

# Supporting Information

**Visible-light-induced self-catalyzed fluoroalkylation/cyclization of *N*-arylcinnamamides:  
Synthesis of fluoroalkyl-containing 3,4-disubstituted dihydro-1,5-naphthyridin-2(1*H*)-ones and  
7,8-disubstituted dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-ones**

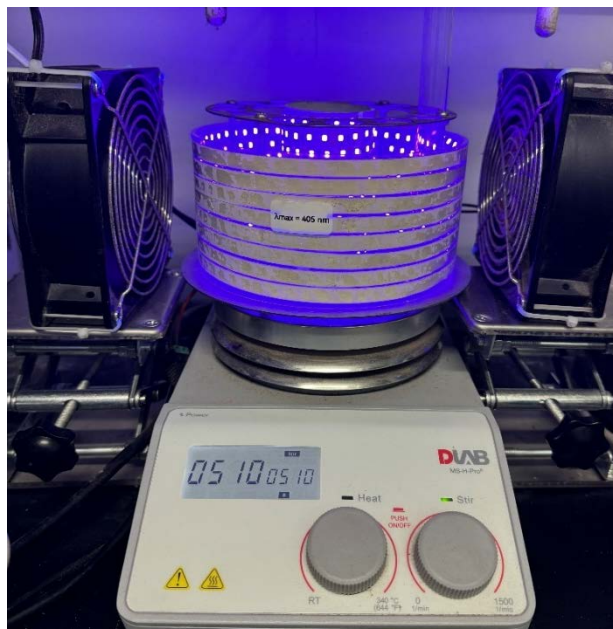
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# Contents

|  |            |
|--|------------|
| <b>1. General consideration .....</b>                            | <b>S2</b>  |
| <b>2. Experimental procedures .....</b>                          | <b>S3</b>  |
| <b>2.1. Determination of the light intensity at 405 nm.....</b>  | <b>S3</b>  |
| <b>2.2. Synthesis of 1.....</b>                                  | <b>S4</b>  |
| <b>2.3 Characterization Data for some substrates .....</b>       | <b>S4</b>  |
| <b>2.3 Synthesis of perfluoroalkanesulfonates .....</b>          | <b>S7</b>  |
| <b>2.4 Preliminary optimization of reaction conditions.....</b>  | <b>S8</b>  |
| <b>2.5 Representative procedure for the model reaction .....</b> | <b>S8</b>  |
| <b>2.6 Scale-up experiment of 3a .....</b>                       | <b>S9</b>  |
| <b>3. Mechanism investigation.....</b>                           | <b>S9</b>  |
| <b>3.1 Control experiments .....</b>                             | <b>S9</b>  |
| <b>3.2 Stern-Volmer experiments .....</b>                        | <b>S11</b> |
| <b>3.3 Determination of singlet oxygen species .....</b>         | <b>S11</b> |
| <b>3.4 Determination of superoxide radicals .....</b>            | <b>S12</b> |
| <b>3.5 UV-visible absorption experiment of substrates .....</b>  | <b>S13</b> |
| <b>3.6 The on/off light illumination experiments .....</b>       | <b>S14</b> |
| <b>3.7 Determination of sulfates .....</b>                       | <b>S15</b> |
| <b>3.8 Determination of peroxides.....</b>                       | <b>S16</b> |
| <b>4. Copies of NMR spectrum of 3g.....</b>                      | <b>S17</b> |
| <b>5. Characterization data for the products .....</b>           | <b>S20</b> |
| <b>6. Reference .....</b>  | <b>S40</b> |
| <b>7. Copies of NMR and HRMS spectra .....</b>                   | <b>S41</b> |

## 1. General consideration

Unless otherwise specified, all reagents and solvents were obtained from commercial suppliers and used without further purification. The NMR spectra were recorded on a Bruker Avance 400 500 or 600 spectrometer at 400 MHz, 500 MHz or 600MHz in CDCl<sub>3</sub> or DMSO-*d*<sub>6</sub> using Tetramethylsilane as the internal standard. Chemical shifts ( $\delta$ ) were given in ppm and coupling constants (*J*) were given in hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, dd = doublet of doublet, t = triplet, dt = doublet of triplet, td = triplet of doublet, q = quartet, m = multiplet, ddd = doublet of doublet of doublet, dddd = doublet of doublet of doublet of doublet. Melting points were determined using an OptiMelt capillary melting point apparatus. High resolution mass spectra (HRMS) were acquired in the ESI mode using a Waters TOF mass analyzer. Electron Paramagnetic Resonance spectra were recorded on a Bruker 100G-18KG/EMX-8/2.7. Luminescence quenching experiments were recorded on a FluoroMax-4 Spectrometer. Column chromatography was performed on silica gel (300-400 mesh). Commercially available LEDs were used in the photoreactor (**Figure S1.**), with the wavelength range of 390 nm-420 nm and the peak wavelength of 405 nm.



**Figure S1.** Photoreactor used in this study

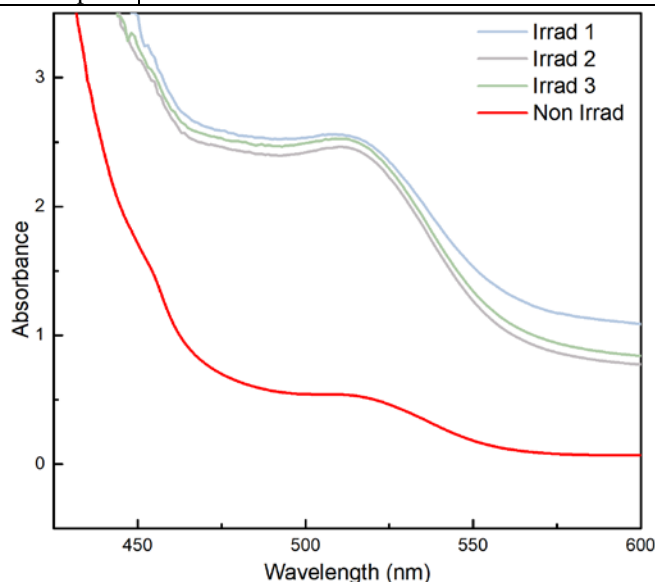
## 2. Experimental procedures

### 2.1. Determination of the light intensity at 405 nm

Standard ferrous oxalate photometric method was used to determine the photon flux of the LEDs ( $\lambda_{\max} = 405 \text{ nm}$ ) applied in this experiment<sup>1</sup>. Ferrioxalate solution (0.15 M) was prepared by dissolving potassium ferrioxalate hydrate (737.0 mg) in 10.0 mL of  $\text{H}_2\text{SO}_4$  (0.05 M). Buffered solution of 1,10-phenanthroline was prepared by dissolving 1,10-phenanthroline (5.0 mg) and  $\text{CH}_3\text{CO}_2\text{Na}$  (1.13 g) in 5.0 mL of  $\text{H}_2\text{SO}_4$  (0.05 M). Both solutions were stored in the dark. The ferrioxalate solution (3.0 mL) was placed in a cuvette and irradiated by the LEDs ( $\lambda_{\max} = 405 \text{ nm}$ ) for 90s. The phenanthroline solution (0.525 mL) was then added into the cuvette, and the mixture was stirred in the dark for 1 h. The absorbance of the mixture was measured at 510 nm. The above experiments were repeated three times under the same LEDs, and a nonirradiated sample was also prepared and the absorbance at 510 nm was measured as well. The obtained results were shown in **Table S1** and **Figure. S2**, and the conversion was calculated using **eq. 1**.

**Table S1.** Absorption of irradiated and non-irradiated samples at 510nm

| $A_{510 \text{ nm}}$                                | Non-irradiation | Irradiation 1 | Irradiation 2 | Irradiation 3 |
|---|-----------------|---------------|---------------|---------------|
|   | 0.5394          | 2.5547        | 2.5229        | 2.4647        |
| Average $A_{510 \text{ nm}}$ of irradiation samples |                 | 2.5141        |               |               |



**Figure S2.** Absorption spectra for irradiated and non-irradiated samples

$$\text{Mol}(\text{Fe}^{2+}) = \frac{V \times \Delta A}{L \times \epsilon} = \frac{3.525 \times 10^{-3} \text{ L} \times (2.5141 - 0.5394)}{1 \text{ cm} \times 11100 \text{ L mol}^{-1} \text{ cm}^{-1}} = 6.271 \times 10^{-7} \text{ mol} \quad (1)$$

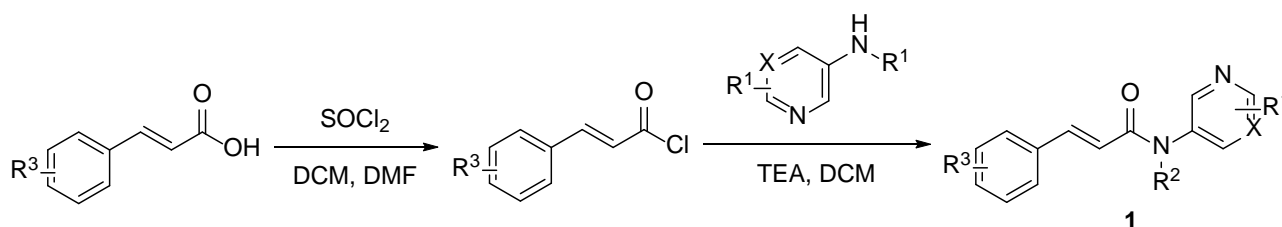
V is the total volume of the solution after adding phenanthroline (0.003525 L).  $\Delta A$  is the absorbance difference between the irradiation samples and non-irradiation sample at 510 nm. L is the width of the cuvette (1.00 cm),  $\epsilon$  is the molar absorptivity of the ferrioxalate actinometer at 510 nm (11,100 L mol<sup>-1</sup>cm<sup>-1</sup>)<sup>2</sup>. The photon flux can be calculated using **eq 2** and **eq 3**.

$$Photo\ flux = \frac{Mol(Fe^{2+})}{\Phi(Fe^{2+}) \times t \times f} = \frac{6.271 \times 10^{-7} mol}{1.19 \times 90 \times 1} = 5.9 \times 10^{-9} \text{ einstein } s^{-1} \quad (2)$$

$$f = 1 - 10^{-A_{405\text{ nm}}} \approx 1 \quad (3)$$

$\Phi$  is the standard quantum yield for the ferrioxalate actinometer (1.19 for a 0.15 M solution at  $\lambda = 405$  nm). t is the time (90.0 s)<sup>3</sup>. f is the fraction of light absorbed at  $\lambda = 405$  nm. The photon flux was calculated to be  $5.9 \times 10^{-9}$  einstein s<sup>-1</sup>.

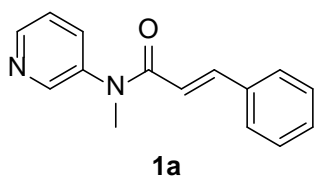
## 2.2. Synthesis of 1



The substrates **1** used in this study were prepared following the literature procedure<sup>4</sup>.

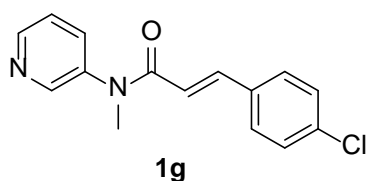
To a 50 mL oven-dried flask with a magnetic stirring bar were added corresponding cinnamic acid (5 mmol), 5 mL of SOCl<sub>2</sub> and a drop of DMF. After stirring at room temperature for 3 h, the redundant SOCl<sub>2</sub> was evaporated under reduced pressure and the residue was dissolved with anhydrous CH<sub>2</sub>Cl<sub>2</sub> (20 mL). The liquid was added into another flask containing arylamine (5 mmol) and TEA (15 mmol) dissolved in anhydrous CH<sub>2</sub>Cl<sub>2</sub> (20 mL) dropwise. The mixture was stirred for 1 h at room temperature. The organic phase was then washed with aqueous K<sub>2</sub>CO<sub>3</sub> and dried over anhydrous Na<sub>2</sub>SO<sub>4</sub>. After the removal of CH<sub>2</sub>Cl<sub>2</sub> by evaporating, the residue was purified by flash column chromatography using a mixture of heptane and ethyl acetate as eluents to give the desired products.

## 2.3 Characterization Data for some substrates



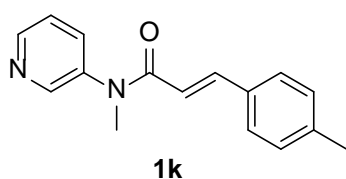
### *N*-methyl-*N*-(pyridin-3-yl)cinnamamide

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate = 10:1) as a white solid (1131.0 mg, 95%), m.p. 100.3–101.4 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.62 (d, *J* = 4.4 Hz, 1H), 8.57 (d, *J* = 2.6 Hz, 1H), 7.73 (d, *J* = 15.5 Hz, 1H), 7.60 (dt, *J* = 8.1, 2.1 Hz, 1H), 7.41 (dd, *J* = 8.1, 4.8 Hz, 1H), 7.35–7.28 (m, 5H), 6.32 (d, *J* = 15.4 Hz, 1H), 3.44 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 166.09, 148.65, 148.60, 143.05, 140.25, 134.83, 134.50, 129.88, 128.78, 127.95, 124.11, 117.80, 37.67. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>15</sub>H<sub>15</sub>N<sub>2</sub>O<sup>+</sup> 239.1179; Found 239.1176.



**(E)-3-(4-chlorophenyl)-N-methyl-N-(pyridin-3-yl)acrylamide**

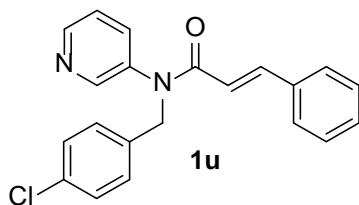
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate = 10:1) as a white solid (1219.3 mg, 89%), m.p. 104.3–106.3 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.64–8.56 (m, 2H), 7.67 (d, *J* = 15.5 Hz, 1H), 7.60 (ddd, *J* = 8.1, 2.4, 1.6 Hz, 1H), 7.42 (dd, *J* = 7.9, 4.7 Hz, 1H), 7.26 (s, overlapping with the residual proton of CDCl<sub>3</sub>, 4H), 6.28 (d, *J* = 15.4 Hz, 1H), 3.44 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 165.83, 148.69, 148.62, 141.69, 140.13, 135.73, 134.48, 133.29, 129.13, 129.02, 124.15, 118.24, 37.72. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>15</sub>H<sub>14</sub><sup>35</sup>ClN<sub>2</sub>O<sup>+</sup> 273.0795; Found 273.0786.



**(E)-N-methyl-N-(pyridin-3-yl)-3-(p-tolyl)acrylamide**

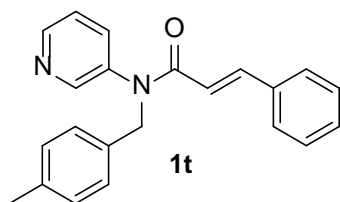
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate = 10:1) as a white solid (927.1 mg, 73%), m.p. 96.5–97.3 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.61 (dd, *J* = 4.7, 1.3 Hz, 1H), 8.57 (d, *J* = 2.4 Hz, 1H), 7.70 (d, *J* = 15.4 Hz, 1H), 7.59 (ddd, *J* = 8.0, 2.6, 1.5 Hz, 1H), 7.40 (dd, *J* = 8.1, 4.8 Hz, 1H), 7.23 (d, *J* = 8.1 Hz, 2H), 7.10 (d, *J* = 8.0 Hz, 2H), 6.27 (d, *J* = 15.4 Hz, 1H), 3.43 (s, 3H), 2.32 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 166.30, 148.59, 148.46,

143.08, 140.32, 140.23, 134.53, 132.05, 129.47, 127.93, 124.07, 116.65, 37.65, 21.40. HRMS (ESI)  $m/z$ :  $[M+H]^+$  calcd for  $C_{16}H_{17}N_2O^+$  253.1341; Found 253.1336.



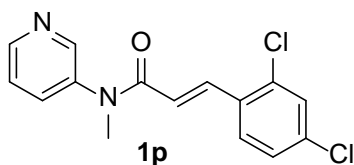
#### ***N*-(4-chlorobenzyl)-*N*-(pyridin-3-yl)cinnamamide**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate = 10:1) as a white solid (1085.5 mg, 62%), m.p. 109.2–110.3 °C.  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  8.60 (d,  $J = 3.6$  Hz, 1H), 8.39 (s, 1H), 7.79 (d,  $J = 15.4$  Hz, 1H), 7.38–7.24 (m, 9H), 7.18 (d,  $J = 8.5$  Hz, 2H), 6.23 (d,  $J = 15.4$  Hz, 1H), 5.01 (s, 2H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  165.96, 149.55, 149.10, 143.94, 138.37, 135.66, 135.36, 134.66, 133.66, 130.10, 130.06, 128.86, 128.80, 128.01, 124.10, 117.54, 52.64. HRMS (ESI)  $m/z$ :  $[M+H]^+$  calcd for  $C_{21}H_{18}^{35}ClN_2O^+$  349.1108; Found 349.1099.



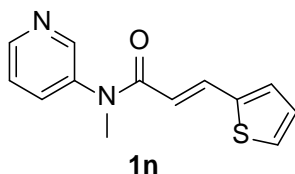
#### ***N*-(4-methylbenzyl)-*N*-(pyridin-3-yl)cinnamamide**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate = 10:1) as a white solid (999.5 mg, 61%), m.p. 108.1–109.8 °C.  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  8.57 (d,  $J = 4.2$  Hz, 1H), 8.37 (s, 1H), 7.78 (d,  $J = 15.4$  Hz, 1H), 7.39–7.29 (m, 7H), 7.10 (q,  $J = 8.1$  Hz, 4H), 6.24 (d,  $J = 15.3$  Hz, 1H), 5.01 (s, 2H), 2.31 (s, 3H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  165.87, 149.61, 148.79, 143.58, 138.59, 137.42, 135.77, 134.80, 133.71, 129.91, 129.34, 128.76, 128.64, 127.97, 123.96, 117.88, 53.00, 21.14. HRMS (ESI)  $m/z$ :  $[M+H]^+$  calcd for  $C_{22}H_{21}N_2O^+$  329.1654; Found 329.1652.



**(E)-3-(2,4-dichlorophenyl)-N-methyl-N-(pyridin-3-yl)acrylamide**

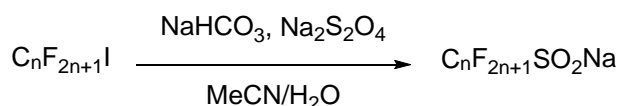
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate = 10:1) as a white solid (1441.9 mg, 94%), m.p. 119.4 – 120.4 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.62 (d, *J* = 4.8 Hz, 1H), 8.57 (s, 1H), 8.01 (d, *J* = 15.4 Hz, 1H), 7.60 (ddd, *J* = 8.1, 2.6, 1.5 Hz, 1H), 7.44 – 7.39 (m, 2H), 7.20 (d, *J* = 8.5 Hz, 1H), 7.13 (dd, *J* = 8.4, 2.1 Hz, 1H), 6.29 (d, *J* = 15.5 Hz, 1H), 3.45 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 165.37, 148.72, 148.54, 140.04, 137.89, 135.82, 135.37, 134.45, 131.80, 129.93, 128.44, 127.32, 124.19, 120.98, 37.74. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>15</sub>H<sub>13</sub><sup>35</sup>Cl<sub>2</sub>N<sub>2</sub>O<sup>+</sup> 307.0405; Found 307.0399.



**(E)-N-methyl-N-(pyridin-3-yl)-3-(thiophen-2-yl)acrylamide**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate = 10:1) as a white solid (1065.7 mg, 87%), m.p. 102.9 – 103.9 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.62 (dd, *J* = 4.8, 1.5 Hz, 1H), 8.57 (d, *J* = 2.6 Hz, 1H), 7.81 (d, *J* = 15.7 Hz, 1H), 7.62 – 7.59 (m, 1H), 7.41 (dd, *J* = 8.1, 4.8 Hz, 1H), 7.32 – 7.25 (m, 2H), 7.08 – 6.99 (m, 2H), 6.45 (d, *J* = 15.7 Hz, 1H), 3.45 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 165.92, 148.51, 140.14, 139.96, 135.61, 134.54, 130.49, 128.01, 127.80, 124.07, 116.51, 37.66. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>13</sub>H<sub>13</sub>N<sub>2</sub>OS<sup>+</sup> 245.0749; Found 245.0742

**2.3 Synthesis of perfluoroalkanesulfinates**



Perfluoroalkanesulfinates used in this study were prepared following the literature procedure<sup>5</sup>.

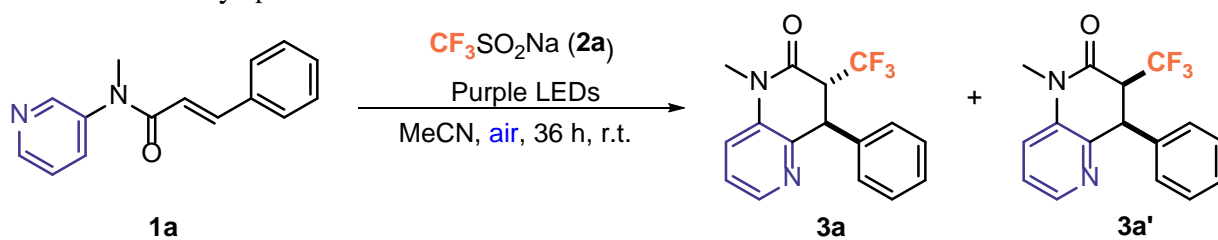
Perfluoroiodine compounds (R<sub>f</sub> = C<sub>4</sub>F<sub>9</sub>, C<sub>6</sub>F<sub>13</sub>) (10 mmol) was added into 6 mL of CH<sub>3</sub>CN at 0 °C.



NaHCO<sub>3</sub> (20 mmol), Na<sub>2</sub>S<sub>2</sub>O<sub>4</sub> (10 mmol), and H<sub>2</sub>O (10 mL) were then added successfully. The reaction mixture was stirred at room temperature for 20 h and then extracted with ethyl acetate (3 × 50 mL). The combined organic layers were dried over anhydrous MgSO<sub>4</sub> and concentrated to dryness. The residue was washed with diethyl ether (3 × 20 mL) and then dried in vacuum to give **2** as a white solid.

## 2.4 Preliminary optimization of reaction conditions

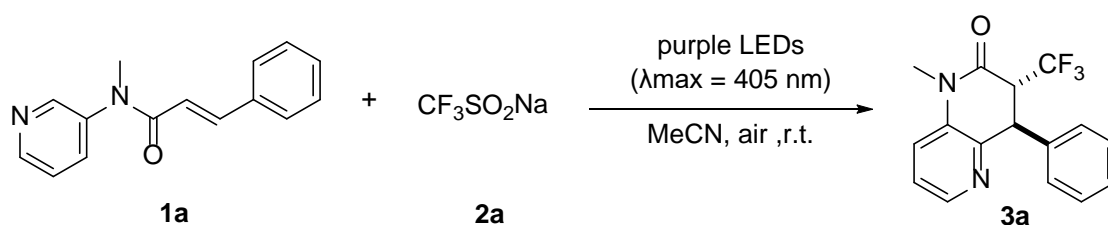
**Table S2.** Preliminary optimization of reaction conditions <sup>a</sup>



| Entry | Dosage of MeCN (mL) | Dosage of <b>2a</b> (mmol) | Yield ( <b>3a</b> , <b>3a'</b> , %) <sup>b</sup> |
|-------|---------------------|----------------------------|--|
| 1     | 5                   | 2.0                        | 49, trace  |
| 2     | 10                  | 2.0                        | 55, trace  |
| 3     | 12                  | 2.0                        | 57, trace  |
| 4     | 15                  | 2.0                        | 53, trace  |
| 5     | 12                  | 1.5                        | 31, trace  |
| 6     | 12                  | 2.5                        | 62, trace  |
| 7     | 12                  | 3                          | 66, trace  |
| 8     | 12                  | 3.5                        | 66, trace  |

<sup>a</sup>Reaction conditions: **1a** (0.5 mmol), **2a**, and MeCN, open-to-air, at room temperature under irradiation with 20 W purple LEDs ( $\lambda_{\text{max}} = 405$  nm) for 36 h. <sup>b</sup> Isolated yields.

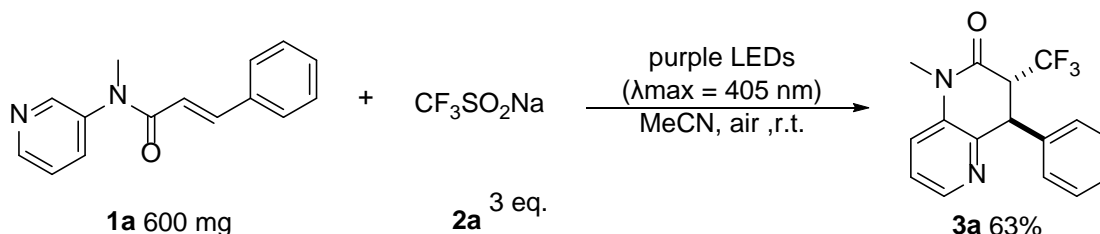
## 2.5 Representative procedure for the model reaction



To a 20 mL of oven-dried tube charged with a magnetic stirring bar were added *N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol) and MeCN (12 mL). The reaction mixture was open to the air and stirred at room temperature under the irradiation of purple LEDs ( $\lambda_{\text{max}} = 405$  nm) for 36 h. After completion of the reaction, the resulting mixture was

extracted with EtOAc (3 × 15 mL) and the organic phase was then removed under vacuum. The residue was purified by flash column chromatography using a mixture of heptane and ethyl acetate as eluents to give the desired product **3a**.

## 2.6 Scale-up experiment of **3a**

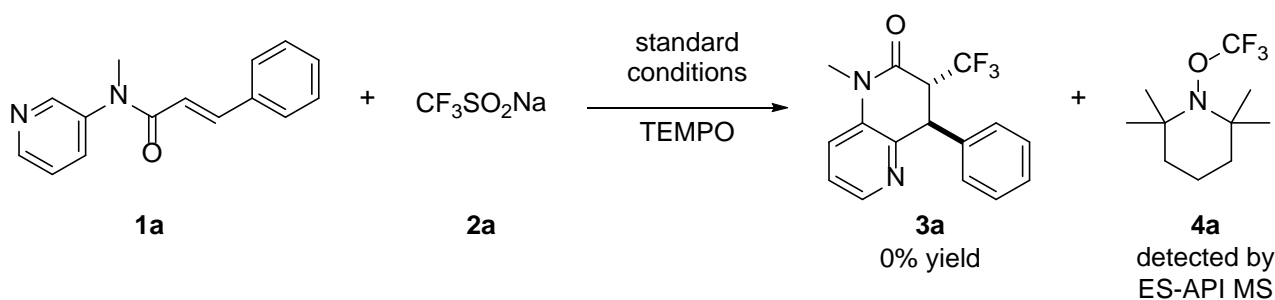


To a 100 mL oven-dried tube charged with a magnetic stirring bar were added *N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 2.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 7.5 mmol) and MeCN (60 mL). The reaction mixture was open to the air and stirred at room temperature under the irradiation of purple LEDs (λ<sub>max</sub> = 405 nm) for 48 h. After completion of the reaction, the resulting mixture was extracted with EtOAc (3 × 30 mL) and the organic phase was then removed under vacuum. The residue was purified by flash column chromatography using a mixture of heptane and ethyl acetate as eluents to give the desired product **3a** with the yield of 63%.

## 3. Mechanism investigation

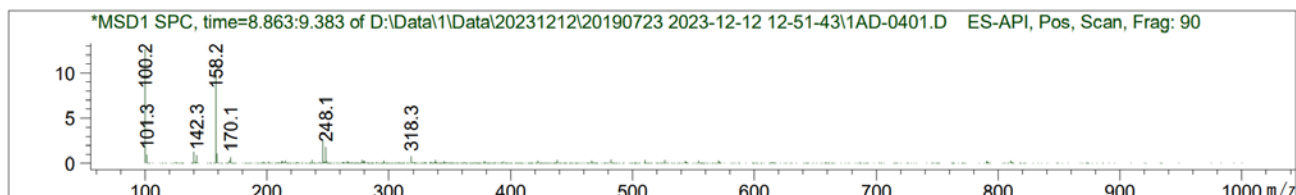
### 3.1 Control experiments

(a) Radical trapped experiment using TEMPO as a radical scavenger



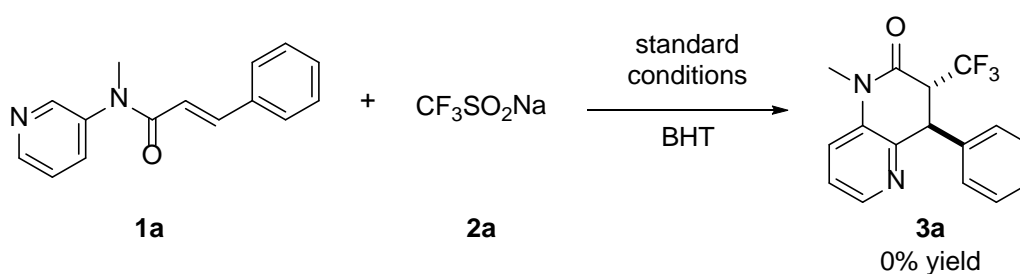
To a 15 mL oven-dried tube charged with a magnetic stirring bar were added *N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol), TEMPO (1.5 mmol) and MeCN (12

mL). The reaction mixture was open to the air and stirred at room temperature under the irradiation of purple LEDs ( $\lambda_{\text{max}} = 405 \text{ nm}$ ) for 36 h, and no product was detected and the adduct **4a** was detected by ESI-API MS shown in **Figure S3**, MS (ES-API)  $m/z$   $\text{C}_{10}\text{H}_{18}\text{F}_3\text{NONa}$   $[\text{M}+\text{Na}]^+$ : found 248.1.



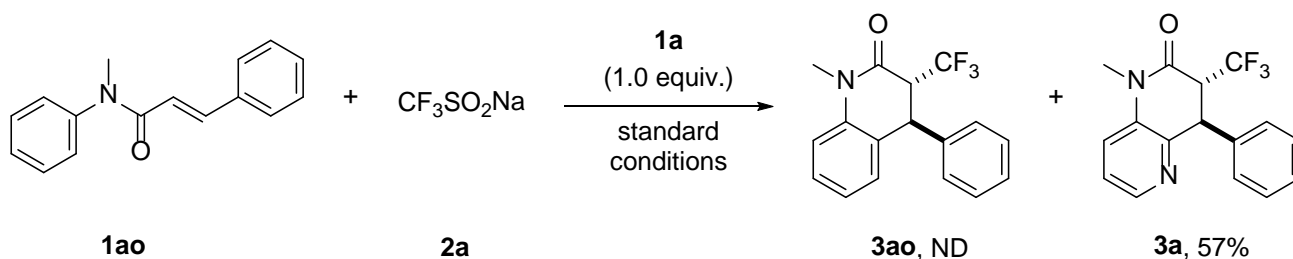
**Figure S3.** Mass spectra of **4a**

(b) Radical trapped experiment using BHT as a radical scavenger



To a 15 mL oven-dried tube charged with a magnetic stirring bar were added *N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 0.5 mmol),  $\text{CF}_3\text{SO}_2\text{Na}$  (**2a**, 1.5 mmol) BHT(1.5 mmol) and MeCN (12 mL). The reaction mixture was open to the air and stirred at room temperature under the irradiation of purple LEDs ( $\lambda_{\text{max}} = 405 \text{ nm}$ ) for 36 h, and no product was detected.

(c) Competitive experiment of **1ao** and **1a**



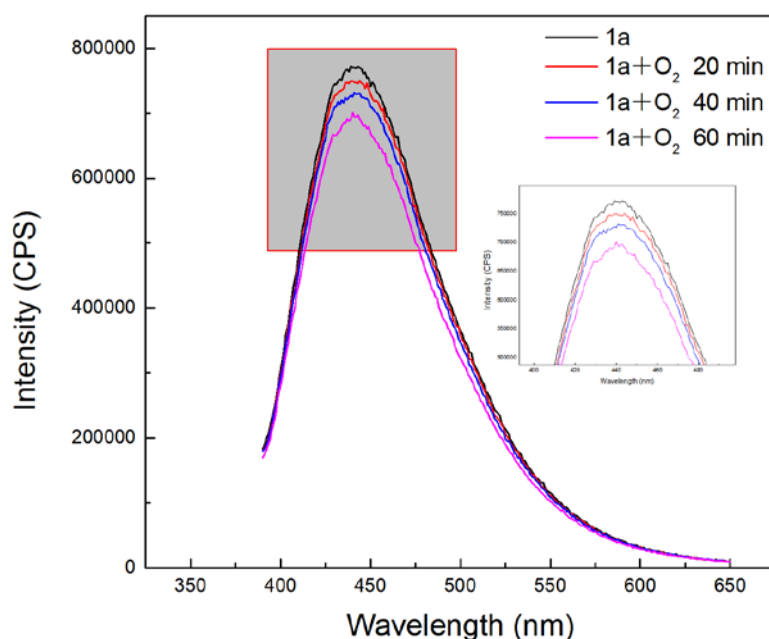
To a 15 mL oven-dried tube charged with a magnetic stirring bar were added *N*-methyl-*N*-

phenylcinnamamide (**1a**, 0.5 mmol), *N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol) and MeCN (12 mL). The reaction mixture was open to the air and stirred at room temperature under the irradiation of purple LEDs ( $\lambda_{\text{max}} = 405 \text{ nm}$ ) for 36 h, only **3a** was obtained in a yield of 57%.

### 3.2 Stern-Volmer experiments

To further elucidate the possible reaction pathway, the related fluorescence quenching experiments were performed and the results were shown in **Figure S4**. The solutions of <sup>1</sup>*N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**) were excited at 380 nm and the emission intensity at 440 nm was observed.

In each experiment, measurement was carried out mixing a 5.0 mmol/L solution of **1a** in MeCN with appropriate amount of quencher in quartz cuvette. The sample solution was pre-gassed and stored under a nitrogen atmosphere. Increasing the interaction time of the interaction of **1a** with oxygen in MeCN. Emission spectrum were recorded after 20 min, 40 min and 60 min. The results shows an obvious change in the emission intensity (CPS) of **1a**.

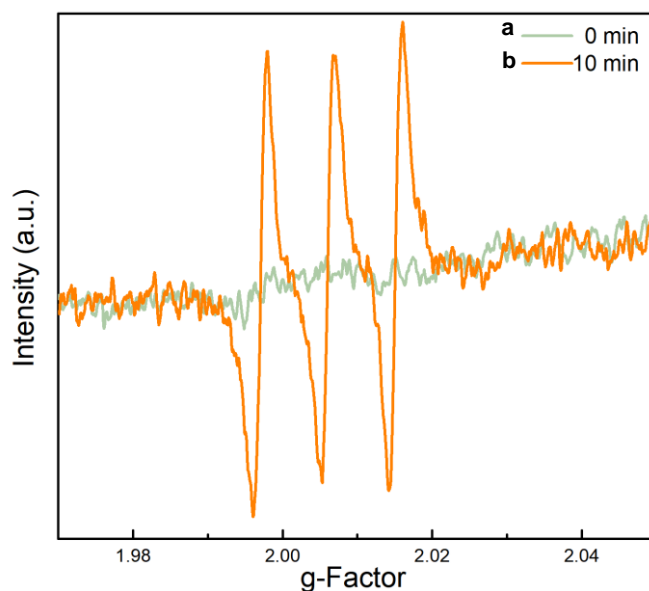


**Figure S4. Luminescence quenching experiments of 1a**

### 3.3 Determination of singlet oxygen species

In order to determine the active species of singlet oxygen involved in the reaction, 2,2,6,6-

tetramethylpiperidine (TEMP) were used to trap  $^1\text{O}_2$  ( $g = 2.0065$ ). Irradiation of reaction solution of TEMP with *N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**) and  $\text{CF}_3\text{SO}_2\text{Na}$  (**2a**) in MeCN under air with purple LEDs ( $\lambda_{\text{max}} = 405$  nm) resulted in the formation of a strong characteristic signal  $^1\text{O}_2$  adduct with TEMP (**Figure S5**), implying that  $^1\text{O}_2$  is also present during the reaction.

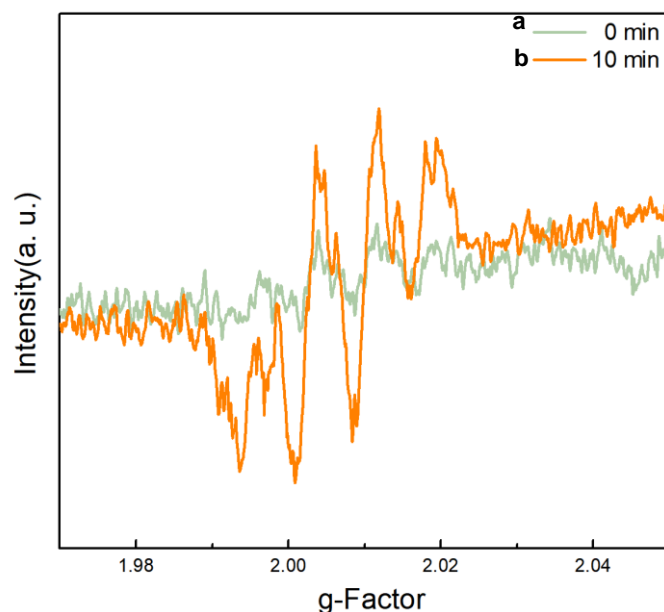


**Figure S5.** EPR spectra of TEMP with  $^1\text{O}_2$

(a) A solution of 2,2,6,6-tetramethylpiperidine (0.20 mol/L) with  $^1N$ -methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**) and  $\text{CF}_3\text{SO}_2\text{Na}$  (**2a**) in 12 mL air-saturated MeCN without light irradiation. (b) A solution of 2,2,6,6-tetramethylpiperidine (0.2 mol/L) with  $^1N$ -methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**) and  $\text{CF}_3\text{SO}_2\text{Na}$  (**2a**) in air-saturated MeCN under LEDs ( $\lambda_{\text{max}} = 405$  nm) irradiation for 10 min.

### 3.4 Determination of superoxide radicals

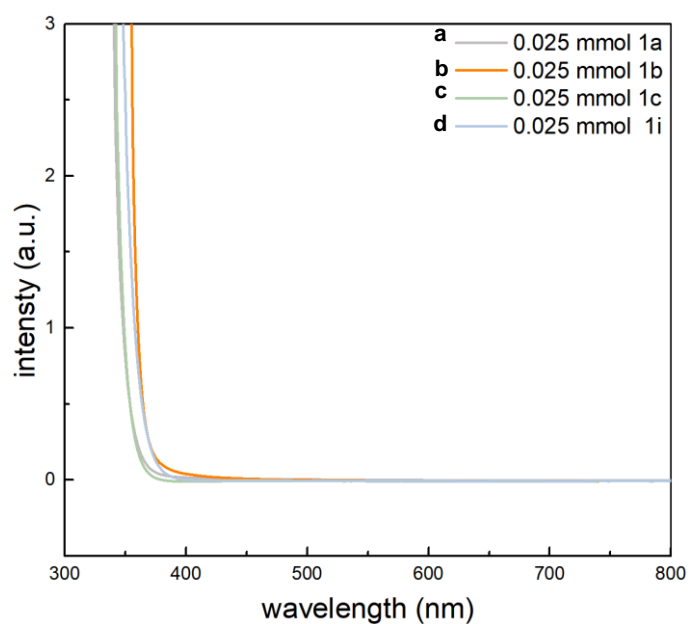
In order to determine the active species of oxygen involved in the present reaction, 5,5-dimethylpyrroline-*N*-oxide (DMPO) were employed to capture  $\text{O}_2^{\cdot-}$  ( $g = 2.0069$ ). There was no signal when DMPO was added into air-saturated MeCN solution of  $^1N$ -methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**) and  $\text{CF}_3\text{SO}_2\text{Na}$  (**2a**) without light irradiation. Irradiation of the above solution in air with purple LEDs ( $\lambda_{\text{max}} = 405$  nm) resulted in the formation of a weak characteristic signal of  $\text{O}_2^{\cdot-}$  adduct with DMPO (**Figure S6**), indicating the formation of  $\text{O}_2^{\cdot-}$  in the reaction.



**Figure S6.** EPR spectra of DMPO with  $O_2^{\bullet-}$

(a) A solution of 5,5-dimethylpyrroline-*N*-oxide (0.20 mol/L) with <sup>1</sup>*N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**) and CF<sub>3</sub>SO<sub>2</sub>Na (**2a**) in 12 mL air-saturated MeCN without light irradiation. (b) A solution of 5,5-dimethylpyrroline-*N*-oxide (0.2 mol/L) with **11***N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**) and CF<sub>3</sub>SO<sub>2</sub>Na (**2a**) in air-saturated MeCN under LEDs ( $\lambda_{\text{max}} = 405$  nm) irradiation for 10 min.

### 3.5 UV-visible absorption experiment of substrates

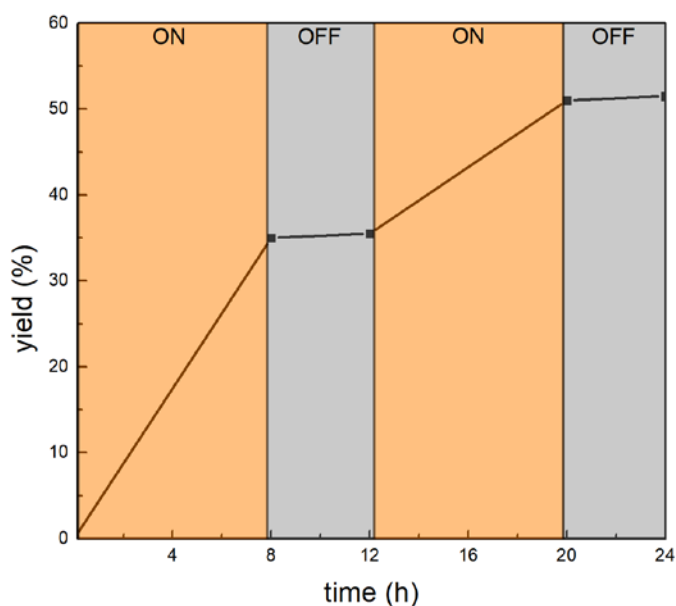


**Figure S7.** UV-visible absorption spectra

(a) UV-visible absorption spectra of **1a** in MeCN (3.0 mL). (b) UV-visible absorption spectra of **1b** in MeCN (3.0 mL). (c) UV-visible absorption spectra of **1c** in MeCN (3.0 mL). (d) UV-visible absorption spectra of **1i** in MeCN (3.0 mL).

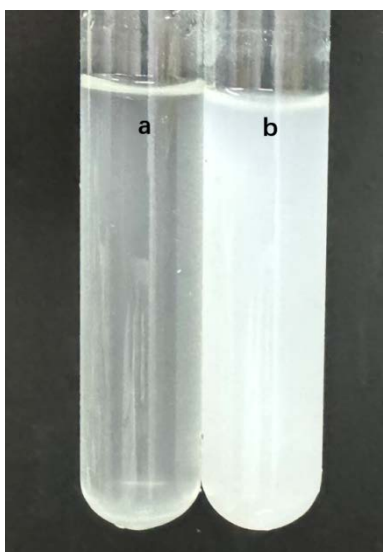
### 3.6 The on/off light illumination experiments

To four oven-dried 15 mL reaction tubes charged with a magnetic stirring bars were added <sup>1</sup>N-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol) and MeCN (12 mL). The purple LEDs were turned on and the mixture was stirred under irradiation at ambient temperature. After 8 h, the purple LEDs were turned off, and one vial was removed from the irradiation setup for analysis. The remaining three vials were stirred in the absence of light for an additional 4 h. Then, one vial was removed for analysis, and the purple LEDs were turned back on to irradiate the remaining two reaction mixtures. After an additional 8 h of irradiation, the purple LEDs were turned off, and one vial was removed for analysis. The remaining vial was stirred in the absence of light for an additional 4 h. Then, the last vial was removed for analysis. The yields were obtained by HPLC using external standard method.



**Figure S8.** The on/off light illumination experiments

### 3.7 Determination of sulfates

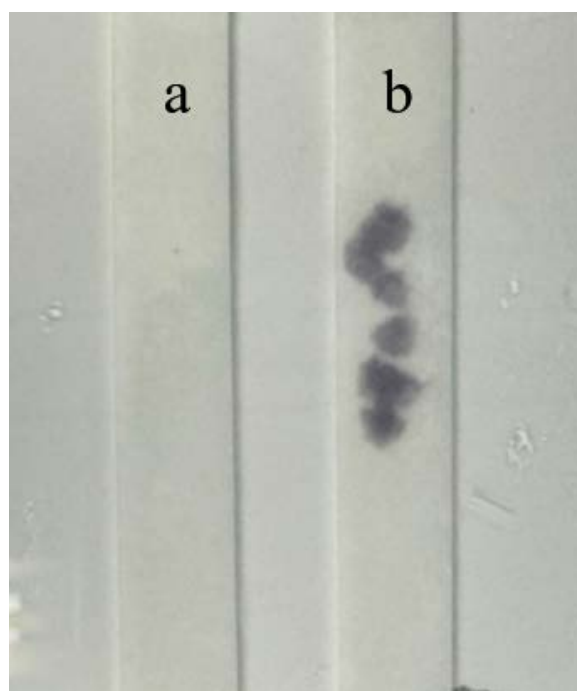


**Figure S9. Sulfates detection experiments**

a) To a 15 mL oven-dried tube charged with a magnetic stirring bar were added *1N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol) and MeCN (12 mL). The reaction mixture was protected by nitrogen and stirred at room temperature in the dark for 36 h. The reaction solution was then concentrated under reduced pressure to remove acetonitrile, and the residue was dissolved with 10 mL of ethyl acetate. The resulting solution was extracted with pure water (5 mL × 3). The aqueous phase was collected and saturated aqueous barium nitrate solution was added dropwise to the aqueous phase until the precipitation stopped increasing. Then, nitric acid solution (1.0 mol/L) was added dropwise until the precipitate stopped decreasing. (b) To a 15 mL oven-dried tube charged with a magnetic stirring bar were added *1N*-methyl-*N*-(pyridin-3-yl)cinnamamide (**1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol) and MeCN (12 mL). The reaction mixture was open to air and stirred at room temperature under the irradiation of purple LEDs ( $\lambda_{\text{max}} = 405 \text{ nm}$ ) for 36 h. The reaction solution was then concentrated under reduced pressure to remove acetonitrile, and the residue was dissolved with 10 mL of ethyl acetate. The resulting solution was extracted with pure water (5 mL × 3). The aqueous phase was collected and saturated aqueous barium nitrate solution was added dropwise to the aqueous phase until the precipitation stopped increasing. Then nitric acid solution (1.0 mol/L) was added dropwise until the precipitate stopped decreasing.



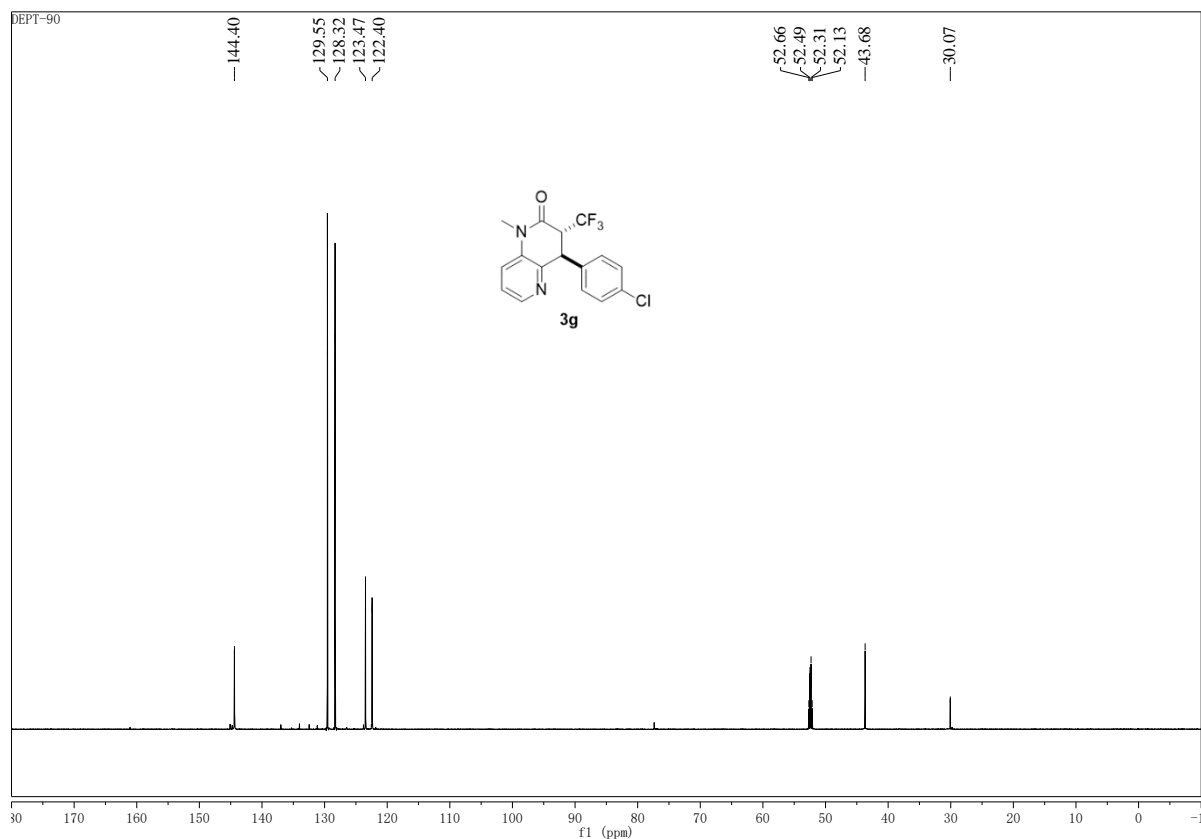
### 3.8 Determination of peroxides



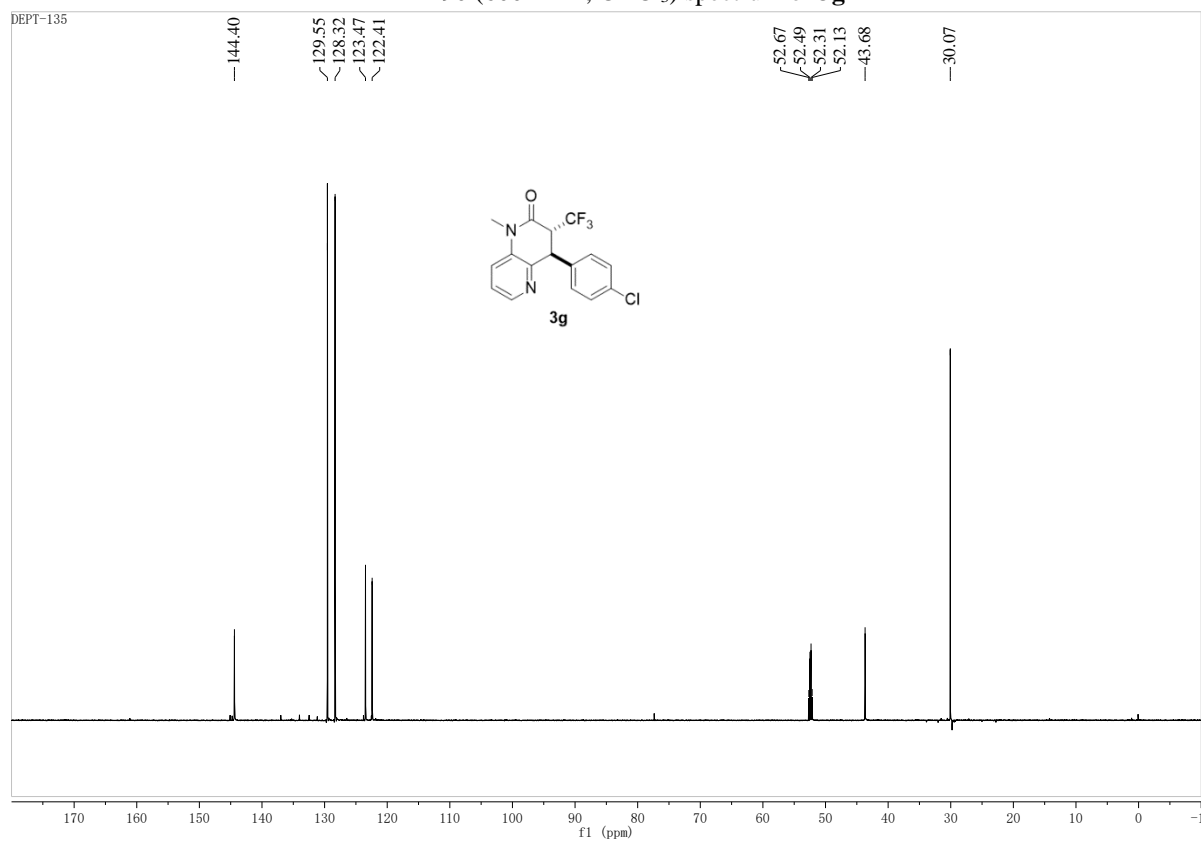
**Figure S10. Peroxide detection experiments**

a) To a 15 mL oven-dried tube charged with a magnetic stirring bar were added 1*N*-methyl-*N*-(pyridin-3-yl)cinnamamide ( **1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol) and MeCN (12 mL). The reaction mixture was protected by nitrogen and stirred at room temperature in the dark for 36 h. After that, the reaction solution was detected by using starch potassium iodide test paper. (b) To a 15 mL oven-dried tube charged with a magnetic stirring bar were added 1*N*-methyl-*N*-(pyridin-3-yl)cinnamamide ( **1a**, 0.5 mmol), CF<sub>3</sub>SO<sub>2</sub>Na (**2a**, 1.5 mmol) and MeCN (12 mL). The reaction mixture was open to air and stirred at room temperature under the irradiation of purple LEDs ( $\lambda_{\text{max}} = 405 \text{ nm}$ ) for 36 h. After that, the reaction solution was detected by using starch potassium iodide test paper.

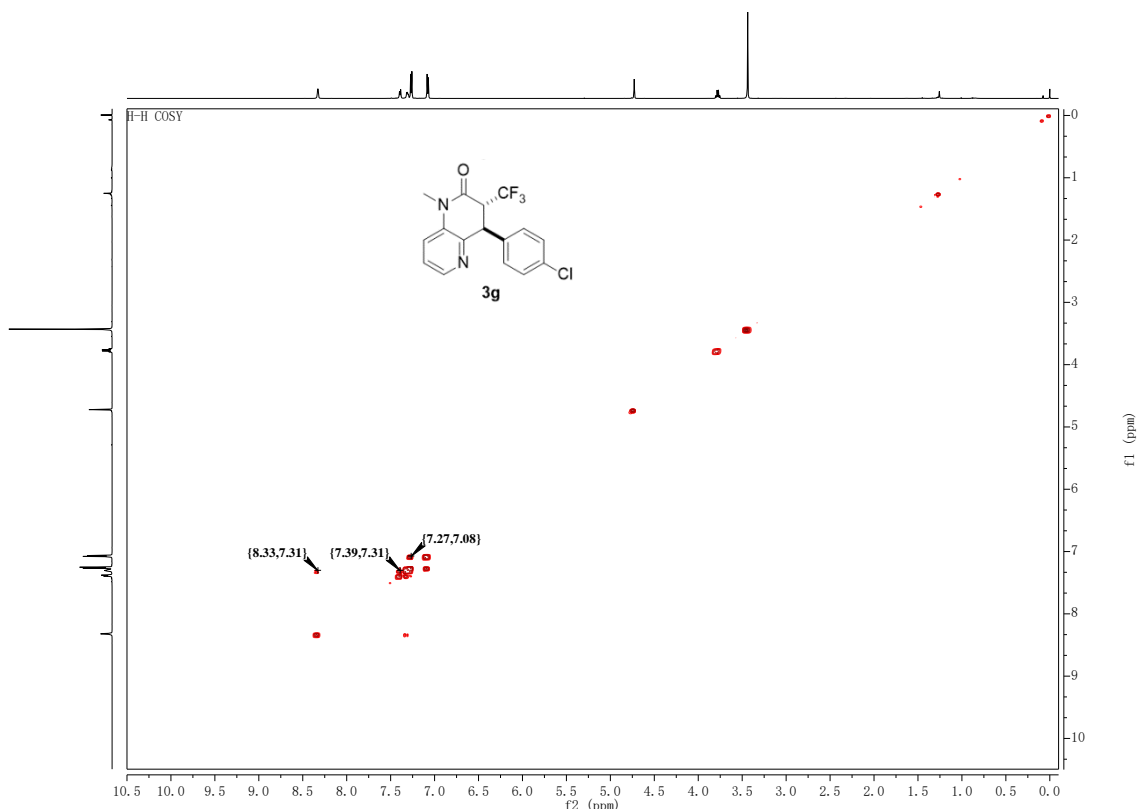
## 4. Copies of NMR spectrum of 3g



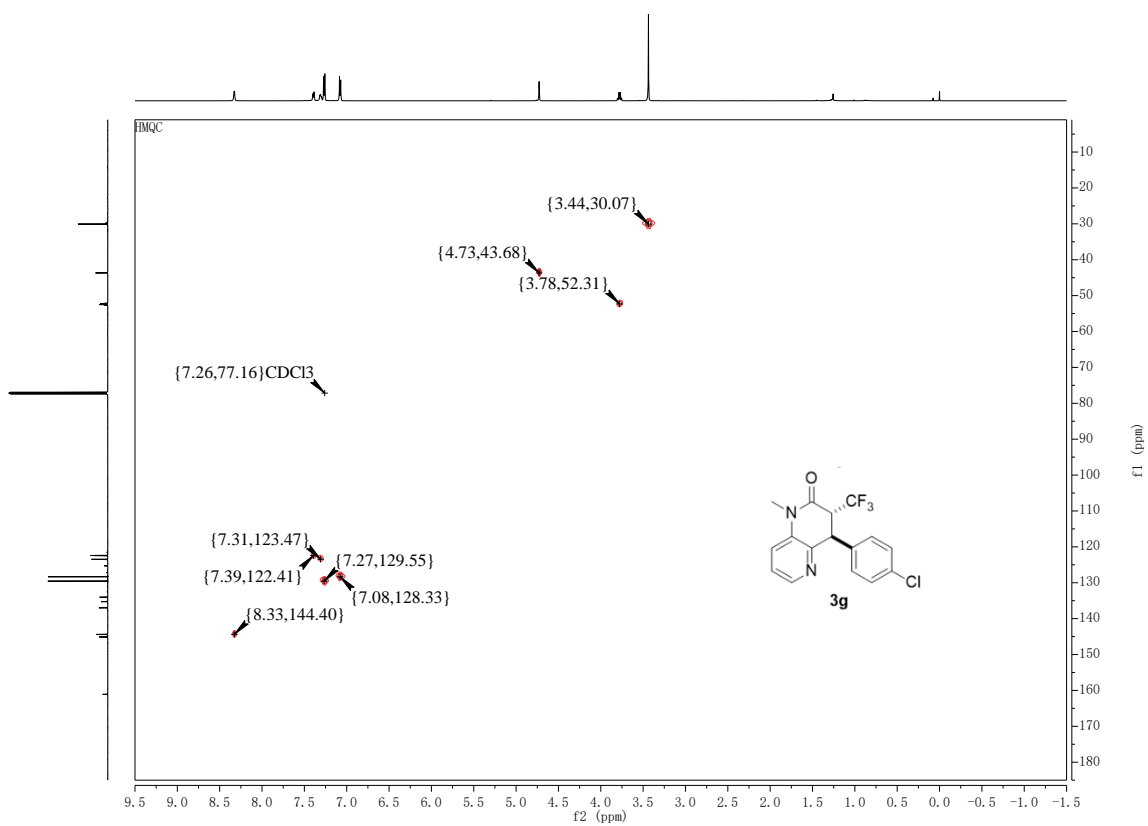
DEPT 90 (600 MHz, CDCl<sub>3</sub>) spectrum of **3g**



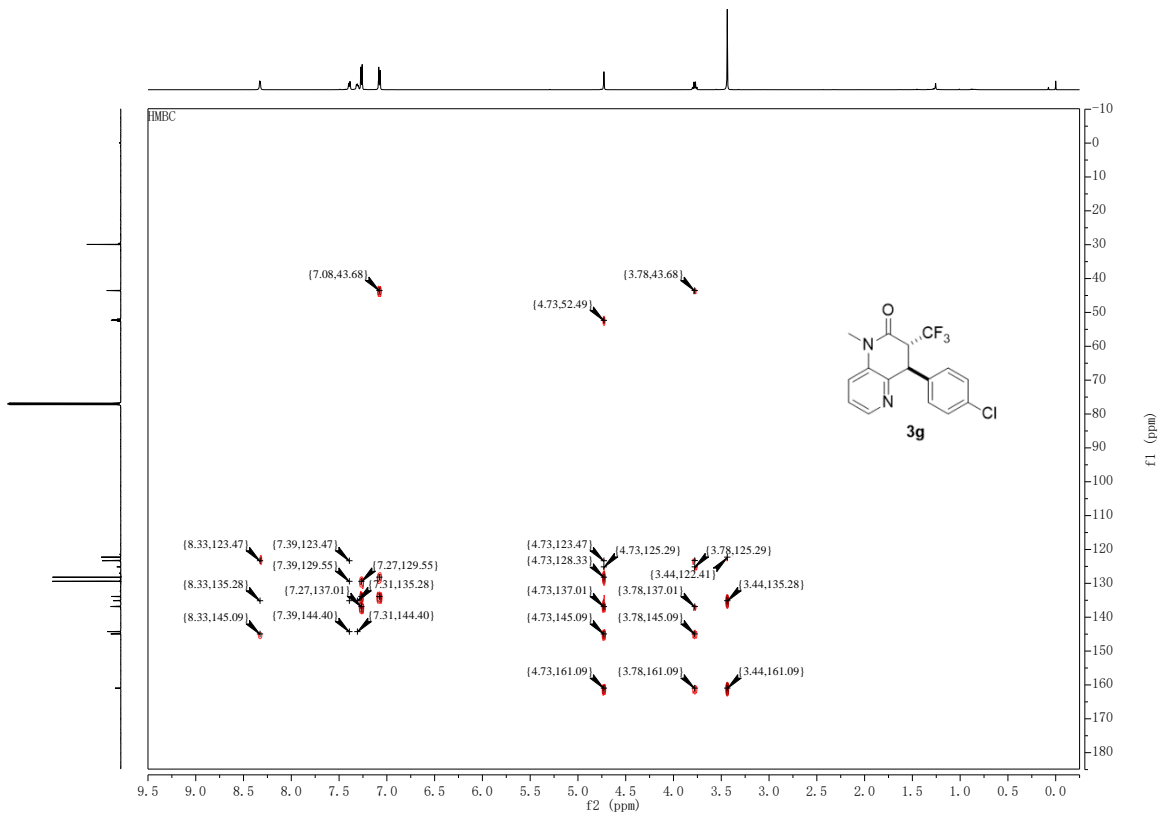
DEPT 135 (600 MHz, CDCl<sub>3</sub>) spectrum of **3g**



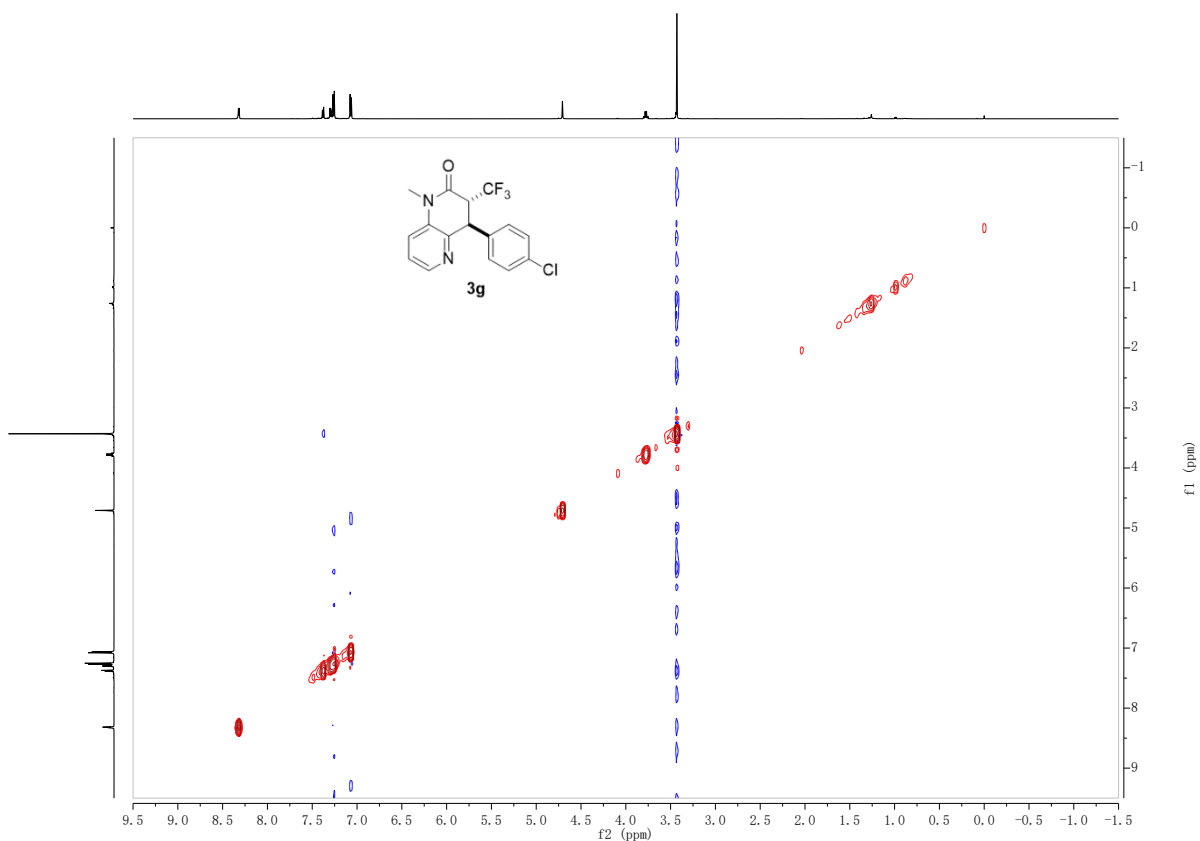
<sup>1</sup>H-<sup>1</sup>H COSY (600 MHz, CDCl<sub>3</sub>) spectrum of **3g**



HMQC (600 MHz, CDCl<sub>3</sub>) spectrum of **3g**



HMBC (600 MHz, CDCl<sub>3</sub>) spectrum of **3g**



Noesy (600 MHz, CDCl<sub>3</sub>) spectrum of **3g**

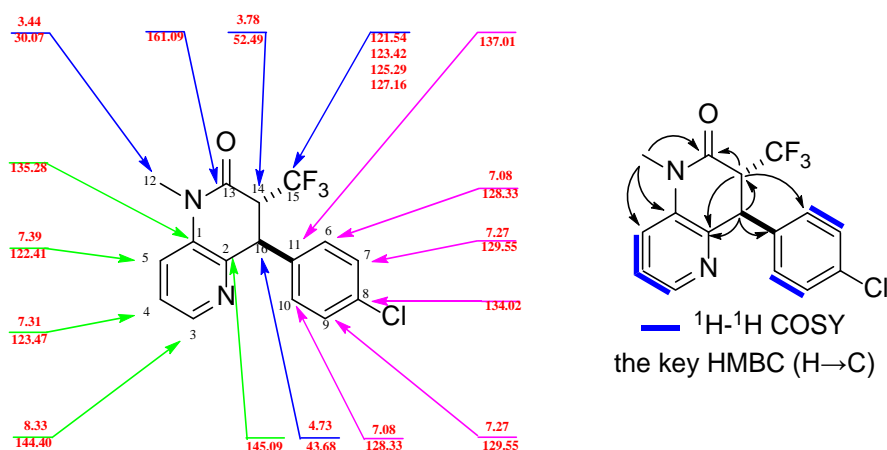
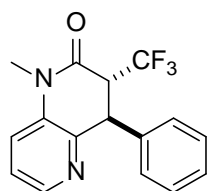


Figure S11. The attribution of chemical shift

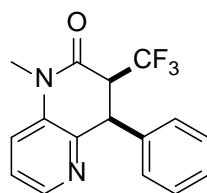
## 5. Characterization data for the products



3a

### 1-methyl-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one (*trans*)

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (101.3 mg, 66%), m.p. 146.4 – 148.1 °C  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  8.32 (d,  $J = 6.2$  Hz, 1H), 7.38 (dd,  $J = 8.3, 1.4$  Hz, 1H), 7.31 – 7.23 (m, overlapping with the residual proton of  $\text{CDCl}_3$ , 4H), 7.17 – 7.07 (m, 2H), 4.74 (s, 1H), 3.81 (q,  $J = 9.5$  Hz, 1H), 3.44 (s, 3H).  $^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ )  $\delta$  161.38, 145.67, 144.34, 138.64, 135.40, 129.46, 128.02, 126.94, 123.57, 124.51 (C-F,  $^1J_{\text{C-F}}, J = 279.8$  Hz), 122.28, 52.68 (C-F,  $^2J_{\text{C-F}}, J = 27.2$  Hz), 44.36, 30.06.  $^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ )  $\delta$  -67.56 (d,  $J = 9.4$  Hz). HRMS (ESI)  $m/z$ :  $[\text{M}+\text{H}]^+$  calcd for  $\text{C}_{16}\text{H}_{14}\text{F}_3\text{N}_2\text{O}^+$  307.1058; Found 307.1061.

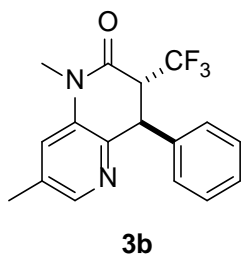


3a'

### 1-methyl-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one (*cis*)

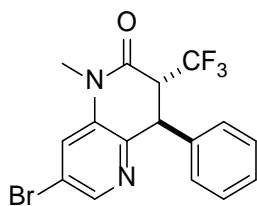
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a colorless oil (117.1 mg, 61%),  $^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ )  $\delta$  8.26 (dd,  $J = 4.8, 1.4$  Hz, 1H), 7.41 (dd,  $J = 8.3, 1.4$  Hz, 1H), 7.29 – 7.25 (m, overlapping with the residual proton of  $\text{CDCl}_3$ , 4H), 7.16 – 7.14 (m, 2H), 4.71 (d,  $J = 6.1$  Hz, 1H), 3.90 – 3.82 (m, 1H), 3.49 (s, 3H).  $^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ )  $\delta$  162.20, 147.54, 144.25, 136.22, 135.39, 129.07, 128.17, 128.01, 124.24 (C-F,  $^1J_{\text{C-F}}$ ,  $J = 279.4$  Hz), 123.31, 122.78, 49.56 (C-F,  $^2J_{\text{C-F}}$ ,  $J = 27.2$  Hz), 45.92, 29.50.  $^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ )  $\delta$  -63.57 (d,  $J = 5.6$  Hz). HRMS (EI)  $m/z$ :  $[\text{M}+\text{H}]^+$  calcd for  $\text{C}_{16}\text{H}_{14}\text{F}_3\text{N}_2\text{O}^+$  307.1058; Found 307.1006.

**TIPS on how to determine the relative configurations of 3a and 3a'**: It can be judged by the dihedral angles ( $\phi_{3\text{a}}$  and  $\phi_{3\text{a}'}$ ) formed by the trifluoromethyl  $\alpha$ -,  $\beta$ -H of  $\text{CF}_3$  and the carbon atoms to which they are attached.  $\phi_{3\text{a}}$  is roughly  $90^\circ$ , and  $\phi_{3\text{a}'}$  is roughly  $45^\circ$ . According to the Karplus formula,<sup>6</sup> coupling constant ( $^3J$ ) of  $\alpha$ - and  $\beta$ -H of  $\text{CF}_3$  in  $3\text{a}'$  is larger than that in  $3\text{a}$ .



### **1,7-dimethyl-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

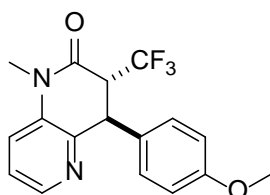
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (96.0 mg, 70%), m.p. 149.3 – 150.4  $^\circ\text{C}$ .  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.15 (s, 1H), 7.30 – 7.19 (m, overlapping with the residual proton of  $\text{CDCl}_3$ , 4H), 7.11 (d,  $J = 7.1$  Hz, 2H), 4.71 (s, 1H), 3.79 (q,  $J = 9.4$  Hz, 1H), 3.43 (s, 3H), 2.38 (s, 3H).  $^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ )  $\delta$  161.48, 144.70, 142.68, 138.93, 135.00, 133.24, 129.39, 127.90, 126.90, 124.53 (C-F,  $^1J_{\text{C-F}}$ ,  $J = 280.4$  Hz), 123.02, 52.83 (C-F,  $^2J_{\text{C-F}}$ ,  $J = 27.2$  Hz), 43.96, 29.99, 18.53.  $^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ )  $\delta$  -67.55 (d,  $J = 10.0$  Hz). HRMS (ESI)  $m/z$ :  $[\text{M}+\text{H}]^+$  calcd for  $\text{C}_{17}\text{H}_{16}\text{F}_3\text{N}_2\text{O}^+$  321.1215; Found 321.1212.



**3c**

**7-bromo-1-methyl-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

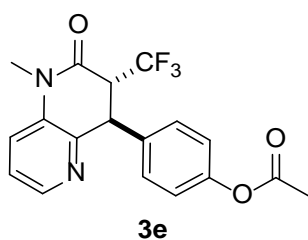
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (117.1 mg, 61%), m.p. 155.5 – 157.1 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.32 (d, *J* = 4.7 Hz, 1H), 7.43 – 7.37 (m, 3H), 7.30 (dd, *J* = 8.3, 4.7 Hz, 1H), 7.02 (d, *J* = 8.3 Hz, 2H), 4.70 (s, 1H), 3.77 (q, *J* = 9.3 Hz, 1H), 3.43 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) δ 161.11, 145.11, 144.55, 137.59, 135.27, 132.51, 128.66, 124.37(q, <sup>1</sup>*J*<sub>C-F</sub> = 283.9 Hz), 123.44, 122.29, 122.10, 52.35(q, <sup>2</sup>*J*<sub>C-F</sub> = 27.2 Hz), 43.85, 30.06. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -67.48(d, *J* = 11.5 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>13</sub><sup>79</sup>BrF<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 385.0163; Found 385.0158.



**3d**

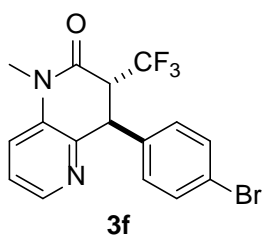
**4-(4-methoxyphenyl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (131.0 mg, 78%), m.p. 121.5 – 122.8 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.32 (d, *J* = 4.7 Hz, 1H), 7.36 (d, *J* = 8.2 Hz, 1H), 7.29 – 7.25 (m, overlapping with the residual proton of CDCl<sub>3</sub>, 1H), 7.04 (d, *J* = 8.4 Hz, 2H), 6.81 (d, *J* = 8.7 Hz, 2H), 4.68 (s, 1H), 3.75 (m, 4H), 3.44 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 160.35, 158.07, 144.97, 143.35, 134.00, 129.58, 126.85, 123.36 (C-F, <sup>1</sup>*J*<sub>C-F</sub>, *J* = 283.5 Hz) 121.92, 120.95, 113.62, 54.26, 51.69 (C-F, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 26.5 Hz) 42.58, 28.87. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.52. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>17</sub>H<sub>16</sub>F<sub>3</sub>N<sub>2</sub>O<sub>2</sub><sup>+</sup> 337.1164; Found 337.1164.



**4-(1-methyl-2-oxo-3-(trifluoromethyl)-1,2,3,4-tetrahydro-1,5-naphthyridin-4-yl)phenyl acetate**

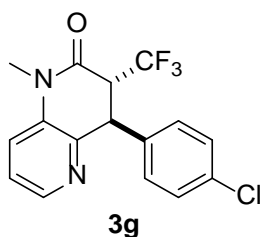
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (120.1 mg, 76%), m.p. 174.5 – 176.2 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.32 (d, *J* = 4.8 Hz, 1H), 7.37 (d, *J* = 8.3 Hz, 1H), 7.30 – 7.27 (m, 1H), 7.18 (d, *J* = 8.6 Hz, 2H), 7.02 (d, *J* = 8.7 Hz, 2H), 4.74 (s, 1H), 3.82 (q, *J* = 9.4 Hz, 1H), 3.44 (s, 3H), 2.27 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 169.29, 161.18, 150.19, 145.33, 144.37, 135.98, 135.06, 124.38 (q, <sup>1</sup>*J*<sub>C-F</sub> = 283.8 Hz), 123.21, 122.39, 122.15, 52.19 (q, <sup>2</sup>*J*<sub>C-F</sub> = 26.3 Hz), 43.69, 29.96, 21.09. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -67.52 (d, *J* = 9.1 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>18</sub>H<sub>16</sub>F<sub>3</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> 365.1113; Found 365.1125.



**4-(4-bromophenyl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

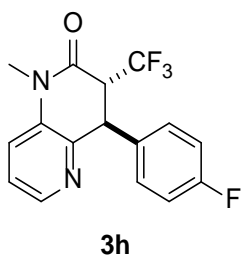
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (121.0 mg, 63%), m.p. 139.8 – 140.7 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.37 (d, *J* = 1.9 Hz, 1H), 7.50 (d, *J* = 1.9 Hz, 1H), 7.30 – 7.23 (m, overlapping with the residual proton of CDCl<sub>3</sub> 3H), 7.11 (d, *J* = 6.8 Hz, 2H), 4.70 (s, 1H), 3.82 (q, *J* = 9.3 Hz, 1H), 3.42 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) δ 161.28, 145.13, 144.27, 138.16, 136.18, 129.54, 128.20, 126.82, 124.78, 124.41 (C-F, <sup>1</sup>*J*<sub>C-F</sub>, *J* = 279.3 Hz), 119.82, 52.41 (C-F, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 27.2 Hz) 44.04, 30.14. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -67.53 (d, *J* = 9.1 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>13</sub><sup>79</sup>BrF<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 385.0163; Found 385.0157.





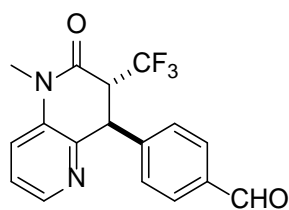
**4-(4-chlorophenyl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (120.7 mg, 71%), m.p. 132.4 – 133.6 °C. <sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) δ 8.33 (d, *J* = 4.5 Hz, 1H), 7.39 (d, *J* = 8.0 Hz, 1H), 7.31 (dd, *J* = 8.1, 4.6 Hz, 1H), 7.27 (d, *J* = 8.4 Hz, 2H), 7.08 (d, *J* = 8.3 Hz, 2H), 4.73 (s, 1H), 3.78 (q, *J* = 9.3 Hz, 1H), 3.44 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) δ 161.09, 145.09, 144.40, 137.01, 135.28, 134.02, 129.55, 128.33, 124.35(q, <sup>1</sup>*J*<sub>C-F</sub> = 283.9), 123.47, 122.41, 52.49(q, <sup>2</sup>*J*<sub>C-F</sub> = 25.7), 43.68, 30.07. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -67.55 (d, *J* = 7.9 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>13</sub><sup>35</sup>ClF<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 341.0669; Found 341.0668.



