Supporting Information for

Controlled Chemoselective Defluorination and Non-Defluorination for [5+1] Aromatic Annulation via Meisenheimer-Type Nitrogen Anion and Radical Intermediates

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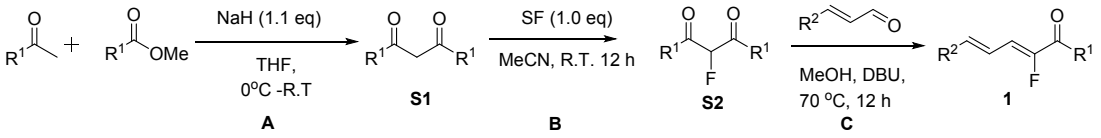
1. General information

All reactions were run using flame-dried glassware and magnetic stirring. Chemicals and solvents were purchased from commercial suppliers and used as received. Proton (^{1}H NMR) and carbon (^{13}C NMR) nuclear magnetic resonance spectra were recorded at 400 MHz and 100 MHz, respectively. Fluorine (^{19}F NMR) nuclear magnetic resonance spectra were recorded at 377 MHz. The chemical shifts are given in parts per million (ppm) on the delta (δ) scale. The solvent peak was used as a reference value, for ^{1}H NMR: $CDCl_3$ = 7.27 ppm, CD_3OD = 4.87, 3.31 ppm; for ^{13}C NMR: $CDCl_3$ = 77.23 ppm, CD_3OD = 49.15 ppm. Analytical TLC was performed on precoated silica gel GF254 plates. Column chromatography was carried out on silica gel (200-300 mesh). High resolution mass spectra (HRMS) were recorded on Bruker MicrOTOF-QII mass instrument (ESI). GC-MS were measured on the QP2010 SE instruments.

General procedures

General procedure A: Synthesis of 2-fluoro-1,3-diketone substrates 1.[1, 2]



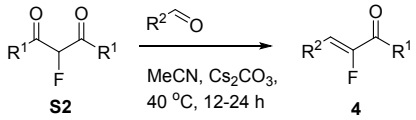
Step A: To a suspension of ketone (10 mmol) in THF (40 mL) was added NaH (0.8g, 20 mmol, 60%). After the reaction mixture was stirred at 0 °C for about 1 h, the ester was added dropwise at the same temperature. Then the mixture was stirred at room temperature until TLC indicated the total consumption of the ketone. The reaction mixture was poured into ice-water (100 mL), acidified with aqueous HCl (3 M) to pH 2~3 and extracted with EtOAc (100 mL x 3). The combined organic layer was dried over sodium sulfate and evaporated under reduced pressure. The crude product was purified by column chromatography to afford the pure 1,3-diketone (All the 1,3-diketones were obtained in the same process.)

Step B: The 1,3-diketone (5 mmol) was added to a solution of Selectfluor™ (1.77 g, 5 mmol) in CH_3CN (30 mL with 3mL water). After stirring at room temperature for 12 h, until TLC indicated the total consumption of the 1,3-diketone. The solvent was removed by rotary evaporation to provide raw products. The residue was then extracted with CH_2Cl_2, dried over Na_2SO_4. The solvent was removed under reduced pressure to yield corresponding 2-fluoro-1,3-diketones (All the products could be used for the next step without further purification).

Step C: The 2-fluoro-1,3-diketone (0.6 mmol) was added to a solution of cinnamyl aldehyde (0.5 mmol) and DBU (0.5 mmol) in CH_3CN (5 mL). After stirring at 70 °C for 12 h, until TLC indicated the total consumption of the 2-fluoro-1,3-diketone. The solvent was removed by rotary evaporation to provide raw products. The

residue was then purified by silica gel flash chromatography using ethyl acetate/petroleum ether as eluent to give the expected product 2-fluoro-2,4-dien-1-one **1** in moderate yields (All the products **1** were not stable at room temperature, needs to be saved at -20 °C and in dark).

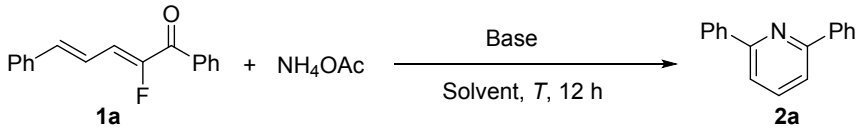
General procedure B: Synthesis of α-fluoro-α,β-unsaturated ketones 4.[1]



The 2-fluoro-1,3-diketone (0.6 mmol) was added to a solution of aldehyde (0.5 mmol) and Cs_2CO_3 (0.5 mmol) in CH_3CN (5 mL). After stirring at 40 °C for 12-24 h, until TLC indicated the total consumption of the 2-fluoro-1,3-diketone. The solvent was removed by rotary evaporation to provide raw products. The residue was then purified by silica gel flash chromatography using ethyl acetate/petroleum ether as eluent to give the expected product α-fluoro-α,β-unsaturated ketones **4** in moderate to excellent yields.

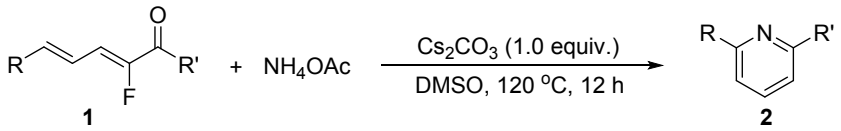
General procedure C: Base promote defluorination to synthesis of 2,6-disubstituted pyridine 2. (Scheme 2)

Table 1. Optimization of the reaction conditions[a]



Entry	base	**1a**:Base:NH_4OAc	solvent	*T* [°C]	Yield [%]
1	Na_2CO_3	1:1:5	DMSO	120	23
2	K_2CO_3	1:1:5	DMSO	120	60
3	Cs_2CO_3	1:1:5	DMSO	120	97 (93)[b]
4	NaOH	1:1:5	DMSO	120	77
5	Cs_2CO_3	1:1.2:5	DMSO	120	90
6	Cs_2CO_3	1:1:2	DMSO	120	66
7	Cs_2CO_3	1:1:10	DMSO	120	93
8	Cs_2CO_3	1:1:5	Toluene	120	52
9	Cs_2CO_3	1:1:5	DMF	120	77
10	Cs_2CO_3	1:1:5	MeCN	120	43
11	Cs_2CO_3	1:1:5	DMSO	100	67
12	Cs_2CO_3	1:1:5	DMSO	150	89
13[c]	Cs_2CO_3	1:1:5	DMSO	120	95

[a] **1a** (0.1 mmol), NH_4OAc, Cs_2CO_3, 12 h, solvent (1.0 mL). yields given by GC-MS using n-dodecane as an internal standard. [b] Yield of isolated products were given in the parentheses. [c] extended reaction time to 24 h.

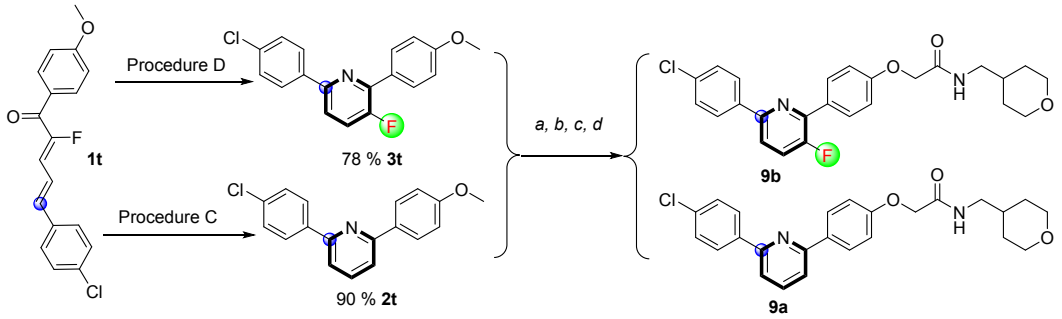


To a solution of 2-fluoro-2,4-dien-1-one **1** (0.1 mmol) and NH_4OAc (0.5 mmol) in DMSO (1 mL) was added Cs_2CO_3 (0.1 mmol) and stirred for 12 h at 120 °C. Upon consumption of 2-fluoro-2,4-dien-1-one **1** (monitored by TLC), the reaction mixture was extracted with EtOAc (5 mL x 3) and purified by silica gel flash chromatography to afford the 2,6-disubstituted pyridine **2a-r**. (All known compounds were compared with the literature).[12]

General procedure D: Cu-catalyst aerobic dehydrogenative to synthesis of 3-fluoro-2,6-disubstituted pyridine 3. (Scheme 3)

CuBr (10 mol %, 0.01 mmol), NH_4OAc (5.0 equiv, 0.5 mmol) and **1** (0.1 mmol) were added in a 10 mL Schlenk flask, after that the reaction tube have been degassed and placed with oxygen (1 atm) three times, then TFA (10 mol %, 0.01 mmol) and DMSO/toluene (1 mL, v/v = 5 %) were added under oxygen atmosphere. After stirring for 12 h under sealed tube conditions at 140 °C, the reaction mixture was concentrated and purified by silica gel flash chromatography to provide the expected 3-fluoro-2,6-disubstituted pyridine **3a-s**.

Procedure E: total synthesis of Blood lipid regulator 9a and F-modified analogue 9b.[3]



a) BBr_3, DCM, 0 °C-RT; *b*) K_2CO_3, $ClCCH_2CO_2Et$, DMF, RT; *c*) LiOH, MeOH, RT; *d*) (tetrahydro-2*H*-pyran-4-yl)methanamine, HOBT, EDCI, 4-ethylmorpholine, DMF, RT;

Procedure C: To a solution of (2Z,4E)-5-(4-chlorophenyl)-2-fluoro-1-(4-methoxyphenyl)penta-2,4-dien-1-one **1t** (5 mmol) and NH_4OAc (25 mmol) in DMSO (50 mL) was added Cs_2CO_3 (5 mmol) and stirred for 12 h at 120 °C. Upon consumption of (2Z,4E)-5-(4-chlorophenyl)-2-fluoro-1-(4-methoxyphenyl)penta-2,4-dien-1-one **1t** (monitored by TLC), the reaction mixture was extracted with EtOAc (50 mL x 3) and purified by silica gel flash chromatography to afford the product **2t**.

Procedure D: CuBr (10 mol %, 0.5 mmol), NH_4OAc (5.0 equiv, 25 mmol) and **1t** (5

mmol) were added in a 500 mL Schlenk flask, after that the reaction tube have been degassed and placed with oxygen (1 atm) three times, then TFA (10 mol %, 0.5 mmol) and DMSO/toluene (50 mL, v/v = 5 %) were added under oxygen atmosphere. After stirring for 12 h under sealed tube conditions at 140 °C, the reaction mixture was concentrated and purified by silica gel flash chromatography to provide the expected product **3t**.

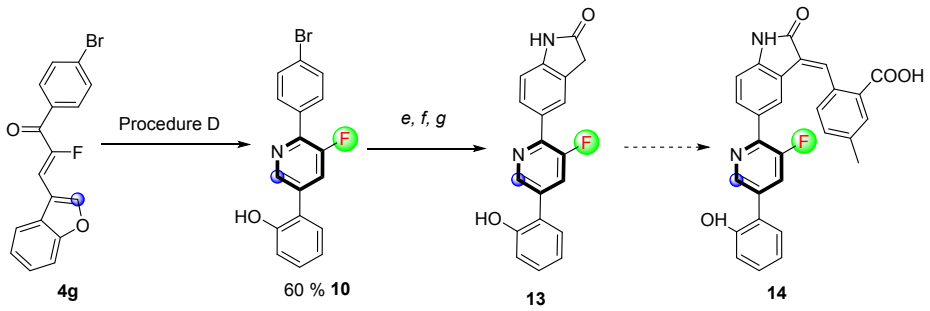
Step a: **2t**/**3t** dissolved in dichloromethane and the solution was cooled to 0 °C by ice-water bath. By use of a syringe a dichloromethane solution (1M) of 5 equivalents of BBr3 per equivalent of methoxyl compound was added drop-vise under nitrogen. The ice bath was removed and reaction mixture stirred at RT for additional 2 hours under nitrogen. Reaction was quenched by addition of water and layers were separated. The water layer was washed two more times by use of dichloromethane. The water layer was neutralized to pH 7 by use of sodium bicarbonate and extracted by ethyl acetate. Collected extracts were dried over anhydrous $MgSO_4$ and solvent was removed. The crude products could be used for the next step without further purification.

Step b: To a solution of **6a**/**6b** (2 mmol) in DMF (10 ml), K_2CO_3 (0.6 g, 2.6 mmol) was added followed by the addition of ethyl 2-chloroacetate (0.32 g, 2.6 mmol) at room temperature and the reaction mixture was stirred at room temperature for 18 hours. The reaction mixture was poured into ice cold water. The water layer was extracted by ethyl acetate. Collected extracts were dried over anhydrous $MgSO_4$ and solvent was removed. The residue was then purified by silica gel flash chromatography using ethyl acetate/petroleum ether as eluent to give the expected product **7a**/**7b**.

Step c: To a solution of the product of step **b** (1.5 mmol) in a mixture of methanol (10 ml), THF (30 ml) and H_2O (10 ml), lithium hydroxide (0.13 g, 3.0 mmol) was added and the reaction mixture was stirred at ambient temperature for 4 hours. The solvents were evaporated under reduced pressure. The residue was dissolved in water and acidified with 1 N HCl. The water layer was extracted by ethyl acetate. Collected extracts were dried over anhydrous $MgSO_4$ and solvent was removed. The crude products **8a**/**8b** could be used for the next step without further purification.

Step d: To a solution of product of step **c** (1.00 mmol) in DMF (3 mL), (tetrahydro-2H-pyran-4-yl)methanamine (126 mg, 1.10 mmoles), HOBT (202 mg, 1.50 mmoles), EDC·HCl (230 mg, 1.20 mmoles) and N-ethyl morpholine (345 mg, 3.00 mmoles) were added and reaction mixture was srirred at room temperature for 20 hours under nitrogen atmosphere. The reaction mixture was poured into ice cold water. The water layer was extracted by ethyl acetate. Collected extracts were dried over anhydrous $MgSO_4$ and solvent was removed. The residue was then purified by silica gel flash chromatography using ethyl acetate/petroleum ether as eluent to give the expected product **9a**/**9b**.

Procedure F: total synthesis of F-modified AMPK receptor inhibitor 14.[4,5,6]



e) CuI, NH_4OH, K_2CO_3, DMSO, 85 °C; *f*) acetic anhydride, DCM, RT; *g*) $Pd(OAc)_2$, AgOAc, ICH_2CO_2Et, TFA, 120 °C.

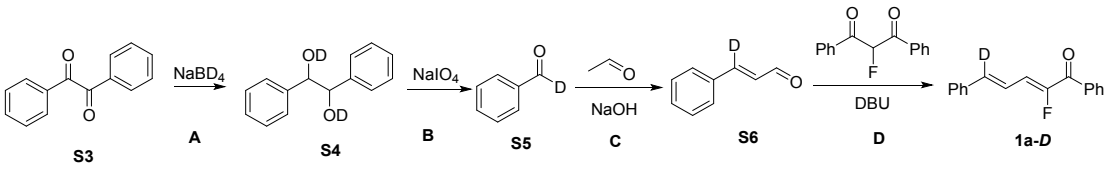
Procedure D: CuBr (10 mol %, 0.3 mmol), NH_4OAc (5.0 equiv, 15 mmol) and **4g** (3 mmol) were added in a 500 mL Schlenk flask, after that the reaction tube have been degassed and placed with oxygen (1 atm) three times, then TFA (10 mol %, 0.3 mmol) and DMSO/toluene (30 mL, v/v = 5 %) were added under oxygen atmosphere. After stirring for 12 h under sealed tube conditions at 140 °C, the reaction mixture was concentrated and purified by silica gel flash chromatography to provide the expected product **10**.

Step e: A mixture of **10** (1 mmol), aqueous ammonia (28%, 0.3 mL, 5.0 mmol), CuI (38 mg, 0.2 mmol) and K_2CO_3 (346 mg, 2.5 mmol) in 2 mL of DMSO was heated at 85 °C for 23 h. Then the cooled mixture was partitioned between water and ethyl acetate. The organic layer was separated, and the aqueous layer was extracted with ethyl acetate (3 x 10 mL). The combined organic layers were washed with brine, dried over Na_2SO_4, and concentrated under vacuum. The residue was purified by chromatography on silica gel with petroleum ether and ethyl acetate as eluent to provide the primary arylamine **11**.

Step f: Arylamine **11** (0.5 mmol; 1 equiv) was added to a round-bottom flask. The flask was purged with N_2 and CH_2Cl_2 (3 mL) was added. Ac_2O (1.2 mmol, 1.2 equiv) was added and the reaction was stirred at r.t. and monitored by TLC. Upon completion, the reaction mixture was washed with a saturated sodium carbonate solution, the organic layer was dried ($MgSO_4$), and the solvent was removed under reduced pressure. The crude product could be used for the next step without further purification.

Step g: A seal-tube (10 mL) initially fitted with a septum containing **12** (0.1 mmol), $Pd(OAc)_2$ (2.6 mg, 0.01 mmol, 10 mol%), and AgOAc (16.7 mg, 0.1 mmol) was evacuated and purged with N_2 three times. TFA (1.0 mL), and ethyl 2-iodoacetate (32 mg, 0.15 mmol) were added to the system and the reaction mixture was stirred at 120 °C for 24 h. The mixture was cooled to RT and filtered through a short Celite pad and washed with CH_2Cl_2 several times. The filtrate was concentrated under vacuum and purified on a silica gel column using petroleum ether/EtOAc as eluent to give the corresponding pure oxindole product **13**.

Procedure G: Synthesis of (2Z,4E)-2-fluoro-1,5-diphenylpenta-2,4-dien-1-one-5-d[7,8]

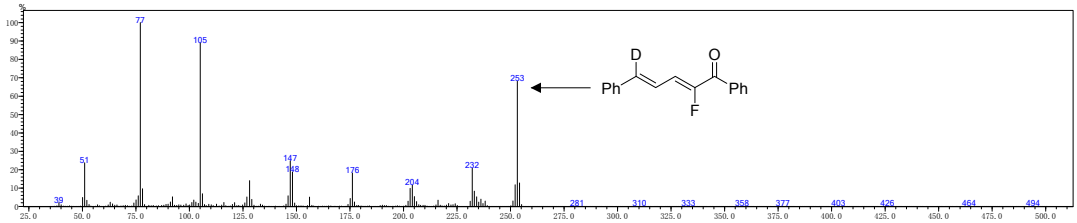


Step A: Following the similar procedure in literature with minor modification:[7] firstly the Benzil (**S3**, 1.05g, 5 mmol) was dissolved in a mixture solvent, which containing dried THF (10 mL) and D_2O (0.5 mL). At 0 °C, $NaBD_4$ (250 mg, 6.2 mmol, >98% D isotopic purity) was added in portion-wise over one hour. The misture was stirred until No **S3** left, monitored via TLC. After general workup, the reaction mixture was extracted with EtOAc, dried over Na_2SO_4, filtered and concentrated to give the product **S4** as a white solid in nearly quantity yield, which was pure enough for the next step.

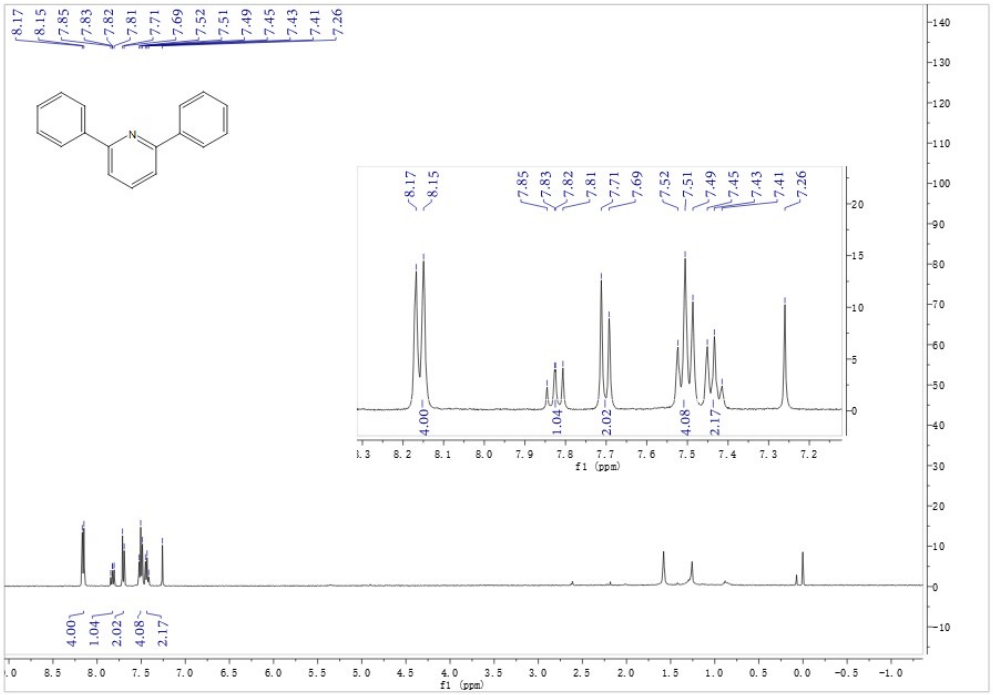
Step B: Following the similar procedure in literature with minor modification:[8]The diol **S4** was oxidized with $NaIO_4$ in ethanol overnight at room temperature. After the reaction was complete (monitored by TLC), the mixture was treated with general workup. Deuteriobenzaldehyde **S5** was purified over silica gel.

Step C: To a solution of sodium hydroxide (0.12 g, 3 mmol) in a mixture of ethanol (8 mL) and water (24 mL) was added aldehyde (3 mmol). The mixture was stirred at 0 °C for 10 minute. Then 40 percent acetaldehyde (0.66 g, 6 mmol) was added dropwise to the mixture over 3 h at the same temperature. Stirring was continued over night at 0 °C. The resuting solution was extracted with DCM, the combined organic layer was washed with water and brine three times, and fried with anhydrous Na_2SO_4. The solution was concentrated and purified by flash chromatography on silica gel to give the pure **S6.**

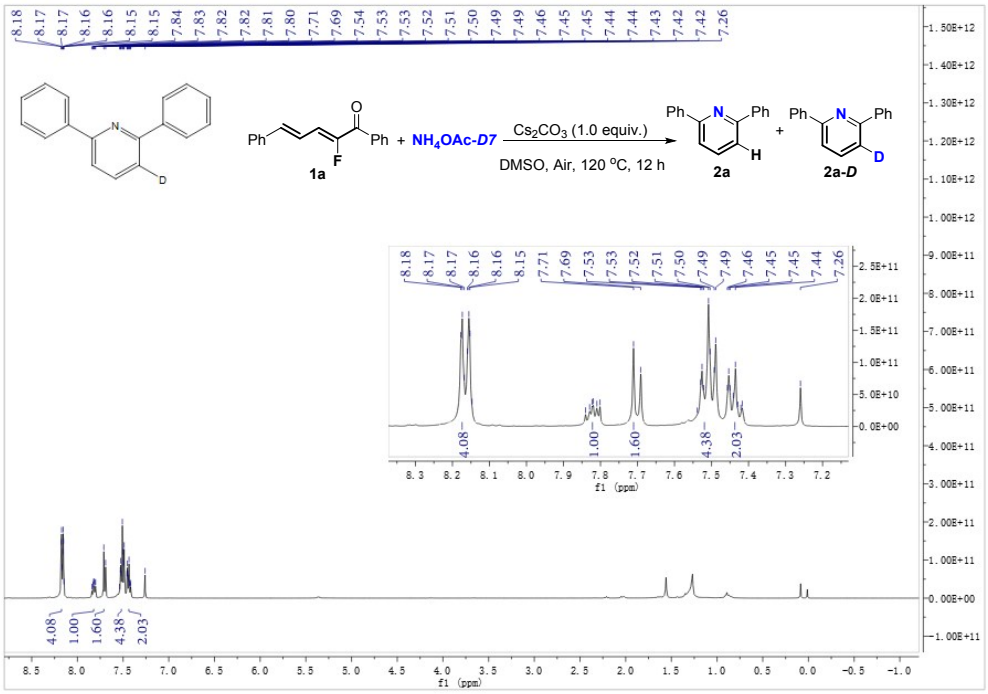
Step D: Following the similar procedure of **General procedure A, Step C.**



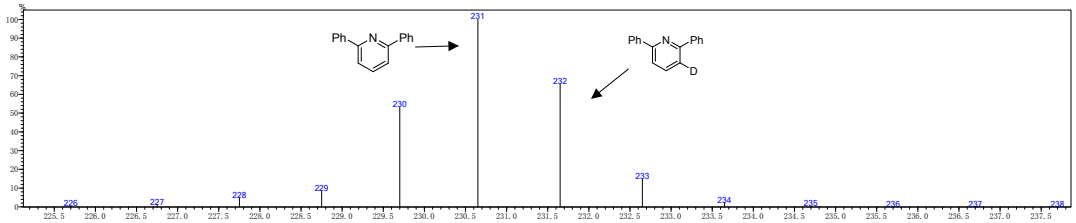
Deuterium labeled reaction result



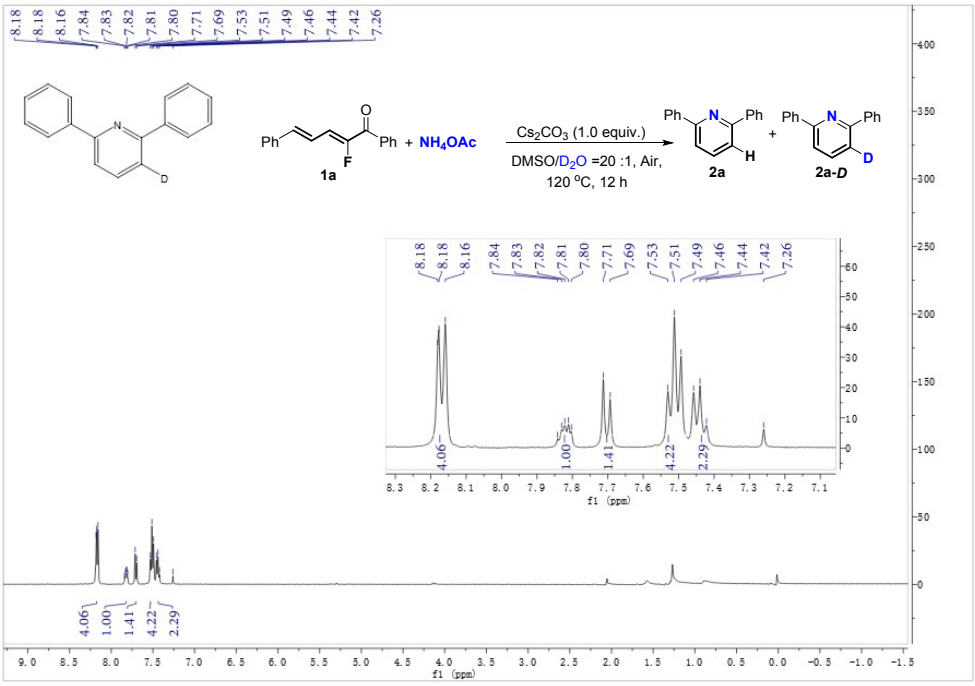
^{1}H-NMR of 2a



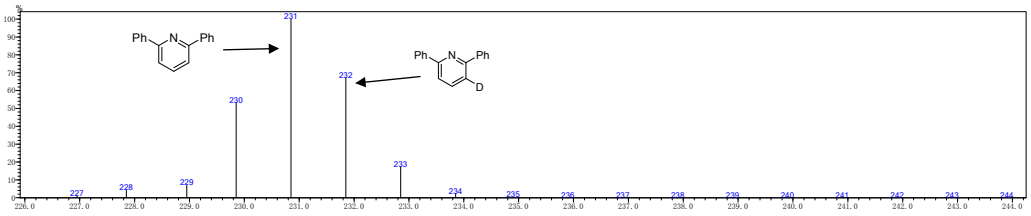
^{1}H-NMR of 2a/2a-D by using NH_4OAc-D7 instead of NH_4OAc



GC-MS Spectrogram of 2a/2a-D by using NH_4OAc-D7 instead of NH_4OAc



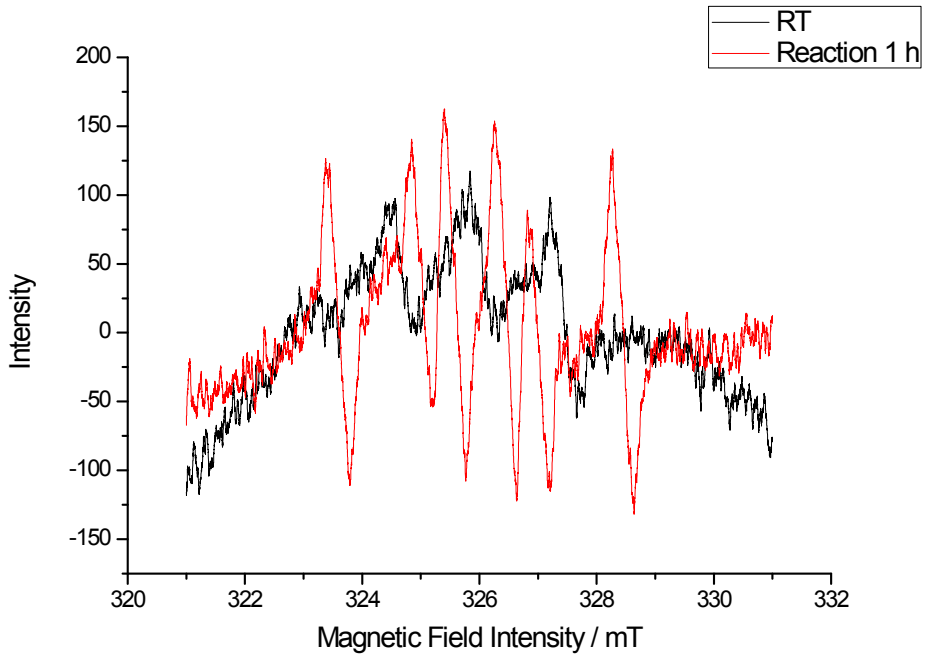
^{1}H-NMR of 2a/2a-D by using DMSO/D_2O = 20:1 as solvent



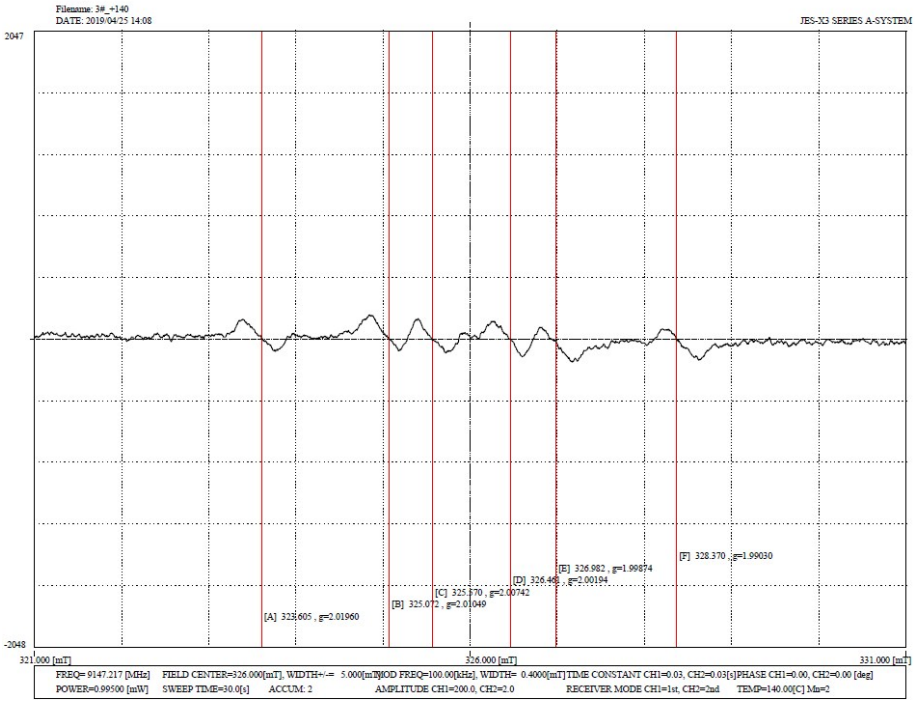
GC-MS Spectrogram of 2a/2a-D by using DMSO/D_2O = 20:1 as solvent

Procedure for Electron Paramagnetic Resonance (EPR)

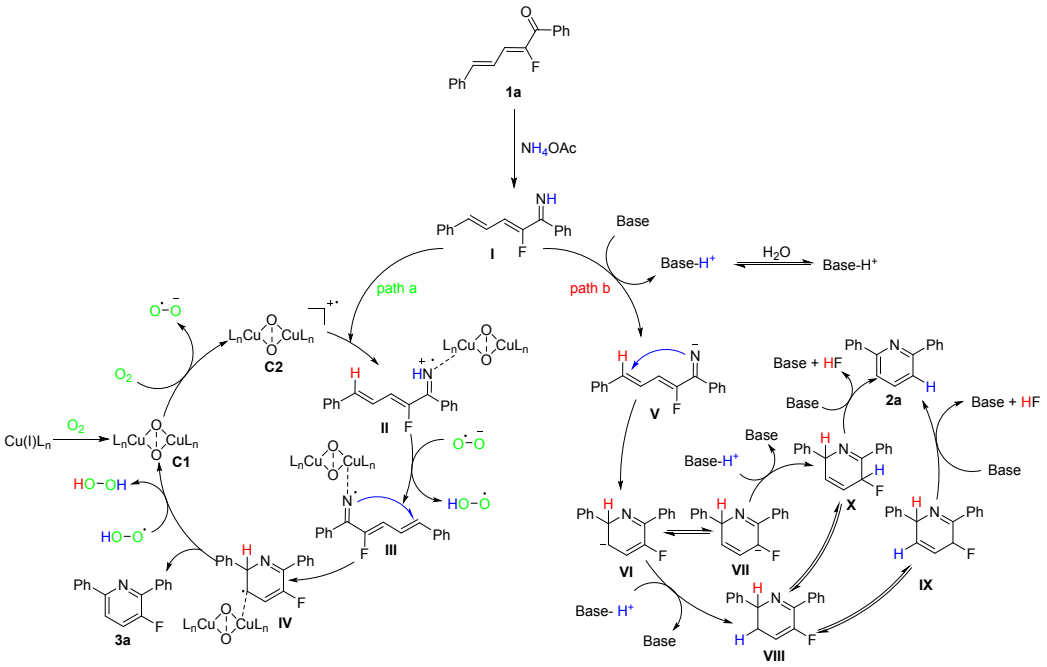
To a test tube, 0.1 mmol **1a**, 0.01 mmol CuBr and TFA, 0.5 mmol NH_4OAc, 1 mL DMSO/toluene (v/v = 5 %) and 10 μL DMPO were added. The result mixture was stirred at room temperature under oxygen atmosphere for 10 min, extract the reaction liquid for EPR testing. Then the reaction was stirred at 140 °C for 1 h, extract the reaction liquid for EPR testing.



The DMPO spin-trapping ESR spectra for $\cdot O_2^-$ in Cu-catalytic system.



The details of ESR spectra.



The proposed mechanism for the direct transformation.

Path a: On the basis of mechanistic studies results and literature survey, a plausible mechanism for the aerobic oxidative non-defluorinative [5+1] aromatic annulation is illustrated. The copper(I) salt was initially oxidized by dioxygen to form the more-active (μ-η^2:η^2-peroxo)dicopper(II) complex **C1**.[9] Then, complex **C1** is oxidized by molecular oxygen, furnishing radical cation **C2** and superoxide radical anion ($\cdot O_2^-$), **C2** then oxidizes **I** via single-electron transfer (SET), producing amine radical cation **II**, followed by subsequent deprotonation and intramolecular cycloaddition forms intermediate **IV**,[10, 11] which underwent hydrogen atom abstraction to give the corresponding 3-fluoropyridine product **3a**, regenerating **C1** for the catalytic cycle.

Path b: Imine anion **V** is deprotonated by base, which then occurred intramolecular cycloaddition reactions to produce **VI**. Intermediates **VI** could be transformed into **VII** or **VIII**, **VII** could be protonated by base-H^+ to produce intermediates **X**. **VIII** could also be produced **X** or **IX** by double bond migration reaction. At last, the product **2a** is generated from **IX** or **X** though defluorination reaction by base-promoted procedure. It should be mentioned that the base-H^+ species could be occurred hydrogen deuterium exchange process with water. As a result of the existence of isotope effect, which may lead to the low rate of deuterium labeled **2a** produced in the deuterium labeled reactions.

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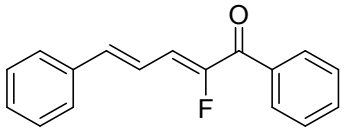
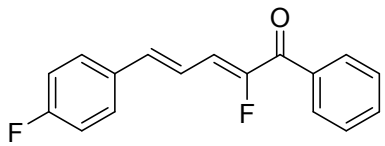
2. Experimental characterization data

(2Z,4E)-2-fluoro-1,5-diphenylpenta-2,4-dien-1-one (1a):



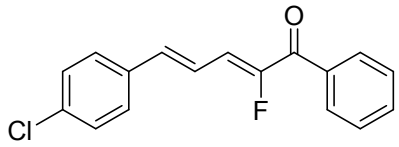
Yellow oil. 81.9 mg, 65 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (s, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.53 – 7.46 (m, 4H), 7.41 – 7.30 (m, 3H), 7.21 (dd, *J* = 15.7, 11.3 Hz, 1H), 6.90 (d, *J* = 15.8 Hz, 1H), 6.75 (dd, *J* = 31.7, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -123.03 (d, *J* = 31.6 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.33 , 154.03 (d, *J* = 269.6 Hz), 140.42 , 136.25 (d, *J* = 39.8 Hz), 132.79 , 129.40 , 129.25 , 129.21 , 128.92 , 128.50 , 127.41 , 122.24 (d, *J* = 12.8 Hz), 119.25 . **HRMS** (ESI) calcd. for $C_{17}H_{14}FO$ [M+H]: 253.1029, found: 253.1031.

(2Z,4E)-2-fluoro-5-(4-fluorophenyl)-1-phenylpenta-2,4-dien-1-one (1b):



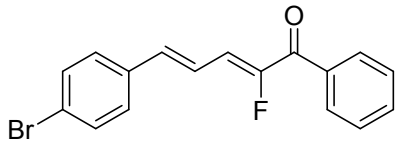
Yellow oil. 98.5 mg, 73 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 7.6 Hz, 2H), 7.60 (t, *J* = 7.4 Hz, 1H), 7.49 (t, *J* = 7.2 Hz, 4H), 7.17 – 7.01 (m, 3H), 6.87 (d, *J* = 15.8 Hz, 1H), 6.74 (dd, *J* = 31.6, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -110.93, -122.97 (d, *J* = 31.6 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.10 (d, *J* = 27.6 Hz), 163.30 (d, *J* = 250.6 Hz), 154.06 (d, *J* = 269.7 Hz), 138.95, 136.38, 132.82, 132.32, 129.22 (d, *J* = 3.7 Hz), 129.10 (d, *J* = 8.3 Hz), 128.49, 121.95, 119.02, 116.02 (d, *J* = 21.9 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{13}F_2O$ [M+H]: 271.0934, found: 271.0935.

(2Z,4E)-2-fluoro-5-(4-chlorophenyl)-1-phenylpenta-2,4-dien-1-one (1c):



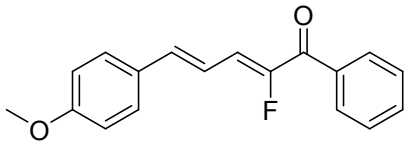
Yellow oil. 100.1 mg, 70 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 7.6 Hz, 2H), 7.63 – 7.56 (m, 1H), 7.49 (t, *J* = 7.5 Hz, 2H), 7.43 (d, *J* = 8.1 Hz, 2H), 7.33 (d, *J* = 8.3 Hz, 2H), 7.17 (dd, *J* = 15.6, 11.4 Hz, 1H), 6.85 (d, *J* = 15.7 Hz, 1H), 6.74 (dd, *J* = 31.5, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -122.17. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.07 (d, *J* = 27.2 Hz), 154.26 (d, *J* = 270.8 Hz), 138.78, 136.31, 135.11, 134.56, 132.89, 129.25 (d, *J* = 3.9 Hz), 129.15, 128.51, 127.20, 121.62 (d, *J* = 9.9 Hz), 119.81 (d, *J* = 3.0 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{13}ClFO$ [M+H]: 287.0639, found: 287.0637.

(2Z,4E)-2-fluoro-5-(4-bromophenyl)-1-phenylpenta-2,4-dien-1-one (1d):



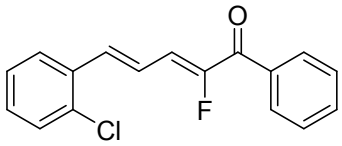
Yellow oil. 114.2 mg, 69 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 7.7 Hz, 2H), 7.61 (t, *J* = 7.5 Hz, 1H), 7.49 (dd, *J* = 8.2, 6.2 Hz, 4H), 7.37 (d, *J* = 8.2 Hz, 2H), 7.19 (dd, *J* = 15.8, 11.3 Hz, 1H), 6.84 (d, *J* = 15.7 Hz, 1H), 6.74 (dd, *J* = 31.5, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -122.04 (d, *J* = 31.4 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.18, 154.30 (d, *J* = 272.3 Hz), 138.79, 136.30, 134.99, 132.88, 132.10, 129.26, 128.73, 128.51, 123.40, 121.48 (d, *J* = 9.5 Hz), 119.90. **HRMS** (ESI) calcd. for $C_{17}H_{13}BrFO$ [M+H]: 331.0314, found: 331.0316.

(2Z,4E)-2-fluoro-5-(4-methoxyphenyl)-1-phenylpenta-2,4-dien-1-one (1e):



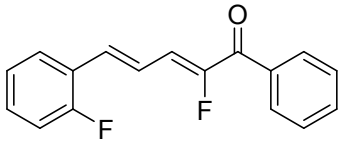
Yellow oil. 79.0 mg, 56 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.6 Hz, 2H), 7.59 (t, *J* = 7.4 Hz, 1H), 7.53 – 7.39 (m, 4H), 7.08 (dd, *J* = 15.6, 11.3 Hz, 1H), 6.96 – 6.83 (m, 3H), 6.75 (dd, *J* = 31.7, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -124.78 (d, *J* = 31.8 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.03, 160.73, 153.58 (d, *J* = 267.1 Hz), 140.21, 136.67, 132.58, 129.17 (d, *J* = 4.0 Hz), 128.94, 128.43, 122.96 (d, *J* = 8.6 Hz), 117.19 (d, *J* = 2.8 Hz), 114.39, 55.40. **HRMS** (ESI) calcd. for $C_{18}H_{16}FO_2$ [M+H]: 283.1134, found: 283.1135.

(2Z,4E)-2-fluoro-5-(2-chlorophenyl)-1-phenylpenta-2,4-dien-1-one (1f):



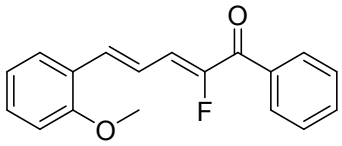
Yellow oil. 87.2 mg, 61 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 – 7.79 (m, 2H), 7.72 (d, *J* = 5.9 Hz, 1H), 7.61 (d, *J* = 7.2 Hz, 1H), 7.52 (d, *J* = 6.4 Hz, 2H), 7.43 – 7.36 (m, 1H), 7.26 (dd, *J* = 30.1, 16.5 Hz, 4H), 6.80 (dd, *J* = 32.7, 11.9 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -121.72 (d, *J* = 31.4 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.16 (d, *J* = 29.1 Hz), 174.39, 154.39 (d, *J* = 272.1 Hz), 136.30, 135.70 (d, *J* = 3.8 Hz), 134.11 (d, *J* = 10.0 Hz), 132.92, 130.13, 129.26 (d, *J* = 4.0 Hz), 128.56, 127.07 (d, *J* = 14.3 Hz), 121.88, 121.74, 121.51, 121.48. **HRMS** (ESI) calcd. for $C_{17}H_{13}ClFO$ [M+H]: 287.0639, found: 287.0641.

(2Z,4E)-2-fluoro-5-(2-fluorophenyl)-1-phenylpenta-2,4-dien-1-one (1g):



Yellow oil. 91.5 mg, 68 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.80 (d, *J* = 37.4 Hz, 2H), 7.61 (s, 2H), 7.50 (s, 3H), 7.30 (d, *J* = 10.8 Hz, 2H), 7.14 – 7.04 (m, 2H), 6.86 – 6.67 (m, 1H).**^{19}F NMR** (377 MHz, $CDCl_3$) δ -110.34 – -120.36 (m), -121.99 (d, *J* = 31.5 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 191.30, 160.82 (d, *J* = 253.3 Hz), 154.28 (d, *J* = 270.7 Hz), 136.34, 134.55, 132.58 (d, *J* = 57.4 Hz), 130.66 (d, *J* = 8.6 Hz), 129.91 (d, *J* = 9.4 Hz), 129.24 (d, *J* = 3.9 Hz), 128.81, 128.52, 127.75, 124.47, 121.44, 116.07 (d, *J* = 22.0 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{13}F_2O$ [M+H]: 271.0934, found: 271.0933.

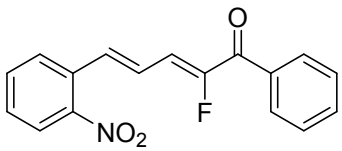
(2Z,4E)-2-fluoro-5-(2-methoxyphenyl)-1-phenylpenta-2,4-dien-1-one (1h):



Yellow oil. 70.5 mg, 50 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 7.6 Hz, 2H), 7.64 – 7.56 (m, 2H), 7.49 (t, *J* = 7.7 Hz, 2H), 7.36 – 7.29 (m, 1H), 7.29 – 7.25 (m, 2H), 6.98 (t, *J* = 7.4 Hz, 1H), 6.90 (d, *J* = 8.3 Hz, 1H), 6.85 – 6.71 (m, 1H), 3.88 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -124.22 (d, *J* = 31.8 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 182.00 (d, *J* = 25.8 Hz), 152.28, 148.36 (d, *J* = 267.5 Hz), 131.38, 130.18 (d, *J* = 4.4 Hz), 127.26, 125.27, 123.86 (d, *J* = 3.8 Hz), 123.12, 122.17, 119.79, 118.23 (d, *J* = 10.1 Hz), 115.57, 114.40 (d, *J* = 3.3 Hz), 105.81, 50.23. **HRMS** (ESI) calcd. for $C_{18}H_{16}FO_2$ [M+H]: 283.1134,

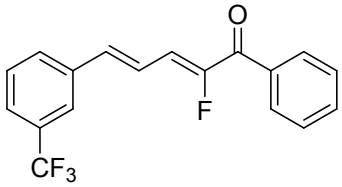
found: 283.1136.

(2Z,4E)-2-fluoro-5-(2-nitrophenyl)-1-phenylpenta-2,4-dien-1-one (1i):



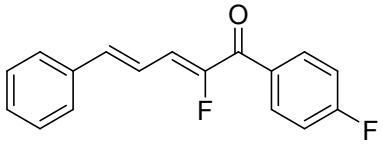
Yellow solid. m.p. 101-103 °C, 105.4 mg, 71 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.2 Hz, 1H), 7.84 (d, *J* = 7.6 Hz, 2H), 7.77 (d, *J* = 7.8 Hz, 1H), 7.63 (q, *J* = 7.8, 7.1 Hz, 2H), 7.50 (t, *J* = 8.5 Hz, 3H), 7.40 (d, *J* = 15.7 Hz, 1H), 7.23 – 7.12 (m, 1H), 6.77 (dd, *J* = 31.3, 11.1 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -119.99 (d, *J* = 31.2 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.18, 154.81 (d, *J* = 272.6 Hz), 148.05, 136.01, 134.28, 133.41, 133.12, 131.58, 129.46, 129.26 (d, *J* = 3.8 Hz), 128.62, 128.49, 124.98, 123.93, 120.93. **HRMS** (ESI) calcd. for $C_{17}H_{13}FNO_3$ [M+H]: 298.0879, found: 298.0881.

(2Z,4E)-2-fluoro-5-(3-(trifluoromethyl)-1-phenylpenta-2,4-dien-1-one (1j):



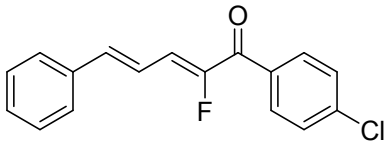
Yellow solid. m.p. 79-81 °C, 126.4 mg, 79 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 – 7.81 (m, 2H), 7.73 (s, 1H), 7.69 (d, *J* = 7.7 Hz, 1H), 7.66 – 7.55 (m, 2H), 7.50 (t, *J* = 7.6 Hz, 3H), 7.26 (ddd, *J* = 15.8, 11.3, 2.3 Hz, 1H), 6.93 (d, *J* = 15.9 Hz, 1H), 6.77 (dd, *J* = 31.4, 11.3 Hz, 1H).**^{19}F NMR** (377 MHz, $CDCl_3$) δ -62.90 , -121.01 (d, *J* = 31.4 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.15, 154.65 (d, *J* = 272.1 Hz), 138.22, 136.84, 136.15, 133.01, 130.22, 129.41, 129.30, 129.27, 128.54, 125.66, 123.96, 120.96. **HRMS** (ESI) calcd. for $C_{18}H_{13}F_4O$ [M+H]: 321.0903, found: 321.0904.

(2Z,4E)-2-fluoro-1-(4-fluorophenyl)-5-phenylpenta-2,4-dien-1-one (1k):



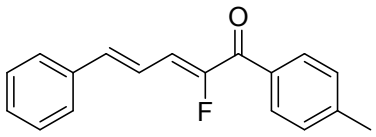
Yellow oil. 95.9 mg, 71 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.92 (dd, *J* = 8.3, 5.4 Hz, 2H), 7.54 – 7.49 (m, 2H), 7.36 (dd, *J* = 11.2, 7.0 Hz, 3H), 7.22 – 7.13 (m, 3H), 6.93 (d, *J* = 15.7 Hz, 1H), 6.79 (dd, *J* = 31.7, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -100.31 – -108.68 (m), -122.74 (d, *J* = 31.7 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 185.23, 165.58 (d, *J* = 254.8 Hz), 154.10 (d, *J* = 270.6 Hz), 140.56, 136.03, 132.53, 132.39 – 131.37 (m), 129.44, 128.93, 127.41, 121.65, 119.13, 115.71 (d, *J* = 22.0 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{13}F_2O$ [M+H]: 271.0934, found: 271.0936.

(2Z,4E)-2-fluoro-1-(4-chlorophenyl)-5-phenylpenta-2,4-dien-1-one (1l):



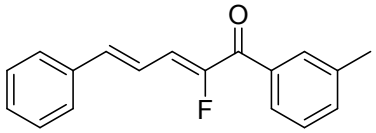
Yellow oil. 94.4 mg, 66 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.82 (d, *J* = 8.1 Hz, 2H), 7.49 (dd, *J* = 20.4, 7.7 Hz, 3H), 7.37 (d, *J* = 7.6 Hz, 3H), 7.29 – 7.12 (m, 2H), 6.94 (d, *J* = 15.7 Hz, 1H), 6.78 (dd, *J* = 31.7, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -123.17 (d, *J* = 31.6 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 185.78, 153.97 (d, *J* = 270.4 Hz), 140.78, 139.33, 135.98, 134.59, 130.72 (d, *J* = 4.7 Hz), 129.50, 128.94, 128.85, 127.44, 121.99, 119.11. **HRMS** (ESI) calcd. for $C_{17}H_{13}ClFO$ [M+H]: 287.0639, found: 287.0641.

(2Z,4E)-2-fluoro-1-(p-tolyl)penta-5-phenylpenta-2,4-dien-1-one (1m):



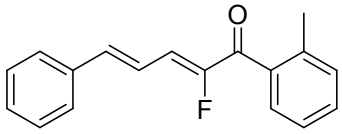
Yellow oil. 71.8 mg, 54 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.80 – 7.74 (m, 2H), 7.54 – 7.47 (m, 2H), 7.41 – 7.31 (m, 3H), 7.28 (d, *J* = 8.0 Hz, 2H), 7.24 – 7.17 (m, 1H), 6.89 (d, *J* = 15.8 Hz, 1H), 6.75 (dd, *J* = 31.8, 11.3 Hz, 1H), 2.43 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -122.50 (d, *J* = 31.7 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 186.63, 154.29 (d, *J* = 273.2 Hz), 143.74, 140.04, 136.13, 133.72, 129.45 (d, *J* = 4.2 Hz), 129.31, 129.19, 128.90, 128.43, 127.36, 126.44, 121.55 (d, *J* = 12.2 Hz), 119.35, 21.73. **HRMS** (ESI) calcd. for $C_{18}H_{16}FO$ [M+H]: 267.1185, found: 267.1187.

(2Z,4E)-2-fluoro-5-phenyl-1-(m-tolyl)penta-2,4-dien-1-one (1n):



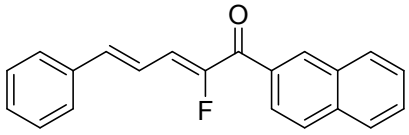
Yellow oil. 66.8 mg, 50 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.64 (s, 2H), 7.51 (d, *J* = 7.4 Hz, 2H), 7.37 (t, *J* = 6.5 Hz, 5H), 7.23 (d, *J* = 11.4 Hz, 1H), 6.91 (d, *J* = 15.8 Hz, 1H), 6.75 (dd, *J* = 31.6, 11.3 Hz, 1H), 2.43 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -122.85 (d, *J* = 31.6 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.41, 171.44, 154.07 (d, *J* = 269.5 Hz), 153.14, 140.28, 138.38 (d, *J* = 8.0 Hz), 134.61, 133.58, 130.60 (d, *J* = 24.2 Hz), 128.91, 128.31, 127.38, 126.38, 122.25 (d, *J* = 10.3 Hz), 119.32, 21.30. **HRMS** (ESI) calcd. for $C_{18}H_{16}FO$ [M+H]: 267.1185, found: 267.1186.

(2Z,4E)-2-fluoro-5-phenyl-1-(o-tolyl)penta-2,4-dien-1-one (1o):



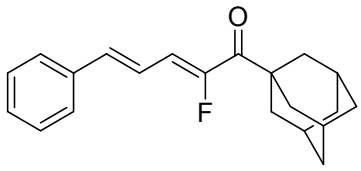
Yellow oil. 65.2 mg, 49 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 7.1 Hz, 2H), 7.39 – 7.33 (m, 4H), 7.28 (d, *J* = 8.8 Hz, 2H), 7.23 – 7.17 (m, 1H), 7.08 (s, 1H), 6.85 (d, *J* = 15.8 Hz, 1H), 6.50 (dd, *J* = 30.8, 11.3 Hz, 1H), 2.38 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.39. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 190.21, 153.90 (d, *J* = 267.5 Hz), 140.94, 136.85, 135.91, 131.11, 130.72, 129.54, 128.93, 128.00, 127.45, 125.38, 124.12 (d, *J* = 9.6 Hz), 119.28, 19.54. **HRMS** (ESI) calcd. for $C_{18}H_{16}FO$ [M+H]: 267.1185, found: 267.1186.

(2Z,4E)-2-fluoro-1-(naphthalen-2-yl)-5-phenylpenta-2,4-dien-1-one (1p):



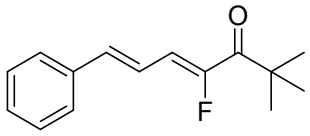
Yellow solid. m.p. 92-95 °C, 83.1 mg, 55 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.41 (s, 1H), 7.94 (dt, *J* = 22.2, 7.9 Hz, 4H), 7.60 (dt, *J* = 19.2, 7.2 Hz, 2H), 7.52 (d, *J* = 7.4 Hz, 2H), 7.37 (dt, *J* = 11.4, 7.0 Hz, 3H), 7.25 (t, *J* = 13.6 Hz, 1H), 6.92 (d, *J* = 15.9 Hz, 1H), 6.83 (dd, *J* = 31.6, 11.3 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -122.41 (d, *J* = 31.7 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.10, 154.32 (d, *J* = 269.0 Hz), 140.38, 136.08, 135.38, 133.65, 132.31, 130.81, 129.54, 129.40, 128.93, 128.57, 128.45, 127.87, 127.41, 126.96, 125.09, 122.14, 119.32. **HRMS** (ESI) calcd. for $C_{21}H_{16}FO$ [M+H]: 303.1185, found: 303.1187.

(2Z,4E)-1-((1S,3s)-adamantan-1-yl)-2-fluoro-5-phenylpenta-2,4-dien-1-one (1q):



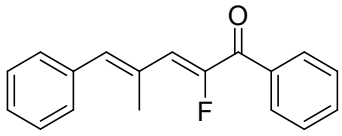
Yellow oil. 66.7 mg, 43 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 6.9 Hz, 2H), 7.48 – 7.36 (m, 3H), 7.19 – 7.04 (m, 1H), 6.93 (dd, *J* = 15.0, 10.7 Hz, 1H), 6.87 – 6.69 (m, 1H), 2.12 (s, 3H), 2.03 (d, *J* = 11.0 Hz, 6H), 1.82 – 1.78 (m, 6H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -124.01. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.37 (d, *J* = 29.6 Hz), 155.75 (d, *J* = 279.1 Hz), 139.27, 136.35, 128.98, 128.81, 127.16, 119.21 (d, *J* = 4.1 Hz), 118.30 – 116.88 (m), 37.05, 36.64, 36.27, 27.96. **HRMS** (ESI) calcd. for $C_{21}H_{24}FO$ [M+H]: 311.1811, found: 311.1813.

(4Z,6E)-4-fluoro-2,2-dimethyl-7-phenylhepta-4,6-dien-3-one (1r):



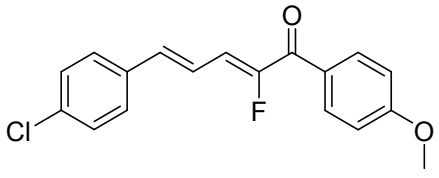
Yellow oil. 70.8 mg, 61 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.49 (d, *J* = 5.8 Hz, 2H), 7.42 – 7.28 (m, 3H), 7.14 – 7.02 (m, 1H), 6.88 (d, *J* = 16.0 Hz, 1H), 6.77 (dd, *J* = 31.3, 11.8 Hz, 1H), 1.27 (s, 9H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -123.32. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.73, 155.16 (d, *J* = 278.3 Hz), 139.46, 136.31, 129.05, 128.85, 127.20, 119.18 (d, *J* = 3.7 Hz), 117.93 (d, *J* = 9.4 Hz), 42.85, 25.76. **HRMS** (ESI) calcd. for $C_{15}H_{18}FO$ [M+H]: 233.1342, found: 233.1344.

(2Z,4E)-2-fluoro-4-methyl-1,5-diphenylpenta-2,4-dien-1-one (1s):



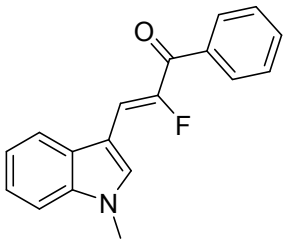
Yellow oil. 58.5 mg, 44 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.04 – 7.97 (m, 1H), 7.84 (d, *J* = 7.7 Hz, 2H), 7.49 (dt, *J* = 9.2, 4.7 Hz, 3H), 7.37 – 7.34 (m, 2H), 6.85 (d, *J* = 15.3 Hz, 1H), 6.63 (d, *J* = 36.3 Hz, 1H), 2.29 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -121.89 (d, *J* = 36.2 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 185.80, 153.43 (d, *J* = 271.9 Hz), 138.67 (d, *J* = 5.7 Hz), 136.54, 132.60 (d, *J* = 21.6 Hz), 129.47, 129.30 (d, *J* = 3.9 Hz), 128.72, 128.45, 128.38, 127.86, 127.21, 125.64, 93.19, 16.68 (d, *J* = 7.7 Hz). **HRMS** (ESI) calcd. for $C_{18}H_{16}FO$ [M+H]: 267.1185, found: 267.1187.

(2Z,4E)-5-(4-chlorophenyl)-2-fluoro-1-(4-methoxyphenyl)penta-2,4-dien-1-one (1t):



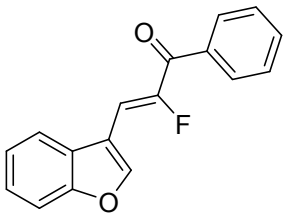
Yellow solid. m.p. 80-82 °C, 2.433 g, 77 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.95 – 7.87 (m, 2H), 7.45 – 7.29 (m, 4H), 7.14 (dd, *J* = 15.7, 11.3 Hz, 1H), 7.02 – 6.93 (m, 2H), 6.83 (d, *J* = 15.8 Hz, 1H), 6.75 (ddd, *J* = 31.8, 11.4, 0.8 Hz, 1H), 3.88 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -120.70. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 185.17 (d, *J* = 26.9 Hz), 163.61, 154.84 (d, *J* = 272.7 Hz), 138.08 (d, *J* = 4.9 Hz), 134.80 (d, *J* = 18.3 Hz), 131.85 (d, *J* = 5.4 Hz), 129.45, 129.10, 128.77, 128.42, 120.17 (d, *J* = 10.4 Hz), 119.91 (d, *J* = 3.5 Hz), 113.81, 55.54. **HRMS** (ESI) calcd. for $C_{18}H_{15}ClFO_2$ [M+H]: 317.0745, found: 317.0747.

