Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Silver-Promoted (Radio)fluorination of Unsaturated Carbamates via a Radical Process

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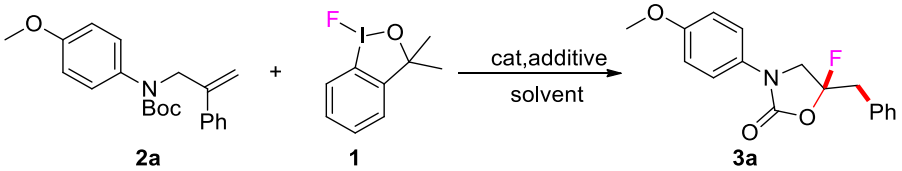
Table S1. Conditions optimizations for the fluorocylization of 2a with 1[a]

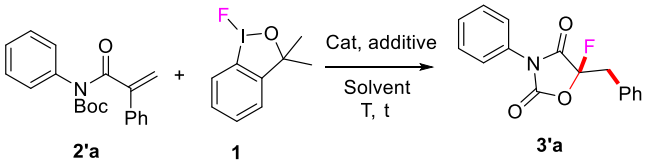


2a **1** **3a**

Entry	Catalyst (mol %)	Additive	Solvent (1 mL)	Temp. (^oC)	Time (h)	Yield[b] (%)
1	$AgBF_4$ (10)	none	DCM	35	12	42
2	$AgBF_4$ (10)	none	THF	35	12	<10
3	$AgBF_4$ (10)	none	MeCN	35	12	trace
4	$AgBF_4$ (10)	none	Dioxane	35	12	trace
5	$AgBF_4$ (10)	none	DCM	45	12	48
6	$AgBF_4$ (10)	none	DCM	55	12	84
7	$AgBF_4$ (10)	none	DCE	55	12	60
8	$AgBF_4$ (10)	none	DCE	65	12	59
9	$AgNTf_2$ (10)	none	DCM	55	12	66
10	AgOTFA (10)	none	DCM	55	12	ND[c]
11	AgOTf (10)	none	DCM	55	12	42
12	$AgNO_3$ (20)	none	DCM	55	12	<5%
13	$AgSbF_6$ (10)	none	DCM	55	12	89 (74[d])
14	AgF_2 (20)	none	DCM	55	12	<5
15	$Cu(OTf)_2$ (10)	none	DCM	55	12	27
16	$Cu(OAc)_2$ (20)	none	DCM	55	12	19
17	CuI (10)	none	DCM	55	12	trace
18	$Fe(OAc)_2$ (20)	none	DCM	55	12	trace
19	$AgSbF_6$ (10)	none	DMSO	55	12	ND
20	$AgSbF_6$ (10)	none	NMP	55	12	ND
21	$AgSbF_6$ (10)	none	TFE	55	12	ND
22	$AgSbF_6$ (10)	4Å Ms (34 mg)	DCM	55	12	ND
23	$AgSbF_6$ (10)	$MgSO_4$ (34 mg)	DCM	55	12	42
24	$AgSbF_6$ (10)	Na_2CO_3 (2.0 equiv)	DCM	55	12	ND
25	$AgSbF_6$ (10)	DABCO (0.4 equiv)	DCM	55	12	ND
26	$AgSbF_6$ (10)	H_2O (10 μL)	DCM	55	12	<10
27	**$AgSbF_6$ (10)**	**none**	**DCM**	**55**	**3.5**	**90 (79[d])**
28	$AgSbF_6$ (10)	none	DCM	55	1	79
29	$AgSbF_6$ (100)	none	DCM	55	3.5	18
30	none	none	DCM	55	3.5	ND

[a] Reaction conditions: substrate **2a** (0.1 mmol), **1** (1.5 equiv), catalyst, solvent, additive, temperature, time. [b] ^1H NMR yield with dibromomethane as internal standard. [c] ND = Not detected. [d] Isolated yield of compound **3a**.

Table S2. Conditions Optimizations for the fluorocylization of 2′a with 1[a]

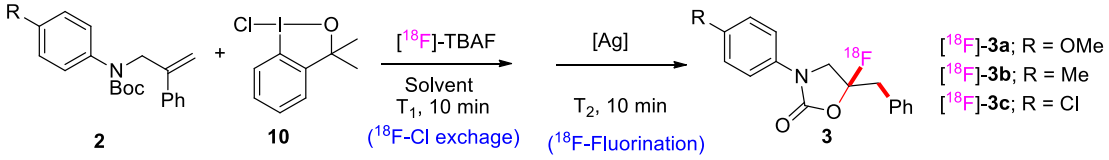


2'a **1** **3'a**

Entry	Catalyst (mol %)	Additive	Solvent (mL)	Temp. (^oC)	Time (h)	Yield[b] (%)
1	$AgSbF_6$ (10)	none	DCM (1)	60	12	21
2	$AgNO_3$ (10)	none	DCM (1)	60	12	ND[c]
3	AgOTf (10)	none	DCM (1)	60	12	ND
4	CH_3COOAg (10)	none	DCM (1)	60	12	ND
5	$AgNTf_2$ (10)	none	DCM (1)	60	12	37
6	$AgPF_6$ (10)	none	DCM (1)	60	12	27
7	$AgBF_4$ (10)	none	DCM (1)	60	12	45
8	$AgBF_4$ (10)	none	DCE (1)	60	12	43
9	$AgBF_4$ (10)	none	DCE (1)	70	12	41
10	$AgBF_4$ (20)	none	DCM (1)	60	12	45
11	$AgBF_4$ (100)	none	DCM (1)	60	12	31
12	$AgBF_4$ (10)	4Å Ms (20 mg)	DCM (1)	60	12	trace
13	$AgBF_4$ (10)	Na_2SO_4 (20 mg)	DCM (1)	60	12	28
14	$AgBF_4$ (10)	$MgSO_4$ (20 mg)	DCM (1)	60	12	43
15	$AgBF_4$ (10)	none	DCM (0.7)	60	7	45
16	$AgBF_4$ (10)	none	THF (1)	60	7	trace
17	$AgBF_4$ (10)	none	Dioxane (1)	60	7	trace
18	$AgBF_4$ (10)	none	DCM (0.5)	60	6	45
19	$AgBF_4$ (10)	none	DCM (0.3)	60	6	47
20	$AgBF_4$ (10)	none	DCM (0.1)	60	6	47
21	**$AgBF_4$ (10)**	**none**	**DCM (0.1)**	**60**	**4**	**49 (48[d])**
22	$AgBF_4$ (10)	none	DCM (0.1)	60	2	35
23	$AgBF_4$ (10)	none	DCM (0.1)	55	4	47
24	$AgBF_4$ (10)	none	DCM (0.1)	50	4	43
25	$AgBF_4$ (10)	none	DCM (0.1)	45	4	30

[a] Reaction conditions: substrate **2′a** (0.1 mmol), **1** (1.5 equiv), catalyst, solvent, additive, temperature, time. [b] ^1H NMR yield with dibromomethane as internal standard. [c] ND = Not detected. [d] Isolated yield of compound **3′a**.

Table S3. Radiosynthesis of [^{18}F]-3a, [^{18}F]-3b, and [^{18}F]-3c（Two steps）



Entry	2 (μM)	10 (equiv)	solvent	T_1 (^{o}C)	[Ag] (equiv)	T_2 (^{o}C)	RCY[a] (%)
1	**2a** (0.24)	1.0	MeCN	60	AgOTf (1.0)	60	3
2	**2a (0.24)**	**1.0**	**MeCN**	**60**	**AgOTf (1.0)**	**80**	**6±1[c]**
3	2a (0.24)	1.0	MeCN	80	AgOTf (1.0)	80	6
4	**2a** (0.24)	1.0	MeCN	60	$AgSbF_6$ (1.0)	80	6[d]
5	**2a** (0.03)	1.0	MeCN	60	AgOTf (1.0)	80	ND[b]
6	**2a** (0.24)	1.0	DMSO	60	AgOTf (1.0)	80	ND
7	**2a** (0.24)	1.0	DMF	60	AgOTf (1.0)	80	ND
8	**2a** (0.24)	1.0	MeCN	60	-	80	ND
9	**2b (0.24)**	**1.0**	**MeCN**	**60**	**AgOTf (1.0)**	**80**	**6±2**
10	**2b** (0.03)	1.0	MeCN	60	AgOTf (1.0)	80	ND
11	**2b** (0.24)	1.0	MeCN	60	$AgBF_4$ (1.0)	80	4
12	**2b** (0.24)	1.0	MeCN	60	$AgSbF_6$ (1.0)	80	7
13	**2b** (0.24)	1.0	MeCN	60	$AgSbF_6$ (0.5)	80	ND
14	**2b** (0.24)	1.0	MeCN	60	$AgSbF_6$ (0.05)	80	ND
15	**2b** (0.24)	1.0	MeCN	60	-	80	ND
16	**2c (0.24)**	**1.0**	**MeCN**	**60**	**AgOTf (1.0)**	**80**	**4±1**
17	**2c** (0.03)	1.0	MeCN	60	AgOTf (1.0)	80	ND

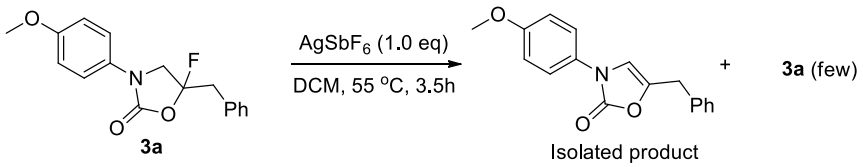
[a] Decay corrected radiochemical yield (RCY) is calculated by dividing the ^{18}F-activity of the isolated product by the decay corrected starting ^{18}F-activity. [b] ND = Not detected. [c] For 3 runs, SA = 34.2±2.1GBq/μmol. [d] SA = 29.8 GBq/μmol.

Specific activity: In order to determine the specific activity of the product after labeling, a standard solution of **3a** was used to establish a UV-HPLC mass curve. Reference compound **3a** was dissolved in MeCN at concentration of 1mg/mL. 1μL, 2μL and 4μL of this solution was then analyzed by HPLC (monitored at 212 nm). The corresponding peak area in the HPLC profile was integrated and a mass curve was acquired based on the relationship between the UV peak area and the analyzed mass of **3a** (as shown below). For example, to determine the specific activity of radiolabeled product ([^{18}F]-**3a**), 1 MBq of [^{18}F]-**3a** was reinjected to the HPLC (monitored at 212 nm). The resulting UV peak had an area of 138.3 integrated area. Using the mass curve below, the mass of [^{18}F]-**3a** was calculated to be 8.62 ng (0.0286 nmol). Based on the activity measured at dose-calibrator (1MBq), the specific activity was calculated to be 1MBq/0.0286nmol =34.9 GBq/μmol. The experiment was repeated two more times and the specific activity was determined to be 31.8 and 35.9GBq/μmol, respectively at the end of synthesis. The average specific activity was determined to be 34.2±2.1GBq/μmol at the end of synthesis.

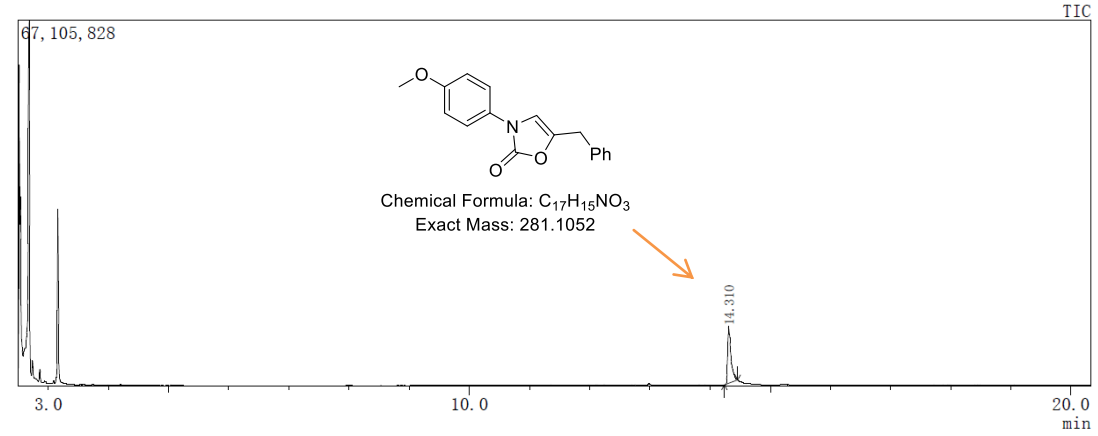

80000
60000
40000
20000
0
Integrated UV area
0
1
2
3
4
5
6
Mass/ug

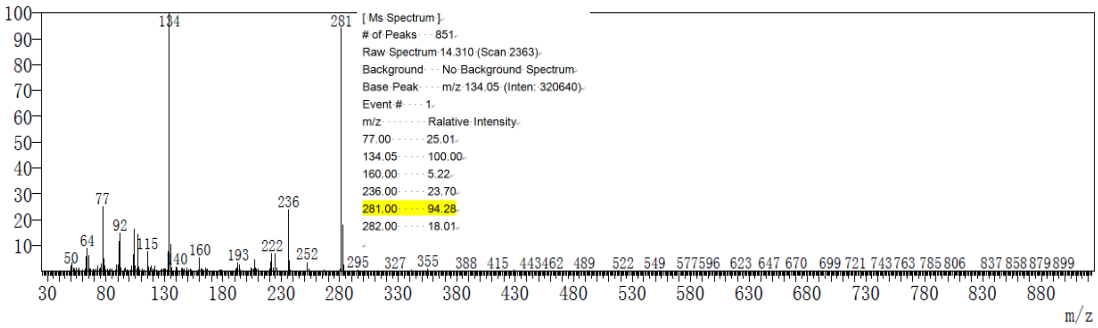
Schemes S1-3

Scheme S1

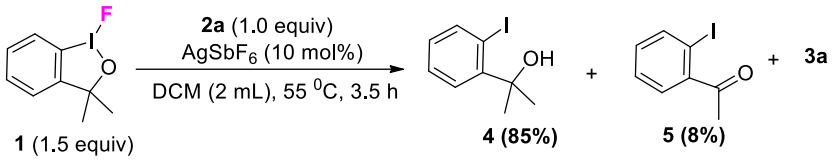


Isolated product: Mp: 45-48 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.28 (m, 7H), 6.92 (d, *J* = 8.9 Hz, 2H), 6.38 (s, 1H), 3.80 (s, 1H), 3.78 (s, 1H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.06, 153.65, 140.57, 135.30, 129.08, 128.92, 128.80, 127.38, 122.90, 114.65, 110.88, 55.68, 32.70 ppm. IR (KBr) ***v*** 3141, 2919, 2849, 1750, 1673, 1515, 1496, 1400, 1252, 1118, 1031, 978, 830, 734, 702.





Scheme S2. The side products **4** and **5** in the template reaction

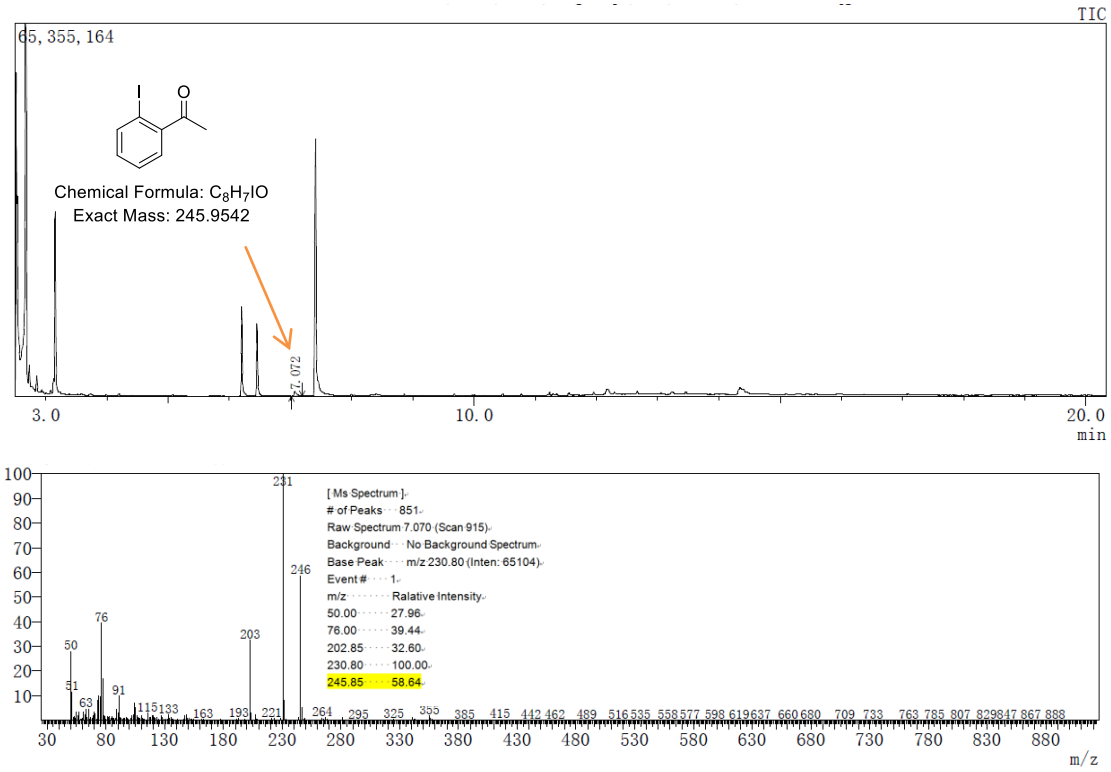


The substrate **2a** (67.8 mg, 0.20 mmol, 1.0 equiv), **1** (84 mg, 0.30 mmol, 1.5 equiv), $AgSbF_6$ (6.8 mg, 0.02 mmol, 0.1 equiv) and DCM (2 mL) were introduced to a glass vial. The vial was then sealed and the mixture was allowed to stir at 55 °C for 3.5 hours. After which, the reaction mixture was concentrated to dryness and CH_2Br_2 was added. 8% NMR yield of compound **5** was calculated by ^1H NMR spectroscopy using CH_2Br_2 as the internal standard. The mixture was purified by column chromatography (EtOAc/PE = 1/15) to afford compound **4** as a yellow oil (66.6 mg, 85% yield on the basis of the molality of compound **1**), and compound **5** with a few impurities (6 mg). The analytical data corresponds to those reported in the literature.

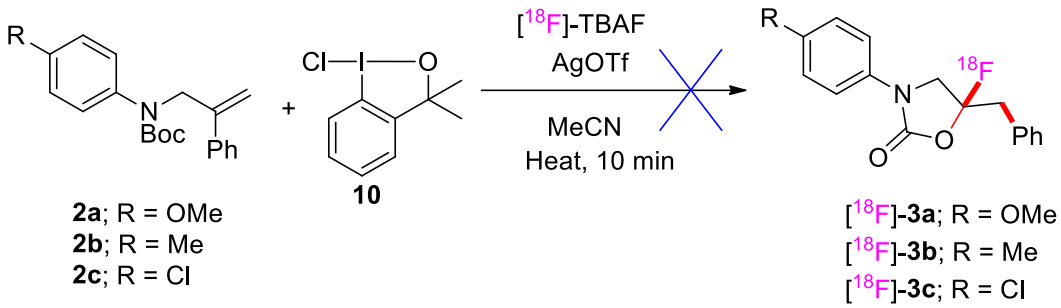
Compound 4[1] ^1H NMR (400 MHz, $CDCl_3$) δ 7.96 (dd, *J* = 7.8, 1.2 Hz, 1H), 7.62 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.32 (td, *J* = 8.0, 1.3 Hz, 1H), 6.89 (td, *J* = 7.7, 1.6 Hz, 1H), 2.62 (brs, 1H), 1.76 (s, 6H) ppm.

Compound 5[2] ^1H NMR (400 MHz, $CDCl_3$) δ 7.94 (dd, *J* = 8.0, 0.8 Hz, 1H), 7.47 (dd, *J* = 7.7, 1.8 Hz, 1H), 7.41 (td, *J* = 7.5, 1.0 Hz, 1H), 7.16 – 7.10 (m, 1H), 2.62 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 201.95, 144.12, 141.01, 131.96, 128.46, 128.20, 91.10, 29.64 ppm.

GCMS of reaction mixture



Scheme S3. One-pot radiosynthesis of [^{18}F]-**3a**, [^{18}F]-**3b**, and [^{18}F]-**3c**



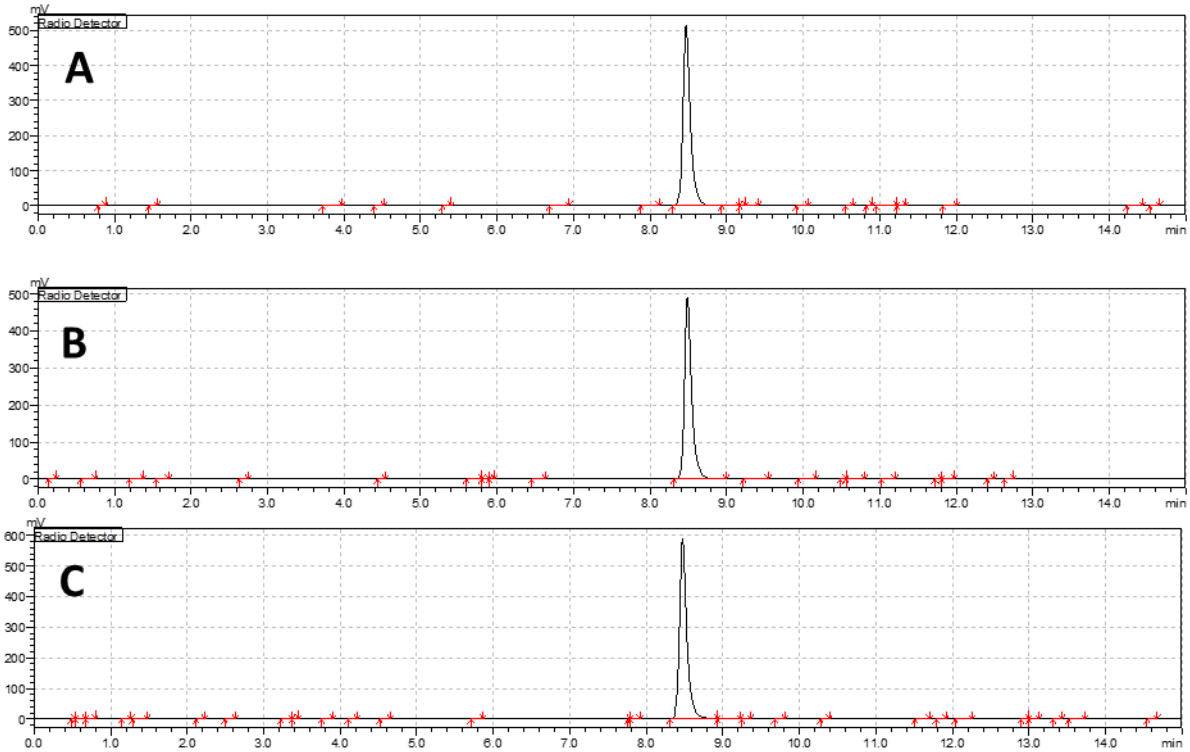
2a; R = OMe
2b; R = Me
2c; R = Cl

10

[^{18}F]-**3a**; R = OMe
[^{18}F]-**3b**; R = Me
[^{18}F]-**3c**; R = Cl

Figure S1. *In vitro* stability test

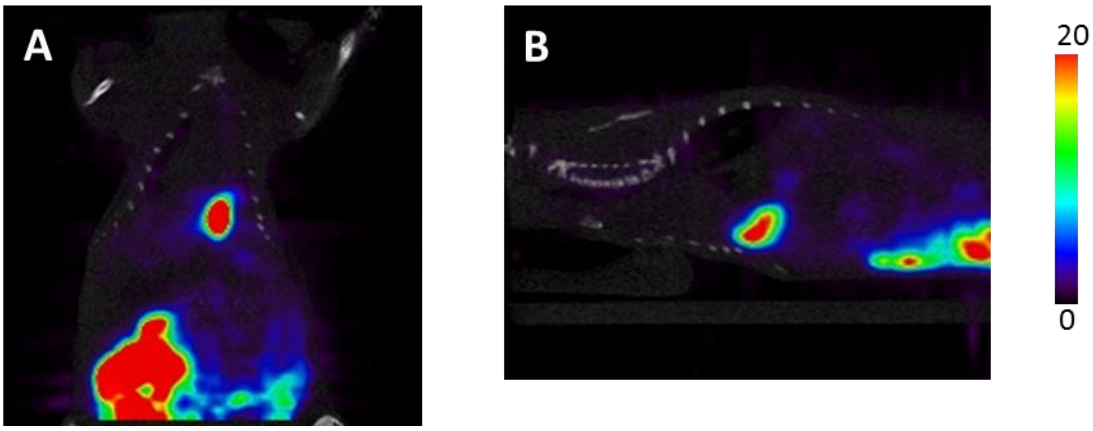
After HPLC purification, a fraction of purified [^{18}F]-**3a** was re-injected into the HPLC to confirm that only single radio peak was obtained at the starting point. Then, the probes were adjusted to pH 7 with 0.1 N NaOH. Then, 10X PBS was added to each solution to reconstruct the solution to 1X PBS. After 1 hour, 2 hours and 3 hours incubation at room temperature, a fraction of each probe (50µCi) was injected into the HPLC.



Radio-HPLC profiles of [^{18}F]-3a after incubation in phosphate buffer solution (PBS) pH=7.5 for 1 hour (A), 2 hours (B) and 3 hours (C)

Figure S2. *In vivo* PET/CT Imaging

For PET image acquiring, nude mice was injected with 0.1 mCi of [^{18}F]-**3a** in 1X PBS pH 7.5 (300 µL) via the tail vein. At post-injection time point, the mice were anesthetized using isoflurane (2% in oxygen), then placed on the imaging cradle with body temperature maintained. The static PET/CT acquisition were then achieved and reconstructed for analysis.



Decay corrected microPET/CT images of nude mice from a static scan at 1 hour post-injection (A: Coronal image, B: Sagittal image) after the injection of [^{18}F]-3a

1 General Information

Chemistry experiments：

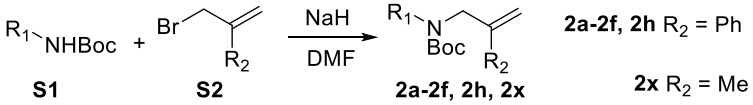
All reagents and solvents were used as received from commercial suppliers unless otherwise noted. All reactions were monitored by thin layer chromatography (TLC) with pre-coated silica gel GF254 plates and visualized by UV (wavelength 254 nm). Column chromatography was performed on silica gel (300-400 mesh). ^{1}H NMR spectra was recorded on FT AM 400 (400 MHz). Chemical shifts are given in parts per million (ppm) referenced to ^{1}H solvent peaks (δ 7.26 ppm for $CDCl_3$, δ 2.50 ppm for DMSO-d_6). The fully decoupled ^{13}C NMR was recorded on FT AM 400 (101 MHz). Chemical shifts were reported in ppm referenced to residue ^{13}C solvent peaks (77.16 ppm for $CDCl_3$, δ 39.52 ppm for DMSO-d_6). The following abbreviations were used to describe peak splitting patterns: br = broad, s = singlet, d = doublet, t = triplet, q = quartet, dd = doublet of doublet, td = triplet of doublet, ddd = doublet of doublet of doublet, m = multiplet. Coupling constants, *J*, were reported in hertz (Hz). Infrared (IR) spectra were recorded neat in KBr cell. Frequencies are given in centimeter inverse (cm^{-1}) and only selected absorbance is reported. High resolution mass spectra (ESI) were obtained by using the UHD Accurate-Mass Q-TOF. High resolution mass spectra (EI) were obtained from National Center for Organic Mass Spectrometry, Shanghai Institute of Organic Chemistry. Melting points were measured with SGW X-4 micro melting point apparatus.

Radiochemistry experiments：

All chemicals are analytical grade and used without further purification. Analytical reversed-phase high-performance liquid chromatography (HPLC) was accomplished on a SHIMADZU chromatography system (Model CBM-20A). The λ absorbance detector and the model 2200 scaler ratemeter radiation detector were added to the HPLC system. HPLC was performed on a Phenomenex, Kinetex® 5μm EVO C18 100 Å, 250 x 4.6 mm LC Column with a flow of 1 mL/min.

2 Preparation and characterization of Substrates

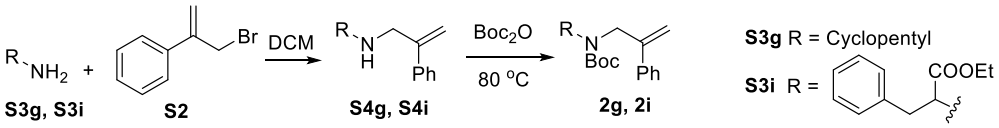
2.1 Synthesis of substrates 2a-2f, 2h, 2x[3]



The typical procedure of preparing **2a** (R_1 = 4-$OMeC_6H_4$; R_2 = C_6H_5)

To a sealing tube was added NaH (60%, 264 mg, 6.6 mmol, 1.5 equiv) and 5 mL DMF, which was filled with N_2 gas. The solution of **S1** (1 g, 4.4 mmol, 1.0 equiv) in DMF (5 mL) was charged to the system dropwise at 0 ^oC. The reaction mixture was allowed to stir at 0 ^oC for 1.5 hours. After which, **S2** (1.14 g, 5.8 mmol, 1.3 equiv) was added. The reaction mixture was allowed to stir at room temperature overnight. EtOAc (30 mL) and water (30 mL) were added to the mixture. Then, the aqueous solution was extracted by EtOAc (30 mL × 2). The combined organic phases were washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford **2a** as a colorless oil (1.35 g, 91% yield).

2.2 Synthesis of substrates 2g, 2i

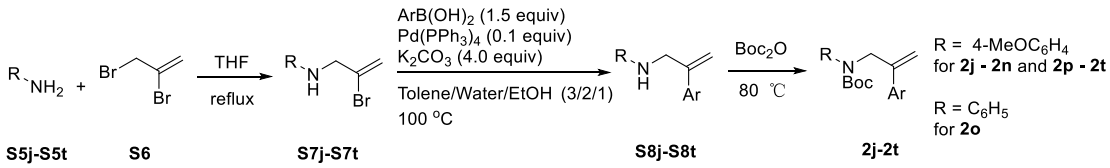


The typical procedures of preparing **2i**

The solution of **S3i** (1.1 g, 5.7 mmol, 2.0 equiv) in DCM (10 mL) was cooled to 0 ^oC. The mixture of **S2** (561 mg, 2.85 mmol, 1.0 equiv) and DCM (5 mL) was dropwise added to the system. The reaction was stirred at room temperature overnight. DCM (30 mL) and water (30 mL) were added to the mixture. Then, the aqueous solution was extracted by DCM (30 mL × 2). The combined organic phases were washed by brine, dried with Na_2SO_4, concentrated and purified by column chromatography (eluted with EtOAc/PE = 1/10) to afford **S4i** as a colorless oil (500 mg, 57% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, *J* = 7.1 Hz, 2H), 7.33 – 7.17 (m, 6H), 7.14 (d, *J* = 7.2 Hz, 2H), 5.38 (s, 1H), 5.18 (s, 1H), 4.12 (q, *J* = 7.1 Hz, 2H), 3.71 (d, *J* = 14.2 Hz, 1H), 3.57 (t, *J* = 7.0 Hz, 1H), 3.47 (d, *J* = 14.2 Hz, 1H), 3.03 – 2.85 (m, 2H), 1.18 (t, *J* = 7.1 Hz, 3H) ppm.

To a sealing tube was added **S4i** (500 mg, 1.62 mmol, 1.0 equiv) and Boc_2O (706 mg, 3.24 mmol, 2.0 equiv).The mixture was allowed to stir at 80 ^oC overnight. The mixture was purified by silica gel column directly and eluted with EtOAc/PE = 1/10 to afford product **2i** as a colorless oil (616 mg, 93% yield).

2.3 Synthesis of substrates 2j-2t



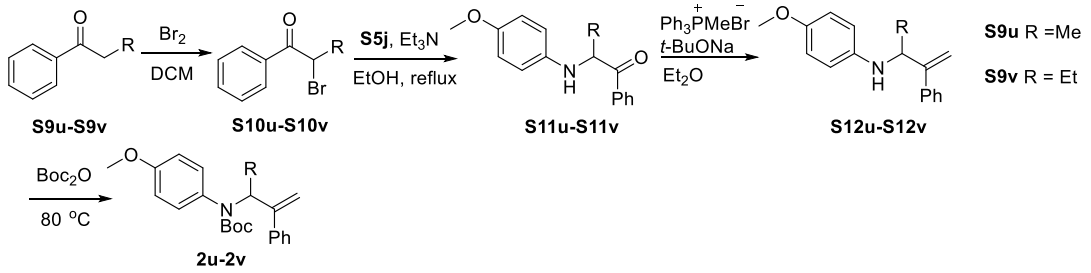
The typical procedures of preparing **2p** (R = 4-$MeOC_6H_4$; Ar = 3,5-diMeC_6H_3)

S6 (8 g, 40 mmol, 1.0 equiv) was added to a solution of **S5p** (24.6 g, 200 mmol, 5.0 equiv) in THF (100 mL). The reaction mixture was allowed to stir at 70 ^oC overnight. The mixture was cooled to room temperature, and then most of the solvent was evaporated. EtOAc (100 mL) and water (100 mL) were added to the mixture. Then, the aqueous solution was extracted by EtOAc (50 mL × 2). The combined organic phases was dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford **S7p** as a dark red oil (7.88 g, 81% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 6.84 – 6.69 (m, 2H), 6.70 – 6.51 (m, 2H), 5.85 (s, 1H), 5.55 (s, 1H), 3.95 (s, 2H), 3.75 (s, 3H) ppm.

(3,5-Dimethylphenyl)boronic acid (900 mg, 6 mmol, 1.5 equiv), $Pd(PPh_3)_4$ (462 mg, 0.4 mmol, 0.1 equiv), and K_2CO_3 (2.2 g, 16 mmol, 4.0 equiv) ware added to a Schlenk tube, which was protected with N_2 gas. **S7p** (968 mg, 4 mmol, 1.0 equiv), dissolved in solvent (tolene/water/ethanol = 3/2/1, 18 mL), was added to the tube. The mixture was allowed to stir at 100 ^oC overnight. TLC monitoring showed the complete consumption of starting material **S7p**. EtOAc (30 mL) and water (30 mL) were added to the mixture. Then, the aqueous solution was extracted by EtOAc (30 mL × 2). The combined organic phases were washed by brine, dried with Na_2SO_4, concentrated and purified by column chromatography (eluted with EtOAc/PE = 1/20) to afford **S8p** as a colorless oil (506 mg, 47% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.06 (s, 2H), 6.96 (s, 1H), 6.82 – 6.75 (m, 2H), 6.64 – 6.56 (m, 2H), 5.42 (s, 1H), 5.28 (d, *J* = 0.8 Hz, 1H), 4.09 (s, 2H), 3.75 (s, 3H), 3.64 (brs, 1H), 2.33 (s, 6H) ppm.

S8p (500 mg, 1.87 mmol, 1.0 equiv) and Boc_2O (2 g, 9.35 mmol, 5.0 equiv) was added to a sealing tube. The mixture was allowed to stir at 80 ^oC overnight. The mixture was purified by silica gel column directly and eluted with DCM/PE (2/1) to afford product **2p** as a colorless oil (365 mg, 53% yield).

2.4 Synthesis of substrate 2u-2v



The typical procedures of preparing **2u**

To a solution of **S9u** (2 g, 15 mmol, 1.0 equiv) in DCM (25 mL) was added bromine (2.4 g, 15 mmol, 1.0 equiv) dropwise at 0 ^oC. The reaction was stirred at room temperature for 30 min. Saturated $NaHCO_3$ solution was added to the reaction mixture. After being added $Na_2S_2O_3$ (1 mol/L, 2 mL), the organic phase was separated, washed by water (30 mL), brine (30 mL) respectively and dried over anhydrous Na_2SO_4. The organic phase was concentrated to afford **S10u** as a colorless oil (3 g, 94% yield). ^1H NMR (400 MHz, CDC_{l3}) δ 8.05 – 8.00 (m, 2H), 7.63 – 7.55 (m, 1H), 7.51 – 7.46 (m, 2H), 5.30 (q, *J* = 6.6 Hz, 1H), 1.91 (d, *J* = 6.6 Hz, 3H) ppm.

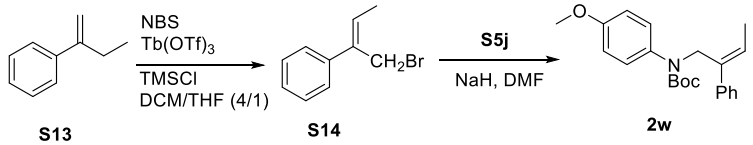
S10u (1.5 g, 7 mmol, 1.0 equiv), **S5j** (1.03 g, 8.4 mmol, 1.2 equiv) and triethylamine (1.4 g, 14 mmol, 2.0 equiv) in a round bottom flask were dissolved in ethanol (20 mL). The reaction

mixture was allowed to reflux for 4 hours, until the complete consumption of **S10u**, which was monitored by TLC. The mixture was cooled to room temperature, and then most of the solvent was removed. EtOAc (30 mL) and water (30 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (30 mL × 2). The combined organic phases were washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/10) to afford **S11u** as a colorless oil (1.69 g, 95% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.06 – 7.95 (m, 2H), 7.61 (t, *J* = 7.4 Hz, 1H), 7.50 (t, *J* = 7.6 Hz, 2H), 6.80 – 6.72 (m, 2H), 6.71 – 6.61 (m, 2H), 5.06 (q, *J* = 6.9 Hz, 1H), 3.73 (s, 3H), 1.46 (d, *J* = 6.9 Hz, 3H) ppm.

Methyltriphenylphosphonium bromide (2.14 g, 6 mmol, 1.5 equiv) and *t*-BuONa (500 mg, 5.2 mmol, 1.3 equiv) were added to a Schlenk tube, which was protected with N_2 gas and cooled to 0 ^{o}C. Then, Et_2O (15 mL) was charged to the tube. The reaction was stirred at the same temperature for 15 min, after which the color of reaction mixture turned into yellow. The solution of **S11u** (1.02 g, 4 mmol, 1.0 equiv) in Et_2O (5 mL) was added to the system. The reaction was allowed to stir at room temperature overnight. Et_2O (30 mL) and water (30 mL) were added to the mixture. The aqueous phase was extracted by Et_2O (20 mL × 2). The combined organic phases were washed by brine, dried with Na_2SO_4, concentrated and purified by column chromatography (eluted with EtOAc/PE = 1/30) to afford **S12u** as a colorless oil (385 mg, 38% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.38 (m, 2H), 7.37 – 7.27 (m, 3H), 6.81 – 6.73 (m, 2H), 6.63 – 6.54 (m, 2H), 5.30 (d, *J* = 1.0 Hz, 1H), 5.26 (d, *J* = 0.8 Hz, 1H), 4.35 (q, *J* = 6.6 Hz, 1H), 3.74 (s, 3H), 3.63 (brs, 1H), 1.33 (d, *J* = 6.6 Hz, 3H) ppm.

To a sealing tube was added **S12u** (380 mg, 1.5 mmol, 1.0 equiv) and Boc_2O (1.64 g, 7.5 mmol, 5.0 equiv). The mixture was allowed to stir at 80 ^{o}C overnight. The mixture was purified by silica gel column directly and eluted with EtOAc/PE (1/20) to afford product **2u** as a colorless oil (513 mg, 97% yield).

2.5 Synthesis of substrate 2w



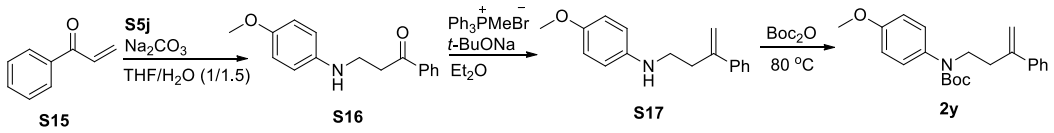
S13 **S14** **2w**

Compound **S14** was prepared according to literature procedures.[4]

To a round bottom flask was added **S13** (700 mg, 5.3 mmol, 1.0 equiv), NBS (1.13 g, 6.4 mmol, 1.2 equiv), $Yb(OTf)_3$ (81 mg, 0.13 mmol, 0.025 equiv) and solvent (DCM/THF = 4/1, 15 mL). The reaction was stirred at room temperature for 30 min. TMSCl (15 mg, 0.13 mmol, 0.025 equiv) was added and the reaction mixture was stirred for 1 hour. After water (30 mL) were added to the mixture, the aqueous solution was extracted by DCM (20 mL × 3). The organic phases were combined, washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with PE) to afford **S14** (760 mg, 90% purity, 61% yield), which participated in the next step without further purification. The analytical data corresponds to those reported in the literature.[4] ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, *J* = 7.5 Hz, 2H), 7.35 (t, *J* = 7.6 Hz, 2H), 7.29 (d, *J* = 7.2 Hz, 1H), 6.10 (q, *J* = 7.1 Hz, 1H), 4.40 (s, 2H), 1.92 (d, *J* = 7.1 Hz, 3H) ppm.

NaH (60%, 180 mg, 4.5 mmol, 1.5 equiv) and 5 mL DMF was added to a sealing tube which was filled with N_2 gas. The solution of **S5j** (669 mg, 3 mmol, 1.0 equiv) in DMF (5 mL) was added to the system dropwise at 0 ^oC. The mixture was allowed to stir at the same temperature for 1.5 hours. After which, **S14** (696 mg, 90% purity, 2.96 mmol, 1.0 equiv) was added. The mixture was allowed to stir at room temperature for 4 hours. EtOAc (30 mL) and water (30 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (15 mL × 2) again. The combined organic phases were washed by brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford **2w** as a white solid (654 mg, 62% yield).

2.6 Synthesis of substrate 2y

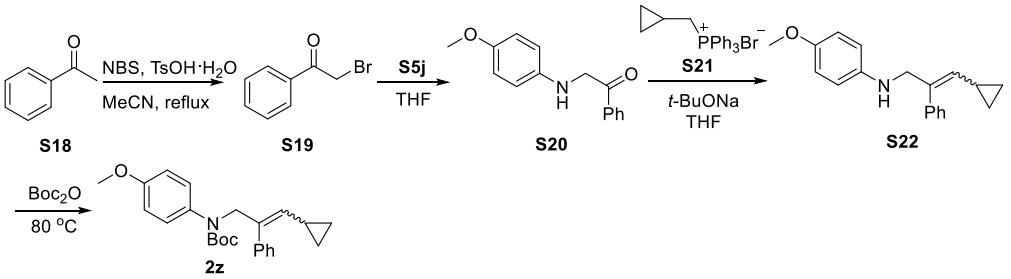


To a round bottom flask was added **S5j** (1.02 g, 8.3 mmol, 1.1 equiv), **S15** (1 g, 7.6 mmol, 1.0 equiv), Na_2CO_3 (1.6 g, 15.2 mmol, 2.0 equiv), H_2O (15 mL) and THF (10 mL). The reaction mixture was stirred at room temperature for 4 hours. Modulating the PH value to neutral by diluted hydrochloric acid (1 mol/L), EtOAc (50 mL) and water (50 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (30 mL × 2). The combined organic phases were washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/10) to afford **S16** as a white solid (920 mg, 47% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 8.03 – 7.88 (m, 2H), 7.61 – 7.54 (m, 1H), 7.49 – 7.42 (m, 2H), 6.85 – 6.72 (m, 2H), 6.67 – 6.56 (m, 2H), 3.85 (brs, 1H), 3.75 (s, 3H), 3.56 (t, *J* = 6.1 Hz, 2H), 3.27 (t, *J* = 6.1 Hz, 2H) ppm.

Methyltriphenylphosphonium bromide (3.86 g, 10.8 mmol, 3.0 equiv) and *t*-BuONa (1.04 g, 10.8mmol, 3.0 equiv) were added to a Schlenk tube, which was protected with N_2 gas and cooled to 0 ^oC. Then, Et_2O (25 mL) was introduced to the tube. The reaction was stirred at the same temperature for 30 min, after which the color of the reaction mixture turned into yellow. The solution of **S16** (0.92 g, 3.6 mmol, 1.0 equiv) in Et_2O (5 mL) was added to the system. The reaction mixture was allowed to stir at room temperature for 24 hours, until the complete consumption of **S16**, which was monitored by TLC. EtOAc (30 mL) and water (30 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (30 mL × 2) again. The combined organic phases were washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford **S17** as a colorless oil (800 mg, 88% yield), which participated in the next step directly.

To a sealing tube was added **S17** (800 mg, 3.16 mmol, 1.0 equiv) and Boc_2O (2.07 g, 9.48 mmol, 3.0 equiv).The mixture was allowed to stir at 80 ^oC for 24 hours. The mixture was purified by silica gel column directly and eluted with EtOAc/PE (1/10) to afford product **2y** as a colorless oil (990 mg, 89% yield).

2.7 Synthesis of substrate 2z



Compound **S19** was prepared according to literature procedures.[5]

To a sealing tube was added **S18** (2.4 g, 20 mmol, 1.0 equiv), NBS (4.63 g, 26 mmol, 1.3 equiv), $TsOH^{\cdot}H_2O$ (380 mg, 2 mmol, 0.1 equiv) and MeCN (30 mL).The reaction mixture was heated to reflux overnight. EtOAc (50 mL) and water (50 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (30 mL × 2) again. The combined organic phases were washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure. The crude product (3.64 g) was used without purification..

To a solution of **S5j** (4.5 g, 36.6 mmol, 2.0 equiv) in THF (80 mL) was dropwise added **S19** (3.64 g, 18.3 mmol, 1.0 equiv), which was dissolved in 20 mL THF. The reaction was stirred at room temperature until **S19** consumption completed, which was monitored by TLC. Then, after most of the solvent was removed, EtOAc (100 mL) and water (100 mL) was added to the mixture. The aqueous phase was extracted by EtOAc (50 mL × 2). The combined organic phases were washed by brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford **S20** as a yellow solid (1.14 g, 26% yield), which was used directly.

(bromomethyl)cyclopropane (2.7 g, 20 mmol, 1.0 equiv) and triphenylphosphane (5.24 g, 20 mmol, 1.0 equiv) was added to a sealing tube . The mixture was allowed to stir at 110 ^oC for 30 min. The reaction system was cooled to room temperature, and then EtOAc (30 mL) was introduced. The mixture was filtered, and the white solid was washed by EtOAc three times to afford **S21** (6.2 g, 78% yield). ^1H NMR (400 MHz, CD_3CN) δ 8.00 – 7.59 (m, 15H), 3.44 (dd, *J* = 12.0, 6.8 Hz, 2H), 1.03 – 0.88 (m, 1H), 0.62 – 0.42 (m, 2H), 0.31 – 0.15 (m, 2H) ppm.

S21 (4.3 g, 10.8 mmol, 2.3 equiv) and *t*-BuONa (0.93 g, 9.4 mmol, 2.0 equiv) were added to a Schlenk tube, which was protected with N_2 gas and cooled to 0 ^oC. Then, THF (15 mL) was added to the tube. The reaction was stirred at the same temperature for 30 min, after which the color of the reaction mixture turned into red. **S20** (1.14 g, 4.7 mmol, 1.0 equiv) dissolved in THF (10 mL) was added to the system. The reaction mixture was allowed to stir at room temperature for 24 hours. The mixture was filtered and got rid of most of the solvent. EtOAc (50 mL) and water (50 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (30 mL × 2) again. The combined organic phases were washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/20) to afford **S22** as a colorless

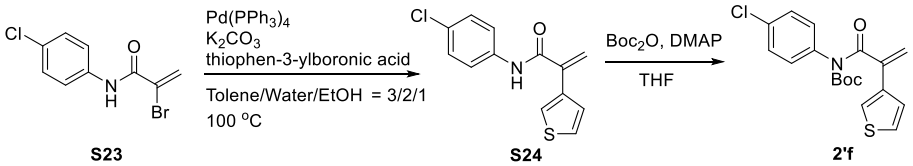
oil (945 mg, 72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.18 (m, 5H), 6.84 – 6.72 (m, 2H), 6.68 – 6.51 (m, 2H), [5.30 (d, *J* = 9.8 Hz), 5.08 (d, *J* = 10.0 Hz), (1H)], [4.20 (s), 3.93 (s), (2H)], [3.76 (s), 3.74 (s), (3H)], 1.51 – 1.39 (m, 1H), [0.92 – 0.85 (m), 0.72 – 0.62 (m), (2H)], [0.56 – 0.48 (m), 0.44 – 0.34 (m), (2H)] ppm.

To a sealing tube was added **S22** (945 mg, 3.4 mmol, 1.0 equiv) and Boc_2O (2.23 g, 10.2 mmol, 3.0 equiv).The mixture was allowed to stir at 80 ^{o}C for 24 hours.The mixture was purified by silica gel column directly and eluted with DCM/PE (1/1) to afford product **2z** as a colorless oil (1.27 g, 98% yield).

2.8 Synthesis of substrate 2′a-2′e

Compound **2′a-2′e** were synthesized according to literature procedures.[3]

2.9 Synthesis of substrate 2′f

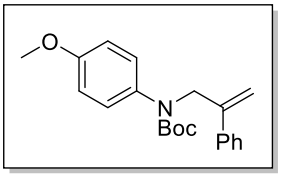


S23 (782 mg, 3 mmol, 1.0 equiv) which was prepared according to literature procedures, [3] thiophen-3-ylboronic acid (684 mg, 4.5 mmol, 1.5 equiv), $Pd(PPh_3)_4$ (347 mg, 0.3 mmol, 0.1 equiv), and K_2CO_3 (2.2 g, 16 mmol, 4.0 equiv) ware added to a Schlenk tube, which was protected with N_2 gas. The solvent (tolene/water/ethanol = 3/2/1, 18 mL) was added to the tube and the mixture was allowed to stir at 100 ^{o}C overnight. After TLC analysis showed the complete consumption of starting material **S23,** EtOAc (30 mL) and water (30 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (30 mL × 2). The combined organic phases were washed by brine, dried over Na_2SO_4, concentrated and purified by column chromatography (eluted with EtOAc/CH_2Cl_2/PE = 1/1/10) to afford **S24** as a white solid (430 mg, 54% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.46 (m, 4H), 7.41 (dd, *J* = 5.0, 3.0 Hz, 1H), 7.34 – 7.28 (m, 2H), 7.22 (dd, *J* = 5.0, 1.3 Hz, 1H), 6.14 (s, 1H), 5.79 (d, *J* = 0.5 Hz, 1H) ppm.

To a round bottom flask was added **S24** (150 mg, 0.57 mmol, 1.0 equiv), Boc_2O (186 mg, 0.85 mmol, 1.5 equiv), DMAP (7.3 mg, 0.06 mmol, 0.1 equiv) and THF (5 mL). The mixture was stirred at room temperature. TLC analysis showed the complete consumption of starting material **S24**. EtOAc (20 mL) and water (20 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (15 mL × 2). The combined organic phases were washed by brine, dried over Na_2SO_4, concentrated and purified by column chromatography (eluted with EtOAc/PE = 1/10) to afford **2′f** as a white solid (200 mg, 96% yield).

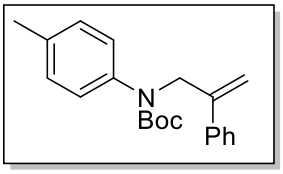
2.10 characterization of Substrates

tert-Butyl (4-methoxyphenyl)(2-phenylallyl)carbamate (2a)



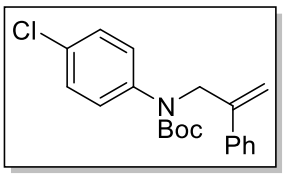
1.35 g, 91% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, *J* = 7.1 Hz, 2H), 7.36 – 7.28 (m, 3H), 6.96 (brs, 2H), 6.78 (d, *J* = 8.2 Hz, 2H), 5.34 (s, 1H), 5.11 (s, 1H), 4.68 (s, 2H), 3.77 (s, 3H), 1.41 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.44, 155.00, 144.84, 139.30, 135.17, 128.32, 127.96, 127.82, 126.63, 114.27, 113.74, 80.28, 55.42, 53.80, 28.36 ppm. IR (KBr) ***v*** 3005, 2919, 2849, 1697, 1513, 1470, 1384, 1275, 1260, 764, 750. HRMS (ESI) m/z calcd. for $C_{21}H_{25}NNaO_3^+$ (M + Na^+): 362.1727, Found: 362.1716.

tert-Butyl (2-phenylallyl)(_p_-tolyl)carbamate (2b)



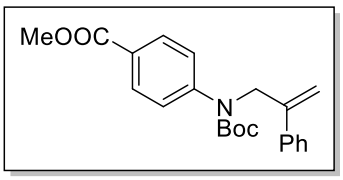
532 mg, 66% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (dd, *J* = 8.0, 1.3 Hz, 2H), 7.36 – 7.27 (m, 3H), 7.07 (d, *J* = 8.0 Hz, 2H), 6.99 (brs, 2H), 5.36 (s, 1H), 5.14 (s, 1H), 4.69 (s, 2H), 2.31 (s, 3H), 1.43 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.83, 144.84, 139.78, 139.39, 135.45, 129.15, 128.35, 127.84, 126.62, 126.32, 113.81, 80.40, 53.74, 28.39, 21.08 ppm. IR (KBr) ***v*** 2976, 2921, 2851, 1670, 1515, 1496, 1420, 1380, 1366, 1277, 1169, 823, 780, 705. HRMS (ESI) m/z calcd. for $C_{21}H_{25}NNaO_3^+$ (M + Na^+): 346.1778, Found: 346.1769.

tert-Butyl (4-chlorophenyl)(2-phenylallyl)carbamate (2c)



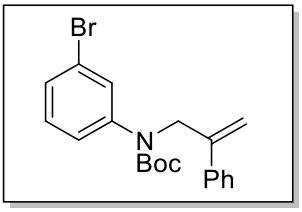
503 mg, 59% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.36 (m, 2H), 7.36 – 7.29 (m, 3H), 7.22 (d, *J* = 8.7 Hz, 2H), 7.02 (brs, 2H), 5.36 (d, *J* = 0.6 Hz, 1H), 5.10 (s, 1H), 4.70 (s, 2H), 1.43 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.38, 144.54, 140.76, 139.01, 131.20, 128.60, 128.42 , 128.00, 127.78, 126.57, 114.21, 80.91, 53.52, 28.32 ppm. IR (KBr) ***v*** 2979, 2920, 1701, 1493, 1367, 1275, 1261, 1164, 764, 750. 705. HRMS (ESI) m/z calcd. for $C_{20}H_{22}ClNNaO_2^+$ (M + Na^+): 366.1231, Found: 366.1235.

Methyl 4-((_tert_-butoxycarbonyl)(2-phenylallyl)amino)benzoate (2d)



1.12 g, 59% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (d, *J* = 8.6 Hz, 2H), 7.36 (dd, *J* = 7.8, 1.5 Hz, 2H), 7.34 – 7.26 (m, 3H), 7.21 (d, *J* = 8.4 Hz, 2H), 5.36 (s, 1H), 5.11 (s, 1H), 4.74 (s, 2H), 3.88 (s, 3H), 1.44 (s, 9H). ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.67, 153.99, 146.61, 144.40, 139.00, 129.96, 128.42, 128.02, 126.83, 126.46, 125.31, 113.69, 81.25, 53.27, 52.08, 28.26 ppm. IR (KBr) ***v*** 3005, 2988, 1717, 1606, 1435, 1368, 1276, 1261, 1163, 764, 750. HRMS (ESI) m/z calcd. for $C_{22}H_{25}NNaO_4^+$ (M + Na^+): 390.1676, Found: 390.1671.

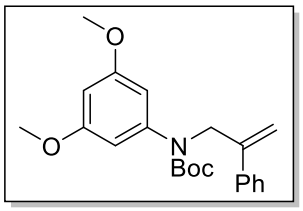
tert-Butyl (3-bromophenyl)(2-phenylallyl)carbamate (2e)



700 mg, 60% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 - 7.25 (m, 7H), 7.12 (t, *J* = 8.1 Hz, 1H), 7.08 - 6.98 (m, 1H), 5.37 (d, *J* = 0.7 Hz, 1H), 5.11 (s, 1H), 4.68 (s, 2H), 1.42 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.11, 144.42, 143.57, 138.99, 129.62, 129.44, 128.69, 128.37, 127.97, 126.49, 124.88,

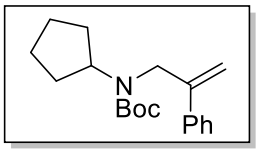
121.71, 113.95, 81.00, 53.49, 28.25 ppm. IR (KBr) ***v*** 3005, 2988, 1701, 1590, 1478, 1368, 1275, 1261, 1159, 764, 750. HRMS (ESI) m/z calcd. for $C_{20}H_{22}BrNNaO_2^+$ (M + Na^+): 410.0726, Found: 410.0725.

tert-Butyl (3,5-dimethoxyphenyl)(2-phenylallyl)carbamate (2f)



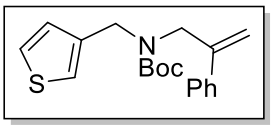
773 mg, 70% yield. White solid, Mp 67-69 ^oC. ^1H NMR (400 MHz, $CDCl_3$) δ 7.39 (d, *J* = 6.9 Hz, 2H), 7.35 – 7.27 (m, 3H), 6.27 (s, 3H), 5.36 (s, 1H), 5.14 (s, 1H), 4.67 (s, 2H), 3.70 (s, 6H), 1.43 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 160.47, 154.44, 144.82, 144.12, 139.37, 128.32, 127.84, 126.63, 113.83, 104.98, 98.23, 80.58, 55.37, 53.81, 28.38 ppm. IR (KBr) ***v*** 3005, 1698, 1594, 1457, 1367, 1275, 1260, 1155, 764, 750. HRMS (ESI) m/z calcd. for $C_{22}H_{27}NNaO_4^+$ (M + Na^+): 392.1832, Found: 392.1828.

tert-Butyl cyclopentyl(2-phenylallyl)carbamate (2g)



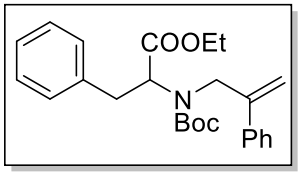
184 mg, 87% yield. Colorless oil. ^1H NMR (400 MHz, $CDCl_3$) δ 7.39 (d, *J* = 7.2 Hz, 2H), 7.36 – 7.27 (m, 3H), 5.35 (s, 1H), 5.08 (s, 1H), 4.43 (brs, 1H), 4.11 (brs, 2H), 1.81 (brs, 2H), 1.64 (brs, 2H), 1.51 (brs, 4H), 1.45 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.81, 145.67, 140.19, 128.41, 127.76, 126.33, 111.74, 79.57, 57.70, 47.68, 29.55, 28.57, 23.97 ppm. IR (KBr) ***v*** 2975, 1693, 1456, 1365, 1275, 1261, 1169, 764, 750, 704. HRMS (ESI) m/z calcd. for $C_{20}H_{29}NNaO_2^+$ (M + Na^+): 324.1934, Found: 324.1939.

tert-Butyl (2-phenylallyl)(thiophen-3-ylmethyl)carbamate (2h)



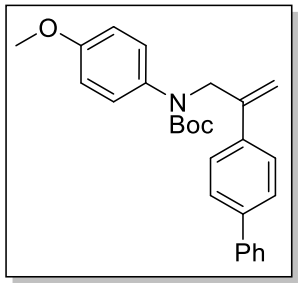
370 mg, 48% yield. Colorless oil. ^1H NMR (400 MHz, $CDCl_3$) δ 7.53 – 7.38 (m, 2H), 7.37 – 7.26 (m, 3H), 7.22 (d, *J* = 6.1 Hz, 1H), 7.01 – 6.83 (m, 2H), [5.53 (s), 5.43 (s), (1H)] , [5.20 (s), 5.15 (s), (1H)], 4.58 - 4.22 (m, 4H), 1.51 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 155.40, 155.18, 144.19, 144.11, 140.81, 139.37, 138.66, 128.42, 128.00, 126.52, 126.36, 125.29, 114.58, 113.98, 80.52, 80.32, 49.54, 48.67, 43.69, 28.51 ppm. IR (KBr) ***v*** 2977, 2922, 2851, 1694, 1632, 1455, 1410, 1366, 1275, 1261, 1167, 764, 750, 701. HRMS (ESI) m/z calcd. for $C_{19}H_{23}NNaO_2S^+$ (M + Na^+): 352.1342, Found: 352.1339.

Ethyl *N*-(*tert*-butoxycarbonyl)-*N*-(2-phenylallyl)phenylalaninate (2i)



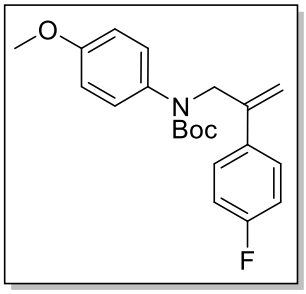
616 mg, 93% yield. Colorless oil. ^1H NMR (400 MHz, CDCl3) δ 7.42 (d, *J* = 6.5 Hz, 1H), 7.38 - 7.14 (m, 9H), [5.46 (s), 5.34 (s), (1H)], 5.06 (s, 1H), [4.58 (d, *J* = 15.7 Hz), 4.34 (d, *J* = 16.3 Hz), (1H)], 4.29 - 3.86 (m, 3H), 3.54 - 3.28 (m, 2H), [3.21 - 3.09 (m), 3.04 - 2.91 (m), (1H)], 1.46 (s, 9H), 1.11 - 0.97 (m, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 170.92, 154.62, 144.17, 143.75, 139.40, 138.49, 129.69, 129.42, 128.52, 128.46, 128.14, 127.71, 126.59, 126.32, 115.68, 114.55, 80.83, 80.37, 60.85, 60.39, 51.41, 36.66, 35.70, 28.32, 28.22, 13.82 ppm. IR (KBr) ***v*** 3005, 2983, 1739, 1680, 1496, 1455, 1367, 1275, 1260, 1164, 764, 750, 701. HRMS (ESI) m/z calcd. for $C_{25}H_{31}NNaO_4^+$ (M + Na^+): 432.2145, Found: 432.2144.

***tert*-Butyl (2-([1,1'-biphenyl]-4-yl)allyl)(4-methoxyphenyl)carbamate (2j)**



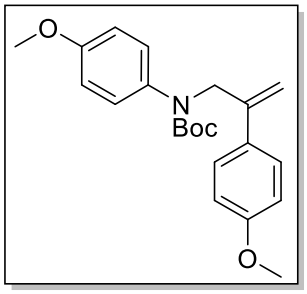
306 mg, 36% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 7.5 Hz, 2H), 7.57 (d, *J* = 7.5 Hz, 2H), 7.50 – 7.42 (m, 4H), 7.35 (t, *J* = 7.2 Hz, 1H), 6.97 (brs, 2H), 6.78 (d, *J* = 7.6 Hz, 2H), 5.40 (s, 1H), 5.13 (s, 1H), 4.71 (s, 2H), 3.78 (s, 3H), 1.41 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.53, 154.96, 144.27, 140.67, 140.54, 138.08, 135.02, 128.83, 127.96, 127.38, 126.99, 126.96, 126.93, 114.26, 113.71, 80.25, 55.33, 53.72, 28.34 ppm. IR (KBr) ***v*** 2975, 2921, 2851, 1696, 1512, 1455, 1387, 1366, 1275, 1259, 1166, 1027, 834, 764, 750, 698. HRMS (ESI) m/z calcd. for $C_{27}H_{29}NNaO_3^+$ (M + Na^+): 438.2040, Found: 438.2035.

***tert*-Butyl (2-(4-fluorophenyl)allyl)(4-methoxyphenyl)carbamate (2k)**



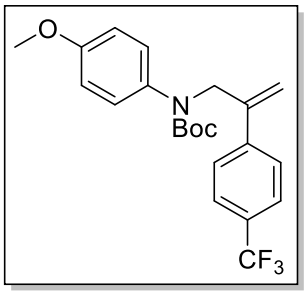
600 mg, 66% yield. White solid, Mp 58-61 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.32 (m, 2H), 7.03 – 6.82 (m, 4H), 6.77 (d, *J* = 8.4 Hz, 2H), 5.27 (s, 1H), 5.08 (s, 1H), 4.66 (s, 2H), 3.75 (s, 3H), 1.40 (s, 9H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -114.60 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.49 (d, *J* = 246.7 Hz), 157.52, 154.88, 143.82, 135.13 (d, *J* = 2.7 Hz), 134.79, 128.25 (d, *J* = 7.9 Hz), 127.92, 115.04 (d, *J* = 21.3 Hz), 114.37, 113.64, 80.25, 55.31, 53.63, 28.25 ppm. IR (KBr) ***v*** 2976, 2931, 2837, 1698, 1603, 1512, 1455, 1385, 1367, 1294, 1248, 1162, 1046, 1027, 863, 835. HRMS (ESI) m/z calcd. for $C_{21}H_{24}FNNaO_3^+$ (M + Na^+): 380.1632, Found: 380.1631.

***tert*-Butyl (4-methoxyphenyl)(2-(4-methoxyphenyl)allyl)carbamate (2l)**



620 mg, 96% yield. White solid, 92-93 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (d, *J* = 8.5 Hz, 2H), 7.19 – 6.83 (m, 4H), 6.77 (d, *J* = 8.3 Hz, 2H), 5.26 (s, 1H), 5.01 (s, 1H), 4.65 (s, 2H), 3.81 (s, 3H), 3.77 (s, 3H), 1.41 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.45, 157.57, 155.06, 144.13, 135.13, 131.74, 128.05, 128.02, 127.77, 113.74, 112.82, 80.27, 55.45, 55.39, 53.85, 28.41 ppm. IR (KBr) ***v*** 3005, 1696, 1512, 1457, 1275, 1260, 1167, 834, 764, 750. HRMS (ESI) m/z calcd. for $C_{22}H_{27}NNaO_4^+$ (M + Na^+): 392.1832, Found: 392.1831.

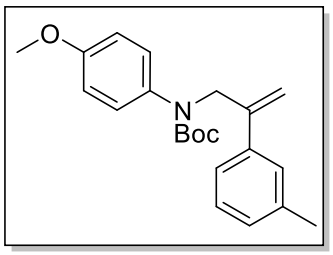
***tert*-Butyl (4-methoxyphenyl)(2-(4-(trifluoromethyl)phenyl)allyl)carbamate (2m)**



296 mg, 48% yield. White solid, Mp 51-54 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, *J* = 8.3 Hz, 2H), 7.49 (d, *J* = 8.1 Hz, 2H), 6.88 (brs, 2H), 6.77 (d, *J* = 8.4 Hz, 2H), 5.39 (s, 1H), 5.19 (s, 1H), 4.69 (s, 2H), 3.77 (s, 3H), 1.38 (s, 9H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.54 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.71, 154.97, 143.94, 142.81, 134.76, 129.86 (q, *J* = 32.4 Hz), 128.03, 127.03, 125.27 (q, *J* = 14.6 Hz), 124.30 (q, *J* = 271.9 Hz), 116.52, 113.83,

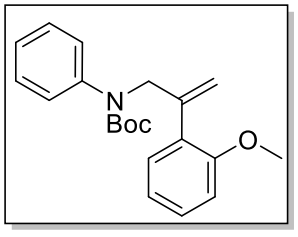
80.51, 55.43, 53.56, 28.34 ppm. IR (KBr) ***v*** 3005, 2989, 2916, 1775, 1512, 1465, 1324, 1275, 1261, 765, 750. HRMS (ESI) m/z calcd. for $C_{22}H_{24}F_3NNaO_3^+$ (M + Na^+): 430.1600, Found: 430.1603.

***tert*-Butyl (4-methoxyphenyl)(2-(*m*-tolyl)allyl)carbamate (2n)**



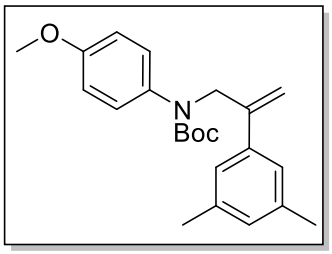
216 mg, 42% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.25 – 7.18 (m, 3H), 7.15 – 6.85 (m, 3H), 6.79 (d, *J* = 8.2 Hz, 2H), 5.35 (d, *J* = 0.7 Hz, 1H), 5.11 (s, 1H), 4.67 (s, 2H), 3.78 (s, 3H), 2.36 (s, 3H), 1.43 (s, 9H) ppm. ^{13}C NMR (101 MHz, DMSO) δ 156.87, 153.85, 144.01, 138.35, 137.21, 134.40, 128.38, 128.09, 127.71, 126.61, 123.17, 113.55, 113.40, 79.28, 55.05, 52.68, 27.81, 20.98 ppm. IR (KBr) ***v*** 2975, 2928, 1698, 1604, 1584, 1513, 1455, 1384, 1366, 1282, 1248, 1166, 1046, 1027, 834, 793, 765. HRMS (ESI) m/z calcd. for $C_{22}H_{27}NNaO_3^+$ (M + Na^+): 376.1883, Found: 376.1882.

***tert*-Butyl (2-(2-methoxyphenyl)allyl)(phenyl)carbamate (2o)**



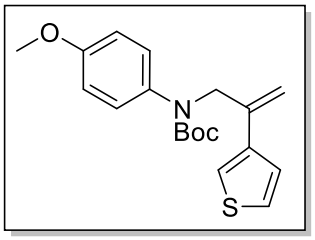
227 mg, 80% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.29 -7.21 (m, 3H), 7.21 – 7.07 (m, 4H), 6.91 (t, *J* = 7.4 Hz, 1H), 6.78 (d, *J* = 8.2 Hz, 1H), 5.25 (s, 1H), 5.14 (s, 1H), 4.64 (s, 2H), 3.63 (s, 3H), 1.42 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.86, 154.67, 145.31, 143.32, 130.65, 129.89, 129.02, 128.33, 125.99, 125.20, 120.63, 114.65, 110.44, 80.31, 55.20, 54.59, 28.37 ppm. IR (KBr) ***v*** 3002, 2977, 2931, 1702, 1598, 1491, 1456, 1379, 1275, 1260, 1170, 1021, 764, 750, 697. HRMS (ESI) m/z calcd. for $C_{21}H_{25}NaO_3^+$ (M + Na^+): 362.1727, Found: 362.1727.

***tert*-Butyl (2-(3,5-dimethylphenyl)allyl)(4-methoxyphenyl)carbamate (2p)**



365 mg, 53% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.20 – 6.86 (m, 5H), 6.80 (d, *J* = 8.1 Hz, 2H), 5.35 (s, 1H), 5.10 (s, 1H), 4.66 (s, 2H), 3.78 (s, 3H), 2.33 (s, 6H), 1.44 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.52, 155.01, 144.98, 139.29, 137.74, 135.40, 129.47, 127.94, 124.47, 113.73, 113.54, 80.23, 55.46, 54.04, 28.39, 21.43 ppm. IR (KBr) ***v*** 2975, 2927, 1698, 1600, 1513, 1455, 1386, 1366, 1294, 1247, 1165, 1046, 1027, 851, 833. HRMS (ESI) m/z calcd. for $C_{23}H_{29}NNaO_3^+$ (M + Na^+): 390.2040, Found: 390.2036.

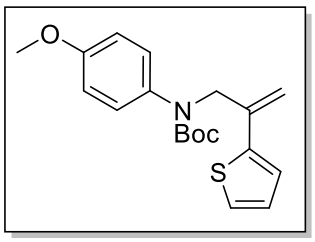
***tert*-Butyl (4-methoxyphenyl)(2-(thiophen-3-yl)allyl)carbamate (2q)**



1.23 g, 98% yield. White solid, Mp 78-81 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 (brs, 1H), 7.29 – 7.22 (m, 2H), 7.00 (brs, 2H), 6.81 (d, *J* = 8.7 Hz, 2H), 5.42 (s, 1H), 5.05 (s, 1H), 4.65 (s, 2H), 3.77 (s, 3H), 1.45 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.60, 155.09, 140.22, 139.11, 135.02, 128.00, 126.07, 125.46, 121.15, 113.75, 113.27, 80.35, 55.40, 53.82, 28.39 ppm. IR (KBr) ***v*** 3096,

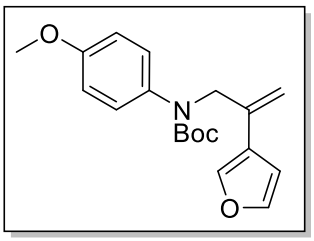
2976, 2931, 2836, 1694, 1512, 1455, 1388, 1366, 1277, 1248, 1164, 1026, 834, 764, 750. HRMS (ESI) m/z calcd. for $C_{19}H_{23}NNaO_3S^+$ (M + Na^+): 368.1291, Found: 368.1287.

***tert*-Butyl (4-methoxyphenyl)(2-(thiophen-2-yl)allyl)carbamate (2r)**



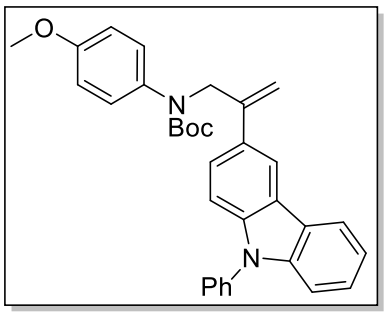
625 mg, 49% yield. White solid, Mp 50-54 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 – 6.94 (m, 5H), 6.79 (d, *J* = 8.2 Hz, 2H), 5.44 (s, 1H), 4.99 (s, 1H), 4.62 (s, 2H), 3.78 (s, 3H), 1.42 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.56, 154.90, 142.60, 137.87, 135.01, 127.79, 127.40, 124.51, 123.99, 113.75, 112.84, 80.33, 55.31, 53.64, 28.31 ppm. IR (KBr) ***v*** 3004, 2979, 2929, 1697, 1512, 1456, 1386, 1276, 1260, 1163, 1027, 833, 764, 750. HRMS (ESI) m/z calcd. for $C_{19}H_{23}NNaO_3S^+$ (M + Na^+): 368.1291, Found: 368.1289.

***tert*-Butyl (2-(furan-3-yl)allyl)(4-methoxyphenyl)carbamate (2s)**



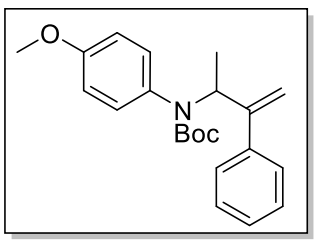
1.07 g, 94% yield. White solid, Mp 82-84 °C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (s, 1H), 7.37 (t, *J* = 1.6 Hz, 1H), 7.02 (brs, 2H), 6.79 (d, *J* = 8.8 Hz, 2H), 6.51 (d, *J* = 1.0 Hz, 1H), 5.28 (s, 1H), 4.94 (s, 1H), 4.49 (s, 2H), 3.77 (s, 3H), 1.41 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.62, 155.04, 143.18, 139.44, 135.79, 135.04, 127.97, 124.55, 113.75, 112.51, 108.34, 80.34, 55.36, 53.45, 28.35 ppm. IR (KBr) ***v*** 2976, 2932, 2837, 1694, 1642, 1513, 1456, 1390, 1367, 1283, 1248, 1163, 1025, 873, 835, 793, 765, 596. HRMS (ESI) m/z calcd. for $C_{19}H_{23}NNaO_4^+$ (M + Na^+): 352.1519, Found: 352.1518.

***tert*-Butyl (4-methoxyphenyl)(2-(9-phenyl-9H-carbazol-3-yl)allyl)carbamate (2t)**



720 mg, 94% yield. Foam. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.27 (s, 1H), 8.20 (d, *J* = 7.7 Hz, 1H), 7.66 – 7.58 (m, 4H), 7.57 – 7.38 (m, 5H), 7.36 – 7.30 (m, 1H), 7.02 (brs, 2H), 6.83 (d, *J* = 7.1 Hz, 2H), 5.49 (s, 1H), 5.20 (s, 1H), 4.89 (s, 2H), 3.79 (s, 3H), 1.48 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.51, 155.11, 145.08, 141.31, 140.63, 137.71, 135.22, 131.21, 129.95, 128.06, 127.53, 127.04, 126.09, 124.92, 123.57, 123.39, 120.43, 120.12, 118.34, 113.69, 113.02, 109.92, 109.56, 80.19, 55.36, 54.17, 28.41 ppm. IR (KBr) ***v*** 3006, 2988, 2927, 1696, 1598, 1511, 1457, 1365, 1275, 1260, 1165, 1026, 834, 764, 750. HRMS (ESI) m/z calcd. for $C_{33}H_{32}N_2NaO_3^+$ (M + Na^+): 527.2305, Found: 527.2302.

