Supporting Information

The Construction of Novel Pyrrole-4H-Chromene-Embed Vinyl Sulfonyl Fluorides *via* a Three-Component Process

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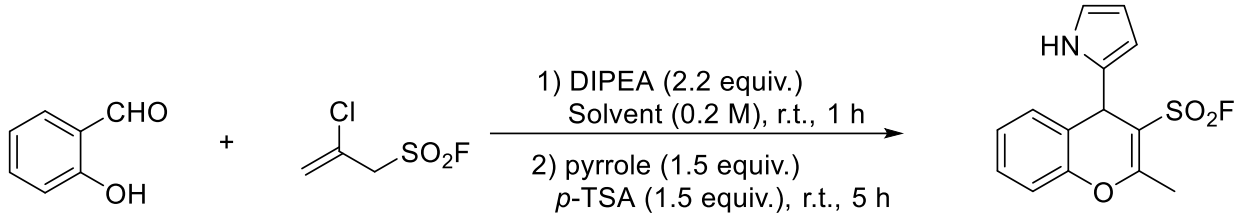
1. General Information

Instrumentation:

The reactions were conducted in standard glassware under ambient air conditions unless otherwise specified. Room temperature (r.t) was maintained at 20-25 °C, while temperatures of 0 °C were achieved using an ice/water bath, and higher temperatures were attained using an oil bath equipped with a contact thermometer. NMR spectra were recorded in $CDCl_3$ or DMSO-d_6 on a Bruker Advance spectrometer operating at 500 MHz (for ^{1}H), 471 MHz (for ^{19}F), and 126 MHz (for ^{13}C), with internal referencing to solvent residual signals ($CDCl_3$: δ H = 7.264 ppm, δ C = 77.16 ppm; DMSO-d_6: δ H = 2.500 ppm, δ C = 39.52 ppm). Chemical shifts were reported in ppm relative to TMS (1H NMR, 0 ppm) as internal standards. HPLC experiments were conducted using a Waters e2695 instrument with a J&K RP-C18 column (5 μm, 4.6 × 150 mm), and product yields were determined using corresponding pure compounds as external standards. Coupling constants were expressed in Hertz (Hz), with abbreviations such as s = singlet, d = doublet, t = triplet, q = quartet, quint = quintet, hept = heptet, m = multiplet, br s = broad singlet, dd = doublet of doublets. Compound numbering for NMR spectra assignment was arbitrary and not based on IUPAC numbering. Chemical structures were named using Chemdraw software. Electrospray ionization (ESI) HRMS experiments were conducted on a TOF-Q EI instrument. Melting points were measured and reported without correction. Reagents used were commercially sourced and utilized without additional purification. Column chromatography was performed using silica gel (60–120 mesh and 100–200 mesh) packed in glass columns. Product spots on thin-layer chromatography (TLC) plates were visualized under ultraviolet light (254 nm or 365 nm) and stained with potassium permanganate or phosphomolybdic acid. Salicylaldehydes, pyrroles, morpholine, 4-methoxyphenol, and 4-(benzyloxy)phenol were purchased commercially and used as received. 2-chloroprop-2-ene-1-sulfonyl fluoride (CESF, **2**) was synthesized following an established procedure.[1]

2. Optimization of the Reaction Conditions

Table S1 Screening the Solvent. [a]

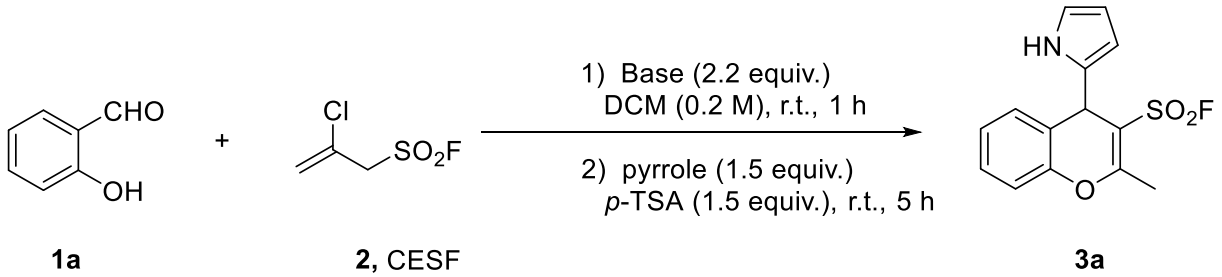


1a **2**, CESF **3a**

Entry	Solvent	Yield (3a, %)[b]
1	**DCM**	**56**
2	DCE	48
3	DMSO	30
4	CH_3CN	14
5	EA	28
6	DMF	27
7	THF	18
8	NMP	31
9	1,4-Dioxane	32
10	EtOH	36
11	CH_3OH	10
12	Acetone	29

[a]Reaction conditions: a mixture of 2-hydroxybenzaldehyde (**1a**, 24 mg, 0.2 mmol, 1.0 equiv.), CESF (**2**, 48 mg, 0.3 mmol, 1.5 equiv.) and DIPEA (57 mg, 0.44 mmol, 2.2 equiv.) in solvent (1.0 mL) was stirred at r.t. for 1 h in a sealed tube. After 1 h of maintaining the same continuous one-pot reaction conditions, then pyrrole (20 mg, 0.3 mmol, 1.5 equiv.) and *p*-TSA (52 mg, 0.3 mmol, 1.5 equiv.) were added to the same reaction tube under air at r.t. for additional 5 h. [b] The yield was determined by HPLC using pure **3a** as the external standard (t_R = 6.067 min, λ_{max} = 209.9 nm, water/methanol =30:70 (v/v)).

Table S2. Screening the base.[a]

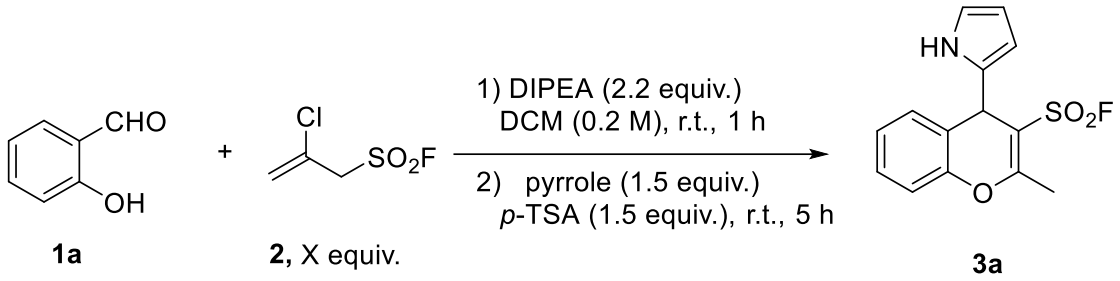


1a **2**, CESF **3a**

Entry	Base (2.2 equiv.)	Yield (3a, %)[b]
1	$NaHCO_3$	N.D.
2	K_2CO_3	N.D.
3	KF	N.D.
4	MgO	N.D.
5	TEA	12
6	DBU	31
7	CsF	N.D.
8	**DIPEA**	**56**
9	NaOH	N.D.
10	Na_2CO_3	N.D.

[a]Reaction conditions: a mixture of 2-hydroxybenzaldehyde (**1a**, 24 mg, 0.2 mmol, 1.0 equiv.), CESF (**2**, 48 mg, 0.3 mmol, 1.5 equiv.) and base (0.44 mmol, 2.2 equiv.) in solvent (1.0 mL) was stirred at r.t. for 1 h in a sealed tube, After 1 h of maintaining the same reaction conditions under the same continuous one-pot reaction, then pyrrole (20 mg, 0.3 mmol, 1.5 equiv.) and *p*-TSA (52 mg, 0.3 mmol, 1.5 equiv.) were added under air at r.t. for additional 5 h. [b]The yield was determined by HPLC using pure **3a** as the external standard (t_R = 6.067 min, λ_{max} = 209.9 nm, water/methanol =30:70 (v/v)). N.D. = Not detected.

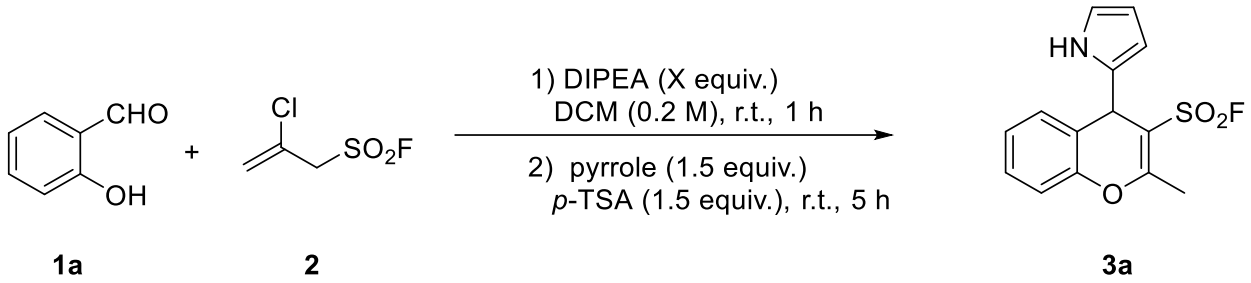
Table S3 Screening the loading of CESF **(2)** [a]



Entry	X equiv.	Yield (3a, %)[b]
1	1.0	46
2	**1.5**	**56**
3	2.0	56
4	2.5	45
5	3.0	49

[a]Reaction conditions: a mixture of 2-hydroxybenzaldehyde (**1a**, 24 mg, 0.2 mmol, 1.0 equiv.), CESF (**2**, X equiv.) and DIPEA (57 mg, 0.44 mmol, 2.2 equiv.) in solvent (1.0 mL) was stirred at r.t. for 1 h in a sealed tube, under the same continuous one-pot reaction, then pyrrole (20 mg, 0.3 mmol, 1.5 equiv.) and *p*-TSA (52 mg, 0.3 mmol, 1.5 equiv.) were added under air at r.t. for additional 5 h. [b]The yield was determined by HPLC using pure **3a** as the external standard (t_R = 6.067 min, λ_{max} = 209.9 nm, water/methanol =30:70 (v/v)).

Table S4. Screening the loading of base.[a]

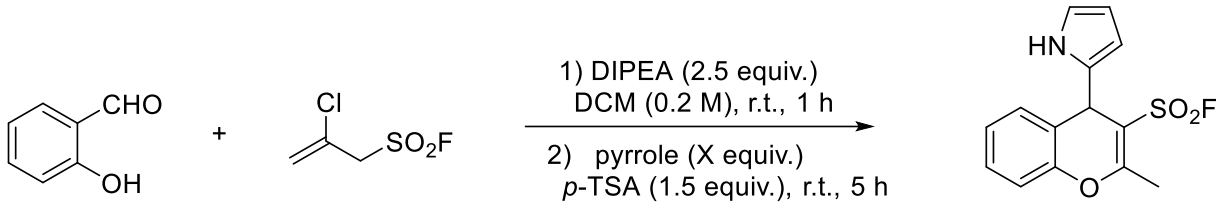


1a **2** **3a**

Entry	DIPEA (x equiv.)	Yield (3a, %)[b]
1	1.0	15
2	1.5	33
3	2.0	54
4	2.2	56
5	**2.5**	**71**
6	3.0	61
7	3.5	59
8	4.0	25
9	4.5	19
10	5.0	15

[a]Reaction conditions: a mixture of 2-hydroxybenzaldehyde (**1a**, 24 mg, 0.2 mmol, 1.0 equiv.), CESF (**2**, 48 mg, 0.3 mmol, 1.5 equiv.) and base (X equiv.) in solvent (1.0 mL) was stirred at r.t. for 1 h in a sealed tube, under the same continuous one-pot reaction, then pyrrole (20 mg, 0.3 mmol, 1.5 equiv.) and *p*-TSA (52 mg, 0.3 mmol, 1.5 equiv.) were added under air at r.t. for additional 5 h. [b]The yield was determined by HPLC using pure **3a** as the external standard (t_R = 6.067 min, λ_{max} = 209.9 nm, water/methanol =30:70 (v/v)).

Table S5. Screening the loading of pyrrole[a]

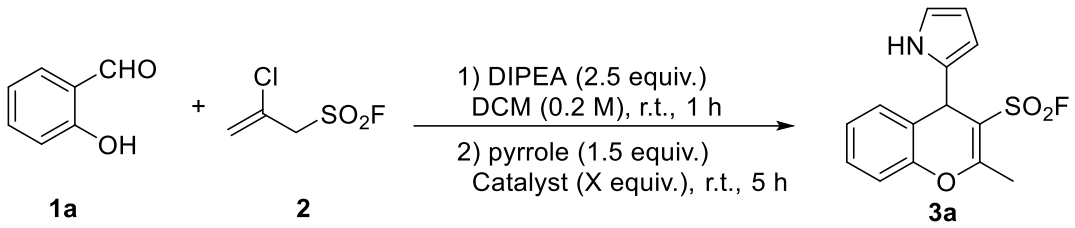


1a **2** **3a**

Entry	pyrrole (x equiv.)	Yield (3a, %)[b]
1	**1.5**	**71**
2	2.0	67
3	2.5	71
4	3.0	68
5	4.0	73

[a]Reaction conditions: a mixture of 2-hydroxybenzaldehyde (**1a**, 24 mg, 0.2 mmol, 1.0 equiv.), CESF (**2**, 48 mg, 0.3 mmol, 1.5 equiv.) and DIPEA (65 mg, 0.5 mmol, 2.5 equiv.) in solvent (1.0 mL) was stirred at r.t. for 1 h in a sealed tube, under the same continuous one-pot reaction, then pyrrole (X equiv.) and *p*-TSA (52 mg, 0.3 mmol, 1.5 equiv.) were added under air at r.t. for additional 5 h. [b]The yield was determined by HPLC using pure **3a** as the external standard (t_R = 6.067 min, λ_{max} = 209.9 nm, water/methanol =30:70 (v/v)).

Table S6. Screening the catalysts. [a]

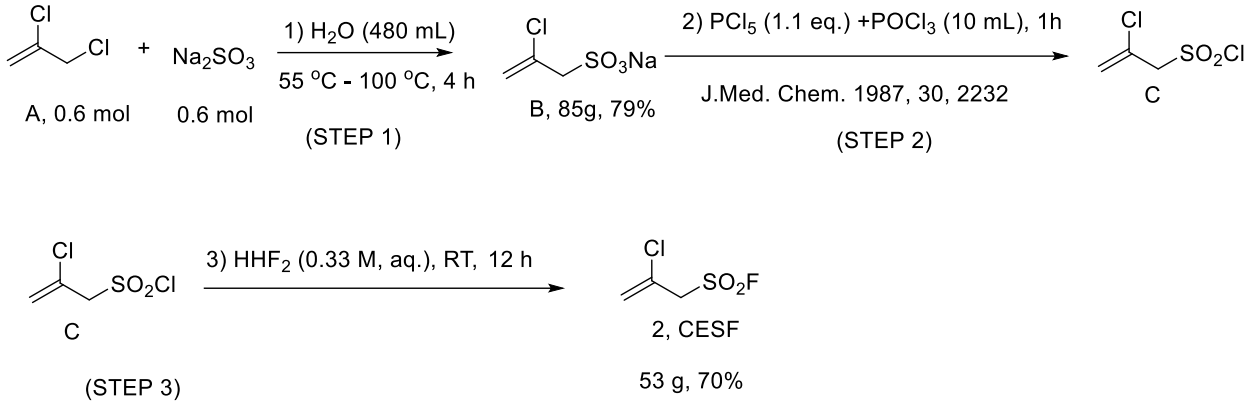


Entry	Catalyst (x equiv.)	Yield (3a, %)[b]
1	$C_6H_5CO_2H$ (1.5)	N.D.
2	HCO_2H (1.5)	N.D.
3	CH_3CO_2H (1.5)	N.D.
4	$MeSO_3H$ (1.5)	66
5	***p*-TSA (1.5)**	**71**
6	*p*-TSA (2.0)	58
7	*p*-TSA (3.0)	43
8	TFA (2.0)	70

[a]Reaction conditions: a mixture of 2-hydroxybenzaldehyde (**1a**, 24 mg, 0.2 mmol, 1.0 equiv.), CESF (**2**, 48 mg, 0.3 mmol, 1.5 equiv.) and DIPEA (65 mg, 0.5 mmol, 2.5 equiv.) in solvent (1.0 mL) was stirred at r.t. for 1 h in a sealed tube, under the same continuous one-pot reaction, then pyrrole (20 mg, 0.3 mmol, 1.5 equiv.)) and catalyst (X equiv.) were added under air at r.t. for additional 5 h. [b]The yield was determined by HPLC using pure **3a** as the external standard (t_R = 6.067 min, λ_{max} = 209.9 nm, water/methanol =30:70 (v/v)). N.D. = Not detected.

3. Experimental Procedures

3.1 Preparation of 2-chloroprop-2-ene-1-sulfonyl fluoride (CESF).[1]



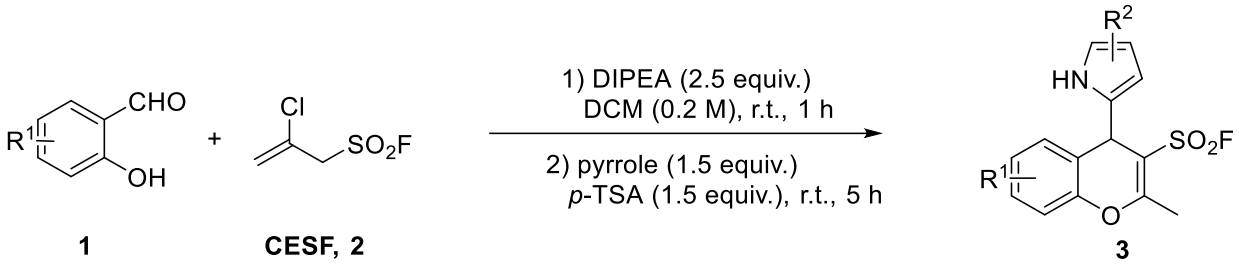
Step1: 1,2-Dichloro-2-propene (**A**, 0.6 mol) was gradually added to a solution containing Na_2SO_3 (0.6 mol) in 480 mL of water with stirring, and the resulting mixture was maintained at 55 °C on an oil bath. Subsequently, the mixture was refluxed for 4 hours, followed by removal of the solvent under vacuum. To the residue, 500 mL of ethanol (EtOH) was added, and the mixture was refluxed with stirring for 10 minutes. Upon filtration of the hot mixture to remove insoluble material, the filtrate was cooled. The resulting crystalline product, sodium 2-chloro-2-propene-1-sulfonate, was obtained by filtration, yielding 85.0 g (B, 0.476 mol, 79% yield).

Step 2: A blend of the sodium salt (**B**, 0.476 mol, 85.0 g) and PCl_5 (1.1 equivalents, 0.474 mol, 99 g) was vigorously stirred until the mixture liquefied, which induced an exothermic reaction lasting approximately 10 minutes. Subsequently, any residual solids on the bottle wall were rinsed with 10 mL of phosphorus oxychloride, and the mixture was swiftly heated on an oil bath at 120°C for 1 hour. After cooling, the mixture was poured onto ice with vigorous stirring and allowed to stand for 30 minutes at ambient temperature.

Step 3: The evaporated 2-chloro-2-propenesulfonyl chloride (**C**) was reacted directly in a solution containing KHF_2 (112 g, 0.33 M) for 12 hours. The resulting mixture underwent extraction with CH_2Cl_2, followed by drying and subsequent evaporation under vacuum. The obtained 2-chloroprop-2-ene-1-sulfonyl fluoride (CESF) was distilled under reduced pressure, yielding 53 g of colorless oil (**2**, 70% yield).**^{1}H NMR** (500 MHz, $CDCl_3$) δ 5.75 (dd, J_1 = 19.6 Hz, J_2 = 2.3 Hz, 2H), 4.33 (d, J = 3.6 Hz, 2H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 56.4 (s, 1F). **^{13}C NMR** (126 MHz,

$CDCl_3$) δ 126.6, 123.6 (d, *J* = 1.6 Hz), 59.34(d, *J* = 19.4 Hz). HRMS-ESI (m/z) calcd. for $[C_3H_5ClFO_2S]^+$ ($[M+H]^+$): 158.9677, found: 158.9674.

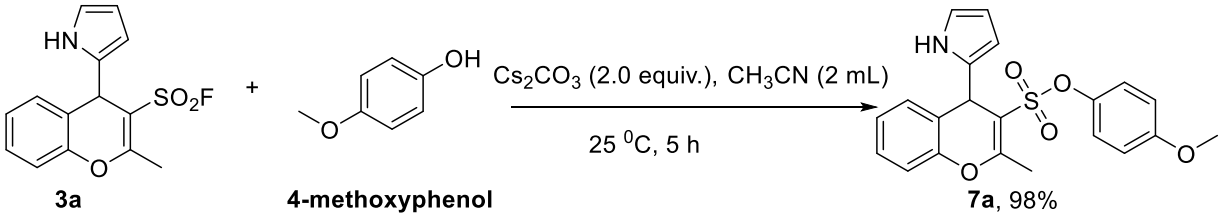
3.2 Procedure for the Synthesis of 3 and 4 (indole).



1 **CESF, 2** **3**

A 20 mL reaction sealed tube, dried in an oven and fitted with a magnetic stirring bar, was loaded with salicylaldehydes (1, 1.0 mmol, 1.0 equiv.), 2-chloroprop-2-ene-1-sulfonyl fluoride (CESF, **2**, 1.5 mmol, 1.5 equiv.), DIPEA (2.5 mmol, 2.5 equiv.), and DCM (0.2 M, 5 mL). The mixture was then allowed to react at room temperature for 1 hour. After maintaining the same reaction conditions for an additional hour, pyrrole (101 mg, 1.5 mmol, 1.5 equiv.) and *p*-TSA (258 mg, 1.5 mmol, 1.5 equiv.) were introduced into the reaction tube under ambient air, and the reaction was continued for another 5 hours. Upon completion, the resulting mixture was diluted with ethyl acetate, followed by washing with water (30 mL × 3). The aqueous phase was further extracted with ethyl acetate (30 mL × 2). The combined organic layers were then dried over anhydrous sodium sulfate and concentrated to yield a residue. Purification of the residue was accomplished via column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate (or dichloromethane) as eluent, leading to the isolation of pure sulfonyl fluoride-substituted pyrrolyl chromenes **3**.

3.3 General procedure for synthesis of vinyl sulfonate from 4-methoxyphenol.[2]

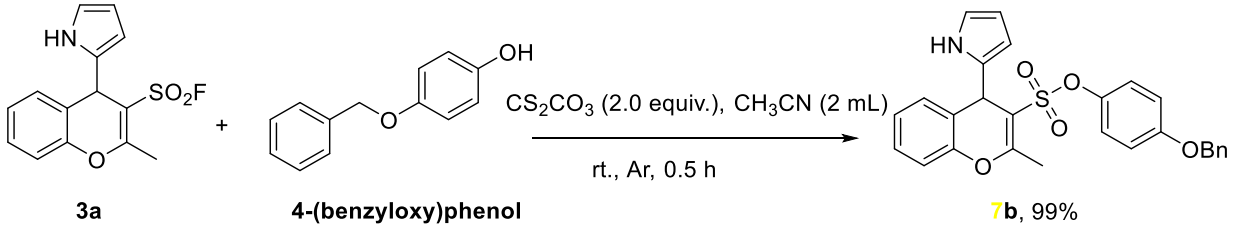


3a **4-methoxyphenol** **7a**, 98%

2-methyl-4-(1H-pyrrol-2-yl)-4H chromene-3-sulfonyl fluoride (**3a**, 0.5 mmol, 147 mg), 4-methoxyphenol (1.0 mmol, 2.0 eq., 124.1 mg), cesium carbonate (1.0 mmol, 2.0 eq., 326.8 mg)

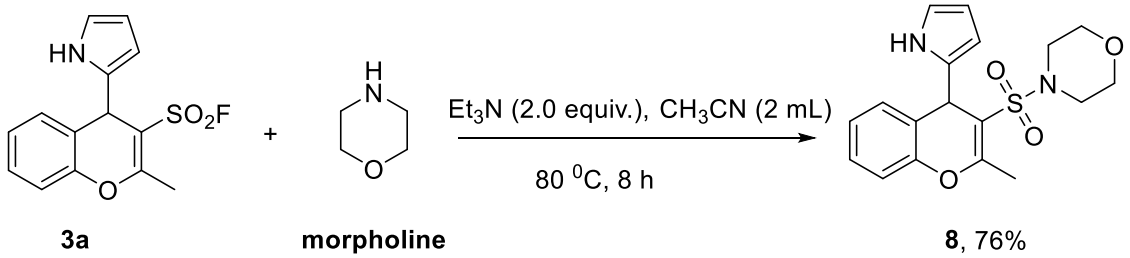
were added in a solution of acetonitrile (2 mL) and reacted at room temperature for 5 h. The reaction mixture was extracted with ethyl acetate (3×20 mL) and the combined organic layers was dried over anhydrous sodium sulfate, filtered and concentrated under reduced pressure. The crude product was further purified by column chromatography on silica gel by gradient elution with petroleum ether/ethyl acetate (20:1 to 10:1, v/v) as eluent to obtain pure vinyl sulfonate **7a** as white solid (194 mg, 98% yield).

3.4 procedure for synthesis of vinyl sulfonate from 4-(benzyloxy)phenol under argon atmosphere.



2-methyl-4-(1H-pyrrol-2-yl)-4H chromene-3-sulfonyl fluoride (**3a**, 0.5 mmol, 147 mg), 4-(benzyloxy)phenol (1.0 mmol, 2.0 eq., 200.2 mg), cesium carbonate (1.0 mmol, 2.0 eq., 326.8 mg) were added in a solution of acetonitrile (2 mL) and reacted at room temperature in an argon atmosphere for 0.5 h. The reaction mixture was extracted with ethyl acetate (3×20 mL) and the combined organic layers was dried over anhydrous sodium sulfate, filtered and concentrated under reduced pressure. The crude product was further purified by column chromatography on silica gel by gradient elution with petroleum ether/ethyl acetate (20:1 to 10:1, v/v) as eluent to obtain pure vinyl sulfonate **7b** as light yellow solid (234 mg, 99% yield).