**4-(4-fluorophenyl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

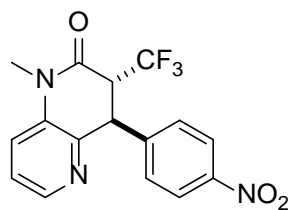
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (110.2 mg, 68%), m.p. 126.8-128.9 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.25 (d, *J* = 4.5 Hz, 1H), 7.31 (d, *J* = 8.2 Hz, 1H), 7.23 – 7.19 (m, 1H), 7.04 – 7.00 (m, 2H), 6.92 – 6.88 (m, 2H), 4.64 (s, 1H), 3.70 (q, *J* = 9.4 Hz, 1H), 3.36 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) δ 163.04, 161.24 (d, <sup>1</sup>*J*<sub>C-F</sub> = 49.8 Hz), 145.35, 144.46, 135.11, 134.36, 128.54 (d, <sup>3</sup>*J*<sub>C-F</sub> = 7.6 Hz), 124.30 (q, <sup>1</sup>*J*<sub>C-F</sub> = 282.4 Hz), 123.23, 122.15, 116.22 (d, <sup>2</sup>*J*<sub>C-F</sub> = 21.1 Hz), 52.62 (q, <sup>2</sup>*J*<sub>C-F</sub> = 27.2 Hz), 43.64, 29.92. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -67.54 (d, *J* = 9.4 Hz), -114.22 (ddd, *J* = 13.0, 8.3, 5.2 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>13</sub>F<sub>4</sub>N<sub>2</sub>O<sup>+</sup> 325.0964; Found 325.0966.



**3i**

**1-methyl-2-oxo-3-(trifluoromethyl)-1,2,3,4-tetrahydro-1,5-naphthyridin-4-ylbenzaldehyde**

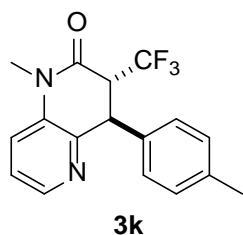
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (111.9 mg, 67%), m.p. 127.2 – 128.2 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 9.96 (s, 1H), 8.34 (dd, *J* = 4.8, 1.4 Hz, 1H), 7.82 (d, *J* = 8.3 Hz, 2H), 7.42 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.33 (dd, *J* = 8.2, 3.9 Hz, 3H), 4.83 (s, 1H), 3.83 (q, *J* = 9.3 Hz, 1H), 3.46 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 191.75, 161.16, 145.31, 144.84, 144.77, 136.15, 135.60, 130.93, 127.98, 124.35 (q, <sup>1</sup>*J*<sub>C-F</sub> = 282.2), 123.85, 122.64, 52.41 (q, <sup>2</sup>*J*<sub>C-F</sub> = 26.5 Hz), 44.66, 30.32. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.44. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>17</sub>H<sub>14</sub>F<sub>3</sub>N<sub>2</sub>O<sub>2</sub><sup>+</sup> 335.1007; Found 335.1007.



**3j**

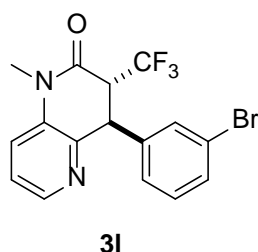
**1-methyl-4-(4-nitrophenyl)-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (63.2 mg, 36%), m.p. 145.6 – 146.7 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.34 (d, *J* = 3.3 Hz, 1H), 8.16 (d, *J* = 8.8 Hz, 2H), 7.42 (d, *J* = 8.3 Hz, 1H), 7.35 (t, 3H), 4.84 (s, 1H), 4.84 (s, 1H), 3.82 (q, *J* = 9.3 Hz, 1H), 3.45 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 160.98, 147.82, 145.80, 145.03, 144.35, 135.52, 128.31, 124.78, 124.18 (q, <sup>1</sup>*J*<sub>C-F</sub> = 282.2), 124.03, 122.70, 52.19 (q, <sup>2</sup>*J*<sub>C-F</sub> = 26.5 Hz), 44.38, 30.35. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.38. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>13</sub>F<sub>3</sub>N<sub>3</sub>O<sub>3</sub><sup>+</sup> 352.0918; Found 352.0909.



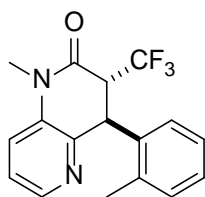
**1-methyl-4-(p-tolyl)-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (110.4 mg, 69%), m.p. 149.9 – 151.8 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.31 (d, *J* = 4.3 Hz, 1H), 7.41 – 7.35 (m, 1H), 7.31 – 7.25 (m, overlapping with the residual proton of CDCl<sub>3</sub>, 1H), 7.09 (d, *J* = 7.9 Hz, 2H), 7.01 (d, *J* = 8.0 Hz, 2H), 4.70 (s, 1H), 3.79 (q, *J* = 9.7 Hz, 1H), 3.43 (s, 3H), 2.28 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 161.69, 146.21, 144.66, 137.95, 135.89, 135.45, 133.24, 130.27, 126.96, 125.61 (q, <sup>1</sup>*J*<sub>C-F</sub> = 247.5) 123.29, 122.30, 52.94 (q, <sup>2</sup>*J*<sub>C-F</sub> = 27.3 Hz), 44.30, 30.22, 21.29. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.54. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>17</sub>H<sub>16</sub>F<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 321.1215; Found 321.1214.



**4-(3-bromophenyl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

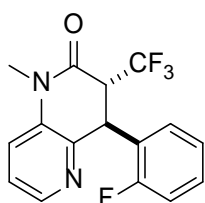
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (138.2 mg, 72%), m.p. 147.3 – 148.1 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.34 (d, *J* = 3.6 Hz, 1H), 7.41 – 7.38 (m, 2H), 7.31 (dd, *J* = 8.3, 4.7 Hz, 1H), 7.27 (dd, *J* = 3.2, 1.3 Hz, 1H), 7.17 (t, *J* = 7.9 Hz, 1H), 7.03 (d, *J* = 7.9 Hz, 1H), 4.71 (s, 1H), 3.78 (q, *J* = 9.4 Hz, 1H), 3.45 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 160.95, 144.79, 144.66, 140.82, 135.31, 131.20, 130.91, 130.31, 125.39, 124.33 (q, <sup>1</sup>*J*<sub>C-F</sub> = 282.2 Hz) 123.48, 123.41, 122.29, 52.47 (q, <sup>2</sup>*J*<sub>C-F</sub> = 26.5 Hz), 44.04, 30.03. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.49. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>16</sub>H<sub>13</sub><sup>79</sup>BrF<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 385.0163; Found 385.0169.



**3m**

**1-methyl-4-(o-tolyl)-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (88.1 mg, 55%), m.p. 145.1 – 146.2 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.31 (d, *J* = 4.7 Hz, 1H), 7.44 (d, *J* = 8.2 Hz, 1H), 7.31 (dd, *J* = 8.3, 4.8 Hz, 1H), 7.23 (d, *J* = 7.5 Hz, 1H), 7.13 (t, *J* = 7.4 Hz, 1H), 6.99 (t, *J* = 7.5 Hz, 1H), 6.42 (d, *J* = 7.7 Hz, 1H), 4.96 (s, 1H), 3.55 (q, *J* = 9.4 Hz, 1H), 3.48 (s, 3H), 2.52 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 161.15, 146.30, 144.88, 137.04, 136.53, 135.88, 132.00, 128.21, 127.10, 126.40, 124.74(C-F, <sup>1</sup>*J*<sub>C-F</sub>, *J* = 283.5 Hz), 123.42, 122.30, 52.82(C-F, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 25.2 Hz), 41.50, 30.30, 19.66. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.87. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>17</sub>H<sub>16</sub>F<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 321.1215; Found 321.1215.

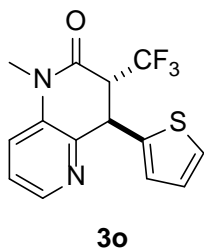


**3n**

**4-(2-fluorophenyl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

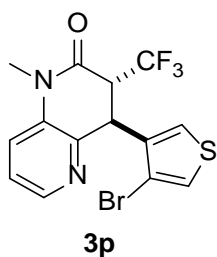
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (118.3 mg, 73%), m.p. 148.1 – 149.2 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.34 (dd, *J* = 4.8, 1.4 Hz, 1H), 7.44 (dd, *J* = 8.3, 1.3 Hz, 1H), 7.33 (dd, *J* = 8.3, 4.8 Hz, 1H), 7.28 – 7.22 (m, overlapping with the residual proton of CDCl<sub>3</sub>, 1H), 7.12 – 7.10 (m, 1H), 6.98 (td, *J* = 7.6, 1.3 Hz, 1H), 6.55 (td, *J* = 7.7, 1.7 Hz, 1H), 5.04 (s, 1H), 3.74 (qd, *J* = 9.4, 1.4 Hz, 1H), 3.45 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 160.93, 160.28 (d, <sup>1</sup>*J*<sub>C-F</sub> = 250.0 Hz), 144.64, 144.14, 136.26, 129.88 (d, <sup>3</sup>*J*<sub>C-F</sub> = 8.8 Hz), 128.15 (d, <sup>4</sup>*J*<sub>C-F</sub> = 3.8 Hz), 125.95, 125.84, 124.71 (d, <sup>4</sup>*J*<sub>C-F</sub> = 3.8 Hz), 124.48 (q, <sup>1</sup>*J*<sub>C-F</sub> = 283.5 Hz), 123.41, 122.03, 116.30 (d, <sup>2</sup>*J*<sub>C-F</sub> = 21.4 Hz), 52.11 (q, <sup>2</sup>*J*<sub>C-F</sub> = 26.5 Hz), 38.85, 29.97. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.87.

NMR (471 MHz, CDCl<sub>3</sub>)  $\delta$  -116.70 (s, F), -67.78 (s, 3F). HRMS (ESI) m/z: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>13</sub>F<sub>4</sub>N<sub>2</sub>O<sup>+</sup> 325.0964; Found 325.0957.



### 1-methyl-4-(thiophen-2-yl)-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

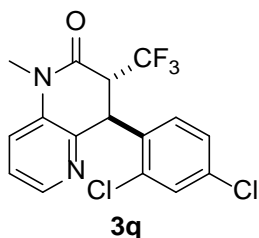
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (101.4 mg, 65%), m.p. 115.3 – 116.1 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.33 (d, *J* = 4.7 Hz, 1H), 7.36 (d, *J* = 8.3 Hz, 1H), 7.30 (dd, *J* = 8.3, 4.7 Hz, 1H), 7.19 (d, *J* = 5.1 Hz, 1H), 6.90 (dd, *J* = 5.1, 3.6 Hz, 1H), 6.81 (d, *J* = 3.3 Hz, 1H), 4.94 (s, 1H), 3.91 (q, *J* = 9.8 Hz, 1H), 3.43 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>)  $\delta$  160.92, 145.24, 144.22, 140.99, 134.64, 127.11, 125.56, 124.62, 123.34, 123.32(q, <sup>1</sup>*J*<sub>C-F</sub> = 279.7 Hz), 122.22, 52.73(q, <sup>2</sup>*J*<sub>C-F</sub> = 27.7 Hz), 40.58, 29.91. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>)  $\delta$  -67.20 (s, 3F). HRMS (ESI) m/z: [M+H]<sup>+</sup> calcd for C<sub>14</sub>H<sub>12</sub>F<sub>3</sub>N<sub>2</sub>OS<sup>+</sup> 313.0622; Found 313.0620.



### 4-(4-bromothiophen-3-yl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

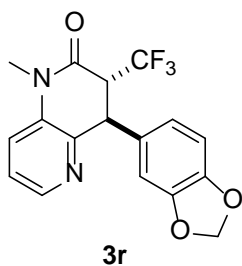
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (99.2 mg, 51%), m.p. 136.8 – 138.0 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.33 (dd, *J* = 4.7, 1.4 Hz, 1H), 7.36 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.31 (dd, *J* = 8.3, 4.7 Hz, 1H), 6.85 (d, *J* = 3.8 Hz, 1H), 6.60 (d, *J* = 3.8 Hz, 1H), 4.83 (s, 1H), 3.86 (q, *J* = 9.1 Hz, 1H), 3.42 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>)  $\delta$  160.70, 144.55, 144.36, 142.46, 134.66, 129.82, 125.02, 123.95 (q, <sup>1</sup>*J*<sub>C-F</sub> = 282.4 Hz),

123.63, 122.37, 112.48, 52.19 (q,  $^2J_{C-F} = 27.2$  Hz), 40.88, 29.99.  $^{19}\text{F}$  NMR (471 MHz,  $\text{CDCl}_3$ )  $\delta$  -67.14 (s, 3F). HRMS (ESI)  $m/z$ :  $[\text{M}+\text{H}]^+$  calcd for  $\text{C}_{14}\text{H}_{11}^{79}\text{BrF}_3\text{N}_2\text{OS}^+$  390.9728; Found 390.9749.



#### 4-(2,4-dichlorophenyl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

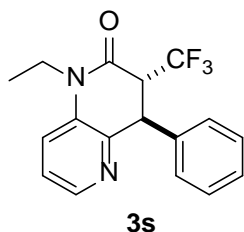
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (130.9 mg, 70%), m.p. 108.2 – 110.6 °C.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.35 (d,  $J = 4.6$  Hz, 1H), 7.49 – 7.45 (m, 2H), 7.37 (dd,  $J = 8.3, 4.7$  Hz, 1H), 7.06 (dd,  $J = 8.4, 2.2$  Hz, 1H), 6.34 (d,  $J = 8.4$  Hz, 1H), 5.13 (s, 1H), 3.73 (q,  $J = 9.2$  Hz, 1H), 3.46 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  160.65, 144.93, 144.16, 136.62, 134.70, 134.48, 134.22, 132.23, 130.59, 129.05, 127.80, 124.19 (q,  $^1J_{C-F} = 284.8$  Hz) 123.75, 122.18, 51.59 (q,  $^2J_{C-F} = 27.3$  Hz), 41.55, 30.03.  $^{19}\text{F}$  NMR (471 MHz,  $\text{CDCl}_3$ )  $\delta$  -67.48 (s, 3F). HRMS (ESI)  $m/z$ :  $[\text{M}+\text{H}]^+$  calcd for  $\text{C}_{16}\text{H}_{12}^{35}\text{Cl}_2\text{F}_3\text{N}_2\text{O}^+$  375.0279; Found 375.0276.



#### 4-(benzo[d][1,3]dioxol-5-yl)-1-methyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

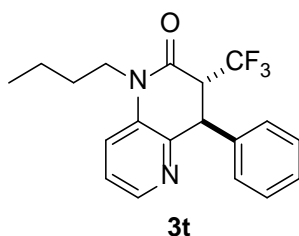
This product was purified by flash column chromatography on silica gel (heptane/ethyl acetate 15:1) as a white solid (129.3 mg, 74%), m.p. 137.3 – 138.8 °C.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.32 (d,  $J = 4.8$  Hz, 1H), 7.37 (d,  $J = 9.6$  Hz, 1H), 7.28 (dd,  $J = 8.0, 4.4$  Hz, 1H), 6.71 (d,  $J = 8.0$  Hz, 1H), 6.65 – 6.47 (m, 2H), 5.91 (s, 2H), 4.65 (s, 1H), 3.75 (q,  $J = 9.4$  Hz, 1H), 3.44 (s, 3H).  $^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ )  $\delta$  161.29, 148.48, 147.35, 145.68, 144.45, 135.27, 132.43, 124.42 (C-F,  $^1J_{C-F}, J = 283.81$  Hz), 123.25, 120.09, 108.95, 107.56, 101.40, 53.02 (C-F,  $^2J_{C-F}, J = 27.3$  Hz), 44.11, 30.03.  $^{19}\text{F}$  NMR (565

MHz, CDCl<sub>3</sub>)  $\delta$  -67.48 (d,  $J$  = 9.3 Hz, 3F). HRMS (ESI)  $m/z$ :  $[M+H]^+$  calcd for C<sub>17</sub>H<sub>14</sub>F<sub>3</sub>N<sub>2</sub>O<sub>3</sub><sup>+</sup> 351.0957; Found 351.0950.



### 1-ethyl-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

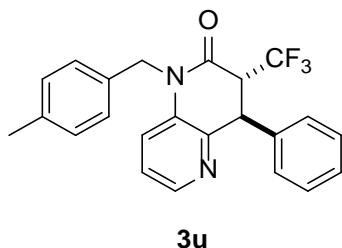
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (86.4 mg, 54%), m.p. 93.7 – 95.0 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.32 (dd,  $J$  = 4.7, 1.4 Hz, 1H), 7.40 (dd,  $J$  = 8.3, 1.4 Hz, 1H), 7.31 – 7.24 (m, overlapping with the residual proton of CDCl<sub>3</sub>, 4H), 7.11 (d,  $J$  = 7.2 Hz, 2H), 4.72 (s, 1H), 4.13 – 4.00 (m, 2H), 3.77 (q,  $J$  = 9.5 Hz, 1H), 1.25 (d,  $J$  = 7.2 Hz, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>)  $\delta$  160.78, 145.90, 144.32, 138.66, 134.12, 129.26, 127.85, 126.89, 124.46 (C-F, <sup>1</sup> $J_{C-F}$ ,  $J$  = 280.8 Hz) 123.24, 121.85, 52.82 (C-F, <sup>2</sup> $J_{C-F}$ ,  $J$  = 26.3 Hz), 44.46, 37.69, 12.02. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>)  $\delta$  -67.44 (s, 3F). HRMS (ESI)  $m/z$ :  $[M+H]^+$  calcd for C<sub>17</sub>H<sub>16</sub>F<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 321.1215; Found 321.1219.



### 1-butyl-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

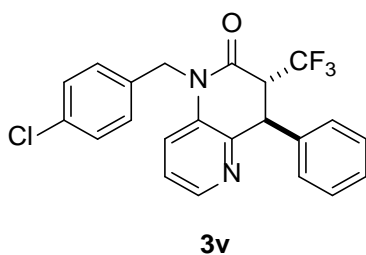
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (92.2 mg, 53%), m.p. 91.9 – 92.8 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.31 (d,  $J$  = 4.6 Hz, 1H), 7.38 (d,  $J$  = 8.2 Hz, 1H), 7.30 – 7.23 (m, 4H), 7.11 (d,  $J$  = 7.1 Hz, 2H), 4.73 (s, 1H), 3.97 (t,  $J$  = 7.7 Hz, 2H), 3.79 (q,  $J$  = 9.4 Hz, 1H), 1.69 – 1.53 (m, 2H), 1.40 – 1.31 (m, 2H), 0.94 (t,  $J$  = 7.3 Hz, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>)  $\delta$  161.06, 145.89, 144.33, 138.68, 134.46, 129.30, 127.92, 126.99, 124.30 (q, <sup>1</sup> $J_{C-F}$  = 252.8 Hz), 123.43, 122.08, 52.84 (q, <sup>2</sup> $J_{C-F}$  = 26.5 Hz), 44.48, 42.55, 28.87,

20.17, 13.82.  $^{19}\text{F}$  NMR (471 MHz,  $\text{CDCl}_3$ )  $\delta$  -67.62 (s, 3F). HRMS (ESI)  $m/z$ :  $[\text{M}+\text{H}]^+$  calcd for  $\text{C}_{19}\text{H}_{20}\text{F}_3\text{N}_2\text{O}^+$  349.1528; Found 349.1527.



### 1-(4-methylbenzyl)-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (81.2 mg, 41%), m.p. 127.9 – 128.8 °C.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.19 (d,  $J$  = 4.7 Hz, 1H), 7.23 – 7.17 (m, 4H), 7.07 – 6.95 (m, 5H), 6.96 (d,  $J$  = 7.9 Hz, 2H), 5.25 (d,  $J$  = 16.0 Hz, 1H), 4.95 (d,  $J$  = 16.0 Hz, 1H), 4.70 (s, 1H), 3.84 (q,  $J$  = 9.4 Hz, 1H), 2.24 (s, 3H).  $^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ )  $\delta$  161.63, 145.72, 144.46, 138.45, 137.62, 134.75, 132.16, 129.78, 129.44, 129.36, 128.01, 127.13, 126.69, 124.63 (q,  $^1J_{\text{C-F}}$  = 282.4 Hz), 123.10, 52.89 (q,  $^2J_{\text{C-F}}$  = 27.2 Hz), 46.37, 44.39, 21.19.  $^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ )  $\delta$  -67.25 (d,  $J$  = 10.0 Hz). HRMS (ESI)  $m/z$ :  $[\text{M}+\text{H}]^+$  Calcd for  $\text{C}_{23}\text{H}_{20}\text{F}_3\text{N}_2\text{O}^+$  397.1528; Found 397.1530.

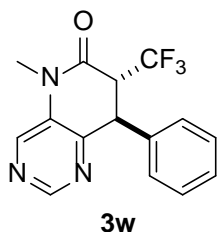


### 1-(4-chlorobenzyl)-4-phenyl-3-(trifluoromethyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (97.8 mg, 47%), m.p. 141.3 – 142.1 °C.  $^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ )  $\delta$  8.23 (d,  $J$  = 4.7 Hz, 1H), 7.21 – 7.14 (m, 6H), 7.08 (dd,  $J$  = 8.2, 4.7 Hz, 1H), 7.05 – 6.93 (m, 4H), 5.24 (d,  $J$  = 16.2 Hz, 1H), 4.97 (d,  $J$  = 16.2 Hz, 1H), 4.72 (s, 1H), 3.87 (q,  $J$  = 9.3 Hz, 1H).  $^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ )  $\delta$  161.94, 146.03, 144.88, 138.40, 134.66, 134.02, 133.98, 129.61, 129.54, 128.35, 128.31, 127.26, 124.78 (q,  $^1J_{\text{C-F}}$  = 282.4 Hz), 123.37, 123.05, 52.94 (q,  $^2J_{\text{C-F}}$  = 25.7 Hz), 46.13, 44.45.  $^{19}\text{F}$

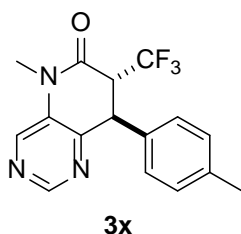


NMR (565 MHz, CDCl<sub>3</sub>)  $\delta$  -67.14 (d,  $J$  = 10.0 Hz). HRMS (ESI)  $m/z$ : [M+H]<sup>+</sup> Calcd for C<sub>22</sub>H<sub>17</sub><sup>35</sup>ClF<sub>3</sub>N<sub>2</sub>O<sup>+</sup> 417.0982; Found 417.0982.



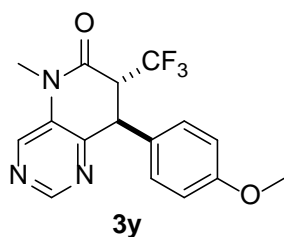
**5-methyl-8-phenyl-7-(trifluoromethyl)-7,8-dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (121.3 mg, 79%), m.p. 102.1 – 104.6 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.93 (s, 1H), 8.49 (s, 1H), 7.35 – 7.28 (m, 3H), 7.15 – 7.17 (m, 2H), 4.68 (s, 1H), 3.87 (q,  $J$  = 9.3 Hz, 1H), 3.49 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>)  $\delta$  161.04, 154.24, 153.87, 142.29, 137.37, 133.60, 129.90, 128.76, 127.01, 124.50 (q, <sup>1</sup> $J_{C-F}$  = 283.9 Hz), 52.13 (q, <sup>2</sup> $J_{C-F}$  = 27.2 Hz), 44.25, 29.83. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>)  $\delta$  -67.68 (d,  $J$  = 10.0 Hz). HRMS (ESI)  $m/z$ : [M+H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>13</sub>F<sub>3</sub>N<sub>3</sub>O<sup>+</sup> 308.1011; Found 308.1008.



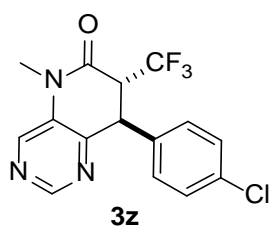
**5-methyl-8-(p-tolyl)-7-(trifluoromethyl)-7,8-dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (120.4 mg, 75%), m.p. 122.3 – 124.1 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>)  $\delta$  8.92 (s, 1H), 8.48 (s, 1H), 7.12 (d,  $J$  = 8.0 Hz, 2H), 7.04 (d,  $J$  = 8.1 Hz, 2H), 4.64 (s, 1H), 3.84 (q,  $J$  = 9.3 Hz, 1H), 3.48 (s, 3H), 2.29 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>)  $\delta$  161.14, 154.21, 154.14, 142.21, 138.67, 134.35, 133.53, 130.52, 126.85, 124.52 (q, <sup>1</sup> $J_{C-F}$  = 283.9 Hz), 52.17 (q, <sup>2</sup> $J_{C-F}$  = 25.7 Hz), 43.91, 29.81, 21.31. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>)  $\delta$  -67.66 (d,  $J$  = 5.7 Hz). HRMS (ESI)  $m/z$ : [M+H]<sup>+</sup> Calcd for C<sub>16</sub>H<sub>15</sub>F<sub>3</sub>N<sub>3</sub>O<sup>+</sup> 322.1167; Found 322.1160.



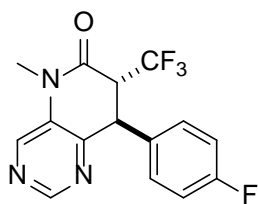
**8-(4-methoxyphenyl)-5-methyl-7-(trifluoromethyl)-7,8-dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a colorless oil (129.7 mg, 77%). <sup>1</sup>H NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ 8.91 (s, 1H), 8.79 (s, 1H), 7.09 (d, *J* = 8.7 Hz, 2H), 6.89 (d, *J* = 8.8 Hz, 2H), 4.59 (s, 1H), 4.31 (q, *J* = 9.8 Hz, 1H), 3.71 (s, 3H), 3.43 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 161.15, 159.84, 158.57, 156.36, 154.20, 142.21, 133.42, 129.29, 128.13, 126.76 (q, <sup>1</sup>*J*<sub>C-F</sub> = 283.8 Hz), 115.21, 55.64, 52.25 (q, <sup>2</sup>*J*<sub>C-F</sub> = 26.3 Hz), 43.53, 29.81. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>16</sub>H<sub>15</sub>F<sub>3</sub>N<sub>3</sub>O<sub>2</sub><sup>+</sup> 338.1116; Found 338.1116.



**8-(4-chlorophenyl)-5-methyl-7-(trifluoromethyl)-7,8-dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-one**

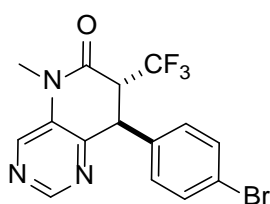
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (108.2 mg, 64%), m.p. 104.1 – 105.2 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.29 (d, *J* = 2.7 Hz, 1H), 8.23 (d, *J* = 2.7 Hz, 1H), 7.29 (d, *J* = 8.5 Hz, 2H), 7.09 (d, *J* = 8.5 Hz, 2H), 4.69 (s, 1H), 3.85 (q, *J* = 9.1 Hz, 1H), 3.54 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 161.81, 147.10, 141.46, 138.84, 136.29, 134.35, 129.65, 128.10, 124.13 (d, <sup>1</sup>*J*<sub>C-F</sub> = 283.8 Hz), 52.09 (q, <sup>2</sup>*J*<sub>C-F</sub> = 27.3 Hz), 42.40, 28.54. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -67.76 (d, *J* = 9.3 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>12</sub><sup>35</sup>ClF<sub>3</sub>N<sub>3</sub>O<sup>+</sup> 338.1116; Found 338.1116.



**3aa**

**8-(4-fluorophenyl)-5-methyl-7-(trifluoromethyl)-7,8-dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-one**

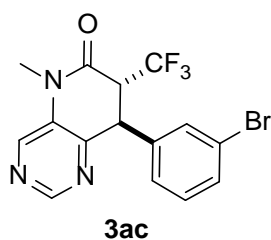
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (112.1 mg, 69%), m.p. 124.1 – 125.2 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.93 (s, 1H), 8.51 (s, 1H), 7.16 – 7.13 (m, 2H), 7.04 – 7.00 (m, 2H), 4.66 (s, 1H), 3.83 (q, *J* = 9.2 Hz, 1H), 3.50 (s, 3H). <sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) δ 163.33, 161.13 (d, <sup>1</sup>*J*<sub>C-F</sub> = 169.1 Hz), 153.96, 153.30, 142.09, 133.15, 132.80, 128.48 (d, <sup>3</sup>*J*<sub>C-F</sub> = 9.1 Hz), 124.07 (q, <sup>1</sup>*J*<sub>C-F</sub> = 282.3 Hz), 116.57 (d, <sup>2</sup>*J*<sub>C-F</sub> = 22.7 Hz), 51.80 (q, <sup>2</sup>*J*<sub>C-F</sub> = 27.2 Hz), 43.21, 29.55. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.65 (s, 3F), -112.98 (s, 1F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>12</sub>F<sub>4</sub>N<sub>3</sub>O<sup>+</sup> 338.1116; Found 338.1116. HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>11</sub>F<sub>4</sub>N<sub>3</sub>O<sup>+</sup> 326.0910; Found 326.0910.



**3ab**

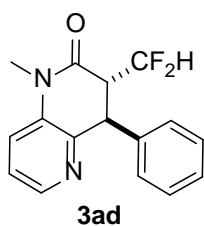
**8-(4-bromophenyl)-5-methyl-7-(trifluoromethyl)-7,8-dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (142.5 mg, 74%), m.p. 163.5 – 164.7 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.93 (s, 1H), 8.50 (s, 1H), 7.46 (d, *J* = 8.5 Hz, 2H), 7.06 (d, *J* = 8.5 Hz, 2H), 4.63 (s, 1H), 3.84 (q, *J* = 9.3 Hz, 1H), 3.49 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 160.50, 154.00, 152.95, 142.15, 135.94, 133.19, 132.71, 128.42, 124.08 (q, <sup>1</sup>*J*<sub>C-F</sub> = 282.8 Hz), 51.52 (q, <sup>2</sup>*J*<sub>C-F</sub> = 27.3 Hz), 43.39, 29.58. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.59 (s, 3F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>12</sub><sup>79</sup>BrF<sub>3</sub>N<sub>3</sub>O<sup>+</sup> 386.0116; Found 386.0113.



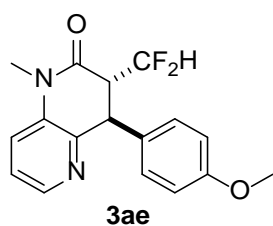
**8-(3-bromophenyl)-5-methyl-7-(trifluoromethyl)-7,8-dihydropyrido[3,2-*d*]pyrimidin-6(5*H*)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (114.2 mg, 72%), m.p. 163.9 – 165.1 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.95 (s, 1H), 8.52 (s, 1H), 7.44 (d, *J* = 7.9 Hz, 1H), 7.33 (t, *J* = 1.9 Hz, 1H), 7.20 (t, *J* = 7.9 Hz, 1H), 7.06 (d, *J* = 7.9 Hz, 1H), 4.64 (s, 1H), 3.83 (q, *J* = 8.6, 8.1 Hz, 1H), 3.50 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 160.35, 154.02, 152.69, 142.21, 139.12, 133.31, 131.71, 131.06, 130.17, 125.10, 124.04 (d, <sup>1</sup>*J*<sub>C-F</sub> = 283.8 Hz), 123.61, 51.61 (q, <sup>2</sup>*J*<sub>C-F</sub> = 27.3 Hz), 43.52, 29.72. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -67.44 (s, 3F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>15</sub>H<sub>12</sub><sup>79</sup>BrF<sub>3</sub>N<sub>3</sub>O<sup>+</sup> 386.0116; Found 386.0120.



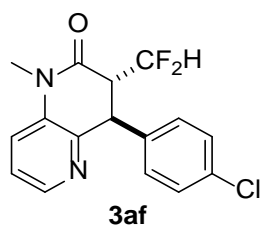
**3-(difluoromethyl)-1-methyl-4-phenyl-3,4-dihydro-1,5-naphthyridin-2(1*H*)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (114.2 mg, 79%), m.p. 109.9 – 112.2 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.31 (d, *J* = 4.7 Hz, 1H), 7.35 (d, *J* = 8.1 Hz, 1H), 7.31 – 7.23 (m, overlapping with the residual proton of CDCl<sub>3</sub>, 4H), 7.14 (d, *J* = 7.1 Hz, 2H), 6.05 (td, *J* = 55.4, 3.5 Hz, 1H), 4.72 (d, *J* = 2.1 Hz, 1H), 3.55 (dddd, *J* = 22.2, 10.1, 3.5, 2.0 Hz, 1H), 3.41 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 146.31, 144.01, 139.68, 135.26, 129.22, 127.64, 127.13, 123.02, 122.07, 114.94 (t, <sup>1</sup>*J*<sub>C-F</sub> = 248.5 Hz), 52.83 (t, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 21.2 Hz), 43.18, 29.70. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -120.01 (ddd, *J* = 284.1, 55.3, 10.3 Hz, 1F), -121.69 (ddd, *J* = 284.4, 55.8, 23.0 Hz, 1F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> Calcd for C<sub>16</sub>H<sub>15</sub>F<sub>2</sub>N<sub>2</sub>O<sup>+</sup> 289.1152; Found 289.1146.



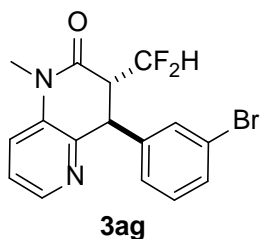
### 3-(difluoromethyl)-4-(4-methoxyphenyl)-1-methyl-3,4-dihydro-1,5-naphthyridin-2(1H)-one

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (126.1 mg, 79%), m.p. 77.2 – 73.9 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 8.30 (dd, *J* = 4.8, 1.4 Hz, 1H), 7.34 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.25 (dd, *J* = 7.7, 4.2 Hz, 1H), 7.06 (d, *J* = 8.8 Hz, 2H), 6.81 (d, *J* = 8.7 Hz, 2H), 6.03 (td, *J* = 55.4, 3.6 Hz, 1H), 4.65 (d, *J* = 2.2 Hz, 1H), 3.75 (s, 3H), 3.53 (dddd, *J* = 22.0, 10.1, 3.6, 2.2 Hz, 1H), 3.41 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 164.16 (d, <sup>3</sup>*J*<sub>C-F</sub> = 5.0 Hz), 158.91, 146.69, 144.10, 135.02, 131.66, 128.15, 122.85, 121.92, 114.89 (t, <sup>1</sup>*J*<sub>C-F</sub> = 248.2 Hz), 114.53, 55.28, 52.88 (t, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 20.2 Hz), 42.55, 29.64. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -120.30 (d, *J* = 282.6 Hz, 1F), -121.60 (d, *J* = 287.3 Hz, 1F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>17</sub>H<sub>17</sub>F<sub>2</sub>N<sub>2</sub>O<sub>2</sub><sup>+</sup> 319.1258; Found 319.1264.



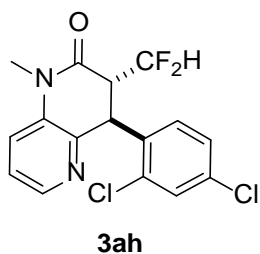
### 4-(4-chlorophenyl)-3-(difluoromethyl)-1-methyl-3,4-dihydro-1,5-naphthyridin-2(1H)-one

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (134.2 mg, 83%), m.p. 98.1 – 99.6 °C. <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) δ 8.31 (d, *J* = 4.1 Hz, 1H), 7.35 (dd, *J* = 8.3, 1.4 Hz, 1H), 7.28 – 7.25 (m, overlapping with the residual proton of CDCl<sub>3</sub>, 3H), 7.08 (d, *J* = 8.4 Hz, 2H), 6.08 (td, *J* = 55.3, 3.3 Hz, 1H), 4.68 (d, *J* = 2.2 Hz, 1H), 3.51 (m, 1H), 3.41 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 163.93 (d, <sup>3</sup>*J*<sub>C-F</sub> = 6.3 Hz), 145.89, 144.34, 138.15, 135.06, 133.52, 129.28, 128.61, 123.11, 121.97, 114.80 (t, <sup>1</sup>*J*<sub>C-F</sub> = 247.0 Hz), 52.47 (t, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 21.4 Hz), 42.68, 29.67. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -119.99 (d, *J* = 284.6 Hz), -122.06 (d, *J* = 284.5 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>14</sub><sup>35</sup>ClF<sub>2</sub>N<sub>2</sub>O<sup>+</sup> 323.0763; Found 323.0761.



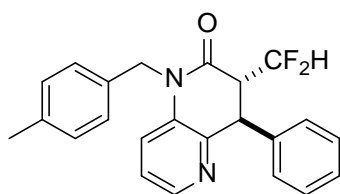
#### 4-(3-bromophenyl)-3-(difluoromethyl)-1-methyl-3,4-dihydro-1,5-naphthyridin-2(1H)-one

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (133.6 mg, 73%), m.p. 109.9 – 111.6 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.36 (dd, *J* = 4.7, 1.4 Hz, 1H), 7.43 – 7.40 (m, 2H), 7.34 – 7.30 (m, 2H), 7.21 (t, *J* = 7.9 Hz, 1H), 7.09 (d, *J* = 7.8 Hz, 1H), 6.12 (td, *J* = 55.3, 3.3 Hz, 1H), 4.72 (d, *J* = 2.4 Hz, 1H), 3.59– 3.50 (m, 1H), 3.46 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 163.79 (d, <sup>3</sup>*J*<sub>C-F</sub> = 10.0 Hz), 145.51, 144.32, 141.99, 135.22, 130.84, 130.71, 130.53, 125.81, 123.27, 123.20, 122.12, 114.82 (t, <sup>1</sup>*J*<sub>C-F</sub> = 248.0 Hz), 52.58 (t, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 21.2 Hz), 42.85, 29.72. <sup>19</sup>F NMR (565 MHz, Chloroform-*d*) δ -120.00 (ddd, *J* = 283.1, 55.0, 9.1 Hz, 1F), -122.14 (ddd, *J* = 284.8, 55.5, 23.3 Hz, 1F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>14</sub><sup>79</sup>BrF<sub>2</sub>N<sub>2</sub>O<sup>+</sup> 367.0258; Found 367.0253.



#### 4-(2,4-dichlorophenyl)-3-(difluoromethyl)-1-methyl-3,4-dihydro-1,5-naphthyridin-2(1H)-one

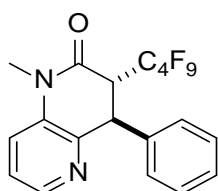
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a colorless oil (158.9 mg, 89%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.30 (dd, *J* = 4.7, 1.4 Hz, 1H), 7.45 – 7.40 (m, 2H), 7.32 (dd, *J* = 8.3, 4.7 Hz, 1H), 7.11 (dd, *J* = 8.4, 2.2 Hz, 1H), 6.58 (d, *J* = 8.4 Hz, 1H), 6.19 (td, *J* = 55.1, 2.9 Hz, 1H), 5.09 (d, *J* = 4.3 Hz, 1H), 3.57 (dddd, *J* = 21.6, 10.4, 4.3, 2.9 Hz, 1H), 3.43 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 164.16 (d, <sup>3</sup>*J*<sub>C-F</sub> = 5.0 Hz), 158.91, 146.69, 144.10, 135.02, 131.66, 128.15, 122.85, 121.92, 114.89 (t, <sup>1</sup>*J*<sub>C-F</sub> = 248.2 Hz), 114.53, 55.28, 52.88 (t, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 20.2 Hz), 42.55, 29.64. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -120.80 (d, *J* = 282.6 Hz, 1F), -122.41 (d, *J* = 282.6 Hz, 1F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>16</sub>H<sub>12</sub><sup>35</sup>Cl<sub>2</sub>F<sub>2</sub>N<sub>2</sub>O<sup>+</sup> 357.0373; Found 357.0368.



**3ai**

**3-(difluoromethyl)-1-(4-methylbenzyl)-4-phenyl-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (149.7mg, 79%), m.p. 147.5 – 149.1 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.26 (dd, *J* = 4.8, 1.3 Hz, 1H), 7.23– 7.30 (m, overlapping with the residual proton of CDCl<sub>3</sub>, 4H), 7.13 – 7.08 (m, 5H), 7.03 (d, *J* = 8.0 Hz, 2H), 6.11 (td, *J* = 55.4, 3.8 Hz, 1H), 5.26 (d, *J* = 16.1 Hz, 1H), 5.06 (d, *J* = 16.0 Hz, 1H), 4.76 (s, 1H), (dddd, *J* = 21.4, 10.4, 3.8, 1.8 Hz, 1H), 2.30 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 164.54 (q, <sup>3</sup>*J*<sub>C-F</sub> = 3.0 Hz), 146.61, 144.52, 139.74, 137.73, 134.82, 132.99, 132.48, 129.95, 129.41, 127.89, 127.51, 126.86, 123.20, 123.15, 115.24 (t, <sup>1</sup>*J*<sub>C-F</sub> = 248.5 Hz), 53.33 (t, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 20.0 Hz), 46.22, 43.62, 21.38. <sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) δ -119.67 (ddd, *J* = 284.8, 55.0, 9.7 Hz), -121.06 (ddd, *J* = 284.9, 55.8, 22.6 Hz). HRMS (ESI) *m/z*: [M+H]<sup>+</sup> calcd for C<sub>23</sub>H<sub>21</sub>F<sub>2</sub>N<sub>2</sub>O<sup>+</sup> 379.1622; Found 379.1620.

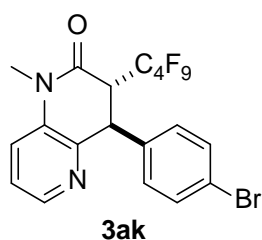


**3aj**

**1-methyl-3-(perfluorobutyl)-4-phenyl-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

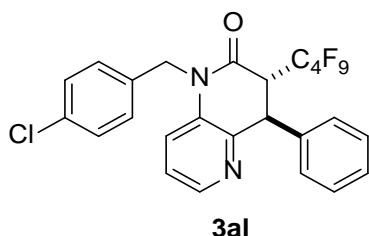
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a colorless oil (194.2 mg, 85%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.33 (d, *J* = 4.8 Hz, 1H), 7.41 (d, *J* = 8.3 Hz, 1H), 7.32 – 7.24 (overlapping with the residual proton of CDCl<sub>3</sub>, m, 4H), 7.09 (d, *J* = 7.1 Hz, 2H), 4.86 (s, 1H), 3.90 (t, *J* = 15.4 Hz, 1H), 3.45 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 161.19, 146.23, 144.68, 138.57, 135.91, 129.70, 128.28, 127.21, 123.46, 122.47, 122.07 – 116.46 (m), 50.98 (t, <sup>2</sup>*J*<sub>C-F</sub>, *J* = 21.4 Hz), 44.13, 30.39. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -80.86 – -80.90 (m, 3F), -111.57 – -113.05 (m, 2F), -120.72 – -122.29 (m, 2F), -124.93 – -126.61 (m, 2F). HRMS (ESI) *m/z*: [M+H]<sup>+</sup>

calcd for  $C_{23}H_{21}F_2N_2O^+$  379.1622; Found 379.1620. HRMS (ESI)  $m/z$ :  $[M+H]^+$  calcd for  $C_{19}H_{14}F_9N_2O^+$  457.0962; Found 457.0966.



#### **4-(4-bromophenyl)-1-methyl-3-(perfluorobutyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a colorless oil (216.7 mg, 81%).  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  8.33 (d,  $J = 4.5$  Hz, 1H), 7.43 – 7.40 (m, 3H), 7.31 (dd,  $J = 8.3, 4.7$  Hz, 1H), 6.99 (d,  $J = 8.5$  Hz, 2H), 4.80 (s, 1H), 3.87 (t,  $J = 15.8$  Hz, 1H), 3.44 (s, 3H).  $^{13}C$  NMR (126 MHz,  $CDCl_3$ )  $\delta$  160.97, 145.67, 144.83, 137.54, 135.80, 132.79, 128.93, 123.65, 122.53, 122.38, 119.02 – 108.53(m), 50.71 (t,  $^2J_{C-F}$ ,  $J = 21.4$  Hz), 43.64, 30.39.  $^{19}F$  NMR (471 MHz,  $CDCl_3$ )  $\delta$  -80.79 (t,  $J = 9.9$  Hz), -111.33 – -112.91 (m, 2F), -119.60 – -121.88 (m, 2F), -122.72 – -126.13 (m, 2F). HRMS (ESI)  $m/z$ :  $[M+H]^+$  calcd for  $C_{19}H_{13}^{79}BrF_9N_2O^+$  535.0068; Found 535.0067.

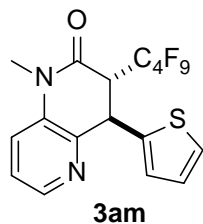


#### **1-(4-chlorobenzyl)-3-(perfluorobutyl)-4-phenyl-3,4-dihydro-1,5-naphthyridin-2(1H)-one**

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (147.4 mg, 52%), m.p. 94.5 – 95.5 °C.  $^1H$  NMR (400 MHz,  $CDCl_3$ )  $\delta$  8.31 (dd,  $J = 4.8, 1.3$  Hz, 1H), 7.30 – 7.24 (m, overlapping with the residual proton of  $CDCl_3$ , 6H), 7.19 (dd,  $J = 8.3, 4.8$  Hz, 1H), 7.09 – 7.02 (m, 4H), 5.27 (d,  $J = 16.1$  Hz, 1H), 5.07 (d,  $J = 16.1$  Hz, 1H), 4.91 (s, 1H), 4.04 (t,  $J = 16.1$  Hz, 1H).  $^{13}C$  NMR (101 MHz,  $CDCl_3$ )  $\delta$  161.29, 146.10, 144.60, 137.76, 134.77, 133.77, 133.73, 129.34, 129.15, 128.32, 128.06, 127.03, 123.11, 122.85, 121.60 – 108.51 (m), 50.53 (t,  $^2J_{C-F}$ ,  $J = 20.2$  Hz), 46.13, 43.63.  $^{19}F$  NMR (565 MHz, Chloroform- $d$ )  $\delta$  -80.78 – -80.91

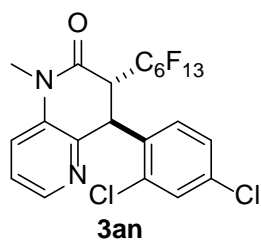


(m,3F), -111.04 – -112.86 (m, 2F), -112.19 – -112.44 (m, 2F), -125.04 – -126.40 (m, 2F). HRMS (ESI) m/z: [M+H]<sup>+</sup> calcd for C<sub>25</sub>H<sub>17</sub><sup>35</sup>ClF<sub>9</sub>N<sub>2</sub>O<sup>+</sup> 567.0886; Found 567.0887.



### 1-methyl-3-(perfluorobutyl)-4-(thiophen-2-yl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a white solid (162.1 mg, 70%), m.p. 70.2 – 71.5 °C. <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.34 (d, *J* = 4.5 Hz, 1H), 7.41 (d, *J* = 8.1 Hz, 1H), 7.33 (dd, *J* = 8.2, 4.7 Hz, 1H), 7.20 (d, *J* = 5.1 Hz, 1H), 6.91 (dd, *J* = 5.1, 3.6 Hz, 1H), 6.85 (d, *J* = 3.2 Hz, 1H), 5.09 (s, 1H), 4.00 (t, *J* = 15.8 Hz, 1H), 3.44 (s, 3H). <sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) δ 160.68, 145.75, 144.32, 140.87, 134.97, 127.25, 125.70, 124.91, 123.43, 122.39, 121.68 – 107.82(m), 50.71(t, <sup>3</sup>*J*<sub>C-F</sub> = 21.2 Hz), 40.26, 30.13. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -80.85 – -80.90 (m, 3F), -111.57 – -113.00 (m, 2F), -120.85 – -122.37 (m, 2F), -124.93 – -126.64 (m, 2F). HRMS (ESI) m/z: [M+H]<sup>+</sup> calcd for C<sub>17</sub>H<sub>12</sub>F<sub>9</sub>N<sub>2</sub>OS<sup>+</sup> 463.0527; Found 463.0521.



### 4-(2,4-dichlorophenyl)-1-methyl-3-(perfluorohexyl)-3,4-dihydro-1,5-naphthyridin-2(1H)-one

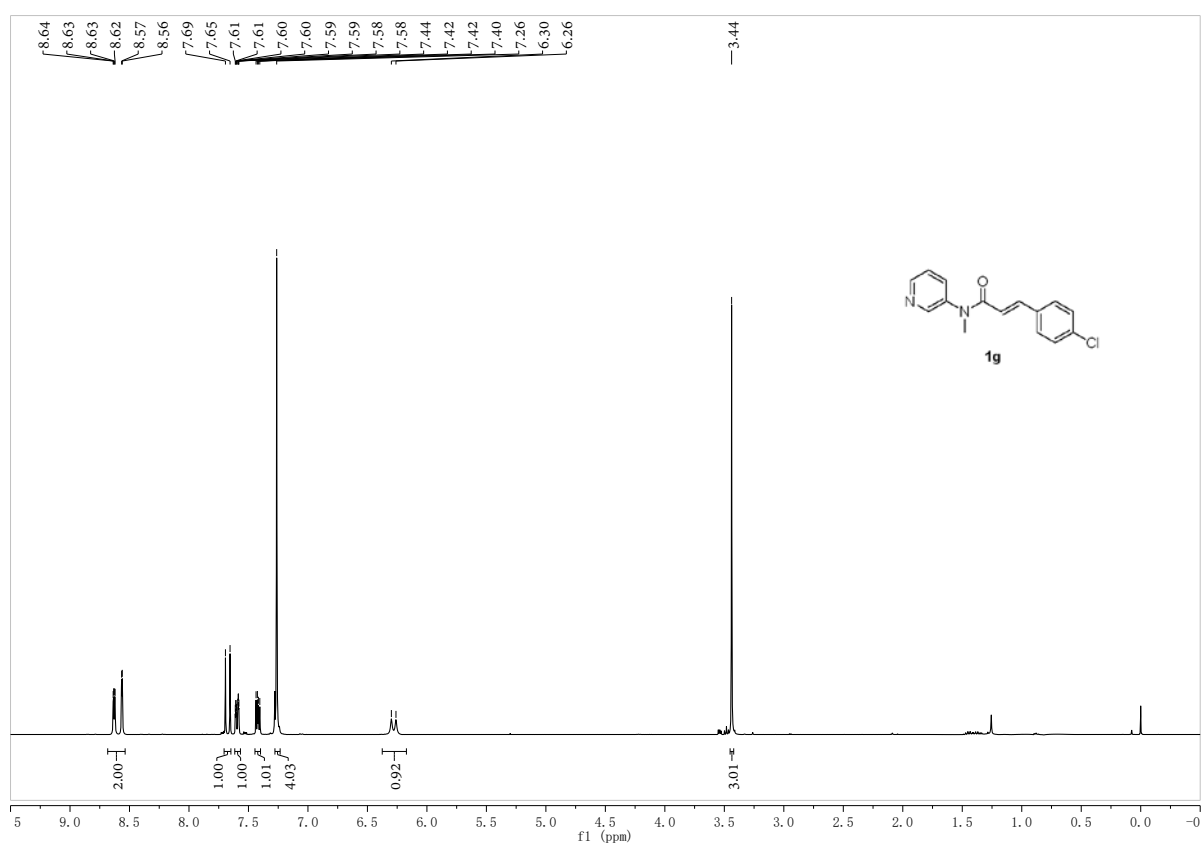
This product was purified by flash column chromatography on silica gel (Heptane/Ethyl acetate 15:1) as a colorless oil (237.5 mg, 76%). <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 8.35 (d, *J* = 3.5 Hz, 1H), 7.48 (dd, *J* = 10.1, 1.7 Hz, 2H), 7.37 (dd, *J* = 8.3, 4.7 Hz, 1H), 7.07 (dd, *J* = 8.4, 2.2 Hz, 1H), 6.35 (d, *J* = 8.4 Hz, 1H), 5.25 (s, 1H), 3.84 (dd, *J* = 20.3, 10.8 Hz, 1H), 3.46 (s, 3H). <sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) δ 160.62, 144.98, 144.90, 137.00, 134.92, 134.57, 133.77, 130.77, 129.21, 127.93, 123.85, 122.34, 120.98–108.42(m), 49.39(t, <sup>3</sup>*J*<sub>C-F</sub> = 21.4 Hz), 41.04, 30.24. <sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) δ -80.78 (t, *J* = 10.0 Hz, 3F), -111.32 – -113.51 (m,2F), -118.38 – -124.40 (m,6F), -125.19 – -126.89 (m, 2F). HRMS (ESI) m/z: [M+H]<sup>+</sup> calcd for C<sub>21</sub>H<sub>12</sub><sup>35</sup>Cl<sub>2</sub>F<sub>13</sub>N<sub>2</sub>O<sup>+</sup> 625.0114; Found 625.0193.

## 6. Reference

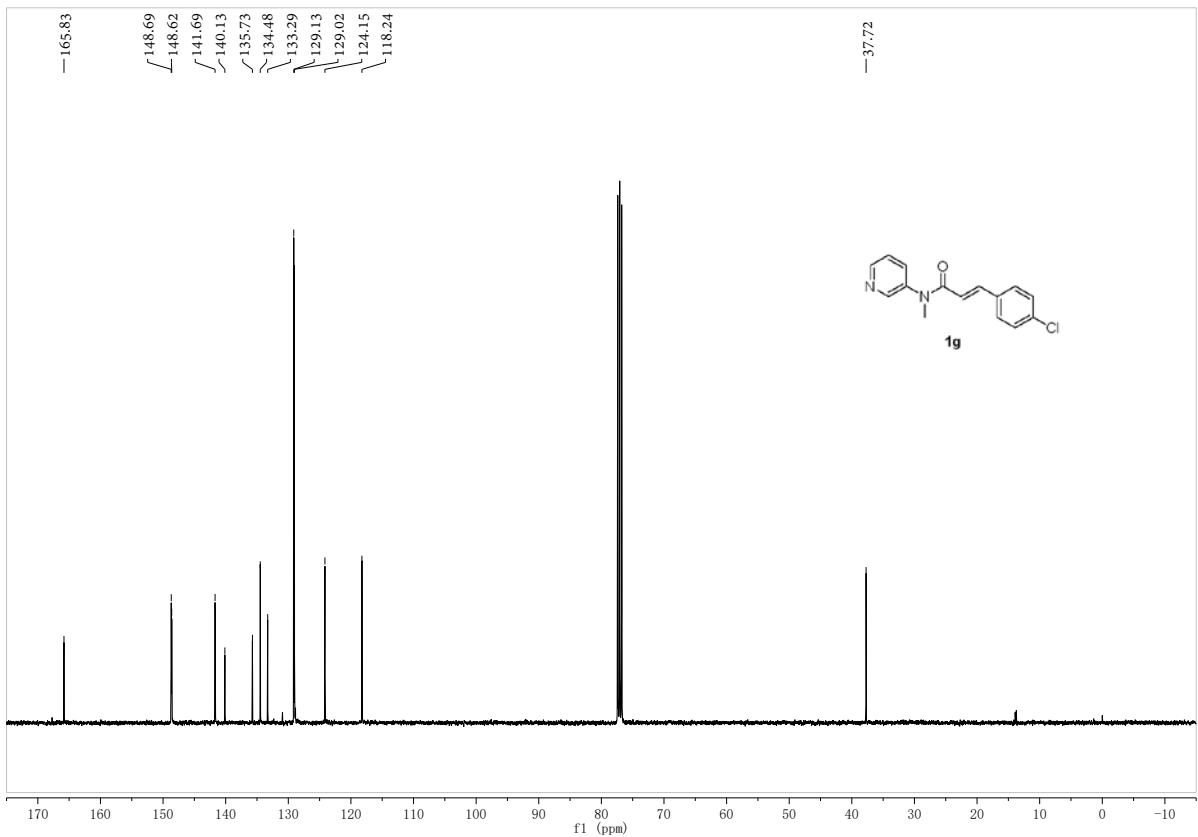
1. Cismesia, M. A.; Yoon, T. P. *Chem. Sci.* **2015**, *6*, 5426-5434.

2. Kuhn, H. J.; Braslavsky, S. E.; Schmidt, R. *Pure Appl. Chem.* **2004**, *76*, 2105-2146.
3. Demas, J. N.; Bowman, W. D.; Zalewski, E. F.; Velapoldi, R. A. *J. Chem. Phys.* **1981**, *85*, 2766-2771.
4. Zheng, L.; Huang, H.; Yang, C.; Xia, W. *Org. Lett.* **2015**, *17*, 1034-1037.
5. Hatchard, C. G.; Parker, C. A.; Bowen, E. J. *Proc. Roy. Soc. (London)* **1956**, *235*, 518-536.
6. Karplus, M. *J. Chem. Phys.* **1959**, *30*, 11-15.

## 7. Copies of NMR and HRMS spectra



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **1g**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **1g**

**Monoisotopic Mass, Even Electron Ions**

871 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

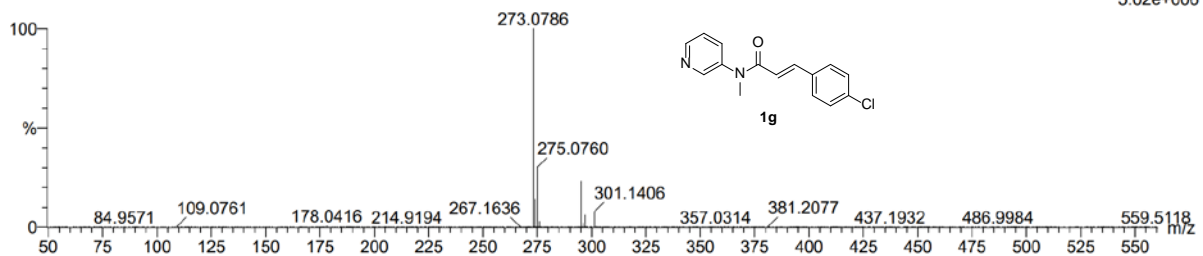
Elements Used:

C: 15-15 H: 14-14 N: 0-200 O: 0-100 Na: 0-2 Cl: 1-4

8

231125-5-1211 14 (0.153)

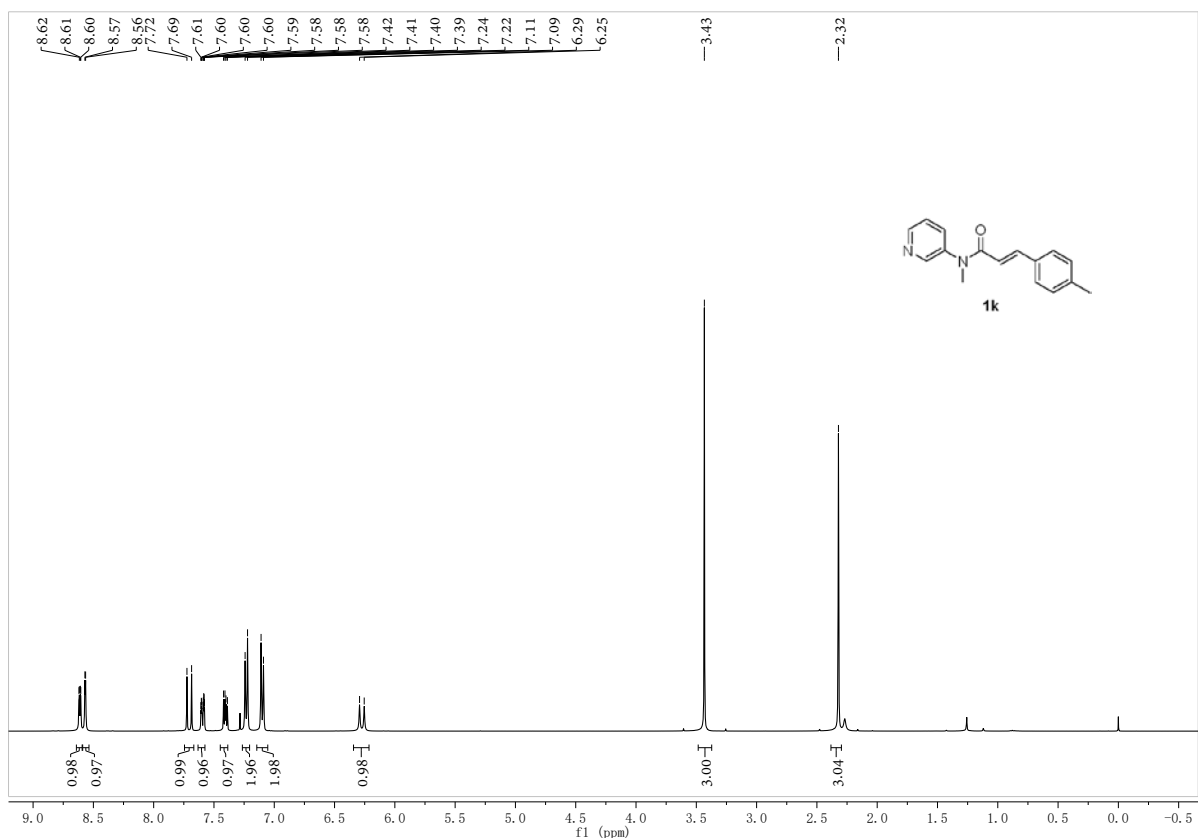
1: TOF MS ES+  
5.02e+006



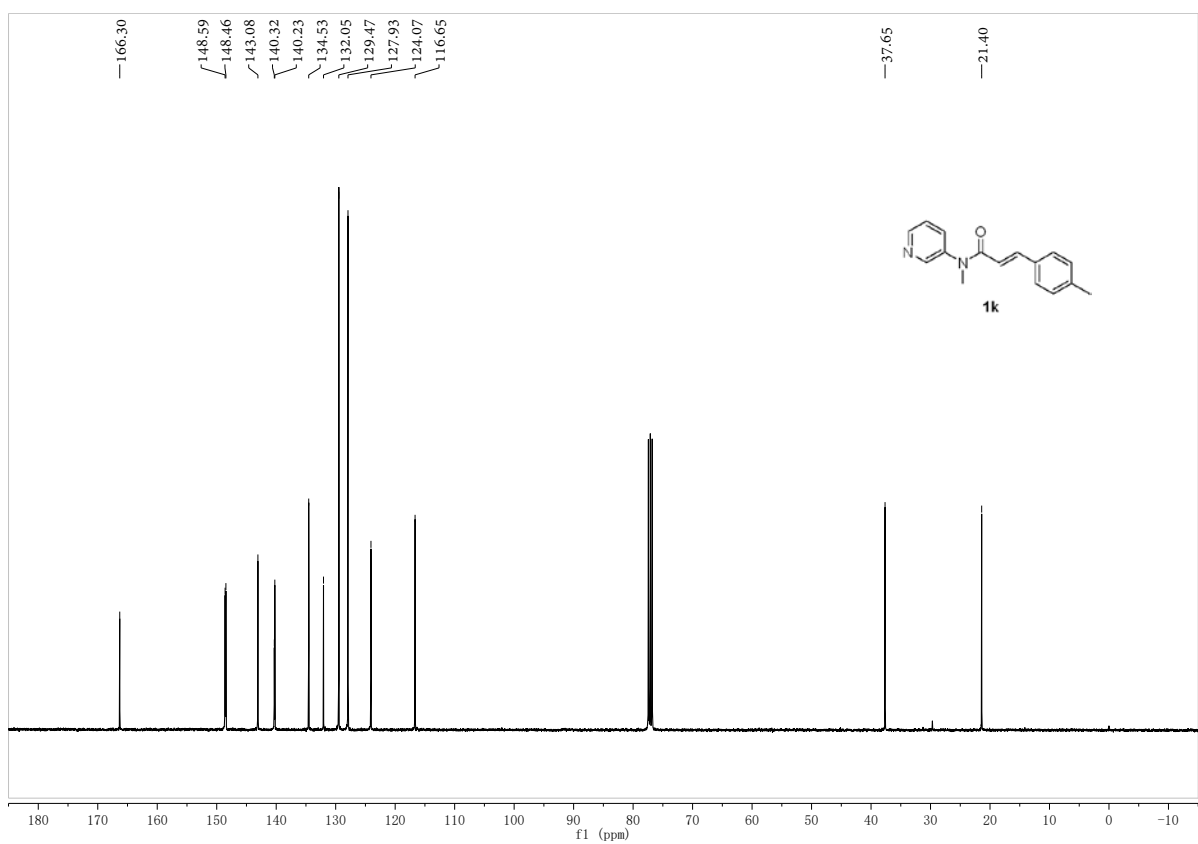
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|-----|-------|------|----------|-----------------|
| 273.0786 | 273.0795   | -0.9 | -3.3 | 9.5 | 231.2 | n/a  | n/a      | C15 H14 N2 O Cl |

HRMS (ESI) spectrum of **1g**



**<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **1k****



**<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **1k****

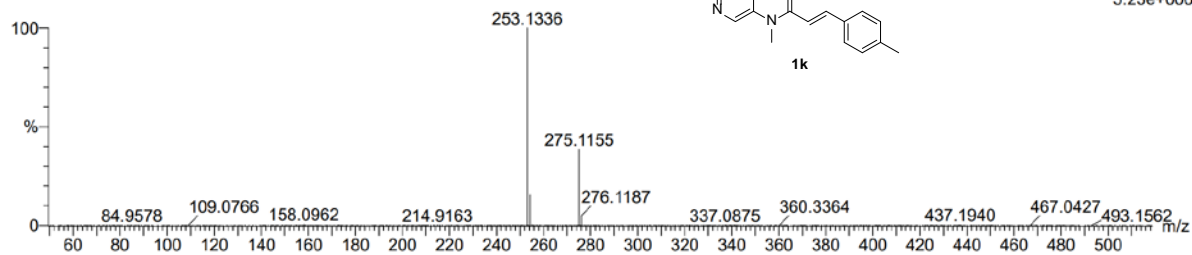
Monoisotopic Mass, Even Electron Ions  
381 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
Elements Used:

C: 16-16 H: 17-17 N: 0-200 O: 0-100 Na: 0-2

8

231125-5-1315 14 (0.153)

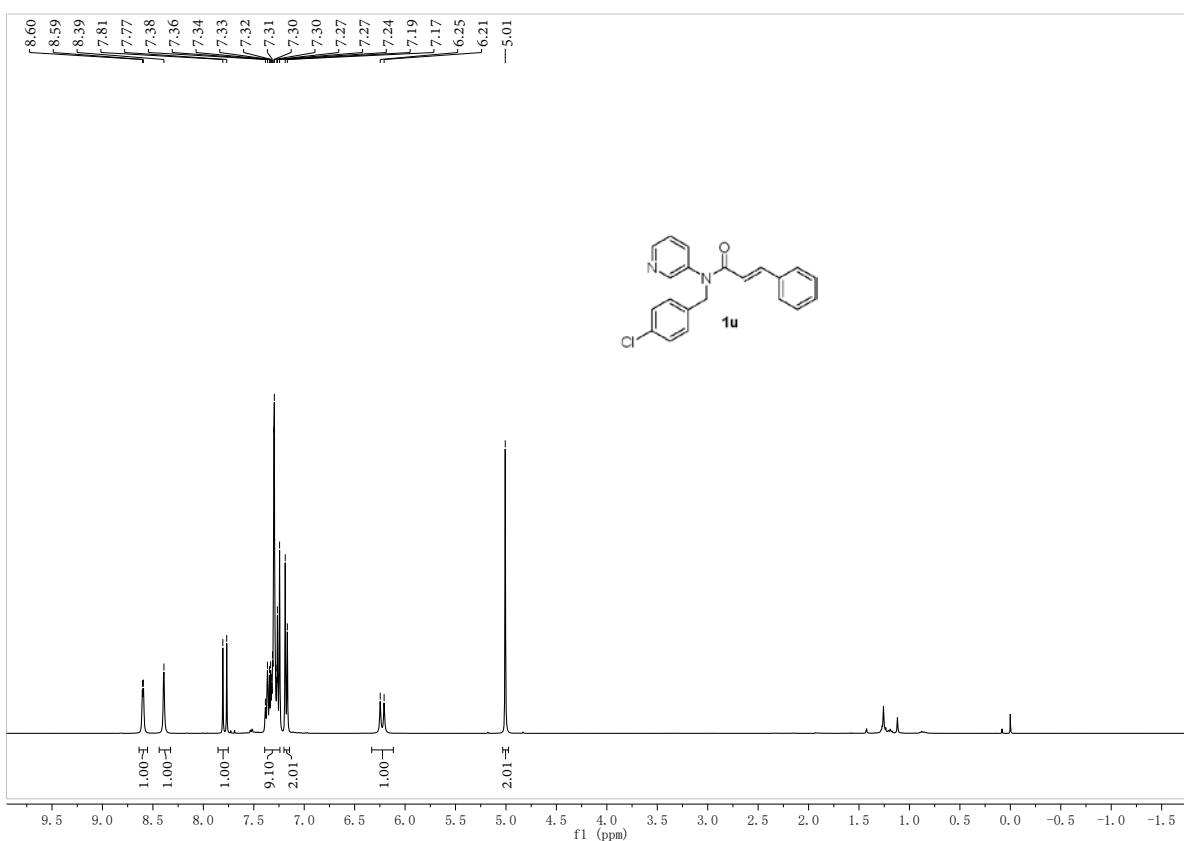
1: TOF MS ES+  
5.23e+006



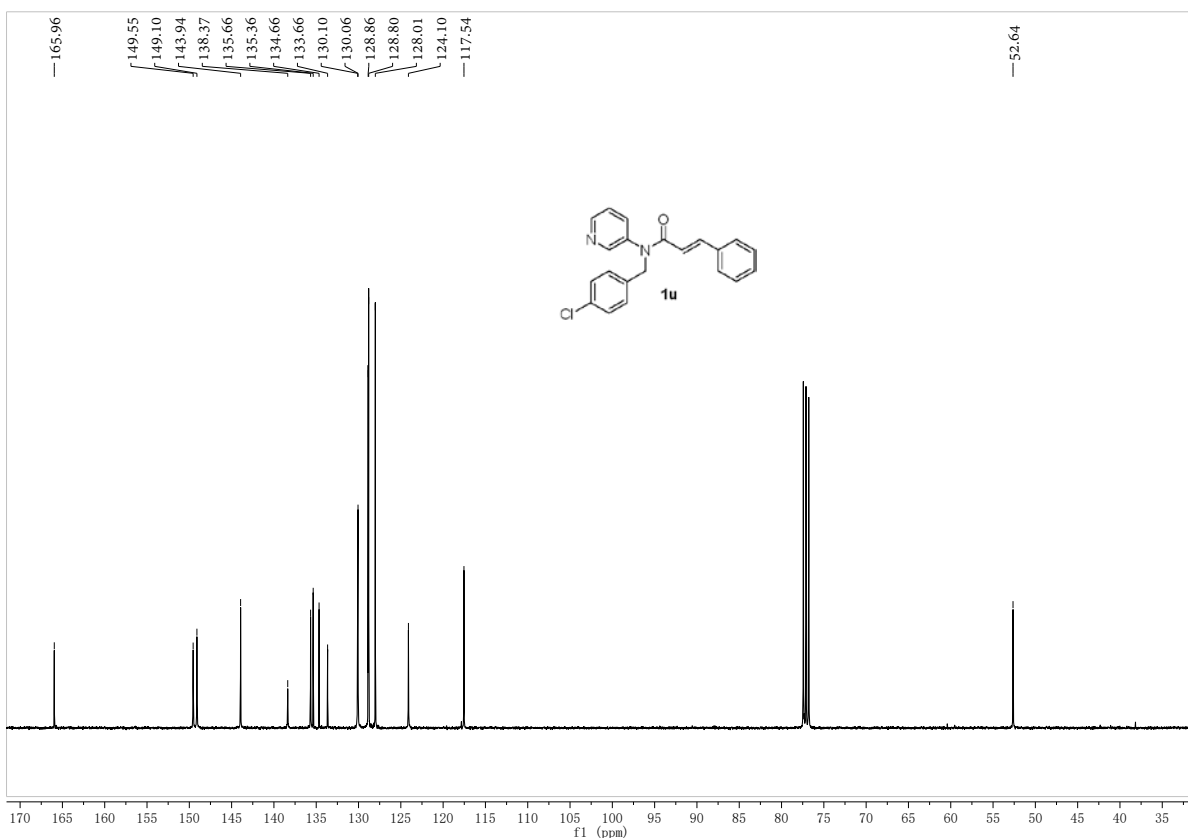
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf(%) | Formula      |
|----------|------------|------|------|-----|-------|------|---------|--------------|
| 253.1336 | 253.1341   | -0.5 | -2.0 | 9.5 | 185.3 | n/a  | n/a     | C16 H17 N2 O |

HRMS (ESI) spectrum of **1k**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **1u**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **1u**

Monoisotopic Mass, Even Electron Ions

1746 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

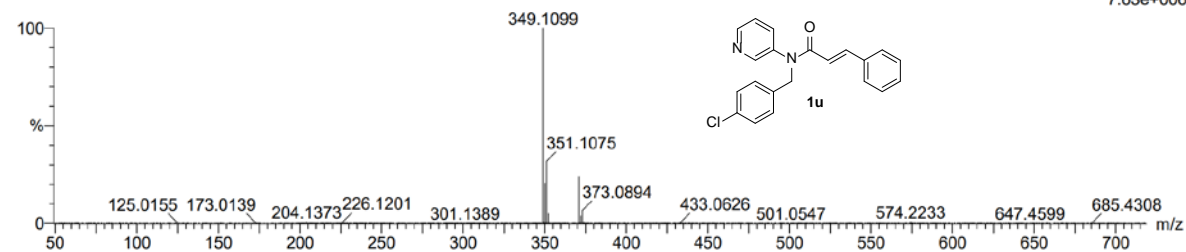
Elements Used:

C: 21-21 H: 18-18 N: 0-200 O: 0-100 Na: 0-2 Cl: 1-4

8

231125-5-1277 14 (0.153)

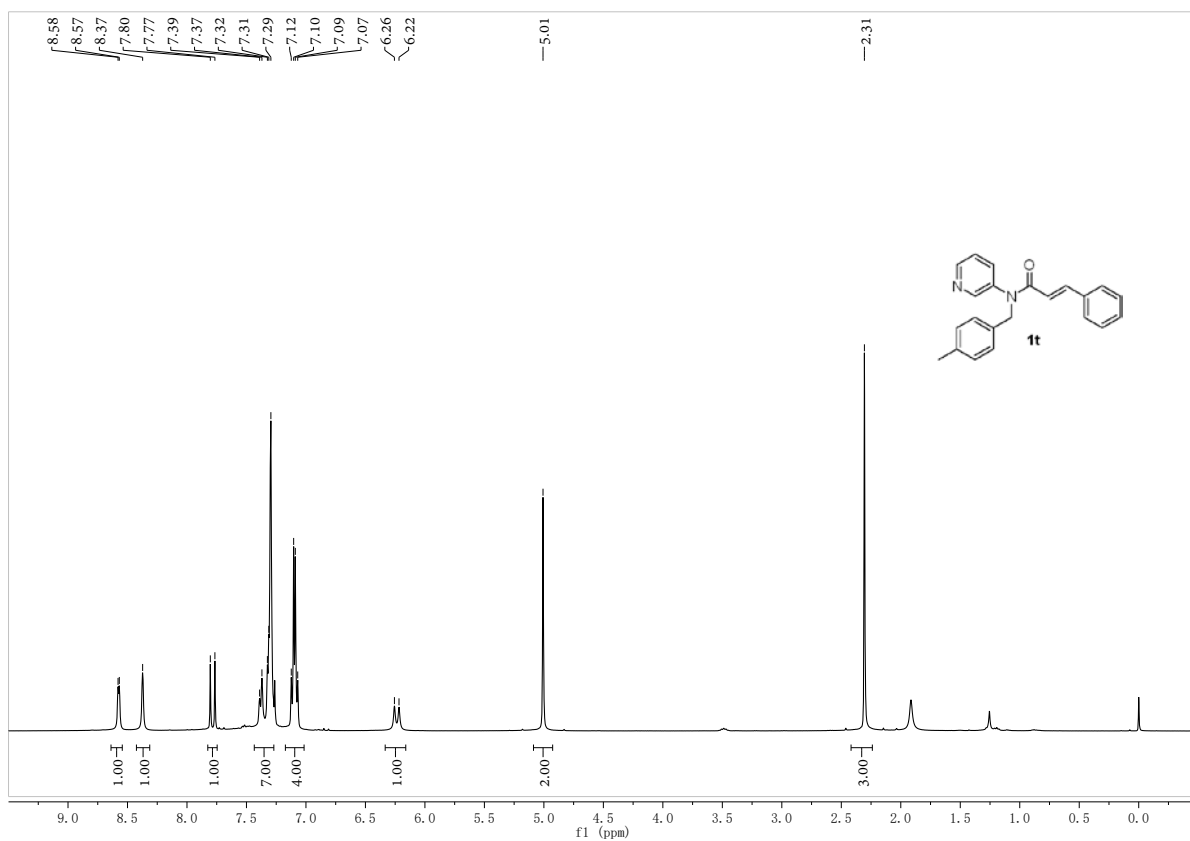
1: TOF MS ES+  
7.63e+006



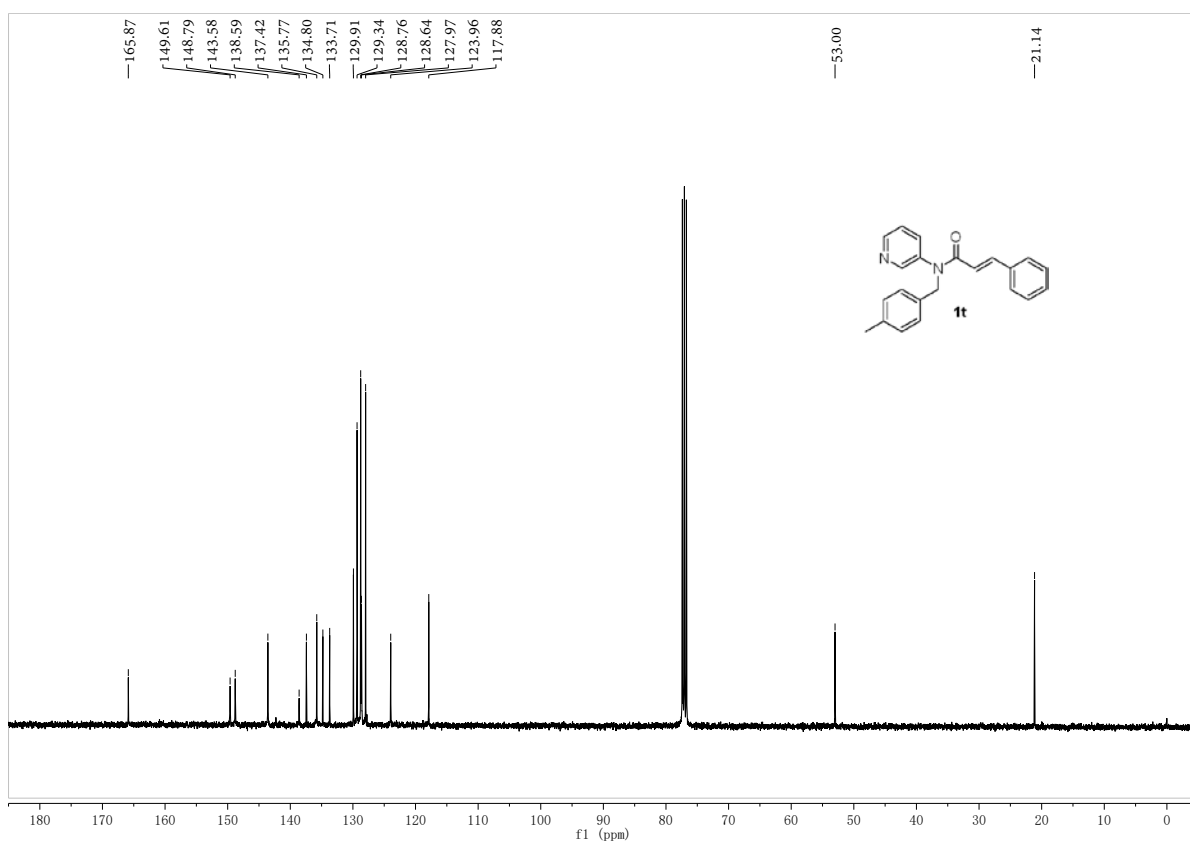
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE  | i-FIT | Norm | Conf (%) | Formula   |
|----------|------------|------|------|------|-------|------|----------|---|
| 349.1099 | 349.1108   | -0.9 | -2.6 | 13.5 | 217.8 | n/a  | n/a      | C <sub>21</sub> H <sub>18</sub> N <sub>2</sub> O Cl |

