Supporting Information

Cu Catalyzed [4+2] Cycloaddition for the Synthesis of Highly Substituted 3-Fluoropyridines

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1. General Information

Unless otherwise noted, all reagents were obtained commercially and used without further purification. Unless otherwise specified, all other reagents were purchased from Acros, Aldrich, Fisher, Adamas-beta Co. Ltd. or TCI and used without further purification. ^{1}H NMR spectra was recorded at 400 MHz, ^{13}C NMR spectra was recorded at 100 MHz. ^{19}F NMR spectra was recorded at 375 MHz. ^{1}H NMR spectra was recorded with tetramethylsilane (δ 0.00 ppm) as internal reference; ^{13}C NMR spectra was recorded with $CDCl_3$ (δ 77.00 ppm) as internal reference. Chemical shifts were reported in parts per million (ppm, δ) downfield from tetramethylsilane. Proton coupling patterns are described as singlet (s), doublet (d), triplet (t), quartet (q), multiplet (m), and broad (br). Chromatography was carried out with silica gel (200-300 mesh) using mixtures of petroleum ether (b.p. 60-80 ℃) and EtOAc as eluents. Mass spectrometry analysis was carried out using an electrospray spectrometer Waters Micromass Q-TOF premier Mass Spectrometer (Waters, Milford, MA, USA).

2. General procedure for the preparation of substrates

2.1 Synthesis of Phenyl Trifluoromethyl Ketamine Derivatives.

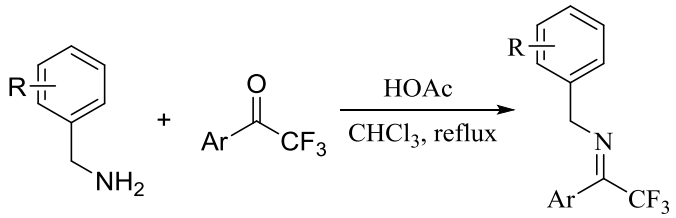


Figure S1. The synthesis of benzyl trifluoromethyl ketamine derivatives.

Benzyl trifluoromethyl ketamine derivatives were synthesized according to the method reported in the literature[1]. To the mixture of benzyl amine (1.0 equiv) and acetic acid (1.0 equiv) in $CHCl_3$ (1.0 mL/mmol) was added the solution of trifluoromethyl ketone (1.0 equiv) in $CHCl_3$ (0.2 mL/mmol) in one portion. The resulting mixture was refluxed until all the ketone was consumed (indicated by TLC or by the disappearance of the insoluble solid). After cooling down to room temperature, CH_2Cl_2 (4.0 mL/mmol) was added and the mixture was washed with $NaHCO_3$ (sat., 2.0 mL/mmol). The aqueous layer was extracted with CH_2Cl_2 (10 mL×2). The organic phase was combined, washed with brine, dried over Na_2SO_4 and concentrated. then it could be used directly.[1]

2.2 Synthesis of alkenes.

General procedure A (2a as an example)

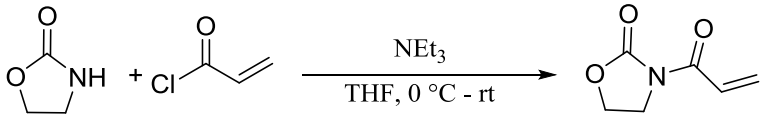
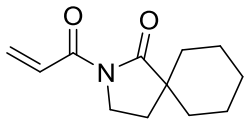


Figure S2. The synthesis of 3-acryloyloxazolidin-2-one.

The dienophile was synthesized according to the following procedure. To a solution of oxazolidin-2-one (1 g, 11.5 mmol) in anhydrous THF (20 mL) at 0 ℃ under argon atmosphere and magnetic stirring, triethylamine (4 mL, 28.8 mmol) was added. After 0.5 h, acryloyl chloride (1.9 mL, 23 mmol) was added dropwise and the mixture was stirred at 0 ℃ for another 2 h and then up to room temperature. The reaction was quenched by NH_4Cl aqueous solution (10 mL) after 15 h, and the resulting mixture

was diluted with dichloromethane and washed successively with saturated solutions of $NaHCO_3$ and NaCl. Concentrated HCl was added to adjust the pH to acidic condition (pH = 3). The organic phase was dried over anhydrous $MgSO_4$, filtered, and concentrated in *vacuo*. Purification of the residue by column chromatography (petroleum ether/EtOAc = 8/1 - 4/1) gave the product (860 mg, 6.1 mmol, 53%).[2]



2-**Acryloyl-2-azaspiro[4.5]decan-1-one (2q),** white solid, purified by flash column chromatography (eluent: petroleum ether / EtOAc = 13/1), 694 mg (50% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 (dd, *J* = 16.8, 10.4 Hz, 1H), 6.50 (dd, *J* = 17.0, 1.8 Hz, 1H), 5.84 (dd, *J* = 10.4, 1.6 Hz, 1H), 3.64 (s, 2H), 2.47 (s, 2H), 1.50 (s, 8H), 1.46 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 175.0, 166.2, 130.8, 129.3, 56.1, 46.3, 36.2, 34.8, 25.5, 22.6 ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{11}H_{16}NO_2$ 208.1138; found 208.1139.

General procedure B (2n as an example)

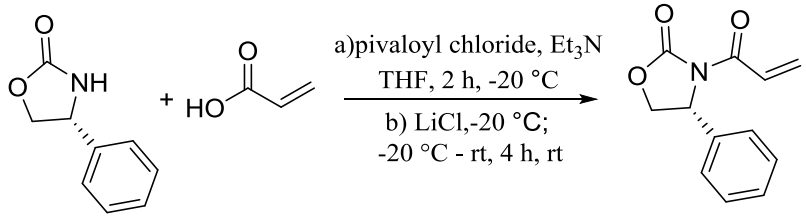


Figure S3. The synthesis of 3-acryloyl-4-phenyloxazolidin-2-one.

To the solution of acrylic acid (1.65 g, 22.9 mmol) and Et_3N (2.5 equiv) in THF (volume corresponded to 0.2 M of the oxazolidinone) was added trimethylacetyl chloride (2.54 g, 21.1 mmol) at -20 ˚C. A white solid was formed instantaneously. The mixture was stirred at -20 ˚C for 2.0 h. Lithium chloride (0.82 g, 19.4 mmol) was added, followed by the oxazolidinone (2.87 g, 17.6 mmol). The mixture was allowed to warm to room temperature slowly and stirred for 4.0 h. The reaction was quenched

by addition of saturated NH_4Cl and the solution was extracted with EtOAc. The organic layer was washed subsequently with saturated $NaHCO_3$, brine and water, dried over anhydrous Na_2SO_4 and filtered. EtOAc was removed in *vacuo*, and the residue was purified by flash column chromatography (silica gel, petroleum ether/EtOAc = 8/1 - 4/1) provided the desired product **2n** (2.73 g, 71%).[3]

General procedure C (2u as an example)

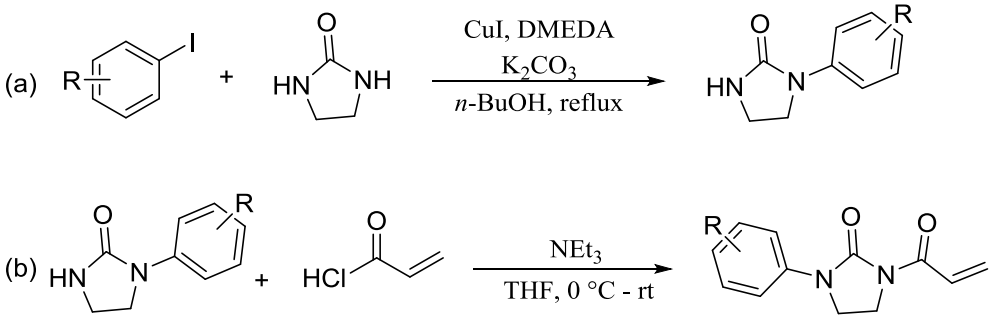
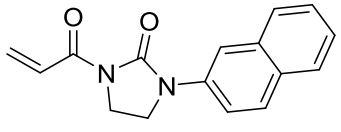


Figure S4. The synthesis of 1-acryloyl-3-phenylimidazolidin-2-one.

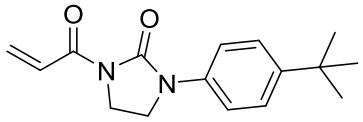
(a) A mixture of the aryl iodide (10 mmol), 2-imidazolidinone (5 equiv, 50 mmol), CuI (0.1 equiv, 1 mmol), *N*,*N'*-dimethylethylenediamine (0.3 equiv, 3 mmol) and K_2CO_3 (3 equiv, 30 mmol) was stirred in *n*-butanol (40 mL) for 5 h at 100 ℃. The crude reaction mixture was poured into a 10 % w/w NH_4Cl aqueous solution and the organic solvent was removed in *vacuo*. The residue was diluted with water and extracted with dichloromethane. The organic solution was washed with a 20 % w/w NaCl aqueous solution, dried over anhydrous Na_2SO_4, filtered and concentrated in *vacuo*. The resulting crude was purified by chromatography on silica gel using cyclohexane / EtOAc or pure EtOAc as eluent.[4]

(b) It was same as General procedure A.

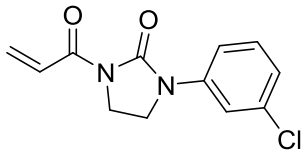


1-Acryloyl-3-(naphthalen-2-yl)imidazolidin-2-one (2t), yellow solid, purified by flash column chromatography (eluent: petroleum ether / EtOAc = 10/1), 727 mg (47% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.82 (m, 3H), 7.68 (dd, *J* = 16.8, 10.4 Hz,

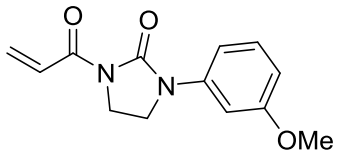
1H), 7.57 – 7.48 (m, 4H), 7.44 (d, *J* = 7.2 Hz, 1H), 6.55 (dd, *J* = 16.8, 1.6 Hz, 1H), 5.80 (dd, *J* = 10.4, 2.0 Hz, 1H), 4.17 (t, *J* = 8.0 Hz, 2H), 3.91 (t, *J* = 8.0 Hz, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 154.1, 134.6, 134.2, 129.9, 128.9, 128.7, 128.4, 127.1, 126.5, 125.6, 124.9, 122.3, 45.2, 40.3 ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{15}N_2O_2$ 267.1134; found 267.1133.



1-Acryloyl-3-(4-(tert-butyl)phenyl)imidazolidin-2-one (2v), white solid, purified by flash column chromatography (eluent: petroleum ether / EtOAc = 10/1), 854 mg (54% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (dd, *J* = 16.8, 10.4 Hz, 1H), 7.44 (dd, *J* = 24.4, 8.8 Hz, 4H), 6.52 (dd, *J* = 17.1, 1.9 Hz, 1H), 5.83 (dd, *J* = 10.5, 1.9 Hz, 1H), 4.06 – 4.02 (m, 2H), 3.94 – 3.90 (m, 2H), 1.32 (s, 9H) ppm; ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.9, 152.6, 147.7, 136.0, 129.9, 128.5, 126.0, 119.1, 41.9, 39.2, 31.3 ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{16}H_{21}N_2O_2$ 273.1603; found 273.1602.



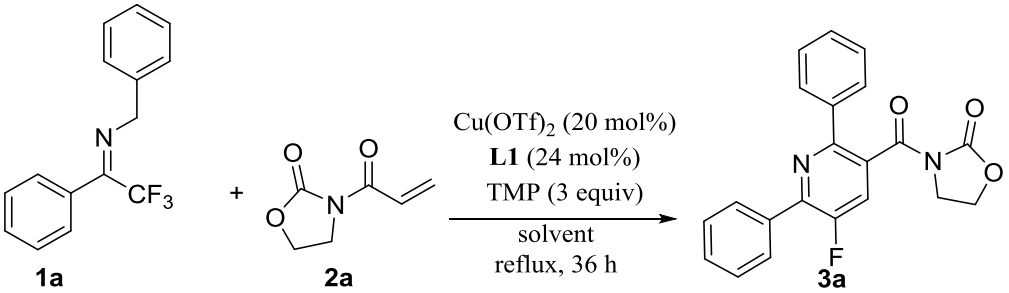
1-Acryloyl-3-(3-chlorophenyl)imidazolidin-2-one (2w), yellow solid, purified by flash column chromatography (eluent: petroleum ether / EtOAc = 10/1), 683 mg (47% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (t, *J* = 2.0 Hz, 1H) 7.61 (dd, *J* = 16.8, 10.4 Hz, 1H), 7.45 (ddd, *J* = 8.4, 2.0, 0.8 Hz 1H), 7.32 (t, *J* = 8.0 Hz, 1H), 7.15 (ddd, *J* = 8.0, 2.0, 0.8 Hz 1H), 6.54 (dd, *J* = 17.0, 1.9 Hz, 1H), 5.86 (dd, *J* = 10.6, 1.9 Hz, 1H), 4.07 – 4.03 (m, 2H), 3.94 – 3.89 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 152.4, 139.9, 134.9, 130.3, 130.1, 128.3, 124.5, 119.1, 116.8, 41.7, 39.1 ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{12}H_{12}ClN_2O_2$ 251.0587; found 251.0586.



1-Acryloyl-3-(3-methoxyphenyl)imidazolidin-2-one (2x), white solid, purified by flash column chromatography (eluent: petroleum ether / EtOAc = 18/1), 801 mg (56% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (dd, *J* = 17.0, 10.6 Hz, 1H), 7.31 – 7.27 (m, 2H), 7.06 (dd, *J* = 8.2, 1.4 Hz, 1H), 6.72 (dd, *J* = 8.2, 1.8 Hz, 1H), 6.53 (dd, *J* = 17.2, 2.0 Hz, 1H), 5.84 (dd, *J* = 10.4, 2.0 Hz, 1H), 4.05 – 4.01 (m, 2H), 3.94 – 3.89 (m, 2H), 3.83 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 165.8, 160.2, 152.5, 140.0, 130.0, 129.8, 128.5, 111.1, 110.2, 105.4, 55.4, 42.0, 39.1 ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{13}H_{15}N_2O_3$ 247.1083; found 247.1082.

3. Optimization of reaction conditions

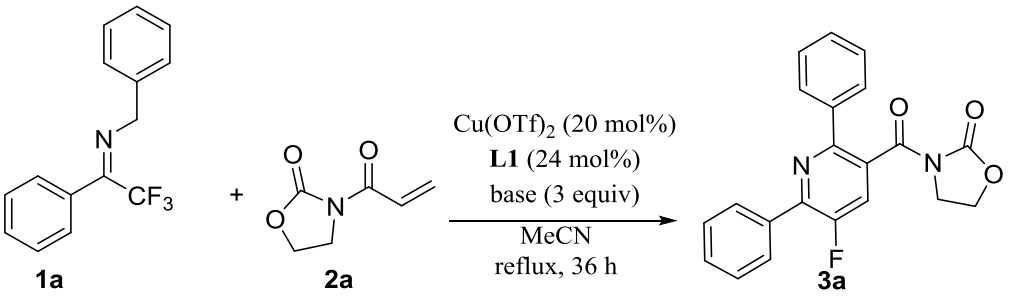
3.1 Screening of solvents in reactions[a]



entry	solvent	yield(%)[b]
1	H_2O	trace
2	HFIP	23
3	THF	trace
4	acetone	32
5	dioxane	43
6	DMF	-
7	DMA	-
8	PhCl	trace
9	$PhCF_3$	25
10	*p*-xylene	trace
11	hexafluorobenze	35
12	DCE: MeCN = 1:1	54

[a] Unless otherwise specified, $Cu(OTf)_2$ (20 mol%), **L1** (24 mol%), **1a** (0.6 mmol) was added to a mixture of **2a** (0.2 mmol) and TMP (0.3 mmol) in 1.0 mL of dry solvent. The solution was heated at 85 ℃ for 36 h. [b] Isolated yields.

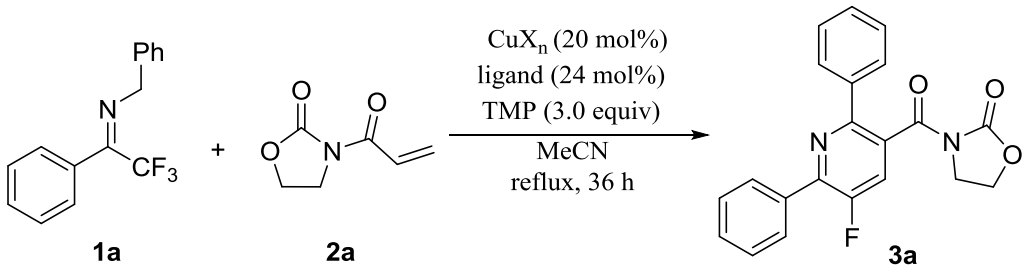
3.2 Screening of base in reactions[a]

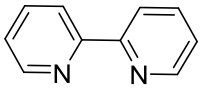


entry	base	yield(%)[b]
1	TMP	52
2	PMP	48
3	DIPEA	trace
4	TBD	-
5	DABCO	-
6	KHMDS	36
7	K_2CO_3	34
8	K_3PO_4	35
9	KO^tBu	29
10	Na_2CO_3	36
11	$NaHCO_3$	trace
12	TBAF	23

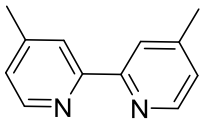
[a] Unless otherwise specified, $Cu(OTf)_2$ (20 mol%), **L1** (24 mol%), **1a** (0.6 mmol) was added to a mixture of **2a** (0.2 mmol) and base (0.3 mmol) in 1.0 mL of dry MeCN. The solution was heated for 36 h at 85 ℃. [b] Isolated yields.

3.3 Screening of CuX_n and ligand in reactions[a]

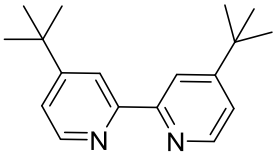




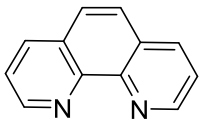
L1



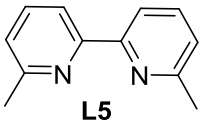
L2



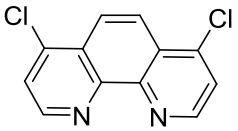
L3



L4



L5



L6

entry	CuX_n	Ligand	yield(%)[b]
1	$Cu(OAc)_2$	**L1**	42
2	$CuBr_2$	**L1**	40
3	CuBr	**L1**	20
4	CuCl	**L1**	35
5	$Cu(OTf)_2$	**L2**	56
6	$Cu(OTf)_2$	**L3**	48
7	$Cu(OTf)_2$	**L4**	62
8	$Cu(OTf)_2$	**L5**	55
9	$Cu(OTf)_2$	**L6**	61

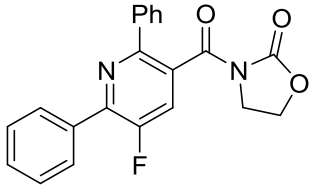
[a] Reaction conditions: [a] Unless otherwise specified, CuX_n (20 mol%), ligand (24 mol%), **1a** (0.6 mmol) was added to a mixture of **2a** (0.2 mmol) and TMP (0.6 mmol) in 2.0 mL of dry MeCN. The solution was heated for 48 h at 85 ℃. [b] Isolated yields.

4. General procedure for the synthesis of products 3 and their characterization data.

4.1 General procedure for the synthesis of products (3a as an example).

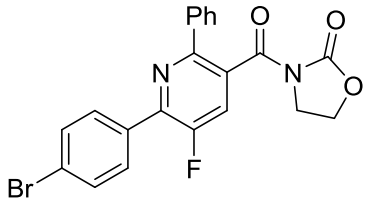
The reaction was carried out in a flame-dried test tube under an argon atmosphere. $Cu(OTf)_2$ (18.4 mg, 0.04 mmol, 20 mol %) and Ligand 4 (16 mg, 0.048 mmol, 24 mol %) were charged to the test tube and followed by addition of freshly distilled MeCN (1.0 mL). This solution was stirred 1.5 h at room temperature under magnetic stirring. Afterwards, 3-acryloyloxazolidin-2-one **2a** (28.4 mg, 0.2 mmol) and the additional freshly distilled MeCN (1.0 mL) were added to this mixture solution successively and stirred for another 0.75 h. Then **1a** (263.1 mg, 1 mmol, 5 equiv) and TMP (0.6 mmol, 84.8 mg) were added. The mixture was moved to 85 ℃ oil bath and refluxed for 48 h. After completion of the reaction, the solution was cooled to room temperature. The reaction was quenched with distilled water (0.6 mL) and extracted with ether (5 mL). The combined organic phases was removed under reduced pressure and the residue was purified by flash chromatography (petroleum ether / EtOAc = 5/1 to 3/1) to give the desired product **3a** as yellow oil (45 mg, 66 % yield).

4.2 Characterization data for products.

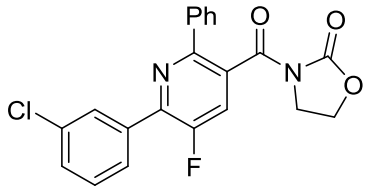


3-(5-Fluoro-2,6-diphenylnicotinoyl)oxazolidin-2-one (**3a**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 45 mg (66% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.11 (d, *J* = 7.6 Hz, 2H), 7.63 – 7.59 (m, 3H), 7.52 – 7.47 (m, 3H), 7.46 – 7.43 (m, 3H), 4.04 (t, *J* = 7.6 Hz, 2H), 3.92 (t, *J* = 7.6 Hz, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.4, 156.1 (d, *J* = 260.7 Hz) 152.5 (d, *J* = 5.4 Hz), 151.9, 146.8 (d, *J* = 10.3 Hz), 138.7, 134.7 (d, *J* = 5.7 Hz), 129.8, 129.2, 129.1, 129.0, 128.8, 128.5, 128.3, 124.4 (d, *J* =23.7 Hz), 62.4, 42.8 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.11 (d, *J* = 10.1 Hz); HRMS (ESI) m/z: $[M + H]^+$ Calcd for

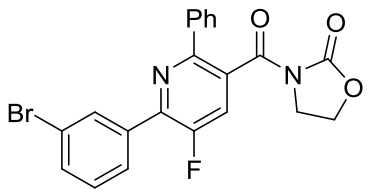
$C_{21}H_{16}FN_2O_3$ 363.1145; Found 363.1146.



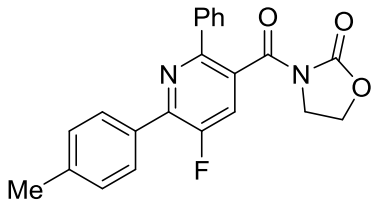
3-(6-(4-Bromophenyl)-5-fluoro-2-phenylnicotinoyl)oxazolidin-2-one (**3b**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 54 mg (61% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.01 (dd, *J* = 8.4, 0.8 Hz, 2H), 7.63 (s, 1H), 7.61 – 7.58 (m, 4H), 7.46 – 7.44 (m, 3H), 4.05 (t, *J* = 7.6 Hz, 2H), 3.93 (t, *J* = 7.6 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.2, 156.0 (d, *J* = 260.9 Hz) 152.6 (d, *J* = 5.1 Hz), 151.9, 145.5 (d, *J* = 9.9 Hz), 138.5, 133.5 (d, *J* = 6.2 Hz), 131.7, 130.7 (d, *J* = 6.8 Hz), 129.1, 128.9 (d, *J* = 2.7 Hz), 128.8, 128.3, 124.5, 124.5 (d, *J* =23.7 Hz), 62.4, 42.8 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -125.64 (d, *J* = 10.3 Hz); HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}BrFN_2O_3$ 441.0250; Found 441.0252.



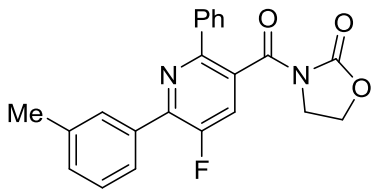
3-(6-(3-Chlorophenyl)-5-fluoro-2-phenylnicotinoyl)oxazolidin-2-one (**3c**, brown oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 51 mg (62% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.13 (s, 1H), 8.02 – 8.00 (m, 1H), 7.65 – 7.59 (m, 3H), 7.46 – 7.42 (m, 5H), 4.06 (t, *J* = 7.6 Hz, 2H), 3.93 (t, *J* = 7.6 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.1, 156.1 (d, *J* = 261.2 Hz), 152.6 (d, *J* = 5.4 Hz), 151.9, 145.1 (d, *J* = 9.8 Hz), 138.5, 136.3 (d, *J* = 5.6 Hz), 134.6, 129.8, 129.7, 129.2, 129.2, 129.1, 128.8, 128.3, 127.3 (d, *J* = 6.9 Hz), 124.5 (d, *J* = 23.7 Hz), 62.4, 42.7 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -125.60 (d, *J* = 10.4 Hz); HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}ClFN_2O_3$ 397.0755; Found 397.0753.



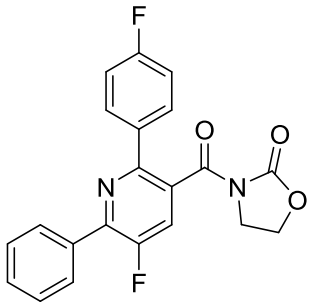
3-(6-(3-Bromophenyl)-5-fluoro-2-phenylnicotinoyl)oxazolidin-2-one (**3d**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 54 mg (63% yield). ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.26 (s, 1H), 8.04 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.64 (d, *J* = 10.2 Hz, 1H), 7.60 – 7.58 (m, 3H), 7.46 – 7.44 (m, 3H), 7.37 (t, *J* = 7.8 Hz, 1H), 4.06 (t, *J* = 7.2 Hz, 2H), 3.93 (t, *J* = 7.8 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.1, 156.1 (d, *J* = 262.0 Hz), 152.7 (d, *J* = 5.6 Hz), 152.0, 145.1 (d, *J* = 11.1 Hz), 138.3, 136.4 (d, *J* = 5.6 Hz), 132.8, 132.0 (d, *J* = 5.4 Hz), 130.0, 129.3 (d, *J* = 4.3 Hz), 129.2, 128.8, 128.3, 127.7 (d, *J* = 6.9 Hz), 124.6 (d, *J* = 23.2 Hz), 122.7, 62.4, 42.7 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -125.45 (d, *J* = 10.1 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}BrFN_2O_3$ 441.0250; Found 441.0249



3-(5-Fluoro-2-phenyl-6-(p-tolyl)nicotinoyl)oxazolidin-2-one (**3e**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 47 mg (64% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.02 (d, *J* = 7.2 Hz, 2H), 7.61 – 7.59 (m, 3H), 7.44 – 7.43 (m, 3H), 7.30 (d, *J* = 8.0 Hz, 2H), 4.04 (t, *J* = 7.6 Hz, 2H), 3.92 (t, *J* = 7.6 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.5, 156.0 (d, *J* = 260.6 Hz), 152.4 (d, *J* = 5.3 Hz), 151.9, 146.9 (d, *J* = 10.4 Hz), 140.0, 138.8, 131.9 (d, *J* = 5.6 Hz), 129.2, 129.1, 129.0, 128.9, 128.8, 128.2, 124.2 (d, *J* =23.6 Hz), 62.3, 42.8, 21.4 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -126.13 (d, *J* = 10.3 Hz); HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{18}FN_2O_3$ 377.1301; Found 377.1300.

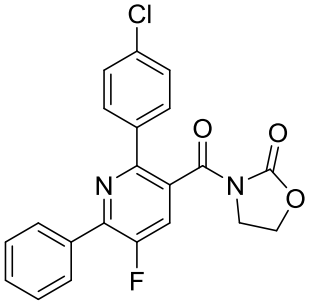


3-(5-Fluoro-2-phenyl-6-(m-tolyl)nicotinoyl)oxazolidin-2-one (**3f**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 48 mg (65% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.91 – 7.87 (m, 2H), 7.62 – 7.60 (m, 3H), 7.45 – 7.43 (m, 3H), 7.38 (t, *J* = 7.6 Hz, 1H), 7.28 (s, 1H), 4.04 (t, *J* = 7.6 Hz, 2H), 3.93 (t, *J* = 7.6 Hz, 2H) , 2.44 (s, 3H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.4, 156.0 (d, *J* = 260.7 Hz), 152.5 (d, *J* = 5.4 Hz), 151.9, 147.1 (d, *J* = 10.2 Hz), 138.8, 138.1, 134.6 (d, *J* = 5.4 Hz), 130.6, 129.7 (d, *J* = 5.0 Hz), 129.0, 128.8, 128.4 (d, *J* = 3.8 Hz), 128.3, 128.2, 126.3 (d, *J* = 6.8 Hz), 124.2 (d, *J* = 23.6 Hz), 62.3, 42.8, 21.6 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -125.96 (d, *J* = 10.2 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{18}FN_2O_3$ 377.1301; Found 377.1302.

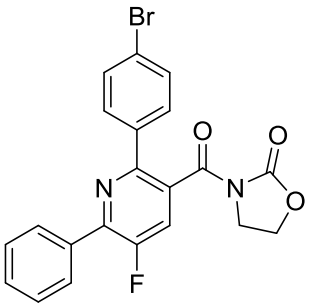


3-(5-Fluoro-2-(4-fluorophenyl)-6-phenylnicotinoyl)oxazolidin-2-one (**3g**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 49 mg (62% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.09 (d, *J* = 7.6 Hz, 2H), 7.62 – 7.58 (m, 3H), 7.52 – 7.45 (m, 3H), 7.13 (t, *J* = 8.6 Hz, 2H), 4.17 (t, *J* = 7.8 Hz, 2H), 3.98 (t, *J* = 7.8 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.2, 163.3 (d, *J* = 248.1 Hz), 156.0 (d, *J* = 261.0 Hz), 151.8, 151.32 (d, *J* = 4.5 Hz), 146.9 (d, *J* = 10.8 Hz), 134.9 (d, *J* = 3.5 Hz), 134.5 (d, *J* = 6.0 Hz), 130.7 (d, *J* = 8.3 Hz), 129.9, 129.1 (d, *J* = 5.9 Hz), 128.5, 128.4 (d, *J* = 3.2 Hz), 124.3 (d, *J* = 24.0 Hz), 115.3 (d, *J* = 21.6 Hz), 62.3, 42.7 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -112.04 – -112.16 (m), -125.98 (d, *J* = 10.4 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}F_2N_2O_3$ 381.1051;

Found 381.1052

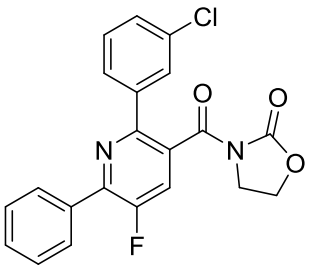


3-(2-(4-Chlorophenyl)-5-fluoro-6-phenylnicotinoyl)oxazolidin-2-one (**3h**, brown oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 49 mg (61% yield). ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.02 (d, *J* = 7.8 Hz, 2H), 7.52 (d, *J* = 10.2 Hz, 1H), 7.48 (d, *J* = 8.4 Hz, 2H), 7.44 – 7.38 (m, 3H), 7.34 (d, *J* = 8.4 Hz, 2H), 4.10 (t, *J* = 7.8 Hz, 2H), 3.91 (t, *J* = 7.8 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.1, 156.1 (d, *J* = 260.7 Hz), 151.8, 151.2 (d, *J* = 4.8 Hz), 146.9 (d, *J* = 11.0 Hz), 137.2, 135.3, 134.5 (d, *J* = 5.4 Hz), 130.7 (d, *J* = 8.3 Hz),130.1, 129.9, 129.1 (d, *J* = 6.5 Hz), 128.5, 124.3 (d, *J* = 24.4 Hz), 115.3 (d, *J* = 21.9 Hz), 62.3, 42.7 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -125.55 (dd, *J* = 28.3, 10.3 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}ClFN_2O_3$ 397.0755; Found 397.0753.

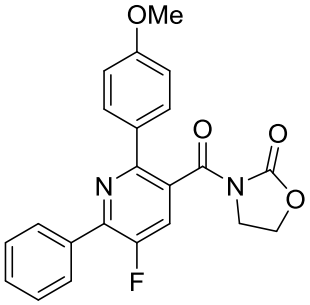


3-(2-(4-Bromophenyl)-5-fluoro-6-phenylnicotinoyl)oxazolidin-2-one (**3i**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 59 mg (67% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.08 (d, *J* = 7.8 Hz, 2H), 7.61 – 7.55 (m, 3H), 7.52 – 7.41 (m, 5H), 4.18 (t, *J* = 7.8 Hz, 2H), 3.98 (t, *J* = 7.8 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.0, 156.1 (d, *J* = 261.9 Hz), 151.9, 151.2 (d, *J* = 5.6 Hz), 147.0 (d, *J* = 11.0 Hz), 137.5, 134.4 (d, *J* = 5.6 Hz), 131.5, 130.4, 130.1,

129.9, 129.1 (d, *J* = 5.8 Hz), 128.6, 124.4 (d, *J* = 23.4 Hz), 123.7, 62.4, 42.7 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -125.55 (dd, *J* = 40.1, 10.1 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}BrFN_2O_3$ 441.0250; Found 441.0250.

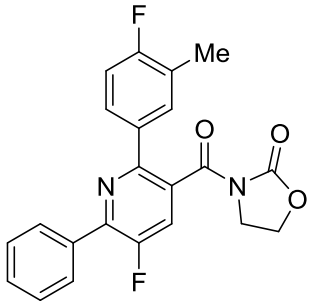


3-(2-(3-Chlorophenyl)-5-fluoro-6-phenylnicotinoyl)oxazolidin-2-one (**3j**, brown oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 50 mg (62% yield). ^{1}H NMR (600 MHz, $CDCl_3$): δ 8.09 (d, *J* = 8.4, 2H), 7.63 – 7.61 (m, 2H), 7.52 – 7.48 (m, 4H), 7.43 – 7.41 (m, 1H), 7.38 (d, *J* = 7.2 Hz, 2H), 4.18 (t, *J* = 7.8 Hz, 2H), 4.00 (t, *J* = 7.8 Hz, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.0, 156.2 (d, *J* = 264.1 Hz), 151.9, 150.7 (d, *J* = 5.4 Hz), 147.1 (d, *J* = 11.1 Hz), 140.3, 134.4 (d, *J* = 5.6 Hz), 134.2, 130.0, 129.6, 129.2, 129.1 (d, *J* = 5.4 Hz), 128.9, 128.6, 128.5, 127.1, 124.5 (d, *J* = 23.6 Hz), 62.4, 42.7 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -125.11 (d, *J* = 9.0 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{21}H_{15}ClFN_2O_3$ 397.0755; Found 397.0756.

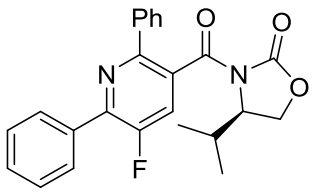


3-(5-Fluoro-2-(4-methoxyphenyl)-6-phenylnicotinoyl)oxazolidin-2-one (**3k**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 3/1), 42 mg (51% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.08 (d, *J* = 8.4 Hz, 2H), 7.60 (d, *J* = 10.2 Hz, 1H) , 7.55 (d, *J* = 9.0 Hz, 1H), 7.51 – 7.46 (m, 3H), 6.96 (d,

J = 8.4 Hz, 2H), 4.13 (t, *J* = 9.0 Hz, 2H), 3.97 (t, *J* = 8.4 Hz, 2H), 3.86 (s, 3H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.4, 160.4, 155.8 (d, *J* = 260.1 Hz), 152.1 (d, *J* = 4.5 Hz), 151.9, 145.6 (d, *J* = 10.3 Hz), 134.5 (d, *J* = 5.6 Hz), 131.0, 130.2, 129.8, 129.2 (d, *J* = 5.6 Hz), 128.5, 128.2 (d, *J* = 2.8 Hz), 124.4 (d, *J* = 23.6 Hz), 62.3, 55.4, 42.8 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -126.76 (d, *J* = 10.2 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{18}FN_2O_4$ 393.1251; Found 393.1250.

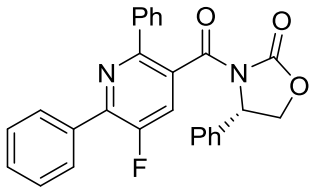


3-(5-Fluoro-2-(4-fluoro-3-methylphenyl)-6-phenylnicotinoyl)oxazolidin-2-one (**3l**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 49 mg (64% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.02 (dd, *J* = 6.6, 1.8 Hz, 2H) , 7.63 (d, *J* = 10.2 Hz, 1H), 7.51 – 7.48 (m, 4H), 7.33 – 7.30 (m, 1H), 7.05 (t, *J* = 9.0 Hz, 1H), 4.18 (t, *J* = 7.8 Hz, 2H), 3.97 (t, *J* = 7.8 Hz, 2H), 2.33 (s, 3H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 167.0, 162.0 (d, *J* = 246.9 Hz), 156.0 (d, *J* = 260.6 Hz), 152.0, 151.6 (d, *J* = 4.6 Hz), 147.1 (d, *J* = 11.2 Hz), 133.7 (dd, *J* = 18.1, 5.4 Hz), 132.3 (d, *J* = 6.1 Hz), 130.1, 129.2 (d, *J* = 5.6 Hz), 128.8 (d, *J* = 3.1 Hz), 128.6, 127.7 (d, *J* = 8.2 Hz), 125.4 (d, *J* = 18.0 Hz), 124.7 (d, *J* = 23.4 Hz), 114.8 (d, *J* = 22.2 Hz), 62.4, 42.7, 14.6 (d, *J* = 2.8 Hz) ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -116.51 (s), -126.22 (d, *J* = 10.2 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{17}F_2N_2O_4$ 395.1207; Found 395.1208.

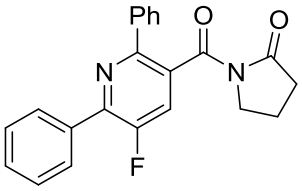


(*R*)-3-(5-Fluoro-2,6-diphenylnicotinoyl)-4-isopropyloxazolidin-2-one (**3m**, yellow

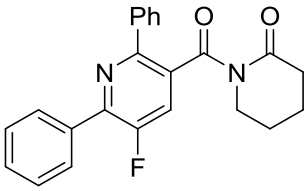
oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 5/1), 52 mg (65% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, *J* = 7.8 Hz, 2H), 7.58 – 7.50 (m, 3H), 7.50 – 7.41 (m, 4H), 7.38 (d, *J* = 3.4 Hz, 5H), 7.17 (d, *J* = 3.0 Hz, 2H), 5.28 (dd, *J* = 7.9, 3.0 Hz, 1H), 4.21 (t, *J* = 8.2 Hz, 1H), 4.13 (dd, *J* = 8.8, 3.5 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.2, 156.0 (d, *J* = 260.5 Hz) 152.7, 152.1 (d, *J* = 4.8 Hz), 146.5 (d, *J* = 10.3 Hz), 138.8, 134.7 (d, *J* = 5.6 Hz), 129.7, 129.2, 129.1, 129.0, 129.0, 128.5, 128.4, 123.9 (d, *J* = 22.3 Hz), 63.7, 59.3, 28.8, 18.1, 14.7 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.28 (s) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{24}H_{22}FN_2O_3$ 405.1614; Found 405.1615. $[\alpha]_D^{23}$ = 50.5° (*c* = 0.075, CH_2Cl_2).