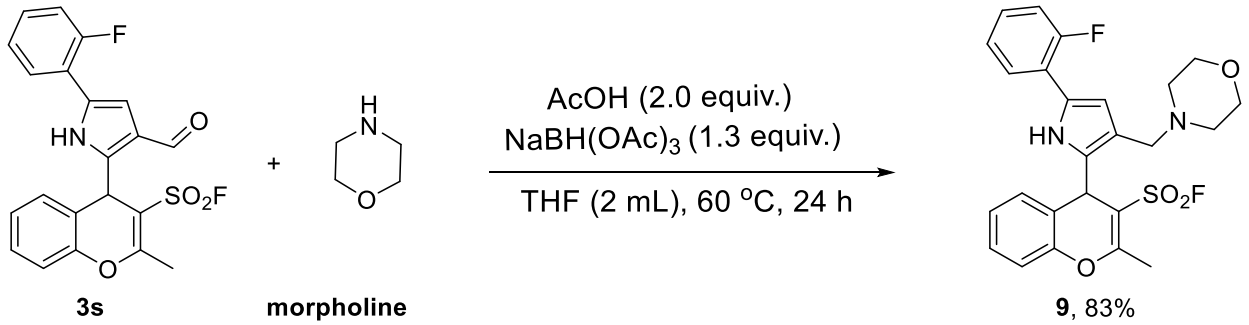
3.5 General procedure for synthesis of vinyl sulfonamide from morpholine.



Morpholine (1.0 mmol, 2.0 eq., 87.1 mg) and triethylamine (1.0 mmol, 2.0 eq., 101.2 mg) were added to a stirred solution of 2-methyl-4-(1H-pyrrol-2-yl)-4H chromene-3-sulfonyl fluoride (**3a**,

0.5 mmol, 147 mg) dissolved in acetonitrile (2 mL) and the resulting mixture reacted at 80 ℃ for 8 h. The reaction was concentrated to dryness and the residue was further purified by column chromatography on silica gel by gradient elution with petroleum ether/ethyl acetate (10:1 to 5:1, v/v) as eluent to obtain pure vinyl sulfonamide **8** as light yellow solid (137 mg, 76% yield).

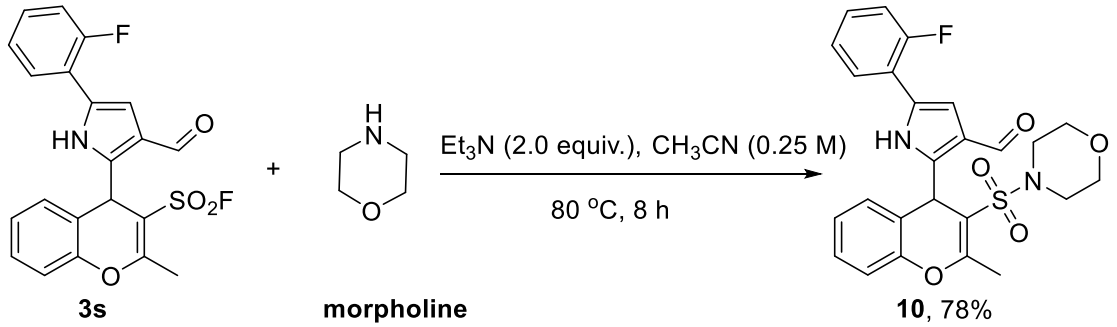
3.6 Procedure for reductive amination diversification from (3S) with morpholine.[3]



3s **morpholine** **9**, 83%

4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**3s**, 0.5 mmol, 208 mg) was dissolved in THF (2 mL) for 5 minutes, then morpholine (1.0 mmol, 2.0 eq., 87.1 mg), acetic acid (1.0 mmol, 2.0 eq., 60.0 mg) and sodium triacetoxyborohydride (0.65 mmol, 1.3 eq., 138 mg) were added to the stirred solution and reacted at room temperature for 24 h. The reaction mixture was extracted with ethyl acetate (3×20 mL) and the combined organic layers was dried over anhydrous sodium sulfate, filtered and concentrated under reduced pressure. The crude product was further purified by column chromatography on silica gel by gradient elution with petroleum ether/ethyl acetate (7:1 to 5:1, v/v) as eluent to obtain pure vinyl sulfonate **9** as light yellow solid (202 mg, 84% yield).

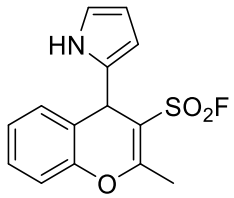
3.7 Procedure of product diversification of (3s) via SUFEx transformations



3s **morpholine** **10**, 78%

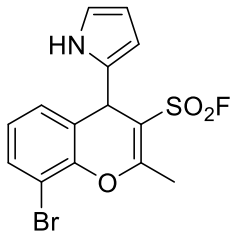
Morpholine (0.6 mmol, 2.0 eq., 52.3 mg) and triethylamine (0.6 mmol, 2.0 eq., 60.7 mg) were added to a stirred solution of 4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**3s**, 0.3 mmol, 125 mg) dissolved in acetonitrile (1.2 mL) and the resulting mixture reacted at 80 ℃ for 8 h. The reaction was concentrated to dryness and the residue was further purified by column chromatography on silica gel by gradient elution with petroleum ether/ethyl acetate (10:1 to 5:1, v/v) as eluent to obtain pure vinyl sulfonamide **10** as light yellow solid (113 mg, 78% yield).

4. Characterization



3a

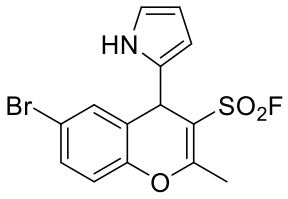
2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3a).** Colorless solid, 179 mg, 61% yield. M.p. 95−96 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.41 (s, 1H), 7.31 (ddd, J_1 = 8.5 Hz, J_2 = 6.9 Hz, J_3 = 2.1 Hz, 1H), 7.20 (qd, J_1 = 7.7 Hz, J_2= 4.4 Hz, 2H), 7.14 (d, J = 8.2 Hz, 1H), 6.70 (q, J = 2.3 Hz, 1H), 6.07 (q, J = 3.0 Hz, 1H), 5.64 (d, J = 3.5 Hz, 1H), 5.19 (s, 1H), 2.49 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.3 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.5, 149.4, 133.2, 129.5, 128.9, 126.1, 121.8, 118.2, 116.7, 109.6 (d, J = 20.0 Hz), 108.7, 107.2, 35.2, 19.9. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{13}FNO_3S]^+$ ($[M+H]^+$): 294.0595, found: 294.0595.



3b

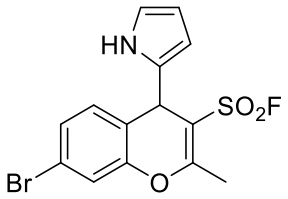
8-bromo-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3b).** Colorless solid, 231 mg, 62% yield. M.p. 118−119 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.40 (s, 1H),

7.53 (dd, J_1 = 7.9 Hz, J_2 = 1.5 Hz, 1H), 7.16 (dd, J_1 = 7.8, J_2 = 1.5 Hz, 1H), 7.05 (t, J = 7.8 Hz, 1H), 6.71 (q, J = 2.3 Hz, 1H), 6.07 (q, J = 2.9 Hz, 1H), 5.68 (d, J = 3.5 Hz, 1H), 5.19 (s, 1H), 2.56 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.3 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.3, 146.4, 132.7, 132.5, 128.6, 126.8, 123.7, 118.5, 110.8, 110.5 (d, J = 20.5 Hz), 108.9, 107.5, 35.7, 19.7. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{12}BrFNO_3S]^+$ ($[M+H]^+$): 371.9700, found: 371.9699.



3c

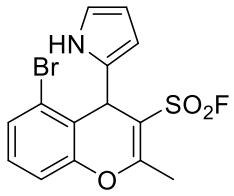
6-bromo-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3c).** Colorless solid, 253 mg, 68% yield. M.p. 114−115 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.43 (s, 1H), 7.41 (dd, J_1 = 8.7 Hz, J_2 = 2.4 Hz, 1H), 7.34 (d, J = 2.3 Hz, 1H), 7.02 (d, J = 8.7 Hz, 1H), 6.72 (q, J = 2.3 Hz, 1H), 6.09 (q, J = 2.9 Hz, 1H), 5.67 (d, J = 3.4 Hz, 1H), 5.13 (s, 1H), 2.48 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.4 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.1, 148.4, 132.5, 132.1, 132.0, 123.85, 118.5, 118.5, 118.4, 109.7 (d, J = 20.4 Hz), 108.9, 107.6, 35.1, 19.8. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{12}BrFNO_3S]^+$ ($[M+H]^+$): 371.9700, found: 371.9701.



3d

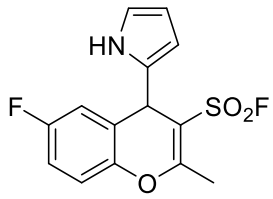
7-bromo-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3d).** Colorless solid, 206 mg, 55% yield. M.p. 101−102 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.42 (s, 1H), 7.34 – 7.28 (m, 2H), 7.08 (d, J = 8.0 Hz, 1H), 6.71 (td, J_1 = 2.7, J_2 =1.5 Hz, 1H), 6.07 (q, J = 2.9 Hz, 1H), 5.63 (ddd, J_1 = 3.7, J_2 = 2.5, J_3 = 1.5 Hz, 1H), 5.13 (s, 1H), 2.48 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.3 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.0, 149.8, 132.5, 130.7, 129.3,

121.7, 120.92, 120.0, 118.4, 110.1 (d, J = 20.3 Hz), 108.9, 107.5, 34.9, 19.7. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{12}BrFNO_3S]^+$ ($[M+H]^+$): 371.9700, found: 371.9699.



3e

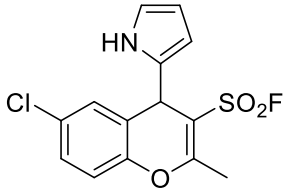
5-bromo-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3e).** Colorless solid, 229 mg, 62% yield. M.p. 141−142 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **H NMR** (500 MHz, $CDCl_3$) δ 8.58 (s, 1H), 7.47 – 7.40 (m, 1H), 7.20 (t, *J* = 8.0 Hz, 1H), 7.13 (d, *J* = 8.2 Hz, 1H), 6.75 – 6.68 (m, 1H), 6.07 (q, *J* = 3.3 Hz, 1H), 5.61 (d, *J* = 3.1 Hz, 1H), 5.32 (s, 1H), 2.50 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.5 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.2, 150.6, 131.3, 130.2, 129.6, 123.9, 122.8, 118.1, 116.2, 110.6 (d, *J* = 20.5 Hz), 108.8, 107.3, 35.8, 19.4. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{12}BrFNO_3S]^+$ ($[M+H]^+$): 371.9700, found: 371.9702.



3f

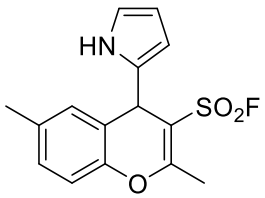
6-fluoro-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3f).** White solid, 173 mg, 58% yield. M.p. 105−106 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.43 (s, 1H), 7.12 (dd, J_1 = 9.0 Hz, J_2 = 4.6 Hz, 1H), 7.01 (td, J_1 = 8.4 Hz, J_2 = 3.0 Hz, 1H), 6.91 (dd, J_1 = 8.2 Hz, J_2 = 3.0 Hz, 1H), 6.71 (q, *J* = 2.4 Hz, 1H), 6.09 (q, *J* = 2.9 Hz, 1H), 5.69 (d, *J* = 3.6 Hz, 1H), 5.15 (s, 1H), 2.49 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.5 (s, 1F), -115.80 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.4, 161.0, 159.0, 145.5 (d, *J* = 2.6 Hz), 132.5, 123.5 (d, *J* = 8.0 Hz), 118.4,

118.2 (d, J = 8.6 Hz), 115.8 (dd, J_1 = 71.6 Hz, J_2 = 23.9 Hz), 109.0 (d, J = 20.4 Hz), 108.9, 107.4, 35.5, 19.8. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{12}F_2NO_3S]^+$ ($[M+H]^+$): 312.0500, found: 312.0500.



3g

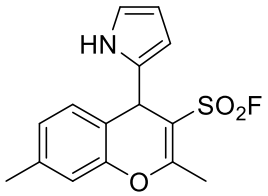
6-chloro-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3g).** Colorless solid, 234 mg, 72% yield. M.p. 116−117 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.50 (s, 1H), 7.37 – 7.31 (m, 1H), 7.27 (s, 1H), 7.15 (d, J = 8.8 Hz, 1H), 6.79 (q, J = 2.3 Hz, 1H), 6.16 (q, J = 2.9 Hz, 1H), 5.75 (q, J = 2.5 Hz, 1H), 5.21 (s, 1H), 2.56 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.4 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.2, 147.9, 132.5, 131.1, 129.1, 129.1, 123.5, 118.5, 118.1, 109.6 (d, J = 20.5 Hz), 108.9, 107.5, 35.2, 19.8. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{12}ClFNO_3S]^+$ ($[M+H]^+$): 328.0205, found: 328.0206.



3h

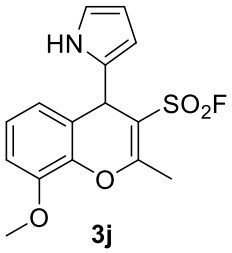
2,6-dimethyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3h).** Colorless solid, 178 mg, 58% yield. M.p. 86−87 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.40 (s, 1H), 7.11 (dd, J_1 = 8.4 Hz, J_2 =2.0 Hz, 1H), 7.07 – 6.98 (m, 2H), 6.73 – 6.67 (m, 1H), 6.09 (q, J = 3.1 Hz, 1H), 5.72 (q, J = 2.2 Hz, 1H), 5.15 (s, 1H), 2.49 (s, 3H), 2.32 (s, 3H). **^{9}F NMR** (471 MHz, $CDCl_3$) δ 69.4 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.5, 147.4, 135.9, 133.3, 129.6, 129.5, 121.4, 118.1,

116.4, 109.3 (d, *J* = 19.8 Hz), 108.7, 107.1, 35.3, 20.9, 19.9. **HRMS-ESI** (m/z) calcd. for $[C_{15}H_{15}FNO_3S]^+$ ($[M+H]^+$): 308.0751, found: 308.0751.



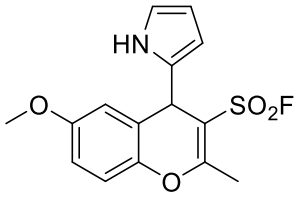
3i

2,7-dimethyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3i).** Colorless solid, 138 mg, 45% yield. M.p. 79−80 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent.**^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.39 (s, 1H), 7.08 (d, *J* = 7.8 Hz, 1H), 7.00 (dd, J_1 = 7.9 Hz, J_2 = 1.7 Hz, 1H), 6.95 (d, *J* = 1.7 Hz, 1H), 6.69 (td, J_1 = 2.7, J_2 = 1.5 Hz, 1H), 6.06 (q, *J* = 2.9 Hz, 1H), 5.65 (td, J_1 = 3.1 Hz, J_2 = 1.7 Hz, 1H), 5.15 (s, 1H), 2.48 (s, 3H), 2.37 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.3 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.5, 149.3, 139.3, 133.4, 129.1, 127.0, 118.7, 118.1, 116.9, 109.7 (d, *J* = 19.6 Hz), 108.7, 107.1, 35.0, 21.2, 19.9. **HRMS-ESI** (m/z) calcd. for $[C_{15}H_{15}FNO_3S]^+$ ($[M+H]^+$): 308.0751, found: 308.0751.



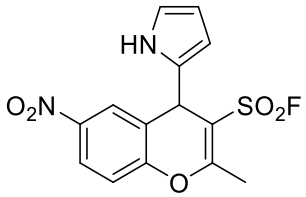
3j

8-methoxy-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3j).** Colorless solid, 219 mg, 68% yield. M.p. 174−175 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.36 (s, 1H), 7.11 (t, *J* = 8.0 Hz, 1H), 6.87 (dd, J_1 = 8.2 Hz, J_2 = 1.4 Hz, 1H), 6.77 (dd, J_1 = 8.0 Hz, J_2 = 1.3 Hz, 1H), 6.68 (q, *J* = 2.4 Hz, 1H), 6.07 (q, *J* = 2.9 Hz, 1H), 5.73 (q, *J* = 2.0 Hz, 1H), 5.17 (s, 1H), 3.92 (s, 3H), 2.53 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.3 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.3, 147.9, 139.1, 133.0, 126.0, 123.0, 120.5, 118.1, 111.0, 109.7 (d, *J* = 20.0 Hz), 108.8, 107.2, 56.2, 35.3, 19.8. **HRMS-ESI** (m/z) calcd. for $[C_{15}H_{15}FNO_4S]^+$ ($[M+H]^+$): 324.0700, found: 324.0705.



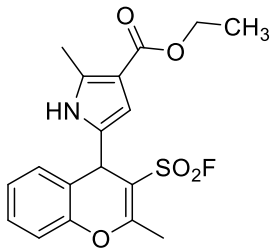
3k

6-methoxy-2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3k).** Colorless solid, 280 mg, 87% yield. M.p. 120−121 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent.**^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.40 (s, 1H), 7.07 (d, *J* = 9.0 Hz, 1H), 6.85 (dd, J_1 = 9.0 Hz, J_2 = 3.0 Hz, 1H), 6.69 (t, *J* = 2.9 Hz, 2H), 6.08 (q, *J* = 2.9 Hz, 1H), 5.73 (dq, J_1 = 3.2 Hz, J_2 = 1.8 Hz, 1H), 5.16 (s, 1H), 3.76 (s, 3H), 2.48 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.5 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 164.7, 157.5, 143.6, 133.0, 122.5, 118.2, 117.6, 115.3, 112.9, 108.7, 108.6, 107.2, 55.9, 35.6, 19.9. **HRMS-ESI** (m/z) calcd. for $[C_{15}H_{15}FNO_4S]^+$ ($[M+H]^+$): 324.0700, found: 324.0704.



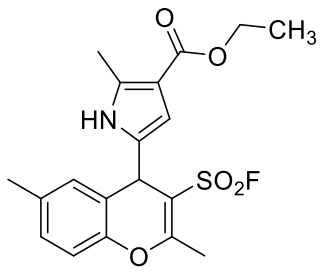
3l

2-methyl-6-nitro-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonyl fluoride **(3l).** Yellow solid, 211 mg, 62% yield. M.p. 147−148 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.53 (s, 1H), 8.19 (dd, J_1 = 9.0 Hz, J_2 = 2.6 Hz, 1H), 8.14 (d, *J* = 2.7 Hz, 1H), 7.28 (s, 1H), 6.74 (q, *J* = 2.3 Hz, 1H), 6.09 (q, *J* = 3.0 Hz, 1H), 5.62 (d, *J* = 3.5 Hz, 1H), 5.23 (s, 1H), 2.54 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.5 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 163.4, 153.1, 145.4, 131.9, 125.7, 124.6, 123.4, 118.9, 117.8, 110.7 (d, *J* = 21.0 Hz), 109.2, 107.9, 35.3, 19.6. **HRMS-ESI** (m/z) calcd. for $[C_{14}H_{12}FN_2O_5S]^+$ ($[M+H]^+$): 339.0445, found: 339.0443.



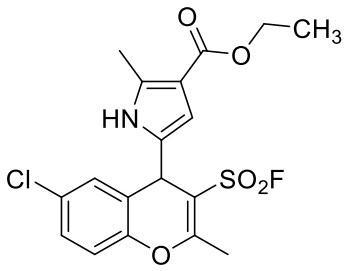
3m

ethyl 5-(3-(fluorosulfonyl)-2-methyl-4H-chromen-4-yl)-2-methyl-1H-pyrrole-3-carboxylate **(3m).** Light yellow solid, 339 mg, 89% yield. M.p. 134−135 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.53 (s, 1H), 7.44 – 7.31 (m, 2H), 7.26 (s, 1H), 7.20 (d, *J* = 8.2 Hz, 1H), 6.00 (d, *J* = 2.9 Hz, 1H), 5.15 (s, 1H), 4.27 (t, *J* = 7.1 Hz, 2H), 2.55 (d, *J* = 13.7 Hz, 6H), 1.35 (d, *J* = 7.1 Hz, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.4 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 165.5, 164.88, 149.3, 135.6, 131.4, 129.3, 129.1, 126.3, 121.2, 116.8, 112.3, 109.1, 108.9, 59.6, 35.0, 19.9, 14.6, 13.5. **HRMS-ESI** (m/z) calcd. for $[C_{18}H_{19}FNO_5S]^+$ ($[M+H]^+$): 380.0962, found: 380.0963.



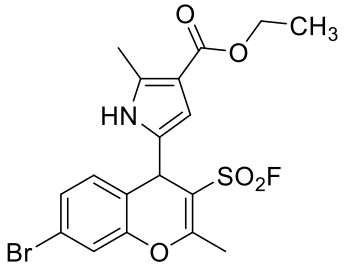
3n

ethyl5-(3-(fluorosulfonyl)-2,6-dimethyl-4H-chromen-4-yl)-2-methyl-1H-pyrrole-3-carboxylate **(3n).** Light yellow solid, 286 mg, 73% yield. M.p. 148−149 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.40 (s, 1H), 7.10 (d, *J* = 8.4 Hz, 1H), 7.01 (d, *J* = 8.4 Hz, 1H), 6.96 (s, 1H), 5.96 (d, *J* = 2.9 Hz, 1H), 5.02 (s, 1H), 4.20 (dt, J_1 = 7.4 Hz, J_2 = 3.7 Hz, 2H), 2.47 (d, *J* = 3.4 Hz, 6H), 2.30 (s, 3H), 1.29 (t, *J* = 7.1 Hz, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.4 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 165.5, 165.0, 147.4, 136.1, 135.6, 131.5, 129.8, 129.4, 120.8, 116.5, 112.3, 109.0, 108.7 (d, *J* = 19.9 Hz), 59.6, 35.0, 20.9, 19.9, 14.6, 13.5. **HRMS-ESI** (m/z) calcd. for $[C_{19}H_{21}FNO_5S]^+$ ($[M+H]^+$): 394.1119, found: 394.1120.



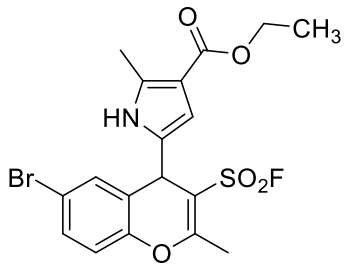
3o

ethyl 5-(6-chloro-3-(fluorosulfonyl)-2-methyl-4H-yl)-2-methyl-1H-purrole-3-carboxylate (**3o**). Light yellow solid, 362 mg, 87% yield. M.p. 169−170 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.67 (s, 1H), 7.38 – 7.35 (m, 1H), 7.27 (s, 1H), 7.17 (d, *J* = 8.8 Hz, 1H), 6.07 (d, *J* = 2.9 Hz, 1H), 5.12 (s, 1H), 4.38 – 4.30 (m, 2H), 2.58 (d, *J* = 7.7 Hz, 6H), 1.40 (t, *J* = 7.1 Hz, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.6 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 165.5, 164.6, 147.8, 135.8, 131.2, 130.7, 129.3, 129.0, 122.9, 118.3, 112.5, 109.4, 109.0 (d, *J* = 20.7 Hz), 59.7, 35.0, 19.8, 14.6, 13.5. **HRMS-ESI** (m/z) calcd. for $[C_{18}H_{18}ClFNO_5S]^+$ ($[M+H]^+$): 414.0573, found: 414.0575.



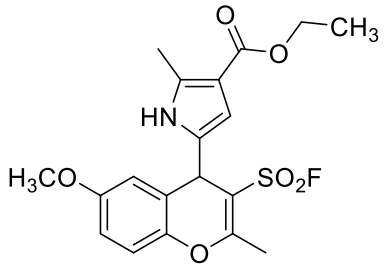
3p

*ethyl 5-(7-bromo-3-(fluorosulfonyl)-2-methyl-4H-chromen-4-yl)-2-methyl-1H-pyrrole-3-*carboxylate (**3p**). Light yellow solid, 414 mg, 90% yield. M.p. 140−141 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.67 (s, 1H), 7.25 (d, *J* = 2.2 Hz, 2H), 7.03 (d, *J* = 8.1 Hz, 1H), 5.96 (d, *J* = 2.9 Hz, 1H), 4.99 (s, 1H), 4.18 (q, *J* = 7.0 Hz, 2H), 2.44 (d, *J* = 18.4 Hz, 6H), 1.27 (t, *J* = 7.2 Hz, 3H). **^{19}F NMR (**471 MHz, $CDCl_3$) δ 69.5 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 165.4, 164.5, 149.7, 135.9, 130.8, 130.6, 129.5, 122.0, 120.3, 120.1, 112.4, 109.5 (d, *J* = 20.6 Hz), 109.3, 59.6, 34.7, 19.8, 14.6, 13.4. **HRMS-ESI** (m/z) calcd. for $[C_{18}H_{18}BrFNO_5S]^+$ ($[M+H]^+$): 458.0068, found: 458.0070.



3q

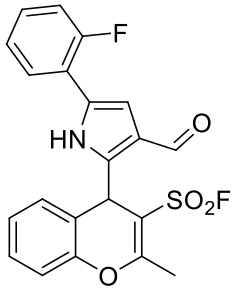
ethyl 5-(6-bromo-3-(fluorosulfonyl)-2-methyl-4H-chromen-4-yl)-2-methyl-1H-pyrrole-3-carboxylate (**3q**). Light yellow solid, 424 mg, 93% yield. M.p. 143−144 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.54 (s, 1H), 7.41 (dd, J_1 = 8.7 Hz, J_2 = 2.3 Hz, 1H), 7.31 (d, J = 2.3 Hz, 1H), 7.01 (d, J = 8.6 Hz, 1H), 5.98 (d, J = 2.9 Hz, 1H), 5.01 (s, 1H), 4.21 (q, J = 7.1 Hz, 2H), 2.47 (d, J = 7.0 Hz, 6H), 1.30 (t, J = 7.1 Hz, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.5 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 165.5, 164.5, 148.3, 135.8, 132.2, 131.9, 130.7, 118.7, 118.6, 112.5, 110.7, 109.4, 109.2 (d, J = 20.6 Hz), 59.7, 34.9, 19.8, 14.6, 13.5. **HRMS-ESI** (m/z) calcd. for $[C_{18}H_{18}BrFNO_5S]^+$ ($[M+H]^+$): 458.0068, found: 458.0071.



