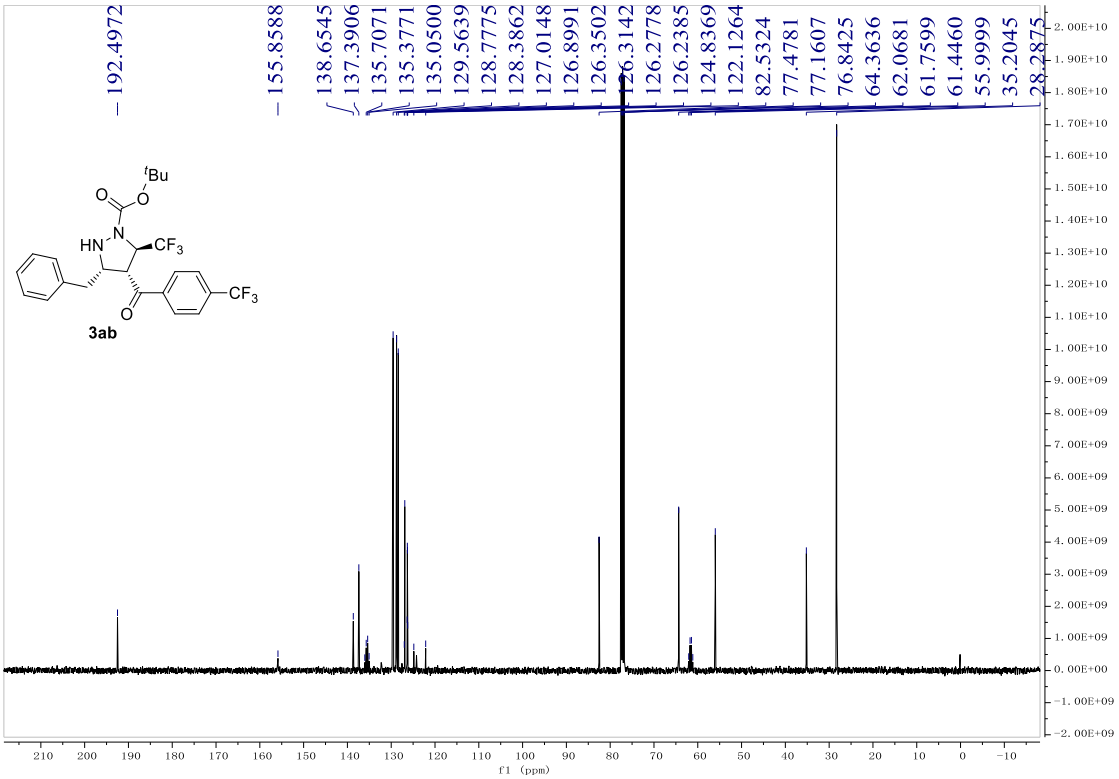
$^{19}F\{^{1}H\}$ NMR of 3aa (376 MHz, $CDCl_3$)



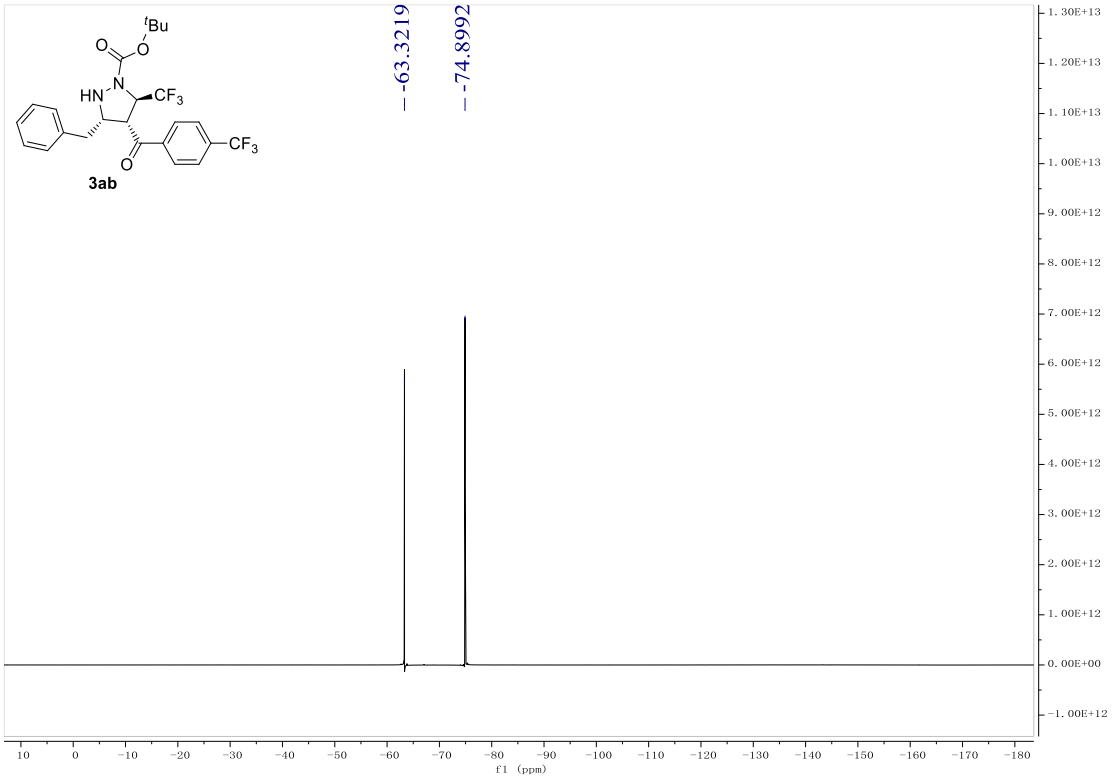
^{1}H NMR of 3ab (400 MHz, $CDCl_3$)



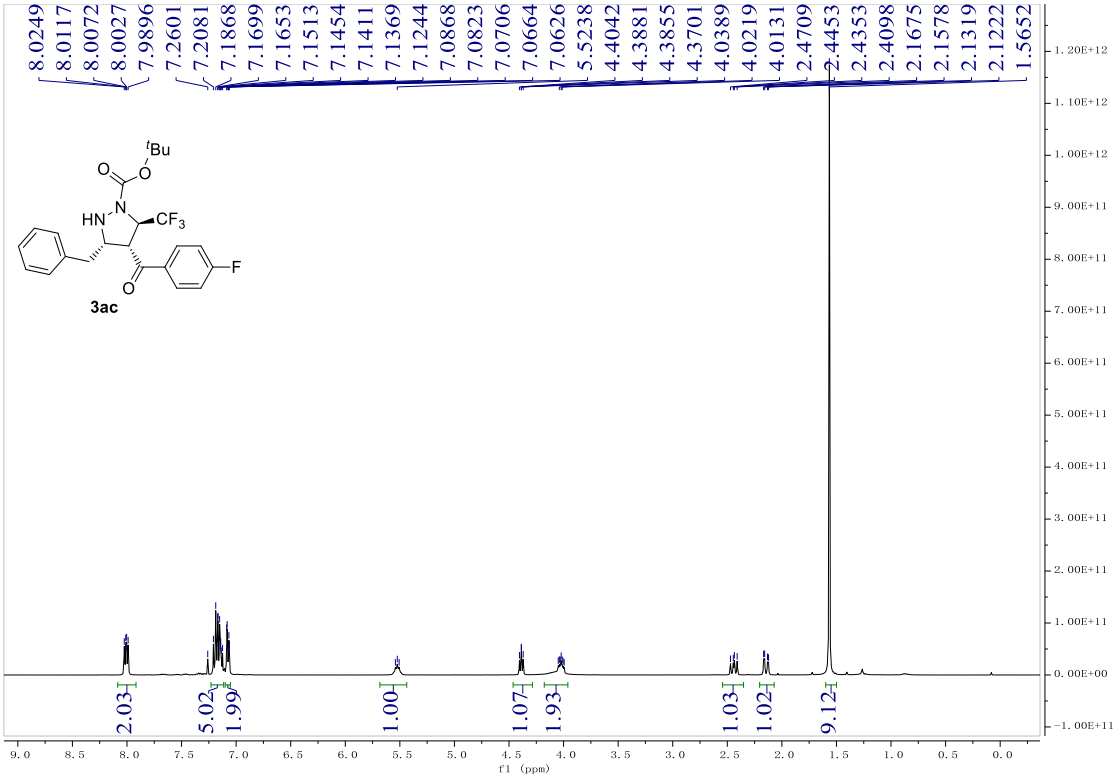
^{13}C{^{1}H} NMR of 3ab (100 MHz, $CDCl_3$)



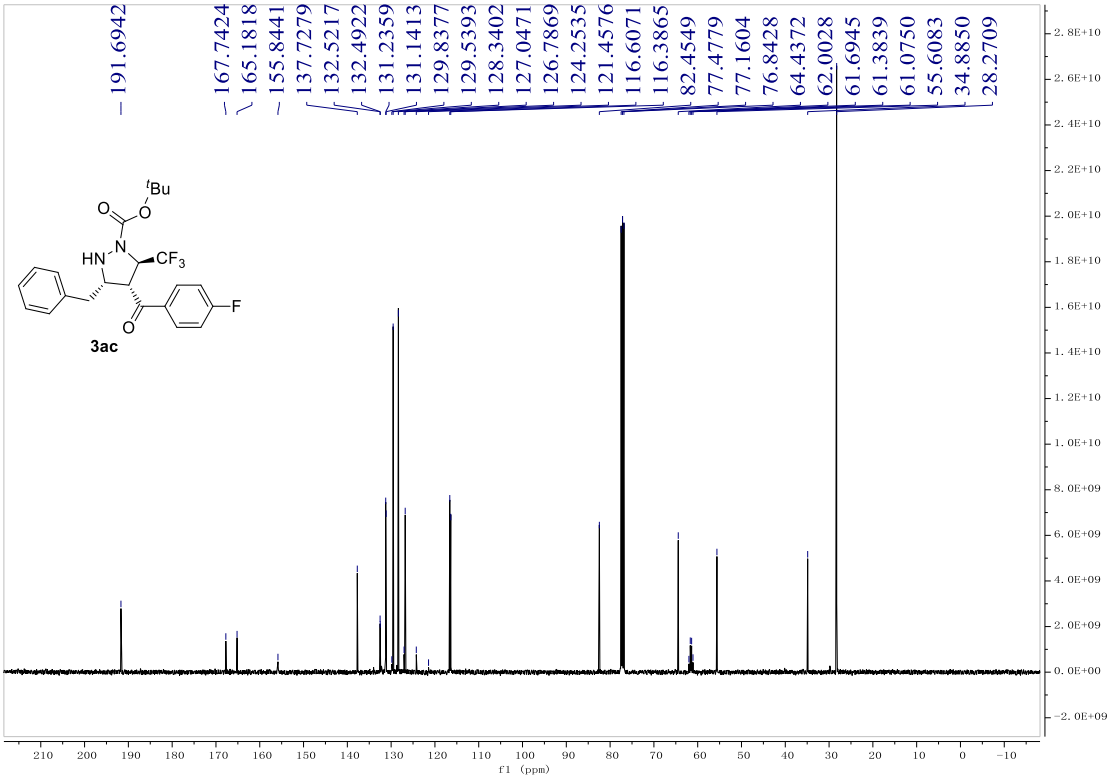
$^{19}F\{^{1}H\}$ NMR of 3ab (376 MHz, $CDCl_3$)



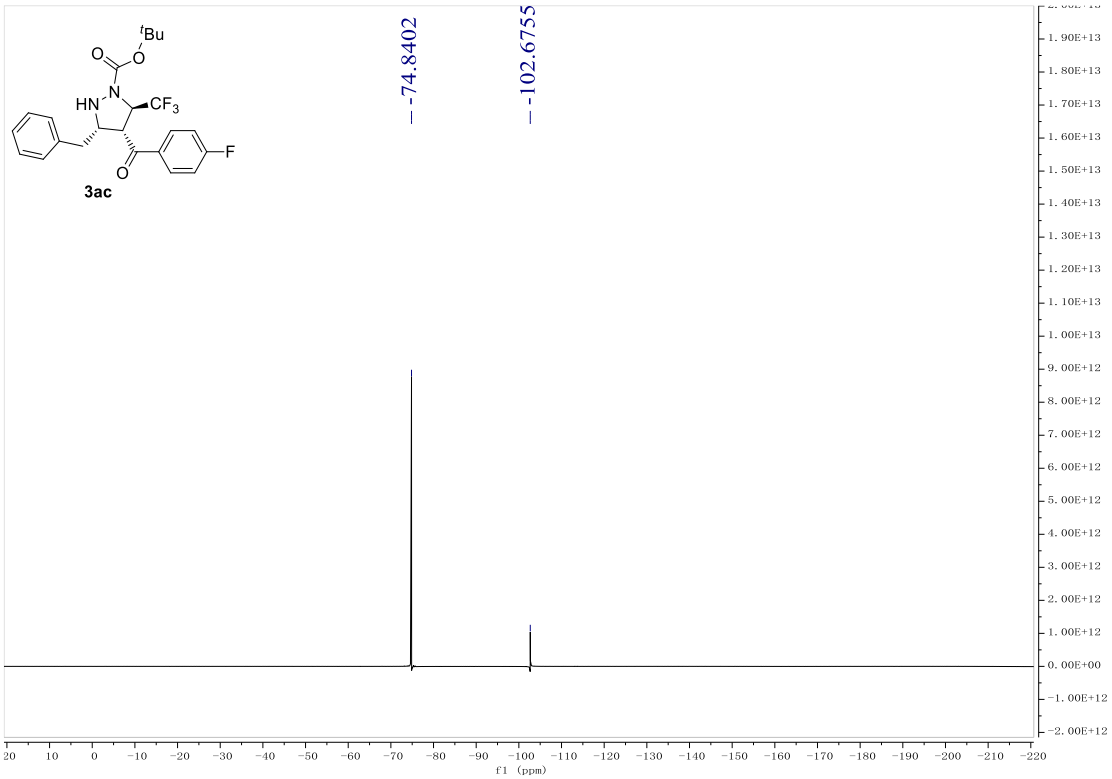
^{1}H NMR of 3ac (400 MHz, $CDCl_3$)



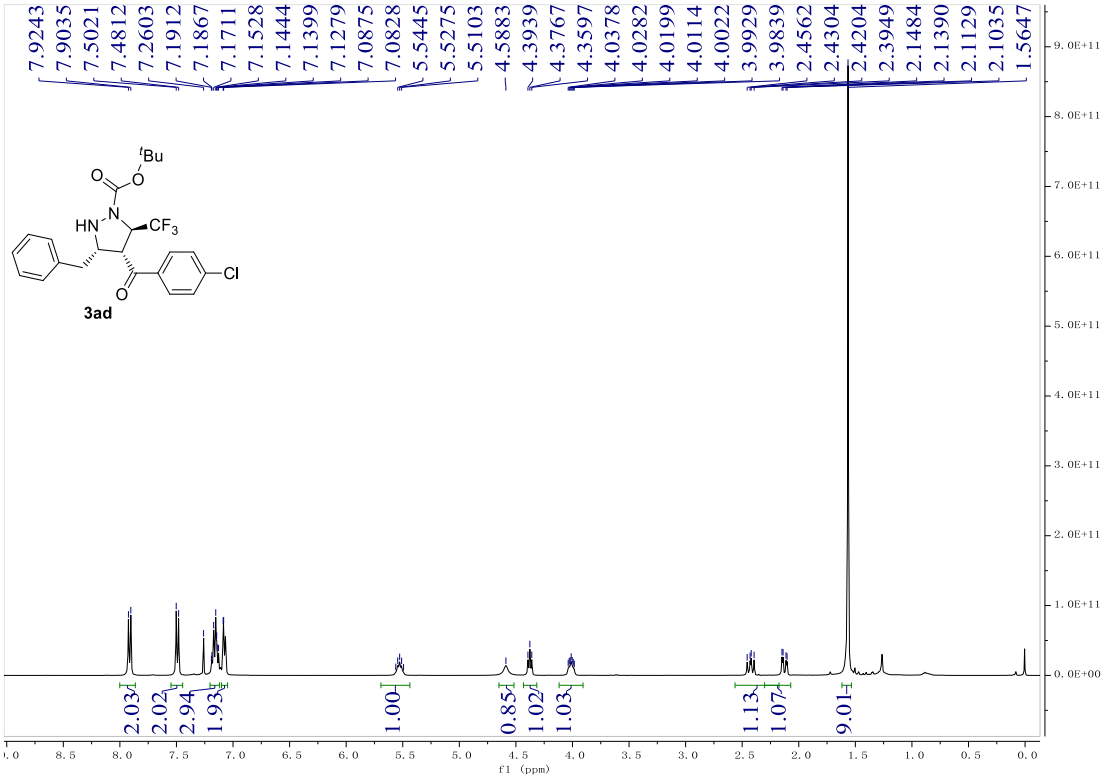
$^{13}C\{^{1}H\}$ NMR of 3ac (100 MHz, $CDCl_3$)



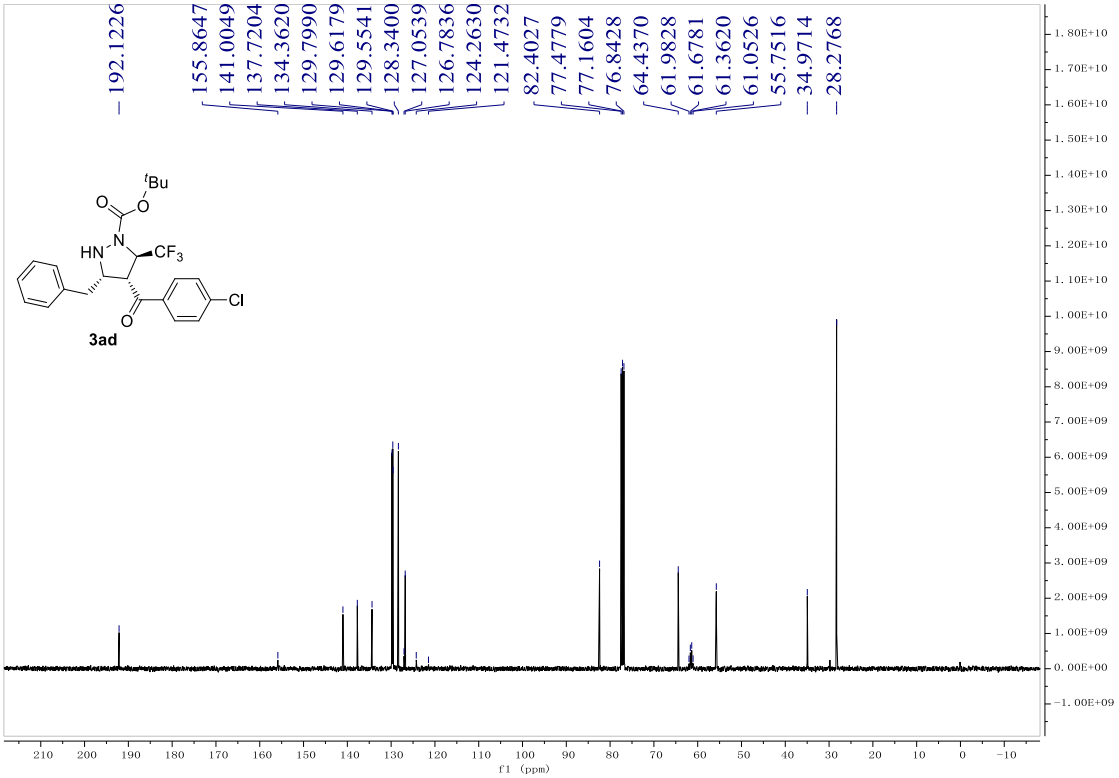
$^{19}F\{^{1}H\}$ NMR of 3ac (376 MHz, $CDCl_3$)



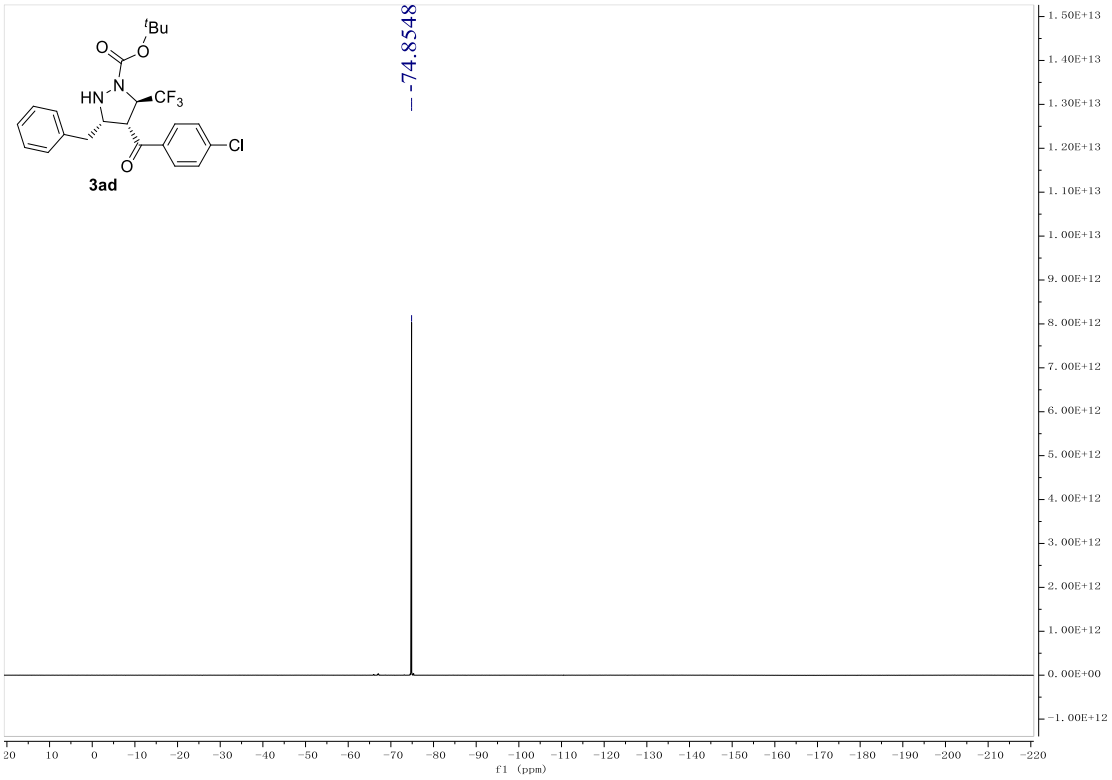
^{1}H NMR of 3ad (400 MHz, $CDCl_3$)



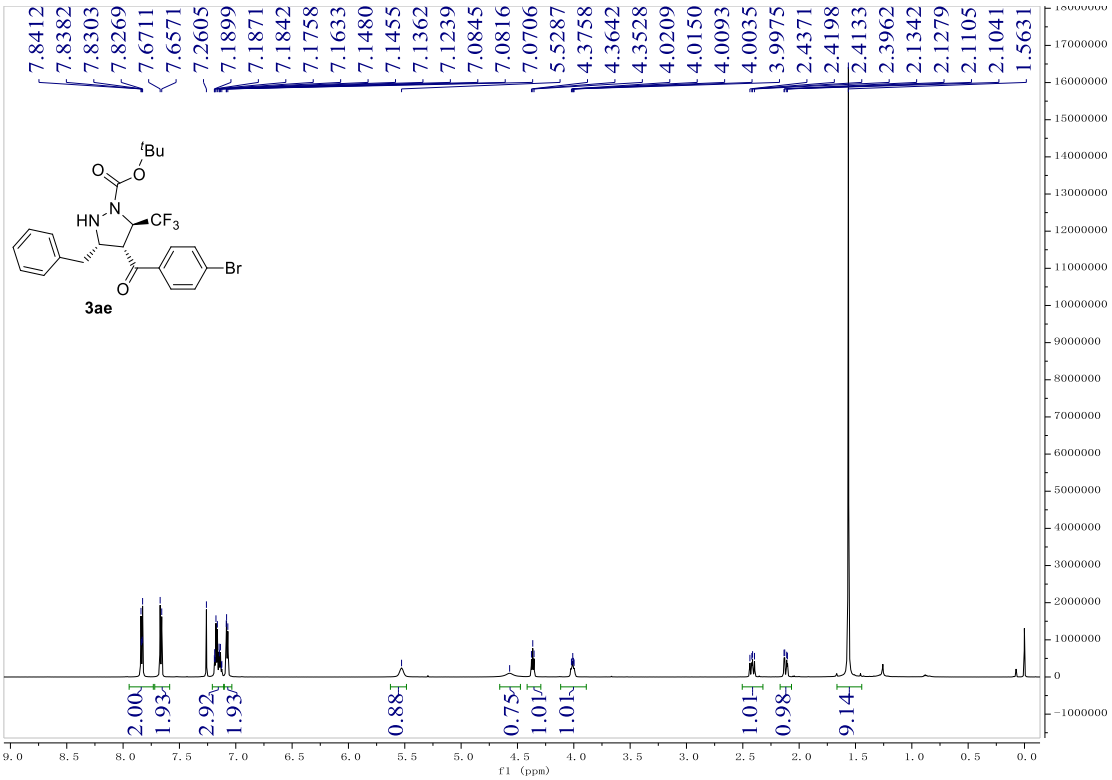
^{13}C{^{1}H} NMR of 3ad (100 MHz, $CDCl_3$)



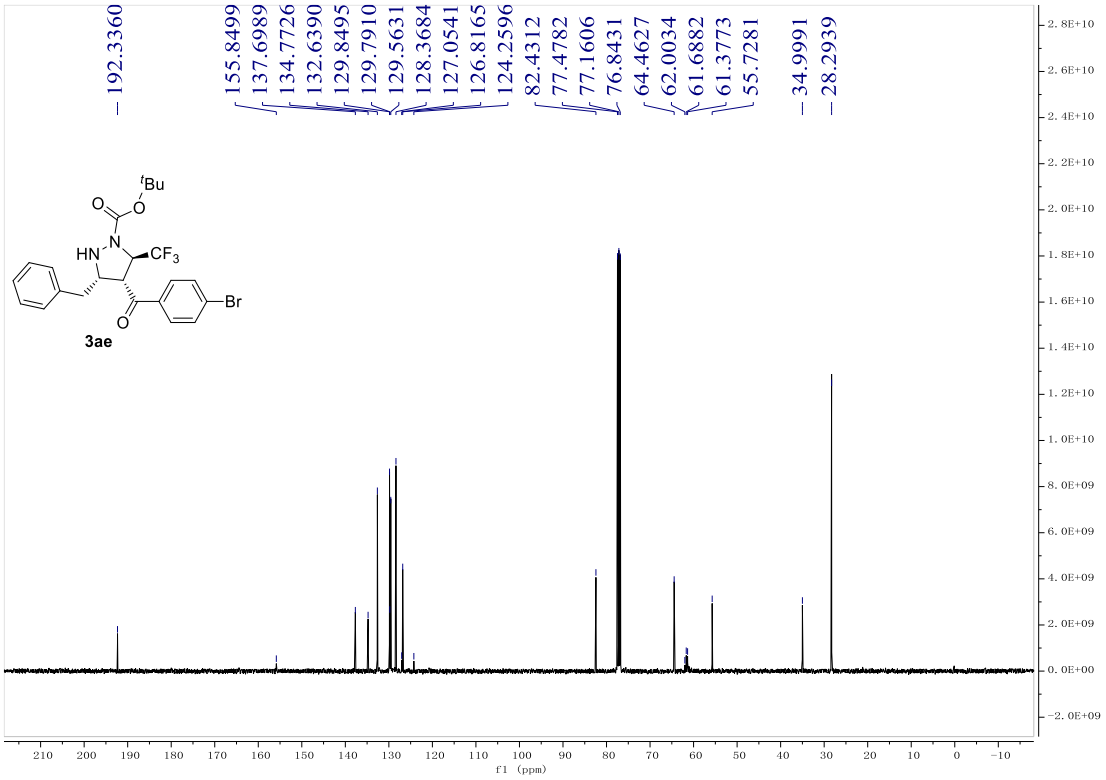
$^{19}F\{^{1}H\}$ NMR of 3ad (376 MHz, $CDCl_3$)



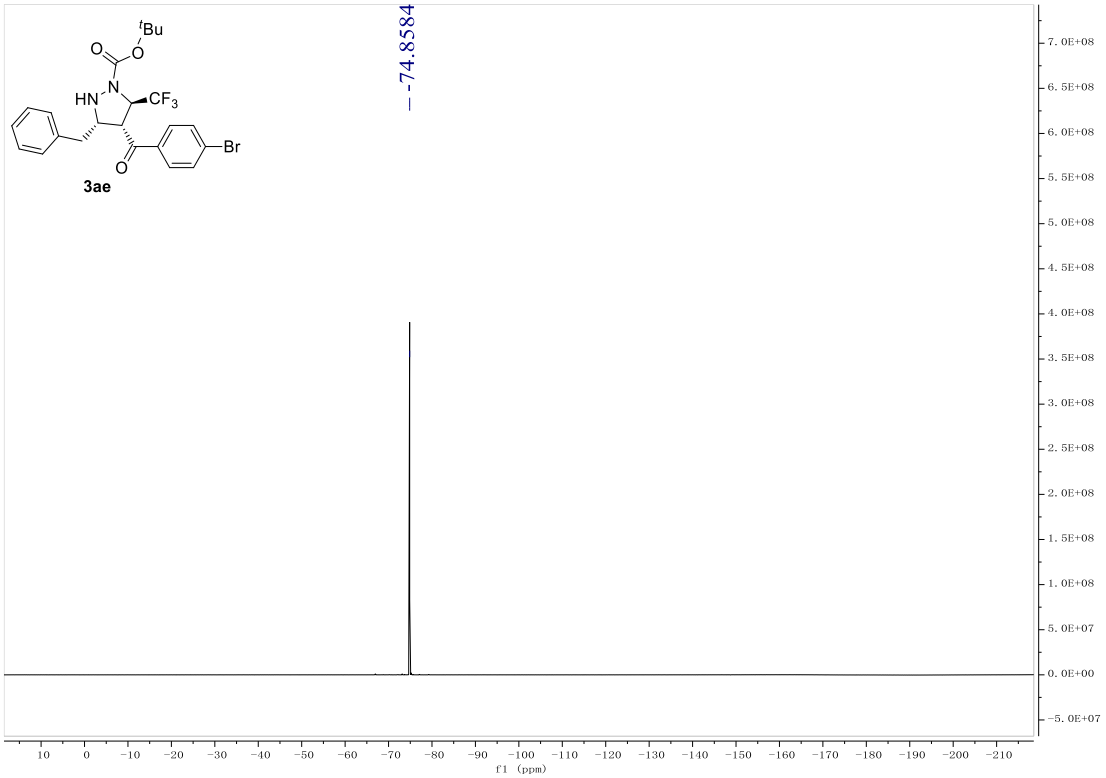
^{1}H NMR of 3ae (400 MHz, $CDCl_3$)



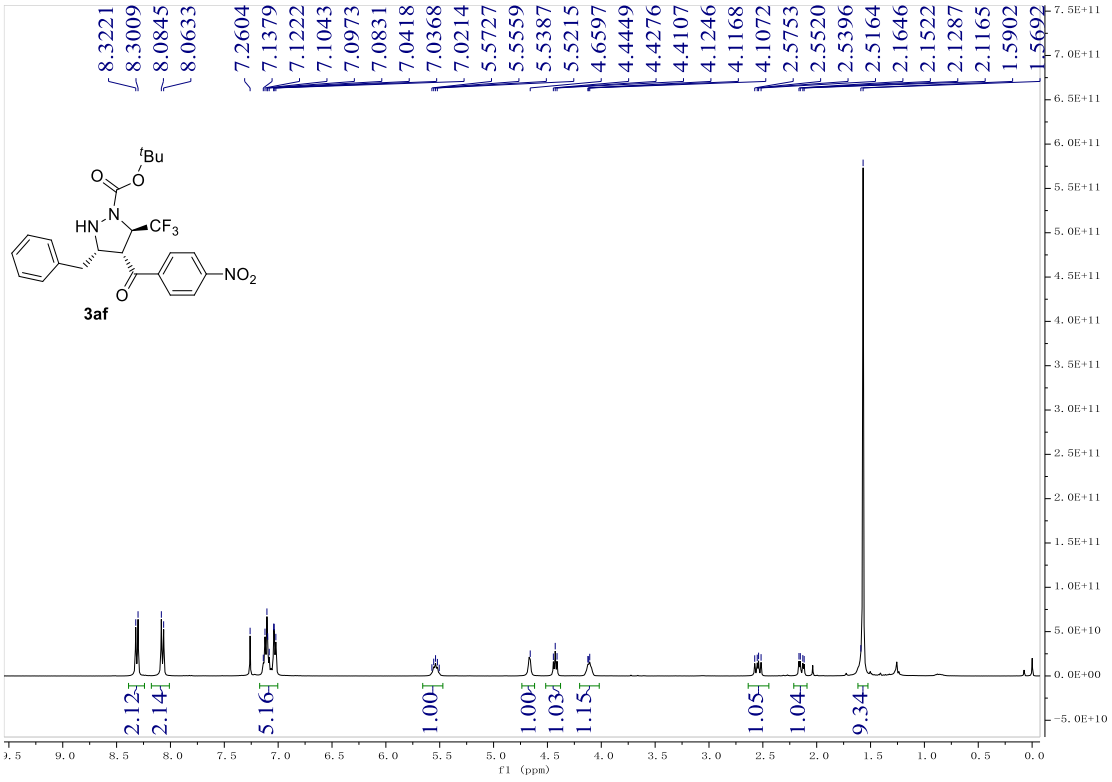
$^{13}C\{^{1}H\}$ NMR of 3ae (100 MHz, $CDCl_3$)



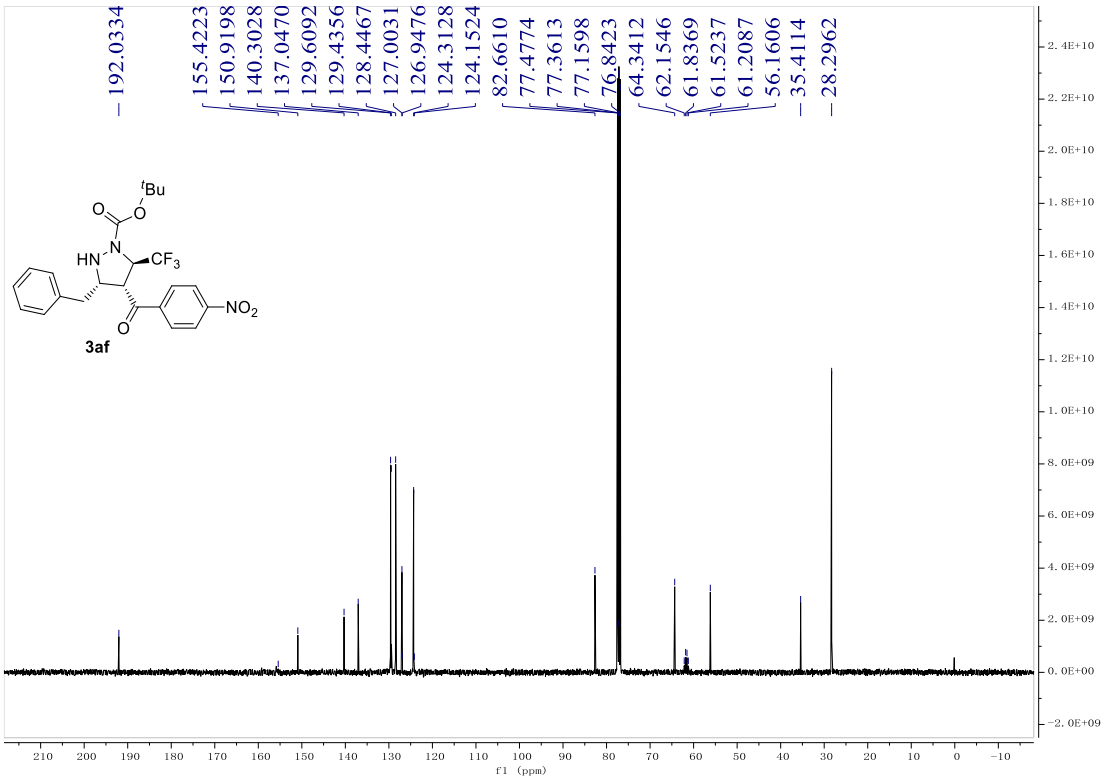
$^{19}F\{^{1}H\}$ NMR of 3ae (376 MHz, $CDCl_3$)



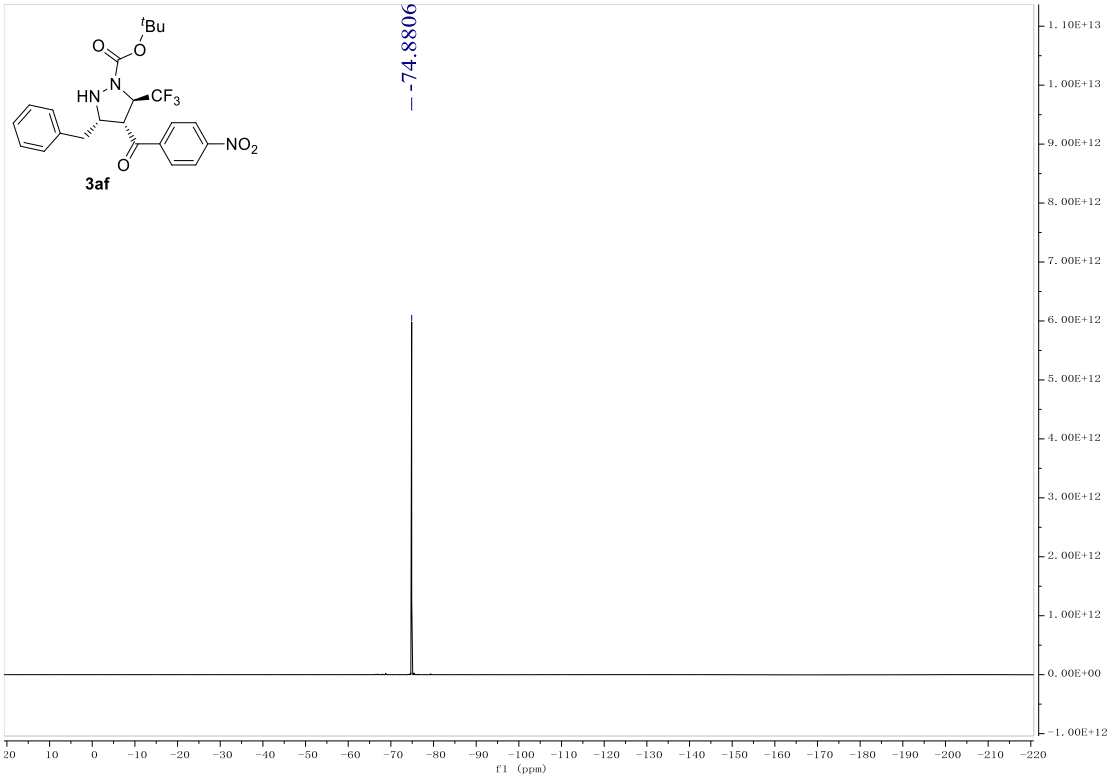
^{1}H NMR of 3af (400 MHz, $CDCl_3$)



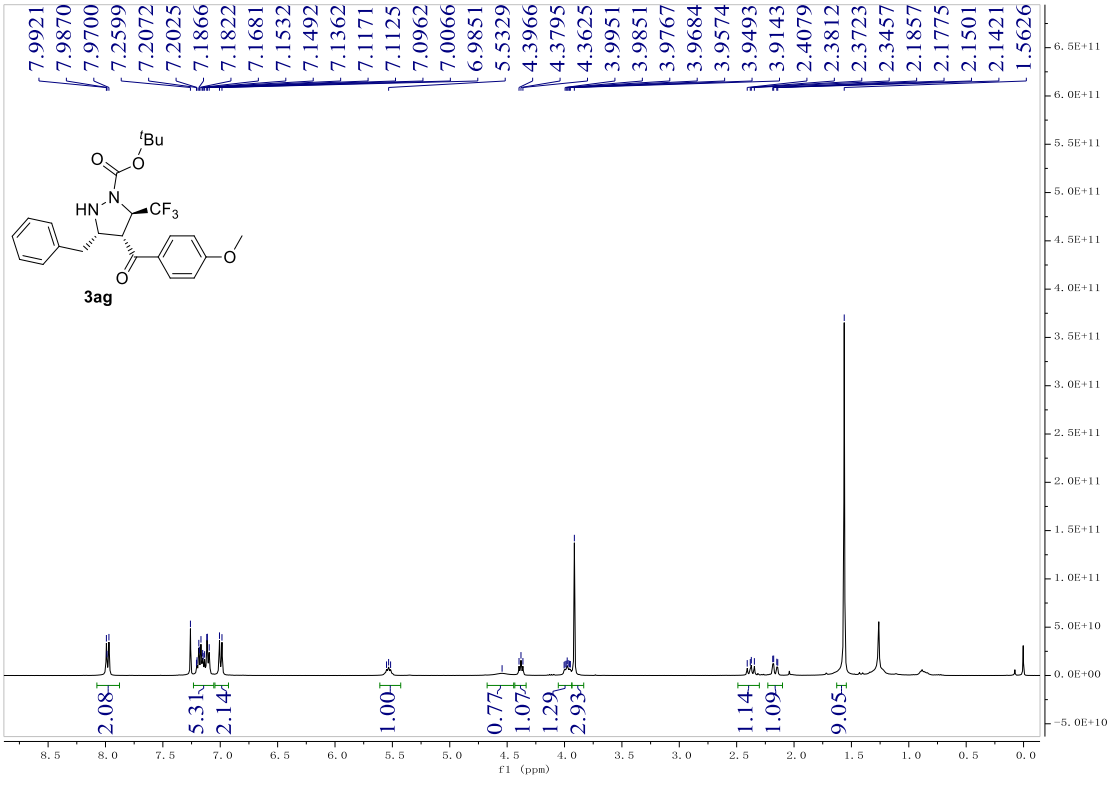
^{13}C{^{1}H} NMR of 3af (100 MHz, $CDCl_3$)



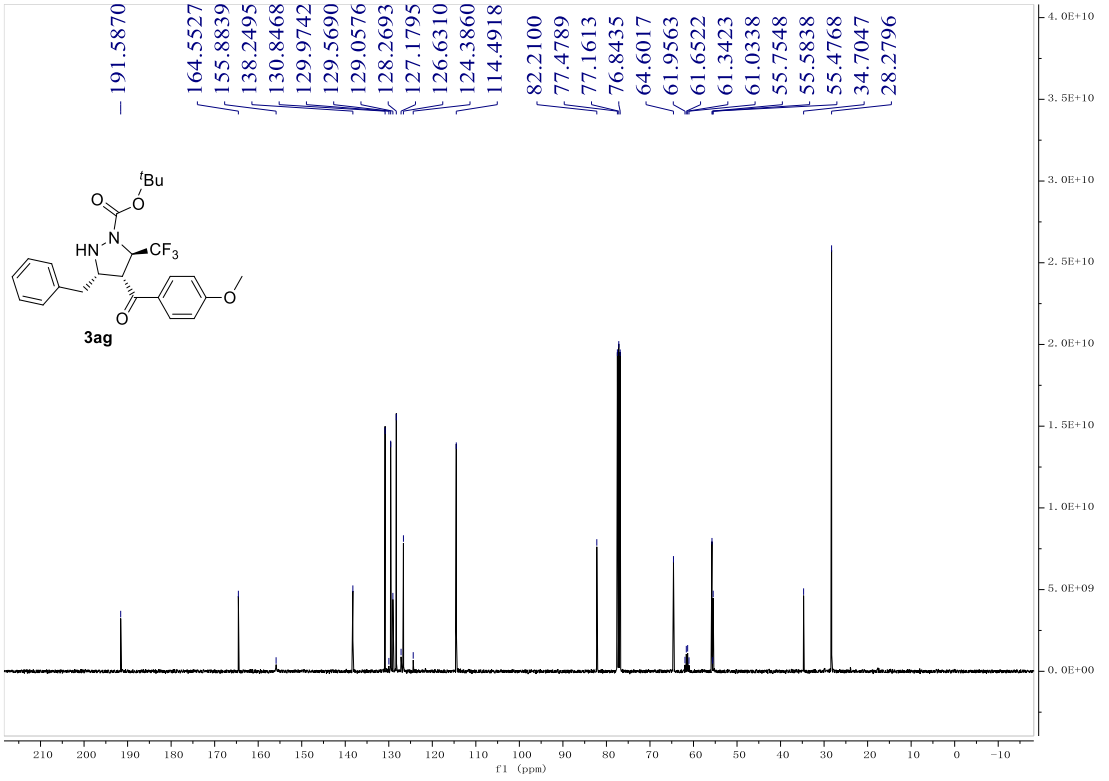
$^{19}F\{^{1}H\}$ NMR of 3af (376 MHz, $CDCl_3$)



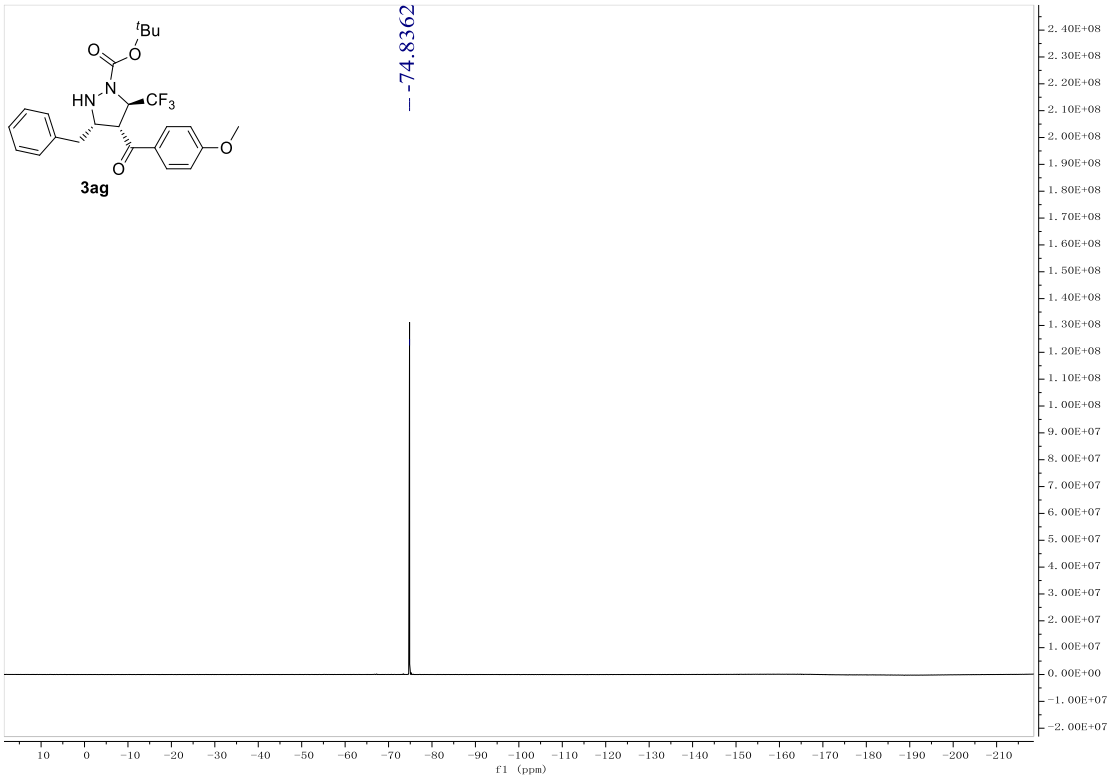
^{1}H NMR of 3ag (400 MHz, $CDCl_3$)



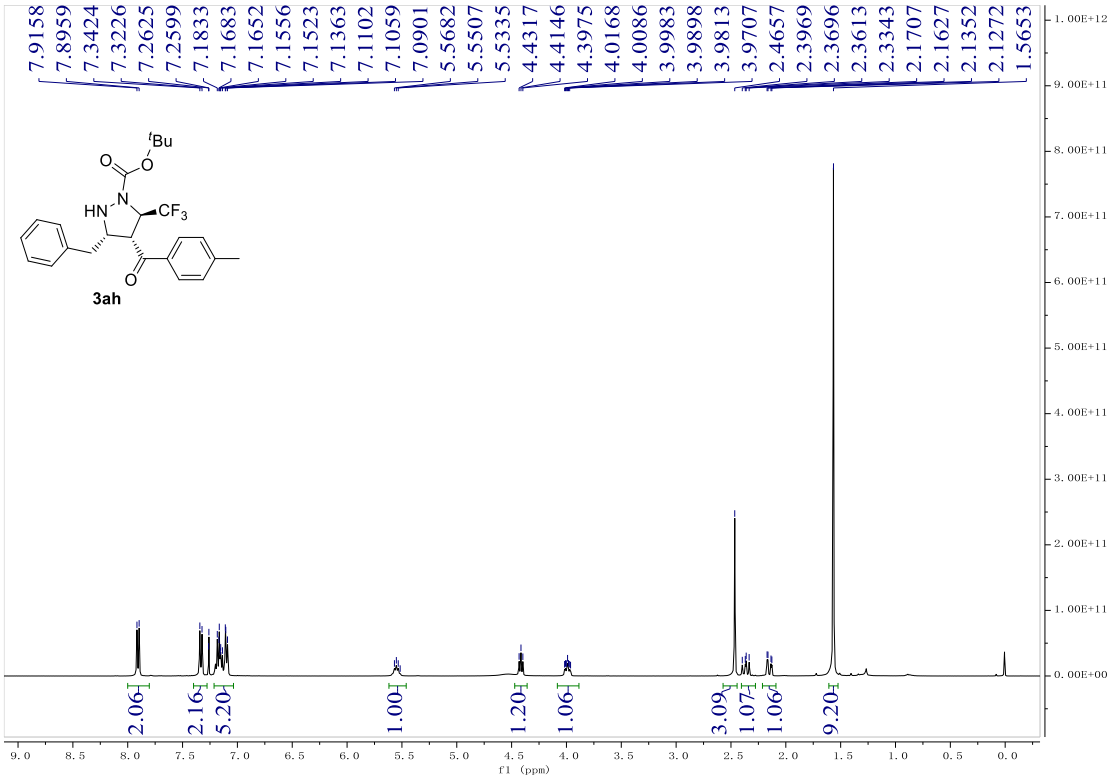
$^{13}C\{^{1}H\}$ NMR of 3ag (100 MHz, $CDCl_3$)



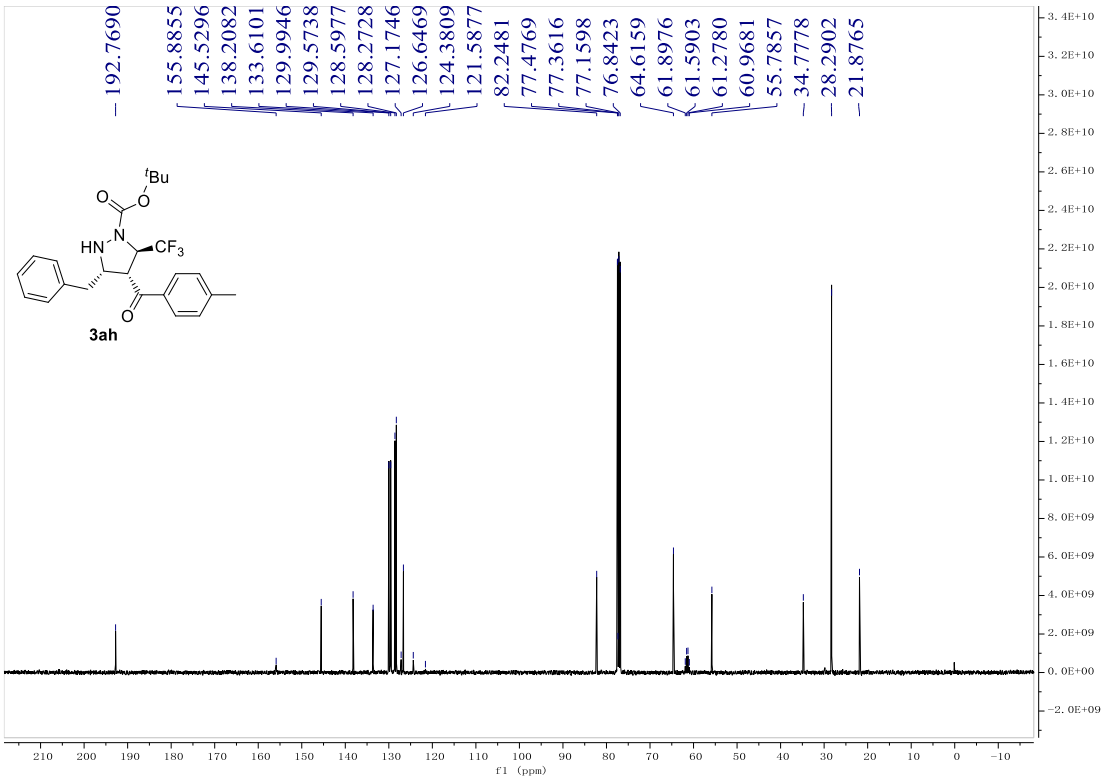
$^{19}F\{^{1}H\}$ NMR of 3ag (565 MHz, $CDCl_3$)



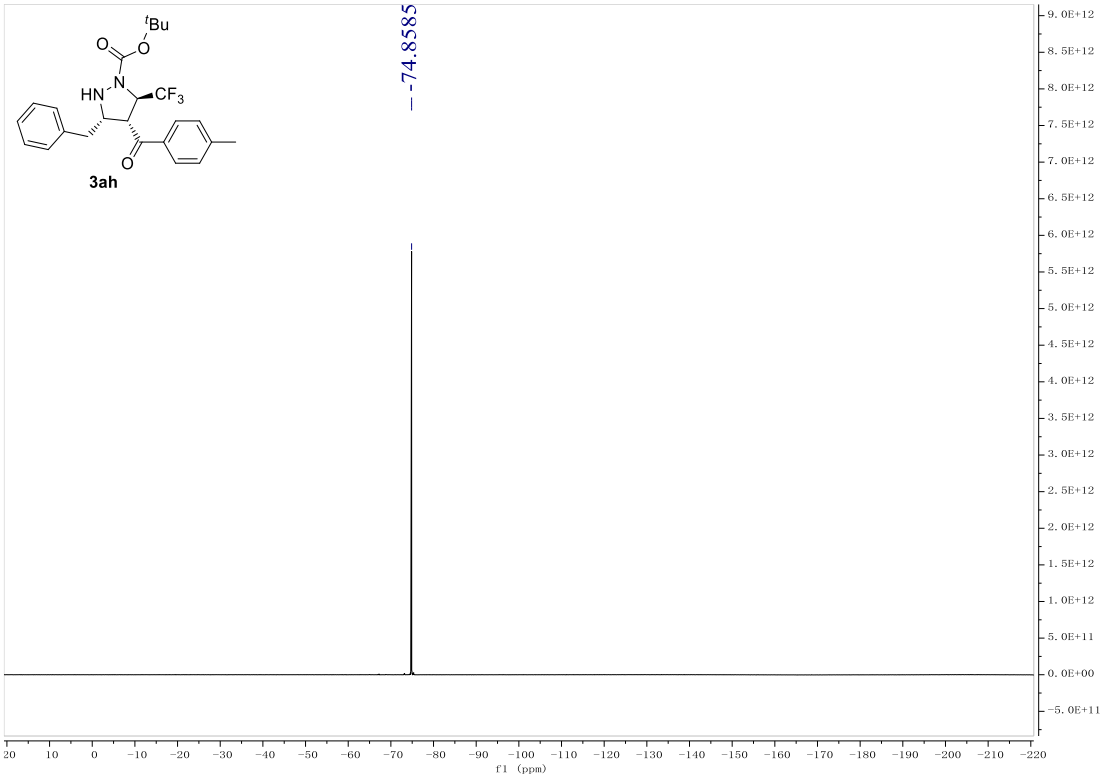
^{1}H NMR of 3ah (400 MHz, $CDCl_3$)



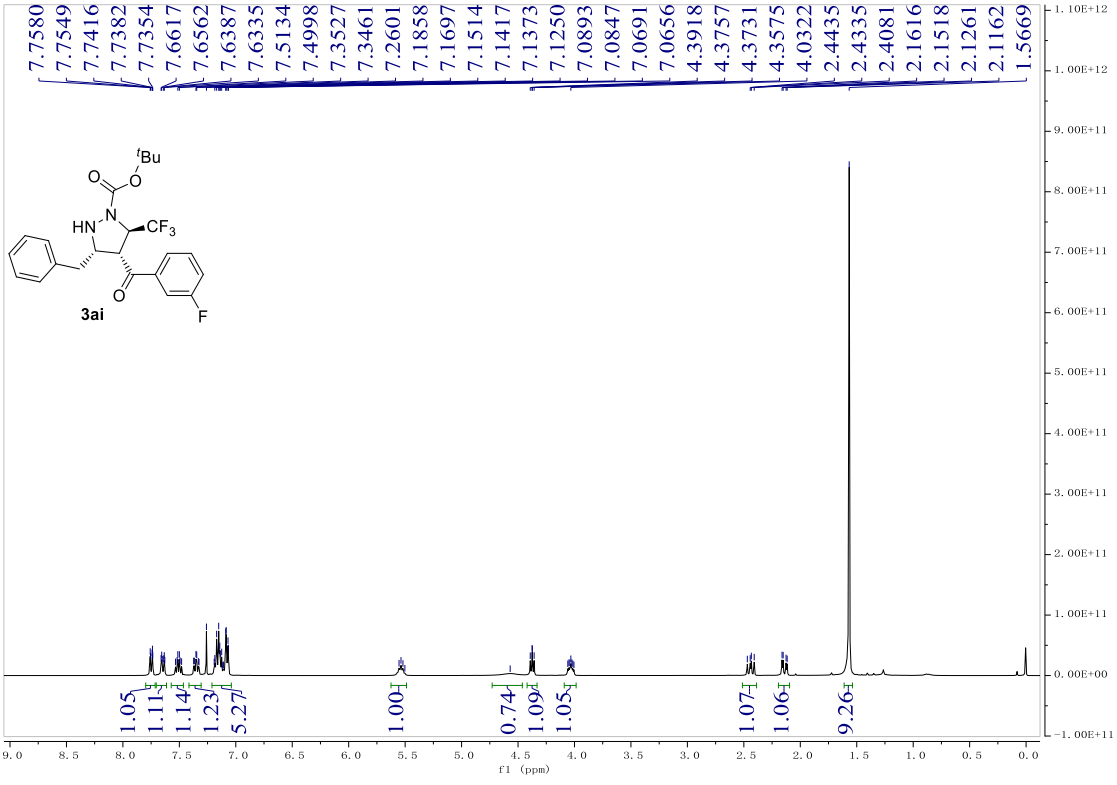
^{13}C{^{1}H} NMR of 3ah (100 MHz, $CDCl_3$)



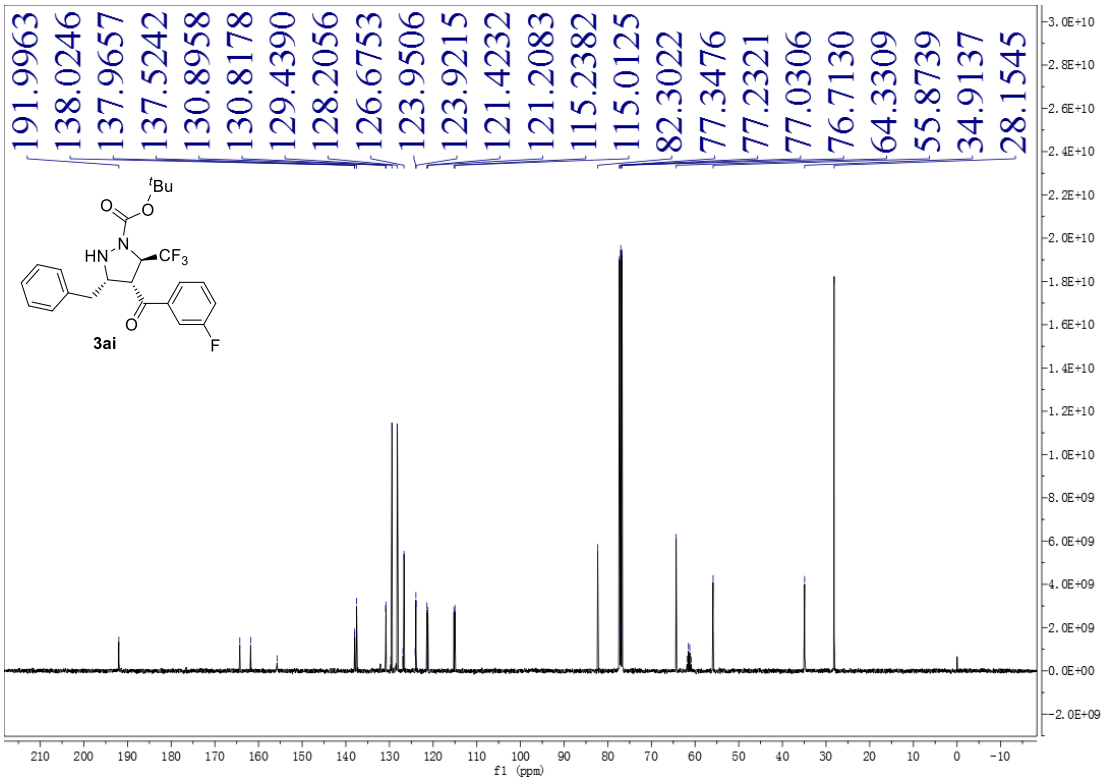
$^{19}F\{^{1}H\}$ NMR of 3ah (376 MHz, $CDCl_3$)



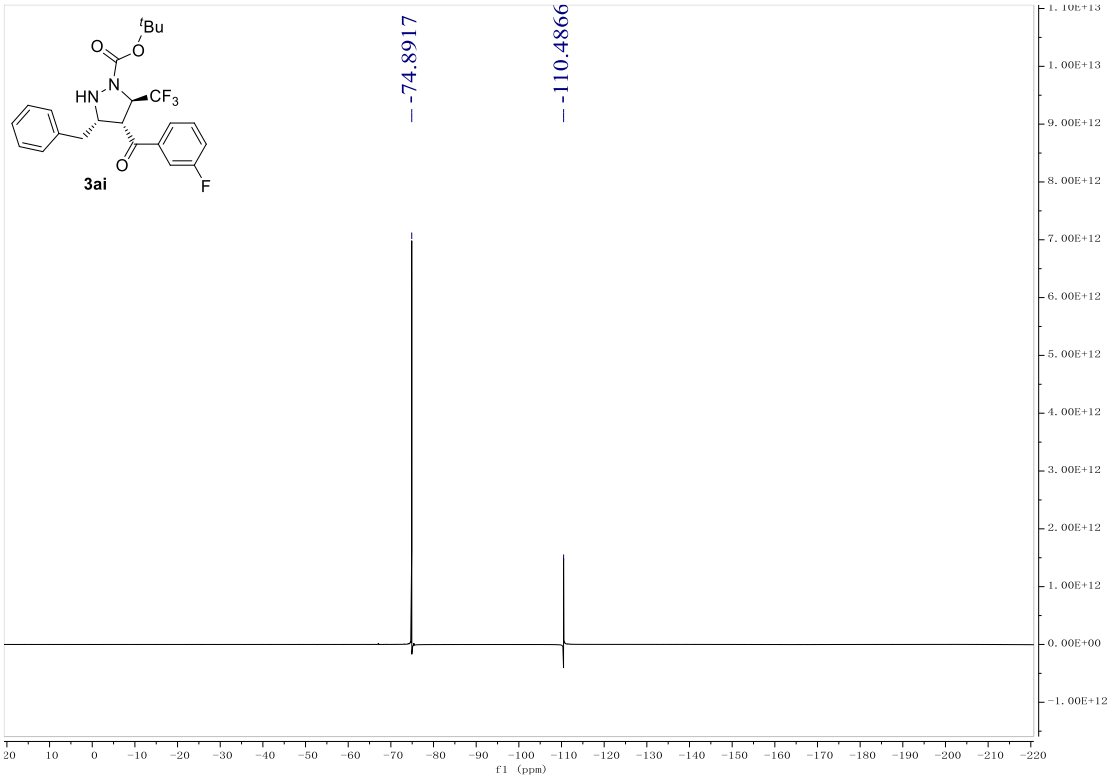
^{1}H-NMR of 3ai (400 MHz, $CDCl_3$)



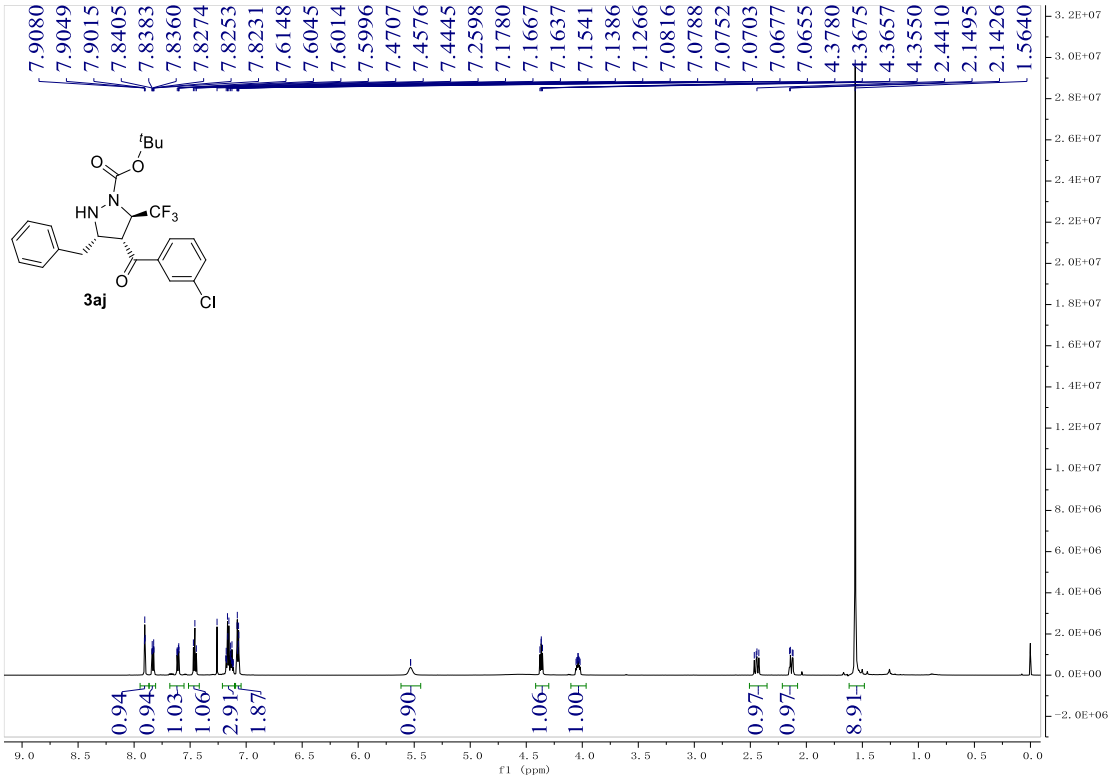
$^{13}C\{^{1}H\}$ NMR of 3ai (100 MHz, $CDCl_3$)



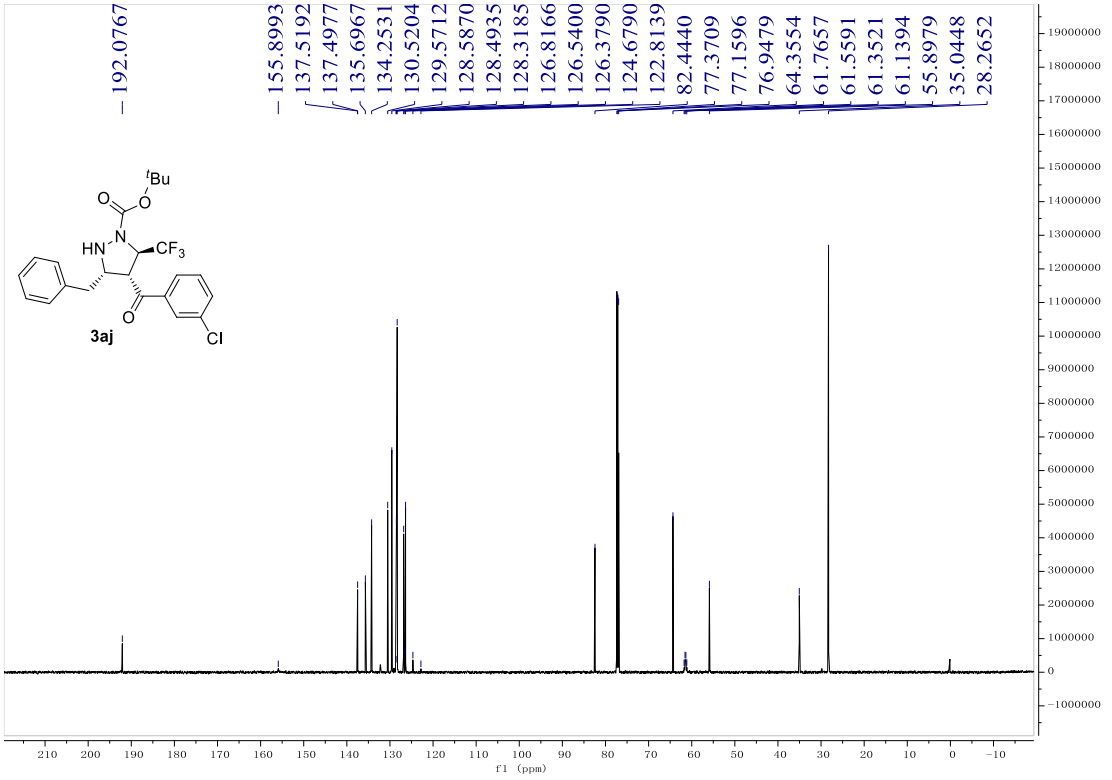
$^{19}F\{^{1}H\}$ NMR of 3ai (376 MHz, $CDCl_3$)



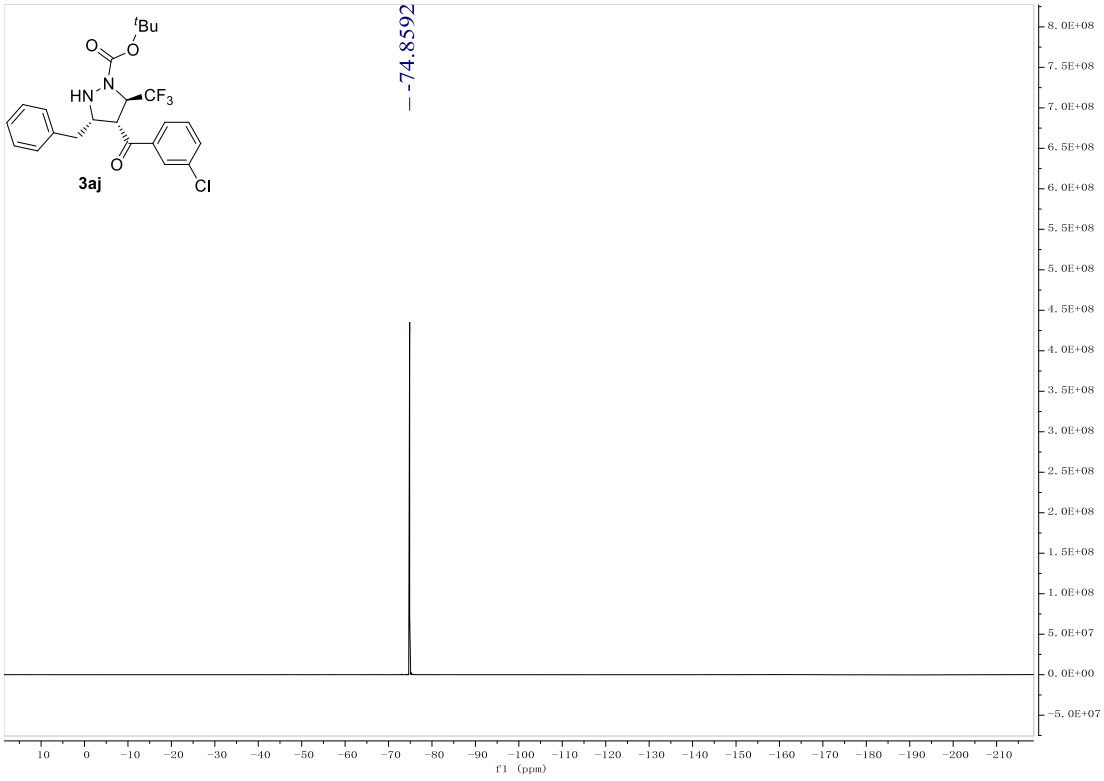
^{1}H NMR of 3aj (600 MHz, $CDCl_3$)



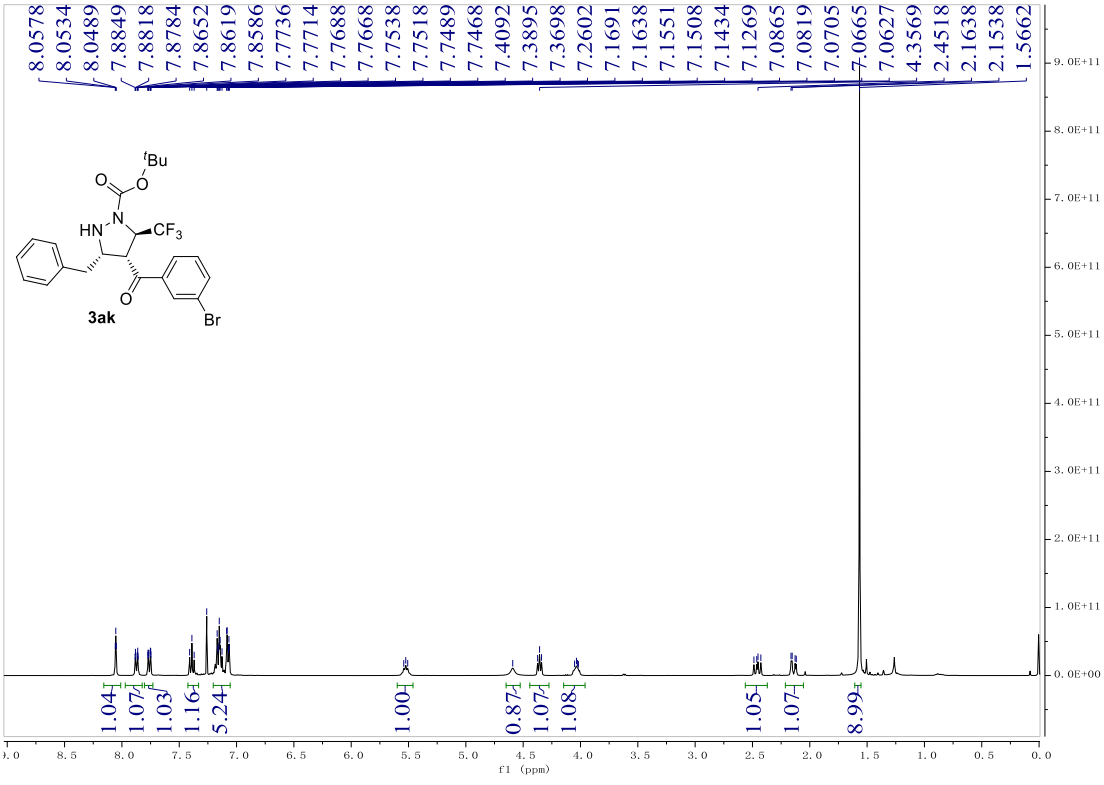
^{13}C{^{1}H} NMR of 3aj (150 MHz, $CDCl_3$)



