

Supporting Information for:

Photoinduced tandem radical cyclization/heteroarylation of *N*-allylbromodifluoroacetamides with quinoxalin-2(1*H*)-ones or coumarins under metal- and photocatalyst-free conditions

Wei Zhao, Liangming Xuan, Yang Liu, Jiayi Yin, Haifeng Wang, Qiongjiao Yan, Wei Wang,* Jin Huang* and Fener Chen*

Table of Contents

1. General Information	S2
2. Reaction Optimization	S3
3. Product Synthesis and Characterization	S5
3.1 List of Substrates	S5
3.2 General procedure for the visible-light-promoted tandem radical cyclization/heteroarylation of bromodifluoroacetamides	S6
4. Scale-Up and Sunlight Experiment	S25
5. Mechanistic Experiments	S26
6. X-Ray Structure of Product 3ap	S30
7. References	S31
8. NMR Spectra	S32

1. General Information

Flash column chromatography was performed using silica gel from Qingdao Haiyang. Anhydrous solvents [tetrahydrofuran (THF), *N,N*-dimethylformamide (DMF), benzotrifluoride (PhCF₃), ethyl acetate (EtOAc), acetonitrile (CH₃CN), methanol (CH₃OH), dichloromethane (DCM), methylsulfoxide (DMSO), *N*-Methyl-2-pyrrolidone (NMP), and 1,4-dioxane] were purchased from Adamas, Energy Chemicals, or Innochem, and used as received. All commercial reagents were purchased from Bidepharm, Energy Chemical, Aladdin, and Adamas of the highest purity grade.

General Analytical Information

All new compounds were characterized by NMR spectroscopy, high-resolution mass spectroscopy, and melting point (if solids). NMR spectra were recorded on a Bruker Ascend™ 400 spectrometer and were calibrated using TMS or residual deuterated solvent as an internal reference (Chloroform-*d*: 7.26 ppm for ¹H NMR and 77.16 ppm for ¹³C NMR, DMSO-*d*₆: 2.50 ppm for ¹H NMR and 39.52 ppm for ¹³C NMR). Data were reported as follows: chemical shift, multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet), coupling constants (hertz), and integration. HRMS spectra were recorded on a Waters Acquity UPLC/Xevo TQD MSMS. Melting points (Mp) were recorded on a MP450 melting point apparatus.

Experimental Set-up

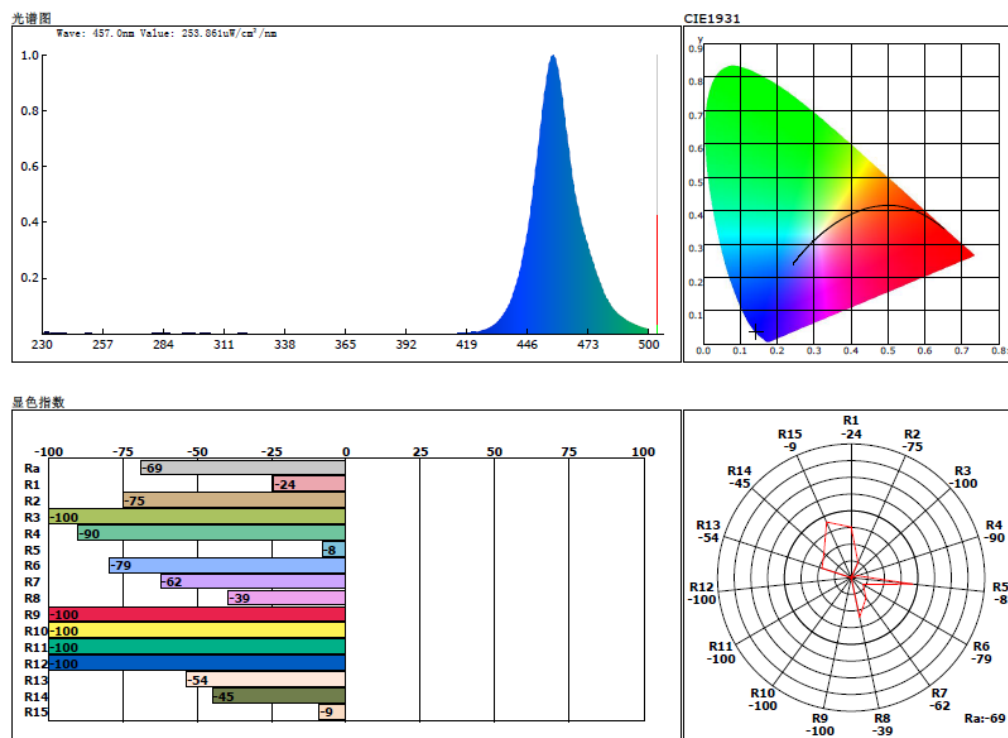


Figure S1 The emission spectra and spectral distribution of the blue LEDs

The Material of the Irradiation Vessel

Manufacturer: GeAo Chemical

Model: 24 W, blue LEDs

Broadband source: $\lambda = 450\text{-}460\text{ nm}$ ($\lambda_{\text{max}} = 457\text{ nm}$)

Material of the irradiation vessel: borosilicate reaction tube

Distance from the light source to the irradiation vessel: 3.0 cm

Not use any filters

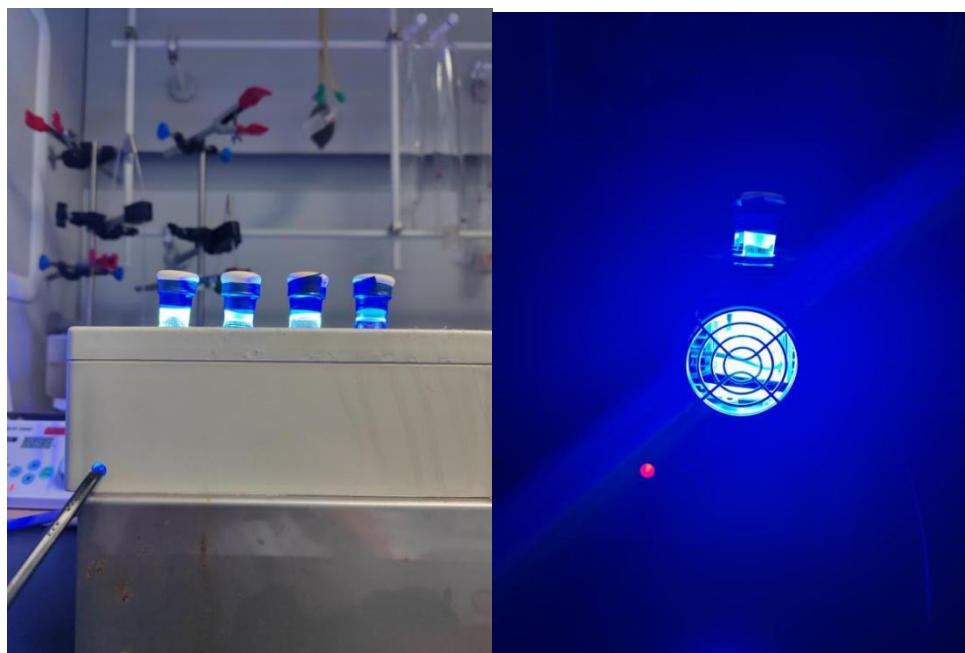
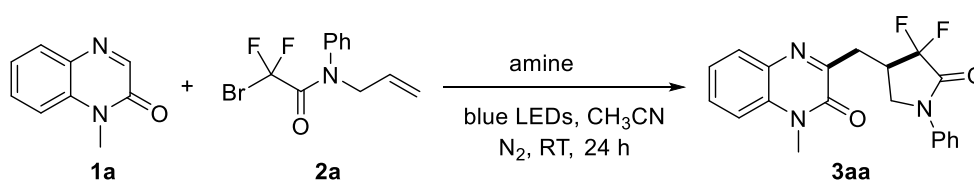


Figure S2 The set-up for the reaction

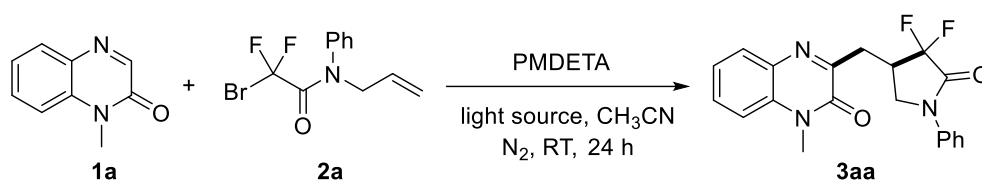
2. Reaction Optimization

Table S1. Effect of organoamines on this reaction^[a]



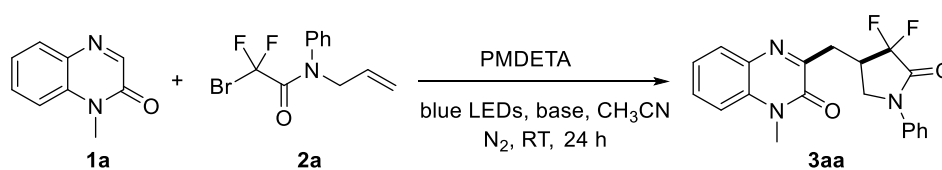
Entry	Organoamine	Yield of 3aa (%) ^[b]
1	DIPEA	33
2	TMEDA	28
3	HE	0
4	Et ₃ N	33
5	Bn ₃ N	31
6	DABCO	31
7	PMDETA	40

[a] Optimizations were performed on 0.1 mmol scale using **1a** (0.1 mmol, 1 equiv.), **2a** (1.5 equiv.), amine (2 equiv.), CH₃CN (1 mL), and 24 W blue LEDs (460 nm) over a period of 24 h. [b] The yield was determined by crude ¹H NMR using CH₂Br₂ as the internal standard.

Table S2. Effect of the dosage of substrates and light source on this reaction^[a]

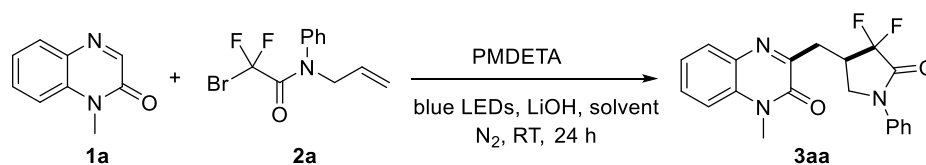
Entry	Light source	1a (mmol)	2a (mmol)	Yield of 3aa (%) ^[b]
1	460 nm	0.1	0.1	20
2	460 nm	0.1	0.15	40
3	460 nm	0.15	0.1	34
4	460 nm	0.1	0.2	65
5	365 nm	0.1	0.2	0
6	400 nm	0.1	0.2	0
7	white LEDs	0.1	0.2	0

[a] Optimizations were performed in 1.0 mL CH₃CN irradiated with light from 24 W LEDs at room temperature for 24 h. [b] The yield was determined by crude ¹H NMR using CH₂Br₂ as the internal standard.

Table S3. Effect of bases on this reaction^[a]

Entry	Base	Yield of 3aa (%) ^[b]
1	CsF	55
2	K ₂ CO ₃	61
3	Li ₂ CO ₃	42
4	LiOtBu	55
5	Cs ₂ CO ₃	88
6	K ₃ PO ₄	66
7	LiOH	90
8	NaOH	49
9 ^[c]	LiOH	98

[a] Optimizations were performed on 0.1 mmol scale using 1a (0.1 mmol, 1 equiv.), 2a (2 equiv.), PMDETA (2 equiv.), base (1 equiv.), CH₃CN (1 mL), and 24 W blue LEDs (460 nm) over a period of 24 h. [b] The yield was determined by crude ¹H NMR using CH₂Br₂ as the internal standard. [c] 36 h.

Table S4. Effect of solvents on this reaction^[a]

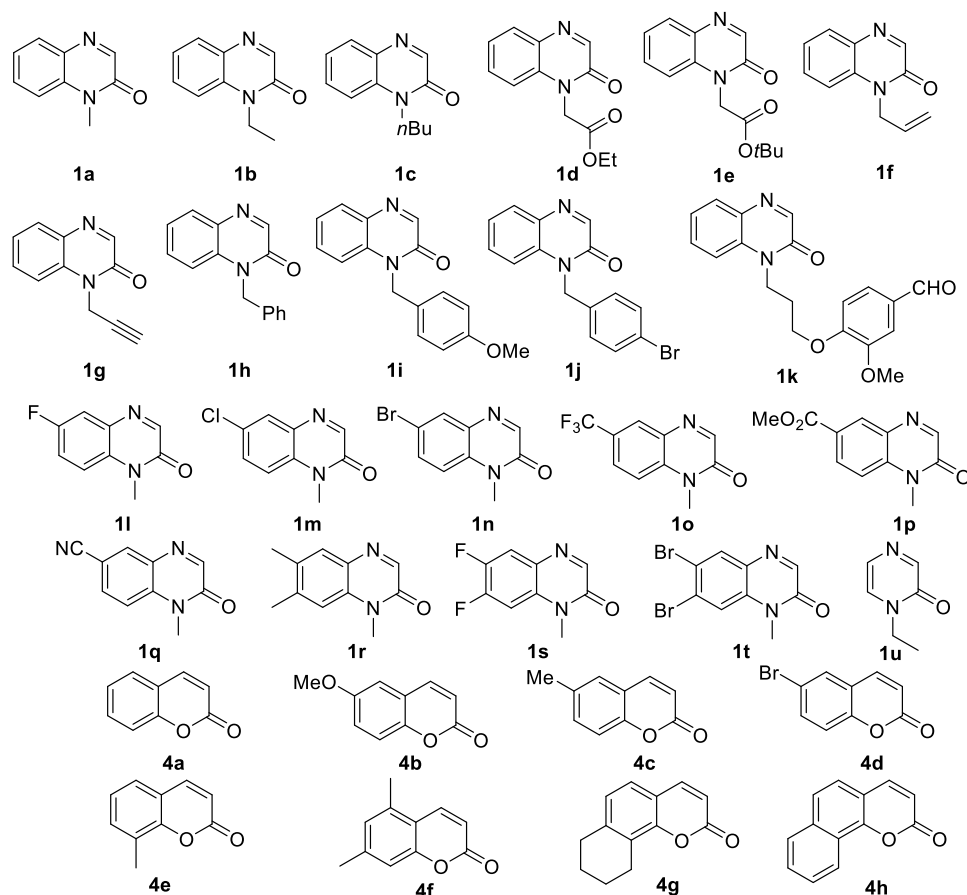
Entry	Solvent	Yield of 3aa (%) ^[b]
1	THF	20
2	EtOAc	22
3	DCM	24
4	DMF	69
5	DMSO	90
6	PhCF ₃	61
7	PhCH ₃	37
8	CH ₃ CN	90
9	NMP	trace
10	1,4-dioxane	35

[a] Optimizations were performed on 0.1 mmol scale using **1a** (0.1 mmol, 1 equiv.), **2a** (2 equiv.), PMDETA (2 equiv.), LiOH (1 equiv.), solvent (1 mL), and 24 W blue LEDs (460 nm) over a period of 24 h. [b] The yield was determined by crude ¹H NMR using CH₂Br₂ as the internal standard.

3. Product Synthesis and Characterization

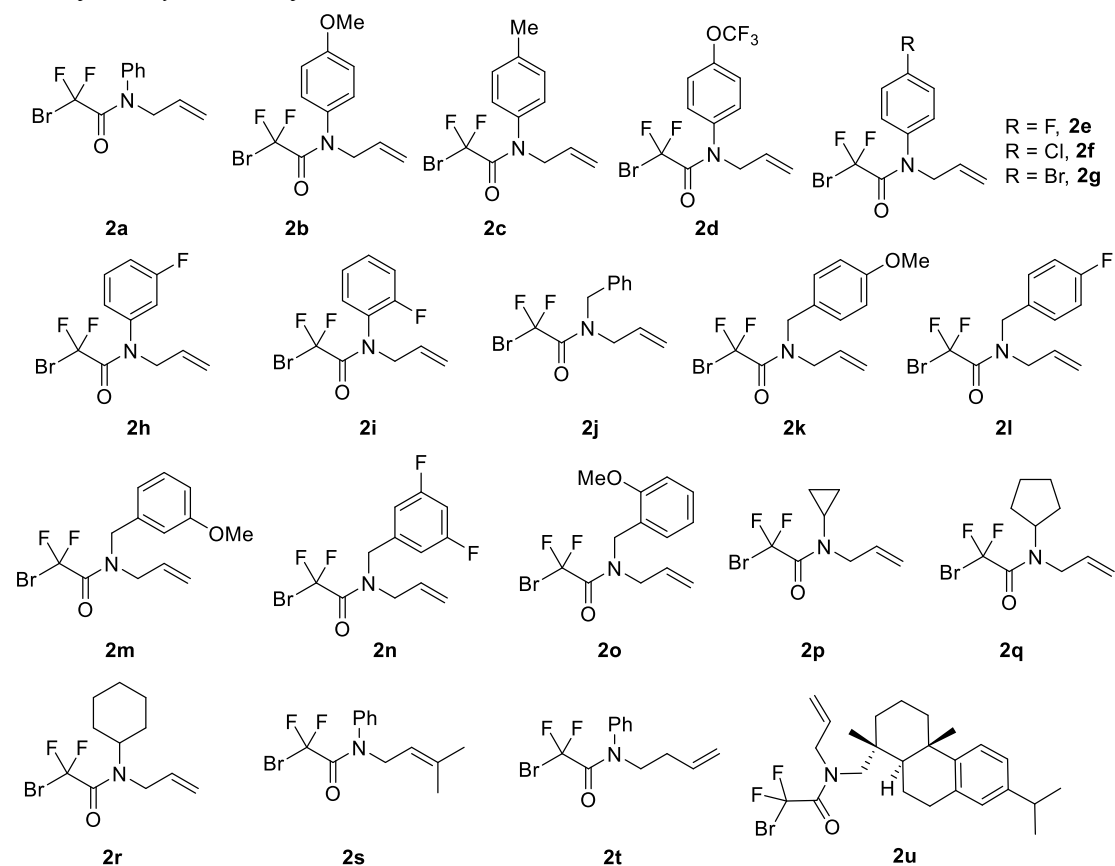
3.1 List of Substrates

List of quinoxalin-2(1H)-ones and coumarins



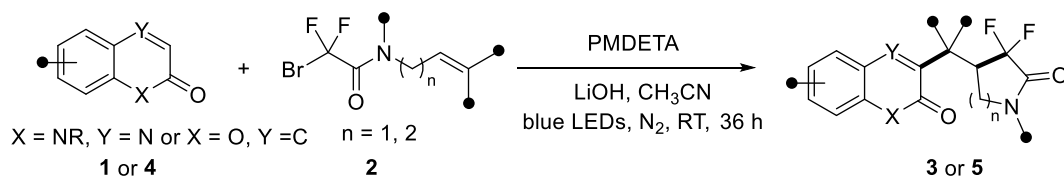
All the quinoxalin-2(1H)-ones and coumarins were synthesized according to the reported procedure.^{1,2}

List of *N*-allylbromodifluoroacetamides



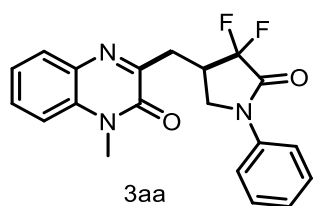
All the *N*-allylbromodifluoroacetamides were synthesized according to the reported procedure.³

3.2 General procedure for the visible-light-promoted tandem radical cyclization/heteroarylation of bromodifluoroacetamides



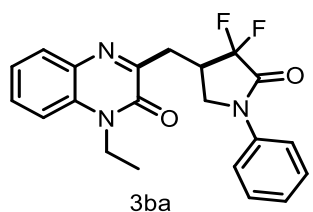
General Procedure:

To an oven-dried quartz vial, quinoxalin-2(1*H*)-one **1** (0.1 mmol, 1.0 equiv.) or coumarin **4** (0.1 mmol, 1.0 equiv.) and LiOH (0.1 mmol, 1.0 equiv.) were added sequentially. The vial was charged with a stir bar and transferred to a glovebox, where the solids were backfilled with an inert atmosphere. In the glovebox, *N*-allylbromodifluoroacetamide **2** (0.2 mmol, 2.0 equiv.) and PMDETA (0.2 mmol, 2.0 equiv.) were added into the vial, followed by CH₃CN (1.0 mL). The vial was sealed with a rubber plug, removed from the glove box, and irradiated and stir by 24 W 460 nm LEDs at room temperature for 36 h. After removal of solvents, the crude mixture was purified by flash chromatography (petroleum ether/ethyl acetate) to afford the pure products **3aa-3ua**, **3ab-3au**, **5aa-5ha**.



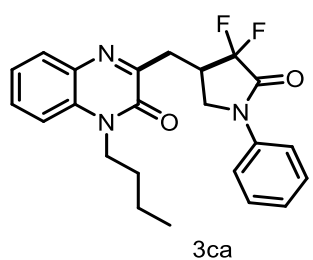
3-((4,4-Difluoro-1-(4-fluorophenyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3aa).³ **General Procedure** was used to prepare the desired product **3aa**.

Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3aa** as a pale yellow solid (37.2 mg, 0.096 mmol, 96%); **Mp**: 196-198 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.75 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.61 – 7.54 (m, 2H), 7.51 (dd, *J* = 8.6, 7.4 Hz, 1H), 7.34 – 7.26 (m, 4H), 7.18 – 7.12 (m, 1H), 4.17 (dd, *J* = 9.5, 7.8 Hz, 1H), 3.65 (s, 3H), 3.62 – 3.53 (m, 1H), 3.50 – 3.37 (m, 2H), 3.24 – 3.14 (m, 1H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.9 – 161.6 (m), 156.4, 154.6, 138.1, 133.2, 132.3, 130.4, 129.9, 129.1, 126.1, 123.9, 120.0, 117.7 (dd, *J* = 253.7, 250.3 Hz), 113.8, 48.9 (d, *J* = 6.1 Hz), 36.8 (dd, *J* = 22.0, 19.9 Hz), 30.1 (d, *J* = 7.4 Hz), 29.2. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.31 (dd, *J* = 268.6, 14.3 Hz), -116.45 (dd, *J* = 267.4, 17.8 Hz). HRMS (DART-TOF) calculated for C₂₀H₁₇F₃N₃O₂⁺ [M+H]⁺ *m/z* 388.1267, found 388.1267.



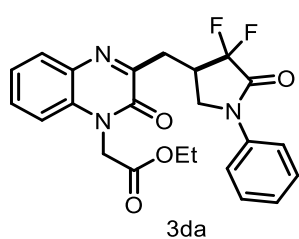
3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-ethylquinoxalin-2(1H)-one (3ba). **General Procedure** was used to prepare the desired product **3ba**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3ba** as a pale yellow solid (30.0 mg, 0.078 mmol, 78%);

Mp: 184-185 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.84 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.74 – 7.51 (m, 3H), 7.45 – 7.30 (m, 4H), 7.30 – 7.18 (m, 1H), 4.35 (q, *J* = 7.2 Hz, 2H), 4.26 (dd, *J* = 9.9, 7.7 Hz, 1H), 3.67 (dd, *J* = 9.5, 7.2 Hz, 1H), 3.62 – 3.39 (m, 2H), 3.33 – 3.17 (m, 1H), 1.40 (t, *J* = 7.2 Hz, 3H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.7 – 162.1 (m), 156.5, 154.1, 138.1, 132.7, 132.1, 130.4, 130.2, 129.1, 126.1, 123.7, 120.0, 117.8 (dd, *J* = 253.8, 250.3 Hz), 113.6, 49.0 (d, *J* = 6.1 Hz), 37.4, 36.9 (dd, *J* = 22.1, 19.9 Hz), 30.0 (d, *J* = 7.4 Hz), 12.4. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -102.74 – -111.69 (m), -116.46 (dd, *J* = 267.3, 17.8 Hz). HRMS (DART-TOF) calculated for C₂₁H₂₀F₂N₃O₂⁺ [M+H]⁺ *m/z* 384.1518, found 384.1523.



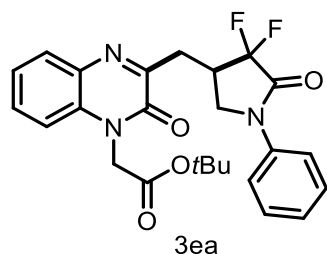
1-Butyl-3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)quinoxalin-2(1H)-one (3ca). **General Procedure** was used to prepare the desired product **3ca**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ca** as a pale yellow solid (33.0 mg, 0.08 mmol, 80%); **Mp**: 197-198 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ

7.83 (dd, *J* = 8.3, 1.5 Hz, 1H), 7.75 – 7.62 (m, 2H), 7.62 – 7.50 (m, 1H), 7.48 – 7.31 (m, 4H), 7.24 (dd, *J* = 12.7, 5.5 Hz, 1H), 4.26 (q, *J* = 9.3, 8.4 Hz, 3H), 3.67 (dd, *J* = 9.6, 7.2 Hz, 1H), 3.62 – 3.43 (m, 2H), 3.36 – 3.13 (m, 1H), 1.83 – 1.68 (m, 2H), 1.51 (p, *J* = 7.4 Hz, 2H), 1.01 (t, *J* = 7.4 Hz, 3H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 163.3 – 161.0 (m), 156.5, 154.4, 138.1, 132.6, 132.4, 130.3, 130.2, 129.1, 126.1, 123.6, 120.0, 120.6 – 114.5 (m), 113.8, 49.0 (d, *J* = 6.1 Hz), 42.2, 36.9 (dd, *J* = 22.1, 19.9 Hz), 30.1 (d, *J* = 7.4 Hz), 29.3, 20.3, 13.8. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.40 (dd, *J* = 267.8, 14.2 Hz), -116.53 (dd, *J* = 267.4, 17.8 Hz). HRMS (DART-TOF) calculated for C₂₃H₂₃F₂N₃O₂Na⁺ [M+Na]⁺ *m/z* 434.1651, found 434.1653.



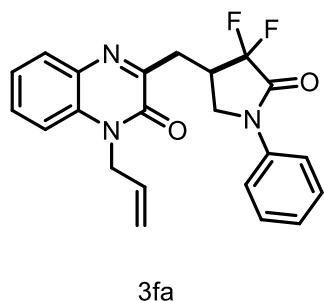
Ethyl 2-(3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-2-oxoquinoxalin-1(2H)-yl)acetate (3da).³

General Procedure was used to prepare the desired product **3da**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3da** as an orange oil (34.0 mg, 0.077 mmol, 77%). ¹H NMR (400 MHz, Chloroform-*d*) δ 7.85 (dd, *J* = 8.1, 1.5 Hz, 1H), 7.67 (d, *J* = 8.1 Hz, 2H), 7.58 – 7.51 (m, 1H), 7.39 (dt, *J* = 15.5, 7.7 Hz, 3H), 7.26 – 7.19 (m, 1H), 7.11 (d, *J* = 8.4 Hz, 1H), 5.15 – 4.92 (m, 2H), 4.27 (q, *J* = 7.3 Hz, 3H), 3.75 – 3.63 (m, 1H), 3.53 (td, *J* = 17.9, 15.5, 6.1 Hz, 2H), 3.28 (dd, *J* = 17.9, 10.2 Hz, 1H), 1.30 (t, *J* = 7.1 Hz, 3H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 166.9, 162.3 (t, *J* = 31.4 Hz), 156.3, 154.2, 138.1, 132.4, 132.3, 130.6, 130.3, 129.2, 126.1, 124.2, 120.0, 117.7 (dd, *J* = 254.2, 250.2 Hz), 113.2, 62.3, 48.9 (d, *J* = 6.1 Hz), 43.6, 37.9 – 35.7 (m), 30.0 (d, *J* = 7.4 Hz), 14.1. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.43 (dd, *J* = 268.0, 14.2 Hz), -116.44 (dd, *J* = 267.5, 18.0 Hz). HRMS (DART-TOF) calculated for C₂₃H₂₂F₂N₃O₄⁺ [M+H]⁺ *m/z* 442.1573, found 442.1578.



Tert-butyl 2-(3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-2-oxoquinoxalin-1(2H)-yl)acetate (3ea).

General Procedure was used to prepare the desired product **3ea**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ea** as a pale yellow solid (37.0 mg, 0.079 mmol, 79%); **Mp**: 161-162 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.84 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.69 – 7.63 (m, 2H), 7.55 (dd, *J* = 8.5, 7.3, 1H), 7.45 – 7.33 (m, 3H), 7.24 (t, *J* = 7.5 Hz, 1H), 7.10 (d, *J* = 8.6 Hz, 1H), 4.96 (q, *J* = 17.2 Hz, 2H), 4.29 – 4.21 (m, 1H), 3.72 – 3.62 (m, 1H), 3.60 – 3.43 (m, 2H), 3.28 (dd, *J* = 17.7, 10.2 Hz, 1H), 1.48 (s, 9H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 165.9, 162.3 (t, *J* = 31.4 Hz), 156.3, 154.2, 138.1, 132.4, 130.5, 130.2, 129.1 (2C), 126.1, 124.1, 120.0, 117.7 (dd, *J* = 253.8, 250.0 Hz), 113.3, 83.5, 48.9 (d, *J* = 6.0 Hz), 44.2, 38.2 – 35.6 (m), 30.0 (d, *J* = 7.5 Hz), 28.0. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.46 (dd, *J* = 267.9, 14.1 Hz), -116.46 (dd, *J* = 267.4, 17.9 Hz). HRMS (DART-TOF) calculated for C₂₅H₂₅F₂N₃O₄Na⁺ [M+Na]⁺ *m/z* 492.1705, found 492.1708.

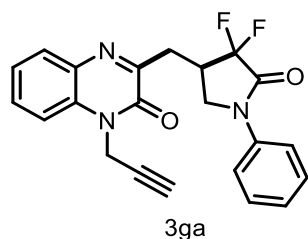


1-Allyl-3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)quinoxalin-2(1H)-one (3fa).³

General Procedure was used to prepare the desired product **3fa**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3fa** as a pale yellow solid (25.0 mg, 0.063 mmol, 63%); **Mp**: 185-187 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.84 (d, *J* = 8.0 Hz, 1H), 7.66 (d, *J* = 8.3 Hz, 2H), 7.54 (t, *J* = 7.9 Hz, 1H), 7.44 – 7.31 (m, 4H), 7.24 (t, *J* = 7.3

Hz, 1H), 6.00 – 5.88 (m, 1H), 5.35 – 5.13 (m, 2H), 4.93 (d, *J* = 5.0 Hz, 2H), 4.26 (t, *J* = 8.9 Hz, 1H), 3.68 (dd, *J* = 9.8, 7.1 Hz, 1H), 3.62 – 3.44 (m, 2H), 3.35 – 3.22 (m, 1H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.4 (t, *J* = 31.3 Hz), 156.5, 154.2, 138.1, 132.5, 132.4, 130.4, 130.3, 130.0, 129.1, 126.1, 123.9, 120.0, 118.4, 117.7 (dd, *J* = 253.6, 250.3 Hz), 114.3, 49.0 (d, *J* =

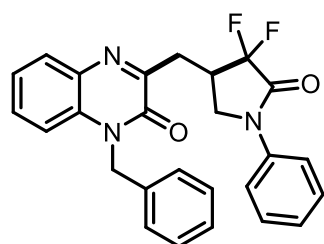
6.1 Hz), 44.6, 38.8 – 35.5 (m), 30.1 (d, $J = 7.5$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.38 (dd, $J = 268.3, 14.1$ Hz), -116.48 (dd, $J = 267.5, 17.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{20}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 396.1518, found 396.1525.



3ga

3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-(prop-2-yn-1-yl)quinoxalin-2(1H)-one (3ga). General

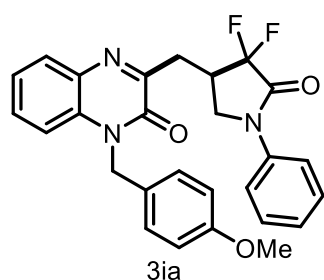
Procedure was used to prepare the desired product **3ga**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ga** as an orange oil (30.0 mg, 0.076 mmol, 76%). ^1H NMR (400 MHz, Chloroform-*d*) δ 7.85 (dd, $J = 8.0, 1.5$ Hz, 1H), 7.71 – 7.59 (m, 3H), 7.50 (d, $J = 8.3$ Hz, 1H), 7.40 (td, $J = 7.6, 4.1$ Hz, 3H), 7.27 – 7.20 (m, 1H), 5.17 – 4.96 (m, 2H), 4.26 (t, $J = 8.9$ Hz, 1H), 3.67 (dd, $J = 9.9, 7.1$ Hz, 1H), 3.62 – 3.41 (m, 2H), 3.27 (dd, $J = 17.9, 10.1$ Hz, 1H), 2.31 (d, $J = 2.4$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.3 (t, $J = 31.3$ Hz), 156.4, 153.6, 138.1, 132.5, 131.6, 130.5, 130.1, 129.2, 126.1, 124.3, 120.0, 117.7 (dd, $J = 254.0, 250.3$ Hz), 114.3, 76.5, 73.5, 48.9 (d, $J = 6.0$ Hz), 36.8 (dd, $J = 22.0, 19.9$ Hz), 31.6, 30.1 (d, $J = 7.5$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.33 (dd, $J = 267.9, 14.2$ Hz), -116.41 (dd, $J = 267.4, 17.9$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{18}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 394.1362, found 394.1366.



3ha

1-Benzyl-3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)quinoxalin-2(1H)-one (3ha).³ General Procedure

was used to prepare the desired product **3ha**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ha** as a pale yellow solid (36.0 mg, 0.081 mmol, 81%); **Mp**: 173-175 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.83 (dd, $J = 7.9, 1.4$ Hz, 1H), 7.67 (d, $J = 8.2$ Hz, 2H), 7.43 (dt, $J = 18.2, 8.1$ Hz, 4H), 7.33 – 7.22 (m, 7H), 5.52 (s, 2H), 4.29 (t, $J = 8.8$ Hz, 1H), 3.79 – 3.47 (m, 3H), 3.33 (dd, $J = 17.6, 9.8$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.7 – 162.1 (m), 156.6, 154.7, 138.1, 135.0, 132.6 (2C), 130.4, 130.1, 129.2, 129.0, 127.9, 126.9, 126.1, 123.9, 120.0, 117.7 (dd, $J = 253.7, 250.3$ Hz), 114.6, 49.0 (d, $J = 6.1$ Hz), 46.0, 37.1 – 36.7 (m), 30.2 (d, $J = 7.4$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.34 (dd, $J = 267.3, 14.2$ Hz), -116.42 (dd, $J = 267.6, 17.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{26}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 446.1675, found 446.1681.

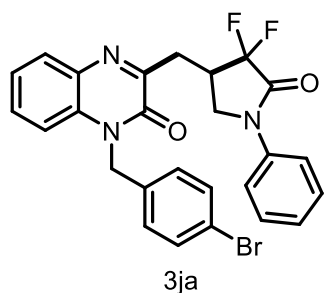


3ia

3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-(4-methoxybenzyl)quinoxalin-2(1H)-one (3ia). General

Procedure was used to prepare the desired product **3ia**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3ia** as a pale yellow solid (36.0 mg, 0.076 mmol, 76%); **Mp**: 187-189 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.82 (dd, $J = 8.0, 1.5$ Hz, 1H), 7.71 – 7.62 (m, 2H), 7.49 – 7.30 (m, 5H), 7.23 (dd, $J = 13.5, 8.1$ Hz, 3H), 6.89 – 6.79 (m, 2H), 5.44 (s, 2H), 4.37 – 4.16 (m, 1H), 3.76 (d, $J = 1.2$ Hz, 3H), 3.73 – 3.66 (m, 1H), 3.64 – 3.48 (m, 2H),

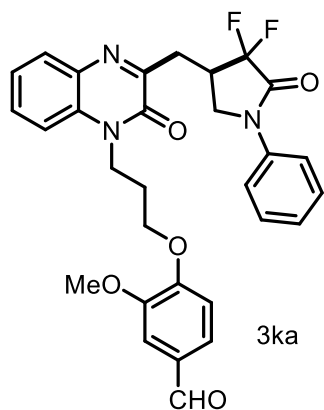
3.32 (dd, $J = 17.7, 9.8$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.7 – 162.1 (m), 159.2, 156.6, 154.7, 138.1, 132.6, 132.5, 130.4, 130.1, 129.1, 128.5, 127.1, 126.1, 123.8, 120.0, 117.8 (dd, $J = 253.3, 250.4$ Hz), 114.6, 114.4, 55.3, 49.0 (d, $J = 6.1$ Hz), 45.5, 37.1 – 36.7 (m), 30.2 (d, $J = 7.5$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.33 (dd, $J = 267.4, 14.2$ Hz), -116.42 (dd, $J = 267.5, 17.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{27}\text{H}_{24}\text{F}_2\text{N}_3\text{O}_3^+$ $[\text{M}+\text{H}]^+$ m/z 476.1780, found 476.1787.



1-(4-Bromobenzyl)-3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)quinoxalin-2(1H)-one (3ja).

General Procedure was used to prepare the desired product **3ja**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3ja** as a pale yellow solid (43.0 mg, 0.082 mmol, 82%); **Mp**: 183-185 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.84 (d, $J = 8.0$ Hz, 1H), 7.67 (d, $J = 8.1$ Hz, 2H), 7.45 (dt, $J = 16.5, 8.1$ Hz, 5H), 7.34 (t, $J = 7.6$ Hz, 1H), 7.27 – 7.22 (m, 2H), 7.13 (d, $J = 8.1$ Hz, 2H), 5.45 (s, 2H),

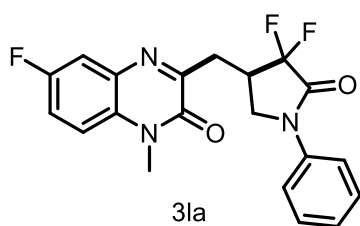
4.29 (t, $J = 8.8$ Hz, 1H), 3.70 (t, $J = 8.5$ Hz, 1H), 3.66 – 3.47 (m, 2H), 3.32 (dd, $J = 17.8, 9.8$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.7 – 161.9 (m), 156.6, 154.6, 138.1, 134.0, 132.6, 132.3, 132.2, 130.5, 130.2, 129.2, 128.7, 126.1, 124.1, 121.9, 120.0, 121.2 – 115.9 (m), 114.3, 49.0 (d, $J = 6.1$ Hz), 45.5, 37.1 – 36.6 (m), 30.2 (d, $J = 7.4$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.27 (dd, $J = 267.6, 14.3$ Hz), -116.39 (dd, $J = 267.5, 17.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{26}\text{H}_{21}\text{BrF}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 524.0780, found 524.0799.



2-(3-(3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-2-oxoquinoxalin-1(2H)-yl)propoxy)-5-methoxybenzaldehyde (3ka).

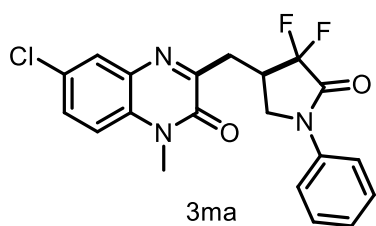
General Procedure was used to prepare the desired product **3ka**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3ka** as a pale yellow solid (10.0 mg, 0.018 mmol, 18%); **Mp**: 165-166 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 9.75 (s, 1H), 7.86 (dd, $J = 8.2, 1.5$ Hz, 1H), 7.74 (dd, $J = 8.3, 1.4$ Hz, 1H), 7.61 – 7.53 (m, 3H), 7.48 (dd, $J = 8.4, 7.0$ Hz, 1H), 7.38 – 7.28 (m, 4H), 7.18 – 7.13 (m, 1H), 6.94 (d, $J = 8.2$ Hz, 1H), 4.78 – 4.63 (m, 2H), 4.28 (t, $J = 6.1$ Hz, 2H), 4.23 – 4.15 (m, 1H), 3.81

(s, 3H), 3.59 (dd, $J = 9.6, 7.0$ Hz, 1H), 3.55 – 3.41 (m, 2H), 3.17 – 3.07 (m, 1H), 2.41 (p, $J = 6.2$ Hz, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 190.8, 162.2 (t, $J = 29.5$ Hz), 155.5, 153.8, 150.0, 146.1, 139.9, 138.3, 138.1, 130.4, 129.7, 129.2, 128.4, 126.9, 126.8, 126.7, 126.1, 120.0, 122.3 – 112.2 (m), 111.8, 109.5, 65.9, 63.5, 56.0, 49.0 (d, $J = 5.7$ Hz), 37.0 (d, $J = 20.8$ Hz), 29.0 (d, $J = 7.5$ Hz), 28.6. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.09 (dd, $J = 14.2, 2.4$ Hz), -116.50 (dd, $J = 267.2, 17.7$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{30}\text{H}_{28}\text{F}_2\text{N}_3\text{O}_5^+$ $[\text{M}+\text{H}]^+$ m/z 548.1992, found 548.1996.



3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-7-fluoro-1-methylquinoxalin-2(1H)-one (3la).³ **General Procedure** was used to prepare the desired product **3la**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3la** as a pale yellow solid (32.0 mg, 0.083 mmol, 83%); **Mp**: 190-191 °C. ¹H

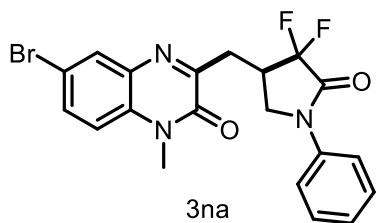
NMR (400 MHz, Chloroform-*d*) δ 7.65 (d, J = 8.1 Hz, 2H), 7.53 (dd, J = 8.6, 2.5 Hz, 1H), 7.41 (t, J = 7.8 Hz, 2H), 7.32 (td, J = 6.4, 5.8, 3.2 Hz, 2H), 7.27 – 7.20 (m, 1H), 4.24 (t, J = 8.8 Hz, 1H), 3.73 (s, 3H), 3.66 (t, J = 8.1 Hz, 1H), 3.61 – 3.42 (m, 2H), 3.27 (dd, J = 17.8, 9.8 Hz, 1H). ¹³C **NMR (101 MHz, Chloroform-*d*)** δ 163.1 – 161.1 (m), 158.8 (d, J = 244.5 Hz), 158.2, 154.3, 138.0, 132.9 (d, J = 11.3 Hz), 129.8 (d, J = 2.2 Hz), 129.2, 126.2, 120.0, 118.2 (d, J = 24.0 Hz), 117.6 (dd, J = 254.0, 250.5 Hz), 115.4 (d, J = 22.6 Hz), 114.9 (d, J = 8.8 Hz), 48.9 (d, J = 5.9 Hz), 36.8 (dd, J = 22.1, 20.0 Hz), 30.3 (d, J = 7.4 Hz), 29.5. ¹⁹F **NMR (376 MHz, Chloroform-*d*)** δ -109.29 (dd, J = 267.5, 14.3 Hz), -116.42 (dd, J = 267.6, 17.7 Hz), -118.43 (td, J = 8.0, 5.1 Hz). **HRMS (DART-TOF)** calculated for C₂₀H₁₇F₃N₃O₂⁺ [M+H]⁺ m/z 388.1267, found 388.1286.



7-Chloro-3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ma).³

General Procedure was used to prepare the desired product **3ma**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3ma** as a pale yellow solid (34.0 mg, 0.084 mmol, 84%); **Mp**: 182-

184 °C. ¹H **NMR (400 MHz, Chloroform-*d*)** δ 7.75 (d, J = 2.4 Hz, 1H), 7.61 – 7.55 (m, 2H), 7.46 (dd, J = 8.9, 2.4 Hz, 1H), 7.37 – 7.28 (m, 2H), 7.20 – 7.11 (m, 2H), 4.17 (dd, J = 9.6, 8.0 Hz, 1H), 3.63 (s, 3H), 3.58 (dd, J = 9.7, 7.2 Hz, 1H), 3.51 – 3.30 (m, 2H), 3.18 (dd, J = 17.8, 9.8 Hz, 1H). ¹³C **NMR (101 MHz, Chloroform-*d*)** δ 162.2 (t, J = 31.3 Hz), 158.0, 154.3, 138.0, 132.8, 131.9, 130.4, 129.2 (3C), 126.1, 120.0, 117.6 (dd, J = 253.8, 250.3 Hz), 115.0, 48.9 (d, J = 6.2 Hz), 36.8 (t, J = 21.1 Hz), 30.2 (d, J = 7.6 Hz), 29.4. ¹⁹F **NMR (376 MHz, Chloroform-*d*)** δ -109.27 (dd, J = 267.3, 14.3 Hz), -116.34 (dd, J = 267.4, 17.6 Hz). **HRMS (DART-TOF)** calculated for C₂₀H₁₇ClF₂N₃O₂⁺ [M+H]⁺ m/z 404.0972, found 404.0989.

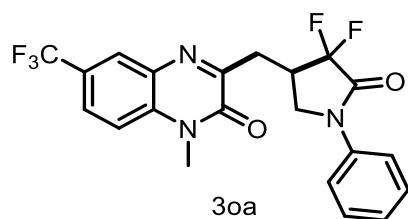


7-bromo-3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3na).³

General Procedure was used to prepare the desired product **3na**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3na** as a pale yellow solid (34.0 mg, 0.076 mmol, 76%); **Mp**: 170-

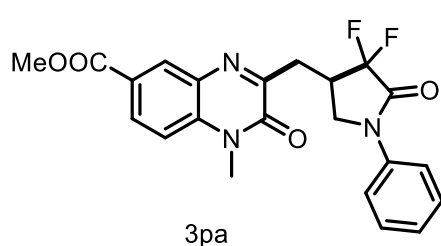
172 °C. ¹H **NMR (400 MHz, Chloroform-*d*)** δ 7.91 (d, J = 2.3 Hz, 1H), 7.58 (dd, J = 8.8, 4.8 Hz, 3H), 7.39 – 7.27 (m, 2H), 7.24 – 7.08 (m, 2H), 4.17 (dd, J = 9.7, 7.8 Hz, 1H), 3.62 (s, 3H), 3.57 (dd, J = 9.7, 7.1 Hz, 1H), 3.51 – 3.30 (m, 2H), 3.17 (dd, J = 17.8, 9.8 Hz, 1H). ¹³C **NMR (101 MHz, Chloroform-*d*)** δ 162.1 (m), 158.0, 154.3, 138.0, 133.2, 133.1, 132.3 (2C), 129.2, 126.1, 120.0, 116.4, 117.6 (dd, J = 253.8, 250.3 Hz), 115.3, 48.9 (d, J = 5.9 Hz), 36.8 (dd, J = 22.1, 19.9 Hz), 30.2 (d, J = 7.6 Hz), 29.3. ¹⁹F **NMR (376 MHz, Chloroform-*d*)** δ -109.26 (dd,

$J = 267.4, 14.2$ Hz), -116.34 (dd, $J = 267.4, 17.5$ Hz). **HRMS (DART-TOF)** calculated for $C_{20}H_{17}BrF_2N_3O_2^+$ $[M+H]^+$ m/z 448.0467, found 448.0477.



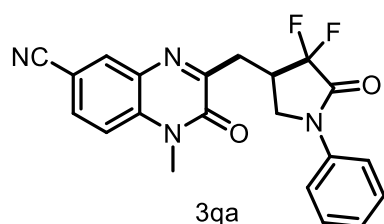
3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-methyl-7-(trifluoromethyl)quinoxalin-2(1H)-one (30a).³ **General Procedure** was used to prepare the desired product **30a**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **30a** as a pale yellow solid

(29.7 mg, 0.068 mmol, 68%); **Mp:** 192-193 °C. **¹H NMR (400 MHz, Chloroform-*d*)** δ 8.15 – 8.09 (m, 1H), 7.81 (dd, $J = 8.8, 2.0$ Hz, 1H), 7.69 – 7.62 (m, 2H), 7.49 – 7.38 (m, 3H), 7.26 – 7.22 (m, 1H), 4.27 (dd, $J = 9.8, 7.9$ Hz, 1H), 3.76 (s, 3H), 3.67 (dd, $J = 9.6, 7.3$ Hz, 1H), 3.62 – 3.43 (m, 2H), 3.28 (dd, $J = 18.0, 9.7$ Hz, 1H). **¹³C NMR (101 MHz, Chloroform-*d*)** δ 162.2 (t, $J = 32.7$ Hz), 158.4, 154.4, 138.0, 135.5, 131.7, 129.2, 127.4 (q, $J = 4.0$ Hz), 126.7 (q, $J = 3.7$ Hz), 126.3 (q, $J = 33.8$ Hz), 126.2, 123.6 (q, $J = 271.6$ Hz), 120.1, 120.8 – 114.7 (m), 114.5, 48.9 (d, $J = 5.9$ Hz), 39.2 – 35.5 (m), 30.2 (d, $J = 7.6$ Hz), 29.5. **¹⁹F NMR (376 MHz, Chloroform-*d*)** δ -62.00, -109.62, -116.77. **HRMS (DART-TOF)** calculated for $C_{21}H_{17}F_5N_3O_2^+$ $[M+H]^+$ m/z 438.1235, found 438.1245.



Methyl 2-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-4-methyl-3-oxo-3,4-dihydroquinoxaline-6-carboxylate (3pa).³ **General Procedure** was used to prepare the desired product **3pa**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3pa** as a pale yellow solid (27.0 mg, 0.063 mmol, 63%);

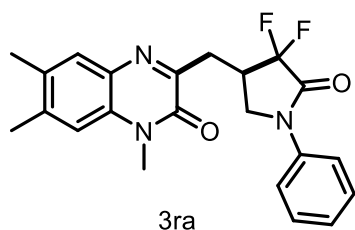
Mp: 215-216 °C. **¹H NMR (400 MHz, Chloroform-*d*)** δ 8.50 (d, $J = 1.9$ Hz, 1H), 8.23 (dd, $J = 8.8, 1.9$ Hz, 1H), 7.66 (d, $J = 8.1$ Hz, 2H), 7.41 (q, $J = 9.2, 8.5$ Hz, 3H), 7.24 (d, $J = 7.4$ Hz, 1H), 4.30 (t, $J = 8.9$ Hz, 1H), 3.97 (s, 3H), 3.75 (s, 3H), 3.71 – 3.63 (m, 1H), 3.63 – 3.42 (m, 2H), 3.26 (dd, $J = 18.0, 10.0$ Hz, 1H). **¹³C NMR (101 MHz, Chloroform-*d*)** δ 165.9, 162.2 (t, $J = 31.4$ Hz), 157.6, 154.5, 138.0, 136.4, 131.7 (2C), 131.1, 129.2, 126.2, 125.8, 120.1, 117.6 (dd, $J = 254.0, 250.4$ Hz), 113.9, 52.4, 49.0 (d, $J = 6.0$ Hz), 37.0 – 36.6 (m), 30.1 (d, $J = 7.4$ Hz), 29.5. **¹⁹F NMR (376 MHz, Chloroform-*d*)** δ -109.40 (dd, $J = 267.7, 14.1$ Hz), -116.36 (dd, $J = 267.5, 17.6$ Hz). **HRMS (DART-TOF)** calculated for $C_{22}H_{20}F_2N_3O_4^+$ $[M+H]^+$ m/z 428.1416, found 428.1442.



2-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-4-methyl-3-oxo-3,4-dihydroquinoxaline-6-carbonitrile (3qa). **General Procedure** was used to prepare the desired product **3qa**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3qa** as a pale yellow solid (19.0 mg, 0.045 mmol, 45%); **Mp:**

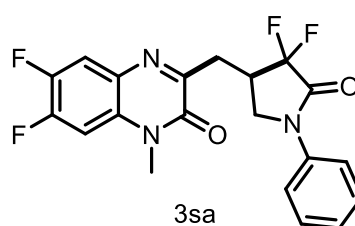
188-189 °C. **¹H NMR (400 MHz, Chloroform-*d*)** δ 7.85 (d, $J = 8.1$ Hz, 1H), 7.62 – 7.51 (m, 4H), 7.37 – 7.31 (m, 2H), 7.17 (d, $J = 7.3$ Hz, 1H), 4.17 (dd, $J = 9.6, 7.8$ Hz, 1H), 3.66 (s, 3H),

3.60 (dd, $J = 9.4, 7.0$ Hz, 1H), 3.56 – 3.36 (m, 2H), 3.23 (dd, $J = 17.9, 9.3$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.1 (t, $J = 31.1$ Hz), 160.3, 154.0, 138.0, 134.3, 133.6, 130.9, 129.2, 126.7, 126.2, 120.0, 117.9, 117.8, 120.1 – 114.3 (m), 113.7, 48.8 (d, $J = 5.9$ Hz), 36.9 – 36.5 (m), 30.5 (d, $J = 7.6$ Hz), 29.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.02 (dd, $J = 267.1, 14.1$ Hz), -116.36 (dd, $J = 267.7, 16.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{16}\text{F}_2\text{N}_4\text{O}_2\text{Na}^+$ $[\text{M}+\text{Na}]^+$ m/z 417.1134, found 417.1140.



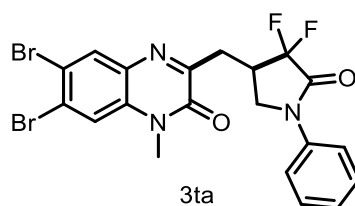
3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1,6,7-trimethylquinoxalin-2(1H)-one (3ra).³ General Procedure was used to prepare the desired product **3ra**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ra** as a pale yellow solid (31.0 mg, 0.078 mmol, 78%); **Mp**: 189-190 °C. ^1H NMR

(400 MHz, Chloroform-*d*) δ 7.69 – 7.62 (m, 1H), 7.58 (s, 1H), 7.45 – 7.36 (m, 1H), 7.26 – 7.18 (m, 1H), 7.10 (s, 1H), 4.23 (dd, $J = 9.5, 7.9$ Hz, 1H), 3.70 (s, 1H), 3.68 – 3.62 (m, 0H), 3.56 – 3.40 (m, 1H), 3.29 – 3.18 (m, 1H), 2.43 (s, 2H), 2.35 (s, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.7 – 162.1 (m), 155.0, 154.7, 140.3, 138.1, 132.8, 131.2, 130.8, 130.0, 129.1, 126.0, 120.0, 117.8 (dd, $J = 253.7, 250.3$ Hz), 114.3, 49.0 (d, $J = 6.1$ Hz), 37.0 (dd, $J = 22.0, 19.9$ Hz), 30.0 (d, $J = 7.4$ Hz), 29.1, 20.6, 19.1. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -106.08 – -114.03 (m), -116.55 (dd, $J = 267.5, 17.6$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 398.1675, found 398.1688.



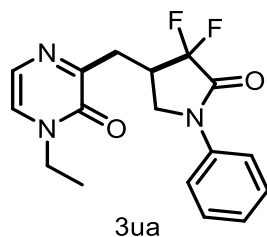
3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-6,7-difluoro-1-methylquinoxalin-2(1H)-one (3sa).³ General Procedure was used to prepare the desired product **3sa**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3sa** as a pale yellow solid (30.0 mg, 0.074 mmol, 74%); **Mp**: 192-194

°C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.71 – 7.58 (m, 3H), 7.44 – 7.36 (m, 2H), 7.28 – 7.20 (m, 1H), 7.15 (dd, $J = 11.2, 7.0$ Hz, 1H), 4.21 (dd, $J = 9.6, 7.8$ Hz, 1H), 3.68 (s, 3H), 3.66 – 3.60 (m, 1H), 3.57 – 3.35 (m, 2H), 3.23 (dd, $J = 17.7, 9.5$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.2 (t, $J = 31.2$ Hz), 157.1 (d, $J = 3.5$ Hz), 154.2, 151.5 (dd, $J = 254.1, 14.4$ Hz), 146.8 (dd, $J = 247.8, 14.1$ Hz), 138.0, 130.6 – 130.0 (m), 129.2, 128.9 – 128.0 (m), 126.2, 120.6 – 114.4 (m), 120.0, 117.6 (dd, $J = 18.0, 2.4$ Hz), 102.5 (d, $J = 23.1$ Hz), 48.8 (d, $J = 6.1$ Hz), 36.7 (dd, $J = 22.0, 19.9$ Hz), 30.1 (d, $J = 7.6$ Hz), 29.7. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.13 (dd, $J = 267.7, 14.3$ Hz), -116.43 (dd, $J = 267.5, 17.5$ Hz), -130.09 (ddd, $J = 22.4, 11.2, 8.0$ Hz), -141.51 (dd, $J = 22.3, 10.1, 6.9$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{20}\text{H}_{16}\text{F}_4\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 406.1173, found 406.1187.



6,7-Dibromo-3-((4,4-difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ta). General Procedure was used to prepare the desired product **3ta**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ta** as a pale yellow

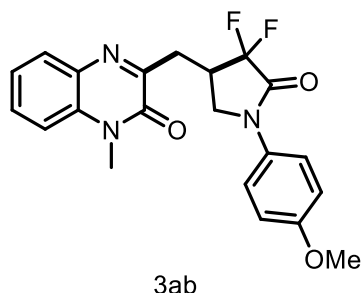
solid (23.0 mg, 0.044 mmol, 44%); **Mp**: 193-194 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 8.07 (d, *J* = 1.3 Hz, 1H), 7.69 – 7.58 (m, 4H), 7.47 – 7.36 (m, 3H), 7.31 – 7.18 (m, 2H), 4.27 – 4.18 (m, 1H), 3.73 – 3.57 (m, 5H), 3.57 – 3.36 (m, 2H), 3.23 (dd, *J* = 18.0, 9.7 Hz, 1H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.4 – 161.6 (m), 158.3, 154.0, 138.0, 133.8, 133.1, 132.0, 129.2, 126.8, 126.2, 120.0, 119.1, 121.0 – 116.4 (m), 118.5, 48.9 (d, *J* = 6.0 Hz), 36.9 – 36.5 (m), 30.3 (d, *J* = 7.5 Hz), 29.4. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.23 (dd, *J* = 267.5, 14.0 Hz), -116.37 (dd, *J* = 267.6, 17.4 Hz). **HRMS (DART-TOF)** calculated for C₂₀H₁₆Br₂F₂N₃O₂⁺ [M+H]⁺ *m/z* 527.9551, found 527.9565.



3ua

3-((4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)methyl)-1-ethylpyrazin-2(1H)-one (3ua). General Procedure was used to prepare the desired product **3ua**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ua** as a brown oil (23.0 mg, 0.068 mmol, 68%). ¹H NMR (400 MHz, Chloroform-*d*) δ 7.62 – 7.52 (m, 2H), 7.37 – 7.29 (m, 2H), 7.23 – 7.11 (m, 2H), 7.03 (d, *J* = 4.4 Hz, 1H), 4.09 (dd, *J* = 9.6, 7.8 Hz, 1H), 3.91 (q, *J* = 7.2 Hz, 2H), 3.54 (dd,

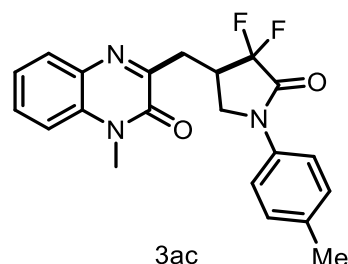
J = 9.8, 7.1 Hz, 1H), 3.42 – 3.17 (m, 2H), 3.05 (dd, *J* = 17.4, 10.1 Hz, 1H), 1.32 (t, *J* = 7.3 Hz, 3H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 163.3 – 161.2 (m), 156.4, 155.5, 138.1, 129.1, 127.3, 126.1, 122.6, 120.0, 117.7 (dd, *J* = 253.7, 250.3 Hz), 48.9 (d, *J* = 6.0 Hz), 44.8, 37.0 (dd, *J* = 21.9, 20.0 Hz), 29.5 (d, *J* = 7.3 Hz), 14.0. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.70 (dd, *J* = 267.8, 14.2 Hz), -116.80 (dd, *J* = 267.3, 17.9 Hz). **HRMS (DART-TOF)** calculated for C₁₇H₁₈F₂N₃O₂⁺ [M+H]⁺ *m/z* 334.1362, found 334.1374.



3ab

3-((4,4-Difluoro-1-(4-methoxyphenyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ab). General Procedure was used to prepare the desired product **3ab**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3ab** as a pale yellow solid (8.0 mg, 0.02 mmol, 20%); **Mp**: 183-184 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.83 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.62 – 7.50 (m, 3H), 7.42 – 7.31 (m, 2H), 6.96 – 6.87 (m,

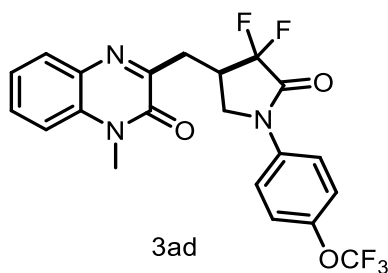
2H), 4.19 (t, *J* = 8.8 Hz, 1H), 3.81 (s, 3H), 3.73 (s, 3H), 3.70 – 3.59 (m, 1H), 3.59 – 3.44 (m, 2H), 3.33 – 3.19 (m, 1H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.2 (t, *J* = 31.2 Hz), 157.6, 156.6, 154.7, 133.2, 132.4, 131.2, 130.4, 130.0, 123.9, 121.8, 116.6 (dd, *J* = 253.4, 2.4 Hz), 114.3, 113.8, 55.5, 49.3 (d, *J* = 6.1 Hz), 37.5 – 35.8 (m), 30.2 (d, *J* = 7.6 Hz), 29.2. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.11 (dd, *J* = 268.0, 14.4 Hz), -116.28 (dd, *J* = 267.4, 17.5 Hz). **HRMS (DART-TOF)** calculated for C₂₁H₂₀F₂N₃O₃⁺ [M+H]⁺ *m/z* 400.1467, found 400.1478.



3ac

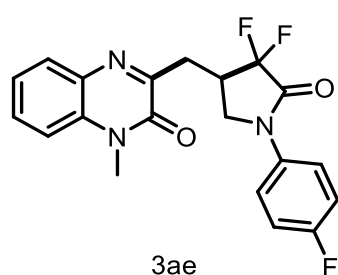
3-((4,4-Difluoro-5-oxo-1-(*p*-tolyl)pyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ac). General Procedure was used to prepare the desired product **3ac**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3ac** as a brown oil (3.8 mg, 0.01 mmol, 10%). ¹H NMR (400 MHz, Chloroform-*d*) δ 7.83 (dd, *J* = 8.0,

1.5 Hz, 1H), 7.59 (dd, $J = 8.6, 7.3$ Hz, 1H), 7.55 – 7.50 (m, 2H), 7.40 – 7.32 (m, 2H), 7.20 (d, $J = 8.2$ Hz, 2H), 4.22 (dd, $J = 9.6, 7.8$ Hz, 1H), 3.73 (s, 3H), 3.64 (dd, $J = 10.0, 7.1$ Hz, 1H), 3.59 – 3.43 (m, 2H), 3.33 – 3.21 (m, 1H), 2.34 (s, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.4 – 160.8 (m), 156.5, 154.6, 136.0, 135.6, 133.2, 132.4, 130.4, 129.9, 129.7, 123.9, 120.0, 117.8 (dd, $J = 253.5, 250.3$ Hz), 113.8, 49.0 (d, $J = 6.0$ Hz), 37.5 – 36.2 (m), 30.2 (d, $J = 7.4$ Hz), 29.2, 21.0. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.26 (dd, $J = 267.7, 14.2$ Hz), -116.34 (dd, $J = 267.3, 17.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{20}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 384.1518, found 384.1520.



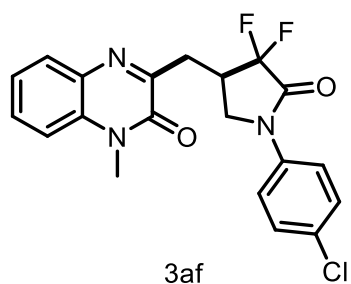
3-((4,4-Difluoro-5-oxo-1-(4-(trifluoromethoxy)phenyl)pyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ad). General Procedure was used to prepare the desired product **3ad**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3ad** as a pale yellow solid (32.2 mg, 0.071 mmol, 71%); **Mp**: 189-190 °C.

^1H NMR (400 MHz, Chloroform-*d*) δ 7.83 (dd, $J = 8.0, 1.5$ Hz, 1H), 7.77 – 7.69 (m, 2H), 7.60 (dd, $J = 8.6, 7.4$ Hz, 1H), 7.43 – 7.32 (m, 2H), 7.30 – 7.20 (m, 2H), 4.32 – 4.18 (m, 1H), 3.73 (s, 3H), 3.67 (dd, $J = 9.3, 7.2$ Hz, 1H), 3.59 – 3.42 (m, 2H), 3.36 – 3.16 (m, 1H). $^{13}\text{C}\{^1\text{H}\}$ NMR (101 MHz, Chloroform-*d*) δ 163.9 – 160.7 (m), 156.3, 154.6, 146.5 (q, $J = 1.9$ Hz), 136.6, 133.2, 132.3, 130.5, 129.9, 123.9, 121.8, 121.2, 120.4 (q, $J = 257.5$ Hz), 117.5 (dd, $J = 254.0, 250.4$ Hz), 113.8, 48.9 (d, $J = 6.1$ Hz), 36.8 (dd, $J = 22.1, 20.0$ Hz), 30.1 (d, $J = 7.3$ Hz), 29.2. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -58.06, -109.47 (dd, $J = 268.5, 14.1$ Hz), -116.36 (dd, $J = 268.1, 17.6$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{17}\text{F}_5\text{N}_3\text{O}_3^+$ $[\text{M}+\text{H}]^+$ m/z 454.1185, found 454.1190.

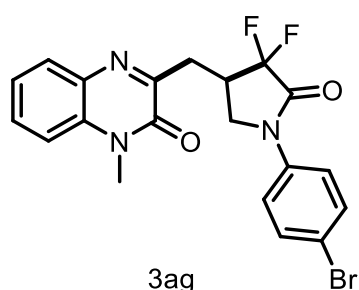


3-((4,4-Difluoro-1-(4-fluorophenyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ae). General Procedure was used to prepare the desired product **3ae**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ae** as a pale yellow solid (26.0 mg, 0.067 mmol, 67%); **Mp**: 190-192 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.83 (dd, $J = 8.0, 1.4$ Hz, 1H), 7.68

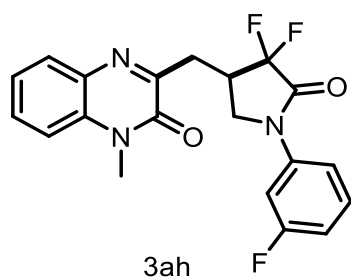
– 7.55 (m, 3H), 7.37 (td, $J = 8.3, 3.8$ Hz, 2H), 7.10 (t, $J = 8.5$ Hz, 2H), 4.22 (t, $J = 8.8$ Hz, 1H), 3.74 (s, 3H), 3.65 (dd, $J = 9.5, 7.1$ Hz, 1H), 3.53 (dt, $J = 15.8, 3.8$ Hz, 2H), 3.27 (dd, $J = 17.9, 10.3$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.3 (t, $J = 31.5$ Hz), 160.3 (d, $J = 246.4$ Hz), 156.4, 154.6, 134.2 (d, $J = 3.1$ Hz), 133.2, 132.3, 130.5, 129.9, 123.9, 121.9 (d, $J = 8.1$ Hz), 117.6 (dd, $J = 253.8, 250.3$ Hz), 116.0 (d, $J = 22.5$ Hz), 113.8, 49.2 (d, $J = 6.1$ Hz), 36.9 (dd, $J = 22.1, 20.0$ Hz), 30.1 (d, $J = 7.5$ Hz), 29.2. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.3 (dd, $J = 268.4, 14.3$ Hz), -115.2 – -115.4 (m), -116.4 (dd, $J = 268.0, 17.6$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{20}\text{H}_{17}\text{F}_3\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 388.1267, found 388.1267.



3-((1-(4-Chlorophenyl)-4,4-difluoro-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3af). General Procedure was used to prepare the desired product **3af**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (7/1) as eluent afforded **3af** as a pale yellow solid (32.0 mg, 0.08 mmol, 80%); **Mp**: 200-201 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.83 (dd, *J* = 7.9, 2.0 Hz, 1H), 7.67 – 7.52 (m, 3H), 7.42 – 7.28 (m, 4H), 4.23 (t, *J* = 8.5 Hz, 1H), 3.76 – 3.69 (m, 3H), 3.69 – 3.60 (m, 1H), 3.60 – 3.46 (m, 3H), 3.31 – 3.21 (m, 1H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.7 – 162.1 (m), 156.3, 154.6, 136.6, 133.2, 132.3, 131.3, 130.5, 129.9, 129.2, 123.9, 121.1, 117.6 (dd, *J* = 253.8, 250.4 Hz), 113.8, 48.9 (d, *J* = 6.1 Hz), 36.8 (dd, *J* = 22.2, 20.0 Hz), 30.1 (d, *J* = 7.4 Hz), 29.2. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -109.30 (dd, *J* = 268.6, 14.0 Hz), -116.30 (dd, *J* = 268.0, 17.7 Hz). HRMS (DART-TOF) calculated for C₂₀H₁₇ClF₂N₃O₂⁺ [M+H]⁺ *m/z* 404.0972, found 404.1001.

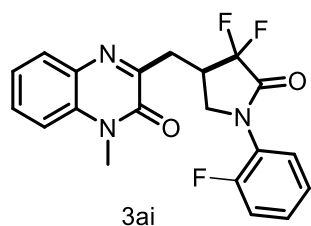


3-((1-(4-Bromophenyl)-4,4-difluoro-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ag). General Procedure was used to prepare the desired product **3ag**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (8/1) as eluent afforded **3ag** as a pale yellow solid (33.0 mg, 0.074 mmol, 74%); **Mp**: 193-195 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.82 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.64 – 7.49 (m, 5H), 7.42 – 7.30 (m, 2H), 4.22 (dd, *J* = 9.7, 7.8 Hz, 1H), 3.73 (s, 3H), 3.63 (dd, *J* = 9.5, 7.1 Hz, 1H), 3.59 – 3.40 (m, 2H), 3.26 (dd, *J* = 18.0, 10.3 Hz, 1H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.7 – 162.1 (m), 156.3, 154.6, 137.1, 133.2, 132.3, 132.2, 130.5, 129.9, 123.9, 121.4, 119.1, 117.5 (dd, *J* = 253.9, 250.3 Hz), 113.8, 48.8 (d, *J* = 6.0 Hz), 36.7 (dd, *J* = 22.0, 19.9 Hz), 30.1 (d, *J* = 7.5 Hz), 29.2. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -102.74 – -112.04 (m), -112.04 – -125.61 (m). HRMS (DART-TOF) calculated for C₂₀H₁₇BrF₂N₃O₂⁺ [M+H]⁺ *m/z* 448.0467, found 448.0448.



3-((4,4-Difluoro-1-(3-fluorophenyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ah). General Procedure was used to prepare the desired product **3ah**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (9/1) as eluent afforded **3ah** as a pale yellow solid (34.9 mg, 0.090 mmol, 90 %); **Mp**: 210-211 °C. ¹H NMR (400 MHz, Chloroform-*d*) δ 7.83 (dd, *J* = 8.0, 1.4 Hz, 1H), 7.65 – 7.48 (m, 2H), 7.47 – 7.31 (m, 4H), 6.99 – 6.88 (m, 1H), 4.25 (t, *J* = 8.7 Hz, 1H), 3.74 (s, 3H), 3.64 (dd, *J* = 9.6, 7.1 Hz, 1H), 3.60 – 3.41 (m, 2H), 3.27 (dd, *J* = 17.9, 10.2 Hz, 1H). ¹³C NMR (101 MHz, Chloroform-*d*) δ 162.9 (d, *J* = 246.2 Hz), 162.5 (t, *J* = 31.6 Hz), 156.3, 154.6, 139.5 (d, *J* = 10.3 Hz), 133.2, 132.3, 130.5, 130.3 (d, *J* = 9.1 Hz), 129.9, 123.9, 120.5 – 114.3 (m), 115.0 (d, *J* = 3.0 Hz), 113.8, 112.8 (d, *J* = 21.3 Hz), 107.5 (d, *J* = 26.4 Hz), 48.8 (d, *J* = 6.1 Hz), 36.7 (dd, *J* = 21.9, 20.0 Hz), 30.1 (d, *J* = 7.4 Hz), 29.2. ¹⁹F NMR (376 MHz, Chloroform-*d*) δ -108.59 – -111.40 (m), -116.03 (d, *J* = 17.9 Hz),

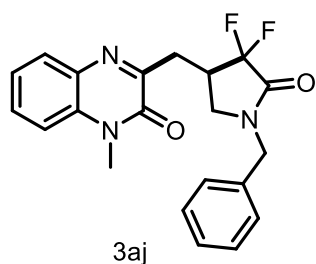
-116.74 (d, $J = 17.5$ Hz). **HRMS (DART-TOF)** calculated for $C_{20}H_{17}F_3N_3O_2^+$ $[M+H]^+$ m/z 388.1267, found 388.1280.



3-((4,4-Difluoro-1-(2-fluorophenyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ai).

General Procedure was used to prepare the desired product **3ai**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (9/1) as eluent afforded **3ai** as a pale yellow solid (20.0 mg, 0.052 mmol, 52%); **Mp**: 162-164 °C. **1H NMR**

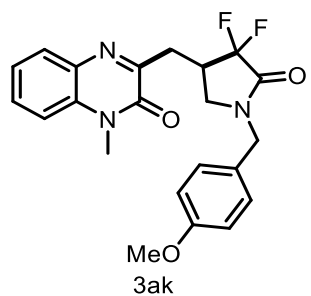
(400 MHz, Chloroform- d) δ 7.82 (dd, $J = 8.0, 1.5$ Hz, 1H), 7.62 – 7.53 (m, 1H), 7.49 (td, $J = 7.7, 1.7$ Hz, 1H), 7.39 – 7.28 (m, 3H), 7.24 – 7.14 (m, 2H), 4.24 – 4.12 (m, 1H), 3.73 (s, 3H), 3.69 (d, $J = 6.5$ Hz, 1H), 3.61 – 3.47 (m, 2H), 3.27 (dd, $J = 18.1, 10.6$ Hz, 1H). **^{13}C NMR (101 MHz, Chloroform- d)** δ 163.6 – 162.0 (m), 156.8 (d, $J = 251.5$ Hz), 156.4, 154.6, 133.2, 132.3, 130.4, 129.9, 129.5 (d, $J = 8.0$ Hz), 127.4, 124.9, 124.7 (d, $J = 3.7$ Hz), 123.8, 117.3 (dd, $J = 254.2, 251.2$ Hz), 116.9 (d, $J = 19.7$ Hz), 113.8, 50.6 (t, $J = 5.3$ Hz), 37.8 (dd, $J = 22.0, 19.8$ Hz), 30.1 (d, $J = 7.6$ Hz), 29.2. **^{19}F NMR (376 MHz, Chloroform- d)** δ -110.73 (dd, $J = 268.4, 14.4$ Hz), -116.96 (dd, $J = 268.7, 17.7$ Hz), -119.89 (dd, $J = 11.8, 7.4$ Hz). **HRMS (DART-TOF)** calculated for $C_{20}H_{17}F_3N_3O_2^+$ $[M+H]^+$ m/z 388.1267, found 388.1260.



3-((1-Benzyl-4,4-difluoro-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3aj).

General Procedure was used to prepare the desired product **3aj**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3aj** as a pale yellow solid (23.0 mg, 0.06 mmol, 60%); **Mp**: 175-176 °C. **1H NMR (400 MHz, Chloroform- d)** δ 7.78 – 7.72 (m, 1H), 7.56 (t, $J = 7.6$ Hz, 1H), 7.32 (dd, $J = 11.0,$

7.5 Hz, 6H), 7.25 (d, $J = 6.2$ Hz, 1H), 4.55 (s, 2H), 3.69 (s, 3H), 3.62 (t, $J = 9.2$ Hz, 1H), 3.41 (dd, $J = 28.0, 17.4$ Hz, 2H), 3.15 – 3.02 (m, 2H). **^{13}C NMR (101 MHz, Chloroform- d)** δ 163.6 (t, $J = 30.8$ Hz), 156.5, 154.6, 134.7, 133.1, 132.3, 130.3, 129.9, 129.0, 128.2 (2C), 123.8, 118.1 (dd, $J = 254.1, 251.6$ Hz), 113.7, 47.4, 47.3 (d, $J = 6.2$ Hz), 37.4 – 36.9 (m), 30.4 (d, $J = 8.0$ Hz), 29.1. **^{19}F NMR (376 MHz, Chloroform- d)** δ -109.81 (dd, $J = 267.8, 15.4$ Hz), -116.34 (dd, $J = 267.8, 16.8$ Hz). **HRMS (DART-TOF)** calculated for $C_{21}H_{20}F_2N_3O_2^+$ $[M+H]^+$ m/z 384.1518, found 384.1524.

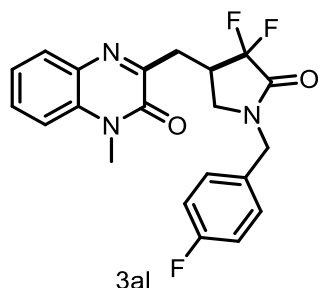


3-((4,4-Difluoro-1-(4-methoxybenzyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ak).

General Procedure was used to prepare the desired product **3ak**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ak** as a pale yellow solid (32.0 mg, 0.078 mmol, 78%); **Mp**: 180-181 °C. **1H NMR**

(400 MHz, Chloroform- d) δ 7.68 (dd, $J = 8.0, 1.5$ Hz, 1H), 7.56 – 7.42 (m, 1H), 7.34 – 7.21 (m, 2H), 7.15 – 7.03 (m, 2H), 6.83 – 6.73 (m, 2H), 4.49 – 4.30 (m, 2H), 3.72 (s, 3H), 3.61 (s, 3H), 3.53 (dd, $J = 10.1, 7.9$ Hz, 1H), 3.40 – 3.16 (m, 2H), 3.09 – 2.90 (m, 2H). **^{13}C NMR (101 MHz, Chloroform- d)** δ 163.7 – 163.1 (m), 159.5, 156.5, 154.6, 133.1, 132.3, 130.3, 129.9, 129.6, 126.7, 123.8, 118.2 (dd, $J = 254.0, 251.1$

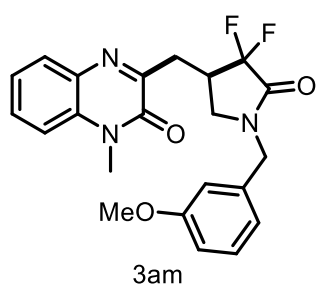
Hz), 114.3, 113.7, 55.3, 47.2 (d, $J = 6.2$ Hz), 46.8, 37.1 (dd, $J = 22.5, 20.0$ Hz), 30.4 (d, $J = 8.0$ Hz), 29.1. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.64 (dd, $J = 267.7, 15.5$ Hz), -116.33 (dd, $J = 267.3, 16.6$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_3^+$ $[\text{M}+\text{H}]^+$ m/z 414.1624, found 414.1602.



3-((4,4-Difluoro-1-(4-fluorobenzyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3al).

General Procedure was used to prepare the desired product **3al**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3al** as a pale yellow solid (27.0 mg, 0.067 mmol, 67%); **Mp**: 177-179 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.76 (d, $J = 7.9$ Hz, 1H), 7.57 (t, $J = 7.6$ Hz, 1H), 7.39 – 7.30 (m, 2H), 7.22 (dd, $J = 8.5, 5.4$ Hz, 2H),

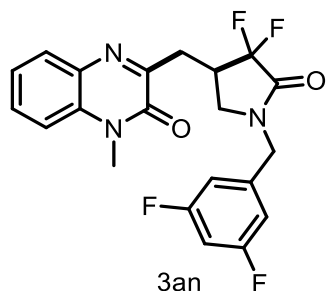
7.03 (t, $J = 8.5$ Hz, 2H), 4.58 – 4.45 (m, 2H), 3.70 (s, 3H), 3.62 (ddd, $J = 10.1, 7.9, 1.9$ Hz, 1H), 3.47 – 3.28 (m, 2H), 3.19 – 3.00 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.9 – 163.0 (m), 162.6 (d, $J = 246.9$ Hz), 156.5, 154.6, 133.1, 132.3, 130.6 – 130.4 (m), 130.4, 130.0 (d, $J = 8.4$ Hz), 129.9, 123.8, 121.2 – 114.8 (m), 116.0, 115.8, 47.3 (d, $J = 6.2$ Hz), 46.7, 37.1 (t, $J = 20.9$ Hz), 30.3 (d, $J = 8.0$ Hz), 29.1. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.82 (dd, $J = 268.1, 15.0$ Hz), -112.90 – -115.23 (m), -115.77 – -118.52 (m). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{19}\text{F}_3\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 402.1424, found 402.1429.



3-((4,4-Difluoro-1-(3-methoxybenzyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3am).

General Procedure was used to prepare the desired product **3am**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3am** as a pale yellow solid (21.0 mg, 0.051 mmol, 51%); **Mp**: 167-168 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.76 (dd, $J = 8.0, 1.4$ Hz, 1H), 7.60 – 7.52 (m, 1H), 7.39 – 7.29 (m, 2H), 7.24 (d, $J = 7.9$ Hz, 1H), 6.88

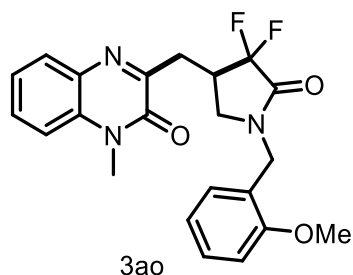
– 6.73 (m, 3H), 4.60 – 4.42 (m, 2H), 3.79 (s, 3H), 3.69 (s, 3H), 3.63 (dd, $J = 10.1, 7.8$ Hz, 1H), 3.40 (dd, $J = 24.3, 17.2$ Hz, 2H), 3.16 – 3.01 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.9 – 163.3 (m), 160.1, 156.5, 154.6, 136.2, 133.1, 132.3, 130.3, 130.0, 129.9, 123.8, 120.4, 118.1 (dd, $J = 254.1, 251.3$ Hz), 113.7 (2C), 113.6, 55.3, 47.3, 47.3 (d, $J = 5.0$ Hz), 37.1 (dd, $J = 22.4, 20.0$ Hz), 30.3 (d, $J = 8.0$ Hz), 29.1. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.52 (dd, $J = 267.2, 15.3$ Hz), -116.67 (dd, $J = 267.2, 16.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_3^+$ $[\text{M}+\text{H}]^+$ m/z 414.1624, found 414.1624.



3-((1-(3,5-Difluorobenzyl)-4,4-difluoro-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3an).