(Z)-2-fluoro-3-(1-methyl-1H-indol-3-yl)-1-phenylprop-2-en-1-one (4d):



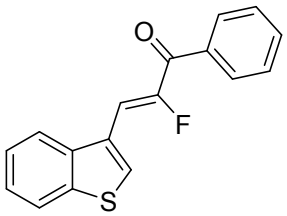
Yellow solid. m.p. 95-97 °C, 60.0 mg, 43 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.87 (d, *J* = 7.6 Hz, 2H), 7.81 (s, 1H), 7.68 (d, *J* = 7.9 Hz, 1H), 7.64 – 7.56 (m, 1H), 7.51 (t, *J* = 7.5 Hz, 2H), 7.39 – 7.31 (m, 2H), 7.24 (dd, *J* = 9.7, 6.3 Hz, 2H), 3.89 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -122.30 (d, *J* = 37.7 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.30, 153.07 (d, *J* = 260.2 Hz), 137.39, 136.84, 133.40 (d, *J* = 14.6 Hz), 132.19, 129.15 (d, *J* = 3.6 Hz), 128.38, 127.51, 123.03, 121.20, 118.79, 115.02, 109.91, 107.12, 33.50. **HRMS** (ESI) calcd. for $C_{18}H_{15}FNO$ [M+H]: 280.1138, found: 280.1139.

(Z)-3-(benzofuran-3-yl)-2-fluoro-1-phenylprop-2-en-1-one (4e):



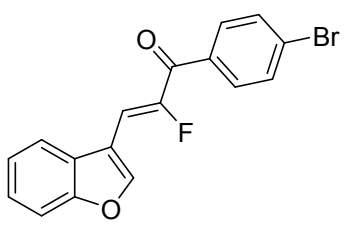
Yellow solid. m.p. 93-95 °C, 83.8 mg, 63 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.22 (d, *J* = 3.6 Hz, 1H), 7.98 – 7.89 (m, 2H), 7.70 (d, *J* = 7.6 Hz, 1H), 7.67 – 7.59 (m, 1H), 7.59 – 7.49 (m, 3H), 7.35 (dt, *J* = 20.1, 7.4 Hz, 2H), 7.11 (dd, *J* = 37.2, 4.1 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -112.33 (d, *J* = 37.1 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 186.77 (d, *J* = 27.0 Hz), 155.26 (d, *J* = 270.3 Hz), 155.05, 147.95 (d, *J* = 14.9 Hz), 136.17, 133.06, 129.39 (d, *J* = 4.3 Hz), 128.58, 125.71, 125.41, 123.61, 119.75, 113.11, 111.87, 109.89 (d, *J* = 11.5 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}FO_2$ [M+H]: 267.0821, found: 267.0823.

(Z)-3-(benzo[b]thiophen-3-yl)-2-fluoro-1-phenylprop-2-en-1-one (4f):



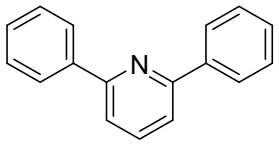
Brown solid. m.p. 76-78 °C, 105.8 mg, 75 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.23 (s, 1H), 7.98 – 7.86 (m, 3H), 7.86 – 7.77 (m, 1H), 7.63 (t, *J* = 7.4 Hz, 1H), 7.53 (t, *J* = 7.5 Hz, 2H), 7.44 (qt, *J* = 8.0, 4.1 Hz, 2H), 7.29 (d, *J* = 29.6 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -116.94 (d, *J* = 35.4 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 187.43 (d, *J* = 30.1 Hz), 155.46 (d, *J* = 272.6 Hz), 139.23, 137.94, 136.28, 133.04, 131.26 (d, *J* = 16.2 Hz), 129.42 (d, *J* = 4.1 Hz), 128.82, 128.58, 126.23, 125.06 (d, *J* = 21.1 Hz), 122.92, 121.23, 111.23 (d, *J* = 8.7 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}FOS$ [M+H]: 283.0593, found: 283.0596.

(Z)-3-(benzofuran-3-yl)-1-(4-bromophenyl)-2-fluoroprop-2-en-1-one (4g):



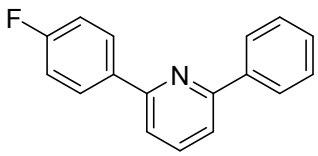
Yellow solid. m.p. 112-114 °C, 1.324 g, 77 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.20 (s, 1H), 7.81 (d, *J* = 8.4 Hz, 2H), 7.71 (d, *J* = 7.5 Hz, 1H), 7.65 (d, *J* = 8.6 Hz, 2H), 7.55 (d, *J* = 8.7 Hz, 1H), 7.43 – 7.30 (m, 2H), 7.12 (d, *J* = 37.2 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -124.43 (d, *J* = 12.5 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 185.38 (d, *J* = 28.7 Hz), 155.15 (d, *J* = 270.6 Hz), 155.07, 148.16, 134.75, 131.91, 130.93 (d, *J* = 4.9 Hz), 128.29, 125.63, 125.49, 123.68, 119.74, 113.08, 111.89, 109.77 (d, *J* = 12.3 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{11}BrFO_2$ [M+H]: 344.9926, found: 344.9928.

2,6-diphenylpyridine (2a):[12a]



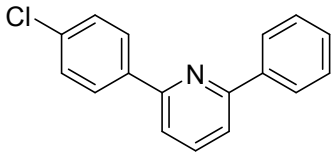
Buff solid. 21.0 mg, 93 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.21 – 8.10 (m, 4H), 7.82 (dd, *J* = 8.4, 7.2 Hz, 1H), 7.70 (d, *J* = 7.7 Hz, 2H), 7.56 – 7.47 (m, 4H), 7.47 – 7.40 (m, 2H).

2-(4-fluorophenyl)-6-phenylpyridine (2b): [12a]



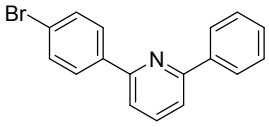
Yellow solid. 22.7 mg, 91 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.19 – 8.11 (m, 3H), 7.82 (t, *J* = 7.9 Hz, 1H), 7.67 (dd, *J* = 17.3, 7.8 Hz, 2H), 7.60 – 7.41 (m, 4H), 7.18 (t, *J* = 8.6 Hz, 2H).

2-(4-chlorophenyl)-6-phenylpyridine (2c): [12a]



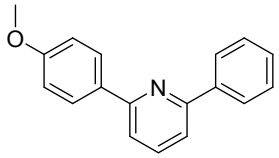
Yellow solid. 23.3 mg, 88 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.16 – 8.06 (m, 4H), 7.82 (t, *J* = 7.8 Hz, 1H), 7.68 (dd, *J* = 17.7, 7.8 Hz, 2H), 7.55 – 7.41 (m, 5H).

2-(4-bromophenyl)-6-phenylpyridine (2d): [12a]



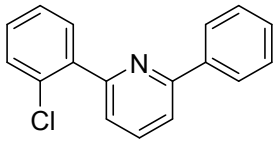
Yellow solid. 26.4 mg, 85 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.13 (dt, *J* = 6.3, 1.3 Hz, 2H), 8.07 – 8.01 (m, 2H), 7.82 (dd, *J* = 8.3, 7.4 Hz, 1H), 7.69 (ddd, *J* = 18.9, 7.9, 1.0 Hz, 2H), 7.64 – 7.60 (m, 2H), 7.54 – 7.47 (m, 2H), 7.47 – 7.41 (m, 1H).

2-(4-bromophenyl)-6-phenylpyridine (2e): [12a]



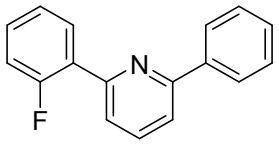
Yellow solid. 22.2 mg, 85 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.19 – 8.06 (m, 4H), 7.78 (t, *J* = 7.8 Hz, 1H), 7.67 – 7.60 (m, 2H), 7.54 – 7.46 (m, 2H), 7.46 – 7.37 (m, 1H), 7.07 – 7.00 (m, 2H), 3.88 (s, 3H).

2-(2-chlorophenyl)-6-phenylpyridine (2f): [12a]



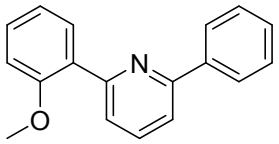
Yellow solid. 23.6 mg, 89 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.11 – 8.05 (m, 2H), 7.84 (t, *J* = 7.8 Hz, 1H), 7.77 – 7.70 (m, 2H), 7.61 (d, *J* = 7.6 Hz, 1H), 7.54 – 7.45 (m, 3H), 7.45 – 7.32 (m, 3H).

2-(2-fluorophenyl)-6-phenylpyridine (2g): [12a]



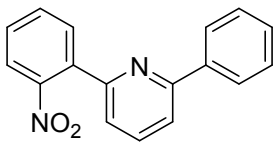
Yellow solid. 21.4 mg, 89 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.21 (td, *J* = 7.9, 1.9 Hz, 1H), 8.15 – 8.09 (m, 2H), 7.87 – 7.75 (m, 2H), 7.72 (dd, *J* = 7.6, 1.2 Hz, 1H), 7.54 – 7.47 (m, 2H), 7.47 – 7.35 (m, 2H), 7.30 (td, *J* = 7.5, 1.2 Hz, 1H), 7.17 (ddd, *J* = 11.5, 8.2, 1.2 Hz, 1H).

2-(2-methoxyphenyl)-6-phenylpyridine (2h): [12a]



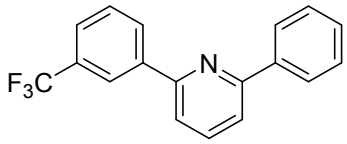
Yellow solid. 21.7 mg, 83 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 – 8.07 (m, 2H), 8.01 (dd, *J* = 7.6, 1.8 Hz, 1H), 7.83 (dt, *J* = 7.8, 1.0 Hz, 1H), 7.77 (t, *J* = 7.7 Hz, 1H), 7.66 (dt, *J* = 7.7, 1.0 Hz, 1H), 7.52 – 7.45 (m, 2H), 7.45 – 7.34 (m, 2H), 7.12 (td, *J* = 7.5, 1.0 Hz, 1H), 7.02 (d, *J* = 8.3 Hz, 1H), 3.89 (s, 3H).

2-(2-nitrophenyl)-6-phenylpyridine (2i): [12a]



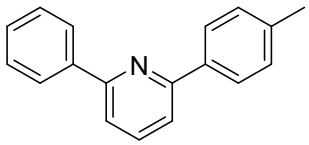
Yellow solid. 23.5 mg, 85 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.02 – 7.93 (m, 2H), 7.88 (t, *J* = 7.7 Hz, 2H), 7.75 (d, *J* = 8.0 Hz, 1H), 7.73 – 7.60 (m, 2H), 7.55 (td, *J* = 7.7, 1.6 Hz, 1H), 7.52 – 7.38 (m, 4H).

2-phenyl-6-(3-(trifluoromethyl)phenyl)pyridine (2j): [12a]



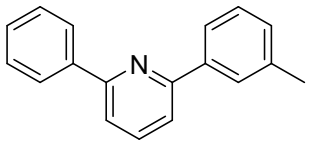
Yellow solid. 26.9 mg, 90 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.41 (s, 1H), 8.34 (d, *J* = 7.9 Hz, 1H), 8.19 – 8.10 (m, 2H), 7.86 (td, *J* = 7.8, 0.9 Hz, 1H), 7.79 – 7.66 (m, 3H), 7.62 (t, *J* = 7.8 Hz, 1H), 7.52 (t, *J* = 7.5 Hz, 2H), 7.49 – 7.40 (m, 1H).

2-phenyl-6-(p-tolyl)pyridine (2m): [12a]



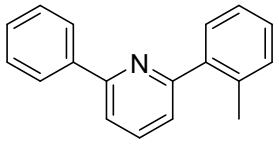
Yellow solid. 21.8 mg, 89 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 7.6 Hz, 2H), 8.05 (d, *J* = 7.8 Hz, 2H), 7.78 (t, *J* = 7.8 Hz, 1H), 7.66 (d, *J* = 7.8 Hz, 2H), 7.49 (t, *J* = 7.5 Hz, 2H), 7.43 (d, *J* = 7.2 Hz, 1H), 7.30 (d, *J* = 7.8 Hz, 2H), 2.42 (s, 3H).

2-phenyl-6-(m-tolyl)pyridine (2n): [12a]



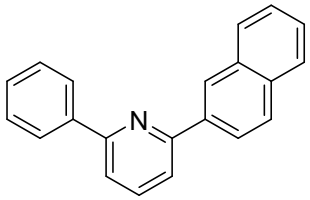
Yellow solid. 21.6 mg, 88 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 (d, *J* = 7.6 Hz, 2H), 7.98 (s, 1H), 7.92 (d, *J* = 7.7 Hz, 1H), 7.80 (t, *J* = 7.8 Hz, 1H), 7.68 (d, *J* = 7.9 Hz, 2H), 7.49 (d, *J* = 7.5 Hz, 2H), 7.46 – 7.34 (m, 3H), 2.46 (s, 3H).

2-phenyl-6-(o-tolyl)pyridine (2o): [12a]



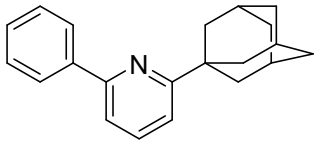
Yellow solid. 20.8 mg, 85 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.13 – 8.04 (m, 2H), 7.81 (t, *J* = 7.8 Hz, 1H), 7.73 – 7.65 (m, 1H), 7.47 (td, *J* = 7.9, 6.0 Hz, 3H), 7.44 – 7.34 (m, 2H), 7.31 (d, *J* = 1.5 Hz, 3H), 2.49 (s, 3H).

2-(naphthalen-2-yl)-6-phenylpyridine (2p): [12a]



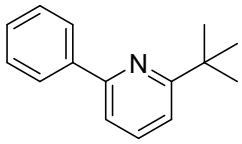
Yellow solid. 25.9 mg, 92 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.61 (s, 1H), 8.33 (d, *J* = 8.6 Hz, 1H), 8.20 (d, *J* = 7.5 Hz, 2H), 7.97 (d, *J* = 9.1 Hz, 2H), 7.87 (d, *J* = 9.0 Hz, 3H), 7.72 (d, *J* = 6.0 Hz, 1H), 7.52 (d, *J* = 7.3 Hz, 4H), 7.46 (d, *J* = 7.0 Hz, 1H).

2-((3r,5r,7r)-adamantan-1-yl)-6-phenylpyridine (2q):



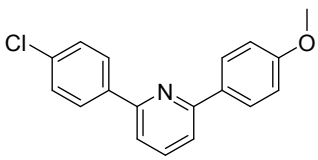
Yellow oil. 19.2 mg, 91 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.10 (d, *J* = 7.6 Hz, 2H), 7.66 (d, *J* = 7.8 Hz, 1H), 7.54 (d, *J* = 7.8 Hz, 1H), 7.46 (t, *J* = 7.5 Hz, 2H), 7.39 (d, *J* = 7.2 Hz, 1H), 7.19 (d, *J* = 7.8 Hz, 1H), 2.13 (s, 3H), 2.08 (s, 6H), 1.81 (s, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.75, 155.50, 140.02, 136.76, 129.90, 128.57, 126.85, 117.16, 116.96, 42.00, 39.29, 36.94, 28.89. **HRMS** (ESI) calcd. for $C_{21}H_{24}N$ [M+H]: 290.1909, found: 290.1910.

2-(tert-butyl)-6-phenylpyridine (2r): [12b]



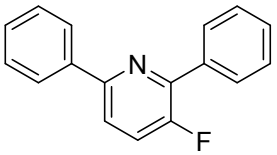
Yellow oil. 19.2 mg, 91 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.15 – 8.06 (m, 2H), 7.67 (t, *J* = 7.8 Hz, 1H), 7.55 (d, *J* = 7.8 Hz, 1H), 7.47 (t, *J* = 7.5 Hz, 2H), 7.39 (t, *J* = 7.3 Hz, 1H), 7.27 (d, *J* = 5.6 Hz, 1H), 1.43 (s, 9H).

2-(4-chlorophenyl)-6-(4-methoxyphenyl)pyridine (2t):



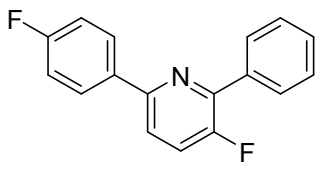
Yellow solid. 1.33 g, 90 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.09 (dq, *J* = 8.8, 1.9 Hz, 4H), 7.82 – 7.73 (m, 1H), 7.68 – 7.56 (m, 2H), 7.45 (dd, *J* = 8.6, 1.8 Hz, 2H), 7.07 – 6.99 (m, 2H), 3.88 (d, *J* = 1.8 Hz, 3H).

3-fluoro-2,6-diphenylpyridine (3a):



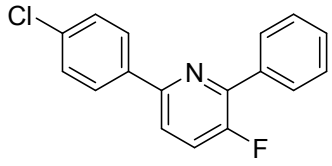
Pink oil. 19.9 mg, 80 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.10 (dd, *J* = 20.5, 7.7 Hz, 4H), 7.69 (dd, *J* = 8.6, 3.0 Hz, 1H), 7.58 – 7.39 (m, 7H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -121.41 – -127.16 (m). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.98 (d, *J* = 260.7 Hz), 152.85 , 145.09 , 138.53 , 135.66 , 129.24 , 128.97 , 128.91 , 128.77 , 128.44 , 126.85 , 124.94 (d, *J* = 21.5 Hz), 120.11 (d, *J* = 4.2 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{13}FN$ [M+H]: 250.1032, found: 250.1033.

3-fluoro-6-(4-fluorophenyl)-2-phenylpyridine (3b):



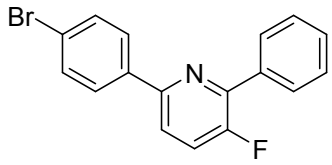
Pink oil. 20.0 mg, 75 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.19 – 8.00 (m, 4H), 7.62 (dd, *J* = 8.5, 3.1 Hz, 1H), 7.49 (dt, *J* = 16.2, 9.4 Hz, 4H), 7.15 (t, *J* = 8.4 Hz, 2H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -107.87 – -117.94 (m), -126.57 (dd, *J* = 10.5, 2.8 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 163.49 (d, *J* = 248.3 Hz), 156.90 (d, *J* = 260.7 Hz), 151.88 , 145.15 , 135.54 , 134.71 , 129.31 , 128.90 (d, *J* = 6.1 Hz), 128.64 (d, *J* = 8.3 Hz), 128.46 , 125.01 (d, *J* = 21.7 Hz), 119.73 (d, *J* = 4.3 Hz), 115.65 (d, *J* = 21.5 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}F_2N$ [M+H]: 268.0938, found: 268.0940.

6-(4-chlorophenyl)-3-fluoro-2-phenylpyridine (3c):



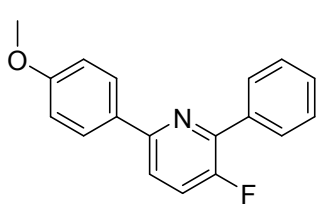
Pink oil. 20.4 mg, 72 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 – 8.07 (m, 2H), 8.05 – 7.98 (m, 2H), 7.67 (dd, *J* = 8.5, 3.2 Hz, 1H), 7.58 – 7.50 (m, 3H), 7.50 – 7.41 (m, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.89 (dd, *J* = 10.7, 3.0 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.04 (d, *J* = 261.2 Hz), 151.65, 136.93, 135.04, 129.36, 128.93, 128.87, 128.48, 128.10, 125.05 (d, *J* = 21.6 Hz), 119.89 (d, *J* = 4.4 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}ClFN$ [M+H]: 284.0642, found: 284.0643.

6-(4-bromophenyl)-3-fluoro-2-phenylpyridine (3d):



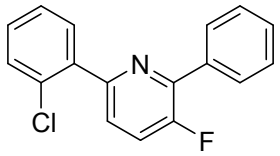
Pink oil. 24.3 mg, 74 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.10 (dt, *J* = 6.9, 1.4 Hz, 2H), 7.98 – 7.92 (m, 2H), 7.66 (dd, *J* = 8.6, 3.1 Hz, 1H), 7.62 – 7.58 (m, 2H), 7.57 – 7.48 (m, 3H), 7.48 – 7.43 (m, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.72 (dt, *J* = 10.3, 2.1 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.05 (d, *J* = 261.3 Hz), 137.35, 135.41, 131.87, 129.36, 128.89 (d, *J* = 6.0 Hz), 128.47, 128.38, 126.97, 125.04 (d, *J* = 21.6 Hz), 123.36, 122.25, 119.85 (d, *J* = 4.4 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}BrFN$ [M+H]: 328.0137, found: 328.0140.

3-fluoro-6-(4-methoxyphenyl)-2-phenylpyridine (3e):



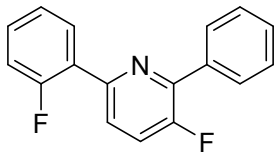
Pink oil. 22.6 mg, 81 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.11 (d, *J* = 7.6 Hz, 2H), 8.03 (d, *J* = 8.3 Hz, 2H), 7.62 (dd, *J* = 8.5, 3.3 Hz, 1H), 7.48 (dt, *J* = 25.3, 7.7 Hz, 4H), 7.00 (d, *J* = 8.3 Hz, 2H), 3.87 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -127.66 (dd, *J* = 10.8, 3.0 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.38, 156.59 (d, *J* = 259.8 Hz), 152.56, 144.81, 135.75 (d, *J* = 5.9 Hz), 131.26, 129.14, 128.92 (d, *J* = 6.0 Hz), 128.40, 128.12, 124.89 (d, *J* = 21.7 Hz), 119.32 (d, *J* = 4.0 Hz), 114.11, 55.40. **HRMS** (ESI) calcd. for $C_{18}H_{15}FNO$ [M+H]: 280.1138, found: 280.1140.

6-(2-chlorophenyl)-3-fluoro-2-phenylpyridine (3f):



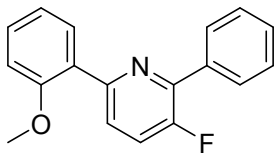
Pink oil. 23.2 mg, 82 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.10 – 8.02 (m, 2H), 7.68 (dd, *J* = 7.3, 2.2 Hz, 1H), 7.63 (dd, *J* = 8.5, 3.4 Hz, 1H), 7.59 – 7.53 (m, 1H), 7.53 – 7.41 (m, 4H), 7.36 (td, *J* = 7.2, 1.8 Hz, 2H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -121.93 – -138.21 (m). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.76 (d, *J* = 261.1 Hz), 152.46, 145.41, 138.44, 135.29, 133.44, 131.78, 130.22, 129.67, 129.27, 128.94 (d, *J* = 5.6 Hz), 128.48, 127.05, 124.71 (d, *J* = 4.4 Hz), 124.11 (d, *J* = 21.4 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}ClFN$ [M+H]: 284.0642, found: 284.0643.

3-fluoro-6-(2-fluorophenyl)-2-phenylpyridine (3g):



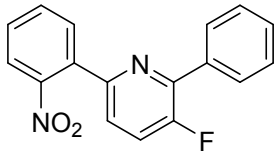
Pink oil. 20.0 mg, 75 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.12 (dd, *J* = 21.9, 7.8 Hz, 3H), 7.79 (d, *J* = 8.6 Hz, 1H), 7.50 (td, *J* = 16.2, 15.3, 7.6 Hz, 4H), 7.38 (q, *J* = 6.9 Hz, 1H), 7.27 (dd, *J* = 12.8, 5.5 Hz, 1H), 7.17 (dd, *J* = 11.5, 8.2 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -114.15 – -118.40 (m), -121.93 – -128.21 (m). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.57 (d, *J* = 249.2 Hz), 158.10, 147.13 (d, *J* = 326.4 Hz), 135.48, 131.20, 130.45, 130.37, 129.28, 128.90 (d, *J* = 5.9 Hz), 128.47, 124.57 (d, *J* = 21.4 Hz), 124.54 (d, *J* = 3.2 Hz), 124.38 (d, *J* = 4.1 Hz), 124.27 (d, *J* = 4.4 Hz), 116.23 (d, *J* = 22.9 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}F_2N$ [M+H]: 268.0938, found: 268.0939.

3-fluoro-6-(2-methoxyphenyl)-2-phenylpyridine (3h):



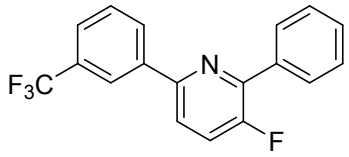
Pink oil. 20.9 mg, 75 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.07 (dq, *J* = 6.8, 1.6 Hz, 2H), 7.95 (dt, *J* = 7.6, 1.7 Hz, 1H), 7.85 (ddd, *J* = 8.6, 3.5, 1.2 Hz, 1H), 7.53 – 7.35 (m, 5H), 7.15 – 7.07 (m, 1H), 7.01 (d, *J* = 8.2 Hz, 1H), 3.89 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.23. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.01, 156.46 (d, *J* = 260.1 Hz), 151.43 (d, *J* = 4.7 Hz), 144.93 (d, *J* = 10.7 Hz), 135.79 (d, *J* = 5.6 Hz), 131.40, 129.95, 128.97, 128.92, 128.86, 128.36, 125.02 (d, *J* = 4.0 Hz), 123.79 (d, *J* = 21.0 Hz), 121.11, 111.43, 55.63. **HRMS** (ESI) calcd. for $C_{18}H_{15}FNO$ [M+H]: 280.1138, found: 280.1139.

3-fluoro-6-(2-nitrophenyl)-2-phenylpyridine (3i):



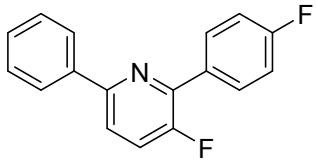
Pink oil. 25.0 mg, 85 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.95 (dt, *J* = 8.2, 1.7 Hz, 2H), 7.89 – 7.84 (m, 1H), 7.68 – 7.63 (m, 2H), 7.63 – 7.51 (m, 2H), 7.51 – 7.39 (m, 4H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -124.37 (dq, *J* = 10.5, 1.9 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.09 (d, *J* = 262.1 Hz), 150.67, 149.60, 145.90, 134.91, 134.26, 132.22, 130.92, 129.50, 129.28, 128.92 (d, *J* = 6.0 Hz), 128.52, 125.21 (d, *J* = 21.7 Hz), 124.45, 122.32 (d, *J* = 4.7 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}FN_2O_2$ [M+H]: 295.0883, found: 295.0885.

3-fluoro-2-phenyl-6-(3-(trifluoromethyl)phenyl)pyridine (3j):



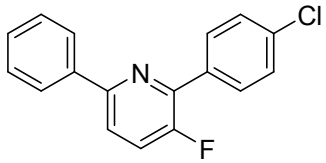
Pink oil. 24.7 mg, 78 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.32 (s, 1H), 8.26 (d, *J* = 7.8 Hz, 1H), 8.11 (d, *J* = 7.6 Hz, 2H), 7.73 (dd, *J* = 8.5, 3.3 Hz, 1H), 7.68 (d, *J* = 7.5 Hz, 1H), 7.60 (t, *J* = 8.0 Hz, 2H), 7.51 (dt, *J* = 15.8, 7.3 Hz, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -62.60 , -114.67 – -130.95 (m). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.27 (d, *J* = 261.7 Hz), 151.27, 145.59, 139.21, 137.80, 135.22, 130.05, 129.48, 129.27, 128.93 (d, *J* = 6.2 Hz), 128.53, 125.47, 125.18 (d, *J* = 21.5 Hz), 123.62, 120.23 (d, *J* = 4.5 Hz), 120.15 – 117.81 (m). **HRMS** (ESI) calcd. for $C_{18}H_{12}F_4N$ [M+H]: 318.0906, found: 318.0907.

3-fluoro-2-(4-fluorophenyl)-6-phenylpyridine (3k):



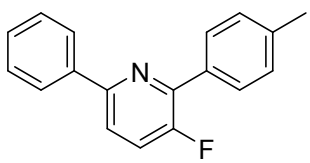
Pink oil. 17.9 mg, 67 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 (ddt, *J* = 6.9, 5.5, 1.4 Hz, 2H), 8.05 (dt, *J* = 6.4, 1.4 Hz, 2H), 7.69 (dd, *J* = 8.5, 3.2 Hz, 1H), 7.60 – 7.41 (m, 4H), 7.19 (td, *J* = 9.1, 2.8 Hz, 2H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -112.07 – -112.25 (m), -122.98 – -133.35 (m). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 163.44 (d, *J* = 248.4 Hz), 156.81 (d, *J* = 260.7 Hz), 152.89, 143.99, 138.40, 130.85, 130.85 (d, *J* = 14.8 Hz), 128.97, 128.79, 126.82, 125.03 (d, *J* = 21.6 Hz), 120.14, 115.42 (d, *J* = 21.6 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}F_2N$ [M+H]: 268.0938, found: 268.0940.

2-(4-chlorophenyl)-3-fluoro-6-phenylpyridine (3l):



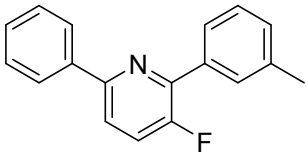
Pink oil. 21.2 mg, 75 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.13 – 8.00 (m, 4H), 7.70 (dd, *J* = 8.6, 3.1 Hz, 1H), 7.49 (dddd, *J* = 18.0, 15.8, 10.0, 7.9 Hz, 6H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -126.15 (d, *J* = 11.0 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.94 (d, *J* = 261.0 Hz), 152.97, 143.78, 138.33, 135.33, 134.06, 130.22 (d, *J* = 6.6 Hz), 129.03, 128.80, 128.66, 126.82, 125.11 (d, *J* = 21.4 Hz), 120.43 (d, *J* = 4.2 Hz). **HRMS** (ESI) calcd. for $C_{17}H_{12}ClFN$ [M+H]: 284.0642, found: 284.0644.

3-fluoro-6-phenyl-2-(p-tolyl)pyridine (3m):



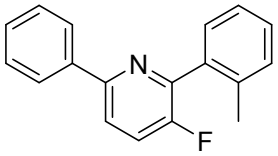
Pink oil. 18.9 mg, 72 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.04 (ddd, *J* = 14.6, 7.4, 3.5 Hz, 4H), 7.69 – 7.62 (m, 1H), 7.52 – 7.45 (m, 3H), 7.43 – 7.40 (m, 1H), 7.31 (d, *J* = 7.9 Hz, 2H), 2.43 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -126.53 (dd, *J* = 10.9, 3.0 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.90 (d, *J* = 260.1 Hz), 152.76, 139.28, 138.62, 137.41, 132.88, 129.17, 128.84, 128.78, 128.74, 126.84, 124.81 (d, *J* = 21.3 Hz), 119.74 (d, *J* = 4.1 Hz), 21.42. **HRMS** (ESI) calcd. for $C_{18}H_{15}FN$ [M+H]: 264.1189, found: 264.1190.

3-fluoro-6-phenyl-2-(m-tolyl)pyridine (3n):



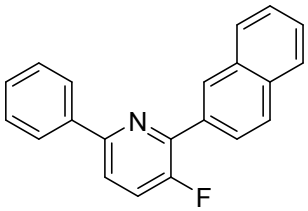
Pink oil. 16.1 mg, 61 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.10 – 8.03 (m, 2H), 7.95 – 7.87 (m, 2H), 7.68 (dd, *J* = 8.5, 3.1 Hz, 1H), 7.58 – 7.47 (m, 3H), 7.41 (q, *J* = 7.6 Hz, 2H), 7.28 (s, 1H), 2.47 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -124.02 – -134.05 (m). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.94 (d, *J* = 260.8 Hz), 152.89, 145.26, 138.60, 138.04, 135.52, 130.18, 130.00, 129.52 (d, *J* = 5.2 Hz), 128.85, 128.74, 126.87, 126.08 (d, *J* = 6.4 Hz), 124.84 (d, *J* = 21.4 Hz), 120.02 (d, *J* = 4.0 Hz), 21.63. **HRMS** (ESI) calcd. for $C_{18}H_{15}FN$ [M+H]: 264.1189, found: 264.1191.

3-fluoro-6-phenyl-2-(o-tolyl)pyridine (3o):



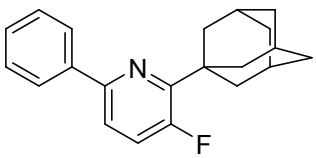
Pink oil. 15.6 mg, 59 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.00 (dt, *J* = 6.2, 1.4 Hz, 2H), 7.73 (dd, *J* = 8.6, 3.4 Hz, 1H), 7.54 (t, *J* = 8.8 Hz, 1H), 7.49 – 7.43 (m, 3H), 7.41 – 7.39 (m, 1H), 7.33 (tdd, *J* = 9.2, 7.1, 4.1 Hz, 3H), 2.35 (d, *J* = 1.3 Hz, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.29 (d, *J* = 9.1 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.33 (d, *J* = 257.1 Hz), 153.00, 147.70, 138.54, 136.85, 135.22, 130.49, 130.09, 128.90, 128.84, 128.75, 126.91, 125.67, 124.14 (d, *J* = 21.1 Hz), 120.36 (d, *J* = 4.0 Hz), 19.90. **HRMS** (ESI) calcd. for $C_{18}H_{15}FN$ [M+H]: 264.1189, found: 264.1190.

3-fluoro-2-(naphthalen-2-yl)-6-phenylpyridine (3p):



Off-white solid, m.p. 78-80 ^{o}C, 25.4 mg, 85 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.61 (s, 1H), 8.36 – 8.26 (m, 1H), 8.19 (d, *J* = 7.3 Hz, 1H), 8.11 (d, *J* = 7.4 Hz, 1H), 8.02 – 7.93 (m, 2H), 7.89 (d, *J* = 4.9 Hz, 1H), 7.84 (d, *J* = 4.5 Hz, 1H), 7.75 – 7.68 (m, 1H), 7.51 (q, *J* = 7.0 Hz, 4H), 7.44 (q, *J* = 6.8, 6.0 Hz, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.92 (d, *J* = 10.8 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.29 (d, *J* = 261.0 Hz), 156.87 (d, *J* = 26.4 Hz), 152.98 (d, *J* = 4.8 Hz), 144.94 (d, *J* = 10.2 Hz), 139.56, 138.57, 137.58, 136.84, 133.71 (d, *J* = 8.0 Hz), 133.40 (d, *J* = 29.5 Hz), 133.00 (d, *J* = 5.8 Hz), 129.00 (d, *J* = 12.0 Hz), 128.79 (d, *J* = 4.7 Hz), 128.38, 128.03, 127.70 (d, *J* = 4.9 Hz), 127.08, 126.91, 126.83, 126.43 (d, *J* = 15.0 Hz), 126.21 (dd, *J* = 7.1, 4.3 Hz), 125.04 (d, *J* = 21.8 Hz), 124.79, 120.16 (d, *J* = 4.4 Hz), 118.88 (d, *J* = 17.5 Hz). **HRMS** (ESI) calcd. for $C_{21}H_{15}FN$ [M+H]: 300.1189, found: 300.1191.

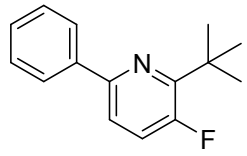
2-((3r,5r,7r)-adamantan-1-yl)-3-fluoro-6-phenylpyridine (3q):



Yellow oil. 9.5 mg, 31 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.03 (d, *J* = 7.9 Hz, 2H), 7.62 – 7.54 (m, 1H), 7.50 – 7.41 (m, 2H), 7.41 – 7.28 (m, 2H), 2.20 (s, 6H), 2.13 (s, 3H), 1.82 (s, 6H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -122.72 (d, *J* = 11.7 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 158.23 (d,

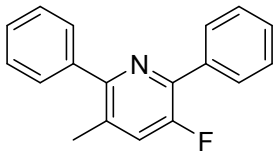
J = 260.9 Hz), 155.12, 151.09, 139.00, 128.63, 128.48, 126.61, 124.17 (d, *J* = 22.0 Hz), 118.37, 40.08 (d, *J* = 3.4 Hz), 37.01, 29.68, 28.83. **HRMS** (ESI) calcd. for $C_{21}H_{13}FN$ [M+H]: 308.1815, found: 308.1818.

2-(tert-butyl)-3-fluoro-6-phenylpyridine (3r):



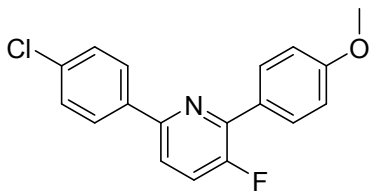
Yellow oil. 14.9 mg, 65 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.07 – 8.00 (m, 2H), 7.60 (dd, *J* = 8.5, 3.0 Hz, 1H), 7.45 (dd, *J* = 8.3, 6.6 Hz, 2H), 7.41 – 7.32 (m, 2H), 1.48 (s, 9H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -121.47 (d, *J* = 11.5 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.88 (d, *J* = 259.9 Hz), 155.33 (d, *J* = 11.2 Hz), 150.77, 138.85, 128.70, 128.57, 126.62, 124.13 (d, *J* = 22.0 Hz), 118.75 (d, *J* = 4.3 Hz), 37.54 (d, *J* = 5.4 Hz), 28.76 (d, *J* = 3.4 Hz). **HRMS** (ESI) calcd. for $C_{15}H_{17}FN$ [M+H]: 230.1345, found: 230.1346.

3-fluoro-5-methyl-2,6-diphenylpyridine (3s):



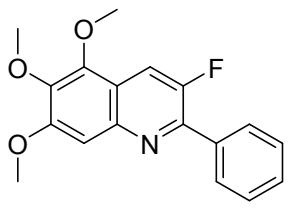
Pink oil. 17.1 mg, 65 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.03 (d, *J* = 7.5 Hz, 2H), 7.59 (d, *J* = 7.5 Hz, 2H), 7.43 (dt, *J* = 24.9, 7.4 Hz, 7H), 2.41 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -127.48 (d, *J* = 11.5 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.40 (d, *J* = 260.8 Hz), 154.36, 139.97, 135.53, 134.66, 131.75, 129.21, 128.85, 128.74 (d, *J* = 5.7 Hz), 128.37, 128.15, 128.00, 126.20 (d, *J* = 20.5 Hz), 19.87. **HRMS** (ESI) calcd. for $C_{18}H_{15}FN$ [M+H]: 264.1189, found: 264.1191.

6-(4-chlorophenyl)-3-fluoro-2-(4-methoxyphenyl)pyridine (3t):



Yellow solid. m.p. 108-110 °C, 1.22 g, 78 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.10 (d, *J* = 8.4 Hz, 2H), 8.01 (dd, *J* = 8.6, 2.5 Hz, 2H), 7.60 (dd, *J* = 8.6, 2.9 Hz, 1H), 7.50 (dd, *J* = 10.8, 8.3 Hz, 1H), 7.47 – 7.41 (m, 2H), 7.04 (dd, *J* = 9.1, 2.6 Hz, 2H), 3.89 (t, *J* = 1.7 Hz, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -120.36 – -136.66 (m). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 159.36 (d, *J* = 253.6 Hz), 155.51, 151.46, 144.93 (d, *J* = 10.3 Hz), 137.11, 134.95, 130.32, 128.87, 128.07, 124.82 (d, *J* = 21.8 Hz), 119.03, 113.90, 55.35. **HRMS** (ESI) calcd. for $C_{18}H_{14}ClFNO$ [M+H]: 314.0748, found: 314.0750.

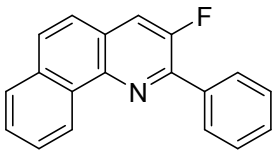
3-fluoro-5,6,7-trimethoxy-2-phenylquinoline (5a):



Yellow oil. 13.1 mg, 42 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.12 (d, *J* = 7.8 Hz, 2H), 7.62 (t, *J* = 7.4 Hz, 1H), 7.50 (q, *J* = 9.6, 7.0 Hz, 2H), 7.32 – 7.27 (m, 1H), 6.69 (d, *J* = 8.7 Hz, 1H), 4.06 (s, 3H), 3.92 (s, 3H), 3.87 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -76.03. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 171.18, 156.96 (d, *J* = 210.8 Hz), 141.84, 133.75, 130.20, 128.86, 128.51, 127.21, 116.63, 107.48, 99.16, 61.84, 61.18, 56.31. **HRMS** (ESI) calcd.

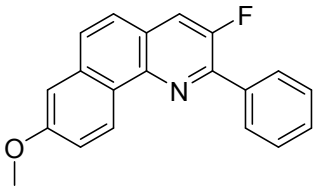
for $C_{18}H_{17}FNO_3$ [M+H]: 314.1192, found: 314.1194.

3-fluoro-2-phenylbenzo[h]quinoline (5b):



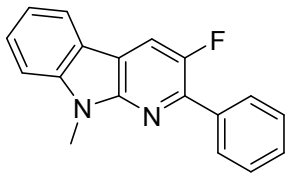
Yellow solid. m.p. 112-114 °C, 21.0 mg, 77 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.37 (d, *J* = 8.1 Hz, 1H), 8.28 (d, *J* = 7.6 Hz, 2H), 7.94 – 7.88 (m, 2H), 7.84 (d, *J* = 8.8 Hz, 1H), 7.74 (d, *J* = 7.7 Hz, 1H), 7.69 (d, *J* = 6.4 Hz, 1H), 7.58 (t, *J* = 7.2 Hz, 2H), 7.52 (d, *J* = 6.6 Hz, 2H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.10 (d, *J* = 11.3 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.17 (d, *J* = 261.0 Hz), 145.77 (d, *J* = 12.7 Hz), 142.81 , 136.10 , 133.25 , 131.48 , 129.49 , 129.44 , 129.38 , 128.96 , 128.55 , 127.99 (d, *J* = 9.9 Hz), 127.35 , 124.69 , 124.28 (d, *J* = 3.0 Hz), 120.79 (d, *J* = 20.1 Hz). **HRMS** (ESI) calcd. for $C_{19}H_{13}FN$ [M+H]: 274.1032, found: 274.1033.

3-fluoro-8-methoxy-2-phenylbenzo[h]quinoline (5c):



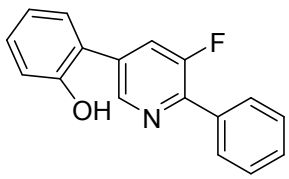
Yellow oil. 24.5 mg, 81 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 9.25 (d, *J* = 9.0 Hz, 1H), 8.26 (dt, *J* = 8.2, 1.6 Hz, 2H), 7.86 (d, *J* = 11.4 Hz, 1H), 7.76 (d, *J* = 8.9 Hz, 1H), 7.64 (d, *J* = 8.9 Hz, 1H), 7.59 – 7.54 (m, 2H), 7.54 – 7.47 (m, 1H), 7.36 (dd, *J* = 9.0, 2.7 Hz, 1H), 7.26 (d, *J* = 3.5 Hz, 1H), 3.99 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -126.52 (dd, *J* = 11.3, 1.9 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 159.52, 155.68 (d, *J* = 259.6 Hz), 145.85, 142.92, 136.18, 134.72, 129.41, 129.35, 128.50, 128.45, 126.42, 125.94, 125.54 (d, *J* = 5.1 Hz), 124.94 (d, *J* = 3.1 Hz), 120.74 (d, *J* = 19.9 Hz), 117.86, 107.90, 55.49. **HRMS** (ESI) calcd. for $C_{20}H_{15}FNO$ [M+H]: 304.1138, found: 304.1139.

3-fluoro-9-methyl-2-phenyl-9H-pyrido[2,3-b]indole (5d):



Yellow solid. m.p. 90-92 °C, 21.8 mg, 79 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.14 (d, *J* = 7.6 Hz, 2H), 8.05 (dd, *J* = 19.1, 9.4 Hz, 2H), 7.53 (q, *J* = 8.6 Hz, 3H), 7.48 – 7.39 (m, 2H), 7.27 (dd, *J* = 13.0, 5.7 Hz, 1H), 3.99 (s, 3H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -135.49 (dd, *J* = 11.0, 1.8 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 153.20 (d, *J* = 246.8 Hz), 147.96, 141.76, 136.46, 129.10, 129.03, 128.78, 128.41, 127.21, 121.31, 119.76, 115.86 (d, *J* = 24.3 Hz), 109.27, 27.77. **HRMS** (ESI) calcd. for $C_{18}H_{14}FN_2$ [M+H]: 277.1141, found: 277.1743.

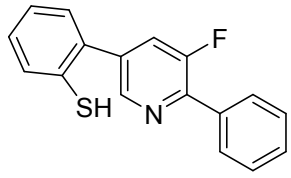
2-(5-fluoro-6-phenylpyridin-3-yl)phenol (5e):



Yellow solid. m.p. 82-84 °C, 18.0 mg, 68 % yield. **^{1}H NMR** ^{1}H NMR (400 MHz, CD_3OD) δ 8.70 (s, 1H), 7.98 – 7.87 (m, 3H), 7.49 (dt, *J* = 12.8, 7.0 Hz, 3H), 7.44 – 7.38 (m, 1H), 7.25 (td, *J* = 7.7, 1.6 Hz, 1H), 6.96 (t, *J* = 7.4 Hz, 2H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -121.61. **^{13}C NMR** (100 MHz, CD_3OD) δ 154.74, 154.42 (d, *J* = 260.1 Hz), 145.04 (d, *J* = 4.9 Hz), 143.39, 135.93, 134.92, 129.80 (d, *J* = 3.2 Hz), 128.88, 128.45, 128.39, 128.12, 124.64

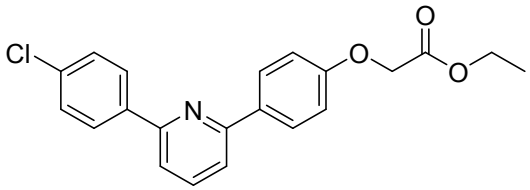
(d, *J* = 21.2 Hz), 122.67, 119.86, 115.81. **HRMS** (ESI) calcd. for $C_{17}H_{13}FNO$ [M+H]: 266.0981, found: 266.0983.

2-(5-fluoro-6-phenylpyridin-3-yl)benzenethiol (5f):



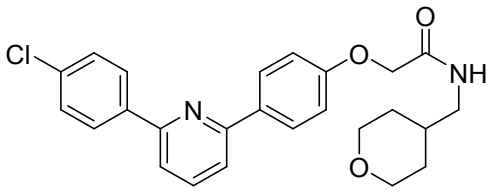
Yellow solid. m.p. 71-74 °C, 17.7 mg, 63 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.47 (d, *J* = 1.5 Hz, 1H), 8.07 – 8.00 (m, 2H), 7.64 (dd, *J* = 6.1, 3.0 Hz, 1H), 7.50 (dt, *J* = 14.6, 7.4 Hz, 3H), 7.40 (dd, *J* = 11.6, 1.7 Hz, 1H), 7.37 – 7.31 (m, 2H), 7.29 – 7.26 (m, 1H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -123.63 (dd, *J* = 11.6, 1.8 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.73 (d, *J* = 261.8 Hz), 145.68 (d, *J* = 4.7 Hz), 145.00 (d, *J* = 10.5 Hz), 137.25, 135.77 (d, *J* = 3.9 Hz), 135.03, 134.97, 130.49, 130.35, 129.47 (d, *J* = 10.5 Hz), 128.84 (d, *J* = 5.7 Hz), 128.58, 128.17, 125.05 (d, *J* = 21.3 Hz), 122.25. **HRMS** (ESI) calcd. for $C_{17}H_{13}FNS$ [M+H]: 282.0753, found: 282.0754.

ethyl 2-(4-(6-(4-chlorophenyl)pyridin-2-yl)phenoxy)acetate (7a):



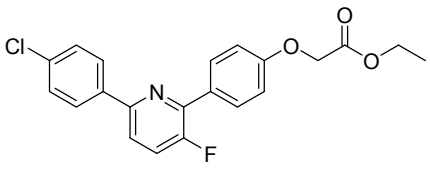
White solid. 667.9 mg, 91 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.31 – 8.10 (m, 4H), 7.82 (t, *J* = 7.9 Hz, 1H), 7.80 – 7.63 (m, 2H), 7.50 (d, *J* = 8.4 Hz, 2H), 7.08 (d, *J* = 8.5 Hz, 2H), 4.74 (s, 2H), 4.34 (q, *J* = 7.2 Hz, 2H), 1.44 – 1.34 (m, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.88, 158.91, 156.48, 155.60, 138.07, 137.66, 135.14, 133.11, 128.93, 128.44, 128.32, 118.33, 117.97, 114.95, 65.62, 61.56, 14.30.

2-(4-(6-(4-chlorophenyl)pyridin-2-yl)phenoxy)-N-((tetrahydro-2H-pyran-4-yl)methyl)acetamide (9a):



White solid. 357.5 mg, 82 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.09 (dd, *J* = 16.8, 8.7 Hz, 4H), 7.79 (t, *J* = 7.7 Hz, 1H), 7.64 (d, *J* = 5.4 Hz, 2H), 7.46 (d, *J* = 8.4 Hz, 2H), 7.04 (d, *J* = 8.8 Hz, 2H), 6.69 (s, 1H), 4.57 (d, *J* = 4.0 Hz, 2H), 3.96 (d, *J* = 12.5 Hz, 2H), 3.36 (t, *J* = 11.6 Hz, 2H), 3.31 – 3.22 (m, 2H), 1.81 (d, *J* = 5.0 Hz, 1H), 1.60 (d, *J* = 14.1 Hz, 2H), 1.38 – 1.29 (m, 2H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 168.18, 158.03, 156.12, 155.63, 137.89, 137.66, 135.14, 133.55, 128.88, 128.58, 128.23, 118.28, 118.10, 114.86, 67.55, 44.70, 35.36, 30.59.

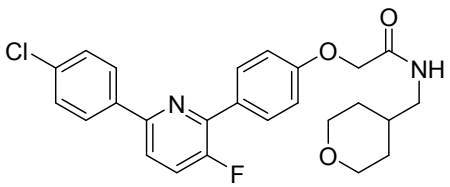
ethyl 2-(4-(6-(4-chlorophenyl)-3-fluoropyridin-2-yl)phenoxy)acetate (7b):



White solid. 622.9 mg, 87 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.09 (d, *J* = 8.4 Hz, 2H), 7.98 (d, *J* = 8.4 Hz, 2H), 7.59 (dd, *J* = 8.6, 3.1 Hz, 1H), 7.49 (dd, *J* = 10.8, 8.5 Hz, 1H), 7.43 (d, *J* = 8.3 Hz, 2H), 7.03 (d, *J* = 8.7 Hz, 2H), 4.69 (s, 2H), 4.29 (q, *J* = 7.1 Hz, 2H), 1.31 (t, *J* = 7.1 Hz, 3H). **^{19}F NMR** (377 MHz, CD_3OD) δ -127.93. **^{13}C**

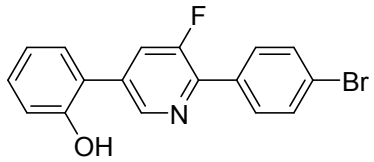
NMR (100 MHz, Chloroform-*d*) δ 168.73, 158.75, 156.82 (d, *J* = 260.8 Hz), 151.46, 144.61, 136.98, 134.97, 130.38 (d, *J* = 6.9 Hz), 129.07 (d, *J* = 6.0 Hz), 128.89, 128.06, 124.94 (d, *J* = 21.6 Hz), 119.34, 114.57, 65.43, 61.50, 14.20. **HRMS** (ESI) calcd. for $C_{21}H_{18}ClFNO_3$ [M+H]: 386.0959, found: 386.0951.

2-(4-(6-(4-chlorophenyl)-3-fluoropyridin-2-yl)phenoxy)-N-((tetrahydro-2H-pyran-4-yl)methyl)acetamide (9b):



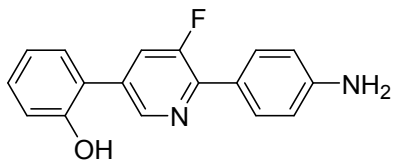
White solid. m.p. 100-103 °C, 340.5 mg, 75 % yield. **^{1}H NMR** (400 MHz, $CDCl_3$) δ 8.12 (d, *J* = 7.9 Hz, 2H), 7.99 (d, *J* = 8.6 Hz, 2H), 7.63 (dd, *J* = 8.5, 3.1 Hz, 1H), 7.52 (dd, *J* = 10.7, 8.6 Hz, 1H), 7.44 (d, *J* = 8.6 Hz, 2H), 7.05 (d, *J* = 8.9 Hz, 2H), 6.69 (s, 1H), 4.58 (s, 2H), 3.96 (dd, *J* = 11.1, 3.3 Hz, 2H), 3.36 (t, *J* = 11.7 Hz, 2H), 3.27 (t, *J* = 6.6 Hz, 2H), 1.84 – 1.75 (m, 1H), 1.60 (d, *J* = 12.9 Hz, 2H), 1.35 (td, *J* = 12.4, 4.1 Hz, 2H). **^{19}F NMR** (377 MHz, $CDCl_3$) δ -125.99. **^{13}C NMR** (100 MHz, Chloroform-*d*) δ 168.11, 157.97 , 156.84 (d, *J* = 260.9 Hz), 151.62, 144.39, 136.91, 135.08, 130.60 (d, *J* = 6.4 Hz), 129.62 (d, *J* = 5.4 Hz), 128.93, 128.06, 125.02 (d, *J* = 20.9 Hz), 119.57, 114.60, 67.52, 67.43, 44.69, 35.35, 30.58. **HRMS** (ESI) calcd. for $C_{21}H_{18}ClFNO_3$ [M+H]: 386.0959, found: 386.0951.

2-(6-(4-bromophenyl)-5-fluoropyridin-3-yl)phenol (10):



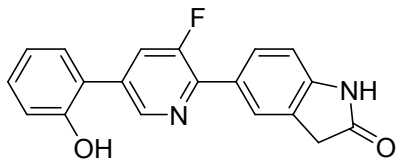
Yellow solid. m.p. 168-170 °C, 617.4 mg, 60 % yield. **^{1}H NMR** (400 MHz, CD_3OD) δ 8.70 (s, 1H), 7.92 (d, *J* = 12.6 Hz, 1H), 7.85 (d, *J* = 7.8 Hz, 2H), 7.64 (d, *J* = 8.5 Hz, 2H), 7.38 (d, *J* = 7.7 Hz, 1H), 7.24 (t, *J* = 7.7 Hz, 1H), 6.95 (dd, *J* = 7.6, 3.9 Hz, 2H). **^{19}F NMR** (377 MHz, DMSO-d_6) δ -124.27. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 157.01 (d, *J* = 258.2 Hz), 154.75, 145.23, 142.01, 136.24, 134.07, 131.32, 130.12 (d, *J* = 5.9 Hz), 129.82 (d, *J* = 4.5 Hz), 124.66 (d, *J* = 21.4 Hz), 123.11, 122.61, 119.88, 115.86. **HRMS** (ESI) calcd. for $C_{17}H_{12}BrFNO$ [M+H]: 344.0086, found: 344.0088.

2-(6-(4-aminophenyl)-5-fluoropyridin-3-yl)phenol (11):



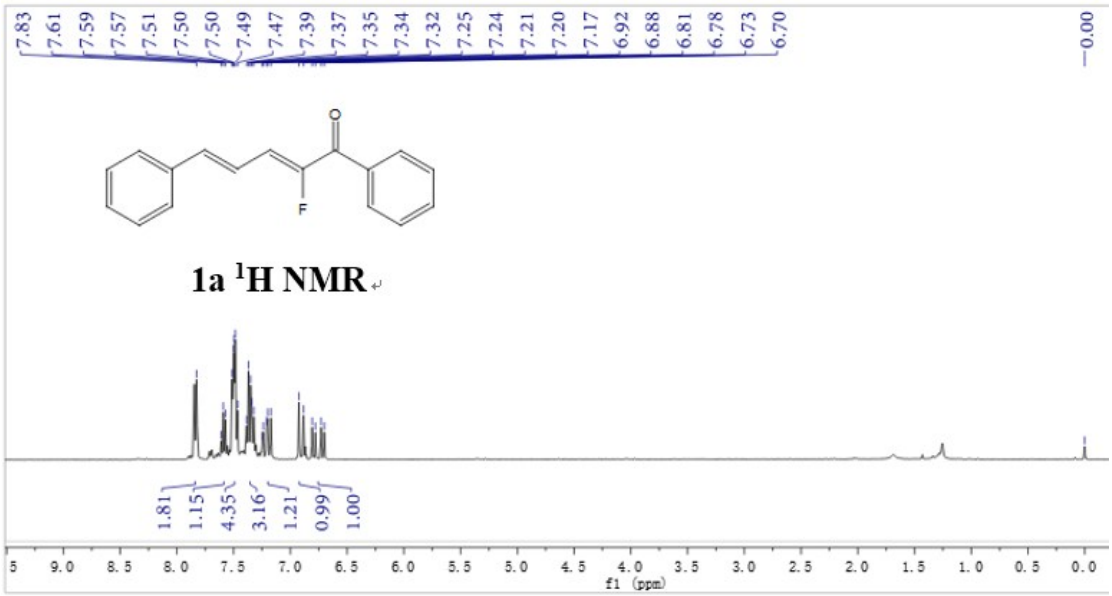
Brown solid. m.p. 196-198 °C, 198.8 mg, 71 % yield. **^{1}H NMR** (400 MHz, CD_3OD) δ 8.60 (s, 1H), 7.85 (dd, *J* = 12.8, 1.8 Hz, 1H), 7.70 (dd, *J* = 8.6, 1.8 Hz, 2H), 7.45 – 7.33 (m, 1H), 7.22 (td, *J* = 7.7, 1.7 Hz, 1H), 6.94 (t, *J* = 7.2 Hz, 2H), 6.84 – 6.73 (m, 2H). **^{19}F NMR** (377 MHz, CD_3OD) δ -126.45. **^{13}C NMR** (100 MHz, $CDCl_3$) δ 156.59 (d, *J* = 256.0 Hz), 154.64, 149.20, 144.53 (d, *J* = 4.4 Hz), 144.14 (d, *J* = 11.8 Hz), 134.18, 129.72, 129.52, 129.47, 124.35 (d, *J* = 21.7 Hz), 123.80 (d, *J* = 5.6 Hz), 122.99, 119.84, 115.80, 114.31. **HRMS** (ESI) calcd. for $C_{17}H_{14}FN_2O$ [M+H]: 344.0086, found: 344.0088.