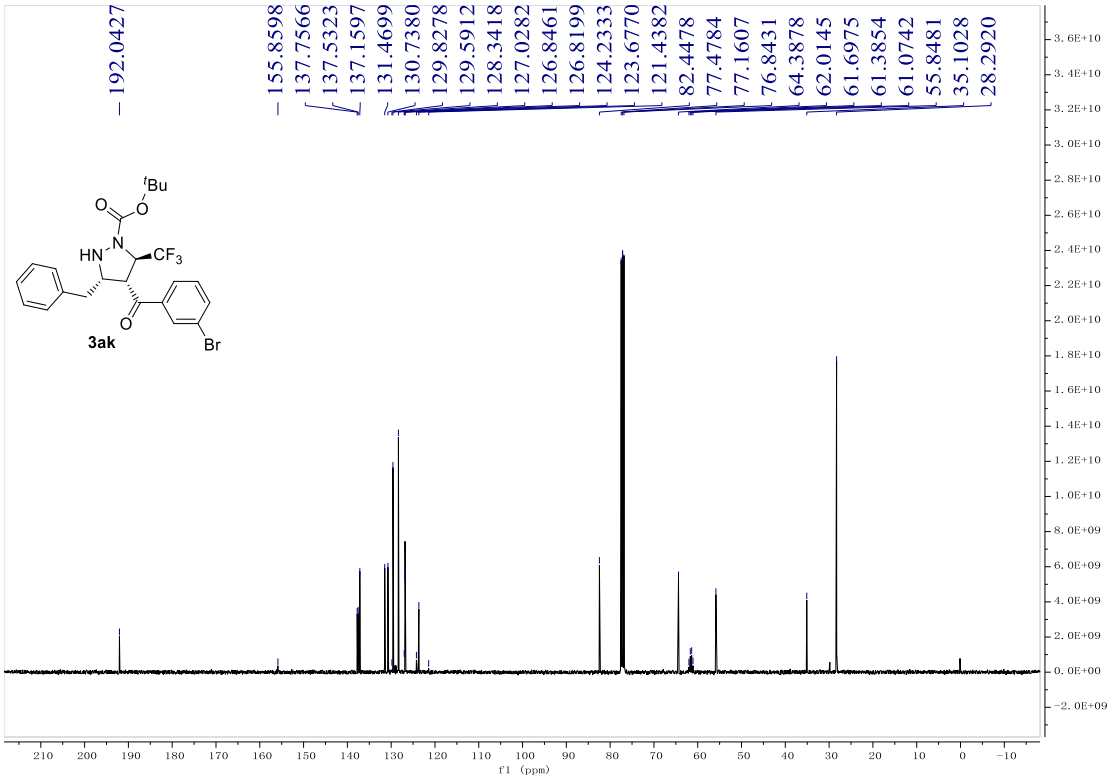
$^{19}F\{^{1}H\}$ NMR of 3aj (565 MHz, $CDCl_3$)



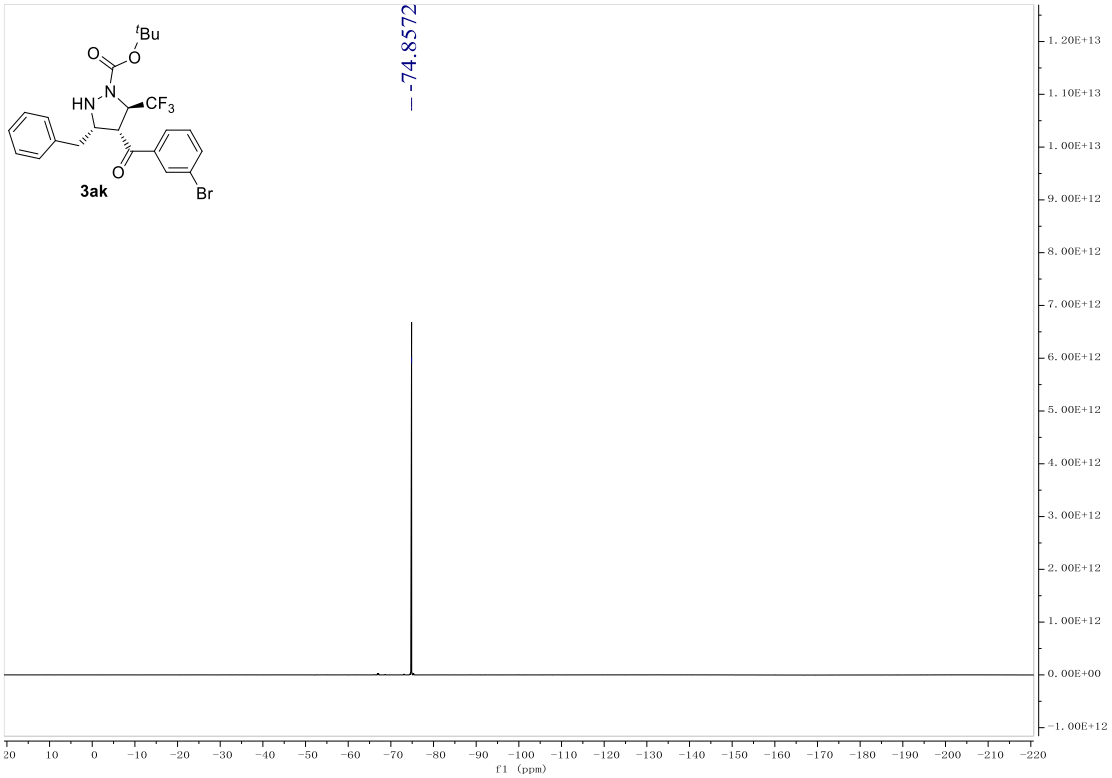
^{1}H NMR of 3ak (400 MHz, $CDCl_3$)



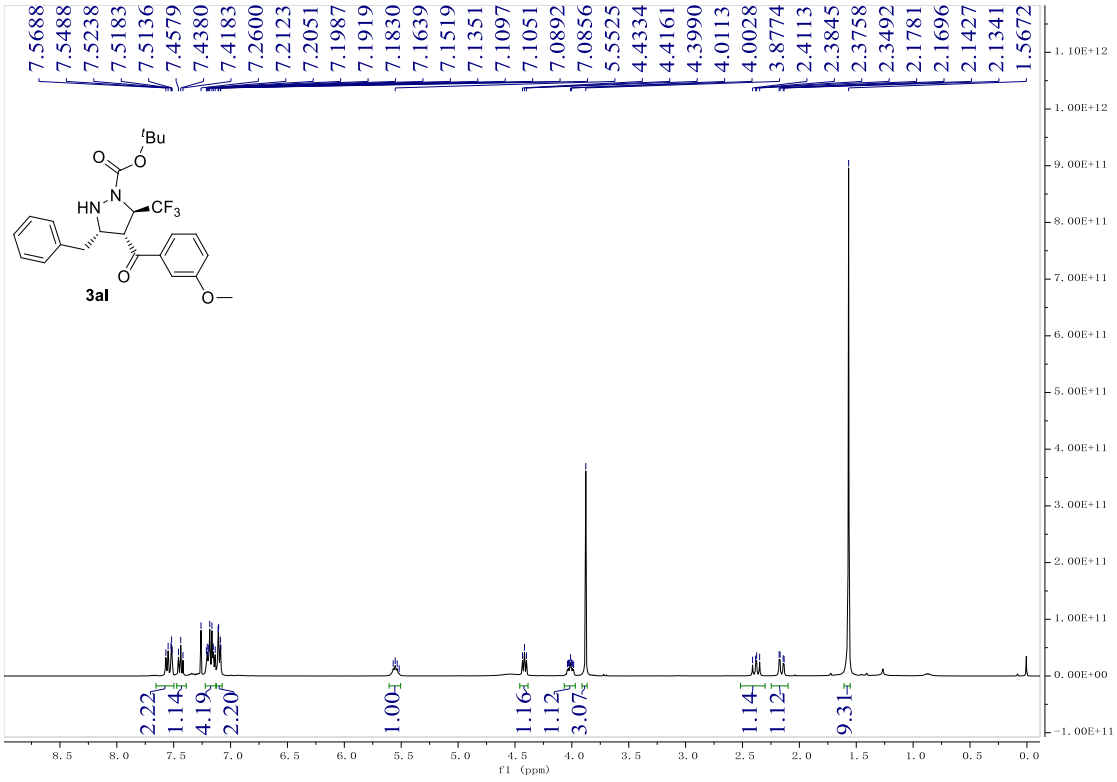
$^{13}C\{^{1}H\}$ NMR of 3ak (100 MHz, $CDCl_3$)



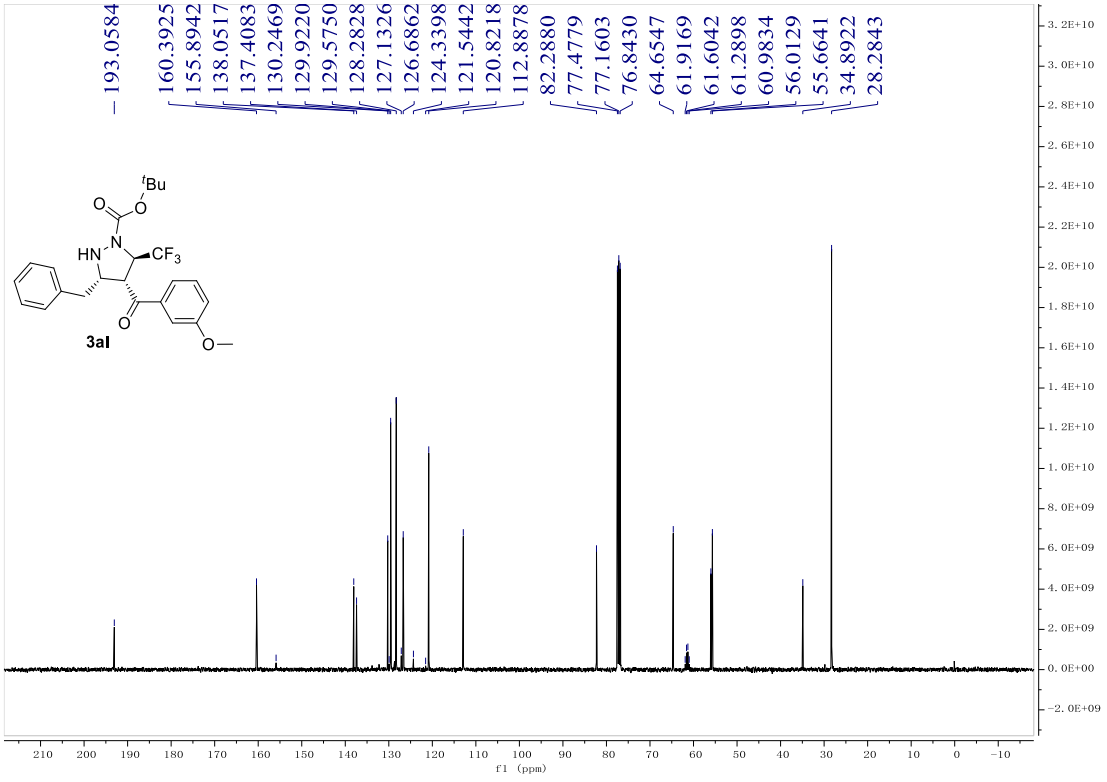
$^{19}F\{^{1}H\}$ NMR of 3ak (376 MHz, $CDCl_3$)



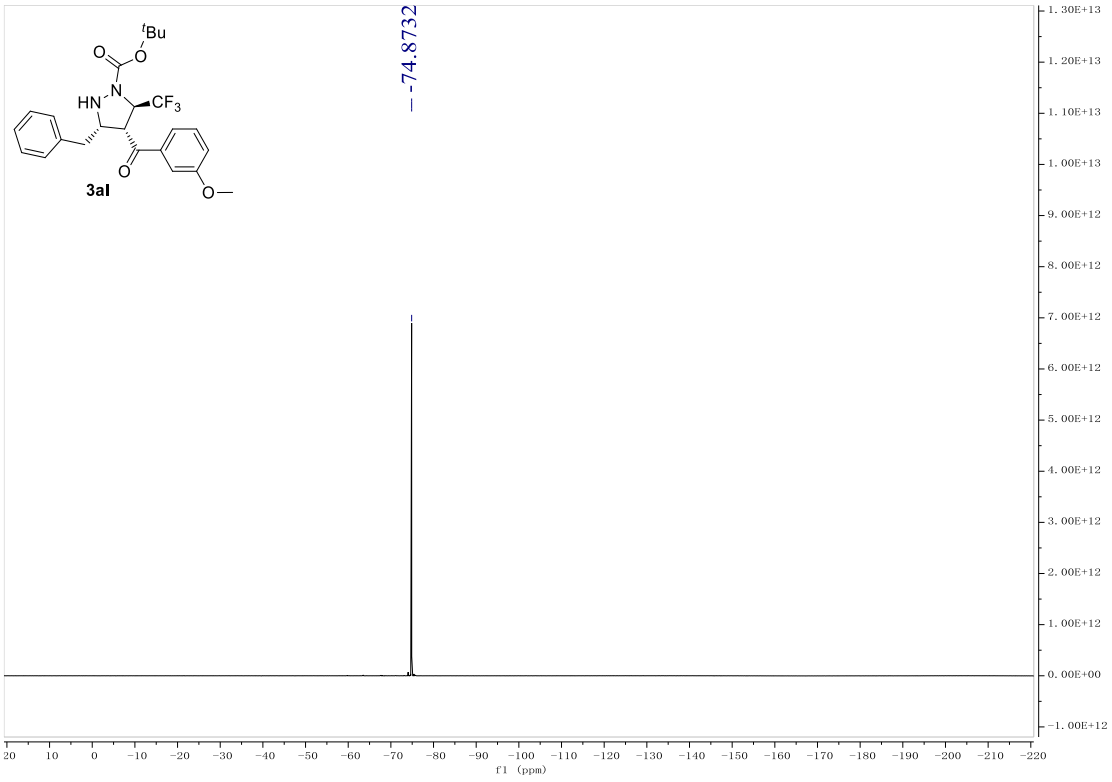
^{1}H NMR of 3al (400 MHz, $CDCl_3$)



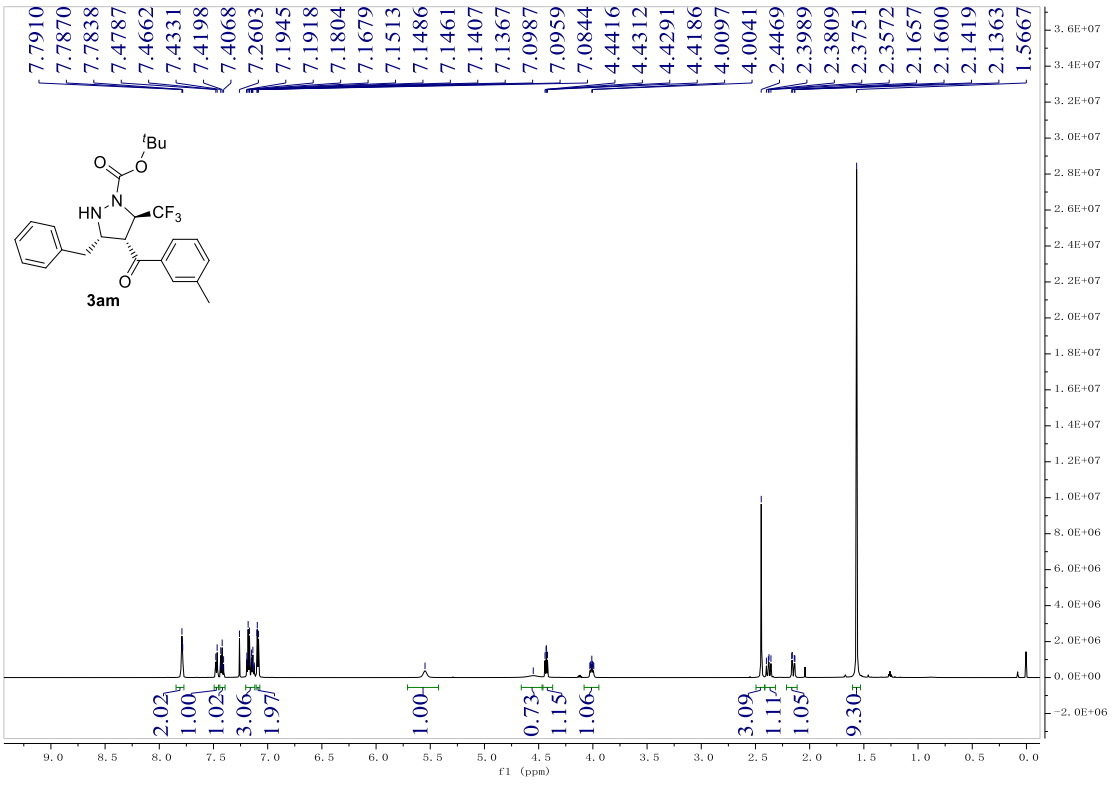
^{13}C{^{1}H} NMR of 3al (100 MHz, $CDCl_3$)



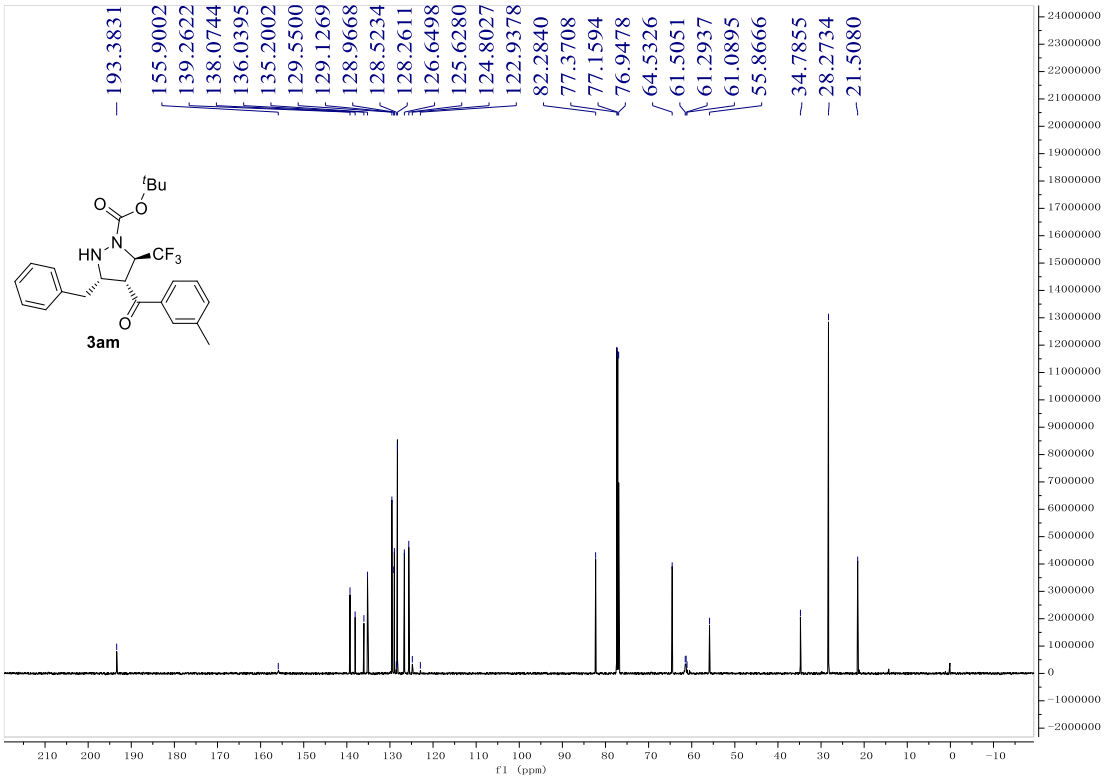
$^{19}F\{^{1}H\}$ NMR of 3al (376 MHz, $CDCl_3$)



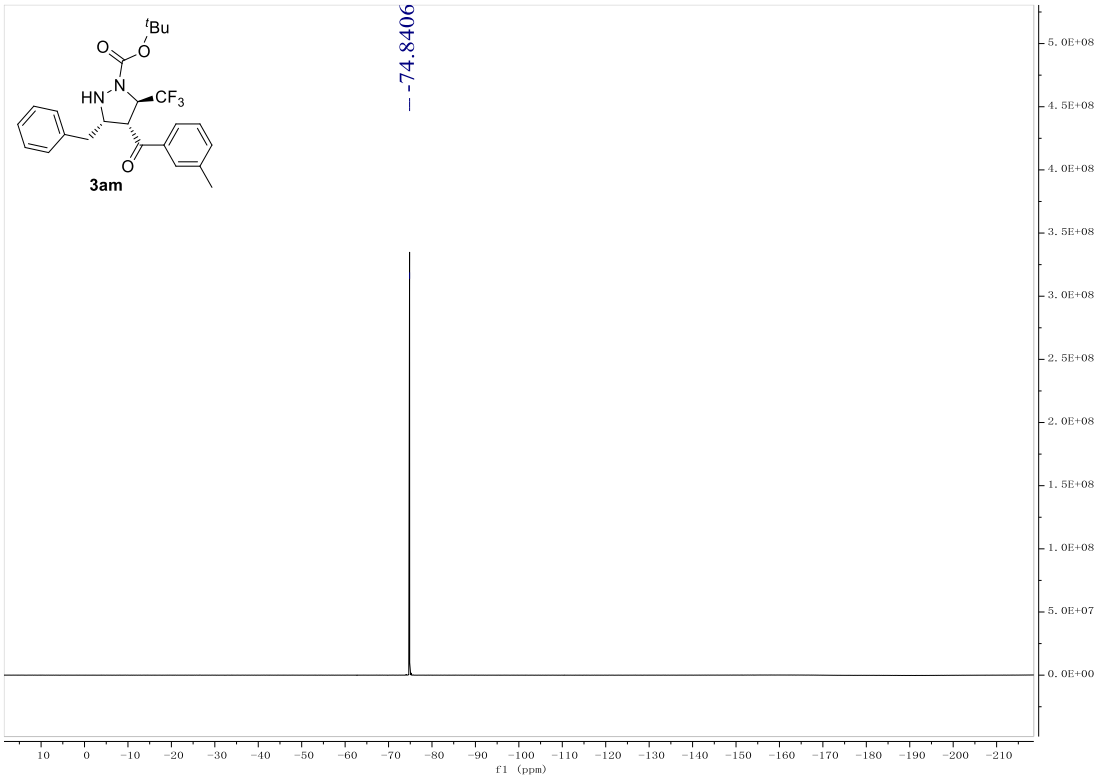
^{1}H NMR of 3am (400 MHz, $CDCl_3$)



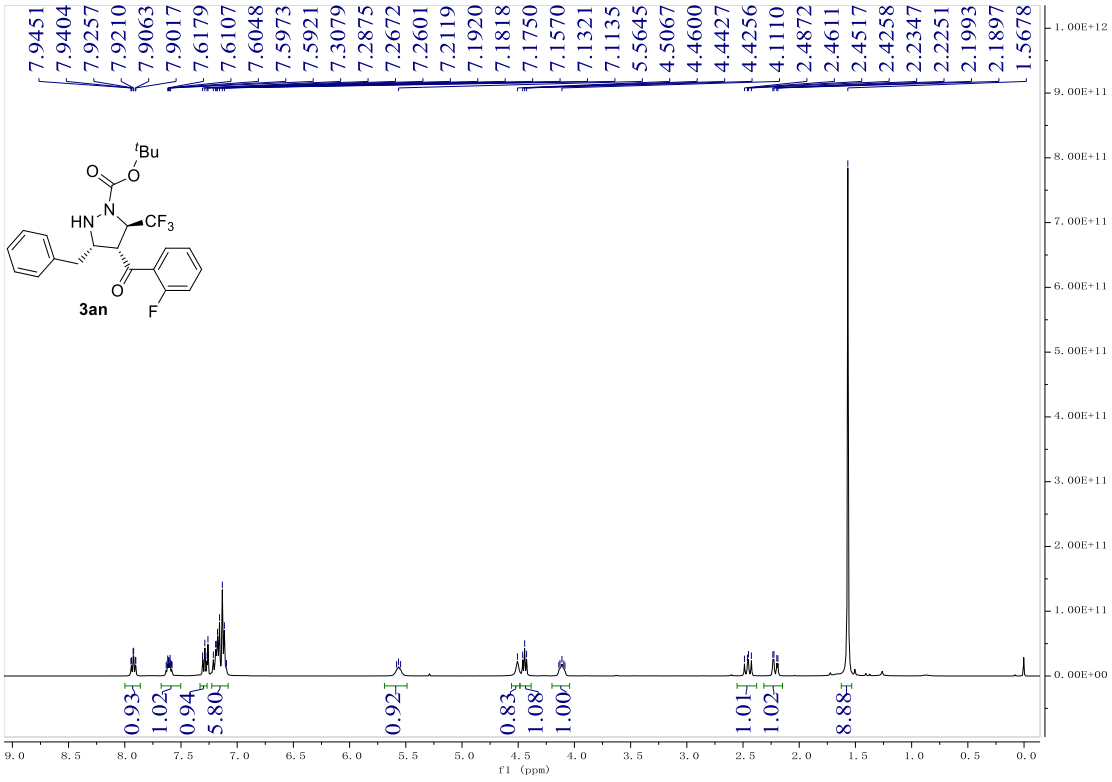
$^{13}C\{^{1}H\}$ NMR of 3am (100 MHz, $CDCl_3$)



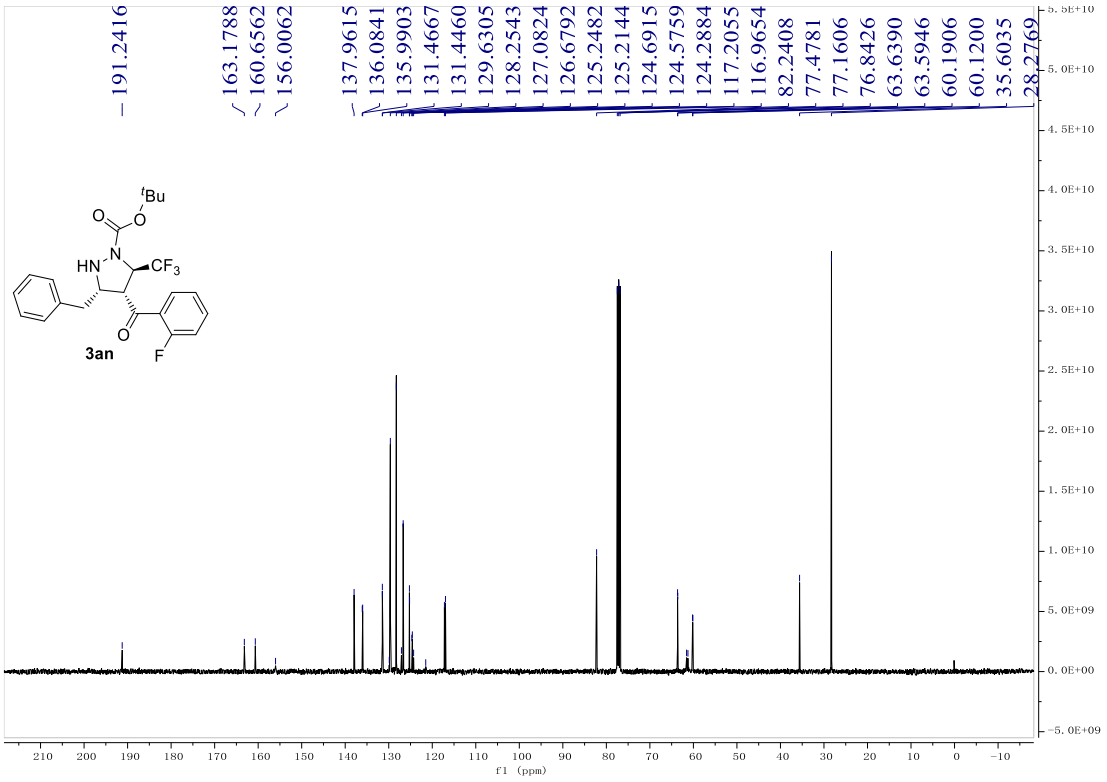
$^{19}F\{^{1}H\}$ NMR of 3am (376 MHz, $CDCl_3$)



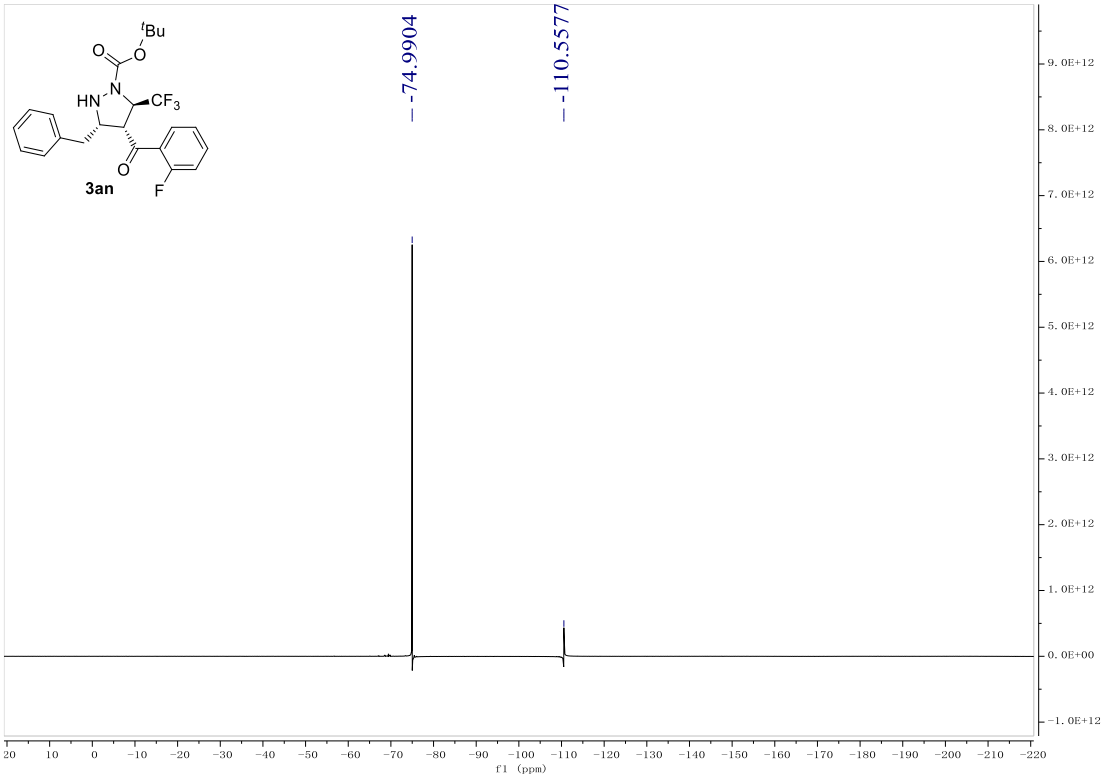
^{1}H NMR of 3an (400 MHz, $CDCl_3$)



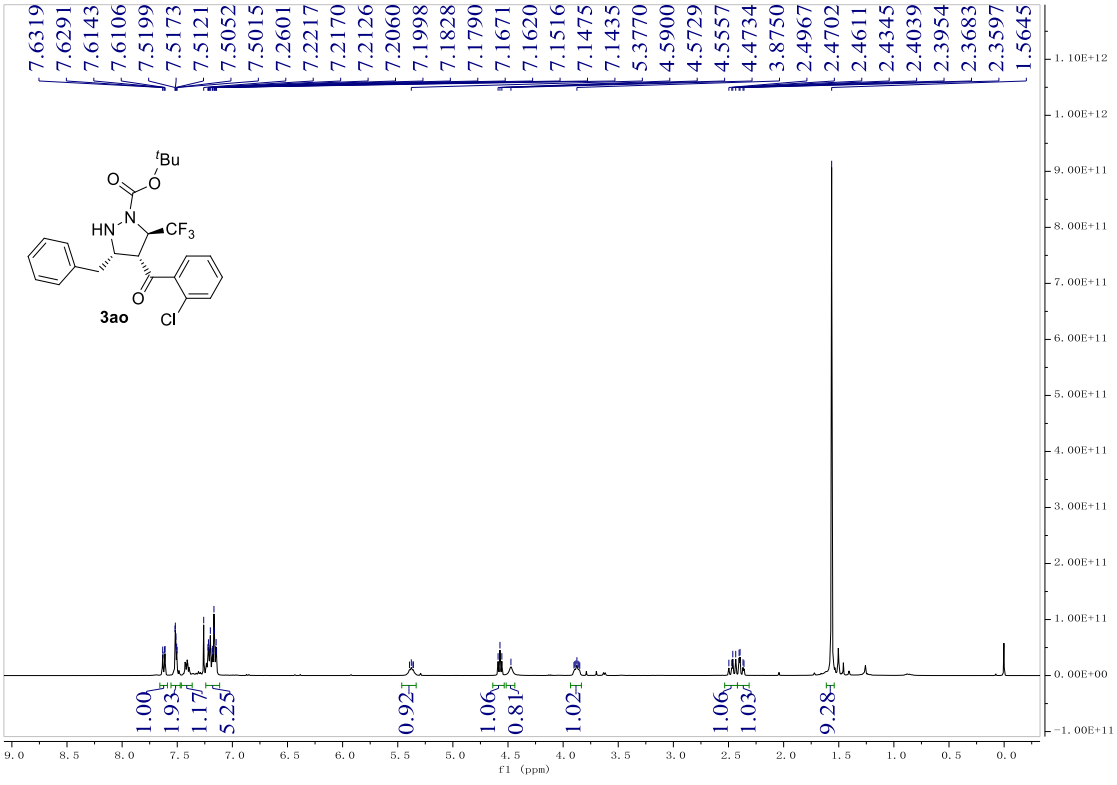
^{13}C{^{1}H} NMR of 3an (150 MHz, $CDCl_3$)



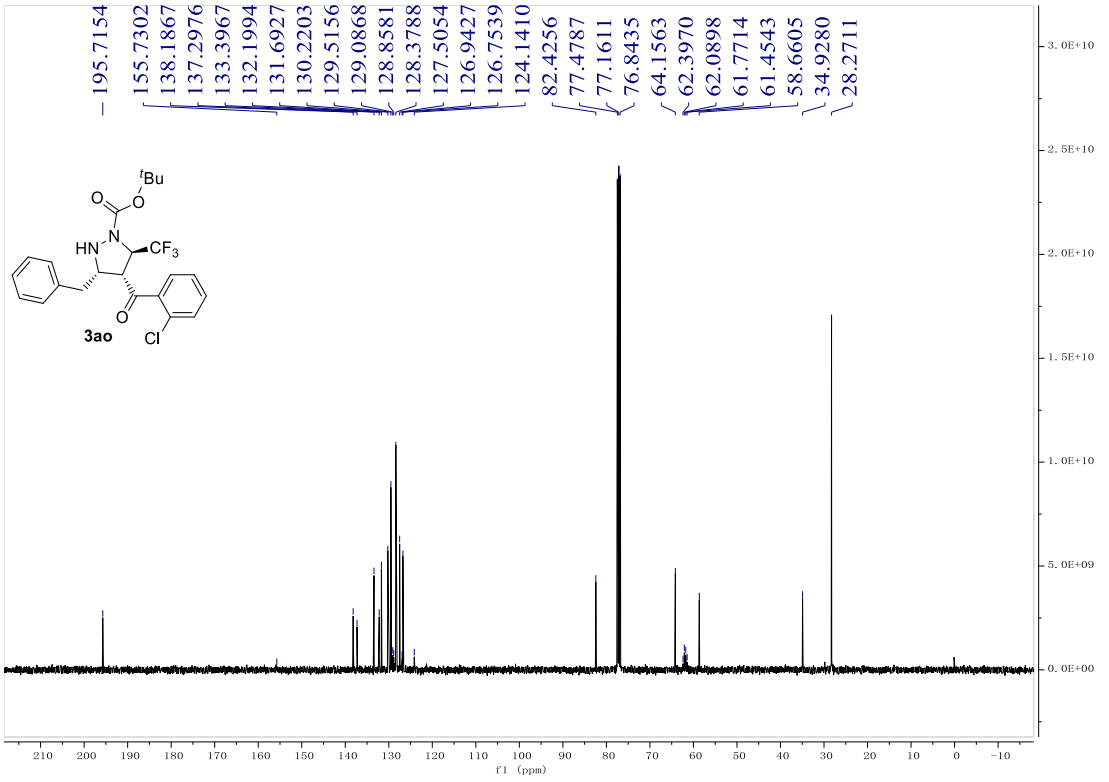
$^{19}F\{^{1}H\}$ NMR of 3an (376 MHz, $CDCl_3$)



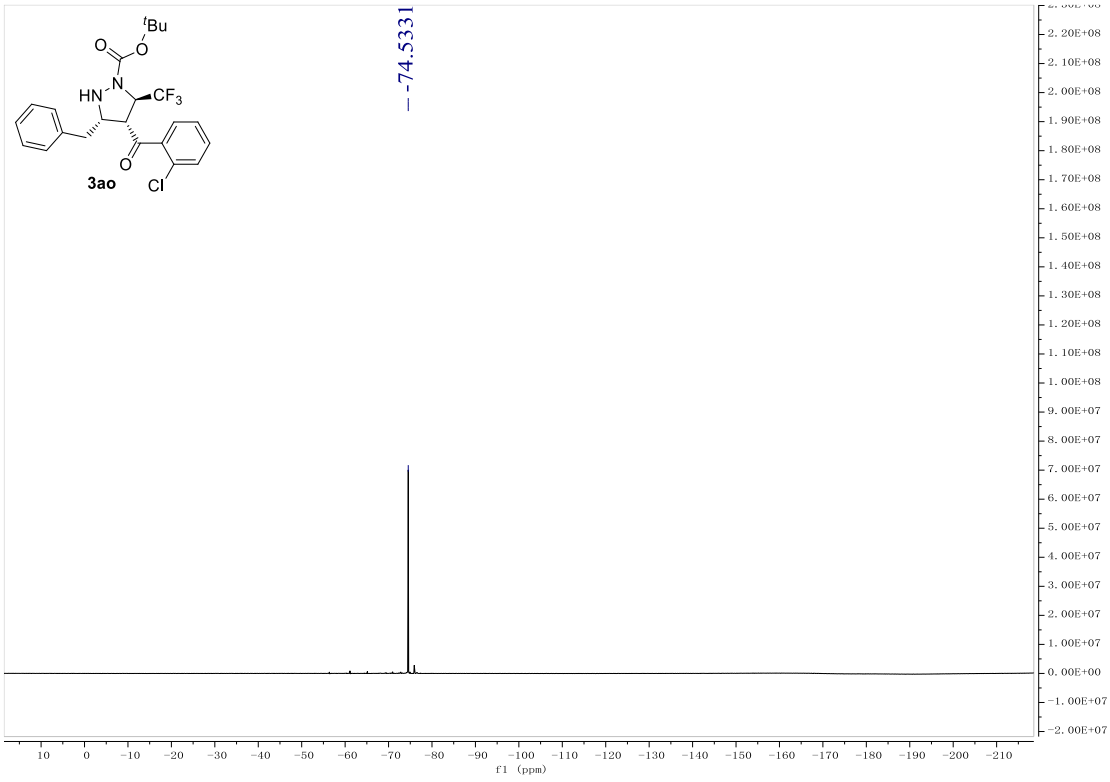
^{1}H NMR of 3ao (400 MHz, $CDCl_3$)



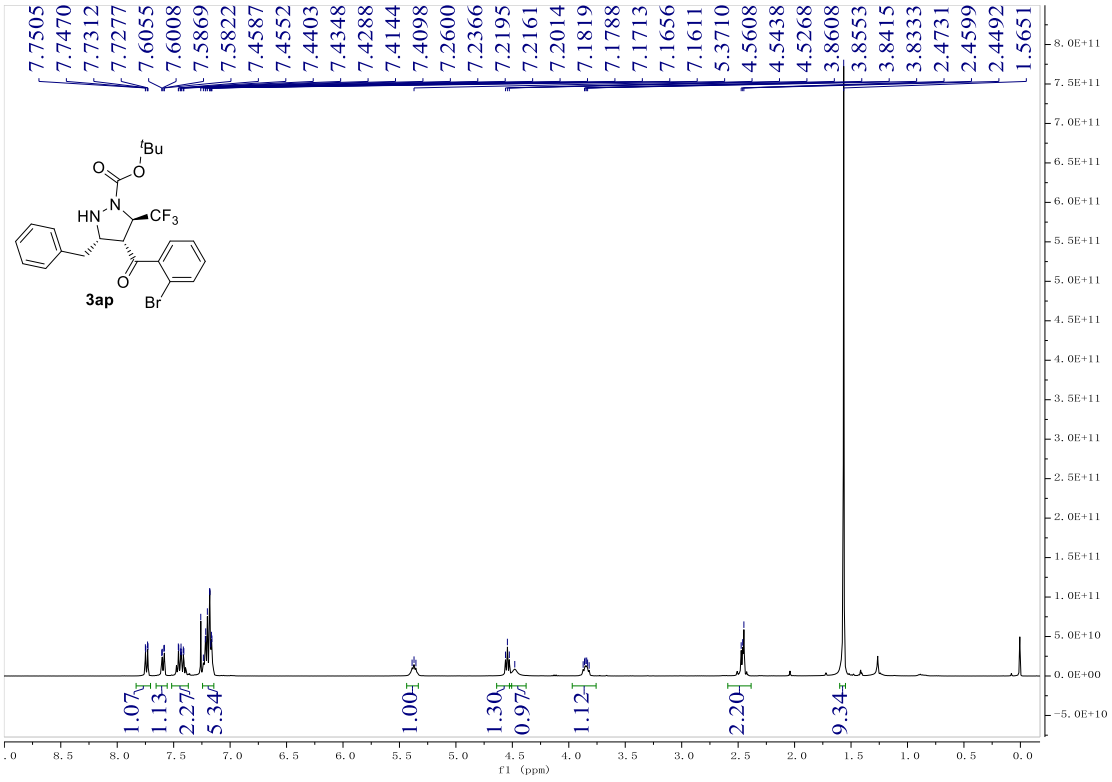
$^{13}C\{^{1}H\}$ NMR of 3ao (100 MHz, $CDCl_3$)



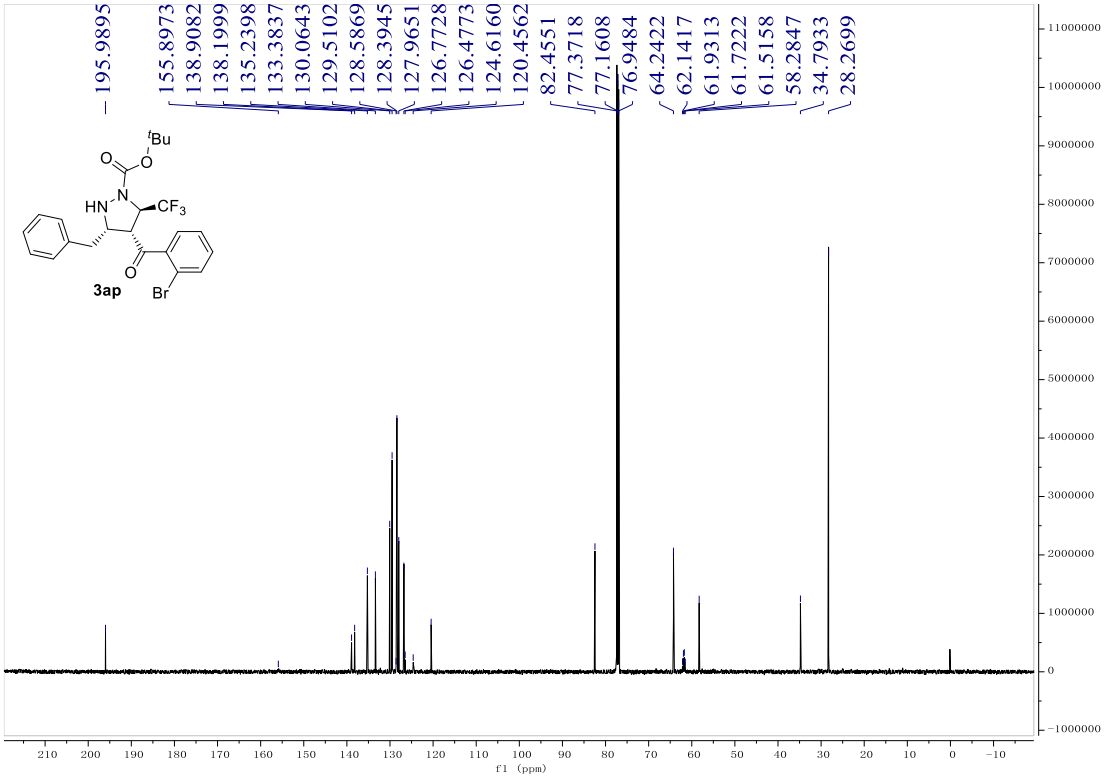
$^{19}F\{^{1}H\}$ NMR of 3ao (376 MHz, $CDCl_3$)



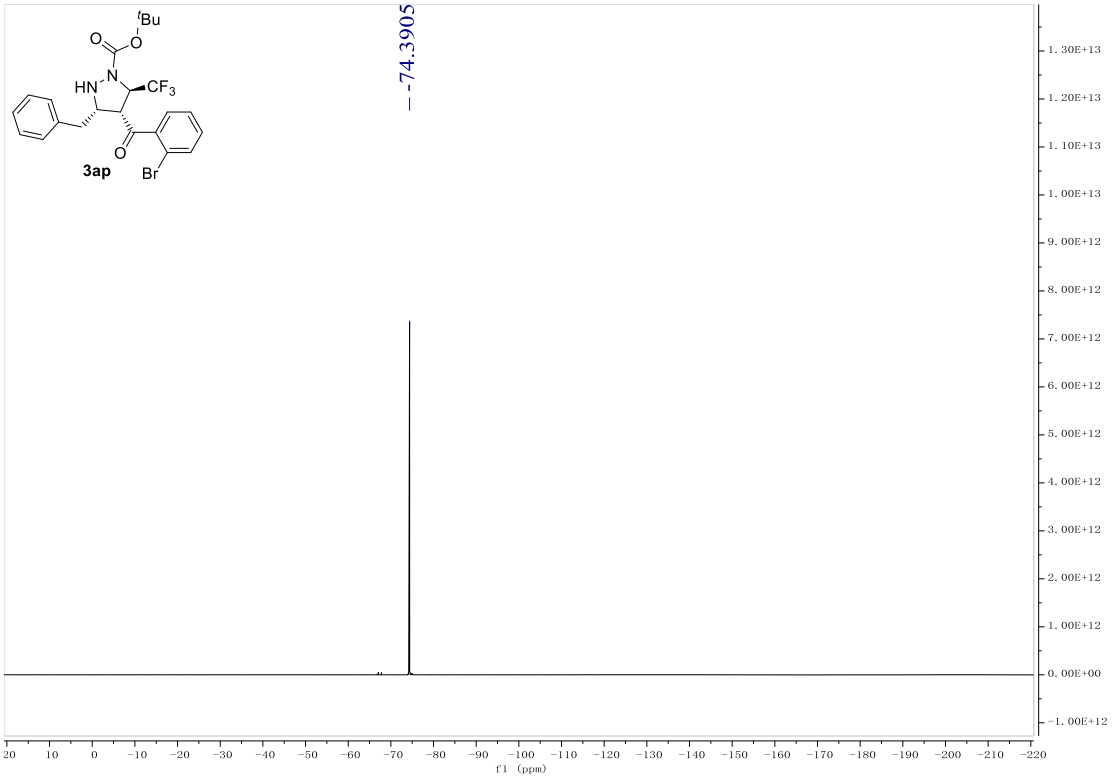
^{1}H NMR of 3ap (400 MHz, $CDCl_3$)



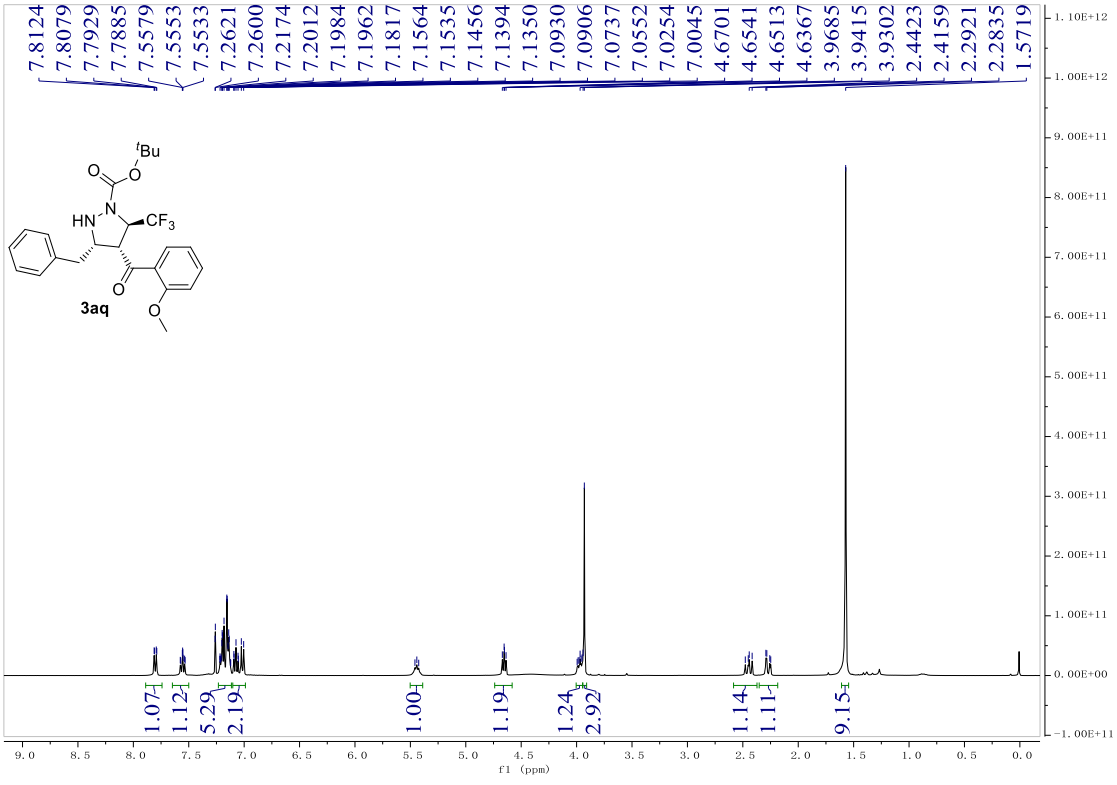
^{13}C{^{1}H} NMR of 3ap (150 MHz, $CDCl_3$)



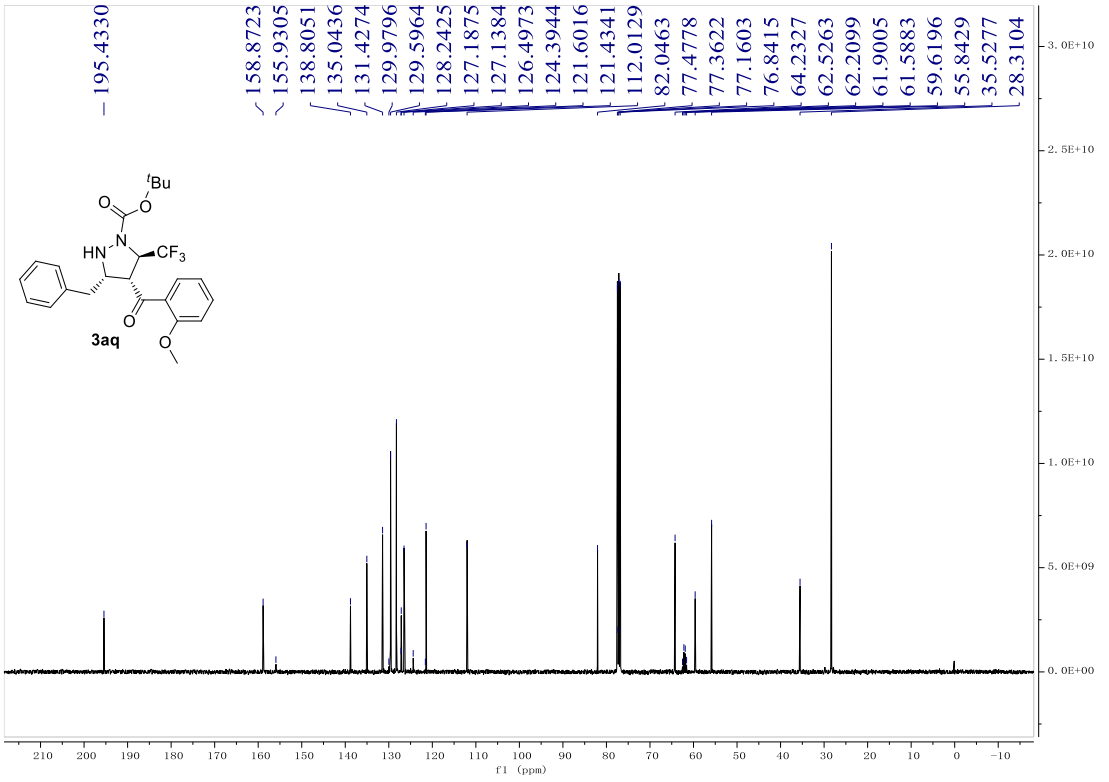
$^{19}F\{^{1}H\}$ NMR of 3ap (376 MHz, $CDCl_3$)



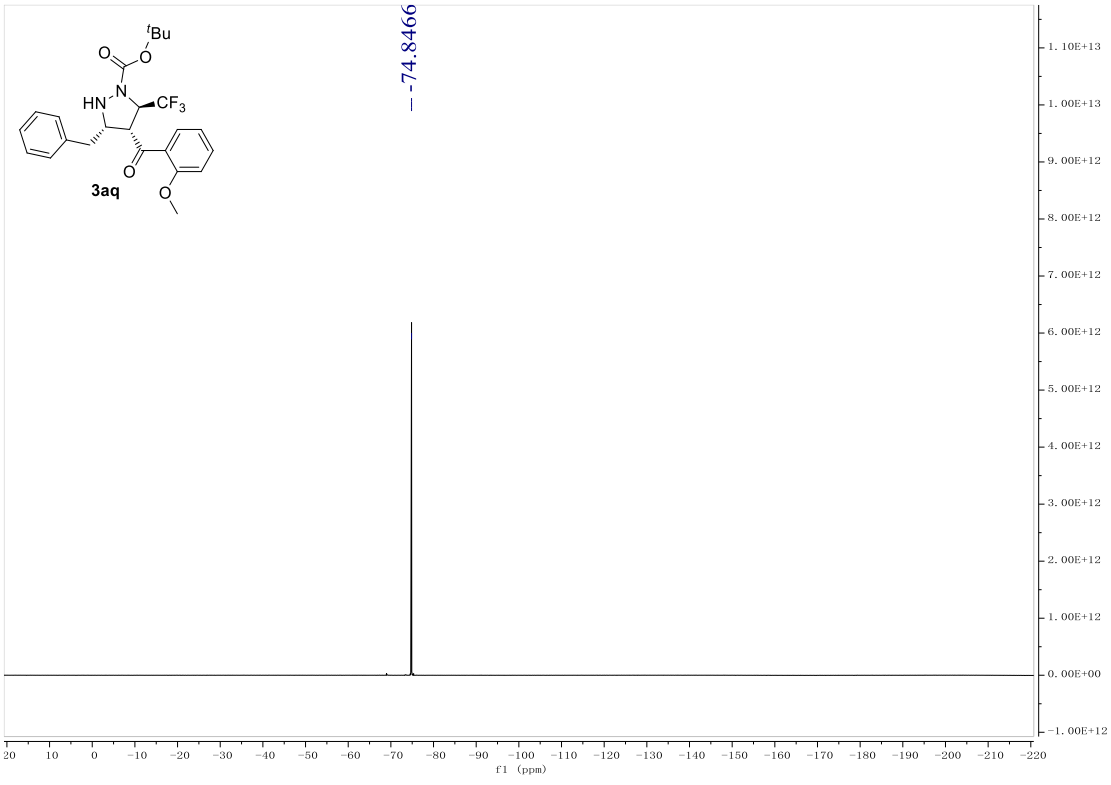
^{1}H NMR of 3aq (400 MHz, $CDCl_3$)



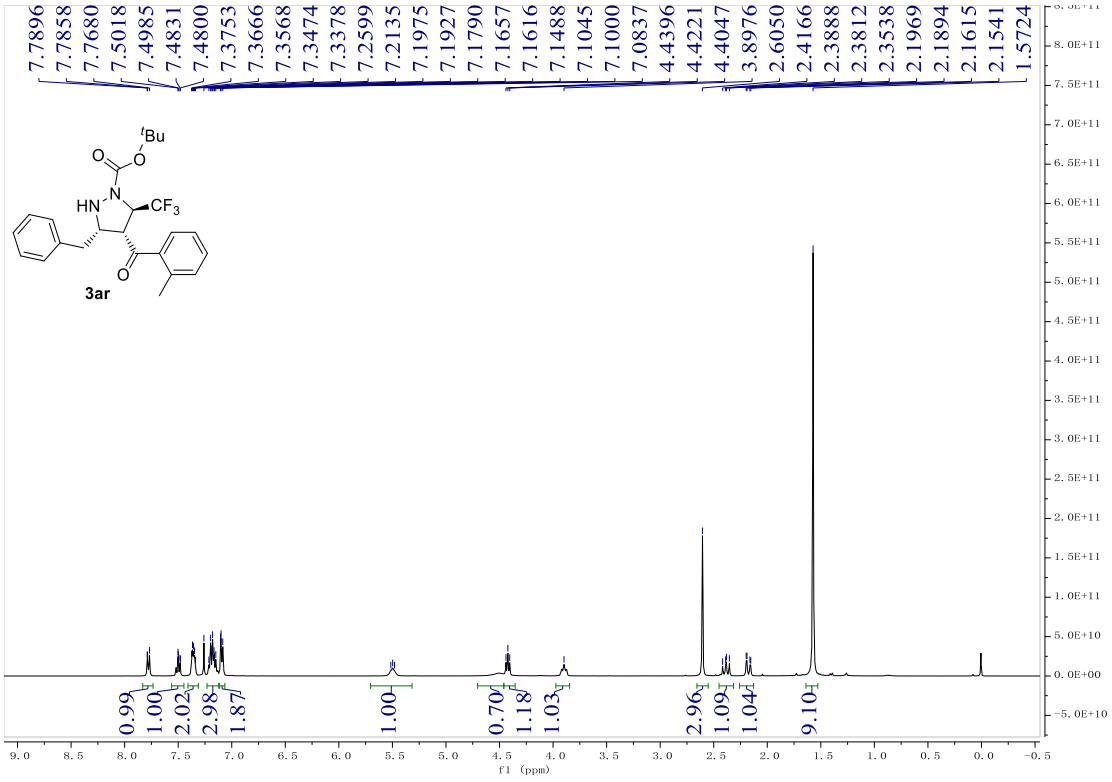
$^{13}C\{^{1}H\}$ NMR of 3aq (100 MHz, $CDCl_3$)



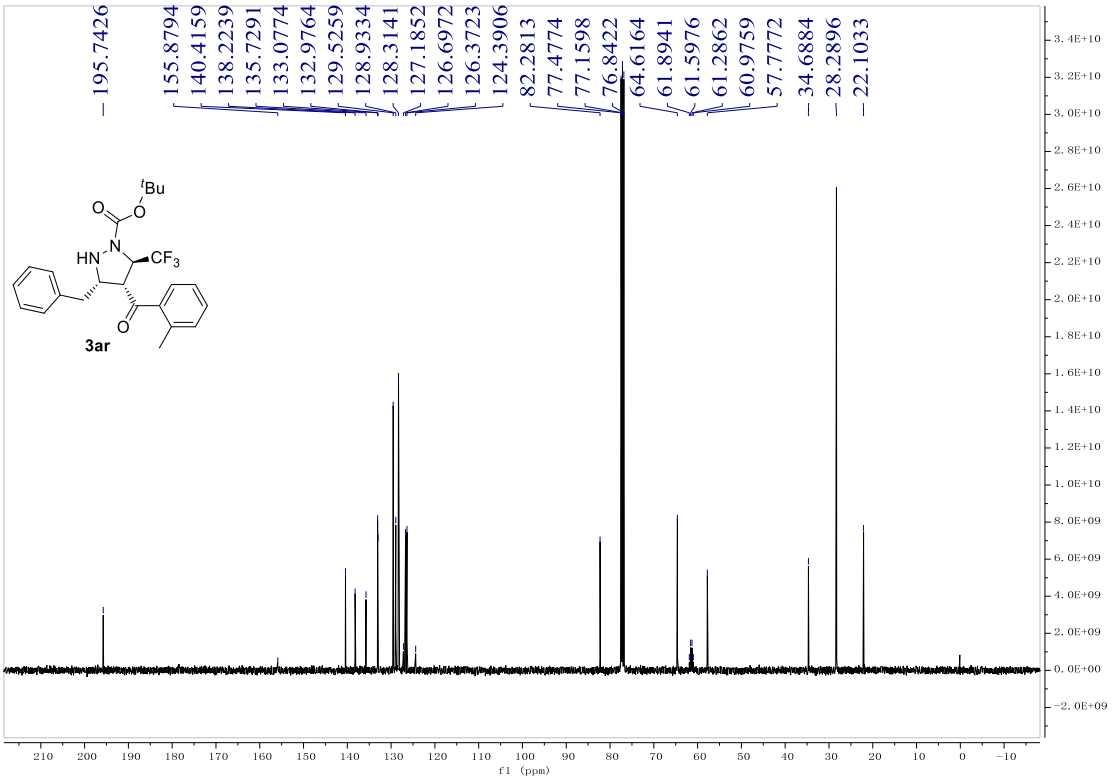
$^{19}F\{^{1}H\}$ NMR of 3aq (376 MHz, $CDCl_3$)



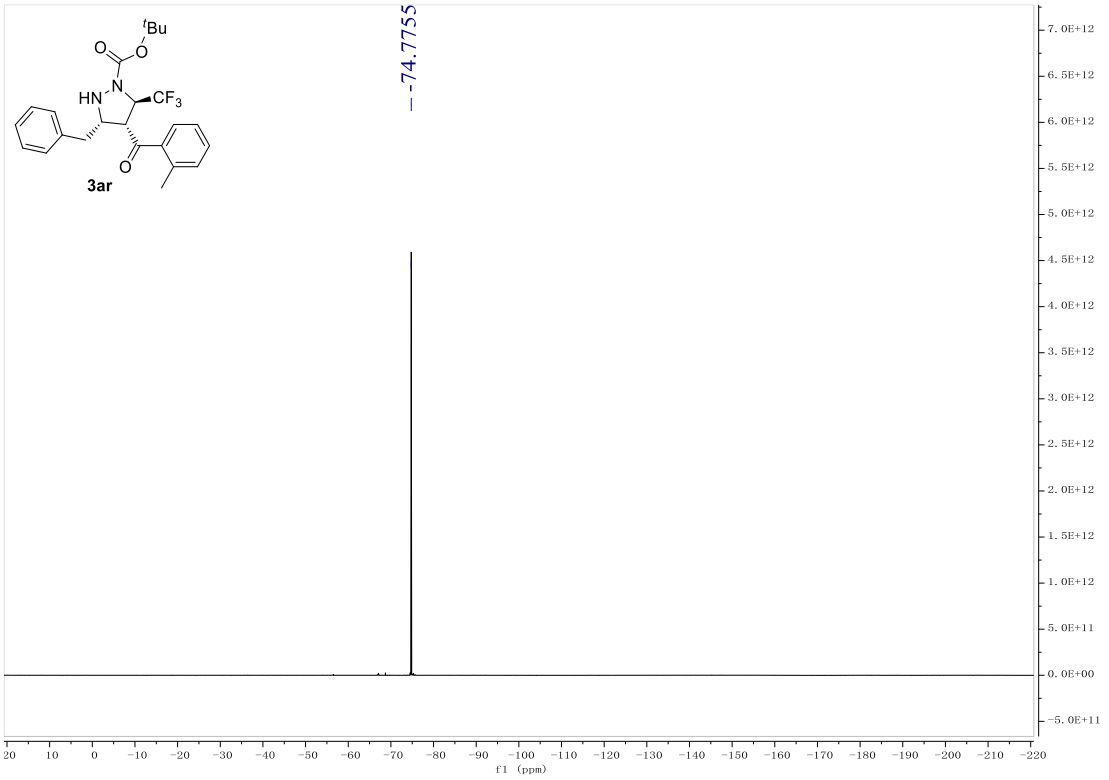
^{1}H NMR of 3ar (400 MHz, $CDCl_3$)



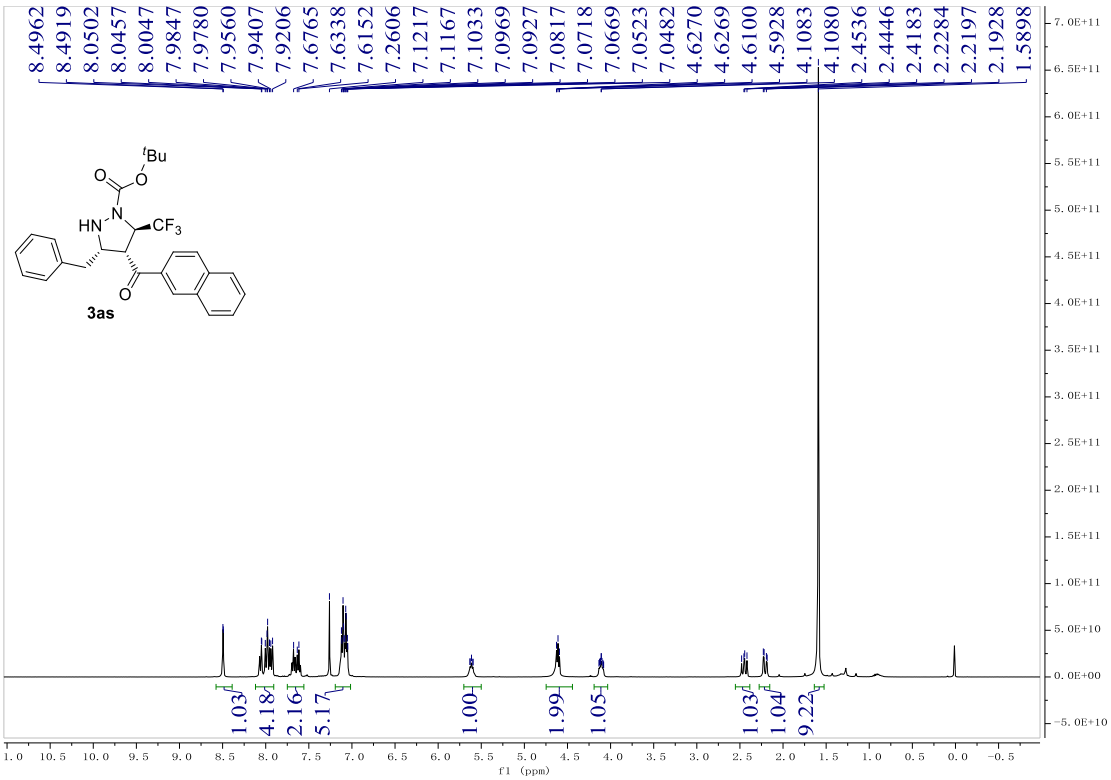
^{13}C{^{1}H} NMR of 3ar (100 MHz, $CDCl_3$)



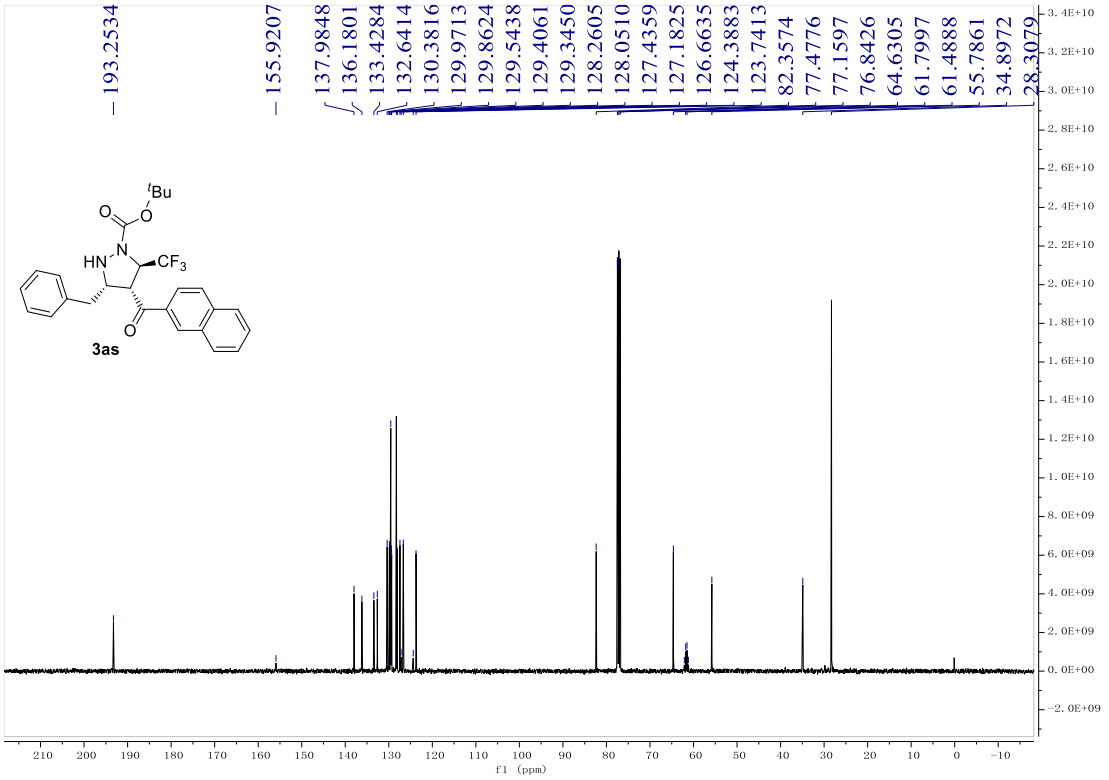
$^{19}F\{^{1}H\}$ NMR of 3ar (376 MHz, $CDCl_3$)



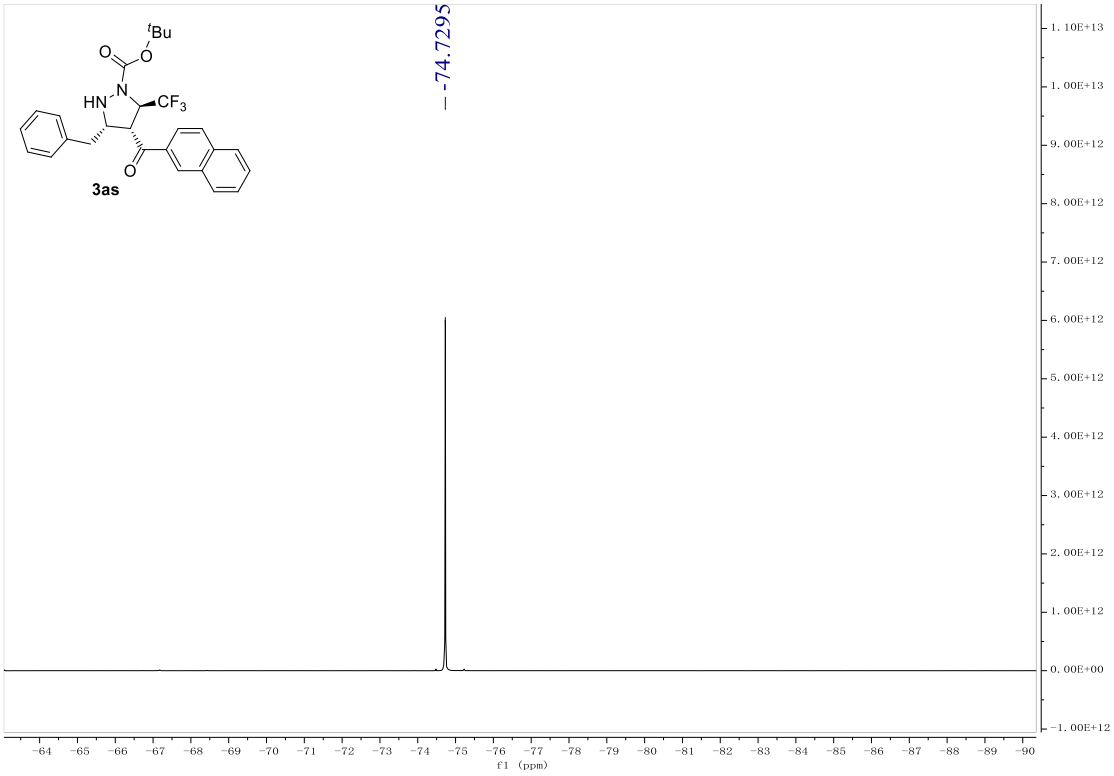
^{1}H NMR of 3as (400 MHz, $CDCl_3$)



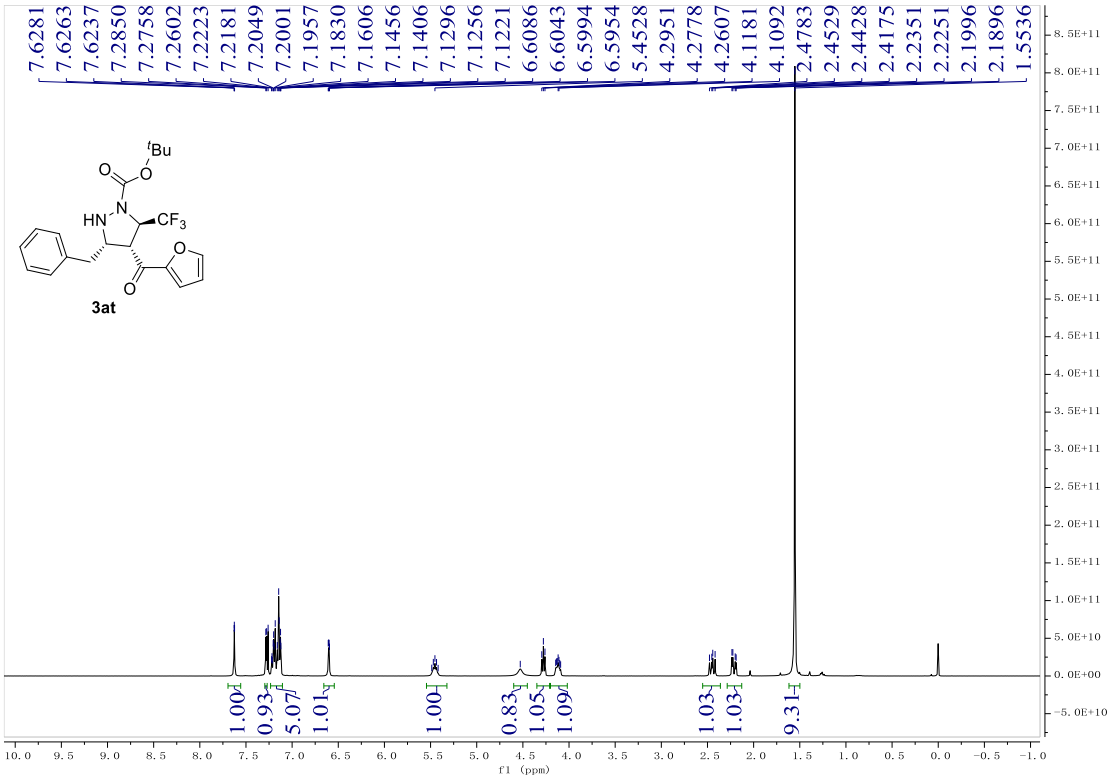
$^{13}C\{^{1}H\}$ NMR of 3as (100 MHz, $CDCl_3$)



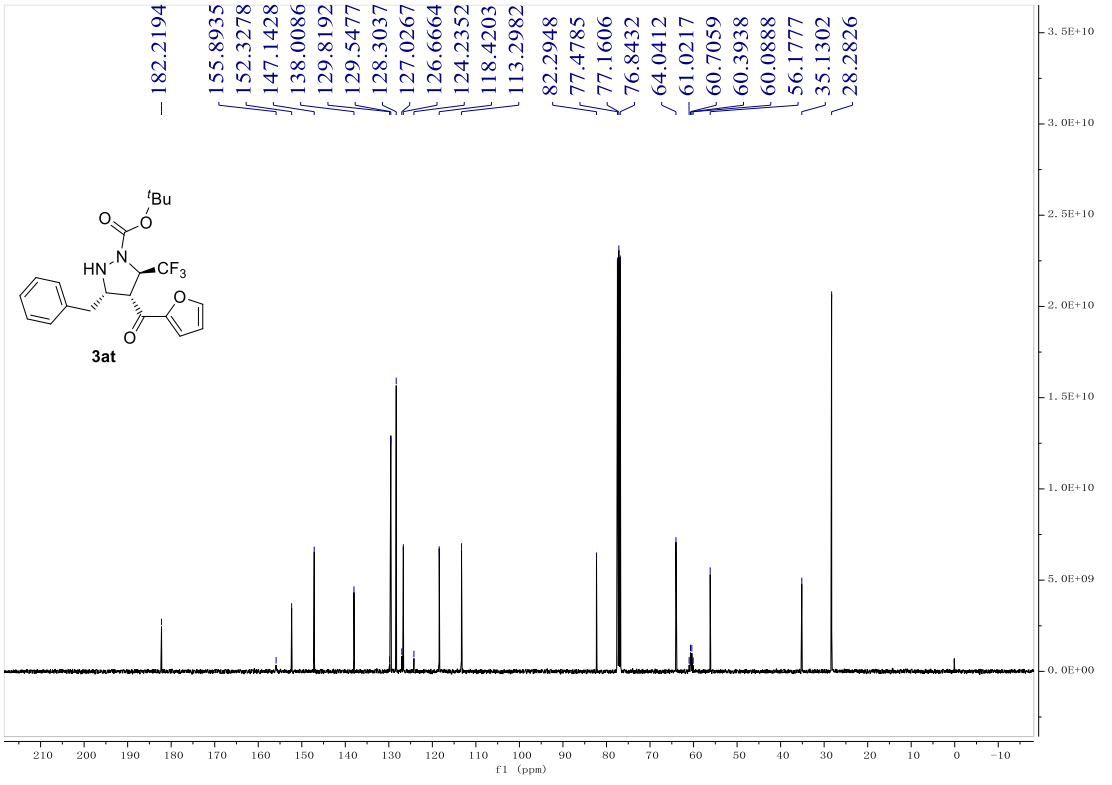
$^{19}F\{^{1}H\}$ NMR of 3as (376 MHz, $CDCl_3$)