3r

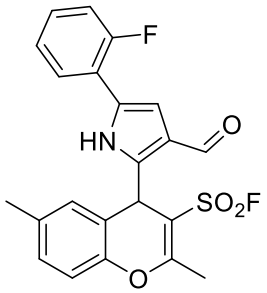
ethyl 5-(3-(fluorosulfonyl)-6-methoxy-2-methyl-4H-chromen-4-yl)-2-methyl-1H-pyrrole-3-carboxylate (**3r**). yellow solid, 284 mg, 69% yield. M.p. 172−173 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.43 (s, 1H), 7.06 (d, J = 9.0 Hz, 1H), 6.85 (dd, J_1 = 9.0 Hz, J_2 = 3.0 Hz, 1H), 6.64 (d, J = 2.9 Hz, 1H), 5.98 (d, J = 2.9 Hz, 1H), 5.04 (s, 1H), 4.20 (qd, J_1 = 7.1, J_2 = 2.0 Hz, 2H), 3.75 (s, 3H), 2.47 (d, J = 2.9 Hz, 6H), 1.29 (t, J = 7.1 Hz, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.5 (s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 165.5, 165.1, 157.6, 143.5, 135.6, 131.2, 121.9, 117.8,

115.4, 112.9, 112.3, 109.1, 108.0 (d, *J* = 20.0 Hz), 59.6, 55.9, 35.4, 19.9, 14.6, 13.5. **HRMS-ESI** (m/z) calcd. for $[C_{19}H_{21}FNO_6S]^+$ ($[M+H]^+$): 410.1068, found: 410.1069.



3s

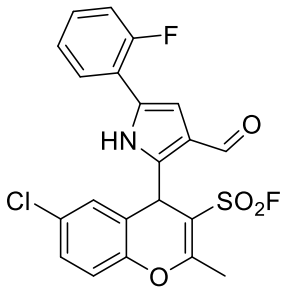
4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**3s).** White solid, 263 mg, 87% yield. M.p. 181−182 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. ^{1}H NMR (500 MHz, DMSO-d_6) δ 12.11 (s, 1H), 9.91 (s, 1H), 7.73 – 7.68 (m, 1H), 7.33 – 7.27 (m, 4H), 7.23 – 7.15 (m, 3H), 6.88 (t, *J* = 2.7 Hz, 1H), 5.97 (s, 1H), 2.54 (s, 3H). **^{19}F NMR** (471 MHz, DMSO-d_6) δ 70.1 (s, 1F), -115.1 (m, 1F). **^{13}C NMR** (126 MHz, DMSO-d_6) δ 186.12, 165.6, 159.9, 157.9, 147.7, 141.7, 129.5 (d, *J* = 2.5 Hz), 129.2 (d, *J* = 8.3 Hz), 128.1 (d, *J* = 3.1 Hz), 126.7, 126.31, 125.1 (d, *J* = 3.4 Hz), 123.1, 120.6, 119.7 (d, *J* = 12.4 Hz), 117.1, 116.6 (d, *J* = 21.8 Hz), 111.2 (d, *J* = 8.5 Hz), 105.8 (d, *J* = 20.4 Hz), 33.3, 20.2. **HRMS-ESI** (m/z) calcd. for $[C_{21}H_{16}F_2NO_4S]^+$ ($[M+H]^+$): 416.0763, found: 416.0773.



3t

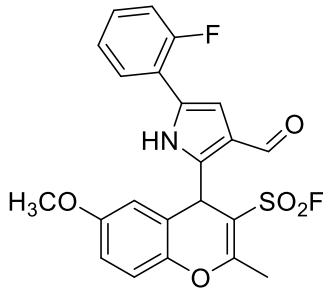
4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-2,6-dimethyl-4H-chromene-3-sulfonyl fluoride (**3t**). White solid, 377 mg, 88% yield. M.p. 173−174 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz,

DMSO-d_6) δ 12.09 (s, 1H), 9.91 (s, 1H), 7.71 (td, J_1 = 7.8 Hz, J_2 = 1.7 Hz, 1H), 7.36 – 7.25 (m, 3H), 7.11 (d, J = 1.2 Hz, 2H), 6.96 (s, 1H), 6.87 (t, J = 2.8 Hz, 1H), 5.91 (s, 1H), 2.52 (s, 3H), 2.19 (s, 3H). **^{19}F NMR** (471 MHz, DMSO-d_6) δ 70.1 (s, 1F), -115.1 (dd, 1F). **^{13}C NMR** (126 MHz, DMSO-d_6) δ 186.1, 165.6, 159.9, 157.9, 145.76, 141.8, 135.6, 130.2, 129.3 (d, J = 10.0 Hz), 128.1 (d, J = 3.2 Hz), 126.7, 125.1 (d, J = 3.2 Hz), 123.1, 120.2, 119.7 (d, J = 12.3 Hz), 116.9, 116.6 (d, J = 21.7 Hz), 111.1 (d, J = 8.4 Hz), 105.5 (d, J = 20.4 Hz), 33.3, 20.74, 20.2. **HRMS-ESI** (m/z) calcd. for $[C_{22}H_{18}F_2NO_4S]^+$ ($[M+H]^+$): 430.0919, found: 430.0920.



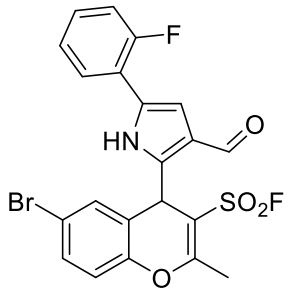
3u

6-chloro-4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**3u).** Light yellow solid, 326 mg, 72% yield. M.p. 141−142 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, DMSO-d_6) δ 12.14 (s, 1H), 9.89 (s, 1H), 7.74 – 7.66 (m, 1H), 7.39 – 7.25 (m, 5H), 7.18 (d, J = 2.5 Hz, 1H), 6.91 (t, J = 2.6 Hz, 1H), 5.94 (s, 1H), 2.52 (s, 3H). **^{19}F NMR** (471 MHz, DMSO-d_6) δ 70.2 (s, 1F), -115.2 (d, 1F). **^{13}C NMR** (126 MHz, DMSO-d_6) δ 186.6, 165.5, 159.9, 157.9, 146.6, 141.8, 135.1, 131.6, 129.5 (dd, J_1 = 34.1Hz, J_2 = 8.7 Hz), 128.4 (d, J = 76.8 Hz), 125.2 (d, J = 3.2 Hz), 123.2, 122.5, 121.1, 119.5 (d, J = 12.3 Hz), 119.2, 116.7 (d, J = 21.7 Hz), 111.6, 105.4 (d, J = 20.9 Hz), 33.3, 20.2. **HRMS-ESI** (m/z) calcd. for $[C_{21}H_{15}ClF_2NO_4S]^+$ ($[M+H]^+$): 450.0373, found: 450.0373.



3v

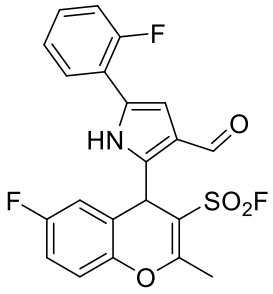
4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-6-methoxy-2-methyl-4H-chromene-3-sulfonyl fluoride (**3v**). Light yellow solid, 204 mg, 46% yield. M.p. 195−196 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, DMSO-d_6) δ 12.11 – 12.07 (m, 1H), 9.91 (s, 1H), 7.70 (td, J_1 = 7.8, J_2 = 1.6 Hz, 1H), 7.36 – 7.25 (m, 3H), 7.19 (d, J = 9.0 Hz, 1H), 6.92 – 6.86 (m, 2H), 6.70 (d, J = 3.0 Hz, 1H), 5.91 (s, 1H), 3.65 (s, 3H), 2.52 (s, 3H). **^{19}F NMR** (471 MHz, DMSO-d_6) δ 70.2 (s, 1F), -115.1 (d, 1F) (d, J = 8.2 Hz). **^{13}C NMR** (126 MHz, DMSO-d_6) δ 186.3, 165.9, 159.9, 157.9, 157.0, 141.7 (d, J = 23.6 Hz), 129.3 (d, J = 8.3 Hz), 128.1 (d, J = 3.1 Hz), 126.7, 125.1 (d, J = 3.2 Hz), 123.1, 121.5, 119.6 (d, J = 12.3 Hz), 118.3, 116.7 (d, J = 21.7 Hz), 115.0, 113.7, 111.2 (d, J = 8.4 Hz), 104.6 (d, J = 20.3 Hz), 55.9, 33.6, 20.3. **HRMS-ESI** (m/z) calcd. for $[C_{22}H_{18}F_2NO_5S]^+$ ([M+H]$^+$): 446.0868, found: 446.0868.



3w

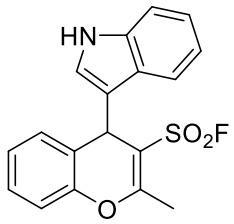
6-bromo-4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**3w**). Light yellow solid, 338 mg, 68% yield. M.p. 130−131 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, DMSO-d_6) δ 12.14 (s, 1H), 9.90 (s, 1H), 7.70 (td, J_1 = 7.8 Hz, J_2 = 1.6 Hz, 1H), 7.48 (dd, J_1 = 8.7 Hz, J_2 = 2.4 Hz, 1H), 7.35 – 7.25 (m, 4H), 7.21 (d, J = 8.7 Hz, 1H), 6.92 (t, J = 2.7 Hz, 1H), 5.94 (s, 1H), 2.52 (s, 3H). **^{19}F NMR** (471 MHz, DMSO-d_6) δ 70.2 (S, 1F), -115.14 (m,

1F). **^{13}C NMR** (126 MHz, DMSO-d_6) δ 186.6, 165.4, 159.9, 157.9, 147.1, 141.8, 140.6, 134.5 (d, J = 7.8 Hz), 132.0 (d, J = 105.7 Hz), 129.4 (d, J = 8.3 Hz), 128.1 (d, J = 3.1 Hz), 126.8, 125.2 (d, J = 3.5 Hz), 123.0 (d, J = 32.5 Hz), 119.5 (d, J = 6.2 Hz), 117.6, 116.7 (d, J = 21.7 Hz), 111.6, 105.5 (d, J = 20.4 Hz), 33.1, 20.2. **HRMS-ESI** (m/z) calcd. for $[C_{21}H_{15}BrF_2NO_4S]^+$ ($[M+H]^+$): 493.9868, found: 493.9871.



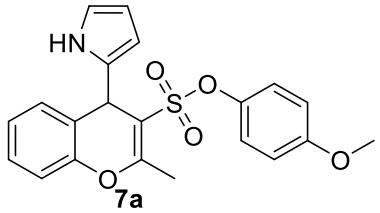
3x

6-fluoro-4-(5-(2-fluorophenyl)-3-formyl-1H-pyrrol-2-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**3x**). Colorless solid, 273 mg, 63% yield. M.p. 164−165 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, DMSO-d_6) δ 12.13 (s, 1H), 9.89 (s, 1H), 7.70 (td, J_1 = 7.8 Hz, J_2 = 1.6 Hz, 1H), 7.37 – 7.26 (m, 4H), 7.18 (td, J_1 = 8.5 Hz, J_2 = 3.0 Hz, 1H), 6.97 (dd, J_1 = 8.8 Hz, J_2 = 3.0 Hz, 1H), 6.90 (t, J = 2.7 Hz, 1H), 5.95 (s, 1H), 2.52 (s, 3H). **^{19}F NMR** (471 MHz, DMSO-d_6) δ 70.2 (s, 1F), -115.20 (t, 1F), -116.4 (s, 1F). **^{13}C NMR** (126 MHz, DMSO-d_6) δ 186.5, 165.7, 160.1 (d, J = 54.2 Hz), 158.1 (d, J = 59.5 Hz), 144.2 (d, J = 2.2 Hz), 140.7, 129.3 (d, J = 8.5 Hz), 128.1 (d, J = 3.1 Hz), 126.8, 125.1 (d, J = 3.4 Hz), 123.2, 122.5 – 122.1 (m), 121.3 (d, J = 8.9 Hz), 119.4 (dd, J_1 = 43.0 Hz, J_2 10.5 Hz), 118.1 (d, J = 25.0 Hz), 116.7 (dd, J_1 = 22.7 Hz, J_2 = 8.4 Hz), 115.2 (d, J = 24.4 Hz), 111.5, 104.9 (d, J = 20.5 Hz), 33.5, 20.2. **HRMS-ESI** (m/z) calcd. for $[C_{21}H_{15}F_3NO_4S]^+$ ($[M+H]^+$): 434.0668, found: 434.0669.



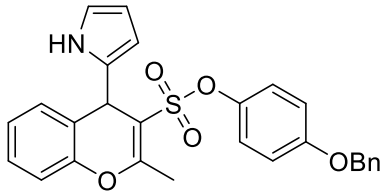
4a

4-(1H-indol-3-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**4a).** Colorless solid, 280 mg, 82% yield. Mp 143-145 °C . Purification by column chromatography on silica gel using petroleum ether/ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.06 (s, 1H), 7.34 (dd, *J* = 15.3, 8.1 Hz, 2H), 7.22 – 7.11 (m, 5H), 7.07 – 7.03 (m, 2H), 5.39 (s, 1H), 2.57 (s, 3H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 70.1(s, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 163.2, 148.7, 136.8, 129.3, 128.3, 125.9, 125.3, 123.4, 122.9, 122.4, 120.1, 118.6, 116.4, 111.7, 110.1 (d, *J* = 19.5 Hz), 34.1, 19.8. Note: In the ^{13}C NMR spectrum of **4a**, there should theoretically be eighteen peaks. However, due to the close proximity of these peaks, distinguishing the overlapping ones is challenging.



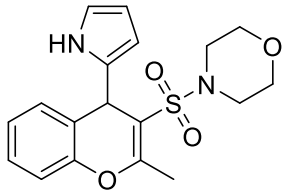
7a

4-methoxyphenyl 2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonate (**7a**). White solid, 194 mg, 98% yield. M.p. 104−105 ºC. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.74 (s, 1H), 7.30 (ddd, J_1 = 8.4 Hz, J_2 = 6.9 Hz, 2.0 Hz, 1H), 7.23 – 7.13 (m, 2H), 7.09 (dd, J_1 = 8.1 Hz, J_2 = 1.2 Hz, 1H), 6.81 – 6.75 (m, 3H), 6.65 (td, J_1 = 2.7 Hz, J_2 = 1.6 Hz, 1H), 6.02 (q, *J* = 2.9 Hz, 1H), 5.45 (dq, J_1 = 3.0 Hz, J_2 = 1.8 Hz, 1H), 5.17 (s, 1H), 3.77 (d, *J* = 1.2 Hz, 4H), 2.07 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 162.8, 158.5, 153.9, 150.2, 149.6, 142.6, 133.7, 129.5, 128.6, 125.6, 123.7, 122.3, 117.7, 116.2 (d, *J* = 17.5 Hz), 114.8 (d, *J* = 36.8 Hz), 110.5, 108.3, 107.0, 55.7, 35.4, 19.2. **HRMS-ESI** (m/z) calcd. for $[C_{21}H_{20}NO_5S]^+$ ($[M+H]^+$): 398.1057, found: 398.1057.



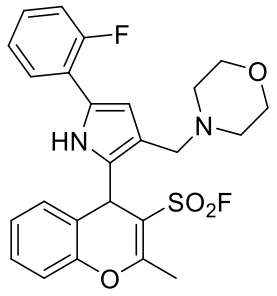
7b

4-(benzyloxy)phenyl 2-methyl-4-(1H-pyrrol-2-yl)-4H-chromene-3-sulfonate (**7b**). Light yellow solid, 234 mg, 99% yield. M.p. 118−119 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 10:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.75 – 8.71 (m, 1H), 7.43 – 7.27 (m, 6H), 7.22 – 7.13 (m, 2H), 7.09 (dd, J_1 = 8.2 Hz, J_2 = 1.2 Hz, 1H), 6.85 – 6.76 (m, 4H), 6.64 (td, J_1 = 2.7, J_2 = 1.5 Hz, 1H), 6.01 (q, J = 2.9 Hz, 1H), 5.47 – 5.41 (m, 1H), 5.17 (s, 1H), 5.02 (s, 2H), 2.05 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 162.8, 157.7, 150.1, 142.8, 136.6, 133.7, 129.5, 128.8, 128.6, 128.3, 127.6, 125.6, 123.7, 122.2, 117.7, 116.3, 115.7, 110.5, 108.3, 107.0, 70.5, 35.4, 19.2. **HRMS-ESI** (m/z) calcd. for $[C_{27}H_{24}NO_5S]^+$ ($[M+H]^+$): 474.1370, found: 474.1373.



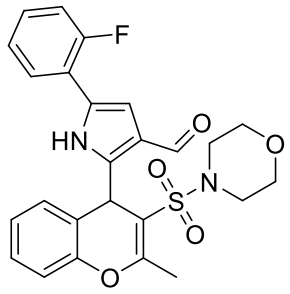
8

4-((2-methyl-4-(1H-pyrrol-2-yl)-4H-chromen-3-yl)sulfonyl)morpholine (**8).** Light yellow solid, 137 mg, 76% yield. M.p. 117−178 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 5:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.00 (s, 1H), 7.30 (ddd, J_1 = 8.5, J_2 = 7.2, J_3 = 1.8 Hz, 1H), 7.21 (dd, J_1 = 7.6 Hz, J_2 = 1.8 Hz, 1H), 7.19 – 7.09 (m, 2H), 6.68 (td, J_1 = 2.7 Hz, J_2 = 1.5 Hz, 1H), 5.98 (q, J = 2.8 Hz, 1H), 5.38 – 5.32 (m, 1H), 4.99 (s, 1H), 3.65 (t, J = 4.8 Hz, 4H), 3.13 – 2.98 (m, 4H), 2.42 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 161.2, 150.8, 133.9, 129.1, 128.5, 125.3, 122.8, 117.7, 116.4, 111.9, 108.2, 106.5, 66.3, 45.3, 36.0, 19.4. **HRMS-ESI** (m/z) calcd. for $[C_{18}H_{21}N_2O_4S]^+$ ($[M+H]^+$): 361.1217, found: 361.1219.



9

4-(5-(2-fluorophenyl)-3-(morpholinomethyl)-1H-pyrrol-2-yl)-2-methyl-4H-chromene-3-sulfonyl fluoride (**9**). Light yellow solid, 202 mg, 83% yield. M.p. 189−190 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 5:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 8.85 – 8.77 (m, 1H), 7.56 – 7.49 (m, 1H), 7.31 (dd, J_1 = 7.8 Hz, J_2 = 1.7 Hz, 1H), 7.25 (dd, J_1 = 7.8 Hz, J_2 = 1.7 Hz, 1H), 7.15 – 7.03 (m, 5H), 6.46 (d, J = 2.8 Hz, 1H), 5.39 (s, 1H), 3.71 – 3.61 (m, 4H), 3.16 (dd, J_1 = 90.9 Hz, J_2 = 12.9 Hz, 2H), 2.57 (s, 3H), 2.45 – 2.20 (m, 4H). **^{19}F NMR** (471 MHz, $CDCl_3$) δ 69.3 (s, 1F), -118.8 (d, 1F). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 163.5, 159.6, 157.7, 148.8, 131.5, 129.6, 128.8, 127.2 (d, J = 8.7 Hz), 126.4 (d, J = 4.5 Hz), 126.1, 125.7, 124.8 (d, J = 3.0 Hz), 121.6, 119.8 (d, J = 10.9 Hz), 116.5, 116.4 (d, J = 22.8 Hz), 110.8 (d, J = 2.4 Hz), 108.6 (d, J = 20.1 Hz), 67.1, 55.0, 53.8, 34.4, 20.1. **HRMS-ESI** (m/z) calcd. for $[C_{25}H_{25}F_2N_2O_4S]^+$ ($[M+H]^+$): 487.1498, found: 487.1498.



10

5-(2-fluorophenyl)-2-(2-methyl-3-(morpholinosulfonyl)-4H-chromen-4-yl)-1H-pyrrole-3-carbaldehyde (**10**). Colorless solid, 113 mg, 78% yield. M.p. 190−191 °C. Purification by column chromatography on silica gel using petroleum ether / ethyl acetate = 5:1 (v/v) as eluent. **^{1}H NMR** (500 MHz, $CDCl_3$) δ 9.81 (s, 1H), 9.28 (s, 1H), 7.55 (td, J_1 = 7.9, J_2 = 1.8 Hz, 1H), 7.33 – 7.27 (m, 1H), 7.26 – 7.06 (m, 6H), 6.93 (d, J = 2.8 Hz, 1H), 5.80 (s, 1H), 3.50 (t, J = 4.8 Hz, 4H), 3.03 (tq,

J_1 = 12.1 Hz, J_2 = 6.0 Hz, 4H), 2.57 (s, 3H). **^{13}C NMR** (126 MHz, $CDCl_3$) δ 186.0, 161.2, 159.8, 157.9, 149.3, 142.0 (d, *J* = 2.5 Hz), 129.0, 128.9, 128.8 (d, *J* = 8.8 Hz), 127.5 (d, *J* = 1.9 Hz), 127.0 (d, *J* = 3.9 Hz), 125.9, 125.2 (d, *J* = 3.1 Hz), 122.0 (d, *J* = 27.7 Hz), 118.6 (d, *J* = 11.0 Hz), 116.7, 116.5 (d, *J* = 22.7 Hz), 110.7, 108.93 (d, *J* = 2.2 Hz), 66.2, 44.9, 34.5, 19.4. **HRMS-ESI** (m/z) calcd. for $[C_{25}H_{24}FN_2O_5S]^+$ ($[M+H]^+$): 483.1384, found: 483.1385.

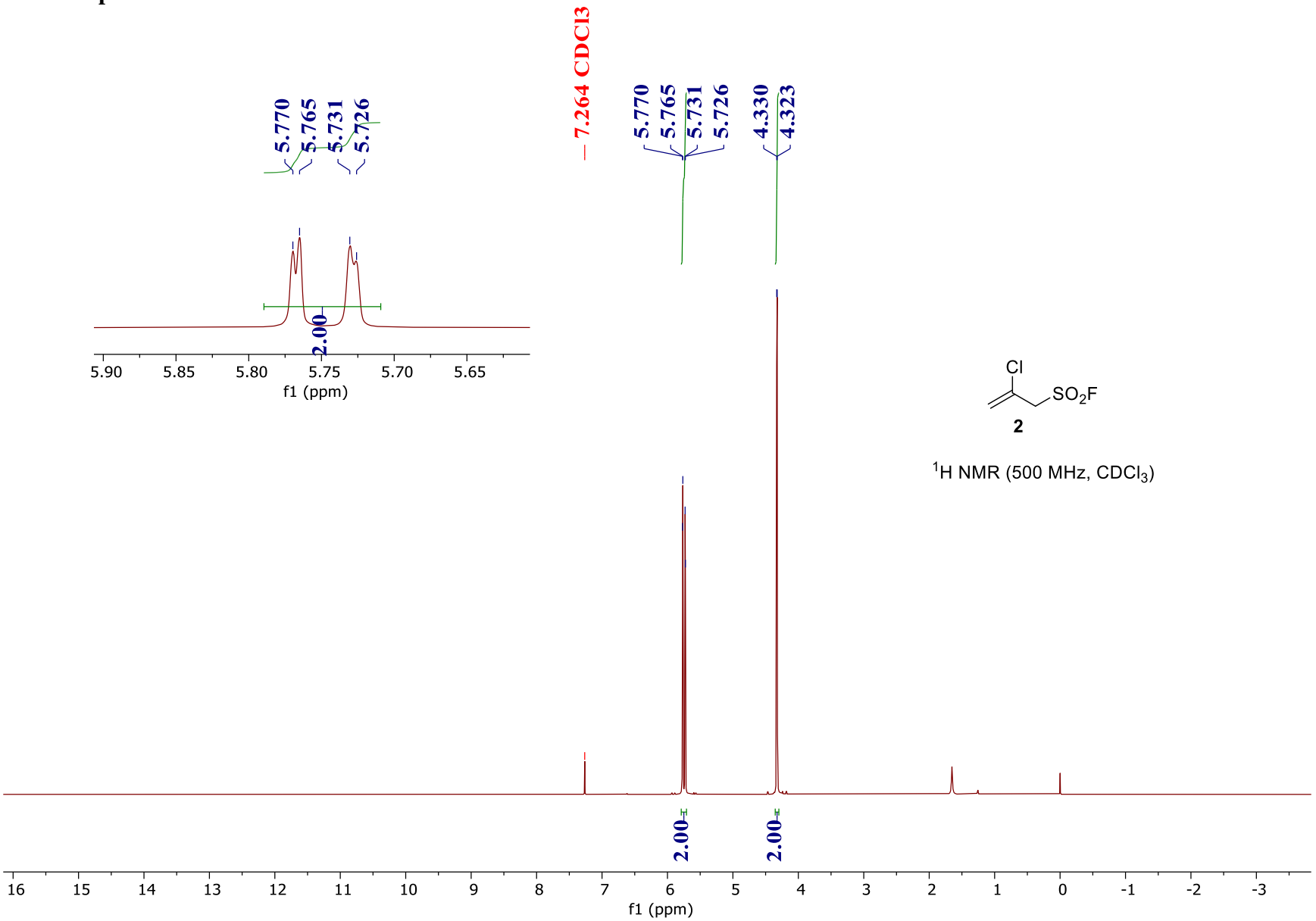
5. References.