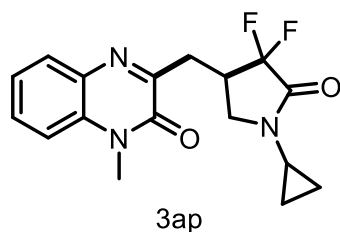
General Procedure was used to prepare the desired product **3an**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3an** as a pale yellow solid (23.0 mg, 0.055 mmol, 55%); **Mp**: 181-183 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.77 (d, $J = 8.0$ Hz, 1H), 7.57 (t, J

= 7.9 Hz, 1H), 7.42 – 7.29 (m, 2H), 6.78 (d, $J = 7.4$ Hz, 3H), 4.51 (s, 2H), 3.70 (s, 3H), 3.69 – 3.62 (m, 1H), 3.51 – 3.31 (m, 2H), 3.20 – 3.06 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 164.6 (d, $J = 12.8$ Hz), 163.6 (t, $J = 30.8$ Hz), 162.1 (d, $J = 12.6$ Hz), 156.4, 154.6, 138.6 (t, $J = 8.8$ Hz), 133.2, 132.3, 130.4, 129.9, 123.8, 121.1 – 114.4 (m), 113.7, 111.0 (d, $J = 25.7$ Hz), 111.0 (d, $J = 11.3$ Hz), 103.8 (t, $J = 25.2$ Hz), 47.5 (d, $J = 6.2$ Hz), 46.7, 38.6 – 35.9 (m), 30.2 (d, $J = 7.8$ Hz), 29.1. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.33 (t, $J = 7.8$ Hz), -110.10 (dd, $J = 268.8, 15.3$ Hz), -116.39 (dd, $J = 268.6, 16.9$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{18}\text{F}_4\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 420.1330, found 420.1335.



3-((4,4-Difluoro-1-(2-methoxybenzyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ao). General Procedure was used to prepare the desired product **3ao**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **3ao** as a pale yellow solid (30.0 mg, 0.073 mmol, 73%); **Mp**: 166-168 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.68 (dd, $J = 8.0, 1.4$ Hz, 1H),

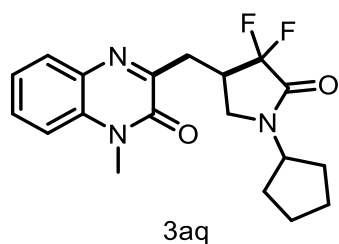
7.48 (dd, $J = 8.5, 7.3$, 1H), 7.31 – 7.17 (m, 3H), 7.11 (dd, $J = 7.5, 1.7$ Hz, 1H), 6.90 – 6.70 (m, 2H), 4.60 – 4.40 (m, 2H), 3.73 (s, 3H), 3.61 (s, 3H), 3.50 – 3.39 (m, 1H), 3.34 – 3.14 (m, 2H), 3.07 – 2.91 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.5 (t, $J = 30.6$ Hz), 157.6, 156.6, 154.6, 133.1, 132.3, 130.3, 130.1, 129.8, 129.5, 123.8, 122.7, 120.8, 120.9 – 115.3 (m), 113.7, 110.5, 55.3, 47.6 (d, $J = 6.2$ Hz), 42.4, 38.4 – 35.2 (m), 30.3 (d, $J = 8.1$ Hz), 29.1. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.75 (dd, $J = 266.9, 15.4$ Hz), -116.53 (dd, $J = 266.9, 16.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_3^+$ $[\text{M}+\text{H}]^+$ m/z 414.1624, found 414.1621.



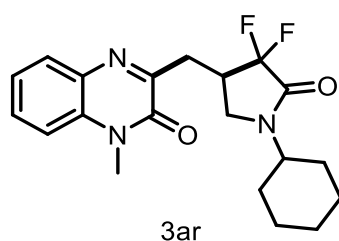
3-((1-Cyclopropyl-4,4-difluoro-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ap). General Procedure was used to prepare the desired product **3ap**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3ap** as a pale yellow solid (23.0 mg, 0.069 mmol, 69%); **Mp**: 210-212 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.76 (dd, $J = 8.0, 1.5$ Hz, 1H), 7.51 (dd, $J = 8.7, 7.4$ Hz, 1H), 7.34 – 7.24 (m, 2H), 3.65 (s, 3H), 3.60 (dd, $J = 9.9, 7.9$ Hz, 1H), 3.36 (dd, $J = 17.3, 4.1$ Hz, 1H), 3.30 – 3.15 (m, 1H), 3.10 – 2.99 (m, 2H), 2.68 (dd, $J = 8.0, 3.6$ Hz, 1H), 0.78 – 0.73 (m, 4H).

^{13}C NMR (101 MHz, Chloroform-*d*) δ 164.7 – 164.1 (m), 156.6, 154.6, 133.1, 132.4, 130.4, 129.9, 123.8, 118.3 (dd, $J = 253.7, 251.1$ Hz), 113.8, 48.2 (d, $J = 5.9$ Hz), 37.2 (dd, $J = 22.3, 19.9$ Hz), 30.3 (d, $J = 8.1$ Hz), 29.2, 26.2, 5.0, 4.9. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.52 (dd, $J = 267.2, 15.3$ Hz), -116.67 (dd, $J = 267.2, 16.8$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{17}\text{H}_{18}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 334.1362, found 334.1366.

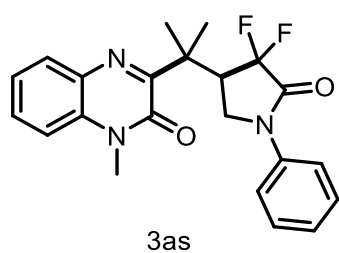
3-((1-Cyclopentyl-4,4-difluoro-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3aq). General Procedure was used to prepare the desired product **3aq**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3aq** as a brown oil (20.0 mg, 0.056 mmol, 56%). ^1H NMR (400 MHz, Chloroform-*d*) δ 7.84 (dd, $J =$



8.0, 1.5 Hz, 1H), 7.59 (dd, $J = 8.6, 7.4$ Hz, 1H), 7.46 – 7.31 (m, 2H), 4.52 (t, $J = 8.0$ Hz, 1H), 3.73 (s, 4H), 3.46 (dd, $J = 17.2, 4.1$ Hz, 2H), 3.22 – 3.04 (m, 2H), 1.98 – 1.85 (m, 2H), 1.75 – 1.69 (m, 2H), 1.66 – 1.50 (m, 4H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.7 – 163.1 (m), 156.7, 154.7, 133.2, 132.4, 130.4, 129.9, 123.8, 118.3 (dd, $J = 253.2, 251.0$ Hz), 113.8, 43.9 (d, $J = 6.2$ Hz), 37.3 (dd, $J = 22.4, 20.0$ Hz), 30.4 (d, $J = 8.0$ Hz), 29.2, 28.7, 28.6, 24.1. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.78 (dd, $J = 266.7, 15.4$ Hz), -116.83 (dd, $J = 266.8, 16.7$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{19}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 362.1675, found 362.1679.

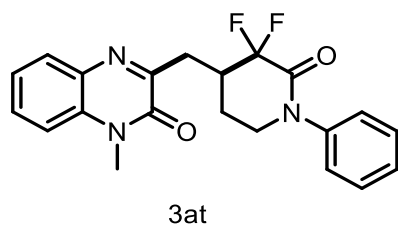


3-((1-Cyclohexyl-4,4-difluoro-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3ar). General Procedure was used to prepare the desired product 3ar. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded 3ar as a pale yellow solid (15.0 mg, 0.040 mmol, 40%); **Mp:** 171-173 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.84 (dd, $J = 8.0, 1.5$ Hz, 1H), 7.62 – 7.50 (m, 1H), 7.41 – 7.29 (m, 2H), 4.01 (q, $J = 9.6$ Hz, 1H), 3.73 (s, 3H), 3.69 (d, $J = 1.8$ Hz, 1H), 3.49 – 3.27 (m, 2H), 3.19 – 3.04 (m, 2H), 1.87 – 1.64 (m, 6H), 1.44 – 1.32 (m, 4H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 163.0 (t, $J = 30.1$ Hz), 156.8, 154.7, 133.2, 132.4, 130.4, 130.0, 123.8, 117.2 (dd, $J = 251.3, 252.6$ Hz), 113.8, 51.5, 43.8 (d, $J = 6.2$ Hz), 37.3 (dd, $J = 22.5, 20.0$ Hz), 30.4 (d, $J = 8.0$ Hz), 29.8, 29.6, 29.2, 25.2 (3C). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -109.96 (dd, $J = 266.5, 15.3$ Hz), -116.82 (dd, $J = 266.5, 16.7$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{20}\text{H}_{24}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 376.1831, found 376.1846.



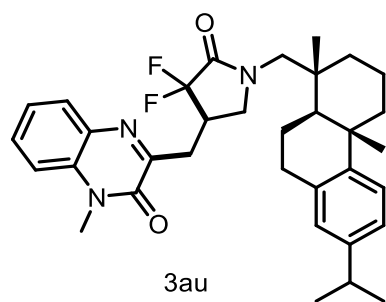
3-(2-(4,4-Difluoro-5-oxo-1-phenylpyrrolidin-3-yl)propan-2-yl)-1-methylquinoxalin-2(1H)-one (3as). General Procedure was used to prepare the desired product 3as. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded 3as as a pale yellow solid (9.0 mg, 0.023 mmol, 23%); **Mp:** 195-197 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.75 (dd, $J = 8.4, 1.5$ Hz, 1H), 7.72 – 7.66 (m, 2H), 7.54 (dd, $J = 8.7, 7.3$ Hz, 1H), 7.44 – 7.37 (m, 2H), 7.31 (dd, $J = 8.4, 6.7$ Hz, 2H), 7.25 – 7.20 (m, 1H), 4.01 – 3.92 (m, 1H), 3.90 – 3.77 (m, 2H), 3.70 (s, 3H), 1.78 – 1.68 (m, 6H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.8 (t, $J = 31.5$ Hz), 160.7, 153.6, 138.2, 133.3, 131.6, 130.4, 130.3, 129.1, 125.9, 123.7, 120.1, 118.8 (dd, $J = 256.7, 247.5$ Hz), 113.4, 45.9 (d, $J = 4.9$ Hz), 45.4 (dd, $J = 21.9, 17.4$ Hz), 44.2, 29.0, 23.3 (2C). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -94.91 (d, $J = 269.9$ Hz), -114.06 (dd, $J = 268.9, 14.0$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{22}\text{F}_2\text{N}_3\text{O}_2^+$ $[\text{M}+\text{H}]^+$ m/z 398.1675, found 398.1681.

3-((3,3-Difluoro-2-oxo-1-phenylpiperidin-4-yl)methyl)-1-methylquinoxalin-2(1H)-one (3at). General Procedure was used to prepare the desired product 3at. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded 3at as a



3at

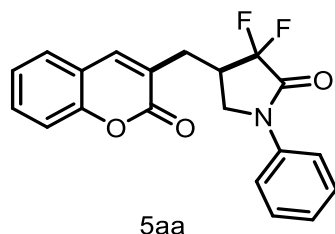
pale yellow solid (18.0 mg, 0.047 mmol, 47%); **Mp**: 196–197 °C. $^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 7.85 (d, $J = 7.9$ Hz, 1H), 7.57 (t, $J = 7.9$ Hz, 1H), 7.47–7.27 (m, 7H), 3.92–3.80 (m, 1H), 3.73 (s, 4H), 3.48 (dd, $J = 16.2, 3.7$ Hz, 1H), 3.30 (td, $J = 13.8, 13.2, 6.2$ Hz, 1H), 3.17 (dd, $J = 16.1, 9.5$ Hz, 1H), 2.28–2.04 (m, 2H). $^{13}\text{C NMR}$ (101 MHz, Chloroform-*d*) δ 161.5 (t, $J = 30.1$ Hz), 157.2, 154.9, 141.3, 133.2, 132.5, 130.2, 129.9, 129.4, 127.6, 125.7, 123.8, 113.8 (d, $J = 495.4$ Hz), 113.7, 49.9, 38.7 (t, $J = 20.9$ Hz), 31.1 (dd, $J = 5.2, 1.9$ Hz), 29.2, 24.7 (d, $J = 7.2$ Hz). $^{19}\text{F NMR}$ (376 MHz, Chloroform-*d*) δ -108.12 (dd, $J = 279.3, 8.0$ Hz), -110.17 (dd, $J = 279.5, 22.0$ Hz). **HRMS (DART-TOF)** calculated for $\text{C}_{21}\text{H}_{20}\text{F}_2\text{N}_3\text{O}_2^+$ [$\text{M}+\text{H}$] $^+$ m/z 384.1518, found 384.1522.



3au

3-((4,4-Difluoro-1-(((1R,4aS,10aR)-7-isopropyl-1,4a-dimethyl-1,2,3,4,4a,9,10,10a-octahydrophenanthren-1-yl)methyl)-5-oxopyrrolidin-3-yl)methyl)-1-methylquinoxalin-2(1H)-one (3au). General Procedure was used to prepare the desired product **3au**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (3/1) as eluent afforded **3au** as a pale yellow solid (51.0 mg, 0.09 mmol, 90%); **Mp**: 164–165 °C.

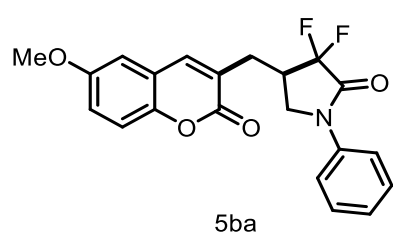
$^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 7.78 (d, $J = 8.0$ Hz, 1H), 7.57 (td, $J = 7.9, 3.8$ Hz, 1H), 7.35 (dd, $J = 18.1, 8.1$ Hz, 2H), 7.15 (dd, $J = 8.8, 5.9$ Hz, 1H), 7.01–6.93 (m, 1H), 6.88 (d, $J = 4.3$ Hz, 1H), 3.93–3.76 (m, 1H), 3.69 (d, $J = 4.4$ Hz, 3H), 3.44–3.23 (m, 5H), 3.12 (dt, $J = 11.9, 3.8$ Hz, 2H), 2.83 (dd, $J = 13.1, 6.4$ Hz, 3H), 2.28 (d, $J = 12.9$ Hz, 1H), 1.95 (d, $J = 7.0$ Hz, 1H), 1.74 (d, $J = 13.7$ Hz, 2H), 1.43–1.35 (m, 4H), 1.26 (s, 3H), 1.17 (d, $J = 7.1$ Hz, 6H), 0.99 (d, $J = 4.3$ Hz, 3H). $^{13}\text{C NMR}$ (101 MHz, Chloroform-*d*) δ 165.1 (td, $J = 30.7, 8.2$ Hz), 156.7, 154.6, 147.0, 145.7, 145.6, 134.5, 134.4, 133.2, 132.4, 130.3, 129.9, 126.9, 126.9, 124.2, 124.0, 123.9, 123.9, 123.8, 123.8, 120.5–114.7 (m), 113.8, 113.7, 56.5, 56.2, 51.9 (d, $J = 6.3$ Hz), 46.4, 46.1, 39.6, 39.6, 38.2, 37.8, 37.7, 37.7, 37.6–37.1 (m), 37.3, 33.5, 33.4, 30.6–29.2 (m), 30.2, 30.1, 30.1, 29.2, 29.1, 25.7, 25.6, 24.0, 24.0, 24.0, 23.9. $^{19}\text{F NMR}$ (376 MHz, Chloroform-*d*) δ -105.44–-115.31 (m), -116.84 (dd, $J = 266.0, 17.3$ Hz). **HRMS (DART-TOF)** calculated for $\text{C}_{34}\text{H}_{42}\text{F}_2\text{N}_3\text{O}_2^+$ [$\text{M}+\text{H}$] $^+$ m/z 562.3240, found 562.3240.



5aa

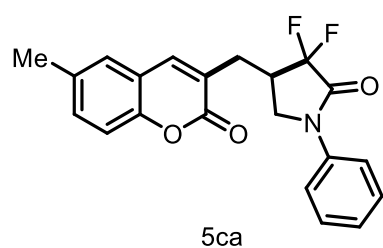
3,3-Difluoro-4-((2-oxo-2H-chromen-3-yl)methyl)-1-phenylpyrrolidin-2-one (5aa).³ General Procedure was used to prepare the desired product **5aa**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5aa** as a pale yellow solid (10.0 mg, 0.028 mmol, 28%); **Mp**: 160–162 °C. $^1\text{H NMR}$ (400 MHz, Chloroform-*d*) δ 7.65 (s, 1H), 7.59–7.52 (m, 2H), 7.51–7.40 (m, 2H), 7.37–7.20 (m, 4H), 7.18–7.12 (m, 1H), 3.90 (dd, $J = 9.6, 8.1$ Hz, 1H), 3.62 (dd, $J = 9.8, 7.8$ Hz, 1H), 3.16 (dt, $J = 18.3, 7.5$ Hz, 1H), 2.97 (dd, $J = 14.1, 7.4$ Hz, 1H), 2.87 (dd, $J = 14.1, 7.1$ Hz, 1H). $^{13}\text{C NMR}$ (101 MHz, Chloroform-*d*) δ 162.0 (t, $J = 31.2$ Hz), 161.5, 153.5, 141.8, 137.8, 131.6, 129.2, 127.7, 126.3, 124.8, 124.7, 120.0, 119.0, 120.6–114.6 (m), 116.6,

48.3 (d, $J = 6.4$ Hz), 38.4 (t, $J = 20.6$ Hz), 27.8 (d, $J = 7.6$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.68 (dd, $J = 267.7, 13.8$ Hz), -117.61 (dd, $J = 267.4, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{20}\text{H}_{16}\text{F}_2\text{NO}_3^+$ $[\text{M}+\text{H}]^+$ m/z 356.1093, found 356.1098.



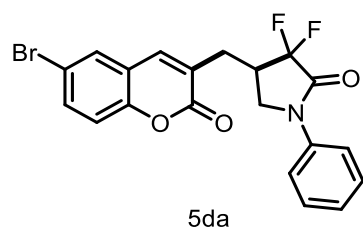
3,3-Difluoro-4-((7-methoxy-2-oxo-2H-chromen-3-yl)methyl)-1-phenylpyrrolidin-2-one (5ba). General Procedure was used to prepare the desired product **5ba**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5ba** as a pale yellow solid (16.0 mg, 0.042 mmol, 42%); **Mp**: 208-210 °C.

^1H NMR (400 MHz, Chloroform-*d*) δ 7.71 – 7.61 (m, 3H), 7.46 – 7.38 (m, 3H), 7.28 – 7.19 (m, 1H), 6.94 – 6.83 (m, 2H), 3.98 (dd, $J = 9.7, 8.1$ Hz, 1H), 3.91 (s, 3H), 3.71 (dd, $J = 9.8, 7.8$ Hz, 1H), 3.23 (dt, $J = 18.3, 7.5$ Hz, 1H), 3.07 – 2.87 (m, 2H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.7, 162.1 (t, $J = 32.3$ Hz), 161.9, 155.3, 141.8, 137.9, 129.2, 128.6, 126.2, 121.0, 120.0, 117.5 (dd, $J = 250.1, 250.3$ Hz), 112.9, 112.7, 100.7, 55.8, 48.3 (d, $J = 6.4$ Hz), 38.6 (t, $J = 20.5$ Hz), 27.6 (d, $J = 7.6$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.75 (dd, $J = 267.5, 13.6$ Hz), -117.71 (dd, $J = 267.5, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{18}\text{F}_2\text{NO}_4^+$ $[\text{M}+\text{H}]^+$ m/z 386.1198, found 386.1200.



3,3-Difluoro-4-((7-methyl-2-oxo-2H-chromen-3-yl)methyl)-1-phenylpyrrolidin-2-one (5ca). General Procedure was used to prepare the desired product **5ca**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5ca** as a pale yellow solid (18.0 mg, 0.049 mmol, 49%); **Mp**: 168-170 °C.

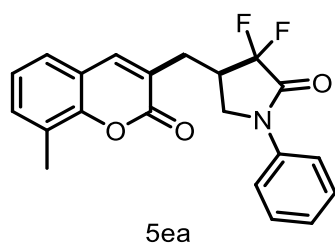
^1H NMR (400 MHz, Chloroform-*d*) δ 7.61 (s, 1H), 7.58 – 7.52 (m, 2H), 7.36 – 7.28 (m, 3H), 7.18 – 7.10 (m, 1H), 7.10 – 7.02 (m, 2H), 3.89 (dd, $J = 9.7, 8.1$ Hz, 1H), 3.61 (dd, $J = 9.8, 7.8$ Hz, 1H), 3.14 (dt, $J = 18.3, 7.6$ Hz, 1H), 2.99 – 2.79 (m, 2H), 2.39 (s, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.1 (t, $J = 32.1$ Hz), 161.8, 153.6, 142.9, 141.8, 137.8, 129.2, 127.3, 126.2, 125.9, 123.4, 120.0, 117.5 (dd, $J = 249.9, 250.2$ Hz), 116.8, 116.7, 48.3 (d, $J = 6.4$ Hz), 38.5 (t, $J = 20.6$ Hz), 27.7 (d, $J = 7.7$ Hz), 21.8. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.75 (dd, $J = 267.5, 13.5$ Hz), -117.68 (dd, $J = 267.5, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{18}\text{F}_2\text{NO}_3^+$ $[\text{M}+\text{H}]^+$ m/z 370.1249, found 370.1259.



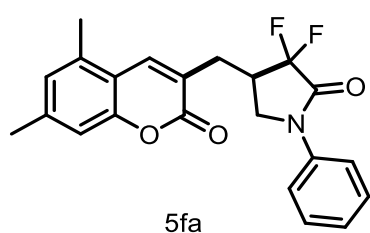
4-((7-Bromo-2-oxo-2H-chromen-3-yl)methyl)-3,3-difluoro-1-phenylpyrrolidin-2-one (5da). General Procedure was used to prepare the desired product **5da**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5da** as a pale yellow solid (13.6 mg, 0.03 mmol, 30%); **Mp**: 188-189 °C.

^1H NMR (400 MHz, Chloroform-*d*) δ 7.62 – 7.52 (m, 3H), 7.46 (d, $J = 1.8$ Hz, 1H), 7.39 – 7.27 (m, 4H), 7.18 – 7.13 (m, 1H), 3.91 (dd, $J = 9.6, 8.1$ Hz, 1H), 3.61 (dd, $J = 9.8, 7.8$ Hz, 1H), 3.14 (dt, $J = 18.4, 7.5$ Hz, 1H), 2.93 (dd, $J = 14.1, 7.7$ Hz, 1H), 2.86 (dd, $J = 14.1, 6.9$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 161.9 (t, $J = 31.7$

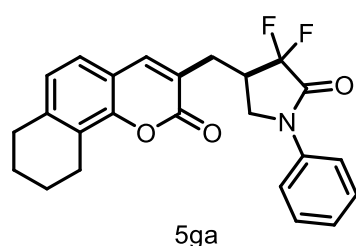
Hz), 160.8, 153.7, 141.1, 137.7, 129.2, 128.6, 128.2, 126.3, 125.5, 125.1, 120.0, 119.9, 117.9, 117.5 (dd, $J = 249.8, 250.1$ Hz), 48.2 (d, $J = 6.3$ Hz), 38.3 (t, $J = 20.5$ Hz), 27.9 (d, $J = 7.6$ Hz). ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.49 (dd, $J = 267.7, 13.2$ Hz), -117.53 (dd, $J = 267.5, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{20}\text{H}_{14}\text{BrF}_2\text{NO}_3\text{Na}^+$ $[\text{M}+\text{H}]^+$ m/z 456.0017, found 456.0019.



3,3-Difluoro-4-((8-methyl-2-oxo-2H-chromen-3-yl)methyl)-1-phenylpyrrolidin-2-one (5ea). General Procedure was used to prepare the desired product **5ea**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5ea** as a pale yellow solid (12.0 mg, 0.033 mmol, 33%); **Mp**: 169-170 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.67 – 7.50 (m, 3H), 7.36 – 7.22 (m, 4H), 7.18 – 7.08 (m, 2H), 3.90 (dd, $J = 9.6, 8.0$, 1H), 3.63 (dd, $J = 9.7, 7.7$ Hz, 1H), 3.16 (dt, $J = 18.3, 7.6$ Hz, 1H), 2.97 (dd, $J = 14.0, 7.3$ Hz, 1H), 2.87 (dd, $J = 14.0, 7.3$ Hz, 1H), 2.40 (s, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.1 (t, $J = 31.3$ Hz), 161.7, 151.9, 142.2, 137.8, 132.9, 129.2, 126.2, 126.1, 125.4, 124.3, 124.3, 120.0, 118.8, 117.5 (dd, $J = 249.7, 249.8$ Hz), 48.3 (d, $J = 6.4$ Hz), 38.5 (t, $J = 20.5$ Hz), 27.7 (d, $J = 7.6$ Hz), 15.4. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.73 (dd, $J = 267.6, 13.8$ Hz), -117.63 (dd, $J = 267.5, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{21}\text{H}_{18}\text{F}_2\text{NO}_3^+$ $[\text{M}+\text{H}]^+$ m/z 370.1249, found 370.1274.

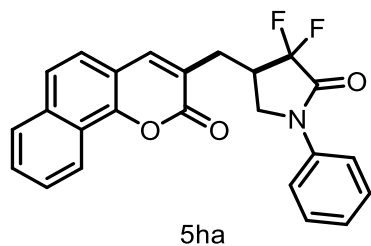


4-((5,7-Dimethyl-2-oxo-2H-chromen-3-yl)methyl)-3,3-difluoro-1-phenylpyrrolidin-2-one (5fa). General Procedure was used to prepare the desired product **5fa**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5fa** as a pale yellow solid (13.0 mg, 0.034 mmol, 34%); **Mp**: 190-192 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.79 (s, 1H), 7.61 – 7.51 (m, 2H), 7.40 – 7.28 (m, 2H), 7.16 (d, $J = 7.5$ Hz, 1H), 6.90 (d, $J = 18.1$ Hz, 2H), 3.89 (dd, $J = 9.6, 8.1$ Hz, 1H), 3.63 (dd, $J = 9.8, 7.8$ Hz, 1H), 3.15 (dt, $J = 18.3, 7.5$ Hz, 1H), 2.96 (dd, $J = 14.1, 7.3$ Hz, 1H), 2.88 (dd, $J = 14.1, 7.2$ Hz, 1H), 2.43 (s, 3H), 2.33 (s, 3H). ^{13}C NMR (101 MHz, Chloroform-*d*) δ 162.1 (t, $J = 32.0$ Hz), 161.8, 154.2, 142.6, 138.9, 137.8, 135.5, 129.2, 127.3, 126.2, 122.6, 120.0, 115.5, 117.6 (dd, $J = 249.8, 249.8$ Hz), 114.8, 48.3 (d, $J = 6.3$ Hz), 38.6 (t, $J = 20.5$ Hz), 27.9 (d, $J = 7.5$ Hz), 21.7, 18.3. ^{19}F NMR (376 MHz, Chloroform-*d*) δ -108.60 (dd, $J = 267.4, 13.6$ Hz), -117.58 (dd, $J = 267.4, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{22}\text{H}_{20}\text{F}_2\text{NO}_3^+$ $[\text{M}+\text{H}]^+$ m/z 384.1406, found 384.1400.



3,3-Difluoro-4-((2-oxo-7,8,9,10-tetrahydro-2H-benzo[h]chromen-3-yl)methyl)-1-phenylpyrrolidin-2-one (5ga). General Procedure was used to prepare the desired product **5ga**. Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5ga** as a pale yellow solid (12.0 mg, 0.029 mmol, 29%); **Mp**: 177-178 °C. ^1H NMR (400 MHz, Chloroform-*d*) δ 7.63 – 7.50 (m,

3H), 7.37 – 7.28 (m, 2H), 7.18 – 7.09 (m, 2H), 6.95 (d, $J = 7.9$ Hz, 1H), 3.88 (dd, $J = 9.7, 8.1$ Hz, 1H), 3.61 (dd, $J = 9.8, 7.7$ Hz, 1H), 3.15 (dt, $J = 18.3, 7.6$ Hz, 1H), 2.94 (dd, $J = 14.0, 7.2$ Hz, 1H), 2.90 – 2.69 (m, 5H), 1.86 – 1.68 (m, 4H). ^{13}C NMR (101 MHz, Chloroform- d) δ 162.2 (t, $J = 30.9$ Hz), 162.0, 151.7, 142.3 (2C), 137.9, 129.2, 126.2, 125.5, 125.3, 124.2, 122.8, 120.0, 117.5 (dd, $J = 249.0, 249.3$ Hz), 116.3, 48.3 (d, $J = 6.3$ Hz), 38.5 (t, $J = 20.5$ Hz), 29.9, 27.7 (d, $J = 7.7$ Hz), 22.6, 22.5, 22.1. ^{19}F NMR (376 MHz, Chloroform- d) δ -108.78 (dd, $J = 267.6, 13.7$ Hz), -117.67 (dd, $J = 267.5, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{24}\text{H}_{22}\text{F}_2\text{NO}_3^+$ $[\text{M}+\text{H}]^+$ m/z 410.1562, found 410.1565.



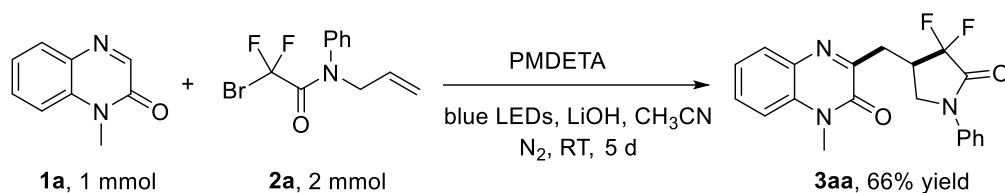
3,3-difluoro-4-((2-oxo-2H-benzo[h]chromen-3-yl)methyl)-1-phenylpyrrolidin-2-one (5ha). General Procedure was used to prepare the desired product **5ha**.

Chromatographic purification on silica gel using petroleum ether/ethyl acetate (5/1) as eluent afforded **5ha** as a pale yellow solid (14.0 mg, 0.035 mmol, 35%); **Mp**: 160-161 °C.

^1H NMR (400 MHz, Chloroform- d) δ 8.53 – 8.42 (m, 1H), 7.86 – 7.74 (m, 2H), 7.68 – 7.52 (m, 5H), 7.42 – 7.29 (m, 3H), 7.18 – 7.12 (m, 1H), 3.93 (dd, $J = 9.6, 8.1$ Hz, 1H), 3.66 (dd, $J = 9.8, 7.8$ Hz, 1H), 3.21 (dt, $J = 18.2, 7.6$ Hz, 1H), 3.03 (dd, $J = 14.1, 7.3$ Hz, 1H), 2.93 (dd, $J = 14.1, 7.3$ Hz, 1H). ^{13}C NMR (101 MHz, Chloroform- d) δ 162.1 (t, $J = 30.7$ Hz), 161.7, 150.7, 142.6, 137.8, 134.7, 129.2, 128.7, 127.9, 127.3, 126.3, 124.8, 124.2, 123.4, 122.9, 122.2, 120.0, 117.5 (dd, $J = 249.6, 249.8$ Hz), 114.5, 48.3 (d, $J = 6.3$ Hz), 38.5 (t, $J = 20.6$ Hz), 27.8 (d, $J = 7.7$ Hz). ^{19}F NMR (376 MHz, Chloroform- d) δ -108.64 (dd, $J = 267.5, 13.5$ Hz), -117.55 (dd, $J = 267.4, 18.3$ Hz). HRMS (DART-TOF) calculated for $\text{C}_{24}\text{H}_{18}\text{F}_2\text{NO}_3^+$ $[\text{M}+\text{H}]^+$ m/z 406.1249, found 406.1258.

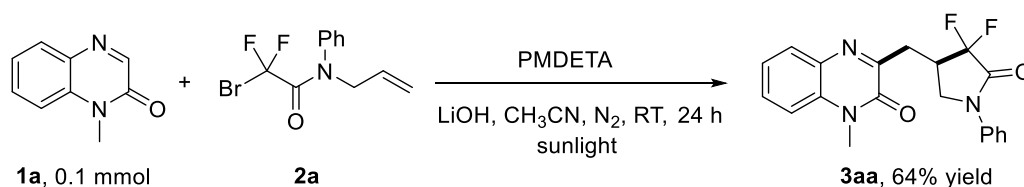
4. Scale-Up and Sunlight Experiment

4.1 Gram-scale synthesis



A mixture of quinoxalin-2(1*H*)-one **1a** (1.0 mmol), *N*-allylbromodifluoroacetamide **2a** (2.0 mmol, 2.0 equiv.), LiOH (1.0 mmol, 1.0 equiv.), PMDETA (2.0 mmol, 2.0 equiv.), and CH₃CN (4 mL) was degassed by three cycles of freeze-pump-thaw. The mixture was irradiated by 24 W 460 nm blue LEDs at room temperature for 5 days. After removal of solvents, the crude mixture was purified by flash chromatography (petroleum ether/ethyl acetate) to afford the pure product **3aa** (0.25 g, 0.66 mmol, 66%).

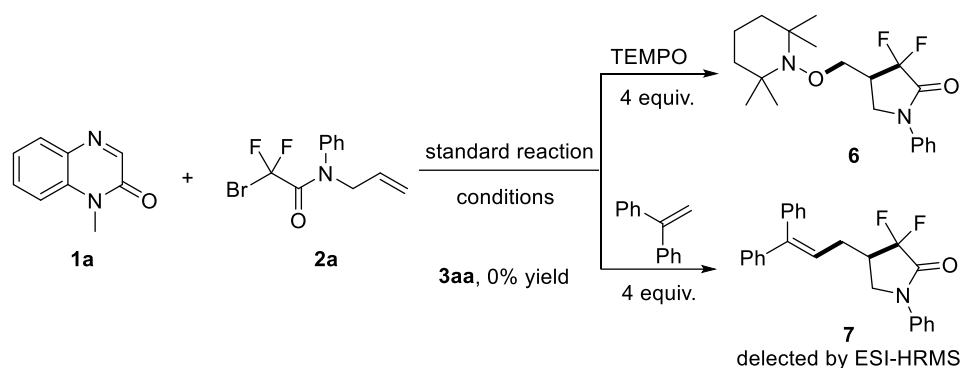
4.2 Sunlight driven experiment



A mixture of quinoxalin-2(1*H*)-one **1a** (0.1 mmol), *N*-allylbromodifluoroacetamide **2a** (0.2 mmol, 2.0 equiv.), LiOH (0.1 mmol, 1.0 equiv.), PMDETA (0.2 mmol, 2.0 equiv.), and CH₃CN (1 mL) was degassed by three cycles of freeze-pump-thaw. The resulting mixture was stirred upon sunlight irradiation under nitrogen atmosphere for 24 h (as an on/off visible light irradiation experiment, the reaction solution was kept in dark place at night). After completion of the reaction, the crude mixture was purified by flash chromatography (petroleum ether/ethyl acetate) to afford the pure product **3aa** (0.023 g, 0.064 mmol, 64%).

5. Mechanistic Experiments

5.1 Radical Inhibition Experiments



To an oven-dried quartz vial, quinoxalin-2(1H)-one **1a** (0.1 mmol, 1.0 equiv.), TEMPO (4.0 equiv.), PMDETA (0.2 mmol, 2.0 equiv.), and LiOH (0.1 mmol, 1.0 equiv.) were added sequentially. The vial was charged with a stir bar and transferred to a glovebox, where the solids were backfilled with an inert atmosphere. In the glovebox, *N*-allylbromodifluoroacetamide **2a** (0.2 mmol, 2.0 equiv.) was added into the vial, followed by CH₃CN (1.0 mL). The vial was sealed with a rubber plug, removed from the glove box, and irradiated and stir by 24 W 460 nm LEDs at room temperature for 36 h. HRMS (DART-TOF): compound **6** calculated for C₂₁H₃₅N₂O₂⁺ [M+H]⁺ m/z 347.2699, found 347.2705

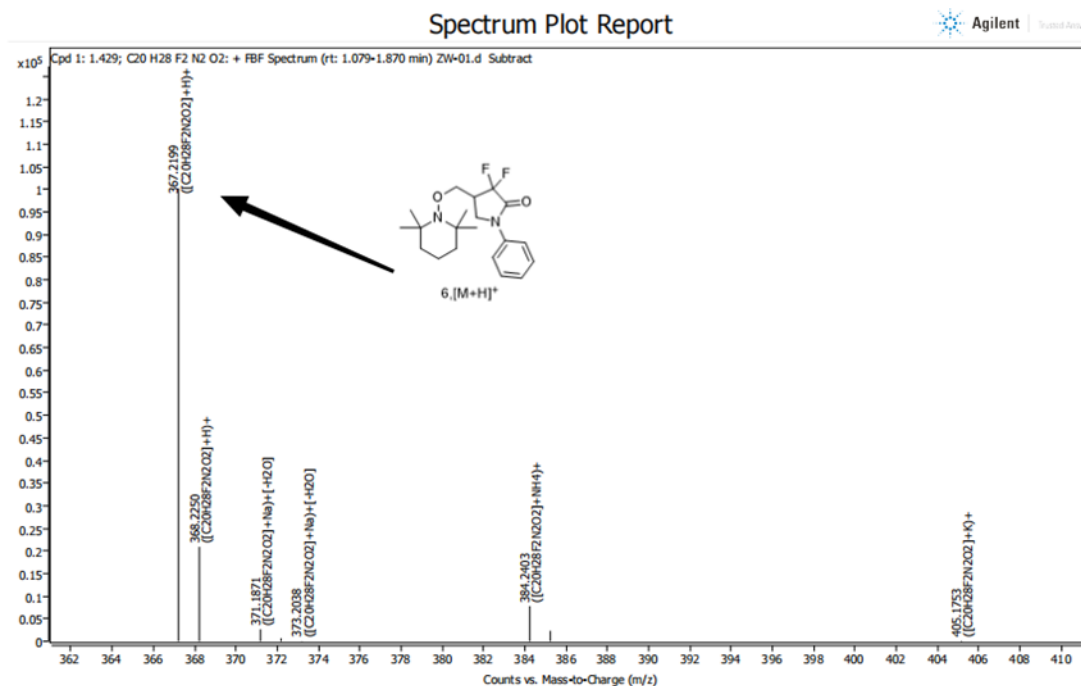


Figure S3 Quinoxalin-2(1H)-one **1a** and *N*-allylbromodifluoroacetamide **2a** under standard conditions with TEMPO (4.0 equiv.)

To an oven-dried quartz vial, quinoxalin-2(1*H*)-one **1a** (0.1 mmol, 1.0 equiv.), ethene-1,1-diyl dibenzene (4 equiv.), PMDETA (0.2 mmol, 2.0 equiv.), and LiOH (0.1 mmol, 1.0 equiv.) were added sequentially. The vial was charged with a stir bar and transferred to a glovebox, where the solids were backfilled with an inert atmosphere. In the glovebox, *N*-allylbromodifluoroacetamide **2a** (0.2 mmol, 2.0 equiv.) was added into the vial, followed by CH₃CN (1.0 mL). The vial was sealed with a rubber plug, removed from the glove box, and irradiated and stir by 24 W 460 nm LEDs at room temperature for 36 h. **HRMS (DART-TOF)**: compound **7** calculated for C₂₅H₂₂F₂NO⁺ [M+H]⁺ *m/z* 390.1664, found 390.1665.

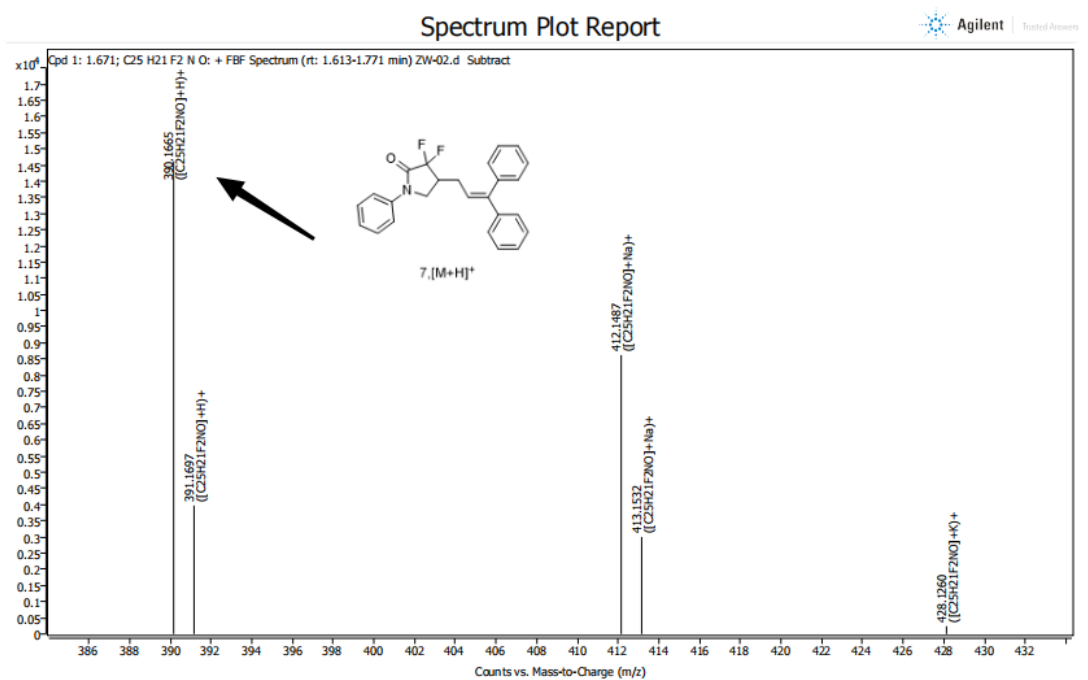


Figure S4 Quinoxalin-2(1*H*)-one **1a** and *N*-allylbromodifluoroacetamide **2a** under standard conditions with ethene-1,1-diyl dibenzene (4.0 equiv.)

5.3 UV-vis absorption spectrometry

UV-vis absorption spectra of **1a** (0.05 M), **2a** (0.05 M), PMDETA, **1a+2a**, **1a+PMDETA**, **2a+PMDETA** in 3 mL CH₃CN were recorded in 1 cm path quartz cuvettes using a Shimadzu UV-1900i UV-vis spectrometer

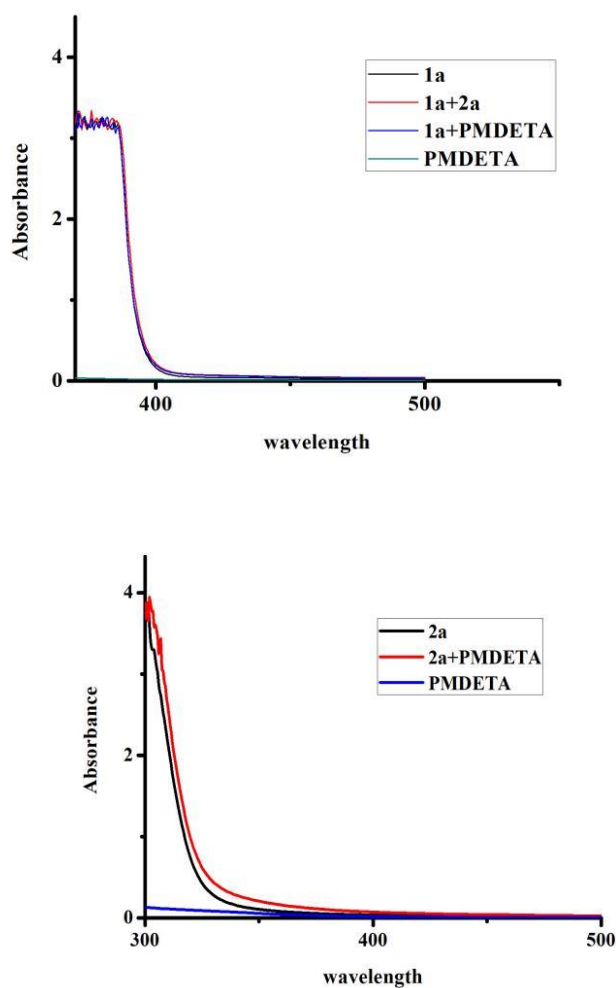


Figure S5 UV-vis absorption spectra

5.4 ^{19}F NMR Titration Experiments

Solutions containing equal molar concentrations of the *N*-allylbromodifluoroacetamide **2a** (0.05 M in CH_3CN) and PMDETA (0.05 M in CH_3CN) were prepared and mixed to cover the ratio of **2a** from 100% to 20%. In NMR titration experiments, we observed ^{19}F NMR (376 MHz) signal of **2a** shifted with the addition of PMDETA, while ^{19}F NMR signal didn't shift only with concentration change of **2a** without the addition of PMDETA.

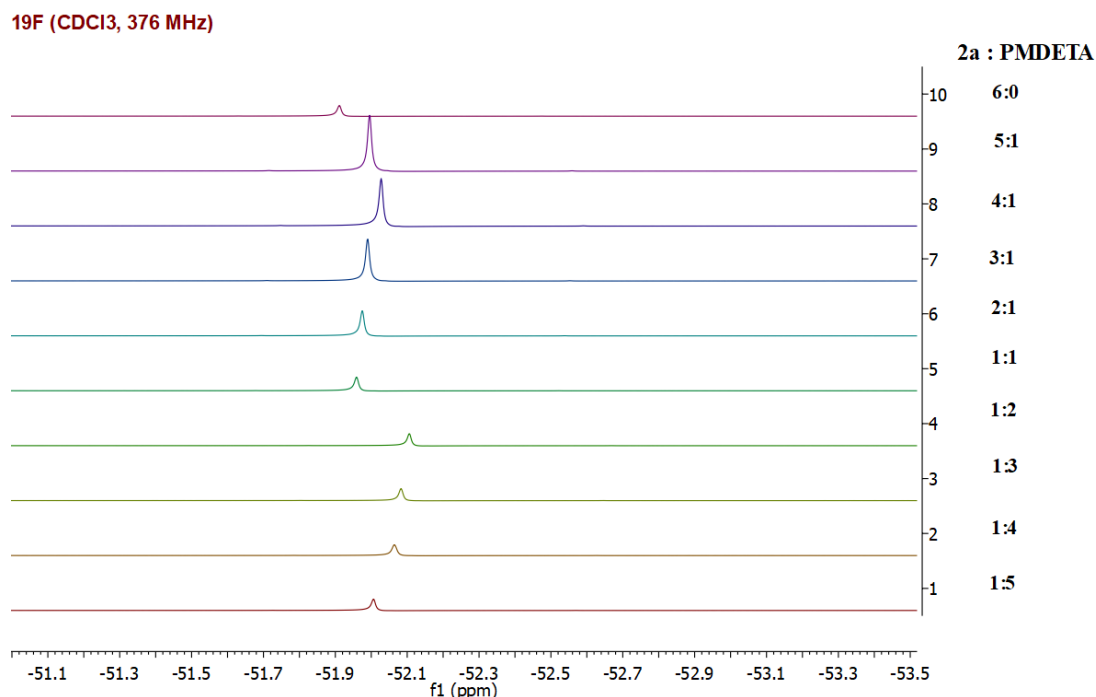


Figure S6 ^{19}F NMR titration between **2a** and PMDETA

5.5 Time profile of the transformation with the light ON/OFF over time

The standard reaction was set up on a 0.20 mmol scale according to the general procedure. After being irradiated for 6 h, an aliquot (100 μL) from the reaction mixture was transferred into a nuclear magnetic tube charged with 0.55 mL of CDCl_3-d_1 . The yield of product was determined by ^1H NMR. Then the reaction mixture was stirred for 6 h with light-off. All of the following yields were analyzed in the identical way after a 6 h light on or off.

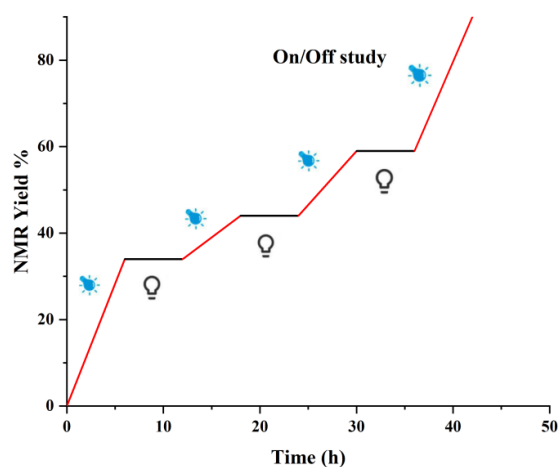


Figure S7 Time profile of the transformation with the light ON/OFF over time

6. X-Ray Structure of Product 3ap

X-ray crystallography of **3ap**

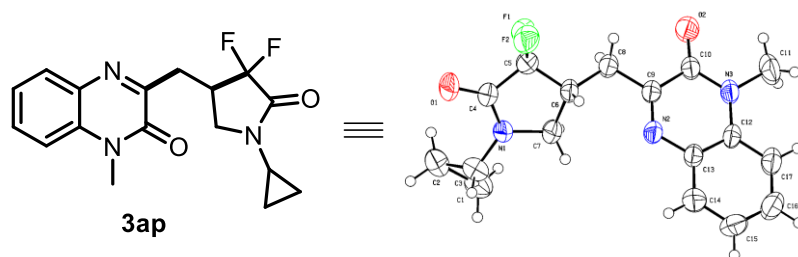


Figure S8 ORTEP diagram (50% probability) of **3ap**

A single crystal of **3ap** was obtained *via* evaporation of its hexanes/dichloromethane solvent mixture. A suitable crystal of **3ap** was selected and analyzed by an Agilent Gemini X-ray Single Crystal Diffractometer. Using Olex2⁵, the structure was solved with the ShelXT⁴ structure solution program using Direct Methods and refined with the ShelXL⁶ refinement package using Least Squares minimization. Details of the crystal, data collection, and structure refinement parameters for crystallographic analysis of **3ap** are summarized in **Table S5**. Crystallographic data (CCDC 2219240) for **3ap** can be obtained free of charge from the Cambridge Crystallographic Data Centre via www.ccdc.cam.ac.uk/data_request/cif.

Table S5. Parameters for crystallographic analysis of **3ap**

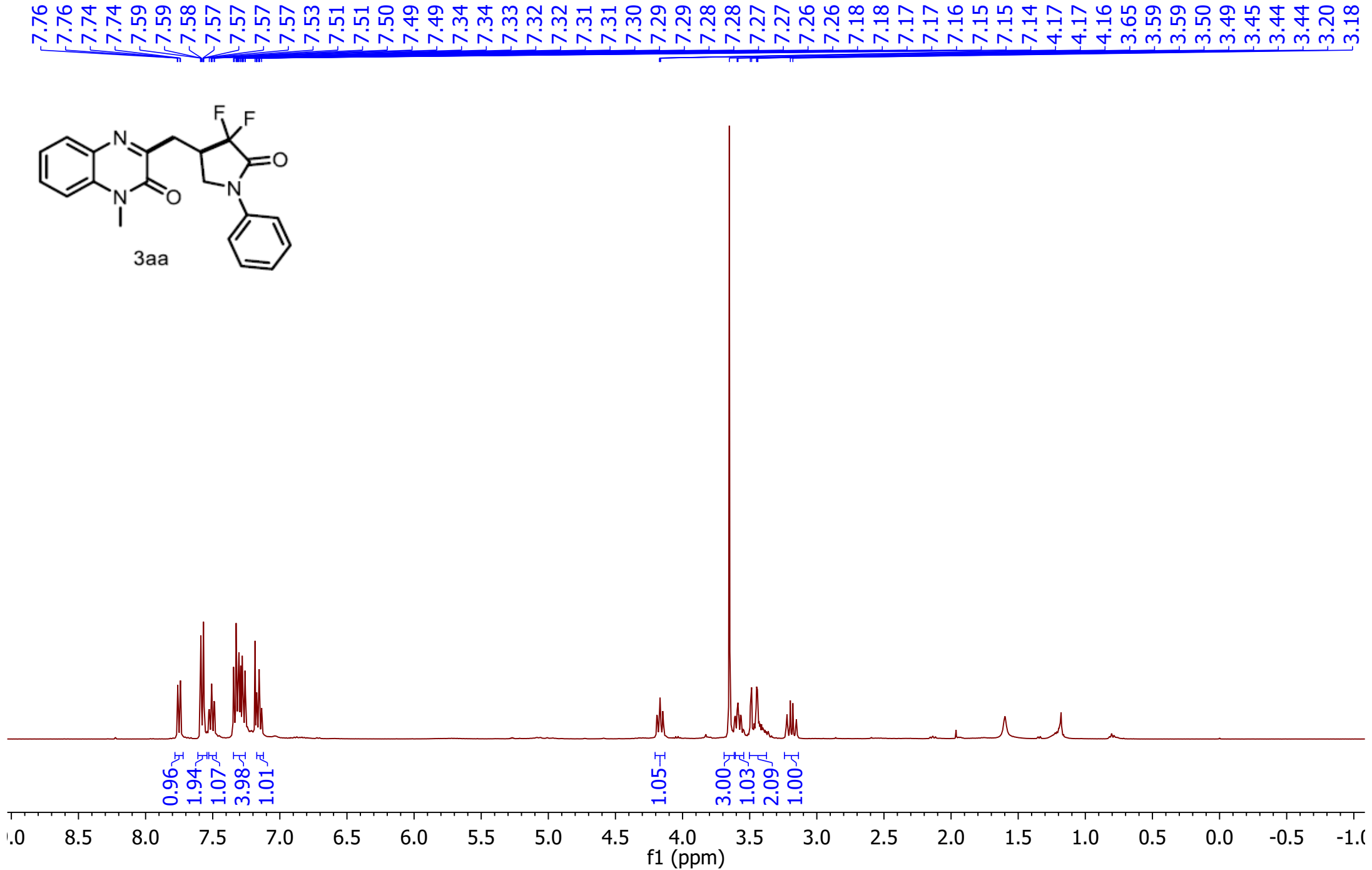
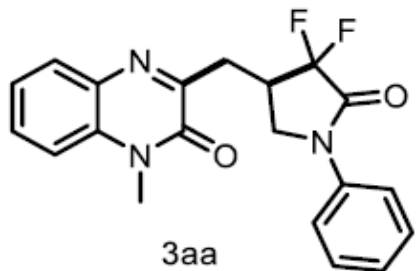
Identification code	1_a
Empirical formula	C ₁₇ H ₁₇ F ₂ N ₃ O ₂
Formula weight	333.33
Temperature	296(2) K
Wavelength	0.71073 Å
Crystal system	Triclinic
Space group	P-1
Unit cell dimensions	a = 7.850(2) Å α = 108.912(7)° b = 10.152(3) Å β = 101.164(6)° c = 10.835(3) Å γ = 96.073(6)°
Volume	788.1(4) Å ³
Z	2
Density (calculated)	1.405 Mg/m ³
Absorption coefficient	0.110 mm ⁻¹
F(000)	348
Crystal size	0.200 x 0.200 x 0.200 mm ³
Theta range for data collection	2.393 to 24.996°.
Index ranges	-9<=h<=9, -12<=k<=11, -12<=l<=12
Reflections collected	20998

Independent reflections	2755 [R(int) = 0.0880]
Completeness to theta = 24.996°	99.3 %
Absorption correction	Semi-empirical from equivalents
Refinement method	Full-matrix least-squares on F ²
Data / restraints / parameters	2755 / 0 / 206
Goodness-of-fit on F ²	1.002
Final R indices [I>2sigma(I)]	R1 = 0.0690, wR2 = 0.1770
R indices (all data)	R1 = 0.1407, wR2 = 0.2173
Extinction coefficient	n/a
Largest diff. peak and hole	0.237 and -0.246 e.Å ⁻³

7. References

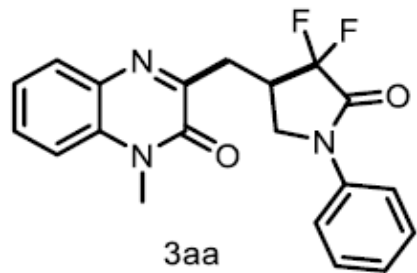
1. Ghosh, P.; Kwon, N. Y.; Kim, S.; Han, S.; Lee, S. H.; An, W.; Mishra, N. K.; Han, S. B.; Kim, I. *S. Angew. Chem., Int. Ed.* **2021**, *60*, 191.
2. Chen, X.-Y.; Li, L.-L.; Pei, C.-C.; Jingya Li, J.-Y.; Zou, D.-P.; Wu, Y.-J.; Wu, Y.-S. *J. Org. Chem.* **2021**, *86*, 2772.
3. (a) Ye, Z.-P.; Liu, F.; Duan, X.-Y.; Gao, J.; Guan, J.-P.; Xiao, J.-A.; Xiang, H.-Y.; Chen, K.; Yang, H. *J. Org. Chem.* **2021**, *86*, 17173. (b) Zhang, Y.-C.; Chen, Y.; Sun, J.; Wang, J.-Y.; Zhou, M.-D. *Chin. J. Chem.* **2022**, *40*, 713.
4. Dolomanov, O. V.; Bourhis, L. J.; Gildea, R. J.; Howard, J. A. K.; Puschmann, H. *J. Appl. Crystallogr.* **2009**, *42*, 339.
5. Sheldrick, G. M. *Acta Crystallogr. Sect. A* **2015**, *71*, 3.
6. Sheldrick, G. M. *Acta Crystallogr. Sect. C* **2015**, *71*, 3.

¹H (CDCl₃, 400 MHz)

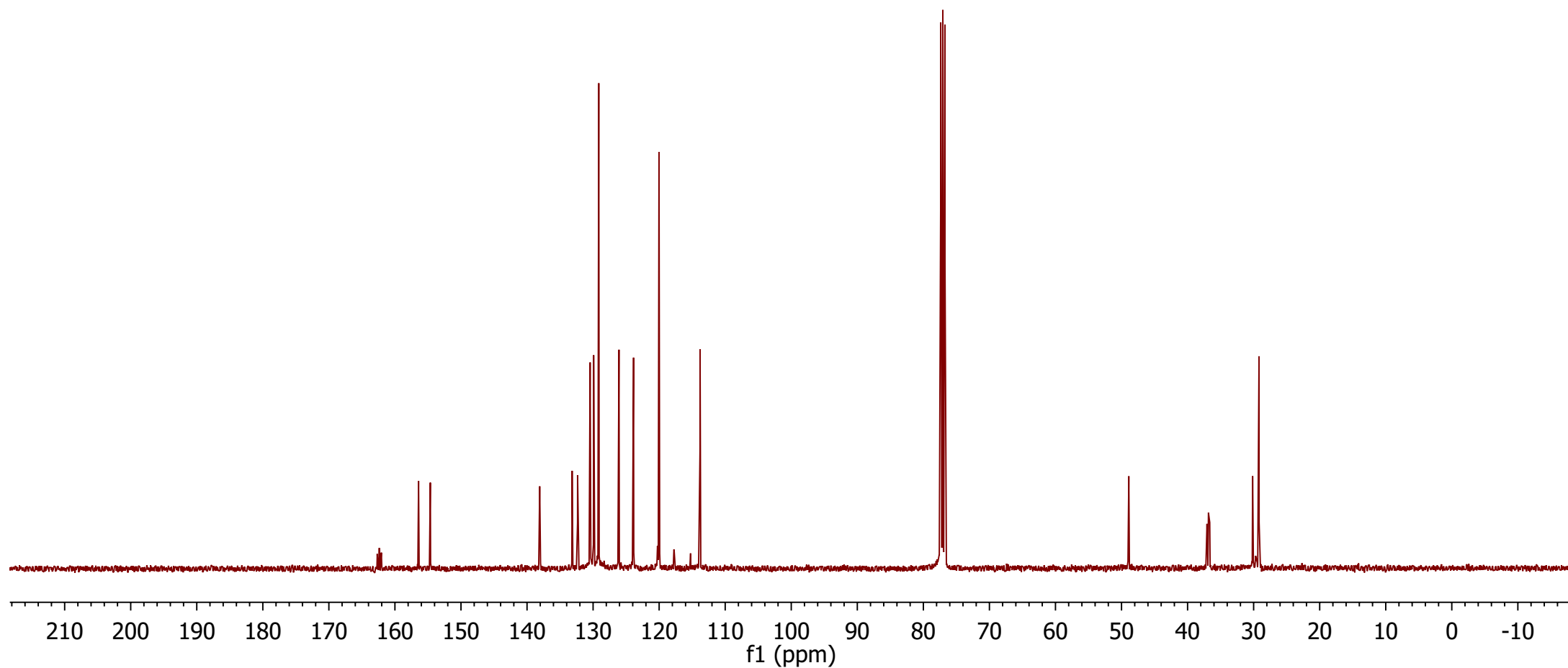


¹H NMR Spectrum of 3aa

¹³C (CDCl₃, 101 MHz)

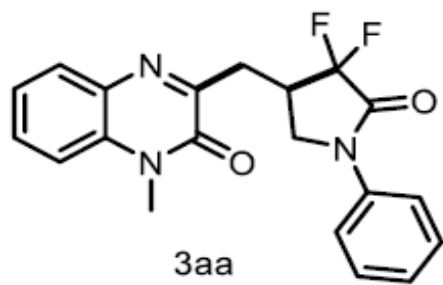


162.7
162.4
162.1
156.4
154.6
138.1
133.2
132.3
130.4
130.0
129.9
129.1
126.1
123.9
120.3
120.0
117.8
117.7
115.2
113.8
77.4
77.3
77.1
76.8
76.7
49.0
48.9
37.1
36.9
36.8
36.6
30.2
30.1
29.7
29.2

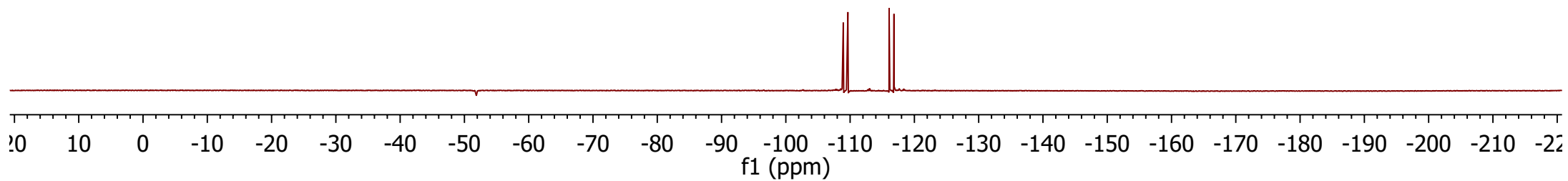


¹³C NMR Spectrum of 3aa

¹⁹F (CDCl₃, 376 MHz)



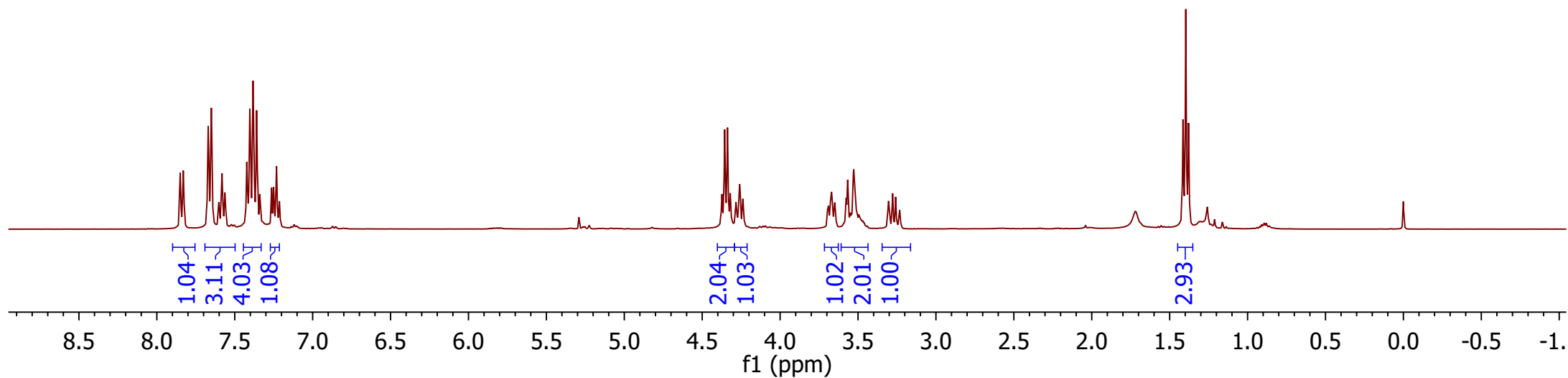
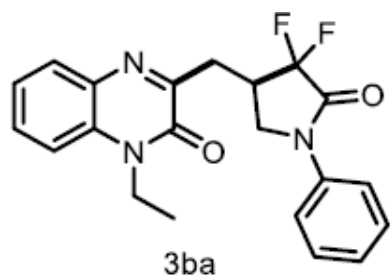
-108.94
-108.97
-109.65
-109.69
-116.07
-116.12
-116.78
-116.83



¹⁹F NMR Spectrum of 3aa

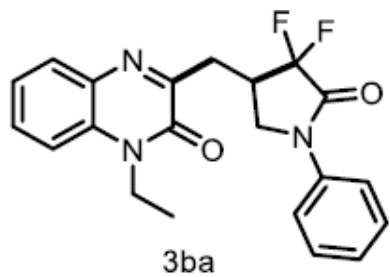
¹H (CDCl₃, 400 MHz)

7.85 7.85 7.83 7.83 7.67 7.65 7.59 7.58 7.56 7.56 7.42 7.40 7.38 7.38 7.36 7.34 7.26 7.25 7.23 7.21 4.37 4.36 4.34 4.32 4.26 4.26 4.24 3.69 3.69 3.68 3.67 3.66 3.65 3.65 3.58 3.57 3.55 3.53 3.52 3.51 3.50 3.49 3.49 3.31 3.30 3.28 3.26 3.23 1.41 1.40 1.38



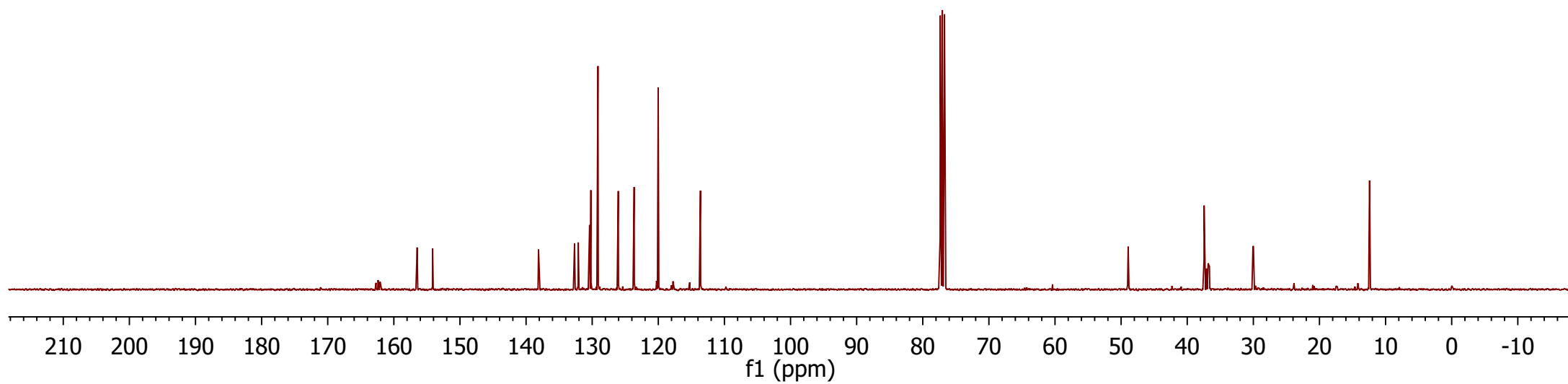
¹H NMR Spectrum of **3ba**

¹³C (CDCl₃, 101 MHz)



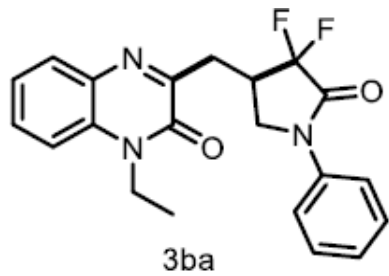
162.7
162.4
162.1
156.5
154.1
138.1
132.7
132.1
130.4
130.2
129.1
126.1
123.7
120.3
120.0
117.8
117.7
115.3
113.6

49.0
48.9
37.4
37.1
36.9
36.8
36.6
30.1
30.0
12.4

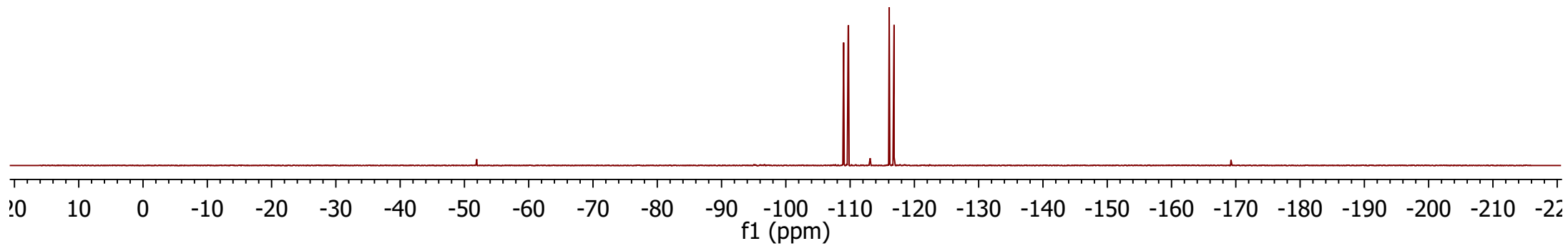


¹³C NMR Spectrum of **3ba**

¹⁹F (CDCl₃, 376 MHz)



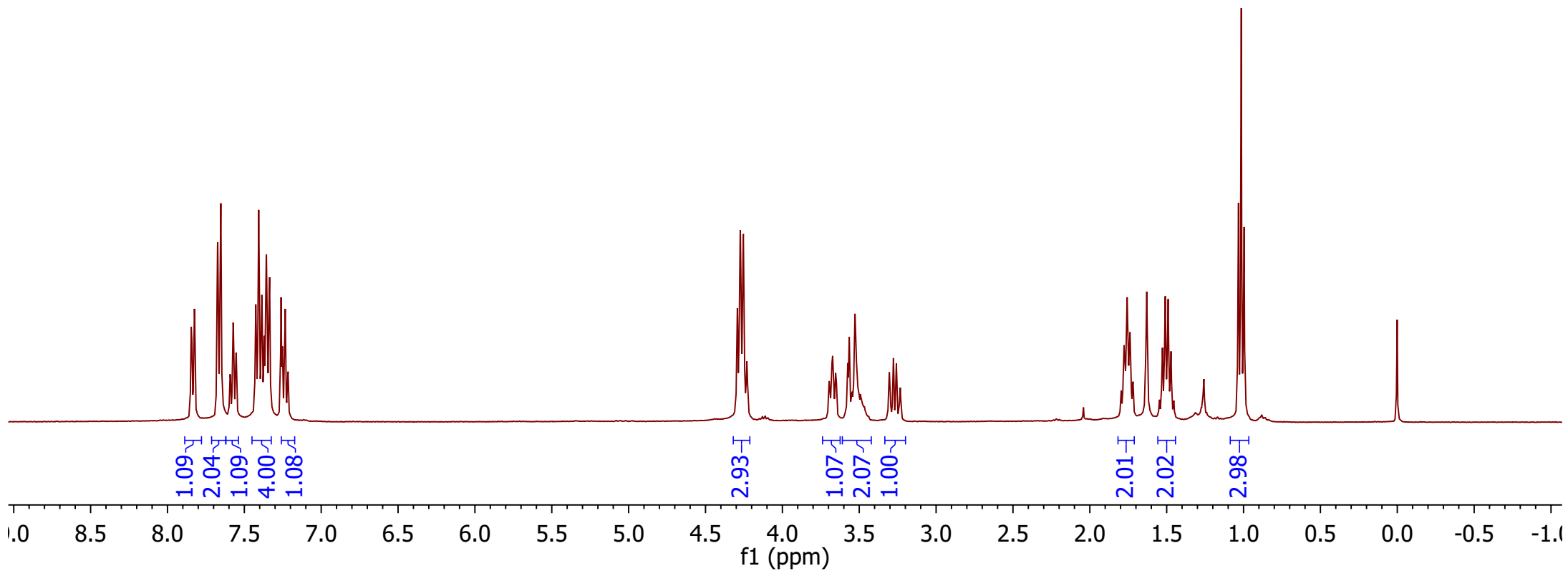
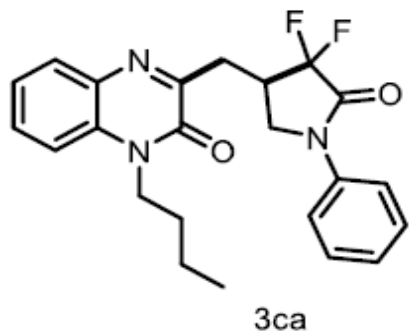
-108.99
-109.03
-109.70
-109.74
-116.08
-116.13
-116.79
-116.84



¹⁹F NMR Spectrum of 3ba

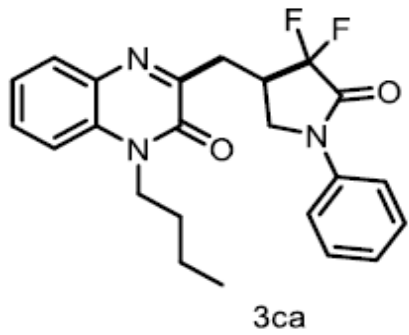
¹H (CDCl₃, 400 MHz)

7.85
7.84
7.82
7.82
7.68
7.67
7.65
7.59
7.57
7.55
7.55
7.43
7.41
7.39
7.39
7.37
7.36
7.36
7.35
7.34
7.33
7.26
7.25
7.23
7.22
4.29
4.27
4.25
4.23
3.68
3.67
3.65
3.57
3.57
3.53
3.52
3.31
3.28
3.26
1.78
1.77
1.76
1.76
1.75
1.74
1.73
1.63
1.53
1.51
1.49
1.47
1.03
1.01
1.00



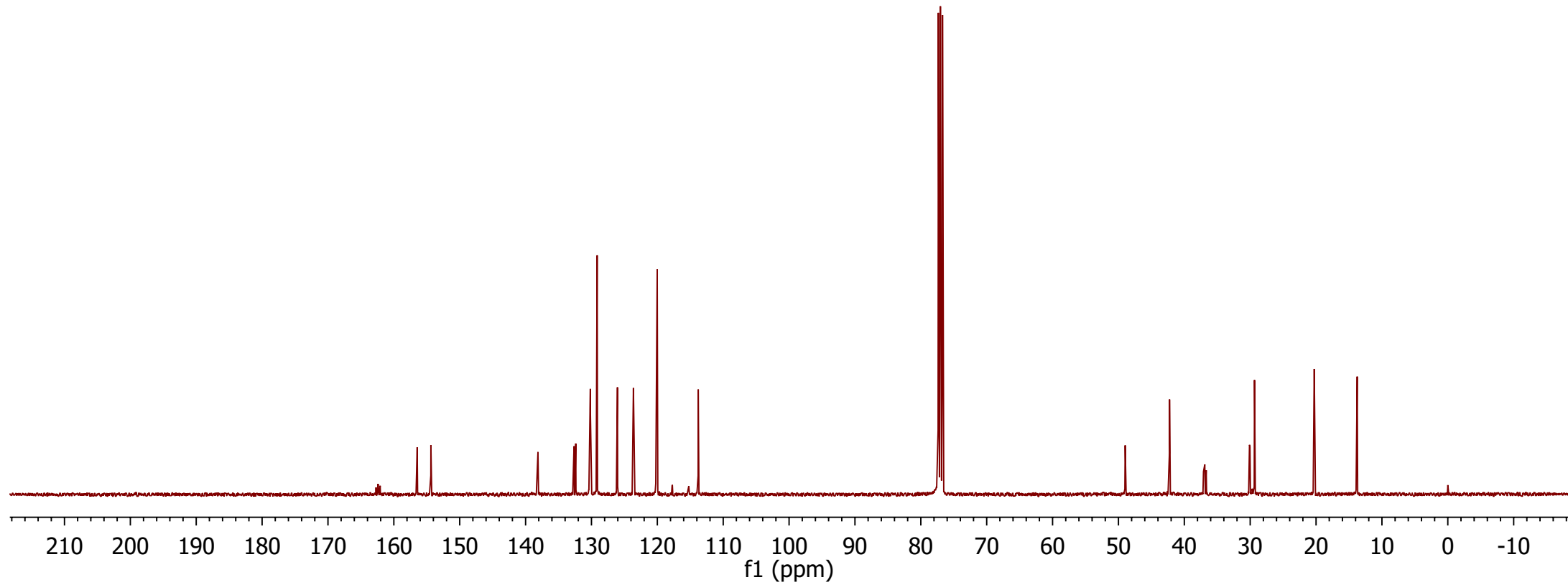
¹H NMR Spectrum of **3ca**

¹³C (CDCl₃, 101 MHz)



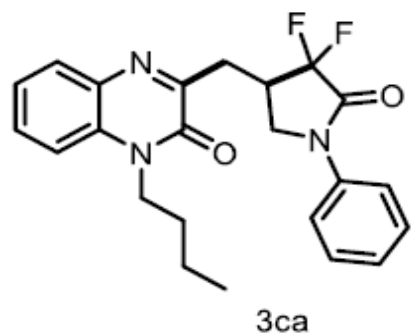
162.7
162.4
162.1
156.5
154.4
138.1
132.6
132.4
130.3
130.2
129.2
129.1
126.1
123.6
120.2
120.0
117.8
117.7
115.2
113.8

49.0
48.9
42.2
37.1
36.9
36.9
36.7
30.1
30.0
29.3
20.3
13.8

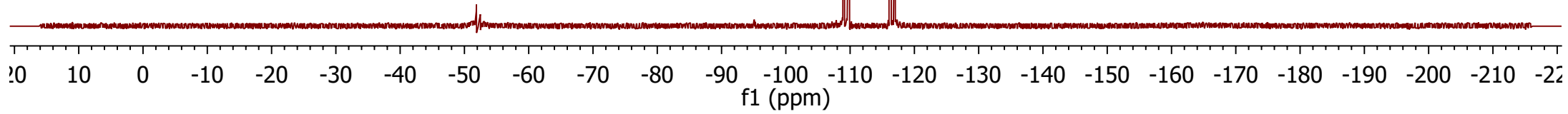


¹³C NMR Spectrum of 3ca

¹⁹F (CDCl₃, 376 MHz)



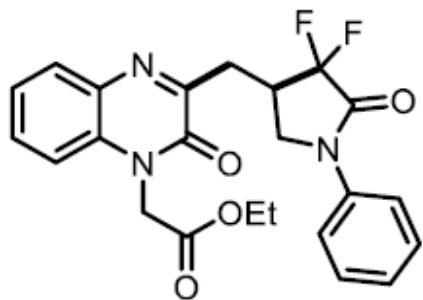
-109.03
-109.07
-109.74
-109.78
-116.15
-116.20
-116.86
-116.91



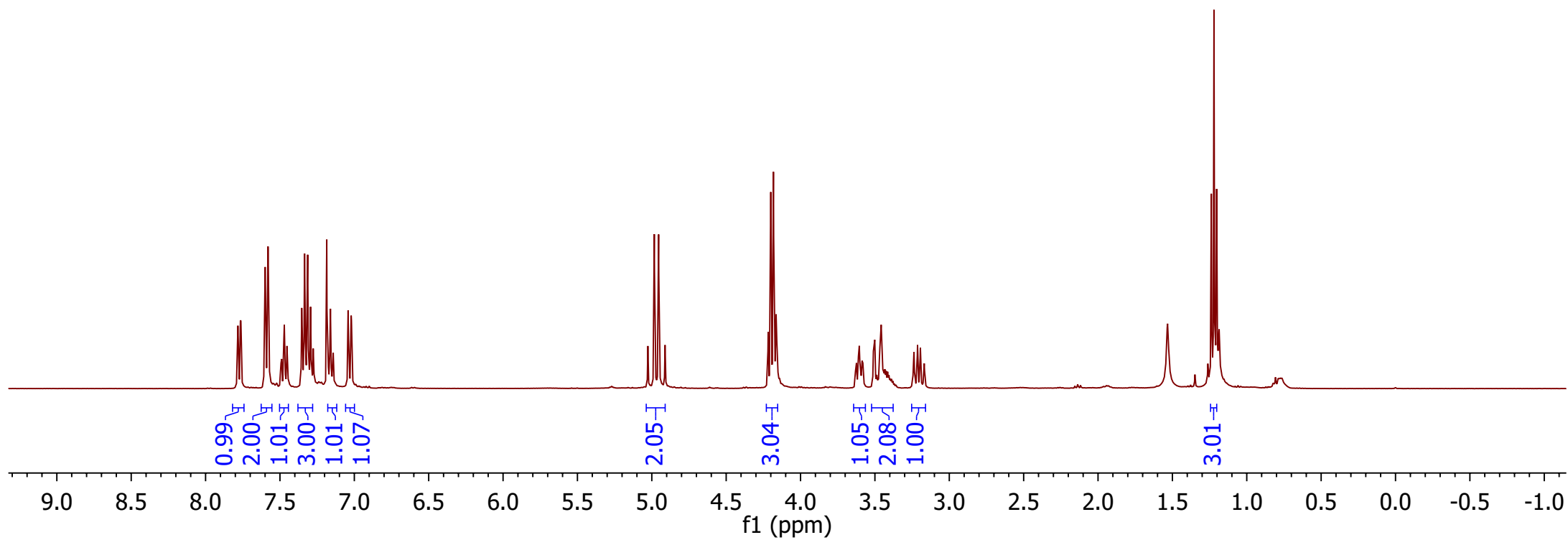
¹⁹F NMR Spectrum of 3ca

¹H (CDCl₃, 400 MHz)

7.79 7.78 7.77 7.76 7.60 7.60 7.59 7.59 7.58 7.58 7.58 7.47 7.47 7.47 7.45 7.45 7.35 7.34 7.33 7.31 7.30 7.29 7.29 7.28 7.27 7.19 7.18 7.18 7.16 7.16 7.04 7.04 7.02 7.02 5.03 4.98 4.95 4.91 4.22 4.20 4.18 4.18 4.16 4.16 4.16 3.60 3.51 3.50 3.47 3.46 3.46 3.24 3.21 3.19