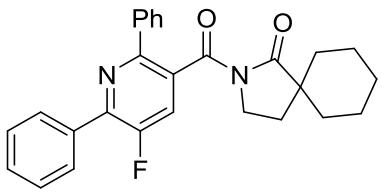
(S)-**3-(5-Fluoro-2,6-diphenylnicotinoyl)-4-phenyloxazolidin-2-one** (**3n**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 5/1), 52 mg (62% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, *J* = 7.6 Hz, 2H), 7.57 – 7.51 (m, 3H), 7.49 – 7.42 (m, 4H), 7.38 – 7.37 (m, 5H), 7.17 (d, *J* = 3.2 Hz, 2H), 5.28 (dd, *J* = 7.6, 2.8 Hz, 1H), 4.21 (t, *J* = 8.0 Hz, 1H), 4.13 (dd, *J* = 8.8, 3.6 Hz, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.7, 156.0 (d, *J* = 261.0 Hz), 152.4 (d, *J* = 5.1 Hz), 152.2, 146.6 (d, *J* = 10.6 Hz), 138.6, 137.8, 134.7 (d, *J* = 5.6 Hz), 129.8, 129.3, 129.2 (d, *J* = 6.0 Hz), 129.0, 128.9, 128.8, 128.7 (d, *J* = 3.0 Hz), 128.6, 128.5, 126.3, 124.2 (d, *J* = 23.7 Hz), 70.3, 58.2 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.29 (d, *J* = 9.3 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{24}H_{22}FN_2O_3$ 439.1458; Found 439.1457. $[\alpha]_D^{23}$ = 76.3° (*c* = 0.064, CH_2Cl_2).



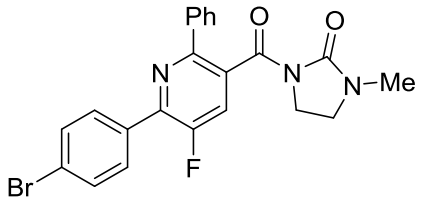
1-(5-Fluoro-2,6-diphenylnicotinoyl)pyrrolidin-2-one (**3o**, white oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 5/1), 40 mg (55% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.04 (d, *J* = 8.0 Hz, 2H), 7.53 (s, 1H), 7.50 – 7.48 (m, 2H), 7.44 – 7.37 (m, 3H), 7.35 – 7.34 (m, 3H), 3.63 (t, *J* = 7.0 Hz, 2H), 1.98 (t, *J* = 7.8 Hz, 2H), 1.63 – 1.60 (m, 2H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$): δ 172.9, 166.9, 155.2 (d, *J* = 260.6 Hz), 151.2 (d, *J* = 4.9 Hz), 145.2 (d, *J* = 10.8 Hz), 138.0, 133.8 (d, *J* = 6.0 Hz), 129.3 (d, *J* = 2.9 Hz), 128.6, 128.1 (d, *J* = 6.2 Hz), 127.9, 127.8, 127.4, 127.1, 123.2 (d, *J* = 23.6 Hz), 44.5, 31.2, 16.4 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -126.24 (d, *J* = 10.5 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{18}FN_2O_2$ 361.1352; Found 361.1347.



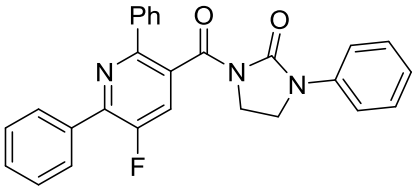
1-(5-Fluoro-2,6-diphenylnicotinoyl)piperidin-2-one (**3p**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 5/1), 35 mg (47% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.08 (d, *J* = 8.0 Hz, 2H), 7.64 (d, *J* = 10.4 Hz, 1H), 7.54 – 7.52 (m, 2H), 7.50 – 7.41 (m, 6H), 3.64 (t, *J* = 5.8 Hz, 2H), 1.84 (t, *J* = 6.2 Hz, 2H), 1.49 – 1.42 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 172.8, 171.1, 156.5 (d, *J* = 260.0 Hz), 150.7 (d, *J* = 5.0 Hz), 145.7 (d, *J* = 10.9 Hz), 139.1, 134.9 (d, *J* = 5.7 Hz), 132.5 (d, *J* = 3.6 Hz), 129.5, 129.2, 129.1, 128.7 (s), 128.4, 128.3, 124.3 (d, *J* = 23.4 Hz), 45.3, 33.7, 21.9, 20.3 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.16 (d, *J* = 10.7 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{23}H_{20}FN_2O_2$ 375.1509; Found 375.1510.



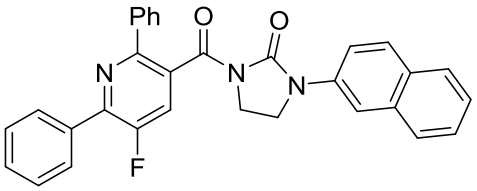
2-(5-Fluoro-2,6-diphenylnicotinoyl)-2-azaspiro[4.5]decan-1-one (**3q**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 5/1), 42 mg (52% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, *J* = 8.0 Hz, 2H), 7.58 – 7.56 (m, 2H), 7.53 (s, 1H), 7.50 – 7.44 (m, 3H), 7.43 – 7.35 (m, 3H), 3.49 (s, 2H), 1.97 (s, 2H), 1.42 – 1.29 (m, 6H) 1.08 (br, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 173.2, 168.0, 156.2 (d, *J* = 260.6 Hz), 152.1 (d, *J* = 5.3 Hz), 146.0 (d, *J* = 10.1 Hz), 139.1, 134.9 (d, *J* = 5.4 Hz), 130.7 (d, *J* = 3.2 Hz), 129.6, 129.1 (d, *J* = 6.5 Hz), 128.9, 128.7, 128.4, 128.3, 123.9 (d, *J* = 23.4 Hz), 55.6, 45.3, 35.7, 34.8, 25.3, 22.5 ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -126.43 (d, *J* = 10.5 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{26}FN_2O_2$ 429.1978; Found 429.1979.



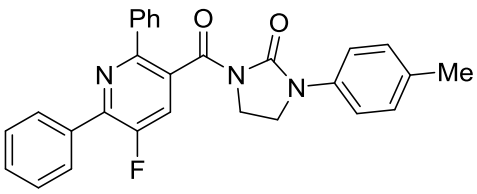
1-(6-(4-Bromophenyl)-5-fluoro-2-phenylnicotinoyl)-3-methylimidazolidin-2-one (**3r**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 1/2), 52 mg (57% yield), ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.00 (d, *J* = 7.8 Hz, 2H), 7.61 – 7.58 (m, 4H), 7.57 (d, *J* = 10.8 Hz, 1H), 7.41 – 7.37 (m, 3H), 3.78 (s, 2H), 3.12 (s, 2H), 2.59 (s, 3H) ppm; ^{13}C NMR (150 MHz, $CDCl_3$) δ 167.0, 156.1 (d, *J* = 260.6 Hz), 153.1, 152.3 (d, *J* = 5.1 Hz), 144.6 (d, *J* = 9.9 Hz), 139.0, 133.9 (d, *J* = 6.2 Hz), 131.6, 130.7 (d, *J* = 2.8 Hz), 130.7 (d, *J* = 6.0 Hz), 128.8, 128.6, 127.9, 124.1 (d, *J* = 23.3 Hz), 124.1, 43.3, 39.8, 30.4 ppn; ^{19}F NMR (565 MHz, $CDCl_3$) δ -126.20 (d, *J* = 10.4 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{22}H_{18}BrFN_3O_2$ 454.0566; Found 454.0544.



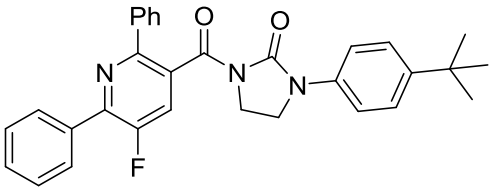
1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-phenylimidazolidin-2-one (**3s**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 5/1), 52 mg (54% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, *J* = 8.0 Hz, 2H), 7.64 – 7.59 (m, 3H), 7.49 – 7.41 (m, 3H), 7.35 – 7.34 (m, 3H), 7.31 – 7.27 (m, 2H), 7.24 – 7.22 (m, 2H), 7.11 (t, *J* = 7.2 Hz, 1H), 3.88 (s, 2H), 3.54 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 166.4, 155.1 (d, *J* = 260.2 Hz), 151.2 (d, *J* = 5.0 Hz), 150.0, 145.1 (d, *J* = 10.3 Hz), 138.1, 137.0, 133.9 (d, *J* = 5.6 Hz), 129.2 (d, *J* = 3.5 Hz), 128.5, 128.1 (d, *J* = 6.3 Hz), 127.9, 127.8, 127.6, 127.4, 127.0, 123.7, 123.4 (d, *J* = 23.4 Hz), 118.2, 41.1, 38.5 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.24 (d, *J* = 10.2 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{21}FN_3O_2$ 438.1618; Found 438.1619.



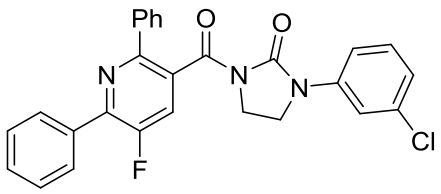
1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-(naphthalen-2-yl)imidazolidin-2-one (**3t**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 52 mg (58% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.02 (d, *J* = 7.6 Hz, 2H), 7.84 – 7.82 (m, 1H), 7.79 (d, *J* = 8.4 Hz, 1H), 7.72 (d, *J* = 6.8 Hz, 2H), 7.64 (d, *J* = 10.4 Hz, 1H), 7.59 – 7.50 (m, 3H), 7.48 – 7.38 (m, 6H), 7.05 (d, *J* = 4.8 Hz, 1H), 4.09 (s, 2H), 3.63 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.7, 156.2 (d, *J* = 260.1 Hz), 152.4, 152.0 (d, *J* = 4.9 Hz), 146.0 (d, *J* = 10.7 Hz), 139.3, 134.9 (d, *J* = 5.8 Hz), 134.5, 133.5, 130.0 (d, *J* = 3.6 Hz), 129.7, 129.5, 129.1, 129.0, 128.9, 128.7, 128.6, 128.4, 128.3, 127.1, 126.6, 124.6, 124.4, 124.1 (d, *J* = 23.5 Hz) 122.1, 45.2, 40.6 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.64 (d, *J* = 10.0 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{31}H_{23}FN_3O_2$ 488.1774; Found 488.1775.



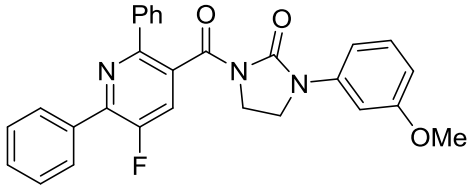
1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-(p-tolyl)imidazolidin-2-one (**3u**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 52 mg (60% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.10 (d, *J* = 8.0 Hz, 2H), 7.64 (s, 1H), 7.61 – 7.59 (m, 2H), 7.49 – 7.40 (m, 3H), 7.36 – 7.35 (m, 3H), 7.10 (s, 4H), 3.88 (s, 2H), 3.53 (s, 2H), 2.29 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.5, 156.2 (d, *J* = 260.1 Hz), 152.3 (d, *J* = 5.1 Hz), 151.0, 146.1 (d, *J* = 10.4 Hz), 139.2, 135.5, 134.9 (d, *J* = 5.7 Hz), 134.6, 130.3 (d, *J* = 3.4 Hz), 129.6, 129.5, 129.2 (d, *J* = 6.3 Hz), 128.8, 128.6, 128.4, 128.0, 124.0 (d, *J* = 23.5 Hz), 119.4, 42.3, 39.6, 20.8 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.46 (d, *J* = 10.7 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{28}H_{23}FN_3O_2$ 452.1774; Found 452.1775.



1-**(4-(*tert*-Butyl)phenyl)-3-(5-fluoro-2,6-diphenylnicotinoyl)imidazolidin-2-one** (**3v**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 3/1), 52 mg (57% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.02 (d, *J* = 8.0 Hz, 2H), 7.56 – 7.53 (m, 3H), 7.40 – 7.37 (m, 3H), 7.30 – 7.28 (m, 3H), 7.22 (t, *J* = 8.2 Hz, 2H), 7.07 (d, *J* = 8.4 Hz, 2H), 3.81 (s, 2H), 3.47 (s, 2H), 1.20 (s, 9H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.5, 156.1 (d, *J* = 260.2 Hz), 152.2 (d, *J* = 5.0 Hz), 151.1 , 148.0, 146.1 (d, *J* = 10.6 Hz), 139.2, 135.4, 135.0 (d, *J* = 5.8 Hz), 130.3 (d, *J* = 3.2 Hz), 129.5, 129.1 (d, *J* = 6.1 Hz), 128.8, 128.6, 128.4, 128.0, 125.9, 123.9 (d, *J* = 23.6 Hz), 119.3, 42.3, 39.6, 34.4, 31.3 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.50 (d, *J* = 10.4 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{31}H_{29}FN_3O_2$ 494.2244; Found 494.2243.



1-(3-Chlorophenyl)-3-(5-fluoro-2,6-diphenylnicotinoyl)imidazolidin-2-one (**3w**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 52 mg (58% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.12 – 8.10 (m, 2H), 7.63 (dd, *J* = 10.4, 3.0 Hz, 1H), 7.60 – 7.58 (m, 2H), 7.49 – 7.42 (m, 3H), 7.35 – 7.34 (m, 3H), 7.28 – 7.24 (m, 1H), 7.20 (td, *J* = 8.0, 2.8 Hz, 1H), 7.13 (d, *J* = 8.4 Hz, 1H), 7.07 (d, *J* = 8.0 Hz, 1H), 3.87 (s, 2H), 3.49 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.4, 156.2 (d, *J* = 260.4 Hz), 152.3 (d, *J* = 5.1 Hz), 150.9, 146.3 (d, *J* = 10.3 Hz), 139.3, 139.1, 134.8 (d, *J* = 5.7 Hz), 134.7, 130.0, 129.9, 129.7, 129.2 (d, *J* = 6.3 Hz), 128.8, 128.7, 128.4, 128.0, 124.6, 124.1 (d, *J* = 23.4 Hz), 119.1, 116.9, 42.0, 39.5 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.21 (d, *J* = 10.4 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{27}H_{20}ClFN_3O_2$ 472.1228; Found 472.1227.



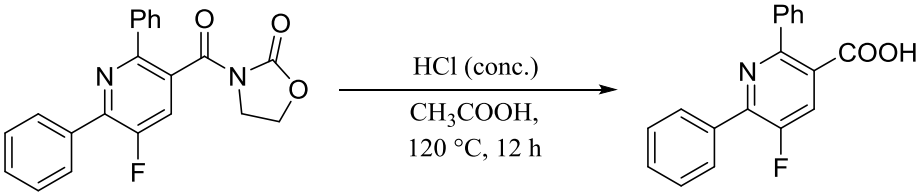
1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-(3-methoxyphenyl)imidazolidin-2-one (**3x**, yellow oil), purified by flash column chromatography (eluent: petroleum ether / EtOAc = 4/1), 52 mg (60% yield). ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.11 (d, *J* = 7.8 Hz, 2H), 7.65 – 7.59 (m, 3H), 7.50 – 7.40 (m, 3H), 7.36 – 7.34 (m, 3H), 7.19 (t, *J* = 8.4 Hz, 1H), 6.90 (s, 1H), 6.78 (dd, *J* = 8.0, 1.2 Hz, 1H), 6.66 (dd, *J* = 8.2, 1.8 Hz, 1H), 3.87 (s, 2H), 3.76 (s, 3H), 3.53 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 167.4, 160.0, 156.2 (d, *J* = 260.3 Hz), 152.3 (d, *J* = 5.2 Hz), 150.9, 146.1 (d, *J* = 10.3 Hz), 139.3, 139.1, 134.9 (d, *J* = 5.7 Hz), 130.2 (d, *J* = 3.2 Hz), 129.7, 129.6, 129.2 (d, *J* = 6.3 Hz), 128.8, 128.7, 128.4, 128.0, 124.1 (d, *J* = 23.4 Hz), 111.3, 110.1, 105.6, 55.4, 42.2, 39.5 ppm; ^{19}F NMR (375 MHz, $CDCl_3$) δ -126.38 (d, *J* = 10.4 Hz) ppm; HRMS (ESI)

m/z: $[M + H]^+$ Calcd for $C_{28}H_{23}FN_3O_3$ 468.1723; Found 468.1724.

4.3 Gram-Scale Experiments (3a as the example).

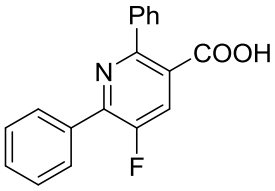
Under argon atmosphere, $Cu(OTf)_2$ (653.2 mg, 1.42 mmol, 20 mol %) and ligand **L4** (568 mg, 1.7 mmol, 24 mol %) were charged to the test tube and followed by addition of freshly distilled MeCN (15 mL). This solution was stirred for 1.5 h at room temperature. Afterwards, 3-acryloyloxazolidin-2-one **2a** (1.0 g, 7.1 mmol) was added into the mixture and stirred for another 0.75 h. Then **1a** (9.34 g, 35.5 mmol, 5 equiv) and 2,2,6,6-tetramethylpiperidine (3.0 g, 21.3 mmol) were added. The mixture was refluxed for 48 h in oil bath. After completion of the reaction, the solution was cooled to room temperature. The reaction was quenched with distilled water and extracted with CH_2Cl_2. The combined organic phase was removed under reduced pressure and the residue was purified by flash chromatography (petroleum ether / EtOAc = 5/1 to 3/1) to give the desired product **3a** as yellow oil (1.49 g, 58% yield).

4.4 General Procedure for the Synthesis of Products 4a.



3a **4a**

To a flame-dried test tube with a magnetic stirring bar was charged **3a** (724 mg, 2.0 mmol), HCl (conc. 0.3 mL, 5.0 mmol) and CH_3COOH (1.2 mL, 20 mmol) under N_2. The reaction was stirred at 120 for 12 h. The reaction mixture was then cooled to room temperature, the organic solvent was removed in *vacuo*. The residue was diluted with $NaHCO_3$ and extracted with dichloromethane. The organic solution was washed with NaCl solution, dried over anhydrous Na_2SO_4, filtered and concentrated in *vacuo*. The resulting crude was purified by flash chromatography (MeOH / CH_2Cl_2 = 1/15) to give the desired product **4a** as yellow oil (316 mg, 54 % yield).



5-**Fluoro-2,6-diphenylnicotinic acid** (**4a**, yellow oil), purified by flash column chromatography (eluent: MeOH / CH_2Cl_2 = 1/8), 316 mg (54% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.04 (d, *J* = 7.8 Hz, 2H), 7.93 (d, *J* = 10.8 Hz, 1H), 7.53 (dd, *J* = 6.2, 2.6 Hz, 2H), 7.44 – 7.39 (m, 3H), 7.34 (t, *J* = 2.7 Hz, 3H). ppm; ^{13}C NMR (150 MHz, $CDCl_3$) δ 169.7, 154.7 (d, *J* = 261.2 Hz), 154.3, 146.7 (d, *J* = 10.1 Hz), 138.2, 133.3 (d, *J* = 6.0 Hz), 129.1, 128.3, 128.2, 128.0, 127.8, 127.5, 127.0, 125.8 (d, *J* = 23.3 Hz) ppm; ^{19}F NMR (565 MHz, $CDCl_3$) δ -126.19 (d, *J* = 10.4 Hz) ppm; HRMS (ESI) m/z: $[M + H]^+$ Calcd for $C_{18}H_{13}FNO_2$ 294.0930; Found 294.0935.

5. Determination of X-ray crystallographic structure 3r

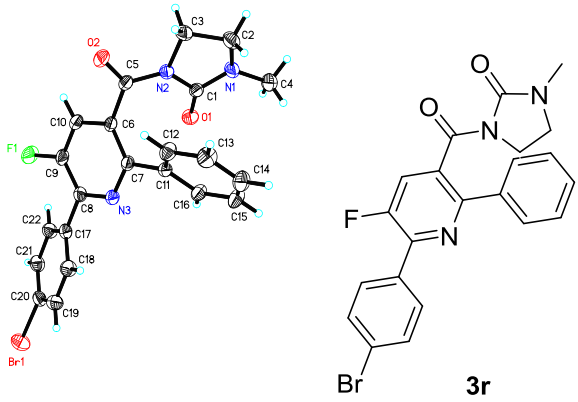


Figure S5. X-Ray crystal structure of compound **3r.**

Table 1. Crystal data and structure refinement for mo_d8v191122_0m.

Identification code	mo_d8v191122_0m	
Empirical formula	C22 H17 Br F N3 O2	
Formula weight	454.29	
Temperature	293(2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21/n	
Unit cell dimensions	a = 8.8225(3) Å	α= 90 °.

	b = 20.5256(8) Å	β= 104.6210(10) °.
	c = 11.2425(4) Å	γ = 90 °.
Volume	1969.94(12) Å^3	
Z	4	
Density (calculated)	1.532 Mg/m^3	
Absorption coefficient	2.120 mm^{-1}	
F(000)	920	
Crystal size	0.170 x 0.140 x 0.110 mm^3	
Theta range for data collection	2.584 to 25.993 °.	
Index ranges	-10<=h<=10, -25<=k<=25, -13<=l<=13	
Reflections collected	29622	
Independent reflections	3853 [R(int) = 0.0365]	
Completeness to theta = 25.242 °	99.6 %	
Absorption correction	Semi-empirical from equivalents	
Max. and min. transmission	0.7456 and 0.5236	
Refinement method	Full-matrix least-squares on F^2	
Data / restraints / parameters	3853 / 0 / 264	
Goodness-of-fit on F^2	1.030	
Final R indices [I>2sigma(I)]	R1 = 0.0325, wR2 = 0.0790	
R indices (all data)	R1 = 0.0468, wR2 = 0.0871	
Extinction coefficient	0.0066(11)	
Largest diff. peak and hole	0.333 and -0.489 e.Å^{-3}	

Table 2. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters ($Å^2$x 10^3)
for mo_d8v191122_0m. U(eq) is defined as one third of the trace of the orthogonalized U^{ij} tensor.

	x	y	z	U(eq)
Br(1)	8501(1)	4330(1)	9296(1)	77(1)
F(1)	7421(2)	4379(1)	3146(1)	71(1)
O(1)	8939(2)	6876(1)	1775(1)	49(1)
O(2)	5059(2)	5903(1)	-403(1)	64(1)
N(1)	8261(2)	7578(1)	137(2)	51(1)
N(2)	6762(2)	6718(1)	104(1)	42(1)
N(3)	6722(2)	6039(1)	3861(2)	40(1)
C(1)	8106(2)	7048(1)	800(2)	38(1)
C(2)	6947(3)	7682(1)	-913(2)	59(1)
C(3)	6224(3)	7011(1)	-1120(2)	51(1)
C(4)	9405(3)	8077(1)	606(2)	69(1)
C(5)	6033(3)	6179(1)	393(2)	43(1)
C(6)	6425(2)	5931(1)	1690(2)	39(1)
C(7)	6364(2)	6297(1)	2727(2)	38(1)
C(8)	7125(2)	5406(1)	4025(2)	39(1)
C(9)	7120(3)	5025(1)	3005(2)	45(1)
C(10)	6772(3)	5274(1)	1840(2)	46(1)
C(11)	5890(2)	6997(1)	2642(2)	38(1)
C(12)	4547(3)	7213(1)	1804(2)	49(1)
C(13)	4167(3)	7872(1)	1727(2)	57(1)
C(14)	5115(3)	8313(1)	2475(2)	59(1)
C(15)	6445(3)	8106(1)	3308(2)	57(1)
C(16)	6824(3)	7452(1)	3401(2)	46(1)
C(17)	7497(2)	5148(1)	5301(2)	41(1)
C(18)	6742(3)	5403(1)	6145(2)	50(1)
C(19)	7036(3)	5170(1)	7329(2)	54(1)
C(20)	8112(3)	4679(1)	7683(2)	48(1)
C(21)	8901(3)	4419(1)	6885(2)	50(1)
C(22)	8581(3)	4652(1)	5693(2)	48(1)

Table 3. Bond lengths [Å] and angles [°] for mo_d8v191122_0m.

Br(1)-C(20)	1.898(2)
F(1)-C(9)	1.354(2)
O(1)-C(1)	1.208(2)
O(2)-C(5)	1.213(2)
N(1)-C(1)	1.344(3)
N(1)-C(4)	1.441(3)
N(1)-C(2)	1.447(3)
N(2)-C(5)	1.359(3)
N(2)-C(1)	1.418(3)
N(2)-C(3)	1.467(2)
N(3)-C(7)	1.343(2)
N(3)-C(8)	1.348(3)
C(2)-C(3)	1.511(3)
C(2)-H(2A)	0.9700
C(2)-H(2B)	0.9700
C(3)-H(3A)	0.9700
C(3)-H(3B)	0.9700
C(4)-H(4A)	0.9600
C(4)-H(4B)	0.9600
C(4)-H(4C)	0.9600
C(5)-C(6)	1.501(3)
C(6)-C(10)	1.384(3)
C(6)-C(7)	1.399(3)
C(7)-C(11)	1.492(3)
C(8)-C(9)	1.387(3)
C(8)-C(17)	1.486(3)
C(9)-C(10)	1.367(3)
C(10)-H(10)	0.9300
C(11)-C(16)	1.386(3)
C(11)-C(12)	1.388(3)
C(12)-C(13)	1.390(3)
C(12)-H(12)	0.9300
C(13)-C(14)	1.368(4)
C(13)-H(13)	0.9300
C(14)-C(15)	1.371(4)
C(14)-H(14)	0.9300

C(15)-C(16)	1.381(3)
C(15)-H(15)	0.9300
C(16)-H(16)	0.9300
C(17)-C(22)	1.389(3)
C(17)-C(18)	1.391(3)
C(18)-C(19)	1.377(3)
C(18)-H(18)	0.9300
C(19)-C(20)	1.373(3)
C(19)-H(19)	0.9300
C(20)-C(21)	1.375(3)
C(21)-C(22)	1.384(3)
C(21)-H(21)	0.9300
C(22)-H(22)	0.9300

C(1)-N(1)-C(4)	122.16(19)
C(1)-N(1)-C(2)	113.52(17)
C(4)-N(1)-C(2)	122.4(2)
C(5)-N(2)-C(1)	129.63(17)
C(5)-N(2)-C(3)	119.81(17)
C(1)-N(2)-C(3)	110.43(16)
C(7)-N(3)-C(8)	120.10(17)
O(1)-C(1)-N(1)	127.99(19)
O(1)-C(1)-N(2)	126.40(18)
N(1)-C(1)-N(2)	105.60(17)
N(1)-C(2)-C(3)	102.21(18)
N(1)-C(2)-H(2A)	111.3
C(3)-C(2)-H(2A)	111.3
N(1)-C(2)-H(2B)	111.3
C(3)-C(2)-H(2B)	111.3
H(2A)-C(2)-H(2B)	109.2
N(2)-C(3)-C(2)	101.83(17)
N(2)-C(3)-H(3A)	111.4
C(2)-C(3)-H(3A)	111.4
N(2)-C(3)-H(3B)	111.4
C(2)-C(3)-H(3B)	111.4
H(3A)-C(3)-H(3B)	109.3
N(1)-C(4)-H(4A)	109.5
N(1)-C(4)-H(4B)	109.5

H(4A)-C(4)-H(4B)	109.5
N(1)-C(4)-H(4C)	109.5
H(4A)-C(4)-H(4C)	109.5
H(4B)-C(4)-H(4C)	109.5
O(2)-C(5)-N(2)	119.60(19)
O(2)-C(5)-C(6)	120.33(19)
N(2)-C(5)-C(6)	120.07(17)
C(10)-C(6)-C(7)	118.42(18)
C(10)-C(6)-C(5)	116.01(17)
C(7)-C(6)-C(5)	125.41(18)
N(3)-C(7)-C(6)	121.98(18)
N(3)-C(7)-C(11)	115.79(17)
C(6)-C(7)-C(11)	122.22(17)
N(3)-C(8)-C(9)	118.97(18)
N(3)-C(8)-C(17)	117.59(17)
C(9)-C(8)-C(17)	123.41(18)
F(1)-C(9)-C(10)	117.89(19)
F(1)-C(9)-C(8)	119.73(19)
C(10)-C(9)-C(8)	122.35(19)
C(9)-C(10)-C(6)	118.04(19)
C(9)-C(10)-H(10)	121.0
C(6)-C(10)-H(10)	121.0
C(16)-C(11)-C(12)	118.40(19)
C(16)-C(11)-C(7)	119.71(18)
C(12)-C(11)-C(7)	121.88(18)
C(11)-C(12)-C(13)	120.3(2)
C(11)-C(12)-H(12)	119.9
C(13)-C(12)-H(12)	119.9
C(14)-C(13)-C(12)	120.4(2)
C(14)-C(13)-H(13)	119.8
C(12)-C(13)-H(13)	119.8
C(13)-C(14)-C(15)	120.0(2)
C(13)-C(14)-H(14)	120.0
C(15)-C(14)-H(14)	120.0
C(14)-C(15)-C(16)	120.1(2)
C(14)-C(15)-H(15)	119.9
C(16)-C(15)-H(15)	119.9
C(15)-C(16)-C(11)	120.9(2)

C(15)-C(16)-H(16)	119.6
C(11)-C(16)-H(16)	119.6
C(22)-C(17)-C(18)	118.03(19)
C(22)-C(17)-C(8)	122.24(19)
C(18)-C(17)-C(8)	119.73(19)
C(19)-C(18)-C(17)	121.5(2)
C(19)-C(18)-H(18)	119.3
C(17)-C(18)-H(18)	119.3
C(20)-C(19)-C(18)	118.9(2)
C(20)-C(19)-H(19)	120.6
C(18)-C(19)-H(19)	120.6
C(19)-C(20)-C(21)	121.5(2)
C(19)-C(20)-Br(1)	119.90(17)
C(21)-C(20)-Br(1)	118.55(17)
C(20)-C(21)-C(22)	119.0(2)
C(20)-C(21)-H(21)	120.5
C(22)-C(21)-H(21)	120.5
C(21)-C(22)-C(17)	121.1(2)
C(21)-C(22)-H(22)	119.5
C(17)-C(22)-H(22)	119.5

Symmetry transformations used to generate equivalent atoms:

Table 4. Anisotropic displacement parameters ($Å^2 x\ 10^3$) for mo_d8v191122_0m. The anisotropic displacement factor exponent takes the form: $-2\pi^2[\ h^2\ a^{*2}U^{11} + ... + 2\ h\ k\ a^*\ b^*\ U^{12}\ ]$

	U^{11}	U^{22}	U^{33}	U^{23}	U^{13}	U^{12}
Br(1)	105(1)	79(1)	47(1)	18(1)	18(1)	-5(1)
F(1)	121(1)	28(1)	60(1)	0(1)	16(1)	12(1)
O(1)	46(1)	54(1)	39(1)	3(1)	-3(1)	-2(1)
O(2)	82(1)	55(1)	44(1)	-6(1)	-5(1)	-27(1)
N(1)	56(1)	50(1)	43(1)	5(1)	5(1)	-17(1)
N(2)	46(1)	41(1)	32(1)	3(1)	0(1)	-7(1)
N(3)	48(1)	31(1)	39(1)	1(1)	10(1)	1(1)
C(1)	39(1)	39(1)	36(1)	-4(1)	9(1)	-2(1)
C(2)	71(2)	56(2)	46(1)	14(1)	6(1)	-6(1)
C(3)	56(1)	55(1)	36(1)	9(1)	1(1)	-5(1)
C(4)	85(2)	64(2)	60(2)	-6(1)	22(1)	-34(1)
C(5)	51(1)	36(1)	38(1)	-6(1)	5(1)	-6(1)
C(6)	46(1)	30(1)	38(1)	-2(1)	6(1)	-7(1)
C(7)	44(1)	30(1)	38(1)	-1(1)	7(1)	-3(1)
C(8)	44(1)	30(1)	44(1)	2(1)	12(1)	-1(1)
C(9)	57(1)	26(1)	51(1)	-1(1)	11(1)	1(1)
C(10)	59(1)	33(1)	42(1)	-8(1)	10(1)	-6(1)
C(11)	48(1)	31(1)	34(1)	1(1)	10(1)	1(1)
C(12)	48(1)	44(1)	49(1)	-4(1)	1(1)	0(1)
C(13)	54(1)	52(1)	60(1)	4(1)	4(1)	16(1)
C(14)	72(2)	36(1)	70(2)	2(1)	18(1)	14(1)
C(15)	66(2)	38(1)	63(2)	-13(1)	7(1)	1(1)
C(16)	54(1)	37(1)	42(1)	-4(1)	2(1)	3(1)
C(17)	47(1)	31(1)	44(1)	4(1)	12(1)	-2(1)
C(18)	57(1)	42(1)	52(1)	4(1)	16(1)	10(1)
C(19)	64(2)	52(1)	50(1)	0(1)	23(1)	1(1)
C(20)	58(1)	43(1)	42(1)	7(1)	11(1)	-10(1)
C(21)	56(1)	41(1)	53(1)	11(1)	11(1)	5(1)
C(22)	54(1)	42(1)	50(1)	5(1)	18(1)	6(1)

Table 5. Hydrogen coordinates (x 10^4) and isotropic displacement parameters ($Å^2$x 10^3) for mo_d8v191122_0m.

	x	y	z	U(eq)
H(2A)	7292	7828	-1622	71
H(2B)	6217	7997	-732	71
H(3A)	5090	7034	-1378	61
H(3B)	6606	6770	-1728	61
H(4A)	8971	8390	1062	103
H(4B)	9686	8291	-68	103
H(4C)	10320	7883	1134	103
H(10)	6767	5009	1168	55
H(12)	3899	6916	1291	59
H(13)	3263	8013	1165	69
H(14)	4858	8753	2417	71
H(15)	7093	8407	3812	69
H(16)	7717	7315	3979	55
H(18)	6023	5739	5903	60
H(19)	6515	5342	7881	65
H(21)	9639	4091	7143	61
H(22)	9100	4474	5144	57

Table 6. Torsion angles [°] for mo_d8v191122_0m.

C(4)-N(1)-C(1)-O(1)	-8.0(4)
C(2)-N(1)-C(1)-O(1)	-172.7(2)
C(4)-N(1)-C(1)-N(2)	173.2(2)
C(2)-N(1)-C(1)-N(2)	8.4(3)
C(5)-N(2)-C(1)-O(1)	5.8(4)
C(3)-N(2)-C(1)-O(1)	-169.9(2)
C(5)-N(2)-C(1)-N(1)	-175.3(2)
C(3)-N(2)-C(1)-N(1)	9.0(2)
C(1)-N(1)-C(2)-C(3)	-21.4(3)
C(4)-N(1)-C(2)-C(3)	173.9(2)
C(5)-N(2)-C(3)-C(2)	162.5(2)
C(1)-N(2)-C(3)-C(2)	-21.3(2)
N(1)-C(2)-C(3)-N(2)	24.2(2)
C(1)-N(2)-C(5)-O(2)	-167.4(2)
C(3)-N(2)-C(5)-O(2)	8.0(3)
C(1)-N(2)-C(5)-C(6)	13.1(3)
C(3)-N(2)-C(5)-C(6)	-171.6(2)
O(2)-C(5)-C(6)-C(10)	50.5(3)
N(2)-C(5)-C(6)-C(10)	-129.9(2)
O(2)-C(5)-C(6)-C(7)	-125.0(2)
N(2)-C(5)-C(6)-C(7)	54.6(3)
C(8)-N(3)-C(7)-C(6)	-1.4(3)
C(8)-N(3)-C(7)-C(11)	178.32(18)
C(10)-C(6)-C(7)-N(3)	4.1(3)
C(5)-C(6)-C(7)-N(3)	179.50(19)
C(10)-C(6)-C(7)-C(11)	-175.61(19)
C(5)-C(6)-C(7)-C(11)	-0.2(3)
C(7)-N(3)-C(8)-C(9)	-1.7(3)
C(7)-N(3)-C(8)-C(17)	-179.53(18)
N(3)-C(8)-C(9)-F(1)	-175.67(19)
C(17)-C(8)-C(9)-F(1)	2.0(3)
N(3)-C(8)-C(9)-C(10)	2.2(3)
C(17)-C(8)-C(9)-C(10)	179.9(2)
F(1)-C(9)-C(10)-C(6)	178.4(2)
C(8)-C(9)-C(10)-C(6)	0.5(3)
C(7)-C(6)-C(10)-C(9)	-3.5(3)

C(5)-C(6)-C(10)-C(9)	-179.3(2)
N(3)-C(7)-C(11)-C(16)	50.7(3)
C(6)-C(7)-C(11)-C(16)	-129.5(2)
N(3)-C(7)-C(11)-C(12)	-130.6(2)
C(6)-C(7)-C(11)-C(12)	49.2(3)
C(16)-C(11)-C(12)-C(13)	0.5(3)
C(7)-C(11)-C(12)-C(13)	-178.1(2)
C(11)-C(12)-C(13)-C(14)	0.2(4)
C(12)-C(13)-C(14)-C(15)	-0.3(4)
C(13)-C(14)-C(15)-C(16)	-0.4(4)
C(14)-C(15)-C(16)-C(11)	1.2(4)
C(12)-C(11)-C(16)-C(15)	-1.3(3)
C(7)-C(11)-C(16)-C(15)	177.4(2)
N(3)-C(8)-C(17)-C(22)	-148.5(2)
C(9)-C(8)-C(17)-C(22)	33.8(3)
N(3)-C(8)-C(17)-C(18)	31.7(3)
C(9)-C(8)-C(17)-C(18)	-146.0(2)
C(22)-C(17)-C(18)-C(19)	-0.9(3)
C(8)-C(17)-C(18)-C(19)	179.0(2)
C(17)-C(18)-C(19)-C(20)	0.7(4)
C(18)-C(19)-C(20)-C(21)	0.3(4)
C(18)-C(19)-C(20)-Br(1)	-178.26(18)
C(19)-C(20)-C(21)-C(22)	-1.0(4)
Br(1)-C(20)-C(21)-C(22)	177.51(17)
C(20)-C(21)-C(22)-C(17)	0.9(4)
C(18)-C(17)-C(22)-C(21)	0.1(3)
C(8)-C(17)-C(22)-C(21)	-179.8(2)

Symmetry transformations used to generate equivalent atoms:

Table 7. Hydrogen bonds for mo_d8v191122_0m [Å and °].