HRMS (ESI) spectrum of **1u**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **1t**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **1t**

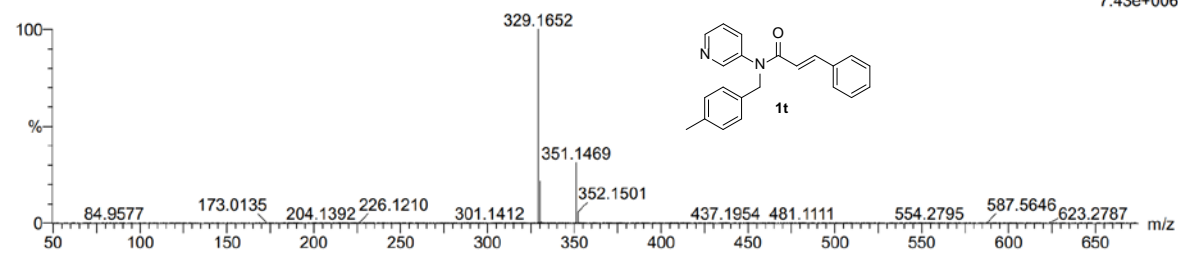
Monoisotopic Mass, Even Electron Ions  
665 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
Elements Used:

C: 22-22 H: 21-21 N: 0-200 O: 0-100 Na: 0-2

8

231125-5-1278 12 (0.136)

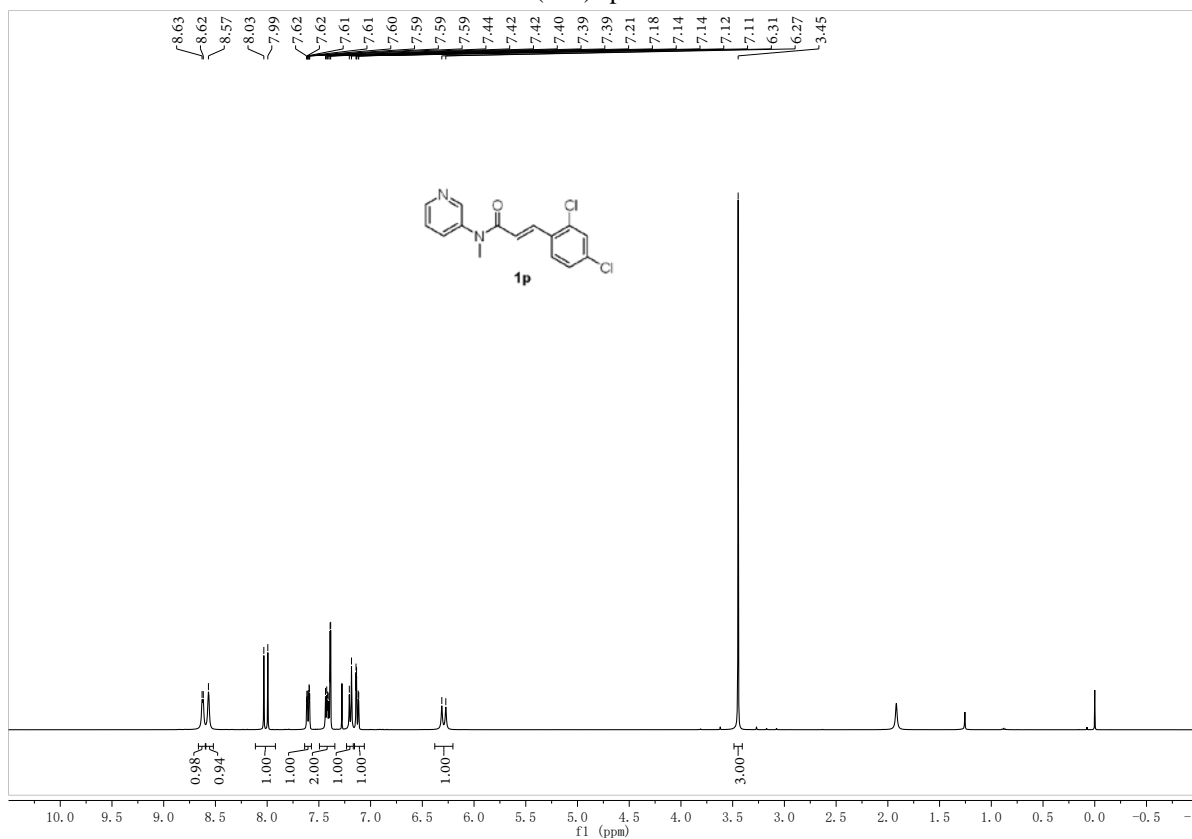
1: TOF MS ES+  
7.43e+006



Minimum: -1.5  
Maximum: 50.0

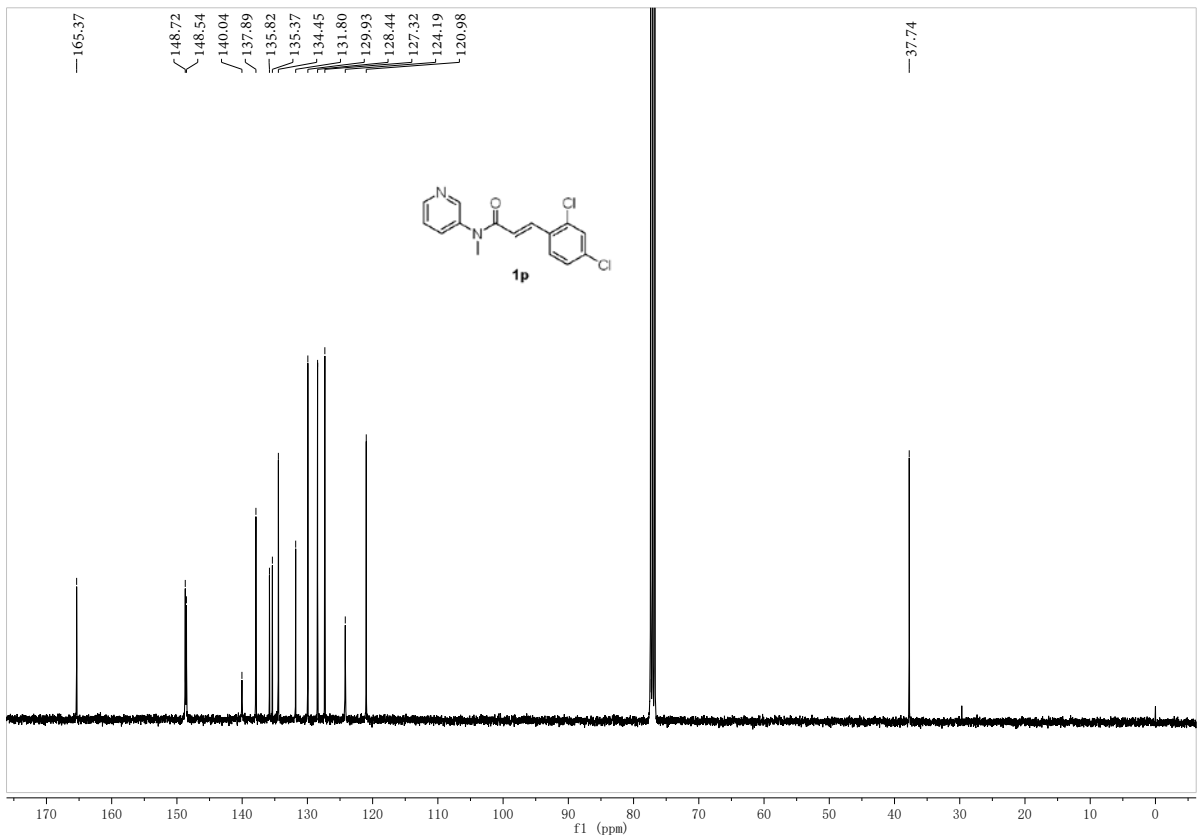
| Mass     | Calc. Mass | mDa  | PPM  | DBE  | i-FIT | Norm | Conf(%) | Formula      |
|----------|------------|------|------|------|-------|------|---------|--------------|
| 329.1652 | 329.1654   | -0.2 | -0.6 | 13.5 | 231.2 | n/a  | n/a     | C22 H21 N2 O |

### HRMS (ESI) spectrum of **1t**



### <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **1p**





<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **1p**

Monoisotopic Mass, Even Electron Ions

1181 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

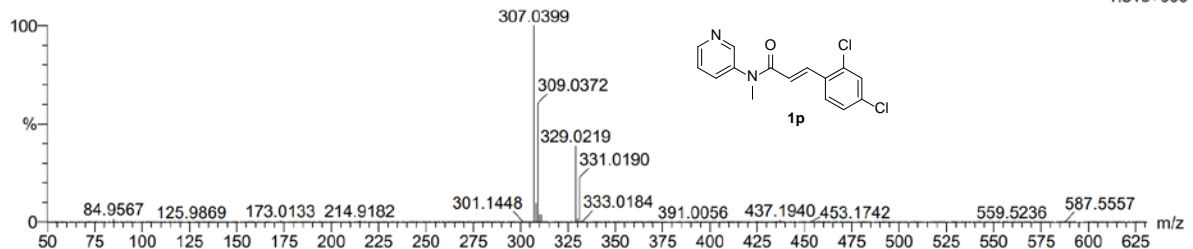
Elements Used:

C: 15-15 H: 13-13 N: 0-200 O: 0-100 Na: 0-2 Cl: 1-4

8

231125-5-1330 14 (0.153)

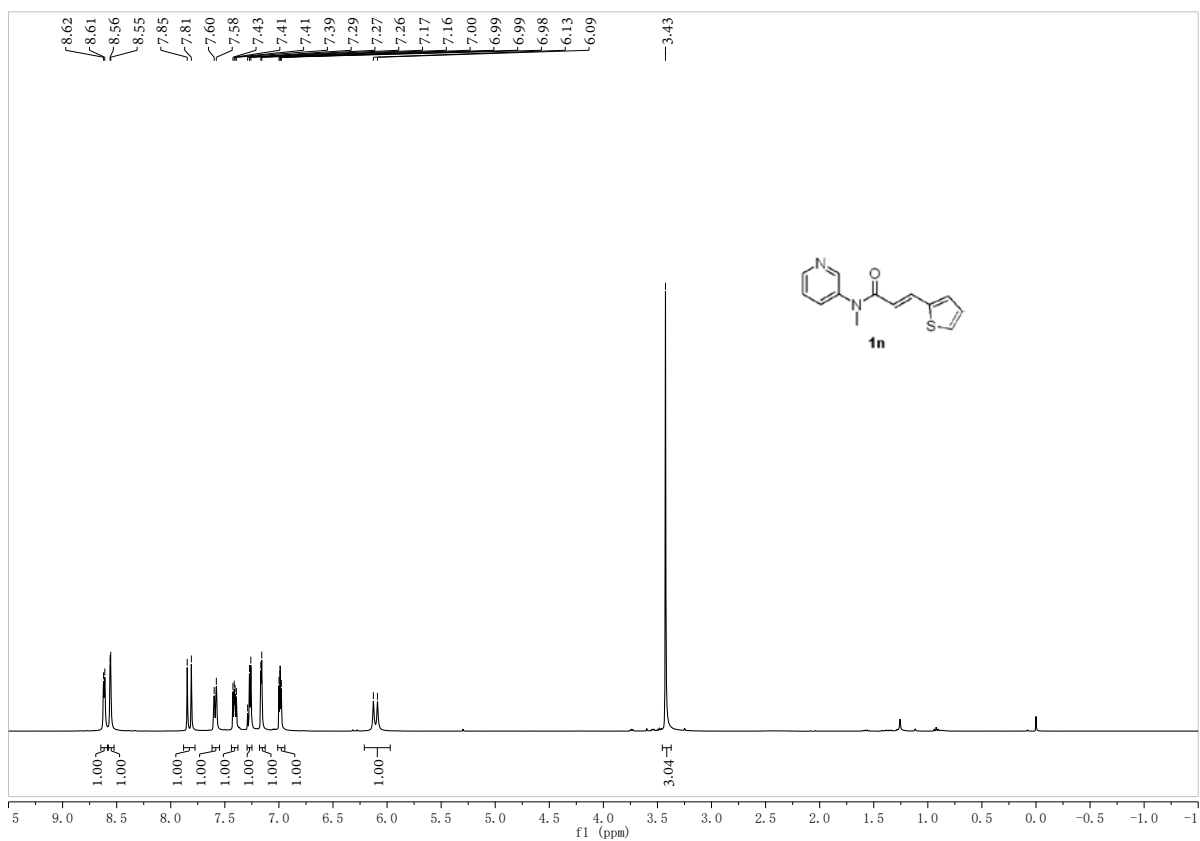
1: TOF MS ES+  
1.51e+006



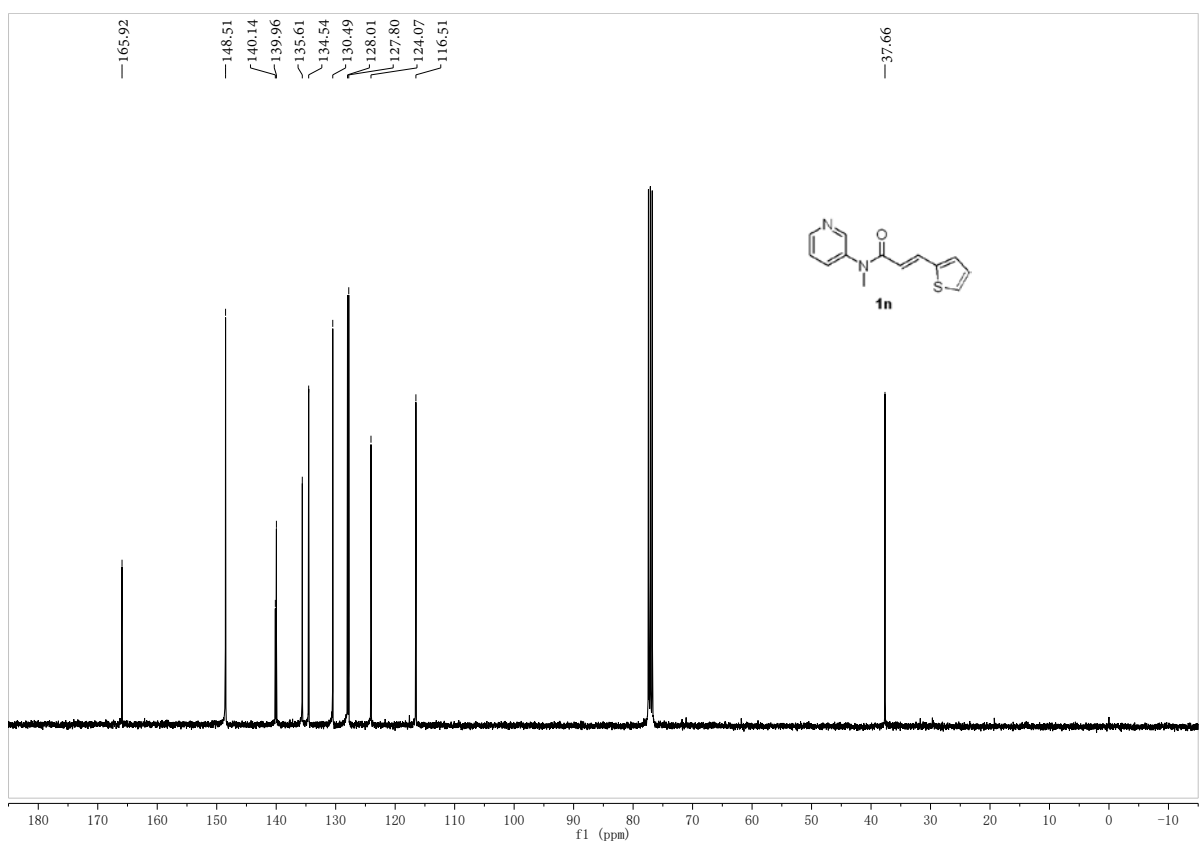
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf(%) | Formula          |
|----------|------------|------|------|-----|-------|------|---------|------------------|
| 307.0399 | 307.0405   | -0.6 | -2.0 | 9.5 | 166.8 | n/a  | n/a     | C15 H13 N2 O Cl2 |

HRMS (ESI) spectrum of **1p**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **1n**



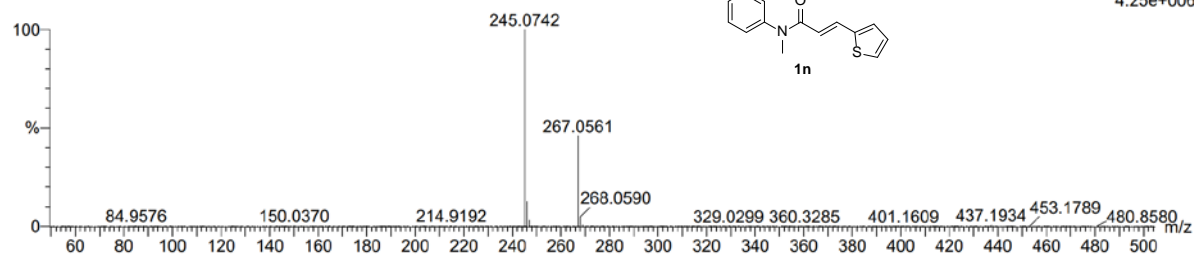
<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **1n**

Monoisotopic Mass, Even Electron Ions  
 596 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:

C: 13-13 H: 13-13 N: 0-200 O: 0-100 Na: 0-2 S: 1-3

8

231125-5-1345 14 (0.153)

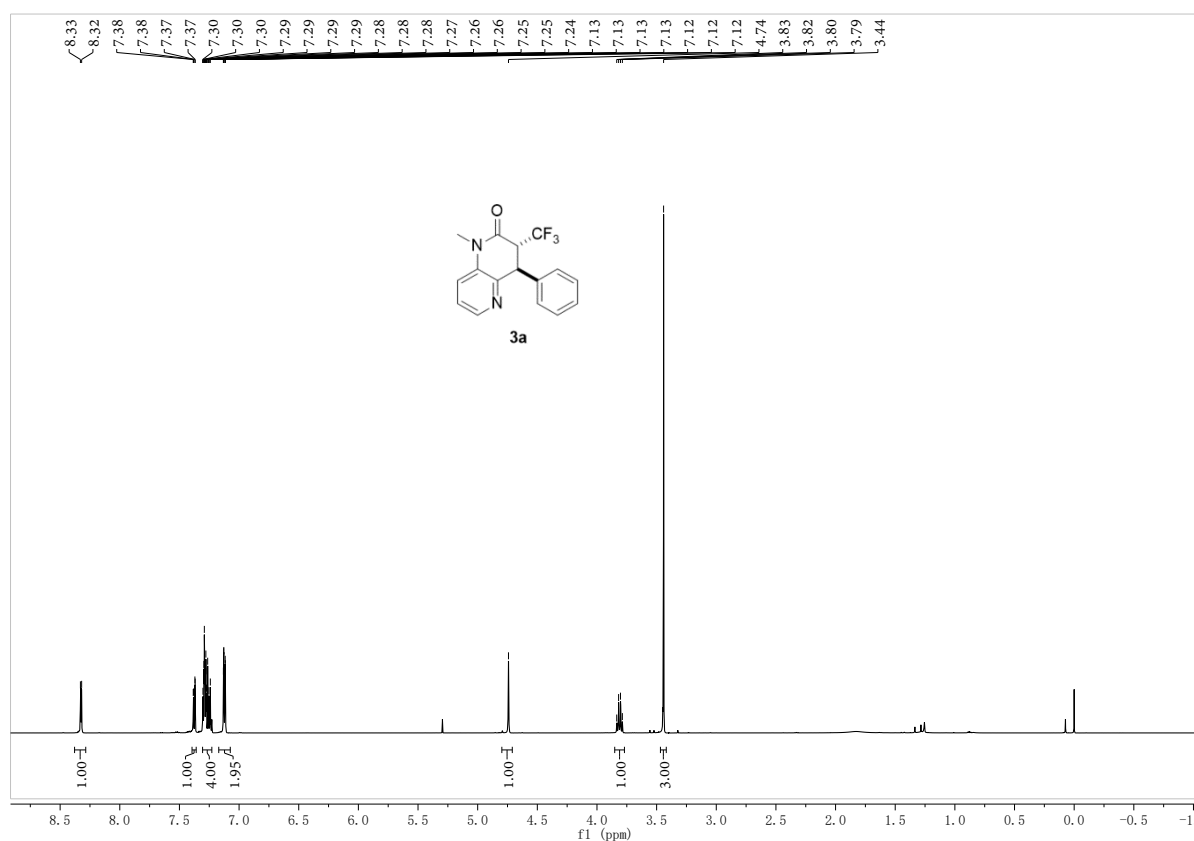


1: TOF MS ES+  
 4.25e+006

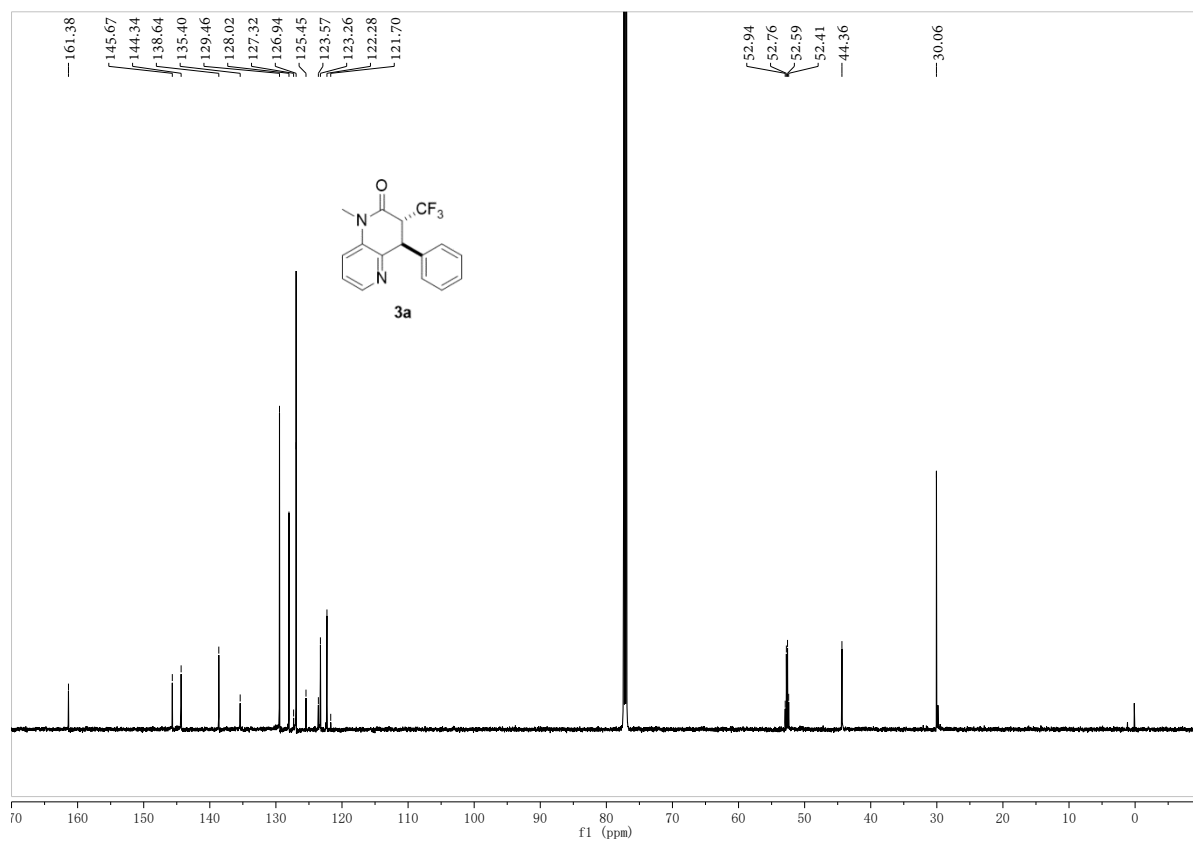
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula        |
|----------|------------|------|------|-----|-------|------|----------|----------------|
| 245.0742 | 245.0749   | -0.7 | -2.9 | 8.5 | 124.1 | n/a  | n/a      | C13 H13 N2 O S |

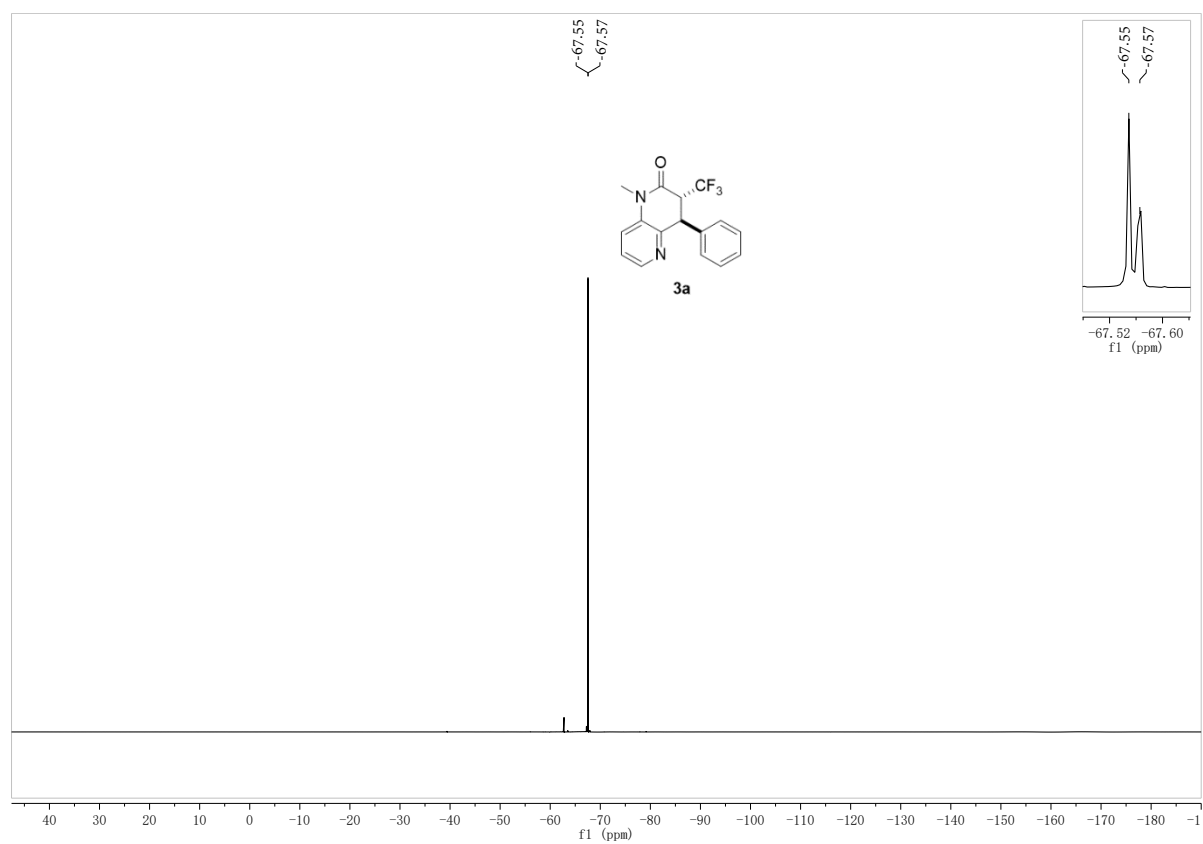
HRMS (ESI) spectrum of **1n**



<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) spectrum of **3a**



<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3a**



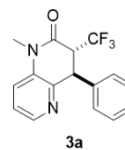
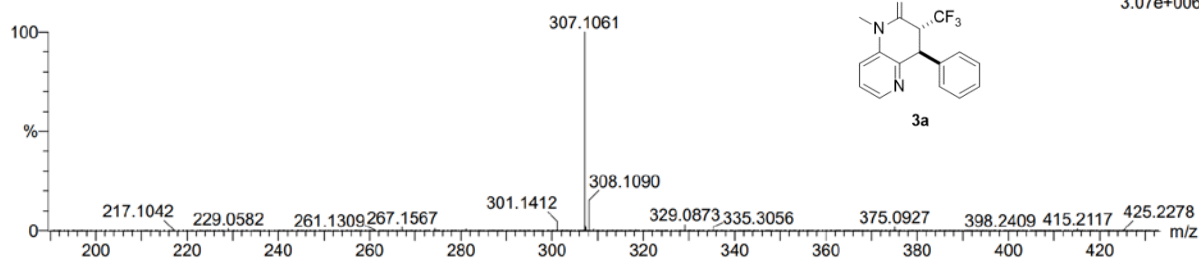
<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3a**

Monoisotopic Mass, Even Electron Ions  
 144 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:

C: 16-16 H: 14-14 N: 0-200 O: 0-200 F: 3-3

21

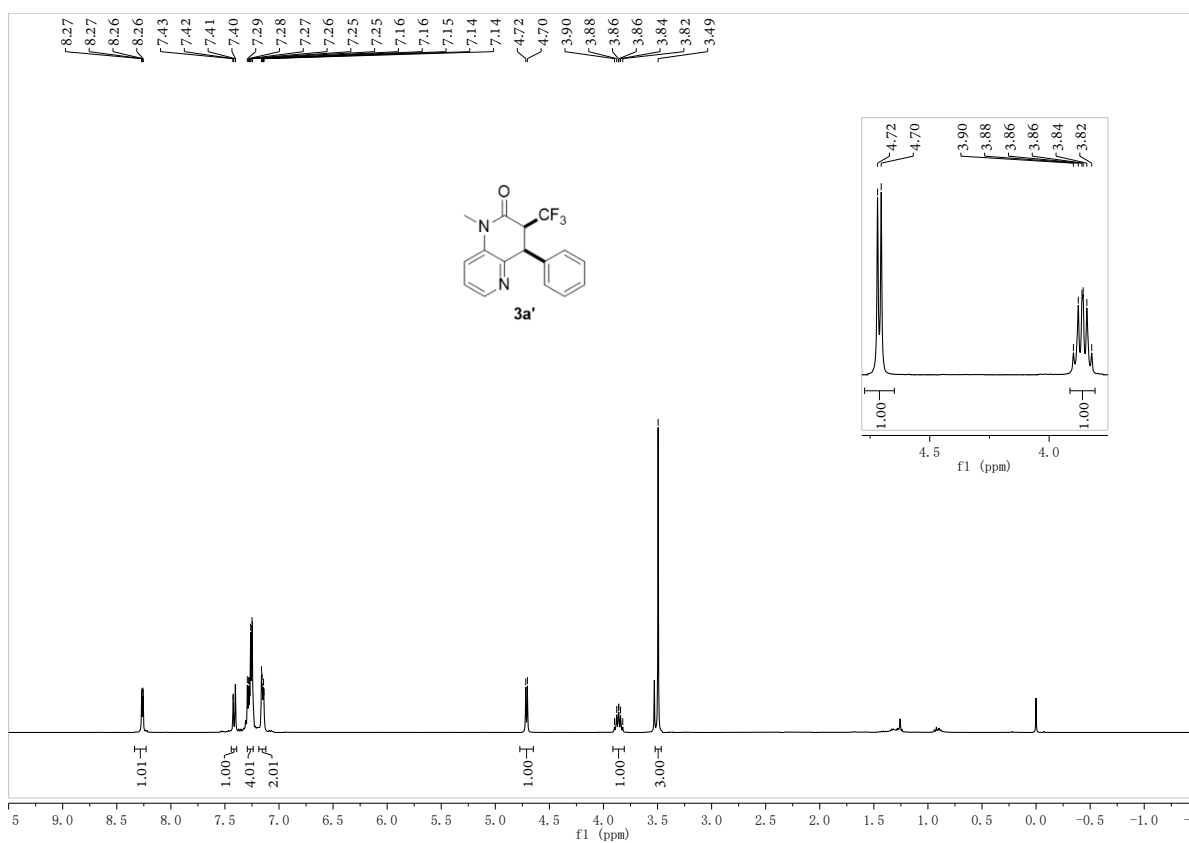
231028-13-weizhi 6 (0.088)



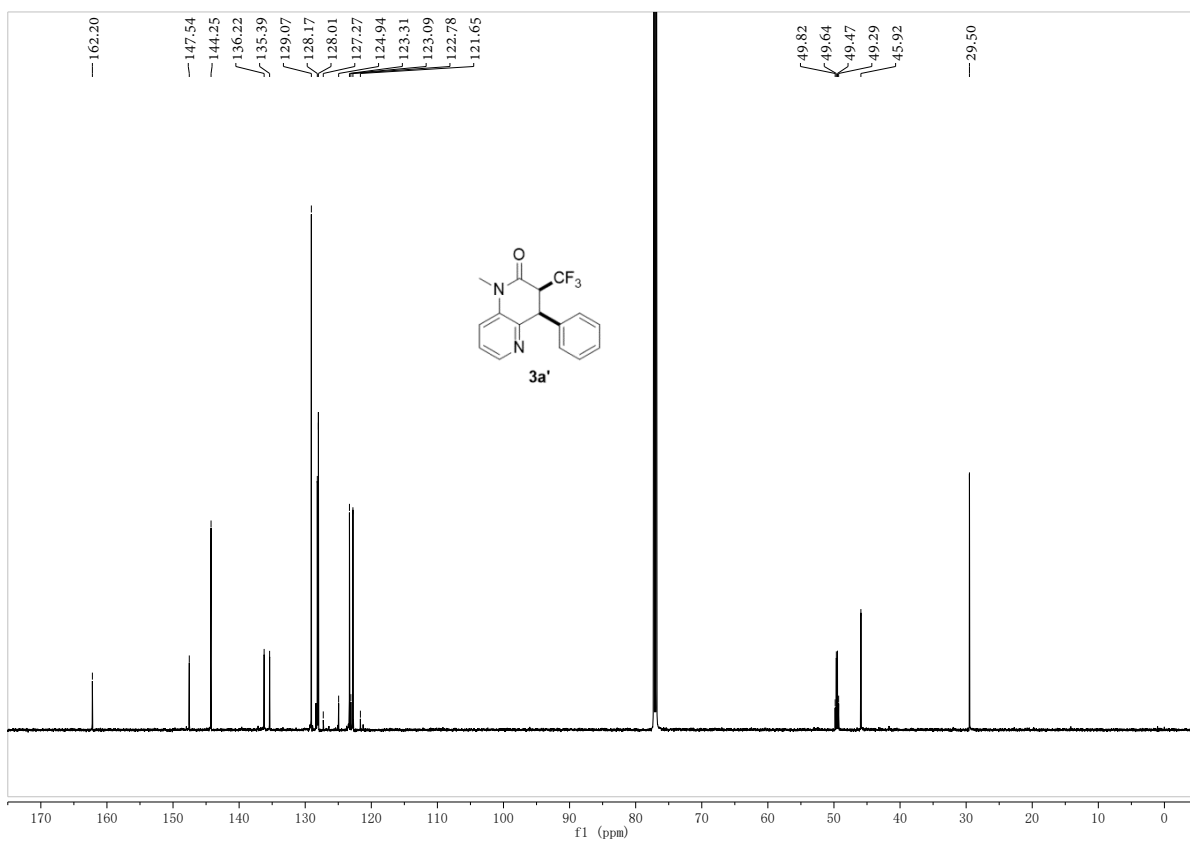
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|-----|-----|-----|-------|------|----------|-----------------|
| 307.1061 | 307.1058   | 0.3 | 1.0 | 9.5 | 404.8 | n/a  | n/a      | C16 H14 N2 O F3 |

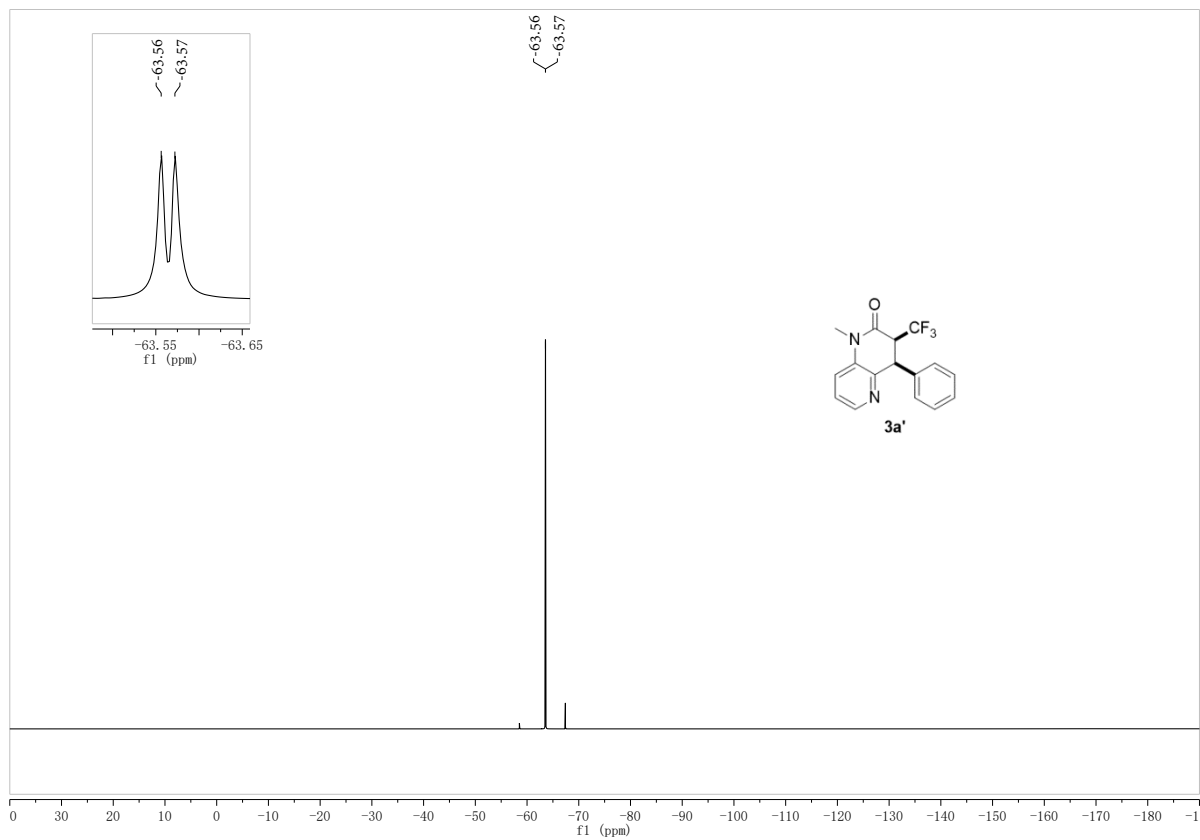
HRMS (ESI) spectrum of **3a**



<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) spectrum of **3a'**



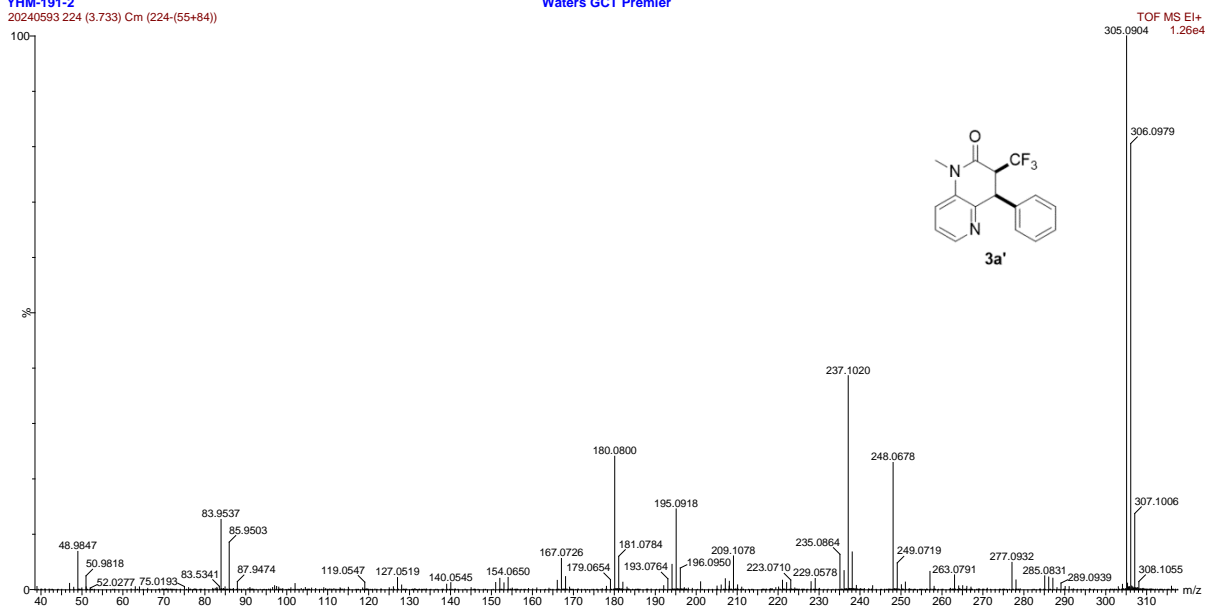
<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3a'**



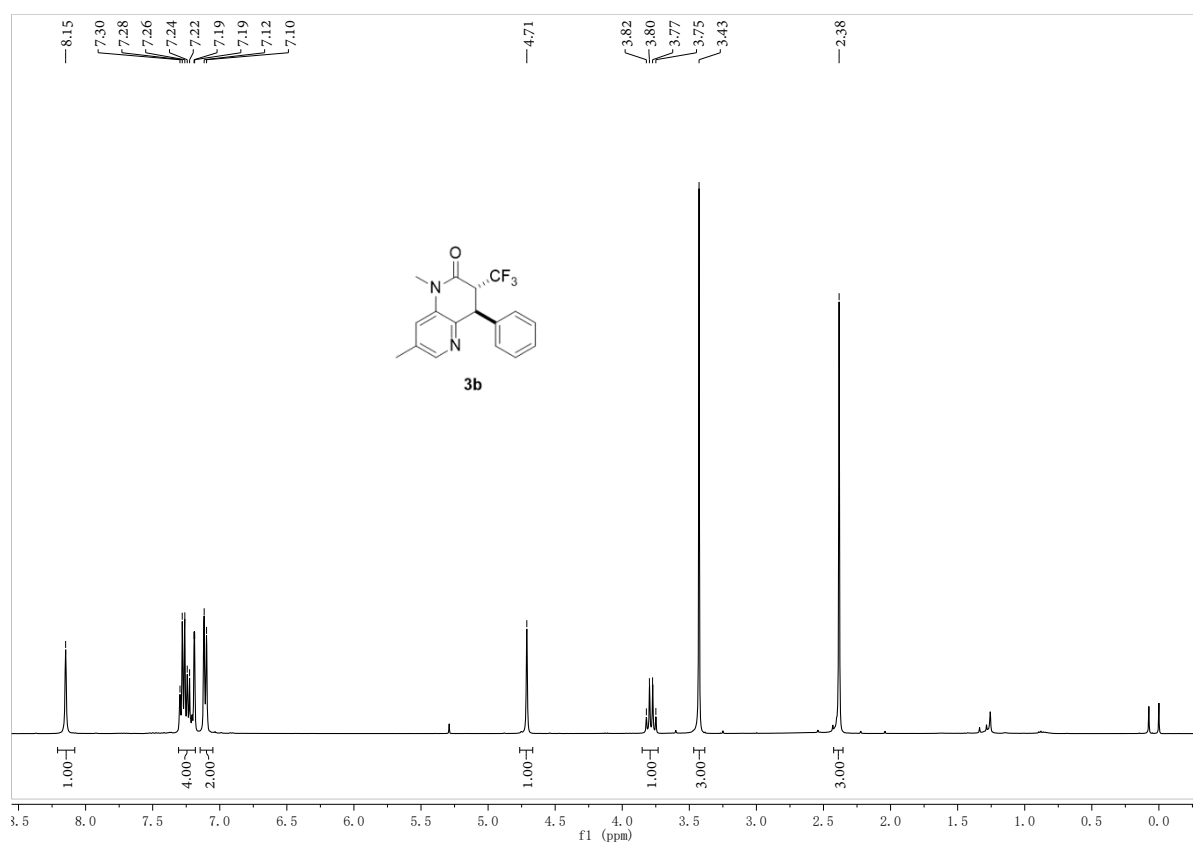
<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3a'**

YHM-191-2  
20240593 224 (3.733) Cm (224-(55+84))

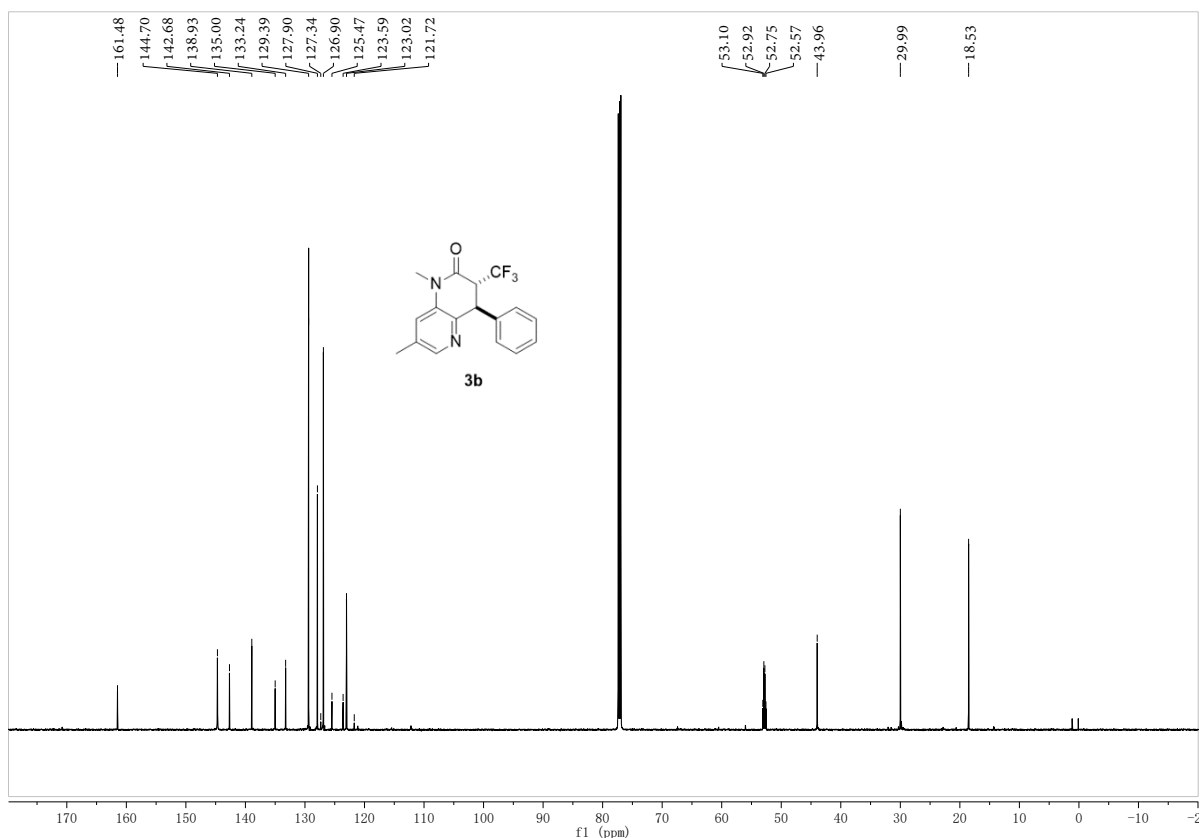
Waters GCT Premier



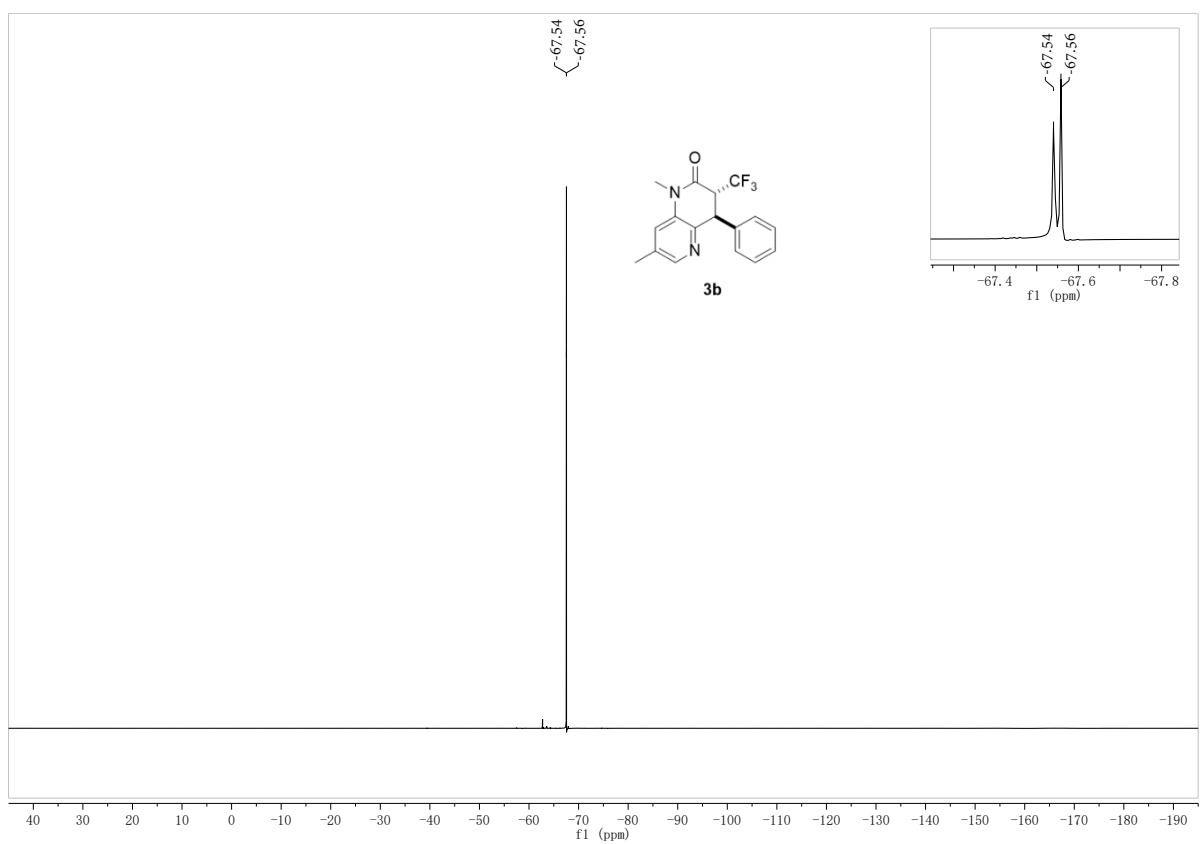
HRMS (ESI) spectrum of **3a'**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3b**



<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3b**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) of **3b**



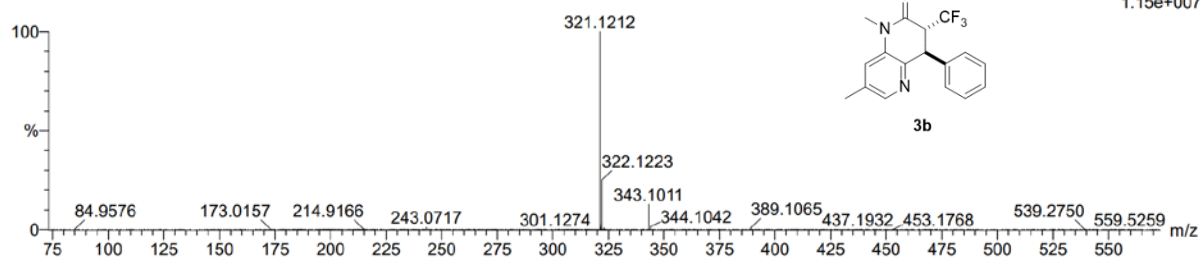
Monoisotopic Mass, Even Electron Ions  
420 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 17-17 H: 16-16 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

4

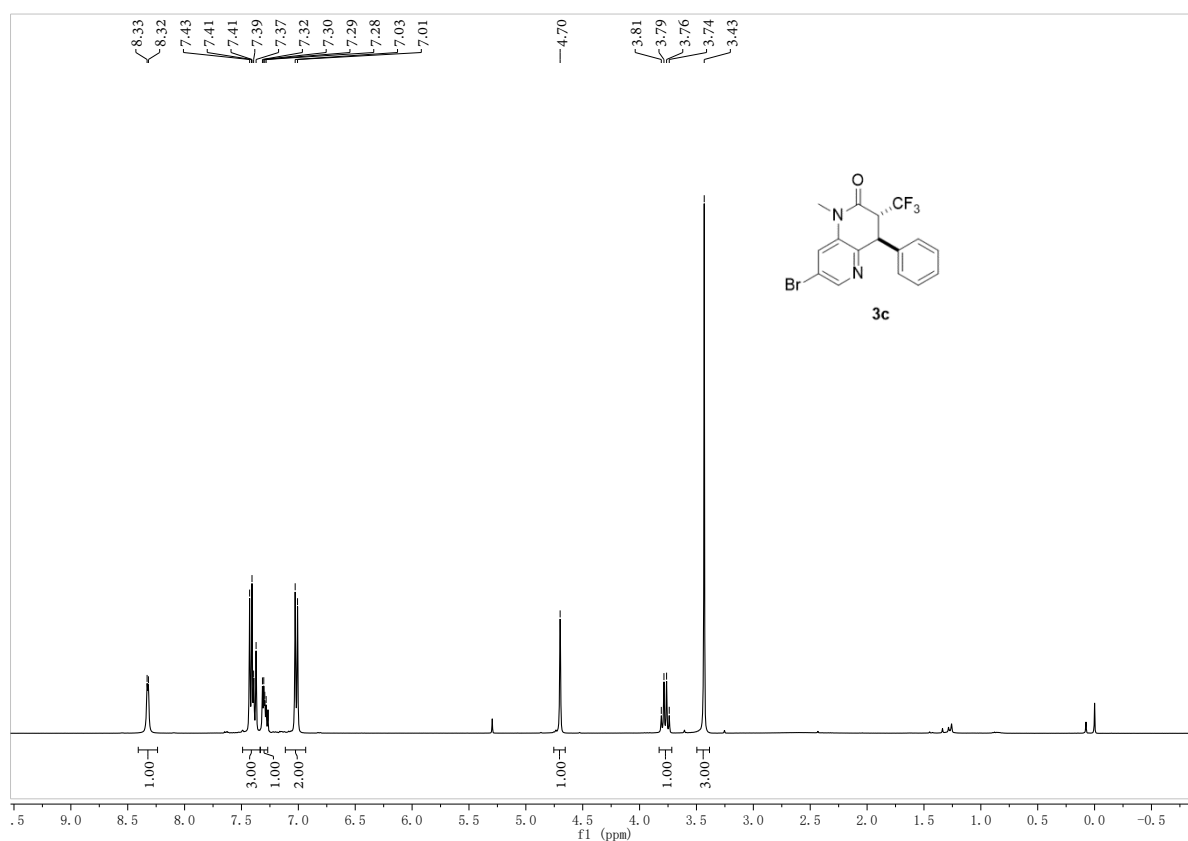
231125-5-215 15 (0.162)



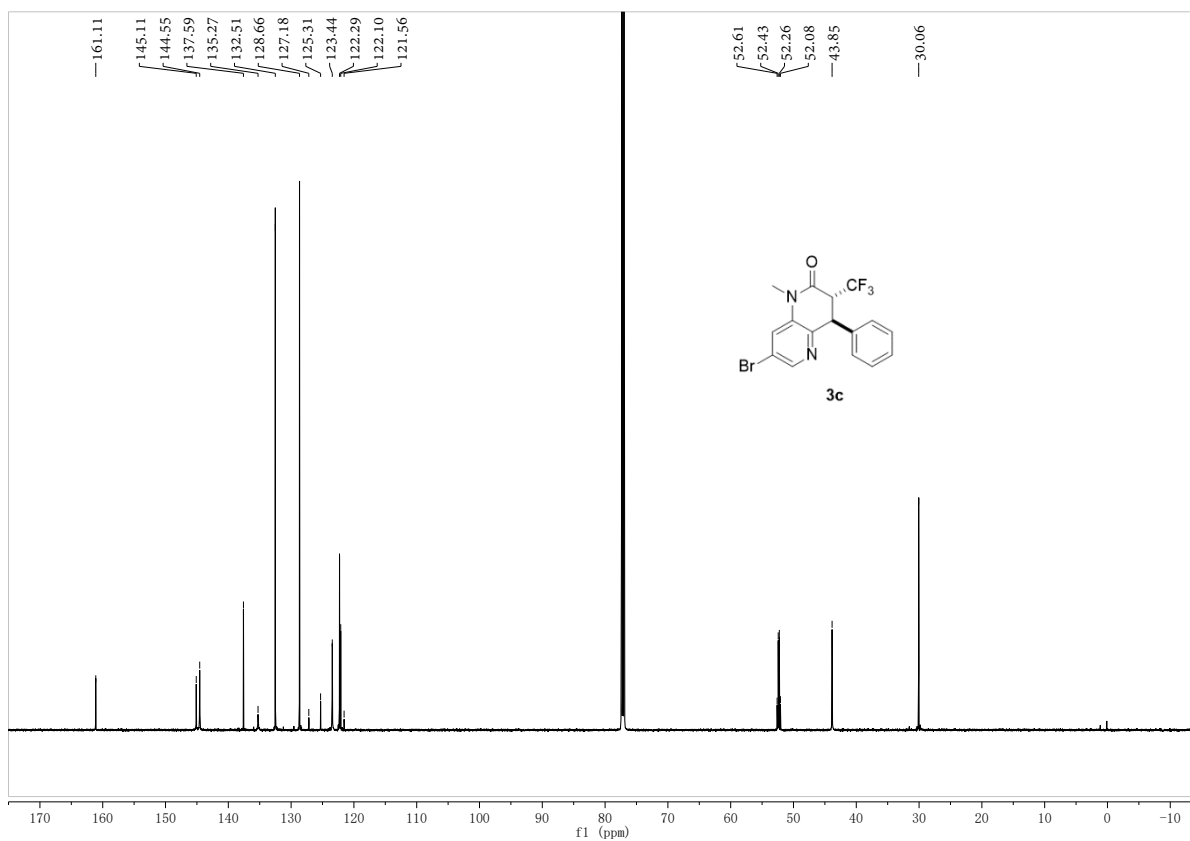
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|-----|-------|------|----------|-----------------|
| 321.1212 | 321.1215   | -0.3 | -0.9 | 9.5 | 411.4 | n/a  | n/a      | C17 H16 N2 O F3 |

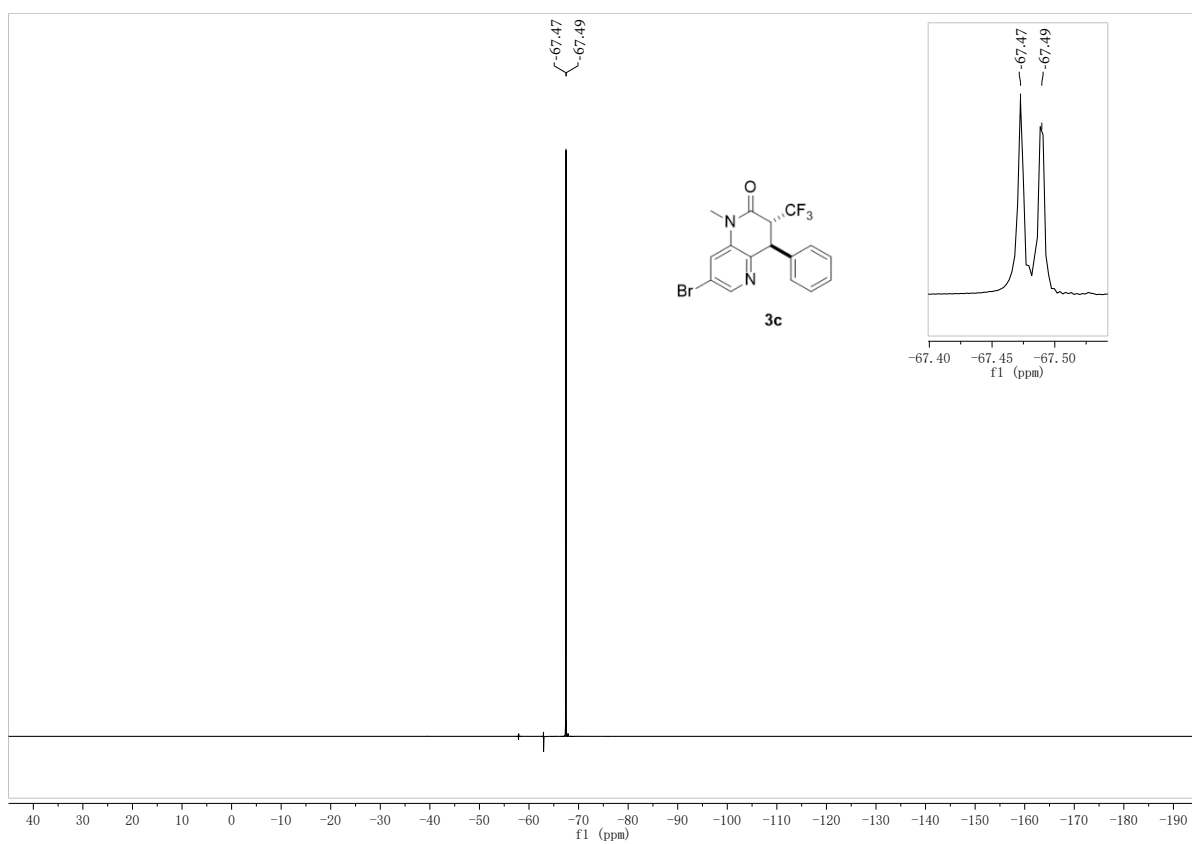
HRMS (ESI) spectrum of **3b**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3c**



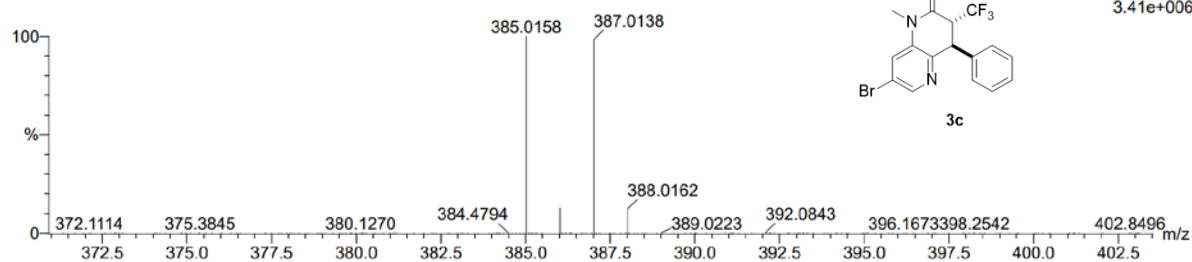
<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3c**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) of **3c**

Monoisotopic Mass, Even Electron Ions  
 598 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 16-216 H: 13-13 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Br: 1-3

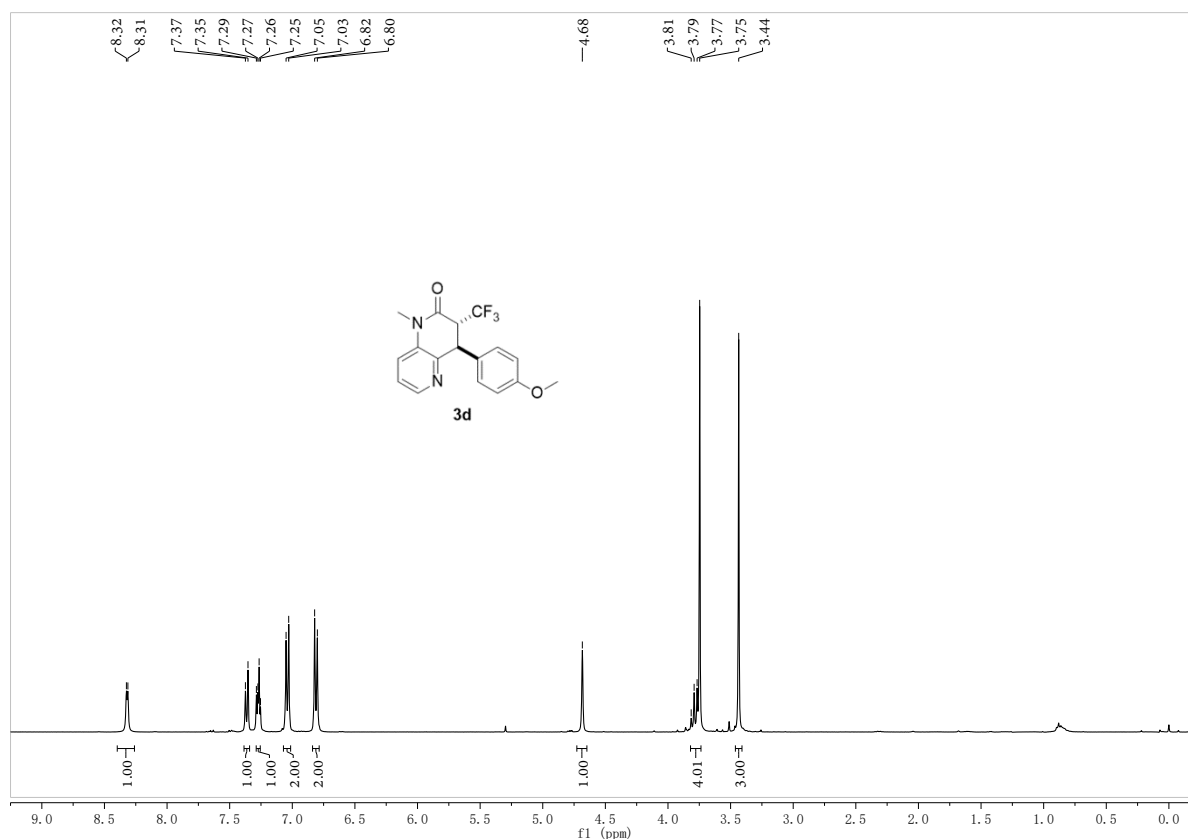
4  
 231125-5-212 15 (0.162)

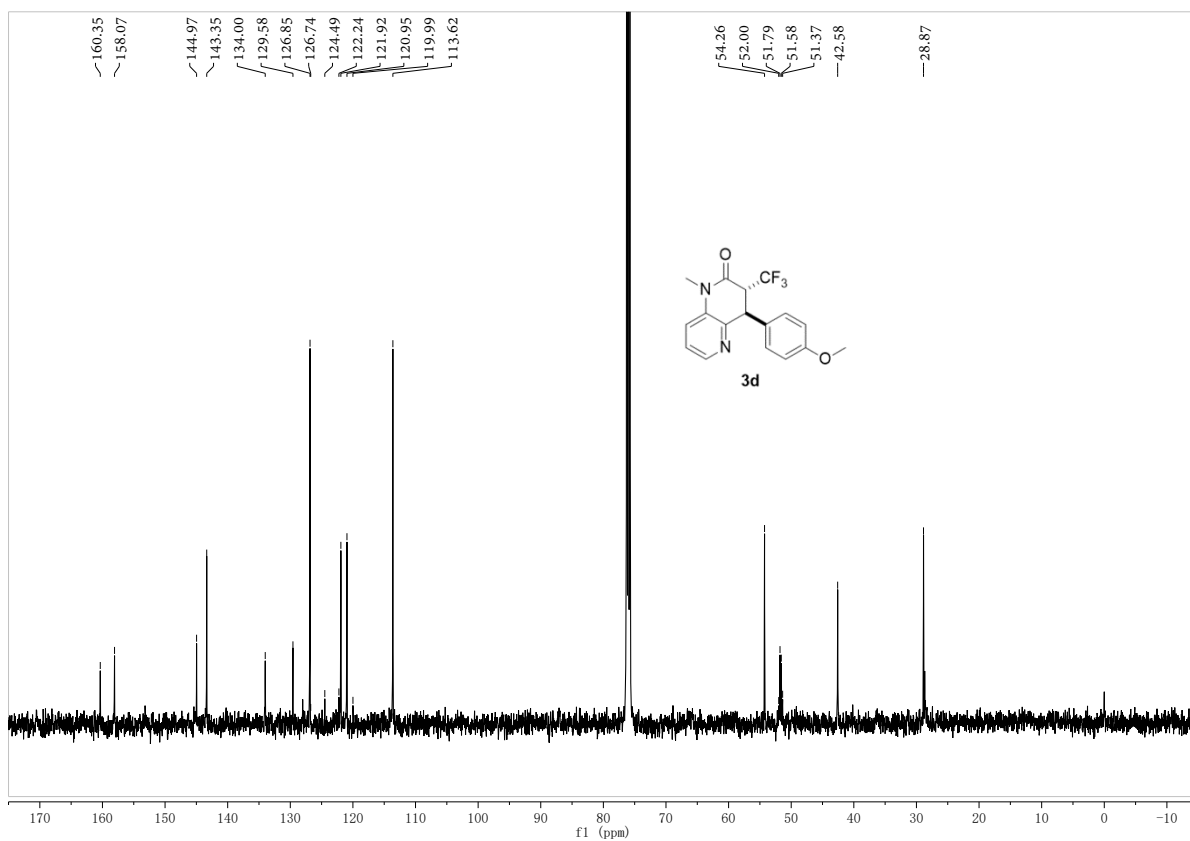


Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

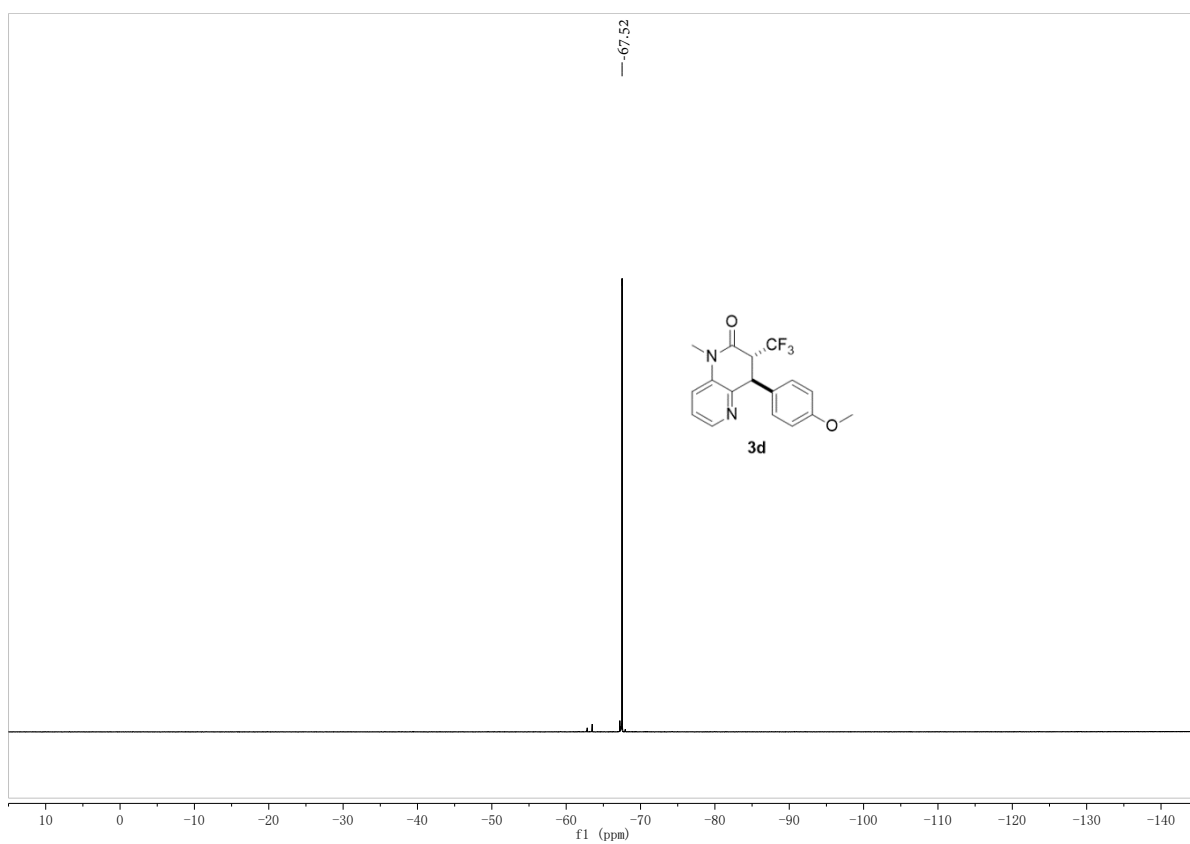
| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|------|------|-----|-------|------|----------|--------------------|
| 385.0158 | 385.0163   | -0.5 | -1.3 | 9.5 | 195.3 | n/a  | n/a      | C16 H13 N2 O F3 Br |

HRMS (ESI) spectrum of **3c**





$^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ ) spectrum of **3d**



$^{19}\text{F}$  NMR (471 MHz,  $\text{CDCl}_3$ ) spectrum of **3d**

Monoisotopic Mass, Even Electron Ions

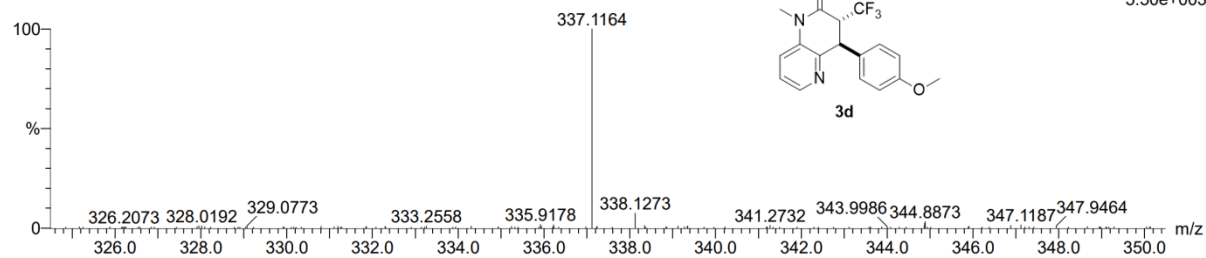
466 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 17-17 H: 16-16 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

8

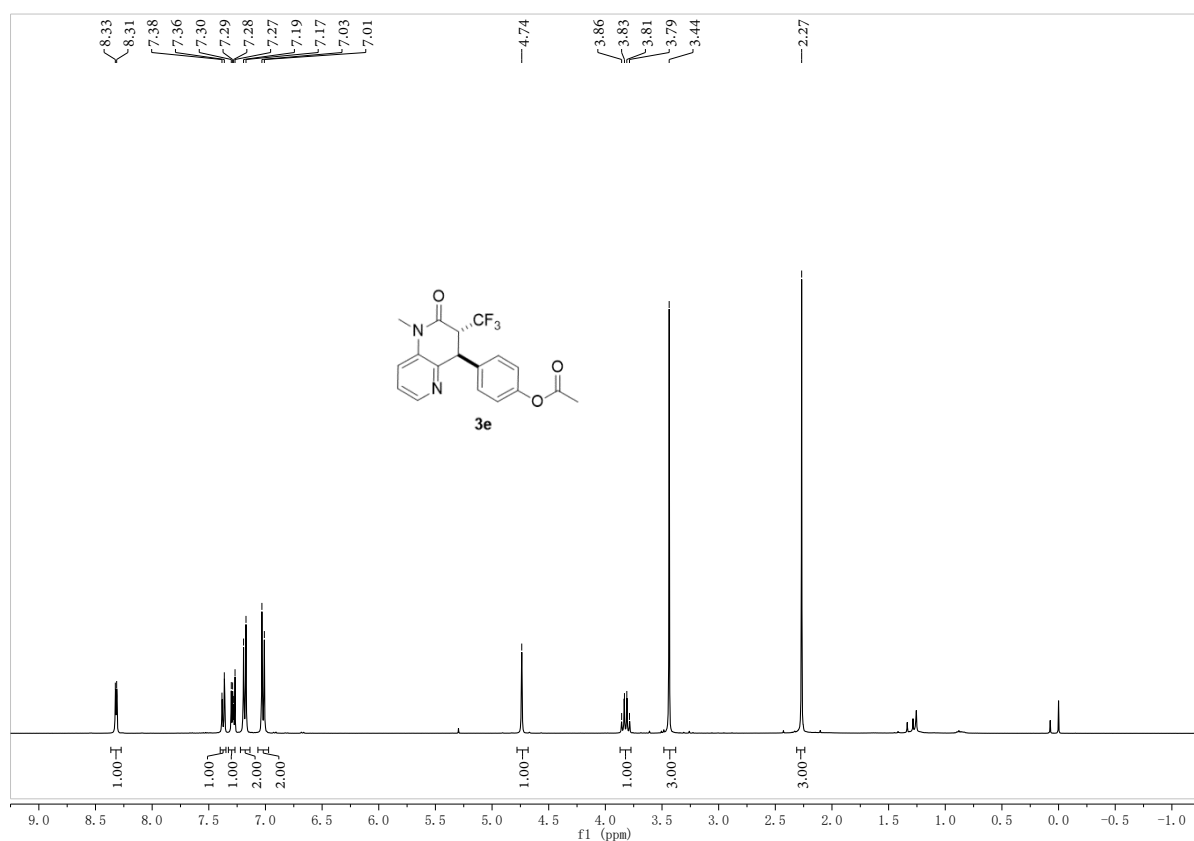
231125-5-279 26 (0.264)