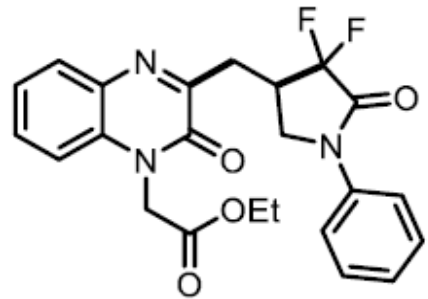


3da



¹H NMR Spectrum of 3da

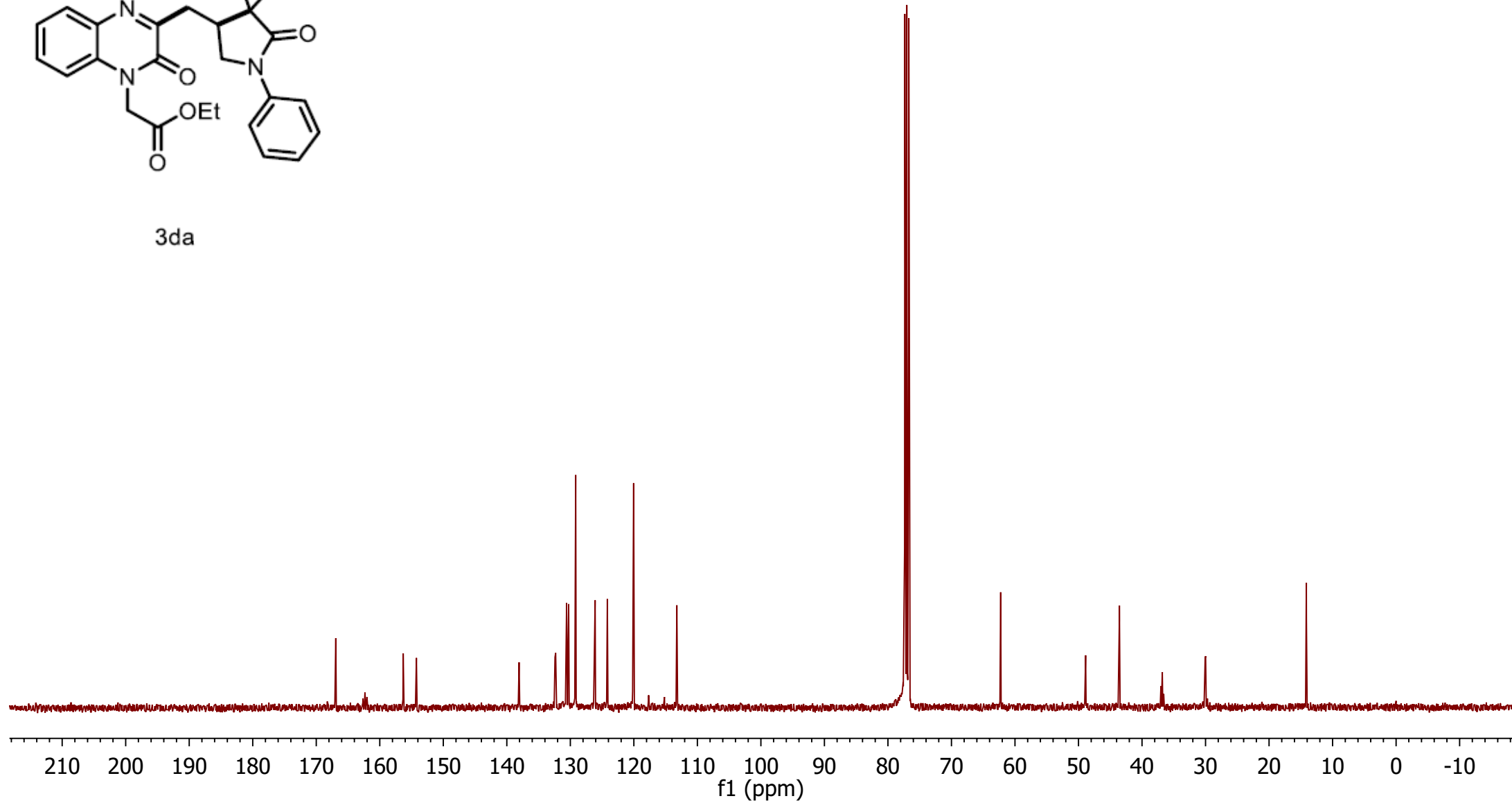
¹³C (CDCl₃, 101 MHz)



3da

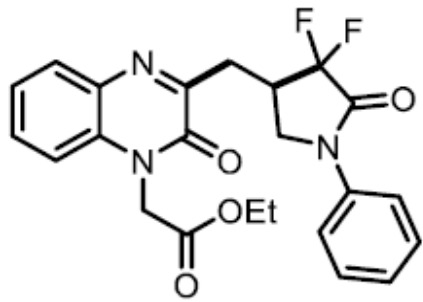
166.9
162.6
162.3
162.0
156.3
154.2
138.1
132.4
132.3
130.6
130.3
129.2
126.1
124.2
120.2
120.0
117.7
117.7
115.2
113.2

-62.3
48.9
48.9
43.6
37.0
36.8
36.6
30.1
30.0
-14.1



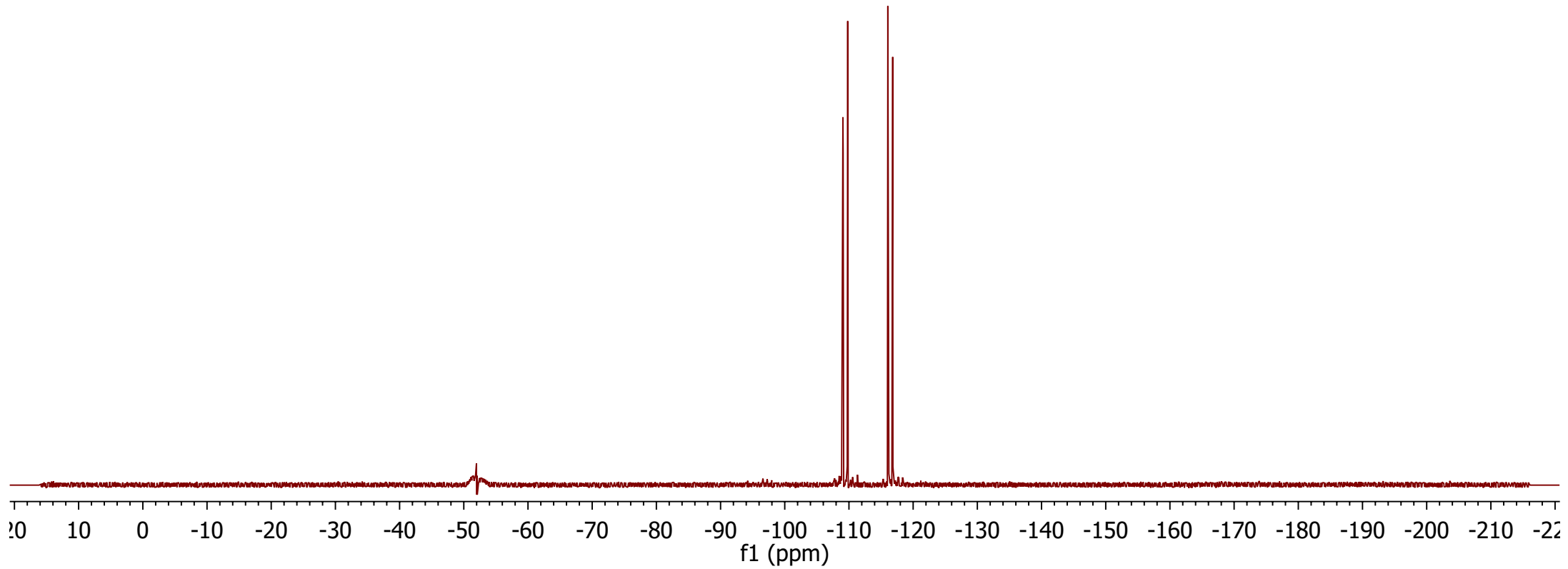
¹³C NMR Spectrum of **3da**

¹⁹F (CDCl₃, 376 MHz)



3da

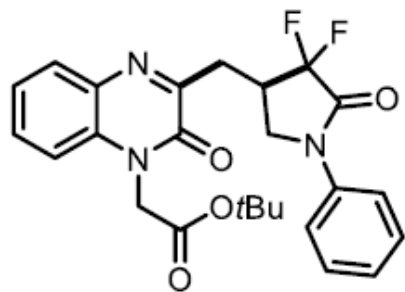
-109.06
-109.10
-109.77
-109.81
-116.06
-116.11
-116.77
-116.82



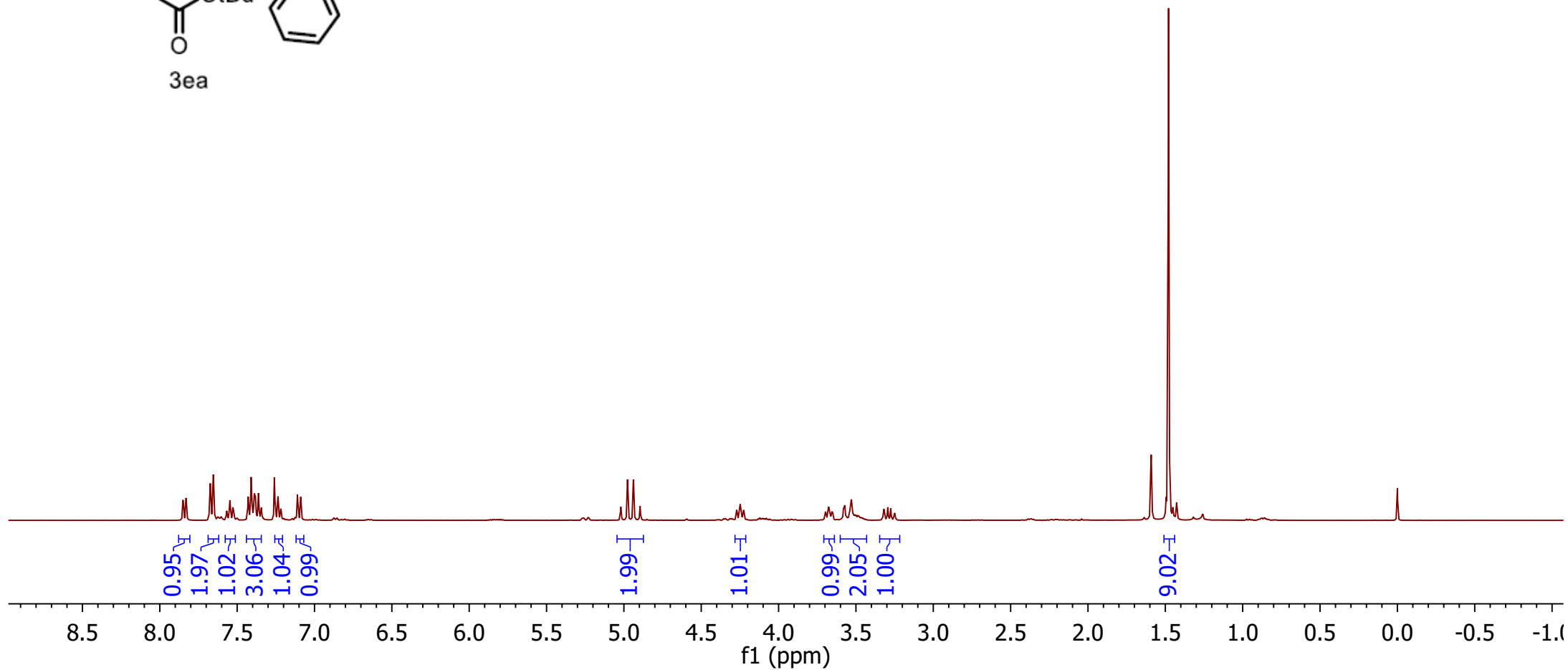
¹⁹F NMR Spectrum of 3da

¹H (CDCl₃, 400 MHz)

7.85 7.85 7.83 7.83 7.68 7.67 7.66 7.65 7.65 7.57 7.55 7.55 7.54 7.53 7.52 7.43 7.42 7.41 7.39 7.38 7.38 7.36 7.36 7.34 7.34 7.26 7.25 7.24 7.22 7.22 7.11 7.09 5.02 4.98 4.94 4.90 4.27 4.27 4.25 4.25 4.24 4.23 3.68 3.68 3.66 3.58 3.57 3.54 3.53 3.53 3.32 3.29 3.28 1.48

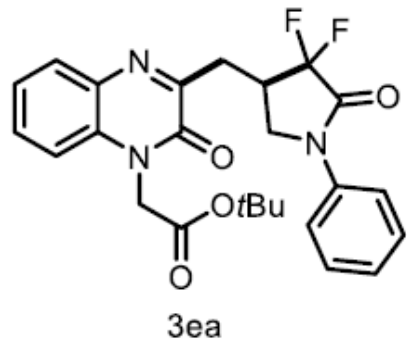


3ea



¹H NMR Spectrum of 3ea

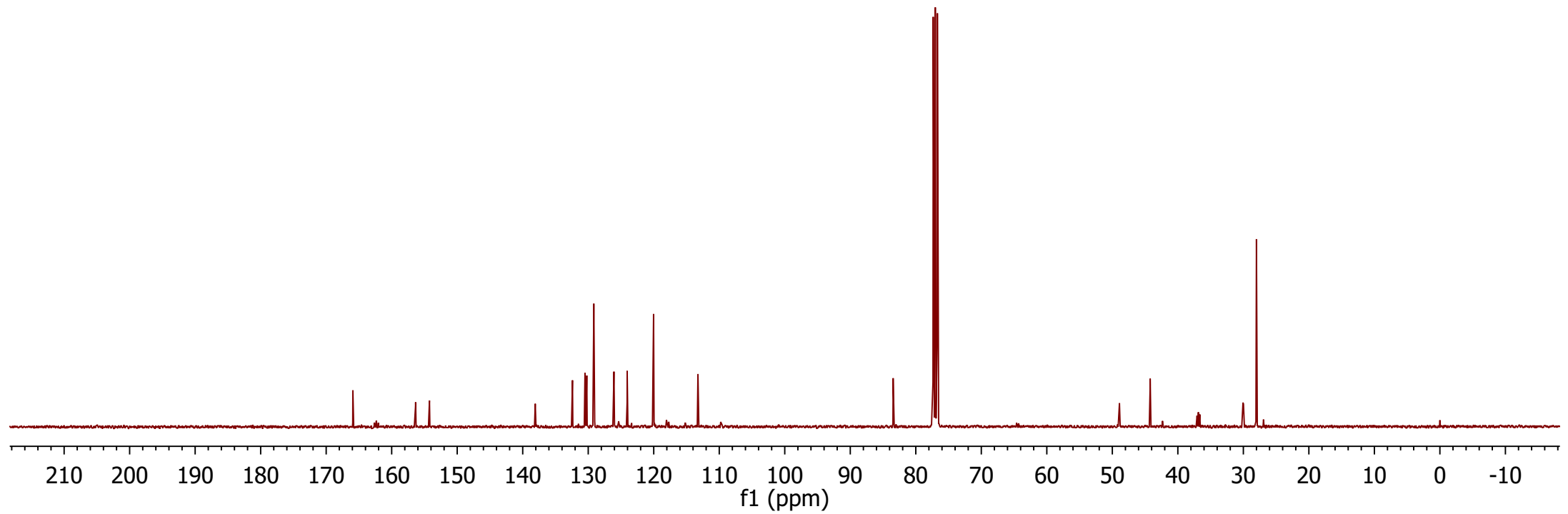
¹³C (CDCl₃, 101 MHz)



165.9
162.7
162.3
162.0
156.3
154.2
138.1
132.4
130.5
130.2
129.1
129.1
126.1
124.1
120.0
113.3

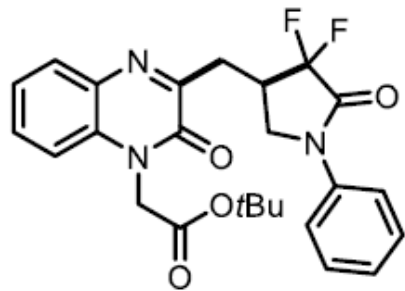
—83.5

48.9
48.9
44.2
37.1
36.9
36.7
30.1
30.0
28.0



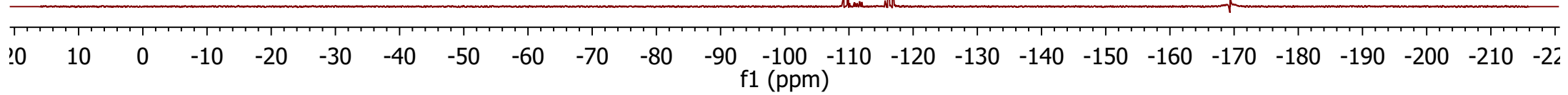
¹³C NMR Spectrum of 3ea

19F (CDCl3, 376 MHz)



3ea

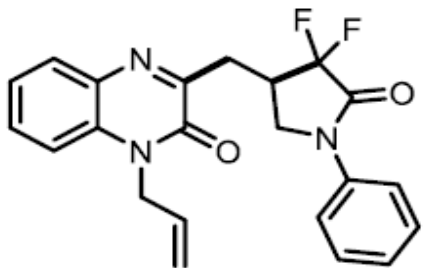
-109.09
-109.12
-109.80
-109.83
-116.08
-116.13
-116.79
-116.84



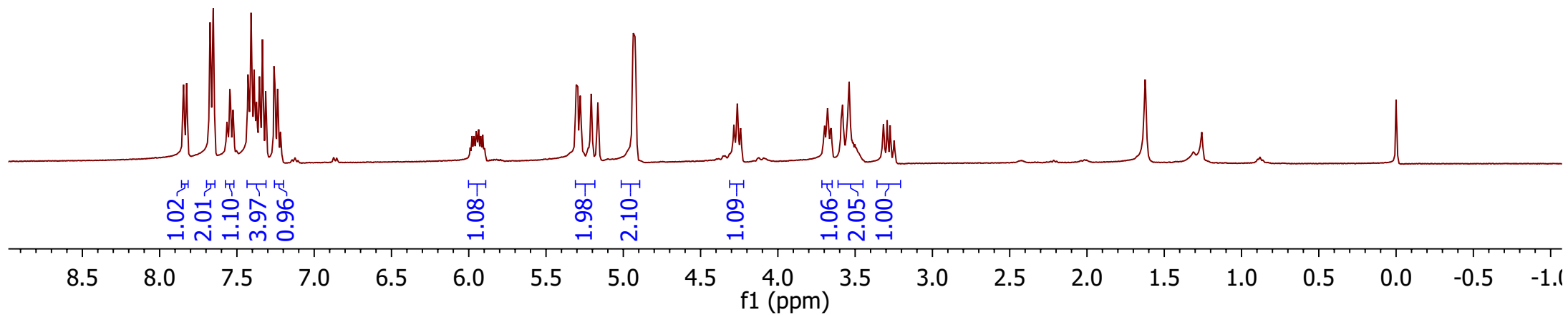
¹⁹F NMR Spectrum of 3ea

¹H (CDCl₃, 400 MHz)

7.85 7.83 7.67 7.67 7.65 7.56 7.55 7.53 7.43 7.42 7.41 7.39 7.38 7.37 7.35 7.33 7.31 7.26 7.25 7.24 7.22 5.98 5.97 5.95 5.95 5.94 5.92 5.91 5.30 5.29 5.29 5.28 5.21 5.16 4.94 4.92 4.28 4.26 4.24 3.70 3.70 3.68 3.68 3.67 3.66 3.65 3.59 3.58 3.57 3.56 3.54 3.32 3.29 3.27

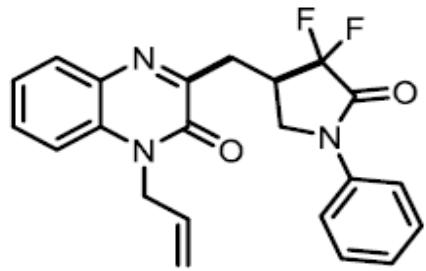


3fa



¹H NMR Spectrum of **3fa**

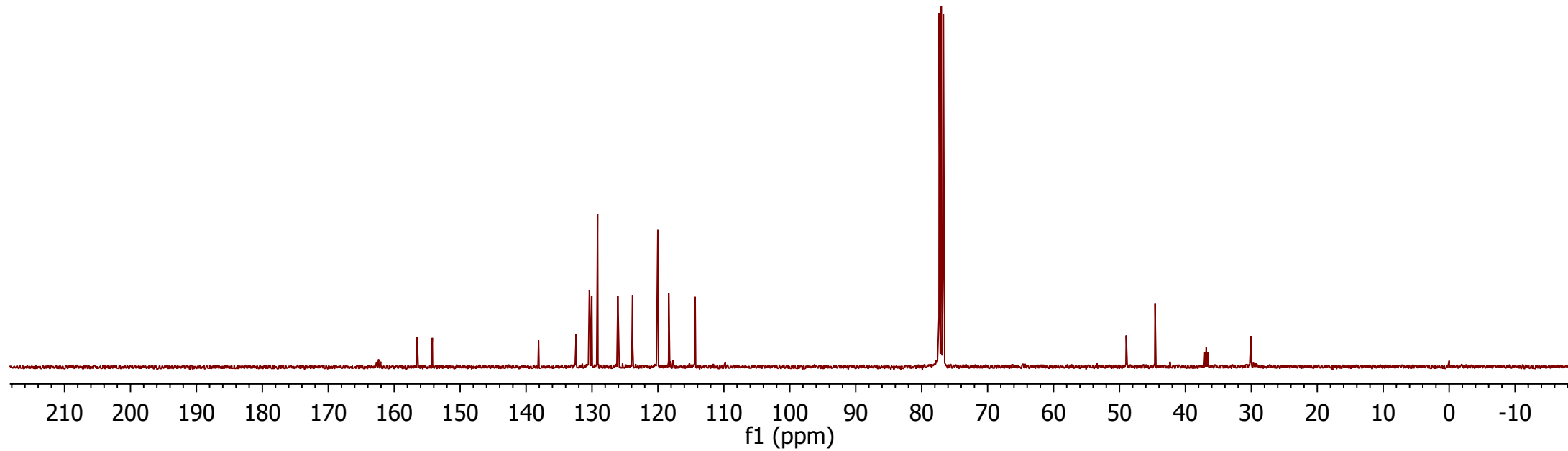
¹³C (CDCl₃, 101 MHz)



3fa

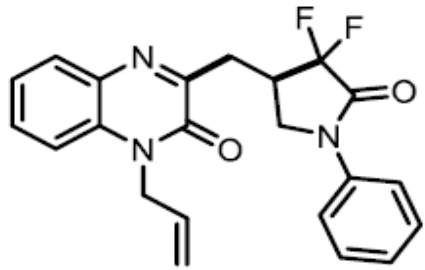
162.7
162.4
162.1
156.5
154.2
138.1
132.5
132.4
130.4
130.3
130.0
129.1
126.1
123.9
120.2
120.0
118.4
117.7
114.3
109.8

49.0
48.9
44.6
37.1
36.9
36.8
36.6
30.1
30.1
29.7

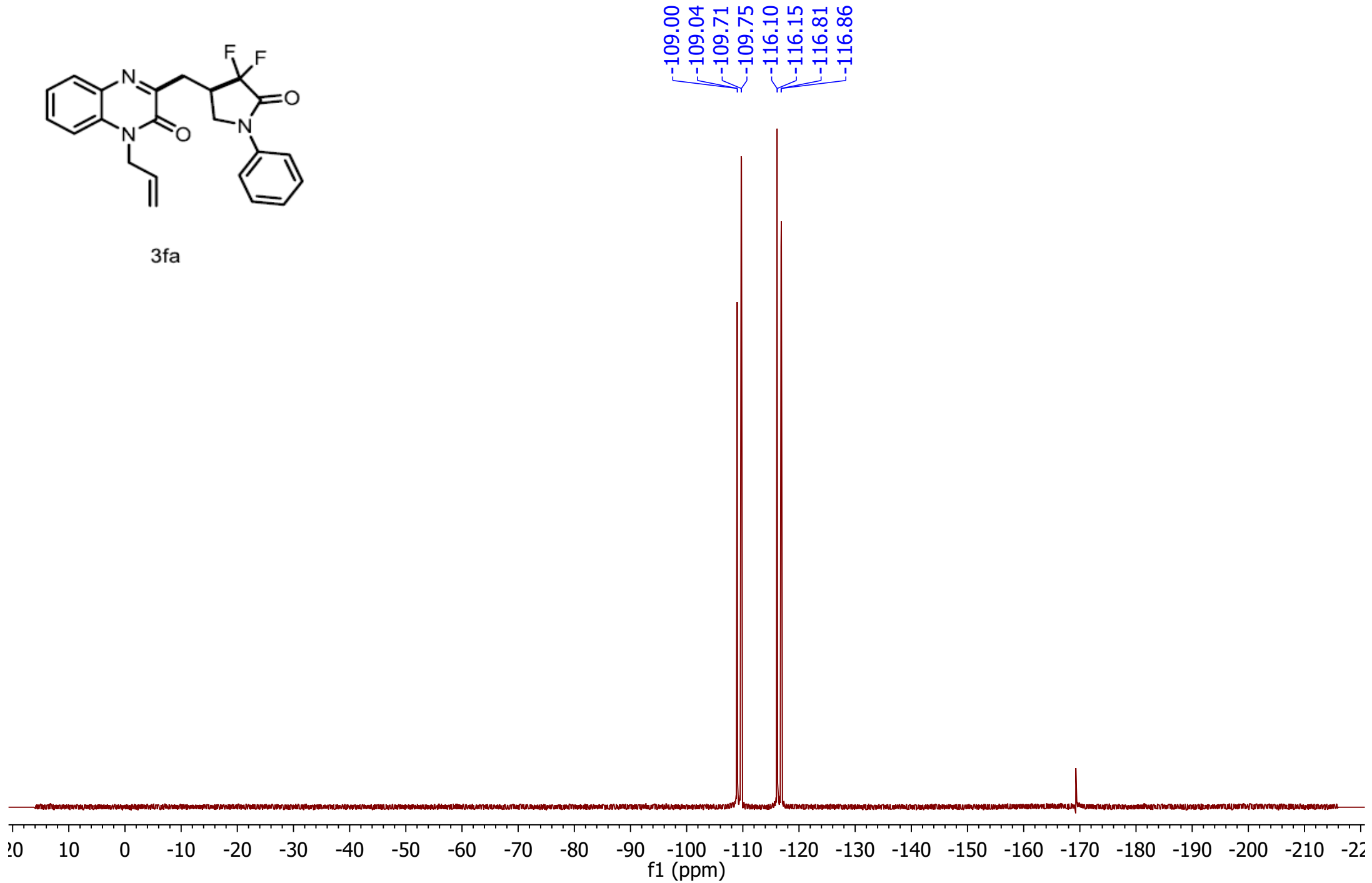


¹³C NMR Spectrum of 3fa

¹⁹F (CDCl₃, 376 MHz)



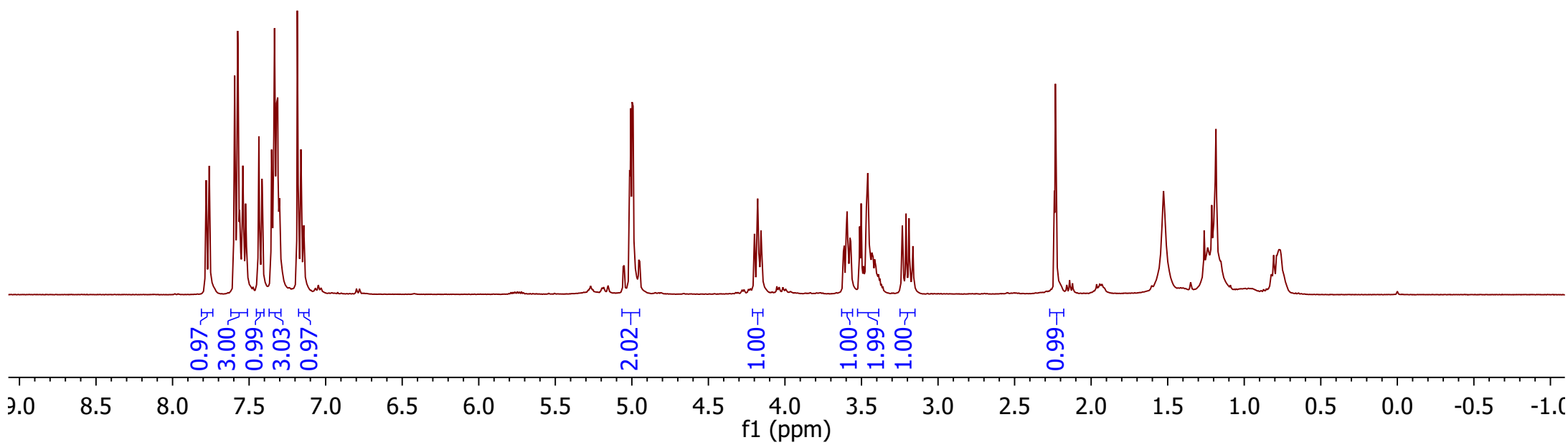
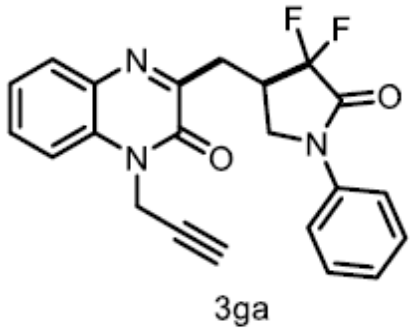
3fa



¹⁹F NMR Spectrum of 3fa

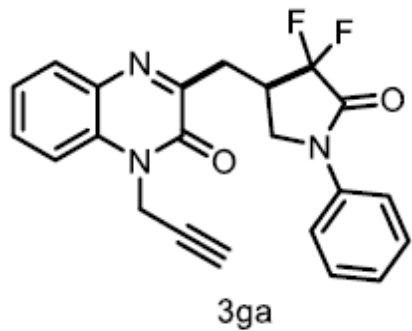
¹H (CDCl₃, 400 MHz)

7.78 7.78 7.76 7.76 7.60 7.59 7.59 7.57 7.56 7.56 7.54 7.54 7.54 7.52 7.52 7.44 7.44 7.42 7.41 7.35 7.35 7.34 7.33 7.33 7.32 7.32 7.31 7.30 7.30 7.19 7.18 7.18 7.16 7.14 5.01 5.01 5.00 4.99 4.99 4.18 4.18 4.17 3.60 3.59 3.51 3.50 3.47 3.46 3.46 3.23 3.21 3.19 2.24 2.23 2.23

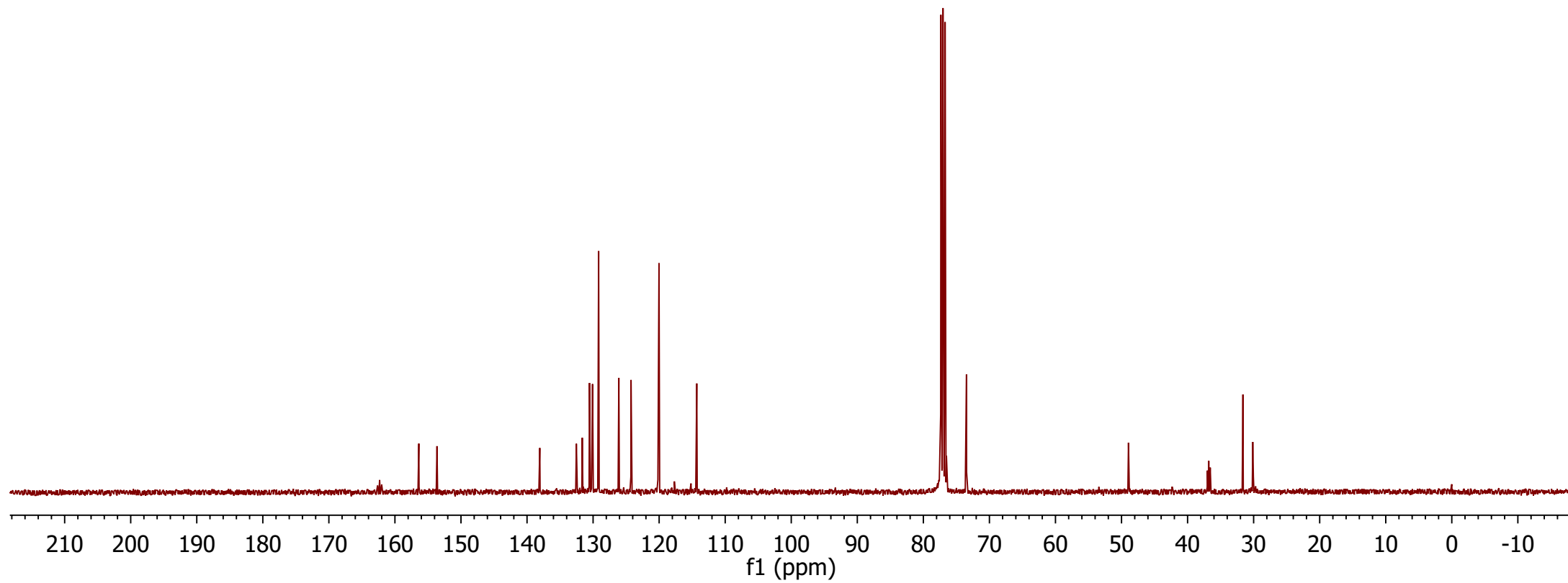


¹H NMR Spectrum of 3ga

¹³C (CDCl₃, 101 MHz)

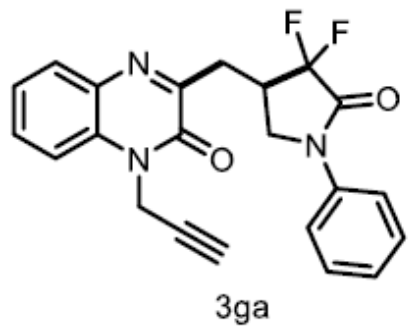


162.6
162.3
162.0
156.4
153.6
138.1
132.5
131.6
130.5
130.1
129.2
126.1
124.3
120.2
120.0
117.7
115.2
114.3
~76.5
~73.5
48.9
48.9
37.0
36.8
36.8
36.6
31.6
30.1
30.1

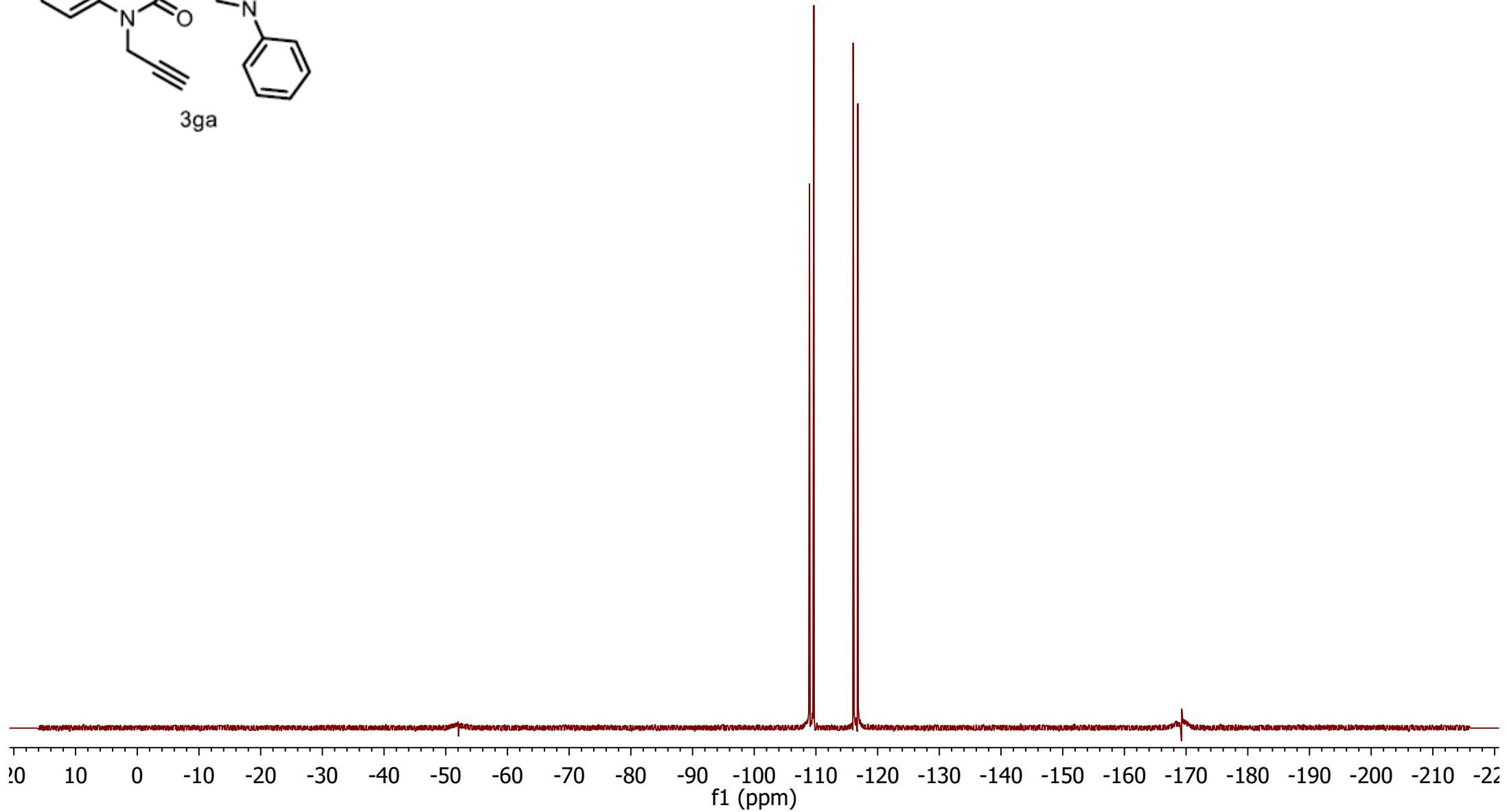


¹³C NMR Spectrum of 3ga

¹⁹F (CDCl₃, 376 MHz)



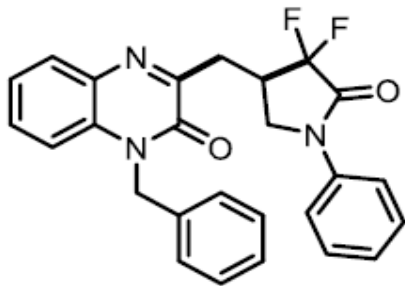
-108.95
-108.99
-109.67
-109.70
-116.03
-116.08
-116.74
-116.79



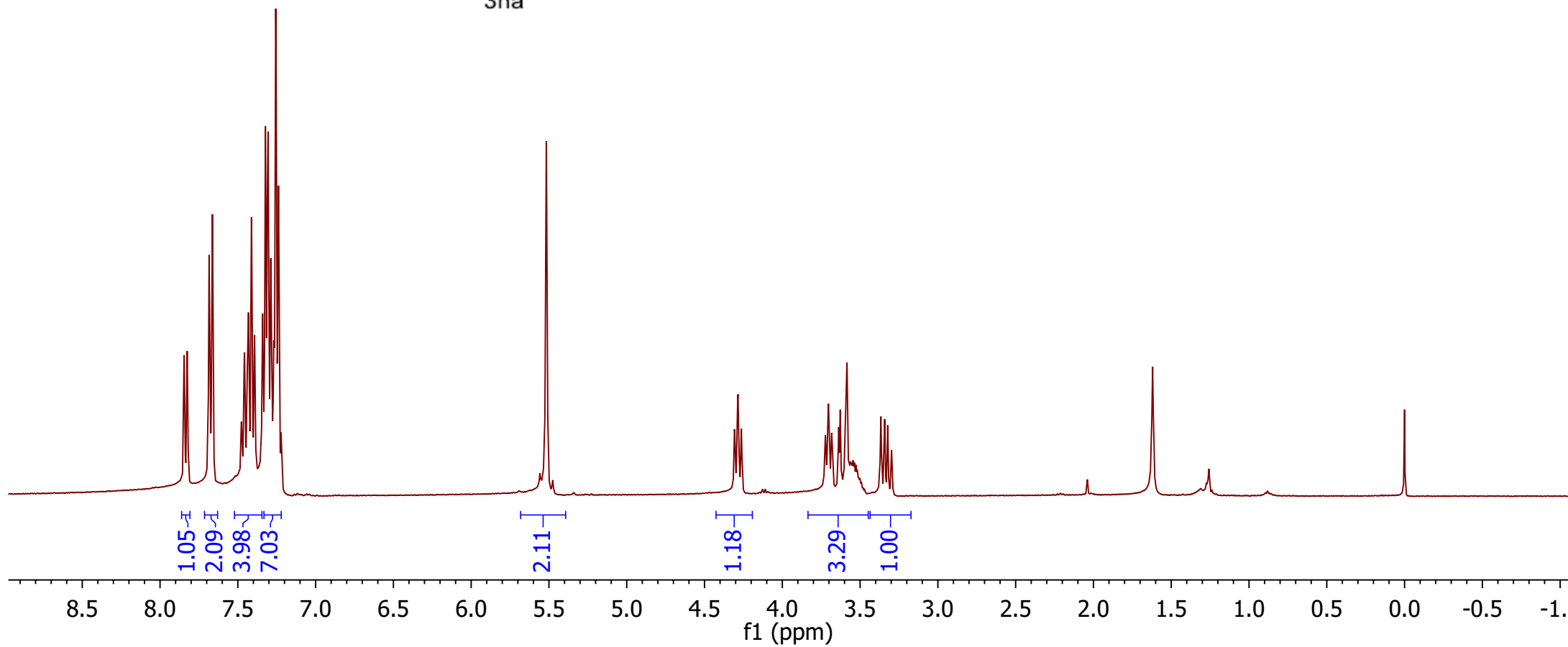
¹⁹F NMR Spectrum of 3ga

¹H (CDCl₃, 400 MHz)

7.85
7.84
7.83
7.82
7.68
7.66
7.48
7.47
7.46
7.44
7.43
7.41
7.39
7.34
7.32
7.32
7.31
7.30
7.29
7.27
7.26
7.24
7.22
5.52
4.31
4.28
4.26
3.72
3.71
3.70
3.70
3.68
3.68
3.64
3.63
3.62
3.59
3.58
3.57
3.56
3.55
3.54
3.54
3.53
3.52
3.51
3.50
3.37
3.34
3.32
3.30

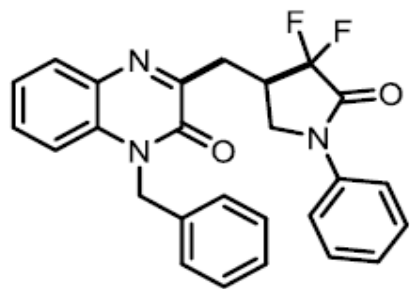


3ha



¹H NMR Spectrum of 3ha

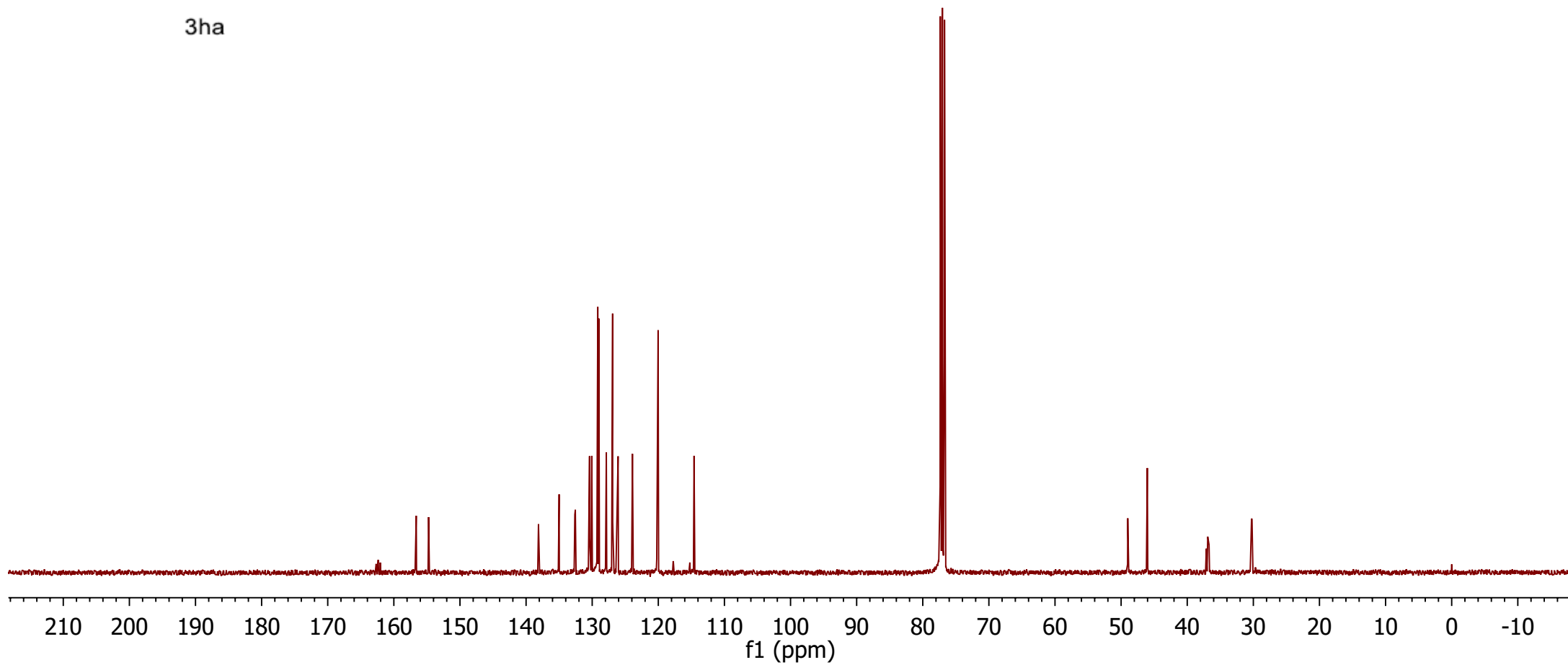
¹³C (CDCl₃, 101 MHz)



3ha

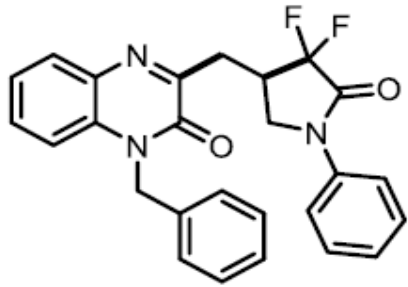
162.7
162.4
162.1
156.6
154.7
138.1
135.0
132.6
132.6
130.4
130.1
129.2
129.0
127.9
126.9
126.1
123.9
120.2
120.0
117.8
117.7
115.2
114.6

49.0
48.9
46.0
37.1
36.9
36.7
30.3
30.2



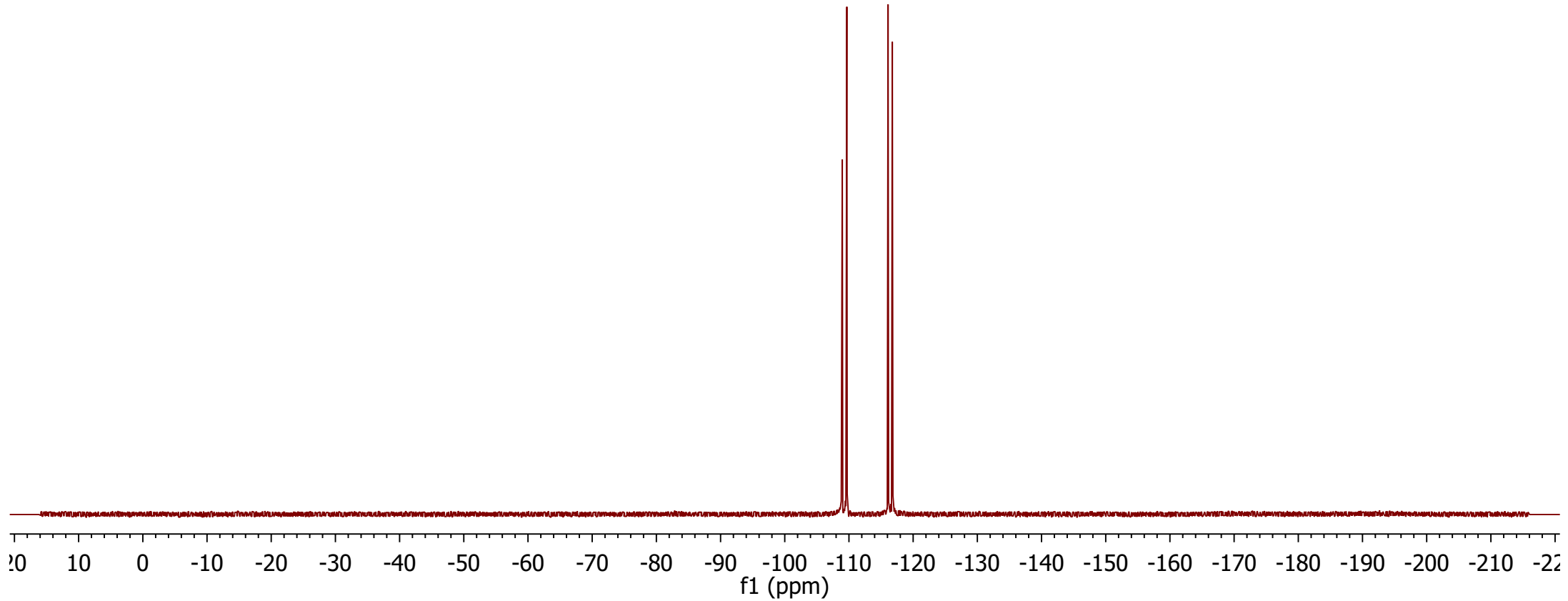
¹³C NMR Spectrum of **3ha**

¹⁹F (CDCl₃, 376 MHz)



3ha

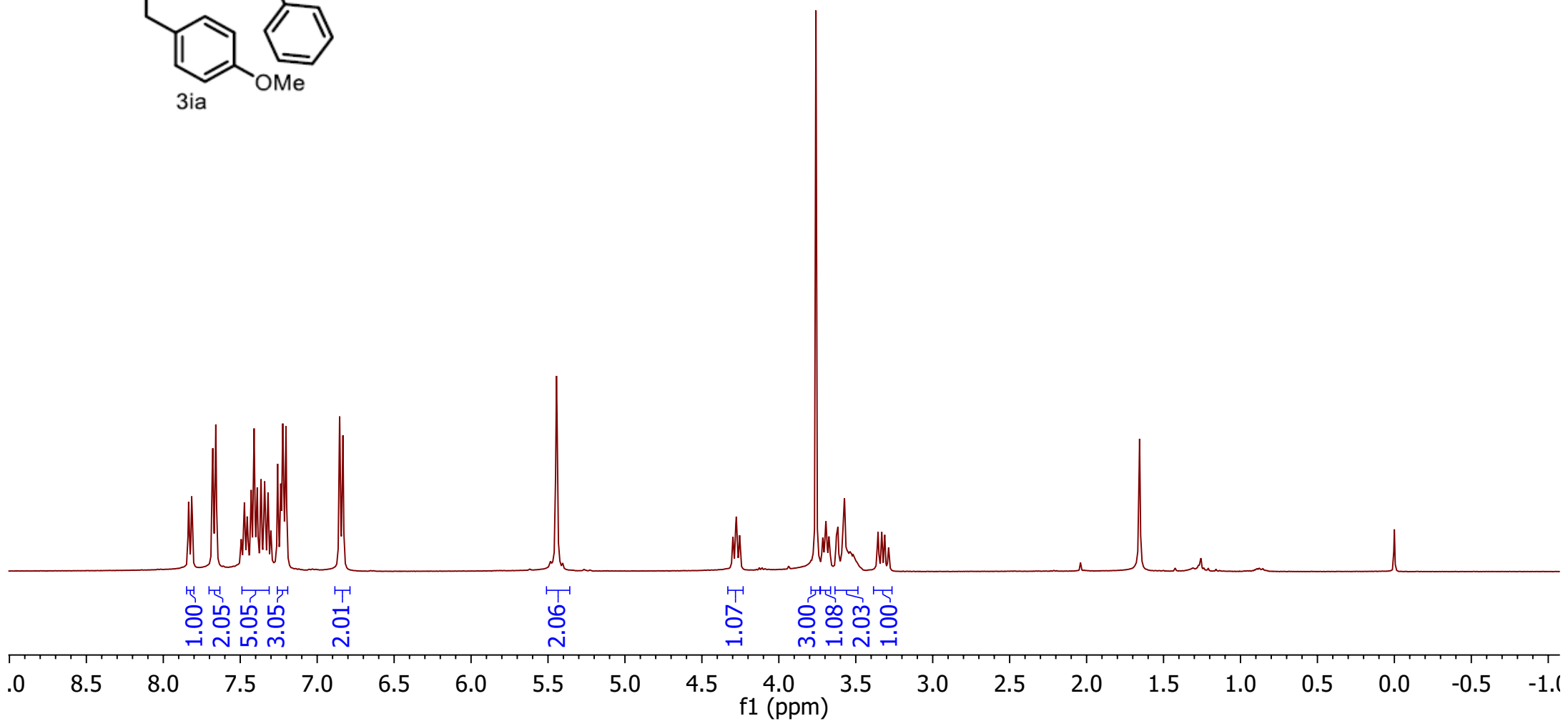
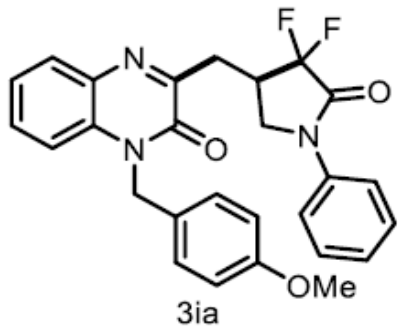
-108.96
-109.00
-109.67
-109.71
-116.04
-116.09
-116.76
-116.80



¹⁹F NMR Spectrum of 3ha

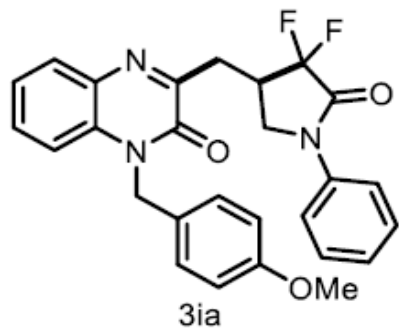
¹H (CDCl₃, 400 MHz)

7.84
7.83
7.82
7.81
7.68
7.68
7.66
7.66
7.49
7.48
7.47
7.47
7.46
7.45
7.43
7.41
7.39
7.39
7.37
7.36
7.34
7.34
7.34
7.32
7.30
7.30
7.26
7.24
7.22
7.22
7.20
6.85
6.85
6.84
6.83
5.44
4.30
4.28
4.28
4.27
4.25
3.76
3.76
3.72
3.70
3.69
3.67
3.63
3.62
3.58
3.57
3.36
3.33
3.31



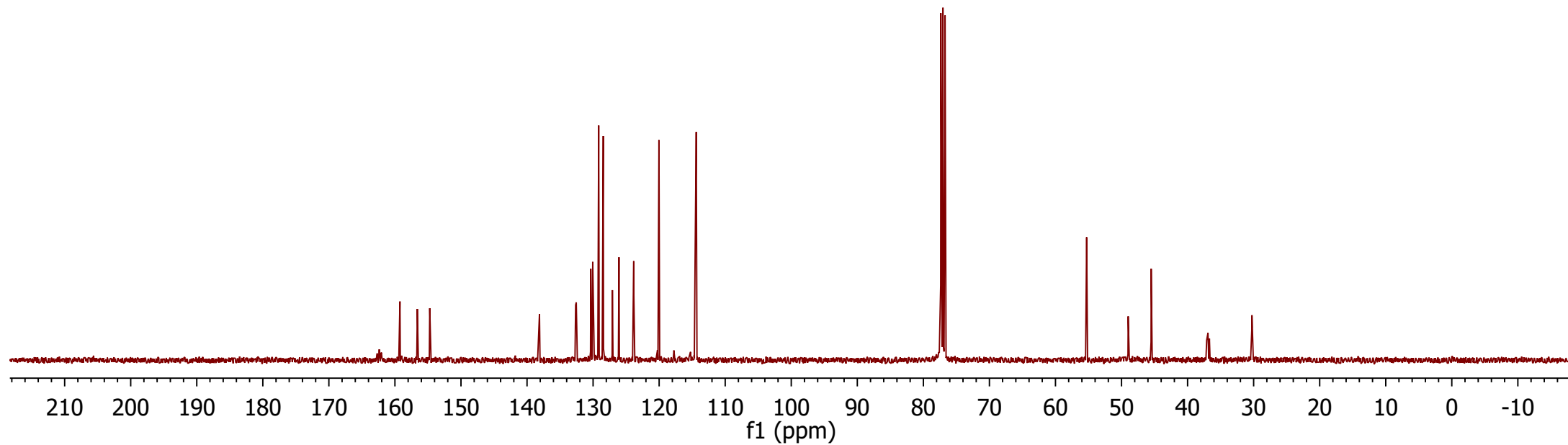
¹H NMR Spectrum of **3ia**

¹³C (CDCl₃, 101 MHz)



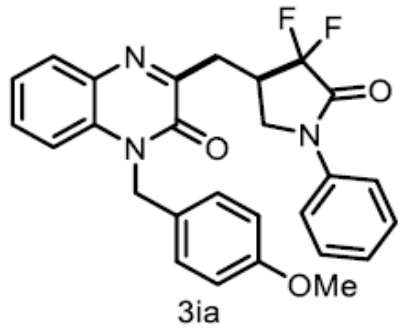
162.7
162.4
162.1
159.2
156.6
154.7
138.1
132.6
132.5
130.4
130.1
129.1
128.5
127.1
126.1
123.8
120.3
120.0
117.8
115.2
114.6
114.4

55.3
49.0
48.9
45.5
37.1
36.9
36.7
30.3
30.2

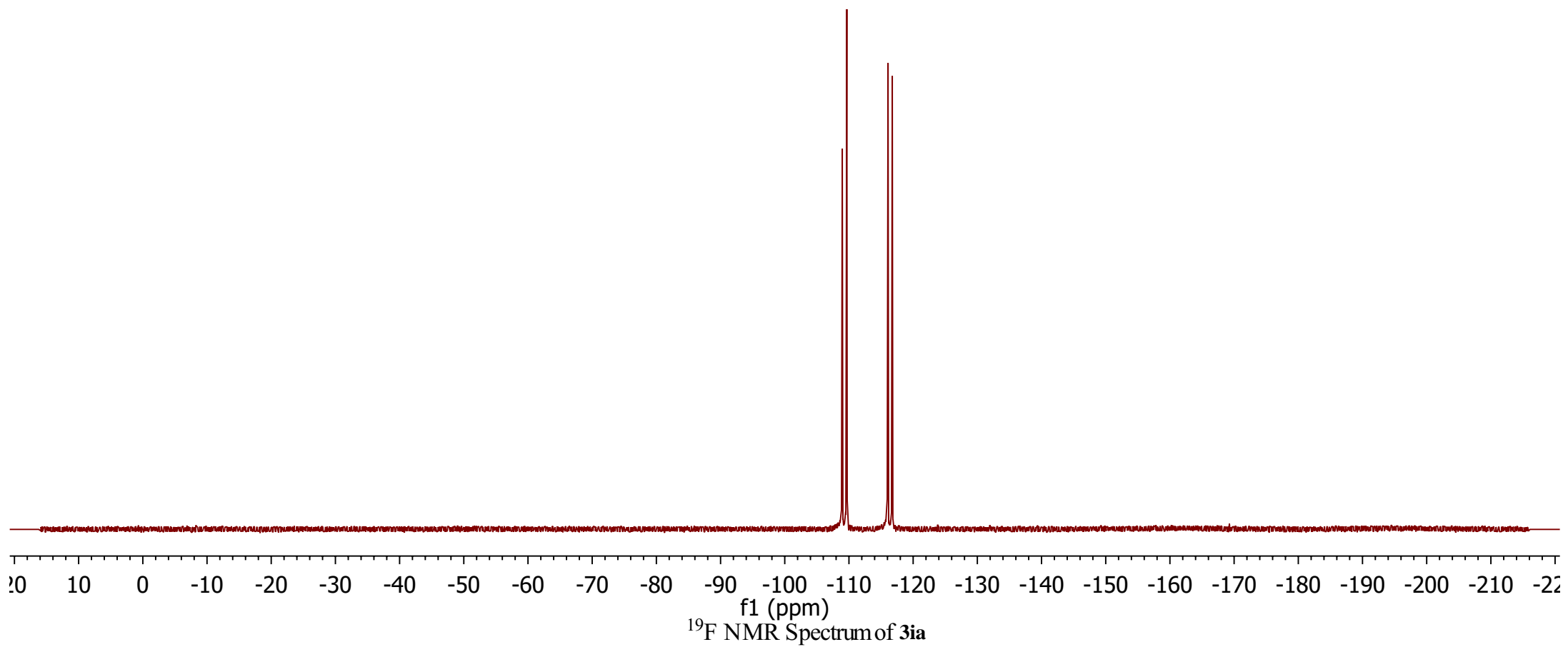


¹³C NMR Spectrum of 3ia

¹⁹F (CDCl₃, 376 MHz)

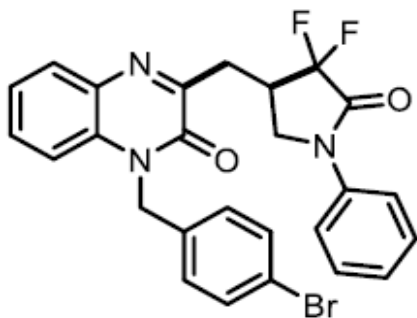


-108.96
-109.00
-109.67
-109.71
-116.04
-116.09
-116.75
-116.80

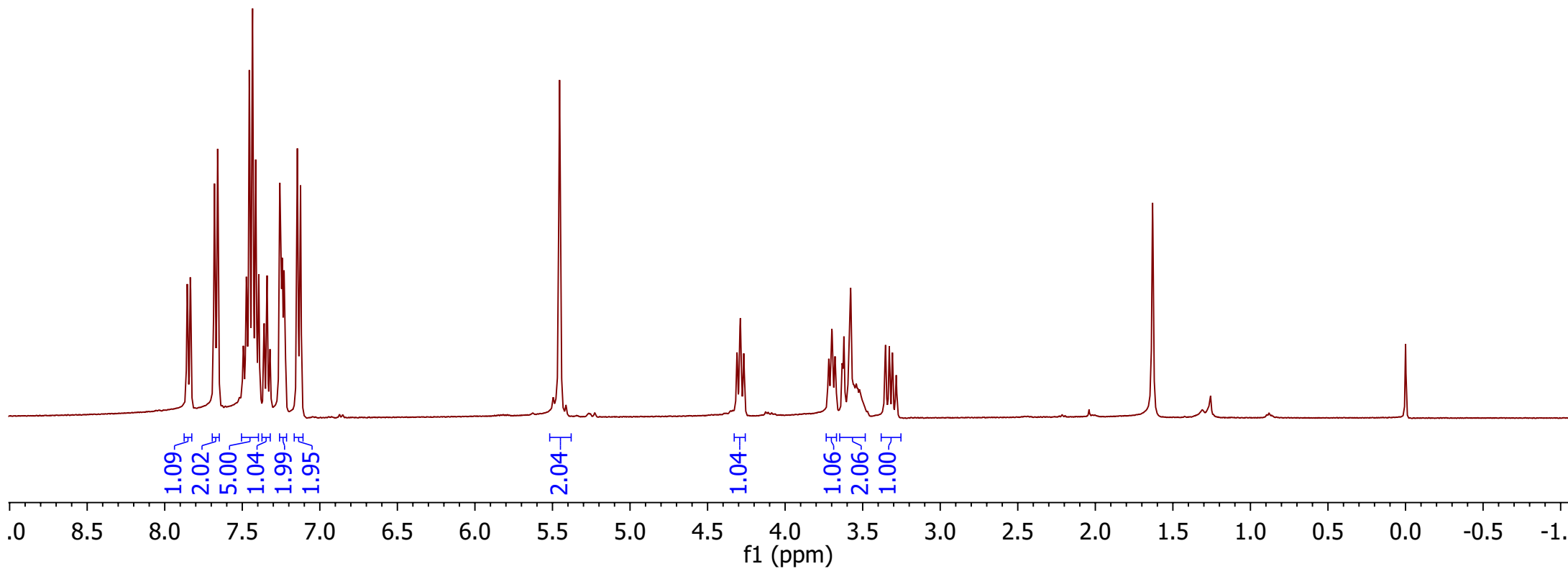


¹H (CDCl₃, 400 MHz)

7.85
7.83
7.68
7.66
7.52
7.49
7.47
7.45
7.43
7.41
7.39
7.36
7.34
7.32
7.26
7.25
7.24
7.23
7.22
7.14
7.12
5.45
4.31
4.29
4.27
3.72
3.70
3.68
3.63
3.62
3.60
3.59
3.58
3.55
3.54
3.53
3.52
3.51
3.50
3.50
3.49
3.35
3.33
3.31
3.28

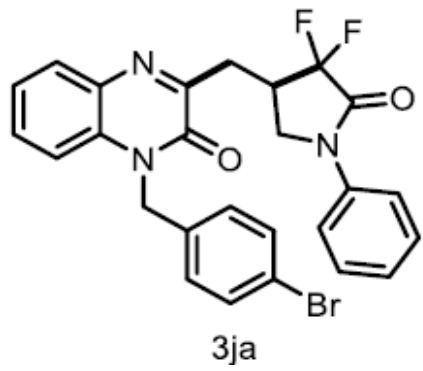


3ja



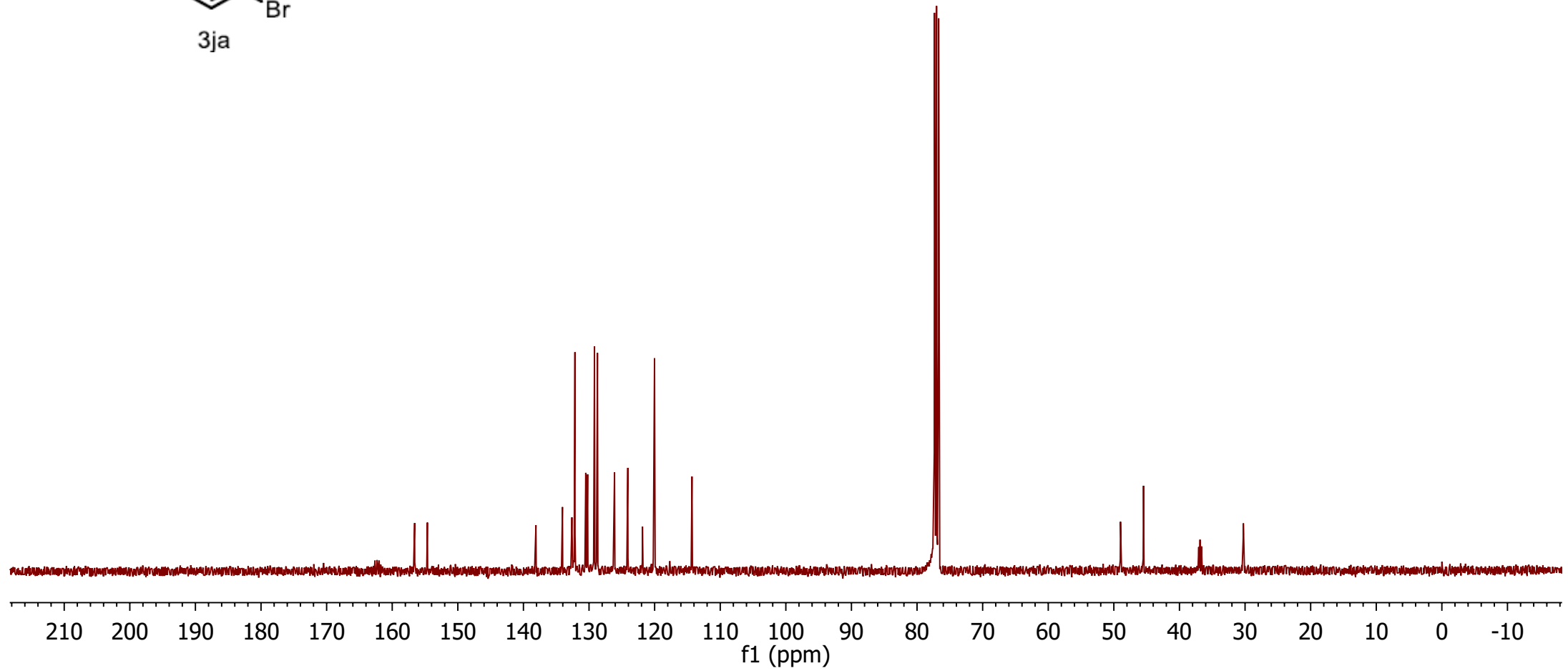
¹H NMR Spectrum of 3ja

¹³C (CDCl₃, 101 MHz)



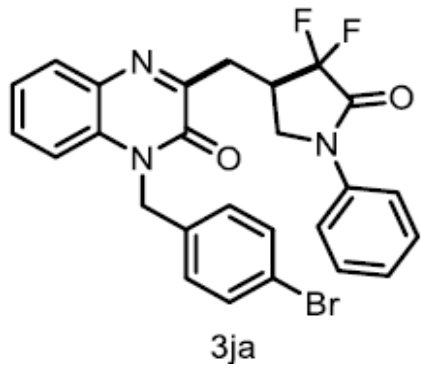
162.3
156.6
154.6
138.1
134.1
132.6
132.3
132.2
130.5
130.2
129.2
128.7
126.1
124.1
121.9
120.0
114.3

49.0
48.9
45.5
37.1
36.9
36.6
30.3
30.2

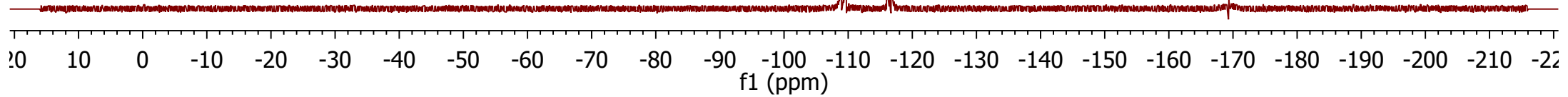


¹³C NMR Spectrum of 3ja

¹⁹F (CDCl₃, 376 MHz)



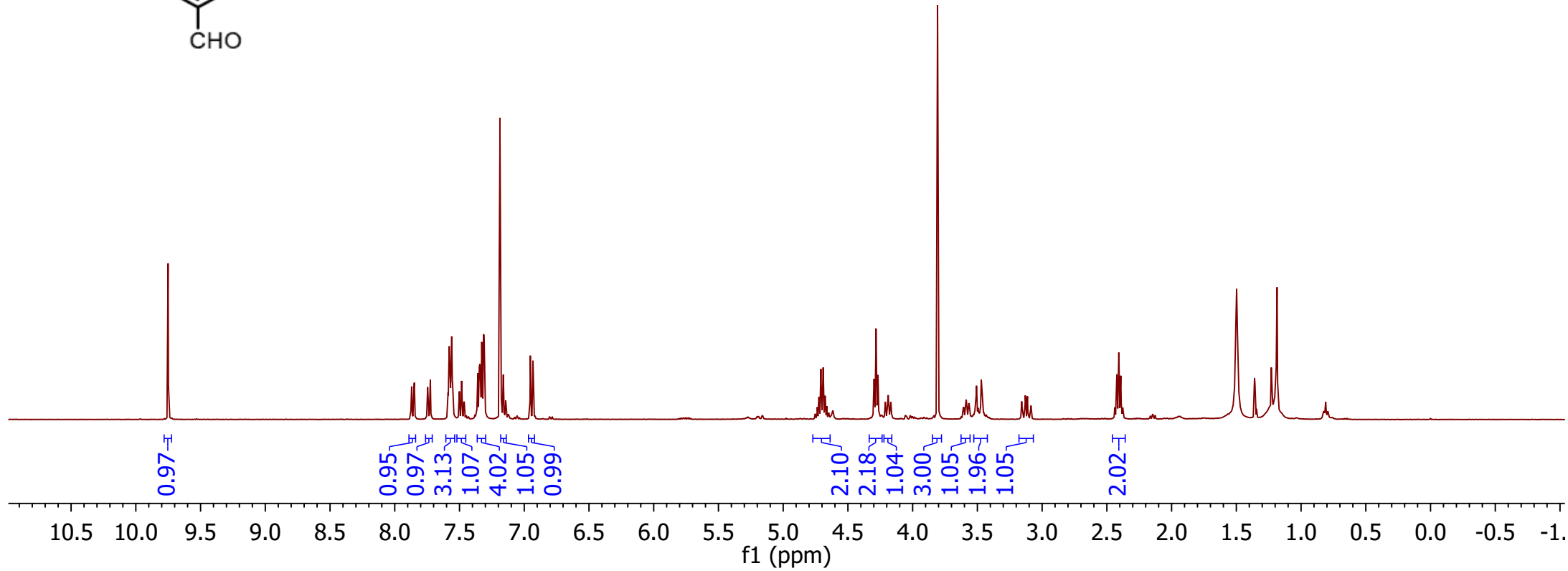
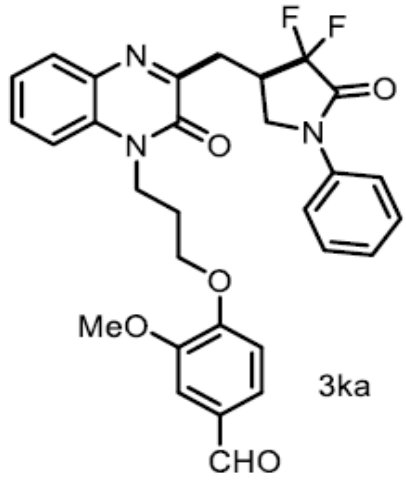
-108.90
-108.94
-109.61
-109.65
-116.01
-116.06
-116.72
-116.77



¹⁹F NMR Spectrum of 3ja

¹H (CDCl₃, 400 MHz)

9.75
7.87
7.87
7.85
7.85
7.75
7.75
7.73
7.73
7.59
7.58
7.58
7.57
7.57
7.57
7.56
7.56
7.56
7.55
7.55
7.50
7.50
7.48
7.48
7.36
7.36
7.35
7.34
7.34
7.33
7.32
7.32
7.31
7.31
7.19
7.18
7.18
7.16
6.95
6.93
4.71
4.71
4.69
4.69
4.30
4.28
4.27
4.19
3.81
3.51
3.47
2.42
2.41
2.39

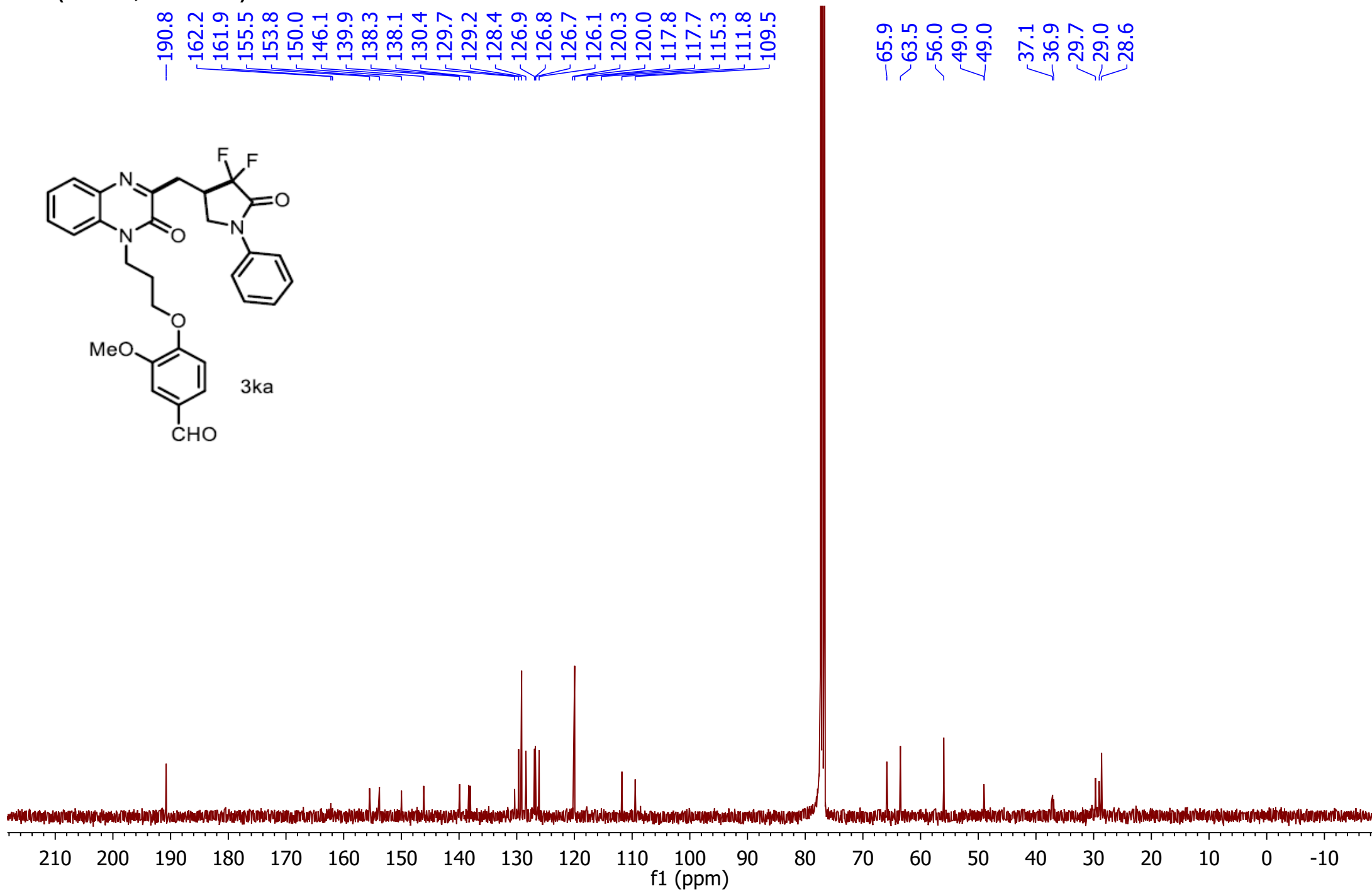
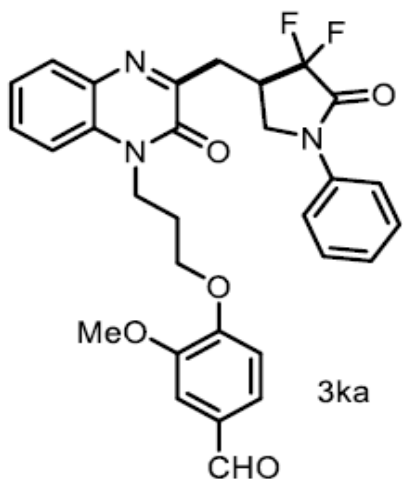


¹H NMR Spectrum of **3ka**

¹³C (CDCl₃, 101 MHz)

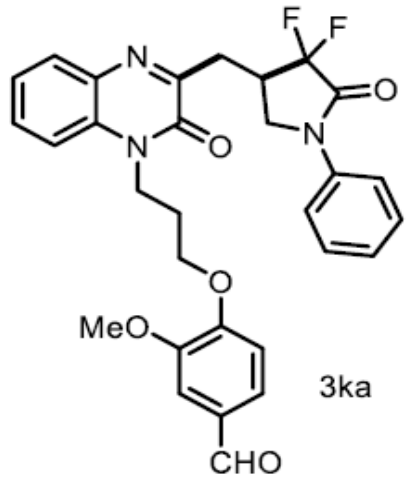
190.8
162.2
161.9
155.5
153.8
150.0
146.1
139.9
138.3
138.1
130.4
129.7
129.2
128.4
126.9
126.8
126.7
126.1
120.3
120.0
117.8
117.7
115.3
111.8
109.5

65.9
63.5
56.0
49.0
49.0
37.1
36.9
29.7
29.0
28.6

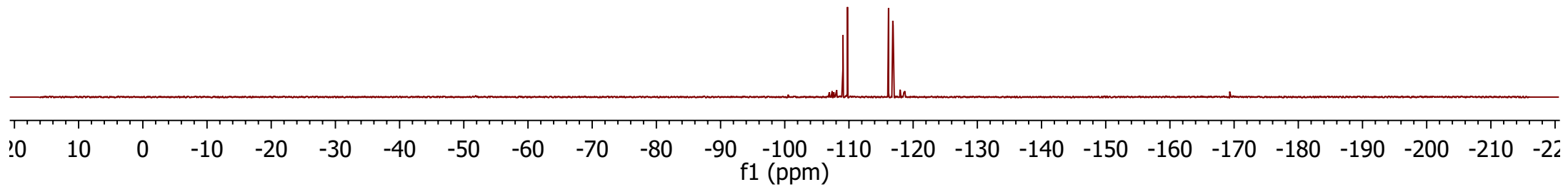


¹³C NMR Spectrum of 3ka

¹⁹F (CDCl₃, 376 MHz)



-109.06
-109.07
-109.10
-109.11
-109.77
-109.78
-109.81
-109.82
-116.12
-116.17
-116.83
-116.88

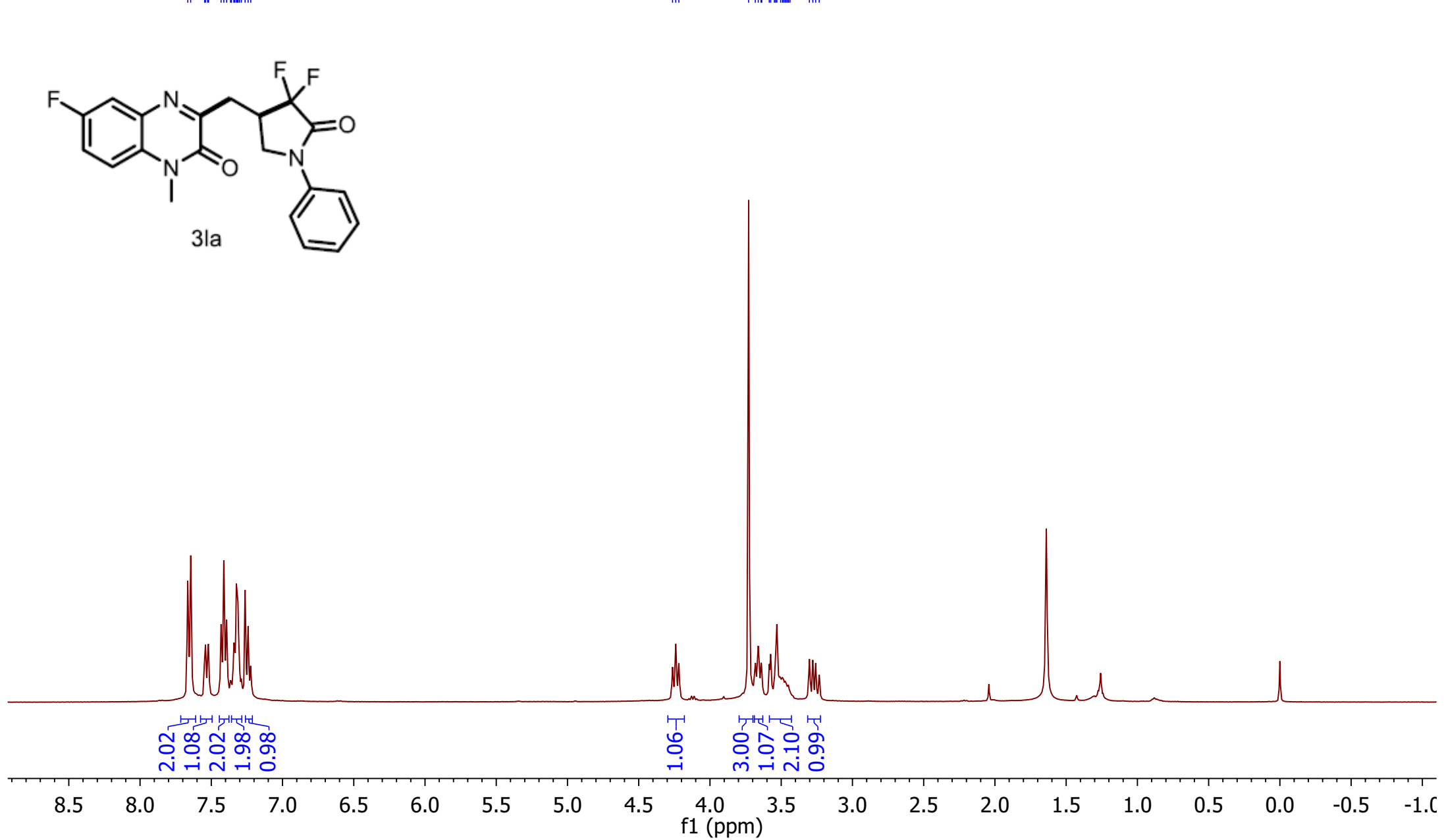
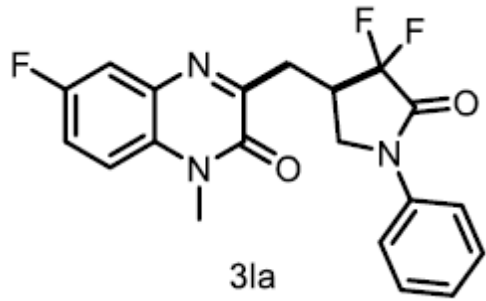