D-H...A	d(D-H)	d(H...A)	d(D...A)	<(DHA)
C(21)-H(21)...O(1)#1	0.93	2.49	3.393(3)	162.5
C(10)-H(10)...O(2)#2	0.93	2.48	3.120(3)	126.3
C(21)-H(21)...O(1)#1	0.93	2.49	3.393(3)	162.5
C(10)-H(10)...O(2)#2	0.93	2.48	3.120(3)	126.3
C(4)-H(4A)...F(1)#3	0.96	2.64	3.585(3)	167.6
C(10)-H(10)...O(2)#2	0.93	2.48	3.120(3)	126.3
C(21)-H(21)...O(1)#1	0.93	2.49	3.393(3)	162.5

Symmetry transformations used to generate equivalent atoms:

#1 -x+2,-y+1,-z+1 #2 -x+1,-y+1,-z #3 -x+3/2,y+1/2,-z+1/2

6. Reference

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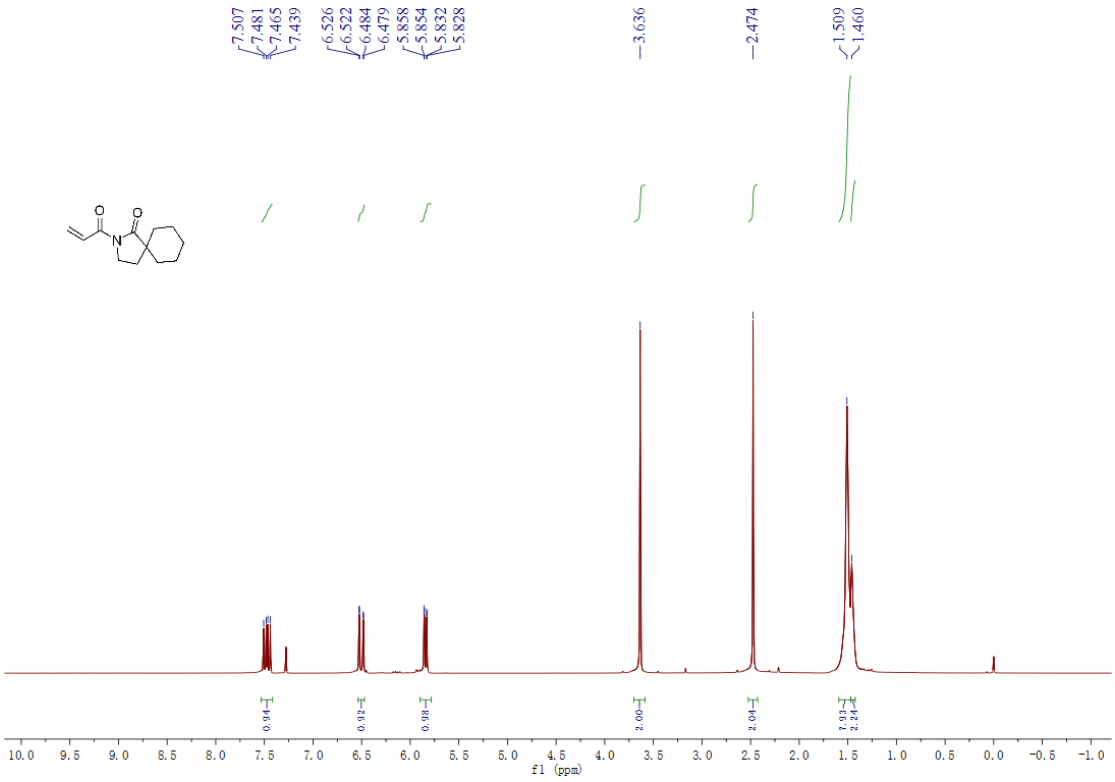
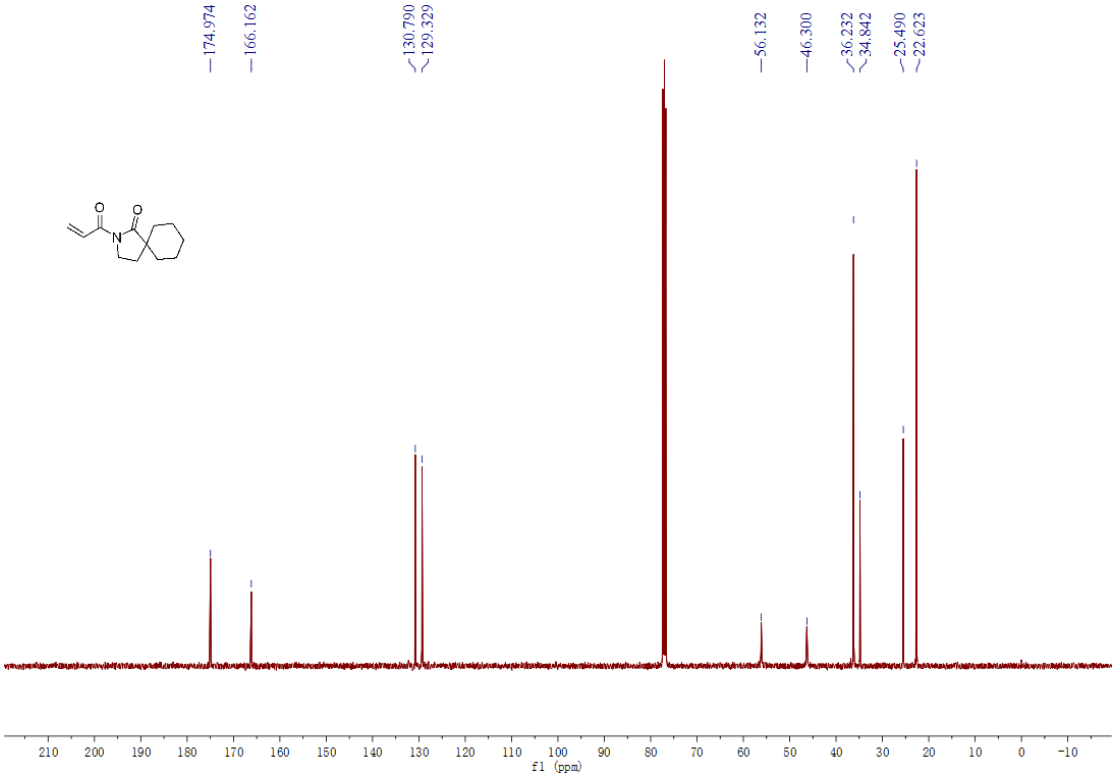
7. 1H, 13C and 19F NMR spectra

2-Acryloyl-2-azaspiro[4.5]decan-1-one (2q)

[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]

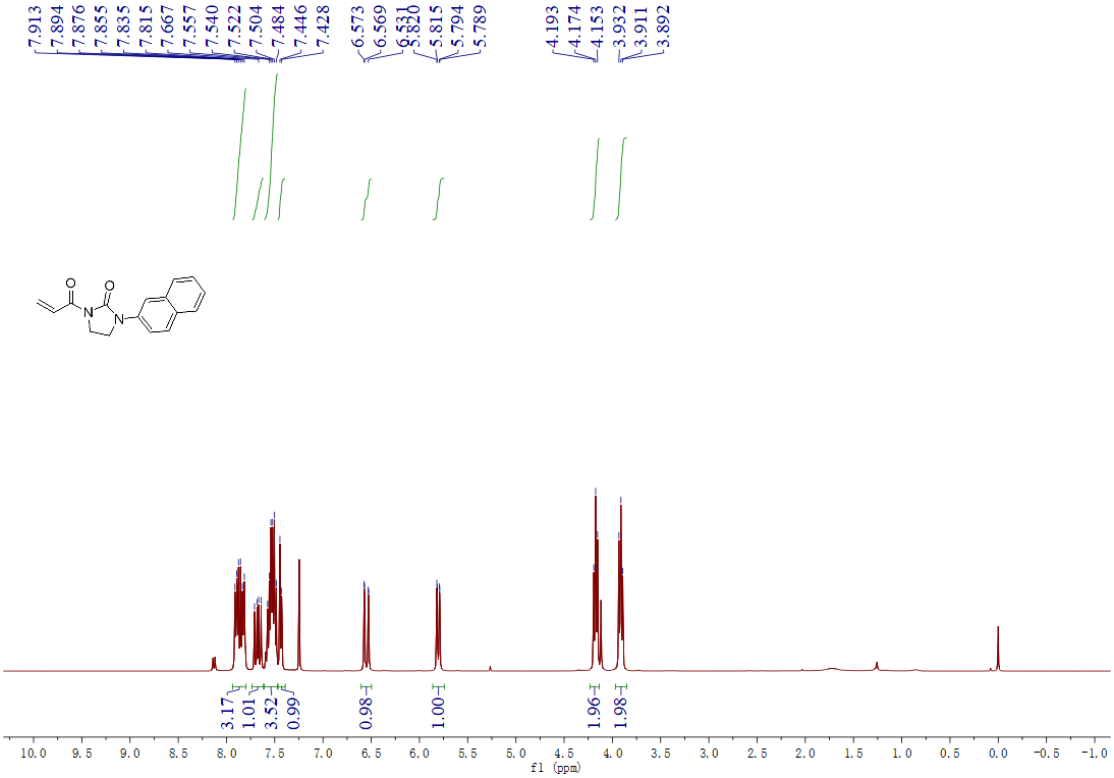


[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

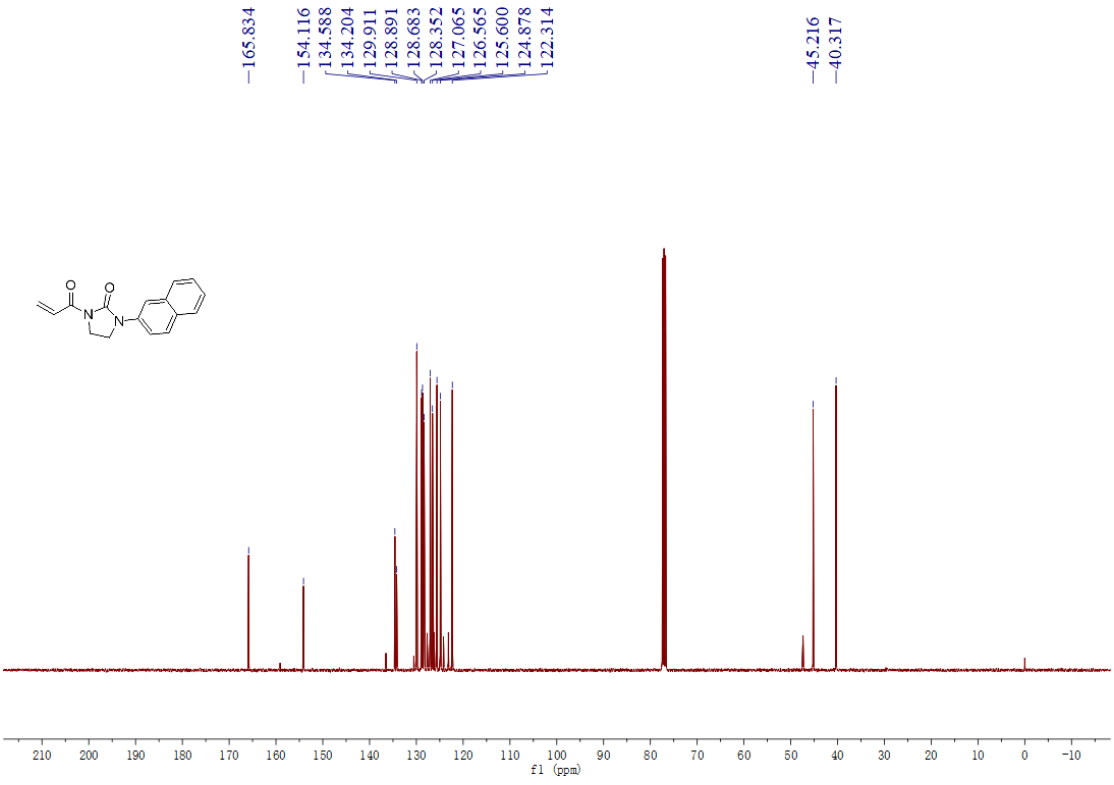


1-Acryloyl-3-(naphthalen-2-yl)imidazolidin-2-one (2t)

[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]

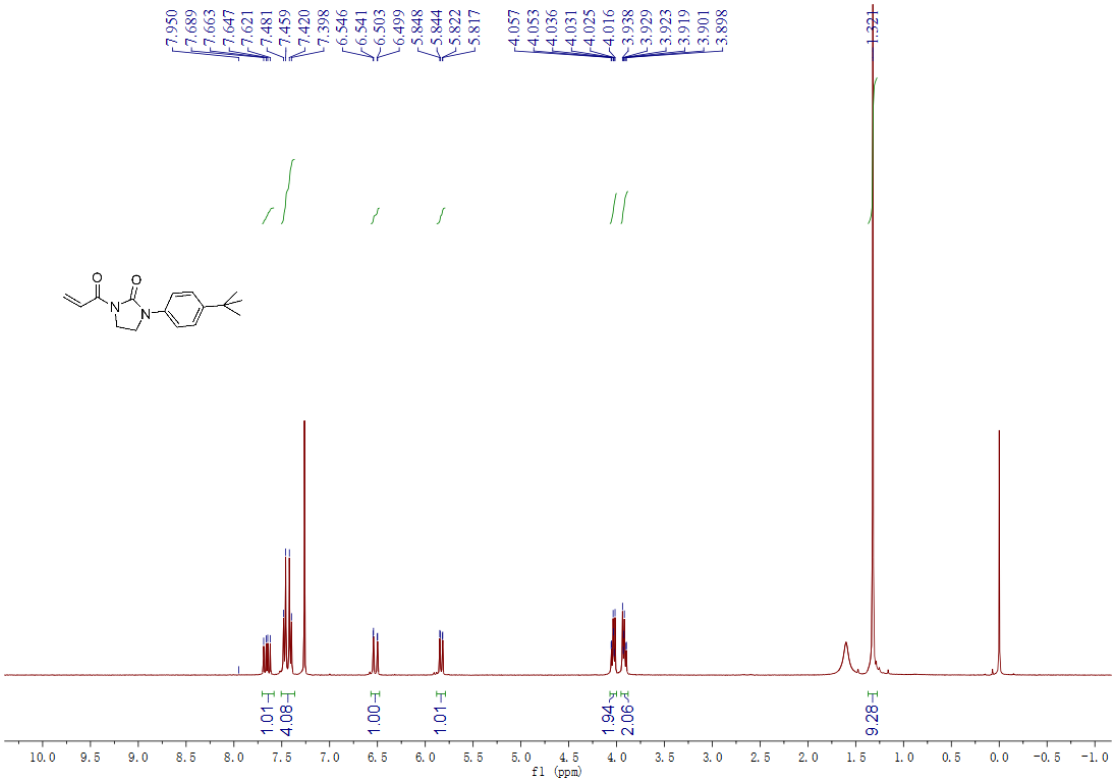


[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

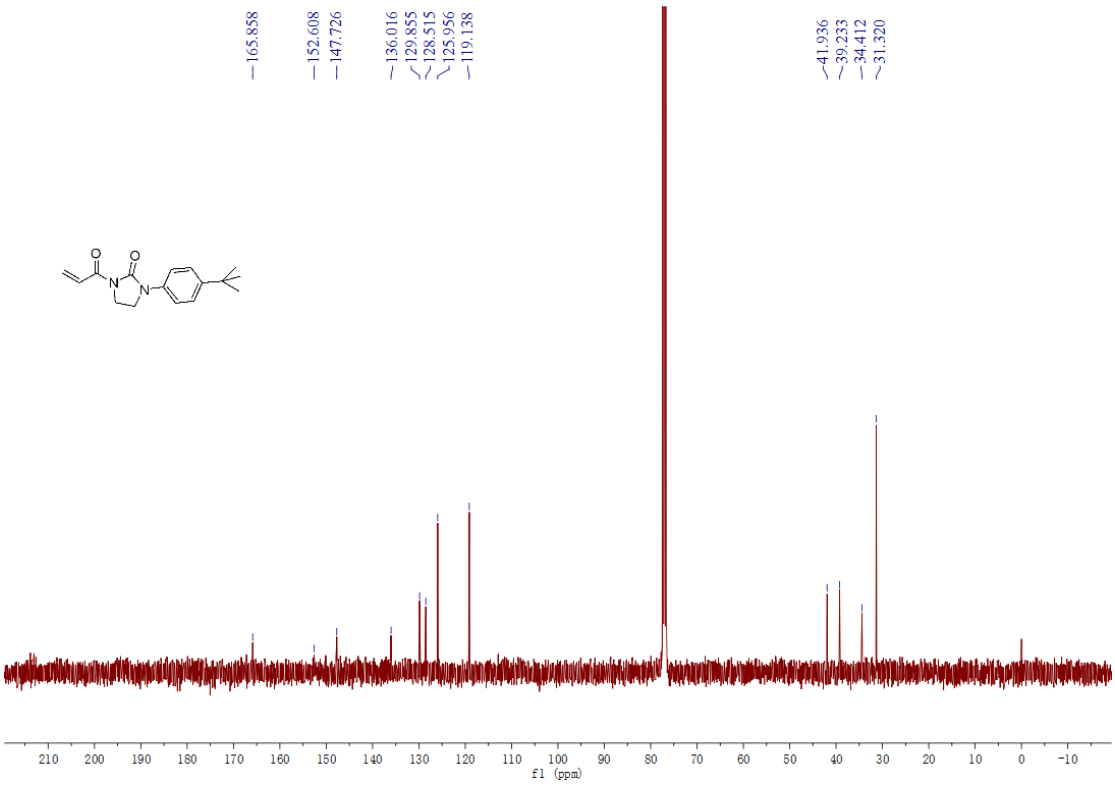


Acryloyl-3-(4-(tert-butyl)phenyl)imidazolidin-2-one (2v)

[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]

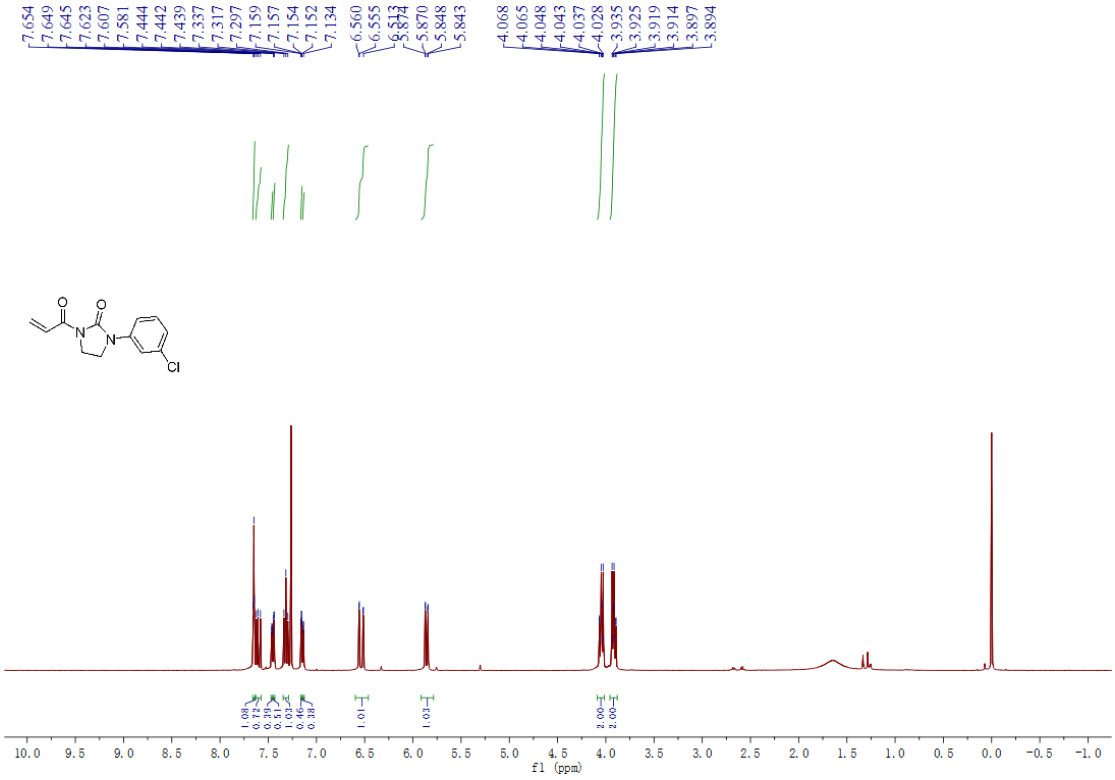


[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

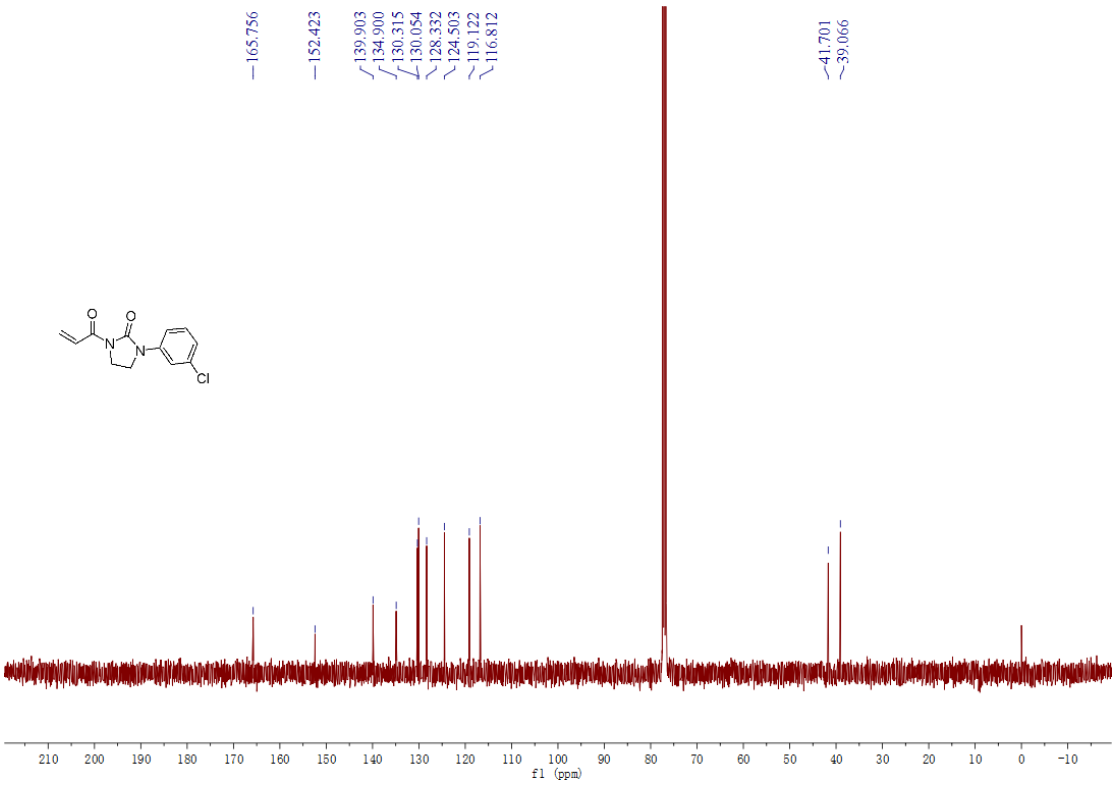


Acryloyl-3-(3-chlorophenyl)imidazolidin-2-one (2w)

[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]

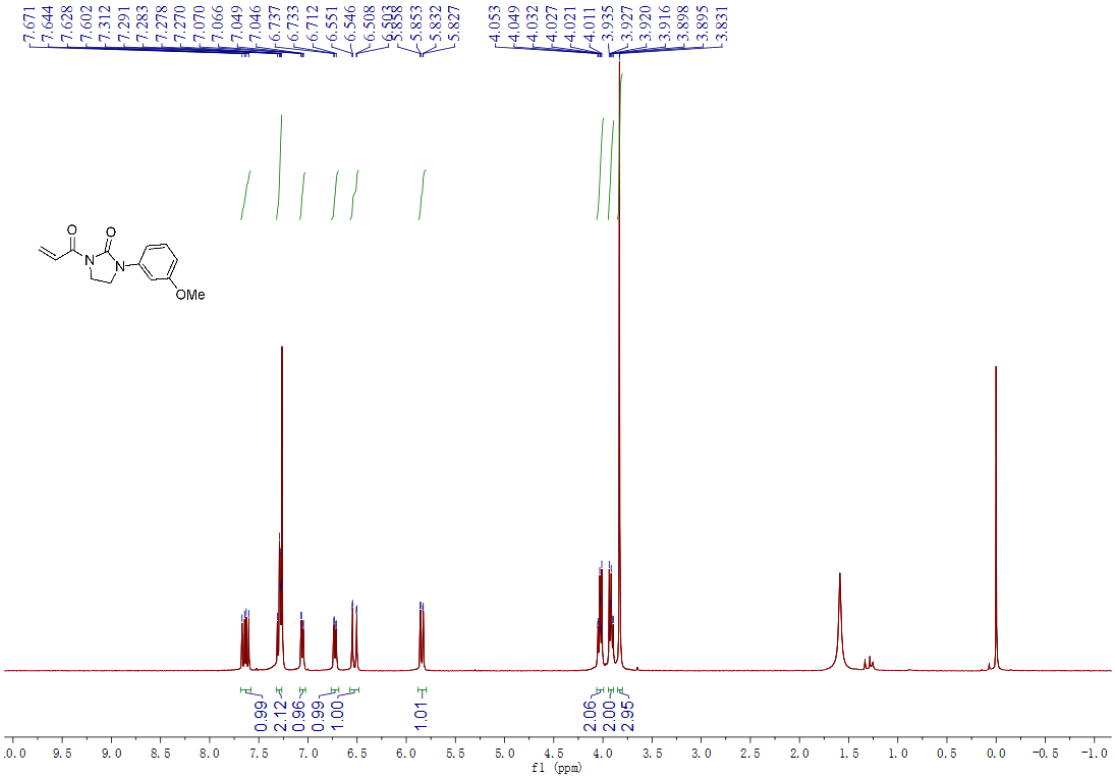


[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

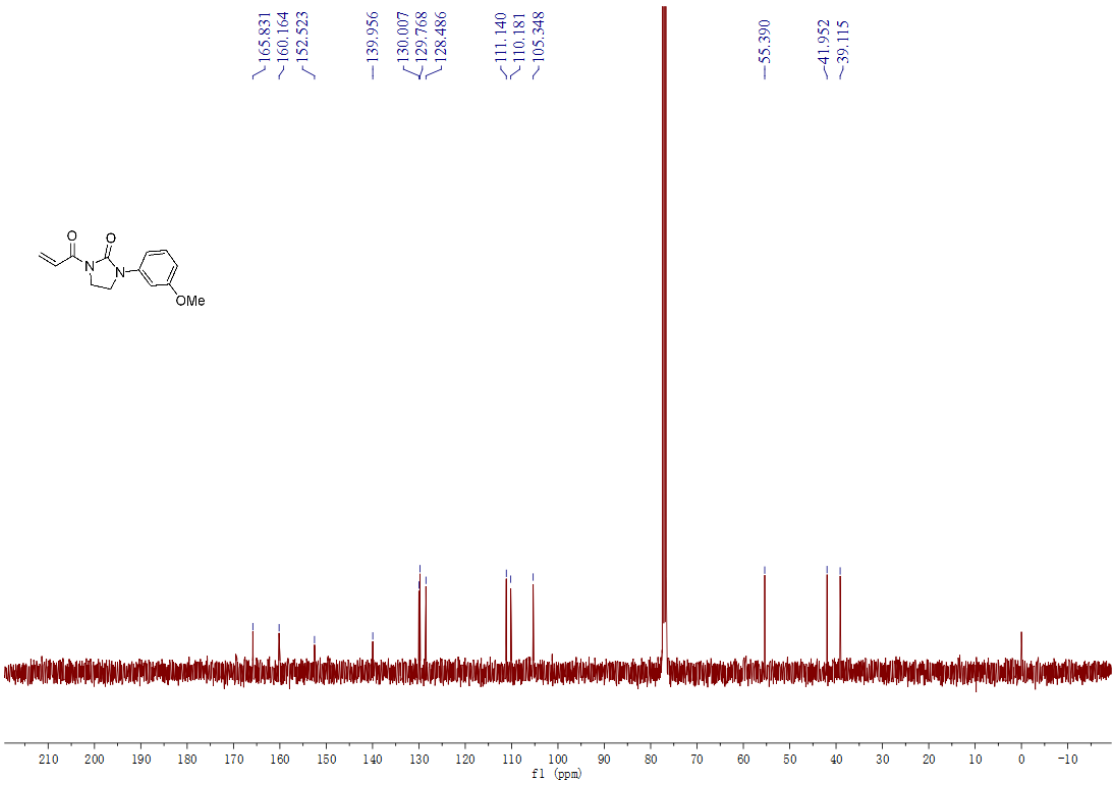


Acryloyl-3-(3-methoxyphenyl)imidazolidin-2-one (2x)

[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]

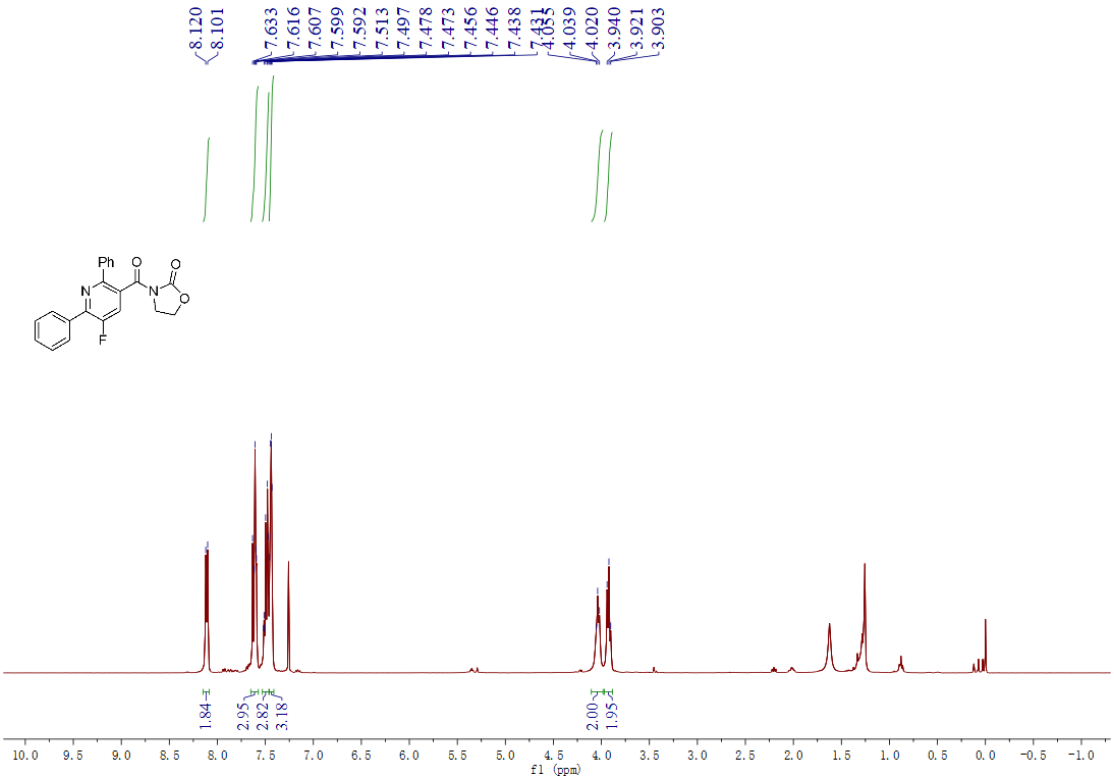


[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

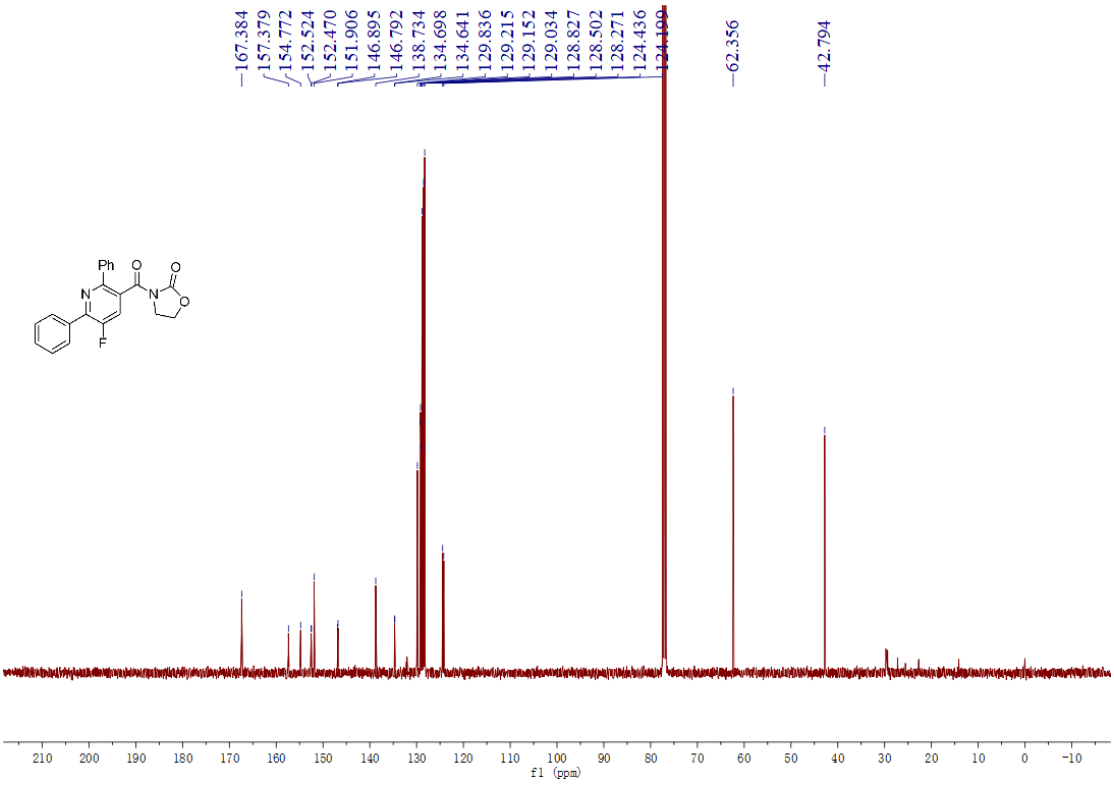


3-(5-Fluoro-2,6-diphenylnicotinoyl)oxazolidin-2-one (3a)

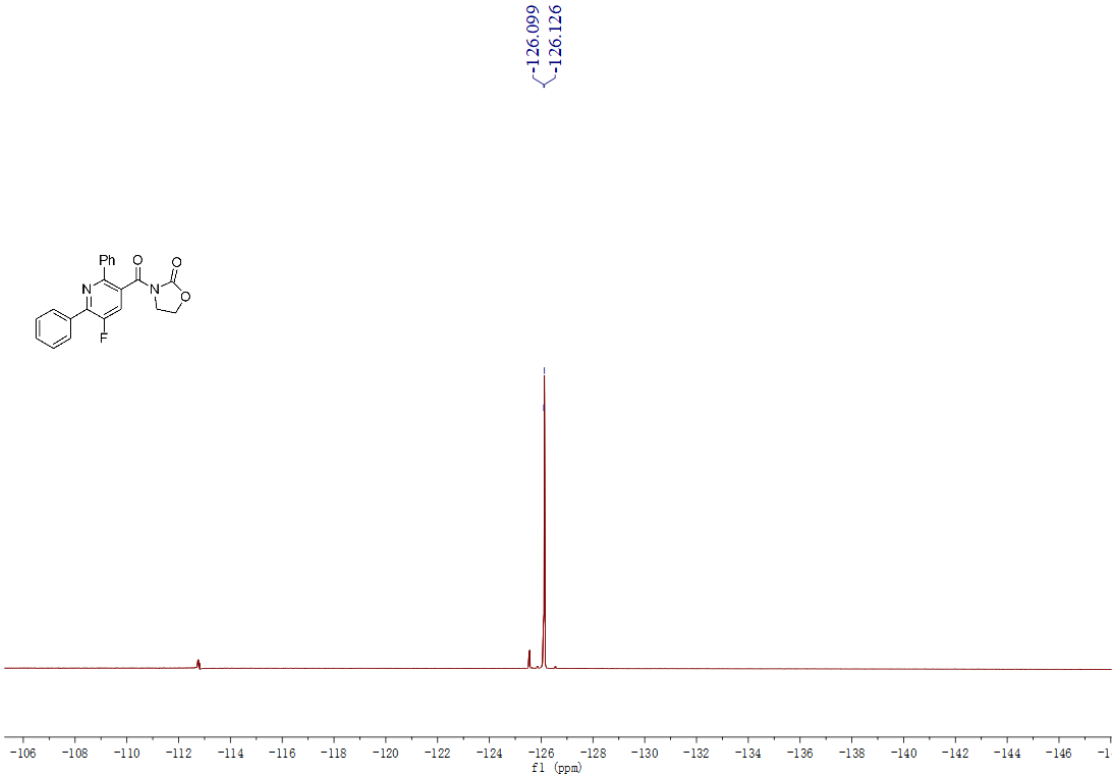
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

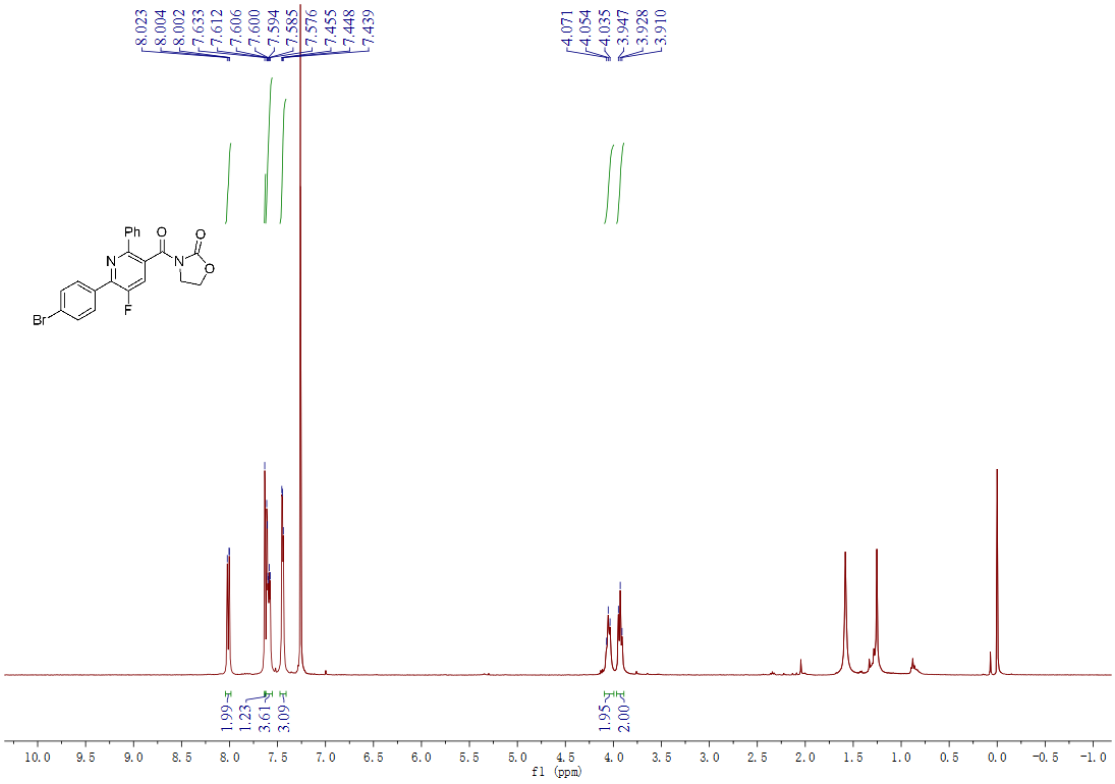


[^{19}F_NMR_375 MHz]