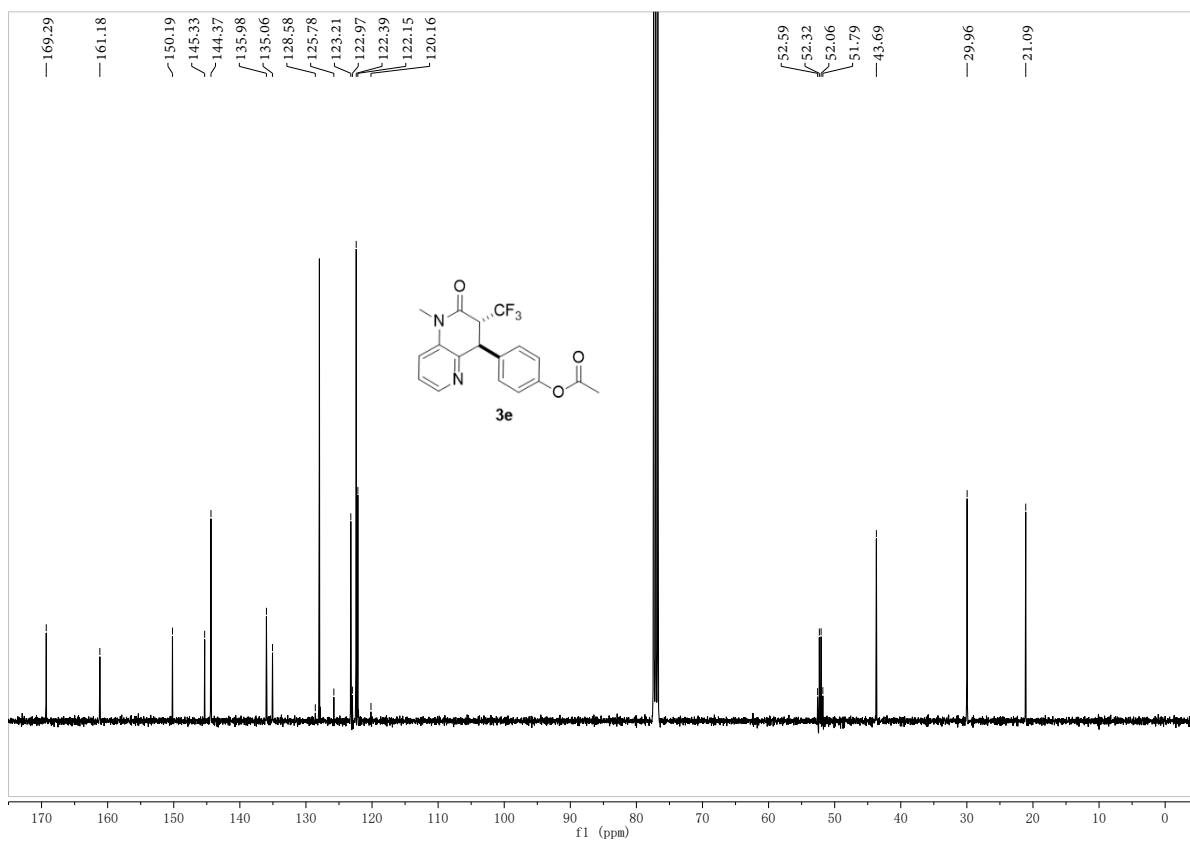


Minimum: -1.5  
Maximum: 5.0 10.0 50.0

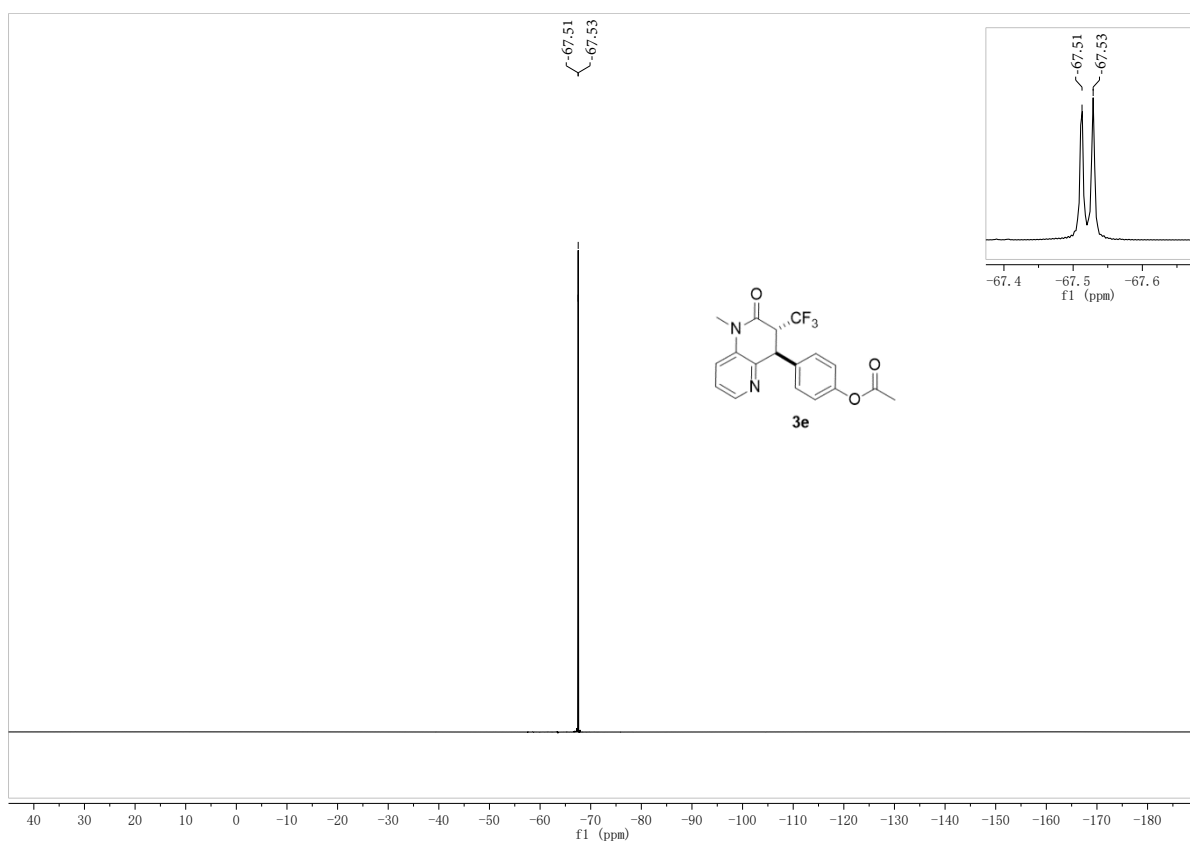
| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula          |
|----------|------------|-----|-----|-----|-------|------|----------|------------------|
| 337.1164 | 337.1164   | 0.0 | 0.0 | 9.5 | 93.1  | n/a  | n/a      | C17 H16 N2 O2 F3 |

### HRMS (ESI) spectrum of **3d**





<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3e**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) of **3e**

Monoisotopic Mass, Even Electron Ions

559 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

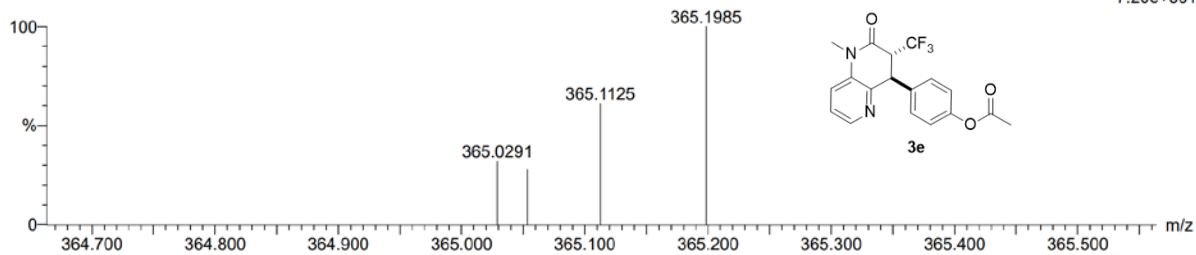
Elements Used:

C: 18-18 H: 16-16 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

8

231125-5-559 14 (0.153)

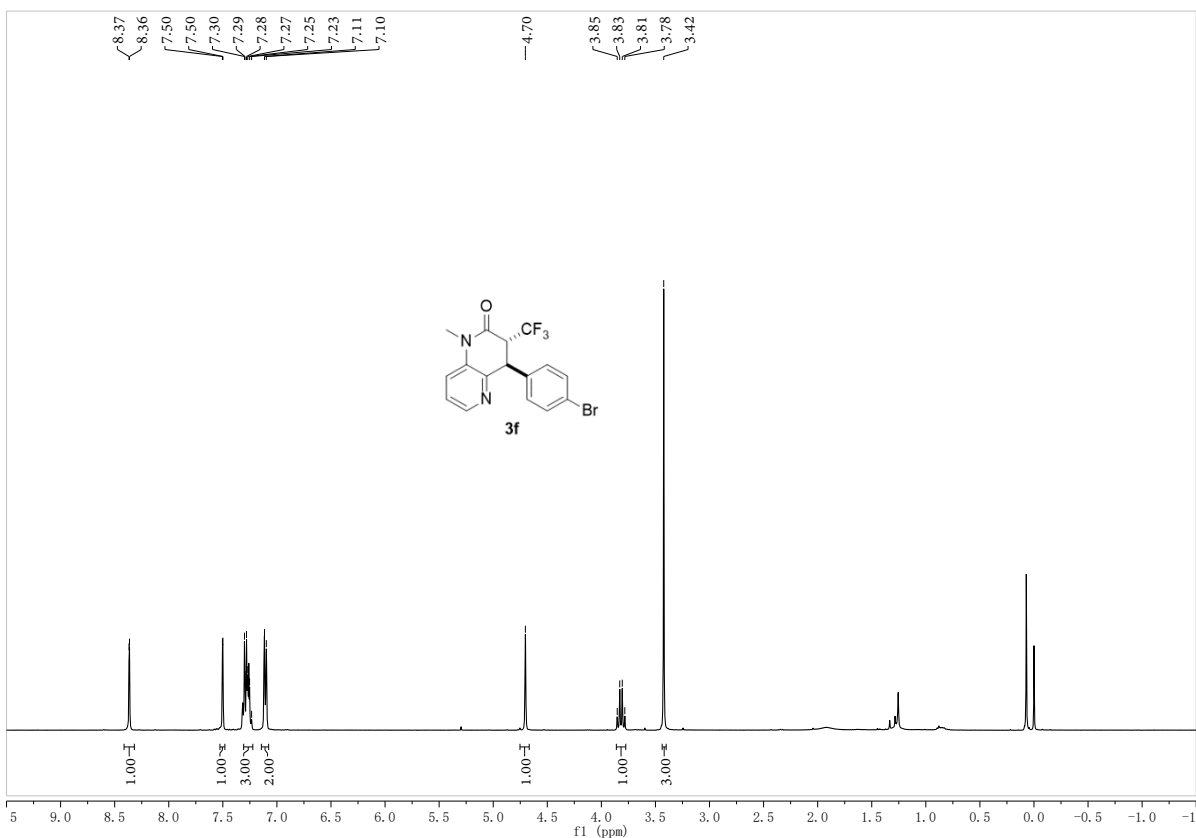
1: TOF MS ES+  
7.20e+001



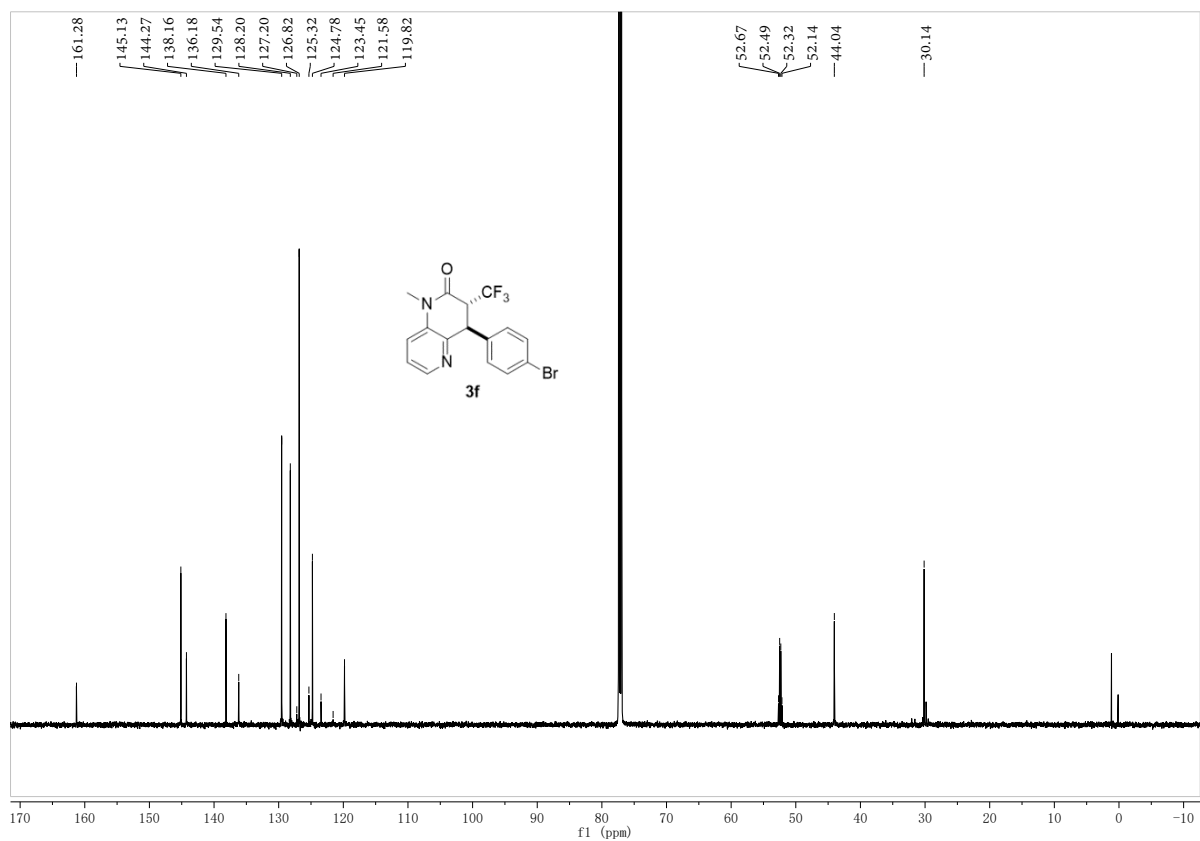
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE  | i-FIT | Norm | Conf (%) | Formula          |
|----------|------------|-----|-----|------|-------|------|----------|------------------|
| 365.1125 | 365.1113   | 1.2 | 3.3 | 10.5 | 23.7  | n/a  | n/a      | C18 H16 N2 O3 F3 |

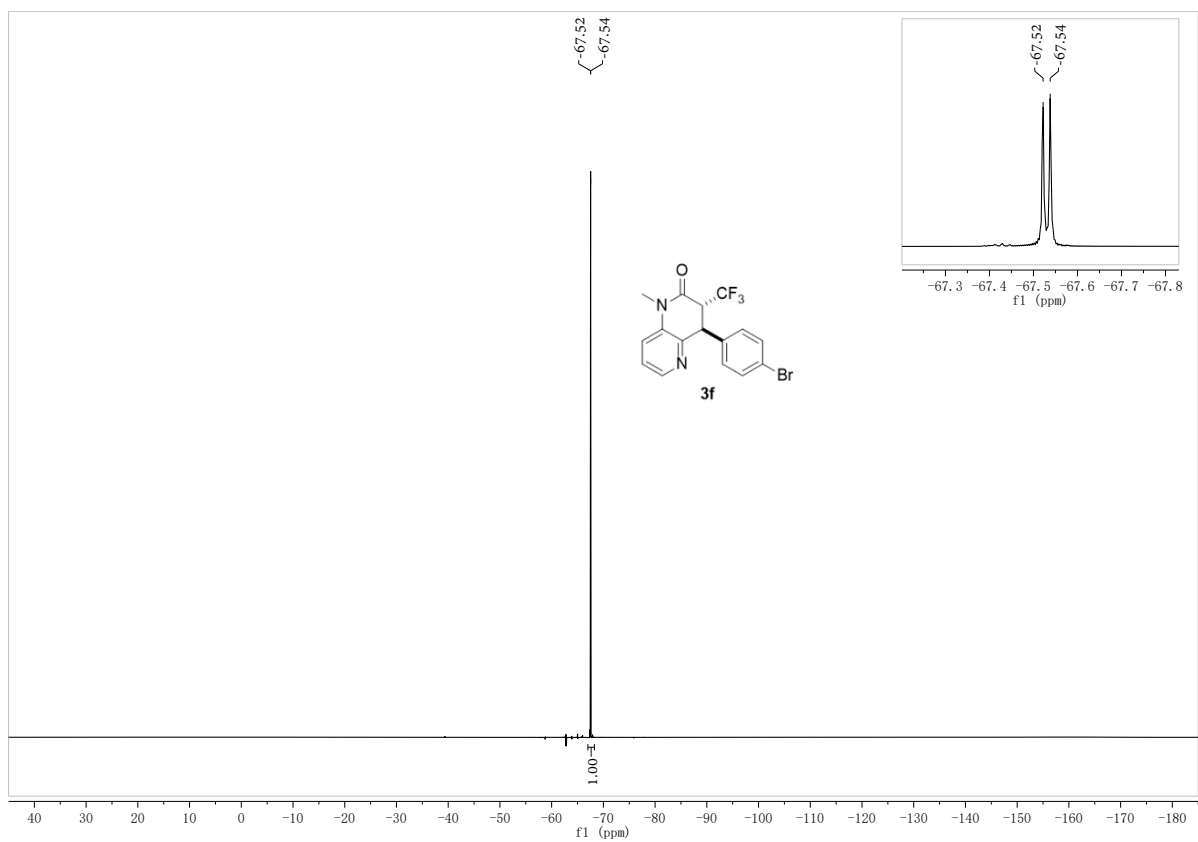
### HRMS (ESI) spectrum of **3e**



### <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3f**



<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3f**

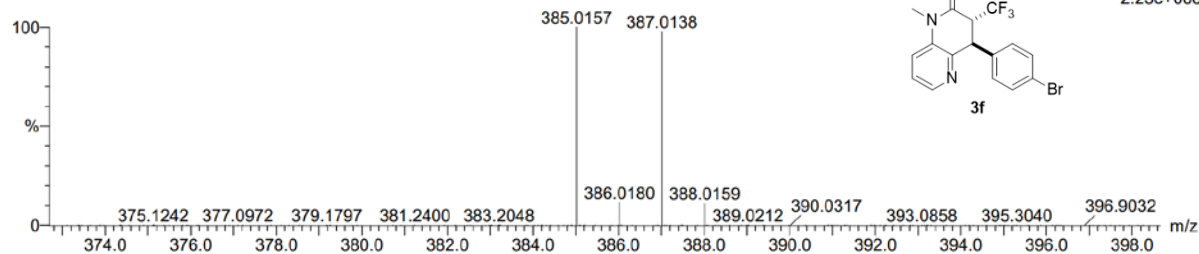


<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) of **3f**



Monoisotopic Mass, Even Electron Ions  
 598 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 16-16 H: 13-13 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Br: 1-3

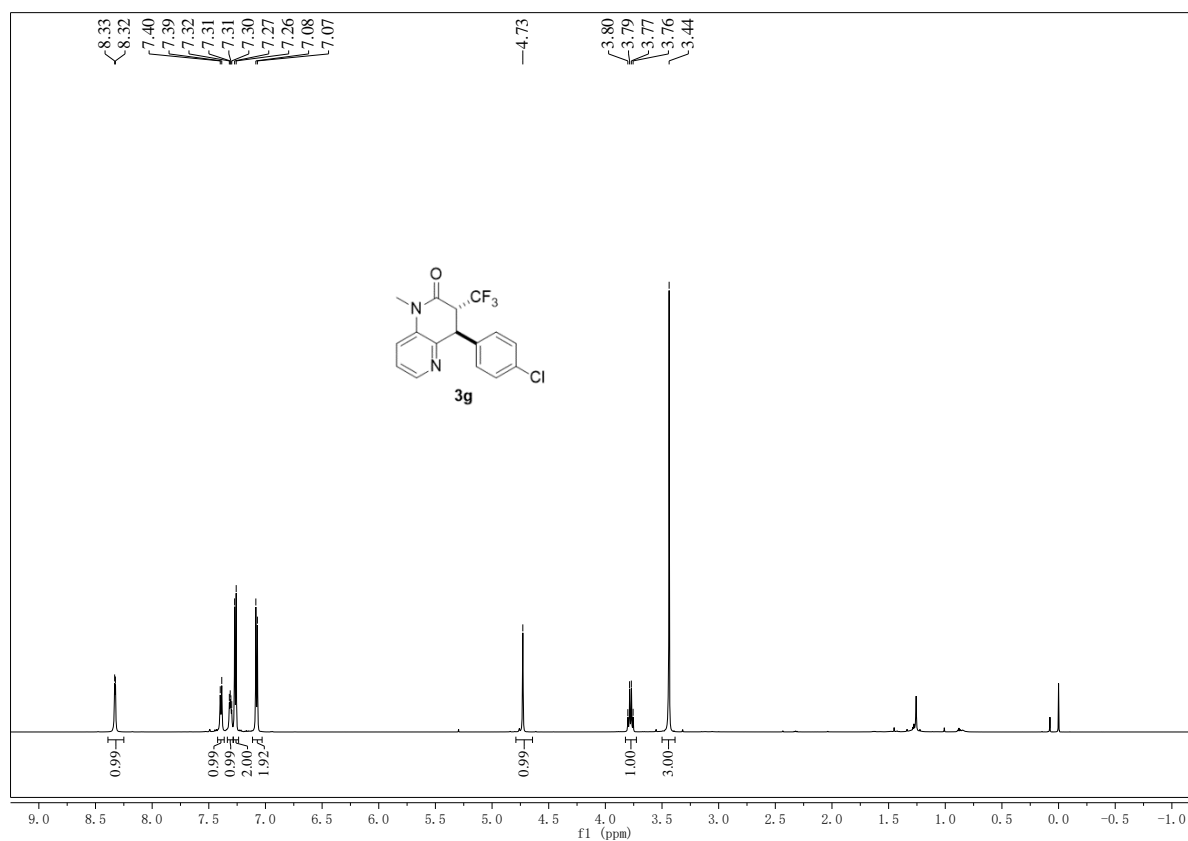
4  
 231125-5-206 14 (0.153)



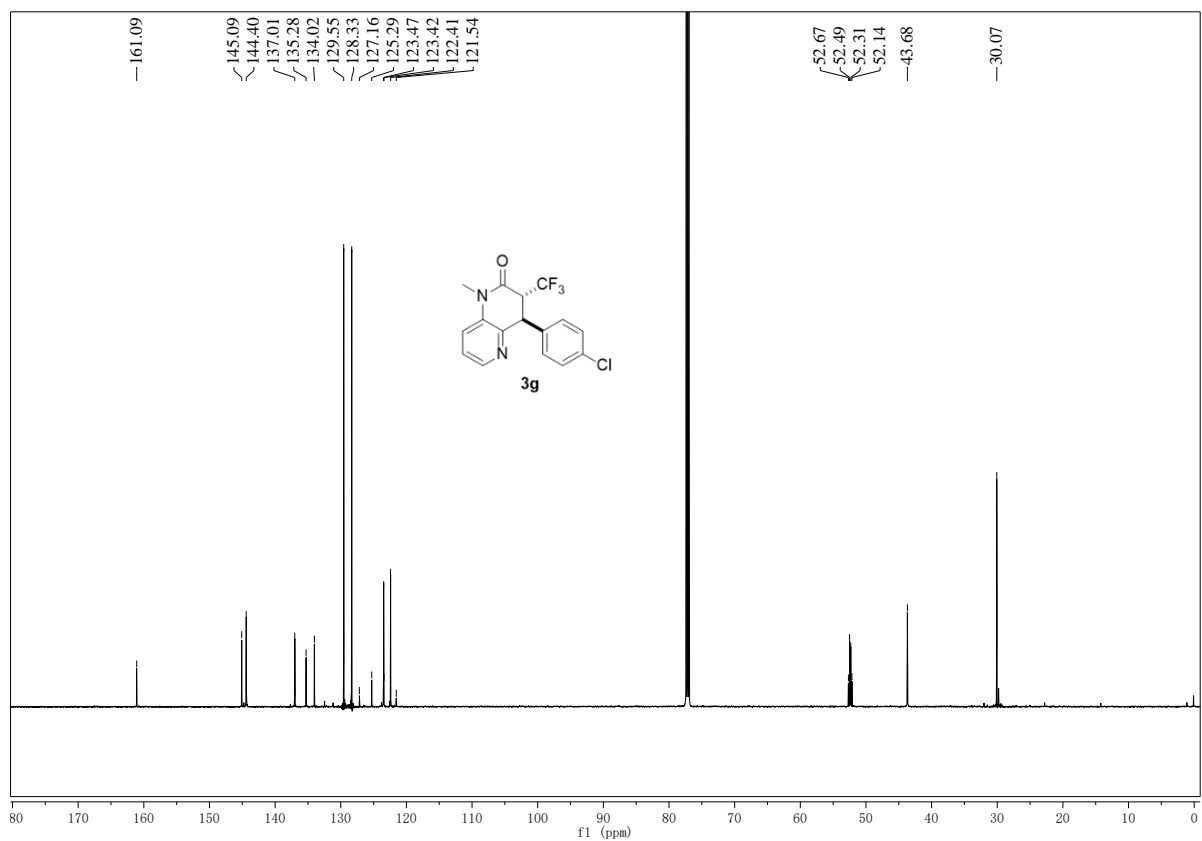
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|------|------|-----|-------|------|----------|--------------------|
| 385.0157 | 385.0163   | -0.6 | -1.6 | 9.5 | 167.8 | n/a  | n/a      | C16 H13 N2 O F3 Br |

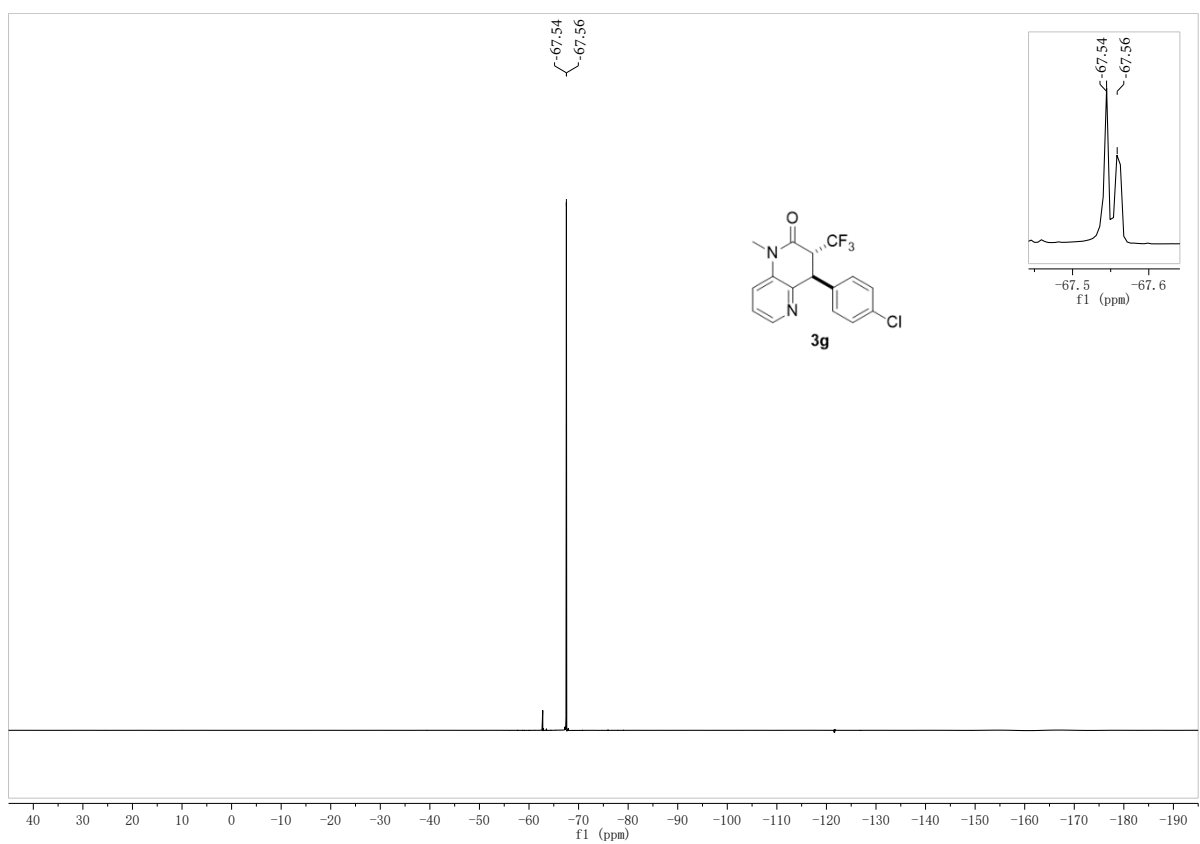
HRMS (ESI) spectrum of **3f**



<sup>1</sup>H NMR (600 MHz, CDCl<sub>3</sub>) spectrum of **3g**



<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3g**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) of **3g**

Monoisotopic Mass, Even Electron Ions

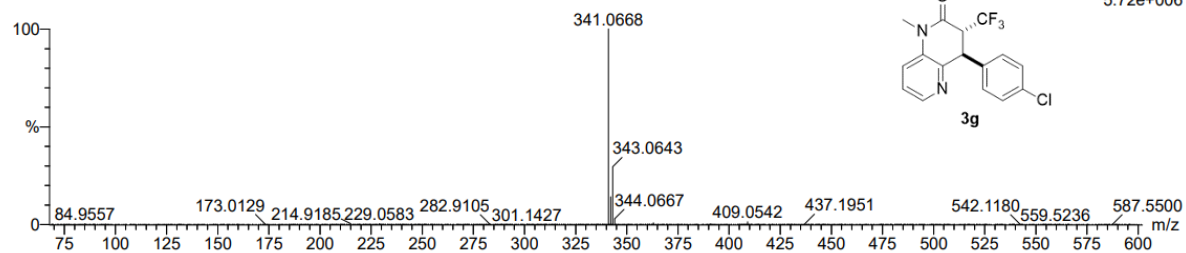
981 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 16-16 H: 13-13 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Cl: 1-4

8

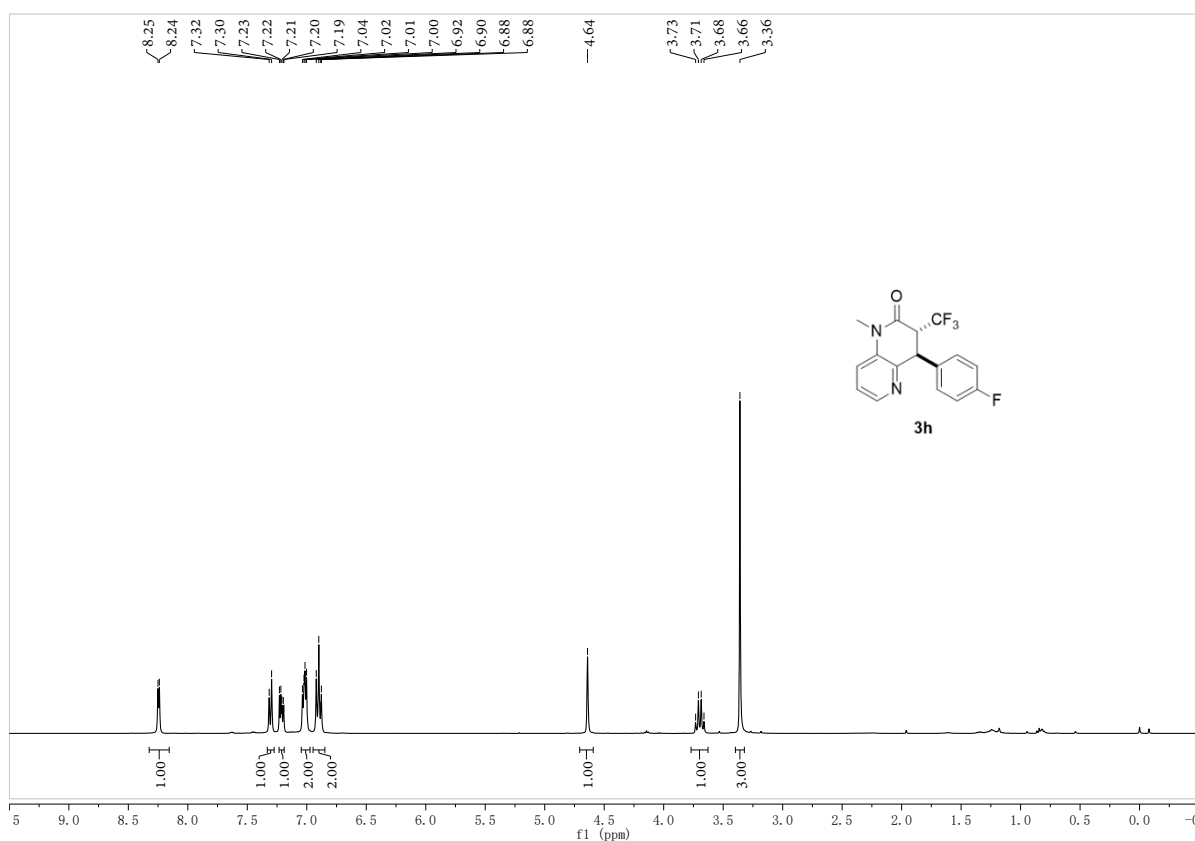
231125-5-211 13 (0.145)



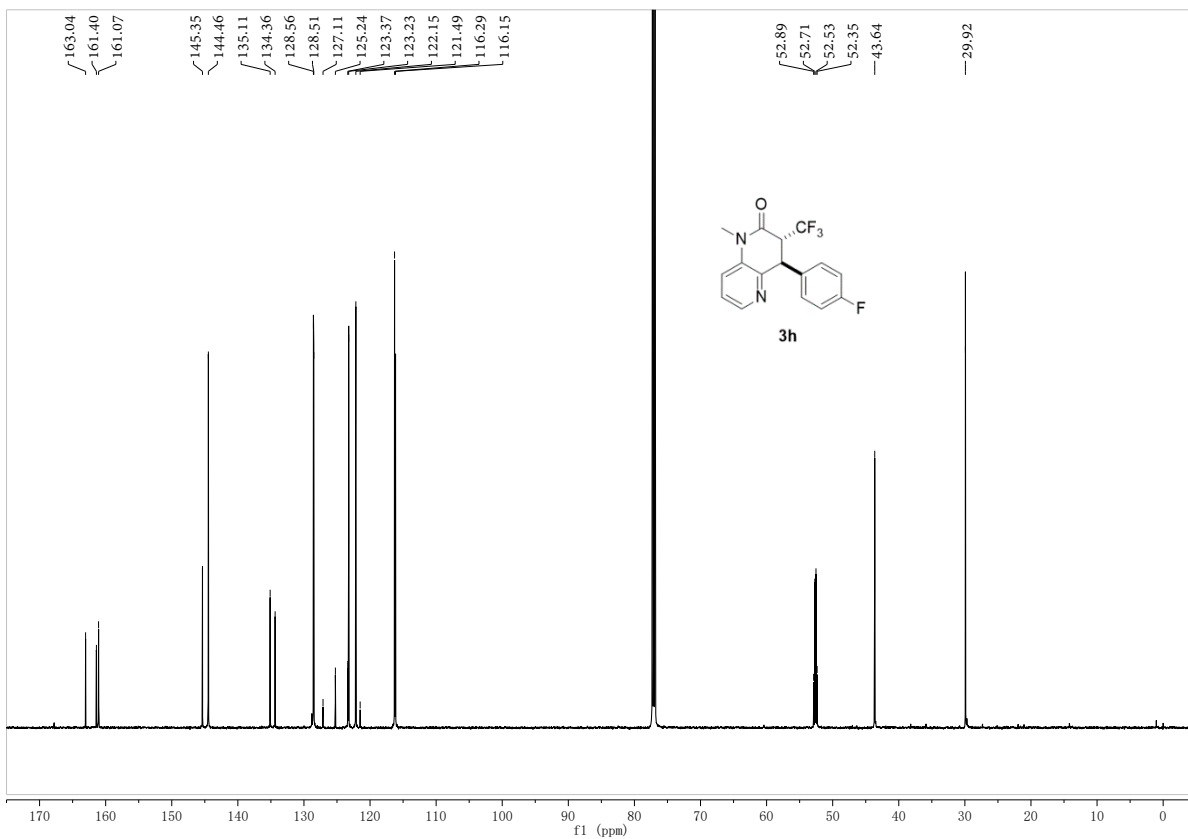
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|------|------|-----|-------|------|----------|--------------------|
| 341.0668 | 341.0669   | -0.1 | -0.3 | 9.5 | 186.7 | n/a  | n/a      | C16 H13 N2 O F3 Cl |

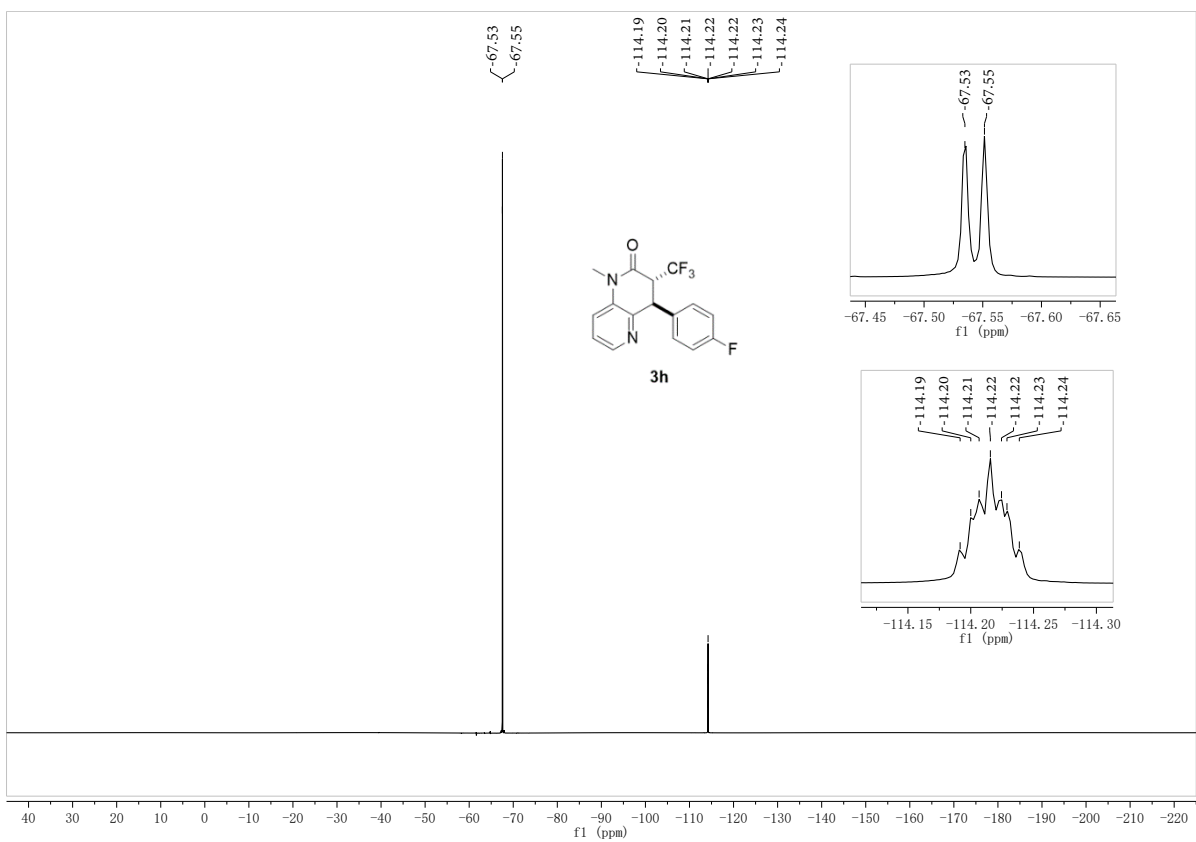
HRMS (ESI) spectrum of **3g**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3h**



<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3h**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) of **3h**

Monoisotopic Mass, Even Electron Ions

371 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

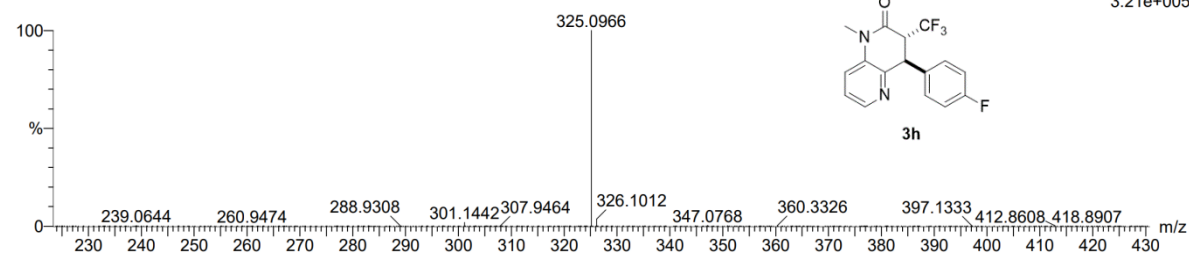
Elements Used:

C: 16-16 H: 13-13 N: 0-200 O: 0-100 F: 4-4 Na: 0-2

8

231125-5-567 18 (0.188)

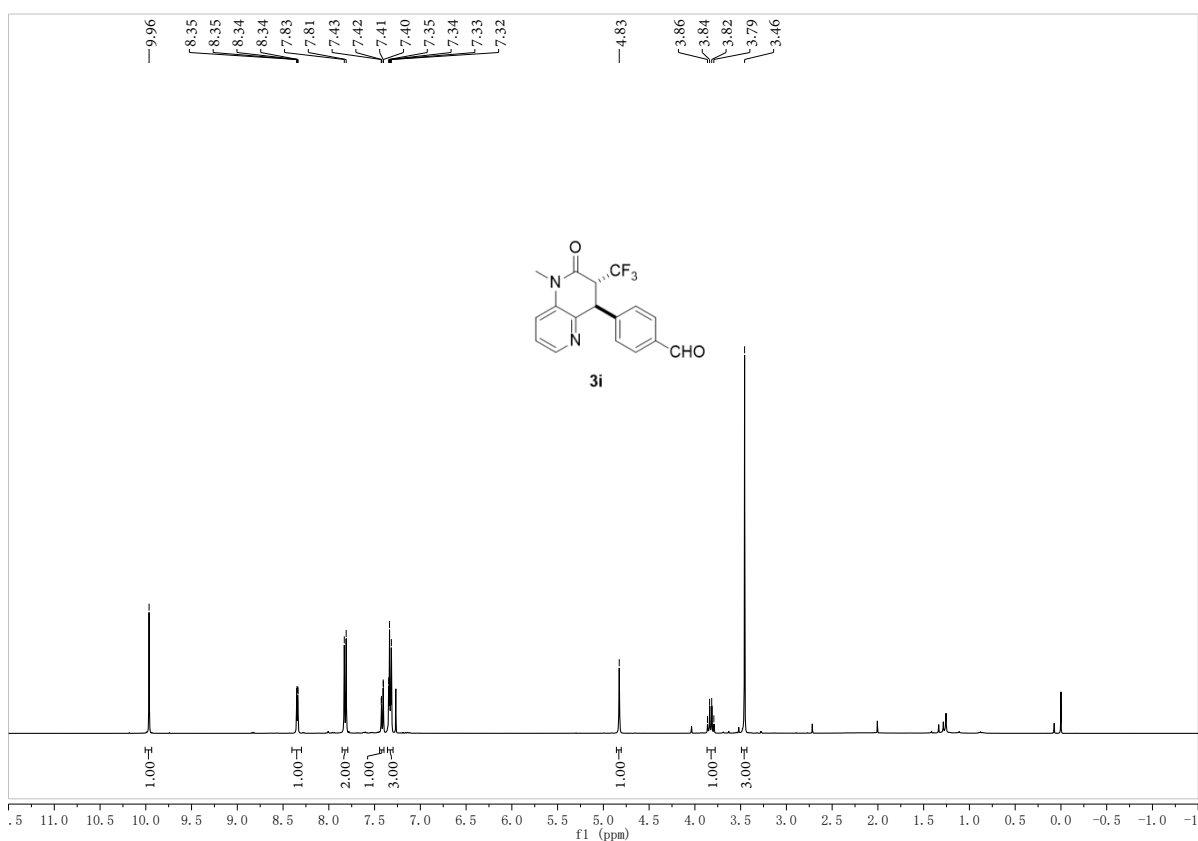
1: TOF MS ES+  
3.21e+005



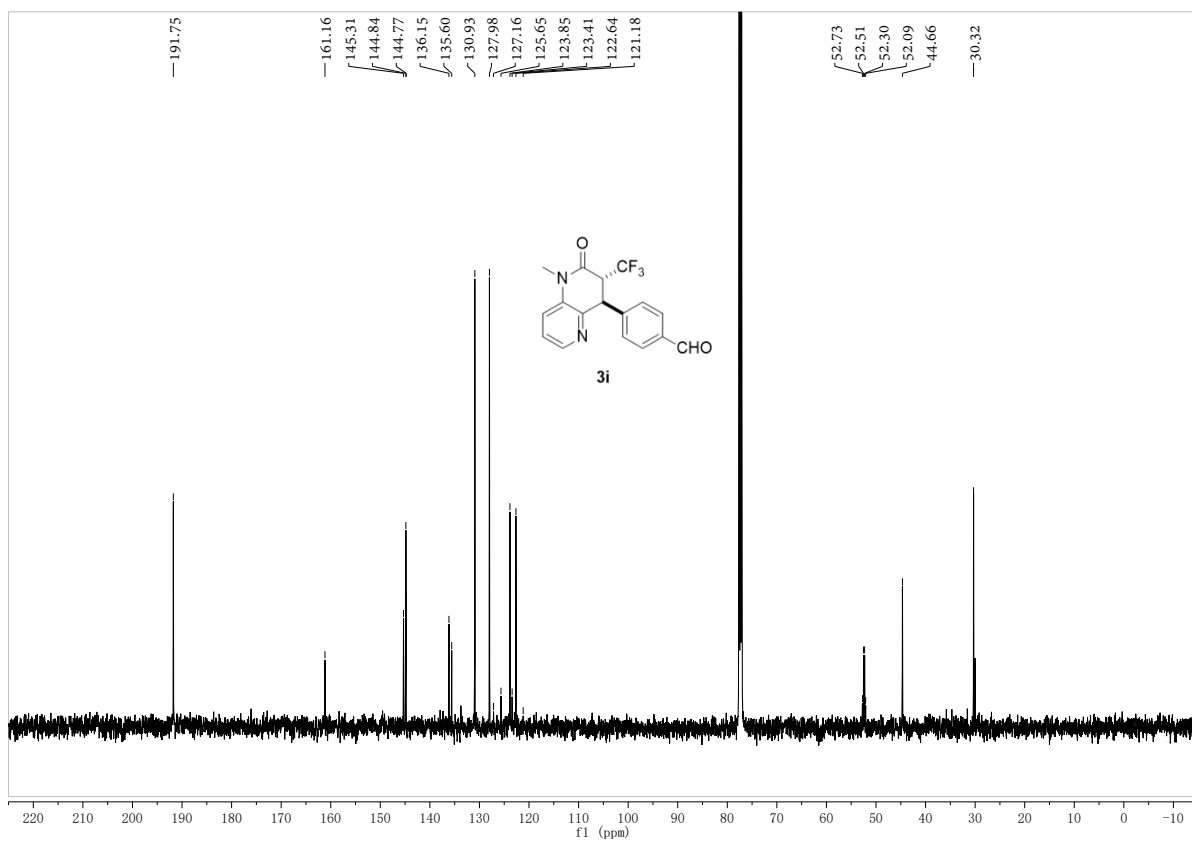
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|-----|-----|-----|-------|------|----------|-----------------|
| 325.0966 | 325.0964   | 0.2 | 0.6 | 9.5 | 154.1 | n/a  | n/a      | C16 H13 N2 O F4 |

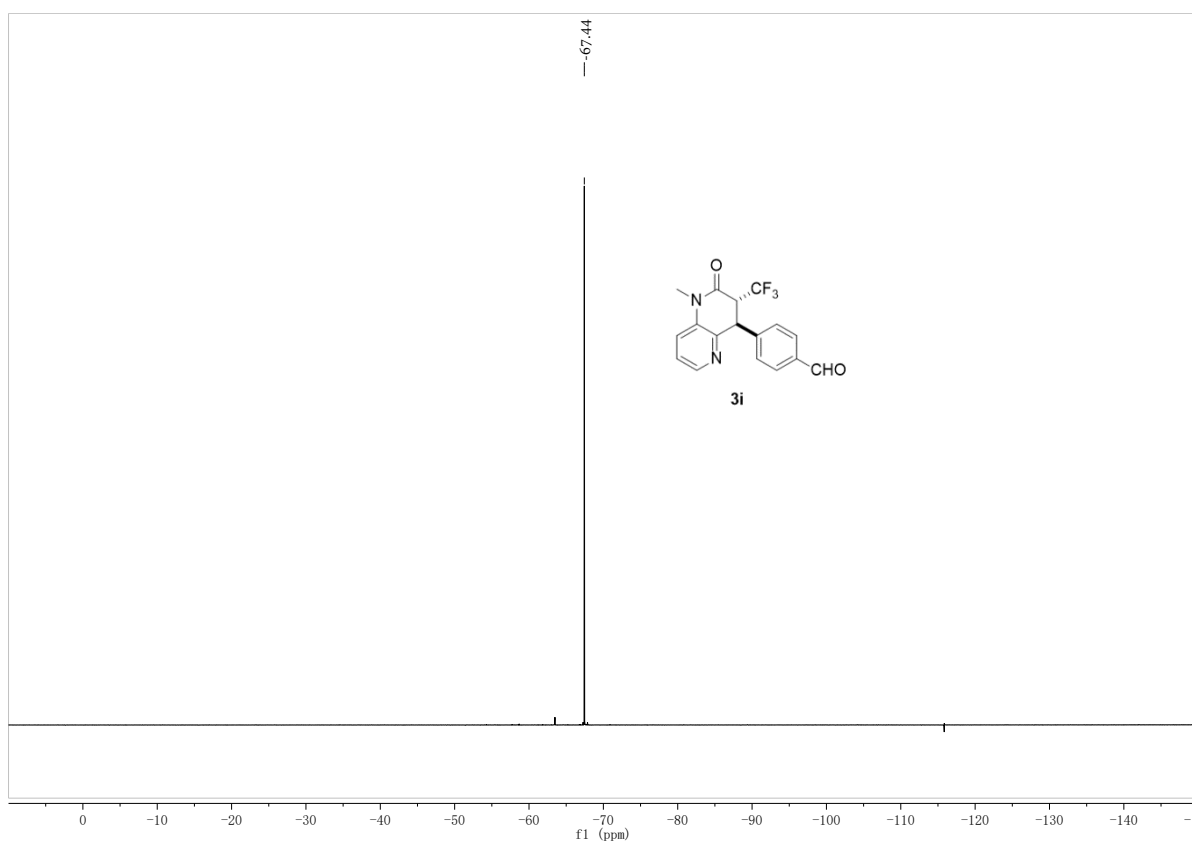
### HRMS (ESI) spectrum of **3h**



### <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3i**



<sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) spectrum of **3i**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) of **3i**

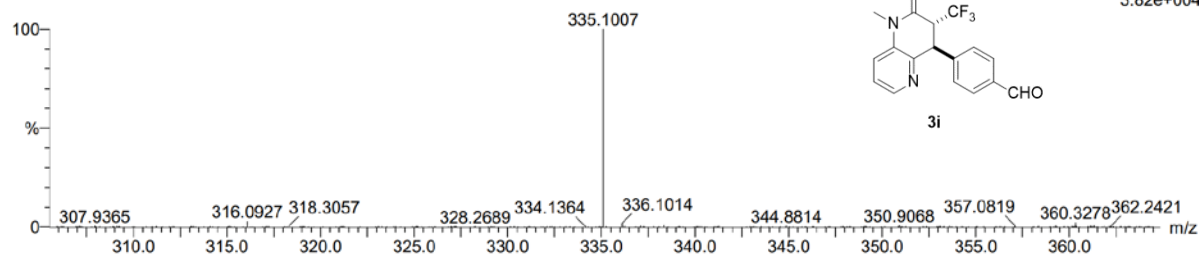
Monoisotopic Mass, Even Electron Ions  
459 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 17-17 H: 14-14 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

4

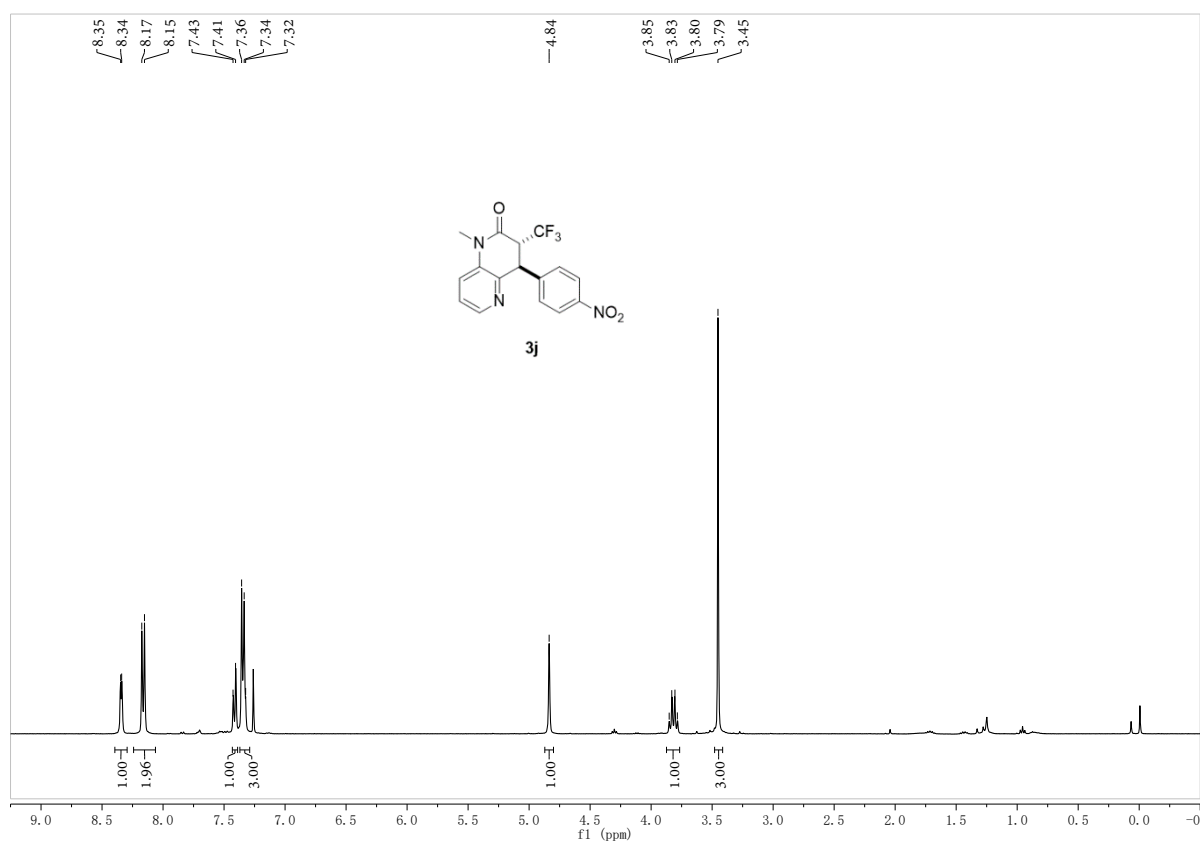
231125-5-558 16 (0.170)



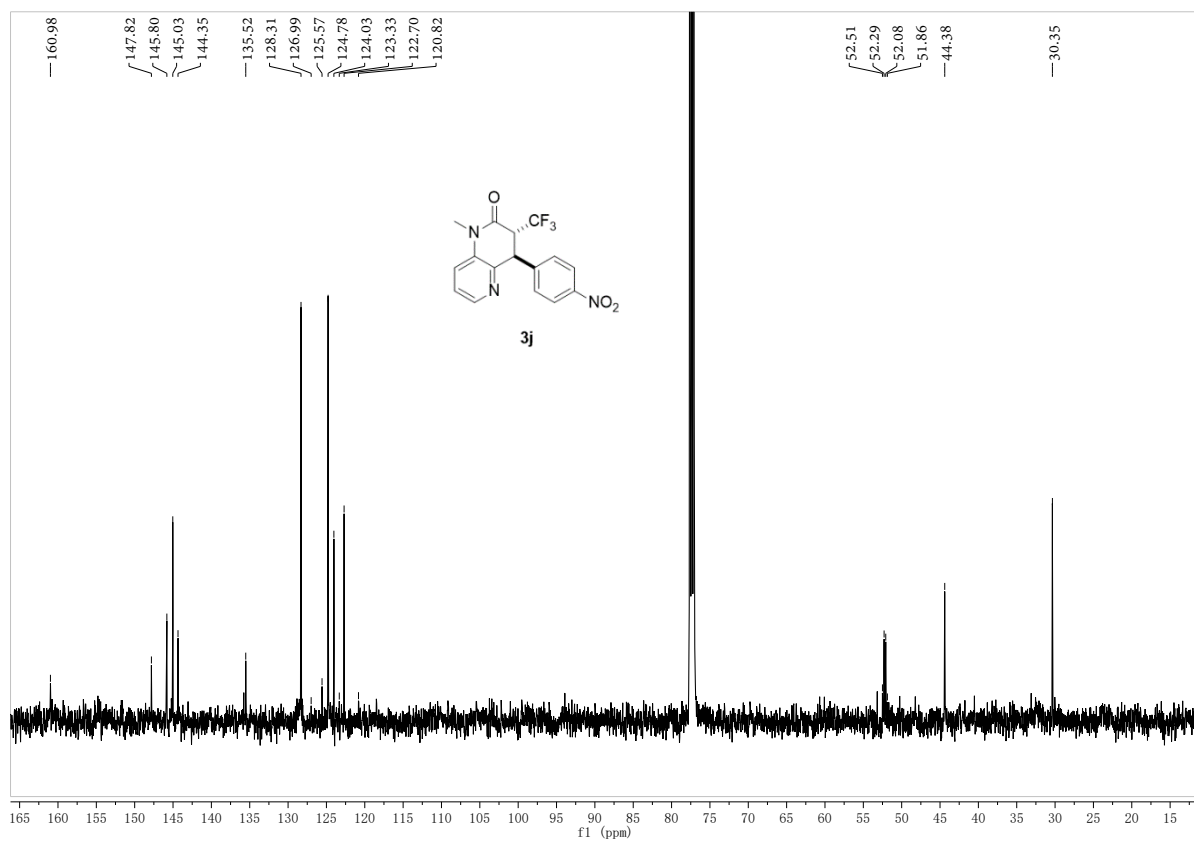
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE  | i-FIT | Norm | Conf (%) | Formula          |
|----------|------------|-----|-----|------|-------|------|----------|------------------|
| 335.1007 | 335.1007   | 0.0 | 0.0 | 10.5 | 118.3 | n/a  | n/a      | C17 H14 N2 O2 F3 |

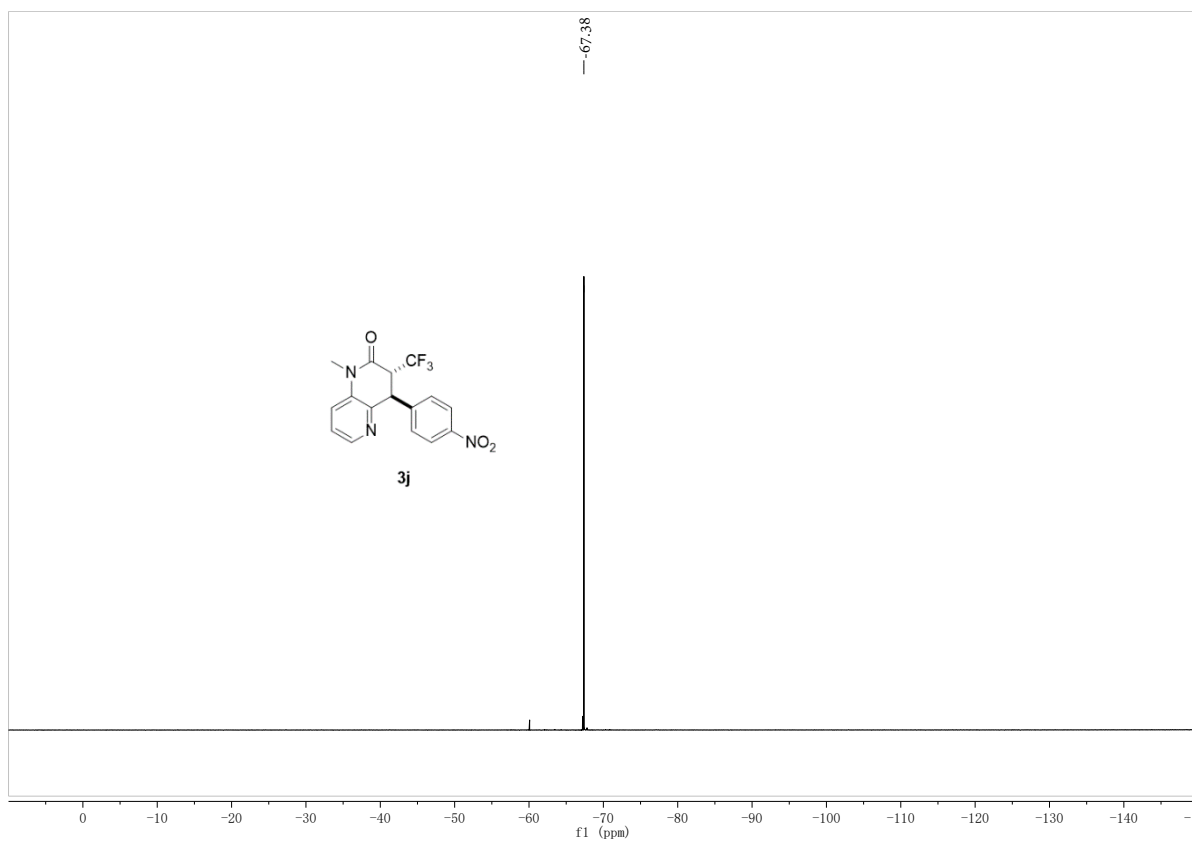
HRMS (ESI) spectrum of **3i**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3j**



<sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) spectrum of **3j**

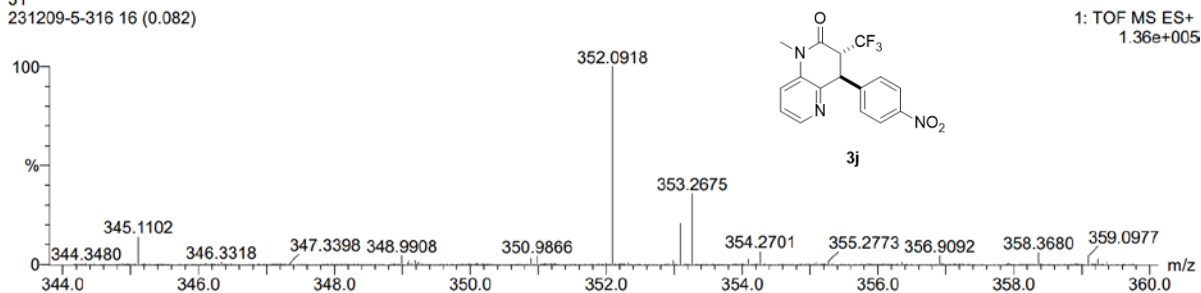


<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) of **3j**



Monoisotopic Mass, Even Electron Ions  
 500 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 16-16 H: 13-13 N: 0-100 O: 0-100 Na: 0-2 F: 3-3

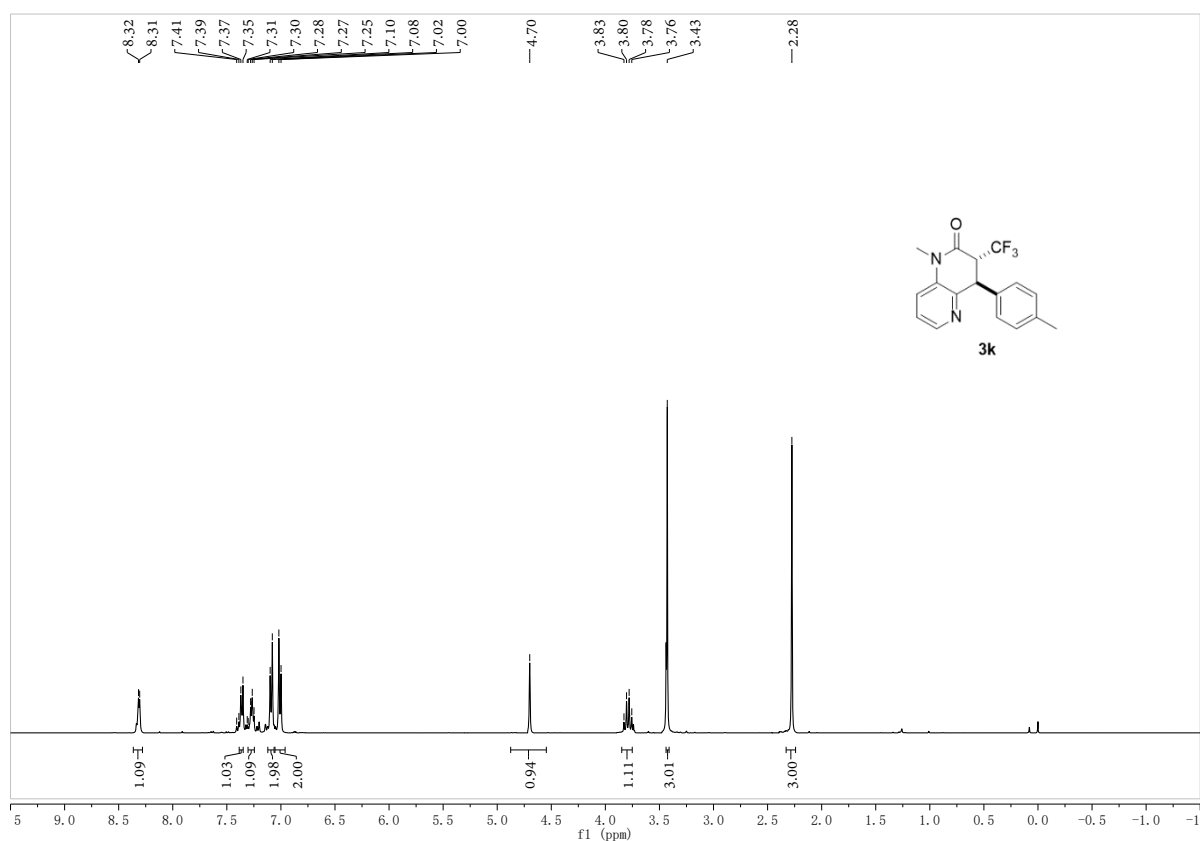
31  
 231209-5-316 16 (0.082)



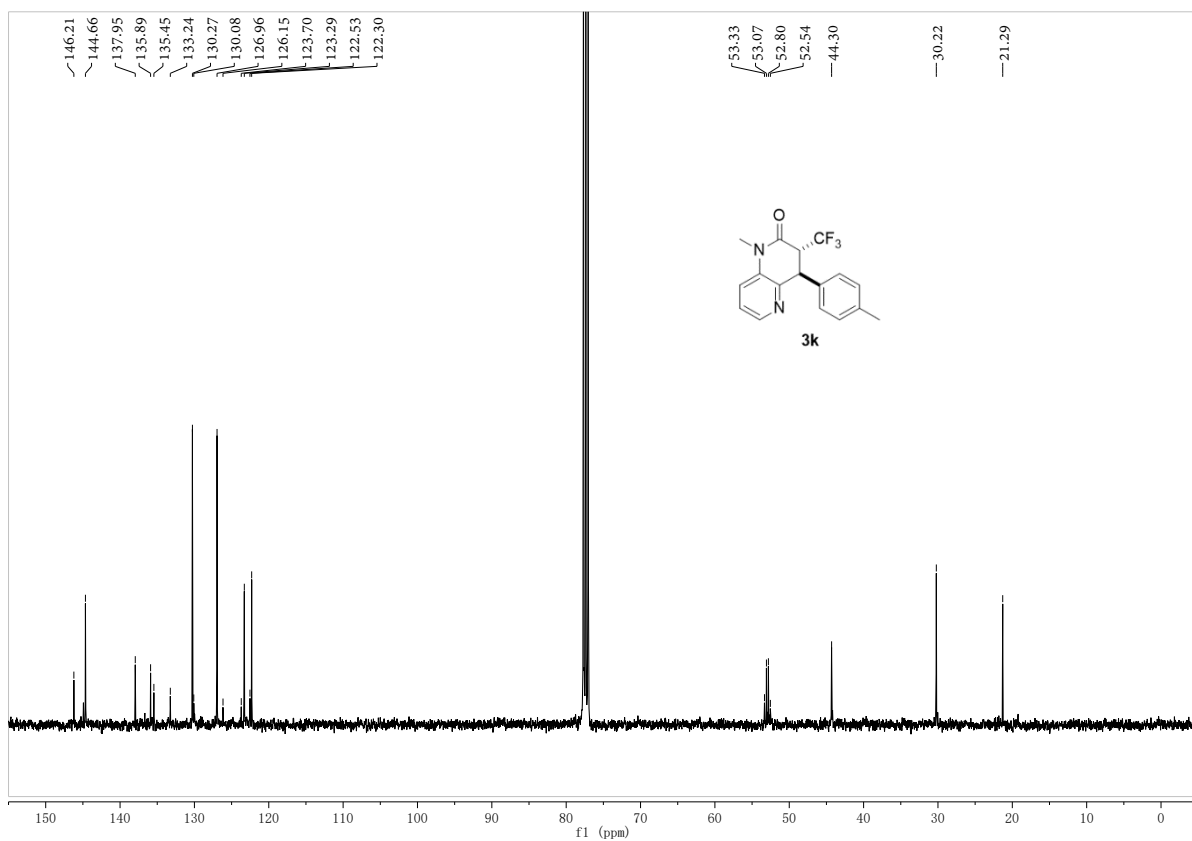
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE  | i-FIT | Norm | Conf (%) | Formula          |
|----------|------------|-----|-----|------|-------|------|----------|------------------|
| 352.0918 | 352.0909   | 0.9 | 2.6 | 10.5 | 897.4 | n/a  | n/a      | C16 H13 N3 O3 F3 |

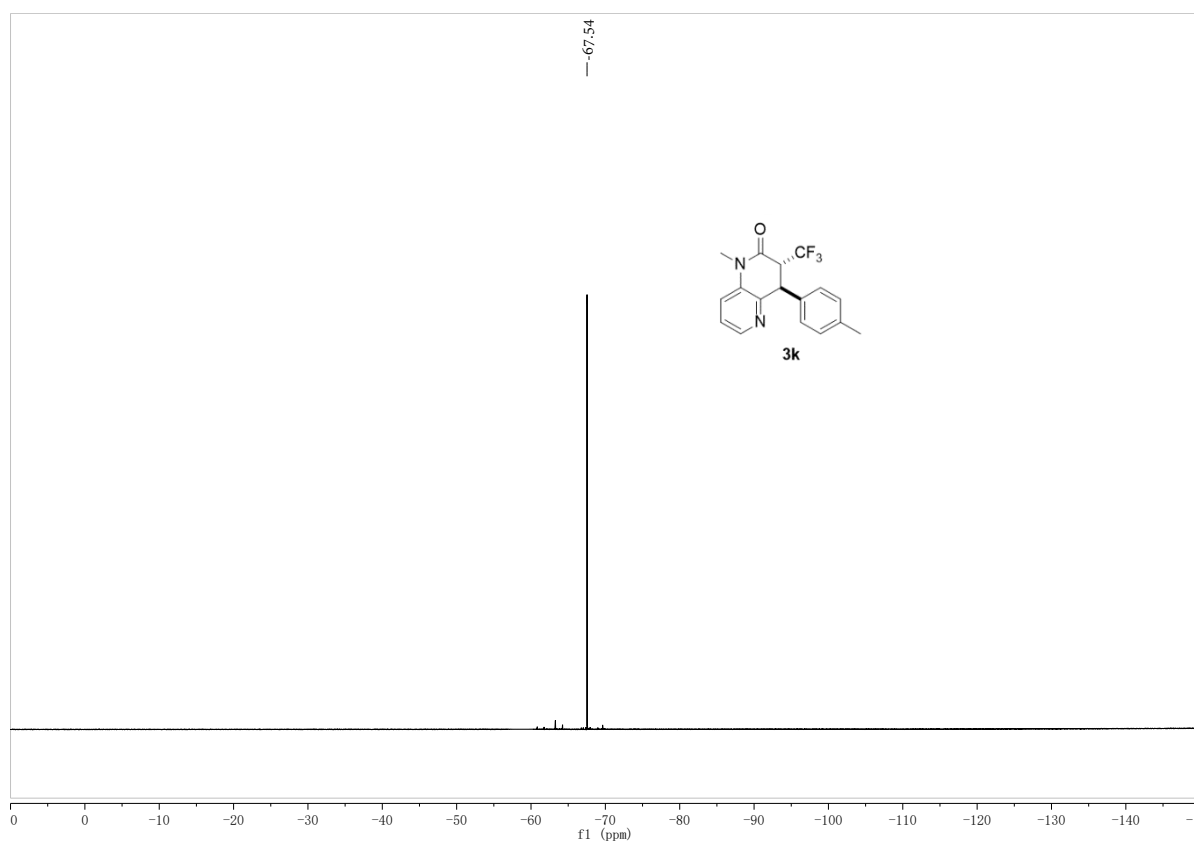
HRMS (ESI) spectrum of **3j**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3k**



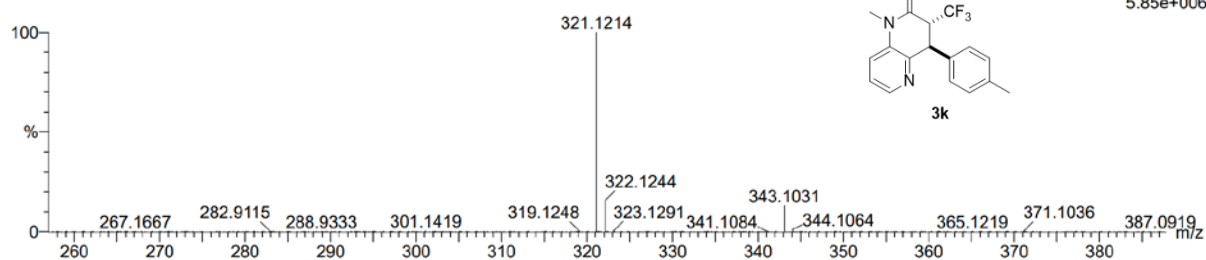
<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3k**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) of **3k**

Monoisotopic Mass, Even Electron Ions  
 420 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 17-17 H: 16-16 N: 0-200 O: 0-100 Na: 0-2 F: 3-3

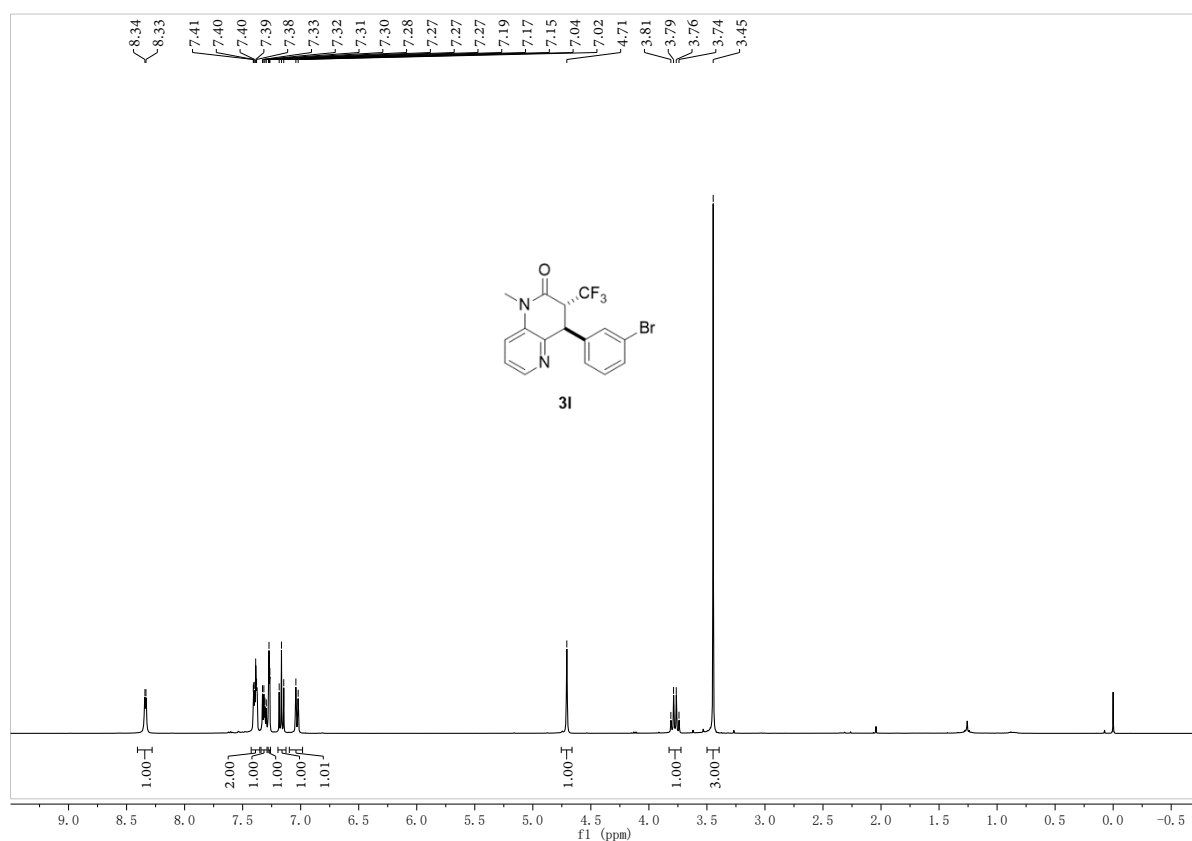
8  
 231125-5-315 14 (0.153)



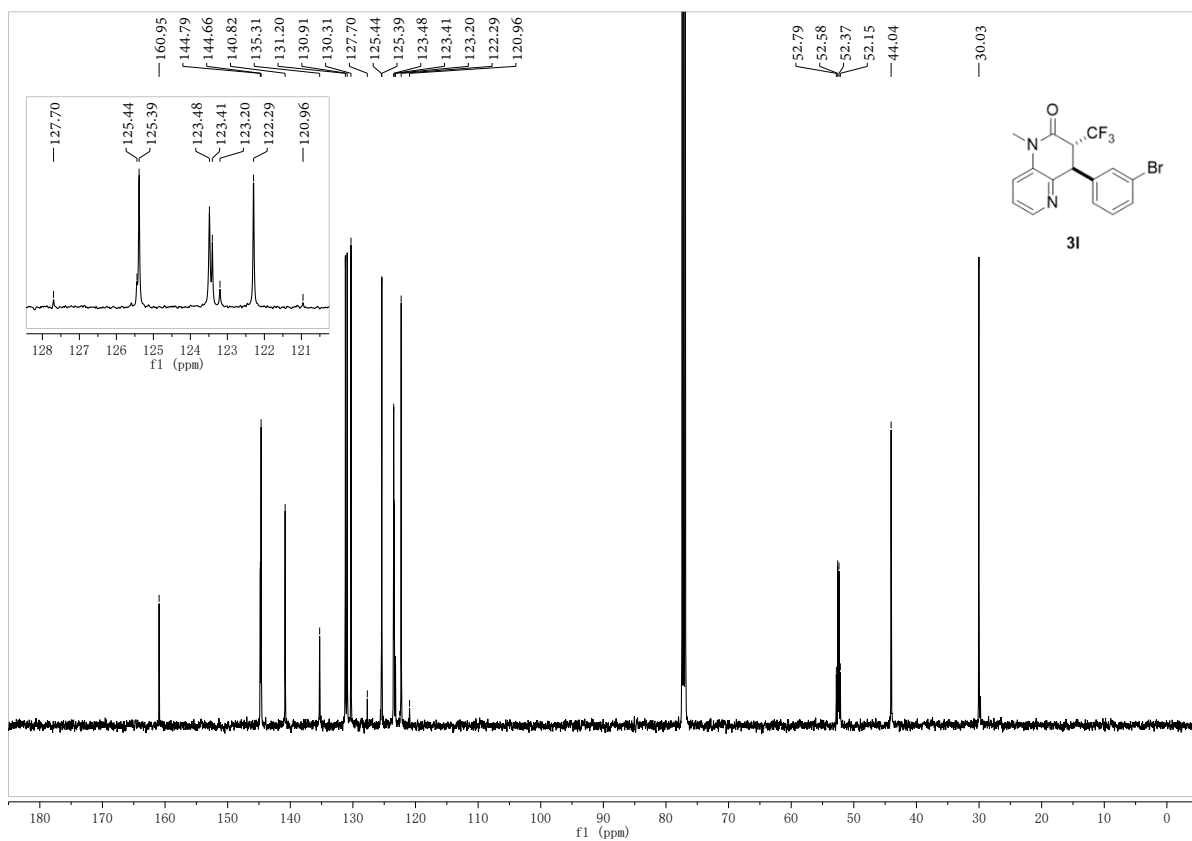
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf(%) | Formula         |
|----------|------------|------|------|-----|-------|------|---------|-----------------|
| 321.1214 | 321.1215   | -0.1 | -0.3 | 9.5 | 164.4 | n/a  | n/a     | C17 H16 N2 O F3 |