¹⁹F NMR Spectrum of 3ka

¹H (CDCl₃, 400 MHz)

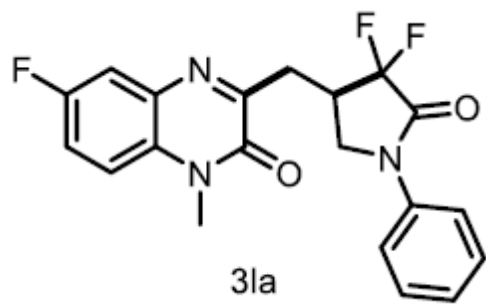
7.66
7.64
7.55
7.54
7.53
7.52
7.43
7.41
7.39
7.36
7.36
7.34
7.34
7.32
7.32
7.31
7.30
7.29
7.26
7.24
7.22

4.26
4.24
4.22
3.73
3.68
3.66
3.64
3.64
3.58
3.57
3.55
3.54
3.53
3.50
3.49
3.48
3.47
3.46
3.45
3.45
3.44
3.30
3.28
3.26
3.23



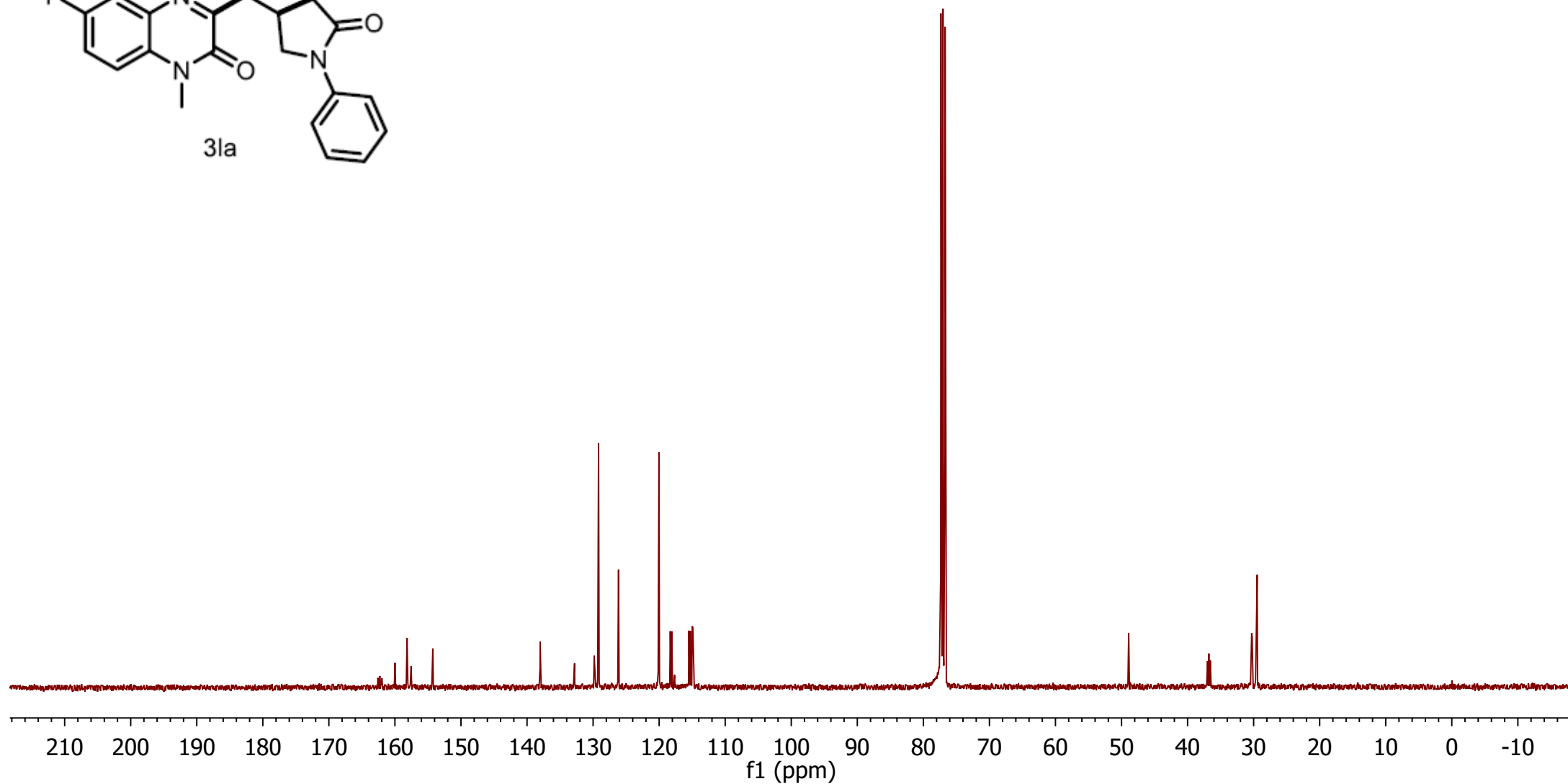
¹H NMR Spectrum of **3la**

¹³C (CDCl₃, 101 MHz)



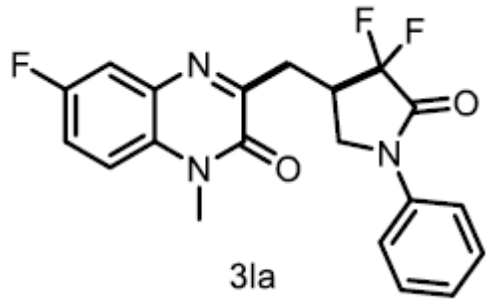
162.6
162.3
162.0
160.0
158.2
157.6
154.3
138.0
132.9
132.8
129.9
129.8
129.2
126.2
120.1
120.0
118.3
118.1
117.7
115.5
115.3
115.1
115.0
114.9

48.9
48.9
37.0
36.8
36.8
36.6
30.3
30.2
29.5

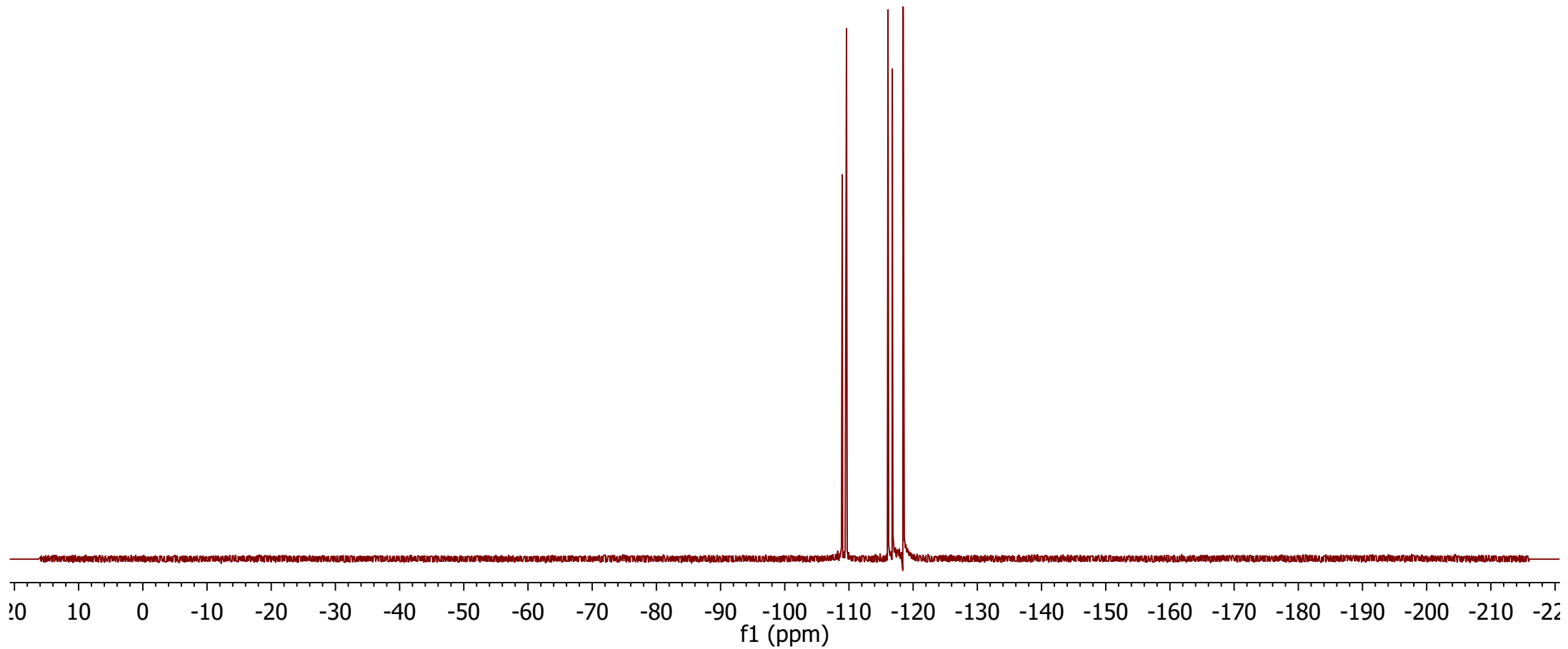


¹³C NMR Spectrum of 3la

¹⁹F (CDCl₃, 376 MHz)



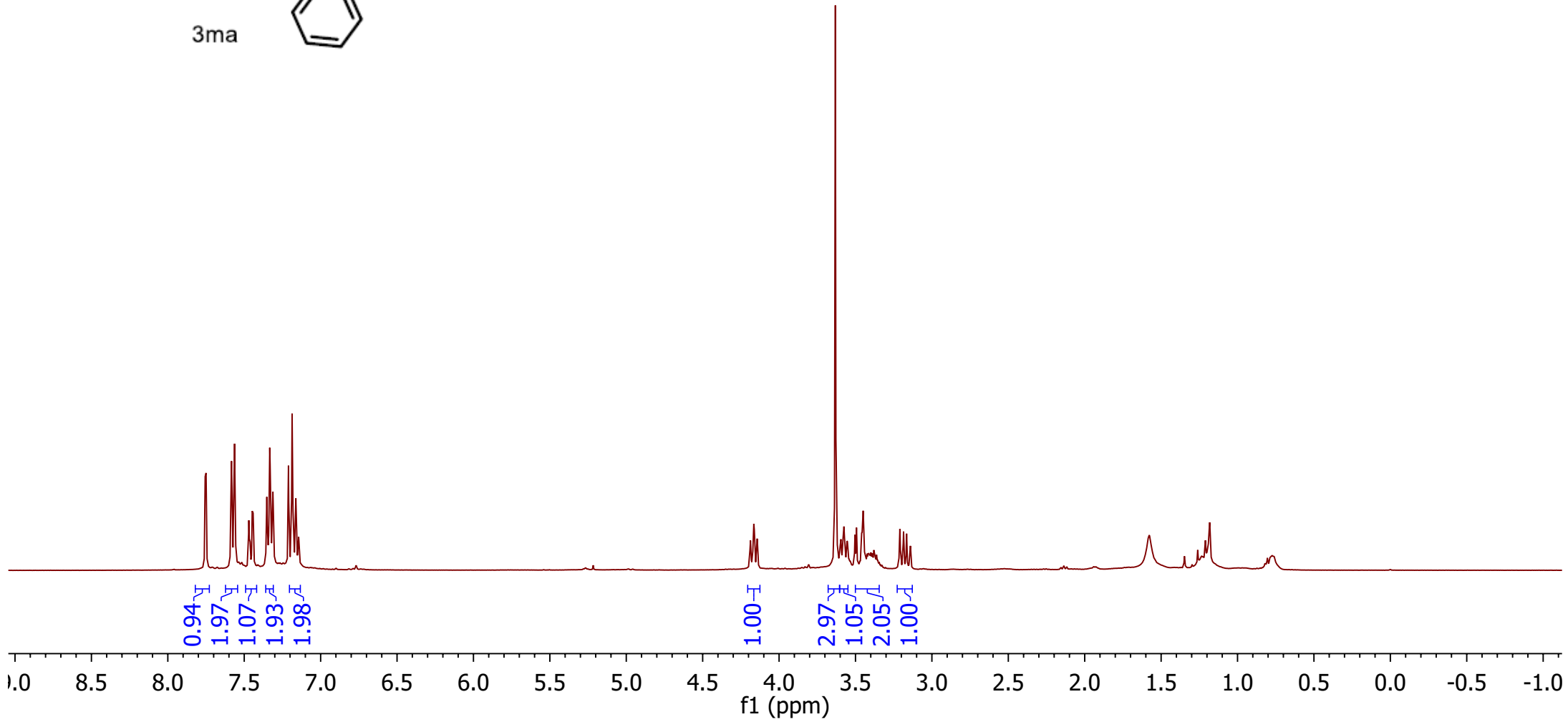
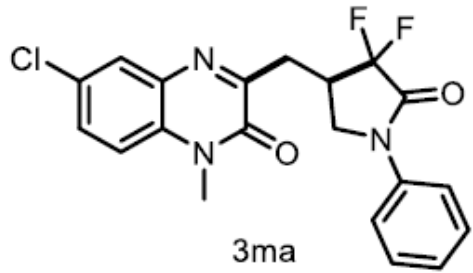
-108.91
-108.95
-109.62
-109.66
-116.04
-116.08
-116.75
-116.80
-118.40
-118.42
-118.43
-118.44
-118.45
-118.46



¹⁹F NMR Spectrum of 3la

¹H (CDCl₃, 400 MHz)

7.76
7.75
7.59
7.58
7.58
7.57
7.56
7.56
7.56
7.47
7.46
7.45
7.44
7.35
7.35
7.33
7.33
7.32
7.31
7.21
7.19
7.18
7.18
7.16
7.14
7.14
4.19
4.19
4.17
4.17
4.16
4.14
4.14
3.63
3.62
3.60
3.59
3.58
3.58
3.57
3.56
3.55
3.50
3.49
3.46
3.45
3.42
3.40
3.39
3.38
3.21
3.19
3.17
3.14

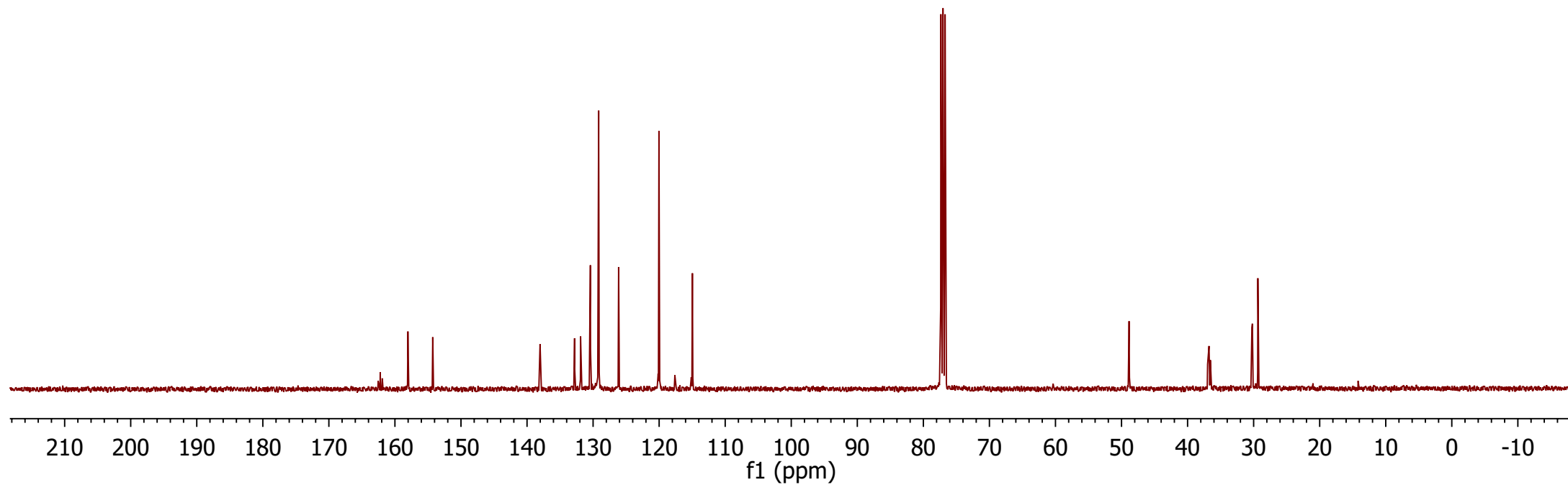
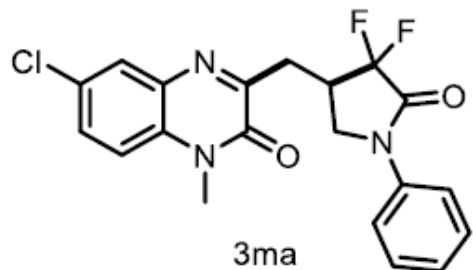


¹H NMR Spectrum of **3ma**

¹³C (CDCl₃, 101 MHz)

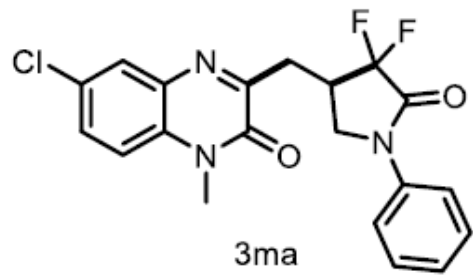
162.5
162.2
161.9
158.0
154.3
138.0
132.8
131.9
130.4
129.2
129.2
129.2
126.1
120.1
120.0
117.6
115.1
115.0

48.9
48.9
37.0
36.8
36.6
30.3
30.2
29.4

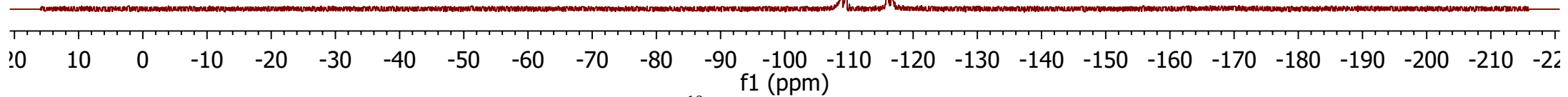


¹³C NMR Spectrum of 3ma

¹⁹F (CDCl₃, 376 MHz)



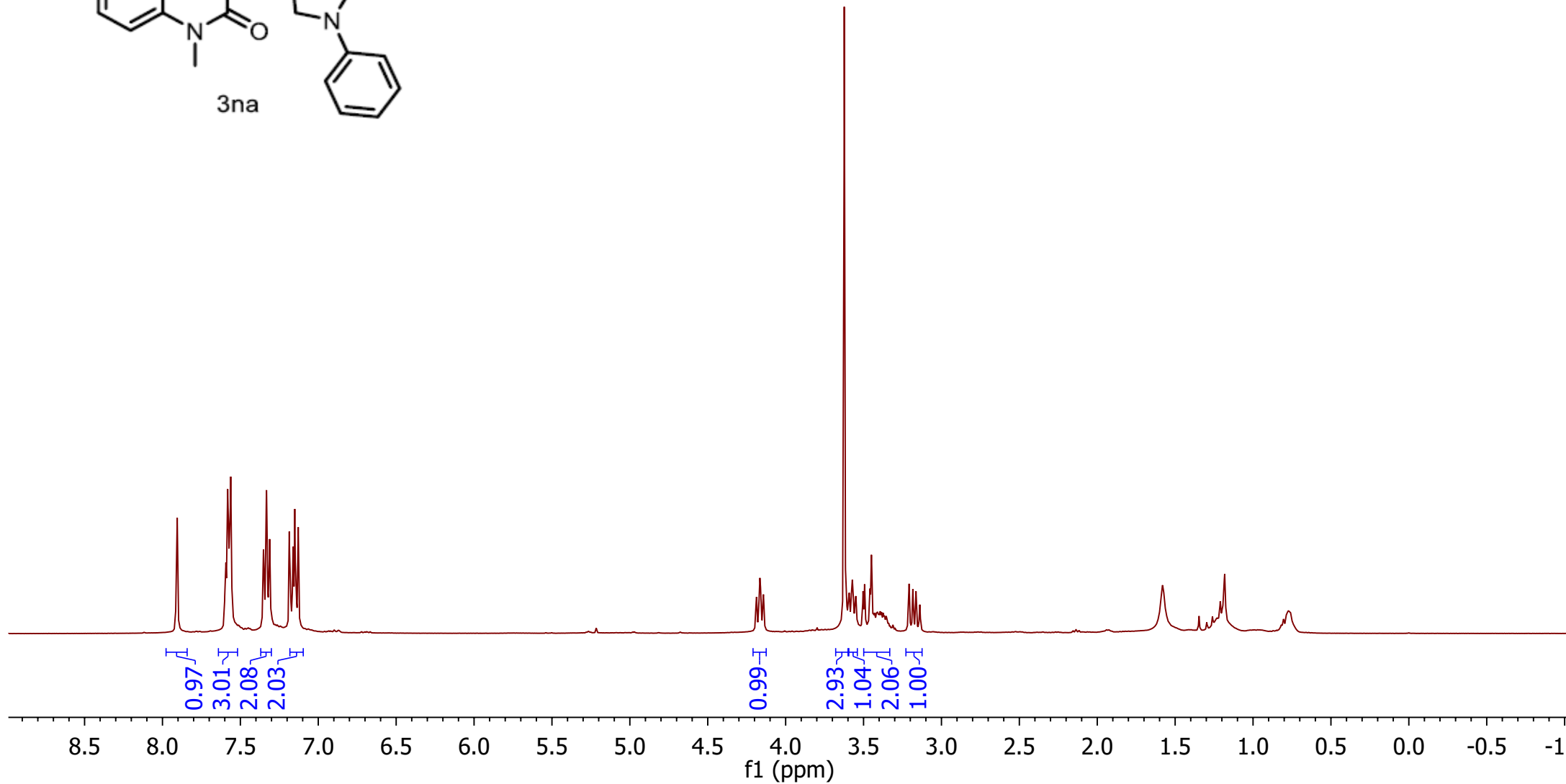
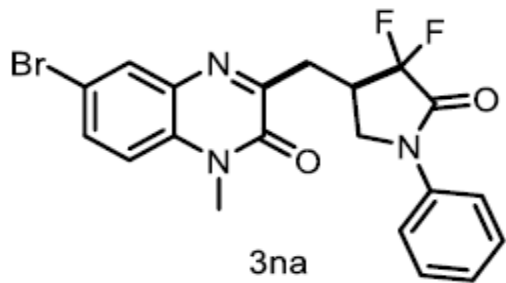
-108.90
-108.94
-109.61
-109.65
-115.97
-116.01
-116.68
-116.72



¹⁹F NMR Spectrum of 3ma

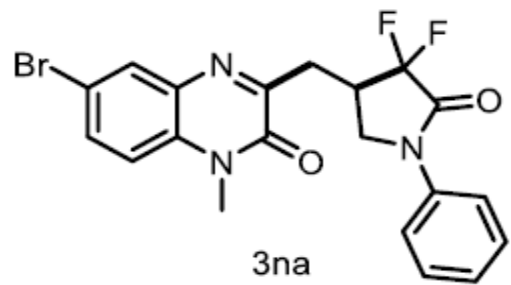
¹H (CDCl₃, 400 MHz)

7.91 7.91 7.60 7.59 7.58 7.58 7.57 7.56 7.56 7.35 7.35 7.33 7.33 7.32 7.31 7.19 7.18 7.18 7.16 7.15 7.14 7.14 7.13 4.19 4.19 4.17 4.17 4.16 4.14 4.14 3.62 3.61 3.60 3.59 3.58 3.57 3.57 3.55 3.55 3.50 3.49 3.46 3.45 3.43 3.42 3.41 3.39 3.38 3.37 3.21 3.18 3.16 3.14



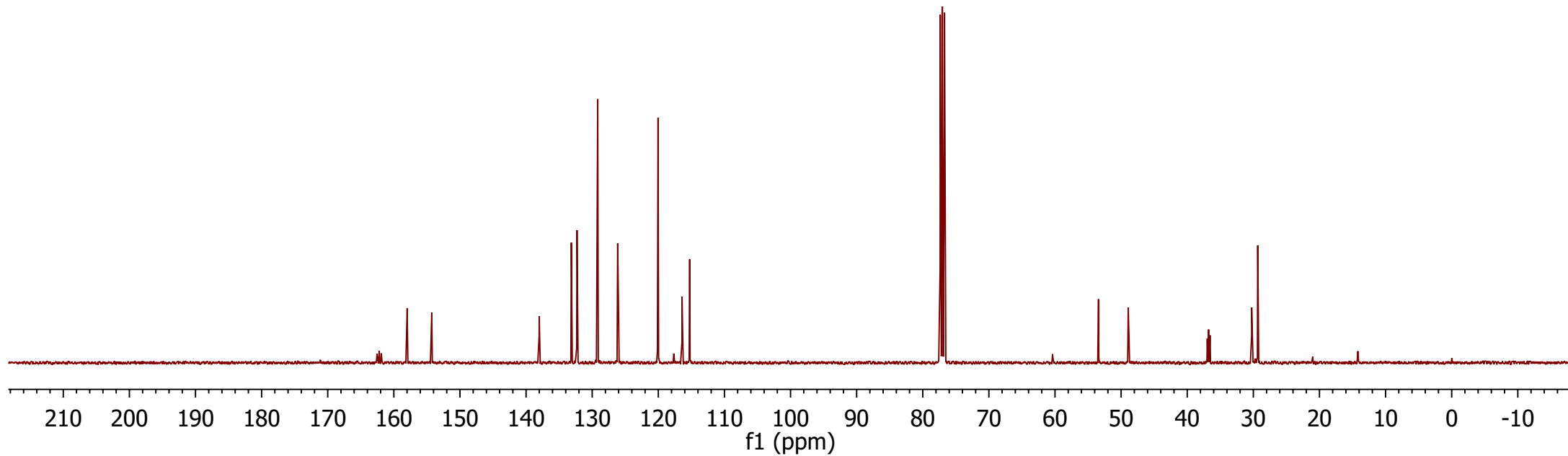
¹H NMR Spectrum of **3na**

¹³C (CDCl₃, 101 MHz)



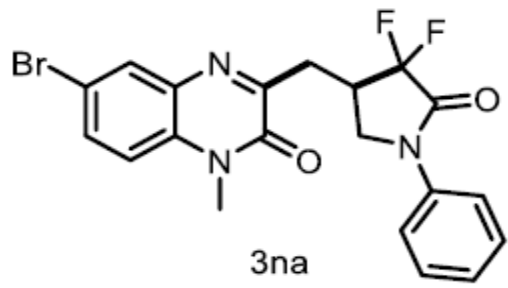
162.5
162.2
161.9
158.0
154.3
138.0
133.2
133.1
132.3
132.3
129.2
126.1
120.1
120.0
117.7
116.4
115.3
115.1

48.9
48.9
37.0
36.8
36.7
36.5
30.3
30.2
29.3

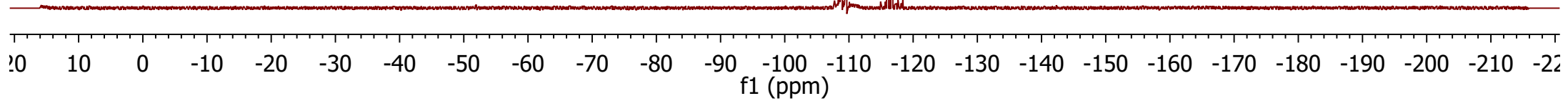


¹³C NMR Spectrum of **3na**

¹⁹F (CDCl₃, 376 MHz)



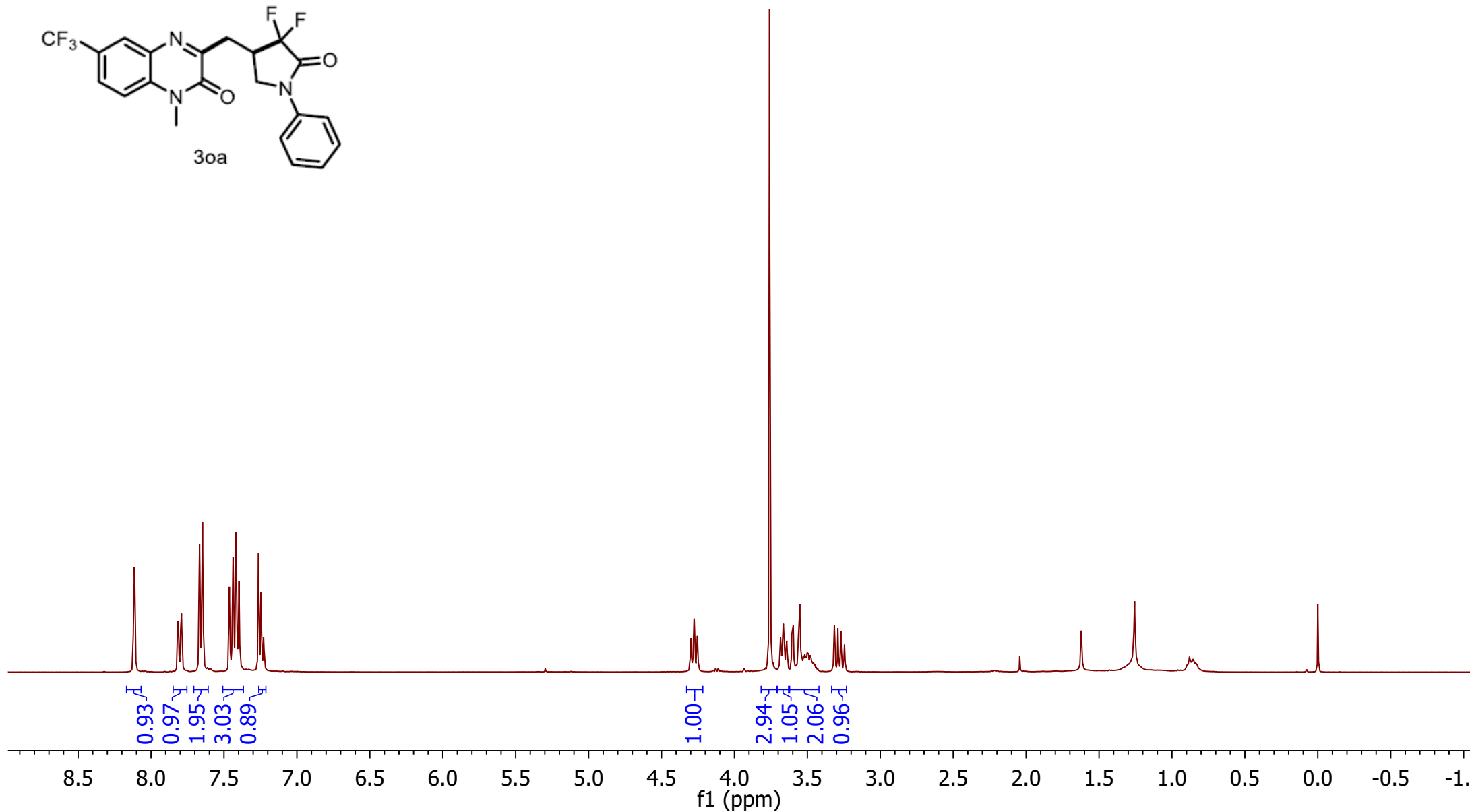
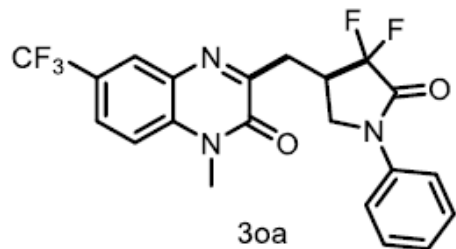
-108.89
-108.93
-109.60
-109.64
-115.96
-116.01
-116.67
-116.72



¹⁹F NMR Spectrum of 3na

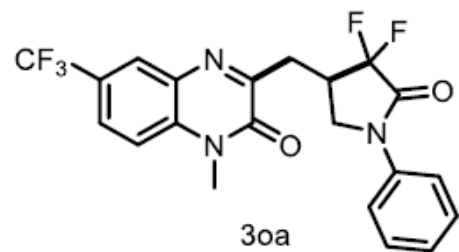
¹H (CDCl₃, 400 MHz)

8.12
8.11
7.82
7.81
7.80
7.79
7.67
7.67
7.66
7.65
7.65
7.64
7.46
7.44
7.44
7.43
7.42
7.41
7.40
7.40
7.39
7.26
7.25
7.23
7.23
7.22
4.30
4.30
4.28
4.28
4.27
4.26
4.25
3.76
3.69
3.68
3.67
3.66
3.66
3.64
3.64
3.61
3.60
3.56
3.55
3.52
3.50
3.50
3.49
3.31
3.29
3.27
3.25



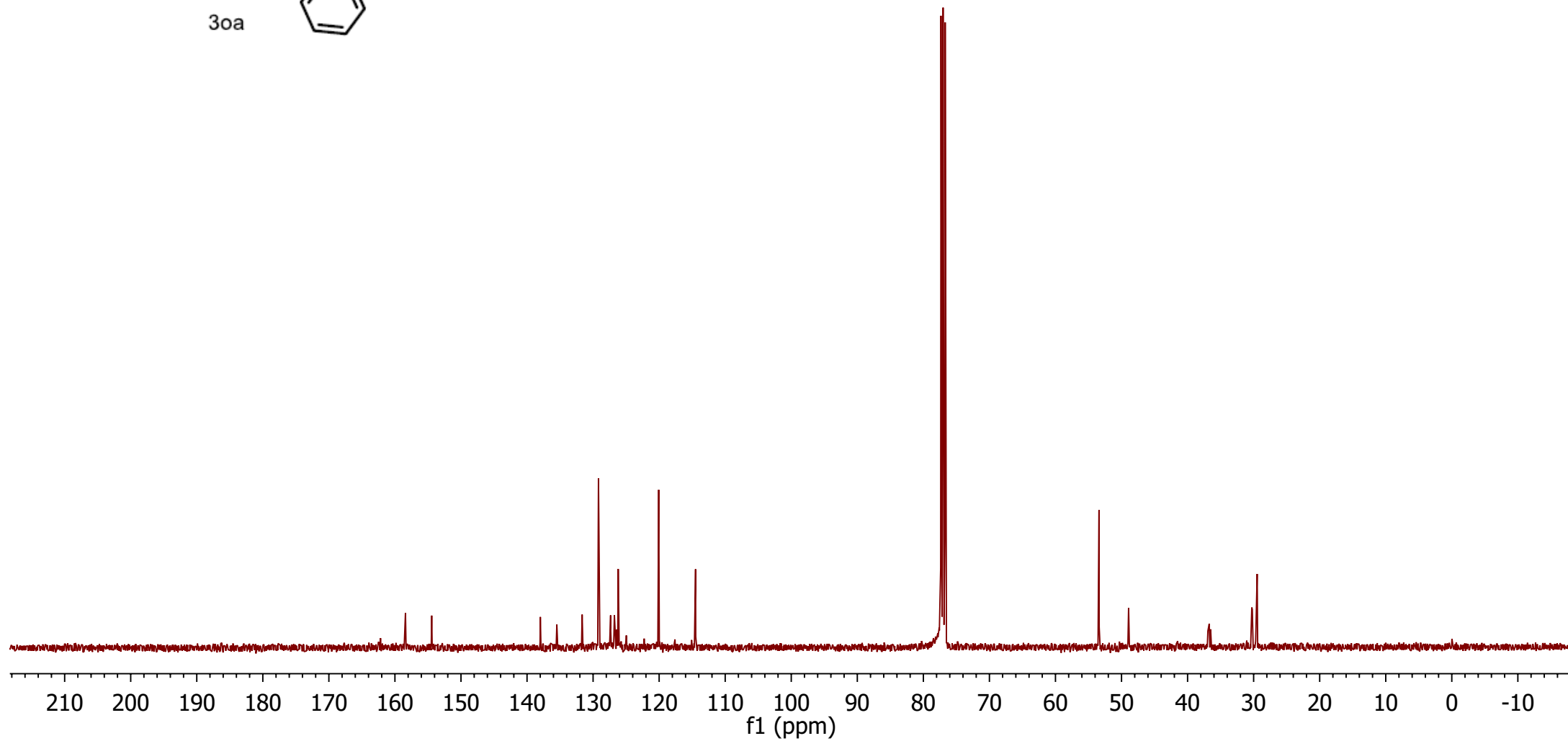
¹H NMR Spectrum of 3oa

¹³C (CDCl₃, 101 MHz)



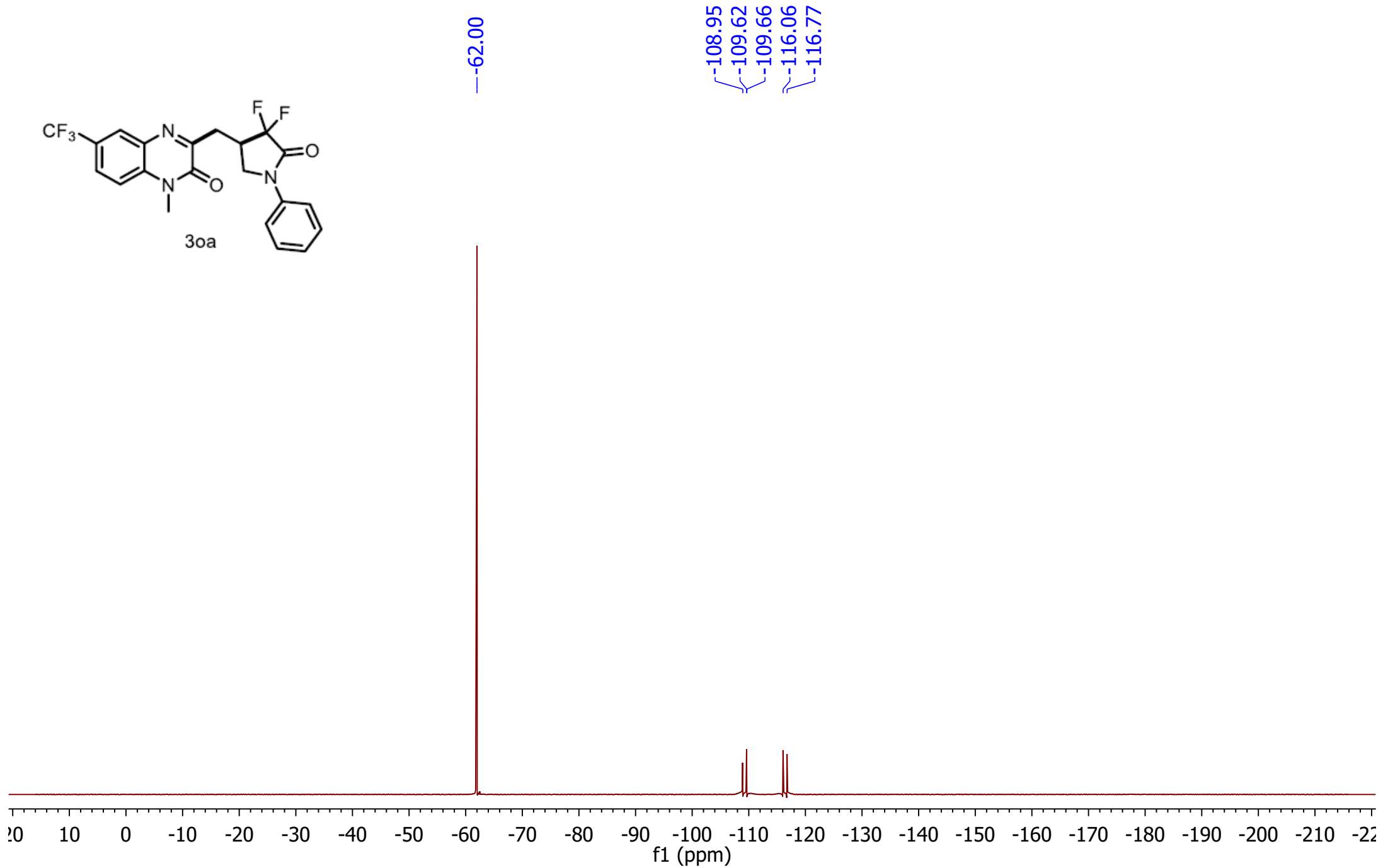
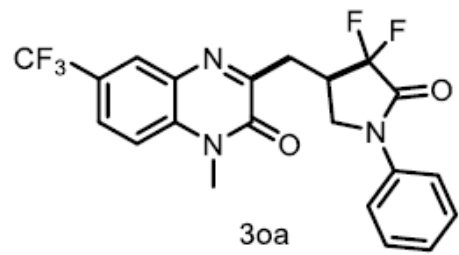
158.4
154.4
138.0
135.5
131.7
129.2
127.4
127.3
126.8
126.7
126.4
126.2
126.1
125.0
120.1
114.5

48.9
48.9
36.9
36.7
36.5
30.3
30.2
29.5



¹³C NMR Spectrum of 30a

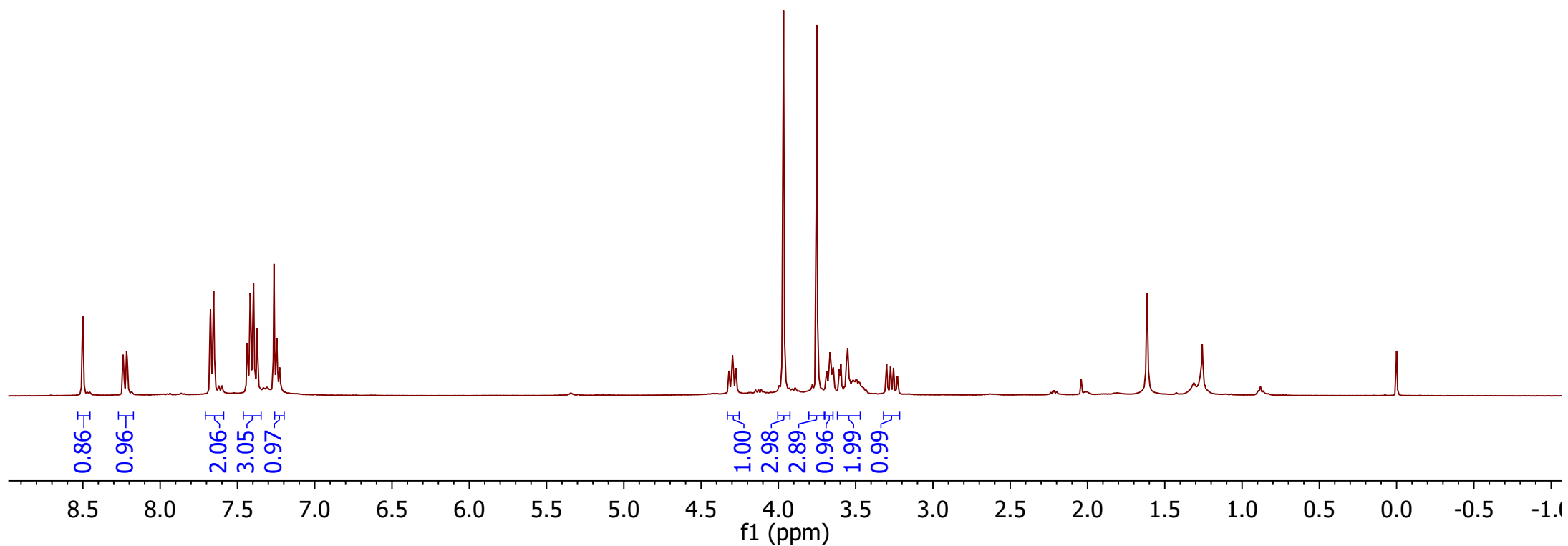
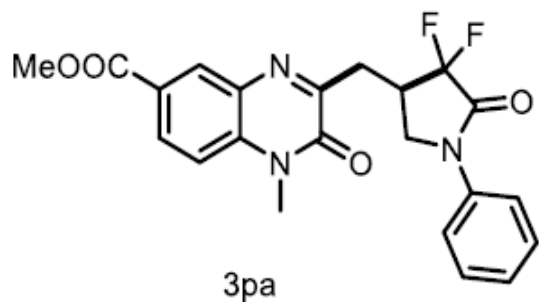
19F (CDCl3, 376 MHz)



¹⁹F NMR Spectrum of 3oa

¹H (CDCl₃, 400 MHz)

8.50 8.50 8.24 8.22 8.21 7.65 7.62 7.60 7.44 7.42 7.40 7.37 7.26 7.25 7.23 4.32 4.30 4.27 4.00 3.97 3.93 3.91 3.89 3.78 3.75 3.72 3.69 3.67 3.65 3.64 3.61 3.60 3.57 3.56 3.55 3.54 3.53 3.52 3.51 3.50 3.49 3.48 3.47 3.46 3.46 3.45 3.44 3.43 3.30 3.27 3.25 3.23

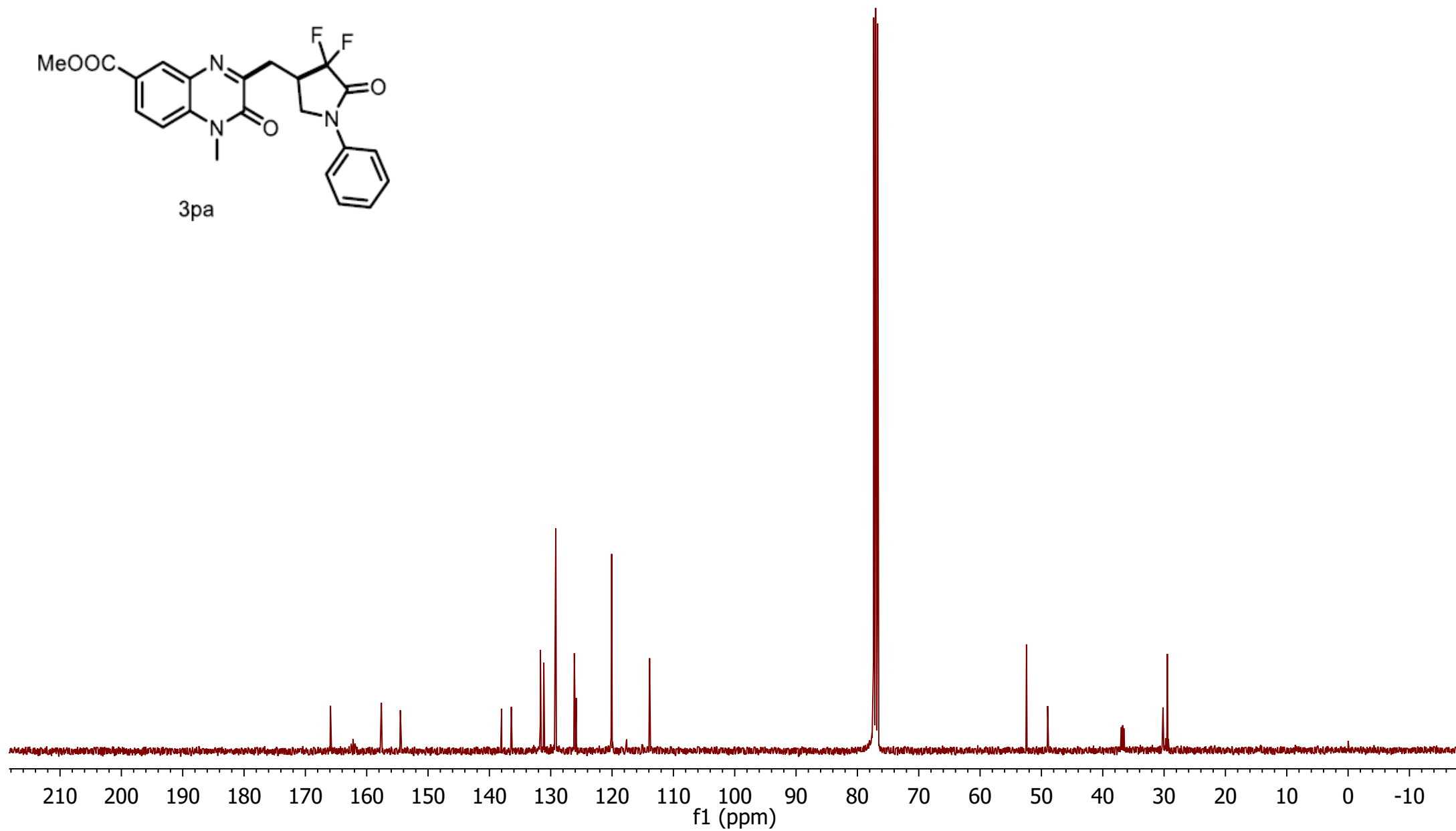
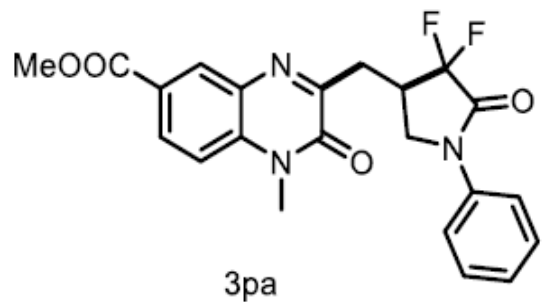


¹H NMR Spectrum of **3pa**

¹³C (CDCl₃, 101 MHz)

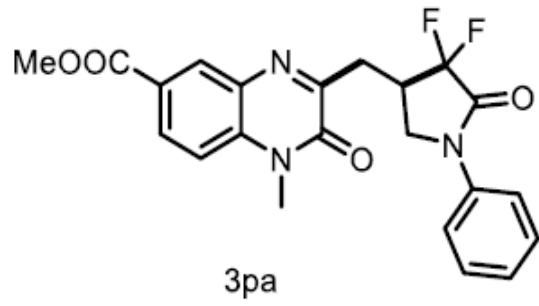
~165.9
~162.2
~157.6
~154.5
138.0
136.4
131.7
131.7
131.1
129.2
126.2
125.8
120.1
117.6
113.9

52.4
49.0
48.9
37.0
36.8
36.6
30.2
30.1
29.7
29.5
29.3

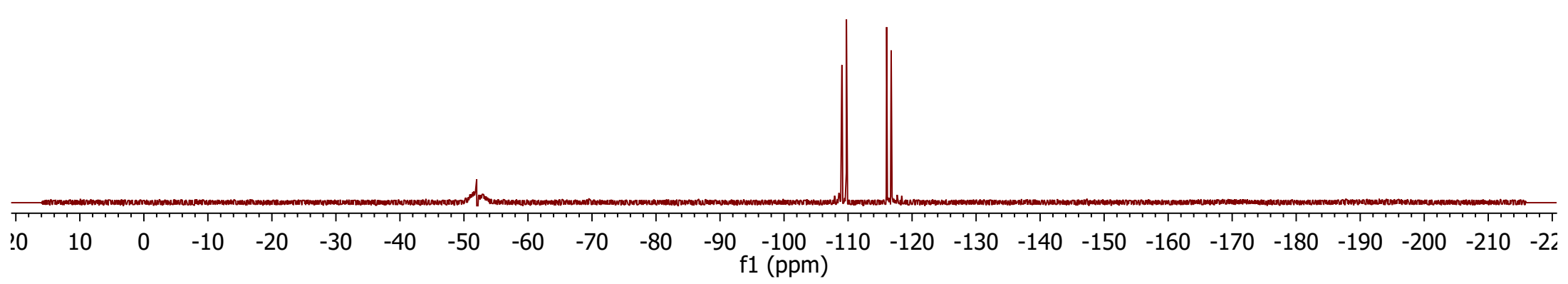


¹³C NMR Spectrum of 3pa

19F (CDCl3, 376 MHz)



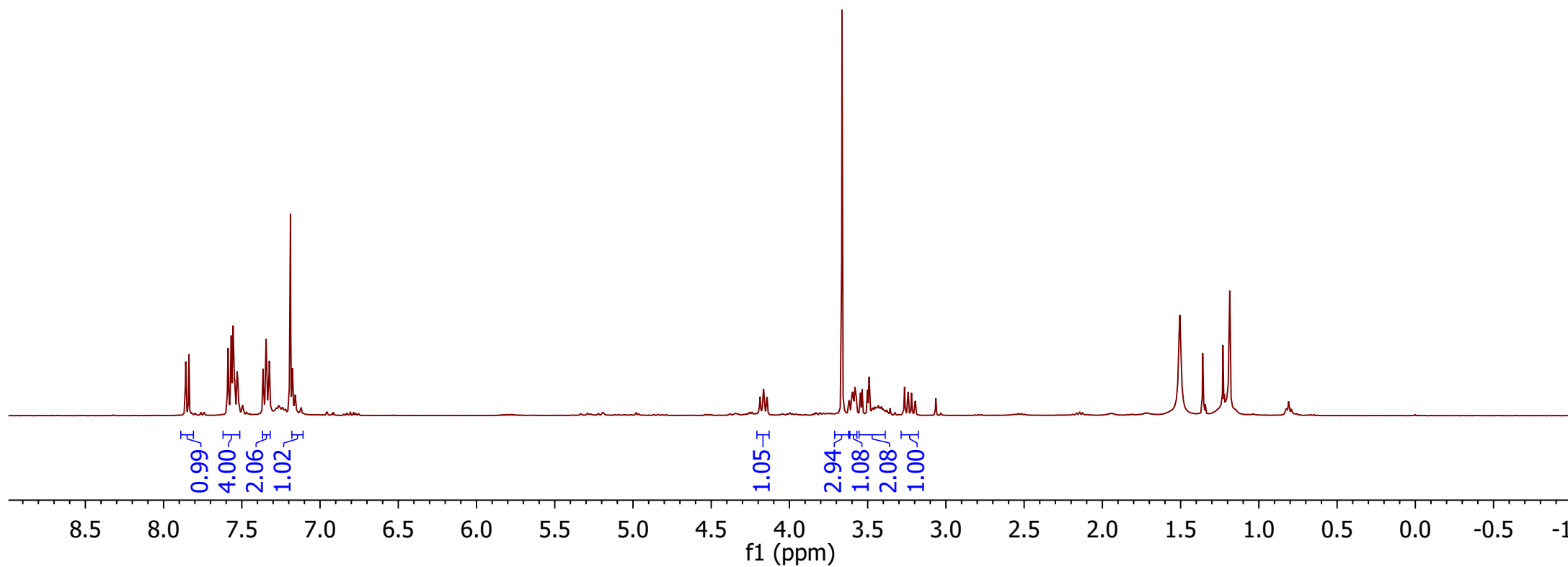
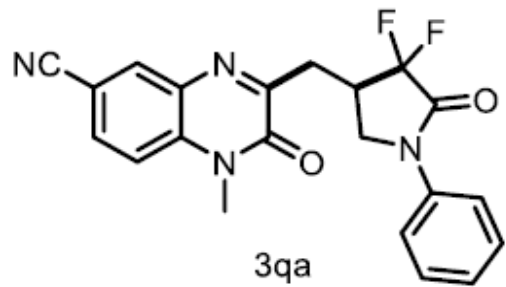
-109.03
-109.07
-109.74
-109.78
-115.98
-116.03
-116.69
-116.74



¹⁹F NMR Spectrum of 3pa

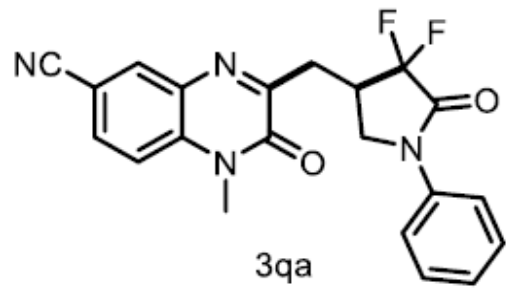
¹H (CDCl₃, 400 MHz)

7.86
7.84
7.59
7.59
7.59
7.58
7.57
7.57
7.57
7.57
7.56
7.56
7.55
7.55
7.53
7.53
7.36
7.36
7.35
7.35
7.34
7.33
7.33
7.32
7.20
7.20
7.19
7.18
7.18
7.16
7.16
4.19
4.19
4.17
4.17
4.16
4.14
4.14
3.66
3.62
3.62
3.60
3.60
3.59
3.58
3.57
3.55
3.54
3.50
3.49
3.26
3.24
3.22
3.20



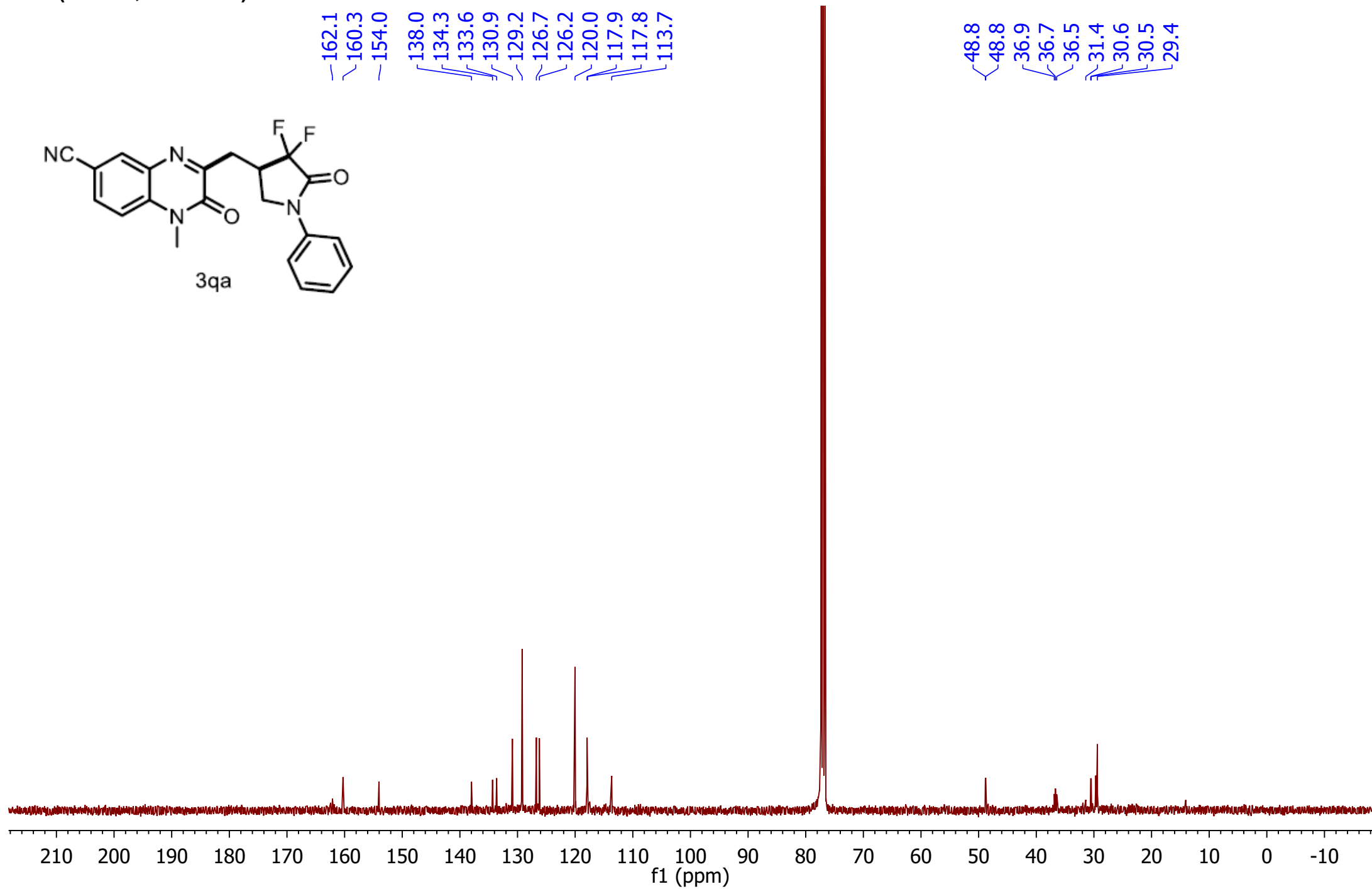
¹H NMR Spectrum of **3qa**

¹³C (CDCl₃, 101 MHz)



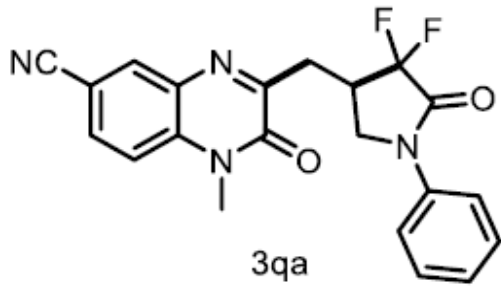
162.1
160.3
154.0
138.0
134.3
133.6
130.9
129.2
126.7
126.2
120.0
117.9
117.8
113.7

48.8
48.8
36.9
36.7
36.5
31.4
30.6
30.5
29.4

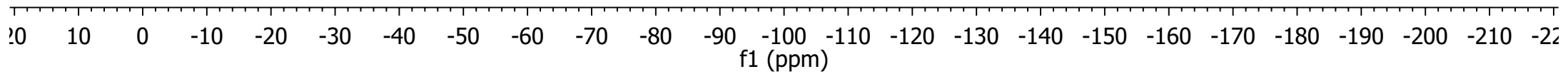


¹³C NMR Spectrum of 3qa

¹⁹F (CDCl₃, 376 MHz)



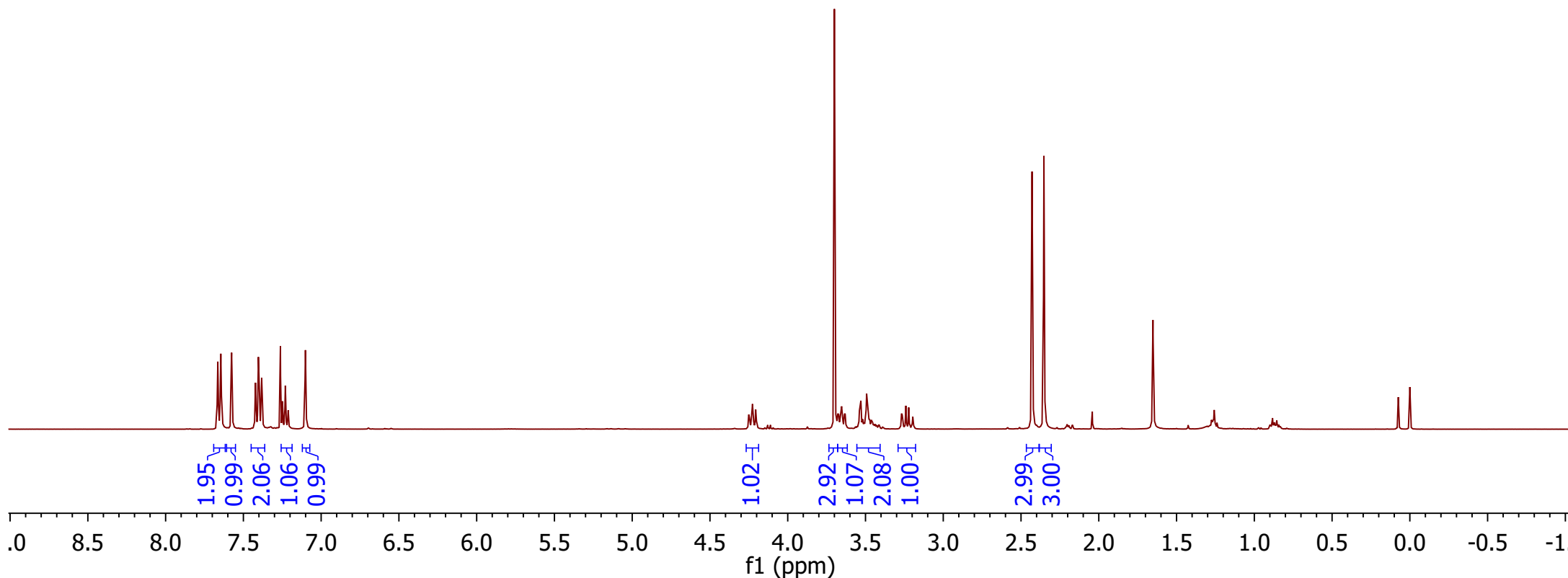
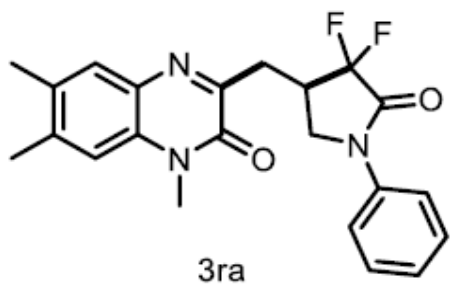
-108.64
-108.68
-109.35
-109.39
-115.98
-116.02
-116.69
-116.74



¹⁹F NMR Spectrum of 3qa

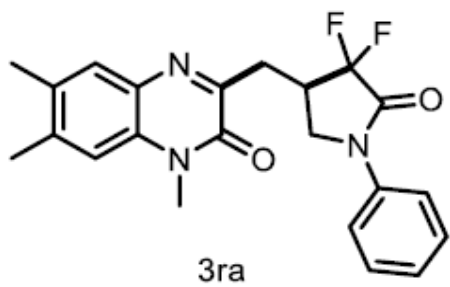
¹H (CDCl₃, 400 MHz)

7.67 7.66 7.66 7.65 7.65 7.65 7.64 7.64 7.58 7.42 7.42 7.41 7.40 7.40 7.40 7.39 7.38 7.26 7.25 7.25 7.23 7.23 7.23 7.21 7.10 4.25 4.25 4.23 4.23 4.22 4.21 4.20 3.70 3.68 3.67 3.66 3.65 3.65 3.64 3.63 3.63 3.54 3.53 3.49 3.49 3.48 3.27 3.26 3.24 3.22 3.20 2.43 2.35



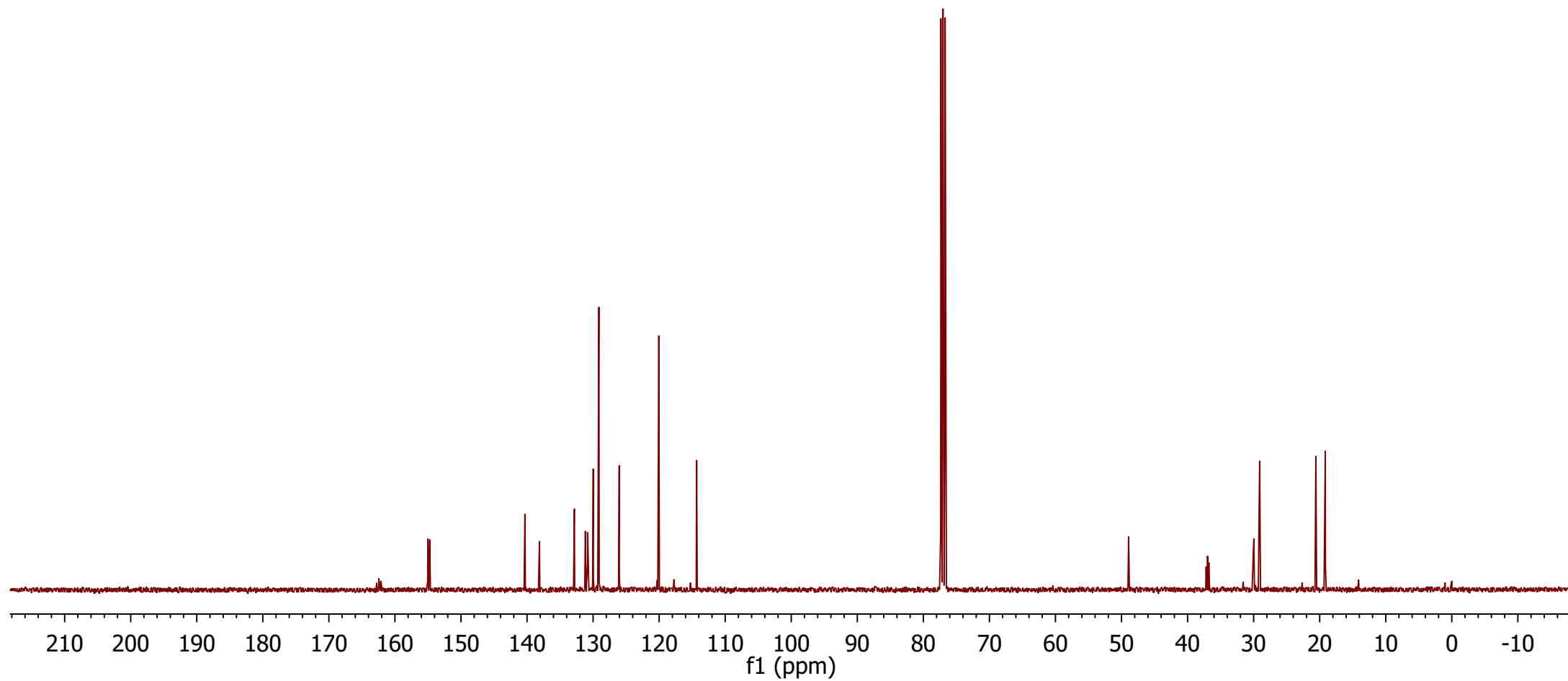
¹H NMR Spectrum of **3ra**

¹³C (CDCl₃, 101 MHz)



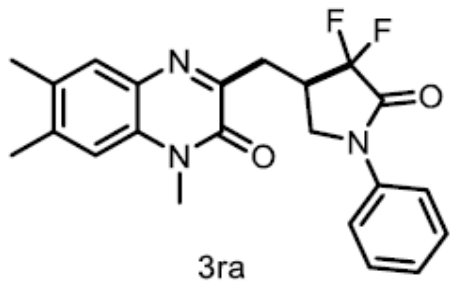
162.7
162.4
162.1
155.0
154.7
140.3
138.1
132.8
131.2
130.8
130.0
129.1
126.0
120.3
120.0
117.8
117.7
115.3
114.3

49.0
48.9
37.2
37.0
37.0
36.8
30.0
30.0
29.1
20.6
19.1

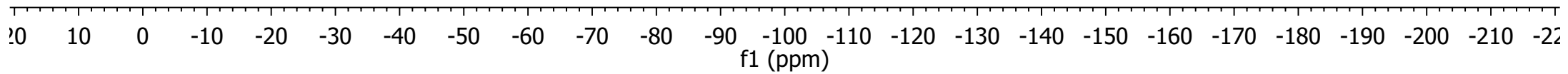


¹³C NMR Spectrum of 3ra

¹⁹F (CDCl₃, 376 MHz)



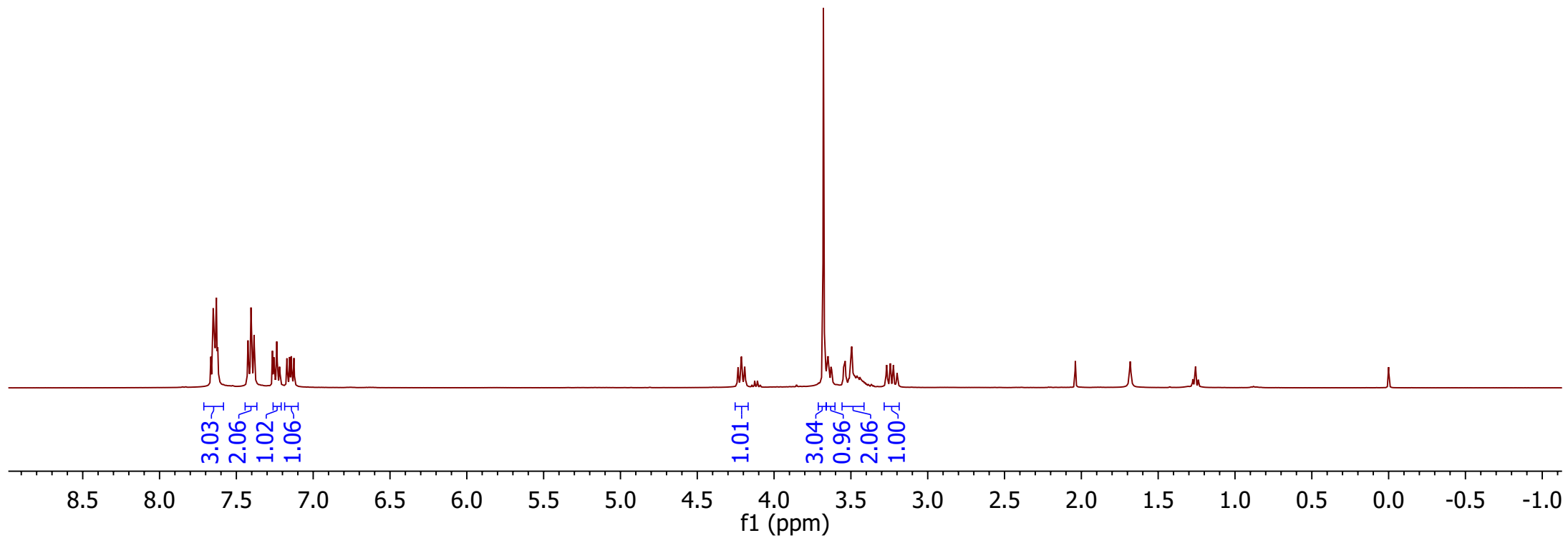
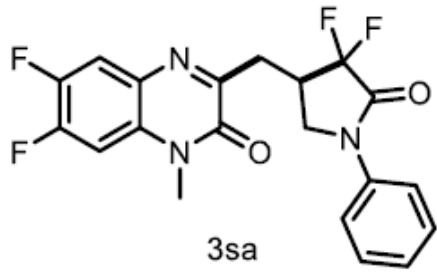
-109.09
-109.13
-109.80
-109.81
-109.84
-116.18
-116.22
-116.89
-116.93



¹⁹F NMR Spectrum of 3ra

¹H (CDCl₃, 400 MHz)

7.67
7.65
7.65
7.65
7.64
7.63
7.63
7.62
7.42
7.42
7.41
7.40
7.39
7.38
7.27
7.26
7.25
7.24
7.22
7.22
7.22
7.17
7.15
7.14
7.13
4.24
4.23
4.22
4.21
4.21
4.19
4.19
3.68
3.67
3.65
3.65
3.64
3.63
3.62
3.55
3.54
3.51
3.50
3.49
3.48
3.47
3.47
3.46
3.45
3.44
3.27
3.24
3.22
3.20

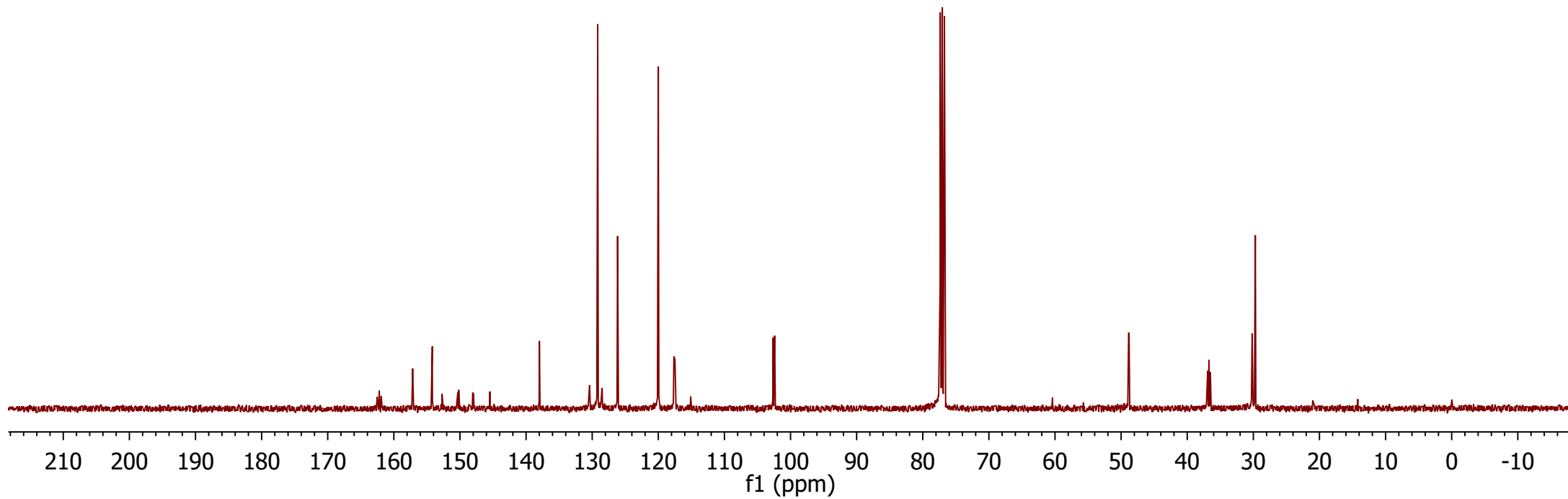
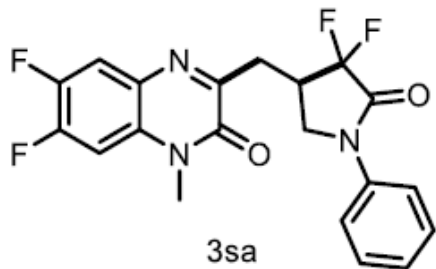


¹H NMR Spectrum of 3sa

¹³C (CDCl₃, 101 MHz)

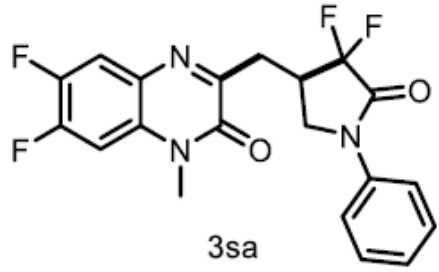
162.2
157.2
157.1
154.2
150.3
150.2
148.1
145.6
145.5
138.0
130.5
130.5
130.4
129.2
128.6
128.5
128.5
126.2
120.1
120.0
117.7
117.6
117.6
117.5
117.5
102.8
102.4

48.9
48.8
36.9
36.7
36.7
36.5
30.2
30.1
29.7

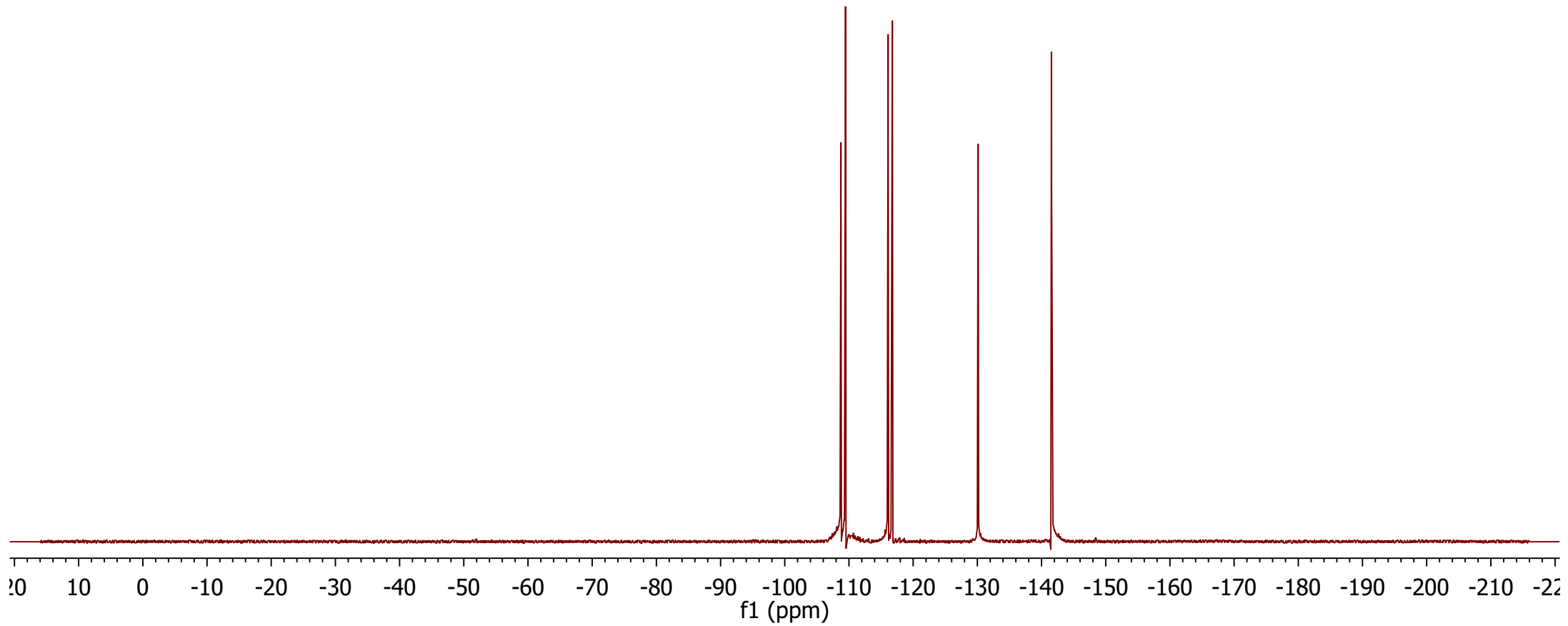


¹³C NMR Spectrum of 3sa

¹⁹F (CDCl₃, 376 MHz)