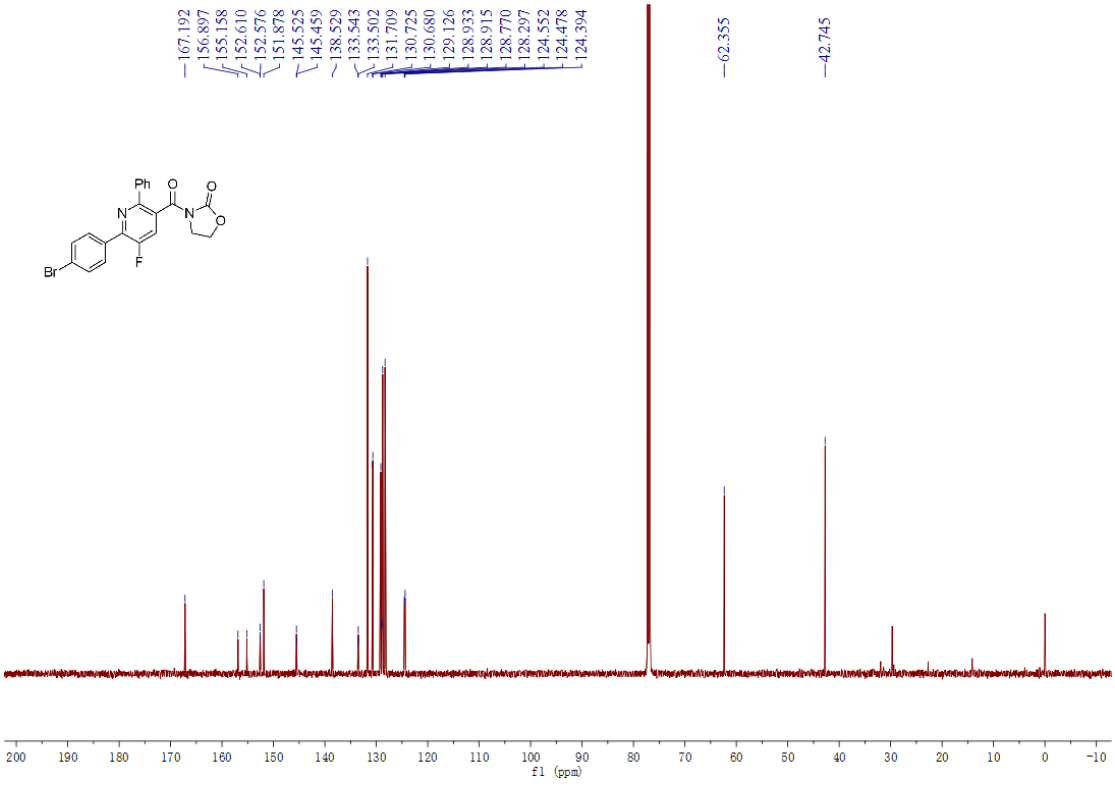


3-(6-(4-Bromophenyl)-5-fluoro-2-phenylnicotinoyl)oxazolidin-2-one (3b)

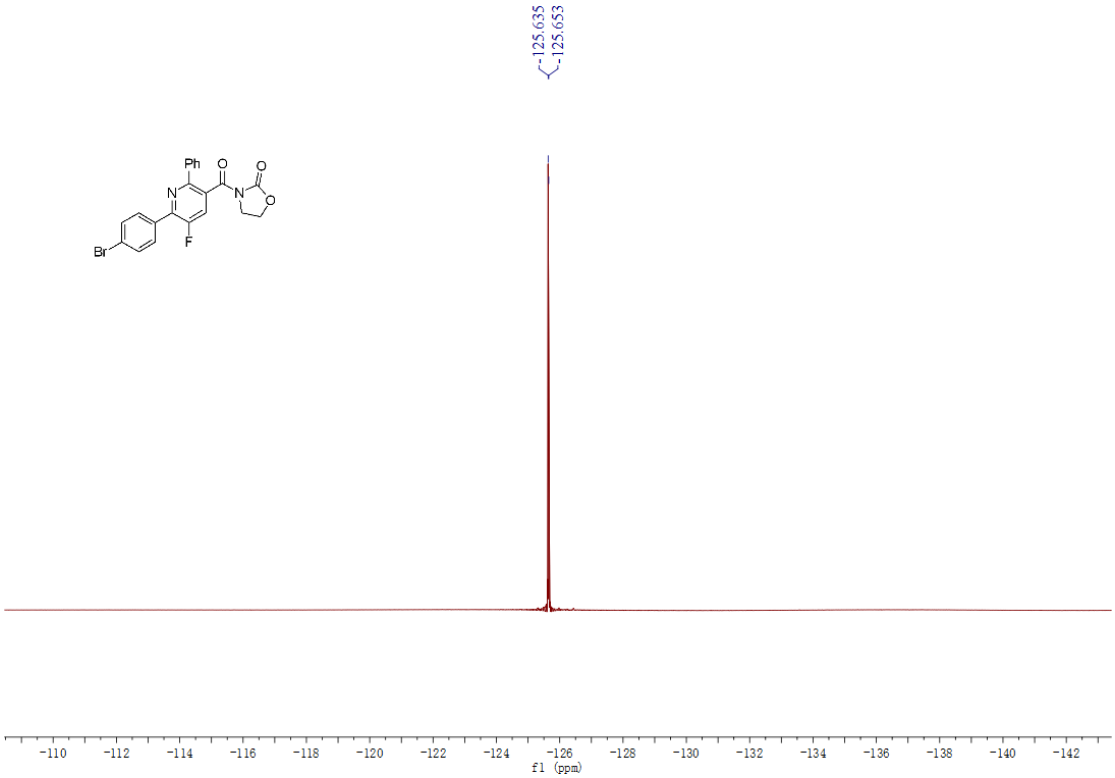
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

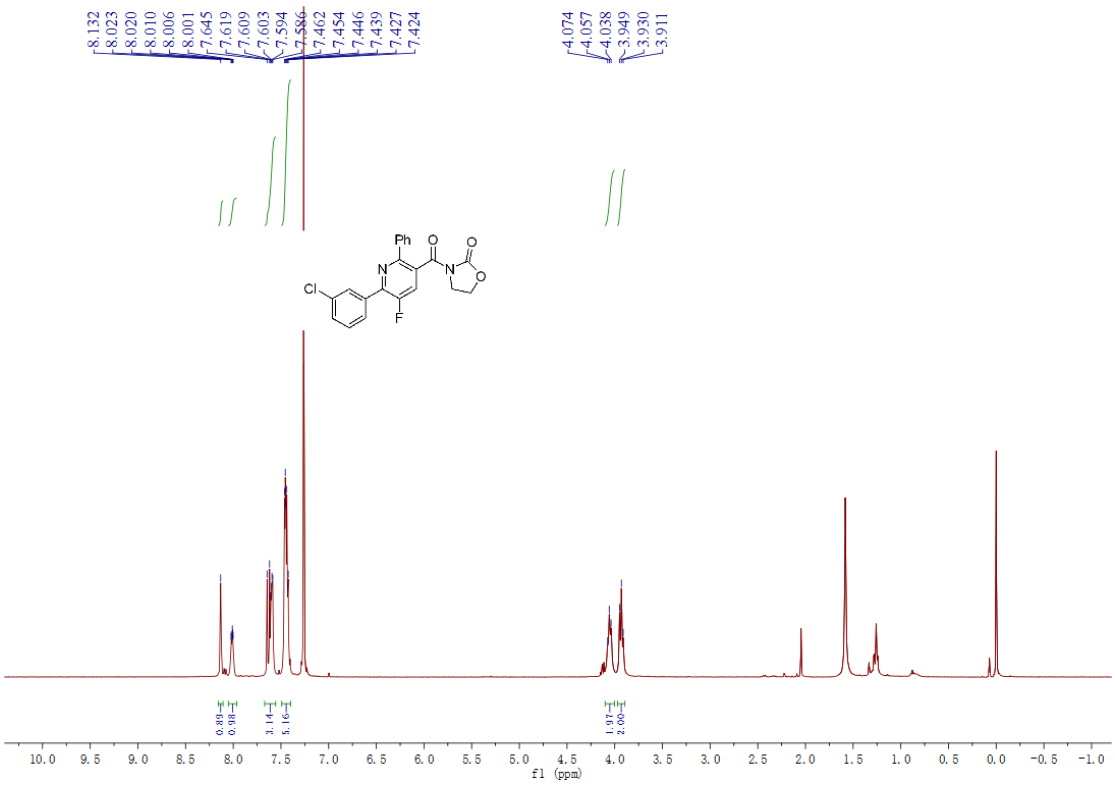


[^{19}F_NMR_565 MHz]

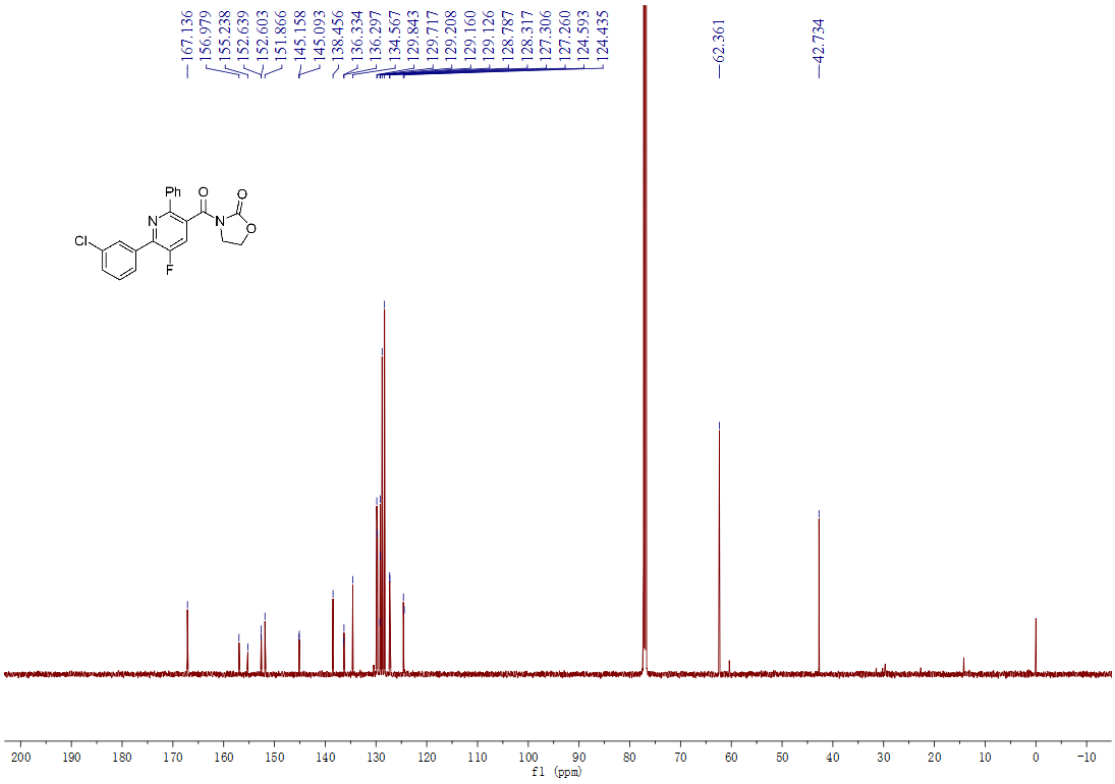


3-(6-(3-Chlorophenyl)-5-fluoro-2-phenylnicotinoyl)oxazolidin-2-one (3c)

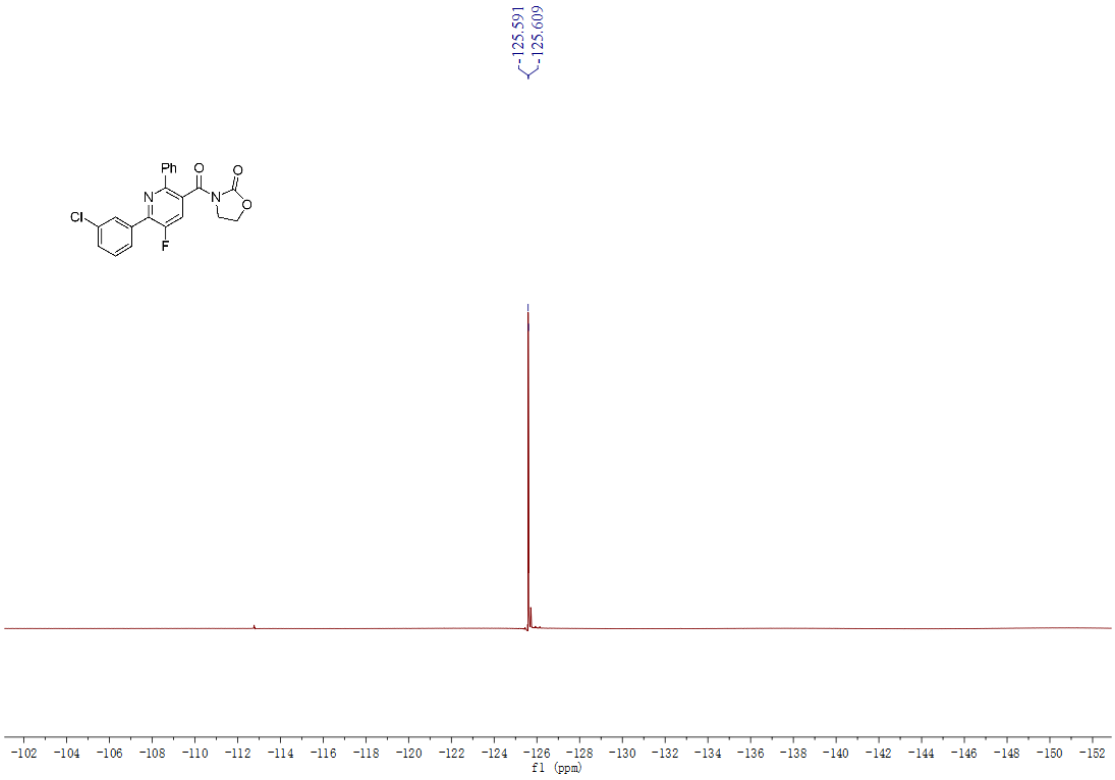
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

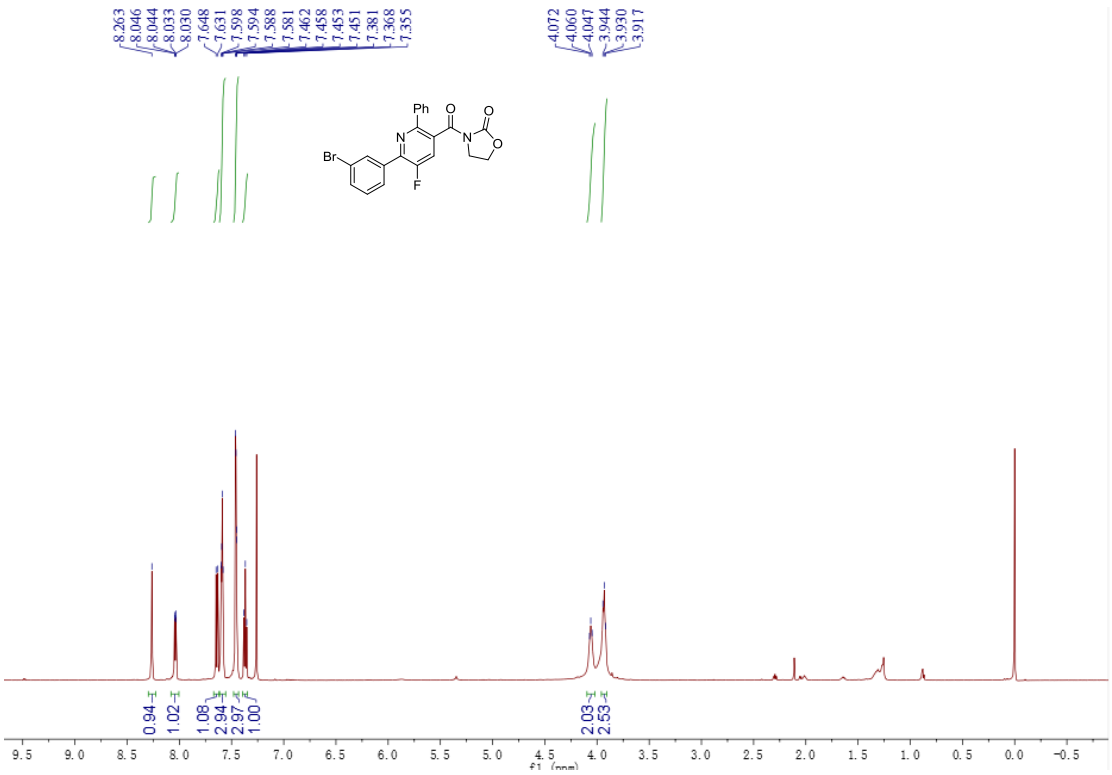


[^{19}F_NMR_565 MHz]

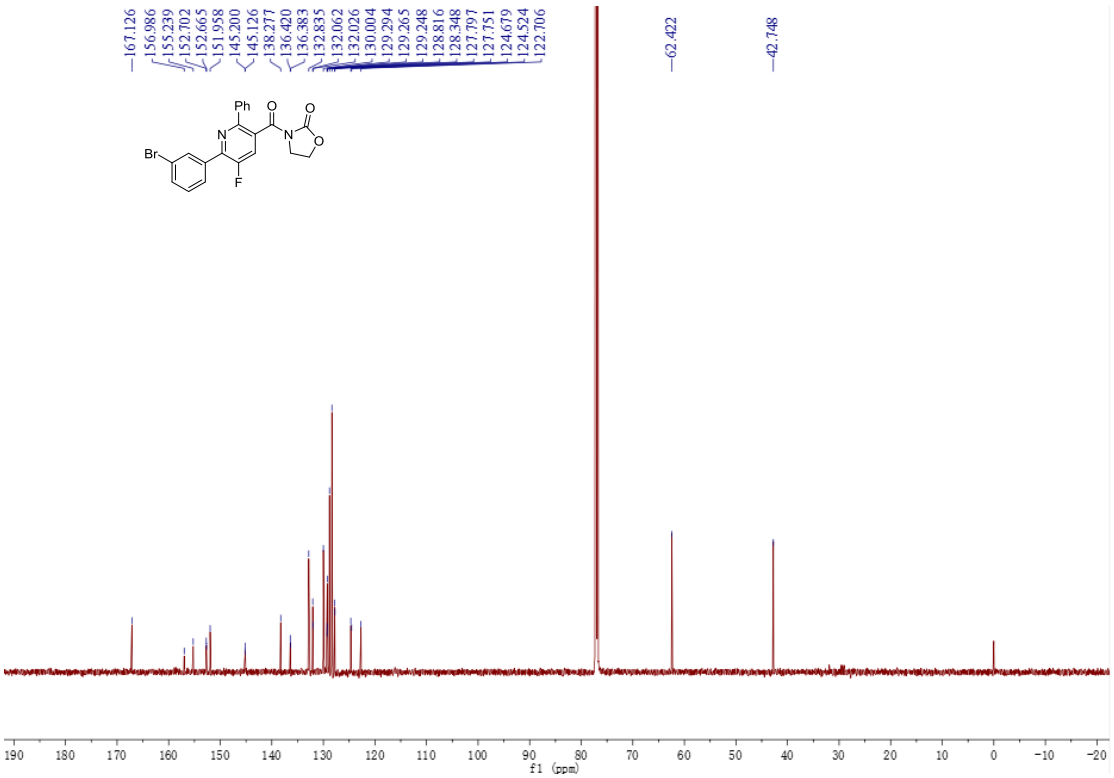


3-(6-(3-Bromophenyl)-5-fluoro-2-phenylnicotinoyl)oxazolidin-2-one (3d)

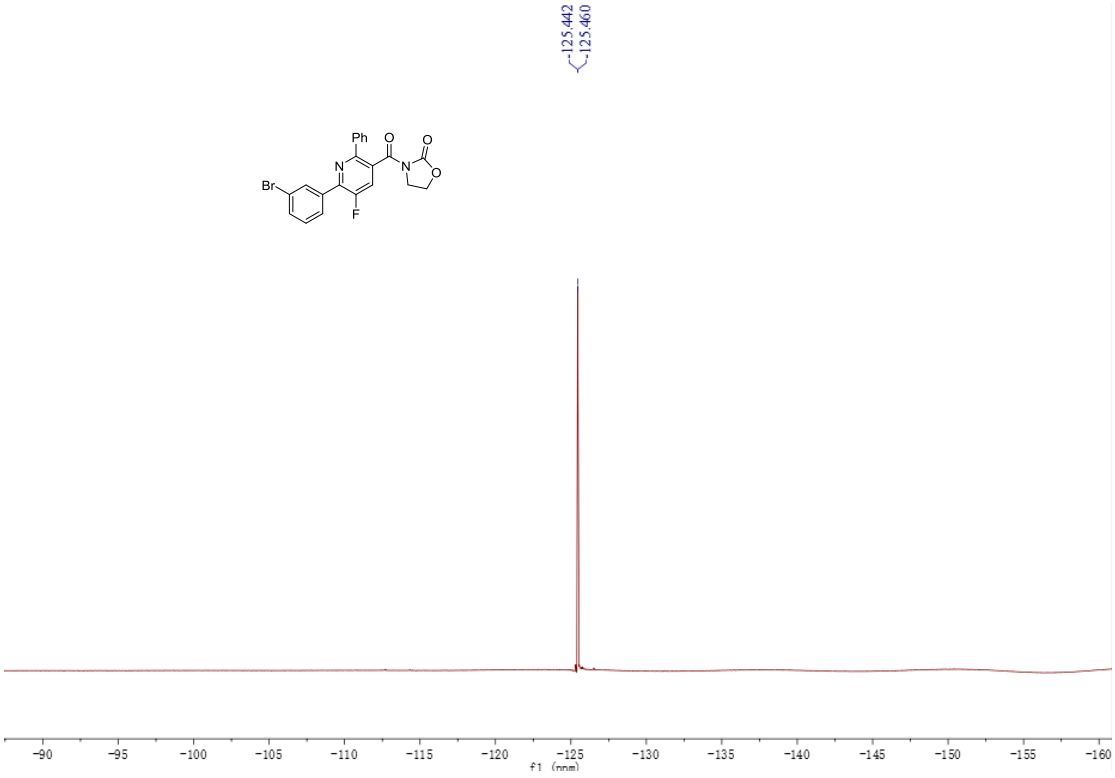
[^{1}H_NMR_600 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

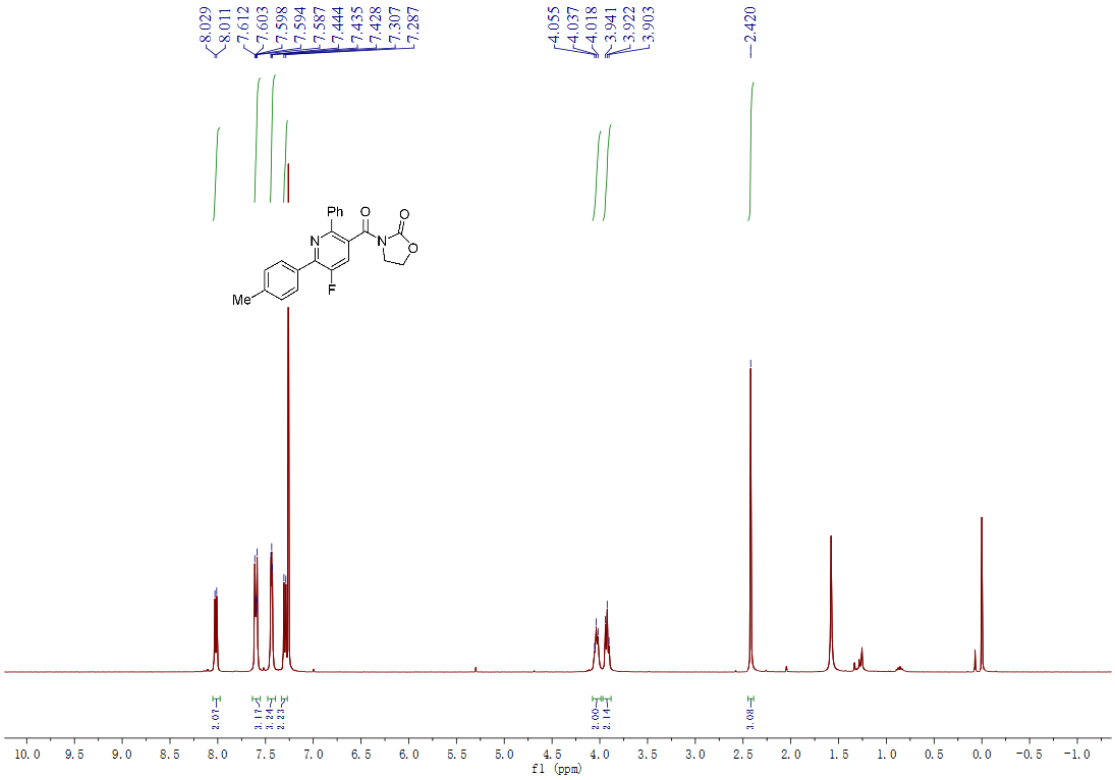


[^{19}F_NMR_565 MHz]

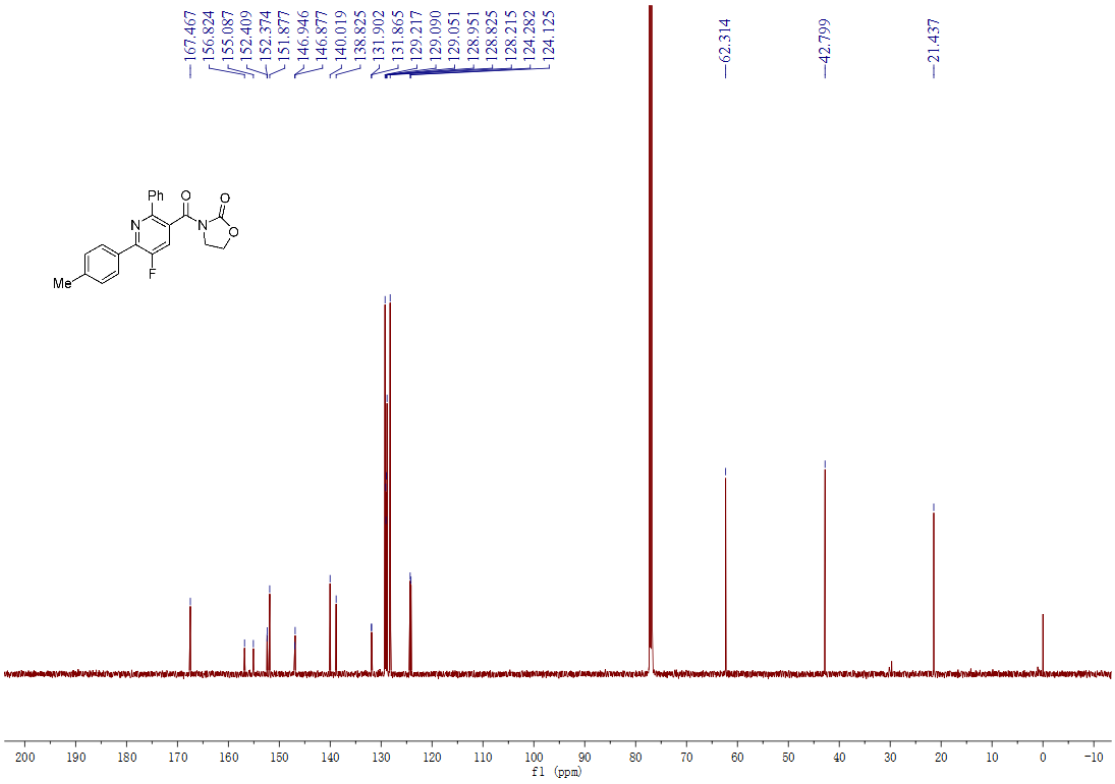


3-(5-Fluoro-2-phenyl-6-(p-tolyl)nicotinoyl)oxazolidin-2-one (3e)

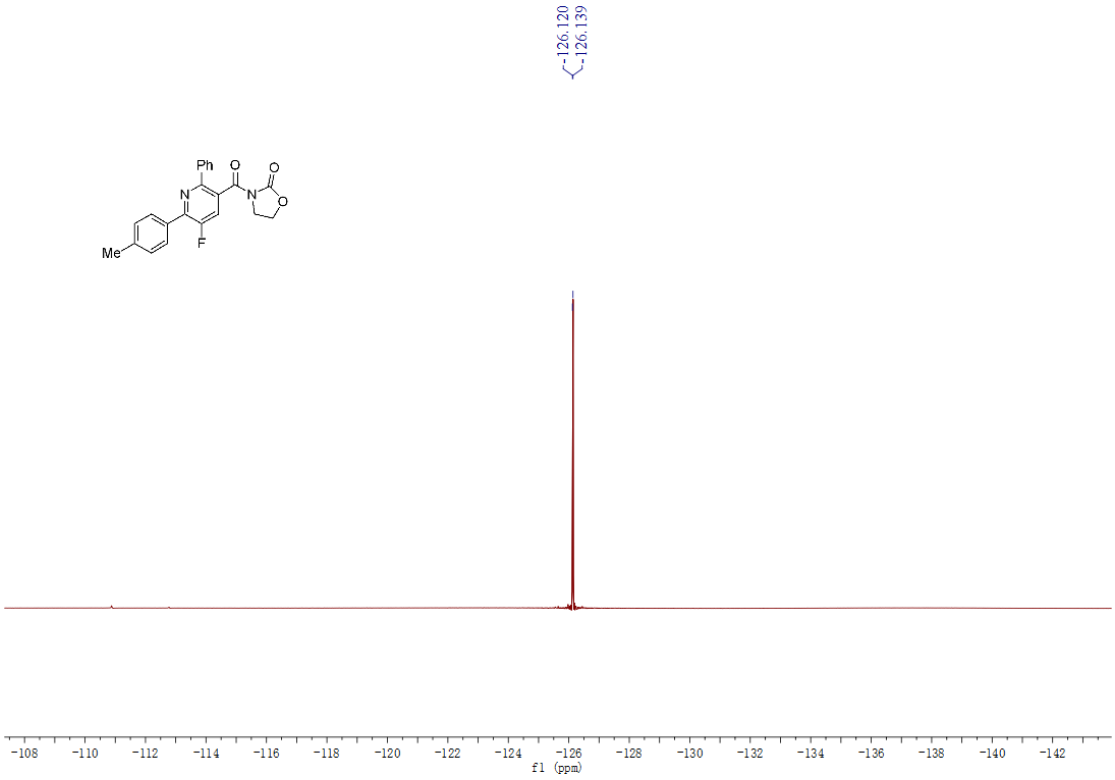
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

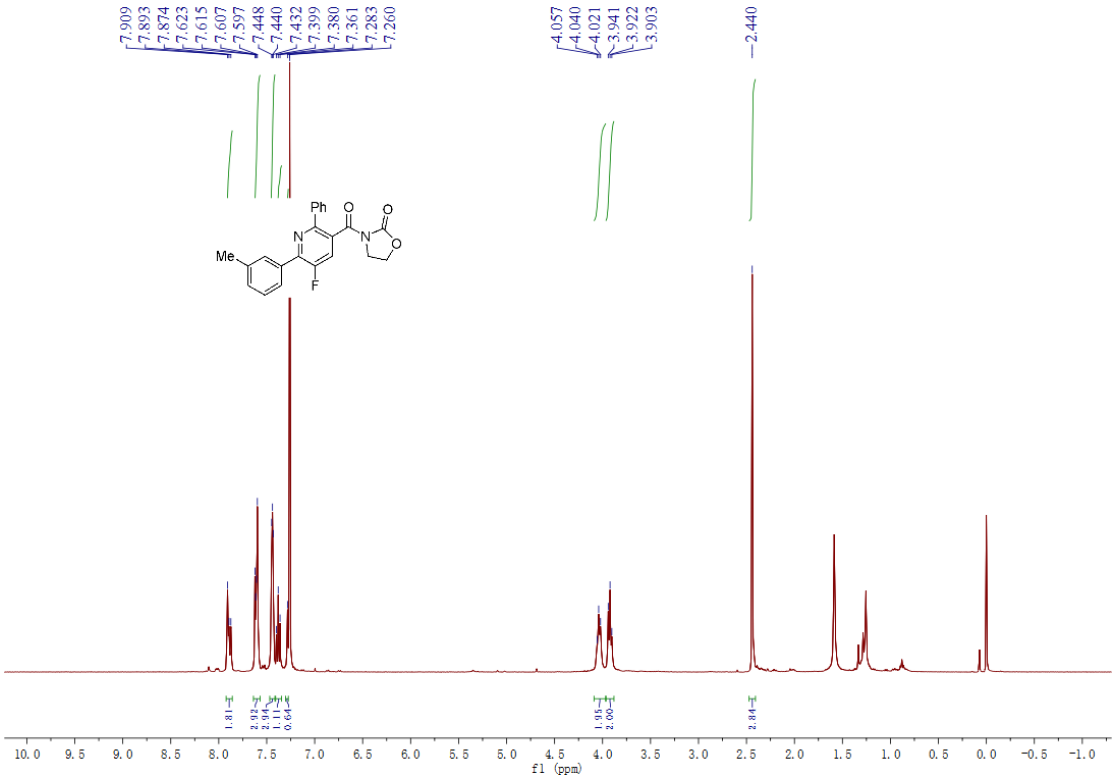


[^{19}F_NMR_565 MHz]

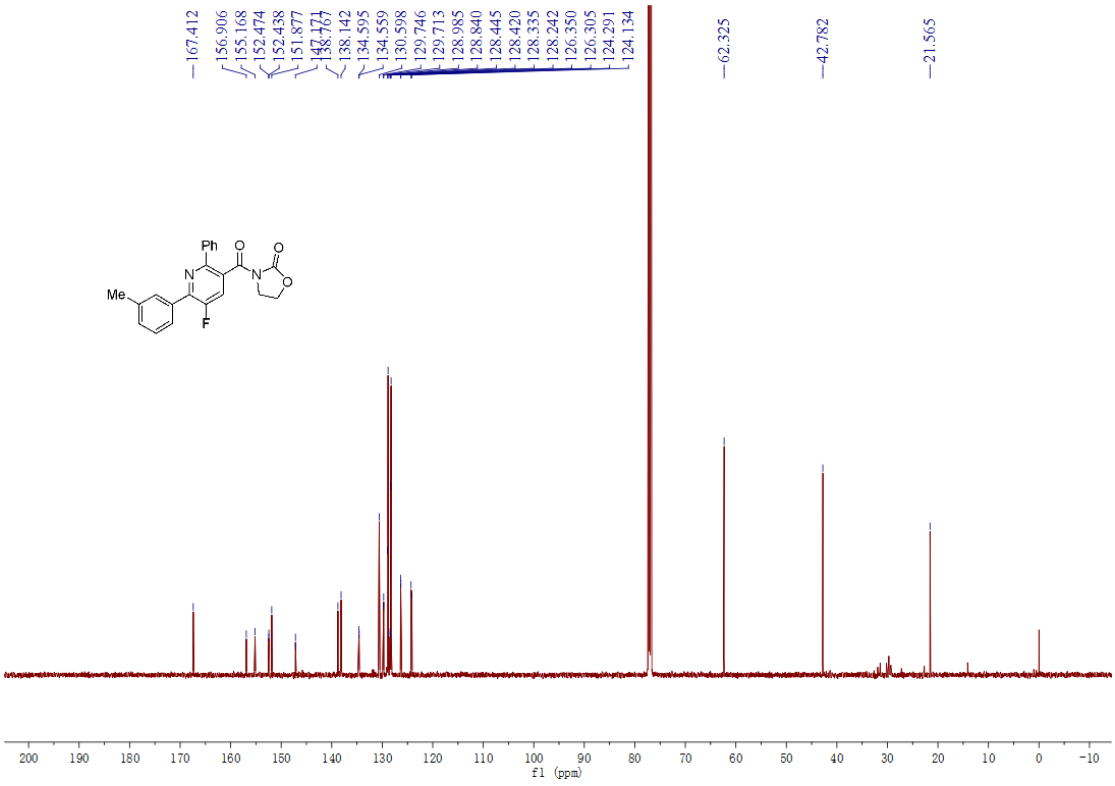


3-(5-Fluoro-2-phenyl-6-(m-tolyl)nicotinoyl)oxazolidin-2-one (3f)

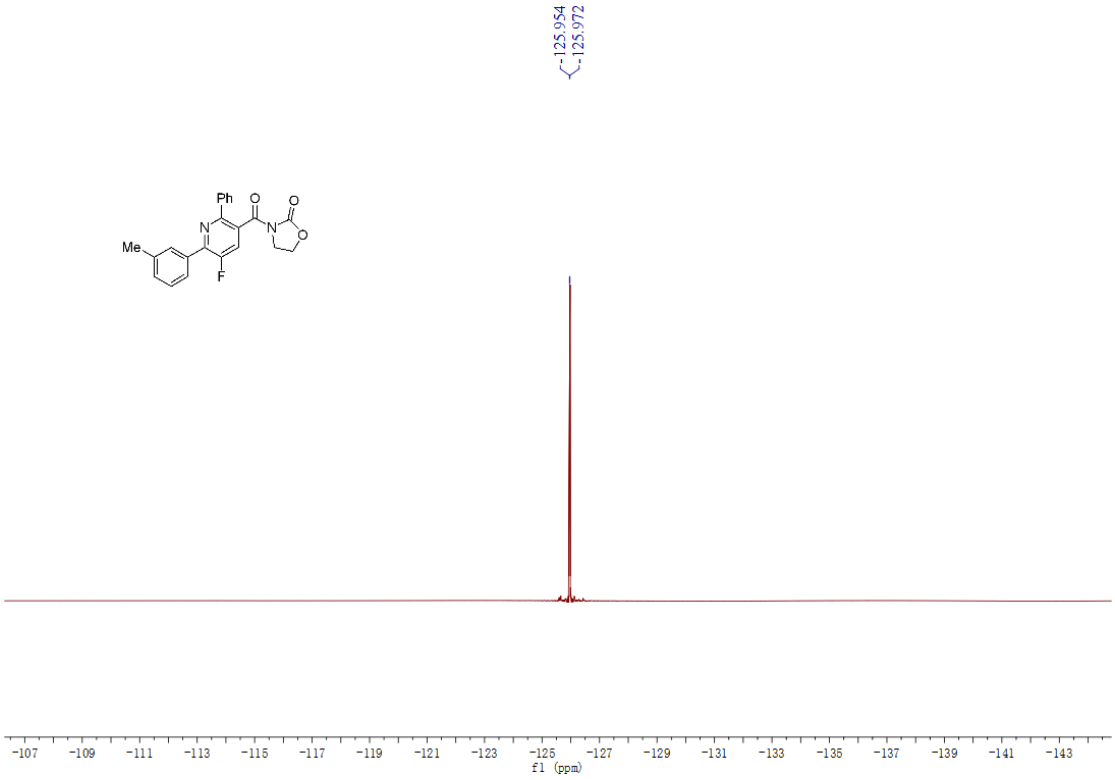
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