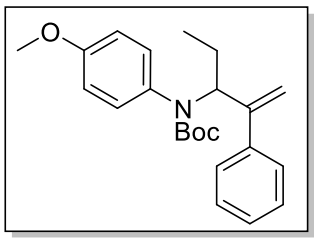
***tert*-Butyl (4-methoxyphenyl)(3-phenylbut-3-en-2-yl)carbamate (2u)**



513 mg, 97% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 (d, *J* = 7.3 Hz, 2H), 7.39 – 7.27 (m, 3H), 6.70 (brs, 4H), 5.68 (brs, 1H), 5.31 (s, 1H), 4.97 (d, *J* = 1.1 Hz, 1H), 3.77 (s, 3H), 1.42 (d, *J* = 6.9 Hz, 3H), 1.32 (brs, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.15, 155.32, 149.02, 140.67, 131.82, 130.56, 128.29, 127.67, 126.92, 114.74, 113.24, 79.86, 55.32, 53.04,

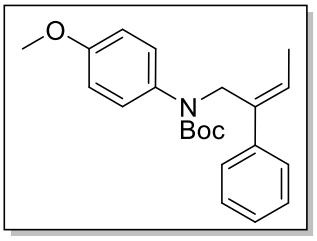
28.36, 18.01 ppm. IR (KBr) ***v*** 3051, 3002, 2977, 2934, 2836, 1689, 1512, 1456, 1386, 1367, 1322, 1247, 1167, 1076, 1048, 1032, 837, 764, 750, 697. HRMS (ESI) m/z calcd. for $C_{22}H_{27}NNaO_3^+$ (M + Na^+): 376.1883, Found: 376.1883.

tert-Butyl (4-methoxyphenyl)(2-phenylpent-1-en-3-yl)carbamate (2v)



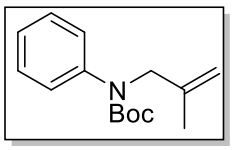
544 mg, 86% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, *J* = 7.3 Hz, 2H), 7.39 – 7.27 (m, 3H), 6.72 (brs, 4H), 5.46 (brs, 1H), 5.34 (s, 1H), 4.86 (s, 1H), 3.77 (s, 3H), 1.90 - 1.75 (m, 2H), 1.31 (brs, 9H), 1.14 (t, *J* = 7.3 Hz, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.21, 155.82, 147.44, 141.01, 131.76, 130.65, 128.37, 127.71, 126.89, 115.39, 113.33, 79.84, 58.76, 55.39, 28.41, 24.84, 11.48 ppm. IR (KBr) ***v*** 3005, 2986, 1689, 1512, 1456, 1387, 1275, 1260, 1167, 764, 750. HRMS (ESI) m/z calcd. for $C_{23}H_{29}NNaO_3^+$ (M + Na^+): 390.2040, Found: 390.2040.

tert-Butyl (Z)-(4-methoxyphenyl)(2-phenylbut-2-en-1-yl)carbamate (2w)



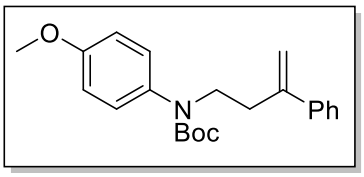
654 mg, 62% yield. White solid, Mp 76-79 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 – 7.18 (m, 5H), 6.73 (brs, 4H), 5.74 (d, *J* = 6.7 Hz, 1H), 4.79 (s, 2H), 3.76 (s, 3H), 1.58 (d, *J* = 6.9 Hz, 3H), 1.34 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.80, 155.24, 141.33, 137.31, 134.25, 128.91, 128.04, 127.07, 126.84, 113.55, 79.98, 55.41, 46.47, 28.36, 13.85 ppm. IR (KBr) ***v*** 3005, 2987, 2929, 1691, 1512, 1456, 1388, 1275, 1260, 1166, 1027, 834, 764, 750, 699. HRMS (ESI) m/z calcd. for $C_{22}H_{27}NNaO_3^+$ (M + Na^+): 376.1883, Found: 376.1883.

tert-Butyl (2-methylallyl)(phenyl)carbamate (2x)[3]



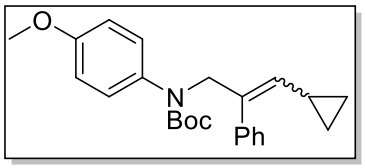
593 mg, 92% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (t, *J* = 7.7 Hz, 2H), 7.24 (d, *J* = 7.7 Hz, 2H), 7.15 (t, *J* = 7.2 Hz, 1H), 4.85 (s, 1H), 4.82 (s, 1H), 4.17 (s, 2H), 1.76 (s, 3H), 1.45 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.71, 142.96, 141.73, 128.54, 126.03, 125.58, 111.37, 80.39, 55.89, 28.34, 20.22 ppm.

tert-Butyl (4-methoxyphenyl)(3-phenylbut-3-en-1-yl)carbamate (2y)



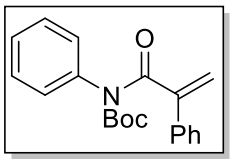
990 mg, 89% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.35 (d, *J* = 7.1 Hz, 2H), 7.32 – 7.22 (m, 3H), 7.08 (brs, 2H), 6.85 (d, *J* = 8.8 Hz, 2H), 5.33 (s, 1H), 5.07 (d, *J* = 0.7 Hz, 1H), 3.81 (s, 3H), 3.74 – 3.68 (m, 2H), 2.81 – 2.71 (m, 2H), 1.42 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.70, 154.97, 145.43, 140.58, 135.37, 128.46, 128.38, 127.54, 125.99, 114.01, 113.91, 80.01, 55.48, 49.67, 34.18, 28.43 ppm. IR (KBr) ***v*** 2976, 2933, 2837, 1695, 1513, 1455, 1392, 1365, 1293, 1247, 1166, 1146, 1033, 835, 778, 707, 604, 575, 542. HRMS (ESI) m/z calcd. for $C_{22}H_{27}NNaO_3^+$ (M + Na^+): 376.1883, Found: 376.1881.

tert-butyl (3-cyclopropyl-2-phenylallyl)(4-methoxyphenyl)carbamate (2z)



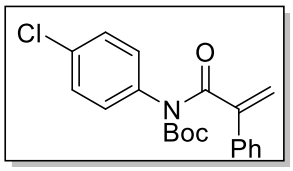
1.27 g, 98% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 – 7.22 (m, 5H), 6.97 (brs, 2H), [6.79 (d, *J* = 8.1 Hz), 6.74 (d, *J* = 8.1 Hz), (2H)], [5.05 (d, *J* = 9.6 Hz), 4.83 (d, *J* = 9.9 Hz), (1H)], [4.93 (s), 4.49 (s), (2H)], [3.77 (s), 3.76 (s), (3H)], 1.49 – 1.24 (m, 10H), 0.71 – 0.59 (m, 2H), 0.35 – 0.25 (m, 2H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.79, 157.40, 154.93, 139.03, 137.38, 135.53, 134.91, 133.84, 129.26, 129.07, 128.08, 127.99, 126.91, 126.68, 113.69, 113.55, 80.03, 56.57, 55.49, 55.45, 28.39, 28.34, 11.07, 10.76, 7.55, 7.51 ppm. IR (KBr) ***v*** 3002, 2975, 2929, 2833, 1697, 1512, 1379, 1366, 1247, 1159, 1027, 833, 765, 702. HRMS (ESI) m/z calcd. for $C_{24}H_{29}NNaO_3^+$ (M + Na^+): 402.2040, Found: 402.2041.

tert-Butyl phenyl(2-phenylacryloyl)carbamate (2′a)[3]



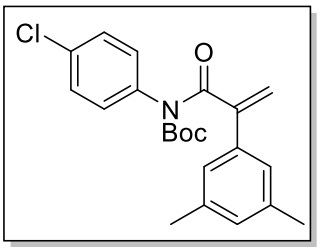
760 mg, 60% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.44 (m, 2H), 7.42 – 7.28 (m, 6H), 7.21 – 7.15 (m, 2H), 5.78 (s, 2H), 1.22 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.97, 152.53, 146.93, 138.39, 136.23, 129.09, 128.50, 128.38, 127.99, 127.94, 126.74, 118.14, 83.78, 27.53 ppm.

tert-Butyl (4-chlorophenyl)(2-phenylacryloyl)carbamate (2′b)



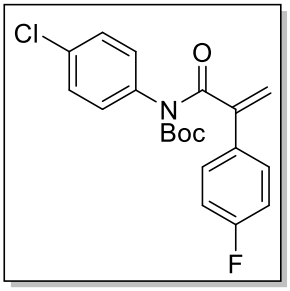
680mg, 98% yield. White solid, Mp 92-93 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.41 (m, 2H), 7.40 – 7.29 (m, 5H), 7.15 – 7.10 (m, 2H), 5.79 (s, 1H), 5.78 (s, 1H), 1.22 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.85, 152.20, 146.78, 136.91, 136.16, 133.85, 129.45, 129.35, 128.61, 128.54, 126.76, 118.54, 84.23, 27.59 ppm. IR (KBr) ***v*** 3002, 2981, 2929, 1741, 1688, 1492, 1369, 1275, 1260, 1152, 1091 1015, 843, 764, 750, 702. HRMS (ESI) m/z calcd. for $C_{20}H_{20}ClNNaO_3^+$ (M + Na^+): 380.1204, Found: 380.1201.

tert-Butyl (4-chlorophenyl)(2-(3,5-dimethylphenyl)acryloyl)carbamate (2′c)[3]



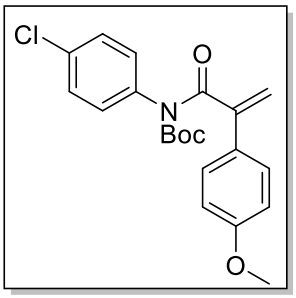
110 mg. 36% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (d, *J* = 8.6 Hz, 2H), 7.12 (d, *J* = 8.6 Hz, 2H), 7.04 (s, 2H), 6.96 (s, 1H), 5.76 (s, 1H), 5.72 (s, 1H), 2.33 (s, 6H), 1.26 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.00, 152.27, 146.91, 138.00, 136.97, 135.91, 133.75, 130.15, 129.44, 129.29, 124.66, 117.96, 84.15, 27.59, 21.41 ppm.

tert-Butyl (4-chlorophenyl)(2-(4-fluorophenyl)acryloyl)carbamate (2′d)[3]



340 mg. 45% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.46 – 7.34 (m, 4H), 7.13 – 7.03 (m, 4H), 5.74 (s, 1H), 5.73 (s, 1H), 1.25 (s, 9H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -113.07 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.70, 162.89 (d, *J* = 248.3 Hz), 152.20, 145.74, 136.77, 133.91, 132.33 (d, *J* = 3.4 Hz), 129.38, 129.35, 128.66 (d, *J* = 8.2 Hz), 118.17, 115.56 (d, *J* = 21.7 Hz), 84.31, 27.61 ppm.

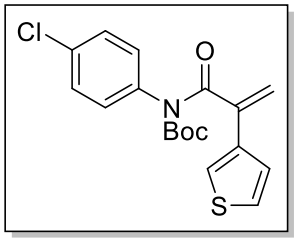
***tert*-Butyl (4-chlorophenyl)(2-(4-methoxyphenyl)acryloyl)carbamate (2′e)**[3]



300 mg, 70% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.32 (m, 4H), 7.15 – 7.04 (m, 2H), 6.94 – 6.82 (m, 2H), 5.69 (s, 1H), 5.64 (s, 1H), 3.82 (s, 3H), 1.25 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.18, 159.97, 152.35, 146.26, 137.00, 133.84, 129.44, 129.35, 128.73, 128.11, 116.37, 114.04, 84.25, 55.48, 27.67 ppm.

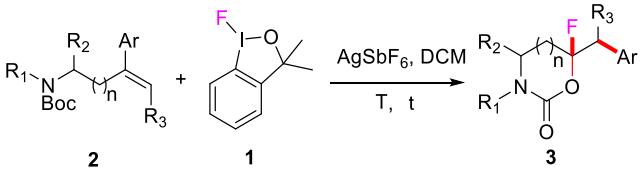
***tert*-Butyl (4-chlorophenyl)(2-(thiophen-3-yl)acryloyl)carbamate (2′f)**

200 mg, 97% yield. White solid, Mp 102-105 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.36 (m, 3H), 7.32 (dd, *J* = 5.1, 2.9 Hz, 1H), 7.26 (dd, *J* = 5.0, 1.3 Hz, 1H), 7.18 – 7.11 (m, 2H), 5.76 (s, 1H), 5.68 (s, 1H), 1.27 (s, 9H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.56, 152.44, 141.60, 137.16, 136.92, 133.90, 129.45, 129.32, 126.22, 125.85, 122.86, 116.74, 84.47, 27.59 ppm. IR (KBr) ***v*** 3005, 2988, 1741, 1687, 1491, 1345, 1275, 1260, 1152, 1091, 1016, 765, 750, 704. HRMS (ESI) m/z calcd. for $C_{18}H_{18}ClNNaO_3S^+$ (M + Na^+): 386.0588, Found: 386.0587.



3 General Procedures for the fluorocyclizations

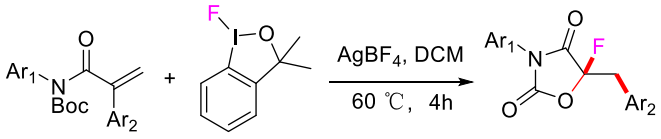
3.1 Procedures for the fluorocyclizations of 2a-2y



2 1 3

Compound 3. The substrate **2** (0.2 mmol, 1.0 equiv), the required amount of compound **1**, $AgSbF_6$ (6.8 mg, 0.02 mmol, 0.1 equiv) and DCM (2 mL) were introduced to a glass vial. The vial was then sealed and the mixture was allowed to stir at the matched temperature for the required time. After which, the reaction mixture was concentrated to dryness and CH_2Br_2 was added. The NMR yield was calculated by ^1H NMR spectroscopy using CH_2Br_2 as the internal standard and the dr value was determined from ^{19}F NMR spectrum analysis. The mixture was purified by column chromatography to afford product **3**.

3.2 Procedures for the fluorocyclizations of 2′a-2′f

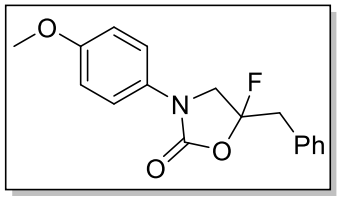


2' 1 3'

Compound 3′. The substrate **2′** (0.2 mmol, 1.0 equiv), compound **1** (0.3 mmol, 1.5 equiv), $AgBF_4$ (3.8 mg, 0.02 mmol, 0.1 equiv) and DCM (0.2 mL) were introduced to a glass vial. The vial was then sealed and the mixture was allowed to stir at 60 ^oC for 4 hours. After which, the reaction mixture was concentrated to dryness and CH_2Br_2 was added. The NMR yield was calculated by ^1H NMR spectroscopy using CH_2Br_2 as the internal standard. The mixture was purified by column chromatography to afford product **3′**.

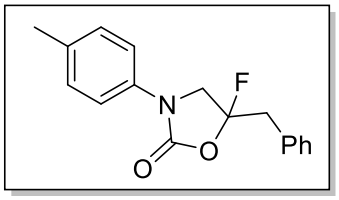
3.3 Characterization of Products

5-Benzyl-5-fluoro-3-(4-methoxyphenyl)oxazolidin-2-one (3a)



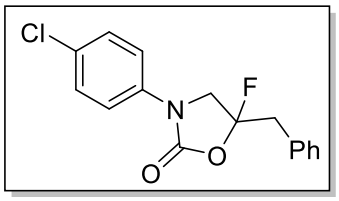
47.6 mg, 79% yield. White solid, Mp 123-129 ^oC. ^1H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.29 (m, 7H), 6.90 – 6.84 (m, 2H), 4.04, 3.89 (ABq, *J* = 10.9 Hz, 1H), 3.96, 3.84 (ABq, *J* = 10.9 Hz, 1H), 3.78 (s, 3H), 3.46 – 3.27 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.52 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.96, 152.32 (d, *J* = 1.7 Hz), 132.23 (d, *J* = 4.2 Hz), 130.37, 130.20, 128.95, 128.03, 120.68, 114.49, 112.31 (d, *J* = 233.1 Hz), 55.58, 54.10 (d, *J* = 30.6 Hz), 42.03 (d, *J* = 29.1 Hz) ppm. IR (KBr) ***v*** 3005, 2990, 1771, 1515, 1456, 1339, 1275, 1360, 1080, 828, 764, 750, 704. HRMS (ESI) m/z calcd. for $C_{17}H_{16}FNNaO_3^+$ (M + Na^+): 324.1006, Found: 324.1002.

5-Benzyl-5-fluoro-3-(*p*-tolyl)oxazolidin-2-one (3b)



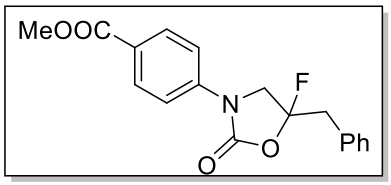
41.4 mg, 73% yield. White solid, Mp 115-117 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 - 7.28 (m, 7H), 7.15 (d, *J* = 8.6 Hz, 2H), 4.04, 3.92 (ABq, *J* = 10.9 Hz, 1H), 3.96, 3.86 (ABq, *J* = 10.9Hz, 1H), 3.46 – 3.28 (m, 2H), 2.31 (s, 3H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.40 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 152.13, 134.70, 132.25 (d, *J* = 4.3 Hz), 130.42, 129.86, 129.04, 128.11, 118.69, 112.31 (d, *J* = 233.1 Hz), 53.77 (d, *J* = 30.7 Hz), 42.15 (d, *J* = 29.1 Hz), 20.90 ppm. IR (KBr) ***v*** 3033, 3006, 2986, 2921, 2851, 1774, 1517, 1468, 1404, 1335, 1275, 1261, 1080, 976, 810, 764, 750, 702. HRMS (ESI) m/z calcd. for $C_{17}H_{16}FNNaO_2^+$ (M + Na^+): 308.1057, Found: 308.1045.

5-Benzyl-3-(4-chlorophenyl)-5-fluorooxazolidin-2-one (3c)



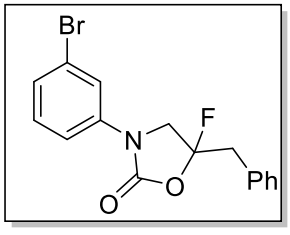
46.4 mg, 76% yield. White solid, Mp 123-125 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.27 (m, 9H), 4.04, 3.91 (ABq, *J* = 10.8 Hz, 1H), 3.96, 3.86 (ABq, *J* = 10.8 Hz, 1H), 3.47 – 3.29 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.42 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 151.90, 135.81, 132.00 (d, *J* = 4.2 Hz), 130.39, 130.18, 129.36, 129.08, 128.20, 119.66, 112.24 (d, *J* = 233.9 Hz), 53.51 (d, *J* = 30.8 Hz), 42.03 (d, *J* = 28.9 Hz) ppm. IR (KBr) ***v*** 3005, 2986, 1771, 1496, 1338, 1275, 1261, 1094, 1080, 978, 826, 764, 750, 704. HRMS (ESI) m/z calcd. for $C_{16}H_{14}ClFNO_2^+$ (M + H^+): 306.0692, Found: 306.0688.

Methyl 4-(5-benzyl-5-fluoro-2-oxooxazolidin-3-yl)benzoate (3d)



27.7 mg, 42% yield. White solid, Mp 136-140 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 8.7 Hz, 2H), 7.53 (d, *J* = 8.7 Hz, 2H), 7.40 – 7.29 (m, 5H), 4.09, 3.98 (ABq, *J* = 10.9 Hz, 1H), 4.01, 3.93 (ABq, *J* = 10.9 Hz, 1H), 3.90 (s, 3H), 3.49 – 3.30 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.28 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 166.44, 151.72, 141.16, 131.93 (d, *J* = 4.2 Hz), 131.01, 130.41, 129.14, 128.27, 126.24, 117.51, 112.27 (d, *J* = 234.1 Hz), 53.36 (d, *J* = 30.8 Hz), 52.27, 42.06 (d, *J* = 28.9 Hz) ppm. IR (KBr) ***v*** 3033, 3004, 2951, 2920, 2849, 1778, 1717, 1608, 1517, 1497, 1281, 1187, 1112, 980, 853, 767, 748, 703. HRMS (ESI) m/z calcd. for $C_{18}H_{16}FNNaO_4^+$ (M + Na^+): 352.0956, Found: 352.0956.

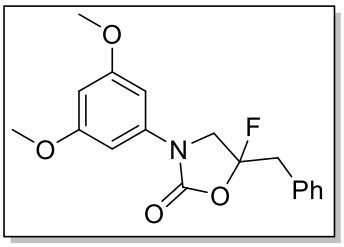
5-Benzyl-3-(3-bromophenyl)-5-fluorooxazolidin-2-one (3e)



41.4 mg, 59% yield. White solid, Mp 114-118 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (t, *J* = 1.9 Hz, 1H), 7.48 – 7.31 (m, 6H), 7.30 – 7.25 (m, 1H), 7.21 (t, *J* = 8.1 Hz, 1H), 4.03, 3.92 (ABq, *J* = 10.8 Hz, 1H), 3.96, 3.87 (ABq, *J* = 10.8 Hz, 1H), 3.48 – 3.28 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.30 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 151.73, 138.48, 131.95 (d, *J* = 4.3 Hz), 130.62, 130.39, 129.11, 128.23, 127.83, 123.08, 121.27, 116.89, 112.26 (d, *J* = 234.0 Hz), 53.39 (d, *J* = 30.8 Hz), 42.00 (d, *J* = 28.8 Hz) ppm. IR (KBr) ***v*** 3004, 2990, 2920, 2849, 1779, 1593, 1482, 1339,

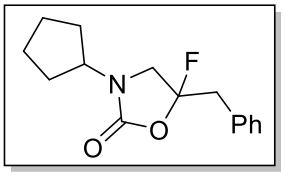
1275, 1261, 1080, 992, 938, 764, 750, 700. HRMS (ESI) m/z calcd. for $C_{16}H_{14}BrFNO_2^+$ (M + H^+): 350.0186, Found: 350.0184.

5-Benzyl-3-(3,5-dimethoxyphenyl)-5-fluorooxazolidin-2-one (3f)



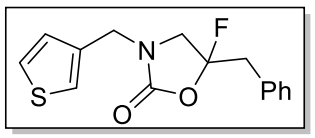
27.1 mg, 41% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 – 7.30 (m, 5H), 6.64 (d, *J* = 2.1 Hz, 2H), 6.25 (t, *J* = 2.1 Hz, 1H), 4.01, 3.89 (ABq, *J* = 10.9 Hz, 1H), 3.93, 3.84 (ABq, *J* = 10.9 Hz, 1H), 3.77 (s, 6H), 3.45 – 3.27 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.27 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.37, 151.87, 139.05, 132.15 (d, *J* = 4.3 Hz), 130.40, 129.05, 128.14, 112.18 (d, *J* = 233.2 Hz), 97.21, 96.67, 55.63, 53.77 (d, *J* = 30.7 Hz), 42.08 (d, *J* = 29.1 Hz) ppm. IR (KBr) ***v*** 3005, 2984, 1771, 1596, 1456, 1275, 1261, 1205, 1156, 1012, 764, 750, 704. HRMS (ESI) m/z calcd. for $C_{18}H_{18}FNNaO_4^+$ (M + Na^+): 354.1112 Found: 354.1112

5-Benzyl-3-cyclopentyl-5-fluorooxazolidin-2-one (3g)



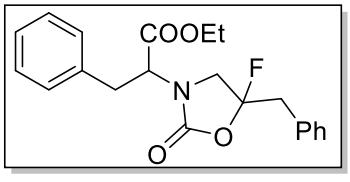
41.0 mg, 78% yield. White solid, Mp 79-82 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.27 (m, 5H), 4.16 (p, *J* = 8.1 Hz, 1H), 3.57 – 3.18 (m, 4H), 1.95 – 1.82 (m, 1H), 1.81 – 1.69 (m, 1H), 1.67 – 1.50 (m, 4H), 1.50 – 1.39 (m, 1H), 1.36 – 1.24 (m, 1H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -93.00 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.64, 132.54 (d, *J* = 4.3 Hz), 130.29, 128.83, 127.85, 113.11 (d, *J* = 232.5 Hz), 54.47, 49.57 (d, *J* = 30.4 Hz), 42.20 (d, *J* = 29.6 Hz), 29.37, 28.68, 23.89, 23.81 ppm. IR (KBr) ***v*** 3005, 2989, 1771, 1456, 1275, 1260, 1040, 908, 765, 704. HRMS (ESI) m/z calcd. for $C_{15}H_{18}FNNaO_2^+$ (M + Na^+): 286.1214, Found: 286.1214.

5-Benzyl-5-fluoro-3-(thiophen-3-ylmethyl)oxazolidin-2-one (3h)



43.8 mg, 75% yield. White solid, Mp 68-72 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.28 (m, 3H), 7.28 – 7.19 (m, 3H), 6.95 – 6.90 (m, 1H), 6.84 (d, *J* = 3.3 Hz, 1H), 4.57 (s, 2H), 3.54, 3.43 (ABq, *J* = 10.8 Hz, 1H), 3.46, 3.37 (ABq, *J* = 10.8 Hz, 1H), 3.32 – 3.17 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -93.09 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 154.74, 137.07, 132.29 (d, *J* = 4.7 Hz), 130.33, 128.86, 127.88, 127.20, 127.12 , 126.22, 113.10 (d, *J* = 233.9 Hz), 52.03 (d, *J* = 30.3 Hz), 42.38, 42.07 (d, *J* = 29.4 Hz) ppm. IR (KBr) ***v*** 3005, 2989, 1776, 1473, 1275, 1261, 1029, 897, 765, 750, 703. HRMS (ESI) m/z calcd. for $C_{15}H_{15}FNO_2S^+$ (M + H^+): 292.0802, Found: 292.0807.

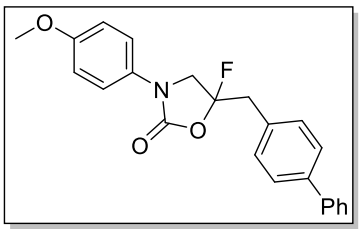
Ethyl 2-(5-benzyl-5-fluoro-2-oxooxazolidin-3-yl)-3-phenylpropanoate (3i)



48.9 mg, 66% yield, dr = 1.3:1. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.14 (m, 9H), 7.06 – 7.00 (m, 1H), [4.77 (dd, *J* = 10.4, 5.6 Hz), 4.74 (dd, *J* = 10.6, 5.5 Hz), (1H)], 4.23 – 4.07 (m, 2H), 3.91 – 3.36 (m, 2H), 3.35 – 3.04 (m, 3H), 2.95 – 2.81 (m, 1H), [1.23 (t, *J* = 7.1 Hz), 1.18 (t, *J* = 7.1 Hz), (3H)] ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.12, -94.35 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 169.95,

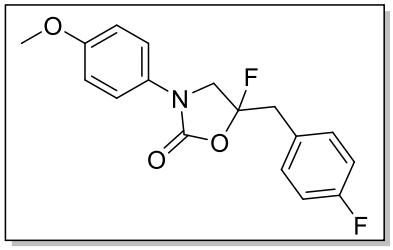
169.81, 155.15 (d, *J* = 1.5 Hz), 154.92 (d, *J* = 1.4 Hz), 135.71, 135.63, 132.33 (d, *J* = 3.2 Hz), 132.31 (d, *J* = 4.7 Hz), 130.38, 130.30, 128.92, 128.89, 128.85, 128.81, 128.69, 128.54, 127.89, 127.85, 127.36, 127.29, 113.42 (d, *J* = 234.4 Hz), 113.38 (d, *J* = 234.5 Hz), 61.92, 61.83, 56.63, 56.54, 50.60 (d, *J* = 29.6 Hz), 50.48 (d, *J* = 30.7 Hz), 42.18 (d, *J* = 28.9 Hz), 42.06 (d, *J* = 29.5 Hz), 35.48, 35.18, 14.14 ppm. IR (KBr) ***v*** 3005, 2989, 1779, 1738, 1456, 1275, 1261, 1031, 897, 765, 750, 703. HRMS (ESI) m/z calcd. for $C_{21}H_{22}FNNaO_4^+$ (M + Na^+): 394.1425, Found: 394.1425.

5-([1,1'-Biphenyl]-4-ylmethyl)-5-fluoro-3-(4-methoxyphenyl)oxazolidin-2-one (3j)



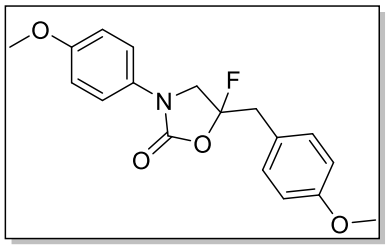
59.6 mg, 79% yield. White solid, Mp 197-201 ^oC. ^1H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 7.9 Hz, 4H), 7.49 – 7.39(m, 4H), 7.39 – 7.31 (m, 3H), 6.88 (d, *J* = 9.1 Hz, 2H), 4.08, 3.95 (ABq, *J* = 10.9 Hz, 1H), 4.00, 3.89 (ABq, *J* = 10.9 Hz, 1H), 3.78 (s, 3H), 3.55 – 3.29 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.48 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.01, 152.33, 140.99, 140.53, 131.20 (d, *J* = 4.1 Hz), 130.81, 130.24, 128.95, 127.67, 127.63, 127.17, 120.70, 114.54, 112.32 (d, *J* = 233.2 Hz), 55.62, 54.20 (d, *J* = 30.6 Hz), 41.75 (d, *J* = 29.2 Hz) ppm. IR (KBr) ***v*** 3006, 2919, 2849, 1765, 1748, 1520, 1470, 1275, 1259, 1158, 824, 764, 750, 692. HRMS (ESI) m/z calcd. for $C_{23}H_{21}FNO_3^+$ (M + H^+): 378.1500, Found: 378.1495.

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



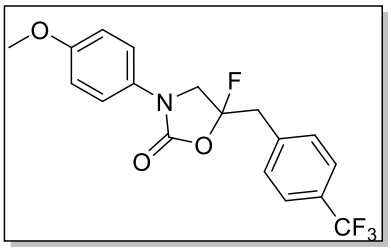
41.5 mg, 65% yield. White solid, Mp 124-126 ^oC. ^1H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.27 (m, 4H), 7.05 (t, *J* = 8.5 Hz, 2H), 6.88 (d, *J* = 8.9 Hz, 2H), 4.04 – 3.83 (m, 2H), 3.78 (s, 3H), 3.43 – 3.23 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -93.10, -114.22 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 162.64 (d, *J* = 246.9 Hz), 157.06, 152.23, 132.03 (d, *J* = 8.1 Hz), 130.13, 127.96 (t, *J* = 3.7 Hz), 120.72, 115.93 (d, *J* = 21.4 Hz), 114.56, 112.07 (dd, *J* = 233.0, 1.2 Hz), 55.63, 54.19 (d, *J* = 30.6 Hz), 41.32 (d, *J* = 29.6 Hz) ppm. IR (KBr) ***v*** 3008, 2992, 2920, 2845, 1771, 1760, 1512, 1275, 1258, 1080, 826, 764, 750. HRMS (ESI) m/z calcd. for $C_{17}H_{16}F_2NO_3^+$ (M + H^+): 320.1093, Found: 320.1091.

5-Fluoro-5-(4-methoxybenzyl)-3-(4-methoxyphenyl)oxazolidin-2-one (3l)



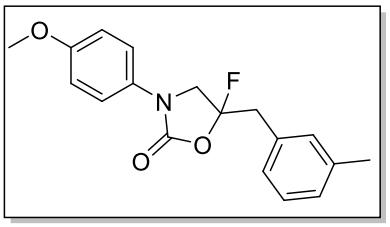
44.2 mg, 66% yield. White solid, Mp 135-137 ^oC. ^1H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, *J* = 9.1 Hz, 2H), 7.25 (d, *J* = 9.1 Hz, 2H), 6.93 – 6.84 (m, 4H), 4.01, 3.88 (ABq, *J* = 10.8 Hz, 1H), 3.94, 3.83 (ABq, *J* = 10.8 Hz, 1H), 3.80 (s, 3H), 3.78 (s, 3H), 3.38 – 3.21 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.77 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 159.46, 157.00, 152.40, 131.46, 130.31, 124.19 (d, *J* = 4.6 Hz), 120.69, 114.55, 114.43, 112.49 (d, *J* = 232.9 Hz), 55.64, 55.41, 54.04 (d, *J* = 30.6 Hz), 41.23 (d, *J* = 29.4 Hz) ppm. IR (KBr) ***v*** 3005, 2984, 1771, 1515, 1456, 1339, 1275, 1260, 764, 750. HRMS (ESI) m/z calcd. for $C_{18}H_{18}FNNaO_4^+$ (M + Na^+): 354.1112, Found: 354.1104.

5-Fluoro-3-(4-methoxyphenyl)-5-(4-(trifluoromethyl)benzyl)oxazolidin-2-one (3m)



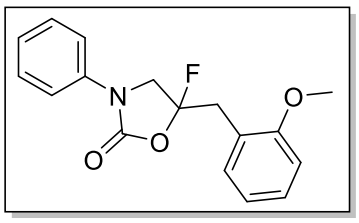
42.8 mg, 58% yield. White solid, Mp 151-155 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, *J* = 8.1 Hz, 2H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.36 – 7.29 (m, 2H), 6.92 – 6.85 (m, 2H), 4.02, 3.95 (ABq, *J* = 10.9 Hz, 1H), 3.95, 3.90 (ABq, *J* = 10.9 Hz, 1H), 3.79 (s, 3H), 3.51 – 3.34 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.69, -92.86 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.18, 152.07 (d, *J* = 1.7 Hz), 136.22 (dd, *J* = 3.2, 1.3 Hz), 130.84 (d, *J* = 0.8 Hz), 130.52 (q, *J* = 32.6 Hz), 130.03, 125.93 (q, *J* = 3.7 Hz), 124.10 (q, *J* = 272.1 Hz), 120.80, 114.63, 111.72 (d, *J* = 233.4 Hz), 55.66, 54.46 (d, *J* = 30.6 Hz), 42.02 (d, *J* = 29.5 Hz) ppm. IR (KBr) ***v*** 3005, 2990, 1759, 1275, 1261, 1159, 1123, 825, 764, 750. HRMS (ESI) m/z calcd. for $C_{18}H_{16}F_4NO_3^+$ (M + H^+): 370.1061, Found: 370.1065.

5-Fluoro-3-(4-methoxyphenyl)-5-(3-methylbenzyl)oxazolidin-2-one (3n)



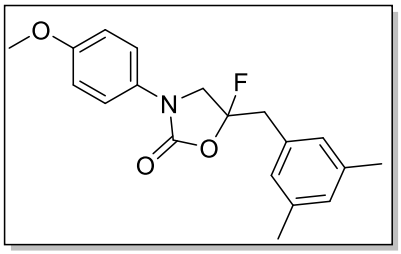
52.3 mg, 83% yield. White solid, Mp 63-68 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.31 (m, 2H), 7.25 (t, *J* = 7.6 Hz, 1H), 7.17 – 7.11 (m, 3H), 6.91 – 6.84 (m, 2H), 4.04, 3.89 (ABq, *J* = 10.9 Hz, 1H), 3.96, 3.84 (ABq, *J* = 10.9 Hz, 1H), 3.78 (s, 3H), 3.42 – 3.22 (m, 2H), 2.36 (s, 3H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.42 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.92, 152.36, 138.66, 132.12 (d, *J* = 4.1 Hz), 131.13, 130.24, 128.81, 128.78, 127.35, 120.64, 114.48, 112.38 (d, *J* = 233.1 Hz), 55.60, 54.06 (d, *J* = 30.6 Hz), 41.95 (d, *J* = 29.0 Hz), 21.49 ppm. IR (KBr) ***v*** 3005, 2989, 1771, 1515, 1457, 1339, 1275, 1260, 1086, 764, 750, 706. HRMS (ESI) m/z calcd. for $C_{18}H_{18}FNNaO_3^+$ (M + Na^+): 338.1163, Found: 338.1162.

5-Fluoro-5-(2-methoxybenzyl)-3-phenyloxazolidin-2-one (3o)



42.1 mg, 70% yield. White solid, Mp 88-90 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (dd, *J* = 8.7, 0.9 Hz, 2H), 7.39 – 7.27 (m, 4H), 7.14 (t, *J* = 7.4 Hz, 1H), 6.97 (t, *J* = 7.5 Hz, 1H), 6.92 (d, *J* = 8.3 Hz, 1H), 4.14, 3.94 (ABq, *J* = 11.0 Hz, 1H), 4.06, 3.89 (ABq, *J* = 11.0 Hz, 1H), 3.88 (s, 3H), 3.54 – 3.37 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -91.60 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.56, 152.26 (d, *J* = 2.0 Hz), 137.48, 132.80, 129.48, 129.31, 124.70, 121.27, 120.72 (d, *J* = 5.1 Hz), 118.49, 112.77 (d, *J* = 233.2 Hz), 111.00, 55.70, 53.53 (d, *J* = 30.4 Hz), 34.98 (d, *J* = 30.1 Hz) ppm. IR (KBr) ***v*** 3391, 3004, 2920, 2849, 1778, 1646, 1601, 1503, 1496, 1468, 1406, 1336, 1248, 752, 696, 669. HRMS (ESI) m/z calcd. for $C_{17}H_{16}FNNaO_3^+$ (M + Na^+): 324.1006, Found: 324.0998.

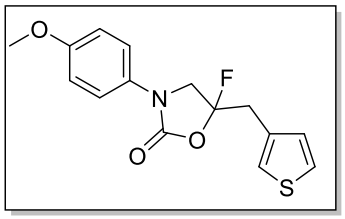
5-(3,5-Dimethylbenzyl)-5-fluoro-3-(4-methoxyphenyl)oxazolidin-2-one (3p)



54.0 mg, 82% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.31 (m, 2H), 6.96 (s, 1H), 6.94 (s, 2H), 6.91 – 6.85 (m, 2H), 4.03, 3.89 (ABq, *J* = 10.9 Hz, 1H), 3.96, 3.84 (ABq, *J* = 10.9 Hz, 1H), 3.78 (s, 3H), 3.39 – 3.18 (m, 2H), 2.32 (s, 6H) ppm. ^{19}F NMR (376 MHz,

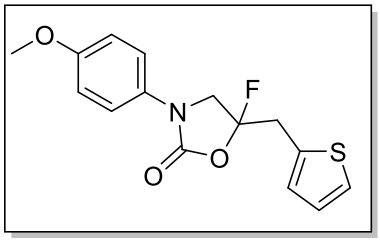
$CDCl_3$) δ -92.25 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.97, 152.44, 138.53, 132.08 (d, *J* = 4.2 Hz), 130.34, 129.69, 128.16, 120.70, 114.53, 112.48 (d, *J* = 233.0 Hz), 55.64, 54.10 (d, *J* = 30.6 Hz), 41.93 (d, *J* = 28.9 Hz), 21.38 ppm. IR (KBr) ***v*** 3005, 2988, 1771, 1515, 1457, 1339, 1275, 1260, 1086, 1067, 764, 750. HRMS (ESI) m/z calcd. for $C_{19}H_{20}FNNaO_3^+$ (M + Na^+): 352.1319, Found: 352.1314.

5-Fluoro-3-(4-methoxyphenyl)-5-(thiophen-3-ylmethyl)oxazolidin-2-one (3q)



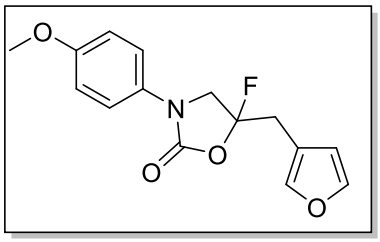
47.3 mg, 77% yield. White solid, Mp 95-98 °C. ^1H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.29 (m, 3H), 7.23 (d, *J* = 1.8 Hz, 1H), 7.08 (d, *J* = 4.9 Hz, 1H), 6.91 – 6.83 (m, 2H), 4.01, 3.92 (ABq, *J* = 10.9 Hz, 1H), 3.93, 3.87 (ABq, *J* = 10.9 Hz, 1H), 3.78 (s, 3H), 3.49 – 3.32 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.91 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.00, 152.27, 132.24 (d, *J* = 4.4 Hz), 130.18, 128.99, 126.64, 124.68, 120.72, 114.53, 112.05 (d, *J* = 232.9 Hz), 55.62, 54.19 (d, *J* = 30.5 Hz), 36.79 (d, *J* = 30.7 Hz) ppm. IR (KBr) ***v*** 2920, 2849, 1771, 1646, 1515, 1469, 1338, 1276, 1255, 1090, 1060, 830, 764, 750. HRMS (ESI) m/z calcd. for $C_{15}H_{15}FNO_3S^+$ (M + H^+): 308.0751, Found: 308.0742.

5-Fluoro-3-(4-methoxyphenyl)-5-(thiophen-2-ylmethyl)oxazolidin-2-one (3r)



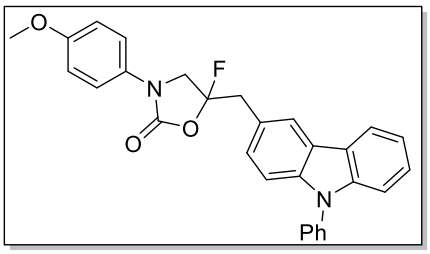
36.8 mg, 60% yield. White solid, Mp 82-85 °C. ^1H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.31 (m, 2H), 7.28 – 7.25 (m, 1H), 7.06 – 6.96 (m, 2H), 6.93 – 6.84 (m, 2H), 4.09, 3.96 (ABq, *J* = 10.9 Hz, 1H), 4.02, 3.91 (ABq, *J* = 10.9 Hz, 1H), 3.79 (s, 3H), 3.67 – 3.51 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -93.23 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.10, 152.14, 133.14 (d, *J* = 5.2 Hz), 130.17, 128.56, 127.47, 126.20, 120.82, 114.59, 111.68 (d, *J* = 233.3 Hz), 55.65, 54.00 (d, *J* = 30.4 Hz), 36.57 (d, *J* = 32.4 Hz) ppm. IR (KBr) ***v*** 3006, 2920, 2849, 1775, 1646, 1515, 1469, 1338, 1275, 1257, 975, 829, 764, 750. HRMS (ESI) m/z calcd. for $C_{15}H_{15}FNO_3S^+$ (M + H^+): 308.0751, Found: 308.0747.

5-Fluoro-5-(furan-3-ylmethyl)-3-(4-methoxyphenyl)oxazolidin-2-one (3s)



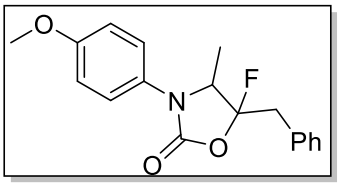
37.8 mg, 65% yield. White solid, Mp 104-108 °C. ^1H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.39 (m, 2H), 7.38– 7.32 (m, 2H), 6.93 – 6.84 (m, 2H), 6.43 (s, 1H), 4.02, 3.95 (ABq, *J* = 10.9 Hz, 1H), 3.94, 3.90 (ABq, *J* = 10.9 Hz, 1H), 3.79 (s, 3H), 3.29 – 3.11 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -93.33 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.13, 152.28, 143.81, 141.47, 130.28, 120.79, 116.06 (d, *J* = 4.9 Hz), 114.63, 112.10 (d, *J* = 232.6 Hz), 111.69, 55.66, 54.28 (d, *J* = 30.6 Hz), 32.20 (d, *J* = 31.7 Hz) ppm. IR (KBr) ***v*** 3392, 3006, 2920, 2849, 1771, 1646, 1515, 1469, 1338, 1251, 1092, 1024, 874, 749. HRMS (ESI) m/z calcd. for $C_{15}H_{15}FNO_4^+$ (M + H^+): 292.0980, Found: 292.0967.

5-Fluoro-3-(4-methoxyphenyl)-5-((9-phenyl-9H-carbazol-3-yl)methyl)oxazolidin-2-one (3t)



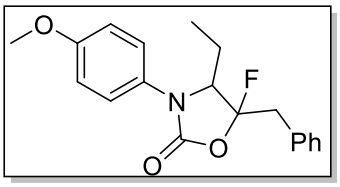
26.1 mg, 28% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 7.8 Hz, 1H), 8.09 (s, 1H), 7.61 (t, *J* = 7.7 Hz, 2H), 7.55 (d, *J* = 7.6 Hz, 2H), 7.51 – 7.27 (m, 8H), 6.84 (d, *J* = 9.0 Hz, 2H), 4.12, 3.90 (ABq, *J* = 10.9 Hz, 1H), 4.04, 3.85 (ABq, *J* = 10.9 Hz, 1H), 3.76 (s, 3H), 3.65 – 3.46 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.29 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.91 152.48, 141.39, 140.63, 137.60, 130.36, 130.08, 128.11, 127.79, 127.20, 126.48, 123.87 123.58 (d, *J* = 4.4 Hz), 122.99, 122.12, 120.59 , 120.54, 120.29, 114.50, 112.82 (d, *J* = 232.9 Hz), 110.31, 110.09, 55.63, 54.03 (d, *J* = 30.7 Hz), 42.10 (d, *J* = 29.1 Hz) ppm. IR (KBr) ***v*** 3055, 3006, 2955, 2930, 2835, 1774, 1597, 1514, 1503, 1458, 1333, 1251, 1234, 1151, 977, 937, 828, 763, 749, 698. HRMS (ESI) m/z calcd. for $C_{29}H_{23}FN_2NaO_3^+$ (M + Na^+): 489.1585, Found: 489.1583.

5-Benzyl-5-fluoro-3-(4-methoxyphenyl)-4-methyloxazolidin-2-one (3u)



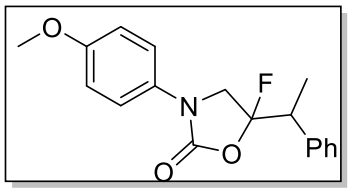
50.0 mg, 79% yield, dr = 2.3:1. White solid, Mp 102-105 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.28 (m, 5.6H), 7.12 – 7.05 (m, 1.4H), 6.94 – 6.85 (m, 2H), [4.36 (dq, *J* = 19.3, 6.7 Hz), 4.22 (dq, *J* = 21.0, 6.5 Hz), (1H)], [3.80 (s), 3.78 (s), (3H)], 3.49 – 3.16 (m, 2H), [1.27 (d, *J* = 6.7 Hz), 1.03 (dd, *J* = 6.5, 2.4 Hz), (3H)] ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -93.67, -111.55 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.37, 157.89, 153.47 (d, *J* = 1.4 Hz), 152.40 (d, *J* = 1.6 Hz), 132.32, 132.27, 130.58 (d, *J* = 1.2 Hz), 130.51, 128.87, 128.58, 128.41, 127.95, 127.87, 127.61, 126.06, 124.52, 114.74, 114.65, 114.52 (d, *J* = 232.8 Hz), 113.64 (d, *J* = 238.9 Hz), 62.40 (d, *J* = 31.4 Hz), 59.18 (d, *J* = 25.7 Hz), 55.60, 55.58, 41.87 (d, *J* = 29.6 Hz), 38.78 (d, *J* = 26.4 Hz), 14.78 (d, *J* = 9.1 Hz), 12.41 (d, *J* = 12.0 Hz) ppm. IR (KBr) ***v*** 3000, 2920, 2849, 1775, 1646, 1515, 1456, 1396, 1297, 1250, 1151, 1038, 989, 962, 831, 750, 702. HRMS (ESI) m/z calcd. for $C_{18}H_{18}FNNaO_3^+$ (M + Na^+): 338.1163 Found: 338.1163.

5-Benzyl-4-ethyl-5-fluoro-3-(4-methoxyphenyl)oxazolidin-2-one (3v)



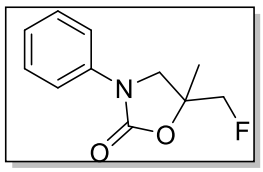
49.4 mg, 75% yield, dr = 1.5:1. White solid, Mp 100-104 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.29 (m, 6H), 7.06 – 6.97 (m, 1H), 6.94 – 6.89 (m, 1H), 6.89 – 6.84 (m, 1H), [4.35 (ddd, *J* = 18.8, 5.6, 4.2 Hz), 4.03 (ddd, *J* = 20.4, 9.2, 3.9 Hz), (1H)], [3.80 (s), 3.77 (s), (3H)], 3.55 – 3.09 (m, 2H), 1.90 – 1.56 (m, 2H), 0.95 – 0.85 (m, 3H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -90.21, -111.31 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.47, 157.69, 153.38, 152.81, 132.47 (d, *J* = 7.4 Hz), 132.28, 130.71, 130.59 (d, *J* = 0.9 Hz), 129.06, 128.89, 128.56, 128.22, 127.93, 127.61, 126.32, 124.19, 114.68, 114.66, 114.26 (d, *J* = 232.6 Hz), 113.92 (d, *J* = 239.1 Hz), 66.52 (d, *J* = 29.5 Hz), 63.72 (d, *J* = 24.9 Hz), 55.59, 55.56, 43.27 (d, *J* = 30.9 Hz), 38.67 (d, *J* = 26.4 Hz), 21.56 (d, *J* = 8.9 Hz), 20.85 (d, *J* = 10.7 Hz), 9.95 (d, *J* = 2.4 Hz), 8.61 ppm. IR (KBr) ***v*** 3006, 2986, 2921, 2851, 1776, 1515, 1456, 1403, 1275, 1259, 1125, 1032, 978, 829, 764, 750, 701. HRMS (ESI) m/z calcd. for $C_{19}H_{21}FNO_3^+$ (M + H^+): 330.1500, Found: 330.1500.

5-Fluoro-3-(4-methoxyphenyl)-5-(1-phenylethyl)oxazolidin-2-one (3w)



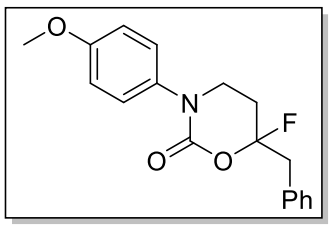
25.8 mg, 41% yield, dr = 1.1:1. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.24 (m, 7H), 6.91 – 6.82 (m, 2H), 4.01 – 3.64 (m, 5H), [3.40 (dq, *J* = 10.3, 7.2 Hz), 3.27 (dq, *J* = 21.2, 7.0 Hz), (1H)], 1.55 (t, *J* = 6.9 Hz, 3H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -97.07, -106.34 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 157.00, 156.95, 152.54 (d, *J* = 1.7 Hz), 152.43, 138.48 (d, *J* = 4.7 Hz), 138.33, 130.27, 130.22, 129.00, 128.97, 128.79, 128.74 (d, *J* = 2.0 Hz), 128.12, 128.08, 120.79, 120.69, 114.51, 114.49, 113.87(d, *J* = 234.9 Hz), 113.65 (d, *J* = 237.8 Hz), 55.63, 54.49 (d, *J* = 30.9 Hz), 53.46 (d, *J* = 31.1 Hz), 46.50 (d, *J* = 26.2 Hz), 45.21 (d, *J* = 27.6 Hz), 14.98 (d, *J* = 5.0 Hz), 14.87 (d, *J* = 3.9 Hz) ppm. IR (KBr) ***v*** 3005, 2989, 2918, 2849, 1773, 1514, 1463, 1406, 1337, 1275, 1260, 897, 765, 750. HRMS (ESI) m/z calcd. for $C_{18}H_{18}FNNaO_3^+$ (M + Na^+): 338.1163, Found: 338.1165.

5-(Fluoromethyl)-5-methyl-3-phenyloxazolidin-2-one (3x)



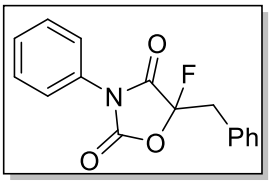
18.4 mg, 44% yield. Colorless oil. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 8.1 Hz, 2H), 7.38 (t, *J* = 7.9 Hz, 2H), 7.15 (t, *J* = 7.4 Hz, 1H), 4.57, 4.43 (ABq, *J* = 9.9 Hz, 1H), 4.45, 4.32 (ABq, *J* = 9.9 Hz, 1H), 4.09 (d, *J* = 8.9 Hz, 1H), 3.76 (dd, *J* = 9.0, 1.4 Hz, 1H), 1.56 (d, *J* = 2.1 Hz, 3H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -227.85 ppm. ^{13}C NMR (101 MHz, DMSO) δ 153.44, 138.29, 128.92, 123.57, 117.98, 85.80 (d, *J* = 174.2 Hz), 77.19 (d, *J* = 17.5 Hz), 51.19 (d, *J* = 5.2 Hz), 21.00 (d, *J* = 4.8 Hz) ppm. IR (KBr) ***v*** 3005, 2989, 2920, 2851, 1749, 1460, 1414, 1322, 1275, 1261, 1119, 897, 763, 750, 706. HRMS (ESI) m/z calcd. for $C_{11}H_{12}FNNaO_2^+$ (M + Na^+): 232.0744, Found: 232.0737.

6-Benzyl-6-fluoro-3-(4-methoxyphenyl)-1,3-oxazinan-2-one (3y)



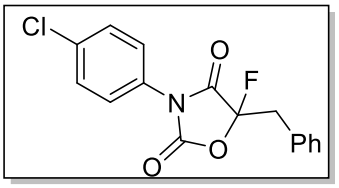
35.0 mg, 56% yield. White solid, Mp 142-146 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 – 7.29 (m, 5H), 7.23 – 7.18 (m, 2H), 6.93 – 6.86 (m, 2H), 3.93 – 3.83 (m, 1H), 3.80 (s, 3H), 3.46 – 3.40 (m, 1H), 3.38 – 3.21 (m, 2H), 2.15 – 1.98 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -101.73 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 158.66, 150.16, 135.14, 133.39 (d, *J* = 4.9 Hz), 130.60, 128.74, 127.69, 127.23, 114.75, 113.29 (d, *J* = 226.8 Hz), 55.63, 44.73 (d, *J* = 26.2 Hz), 44.52 (d, *J* = 4.5 Hz), 28.43 (d, *J* = 26.0 Hz) ppm. IR (KBr) ***v*** 3005, 2989, 2916, 1719, 1512, 1478, 1426, 1275, 1260, 1164, 832, 763, 750, 705. HRMS (ESI) m/z calcd. for $C_{18}H_{18}FNNaO_3^+$ (M + Na^+): 338.1163, Found: 338.1157.

5-Benzyl-5-fluoro-3-phenyloxazolidine-2,4-dione (3′a)[3]



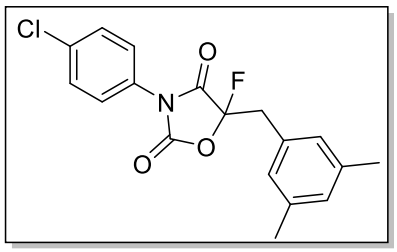
27.4 mg, 48% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.38 (m, 3H), 7.38 – 7.30 (m, 5H), 7.06 – 6.97 (m, 2H), 3.63 – 3.52 (m, 2H) ppm.^{19}F NMR (376 MHz, $CDCl_3$) δ -110.11 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.52 (d, *J* = 24.3 Hz), 150.78, 130.62, 129.79, 129.68, 129.59, 129.18, 128.65, 125.58, 110.06 (d, *J* = 244.5 Hz), 38.91 (d, *J* = 28.2 Hz) ppm.

5-Benzyl-3-(4-chlorophenyl)-5-fluorooxazolidine-2,4-dione (3′b)



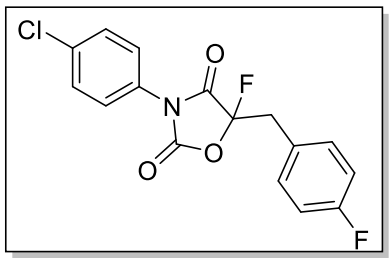
34.6 mg, 54% yield. White solid, Mp 136-139 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.33 (m,5H), 7.32 – 7.28 (m, 2H), 7.02 – 6.94 (m, 2H), 3.62 – 3.51 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -110.11 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.23 (d, *J* = 24.4 Hz), 150.40, 135.56, 130.58, 129.82, 129.60 (d, *J* = 10.4 Hz), 129.21, 128.71, 128.21, 126.70, 110.09 (d, *J* = 245.1 Hz), 38.91 (d, *J* = 28.1 Hz) ppm. IR (KBr) ***v*** 3005, 2987, 2922, 2847, 1842, 1765, 1500, 1426, 1275, 1260, 825, 764, 750, 699. HRMS (EI) m/z calcd. for $C_{16}H_{11}ClFNO_3^+$: 319.0406, Found: 319.0406

3-(4-Chlorophenyl)-5-(3,5-dimethylbenzyl)-5-fluorooxazolidine-2,4-dione (3′c)[3]



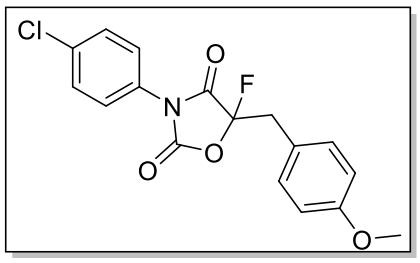
30.1 mg, 43% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.40 (d, *J* = 8.6 Hz, 2H), 7.01 (d, *J* = 8.6 Hz, 2H), 6.95 (s, 1H), 6.90 (s, 2H), 3.61 – 3.35 (m, 2H), 2.28 (s, 6H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -110.37 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.43 (d, *J* = 24.6 Hz), 150.50, 138.83, 135.55, 130.25, 129.83, 129.39 (d, J = 10.2 Hz), 128.35, 128.25, 126.72, 110.19 (d, *J* = 245.0 Hz), 38.79 (d, *J* = 27.7 Hz), 21.31 ppm.

3-(4-Chlorophenyl)-5-fluoro-5-(4-fluorobenzyl)oxazolidine-2,4-dione (3′d)[3]



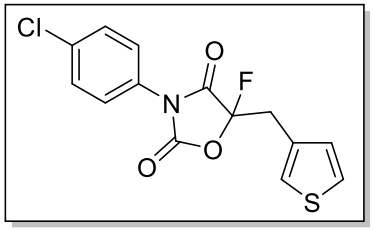
33.1 mg, 49% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (d, *J* = 8.5 Hz, 2H), 7.33 – 7.24 (m, 2H),7.10 – 7.01 (m, 4H), 3.61 – 3.46 (m, 2H). ^{19}F NMR (376 MHz, $CDCl_3$) δ -109.62, -112.81 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.11 (d, *J* = 24.5 Hz), 162.93 (d, *J* = 248.4 Hz), 150.33, 135.65, 132.35 (d, *J* = 8.2 Hz), 129.91, 128.17, 126.56, 125.37 (dd, *J* = 10.3, 3.4 Hz), 116.25 (d, *J* = 21.6 Hz), 109.72 (dd, *J* = 244.7, 1.7 Hz), 37.99 (d, *J* = 28.6 Hz) ppm.

3-(4-Chlorophenyl)-5-fluoro-5-(4-methoxybenzyl)oxazolidine-2,4-dione (3′e)[3]



39.2 mg, 56% yield. White solid. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 (d, *J* = 8.2 Hz, 2H), 7.21 (d, *J* = 8.2 Hz, 2H), 7.03 (d, *J* = 8.2 Hz, 2H), 6.86 (d, *J* = 8.1 Hz, 2H), 3.79 (s, 3H), 3.58 – 3.43 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -110.15 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.35 (d, *J* = 24.5 Hz), 159.83, 150.50, 135.51, 131.71, 129.81, 128.26, 126.69, 121.28 (d, *J* = 10.8 Hz), 114.57, 110.15 (d, *J* = 245.3 Hz), 55.43, 37.98 (d, *J* = 28.1 Hz) ppm.

3-(4-Chlorophenyl)-5-fluoro-5-(thiophen-3-ylmethyl)oxazolidine-2,4-dione (3′f)

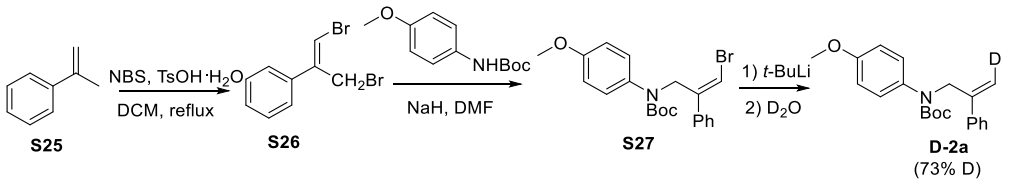


28.0mg, 43% yield. White solid, Mp 140-142 ^{o}C. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.41 (d, *J* = 8.2 Hz, 2H), 7.37 – 7.32 (m,

1H), 7.25 (s, 1H), 7.07 – 7.01 (m, 3H), 3.71 – 3.54 (m, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -111.01 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 165.29 (d, *J* = 24.5 Hz), 150.47, 135.64, 129.89, 129.59 (d, *J* = 10.9 Hz), 128.91, 128.23, 127.17, 126.76, 126.01, 109.69 (d, *J* = 245.4 Hz), 33.52 (d, *J* = 29.6 Hz) ppm. IR (KBr) ***v*** 3005, 2989, 1765,1501, 1457, 1427, 1275, 1261, 763, 750, 706. HRMS (EI) m/z calcd. for $C_{14}H_9ClFNO_3S^+$: 324.9970, Found: 324.9969

4. Studies on the Mechanism

4.1 Deuterium experiments



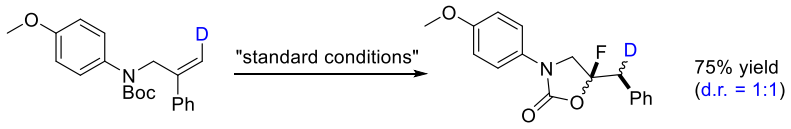
Compound **S26** was prepared according to literature procedures.[6]

Compound D-2a. To a sealing tube was added **S25** (1 g, 8.5 mmol, 1.0 equiv), NBS (3.8 g, 21.2 mmol, 2.5 equiv), $TsOH{\cdot}H_2O$ (155 mg, 0.9 mmol, 0.1 equiv) and DCM (30 mL).The reaction was refluxed overnight. DCM (30 mL) and water (30 mL) were added to the mixture. The aqueous phase was extracted by DCM (20 mL × 2) again. The combined organic phases were washed by brine (30 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with PE) to afford **S26** as a colorless oil (1.04 g, 44% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 – 7.35 (m, 5H), 6.67 (s, 1H), 4.49 (s, 2H) ppm.

NaH (60%, 135 mg, 3.36 mmol, 1.5 equiv) and 3 mL DMF was added to a sealing tube, which was filled with N_2 gas. The solution of *tert*-butyl (4-methoxyphenyl)carbamate (500 mg, 2.24 mmol, 1.0 equiv) in DMF (3 mL) was charged to the system dropwise at 0 ^{o}C. The mixture was allowed to stir at 0 ^{o}C for 1.5 hours. After which, **S26** (870 mg, 3.13 mmol, 1.4 equiv) was added. The mixture was allowed to stir at room temperature overnight. EtOAc (20 mL) and water (20 mL) were added to the mixture. The aqueous phase was extracted by EtOAc (20 mL × 2). The combined organic phases were washed by brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford **S27** as a white solid (870 mg, 93% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 – 7.28 (m, 3H), 7.22 (brs, 2H), 6.70 (brs, 4H), 6.31 (s, 1H), 5.00 (s, 2H), 3.77 (s, 3H), 1.30 (brs, 9H) ppm.

To a dried flask was added **S27** (418 mg, 1 mmol, 1.0 equiv) and anhydrous Et_2O (40 mL). The mixture was cooled to -78 ^{o}C. *t*-BuLi (1.6 M, 1 mL, 1.5 mmol, 1.5 equiv) was introduced cautiously at this temperature. The mixture was stirred at this temperature for 30 min before the D_2O (0.1 g) was added. Then, the reaction mixture was allowed to stir at room temperature overnight, after which, it was quenched by water (15 mL). The mixture was extracted by Et_2O (20 mL × 2). The combined organic phases were washed by brine (20 mL), dried over Na_2SO_4 and concentrated under reduced pressure successively. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/30) to afford **(z)-D-2a** as a white solid (193 mg, 57% yield, 73% D). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.39 (d, *J* = 6.8 Hz, 2H), 7.35 – 7.27 (m, 3H),

7.10 – 6.66 (m, 4H), 5.34 (s, 0.27H), 5.32 (s, 0.73H), 5.10 (s, 0.27H), 4.66 (s, 2H), 3.77 (s, 3H), 1.40 (s, 9H) ppm.



(z)-D-2a
(73% D)

D-3a
(72% D)

Compound D-3a. 1-Fluoro-3,3-dimethyl-1,3-dihydro-λ^3-benzo[d][1,2]iodoxole **1** (42 mg, 0.15 mmol, 1.5 equiv), the substrate **(z)-D-2a** (34 mg, 0.1 mmol, 1.0 equiv), $AgSbF_6$ (3.4 mg, 0.01 mmol, 0.1 equiv) and DCM (1 mL) were introduced to a glass vial. The vial was then sealed and the mixture was allowed to stir at 55 ^oC for 3.5 hours. After that, the reaction mixture was concentrated on a rotary evaporator. The dr value was determined by ^{19}F NMR analysis of the crude product, which was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford product **D-3a** as a white solid (22.7 mg, 75% yield, dr =1:1, 72% D). ^1H NMR (400 MHz, $CDCl_3$) δ 7.41 – 7.30 (m, 7H), 6.87 (d, *J* = 9.0 Hz, 2H), 4.03, 3.90 (ABq, *J* = 10.9 Hz, 1H), 3.95, 3.89 (ABq, *J* = 10.9 Hz, 1H), 3.78 (s, 3H), 3.47 – 3.27 (m, 1.28H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -92.51, -92.65, -92.69 ppm. HRMS (ESI) m/z calcd. for $C_{17}H_{15}DFNNaO_3^+$ (M + Na^+): 325.1069 Found: 325.1067. The dr value was determined by ^{19}F NMR analysis, which was illustrated as below:

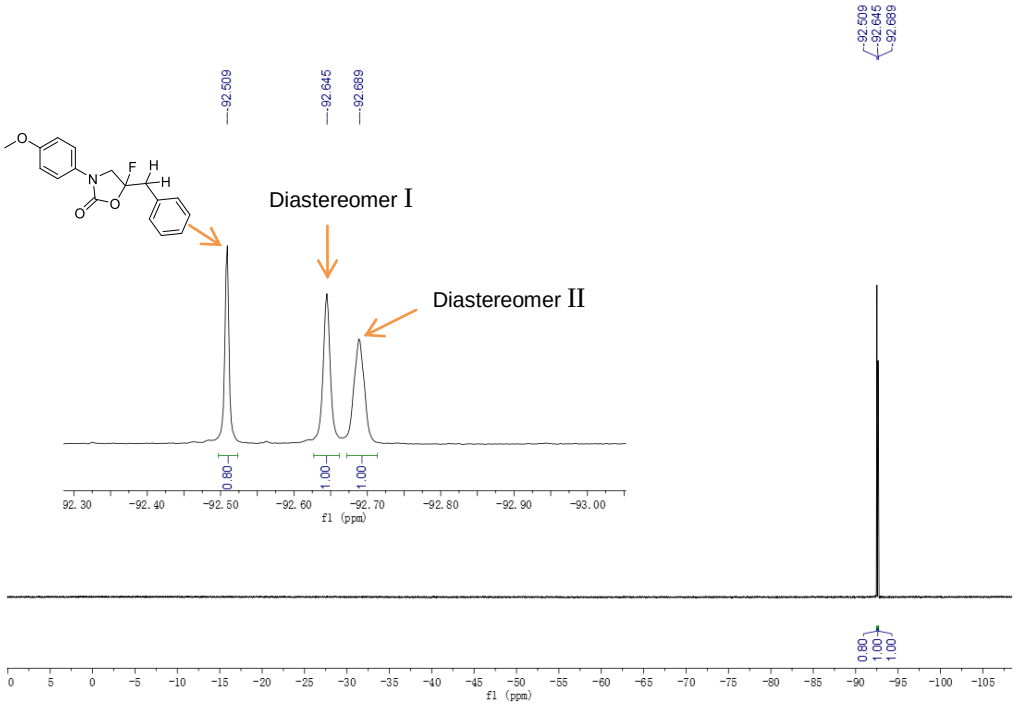
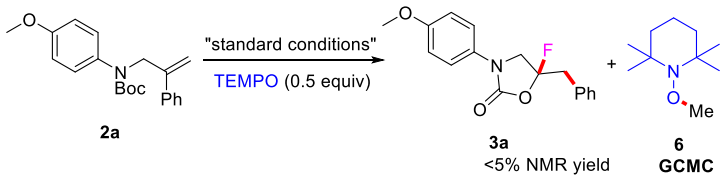


Figure S3. ^{19}FNMR (376 MHz) of compound **D-3a**

4.2 Radical trapping experiments

4.2.1 Tempo as a radical trapping reagent



1-Fluoro-3,3-dimethyl-1,3-dihydro-λ^3-benzo[d][1,2]iodoxole **1** (42 mg, 0.15 mmol, 1.5 equiv), the substrate **2a** (33.9 mg, 0.1 mmol, 1.0 equiv), Tempo (7.8 mg, 0.05 mmol, 0.5 equiv), $AgSbF_6$ (3.4 mg, 0.01 mmol, 0.1 equiv) and DCM (1 mL) were introduced to a glass vial. The vial was then sealed and the mixture was allowed to stir at 55 ^{o}C for 3.5 hours. After which, the reaction mixture was concentrated to dryness and CH_2Br_2 was added. The NMR yield was calculated by ^{1}H NMR spectroscopy using CH_2Br_2 as the internal standard. Compound **6** was detected by GCMS analysis.

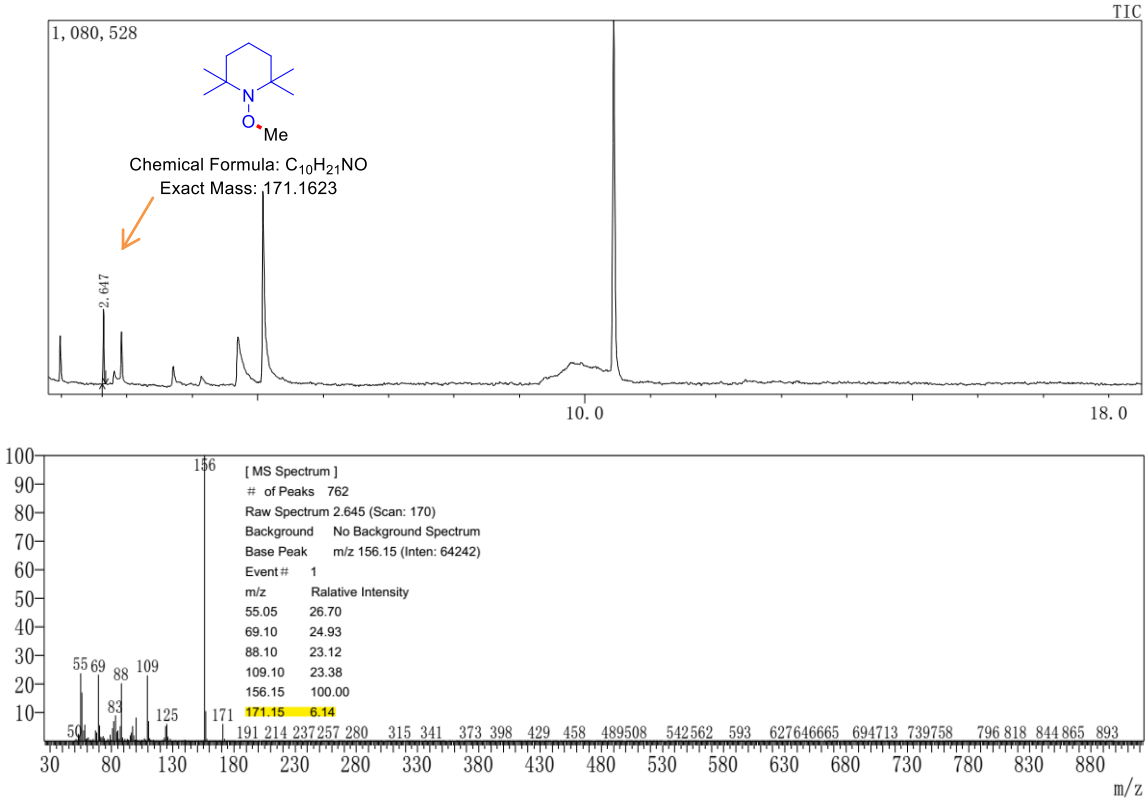
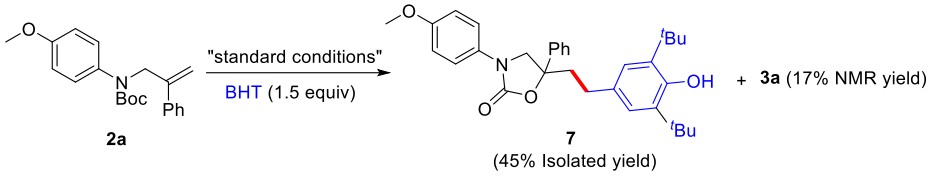


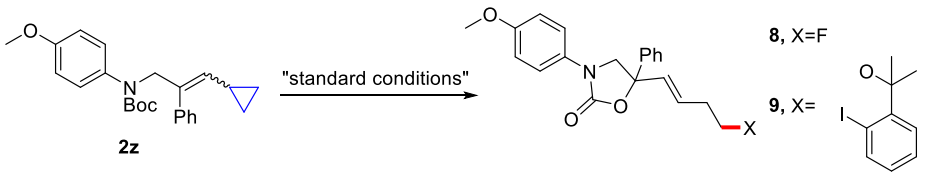
Figure S4. GCMS analysis of compound **6**

4.2.2 BHT as a radical trapping reagent



1-Fluoro-3,3-dimethyl-1,3-dihydro-λ^3-benzo[d][1,2]iodoxole **1** (42 mg, 0.15 mmol, 1.5 equiv), the substrate **2a** (33.9 mg, 0.1 mmol, 1.0 equiv), BHT (33 mg, 0.15 mmol, 1.5 equiv), $AgSbF_6$ (3.4 mg, 0.01 mmol, 0.1 equiv) and DCM (1 mL) were introduced to a glass vial. The vial was then sealed and the mixture was allowed to stir at 55 ^oC for 3.5 hours. After which, the reaction mixture was concentrated to dryness and CH_2Br_2 was added. The NMR yield was calculated by ^1H NMR spectroscopy using CH_2Br_2 as the internal standard. The NMR yield of **7** and **3a** were 47% and 17% respectively. The mixture was purified by column chromatography (eluted with EtOAc/PE = 1/30→1/15) to afford compound **7** as a thick oil (22.4 mg, 45% yield). ^1H NMR (400 MHz, $CDCl_3$) δ 7.52 – 7.38 (m, 6H), 7.35 (t, *J* = 7.0 Hz, 1H), 6.92 – 6.86 (m, 4H), 5.04 (s, 1H), 4.13 (dd, *J* = 22.7, 8.6 Hz, 2H), 3.79 (s, 3H), 2.81 – 2.65 (m, 1H), 2.45 – 2.31 (m, 3H), 1.40 (s, 18H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.62, 154.76, 152.19, 142.71, 136.13, 131.49, 131.47, 128.99, 128.15, 124.88, 124.51, 120.61, 114.46, 81.64, 58.18, 55.68, 44.30, 34.45, 30.46, 29.74 ppm. IR (KBr) ***v*** 3642, 3627, 3004, 2986, 2955, 2920, 1747, 1514, 1434, 1403, 1275, 1260, 1148, 828, 764, 750, 702. HRMS (ESI) m/z calcd. for $C_{32}H_{39}NNaO_4^+$ (M + Na^+): 524.2771 Found: 524.2773.

4.3 Radical clock experiments



Compound 8, 9. 1-Fluoro-3,3-dimethyl-1,3-dihydro-λ^3-benzo[d][1,2]iodoxole **1** (126 mg, 0.45 mmol, 1.5 equiv), the substrate **2z** (114 mg, 0.3 mmol, 1.0 equiv), $AgSbF_6$ (10.3 mg, 0.03 mmol, 0.1 equiv) and DCM (3 mL) were introduced to a glass vial. The vial was then sealed and the mixture was allowed to stir at 55 ^oC for 3.5 hours. After that, the reaction mixture was concentrated on a rotary evaporator. The residue was purified by column chromatography (eluted with EtOAc/PE = 1/15) to afford compound **8** (9.6 mg, 9% yield, thick oil) and compound **9** (14.1 mg, 8% yield, thick oil).

compound 8. ^1H NMR (400 MHz, $CDCl_3$) δ 7.48 – 7.38 (m, 6H), 7.38 – 7.31 (m, 1H), 6.94 – 6.83 (m, 2H), 5.99 (d, *J* = 15.6 Hz, 1H), 5.84 (dt, *J* = 15.5, 6.7 Hz, 1H), 4.47 (dt, *J* = 47.1, 6.1 Hz, 2H), 4.24 (d, *J* = 8.8 Hz, 1H), 4.19 (d, *J* = 8.8 Hz, 1H), 3.79 (s, 3H), 2.49 (ddd, *J* = 24.8, 12.8, 6.4 Hz, 2H) ppm. ^{19}F NMR (376 MHz, $CDCl_3$) δ -218.12 ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.66, 154.48, 141.26, 133.94, 131.39, 128.94, 128.46, 127.53 (d, *J* = 5.9 Hz), 125.10, 120.68, 114.45, 82.54 (d, *J* = 168.0 Hz), 80.82, 57.84, 55.67, 33.29 (d, *J* = 20.6 Hz) ppm. IR (KBr) ***v*** 3005, 2989, 1750, 1514, 1400, 1275, 1260, 1153, 829, 765, 750, 704. HRMS (ESI) m/z calcd. for $C_{20}H_{20}FNNaO_3^+$ (M + Na^+): 364.1319 Found: 364.1320.

compound 9. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 (d, *J* = 7.8 Hz, 1H), 7.47 – 7.37 (m, 6H), 7.35 – 7.27 (m, 3H), 6.93 – 6.83 (m, 3H), 5.91 (d, *J* = 15.7 Hz, 1H), 5.83 (dt, *J* = 15.5, 6.2 Hz, 1H), 4.24 (d, *J* = 8.7 Hz, 1H), 4.15 (d, *J* = 8.7 Hz, 1H), 3.79 (s, 3H), 3.12 (t, *J* = 7.0 Hz, 2H), 2.44 (dd, *J* = 13.2, 6.8 Hz, 2H), 1.64 (s, 3H), 1.63 (s, 3H) ppm. ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.59, 154.55, 145.40, 143.41, 141.58, 132.42, 131.54, 130.13, 128.86, 128.82, 128.30, 128.25, 128.02, 125.21, 120.60, 114.43, 93.71, 81.05, 61.87, 57.80, 55.67, 33.29, 27.29 ppm. IR (KBr) ***v*** 3004, 2985, 2927, 2853, 1748, 1514, 1399, 1275, 1260, 1155, 1073, 1006, 827, 764, 750, 699. HRMS (ESI) m/z calcd. for $C_{29}H_{30}INNaO_4^+$ (M + Na^+): 606.1112 Found: 606.1112.

5 Radiosynthesis of [^{18}F]-3:

No-carrier-added ^{18}F-fluoride was produced via the ^{18}O(p,n)^{18}F reaction using GE PETrace 880 (GE Health, IL, USA) under 55 μA irradiation for 20min. The cyclotron-produced aqueous ^{18}F-fluoride was trapped on a pre-conditioned QMA anion-exchange cartridge followed by releasing with phase transfer reagent (477μL acetonitrile and 70μL 20% tetrabutylammonium bicarbonate aqueous solution). The ^{18}F-fluoride was azeotropically dried at 70^{o}C under a stream of nitrogen with vacuum on for 4 min, the reactor was then heated to 100^{o}C under vacuum for 2 min. The ^{18}F-fluoride was then dissolved in 1 mL anhydrous acetonitrile for following procedures.

The radiolabeling reactions were performed using the following protocol. The alkene precursor **2a**, **2b**, or **2c** (6 μmol) was mixed with 1.0 equivalent of chloroiodane (**10**) in 20 μL of anhydrous MeCN. The resulting solution was then combined with [^{18}F]-TBAF in 20 μL MeCN. The reaction mixture was incubated at elevated temperature (60/80 ^{o}C) to allow ^{18}F-Cl exchange reaction to proceed. Then, the Ag salt (1.0 equiv.) in acetonitrile was added to the reaction mixture. After addition of Ag salt, the reaction was incubated at elevated temperature (60/80 ^{o}C) for another 10 min to allow ^{18}F-radiofluorination to process, quenched with 1 mL of 1:1 (v/v) water: MeCN, and passed through Sep-Pak light alumina N cartridge, respectively. An aliquot of aqueous fraction was analyzed by HPLC using method A. The identity of [^{18}F]-fluorinated heterocycles ([^{18}F]-**3a**, [^{18}F]-**3b**, and [^{18}F]-**3c**) was confirmed by the comparison of their retention times with those of non-radiolabeled analogues (**3a**, **3b**, and **3c**).

HPLC Method A：Phenomenex, Kinetex® 5μm EVO C18 100 Å, 250 x 4.6 mm LC Column. Solvent A: 0.1% TFA water; Solvent B: 0.1% TFA acetonitrile; 0 to 2 min: isocratic elution at 50% solvent B, 2 to 12 min, 50% to 95% solvent B. Flow rate: 1 mL/min, column temperature: 19 to 21 ^{o}C.

6 References

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[6] M. Cheng, Y. Cheng. *Org. Lett*., 2016, **18**, 1682.