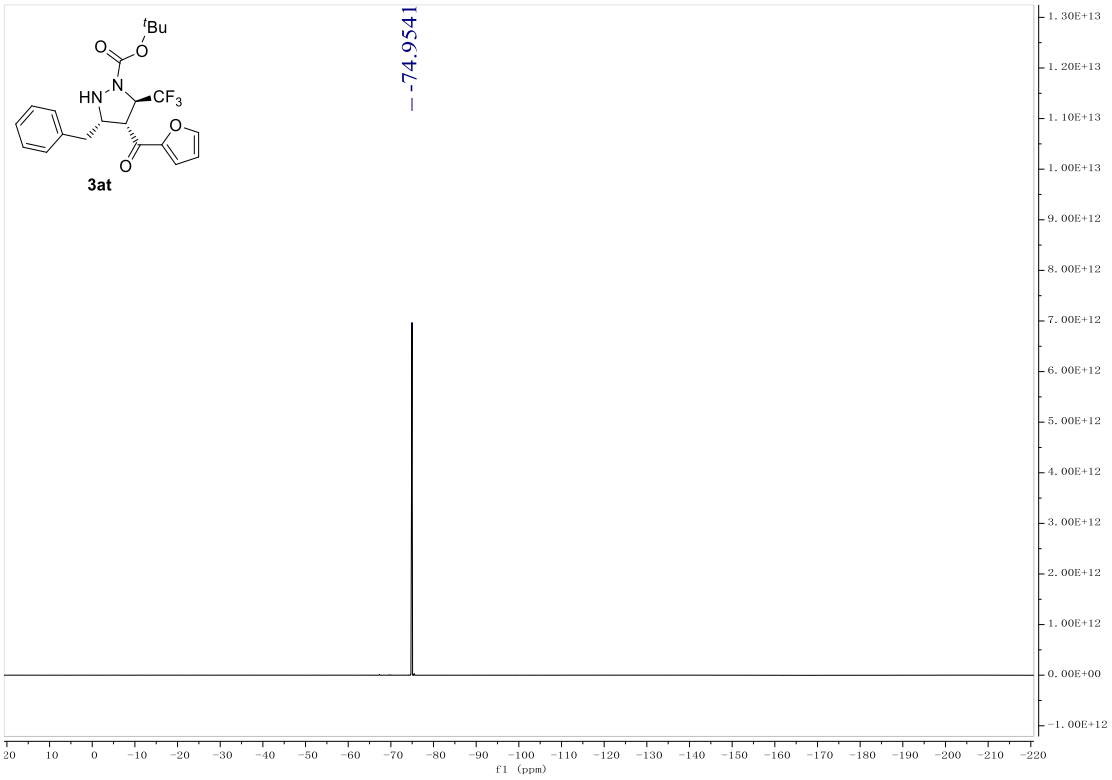
^{1}H NMR of 3at (400 MHz, $CDCl_3$)



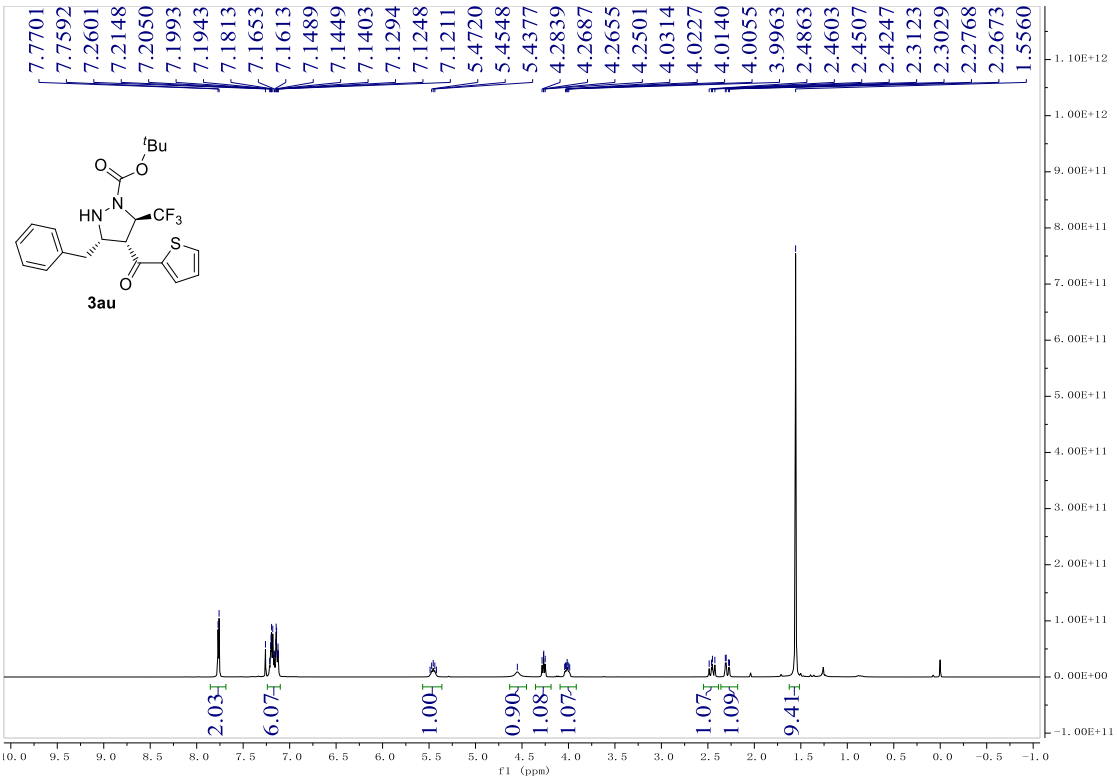
^{13}C{^{1}H} NMR of 3at (100 MHz, $CDCl_3$)



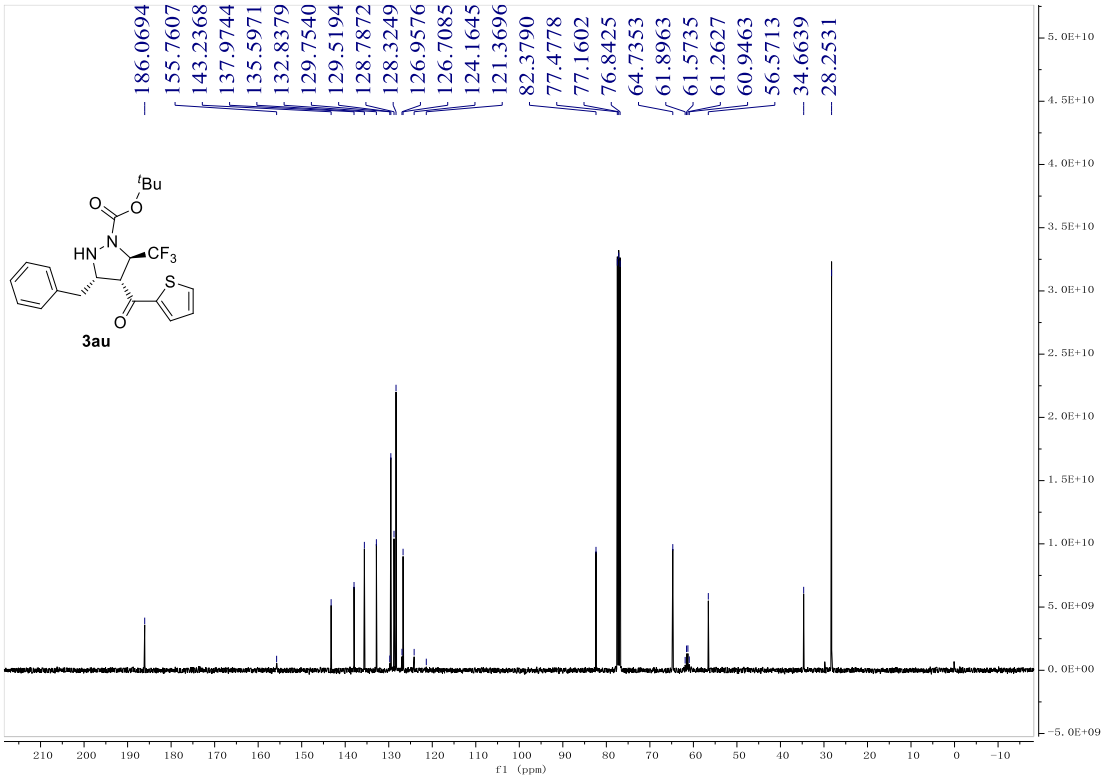
$^{19}F\{^{1}H\}$ NMR of 3at (376 MHz, $CDCl_3$)



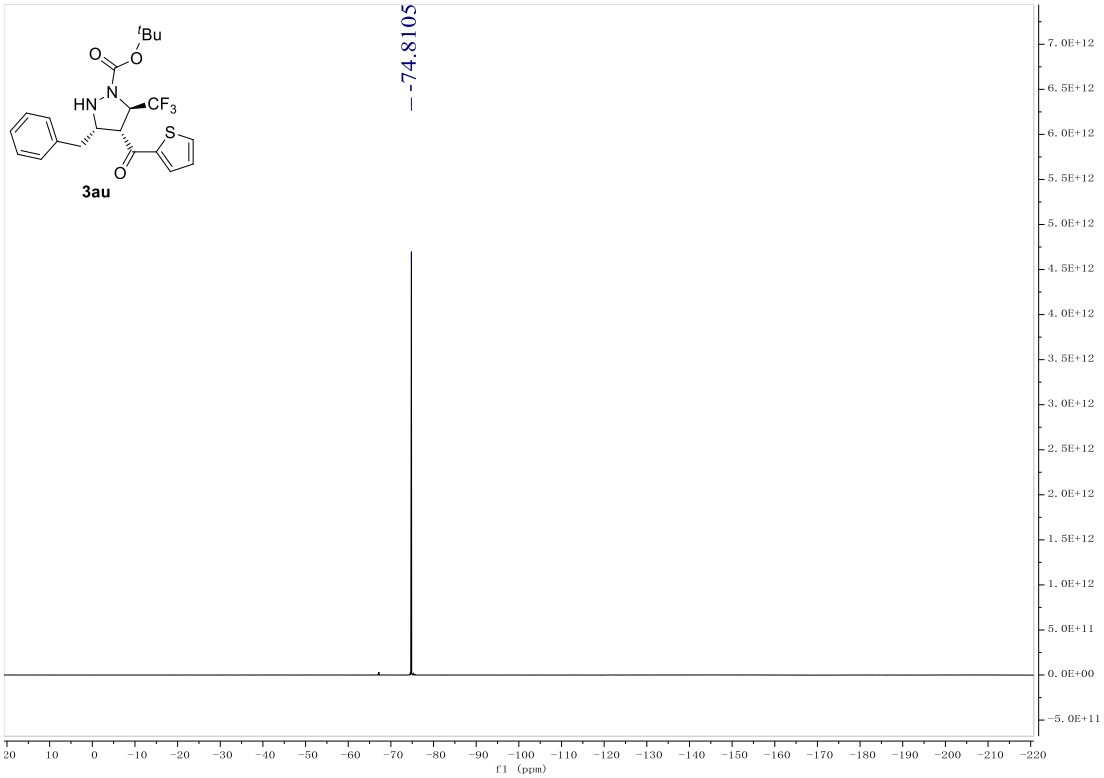
^{1}H NMR of 3au (400 MHz, $CDCl_3$)



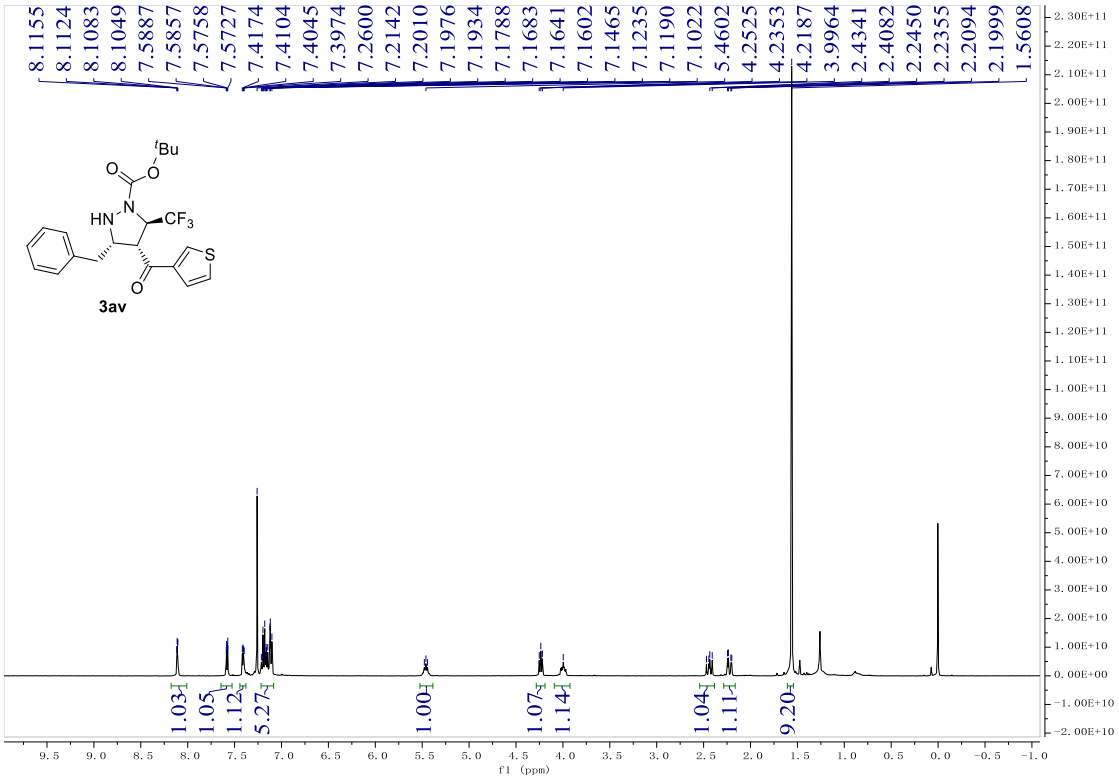
$^{13}C\{^{1}H\}$ NMR of 3au (100 MHz, $CDCl_3$)



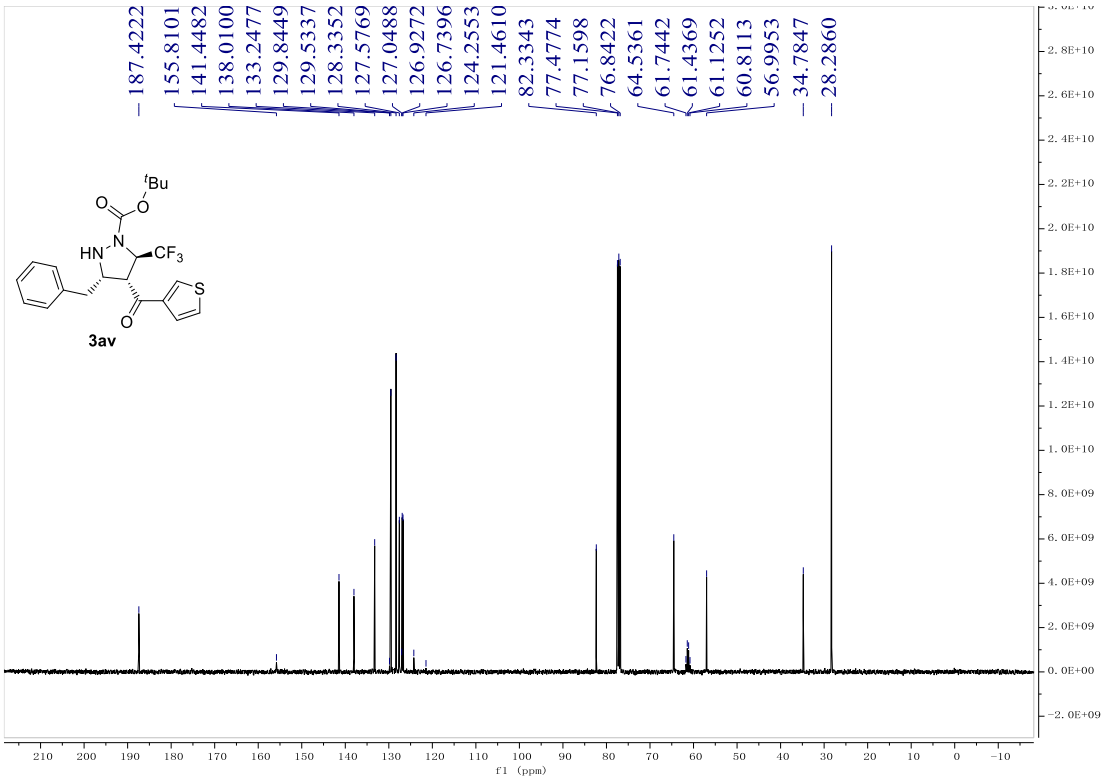
$^{19}F\{^{1}H\}$ NMR of 3au (376 MHz, $CDCl_3$)



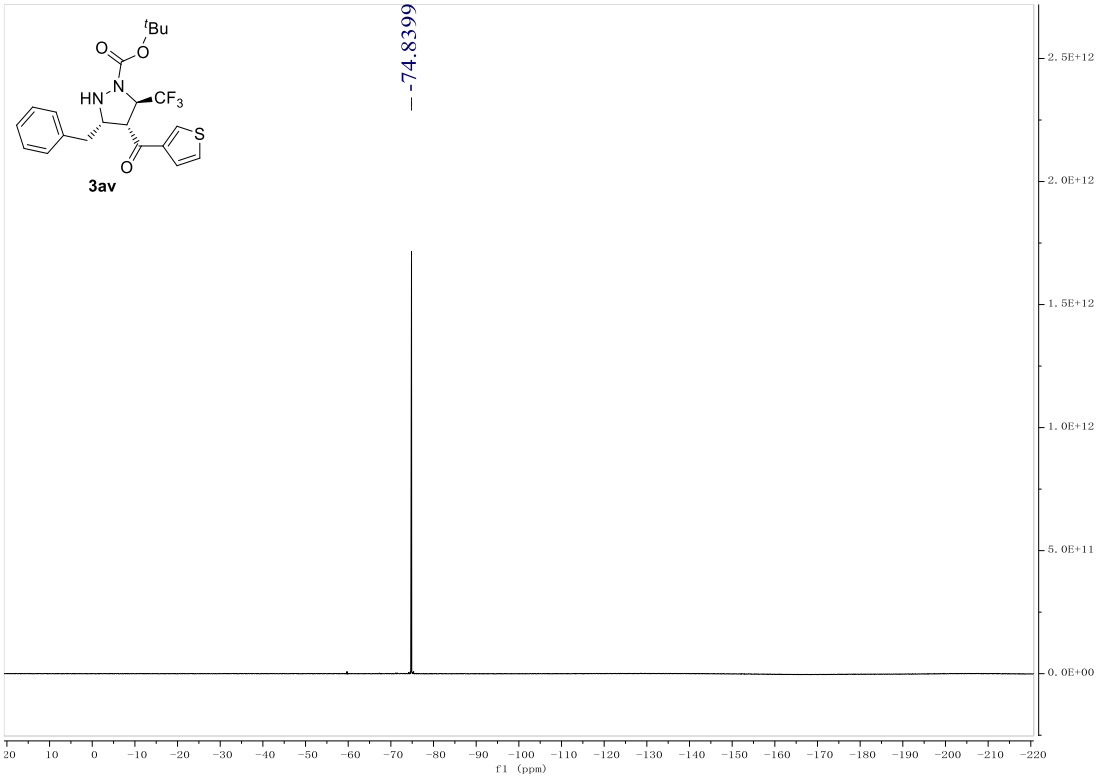
^{1}H NMR of 3av (400 MHz, $CDCl_3$)



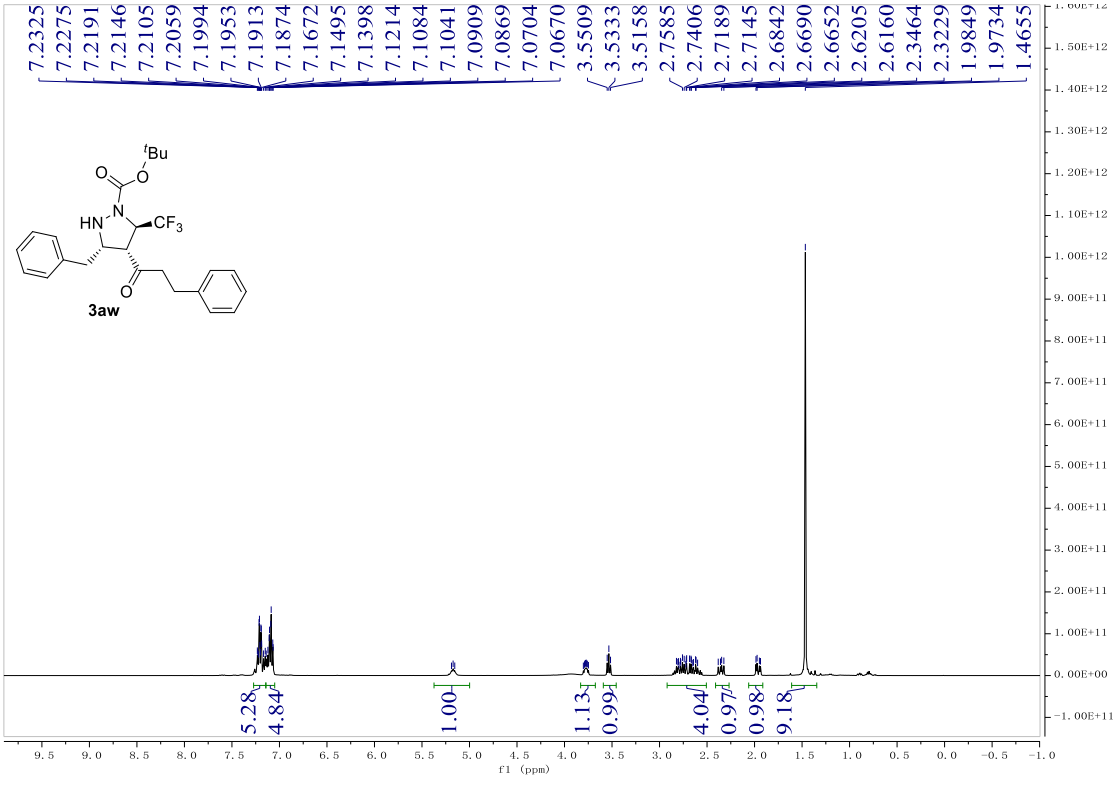
^{13}C{^{1}H} NMR of 3av (100 MHz, $CDCl_3$)



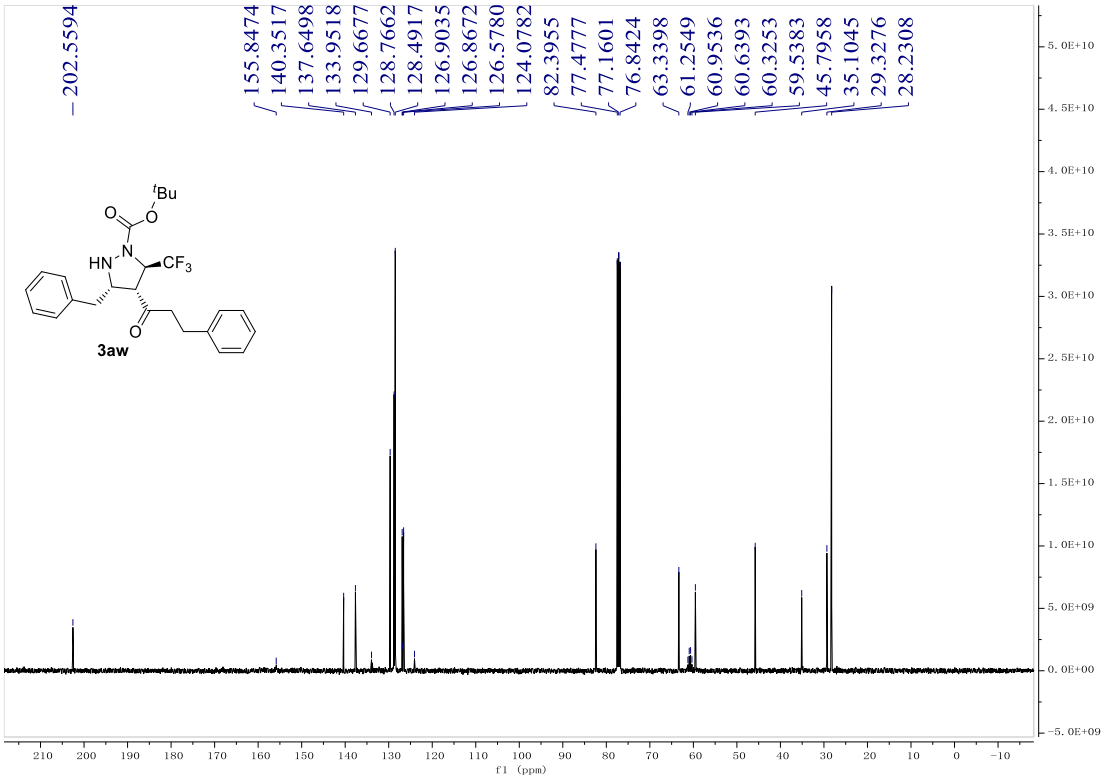
$^{19}F\{^{1}H\}$ NMR of 3av (376 MHz, $CDCl_3$)



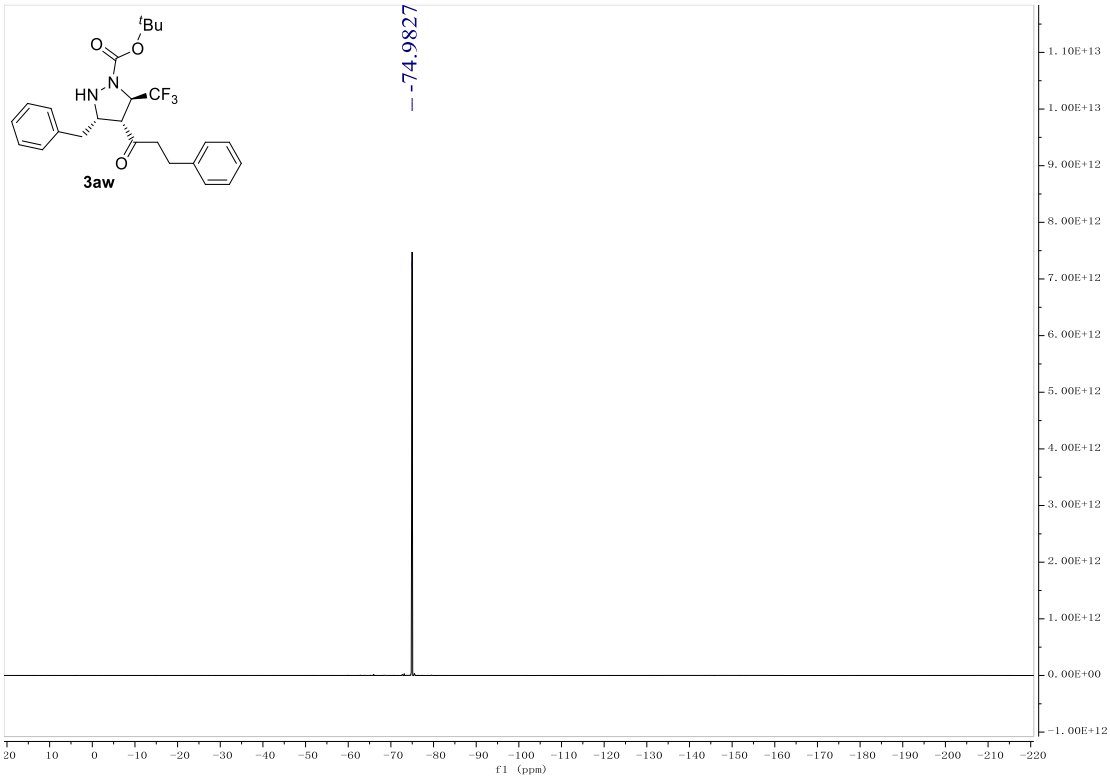
^{1}H NMR of 3aw (400 MHz, $CDCl_3$)



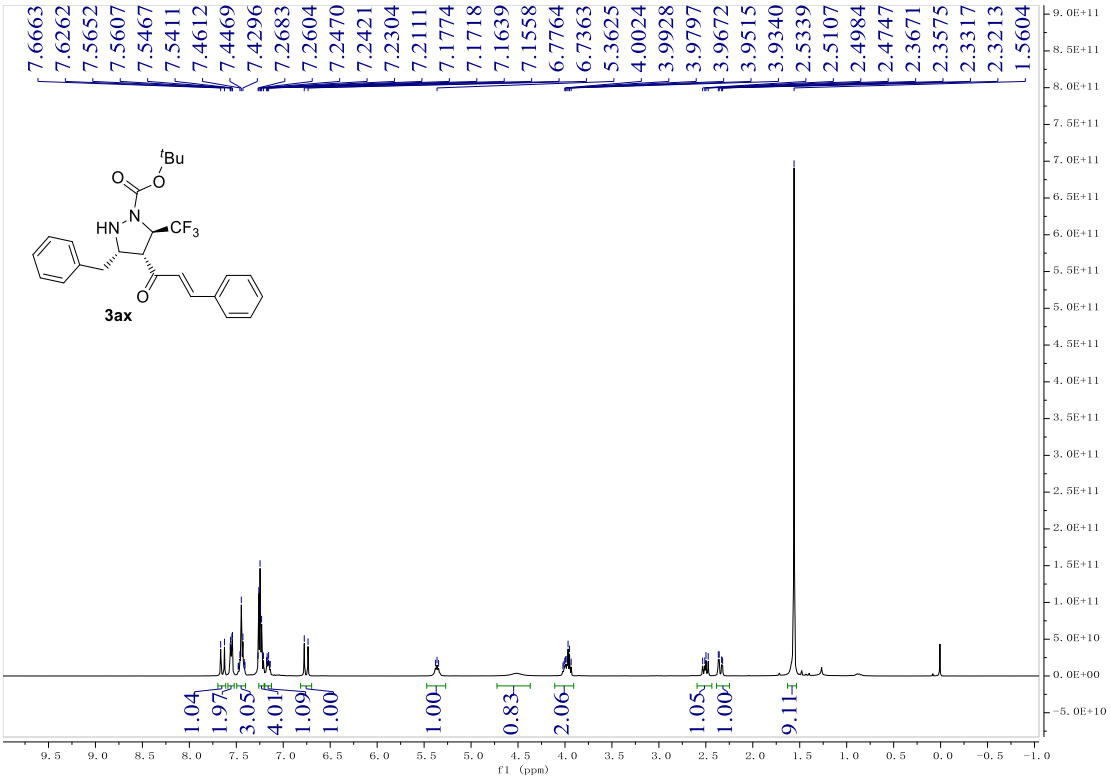
$^{13}C\{^{1}H\}$ NMR of 3aw (100 MHz, $CDCl_3$)



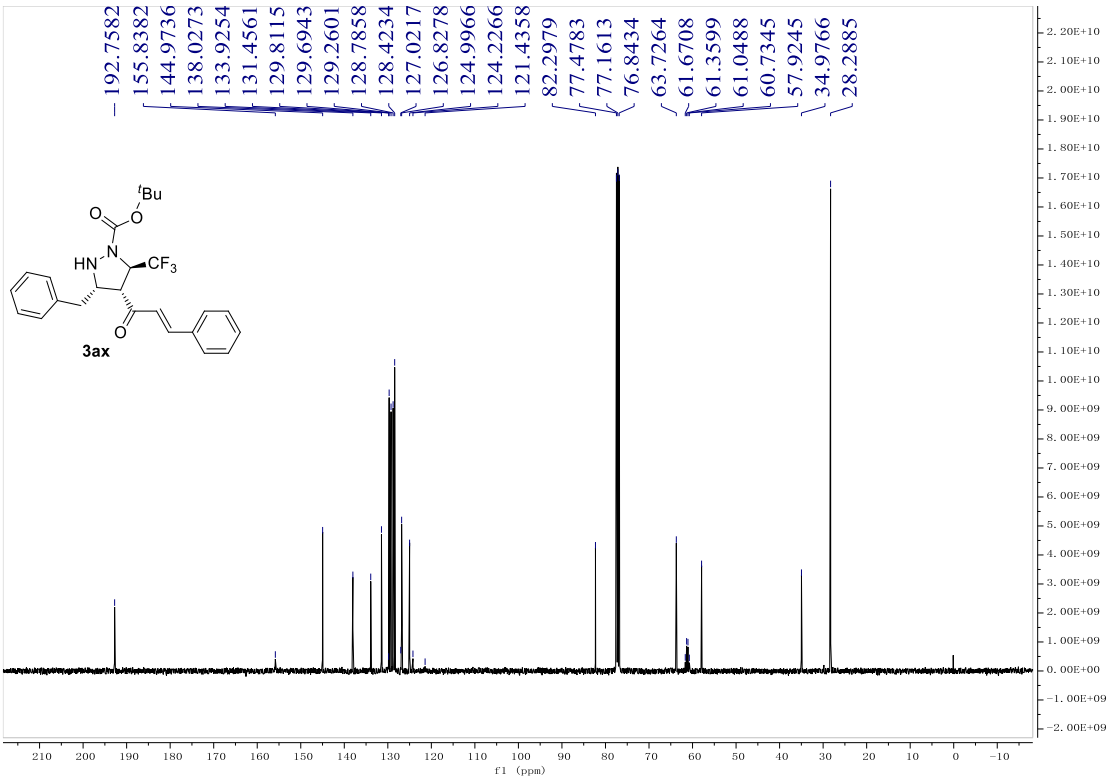
$^{19}F\{^{1}H\}$ NMR of 3aw (376 MHz, $CDCl_3$)



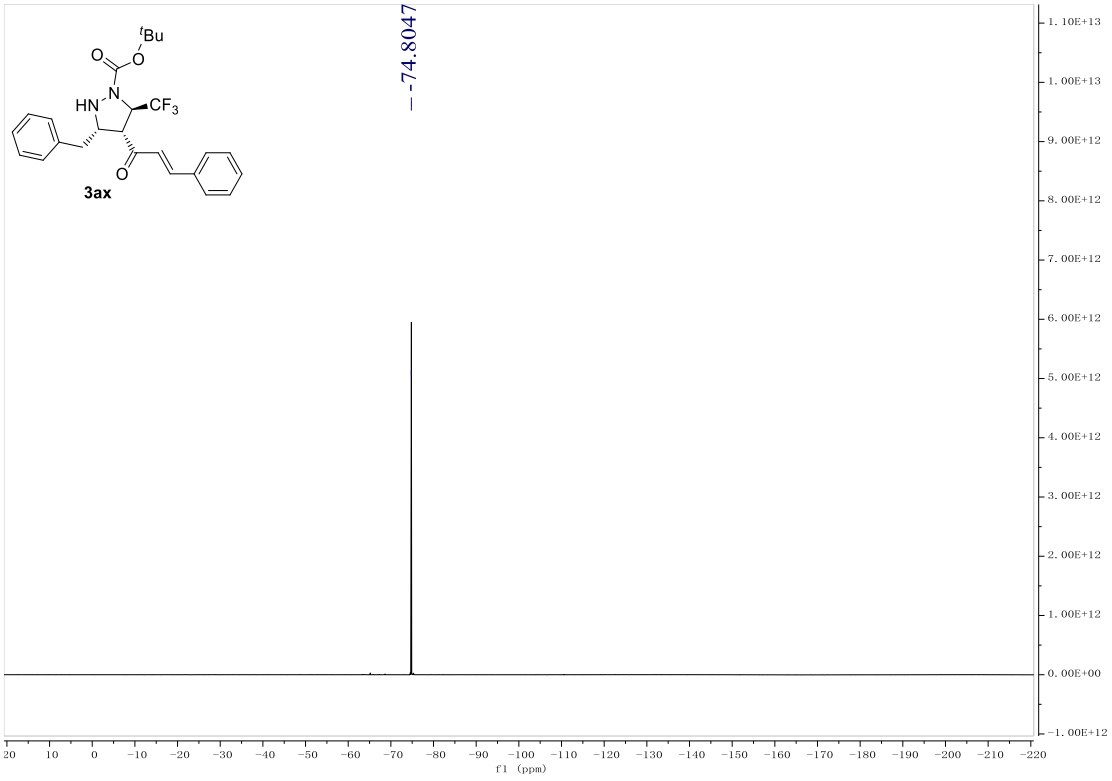
^{1}H NMR of 3ax (400 MHz, $CDCl_3$)



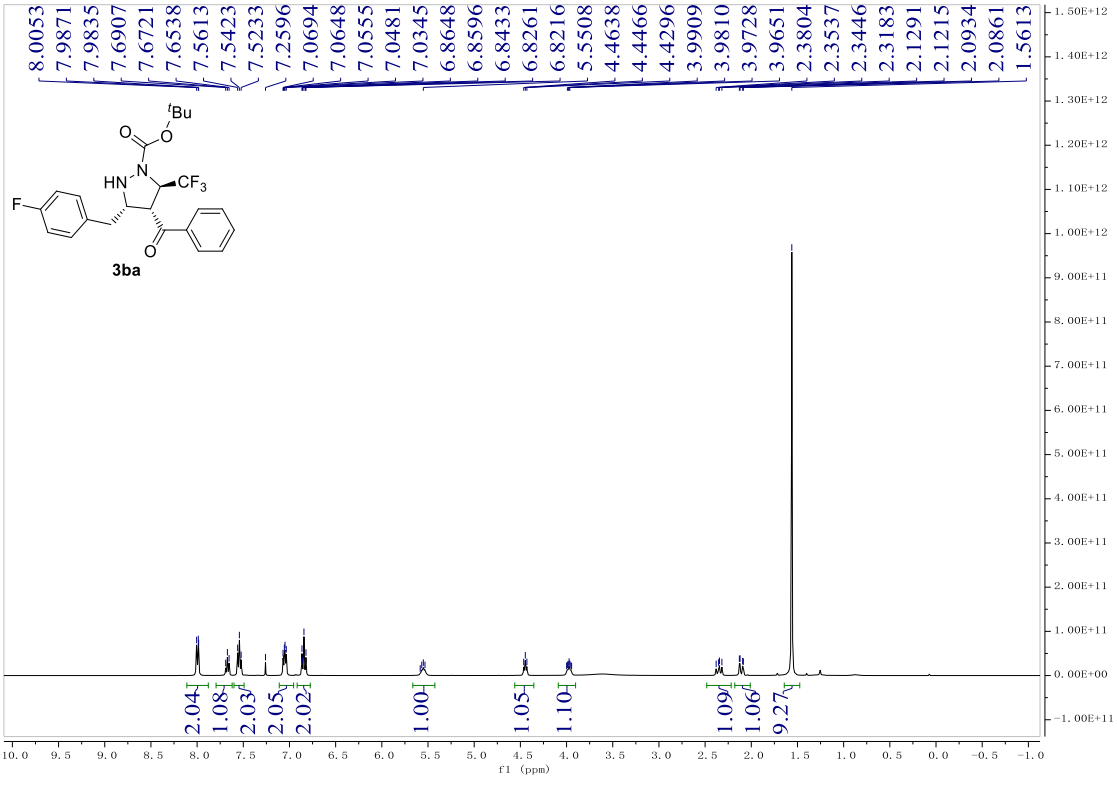
^{13}C{^{1}H} NMR of 3ax (100 MHz, $CDCl_3$)



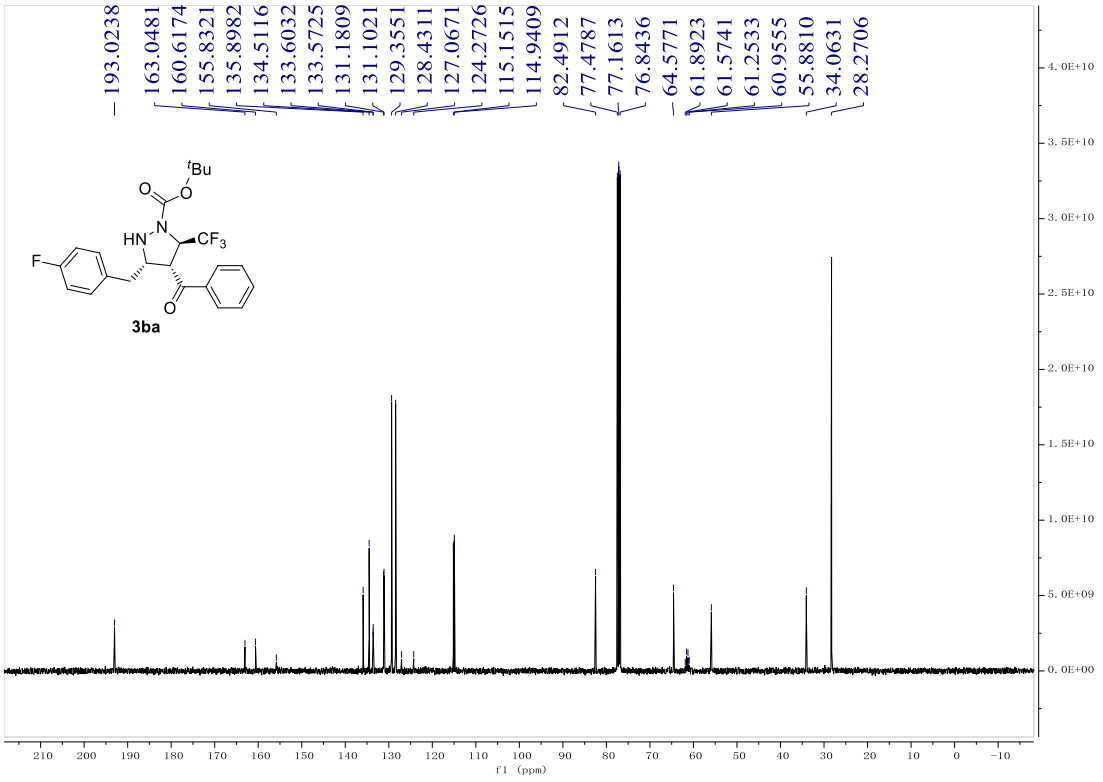
$^{19}F\{^{1}H\}$ NMR of 3ax (376 MHz, $CDCl_3$)



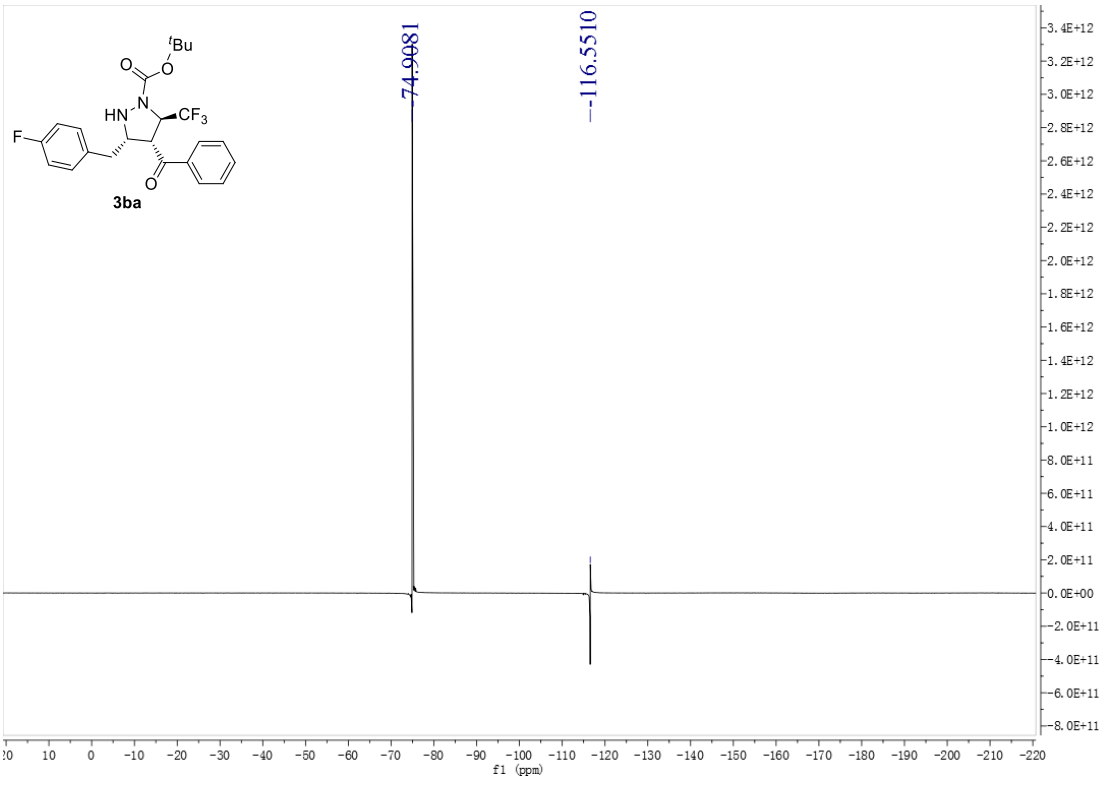
^{1}H NMR of 3ba (400 MHz, $CDCl_3$)



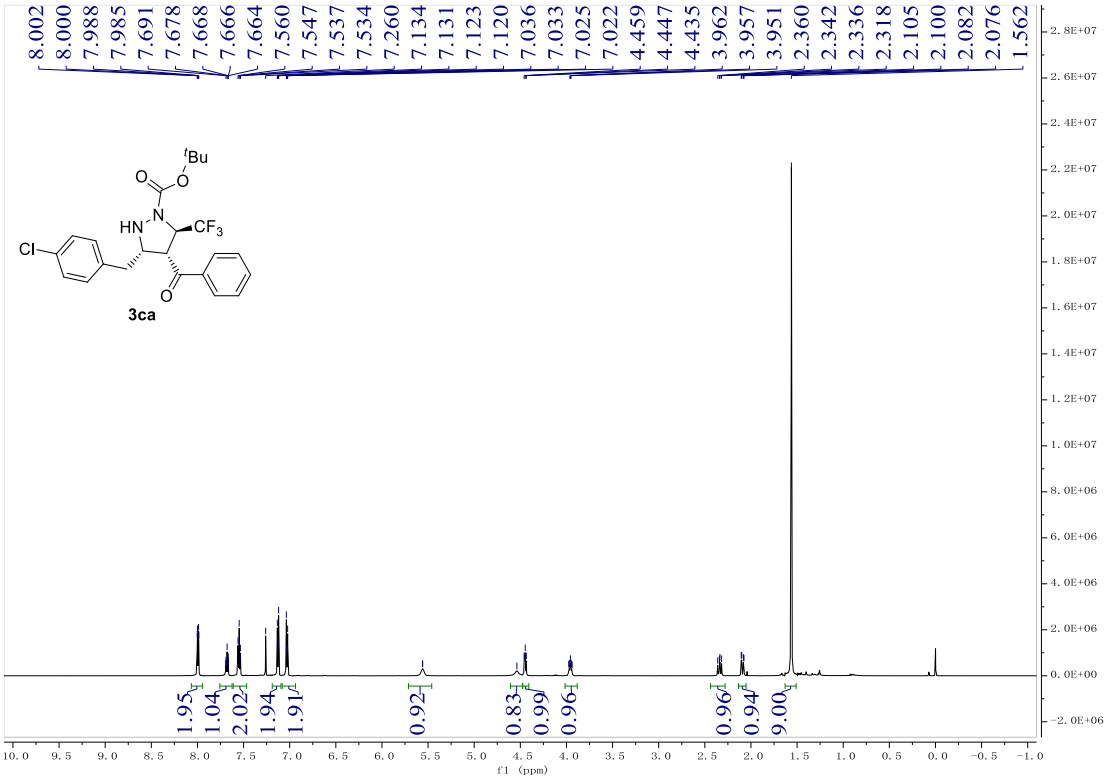
$^{13}C\{^{1}H\}$ NMR of 3ba (100 MHz, $CDCl_3$)



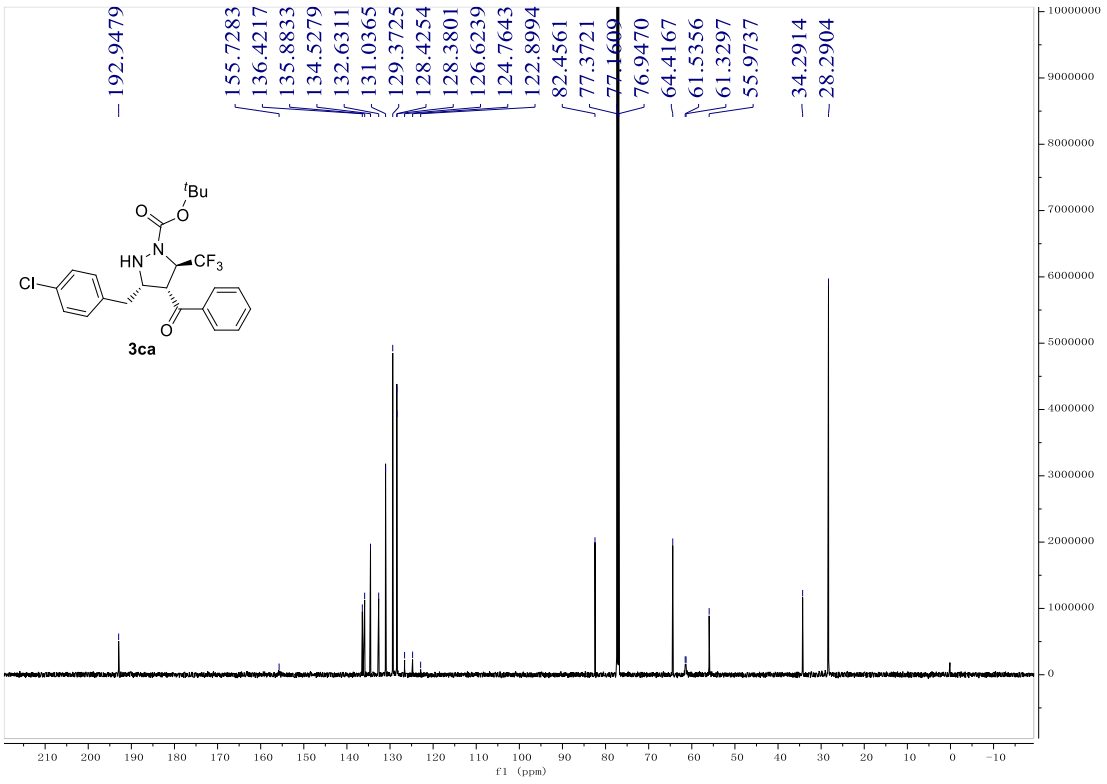
$^{19}F\{^{1}H\}$ NMR of 3ba (376 MHz, $CDCl_3$)



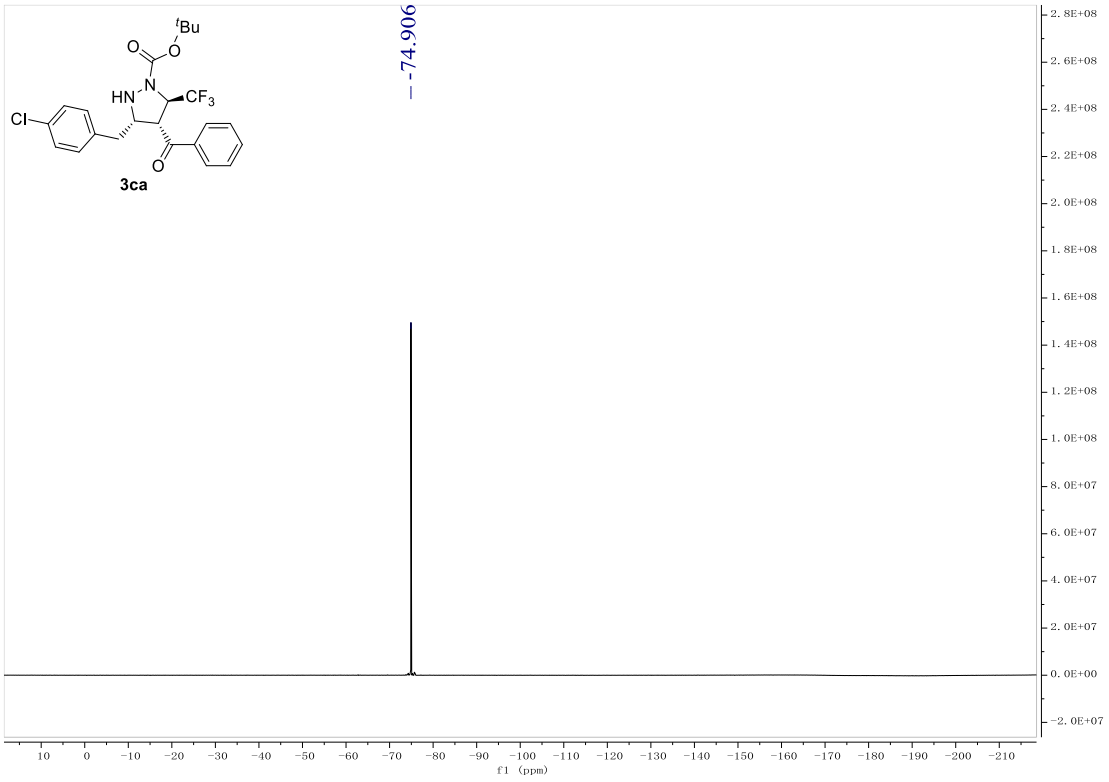
^{1}H NMR of 3ca (600 MHz, $CDCl_3$)



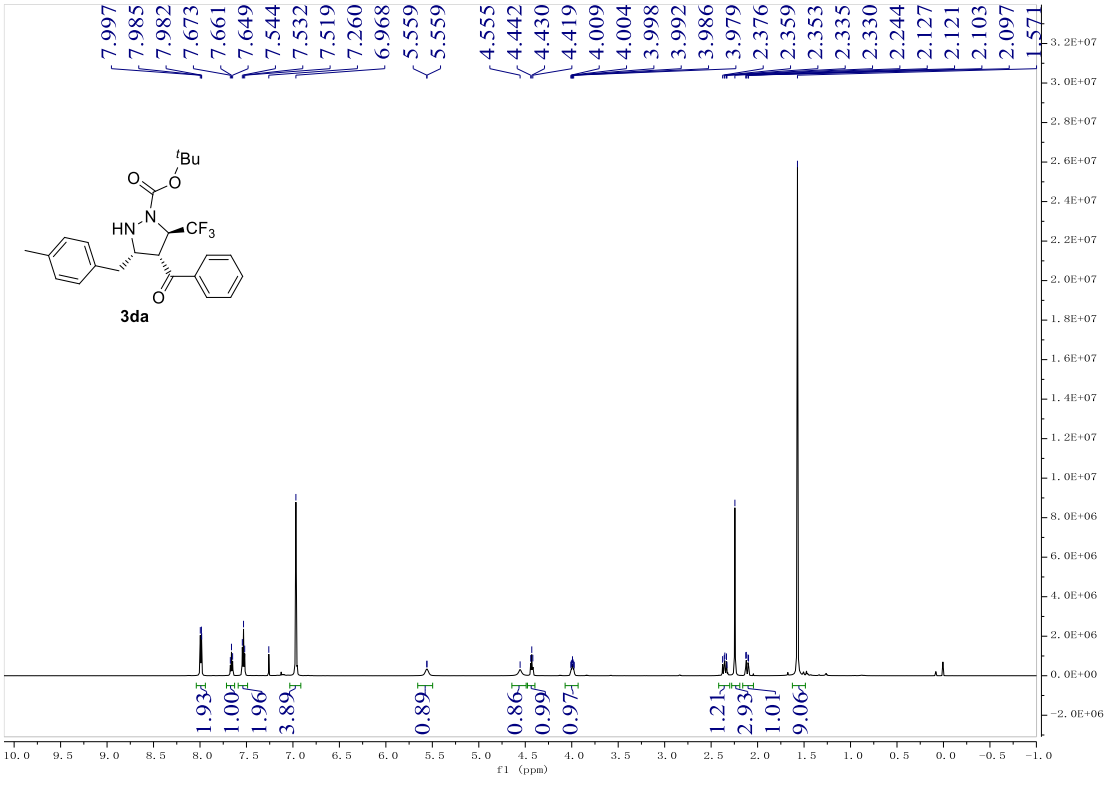
^{13}C{^{1}H} NMR of 3ca (150 MHz, $CDCl_3$)



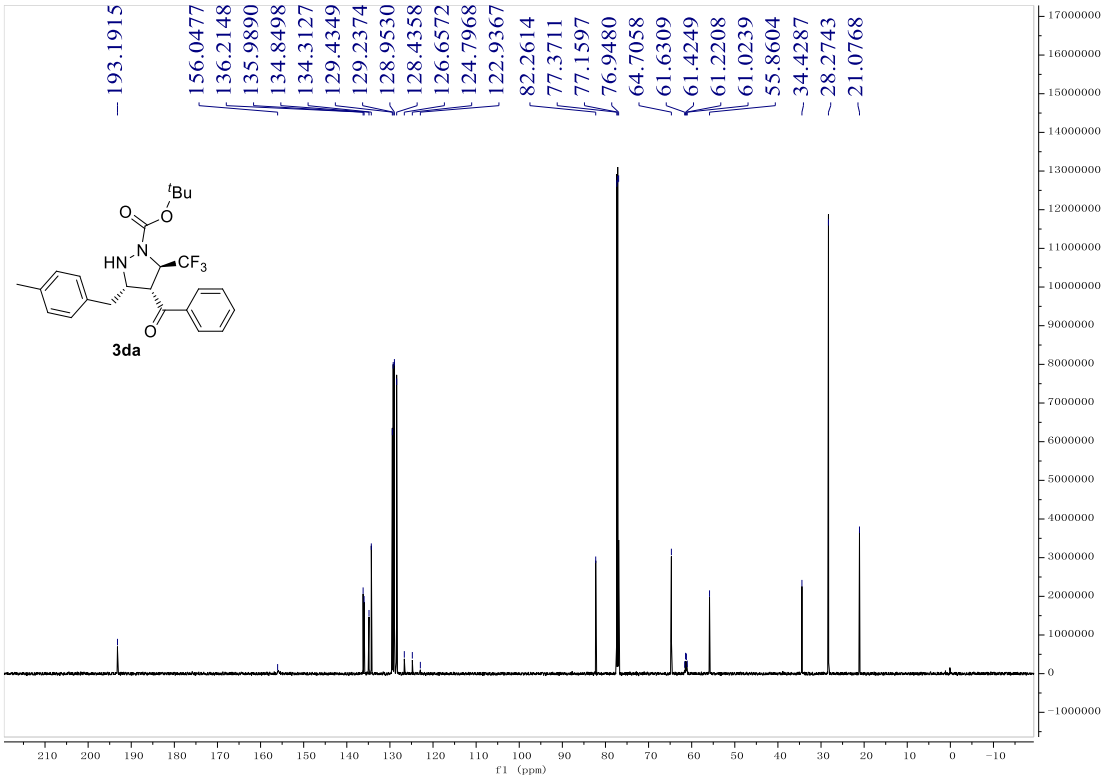
$^{19}F\{^{1}H\}$ NMR of 3ca (565 MHz, $CDCl_3$)



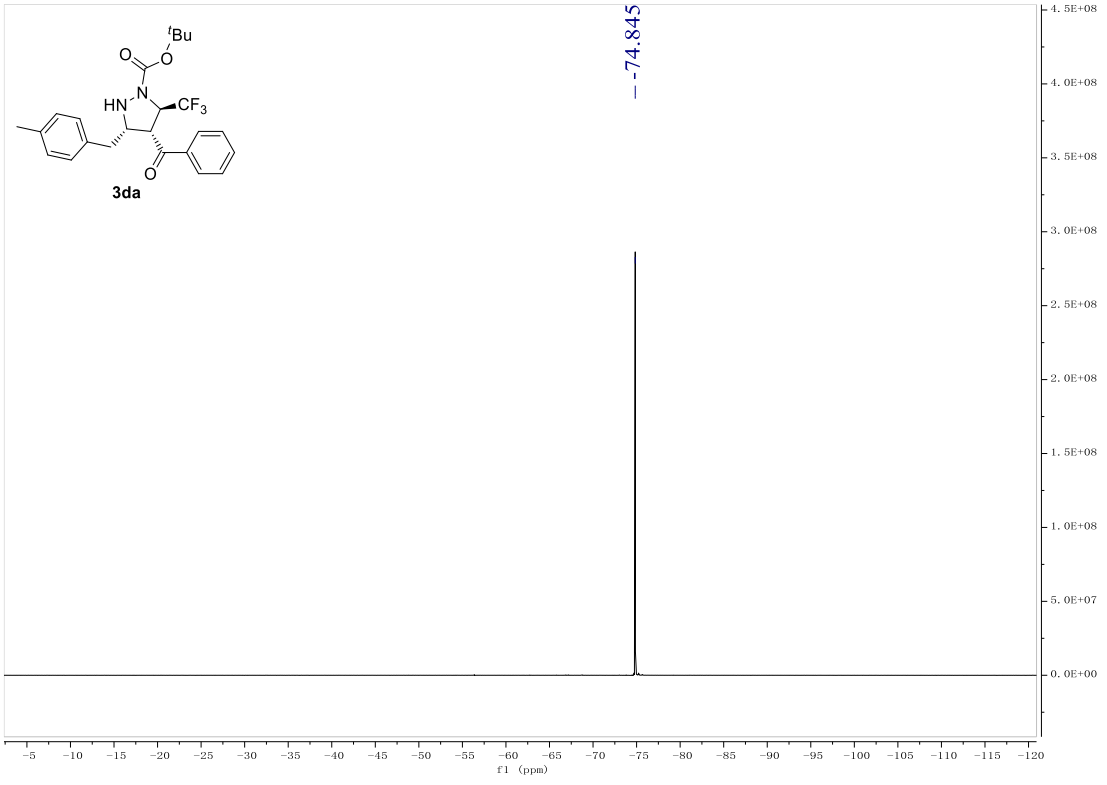
^{1}H NMR of 3da (600 MHz, $CDCl_3$)



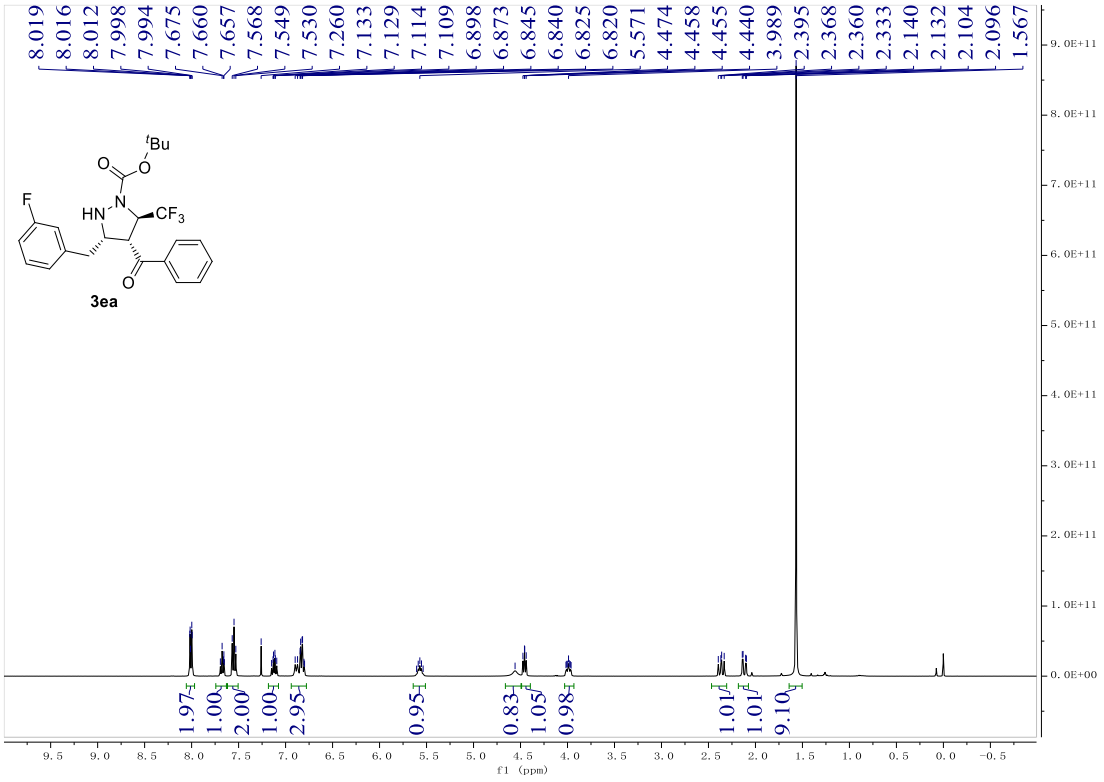
$^{13}C\{^{1}H\}$ NMR of 3da (100 MHz, $CDCl_3$)



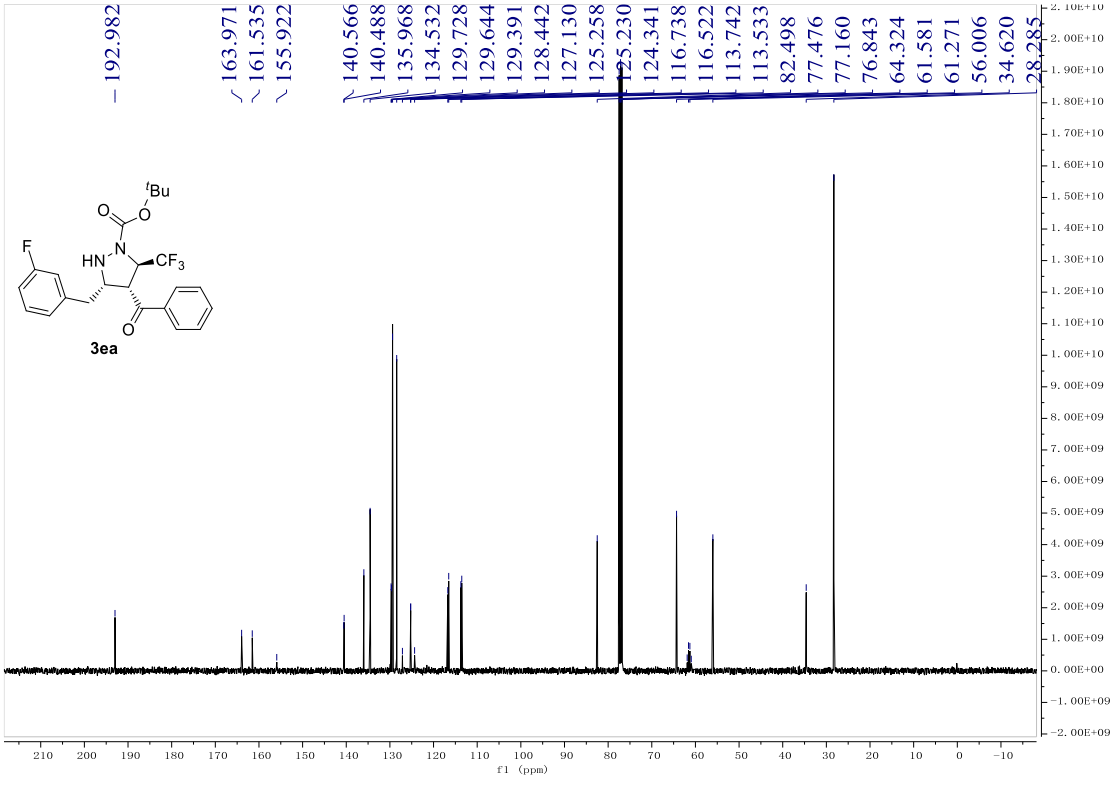
$^{19}F\{^{1}H\}$ NMR of 3da (565 MHz, $CDCl_3$)



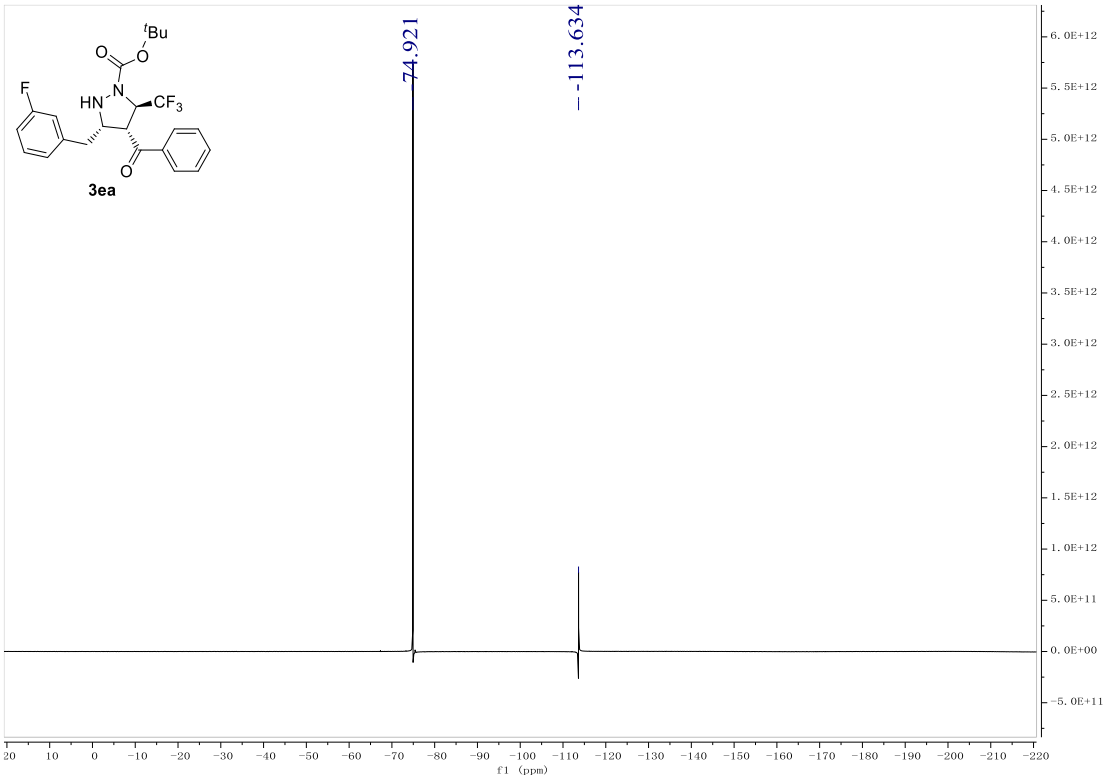
^{1}H NMR of 3ea (400 MHz, $CDCl_3$)



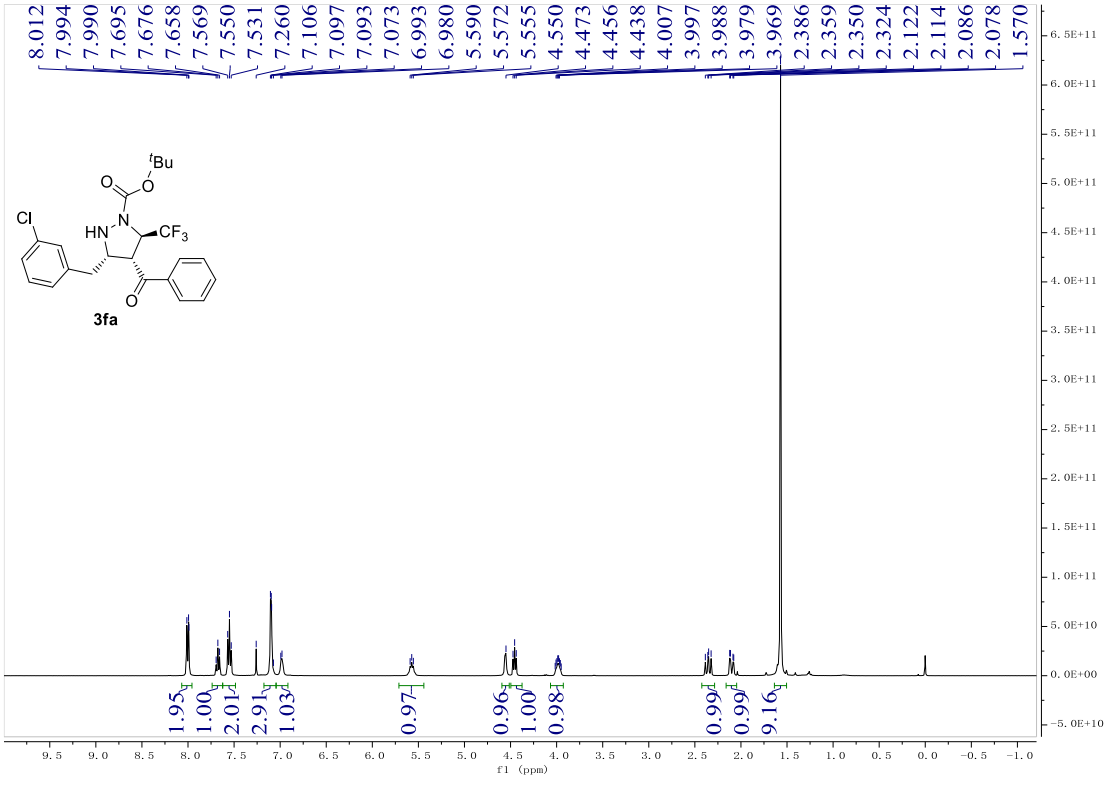
^{13}C{^{1}H} NMR of 3ea (100 MHz, $CDCl_3$)



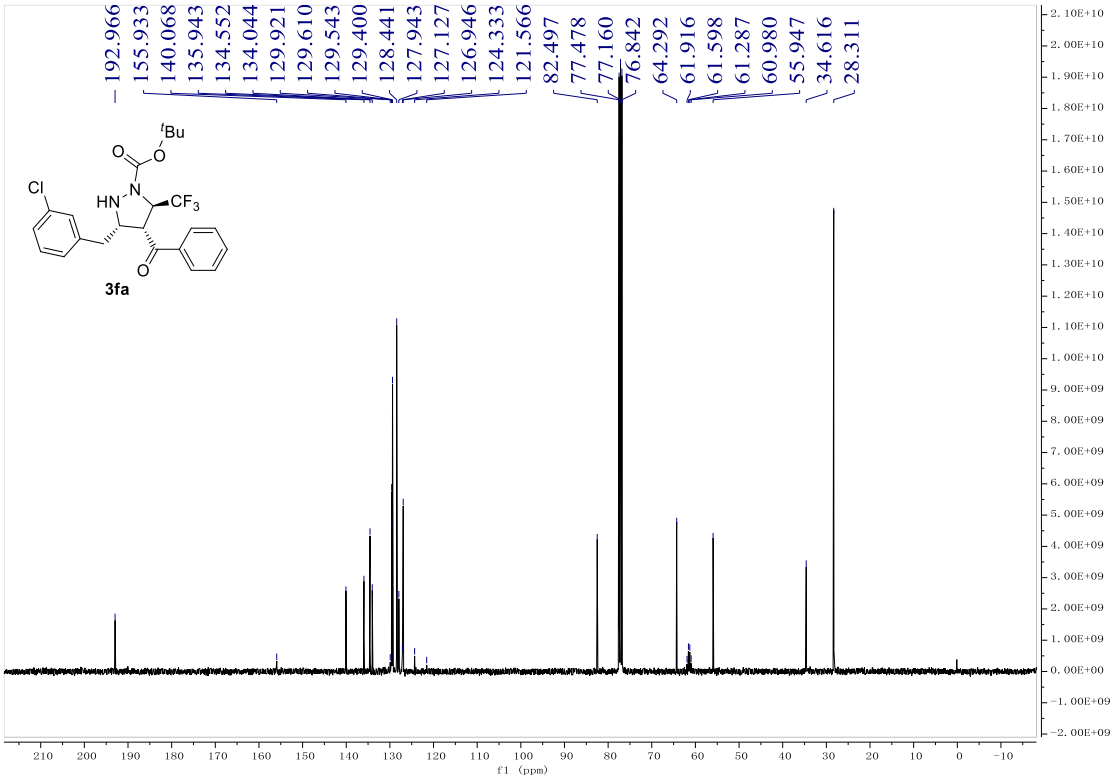
$^{19}F\{^{1}H\}$ NMR of 3ea (376 MHz, $CDCl_3$)