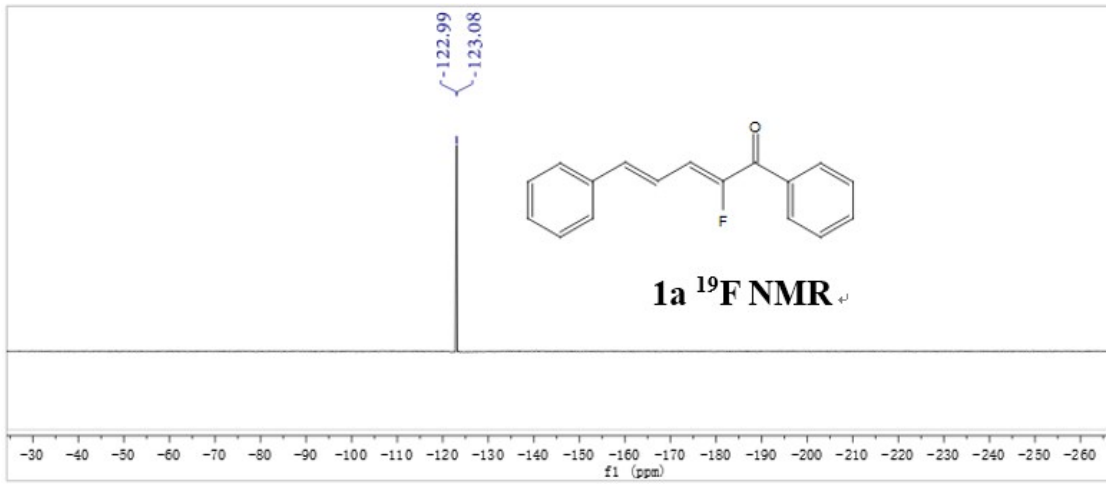
5-(3-fluoro-5-(2-hydroxyphenyl)pyridin-2-yl)indolin-2-one (13):

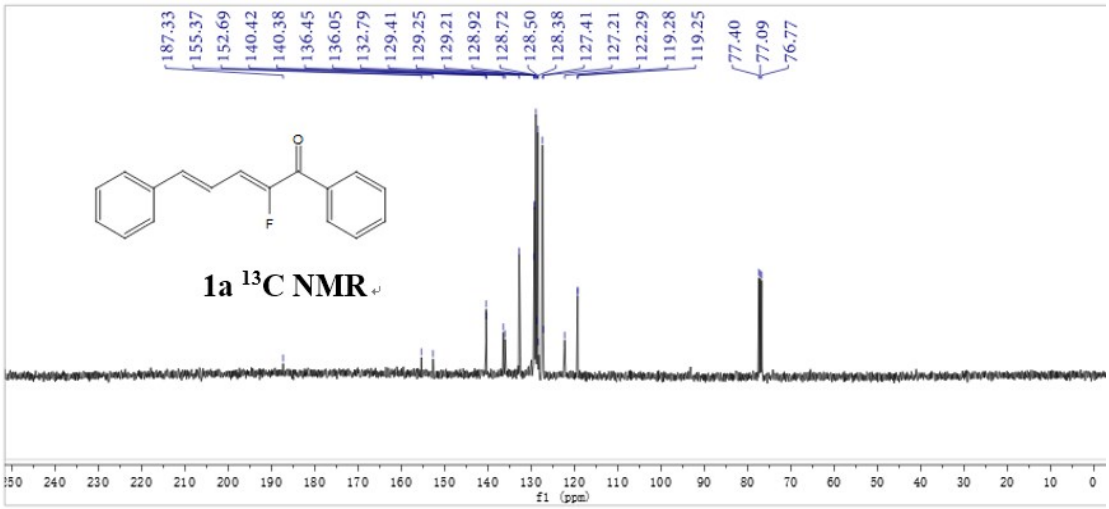


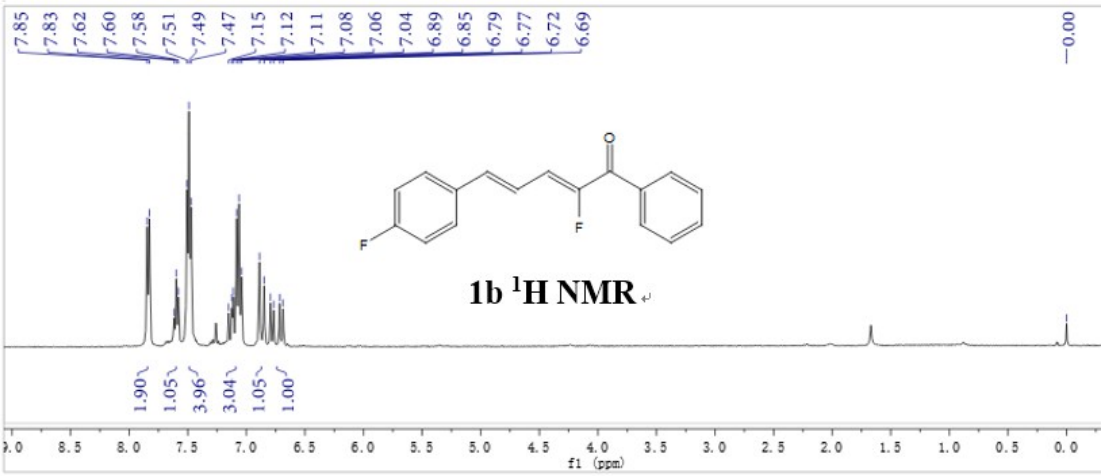
Brown solid. (thermal instability), 15.0 mg, 47 % yield. **^{1}H NMR** (400 MHz, CD_3OD) δ 8.72 (s, 1H), 8.05 (dd, *J* = 11.1, 1.8 Hz, 1H), 7.84 – 7.77 (m, 2H), 7.61 – 7.50 (m, 1H), 7.44 (dd, *J* = 7.7, 1.7 Hz, 1H), 7.27 (td, *J* = 7.8, 1.7 Hz, 1H), 6.97 (t, *J* = 8.3 Hz, 2H), 3.72 (s, 2H). **^{19}F NMR** (377 MHz, CD_3OD) -124.10 (d, *J* = 11.2 Hz). **^{13}C NMR** (100 MHz, CD_3OD) δ 173.25, 159.12 (d, *J* = 190.1 Hz), 155.20 (d, *J* = 87.3 Hz), 144.17, 143.26 (d, *J* = 16.2 Hz), 137.40, 136.74, 134.86, 131.29, 131.03, 130.04, 129.90, 125.06 (d, *J* = 21.4 Hz), 123.03, 122.37, 119.93, 119.17, 115.85, 38.86. **HRMS** (ESI) calcd. for $C_{19}H_{14}FN_2O_2$ [M+H]: 321.1039, found: 321.1040.

3. Copies of ^{1}H, ^{19}F, ^{13}C NMR

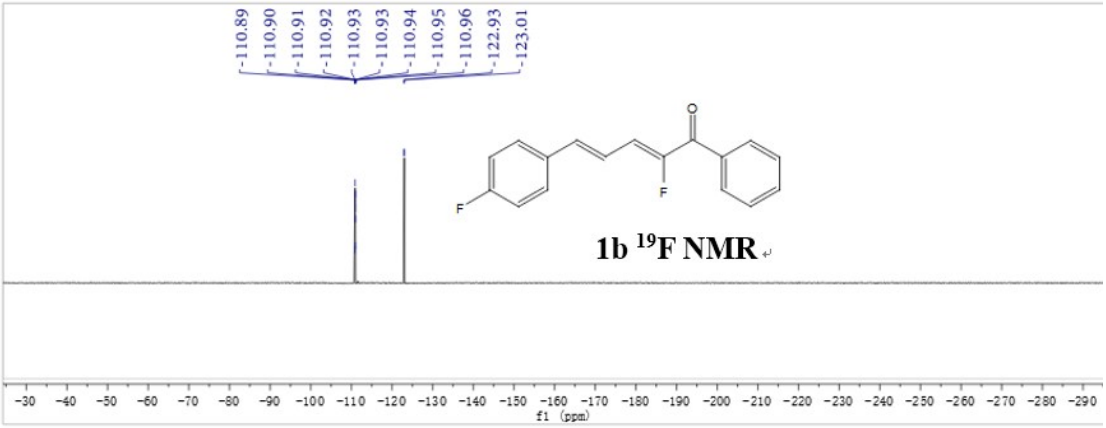




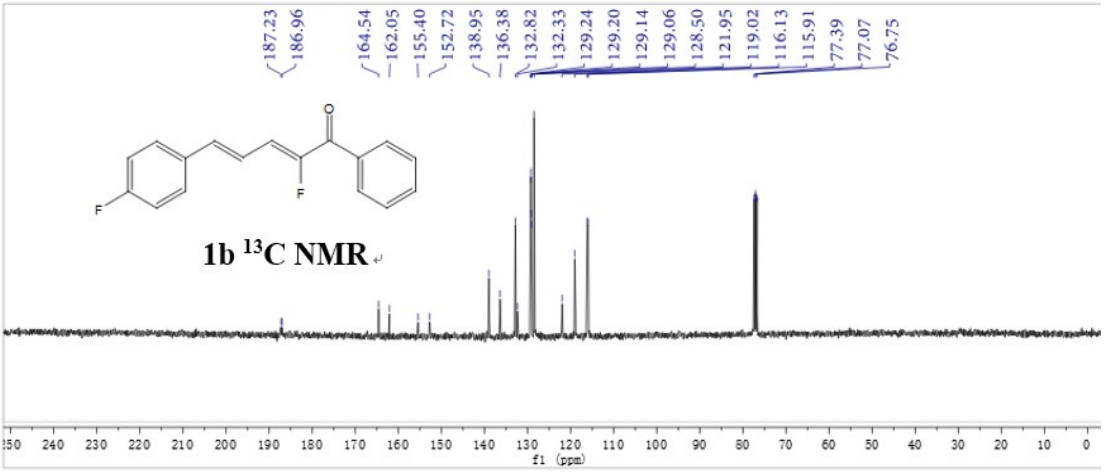




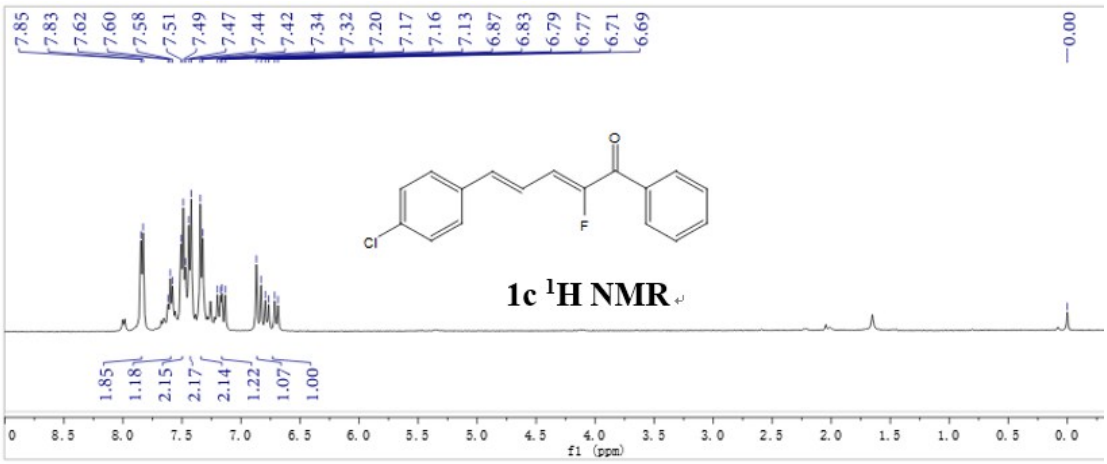
1b ^{1}H NMR



1b ^{19}F NMR



1b ^{13}C NMR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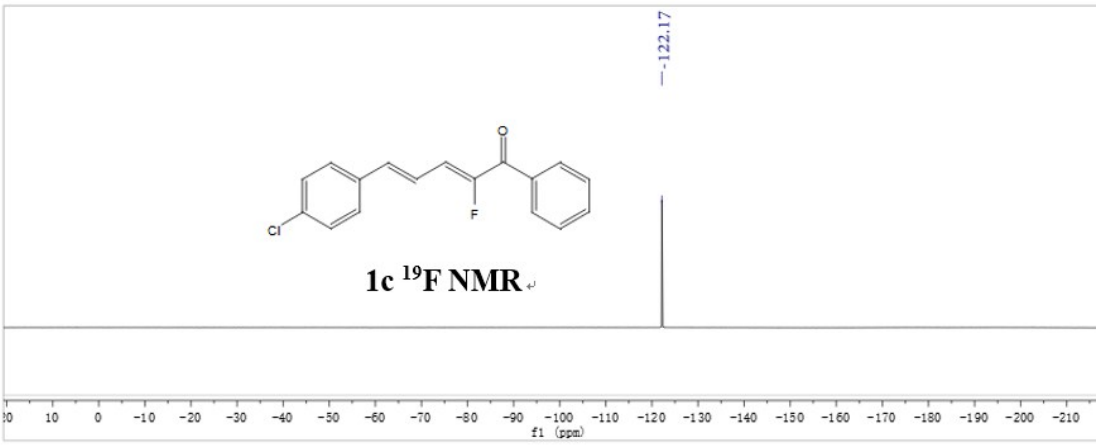
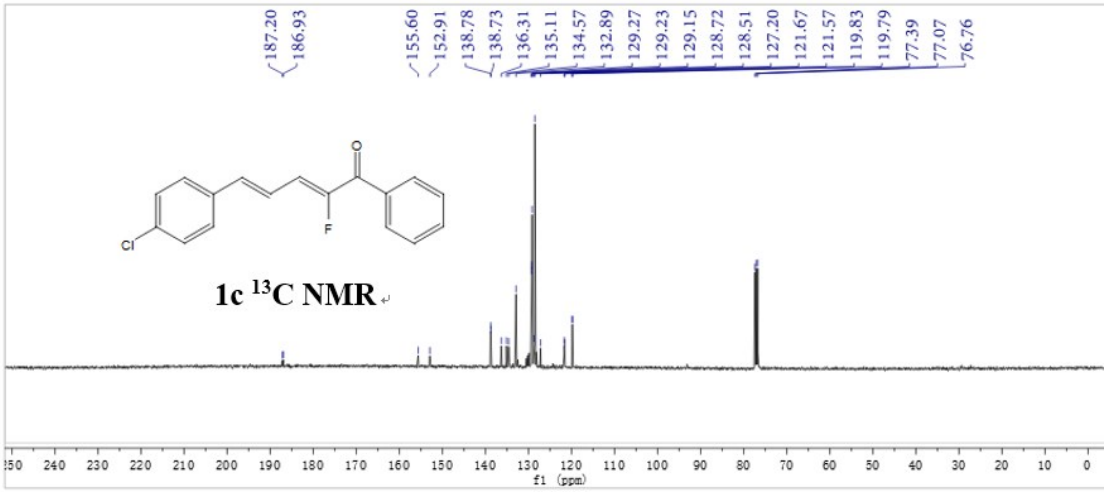
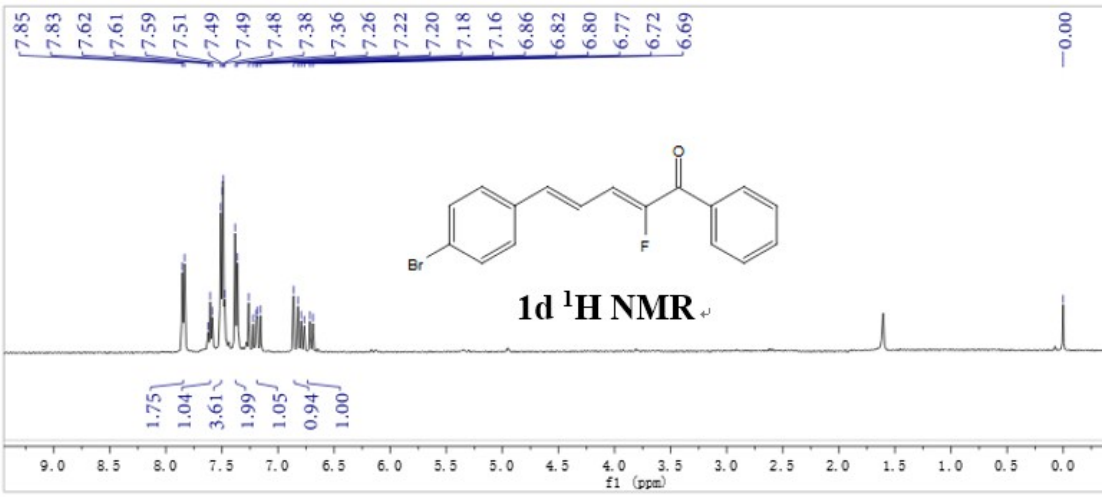
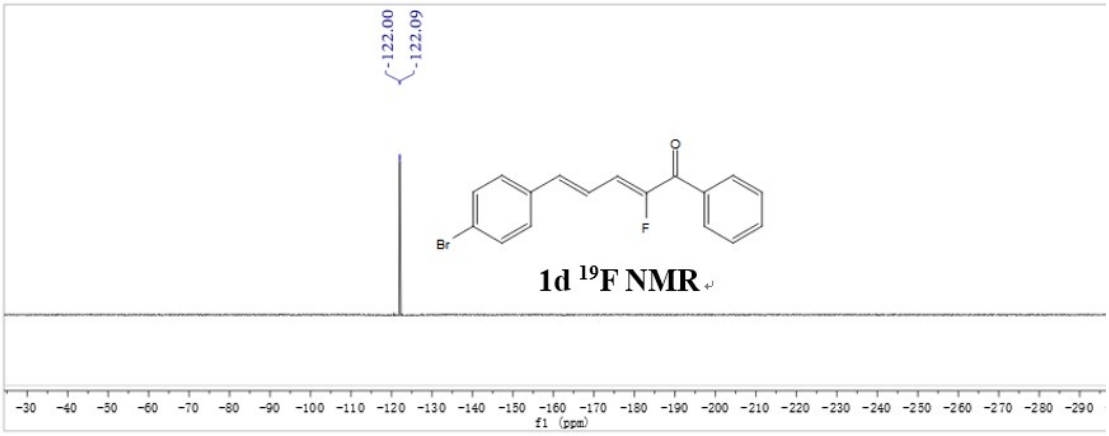
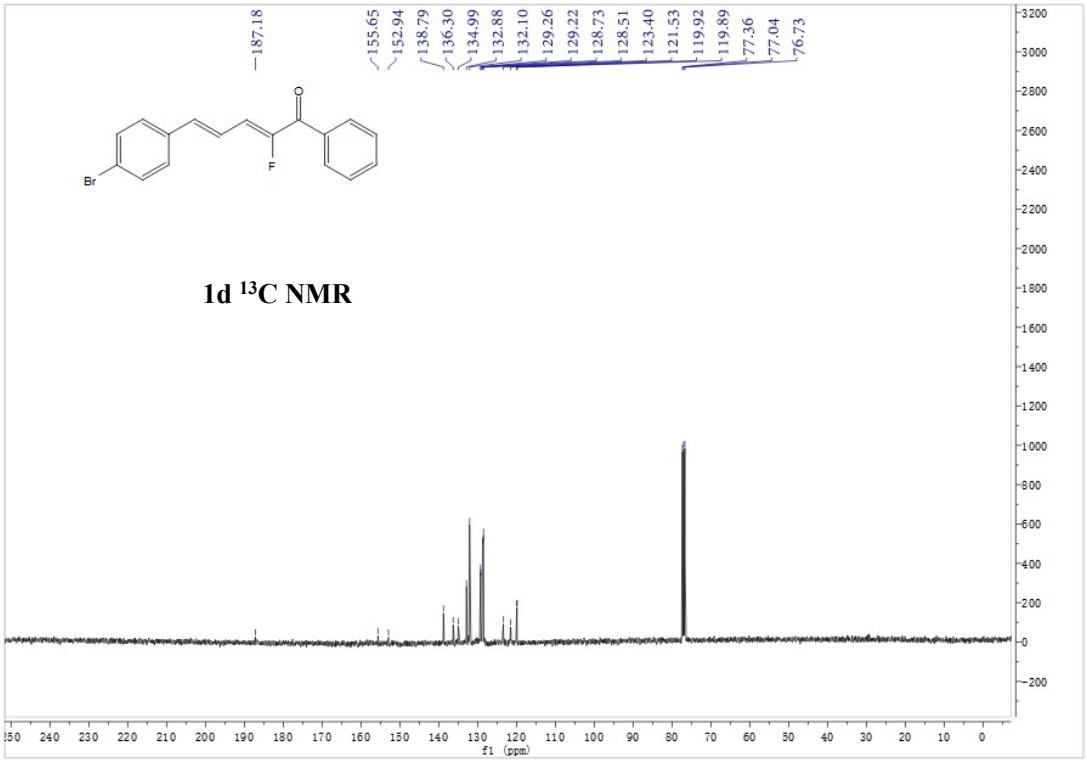
7.83
7.62
7.60
7.58
7.51
7.49
7.47
7.44
7.42
7.34
7.32
7.20
7.17
7.16
7.13
6.87
6.83
6.79
6.77
6.71
6.69
0.00
O
F
Cl
1c ^{1}H NMR
1.85
1.18
2.15
2.17
2.14
1.22
1.07
1.00
f1 (ppm)


-122.17
O
F
Cl
1c ^{19}F NMR
f1 (ppm)


187.20
186.93
155.60
152.91
138.78
138.73
136.31
135.11
134.57
132.89
129.27
129.23
129.15
128.72
128.51
127.20
121.67
121.57
119.83
119.79
77.39
77.07
76.76
O
F
Cl
1c ^{13}C NMR
f1 (ppm)


7.85
7.83
7.62
7.61
7.59
7.51
7.49
7.49
7.48
7.38
7.36
7.26
7.22
7.20
7.18
7.16
6.86
6.82
6.80
6.77
6.72
6.69
0.00
Br
F
1d ^{1}H NMR
1.75
1.04
3.61
1.99
1.05
0.94
1.00
f1 (ppm)


122.00
122.09
Br
F
1d ^{19}F NMR
f1 (ppm)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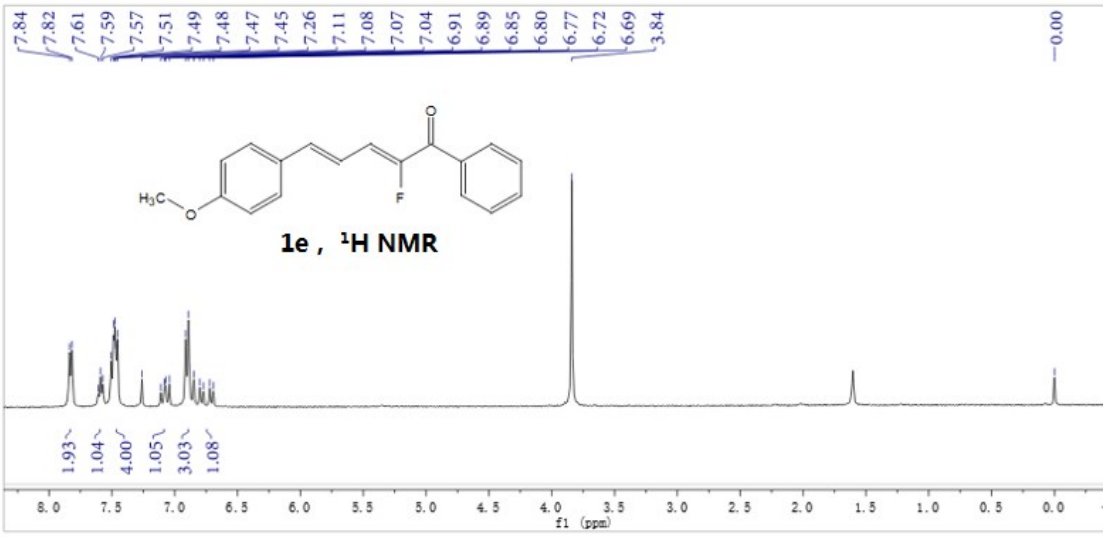
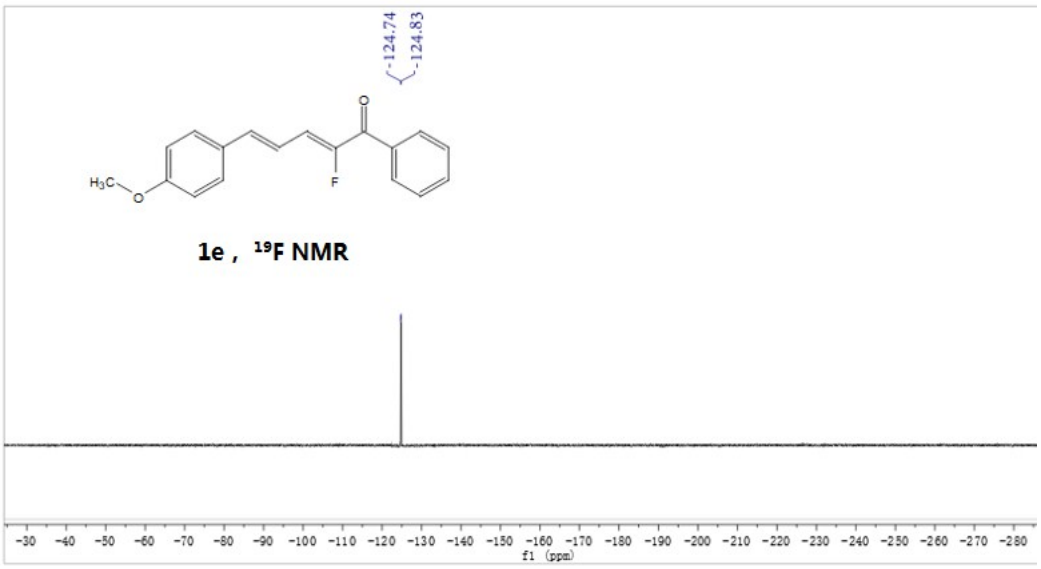
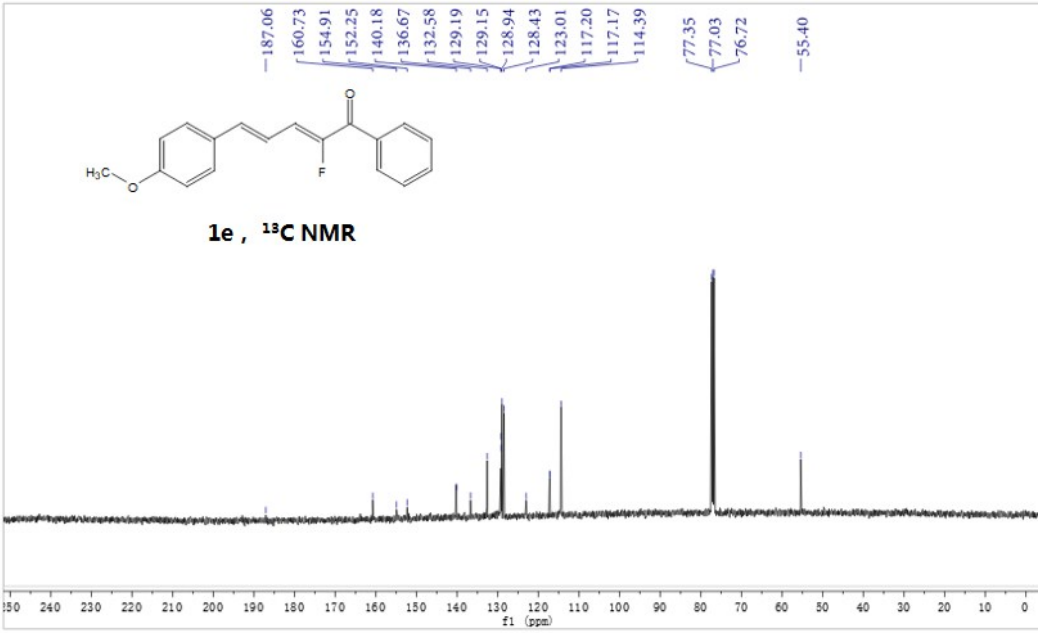
155.65
152.94
138.79
136.30
134.99
132.88
132.10
129.26
129.22
128.73
128.51
123.40
121.53
119.92
119.89
77.36
77.04
76.73
Br
F
1d ^{13}C NMR
f1 (ppm)


7.84
7.82
7.61
7.59
7.57
7.51
7.49
7.48
7.47
7.45
7.26
7.11
7.08
7.07
7.04
6.91
6.89
6.85
6.80
6.77
6.72
6.69
3.84
0.00
O
F
H3C
O
1e , 1H NMR
1.93
1.04
4.00
1.05
3.03
1.08
f1 (ppm)


-124.74
-124.83
O
F
H3C
O
1e , 19F NMR
f1 (ppm)


187.06
160.73
154.91
152.25
140.18
136.67
132.58
129.19
129.15
128.94
128.43
123.01
117.20
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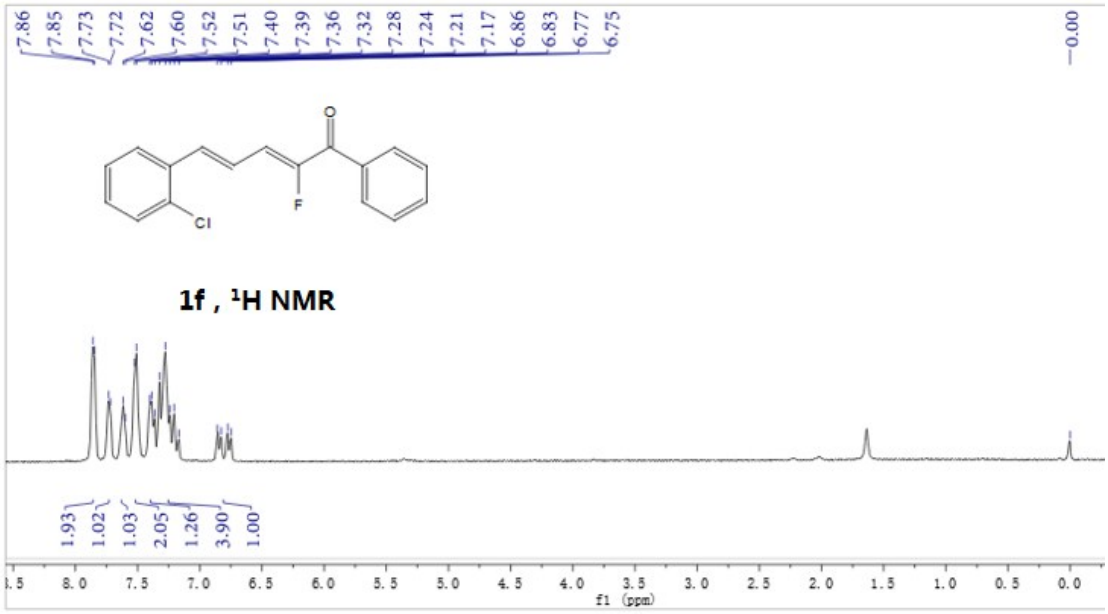
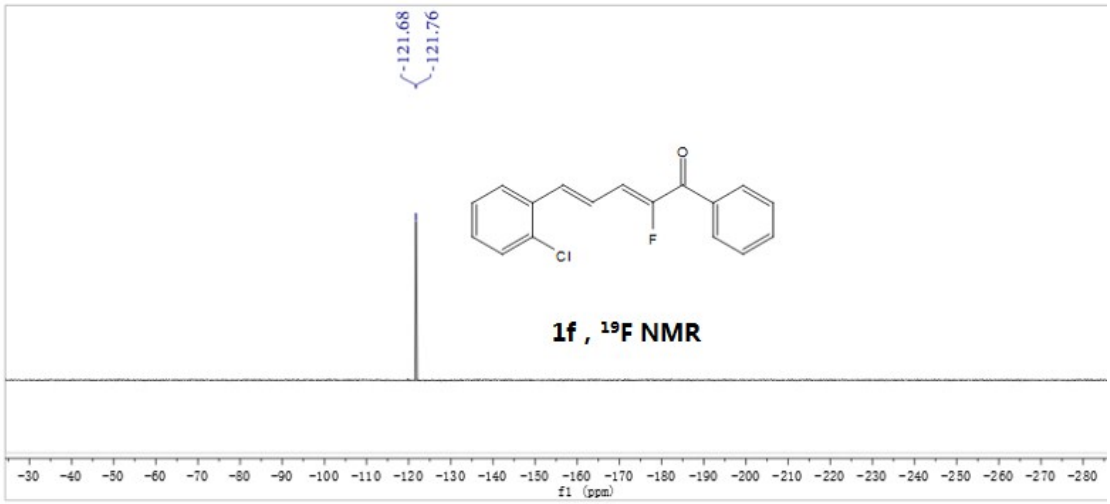
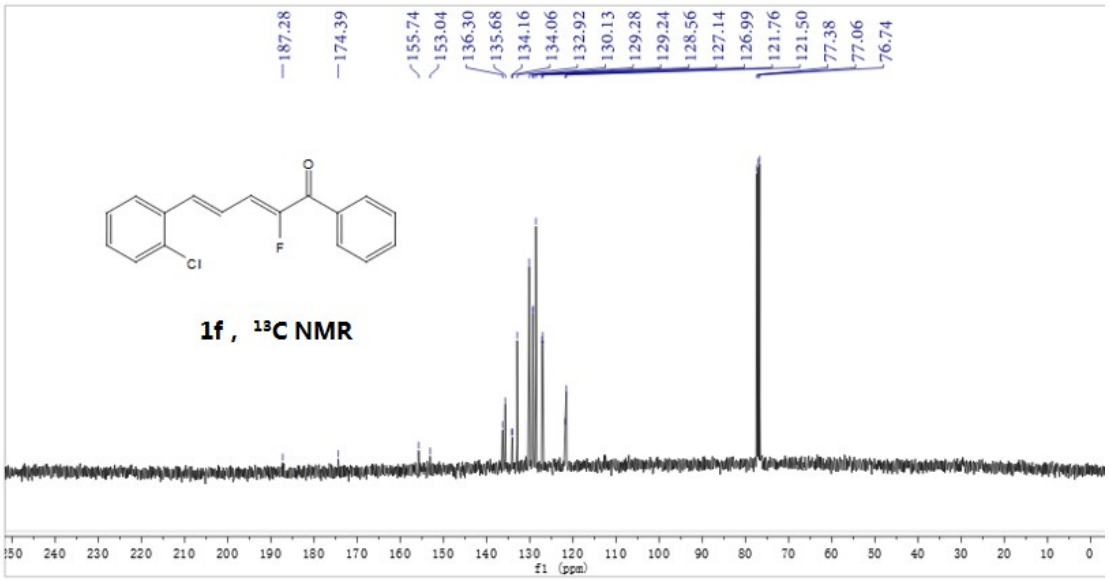
O
F
H3C
O
1e , 13C NMR
f1 (ppm)


7.86
7.85
7.73
7.72
7.62
7.60
7.52
7.51
7.40
7.39
7.36
7.32
7.28
7.24
7.21
7.17
6.86
6.83
6.77
6.75
0.00
O
F
Cl
1f , ¹H NMR
1.93
1.02
1.03
2.05
1.26
3.90
1.00
f1 (ppm)


-121.68
-121.76
O
F
Cl
1f , ¹⁹F NMR
f1 (ppm)


187.28
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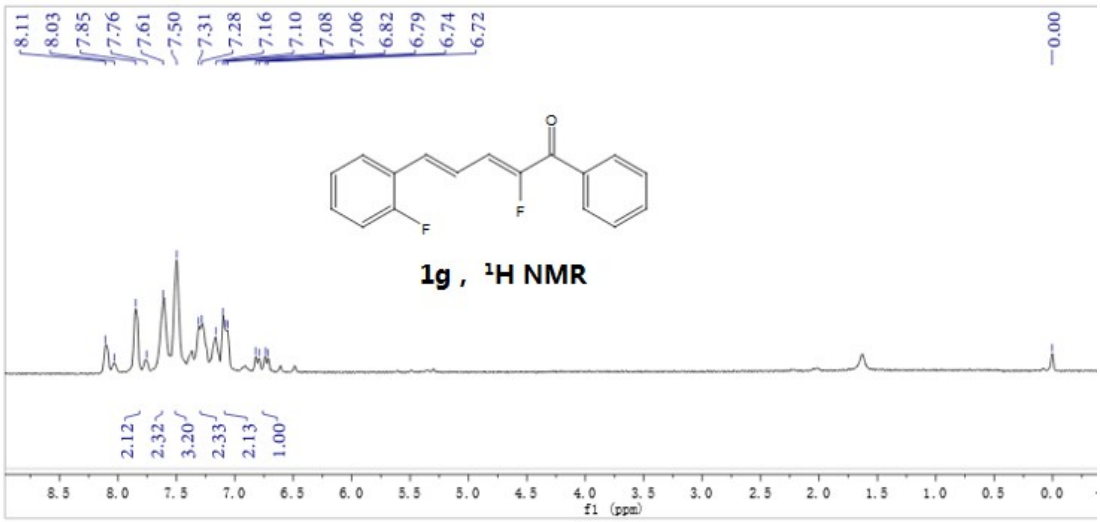
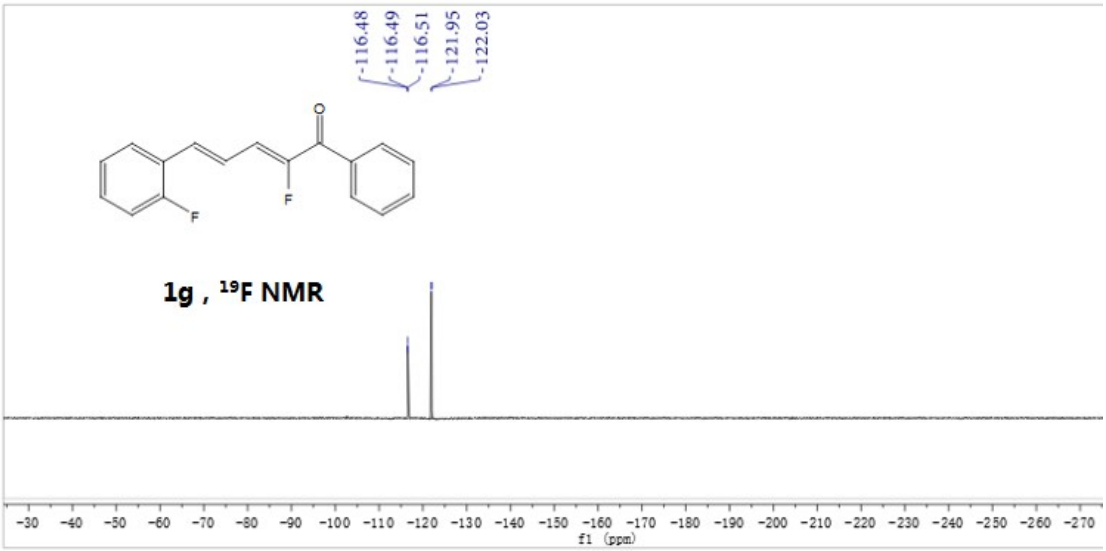
153.04
136.30
135.68
134.16
134.06
132.92
130.13
129.28
129.24
128.56
127.14
126.99
121.76
121.50
77.38
77.06
76.74
O
F
Cl
1f , ¹³C NMR
f1 (ppm)


8.11
8.03
7.85
7.76
7.61
7.50
7.31
7.28
7.16
7.10
7.08
7.06
6.82
6.79
6.74
6.72
0.00
O
F
F
1g , ¹H NMR
2.12
2.32
3.20
2.33
2.13
1.00
f1 (ppm)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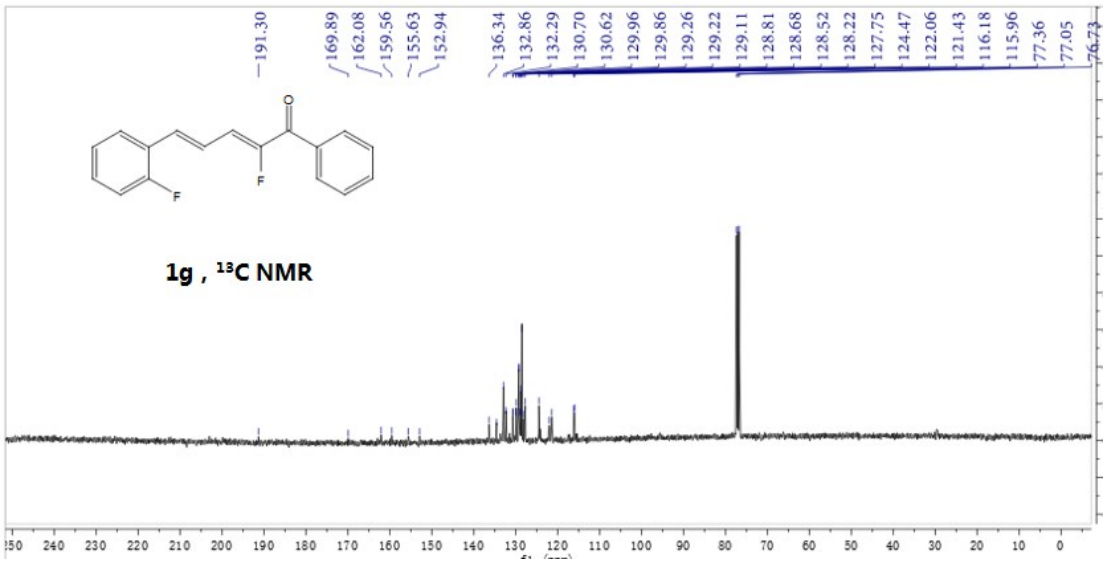
-116.49
-116.51
-121.95
-122.03
O
F
F
1g , ¹⁹F NMR
f1 (ppm)


191.30
169.89
162.08
159.56
155.63
152.94
136.34
132.86
132.29
130.70
130.62
129.96
129.86
129.26
129.22
129.11
128.81
128.68
128.52
128.22
127.75
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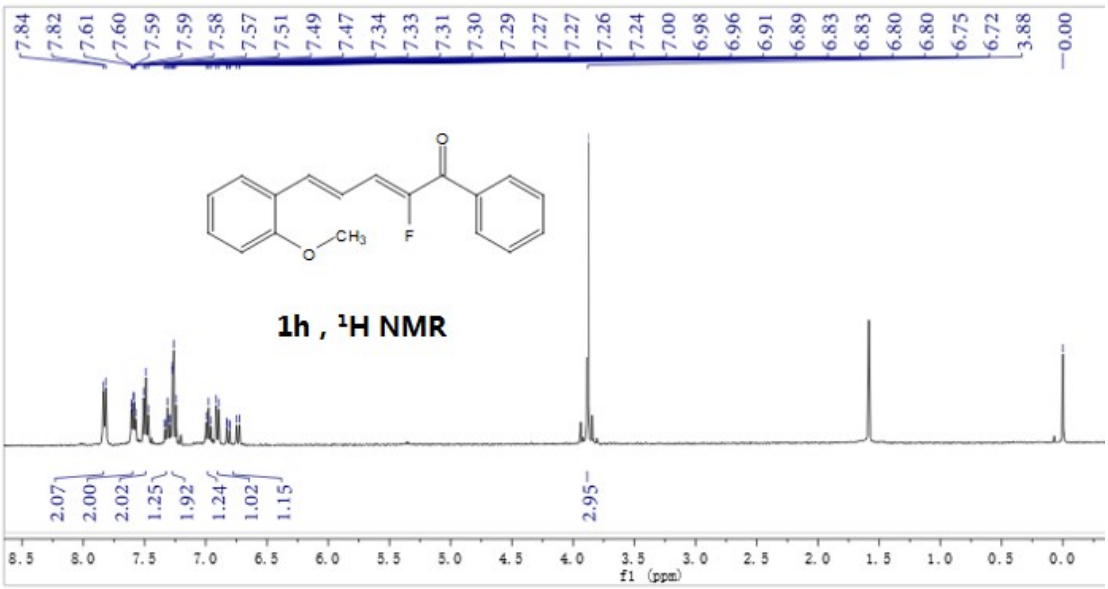
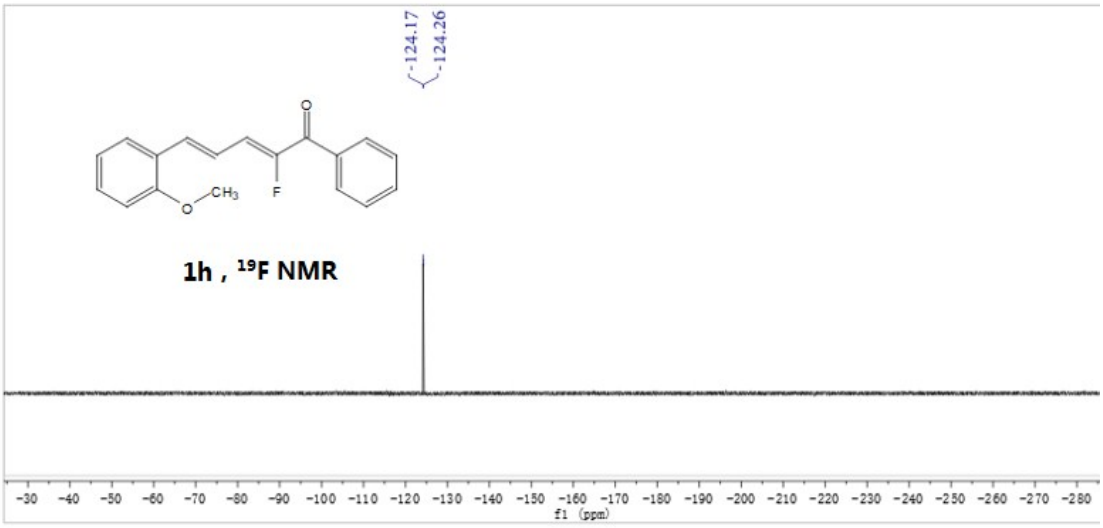
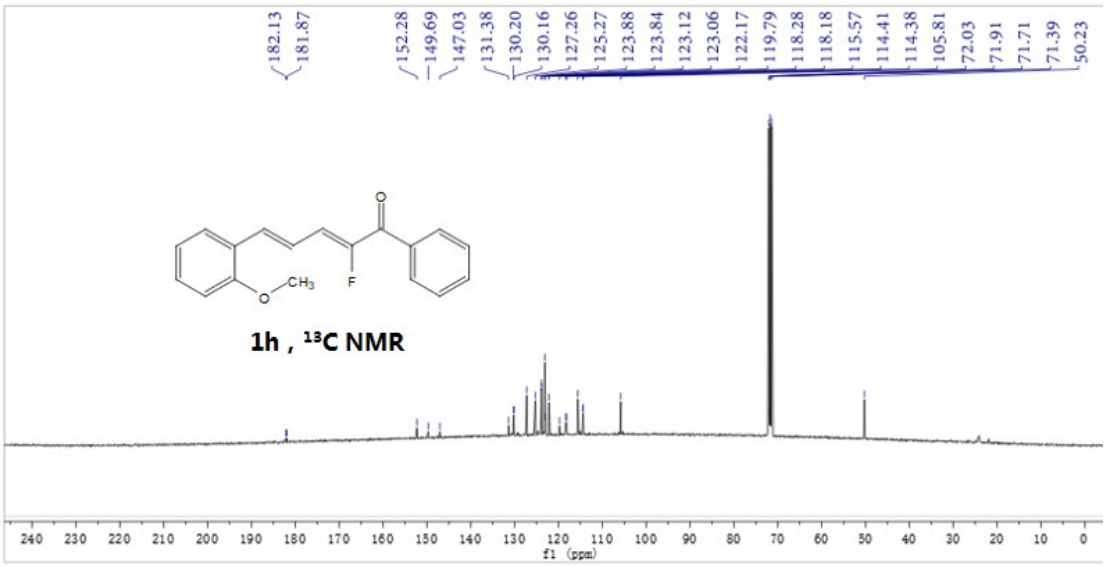
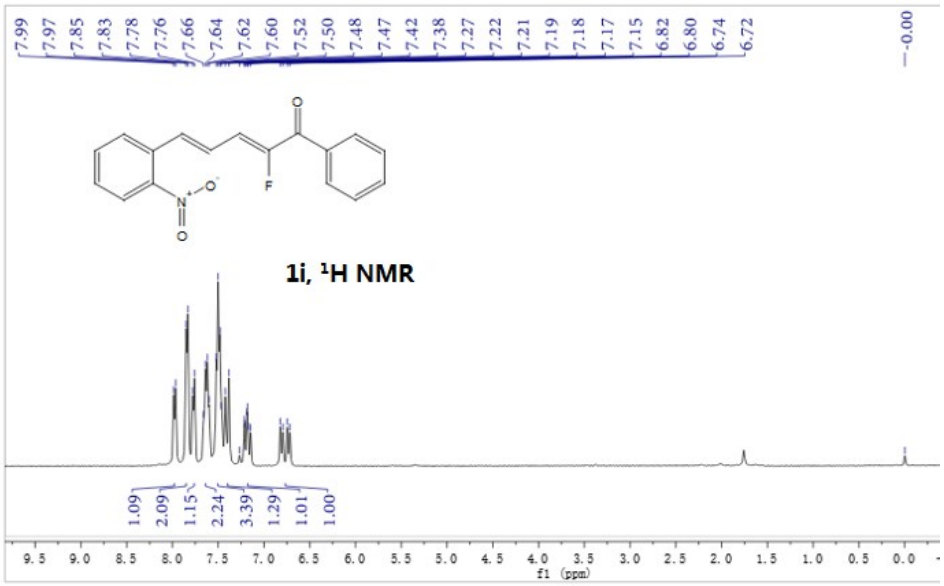
77.05
76.73
O
F
F
1g , ¹³C NMR

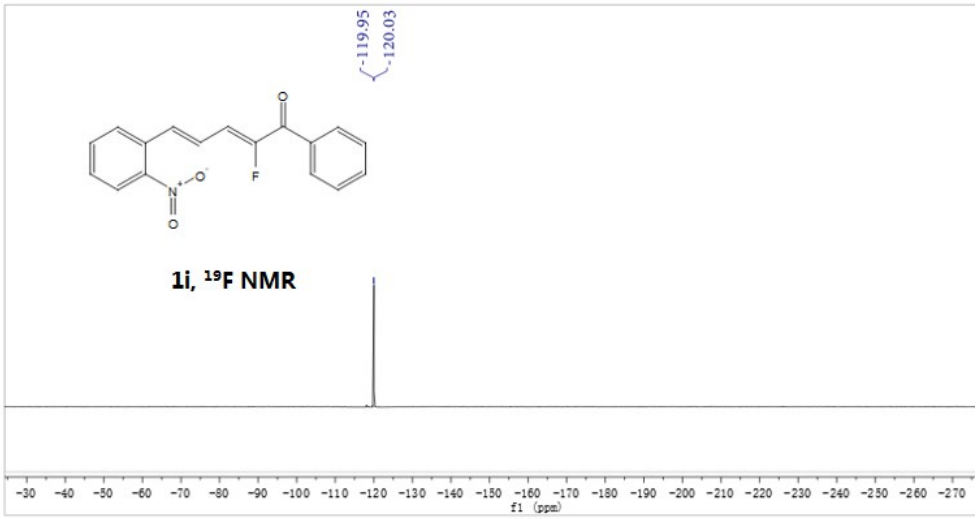

7.84 7.82 7.61 7.60 7.59 7.59 7.58 7.57 7.51 7.49 7.47 7.34 7.33 7.31 7.30 7.29 7.27 7.27 7.26 7.24 7.00 6.98 6.96 6.91 6.89 6.83 6.83 6.80 6.80 6.75 6.72 3.88 0.00
O
CH3
O
F
1h , 1H NMR
2.07 2.00 2.02 1.25 1.92 1.24 1.02 1.15 2.95
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


-124.17
-124.26
O
CH3
O
F
1h , 19F NMR
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220 -230 -240 -250 -260 -270 -280
f1 (ppm)

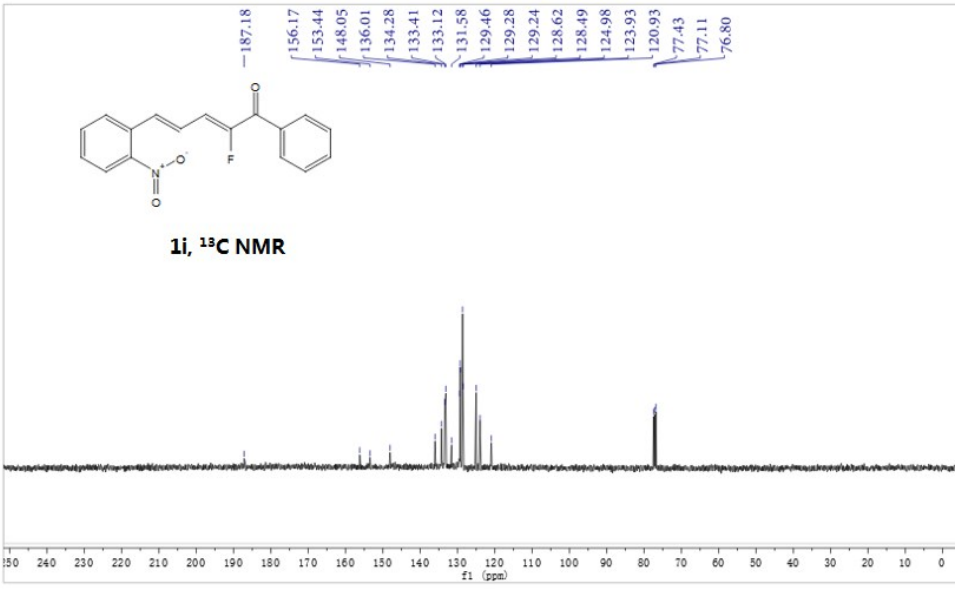

182.13 181.87 152.28 149.69 147.03 131.38 130.20 130.16 127.26 125.27 123.88 123.84 123.12 123.06 122.17 119.79 118.28 118.18 115.57 114.41 114.38 105.81 72.03 71.91 71.71 71.39 50.23
O
CH3
O
F
1h , 13C NMR
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