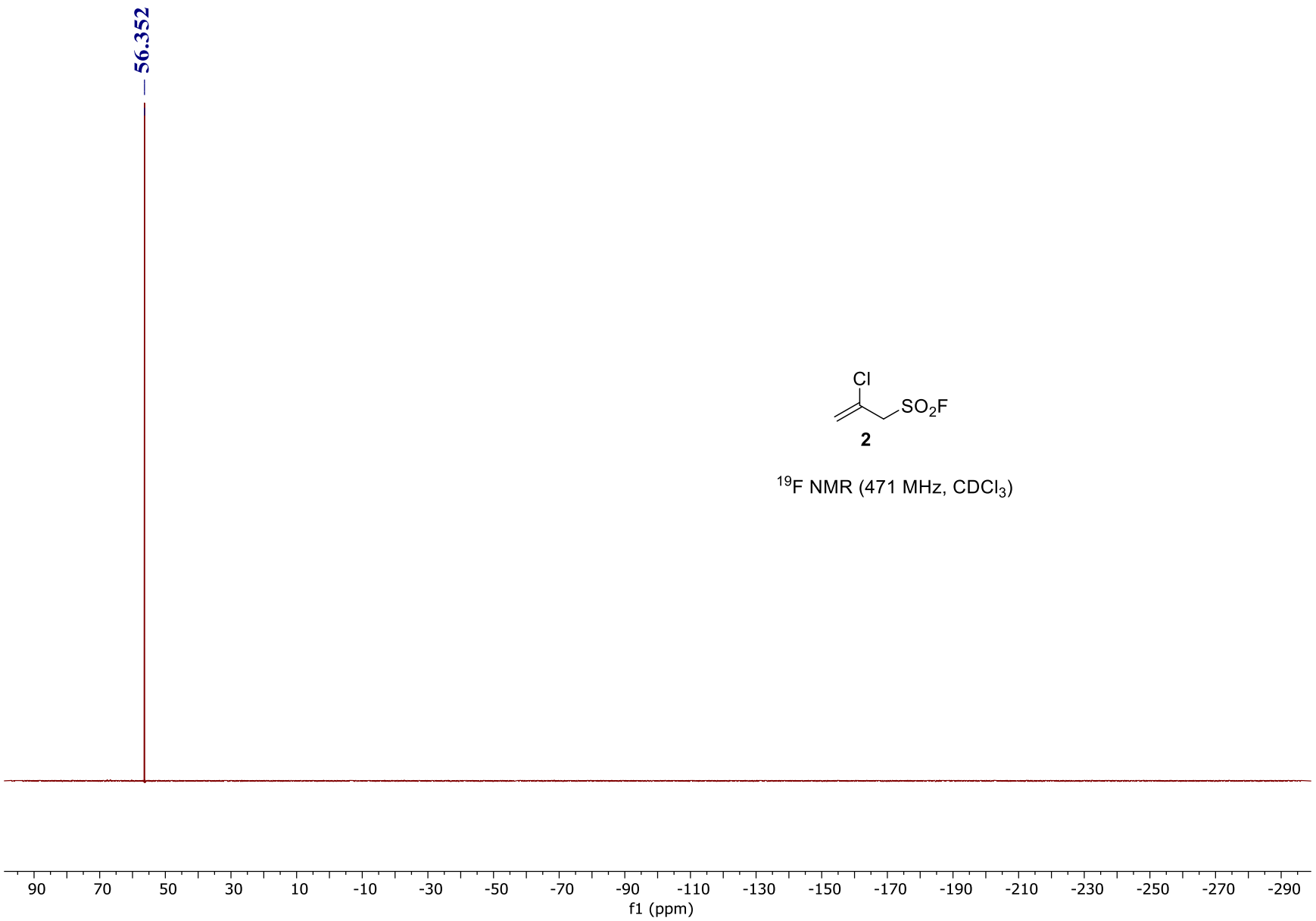
1 M. J. Brienne, D. Varech, M. Leclercq, J. Jacques, N. Radembino, C. Dessalles, G. Mahuzier, C. Gueyouche and C. Bories, *J. Med. Chem.*, 1987, **30**, 2232–2239.

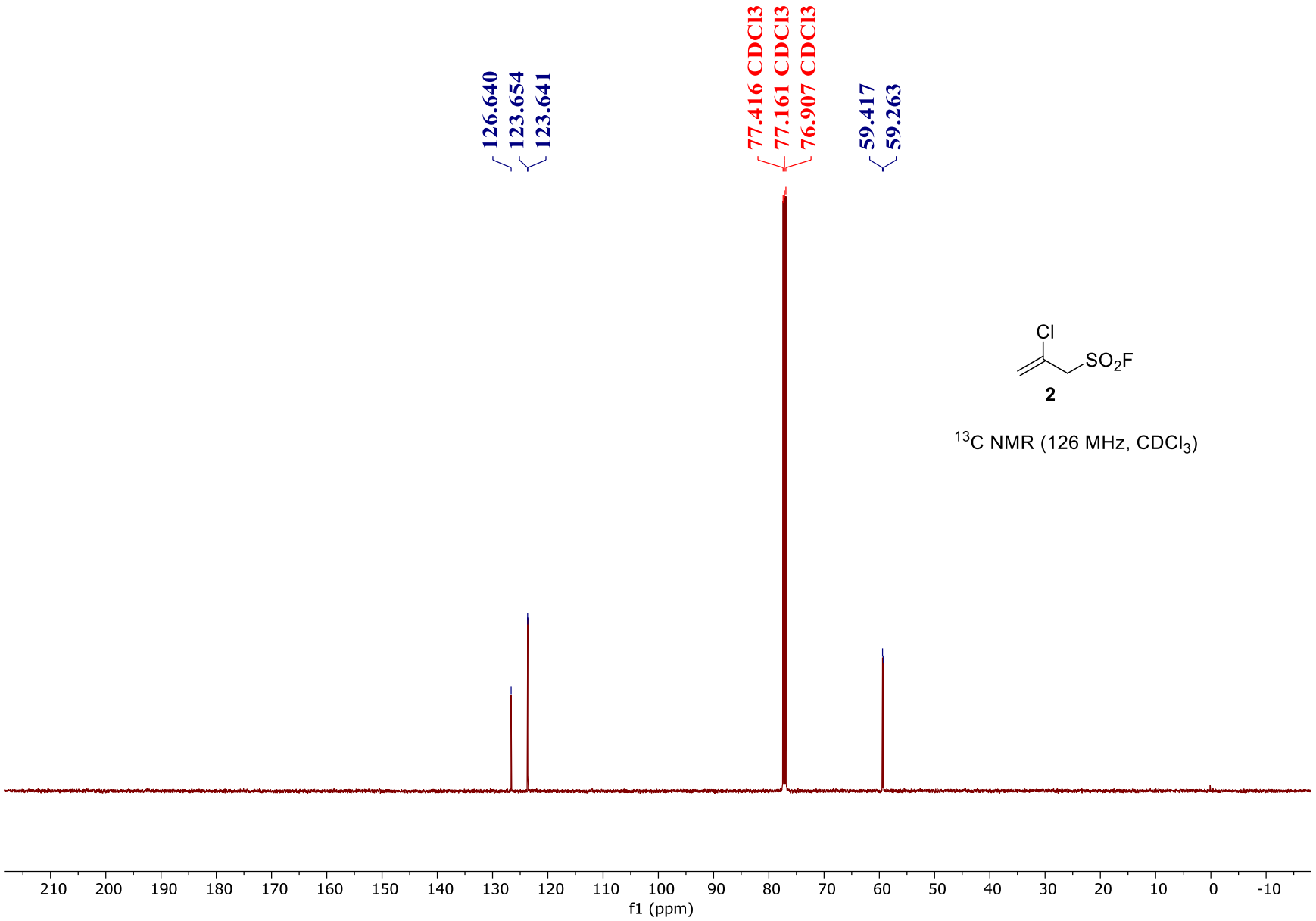
2 X. Zhang, W. Fang, R. Lekkala, W. Tang and H. Qin, *Adv. Synth. Catal.*, 2020, **362**, 3358–3363.

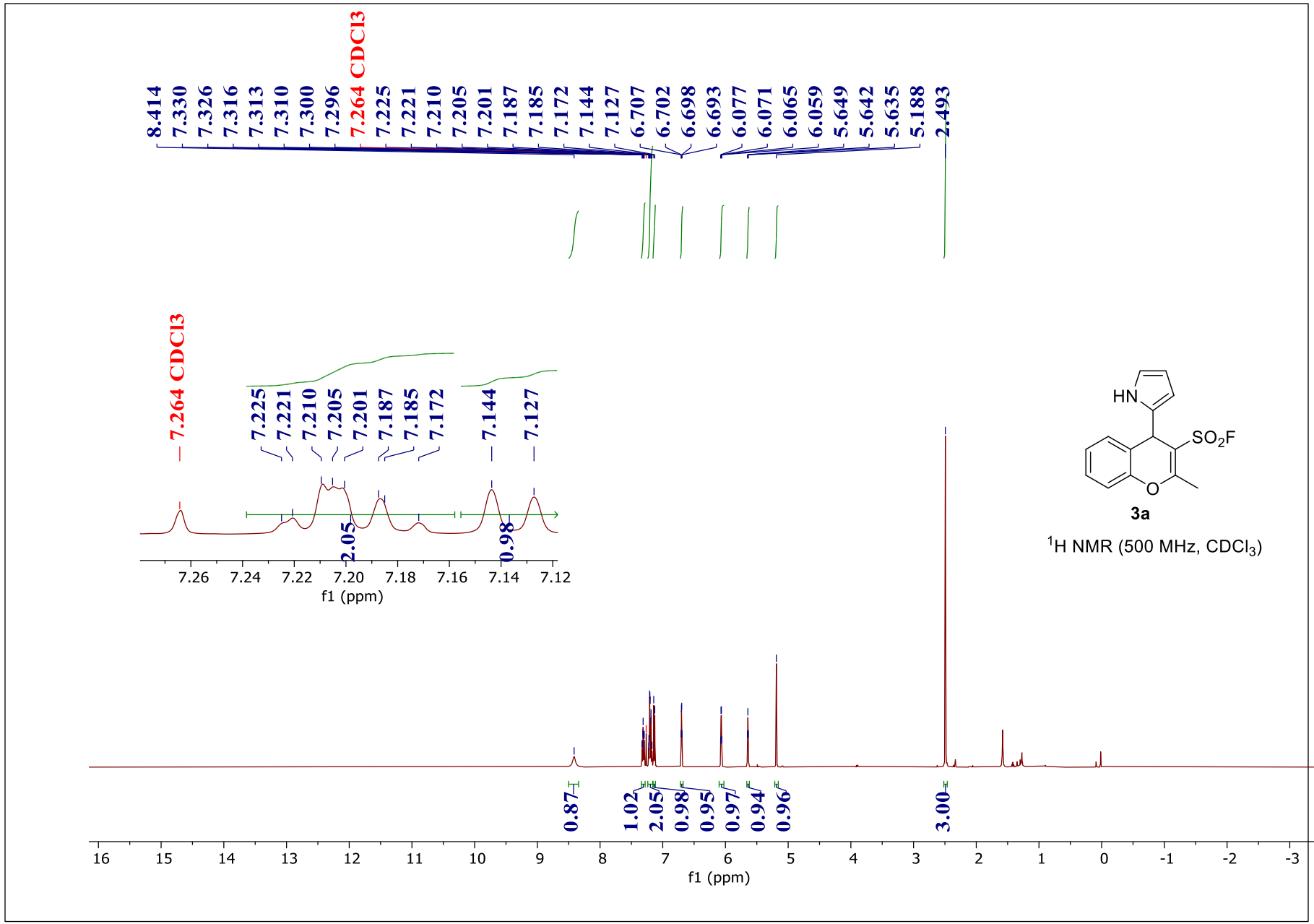
3 A. F. Abdel-Magid, K. G. Carson, B. D. Harris, C. A. Maryanoff and R. D. Shah, *J. Org. Chem.*, 1996, **61**, 3849–3862.

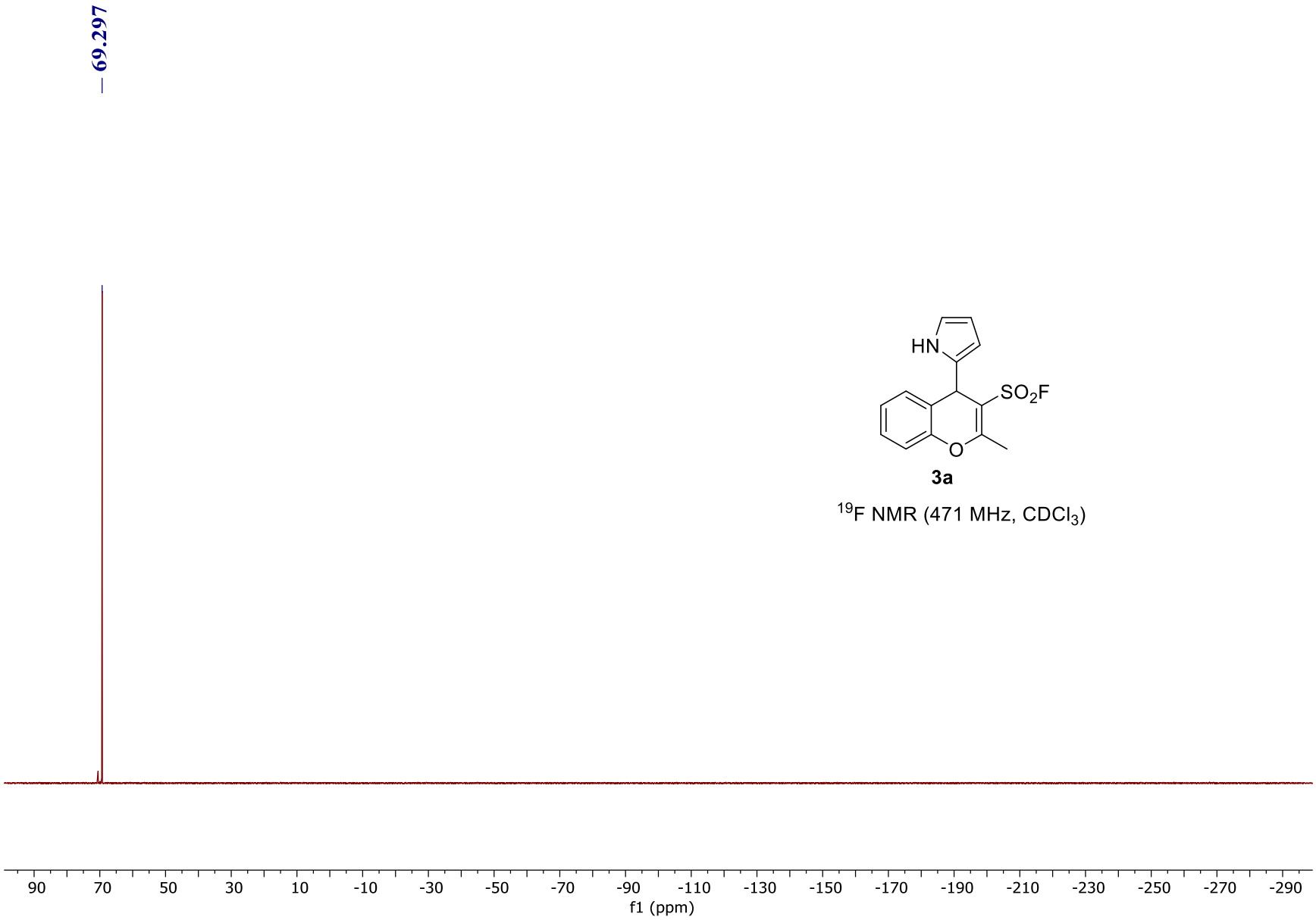
6.NMR Spectra




56.352
Cl
SO2F
2
19F NMR (471 MHz, CDCl3)
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
f1 (ppm)

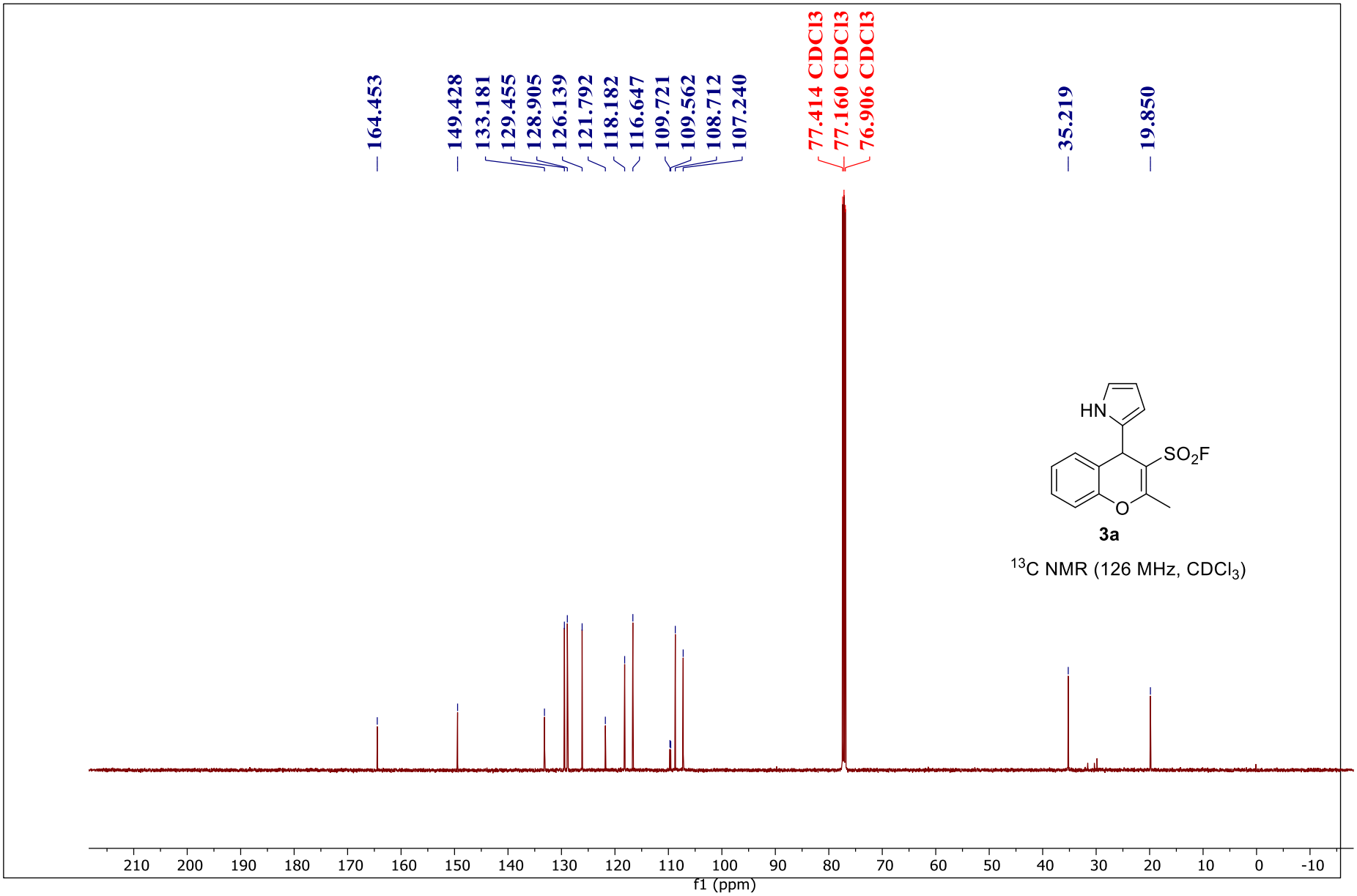

126.640
123.654
123.641
77.416 CDCl3
77.161 CDCl3
76.907 CDCl3
59.417
59.263
Cl
SO2F
2
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

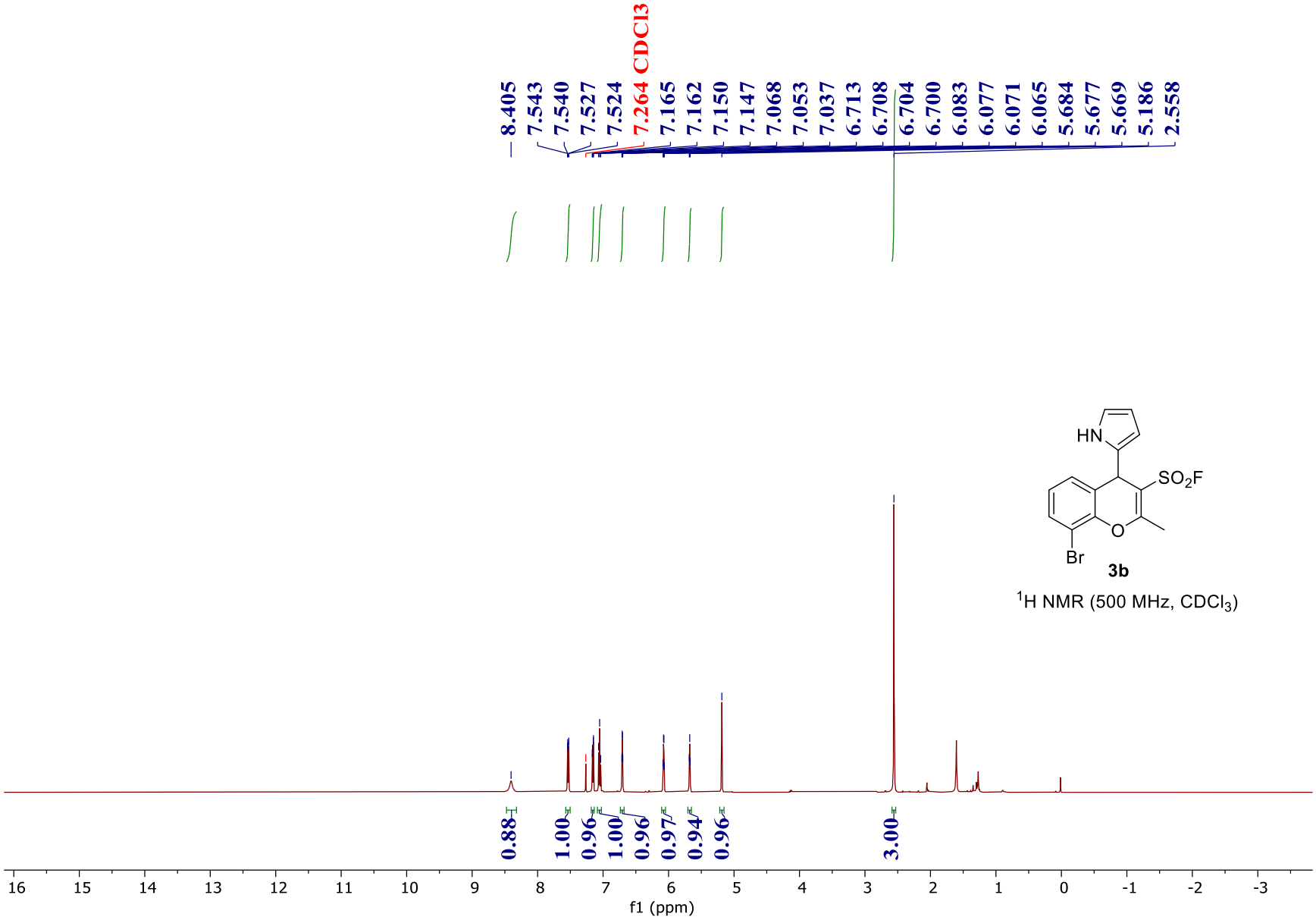

8.414
7.330
7.326
7.316
7.313
7.310
7.300
7.296
7.264 CDCl3
7.225
7.221
7.210
7.205
7.201
7.187
7.185
7.172
7.144
7.127
6.707
6.702
6.698
6.693
6.077
6.071
6.065
6.059
5.649
5.642
5.635
5.188
2.493
7.264 CDCl3
2.05
0.98
f1 (ppm)
HN
SO2F
O
3a
1H NMR (500 MHz, CDCl3)
0.87
1.02
2.05
0.98
0.95
0.97
0.94
0.96
3.00
f1 (ppm)

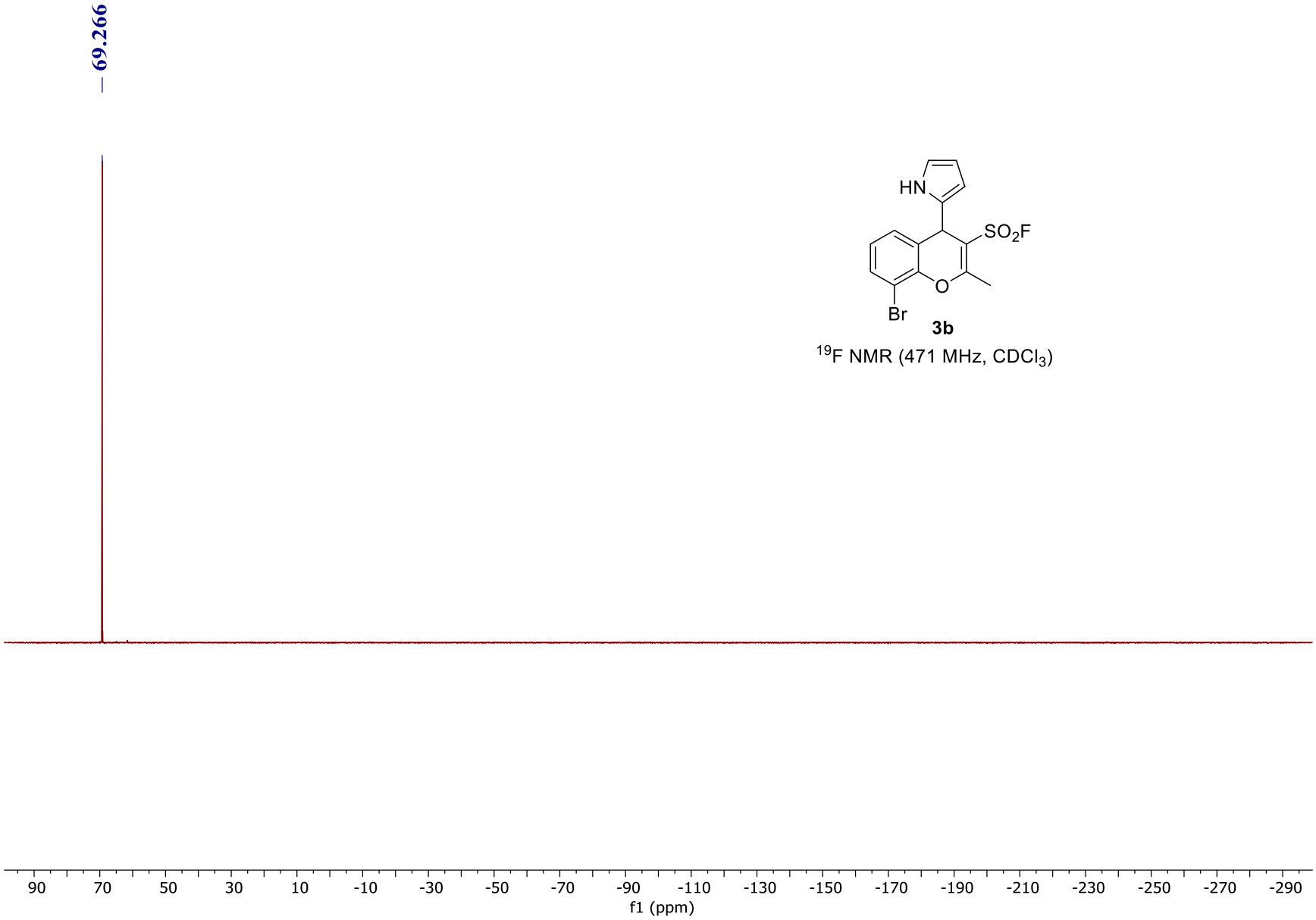


3a

^{19}F NMR (471 MHz, $CDCl_3$)