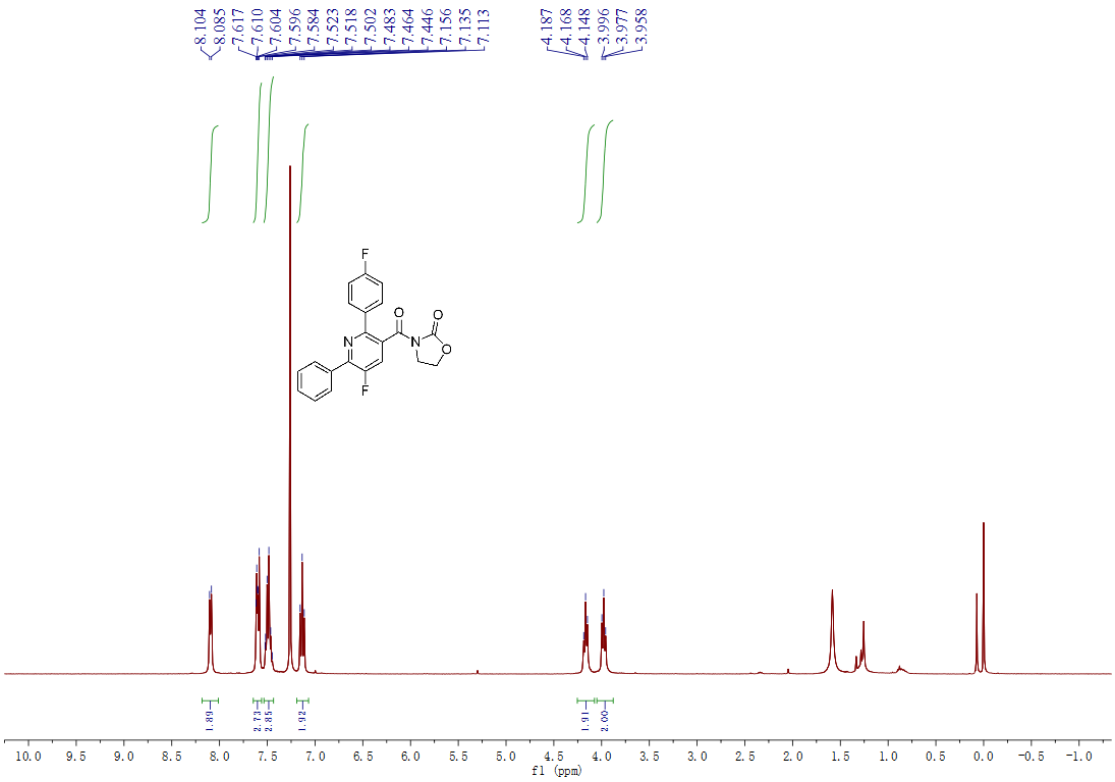


[^{19}F_NMR_565 MHz]

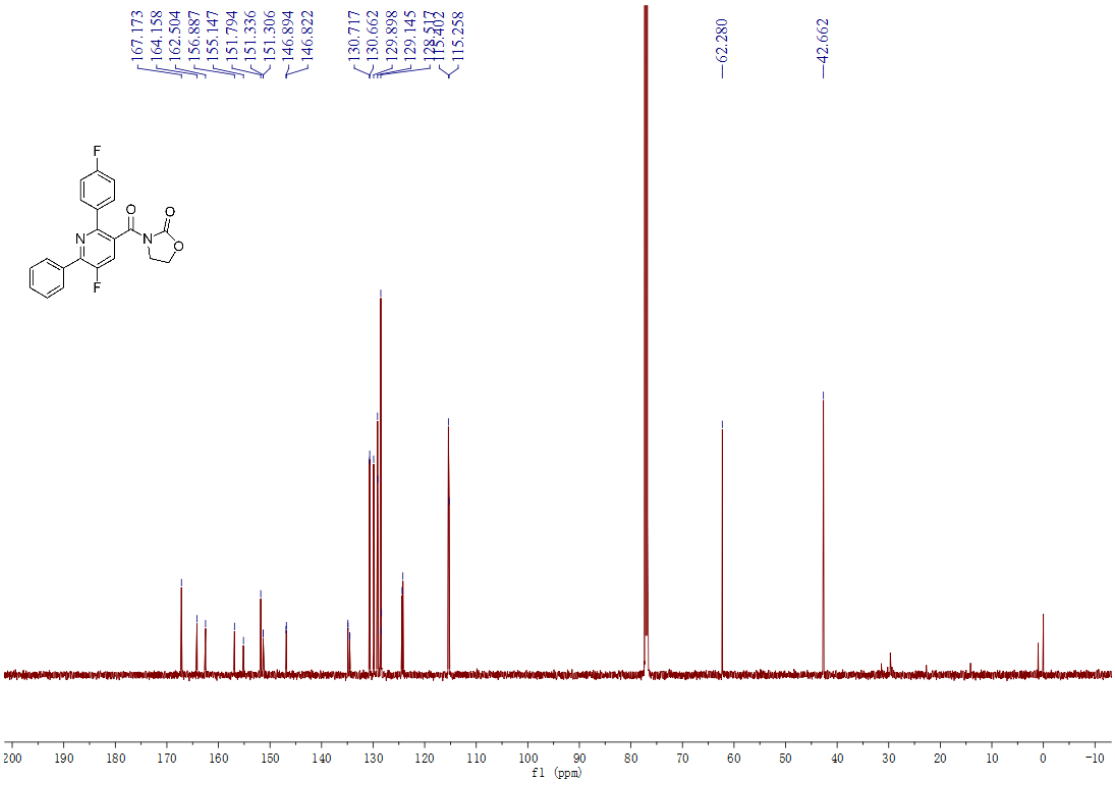


3-(5-Fluoro-2-(4-fluorophenyl)-6-phenylnicotinoyl)oxazolidin-2-one (3g)

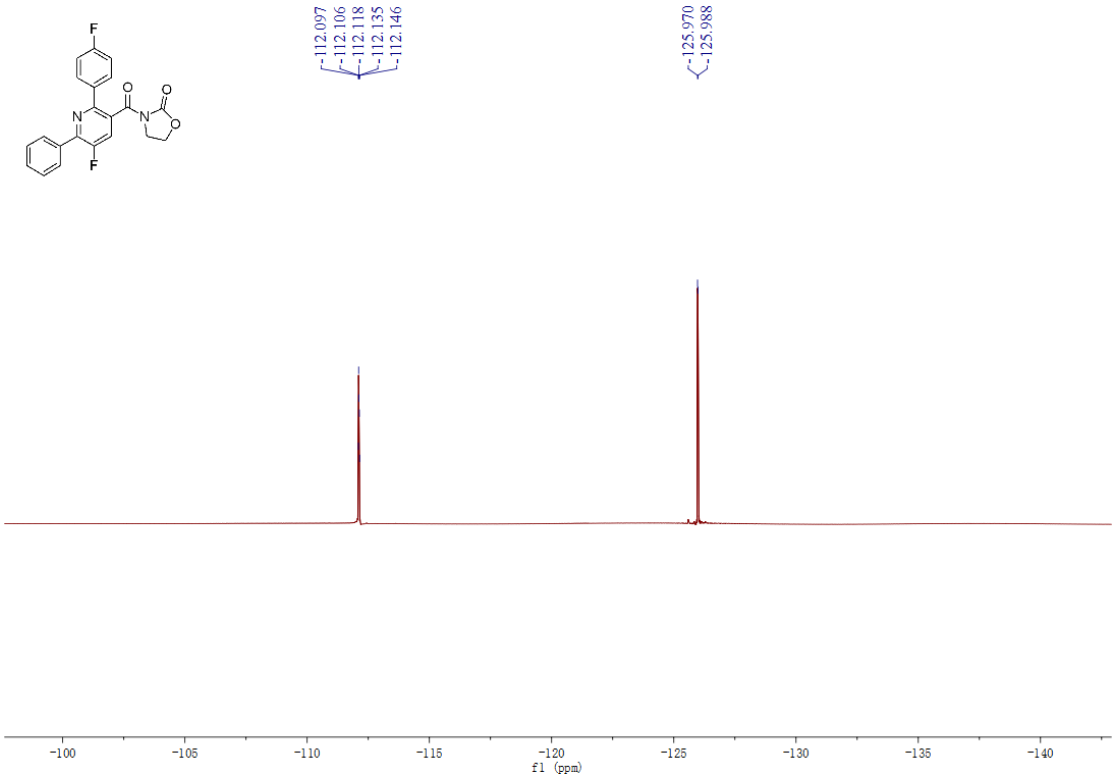
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

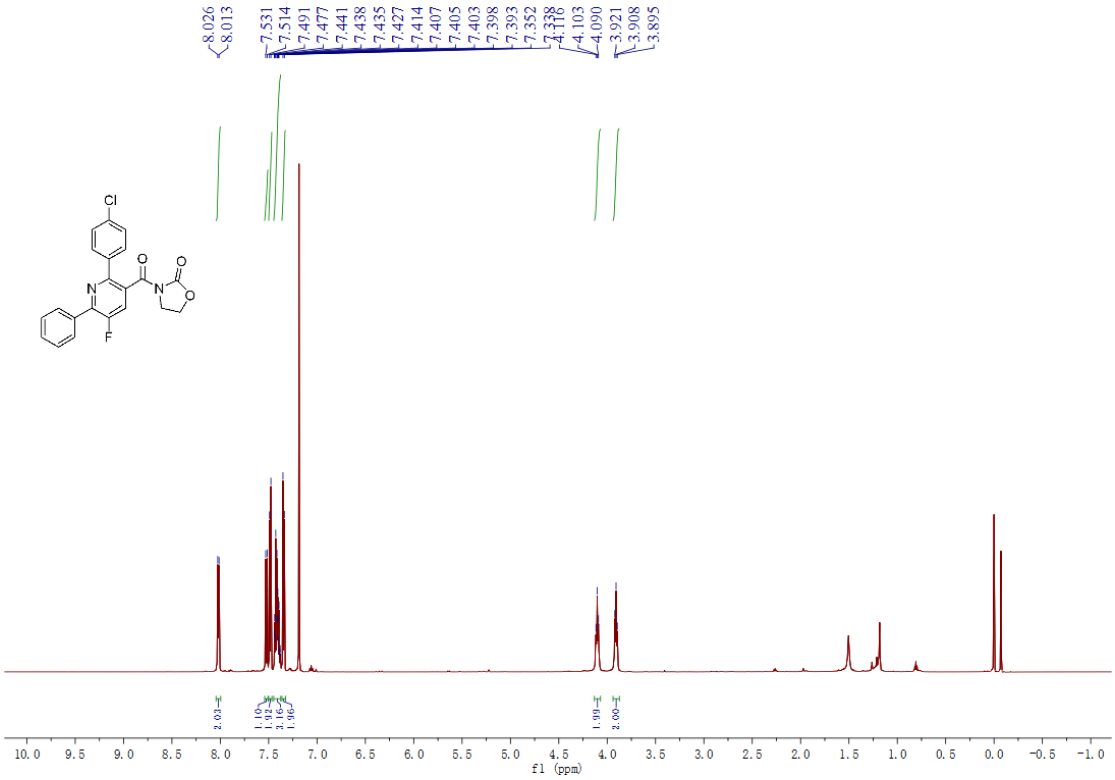


[^{19}F_NMR_565 MHz]

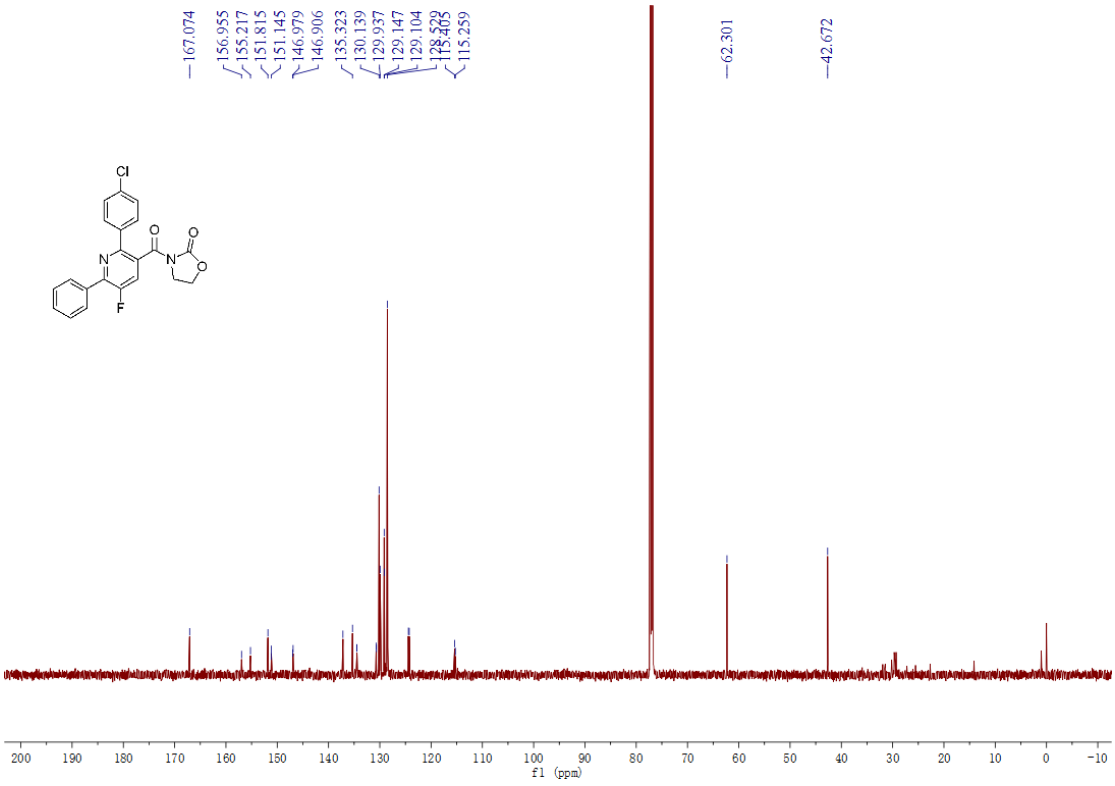


3-(2-(4-Chlorophenyl)-5-fluoro-6-phenylnicotinoyl)oxazolidin-2-one (3h)

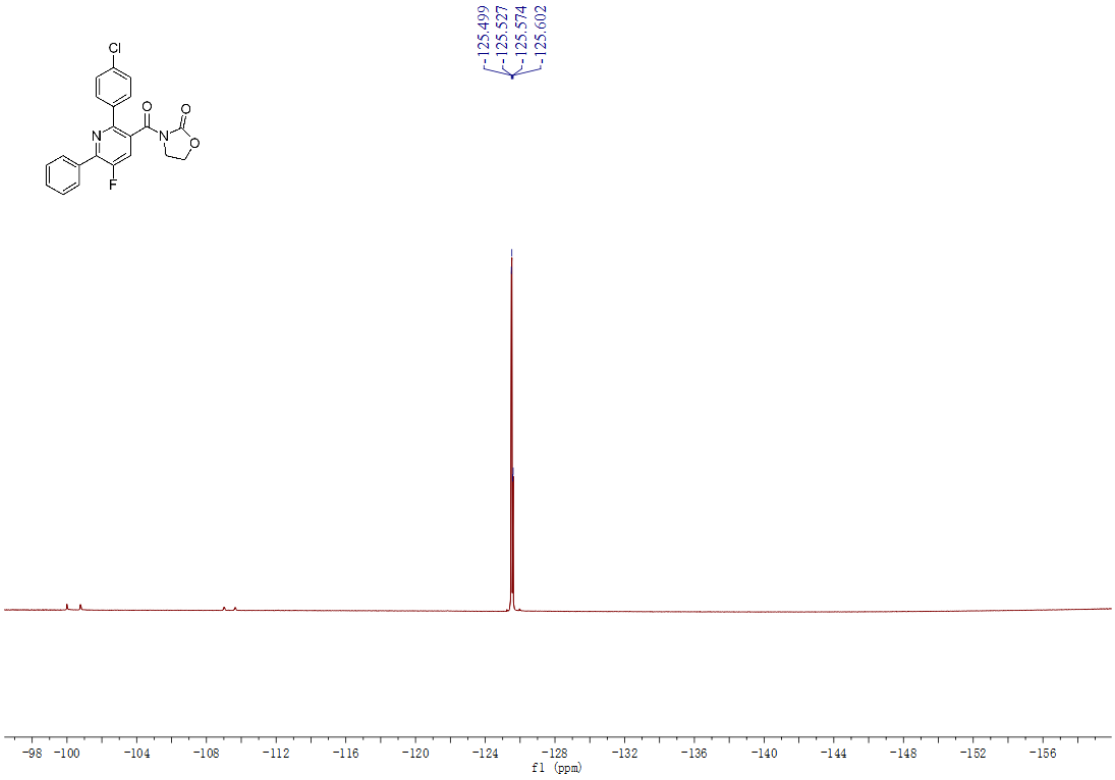
[^{1}H_NMR_600 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

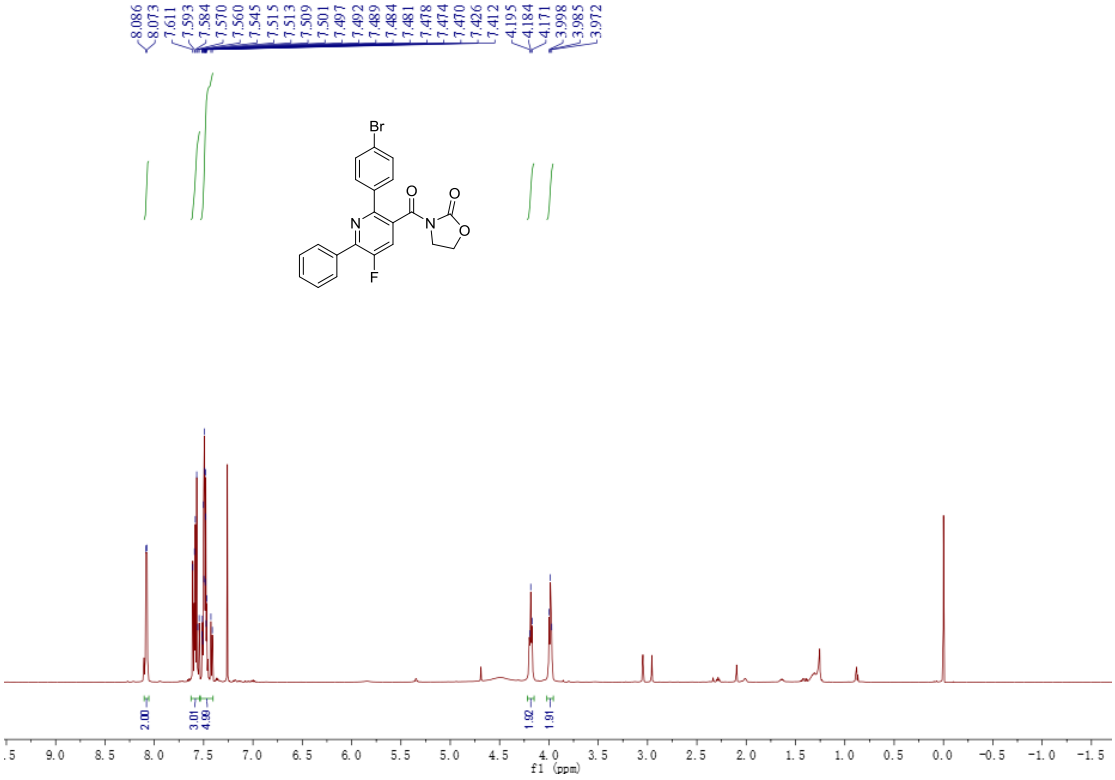


[^{19}F_NMR_375 MHz]

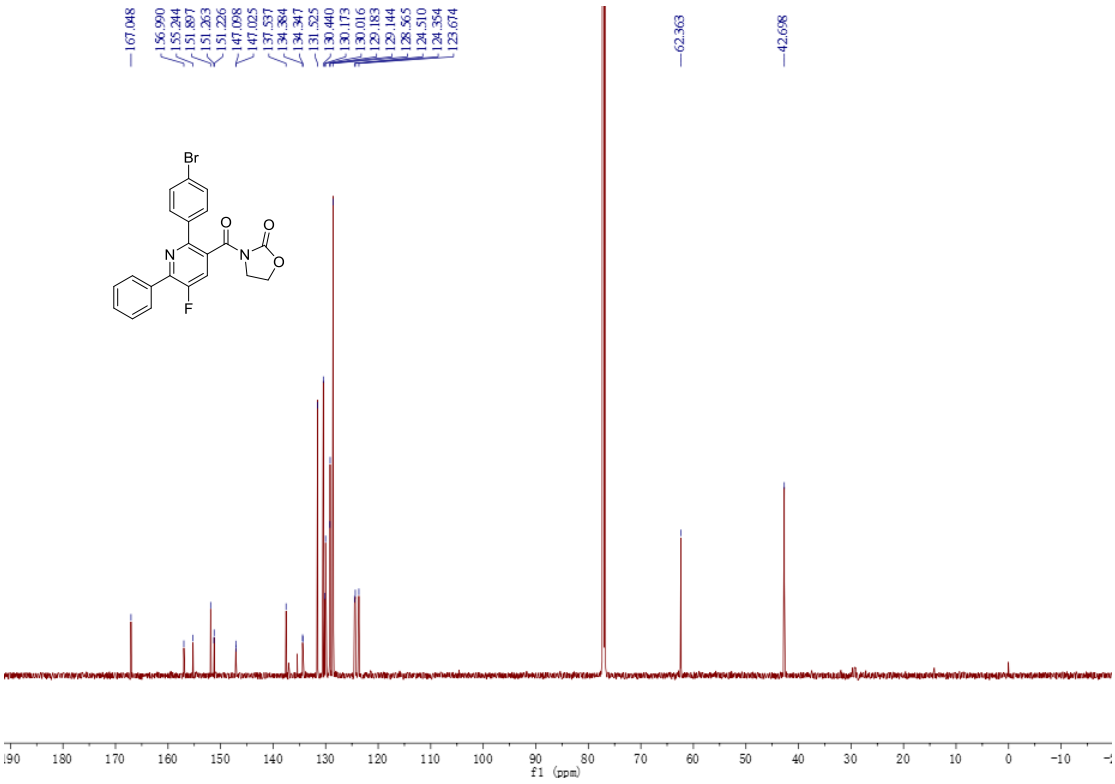


3-(2-(4-Bromophenyl)-5-fluoro-6-phenylnicotinoyl)oxazolidin-2-one (3i)

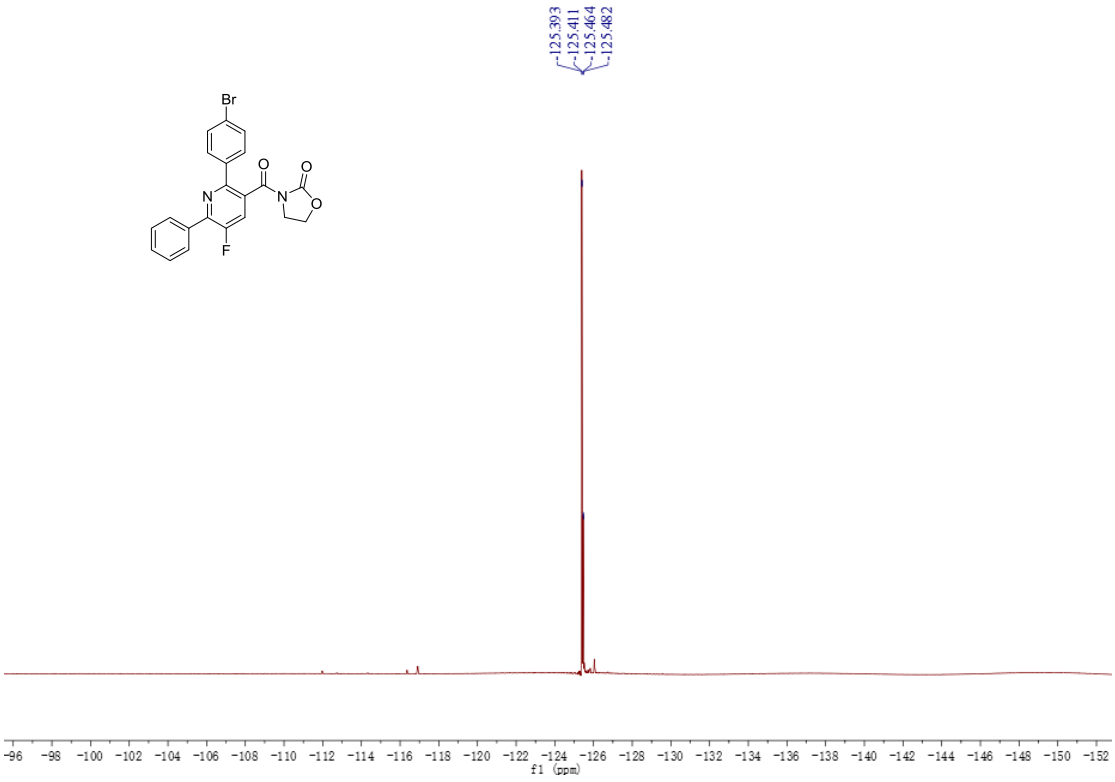
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

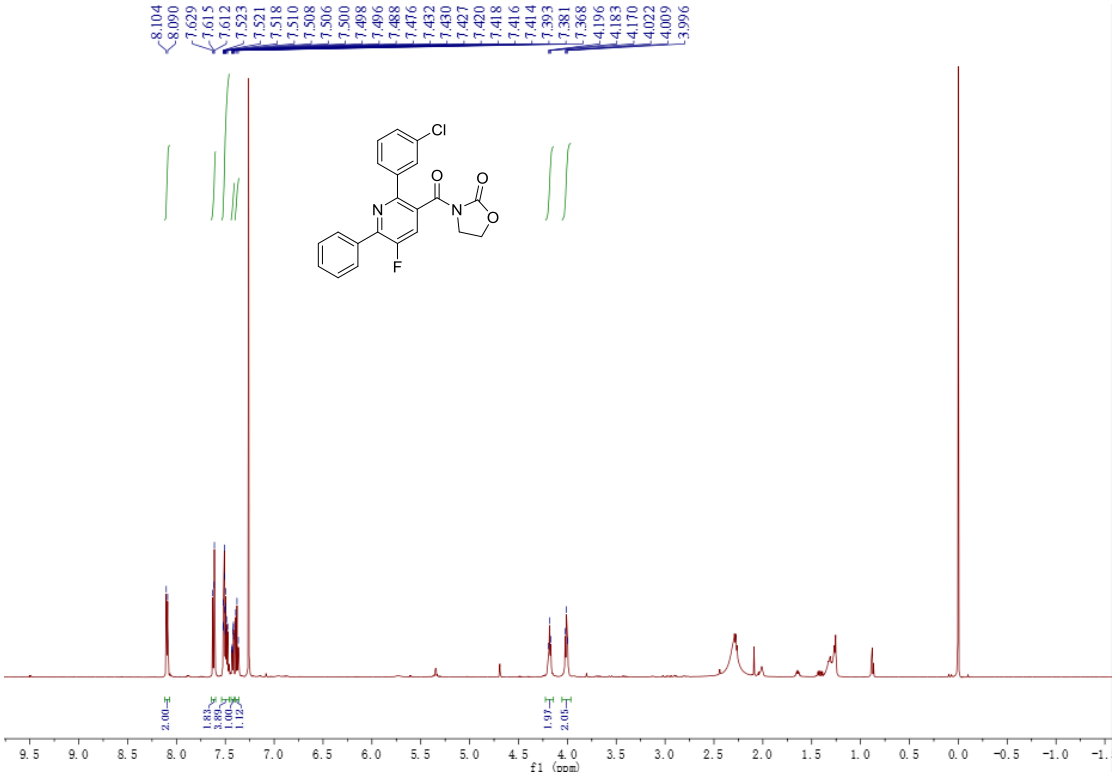


[^{19}F_NMR_375 MHz]

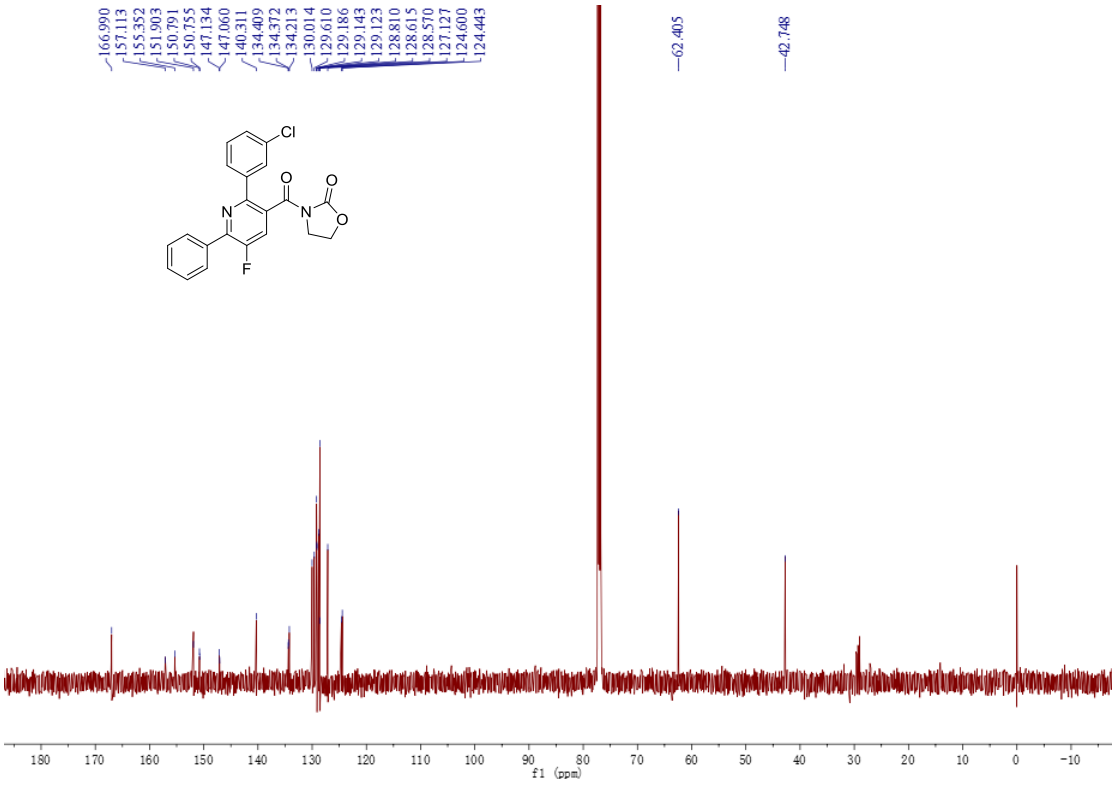


3-(2-(3-Chlorophenyl)-5-fluoro-6-phenylnicotinoyl)oxazolidin-2-one (3j)

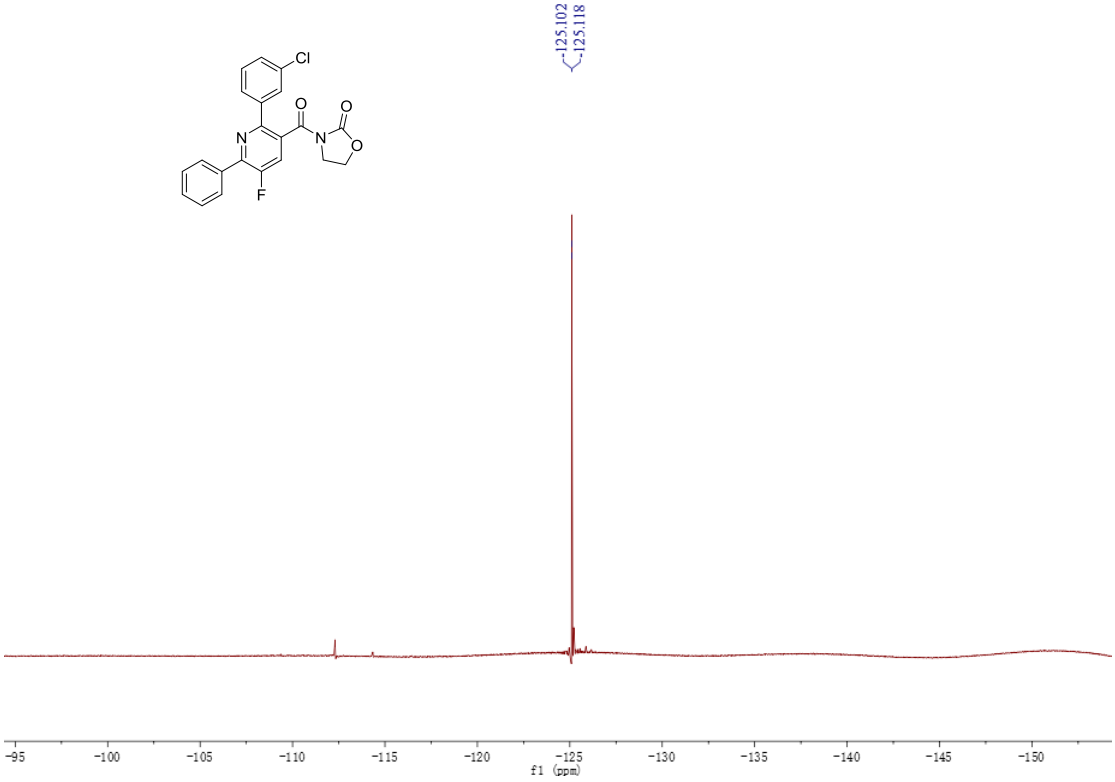
[^{1}H_NMR_600 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

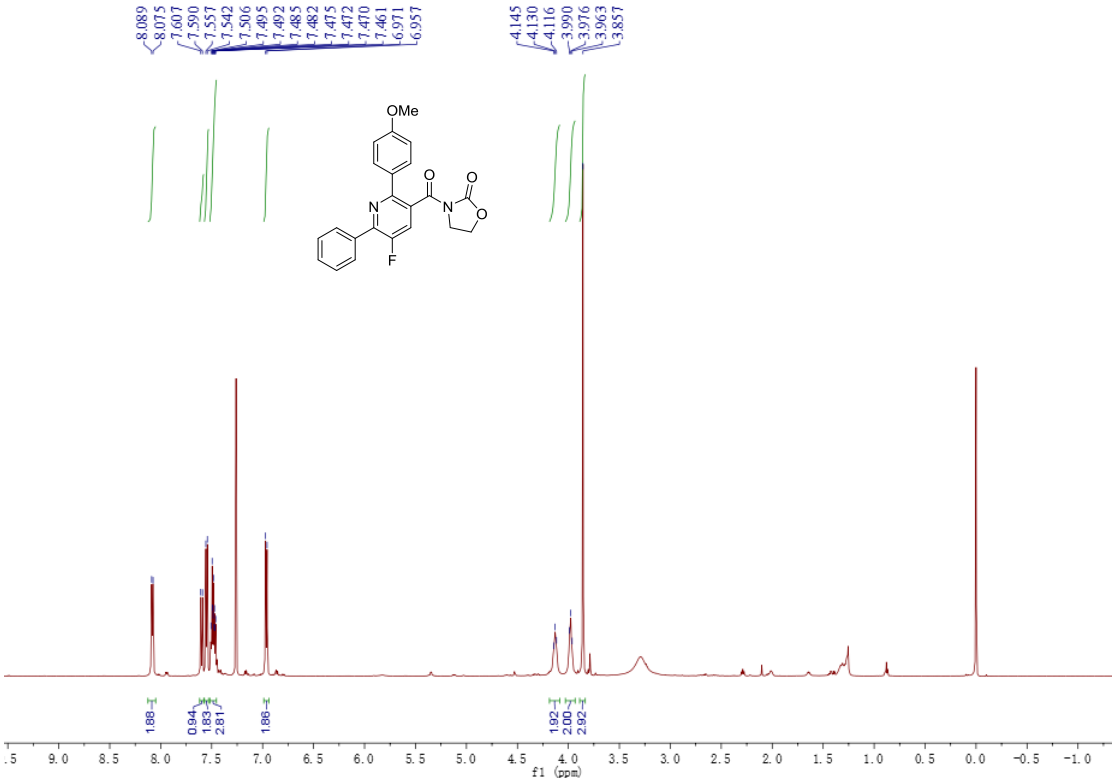


[^{19}F_NMR_565 MHz]

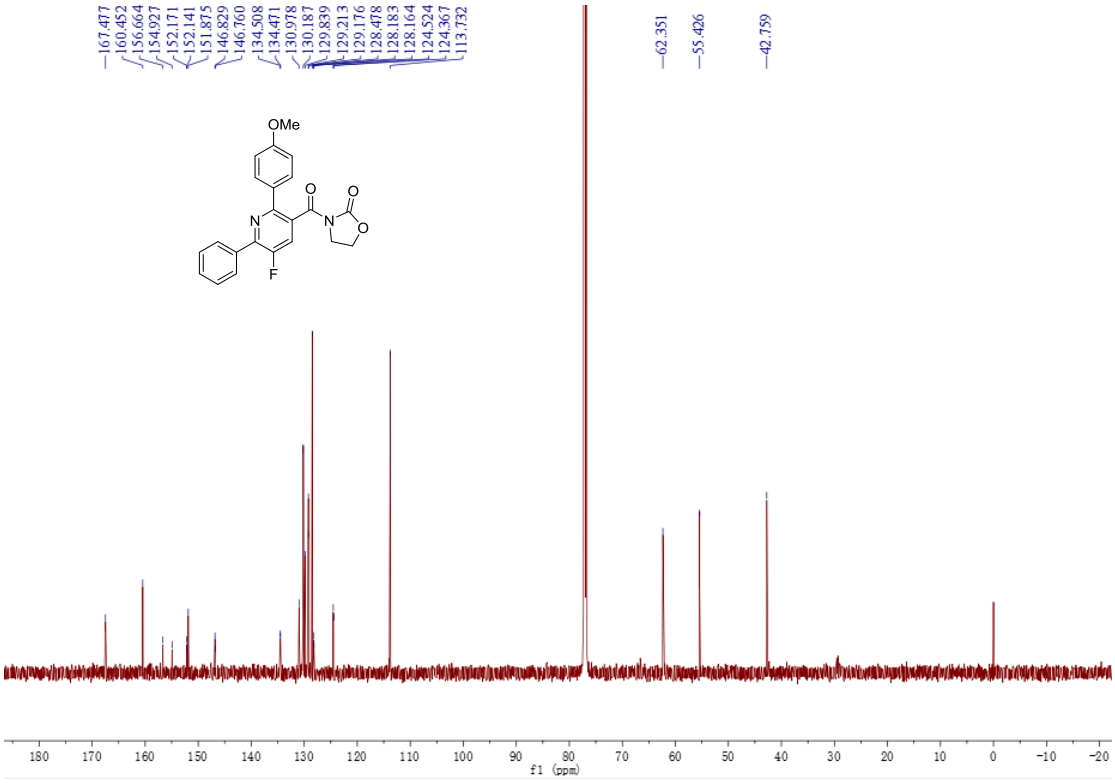


3-(5-Fluoro-2-(4-methoxyphenyl)-6-phenylnicotinoyl)oxazolidin-2-one (3k)