7 Data Analysis for radiochemistry experiments

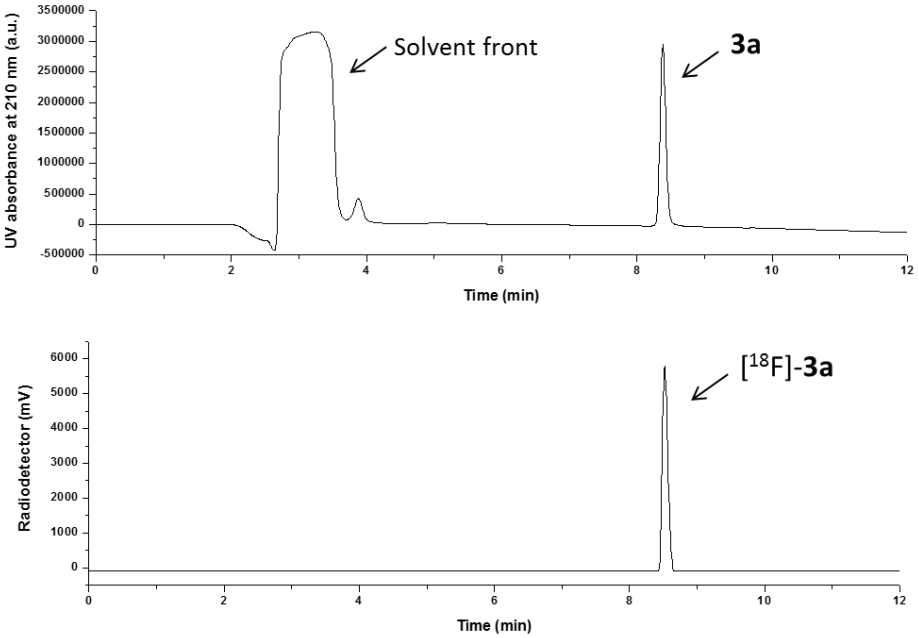


Figure S5. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3a** solution co-injected with the standard (**3a**)

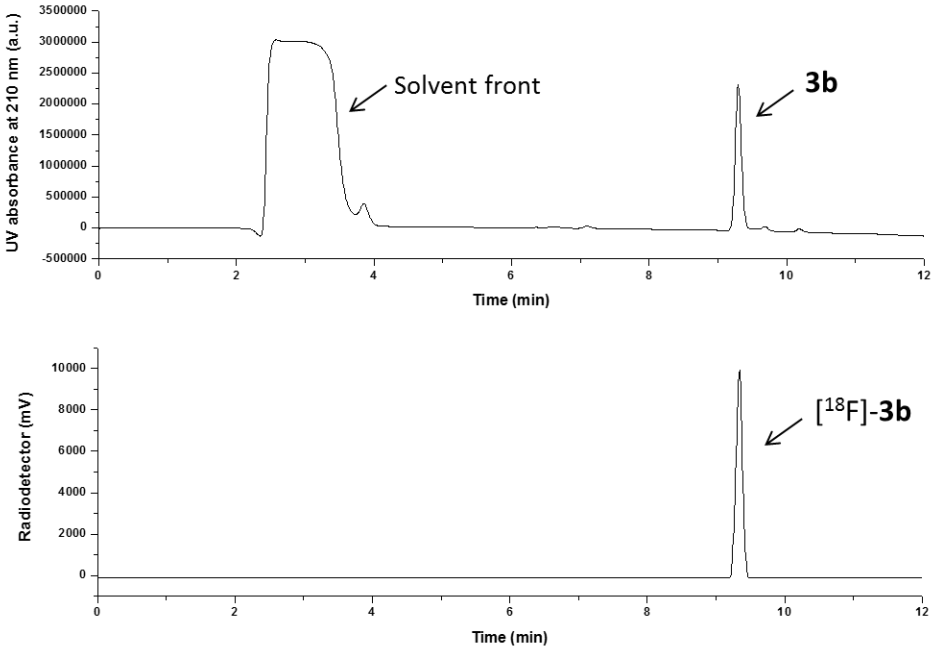


Figure S6. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3b** solution co-injected with the standard (**3b**)

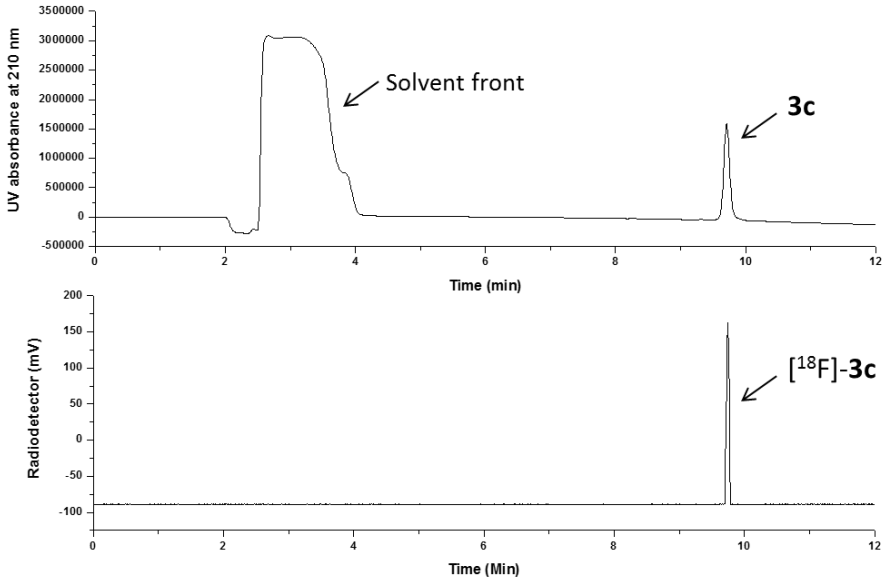


Figure S7. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3c** solution co-injected with the standard (**3c**)

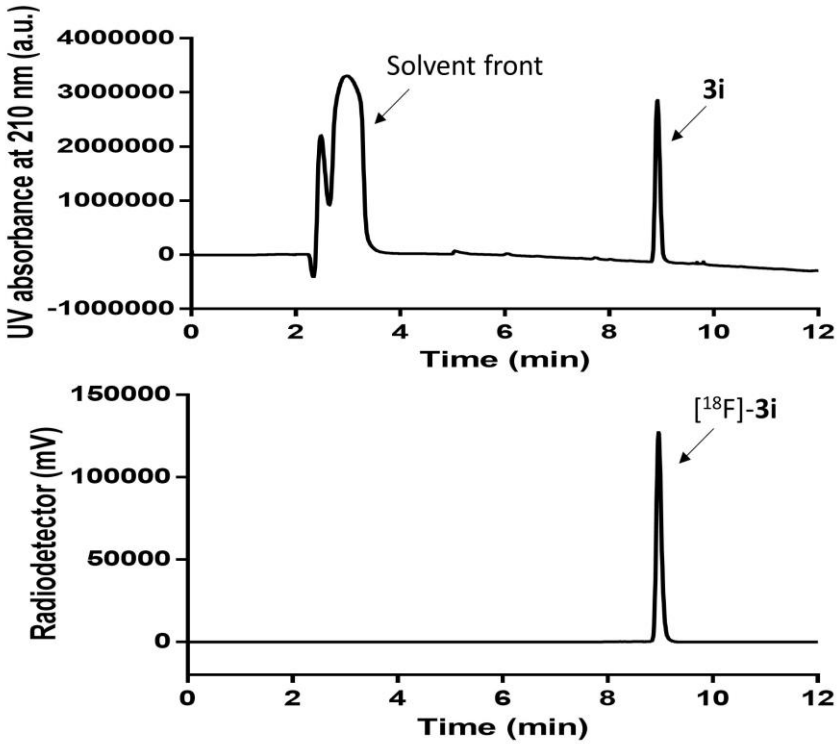


Figure S8. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3i** solution co-injected with the standard (**3i**)

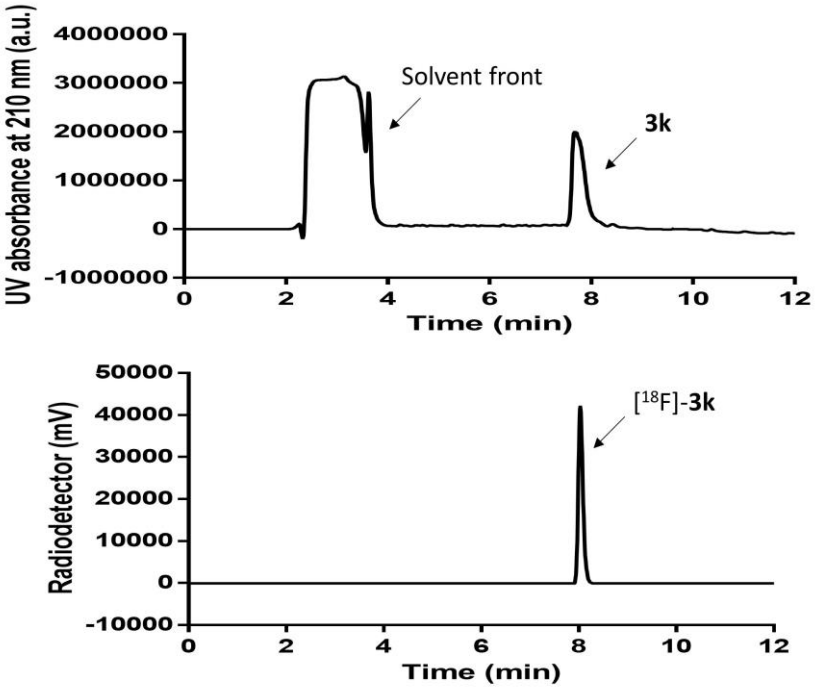


Figure S9. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3k** solution co-injected with the standard (**3k**)

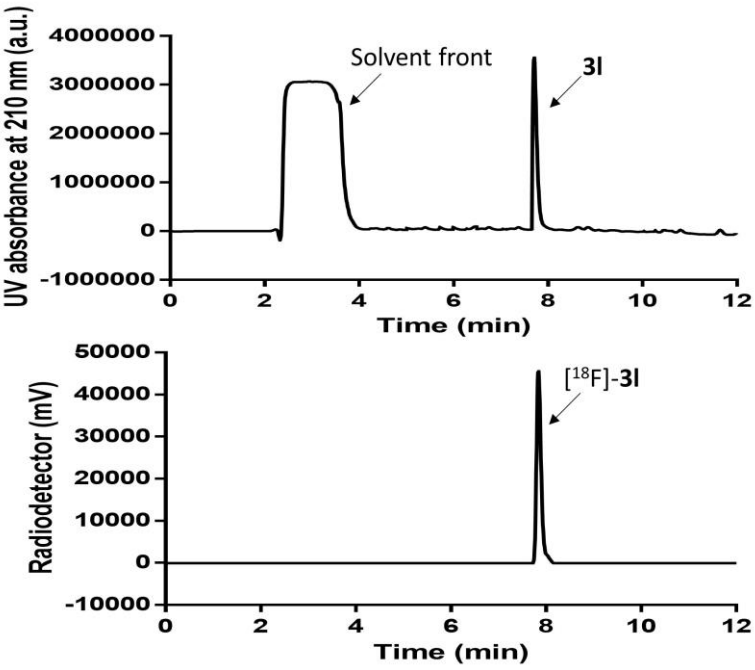


Figure S10. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3l** solution co-injected with the standard (**3l**)

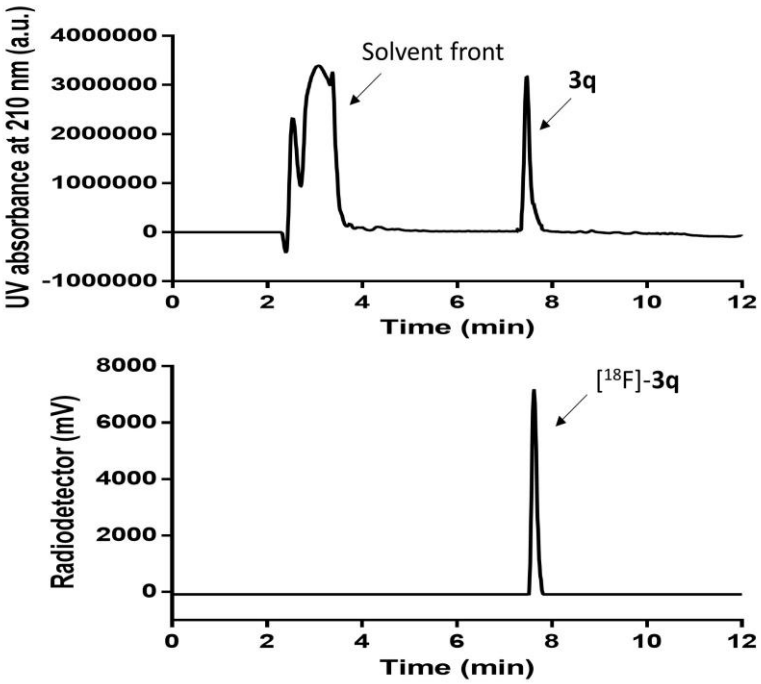


Figure S11. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3q** solution co-injected with the standard (**3q**)

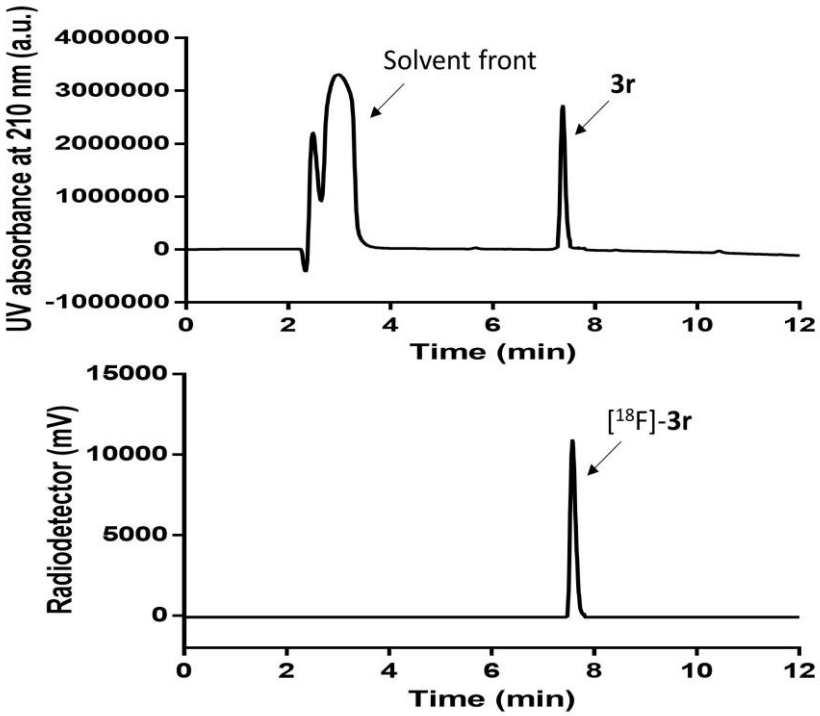
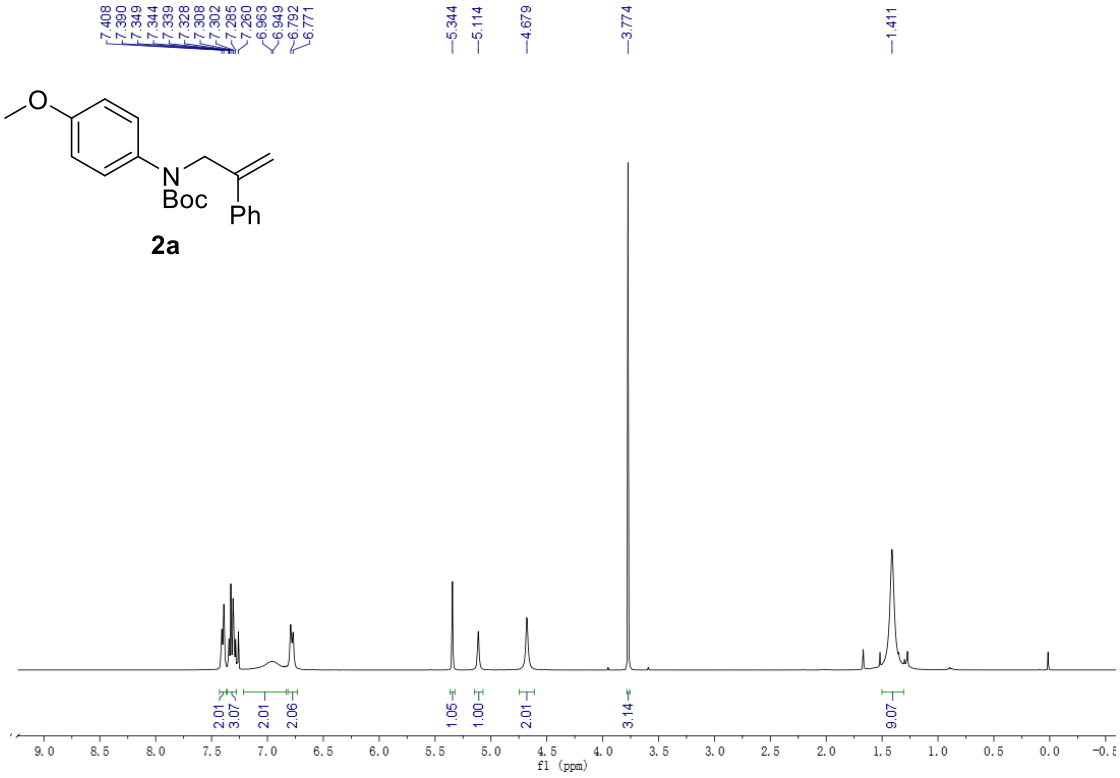
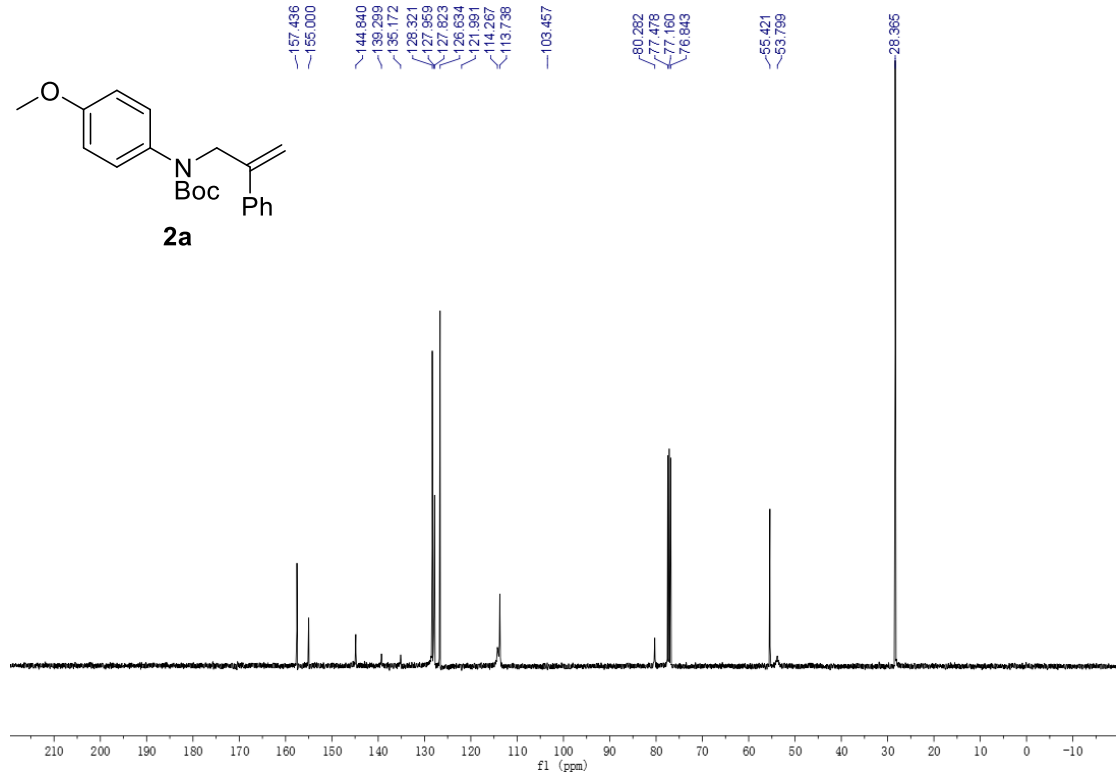
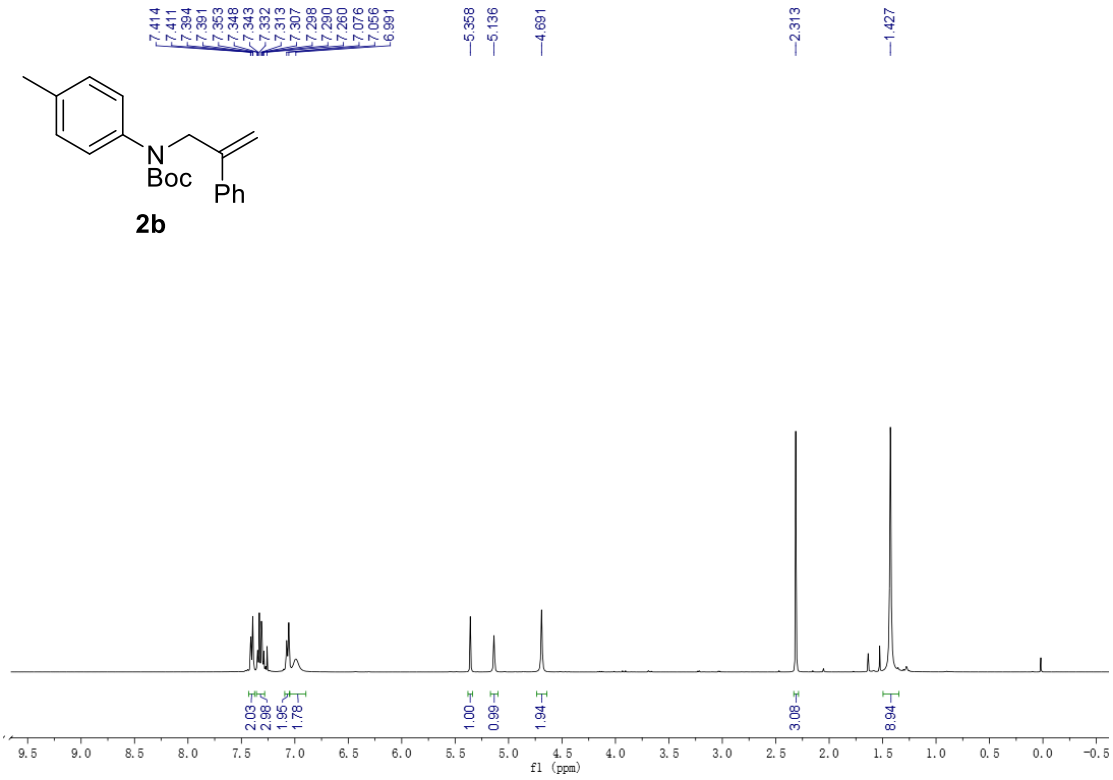


Figure S12. HPLC UV-Chromatogram (above) and radio-chromatogram (below) of the HPLC purified [^{18}F]-**3r** solution co-injected with the standard (**3r**)

8 NMR Spectra



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7.056
6.991
5.358
5.136
4.691
2.313
1.427
N
Boc
Ph
2b
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0.99
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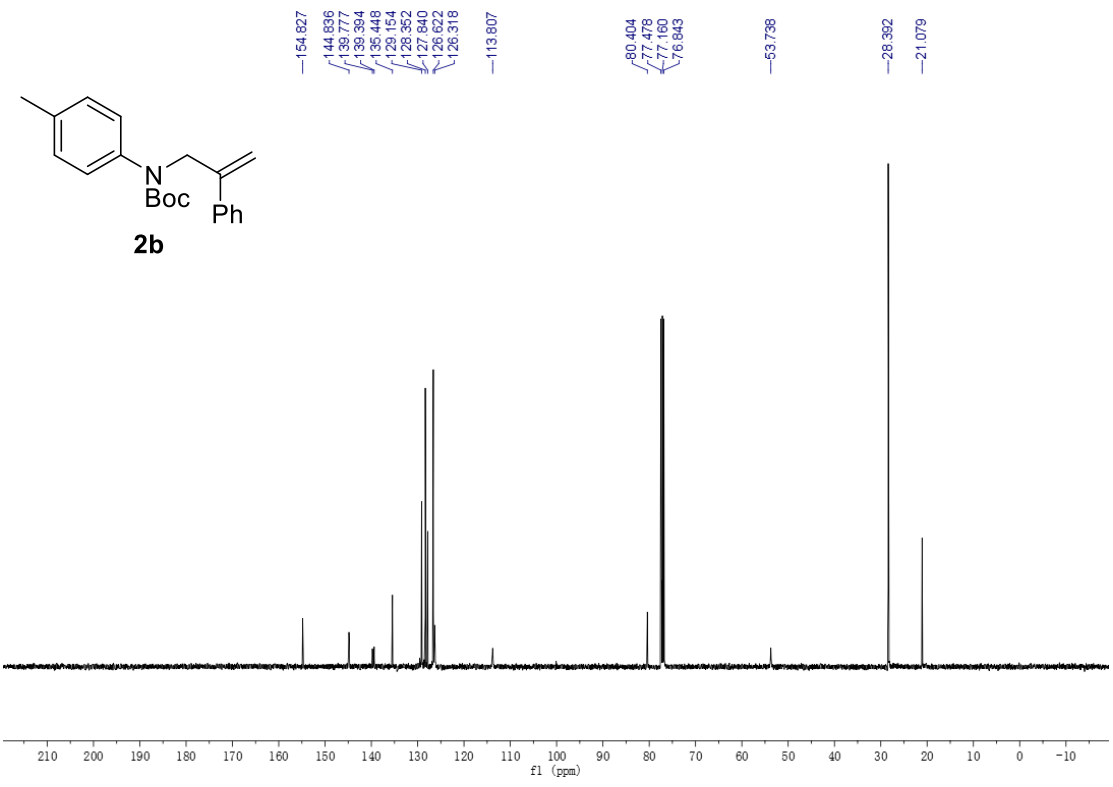
3.08
8.94
f1 (ppm)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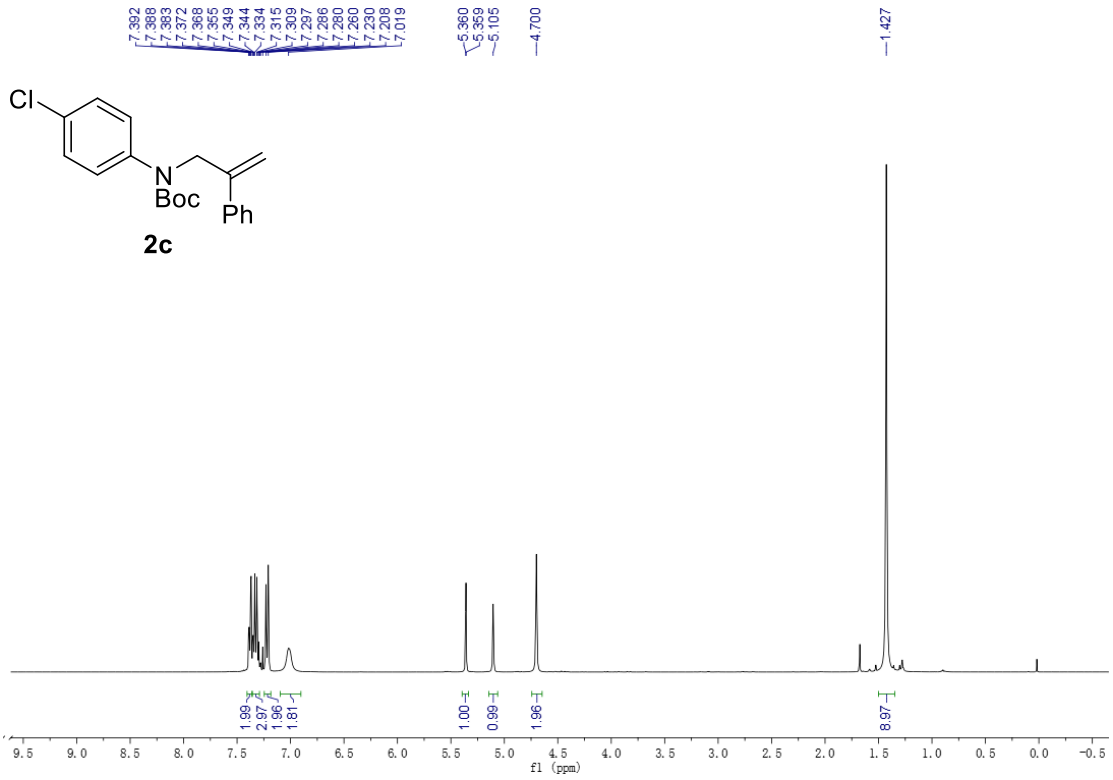
Boc
Ph
2b
f1 (ppm)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5.359
5.105
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1.427
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Boc
Ph
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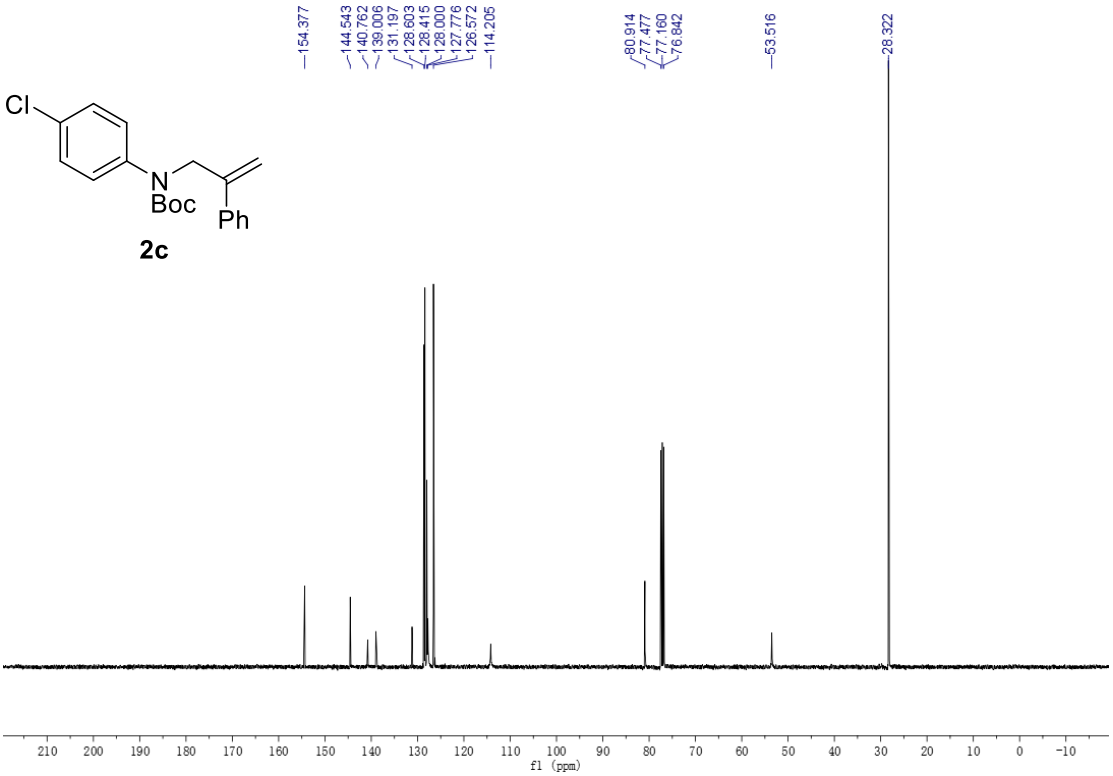
f1 (ppm)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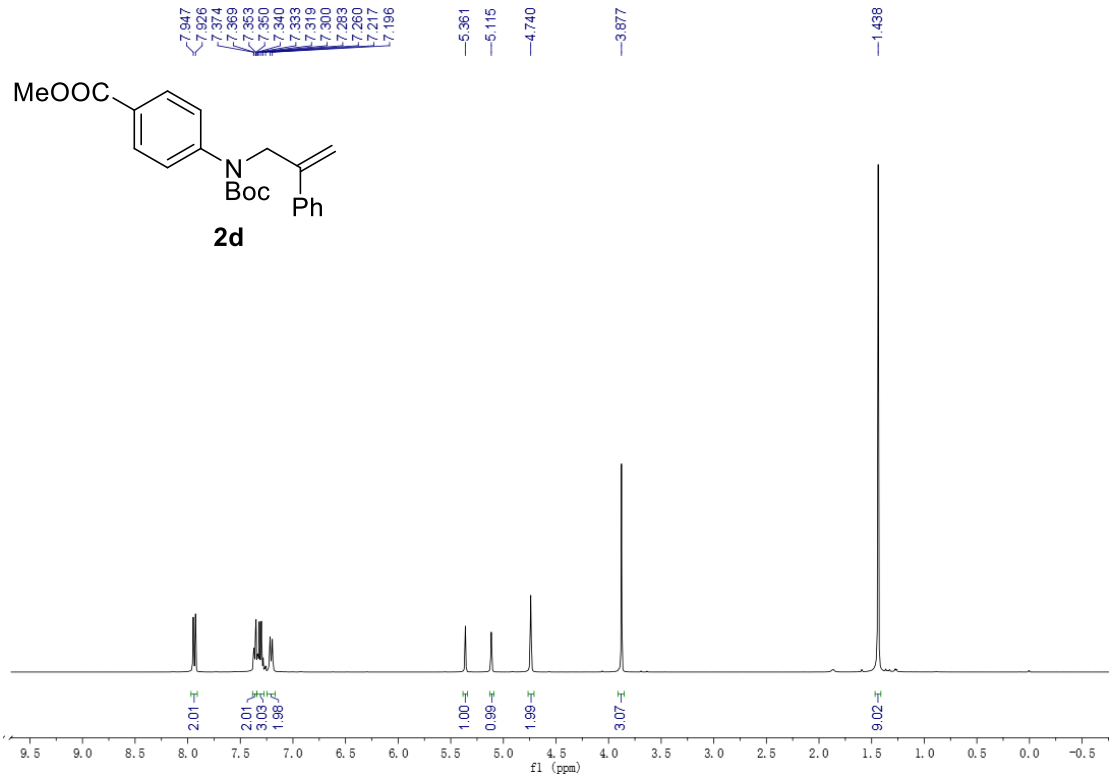
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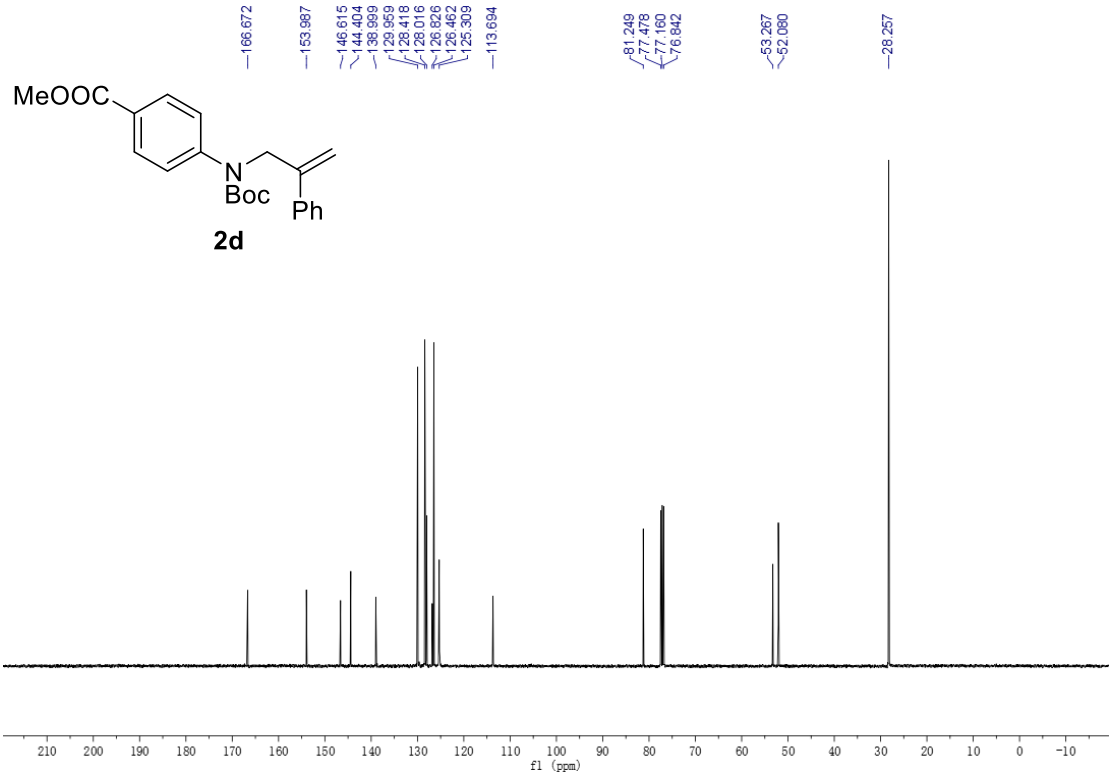
MeOOC
N
Boc
Ph
2d
2.01
2.01
3.03
1.98
1.00
0.99
1.99
3.07
9.02
f1 (ppm)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144.404
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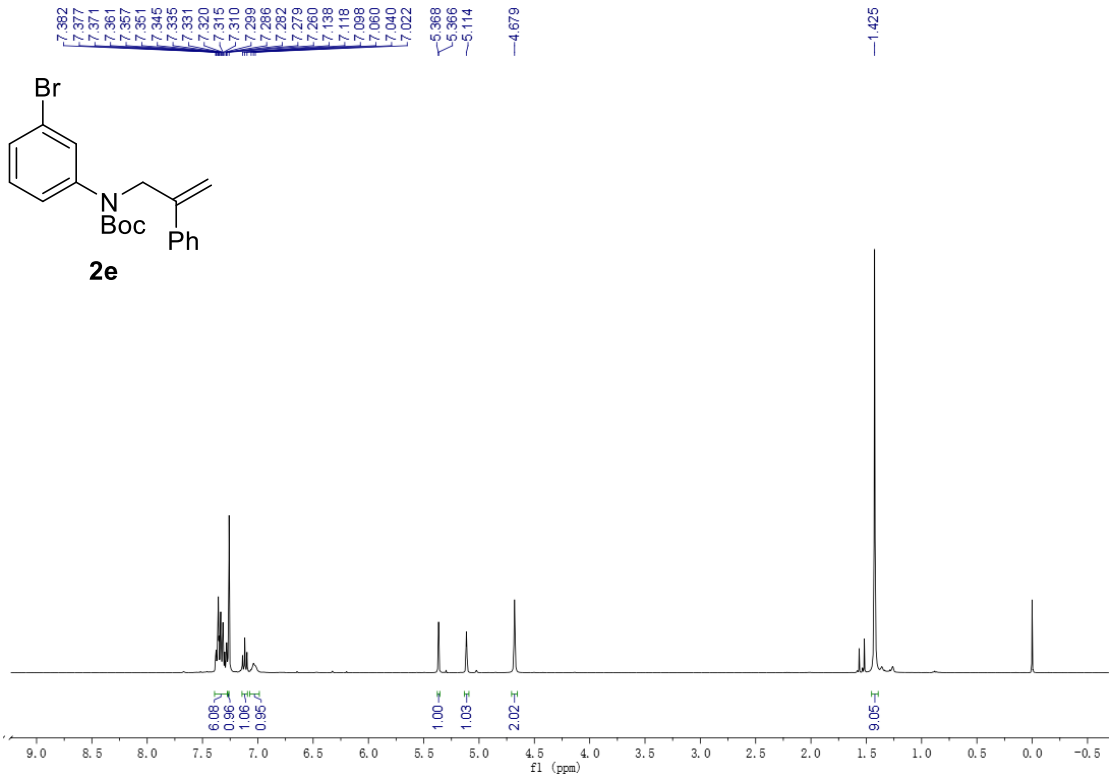
129.959
128.418
128.016
126.826
126.462
125.309
113.694
81.249
77.478
77.160
76.842
53.267
52.080
28.257
MeOOC
N
Boc
Ph
2d
f1 (ppm)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7.345
7.335
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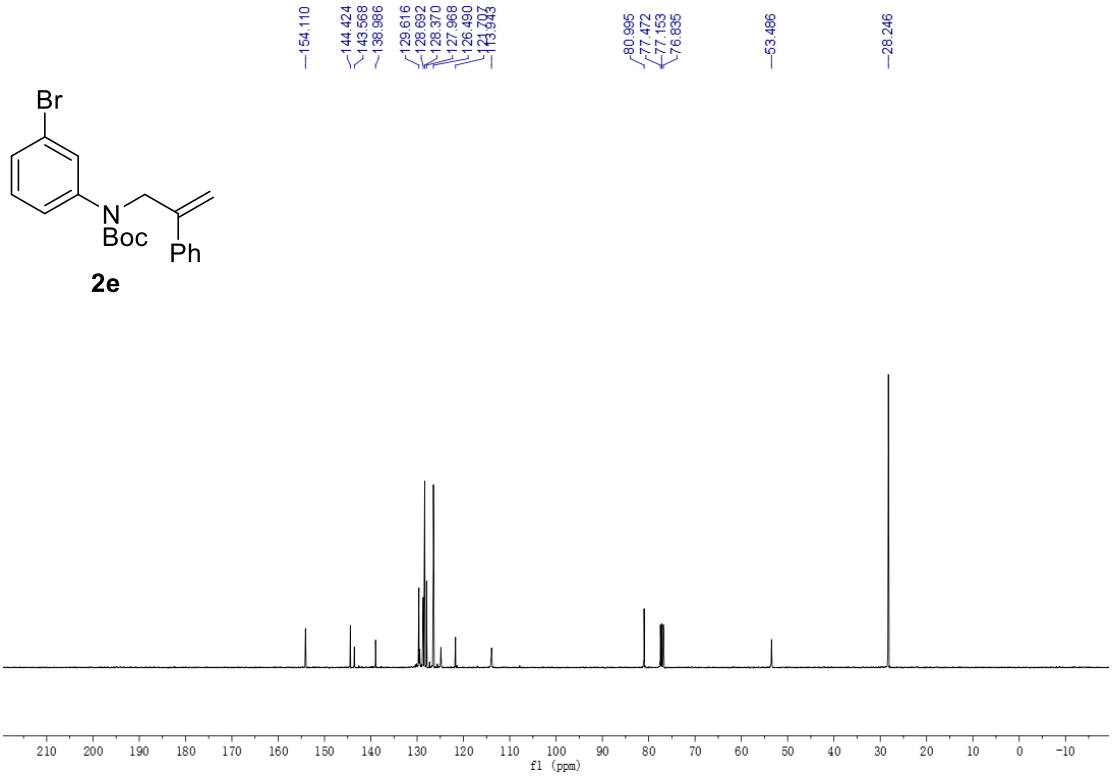
7.315
7.310
7.299
7.286
7.282
7.279
7.260
7.138
7.118
7.098
7.060
7.040
7.022
5.368
5.366
5.114
4.679
1.425
Br
N
Boc
Ph
2e
6.08
0.96
1.06
0.95
1.00
1.03
2.02
9.05
f1 (ppm)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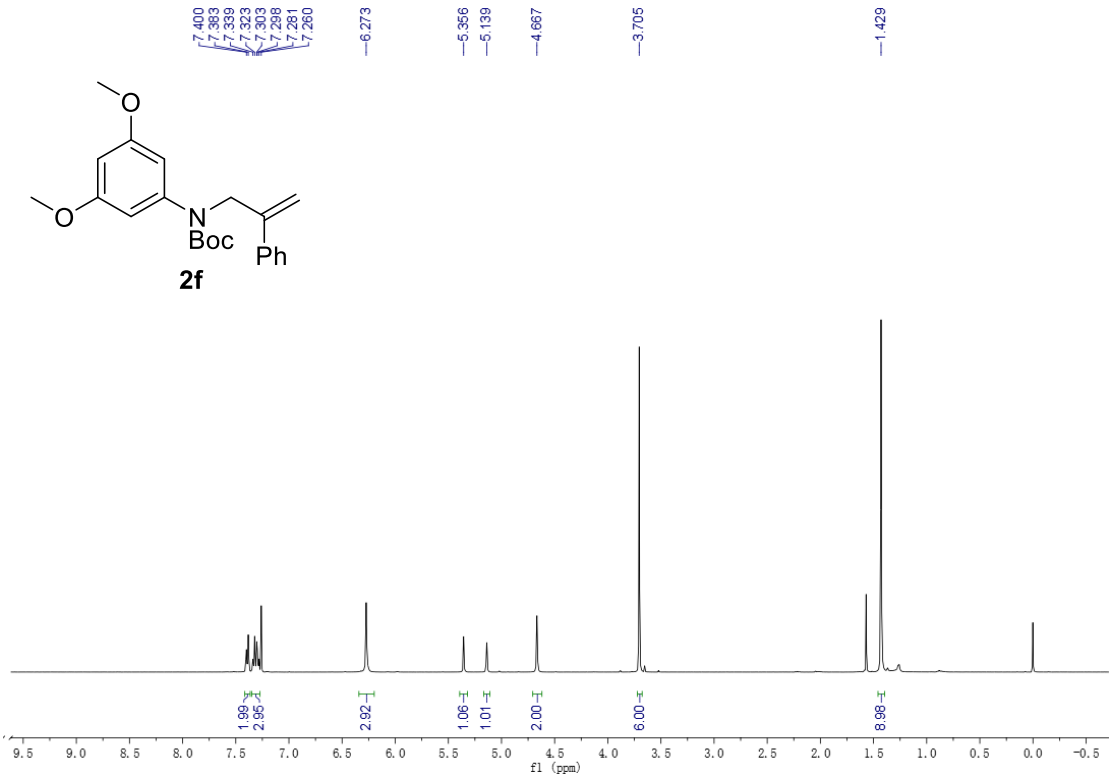
77.153
76.835
53.486
28.246
Br
N
Boc
Ph
2e
f1 (ppm)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7.339
7.323
7.303
7.298
7.281
7.260
6.273
5.356
5.139
4.667
3.705
1.429
O
O
N
Boc
Ph
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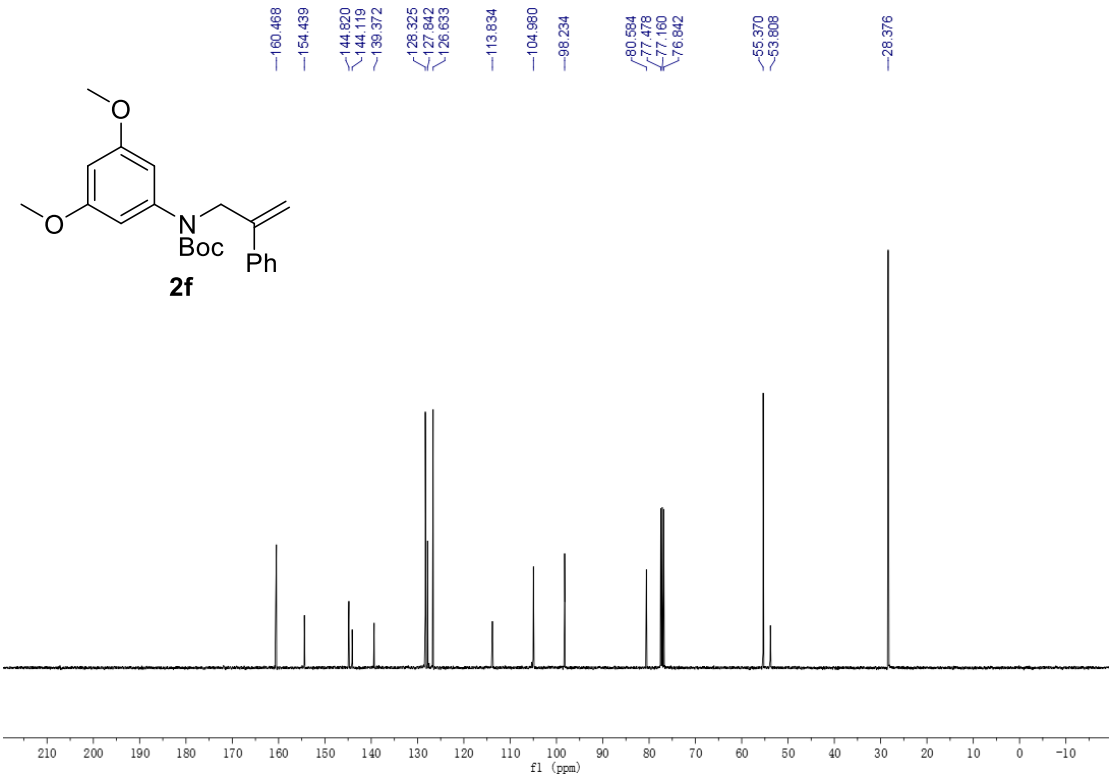
2.95
2.92
1.06
1.01
2.00
6.00
8.98
f1 (ppm)

2f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139.372
128.325
127.842
126.633
113.834
104.980
98.234
80.584
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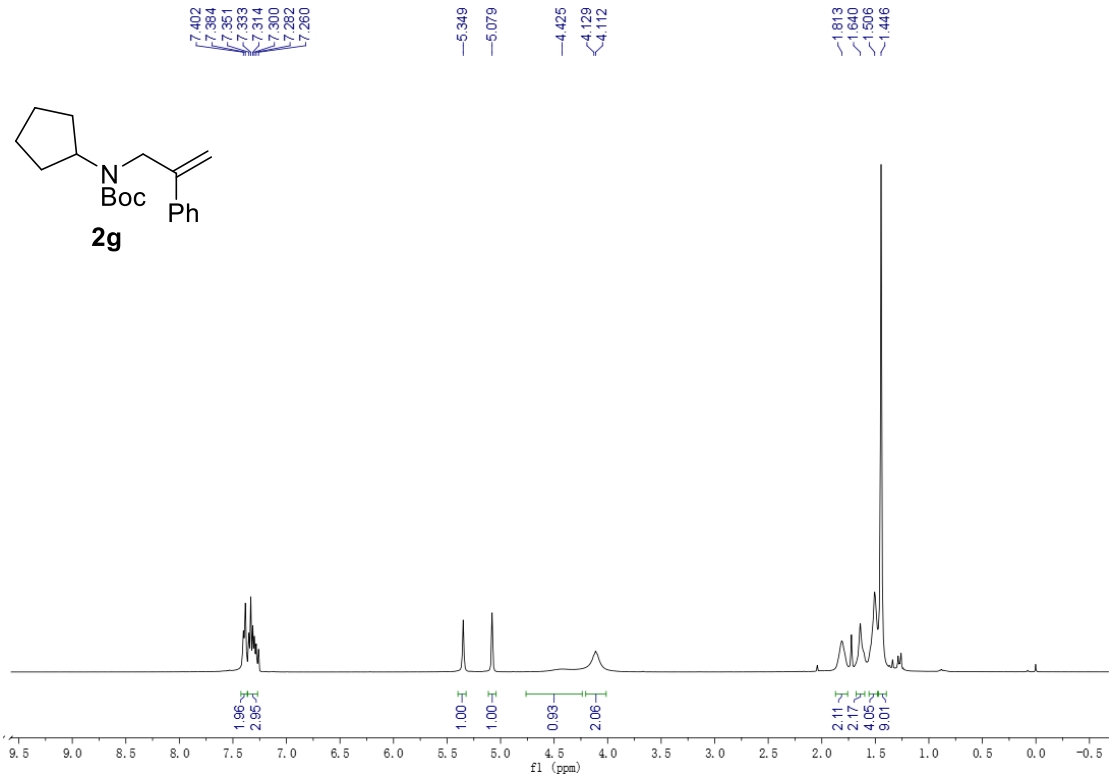
77.160
76.842
55.370
53.808
28.376
O
O
N
Boc
Ph
f1 (ppm)

2f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5.079
4.425
4.129
4.112
1.813
1.640
1.506
1.446
N
Boc
Ph
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1.00
1.00
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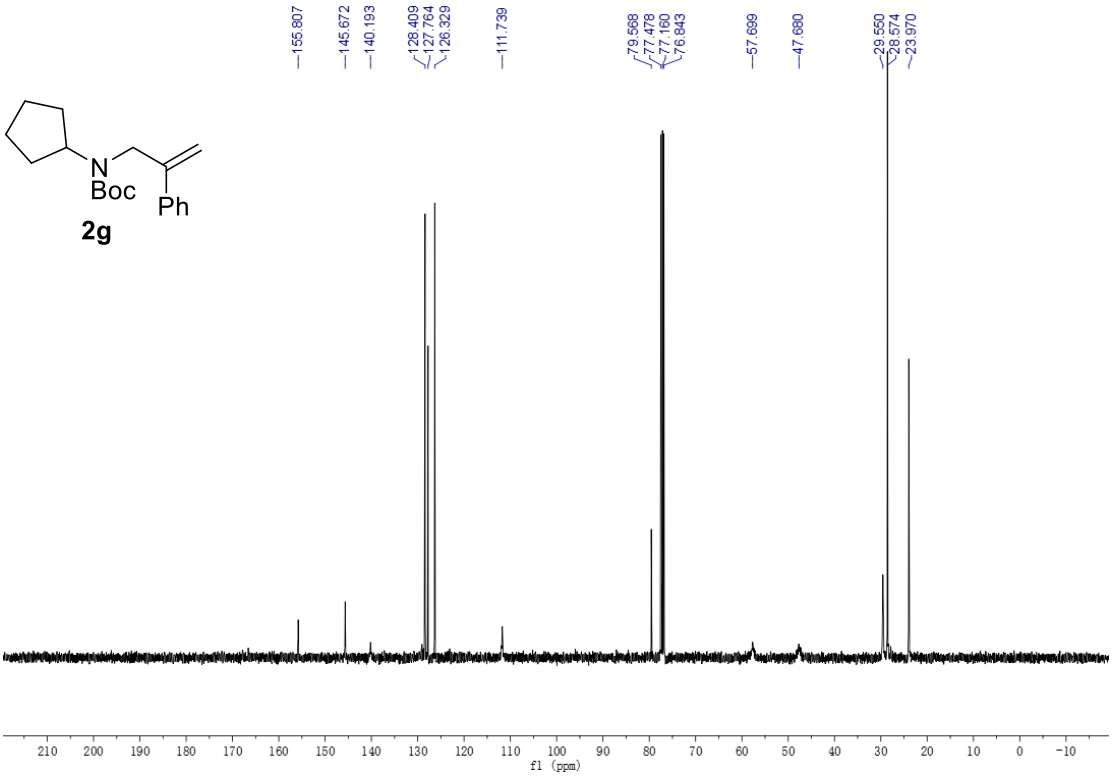
2.06
2.11
2.17
4.05
9.01
f1 (ppm)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145.672
140.193
128.409
127.764
126.329
111.739
79.568
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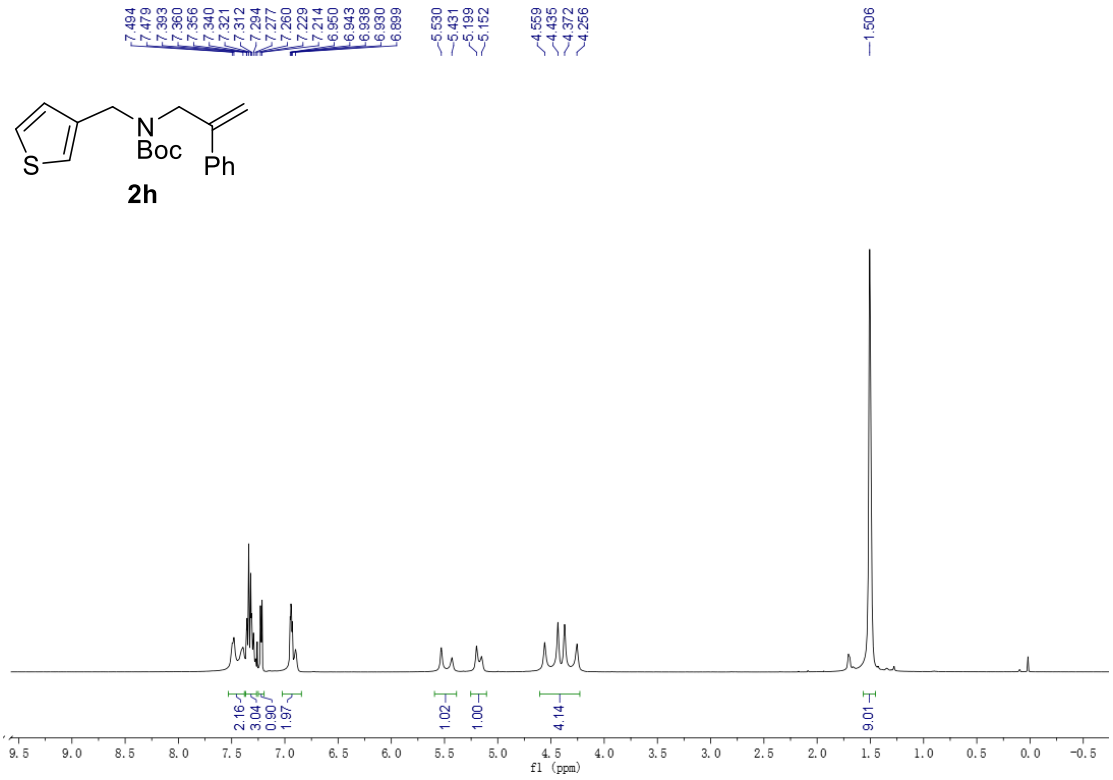
47.680
29.550
28.574
23.970
N
Boc
Ph
2g
f1 (ppm)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7.340
7.321
7.312
7.294
7.277
7.260
7.229
7.214
6.950
6.943
6.938
6.930
6.899
5.530
5.431
5.199
5.152
4.559
4.435
4.372
4.256
1.506
N
Boc
S
Ph
2h
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3.04
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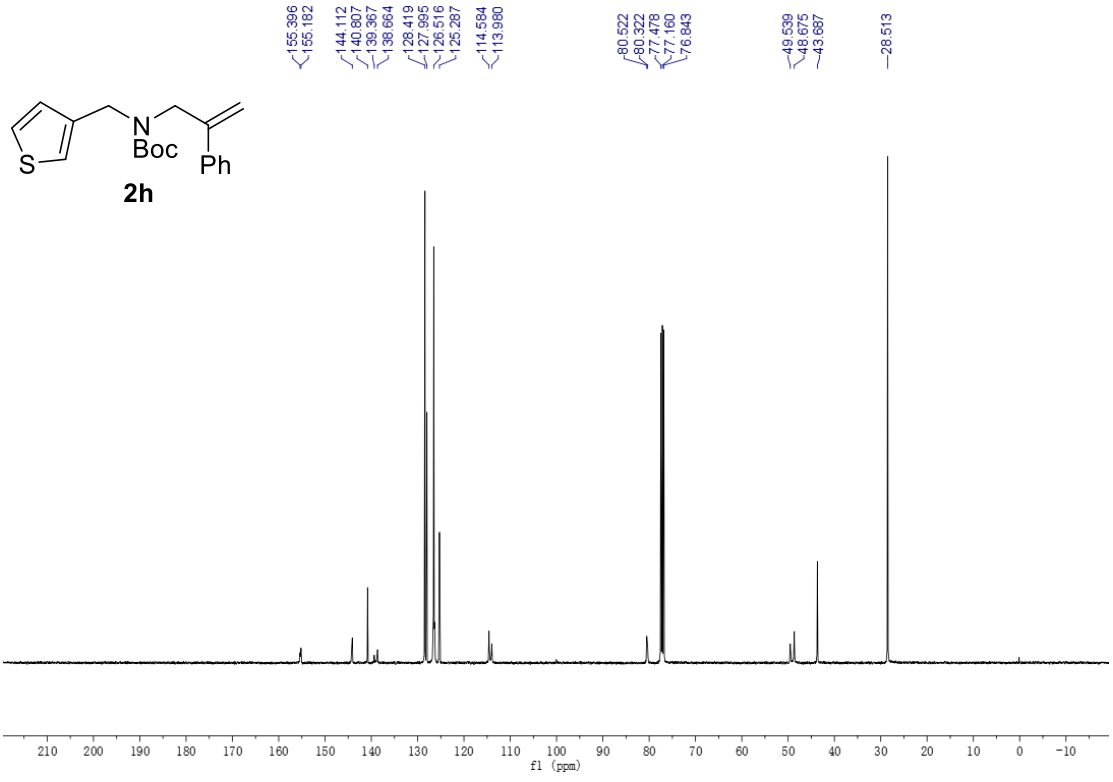
1.97
1.02
1.00
4.14
9.01
f1 (ppm)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144.112
140.807
139.367
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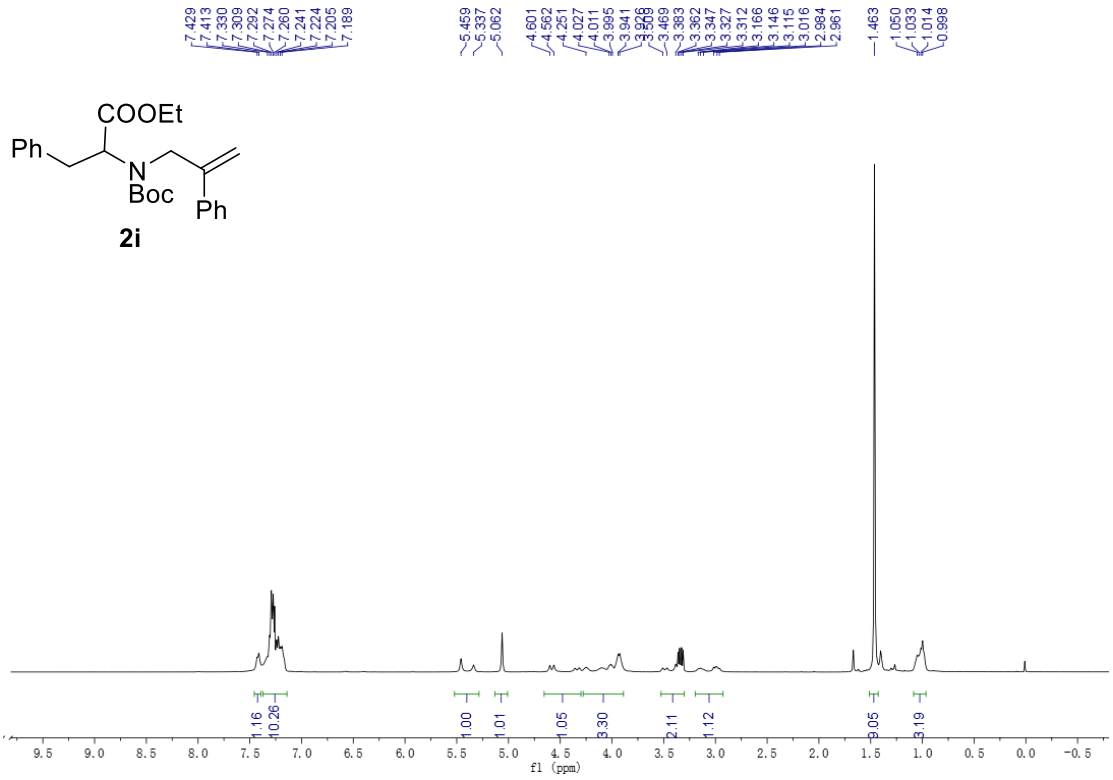
128.419
127.995
126.516
125.287
114.584
113.980
80.522
80.322
77.478
77.160
76.843
49.539
48.675
43.887
28.513
N
Boc
S
Ph
2h
f1 (ppm)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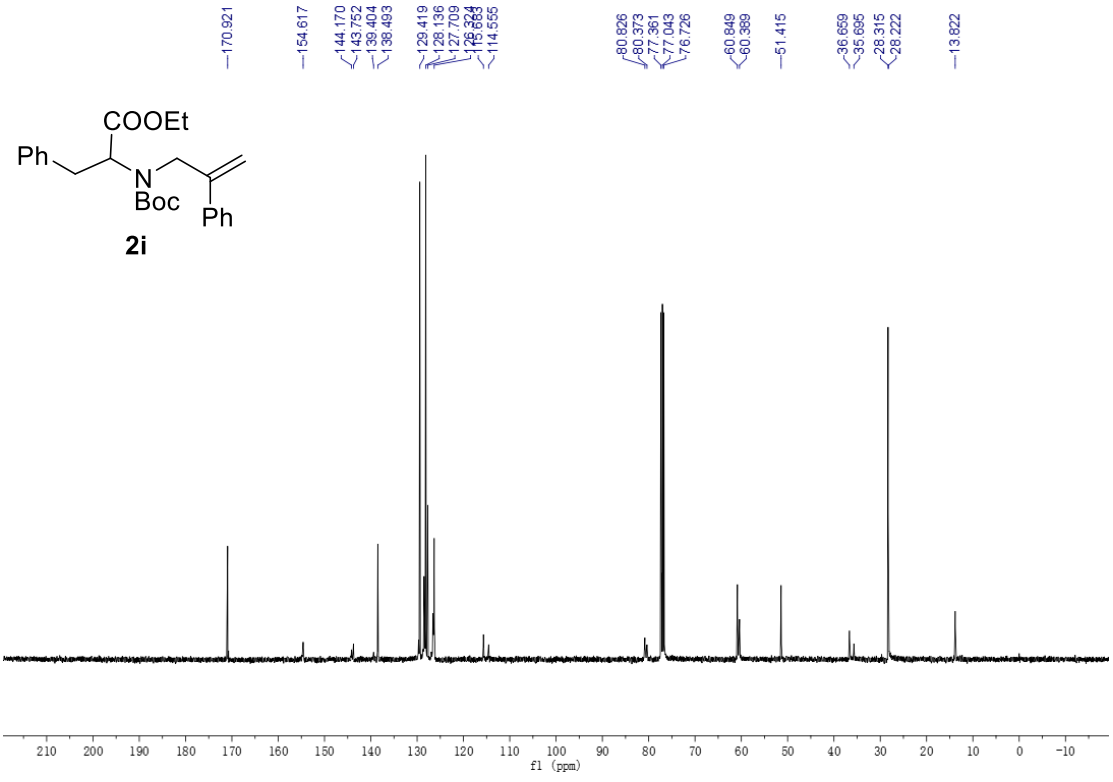
7.413
7.330
7.309
7.292
7.274
7.260
7.241
7.224
7.205
7.189
5.459
5.337
5.062
4.601
4.562
4.251
4.027
4.011
3.995
3.941
3.926
3.909
3.469
3.383
3.362
3.347
3.327
3.312
3.166
3.146
3.115
3.016
2.984
2.961
1.463
1.050
1.033
1.014
0.998
COOEt
Ph
N
Boc
Ph
2i
1.16
10.26
1.00
1.01
1.05
3.30
2.11
1.12
9.05
3.19
f1 (ppm)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144.170
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139.404
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129.419
128.136
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80.826
80.373
77.361
77.043
76.726
60.849
60.389
51.415
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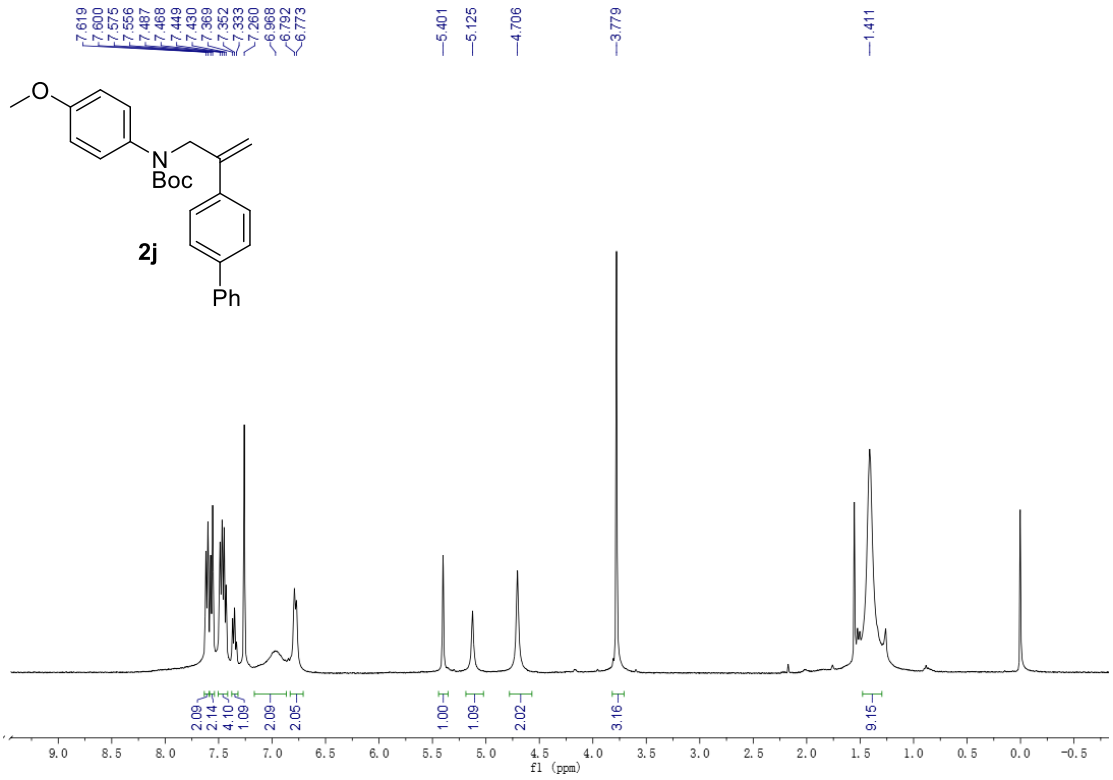
35.695
28.315
28.222
13.822
COOEt
Ph
N
Boc
Ph
2i
f1 (ppm)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7.430
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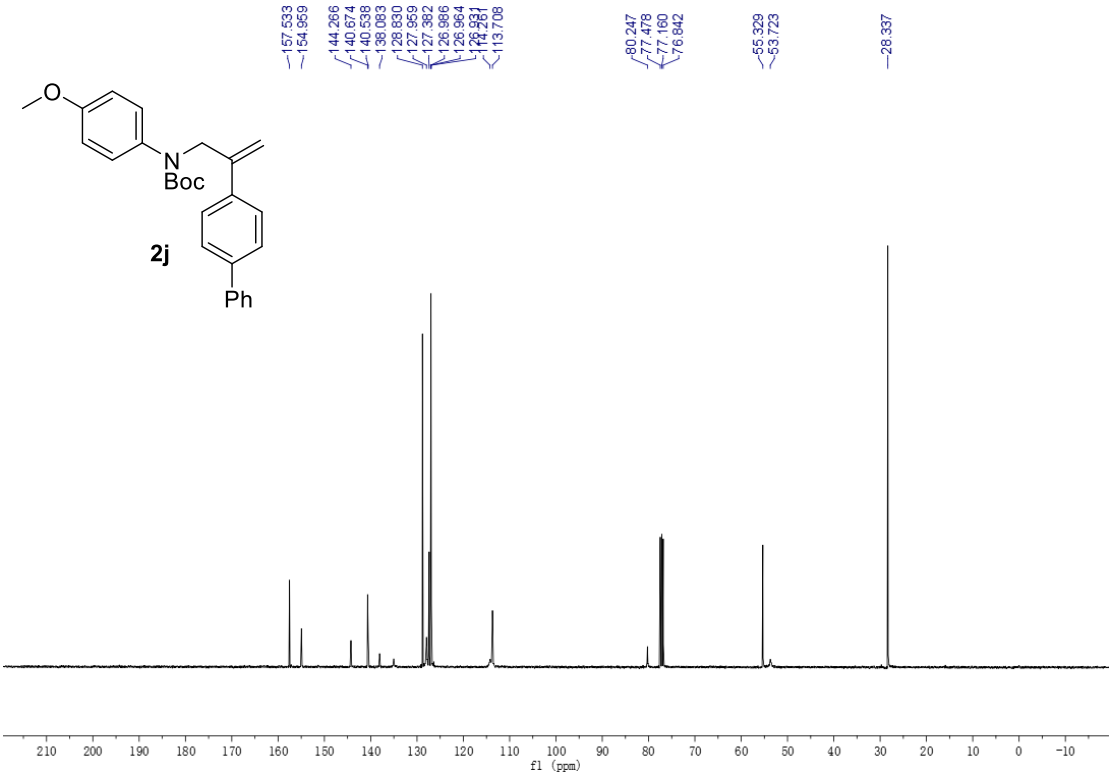
7.333
7.260
6.968
6.792
6.773
5.401
5.125
4.706
3.779
1.411
O
N
Boc
2j
Ph
2.09
2.14
4.10
1.09
2.09
2.05
1.00
1.09
2.02
3.16
9.15
f1 (ppm)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127.959
127.382
126.986
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114.281
113.708
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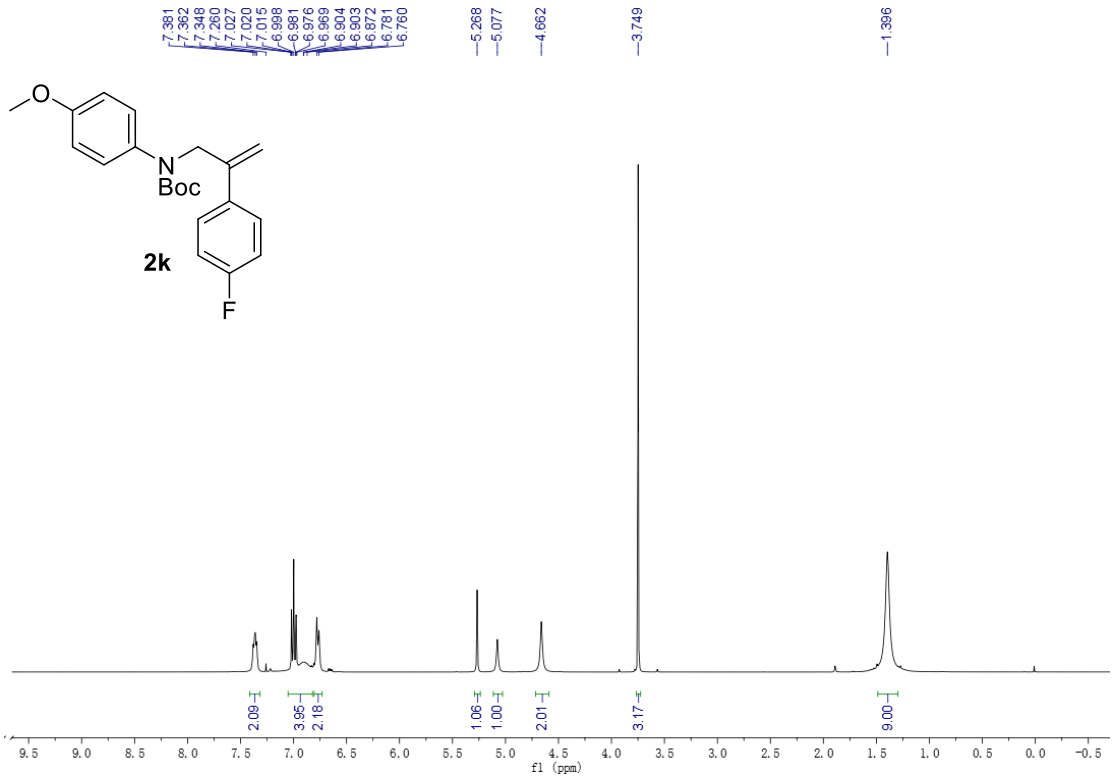
77.160
76.842
55.329
53.723
28.337
O
N
Boc
2j
Ph
f1 (ppm)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7.362
7.348
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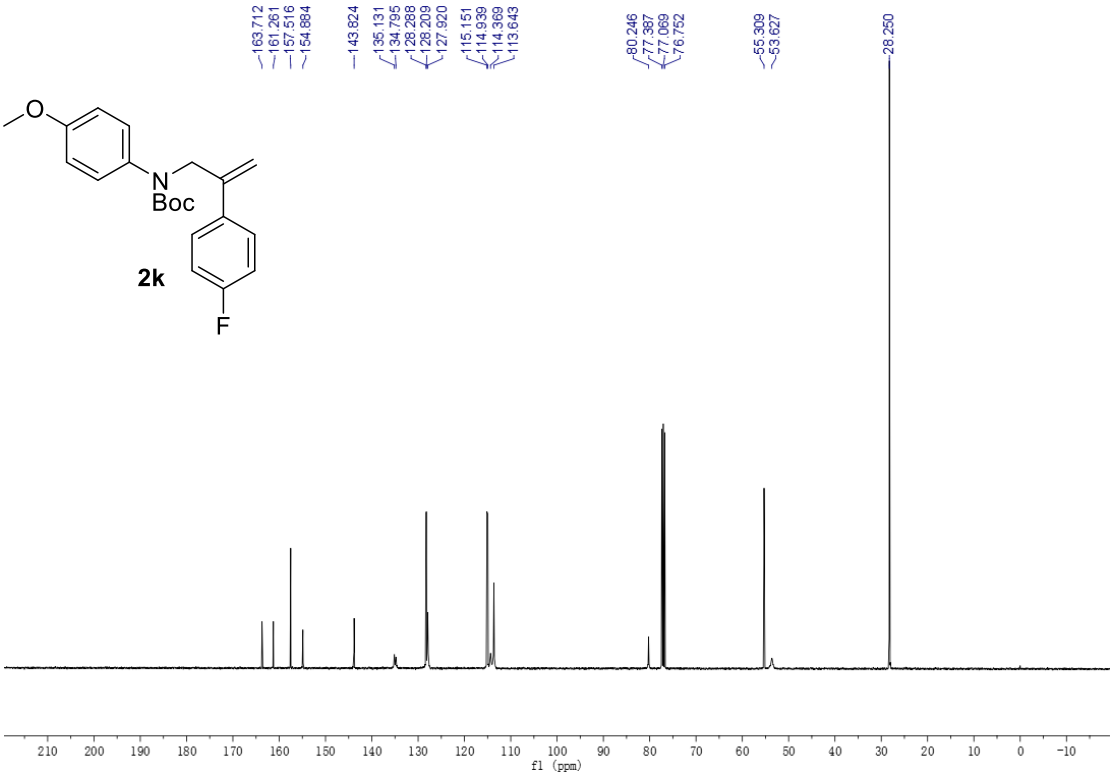
7.027
7.020
7.015
6.998
6.981
6.976
6.969
6.904
6.903
6.872
6.781
6.760
5.268
5.077
4.662
3.749
1.396
O
N
Boc
2k
F
2.09
3.95
2.18
1.06
1.00
2.01
3.17
9.00
f1 (ppm)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135.131
134.795
128.288
128.209
127.920
115.151
114.939
114.369
113.643
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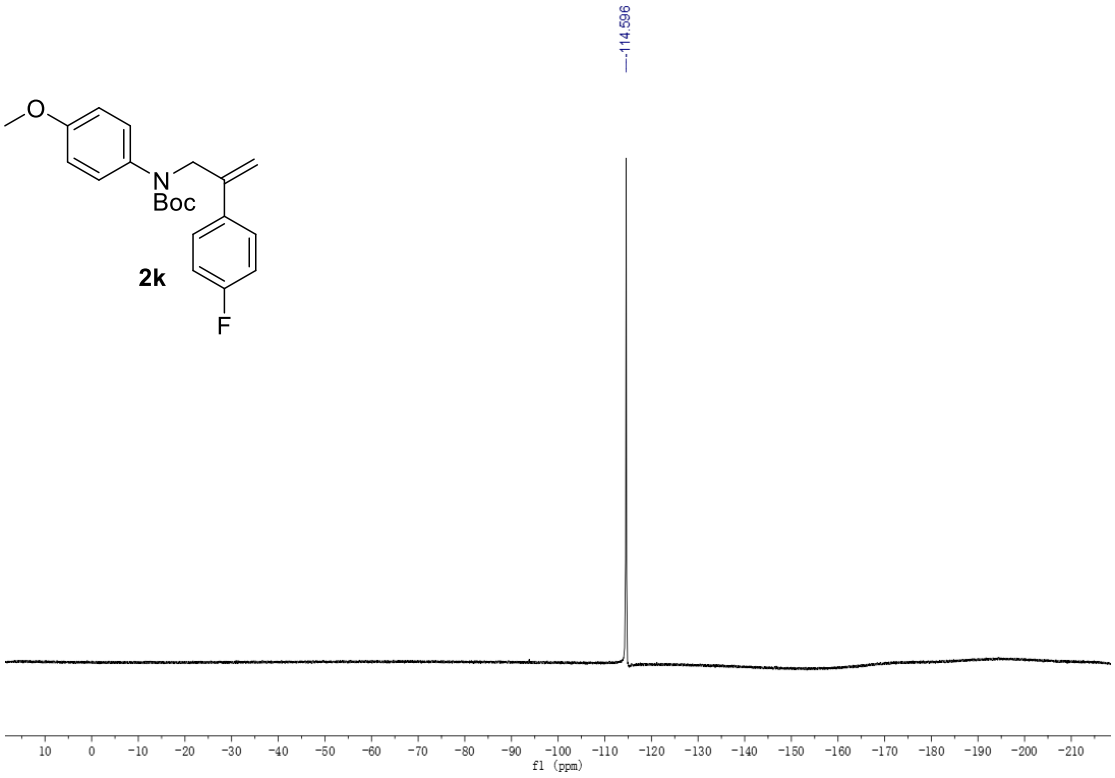
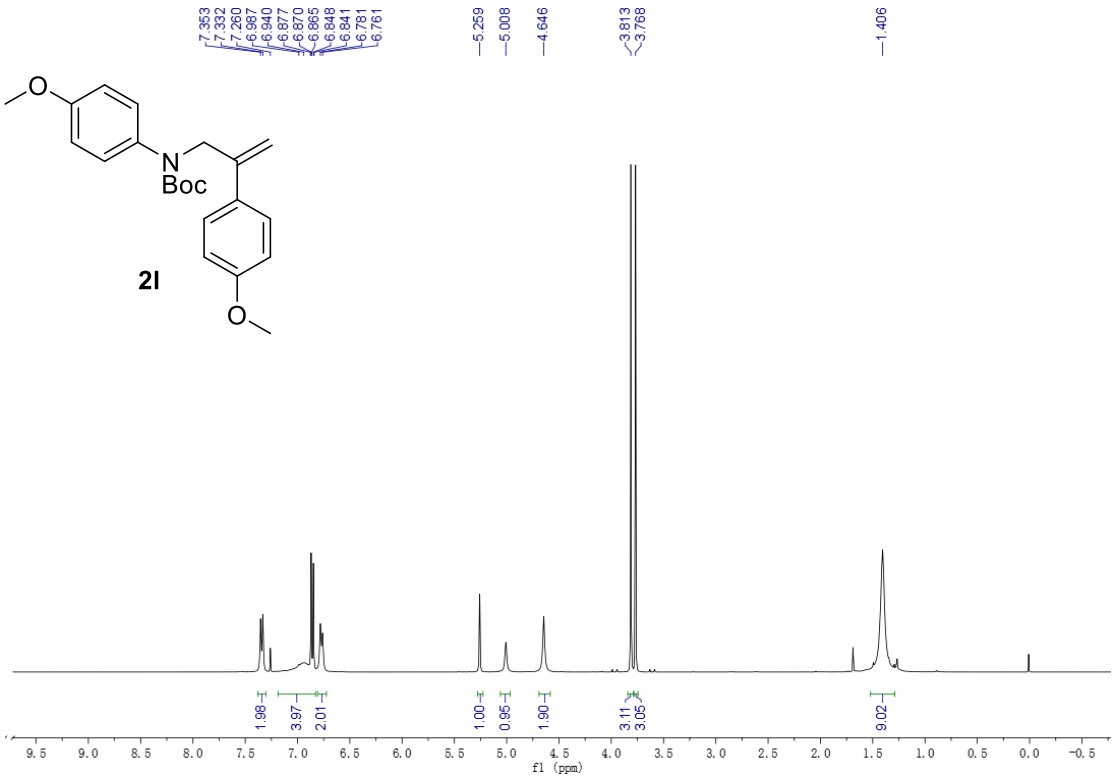
77.069
76.752
55.309
53.627
28.250
O
N
Boc
2k
F
f1 (ppm)