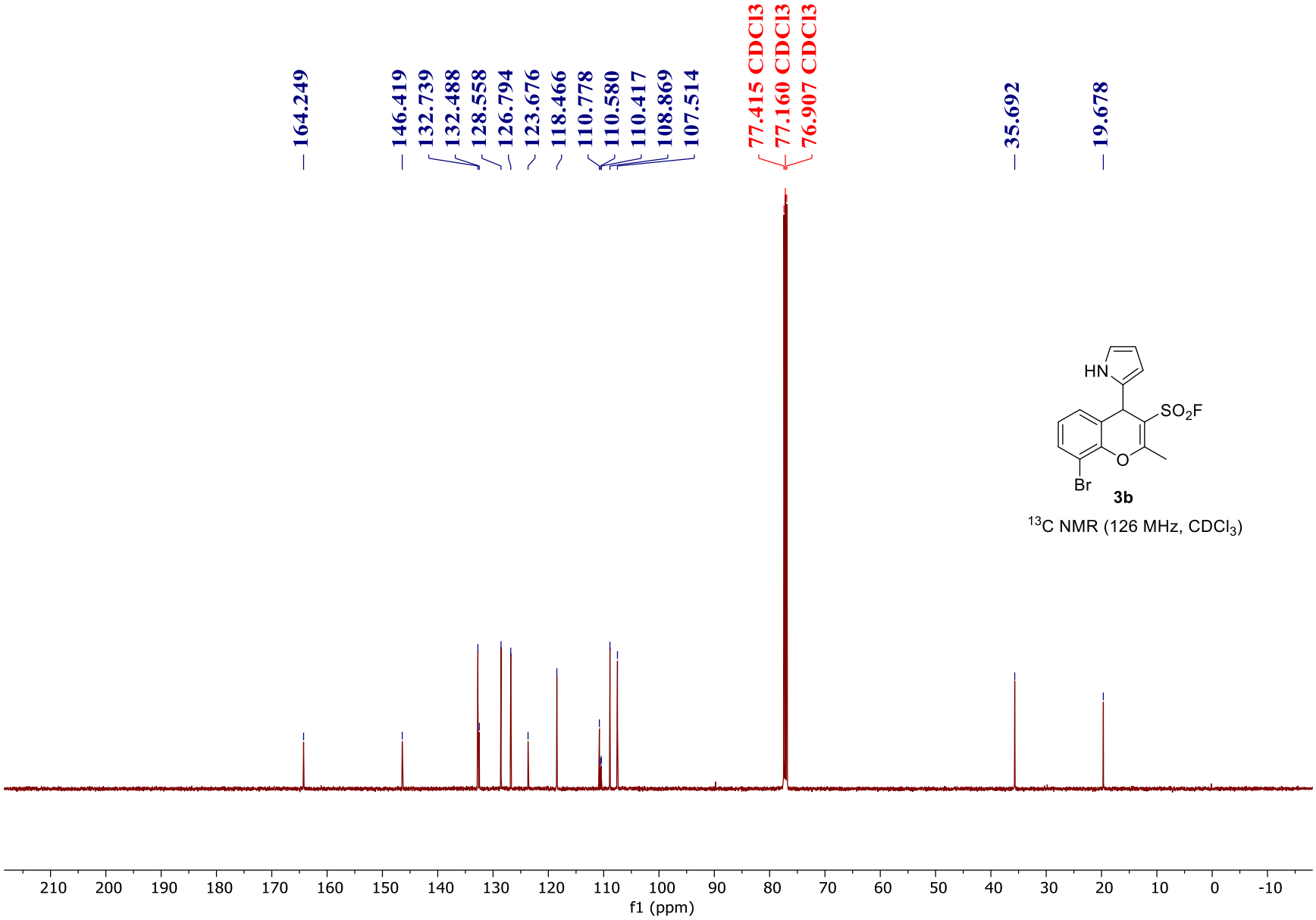

164.453
149.428
133.181
129.455
128.905
126.139
121.792
118.182
116.647
109.721
109.562
108.712
107.240
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
35.219
19.850
HN
SO2F
O
3a
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

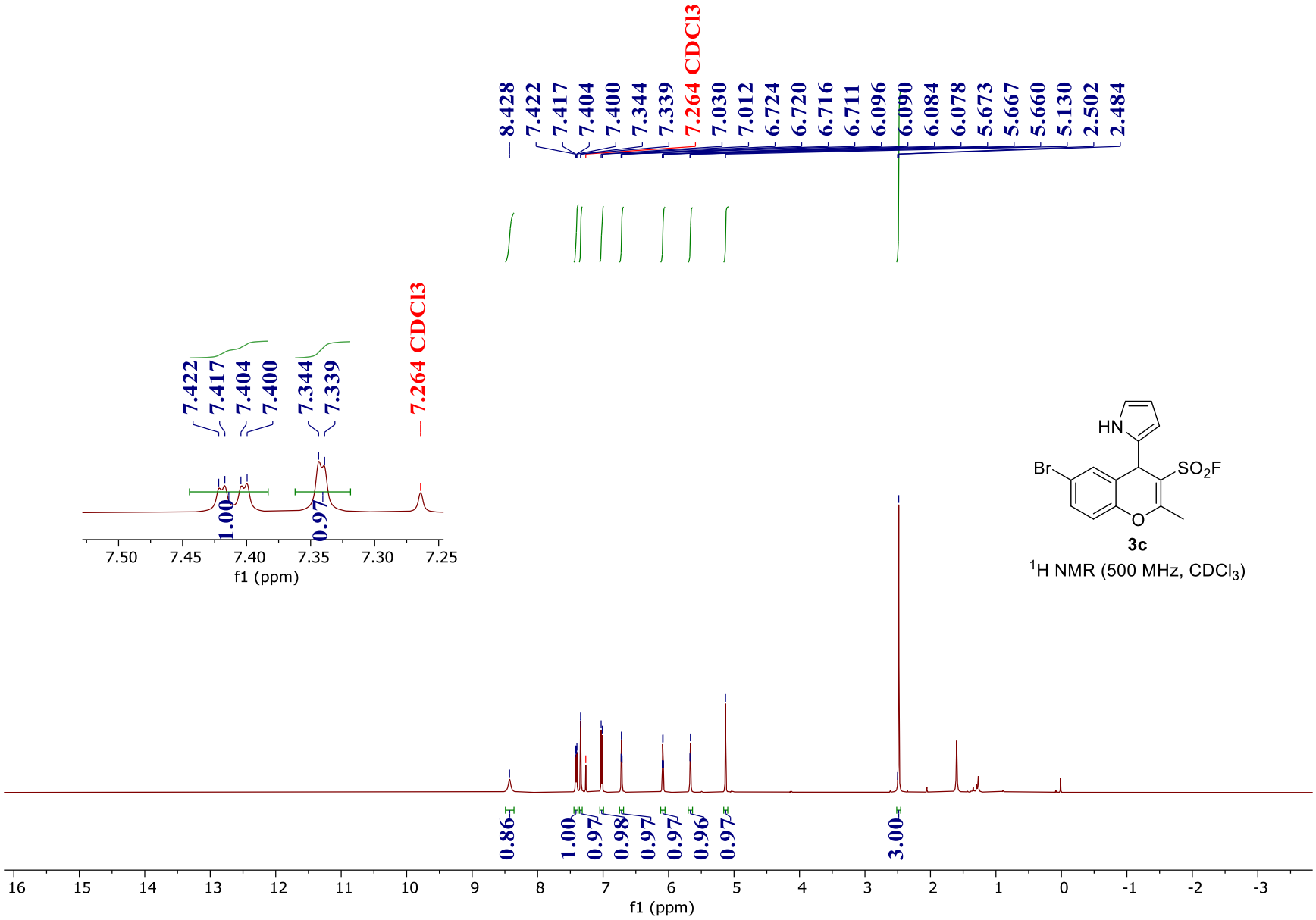

8.405
7.543
7.540
7.527
7.524
7.264 CDCl3
7.165
7.162
7.150
7.147
7.068
7.053
7.037
6.713
6.708
6.704
6.700
6.083
6.077
6.071
6.065
5.684
5.677
5.669
5.186
2.558
HN
SO2F
O
Br
3b
1H NMR (500 MHz, CDCl3)
0.88
1.00
0.96
1.00
0.96
0.97
0.94
0.96
3.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)

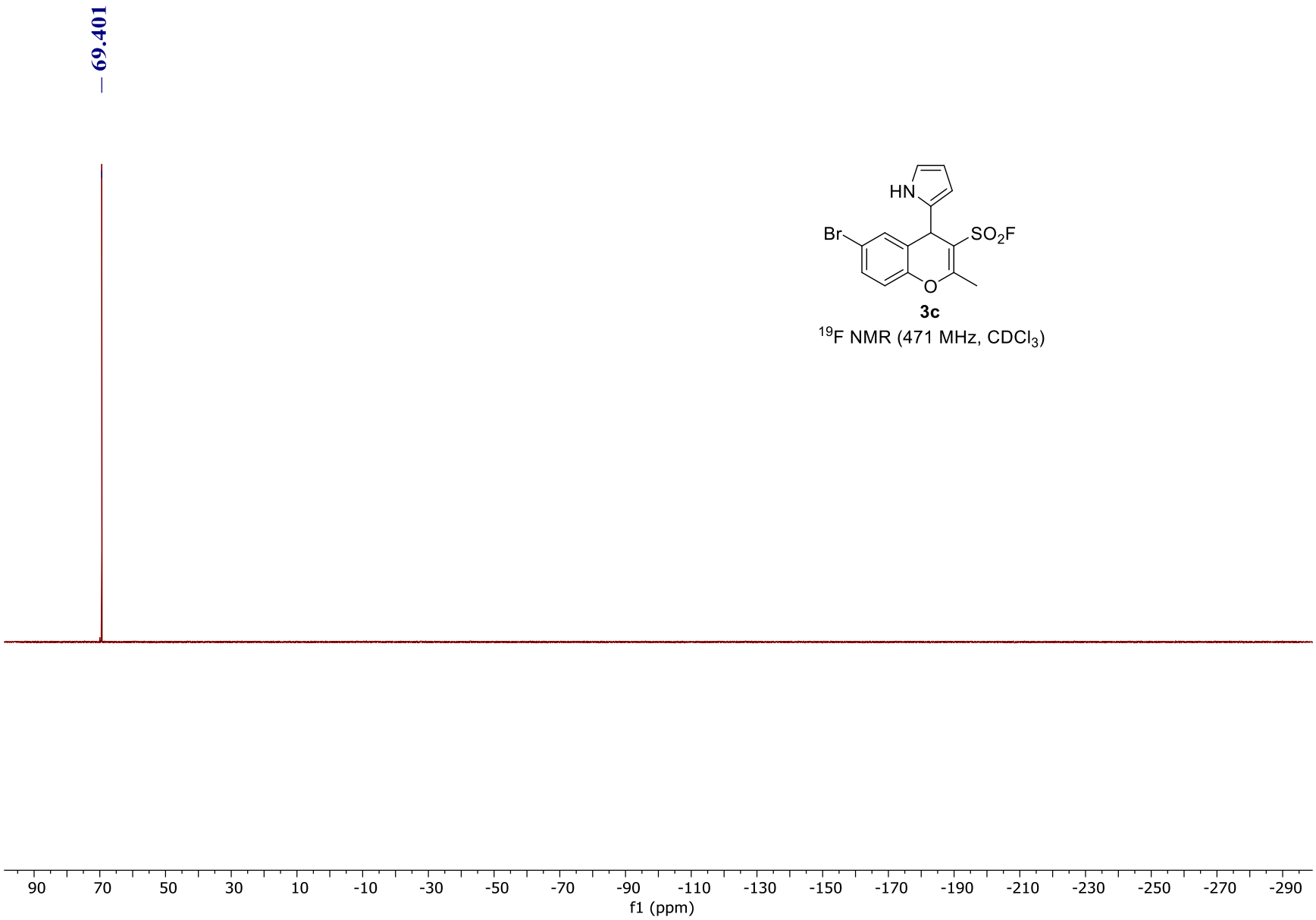


3b

^{19}F NMR (471 MHz, $CDCl_3$)

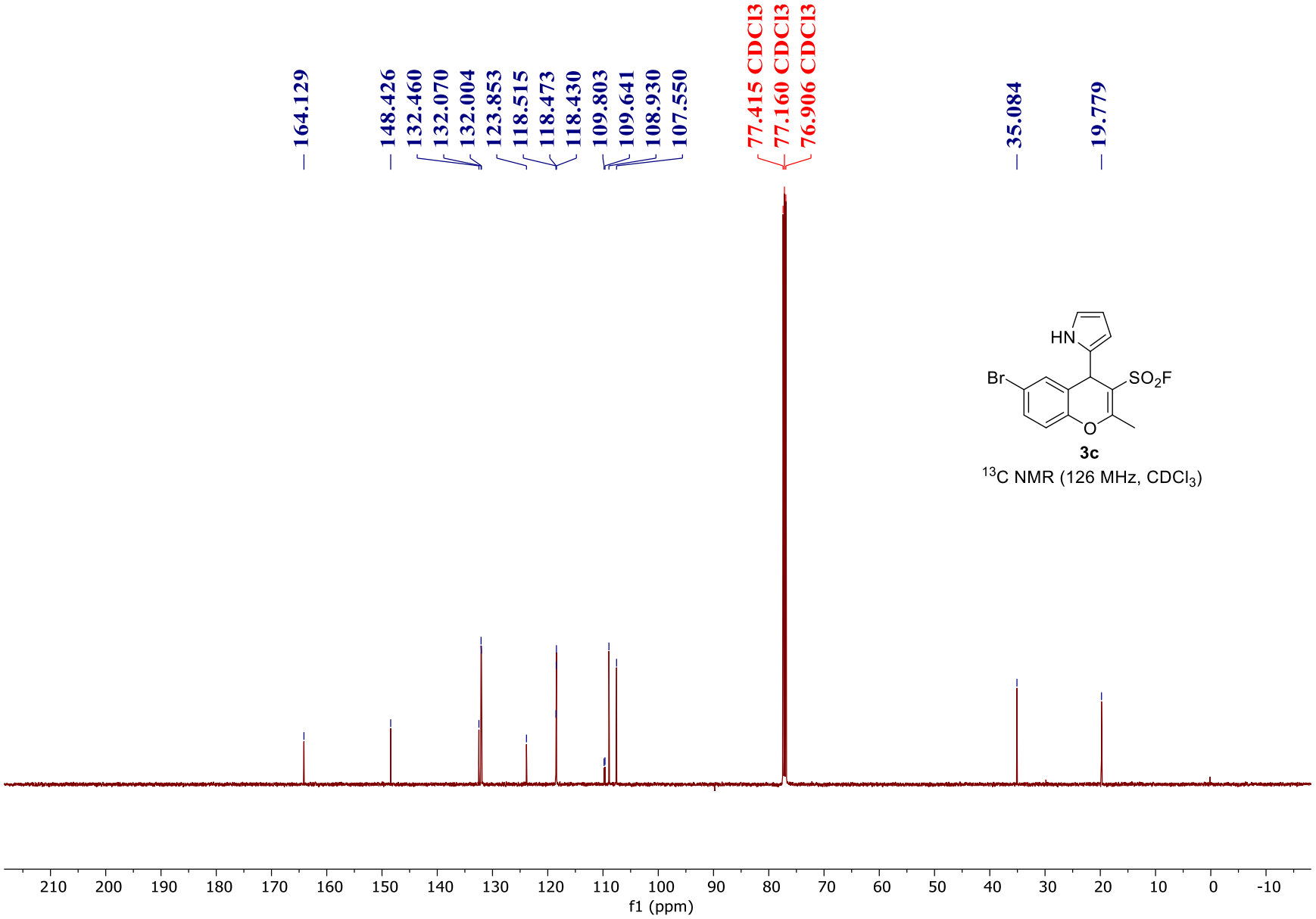

164.249
146.419
132.739
132.488
128.558
126.794
123.676
118.466
110.778
110.580
110.417
108.869
107.514
77.415 CDCl3
77.160 CDCl3
76.907 CDCl3
35.692
19.678
HN
SO2F
O
Br
3b
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

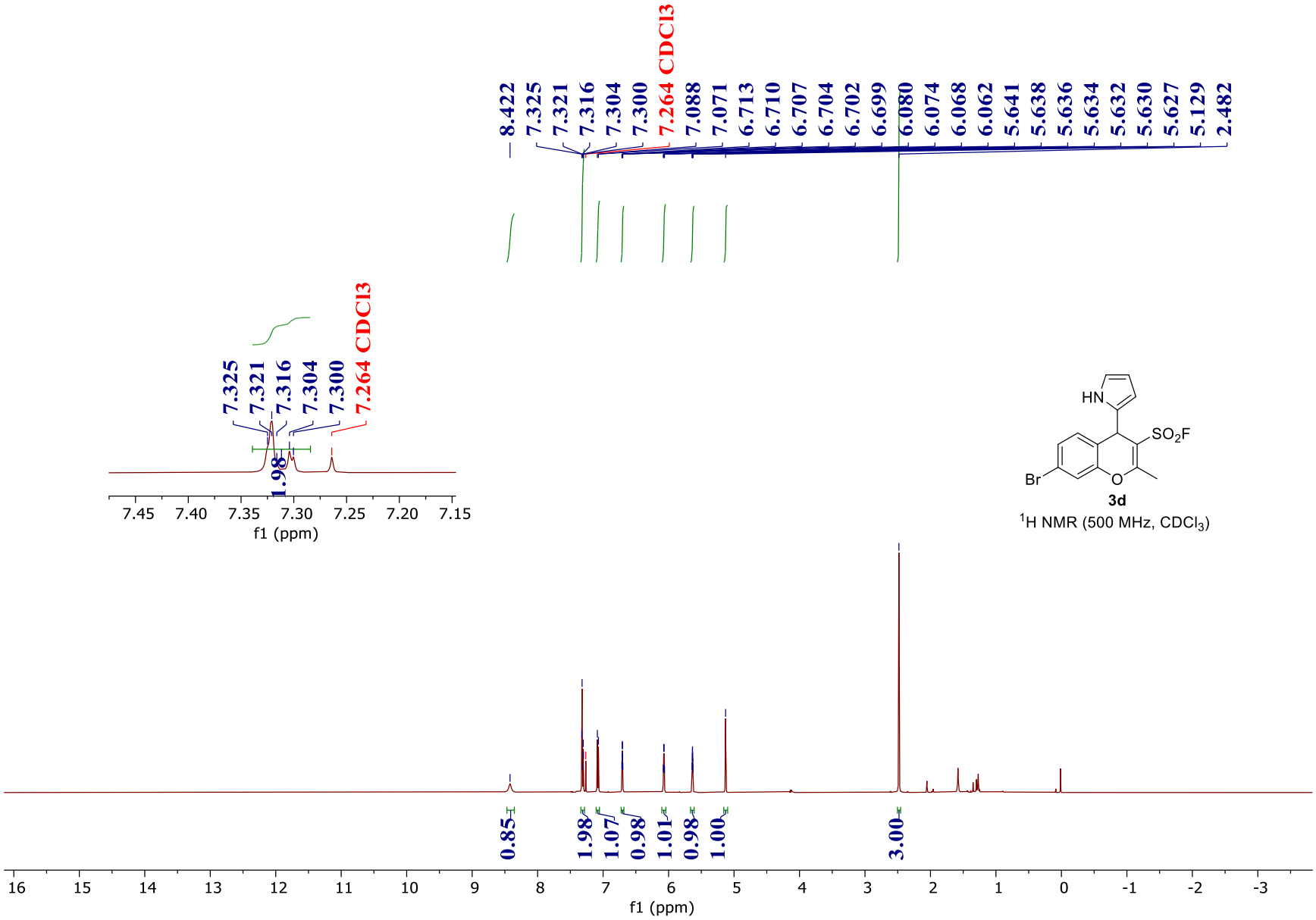

8.428
7.422
7.417
7.404
7.400
7.344
7.339
7.264 CDCl3
7.030
7.012
6.724
6.720
6.716
6.711
6.096
6.090
6.084
6.078
5.673
5.667
5.660
5.130
2.502
2.484
7.422
7.417
7.404
7.400
7.344
7.339
7.264 CDCl3
1.00
0.97
7.50
7.45
7.40
7.35
7.30
7.25
f1 (ppm)
HN
Br
SO2F
O
3c
1H NMR (500 MHz, CDCl3)
0.86
1.00
0.97
0.98
0.97
0.97
0.96
0.97
3.00
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)

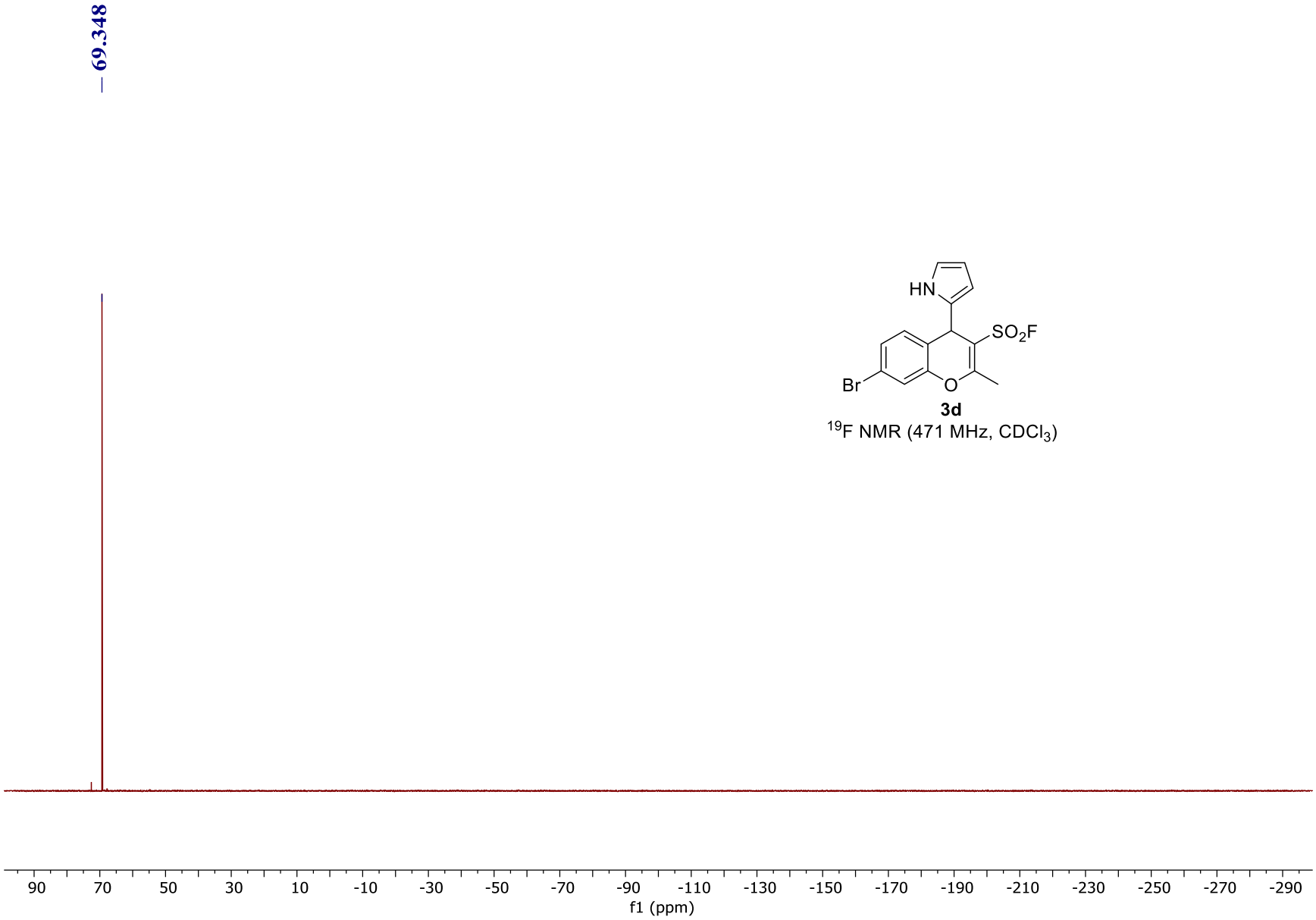


3c

^{19}F NMR (471 MHz, $CDCl_3$)