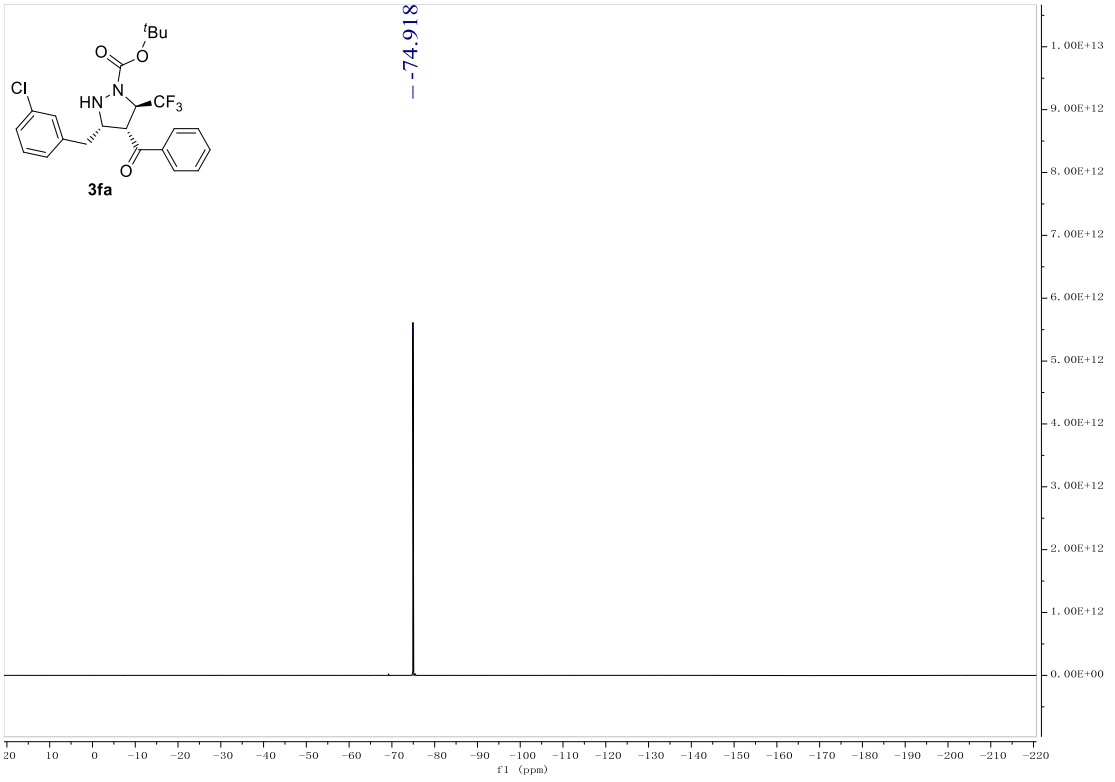
^{1}H NMR of 3fa (400 MHz, $CDCl_3$)



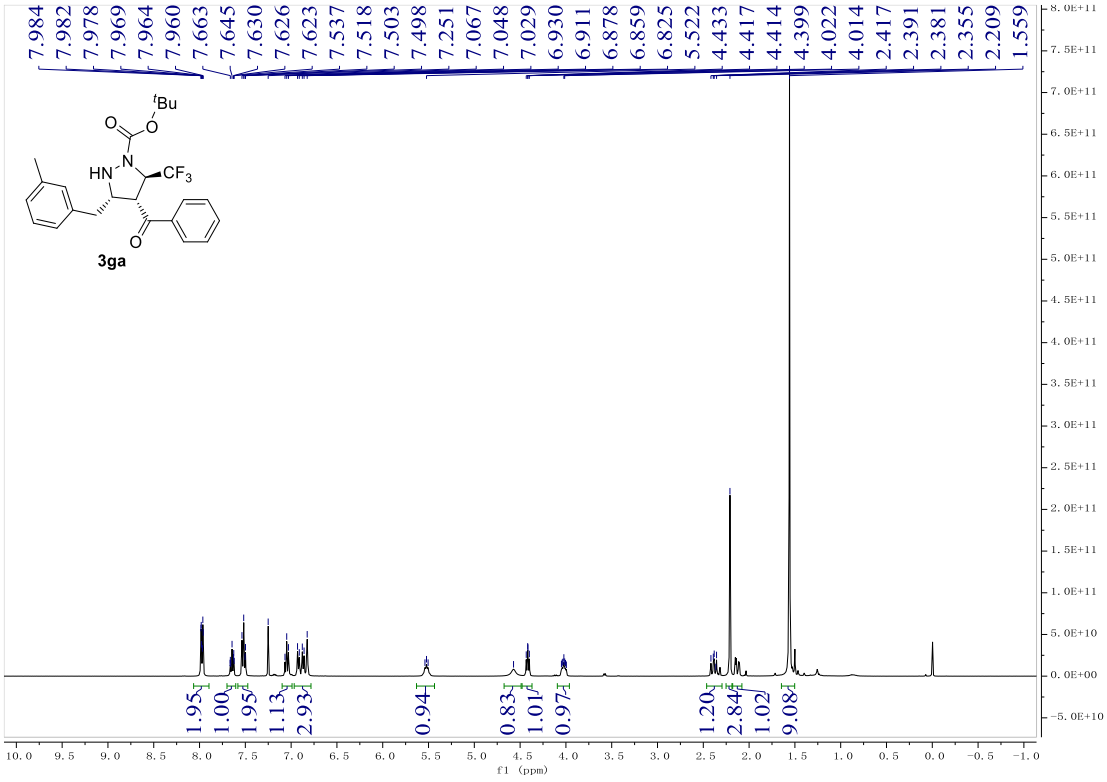
$^{13}C\{^{1}H\}$ NMR of 3fa (100 MHz, $CDCl_3$)



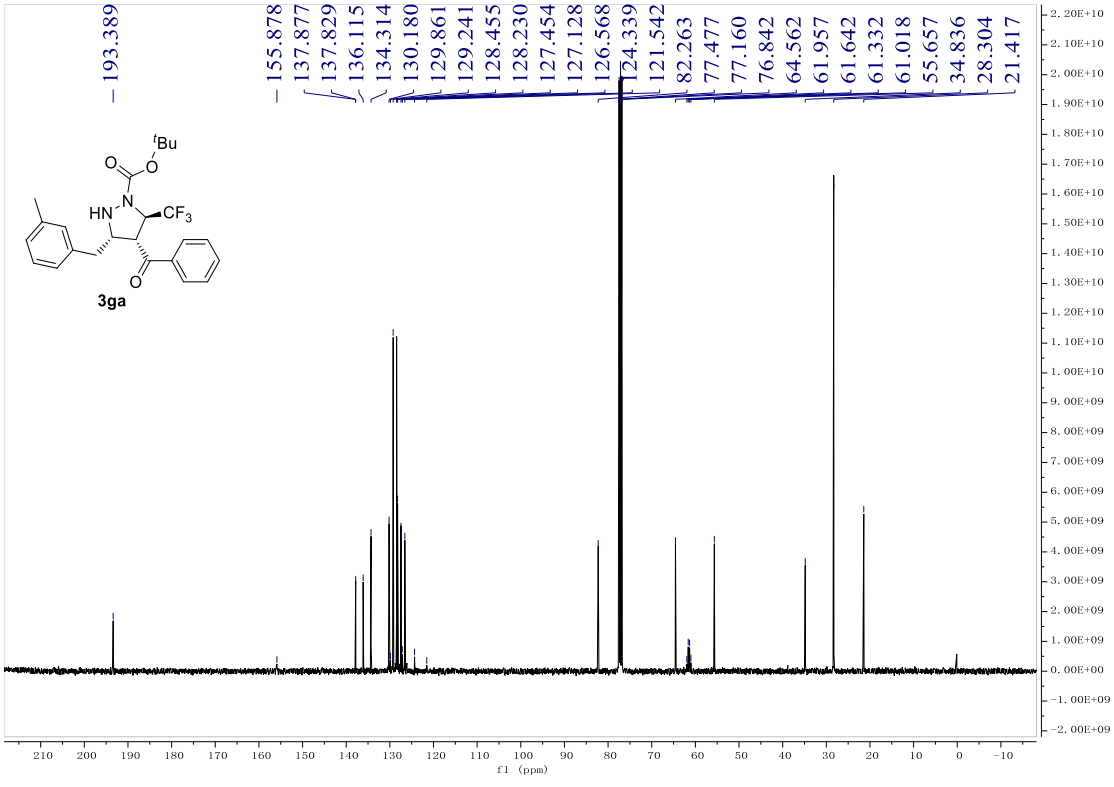
$^{19}F\{^{1}H\}$ NMR of 3fa (376 MHz, $CDCl_3$)



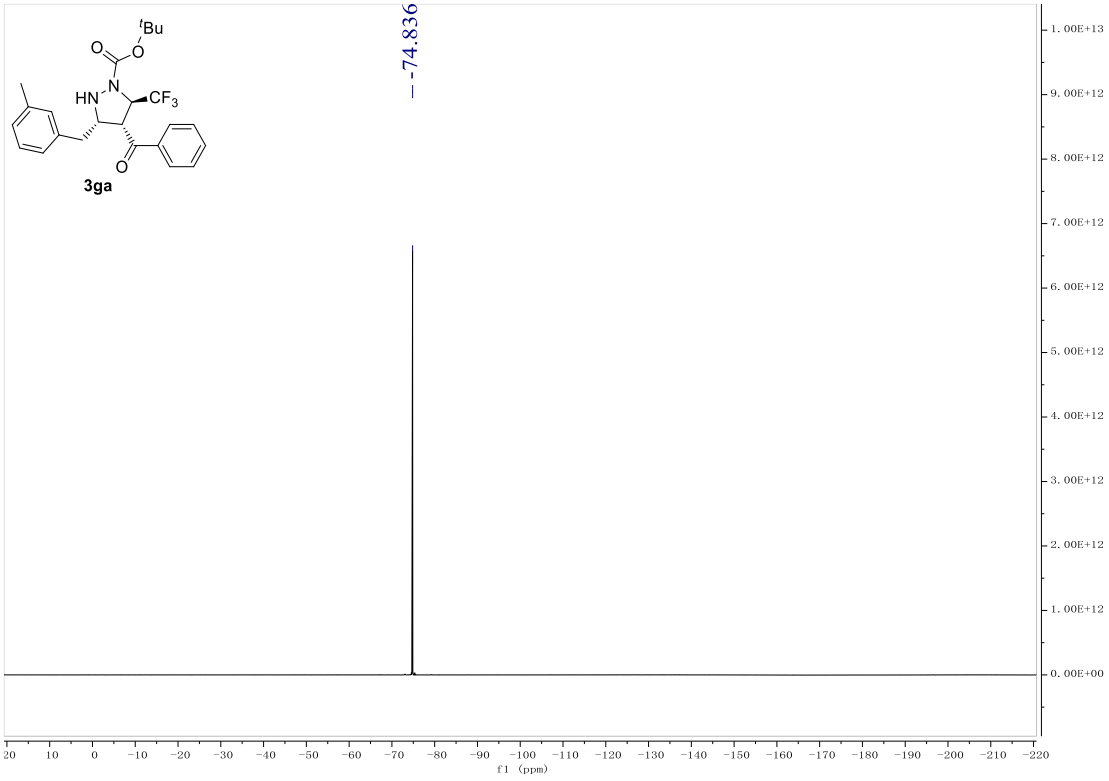
^{1}H NMR of 3ga (400 MHz, $CDCl_3$)



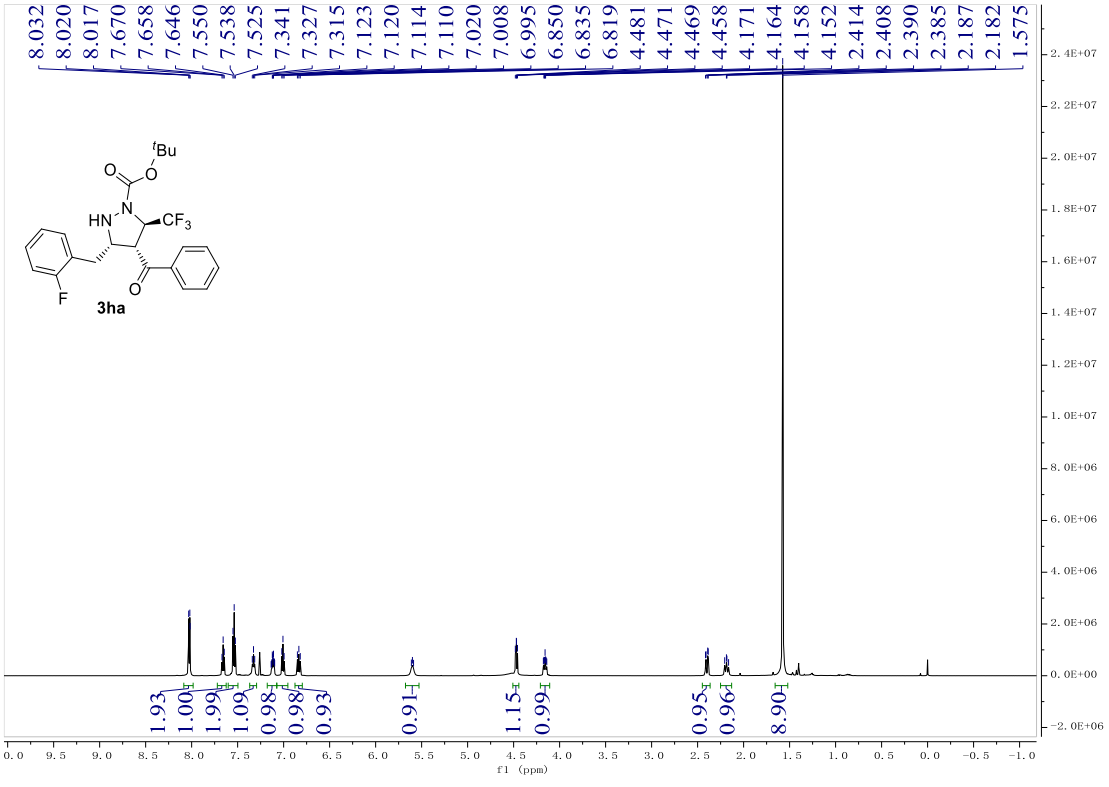
^{13}C{^{1}H} NMR of 3ga (100 MHz, $CDCl_3$)



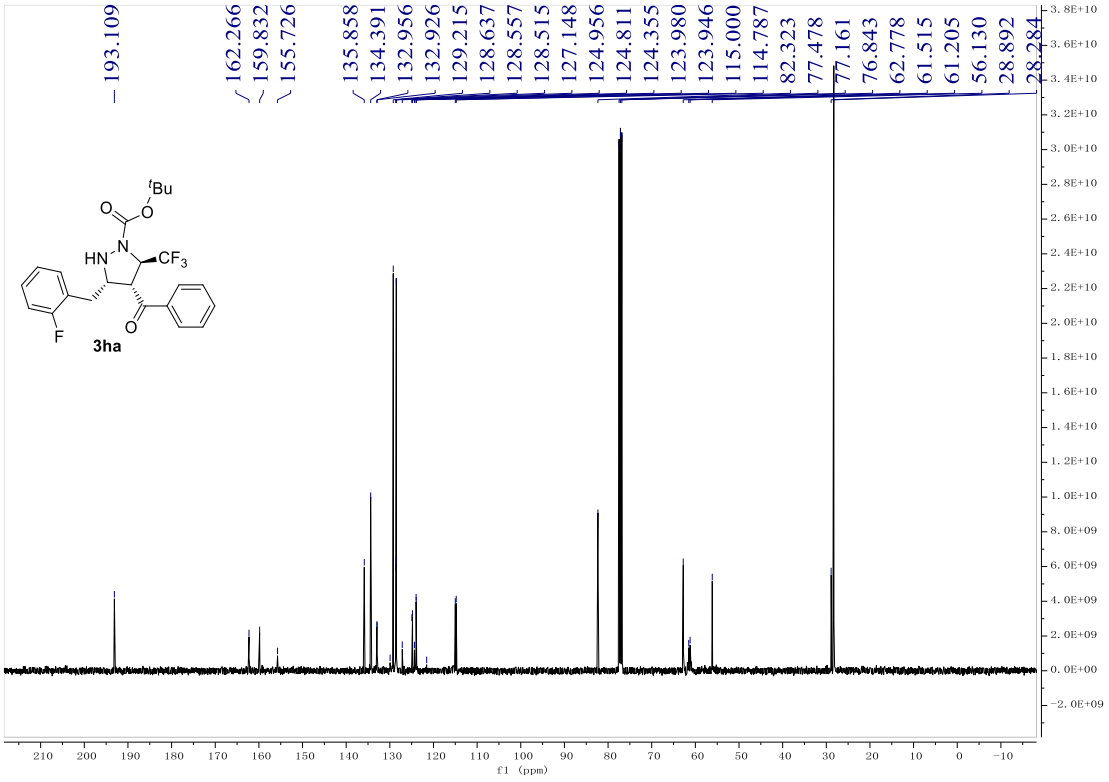
$^{19}F\{^{1}H\}$ NMR of 3ga (376 MHz, $CDCl_3$)



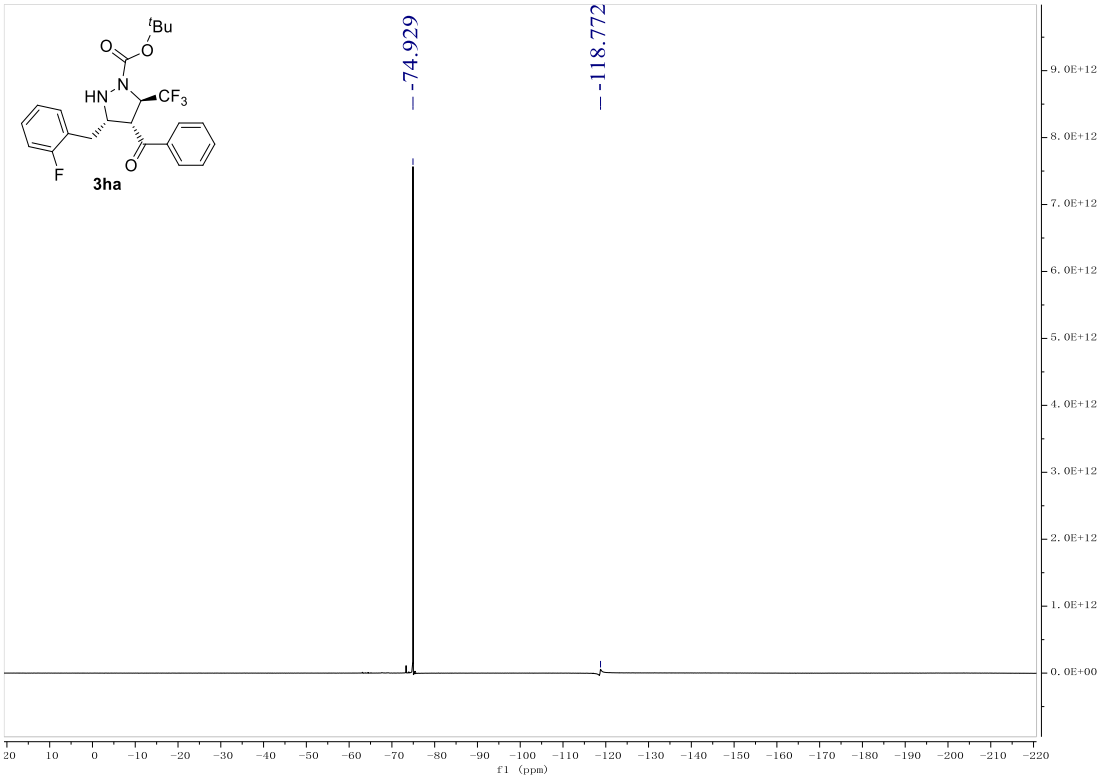
^{1}H NMR of 3ha (600 MHz, $CDCl_3$)



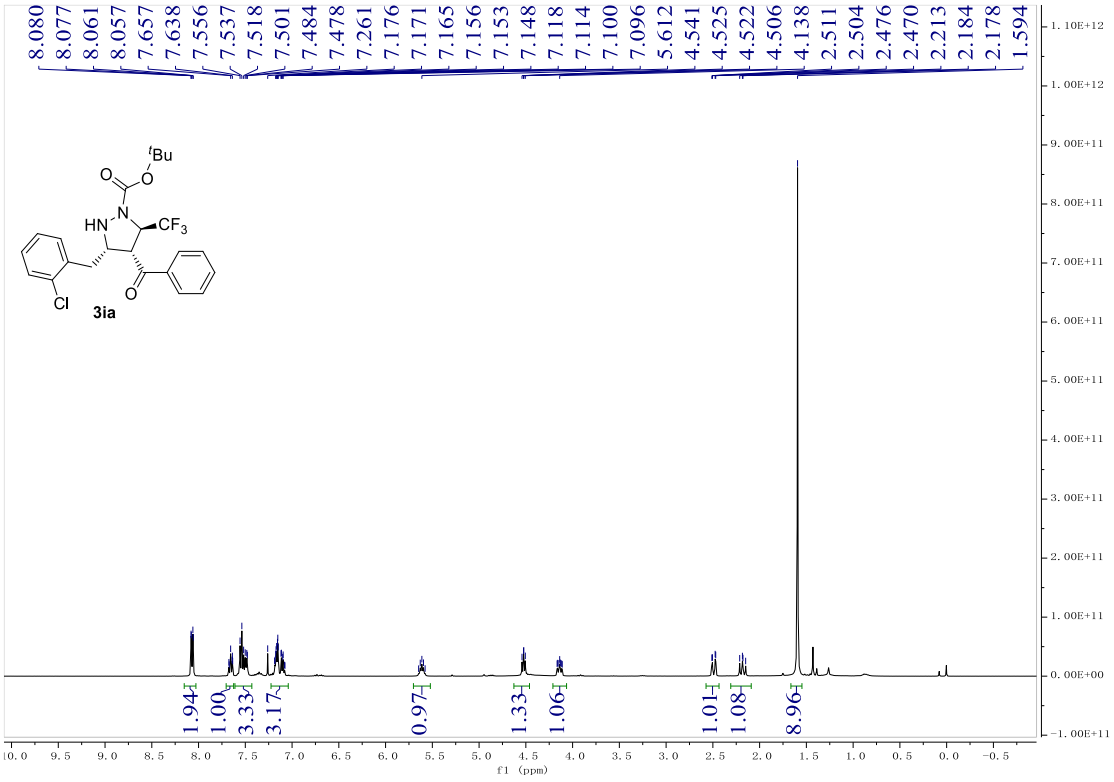
$^{13}C\{^{1}H\}$ NMR of 3ha (100 MHz, $CDCl_3$)



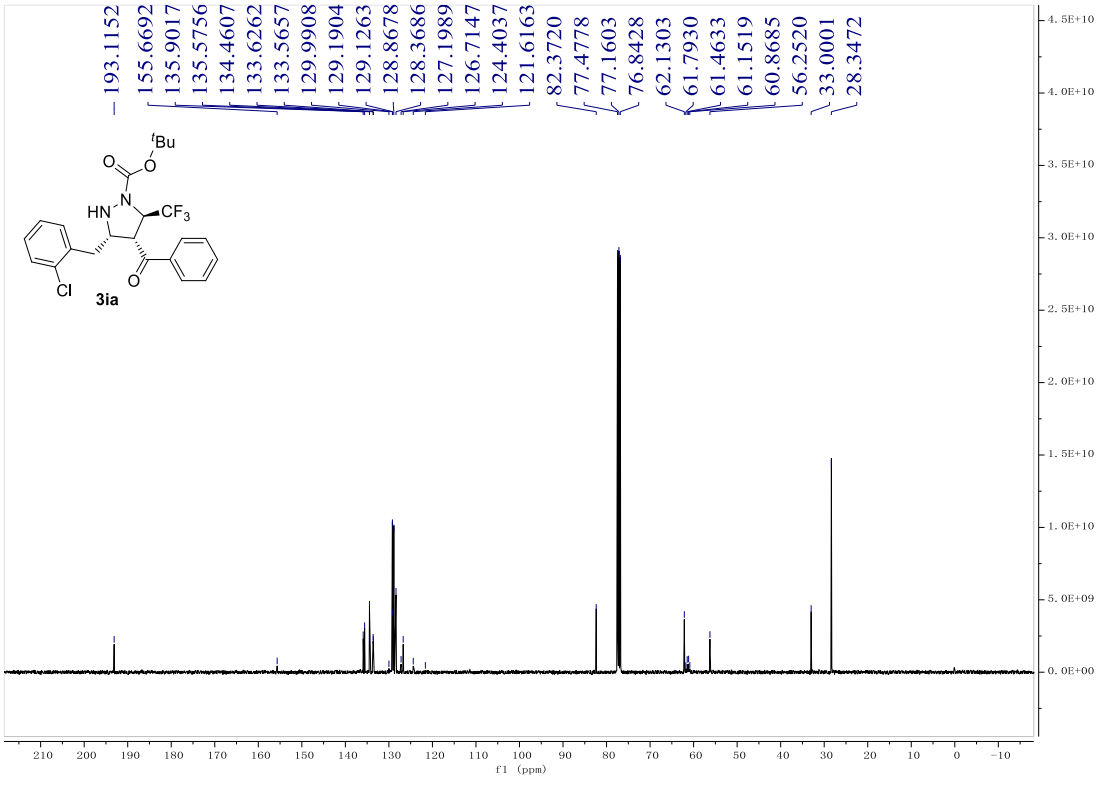
$^{19}F\{^{1}H\}$ NMR of 3ha (376 MHz, $CDCl_3$)



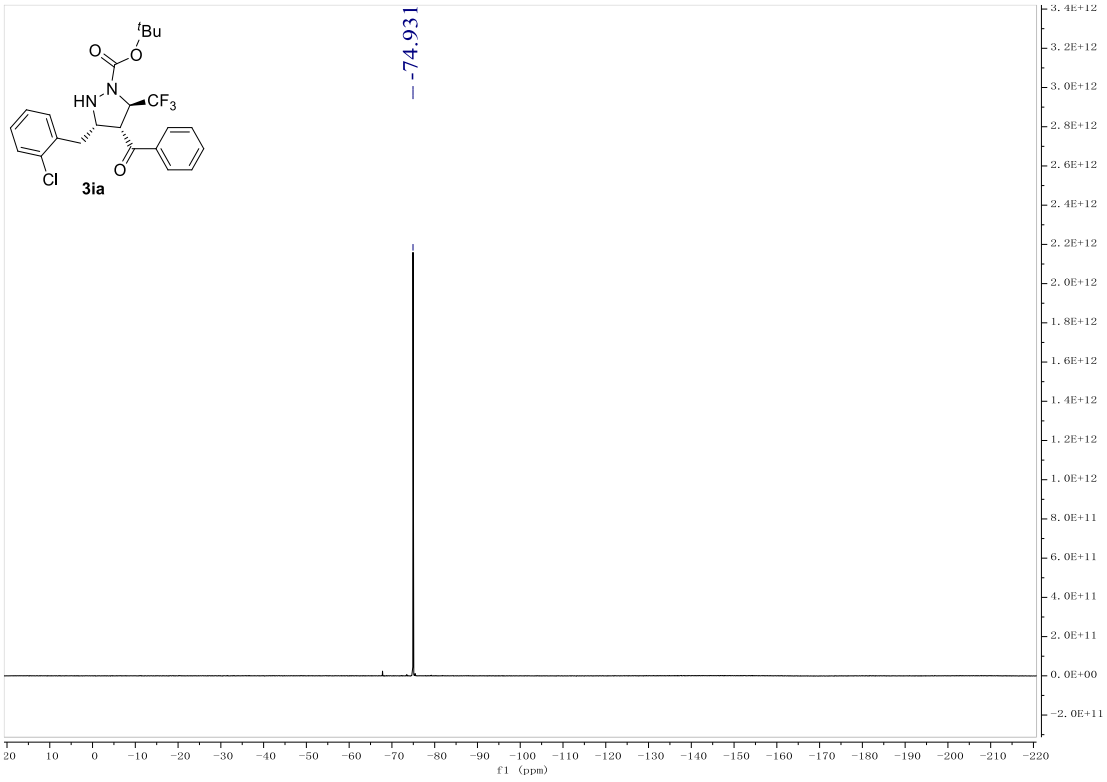
^{1}H NMR of 3ia (400 MHz, $CDCl_3$)



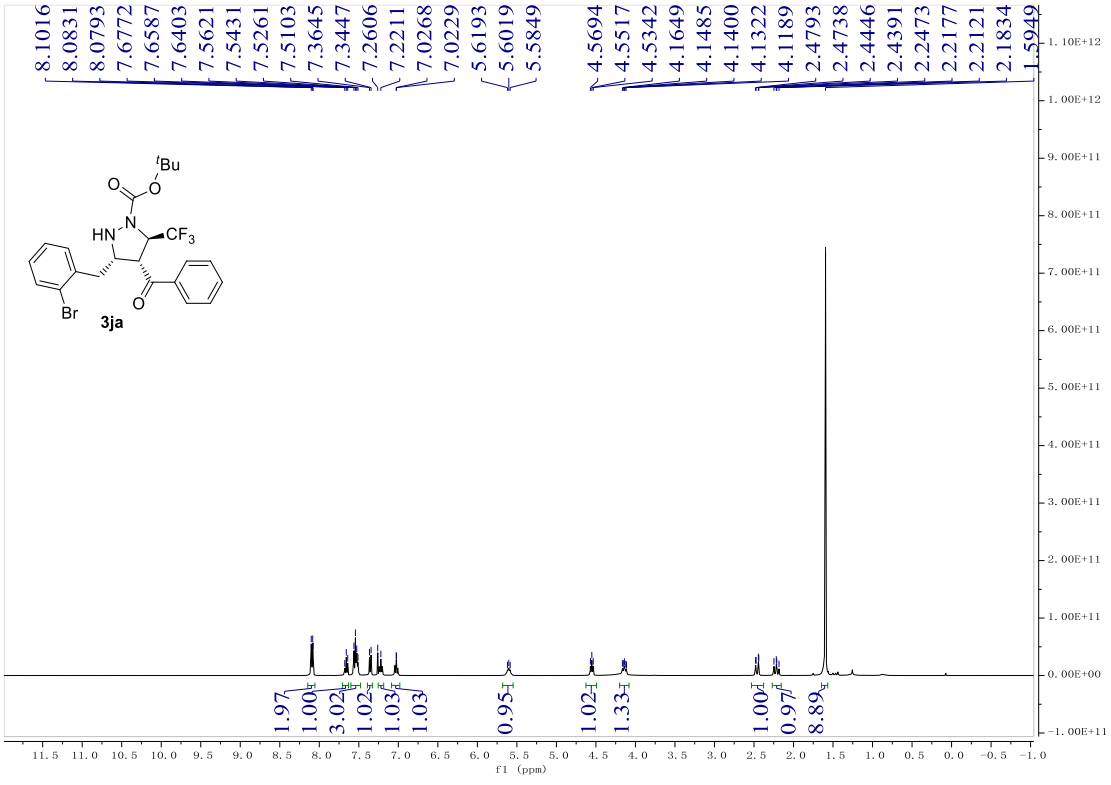
^{13}C{^{1}H} NMR of 3ia (100 MHz, $CDCl_3$)



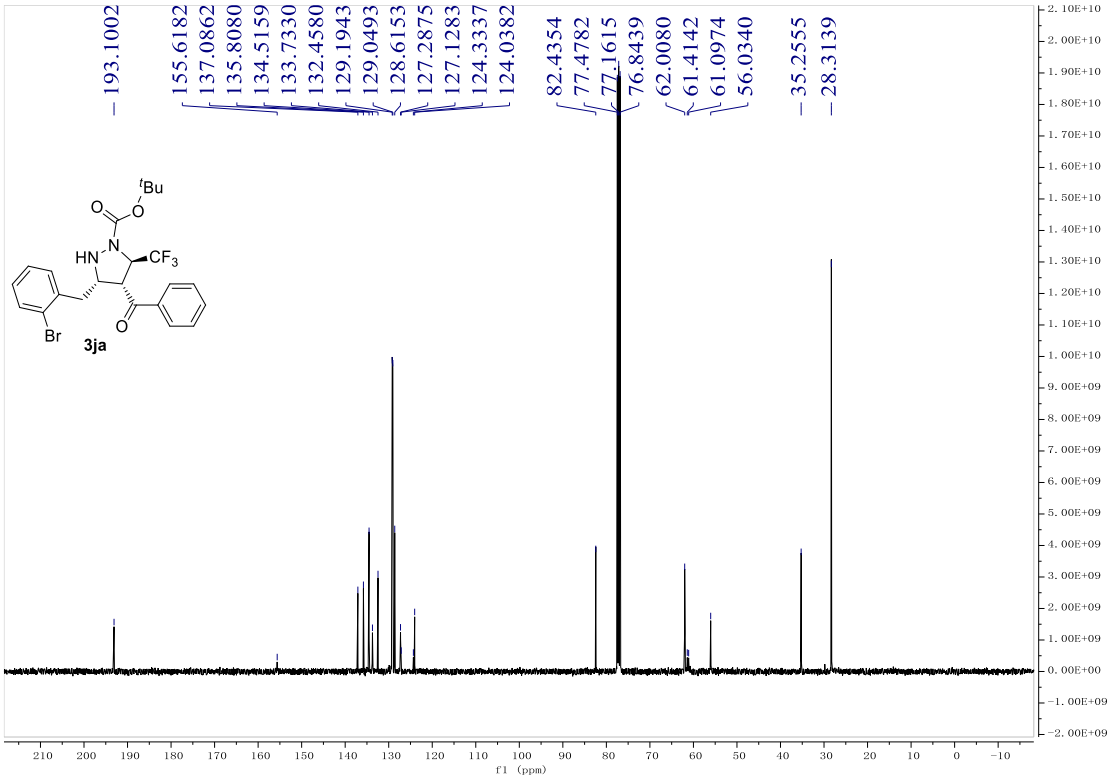
$^{19}F\{^{1}H\}$ NMR of 3ia (376 MHz, $CDCl_3$)



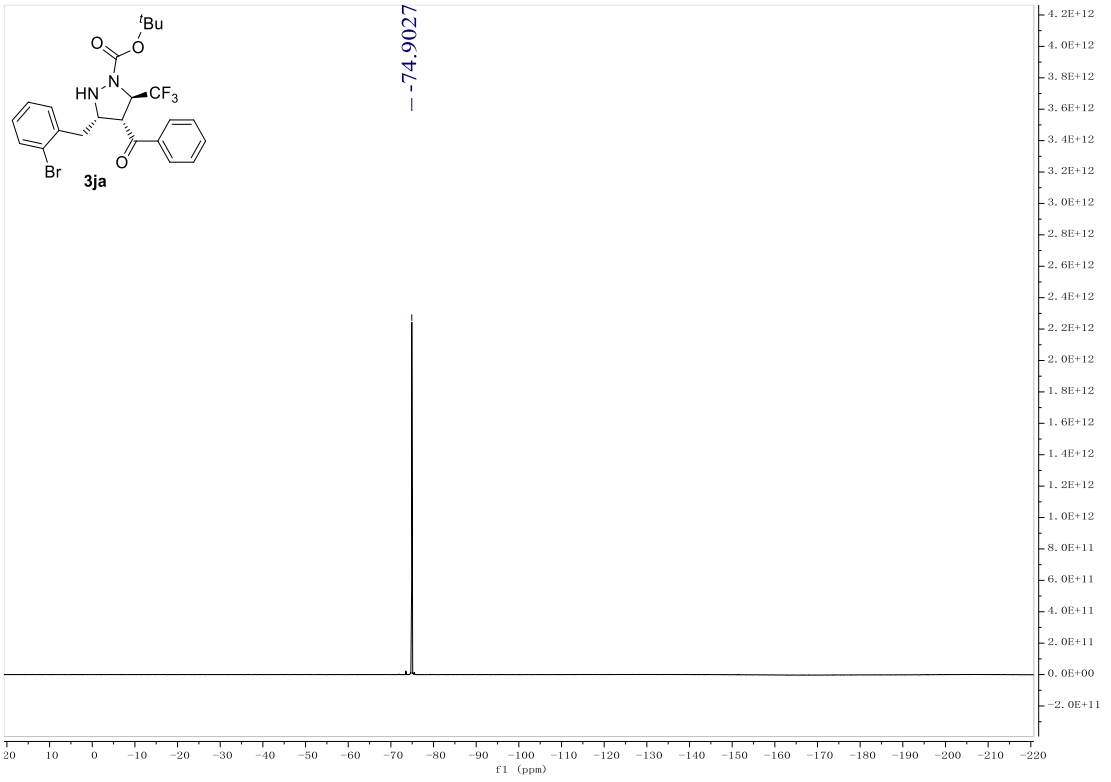
^{1}H NMR of 3ja (400 MHz, $CDCl_3$)



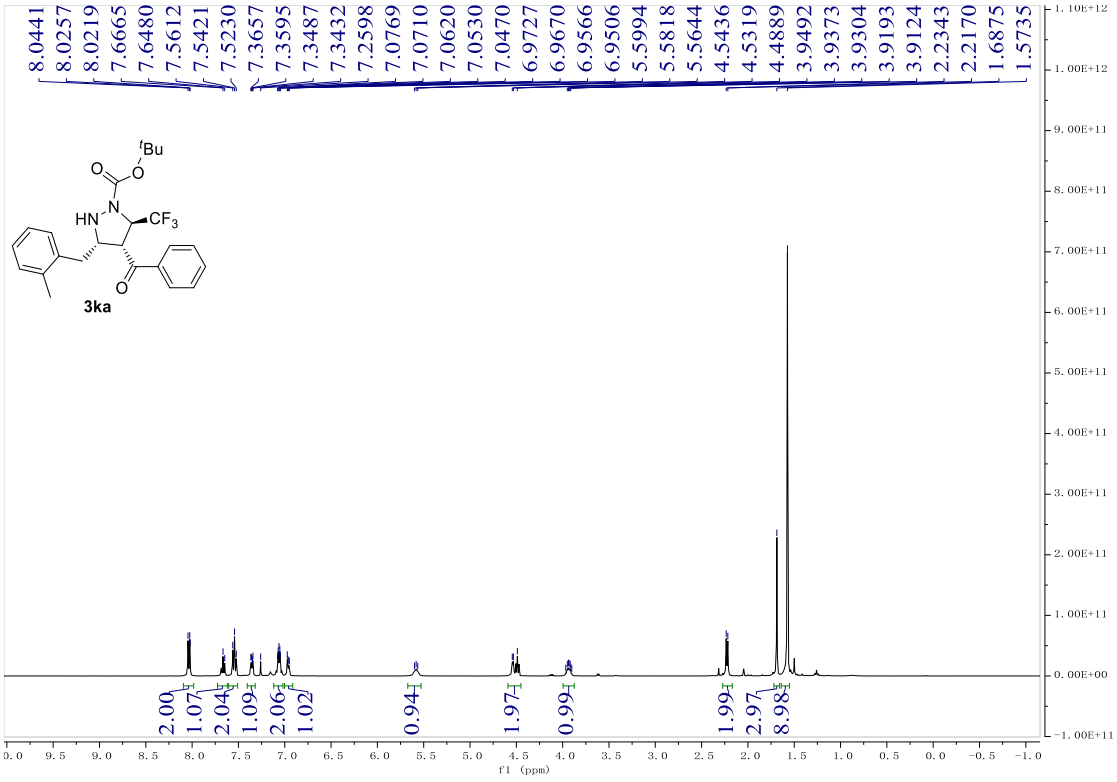
$^{13}C\{^{1}H\}$ NMR of 3ja (100 MHz, $CDCl_3$)



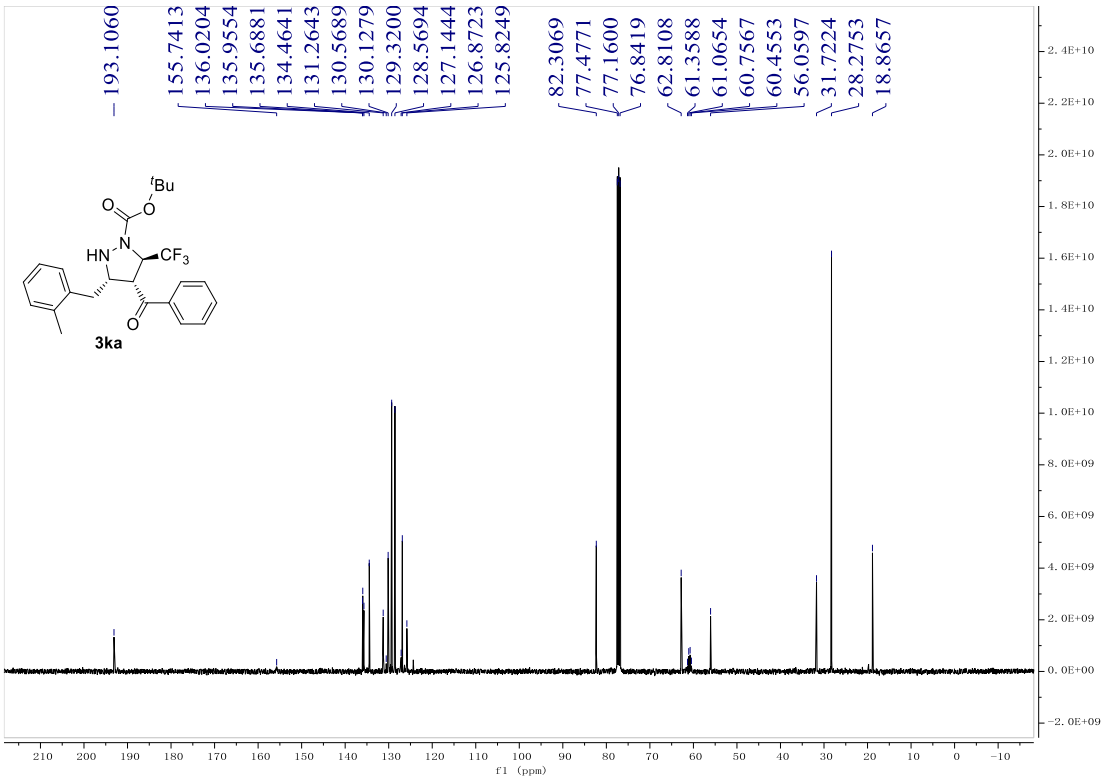
$^{19}F\{^{1}H\}$ NMR of 3ja (376 MHz, $CDCl_3$)



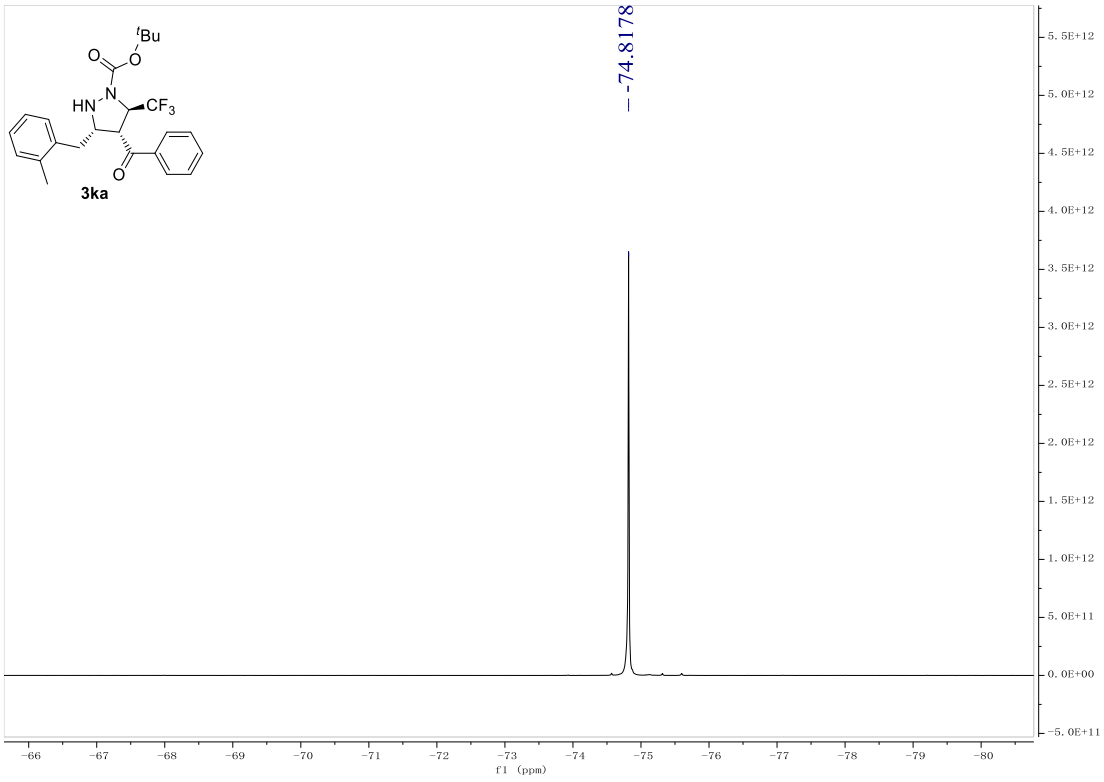
^{1}H NMR of 3ka (400 MHz, $CDCl_3$)



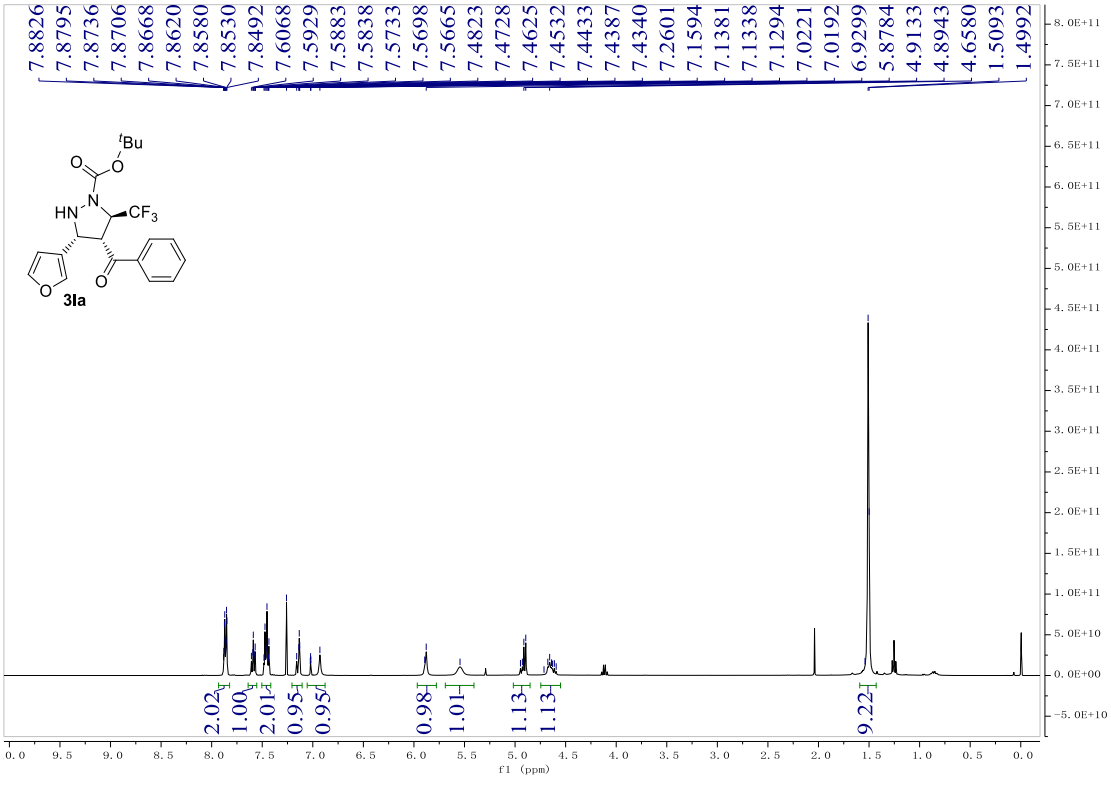
^{13}C{^{1}H} NMR of 3ka (100 MHz, $CDCl_3$)



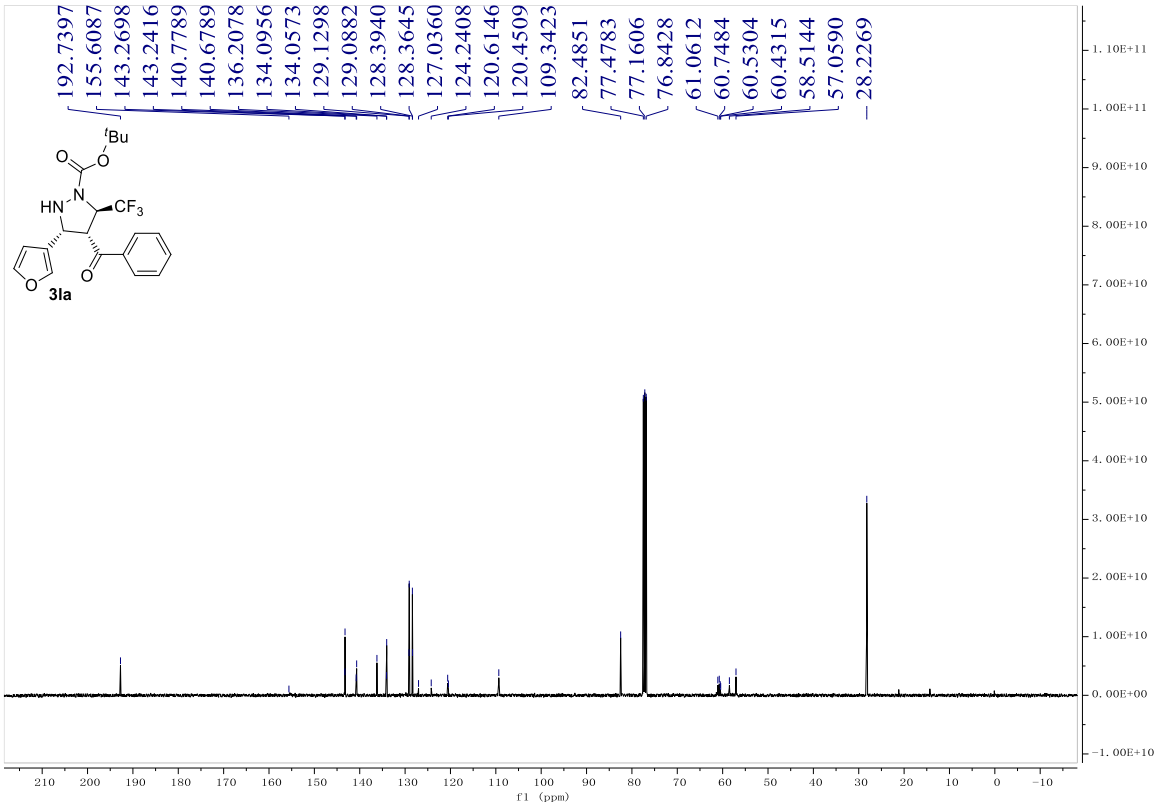
$^{19}F\{^{1}H\}$ NMR of 3ka (376 MHz, $CDCl_3$)



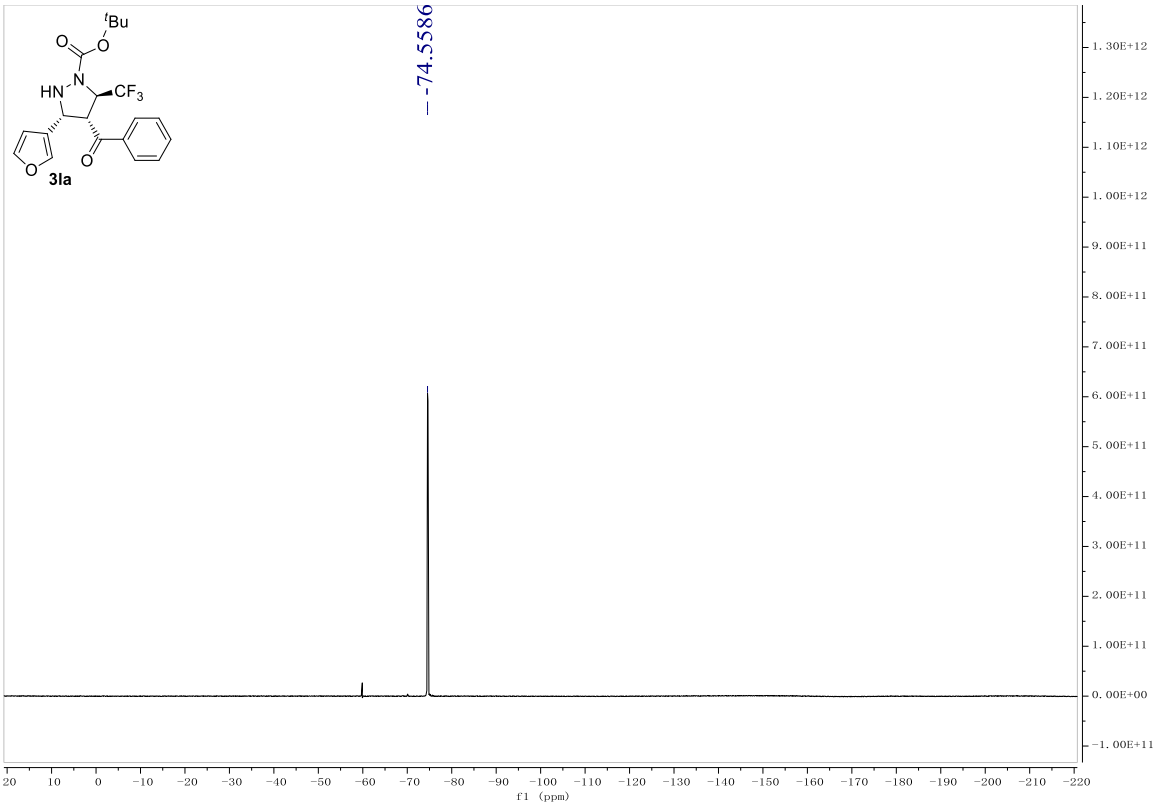
^{1}H NMR of 3la (400 MHz, $CDCl_3$)



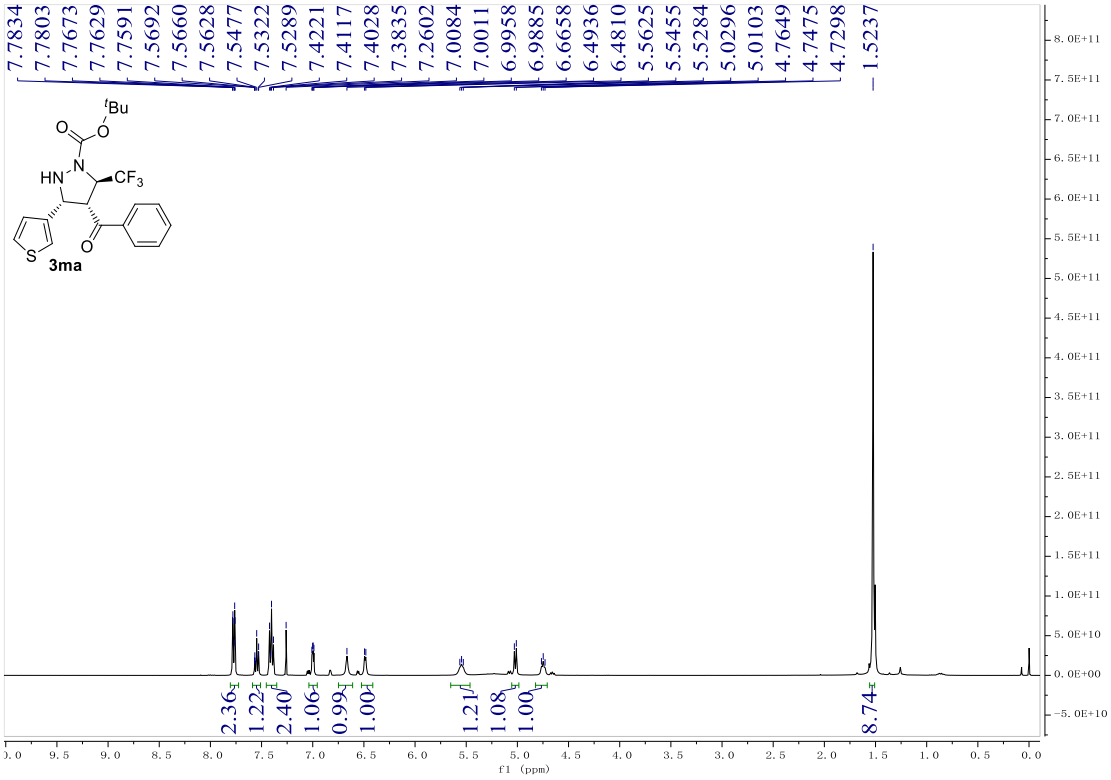
$^{13}C\{^{1}H\}$ NMR of 3la (100 MHz, $CDCl_3$)



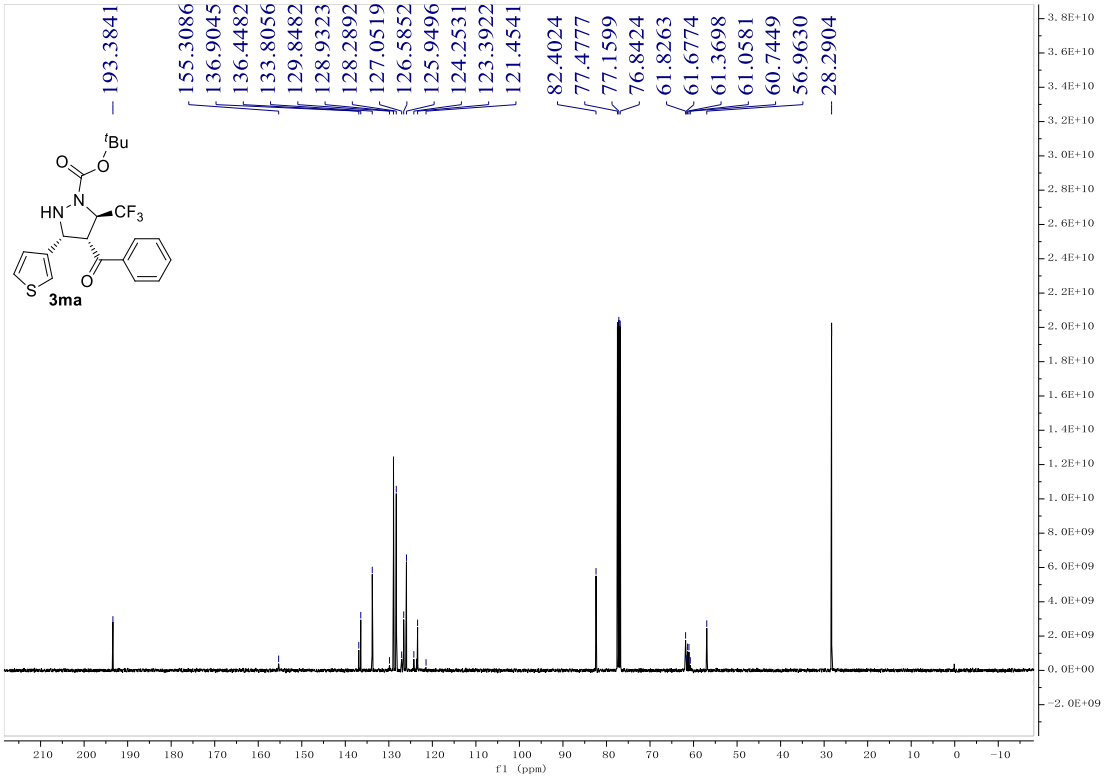
$^{19}F\{^{1}H\}$ NMR of 3la (376 MHz, $CDCl_3$)



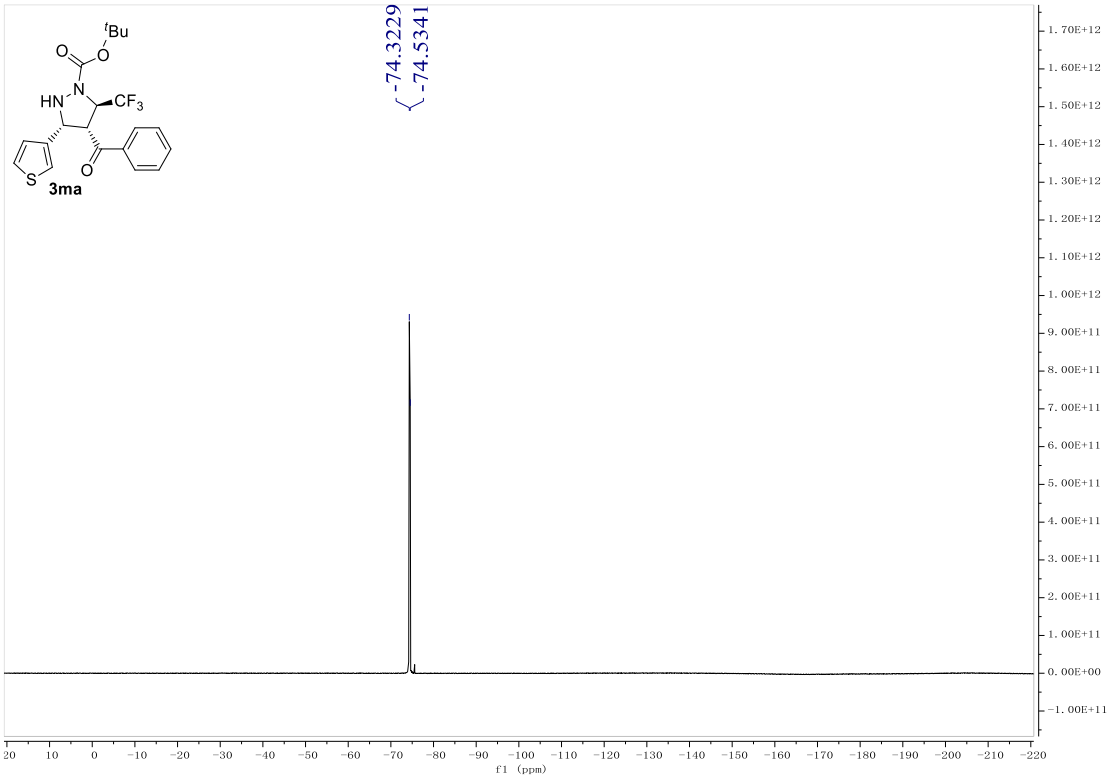
^{1}H NMR of 3ma (400 MHz, $CDCl_3$)



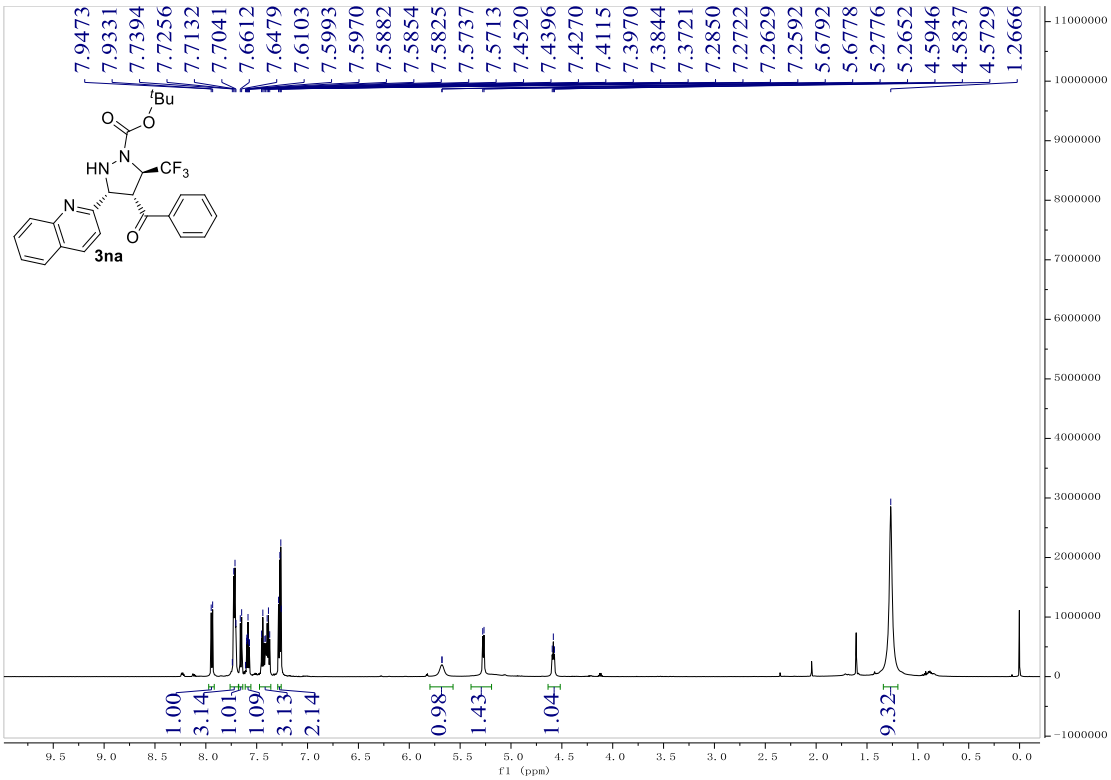
^{13}C{^{1}H} NMR of 3ma (100 MHz, $CDCl_3$)



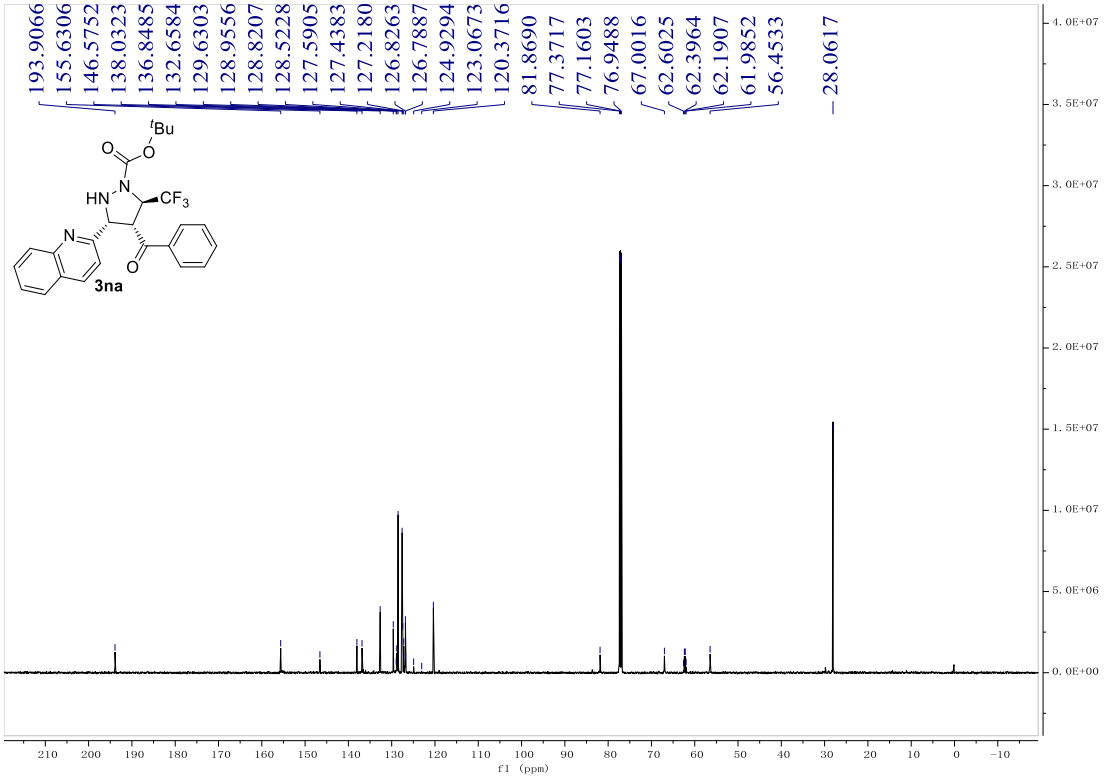
$^{19}F\{^{1}H\}$ NMR of 3ma (376 MHz, $CDCl_3$)



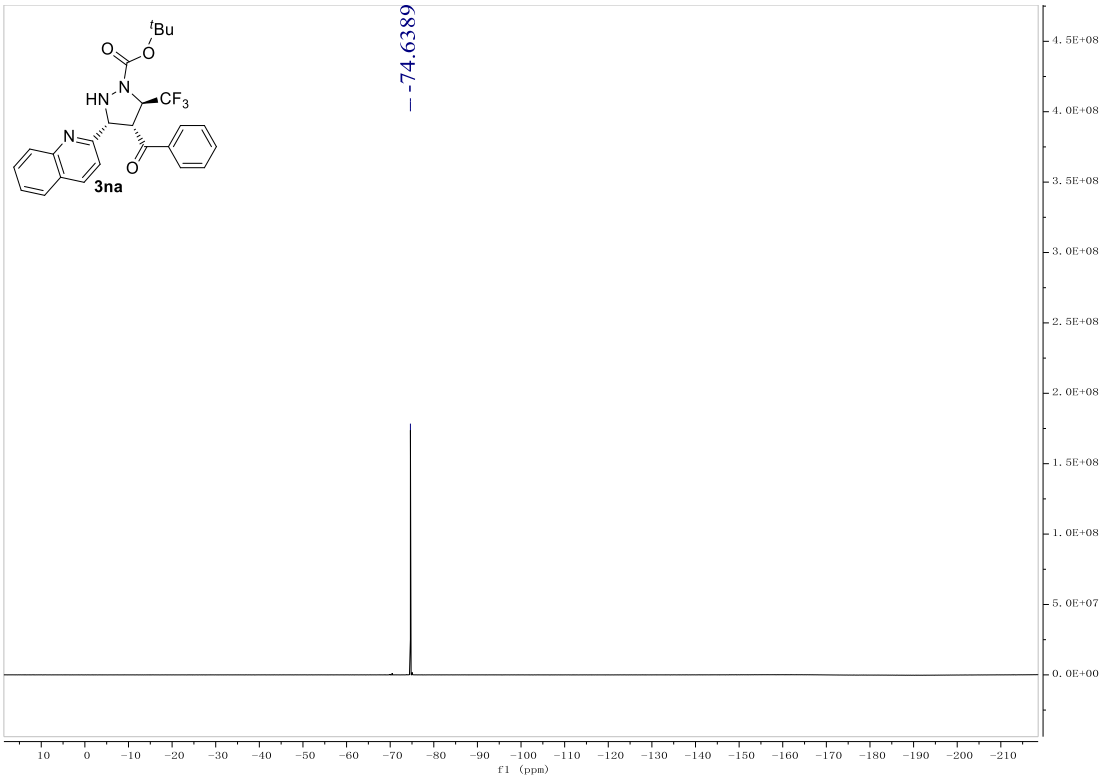
^{1}H NMR of 3na (600 MHz, $CDCl_3$)



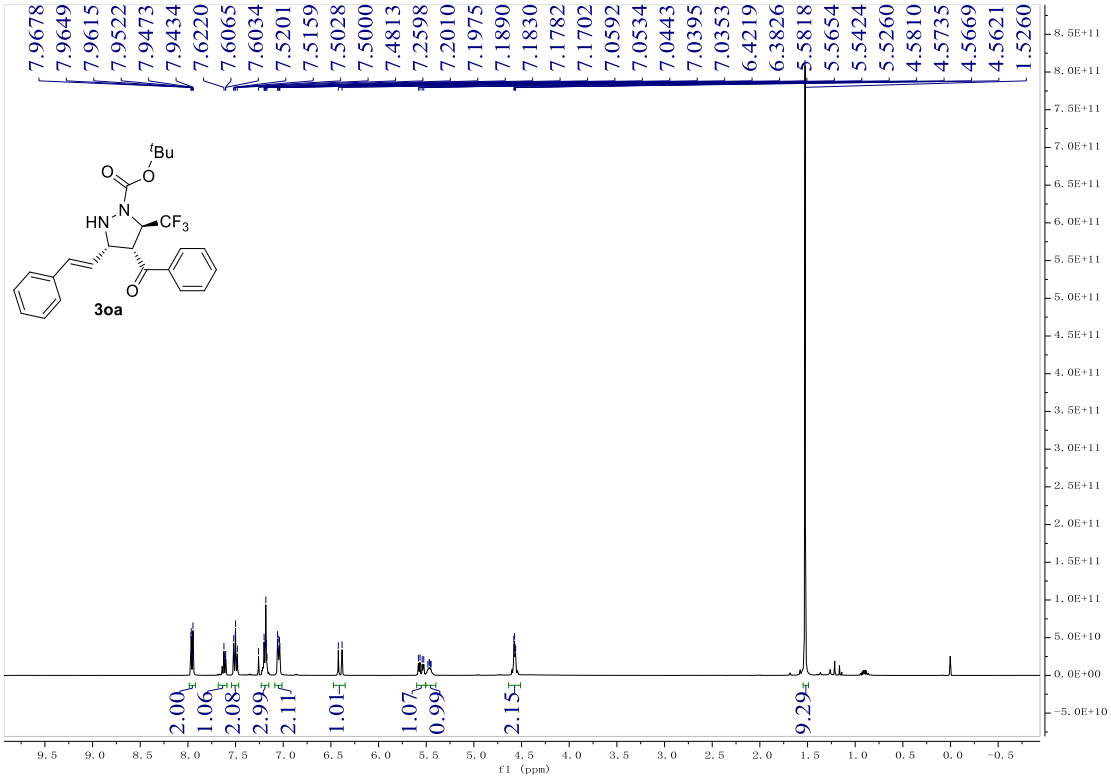
$^{13}C\{^{1}H\}$ NMR of 3na (150 MHz, $CDCl_3$)



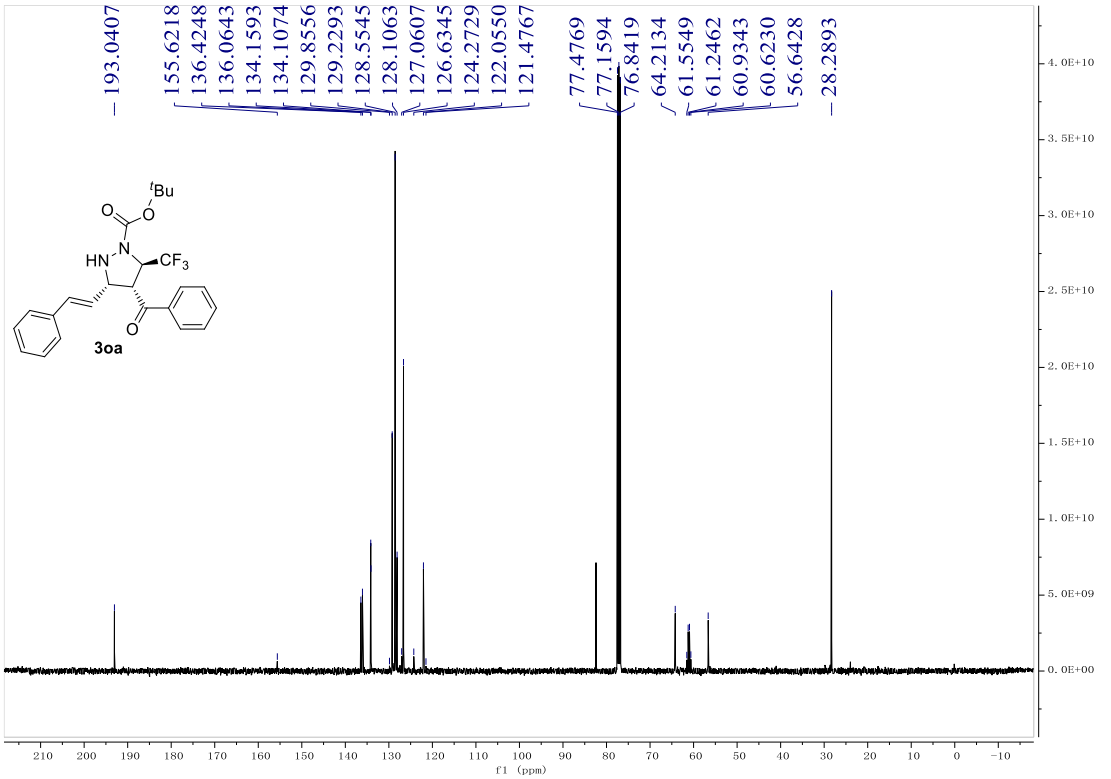
$^{19}F\{^{1}H\}$ NMR of 3na (565 MHz, $CDCl_3$)