-114.596
O
N
Boc
F
2k
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)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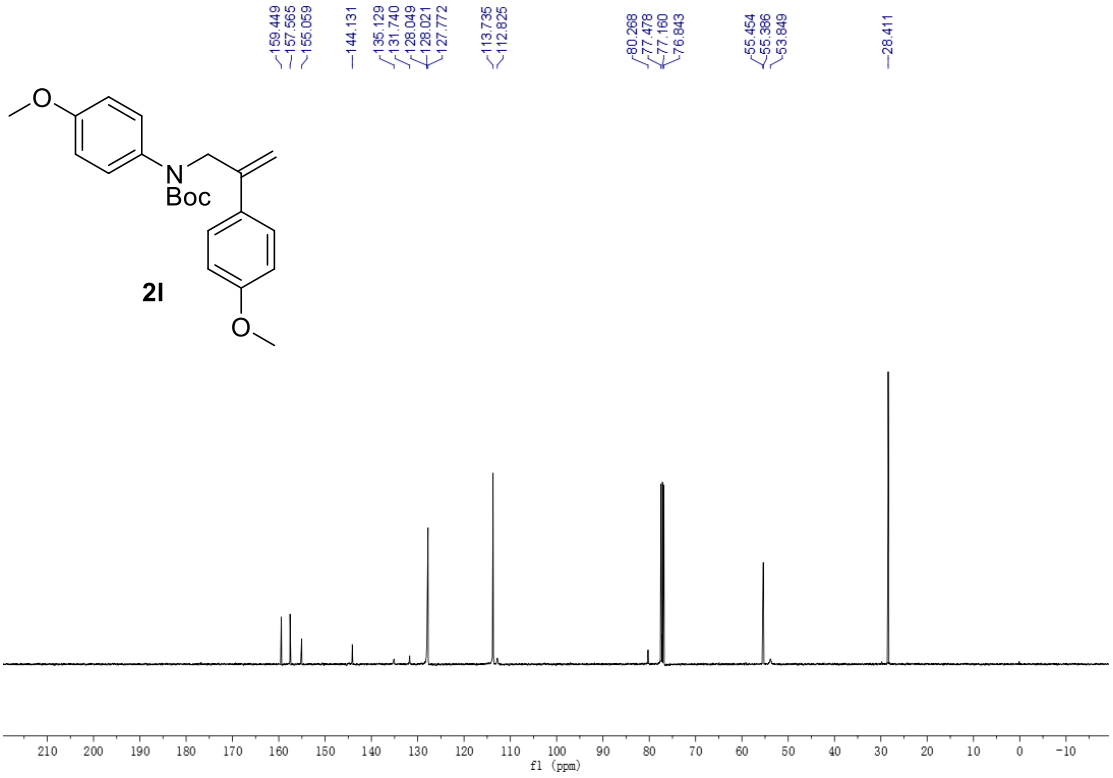
5.008
4.646
3.813
3.768
1.406
O
N
Boc
O
2l
1.98
3.97
2.01
1.00
0.95
1.90
3.11
3.05
9.02
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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131.740
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128.021
127.772
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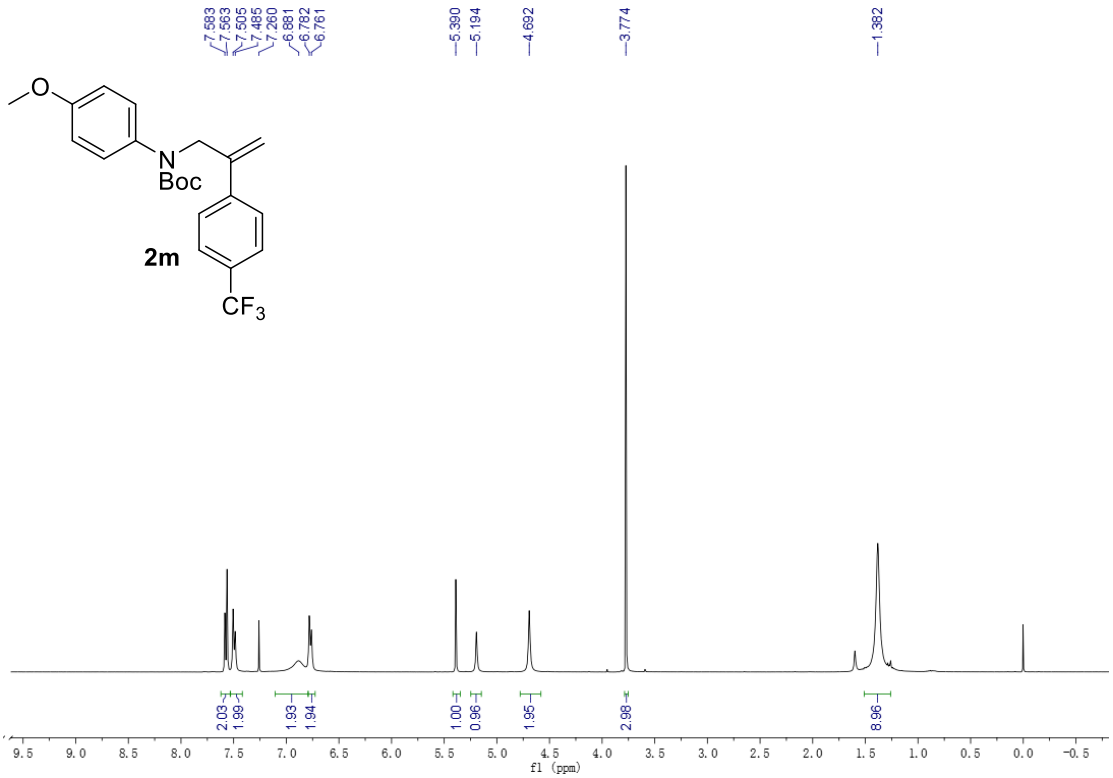
112.825
80.268
77.478
77.160
76.843
55.454
55.386
53.849
28.411
O
N
Boc
2l
O
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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6.761
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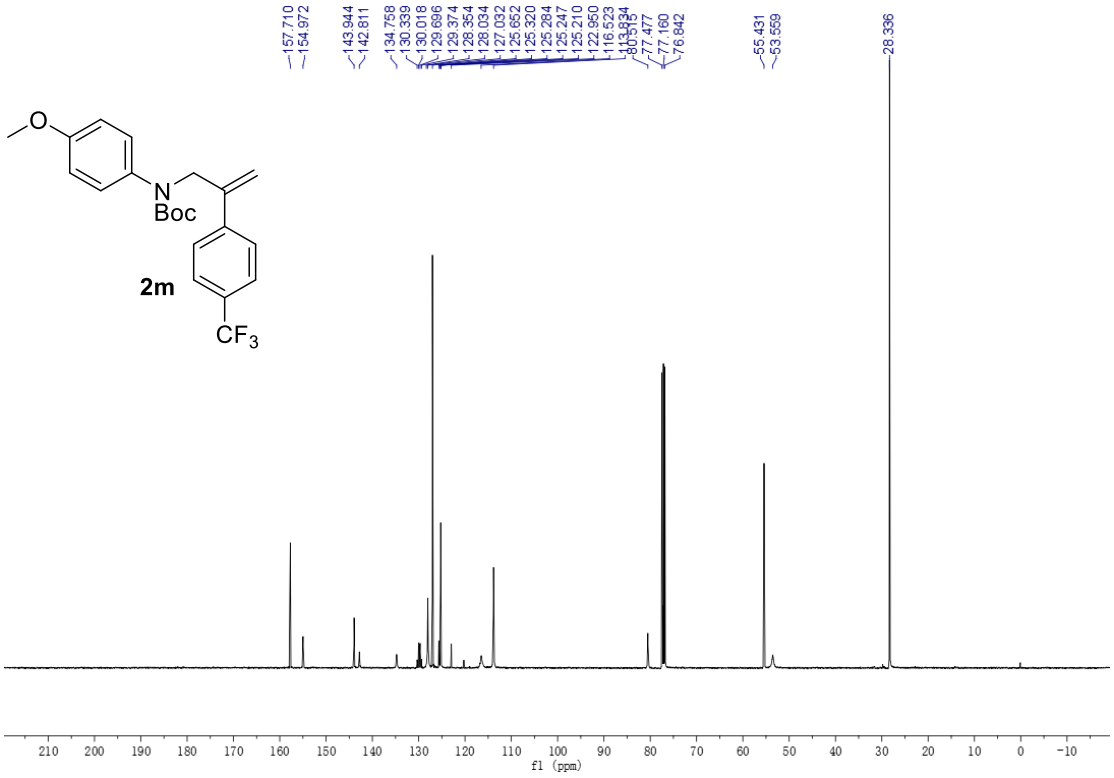
5.194
4.692
3.774
1.382
O
N
Boc
2m
CF3
2.03
1.99
1.93
1.94
1.00
0.96
1.95
2.98
8.96
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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129.374
128.354
128.034
127.032
125.652
125.320
125.284
125.247
125.210
122.950
116.523
113.334
77.477
77.160
76.842
55.431
53.559
28.336
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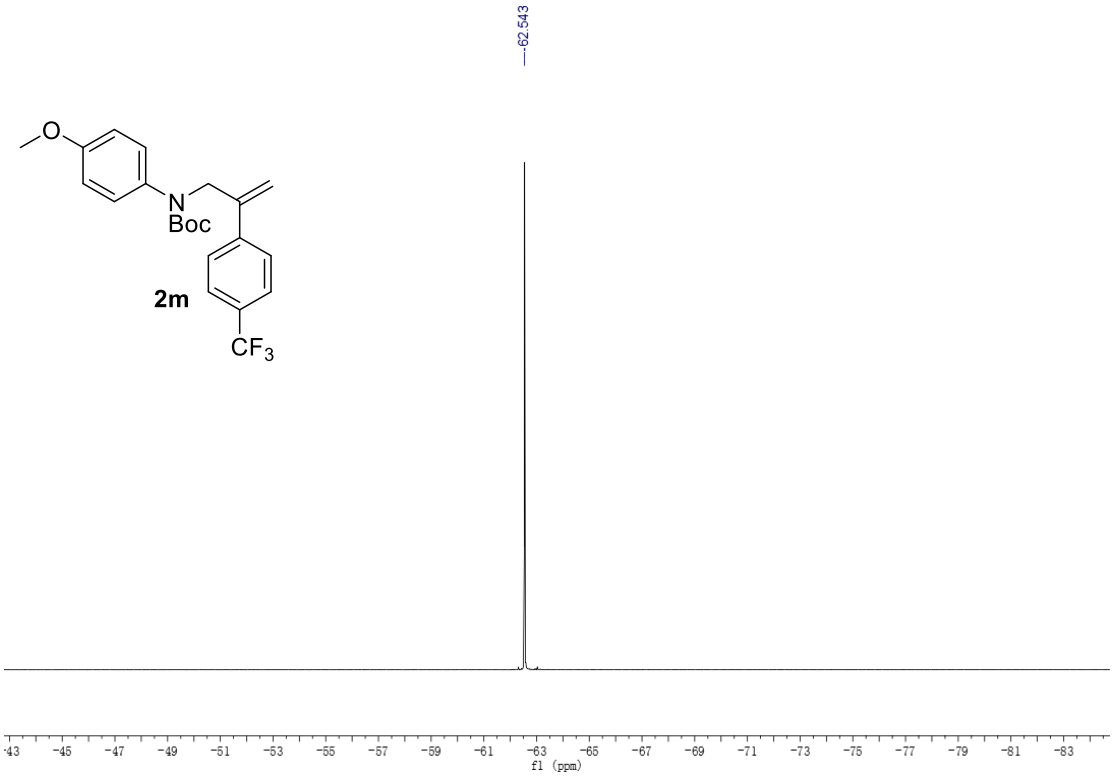
N
Boc
2m
CF3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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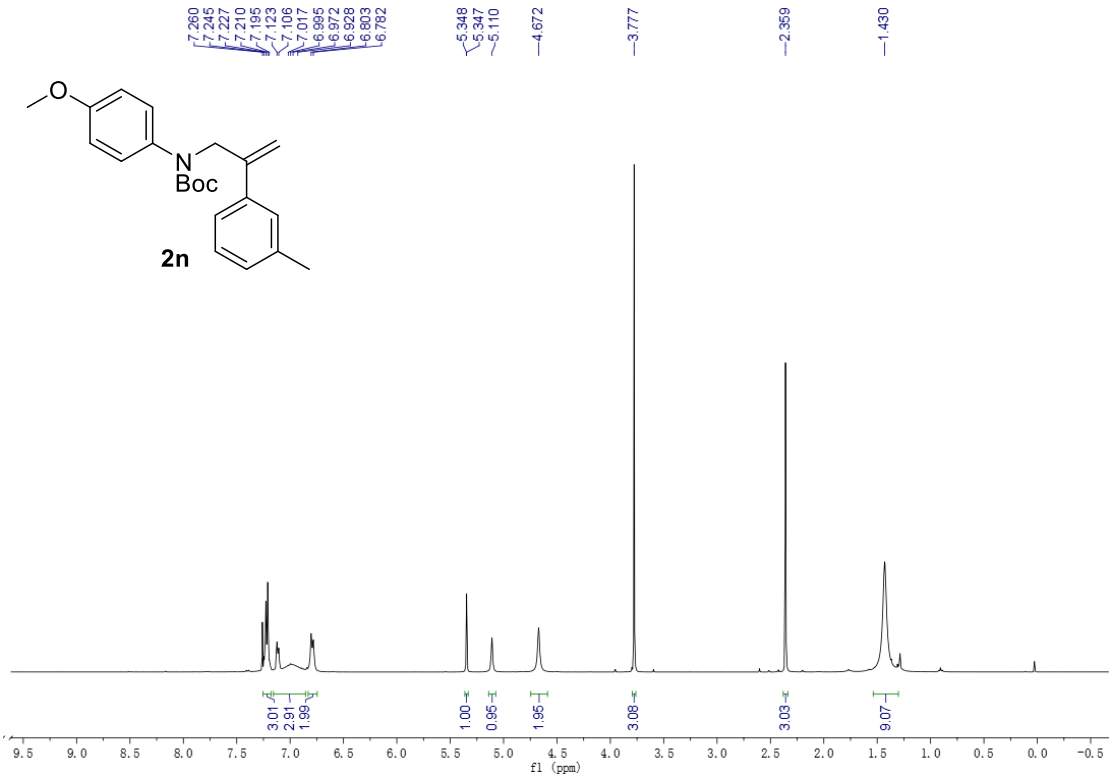
CF3
-43 -45 -47 -49 -51 -53 -55 -57 -59 -61 -63 -65 -67 -69 -71 -73 -75 -77 -79 -81 -83
f1 (ppm)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7.017
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6.972
6.928
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5.348
5.347
5.110
4.672
3.777
2.359
1.430
O
N
Boc
2n
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1.00
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1.95
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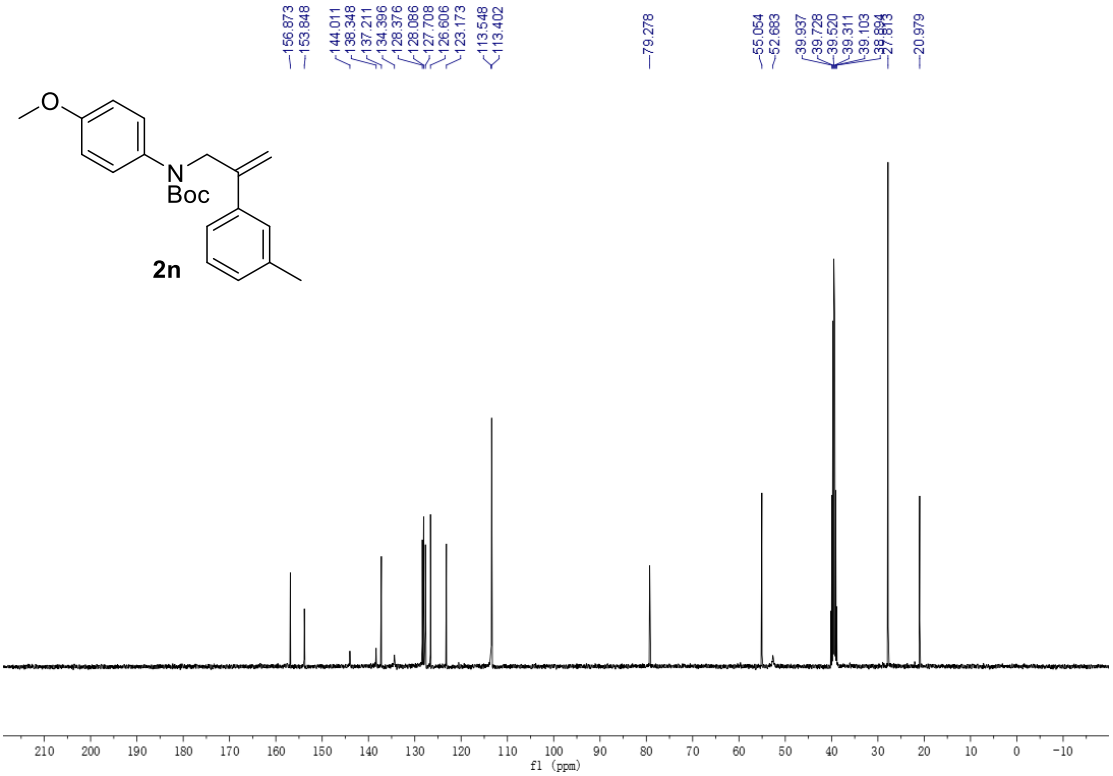
3.03
9.07
f1 (ppm)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113.402
79.278
55.054
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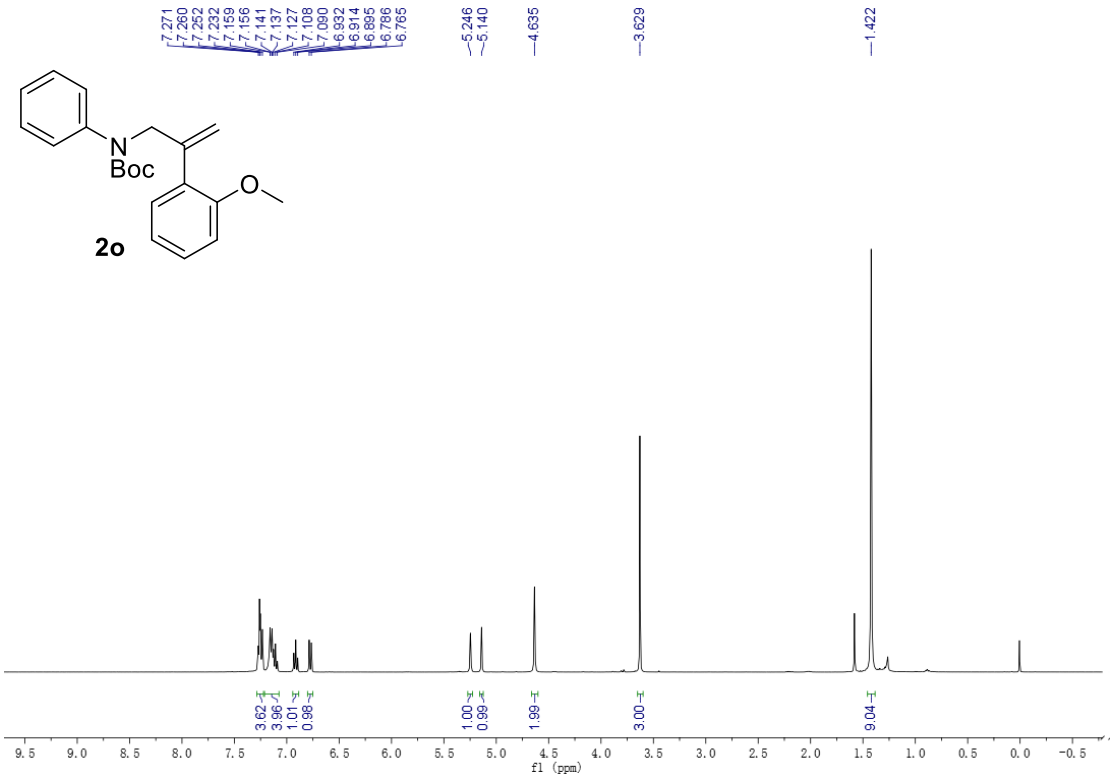
Boc
2n
f1 (ppm)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6.914
6.895
6.786
6.765
5.246
5.140
4.635
3.629
1.422
N
Boc
O
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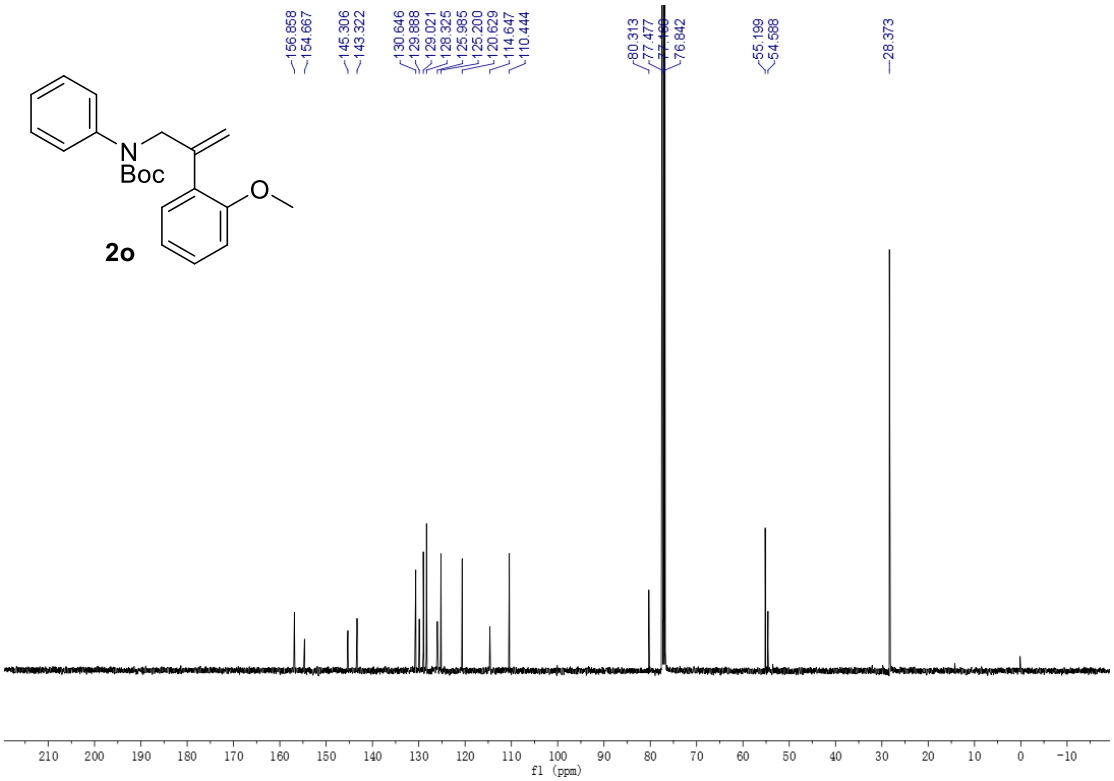
1.99
3.00
9.04
f1 (ppm)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125.200
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77.477
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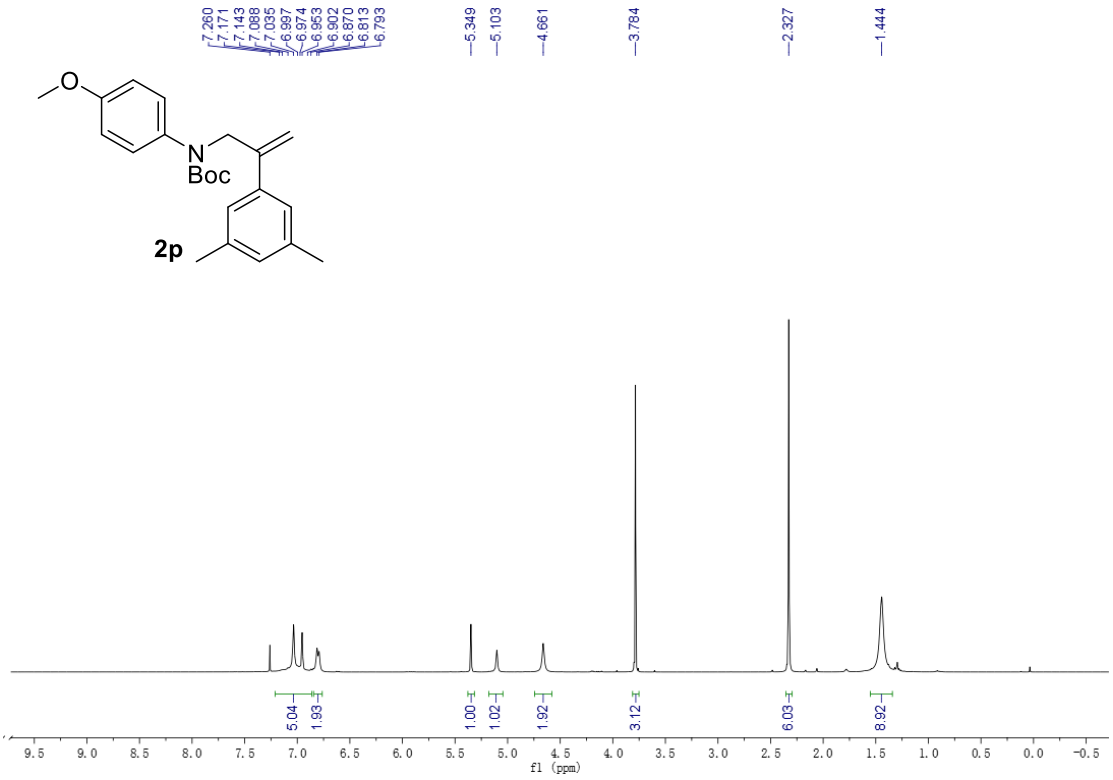
55.199
54.588
28.373
N
Boc
O
2o
f1 (ppm)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6.870
6.813
6.793
5.349
5.103
4.661
3.784
2.327
1.444
O
N
Boc
2p
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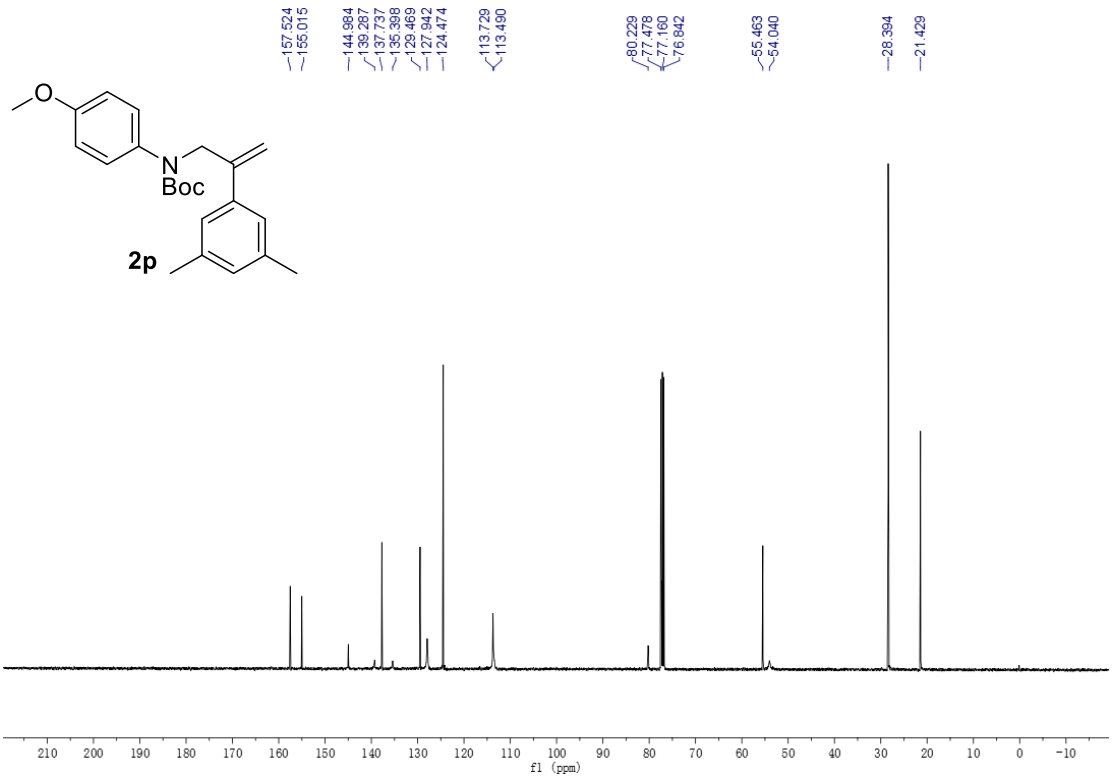
1.00
1.02
1.92
3.12
6.03
8.92
f1 (ppm)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77.160
76.842
55.463
54.040
28.394
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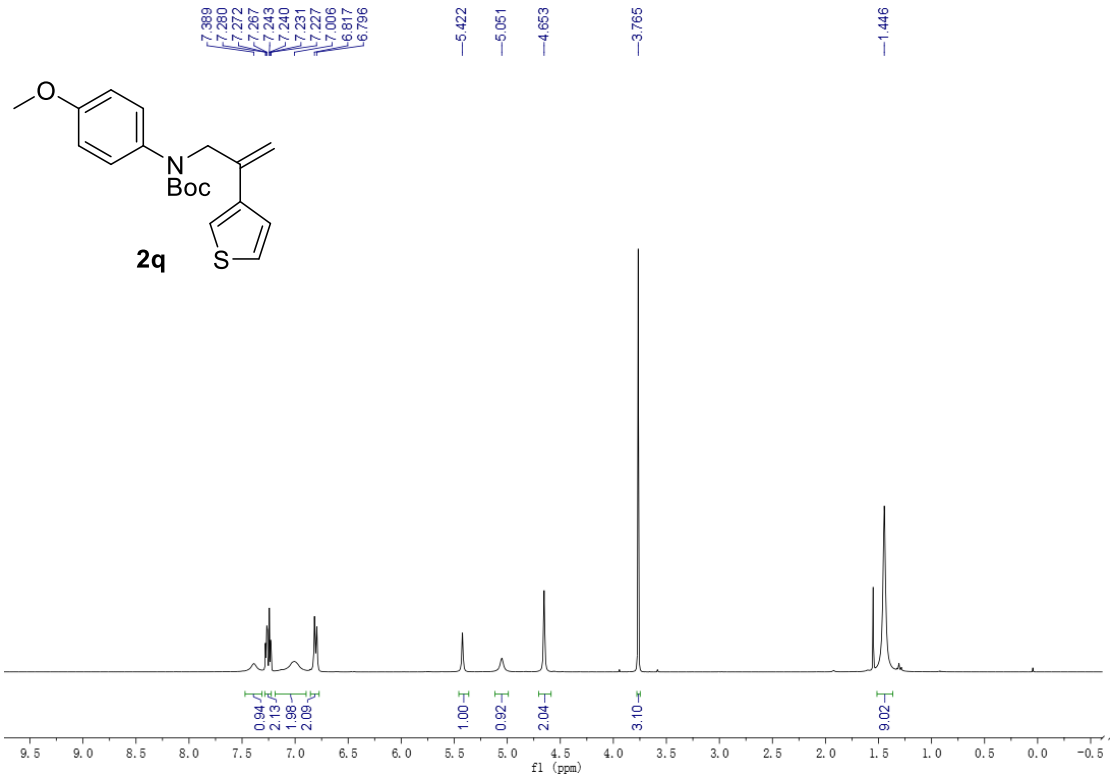
O
N
Boc
2p
f1 (ppm)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7.227
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5.051
4.653
3.765
1.446
O
N
Boc
S
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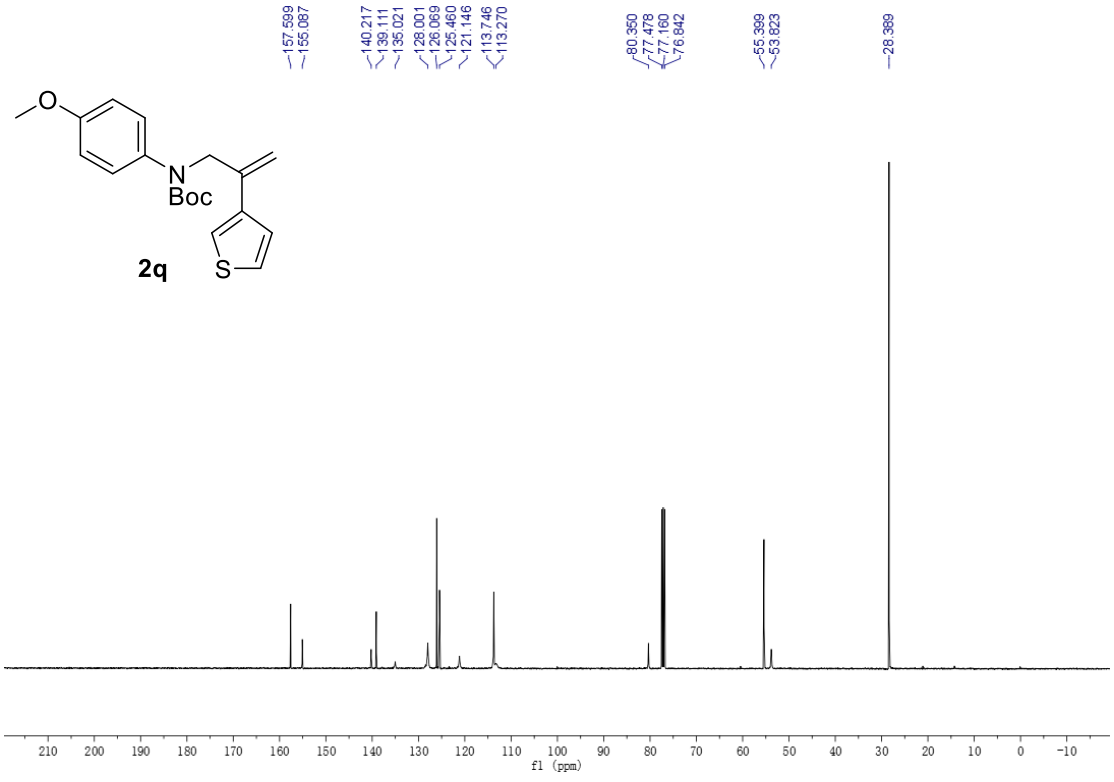
2.04
3.10
9.02
f1 (ppm)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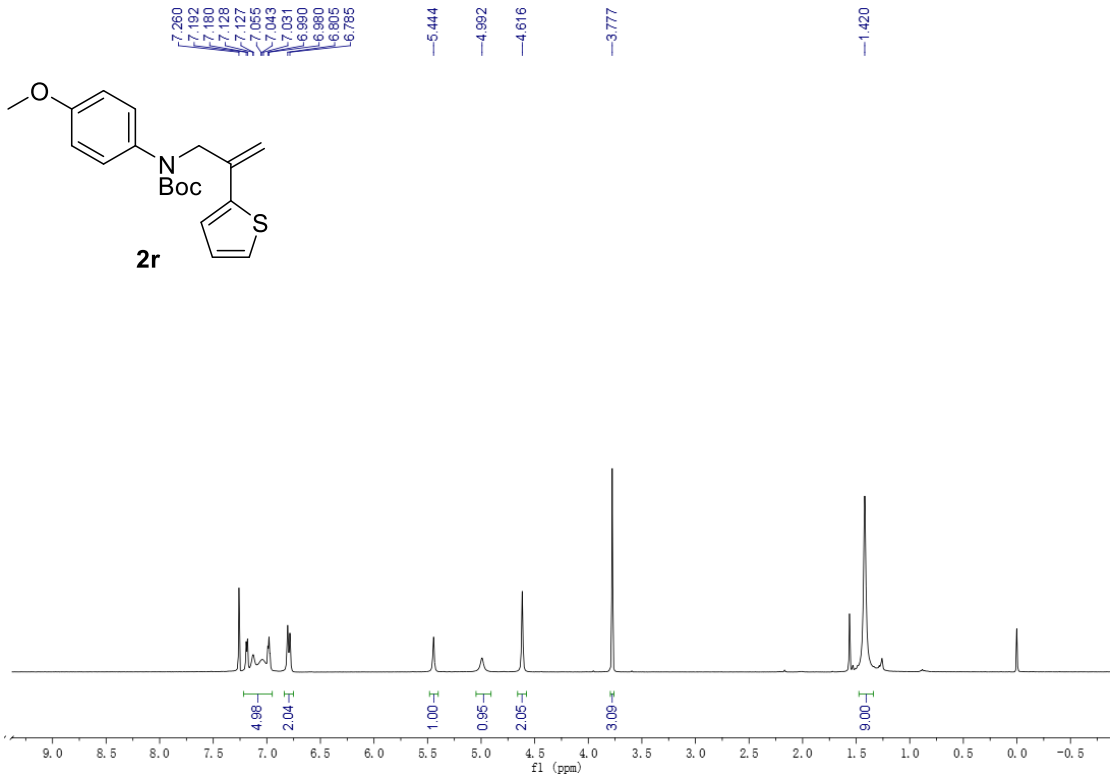
80.350
77.478
77.160
76.842
55.399
53.823
28.389
O
N
Boc
S
2q
f1 (ppm)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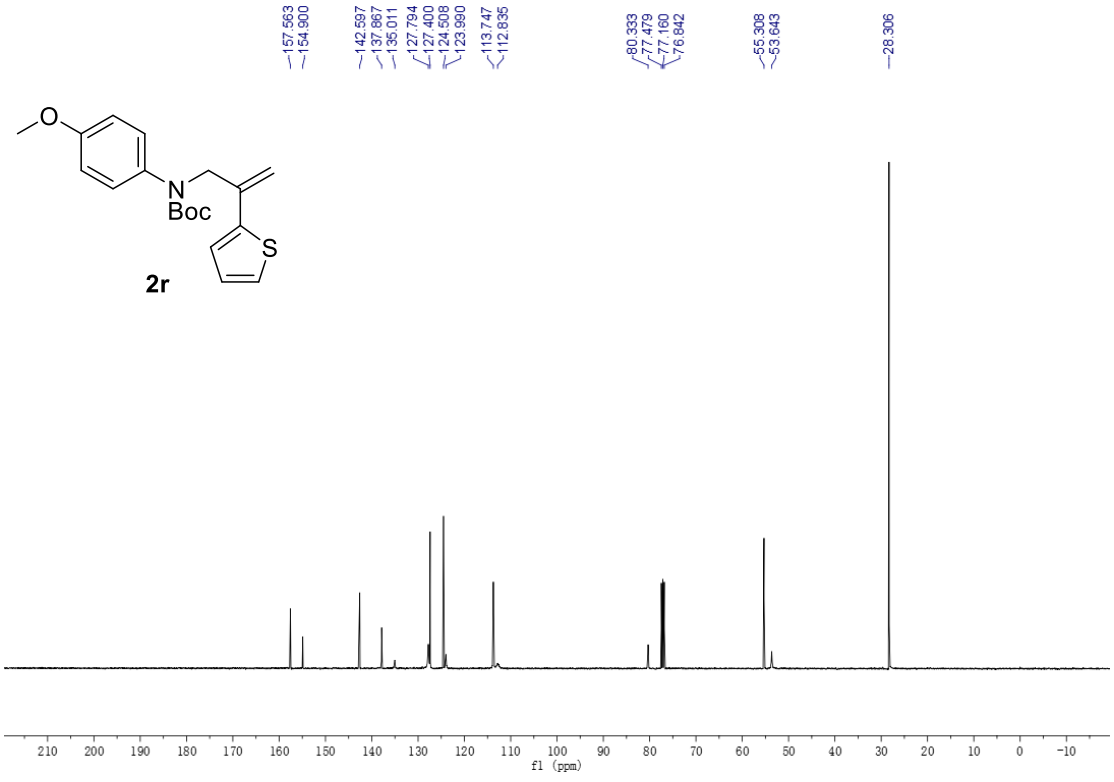
7.192
7.180
7.128
7.127
7.055
7.043
7.031
6.990
6.980
6.805
6.785
5.444
4.992
4.616
3.777
1.420
O
N
Boc
S
2r
4.98
2.04
1.00
0.95
2.05
3.09
9.00
f1 (ppm)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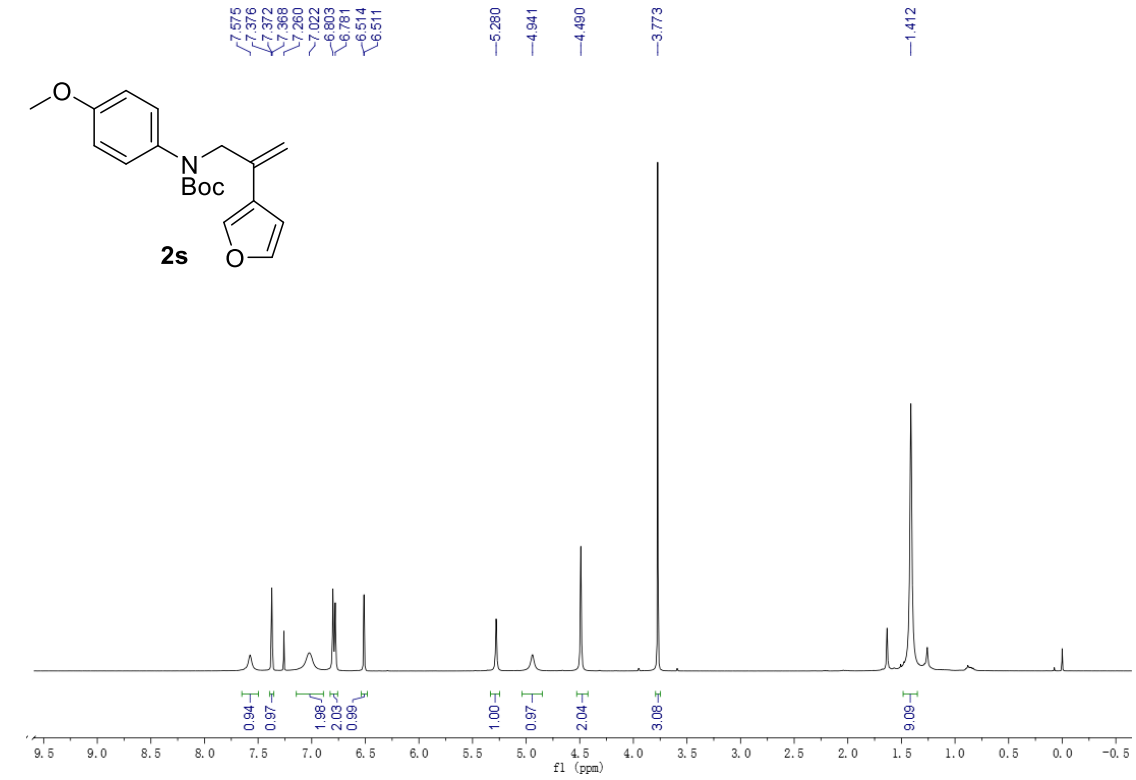
154.900
142.597
137.867
135.011
127.794
127.400
124.508
123.990
113.747
112.835
80.333
77.479
77.160
76.842
55.308
53.643
28.306
O
N
Boc
S
2r
f1 (ppm)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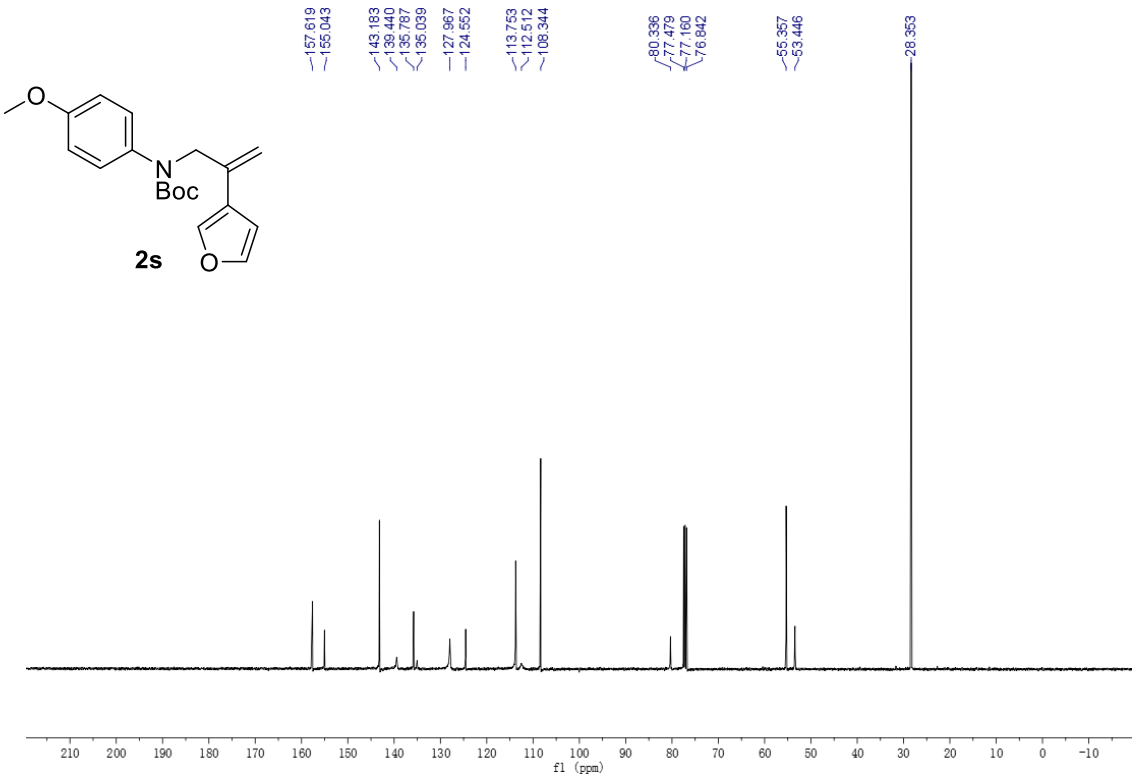
7.376
7.372
7.368
7.260
7.022
6.803
6.781
6.514
6.511
5.280
4.941
4.490
3.773
1.412
O
N
Boc
O
2s
0.94
0.97
1.98
2.03
0.99
1.00
0.97
2.04
3.08
9.09
f1 (ppm)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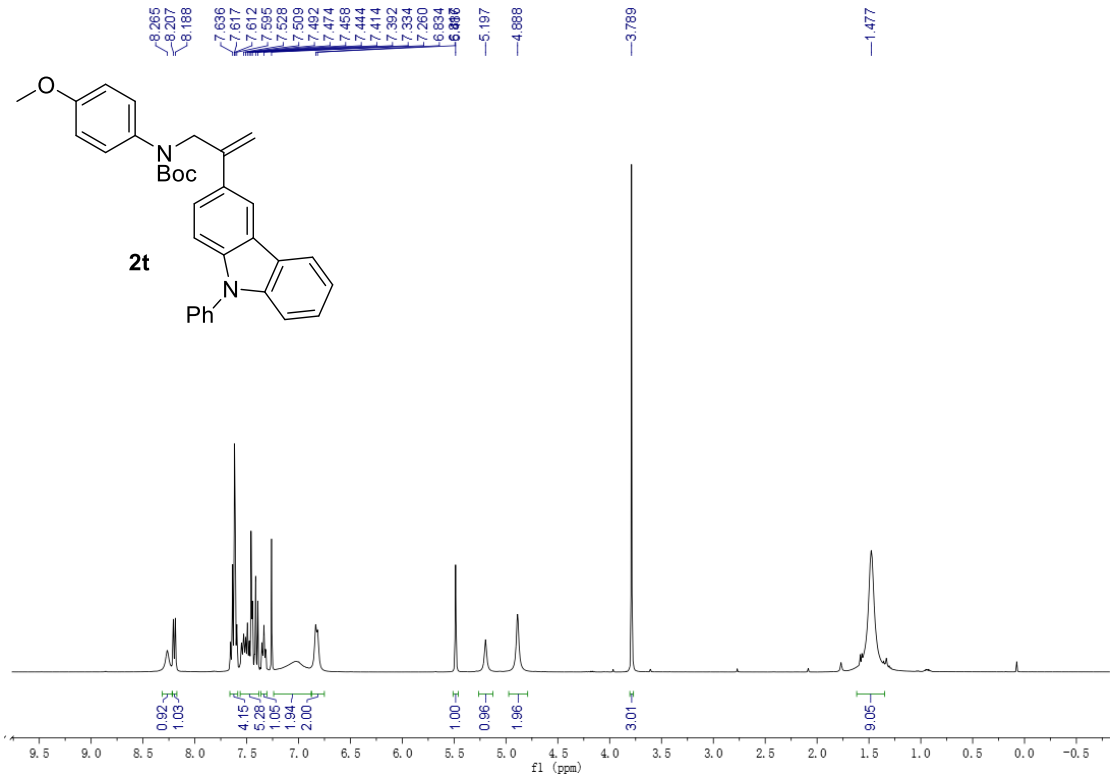
135.039
127.967
124.552
113.753
112.512
108.344
80.336
77.479
77.160
76.842
55.357
53.446
28.353
O
N
Boc
O
2s
f1 (ppm)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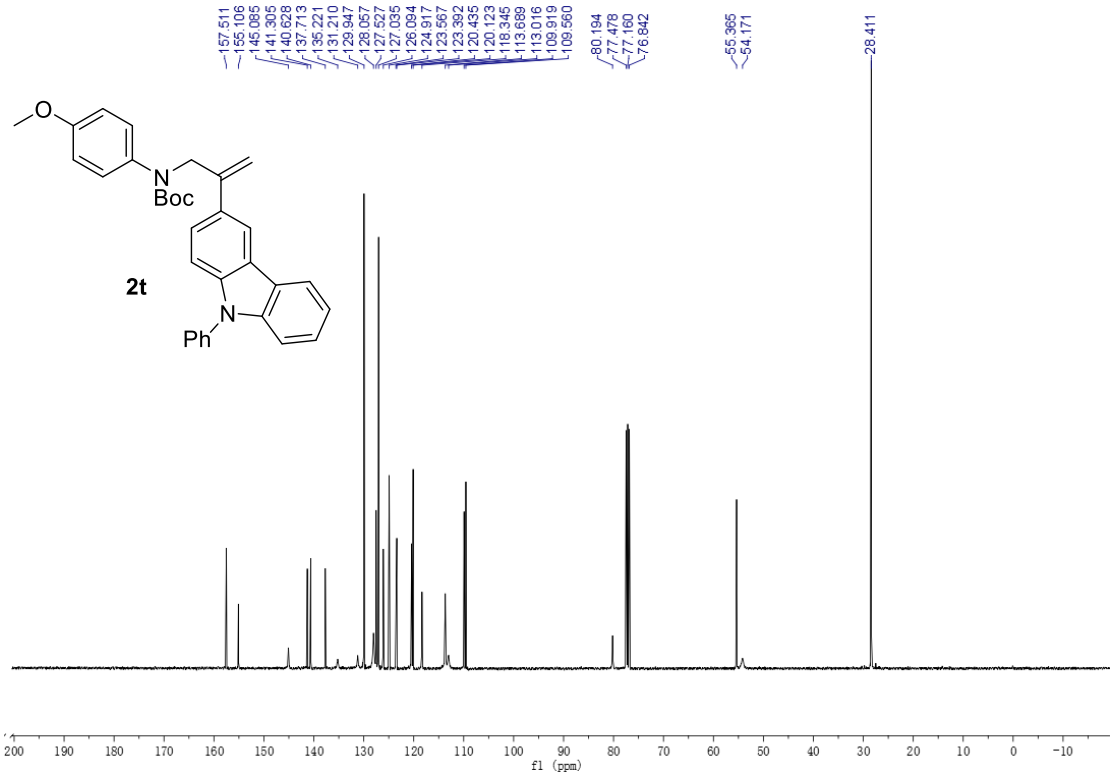
8.207
8.188
7.636
7.617
7.612
7.595
7.528
7.509
7.492
7.474
7.458
7.444
7.414
7.392
7.334
7.260
6.834
5.197
4.888
3.789
1.477
O
N
Boc
2t
N
Ph
0.92
1.03
4.15
5.28
1.05
1.94
2.00
1.00
0.96
1.96
3.01
9.05
f1 (ppm)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145.085
141.305
140.628
137.713
135.221
131.210
129.947
128.057
127.527
127.035
126.094
124.917
123.567
123.392
120.435
120.123
118.345
113.689
113.016
109.919
109.560
80.194
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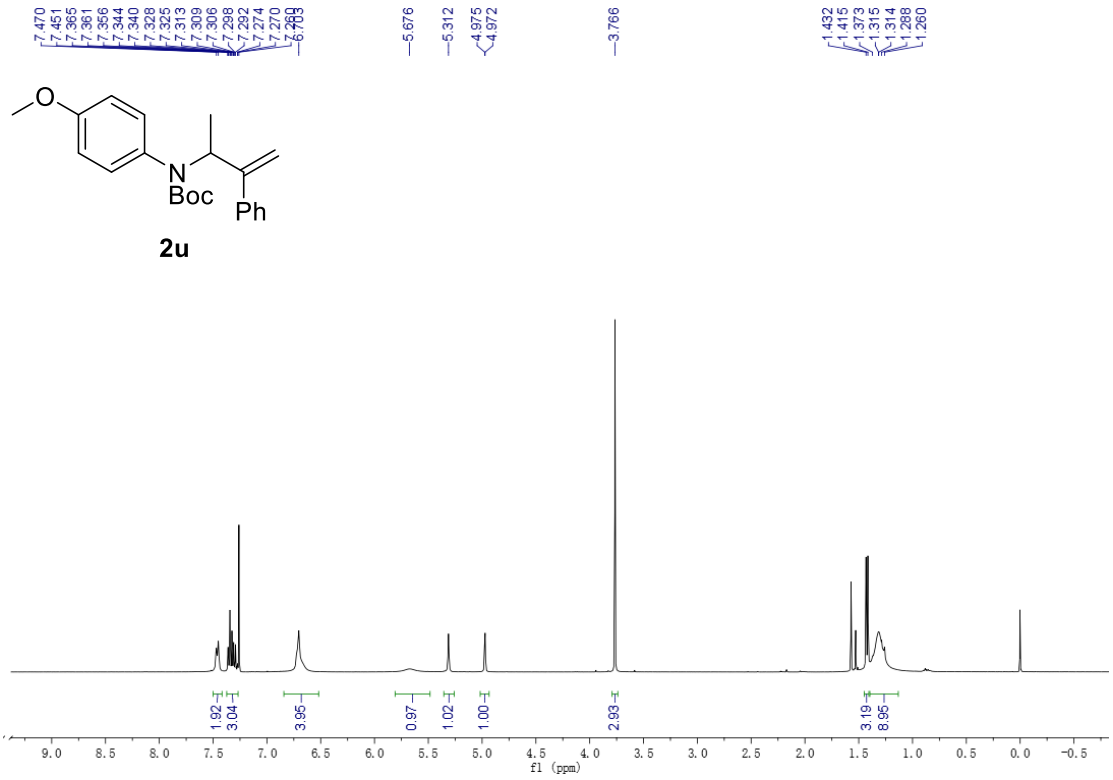
77.160
76.842
55.365
54.171
28.411
O
N
Boc
2t
N
Ph
f1 (ppm)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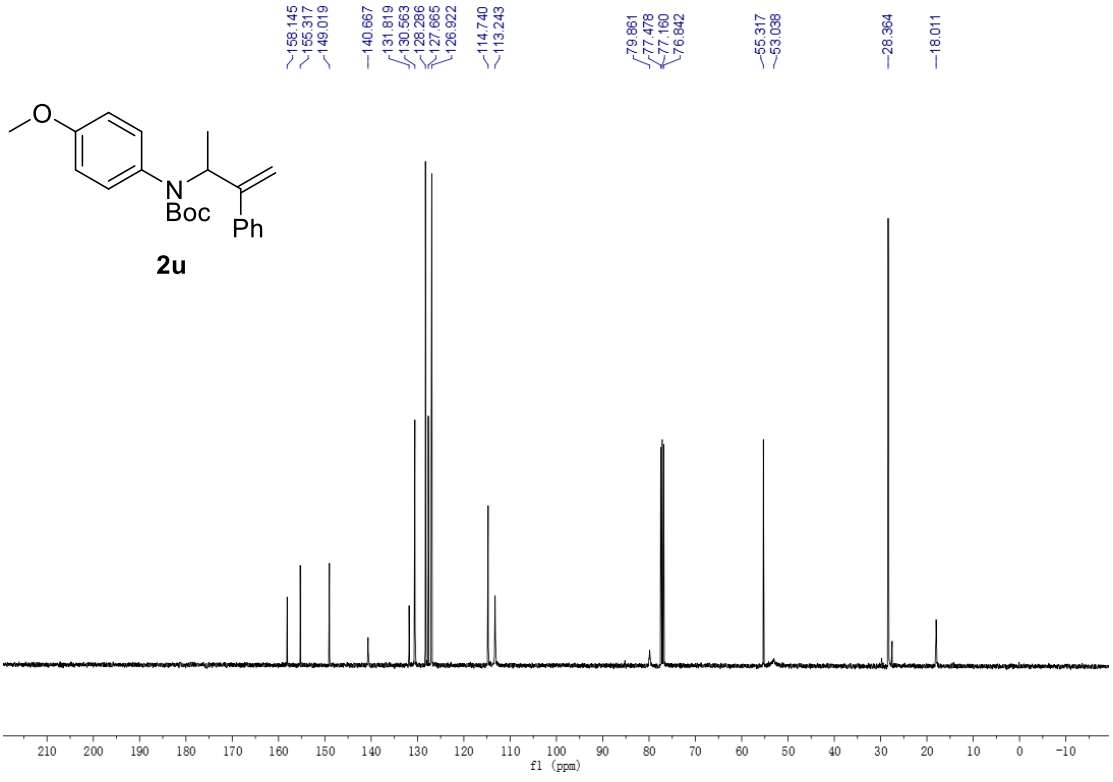
7.344
7.340
7.328
7.325
7.313
7.309
7.306
7.298
7.292
7.274
7.270
7.260
6.703
5.676
5.312
4.975
4.972
3.766
1.432
1.415
1.373
1.315
1.314
1.288
1.260
O
N
Boc
Ph
1.92
3.04
3.95
0.97
1.02
1.00
2.93
3.19
8.95
f1 (ppm)

2u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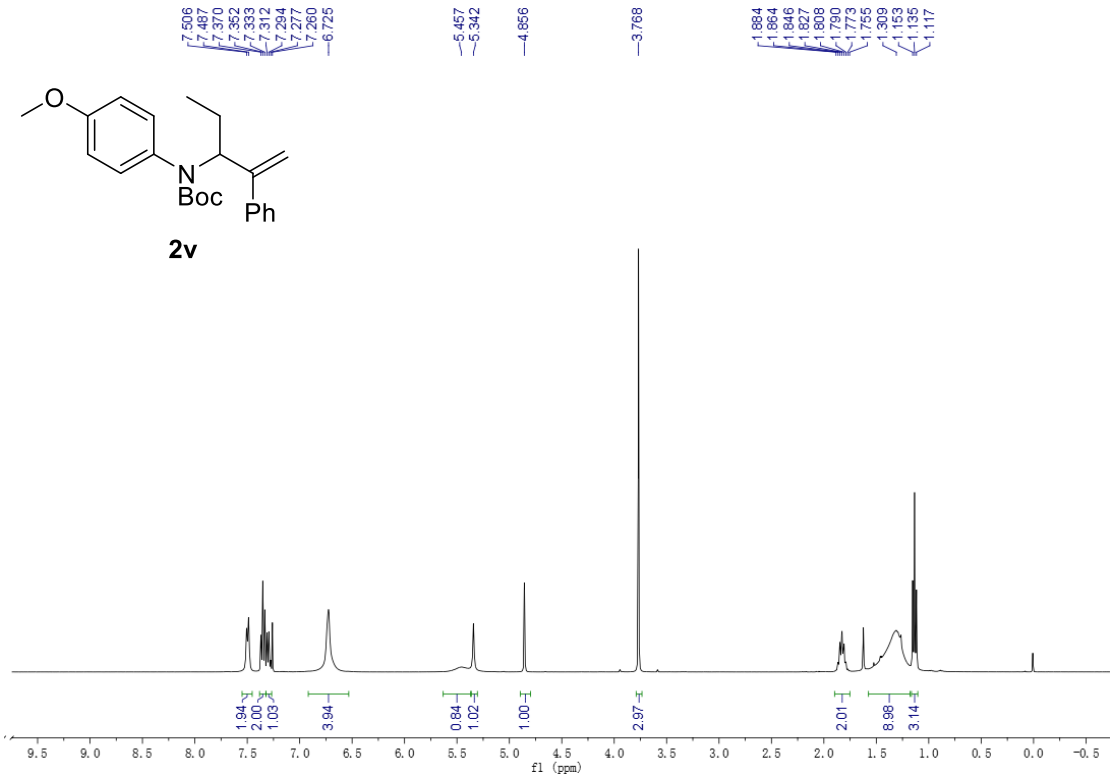
155.317
149.019
140.667
131.819
130.563
128.286
127.665
126.922
114.740
113.243
79.961
77.478
77.160
76.842
55.317
53.038
28.364
18.011
O
N
Boc
Ph
f1 (ppm)

2u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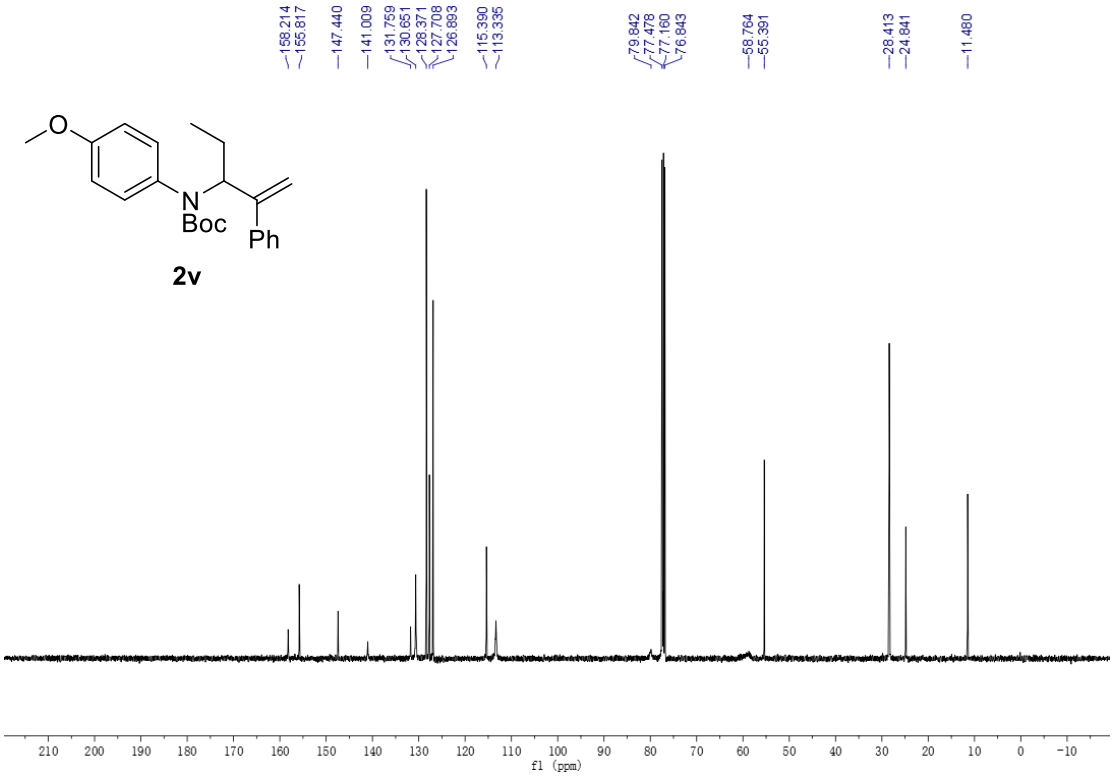
7.487
7.370
7.352
7.333
7.312
7.294
7.277
7.260
6.725
5.457
5.342
4.856
3.768
1.884
1.864
1.846
1.827
1.808
1.790
1.773
1.755
1.309
1.153
1.135
1.117
O
N
Boc
Ph
2v
1.94
2.00
1.03
3.94
0.84
1.02
1.00
2.97
2.01
8.98
3.14
f1 (ppm)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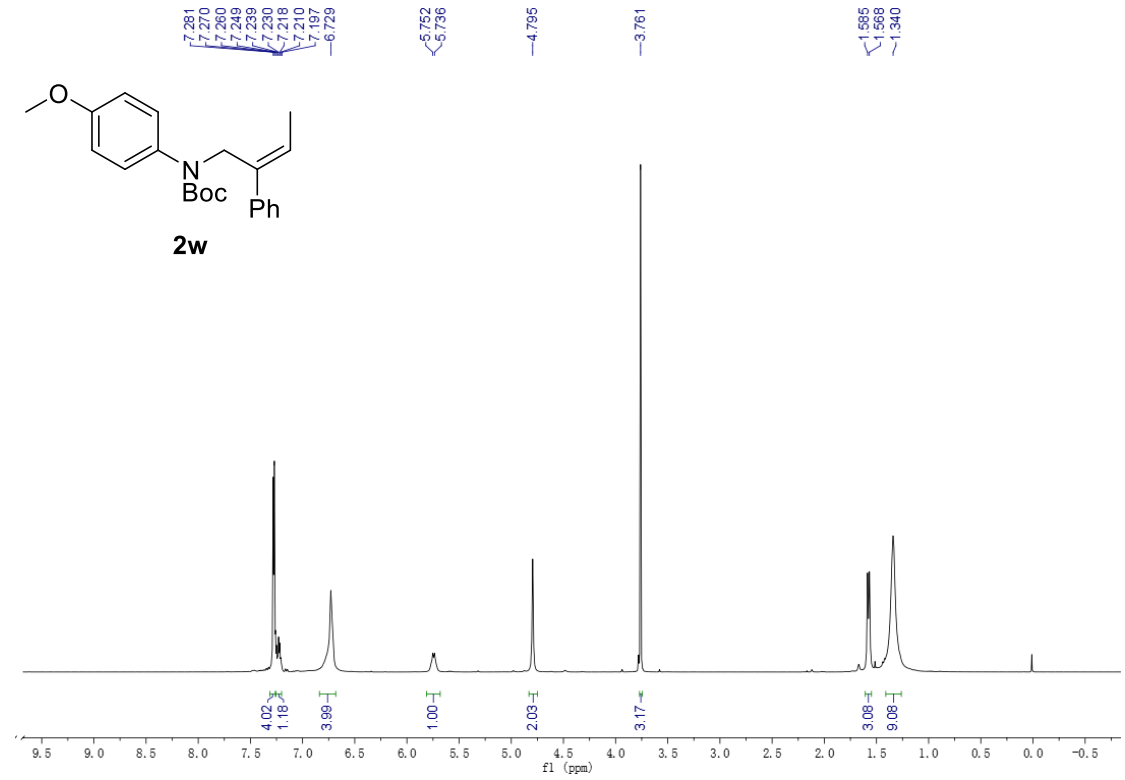
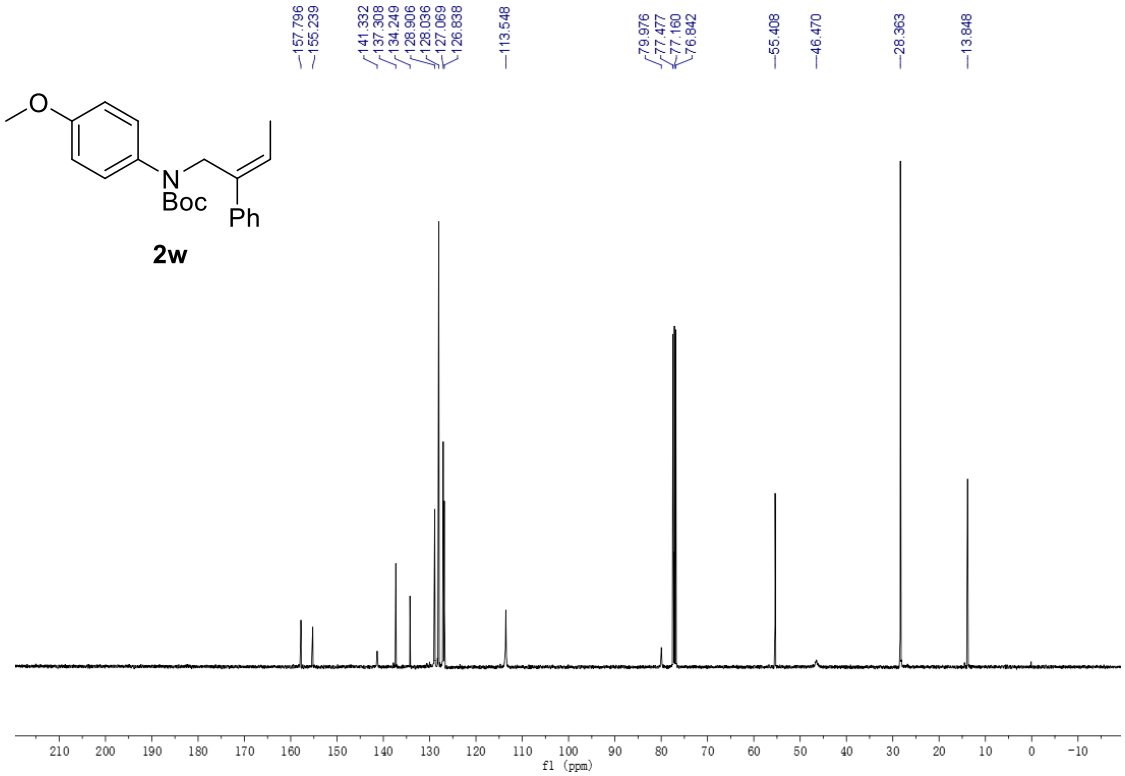
155.817
147.440
141.009
131.759
130.651
128.371
127.708
126.893
115.390
113.335
79.842
77.478
77.160
76.843
58.764
55.391
28.413
24.841
11.480
O
N
Boc
Ph
2v
f1 (ppm)


7.281
7.270
7.260
7.249
7.239
7.230
7.218
7.210
7.197
6.729
5.752
5.736
4.795
3.761
1.585
1.568
1.340
O
N
Boc
Ph
2w
4.02
1.18
3.99
1.00
2.03
3.17
3.08
9.08
f1 (ppm)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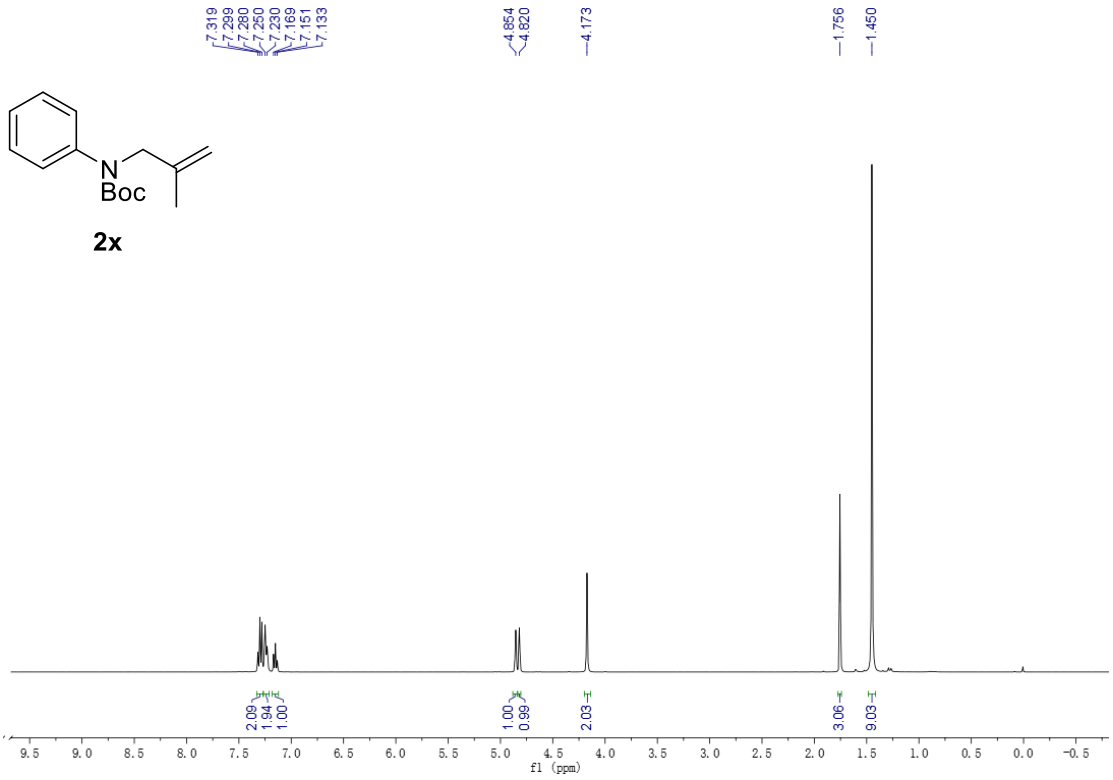
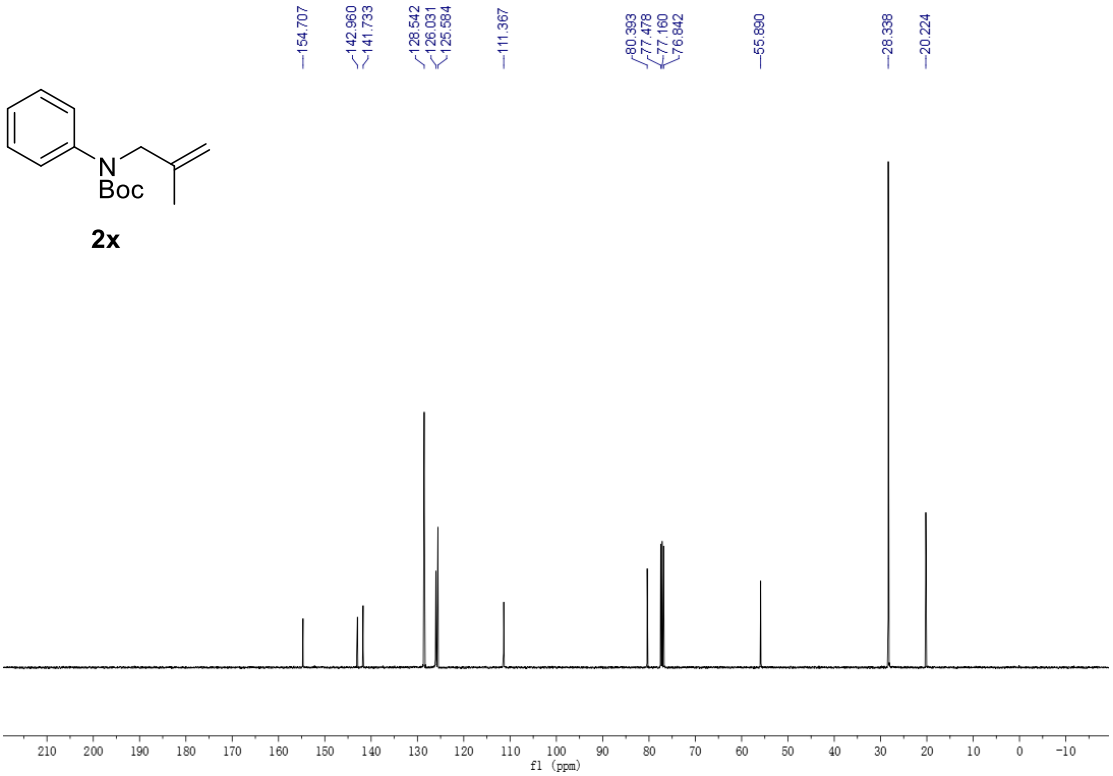
141.332
137.308
134.249
128.906
128.036
127.069
126.838
113.548
79.976
77.477
77.160
76.842
55.408
46.470
28.363
13.848
O
N
Boc
Ph
2w
f1 (ppm)