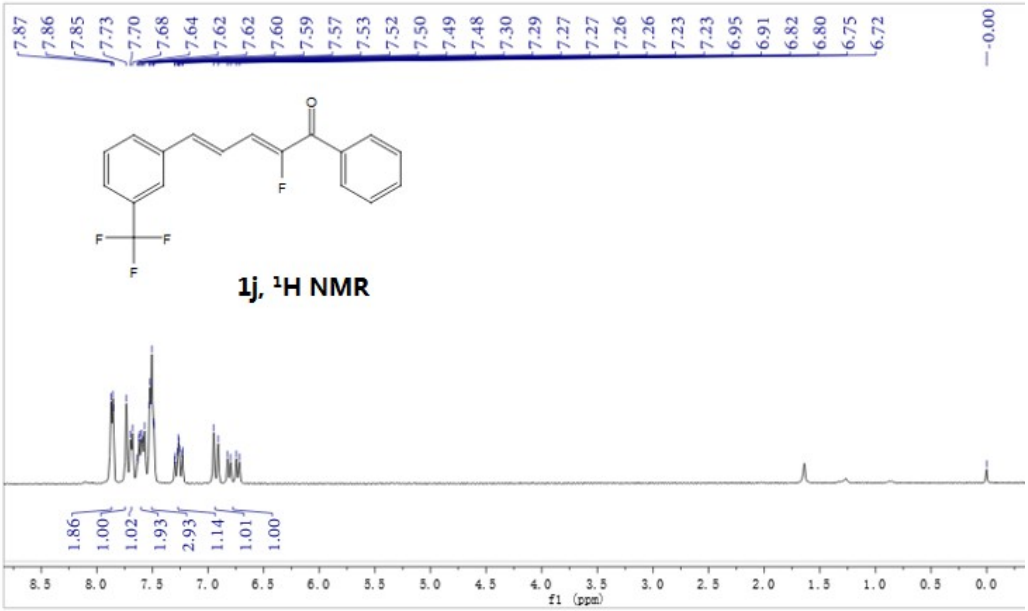
1i, ^{1}H NMR



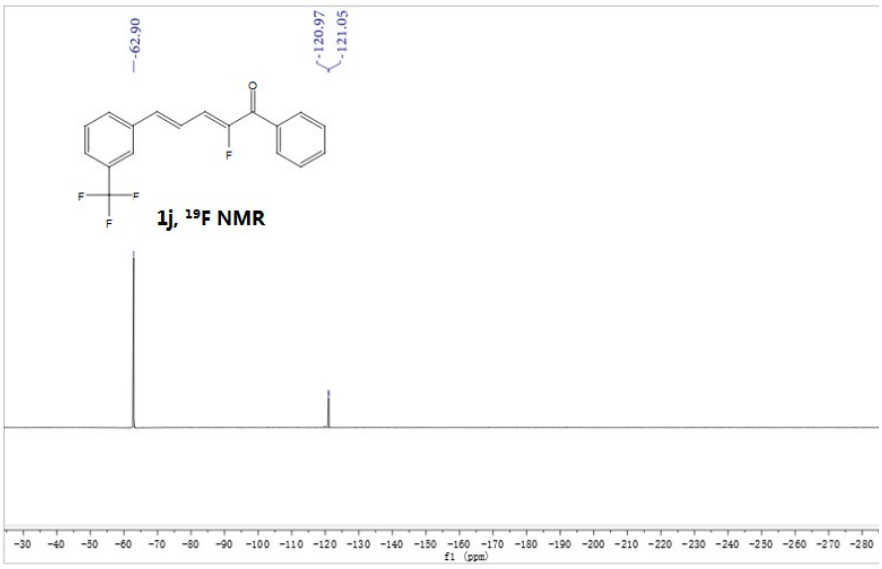
1i, ^{19}F NMR



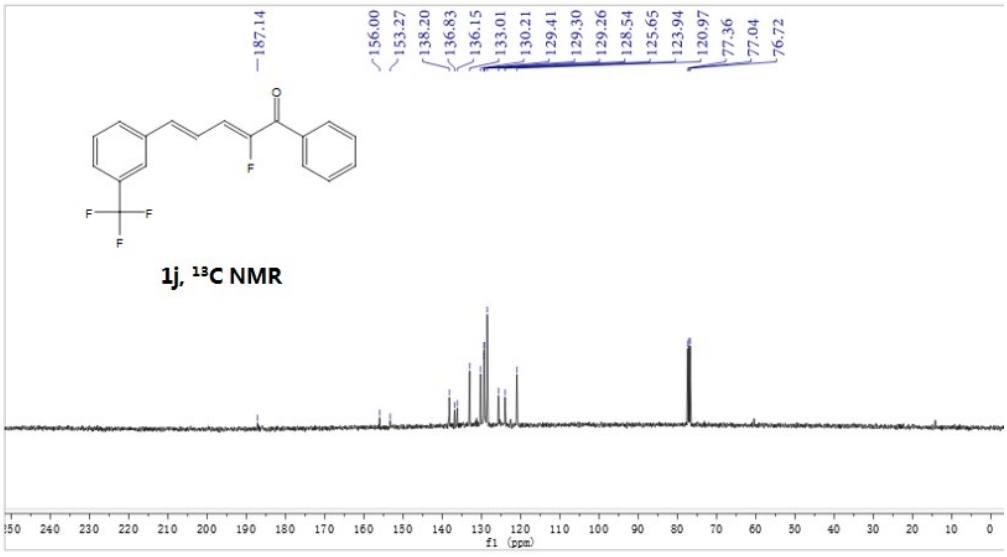
1i, ^{13}C NMR



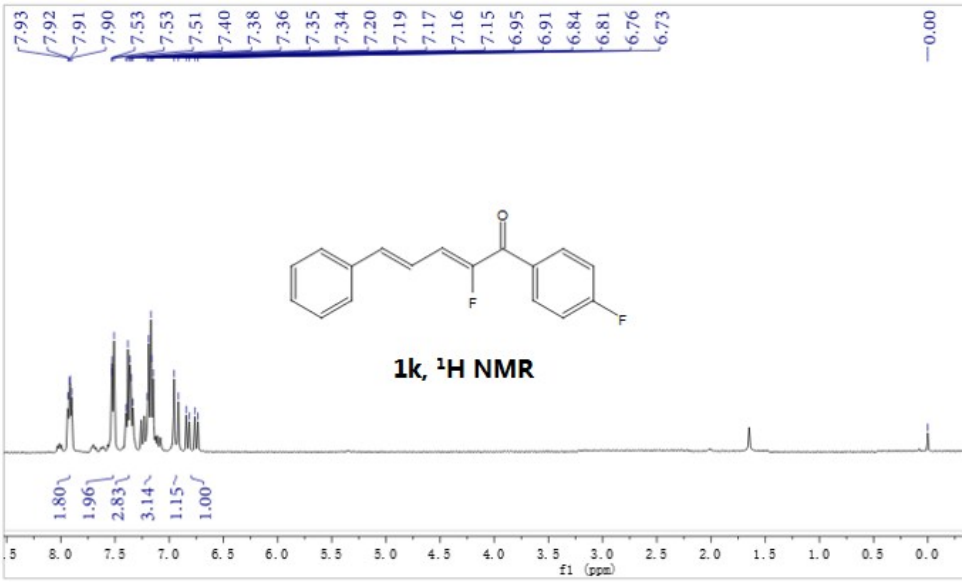
1j, ^{1}H NMR



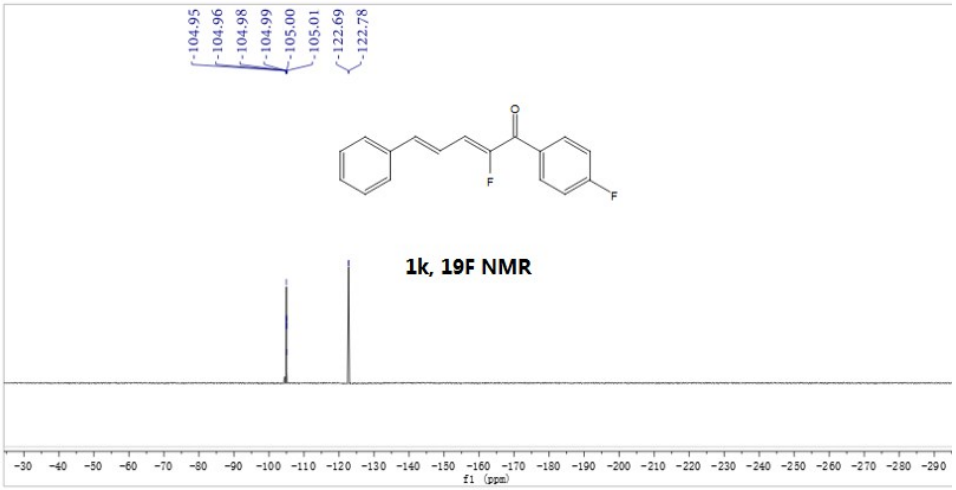
1j, ^{19}F NMR



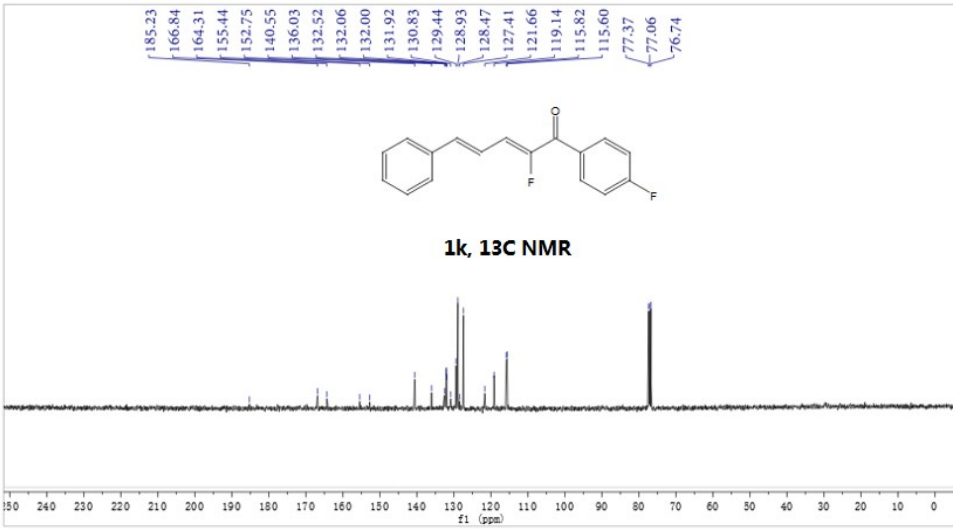
1j, ^{13}C NMR



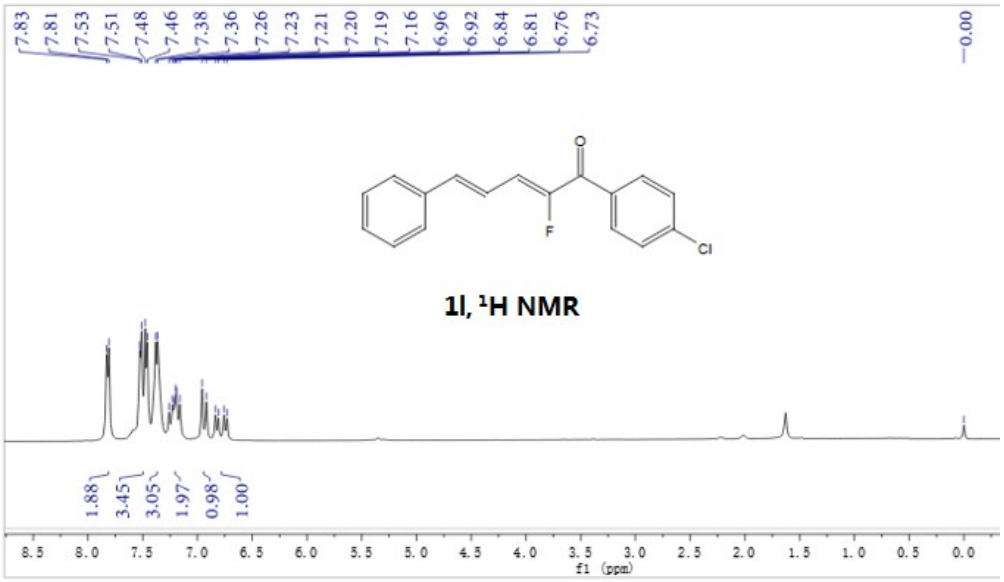
1k, ^{1}H NMR

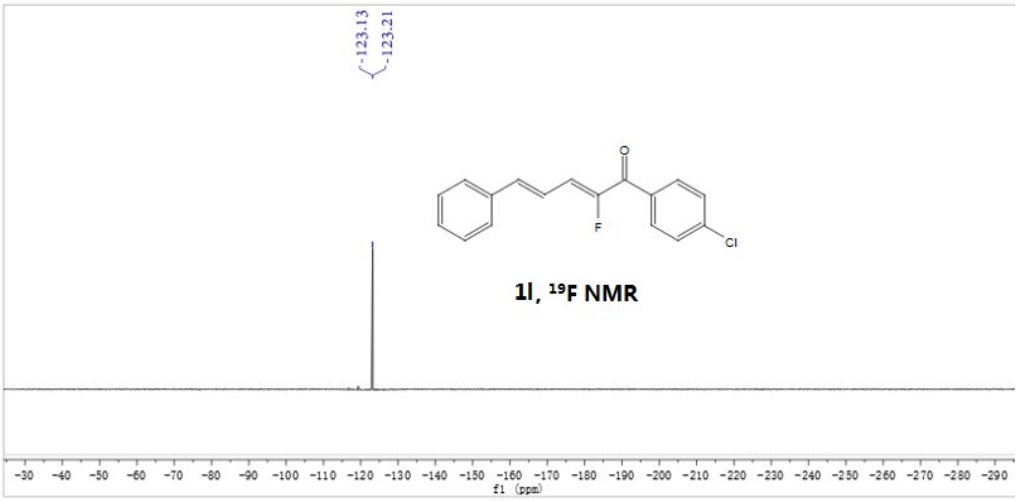


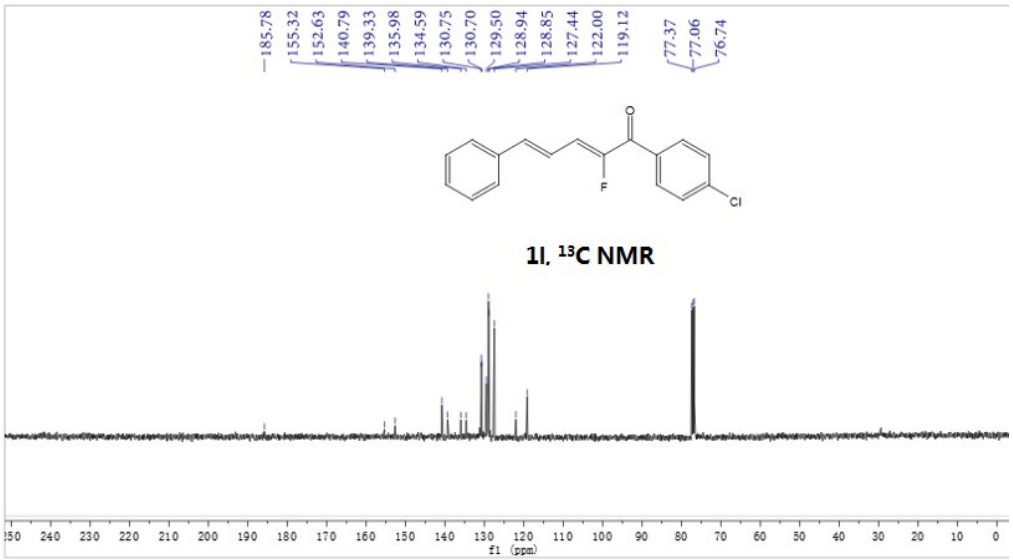
1k, 19F NMR

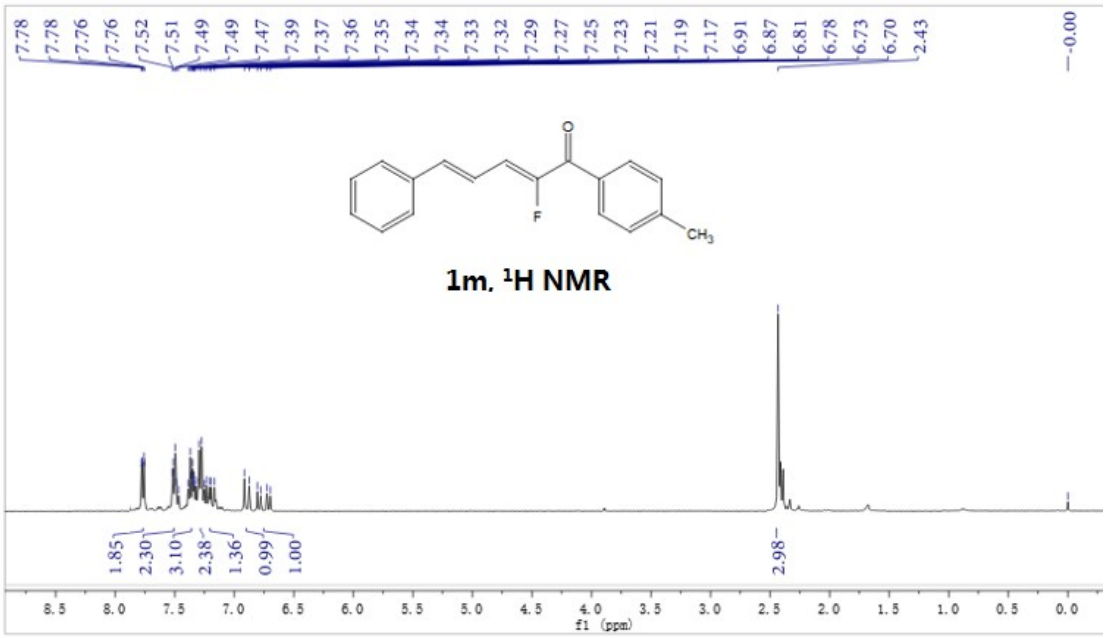


1k, 13C NMR

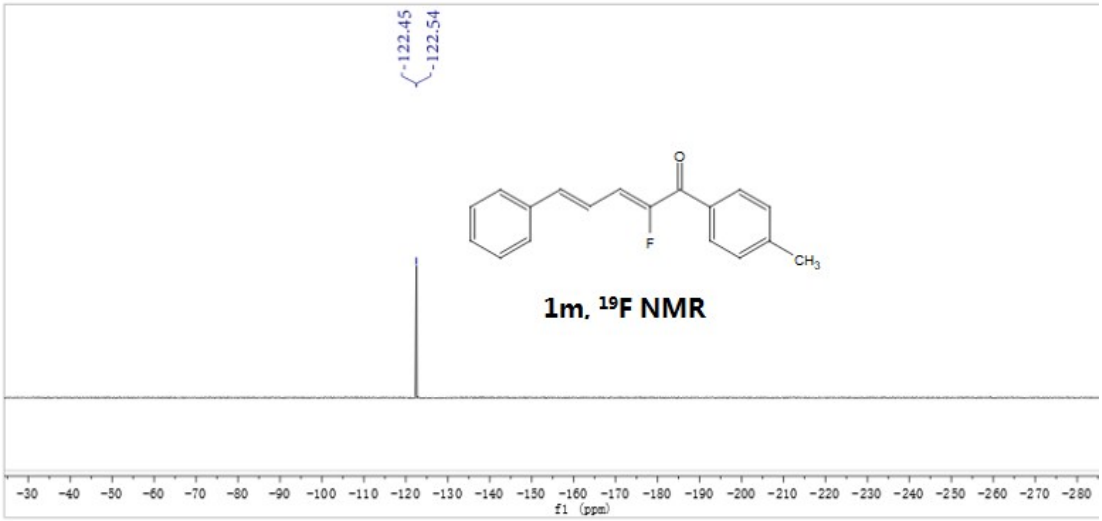

7.83
7.81
7.53
7.51
7.48
7.46
7.38
7.36
7.26
7.23
7.21
7.20
7.19
7.16
6.96
6.92
6.84
6.81
6.76
6.73
0.00
O
F
Cl
1l, ¹H NMR
1.88
3.45
3.05
1.97
0.98
1.00
8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


-123.13
-123.21
O
F
Cl
1l, ¹⁹F NMR
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220 -230 -240 -250 -260 -270 -280 -290
f1 (ppm)

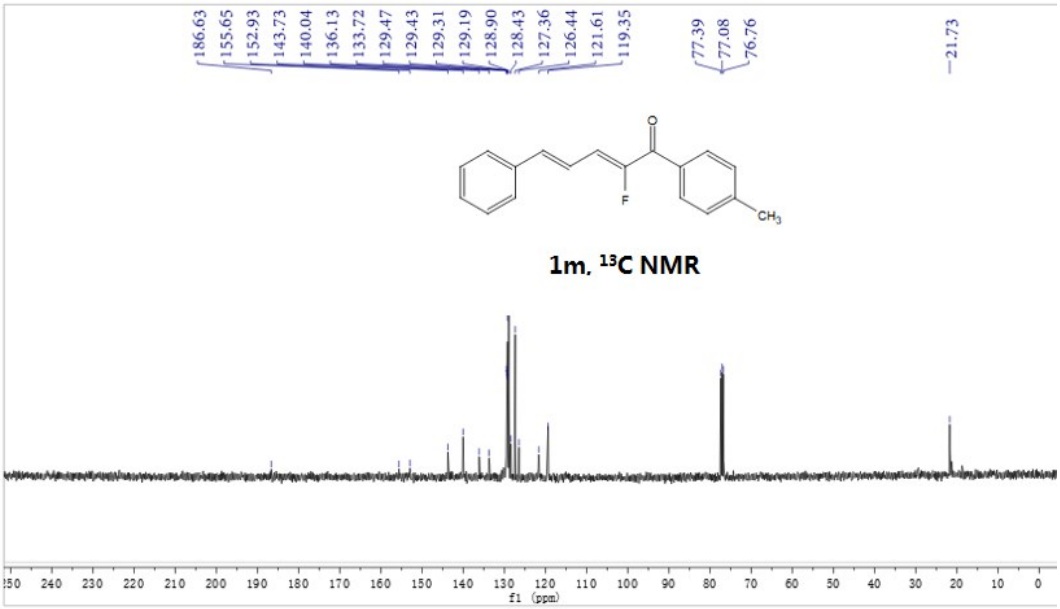

185.78
155.32
152.63
140.79
139.33
135.98
134.59
130.75
130.70
129.50
128.94
128.85
127.44
122.00
119.12
77.37
77.06
76.74
O
F
Cl
1l, ¹³C NMR
250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



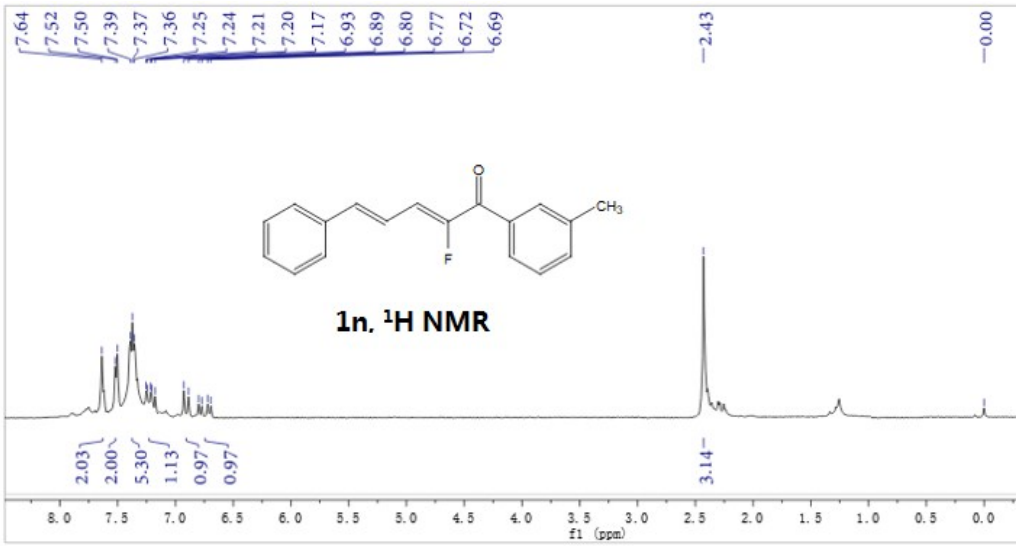
1m, ^{1}H NMR



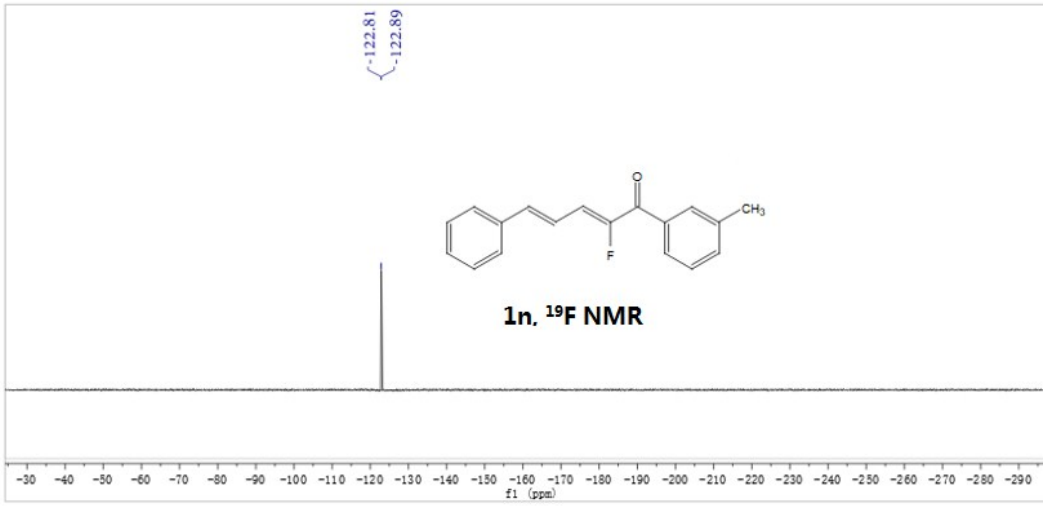
1m, ^{19}F NMR



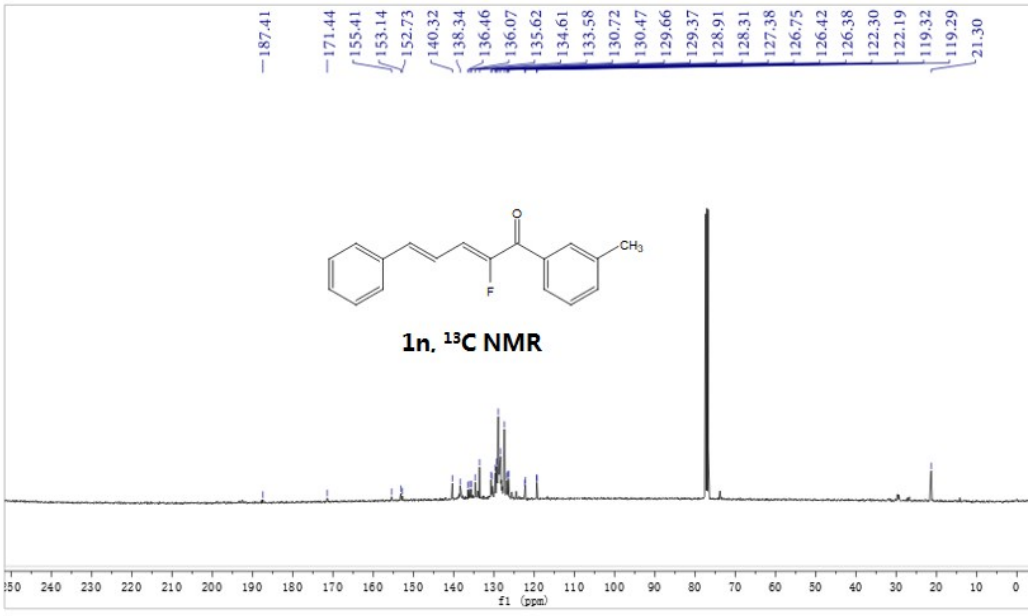
1m, ^{13}C NMR



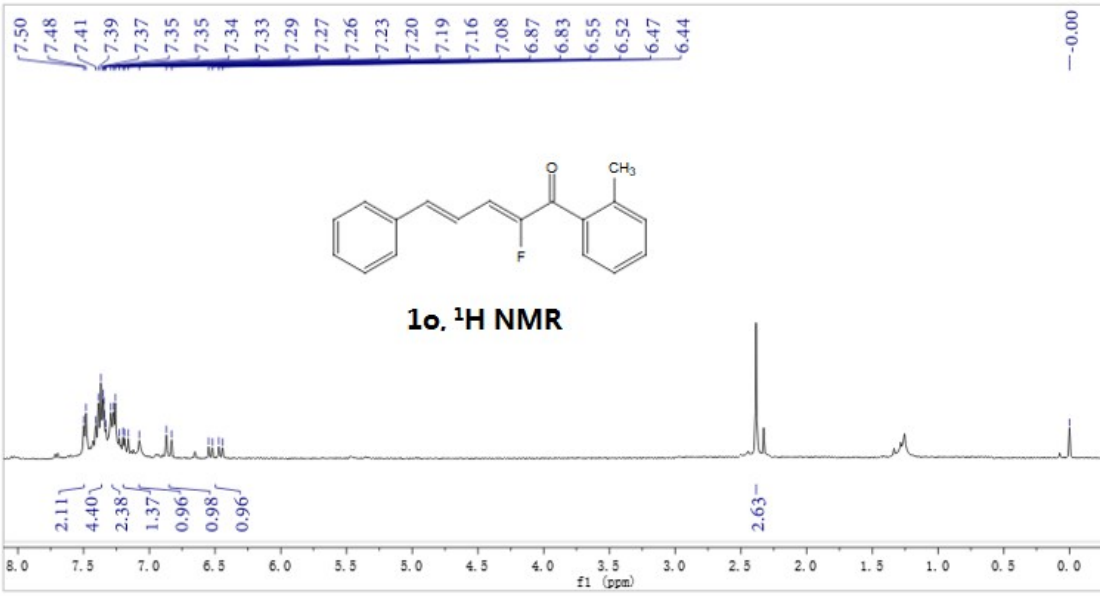
1n, ^{1}H NMR



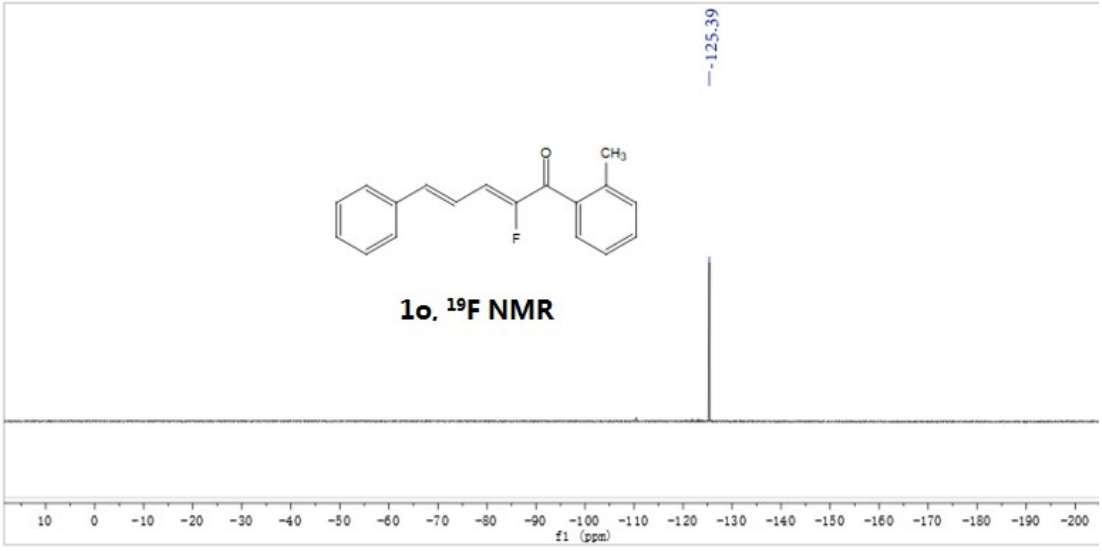
1n, ^{19}F NMR



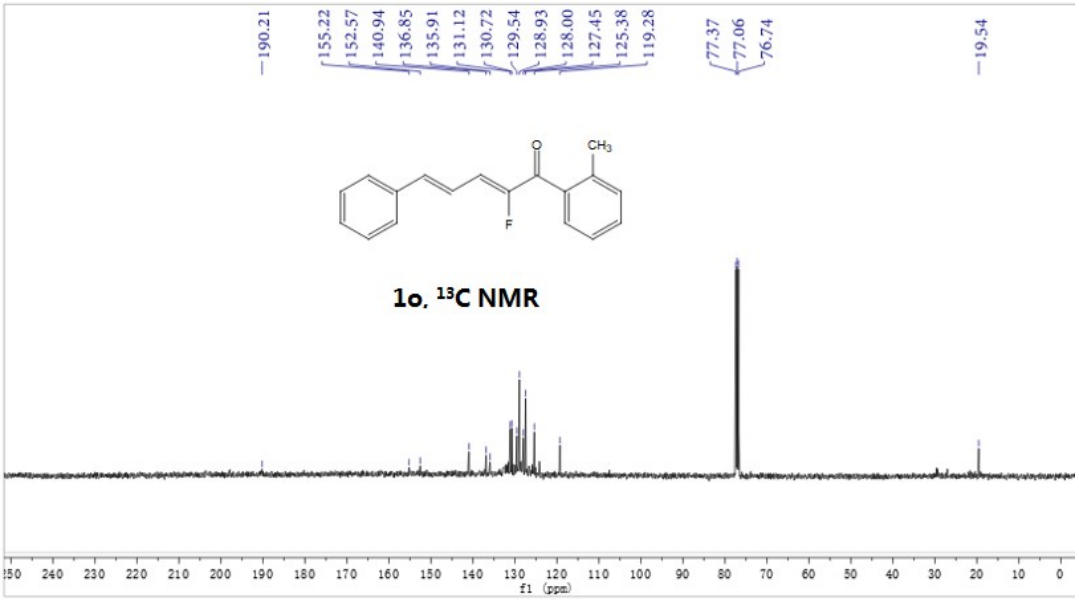
1n, ^{13}C NMR



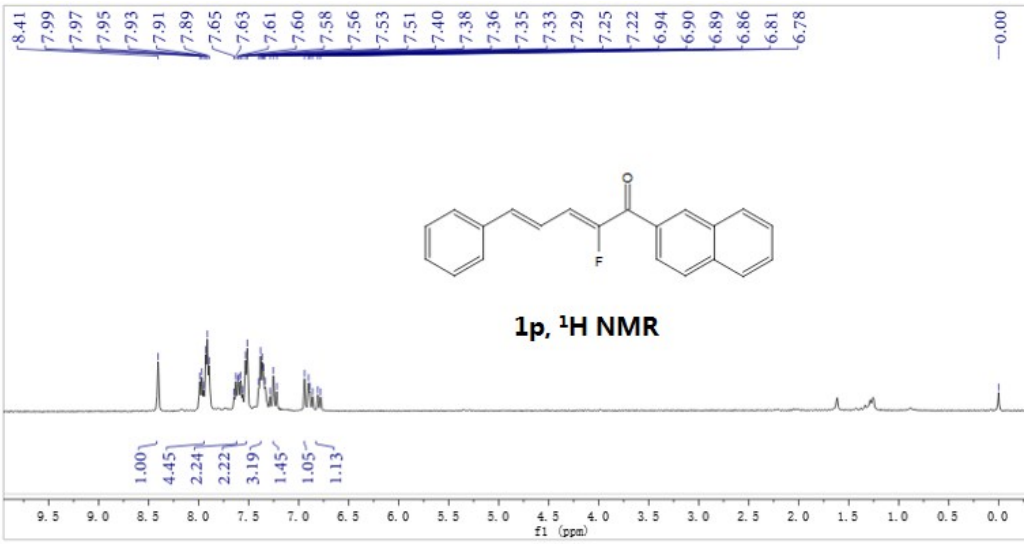
1o, ^{1}H NMR

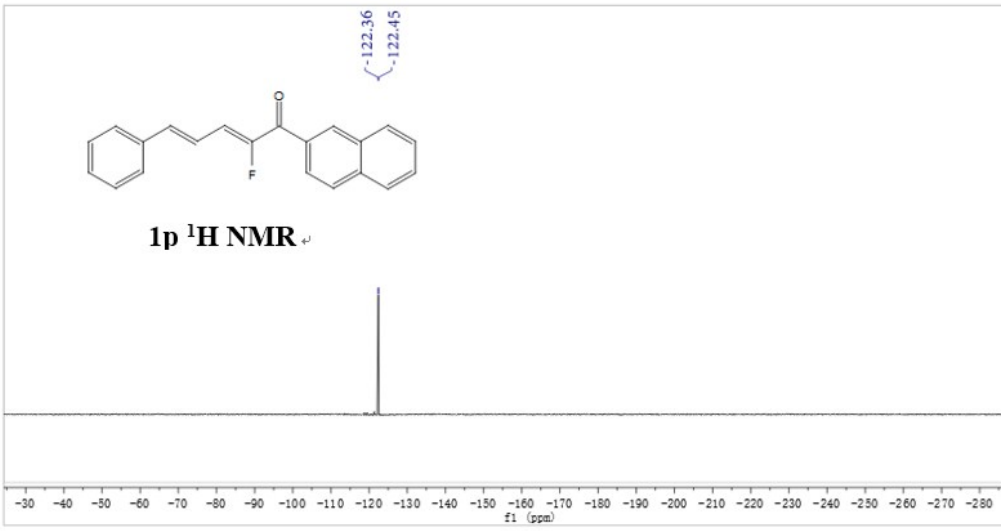


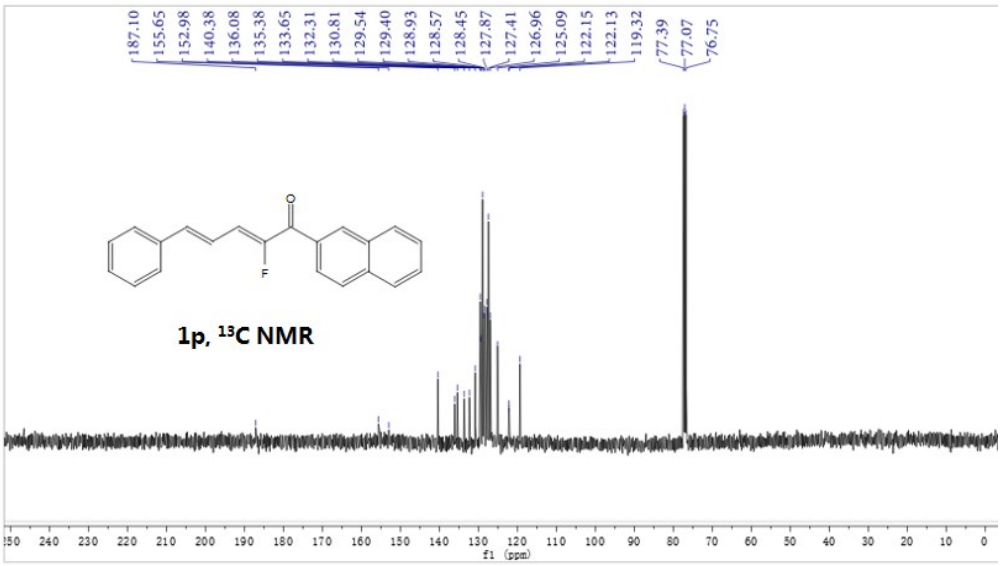
1o, ^{19}F NMR

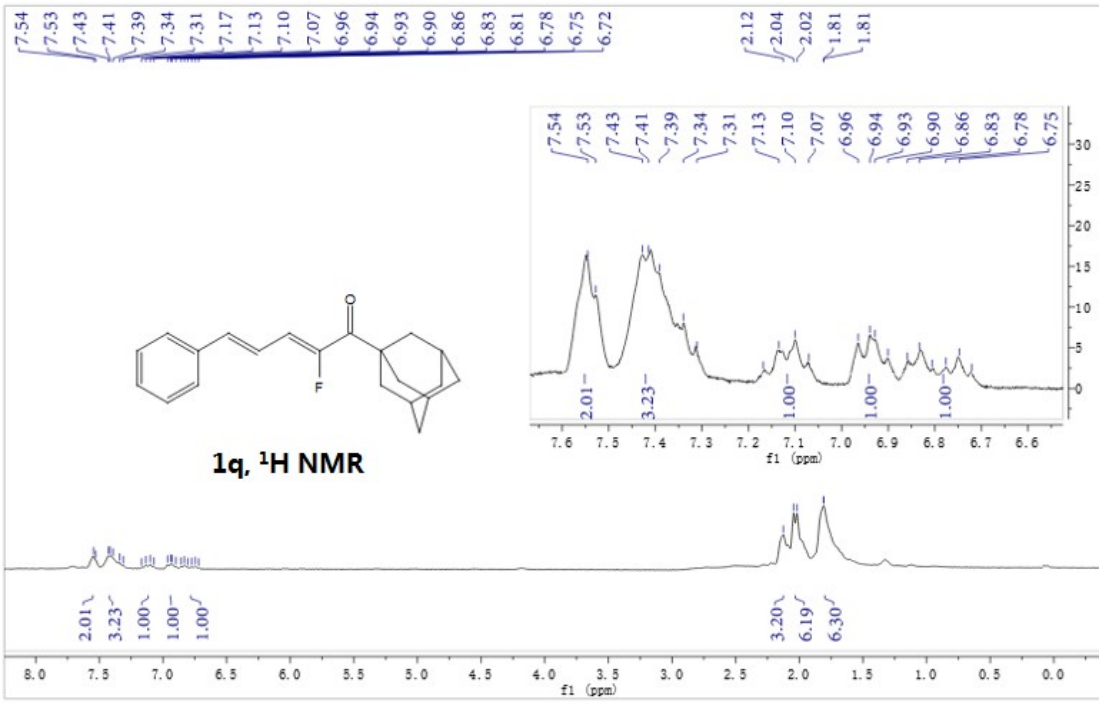


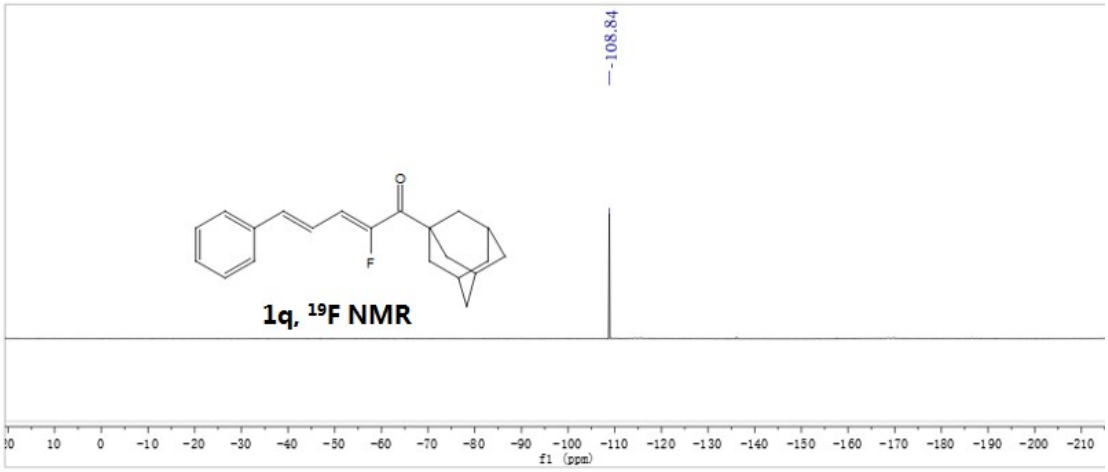
1o, ^{13}C NMR

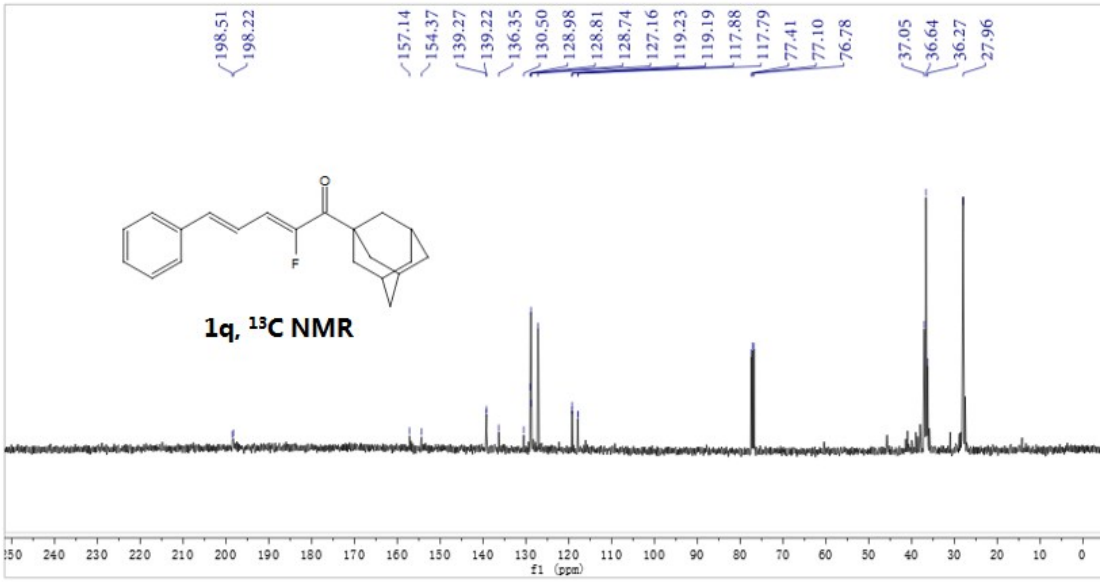

8.41
7.99
7.97
7.95
7.93
7.91
7.89
7.65
7.63
7.61
7.60
7.58
7.56
7.53
7.51
7.40
7.38
7.36
7.35
7.33
7.29
7.25
7.22
6.94
6.90
6.89
6.86
6.81
6.78
0.00
O
F
1p, ¹H NMR
1.00
4.45
2.24
2.22
3.19
1.45
1.05
1.13
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

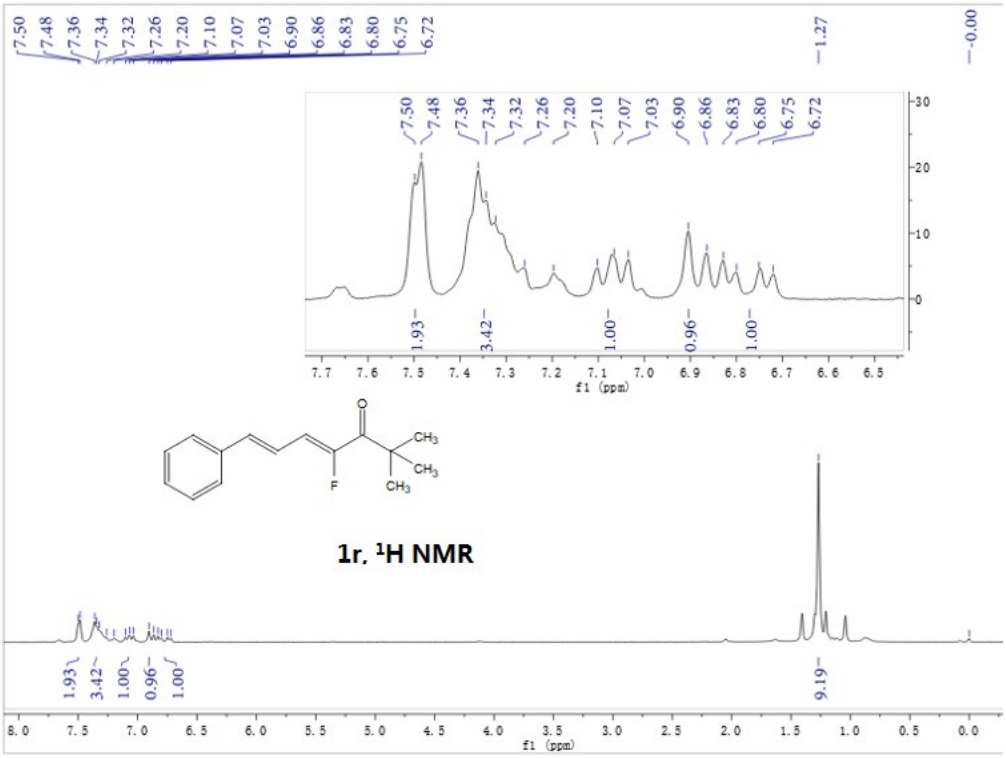

-122.36
-122.45
O
F
1p ¹H NMR
-30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210 -220 -230 -240 -250 -260 -270 -280
f1 (ppm)


187.10
155.65
152.98
140.38
136.08
135.38
133.65
132.31
130.81
129.54
129.40
128.93
128.57
128.45
127.87
127.41
126.96
125.09
122.15
122.13
119.32
77.39
77.07
76.75
O
F
1p, ¹³C NMR
250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

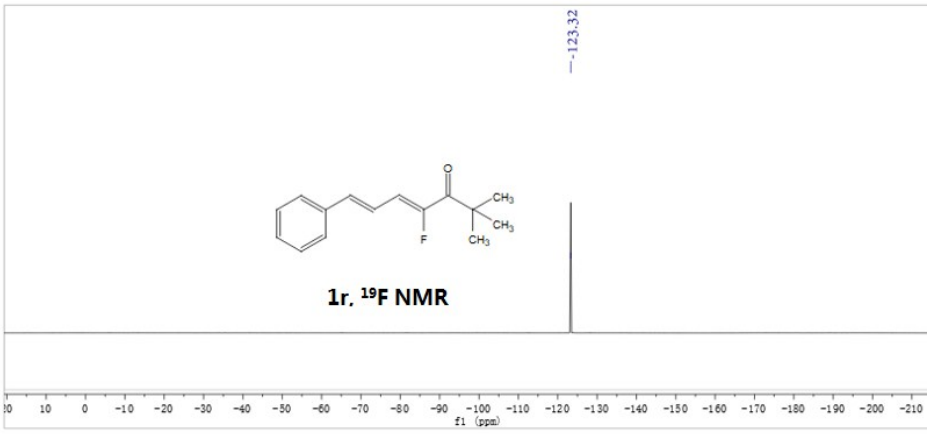

7.54
7.53
7.43
7.41
7.39
7.34
7.31
7.17
7.13
7.10
7.07
6.96
6.94
6.93
6.90
6.86
6.83
6.81
6.78
6.75
6.72
2.12
2.04
2.02
1.81
1.81
O
F
1q, 1H NMR
2.01
3.23
1.00
1.00
1.00
3.20
6.19
6.30
f1 (ppm)


-108.84
O
F
1q, 19F NMR
f1 (ppm)

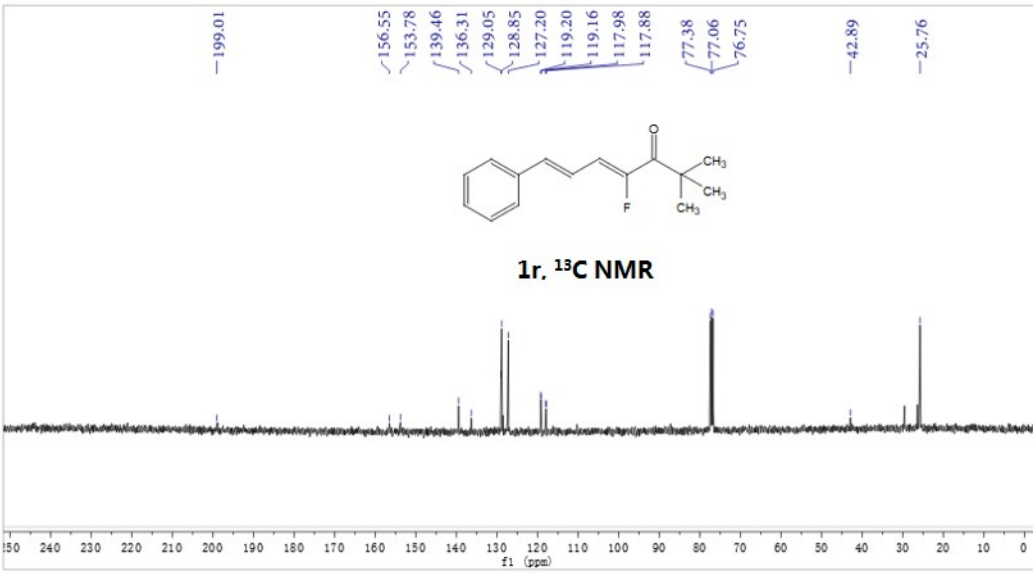

198.51
198.22
157.14
154.37
139.27
139.22
136.35
130.50
128.98
128.81
128.74
127.16
119.23
119.19
117.88
117.79
77.41
77.10
76.78
37.05
36.64
36.27
27.96
O
F
1q, 13C NMR
f1 (ppm)



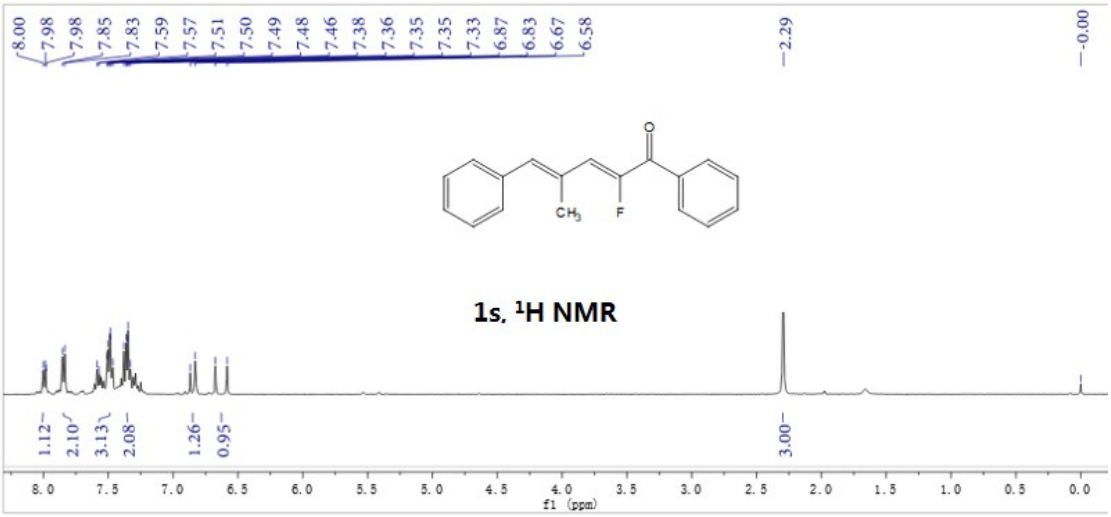
1r, ^{1}H NMR



1r, ^{19}F NMR



1r, ^{13}C NMR


8.00
7.98
7.98
7.85
7.83
7.59
7.57
7.51
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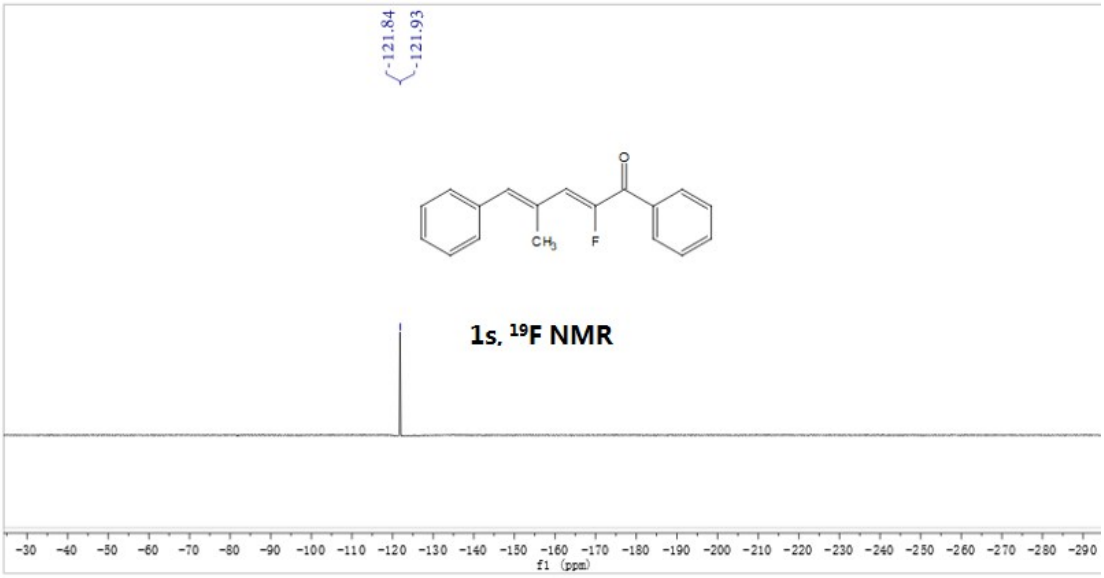
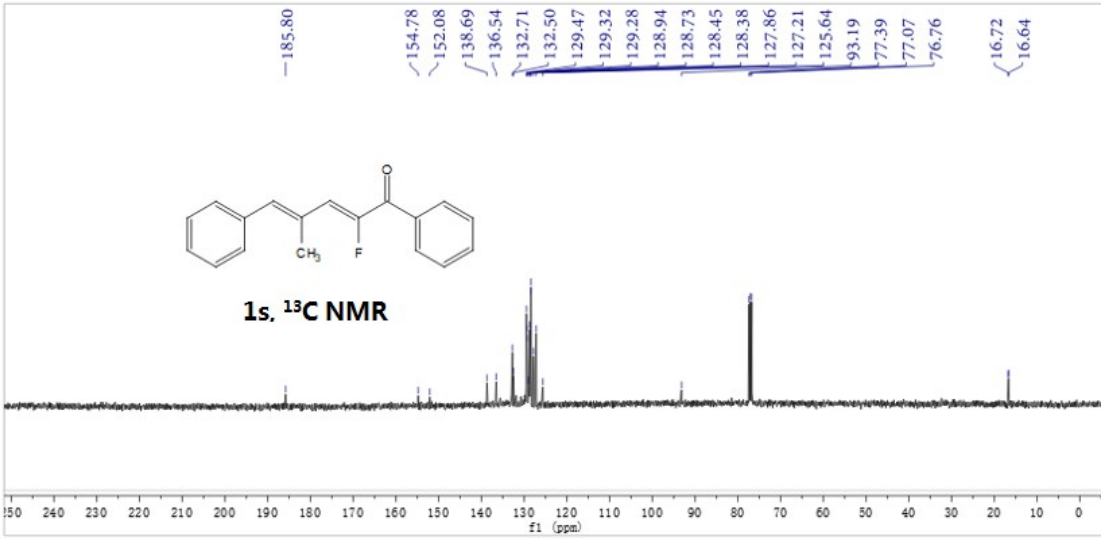
7.49
7.48
7.46
7.38
7.36
7.35
7.35
7.33
6.87
6.83
6.67
6.58
2.29
0.00
O
CH3
F
1s, 1H NMR
1.12
2.10
3.13
2.08
1.26
0.95
3.00
f1 (ppm)


-121.84
-121.93
O
CH3
F
1s, 19F NMR
f1 (ppm)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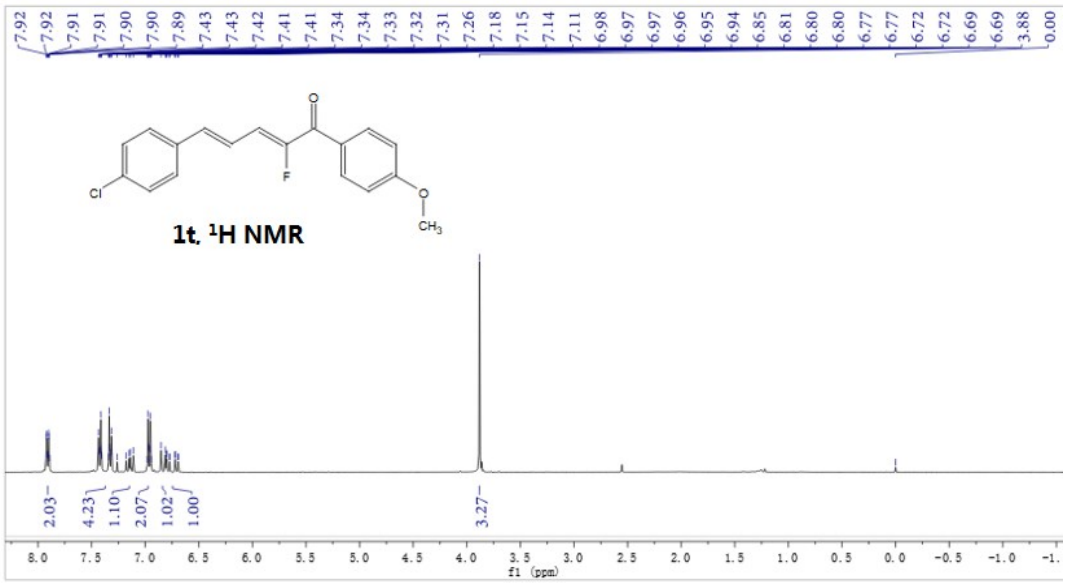
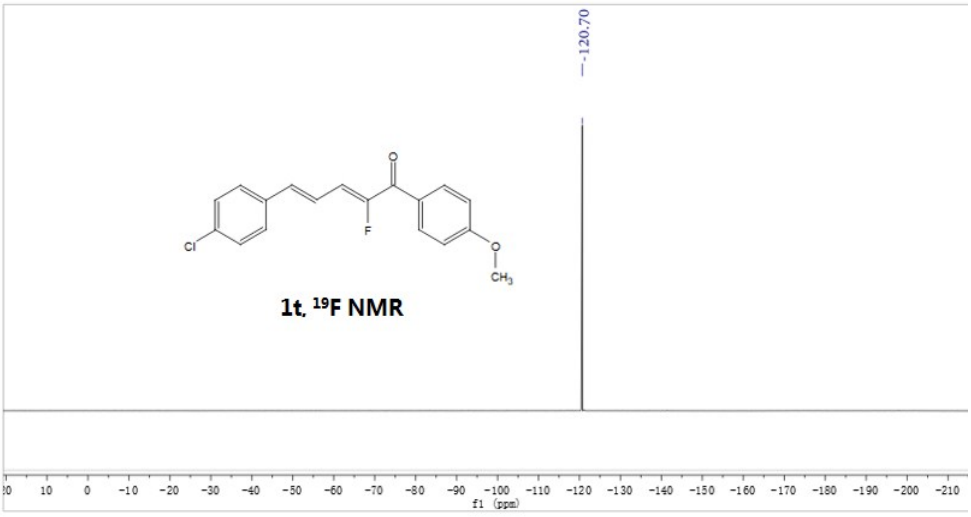
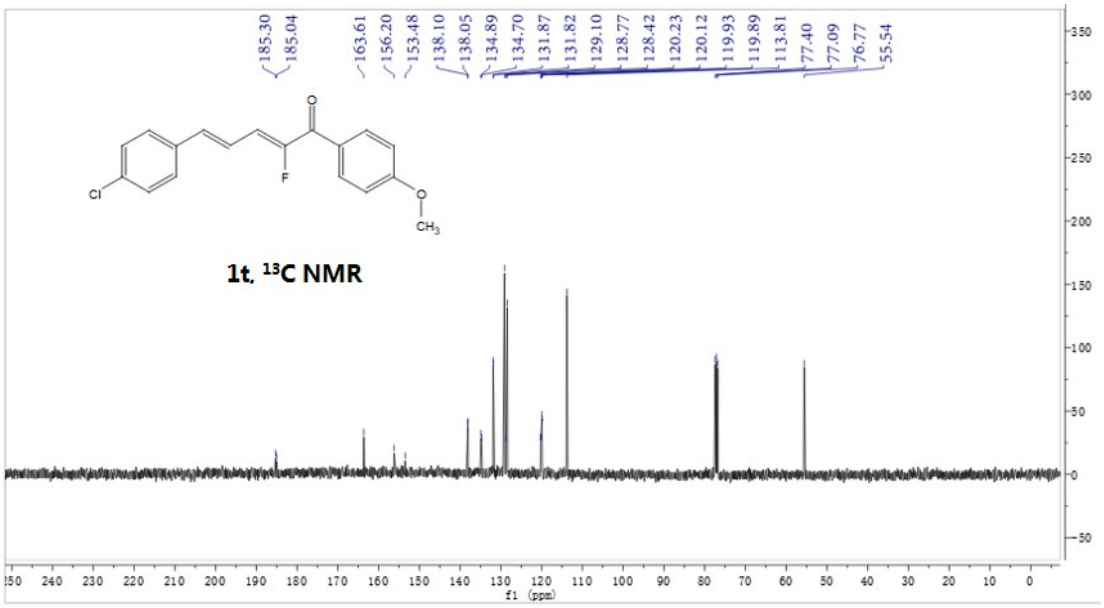
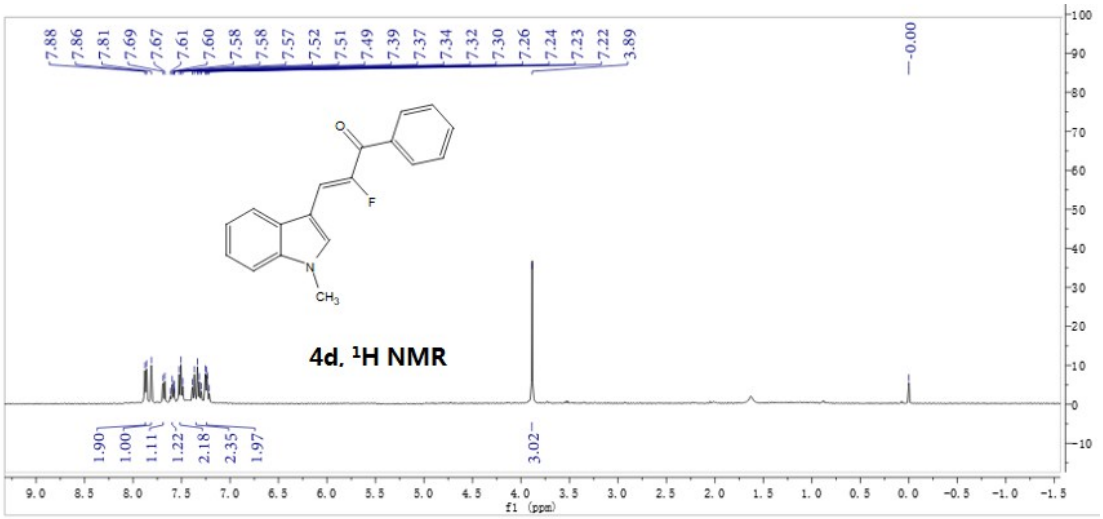
152.08
138.69
136.54
132.71
132.50
129.47
129.32
129.28
128.94
128.73
128.45
128.38
127.86
127.21
125.64
93.19
77.39
77.07
76.76
16.72
16.64
O
CH3
F
1s, 13C NMR
f1 (ppm)


7.92 7.92 7.91 7.91 7.90 7.90 7.89 7.43 7.43 7.42 7.41 7.41 7.34 7.34 7.33 7.32 7.31 7.26 7.18 7.15 7.14 7.11 6.98 6.97 6.97 6.96 6.95 6.94 6.85 6.81 6.80 6.80 6.77 6.77 6.72 6.72 6.69 6.69 3.88 0.00
O
F
Cl
O
CH3
1t, 1H NMR
2.03 4.23 1.10 2.07 1.02 1.00 3.27
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 -1.0
f1 (ppm)


-120.70
O
F
Cl
O
CH3
1t, 19F NMR
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)


185.30 185.04 163.61 156.20 153.48 138.10 138.05 134.89 134.70 131.87 131.82 129.10 128.77 128.42 120.23 120.12 119.93 119.89 113.81 77.40 77.09 76.77 55.54
O
F
Cl
O
CH3
1t, 13C NMR
350 300 250 200 150 100 50 0 -50
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