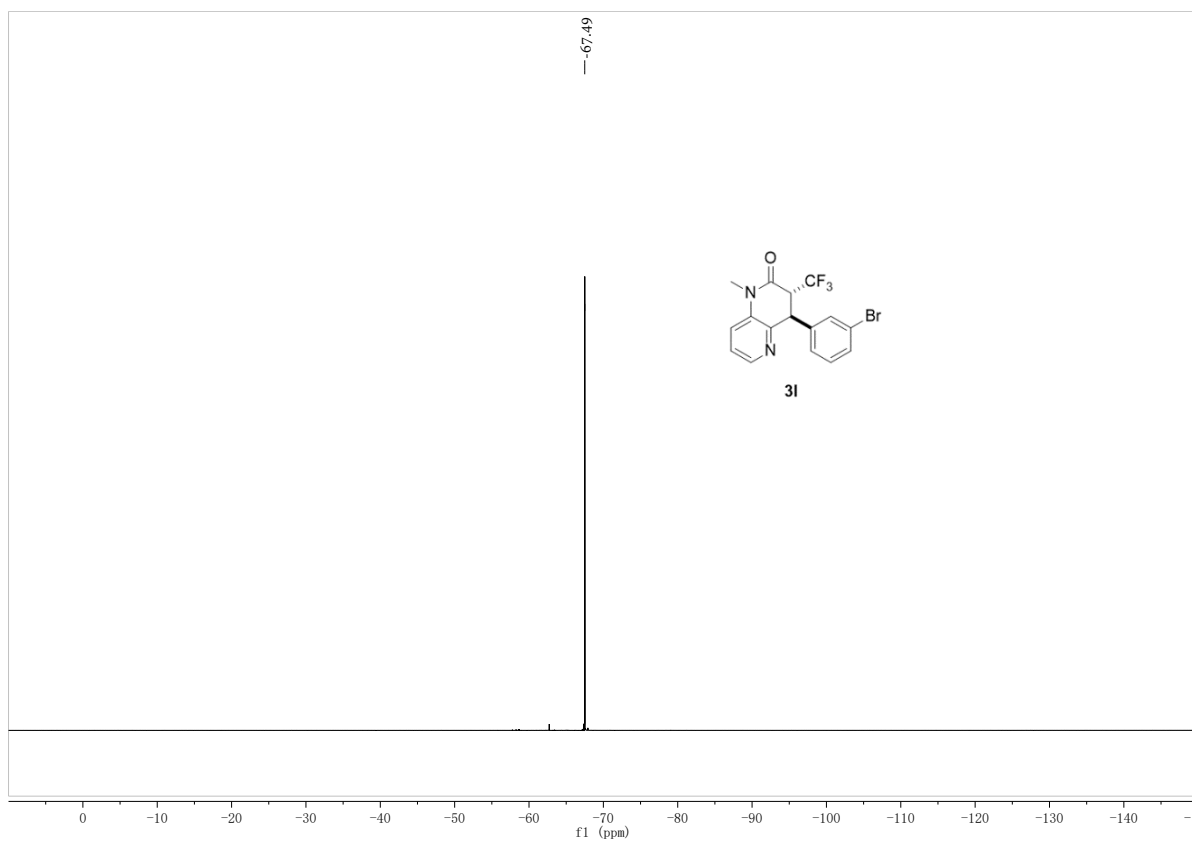
HRMS (ESI) spectrum of **3k**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3l**



<sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) spectrum of **31**

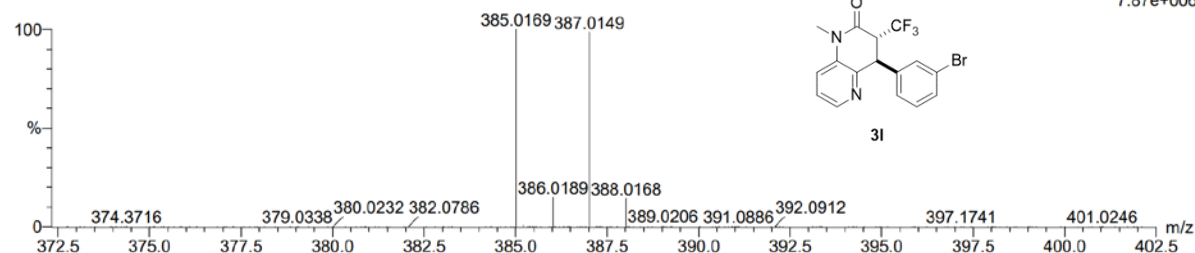


<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **31**

Monoisotopic Mass, Even Electron Ions  
 598 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 16-16 H: 13-13 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Br: 1-3

8  
 231125-5-338 13 (0.145)

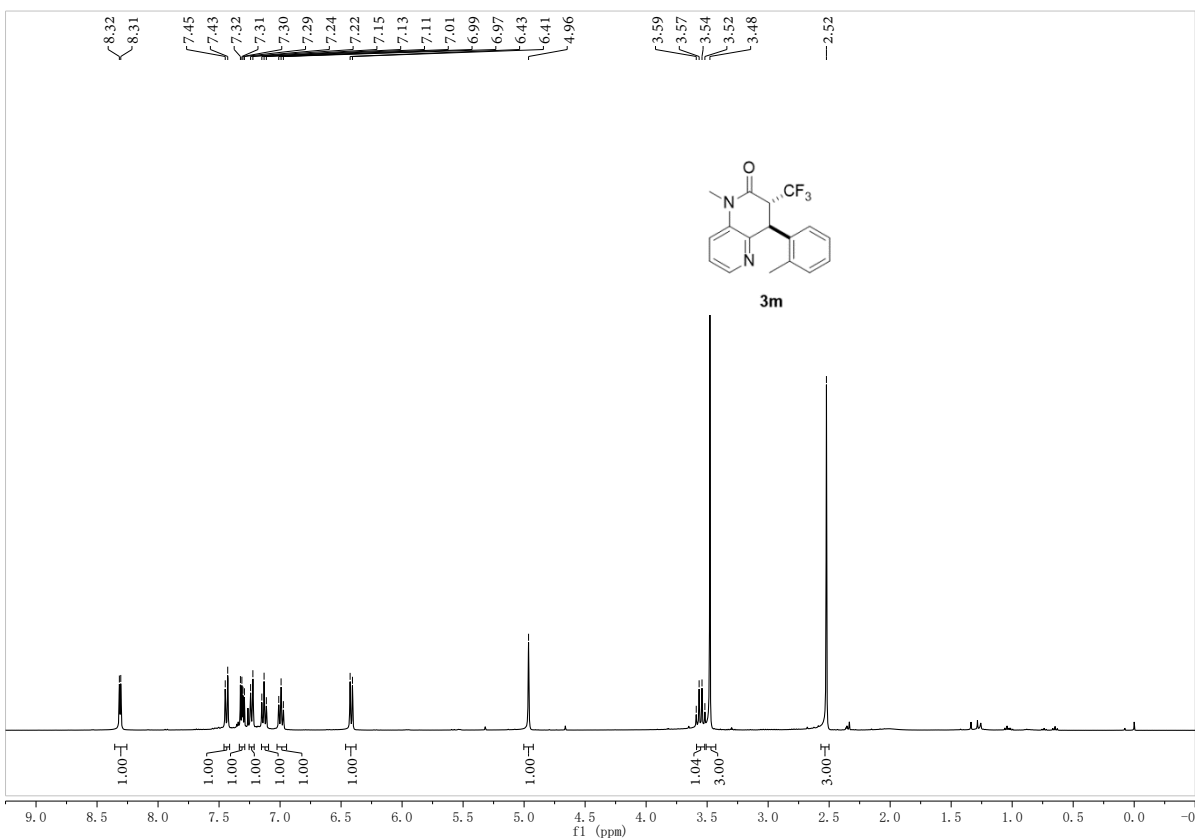
1: TOF MS ES+  
 7.87e+006



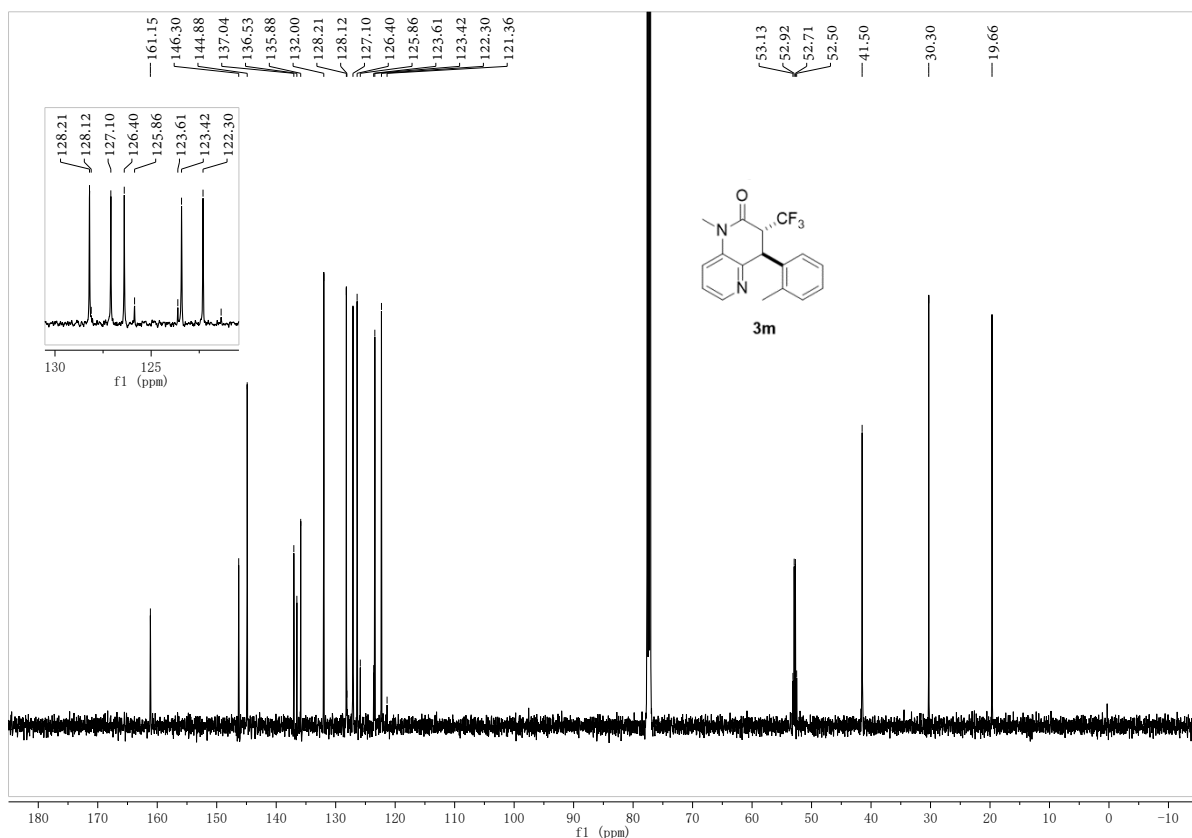
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|-----|-----|-----|-------|------|----------|--------------------|
| 385.0169 | 385.0163   | 0.6 | 1.6 | 9.5 | 339.8 | n/a  | n/a      | C16 H13 N2 O F3 Br |

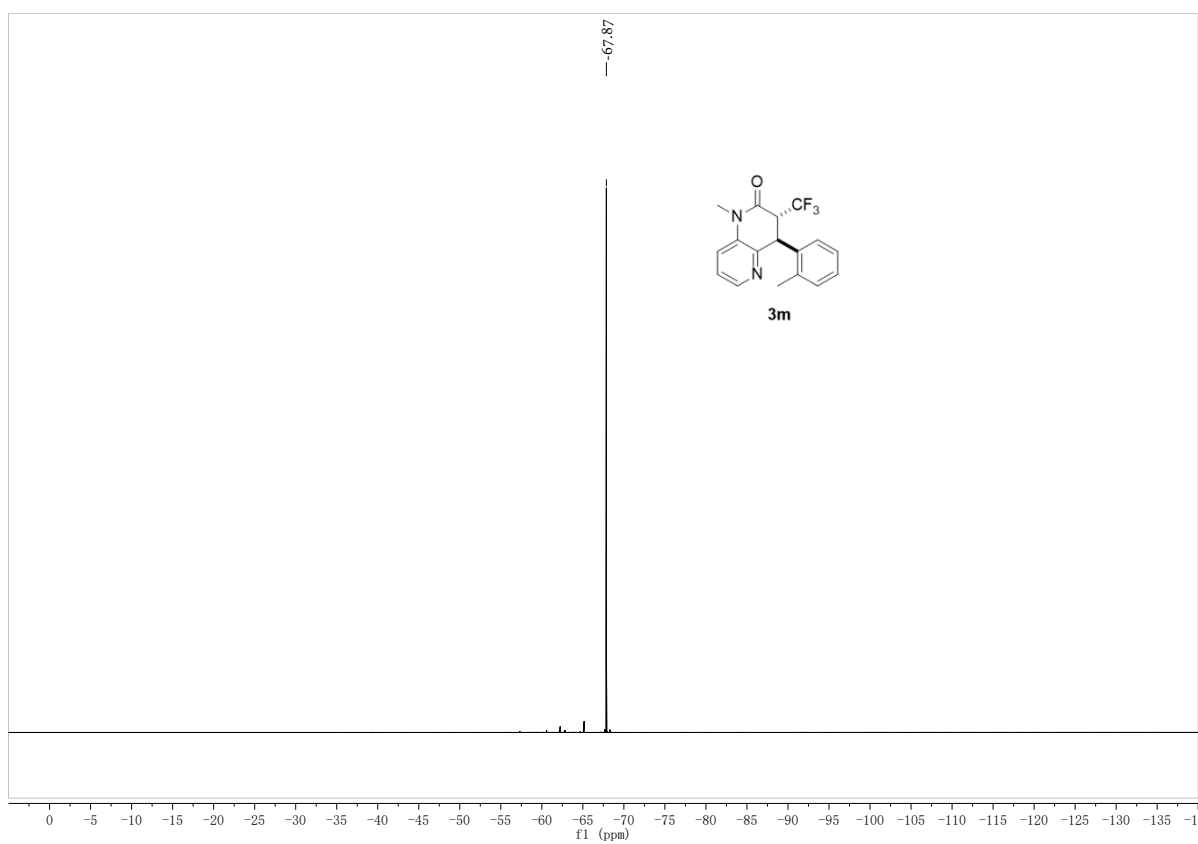
HRMS (ESI) spectrum of **31**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3m**

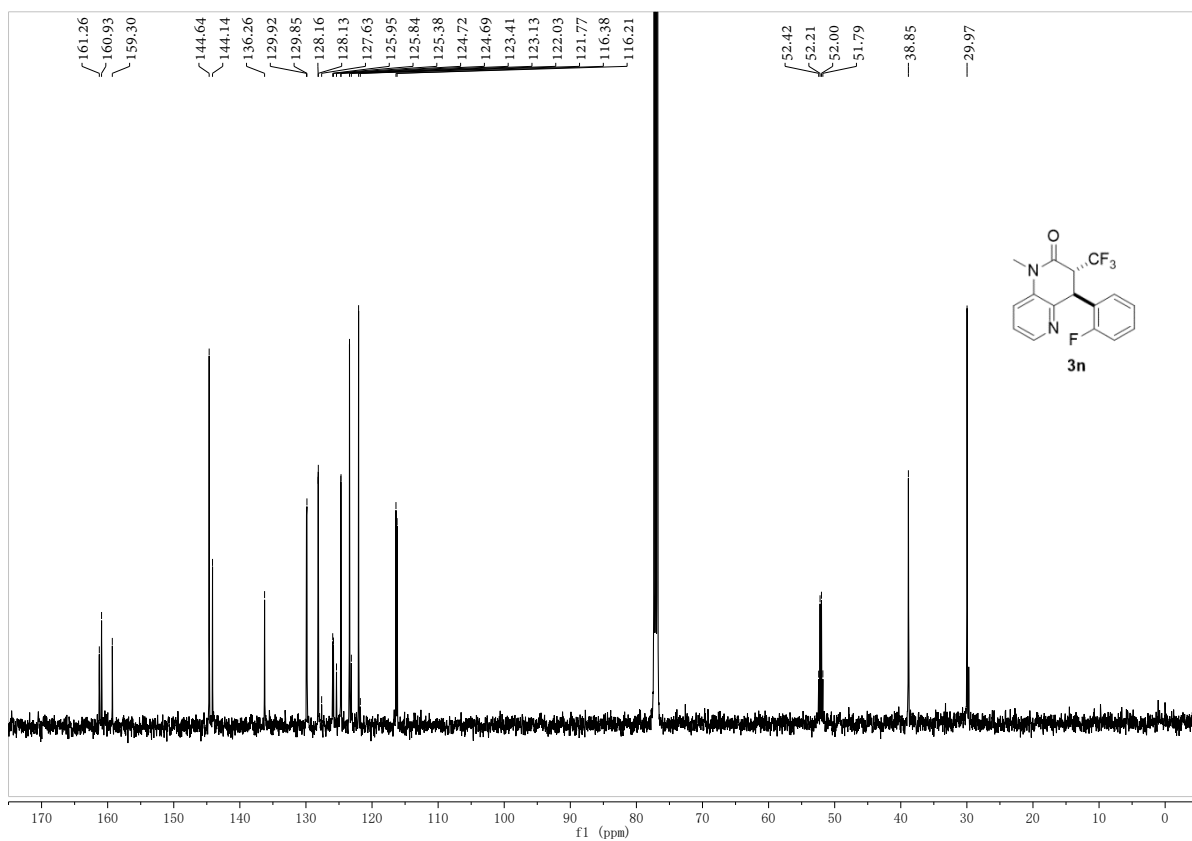


<sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) spectrum of **3m**

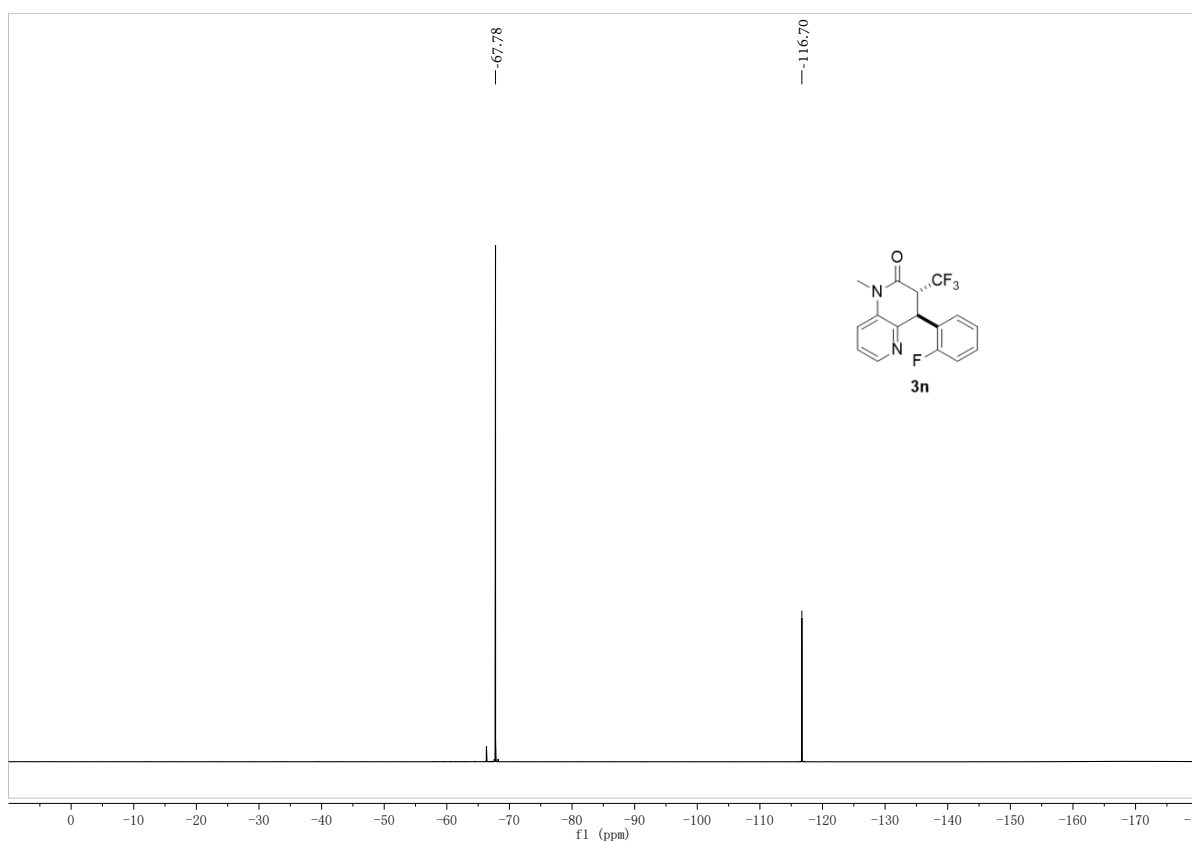


<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) of **3m**





<sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) spectrum of **3n**

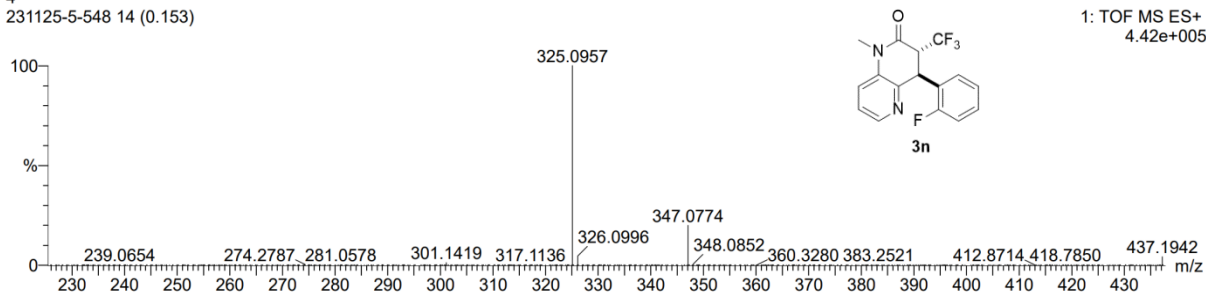


<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3n**



Monoisotopic Mass, Even Electron Ions  
 371 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 16-16 H: 13-13 N: 0-200 O: 0-100 Na: 0-2 F: 4-4

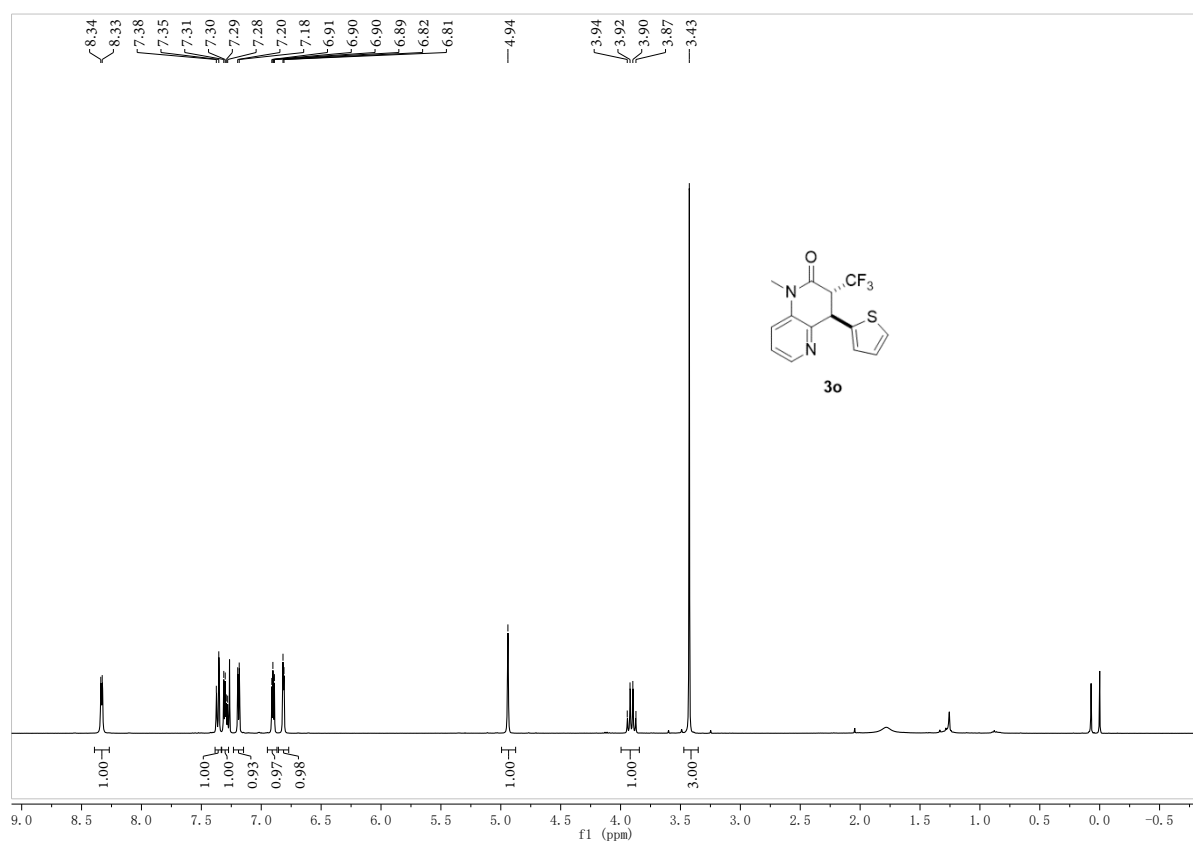
4  
 231125-5-548 14 (0.153)



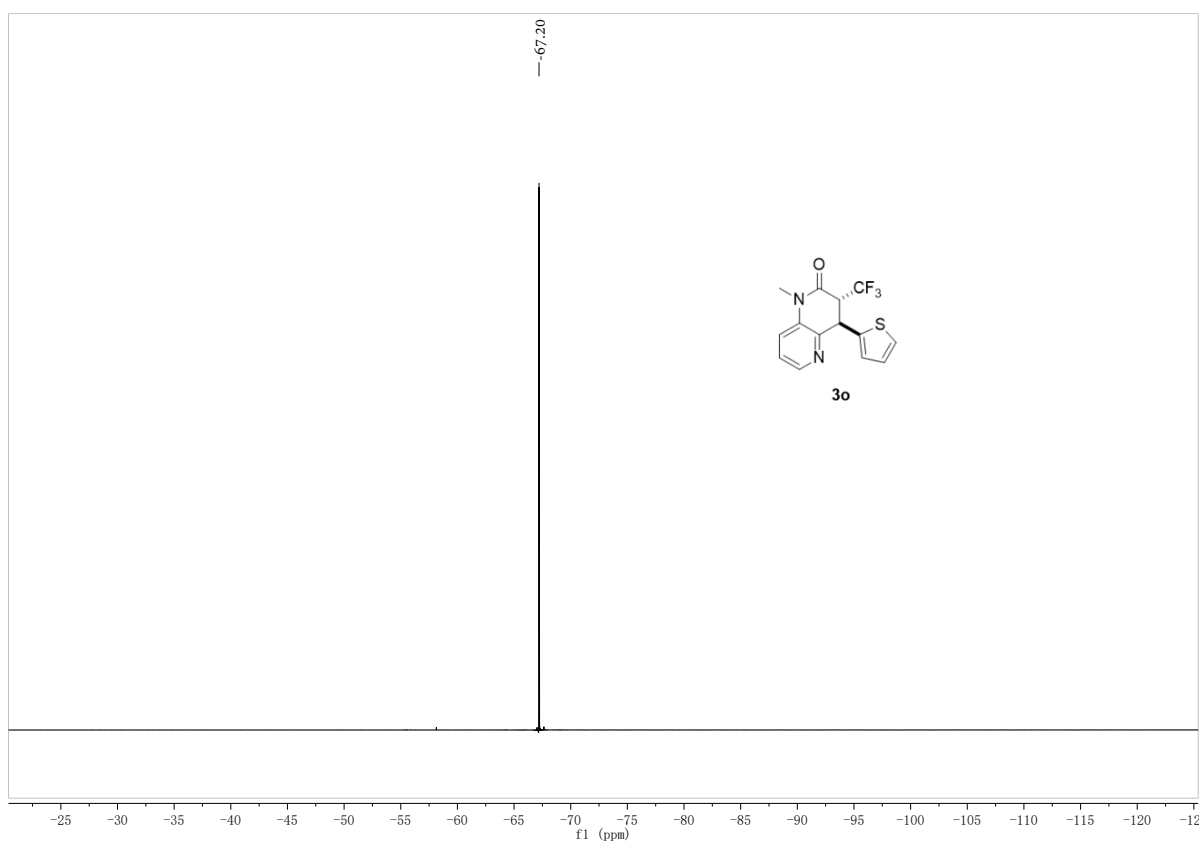
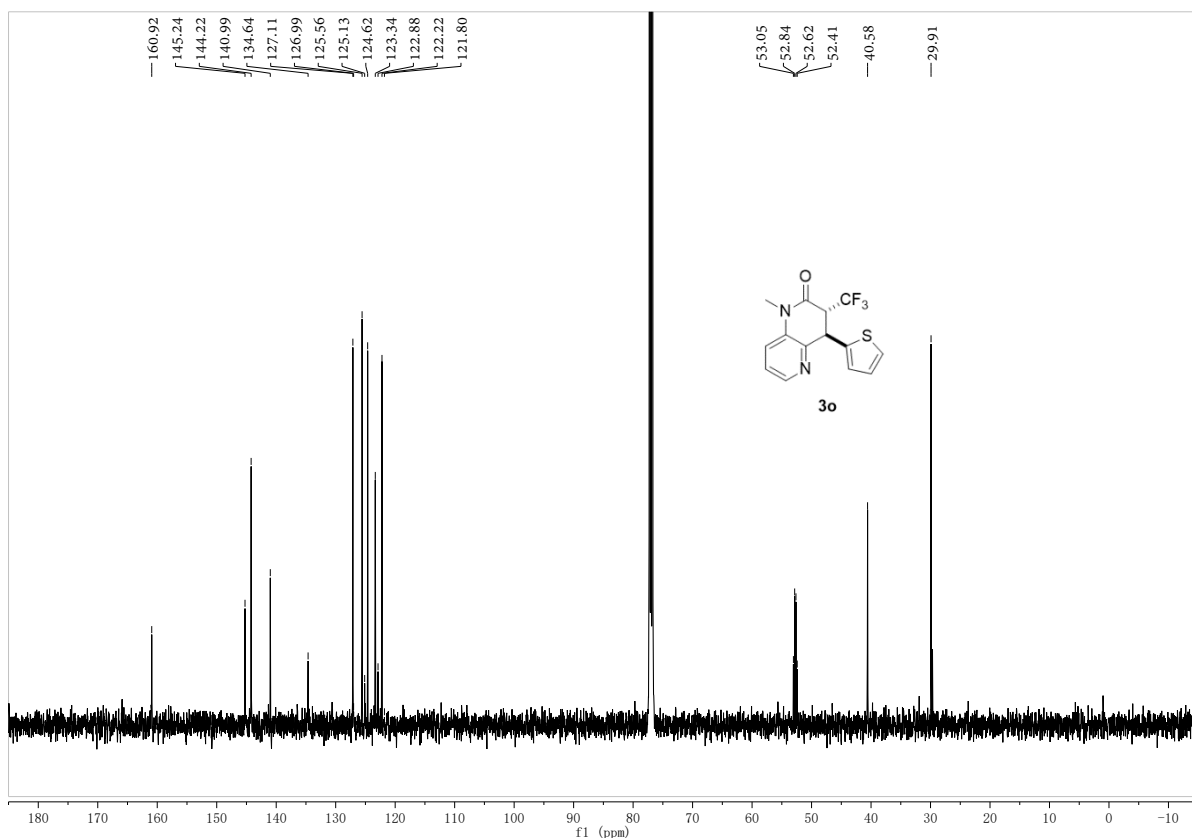
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|-----|-------|------|----------|-----------------|
| 325.0957 | 325.0964   | -0.7 | -2.2 | 9.5 | 134.5 | n/a  | n/a      | C16 H13 N2 O F4 |

HRMS (ESI) spectrum of **3n**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3o**



Monoisotopic Mass, Even Electron Ions

680 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

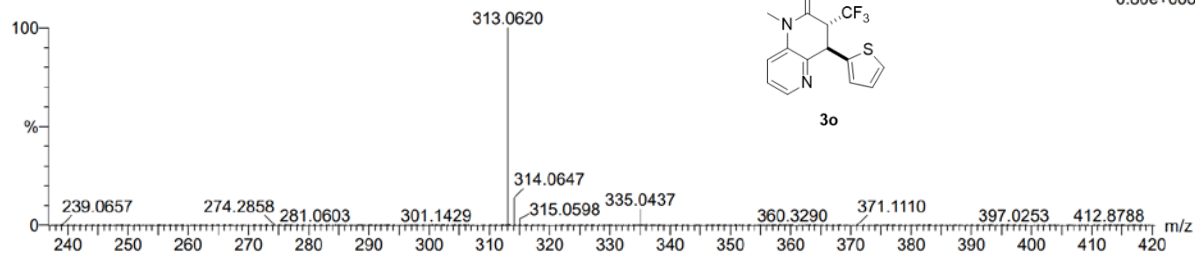
Elements Used:

C: 14-14 H: 12-12 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 S: 1-3

8

231125-5-345 13 (0.145)

1: TOF MS ES+  
6.80e+006



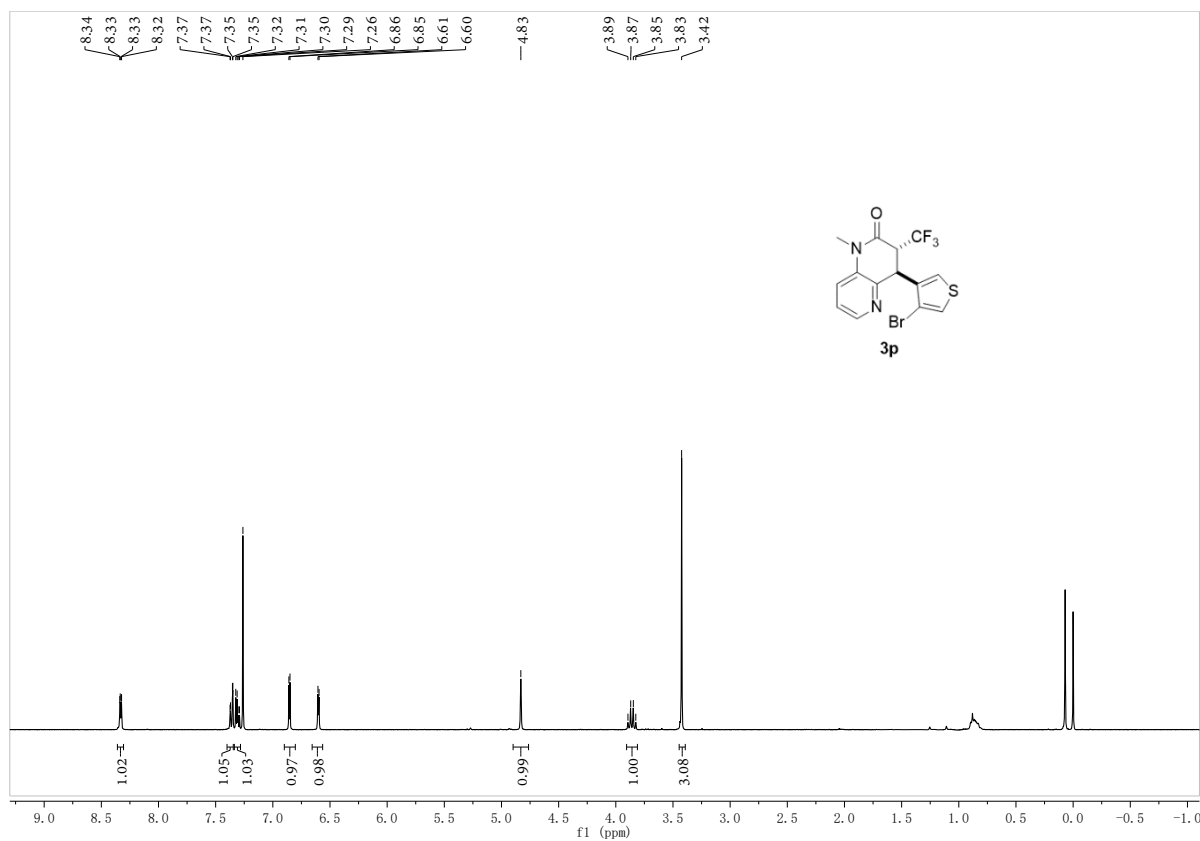
Minimum:

Maximum:

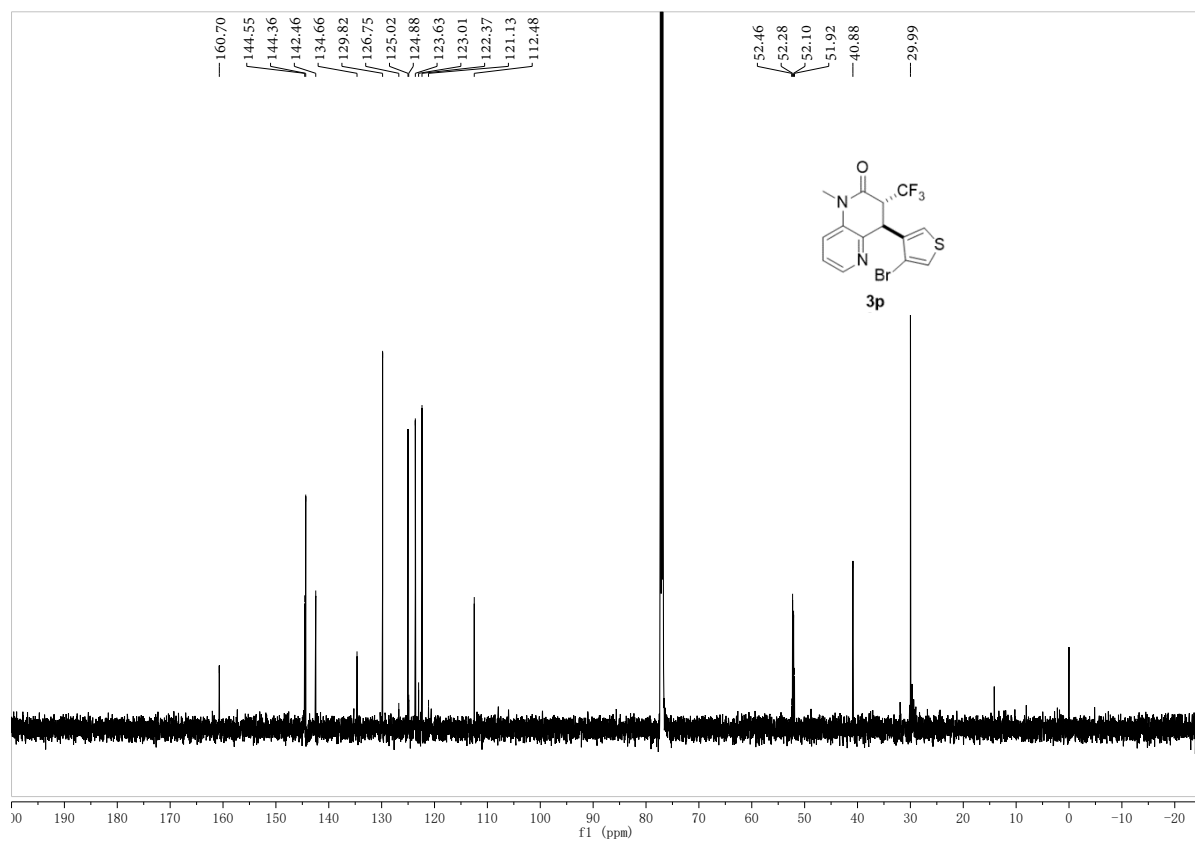
5.0 10.0 -1.5  
-0.6 8.5

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula           |
|----------|------------|------|------|-----|-------|------|----------|-------------------|
| 313.0620 | 313.0622   | -0.2 | -0.6 | 8.5 | 163.7 | n/a  | n/a      | C14 H12 N2 O F3 S |

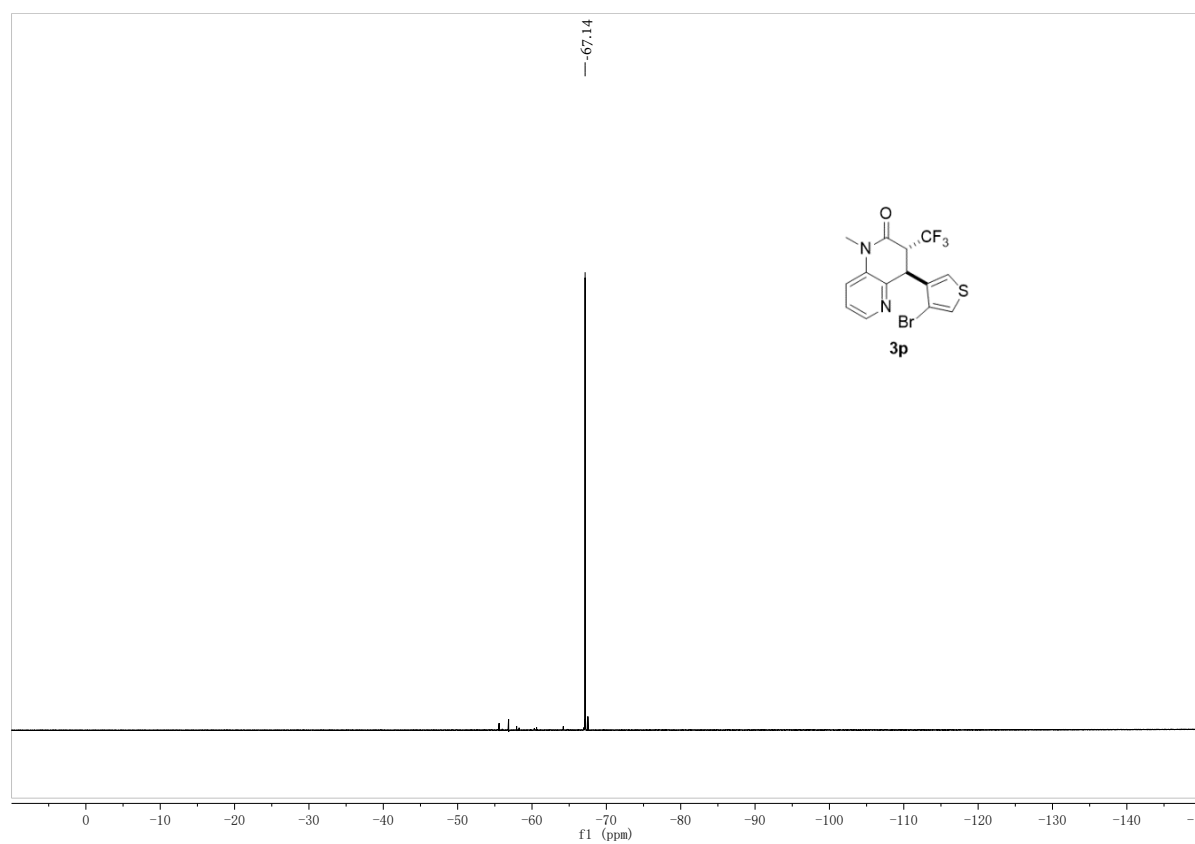
HRMS (ESI) spectrum of **3o**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3p**



$^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ ) spectrum of **3p**



$^{19}\text{F}$  NMR (471 MHz,  $\text{CDCl}_3$ ) of **3p**

Monoisotopic Mass, Even Electron Ions

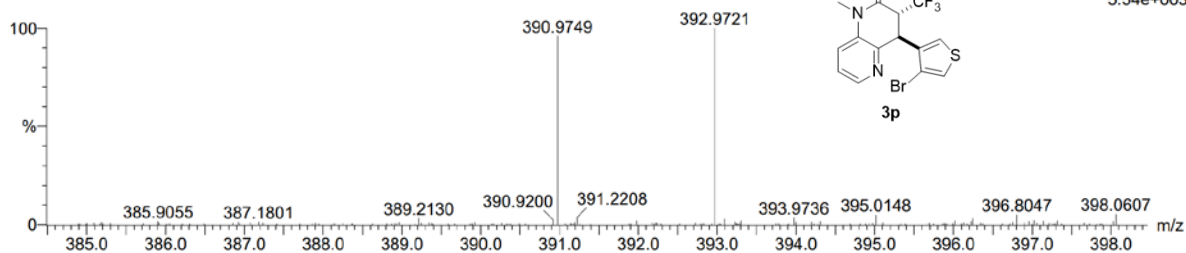
96 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 14-14 H: 0-115 N: 0-8 O: 0-15 F: 3-3 S: 1-1 Br: 1-1

14

231118-5-543-----c 11 (0.128)

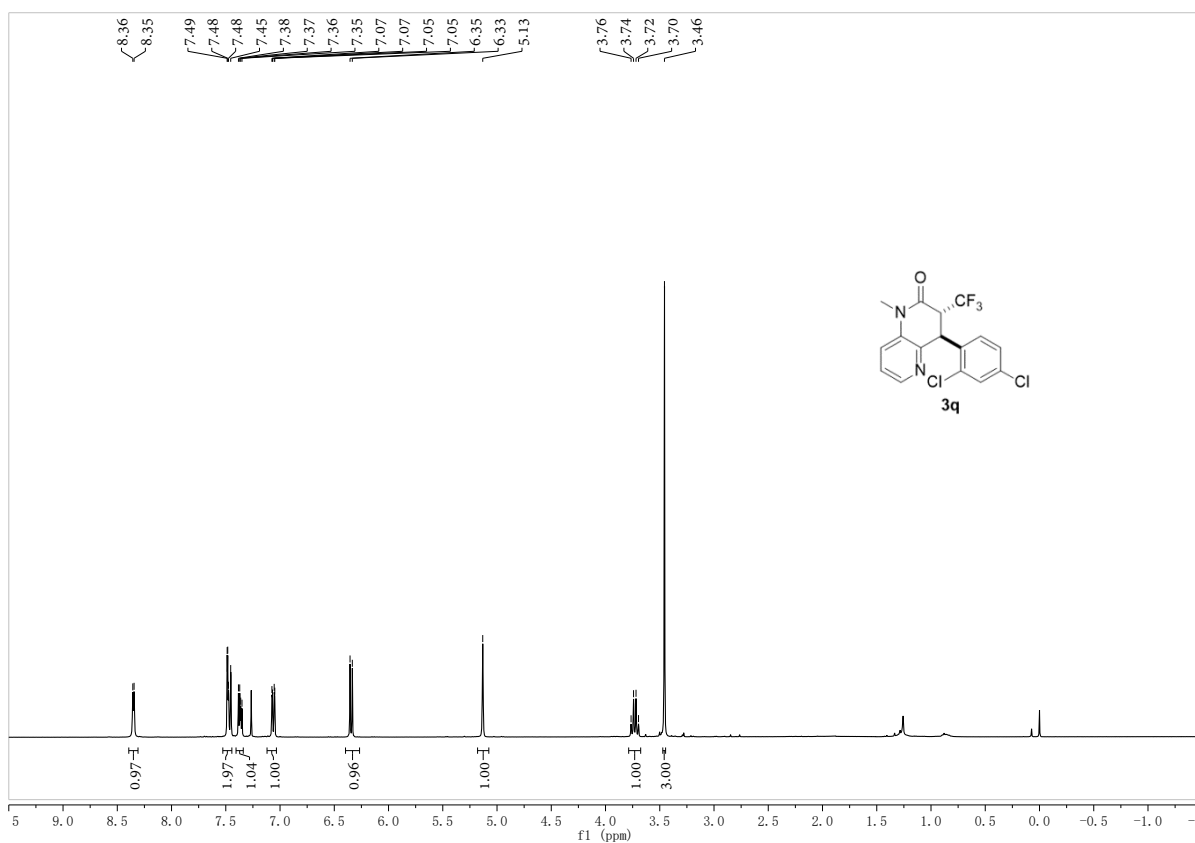


1: TOF MS ES+  
5.54e+003

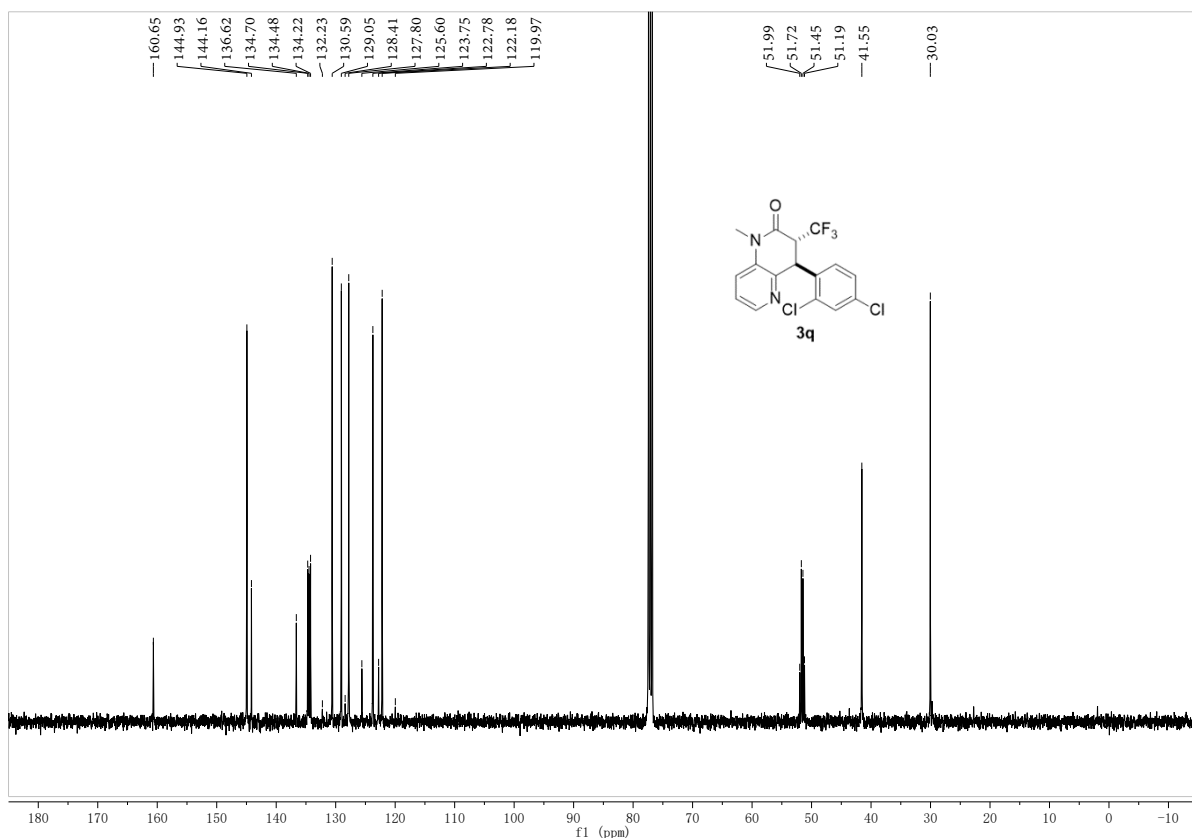
Minimum: -1.5  
Maximum: 5.0 20.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf(%) | Formula              |
|----------|------------|-----|-----|-----|-------|------|---------|----------------------|
| 390.9749 | 390.9728   | 2.1 | 5.4 | 8.5 | 233.1 | n/a  | n/a     | C14 H11 N2 O F3 S Br |

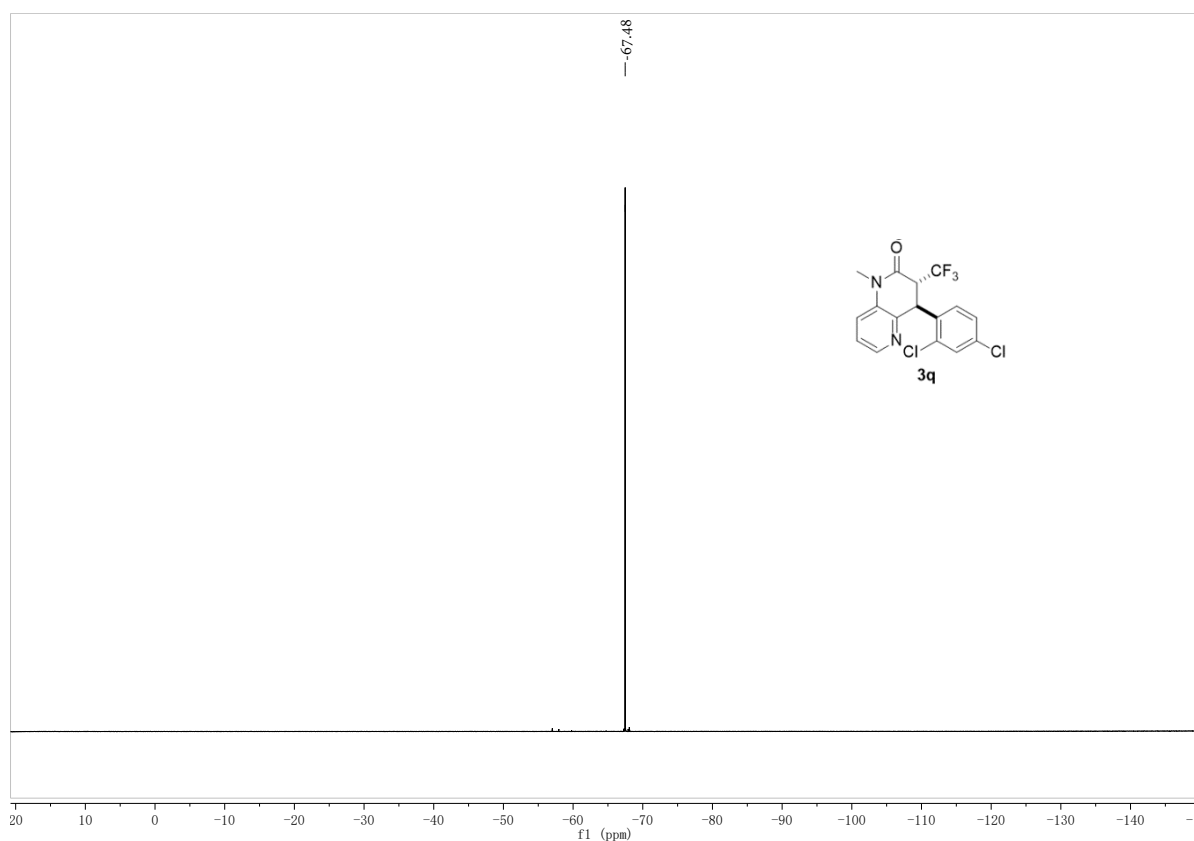
HRMS (ESI) spectrum of **3p**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3q**

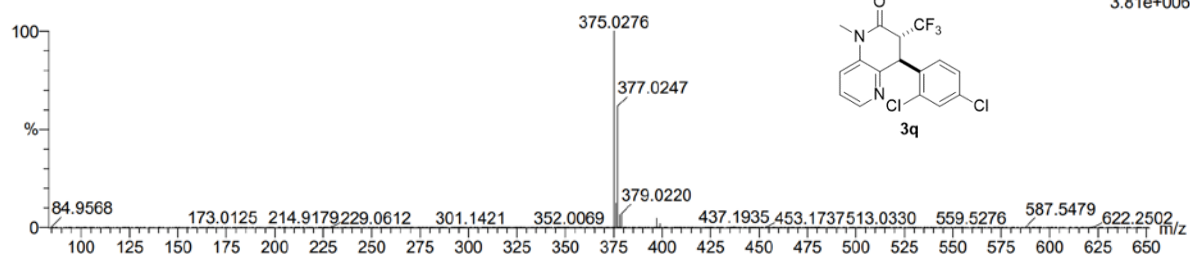


<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3q**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) of **3q**

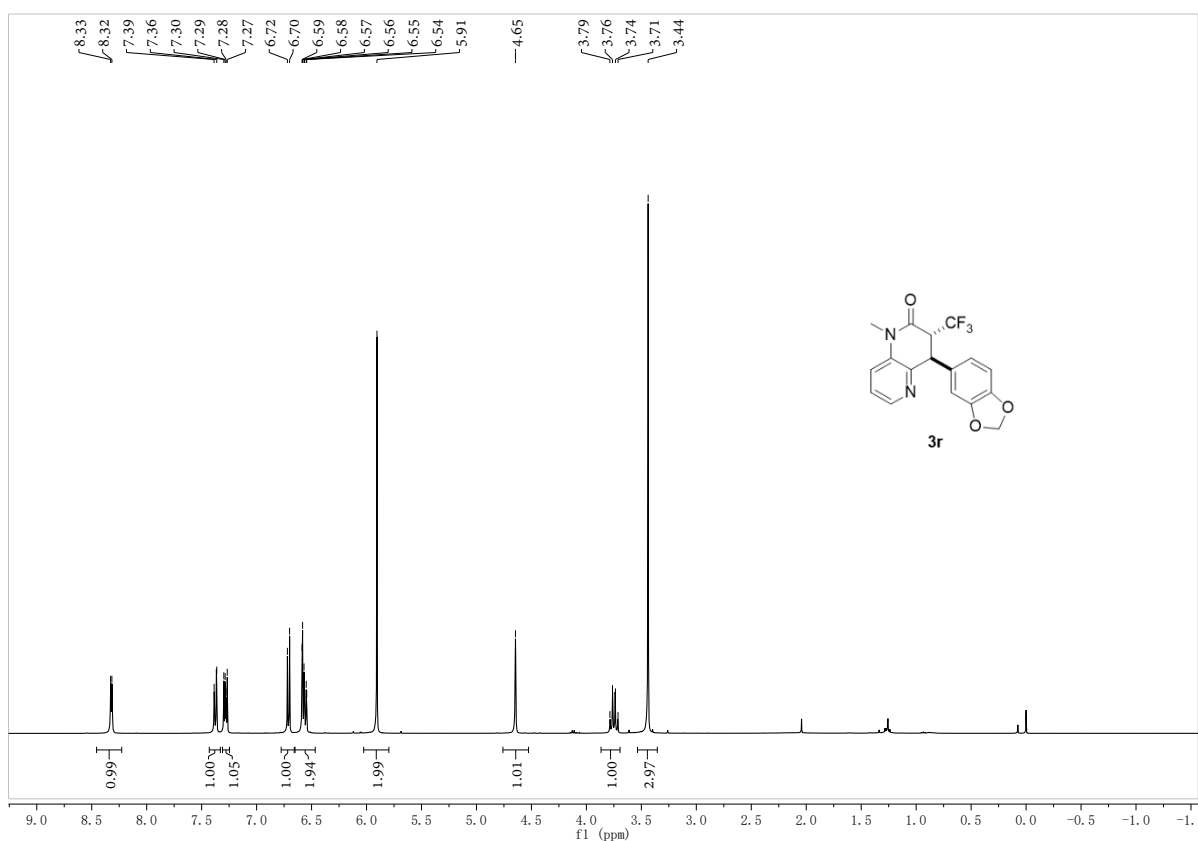
Monoisotopic Mass, Even Electron Ions  
 1309 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 16-16 H: 12-12 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Cl: 1-4  
 8  
 231125-5-330 14 (0.153)



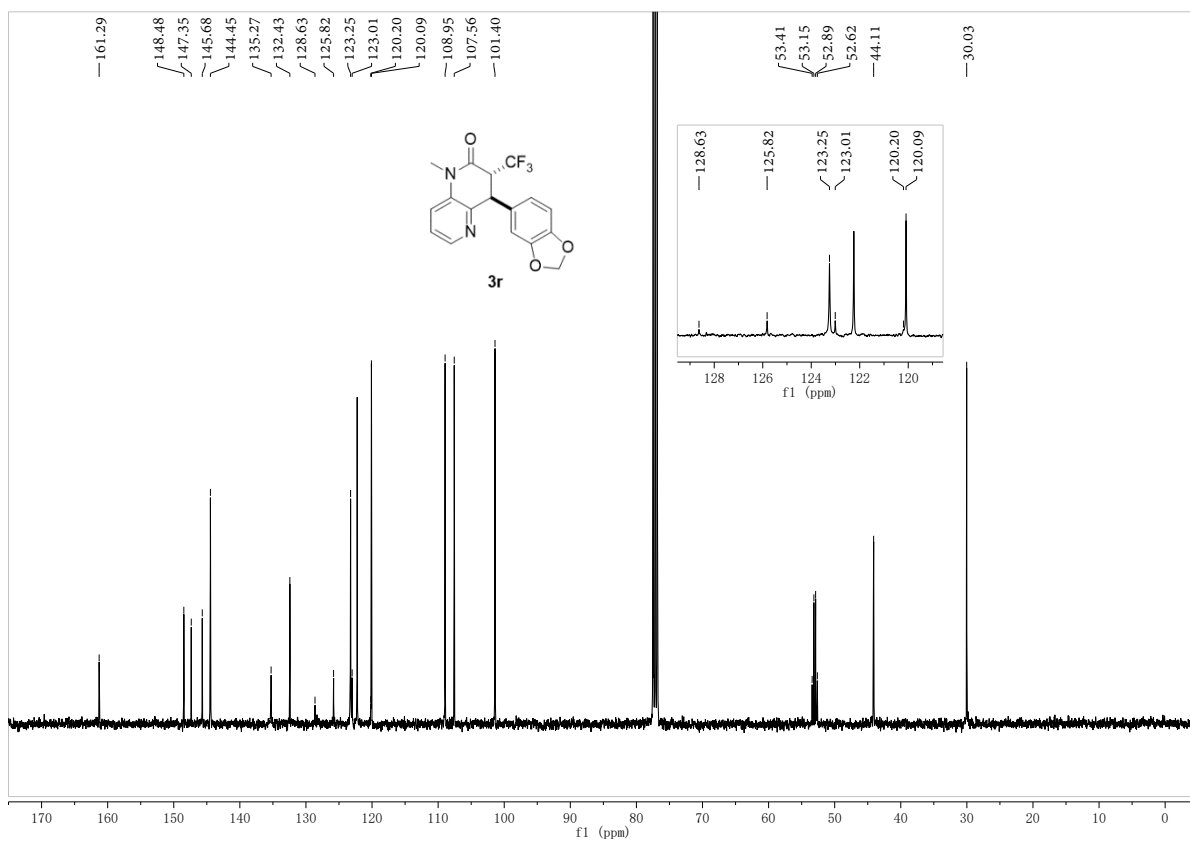
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula             |
|----------|------------|------|------|-----|-------|------|----------|---------------------|
| 375.0276 | 375.0279   | -0.3 | -0.8 | 9.5 | 151.5 | n/a  | n/a      | C16 H12 N2 O F3 Cl2 |

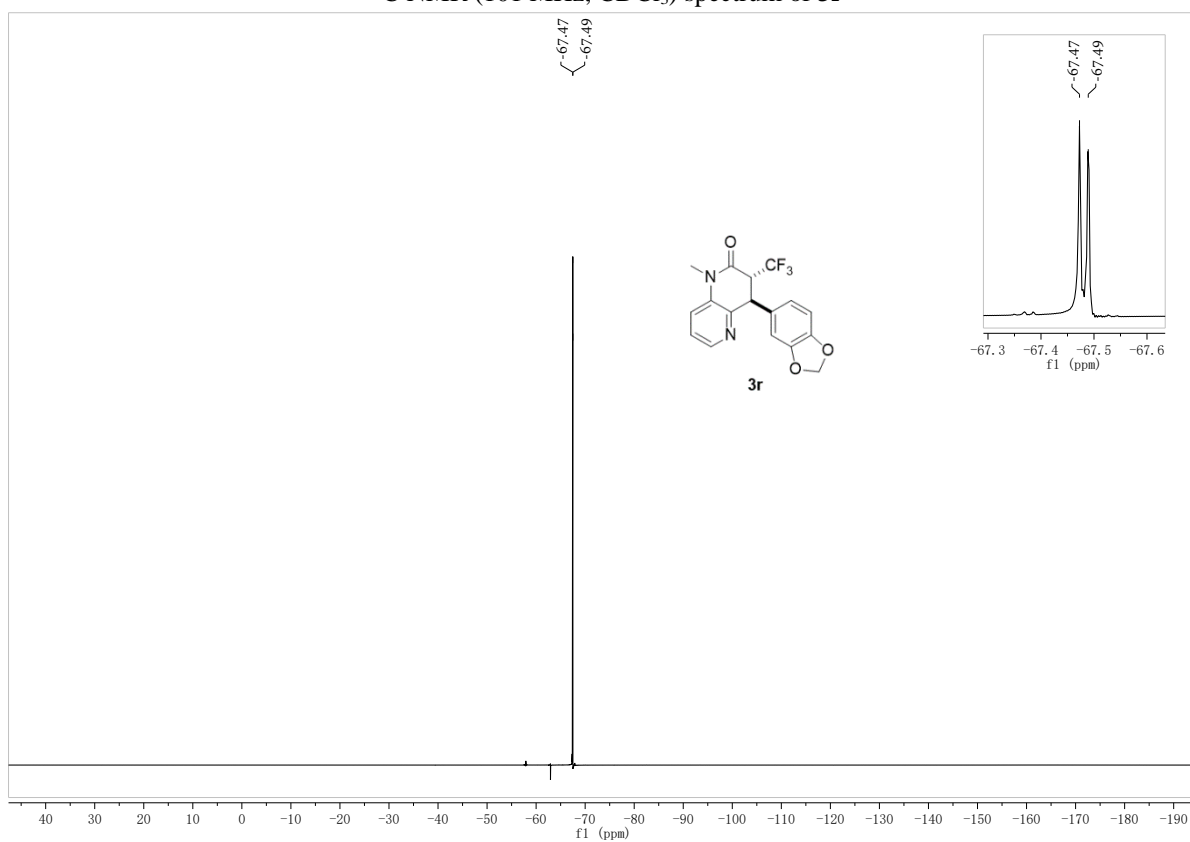
HRMS (ESI) spectrum of **3q**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3r**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3r**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) of **3r**



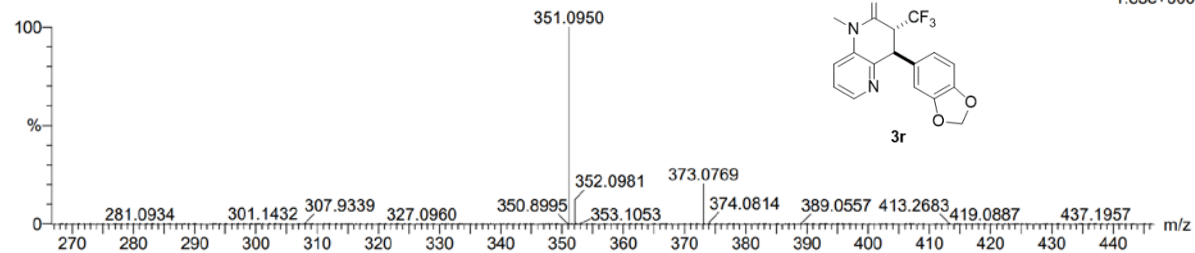
Monoisotopic Mass, Even Electron Ions  
 506 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:

C: 17-17 H: 14-14 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

8

231125-5-314 11 (0.127)

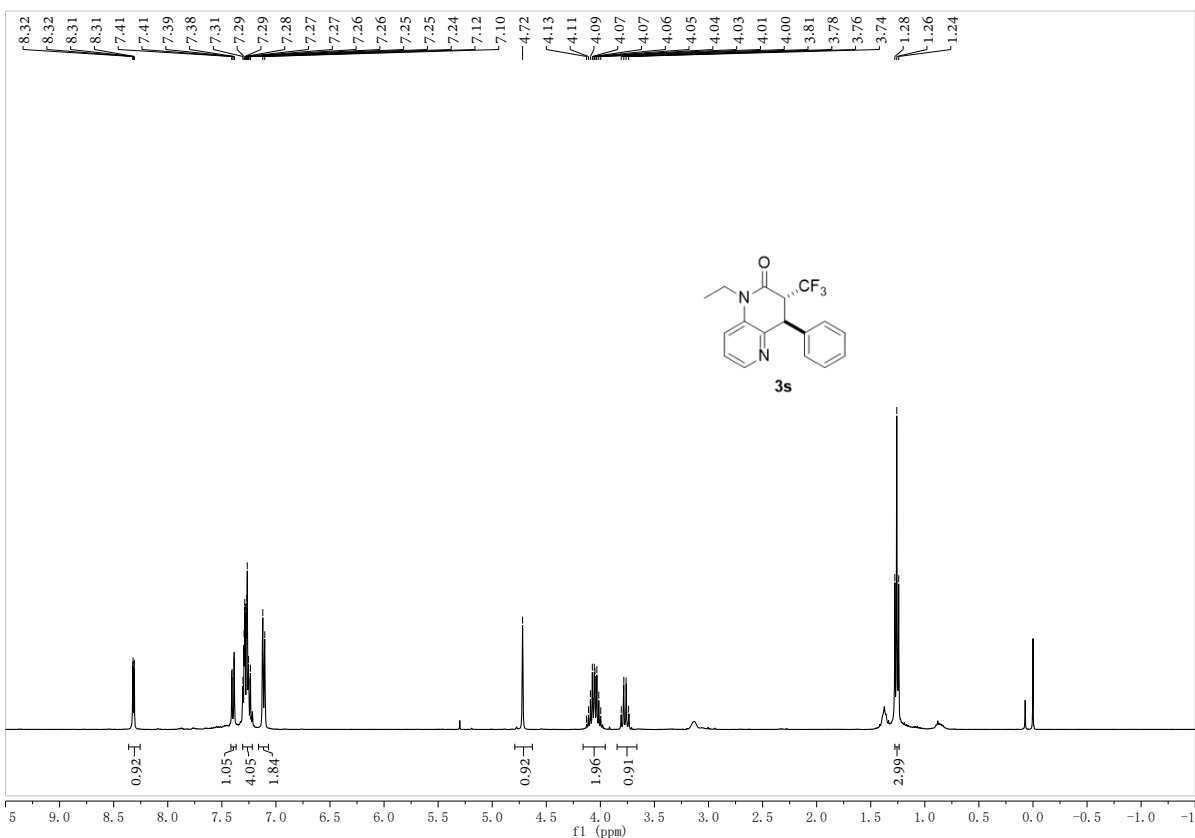
1: TOF MS ES+  
 1.85e+006



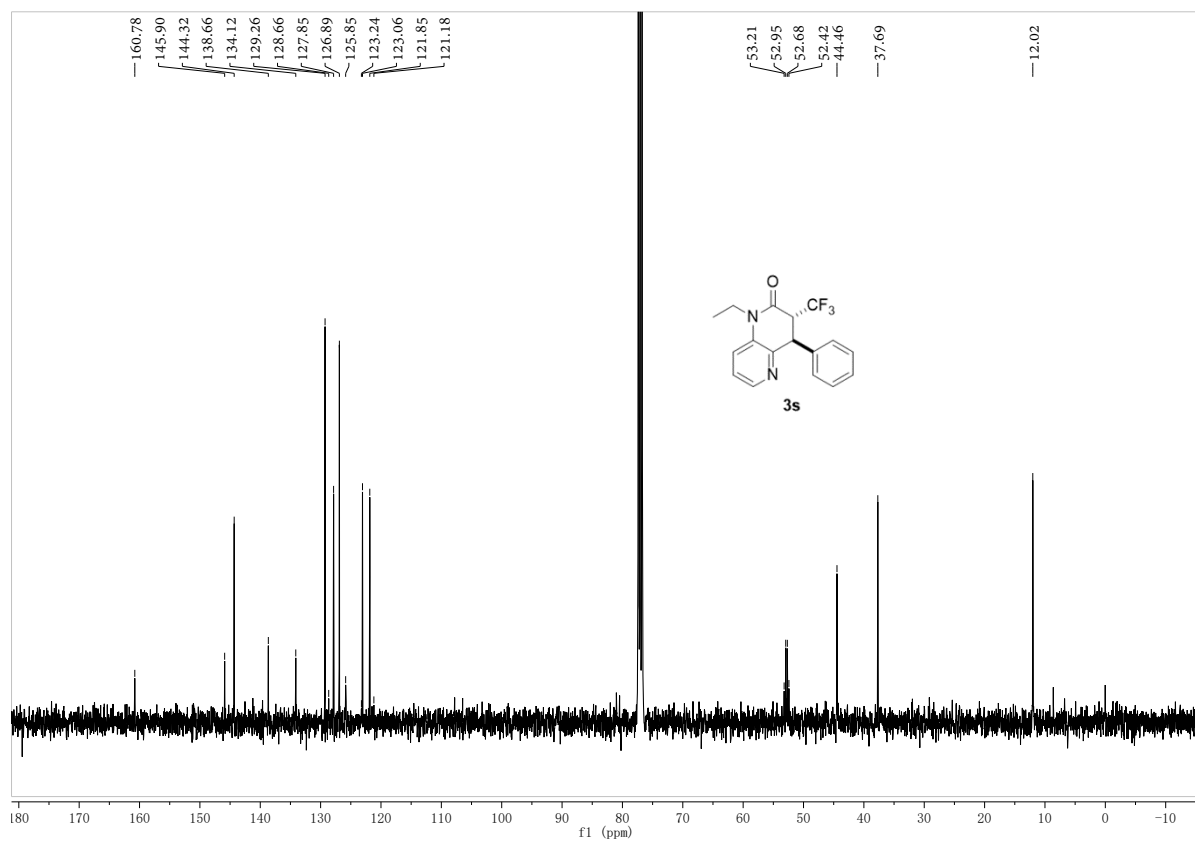
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE  | i-FIT | Norm | Conf (%) | Formula          |
|----------|------------|------|------|------|-------|------|----------|------------------|
| 351.0950 | 351.0957   | -0.7 | -2.0 | 10.5 | 151.6 | n/a  | n/a      | C17 H14 N2 O3 F3 |

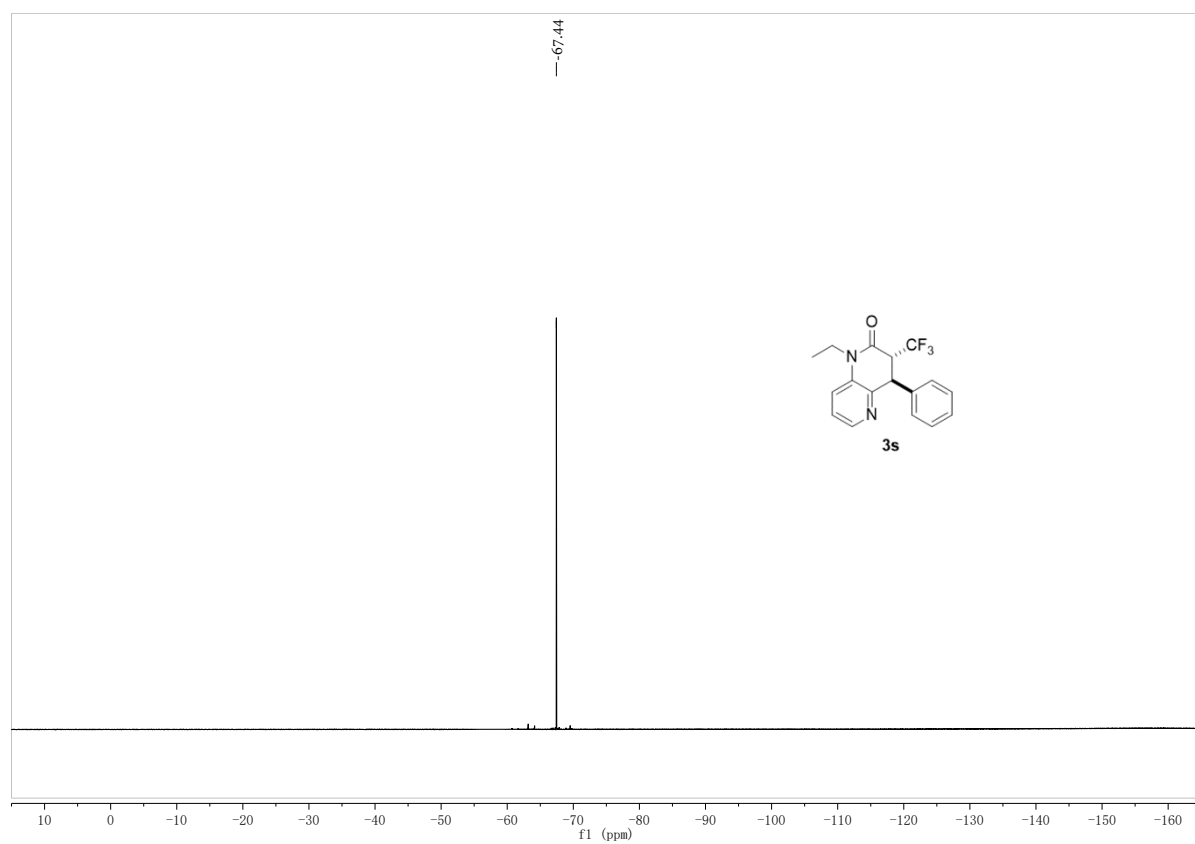
### HRMS (ESI) spectrum of **3r**



### <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3s**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3s**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3s**

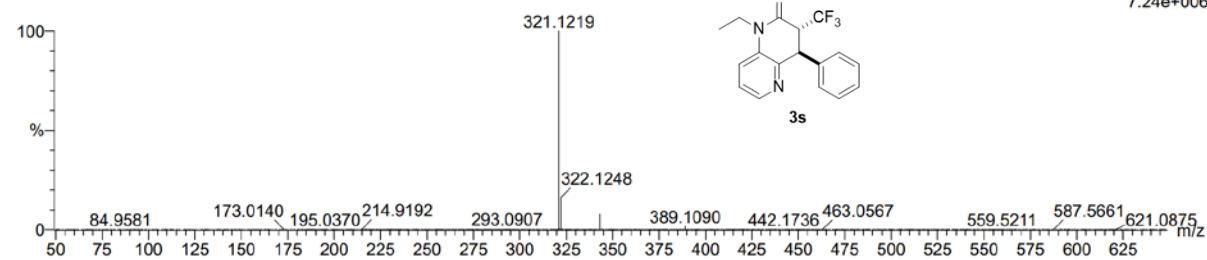
Monoisotopic Mass, Even Electron Ions  
 420 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:

C: 17-17 H: 16-16 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

8

231125-5-282 16 (0.170)