7.319
7.299
7.280
7.250
7.230
7.169
7.151
7.133
4.854
4.820
4.173
1.756
1.450
N
Boc
2x
2.09
1.94
1.00
1.00
0.99
2.03
3.06
9.03
f1 (ppm)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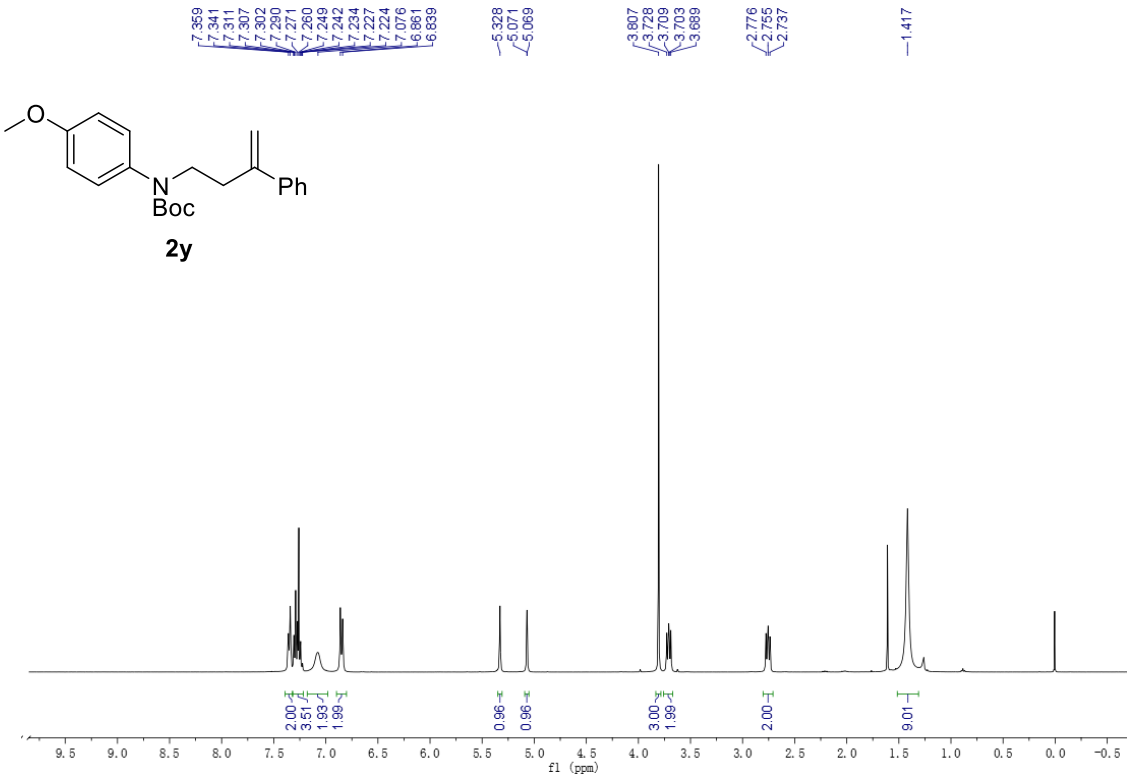
142.960
141.733
128.542
126.031
125.584
111.367
80.393
77.478
77.160
76.842
55.890
28.338
20.224
N
Boc
2x
f1 (ppm)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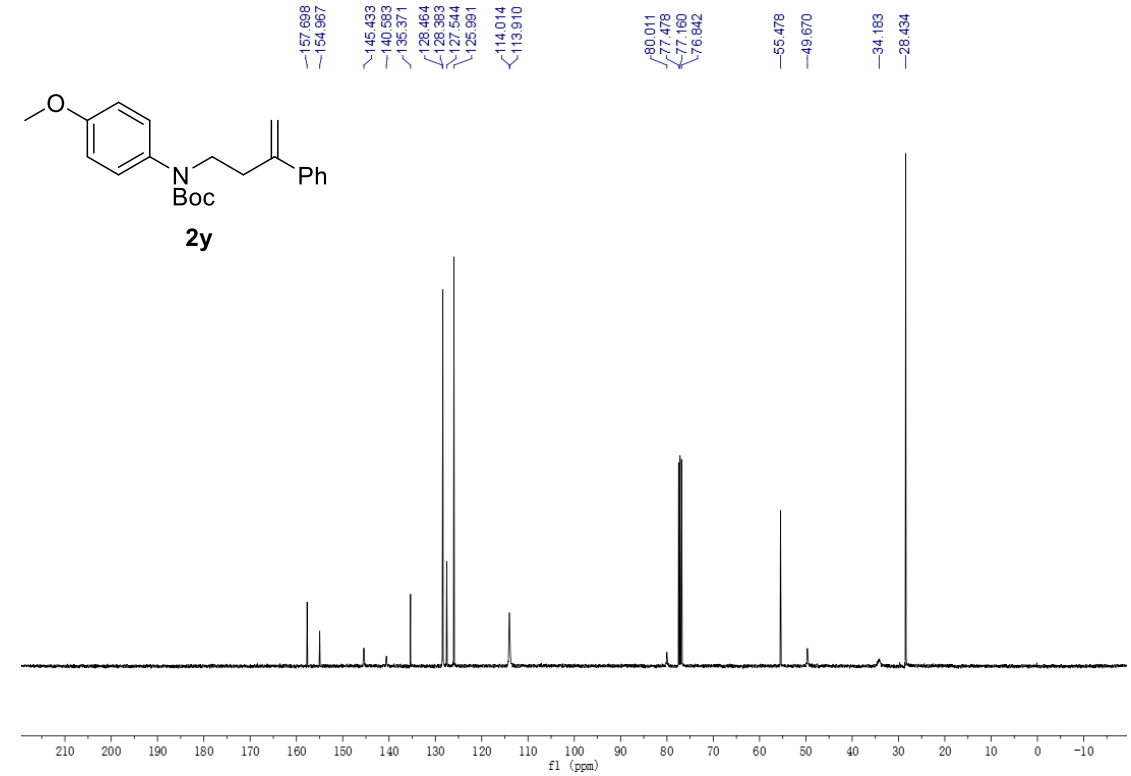
7.341
7.311
7.307
7.302
7.290
7.271
7.260
7.249
7.242
7.234
7.227
7.224
7.076
6.861
6.839
5.328
5.071
5.069
3.807
3.728
3.709
3.703
3.689
2.776
2.755
2.737
1.417
O
N
Boc
Ph
2y
2.00
3.51
1.93
1.99
0.96
0.96
3.00
1.99
2.00
9.01
f1 (ppm)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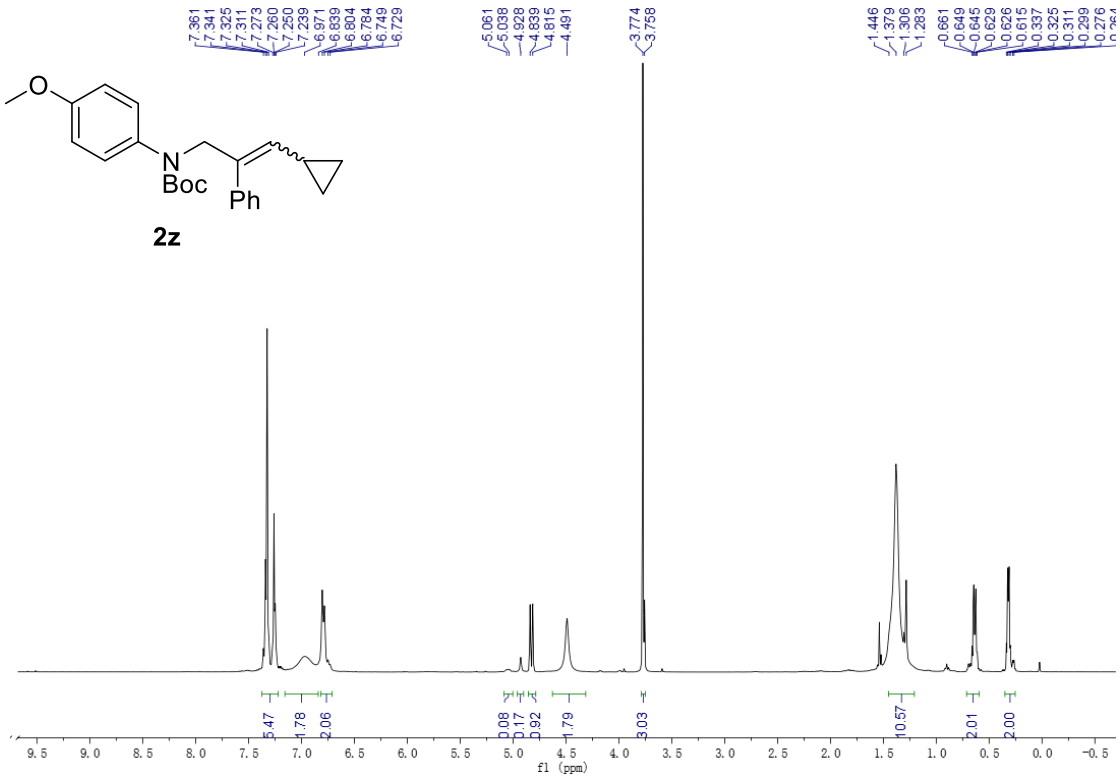
145.433
140.583
135.371
128.464
128.383
127.544
125.991
114.014
113.910
80.011
77.478
77.160
76.842
55.478
49.670
34.183
28.434
O
N
Boc
Ph
2y
f1 (ppm)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7.311
7.273
7.260
7.250
7.239
6.971
6.839
6.804
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6.749
6.729
5.061
5.038
4.928
4.839
4.815
4.491
3.774
3.758
1.446
1.379
1.306
1.283
0.661
0.649
0.645
0.629
0.626
0.615
0.337
0.325
0.311
0.299
0.276
O
N
Boc
Ph
2z
5.47
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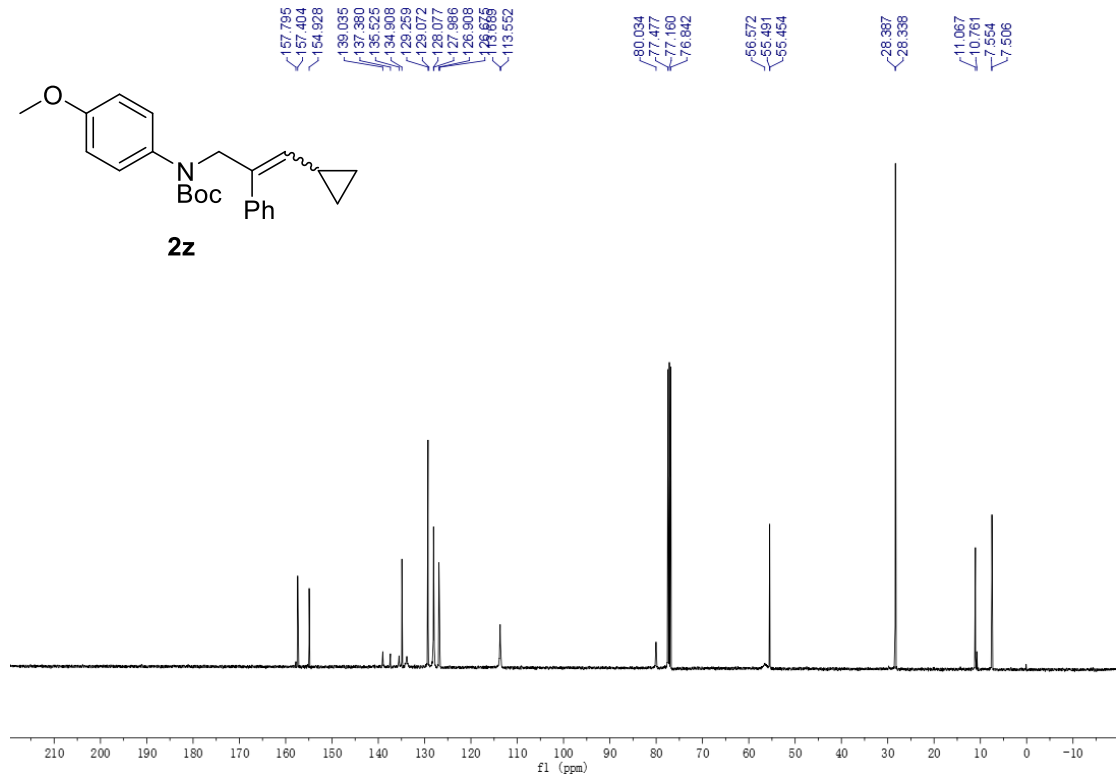
2.06
0.08
0.17
0.92
1.79
3.03
10.57
2.01
2.00
f1 (ppm)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157.404
154.928
139.035
137.390
135.525
134.908
129.259
129.072
128.077
127.986
126.908
113.552
80.034
77.477
77.160
76.842
56.572
55.491
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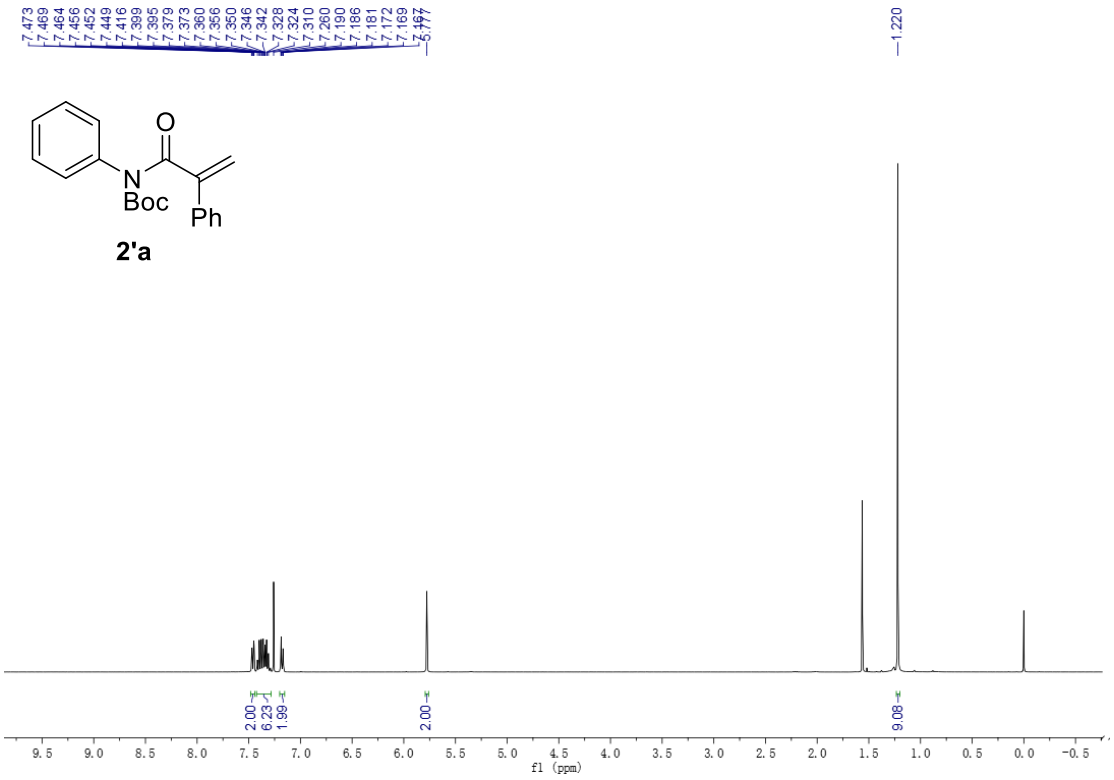
28.387
28.338
11.067
10.761
7.554
7.506
O
N
Boc
Ph
2z
f1 (ppm)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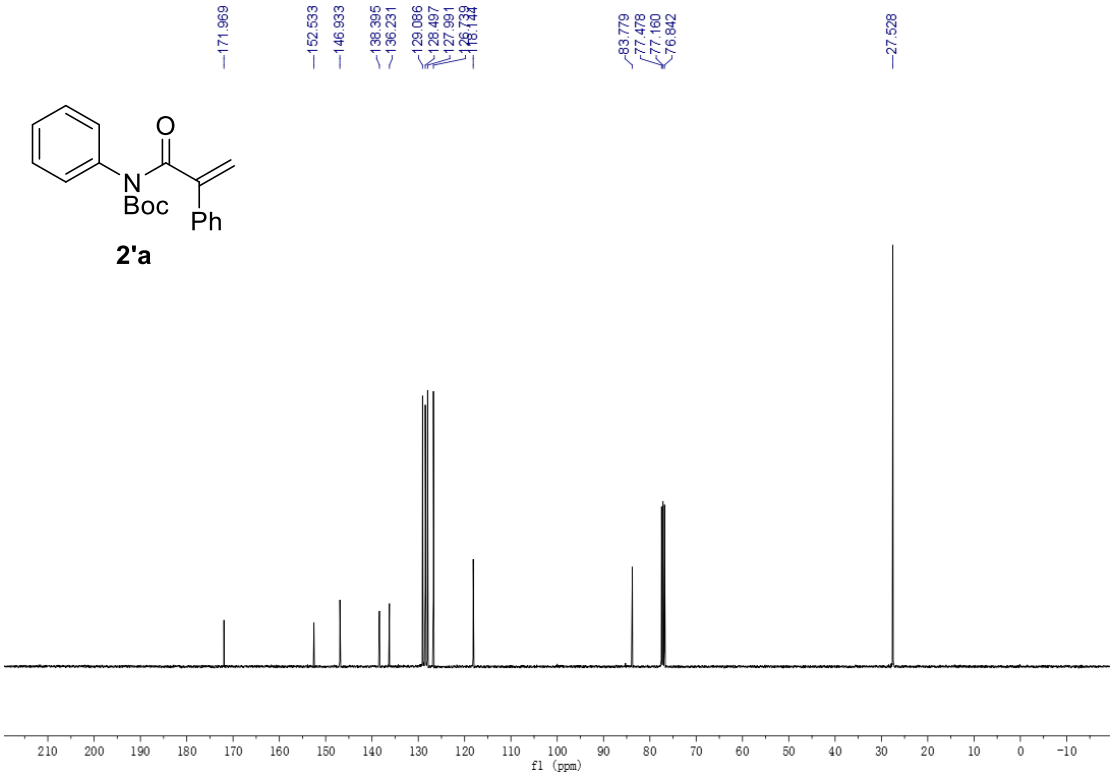
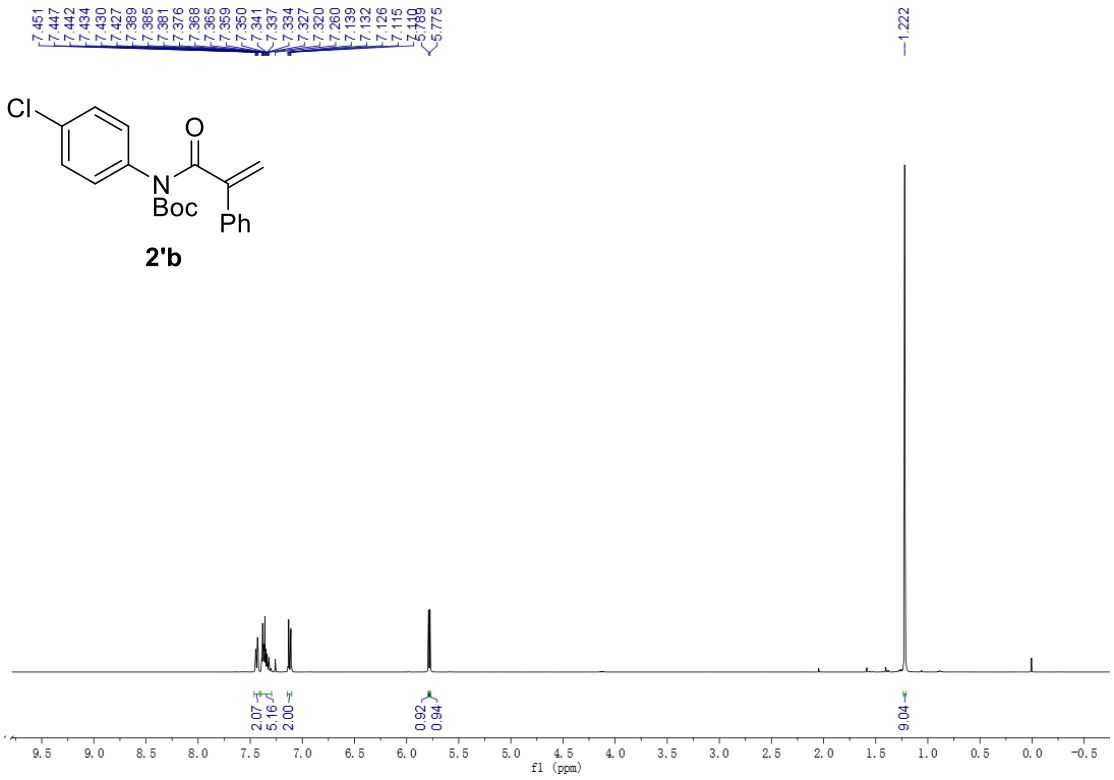
7.452
7.449
7.416
7.399
7.395
7.379
7.373
7.360
7.356
7.350
7.346
7.342
7.328
7.324
7.310
7.260
7.190
7.186
7.181
7.172
7.169
5.777
1.220
O
N
Boc
Ph
2.00
6.23
1.99
2.00
9.08
f1 (ppm)

2'a


171.969
152.533
146.933
138.395
136.231
129.086
128.497
127.981
126.739
83.779
77.478
77.160
76.842
27.528
O
N
Boc
Ph
f1 (ppm)

2'a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7.385
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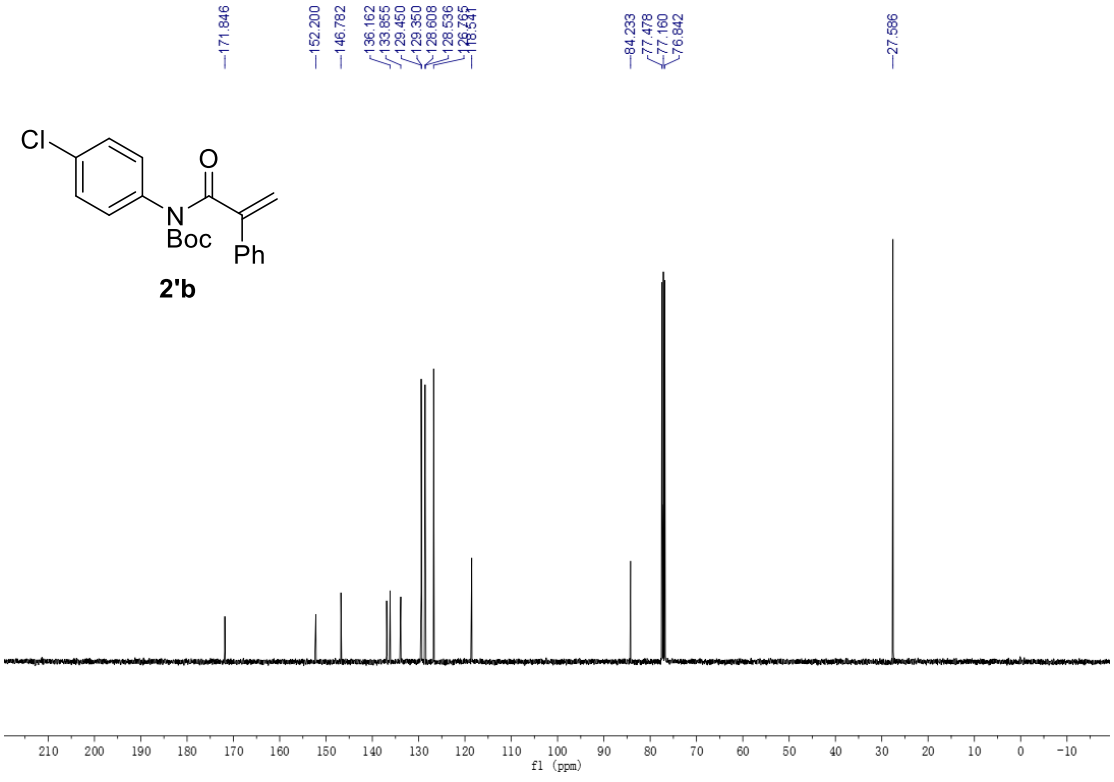
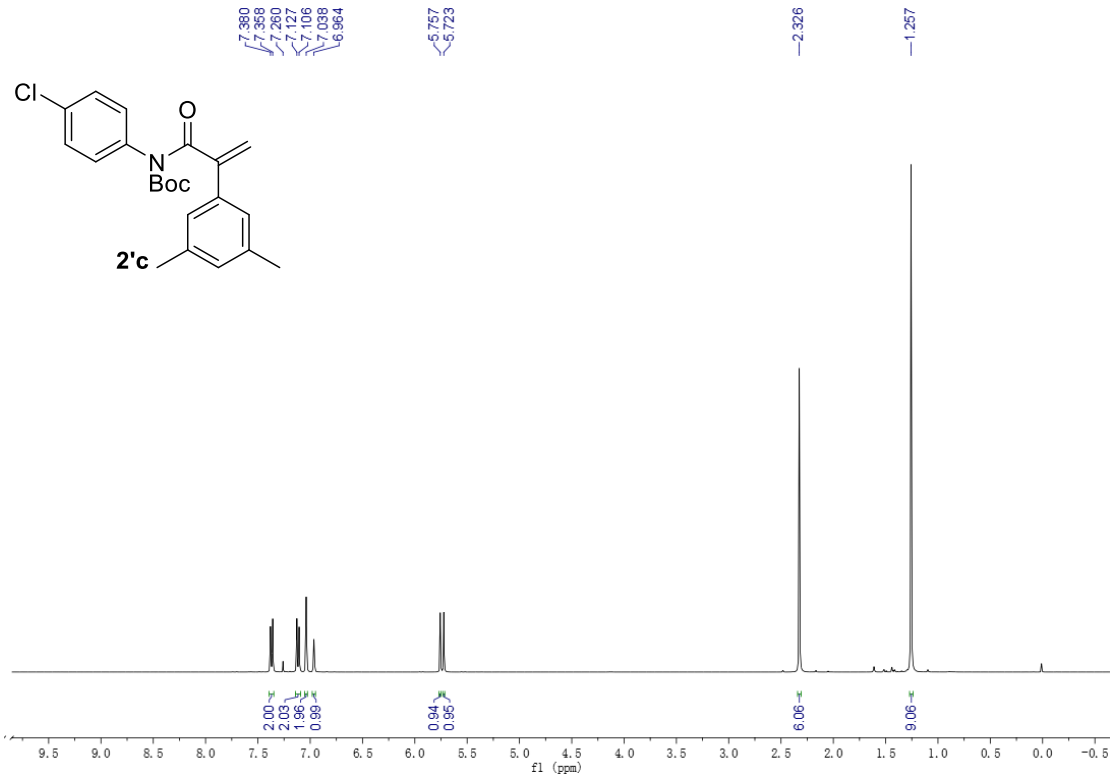
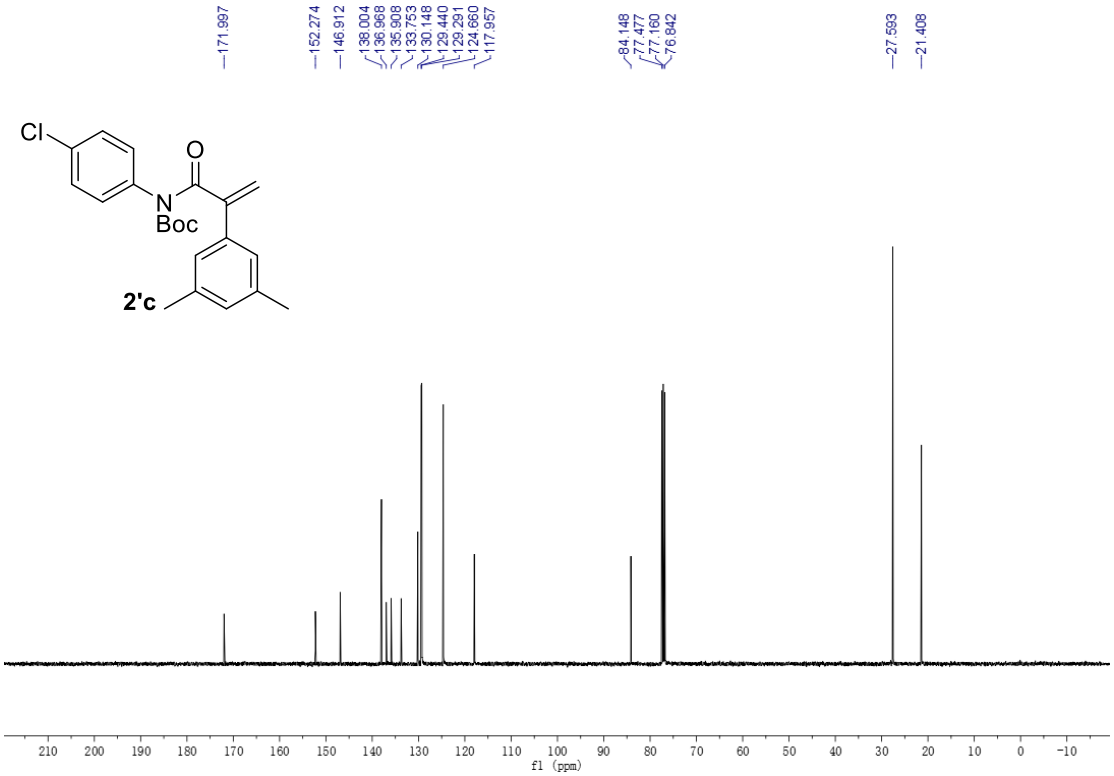
7.376
7.368
7.365
7.359
7.350
7.341
7.337
7.334
7.327
7.320
7.260
7.139
7.132
7.126
7.115
5.775
1.222
Cl
O
N
Boc
Ph
2.07
5.16
2.00
0.92
0.94
9.04
f1 (ppm)

2'b


171.846
152.200
146.782
136.162
133.855
129.450
129.350
128.608
128.536
126.765
118.541
84.233
77.478
77.160
76.842
27.596
Cl
O
N
Boc
Ph
f1 (ppm)

2'b


7.380
7.358
7.260
7.127
7.106
7.038
6.964
5.757
5.723
2.326
1.257
Cl
O
N
Boc
2'c
2.00
2.03
1.96
0.99
0.94
0.95
6.06
9.06
f1 (ppm)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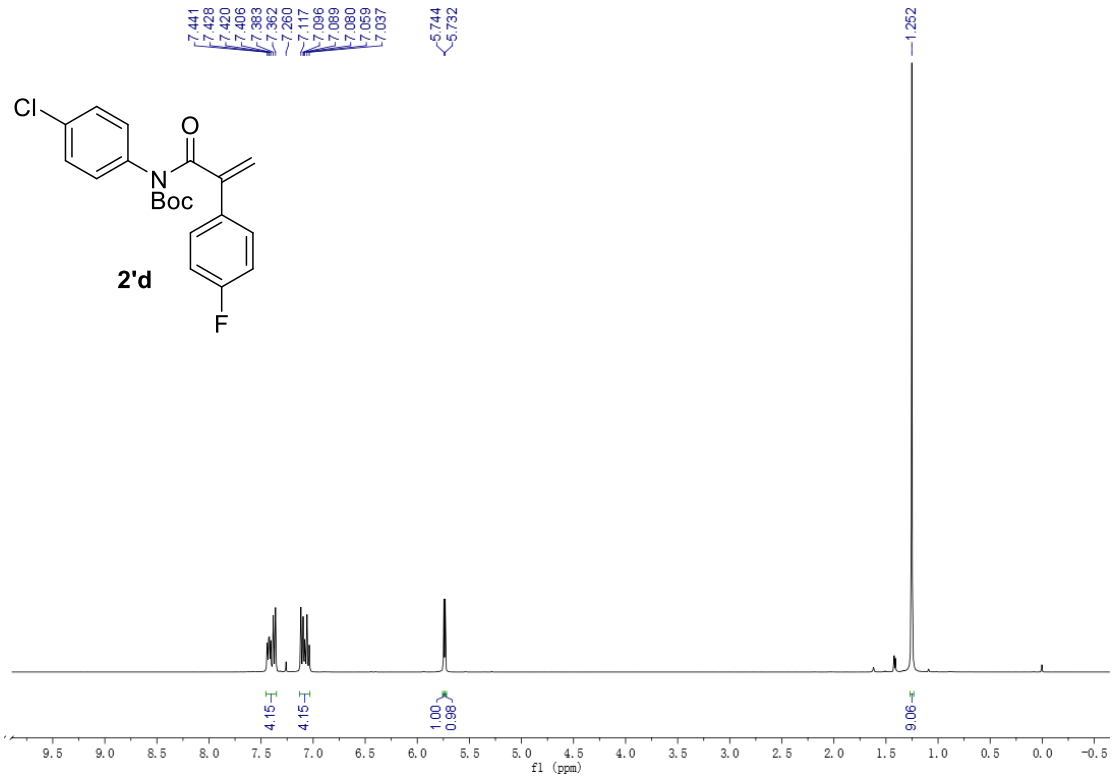
138.004
136.968
135.908
133.753
130.148
129.440
129.291
124.660
117.957
84.148
77.477
77.160
76.842
27.593
21.408
Cl
O
N
Boc
2'c
f1 (ppm)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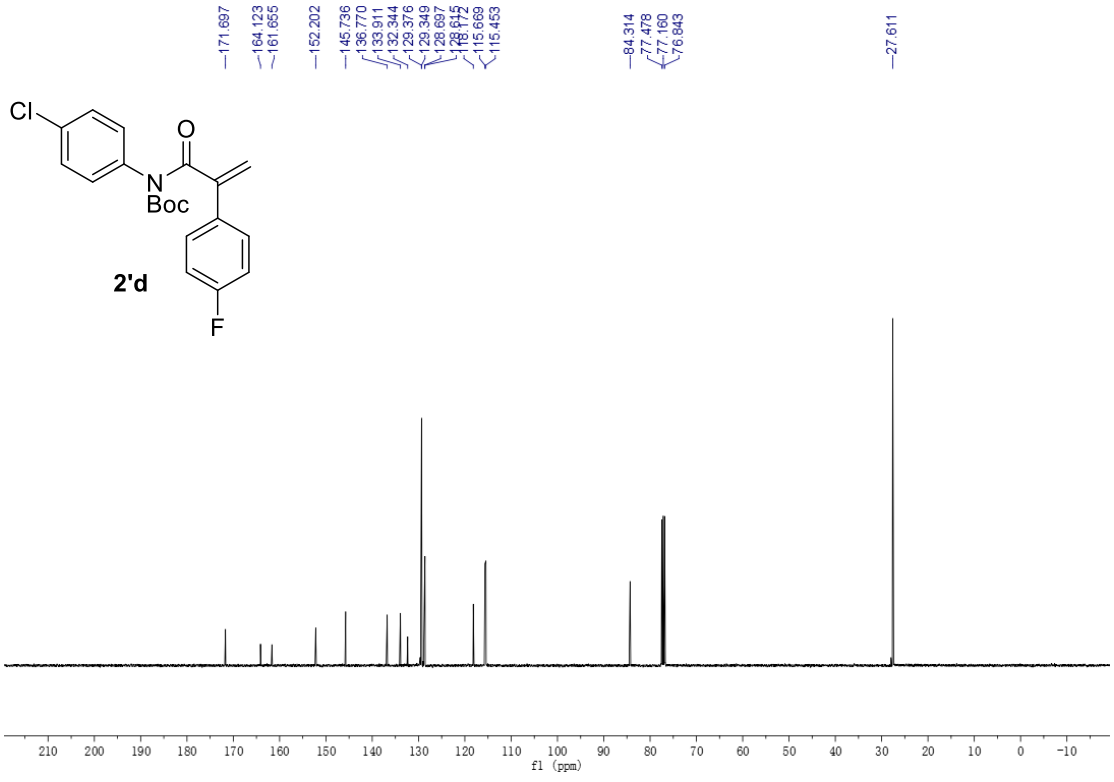
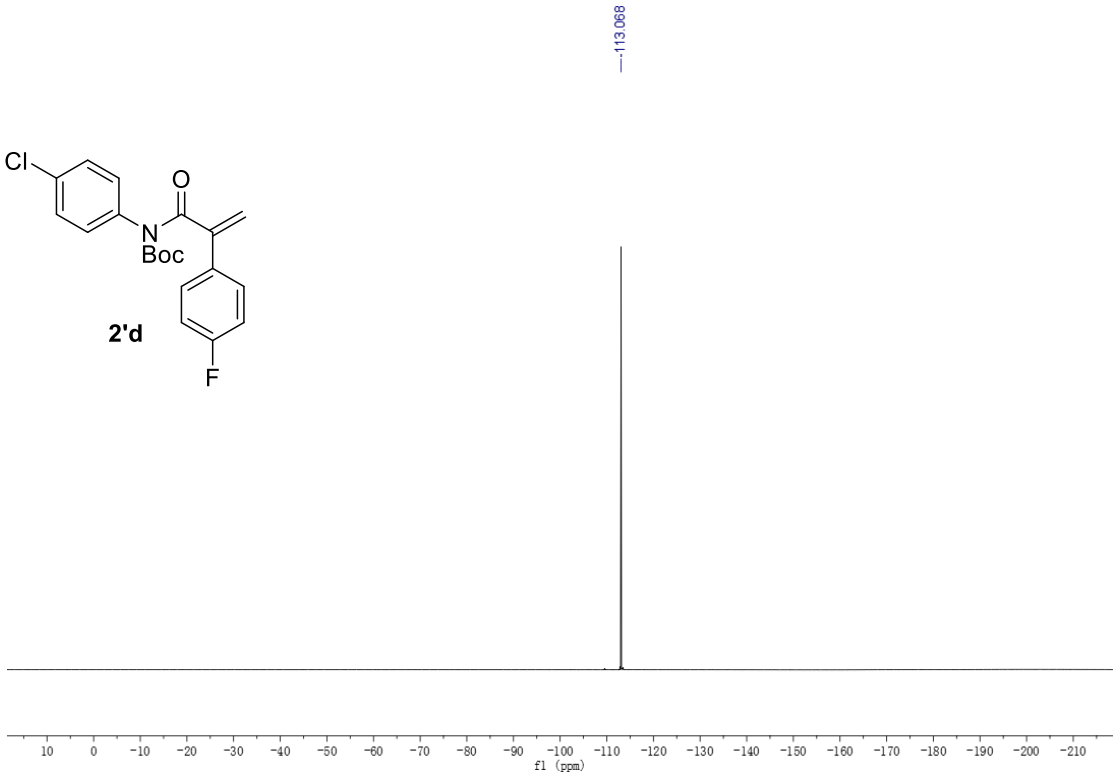
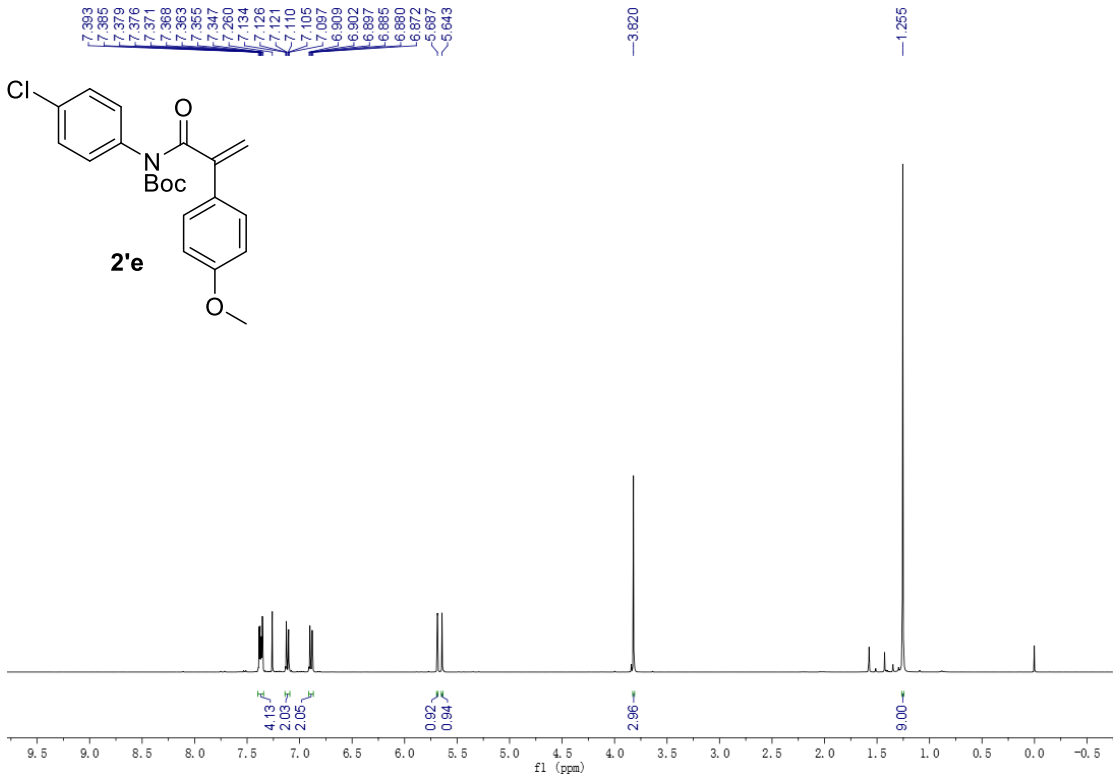
7.428
7.420
7.406
7.383
7.362
7.260
7.117
7.096
7.089
7.080
7.059
7.037
5.744
5.732
1.252
Cl
O
N
Boc
F
2'd
4.15
4.15
1.00
0.98
9.06
f1 (ppm)


171.697
164.123
161.655
152.202
145.736
136.770
133.911
132.344
129.376
129.349
128.697
115.689
115.453
84.314
77.478
77.160
76.843
27.611
Cl
O
N
Boc
F
2'd
f1 (ppm)


-113.068
Cl
O
N
Boc
F
2'd
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)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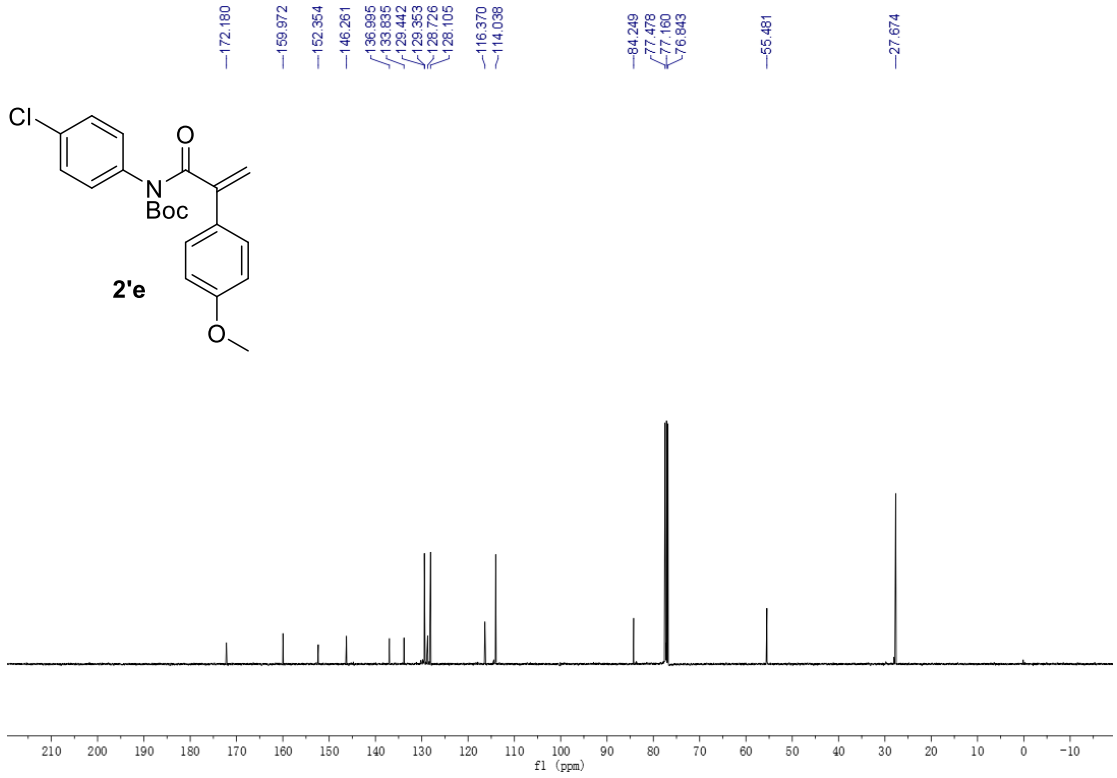
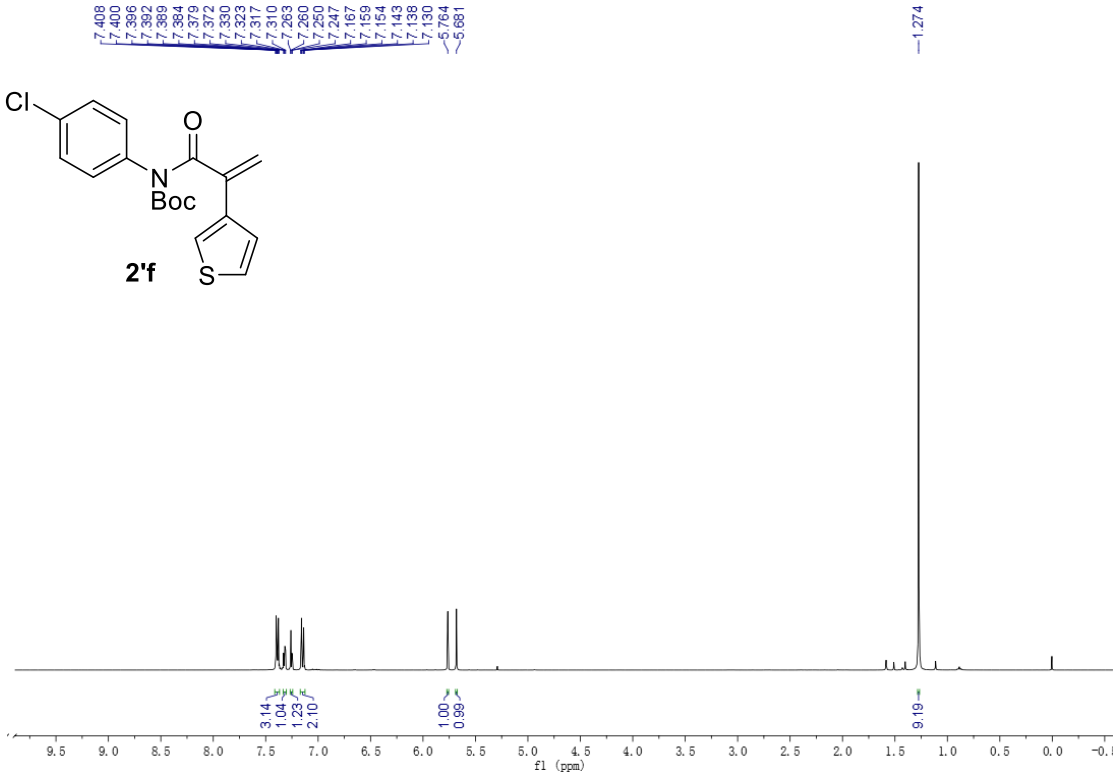
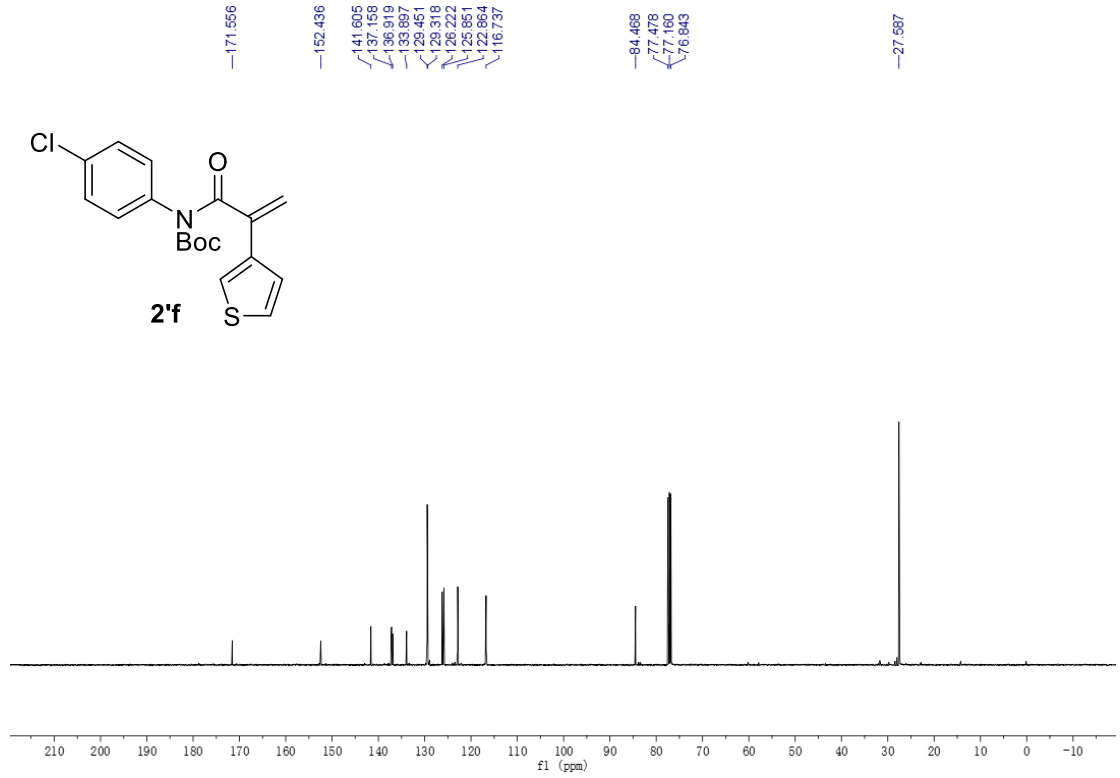
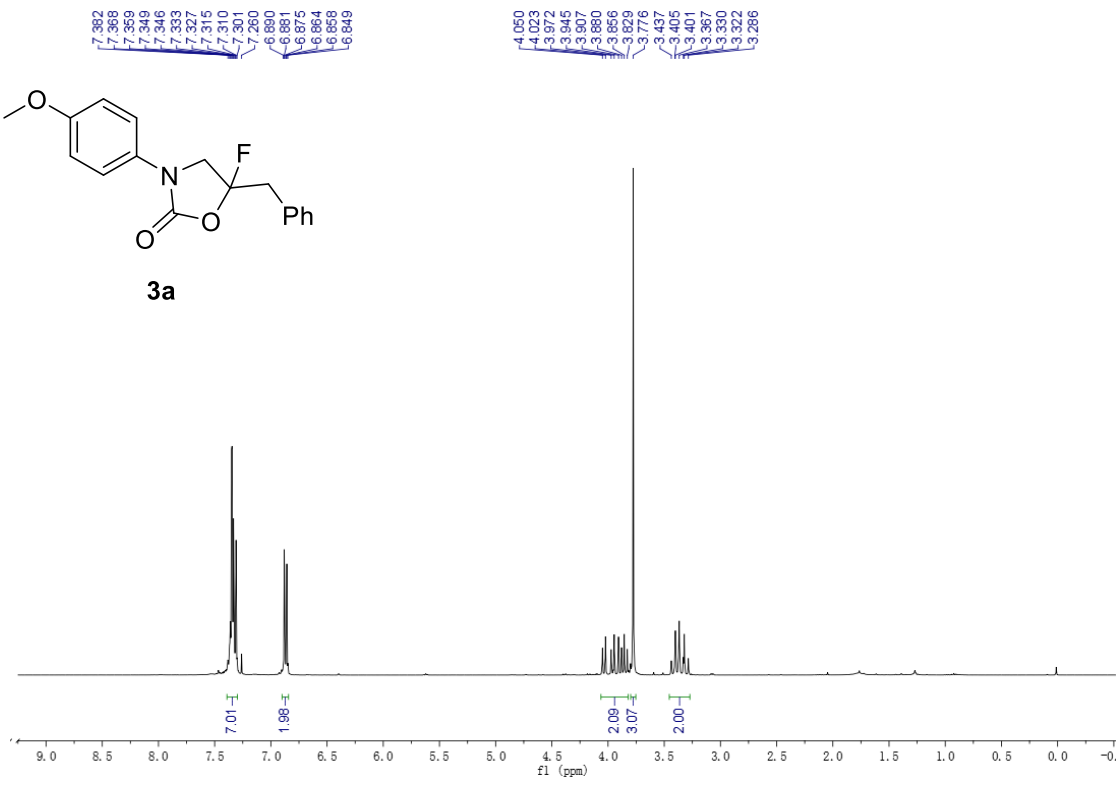
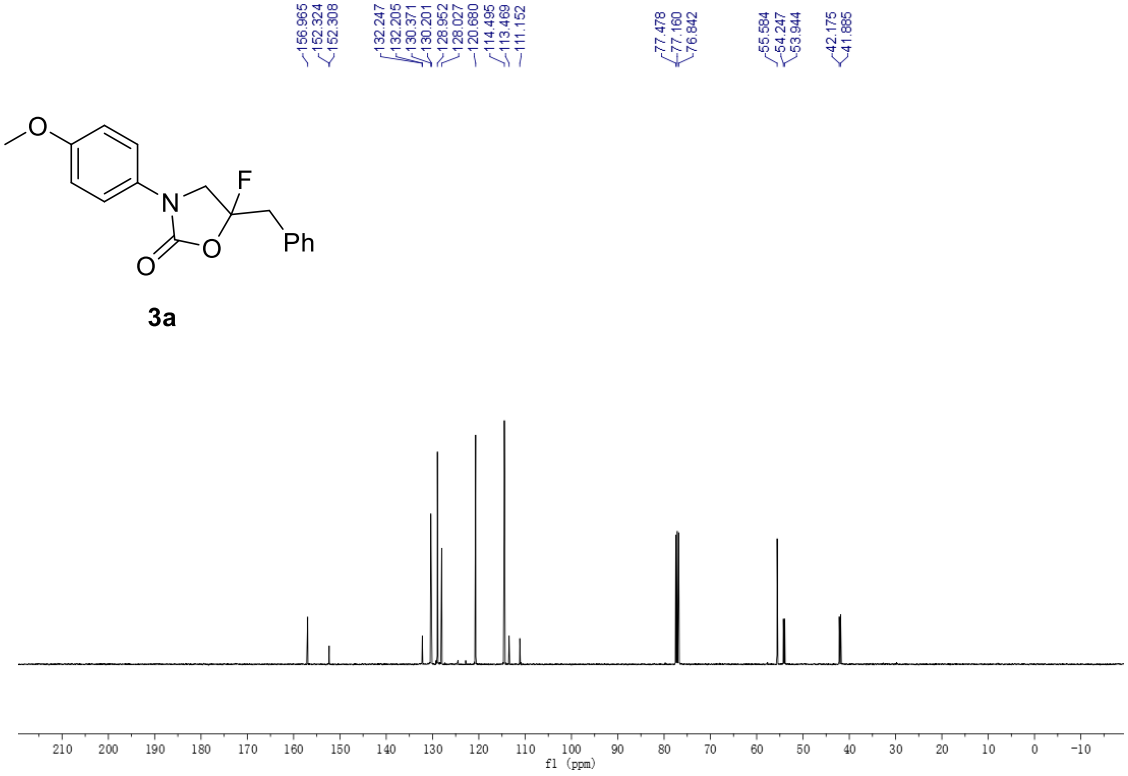
7.385
7.379
7.376
7.371
7.368
7.363
7.355
7.347
7.260
7.134
7.126
7.121
7.110
7.105
7.097
6.909
6.902
6.897
6.885
6.880
6.872
5.687
5.643
3.820
1.255
Cl
O
N
Boc
O
2'e
4.13
2.03
2.05
0.92
0.94
2.96
9.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


172.180
159.972
152.354
146.261
136.995
133.835
129.442
129.353
128.726
128.105
116.370
114.038
84.249
77.478
77.160
76.843
55.481
27.674
Cl
O
N
Boc
O
2'e
f1 (ppm)

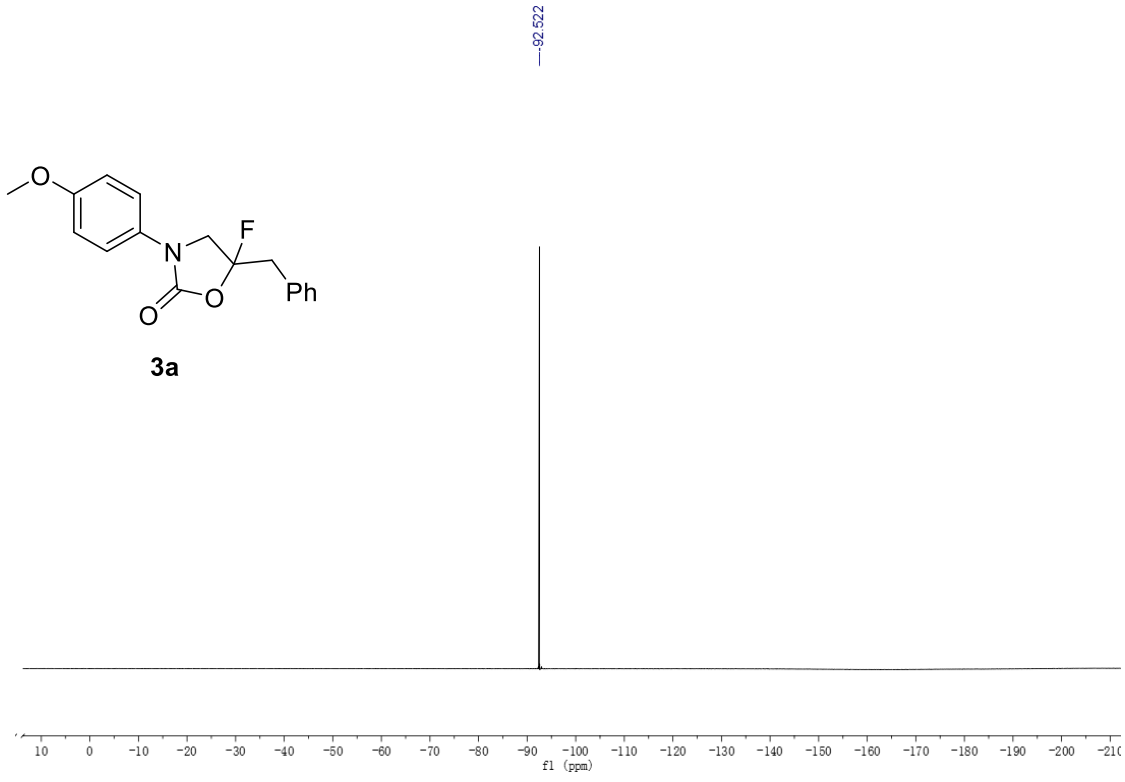

7.408
7.400
7.396
7.392
7.389
7.384
7.379
7.372
7.330
7.323
7.317
7.310
7.263
7.260
7.250
7.247
7.167
7.159
7.154
7.143
7.138
7.130
5.764
5.681
1.274
Cl
O
N
Boc
S
2'f
3.14
1.04
1.23
2.10
1.00
0.99
9.19
f1 (ppm)


171.556
152.436
141.605
137.158
136.919
133.897
129.451
129.318
126.222
125.851
122.864
116.737
84.468
77.478
77.160
76.843
27.587
Cl
O
N
Boc
S
2'f
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

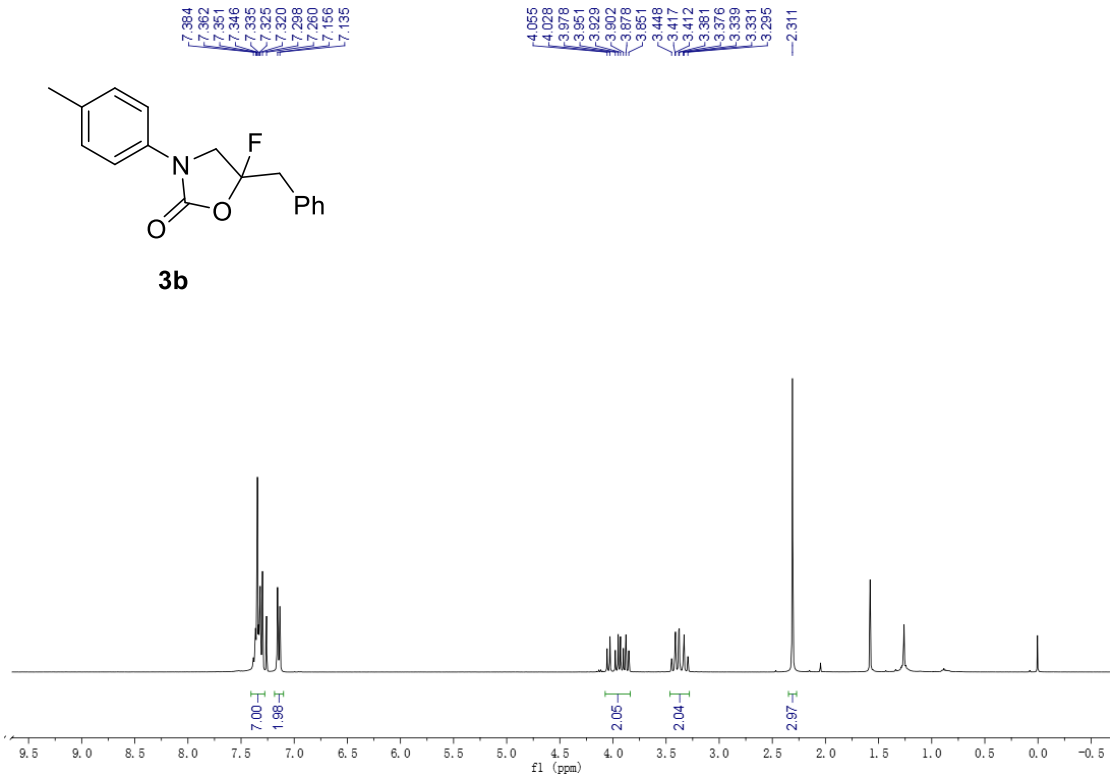

7.382
7.368
7.359
7.349
7.346
7.333
7.327
7.315
7.310
7.301
7.260
6.890
6.881
6.875
6.864
6.858
6.849
4.050
4.023
3.972
3.945
3.907
3.880
3.856
3.829
3.776
3.437
3.405
3.401
3.367
3.330
3.322
3.286
O
N
F
Ph
O
O
3a
7.01
1.98
2.09
3.07
2.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


156.965
152.324
152.308
132.247
132.205
130.371
130.201
128.852
128.027
120.680
114.495
113.469
111.152
77.478
77.160
76.842
55.584
54.247
53.944
42.175
41.885
O
N
F
O
O
Ph
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

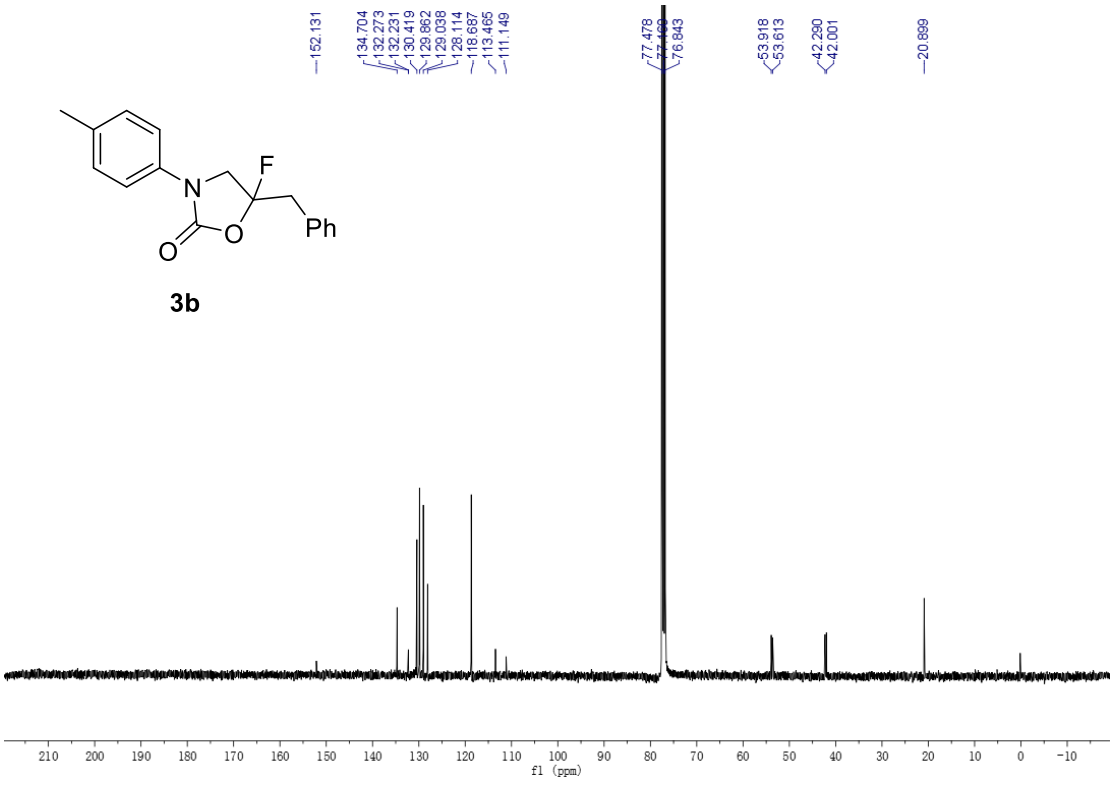
3a


-92.522
O
N
F
O
O
Ph
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

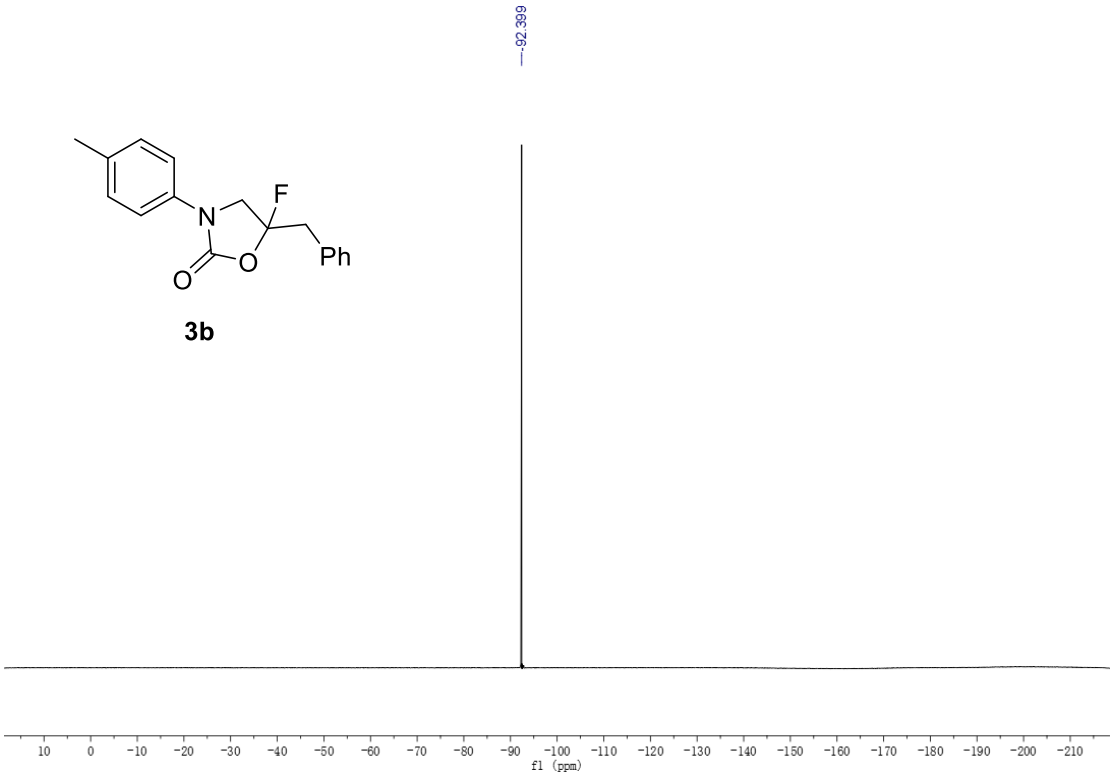
3a


7.384
7.362
7.351
7.346
7.335
7.325
7.320
7.298
7.260
7.156
7.135
4.055
4.028
3.978
3.951
3.929
3.902
3.878
3.851
3.448
3.417
3.412
3.381
3.376
3.339
3.331
3.295
2.311
F
N
O
O
Ph
7.00
1.98
2.05
2.04
2.97
f1 (ppm)

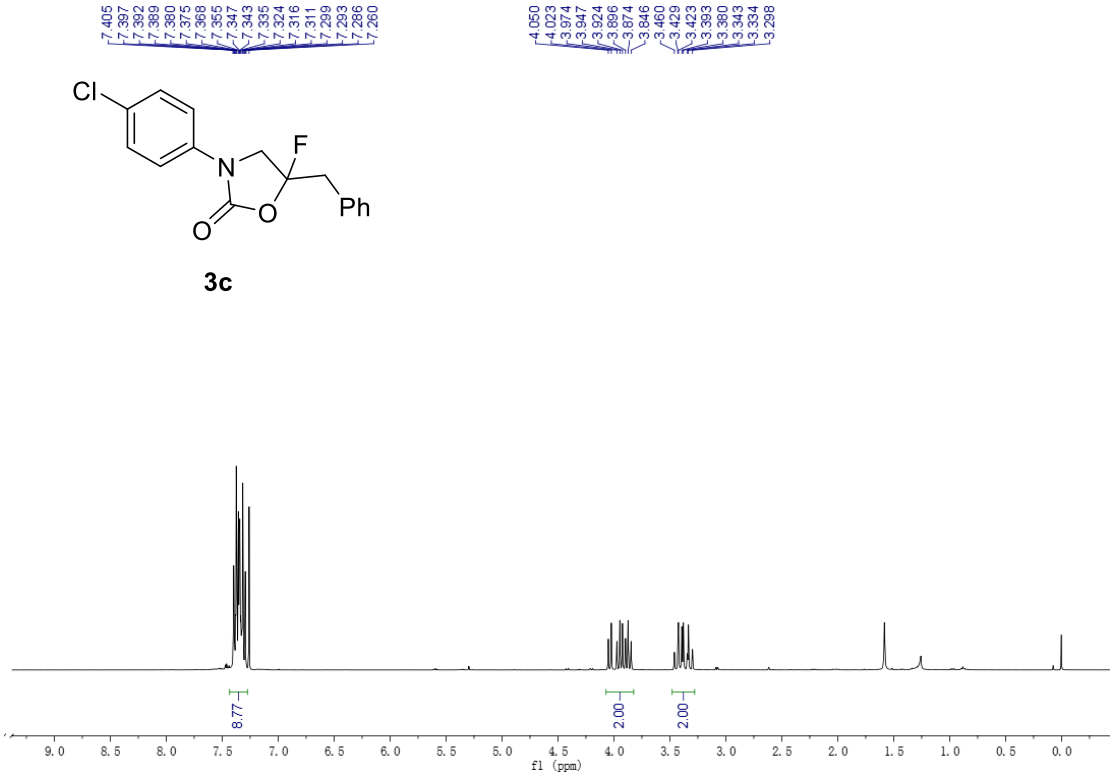
3b


152.131
134.704
132.273
132.231
130.419
129.862
129.038
128.114
118.687
113.465
111.149
77.478
76.843
53.918
53.613
42.290
42.001
20.899
F
N
O
O
Ph
f1 (ppm)

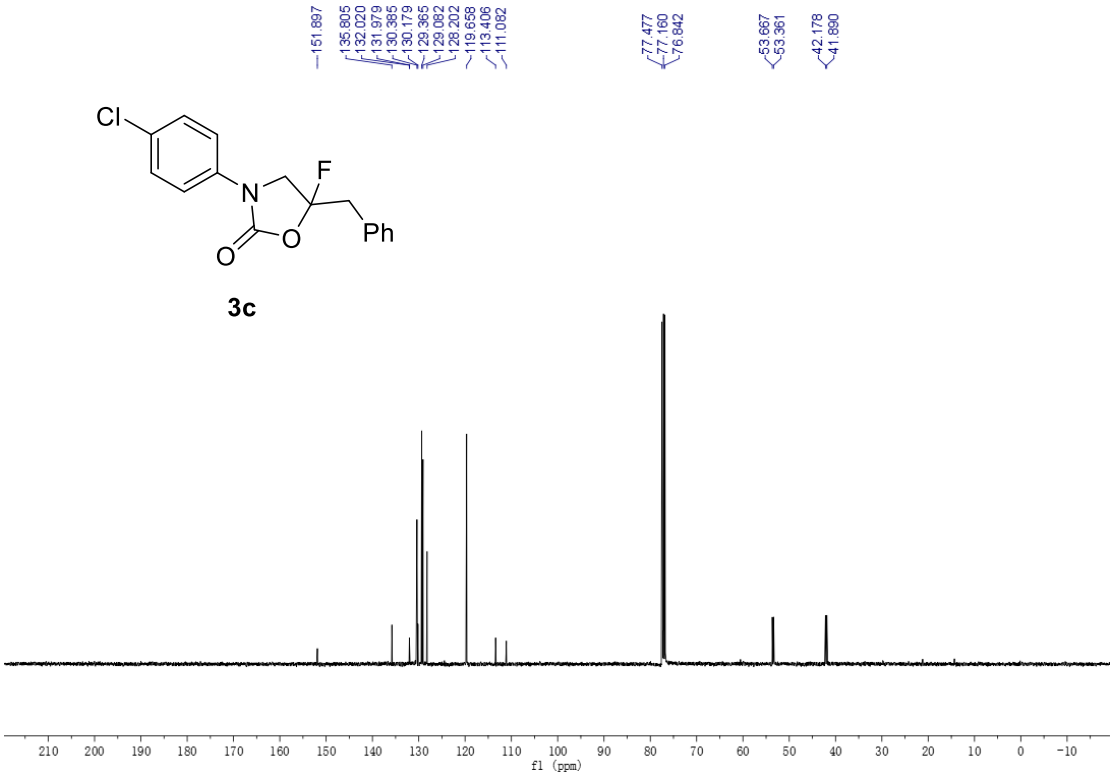
3b

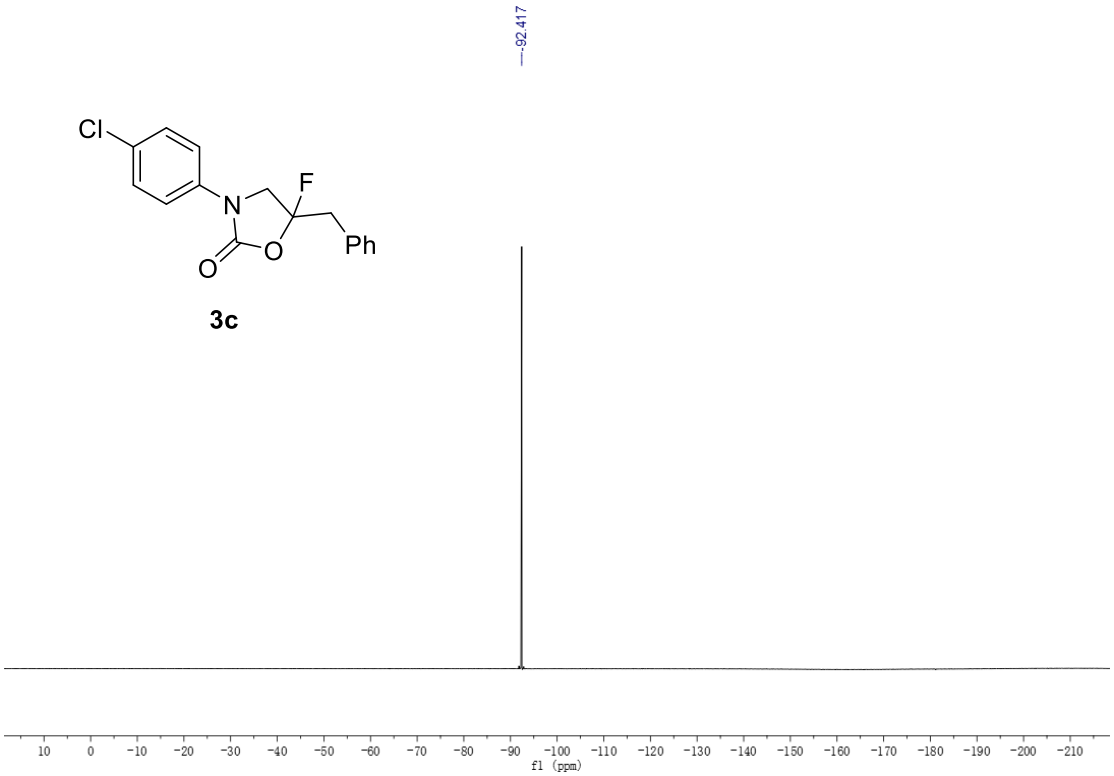

-92.399
F
N
O
O
Ph
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

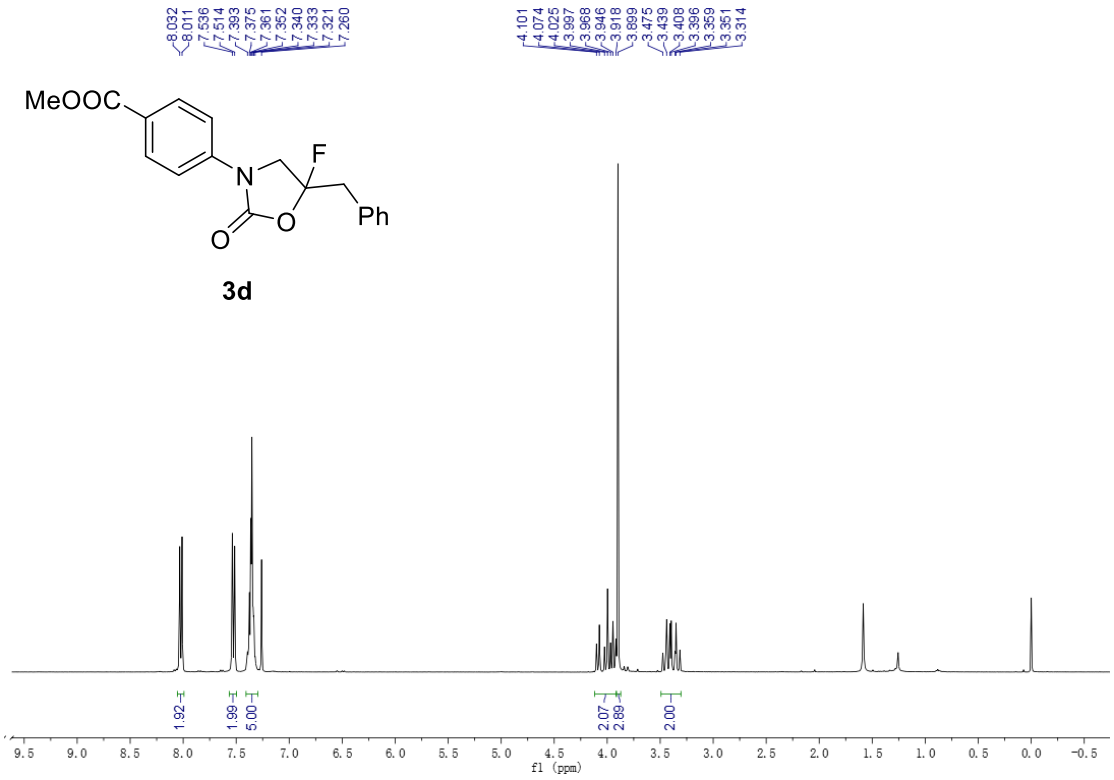
3b


7.405
7.397
7.392
7.389
7.380
7.375
7.368
7.355
7.347
7.343
7.335
7.324
7.316
7.311
7.299
7.293
7.286
7.260
4.050
4.023
3.974
3.947
3.924
3.896
3.874
3.846
3.460
3.429
3.423
3.393
3.380
3.343
3.334
3.298
Cl
N
F
O
O
Ph
8.77
2.00
2.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

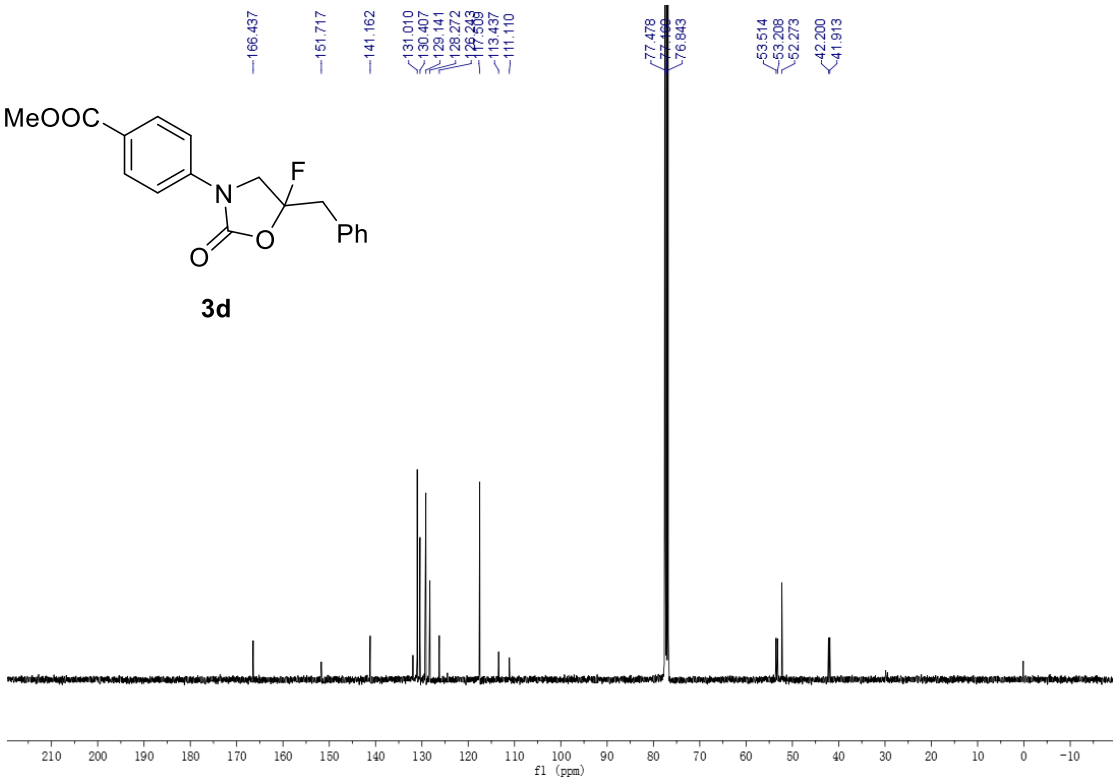
3c


151.897
135.805
132.020
131.979
130.385
130.179
129.365
129.082
128.202
119.658
113.406
111.082
77.477
77.160
76.842
53.667
53.361
42.178
41.890
Cl
F
N
O
O
Ph
3c
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