7.88
7.86
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7.67
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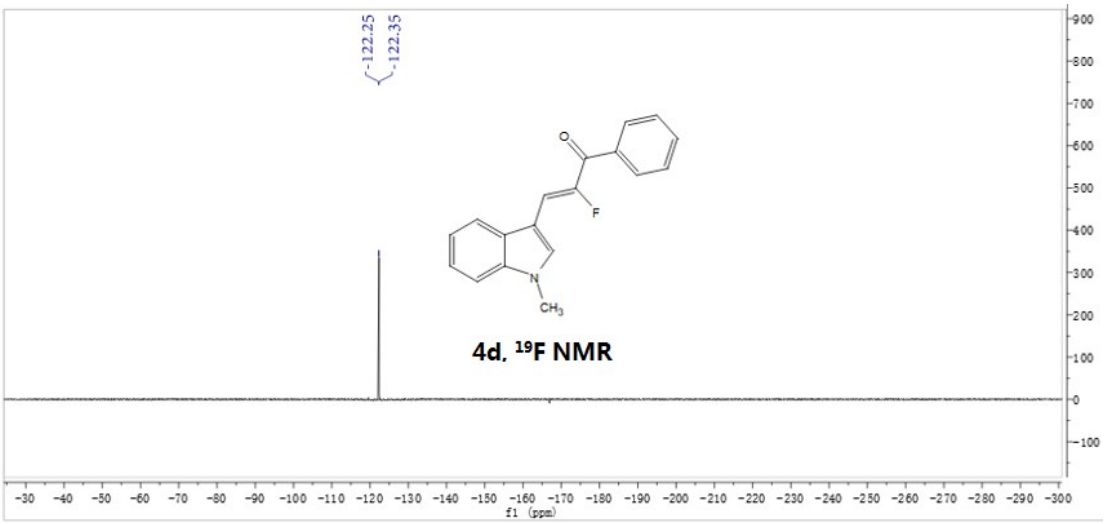
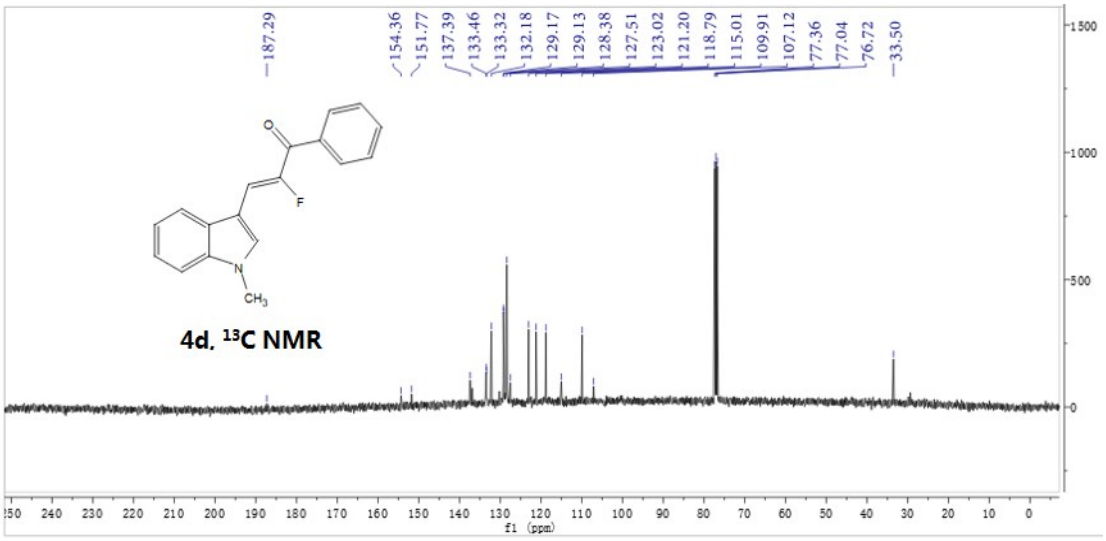
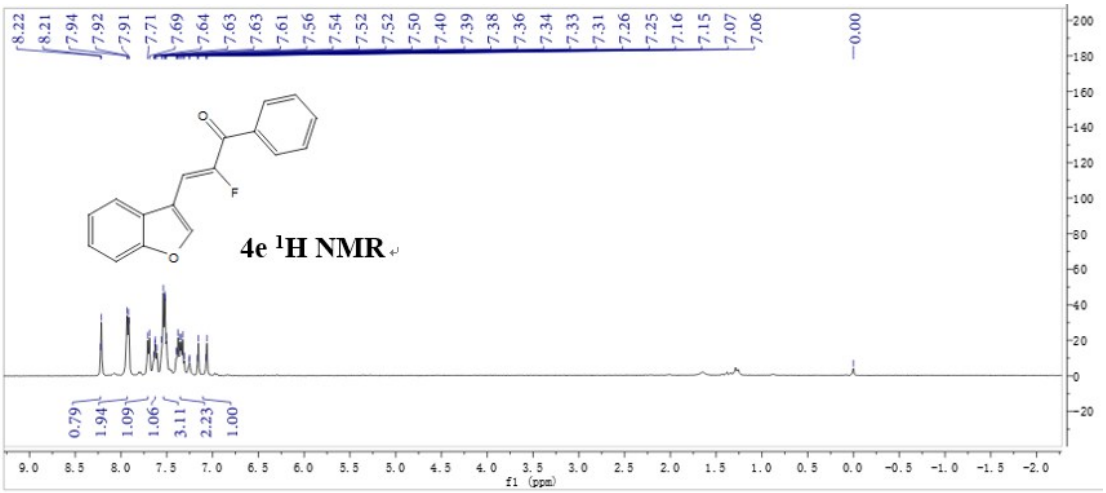
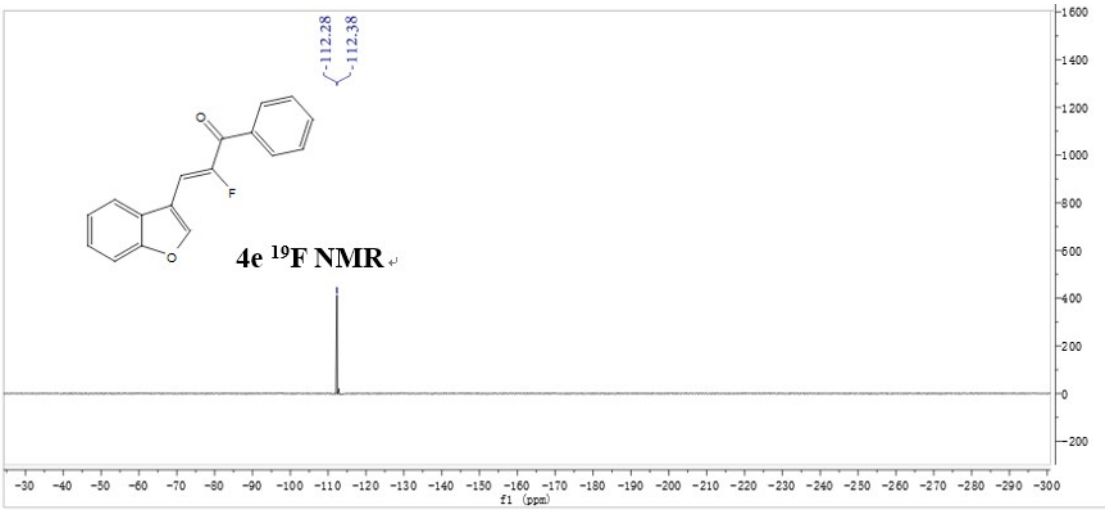
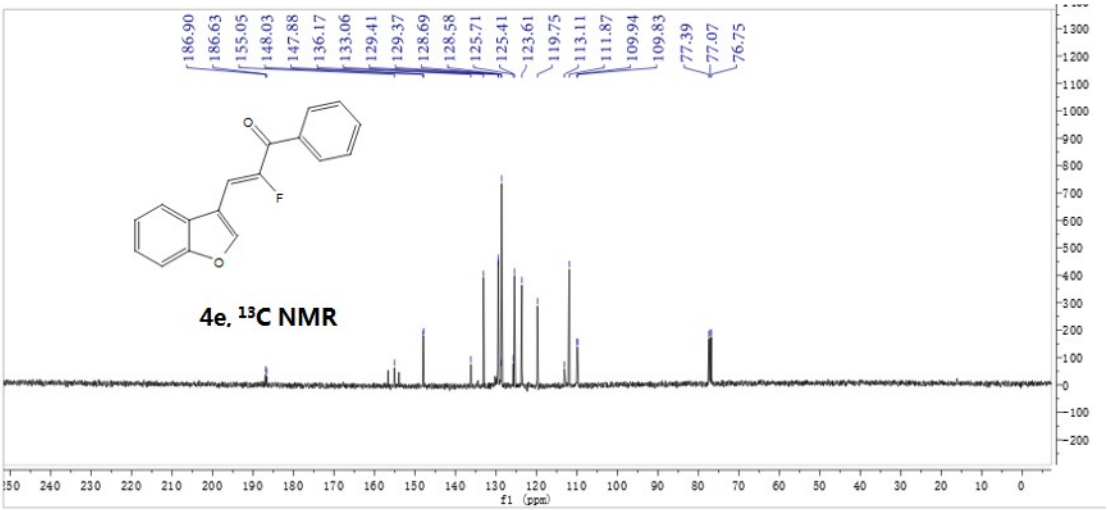
7.60
7.58
7.58
7.57
7.52
7.51
7.49
7.39
7.37
7.34
7.32
7.30
7.26
7.24
7.23
7.22
3.89
0.00
O
F
N
CH3
4d, 1H NMR
1.90
1.00
1.11
1.22
2.18
2.35
1.97
3.02
f1 (ppm)


122.25
122.35
O
F
N
CH3
4d, 19F NMR
f1 (ppm)


187.29
154.36
151.77
137.39
133.46
133.32
132.18
129.17
129.13
128.38
127.51
123.02
121.20
118.79
115.01
109.91
107.12
77.36
77.04
76.72
33.50
O
F
N
CH3
4d, 13C NMR
f1 (ppm)


8.22
8.21
7.94
7.92
7.91
7.71
7.69
7.64
7.63
7.63
7.61
7.56
7.54
7.52
7.52
7.50
7.40
7.39
7.38
7.36
7.34
7.33
7.31
7.26
7.25
7.16
7.15
7.07
7.06
0.00
O
F
O
4e ^{1}H NMR
0.79
1.94
1.09
1.06
3.11
2.23
1.00
f1 (ppm)


-112.28
-112.38
O
F
O
4e ^{19}F NMR
f1 (ppm)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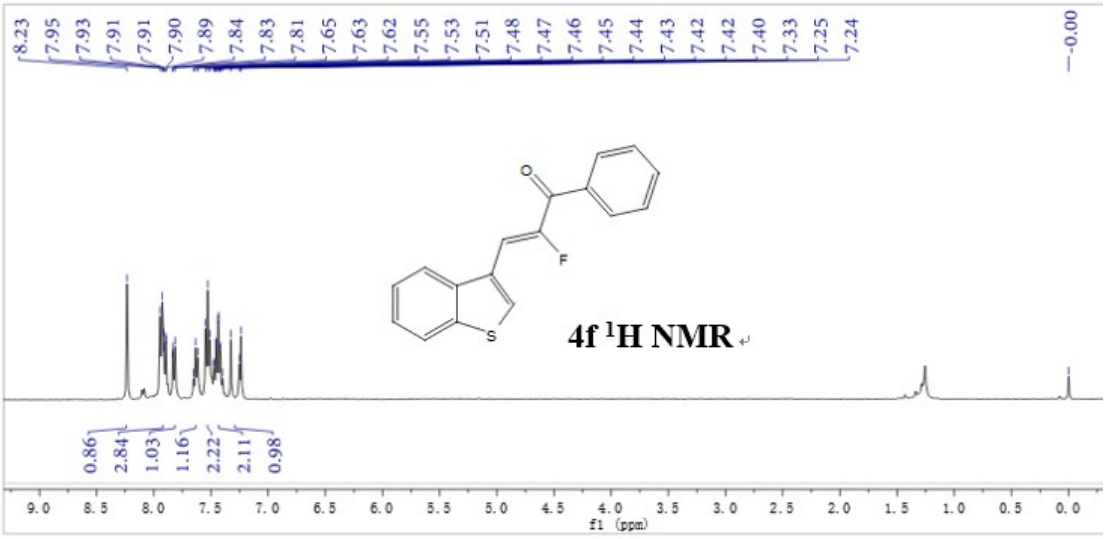
186.63
155.05
148.03
147.88
136.17
133.06
129.41
129.37
128.69
128.58
125.71
125.41
123.61
119.75
113.11
111.87
109.94
109.83
77.39
77.07
76.75
O
F
O
4e. ^{13}C NMR
f1 (ppm)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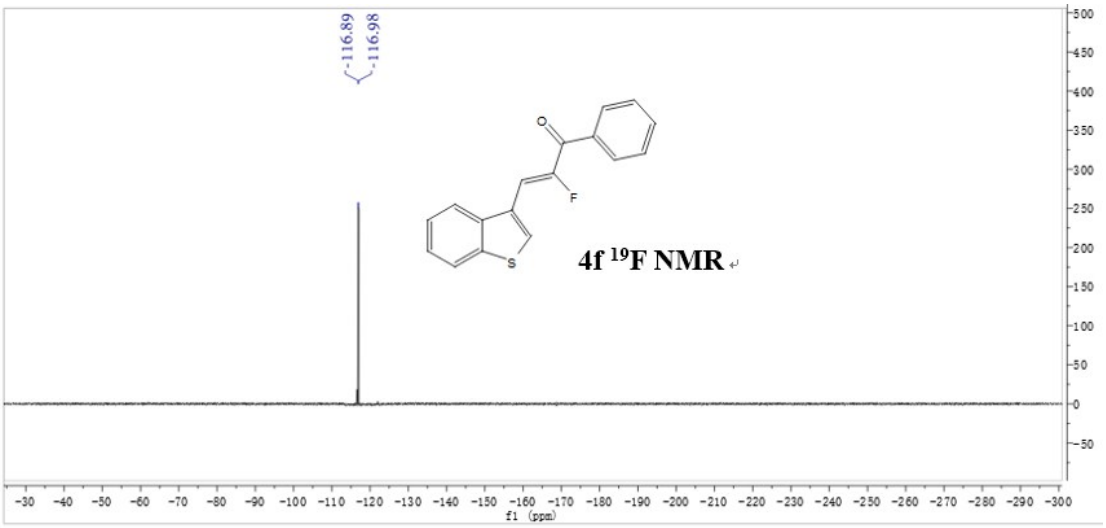
7.95
7.93
7.91
7.91
7.90
7.89
7.84
7.83
7.81
7.65
7.63
7.62
7.55
7.53
7.51
7.48
7.47
7.46
7.45
7.44
7.43
7.42
7.42
7.40
7.33
7.25
7.24
-0.00
O
F
S
4f ^{1}H NMR
0.86
2.84
1.03
1.16
2.22
2.11
0.98
f1 (ppm)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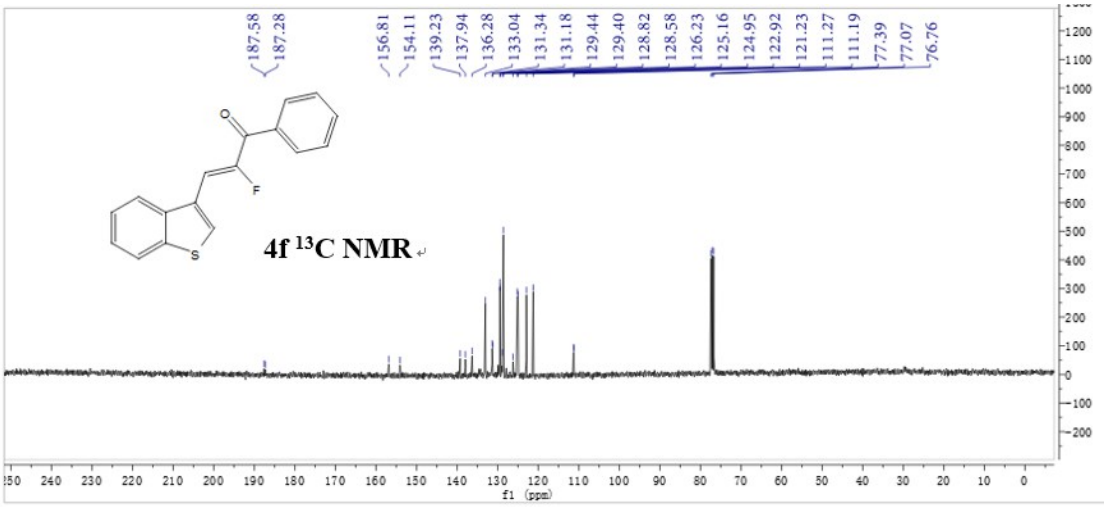
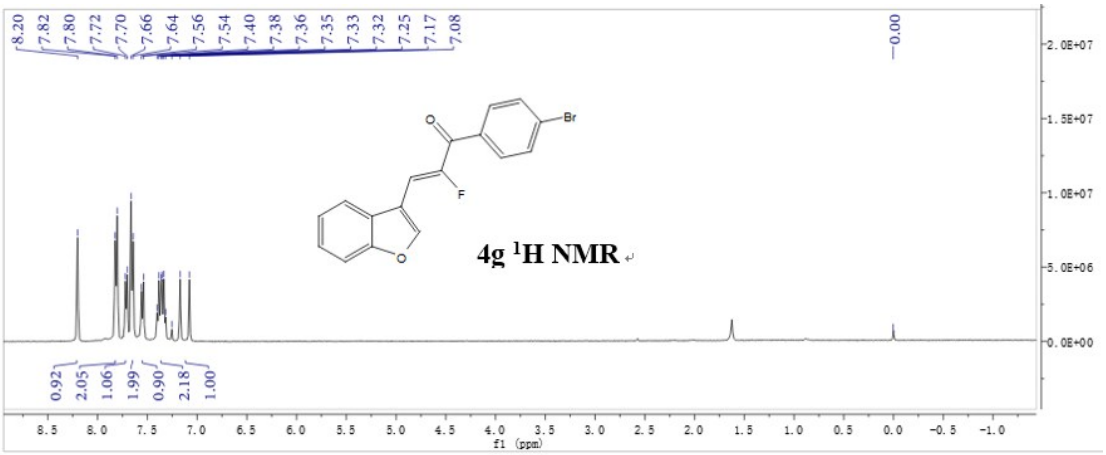
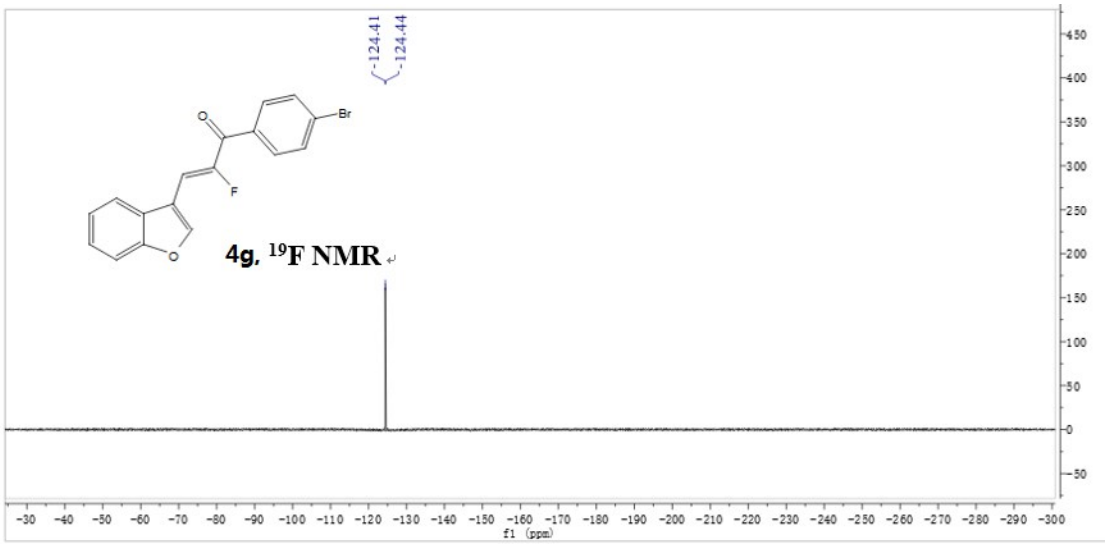
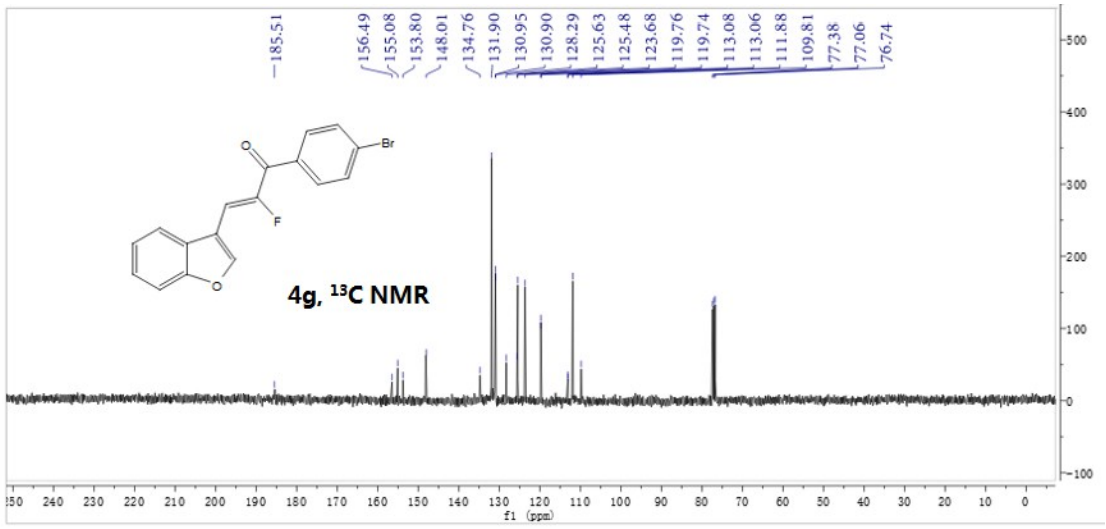
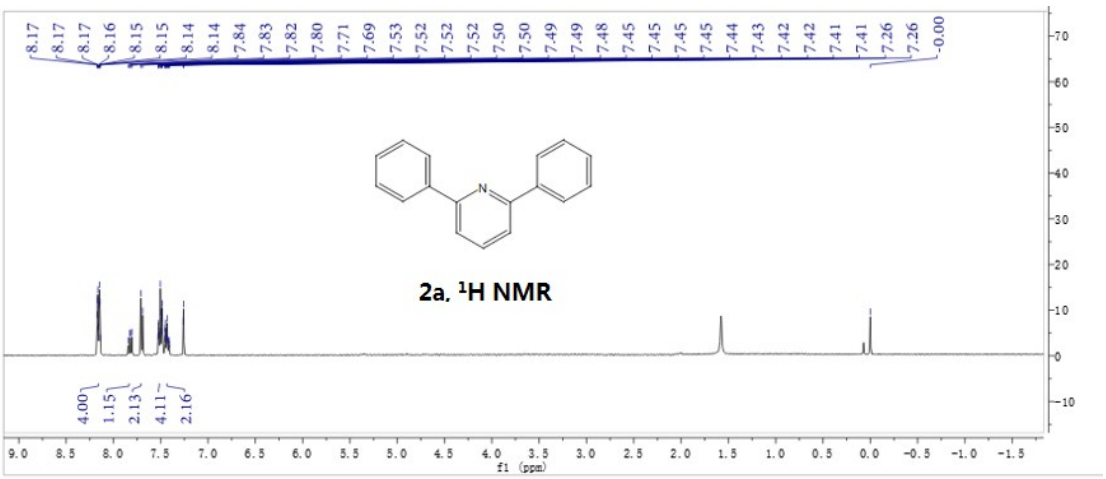
-116.98
O
F
S
4f ^{19}F NMR
f1 (ppm)


187.58
187.28
156.81
154.11
139.23
137.94
136.28
133.04
131.34
131.18
129.44
129.40
128.82
128.58
126.23
125.16
124.95
122.92
121.23
111.27
111.19
77.39
77.07
76.76
O
F
S
4f ^{13}C NMR
f1 (ppm)

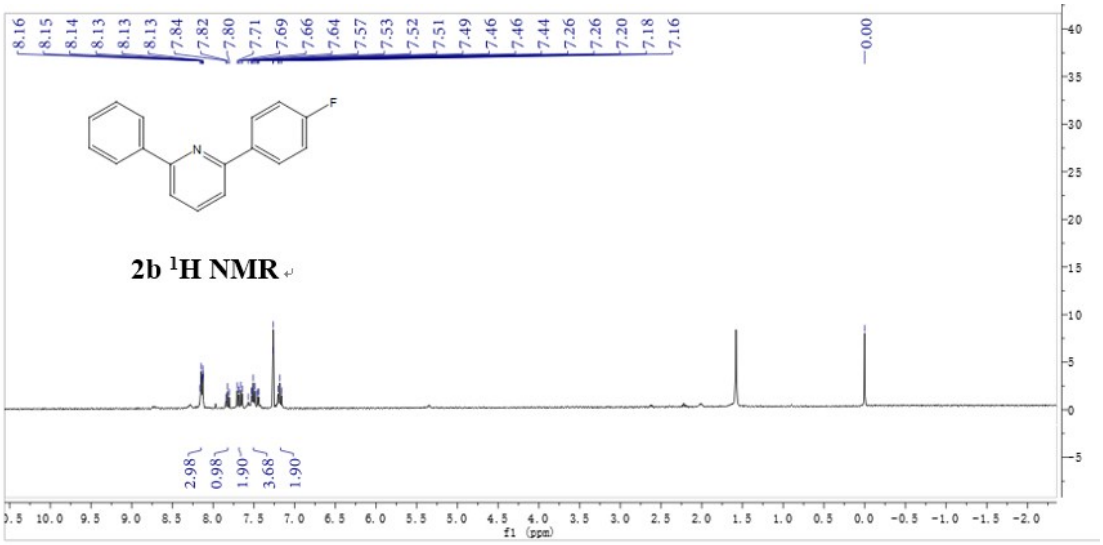

8.20
7.82
7.80
7.72
7.70
7.66
7.64
7.56
7.54
7.40
7.38
7.36
7.35
7.33
7.32
7.25
7.17
7.08
0.00
Br
O
F
O
4g ^{1}H NMR
0.92
2.05
1.06
1.99
0.90
2.18
1.00
f1 (ppm)


-124.41
-124.44
Br
O
F
O
4g, ^{19}F NMR
f1 (ppm)

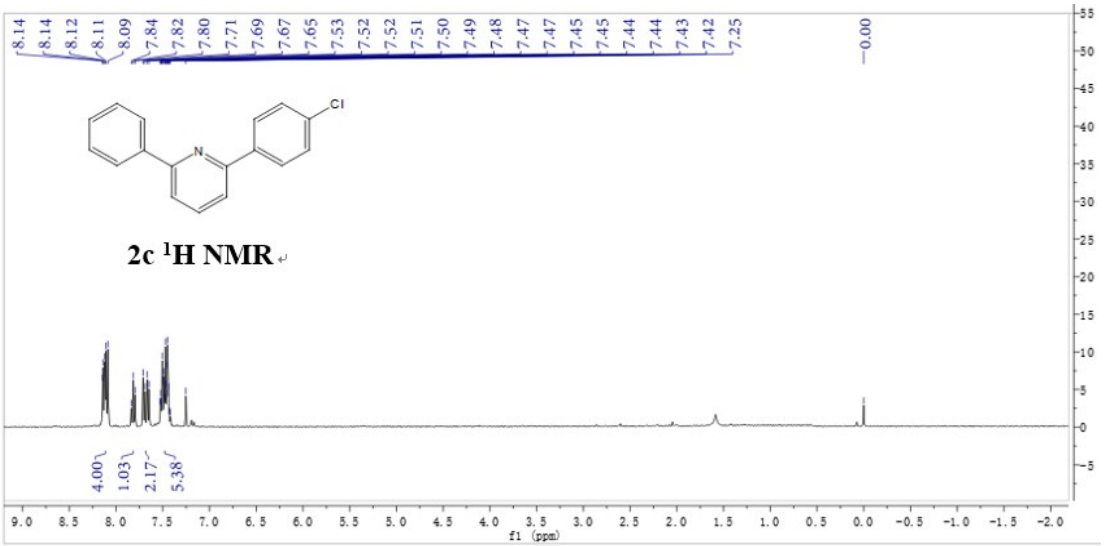

185.51
156.49
155.08
153.80
148.01
134.76
131.90
130.95
130.90
128.29
125.63
125.48
123.68
119.76
119.74
113.08
113.06
111.88
109.81
77.38
77.06
76.74
Br
O
F
O
4g, ^{13}C NMR
f1 (ppm)



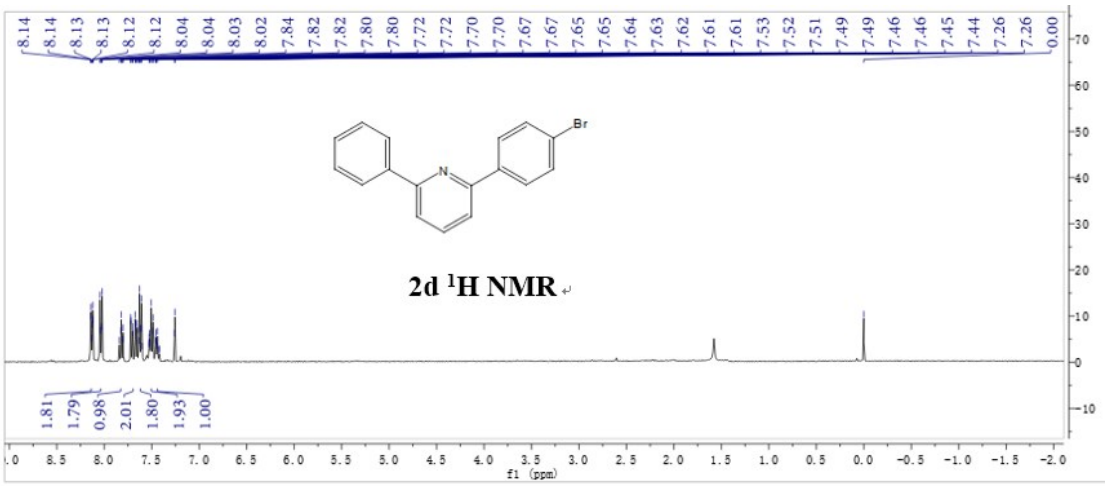
2a, ^{1}H NMR

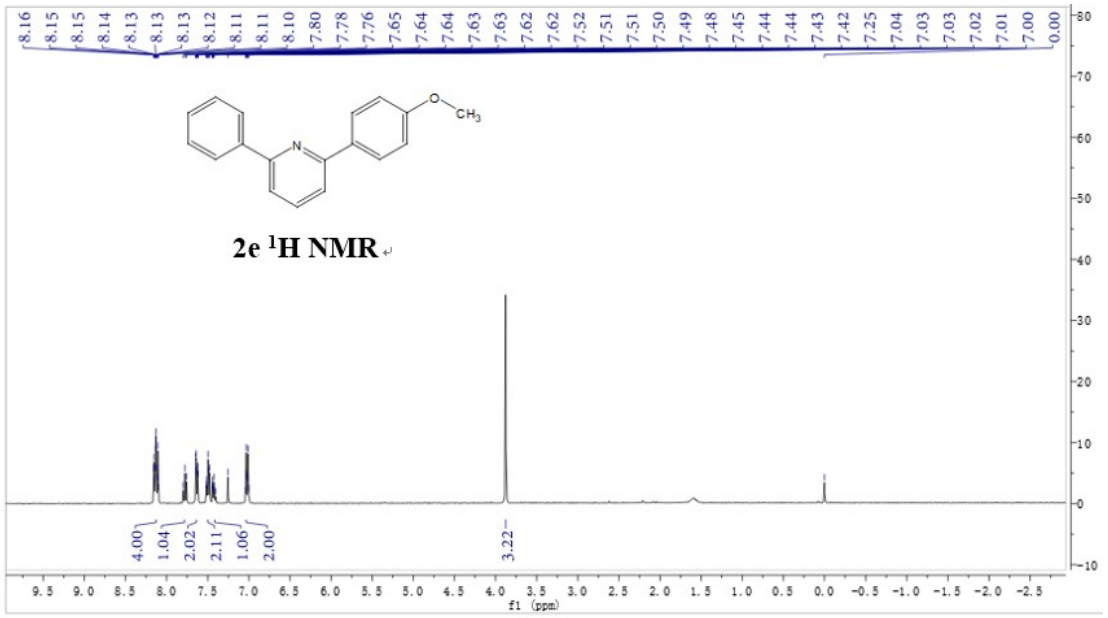


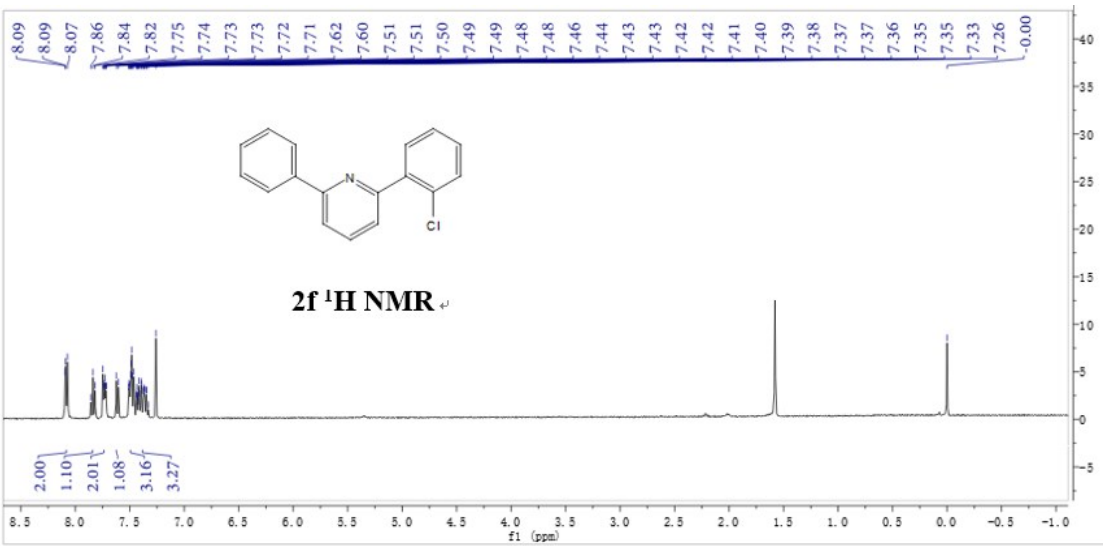
2b ^{1}H NMR

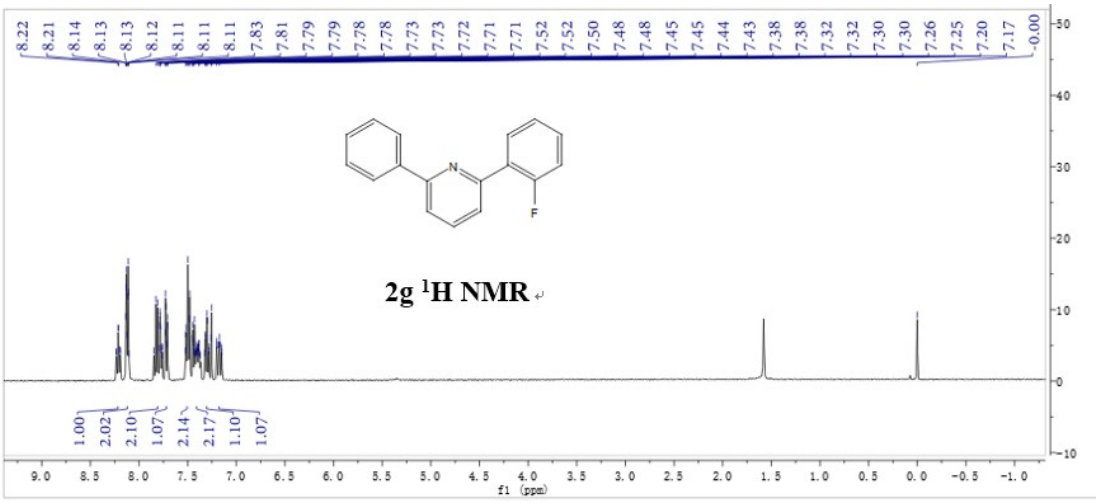


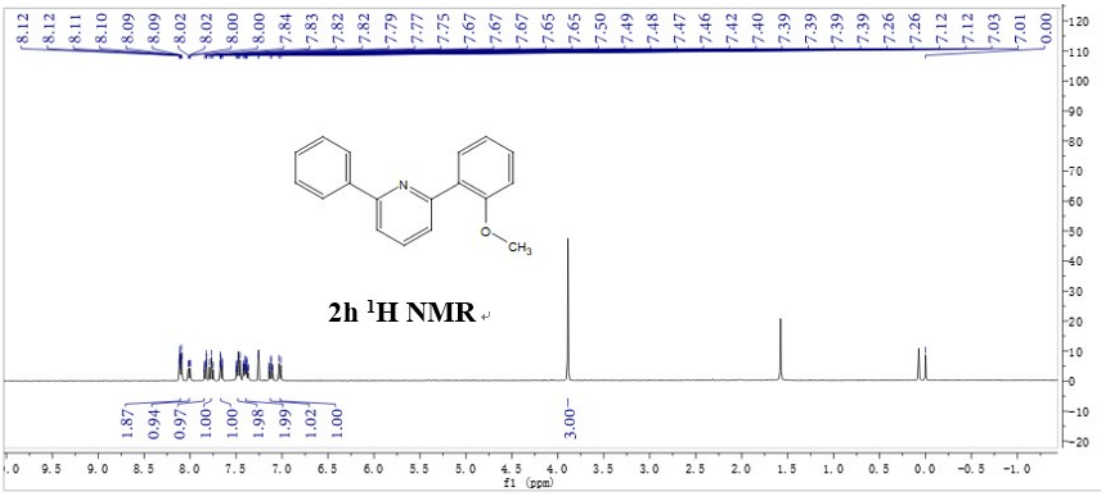
2c ^{1}H NMR

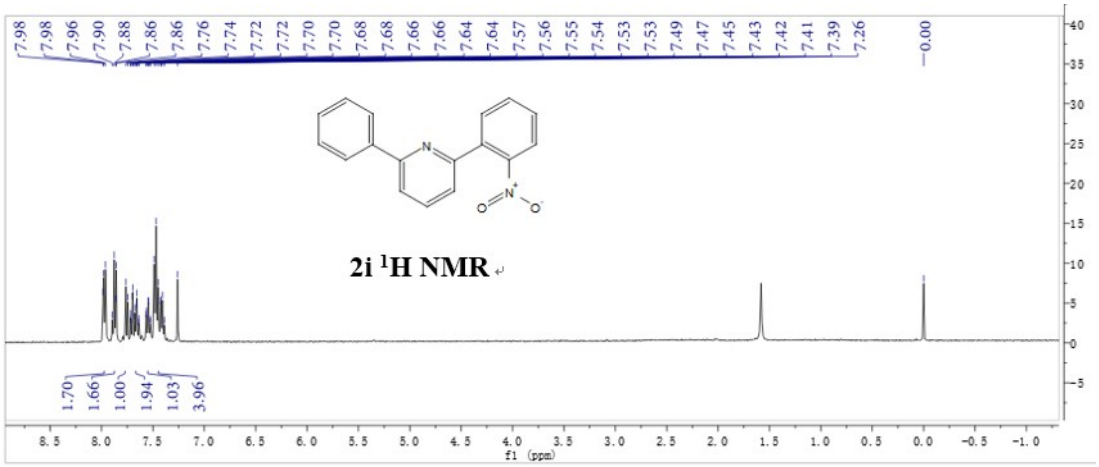

Br
N
2d ^{1}H NMR
1.81
1.79
0.98
2.01
1.80
1.93
1.00
f1 (ppm)

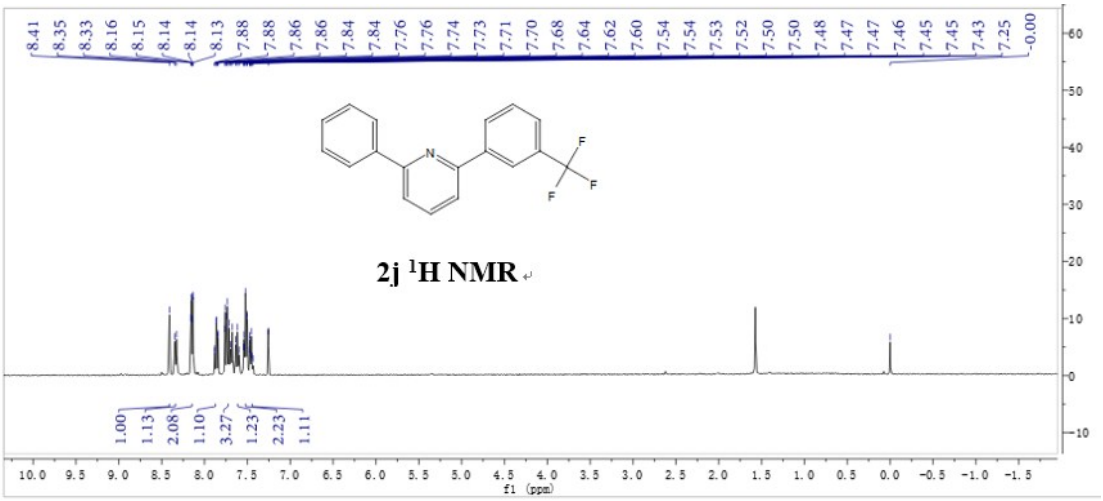

O
CH3
N
2e ^{1}H NMR
4.00
1.04
2.02
2.11
1.06
2.00
3.22
f1 (ppm)

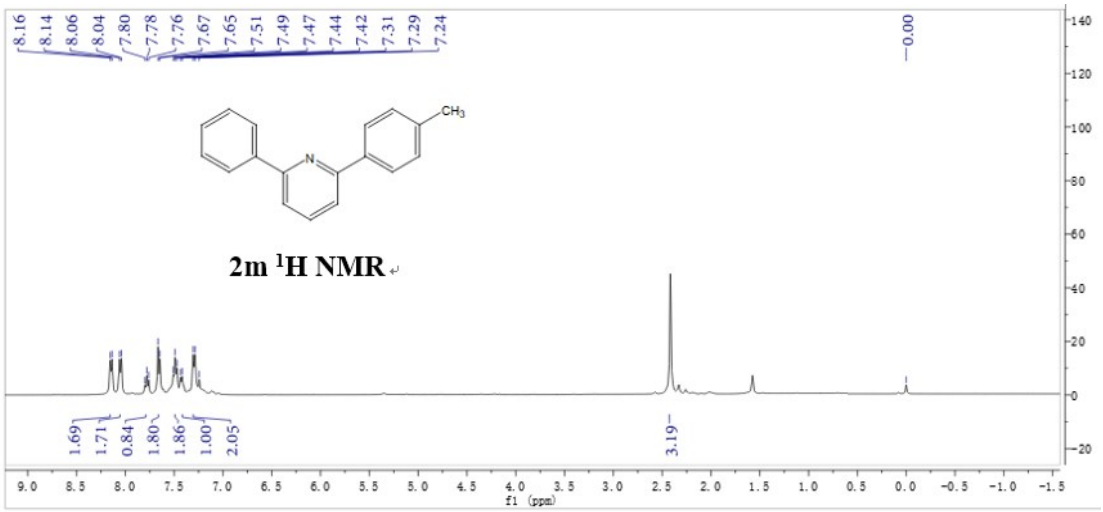

N
Cl
2f ^{1}H NMR
2.00
1.10
2.01
1.08
3.16
3.27
f1 (ppm)

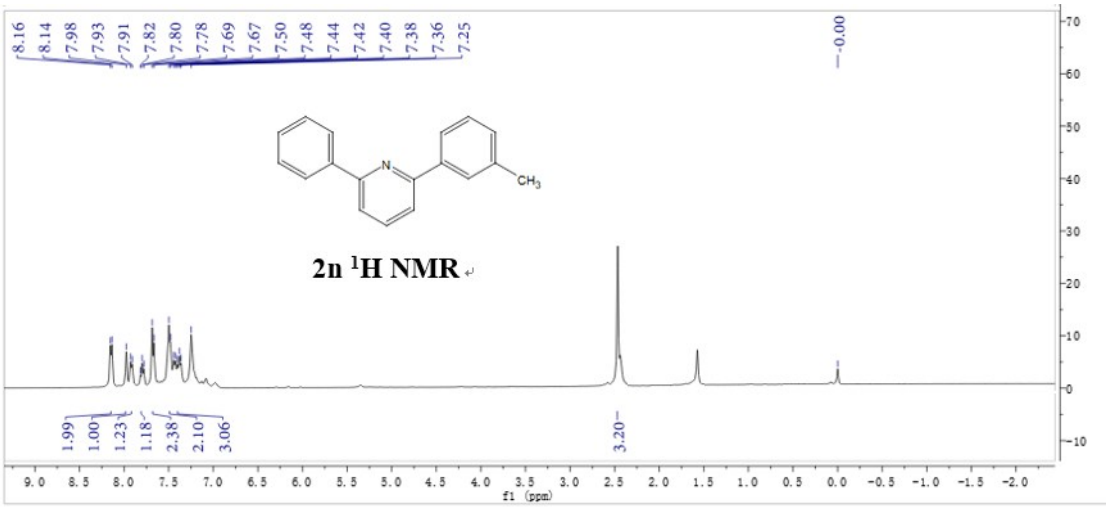

2g ^{1}H NMR

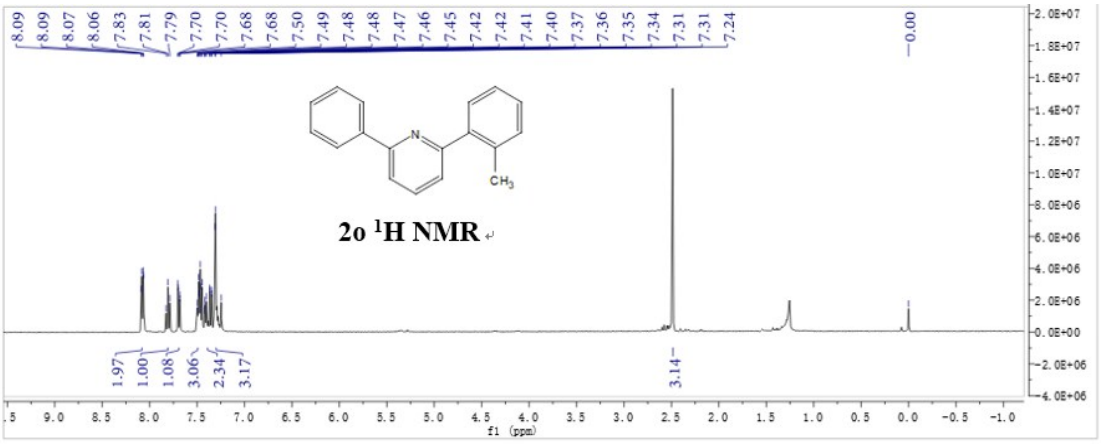

2h ^{1}H NMR

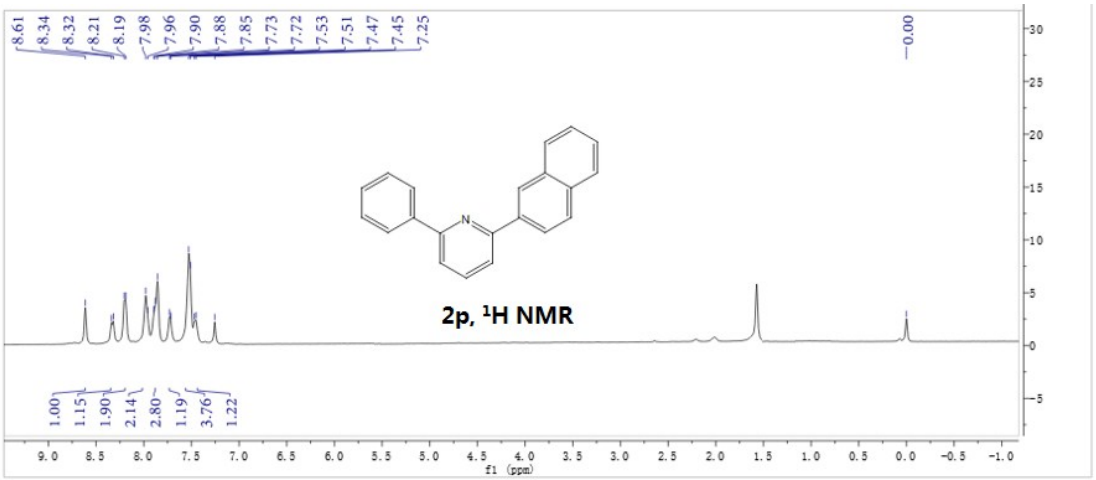

2i ^{1}H NMR

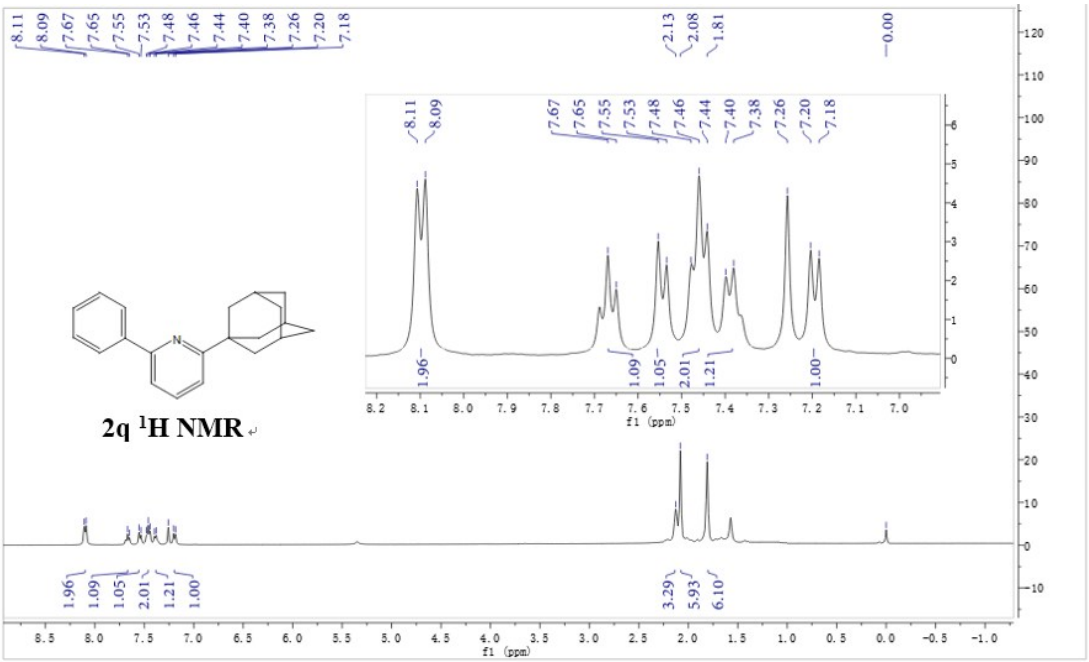

8.41 8.35 8.33 8.16 8.15 8.14 8.14 8.13 7.88 7.88 7.86 7.86 7.84 7.84 7.76 7.76 7.74 7.73 7.71 7.70 7.68 7.64 7.62 7.60 7.54 7.54 7.53 7.52 7.50 7.50 7.48 7.47 7.47 7.46 7.45 7.45 7.43 7.25 0.00
N
F
F
F
2j ^{1}H NMR
1.00 1.13 2.08 1.10 3.27 1.23 2.23 1.11
f1 (ppm)

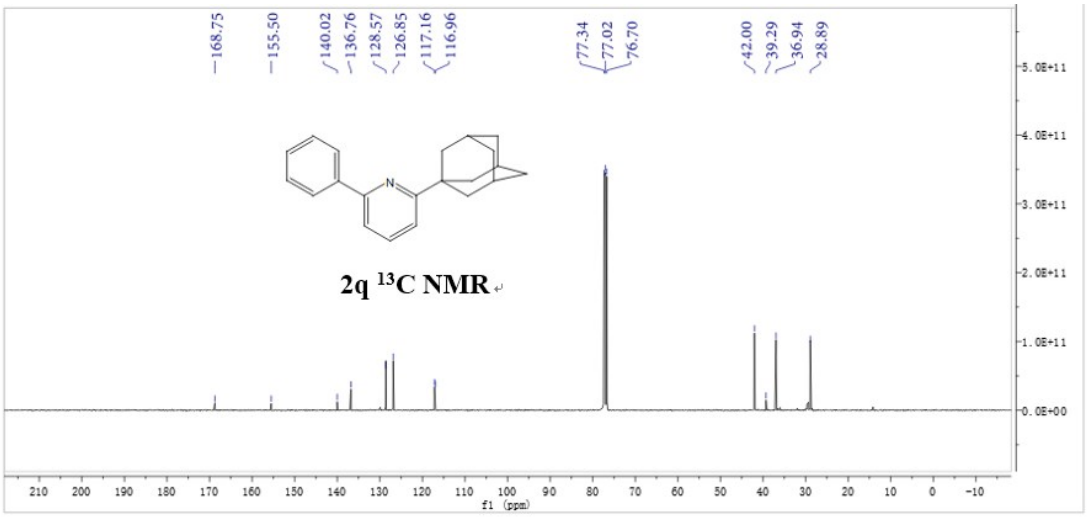

8.16 8.14 8.06 8.04 7.80 7.78 7.76 7.67 7.65 7.51 7.49 7.47 7.44 7.42 7.31 7.29 7.24 0.00
CH3
N
2m ^{1}H NMR
1.69 1.71 0.84 1.80 1.86 1.00 2.05 3.19
f1 (ppm)


8.16 8.14 7.98 7.93 7.91 7.82 7.80 7.78 7.69 7.67 7.50 7.48 7.44 7.42 7.40 7.38 7.36 7.25 0.00
CH3
N
2n ^{1}H NMR
1.99 1.00 1.23 1.18 2.38 2.10 3.06 3.20
f1 (ppm)