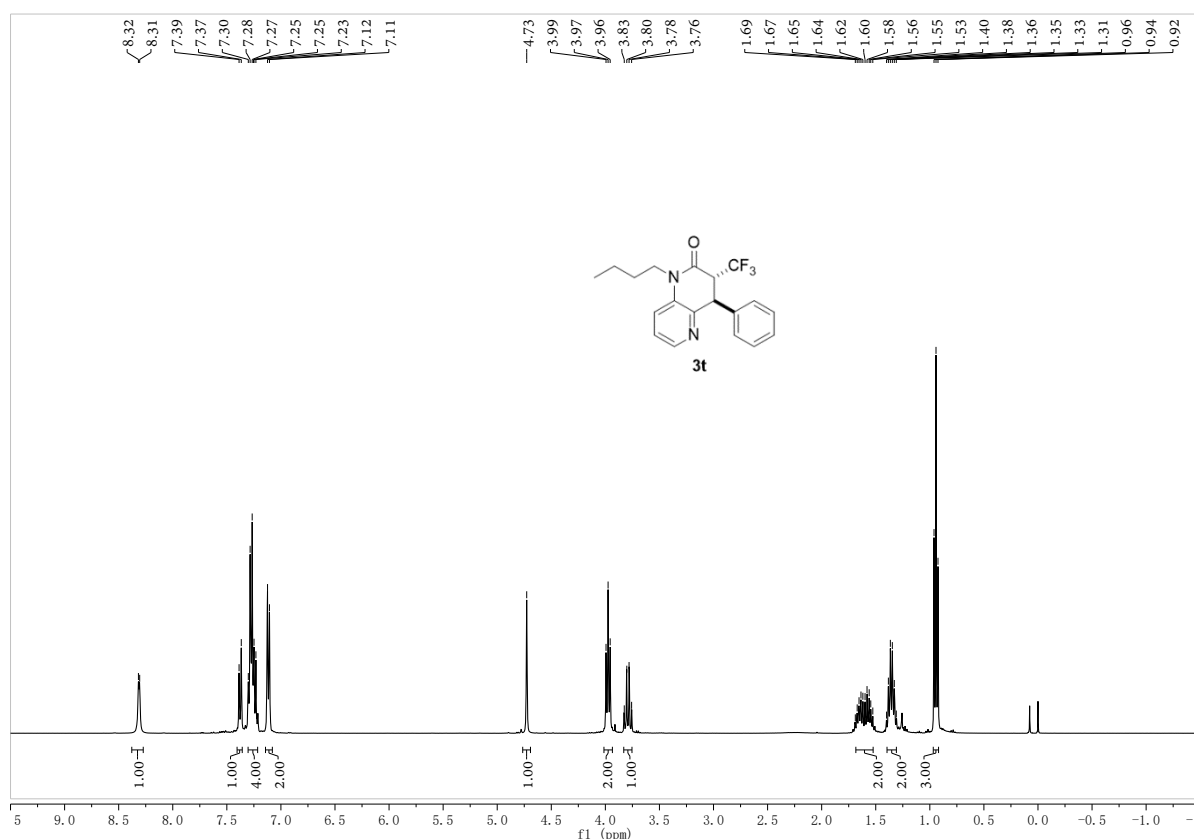
1: TOF MS ES+  
 7.24e+006



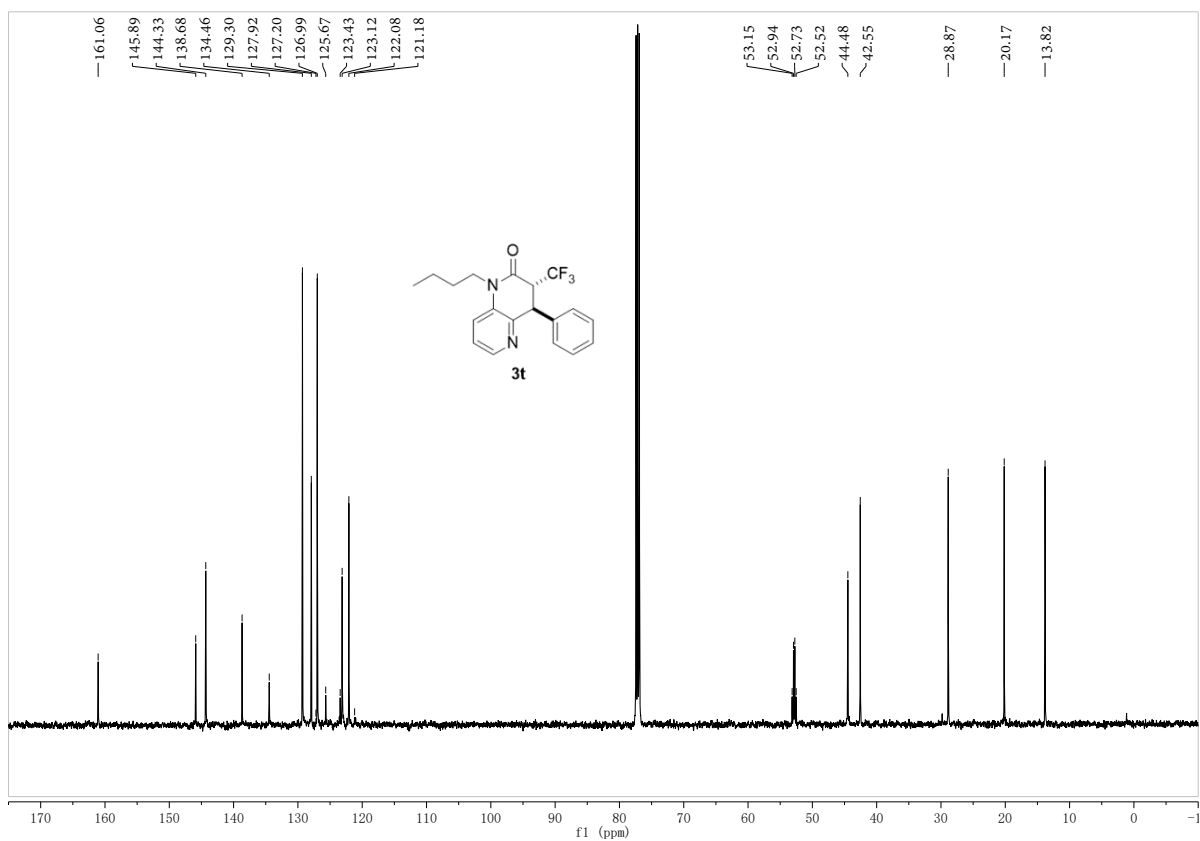
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|-----|-----|-----|-------|------|----------|-----------------|
| 321.1219 | 321.1215   | 0.4 | 1.2 | 9.5 | 201.5 | n/a  | n/a      | C17 H16 N2 O F3 |

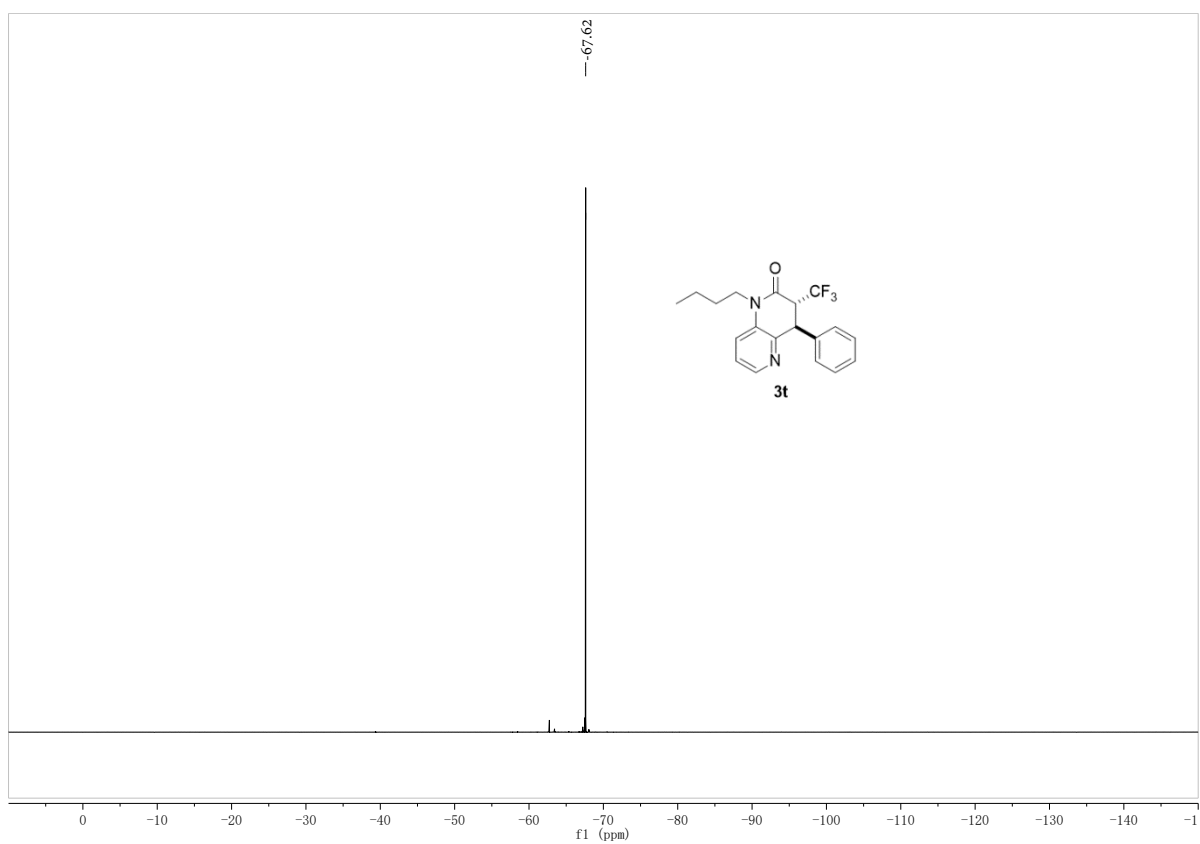
HRMS (ESI) spectrum of 3s



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of 3t



$^{13}\text{C}$  NMR (126 MHz,  $\text{CDCl}_3$ ) spectrum of **3t**



$^{19}\text{F}$  NMR (471 MHz,  $\text{CDCl}_3$ ) spectrum of **3t**

Monoisotopic Mass, Even Electron Ions

517 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

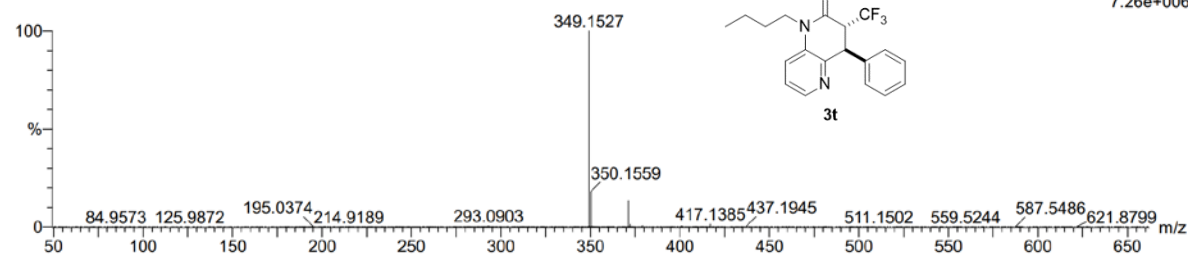
Elements Used:

C: 19-19 H: 20-20 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

4

231125-5-379 17 (0.179)

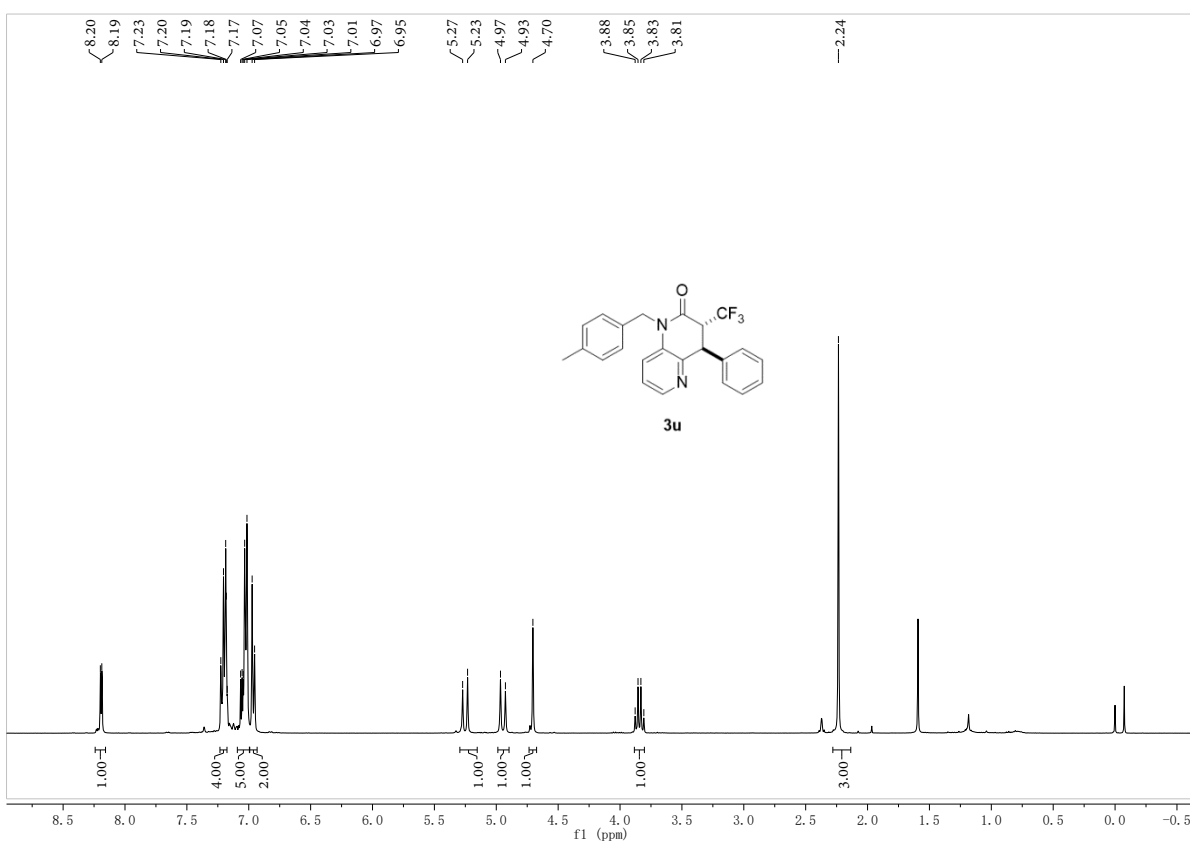
1: TOF MS ES+  
7.26e+006



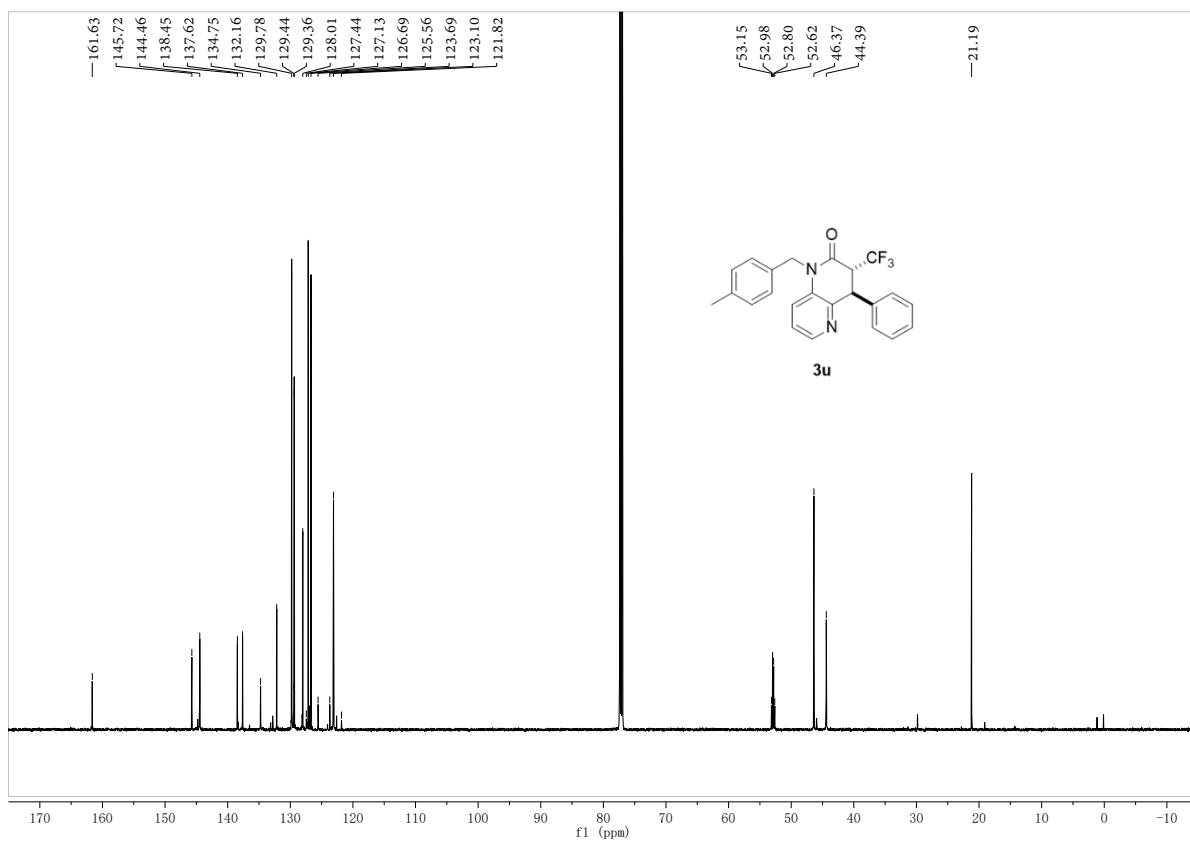
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|-----|-------|------|----------|-----------------|
| 349.1527 | 349.1528   | -0.1 | -0.3 | 9.5 | 202.7 | n/a  | n/a      | C19 H20 N2 O F3 |

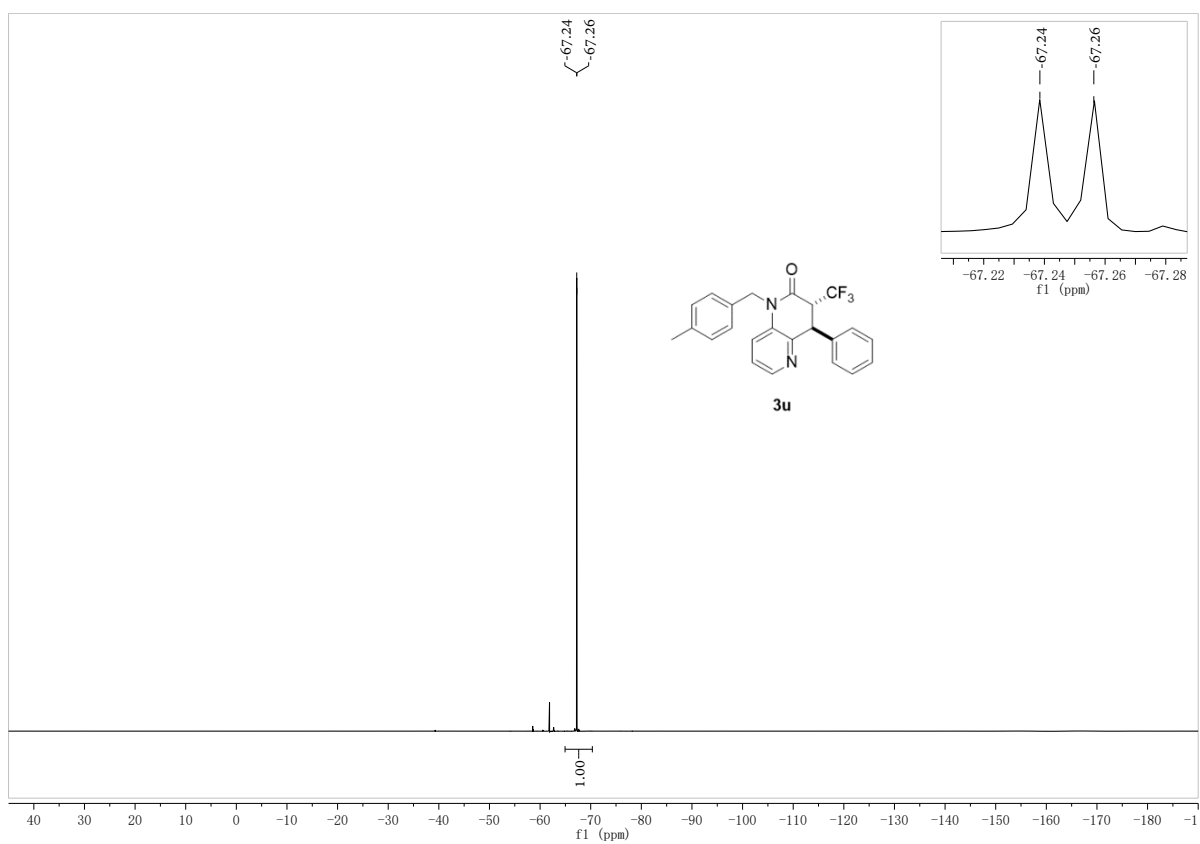
HRMS (ESI) spectrum of **3t**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3u**

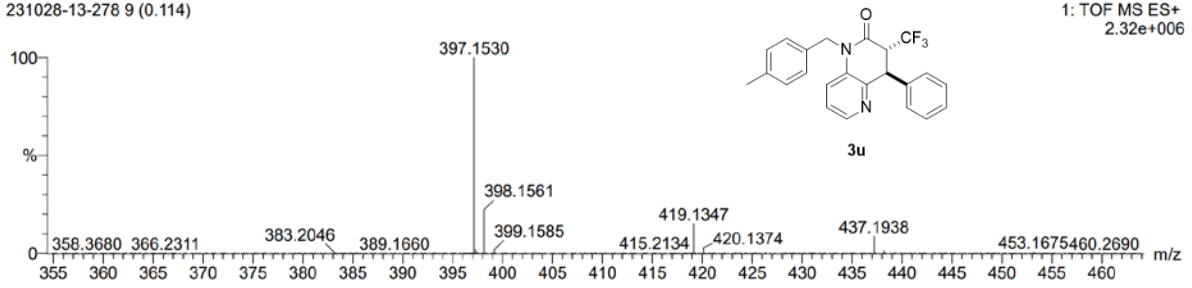


<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3u**



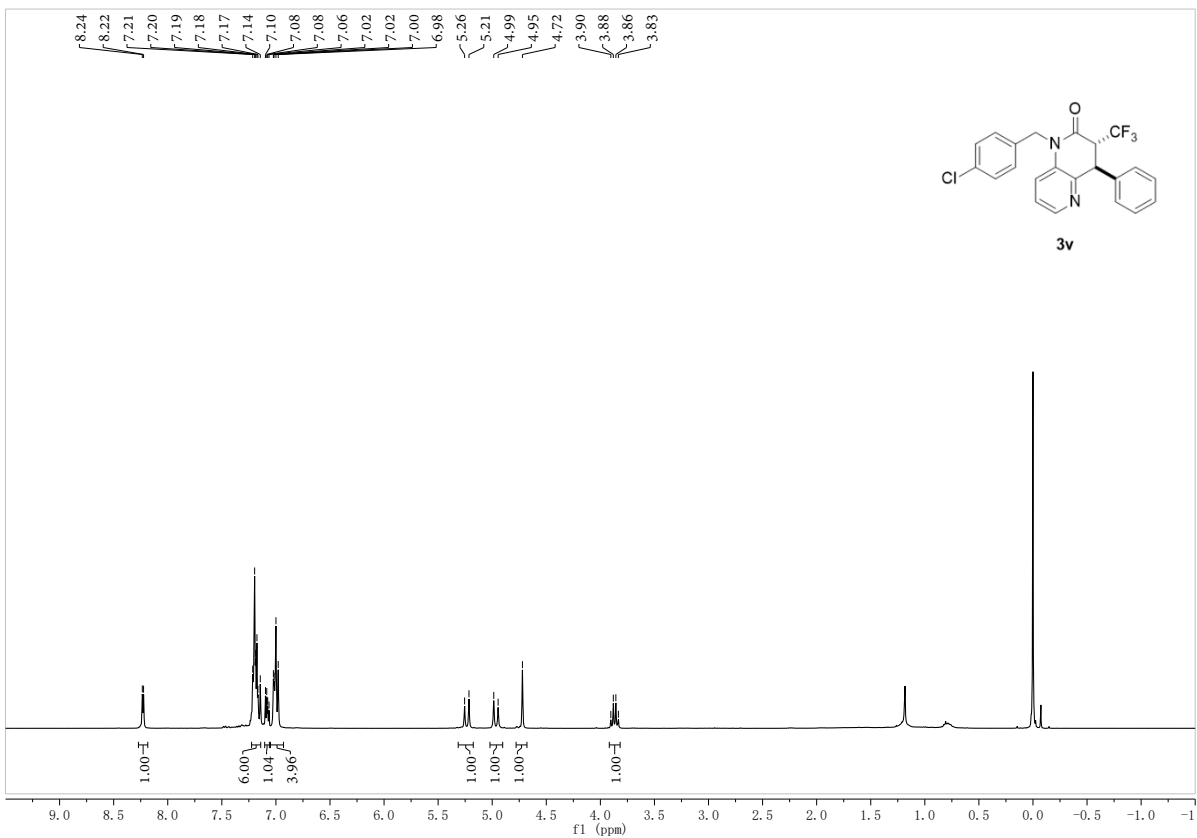
<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3u**

Monoisotopic Mass, Even Electron Ions  
 268 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 23-23 H: 20-20 N: 0-200 O: 0-200 F: 3-3  
 21  
 231028-13-278 9 (0.114)

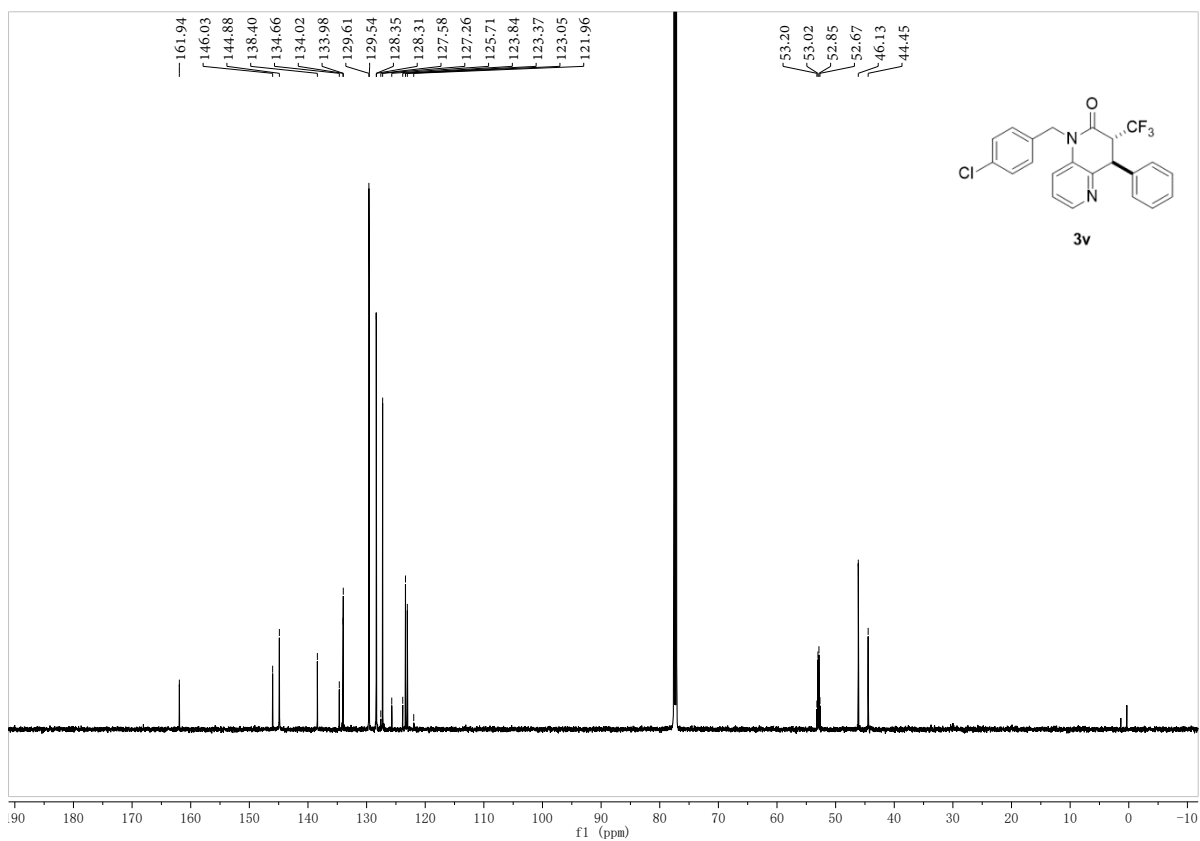


| Mass     | Calc. Mass | mDa | PPM | DBE  | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|-----|-----|------|-------|------|----------|-----------------|
| 397.1530 | 397.1528   | 0.2 | 0.5 | 13.5 | 351.0 | n/a  | n/a      | C23 H20 N2 O F3 |

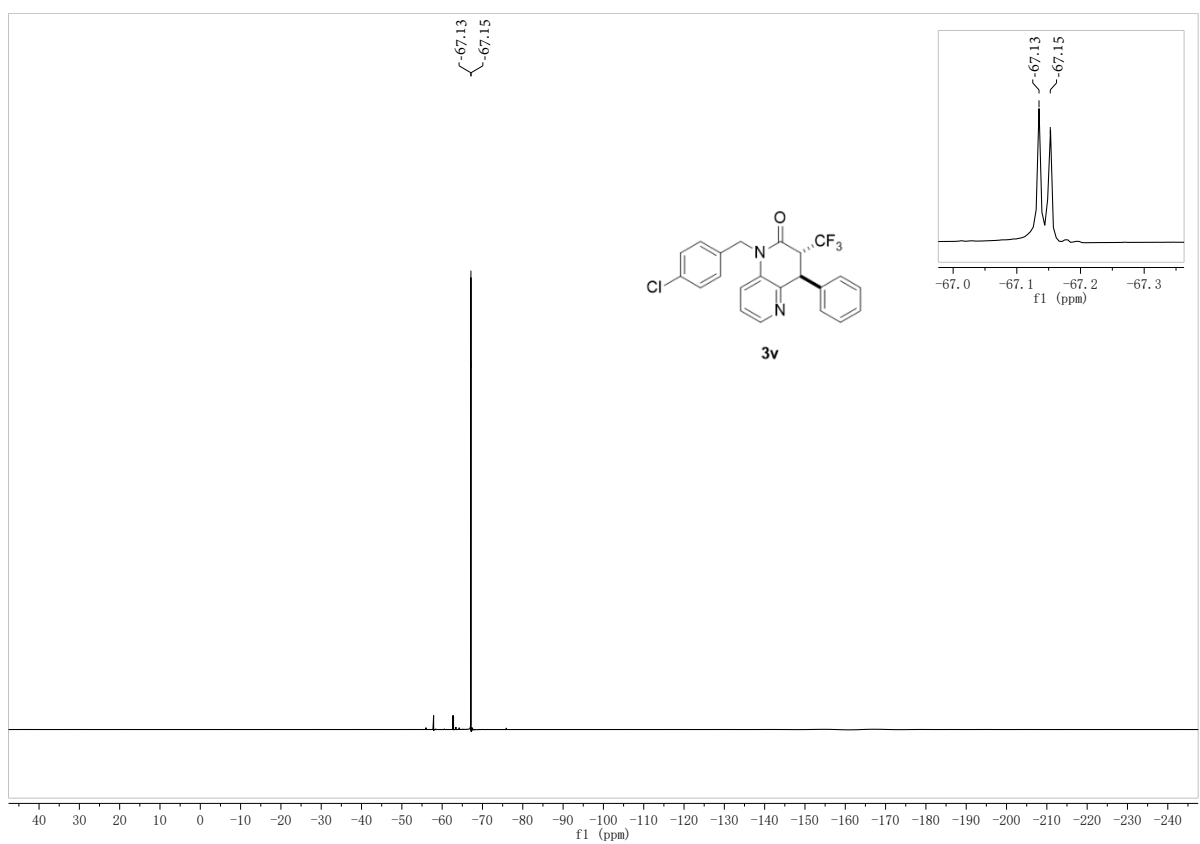
HRMS (ESI) spectrum of **3u**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3v**



<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3v**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3v**



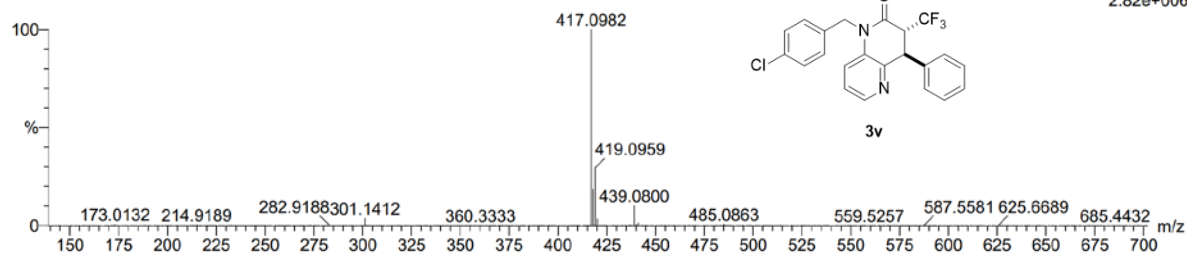
Monoisotopic Mass, Even Electron Ions  
 1898 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:

C: 22-22 H: 17-17 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Cl: 1-4

4

231125-5-277 16 (0.171)

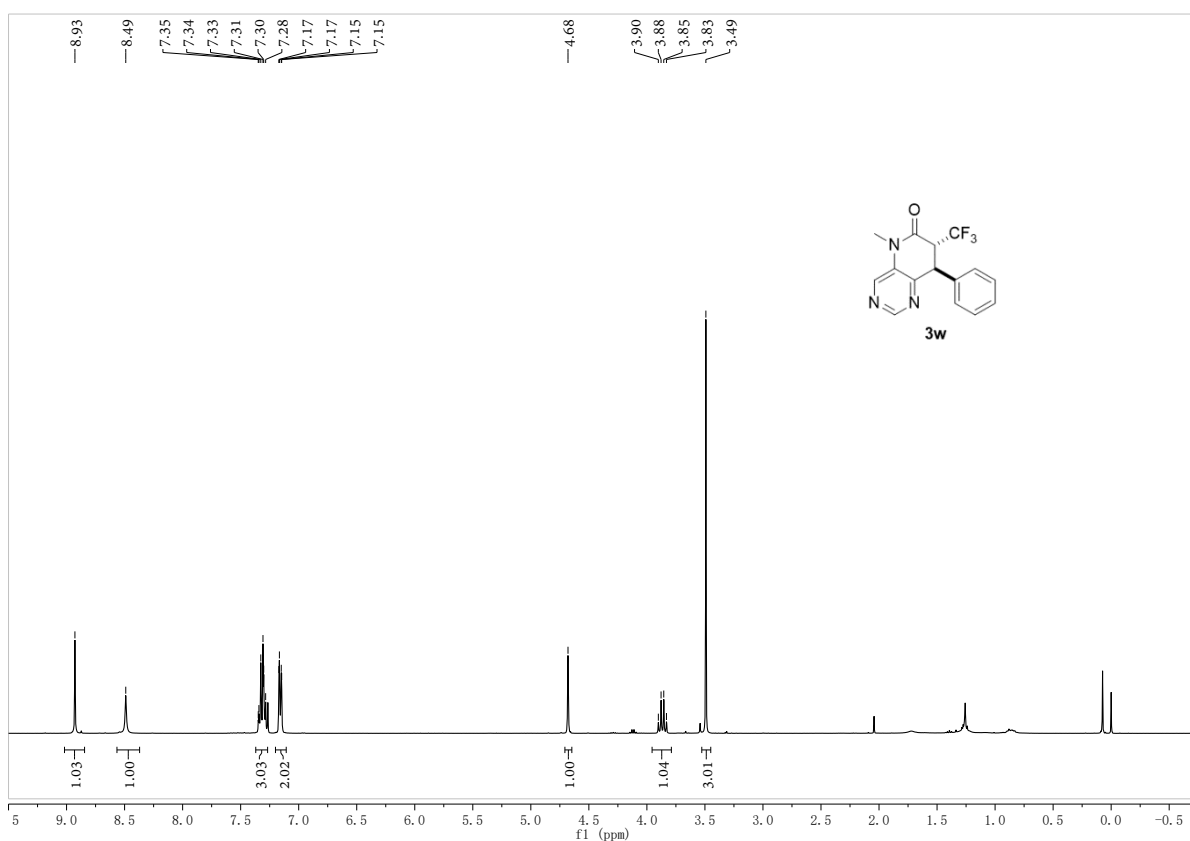
1: TOF MS ES+  
 2.82e+006



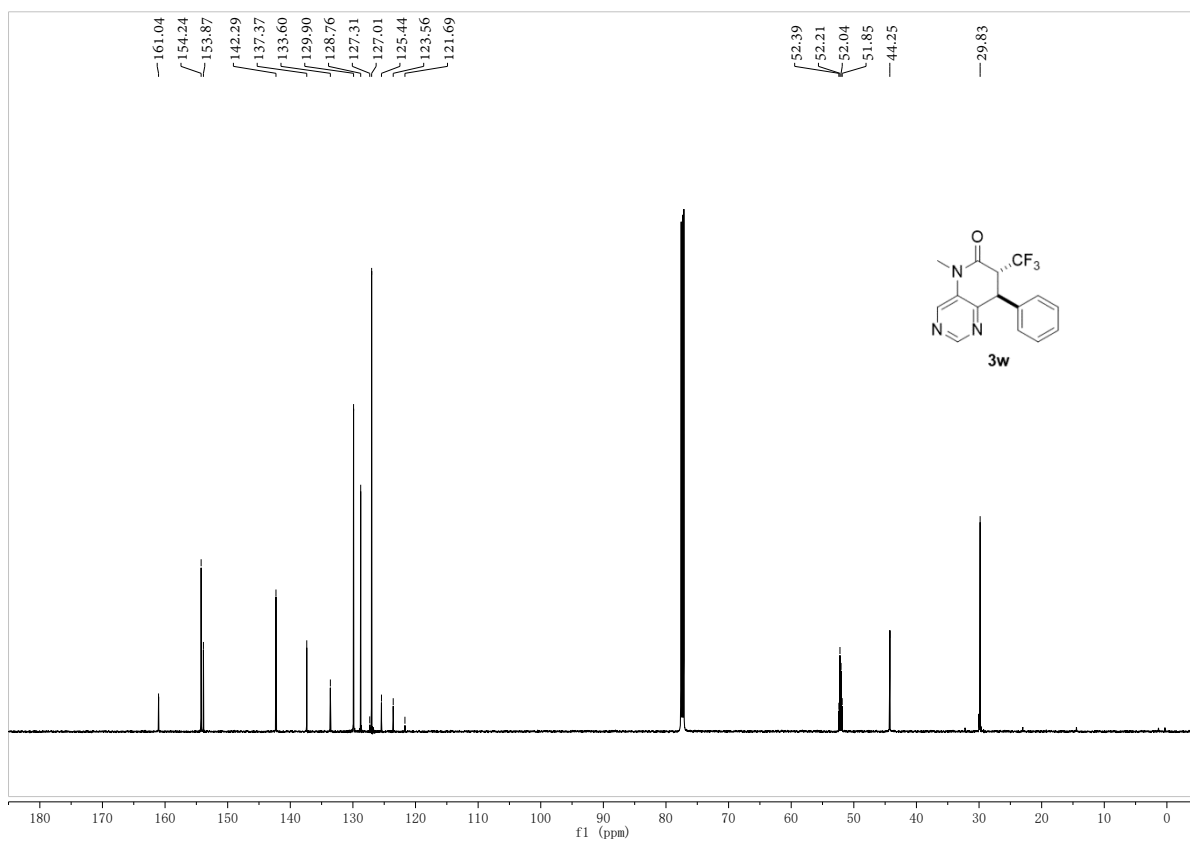
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE  | i-FIT | Norm | Conf(%) | Formula            |
|----------|------------|-----|-----|------|-------|------|---------|--------------------|
| 417.0982 | 417.0982   | 0.0 | 0.0 | 13.5 | 137.9 | n/a  | n/a     | C22 H17 N2 O F3 Cl |

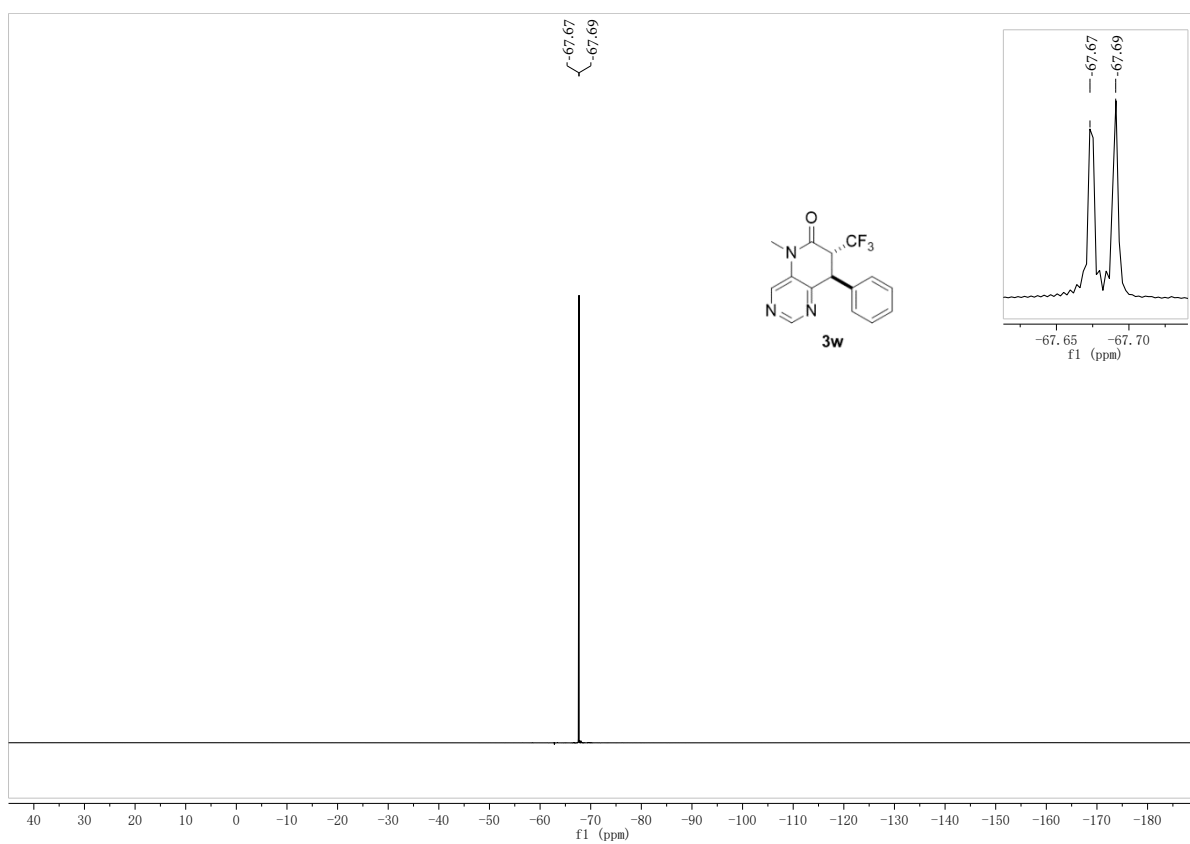
HRMS (ESI) spectrum of **3v**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3w**



$^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ ) spectrum of **3w**



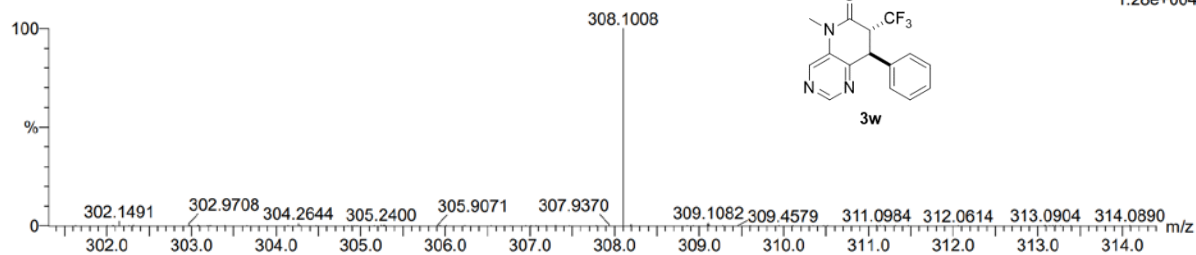
$^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ ) spectrum of **3w**

Monoisotopic Mass, Even Electron Ions  
 368 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:

C: 15-15 H: 13-13 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

8  
 231125-5-418 22 (0.230)

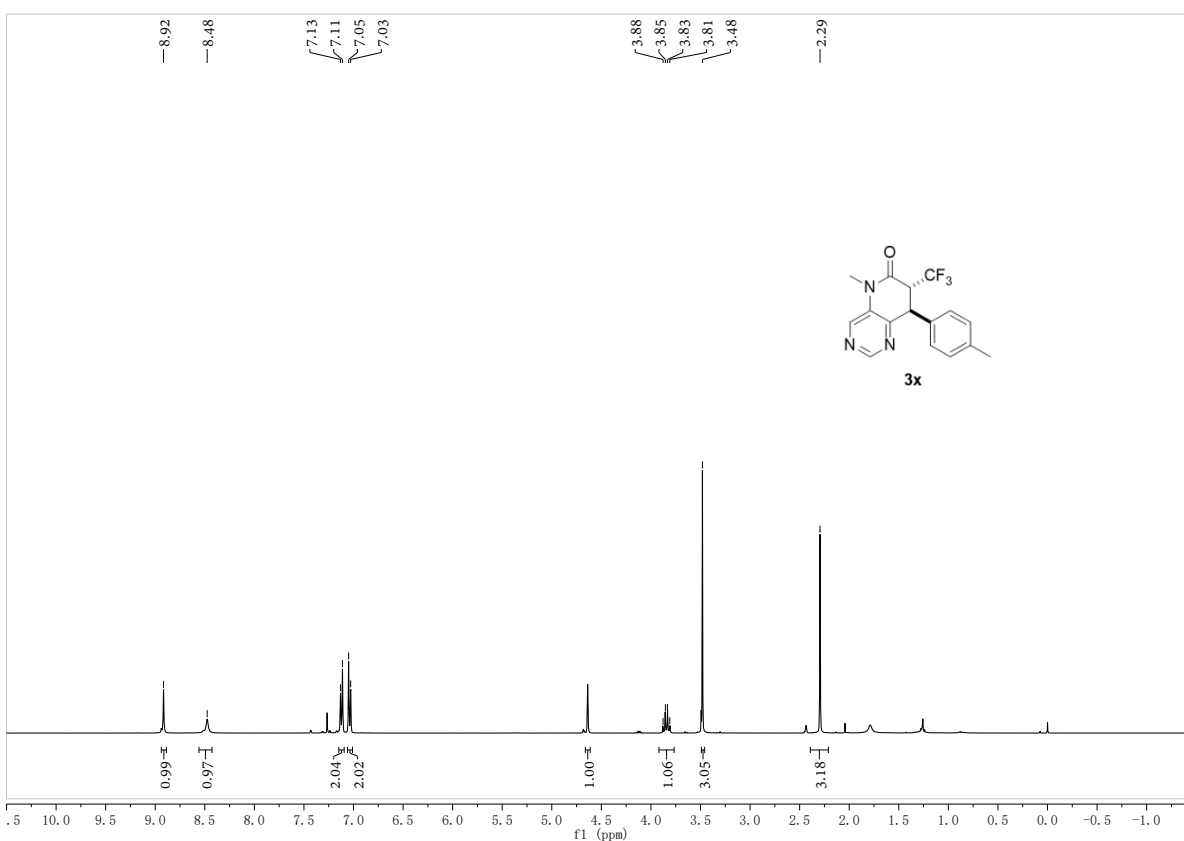
1: TOF MS ES+  
 1.28e+004



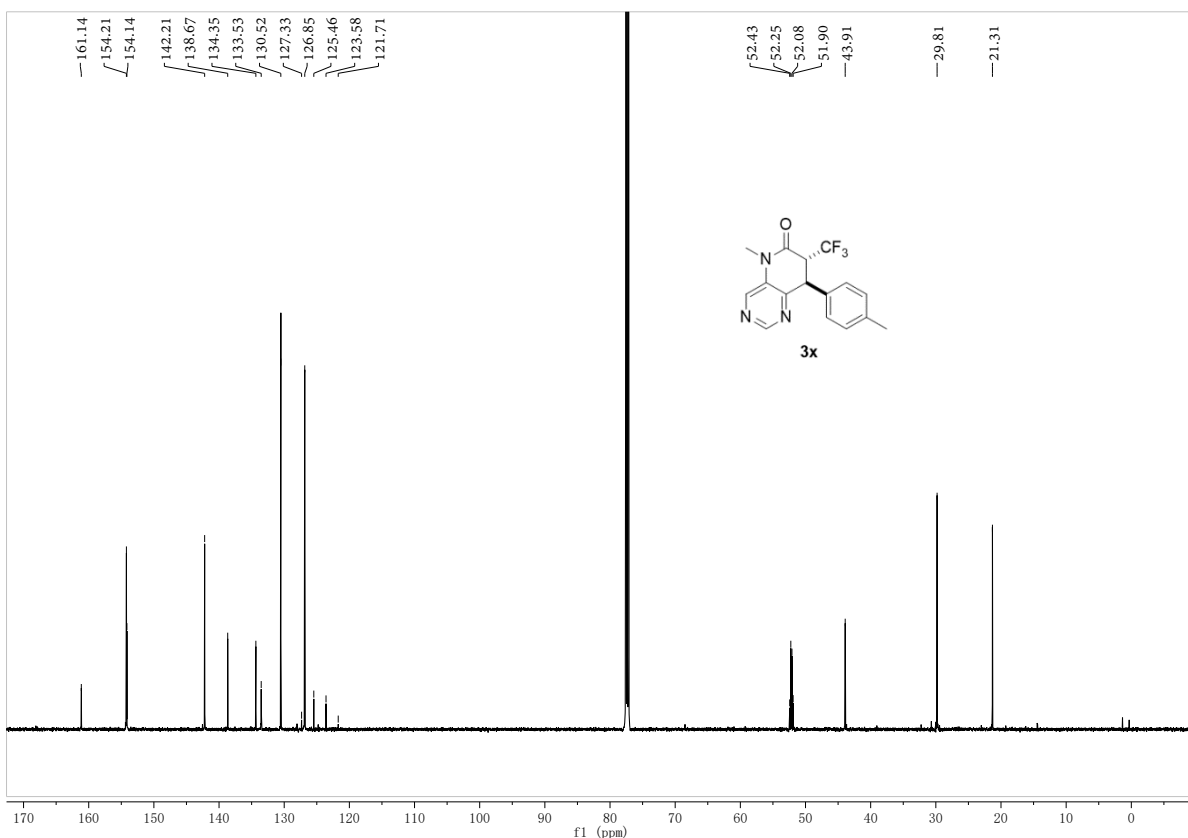
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|-----|-------|------|----------|-----------------|
| 308.1008 | 308.1011   | -0.3 | -1.0 | 9.5 | 115.3 | n/a  | n/a      | C15 H13 N3 O F3 |

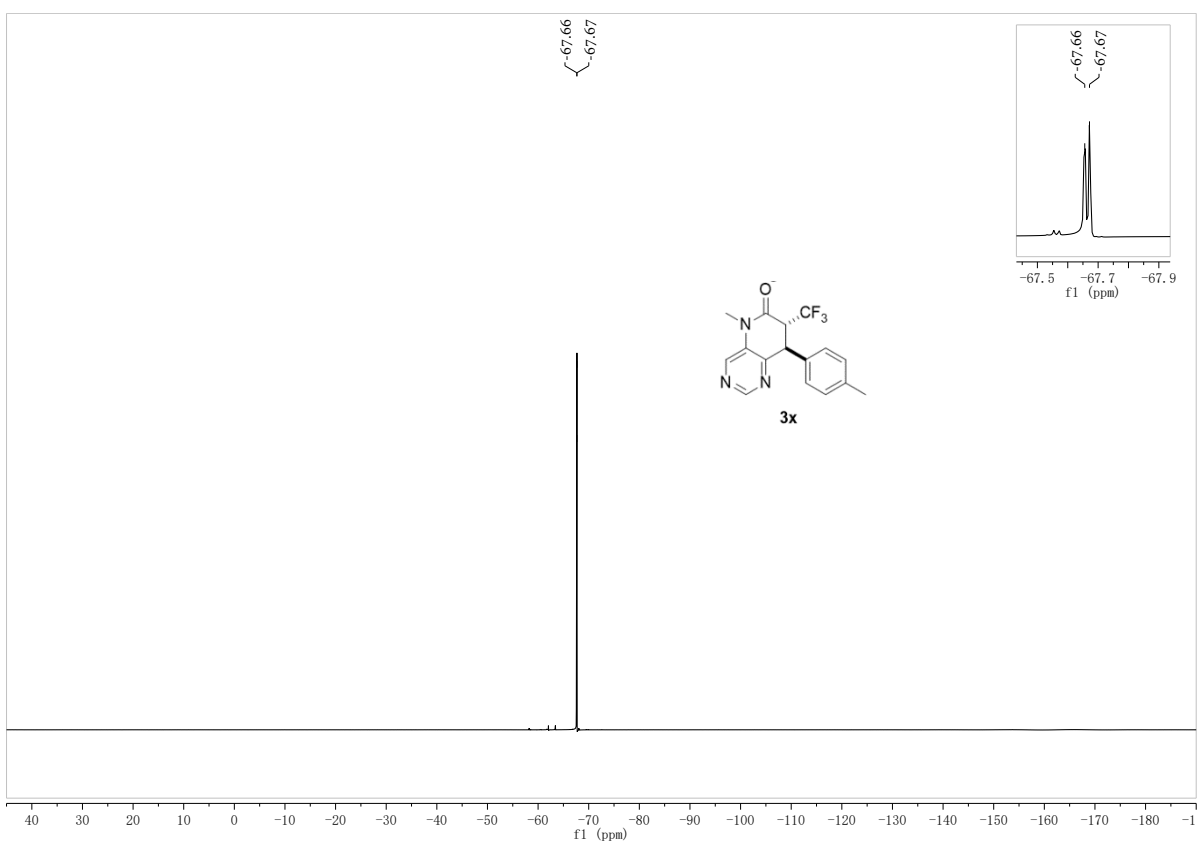
HRMS (ESI) spectrum of **3w**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3x**



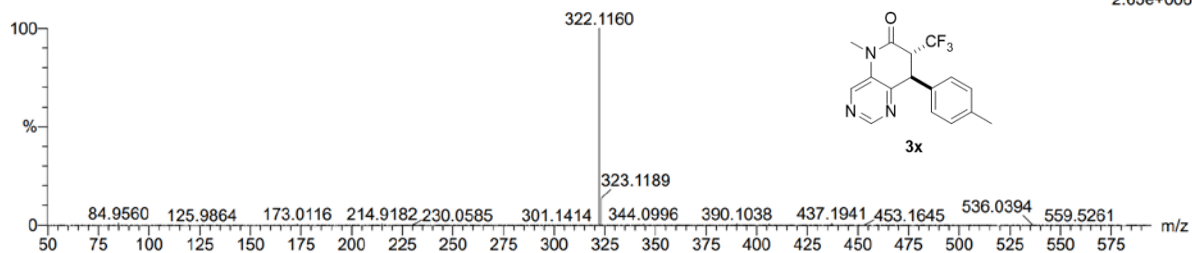
<sup>13</sup>C NMR (151 MHz, CDCl<sub>3</sub>) spectrum of **3x**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3x**

Monoisotopic Mass, Even Electron Ions  
 412 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 16-16 H: 15-15 N: 0-200 O: 0-100 F: 3-3 Na: 0-2  
 8  
 231125-5-448 13 (0.145)

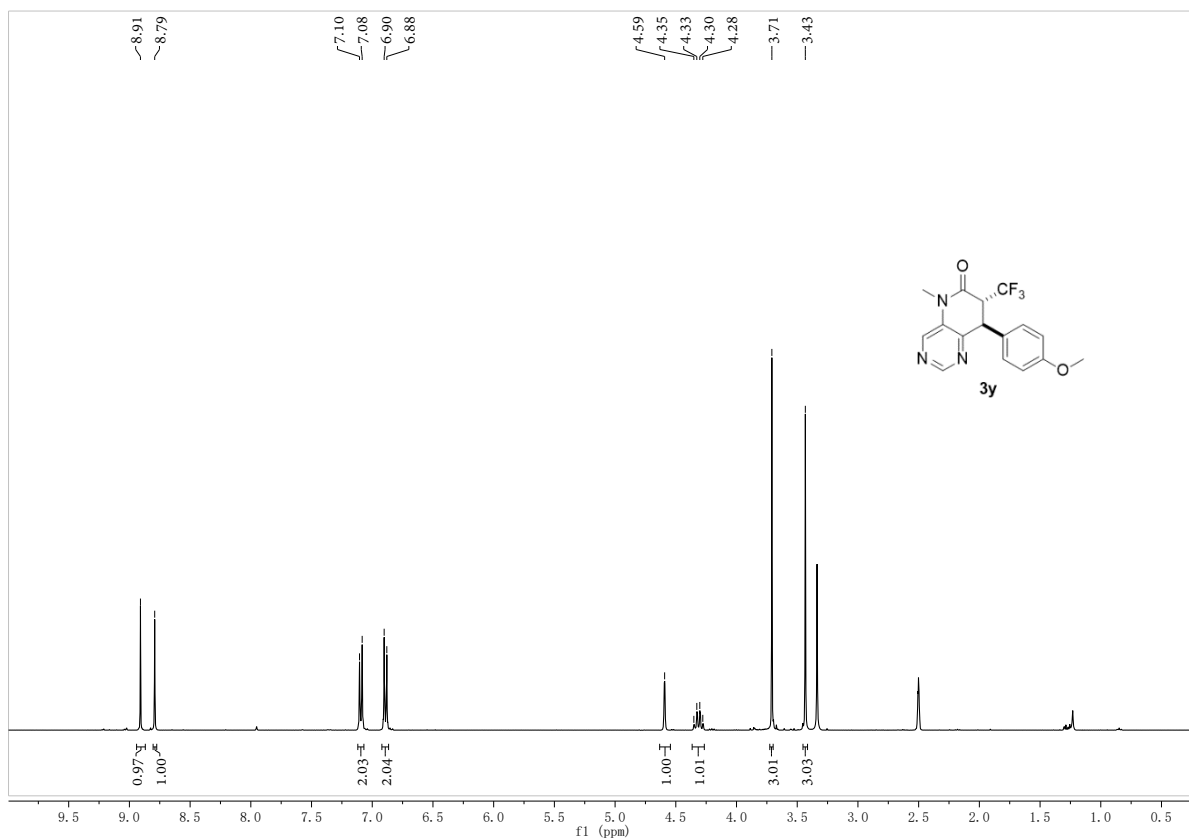
1: TOF MS ES+  
2.65e+006



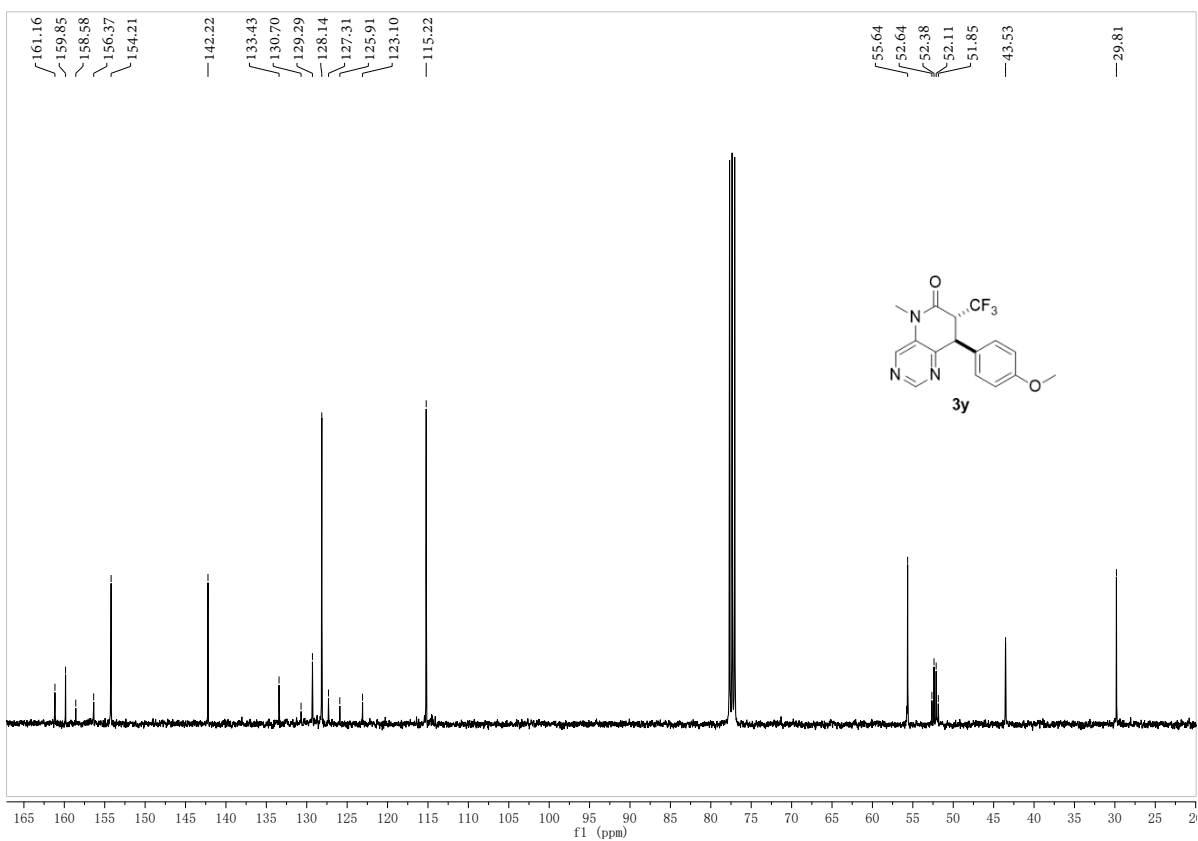
Minimum: -1.5  
 Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|-----|-------|------|----------|-----------------|
| 322.1160 | 322.1167   | -0.7 | -2.2 | 9.5 | 149.4 | n/a  | n/a      | C16 H15 N3 O F3 |

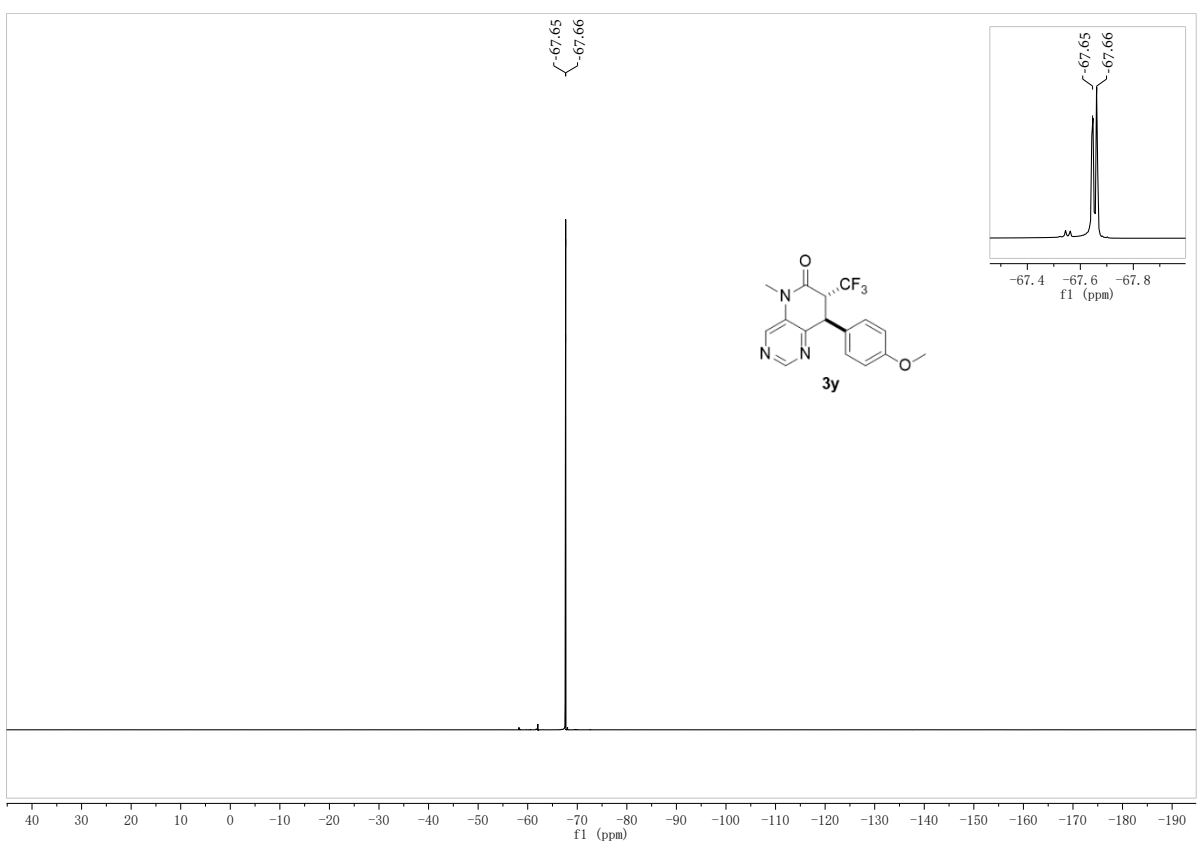
### HRMS (ESI) spectrum of **3x**



### <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3y**



$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ) spectrum of **3y**



$^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ ) spectrum of **3y**

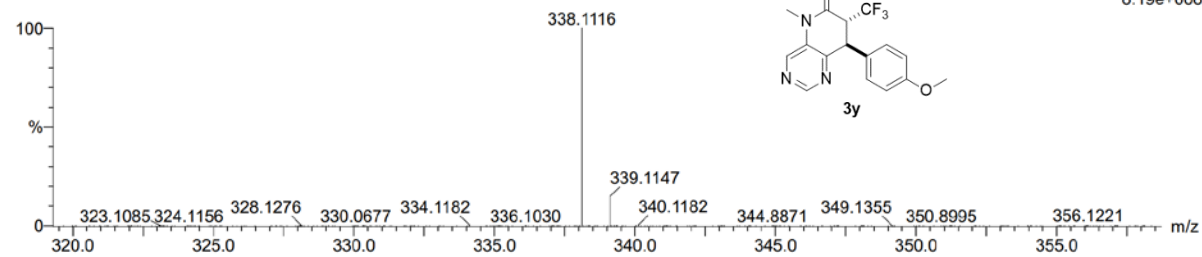
Monoisotopic Mass, Even Electron Ions  
457 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 16-16 H: 15-15 N: 0-200 O: 0-100 F: 3-3 Na: 0-2

8

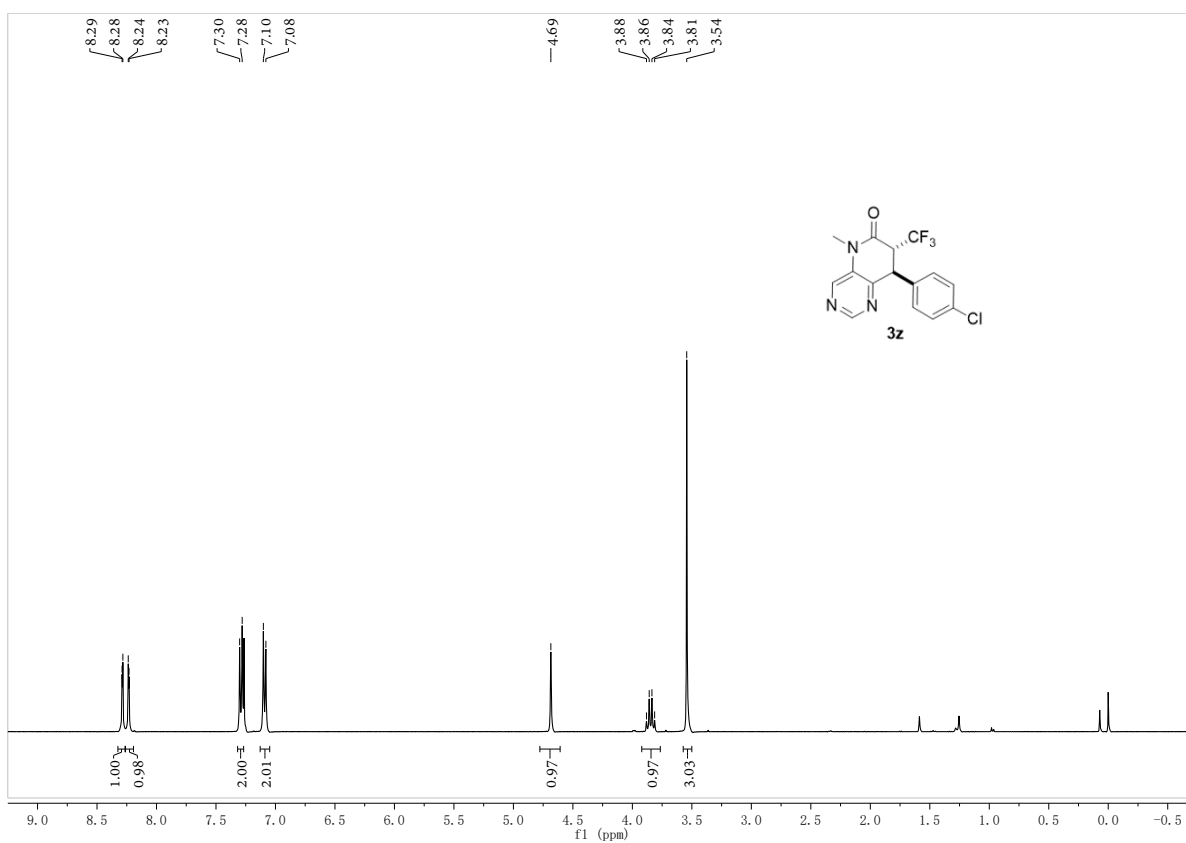
231125-5-440 15 (0.162)



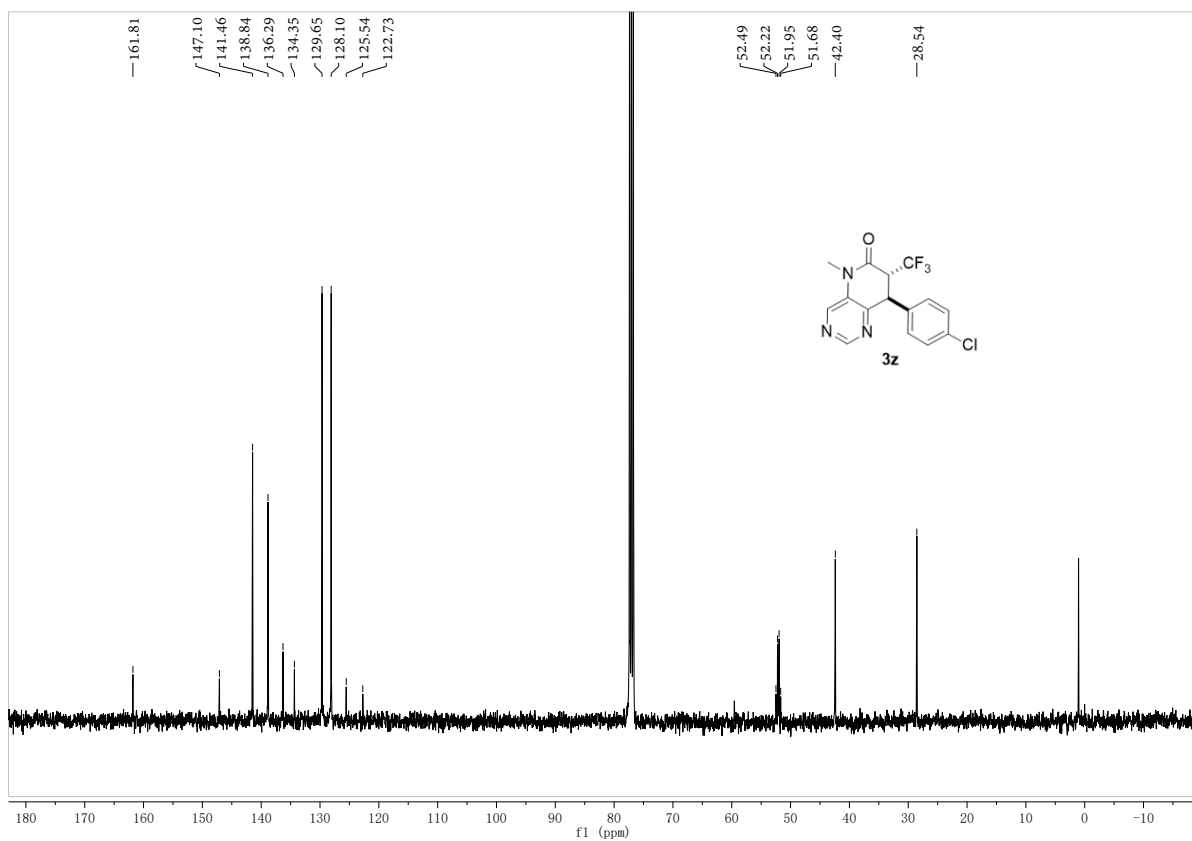
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula          |
|----------|------------|-----|-----|-----|-------|------|----------|------------------|
| 338.1116 | 338.1116   | 0.0 | 0.0 | 9.5 | 250.6 | n/a  | n/a      | C16 H15 N3 O2 F3 |

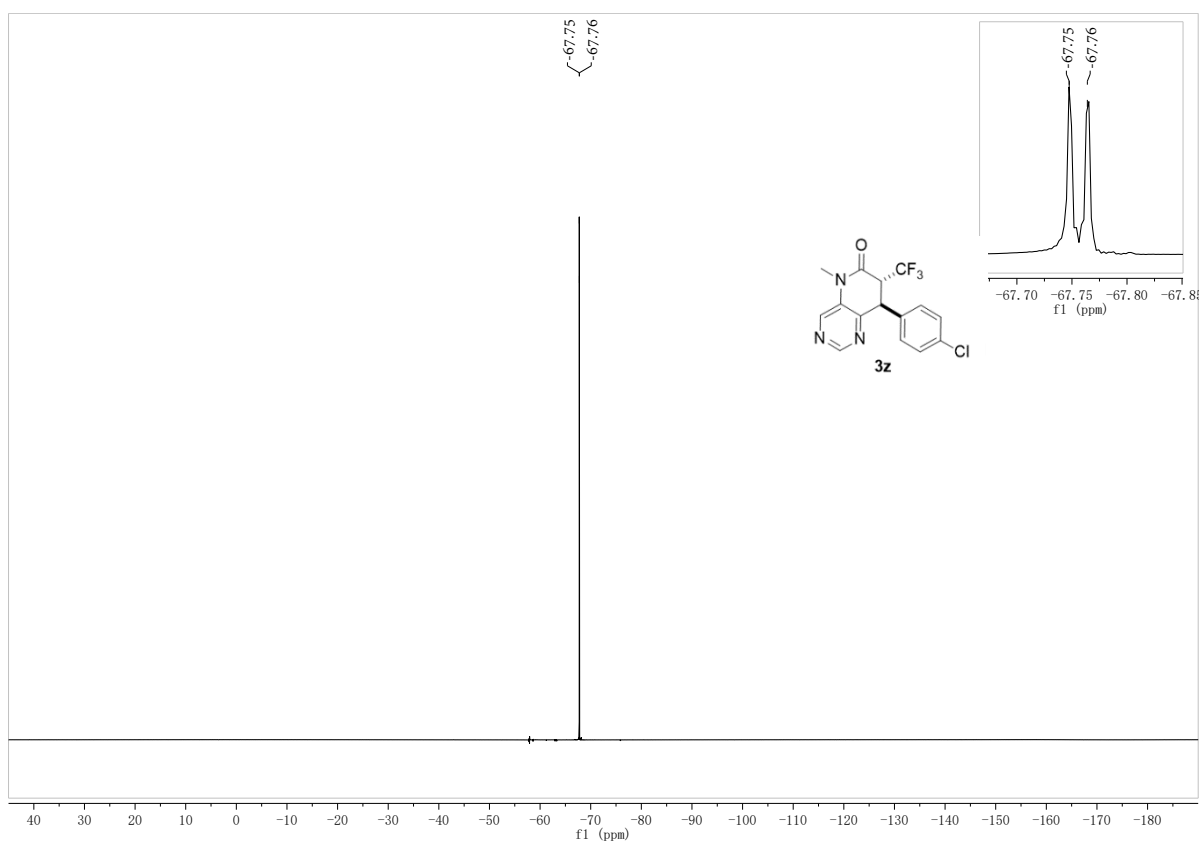
HRMS (ESI) spectrum of **3y**



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ) spectrum of **3z**



$^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ ) spectrum of **3z**



$^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ ) spectrum of **3z**



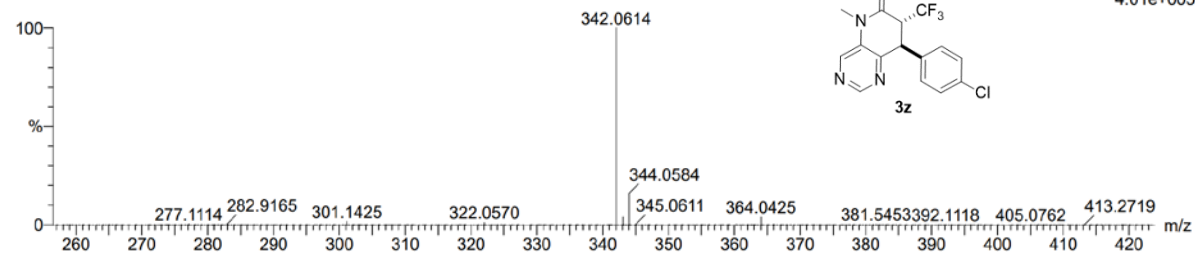
Monoisotopic Mass, Even Electron Ions  
977 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 15-15 H: 12-12 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Cl: 1-4

8

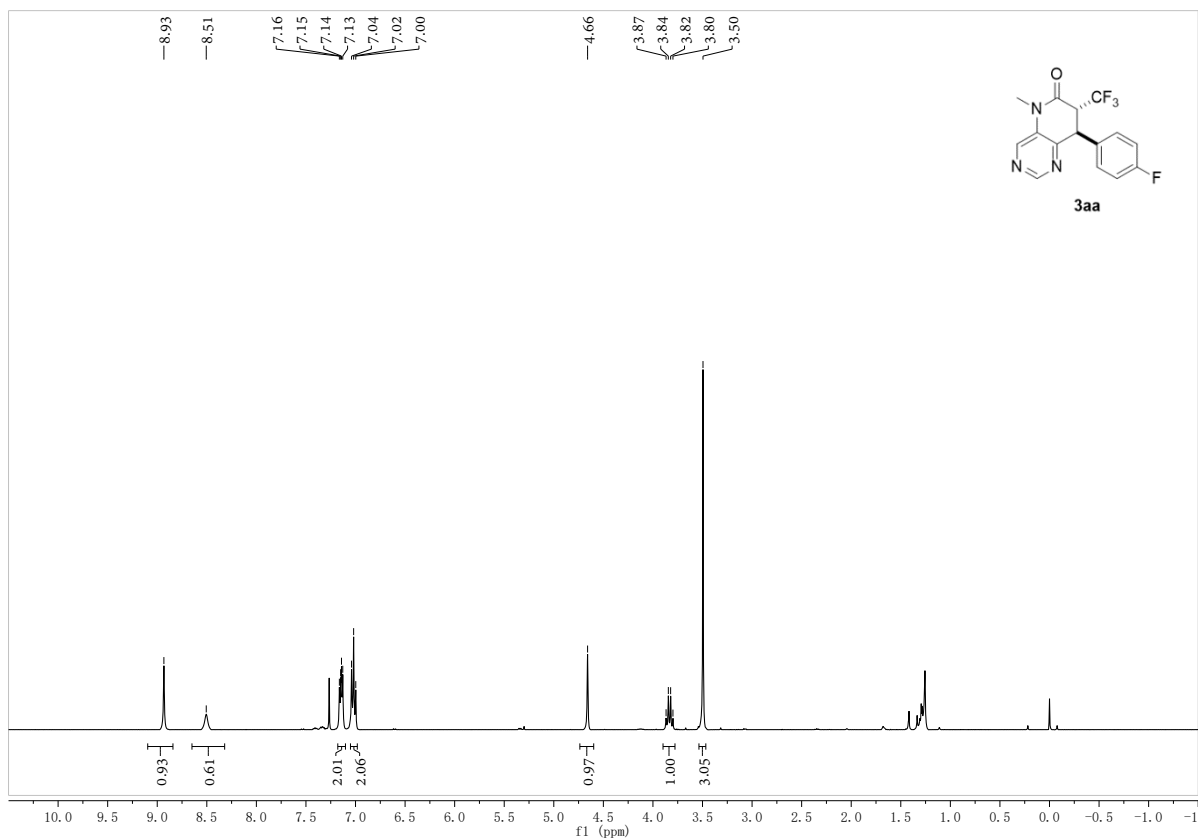
231125-5-422 16 (0.170)