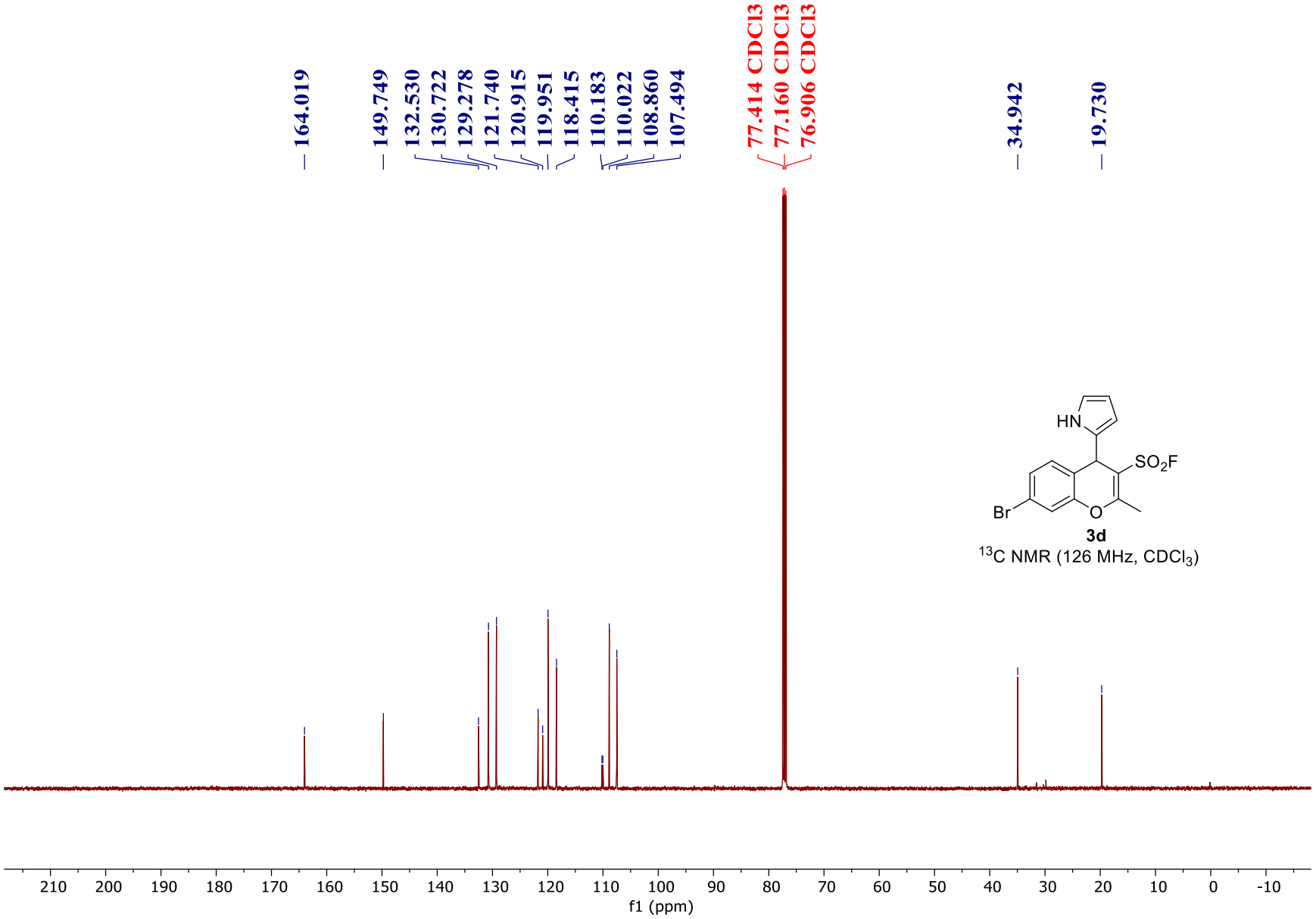

164.129
148.426
132.460
132.070
132.004
123.853
118.515
118.473
118.430
109.803
109.641
108.930
107.550
77.415 CDCl3
77.160 CDCl3
76.906 CDCl3
35.084
19.779
HN
Br
SO2F
O
3c
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

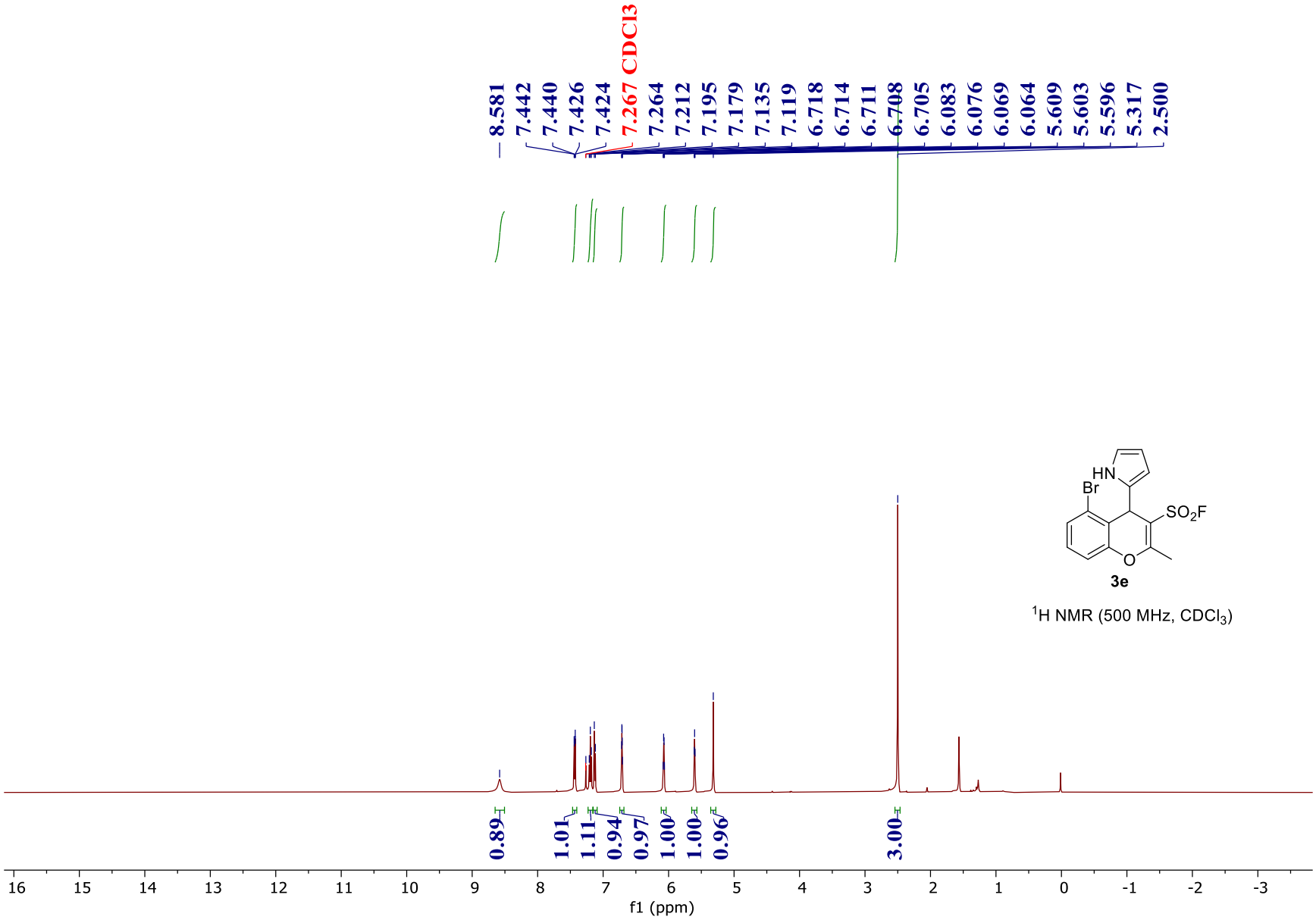

8.422
7.325
7.321
7.316
7.304
7.300
7.264 CDCl3
7.088
7.071
6.713
6.710
6.707
6.704
6.702
6.699
6.080
6.074
6.068
6.062
5.641
5.638
5.636
5.634
5.632
5.630
5.627
5.129
2.482
7.325
7.321
7.316
7.304
7.300
7.264 CDCl3
1.98
7.45 7.40 7.35 7.30 7.25 7.20 7.15
f1 (ppm)
HN
SO2F
Br
O
3d
1H NMR (500 MHz, CDCl3)
0.85
1.98
1.07
0.98
1.01
0.98
1.00
3.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)

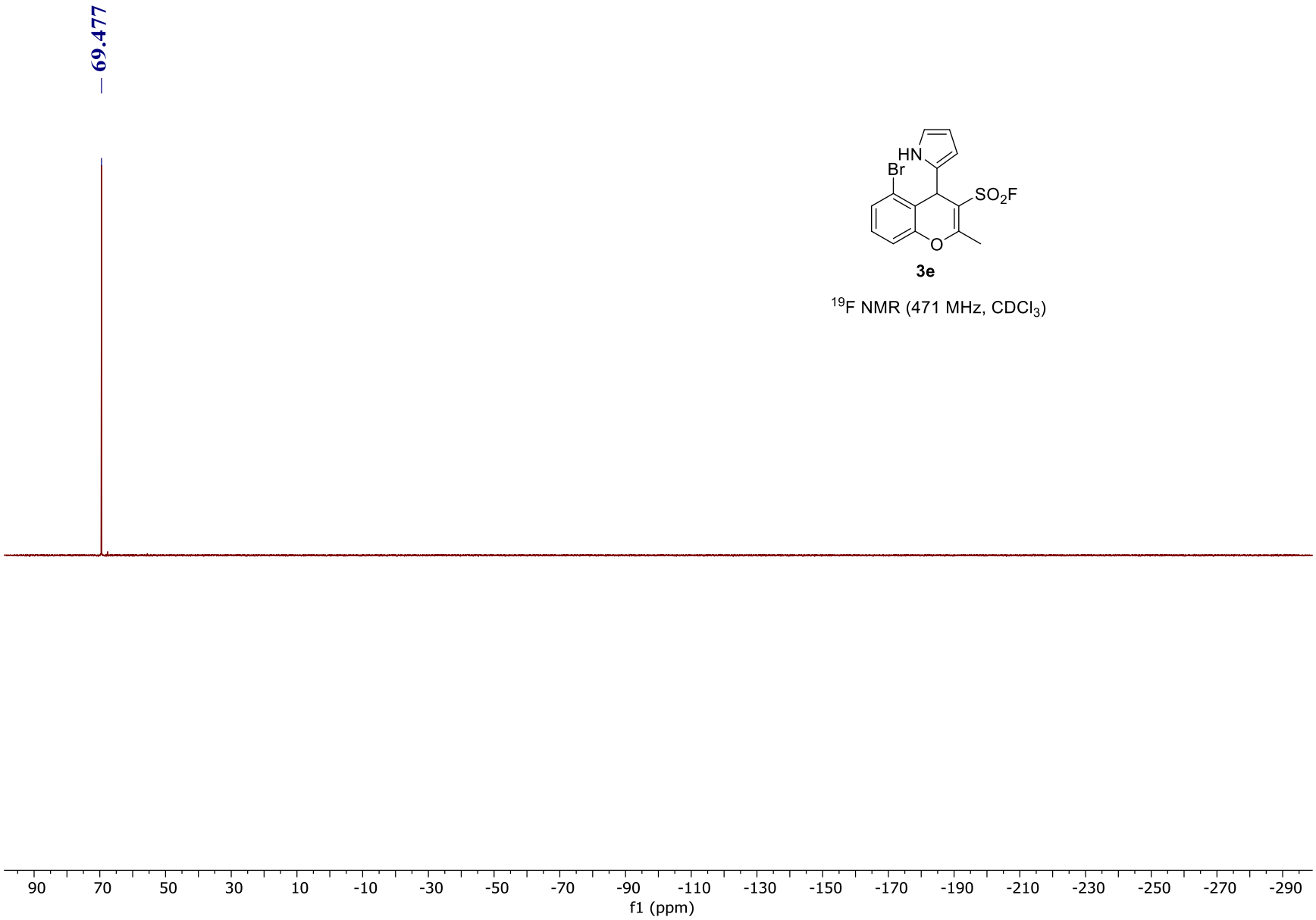


3d

^{19}F NMR (471 MHz, $CDCl_3$)

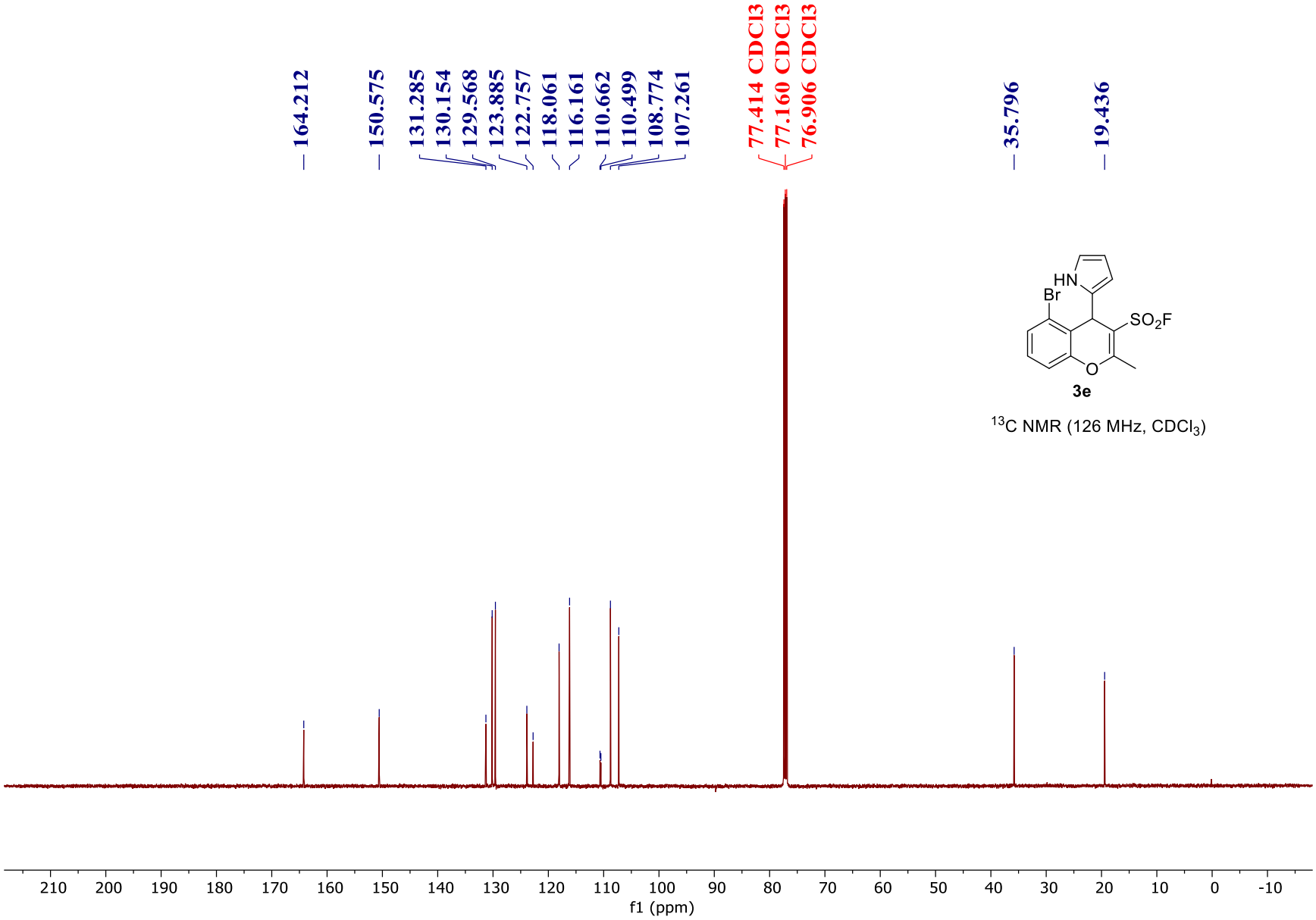

164.019
149.749
132.530
130.722
129.278
121.740
120.915
119.951
118.415
110.183
110.022
108.860
107.494
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
34.942
19.730
HN
SO2F
Br
O
3d
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

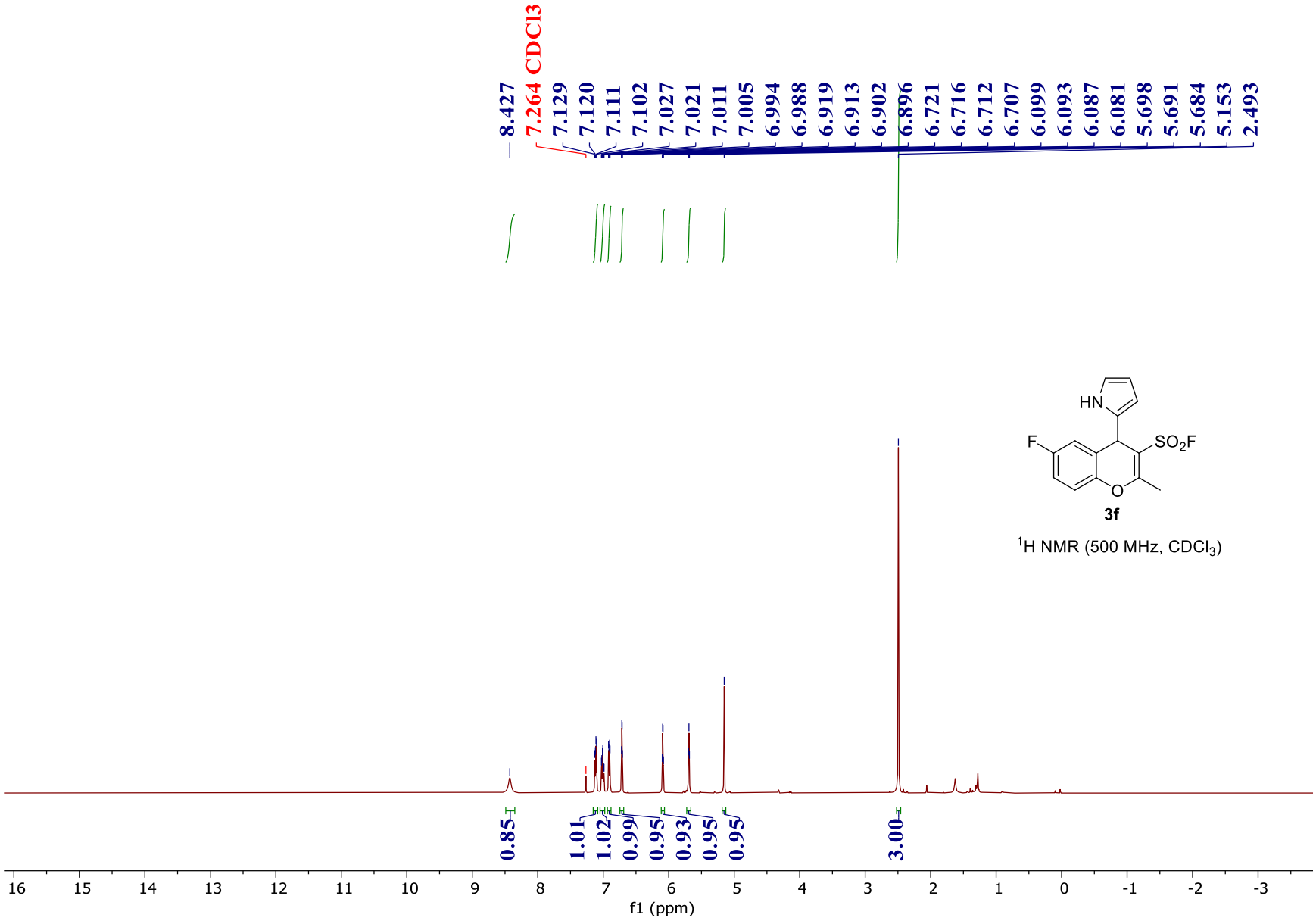

8.581
7.442
7.440
7.426
7.424
7.267 CDCl3
7.264
7.212
7.195
7.179
7.135
7.119
6.718
6.714
6.711
6.708
6.705
6.083
6.076
6.069
6.064
5.609
5.603
5.596
5.317
2.500
HN
Br
SO2F
O
3e
1H NMR (500 MHz, CDCl3)
0.89
1.01
1.11
0.94
0.97
1.00
1.00
0.96
3.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)

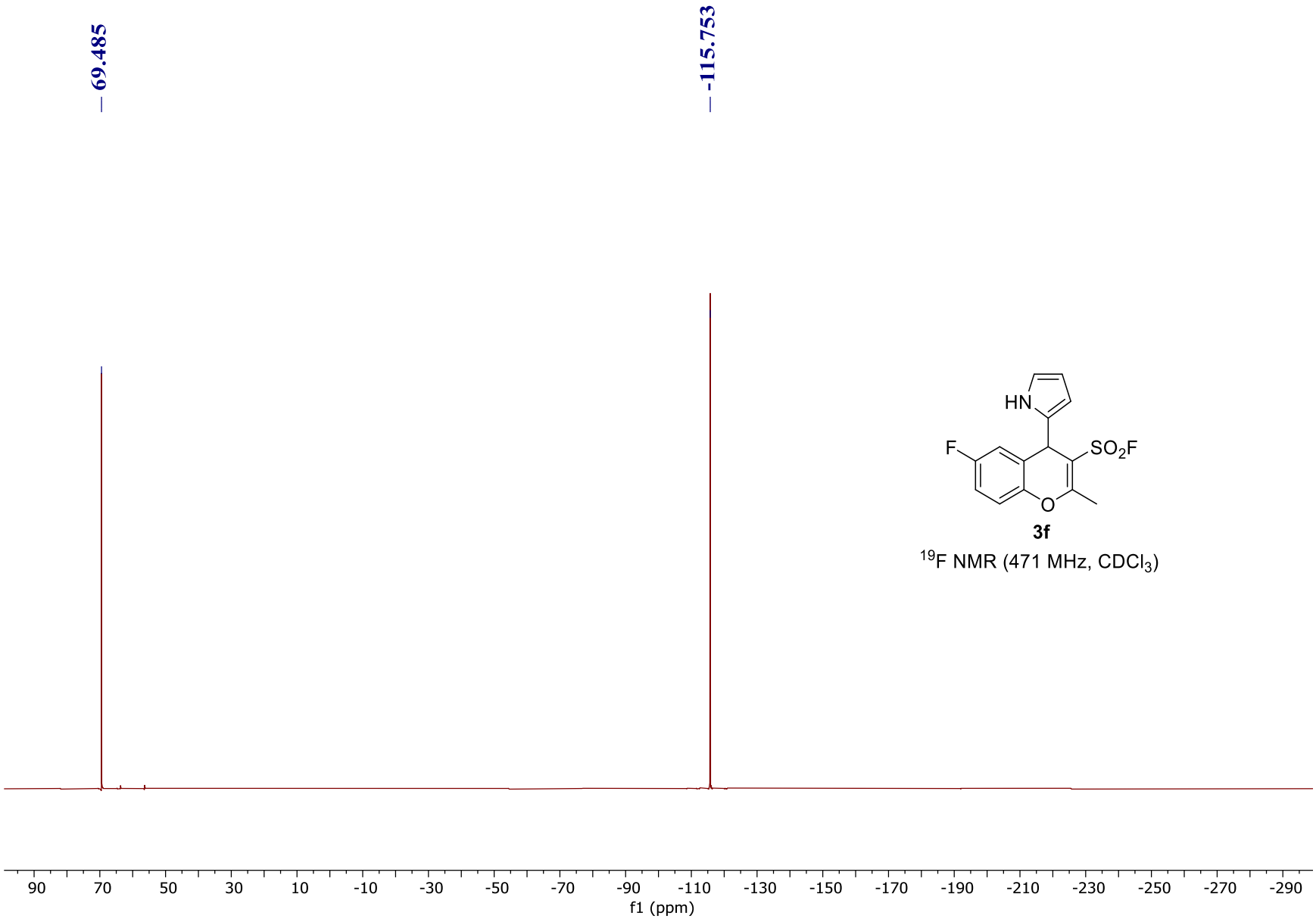


3e

^{19}F NMR (471 MHz, $CDCl_3$)

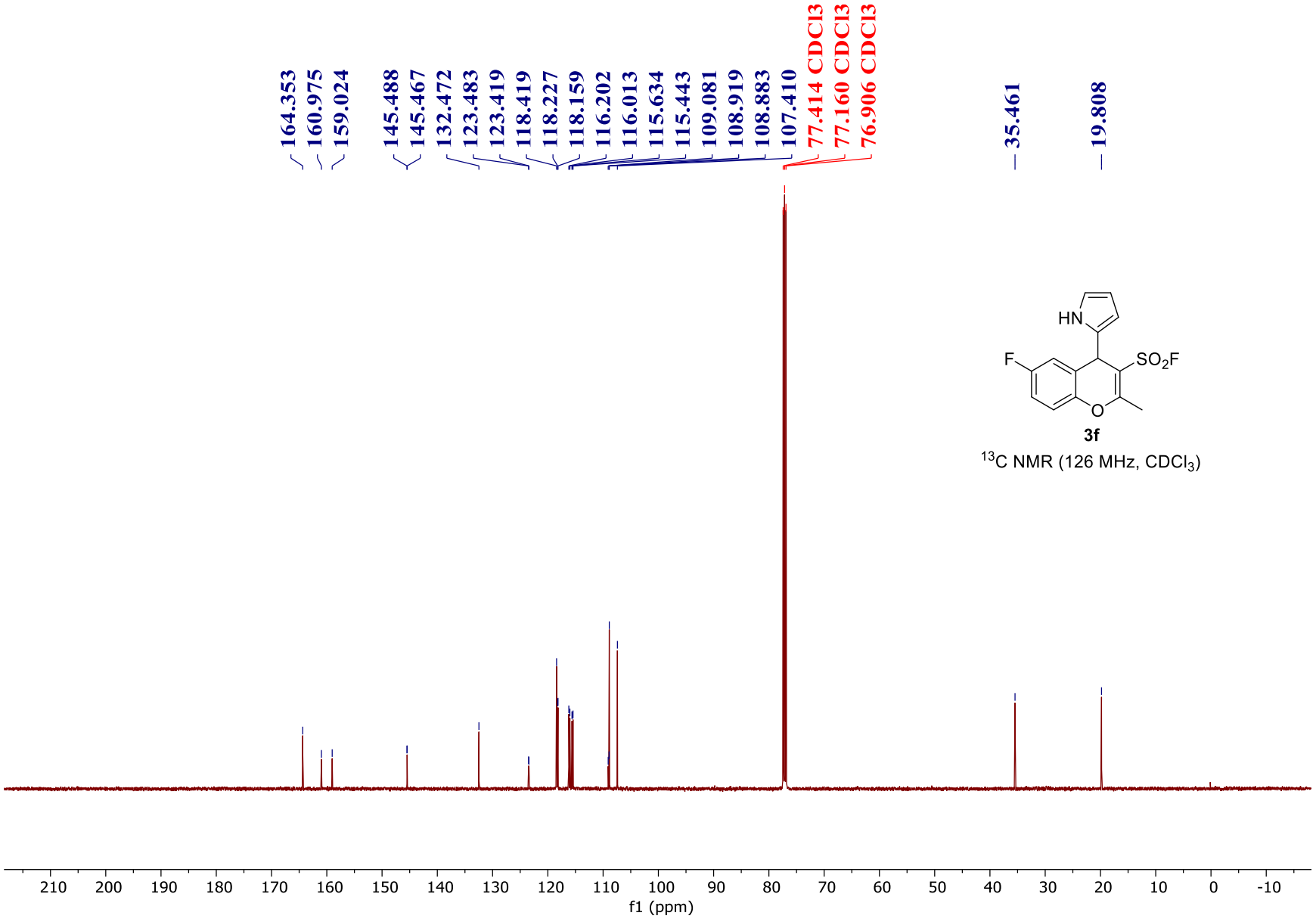

164.212
150.575
131.285
130.154
129.568
123.885
122.757
118.061
116.161
110.662
110.499
108.774
107.261
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
35.796
19.436
HN
Br
SO2F
O
3e
13C NMR (126 MHz, CDCl3)
f1 (ppm)