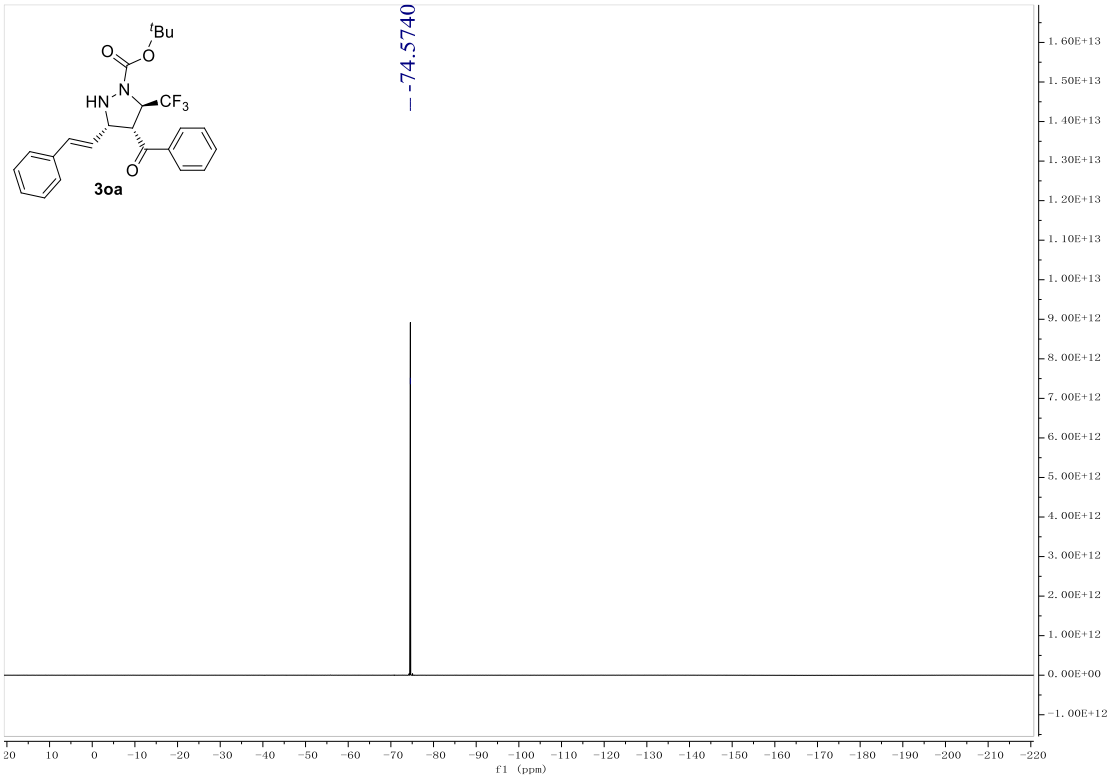
^{1}H NMR of 3oa (400 MHz, $CDCl_3$)



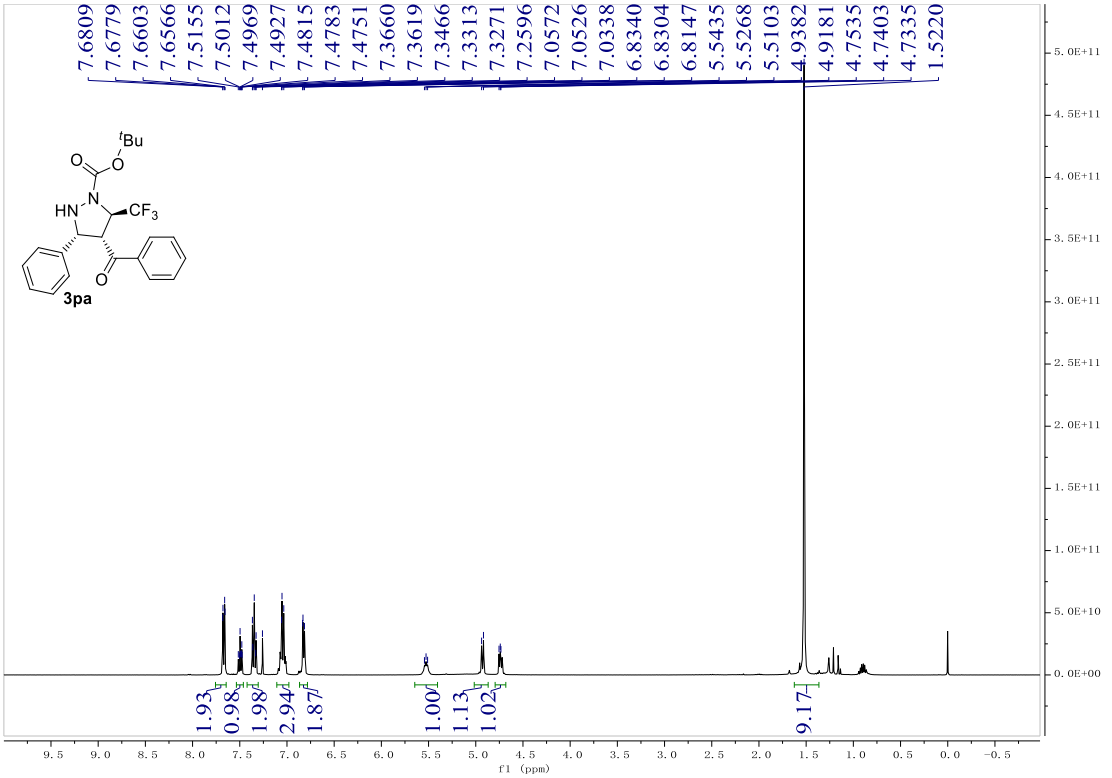
^{13}C{^{1}H} NMR of 3oa (100 MHz, $CDCl_3$)



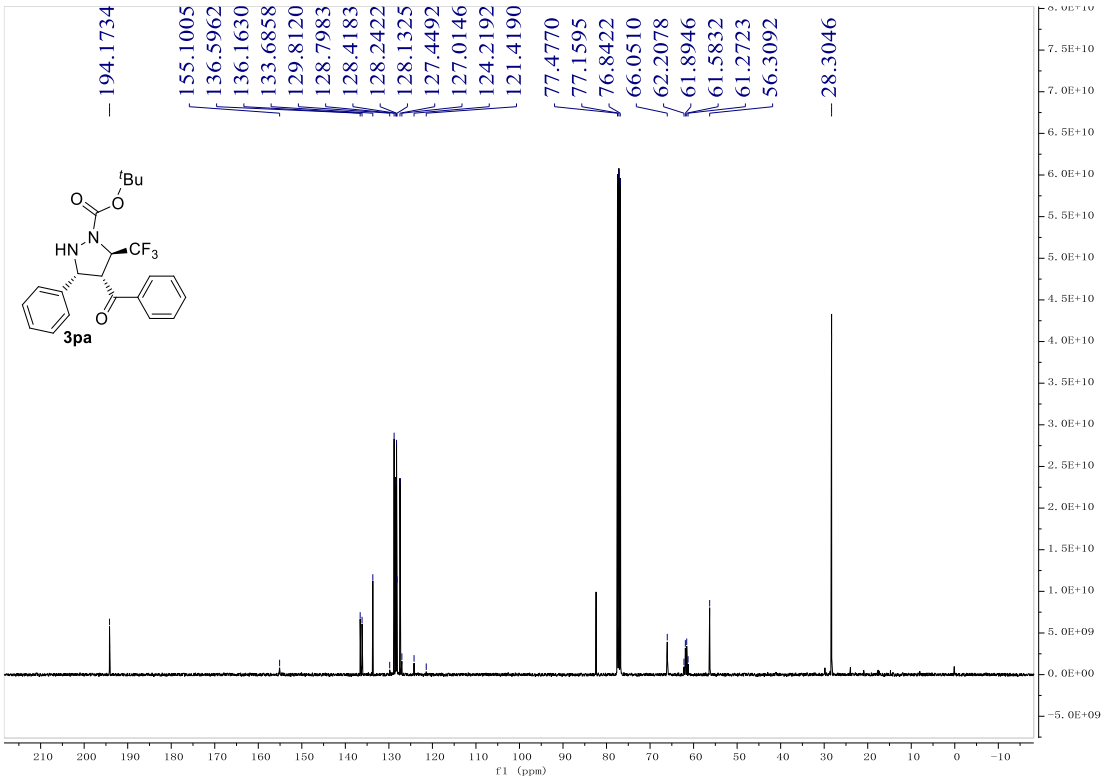
$^{19}F\{^{1}H\}$ NMR of 3oa (376 MHz, $CDCl_3$)



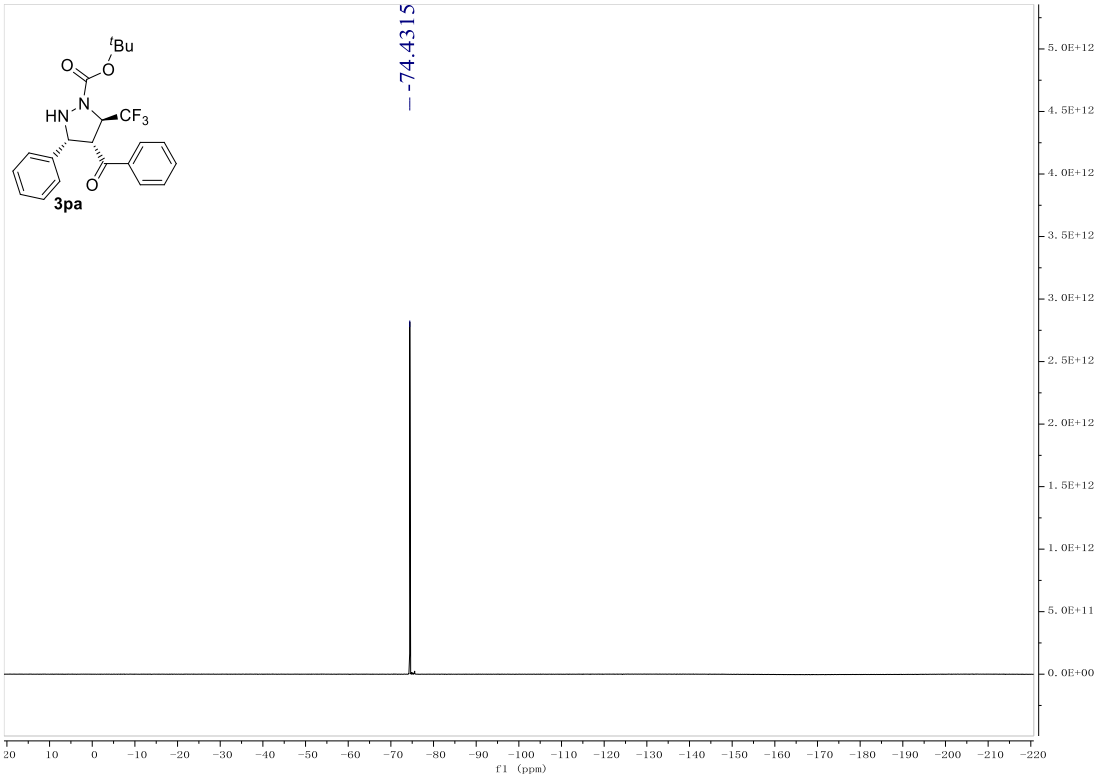
^{1}H NMR of 3pa (400 MHz, $CDCl_3$)



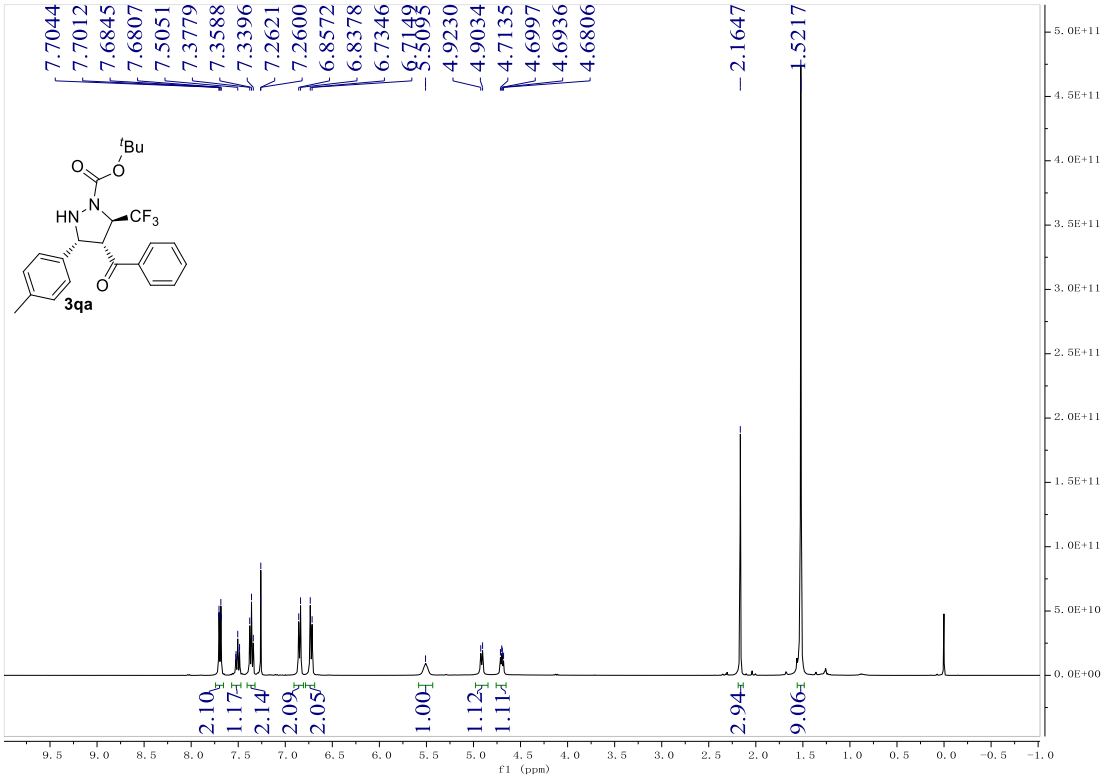
$^{13}C\{^{1}H\}$ NMR of 3pa (100 MHz, $CDCl_3$)



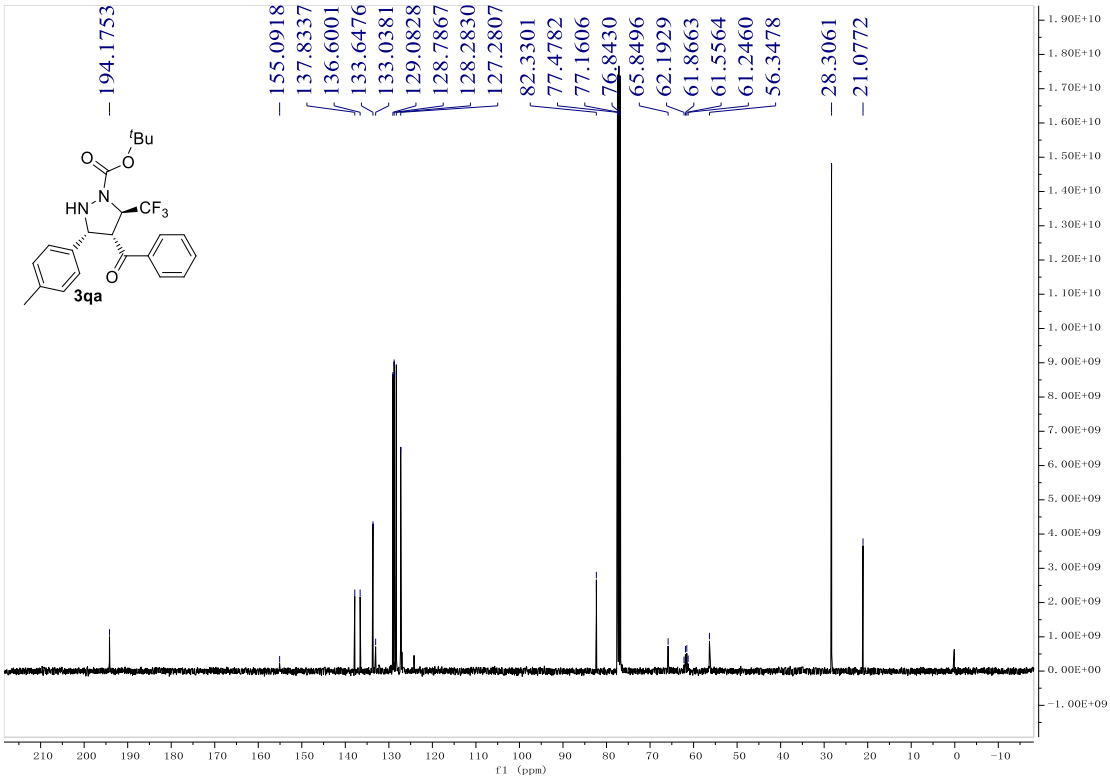
$^{19}F\{^{1}H\}$ NMR of 3pa (376 MHz, $CDCl_3$)



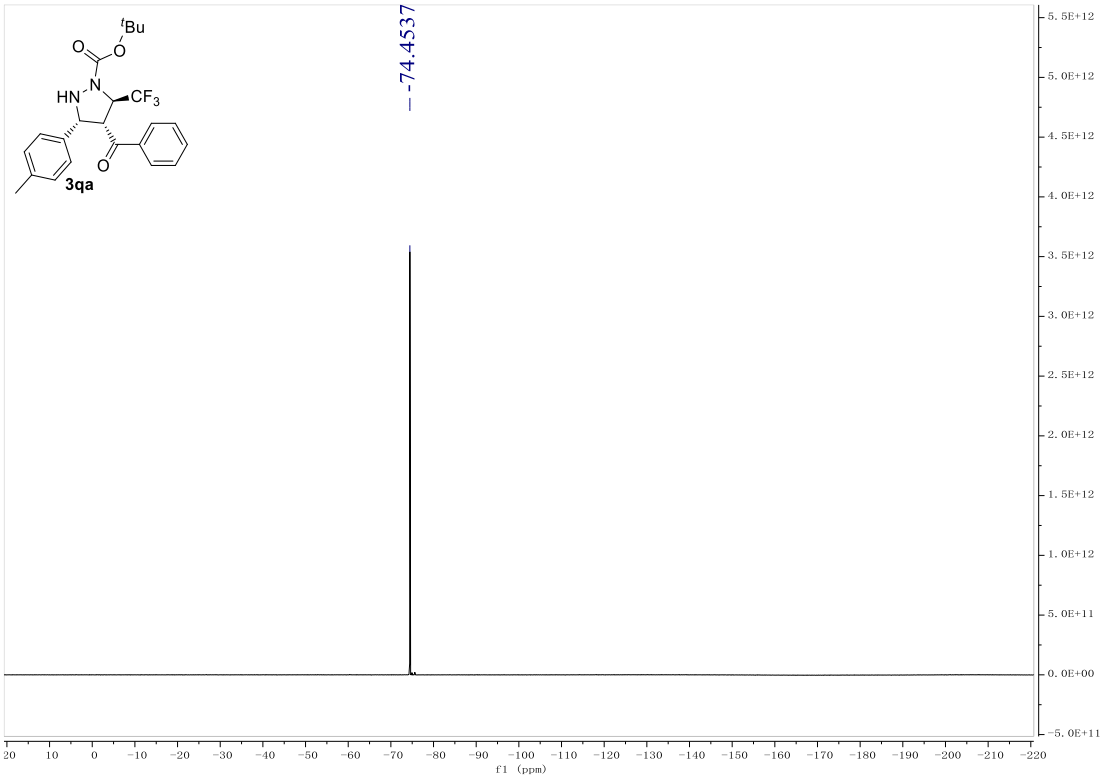
^{1}H NMR of 3qa (400 MHz, $CDCl_3$)



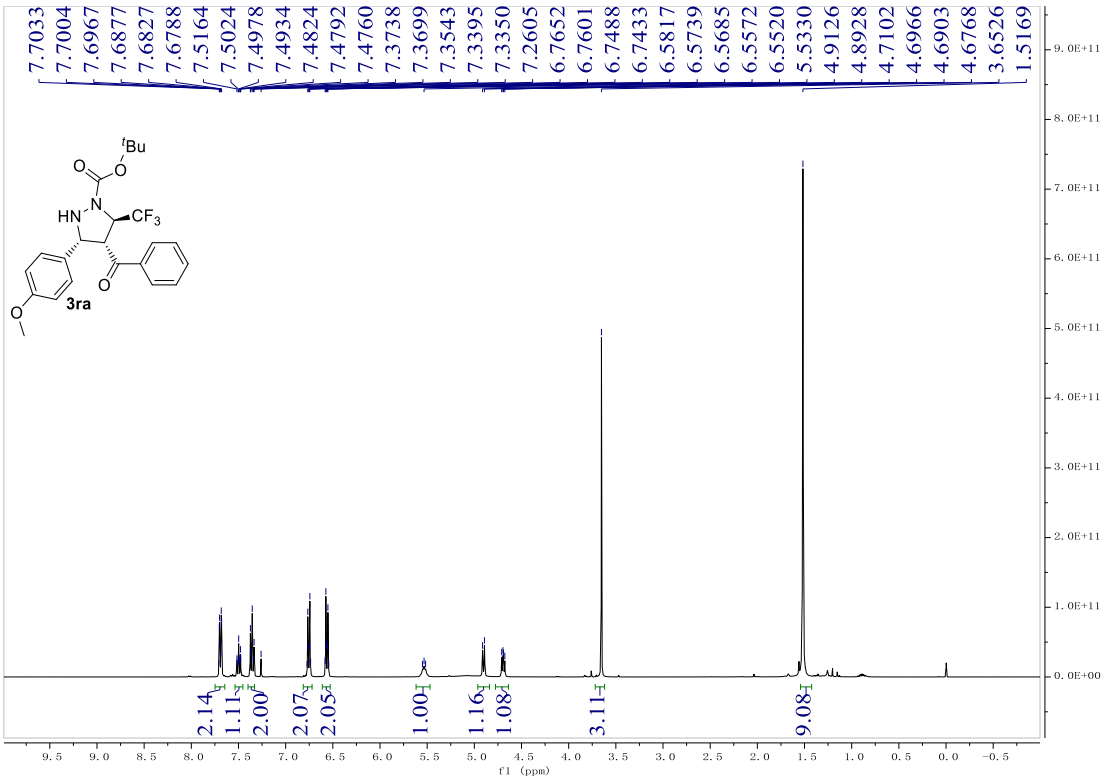
^{13}C{^{1}H} NMR of 3qa (100 MHz, $CDCl_3$)



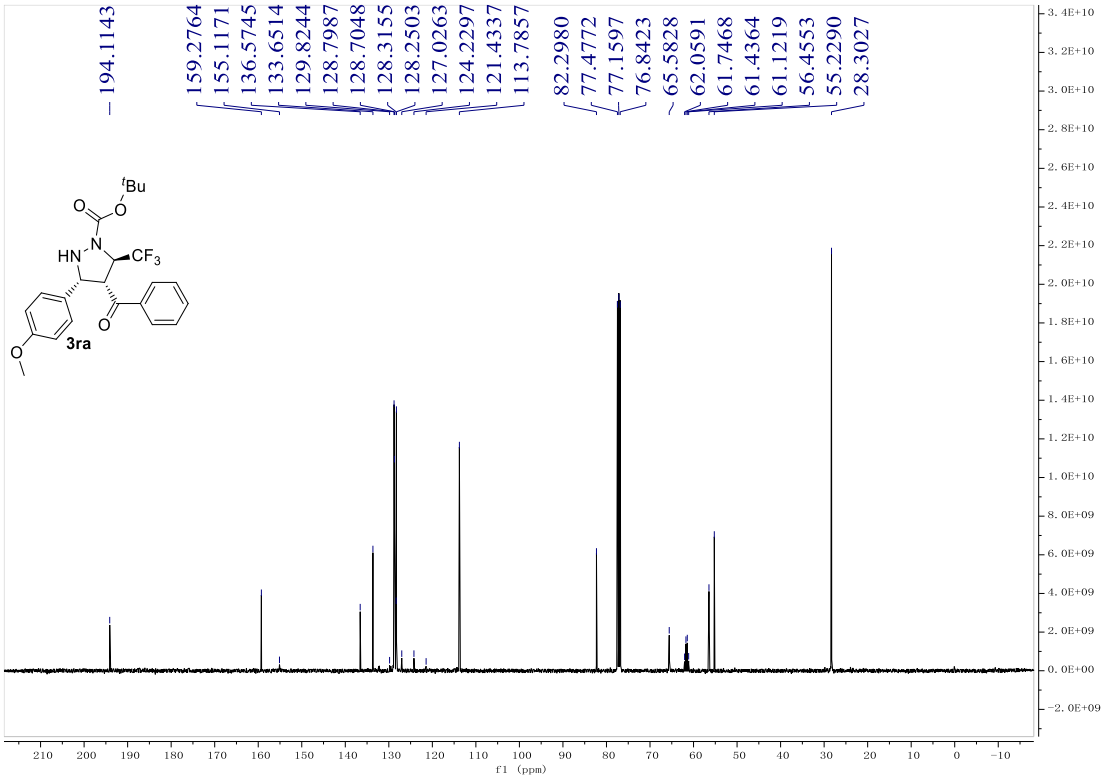
$^{19}F\{^{1}H\}$ NMR of 3qa (376 MHz, $CDCl_3$)



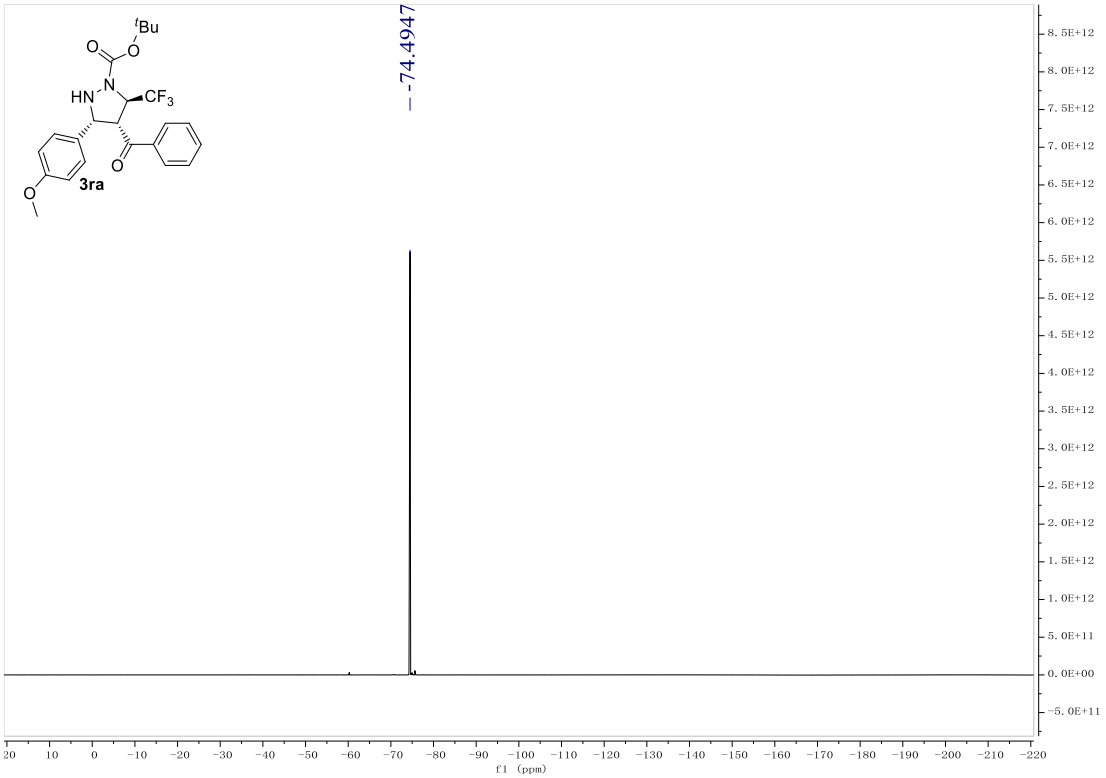
^{1}H NMR of 3ra (400 MHz, $CDCl_3$)



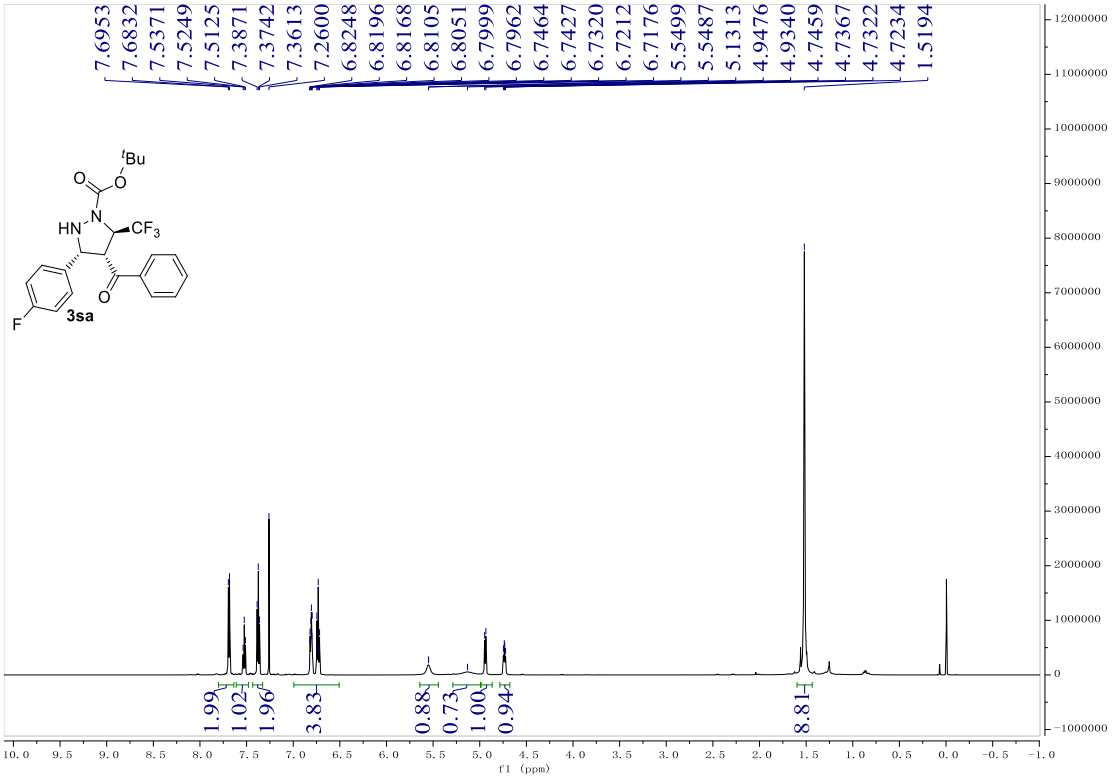
$^{13}C\{^{1}H\}$ NMR of 3ra (100 MHz, $CDCl_3$)



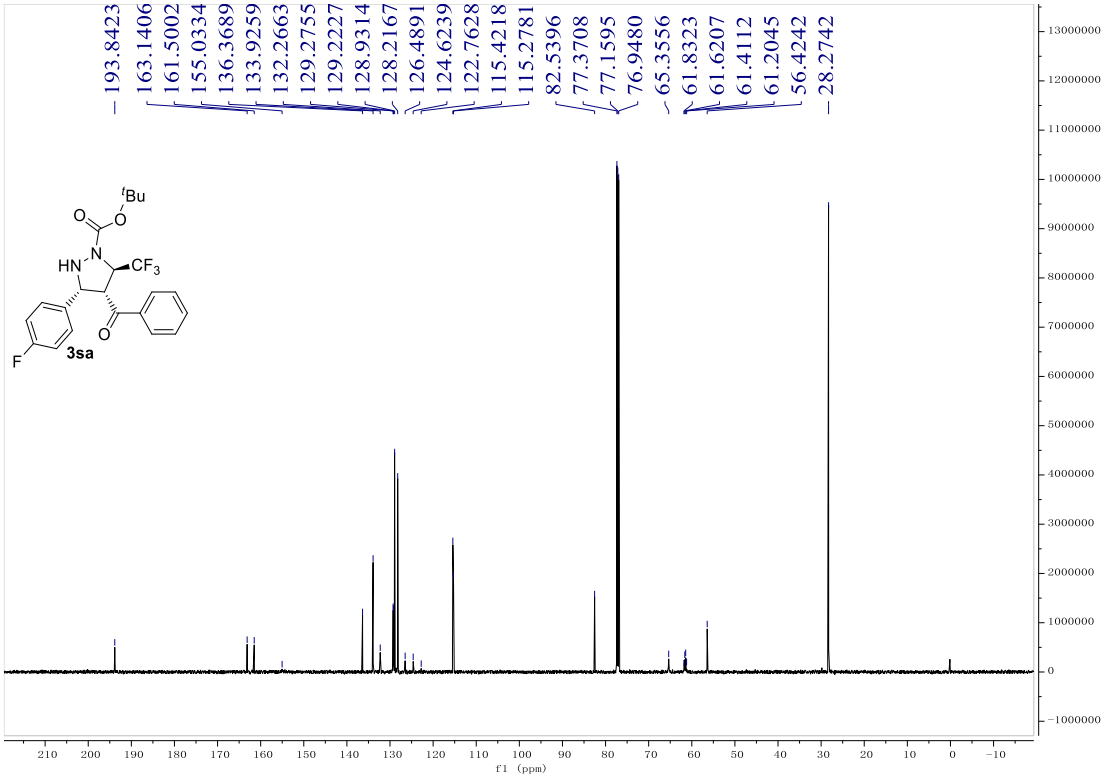
$^{19}F\{^{1}H\}$ NMR of 3ra (376 MHz, $CDCl_3$)



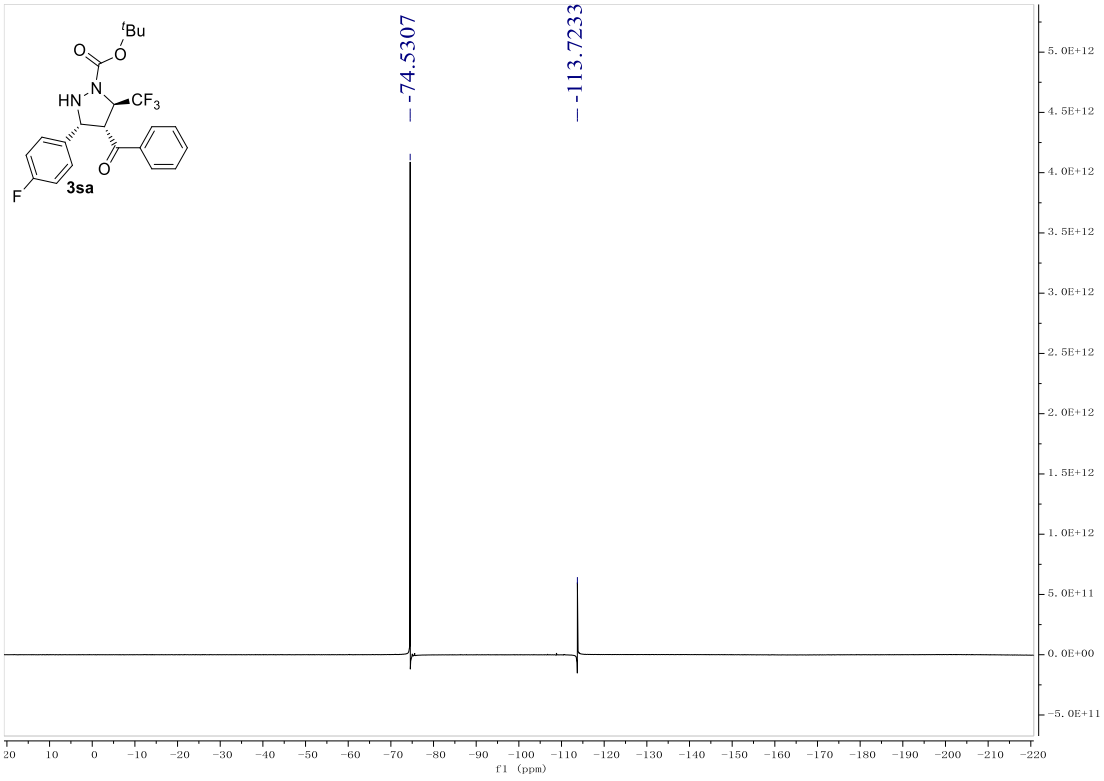
^{1}H NMR of 3sa (600 MHz, $CDCl_3$)



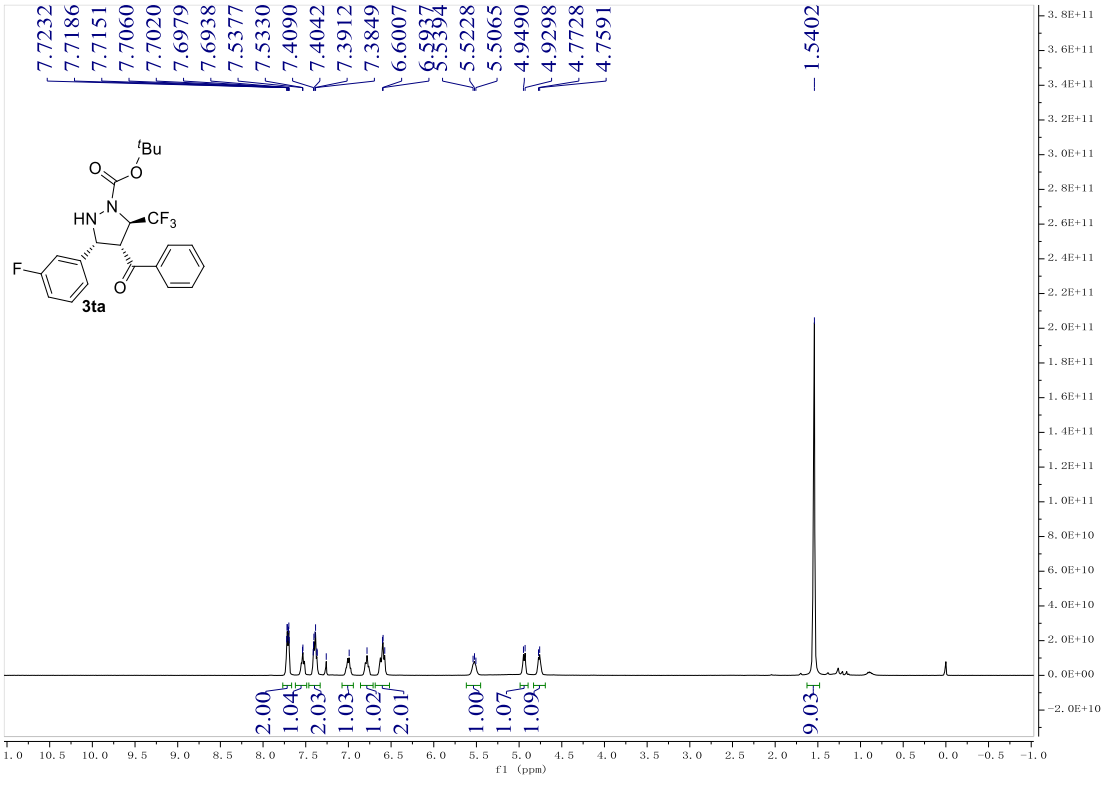
^{13}C{^{1}H} NMR of 3sa (150 MHz, $CDCl_3$)



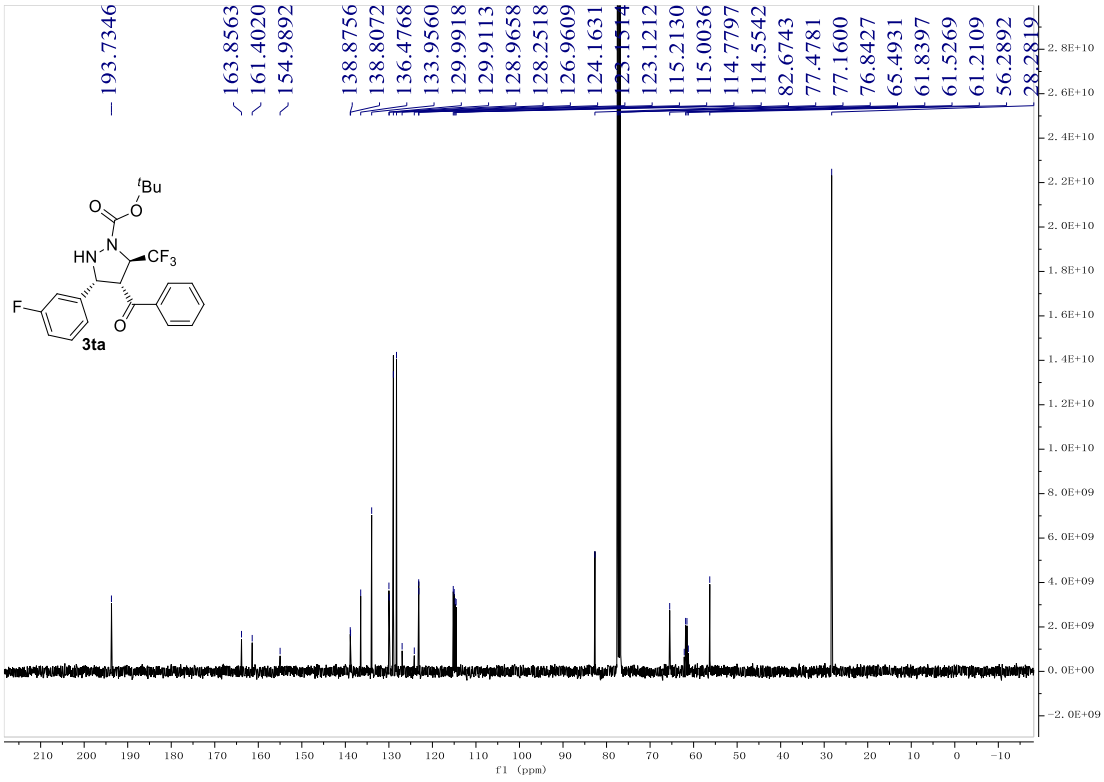
$^{19}F\{^{1}H\}$ NMR of 3sa (376 MHz, $CDCl_3$)



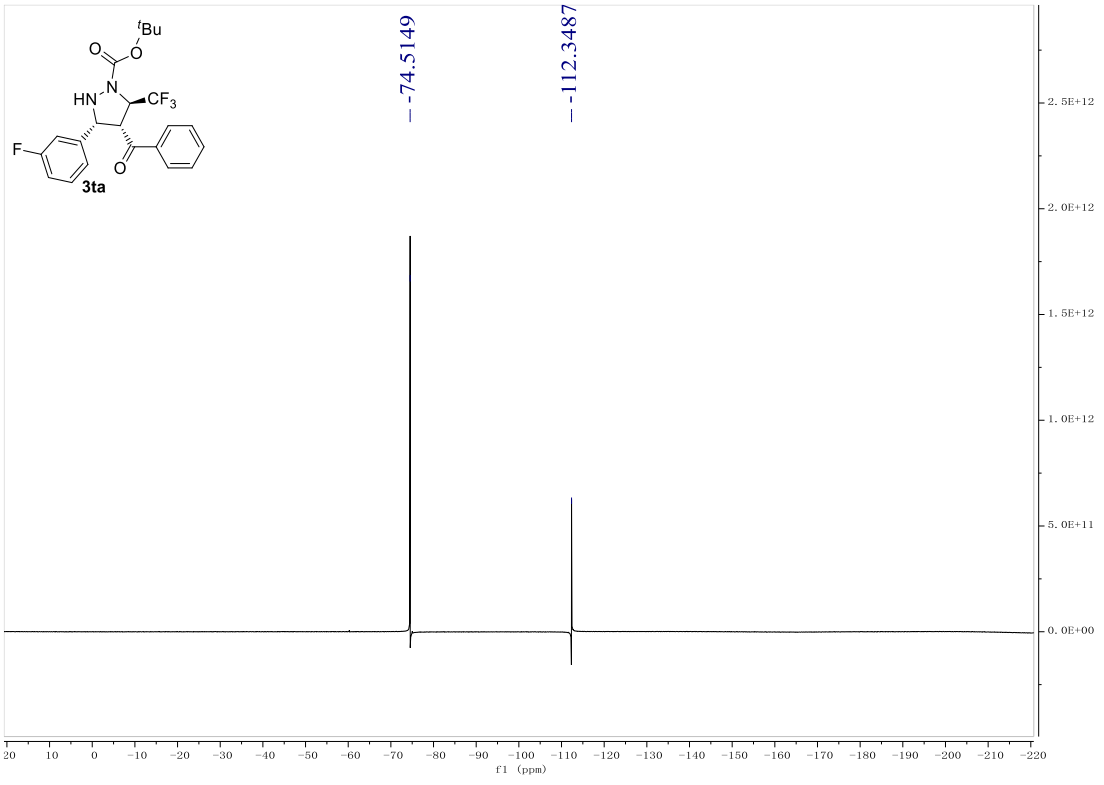
^{1}H NMR of 3ta (400 MHz, $CDCl_3$)



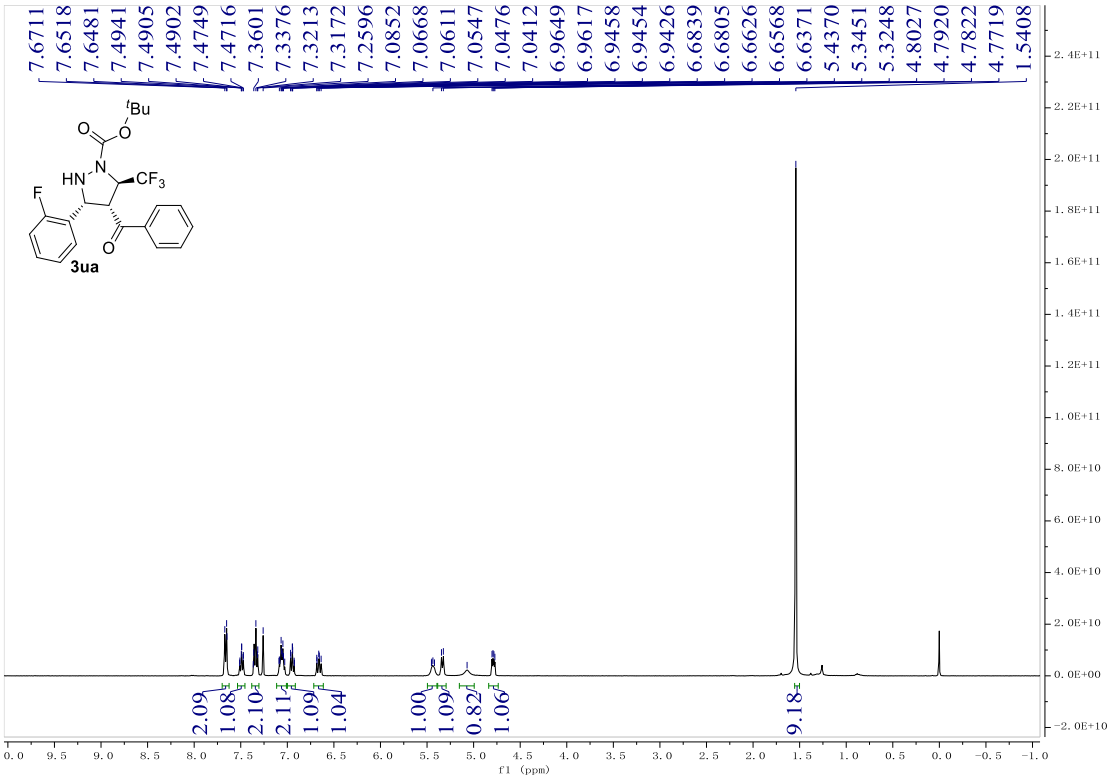
$^{13}C\{^{1}H\}$ NMR of 3ta (100 MHz, $CDCl_3$)



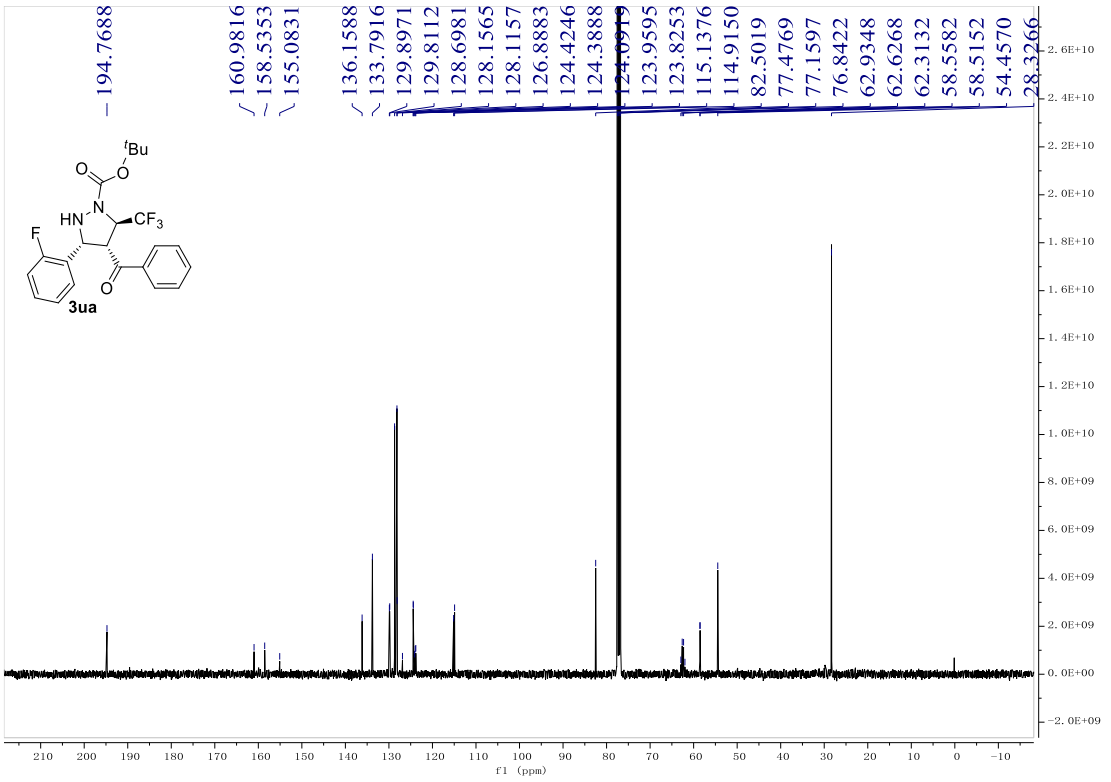
$^{19}F\{^{1}H\}$ NMR of 3ta (376 MHz, $CDCl_3$)



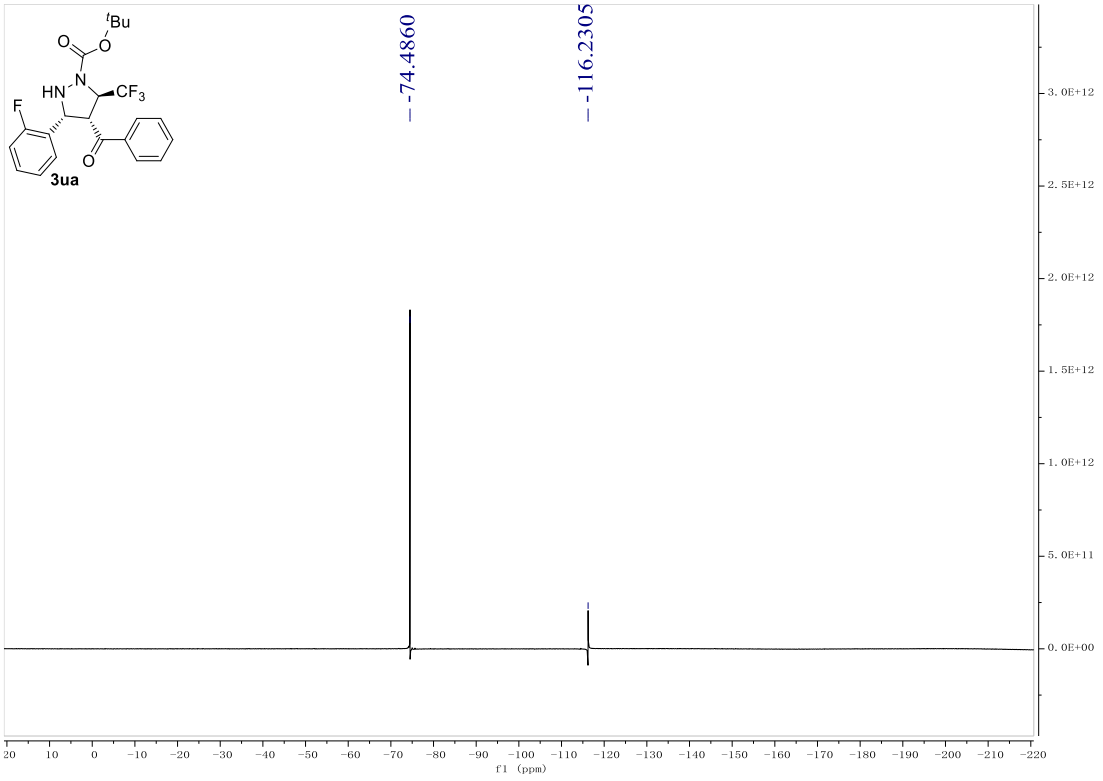
^{1}H NMR of 3ua (400 MHz, $CDCl_3$)



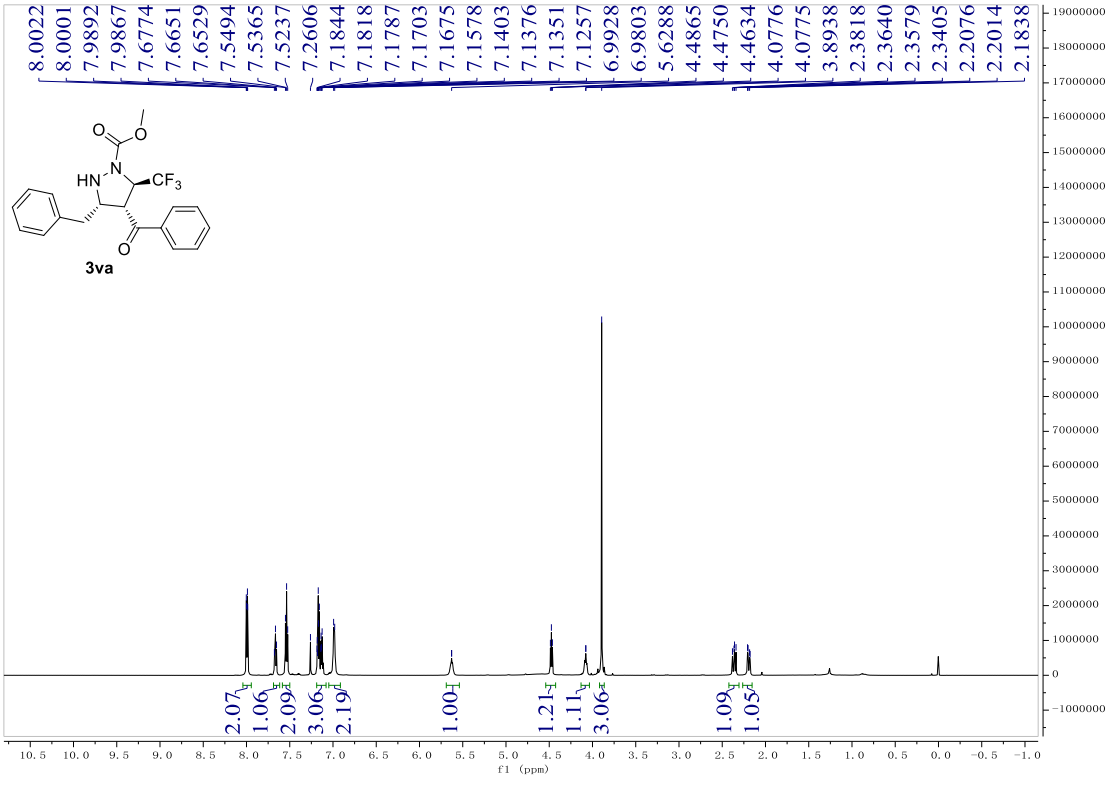
^{13}C{^{1}H} NMR of 3ua (100 MHz, $CDCl_3$)



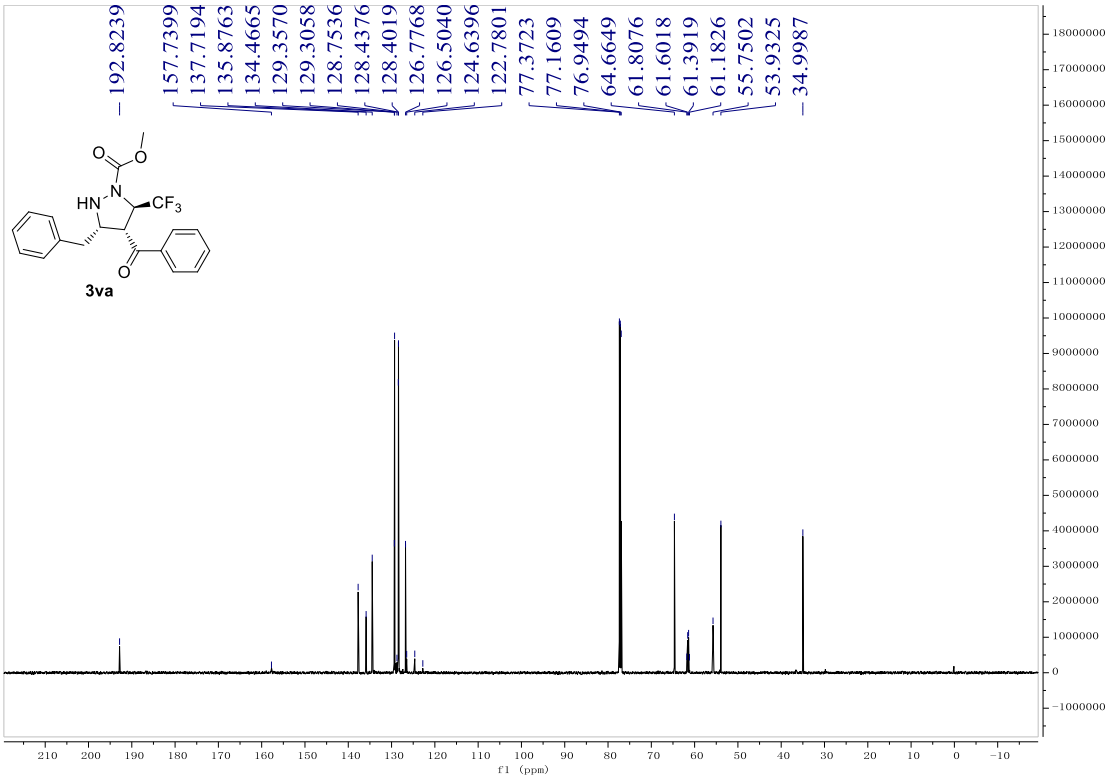
$^{19}F\{^{1}H\}$ NMR of 3ua (376 MHz, $CDCl_3$)



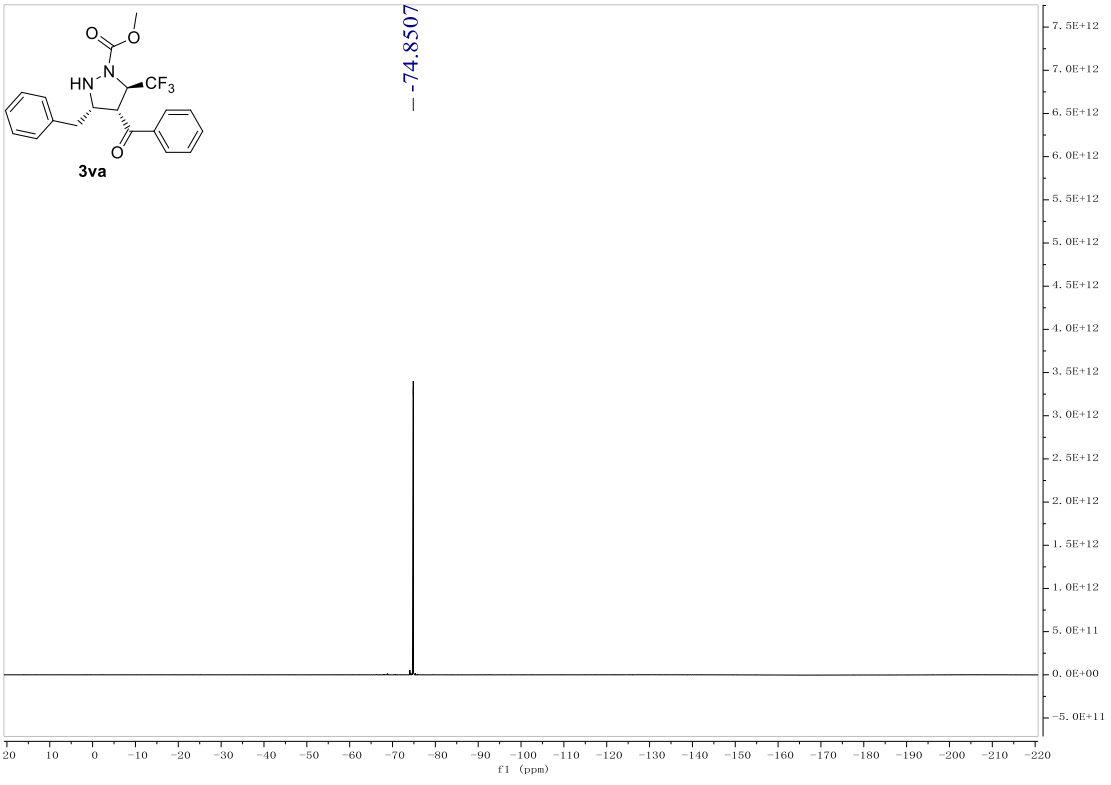
^{1}H NMR of 3va (600 MHz, $CDCl_3$)



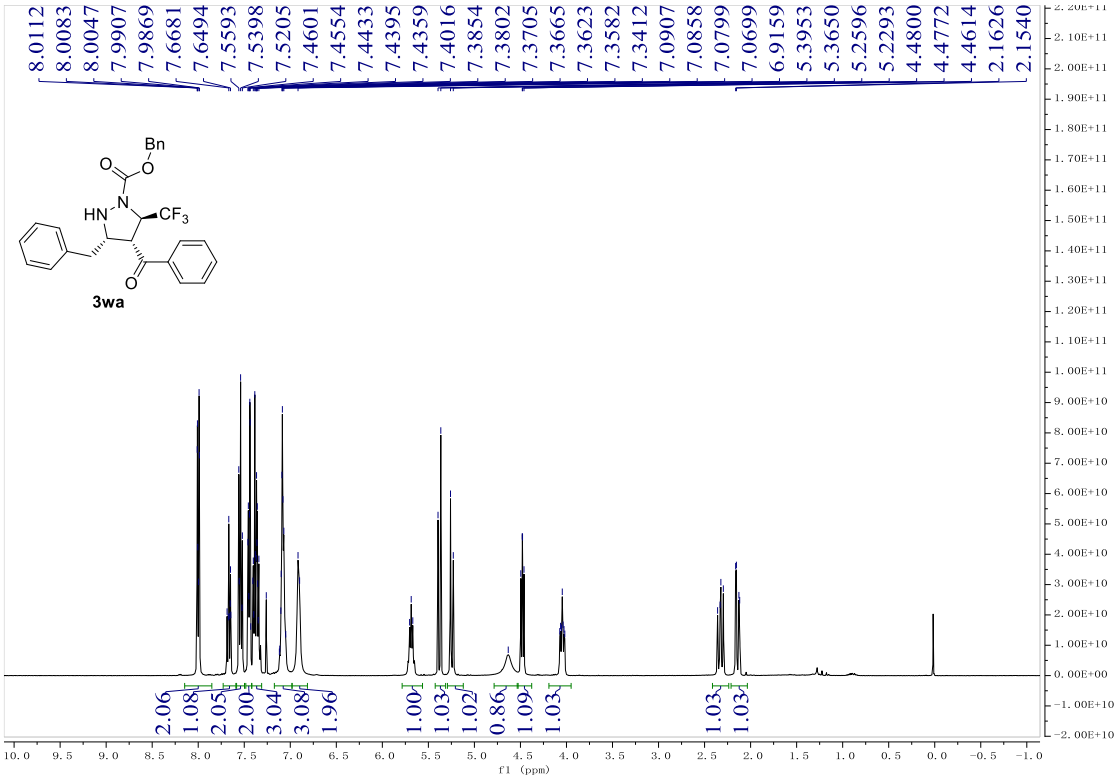
$^{13}C\{^{1}H\}$ NMR of 3va (150 MHz, $CDCl_3$)



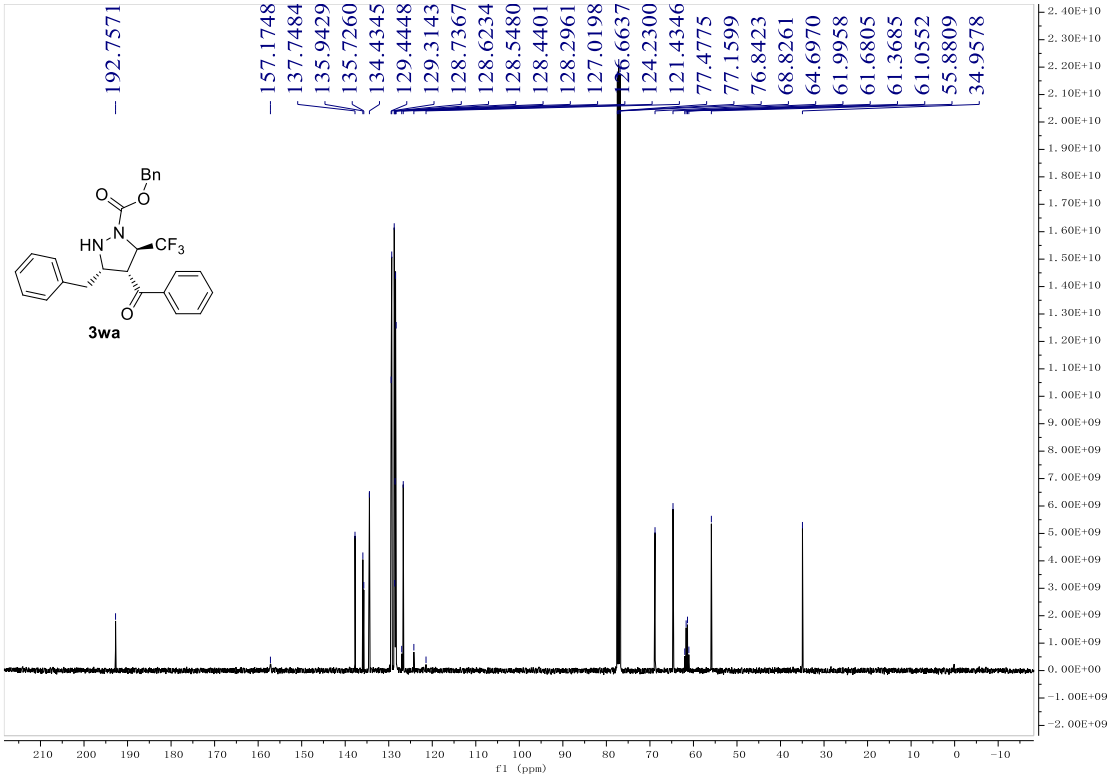
$^{19}F\{^{1}H\}$ NMR of 3va (376 MHz, $CDCl_3$)



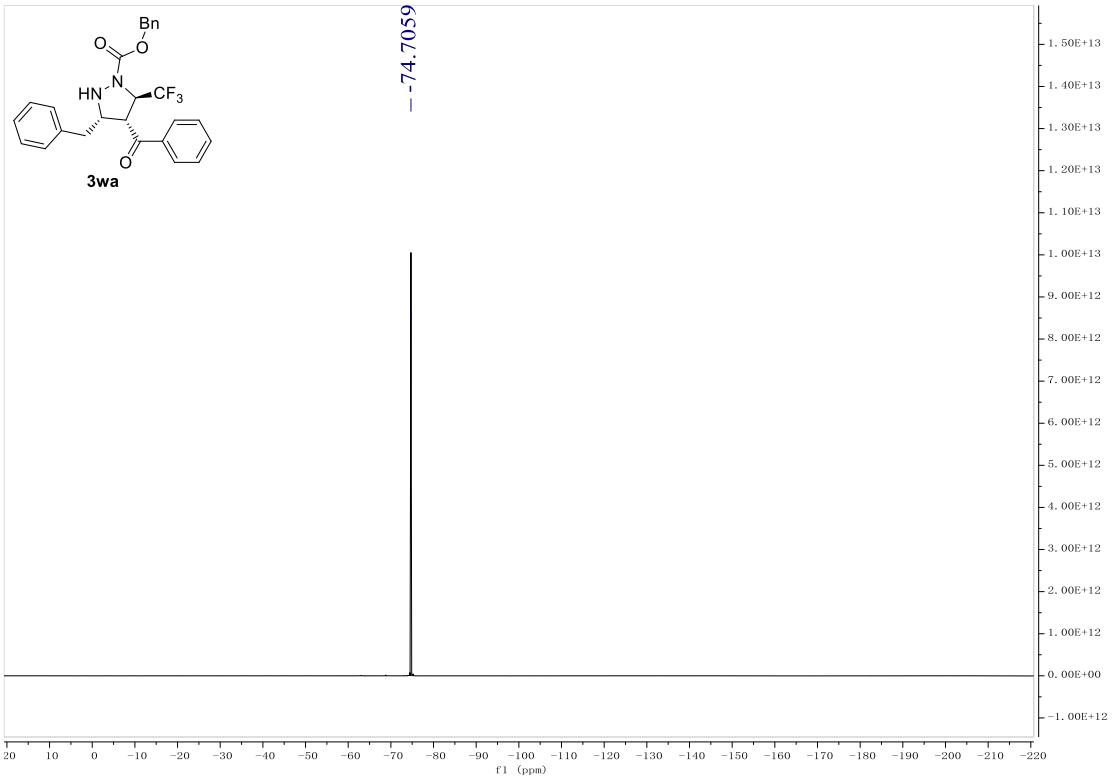
^{1}H NMR of 3wa (400 MHz, $CDCl_3$)



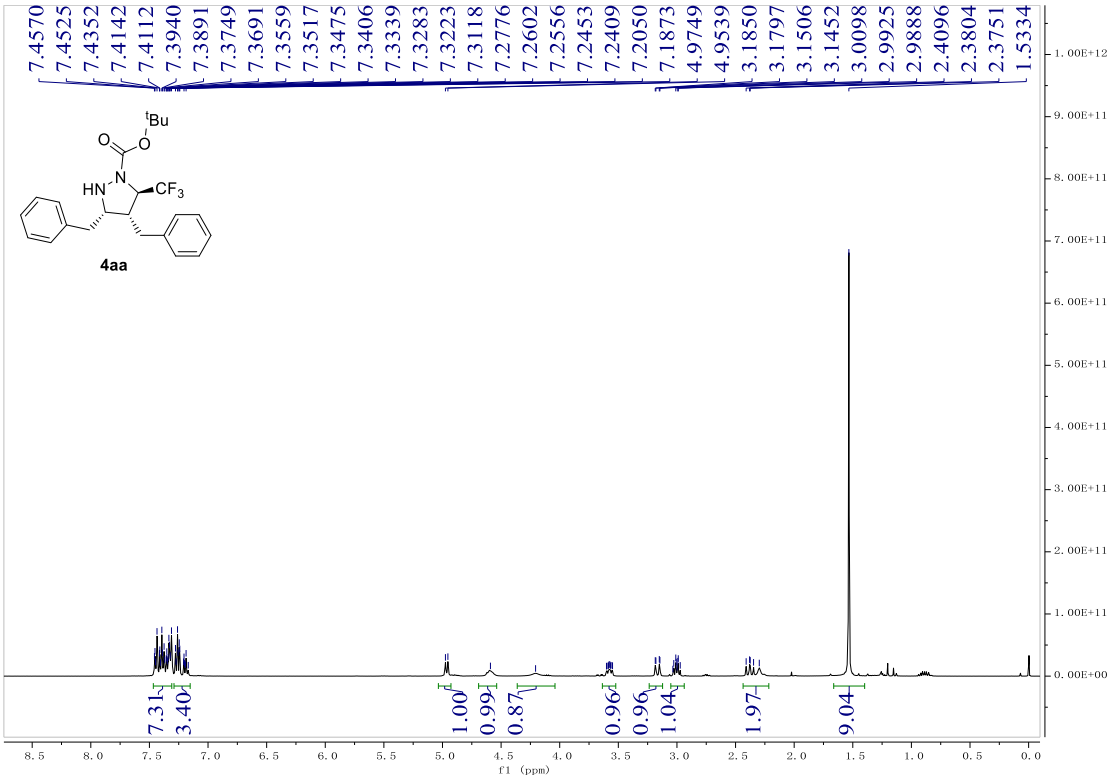
^{13}C{^{1}H} NMR of 3wa (100 MHz, $CDCl_3$)



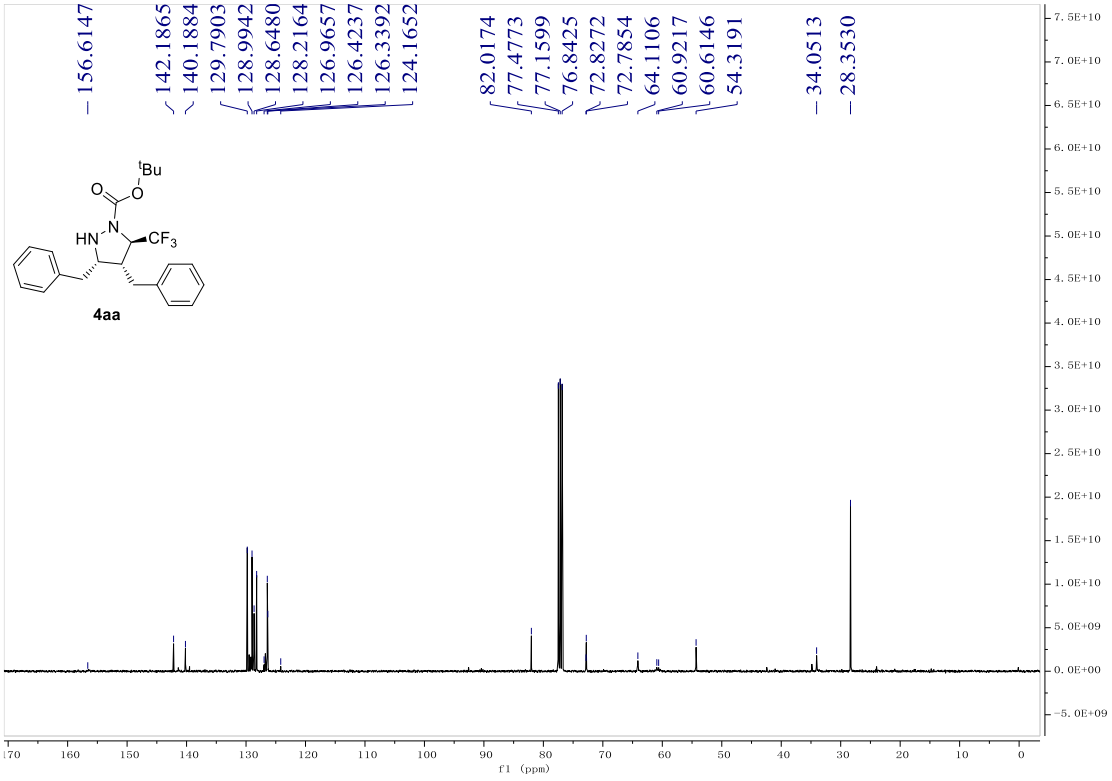
$^{19}F\{^{1}H\}$ NMR of 3wa (376 MHz, $CDCl_3$)