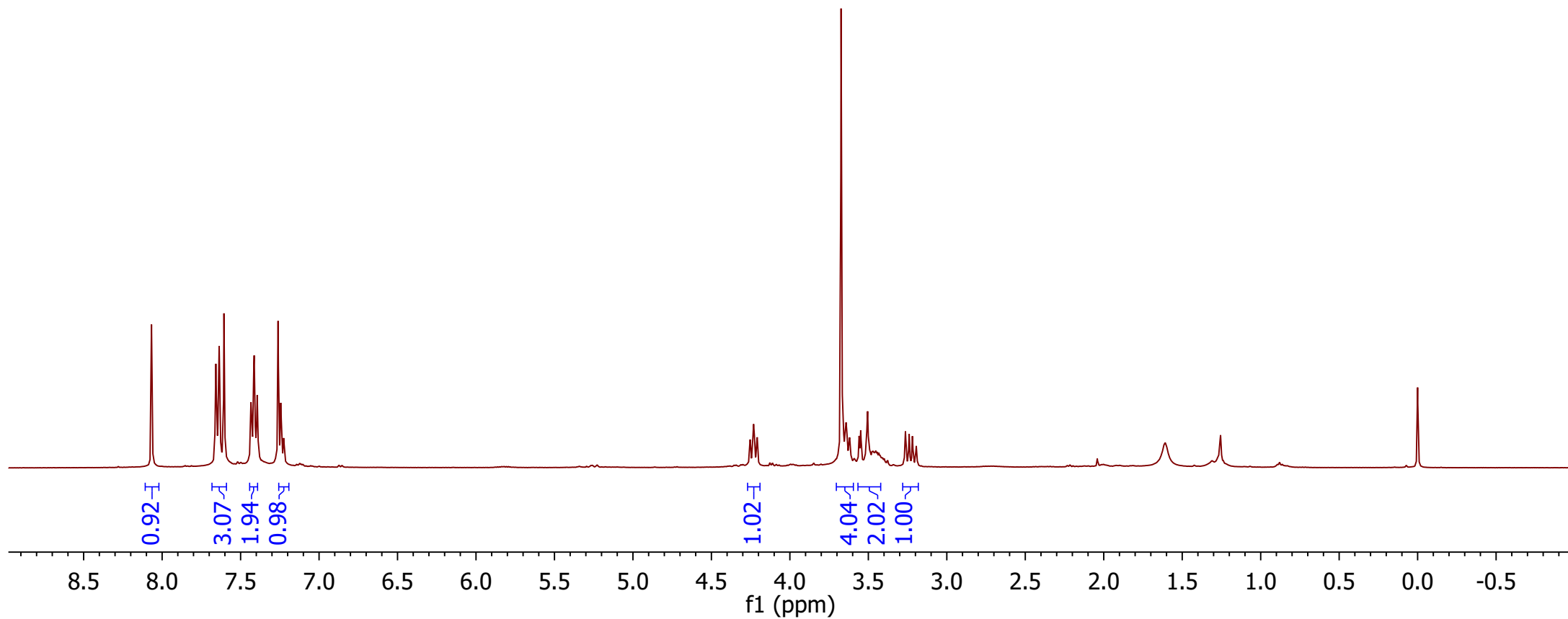
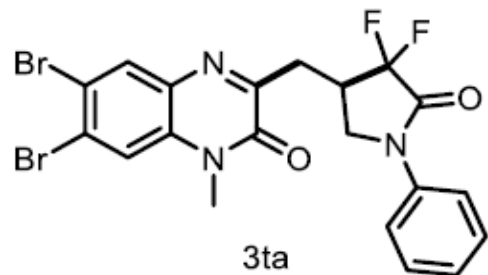
-108.75
-108.79
-109.47
-109.50
-116.05
-116.10
-116.76
-116.81
-130.03
-130.05
-130.06
-130.08
-130.09
-130.11
-130.12
-130.14
-141.46
-141.48
-141.49
-141.50
-141.52
-141.54
-141.55
-141.55
-141.56



¹⁹F NMR Spectrum of 3sa

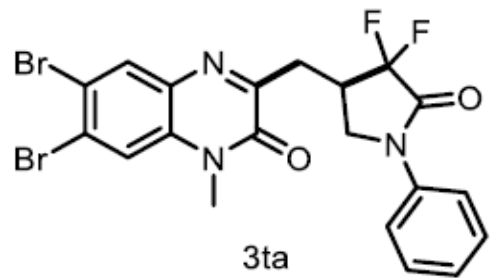
¹H (CDCl₃, 400 MHz)

8.07 8.06 7.66 7.66 7.65 7.64 7.64 7.61 7.60 7.45 7.43 7.43 7.42 7.41 7.39 7.26 7.26 7.24 7.24 7.23 7.23 7.22 4.25 4.24 4.23 4.23 4.21 4.21 3.69 3.67 3.67 3.66 3.65 3.64 3.64 3.62 3.62 3.56 3.55 3.51 3.50 3.49 3.49 3.48 3.47 3.46 3.45 3.44 3.43 3.42 3.26 3.24 3.22 3.19



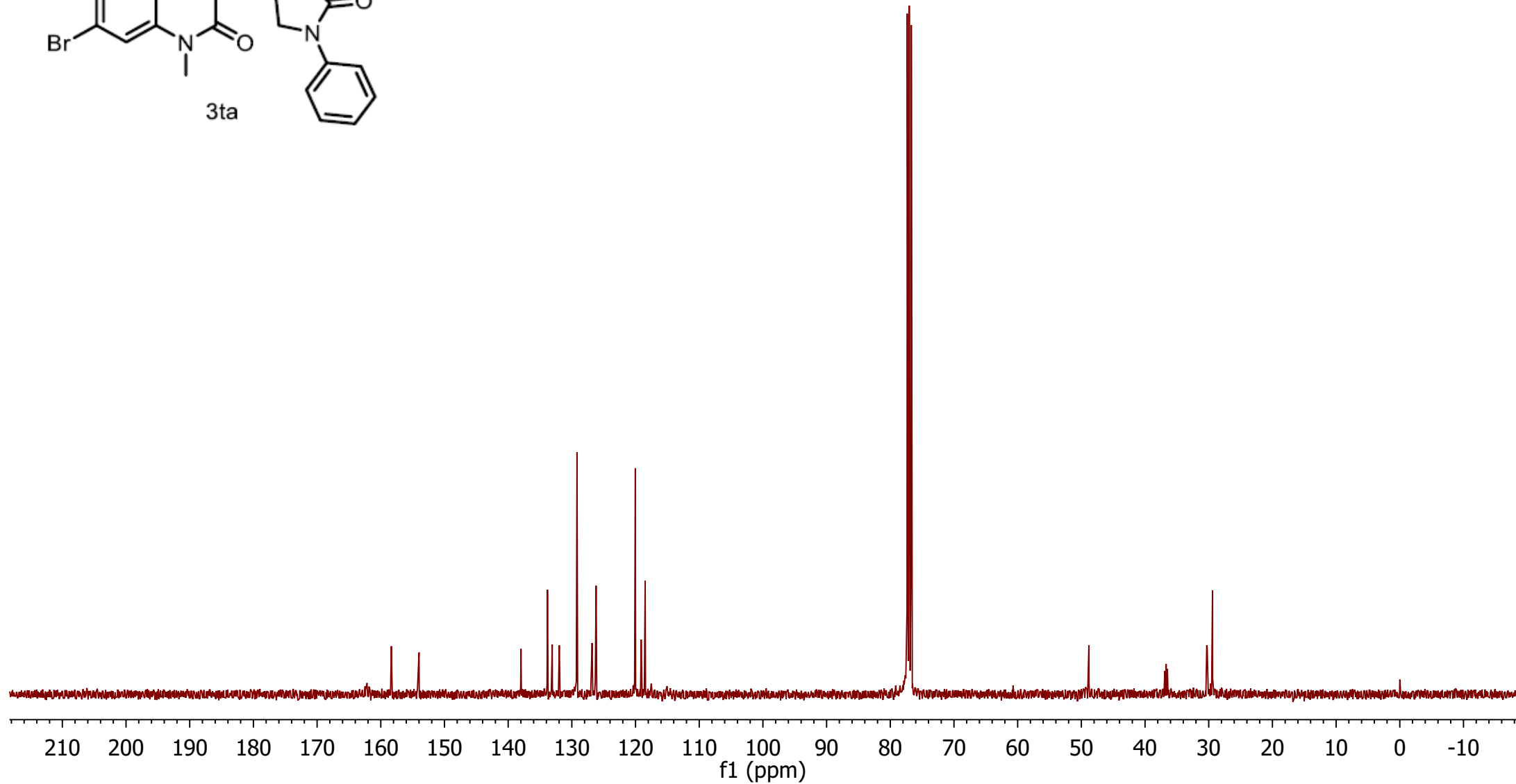
¹H NMR Spectrum of 3ta

¹³C (CDCl₃, 101 MHz)



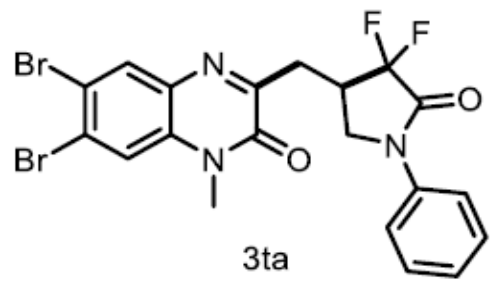
162.2
158.3
154.0
138.0
133.8
133.1
132.0
129.3
129.2
126.8
126.2
120.0
119.1
118.5

48.9
48.8
36.9
36.7
36.5
30.3
30.2
29.4

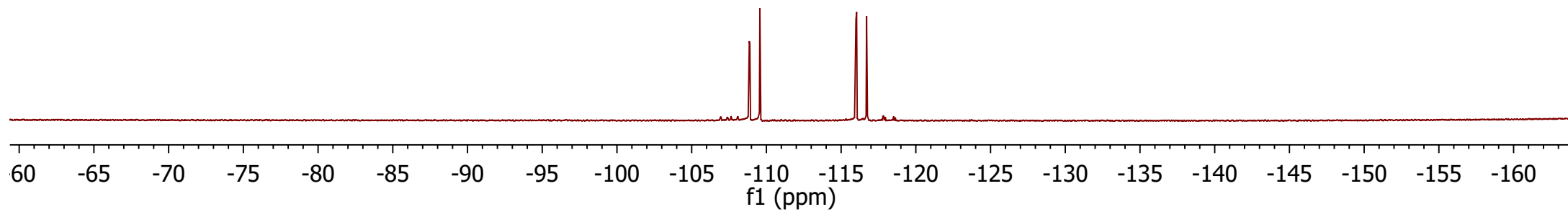


¹³C NMR Spectrum of 3ta

19F (CDCl3, 376 MHz)



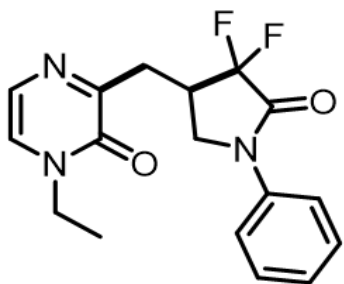
-108.85
-108.89
-109.56
-109.60
-115.99
-116.04
-116.70
-116.75



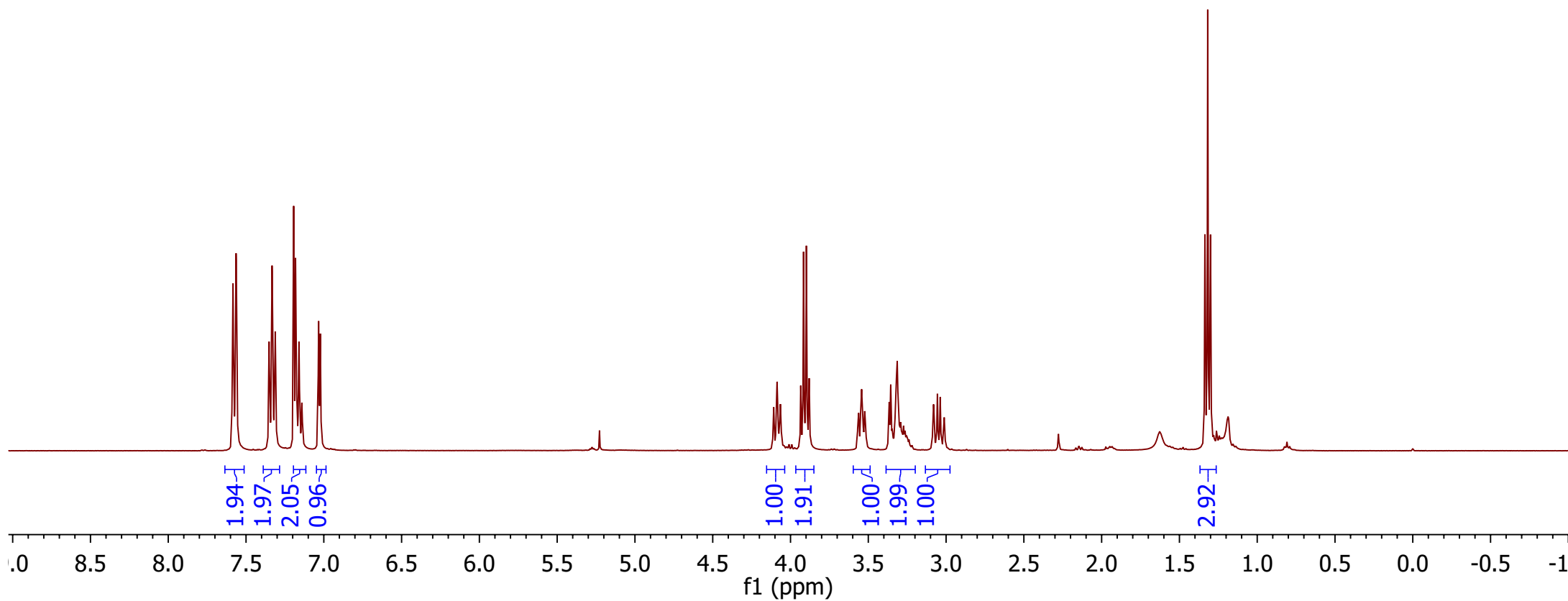
¹⁹F NMR Spectrum of 3ta

¹H (CDCl₃, 400 MHz)

7.59
7.58
7.58
7.56
7.56
7.56
7.35
7.35
7.33
7.33
7.32
7.31
7.31
7.19
7.18
7.18
7.17
7.16
7.14
7.14
7.14
7.03
7.02
4.11
4.11
4.09
4.09
4.08
4.07
4.06
3.93
3.92
3.90
3.88
3.57
3.56
3.55
3.54
3.54
3.52
3.52
3.37
3.36
3.33
3.32
3.31
3.29
3.08
3.06
3.04
3.01
1.34
1.32
1.30

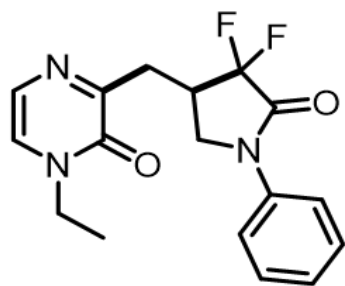


3ua



¹H NMR Spectrum of **3ua**

¹³C (CDCl₃, 101 MHz)

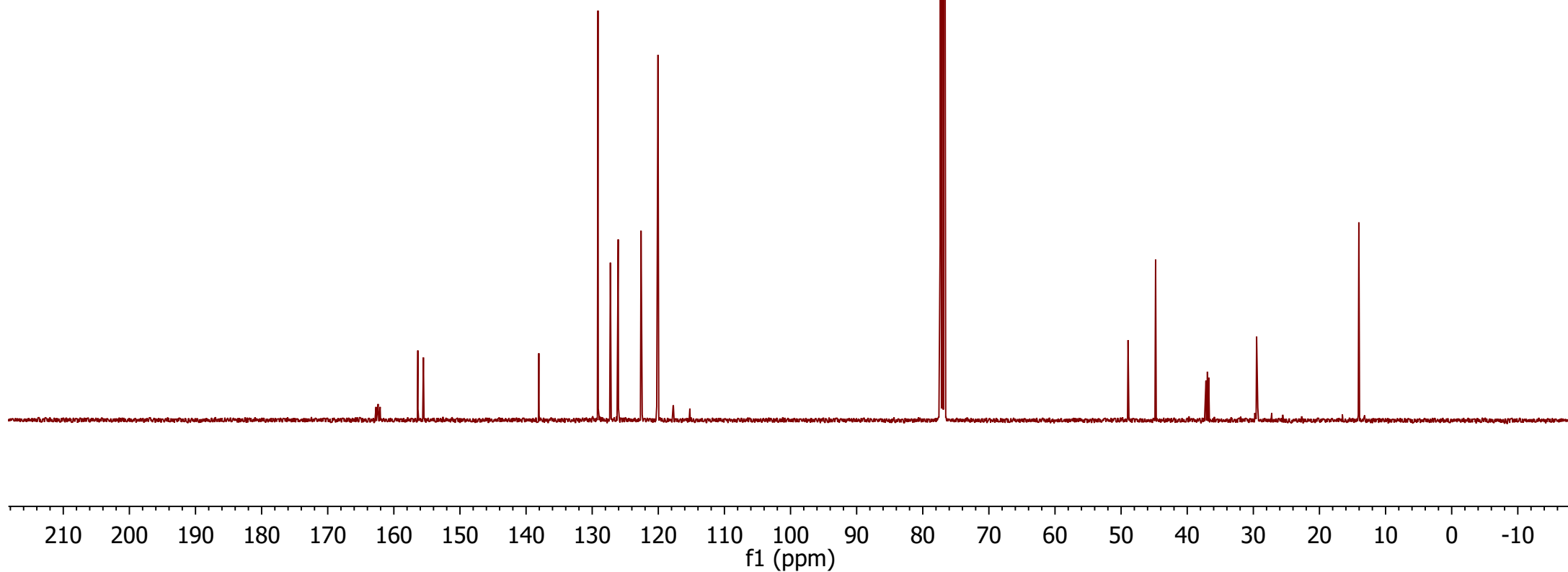


3ua

162.7
162.4
162.1
156.4
155.5

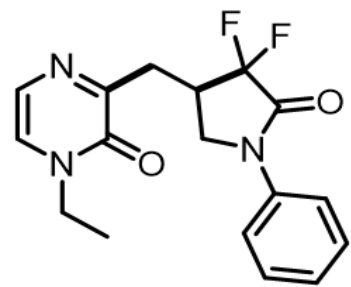
138.1
129.1
127.3
126.1
122.6
120.2
120.0
117.8
117.7
115.2

49.0
48.9
44.8
37.2
37.0
36.9
36.8
29.5
29.4
14.0



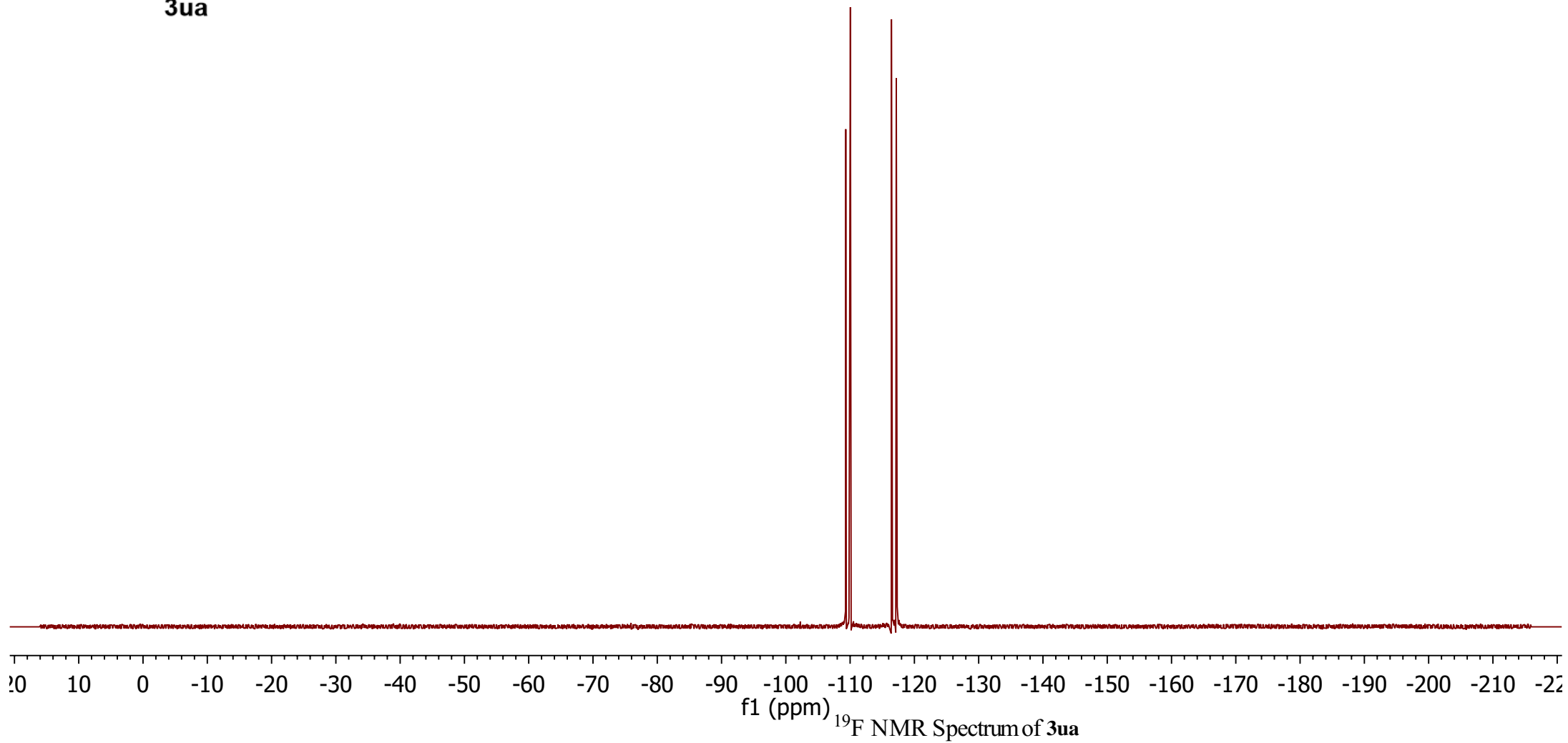
¹³C NMR Spectrum of 3ua

19F (CDCl3, 376 MHz)



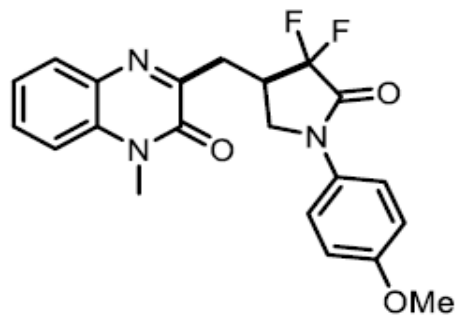
3ua

-109.33
-109.36
-110.04
-110.07
-116.43
-116.47
-117.14
-117.18

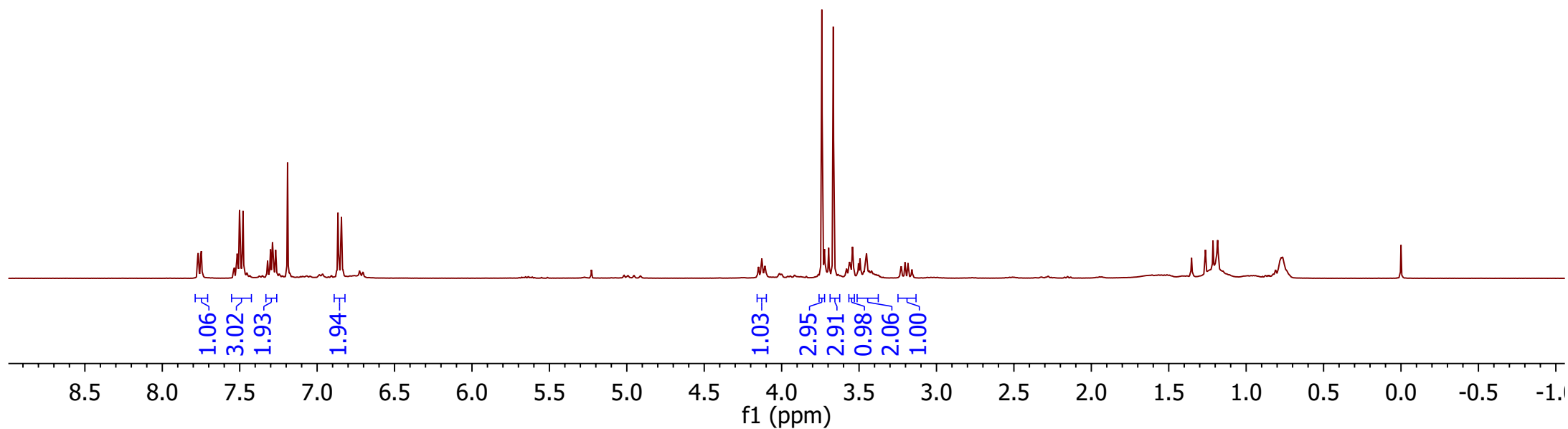


¹H (CDCl₃, 400 MHz)

7.77 7.77 7.75 7.75 7.52 7.52 7.51 7.51 7.50 7.50 7.48 7.48 7.32 7.32 7.30 7.30 7.30 7.29 7.28 7.27 7.27 7.19 6.87 6.86 6.85 6.84 4.15 4.15 4.13 4.13 4.12 4.11 4.10 3.74 3.72 3.71 3.70 3.67 3.59 3.58 3.57 3.56 3.55 3.54 3.54 3.50 3.49 3.46 3.46 3.45 3.23 3.23 3.20 3.18 3.16

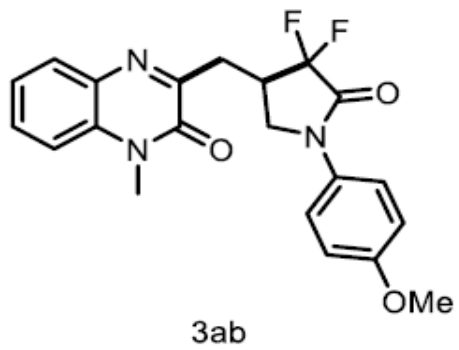


3ab



¹H NMR Spectrum of 3ab

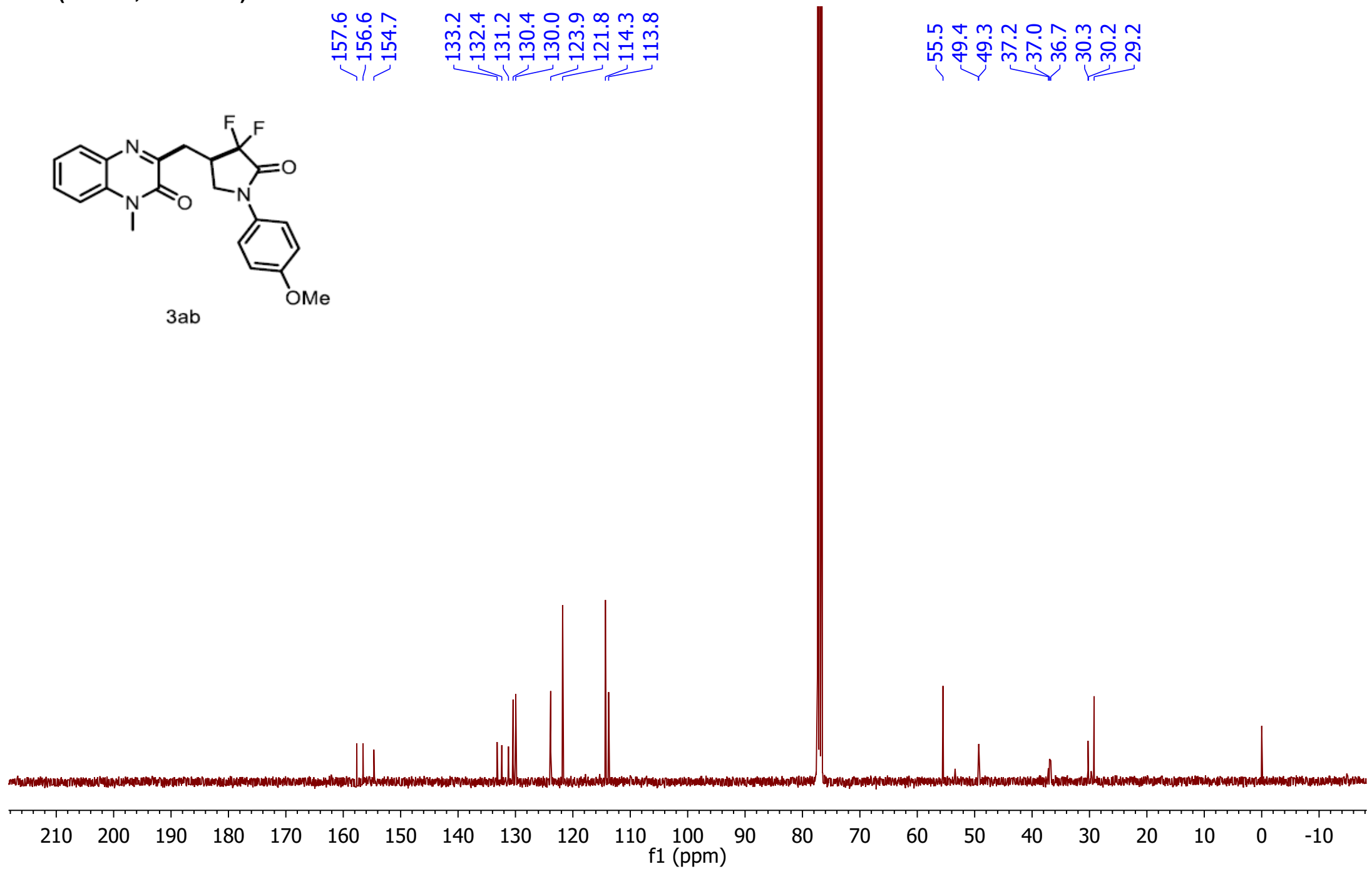
¹³C (CDCl₃, 101 MHz)



157.6
156.6
154.7

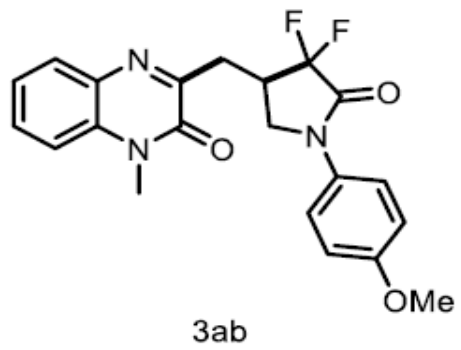
133.2
132.4
131.2
130.4
130.0
123.9
121.8
114.3
113.8

55.5
49.4
49.3
37.2
37.0
36.7
30.3
30.2
29.2

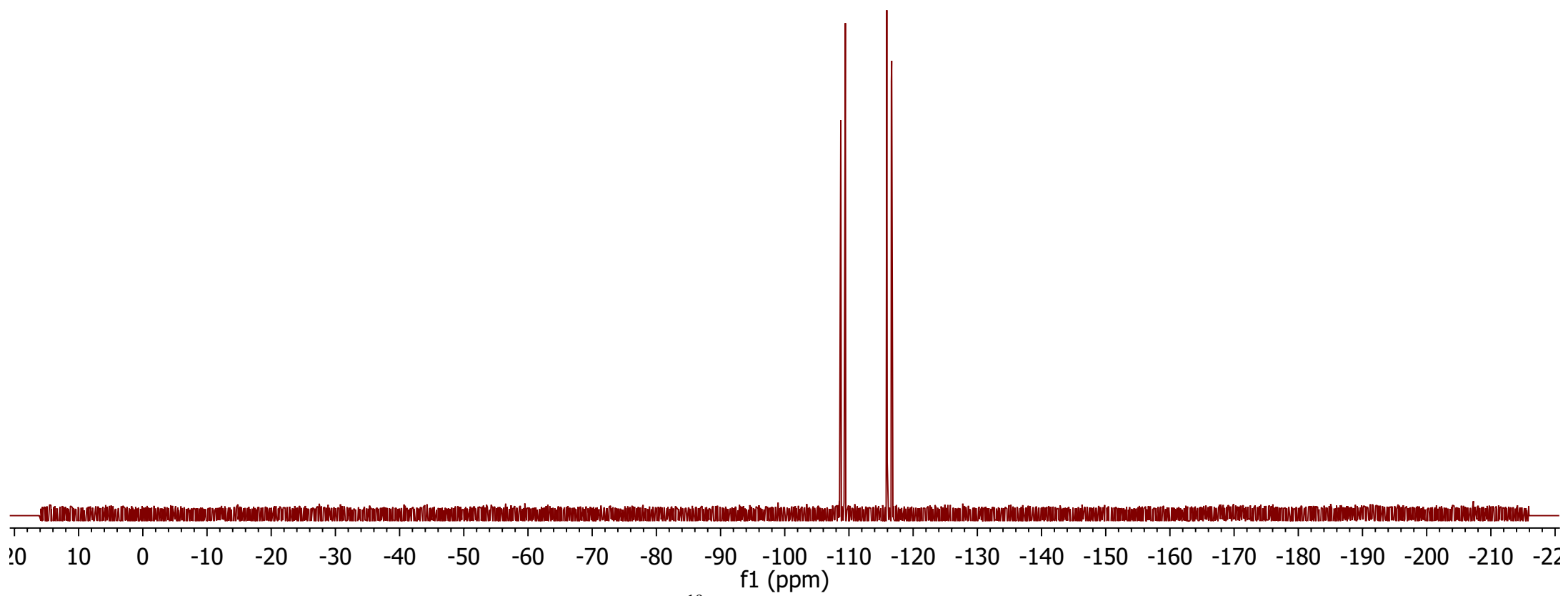


¹³C NMR Spectrum of 3ab

¹⁹F (CDCl₃, 376 MHz)



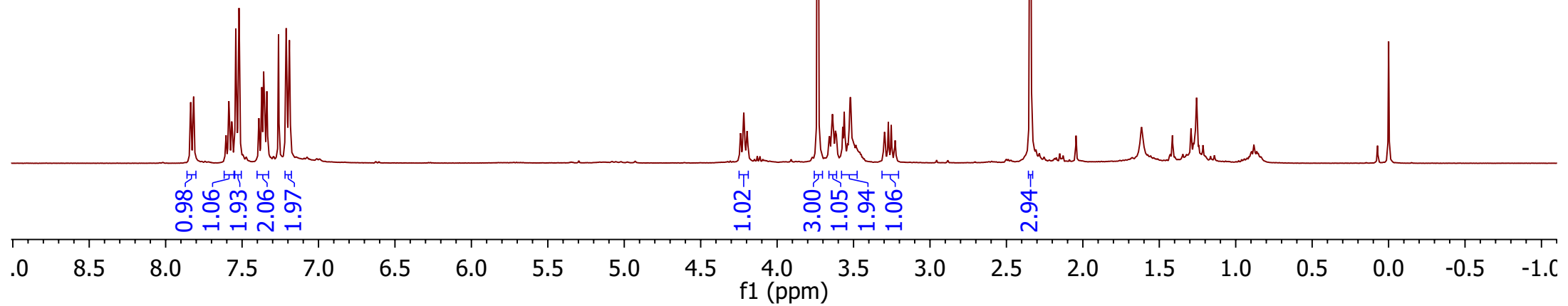
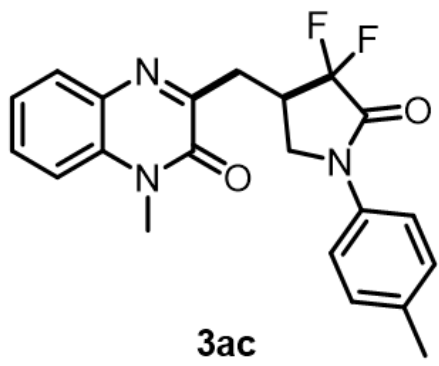
-108.73
-108.77
-109.44
-109.48
-115.90
-115.95
-116.61
-116.66



¹⁹F NMR Spectrum of 3ab

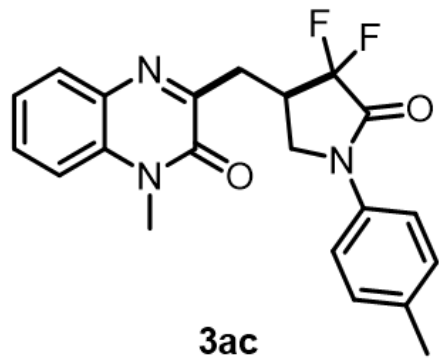
¹H (CDCl₃, 400 MHz)

7.84 7.84 7.82 7.82 7.61 7.60 7.59 7.59 7.58 7.57 7.57 7.54 7.54 7.52 7.52 7.39 7.39 7.37 7.37 7.36 7.35 7.34 7.26 7.21 7.19 4.24 4.24 4.22 4.22 4.21 4.21 4.20 4.19 3.73 3.66 3.66 3.64 3.64 3.63 3.62 3.61 3.57 3.56 3.54 3.52 3.52 3.50 3.49 3.48 3.30 3.30 3.27 3.25 3.23 2.34



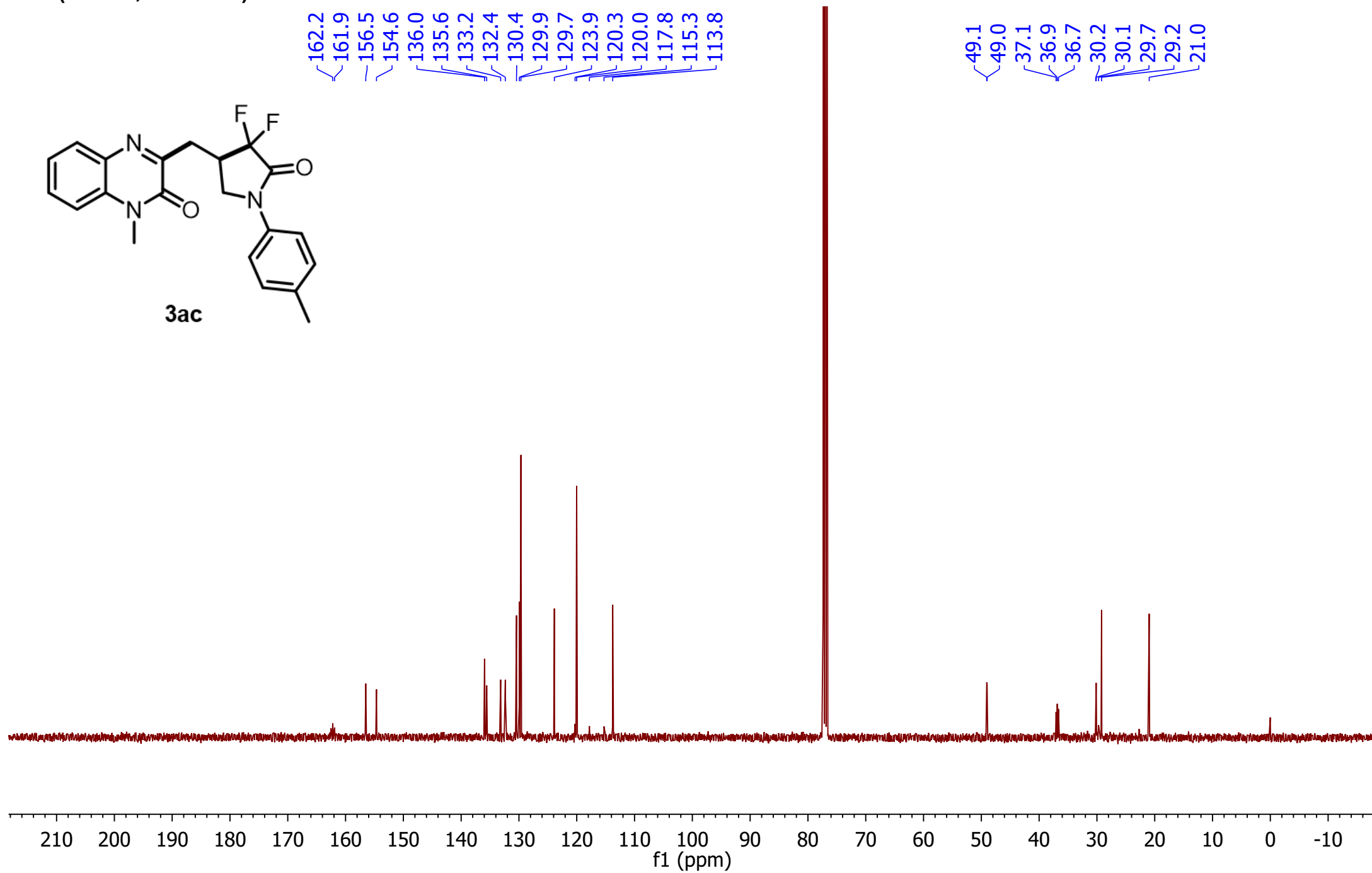
¹H NMR Spectrum of **3ac**

¹³C (CDCl₃, 101 MHz)



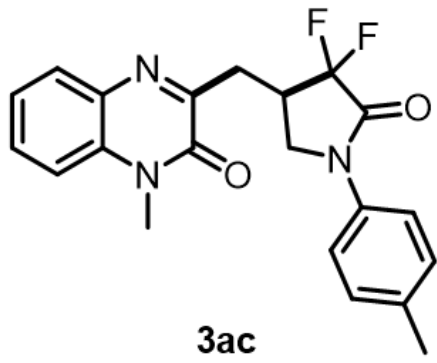
162.2
161.9
156.5
154.6
136.0
135.6
133.2
132.4
130.4
129.9
129.7
123.9
120.3
120.0
117.8
115.3
113.8

49.1
49.0
37.1
36.9
36.7
30.2
30.1
29.7
29.2
21.0

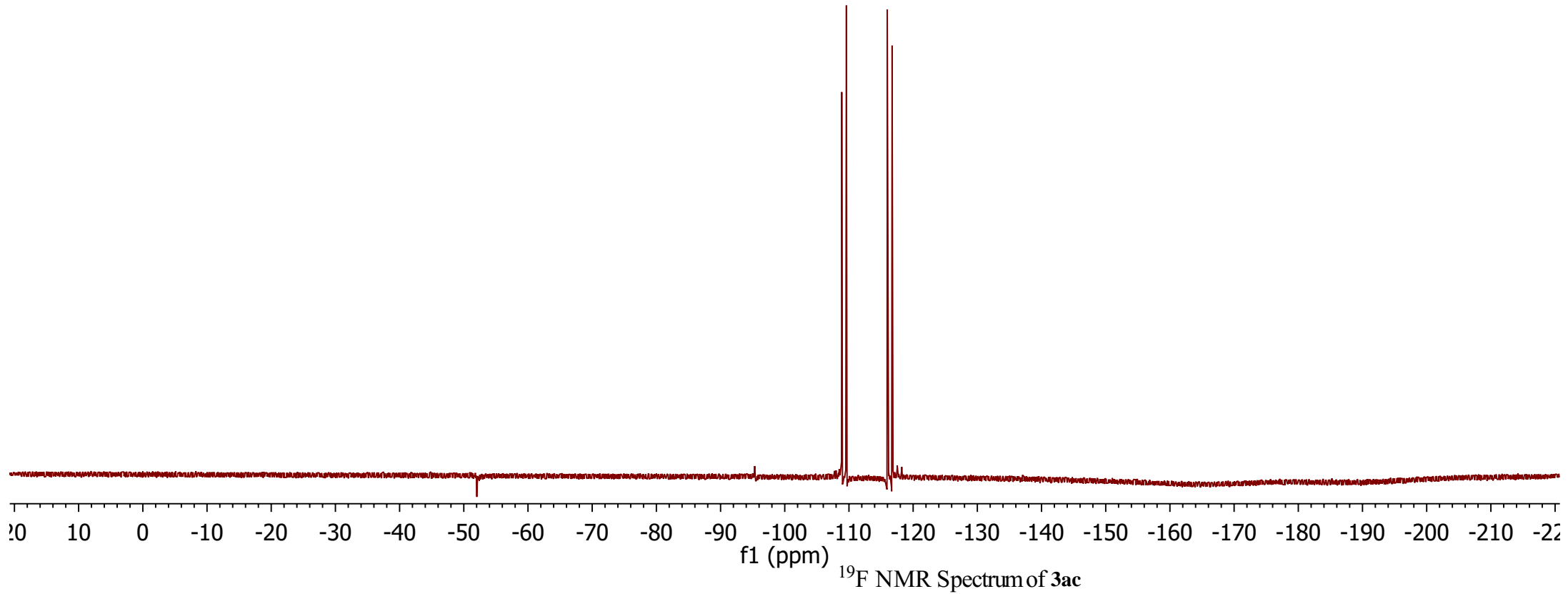


¹³C NMR Spectrum of 3ac

¹⁹F (CDCl₃, 376 MHz)

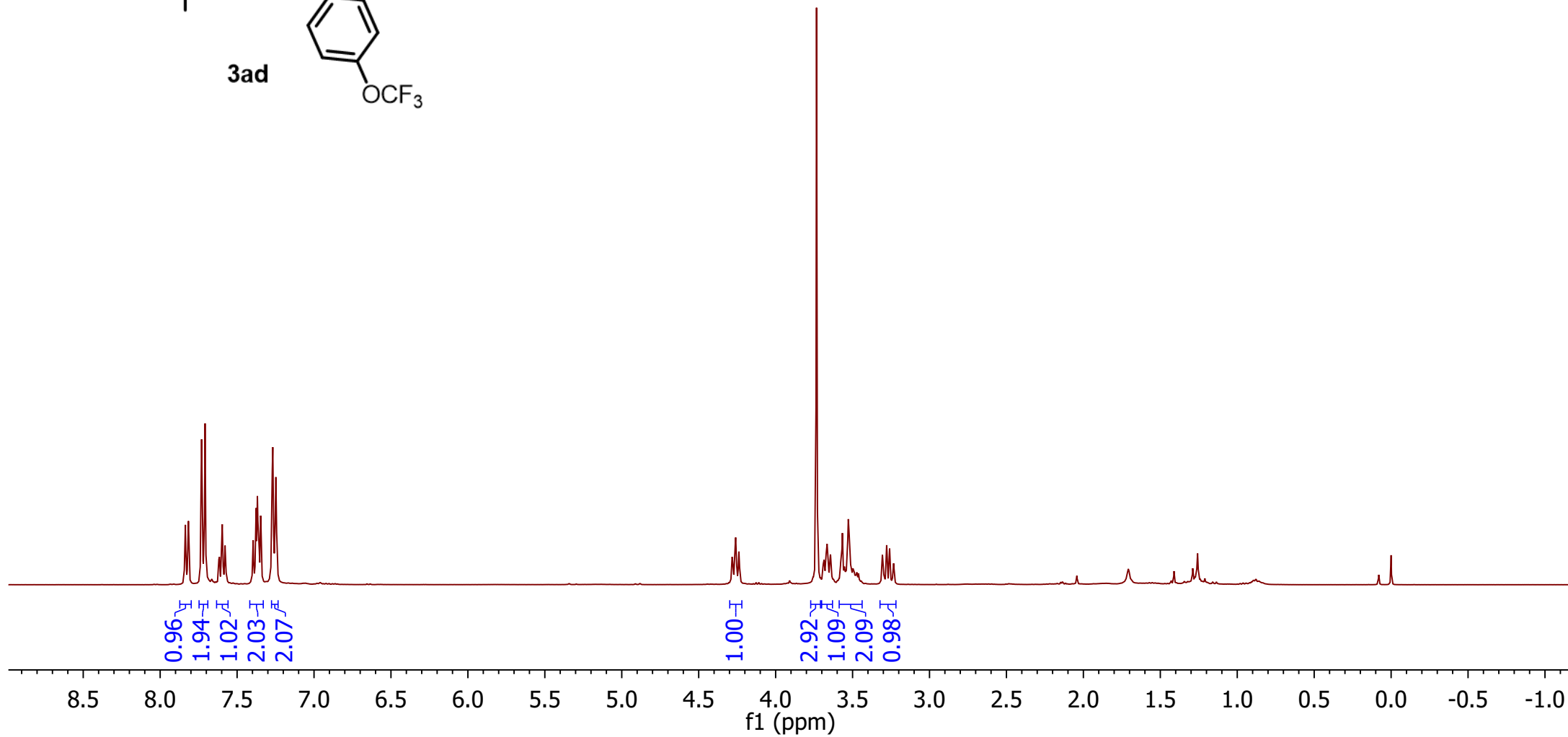
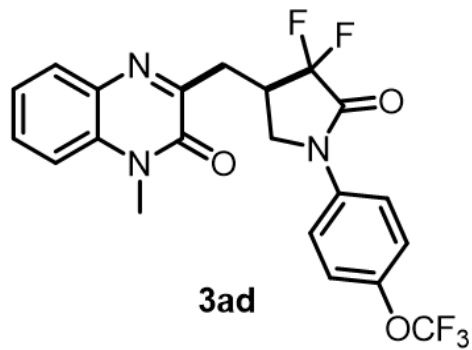


-108.88
-108.92
-109.59
-109.63
-115.97
-116.01
-116.68
-116.72



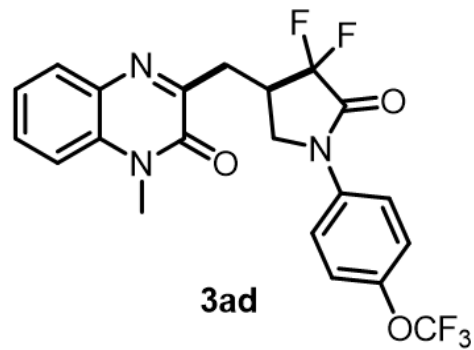
¹H (CDCl₃, 400 MHz)

7.84 7.84 7.82 7.82 7.74 7.73 7.73 7.71 7.71 7.70 7.62 7.61 7.60 7.60 7.59 7.58 7.57 7.40 7.40 7.38 7.38 7.37 7.36 7.36 7.35 7.34 7.27 7.27 7.25 4.28 4.28 4.26 4.26 4.26 4.24 4.24 3.73 3.69 3.68 3.67 3.67 3.66 3.65 3.64 3.58 3.57 3.53 3.52 3.52 3.31 3.30 3.28 3.26 3.23

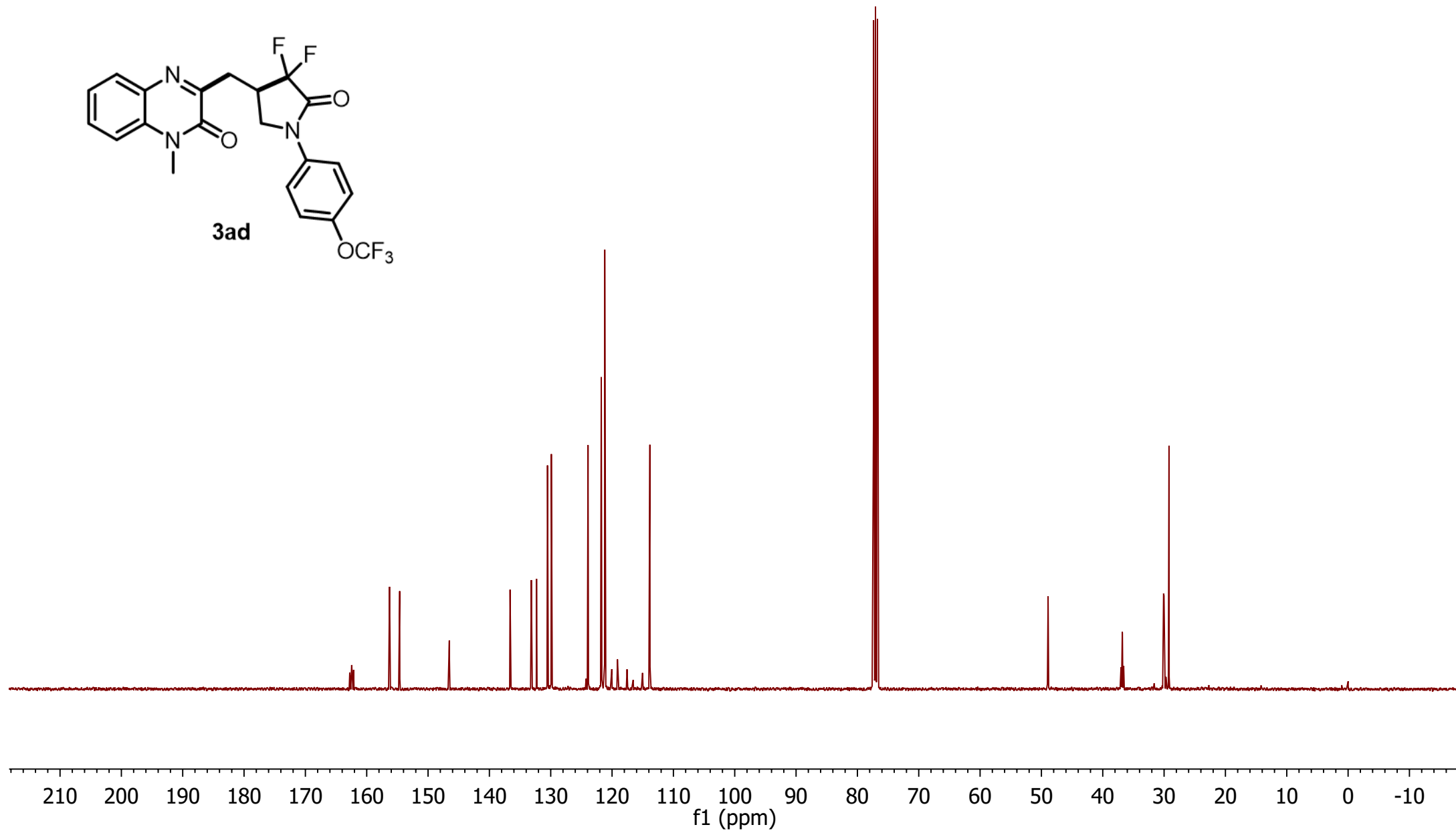


¹H NMR Spectrum of **3ad**

¹³C (CDCl₃, 101 MHz)

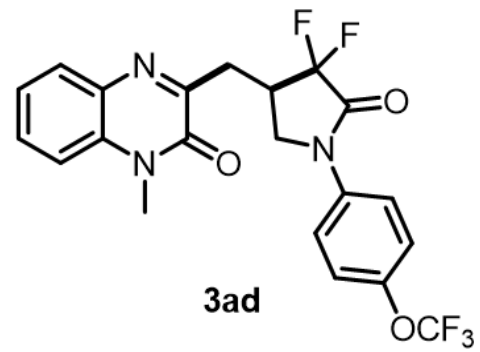


162.8
162.5
162.1
156.3
154.6
146.6
146.6
146.5
146.5
136.6
133.2
132.3
130.5
129.9
124.2
123.9
121.8
121.7
121.2
120.0
119.1
117.6
117.5
116.6
115.0
113.8
49.0
48.9
37.0
36.8
36.8
36.6
30.1
30.0
29.2



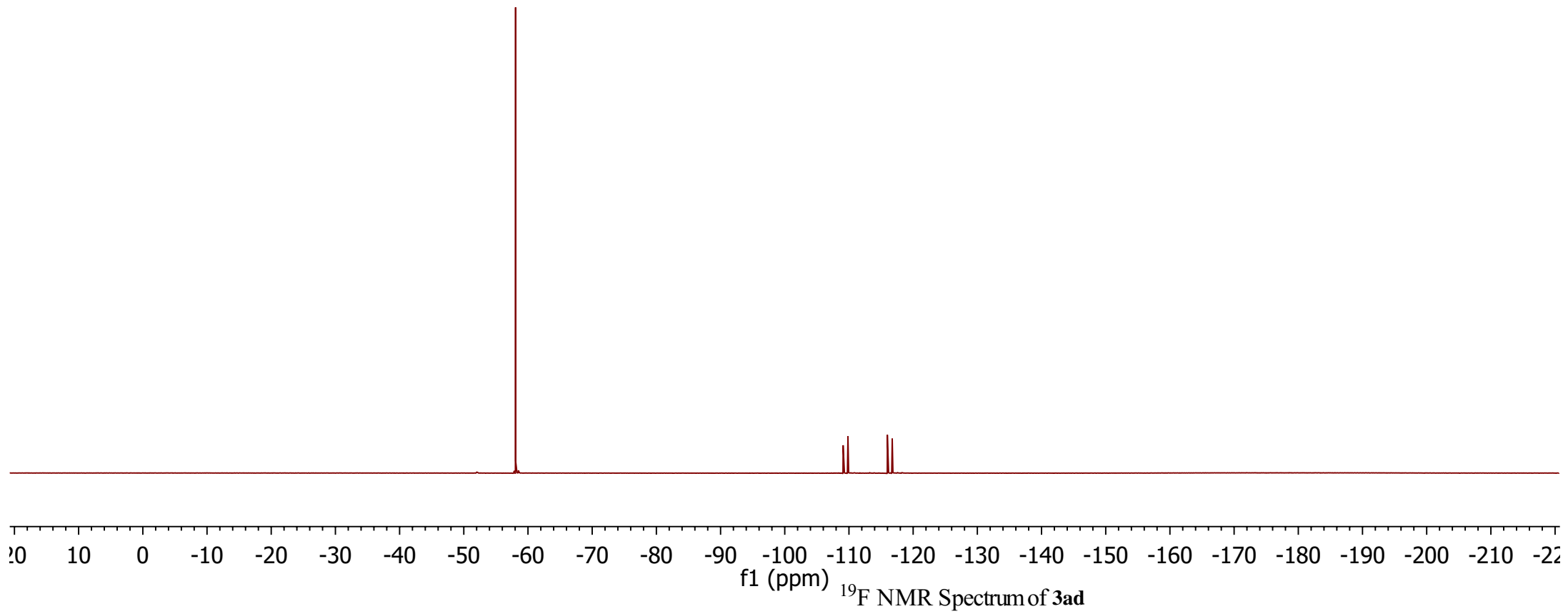
¹³C NMR Spectrum of **3ad**

19F (CDCl3, 376 MHz)



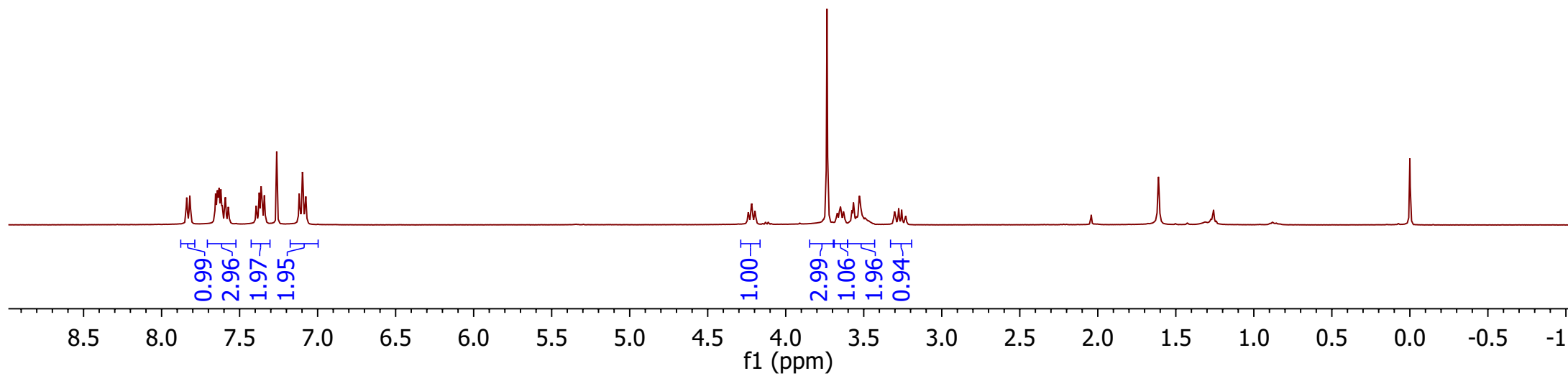
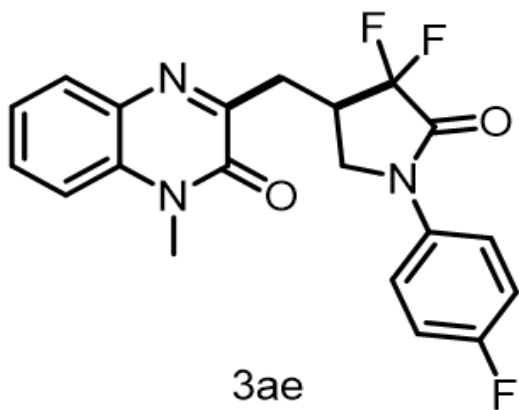
--58.06

-109.09
-109.13
-109.81
-109.84
-115.98
-116.03
-116.70
-116.74



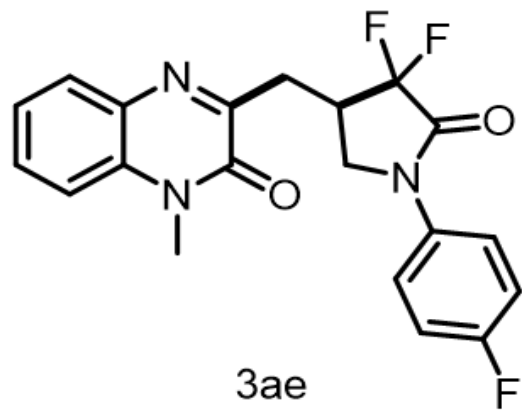
¹H (CDCl₃, 400 MHz)

7.84 7.84 7.82 7.82 7.65 7.64 7.63 7.62 7.61 7.61 7.59 7.57 7.57 7.39 7.39 7.37 7.36 7.36 7.35 7.34 7.26 7.12 7.11 7.10 7.08 4.22 4.20 3.78 3.75 3.74 3.67 3.67 3.66 3.65 3.64 3.63 3.63 3.58 3.57 3.56 3.55 3.53 3.52 3.51 3.50 3.49 3.48 3.47 3.30 3.28 3.26 3.23



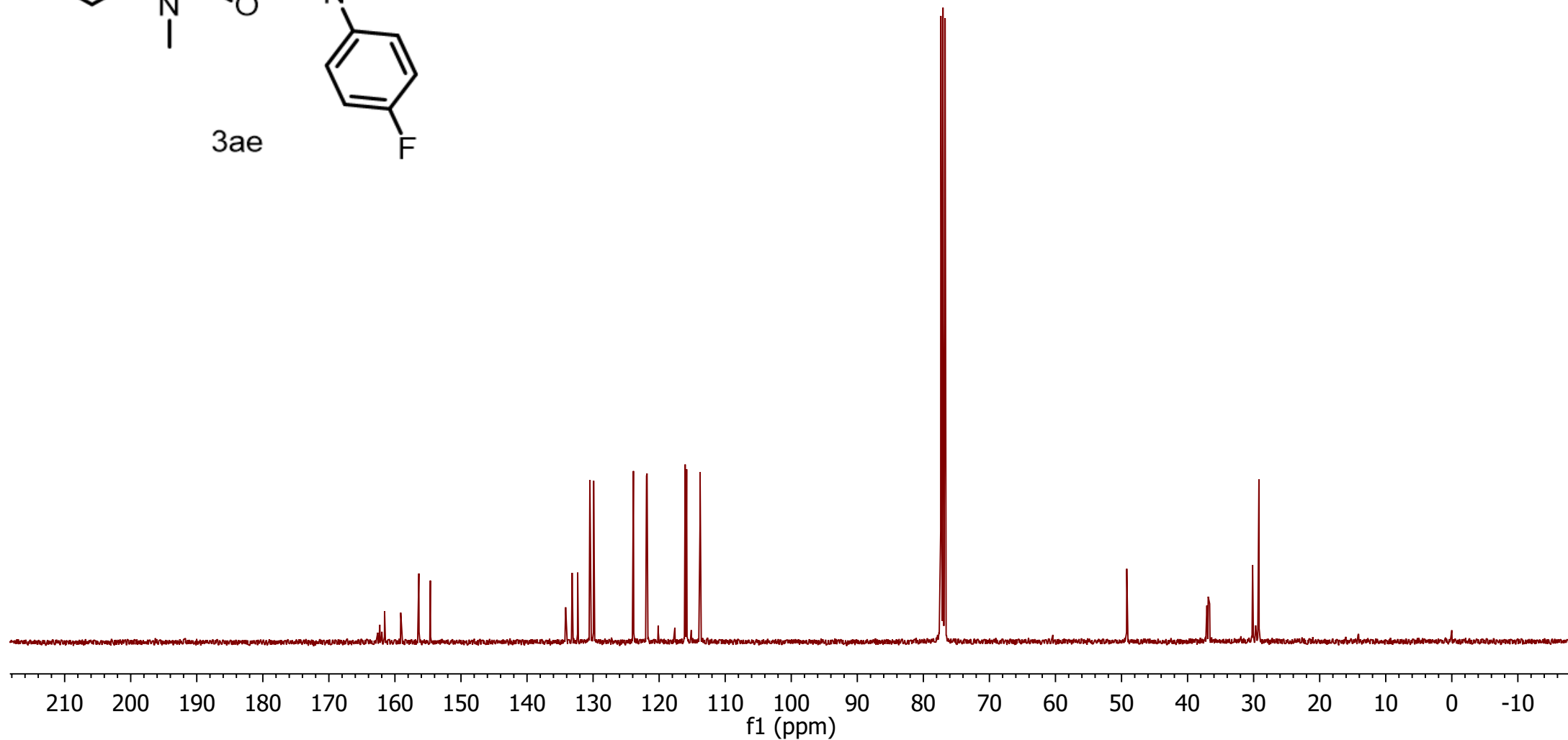
¹H NMR Spectrum of **3ae**

¹³C (CDCl₃, 101 MHz)



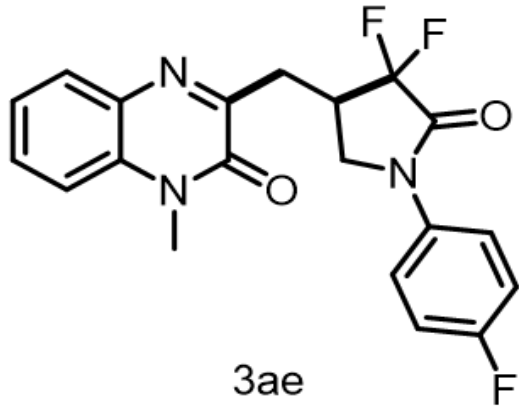
162.6
162.3
162.0
161.6
159.1
156.4
154.6
134.2
134.2
133.2
132.3
130.5
129.9
123.9
121.9
121.8
120.1
117.6
116.1
115.8
115.1
113.8

49.2
49.1
37.1
36.9
36.9
36.7
30.2
30.1
29.2

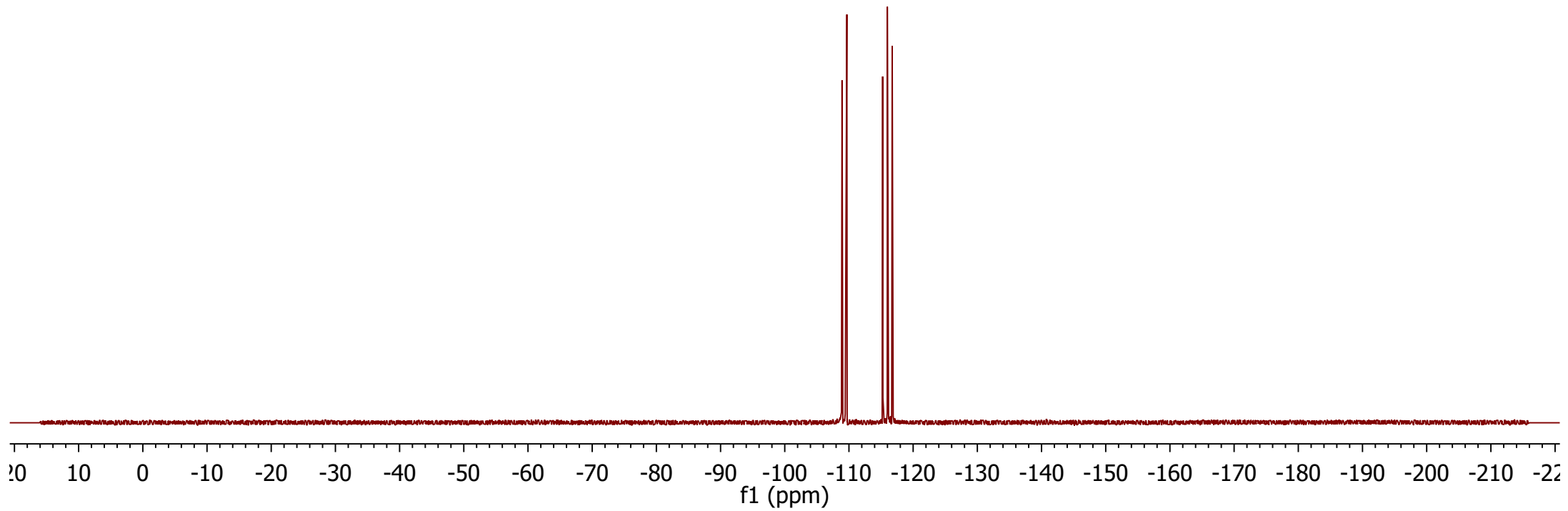


¹³C NMR Spectrum of 3ae

¹⁹F (CDCl₃, 376 MHz)



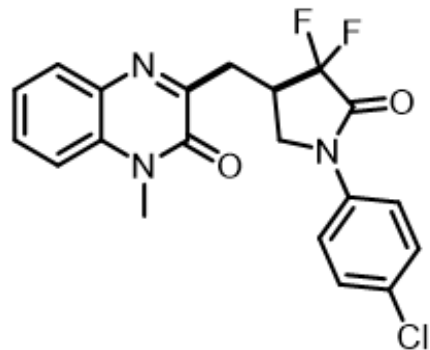
-108.93
-108.96
-109.64
-109.68
-115.21
-115.23
-115.24
-115.25
-115.26
-115.27
-115.28
-115.98
-116.03
-116.69
-116.74



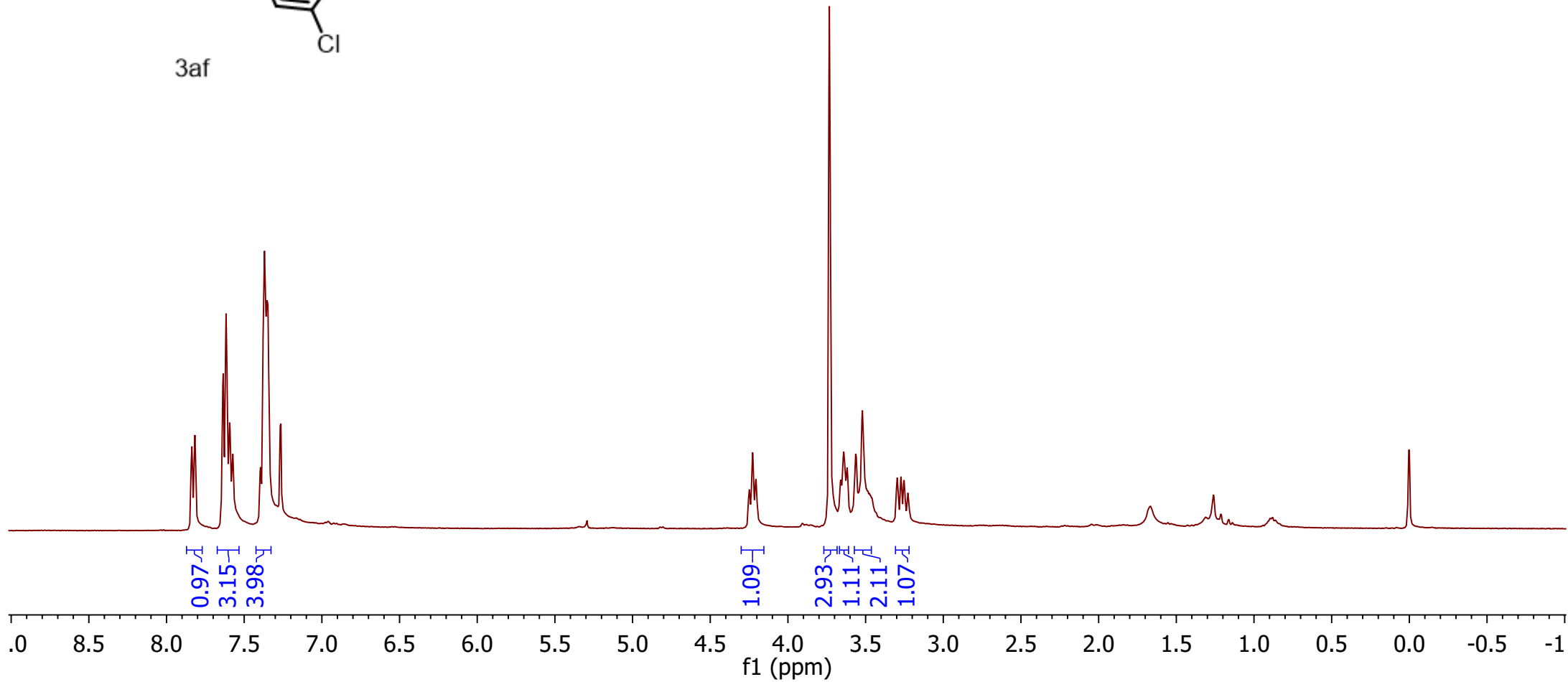
¹⁹F NMR Spectrum of 3ae

¹H (CDCl₃, 400 MHz)

7.84 7.84 7.82 7.82 7.81 7.64 7.64 7.63 7.62 7.61 7.59 7.58 7.57 7.55 7.54 7.40 7.39 7.38 7.37 7.36 7.35 7.35 7.34 3.74 3.73 3.73 3.71 3.66 3.64 3.64 3.62 3.57 3.56 3.56 3.52 3.49 3.48 3.47 3.47 3.46 3.30 3.27 3.27 3.25 3.25 3.23 3.22

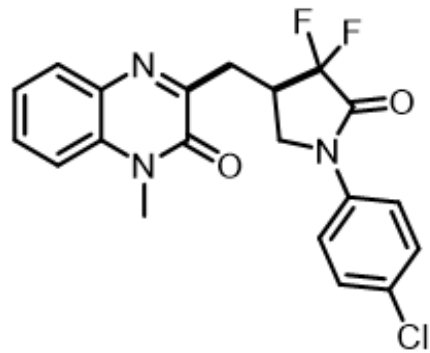


3af



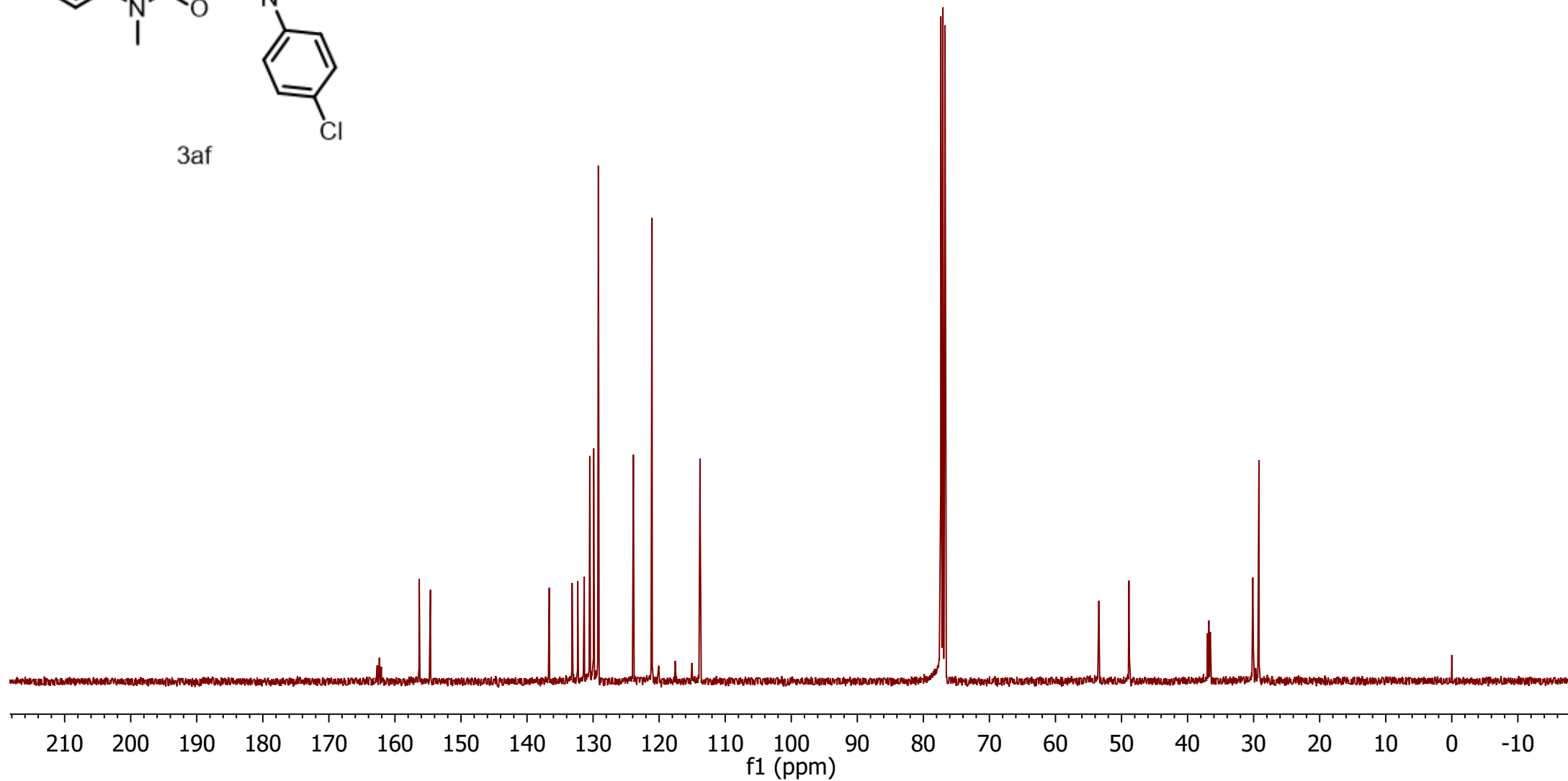
¹H NMR Spectrum of **3af**

¹³C (CDCl₃, 101 MHz)



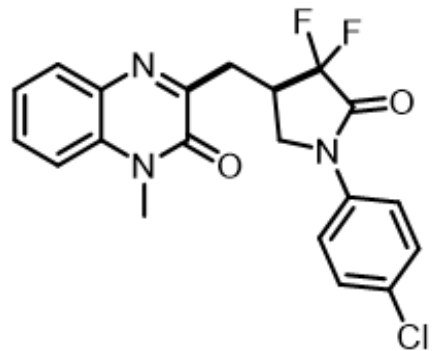
162.7
162.4
162.1
156.3
154.6
136.6
133.2
132.3
131.3
130.5
129.9
129.2
123.9
121.1
120.1
117.6
115.0
113.8

48.9
48.8
37.0
36.8
36.8
36.6
30.1
30.1
29.2



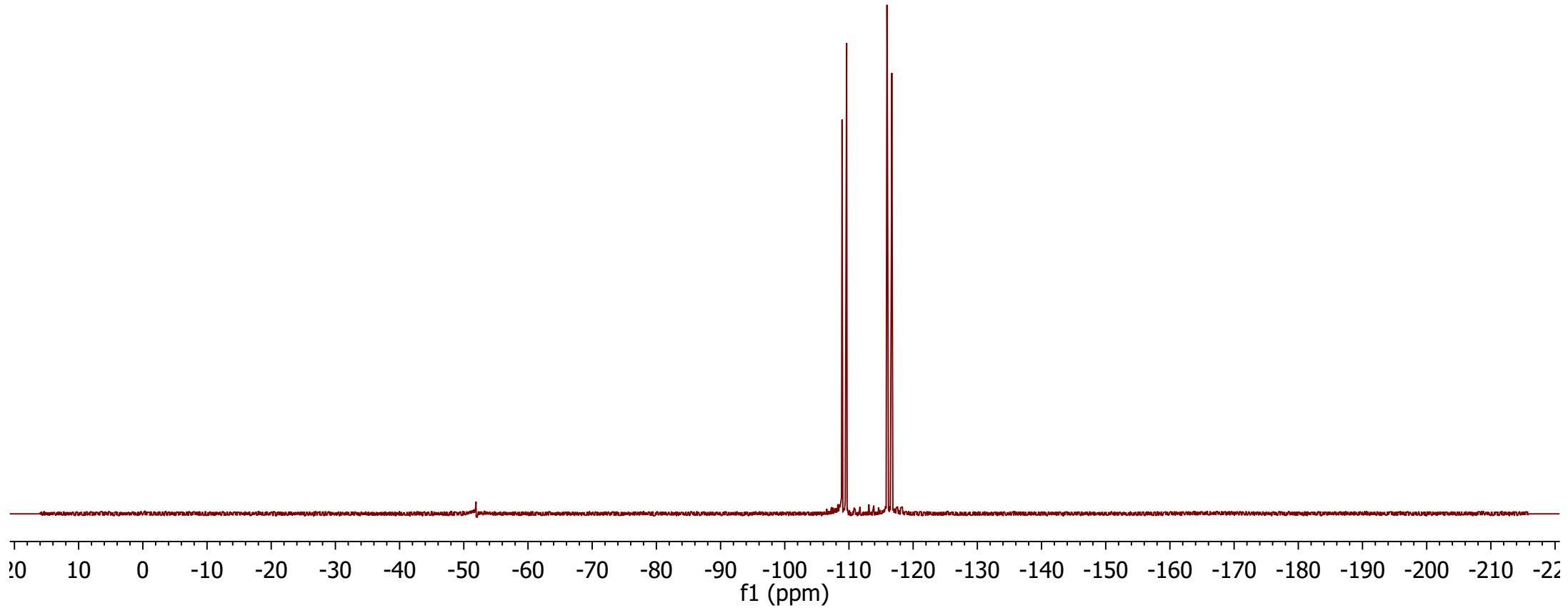
¹³C NMR Spectrum of 3af

¹⁹F (CDCl₃, 376 MHz)