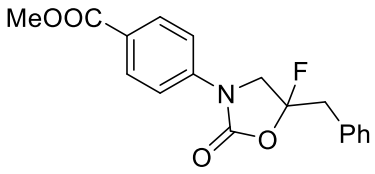

-92.417
Cl
F
N
O
O
Ph
3c
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


8.032
8.011
7.536
7.514
7.393
7.375
7.361
7.352
7.340
7.333
7.321
7.260
4.101
4.074
4.025
3.997
3.968
3.946
3.918
3.899
3.475
3.439
3.408
3.396
3.359
3.351
3.314
MeOOC
N
F
O
O
Ph
1.92
1.99
5.00
2.07
2.89
2.00
f1 (ppm)

3d


166.437
151.717
141.162
131.010
130.407
129.141
128.272
113.437
111.110
77.478
76.843
53.514
53.208
52.273
42.200
41.913
MeOOC
N
F
O
O
Ph
f1 (ppm)

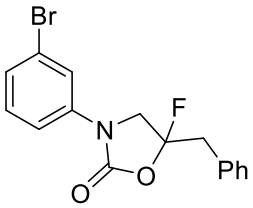
3d


MeOOC
N
F
Ph
O
O

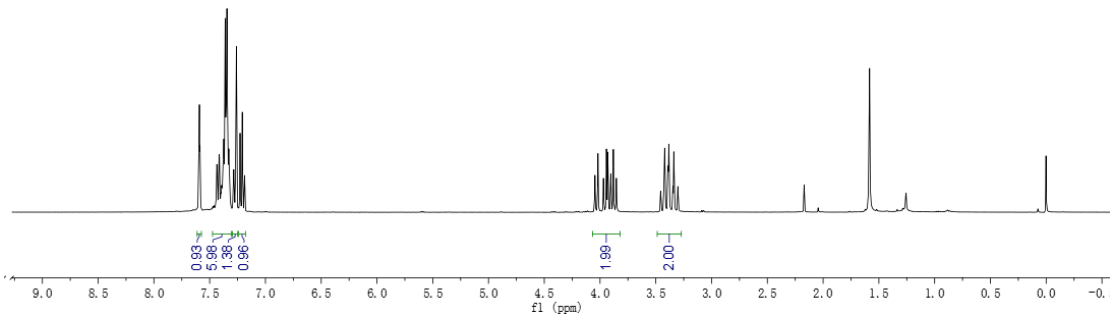
3d

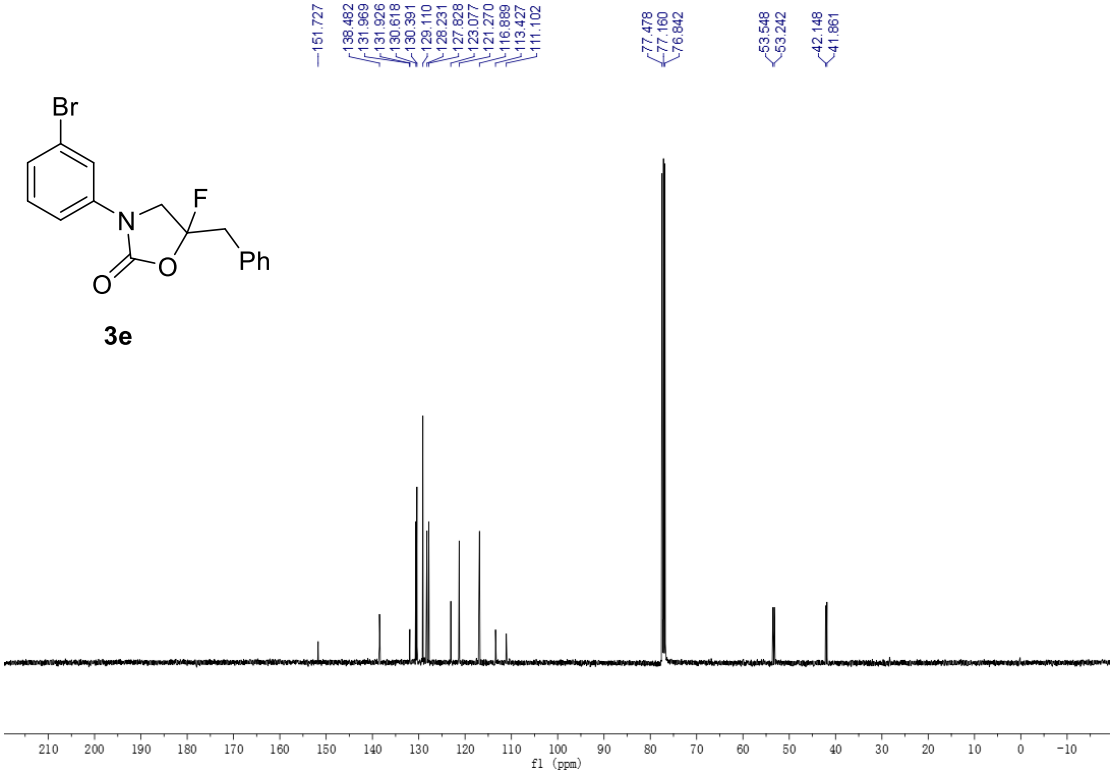
-92.279
70 60 50 40 30 20 10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260
f1 (ppm)

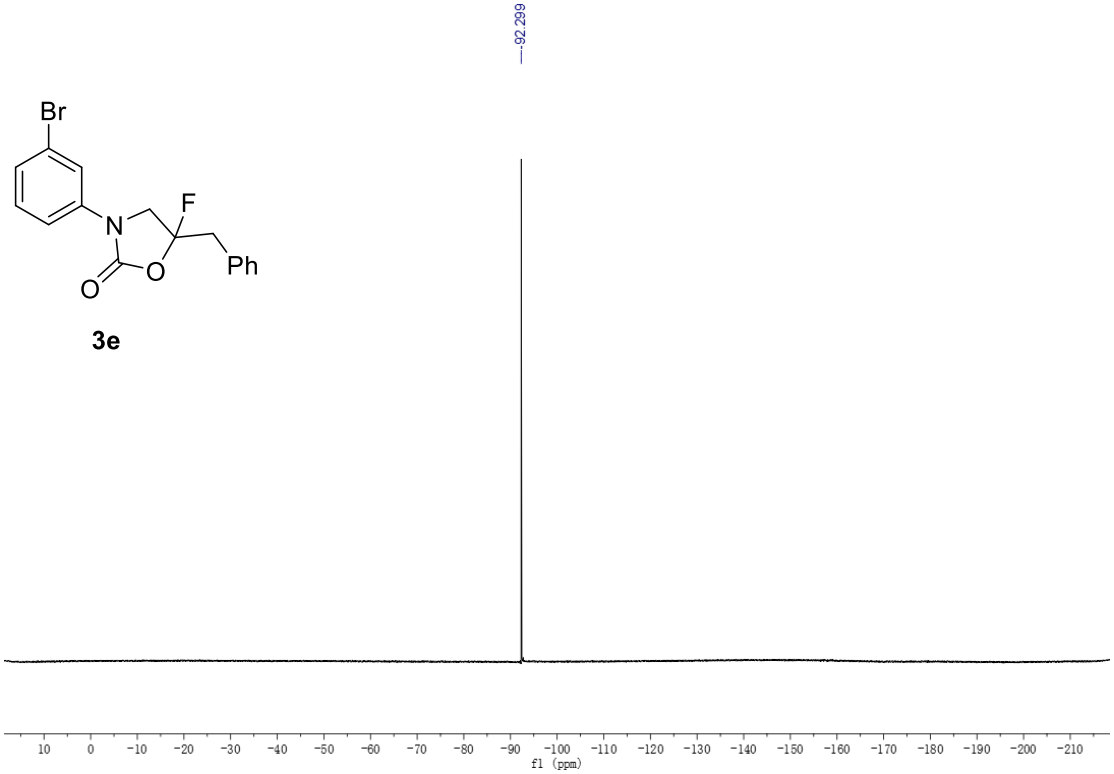

7.597
7.592
7.587
7.470
7.460
7.438
7.436
7.433
7.431
7.418
7.415
7.413
7.400
7.394
7.383
7.373
7.361
7.352
7.345
7.328
7.284
7.280
7.260
7.227
7.207
7.187
4.046
4.019
3.970
3.943
3.931
3.904
3.881
3.854
3.457
3.426
3.421
3.390
3.383
3.347
3.339
3.302

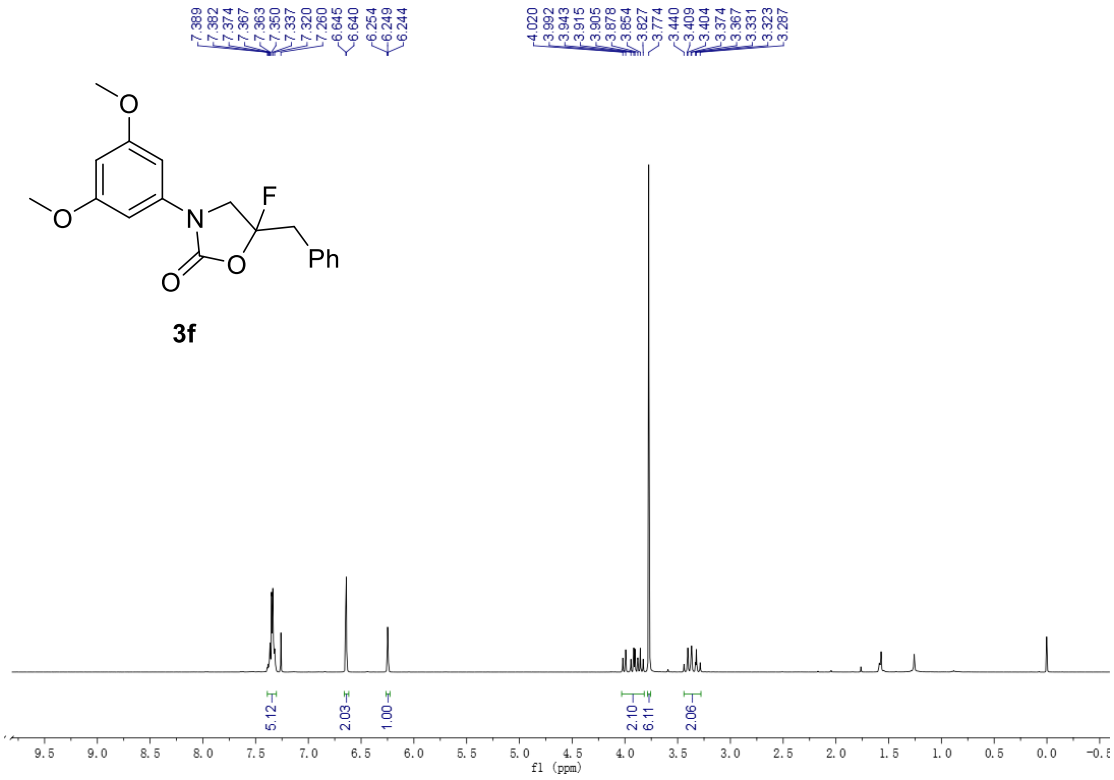

Br
N
F
Ph
O
O

3e

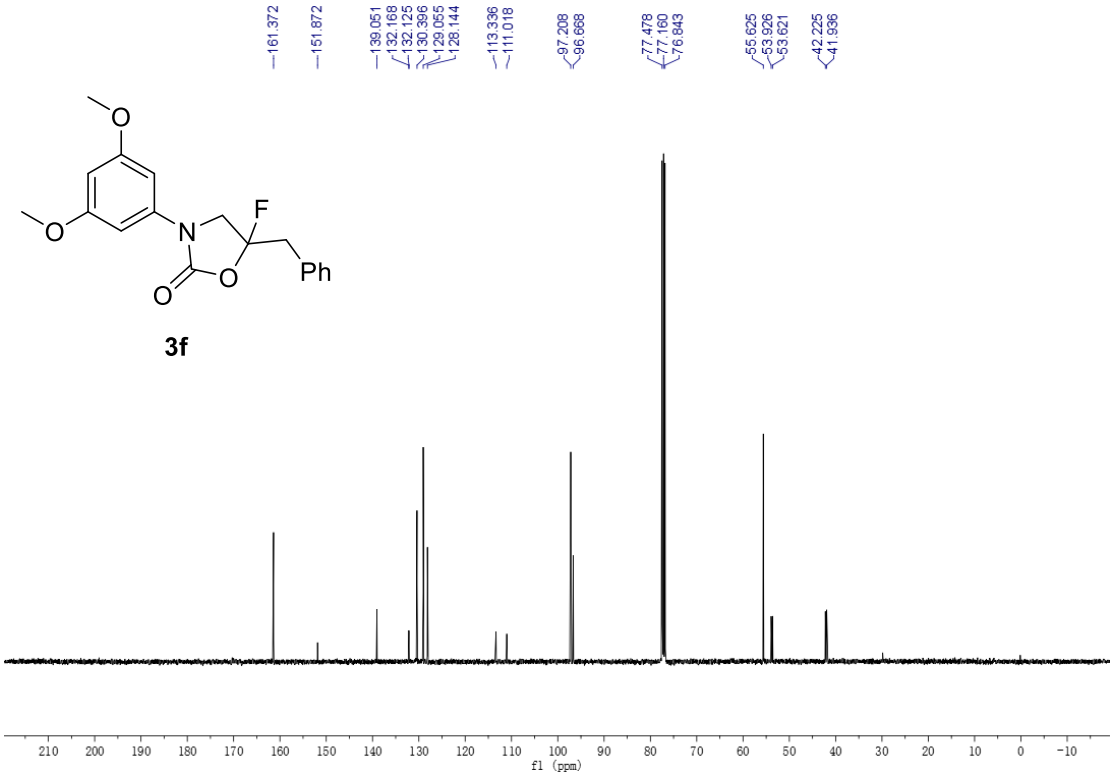

0.93
5.98
1.38
0.96
1.99
2.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


151.727
138.482
131.969
131.926
130.618
130.391
129.110
128.231
127.828
123.077
121.270
116.889
113.427
111.102
77.478
77.160
76.842
53.548
53.242
42.148
41.861
Br
F
N
O
O
Ph
3e
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

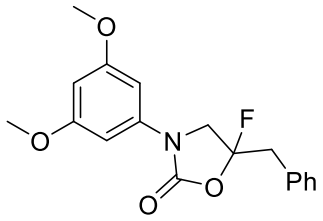

-92.299
Br
F
N
O
O
Ph
3e
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.389
7.382
7.374
7.367
7.363
7.350
7.337
7.320
7.260
6.645
6.640
6.254
6.249
6.244
4.020
3.992
3.943
3.915
3.905
3.878
3.854
3.827
3.774
3.440
3.409
3.404
3.374
3.367
3.331
3.323
3.287
O
O
N
F
O
O
Ph
O
5.12
2.03
1.00
2.10
6.11
2.06
f1 (ppm)

3f


161.372
151.872
139.051
132.168
132.125
130.396
129.055
128.144
113.336
111.018
97.208
96.668
77.478
77.160
76.843
55.625
53.926
53.621
42.225
41.936
O
O
N
F
O
O
Ph
f1 (ppm)

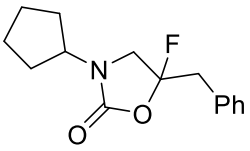
3f


O
O
N
F
O
O
Ph

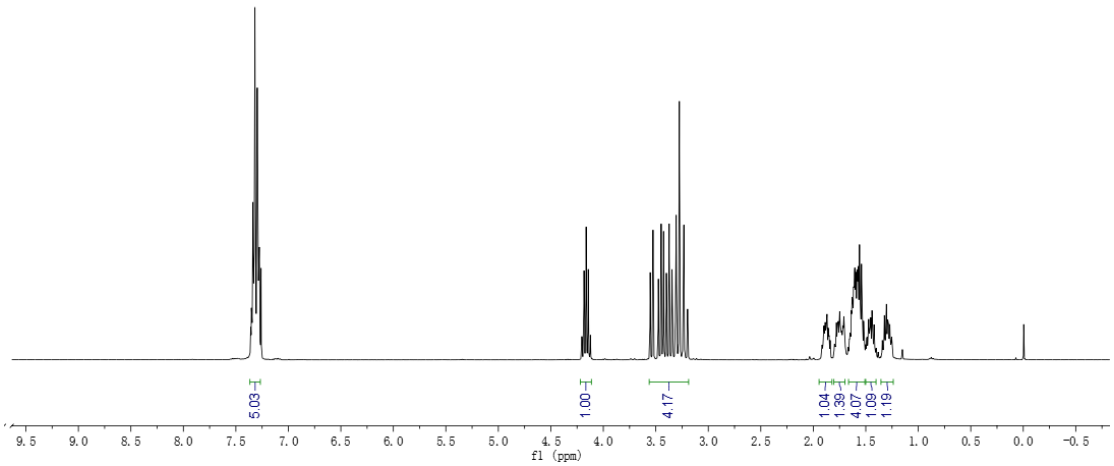
3f

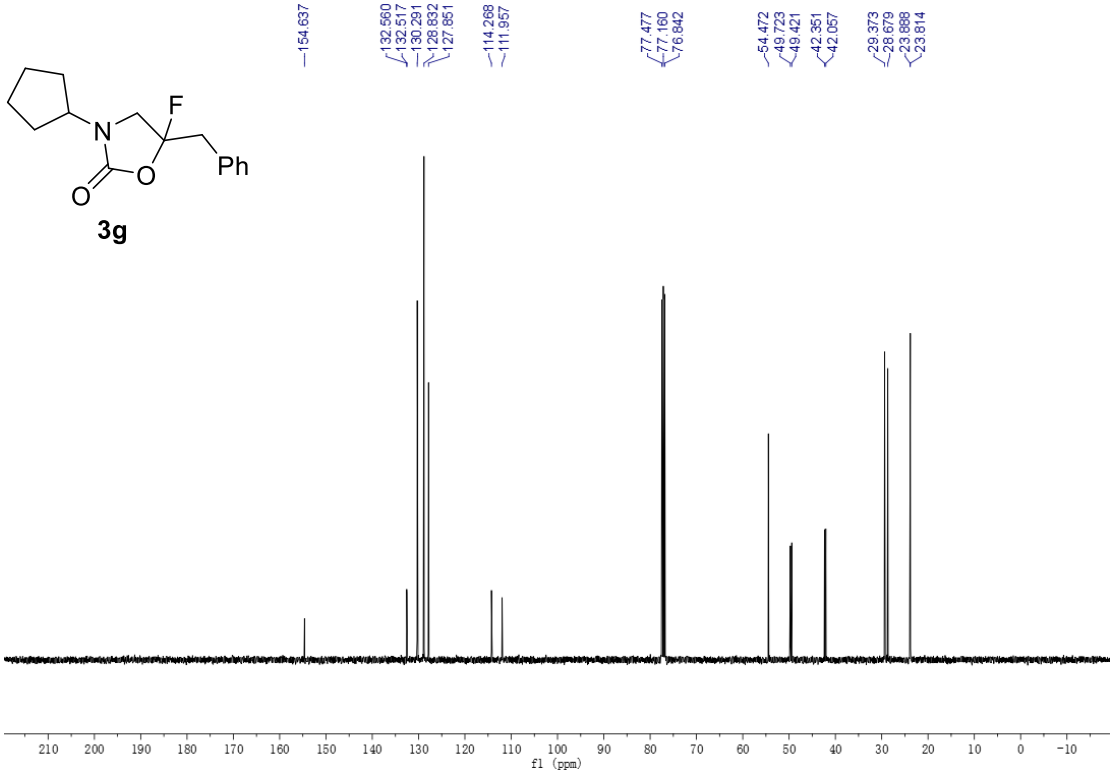
-92.272
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

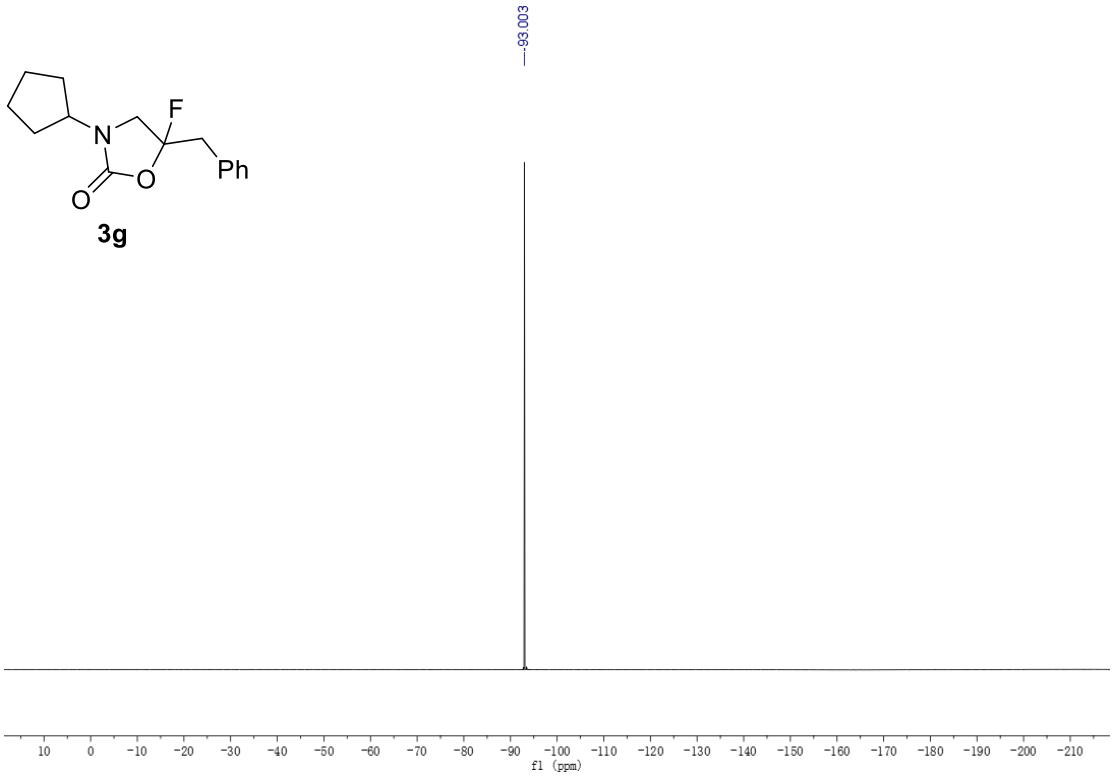

7.358
7.352
7.348
7.337
7.318
7.311
7.296
7.282
7.276
7.260
4.184
4.164
4.143
3.553
3.526
3.476
3.449
3.426
3.399
3.373
3.345
3.311
3.306
3.276
3.240
3.233
3.197
1.899
1.886
1.880
1.872
1.869
1.858
1.780
1.768
1.761
1.749
1.717
1.708
1.645
1.637
1.630
1.627
1.623
1.615
1.604
1.597
1.593
1.584
1.581
1.573
1.570
1.560
1.551
1.541
1.533
1.529
1.521
1.472
1.461
1.453
1.441
1.437
1.421
1.323
1.310
1.303
1.291
1.283
1.271


N
F
O
O
Ph

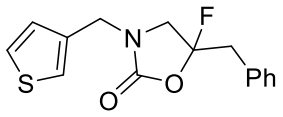
3g


5.03
1.00
4.17
1.04
1.39
4.07
1.09
1.19
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

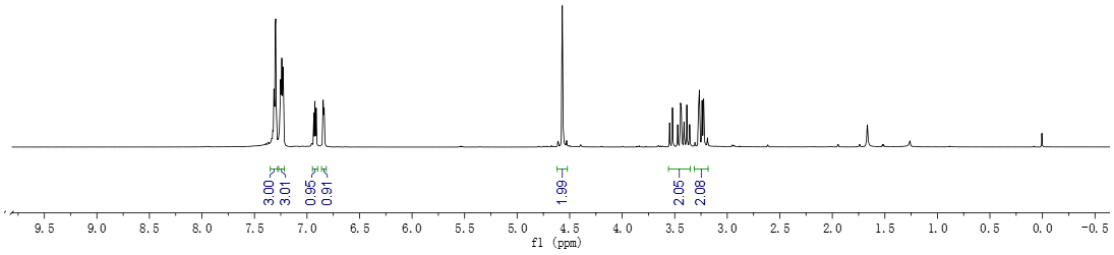

154.637
132.560
132.517
130.291
128.832
127.851
114.268
111.957
77.477
77.160
76.842
54.472
49.723
49.421
42.351
42.057
29.373
28.679
23.888
23.814
F
N
O
O
Ph
3g
f1 (ppm)


-93.003
F
N
O
O
Ph
3g
f1 (ppm)

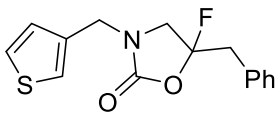

7.344
7.338
7.333
7.326
7.324
7.315
7.311
7.302
7.298
7.276
7.271
7.260
7.251
7.240
7.238
7.227
6.934
6.925
6.921
6.912
6.846
6.838
4.570
3.549
3.522
3.472
3.445
3.439
3.412
3.385
3.358
3.307
3.271
3.265
3.239
3.225
3.189


F
N
S
O
O
Ph

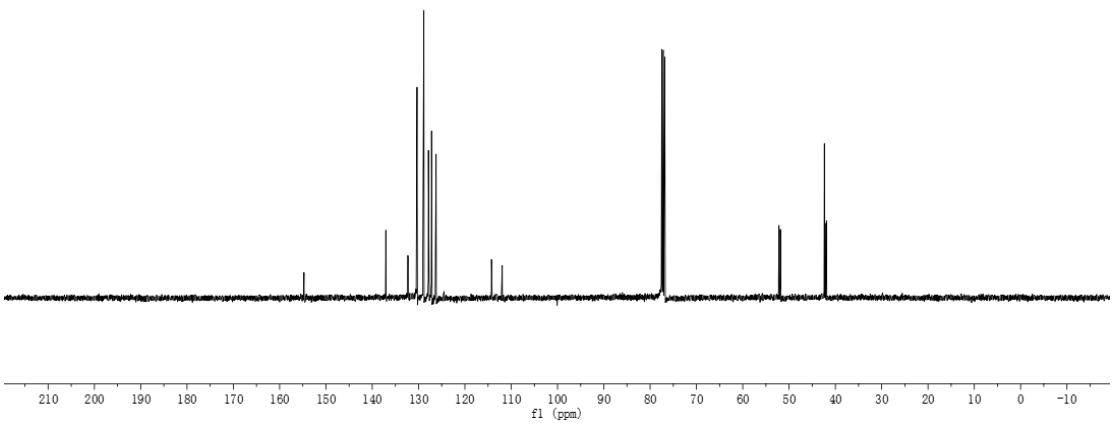
3h

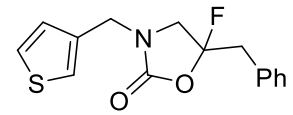

3.00
3.01
0.95
0.91
1.99
2.05
2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


154.738
137.073
132.313
132.266
130.332
128.859
127.879
127.199
127.119
126.218
114.259
111.934
77.478
77.160
76.842
52.176
51.875
42.381
42.217
41.925


F
N
S
O
O
Ph

3h


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


F
N
S
O
O
Ph

3h

-93.088
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.337
7.333
7.319
7.316
7.306
7.300
7.289
7.284
7.270
7.260
7.252
7.246
7.230
7.227
7.219
7.190
7.182
7.171
7.167
7.150
7.047
7.041
7.028
7.024
4.781
4.769
4.763
4.755
4.750
4.737
4.723
4.192
4.178
4.174
4.160
4.144
4.126
4.109
4.091
3.676
3.649
3.621
3.595
3.526
3.500
3.459
3.451
3.424
3.408
3.305
3.284
3.270
3.247
3.232
3.197
3.190
3.184
3.162
3.130
3.087
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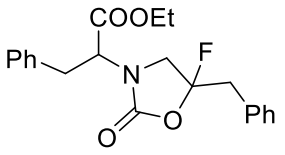
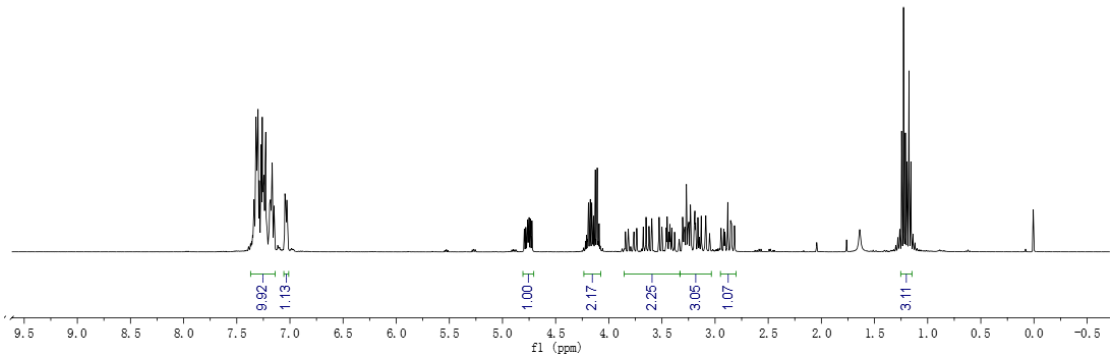
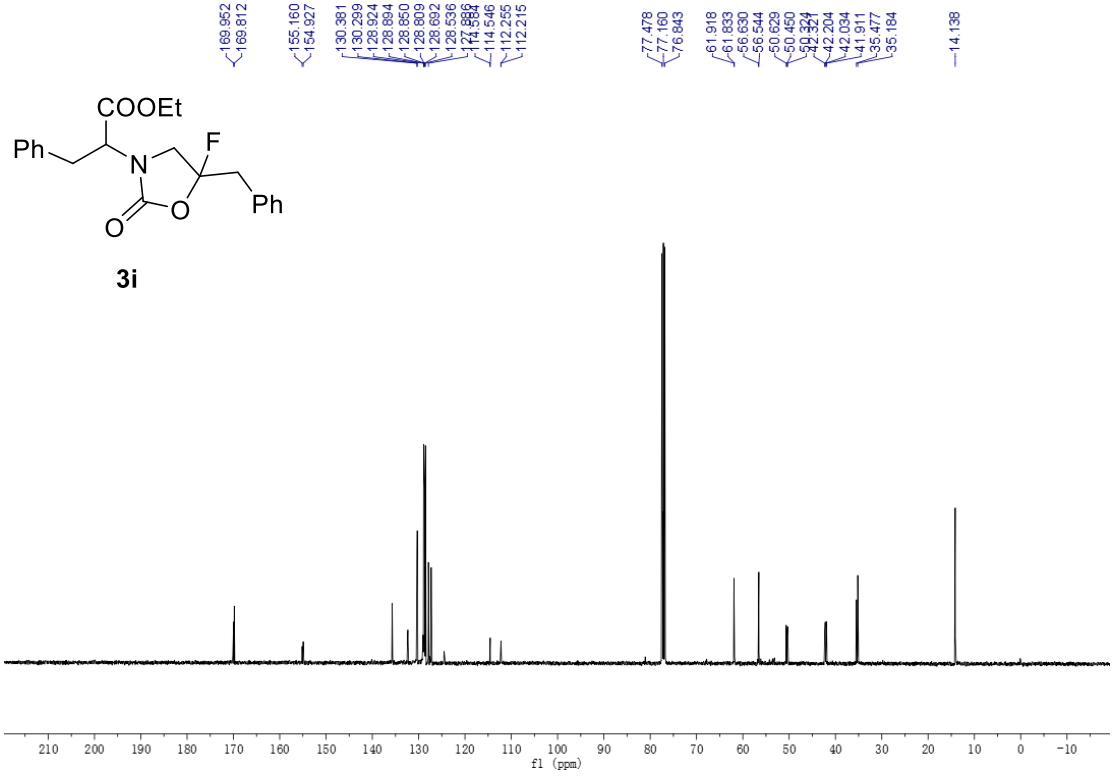
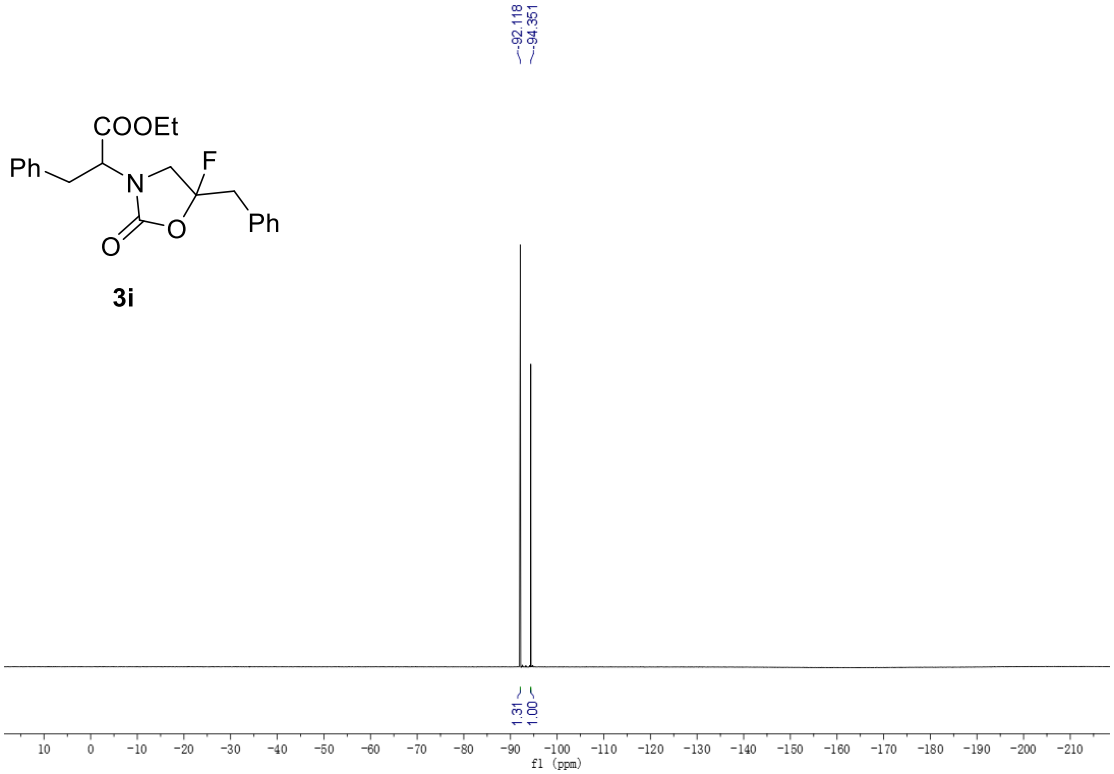
2.854
2.844
2.818
1.245
1.227
1.209
1.194
1.176
1.158

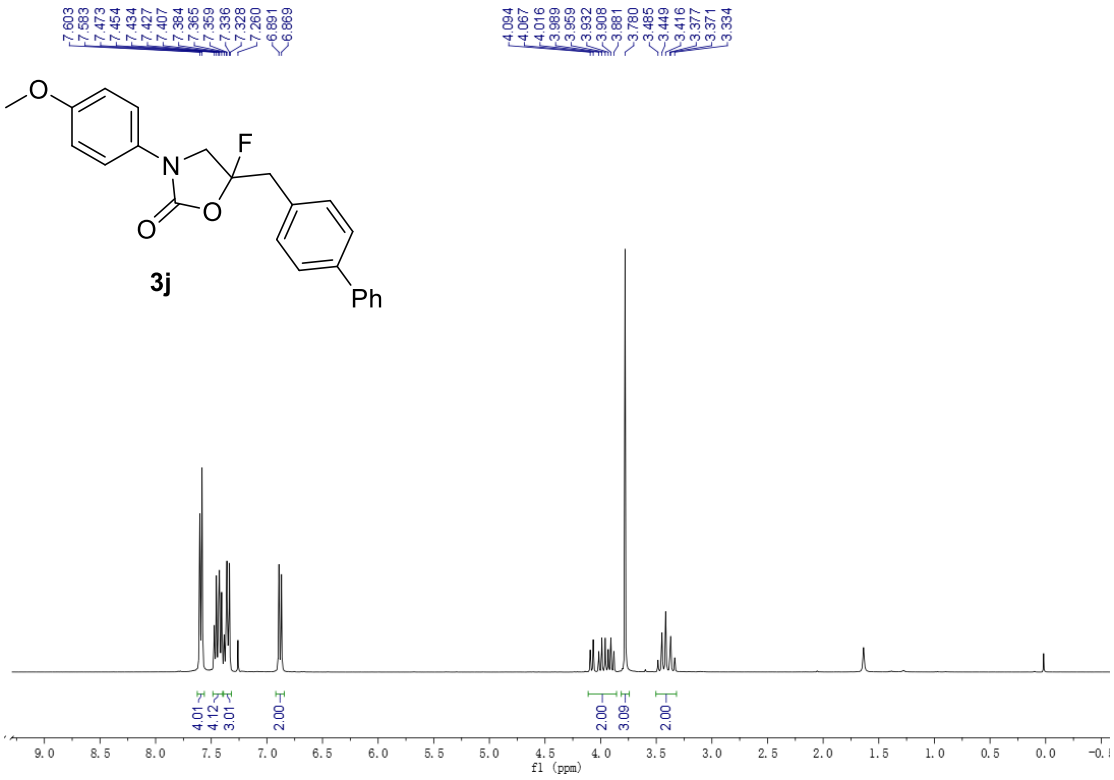

COOEt
Ph
N
F
O
O
Ph

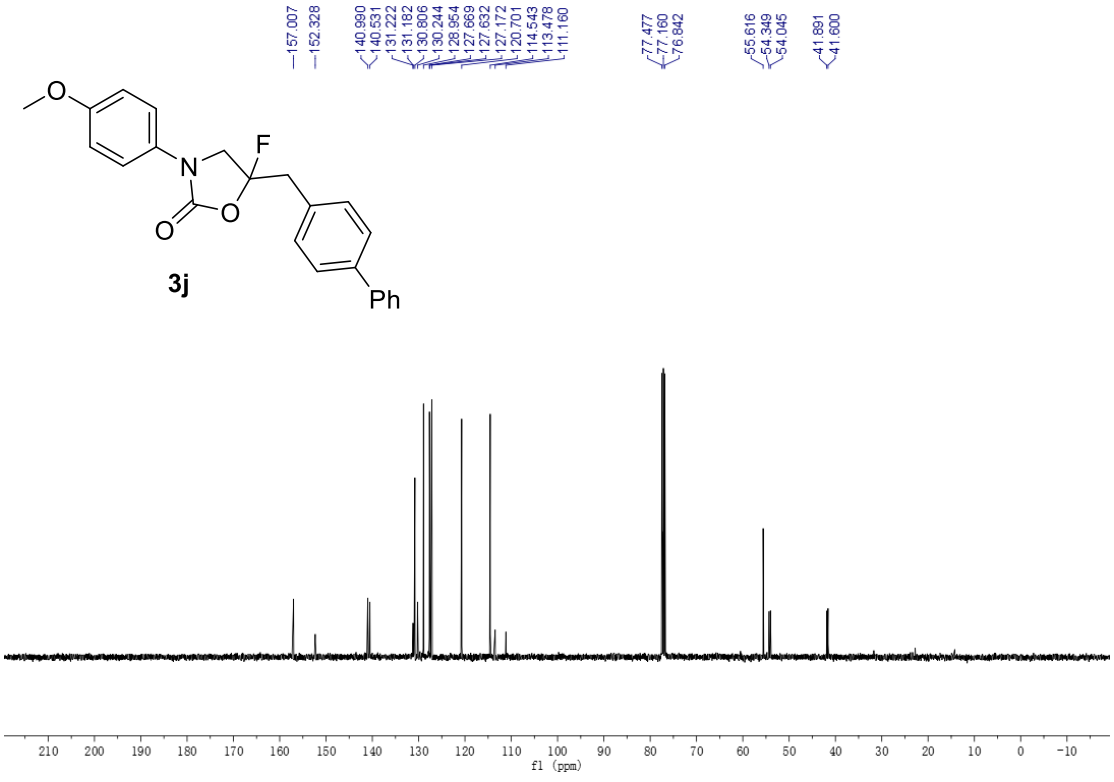
3i

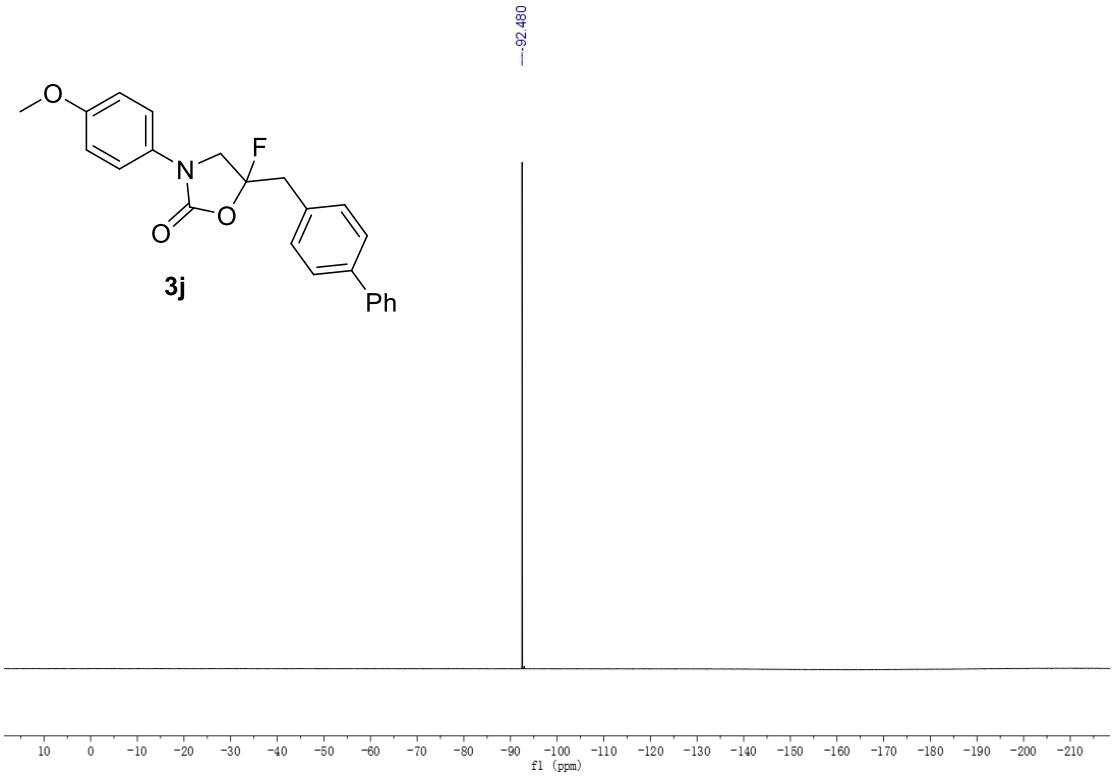

9.92
1.13
1.00
2.17
2.25
3.05
1.07
3.11
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

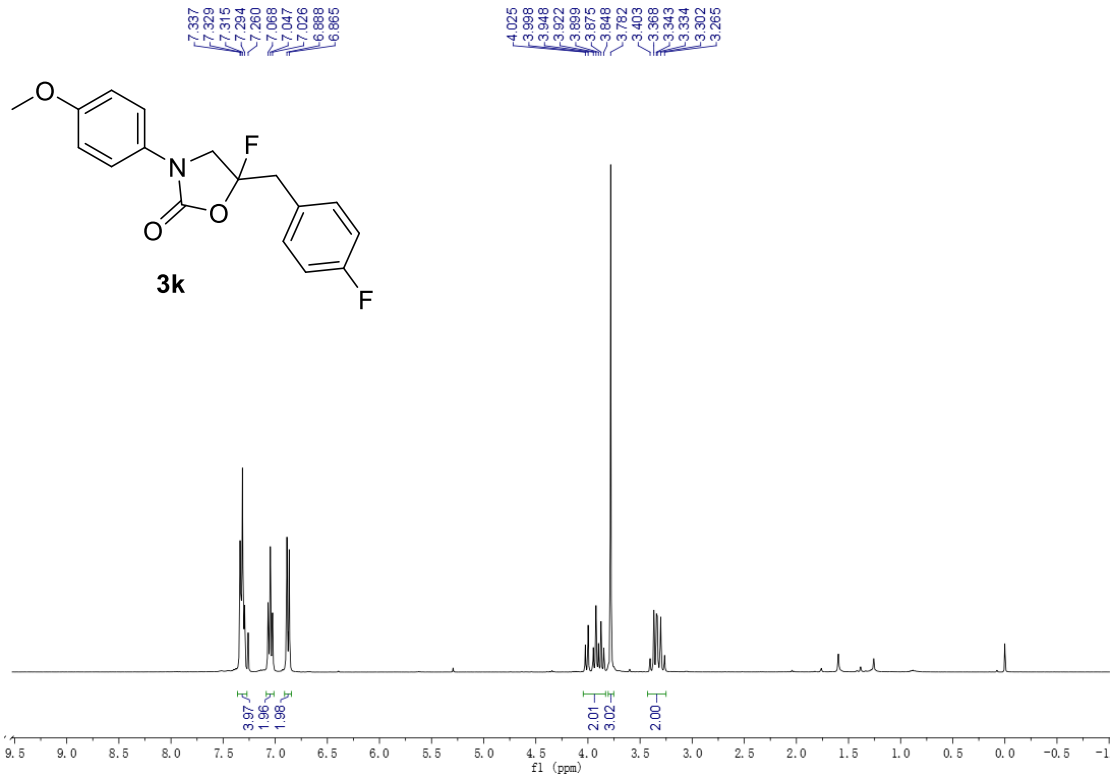

169.952
169.812
155.160
154.927
130.381
130.299
128.924
128.894
128.850
128.809
128.692
128.536
114.546
112.255
112.215
77.478
77.160
76.843
61.918
61.833
56.630
56.544
50.629
50.450
42.204
42.034
41.911
35.477
35.184
14.138
COOEt
Ph
N
F
O
O
Ph
3i
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

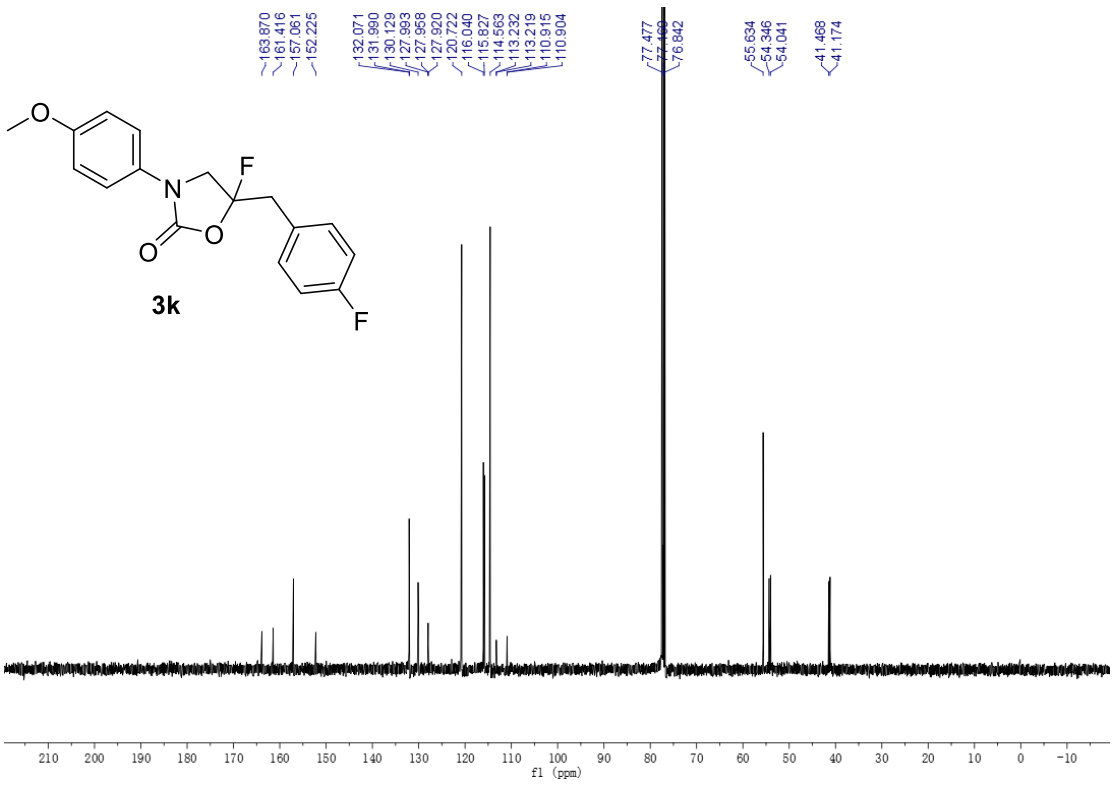

92.118
94.351
COOEt
Ph
N
F
O
O
Ph
3i
1.31
1.00
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

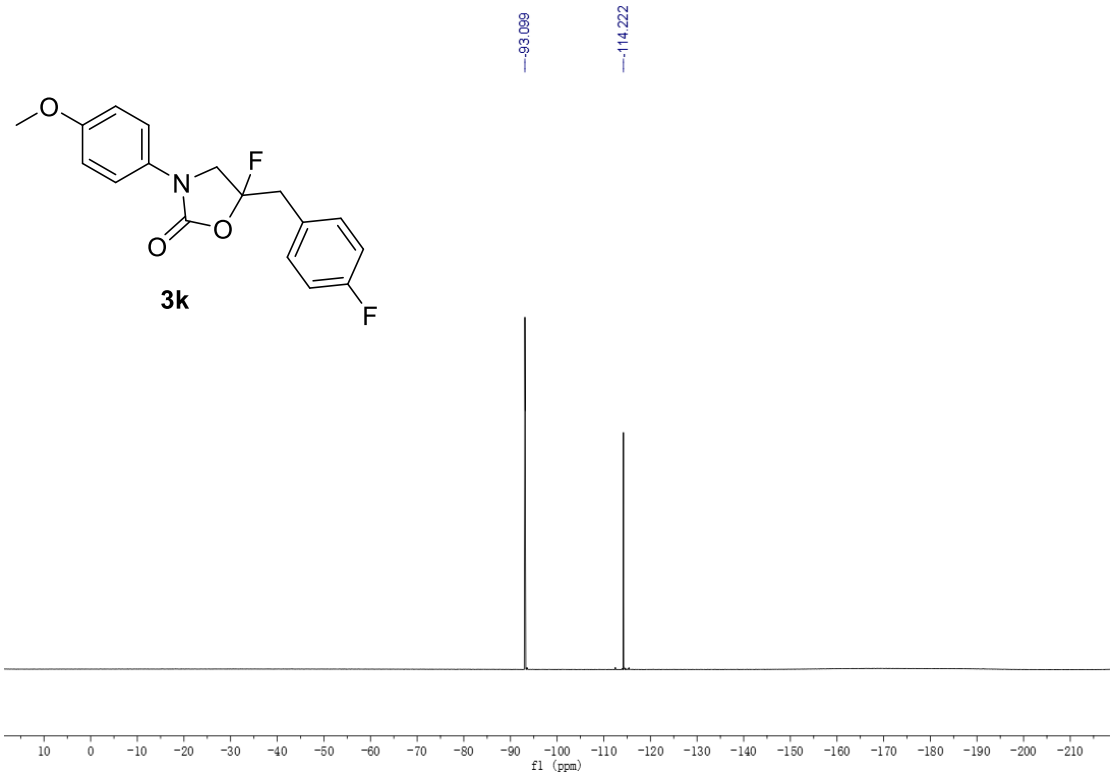

7.603
7.583
7.473
7.454
7.434
7.427
7.407
7.384
7.365
7.359
7.336
7.328
7.260
6.891
6.869
4.094
4.067
4.016
3.989
3.959
3.932
3.908
3.881
3.780
3.485
3.449
3.416
3.377
3.371
3.334
O
F
N
O
O
Ph
3j
4.01
4.12
3.01
2.00
2.00
3.09
2.00
f1 (ppm)

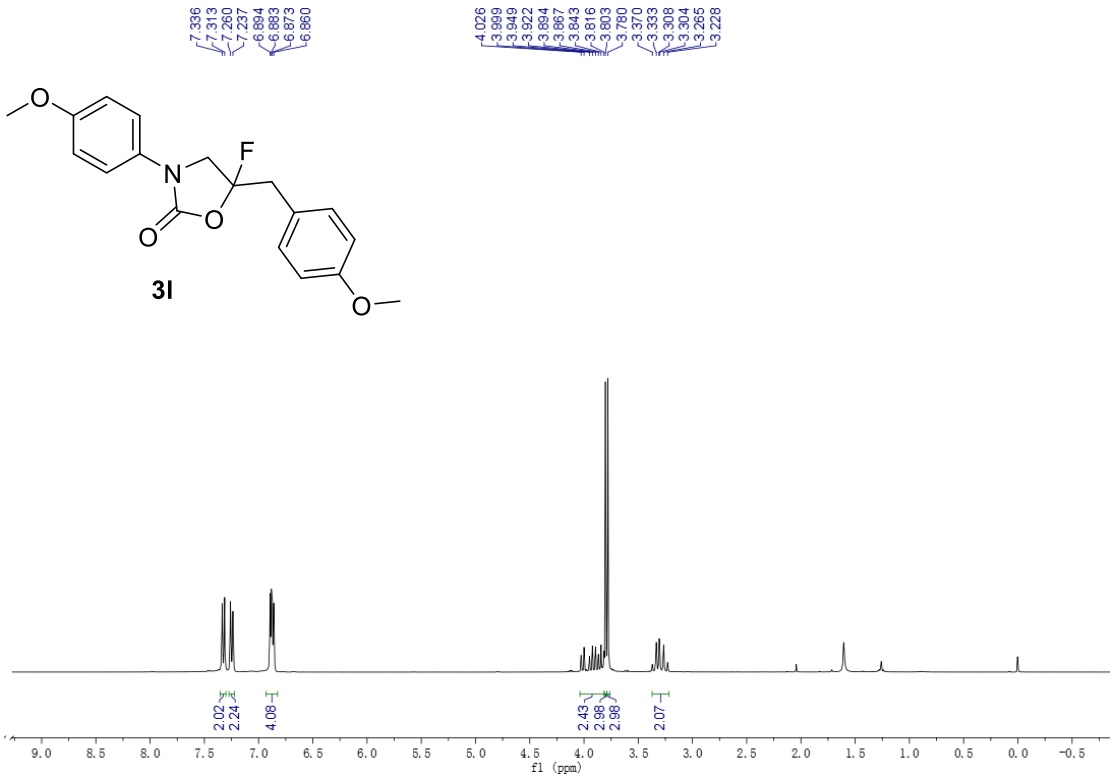

157.007
152.328
140.990
140.531
131.222
131.182
130.806
130.244
128.954
127.669
127.632
127.172
120.701
114.543
113.478
111.160
77.477
77.160
76.842
55.616
54.349
54.045
41.891
41.600
O
F
N
O
O
Ph
3j
f1 (ppm)

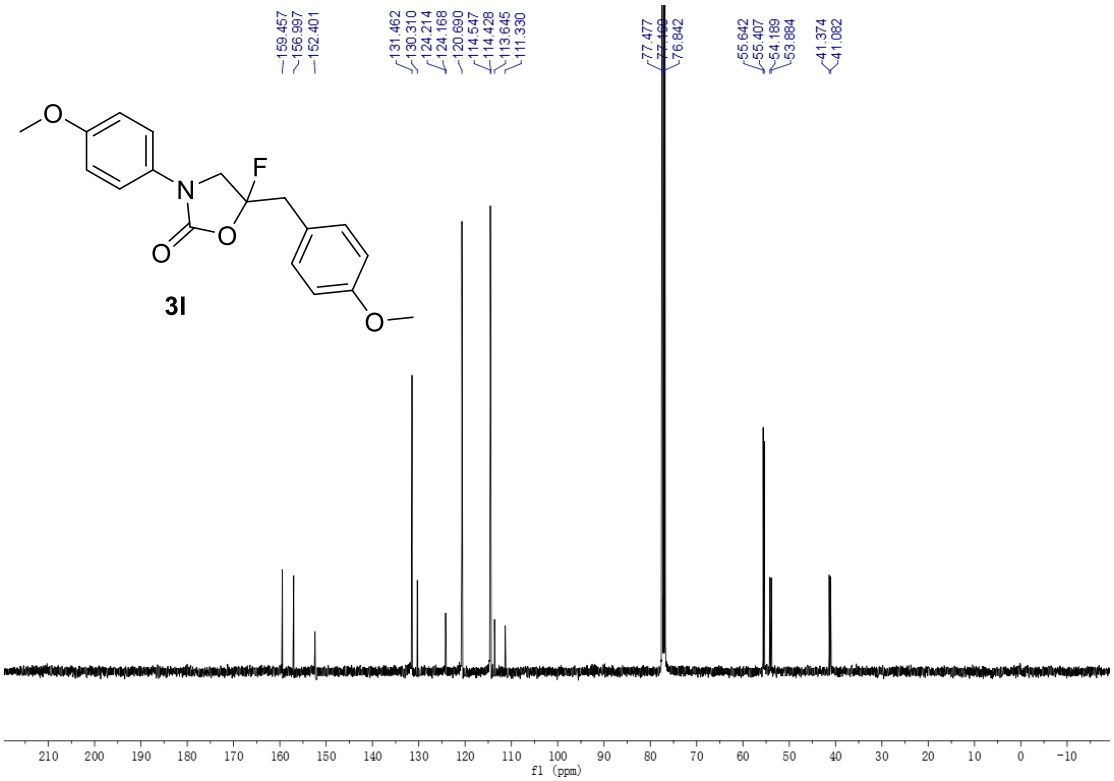

-92.480
O
N
F
O
O
Ph
3j
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

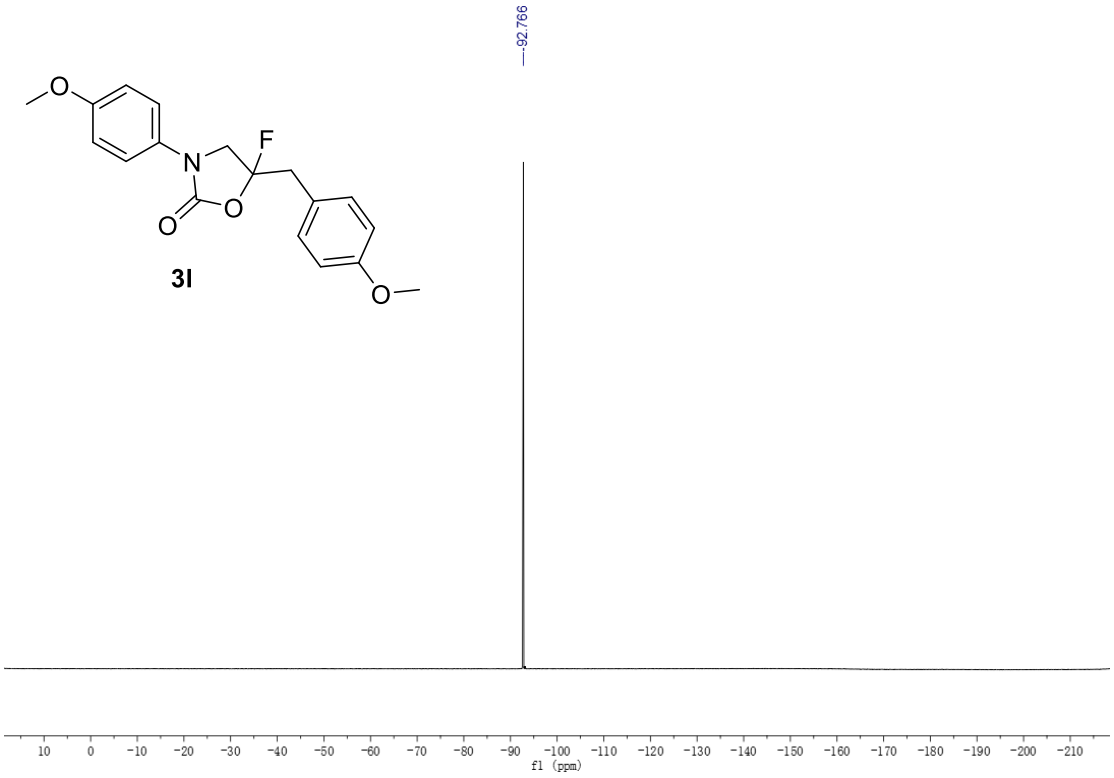

7.337
7.329
7.315
7.294
7.260
7.068
7.047
7.026
6.888
6.865
4.025
3.998
3.948
3.922
3.899
3.875
3.848
3.782
3.403
3.368
3.343
3.334
3.302
3.265
O
N
F
O
O
F
3k
3.97
1.96
1.98
2.01
3.02
2.00
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1
f1 (ppm)

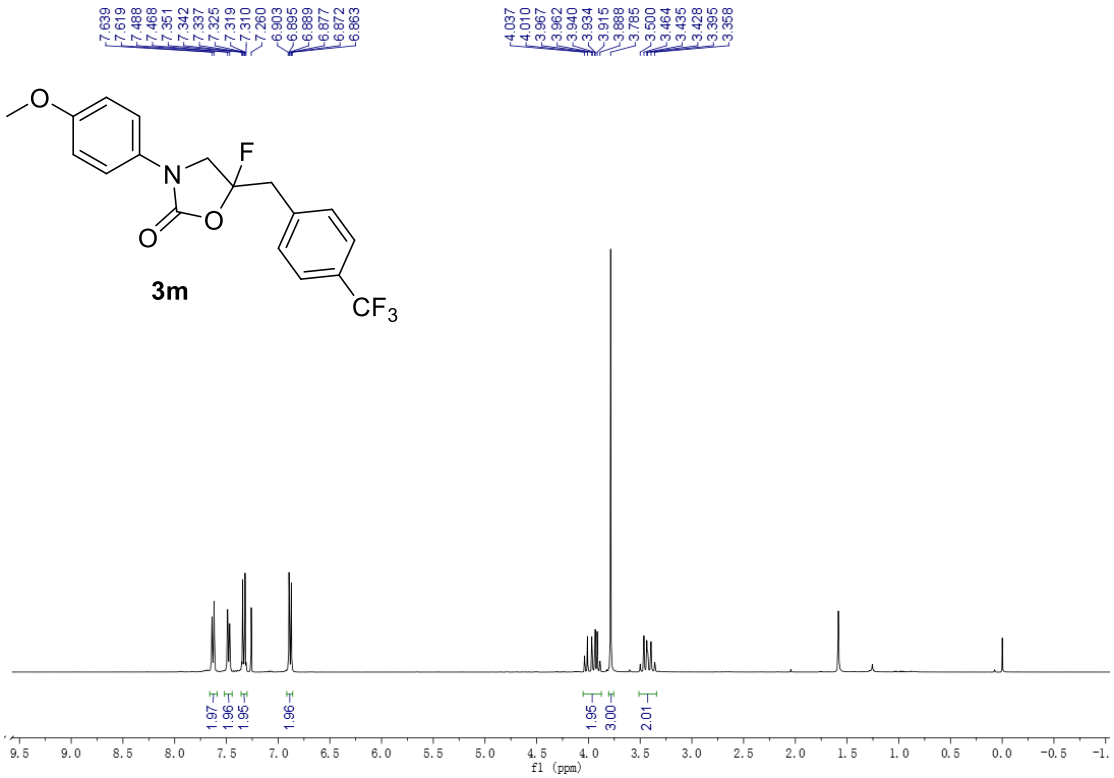

163.870
161.416
157.061
152.225
132.071
131.990
130.129
127.993
127.958
127.920
120.722
116.040
115.827
114.563
113.232
113.219
110.915
110.904
77.477
76.842
55.634
54.346
54.041
41.468
41.174
O
N
F
O
O
F
3k
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

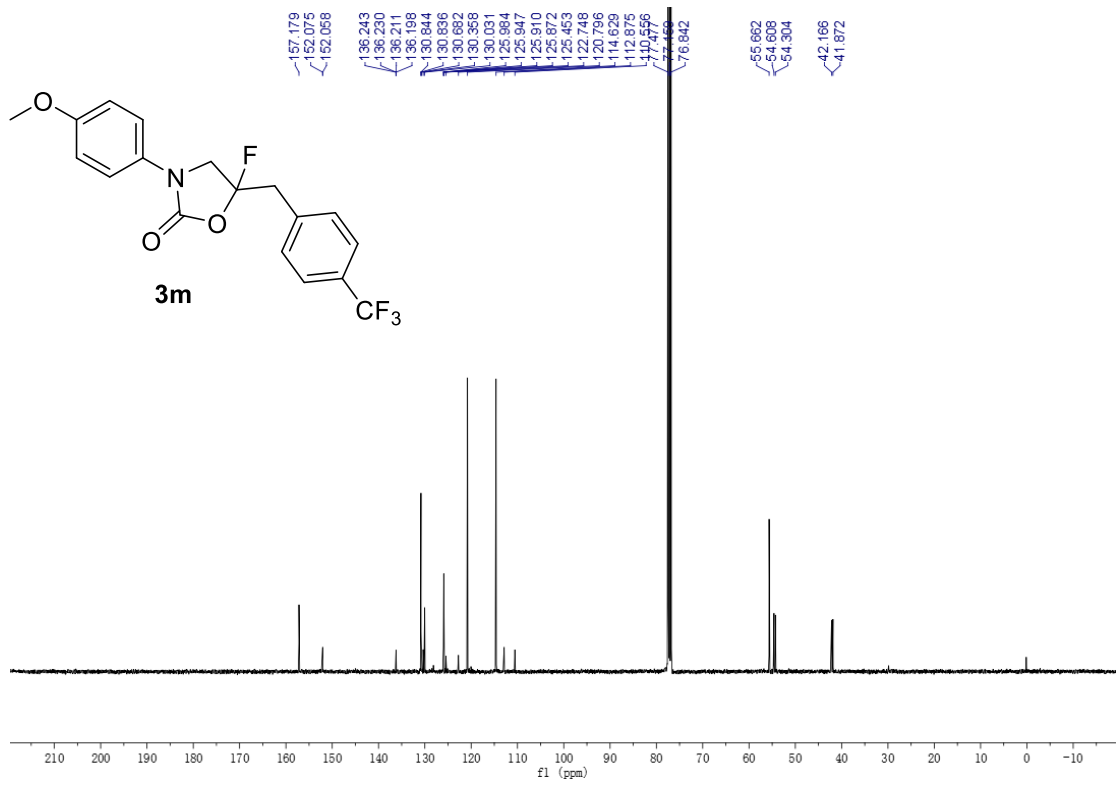

-93.099
-114.222
O
N
F
O
O
F
3k
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

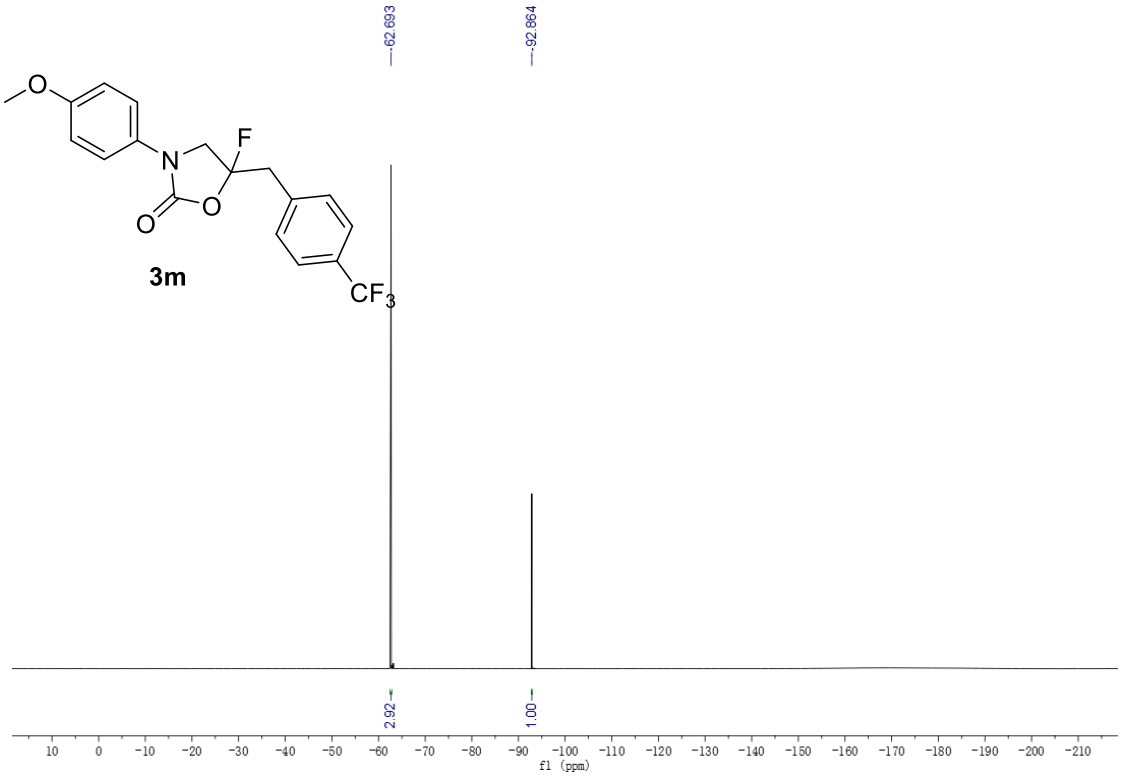

7.336
7.313
7.260
7.237
6.894
6.883
6.873
6.860
4.026
3.999
3.949
3.922
3.894
3.867
3.843
3.816
3.803
3.780
3.370
3.333
3.308
3.304
3.265
3.228
O
N
F
O
O
O
3l
2.02
2.24
4.08
2.43
2.98
2.98
2.07
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

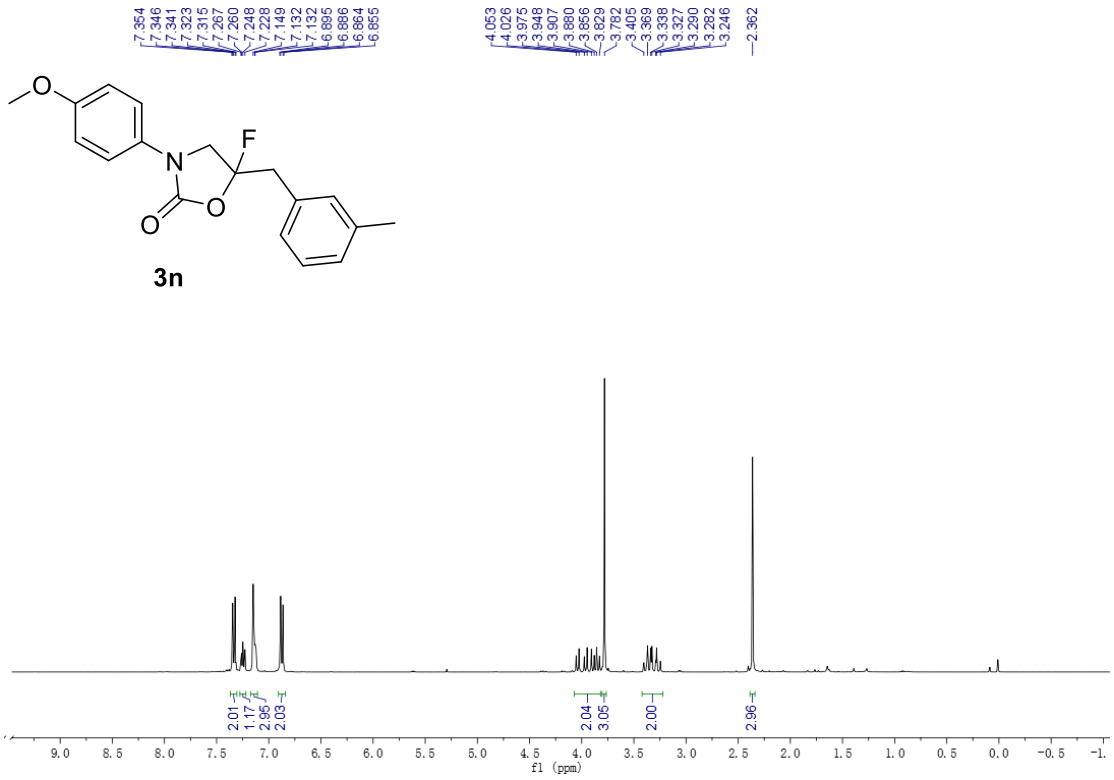

159.457
156.997
152.401
131.462
130.310
124.214
124.168
120.690
114.547
114.428
113.645
111.330
77.477
77.163
76.842
55.642
55.407
54.189
53.884
41.374
41.082
O
N
F
O
O
O
3l
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

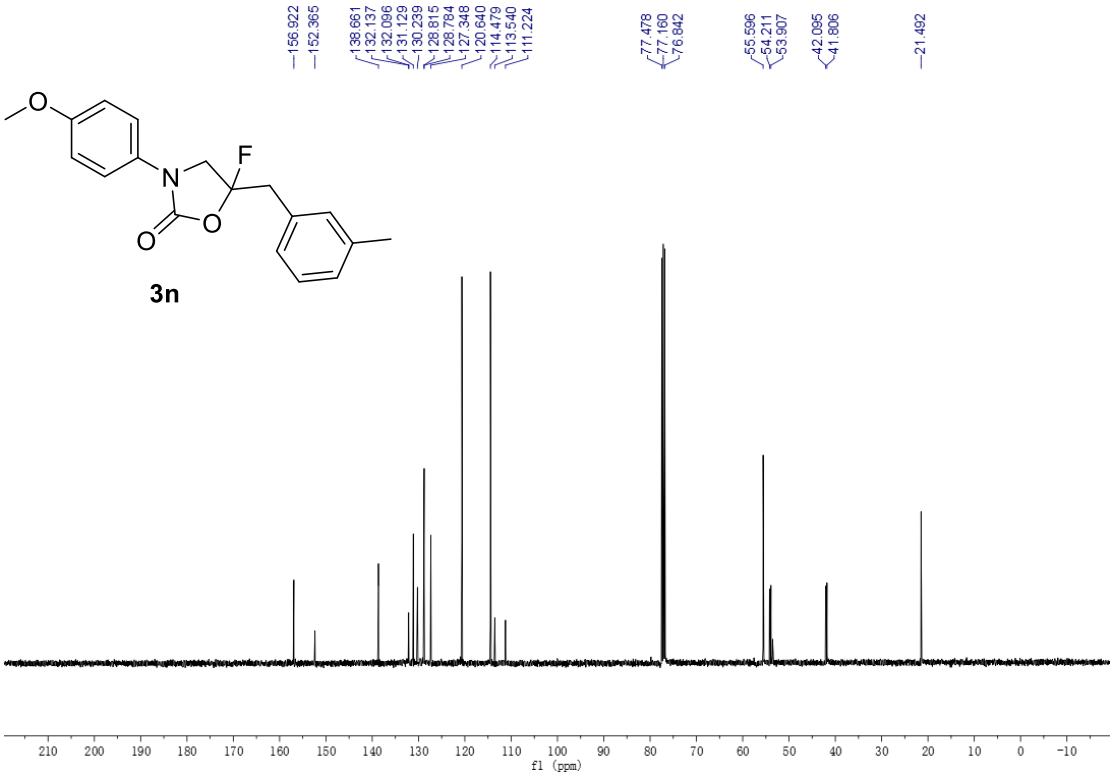

-92.766
O
N
F
O
O
O
3l
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

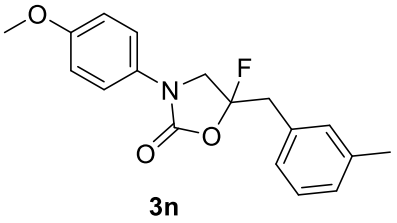

7.639
7.619
7.488
7.468
7.351
7.342
7.337
7.325
7.319
7.310
7.260
6.903
6.895
6.889
6.877
6.872
6.863
4.037
4.010
3.967
3.962
3.940
3.934
3.915
3.888
3.785
3.500
3.464
3.435
3.428
3.395
3.358
O
N
F
O
O
O
CF3
3m
1.97
1.96
1.95
1.96
1.95
3.00
2.01
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.
f1 (ppm)


157.179
152.075
152.058
136.243
136.230
136.211
136.198
130.844
130.836
130.682
130.358
130.031
125.984
125.947
125.910
125.872
125.453
122.748
120.796
114.629
112.875
110.556
77.477
77.159
76.842
55.662
54.608
54.304
42.166
41.872
O
N
F
O
O
3m
CF3
f1 (ppm)


-62.693
-92.864
O
N
F
O
O
3m
CF3
2.92
1.00
f1 (ppm)


7.354
7.346
7.341
7.323
7.315
7.267
7.260
7.248
7.228
7.149
7.132
7.132
6.895
6.886
6.864
6.855
4.053
4.026
3.975
3.948
3.907
3.880
3.856
3.829
3.782
3.405
3.369
3.338
3.327
3.290
3.282
3.246
2.362
O
N
F
O
O
3n
2.01
1.17
2.95
2.03
2.04
3.05
2.00
2.96
f1 (ppm)


156.922
152.365
138.661
132.137
132.096
131.129
130.239
128.815
128.784
127.348
120.640
114.479
113.540
111.224
77.478
77.160
76.842
55.596
54.211
53.907
42.095
41.806
21.492
O
N
F
O
O
3n
f1 (ppm)


O
N
F
O
O

3n

-92.417
70 60 50 40 30 20 10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260
f1 (ppm)