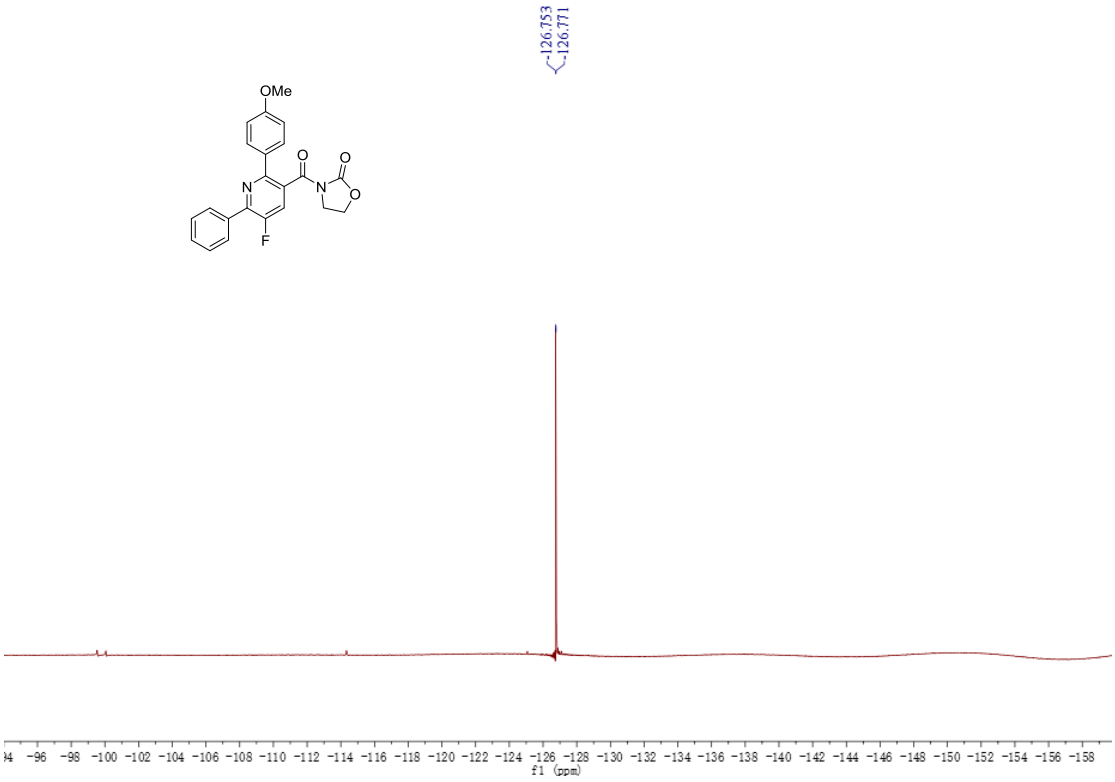
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

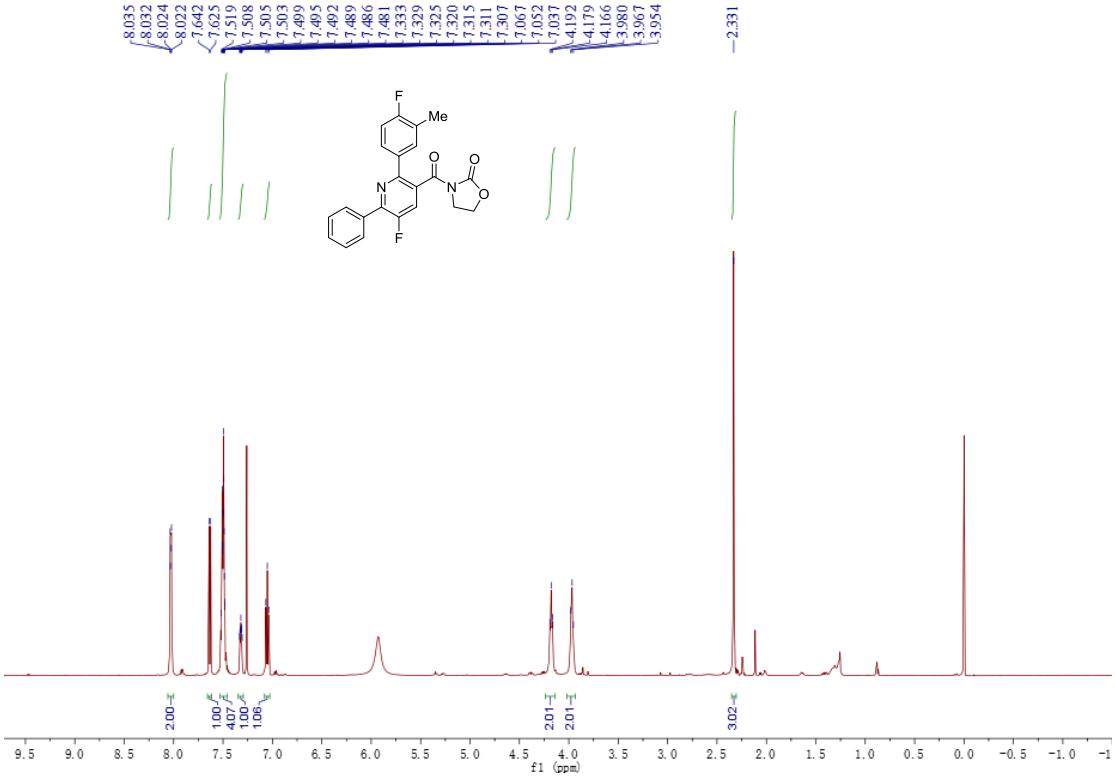


[^{19}F_NMR_565 MHz]

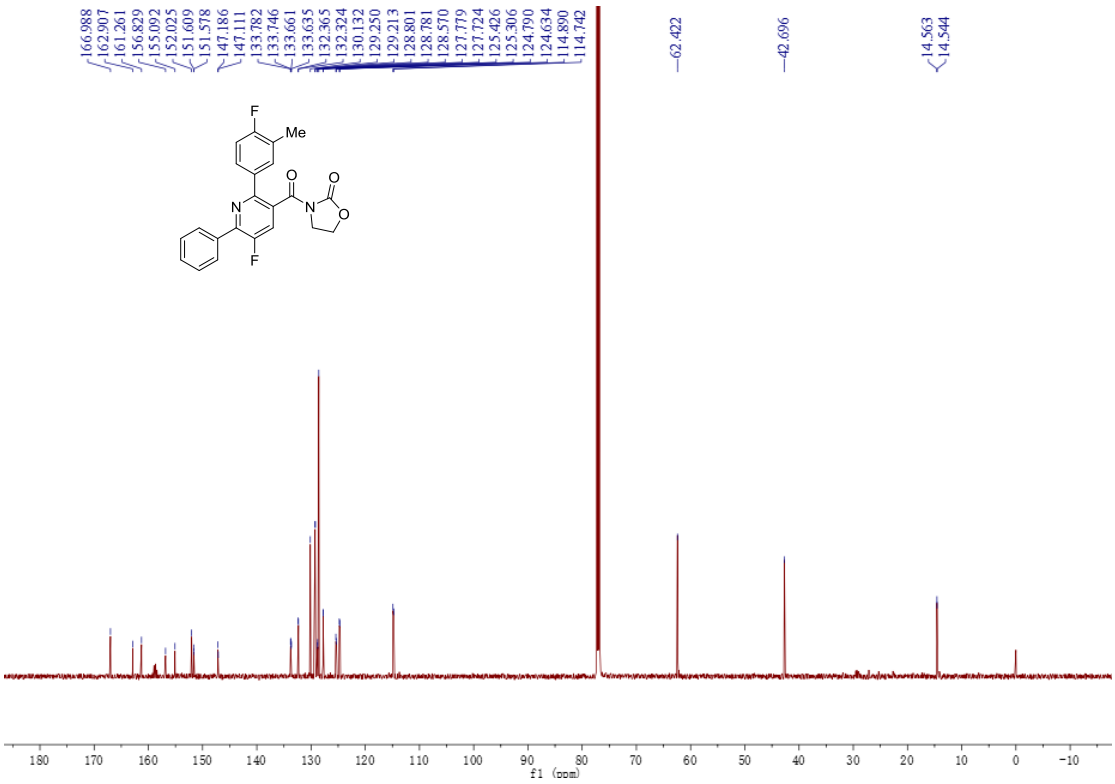


3-(5-Fluoro-2-(4-fluoro-3-methylphenyl)-6-phenylnicotinoyl)oxazolidin-2-one (3l)

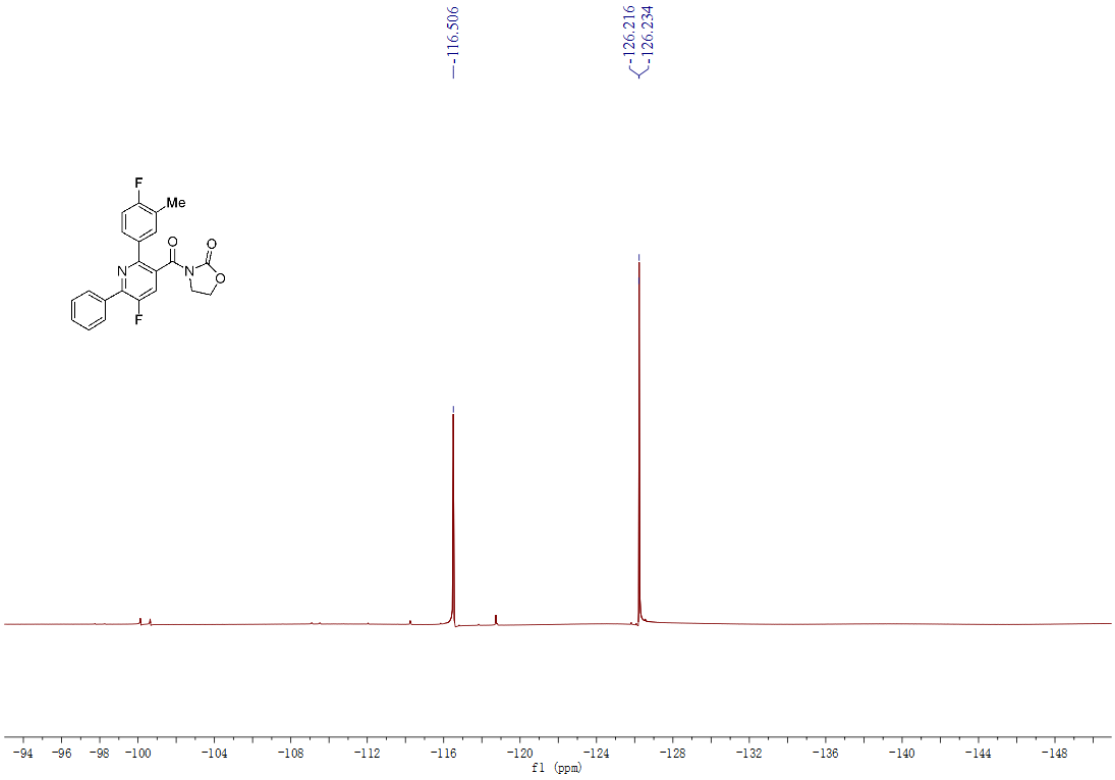
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

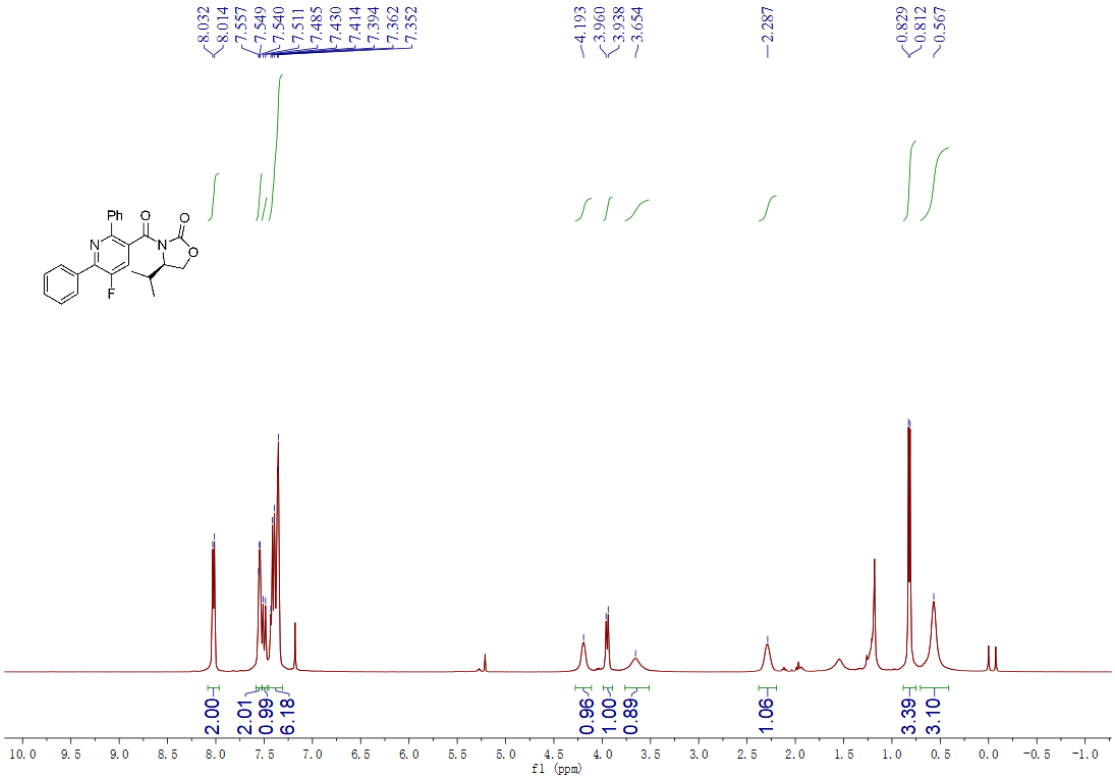


[^{19}F_NMR_565 MHz]

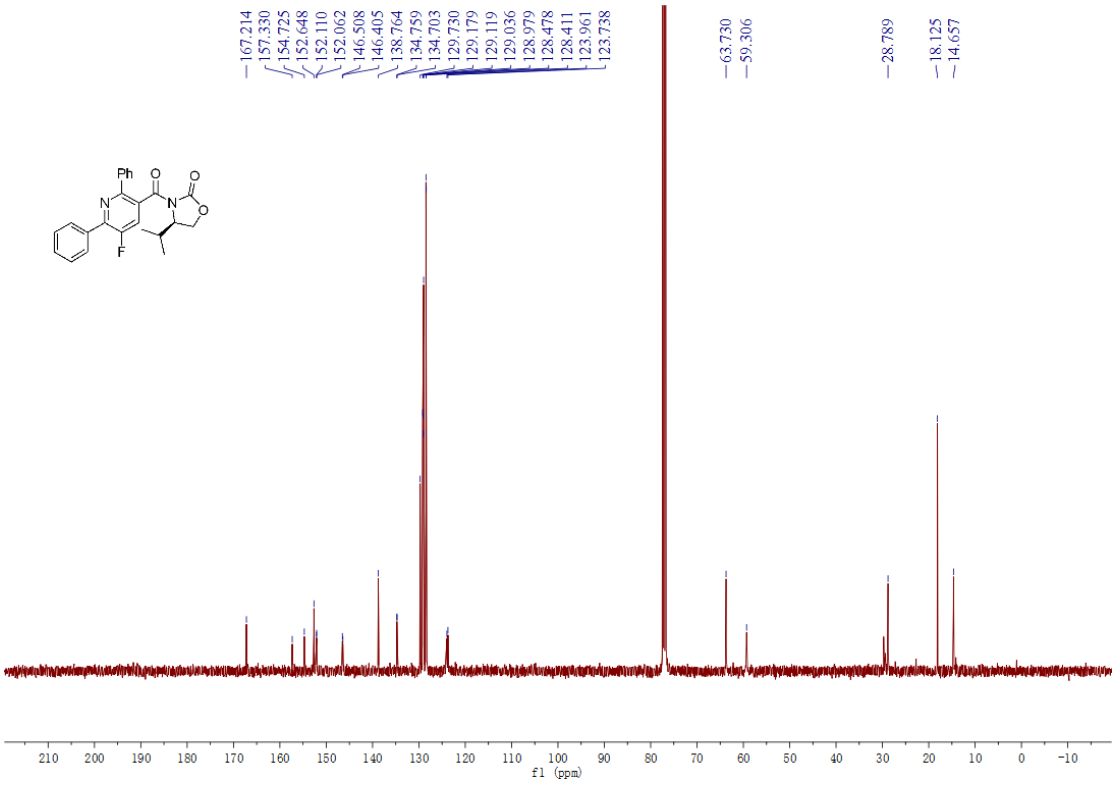


(R)-3-(5-Fluoro-2,6-diphenylnicotinoyl)-4-isopropyloxazolidin-2-one (3m)

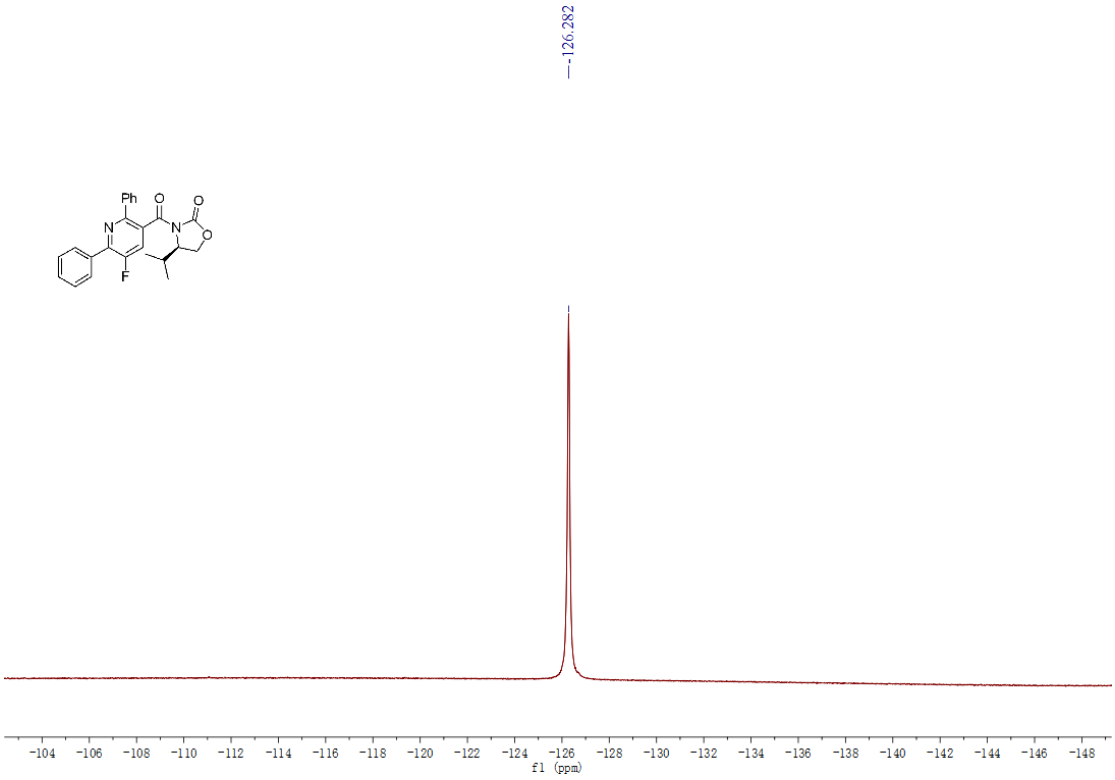
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

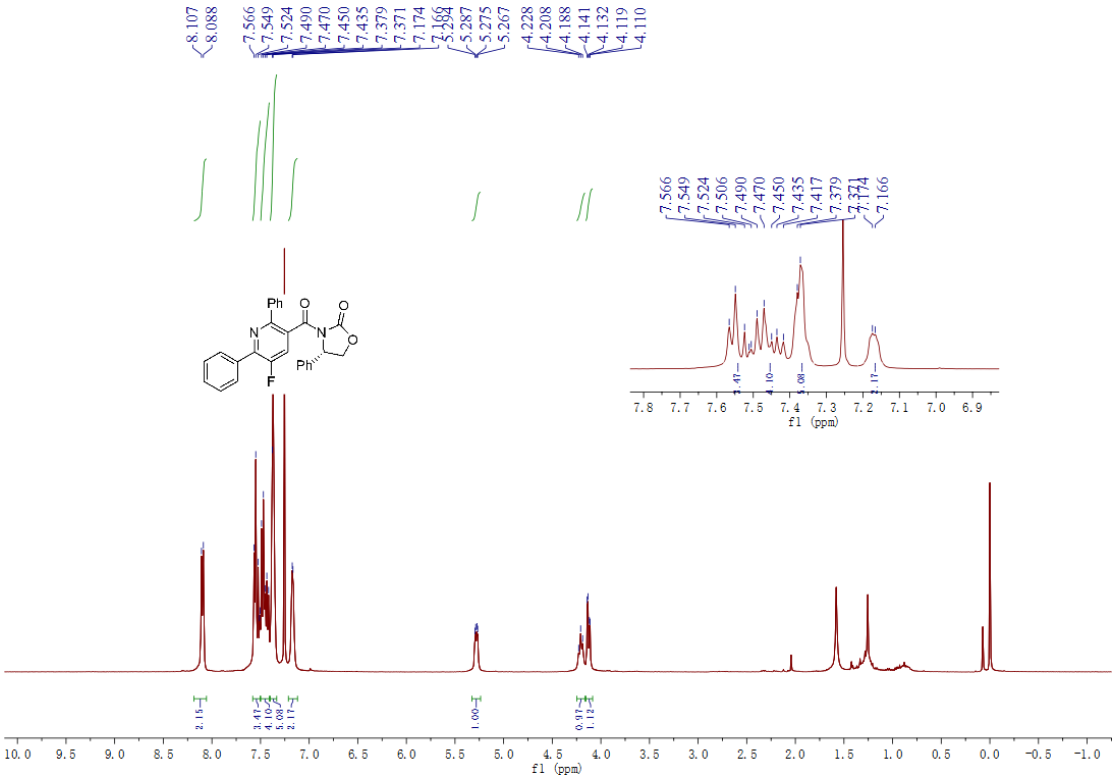


[^{19}F_NMR_375 MHz]

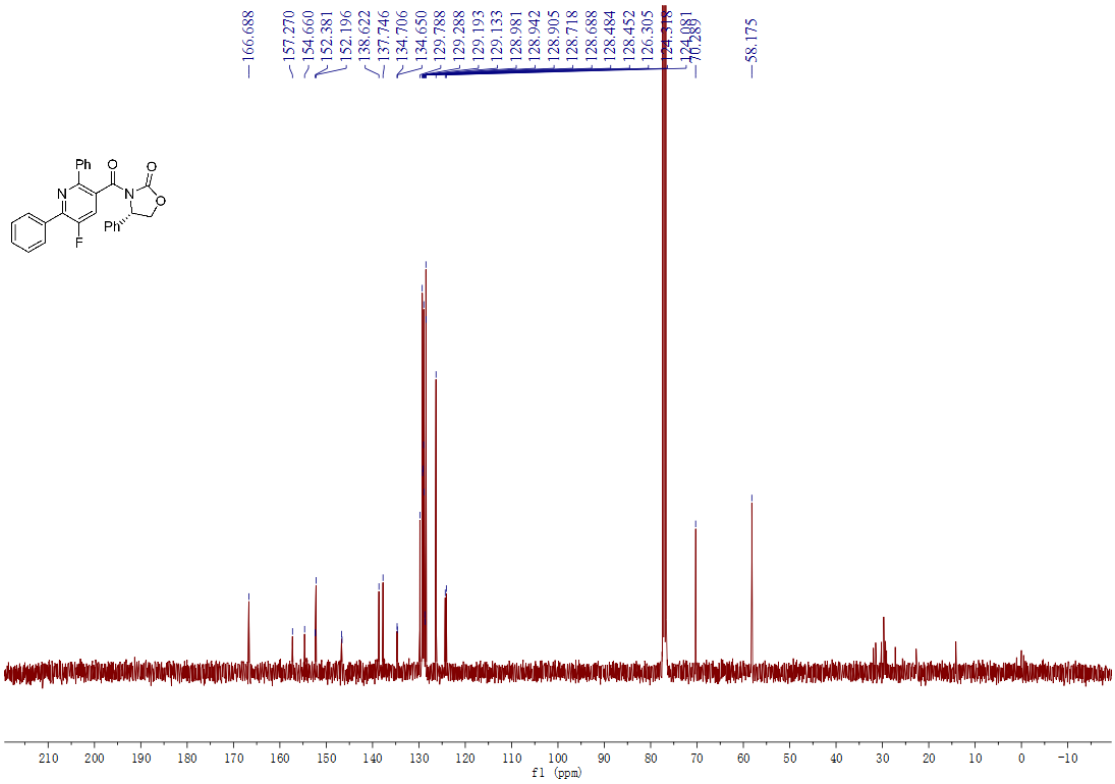


(S)-3-(5-Fluoro-2,6-diphenylnicotinoyl)-4-phenyloxazolidin-2-one (3n)

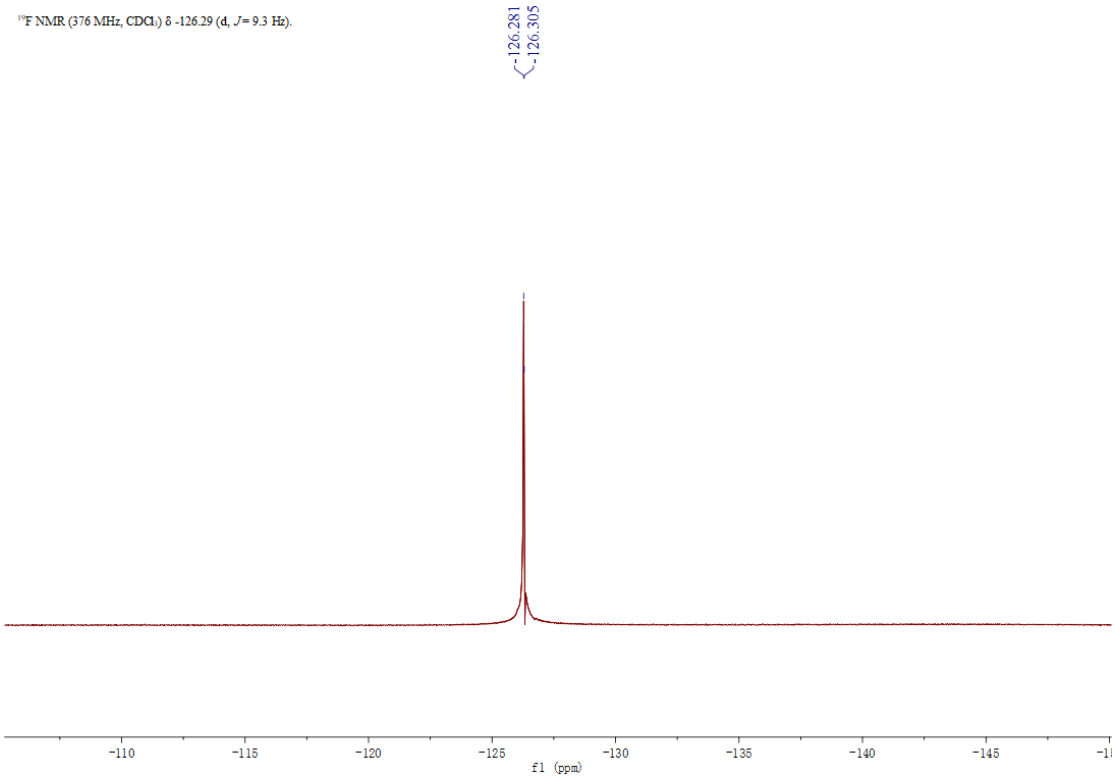
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

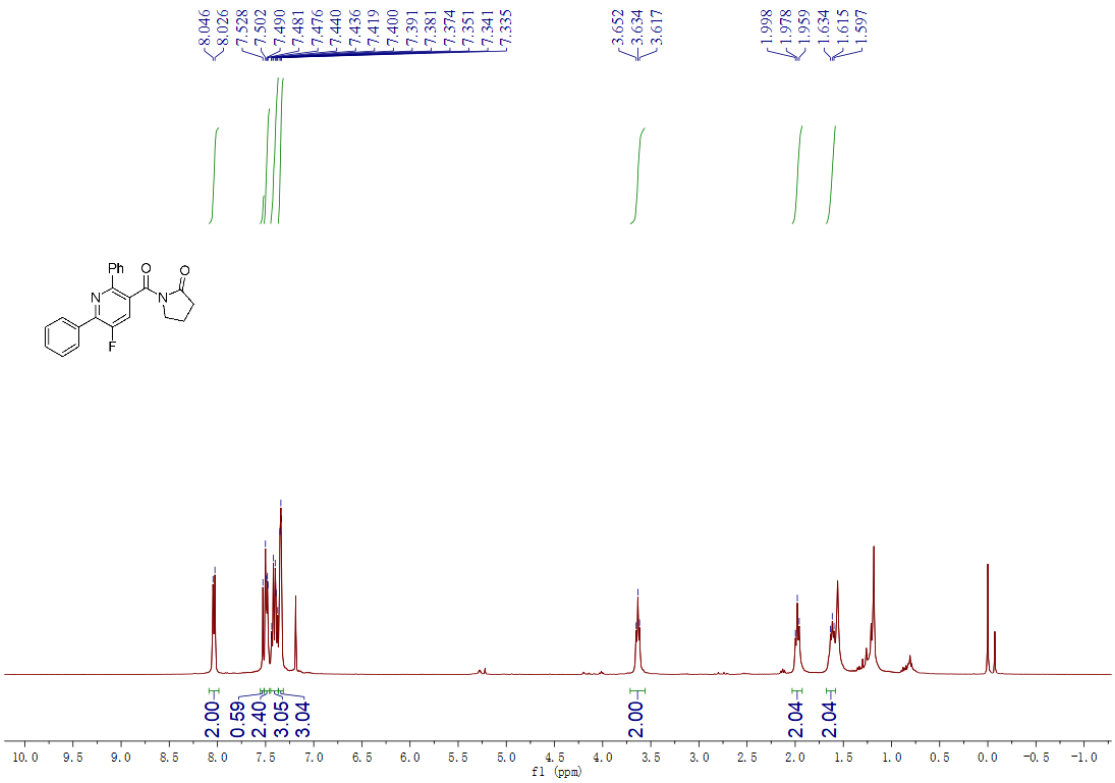


[^{19}F_NMR_375 MHz]

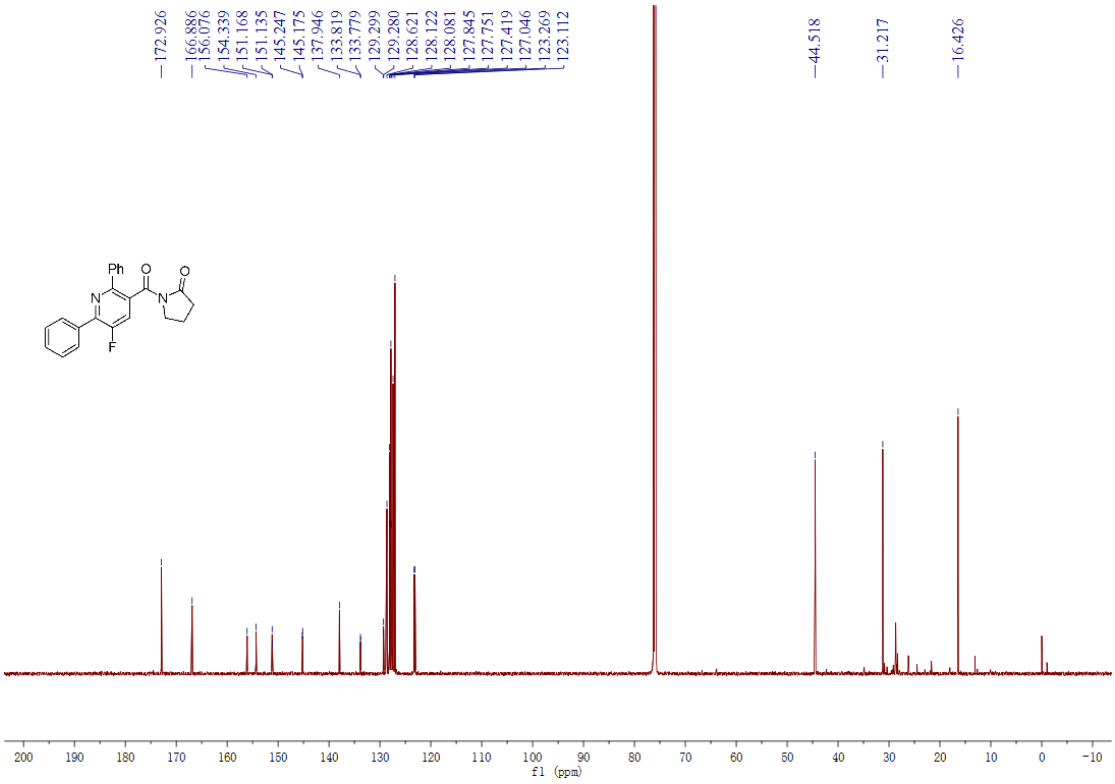


1-(5-Fluoro-2,6-diphenylnicotinoyl)pyrrolidin-2-one (3o)

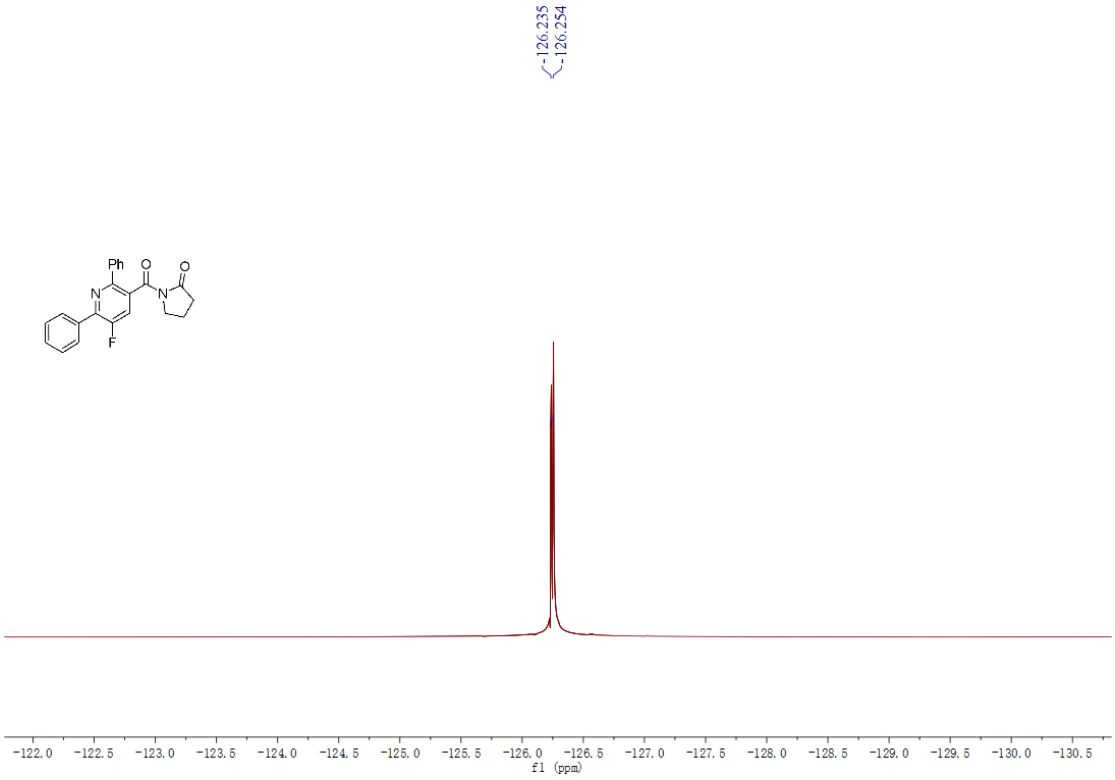
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

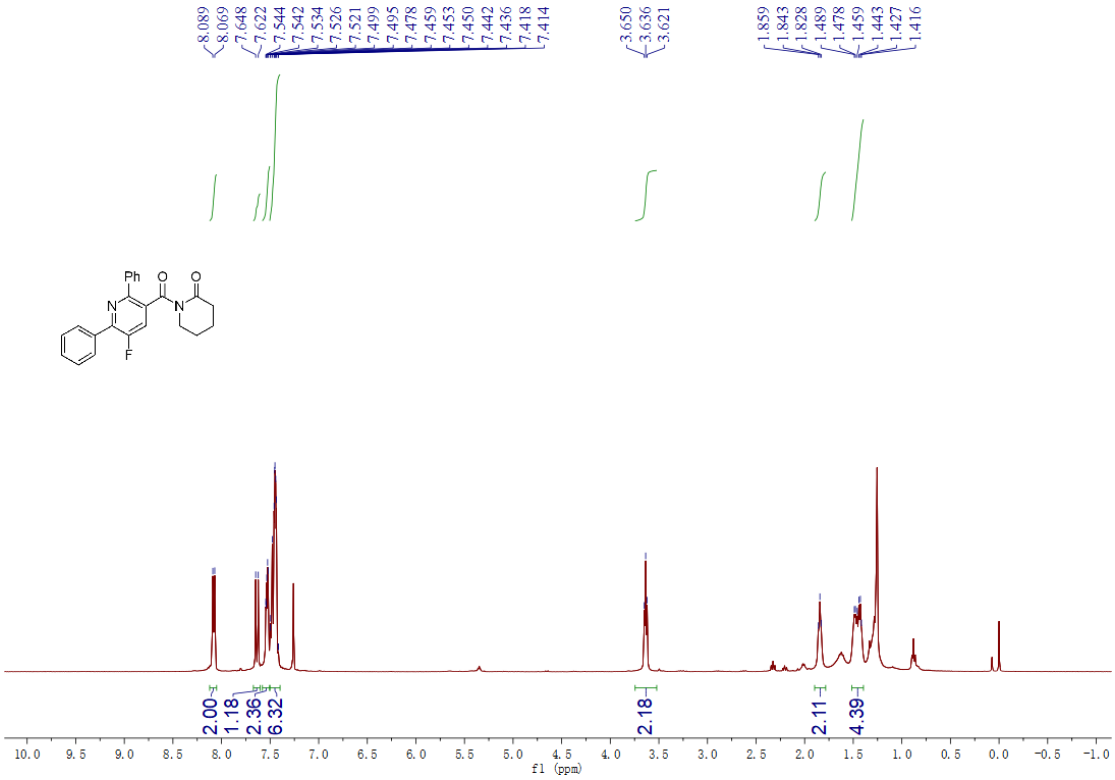


[^{19}F_NMR_565 MHz]