3af

-108.93
-108.96
-109.64
-109.68
-115.92
-115.97
-116.63
-116.68

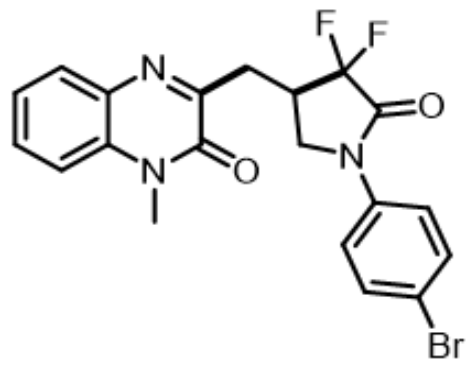


¹⁹F NMR Spectrum of 3af

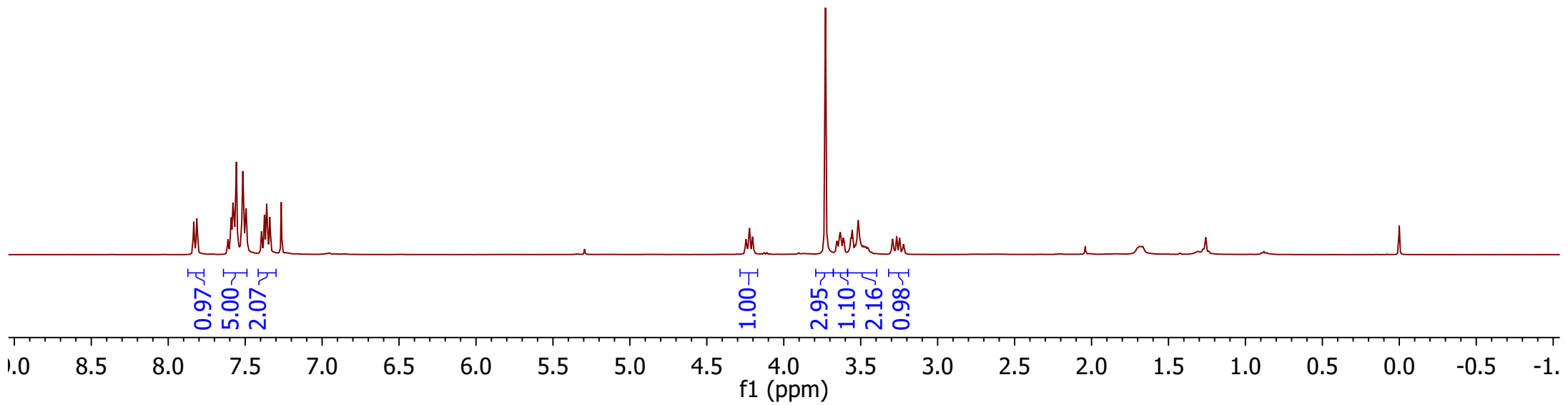
¹H (CDCl₃, 400 MHz)

7.84
7.83
7.82
7.81
7.61
7.61
7.59
7.58
7.57
7.57
7.56
7.52
7.49
7.39
7.37
7.36
7.34

4.25
4.23
4.22
4.20
3.73
3.71
3.66
3.65
3.64
3.63
3.63
3.61
3.61
3.56
3.56
3.54
3.52
3.49
3.48
3.47
3.47
3.45
3.29
3.27
3.25
3.22

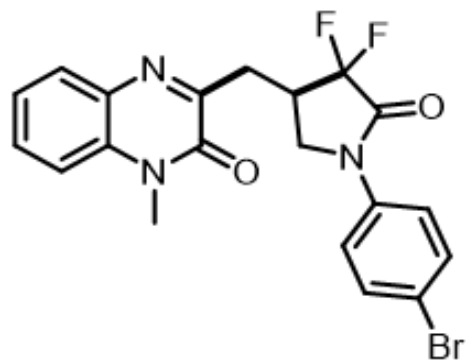


3ag



¹H NMR Spectrum of 3ag

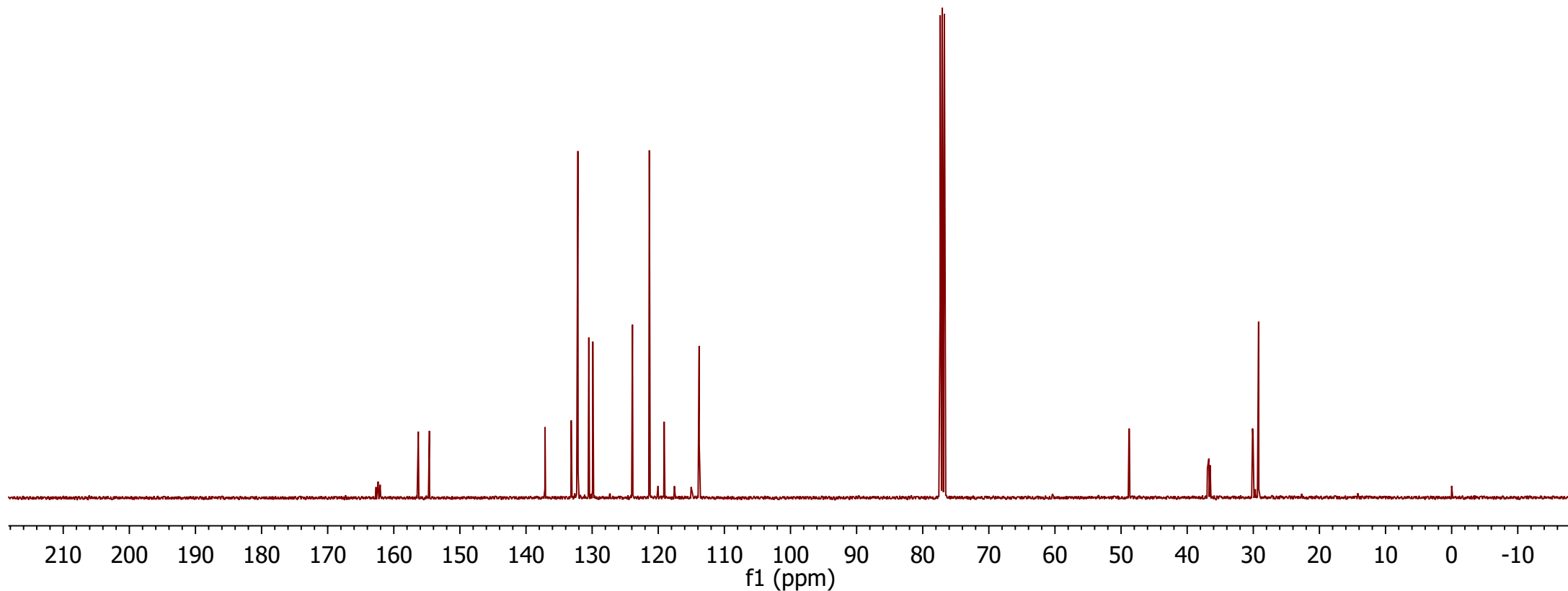
¹³C (CDCl₃, 101 MHz)



3ag

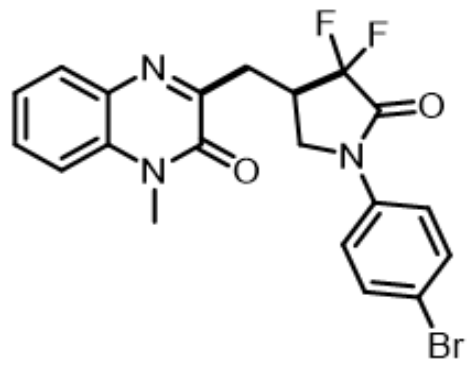
162.7
162.4
162.1
156.3
154.6
137.1
133.2
132.3
132.2
132.2
130.5
129.9
123.9
121.4
120.0
119.1
117.6
117.5
115.0
113.8

48.8
48.7
36.9
36.7
36.7
36.5
30.1
30.0
29.2



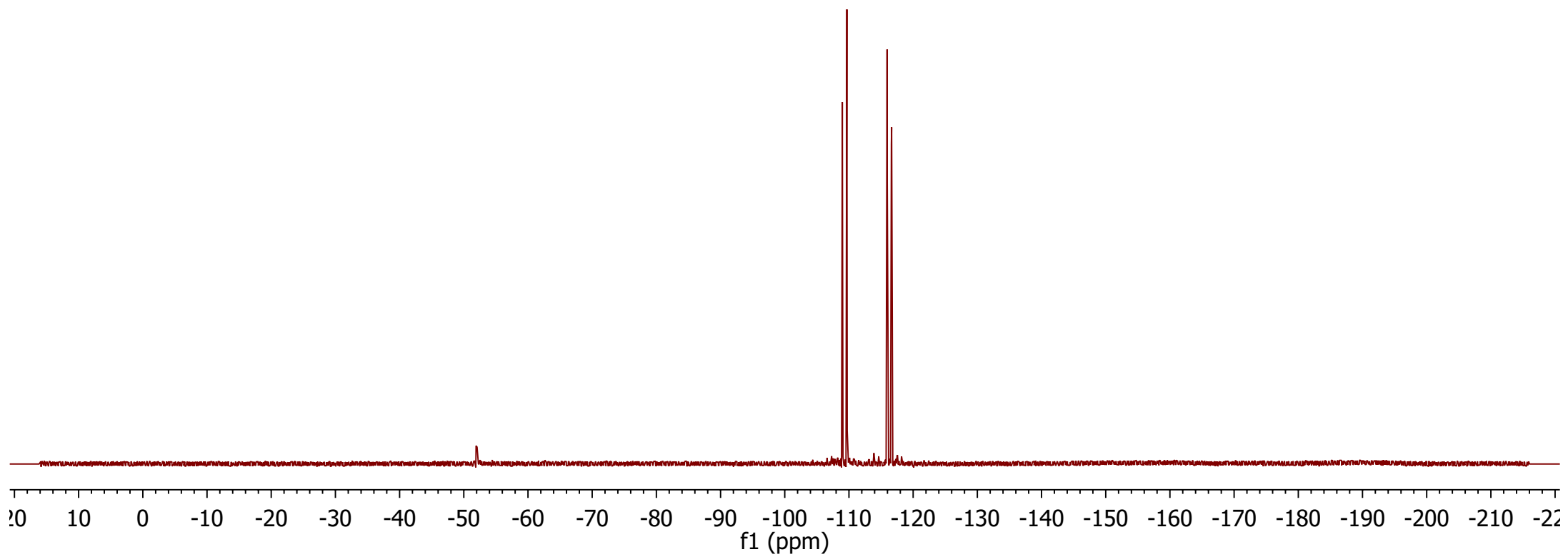
¹³C NMR Spectrum of **3ag**

19F (CDCl3, 376 MHz)



3ag

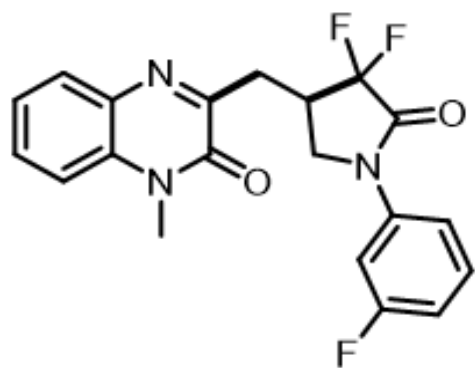
108.92
108.93
108.95
108.97
108.99
109.64
109.65
109.66
109.67
109.68
109.70
115.89
115.90
115.91
115.94
115.96
116.60
116.61
116.63
116.65
116.66
116.67



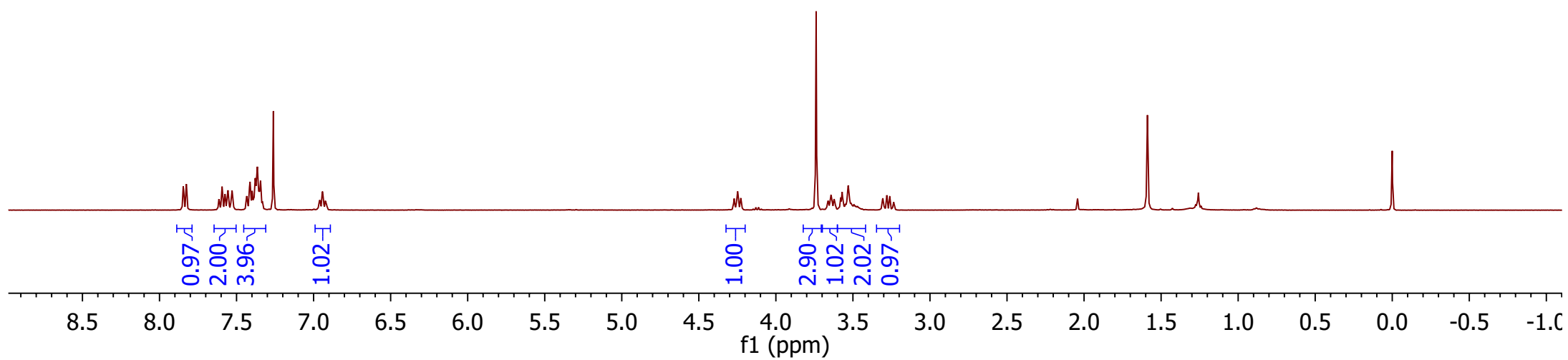
19F NMR Spectrum of 3ag

¹H (CDCl₃, 400 MHz)

7.85 7.84 7.83 7.82 7.62 7.60 7.59 7.58 7.57 7.56 7.56 7.55 7.53 7.53 7.52 7.44 7.43 7.43 7.42 7.41 7.41 7.41 7.40 7.40 7.39 7.38 7.37 7.36 7.36 7.35 7.34 6.96 6.96 6.96 6.94 6.94 6.94 4.27 4.25 4.23 3.74 3.65 3.64 3.64 3.62 3.62 3.58 3.57 3.53 3.53 3.31 3.28 3.26

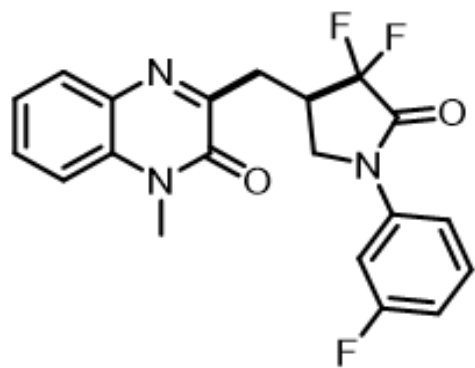


3ah



¹H NMR Spectrum of **3ah**

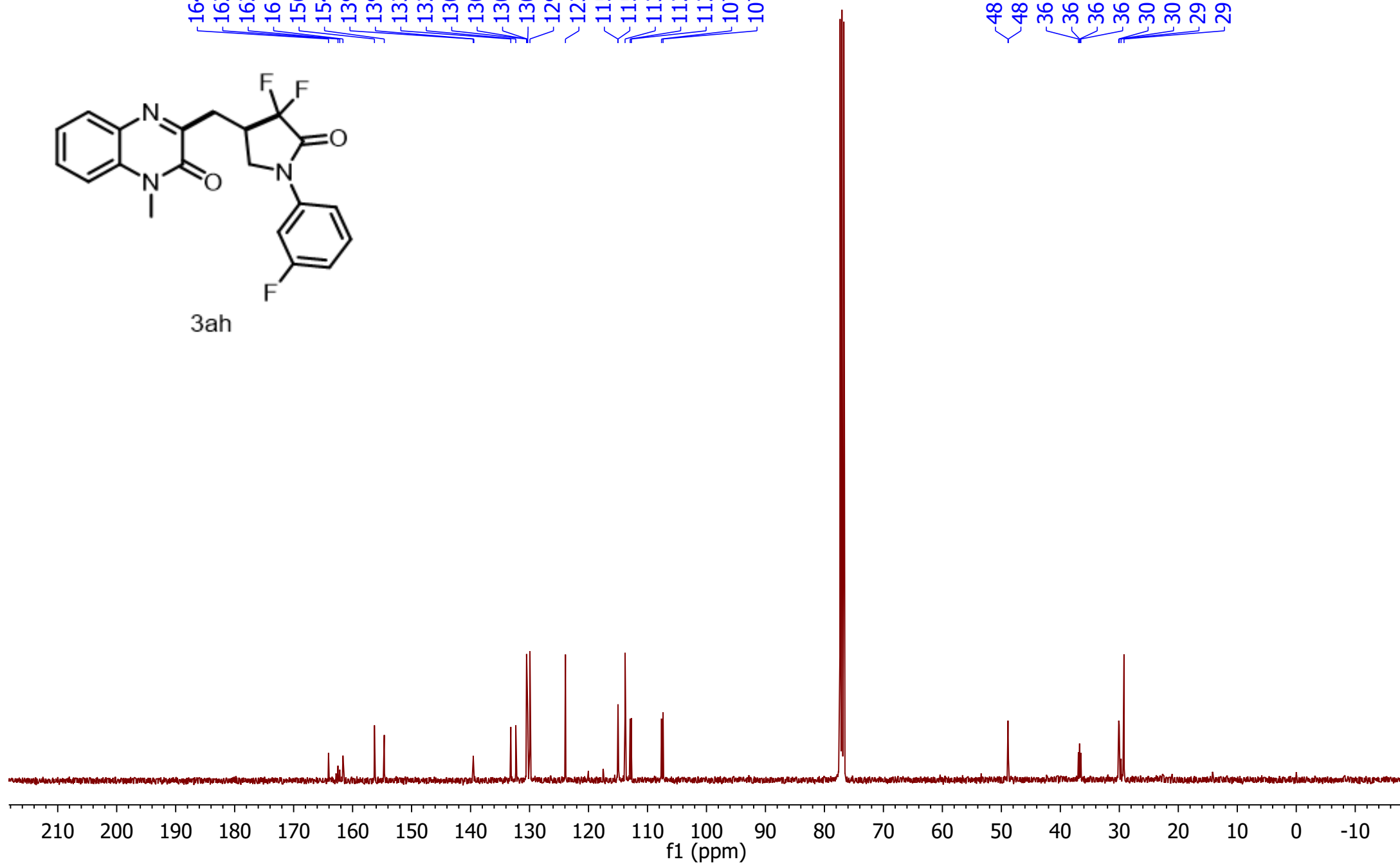
¹³C (CDCl₃, 101 MHz)



3ah

164.1
162.5
162.2
161.6
156.3
154.6
139.5
139.4
133.2
132.3
130.5
130.4
130.4
130.3
129.9
123.9
115.0
115.0
113.8
112.9
112.7
107.6
107.4

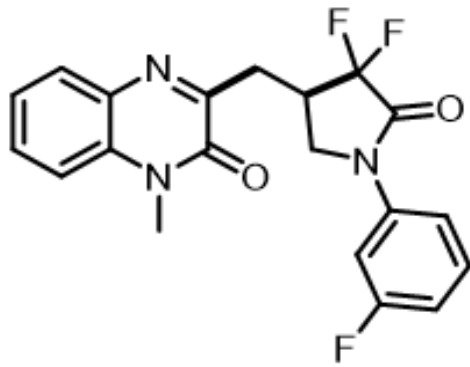
48.9
48.8
36.9
36.7
36.7
36.5
30.1
30.0
29.7
29.2



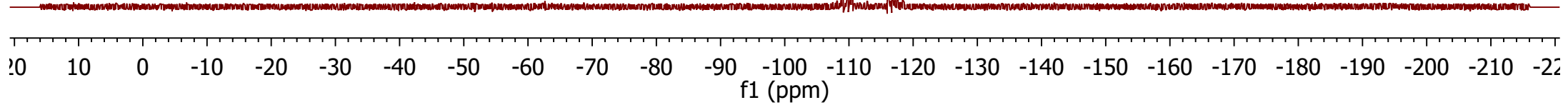
¹³C NMR Spectrum of 3ah

¹⁹F (CDCl₃, 376 MHz)

-109.06
-109.10
-109.78
-109.81
-110.46
-110.48
-110.49
-110.50
-110.51
-110.53
-116.00
-116.05
-116.72
-116.74
-116.76



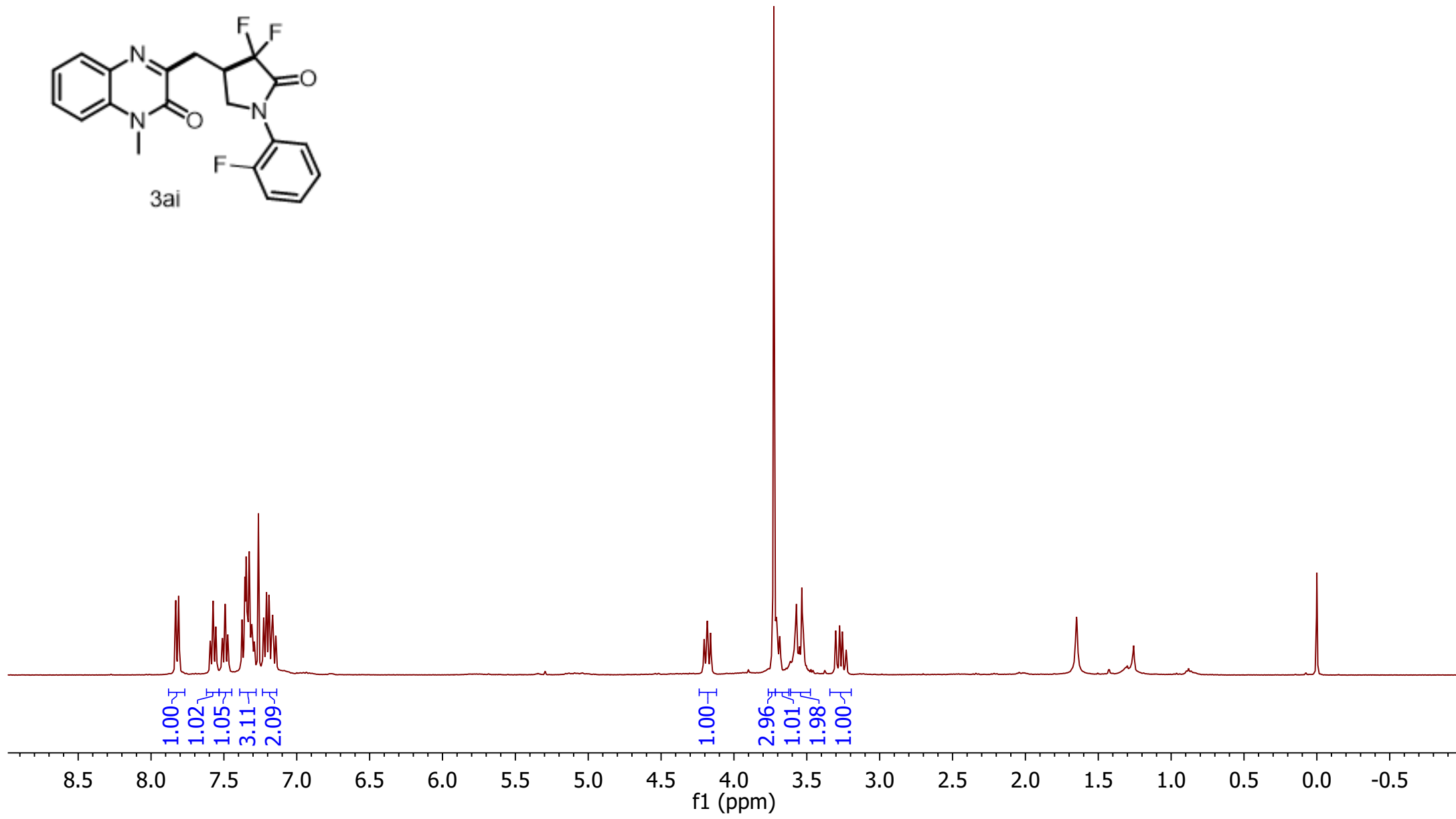
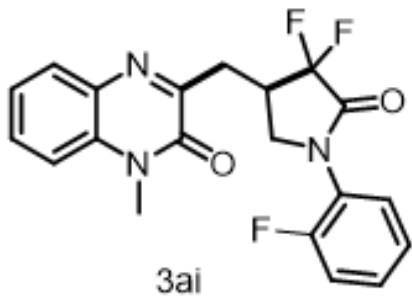
3ah



¹⁹F NMR Spectrum of 3ah

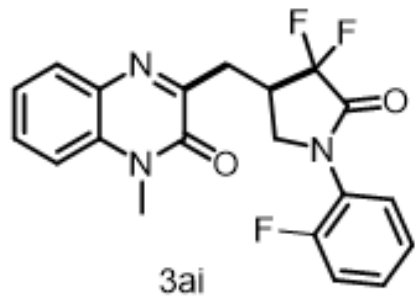
¹H (CDCl₃, 400 MHz)

7.83 7.83 7.81 7.81 7.60 7.59 7.57 7.56 7.55 7.51 7.49 7.49 7.47 7.47 7.38 7.37 7.36 7.35 7.34 7.34 7.33 7.31 7.31 7.30 7.29 7.29 7.23 7.23 7.21 7.21 7.19 7.19 7.17 7.17 7.16 7.14 7.14 4.20 4.19 4.18 4.18 4.16 3.73 3.71 3.70 3.69 3.58 3.57 3.53 3.52 3.30 3.28 3.26



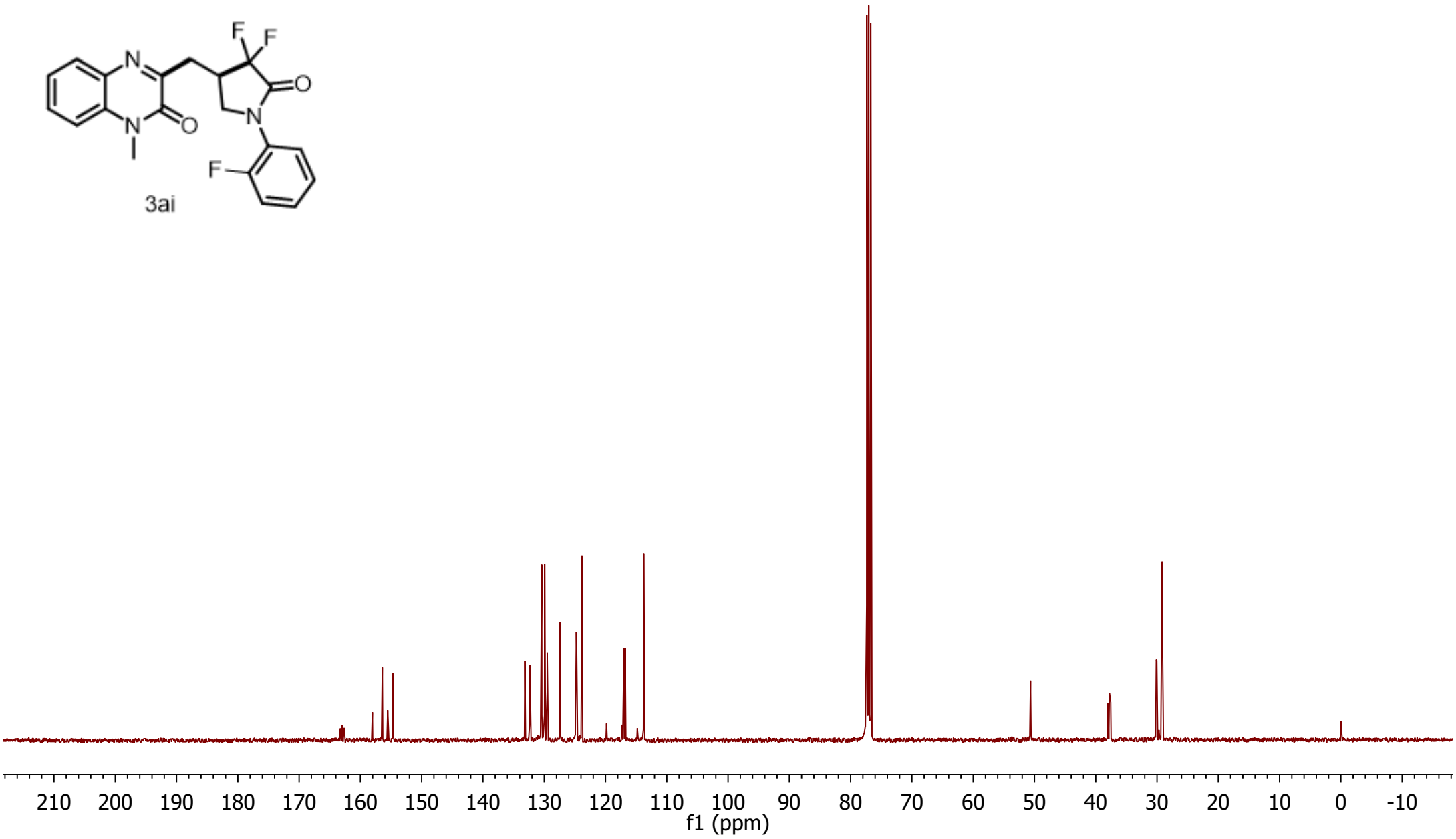
¹H NMR Spectrum of **3ai**

¹³C (CDCl₃, 101 MHz)



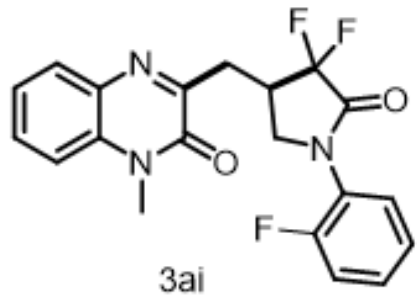
163.3
163.0
162.7
158.0
156.4
155.5
154.6
133.2
132.3
130.4
129.9
129.5
129.4
127.4
124.9
124.8
124.7
123.8
117.3
117.3
117.0
116.8
113.8

50.7
50.6
50.6
38.0
37.8
37.8
37.6
30.1
30.0
29.7
29.2

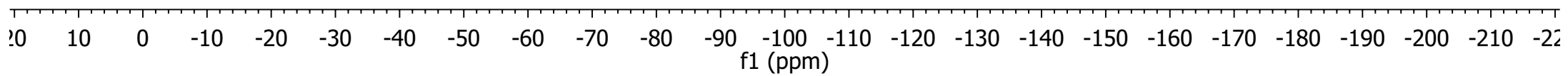


¹³C NMR Spectrum of 3ai

19F (CDCl3, 376 MHz)

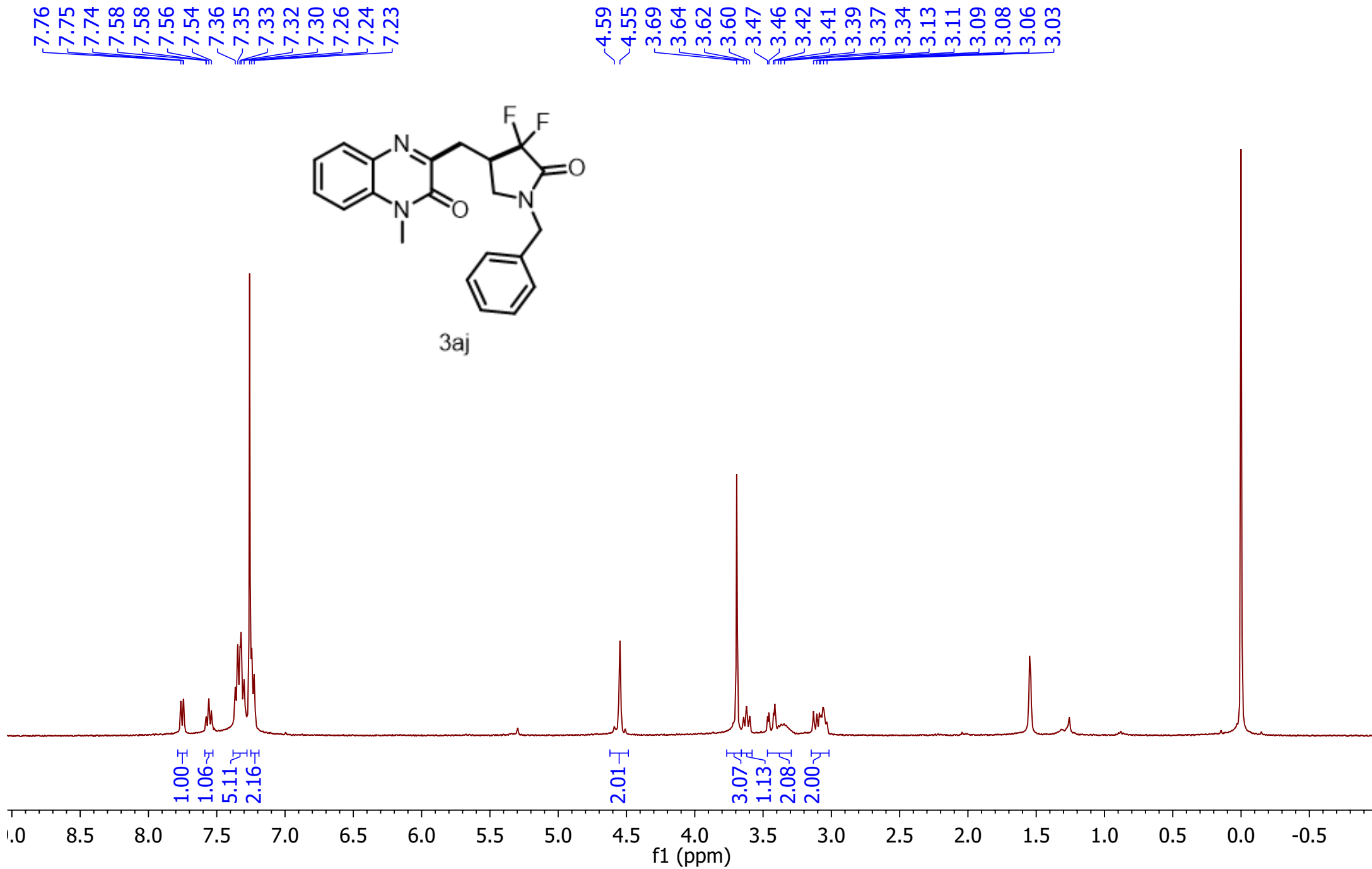


-110.36
-110.39
-111.07
-111.11
-116.58
-116.63
-117.30
-117.34
-119.86
-119.87
-119.88
-119.89
-119.90
-119.91
-119.92



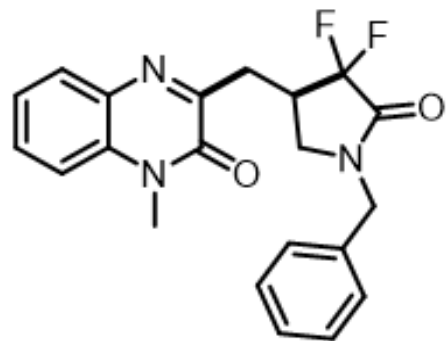
¹⁹F NMR Spectrum of 3ai

¹H (CDCl₃, 400 MHz)



¹H NMR Spectrum of **3aj**

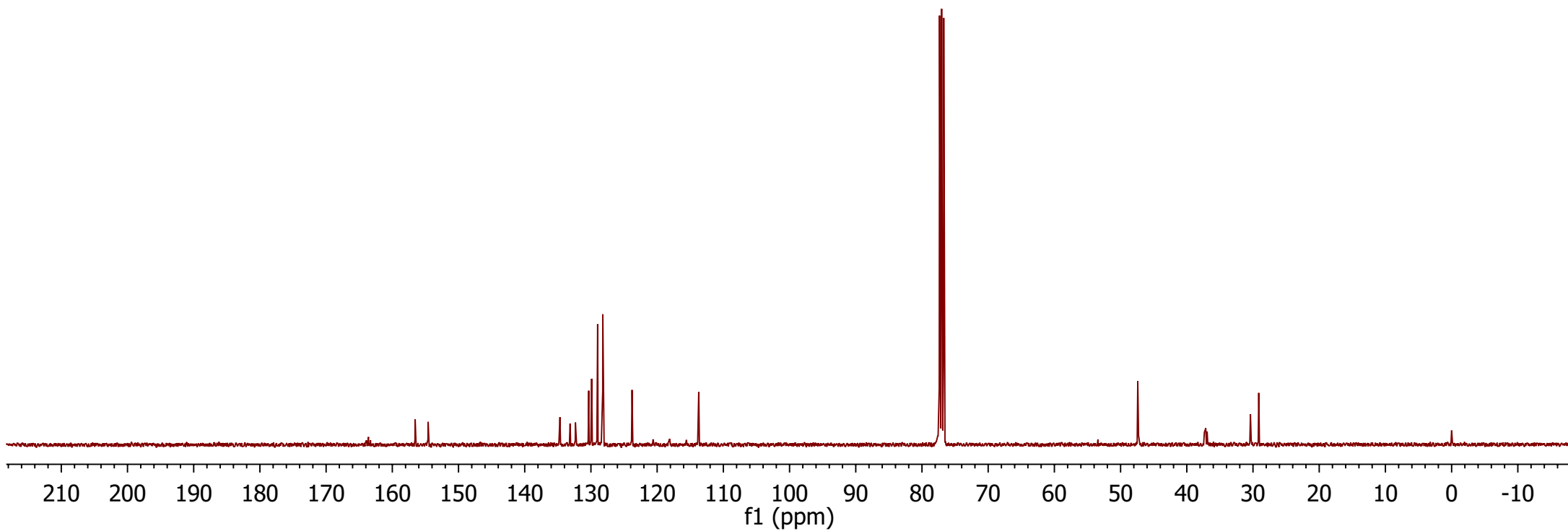
¹³C (CDCl₃, 101 MHz)



3aj

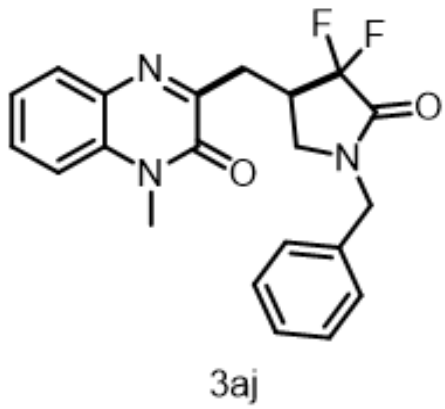
163.9
163.6
163.3
156.5
154.6
134.7
133.1
132.3
130.3
129.9
129.0
128.2
128.2
123.8
120.6
118.1
113.7

47.4
47.4
47.3
37.4
37.1
36.9
30.4
30.3
29.1

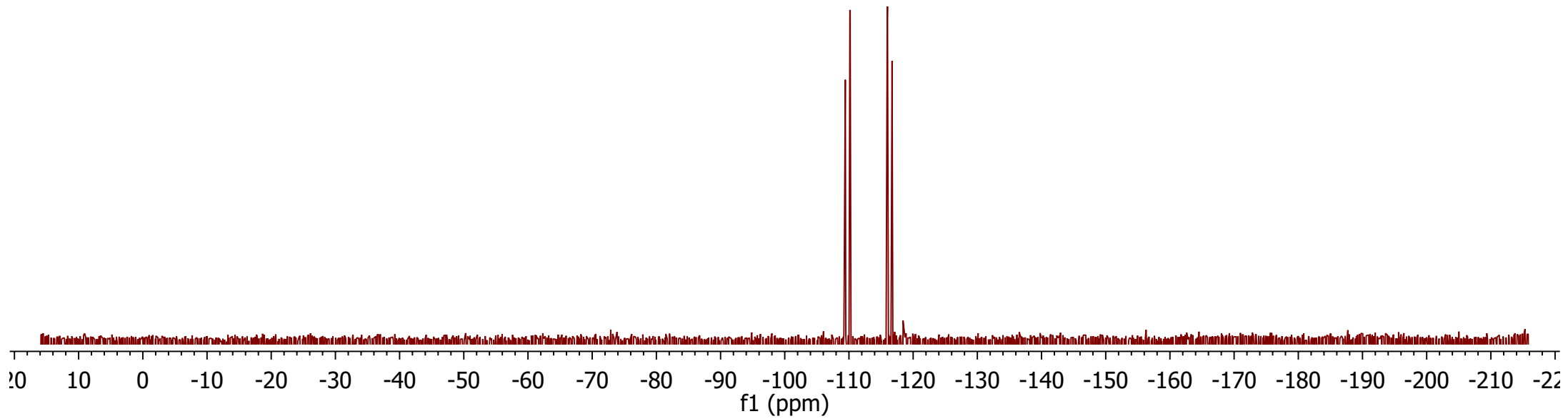


¹³C NMR Spectrum of 3aj

¹⁹F (CDCl₃, 376 MHz)



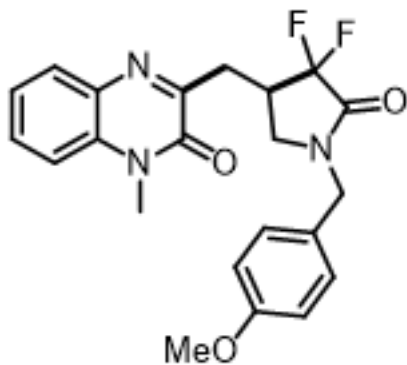
-109.43
-109.48
-110.15
-110.19
-115.96
-116.01
-116.67
-116.72



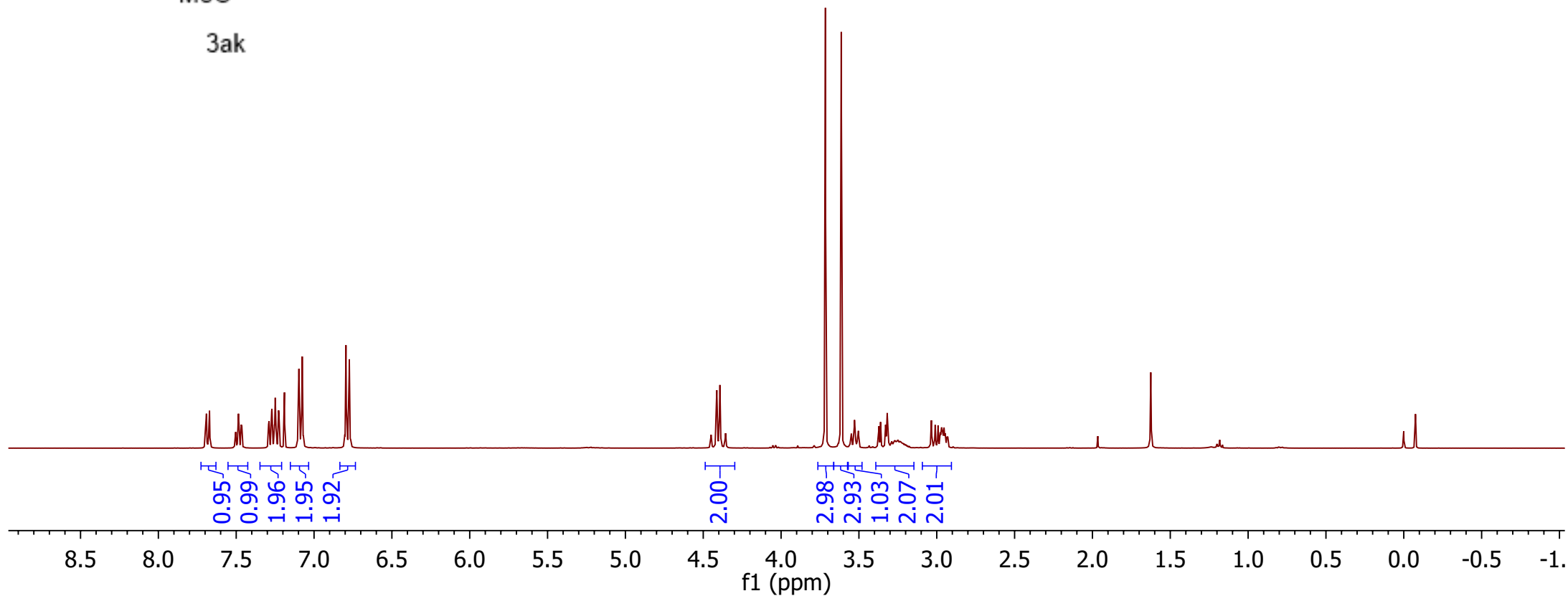
¹⁹F NMR Spectrum of 3aj

¹H (CDCl₃, 400 MHz)

7.69 7.69 7.68 7.67 7.51 7.50 7.49 7.49 7.48 7.47 7.46 7.29 7.29 7.27 7.27 7.25 7.25 7.25 7.23 7.23 7.19 7.10 7.09 7.08 7.08 6.80 6.79 6.78 6.77 4.41 4.41 4.39 4.36 3.72 3.72 3.61 3.53 3.53 3.52 3.51 3.50 3.37 3.36 3.33 3.32 3.03 3.01 2.99 2.98 2.97 2.97 2.96 2.95

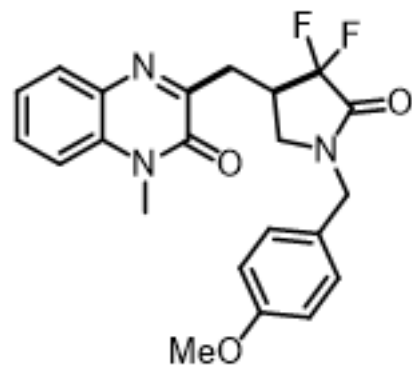


3ak

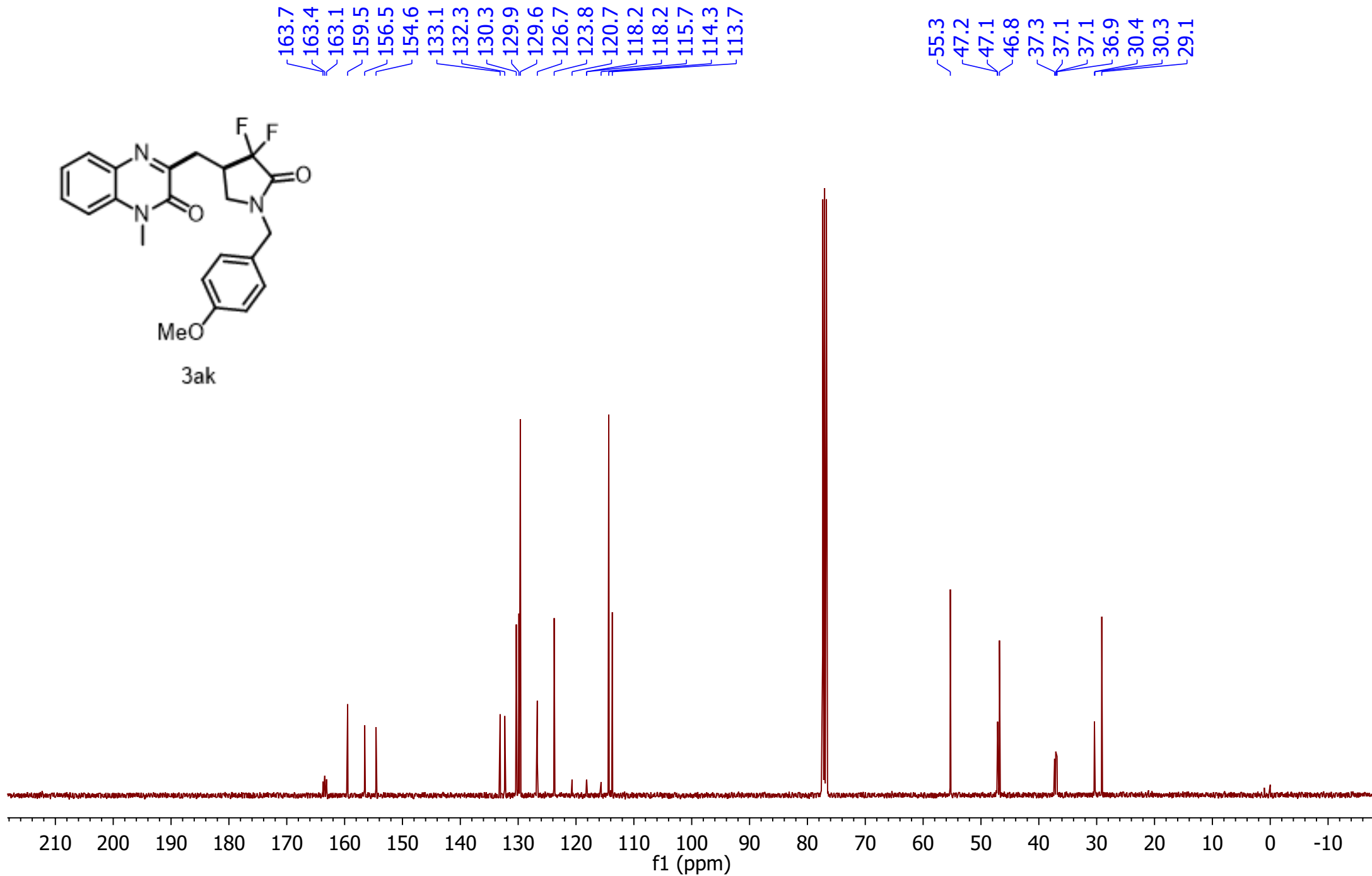


¹H NMR Spectrum of **3ak**

¹³C (CDCl₃, 101 MHz)

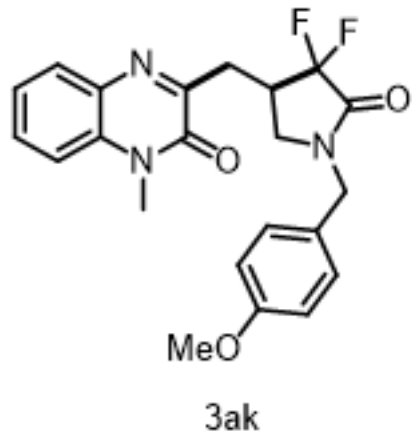


3ak

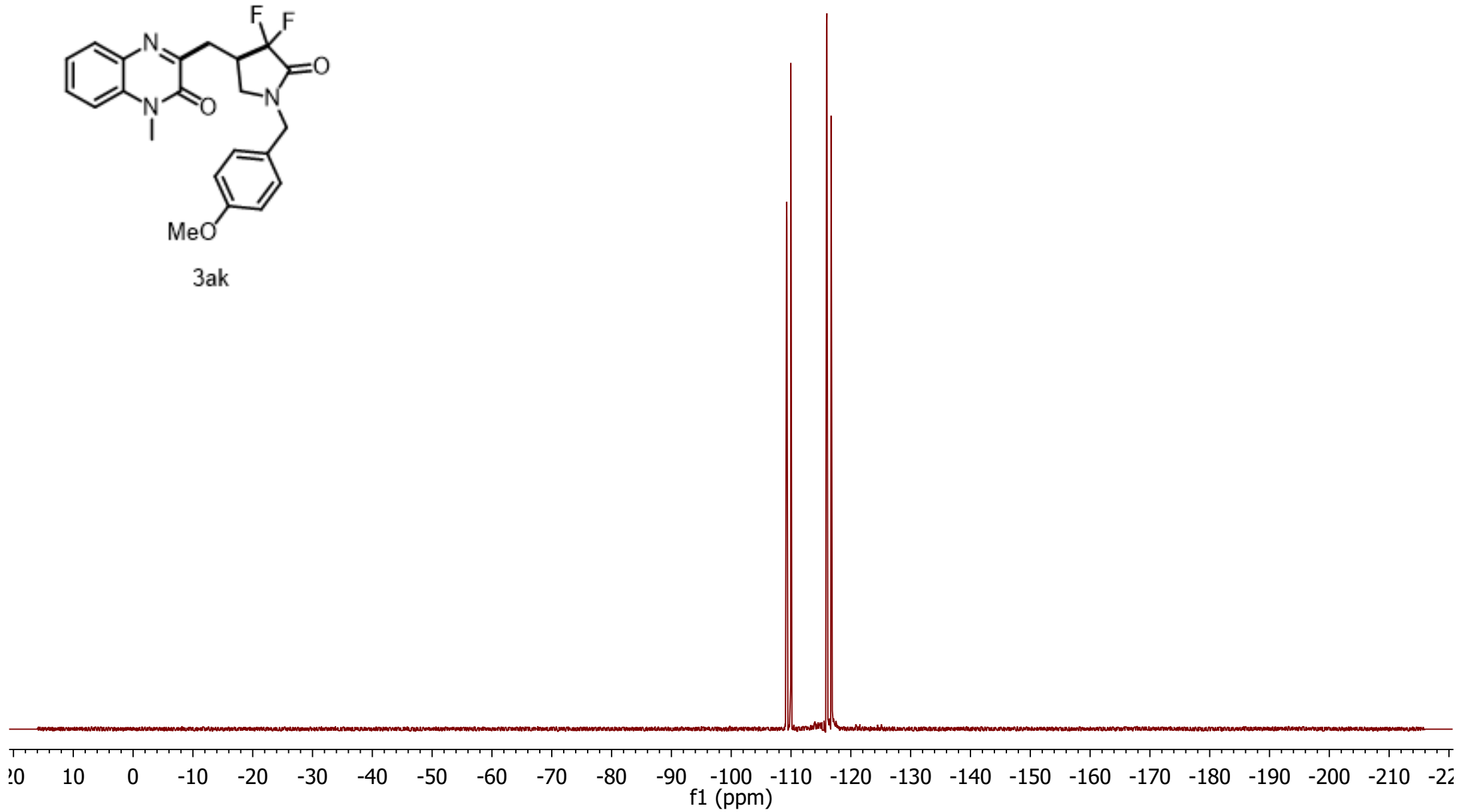


¹³C NMR Spectrum of **3ak**

¹⁹F (CDCl₃, 376 MHz)



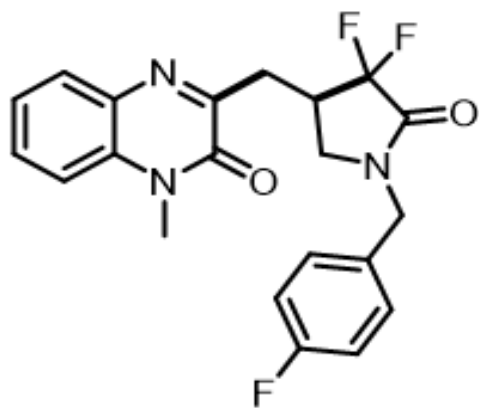
-109.26
-109.26
-109.30
-109.30
-109.97
-109.97
-110.01
-110.02
-115.95
-116.00
-116.66
-116.71



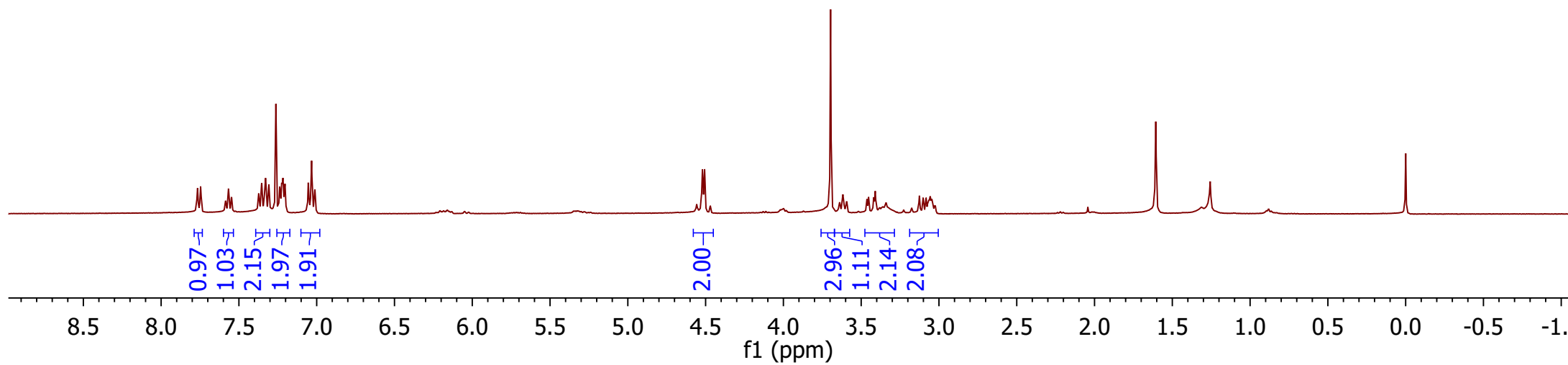
¹⁹F NMR Spectrum of 3ak

¹H (CDCl₃, 400 MHz)

7.77 7.75 7.59 7.57 7.55 7.54 7.37 7.35 7.33 7.33 7.31 7.28 7.26 7.24 7.23 7.22 7.22 7.20 7.05 7.03 7.02 7.01 4.56 4.52 4.51 4.47 3.71 3.70 3.64 3.64 3.62 3.62 3.61 3.60 3.59 3.46 3.45 3.42 3.41 3.38 3.37 3.34 3.18 3.13 3.10 3.08 3.07 3.07 3.06 3.05 3.04 3.03 3.02

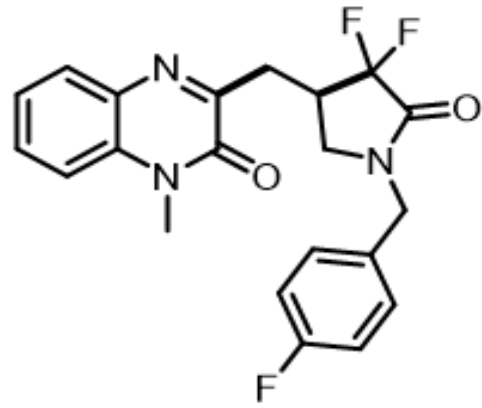


3al



¹H NMR Spectrum of **3al**

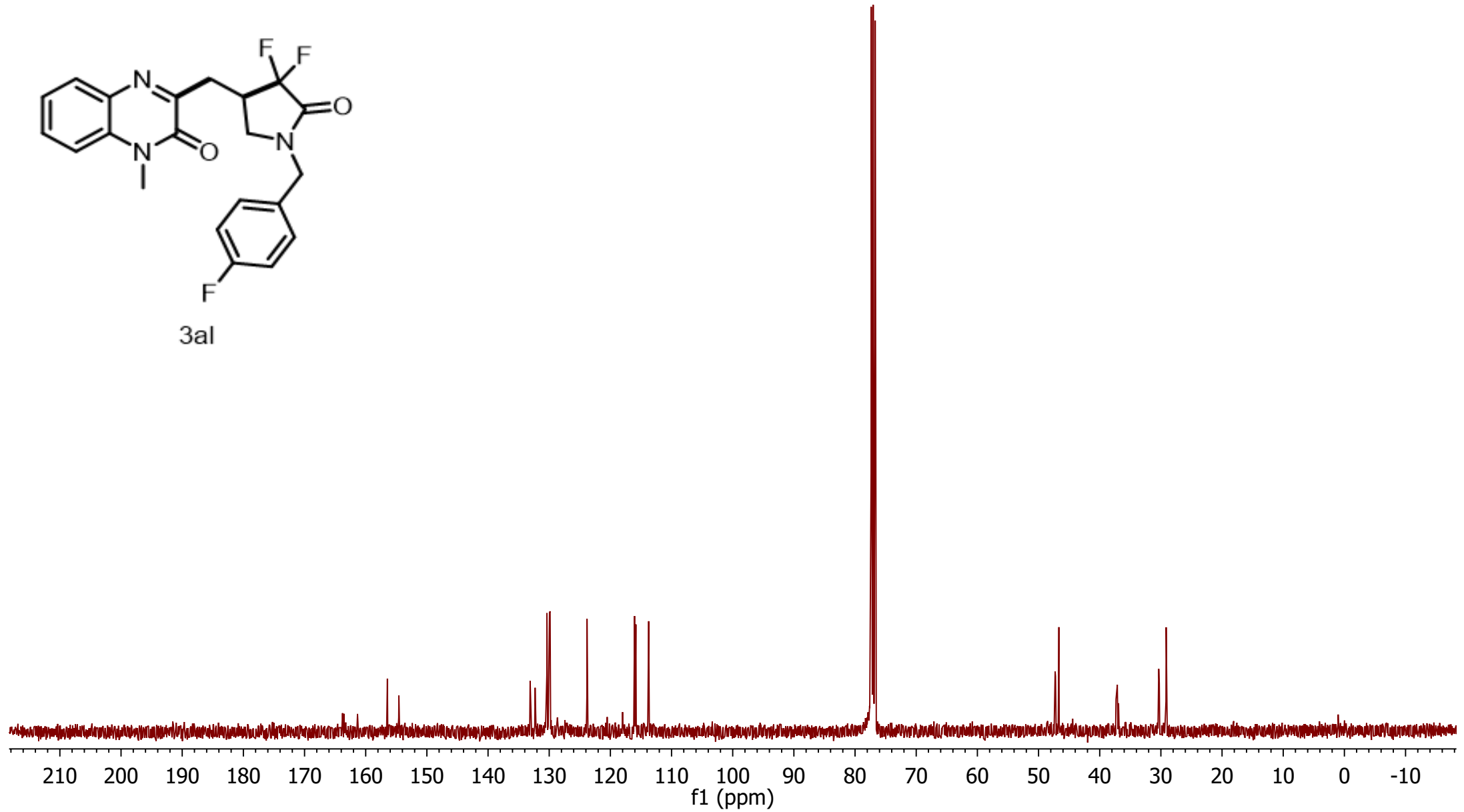
¹³C (CDCl₃, 101 MHz)



3al

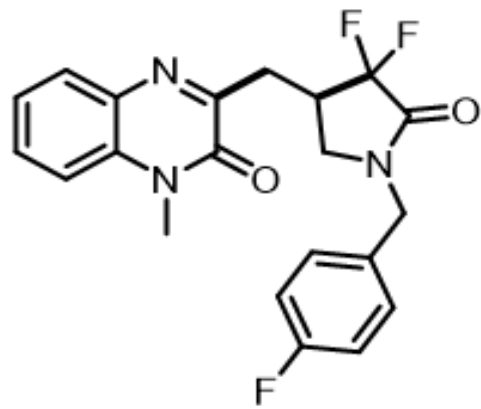
163.8
163.6
161.3
156.5
154.6
133.1
132.3
130.5
130.4
130.0
130.0
129.9
123.8
116.0
115.8
113.7

47.3
47.2
46.7
37.3
37.1
36.9
30.3
30.3
29.1



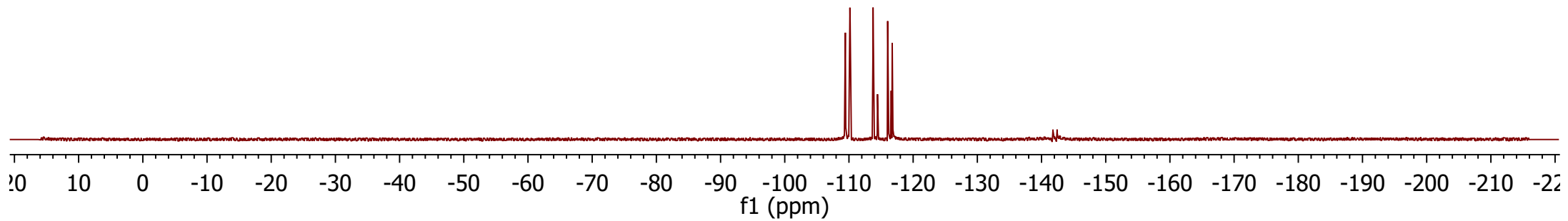
¹³C NMR Spectrum of 3al

¹⁹F (CDCl₃, 376 MHz)



3al

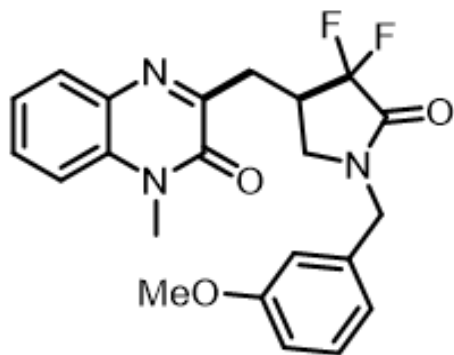
-109.44
-109.45
-109.48
-109.49
-110.15
-110.17
-110.19
-110.21
-113.72
-113.73
-113.74
-113.75
-113.76
-113.77
-113.79
-113.81
-114.45
-114.46
-116.03
-116.05
-116.07
-116.09
-116.58
-116.59
-116.74
-116.76
-116.79
-116.80



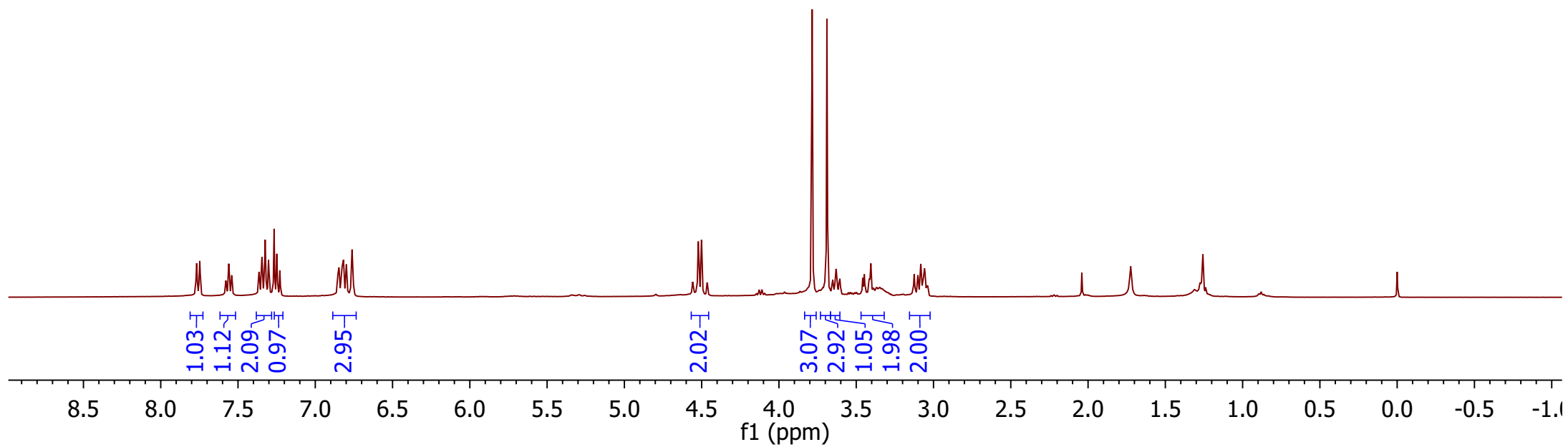
¹⁹F NMR Spectrum of 3al

¹H (CDCl₃, 400 MHz)

7.77 7.77 7.75 7.75 7.58 7.58 7.56 7.56 7.54 7.54 7.37 7.36 7.34 7.32 7.30 7.27 7.27 7.25 7.23 6.85 6.85 6.83 6.83 6.82 6.80 6.77 6.76 6.76 4.56 4.52 4.50 4.46 3.81 3.80 3.79 3.69 3.66 3.65 3.64 3.63 3.62 3.61 3.61 3.46 3.45 3.42 3.41 3.13 3.10 3.08 3.07 3.06 3.04 3.04



3am

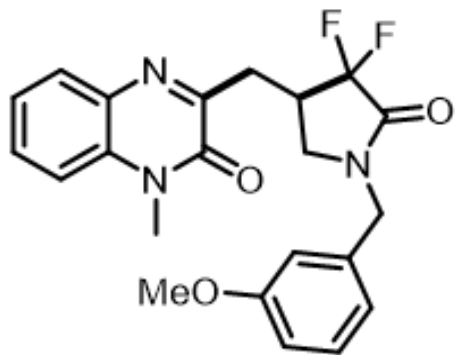


¹H NMR Spectrum of 3am

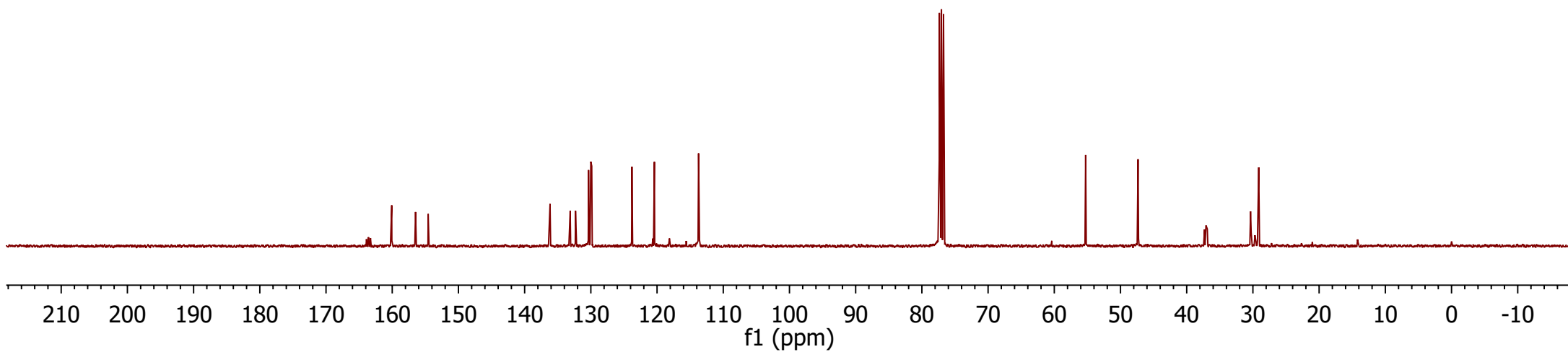
¹³C (CDCl₃, 101 MHz)

163.9
163.6
163.3
160.1
156.5
154.6
136.2
133.1
132.3
130.3
130.0
129.9
123.8
120.4
118.1
113.7
113.7
113.6

55.3
47.3
47.3
37.3
37.1
37.1
36.9
30.4
30.3
29.1

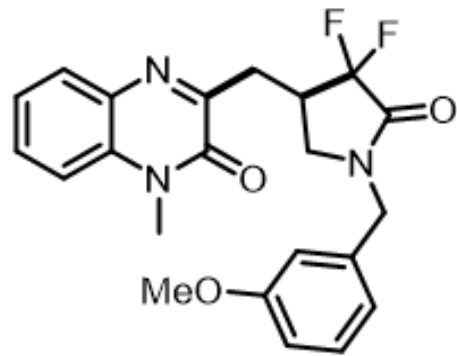


3am



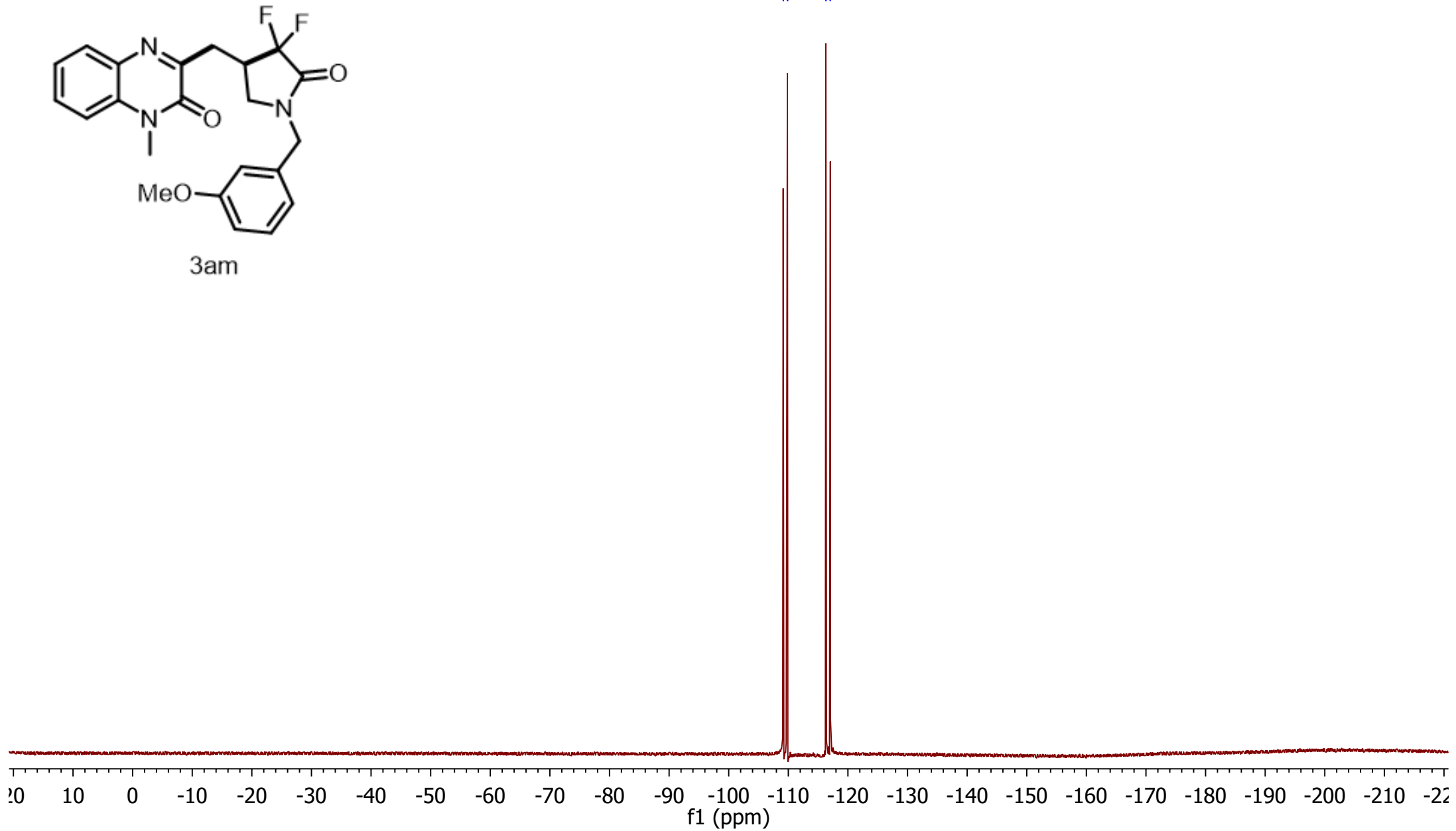
¹³C NMR Spectrum of **3am**

¹⁹F (CDCl₃, 376 MHz)



3am

-109.14
-109.15
-109.18
-109.19
-109.85
-109.86
-109.89
-109.90
-116.30
-116.34
-117.01
-117.05

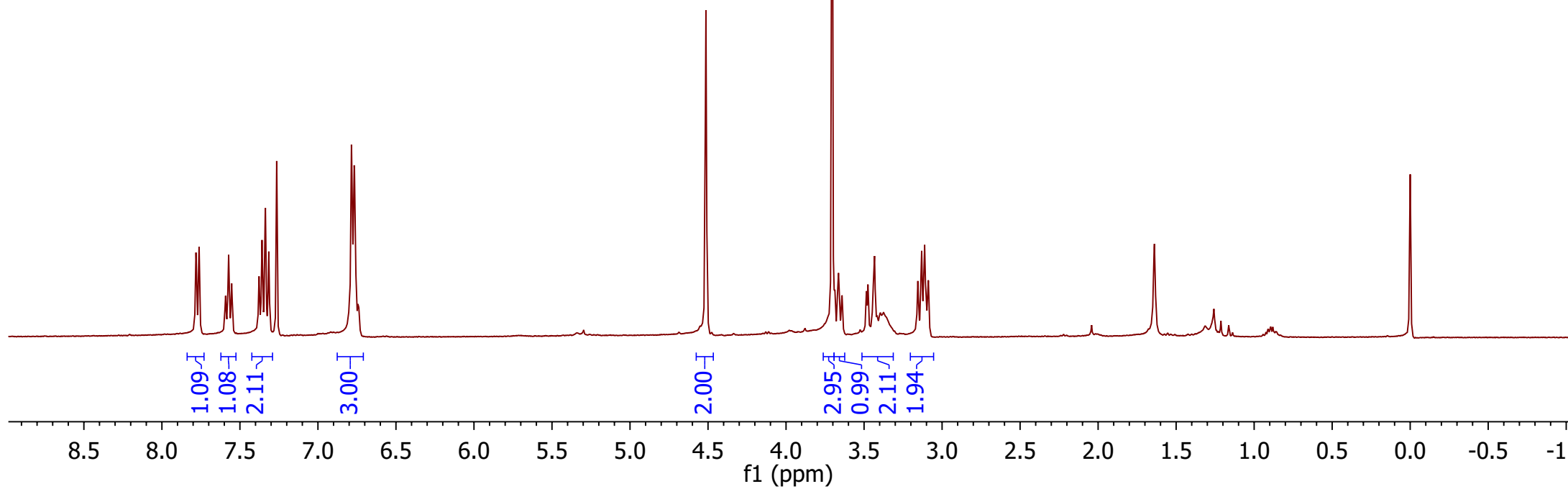
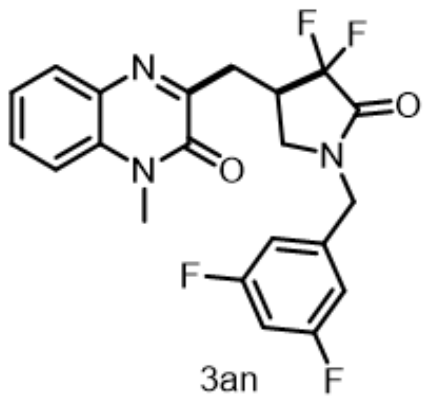


¹⁹F NMR Spectrum of 3am

¹H (CDCl₃, 400 MHz)

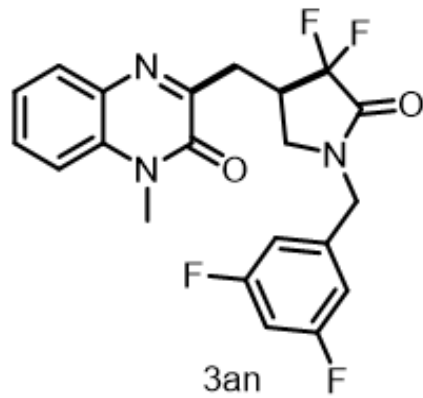
7.78
7.76
7.59
7.57
7.55
7.38
7.36
7.34
7.31
7.26
6.79
6.77
6.74
6.74

4.51
3.73
3.70
3.69
3.68
3.66
3.64
3.64
3.49
3.47
3.44
3.43
3.42
3.41
3.40
3.38
3.16
3.13
3.11
3.10
3.09



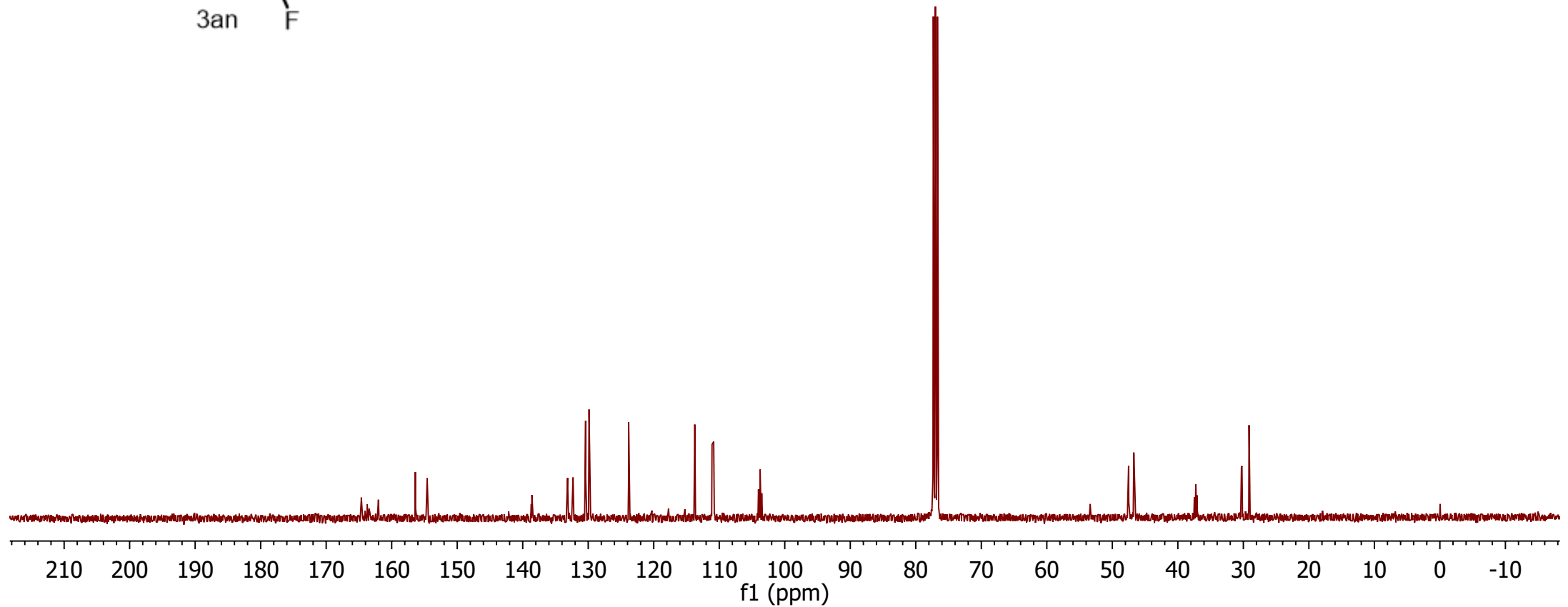
¹H NMR Spectrum of **3an**

¹³C (CDCl₃, 101 MHz)



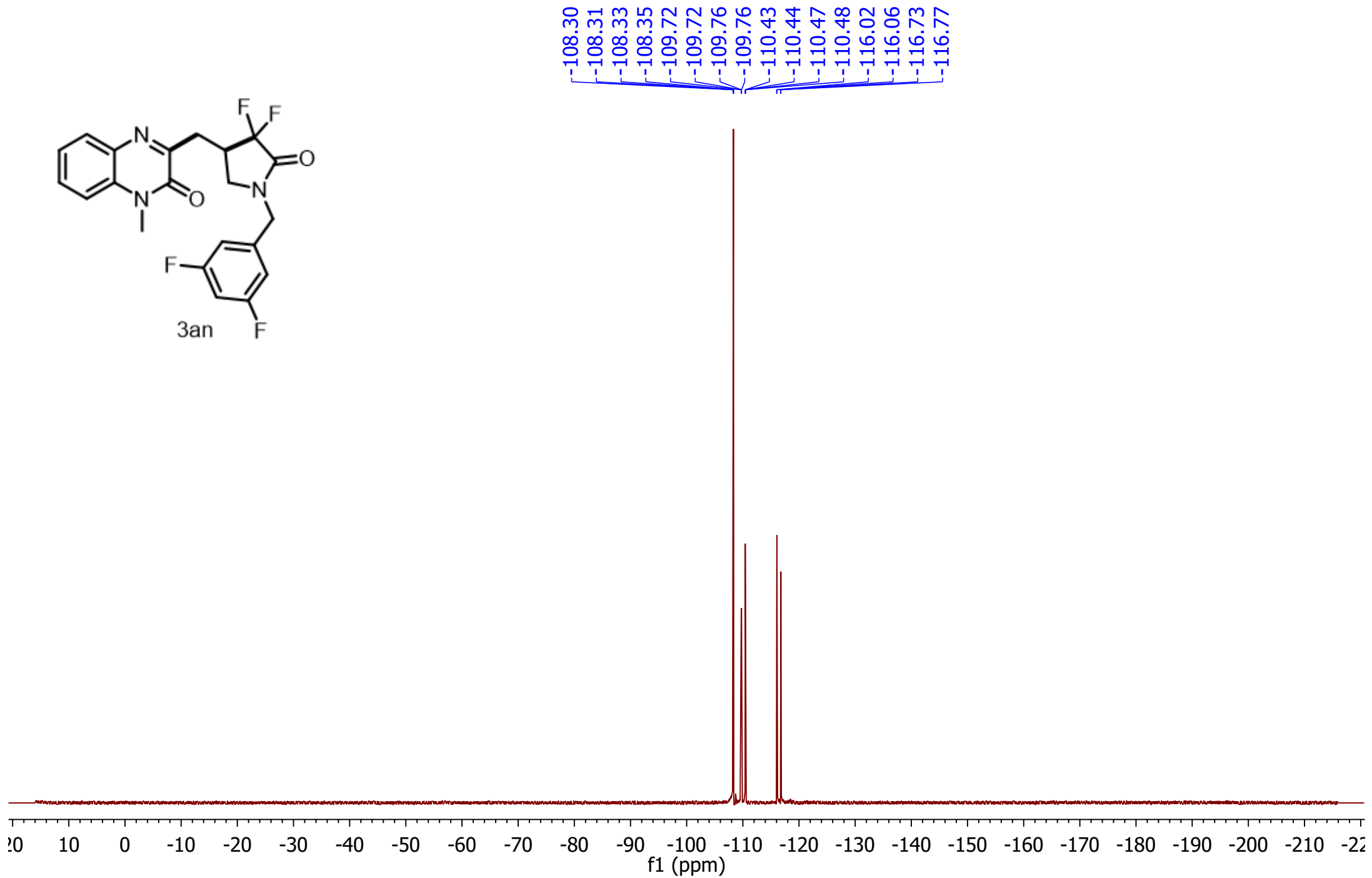
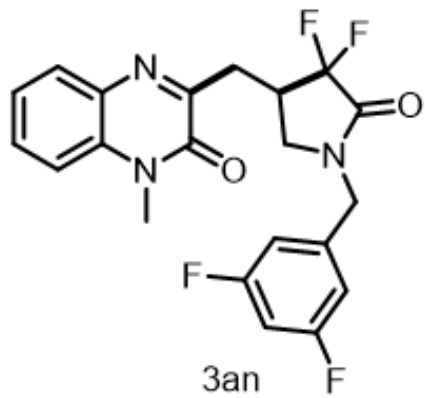
164.6
164.5
163.7
163.4
162.1
162.0
156.4
154.6
138.7
138.6
138.5
133.2
132.3
130.4
129.9
123.8
115.2
113.7
111.1
111.0
110.9
110.8
104.0
103.8
103.5