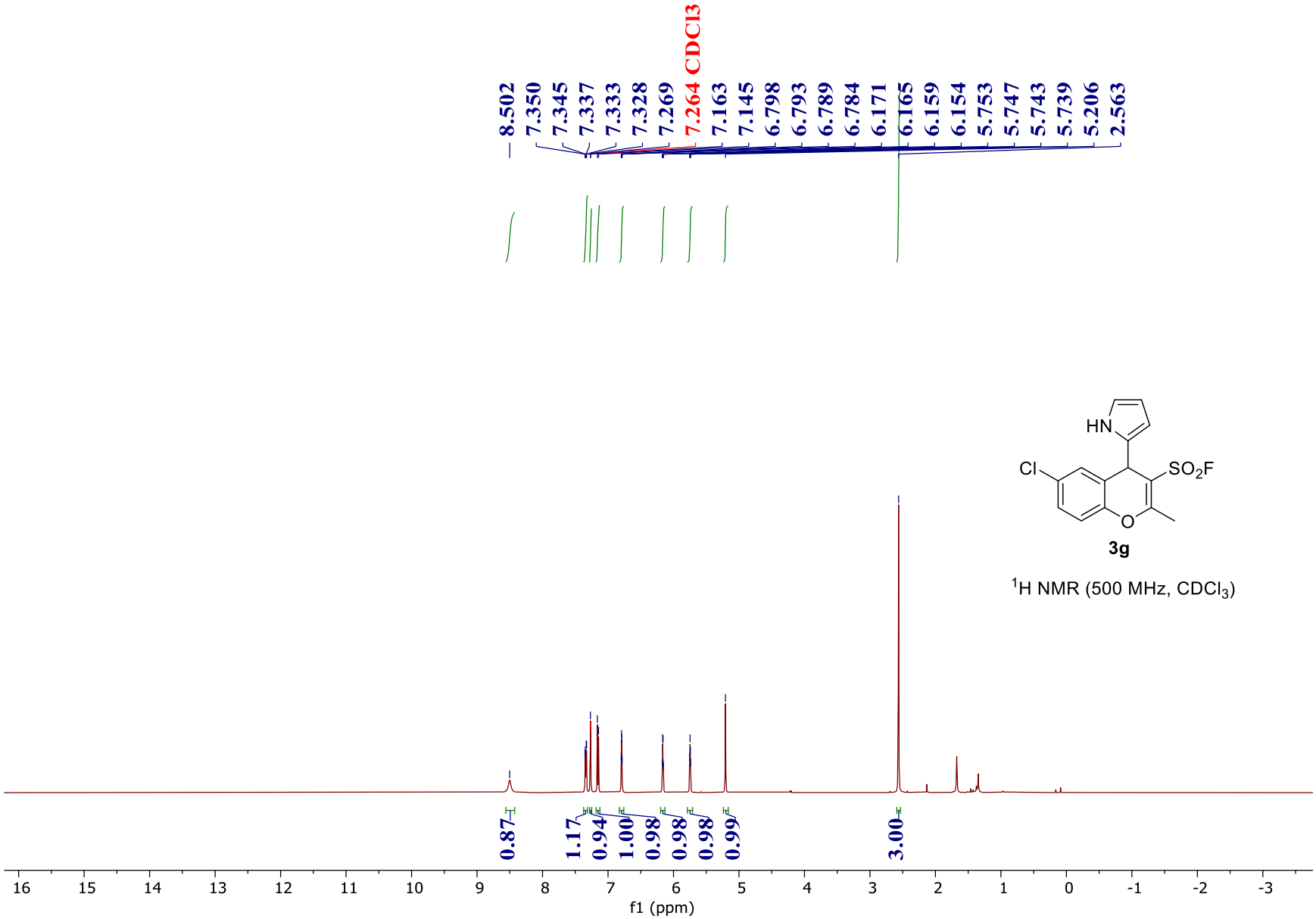

8.427
7.264 CDCl3
7.129
7.120
7.111
7.102
7.027
7.021
7.011
7.005
6.994
6.988
6.919
6.913
6.902
6.896
6.721
6.716
6.712
6.707
6.099
6.093
6.087
6.081
5.698
5.691
5.684
5.153
2.493
HN
F
SO2F
O
3f
1H NMR (500 MHz, CDCl3)
0.85
1.01
1.02
0.99
0.95
0.93
0.95
0.95
3.00
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)

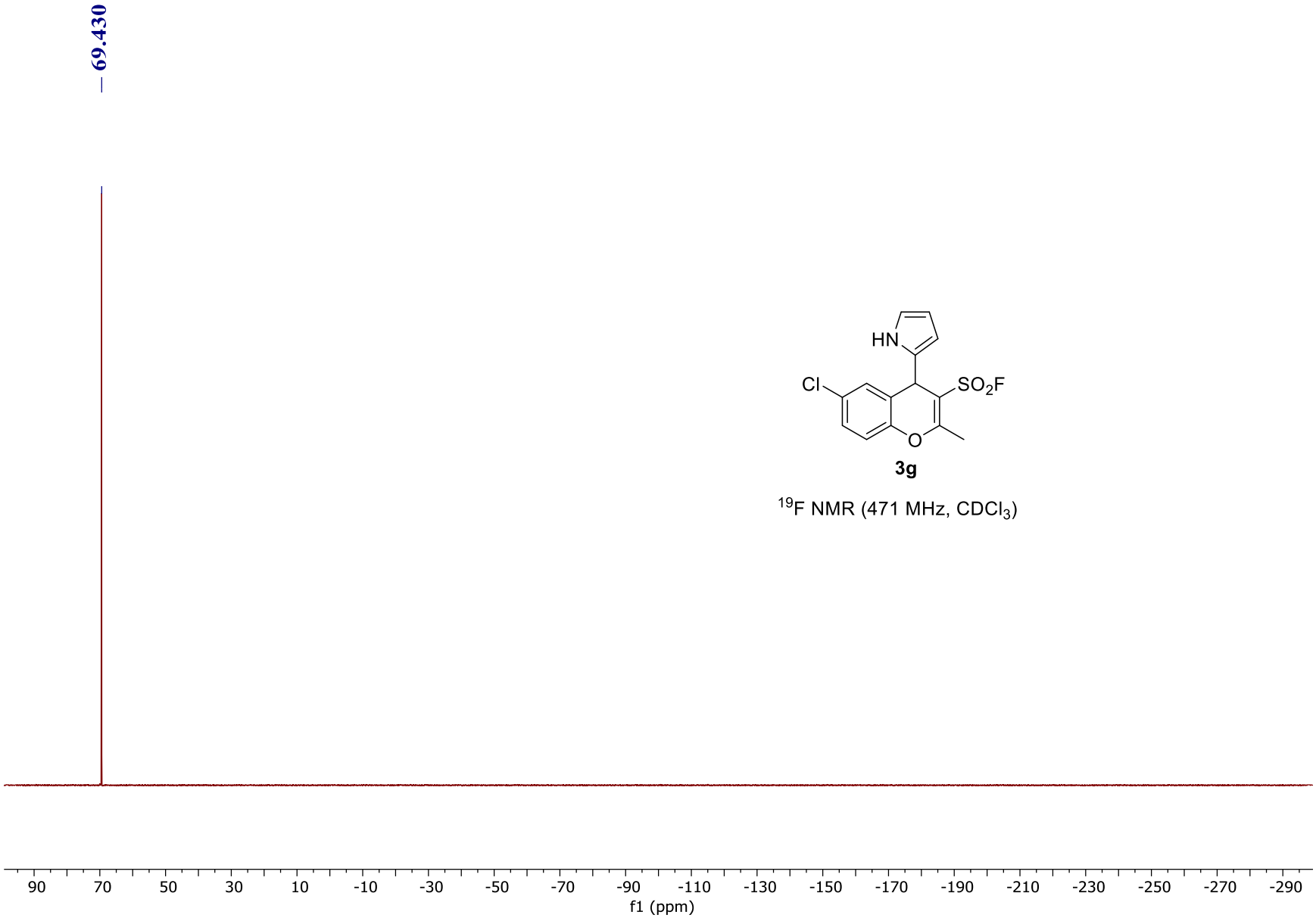


3f

^{19}F NMR (471 MHz, $CDCl_3$)

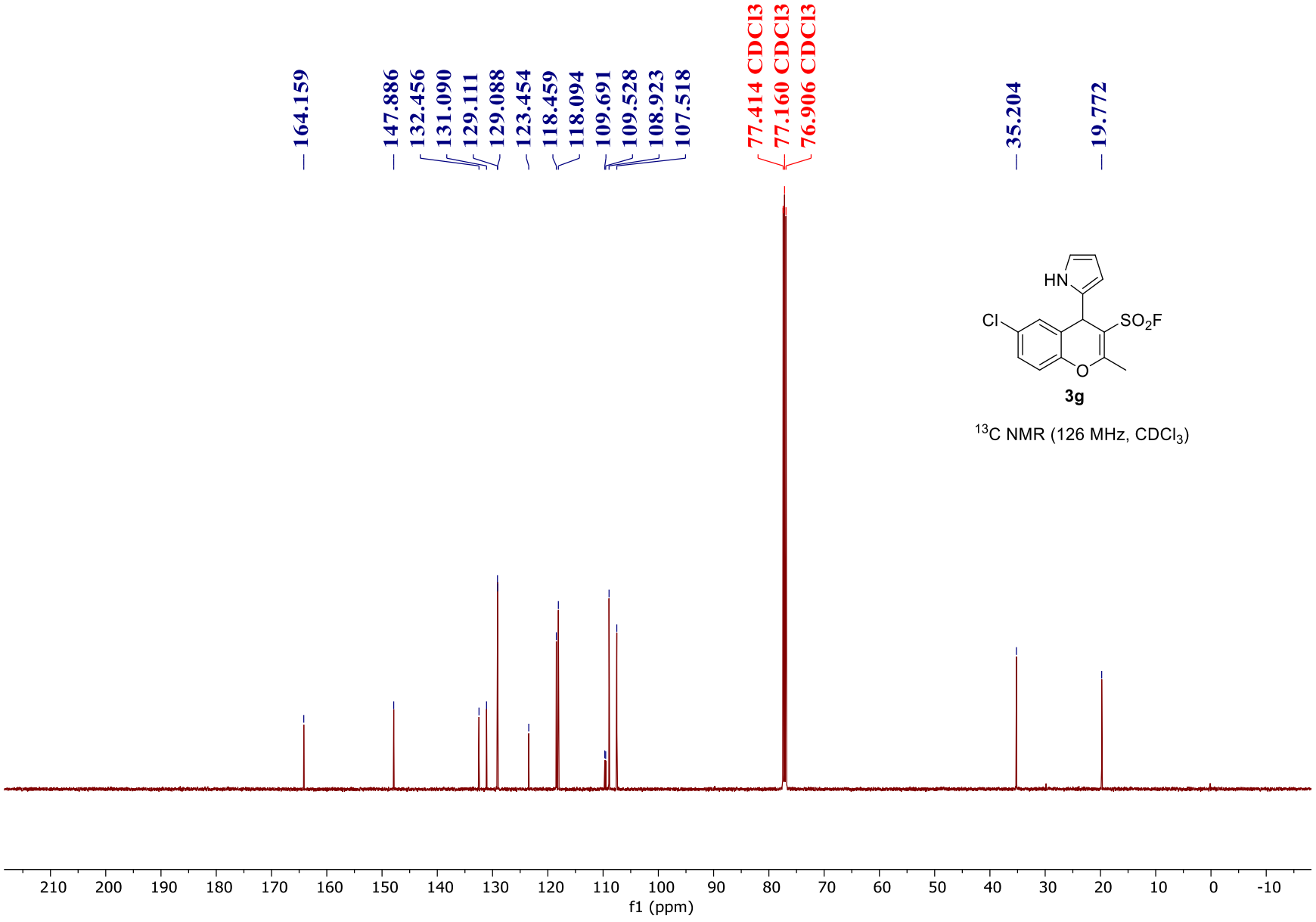

164.353
160.975
159.024
145.488
145.467
132.472
123.483
123.419
118.419
118.227
118.159
116.202
116.013
115.634
115.443
109.081
108.919
108.883
107.410
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
35.461
19.808
HN
F
SO2F
O
3f
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

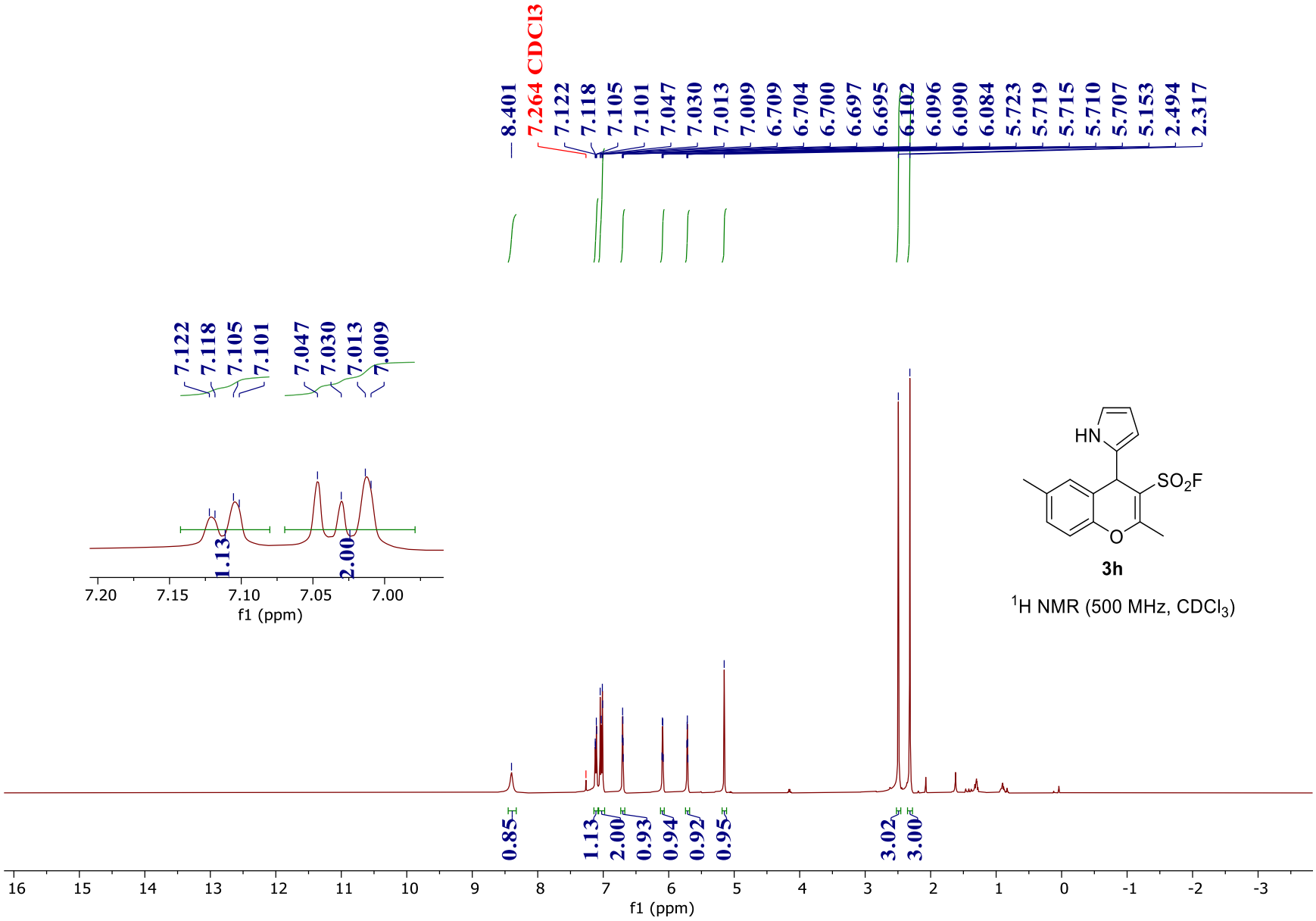

8.502
7.350
7.345
7.337
7.333
7.328
7.269
7.264 CDCl3
7.163
7.145
6.798
6.793
6.789
6.784
6.171
6.165
6.159
6.154
5.753
5.747
5.743
5.739
5.206
2.563
HN
Cl
SO2F
O
3g
1H NMR (500 MHz, CDCl3)
0.87
1.17
0.94
1.00
0.98
0.98
0.98
0.99
3.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)

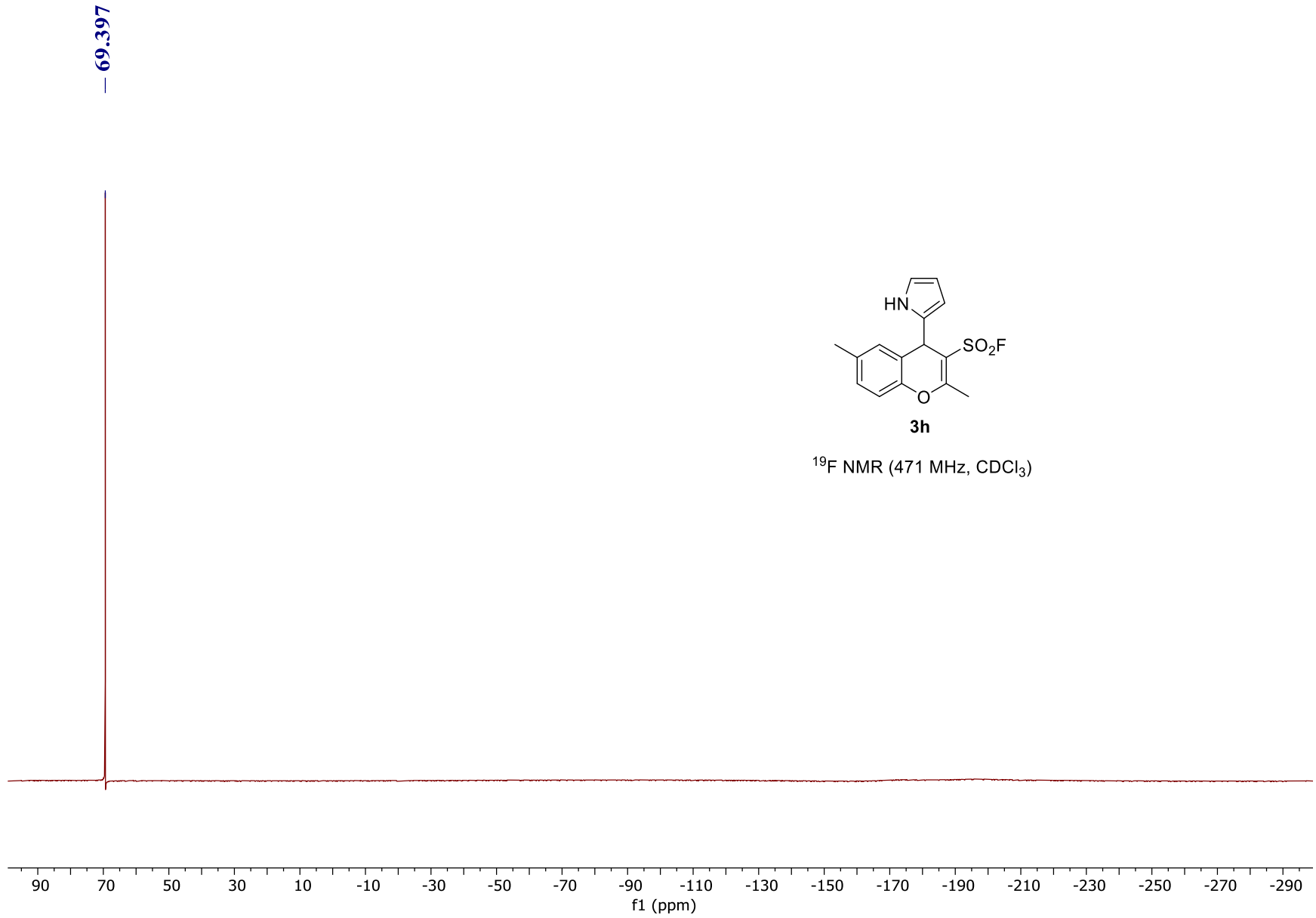


3g

^{19}F NMR (471 MHz, $CDCl_3$)

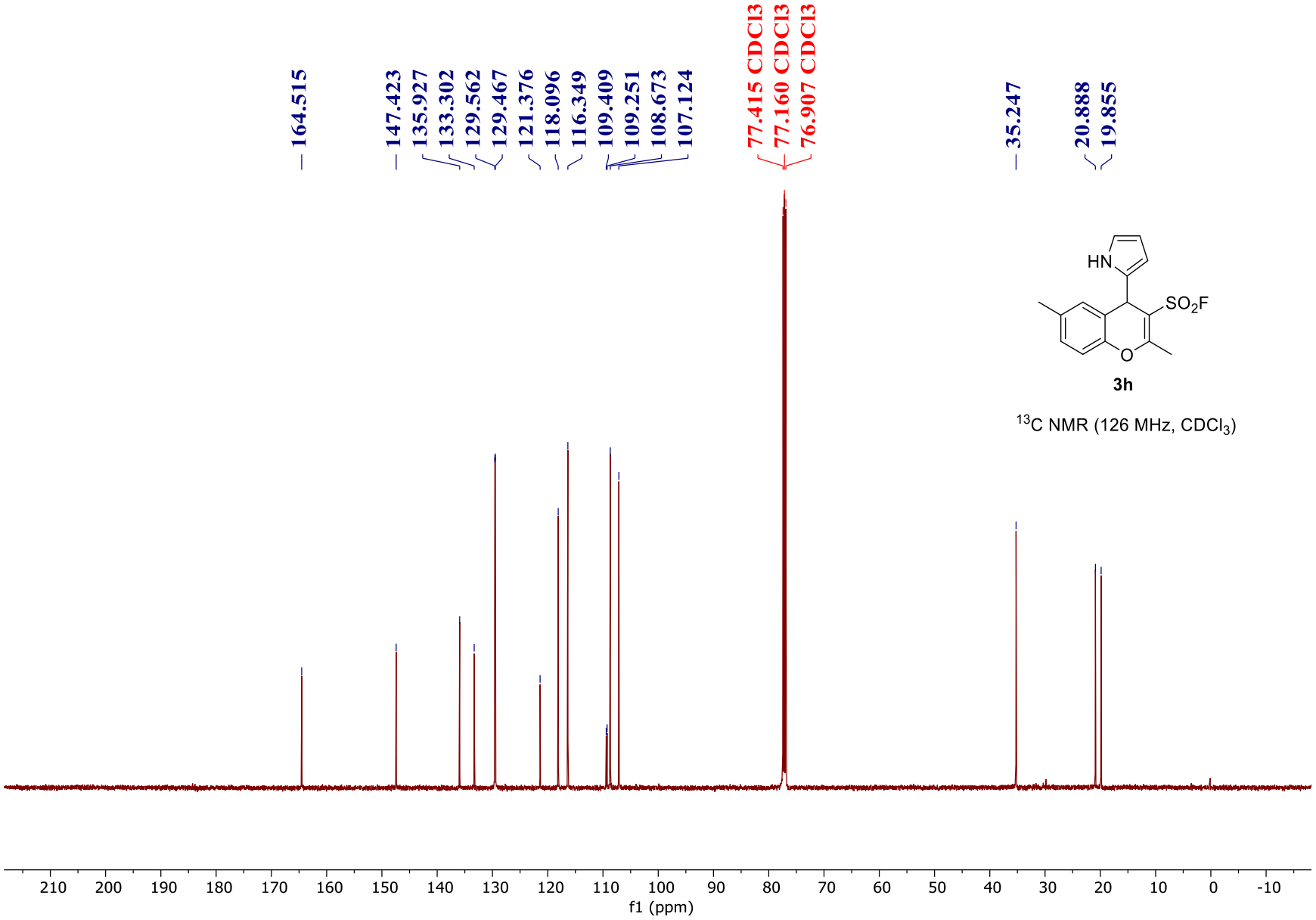

164.159
147.886
132.456
131.090
129.111
129.088
123.454
118.459
118.094
109.691
109.528
108.923
107.518
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
35.204
19.772
HN
Cl
SO2F
O
3g
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