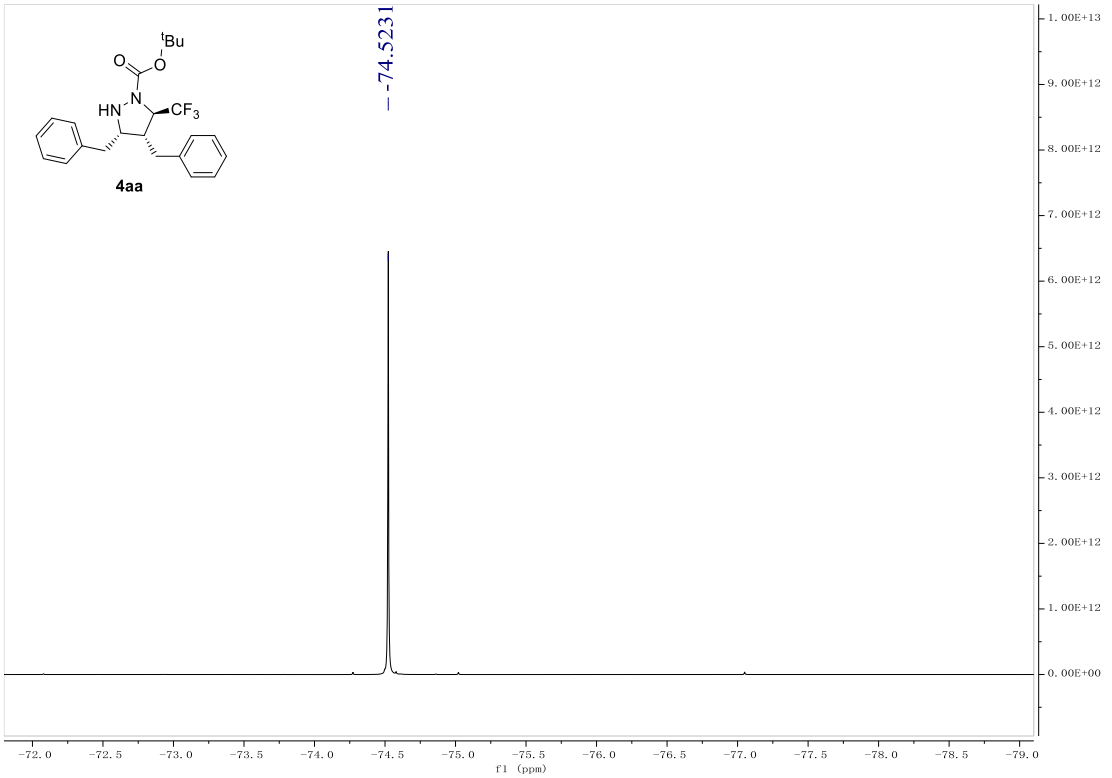
^{1}H NMR of 4aa (400 MHz, $CDCl_3$)



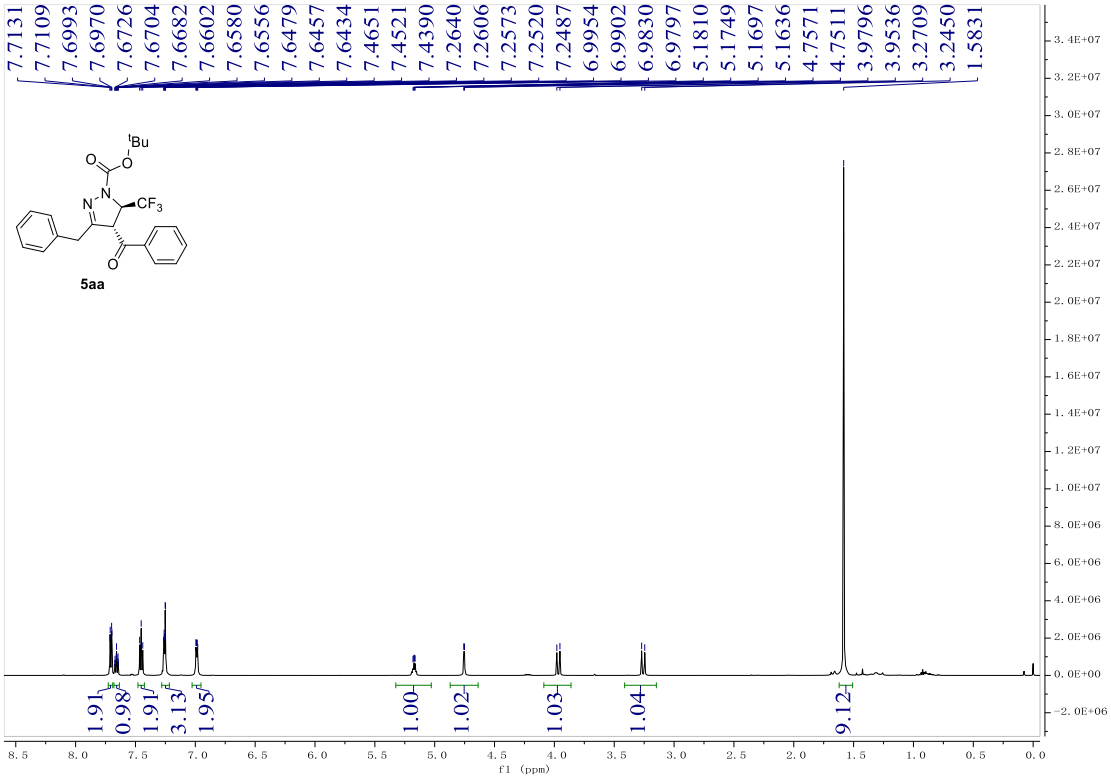
$^{13}C\{^{1}H\}$ NMR of 4aa (100 MHz, $CDCl_3$)



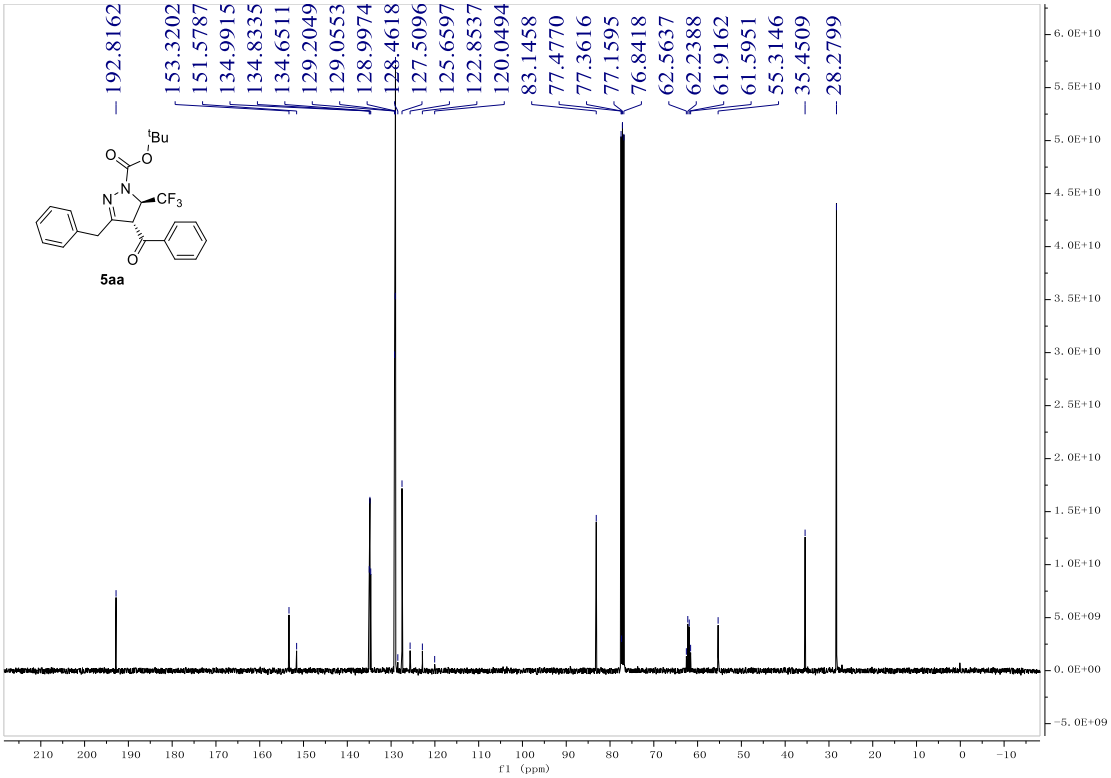
$^{19}F\{^{1}H\}$ NMR of 4aa (376 MHz, $CDCl_3$)



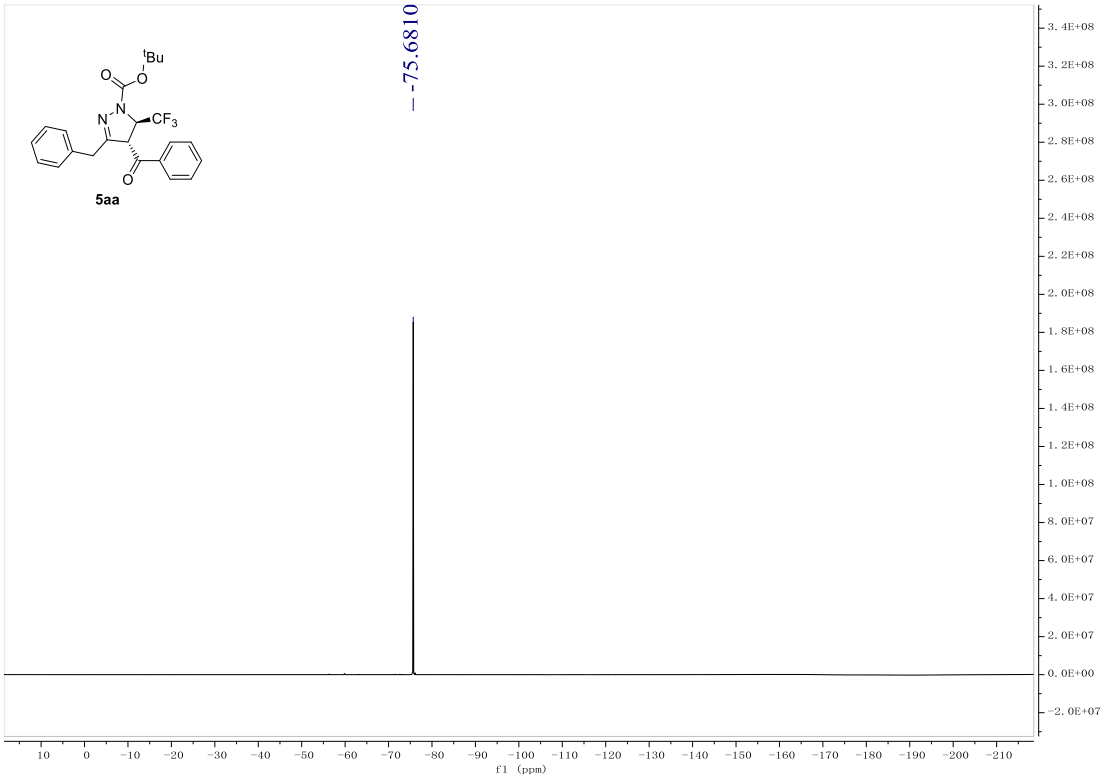
^{1}H NMR of 5aa (600 MHz, $CDCl_3$)



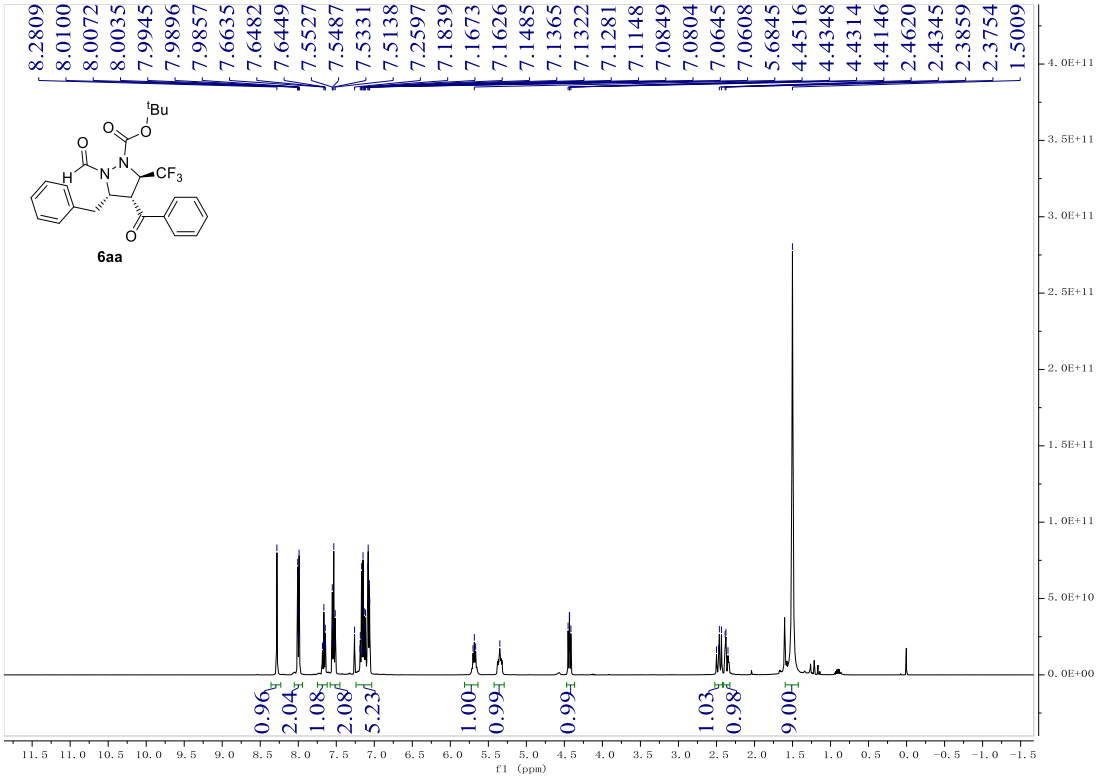
^{13}C{^{1}H} NMR of 5aa (100 MHz, $CDCl_3$)



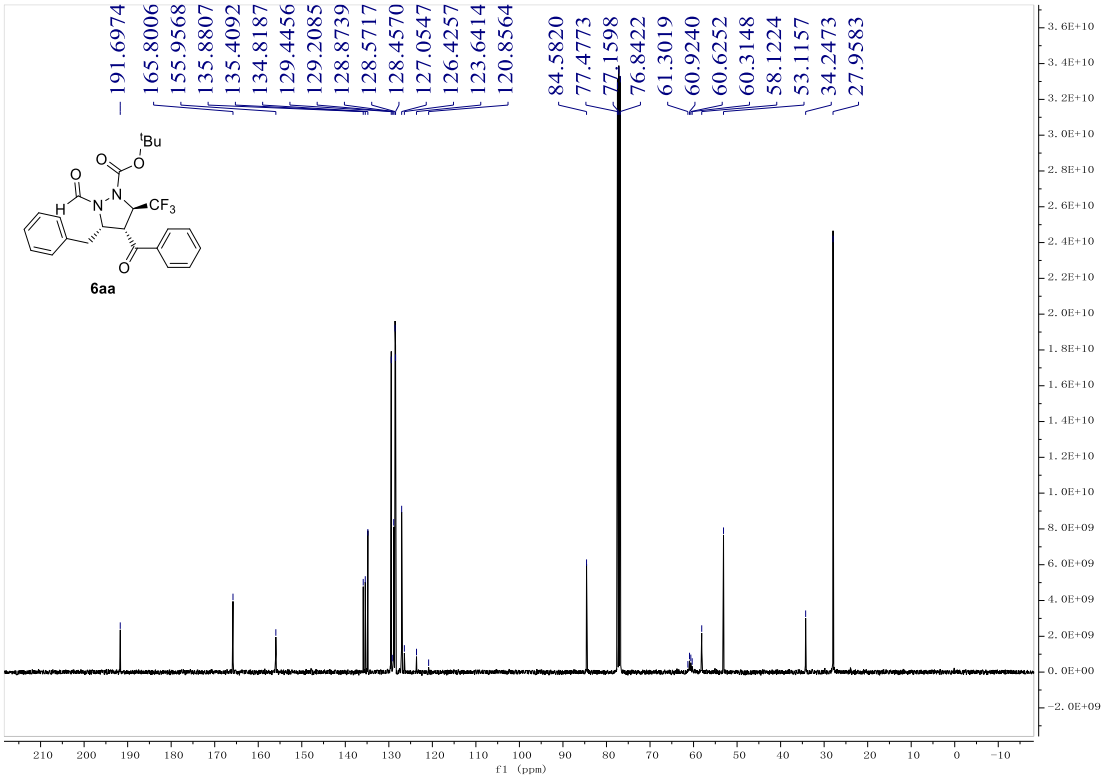
$^{19}F\{^{1}H\}$ NMR of 5aa (565 MHz, $CDCl_3$)



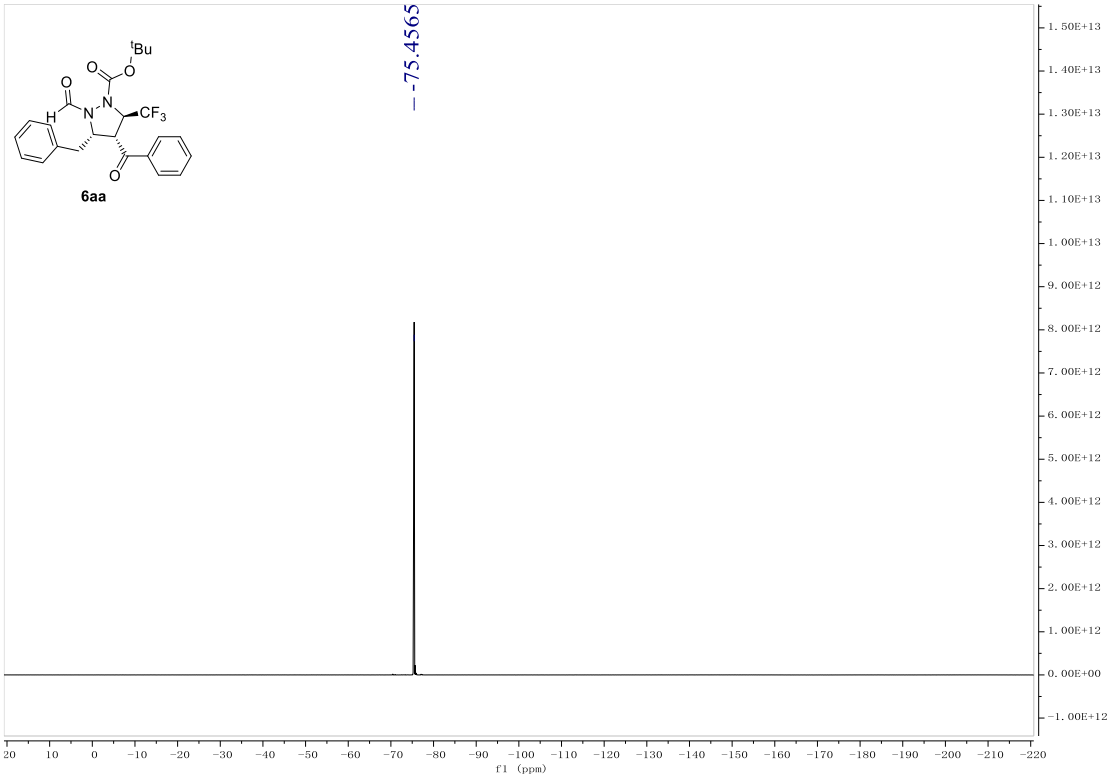
^{1}H NMR of 6aa (400 MHz, $CDCl_3$)



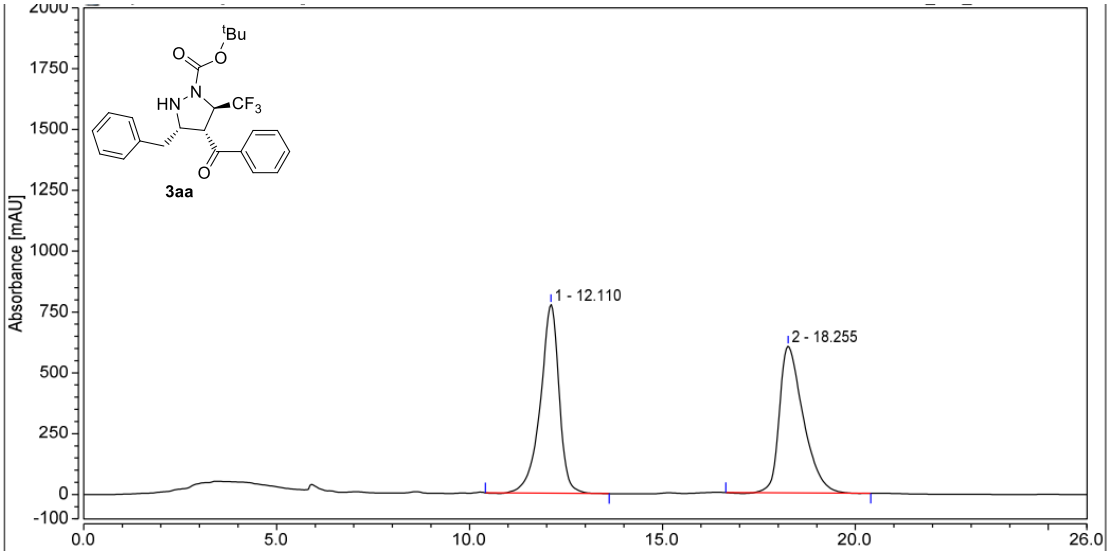
$^{13}C\{^{1}H\}$ NMR of 6aa (100 MHz, $CDCl_3$)



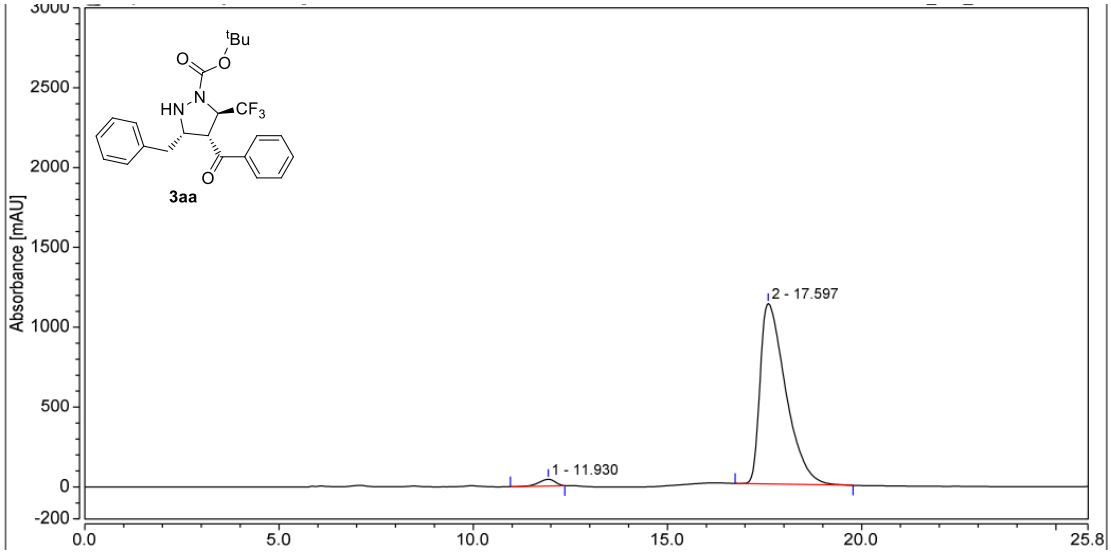
$^{19}F\{^{1}H\}$ NMR of 6aa (376 MHz, $CDCl_3$)



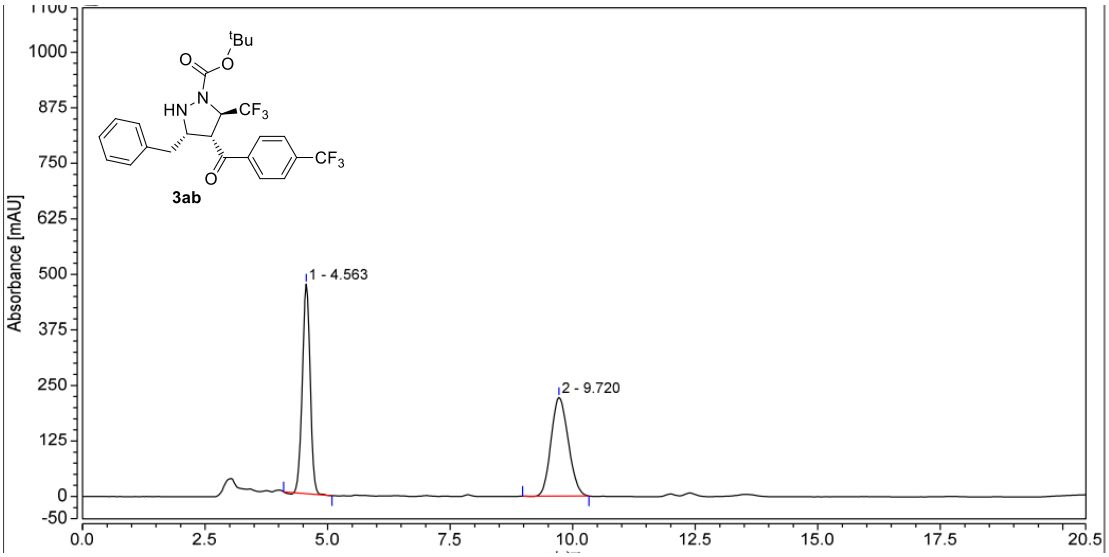
10. Copies of HPLC spectra for racemic and chiral adducts



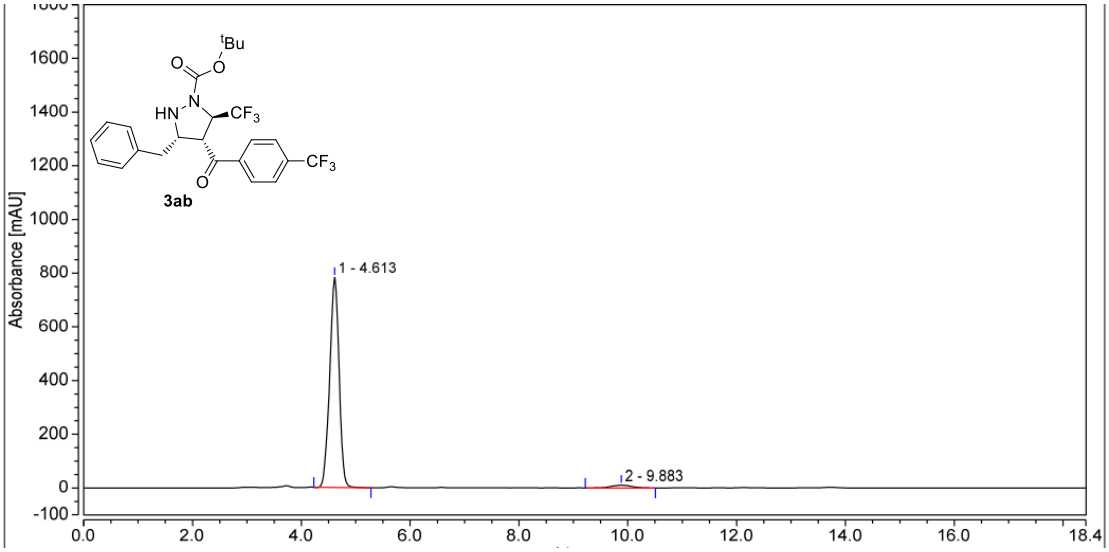
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.110	436.011	775.523	50.24	56.24	n.a.
2		18.255	431.778	603.376	49.76	43.76	n.a.
Total:			**867.788**	**1378.899**	**100.00**	**100.00**	



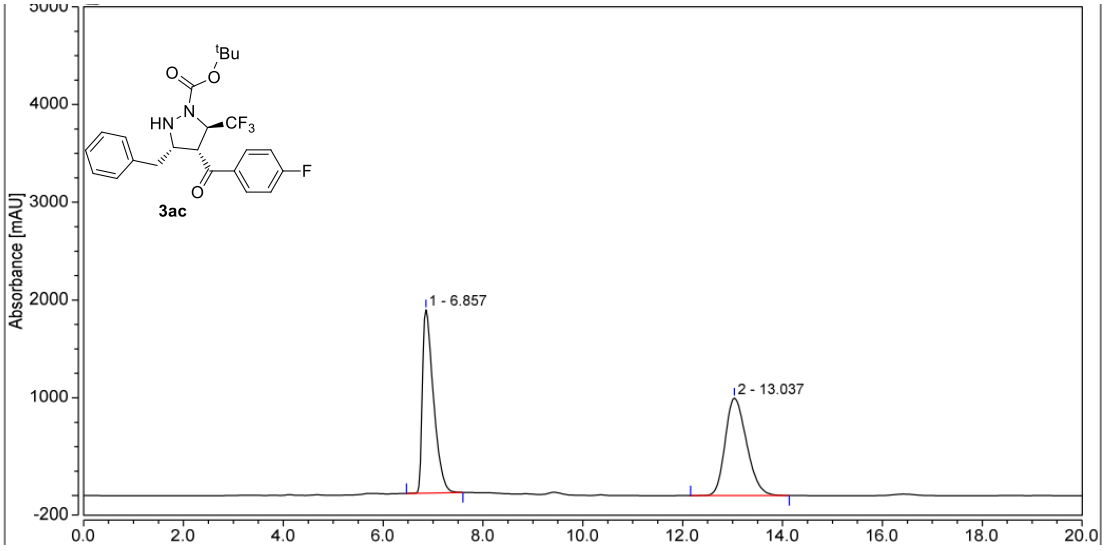
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		11.930	20.534	41.866	2.32	3.57	n.a.
2		17.597	864.988	1130.721	97.68	96.43	n.a.
Total:			**885.522**	**1172.587**	**100.00**	**100.00**	



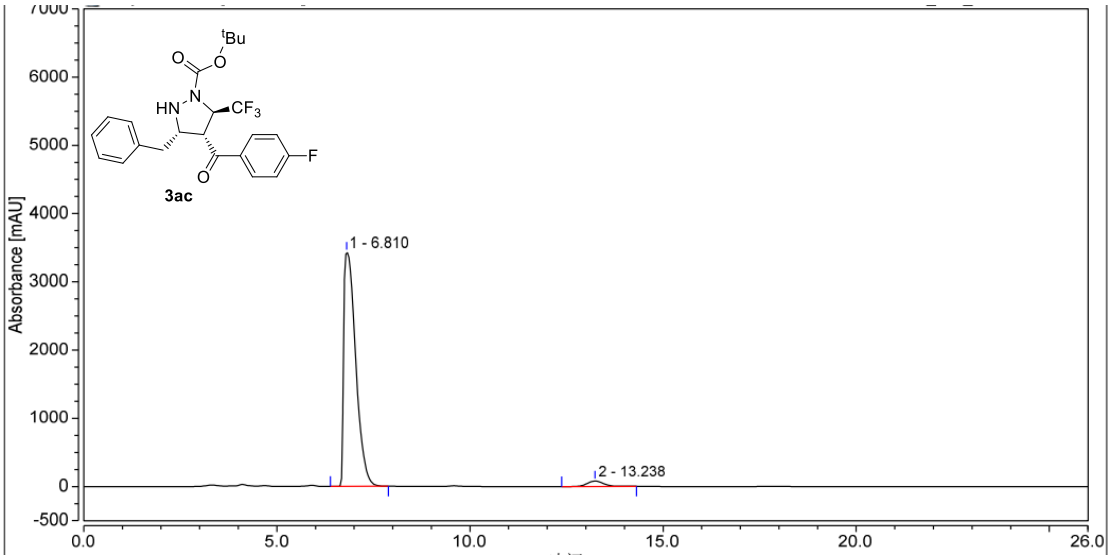
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.563	87.258	471.699	49.10	68.00	n.a.
2		9.720	90.445	221.999	50.90	32.00	n.a.
Total:			**177.703**	**693.698**	**100.00**	**100.00**	



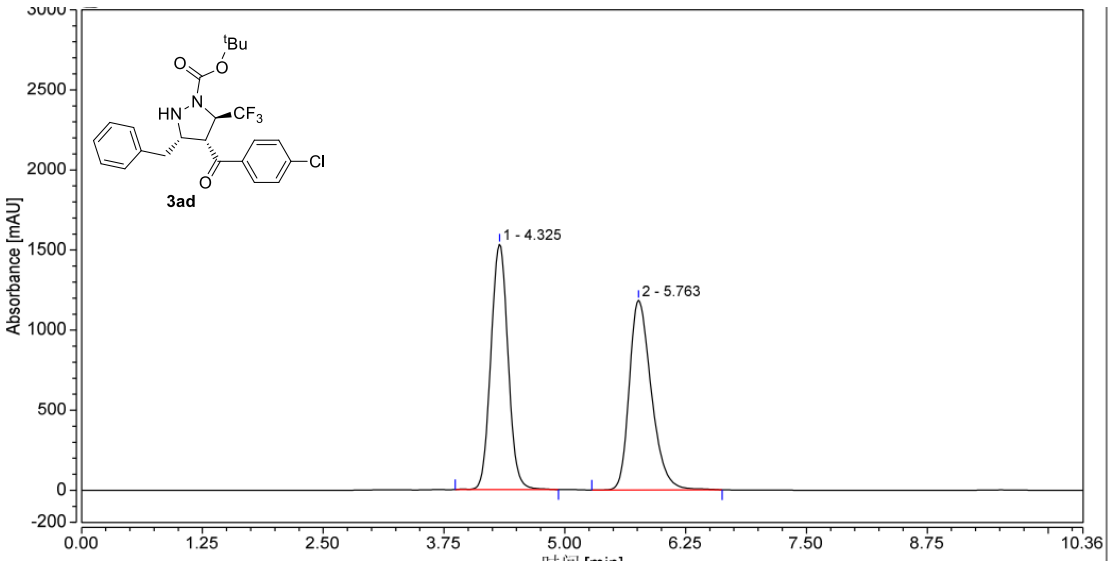
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.613	156.540	782.409	97.33	98.71	n.a.
2		9.883	4.290	10.227	2.67	1.29	n.a.
Total:			**160.829**	**792.636**	**100.00**	**100.00**	



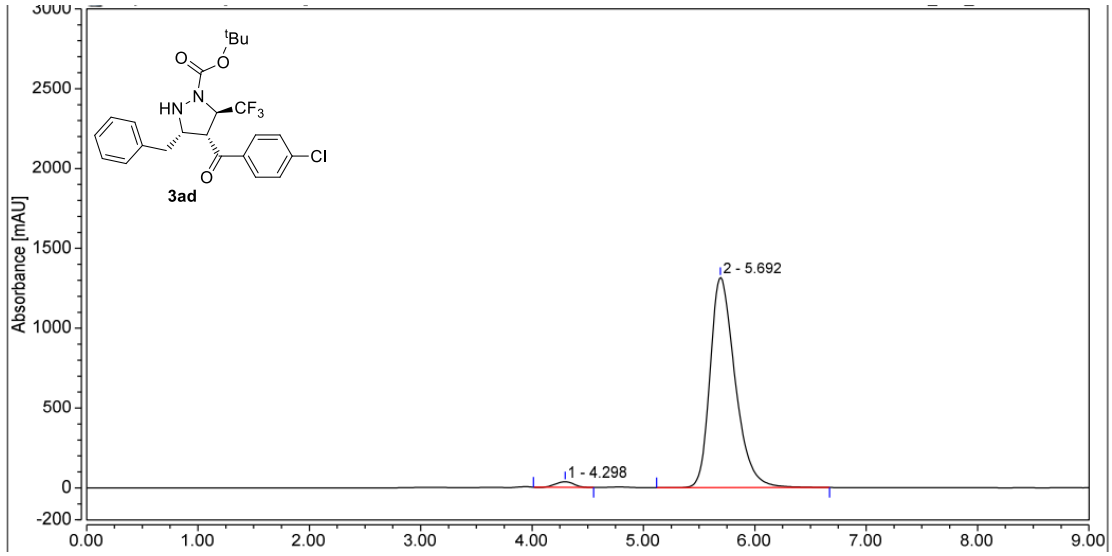
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.857	482.065	1875.921	49.33	65.30	n.a.
2		13.037	495.173	996.739	50.67	34.70	n.a.
Total:			**977.238**	**2872.660**	**100.00**	**100.00**	



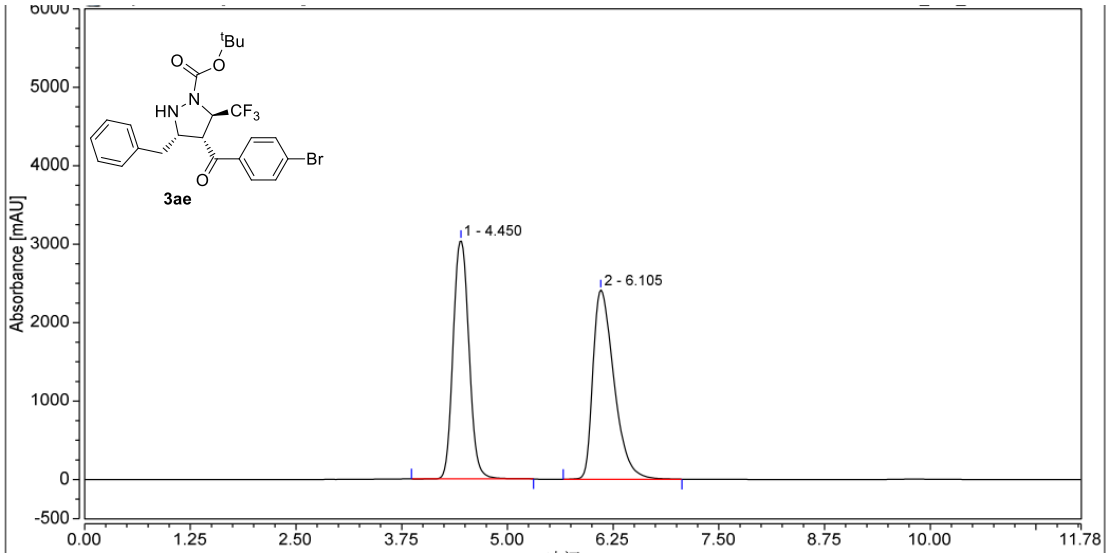
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.810	1232.460	3433.284	96.98	97.77	n.a.
2		13.238	38.396	78.450	3.02	2.23	n.a.
Total:			**1270.856**	**3511.734**	**100.00**	**100.00**	



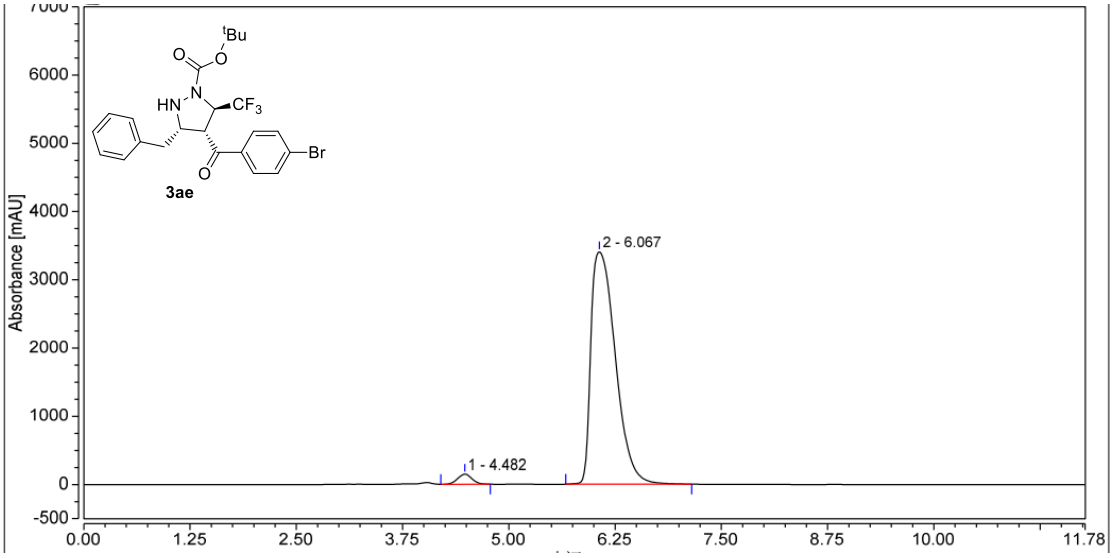
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.325	314.954	1532.471	50.06	56.42	n.a.
2		5.763	314.210	1183.702	49.94	43.58	n.a.
Total:			**629.163**	**2716.173**	**100.00**	**100.00**	



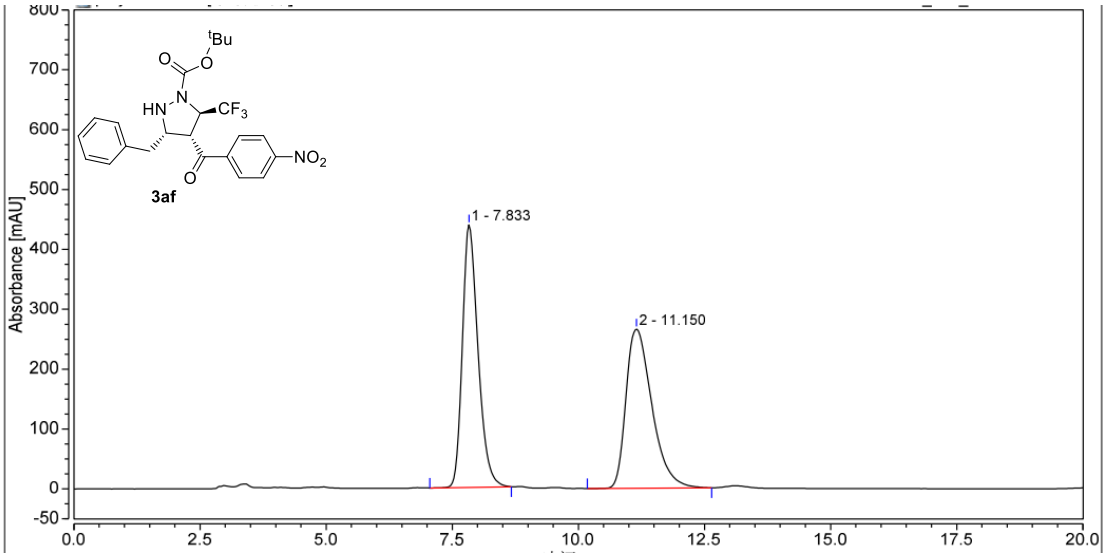
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.298	6.643	35.458	1.90	2.62	n.a.
2		5.692	343.205	1315.838	98.10	97.38	n.a.
Total:			**349.848**	**1351.296**	**100.00**	**100.00**	



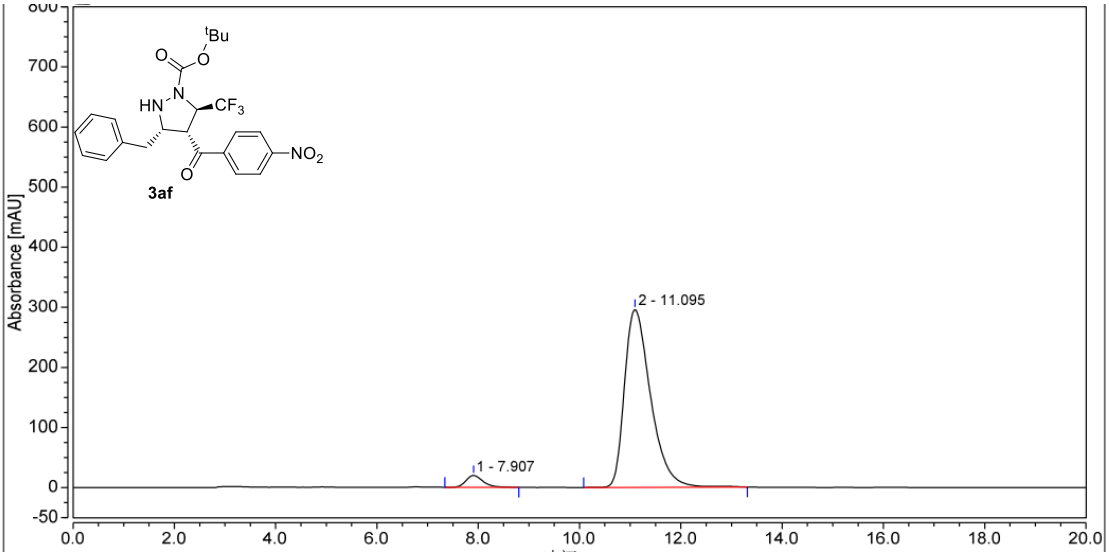
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.450	659.753	3041.594	48.61	55.77	n.a.
2		6.105	697.488	2412.596	51.39	44.23	n.a.
Total:			**1357.241**	**5454.190**	**100.00**	**100.00**	



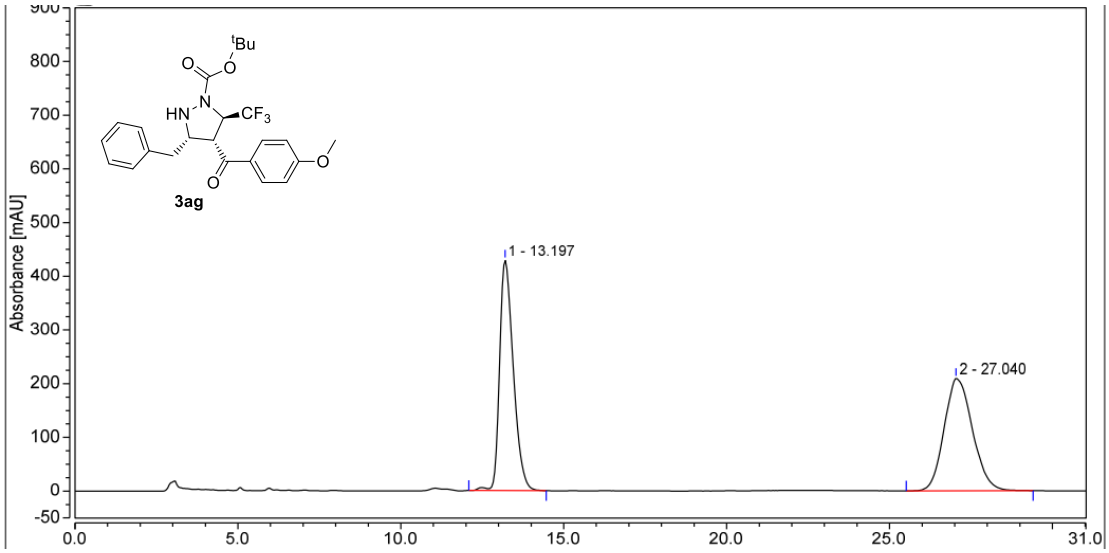
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.482	29.074	149.247	2.49	4.20	n.a.
2		6.067	1136.733	3406.851	97.51	95.80	n.a.
Total:			**1165.807**	**3556.098**	**100.00**	**100.00**	



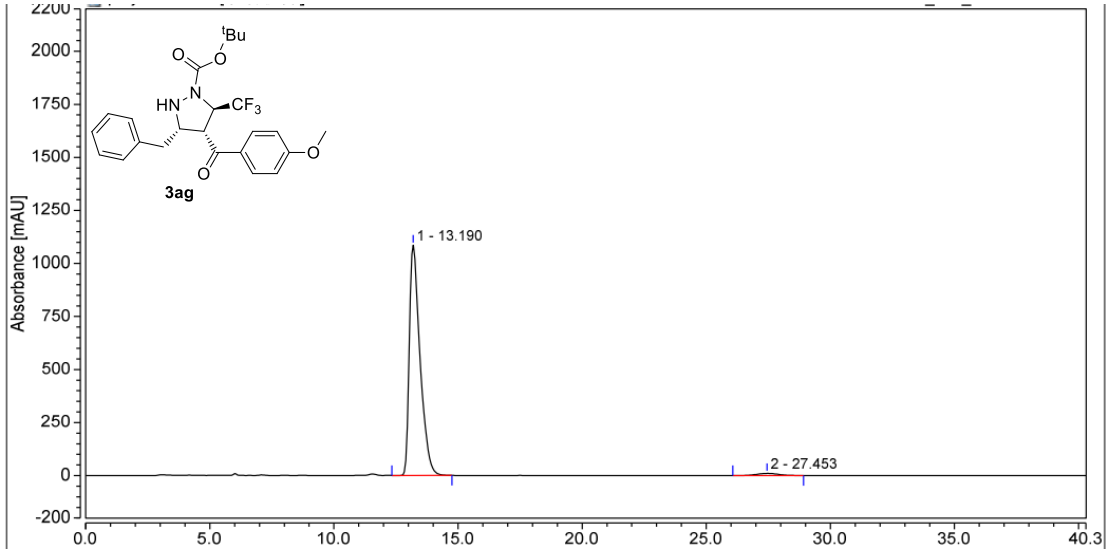
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.833	159.077	438.482	50.13	62.25	n.a.
2		11.150	158.232	265.870	49.87	37.75	n.a.
Total:			**317.308**	**704.352**	**100.00**	**100.00**	



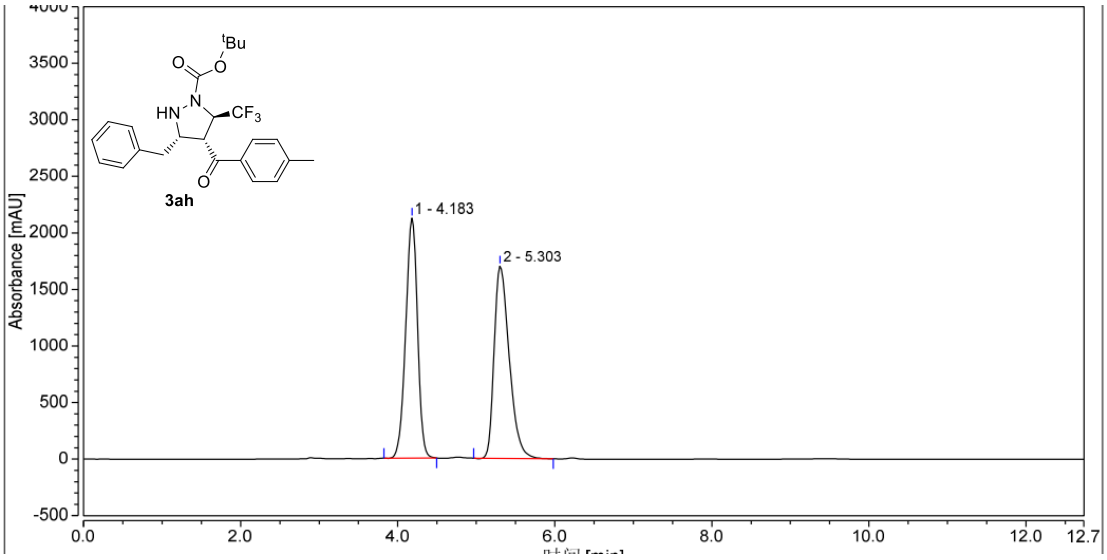
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.907	7.617	19.641	4.13	6.23	n.a.
2		11.095	177.032	295.768	95.87	93.77	n.a.
Total:			**184.648**	**315.409**	**100.00**	**100.00**	



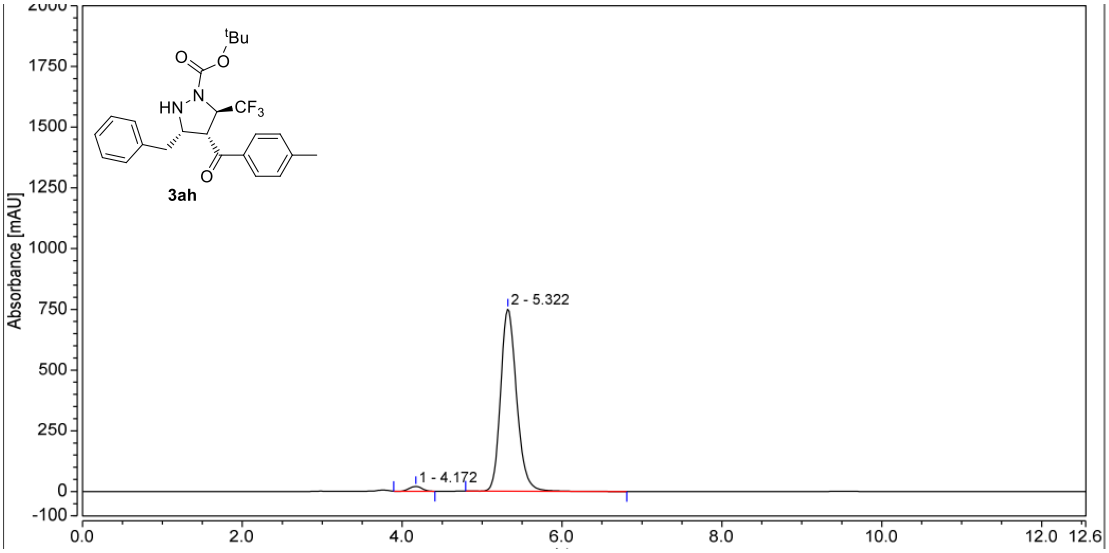
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		13.197	209.031	429.071	49.83	67.21	n.a.
2		27.040	210.467	209.359	50.17	32.79	n.a.
Total:			**419.498**	**638.430**	**100.00**	**100.00**	



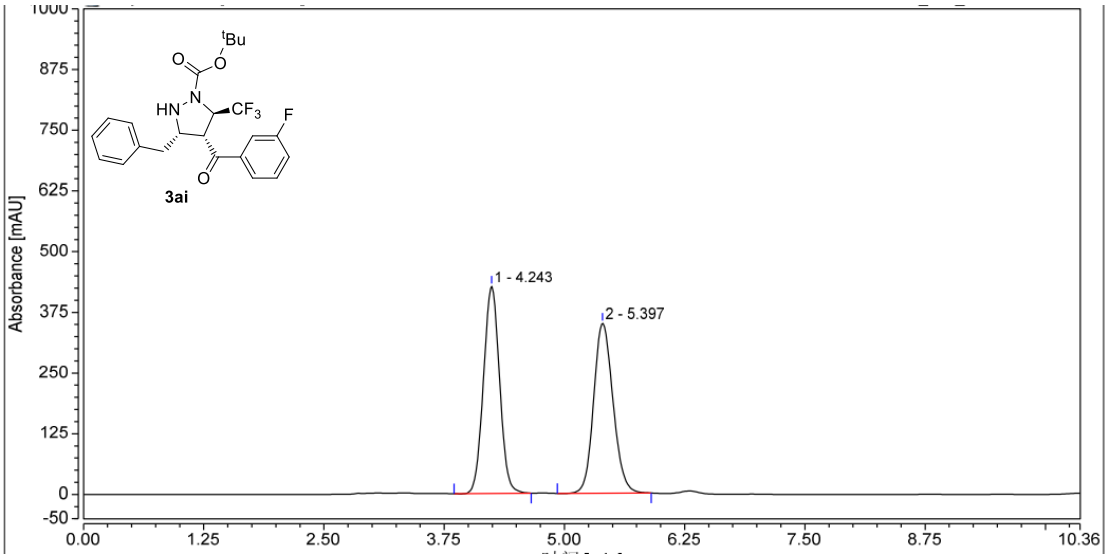
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		13.190	543.448	1085.227	98.15	99.07	n.a.
2		27.453	10.215	10.143	1.85	0.93	n.a.
Total:			**553.663**	**1095.370**	**100.00**	**100.00**	



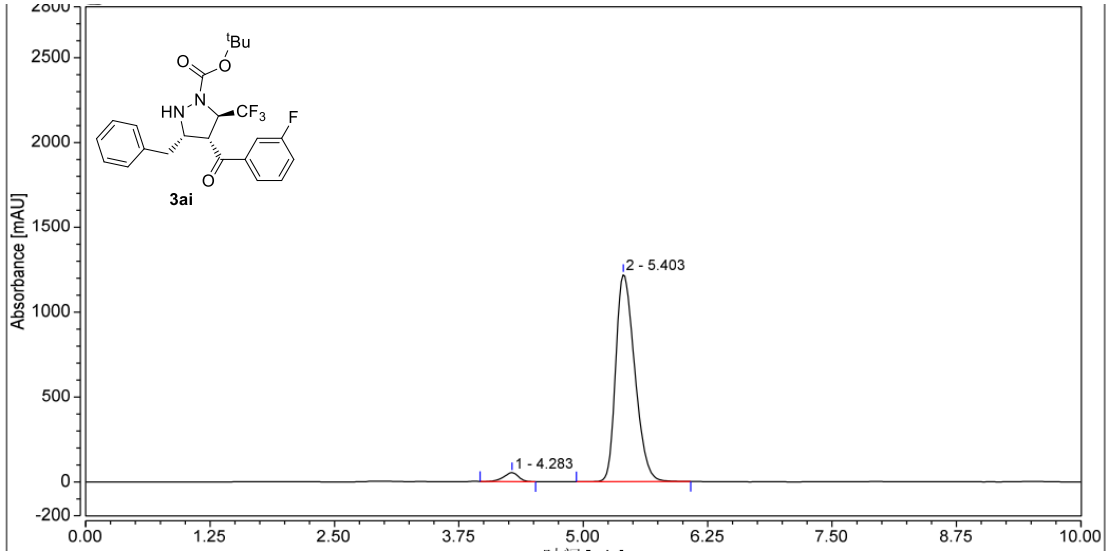
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.183	369.236	2123.138	49.35	55.51	n.a.
2		5.303	378.906	1701.306	50.65	44.49	n.a.
Total:			**748.142**	**3824.444**	**100.00**	**100.00**	



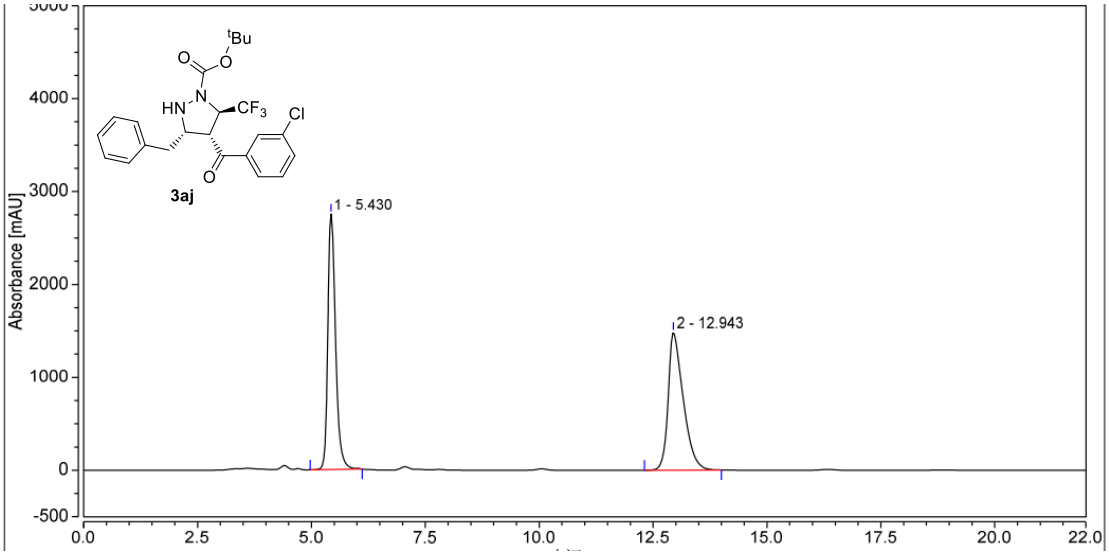
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.172	3.631	19.966	2.05	2.59	n.a.
2		5.322	173.807	750.209	97.95	97.41	n.a.
Total:			**177.438**	**770.175**	**100.00**	**100.00**	



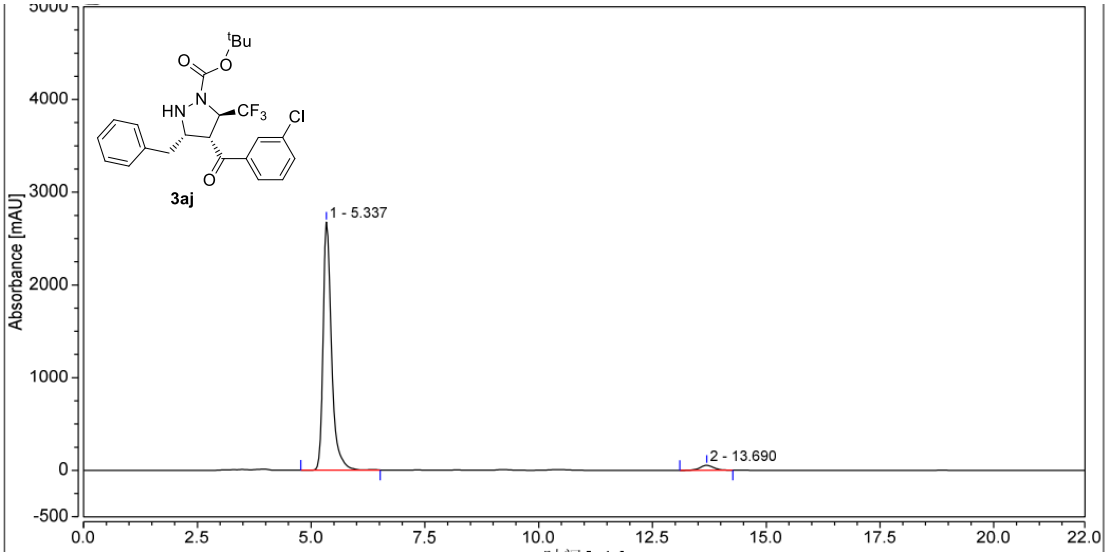
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.243	82.769	426.799	50.31	54.91	n.a.
2		5.397	81.763	350.540	49.69	45.09	n.a.
Total:			**164.532**	**777.339**	**100.00**	**100.00**	



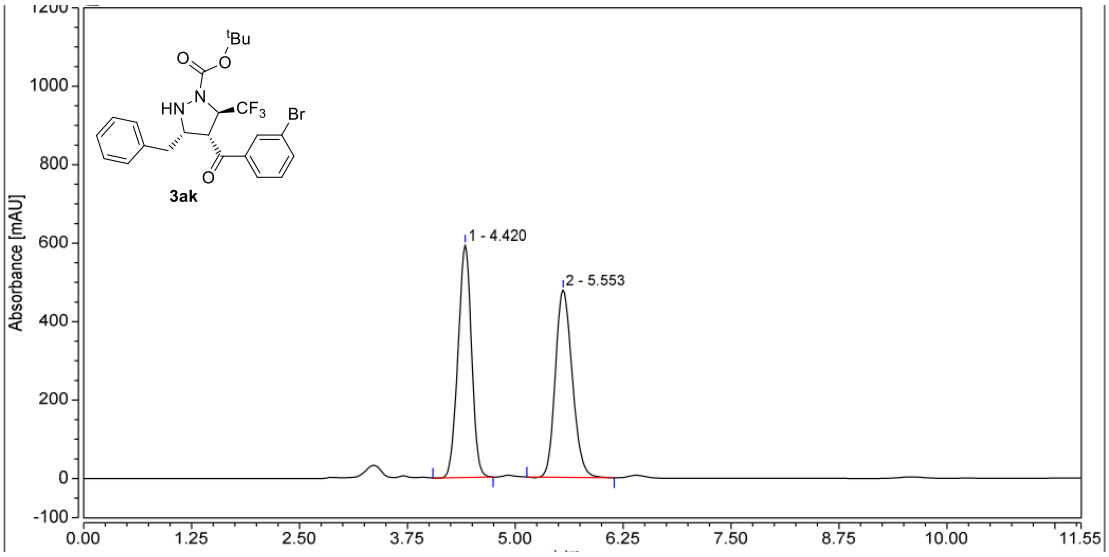
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.283	9.018	52.642	3.23	4.13	n.a.
2		5.403	270.234	1220.713	96.77	95.87	n.a.
Total:			**279.252**	**1273.355**	**100.00**	**100.00**	



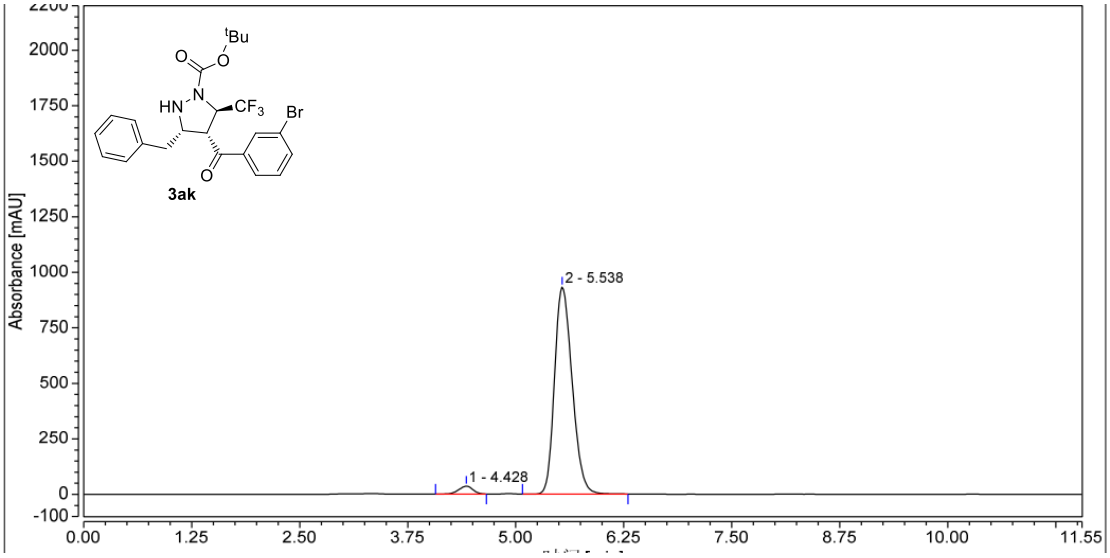
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.430	536.619	2750.032	48.71	64.97	n.a.
2		12.943	564.956	1482.917	51.29	35.03	n.a.
Total:			**1101.576**	**4232.949**	**100.00**	**100.00**	



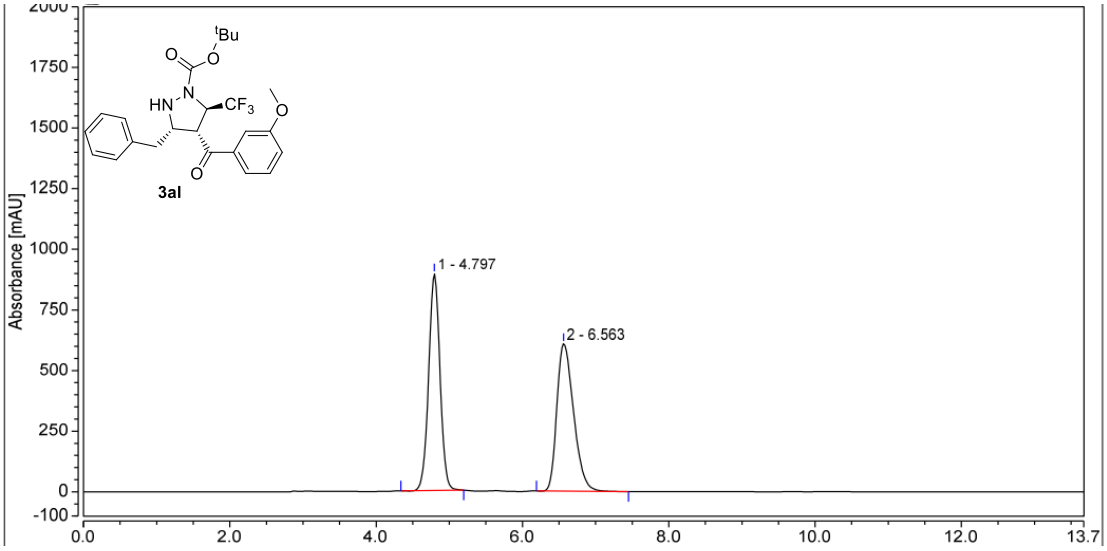
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.337	573.781	2674.915	96.87	98.07	n.a.
2		13.690	18.516	52.750	3.13	1.93	n.a.
Total:			**592.297**	**2727.665**	**100.00**	**100.00**	



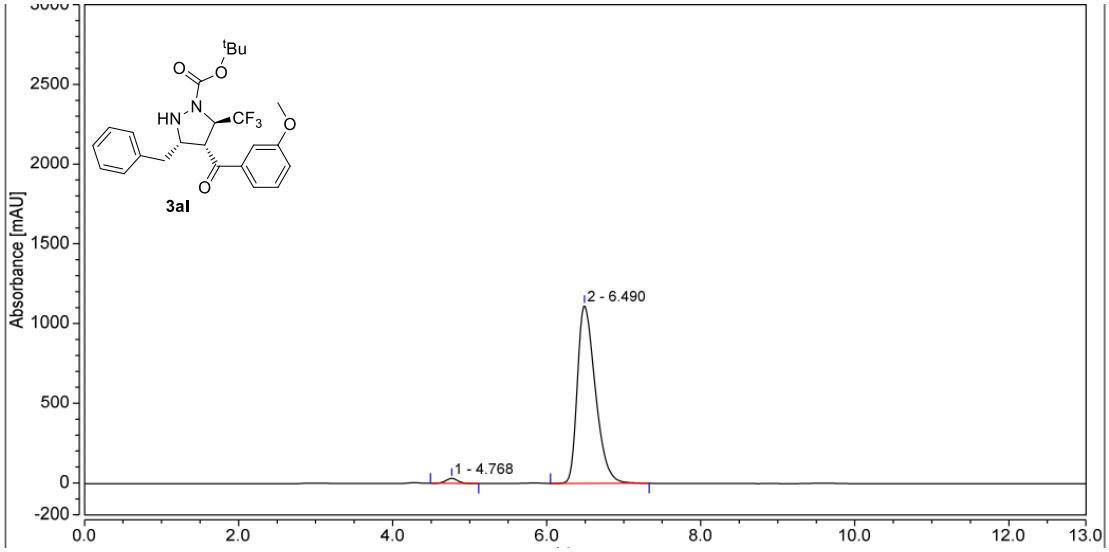
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.420	107.439	592.961	49.81	55.39	n.a.
2		5.553	108.263	477.557	50.19	44.61	n.a.
Total:			**215.702**	**1070.518**	**100.00**	**100.00**	



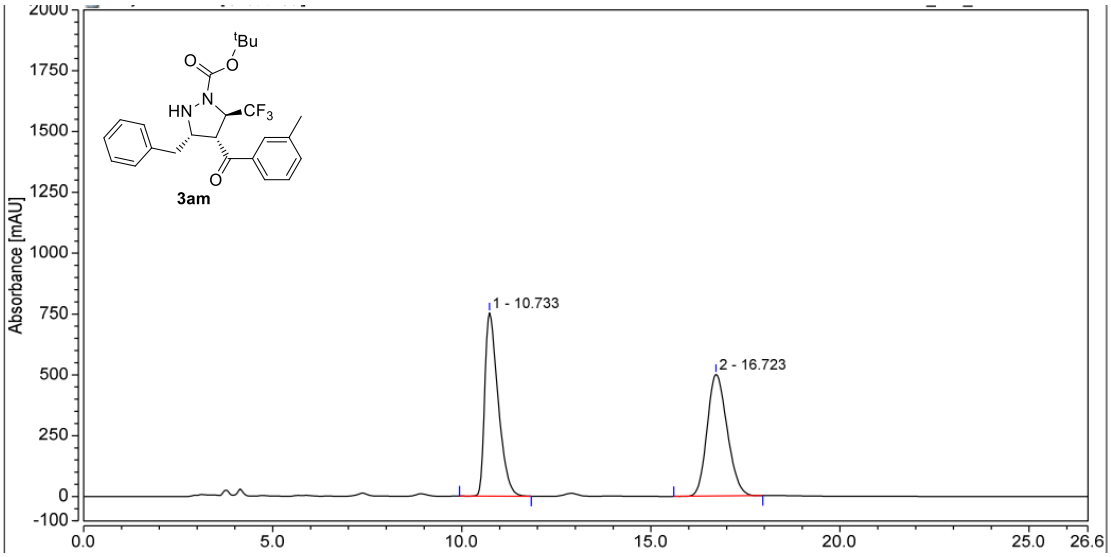
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.428	6.770	35.526	2.98	3.67	n.a.
2		5.538	220.378	932.291	97.02	96.33	n.a.
Total:			**227.148**	**967.817**	**100.00**	**100.00**	



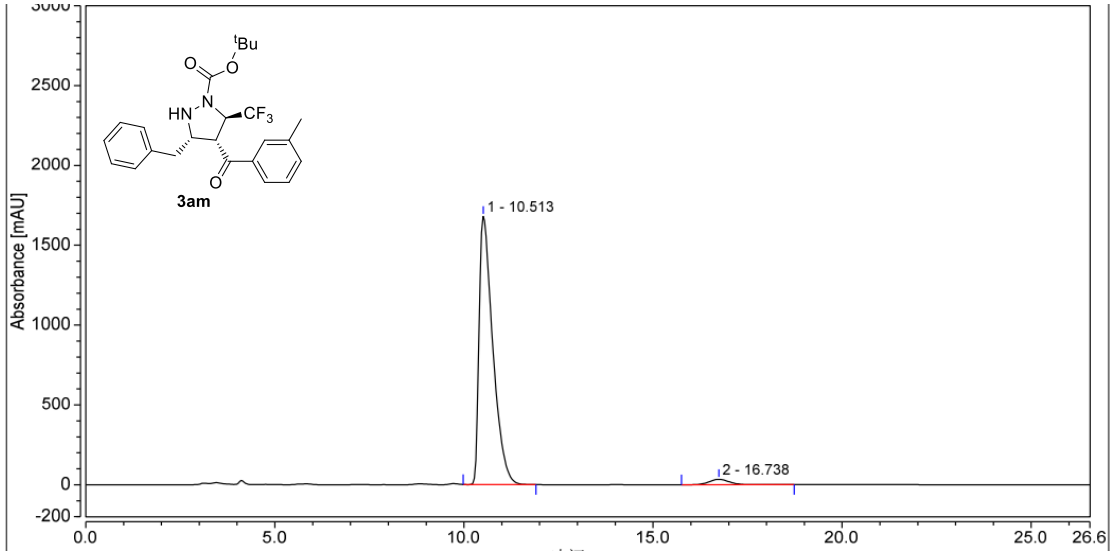
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.797	160.599	893.796	49.95	59.51	n.a.
2		6.563	160.924	608.235	50.05	40.49	n.a.
Total:			**321.523**	**1502.032**	**100.00**	**100.00**	



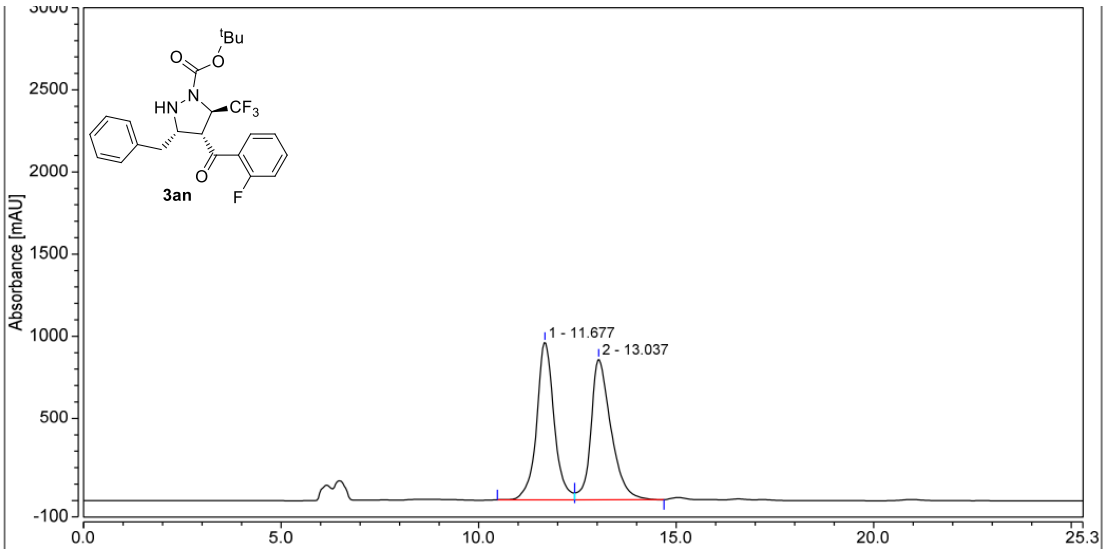
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.768	5.411	31.154	1.76	2.72	n.a.
2		6.490	301.895	1115.796	98.24	97.28	n.a.
Total:			**307.306**	**1146.950**	**100.00**	**100.00**	