7.458
7.455
7.436
7.434
7.371
7.365
7.352
7.349
7.335
7.331
7.323
7.318
7.302
7.300
7.283
7.279
7.260
7.157
7.139
7.120
6.986
6.967
6.948
6.935
6.915
4.151
4.124
4.073
4.046
3.957
3.929
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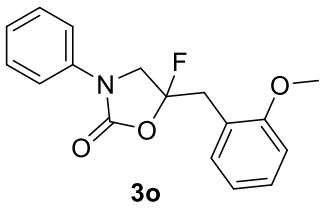
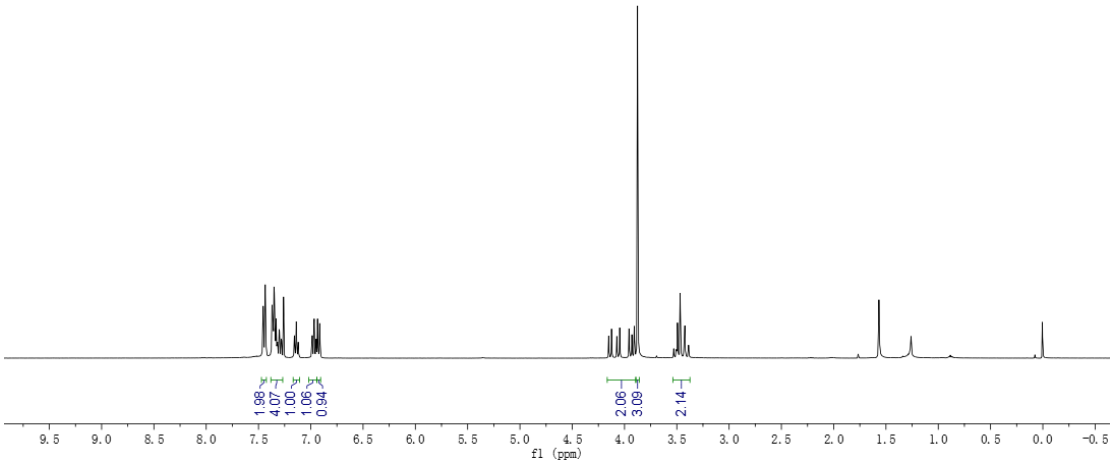
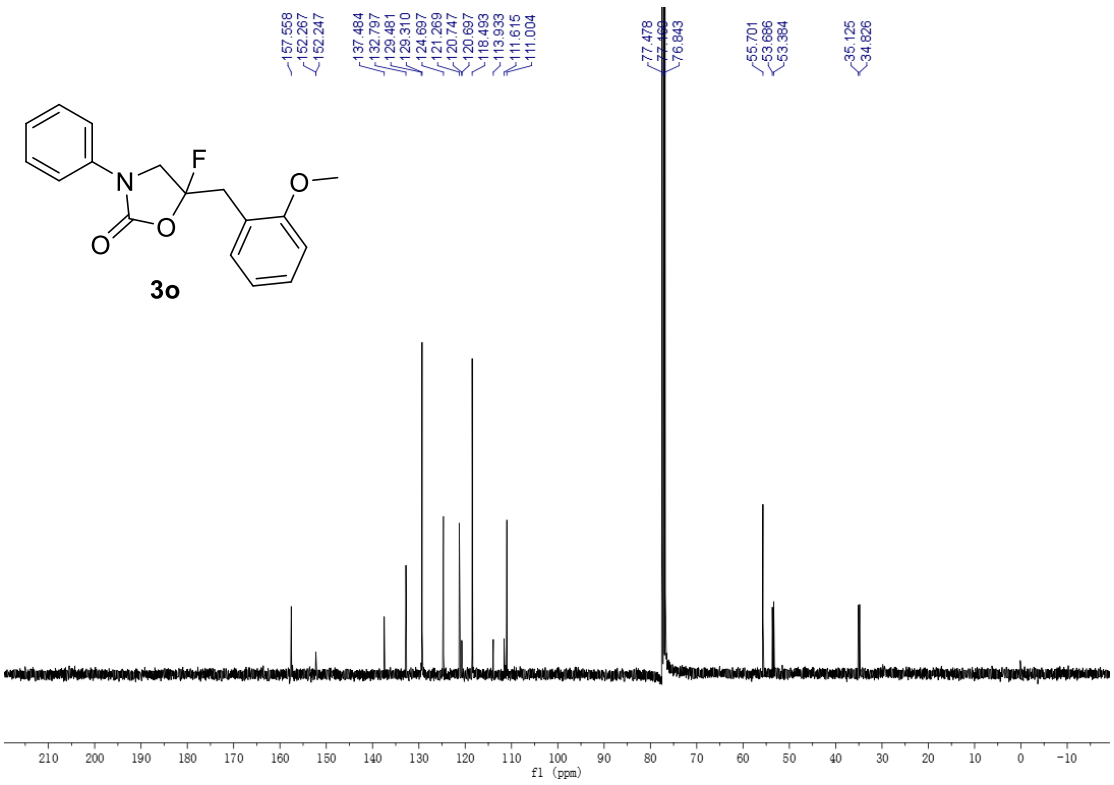
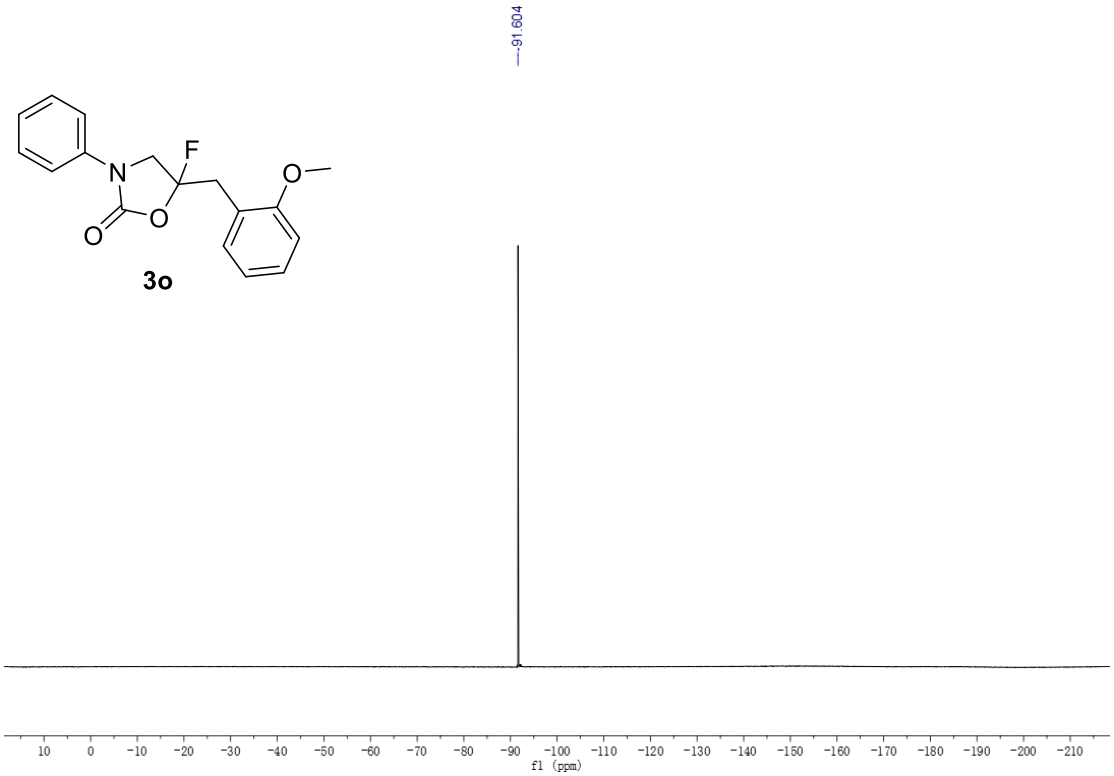
3.504
3.494
3.468
3.432
3.423
3.387

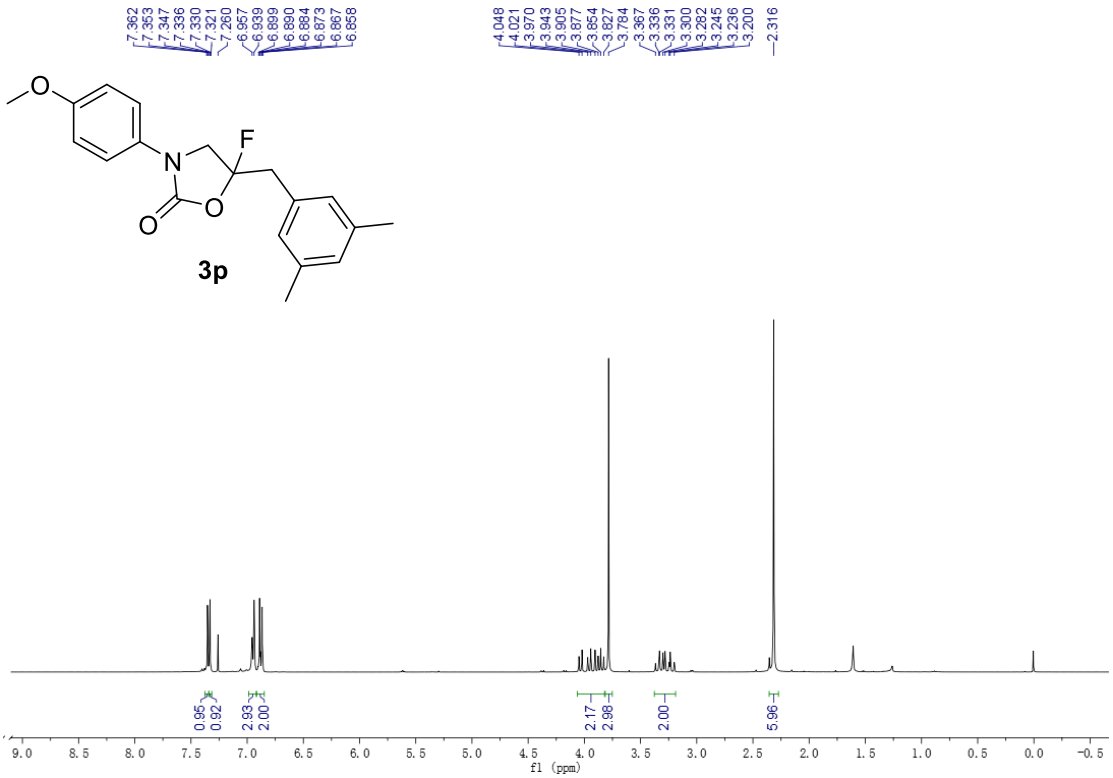

F
N
O
O
O

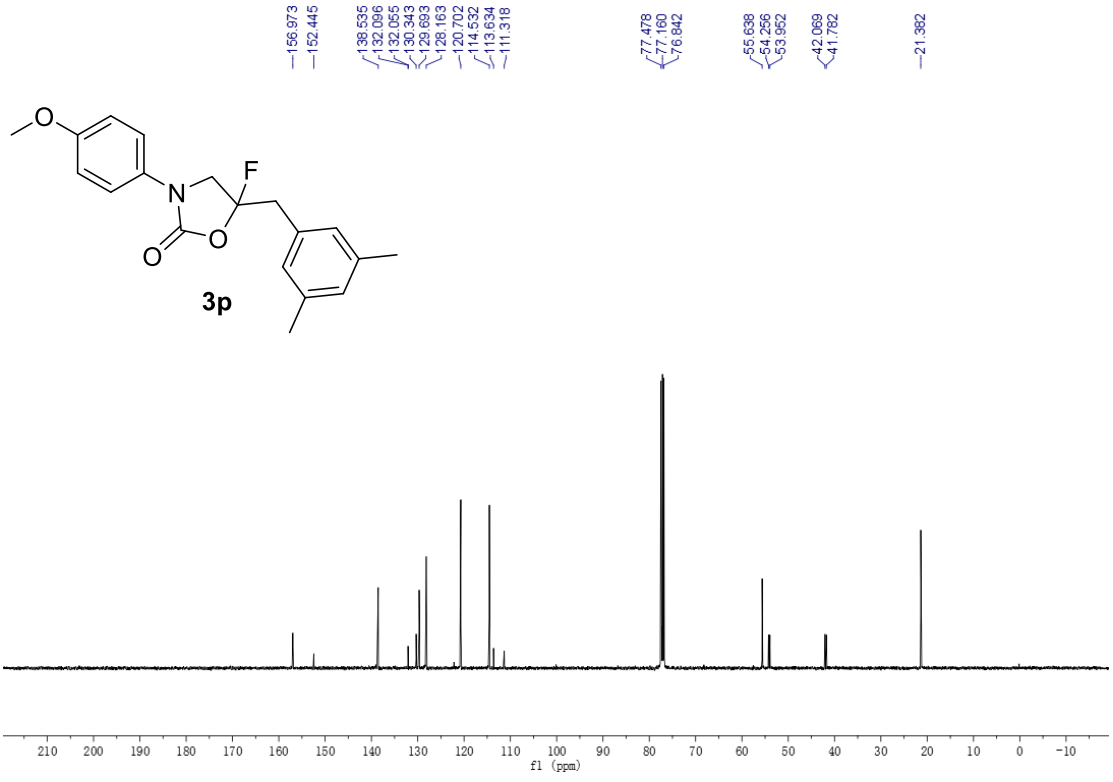
3o

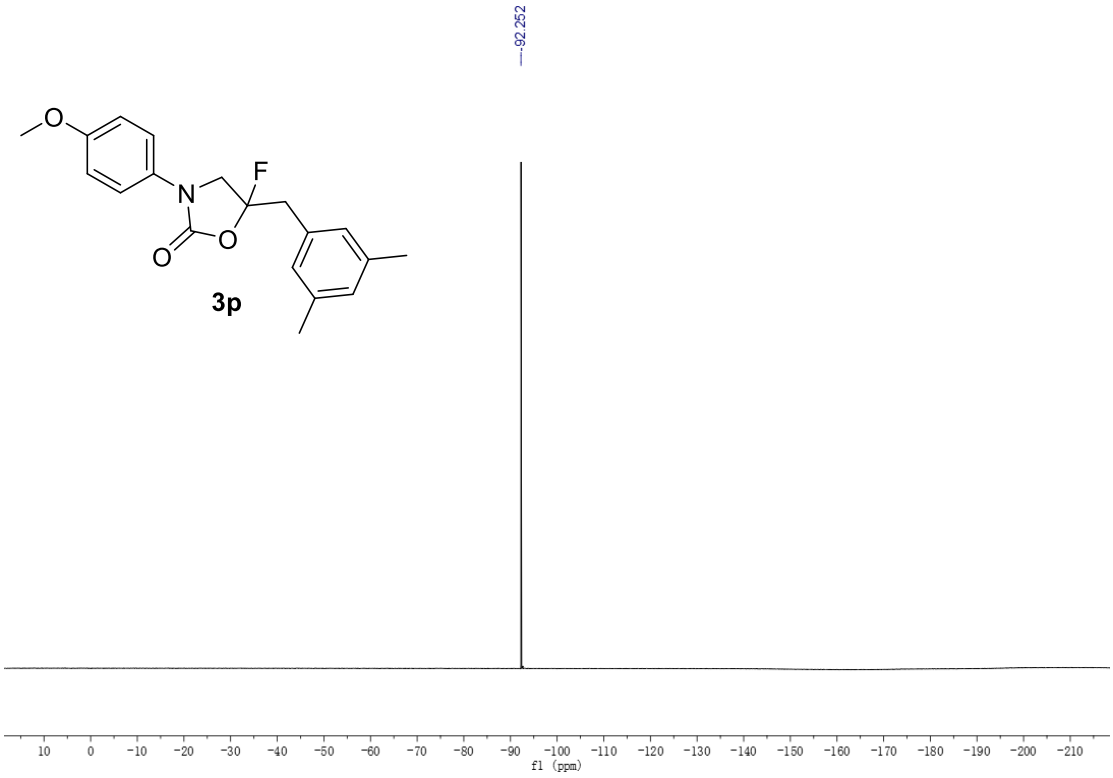

1.98
4.07
1.00
1.06
0.94
2.06
3.09
2.14
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

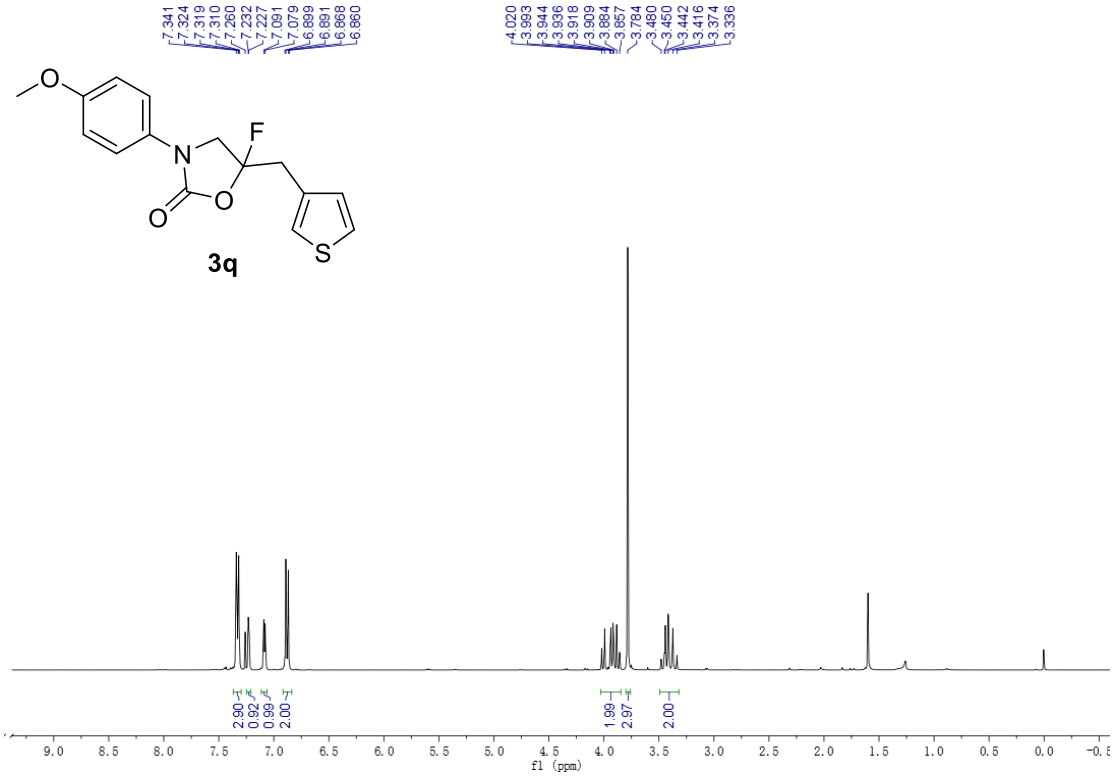

157.558
152.267
152.247
137.484
132.797
129.481
129.310
124.697
121.269
120.747
120.697
118.493
113.933
111.615
111.004
77.478
76.843
55.701
53.686
53.384
35.125
34.826
F
N
O
O
O
3o
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

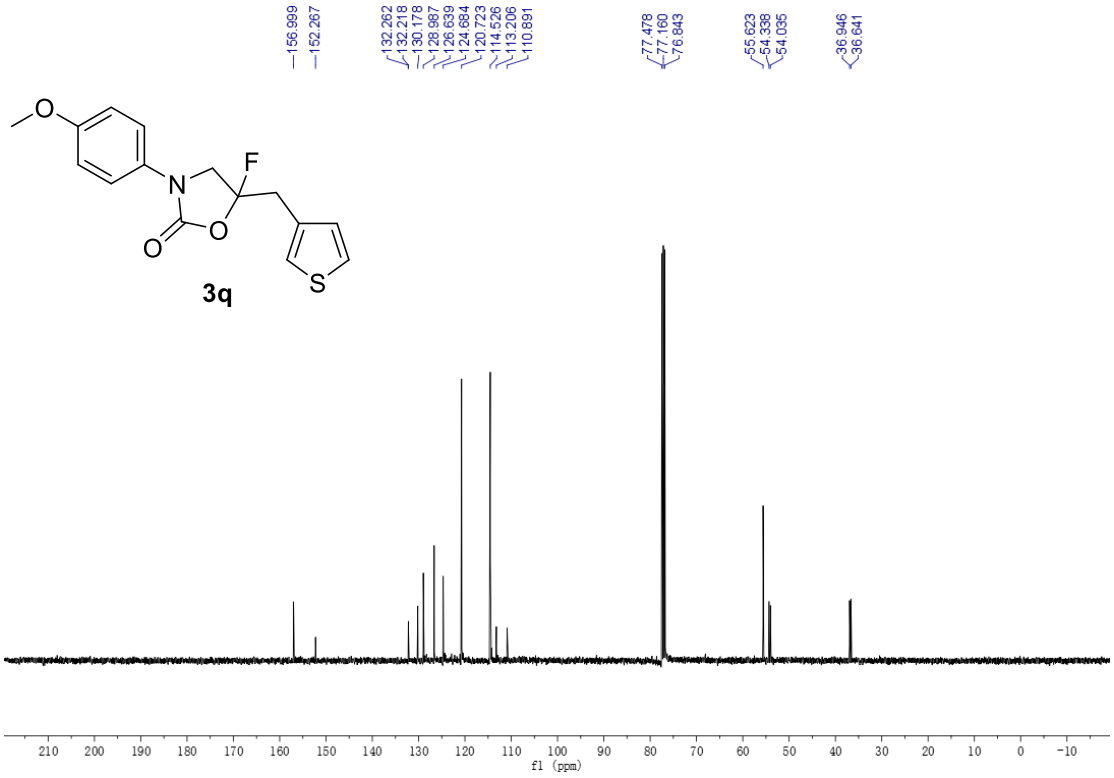

-91.604
F
N
O
O
O
3o
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.362
7.353
7.347
7.336
7.330
7.321
7.260
6.957
6.939
6.899
6.890
6.884
6.873
6.867
6.858
4.048
4.021
3.970
3.943
3.905
3.877
3.854
3.827
3.784
3.367
3.336
3.331
3.300
3.282
3.245
3.236
3.200
2.316
O
N
F
O
O
3p
0.95
0.92
2.93
2.00
2.17
2.98
2.00
5.96
f1 (ppm)


156.973
152.445
138.535
132.086
132.055
130.343
129.693
128.163
120.702
114.532
113.634
111.318
77.478
77.160
76.842
55.638
54.256
53.952
42.069
41.782
21.382
O
N
F
O
O
3p
f1 (ppm)


-92.252
O
F
N
O
O
3p
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.341
7.324
7.319
7.310
7.260
7.232
7.227
7.081
7.079
6.889
6.891
6.868
6.860
4.020
3.993
3.944
3.936
3.918
3.909
3.884
3.857
3.784
3.480
3.450
3.442
3.416
3.374
3.336
O
F
N
O
O
S
3q
2.90
0.92
0.99
2.00
1.99
2.97
2.00
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)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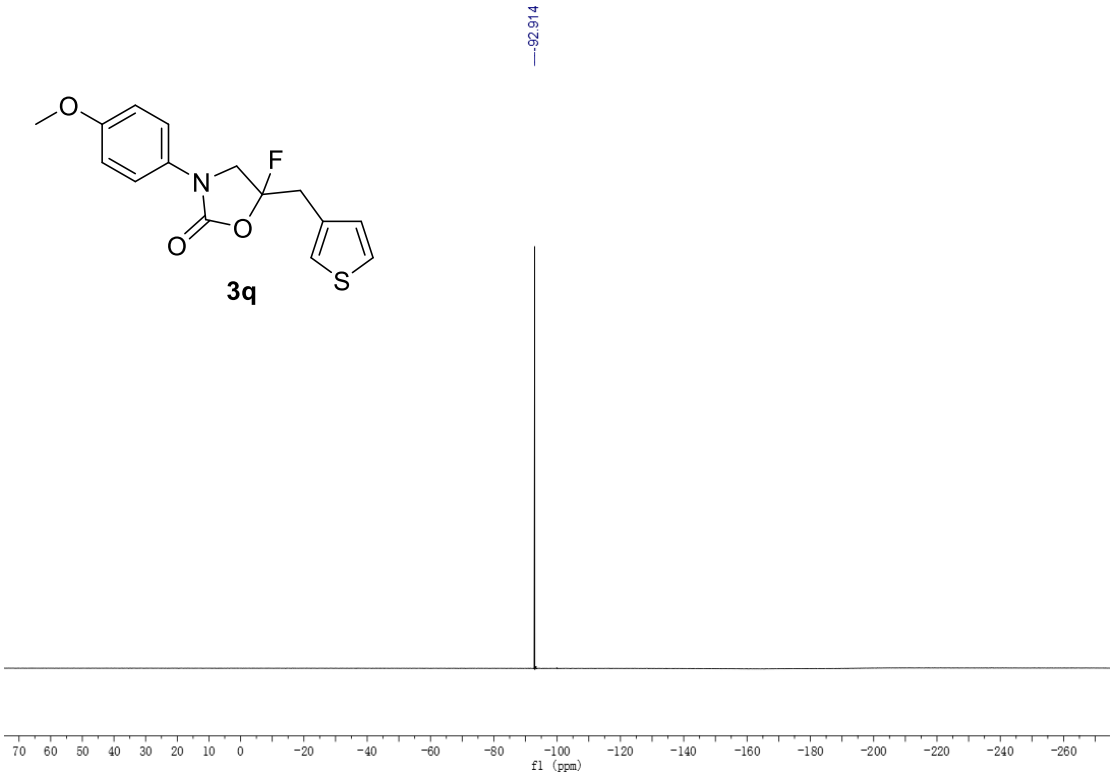
152.267
132.262
132.218
130.178
128.987
126.639
124.684
120.723
114.526
113.206
110.891
77.478
77.160
76.843
55.623
54.338
54.035
36.946
36.641
O
N
F
O
O
S
3q
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-92.914
O
N
F
O
O
S
3q
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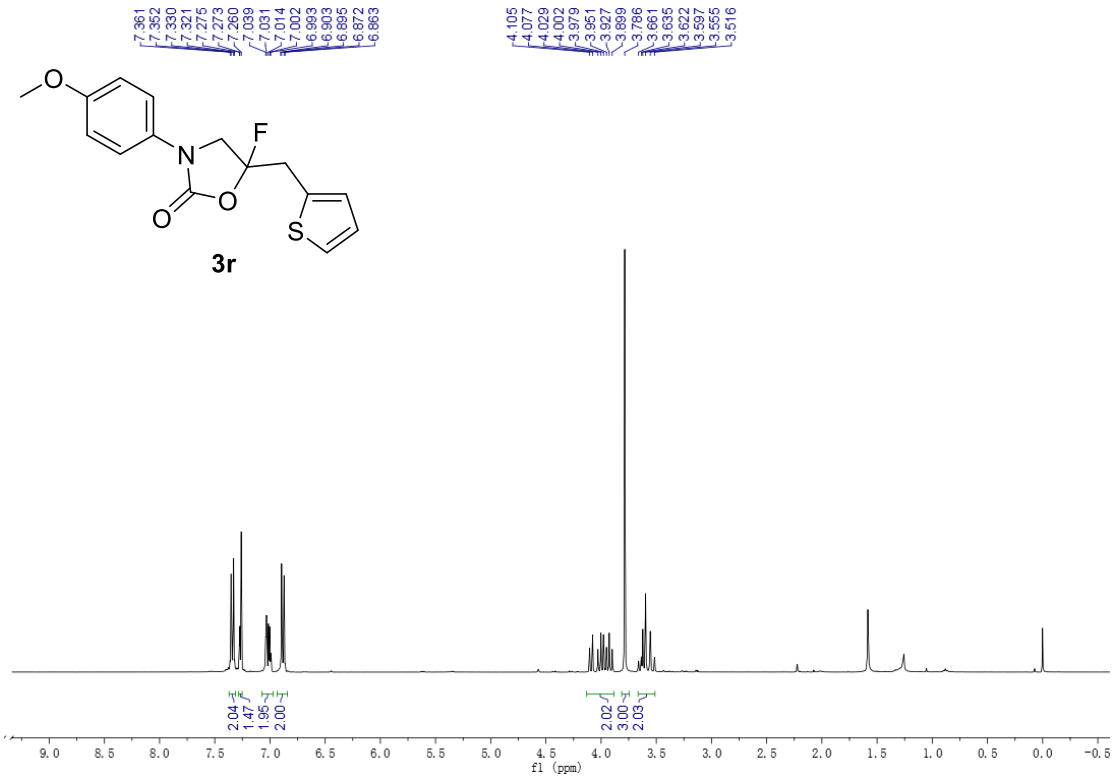
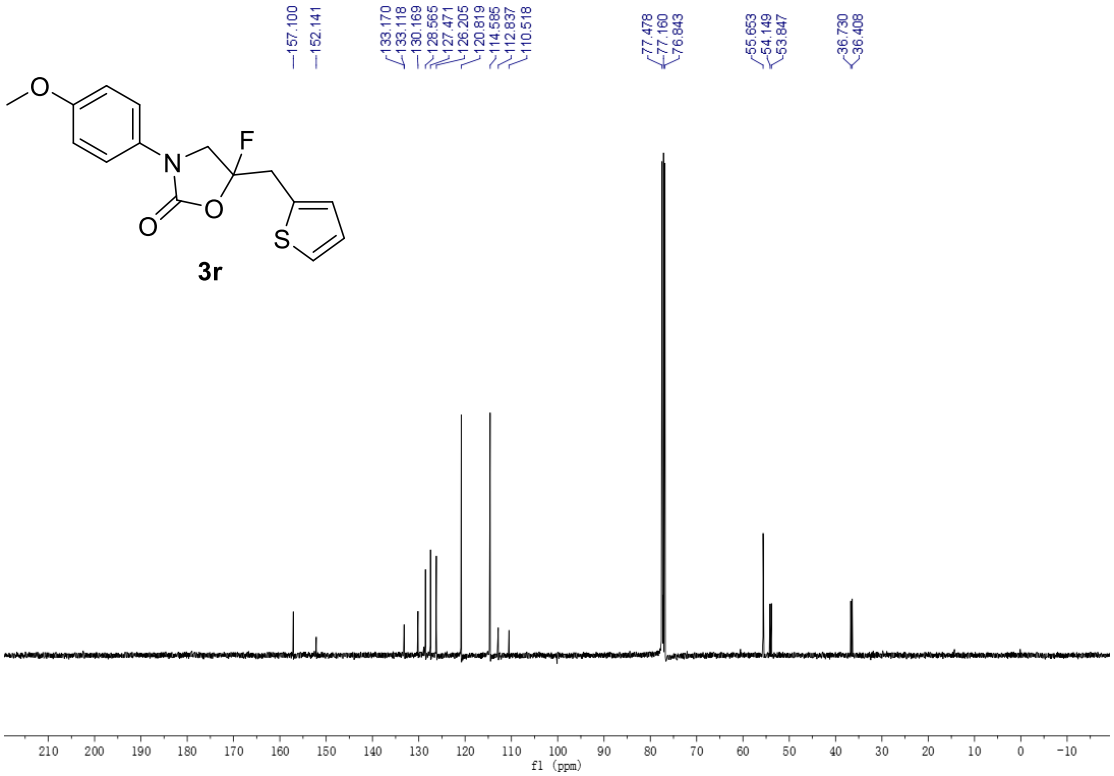
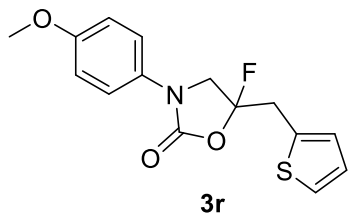
f1 (ppm)

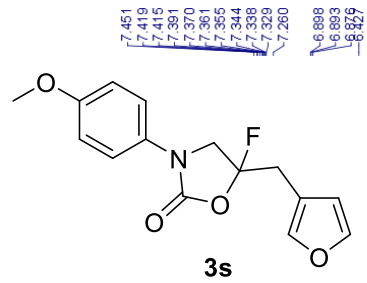

7.361
7.352
7.330
7.321
7.275
7.273
7.260
7.039
7.031
7.014
7.002
6.993
6.903
6.895
6.872
6.863
4.105
4.077
4.029
4.002
3.979
3.951
3.927
3.899
3.786
3.661
3.635
3.622
3.597
3.555
3.516
O
N
F
O
O
S
3r
2.04
1.47
1.95
2.00
2.02
3.00
2.03
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


157.100
152.141
133.170
133.118
130.169
128.565
127.471
126.205
120.819
114.585
112.837
110.518
77.478
77.160
76.843
55.653
54.149
53.847
36.730
36.408
O
N
F
O
O
S
3r
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)



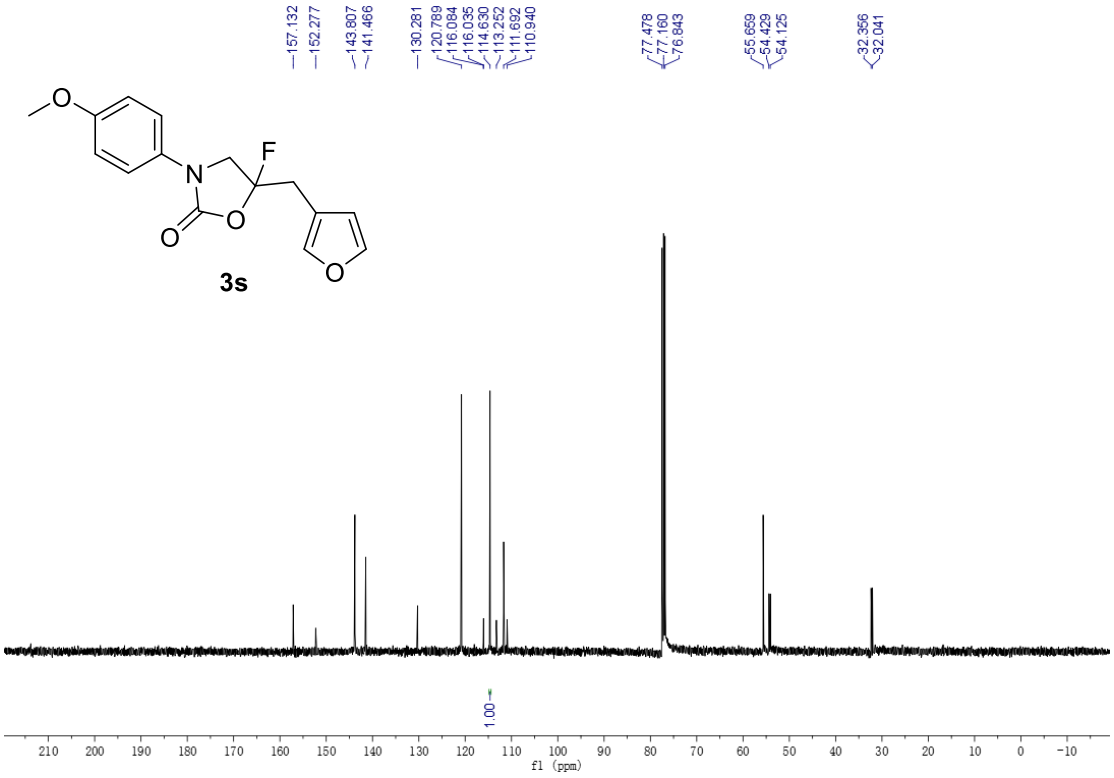
3r

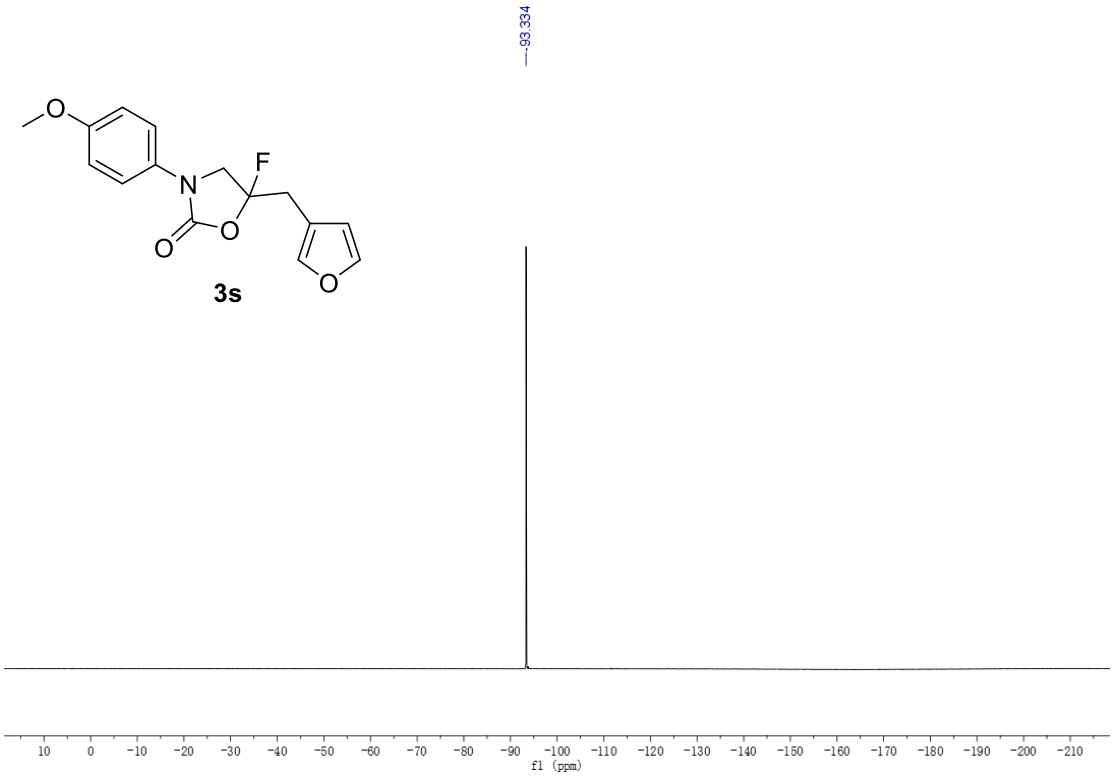
-93.230
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

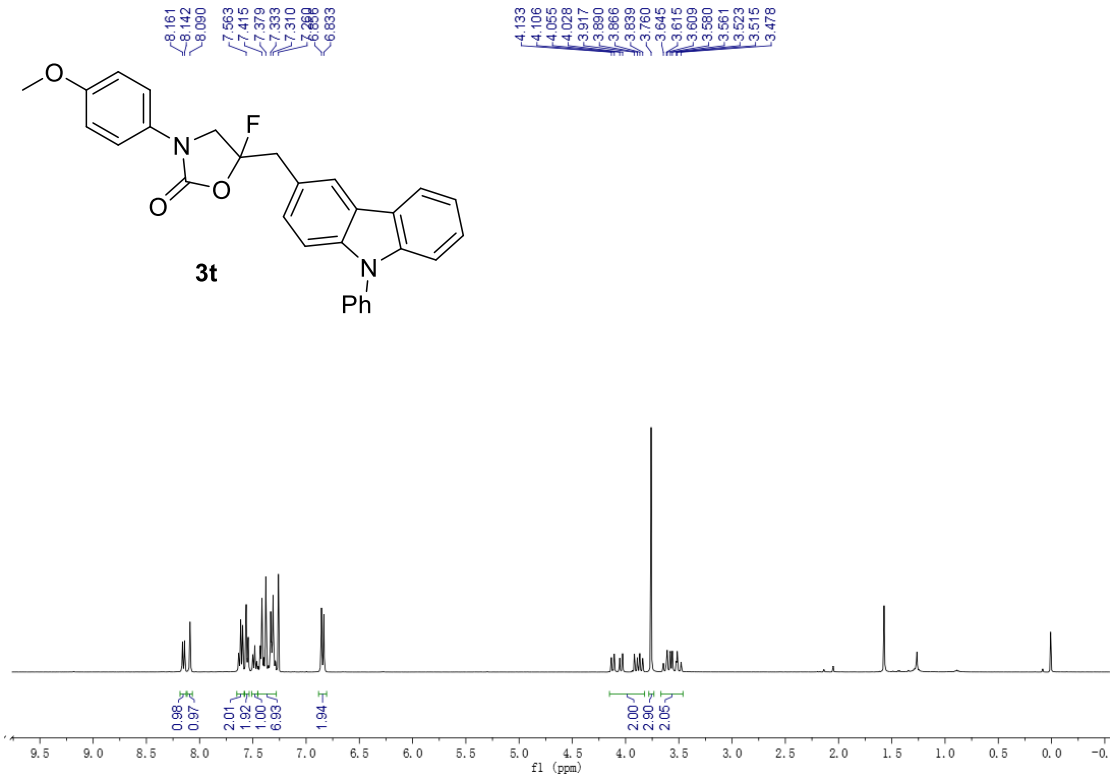


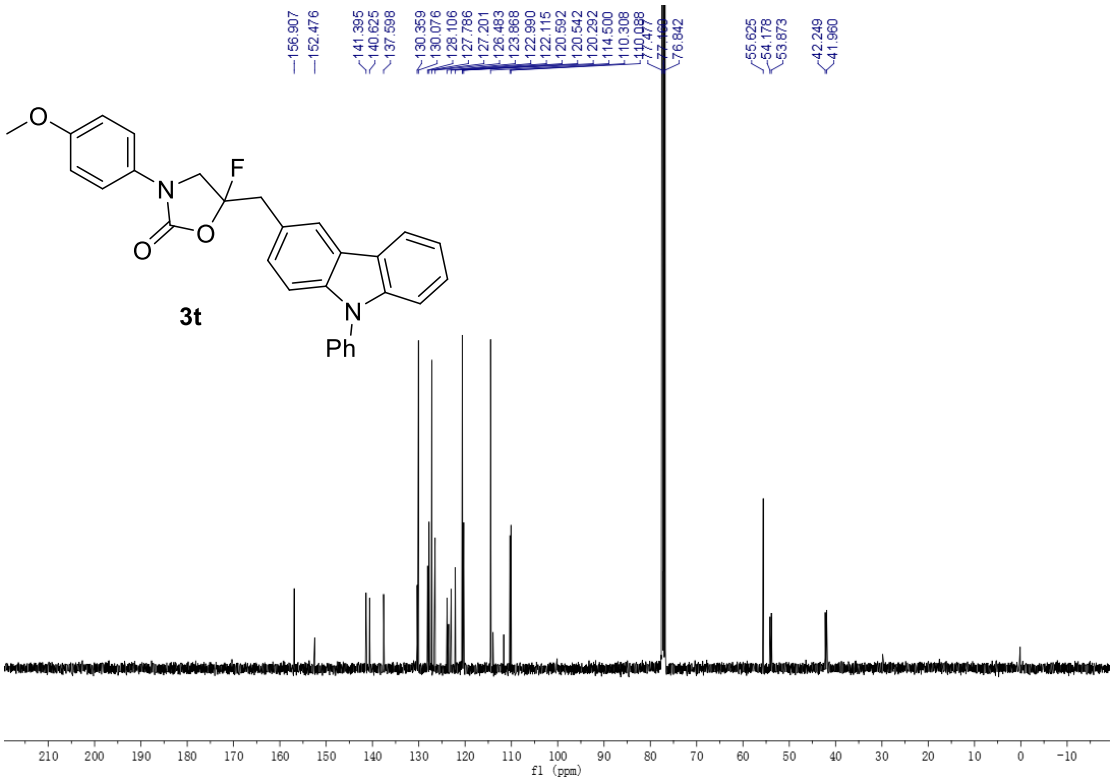
3s

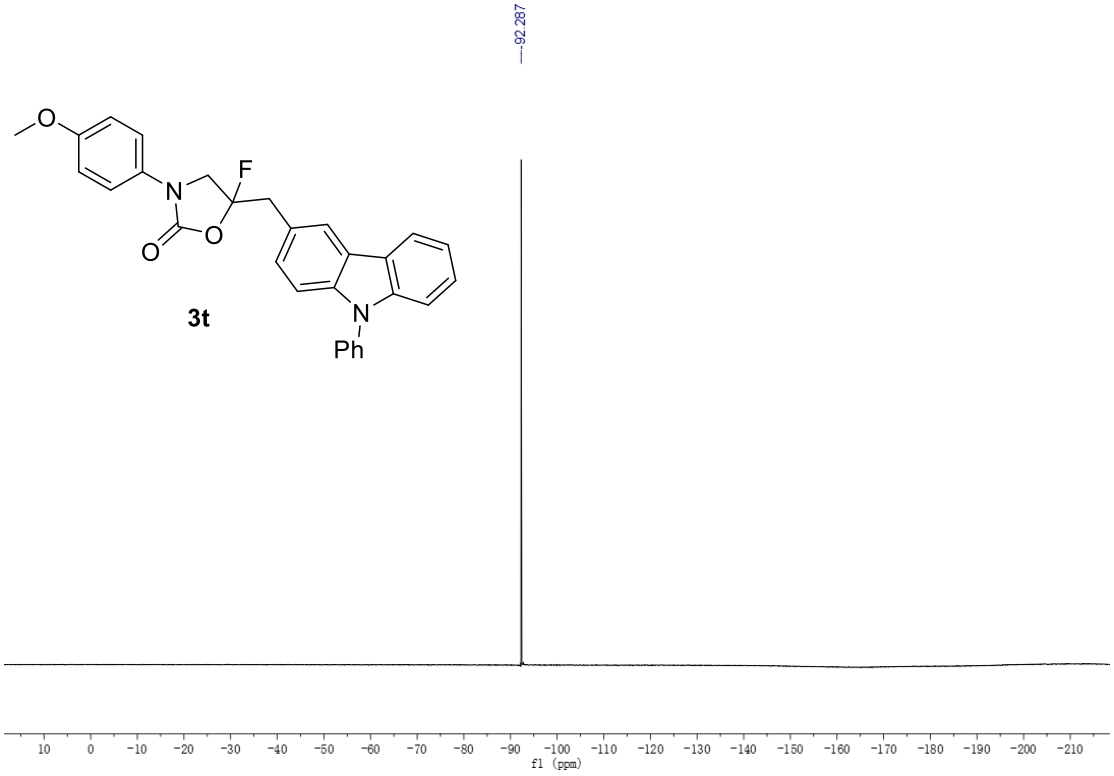
7.451
7.419
7.415
7.391
7.370
7.361
7.355
7.344
7.338
7.329
7.260
6.898
6.893
6.876
6.827
4.031
4.004
3.964
3.956
3.936
3.929
3.910
3.883
3.787
3.277
3.249
3.240
3.213
3.177
3.171
3.133
1.88
2.00
1.92
0.91
2.10
3.02
2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


157.132
152.277
143.807
141.466
130.281
120.789
116.084
116.035
114.630
113.252
111.692
110.940
77.478
77.160
76.843
55.659
54.429
54.125
32.356
32.041
O
N
F
O
O
O
3s
1.00
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

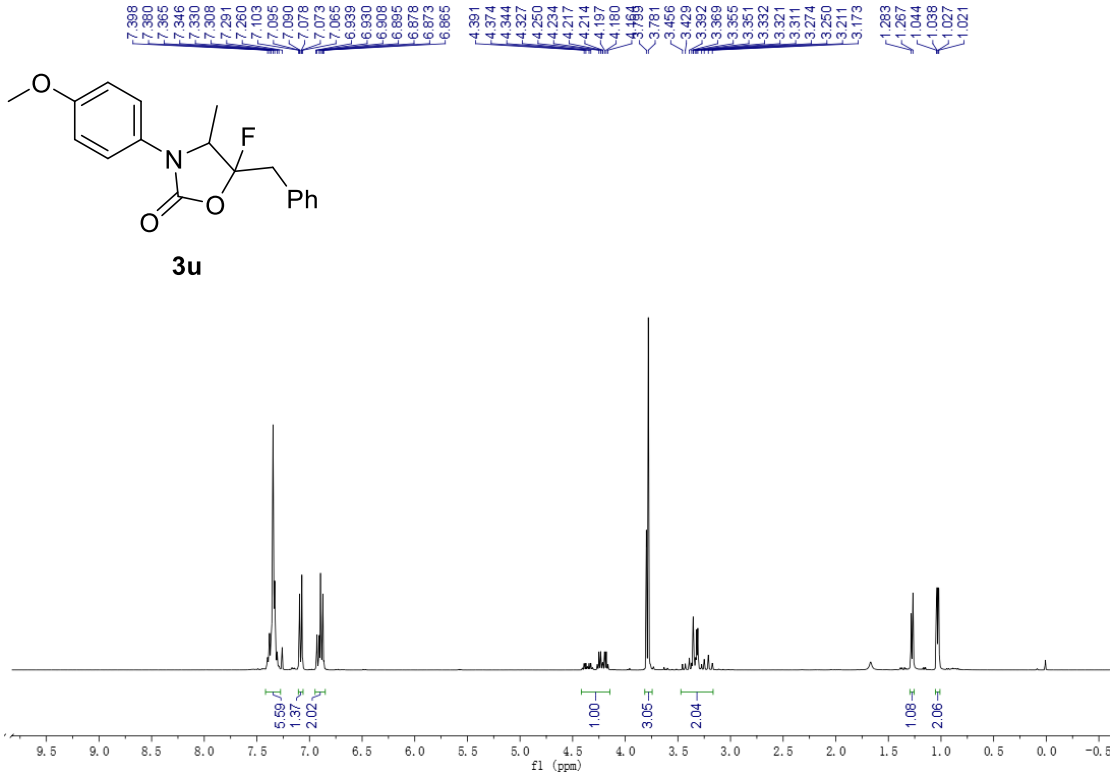

-93.334
O
N
F
O
O
O
3s
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


8.161
8.142
8.090
7.563
7.415
7.379
7.333
7.310
6.833
4.133
4.106
4.055
4.028
3.917
3.890
3.866
3.839
3.760
3.645
3.615
3.609
3.580
3.561
3.523
3.515
3.478
O
N
F
O
O
3t
N
Ph
0.98
0.97
2.01
1.92
1.00
6.93
1.94
2.00
2.90
2.05
f1 (ppm)

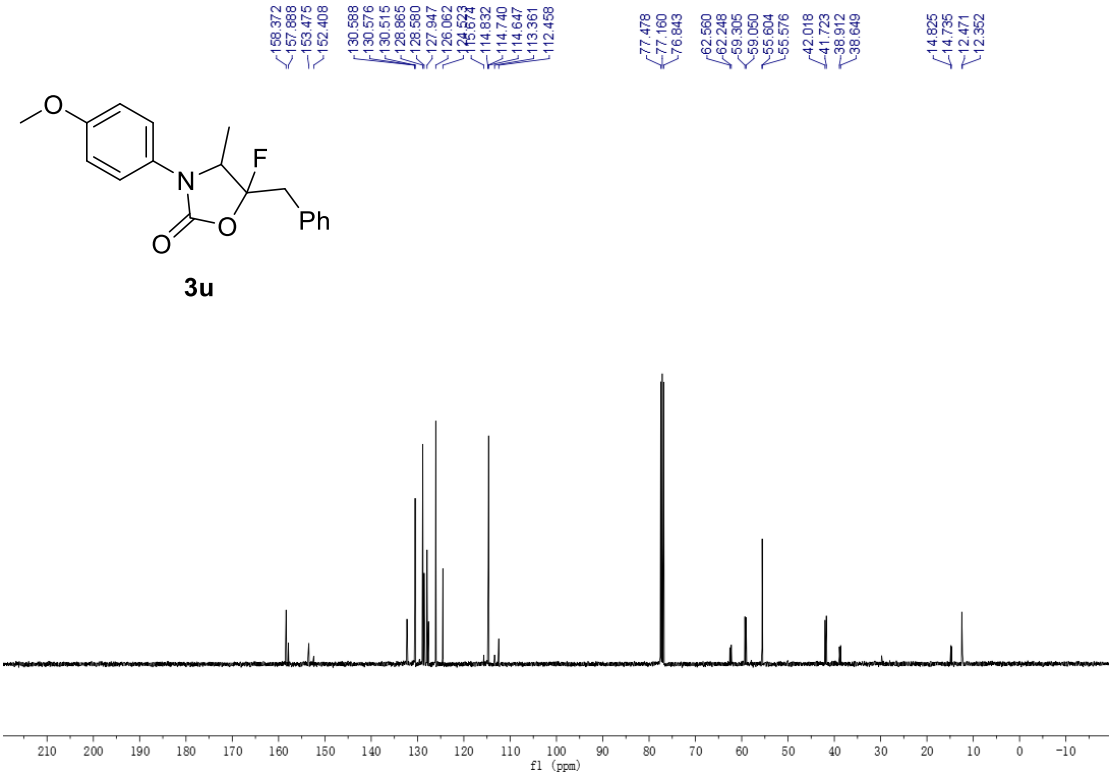

156.907
152.476
141.395
140.625
137.598
130.359
130.076
128.106
127.786
127.201
126.483
123.868
122.990
122.115
120.592
120.542
120.292
114.500
110.308
110.088
77.477
76.842
55.625
54.178
53.873
42.249
41.960
O
N
F
O
O
3t
N
Ph
f1 (ppm)

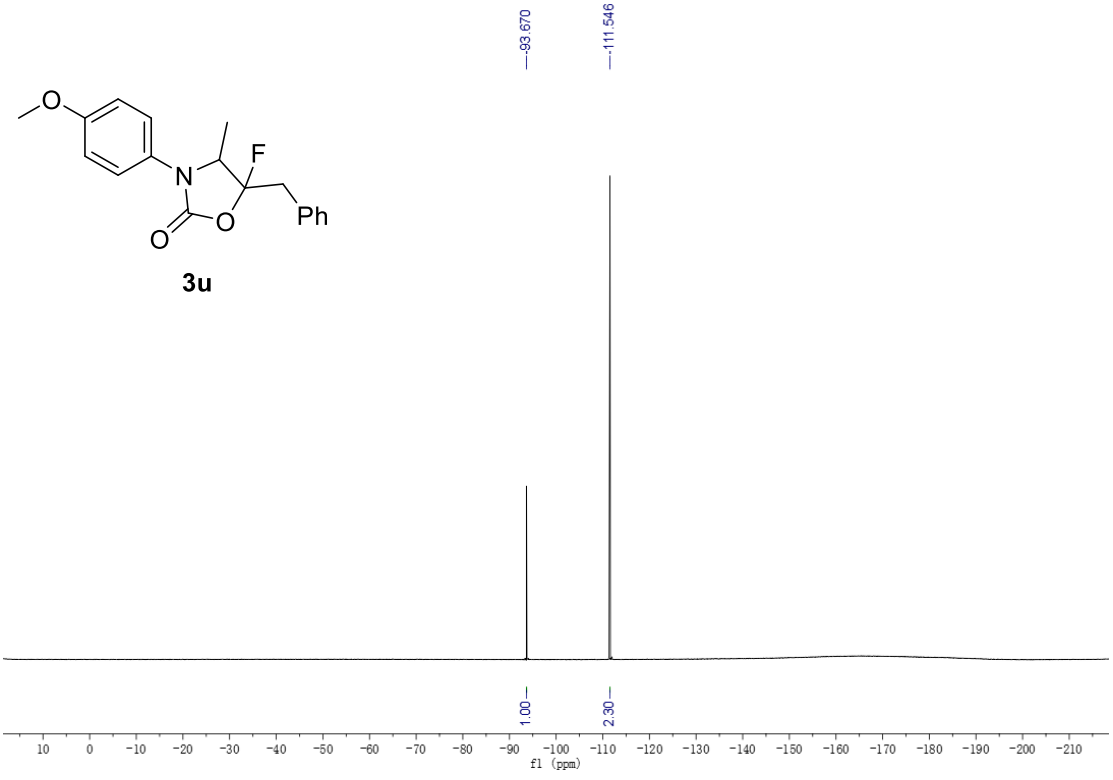

-92.287
O
F
N
O
O
N
Ph
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

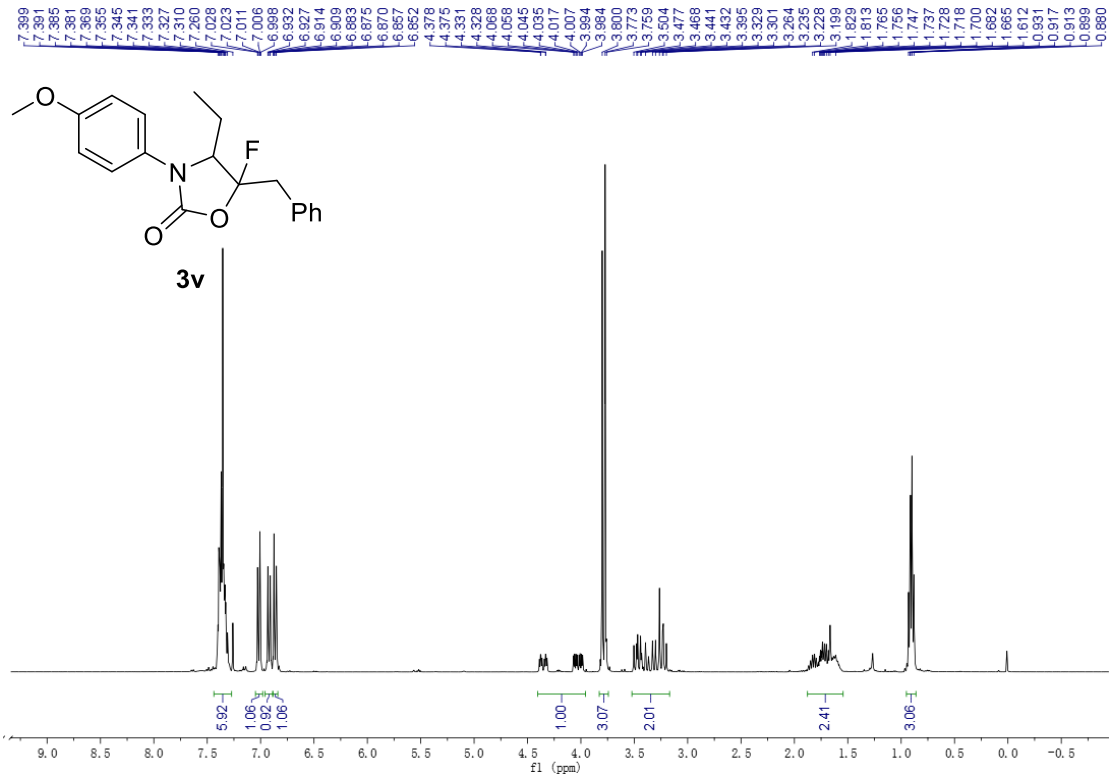
3t

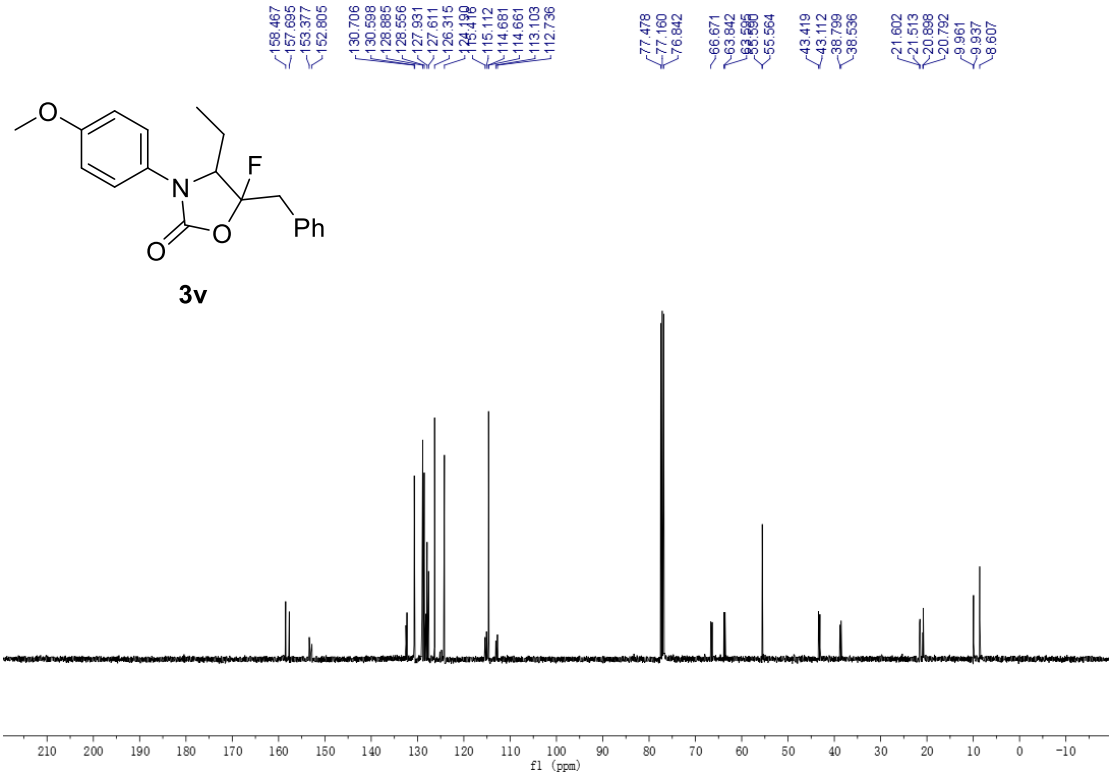

7.398 7.380 7.365 7.346 7.330 7.308 7.291 7.260 7.103 7.095 7.090 7.078 7.073 7.065 6.939 6.930 6.908 6.895 6.878 6.873 6.865
4.391 4.374 4.344 4.327 4.250 4.234 4.217 4.214 4.197 4.180 3.781 3.456 3.429 3.392 3.369 3.355 3.351 3.332 3.321 3.311 3.274 3.250 3.211 3.173
1.283 1.267 1.044 1.038 1.027 1.021
O
F
N
O
O
Ph
5.59 1.37 2.02 1.00 3.05 2.04 1.08 2.06
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

3u


158.372
157.888
153.475
152.408
130.588
130.576
130.515
128.865
128.580
127.947
126.062
124.523
124.474
114.832
114.740
114.647
113.361
112.458
77.478
77.160
76.843
62.560
62.248
59.305
59.050
55.604
55.576
42.018
41.723
38.912
38.649
14.825
14.735
12.471
12.352
O
N
F
Ph
O
O
3u
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-93.670
-111.546
O
N
F
Ph
O
O
3u
1.00
2.30
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)


7.399
7.391
7.385
7.381
7.369
7.355
7.345
7.341
7.333
7.327
7.310
7.260
7.028
7.023
7.011
7.006
6.998
6.932
6.927
6.914
6.909
6.883
6.875
6.870
6.857
6.852
4.378
4.375
4.331
4.328
4.068
4.058
4.045
4.035
4.017
4.007
3.994
3.984
3.800
3.773
3.759
3.504
3.477
3.468
3.441
3.432
3.395
3.329
3.301
3.264
3.235
3.228
3.199
1.829
1.813
1.765
1.756
1.747
1.737
1.728
1.718
1.700
1.682
1.665
1.612
0.931
0.917
0.913
0.899
0.880
O
N
O
O
F
Ph
3v
5.92
1.06
0.92
1.08
1.00
3.07
2.01
2.41
3.06
9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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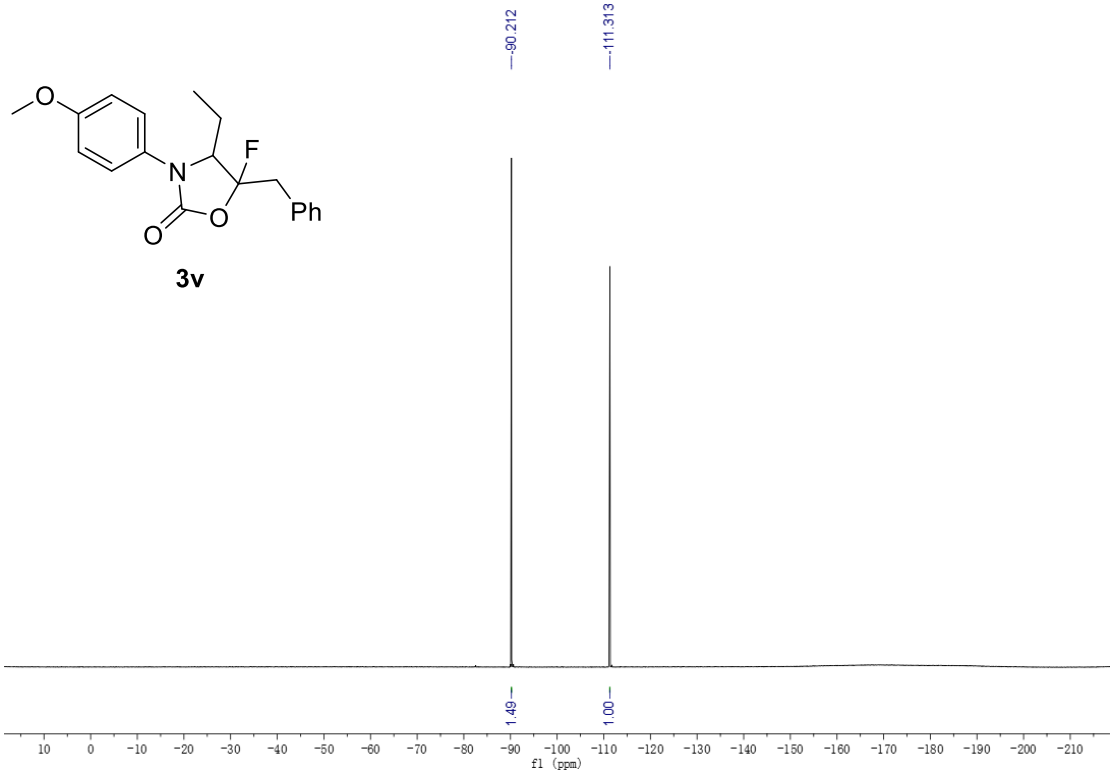
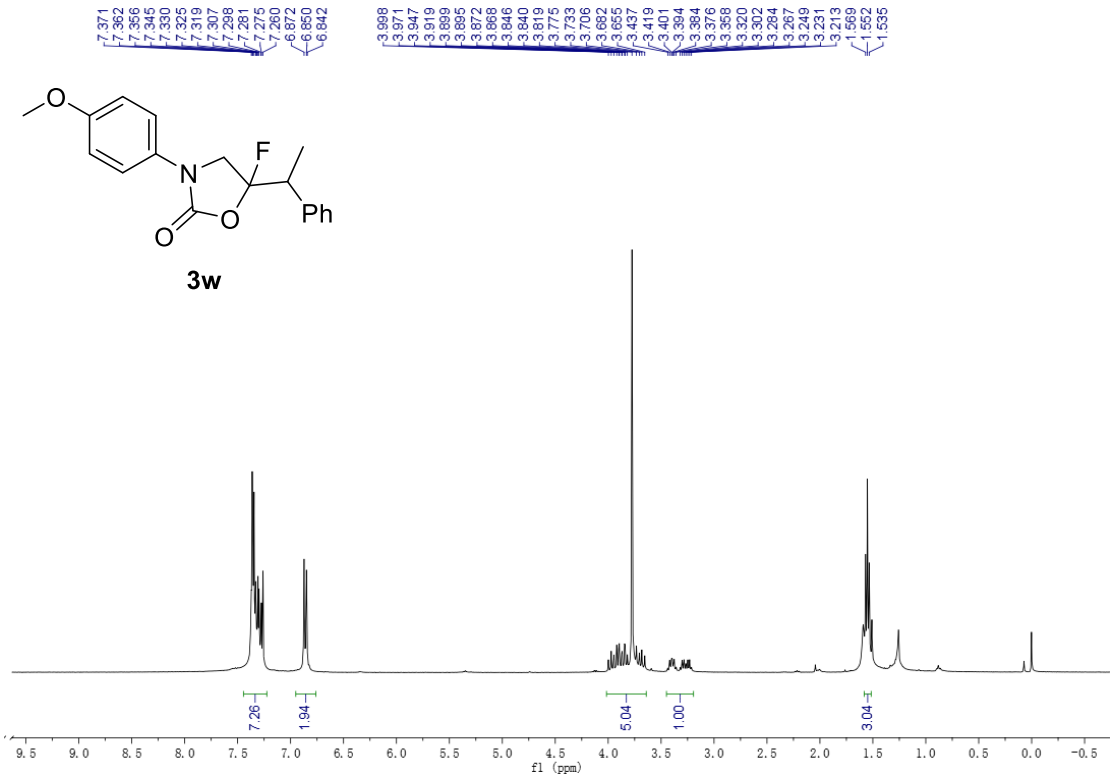
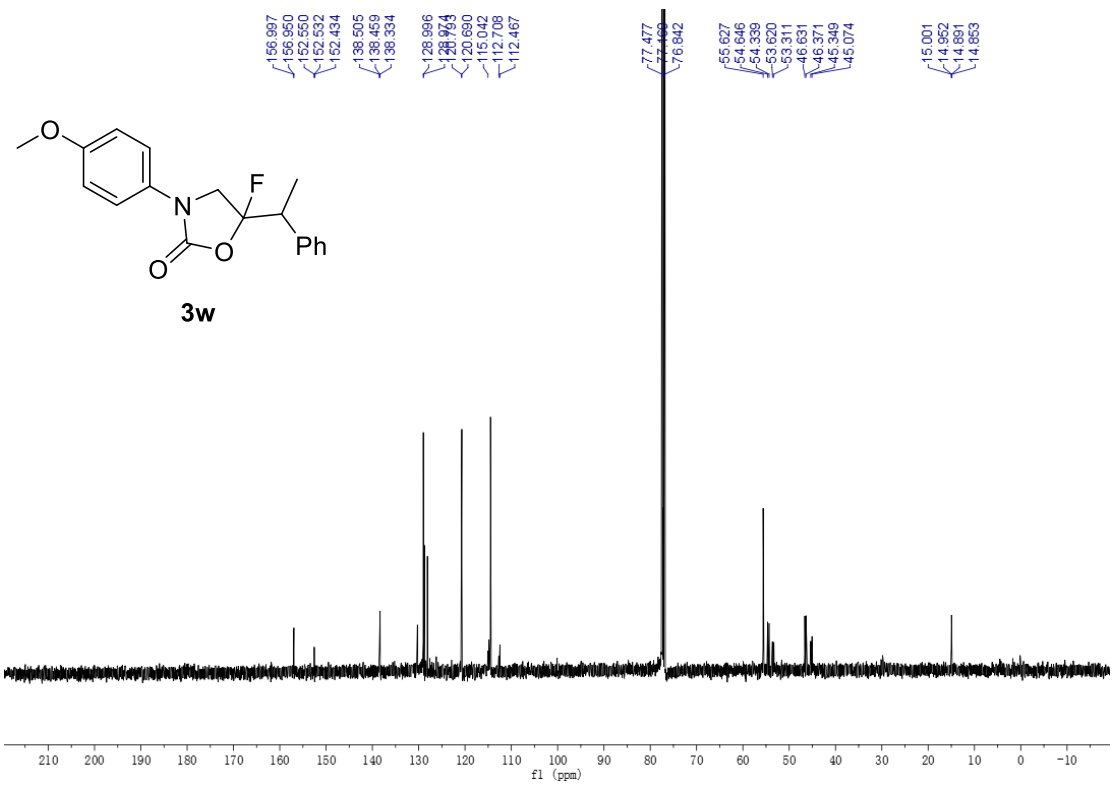
130.598
128.885
128.556
127.931
127.611
126.315
115.112
114.681
114.661
113.103
112.736
77.478
77.160
76.842
66.671
55.564
43.419
43.112
38.799
38.536
21.602
21.513
20.898
20.792
9.961
9.937
8.607
O
N
O
O
F
Ph
3v
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

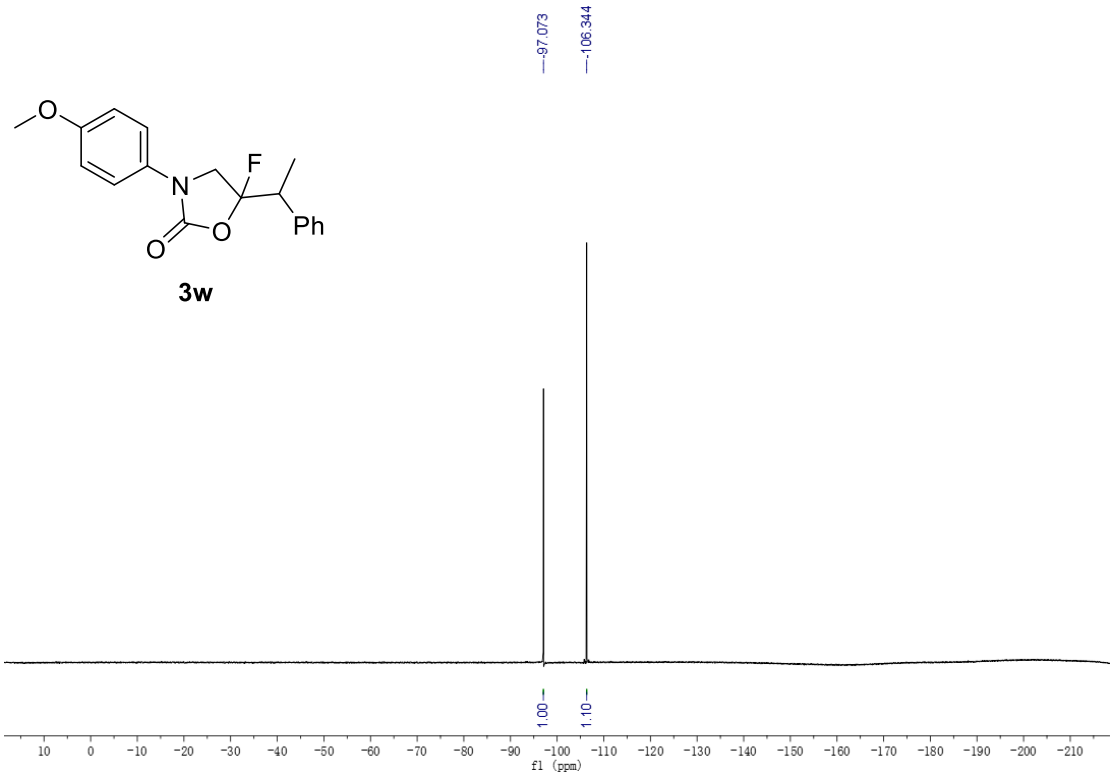


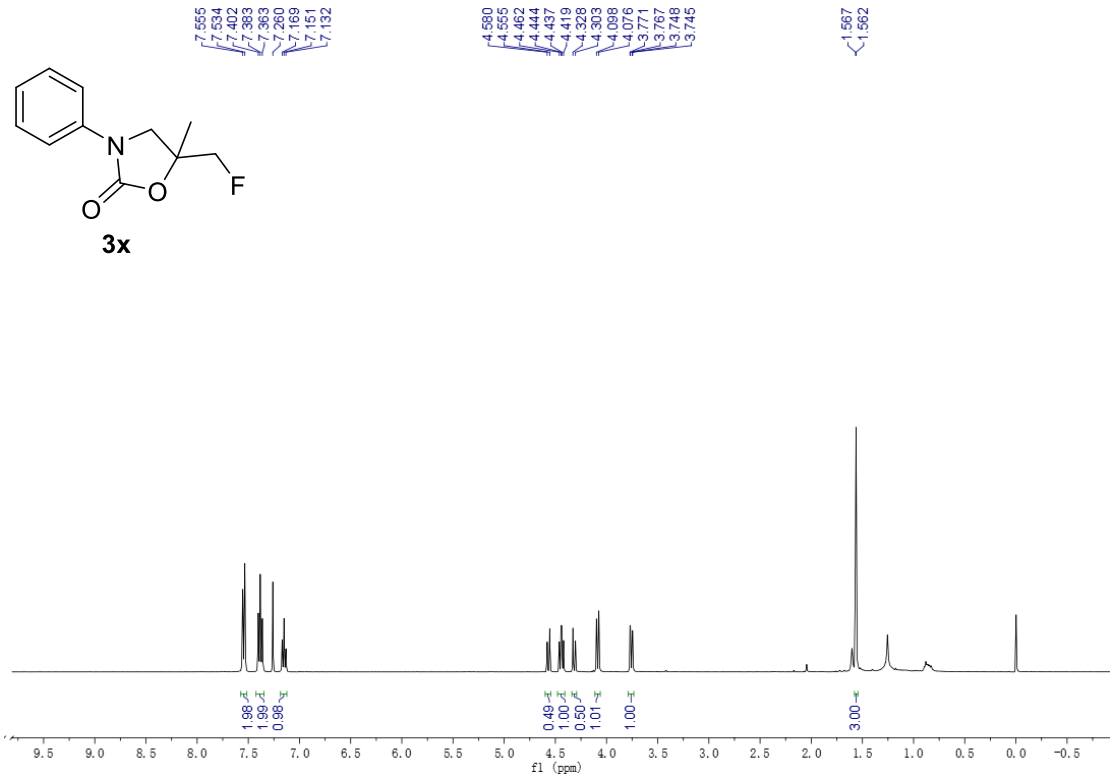
3v



3w


156.997
156.950
152.550
152.532
152.434
138.505
138.459
138.334
128.996
120.793
120.690
115.042
112.708
112.467
77.477
76.842
55.627
54.646
54.339
53.620
53.311
46.631
46.371
45.349
45.074
15.001
14.952
14.891
14.853
O
N
F
O
O
Ph
3w
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-97.073
-106.344
O
N
F
O
O
Ph
3w
1.00
1.10
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)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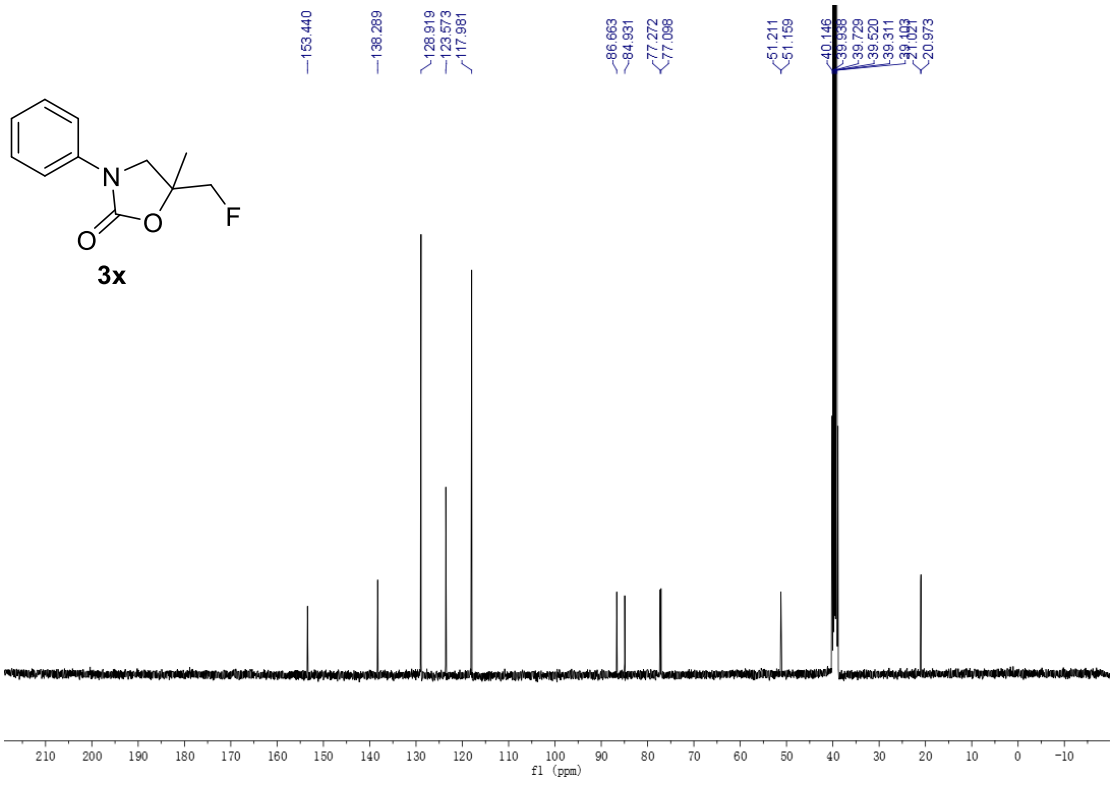
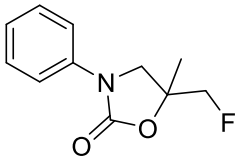
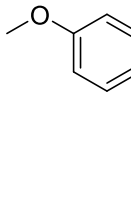
7.534
7.402
7.383
7.363
7.260
7.169
7.151
7.132
4.580
4.555
4.462
4.444
4.437
4.419
4.328
4.303
4.098
4.076
3.771
3.767
3.748
3.745
1.567
1.562
N
O
O
F
3x
1.98
1.99
0.98
0.49
1.00
0.50
1.01
1.00
3.00
f1 (ppm)


153.440
138.289
128.919
123.573
117.981
86.663
84.931
77.272
77.098
51.211
51.159
40.146
39.938
39.729
39.520
39.311
21.021
20.973
N
O
O
F
3x
f1 (ppm)