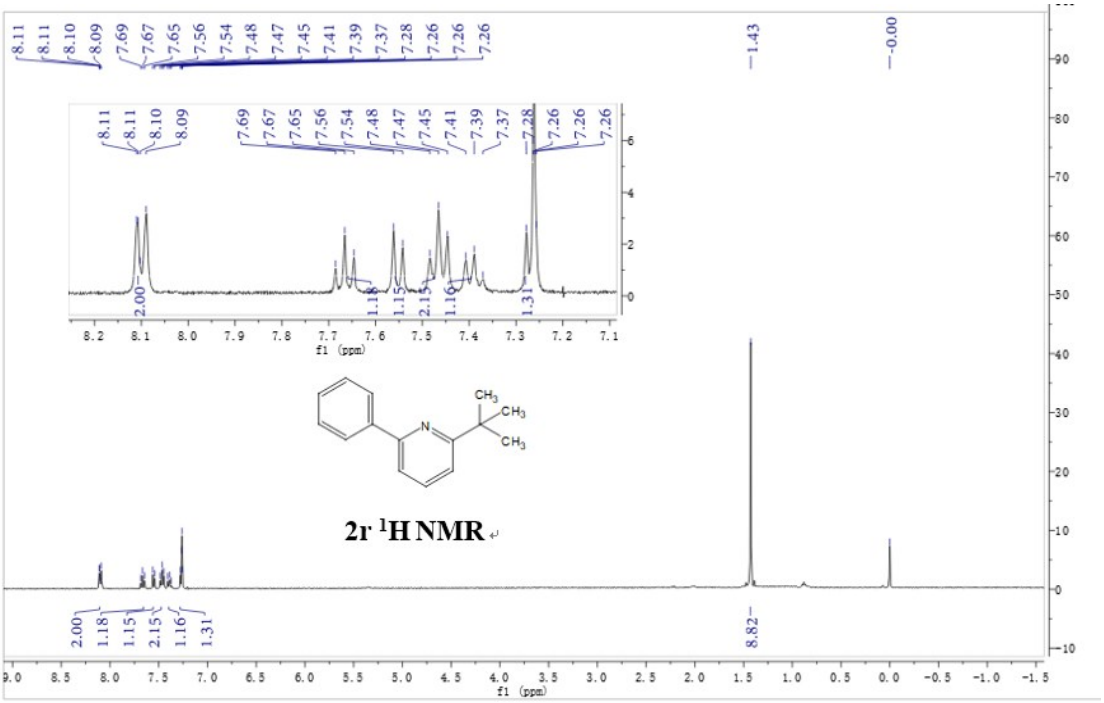

2o ^{1}H NMR


2p, ^{1}H NMR

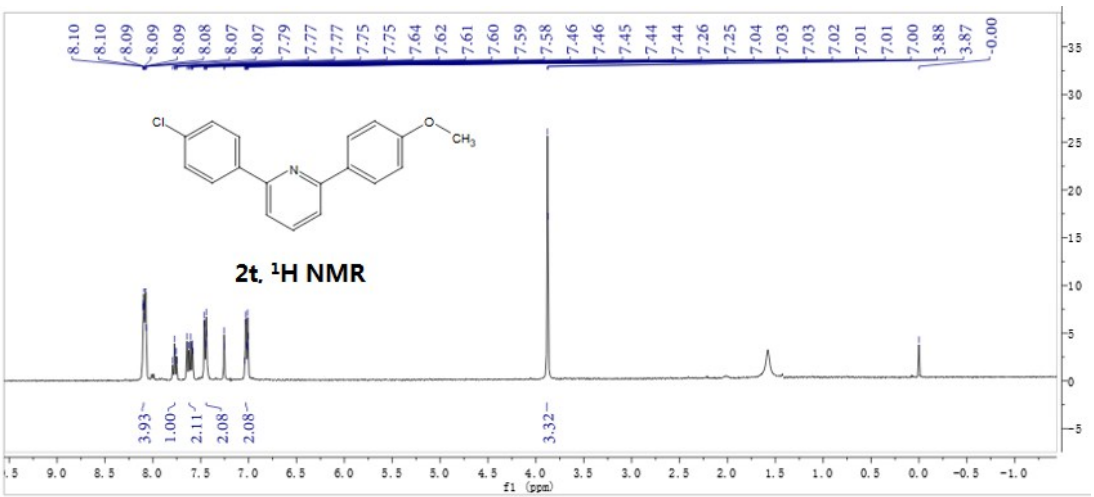

2q ^{1}H NMR



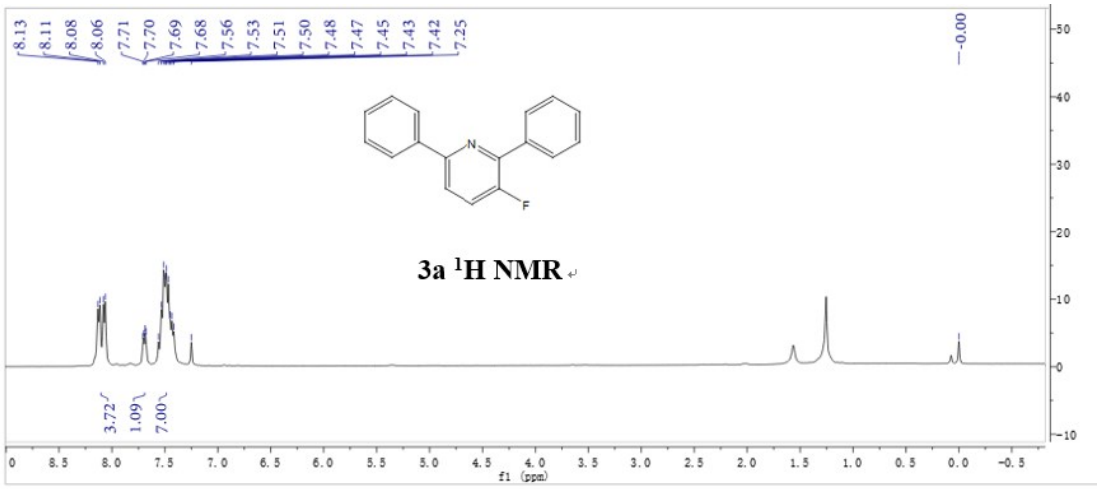
2q ^{13}C NMR



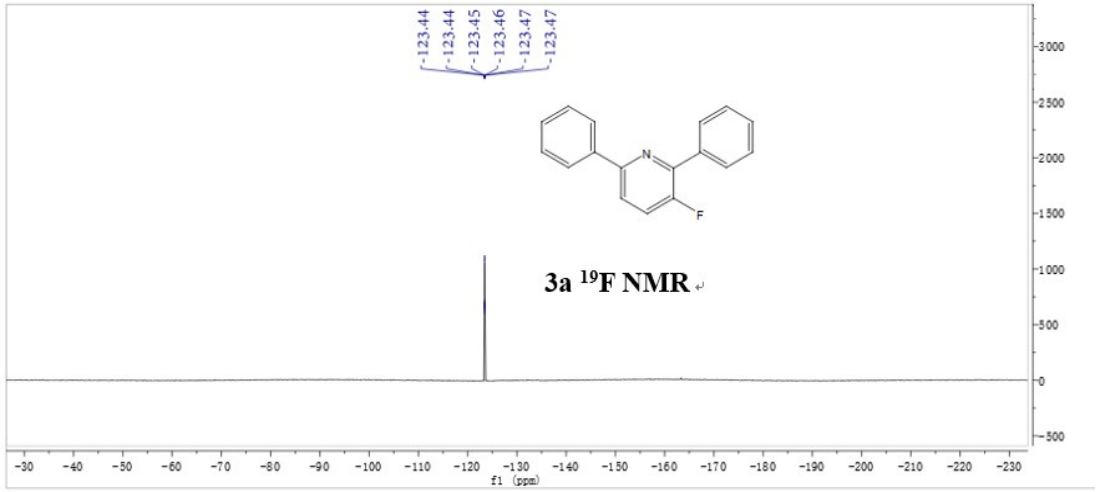
2r ^{1}H NMR



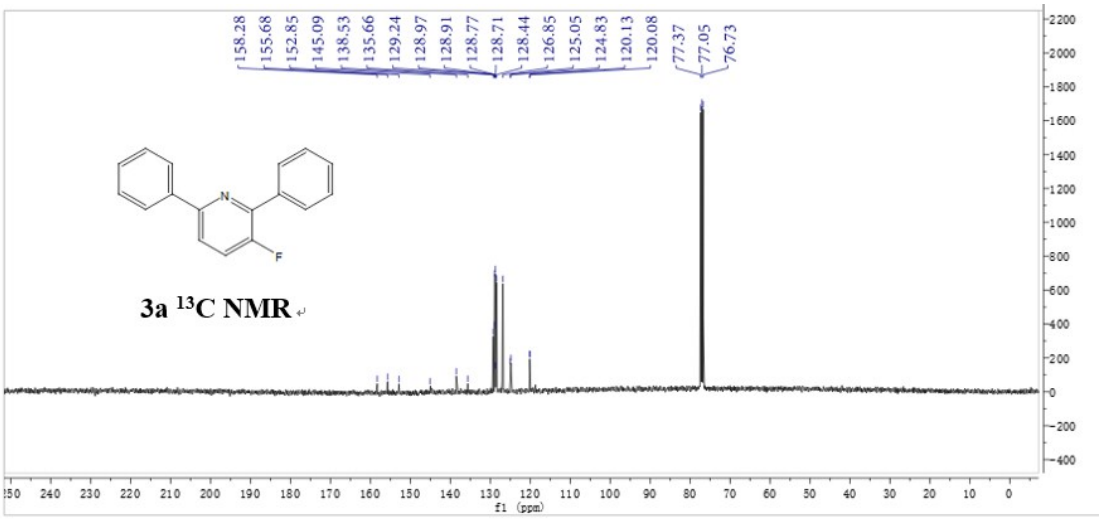
2t, ^{1}H NMR



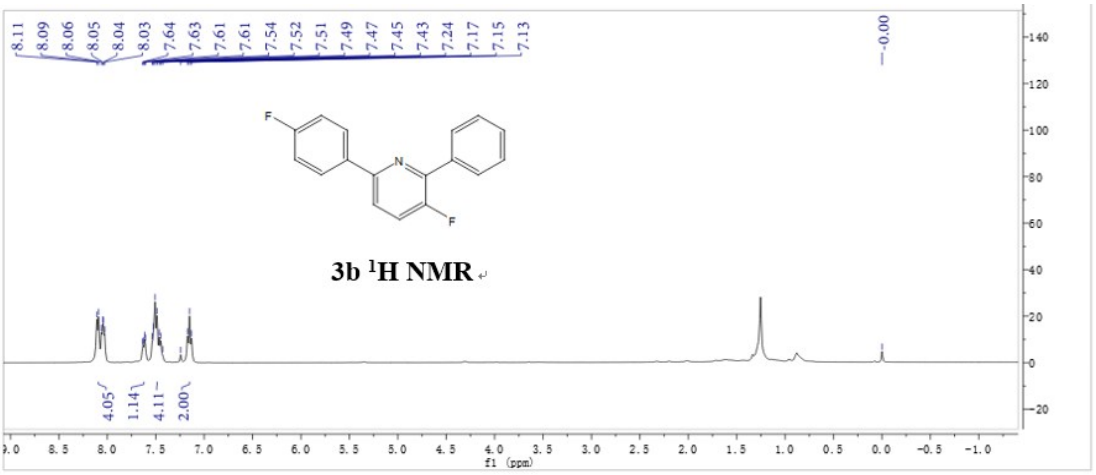
3a ^{1}H NMR



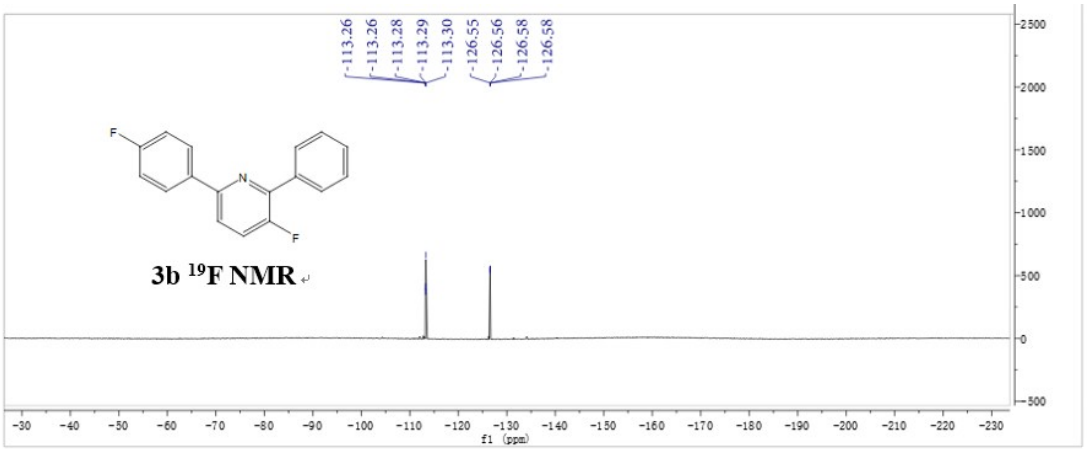
3a ^{19}F NMR



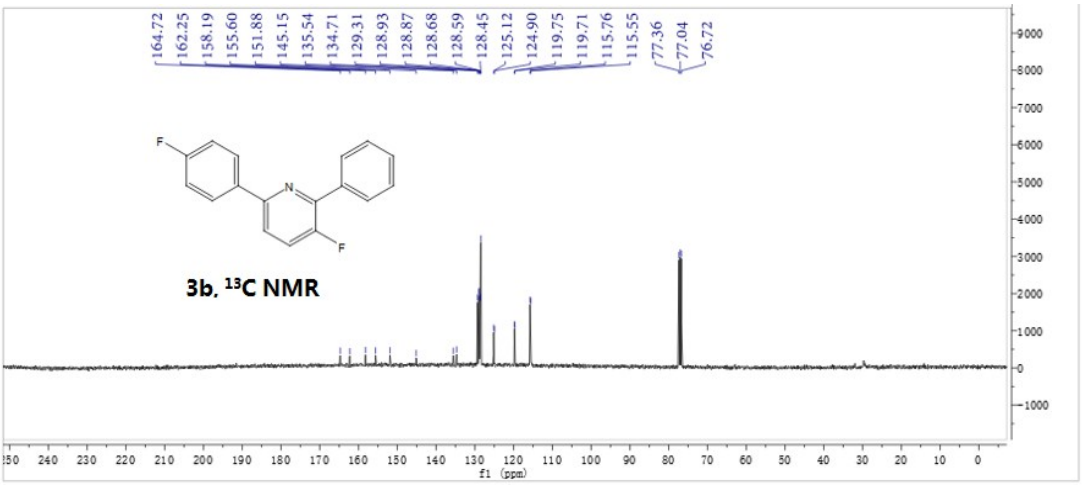
3a ^{13}C NMR



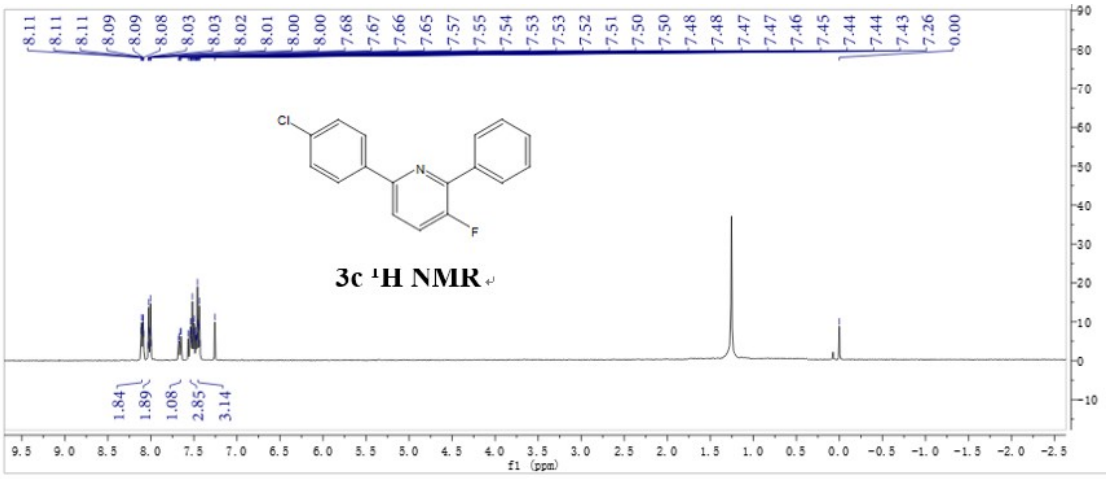
3b ^{1}H NMR



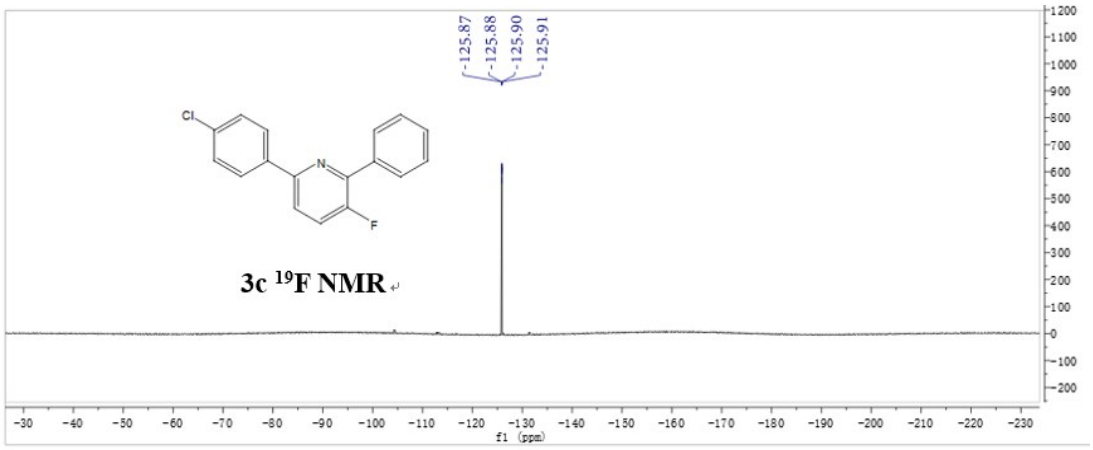
3b ^{19}F NMR



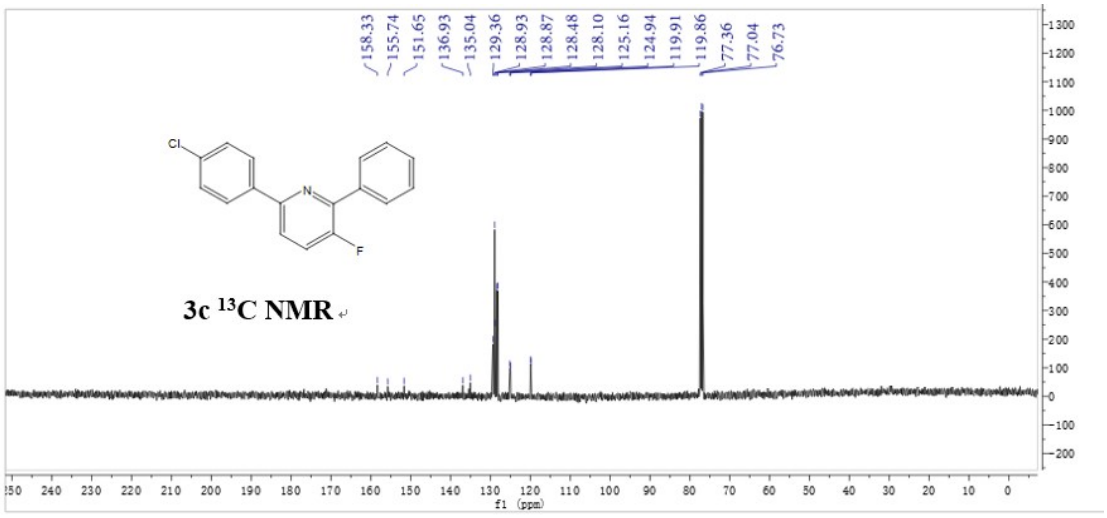
3b, ^{13}C NMR



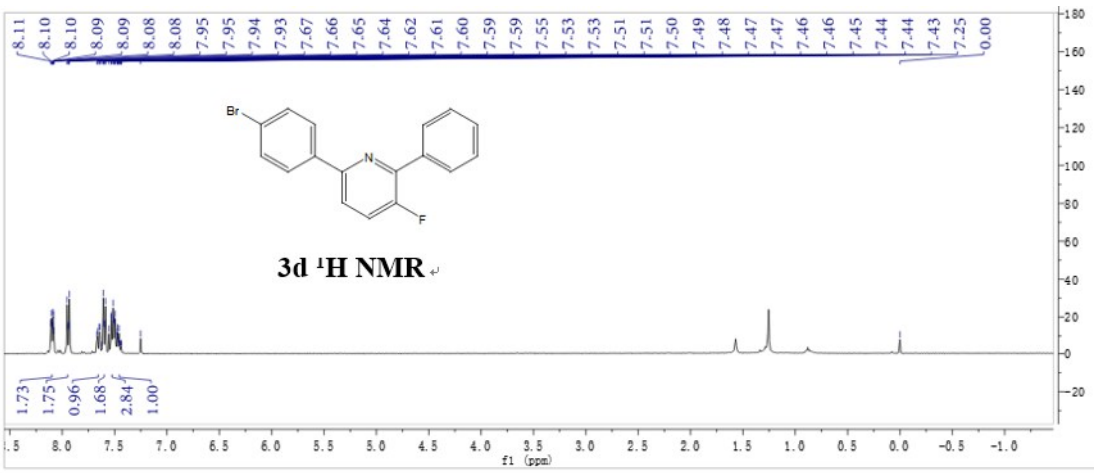
3c ^{1}H NMR

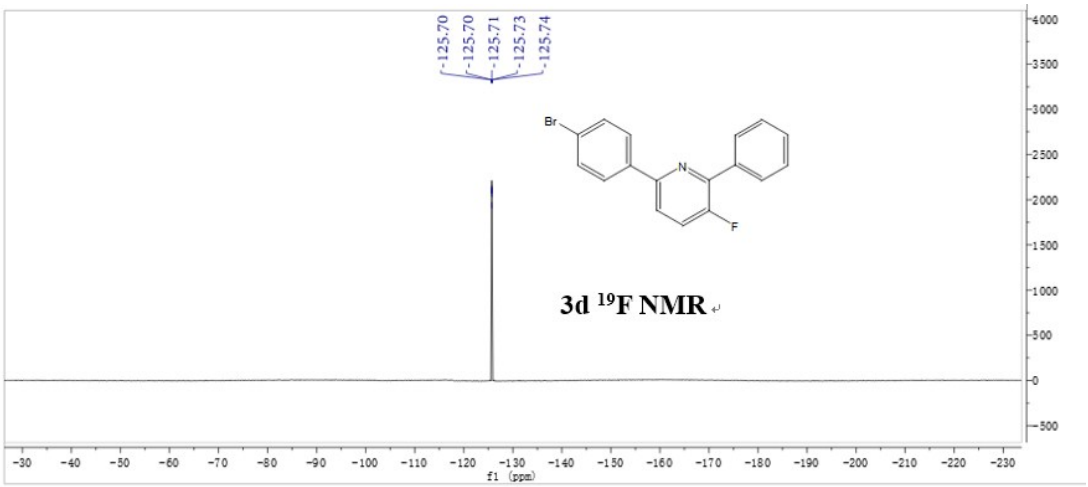


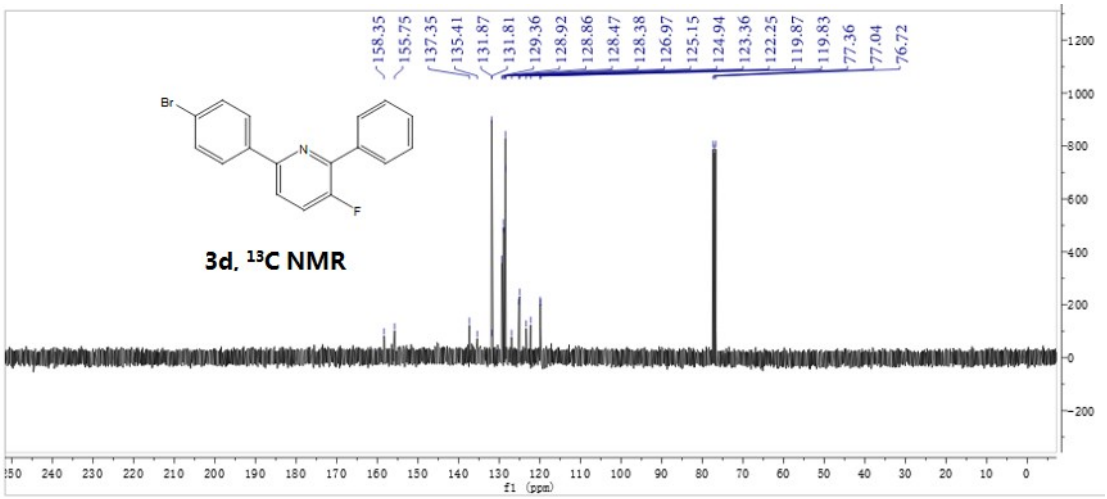
3c ^{19}F NMR

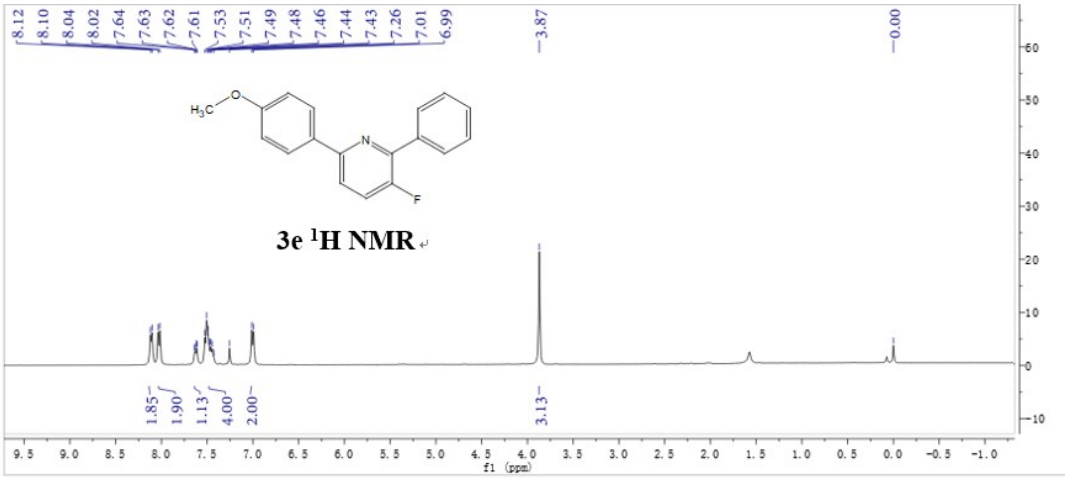


3c ^{13}C NMR

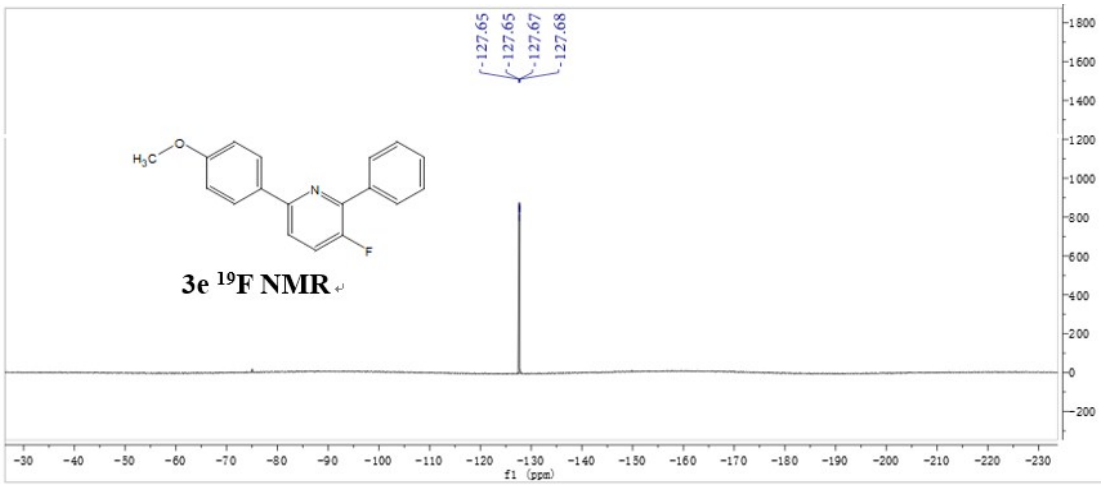

8.11 8.10 8.10 8.09 8.09 8.08 8.08 7.95 7.95 7.94 7.93 7.67 7.66 7.65 7.64 7.62 7.61 7.60 7.59 7.59 7.55 7.53 7.53 7.51 7.51 7.50 7.49 7.48 7.47 7.47 7.46 7.46 7.45 7.44 7.44 7.43 7.25 0.00
Br
N
F
3d ^{1}H NMR
1.73 1.75 0.96 1.68 2.84 1.00
f1 (ppm)


-125.70 -125.70 -125.71 -125.73 -125.74
Br
N
F
3d ^{19}F NMR
f1 (ppm)

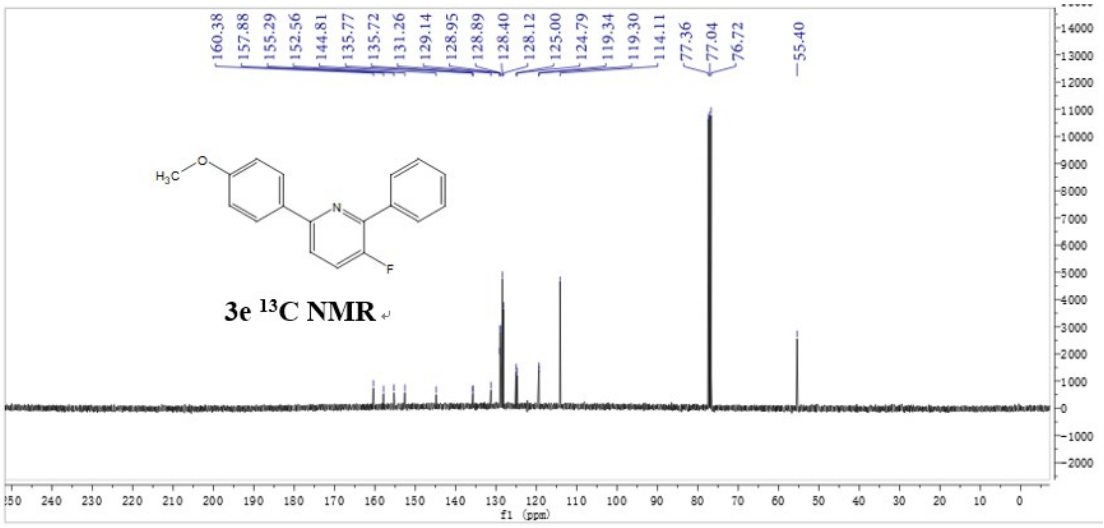

158.35 155.75 137.35 135.41 131.87 131.81 129.36 128.92 128.86 128.47 128.38 126.97 125.15 124.94 123.36 122.25 119.87 119.83 77.36 77.04 76.72
Br
N
F
3d, ^{13}C NMR
f1 (ppm)



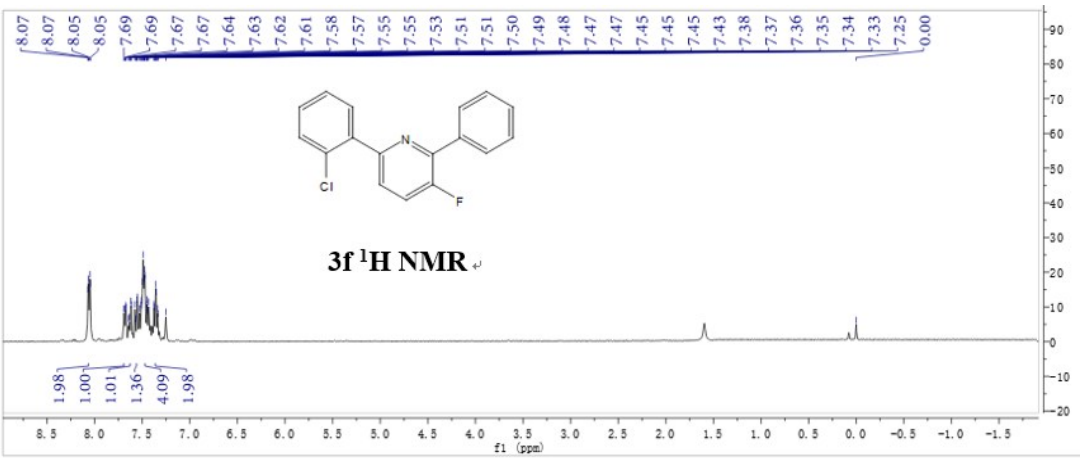
3e ^{1}H NMR



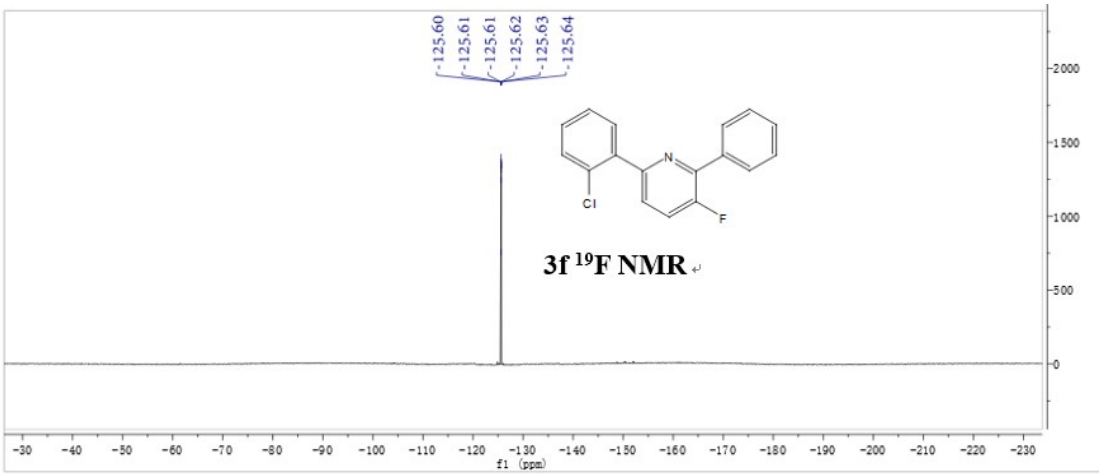
3e ^{19}F NMR



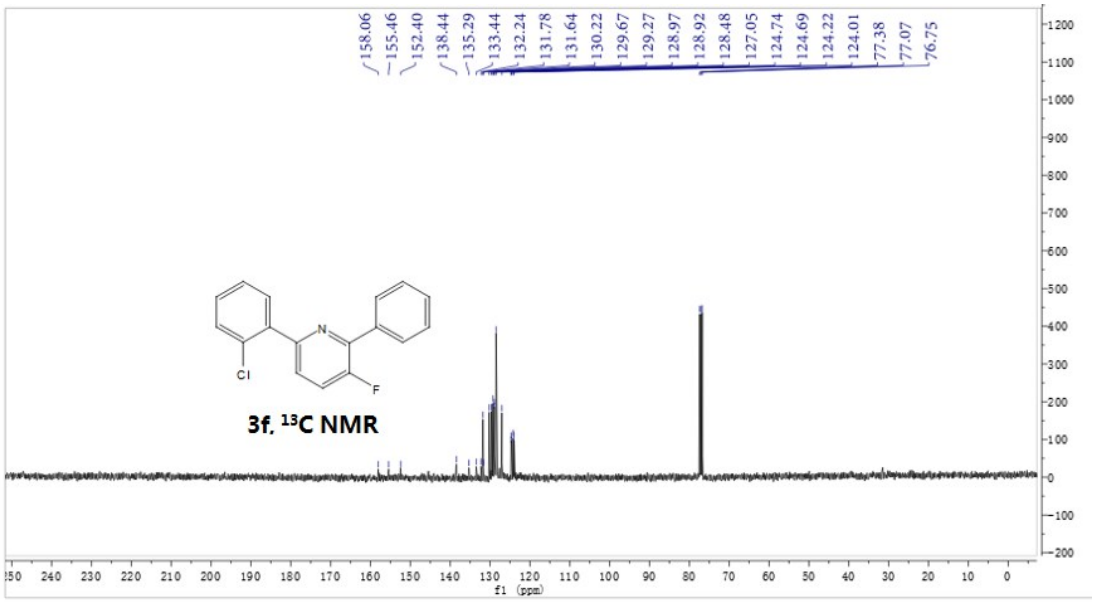
3e ^{13}C NMR



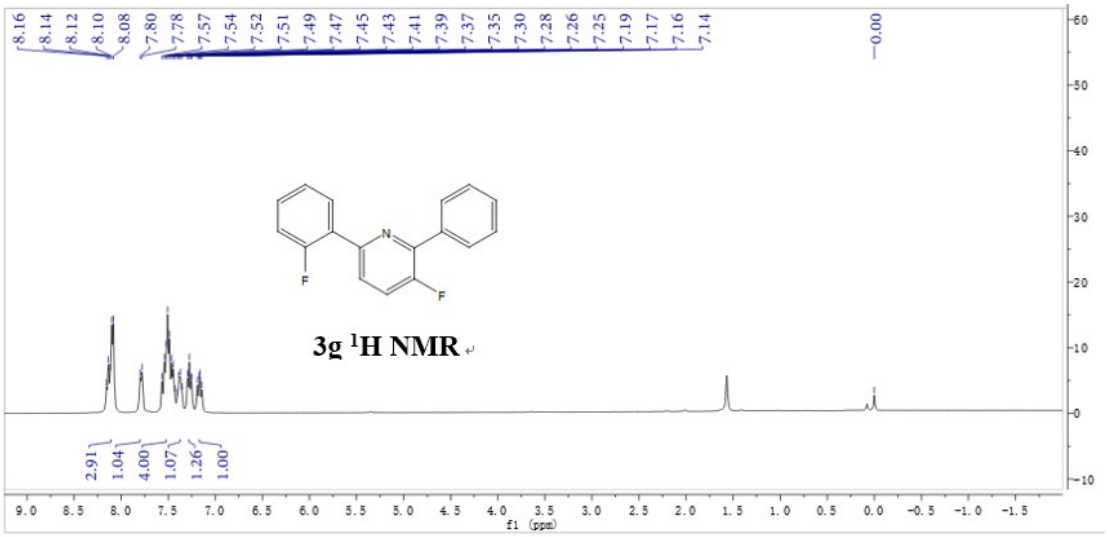
3f ^{1}H NMR



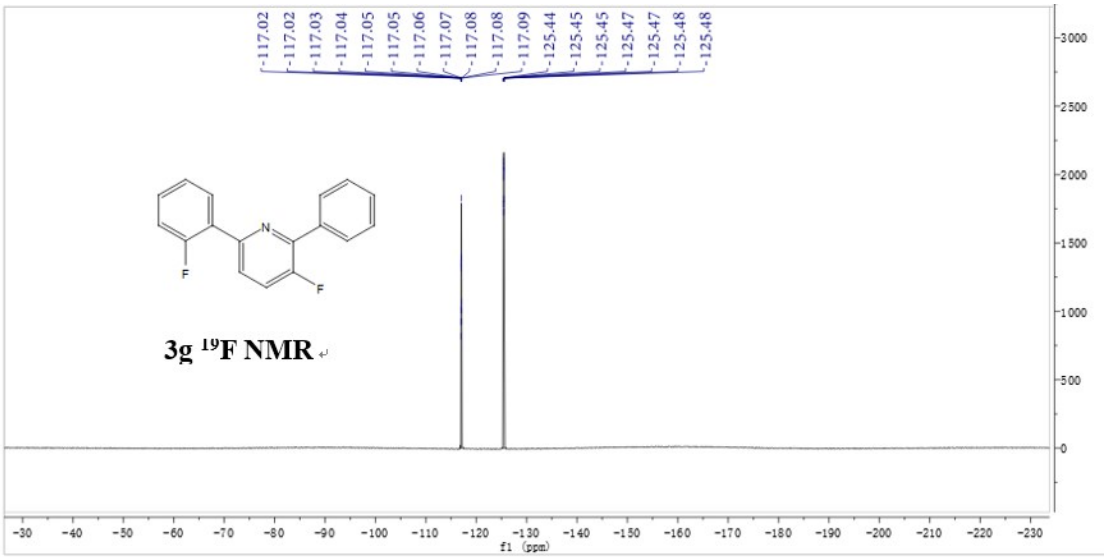
3f ^{19}F NMR



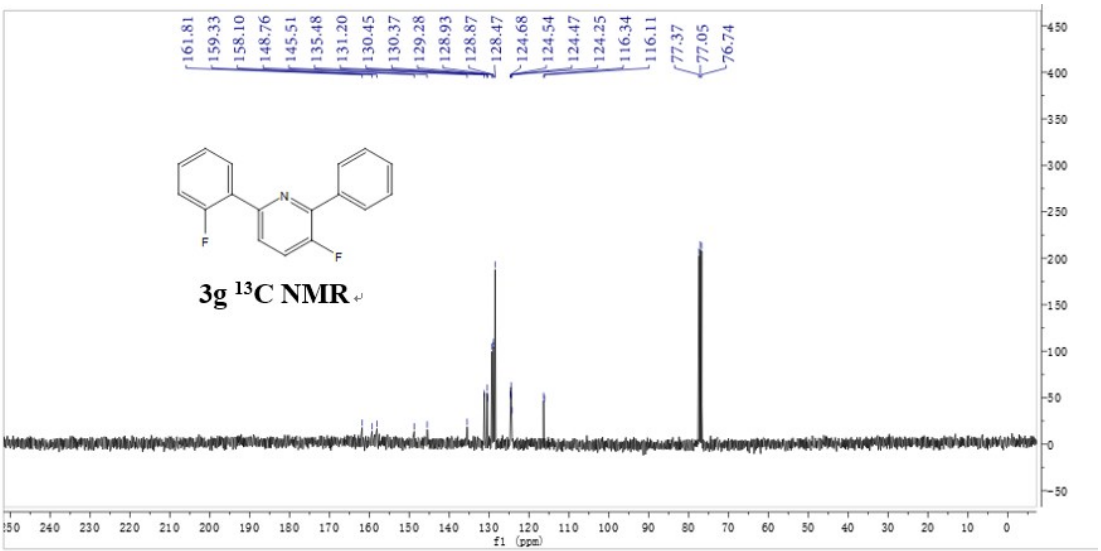
3f, ^{13}C NMR



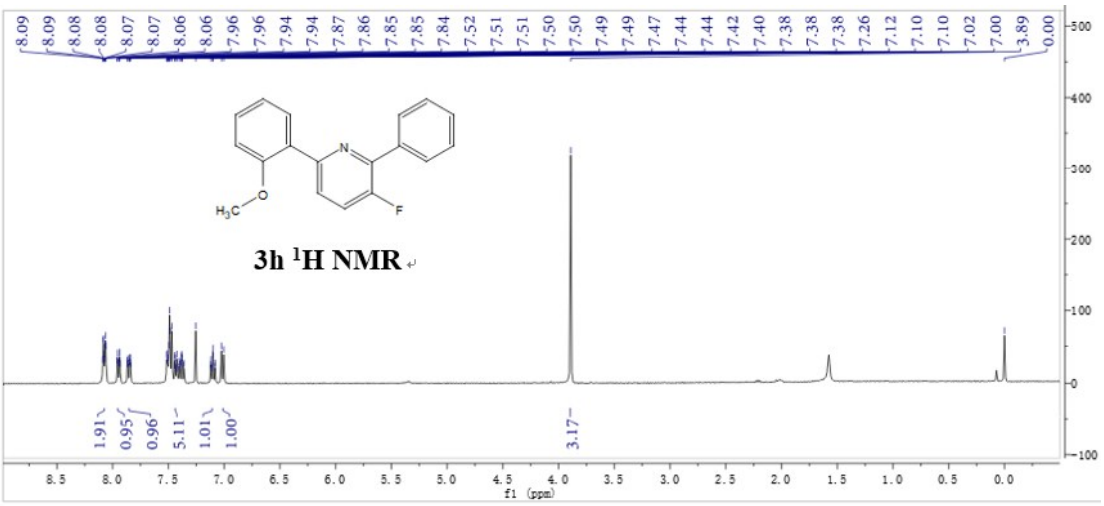
3g ^{1}H NMR



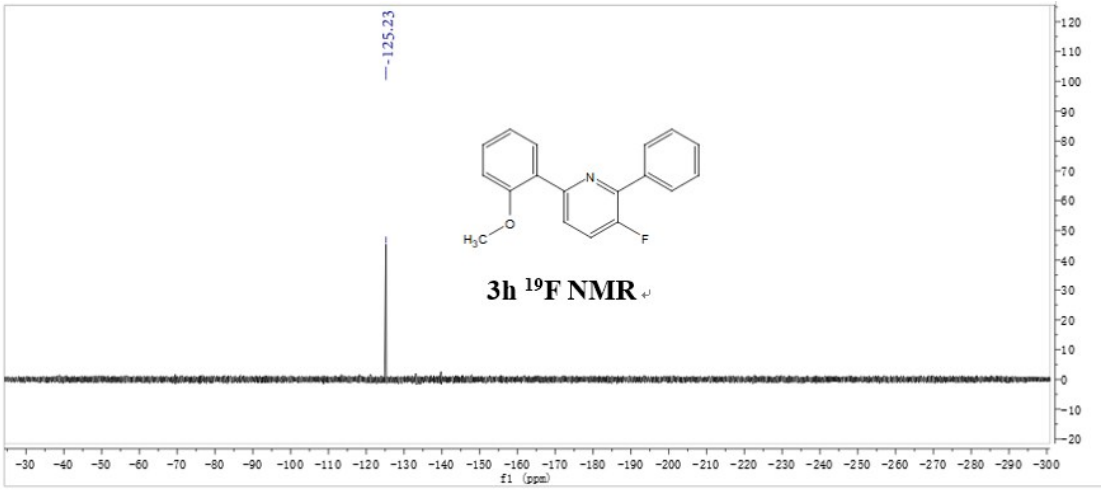
3g ^{19}F NMR



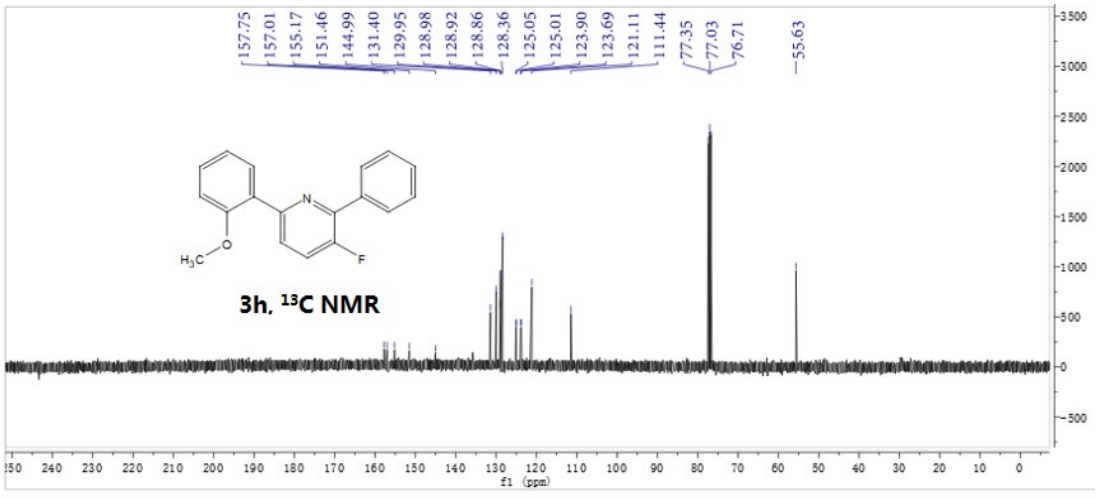
3g ^{13}C NMR



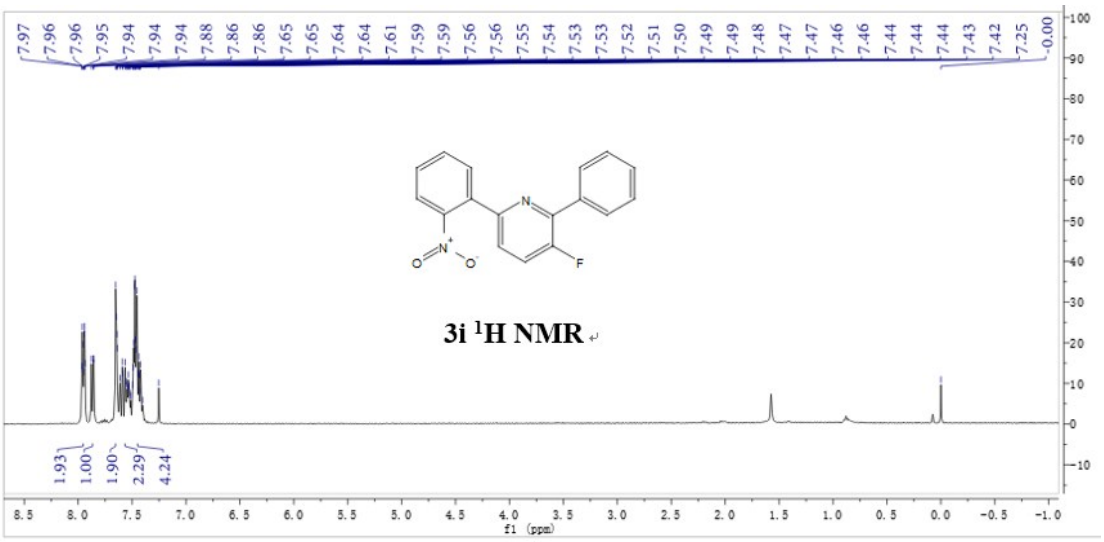
3h ^{1}H NMR



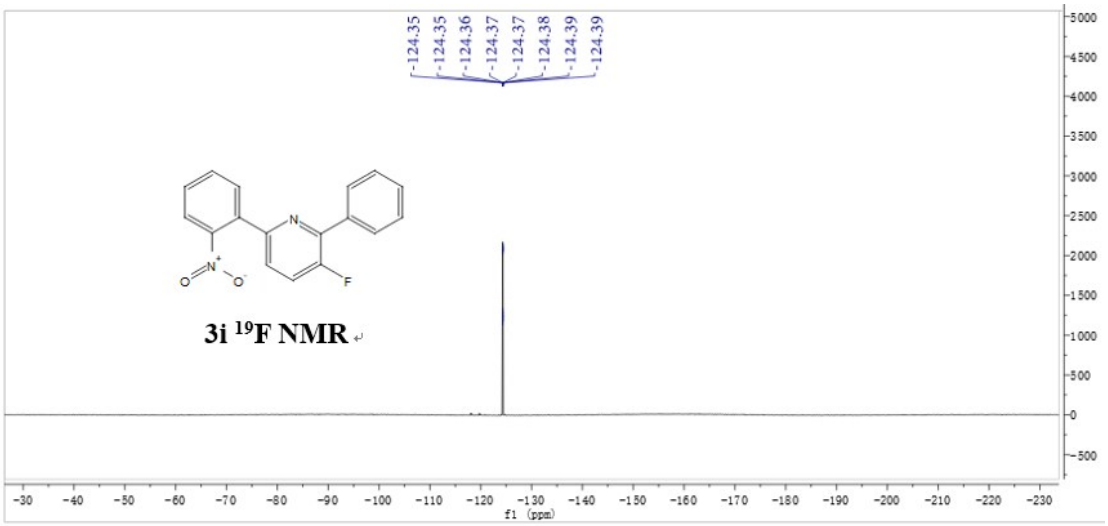
3h ^{19}F NMR



3h, ^{13}C NMR



3i ^{1}H NMR



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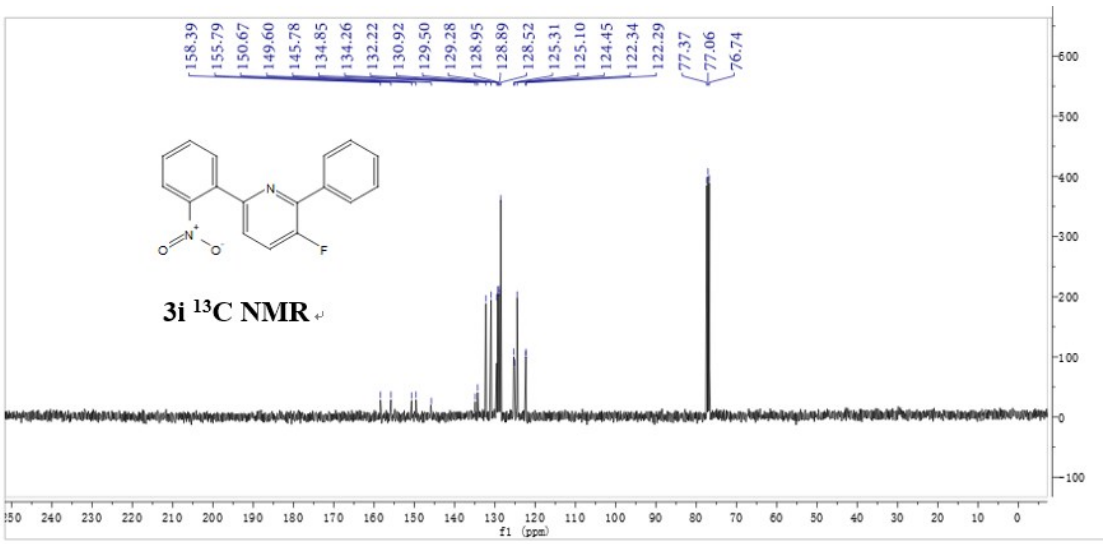

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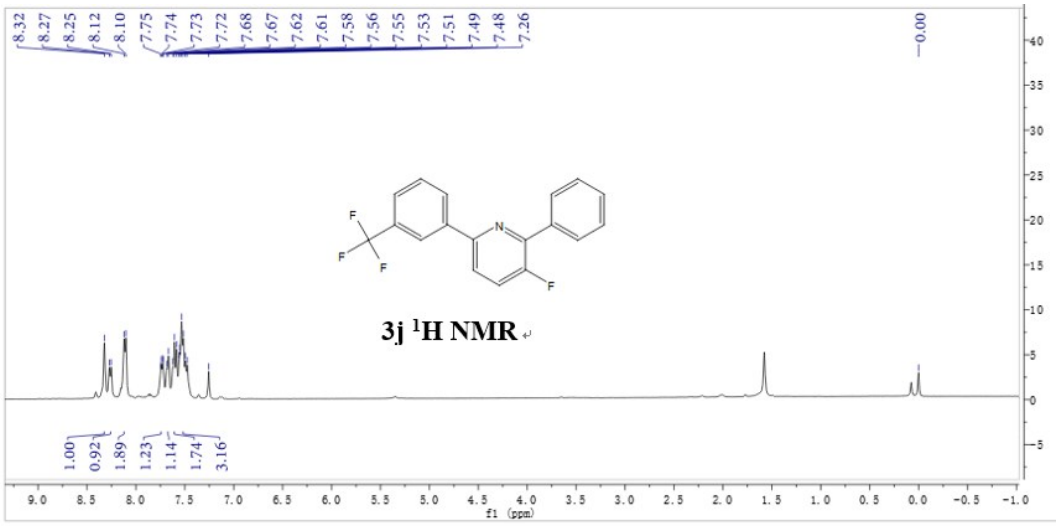

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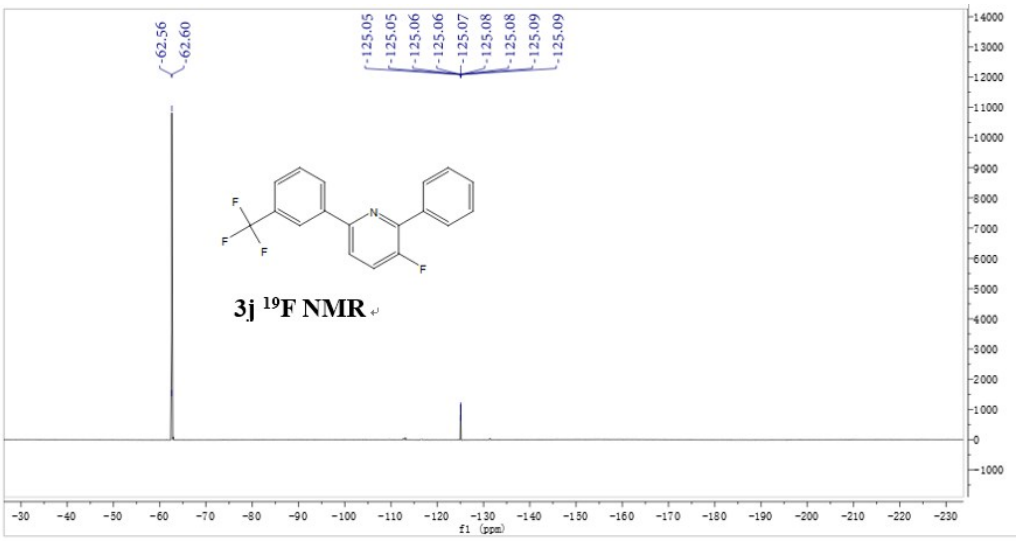

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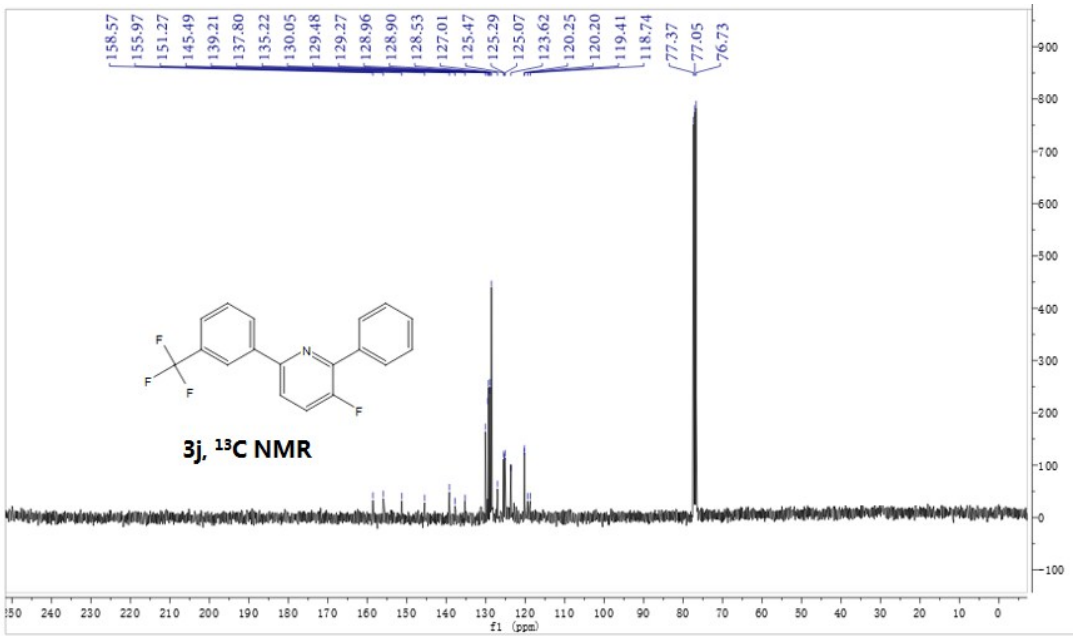

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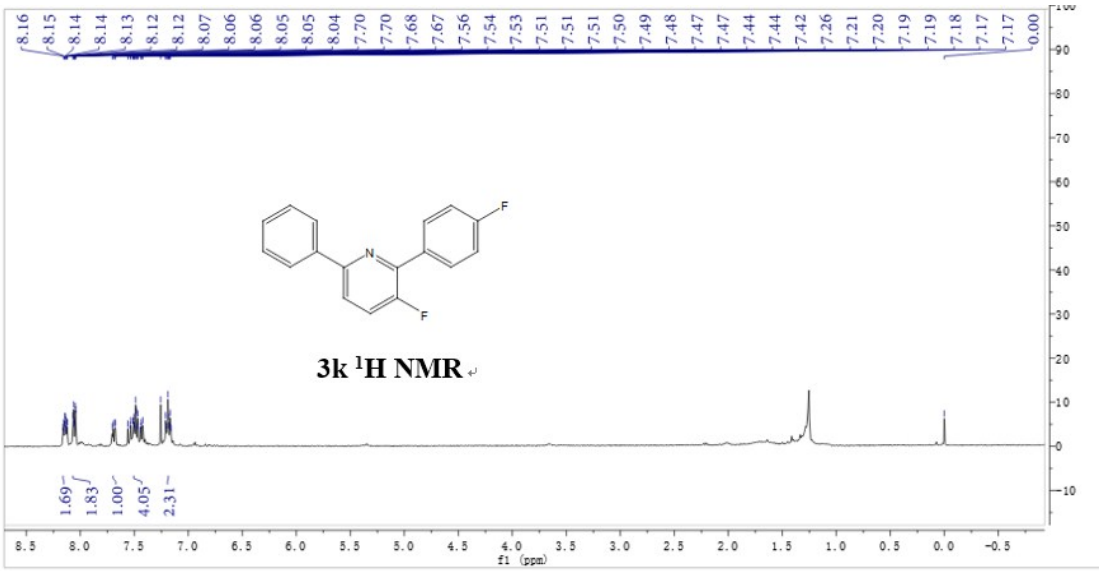

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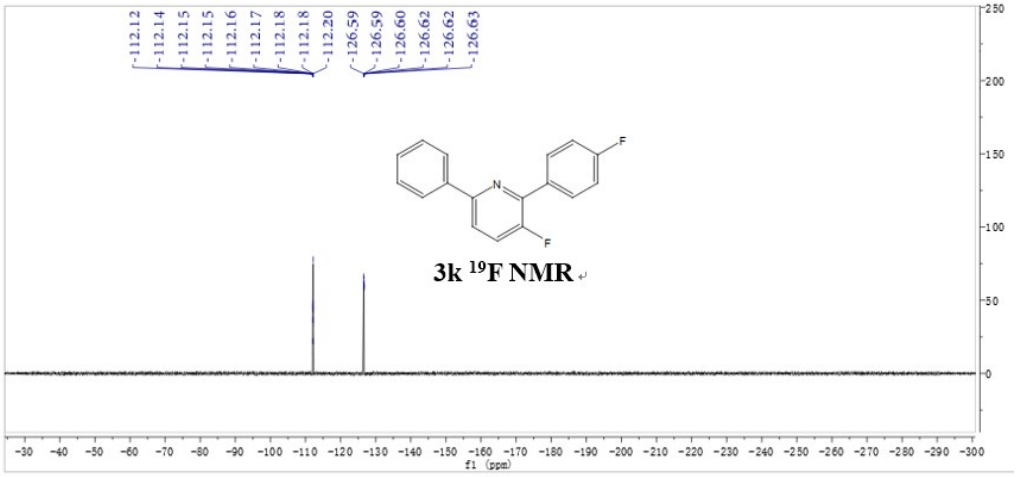

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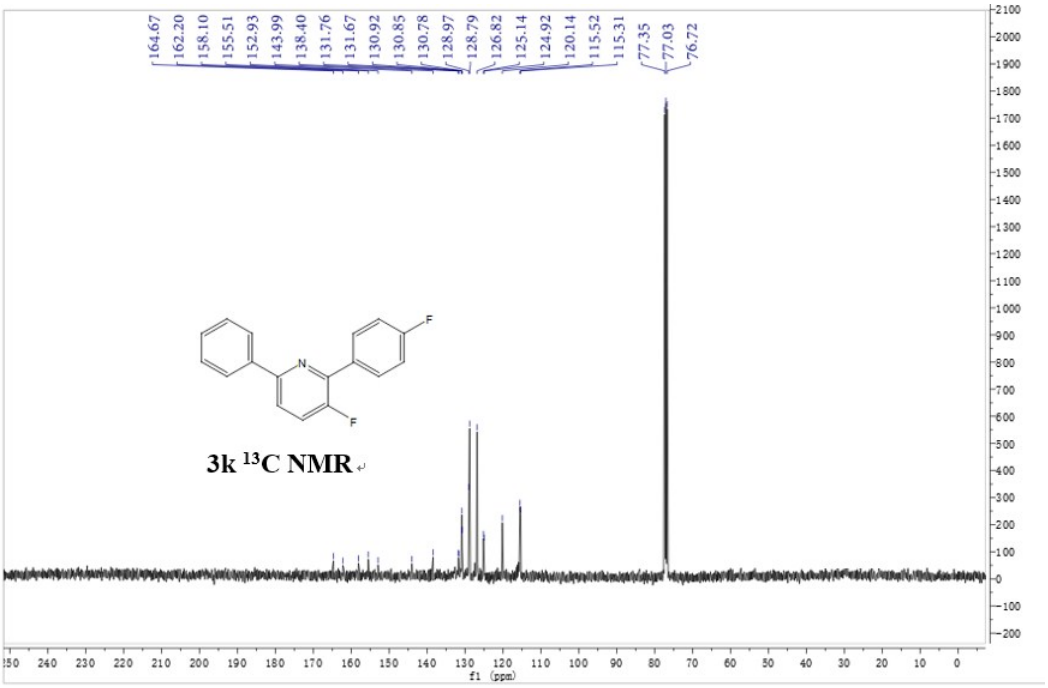

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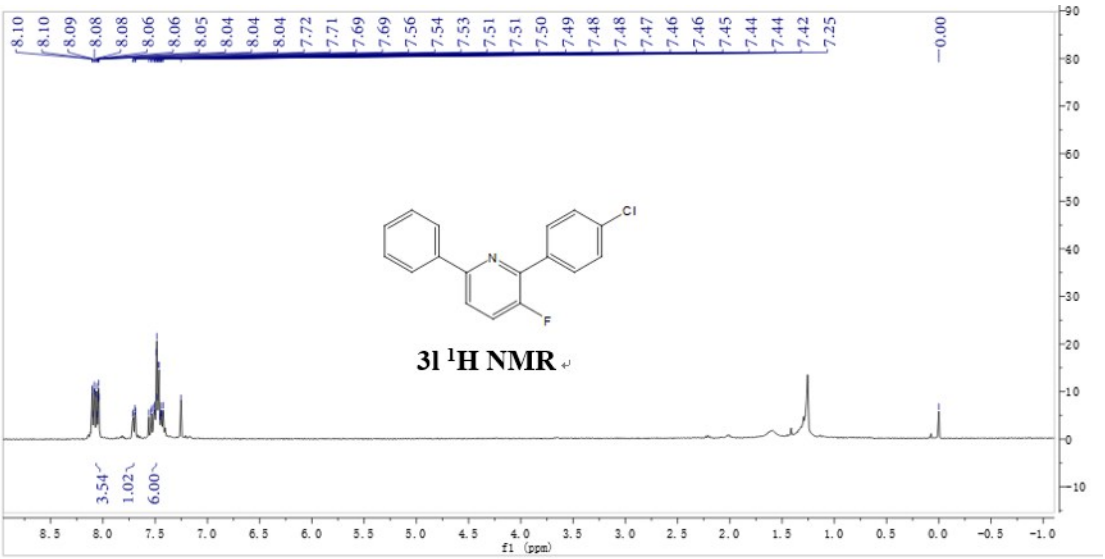
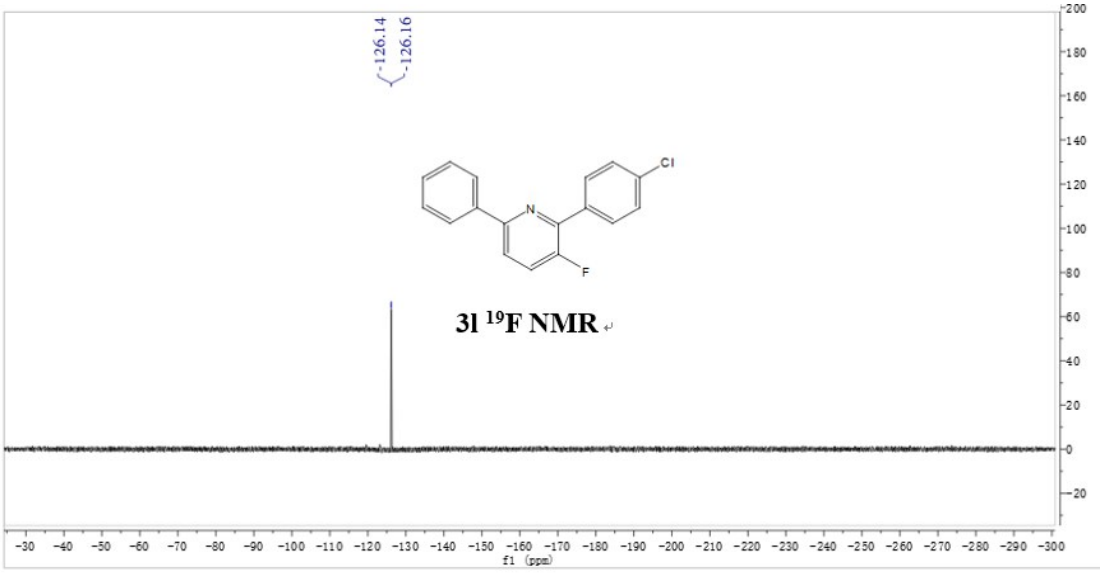
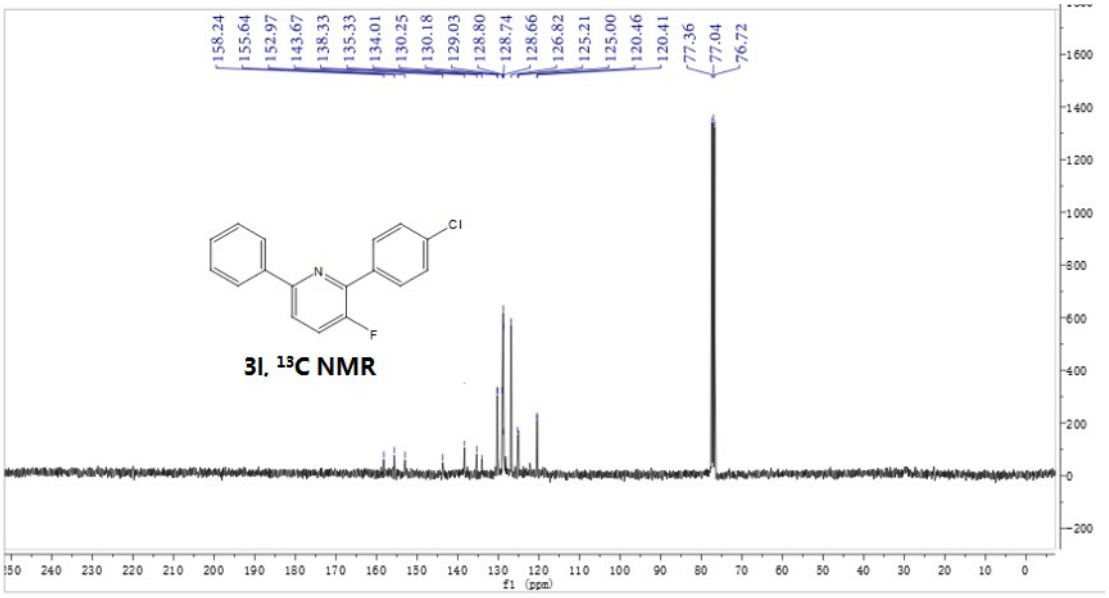