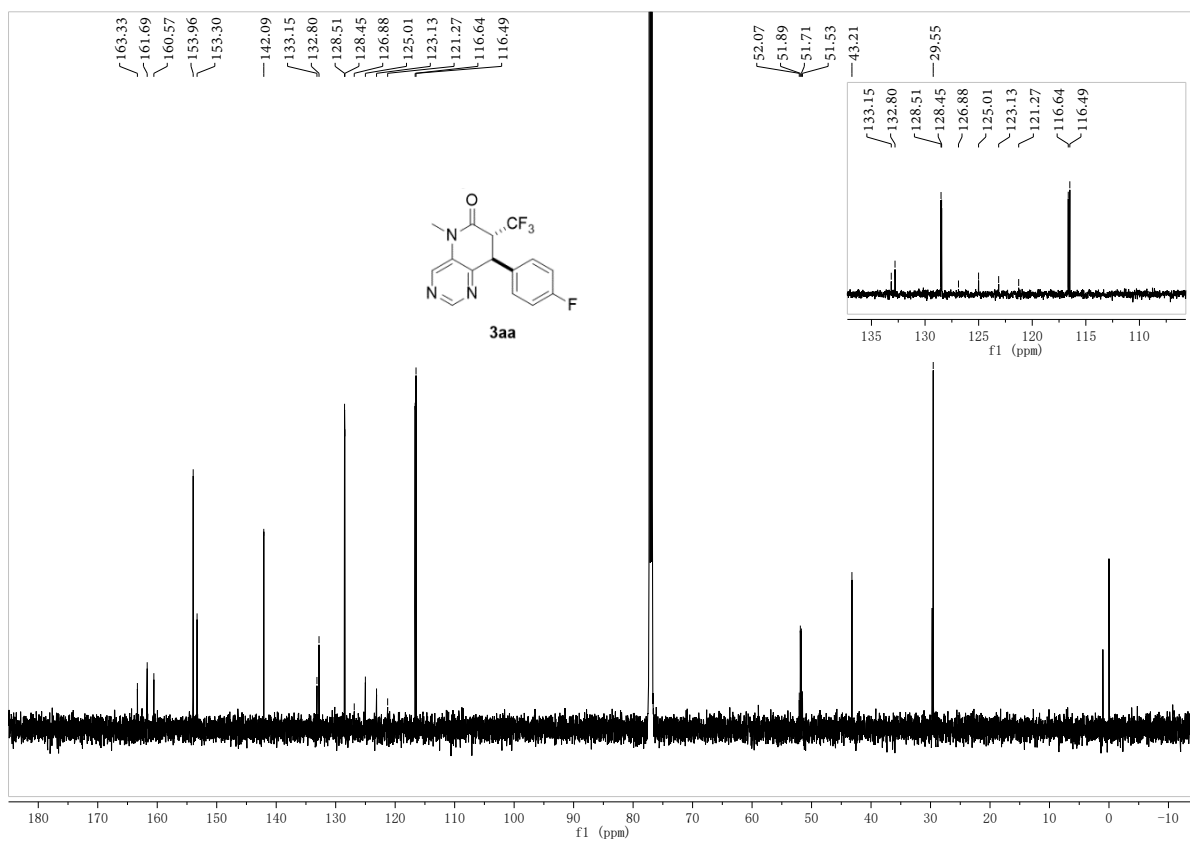
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|------|------|-----|-------|------|----------|--------------------|
| 342.0614 | 342.0621   | -0.7 | -2.0 | 9.5 | 181.4 | n/a  | n/a      | C15 H12 N3 O F3 Cl |

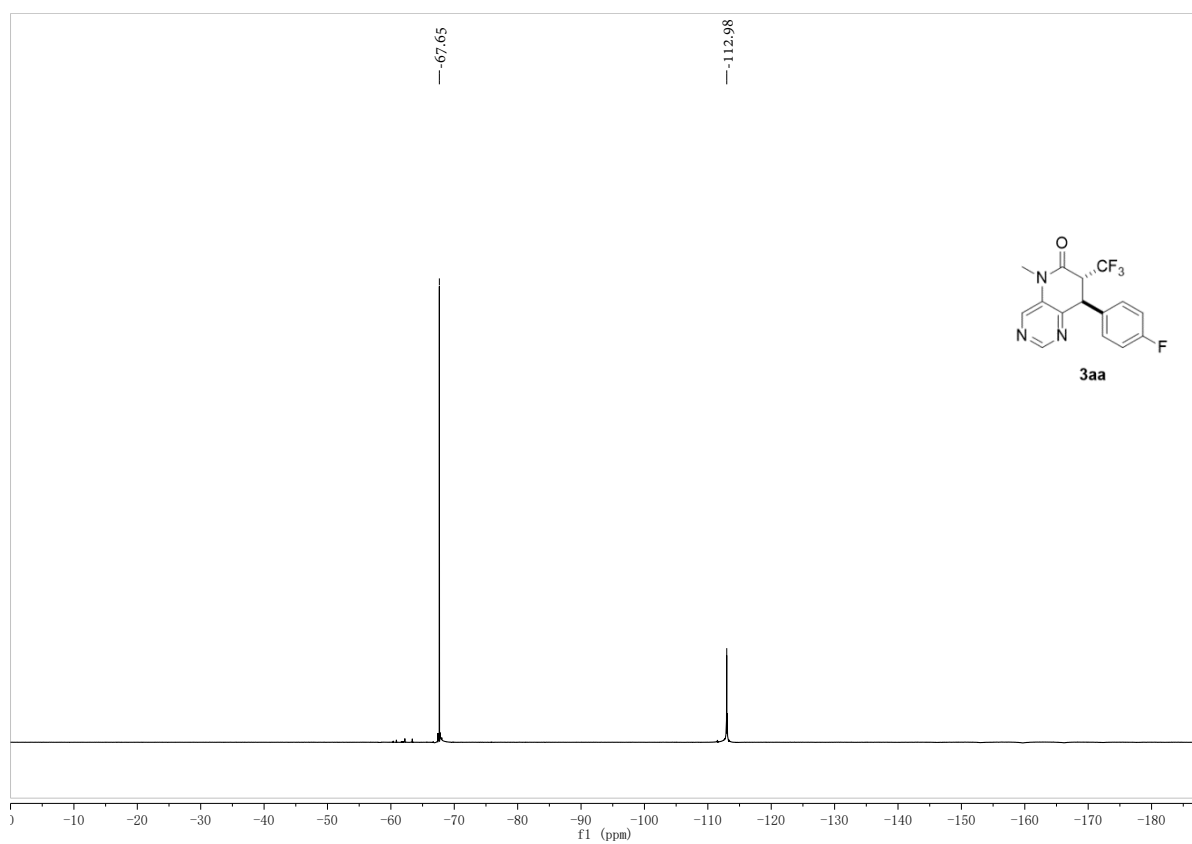
HRMS (ESI) spectrum of **3z**



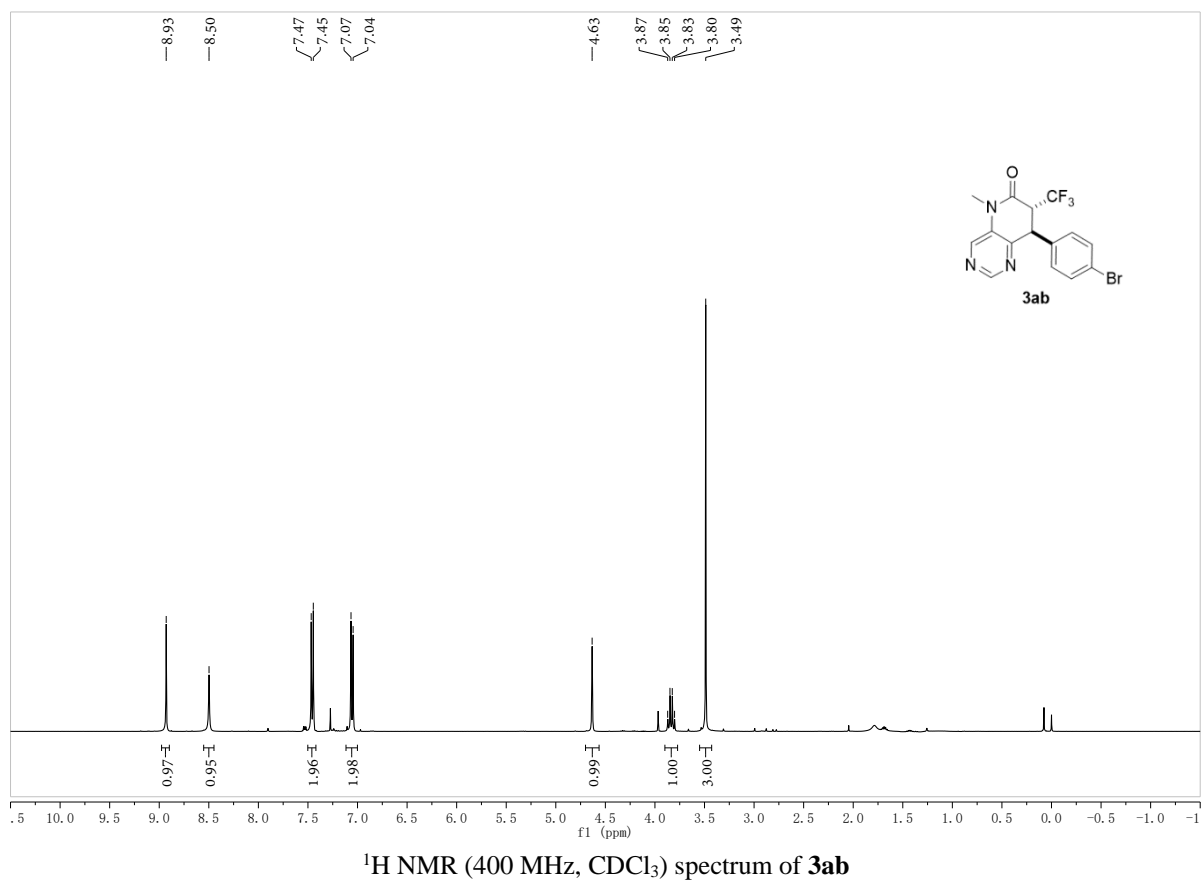
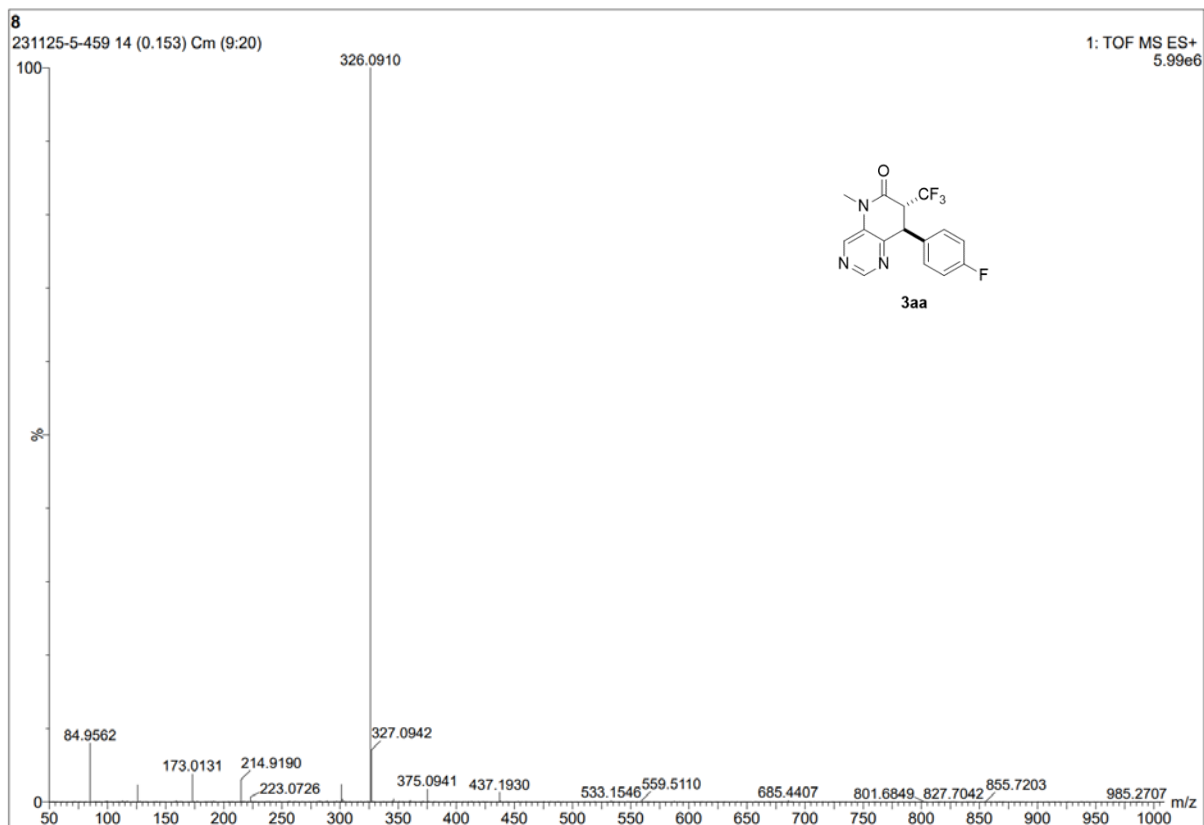
<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3aa**

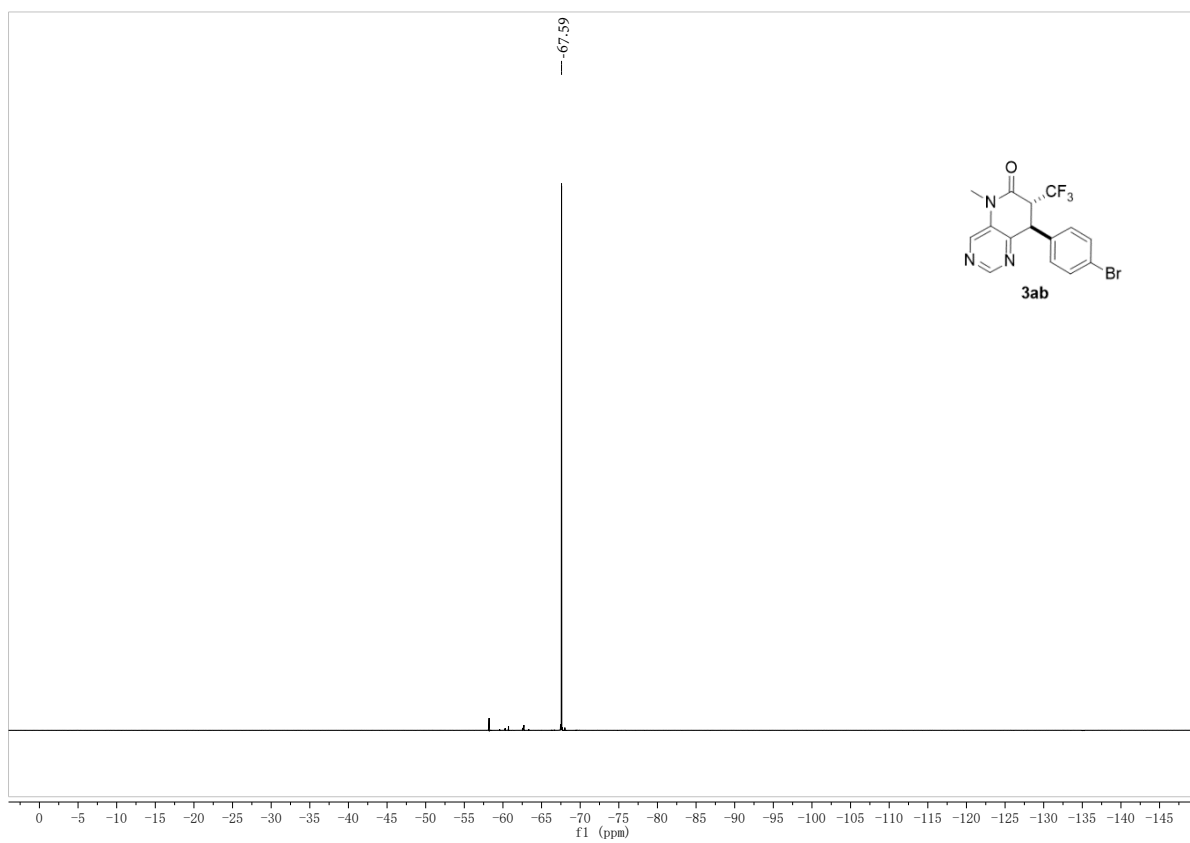
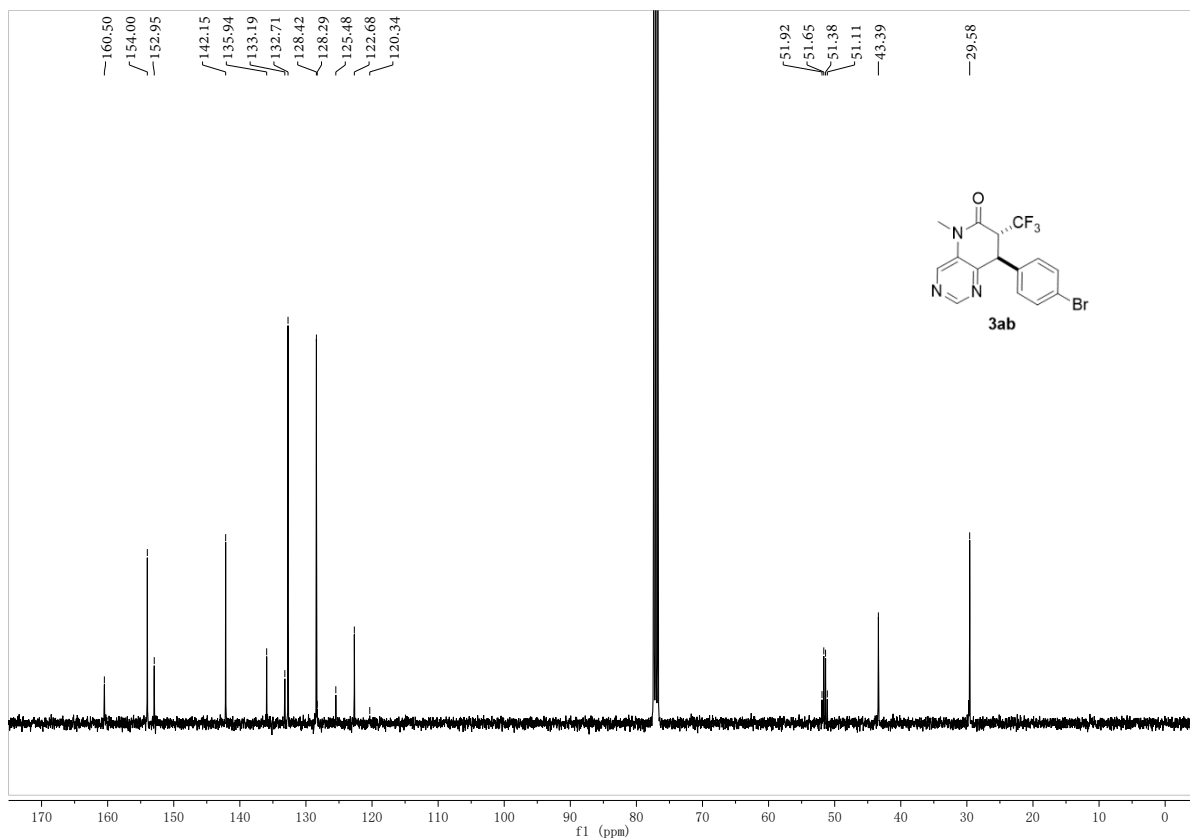


$^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ ) spectrum of **3aa**



$^{19}\text{F}$  NMR (565 MHz,  $\text{CDCl}_3$ ) spectrum of **3aa**





Monoisotopic Mass, Even Electron Ions

596 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

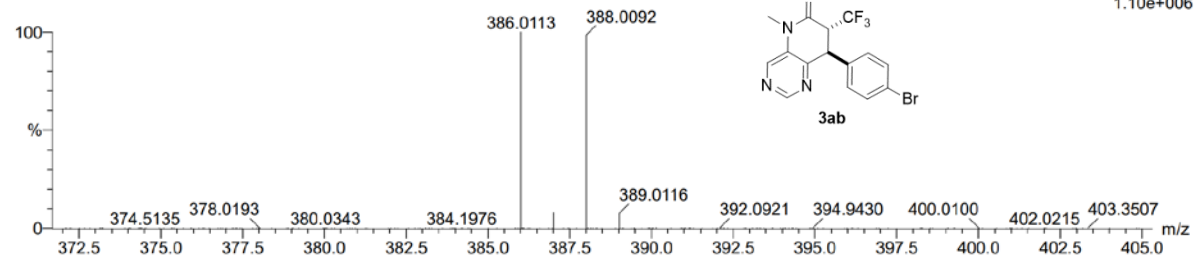
Elements Used:

C: 15-15 H: 12-12 N: 0-200 O: 0-100 F: 3-3 Na: 0-2 Br: 1-3

4

231125-5-466 14 (0.153)

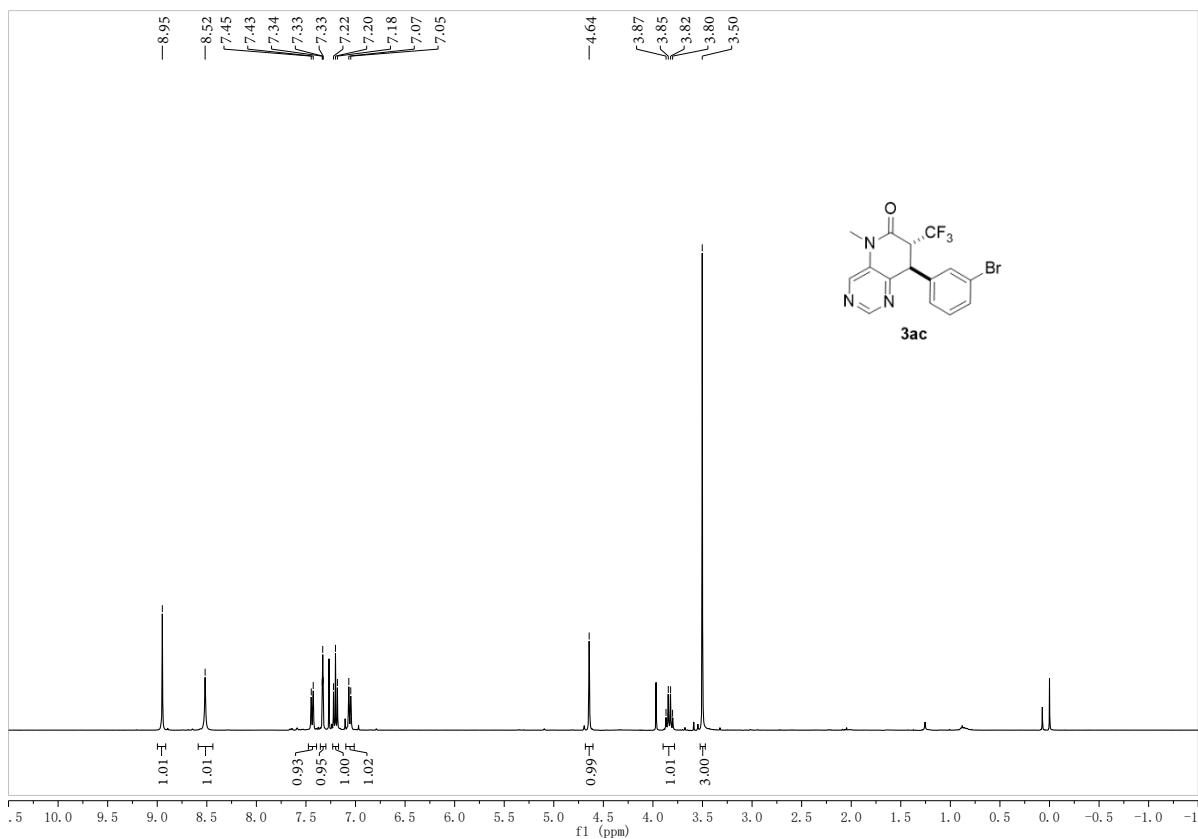
1: TOF MS ES+  
1.10e+006



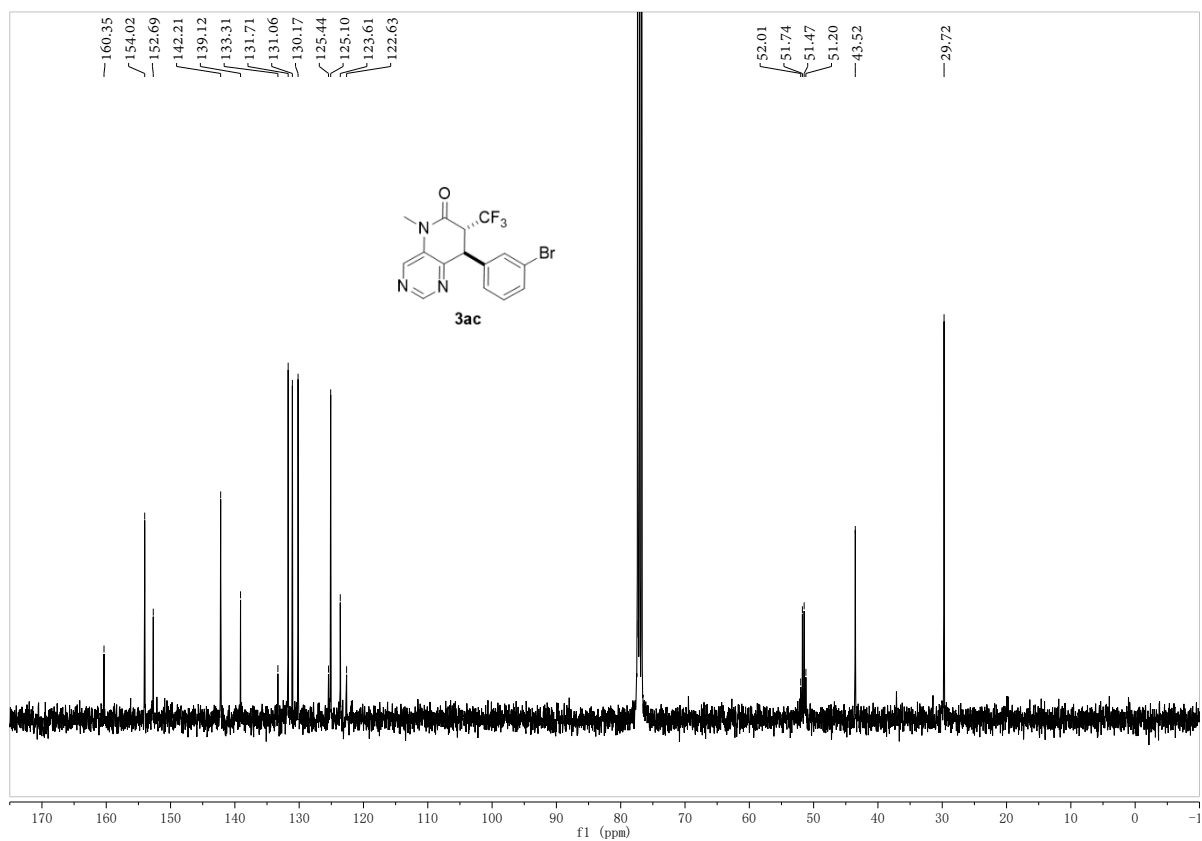
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|------|------|-----|-------|------|----------|--------------------|
| 386.0113 | 386.0116   | -0.3 | -0.8 | 9.5 | 193.9 | n/a  | n/a      | C15 H12 N3 O F3 Br |

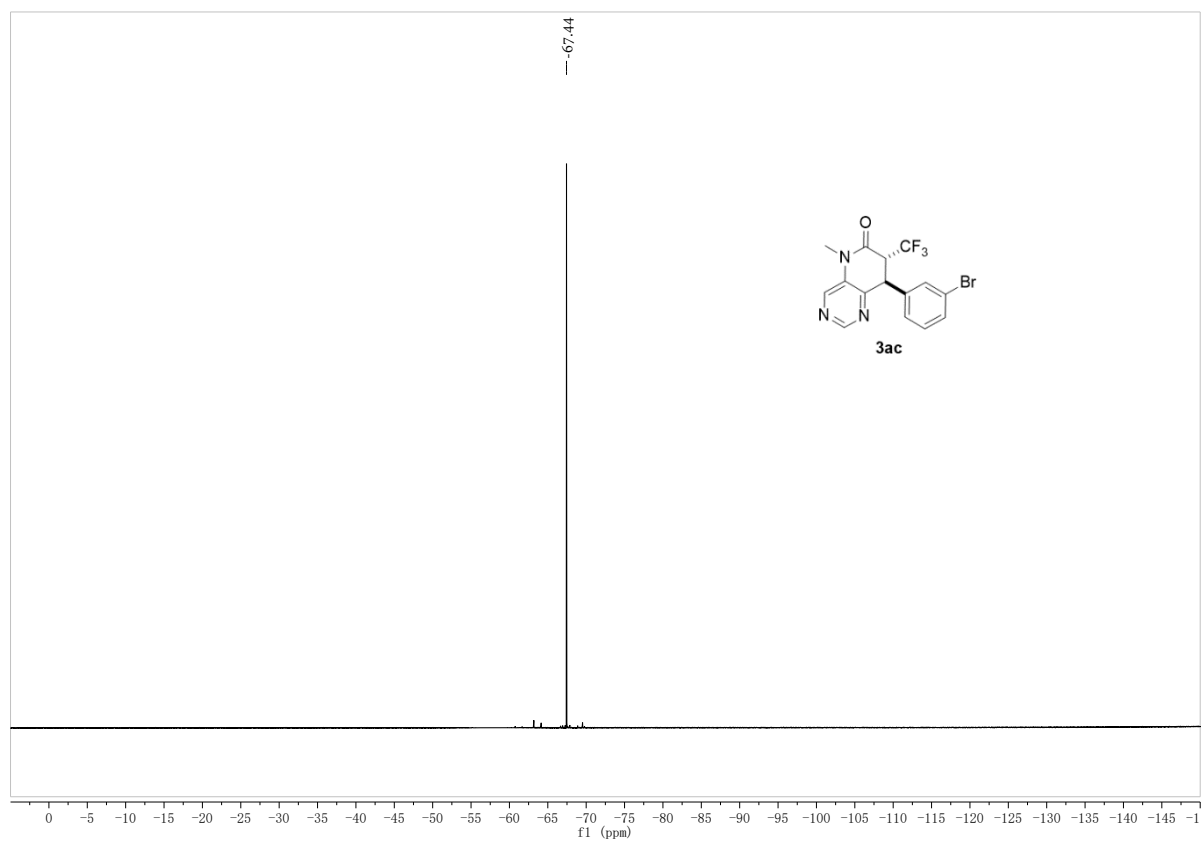
HRMS (ESI) spectrum of **3ab**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3ac**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3ac**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3ac**

Monoisotopic Mass, Even Electron Ions

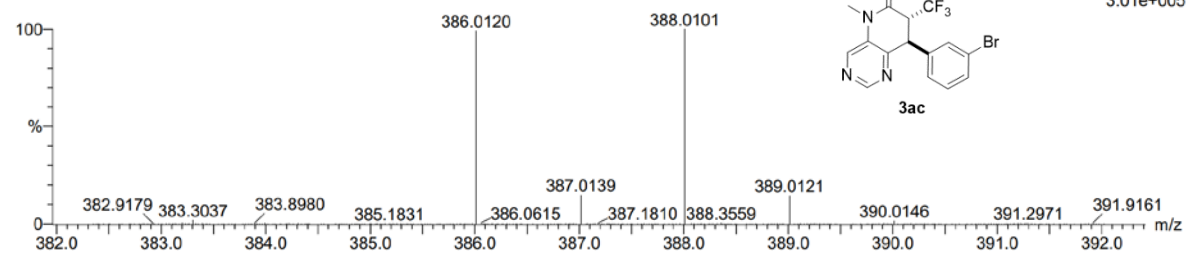
595 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 15-115 H: 12-12 N: 0-100 O: 0-100 F: 3-3 Na: 0-2 Br: 1-3

31

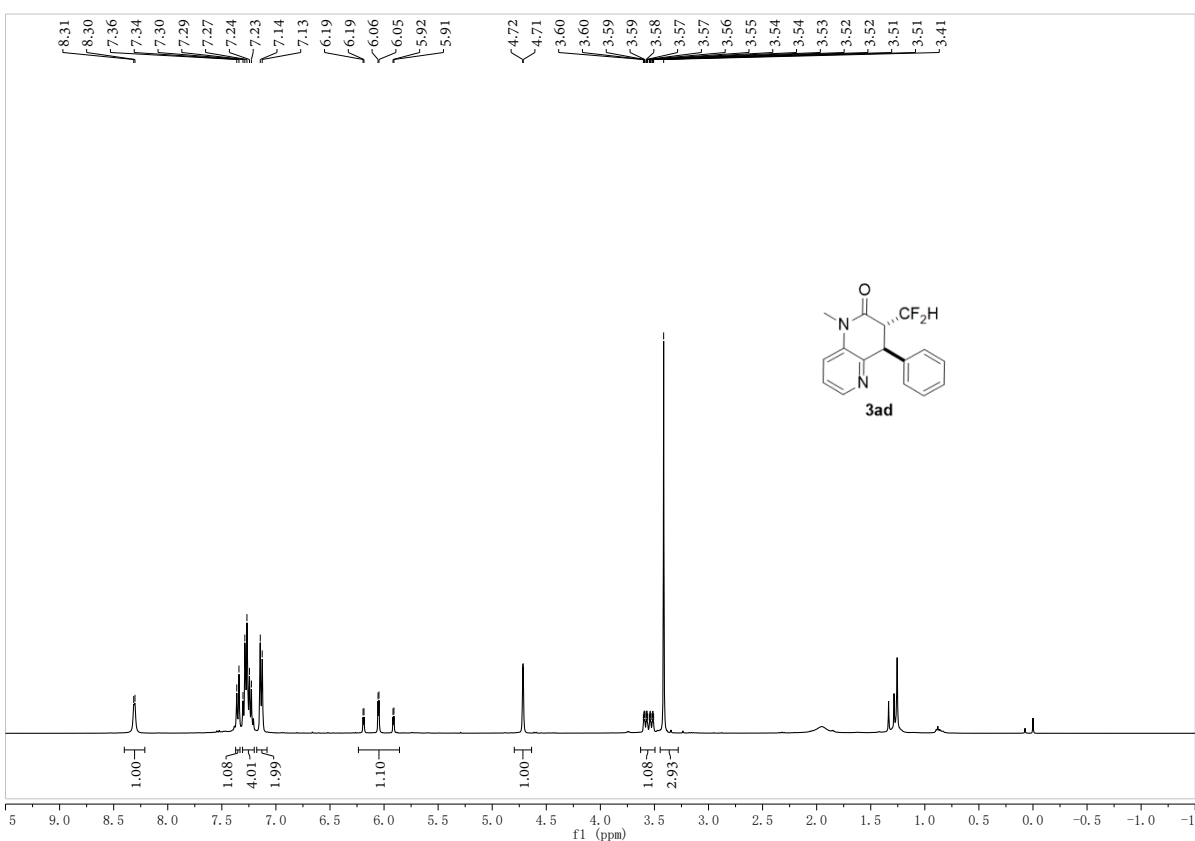
231209-5-463 24 (0.111)



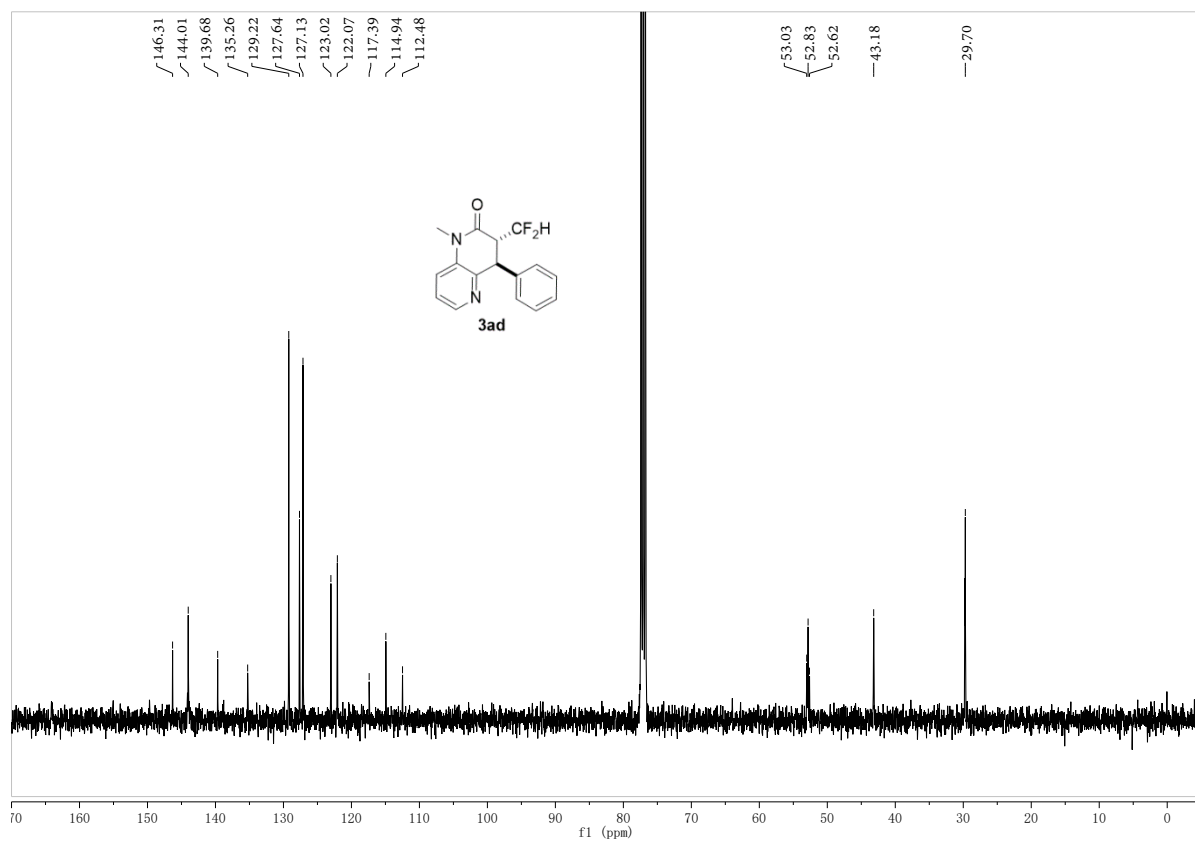
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|-----|-----|-----|-------|------|----------|--------------------|
| 386.0120 | 386.0116   | 0.4 | 1.0 | 9.5 | 793.8 | n/a  | n/a      | C15 H12 N3 O F3 Br |

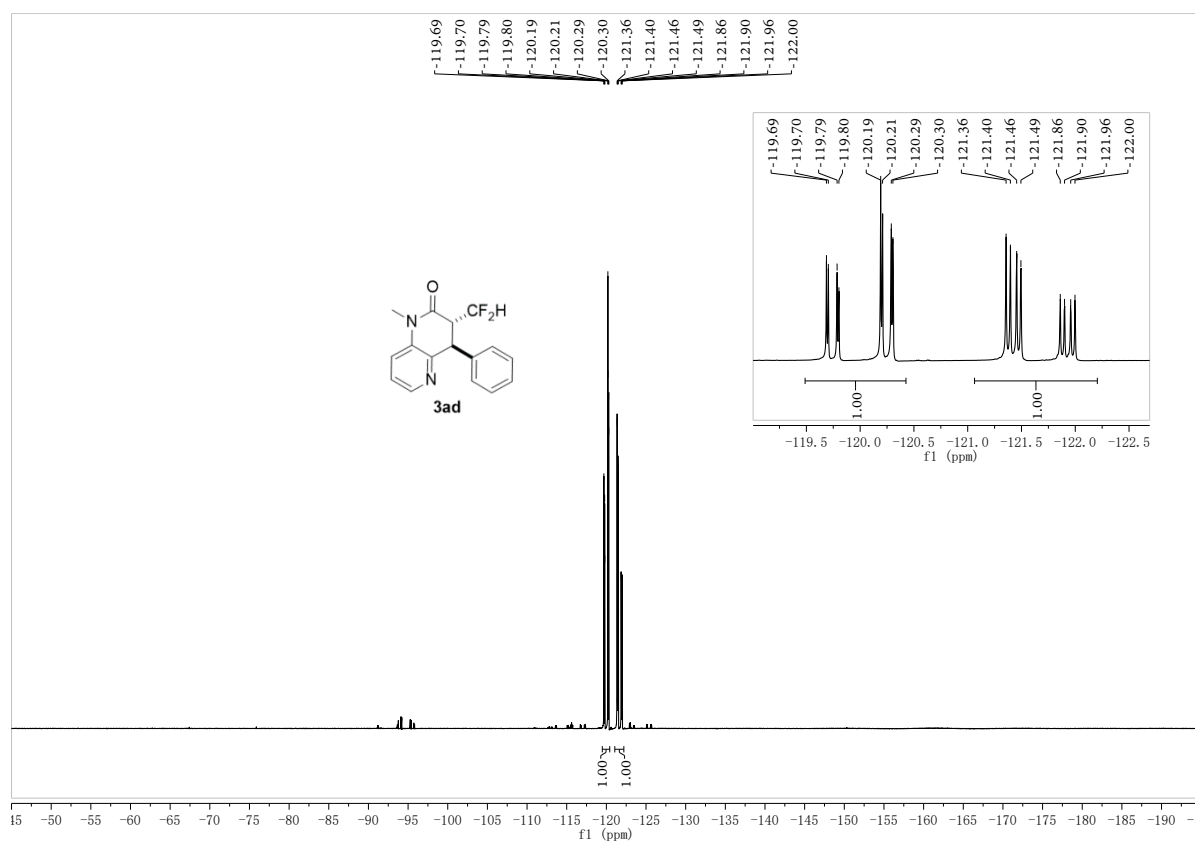
HRMS (ESI) spectrum of 3ac



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of 3ad



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3ad**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3ad**



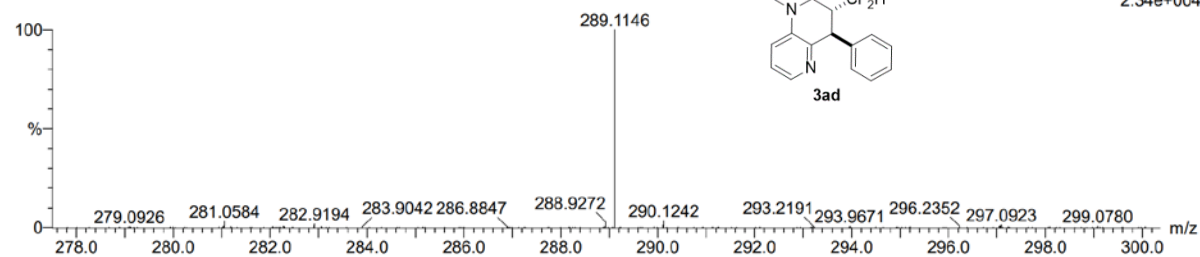
Monoisotopic Mass, Even Electron Ions  
375 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 16-16 H: 15-15 N: 0-200 O: 0-100 F: 2-2 Na: 0-2

8

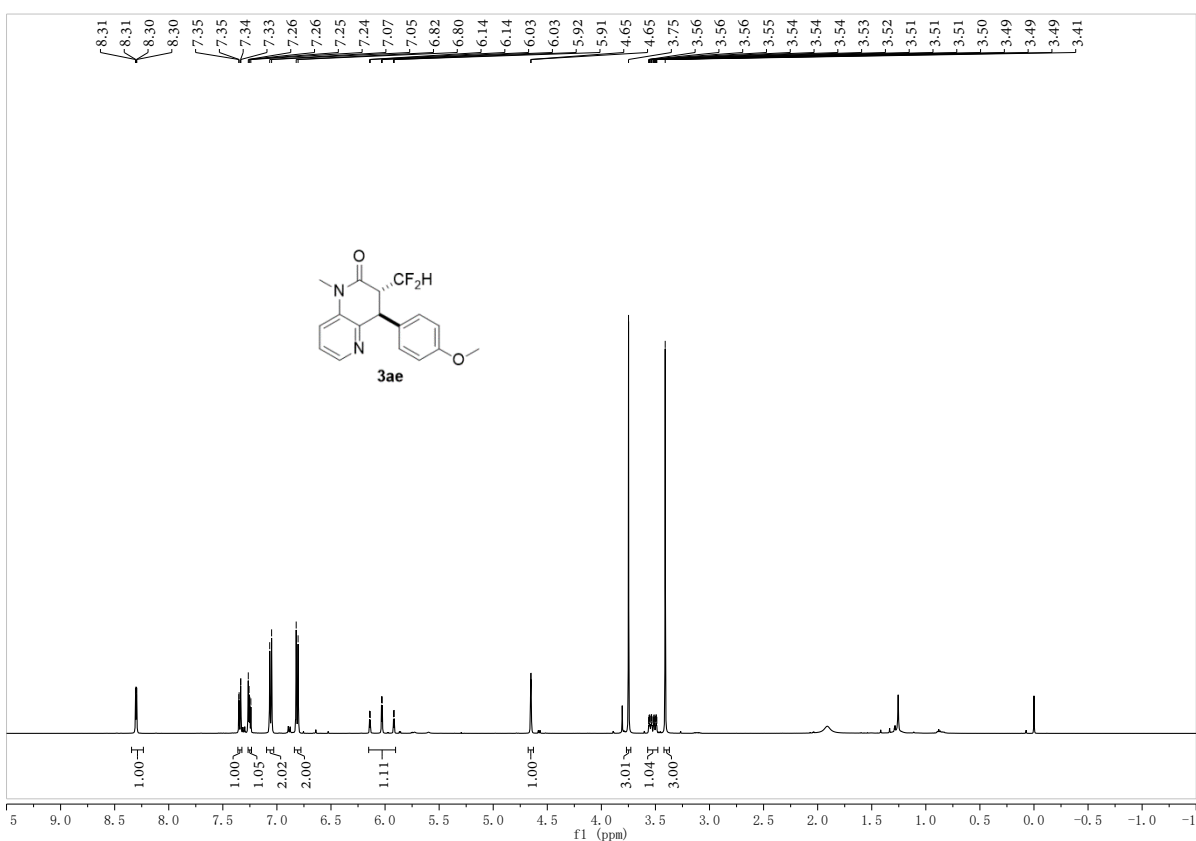
231125-5-509 23 (0.238)



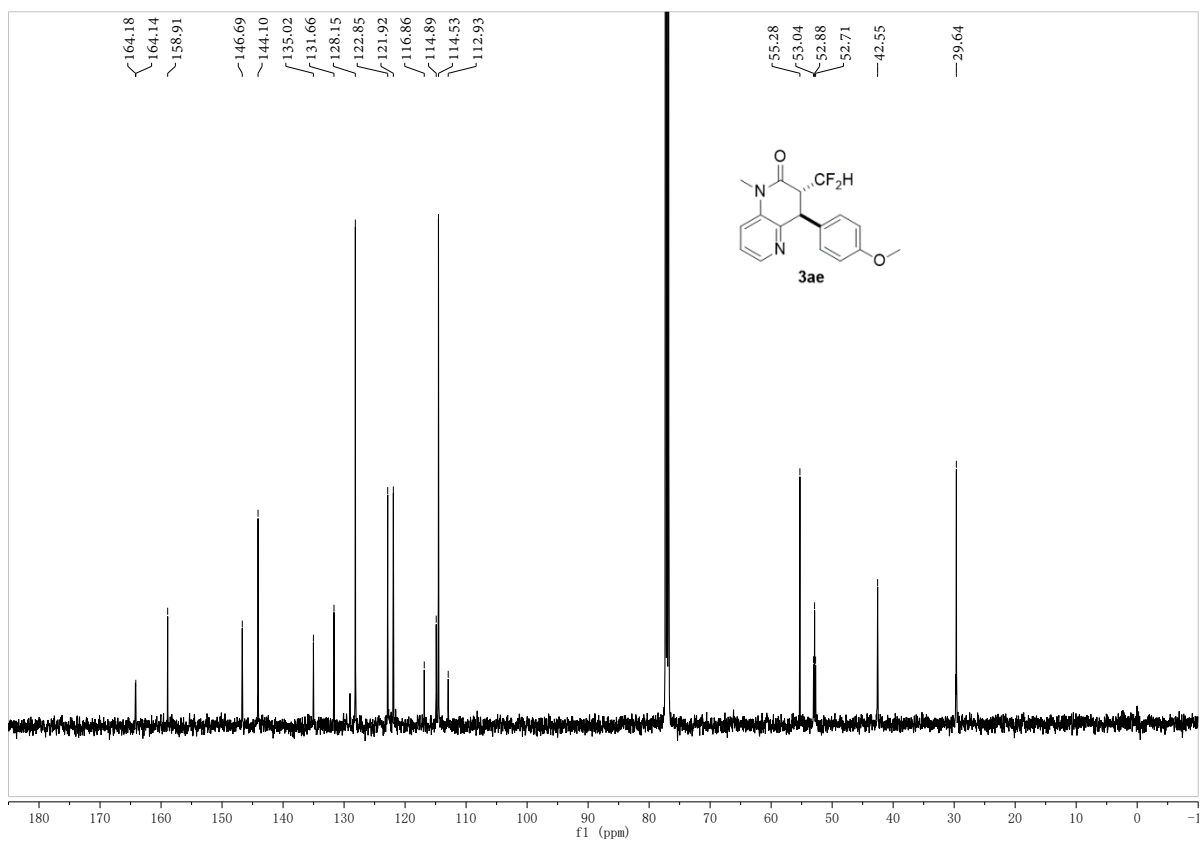
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|-----|-------|------|----------|-----------------|
| 289.1146 | 289.1152   | -0.6 | -2.1 | 9.5 | 151.7 | n/a  | n/a      | C16 H15 N2 O F2 |

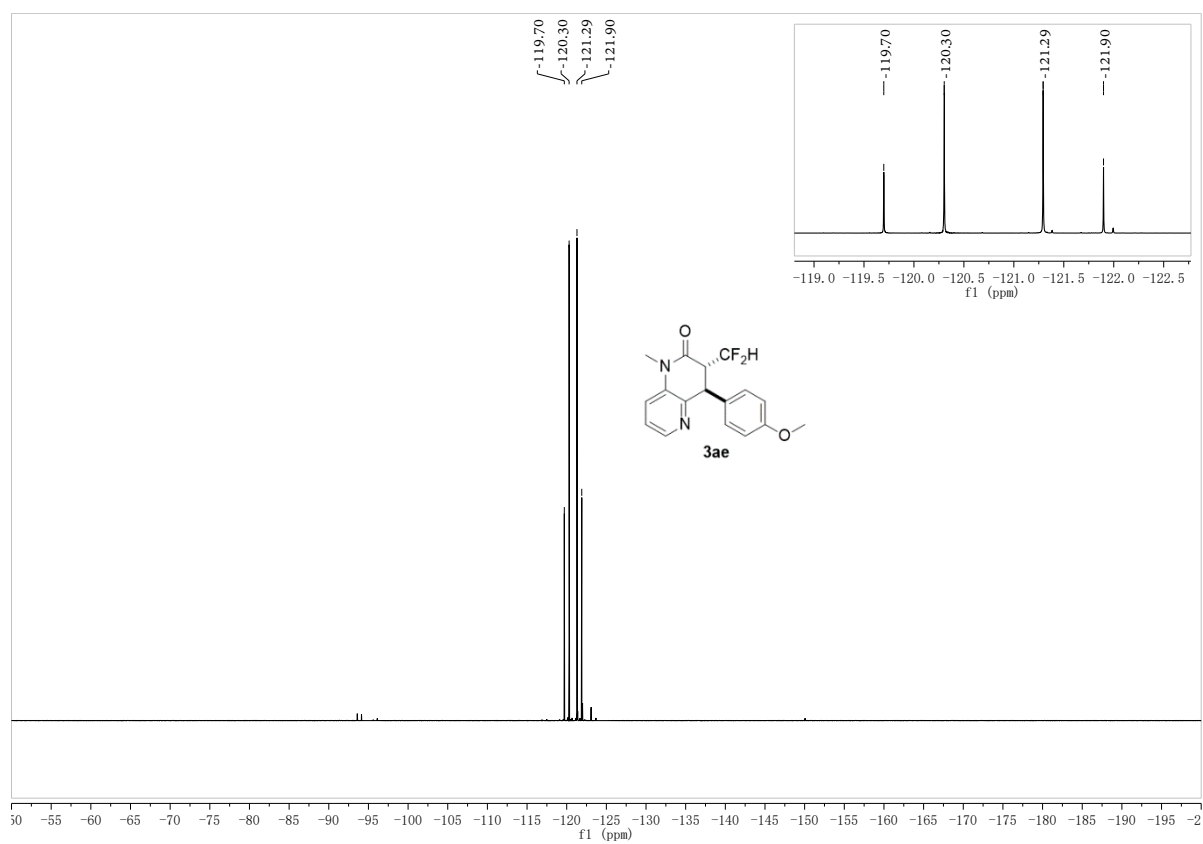
HRMS (ESI) spectrum of **3ad**



<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) spectrum of **3ae**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3ae**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3ae**

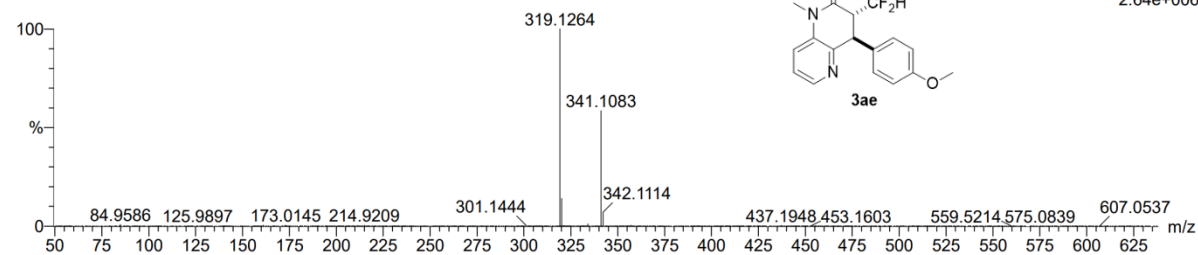
Monoisotopic Mass, Even Electron Ions  
467 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 17-17 H: 17-17 N: 0-200 O: 0-100 F: 2-2 Na: 0-2

4

231125-5-574 13 (0.145)

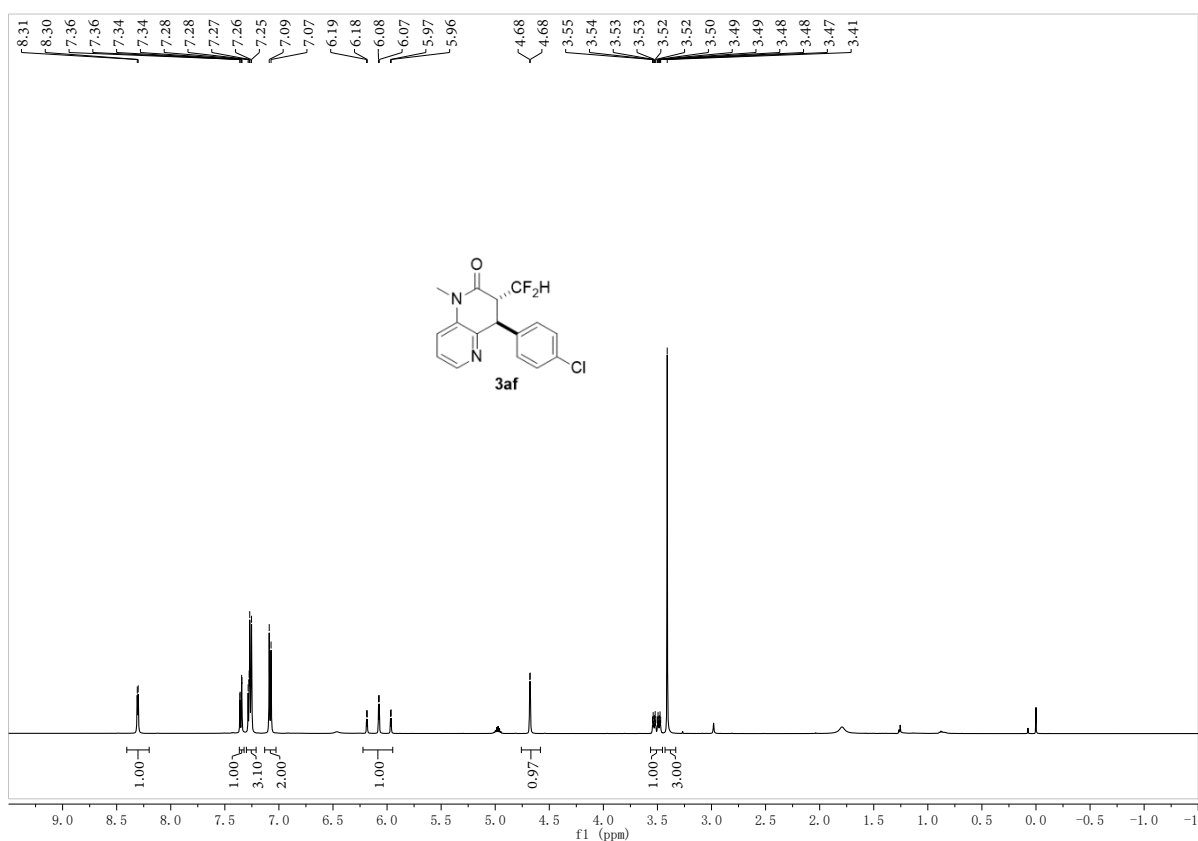


1: TOF MS ES+  
2.64e+006

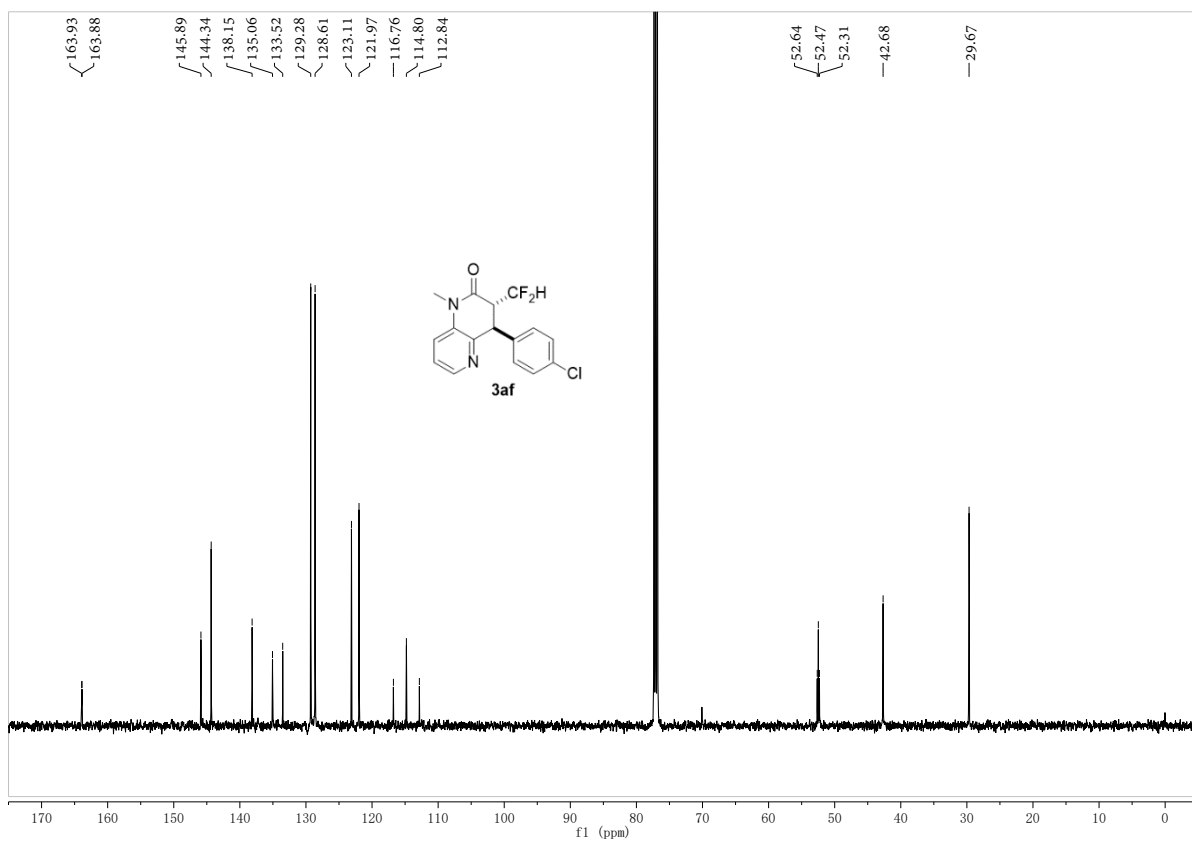
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula          |
|----------|------------|-----|-----|-----|-------|------|----------|------------------|
| 319.1264 | 319.1258   | 0.6 | 1.9 | 9.5 | 161.9 | n/a  | n/a      | C17 H17 N2 O2 F2 |

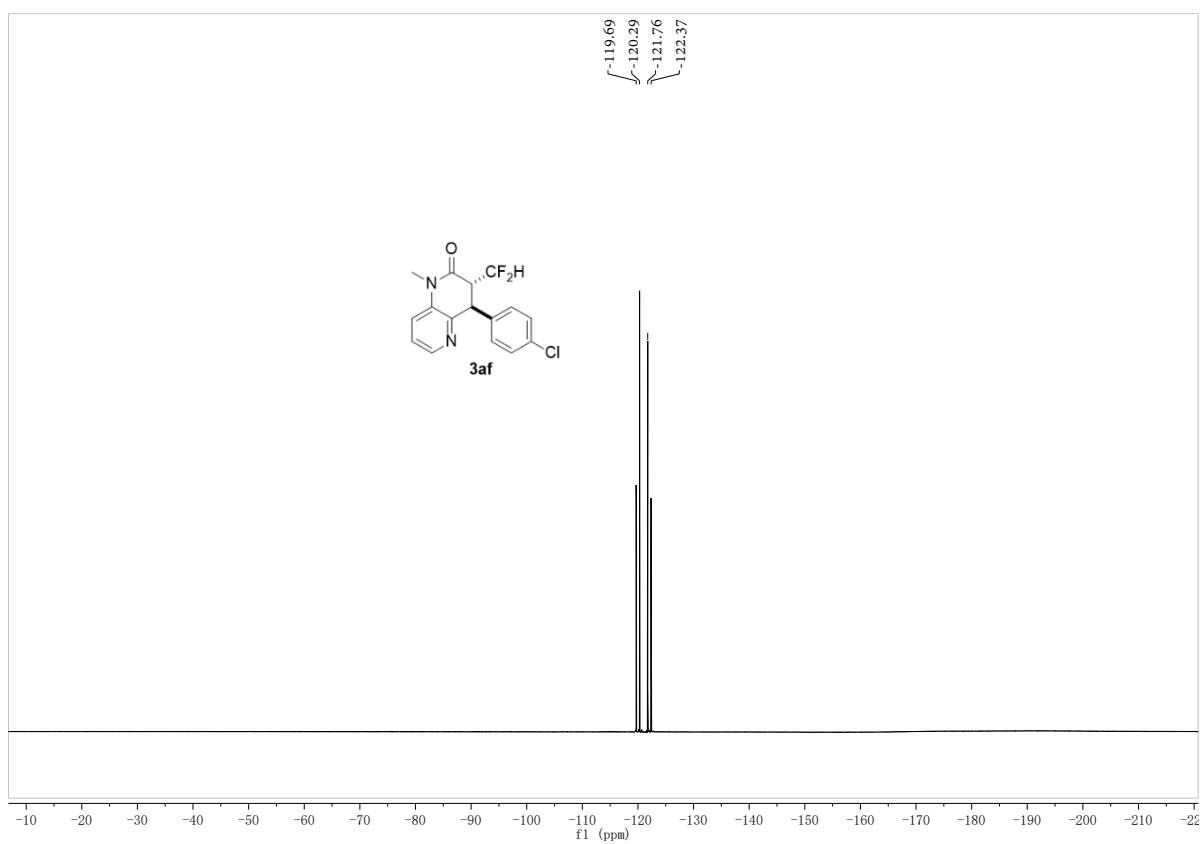
HRMS (ESI) spectrum of **3ae**



<sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>) spectrum of **3af**



<sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) spectrum of **3af**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3af**

Monoisotopic Mass, Even Electron Ions

989 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

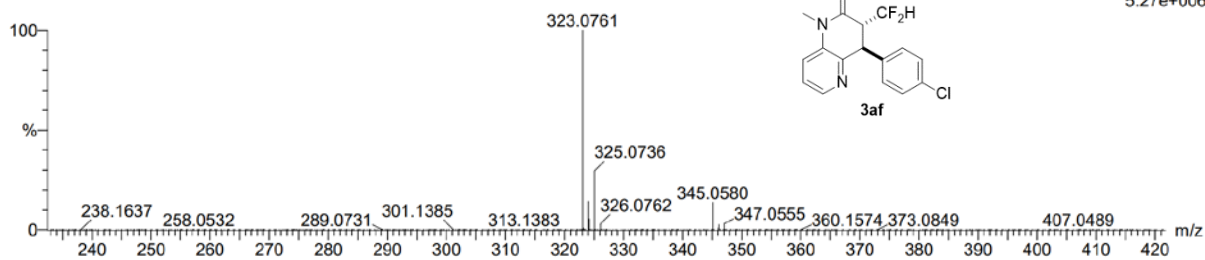
Elements Used:

C: 16-16 H: 14-14 N: 0-200 O: 0-100 F: 2-2 Na: 0-2 Cl: 1-4

8

231125-5-573 15 (0.162)

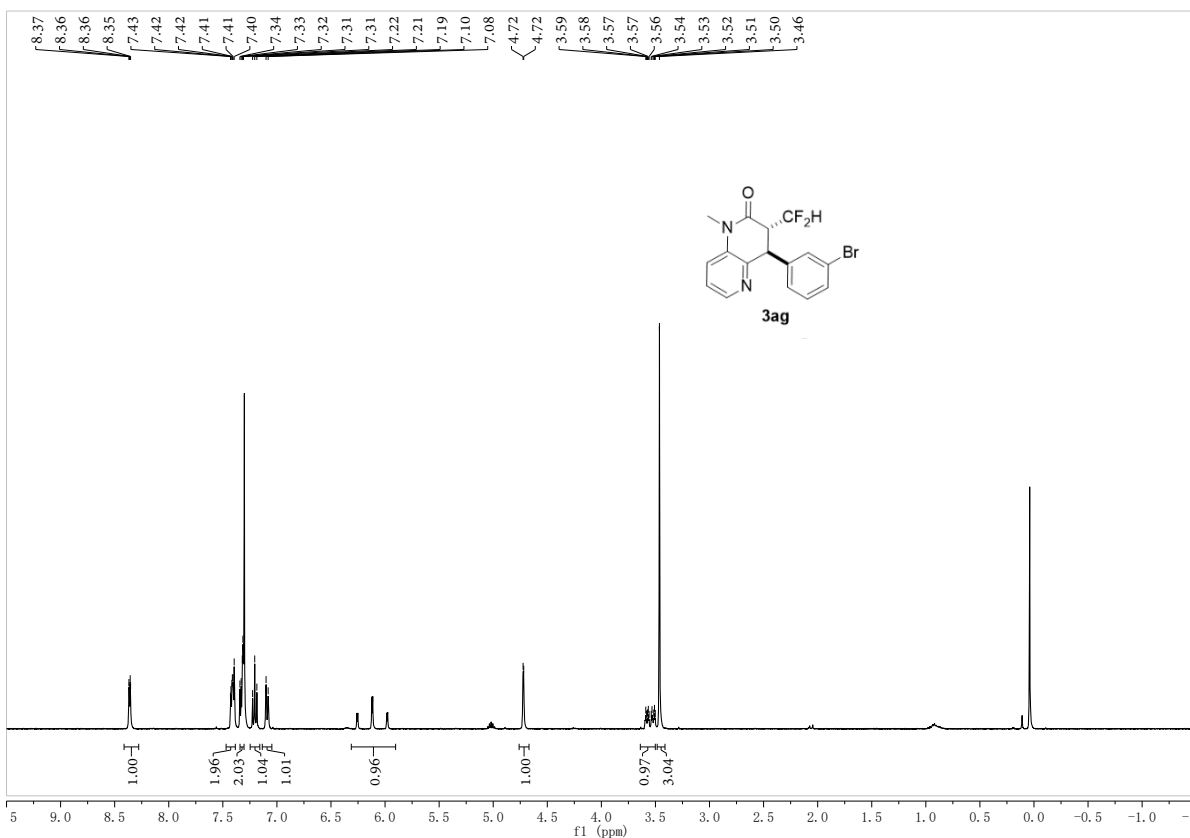
1: TOF MS ES+  
5.27e+006



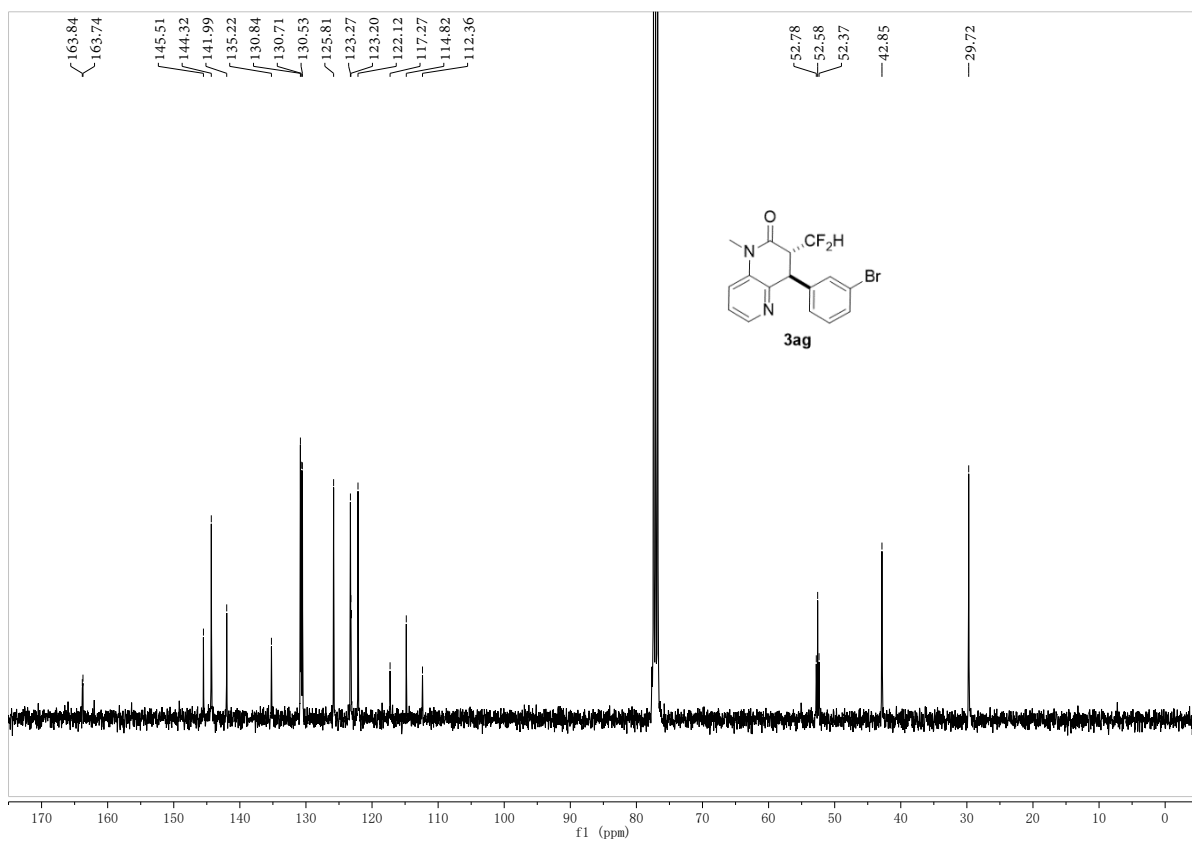
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|------|------|-----|-------|------|----------|--------------------|
| 323.0761 | 323.0763   | -0.2 | -0.6 | 9.5 | 268.7 | n/a  | n/a      | C16 H14 N2 O F2 Cl |

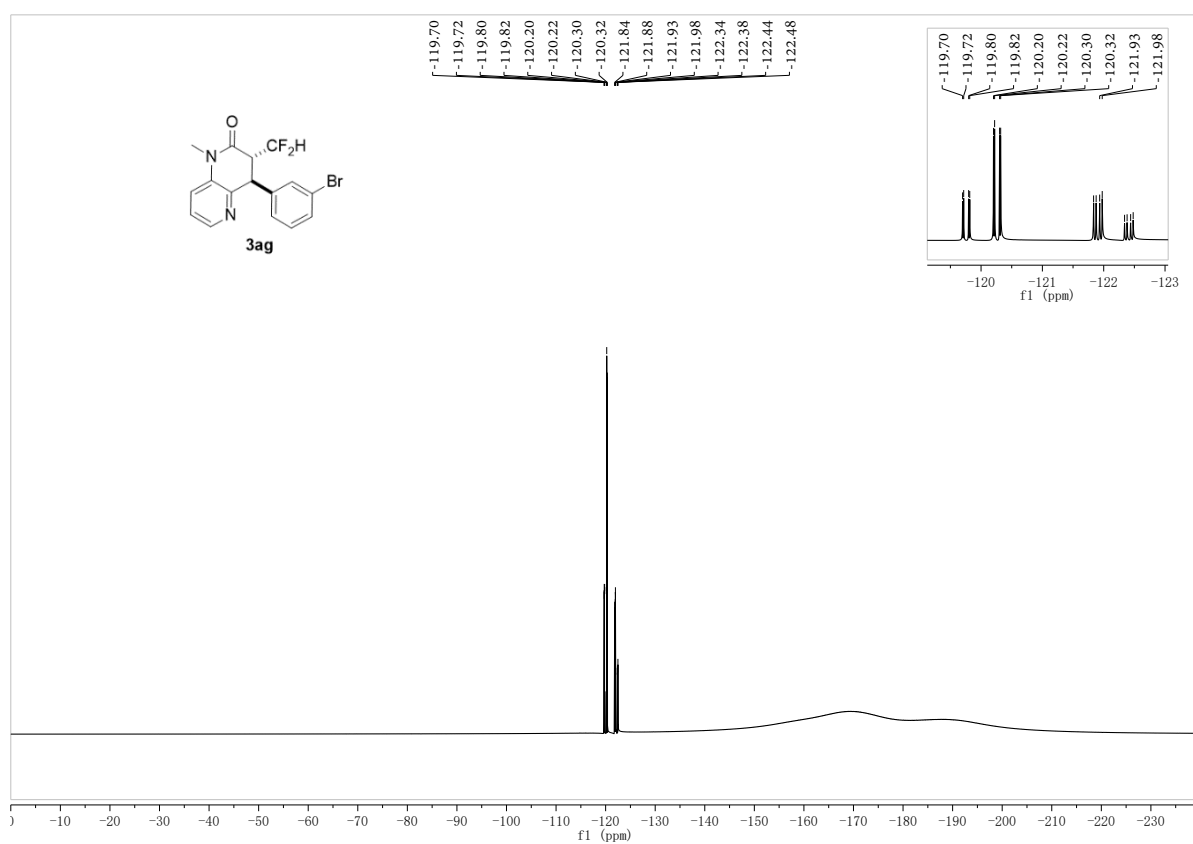
HRMS (ESI) spectrum of **3af**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3ag**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3ag**



<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3ag**

Monoisotopic Mass, Even Electron Ions

93 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

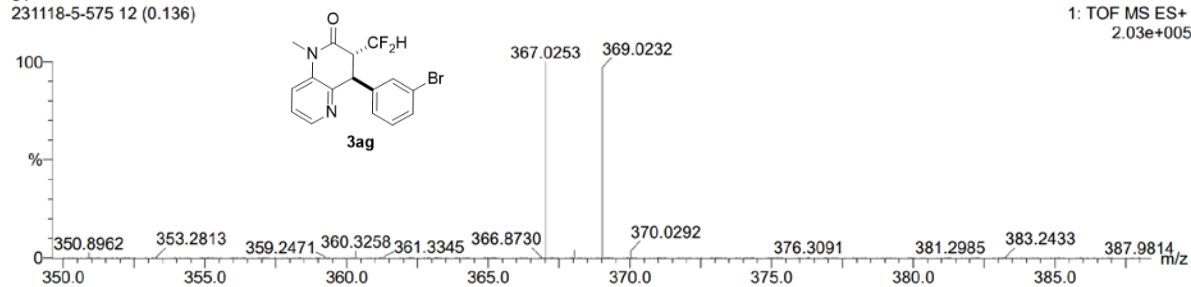
Elements Used:

C: 16-16 H: 0-102 N: 0-8 O: 0-10 F: 2-2 Br: 1-1

31

231118-5-575 12 (0.136)