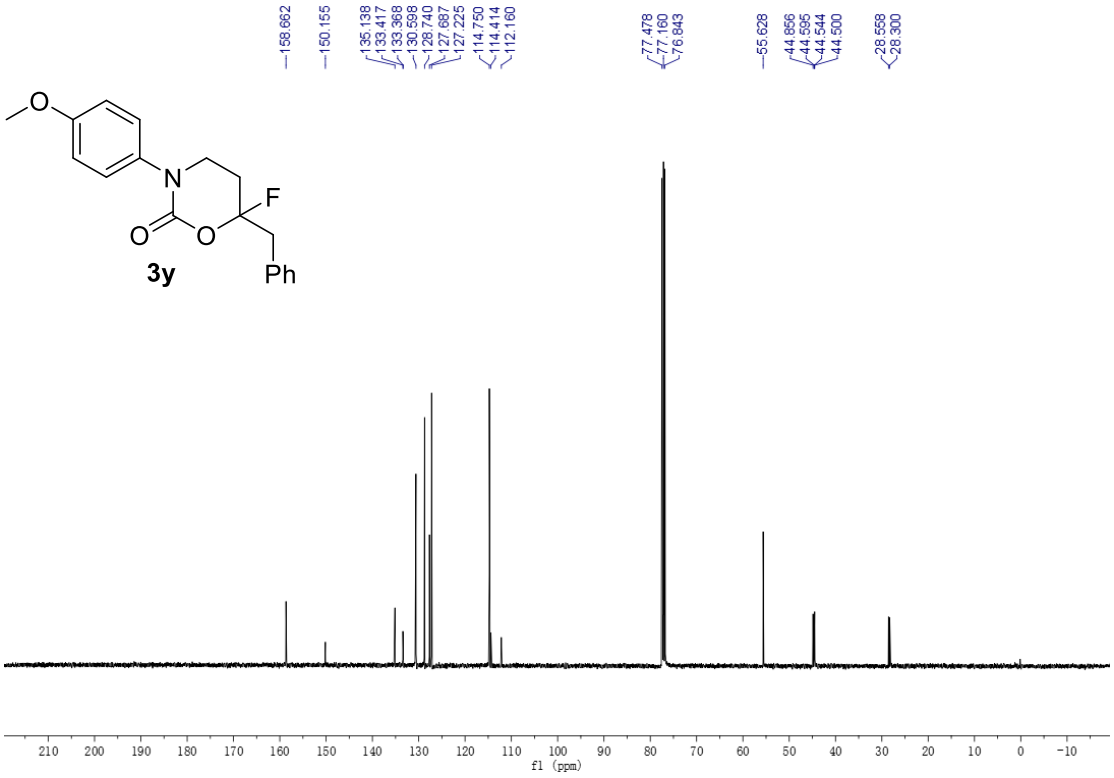
3x

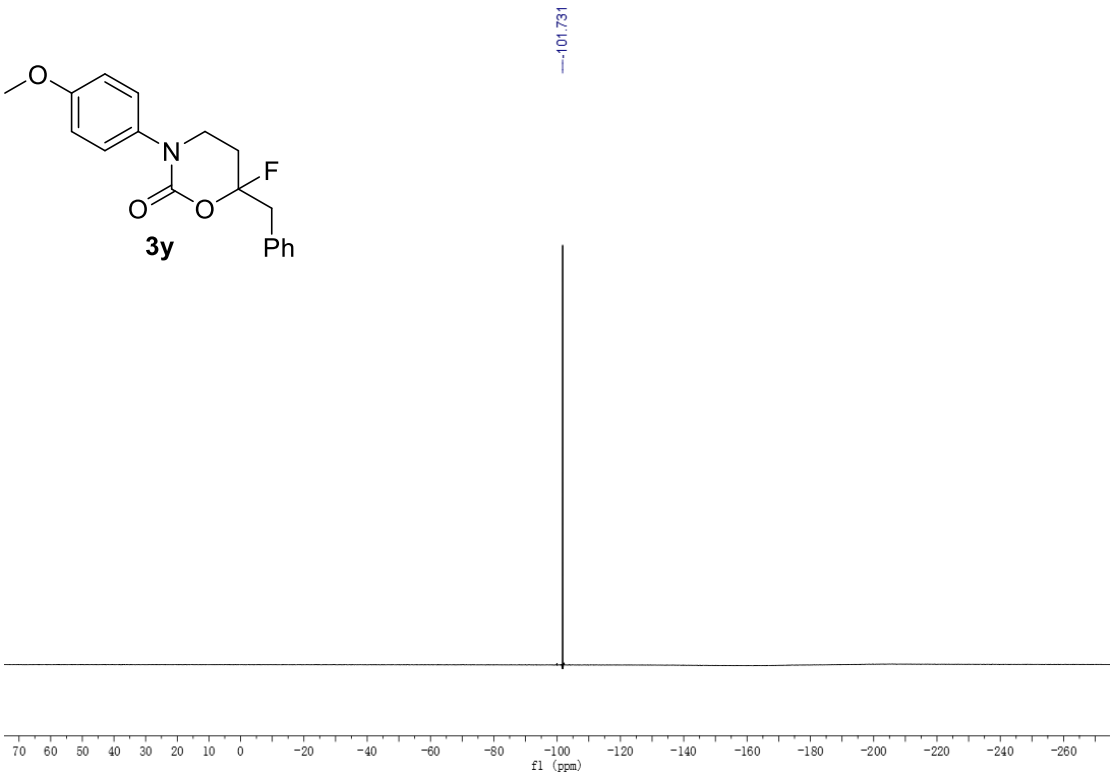
-227.850
70 60 50 40 30 20 10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260
f1 (ppm)



3y

7.380 7.376 7.371 7.366 7.357 7.354 7.350 7.343 7.334 7.329 7.323 7.315 7.312 7.299 7.292 7.260 7.225 7.217 7.211 7.200 7.194 7.186 6.922 6.913 6.908 6.896 6.891 6.882 3.921 3.908 3.902 3.898 3.891 3.877 3.865 3.860 3.848 3.795 3.456 3.448 3.438 3.428 3.426 3.421 3.415 3.410 3.408 3.360 3.330 3.325 3.307 3.295 3.271 3.260 3.224 2.137 2.132 2.124 2.119 2.115 2.109 2.099 2.092 2.084 2.078 2.063 2.046 2.031 2.028 2.011
5.10 2.00 2.02
1.00 3.00 1.01 2.08 2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


158.862
150.155
135.138
133.417
133.368
130.598
128.740
127.687
127.225
114.750
114.414
112.160
77.478
77.160
76.843
55.628
44.856
44.595
44.544
44.500
28.558
28.300
O
N
F
O
O
Ph
3y
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


101.731
O
N
F
O
O
Ph
3y
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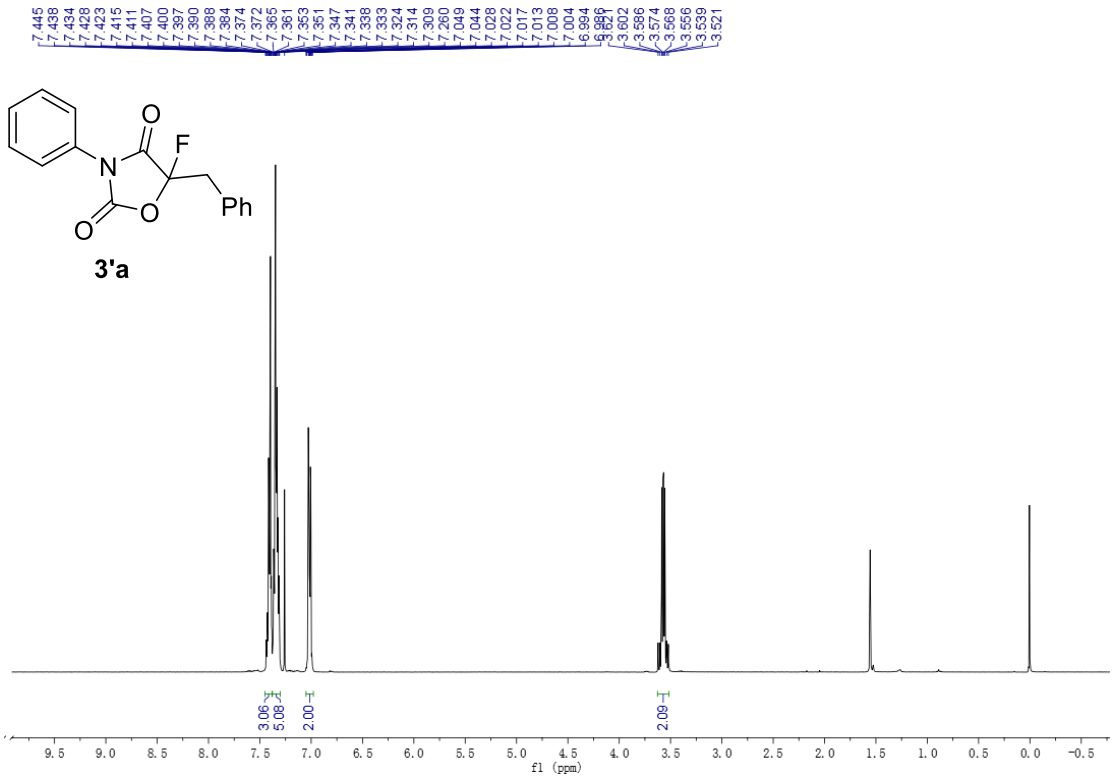
f1 (ppm)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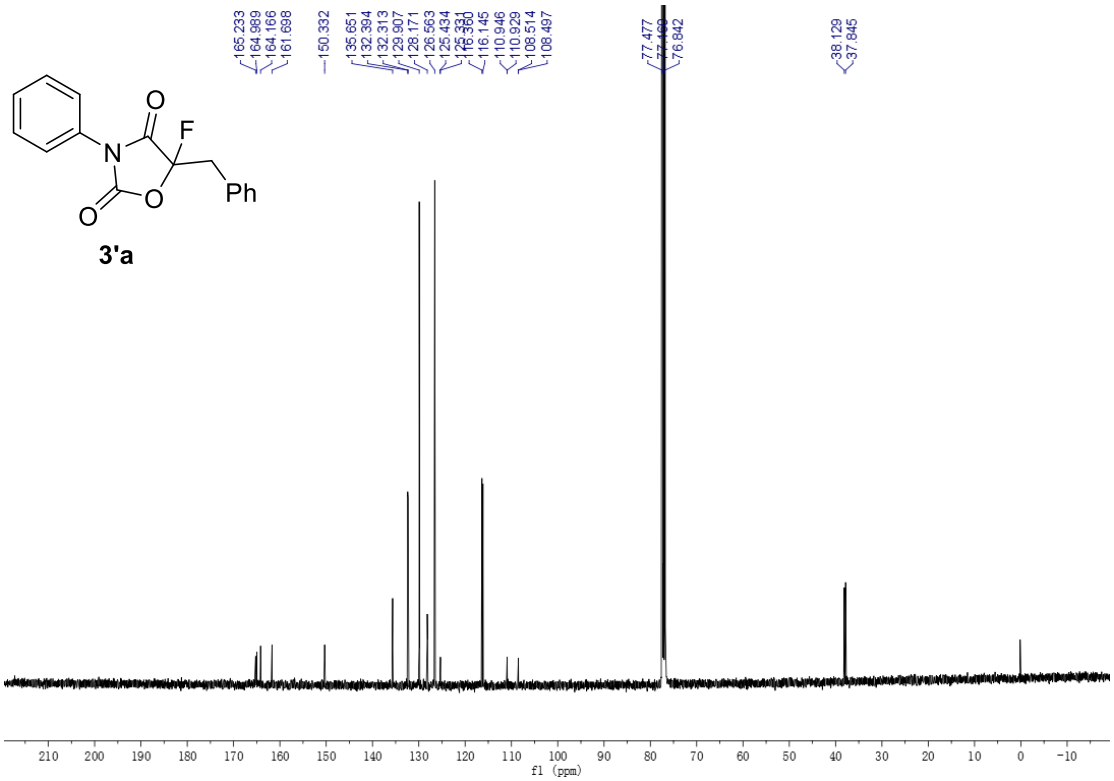
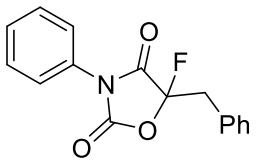
7.428
7.423
7.415
7.411
7.407
7.400
7.397
7.390
7.388
7.384
7.374
7.372
7.365
7.361
7.353
7.351
7.347
7.341
7.338
7.333
7.324
7.314
7.309
7.260
7.049
7.044
7.028
7.022
7.017
7.013
7.008
7.004
6.994
3.602
3.586
3.574
3.568
3.556
3.539
3.521
O
F
N
O
O
Ph
3'a
3.06
5.08
2.00
2.09
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

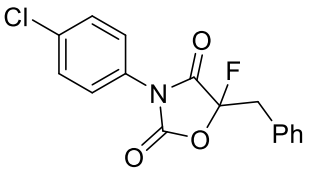

165.233
164.989
164.166
161.698
150.332
135.651
132.394
132.313
129.907
128.171
126.563
125.434
125.331
116.380
116.145
110.946
110.929
108.514
108.497
77.477
76.842
38.129
37.845
O
F
N
O
O
Ph
3'a
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


O
F
N
O
Ph
O

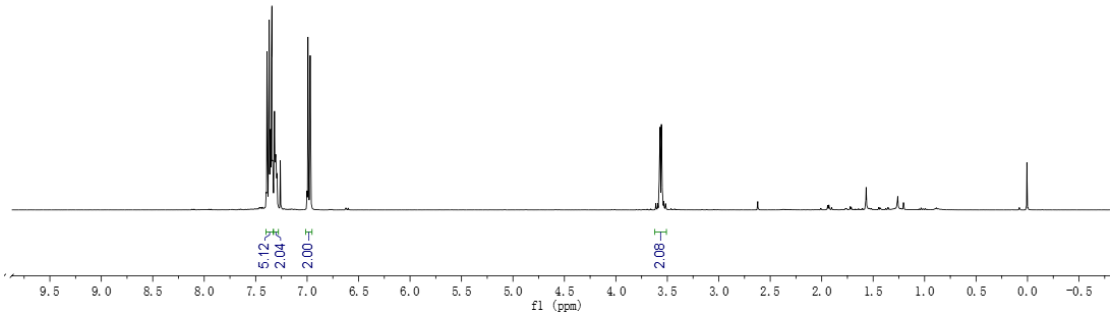
3'a

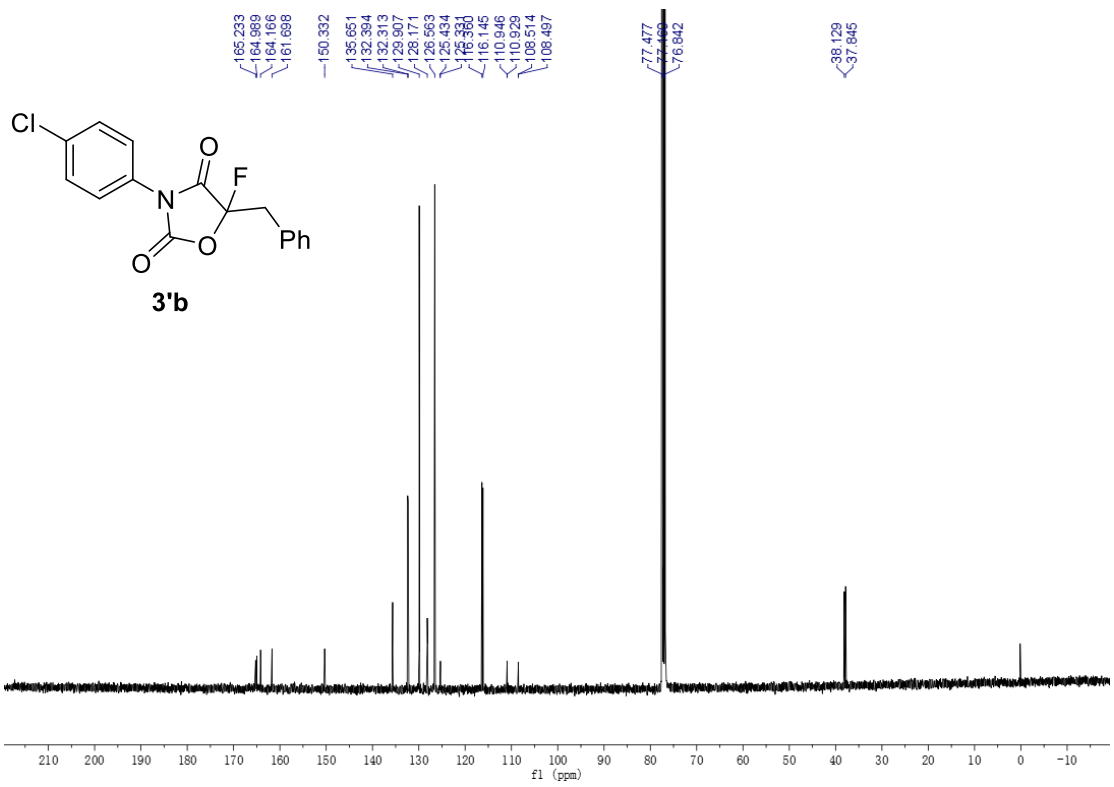
-110.111
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

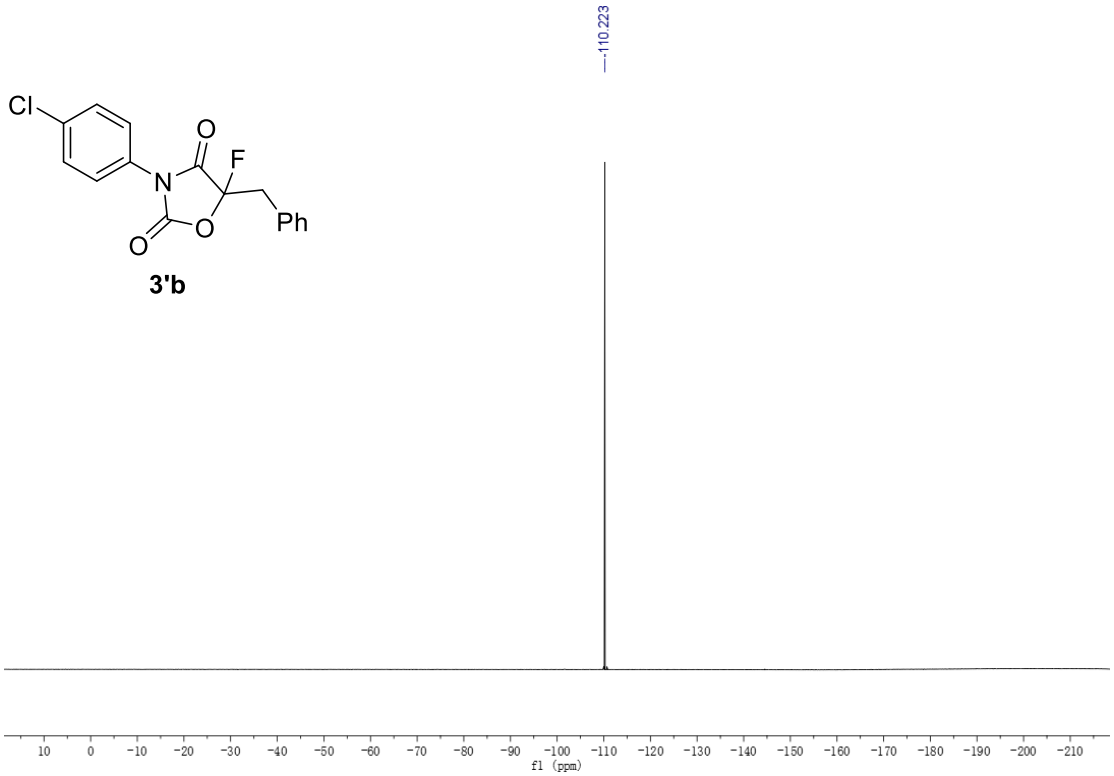

7.398
7.390
7.385
7.374
7.368
7.360
7.356
7.348
7.342
7.336
7.317
7.308
7.298
7.293
7.260
6.999
6.992
6.987
6.975
6.970
6.963
3.611
3.592
3.576
3.570
3.558
3.552
3.535
3.518

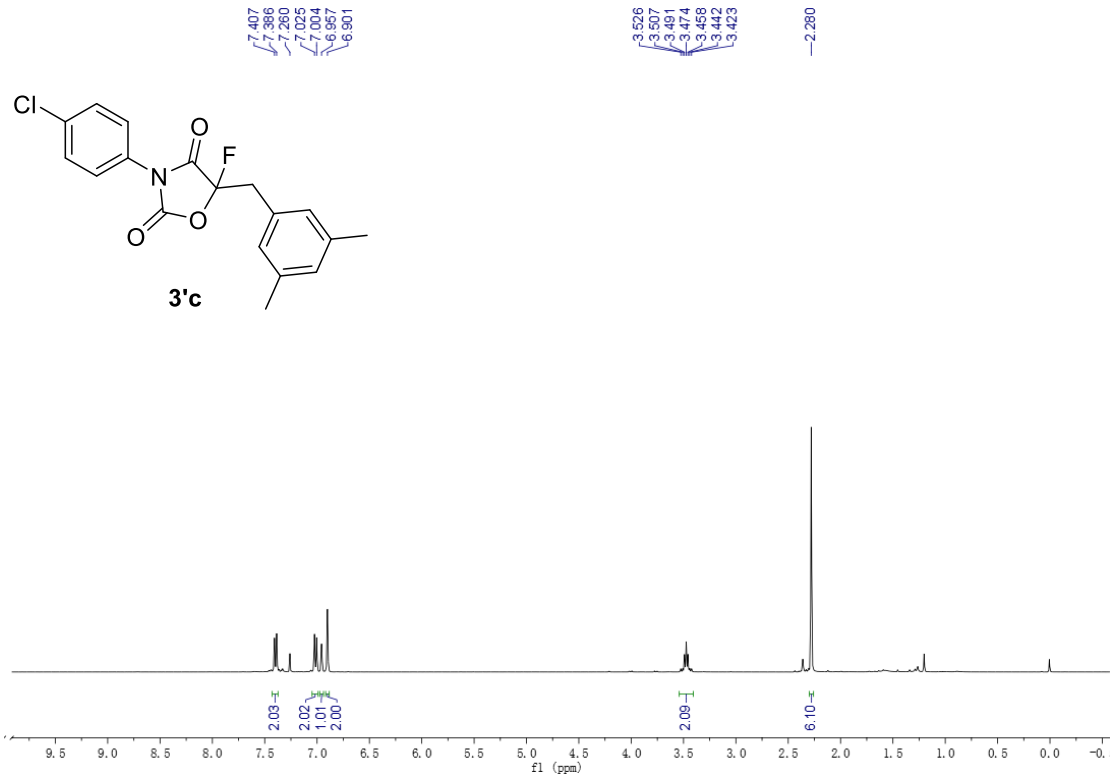

Cl
O
F
N
O
Ph
O

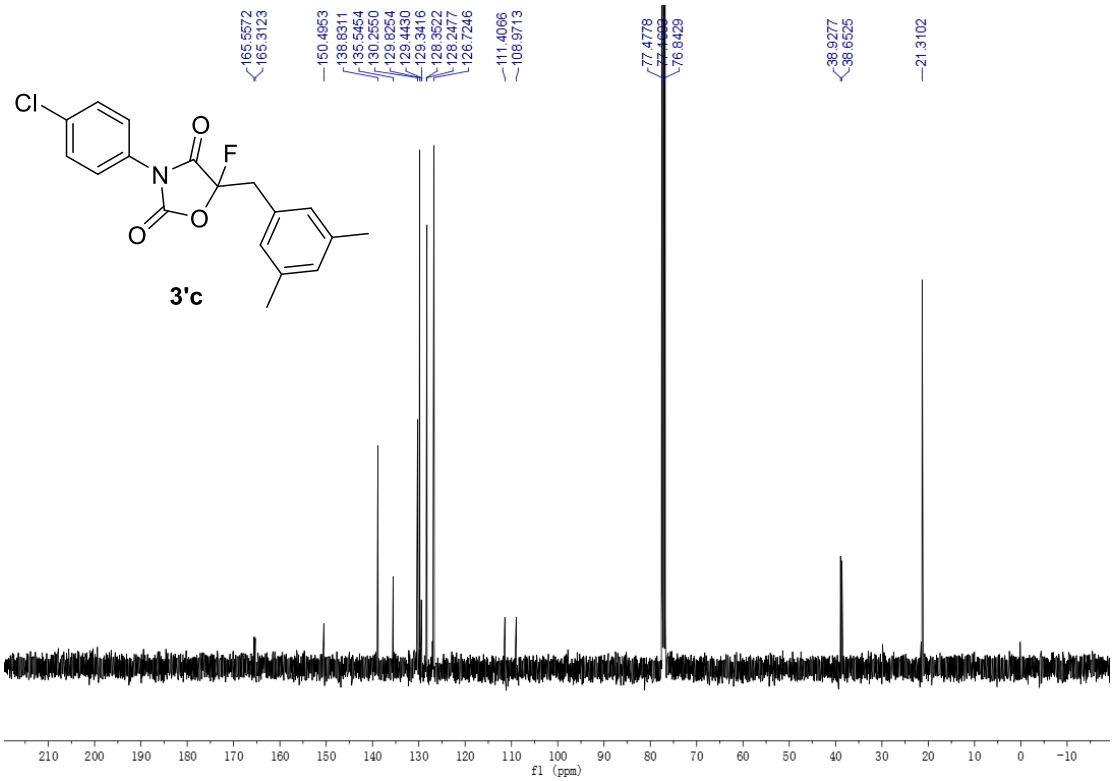
3'b

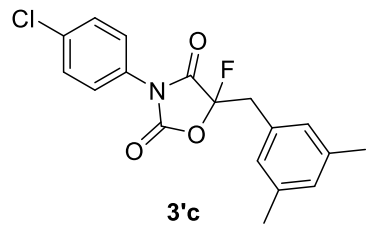

5.12
2.04
2.00
2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


Cl
O
F
N
Ph
O
O
3'b
165.233
164.989
164.166
161.698
150.332
135.651
132.394
132.313
129.907
128.171
126.563
125.434
125.331
116.360
116.145
110.946
110.929
108.514
108.497
77.477
77.160
76.842
38.129
37.845
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


Cl
O
F
N
Ph
O
O
3'b
-110.223
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

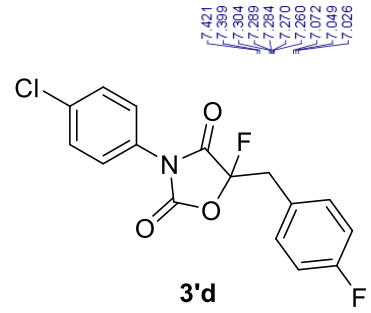

7.407
7.386
7.280
7.025
7.004
6.957
6.901
3.526
3.507
3.491
3.474
3.458
3.442
3.423
2.280
Cl
O
F
N
O
O
3'c
2.03
2.02
1.01
2.00
2.09
6.10
f1 (ppm)


165.5572
165.3123
150.4953
138.8311
135.5454
130.2550
129.8254
129.4430
129.3416
128.3522
128.2477
126.7246
111.4086
108.9713
77.4778
76.8429
38.9277
38.6525
21.3102
Cl
O
F
N
O
O
3'c
f1 (ppm)


Cl
O
F
N
O
O

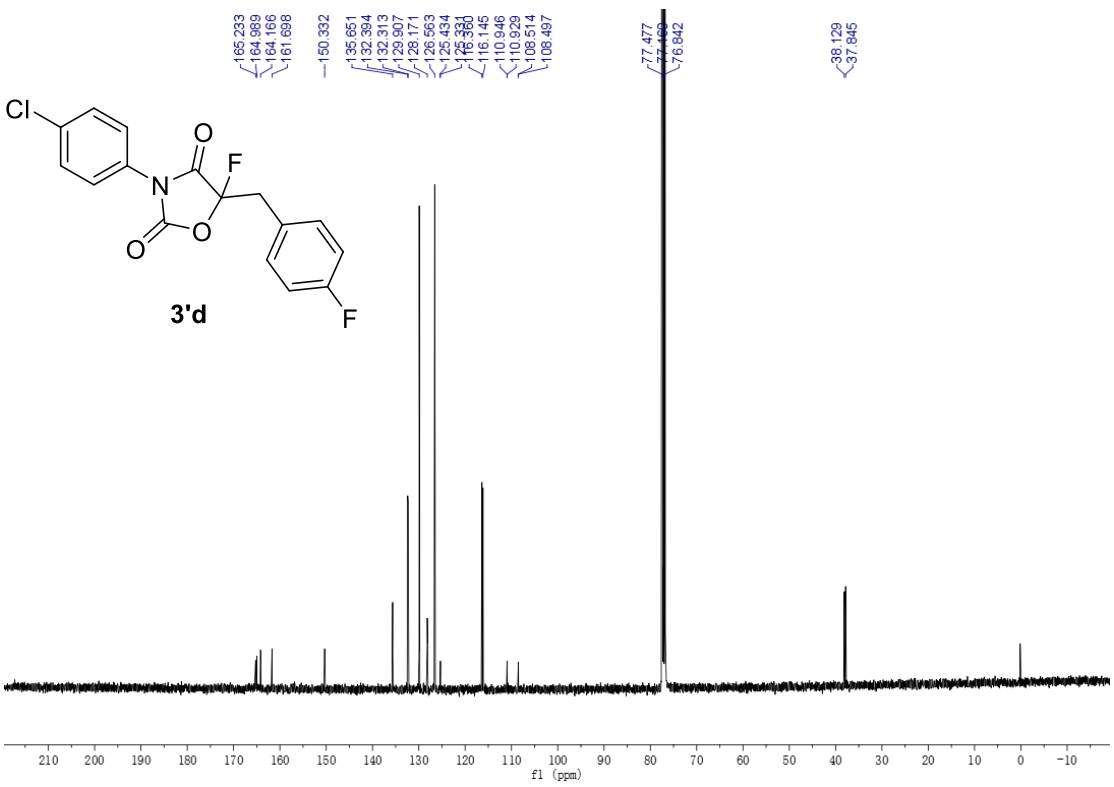
3'c

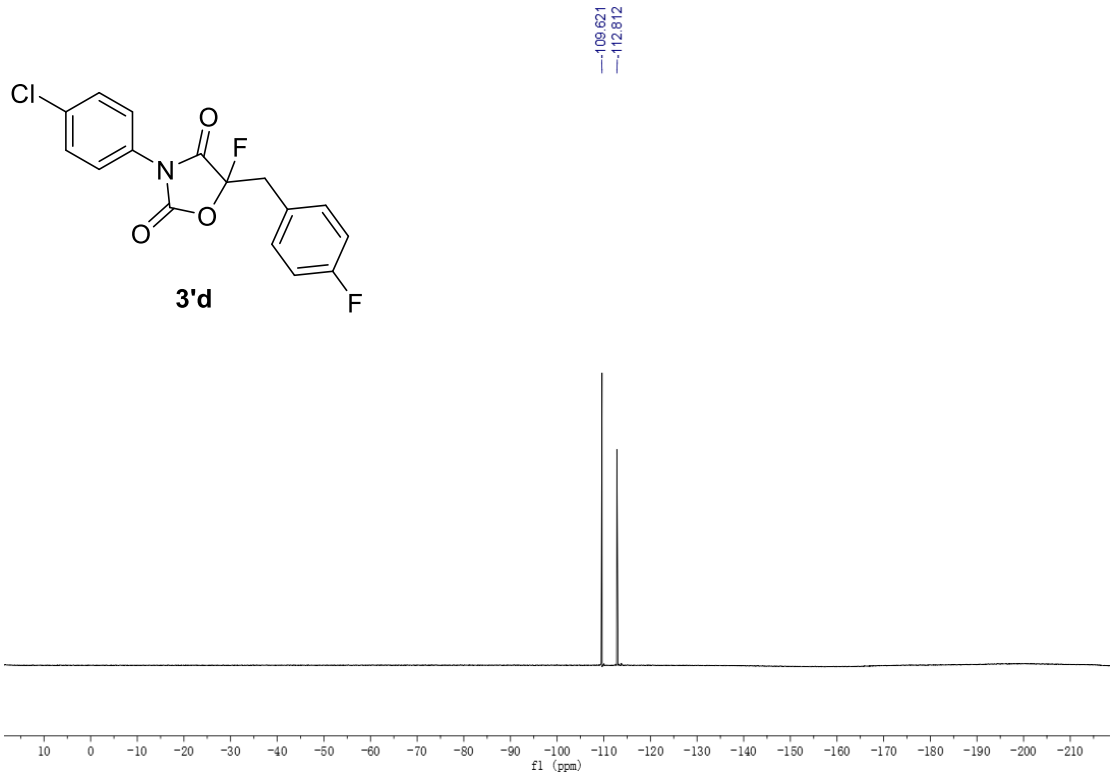
-110.374
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

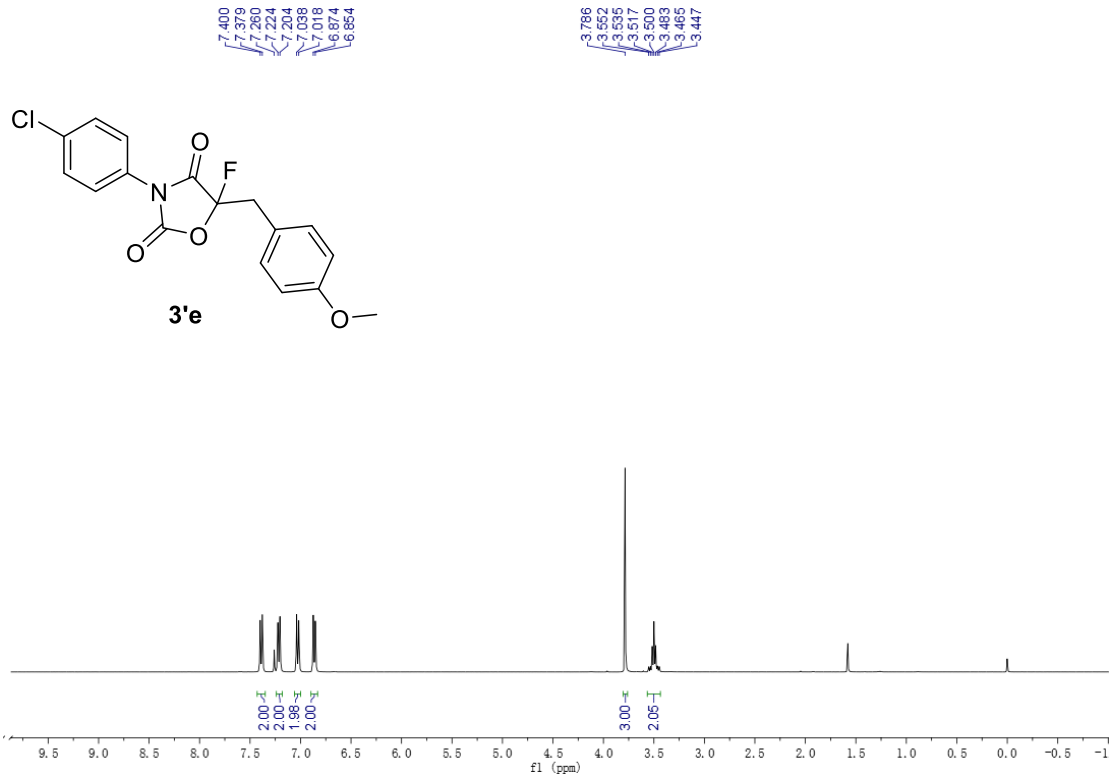

Cl
O
F
N
O
O
F

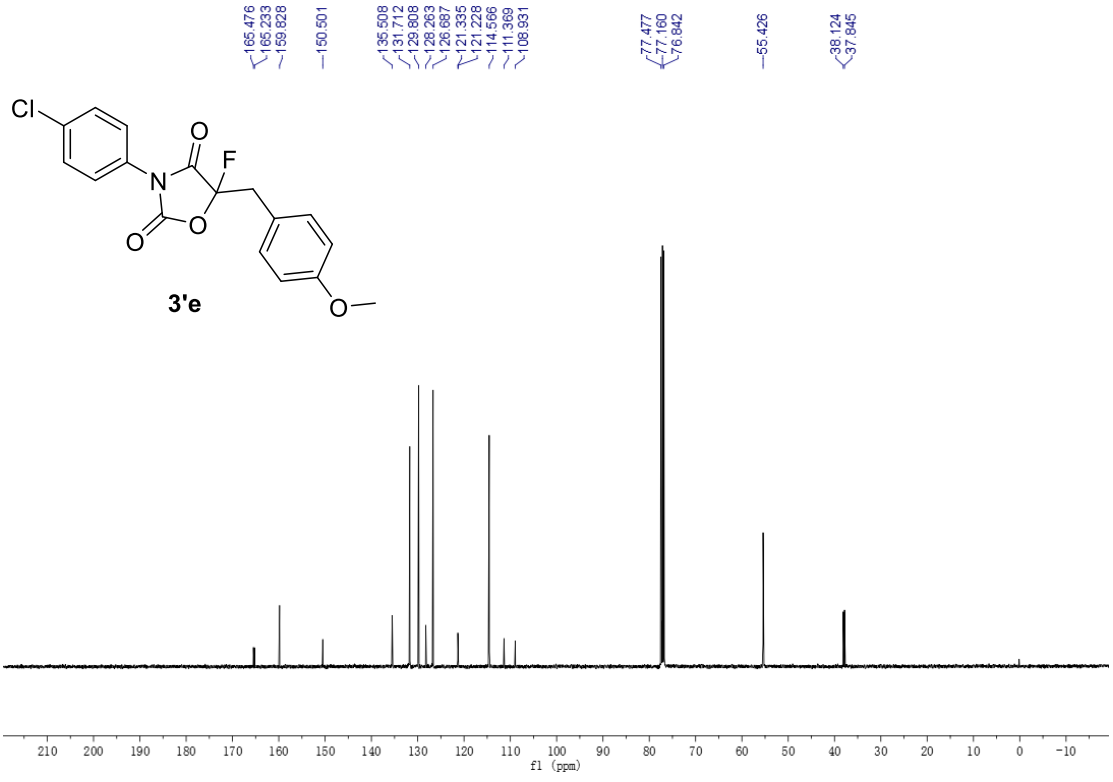
3'd

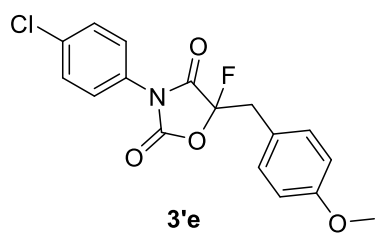
7.421
7.399
7.304
7.289
7.284
7.270
7.260
7.072
7.049
7.026
3.585
3.564
3.546
3.527
3.509
3.490
2.00
1.95
3.98
2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


165.233
164.989
164.166
161.698
150.332
135.651
132.394
132.313
129.907
128.171
126.563
125.434
125.331
116.360
116.145
110.946
110.929
108.514
108.497
77.477
77.163
76.842
38.129
37.845
Cl
O
F
N
O
O
F
3'd
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


-109.621
-112.812
Cl
O
F
N
O
O
F
3'd
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

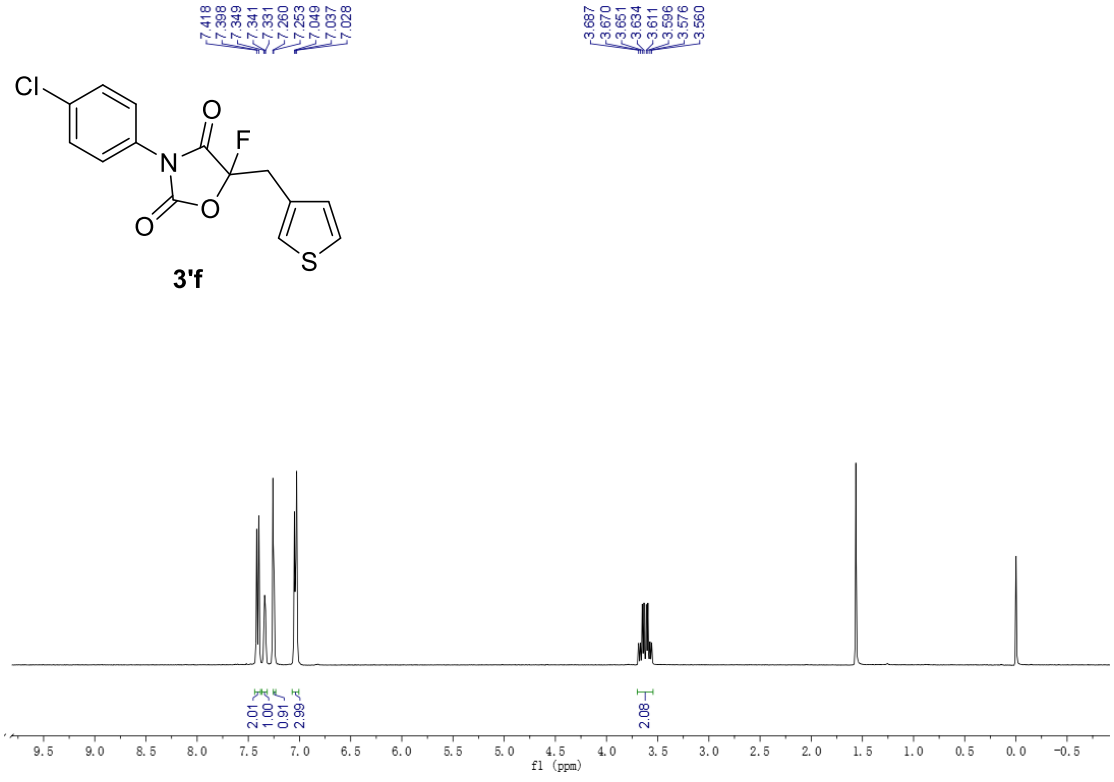

7.400
7.379
7.260
7.224
7.204
7.038
7.018
6.874
6.854
3.786
3.552
3.535
3.517
3.500
3.483
3.465
3.447
Cl
O
F
N
O
O
O
3'e
2.00
2.00
1.98
2.00
3.00
2.05
f1 (ppm)


165.476
165.233
159.828
150.501
135.508
131.712
129.808
128.263
126.687
121.335
121.228
114.566
111.369
108.931
77.477
77.160
76.842
55.426
38.124
37.845
Cl
O
F
N
O
O
O
3'e
f1 (ppm)

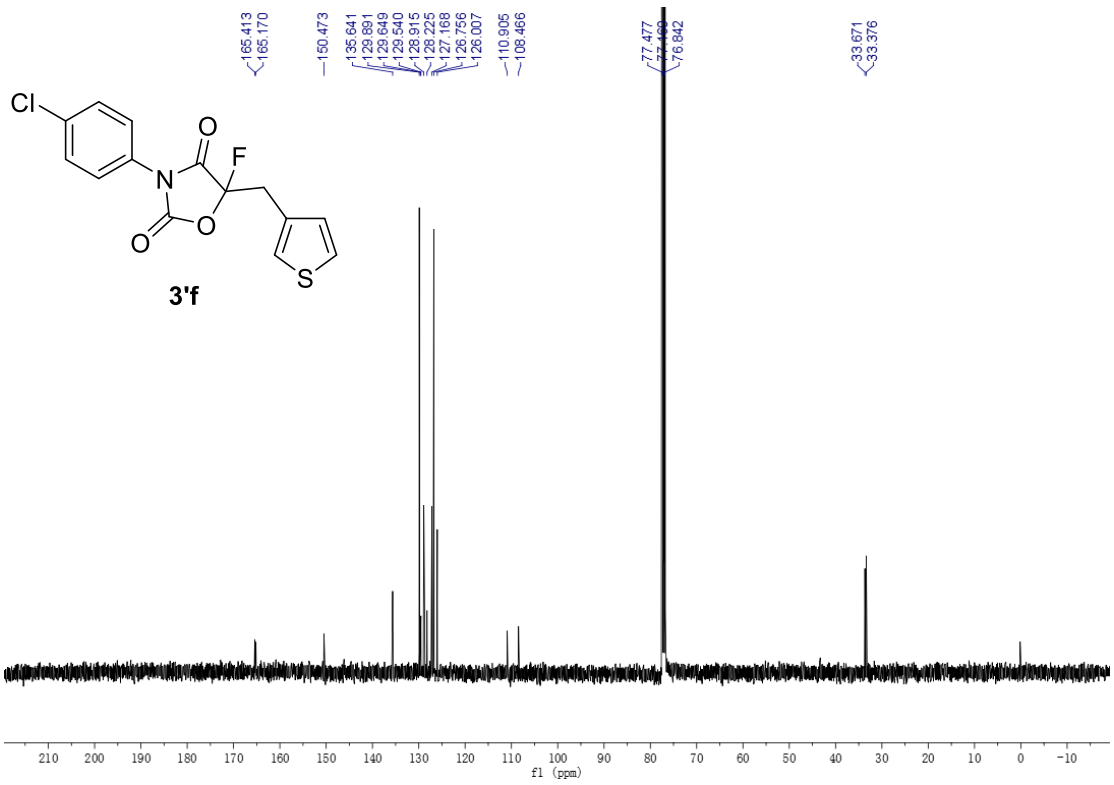

Cl
O
F
N
O
O
O

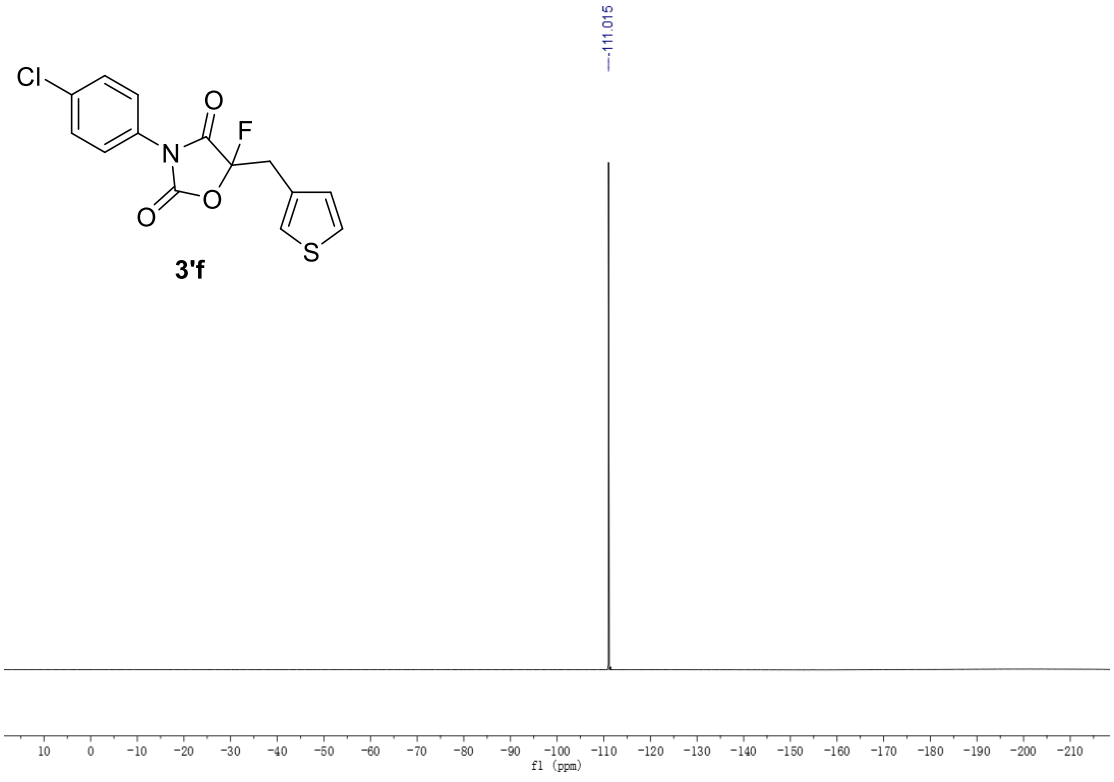
3'e

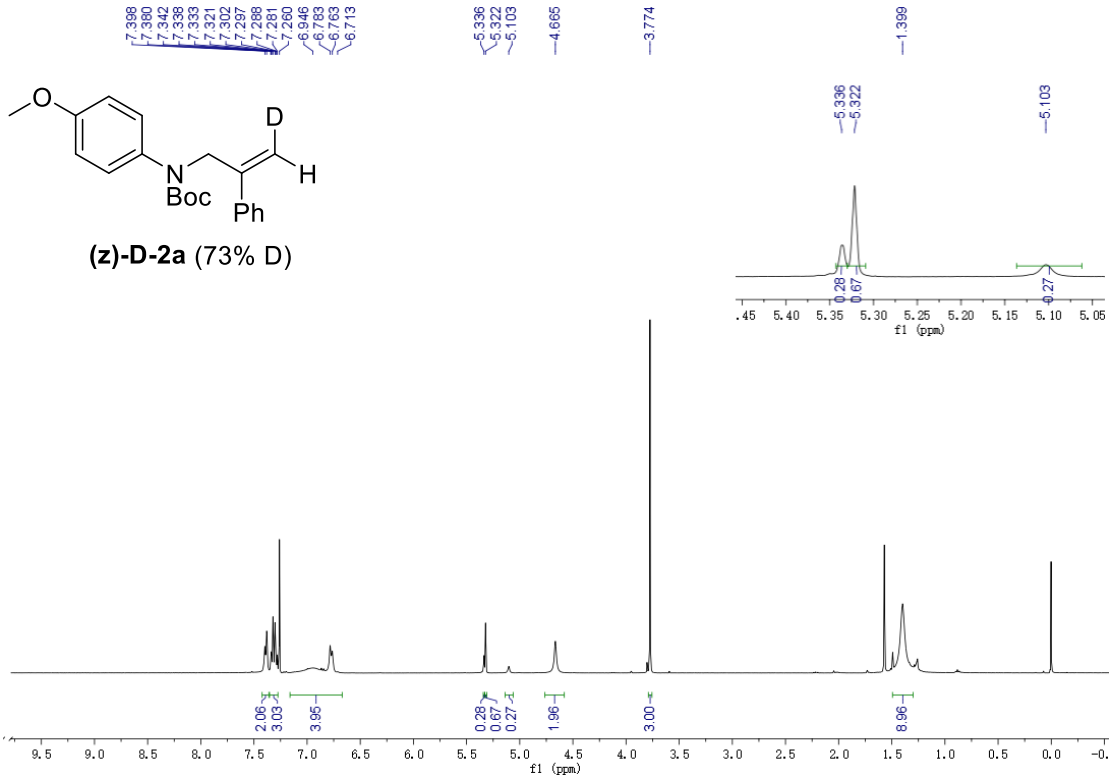
-110.145
70 60 50 40 30 20 10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260
f1 (ppm)


7.418
7.398
7.349
7.341
7.331
7.260
7.253
7.049
7.037
7.028
3.687
3.670
3.651
3.634
3.611
3.596
3.576
3.560
Cl
O
F
N
O
O
S
2.01
1.00
0.91
2.99
2.08
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

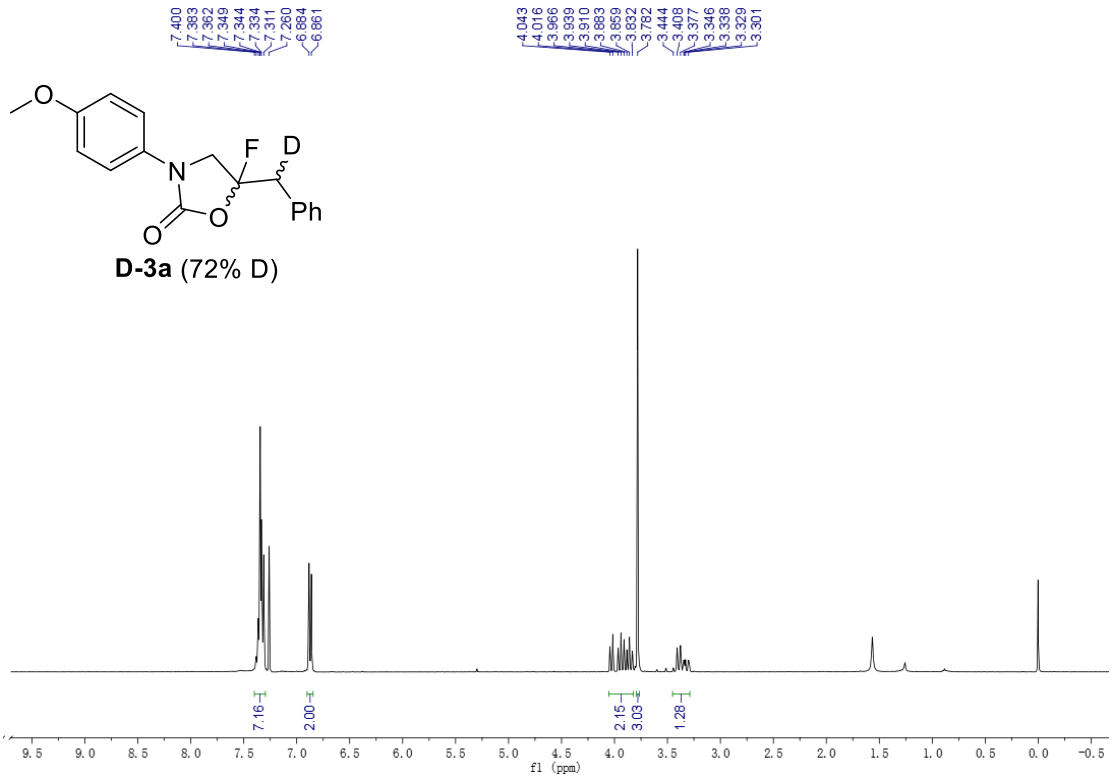
3'f


165.413
165.170
150.473
135.641
129.891
129.649
129.540
128.815
128.225
127.168
126.756
126.007
110.905
108.466
77.477
77.163
76.842
33.671
33.376
Cl
O
F
N
O
O
S
3'f
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

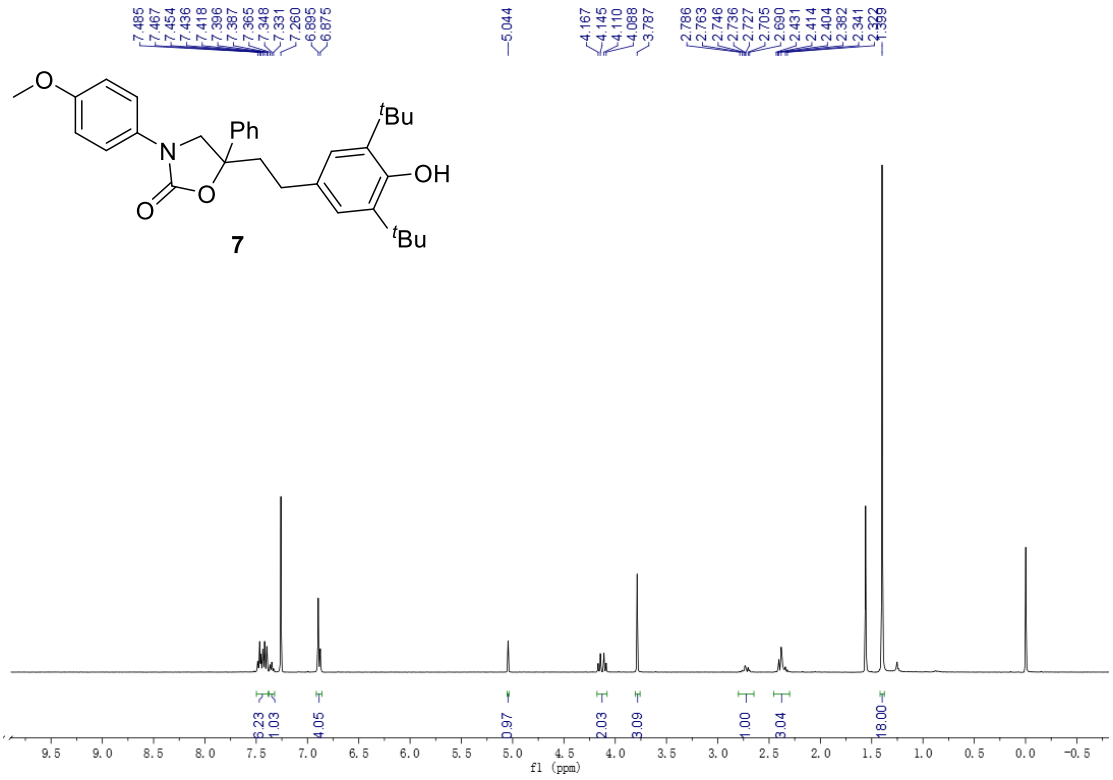

-111.015
Cl
O
F
N
O
O
S
3'f
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

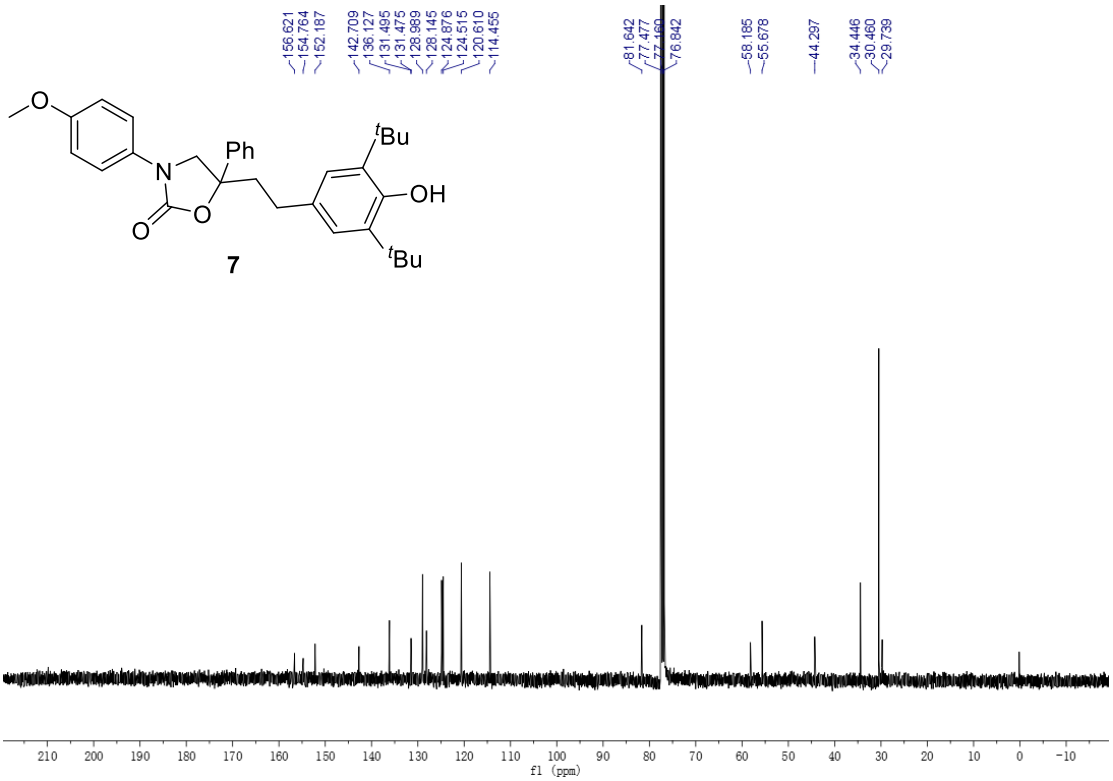


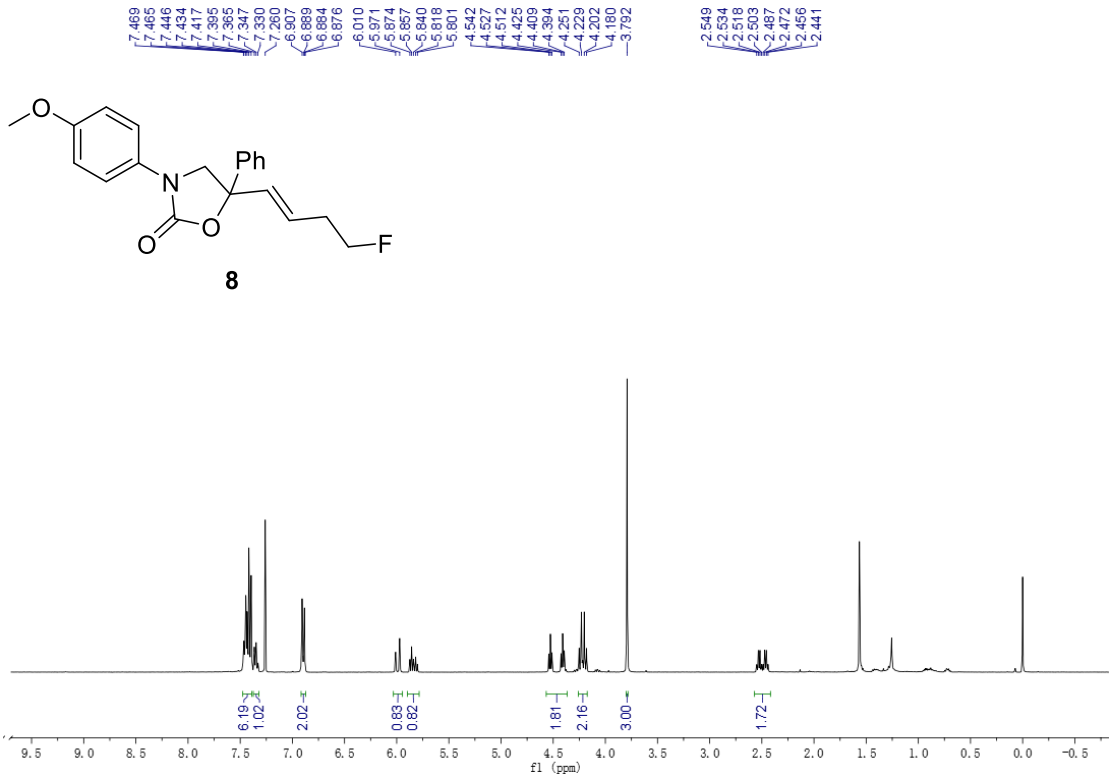
(z)-D-2a (73% D)



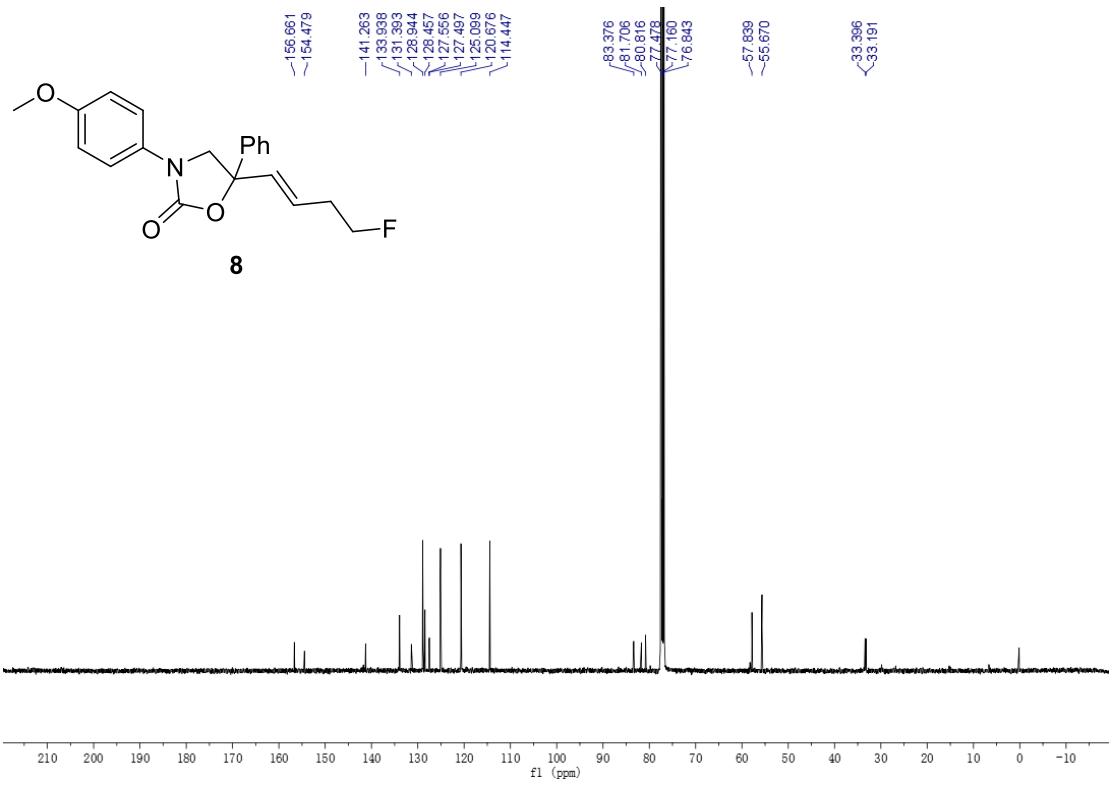
D-3a (72% D)


7.485
7.467
7.454
7.436
7.418
7.396
7.387
7.365
7.348
7.331
7.260
6.895
6.875
5.044
4.167
4.145
4.110
4.088
3.787
2.786
2.763
2.746
2.736
2.727
2.705
2.690
2.431
2.414
2.404
2.382
2.341
1.398
O
N
O
O
Ph
tBu
OH
tBu
7
6.23
1.03
4.05
0.97
2.03
3.09
1.00
3.04
18.00
f1 (ppm)

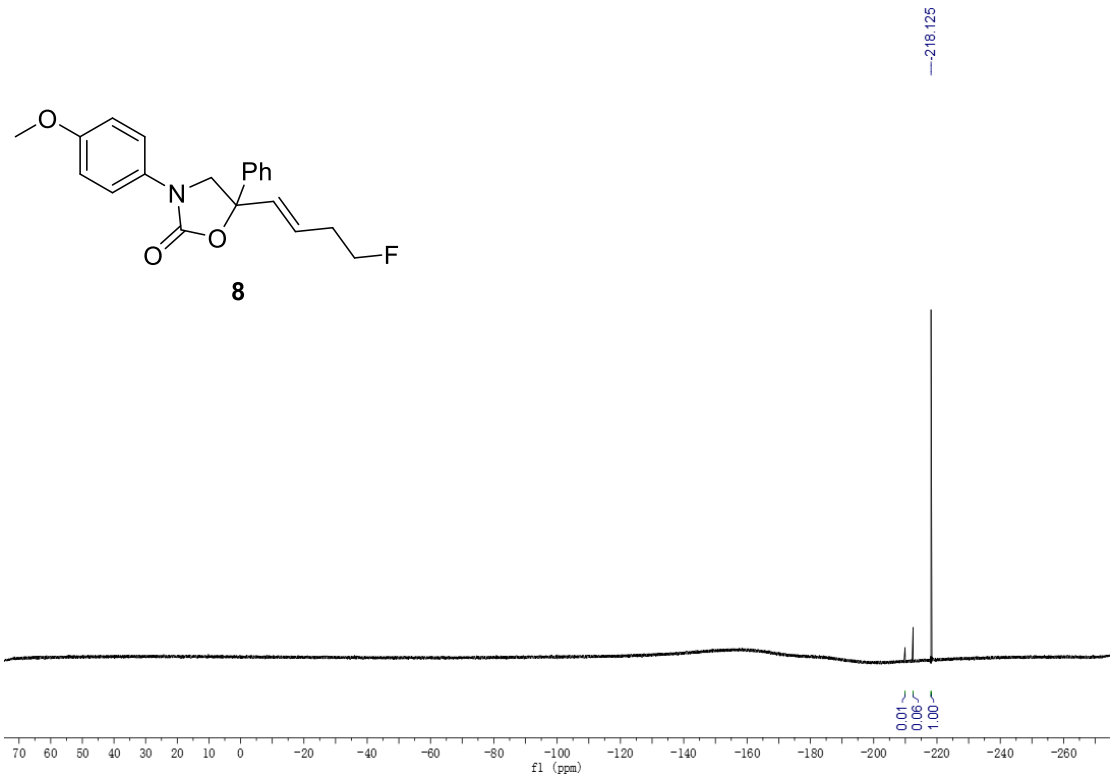

156.621
154.764
152.187
142.709
136.127
131.495
131.475
128.989
128.145
124.876
124.515
120.610
114.455
81.642
77.477
77.160
76.842
58.185
55.678
44.297
34.446
30.460
29.739
O
N
O
O
Ph
tBu
OH
tBu
7
f1 (ppm)


7.469
7.465
7.446
7.434
7.417
7.395
7.365
7.347
7.330
7.260
6.907
6.889
6.884
6.876
6.010
5.971
5.874
5.857
5.840
5.818
5.801
4.542
4.527
4.512
4.425
4.409
4.394
4.251
4.229
4.202
4.180
3.792
2.549
2.534
2.518
2.503
2.487
2.472
2.456
2.441
O
N
Ph
O
O
F
6.19
1.02
2.02
0.83
0.82
1.81
2.16
3.00
1.72
f1 (ppm)

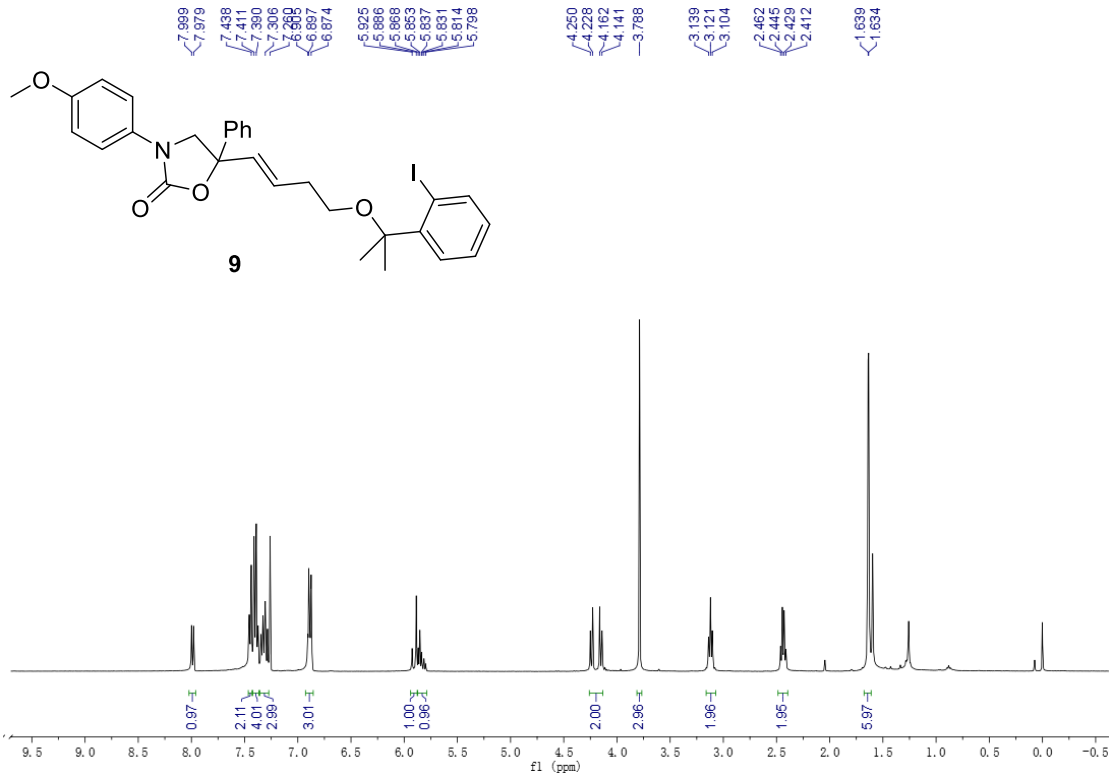
8

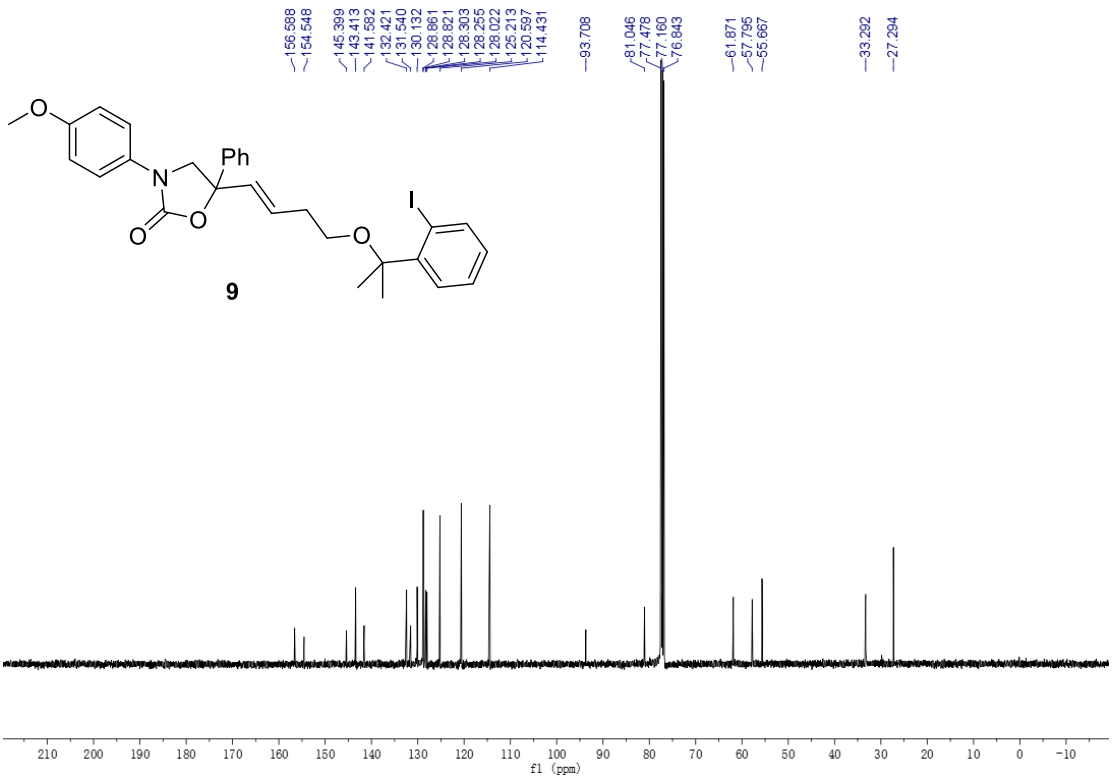

156.661
154.479
141.263
133.938
131.393
128.944
128.457
127.556
127.497
125.099
120.676
114.447
83.376
81.706
80.816
77.478
77.160
76.843
57.839
55.670
33.396
33.191
O
N
Ph
O
O
F
f1 (ppm)

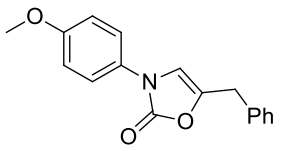
8

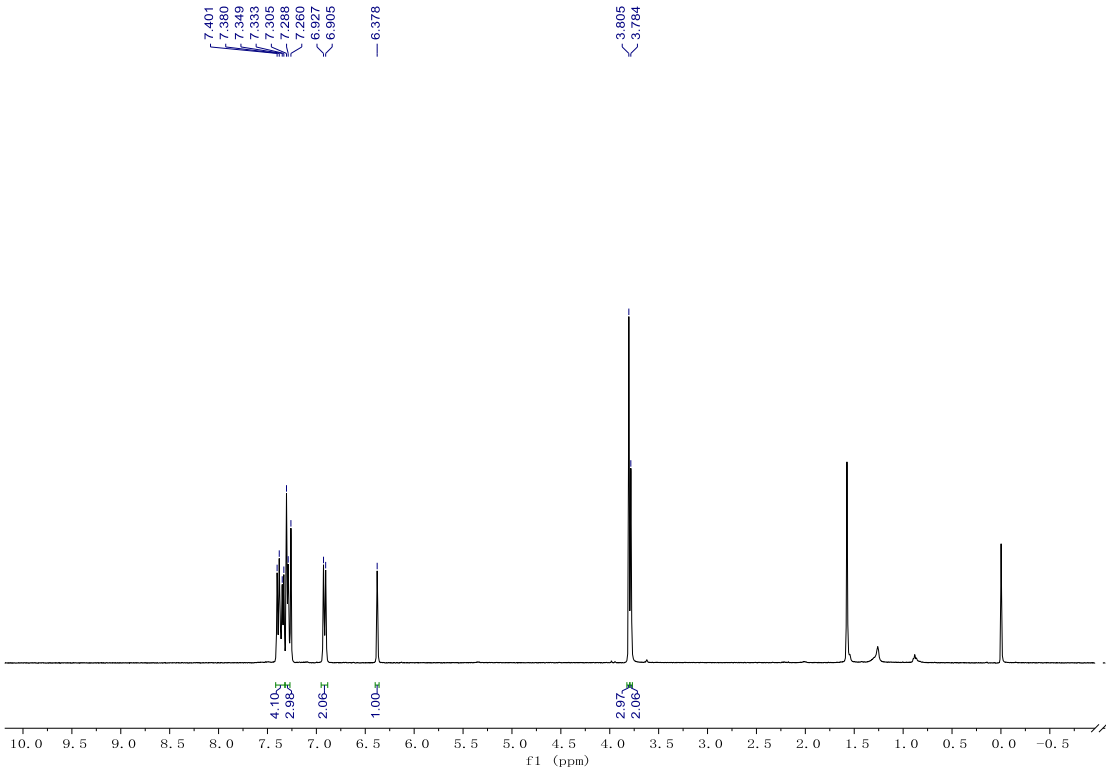

-218.125
O
N
Ph
O
O
F
0.01
0.06
1.00
70 60 50 40 30 20 10 0 -20 -40 -60 -80 -100 -120 -140 -160 -180 -200 -220 -240 -260
f1 (ppm)

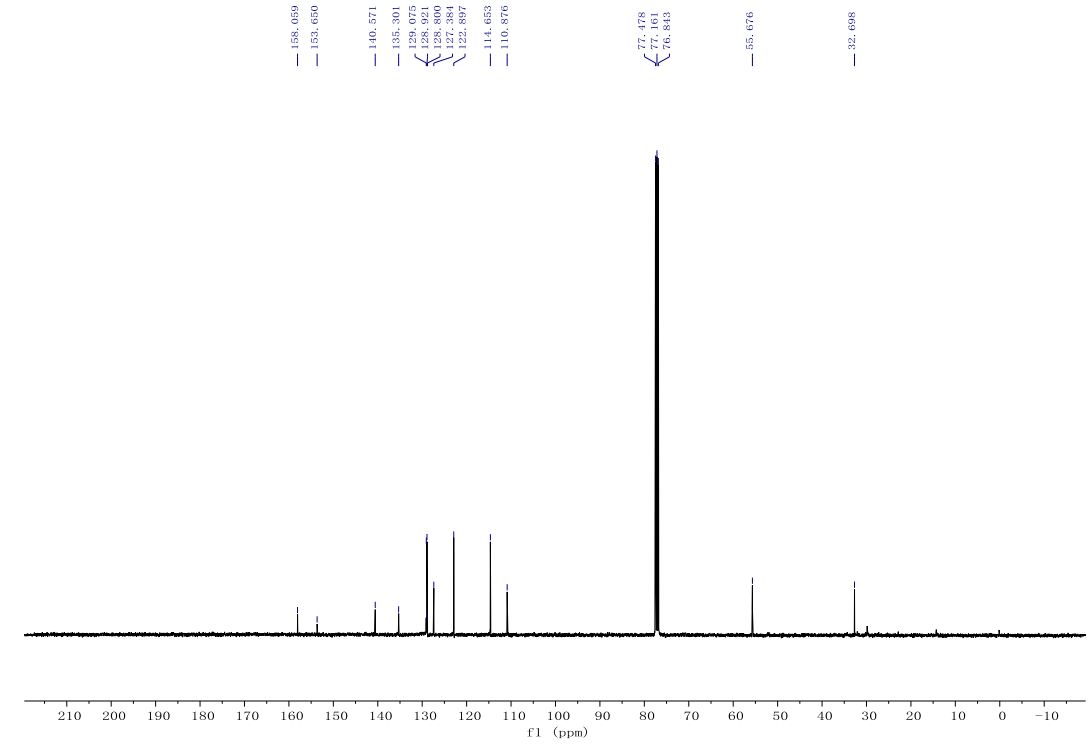
8


7.999
7.979
7.438
7.411
7.390
7.306
6.897
6.874
5.925
5.886
5.868
5.853
5.837
5.831
5.814
5.798
4.250
4.228
4.162
4.141
3.788
3.139
3.121
3.104
2.462
2.445
2.429
2.412
1.639
1.634
O
N
Ph
O
O
O
I
9
0.97
2.11
4.01
2.99
3.01
1.00
0.96
2.00
2.96
1.96
1.95
5.97
f1 (ppm)


156.588
154.548
145.399
143.413
141.582
132.421
131.540
130.132
128.861
128.821
128.303
128.255
128.022
125.213
120.597
114.431
93.708
81.046
77.478
77.160
76.843
61.871
57.795
55.667
33.292
27.294
O
N
Ph
O
O
O
I
9
f1 (ppm)


O
N
O
O
Ph


7.401
7.380
7.349
7.333
7.305
7.288
7.260
6.927
6.905
6.378
3.805
3.784
4.10
2.98
2.06
1.00
2.97
2.06
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 −0.5
f1 (ppm)


158.059
153.650
140.571
135.301
129.075
128.921
128.800
127.384
122.897
114.653
110.876
77.478
77.161
76.843
55.676
32.698
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 −10
f1 (ppm)