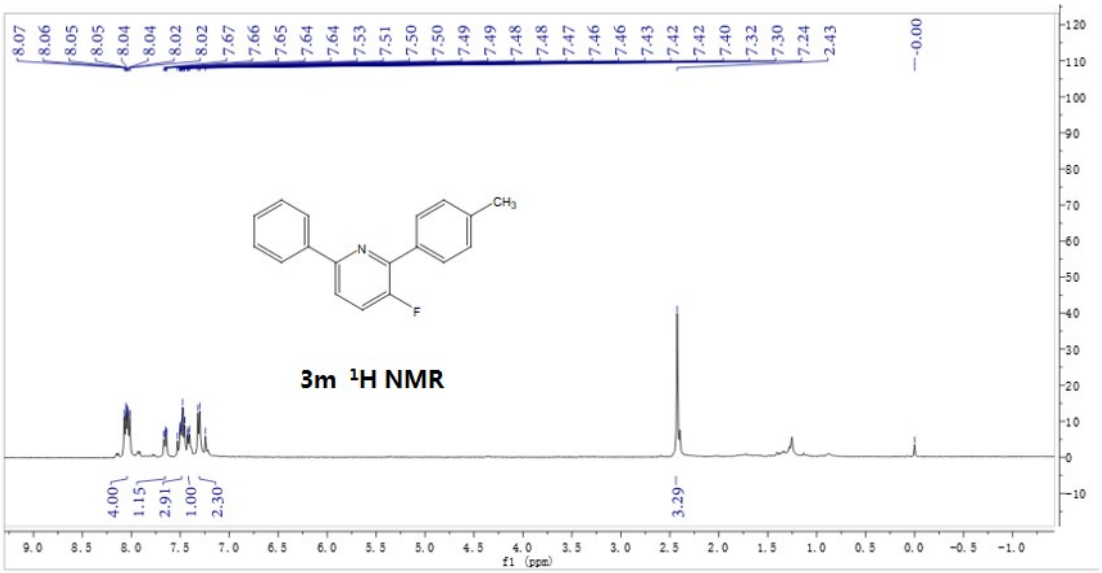
3l ^{1}H NMR



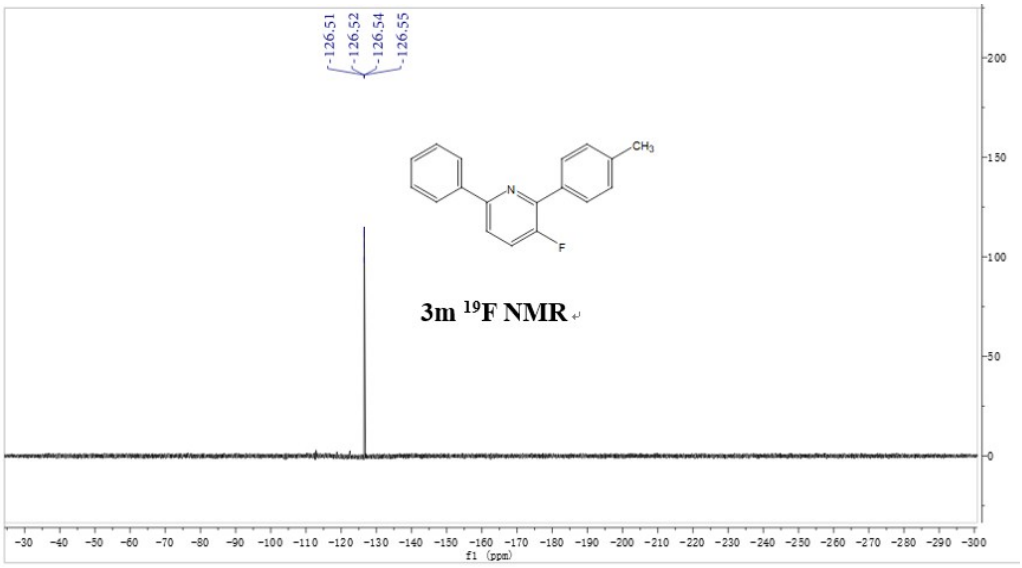
3l ^{19}F NMR



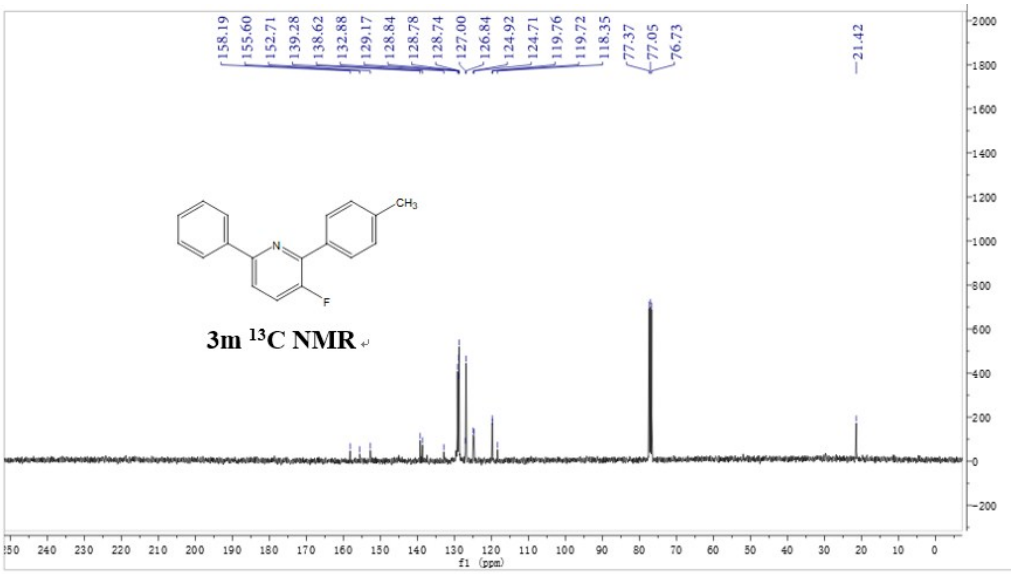
3l, ^{13}C NMR



3m ^{1}H NMR



3m ^{19}F NMR



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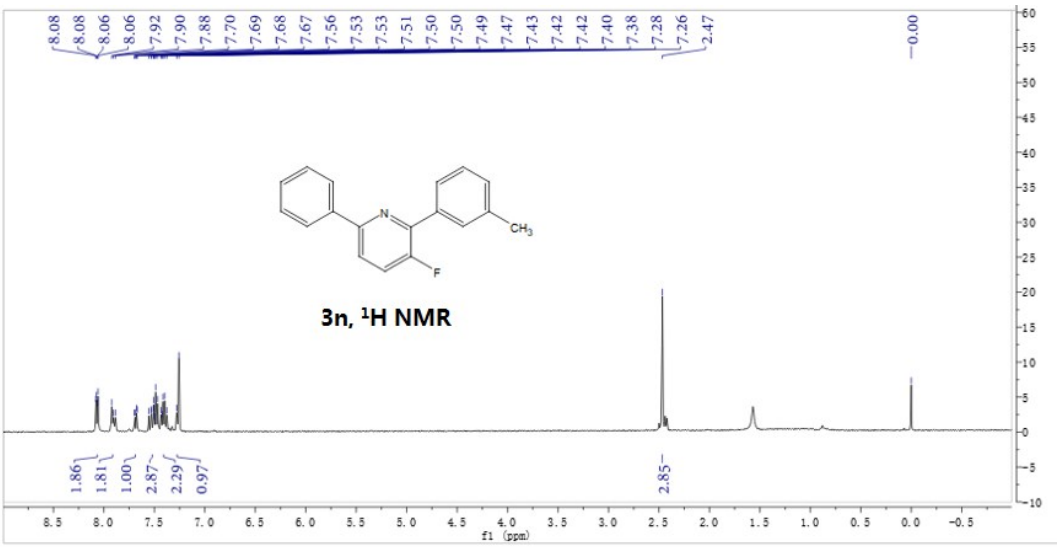
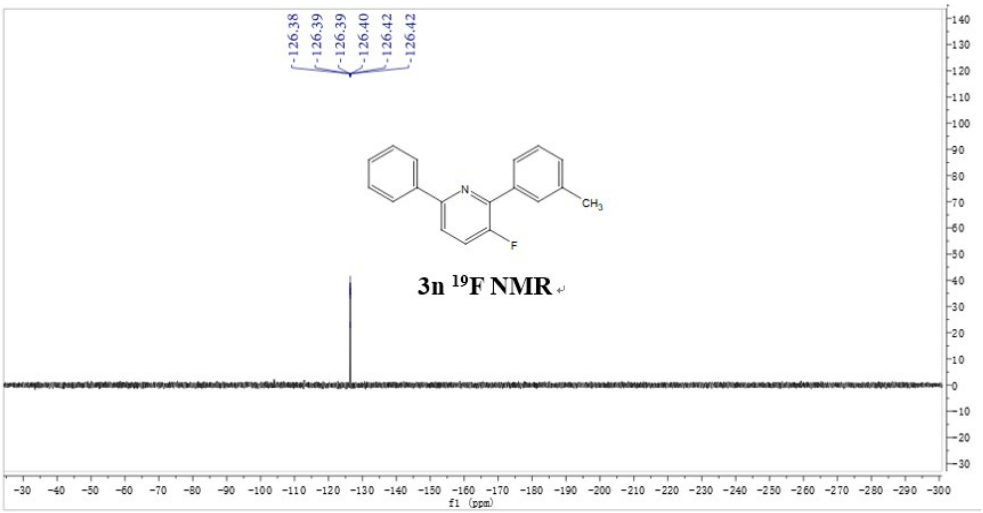
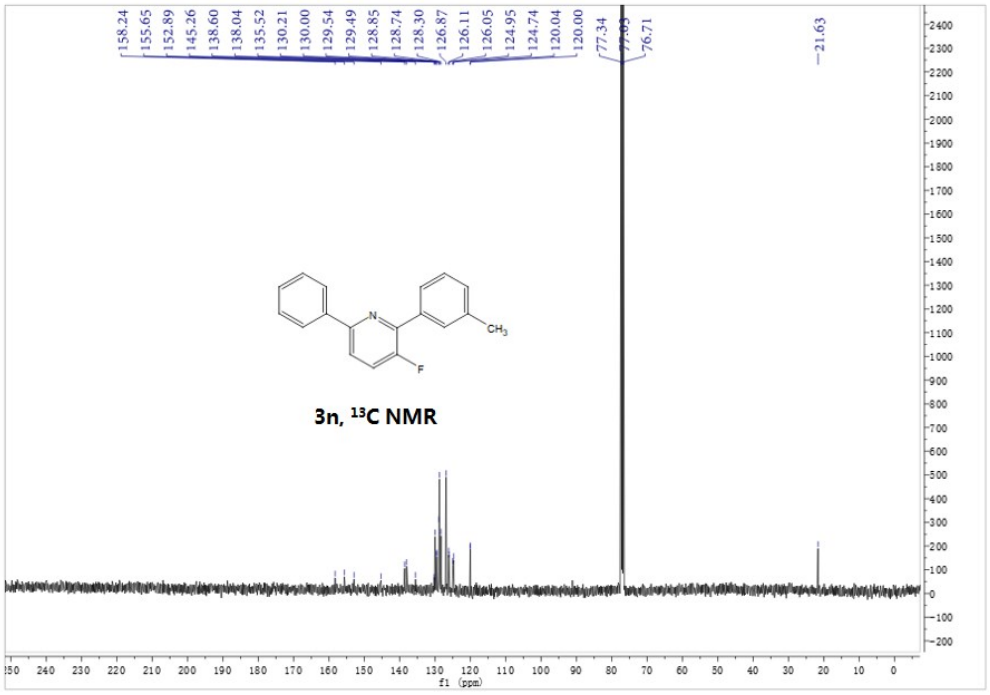


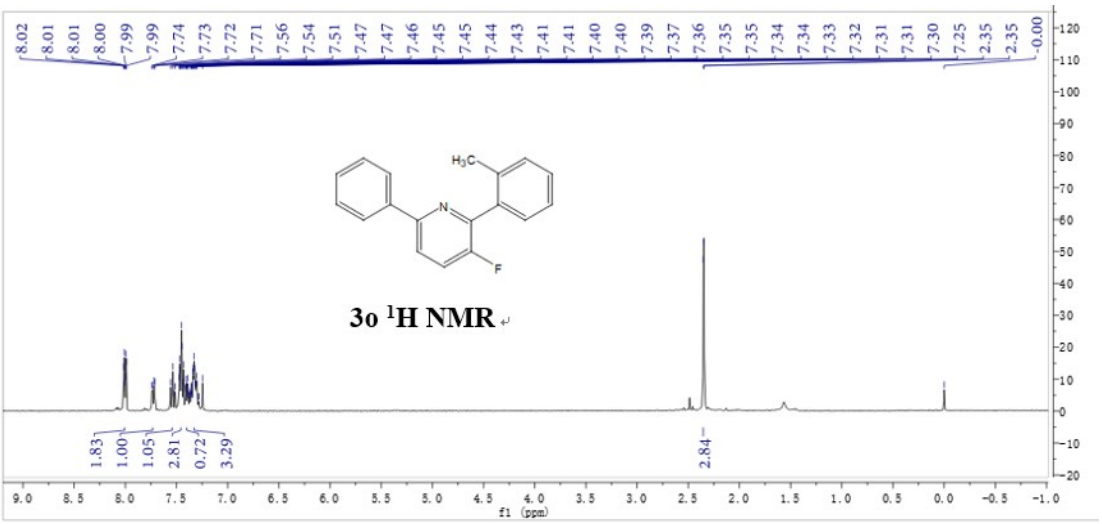
3n, ^{1}H NMR



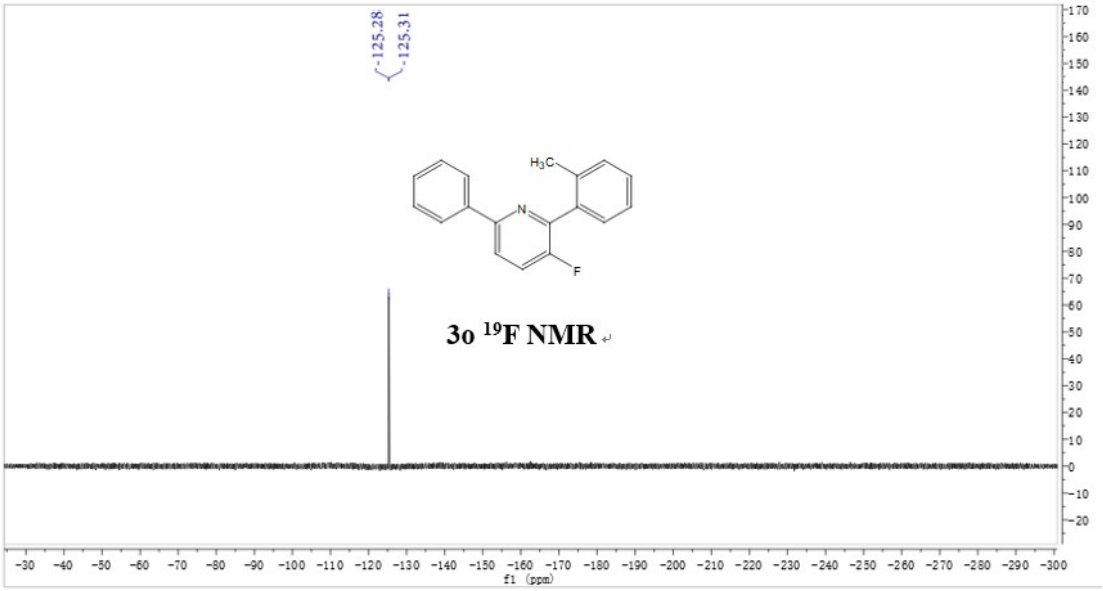
3n ^{19}F NMR



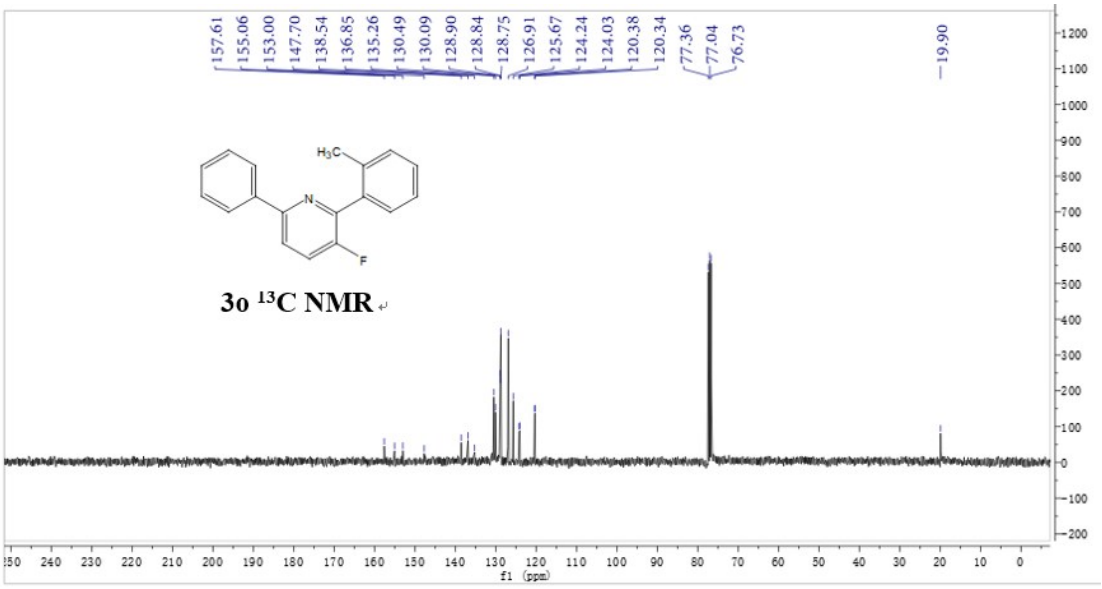
3n, ^{13}C NMR



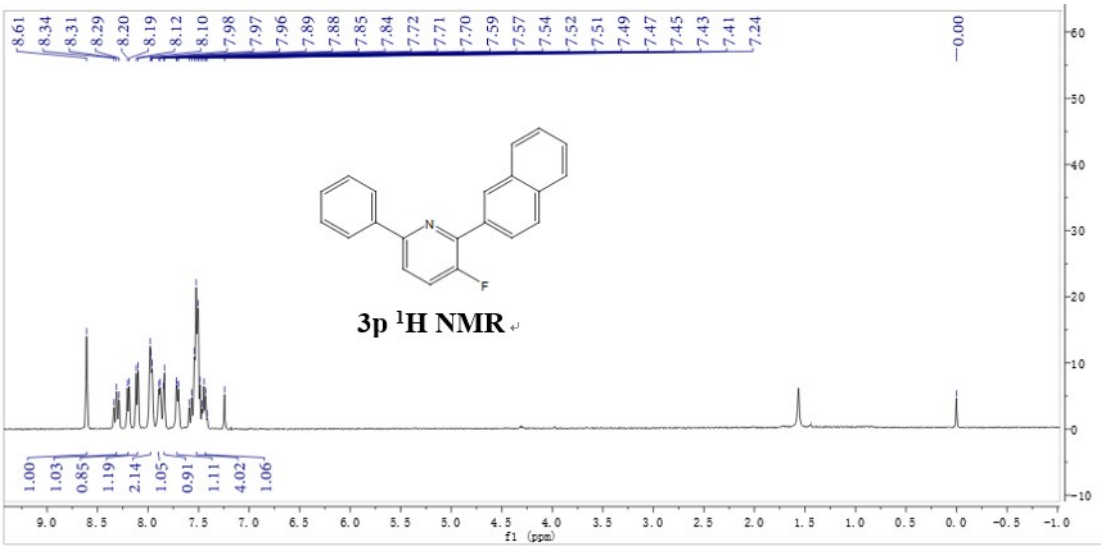
3o ^{1}H NMR



3o ^{19}F NMR



3o ^{13}C NMR



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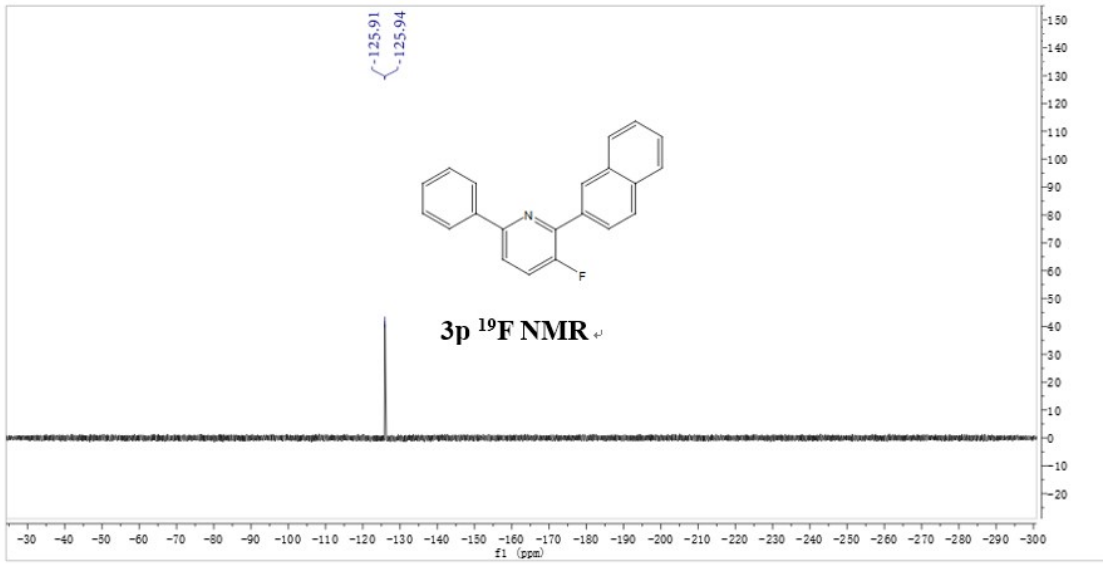

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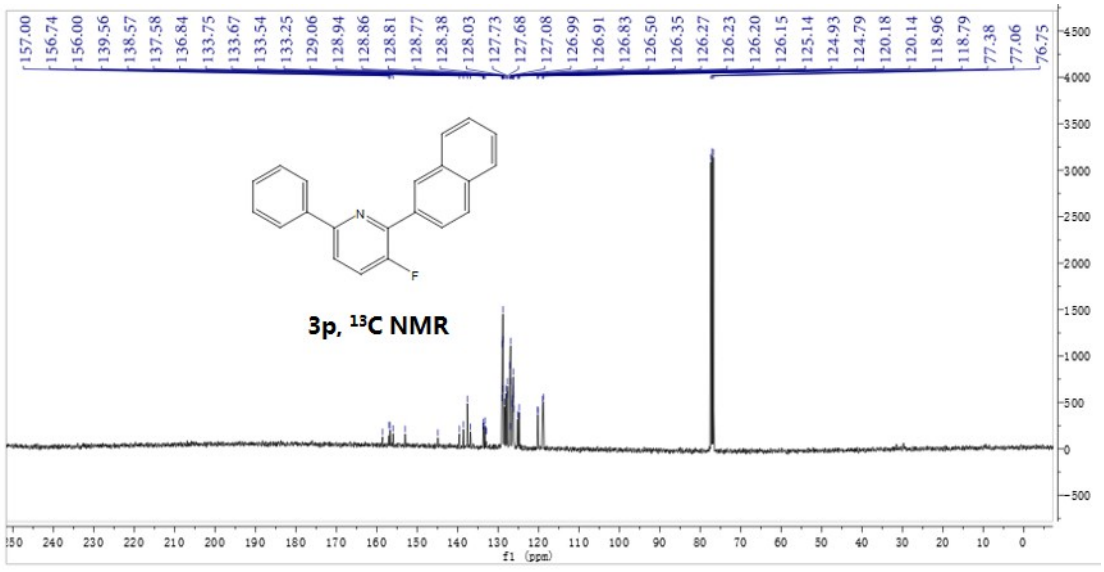
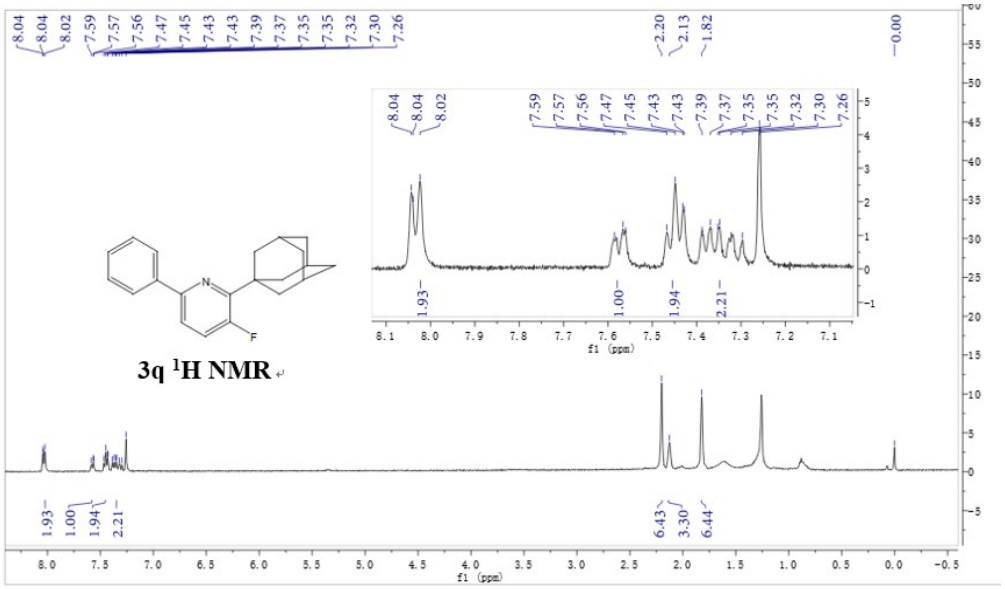
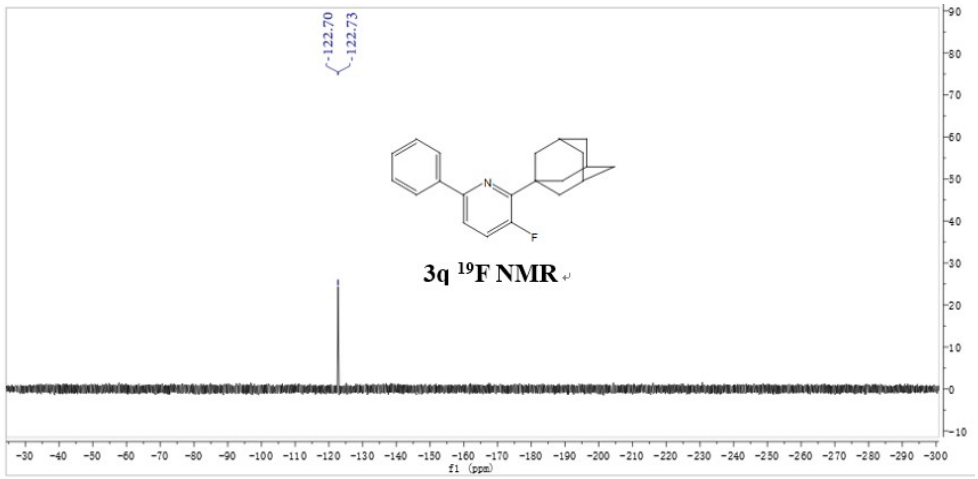


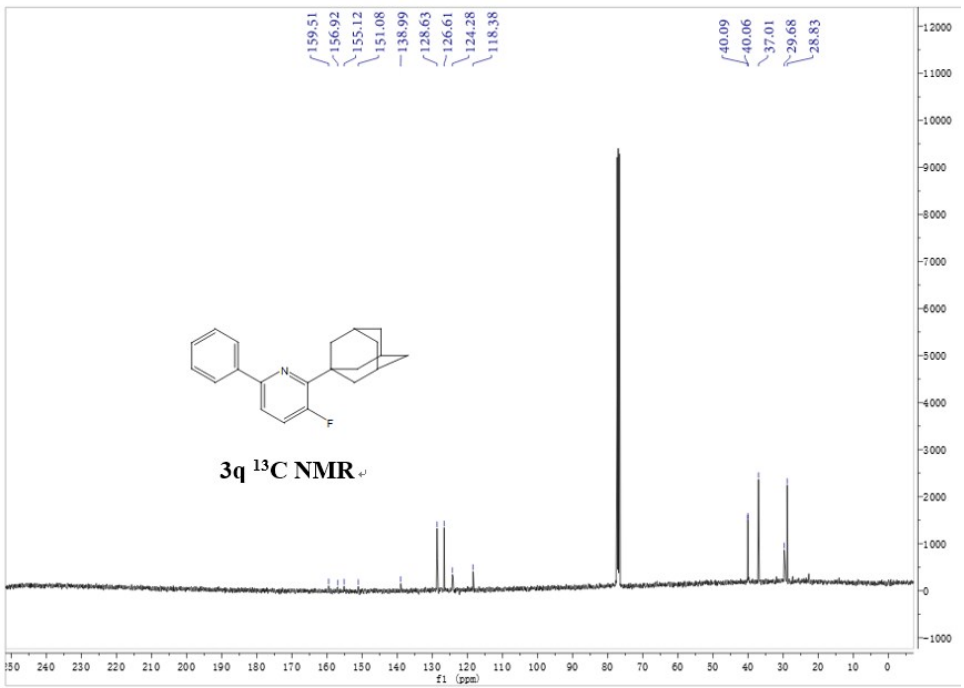
3p, ^{13}C NMR



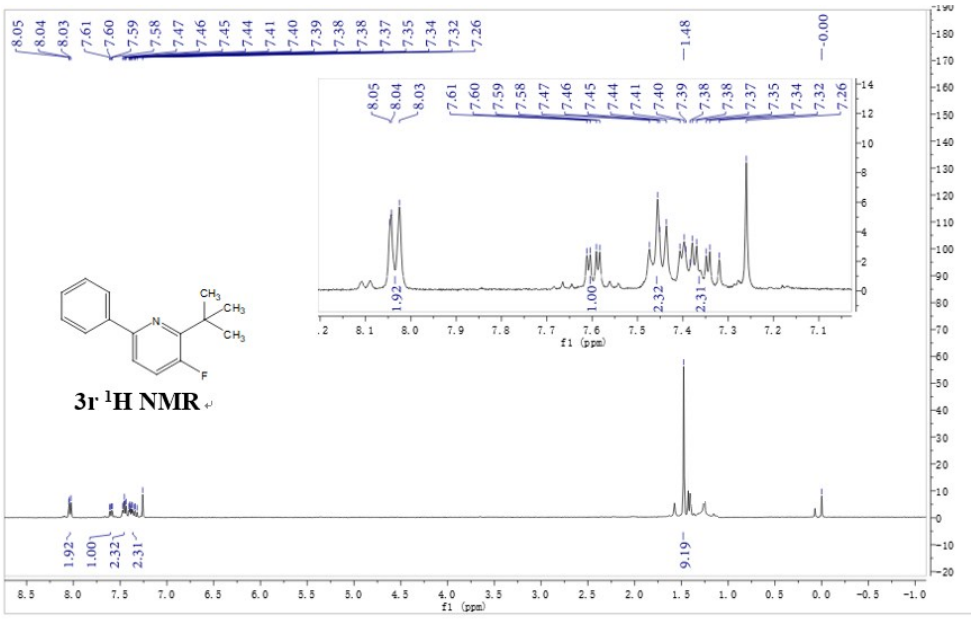
3q ^{1}H NMR



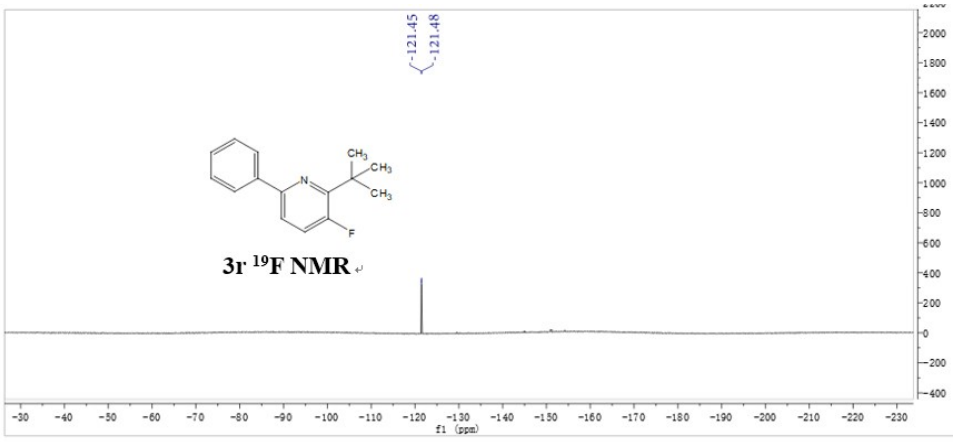
3q ^{19}F NMR



3q ^{13}C NMR



3r ^{1}H NMR



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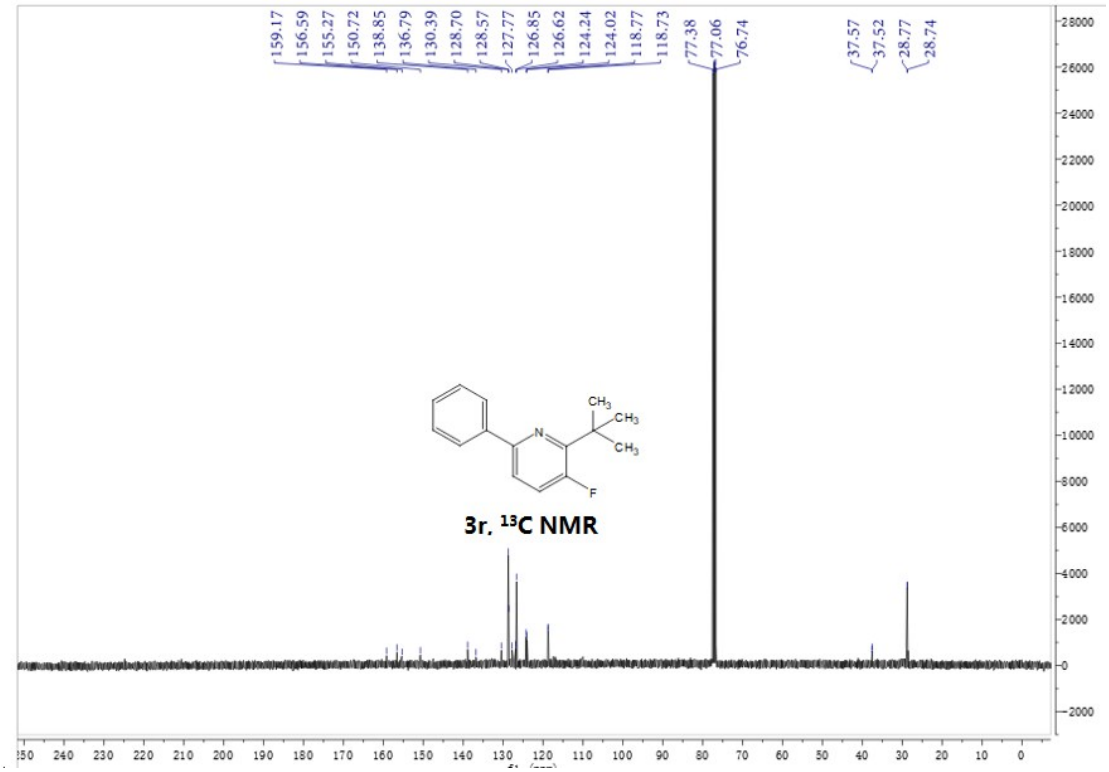
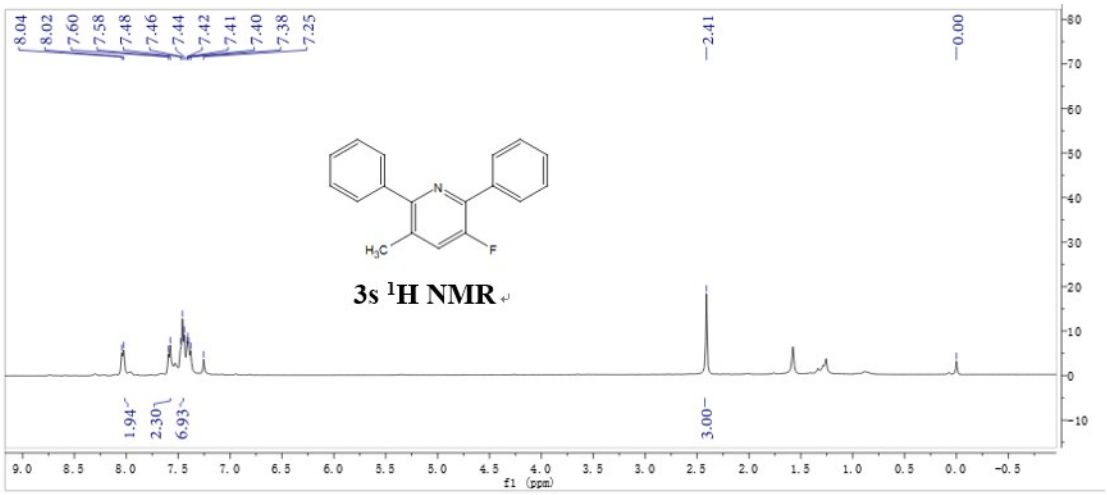
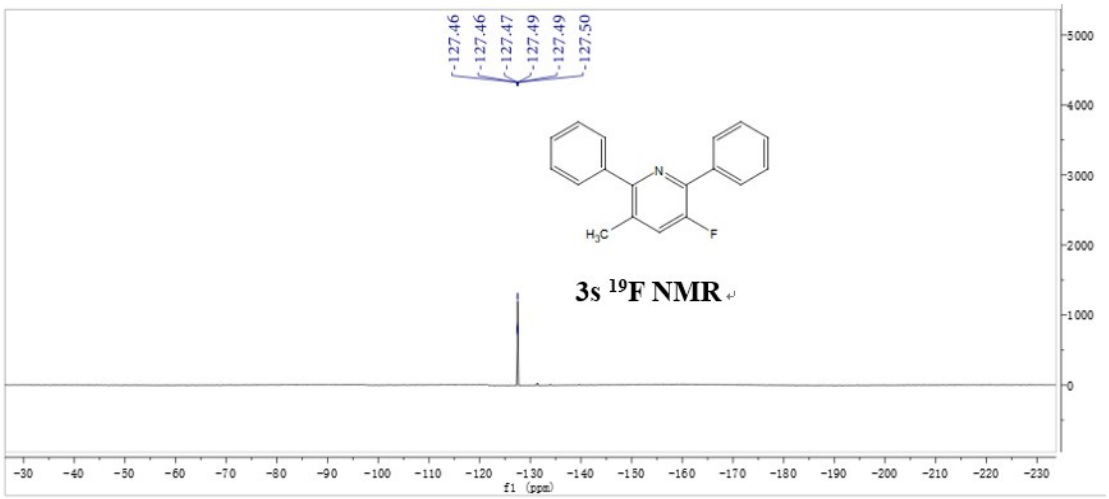


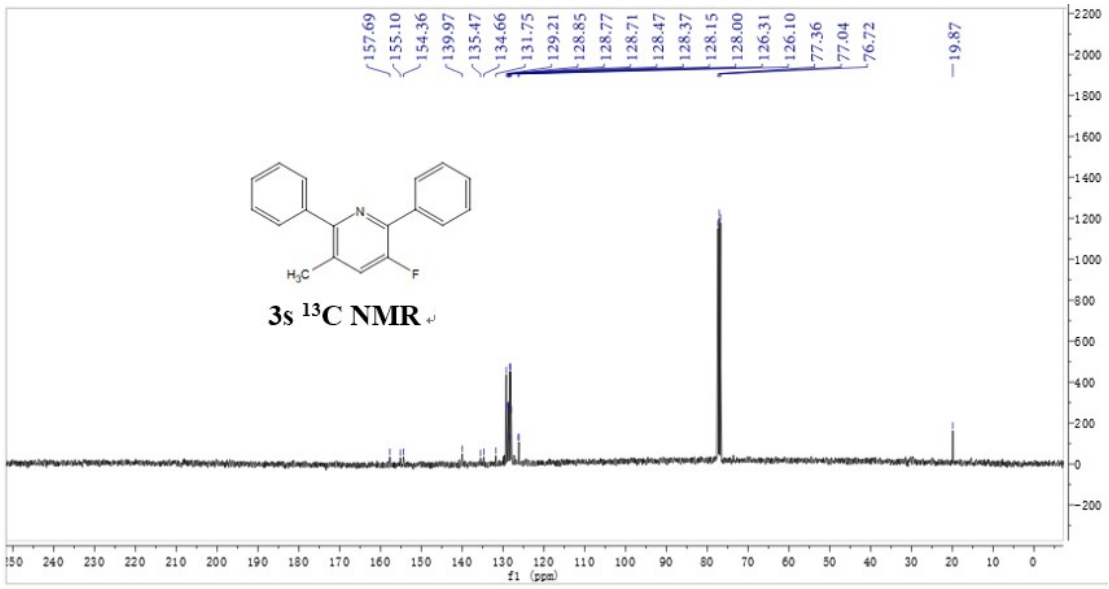
3r, ^{13}C NMR



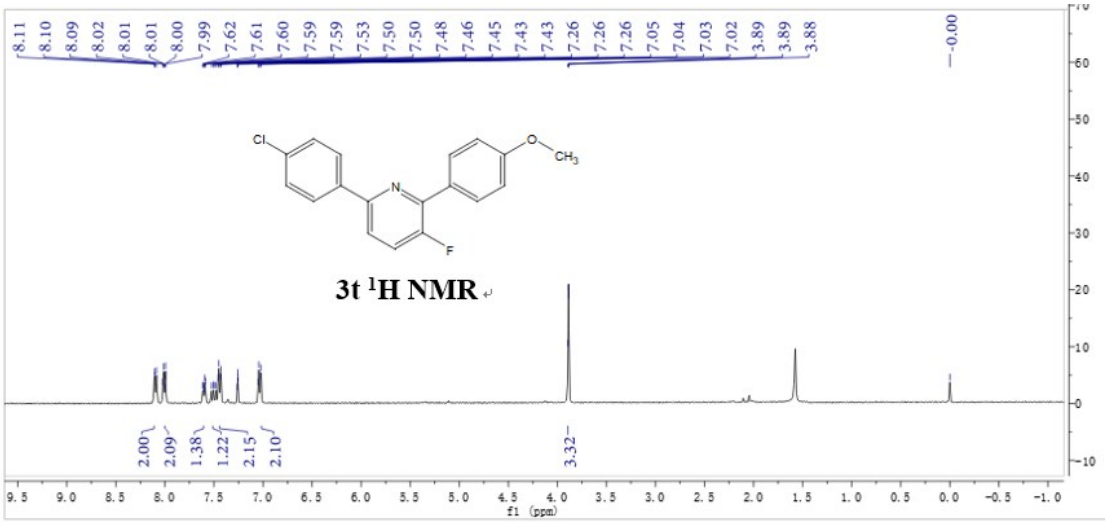
3s ^{1}H NMR



3s ^{19}F NMR



3s ^{13}C NMR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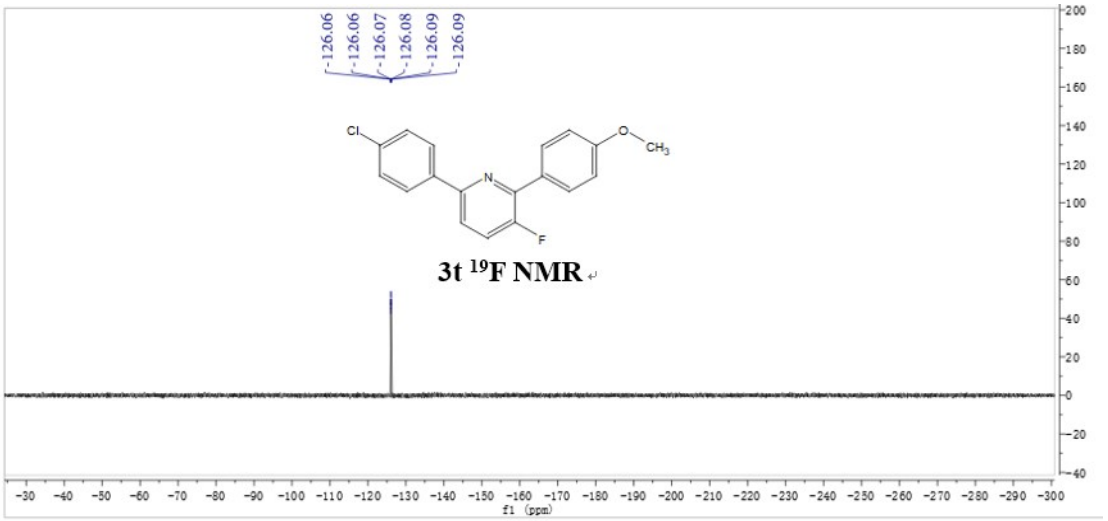
8.10
8.09
8.02
8.01
8.01
8.00
7.99
7.62
7.61
7.60
7.59
7.59
7.53
7.50
7.50
7.48
7.46
7.45
7.43
7.43
7.26
7.26
7.26
7.05
7.04
7.03
7.02
3.89
3.89
3.88
-0.00
Cl
O
CH3
N
F
3t 1H NMR
2.00
2.09
1.38
1.22
2.15
2.10
3.32
f1 (ppm)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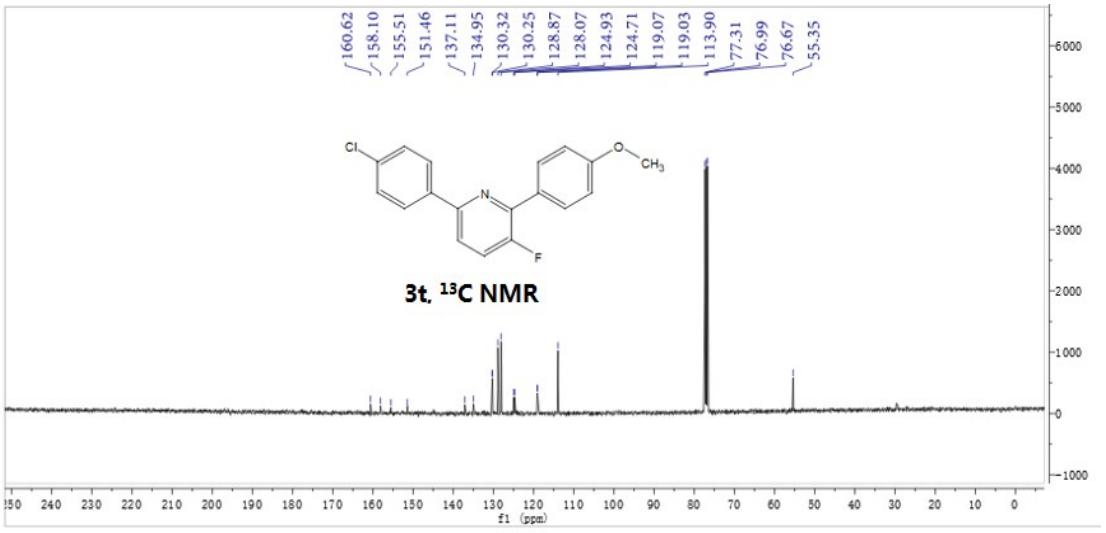
126.06
126.07
126.08
126.09
126.09
Cl
O
CH3
N
F
3t 19F NMR
f1 (ppm)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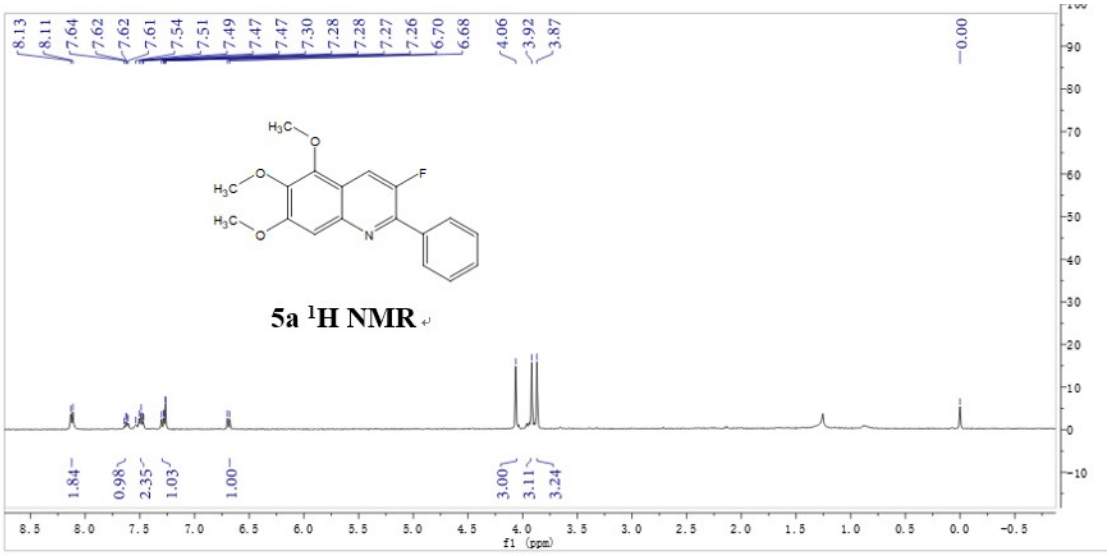
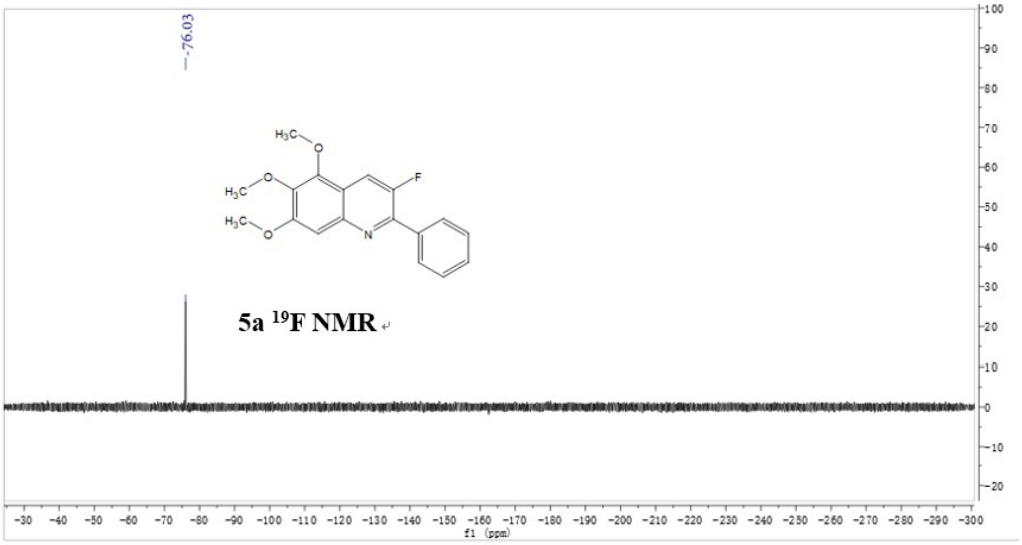
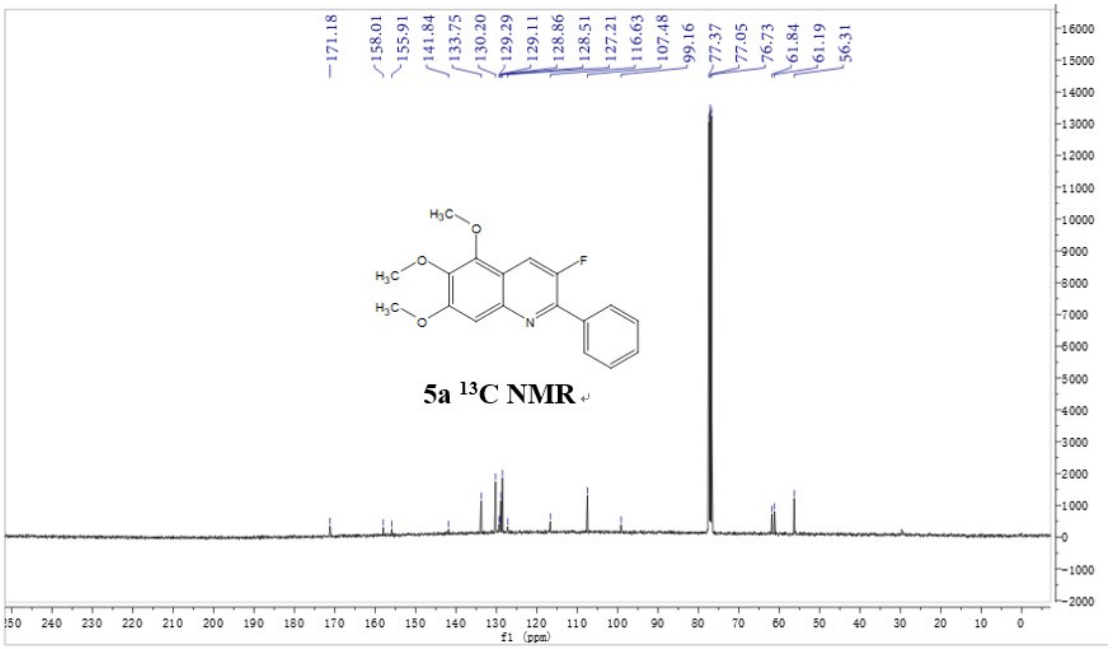
158.10
155.51
151.46
137.11
134.95
130.32
130.25
128.87
128.07
124.93
124.71
119.07
119.03
113.90
77.31
76.99
76.67
55.35
Cl
O
CH3
N
F
3t, 13C NMR
f1 (ppm)