47.6
47.5
46.7
37.5
37.3
37.1
30.3
30.2
29.1



¹³C NMR Spectrum of 3an

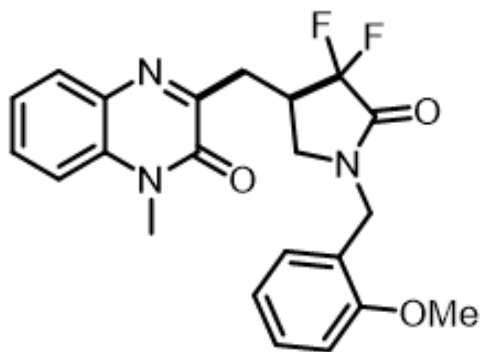
¹⁹F (CDCl₃, 376 MHz)



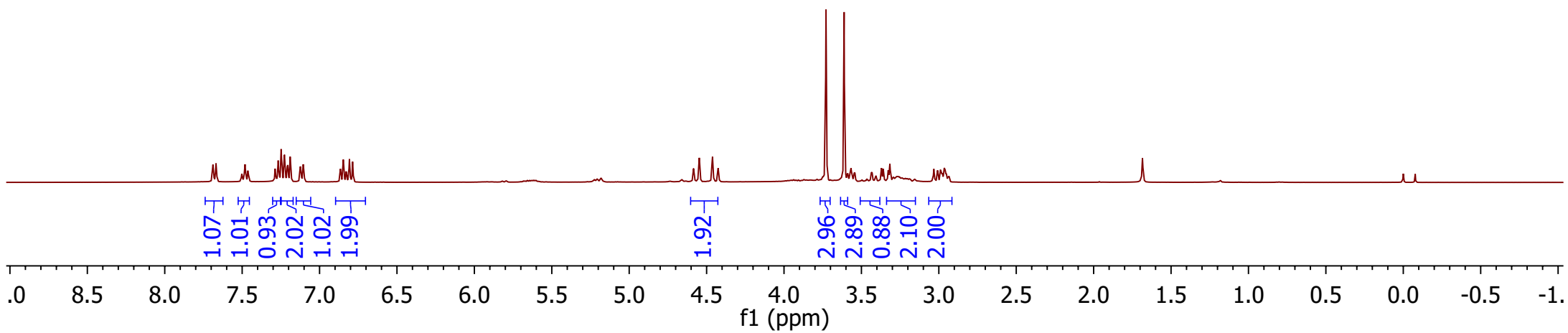
¹⁹F NMR Spectrum of **3an**

¹H (CDCl₃, 400 MHz)

7.69 7.69 7.67 7.67 7.48 7.48 7.48 7.46 7.46 7.29 7.28 7.27 7.27 7.25 7.25 7.23 7.22 7.21 7.20 7.19 7.18 7.12 7.12 7.11 7.10 7.10 6.87 6.86 6.85 6.84 6.83 6.81 6.79 6.79 4.58 4.55 4.46 4.43 3.73 3.61 3.57 3.57 3.56 3.55 3.44 3.43 3.37 3.36 3.33 3.32 3.03 3.01 2.99 2.98 2.97 2.96



3ao

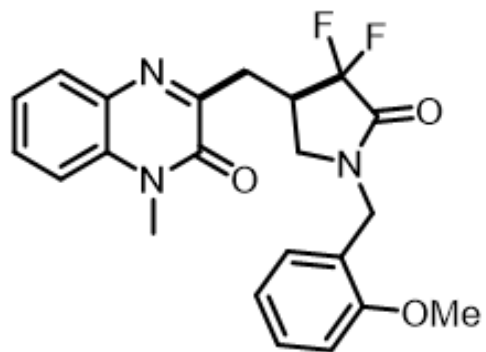


¹H NMR Spectrum of **3ao**

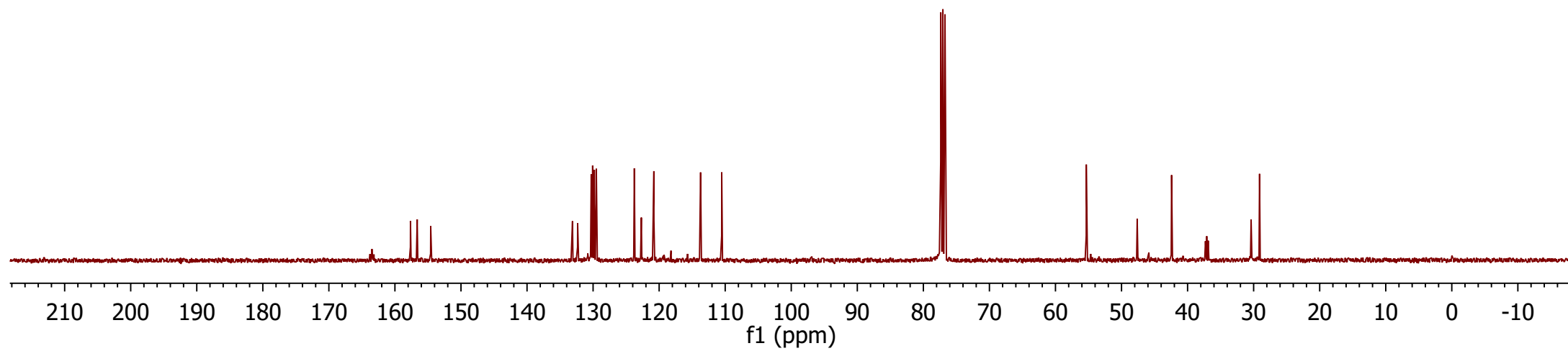
¹³C (CDCl₃, 101 MHz)

163.5
157.6
156.6
154.6
133.1
132.3
130.3
130.1
129.8
129.5
123.8
122.7
120.8
120.7
118.2
113.7
110.5

55.3
47.6
47.6
42.4
37.3
37.1
36.9
30.4
30.3
29.1

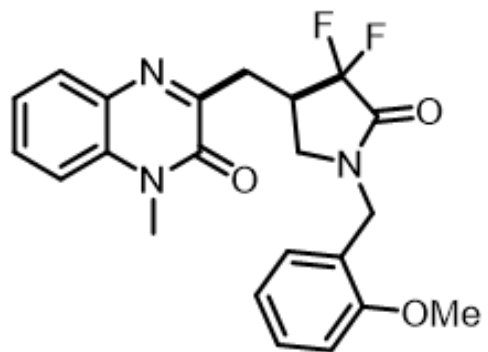


3ao



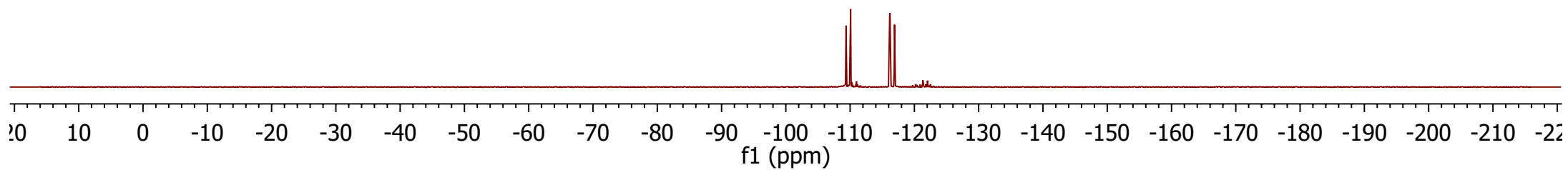
¹³C NMR Spectrum of **3ao**

¹⁹F (CDCl₃, 376 MHz)



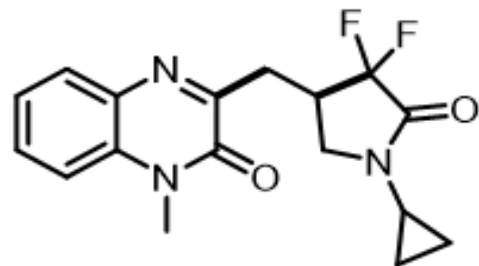
3ao

-109.37
-109.41
-110.08
-110.12
-116.15
-116.20
-116.86
-116.91

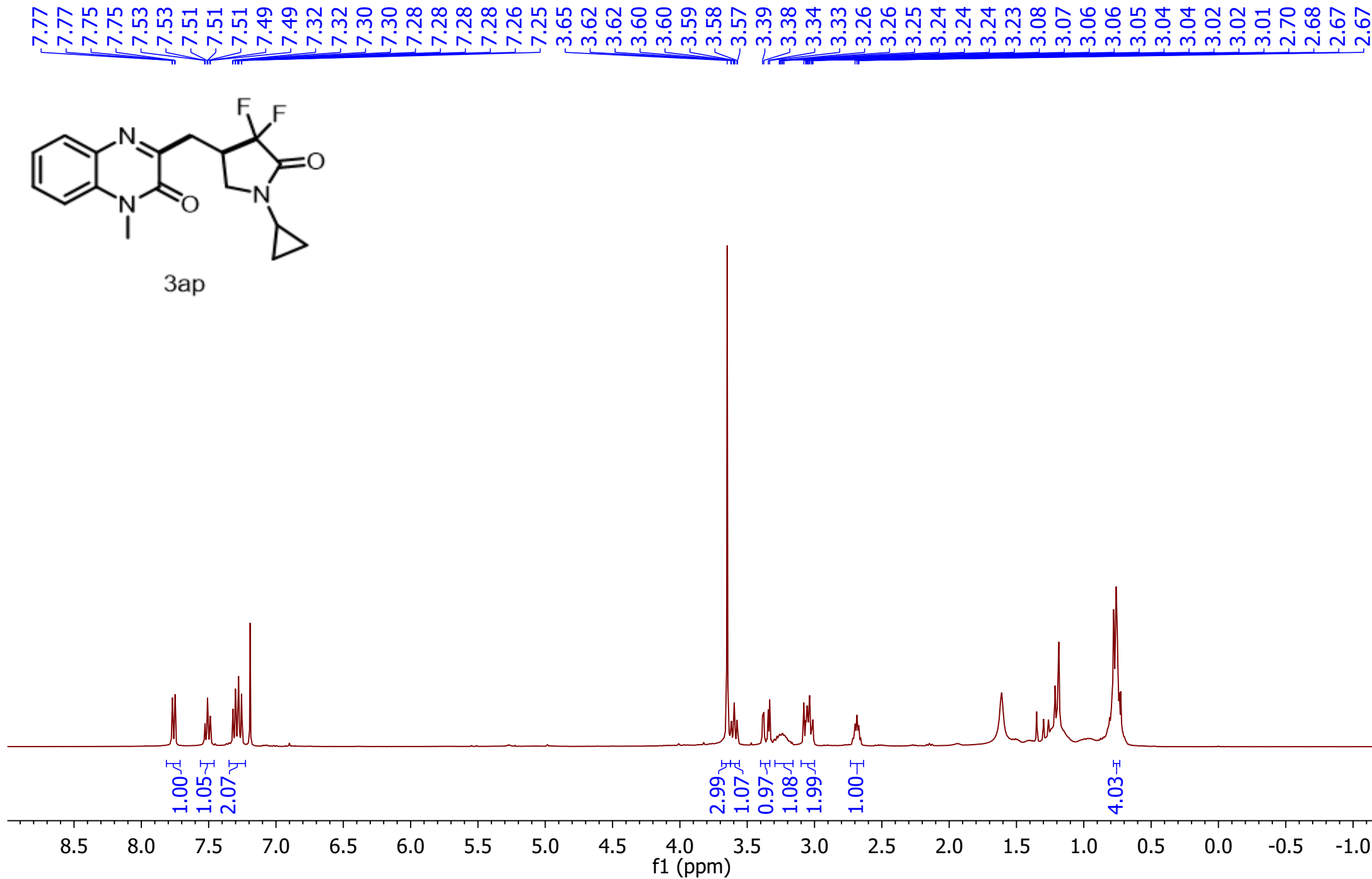


¹⁹F NMR Spectrum of 3ao

¹H (CDCl₃, 400 MHz)



3ap

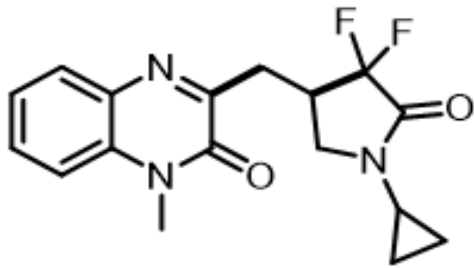


¹H NMR Spectrum of 3ap

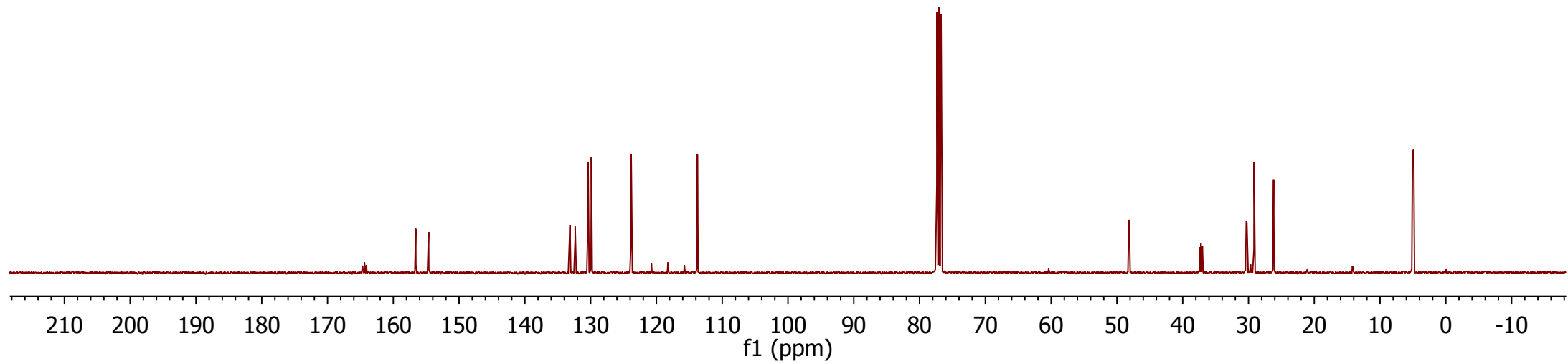
¹³C (CDCl₃, 101 MHz)

164.7
164.4
164.1
156.6
154.6
133.1
132.4
130.4
129.9
123.8
120.8
118.3
118.2
115.7
113.8

48.2
48.1
37.4
37.2
37.2
37.0
30.3
30.2
29.2
26.2
5.1
5.1
4.9

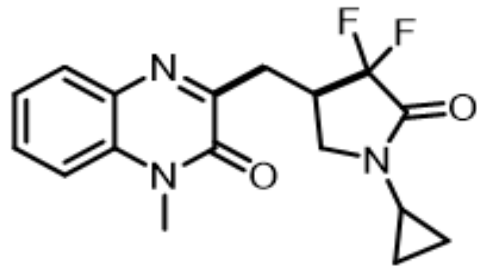


3ap



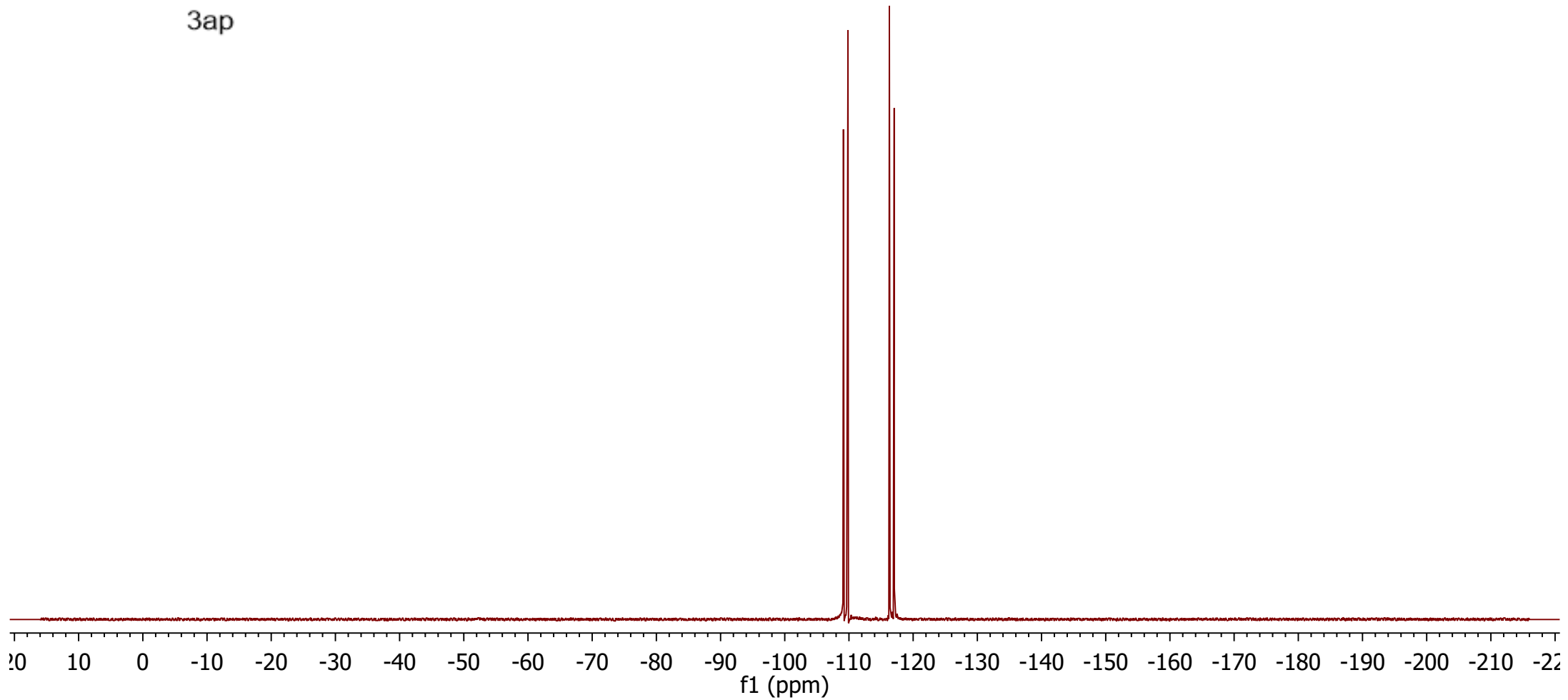
¹³C NMR Spectrum of **3ap**

¹⁹F (CDCl₃, 376 MHz)



3ap

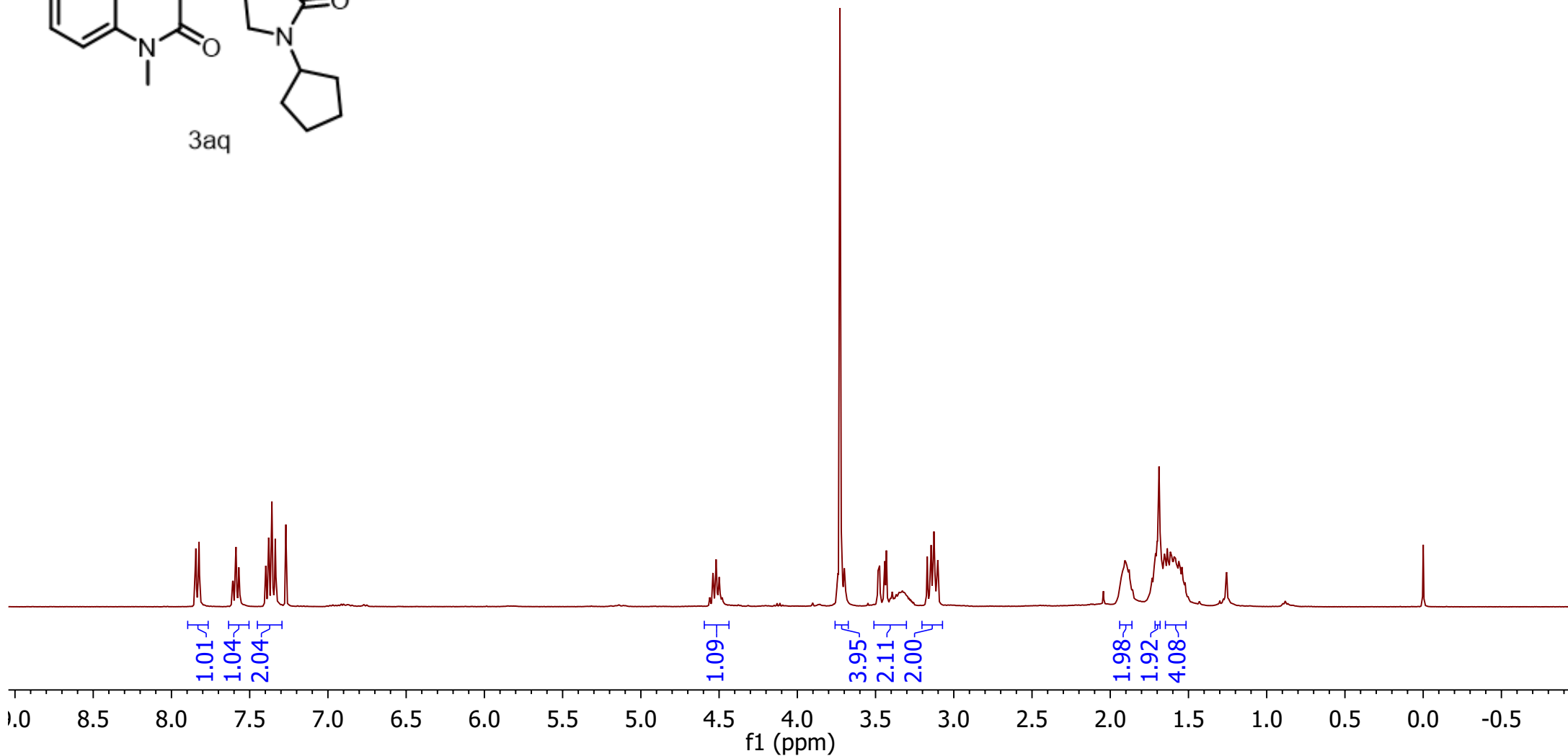
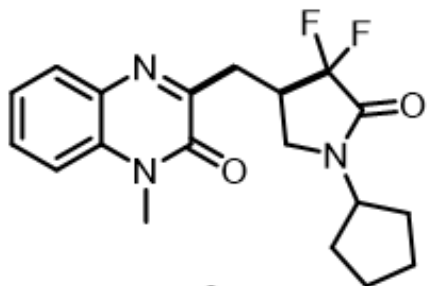
-109.14
-109.15
-109.18
-109.19
-109.85
-109.86
-109.89
-109.90
-116.30
-116.34
-117.01
-117.05



¹⁹F NMR Spectrum of 3ap

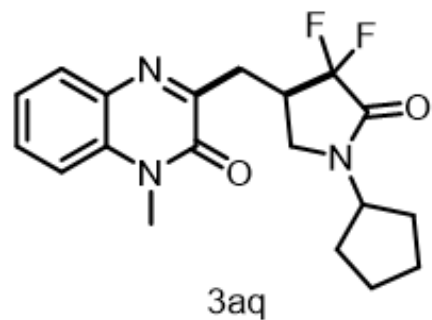
¹H (CDCl₃, 400 MHz)

7.85 7.84 7.83 7.82 7.59 7.58 7.57 7.57 7.40 7.40 7.38 7.36 7.34 7.33 7.27 4.54 4.52 3.74 3.73 3.72 3.70 3.70 3.48 3.47 3.44 3.43 3.17 3.14 3.13 3.10 1.92 1.91 1.90 1.89 1.89 1.88 1.71 1.71 1.70 1.69 1.65 1.65 1.64 1.63 1.61 1.60 1.59 1.58 1.57 1.56 1.56 1.54 1.25



¹H NMR Spectrum of **3aq**

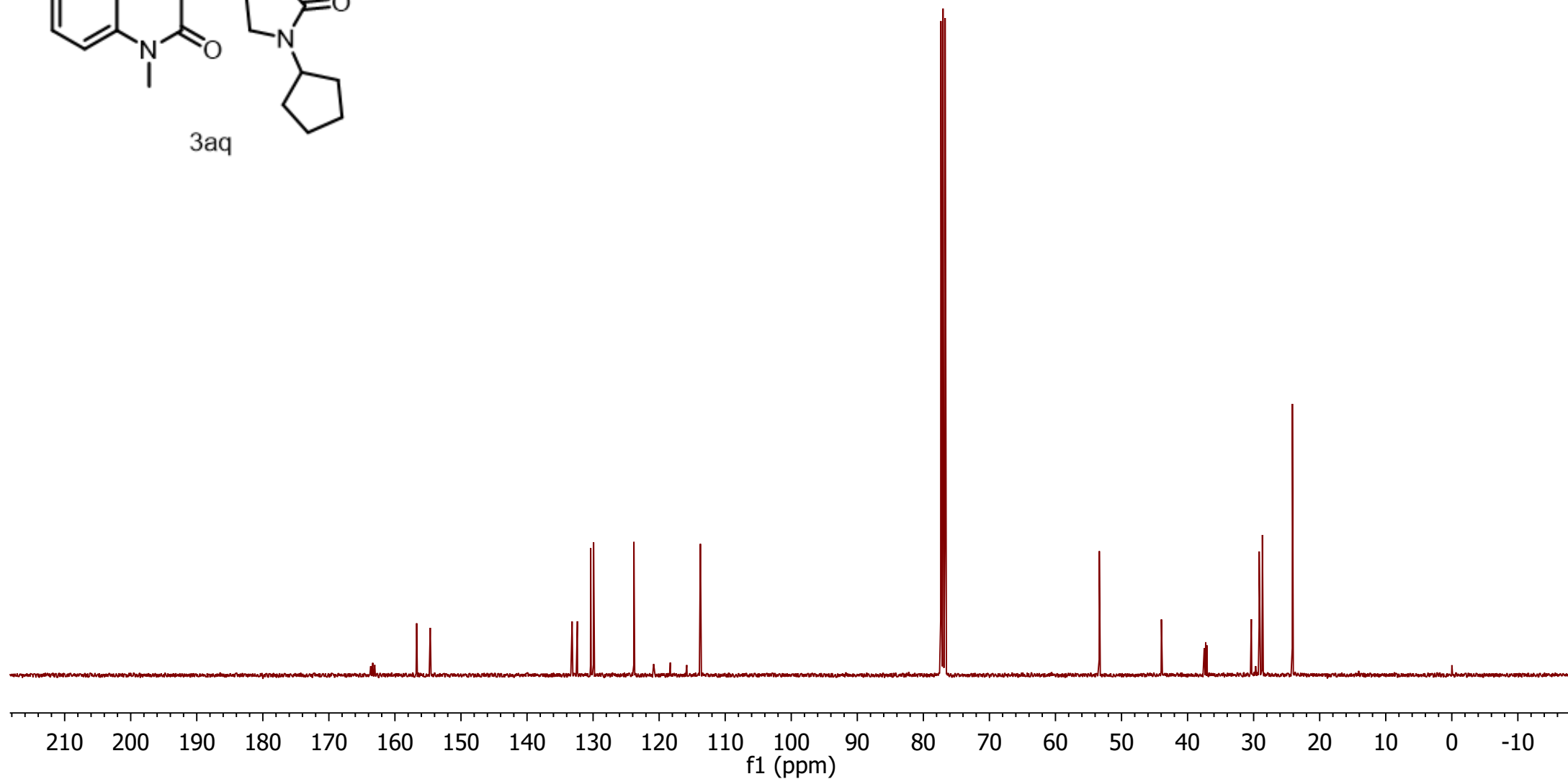
¹³C (CDCl₃, 101 MHz)



163.7
163.4
163.1
156.7
154.7

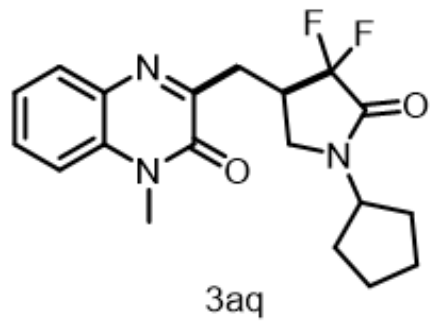
133.2
132.4
130.4
129.9
123.8
120.8
118.3
115.8
113.8

44.0
43.9
37.5
37.3
37.3
37.1
30.4
30.3
29.2
28.7
28.6
24.1

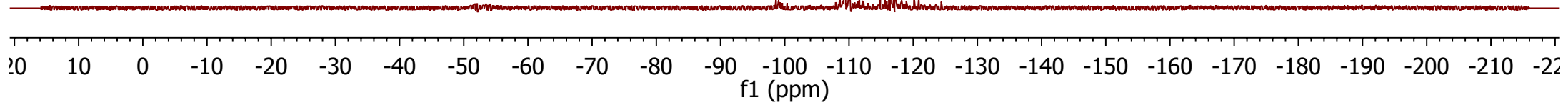


¹³C NMR Spectrum of 3aq

¹⁹F (CDCl₃, 376 MHz)

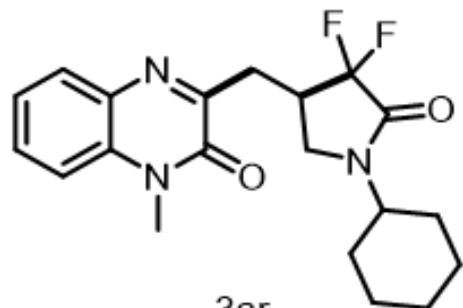


-109.40
-109.41
-109.44
-109.45
-110.11
-110.12
-110.15
-110.16
-116.45
-116.49
-117.16
-117.20

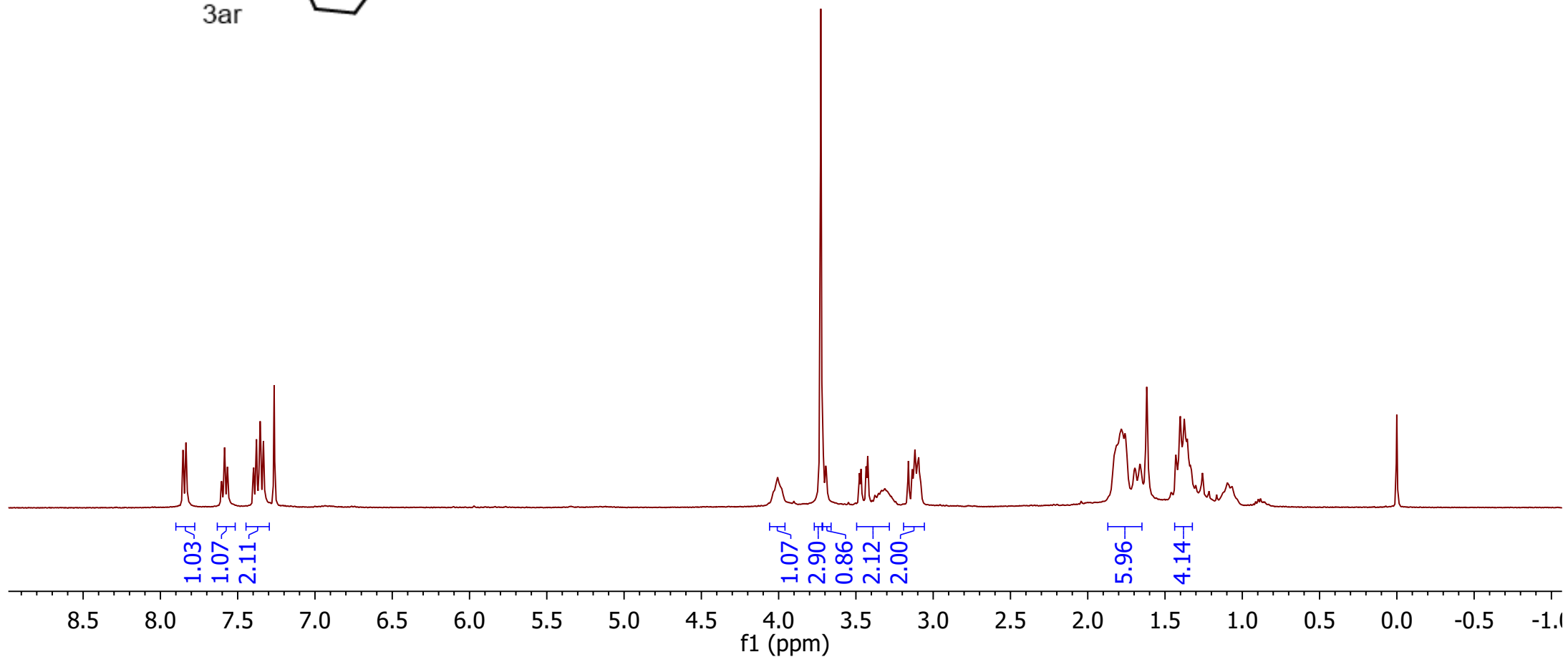


¹⁹F NMR Spectrum of **3aq**

¹H (CDCl₃, 400 MHz)

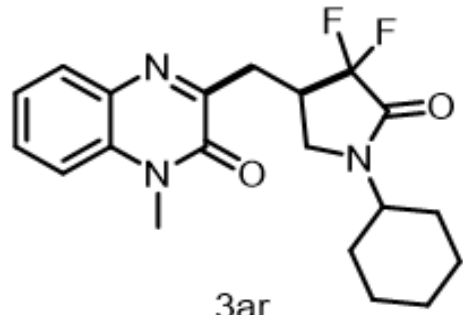


7.86
7.85
7.84
7.83
7.61
7.60
7.59
7.57
7.56
7.40
7.40
7.38
7.36
7.35
7.33
7.26
4.01
4.01
3.98
3.74
3.73
3.72
3.71
3.70
3.69
3.48
3.47
3.43
3.42
3.31
3.16
3.14
3.13
3.12
3.10
3.09
3.08
1.82
1.78
1.75
1.70
1.66
1.62
1.43
1.40
1.38
1.36
1.35
1.34
1.33
1.30
1.26
1.09
1.06



¹H NMR Spectrum of 3ar

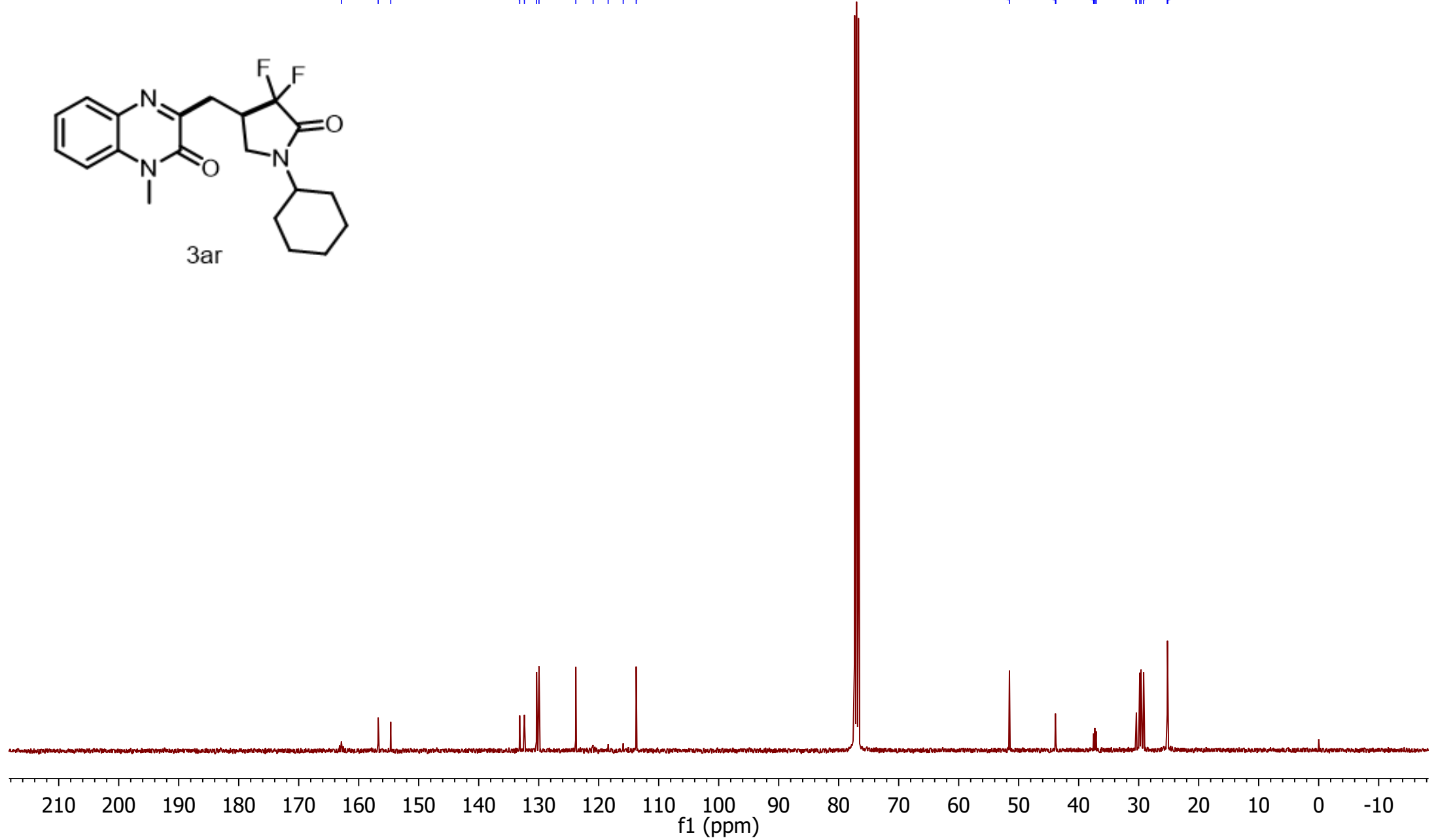
¹³C (CDCl₃, 101 MHz)



162.9
156.8
154.7

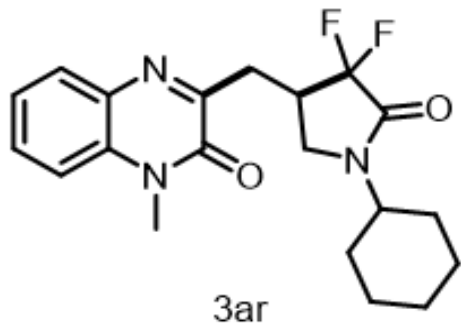
133.2
132.4
130.4
130.0
123.8
120.9
118.4
115.9
113.8

51.5
43.9
43.8
37.5
37.3
37.3
37.1
30.5
30.4
29.8
29.6
29.2
25.2
25.2
25.2

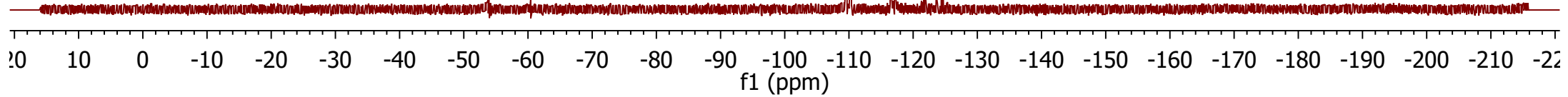


¹³C NMR Spectrum of 3ar

19F (CDCl3, 376 MHz)



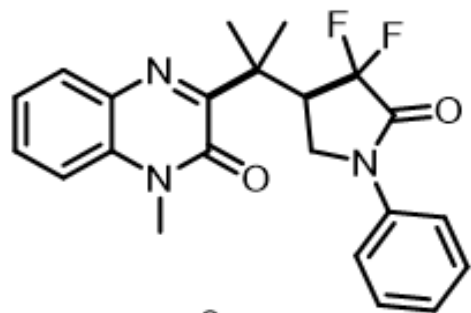
-109.58
-109.59
-109.63
-109.63
-110.29
-110.30
-110.33
-110.34
-116.44
-116.48
-117.15
-117.19



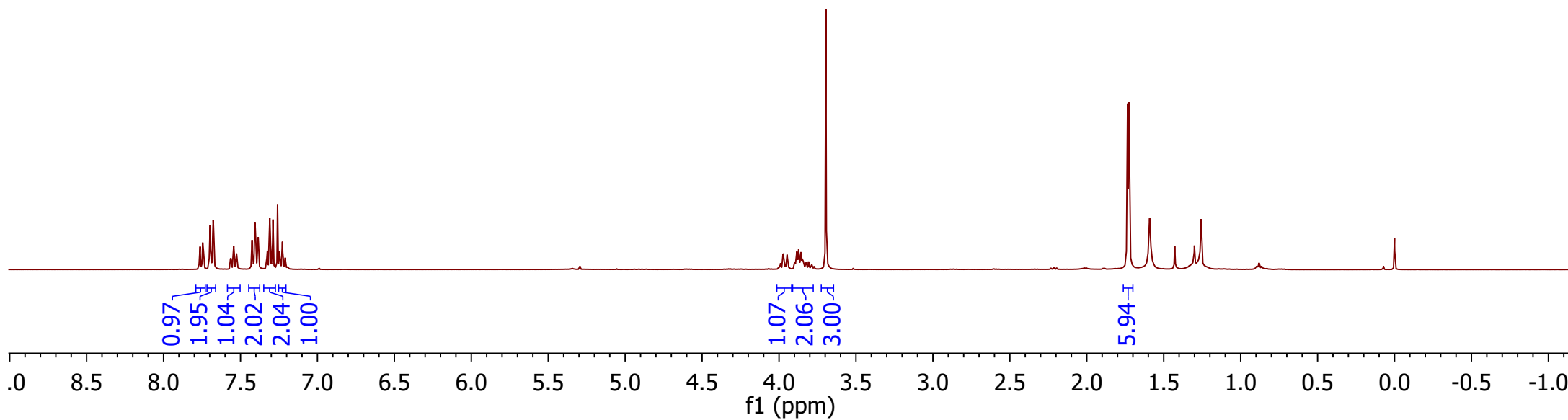
¹⁹F NMR Spectrum of **3ar**

¹H (CDCl₃, 400 MHz)

7.77 7.76 7.75 7.74 7.70 7.70 7.69 7.68 7.68 7.68 7.57 7.56 7.55 7.54 7.54 7.53 7.52 7.43 7.42 7.41 7.40 7.39 7.38 7.33 7.33 7.31 7.31 7.31 7.29 7.29 7.26 7.25 7.25 7.24 7.23 7.23 7.21 3.98 3.97 3.97 3.95 3.94 3.89 3.88 3.88 3.87 3.86 3.85 3.85 3.70 1.74 1.73 1.73

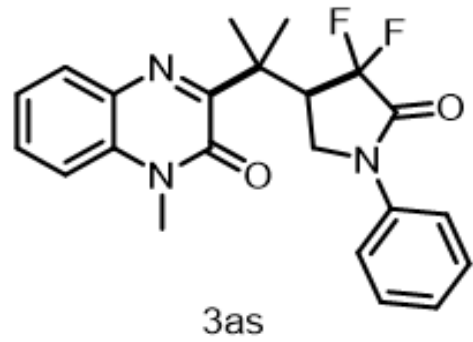


3as



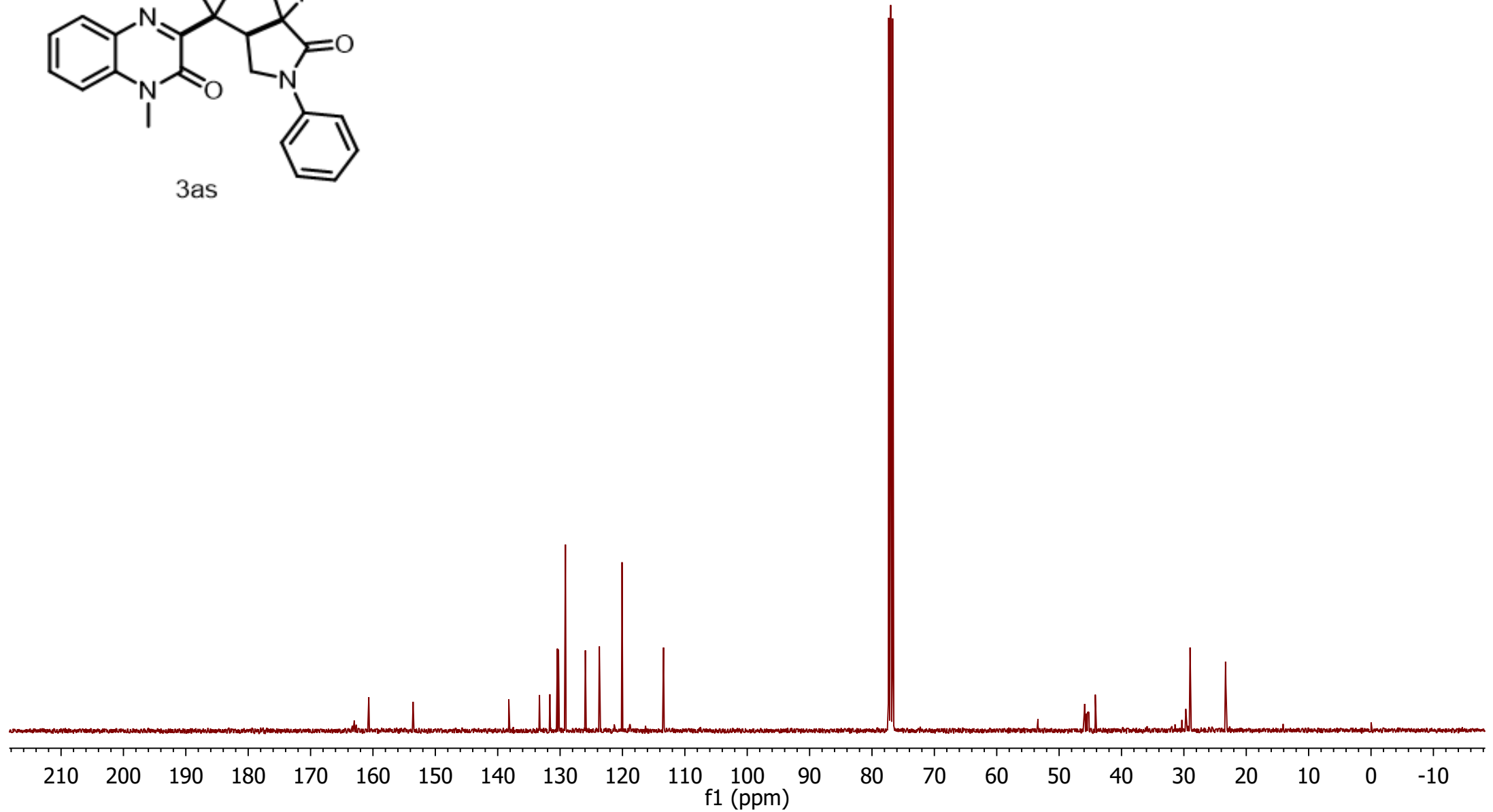
¹H NMR Spectrum of 3as

¹³C (CDCl₃, 101 MHz)



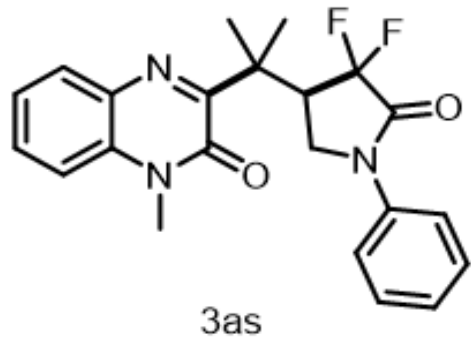
163.3
163.0
162.7
160.7
153.6
138.2
133.3
131.6
130.4
130.3
129.1
125.9
123.7
120.1
113.4

46.0
45.9
45.6
45.4
45.4
45.2
44.2
29.0
23.3
23.3
23.3

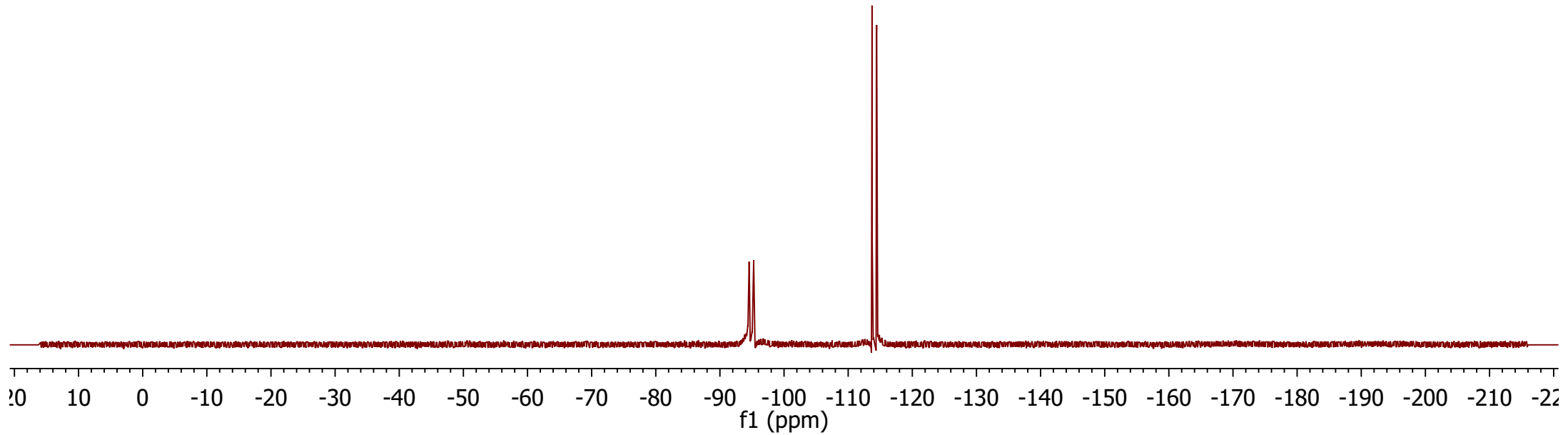


¹³C NMR Spectrum of 3as

¹⁹F (CDCl₃, 376 MHz)



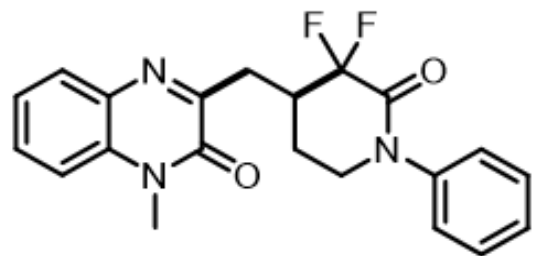
-94.55
-95.27
-113.68
-113.69
-113.73
-114.40
-114.44



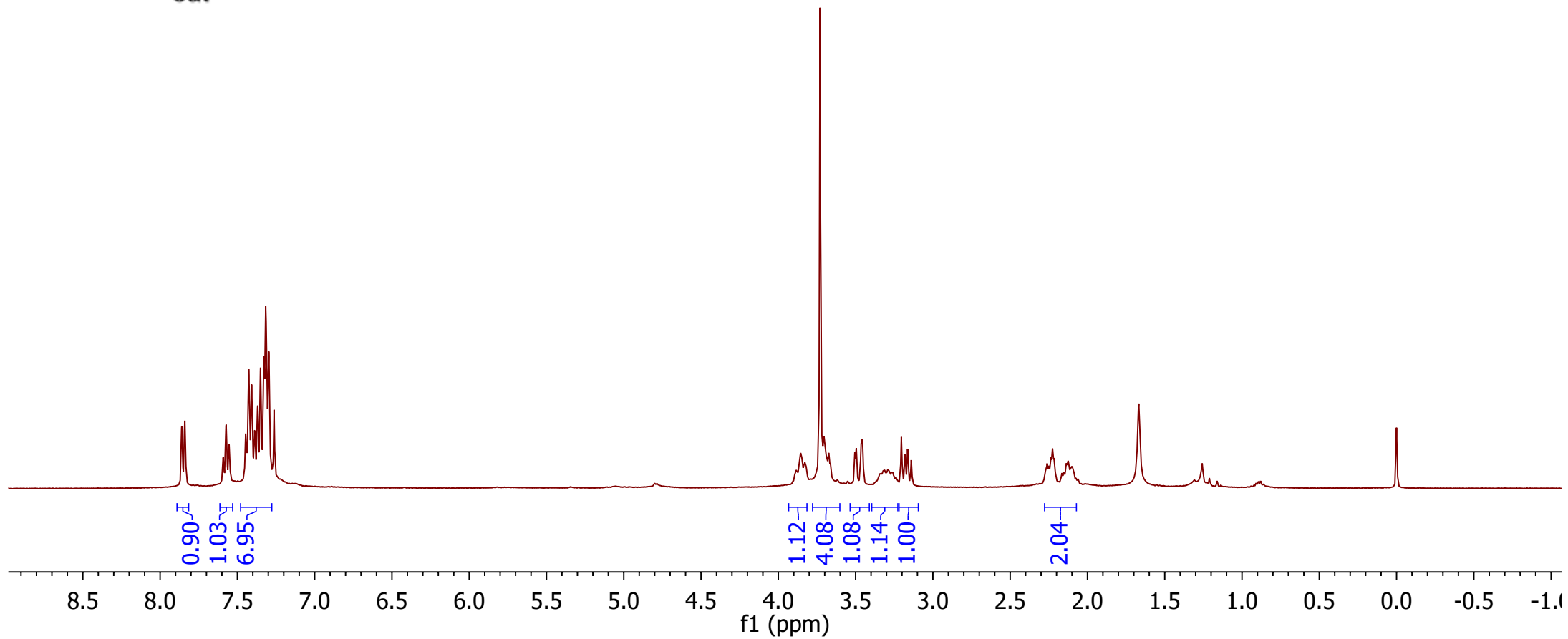
¹⁹F NMR Spectrum of 3as

¹H (CDCl₃, 400 MHz)

7.86
7.84
7.59
7.57
7.55
7.45
7.43
7.41
7.39
7.37
7.35
7.33
7.32
7.31
7.30
7.26
3.88
3.88
3.86
3.86
3.85
3.84
3.84
3.83
3.82
3.73
3.70
3.69
3.69
3.67
3.66
3.51
3.50
3.46
3.46
3.32
3.31
3.29
3.27
3.20
3.18
3.16
3.14
2.27
2.26
2.25
2.24
2.23
2.22
2.15
2.14
2.12
2.10
2.09

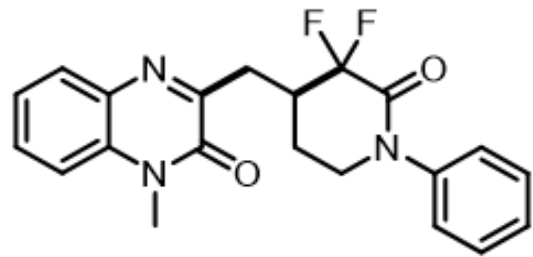


3at



¹H NMR Spectrum of 3at

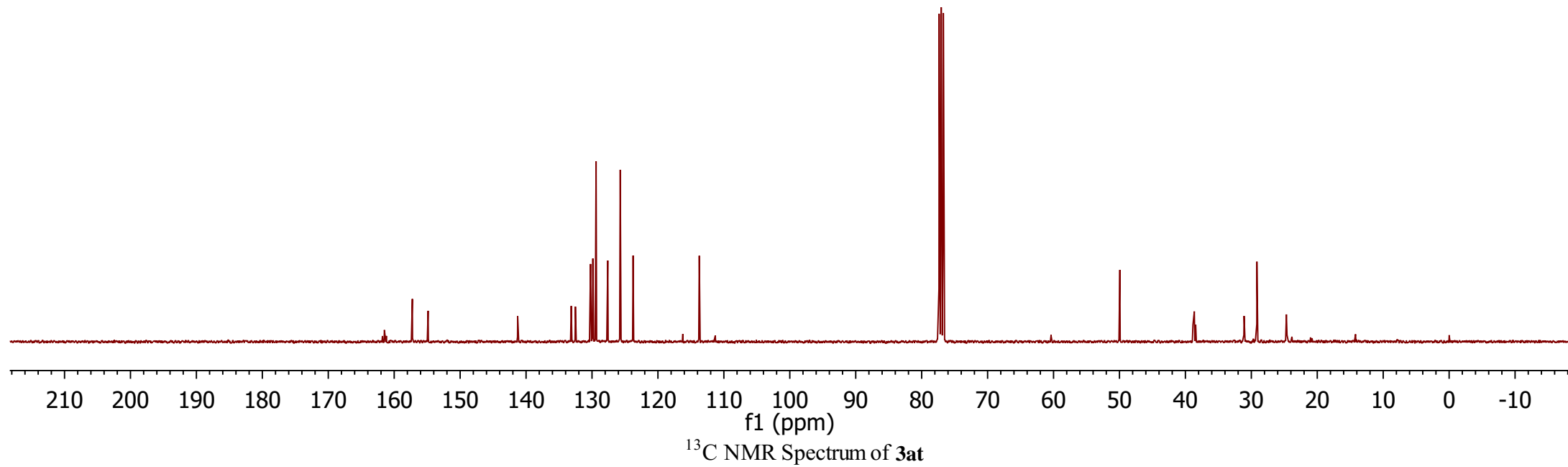
¹³C (CDCl₃, 101 MHz)



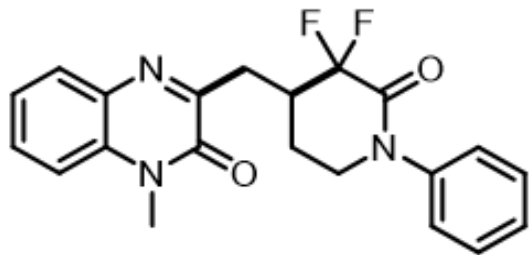
3at

161.8
161.5
161.2
157.2
154.9
141.3
133.2
132.5
130.2
129.9
129.4
127.6
125.7
123.8
116.2
113.7
111.3

49.9
38.9
38.6
38.4
31.1
31.1
31.1
31.0
29.2
24.7
24.6

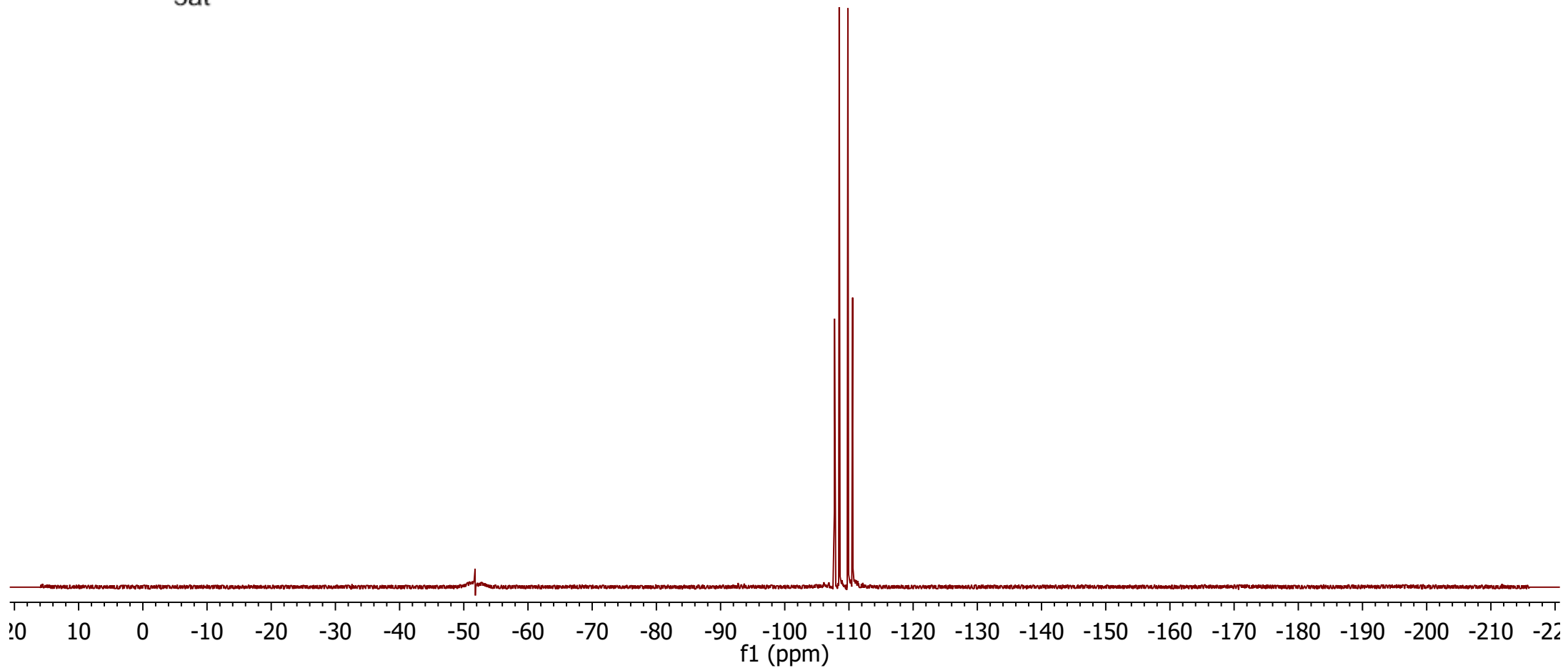


¹⁹F (CDCl₃, 376 MHz)



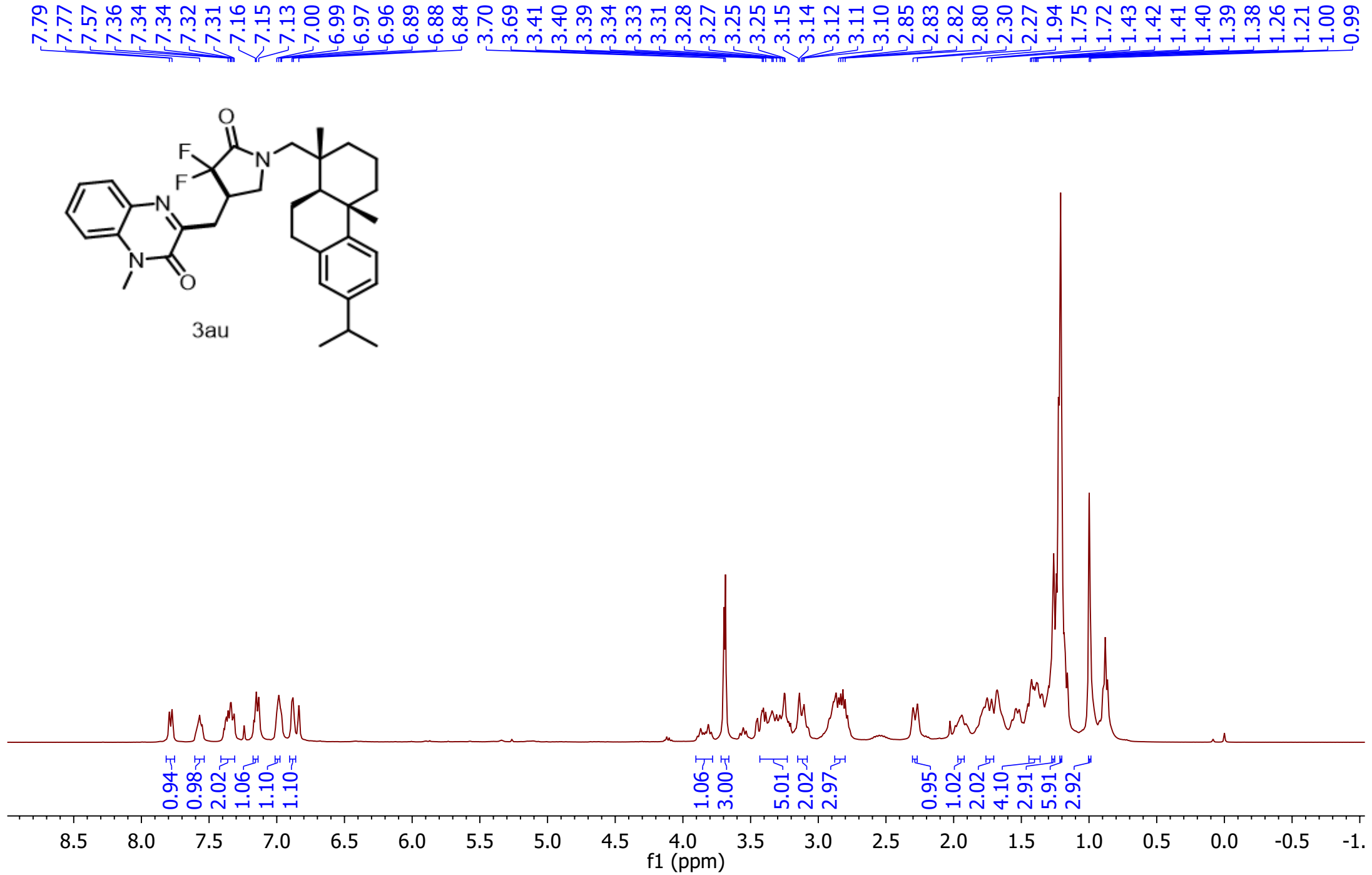
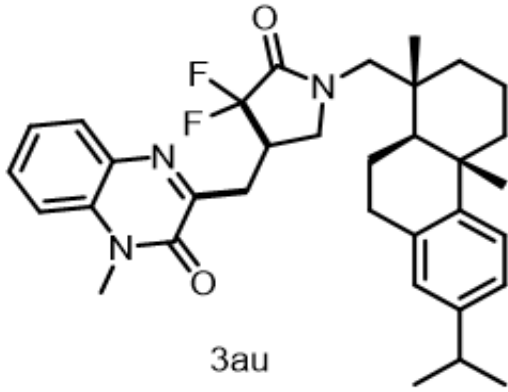
3at

-107.73
-107.74
-107.75
-107.76
-108.47
-108.48
-108.49
-108.50
-109.77
-109.83
-110.51
-110.57



¹⁹F NMR Spectrum of 3at

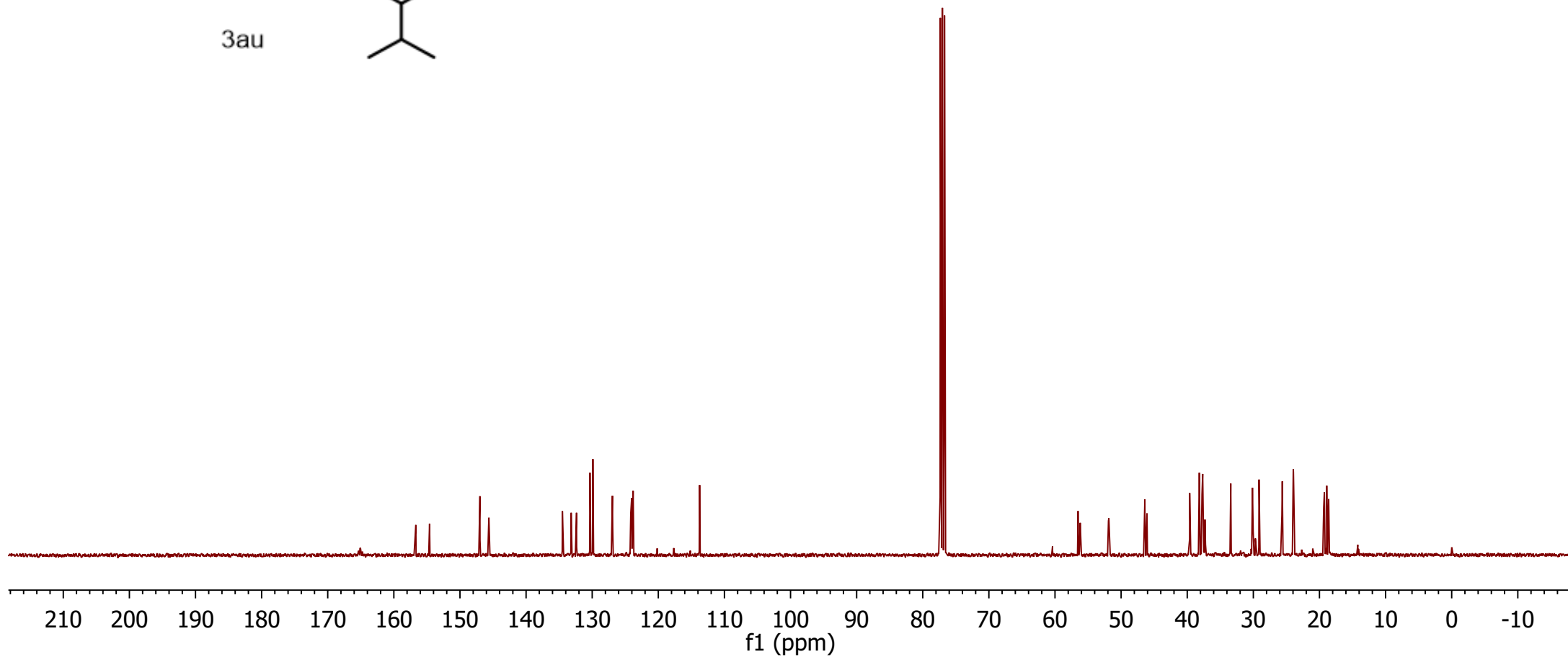
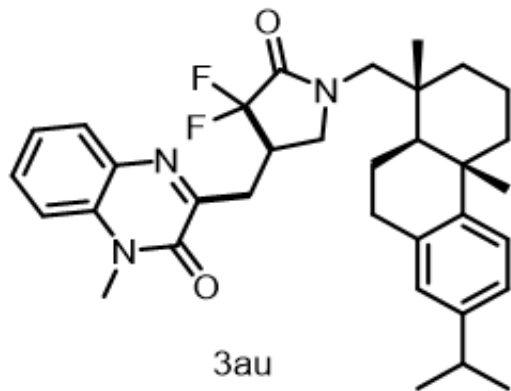
¹H (CDCl₃, 400 MHz)



¹H NMR Spectrum of **3au**

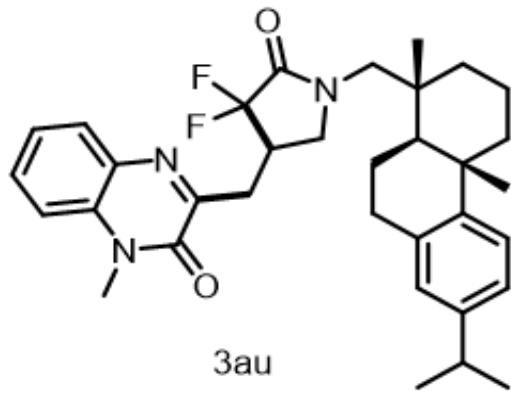
¹³C (CDCl₃, 101 MHz)

156.7
154.6
147.0
145.7
145.6
134.5
134.4
133.2
132.4
130.3
129.9
126.9
126.9
124.2
124.0
123.9
123.9
123.8
123.8
113.8
113.7
56.5
56.2
51.9
51.9
46.4
46.1
39.6
39.6
38.2
37.8
37.7
37.7
37.3
33.5
33.4
30.2
30.1
30.1
30.0
29.2
29.1
25.7
25.6
24.0
24.0
24.0
23.9
19.4
19.3
19.2
18.9
18.6
18.6



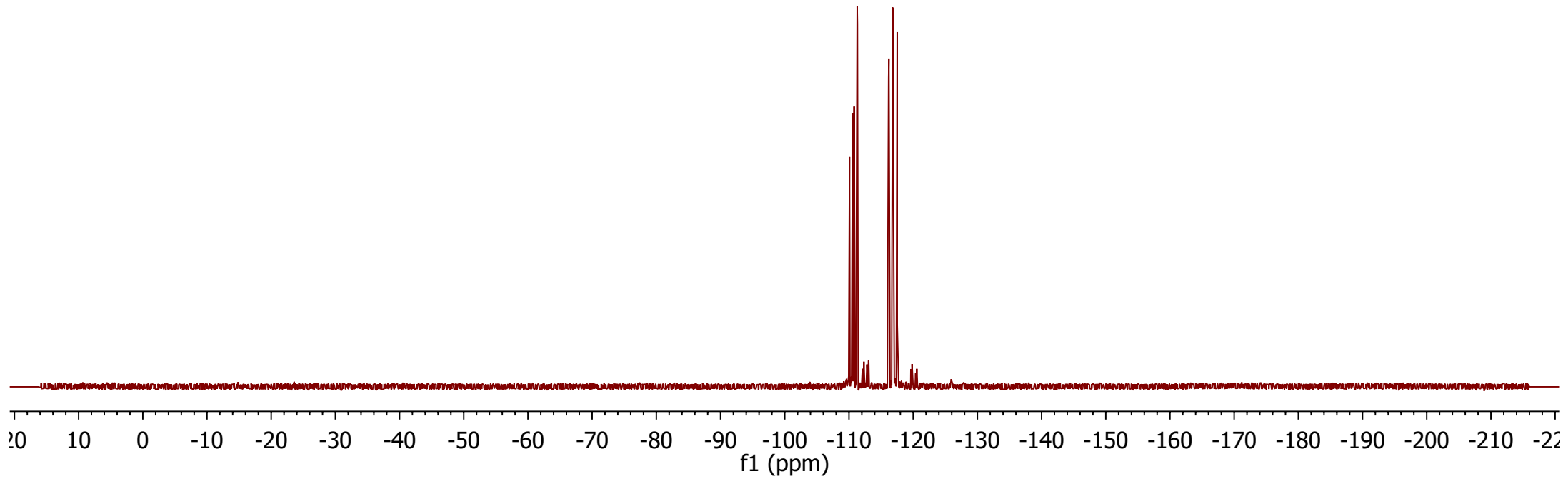
¹³C NMR Spectrum of 3au

19F (CDCl3, 376 MHz)



3au

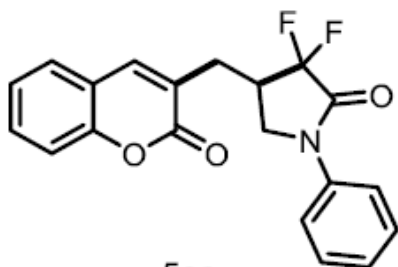
-110.09
-110.12
-110.13
-110.57
-110.58
-110.60
-110.61
-110.80
-110.80
-110.83
-110.84
-111.28
-111.32
-116.17
-116.22
-116.76
-116.80
-116.88
-116.92
-117.46
-117.51



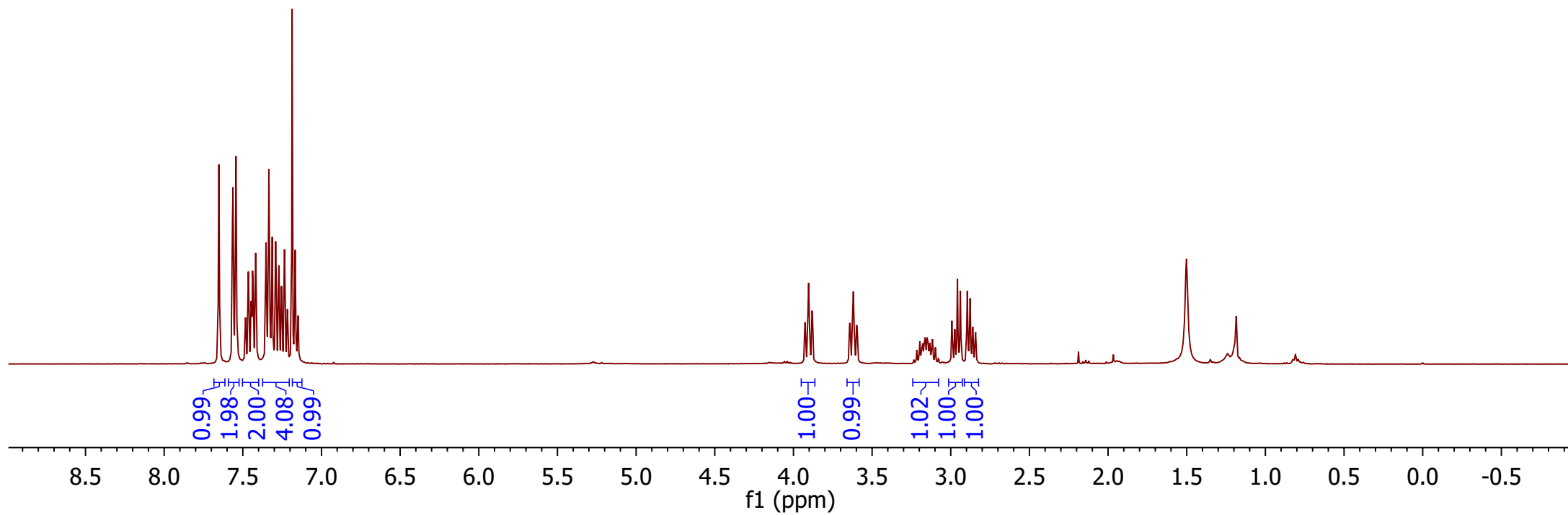
¹⁹F NMR Spectrum of 3au

¹H (CDCl₃, 400 MHz)

7.65
7.57
7.57
7.56
7.56
7.55
7.55
7.54
7.54
7.49
7.48
7.47
7.47
7.46
7.45
7.44
7.44
7.43
7.42
7.41
7.35
7.35
7.33
7.33
7.32
7.31
7.29
7.27
7.25
7.25
7.24
7.23
7.22
7.21
7.19
7.17
7.17
7.16
7.15
3.93
3.91
3.90
3.90
3.88
3.88
3.64
3.64
3.62
3.62
2.99
2.96
2.94
2.90
2.88

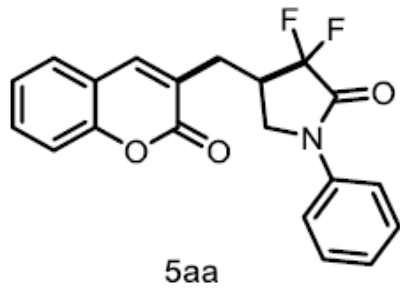


5aa



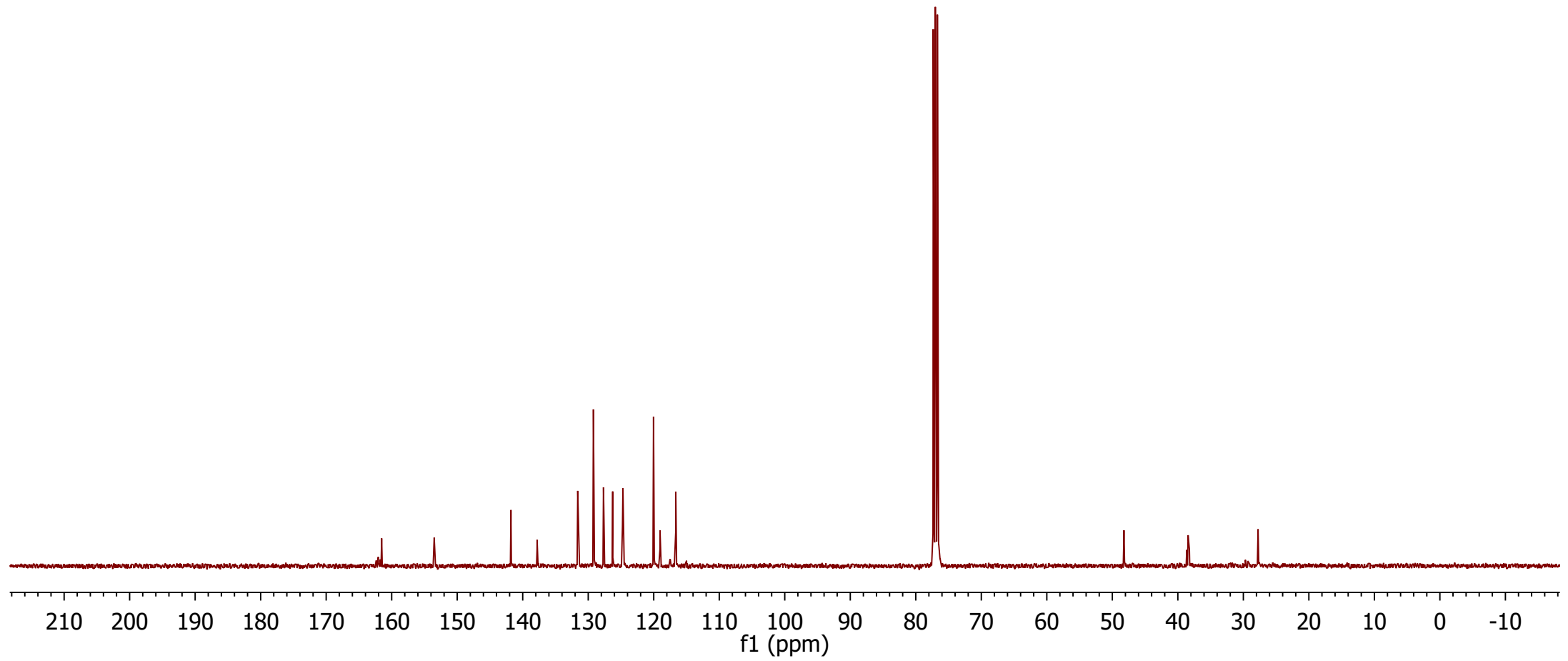
¹H NMR Spectrum of 5aa

¹³C (CDCl₃, 101 MHz)