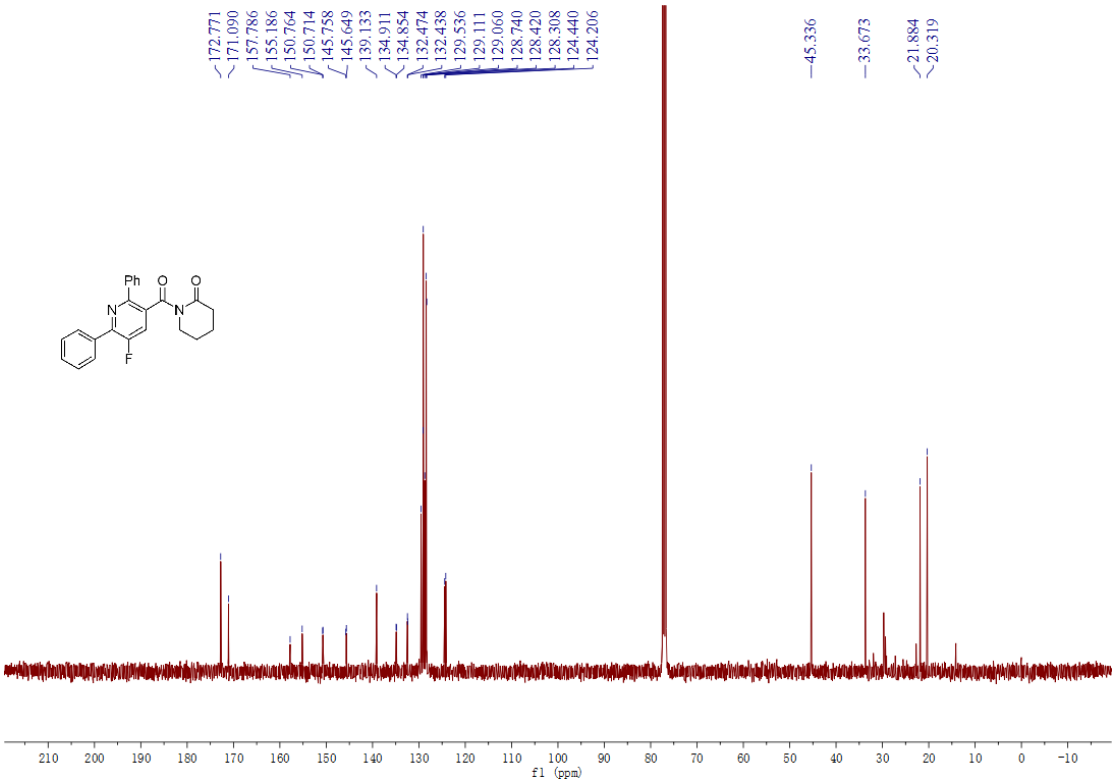


1-(5-Fluoro-2,6-diphenylnicotinoyl)piperidin-2-one (3p)

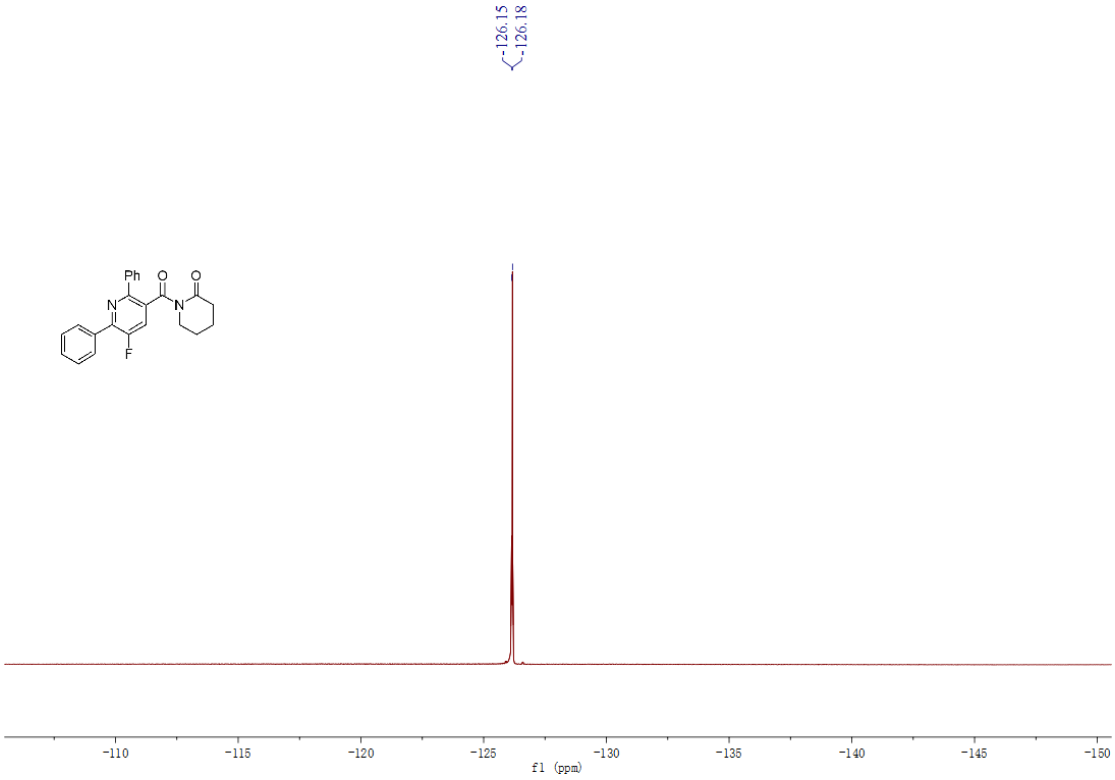
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

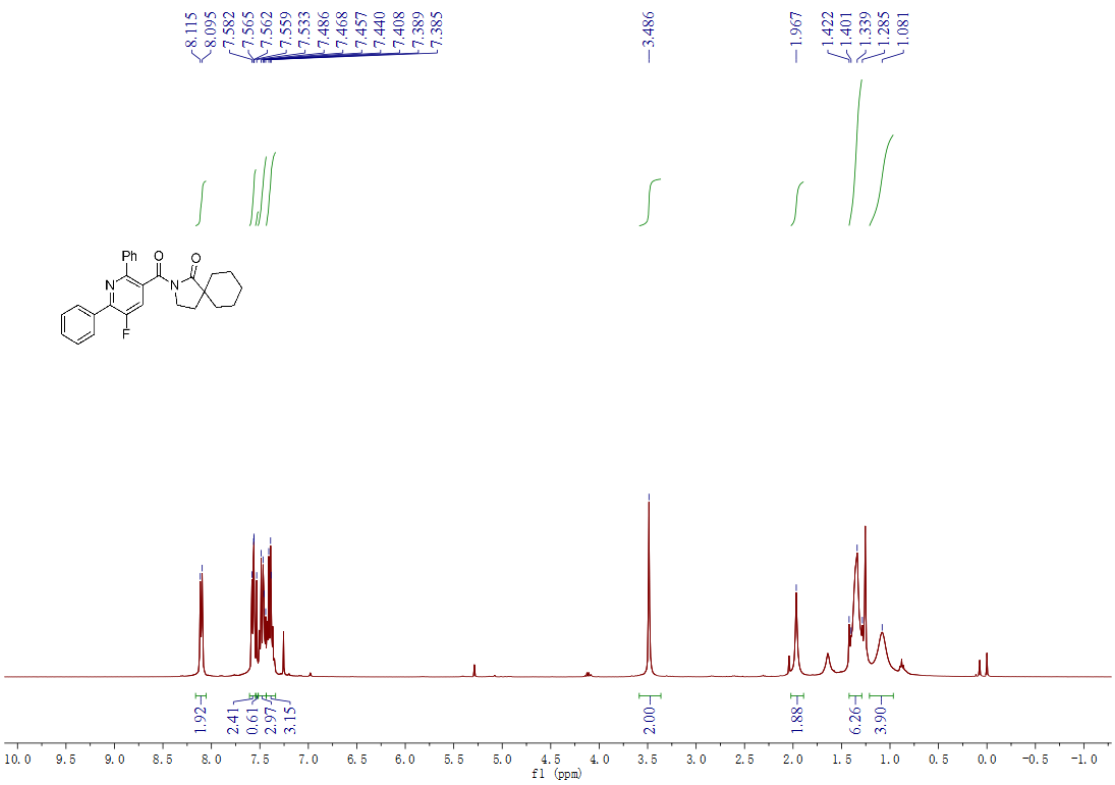


[^{19}F_NMR_375 MHz]

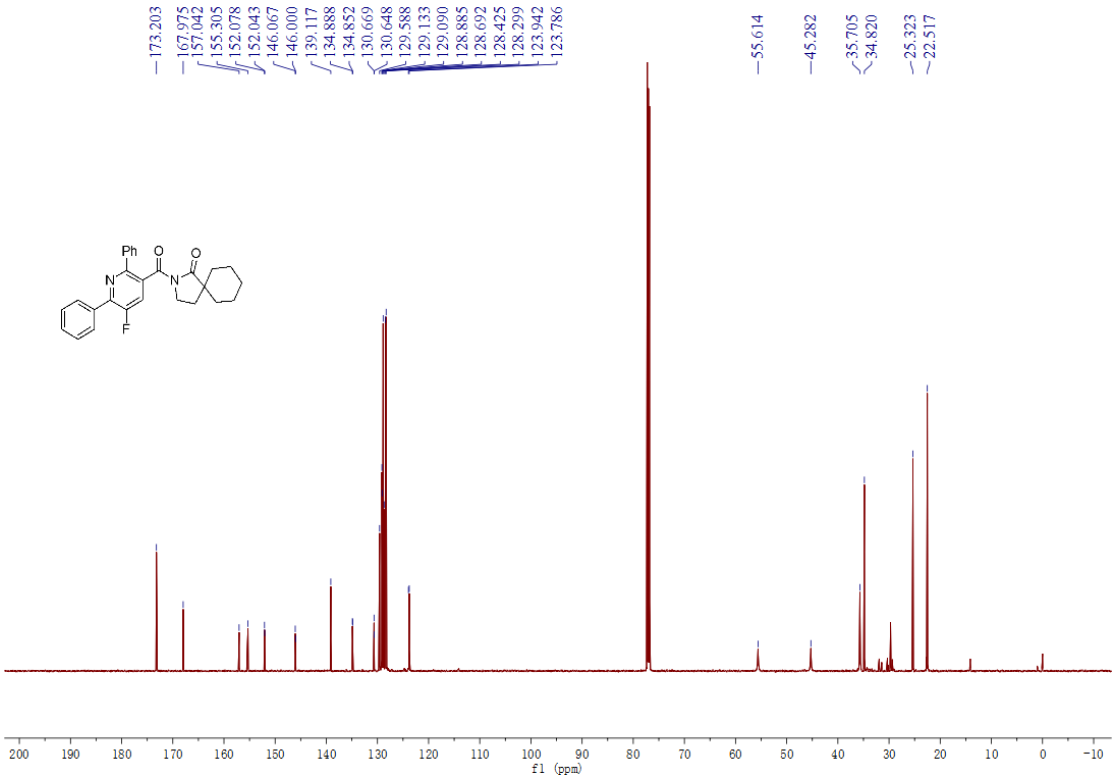


2-(5-Fluoro-2,6-diphenylnicotinoyl)-2-azaspiro[4.5]decan-1-one (3q)

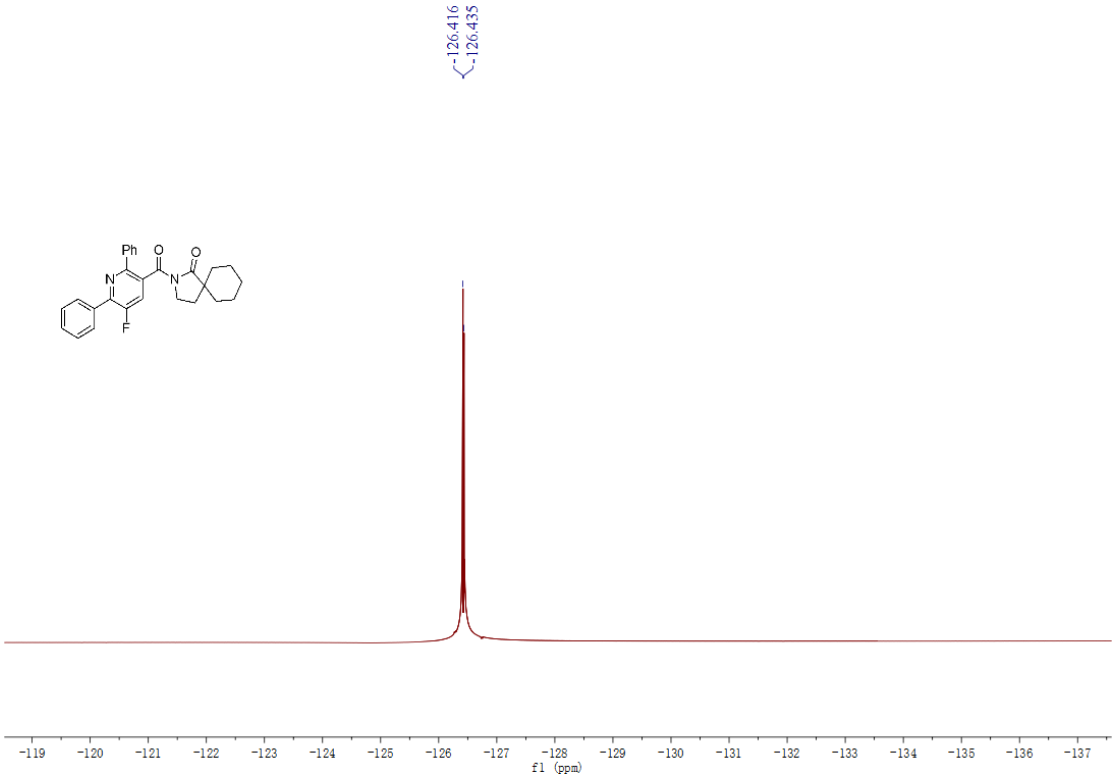
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

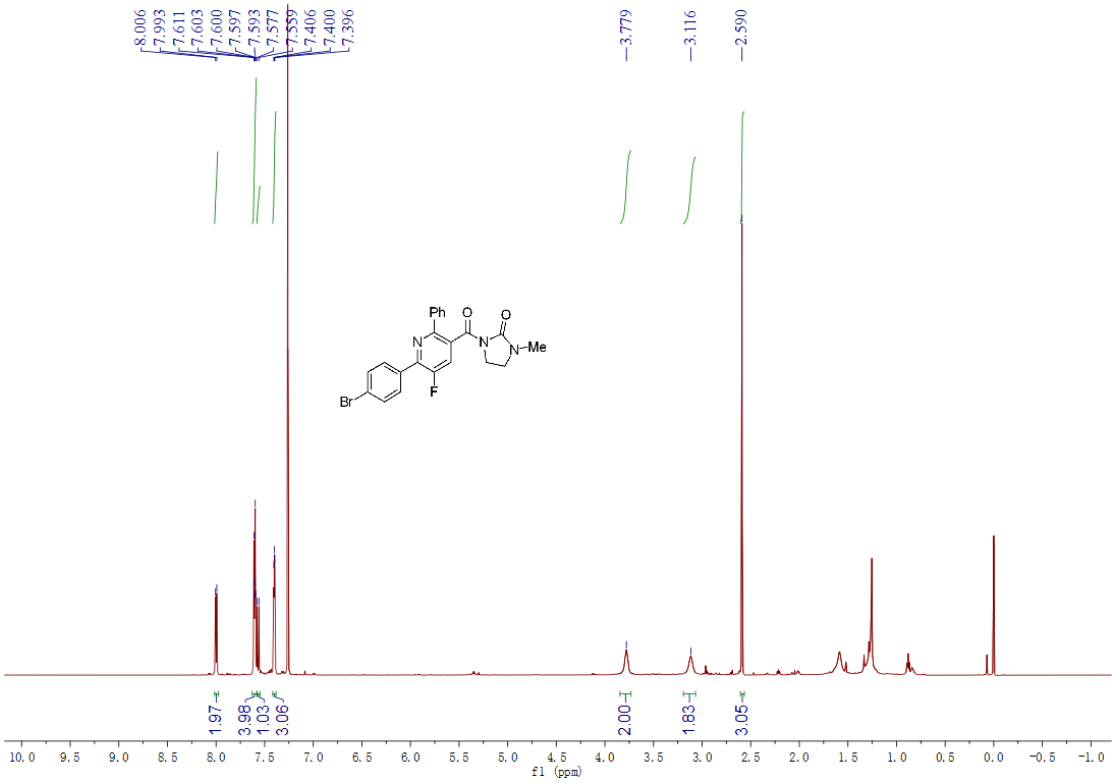


[^{19}F_NMR_565 MHz]

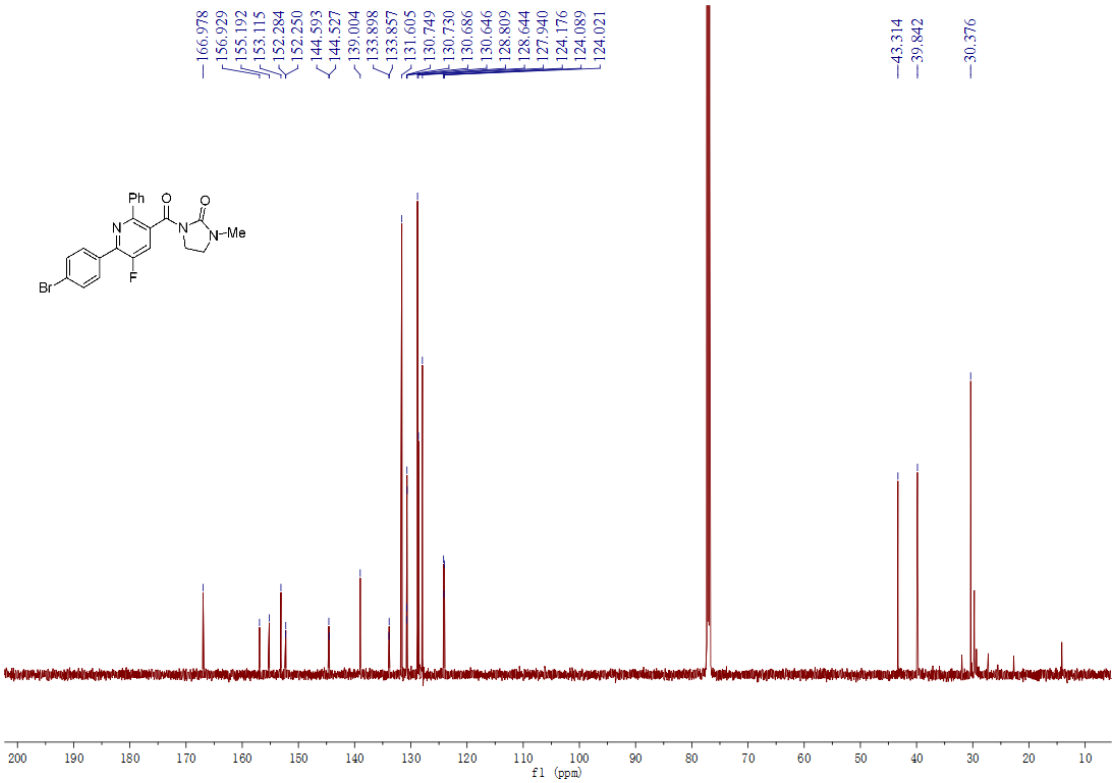


1-(6-(4-Bromophenyl)-5-fluoro-2-phenylnicotinoyl)-3-methylimidazolidin-2-one (3r)

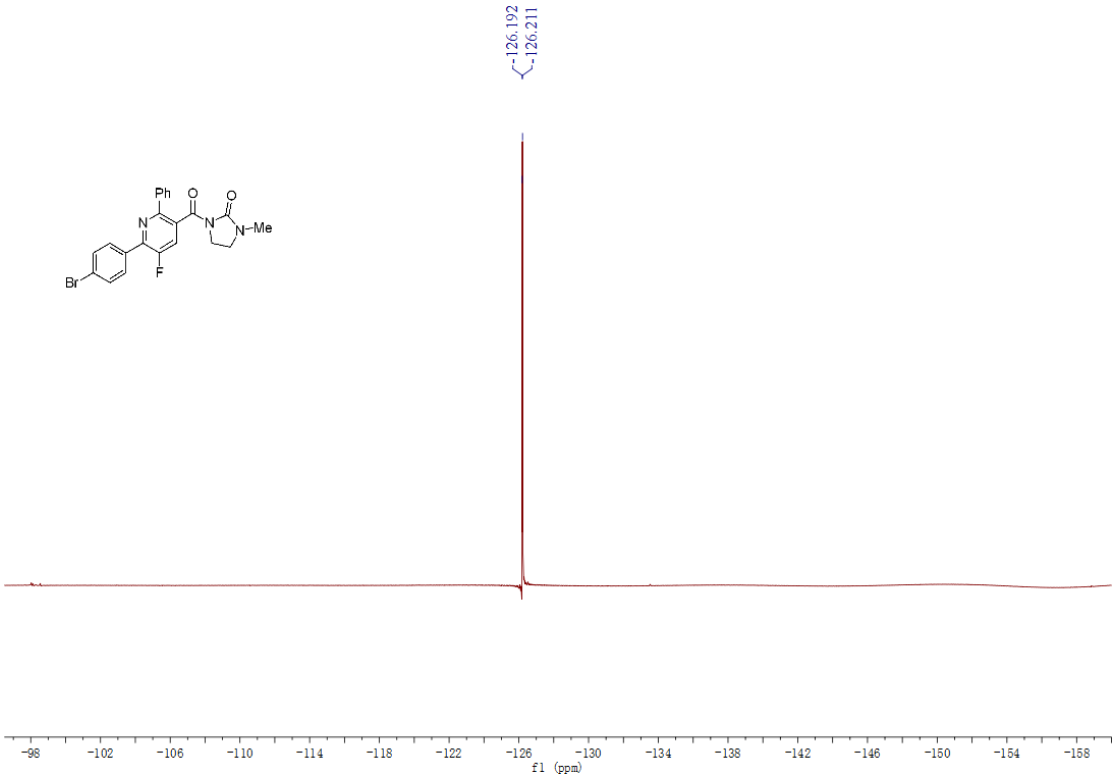
[^{1}H_NMR_600 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]

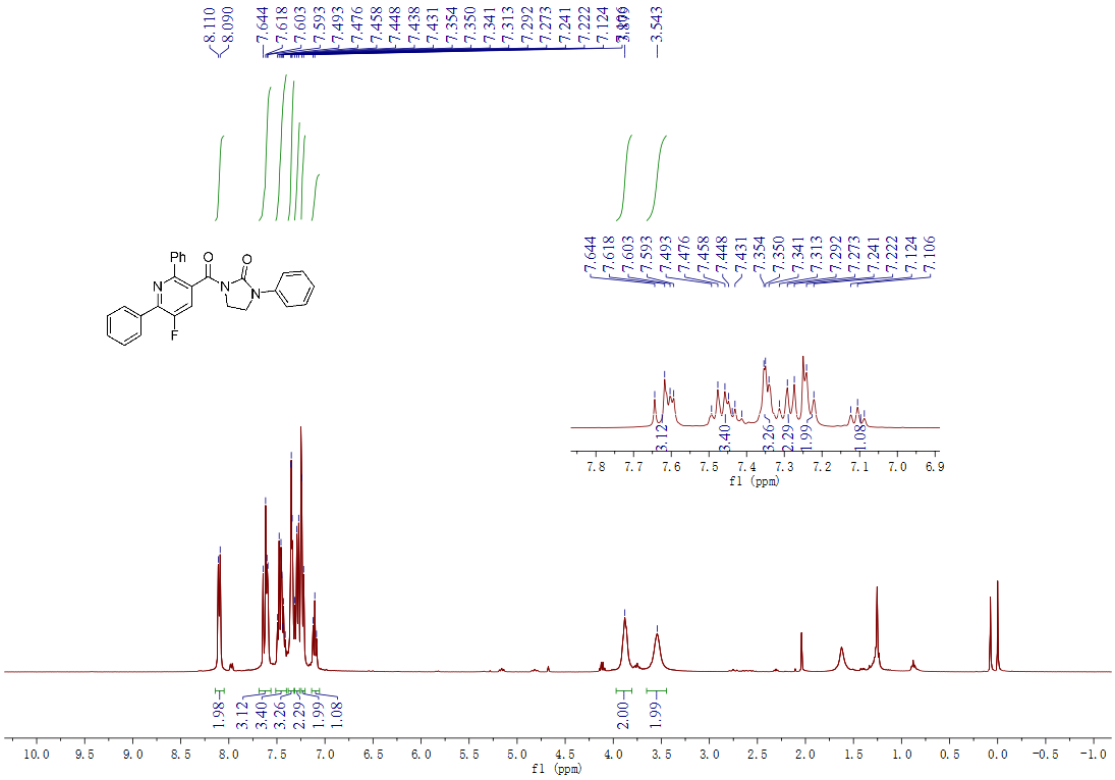


[^{19}F_NMR_565 MHz]

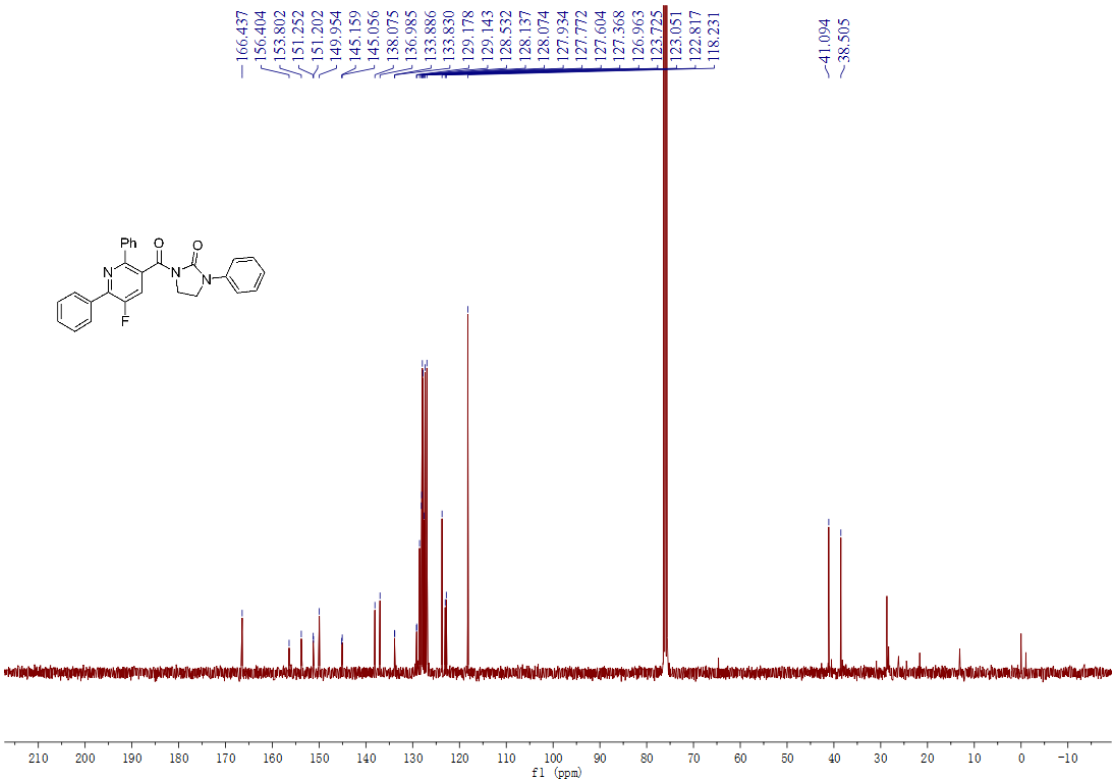


1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-phenylimidazolidin-2-one (3s)

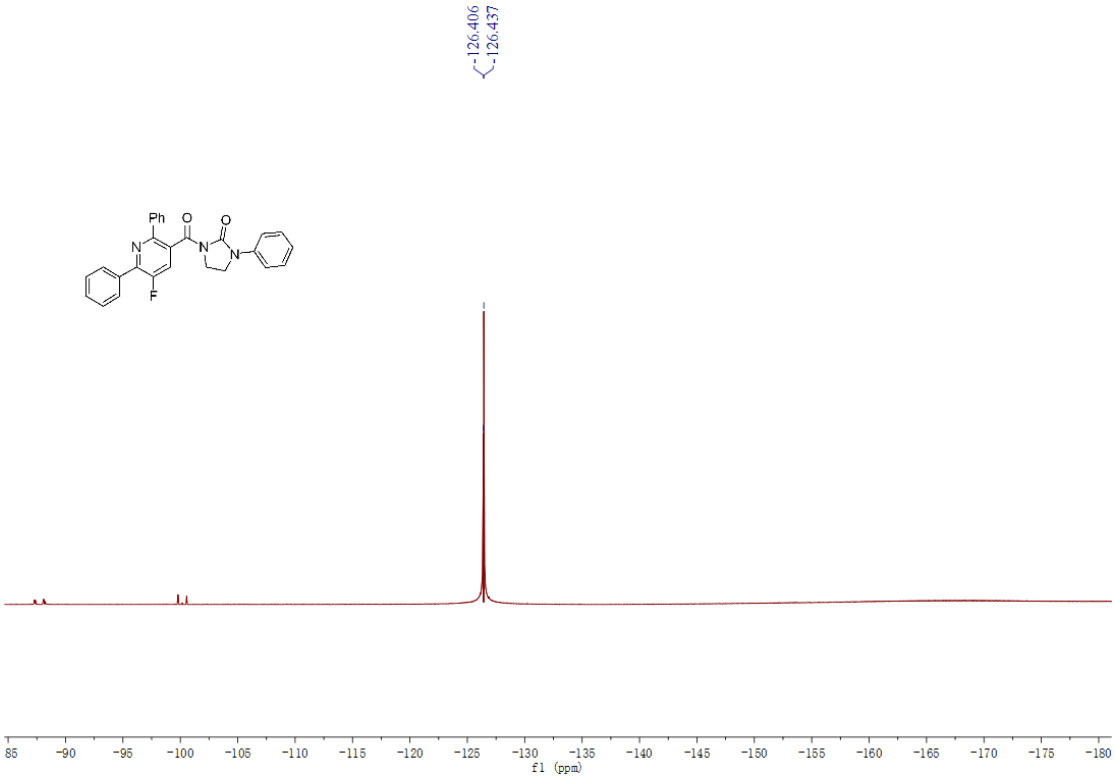
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

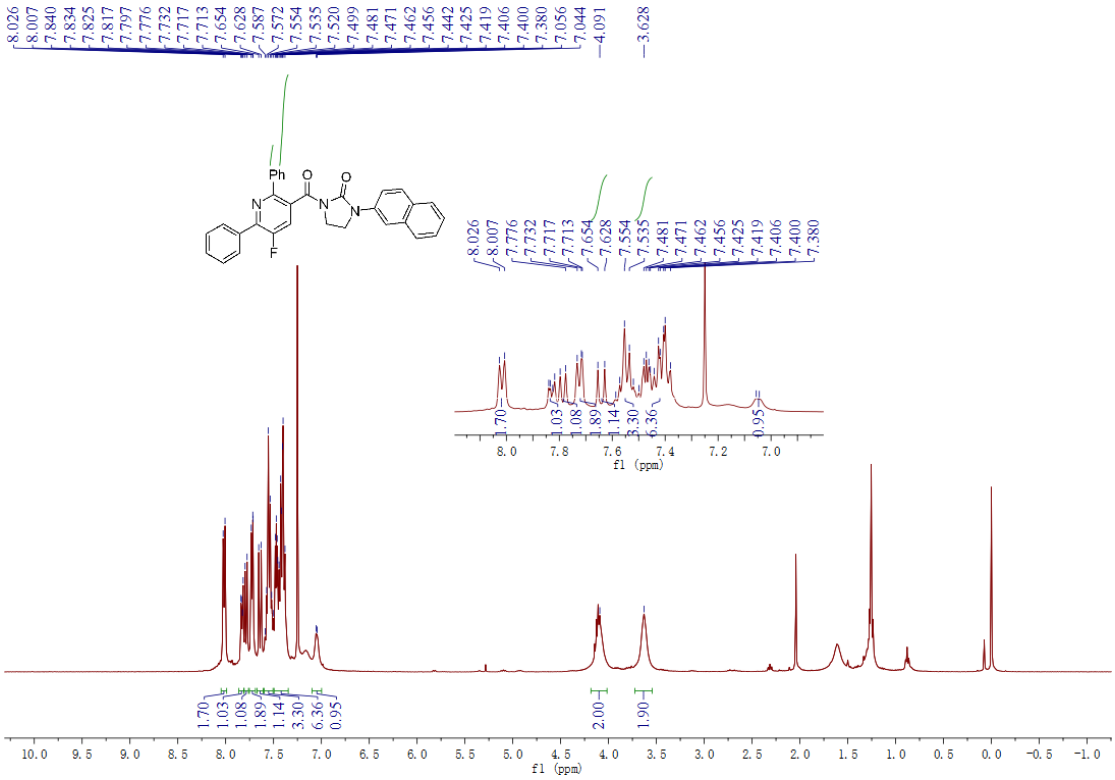


[^{19}F_NMR_375 MHz]

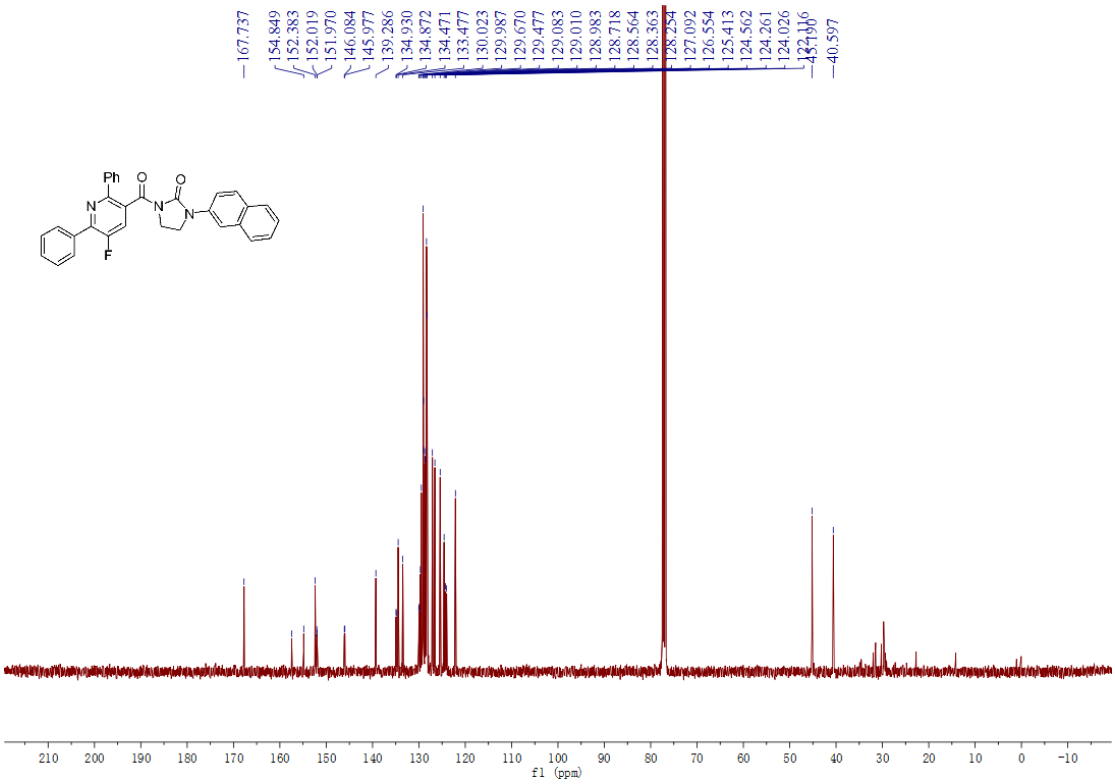


1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-(naphthalen-2-yl)imidazolidin-2-one (3t)

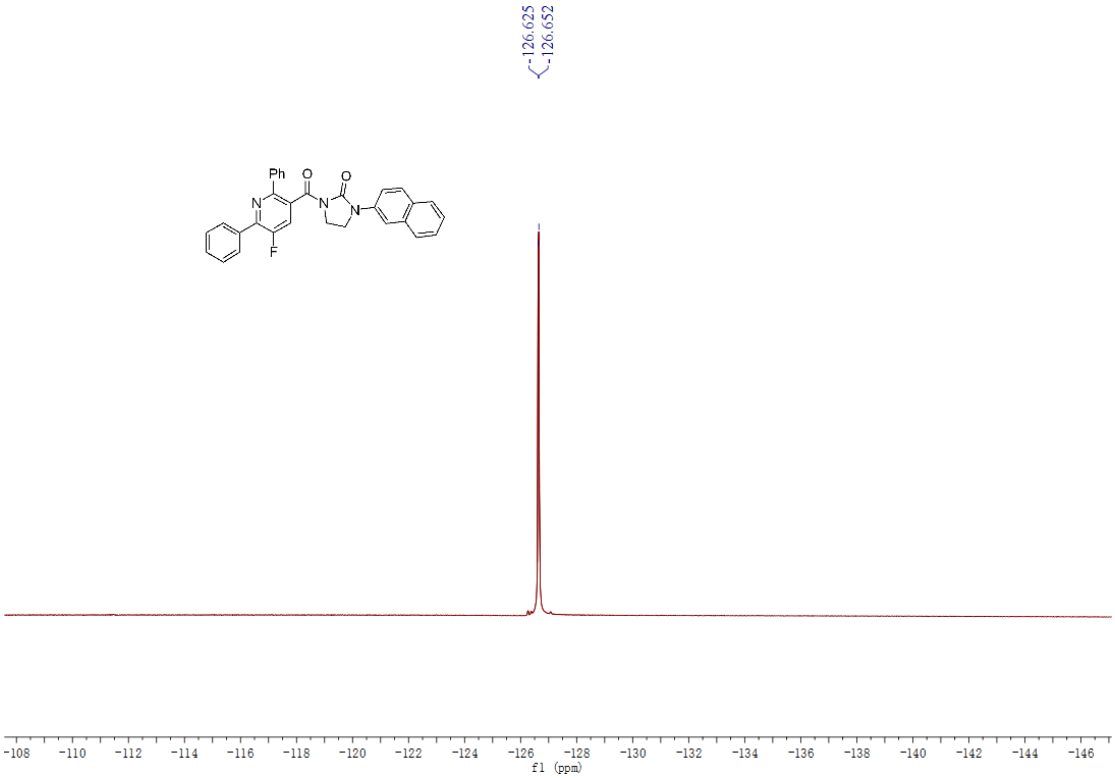
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