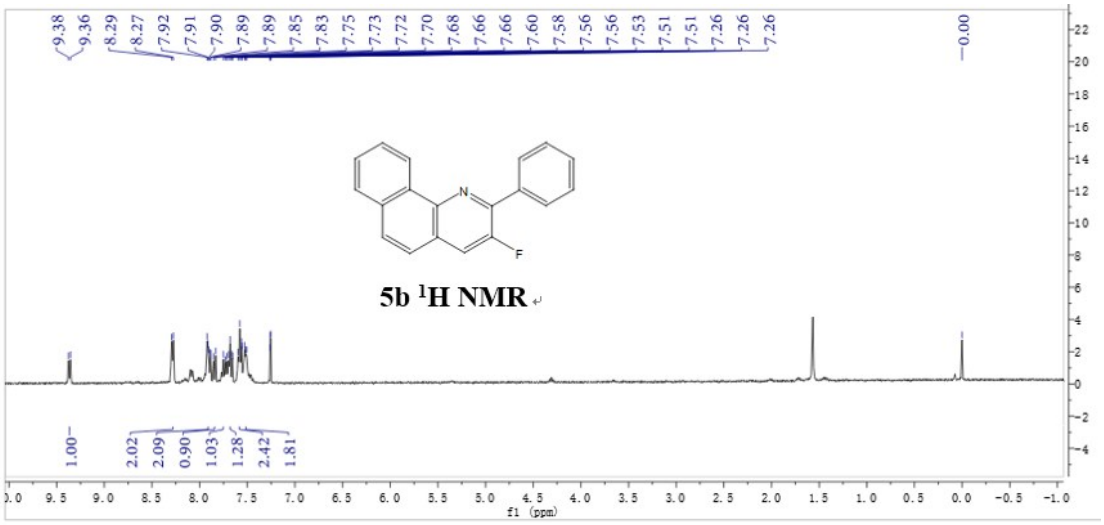
5a ^{1}H NMR



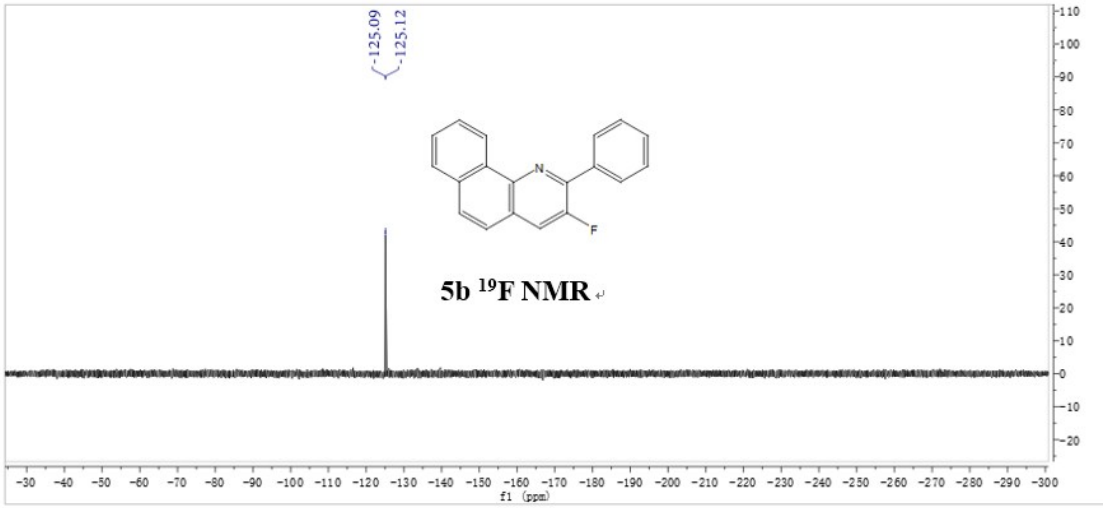
5a ^{19}F NMR



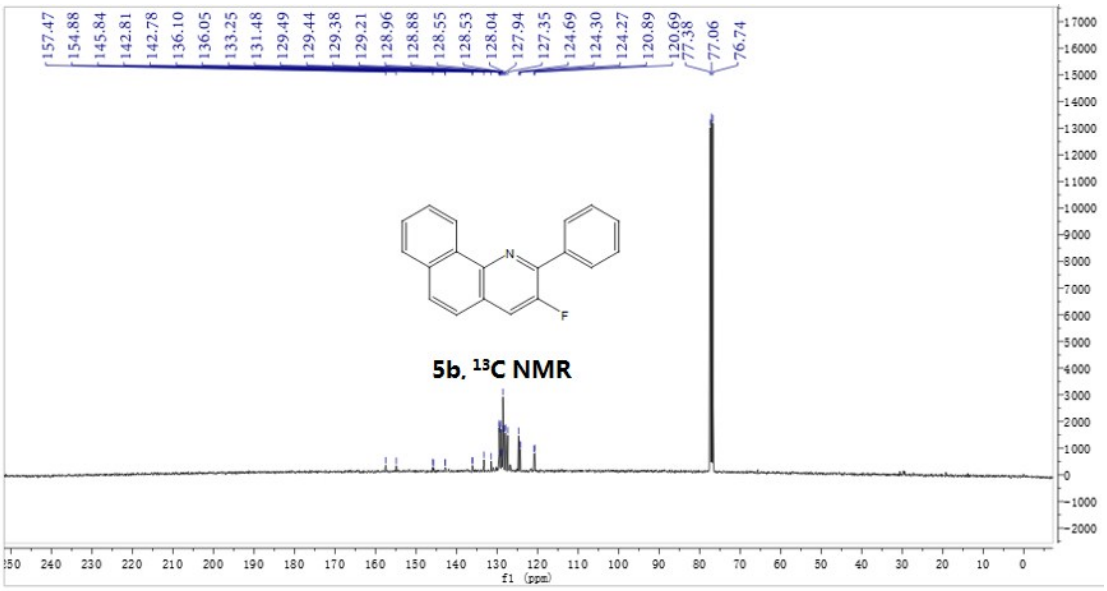
5a ^{13}C NMR



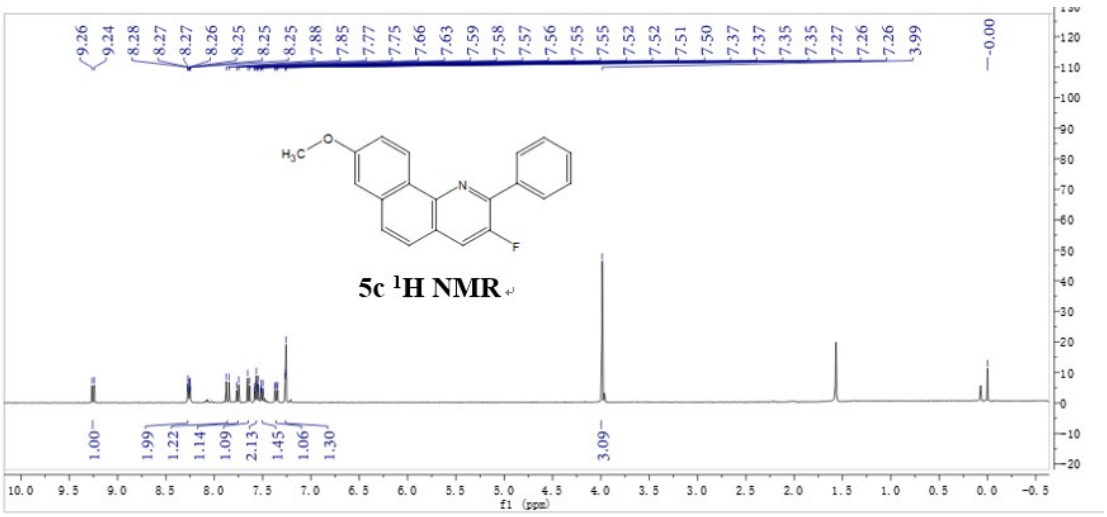
5b ^{1}H NMR



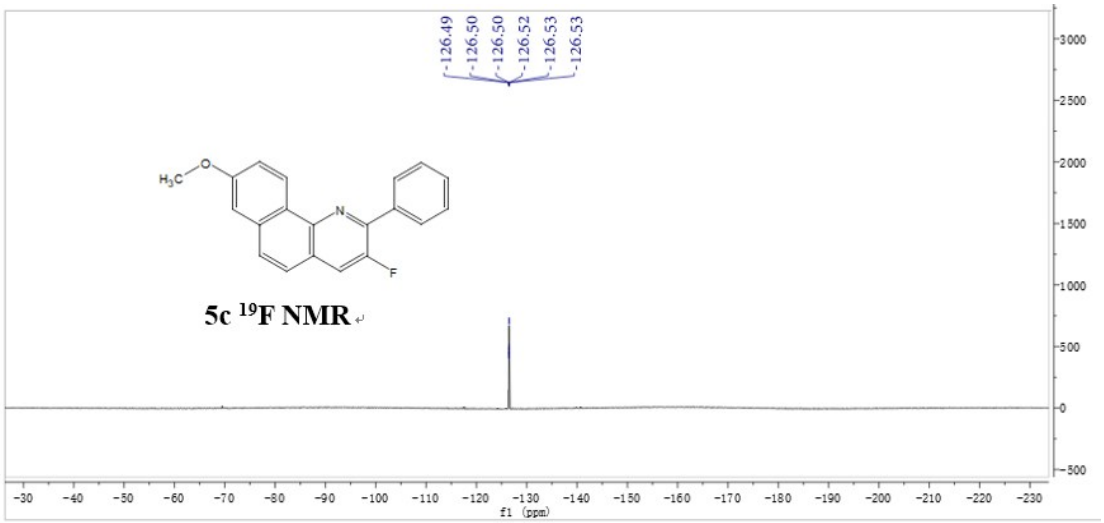
5b ^{19}F NMR



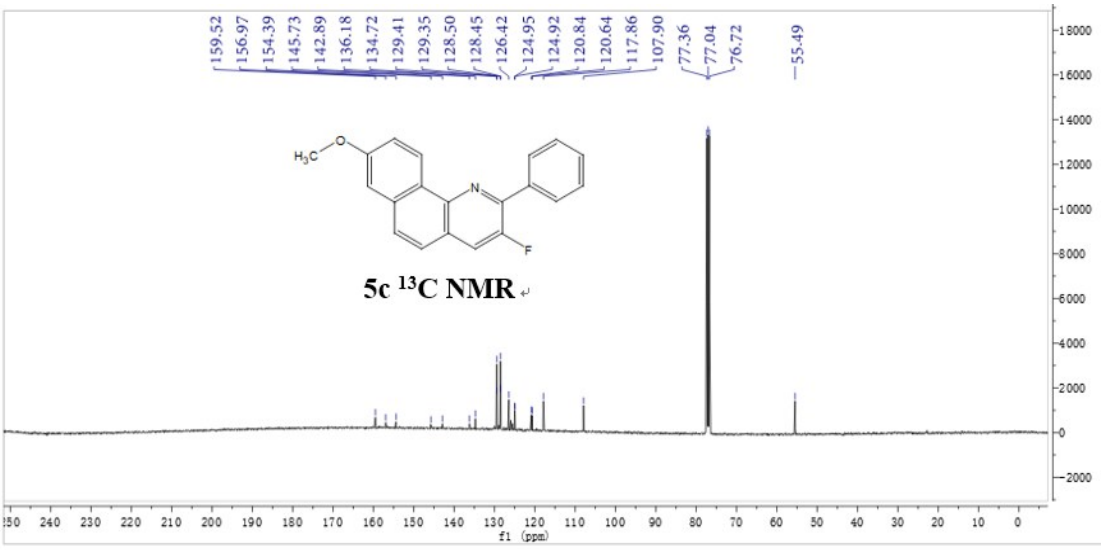
5b, ^{13}C NMR



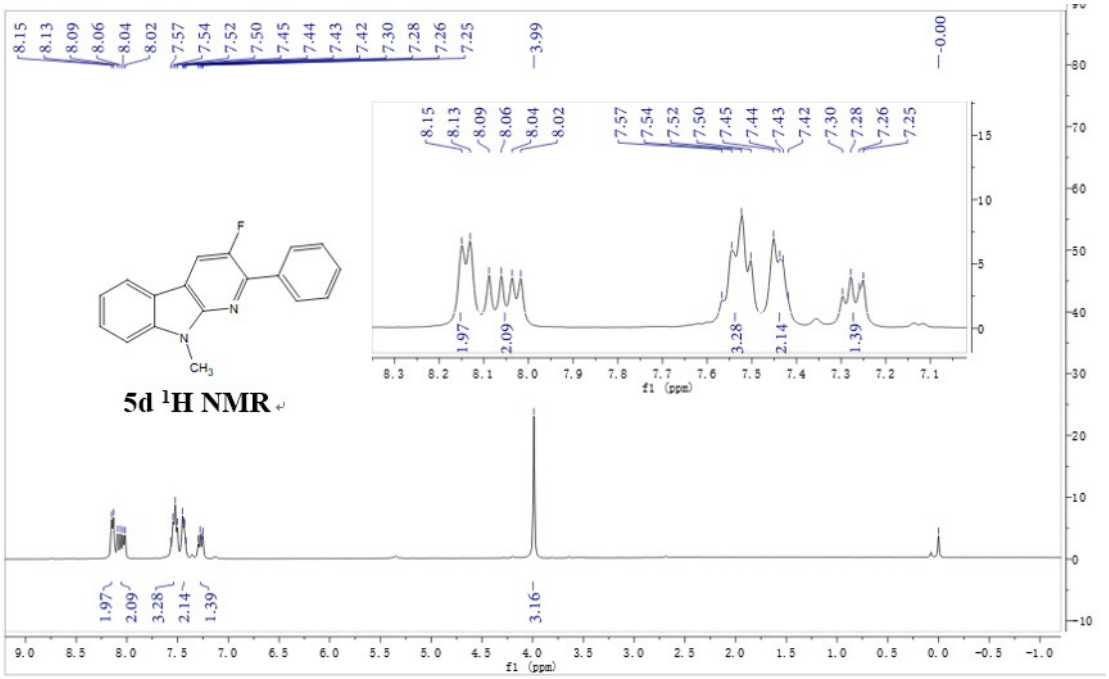
5c ^{1}H NMR



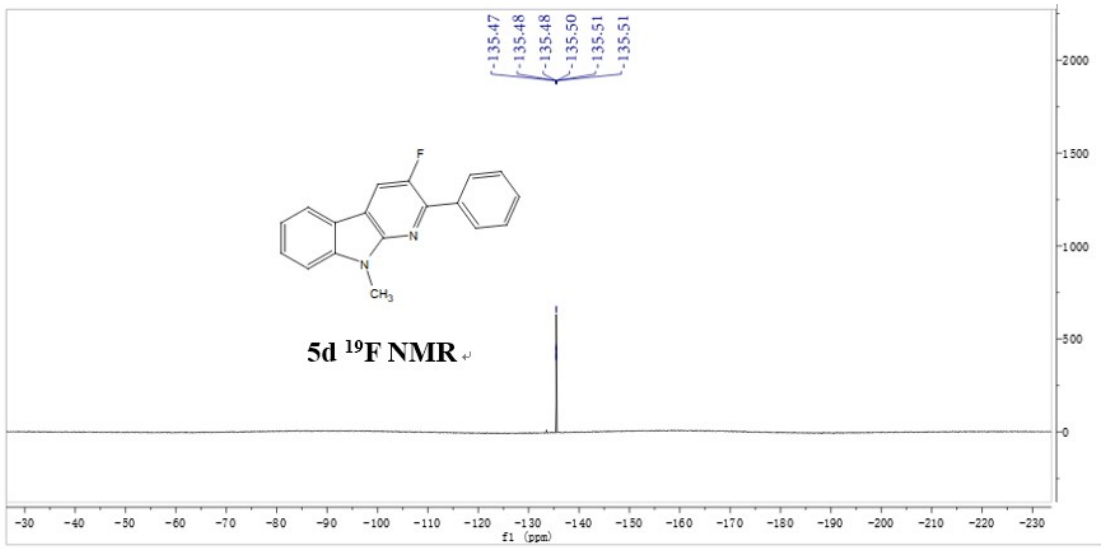
5c ^{19}F NMR



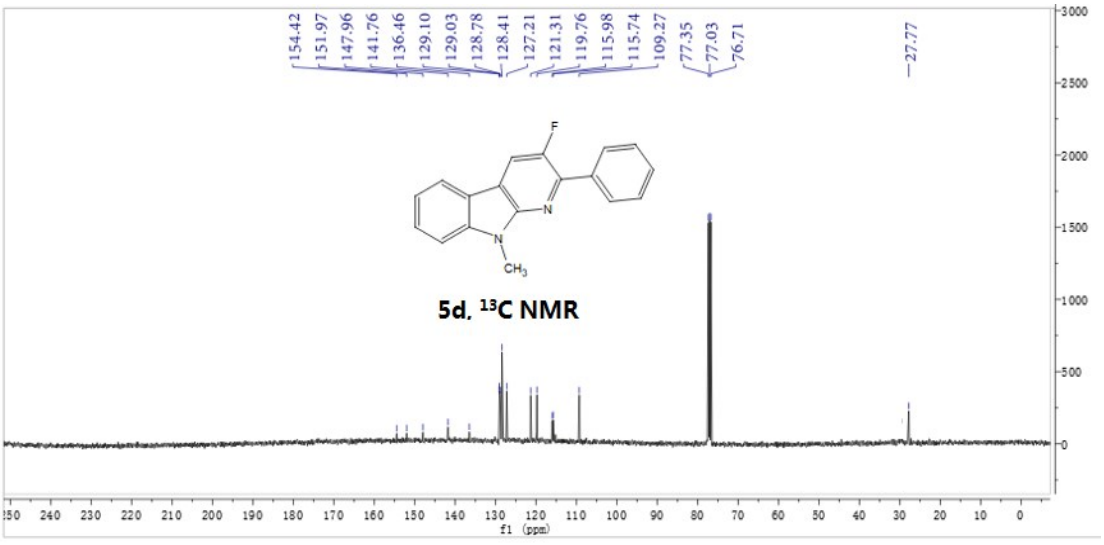
5c ^{13}C NMR



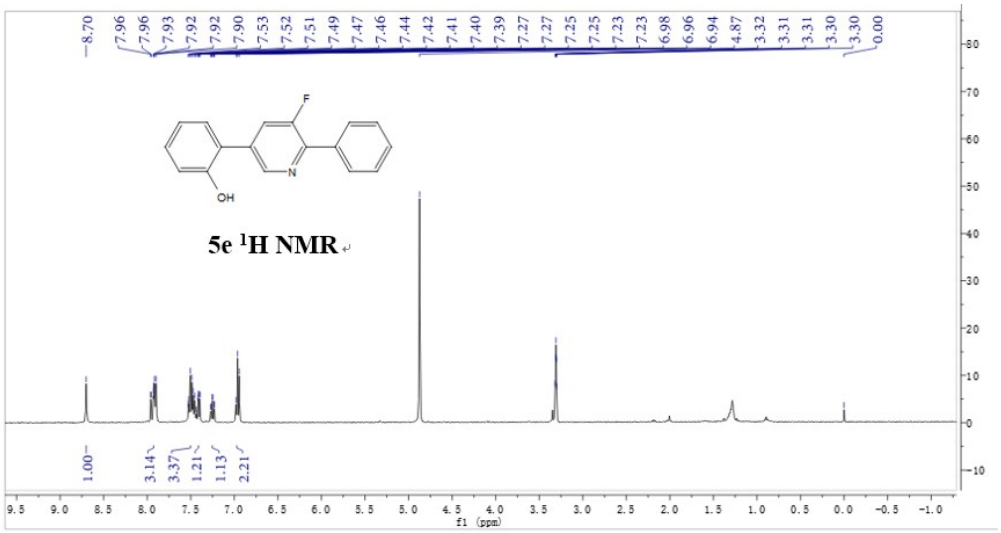
5d ^{1}H NMR



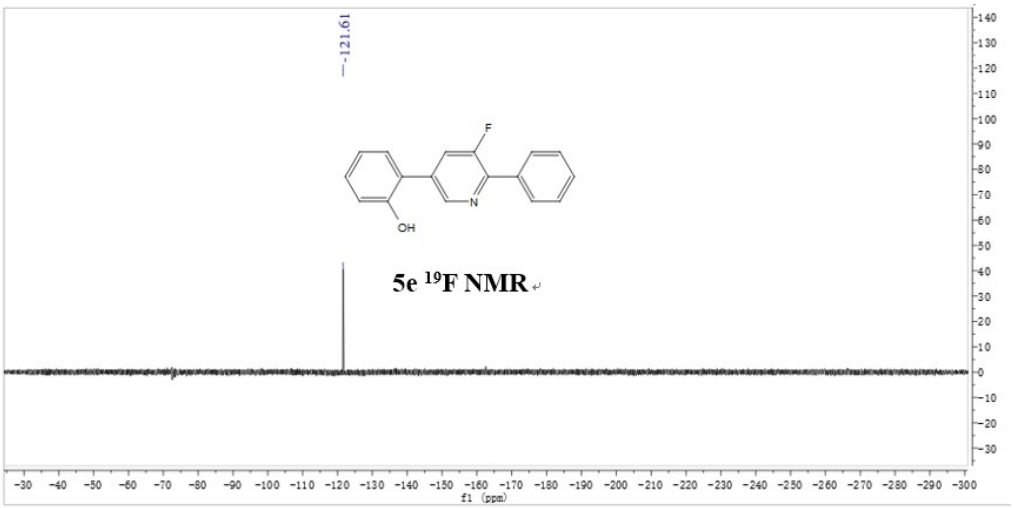
5d ^{19}F NMR



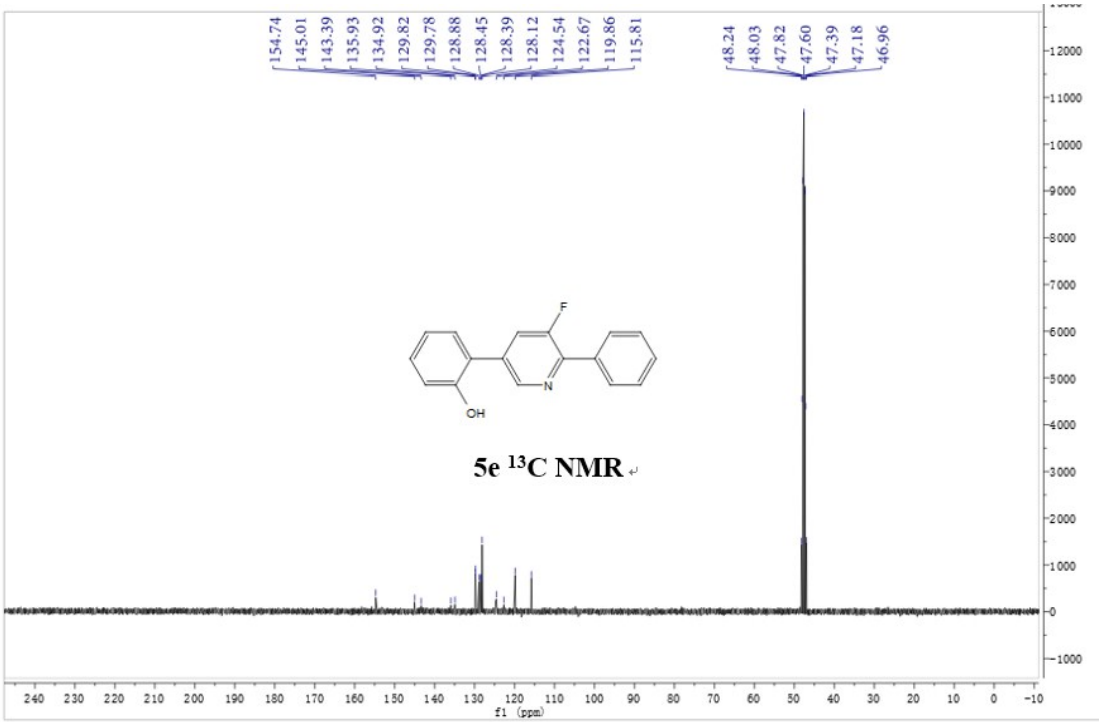
5d. ^{13}C NMR



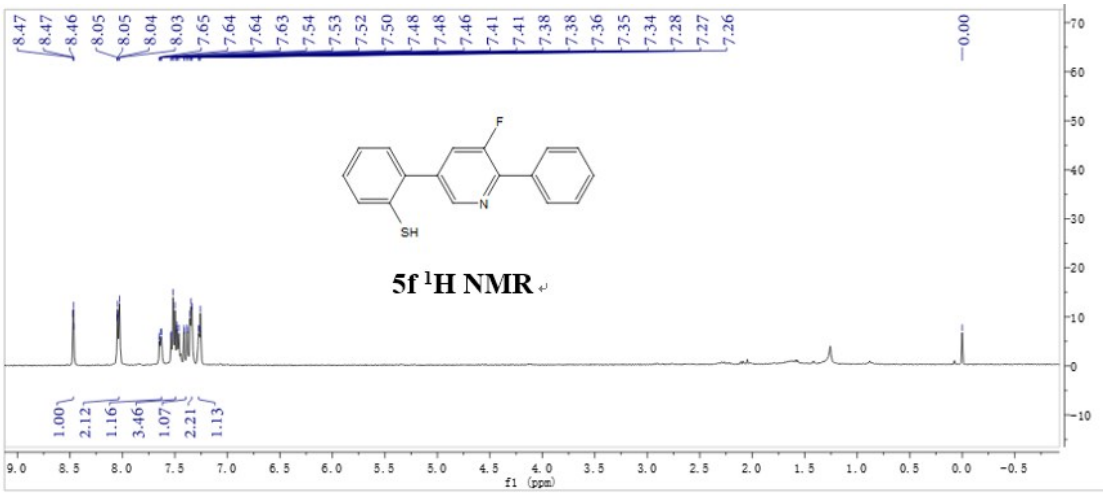
5e ^{1}H NMR



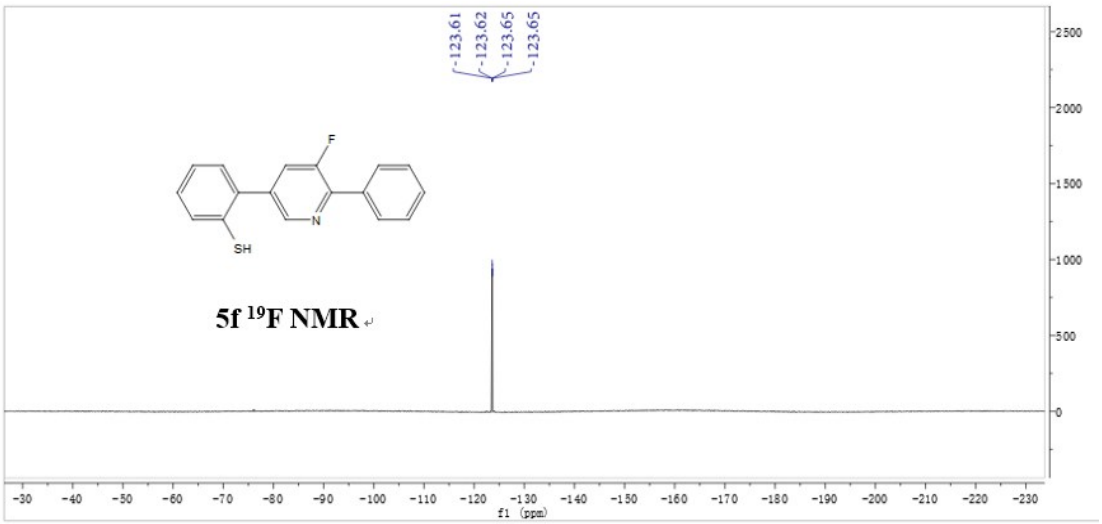
5e ^{19}F NMR



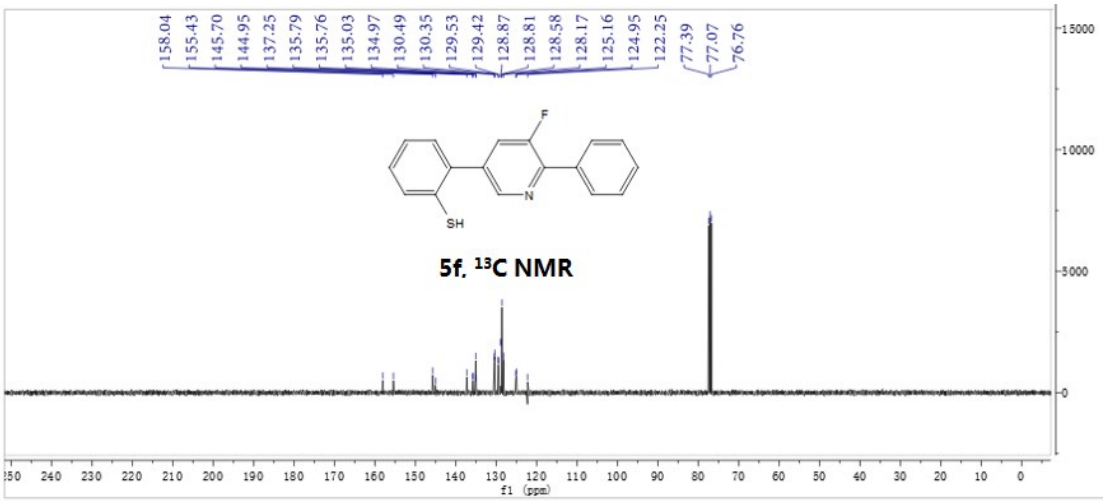
5e ^{13}C NMR



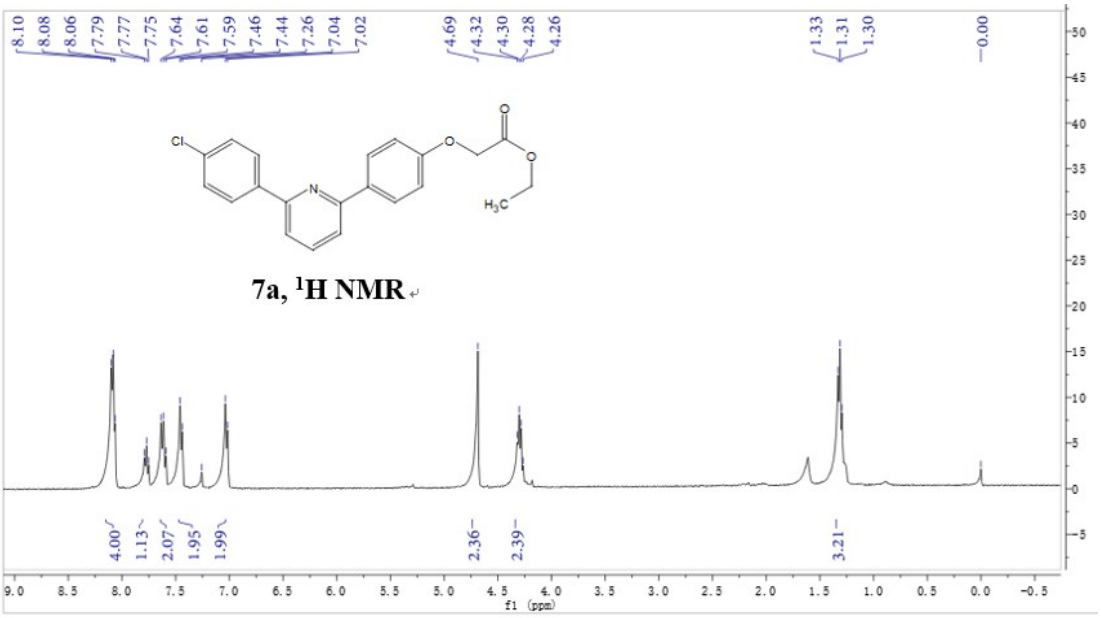
5f ^{1}H NMR



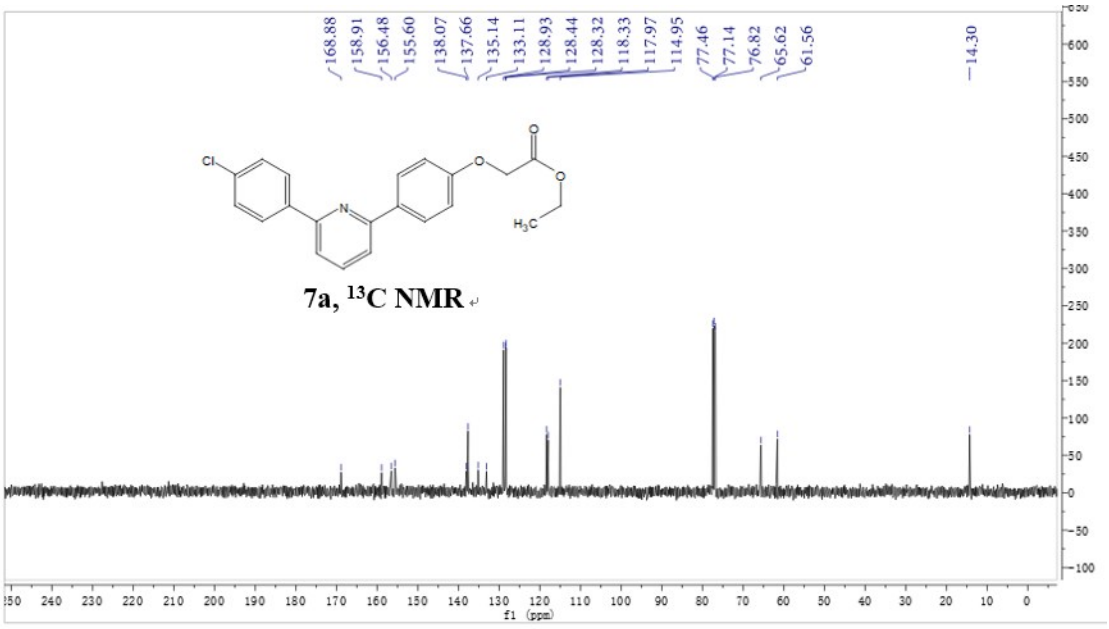
5f ^{19}F NMR



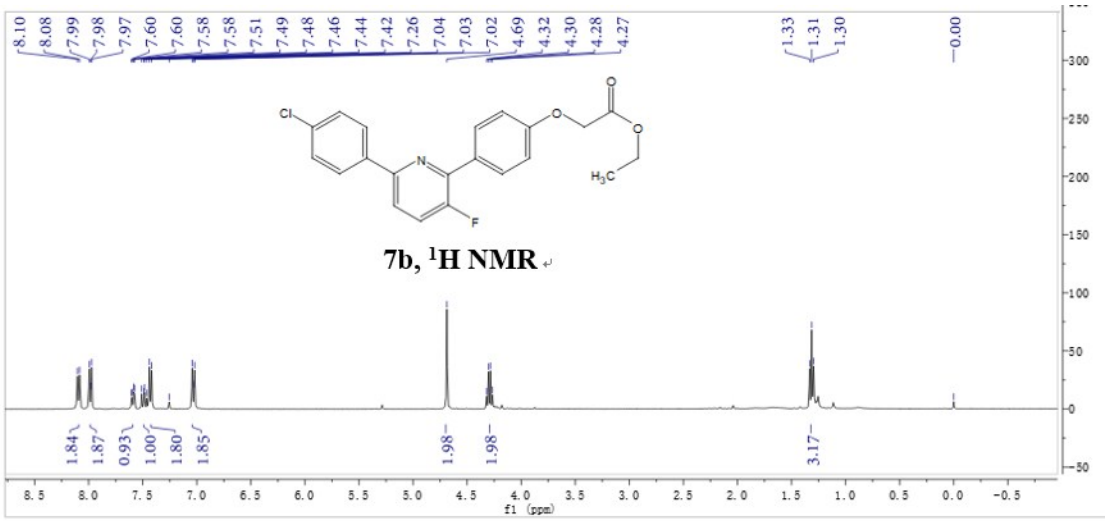
5f, ^{13}C NMR



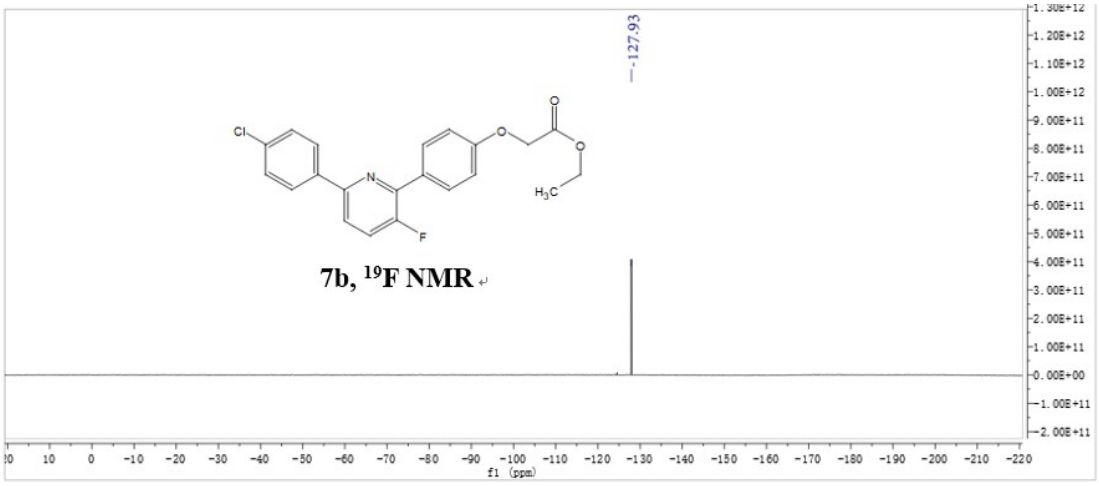
7a, ^{1}H NMR



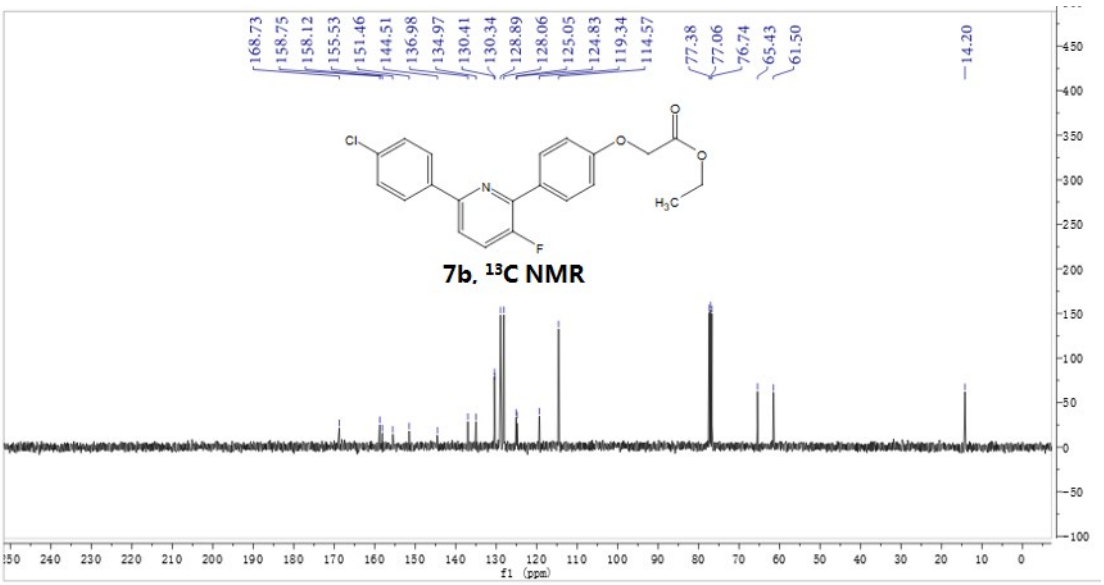
7a, ^{13}C NMR



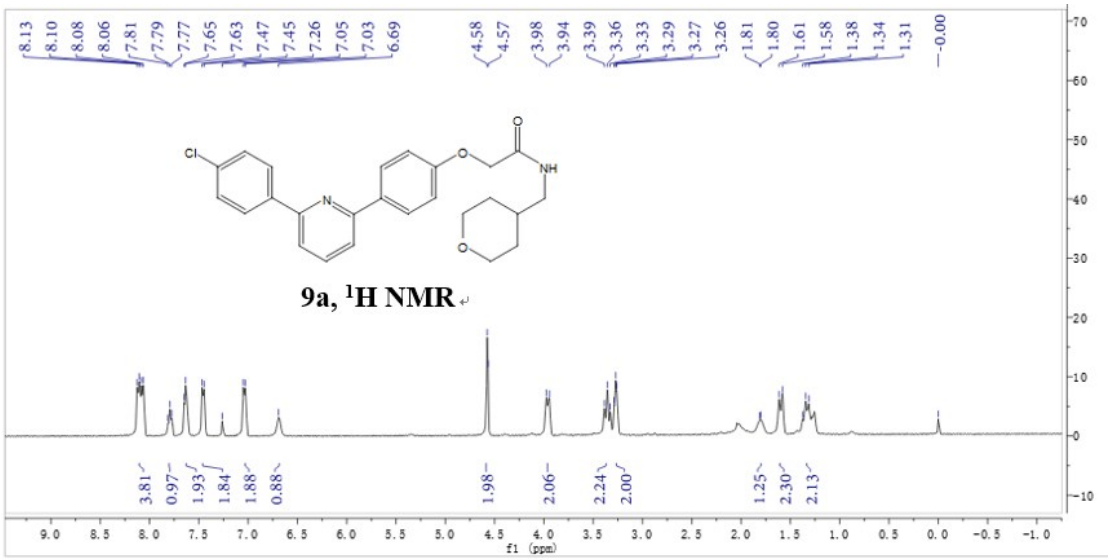
7b, ^{1}H NMR



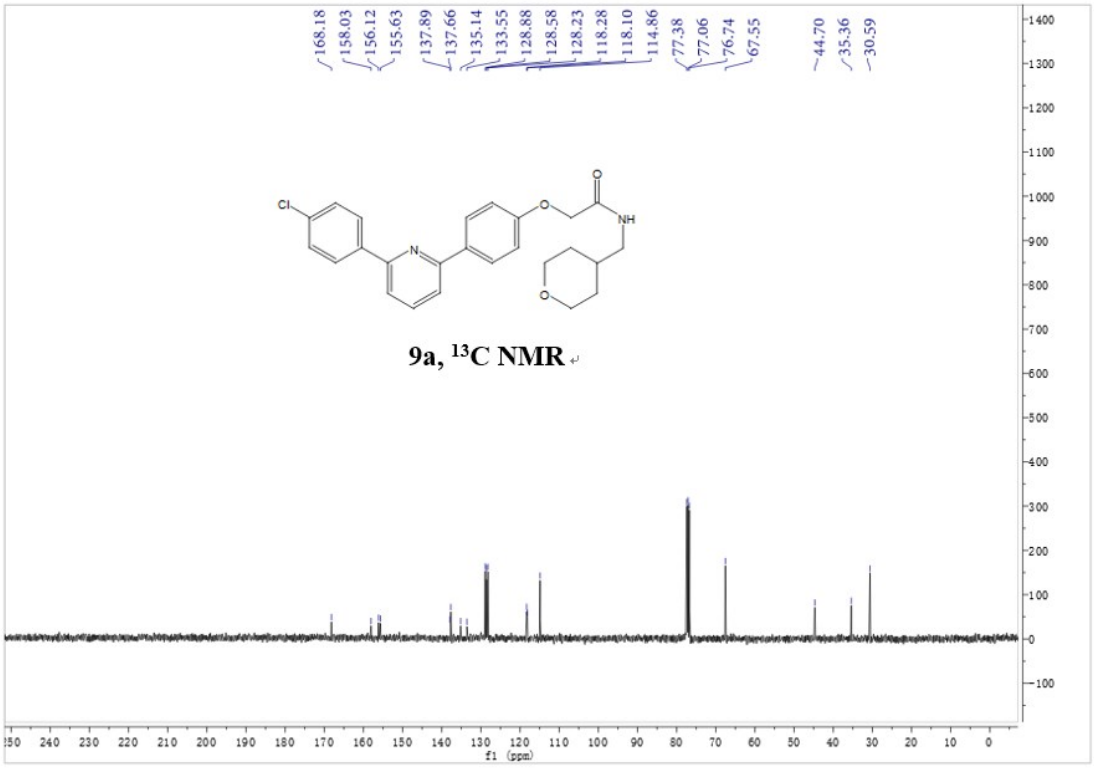
7b, ^{19}F NMR



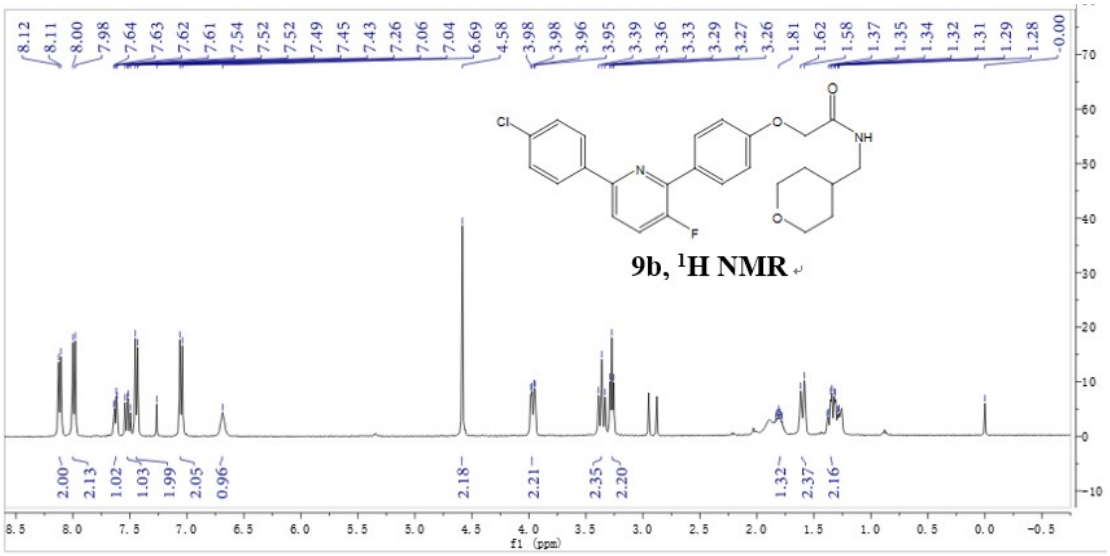
7b, ^{13}C NMR



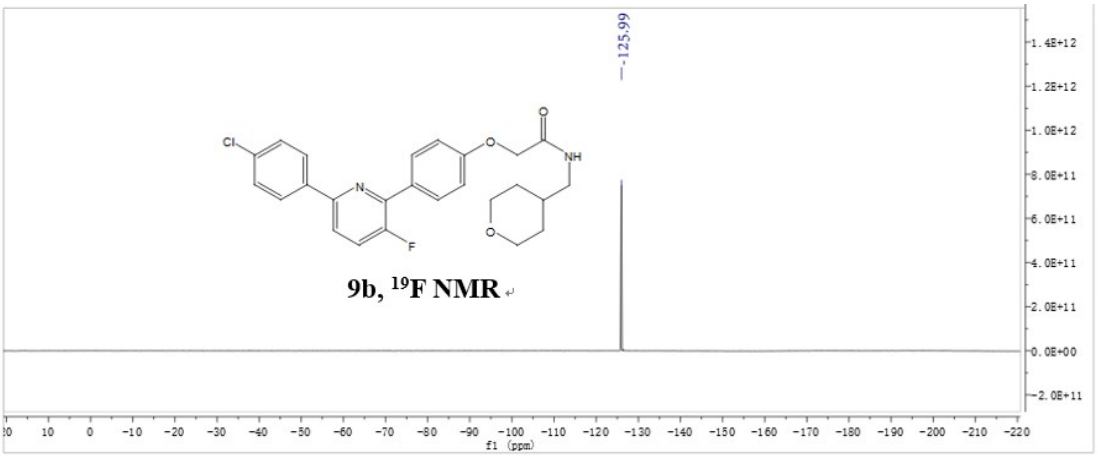
9a, ^{1}H NMR



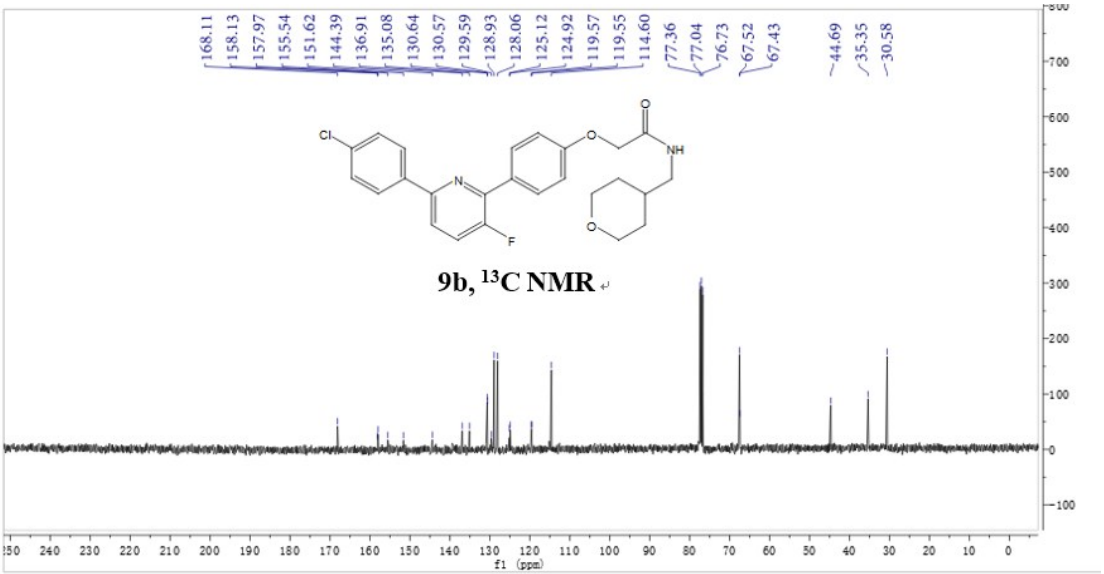
9a, ^{13}C NMR



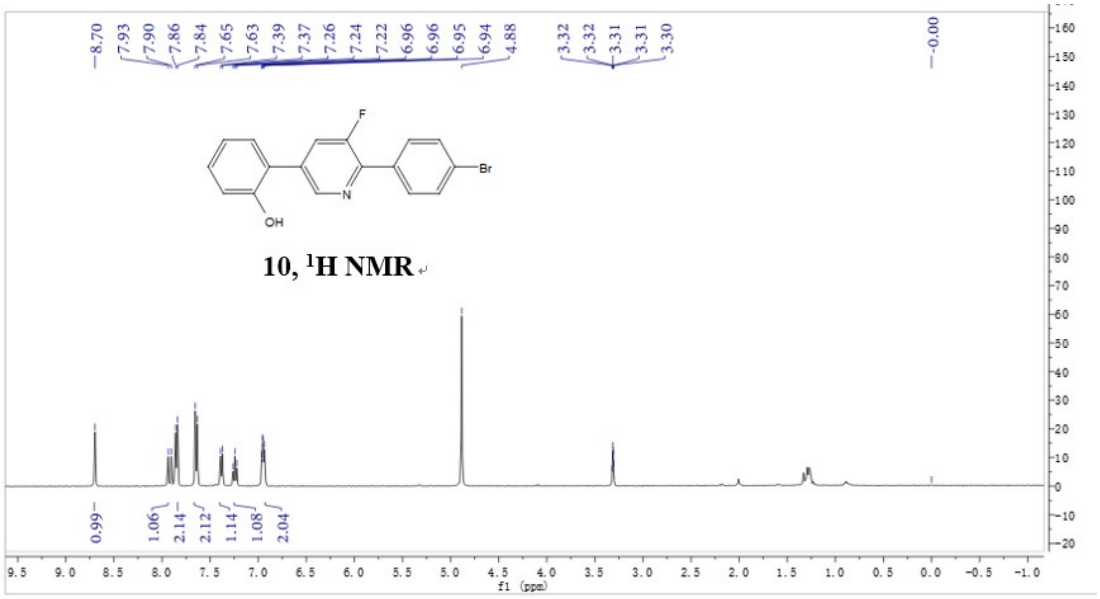
9b, ^{1}H NMR



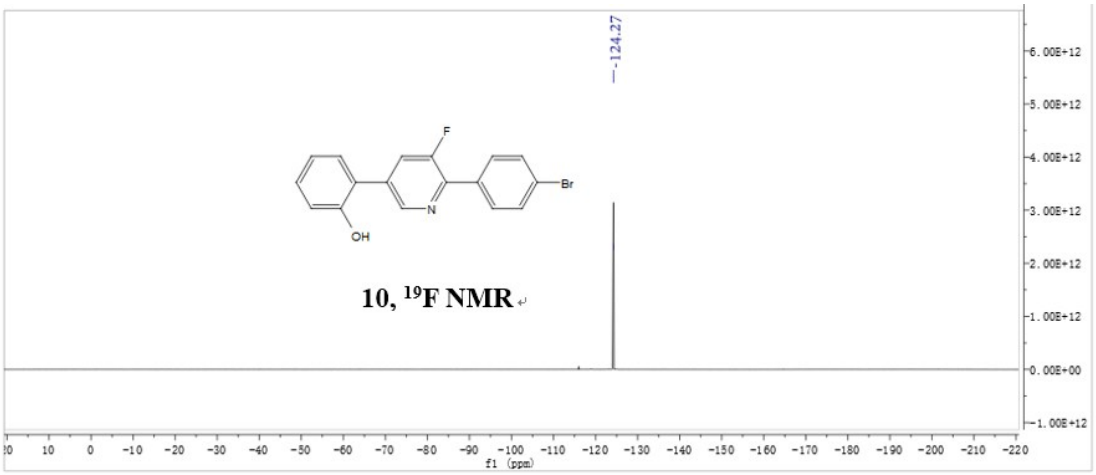
9b, ^{19}F NMR



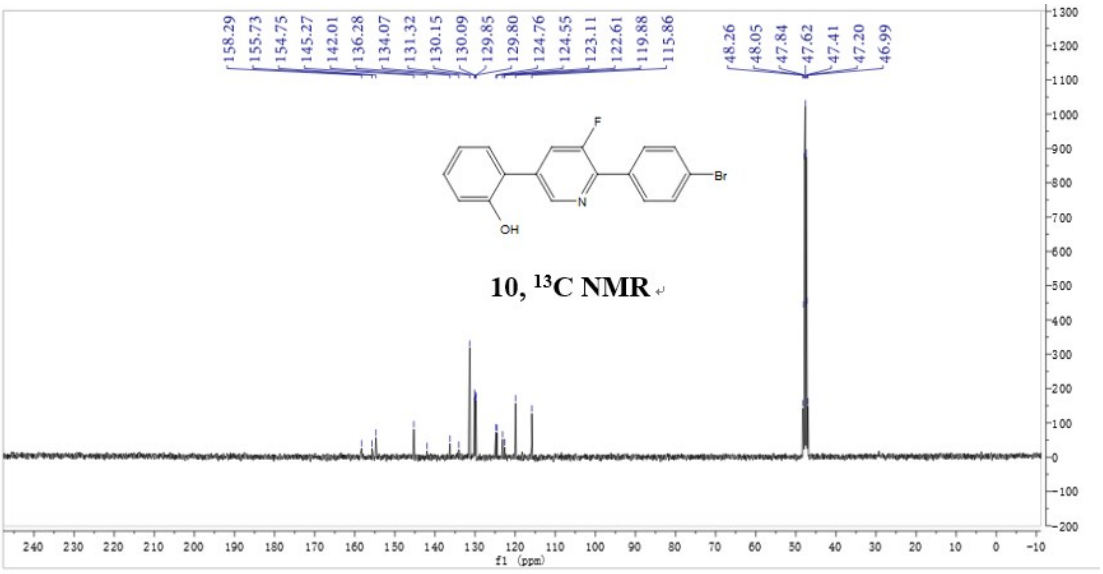
9b, ^{13}C NMR



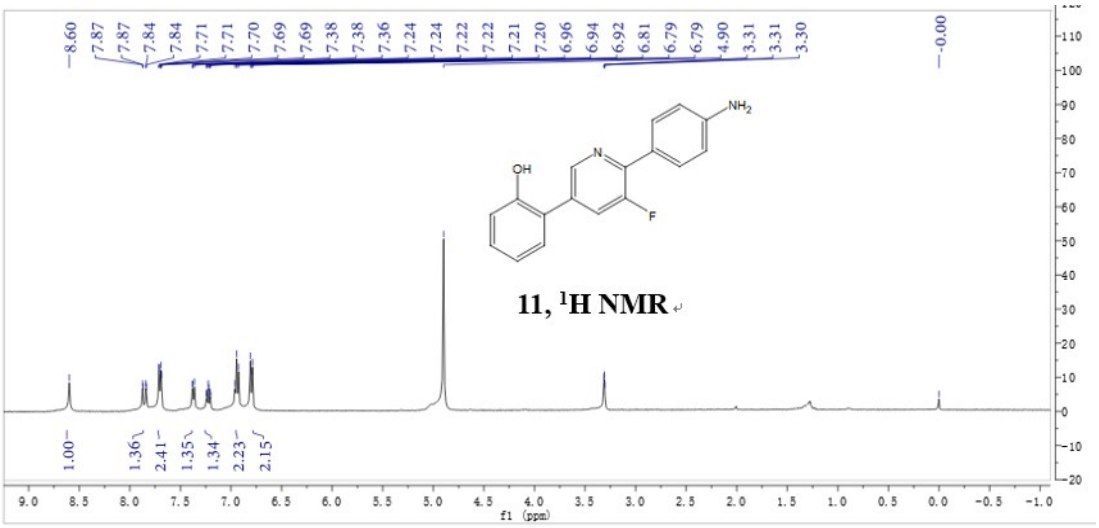
10, ^{1}H NMR



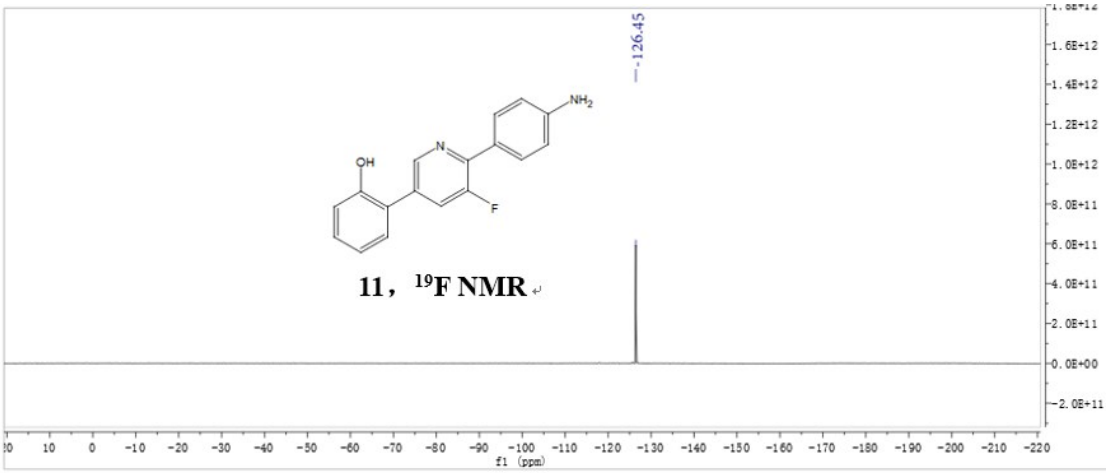
10, ^{19}F NMR



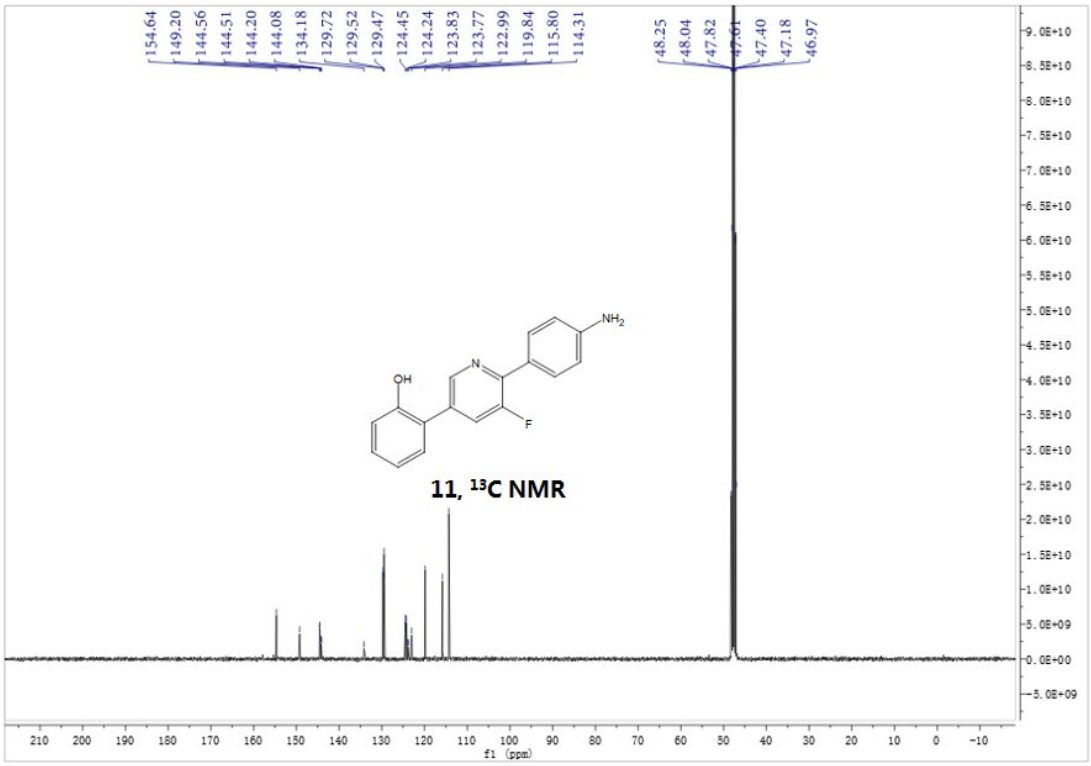
10, ^{13}C NMR



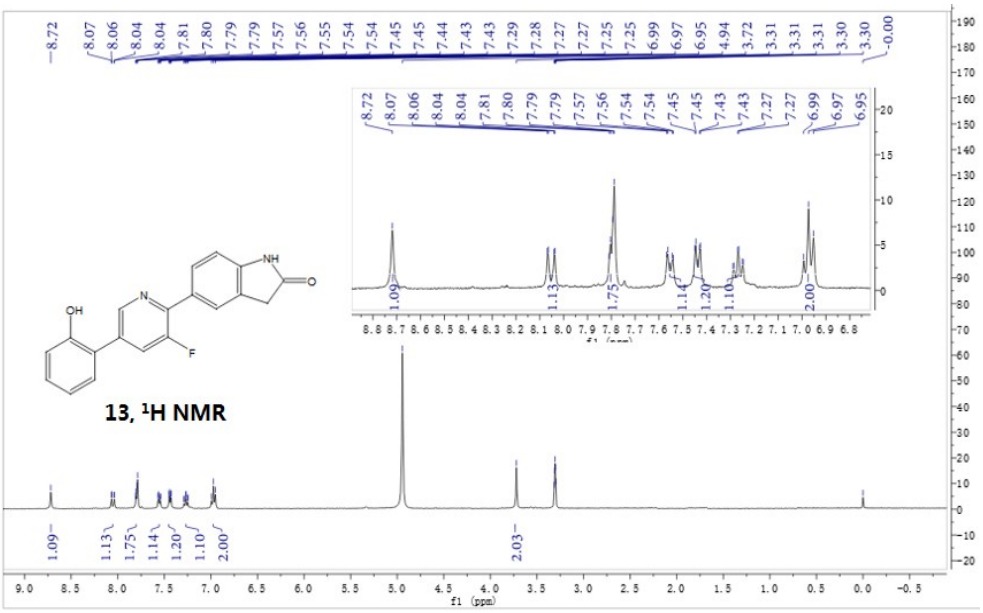
11, ^{1}H NMR

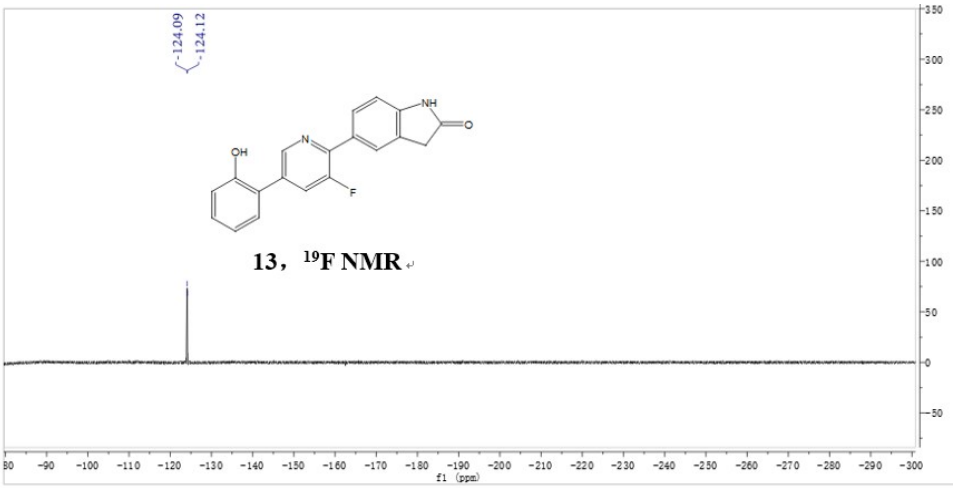


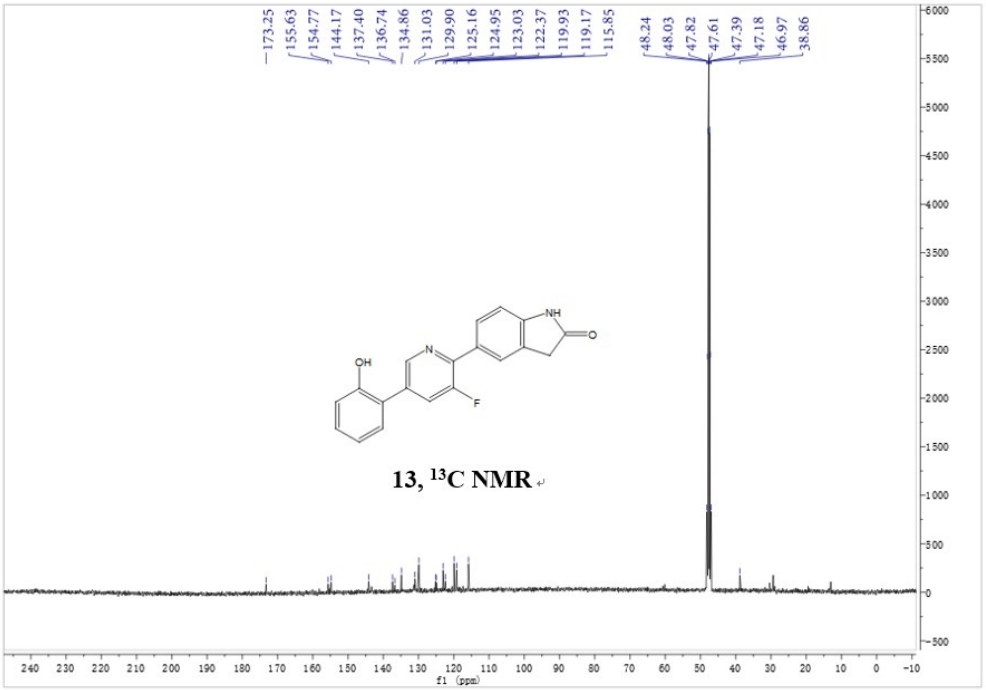
11， ^{19}F NMR



11, ^{13}C NMR


13, ^{1}H NMR


13，^{19}F NMR


13, ^{13}C NMR