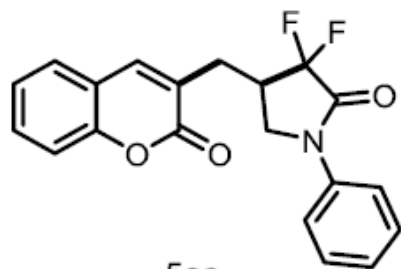
162.0
161.5
153.5
141.8
137.8
131.6
129.2
127.7
126.3
124.8
124.7
120.0
119.0
117.5
117.5
116.6

48.3
48.2
38.6
38.4
38.2
29.7
27.8
27.8



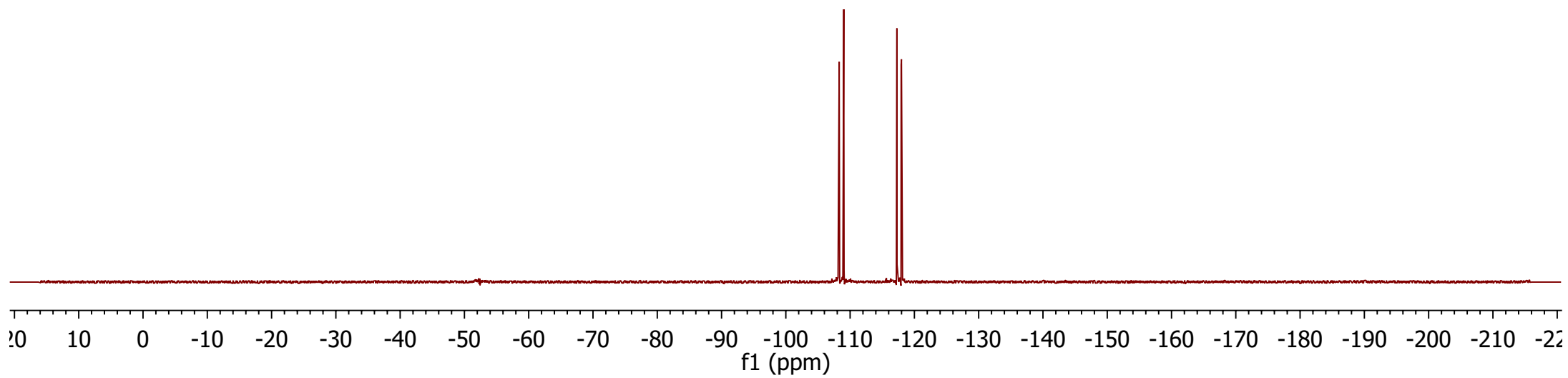
¹³C NMR Spectrum of 5aa

¹⁹F (CDCl₃, 376 MHz)



5aa

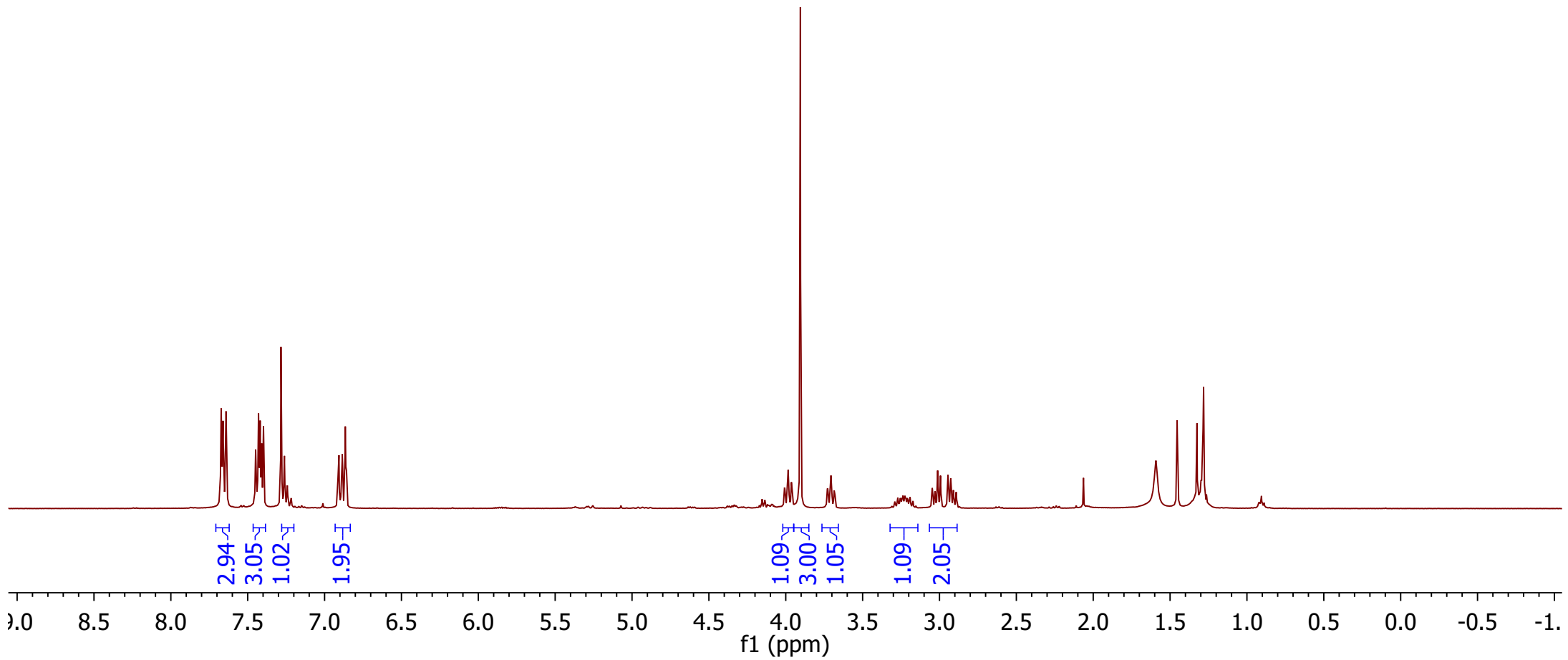
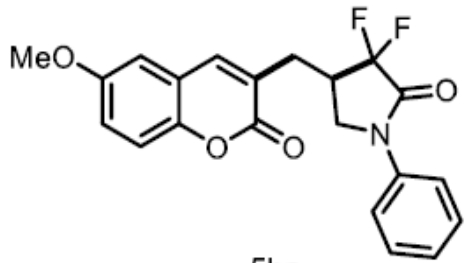
-108.30
-108.34
-109.01
-109.05
-117.23
-117.28
-117.94
-117.99



¹⁹F NMR Spectrum of 5aa

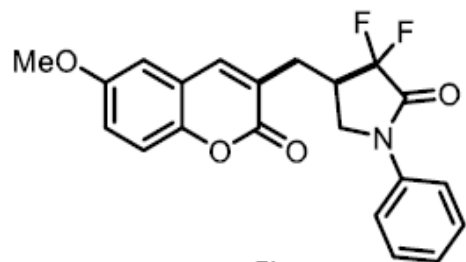
¹H (CDCl₃, 400 MHz)

7.67 7.66 7.66 7.66 7.65 7.64 7.64 7.45 7.45 7.44 7.43 7.43 7.43 7.42 7.41 7.41 7.40 7.28 7.28 7.26 7.26 7.26 7.25 7.24 6.91 6.91 6.89 6.88 6.87 6.86 4.01 4.01 3.99 3.98 3.98 3.96 3.96 3.91 3.73 3.73 3.71 3.71 3.70 3.69 3.05 3.03 3.01 3.01 2.99 2.94 2.93 2.91



¹H NMR Spectrum of **5ba**

¹³C (CDCl₃, 101 MHz)

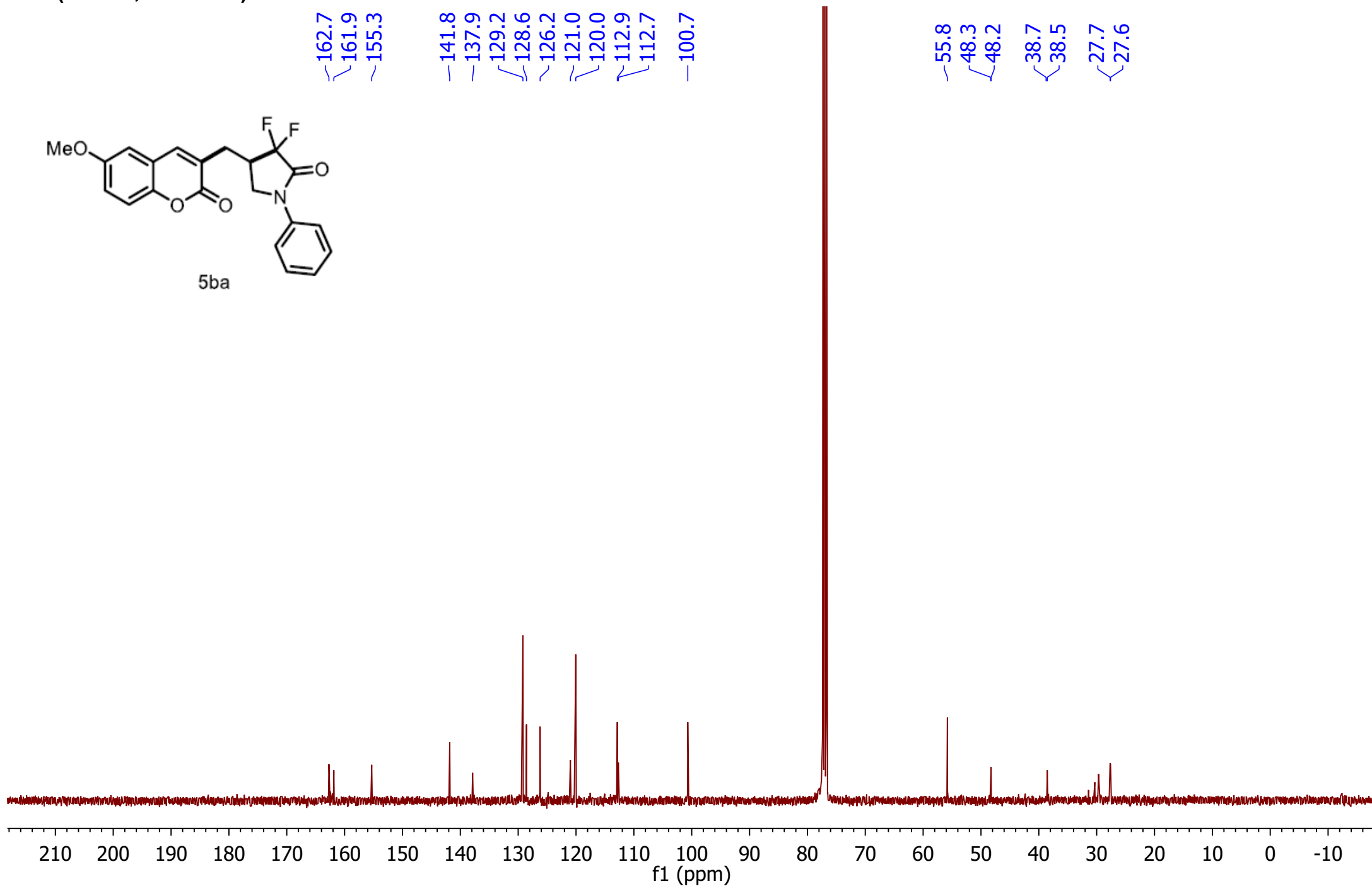


5ba

162.7
161.9
155.3

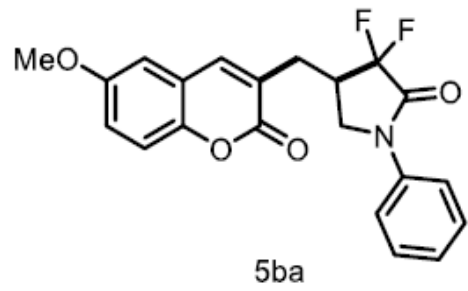
141.8
137.9
129.2
128.6
126.2
121.0
120.0
112.9
112.7
100.7

55.8
48.3
48.2
38.7
38.5
27.7
27.6

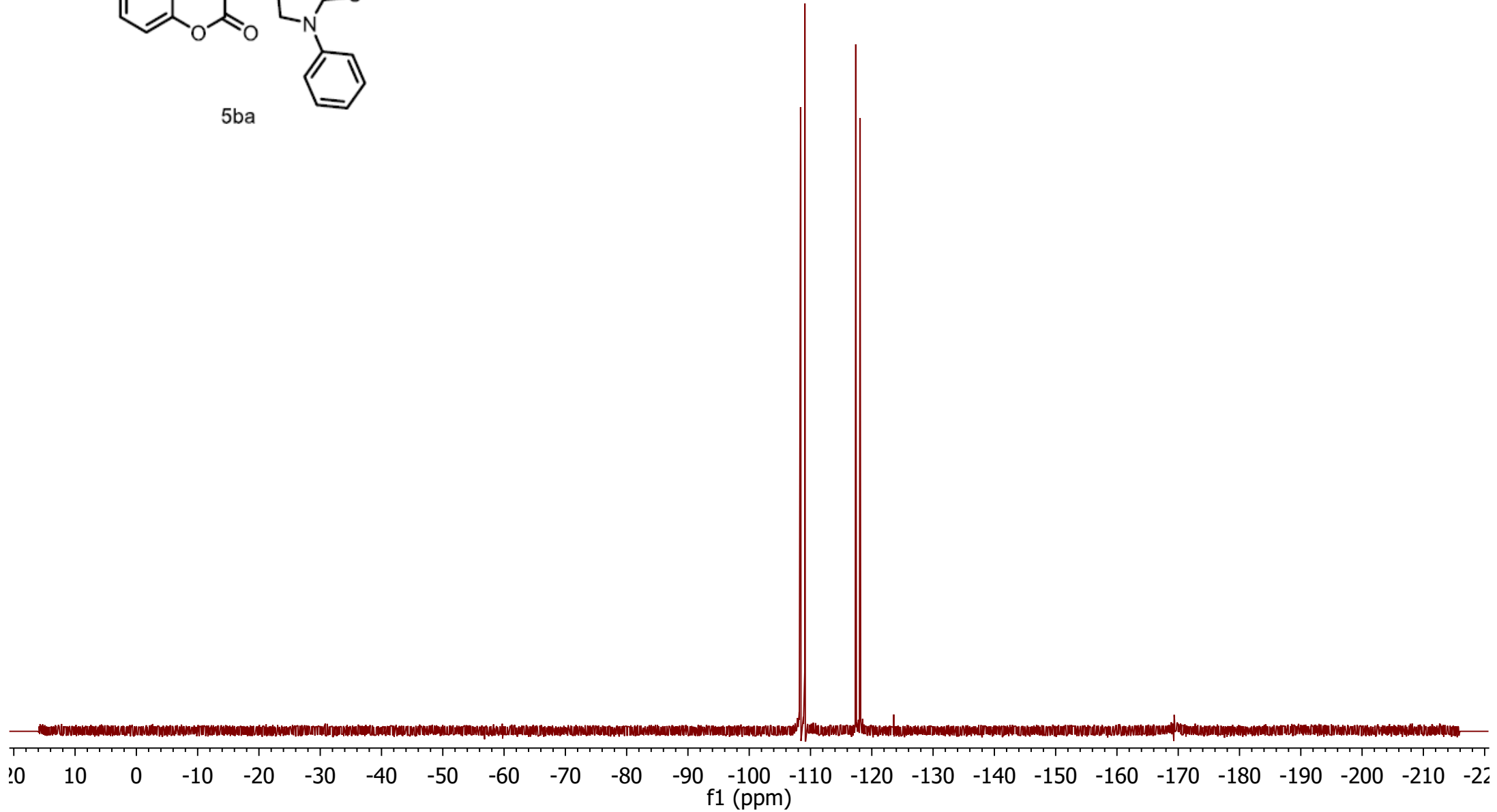


¹³C NMR Spectrum of 5ba

¹⁹F (CDCl₃, 376 MHz)



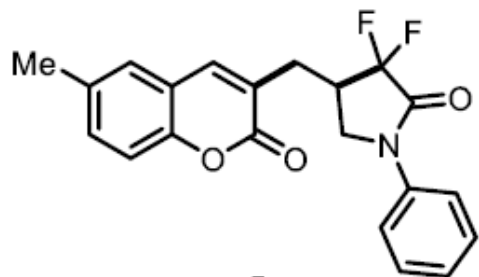
-108.38
-108.41
-109.09
-109.12
-117.33
-117.38
-118.04
-118.09



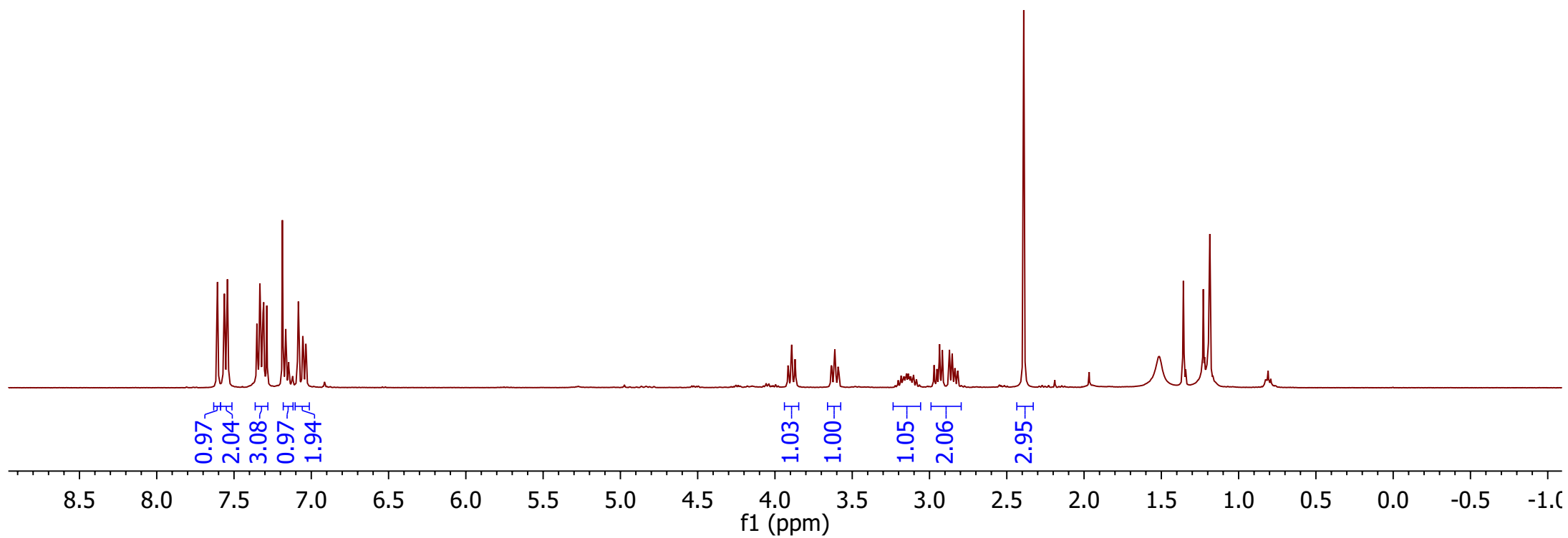
¹⁹F NMR Spectrum of 5ba

¹H (CDCl₃, 400 MHz)

7.61 7.57 7.57 7.56 7.56 7.55 7.55 7.54 7.54 7.53 7.35 7.35 7.33 7.33 7.32 7.32 7.31 7.31 7.29 7.19 7.18 7.18 7.17 7.16 7.15 7.15 7.08 7.06 7.05 7.04 7.03 3.92 3.91 3.90 3.89 3.89 3.87 3.87 3.64 3.63 3.62 3.61 3.61 3.59 3.59 2.97 2.95 2.94 2.92 2.87 2.87 2.85 2.84 2.82 2.39

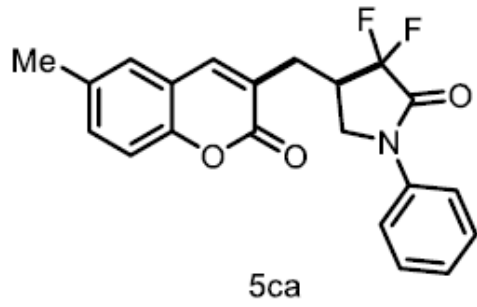


5ca



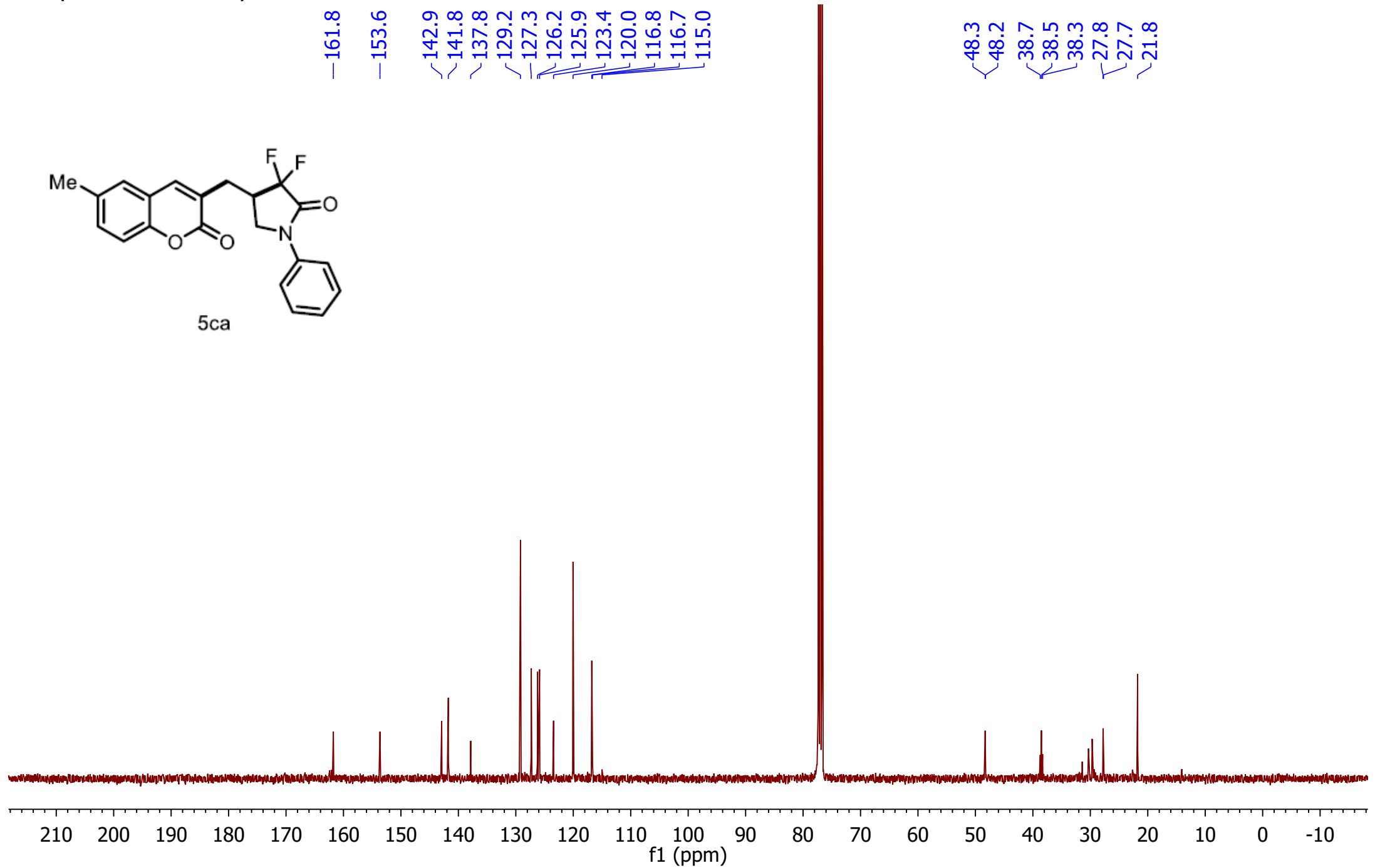
¹H NMR Spectrum of 5ca

¹³C (CDCl₃, 101 MHz)



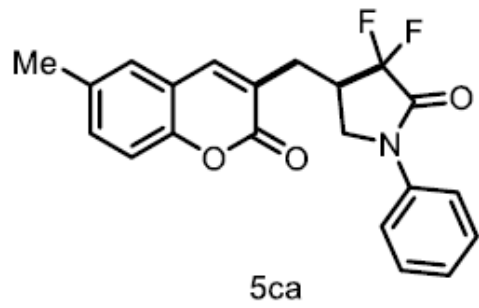
—161.8
—153.6
142.9
141.8
137.8
129.2
127.3
126.2
125.9
123.4
120.0
116.8
116.7
115.0

48.3
48.2
38.7
38.5
38.3
27.8
27.7
21.8

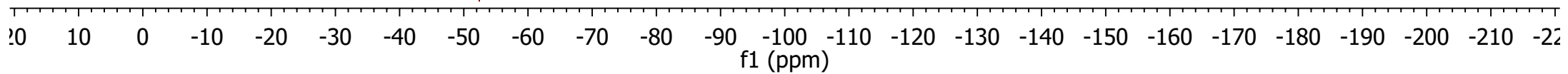


¹³C NMR Spectrum of 5ca

¹⁹F (CDCl₃, 376 MHz)



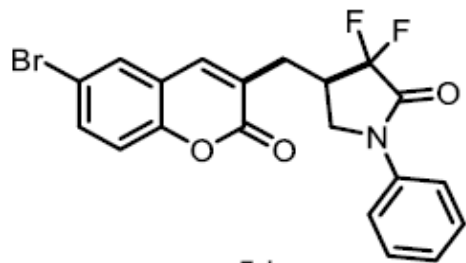
-108.38
-108.41
-109.09
-109.12
-117.30
-117.35
-118.01
-118.06



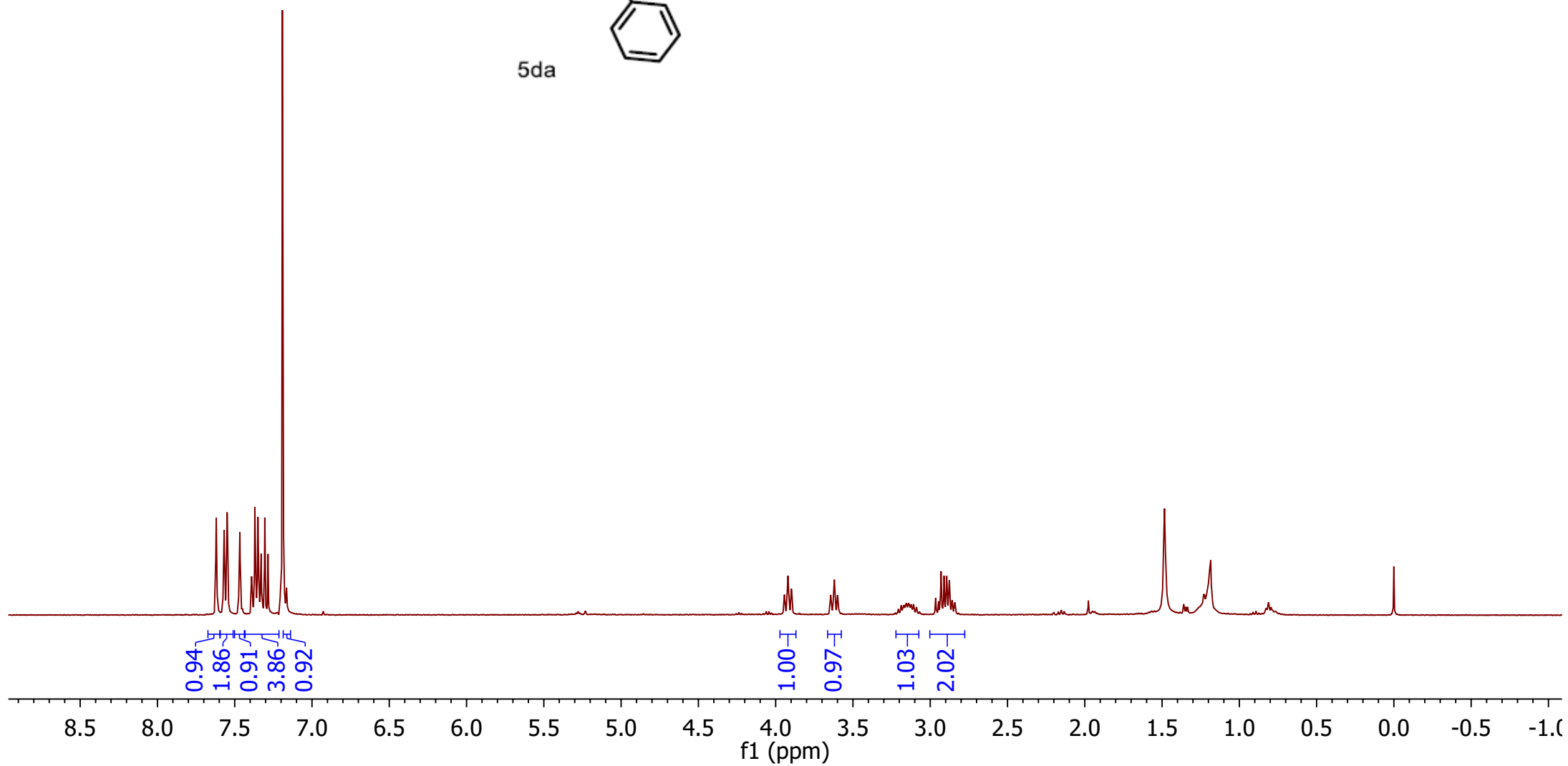
¹⁹F NMR Spectrum of 5ca

¹H (CDCl₃, 400 MHz)

7.62
7.57
7.57
7.56
7.55
7.55
7.54
7.47
7.47
7.39
7.39
7.37
7.37
7.35
7.35
7.33
7.33
7.32
7.31
7.28
7.20
7.20
7.19
7.18
7.17
7.16
7.16
3.94
3.92
3.92
3.90
3.65
3.64
3.63
3.62
3.60
3.19
3.17
3.15
3.14
3.14
3.12
3.11
3.09
2.97
2.95
2.93
2.91
2.89
2.88
2.86
2.84

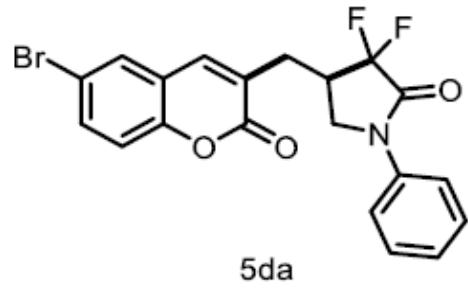


5da



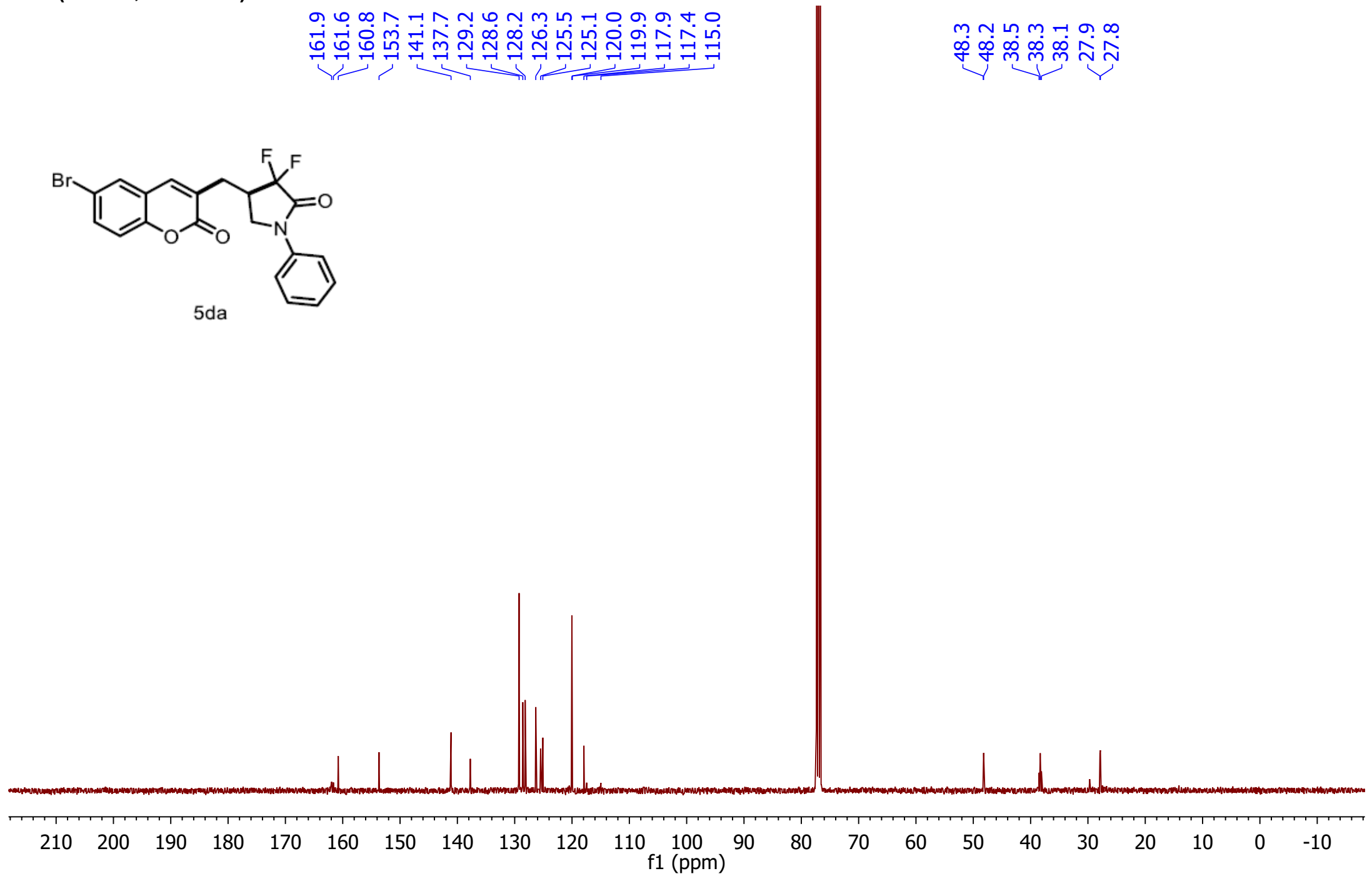
¹H NMR Spectrum of **5da**

¹³C (CDCl₃, 101 MHz)



161.9
161.6
160.8
153.7
141.1
137.7
129.2
128.6
128.2
126.3
125.5
125.1
120.0
119.9
117.9
117.4
115.0

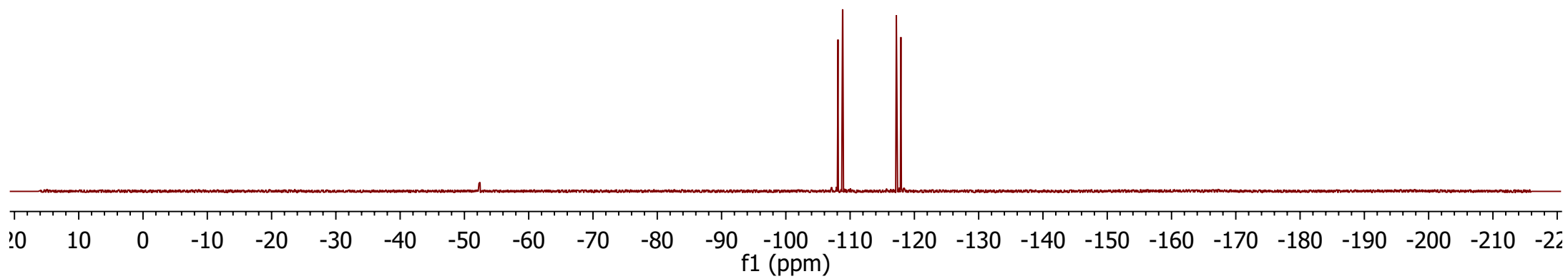
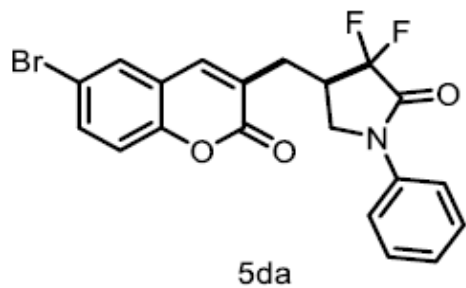
48.3
48.2
38.5
38.3
38.1
27.9
27.8



¹³C NMR Spectrum of 5da

¹⁹F (CDCl₃, 376 MHz)

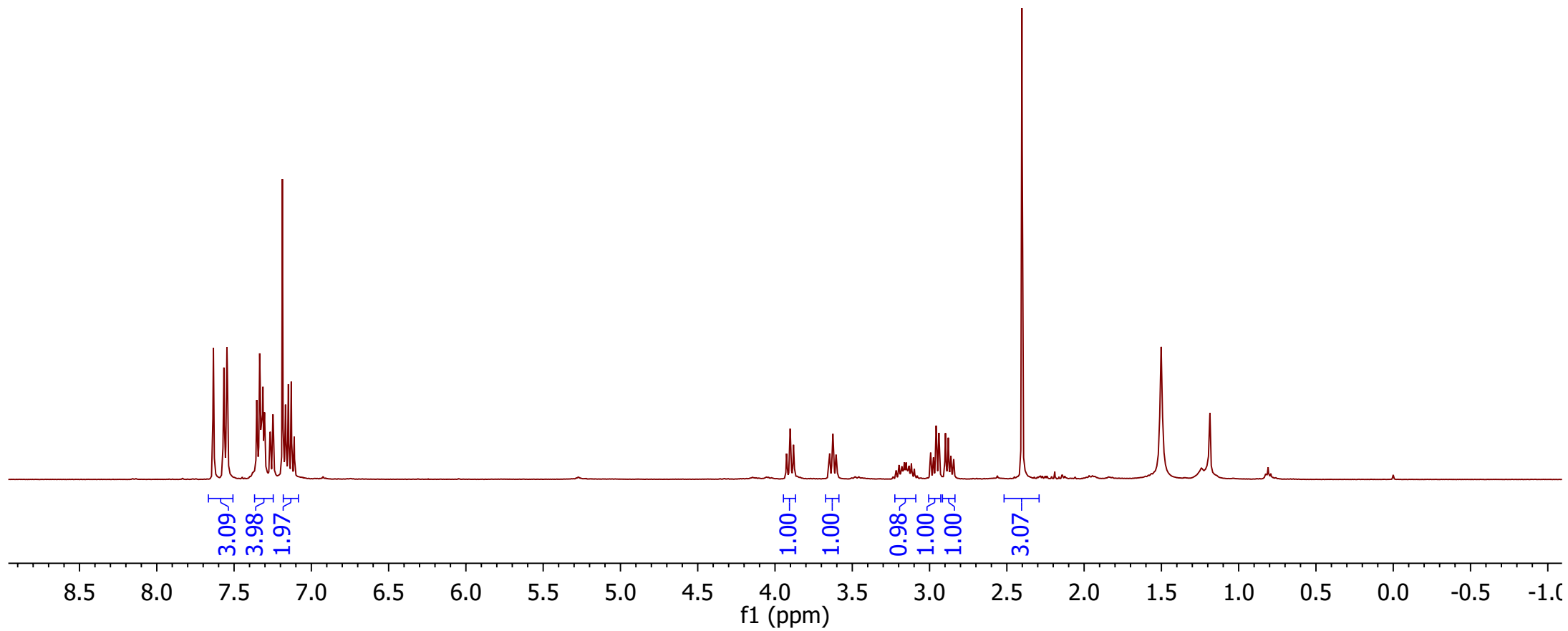
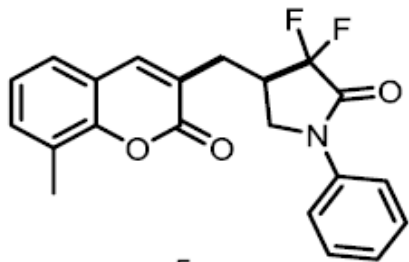
-108.11
-108.15
-108.82
-108.86
-117.15
-117.20
-117.86
-117.91



¹⁹F NMR Spectrum of **5da**

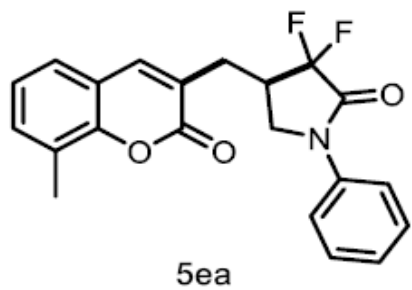
¹H (CDCl₃, 400 MHz)

7.63
7.57
7.57
7.57
7.56
7.55
7.55
7.54
7.54
7.35
7.35
7.33
7.33
7.32
7.32
7.31
7.31
7.30
7.27
7.27
7.26
7.25
7.25
7.19
7.17
7.15
7.13
7.11
3.93
3.92
3.91
3.90
3.90
3.88
3.88
3.65
3.65
3.63
3.63
3.62
3.61
3.60
3.16
3.15
2.99
2.97
2.96
2.94
2.90
2.88
2.86
2.84
2.40



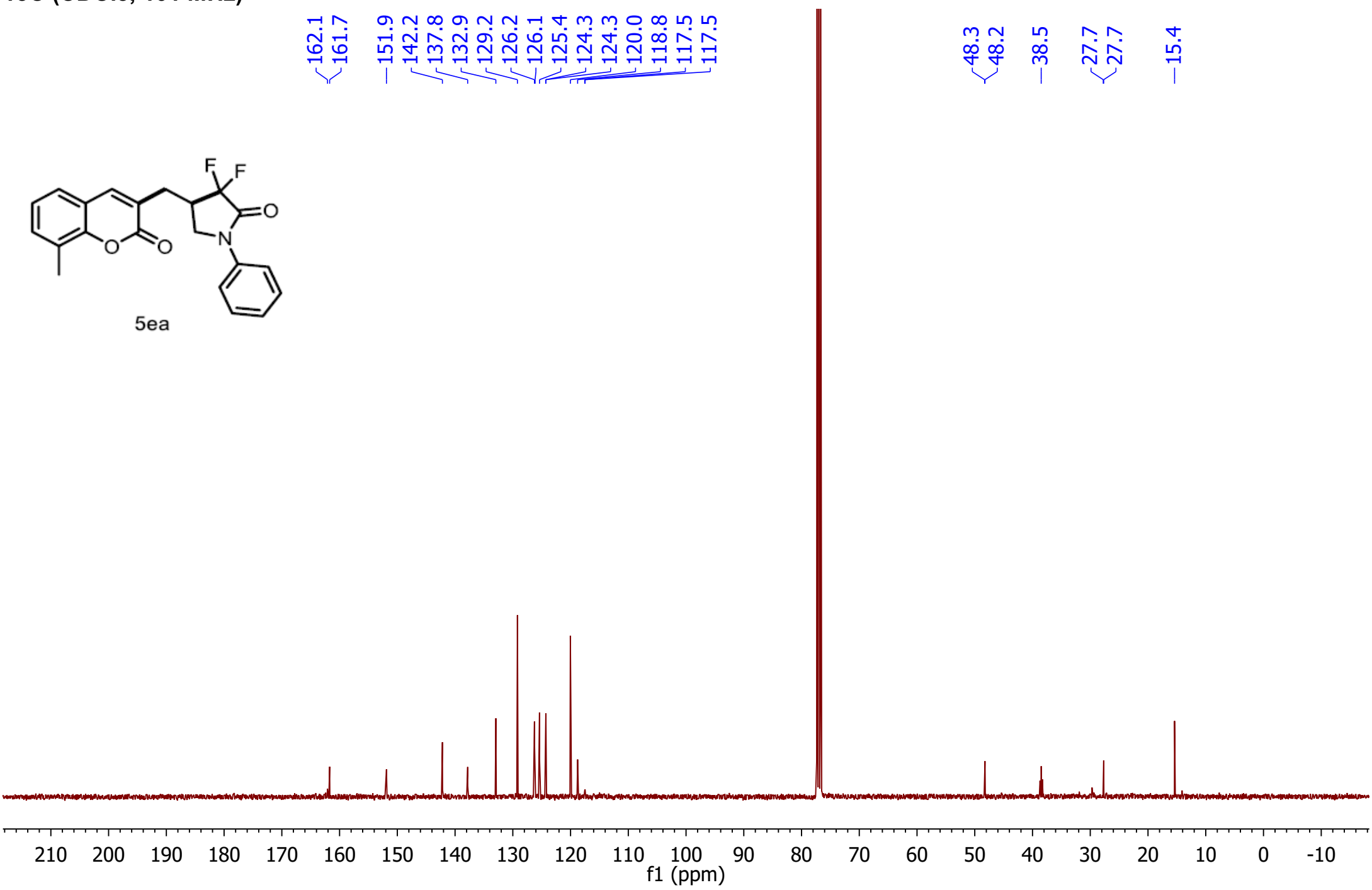
¹H NMR Spectrum of 5ea

¹³C (CDCl₃, 101 MHz)



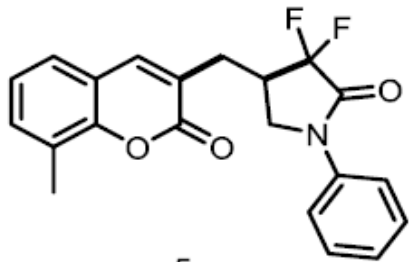
162.1
161.7
— 151.9
142.2
137.8
132.9
129.2
126.2
126.1
125.4
124.3
124.3
120.0
118.8
117.5
117.5

48.3
48.2
— 38.5
27.7
27.7
— 15.4



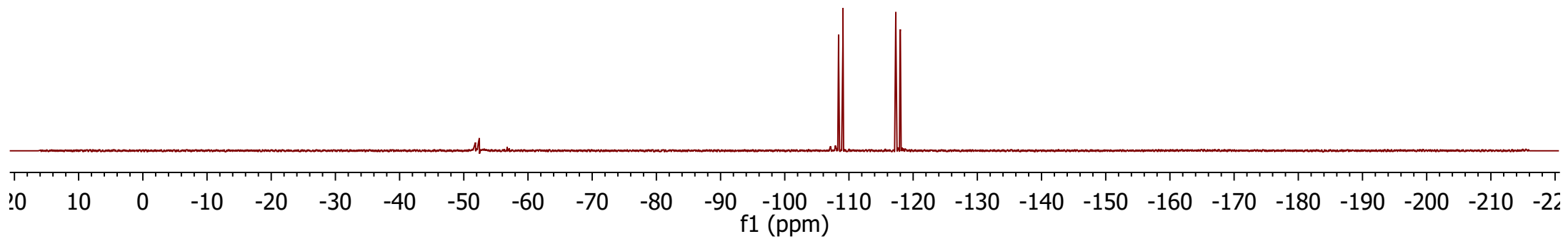
¹³C NMR Spectrum of 5ea

19F (CDCl3, 376 MHz)



5ea

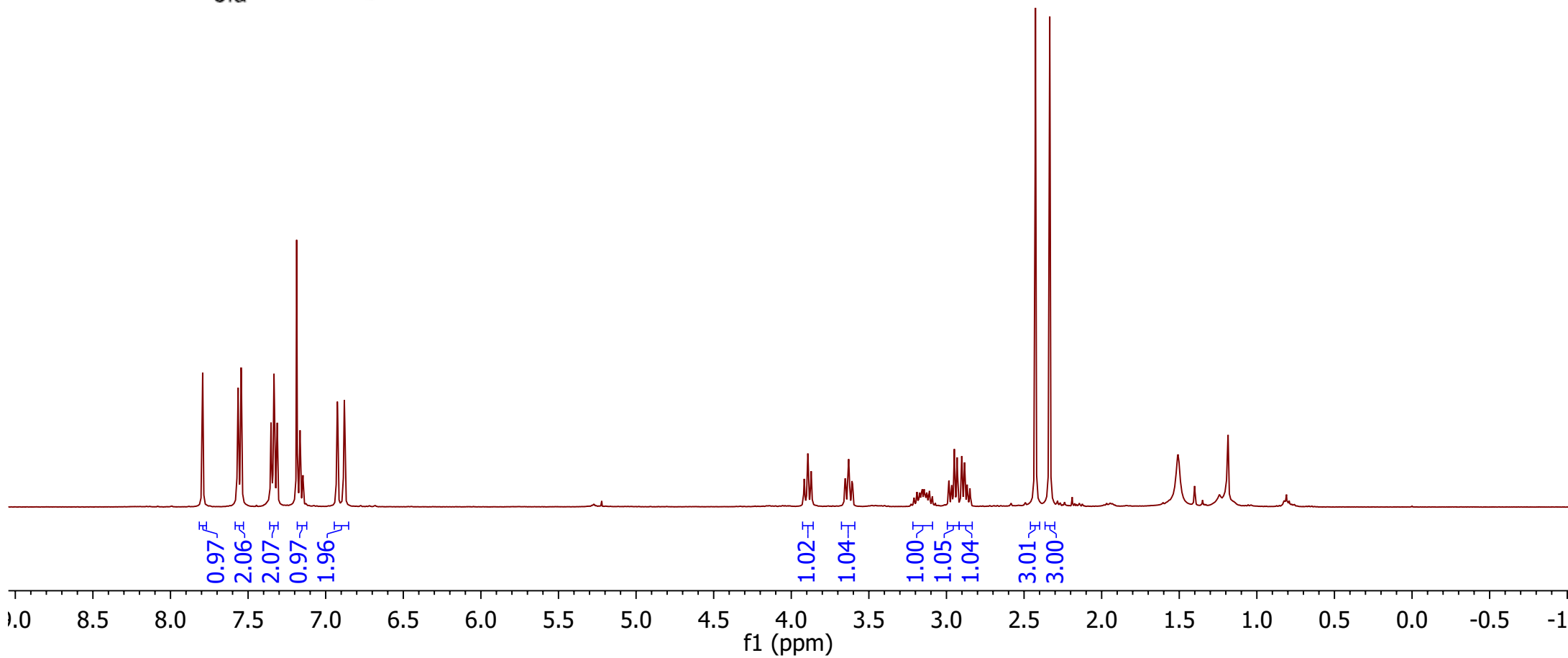
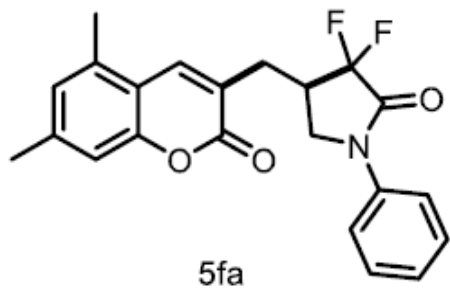
-108.35
-108.39
-109.06
-109.10
-117.25
-117.30
-117.96
-118.01



¹⁹F NMR Spectrum of 5ea

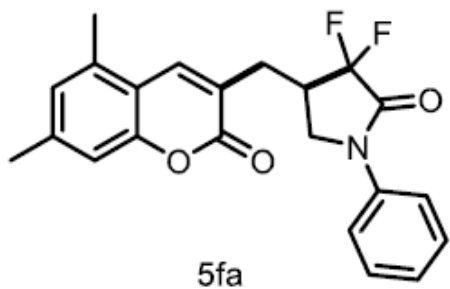
¹H (CDCl₃, 400 MHz)

7.79 7.57 7.57 7.56 7.56 7.55 7.55 7.54 7.54 7.36 7.35 7.35 7.34 7.33 7.33 7.32 7.31 7.19 7.18 7.17 7.15 7.15 7.14 6.93 6.88 3.92 3.91 3.90 3.89 3.89 3.87 3.87 3.65 3.65 3.63 3.63 3.62 3.61 3.61 3.19 3.16 3.14 3.13 3.11 2.98 2.97 2.95 2.93 2.90 2.88 2.87 2.85 2.43 2.33



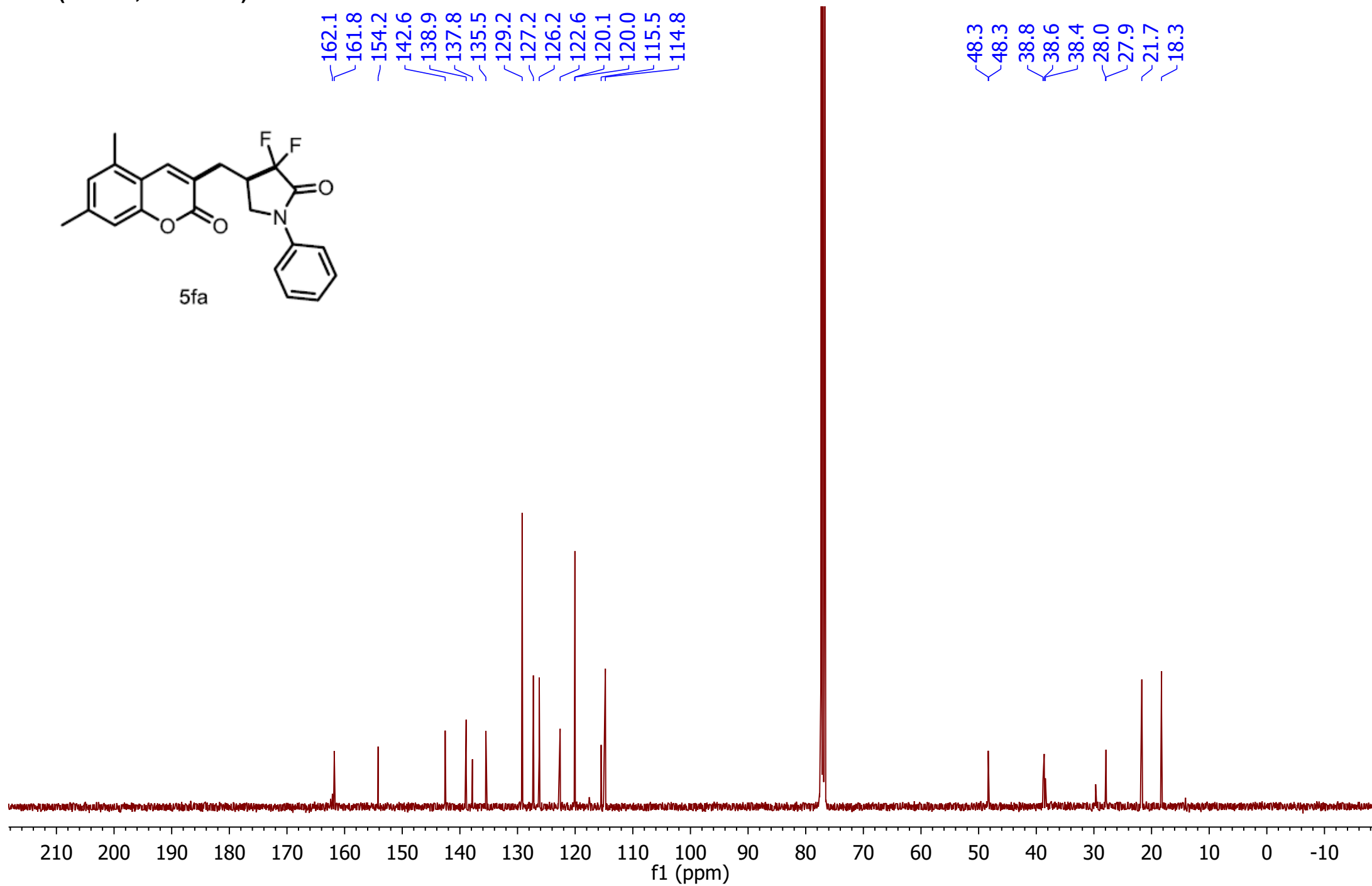
¹H NMR Spectrum of **5fa**

¹³C (CDCl₃, 101 MHz)



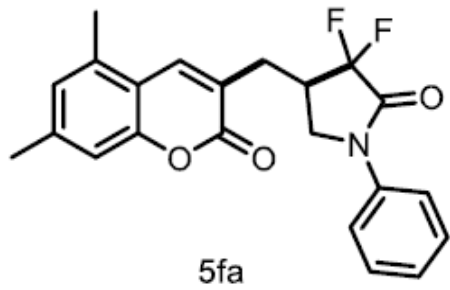
162.1
161.8
154.2
142.6
138.9
137.8
135.5
129.2
127.2
126.2
122.6
120.1
120.0
115.5
114.8

48.3
48.3
38.8
38.6
38.4
28.0
27.9
21.7
18.3

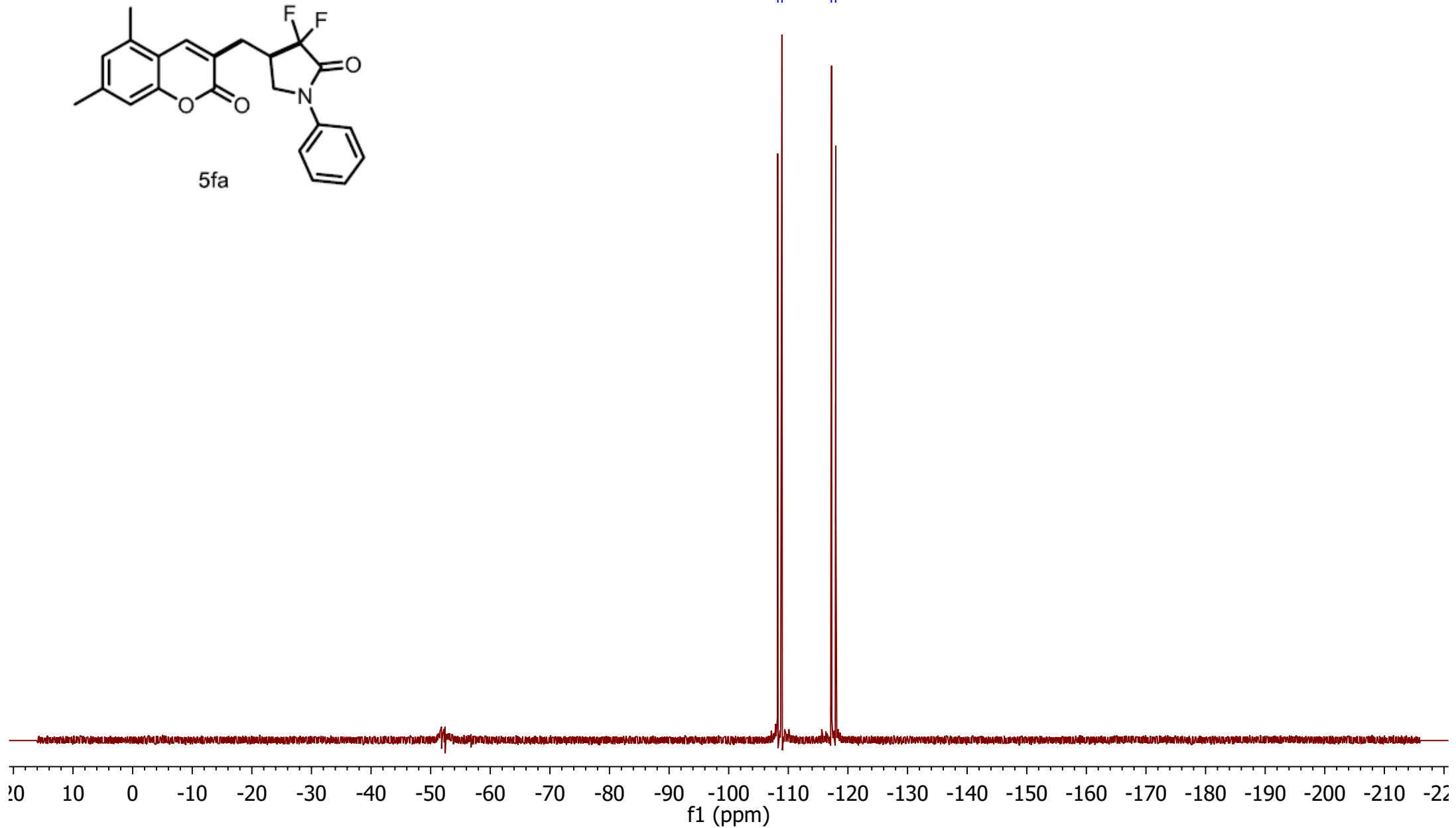


¹³C NMR Spectrum of 5fa

¹⁹F (CDCl₃, 376 MHz)



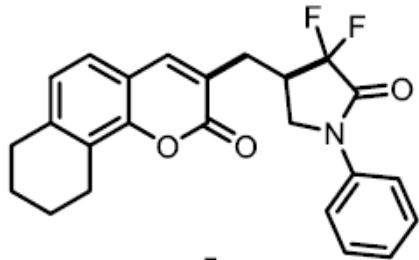
-108.22
-108.26
-108.93
-108.97
-117.20
-117.25
-117.91
-117.96



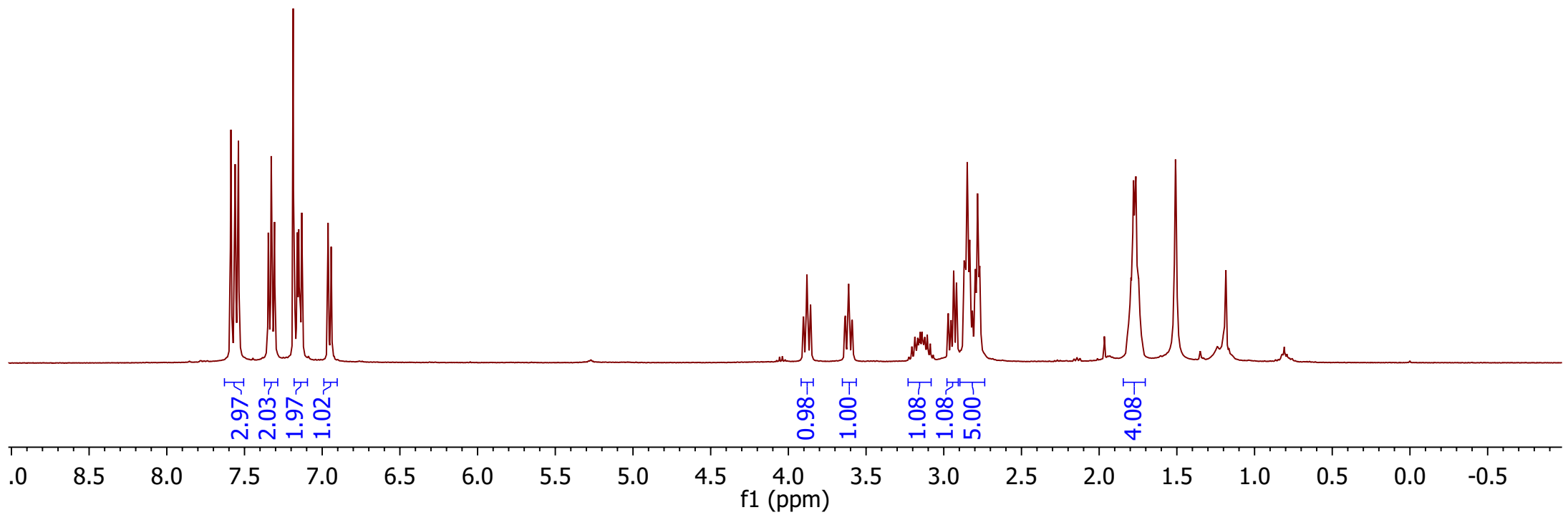
¹⁹F NMR Spectrum of 5fa

¹H (CDCl₃, 400 MHz)

7.59
7.56
7.56
7.55
7.54
7.54
7.54
7.35
7.34
7.33
7.33
7.31
7.31
7.19
7.18
7.18
7.16
7.16
7.15
7.14
7.14
7.13
6.96
6.94
3.88
3.88
3.88
3.86
3.86
3.62
3.61
2.94
2.92
2.87
2.86
2.85
2.84
2.83
2.80
2.78
2.77
1.80
1.80
1.79
1.79
1.78
1.78
1.77
1.76
1.76
1.75
1.75
1.75
1.74



5ga

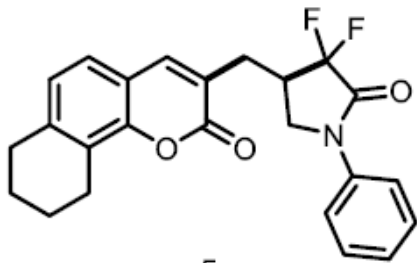


¹H NMR Spectrum of 5ga

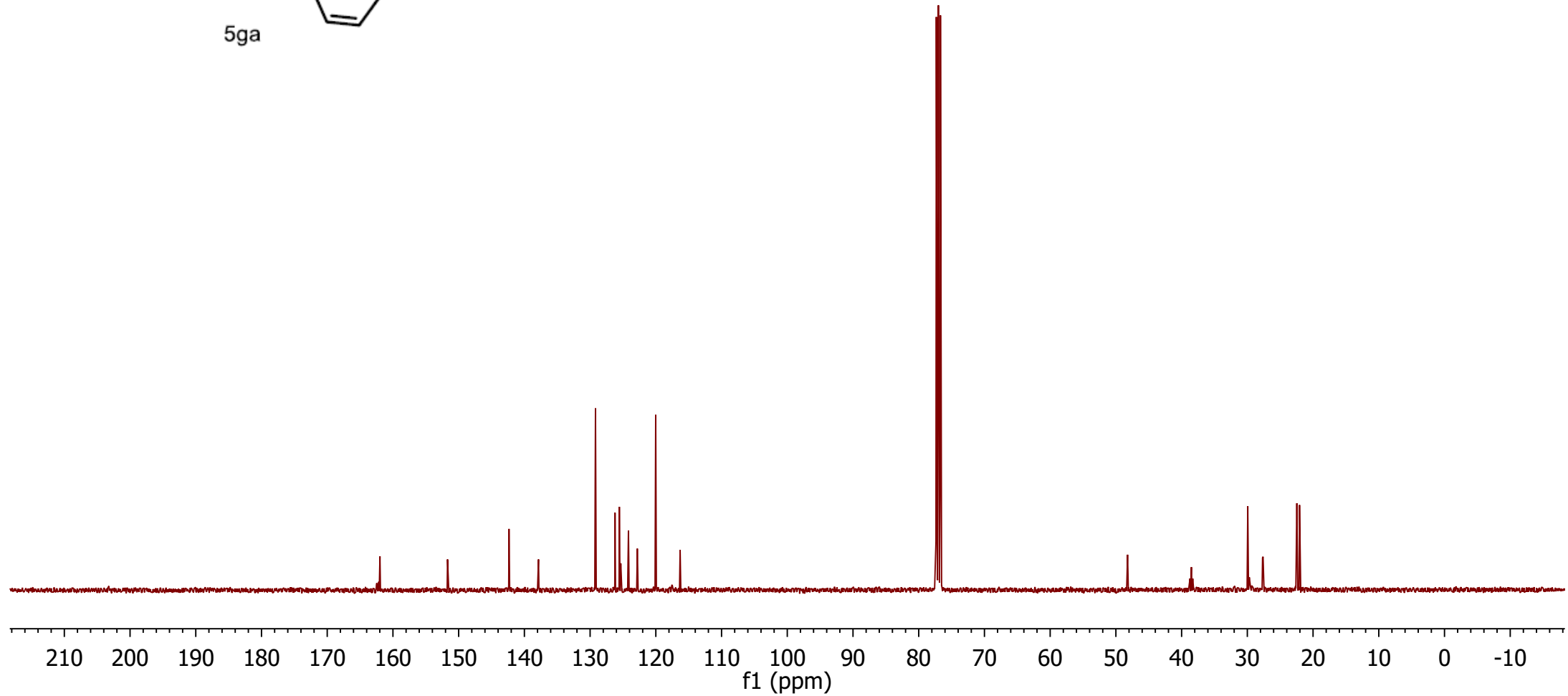
¹³C (CDCl₃, 101 MHz)

162.5
162.2
162.0
— 151.7
142.3
142.3
137.9
129.2
126.2
125.5
125.3
124.2
122.8
120.0
117.6
116.3

48.3
48.2
38.7
38.5
38.3
29.9
27.7
27.6
22.6
22.5
22.1

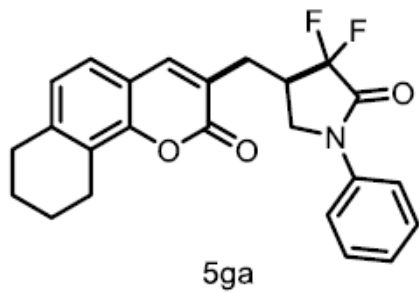


5ga

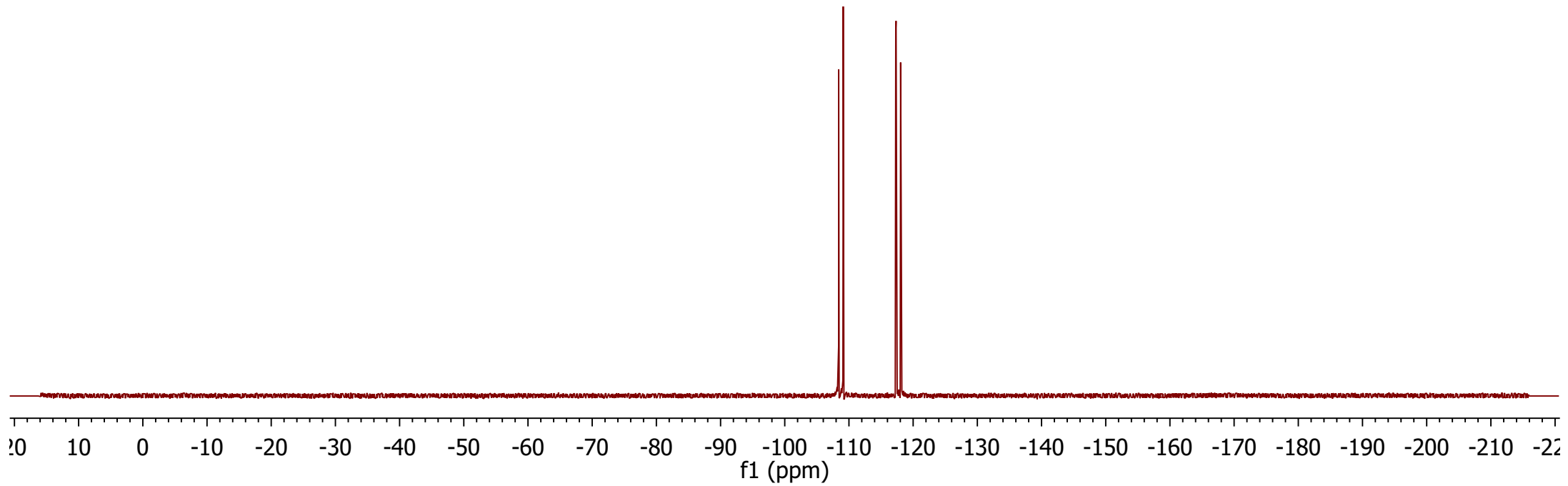


¹³C NMR Spectrum of 5ga

¹⁹F (CDCl₃, 376 MHz)



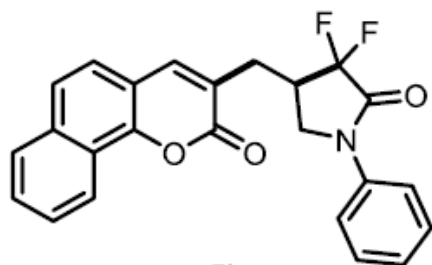
-108.40
-108.44
-109.11
-109.15
-117.29
-117.34
-118.00
-118.05



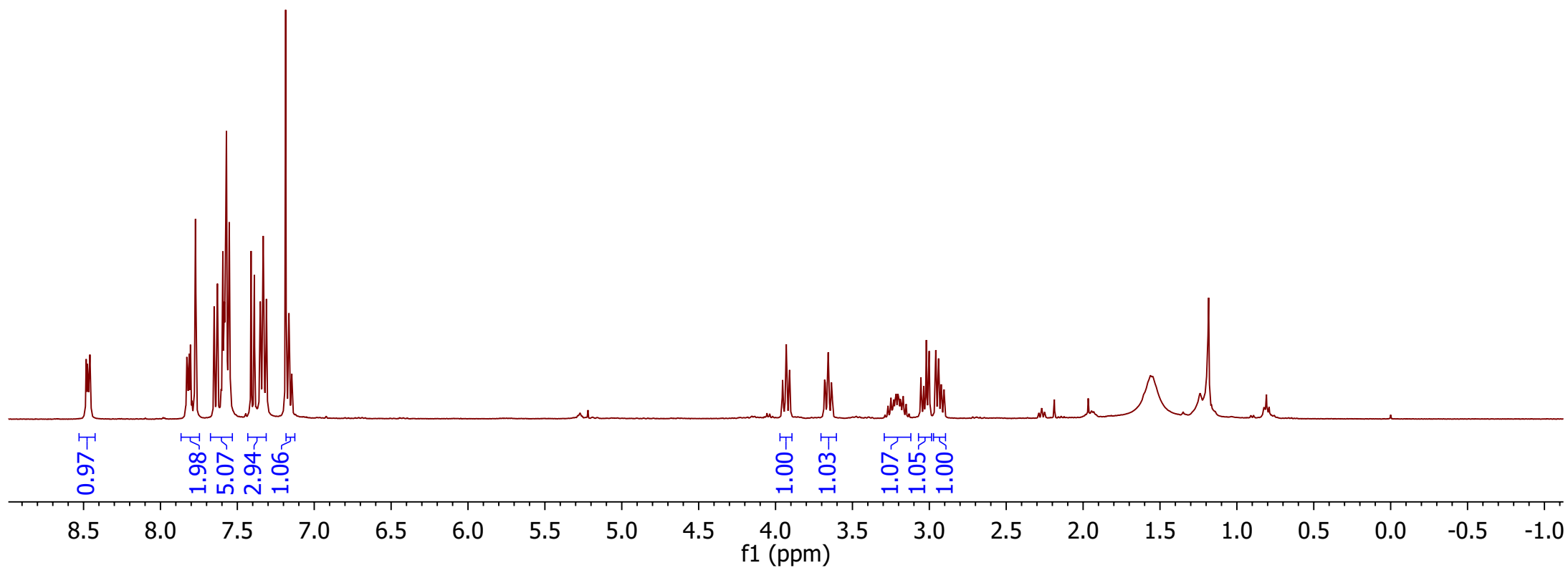
¹⁹F NMR Spectrum of 5ga

¹H (CDCl₃, 400 MHz)

8.48
8.47
8.47
8.46
8.46
7.83
7.82
7.82
7.81
7.80
7.77
7.65
7.63
7.59
7.59
7.58
7.58
7.58
7.57
7.56
7.56
7.55
7.55
7.41
7.39
7.35
7.35
7.34
7.33
7.33
7.32
7.31
7.19
7.18
7.17
7.16
7.15
3.95
3.95
3.93
3.93
3.93
3.91
3.91
3.68
3.68
3.66
3.66
3.64
3.05
3.02
3.00
2.96
2.94

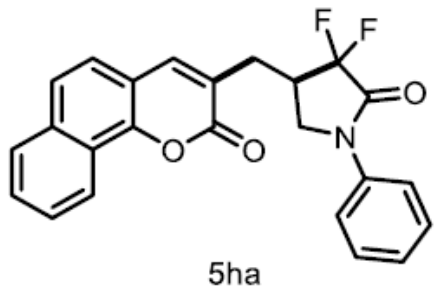


5ha



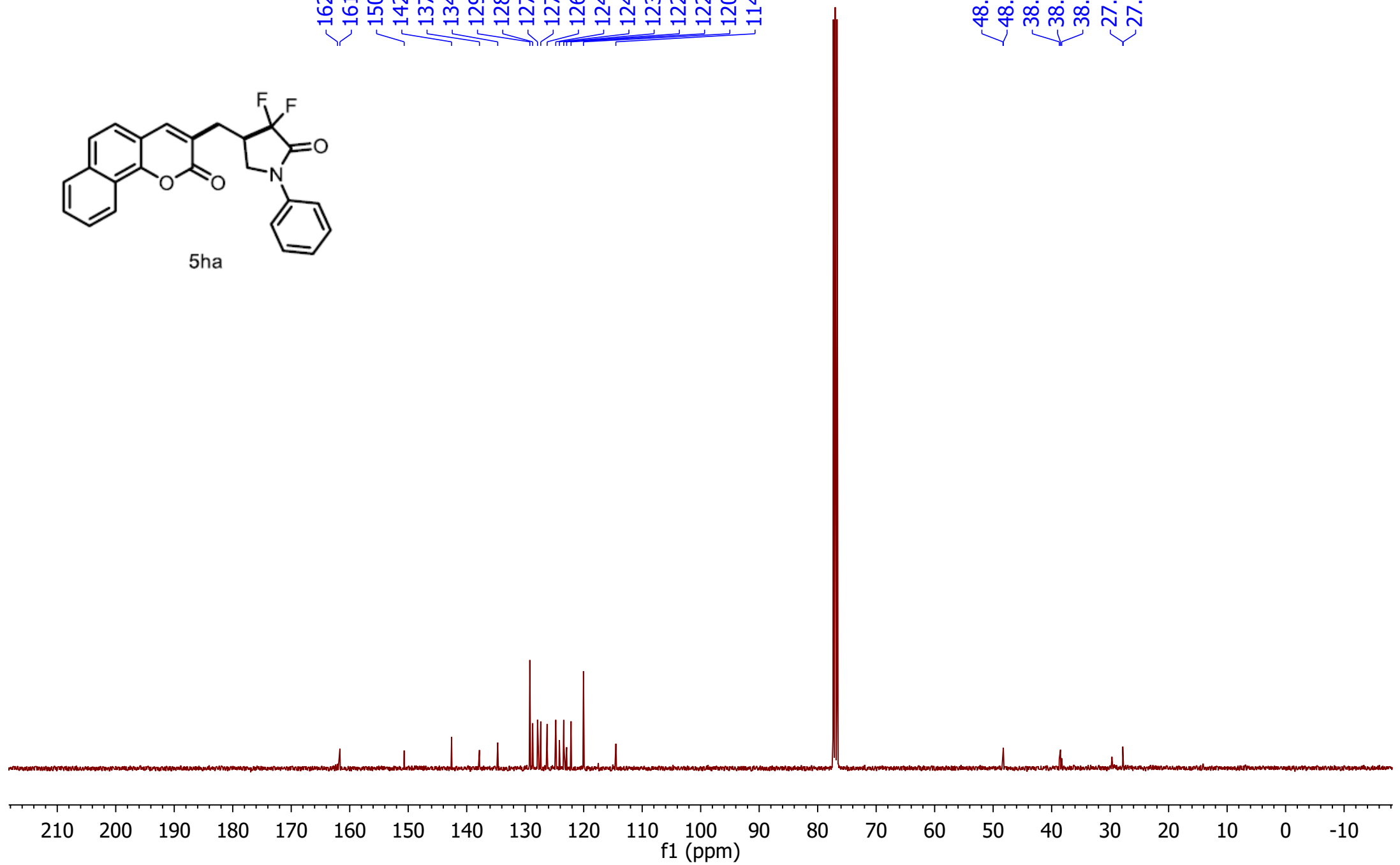
¹H NMR Spectrum of 5ha

¹³C (CDCl₃, 101 MHz)



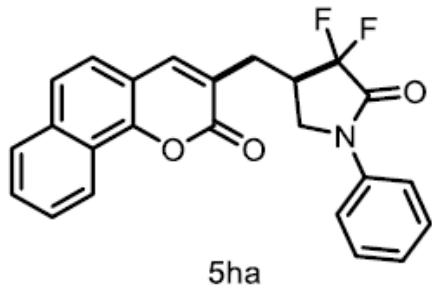
162.1
161.7
150.7
142.6
137.8
134.7
129.2
128.7
127.9
127.3
126.3
124.8
124.2
123.4
122.9
122.2
120.0
114.5

48.3
48.3
38.7
38.5
38.3
27.8
27.8

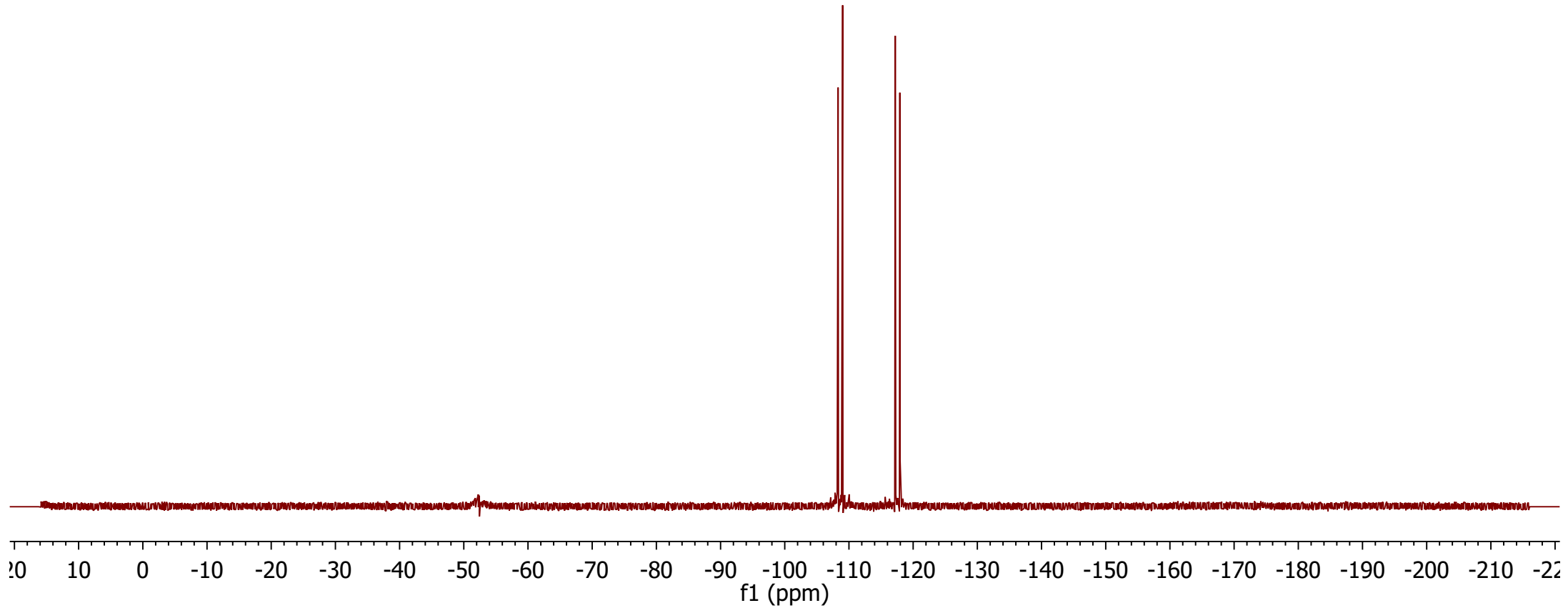


¹³C NMR Spectrum of 5ha

19F (CDCl3, 376 MHz)



108.27
108.31
108.98
109.02
117.17
117.22
117.88
117.93



19F NMR Spectrum of 5ha