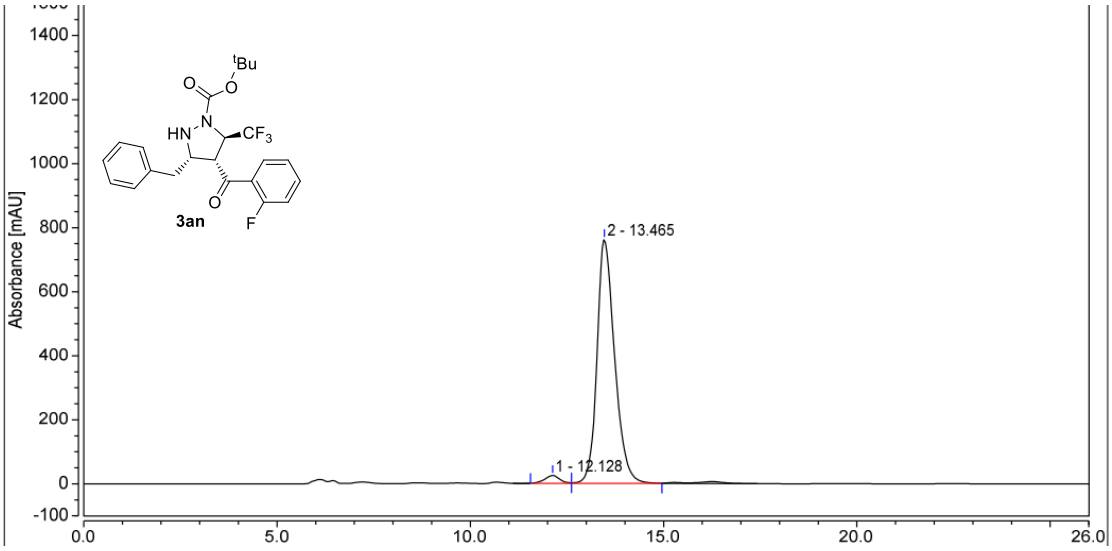
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		10.733	308.830	753.376	50.08	60.10	n.a.
2		16.723	307.873	500.177	49.92	39.90	n.a.
Total:			**616.703**	**1253.553**	**100.00**	**100.00**	



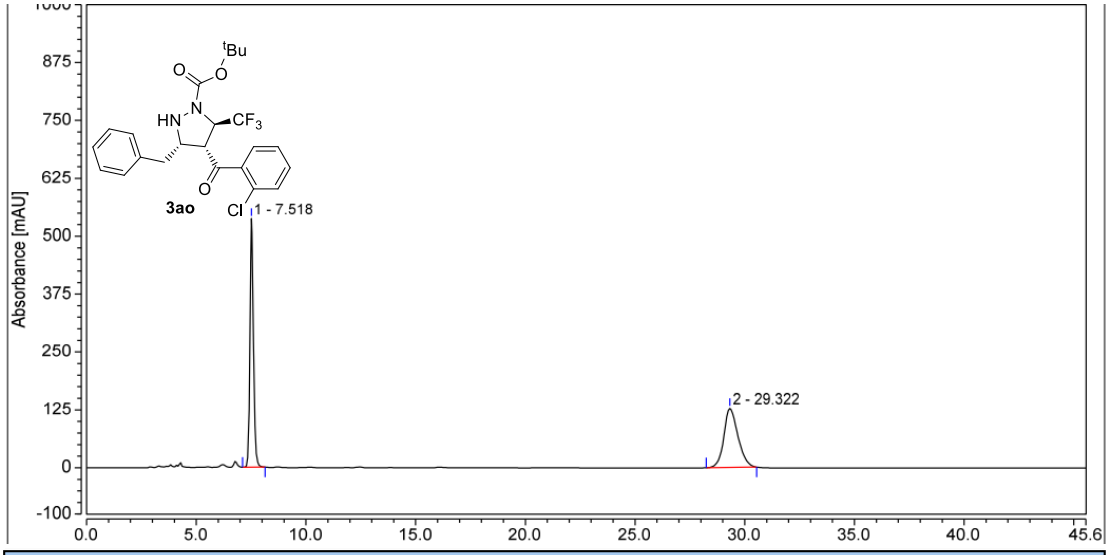
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		10.513	705.585	1679.657	97.16	98.04	n.a.
2		16.738	20.610	33.530	2.84	1.96	n.a.
Total:			**726.195**	**1713.187**	**100.00**	**100.00**	



Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		11.677	490.661	958.402	49.45	52.83	n.a.
2		13.037	501.521	855.784	50.55	47.17	n.a.
Total:			**992.183**	**1814.186**	**100.00**	**100.00**	

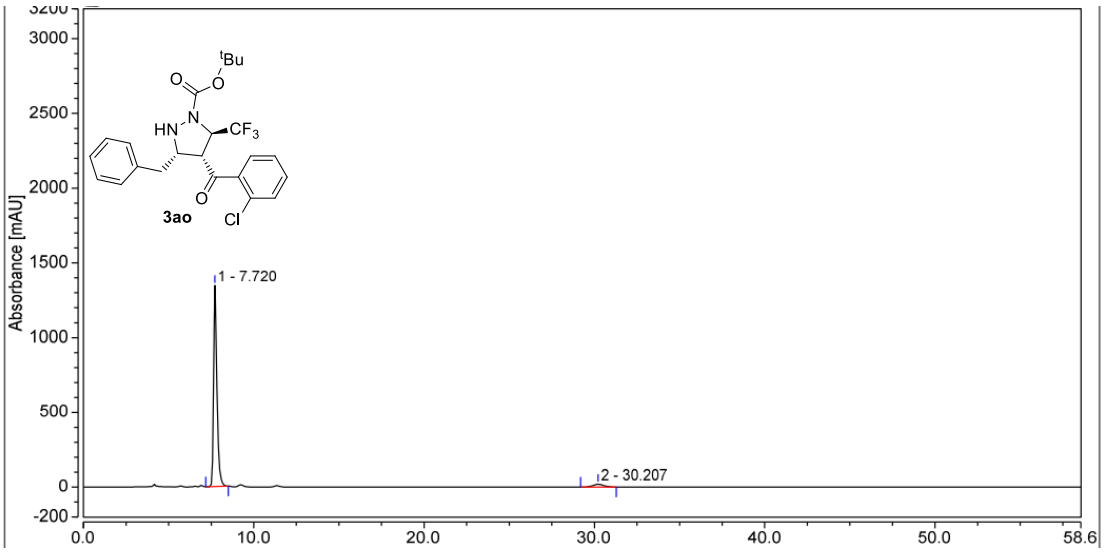


Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.128	11.309	24.900	2.73	3.17	n.a.
2		13.465	403.565	761.525	97.27	96.83	n.a.
Total:			**414.873**	**786.425**	**100.00**	**100.00**	



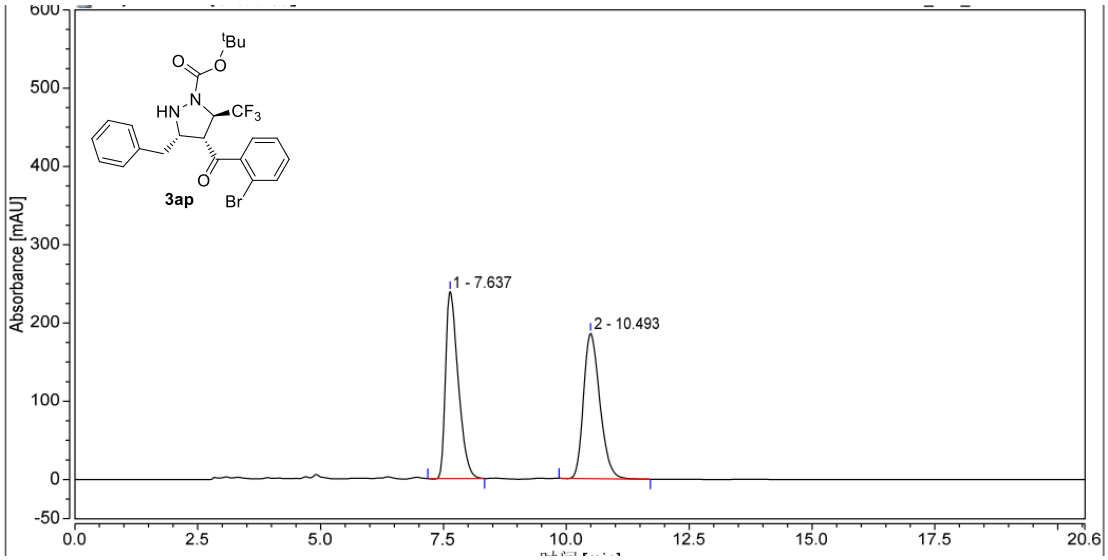
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.518	97.052	537.169	50.46	80.79	n.a.
2		29.322	95.268	127.712	49.54	19.21	n.a.
Total:			**192.320**	**664.882**	**100.00**	**100.00**	

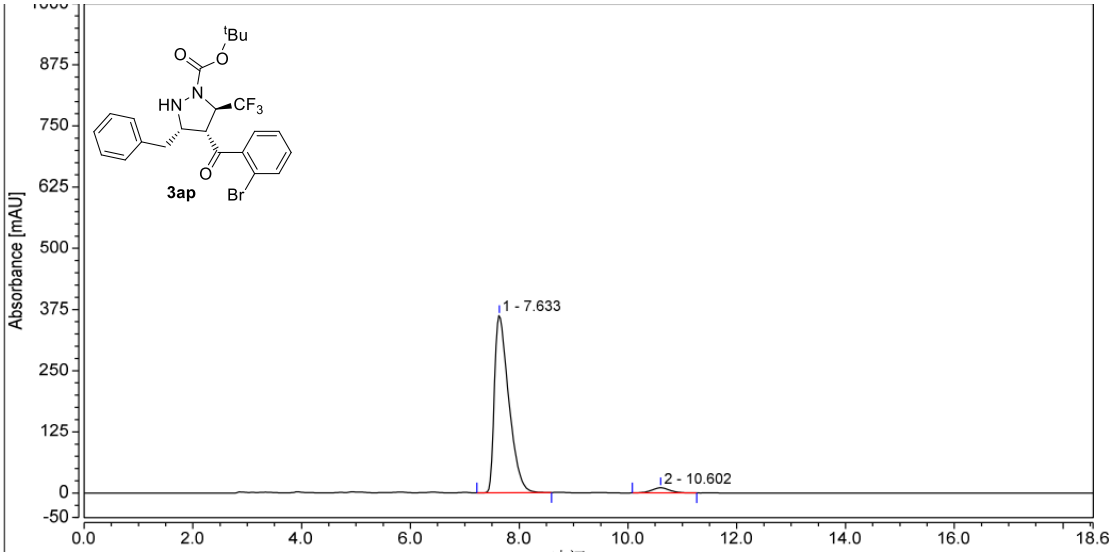


Integration Results

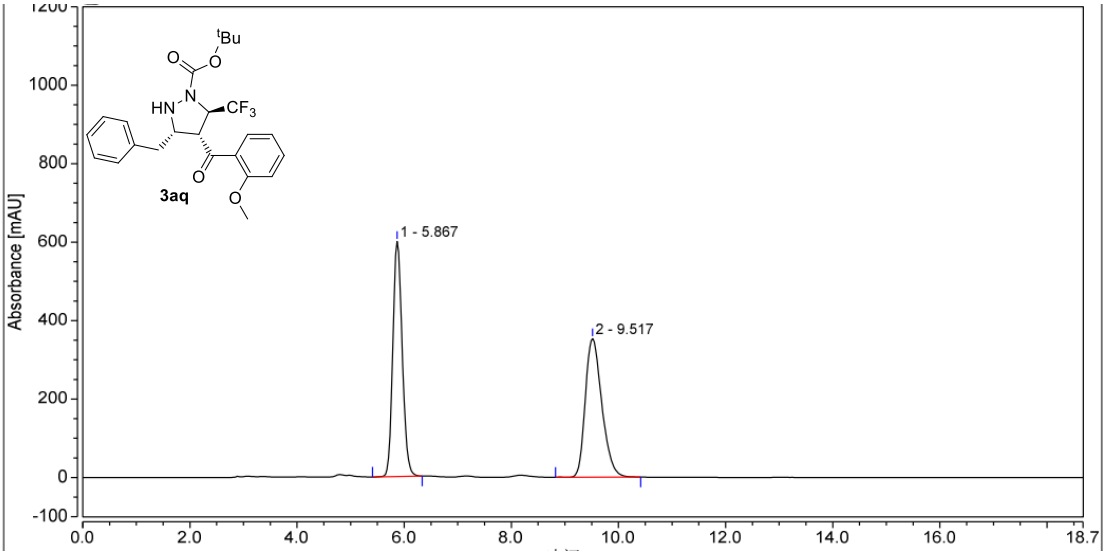
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.720	297.437	1344.208	95.55	98.63	n.a.
2		30.207	13.852	18.626	4.45	1.37	n.a.
Total:			**311.289**	**1362.834**	**100.00**	**100.00**	



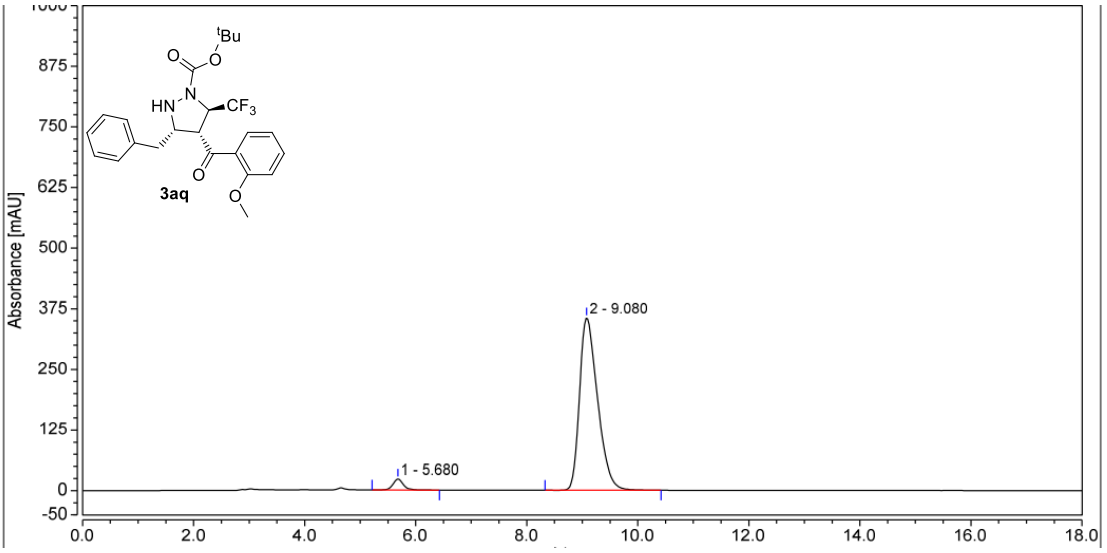
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.637	71.194	238.782	49.91	56.24	n.a.
2		10.493	71.460	185.824	50.09	43.76	n.a.
Total:			**142.654**	**424.606**	**100.00**	**100.00**	



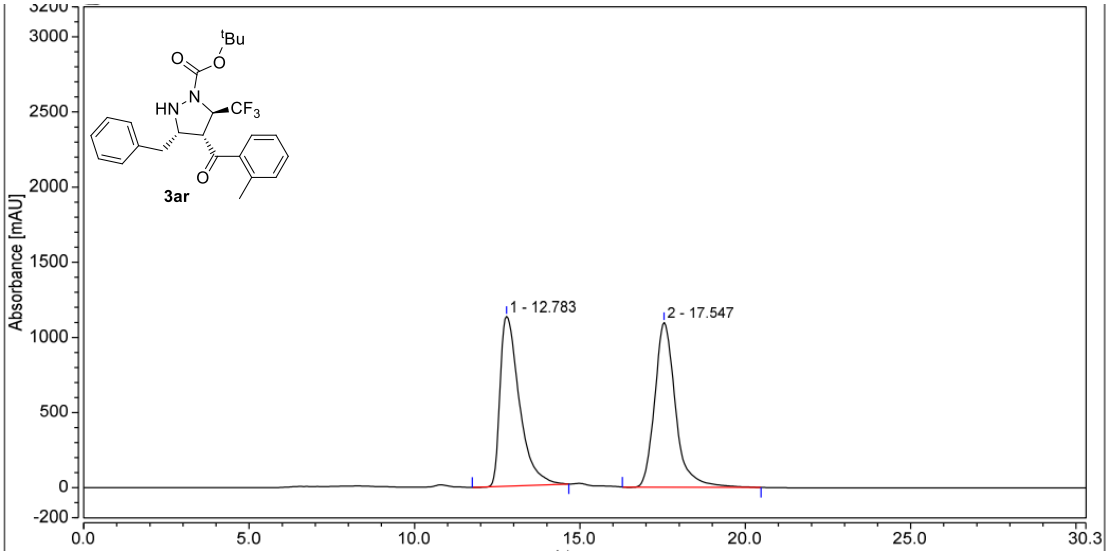
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.633	110.797	362.347	96.42	97.19	n.a.
2		10.602	4.111	10.483	3.58	2.81	n.a.
Total:			**114.908**	**372.830**	**100.00**	**100.00**	



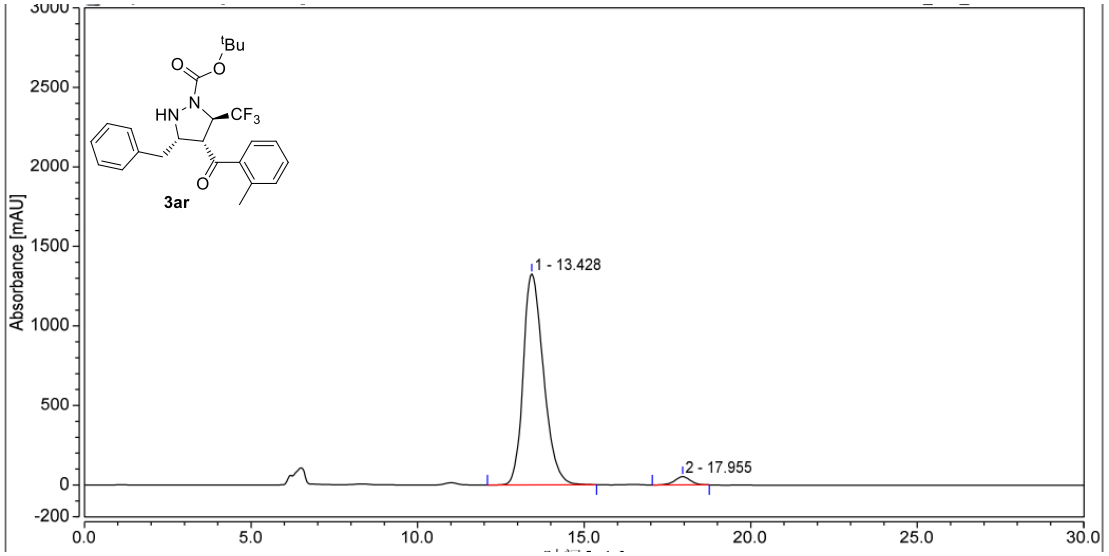
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.867	121.895	599.392	49.11	62.93	n.a.
2		9.517	126.312	353.052	50.89	37.07	n.a.
Total:			**248.207**	**952.444**	**100.00**	**100.00**	



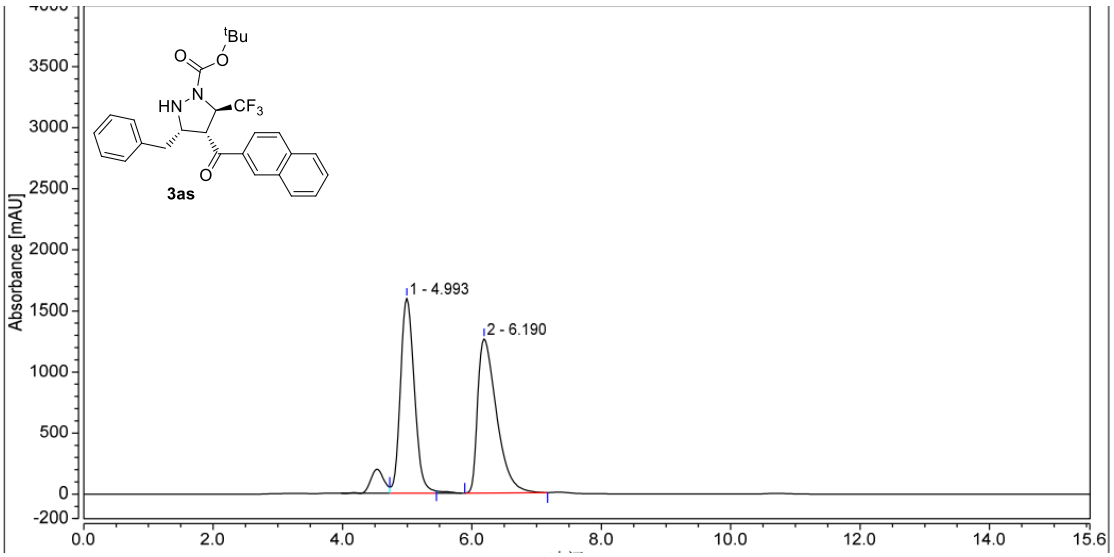
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.680	5.054	22.952	3.64	6.06	n.a.
2		9.080	133.709	355.713	96.36	93.94	n.a.
Total:			**138.763**	**378.665**	**100.00**	**100.00**	



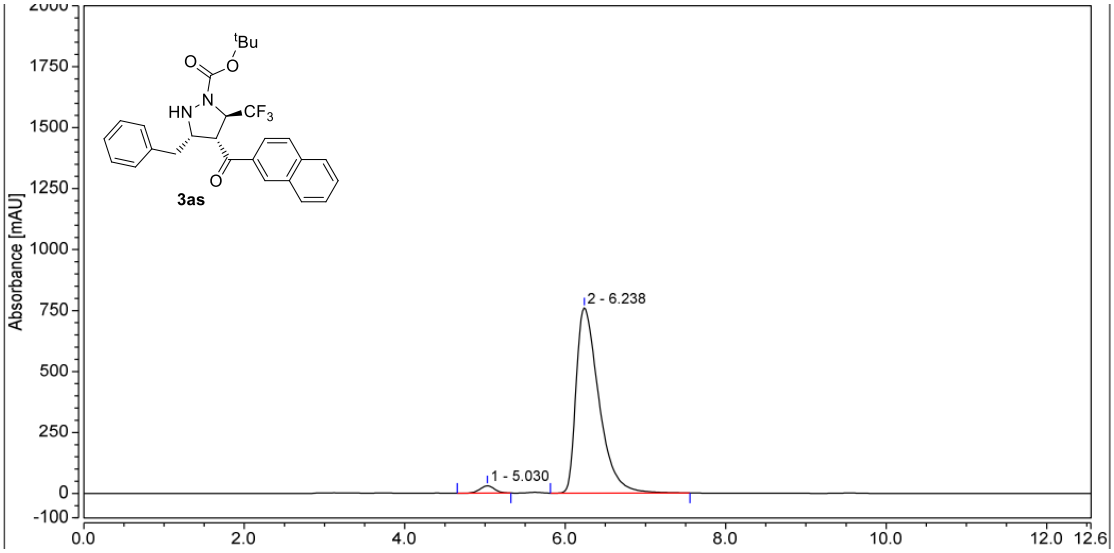
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.783	765.479	1129.895	48.96	50.76	n.a.
2		17.547	797.993	1095.866	51.04	49.24	n.a.
Total:			**1563.472**	**2225.761**	**100.00**	**100.00**	



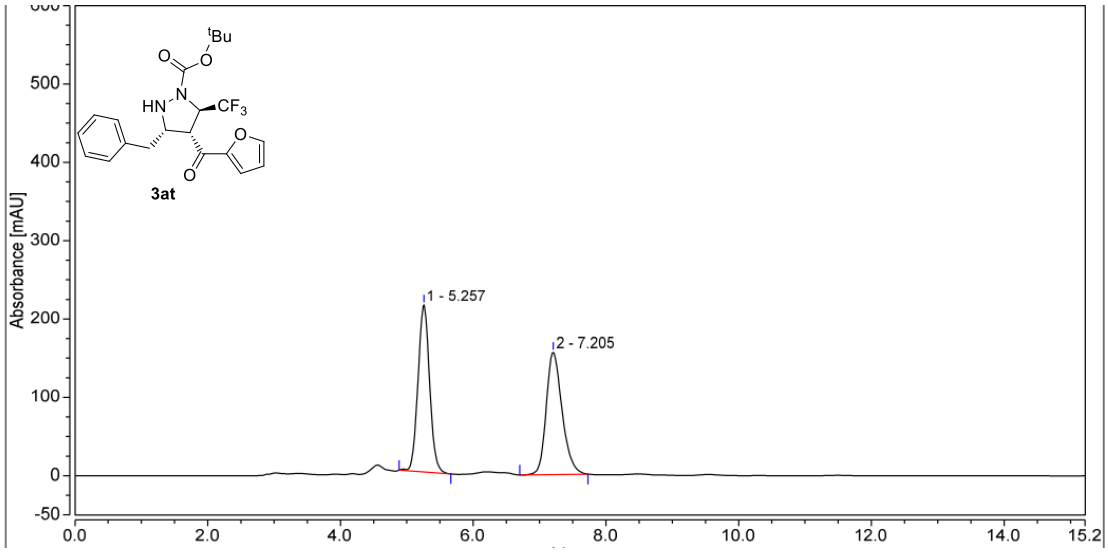
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		13.428	938.401	1326.476	97.03	96.22	n.a.
2		17.955	28.706	52.165	2.97	3.78	n.a.
Total:			**967.107**	**1378.640**	**100.00**	**100.00**	



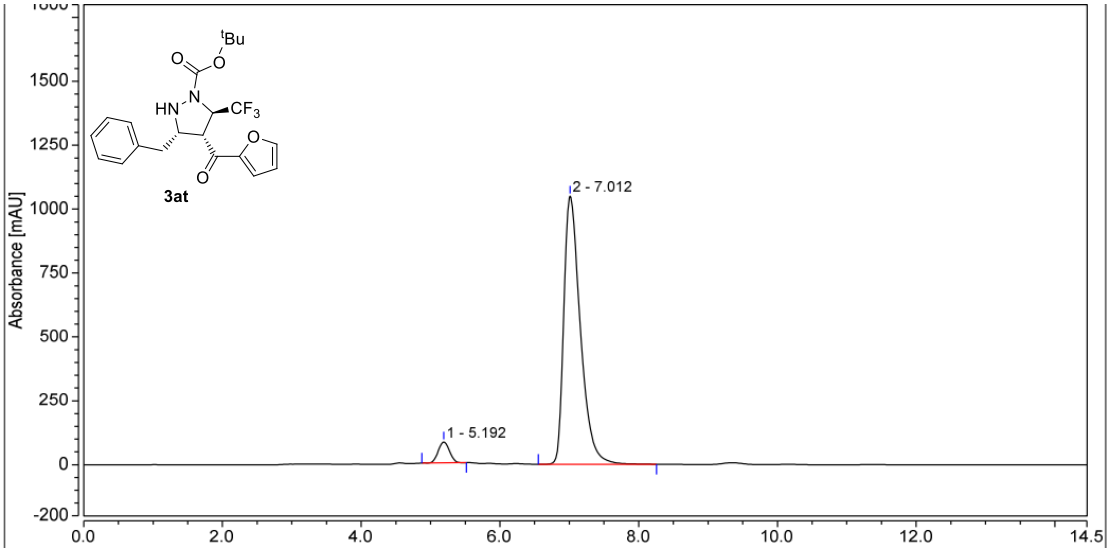
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.993	398.179	1596.408	48.30	55.84	n.a.
2		6.190	426.232	1262.644	51.70	44.16	n.a.
Total:			**824.410**	**2859.052**	**100.00**	**100.00**	



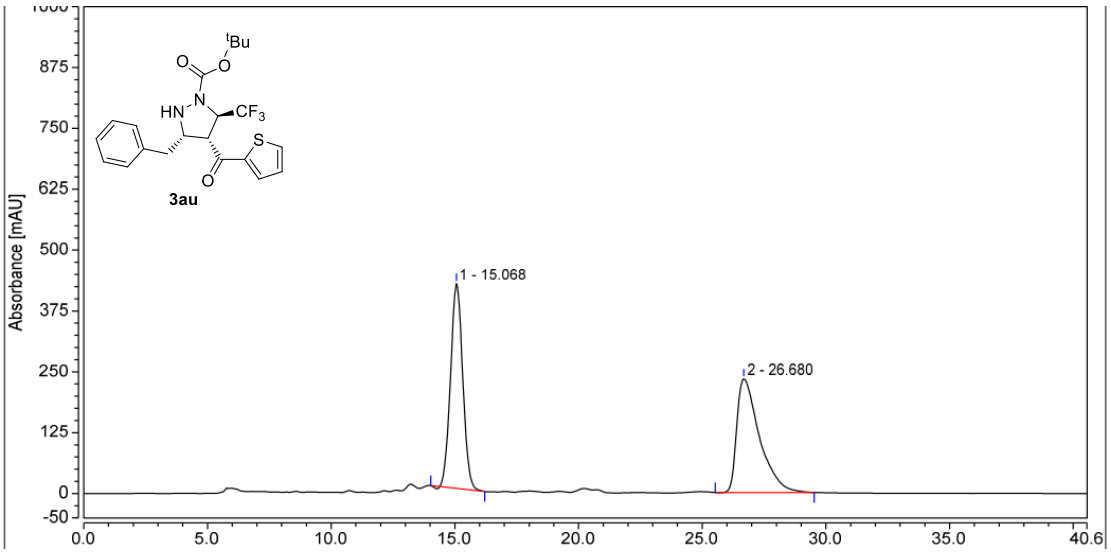
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.030	6.424	30.127	2.50	3.82	n.a.
2		6.238	250.149	759.577	97.50	96.18	n.a.
Total:			**256.573**	**789.704**	**100.00**	**100.00**	



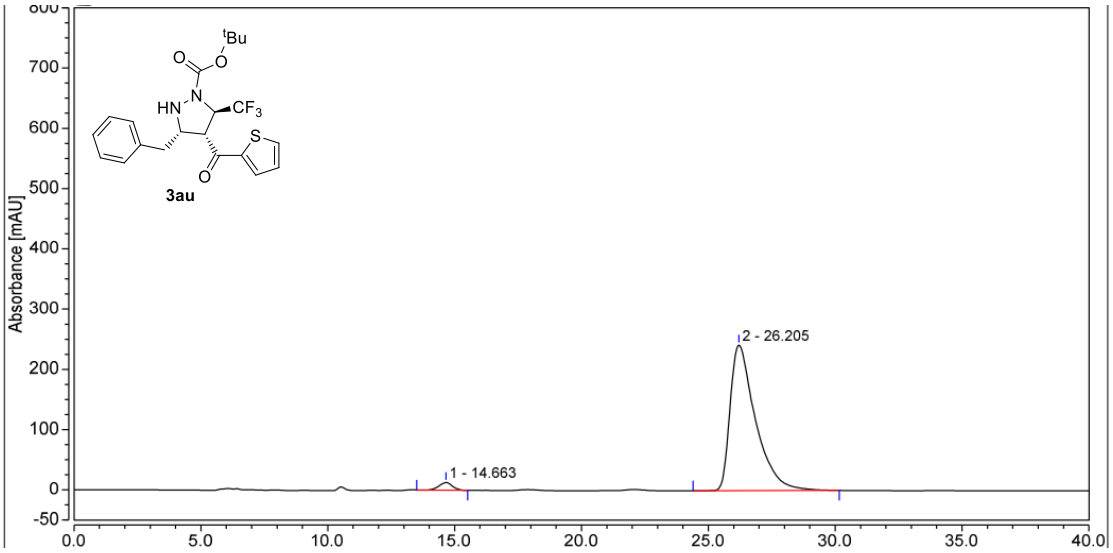
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.257	43.259	213.249	49.97	57.71	n.a.
2		7.205	43.308	156.257	50.03	42.29	n.a.
Total:			**86.567**	**369.506**	**100.00**	**100.00**	



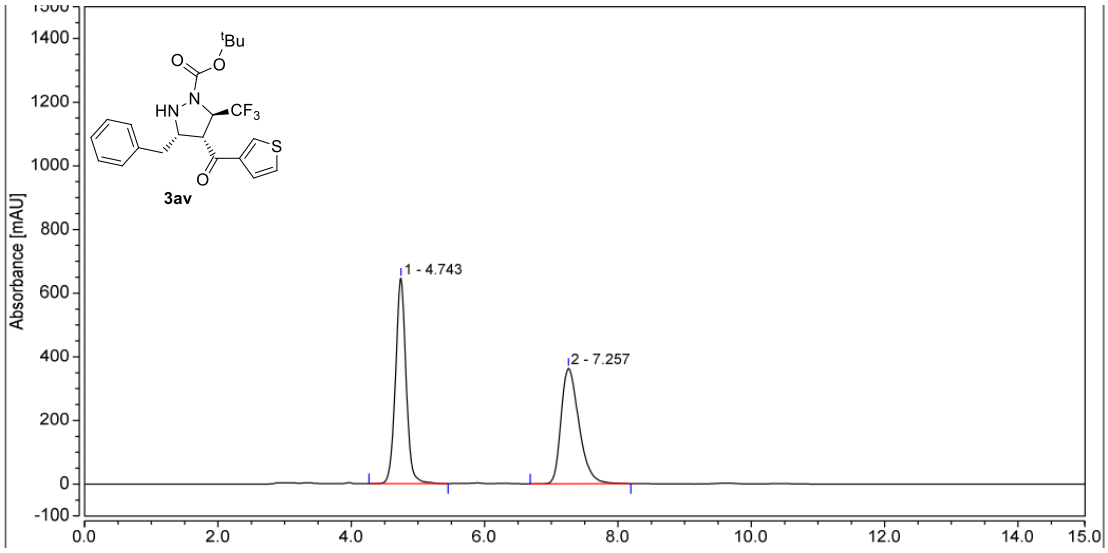
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.192	15.127	81.869	4.96	7.23	n.a.
2		7.012	289.671	1049.982	95.04	92.77	n.a.
Total:			**304.798**	**1131.851**	**100.00**	**100.00**	



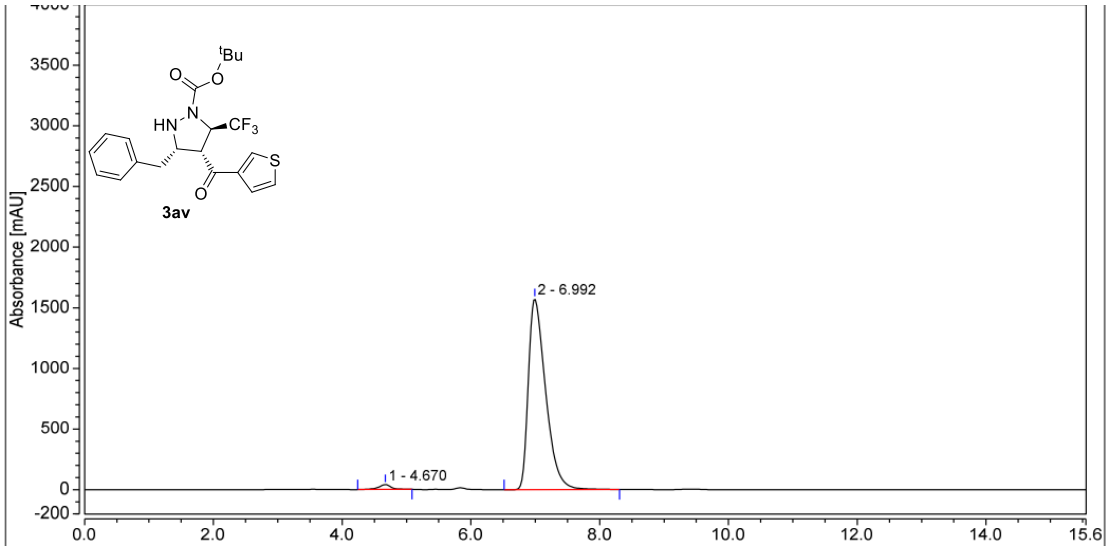
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		15.068	239.728	420.456	49.19	64.30	n.a.
2		26.680	247.597	233.393	50.81	35.70	n.a.
Total:			**487.325**	**653.849**	**100.00**	**100.00**	



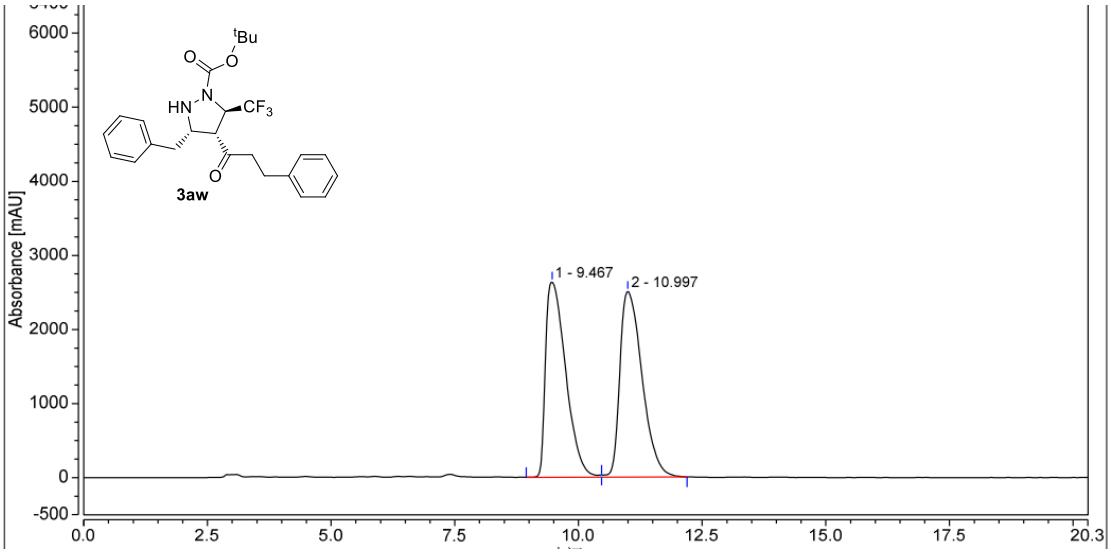
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		14.663	7.765	12.853	2.70	5.05	n.a.
2		26.205	280.079	241.829	97.30	94.95	n.a.
Total:			**287.844**	**254.682**	**100.00**	**100.00**	



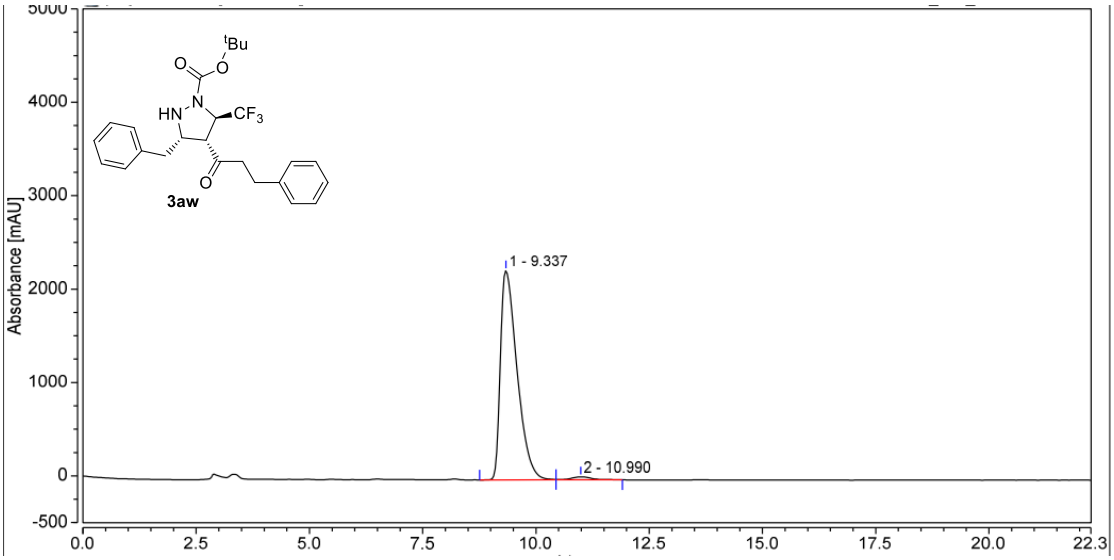
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.743	118.979	645.029	51.21	64.00	n.a.
2		7.257	113.366	362.848	48.79	36.00	n.a.
Total:			**232.345**	**1007.877**	**100.00**	**100.00**	



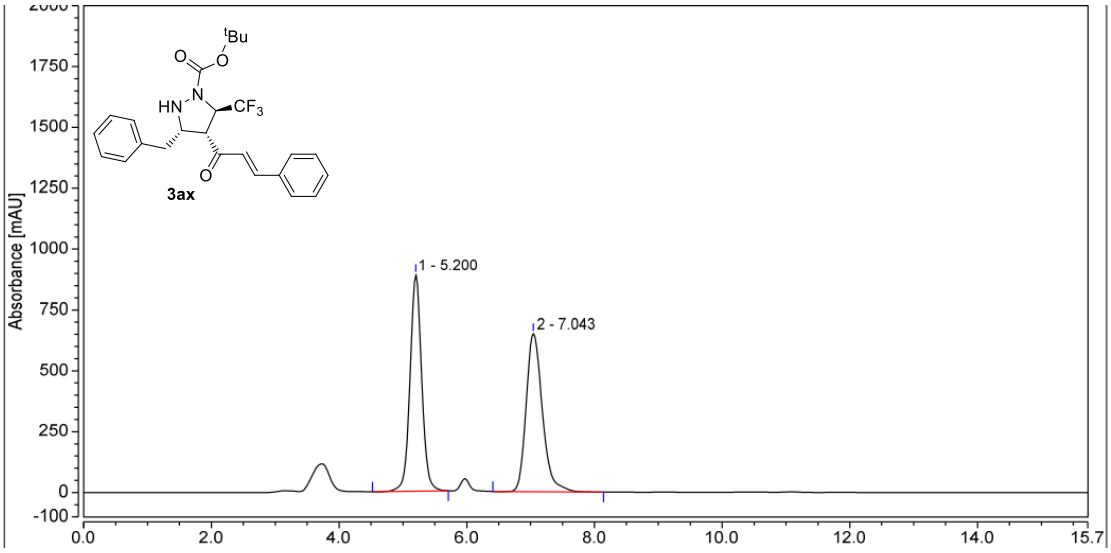
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.670	9.060	40.493	1.82	2.51	n.a.
2		6.992	489.705	1572.932	98.18	97.49	n.a.
Total:			**498.765**	**1613.425**	**100.00**	**100.00**	



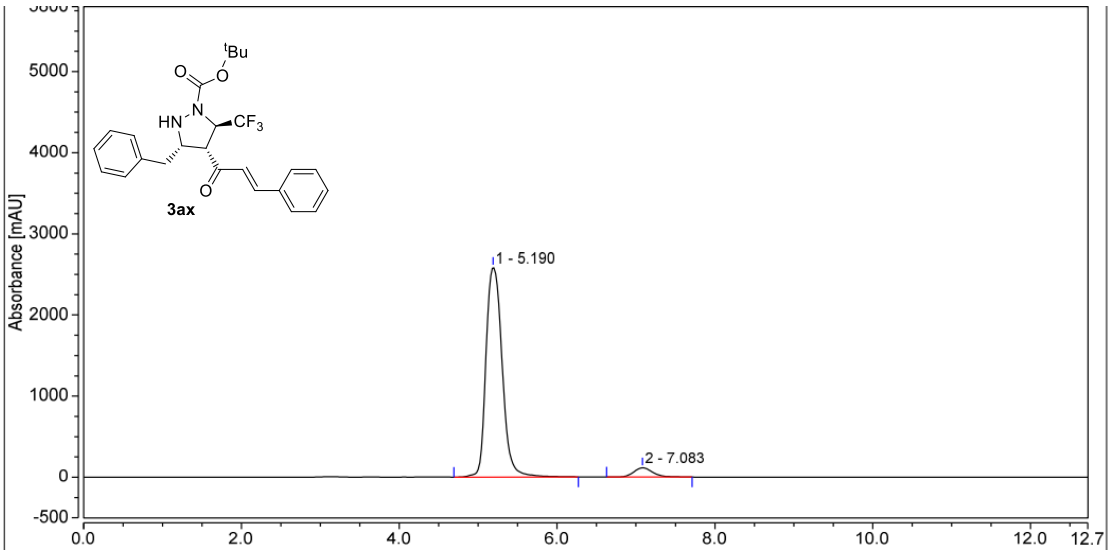
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		9.467	1246.183	2637.485	48.85	51.26	n.a.
2		10.997	1304.925	2507.632	51.15	48.74	n.a.
Total:			**2551.108**	**5145.117**	**100.00**	**100.00**	



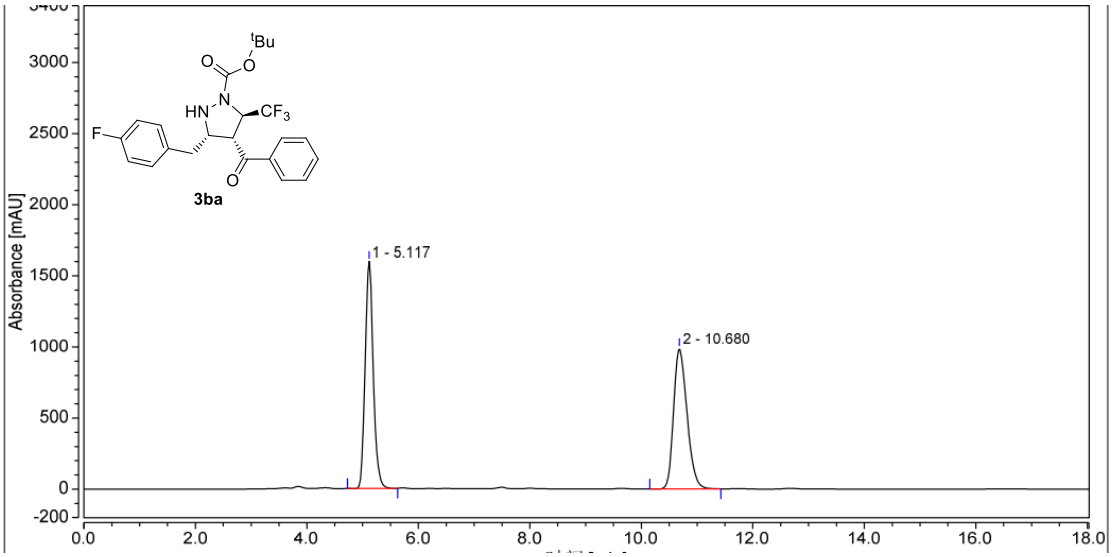
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		9.337	956.475	2239.997	98.37	98.61	n.a.
2		10.990	15.849	31.628	1.63	1.39	n.a.
Total:			**972.324**	**2271.625**	**100.00**	**100.00**	



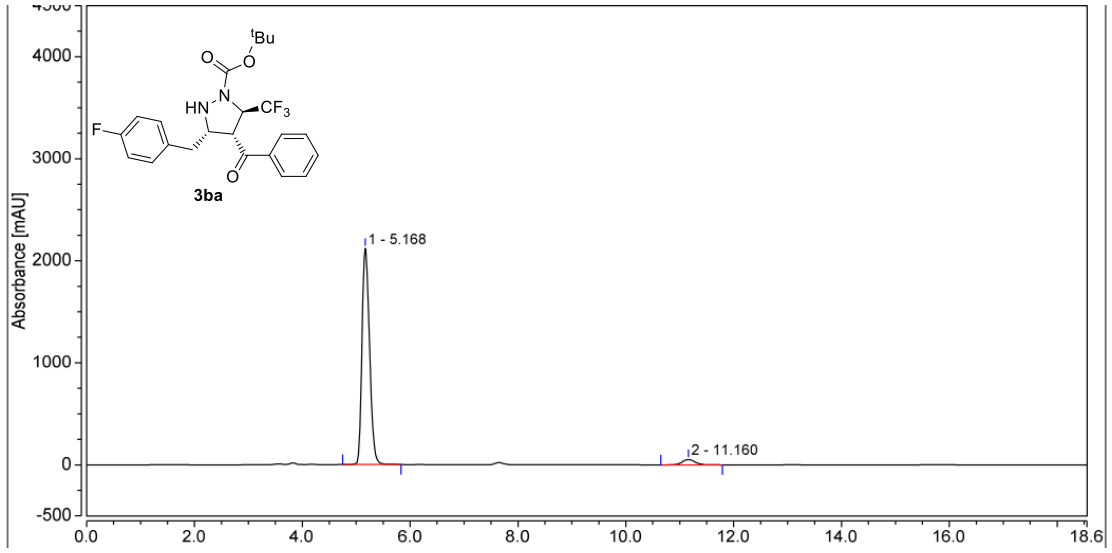
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.200	188.330	890.642	49.58	57.81	n.a.
2		7.043	191.522	650.007	50.42	42.19	n.a.
Total:			**379.852**	**1540.648**	**100.00**	**100.00**	



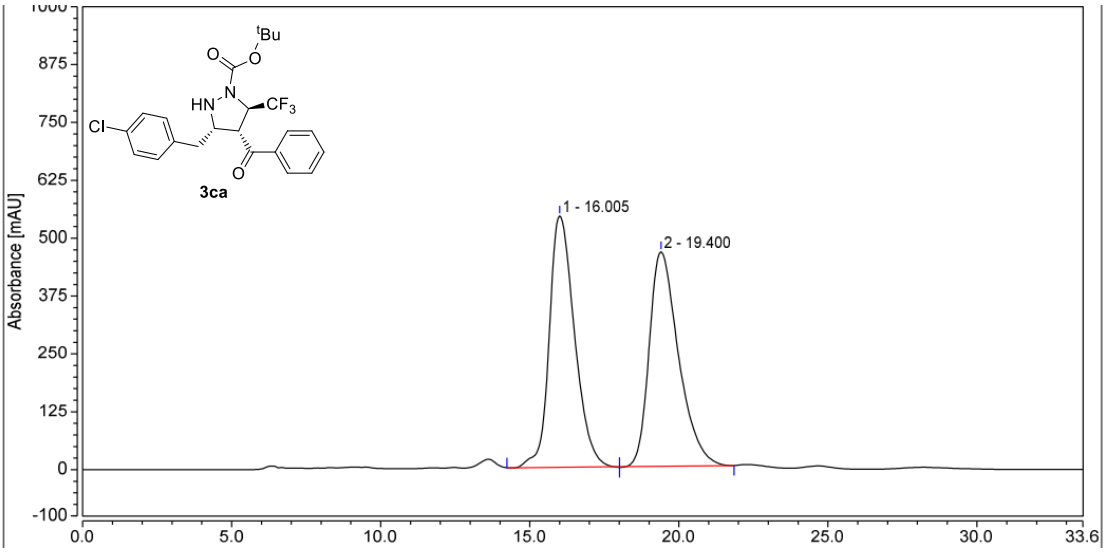
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.190	614.429	2585.115	95.03	95.78	n.a.
2		7.083	32.159	113.887	4.97	4.22	n.a.
Total:			**646.588**	**2699.002**	**100.00**	**100.00**	



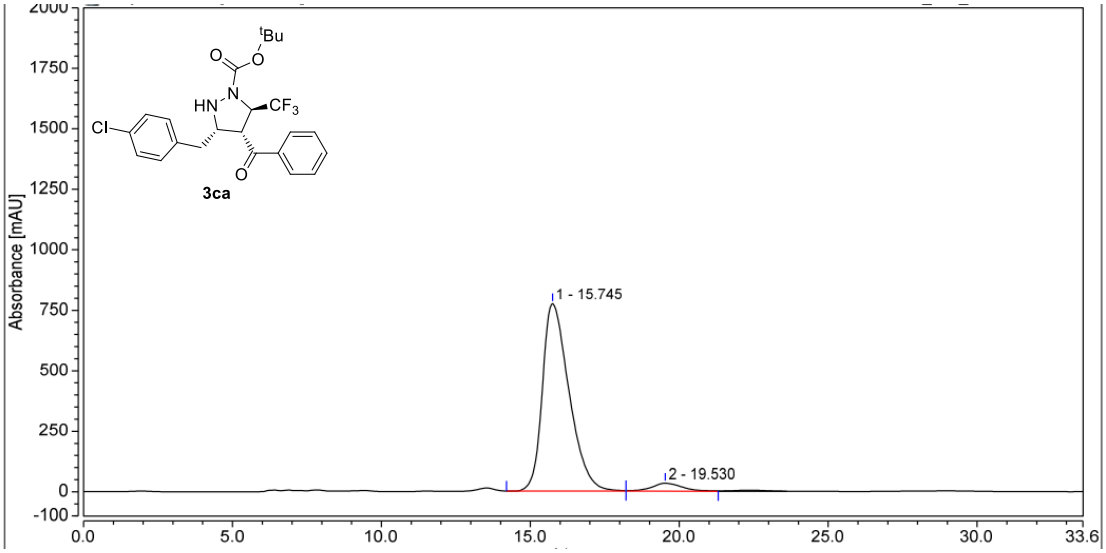
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.117	267.560	1596.445	49.27	61.77	n.a.
2		10.680	275.517	988.066	50.73	38.23	n.a.
Total:			**543.077**	**2584.512**	**100.00**	**100.00**	



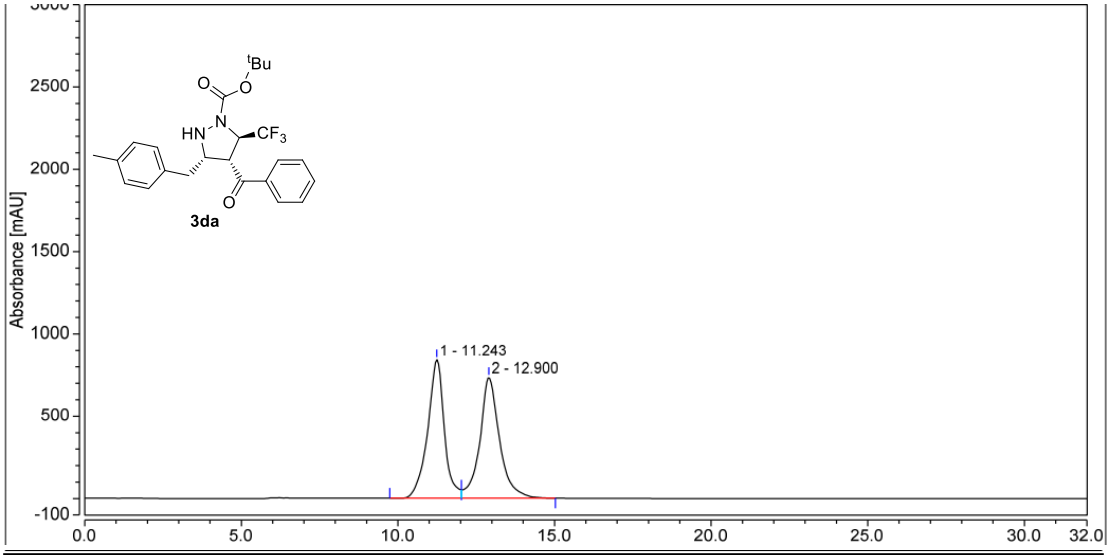
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.168	344.885	2117.860	95.97	97.59	n.a.
2		11.160	14.471	52.270	4.03	2.41	n.a.
Total:			**359.357**	**2170.130**	**100.00**	**100.00**	



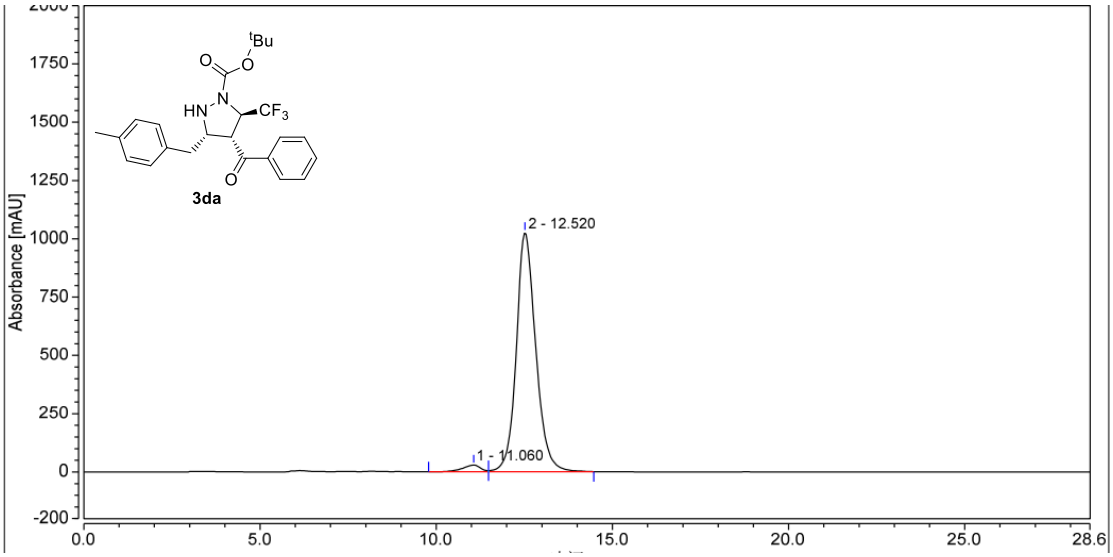
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		16.005	533.208	543.138	50.25	53.96	n.a.
2		19.400	527.890	463.364	49.75	46.04	n.a.
Total:			**1061.098**	**1006.502**	**100.00**	**100.00**	



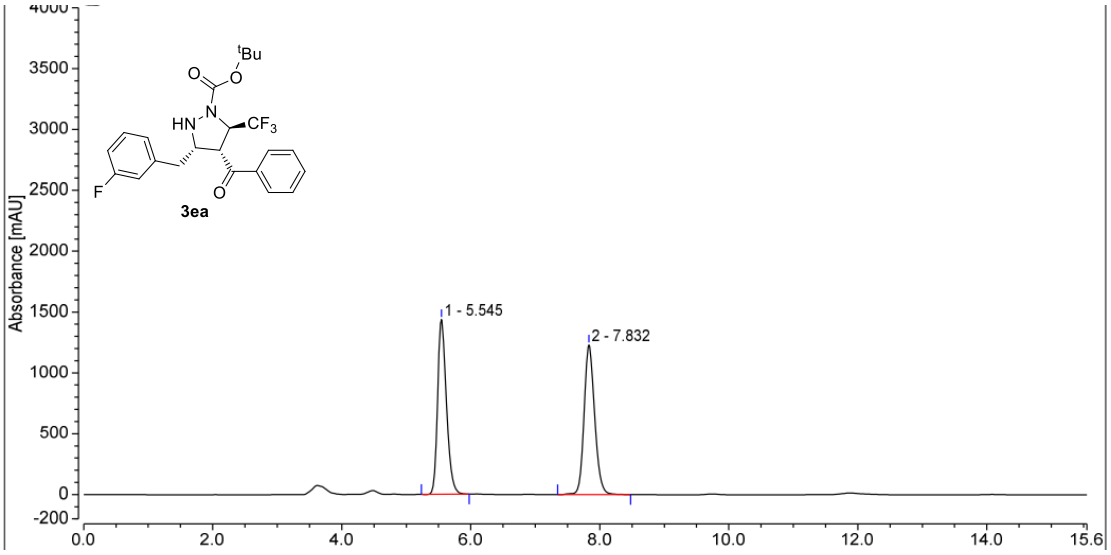
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		15.745	807.445	775.001	95.39	95.90	n.a.
2		19.530	38.991	33.096	4.61	4.10	n.a.
Total:			**846.437**	**808.097**	**100.00**	**100.00**	



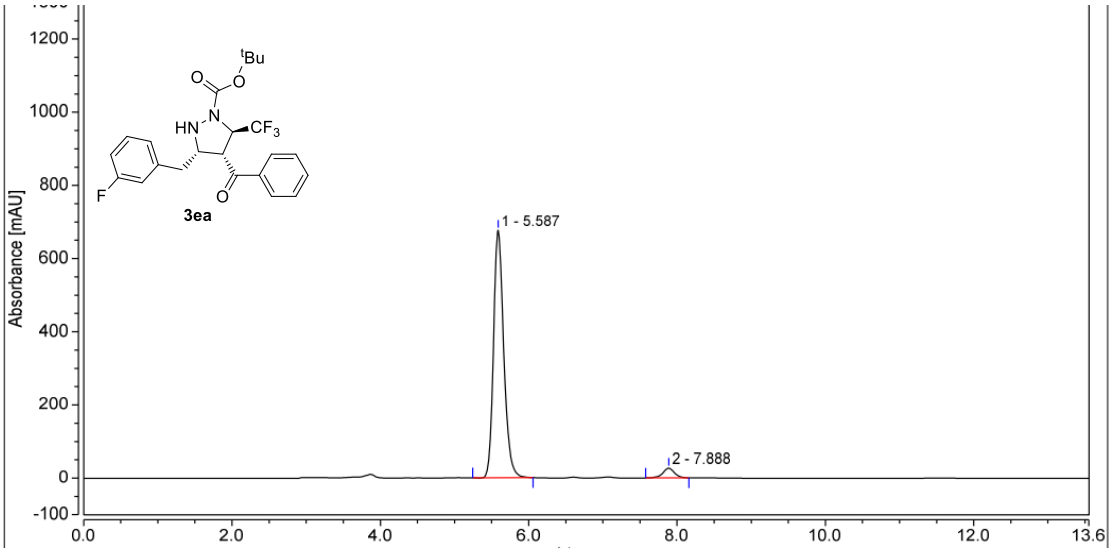
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		11.243	518.343	840.669	49.23	53.42	n.a.
2		12.900	534.616	733.160	50.77	46.58	n.a.
Total:			**1052.959**	**1573.830**	**100.00**	**100.00**	



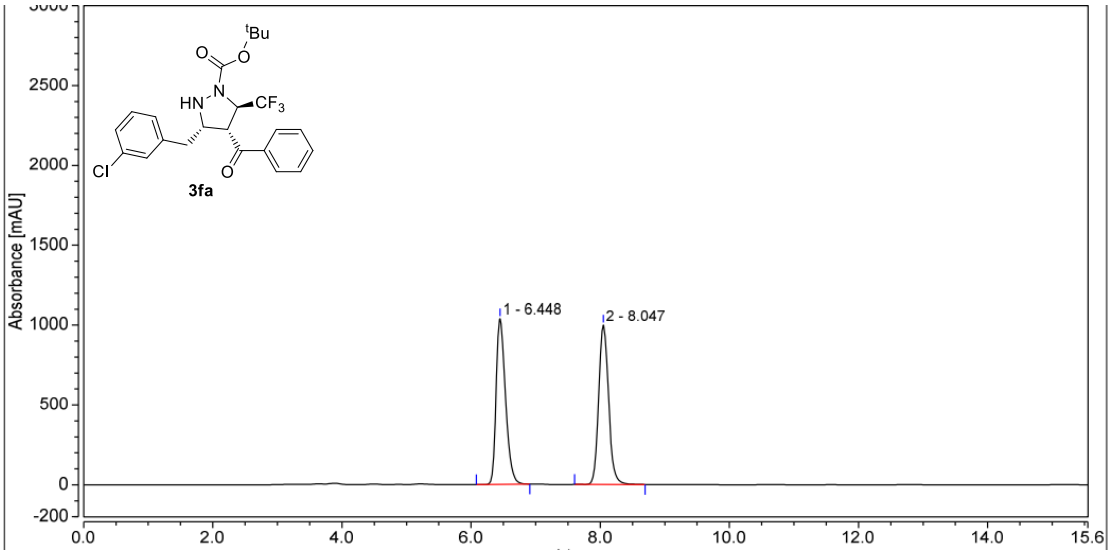
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		11.060	17.248	29.154	2.57	2.76	n.a.
2		12.520	654.480	1025.907	97.43	97.24	n.a.
Total:			**671.728**	**1055.061**	**100.00**	**100.00**	



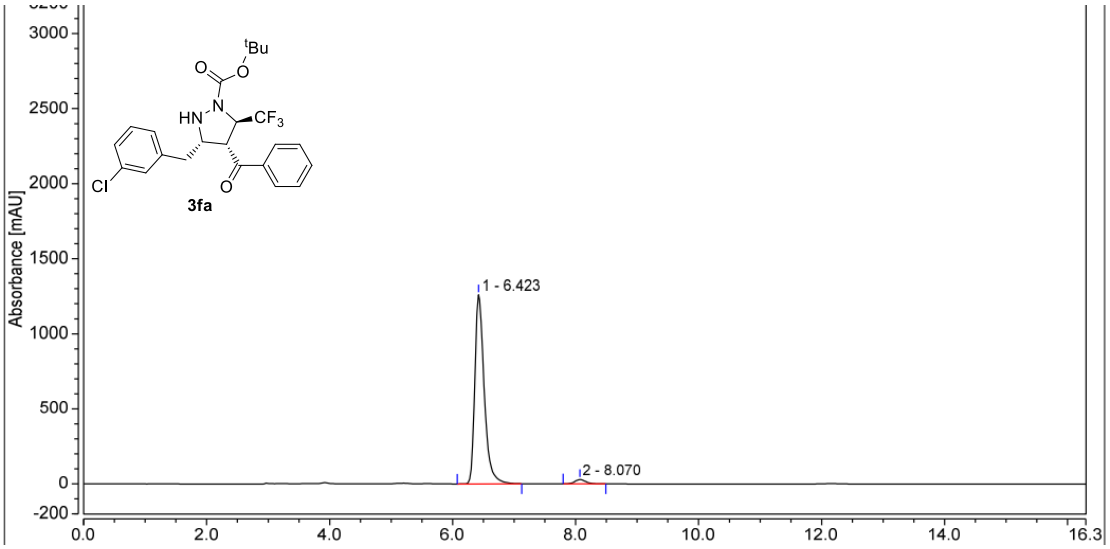
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.545	228.701	1436.217	49.31	53.89	n.a.
2		7.832	235.061	1228.856	50.69	46.11	n.a.
Total:			**463.762**	**2665.074**	**100.00**	**100.00**	



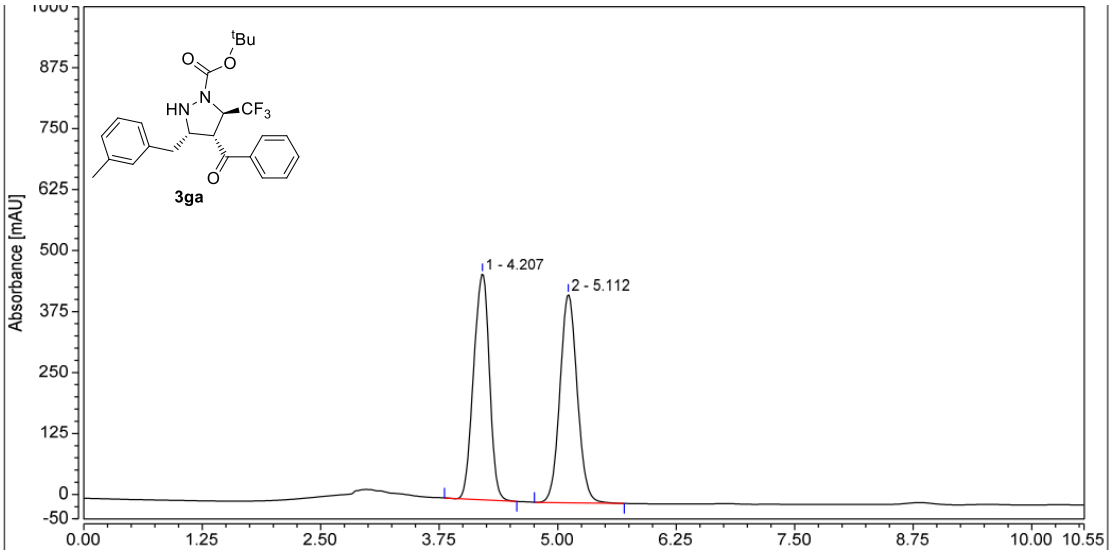
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.587	107.858	676.797	95.76	96.23	n.a.
2		7.888	4.778	26.487	4.24	3.77	n.a.
Total:			**112.637**	**703.284**	**100.00**	**100.00**	



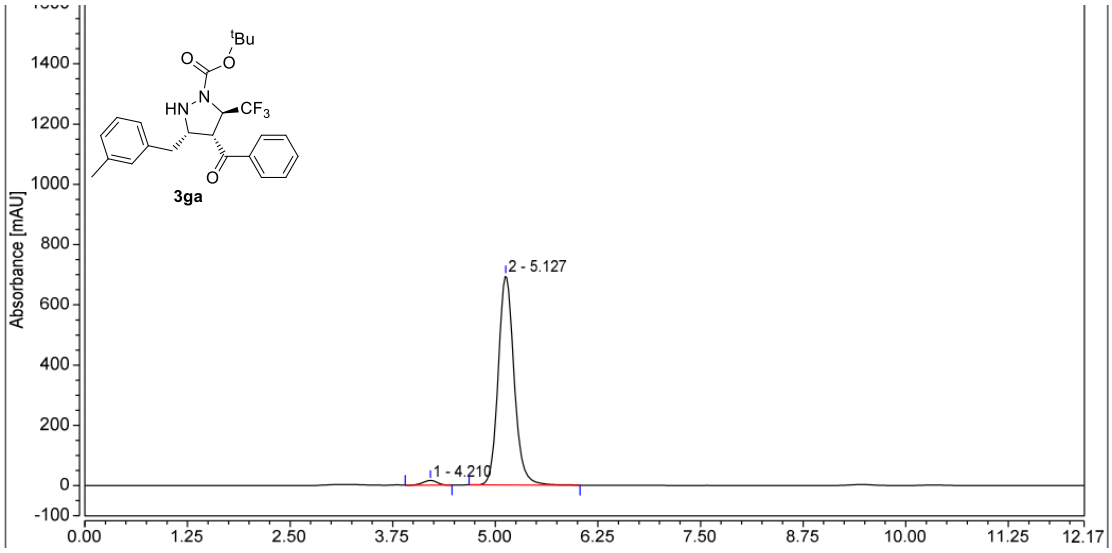
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.448	175.213	1037.516	49.71	50.98	n.a.
2		8.047	177.276	997.786	50.29	49.02	n.a.
Total:			**352.488**	**2035.302**	**100.00**	**100.00**	



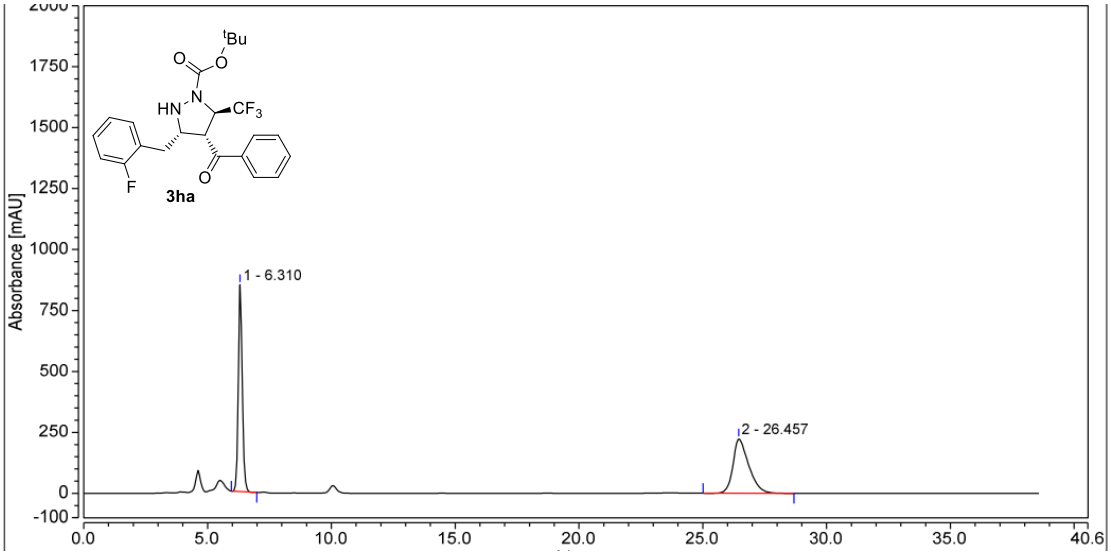
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.423	223.961	1260.124	97.38	97.72	n.a.
2		8.070	6.032	29.392	2.62	2.28	n.a.
Total:			**229.992**	**1289.516**	**100.00**	**100.00**	



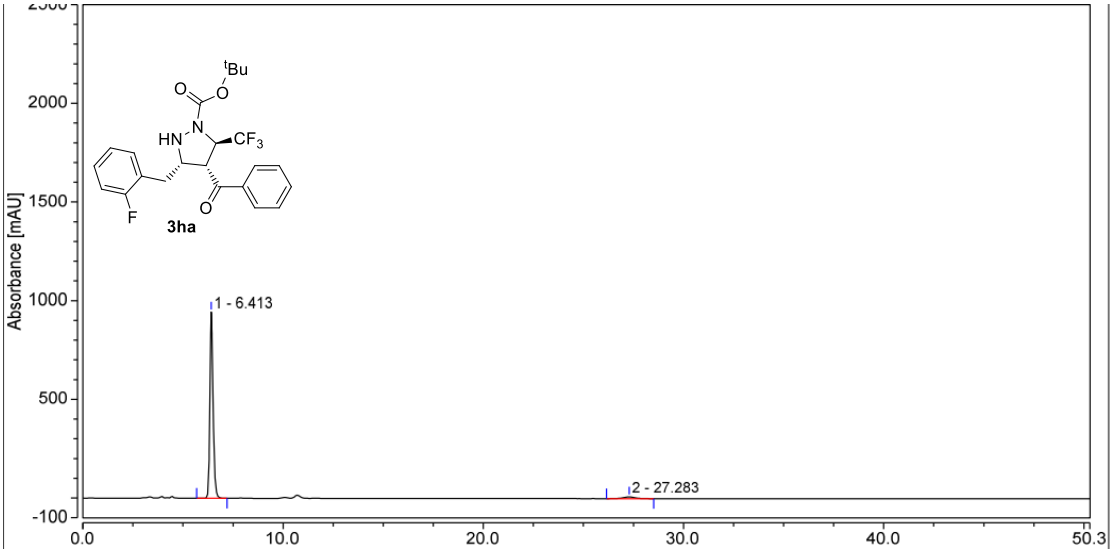
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.207	89.742	463.866	49.79	52.06	n.a.
2		5.112	90.510	427.076	50.21	47.94	n.a.
Total:			**180.252**	**890.942**	**100.00**	**100.00**	



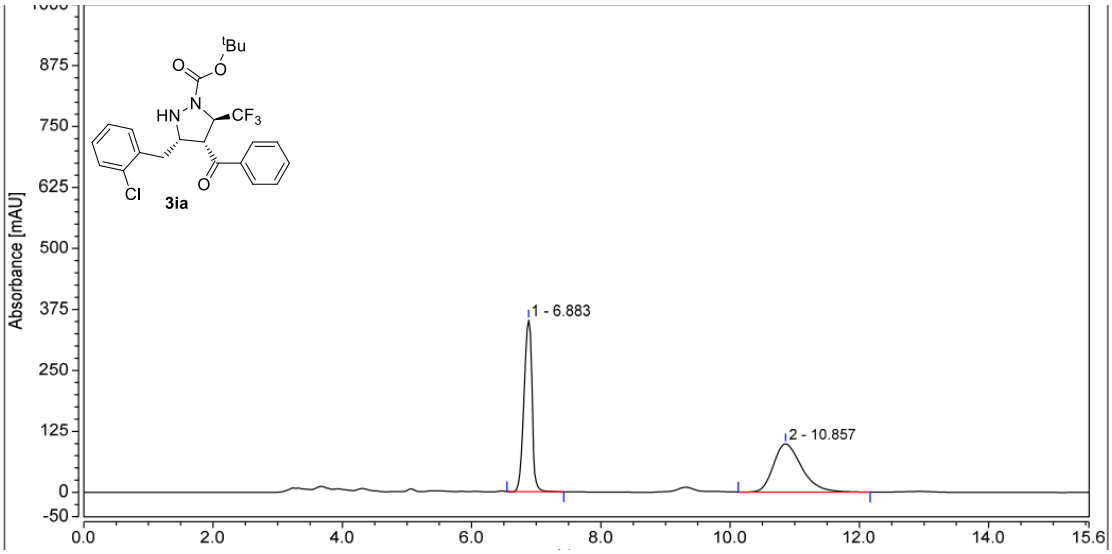
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.210	3.148	15.427	1.98	2.17	n.a.
2		5.127	155.857	694.589	98.02	97.83	n.a.
Total:			**159.005**	**710.016**	**100.00**	**100.00**	