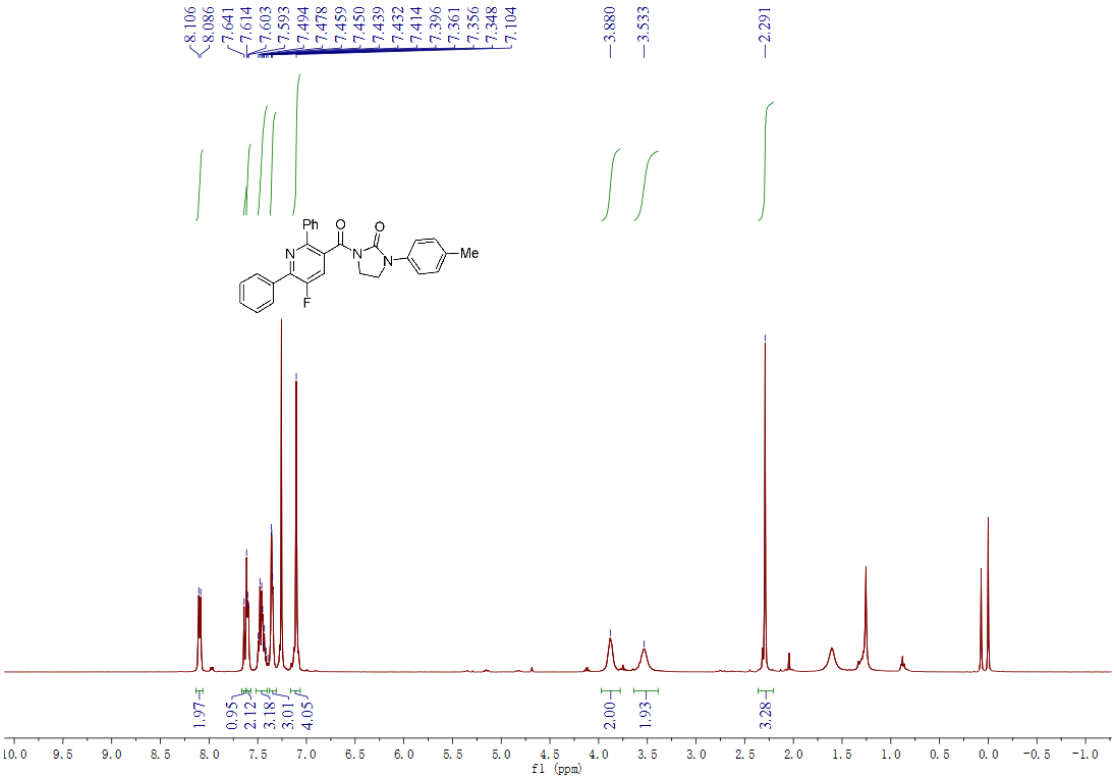


[^{19}F_NMR_375 MHz]

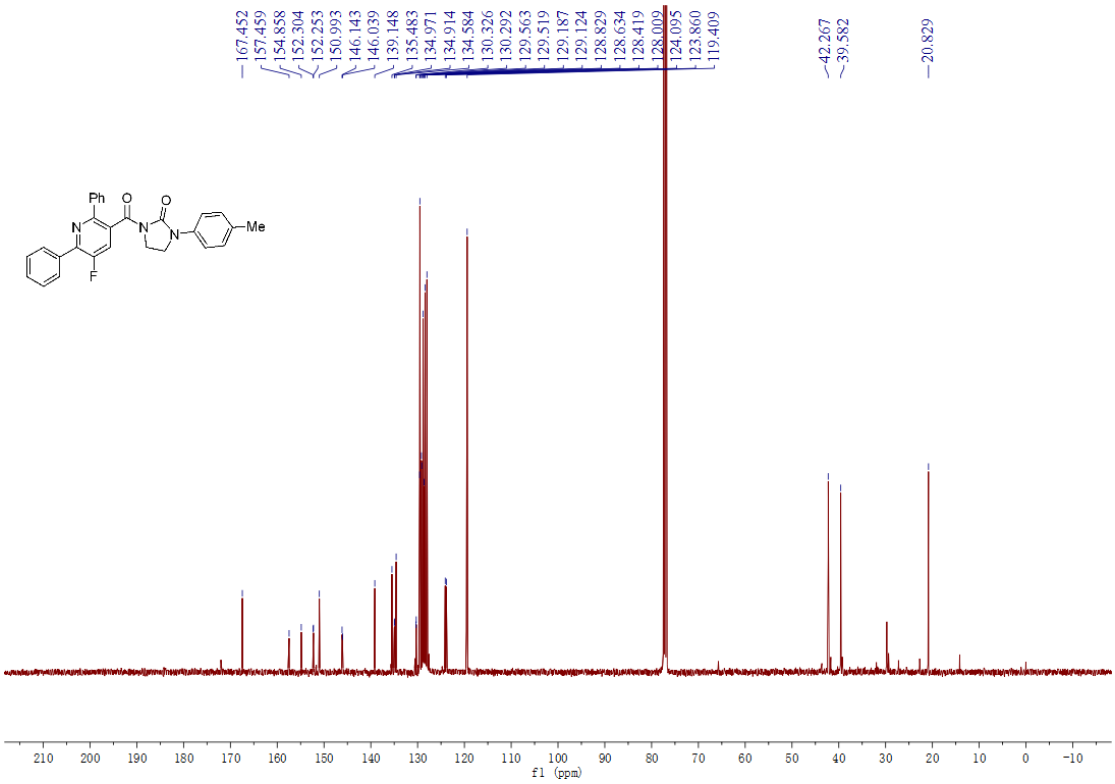


1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-(p-tolyl)imidazolidin-2-one (3u)

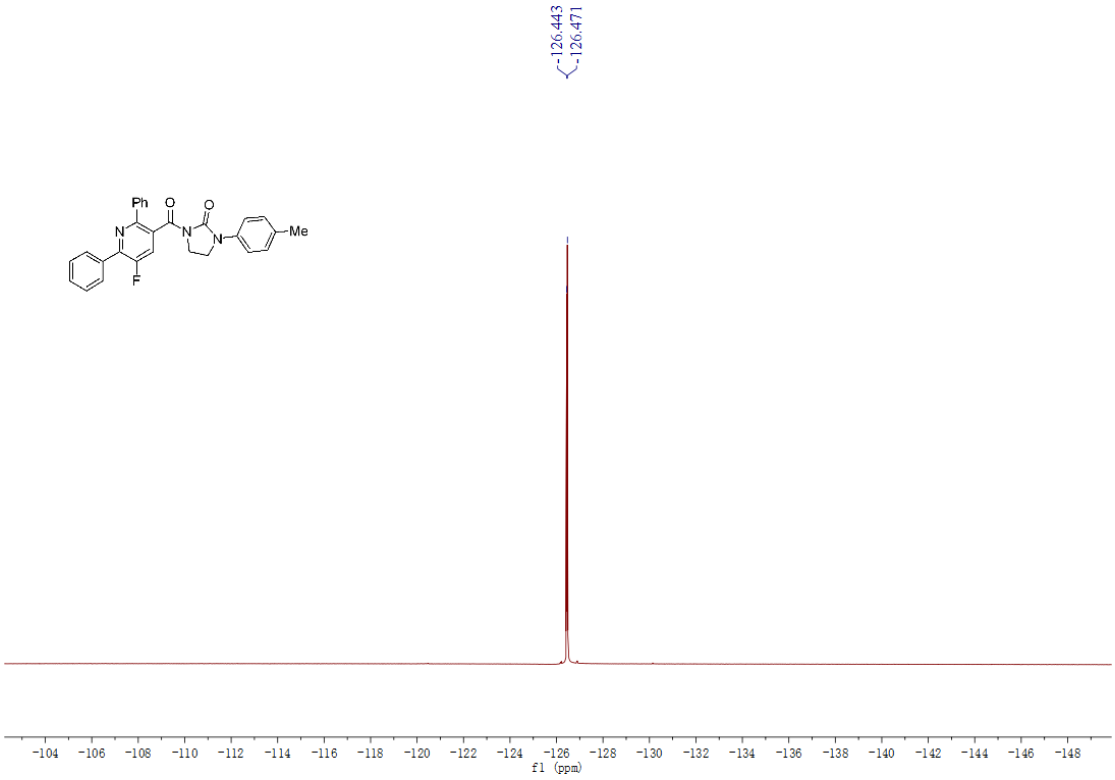
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

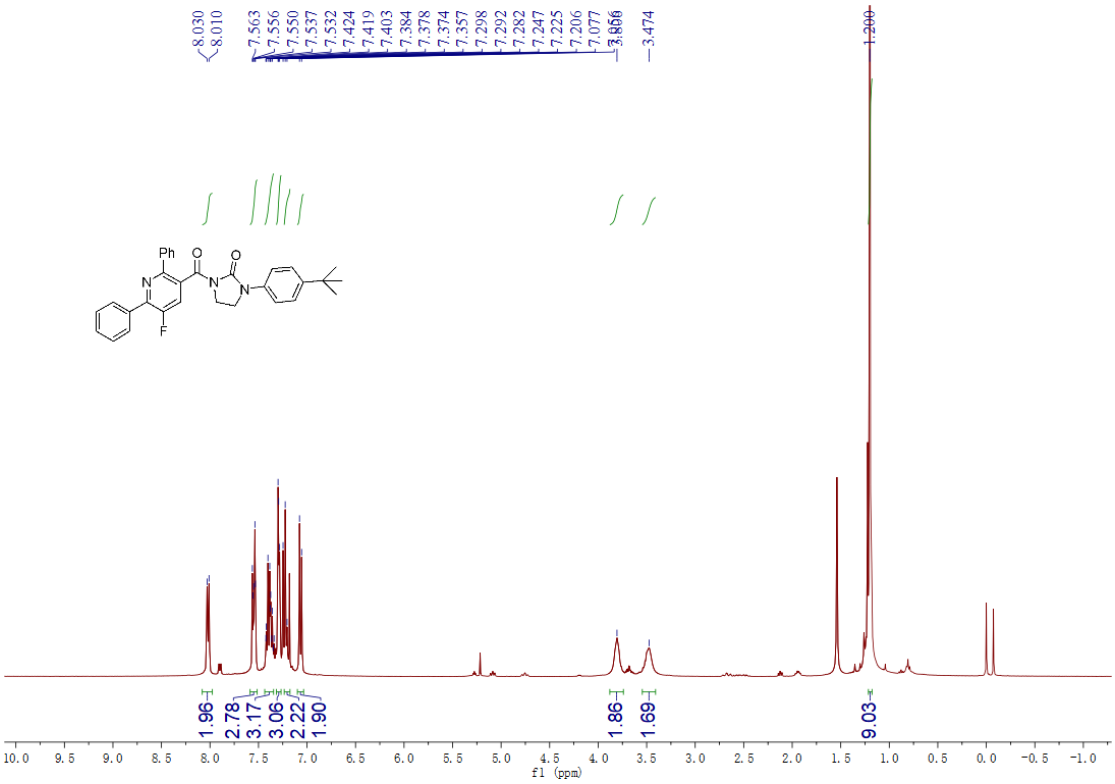


[^{19}F_NMR_375 MHz]

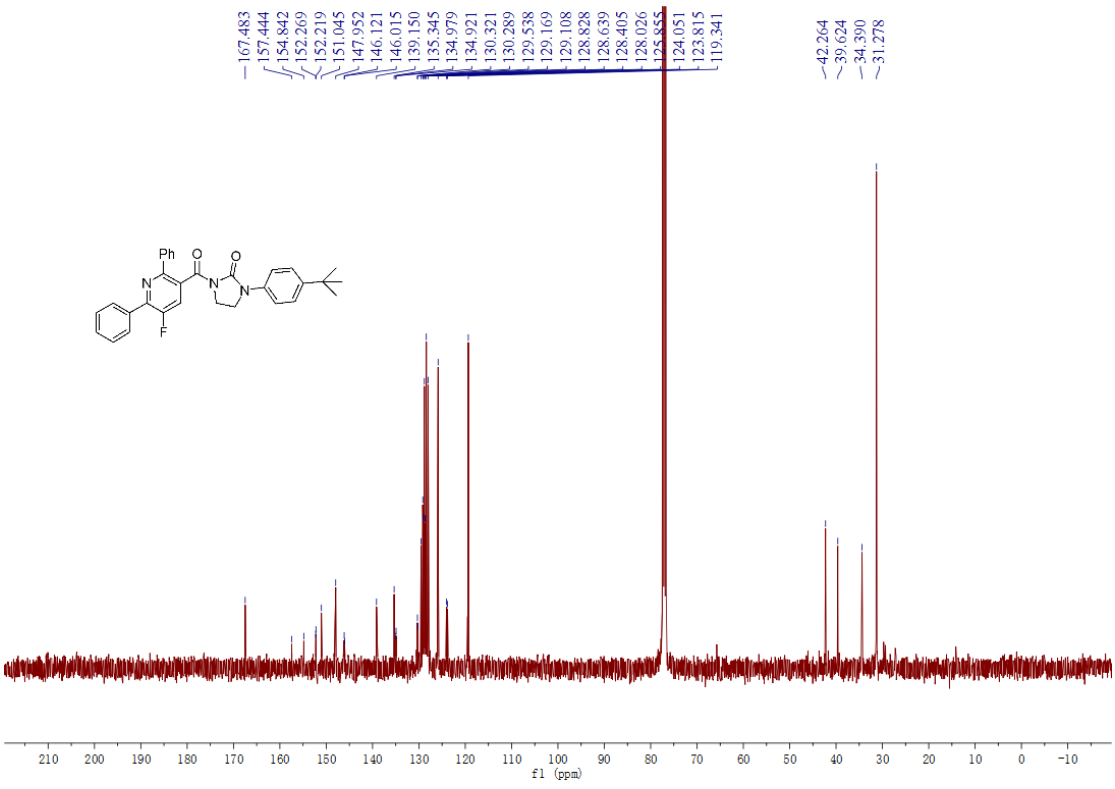


1-(4-(Tert-butyl)phenyl)-3-(5-fluoro-2,6-diphenylnicotinoyl)imidazolidin-2-one (3v)

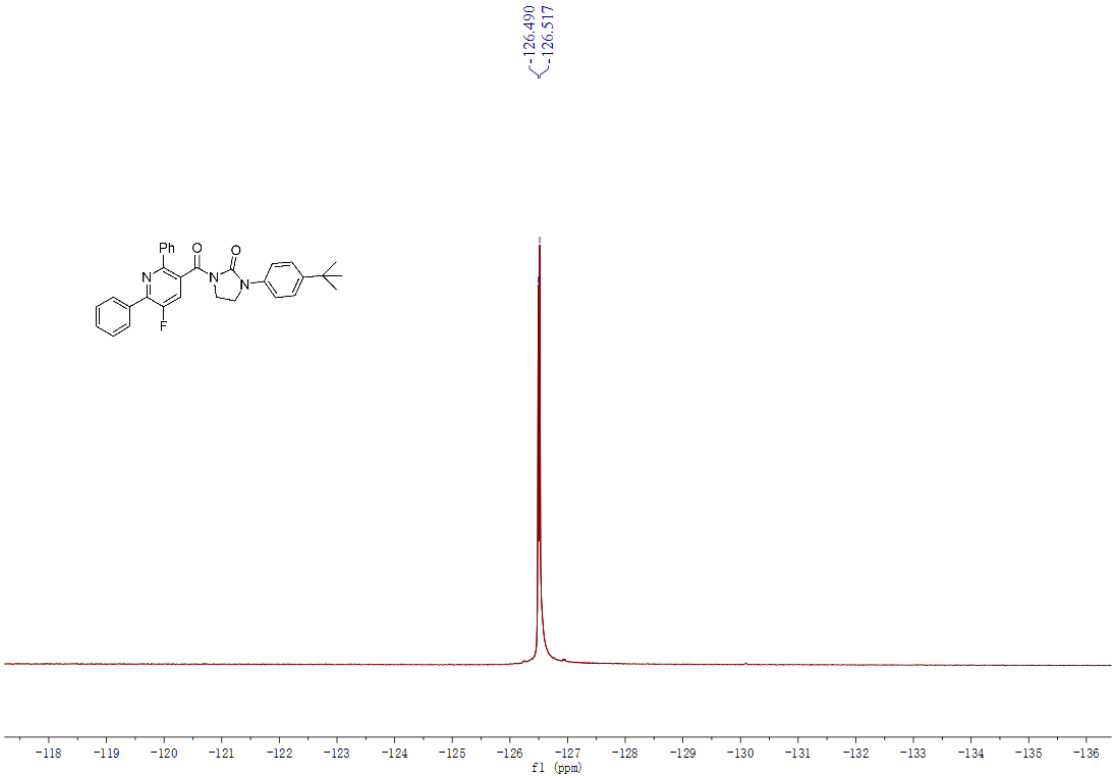
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

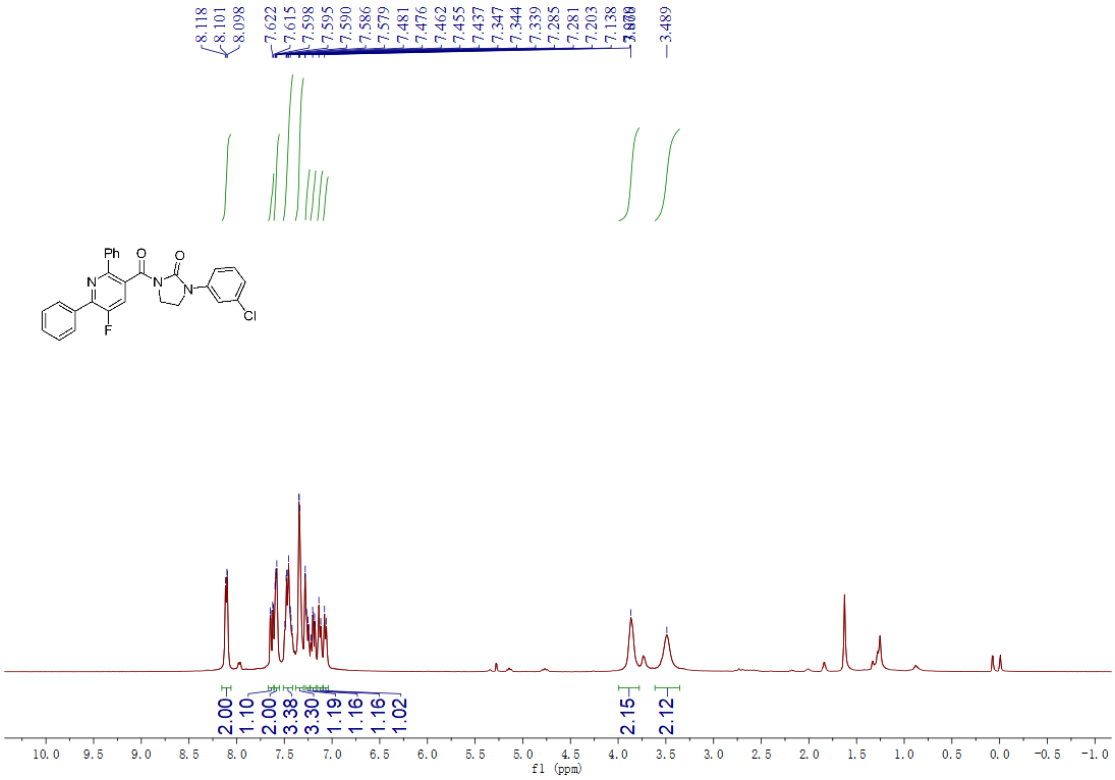


[^{19}F_NMR_375 MHz]

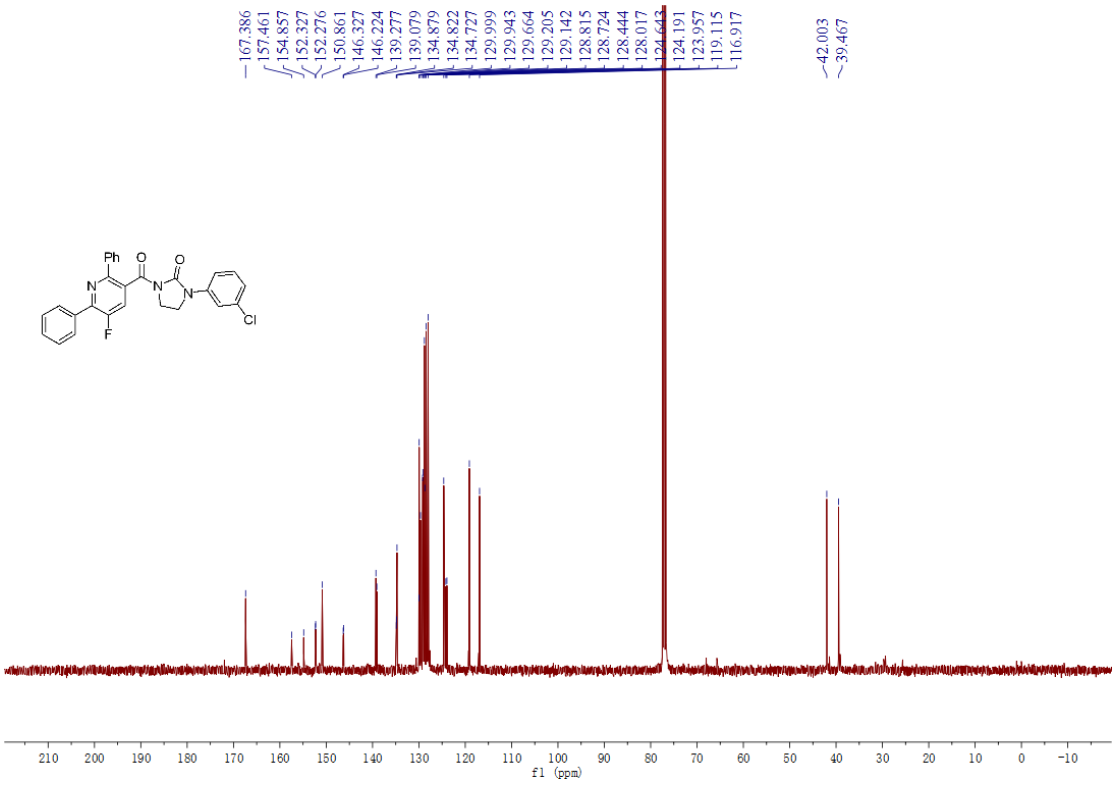


1-(3-Chlorophenyl)-3-(5-fluoro-2,6-diphenylnicotinoyl)imidazolidin-2-one (3w)

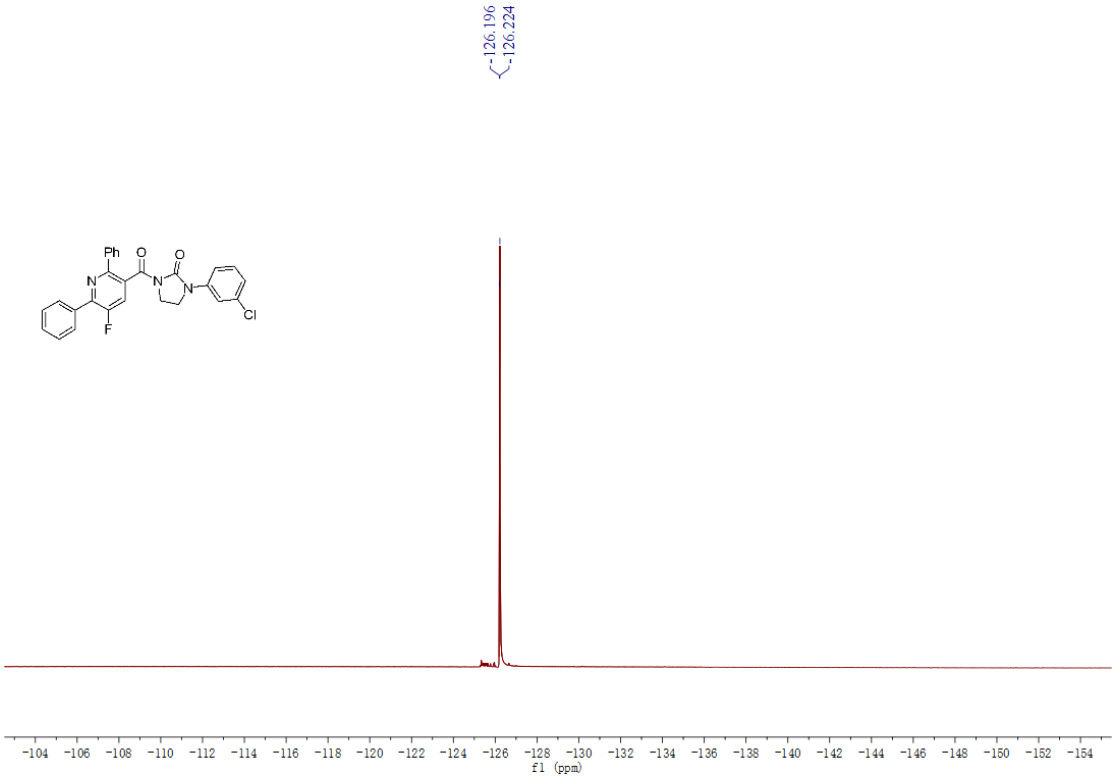
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

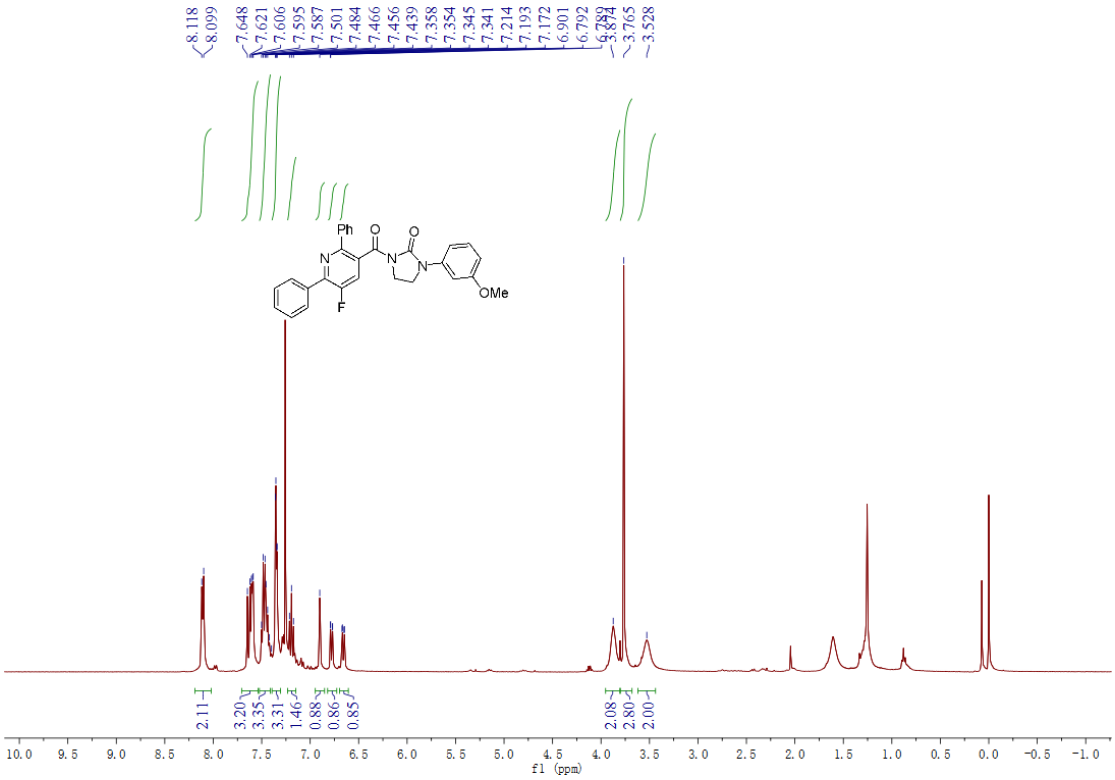


[^{19}F_NMR_375 MHz]

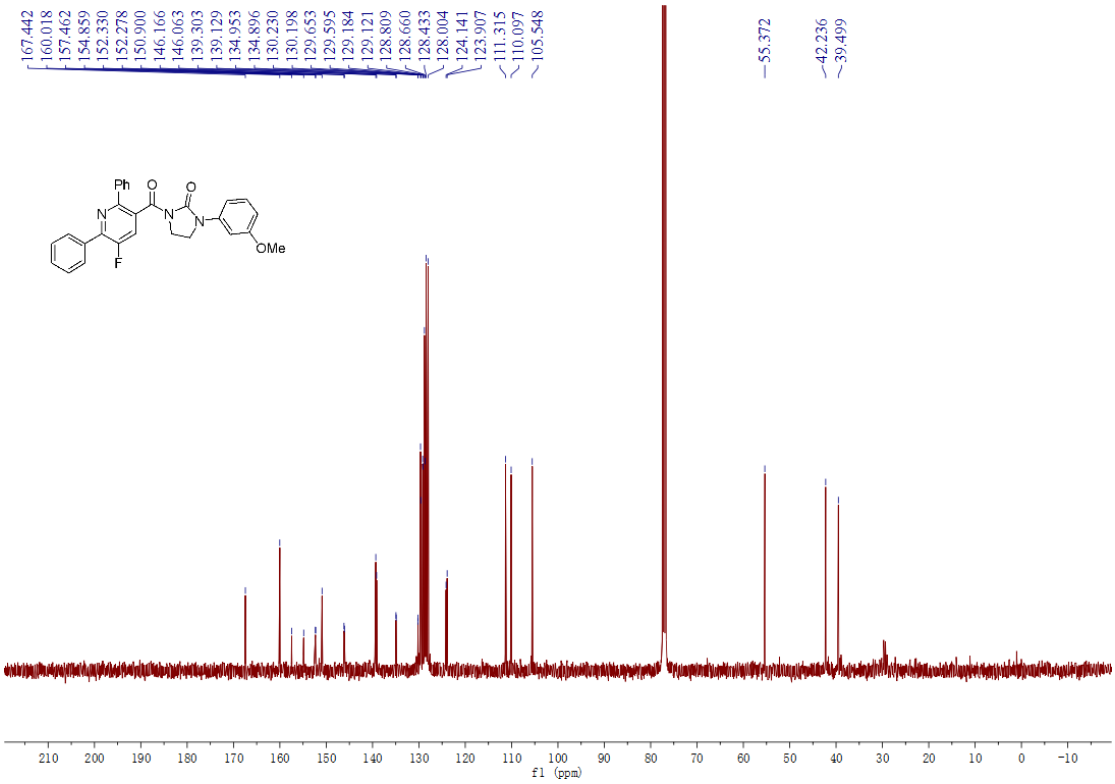


1-(5-Fluoro-2,6-diphenylnicotinoyl)-3-(3-methoxyphenyl)imidazolidin-2-one (3x)

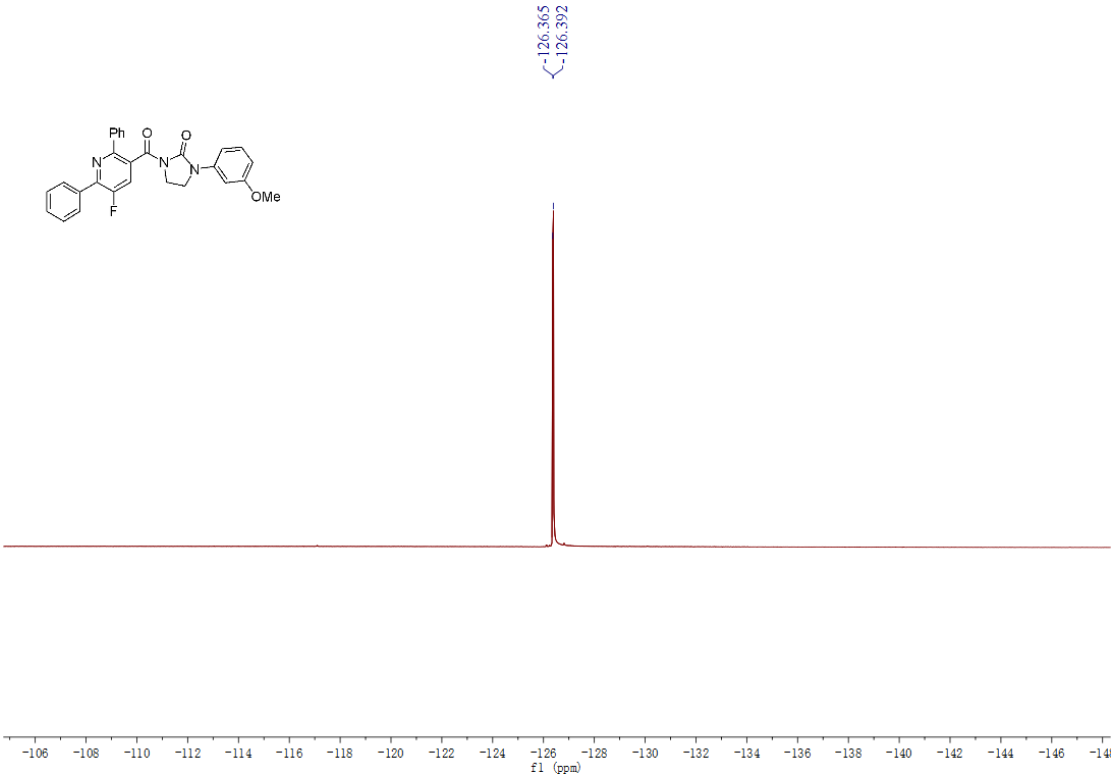
[^{1}H_NMR_400 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_100 MHz_($CDCl_3$: 77.00 ppm)]

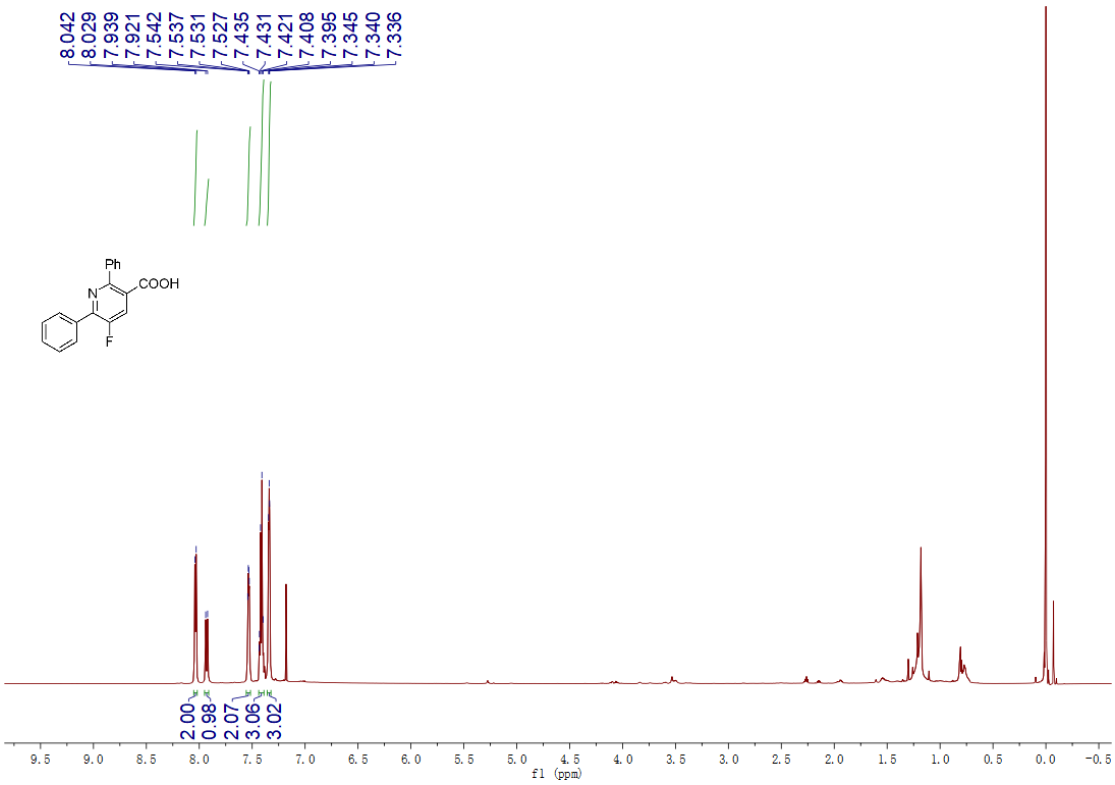


[^{19}F_NMR_375 MHz]

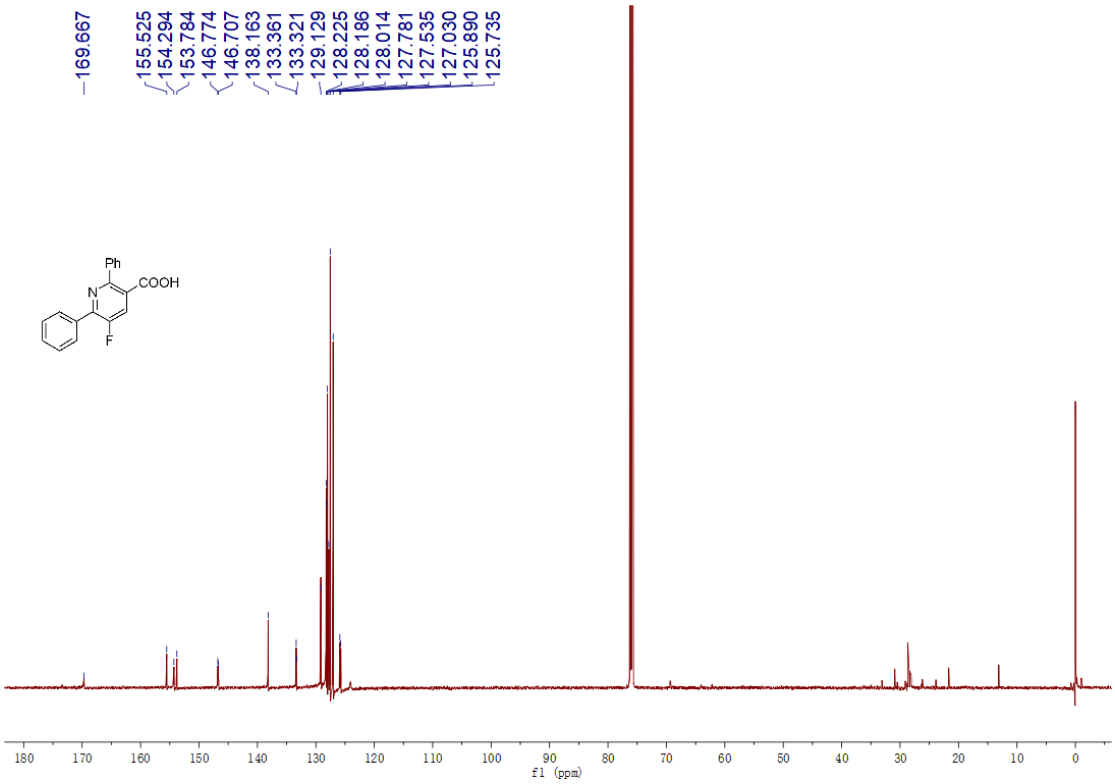


5-Fluoro-2,6-diphenylnicotinic acid (4a)

[^{1}H_NMR_600 MHz_($CDCl_3$: 7.26 ppm)]



[^{13}C_NMR_150 MHz_($CDCl_3$: 77.00 ppm)]



[^{19}F_NMR_565 MHz]