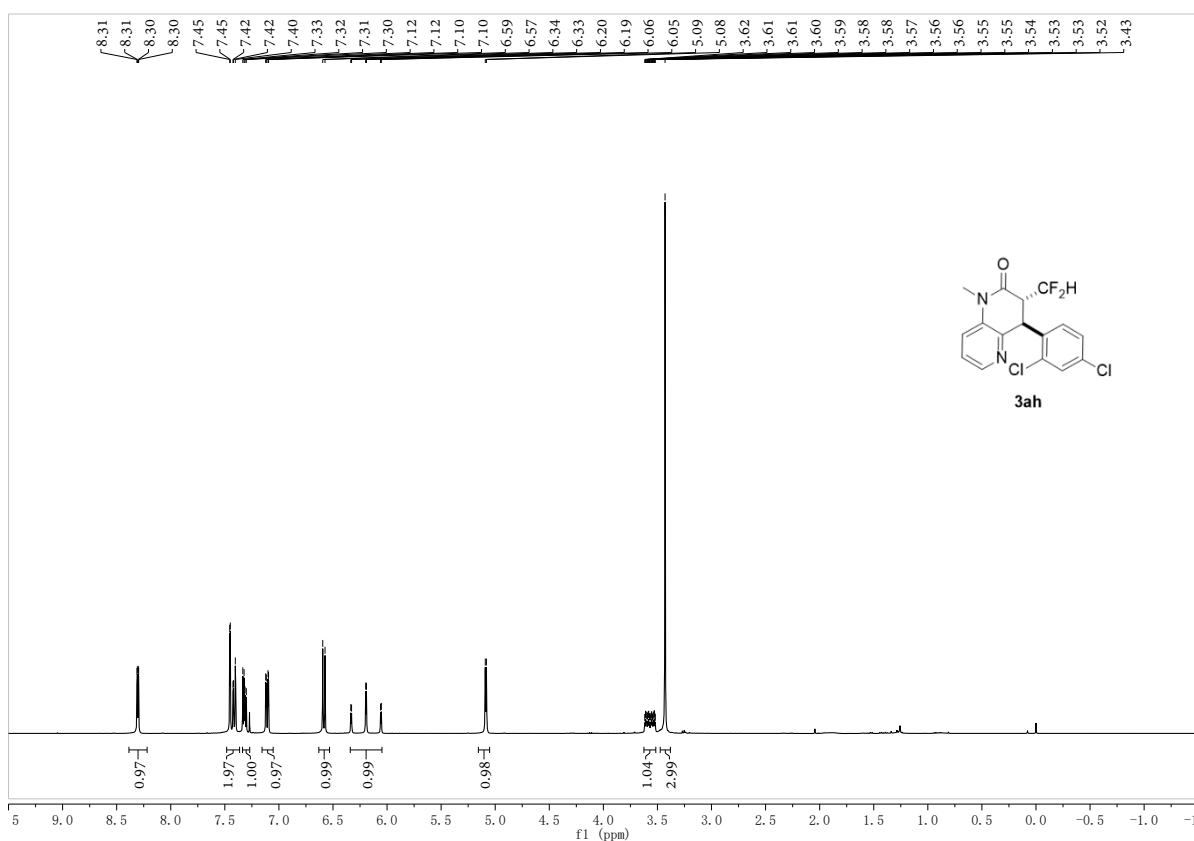
1: TOF MS ES+  
2.03e+005



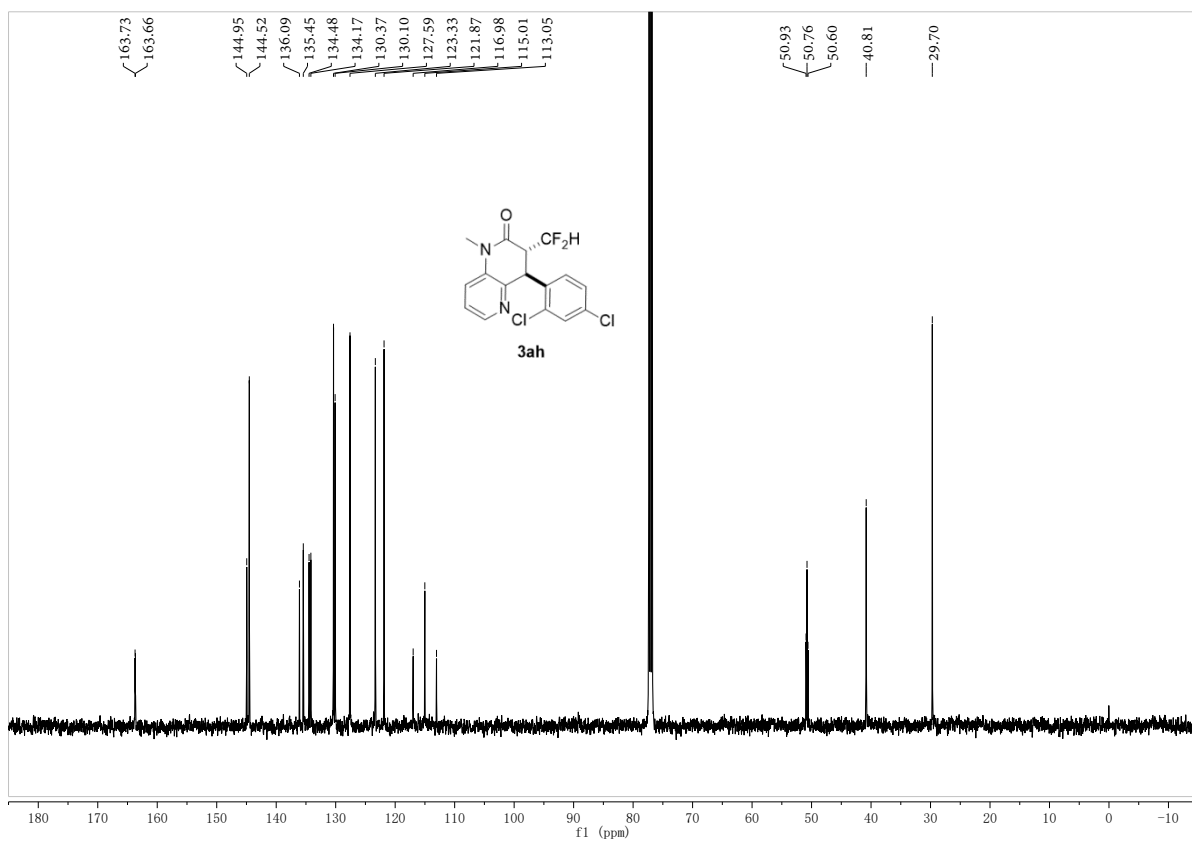
Minimum: -1.5  
Maximum: 5.0 20.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf(%) | Formula            |
|----------|------------|------|------|-----|-------|------|---------|--------------------|
| 367.0253 | 367.0258   | -0.5 | -1.4 | 9.5 | 341.5 | n/a  | n/a     | C16 H14 N2 O F2 Br |

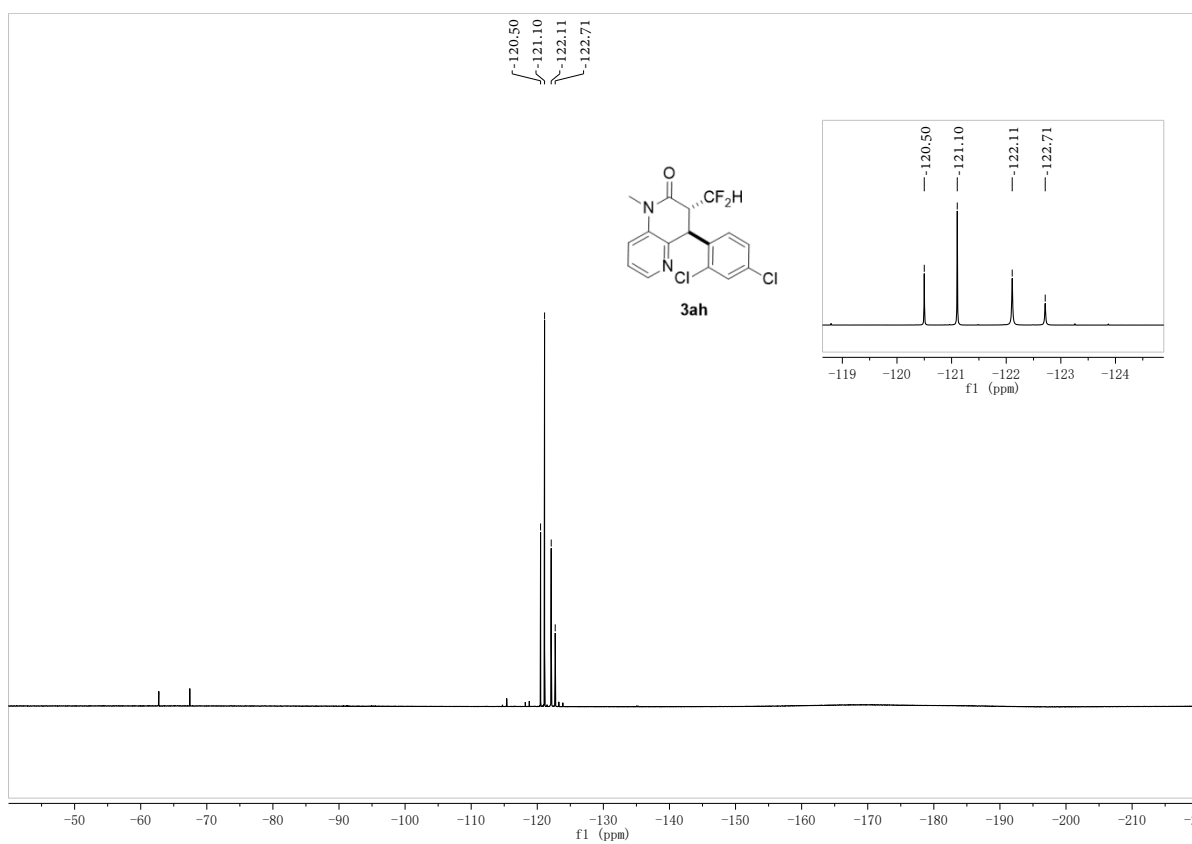
HRMS (ESI) spectrum of 3ag



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of 3ah



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3ah**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3ah**



Monoisotopic Mass, Even Electron Ions

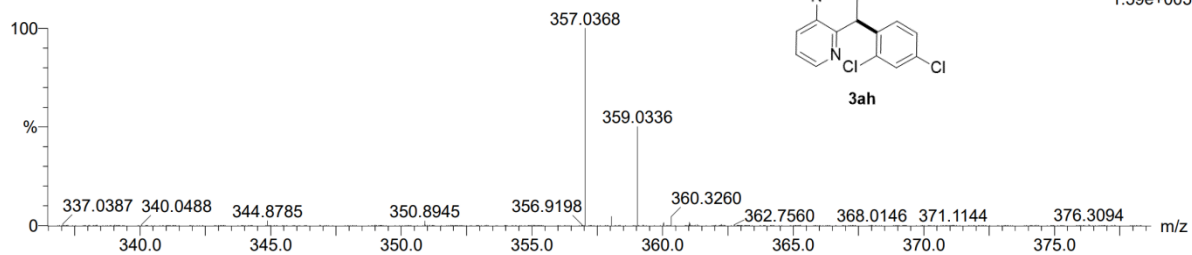
94 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 16-16 H: 0-102 N: 0-8 O: 0-10 F: 2-2 Cl: 2-2

31

231118-5-516 13 (0.145)

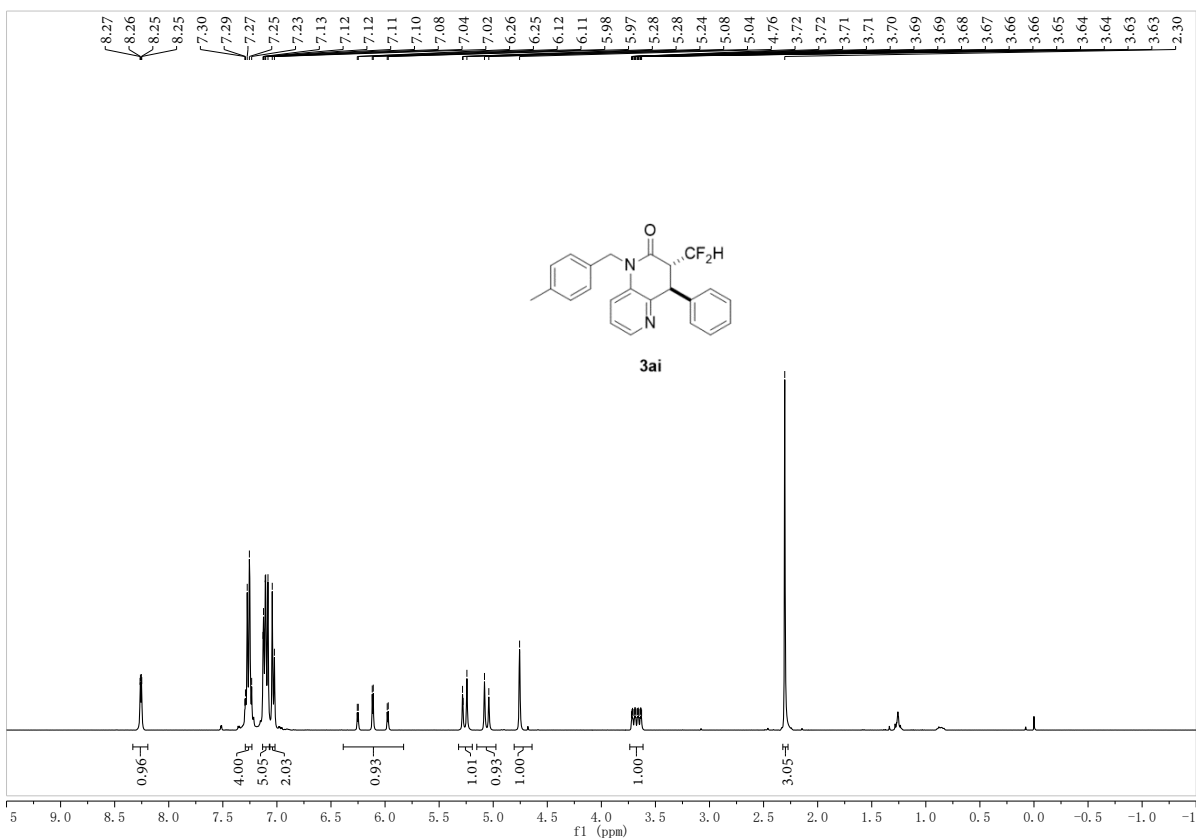


1: TOF MS ES+  
1.59e+005

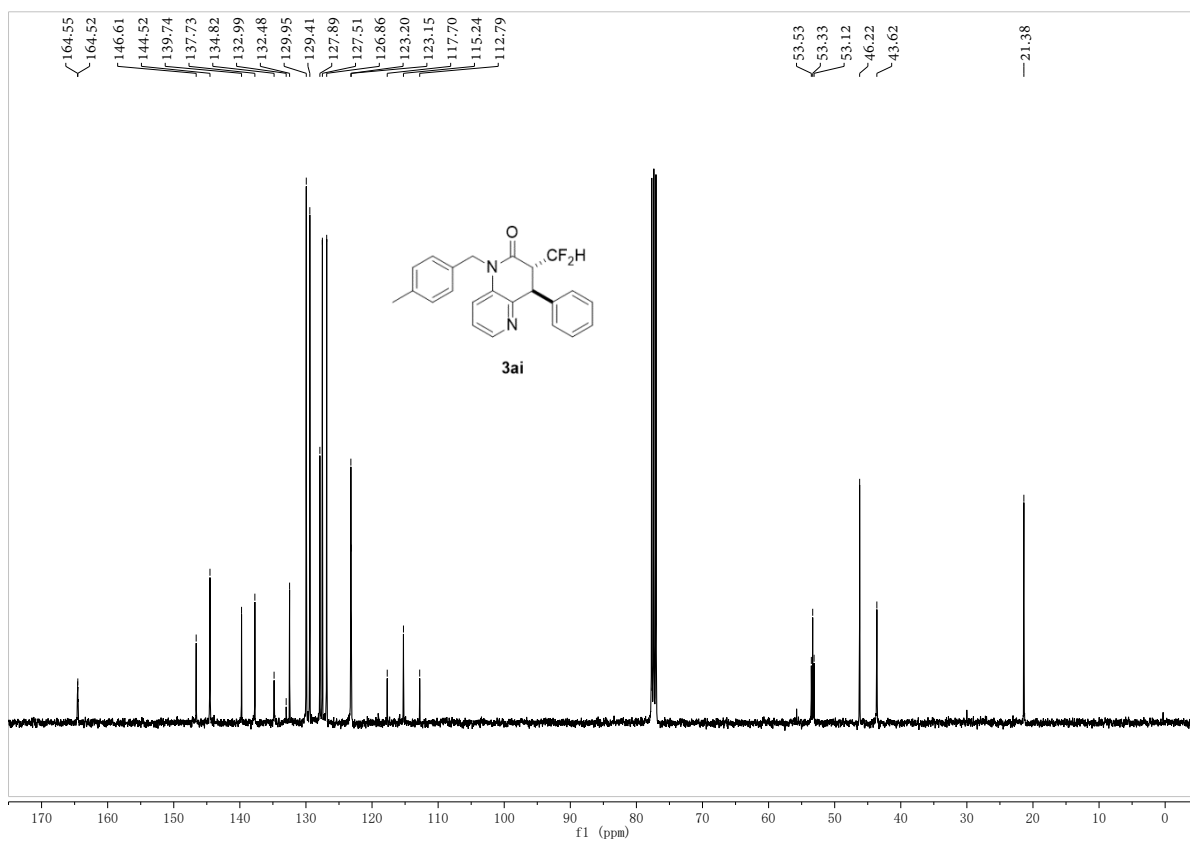
Minimum: -1.5  
Maximum: 5.0 20.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula             |
|----------|------------|------|------|-----|-------|------|----------|---------------------|
| 357.0368 | 357.0373   | -0.5 | -1.4 | 9.5 | 237.5 | n/a  | n/a      | C16 H13 N2 O F2 Cl2 |

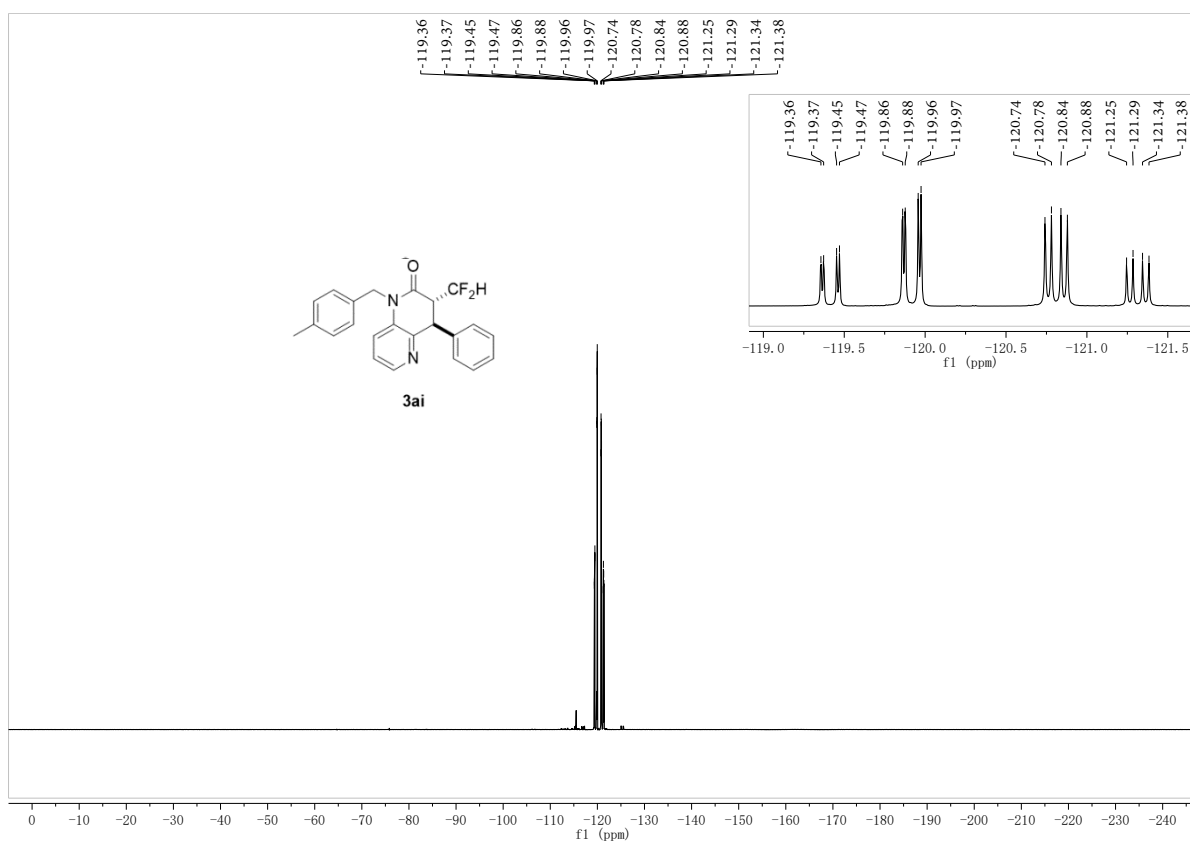
HRMS (ESI) spectrum of 3ah



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of 3ai

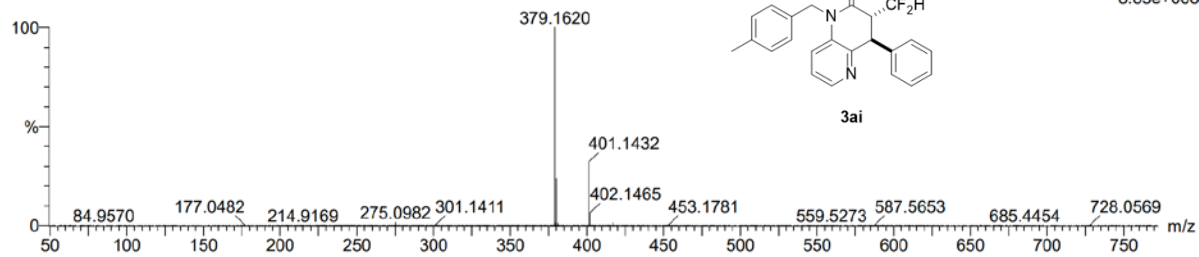


<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3ai**



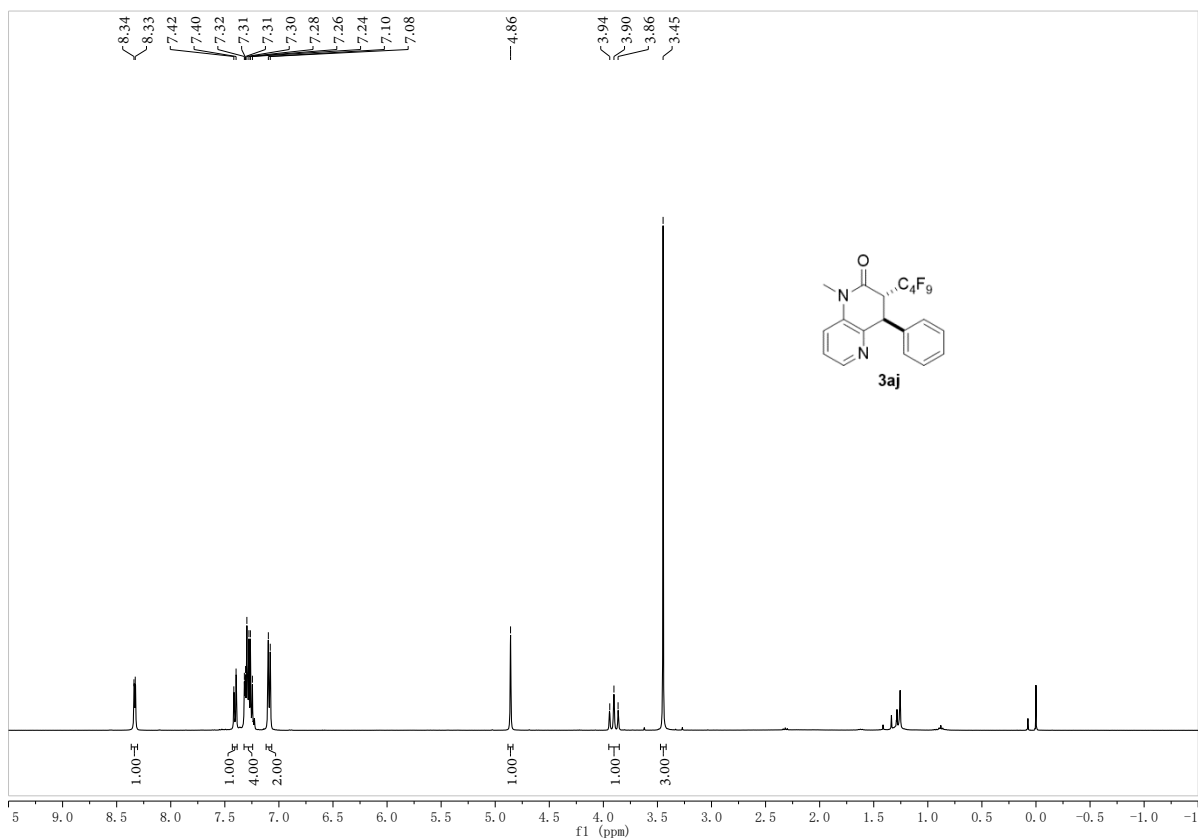
<sup>19</sup>F NMR (565 MHz, CDCl<sub>3</sub>) spectrum of **3ai**

Monoisotopic Mass, Even Electron Ions  
 718 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)  
 Elements Used:  
 C: 23-23 H: 21-21 N: 0-200 O: 0-100 F: 2-2 Na: 0-2  
 4  
 231125-5-576 16 (0.170)

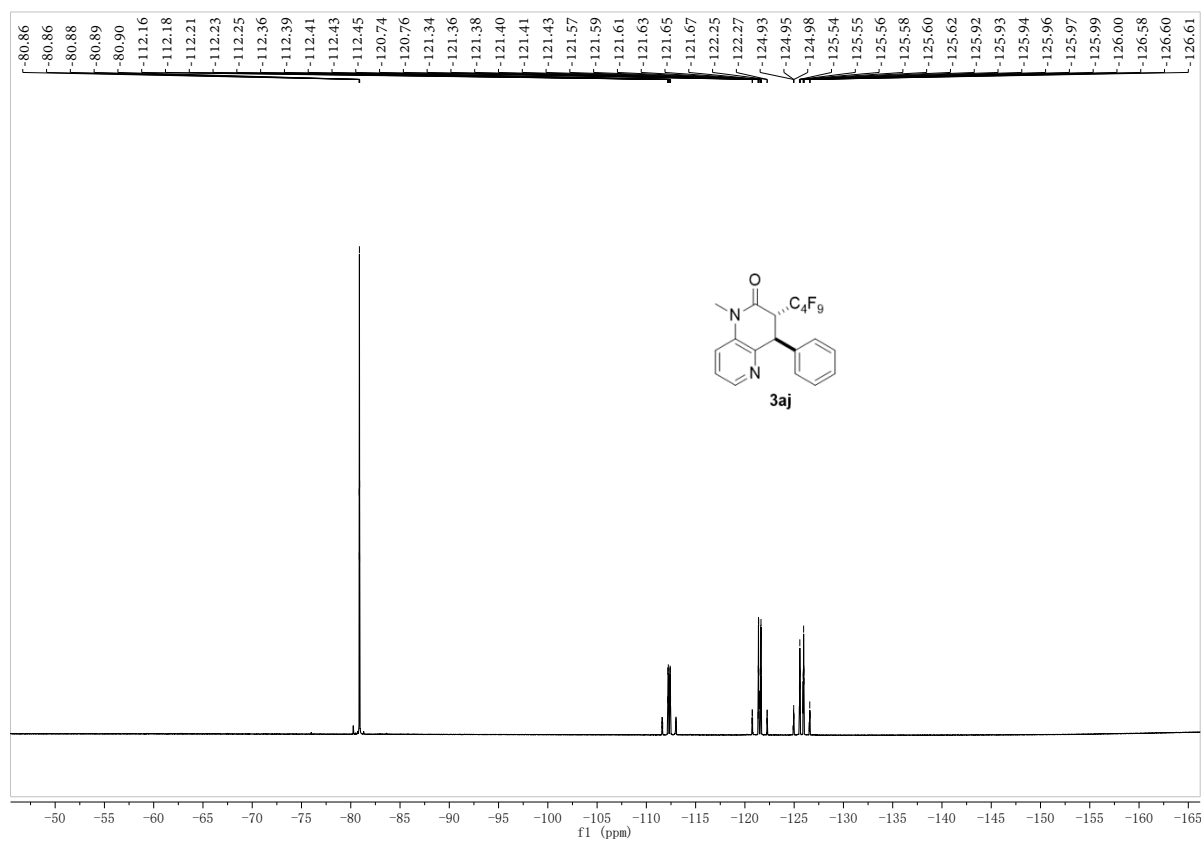
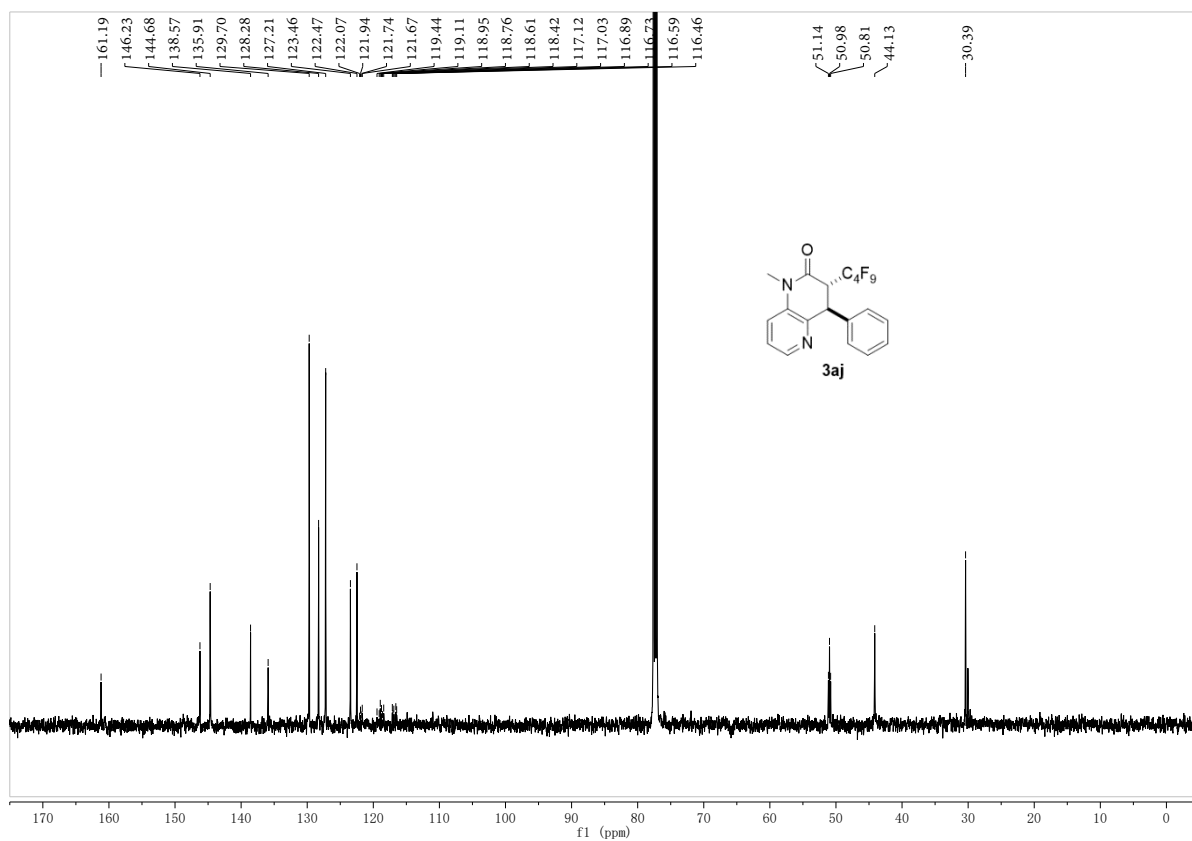


| Mass     | Calc. Mass | mDa  | PPM  | DBE  | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|------|------|------|-------|------|----------|-----------------|
| 379.1620 | 379.1622   | -0.2 | -0.5 | 13.5 | 267.6 | n/a  | n/a      | C23 H21 N2 O F2 |

HRMS (ESI) spectrum of **3ai**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3aj**



Monoisotopic Mass, Even Electron Ions

500 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

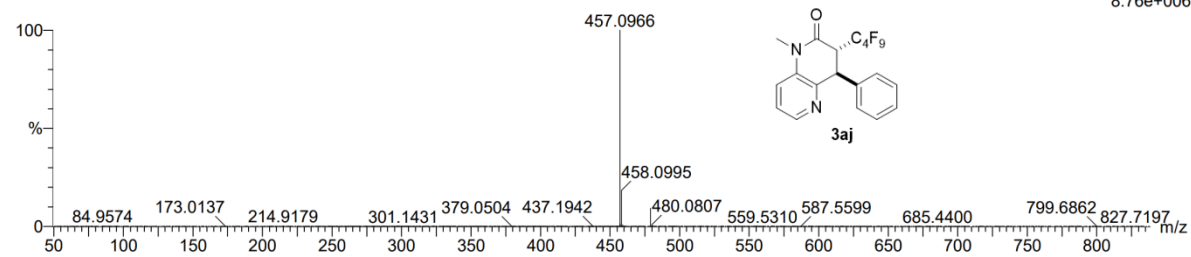
Elements Used:

C: 19-19 H: 14-14 N: 0-200 O: 0-100 F: 9-9 Na: 0-2

8

231125-5-540 16 (0.170)

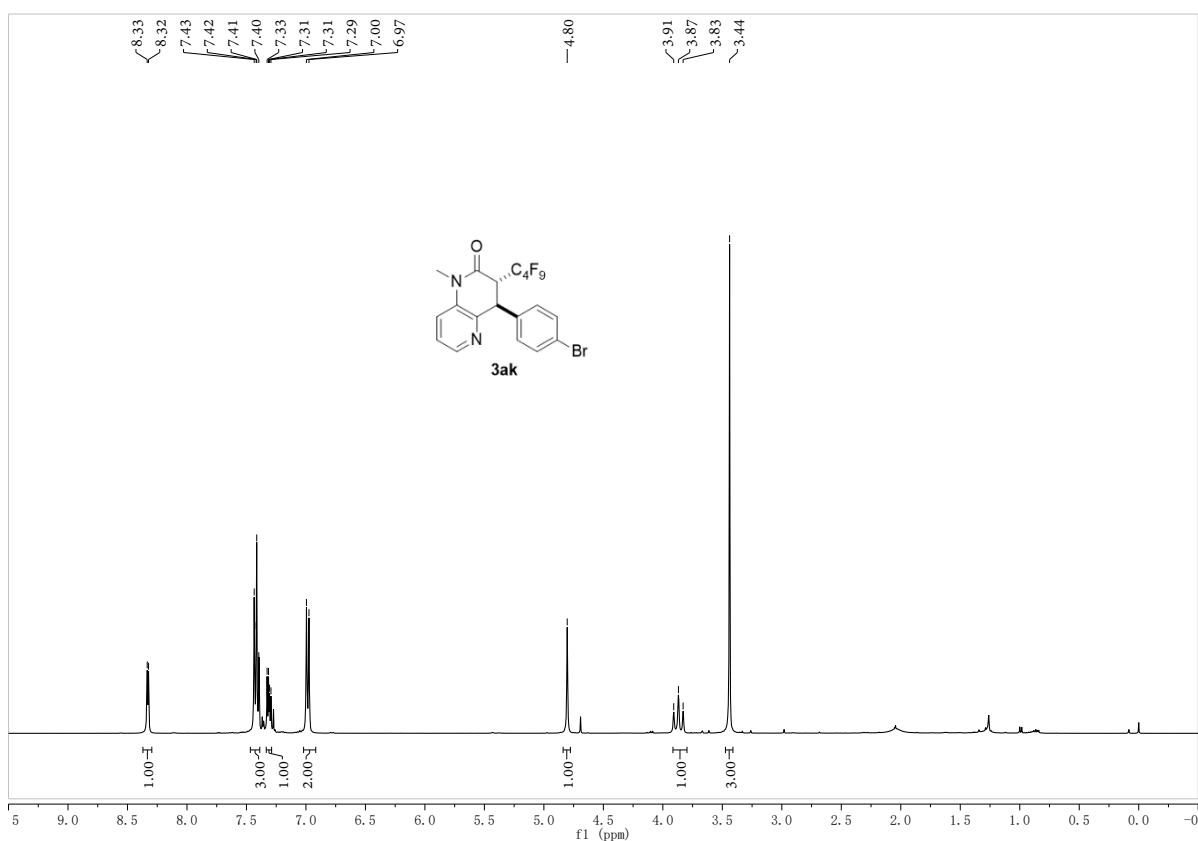
1: TOF MS ES+  
8.76e+006



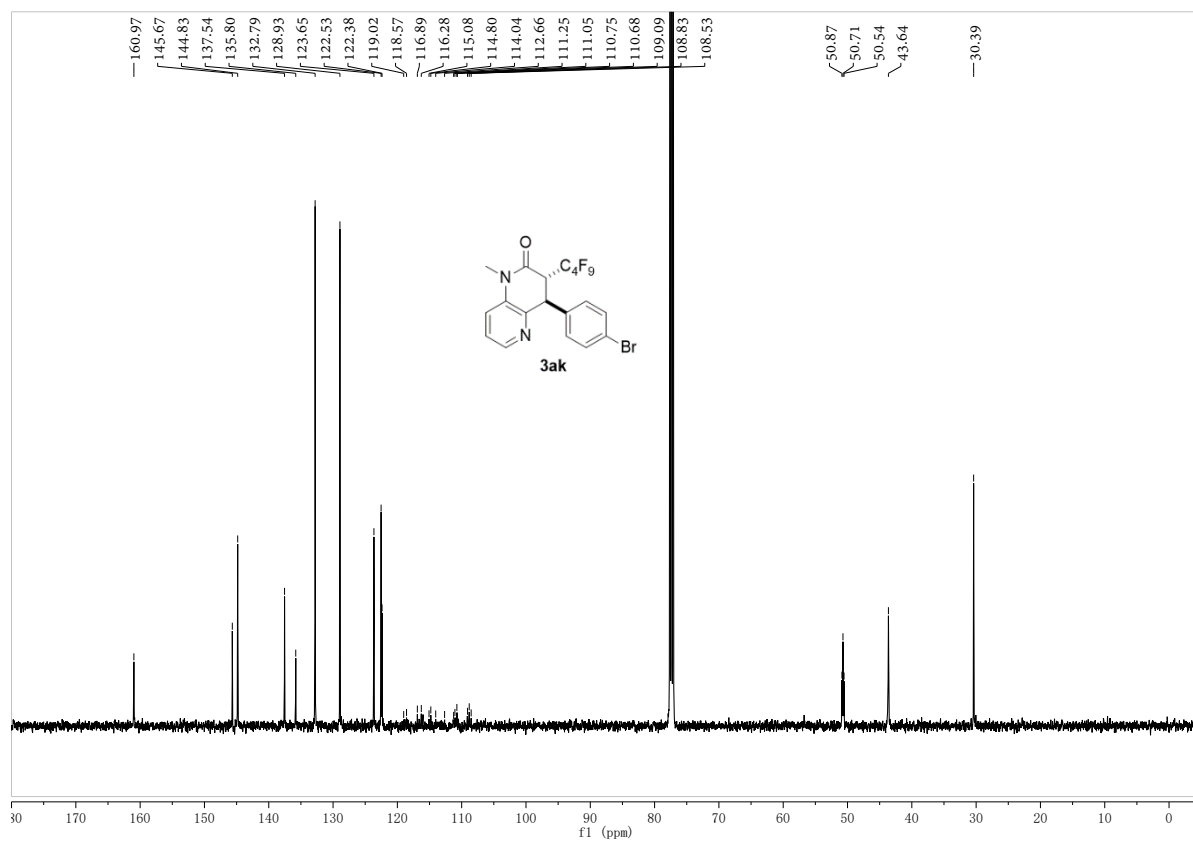
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE | i-FIT | Norm | Conf (%) | Formula         |
|----------|------------|-----|-----|-----|-------|------|----------|-----------------|
| 457.0966 | 457.0962   | 0.4 | 0.9 | 9.5 | 194.3 | n/a  | n/a      | C19 H14 N2 O F9 |

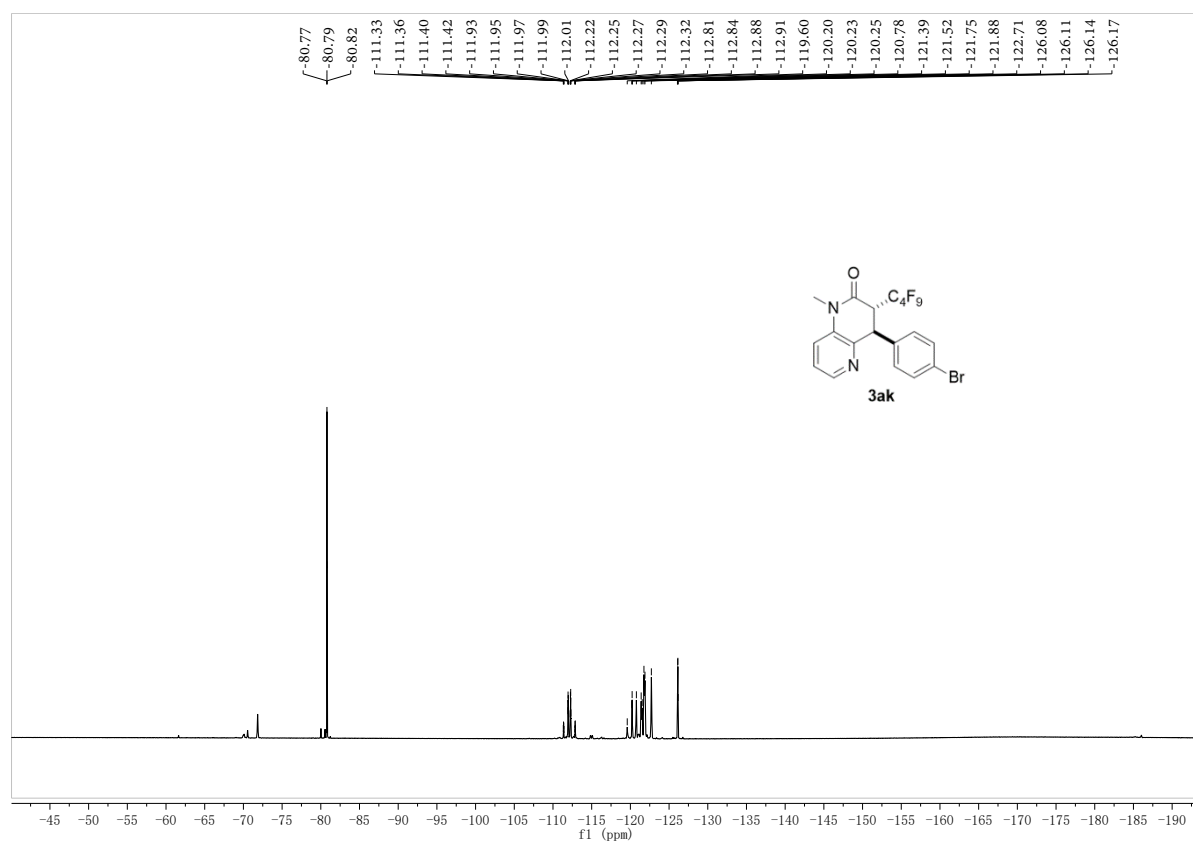
HRMS (ESI) spectrum of 3aj



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of 3ak



<sup>13</sup>C NMR (126 MHz, CDCl<sub>3</sub>) spectrum of **3ak**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3ak**

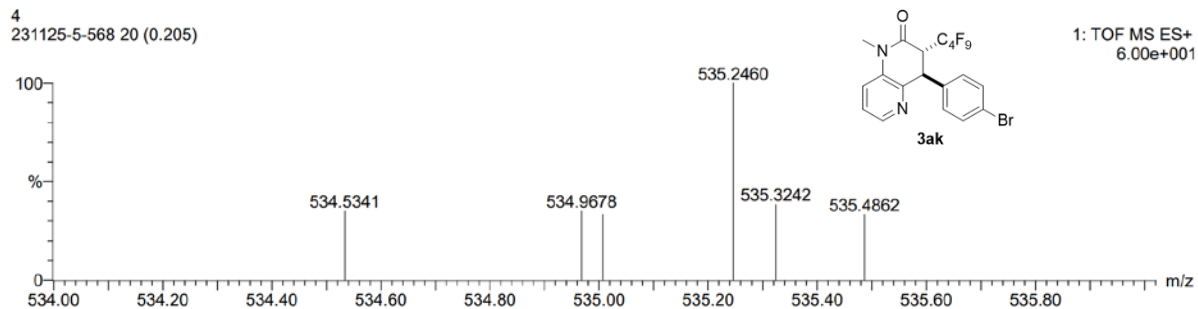
Monoisotopic Mass, Even Electron Ions

860 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 19-19 H: 13-13 N: 0-200 O: 0-100 F: 9-9 Na: 0-2 Br: 1-3

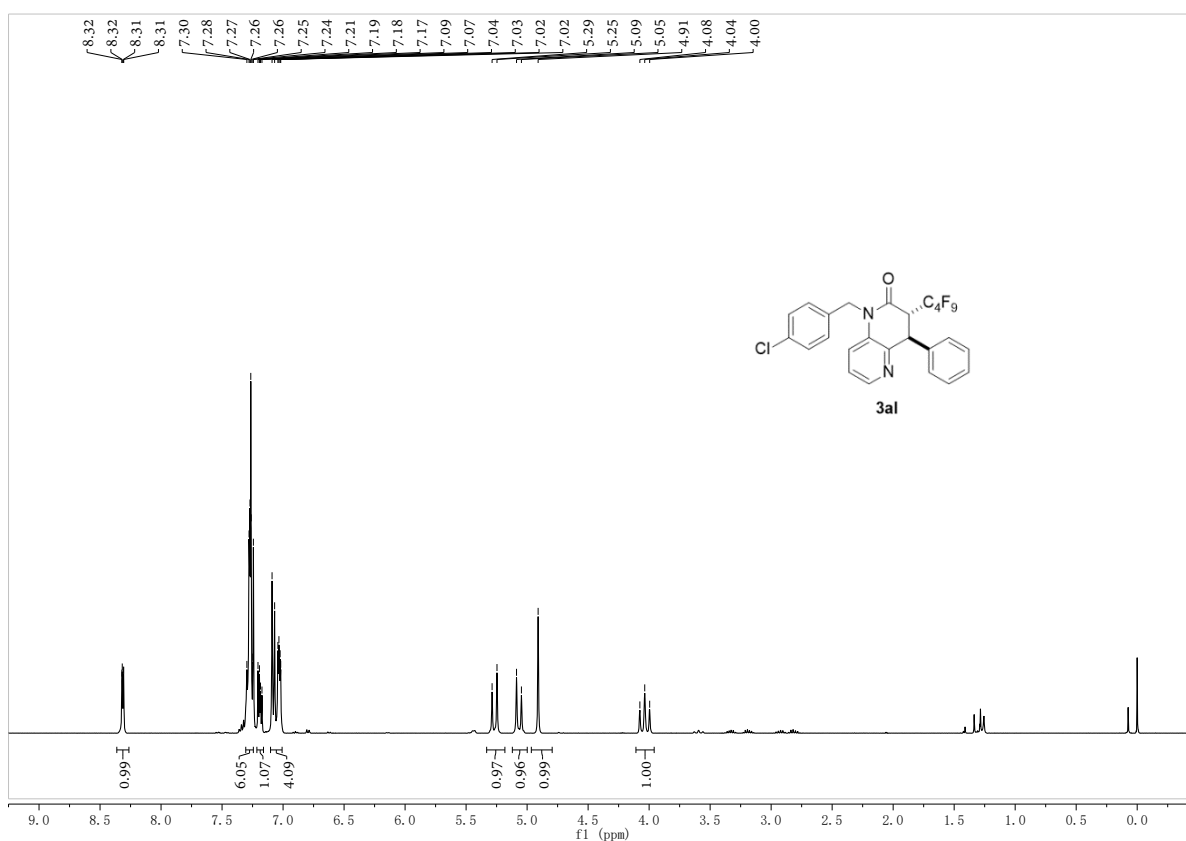
4  
231125-5-568 20 (0.205)



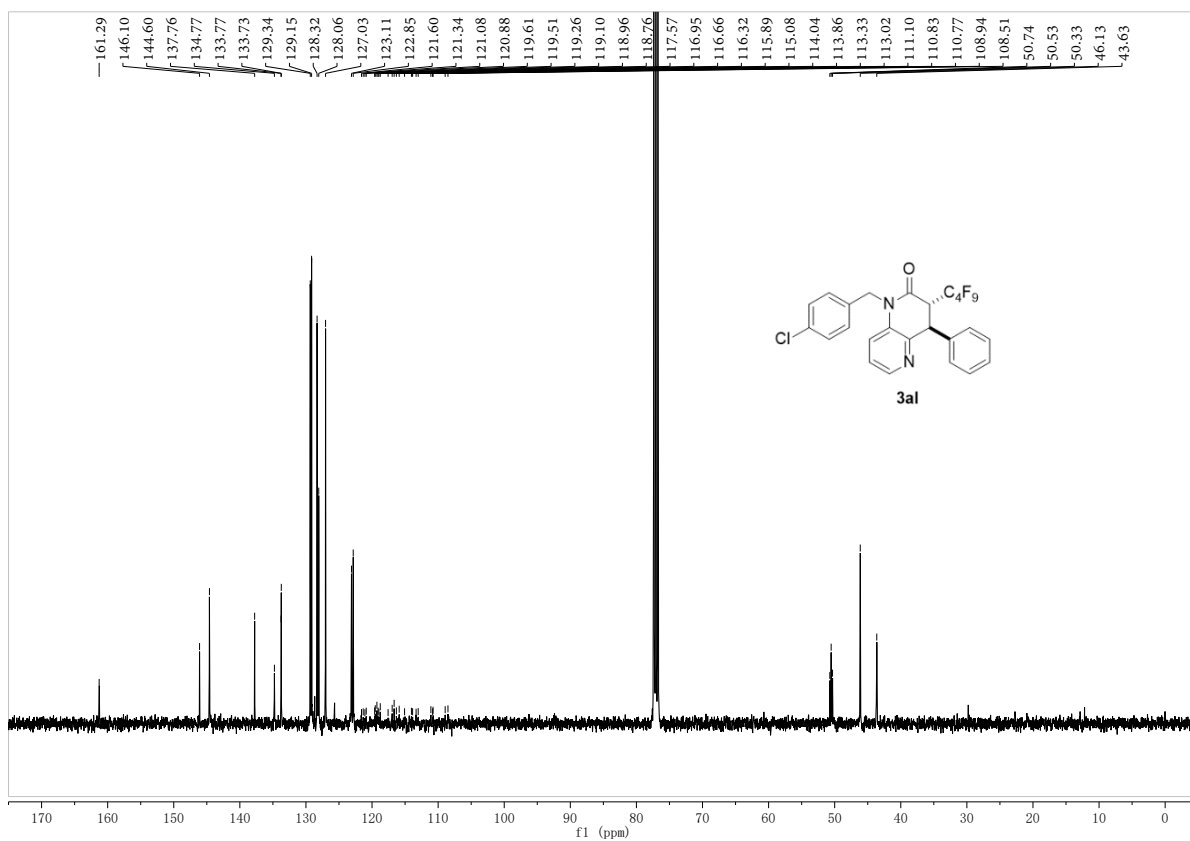
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf(%) | Formula            |
|----------|------------|------|------|-----|-------|------|---------|--------------------|
| 535.0067 | 535.0068   | -0.1 | -0.2 | 9.5 | 36.2  | n/a  | n/a     | C19 H13 N2 O F9 Br |

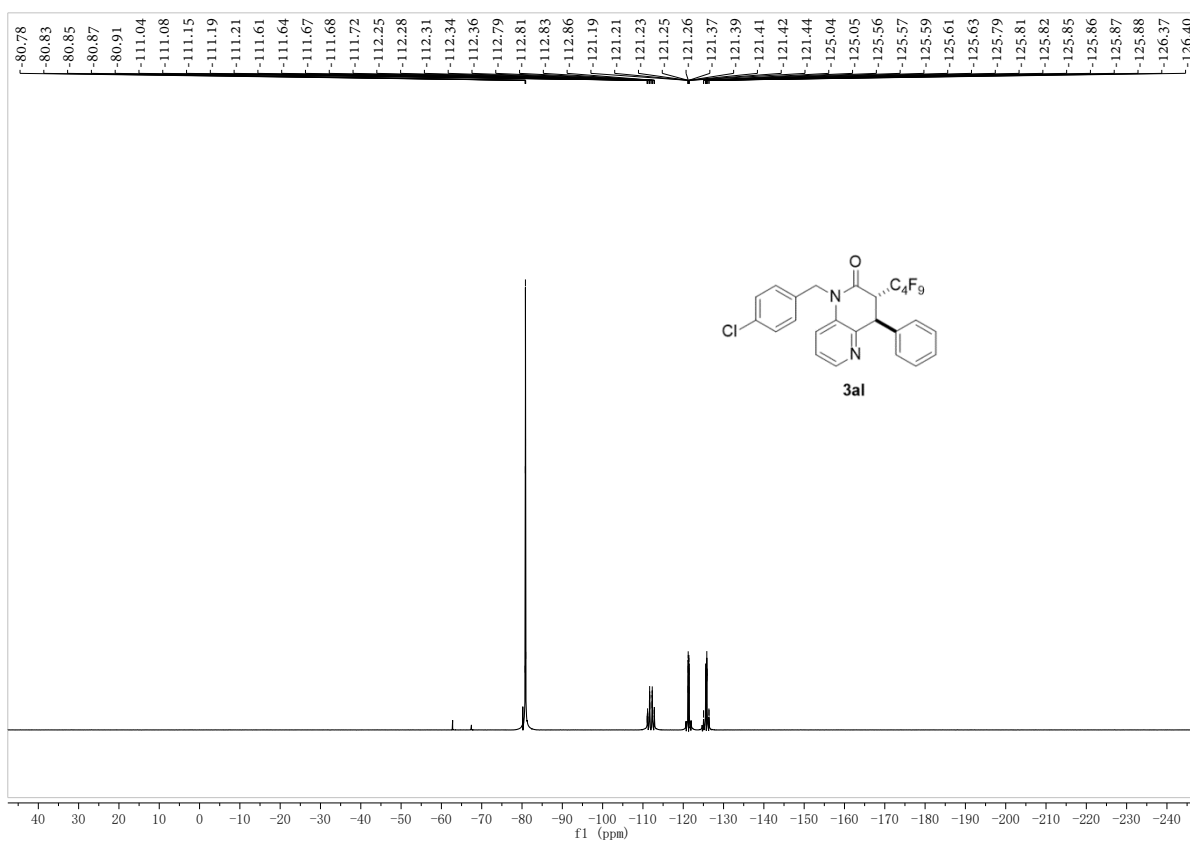
HRMS (ESI) spectrum of **3ak**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3al**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3al**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3al**



Monoisotopic Mass, Even Electron Ions  
2445 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

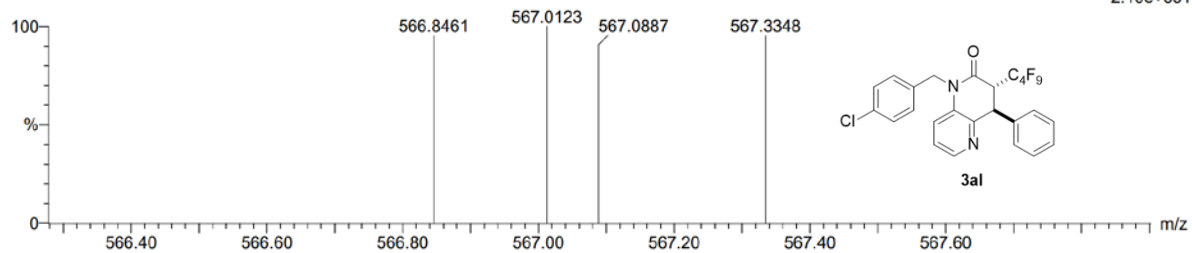
Elements Used:

C: 25-25 H: 17-17 N: 0-200 O: 0-100 F: 9-9 Na: 0-2 Cl: 1-4

8

231125-5-554 24 (0.247)

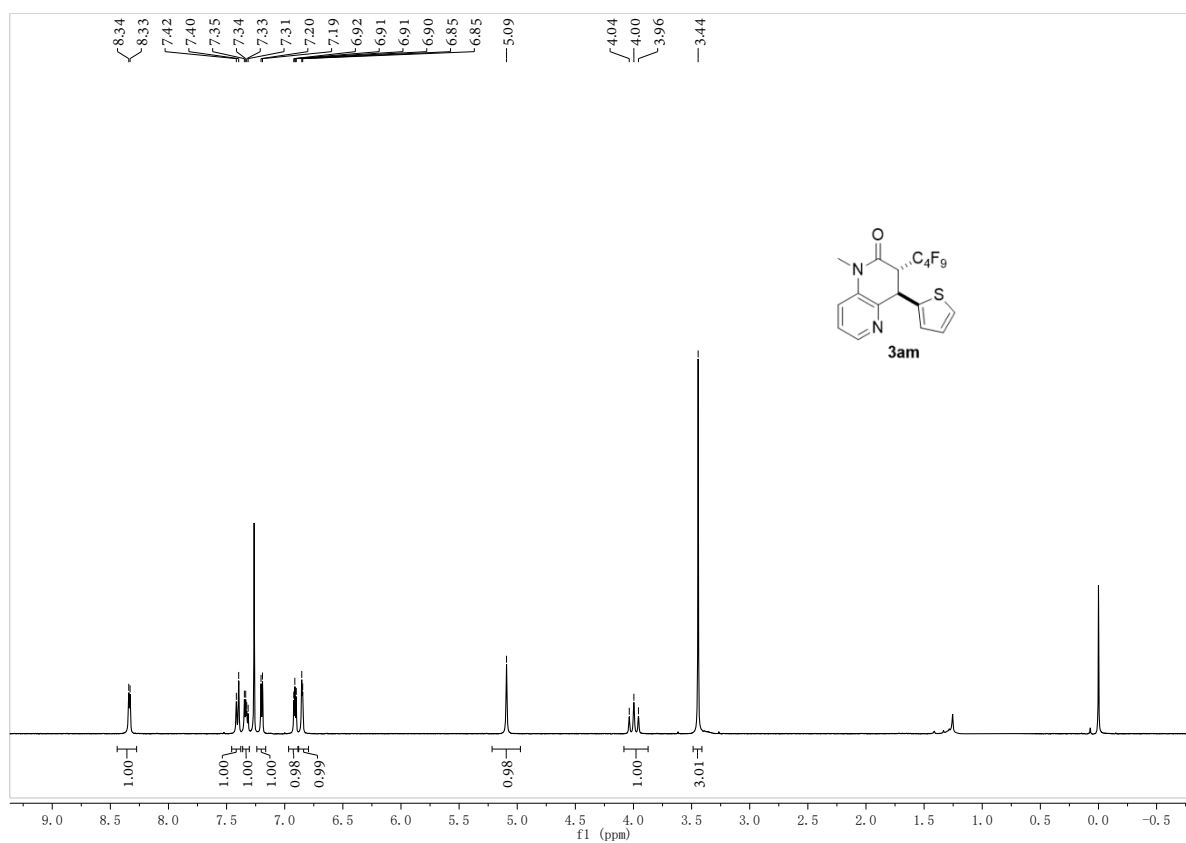
1: TOF MS ES+  
2.10e+001



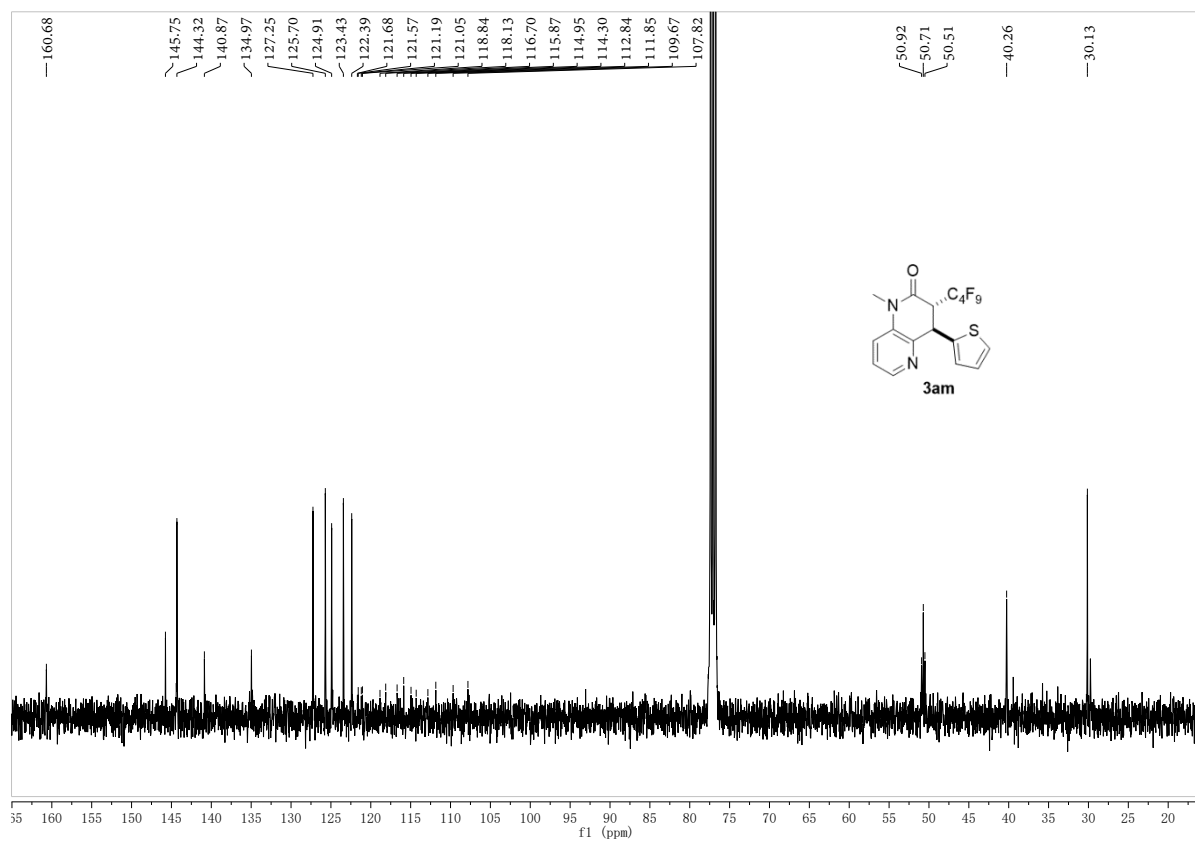
Minimum: -1.5  
Maximum: 5.0 10.0 50.0

| Mass     | Calc. Mass | mDa | PPM | DBE  | i-FIT | Norm | Conf (%) | Formula            |
|----------|------------|-----|-----|------|-------|------|----------|--------------------|
| 567.0887 | 567.0886   | 0.1 | 0.2 | 13.5 | 20.4  | n/a  | n/a      | C25 H17 N2 O F9 Cl |

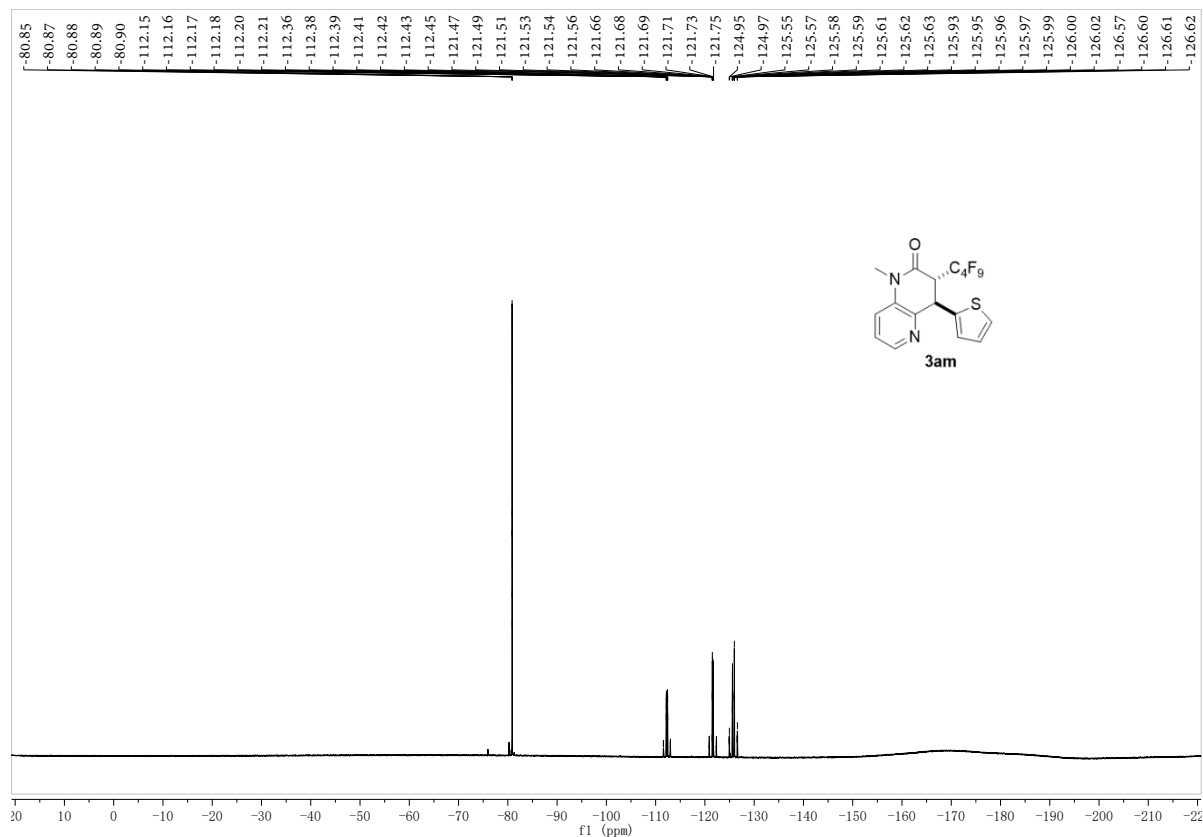
HRMS (ESI) spectrum of **3al**



<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) spectrum of **3am**



<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>) spectrum of **3am**



<sup>19</sup>F NMR (471 MHz, CDCl<sub>3</sub>) spectrum of **3am**

Monoisotopic Mass, Even Electron Ions

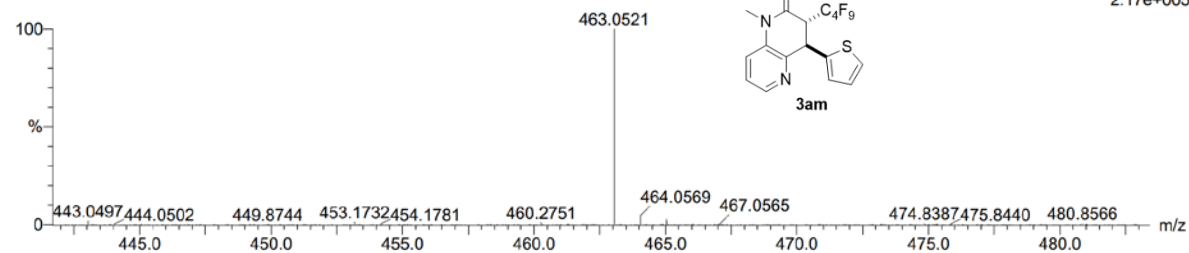
95 formula(e) evaluated with 1 results within limits (up to 50 best isotopic matches for each mass)

Elements Used:

C: 17-17 H: 0-102 N: 0-8 O: 0-10 F: 9-9 S: 1-1

31

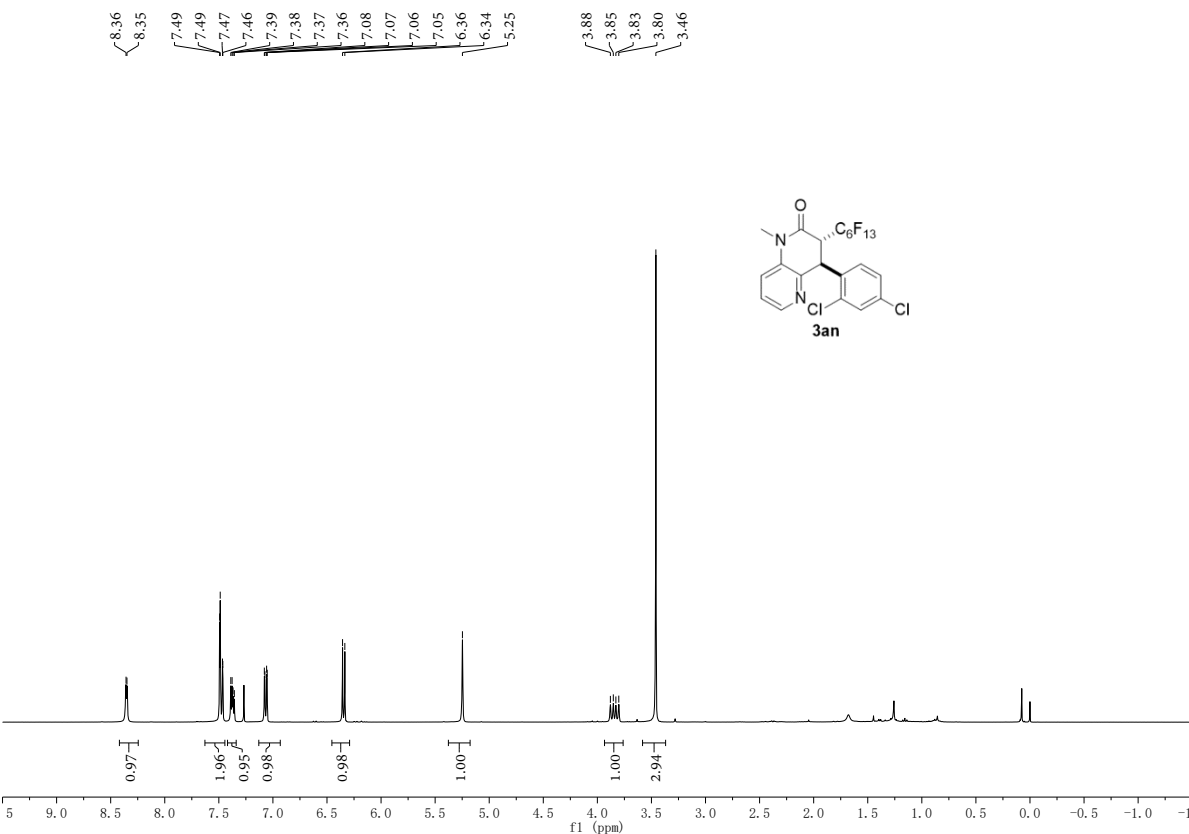
231118-5-542 13 (0.145)

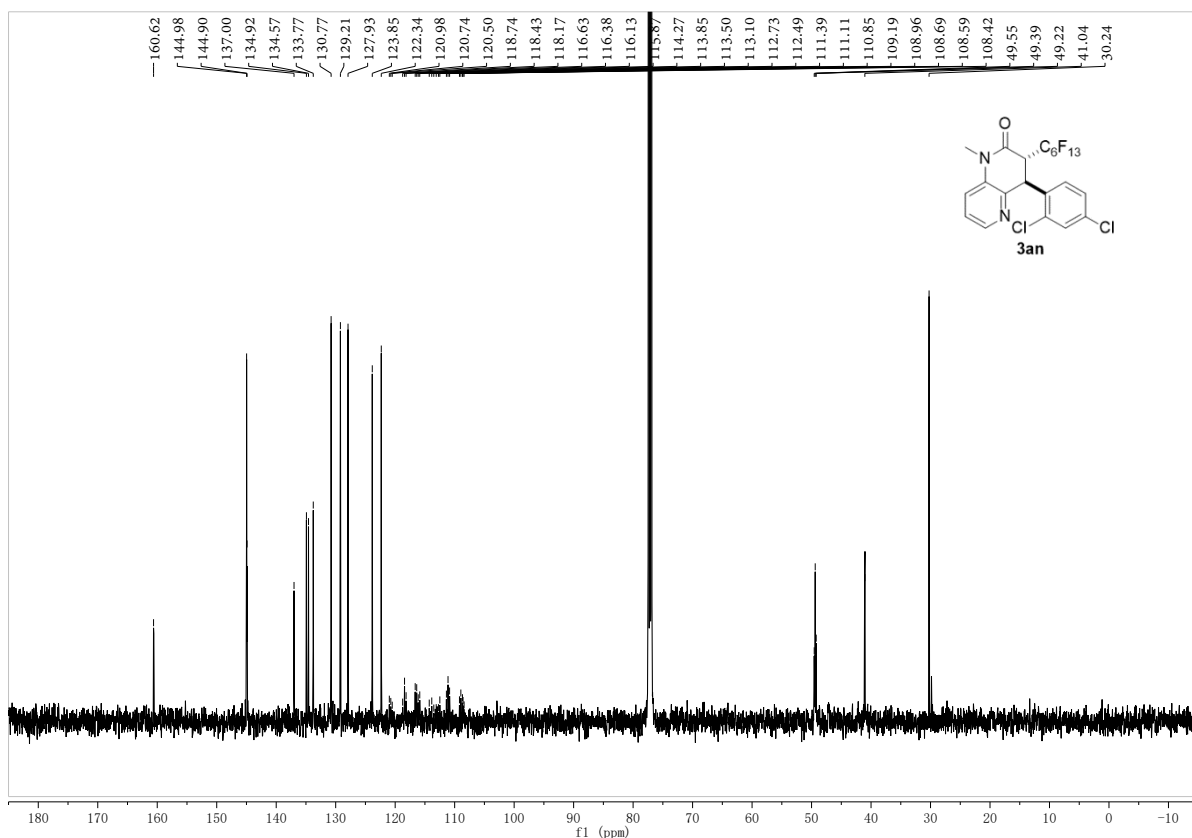


Minimum: -1.5  
Maximum: 5.0 20.0 50.0

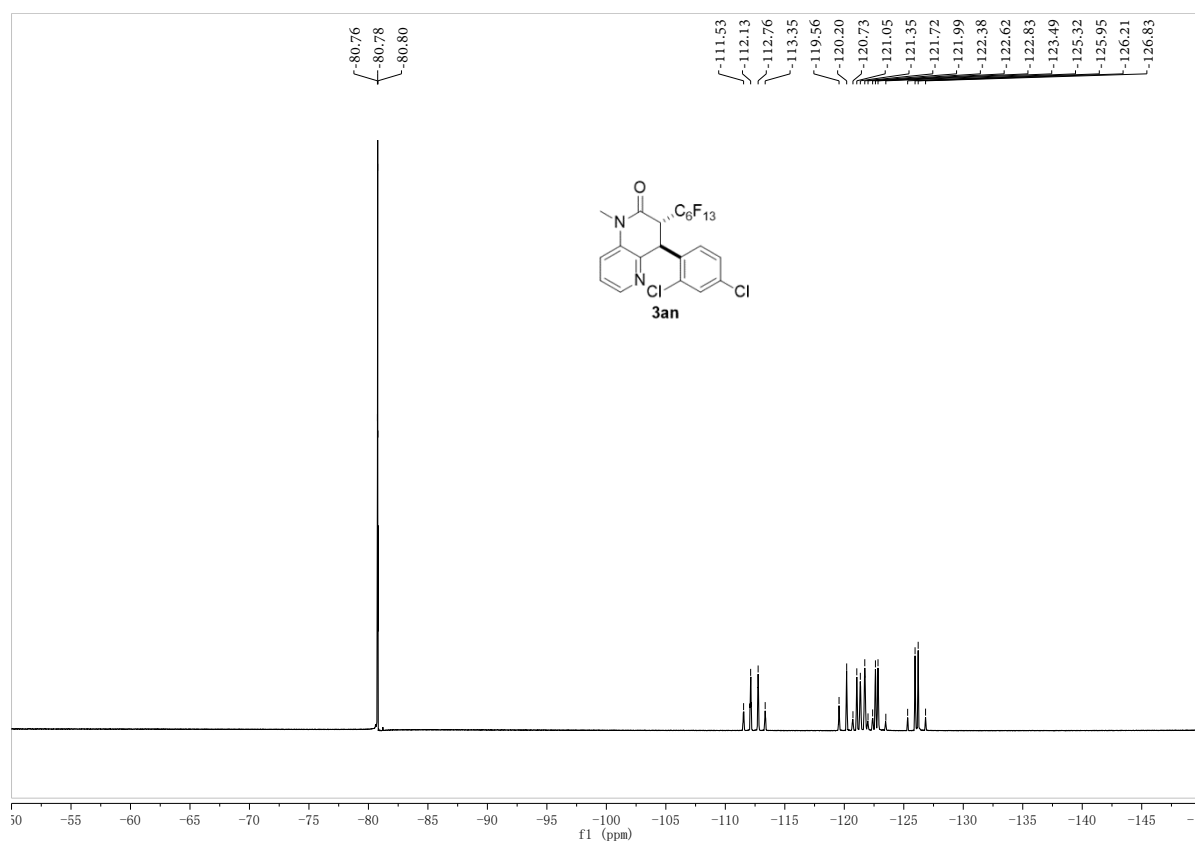
| Mass     | Calc. Mass | mDa  | PPM  | DBE | i-FIT | Norm | Conf (%) | Formula           |
|----------|------------|------|------|-----|-------|------|----------|-------------------|
| 463.0521 | 463.0527   | -0.6 | -1.3 | 8.5 | 283.1 | n/a  | n/a      | C17 H12 N2 O F9 S |

### HRMS (ESI) spectrum of **3am**

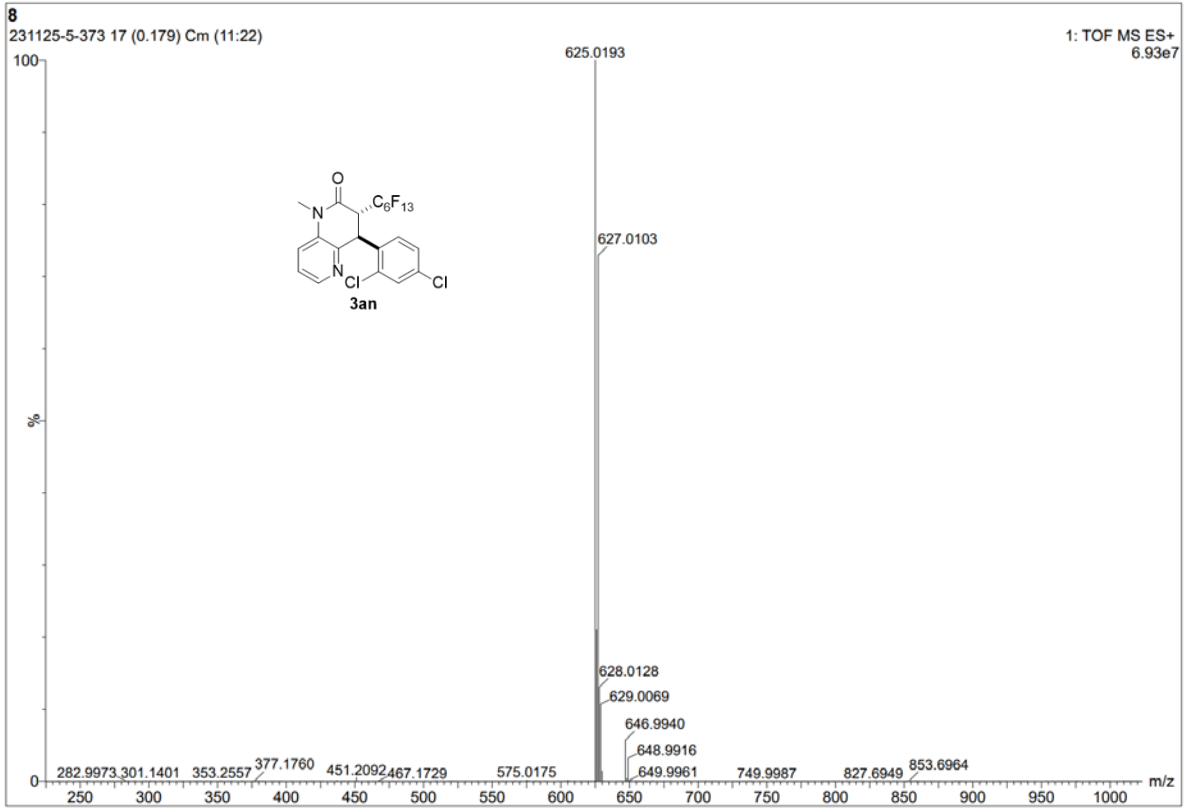




$^{13}C$  NMR (126 MHz,  $CDCl_3$ ) spectrum of **3an**



$^{19}F$  NMR (471 MHz,  $CDCl_3$ ) spectrum of **3an**



HRMS (ESI) spectrum of **3an**