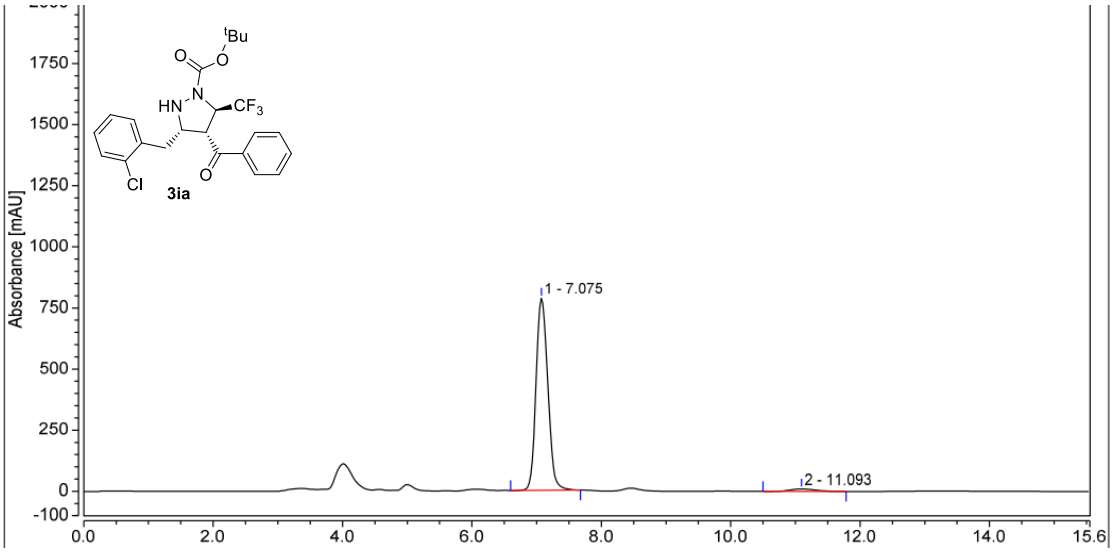
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.310	157.170	849.008	48.87	79.18	n.a.
2		26.457	164.445	223.233	51.13	20.82	n.a.
Total:			**321.615**	**1072.241**	**100.00**	**100.00**	



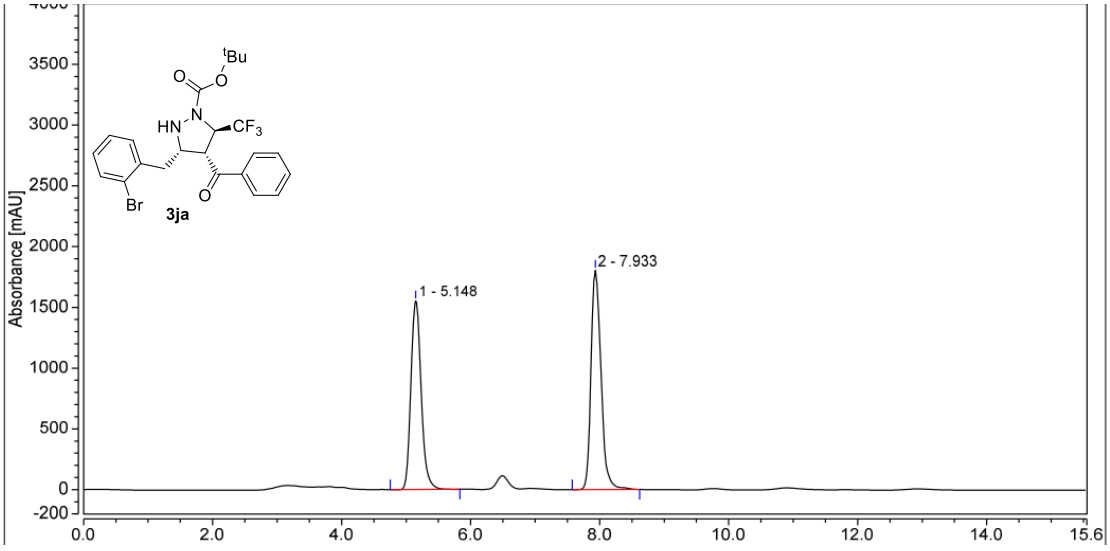
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.413	174.645	942.779	96.64	99.07	n.a.
2		27.283	6.075	8.855	3.36	0.93	n.a.
Total:			**180.720**	**951.634**	**100.00**	**100.00**	



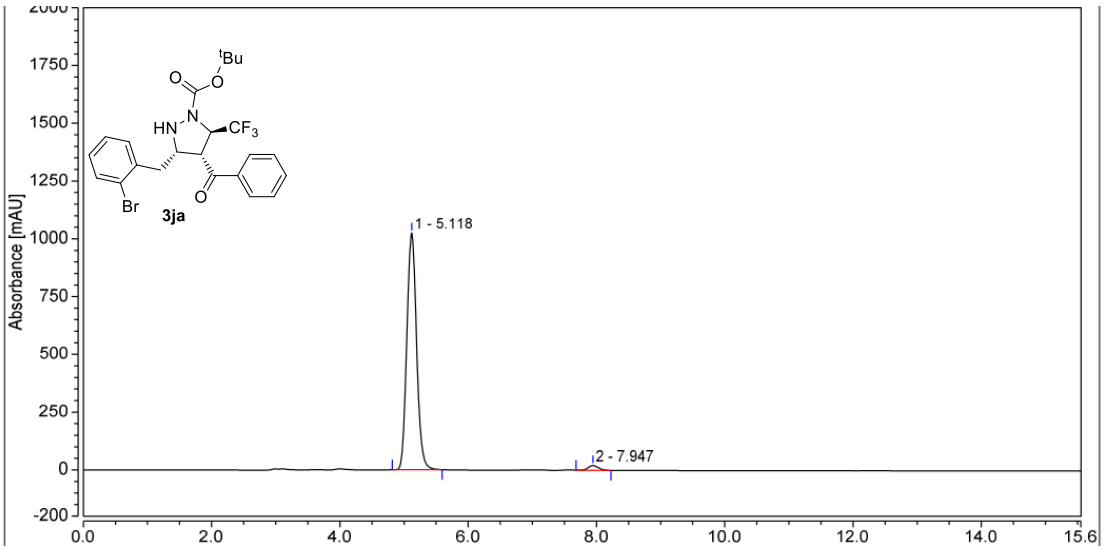
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.883	50.916	351.767	50.44	78.05	n.a.
2		10.857	50.029	98.923	49.56	21.95	n.a.
Total:			**100.945**	**450.690**	**100.00**	**100.00**	



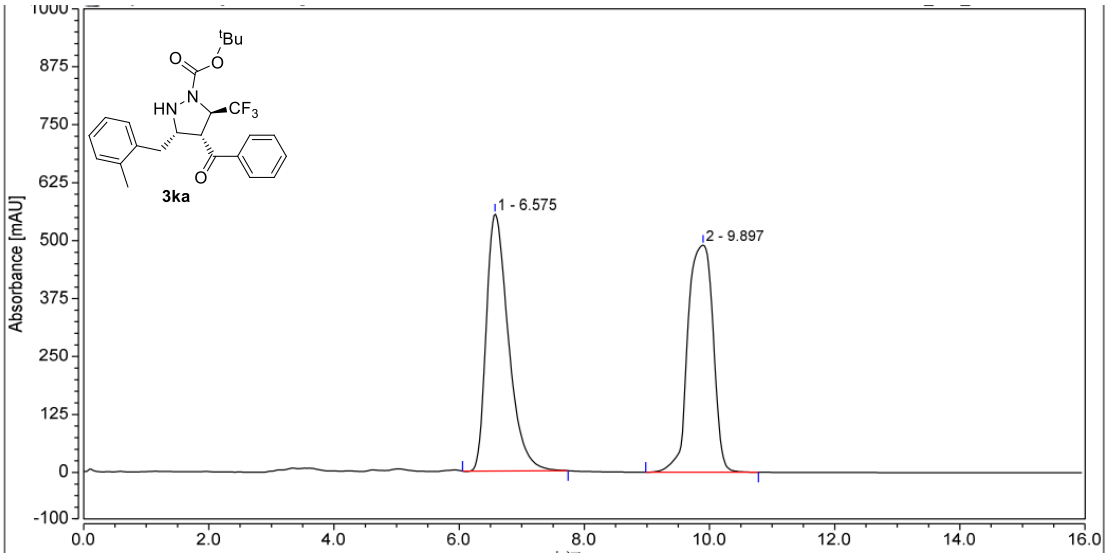
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.075	165.734	786.651	97.28	98.71	n.a.
2		11.093	4.641	10.284	2.72	1.29	n.a.
Total:			**170.375**	**796.935**	**100.00**	**100.00**	



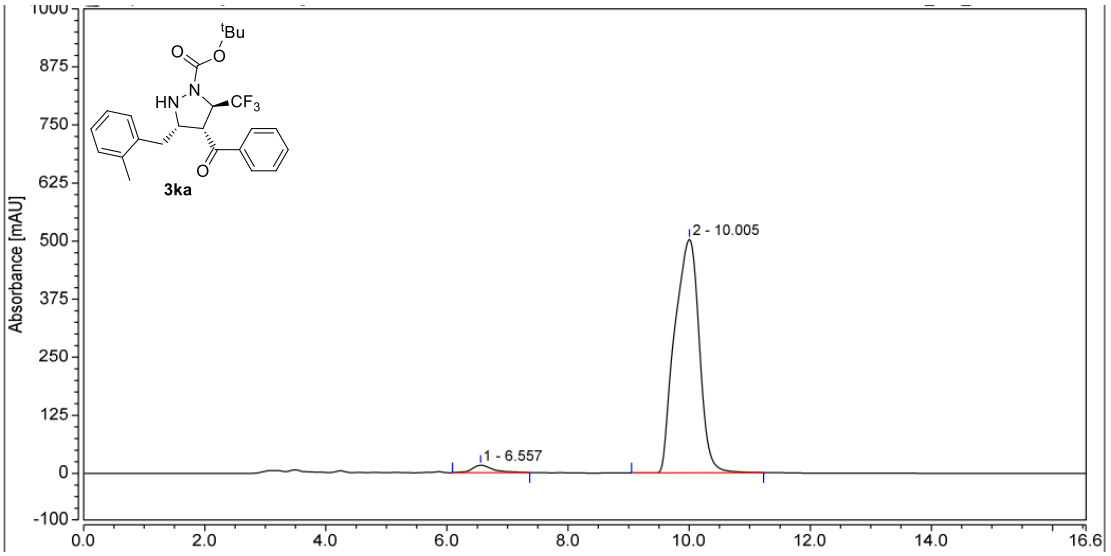
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.148	287.618	1552.516	46.95	46.23	n.a.
2		7.933	324.982	1805.626	53.05	53.77	n.a.
Total:			**612.600**	**3358.142**	**100.00**	**100.00**	



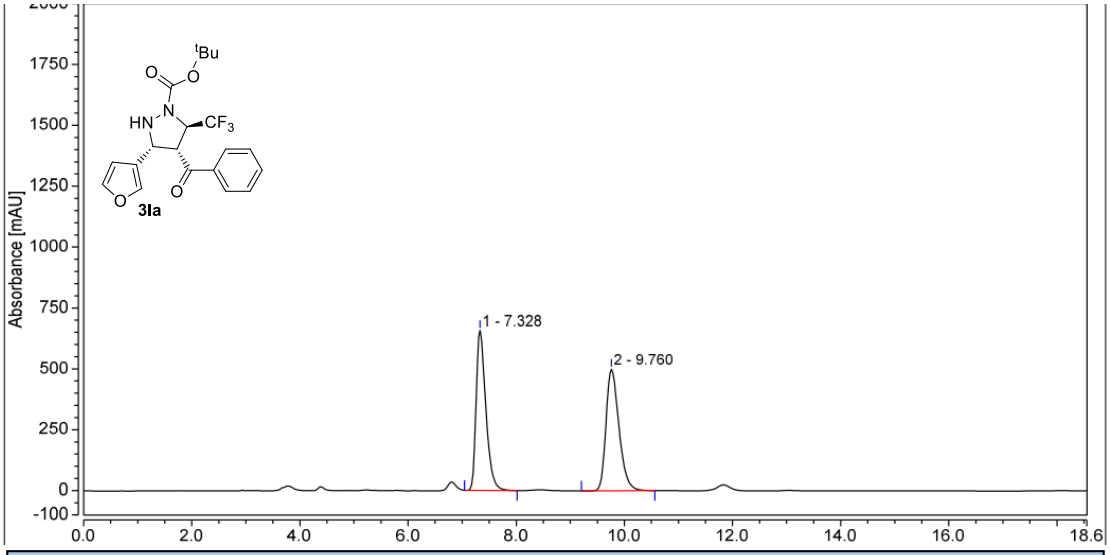
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.118	180.045	1023.699	97.98	98.06	n.a.
2		7.947	3.709	20.280	2.02	1.94	n.a.
Total:			**183.754**	**1043.979**	**100.00**	**100.00**	



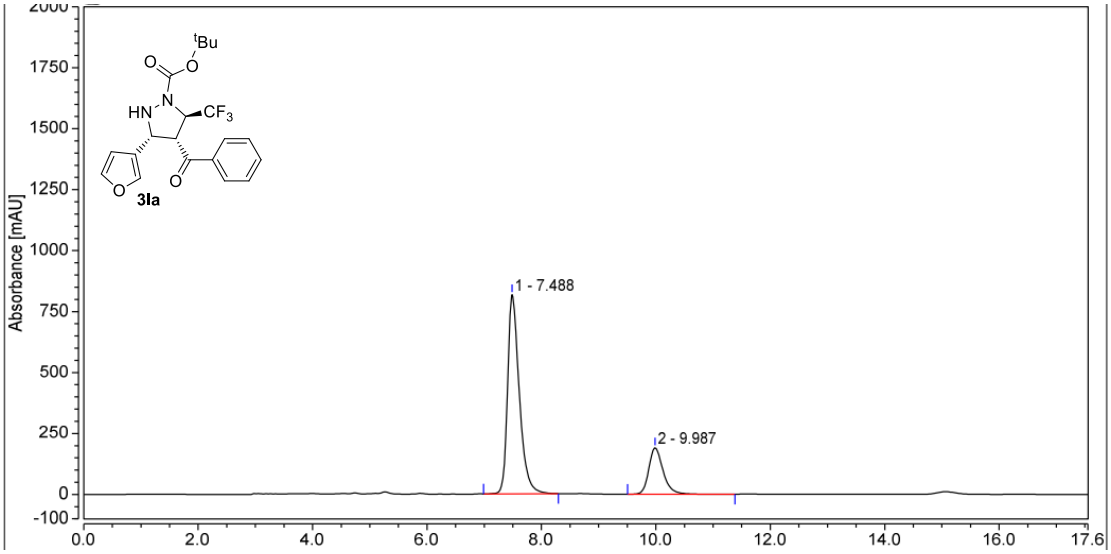
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.575	227.440	554.180	49.86	53.08	n.a.
2		9.897	228.675	489.817	50.14	46.92	n.a.
Total:			**456.115**	**1043.997**	**100.00**	**100.00**	



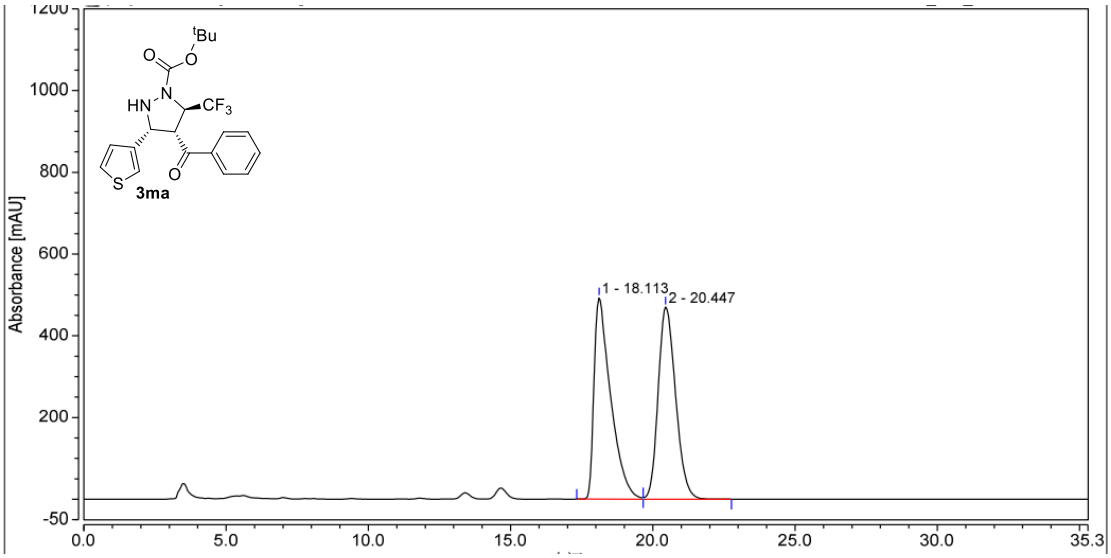
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.557	6.421	15.814	2.65	3.05	n.a.
2		10.005	235.634	502.624	97.35	96.95	n.a.
Total:			**242.055**	**518.438**	**100.00**	**100.00**	



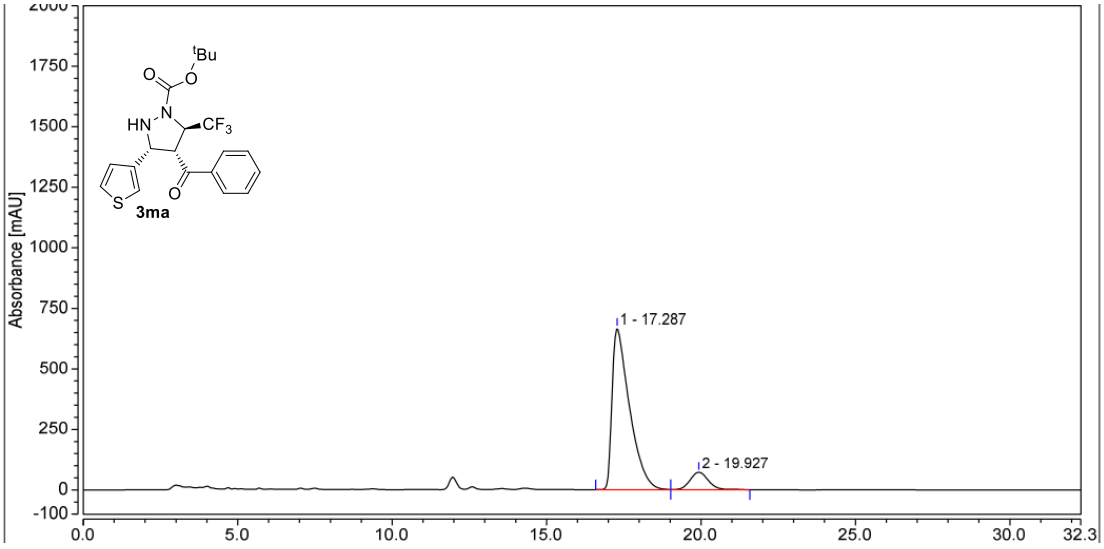
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.328	136.762	656.736	49.58	56.81	n.a.
2		9.760	139.071	499.205	50.42	43.19	n.a.
Total:			**275.833**	**1155.940**	**100.00**	**100.00**	



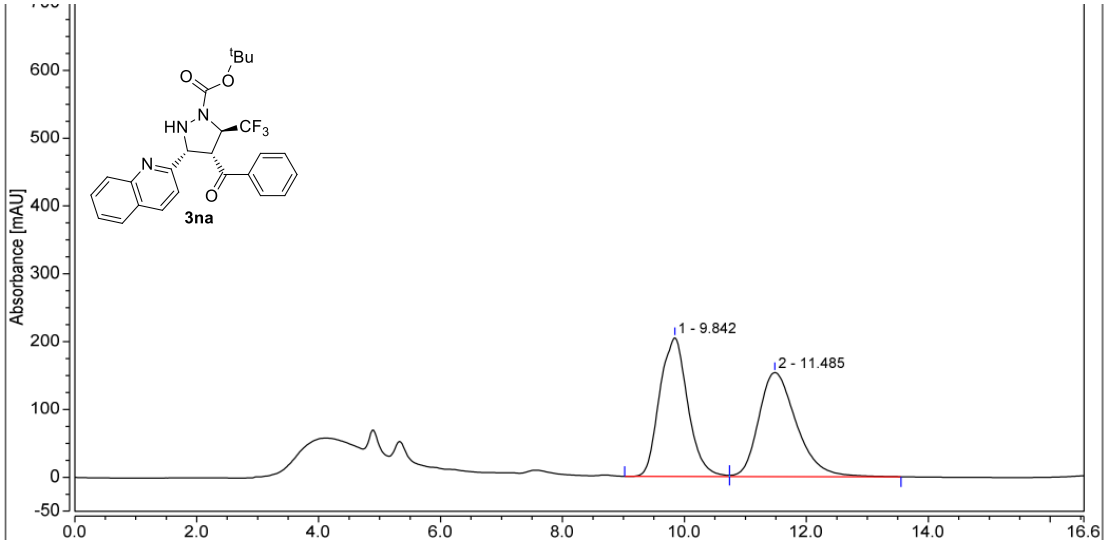
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.488	193.788	816.989	77.87	81.08	n.a.
2		9.987	55.060	190.603	22.13	18.92	n.a.
Total:			**248.848**	**1007.592**	**100.00**	**100.00**	



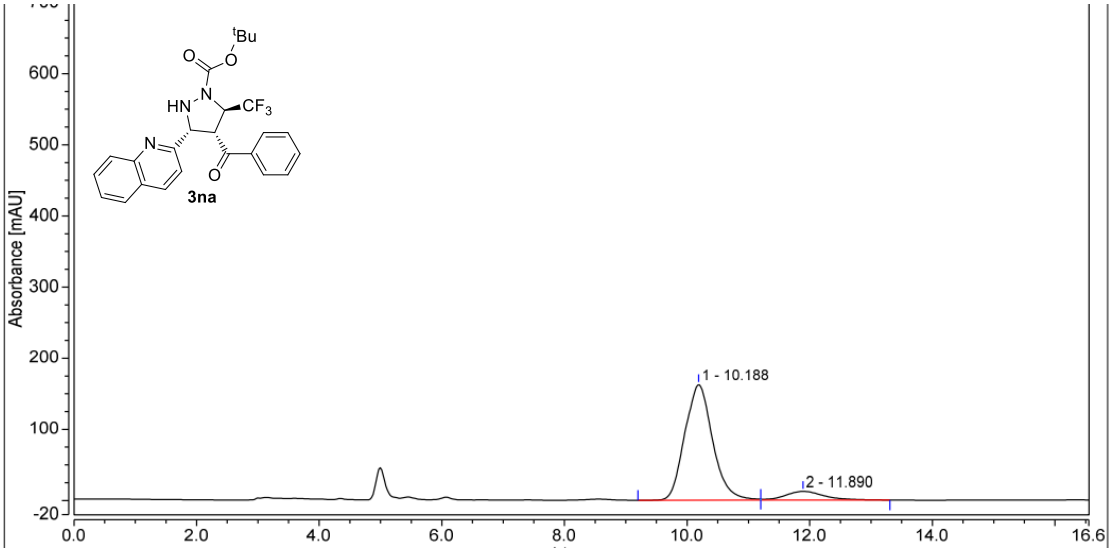
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		18.113	334.481	492.902	50.02	51.17	n.a.
2		20.447	334.171	470.286	49.98	48.83	n.a.
Total:			**668.652**	**963.188**	**100.00**	**100.00**	



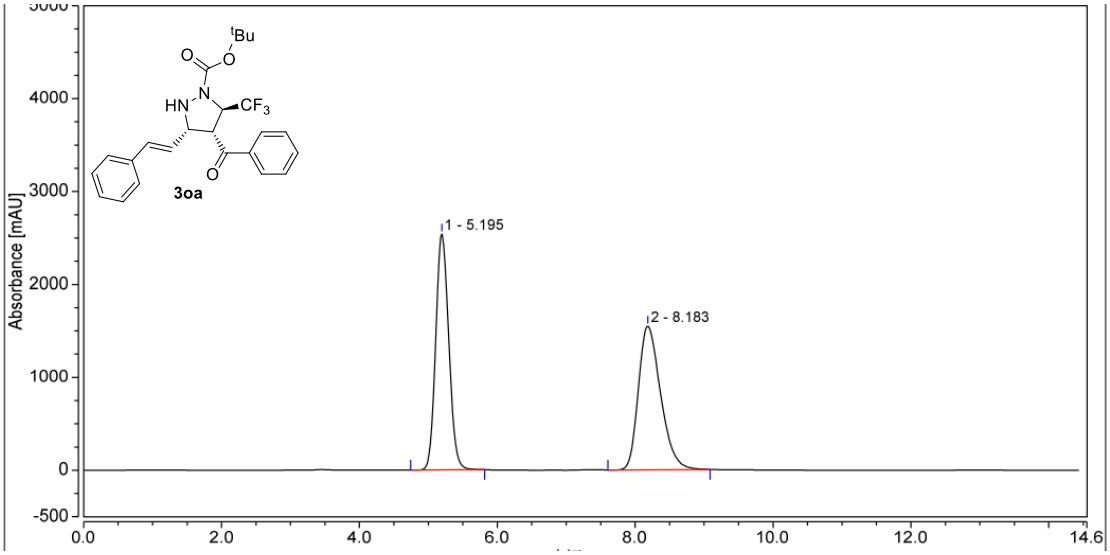
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		17.287	436.632	666.220	89.79	90.30	n.a.
2		19.927	49.635	71.563	10.21	9.70	n.a.
Total:			**486.266**	**737.783**	**100.00**	**100.00**	



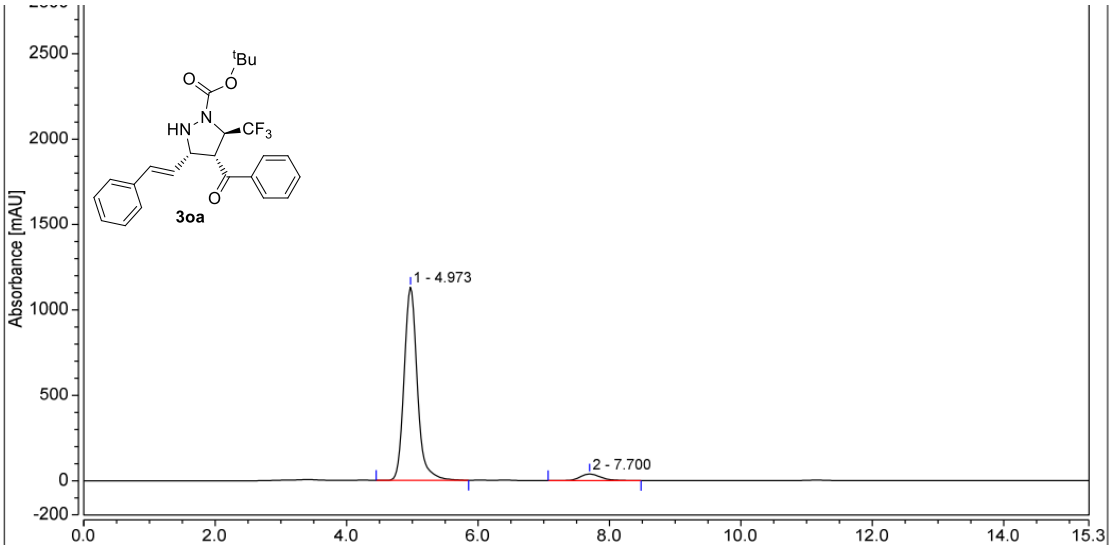
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		9.842	109.211	204.633	49.89	57.14	n.a.
2		11.485	109.691	153.492	50.11	42.86	n.a.
Total:			**218.903**	**358.125**	**100.00**	**100.00**	



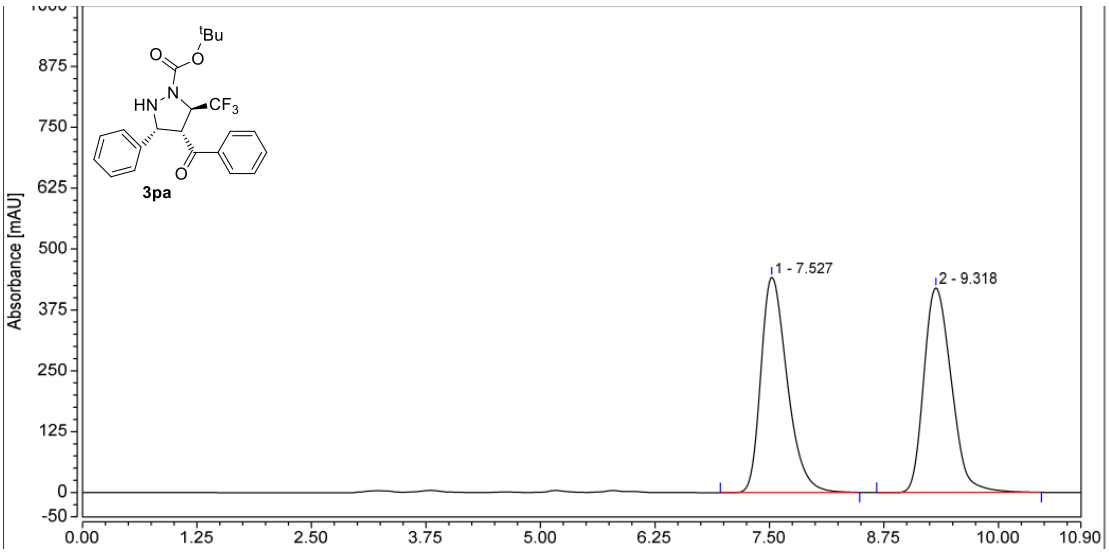
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		10.188	85.647	162.422	90.45	92.99	n.a.
2		11.890	9.045	12.248	9.55	7.01	n.a.
Total:			**94.691**	**174.670**	**100.00**	**100.00**	



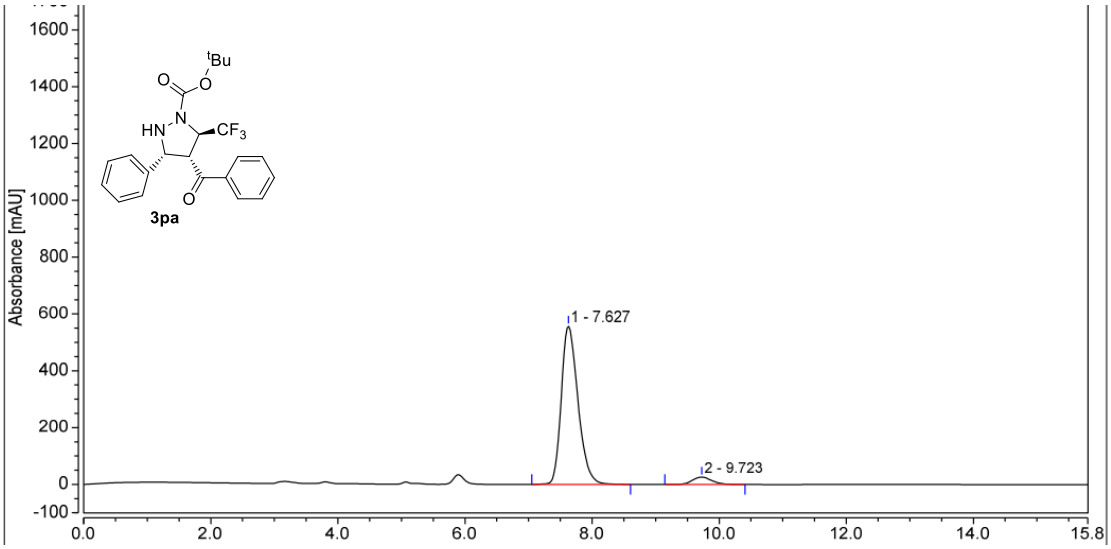
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.195	558.675	2540.854	49.19	62.16	n.a.
2		8.183	577.015	1546.473	50.81	37.84	n.a.
Total:			**1135.690**	**4087.327**	**100.00**	**100.00**	



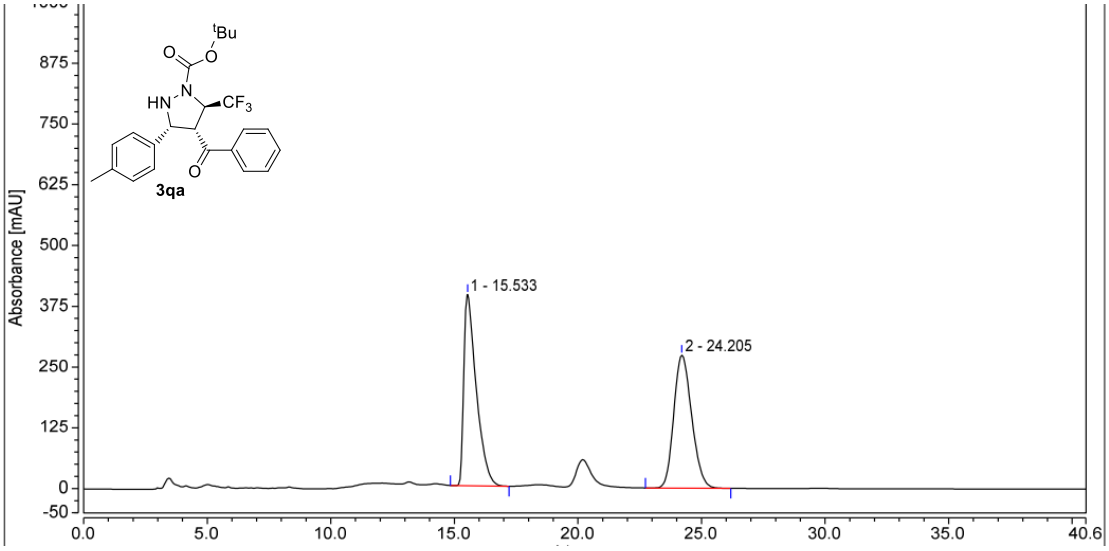
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		4.973	264.044	1130.979	95.05	96.74	n.a.
2		7.700	13.760	38.170	4.95	3.26	n.a.
Total:			**277.804**	**1169.149**	**100.00**	**100.00**	



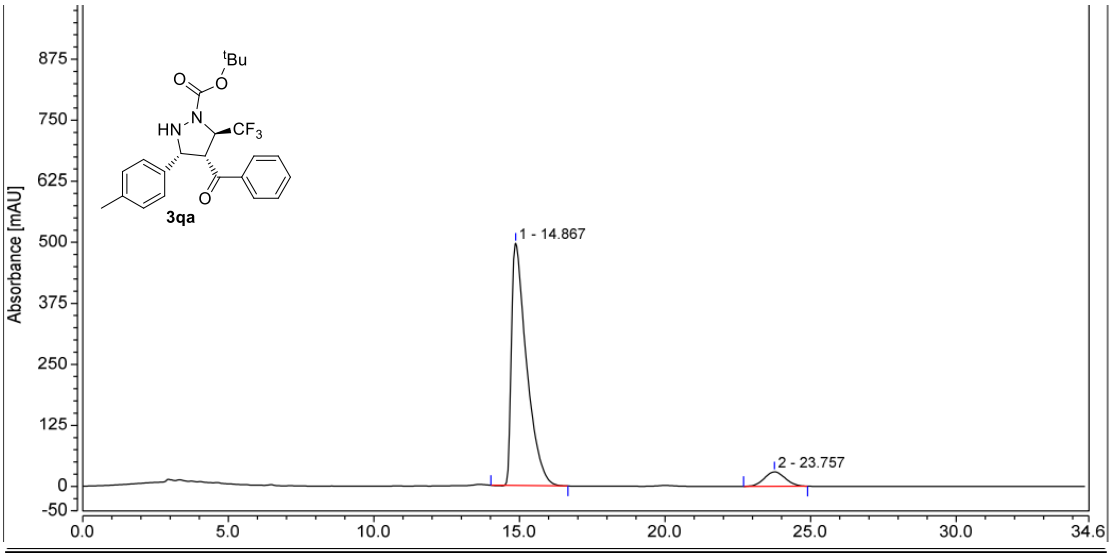
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.527	146.452	442.241	50.01	51.26	n.a.
2		9.318	146.375	420.491	49.99	48.74	n.a.
Total:			**292.827**	**862.732**	**100.00**	**100.00**	



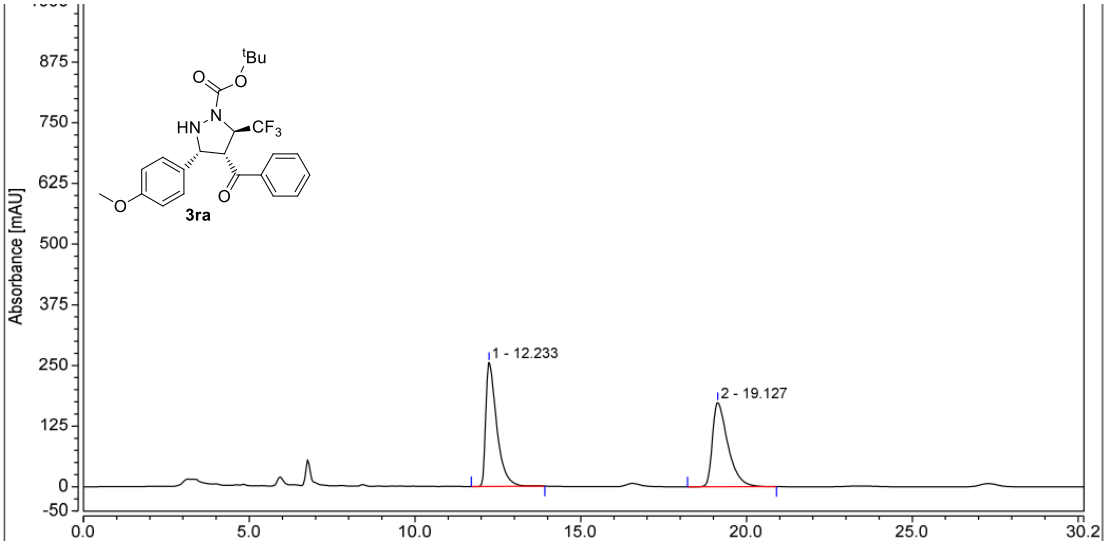
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.627	170.027	557.191	94.88	95.56	n.a.
2		9.723	9.174	25.893	5.12	4.44	n.a.
Total:			**179.201**	**583.084**	**100.00**	**100.00**	



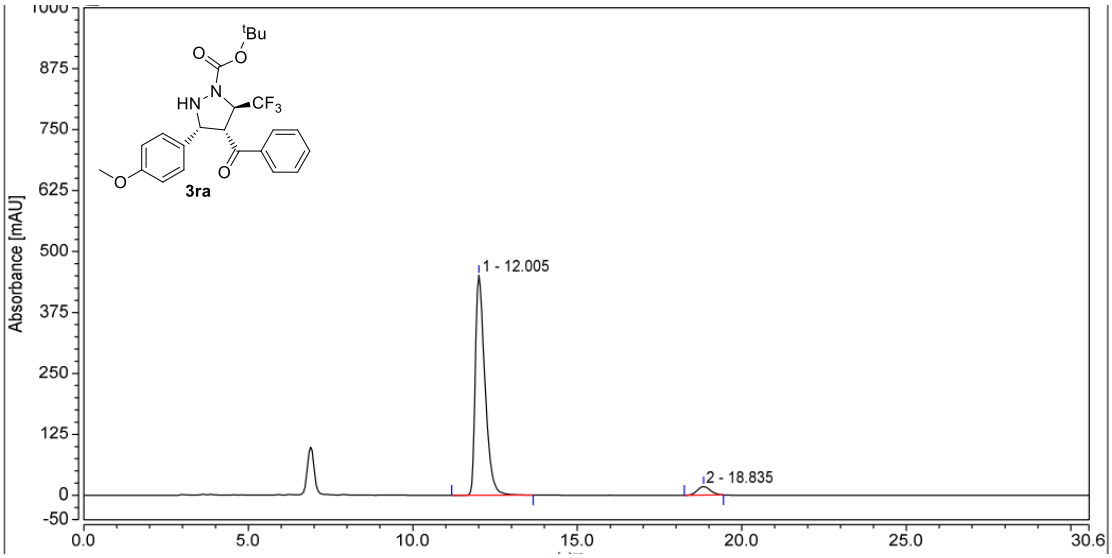
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		15.533	229.716	393.287	50.02	58.96	n.a.
2		24.205	229.566	273.783	49.98	41.04	n.a.
Total:			**459.281**	**667.070**	**100.00**	**100.00**	



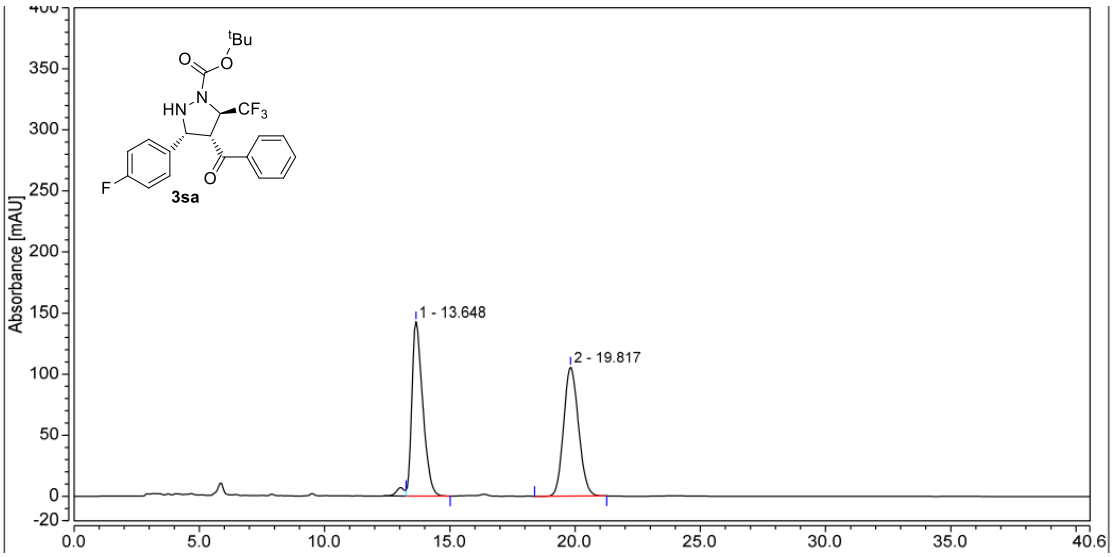
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		14.867	299.256	496.338	92.40	94.38	n.a.
2		23.757	24.630	29.556	7.60	5.62	n.a.
Total:			**323.887**	**525.894**	**100.00**	**100.00**	



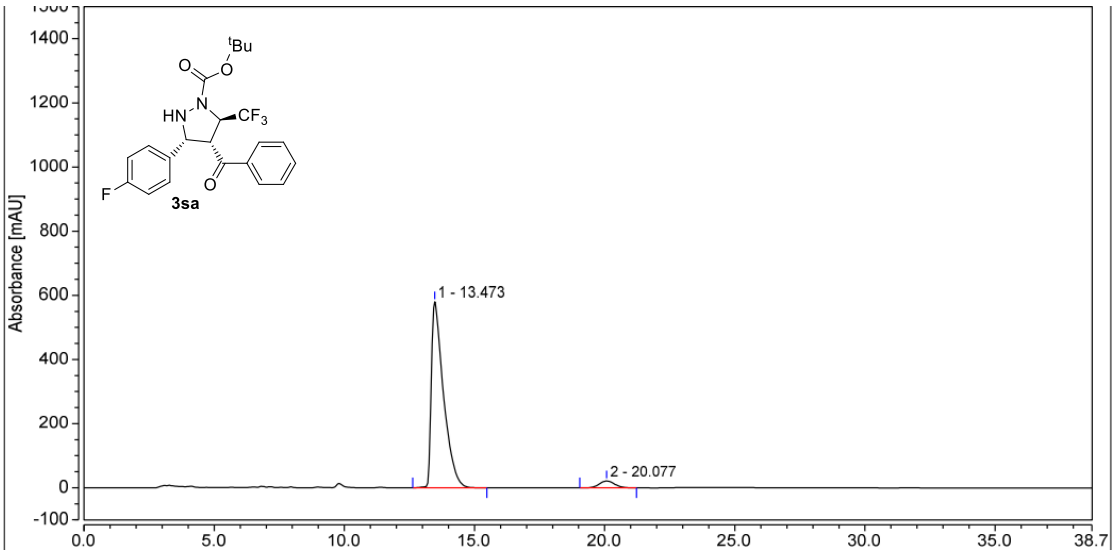
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.233	98.171	255.508	51.10	59.55	n.a.
2		19.127	93.950	173.560	48.90	40.45	n.a.
Total:			**192.121**	**429.068**	**100.00**	**100.00**	



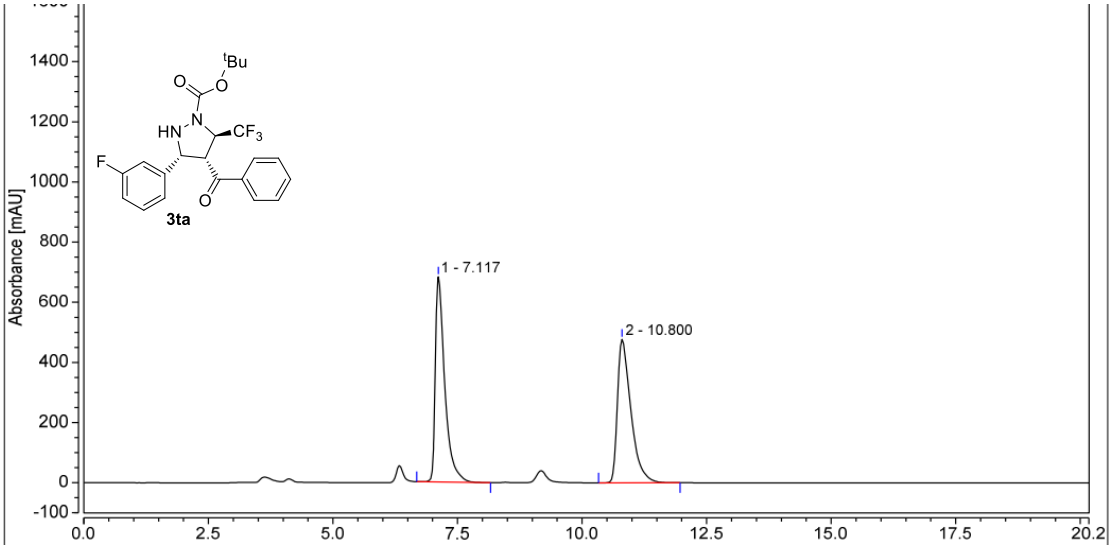
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		12.005	153.364	451.121	94.97	96.24	n.a.
2		18.835	8.128	17.637	5.03	3.76	n.a.
Total:			**161.491**	**468.758**	**100.00**	**100.00**	



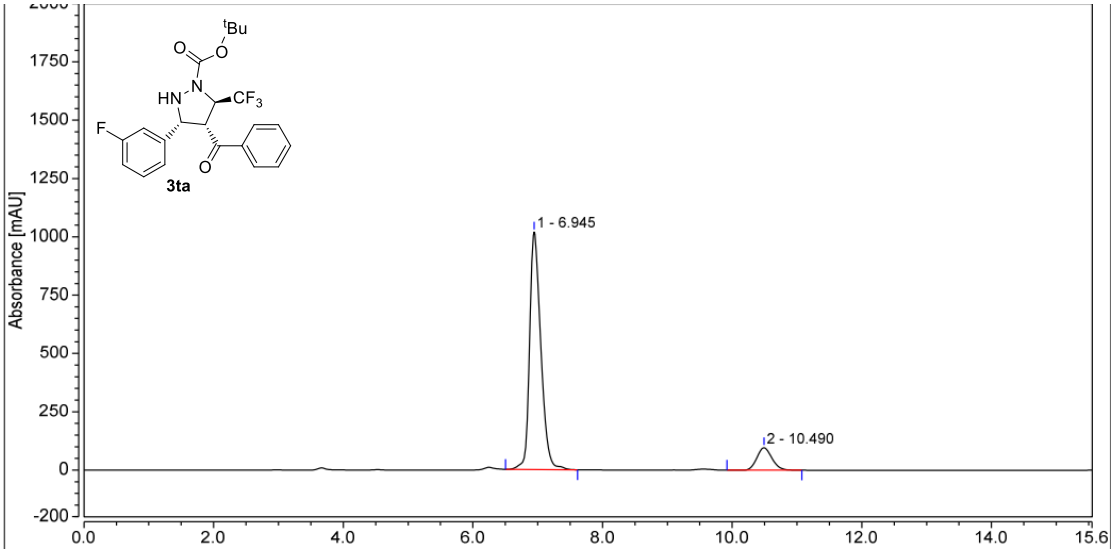
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		13.648	71.953	142.754	49.77	57.46	n.a.
2		19.817	72.605	105.693	50.23	42.54	n.a.
Total:			**144.558**	**248.448**	**100.00**	**100.00**	



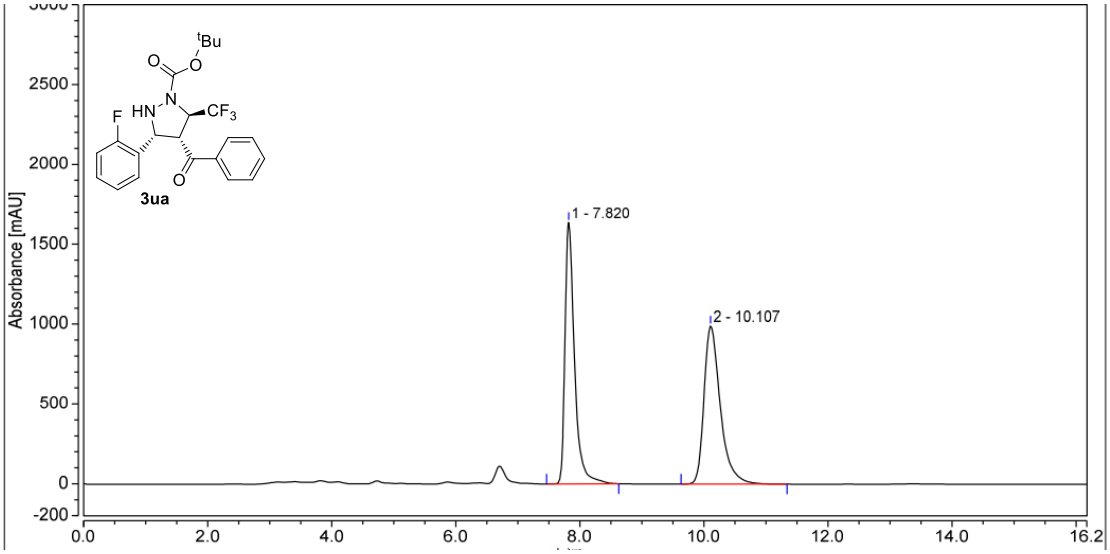
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		13.473	313.505	579.964	95.54	96.44	n.a.
2		20.077	14.646	21.391	4.46	3.56	n.a.
Total:			**328.151**	**601.355**	**100.00**	**100.00**	



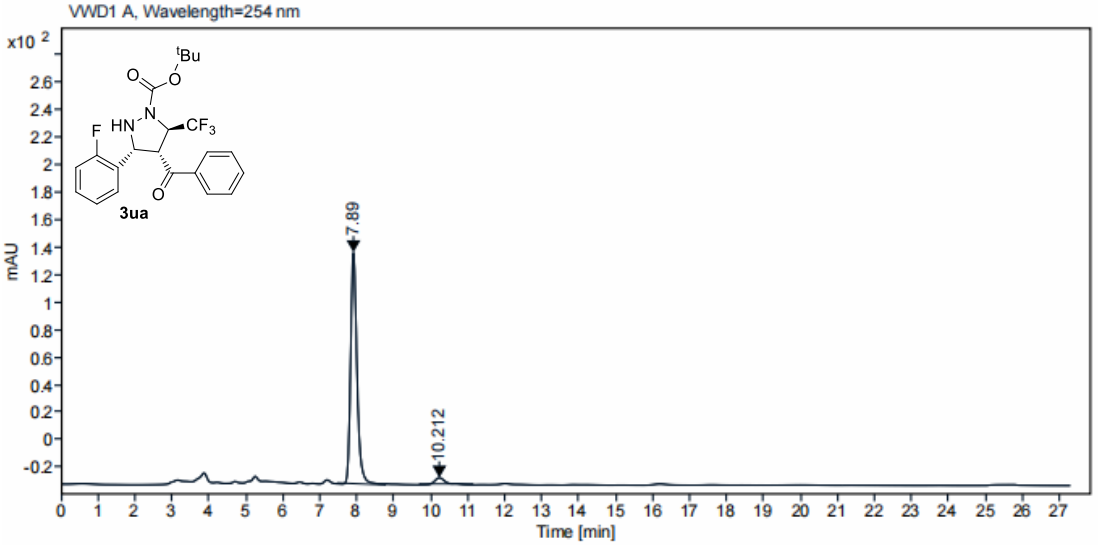
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.117	150.267	682.103	50.22	58.85	n.a.
2		10.800	148.939	476.940	49.78	41.15	n.a.
Total:			**299.206**	**1159.043**	**100.00**	**100.00**	



Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.945	205.682	1018.908	88.78	91.34	n.a.
2		10.490	25.993	96.655	11.22	8.66	n.a.
Total:			**231.675**	**1115.563**	**100.00**	**100.00**	

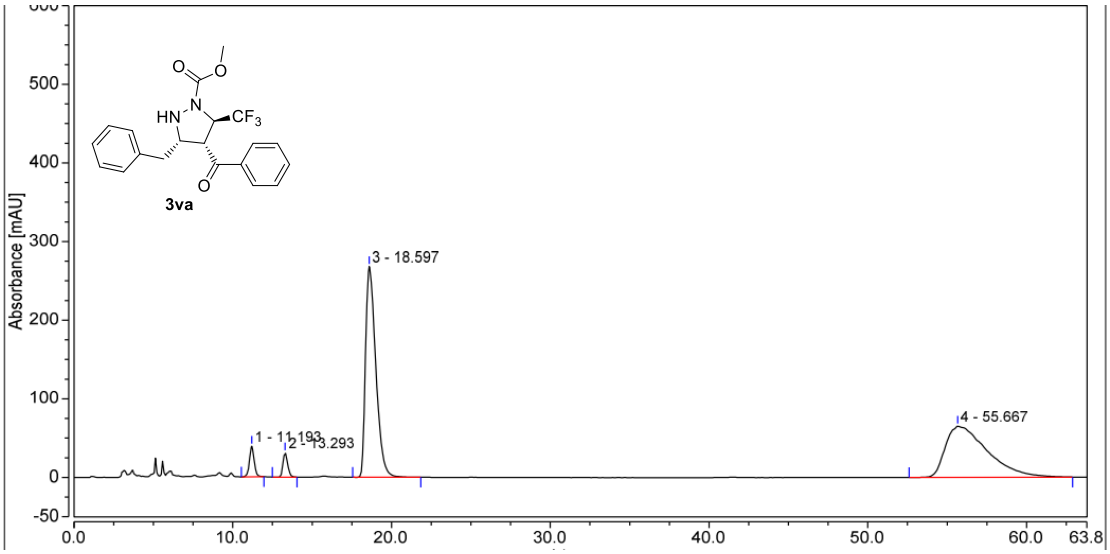


Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		7.820	292.219	1637.189	49.14	62.31	n.a.
2		10.107	302.430	990.314	50.86	37.69	n.a.
Total:			**594.649**	**2627.503**	**100.00**	**100.00**	



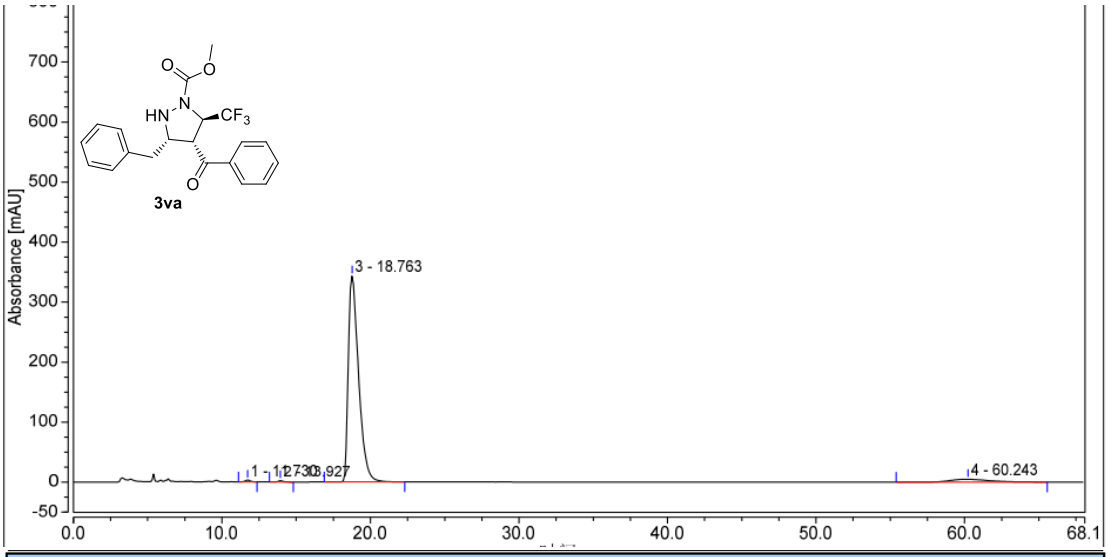
Signal: VWD1 A, Wavelength=254 nm

RT [min]	Area	Height	Area%
7.890	2014.2578	168.0773	96.4472
10.212	74.1993	4.4263	3.5528
Sum	2088.4572		



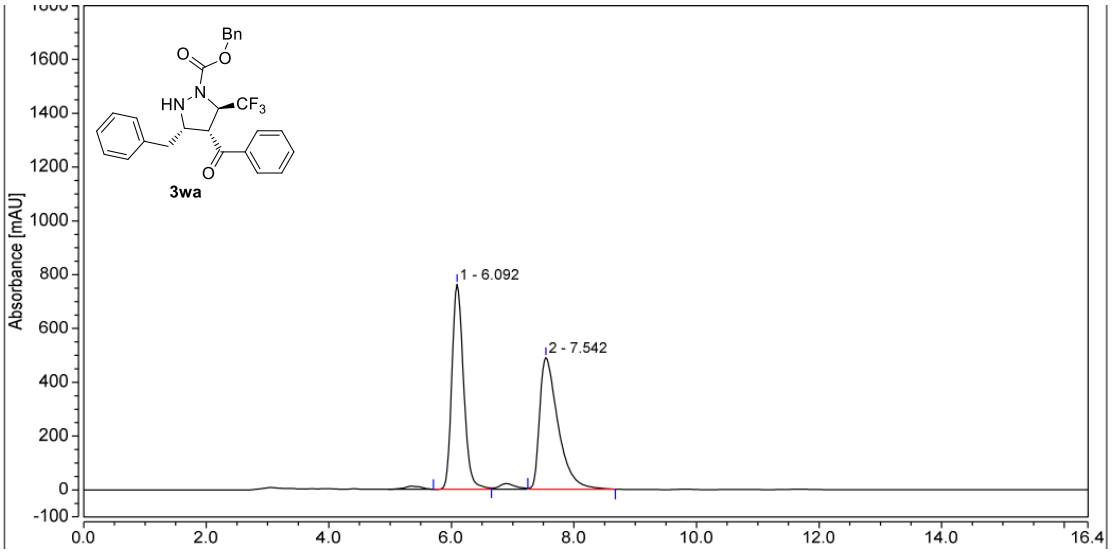
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		11.193	13.574	38.991	3.20	9.67	n.a.
2		13.293	10.622	30.952	2.51	7.68	n.a.
3		18.597	200.965	268.061	47.45	66.49	n.a.
4		55.667	198.404	65.139	46.84	16.16	n.a.
Total:			**423.565**	**403.144**	**100.00**	**100.00**	

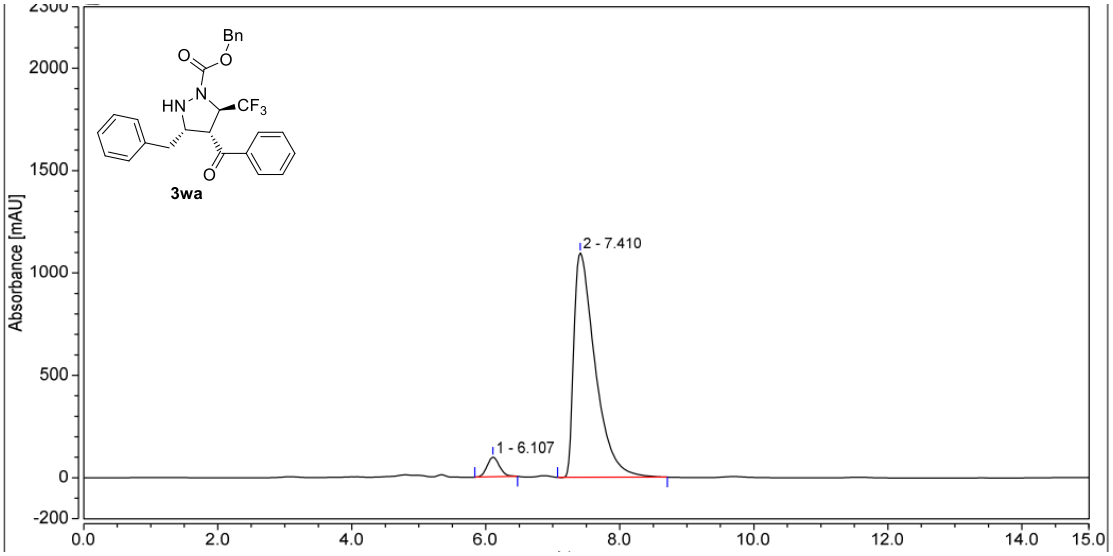


Integration Results

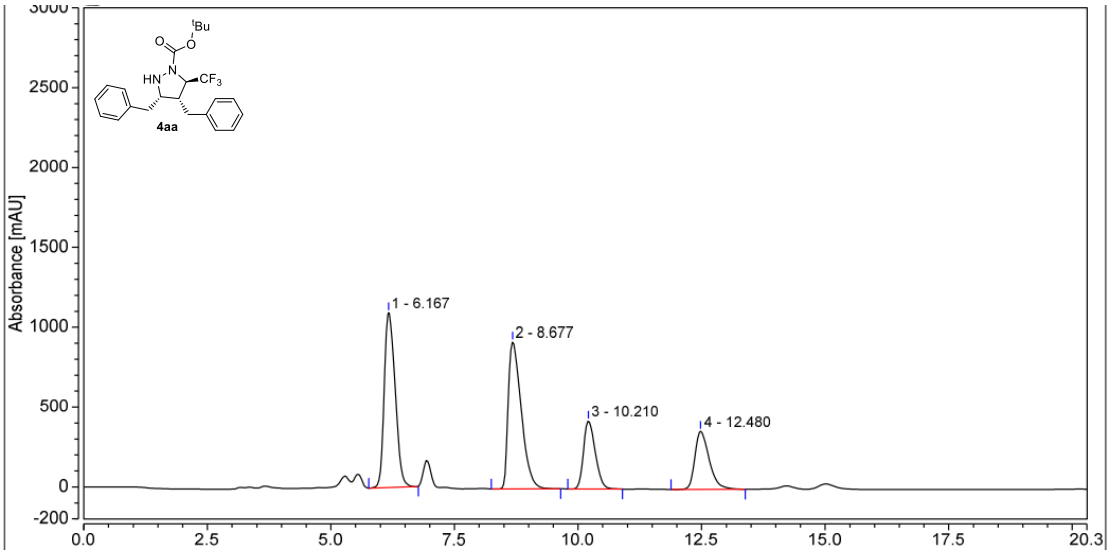
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		11.730	1.046	3.051	0.36	0.86	n.a.
2		13.927	0.803	2.327	0.28	0.66	n.a.
3		18.763	275.145	343.270	94.25	97.11	n.a.
4		60.243	14.934	4.852	5.12	1.37	n.a.
Total:			**291.929**	**353.500**	**100.00**	**100.00**	



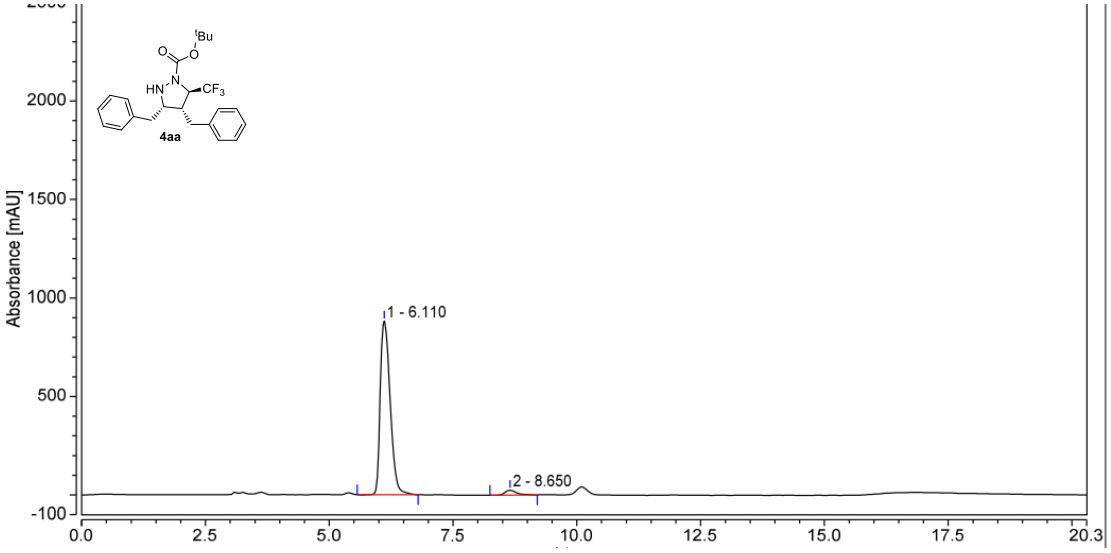
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.092	168.269	761.812	49.67	60.90	n.a.
2		7.542	170.522	489.155	50.33	39.10	n.a.
Total:			**338.791**	**1250.967**	**100.00**	**100.00**	



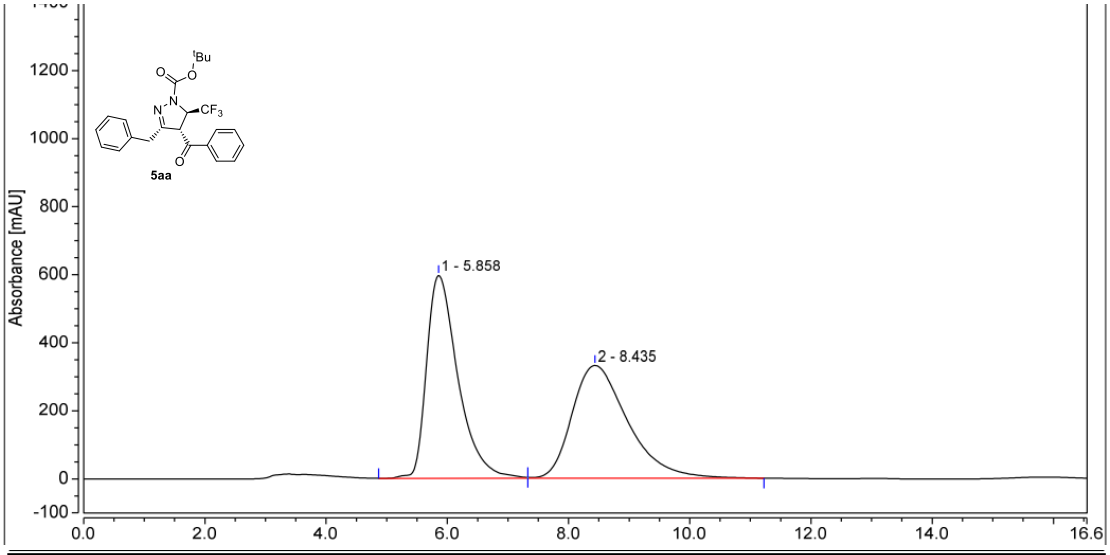
Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.107	20.674	95.929	4.86	8.05	n.a.
2		7.410	404.655	1095.461	95.14	91.95	n.a.
Total:			**425.328**	**1191.391**	**100.00**	**100.00**	



Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.167	280.172	1093.939	34.95	39.01	n.a.
2		8.677	281.749	920.132	35.15	32.81	n.a.
3		10.210	117.931	426.030	14.71	15.19	n.a.
4		12.480	121.684	364.159	15.18	12.99	n.a.
Total:			**801.536**	**2804.260**	**100.00**	**100.00**	

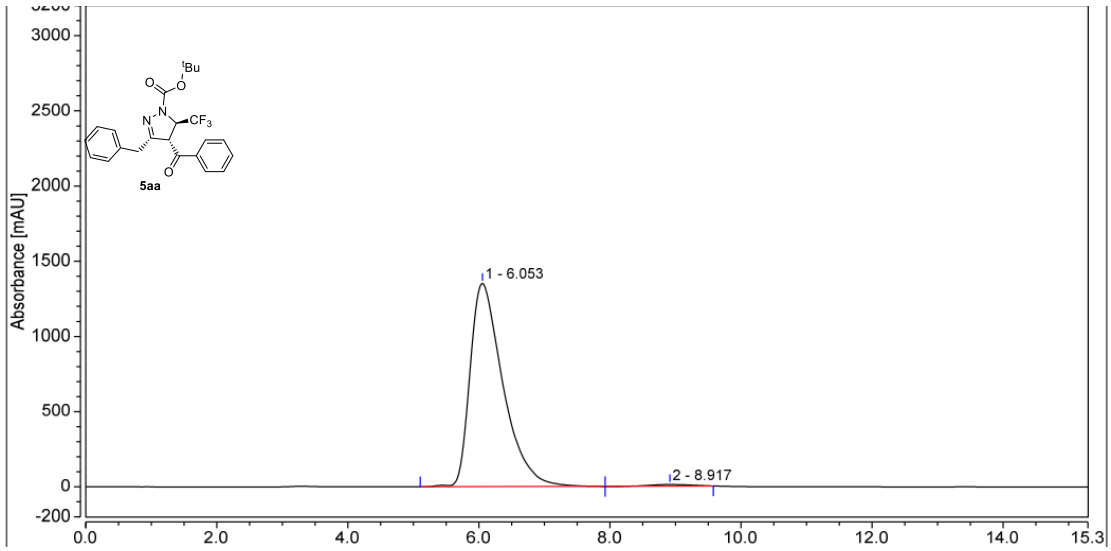


Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.110	205.060	881.514	96.96	97.32	n.a.
2		8.650	6.439	24.318	3.04	2.68	n.a.
Total:			**211.499**	**905.832**	**100.00**	**100.00**	



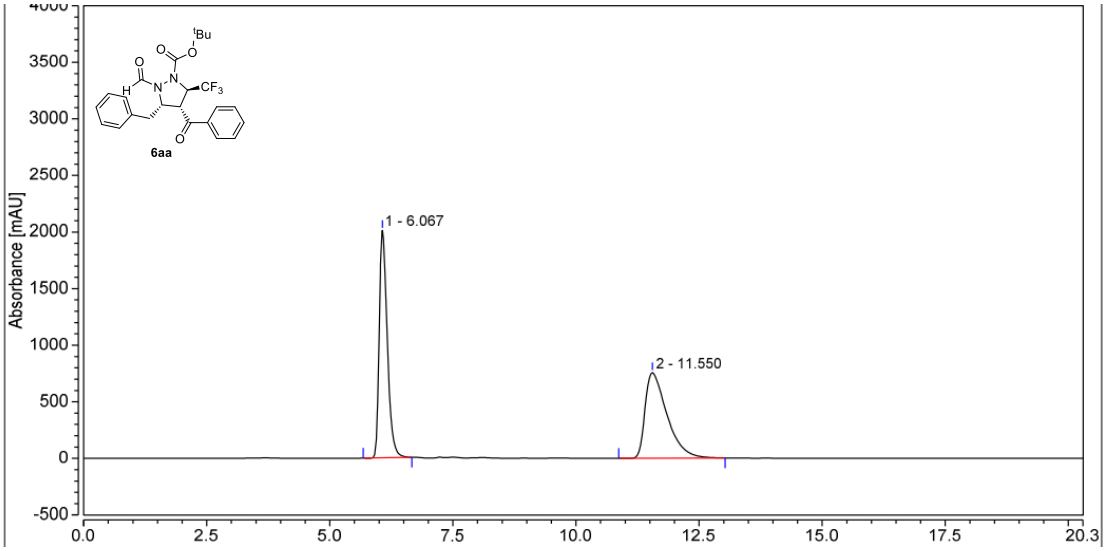
Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		5.858	356.838	596.352	50.32	64.28	n.a.
2		8.435	352.282	331.417	49.68	35.72	n.a.
Total:			**709.120**	**927.769**	**100.00**	**100.00**	

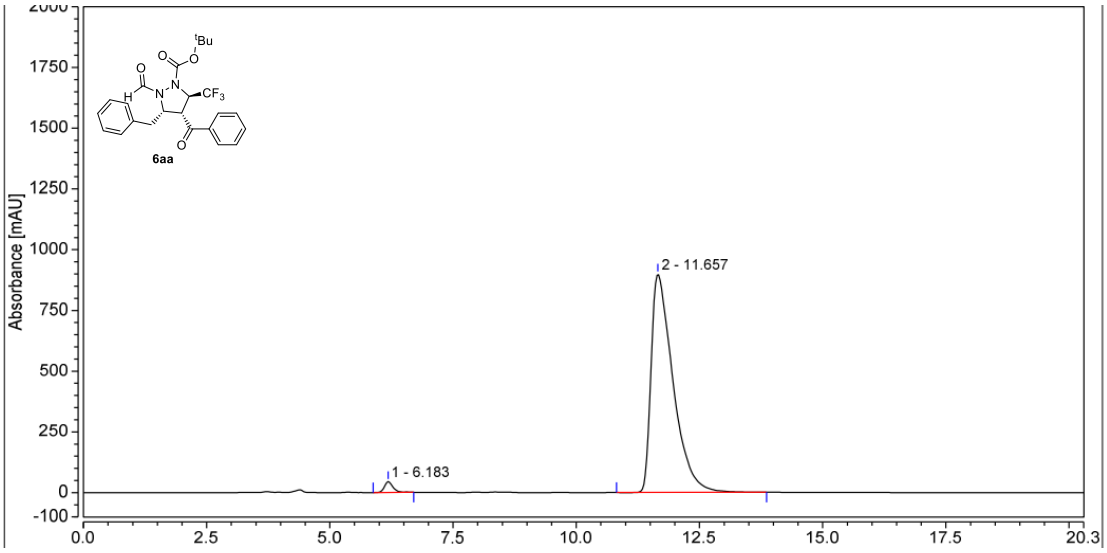


Integration Results

No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.053	785.095	1352.087	99.14	99.23	n.a.
2		8.917	6.823	10.499	0.86	0.77	n.a.
Total:			**791.918**	**1362.585**	**100.00**	**100.00**	



Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.067	381.916	2010.936	49.60	72.67	n.a.
2		11.550	388.109	756.152	50.40	27.33	n.a.
Total:			**770.025**	**2767.088**	**100.00**	**100.00**	



Integration Results							
No.	Peak Name	Retention Time min	Area mAU*min	Height mAU	Relative Area %	Relative Height %	Amount n.a.
1		6.183	8.917	45.082	1.89	4.78	n.a.
2		11.657	462.784	898.984	98.11	95.22	n.a.
Total:			**471.701**	**944.066**	**100.00**	**100.00**	