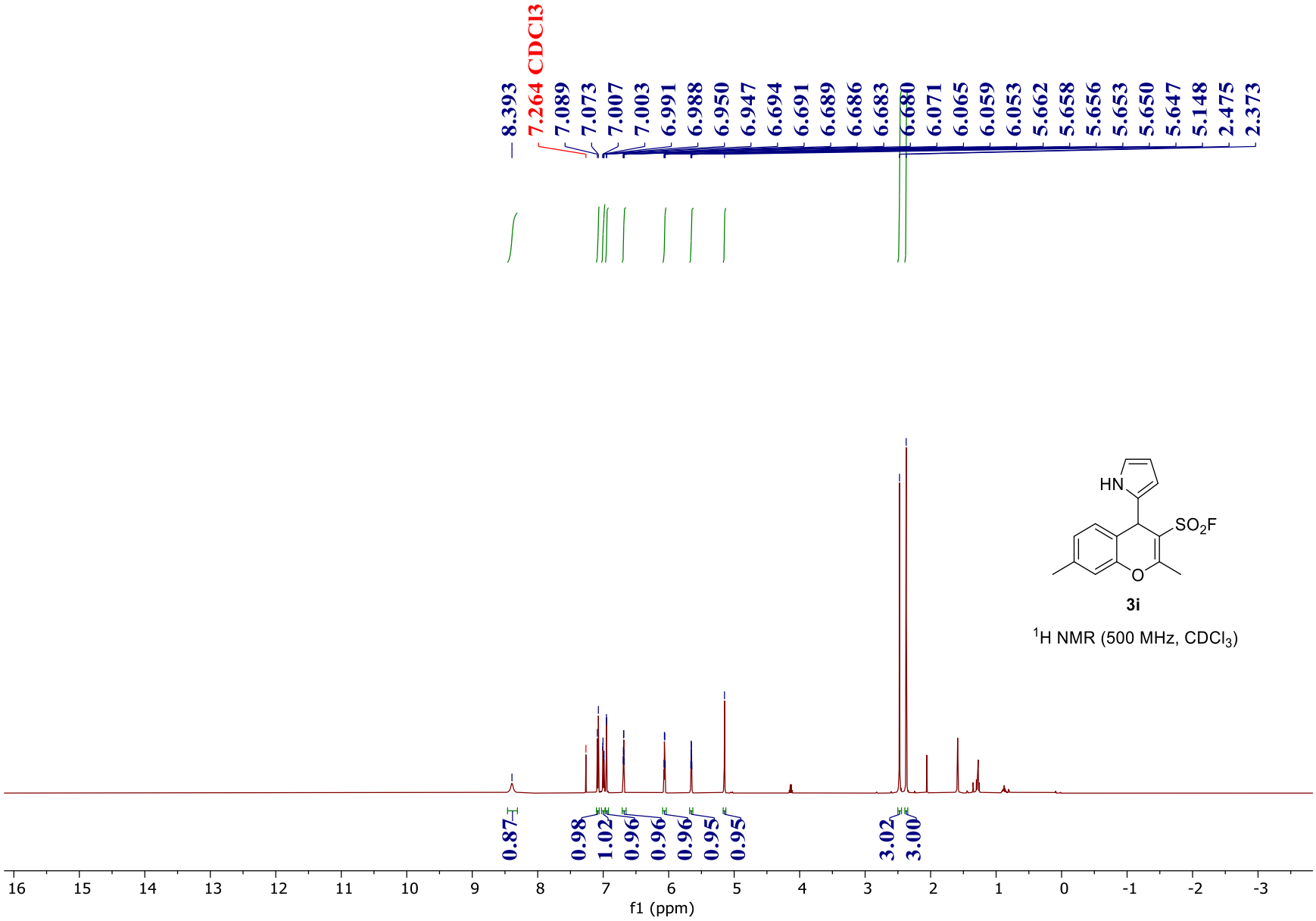

8.401
7.264 CDCl3
7.122
7.118
7.105
7.101
7.047
7.030
7.013
7.009
6.709
6.704
6.700
6.697
6.695
6.102
6.096
6.090
6.084
5.723
5.719
5.715
5.710
5.707
5.153
2.494
2.317
1.13
2.00
7.20
7.15
7.10
7.05
7.00
f1 (ppm)
HN
SO2F
O
3h
1H NMR (500 MHz, CDCl3)
0.85
1.13
2.00
0.93
0.94
0.92
0.95
3.02
3.00
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)

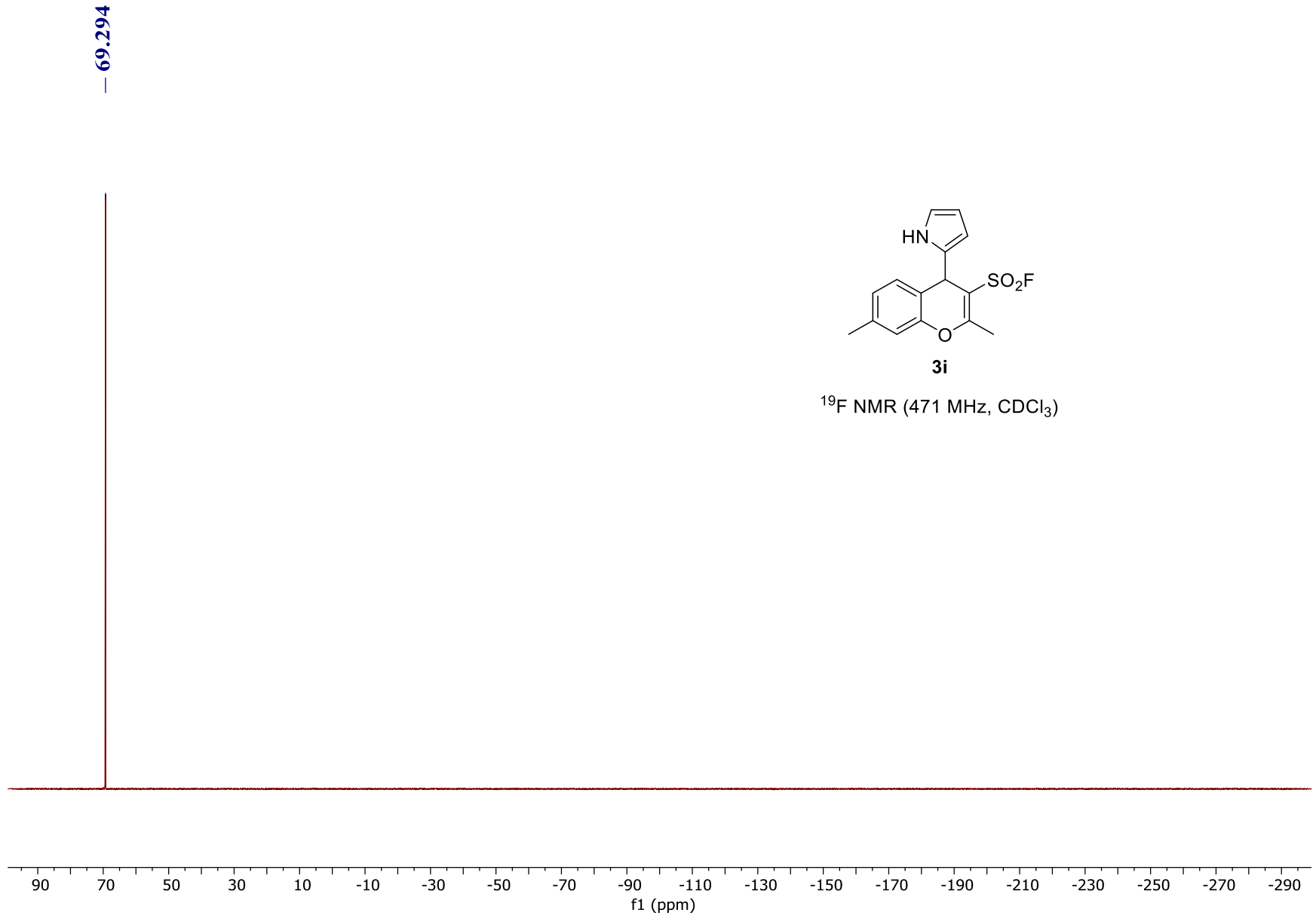


3h

^{19}F NMR (471 MHz, $CDCl_3$)

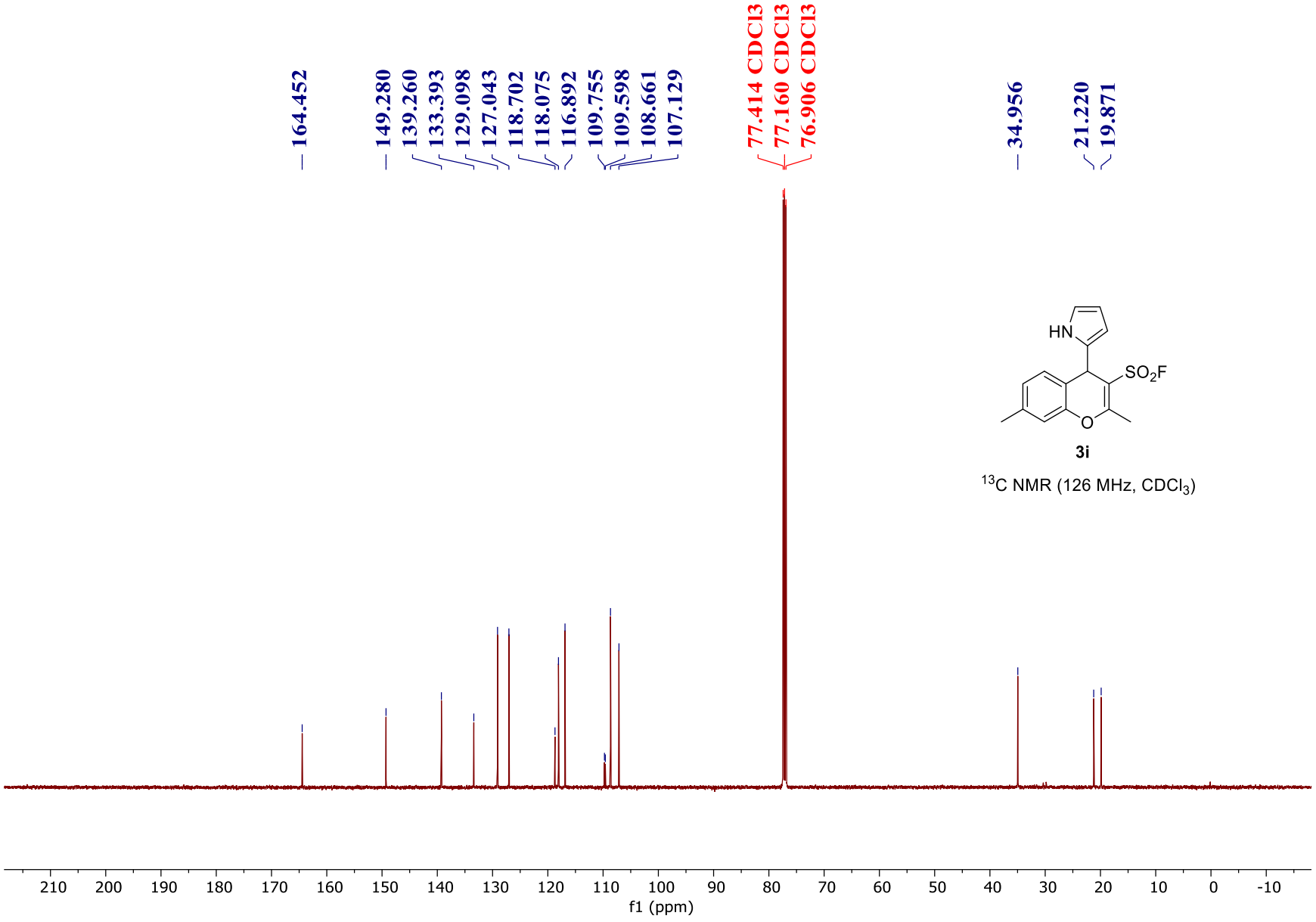

164.515
147.423
135.927
133.302
129.562
129.467
121.376
118.096
116.349
109.409
109.251
108.673
107.124
77.415 CDCl3
77.160 CDCl3
76.907 CDCl3
35.247
20.888
19.855
HN
SO2F
O
3h
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

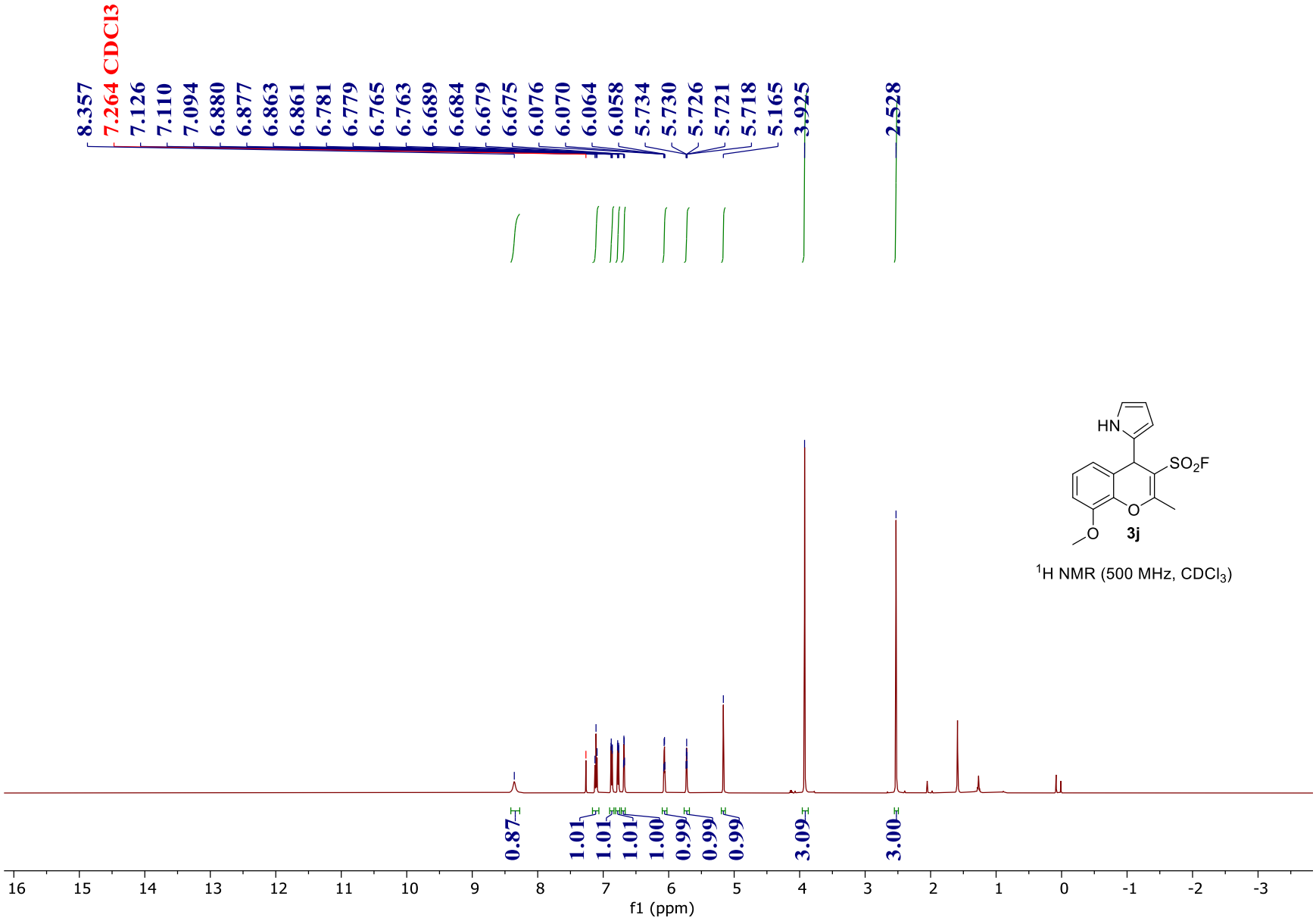

8.393
7.264 CDCl3
7.089
7.073
7.007
7.003
6.991
6.988
6.950
6.947
6.694
6.691
6.689
6.686
6.683
6.680
6.071
6.065
6.059
6.053
5.662
5.658
5.656
5.653
5.650
5.647
5.148
2.475
2.373
HN
SO2F
O
3i
1H NMR (500 MHz, CDCl3)
0.87
0.98
1.02
0.96
0.96
0.96
0.95
0.95
3.02
3.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)

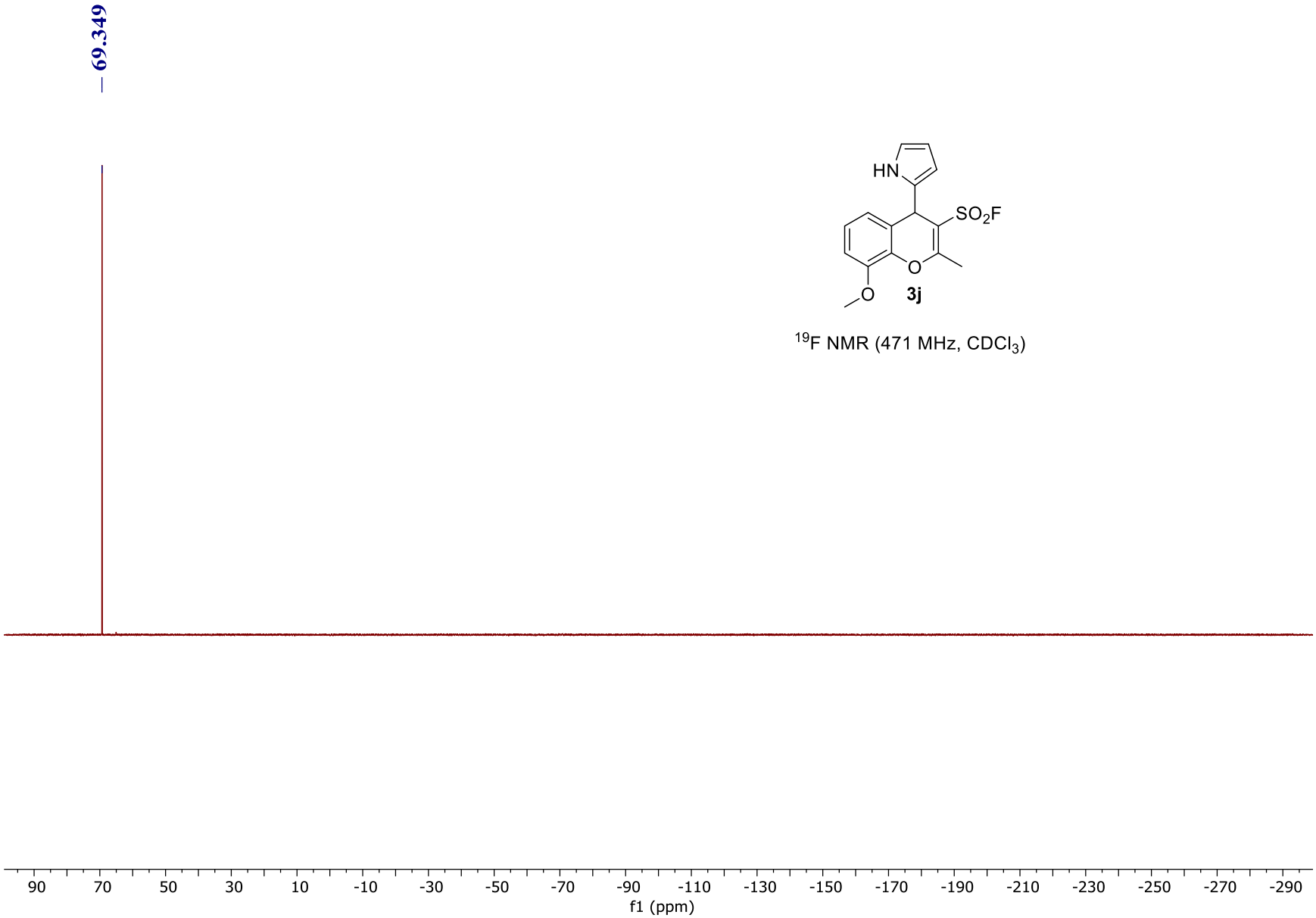


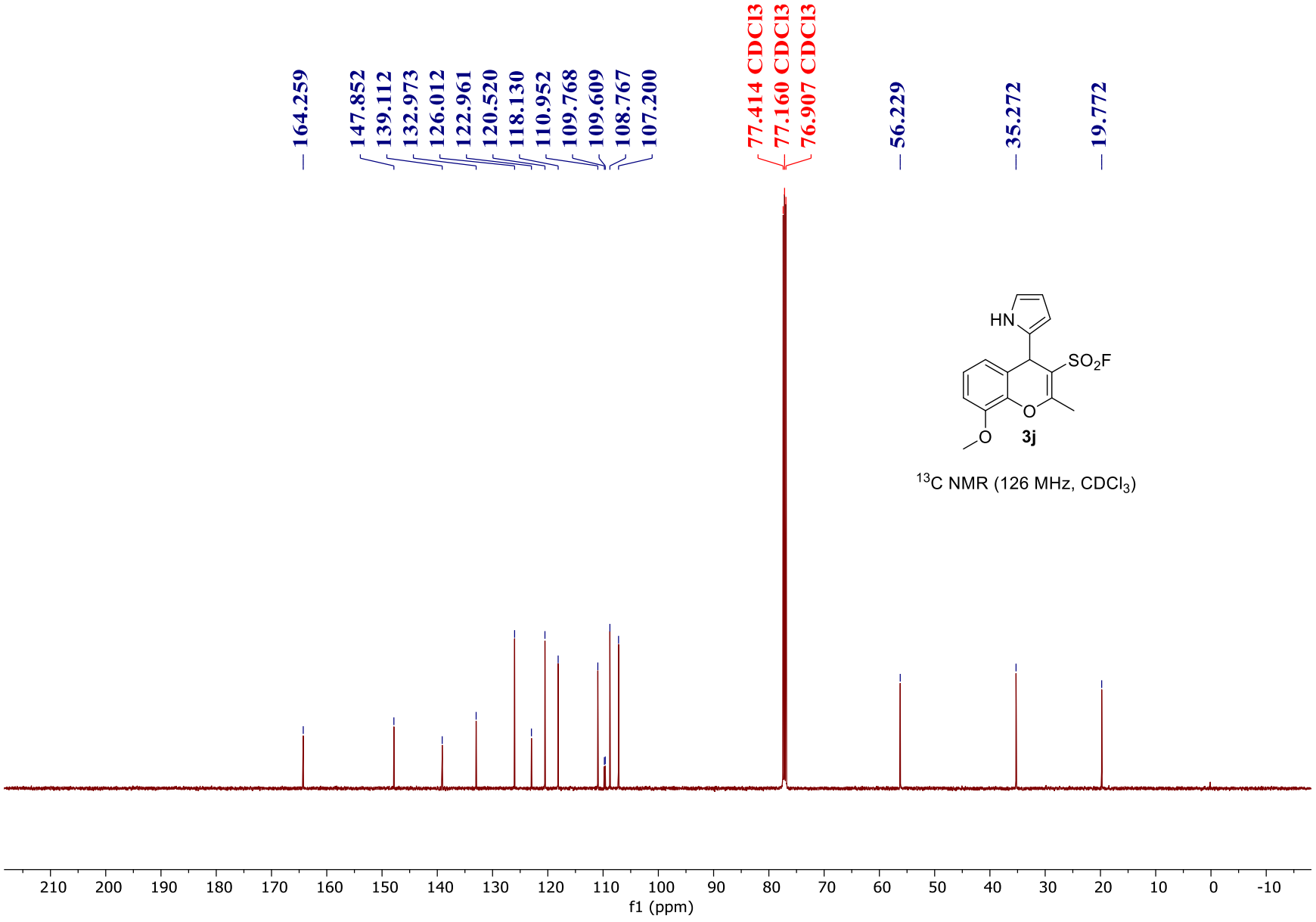
3i

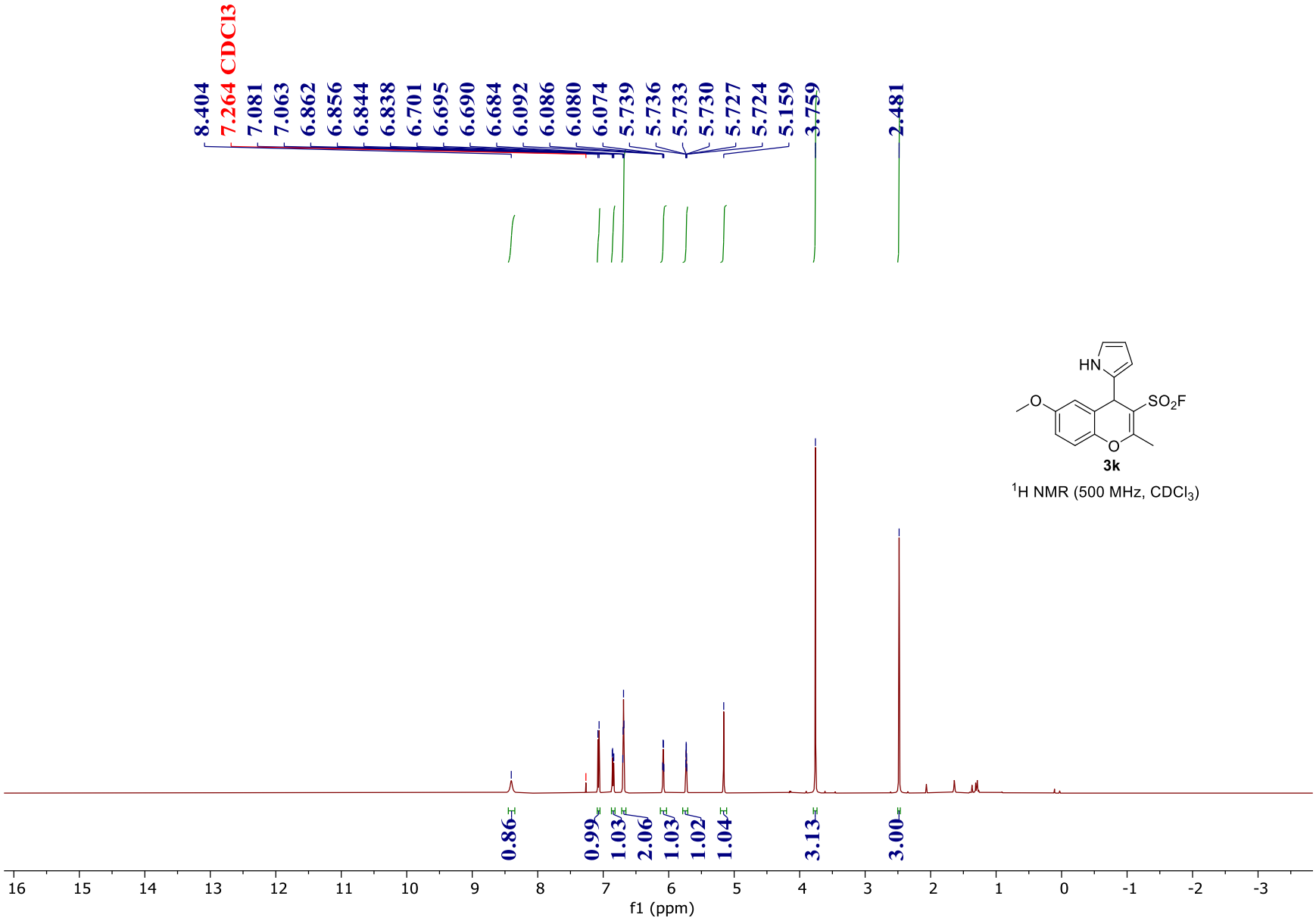
^{19}F NMR (471 MHz, $CDCl_3$)

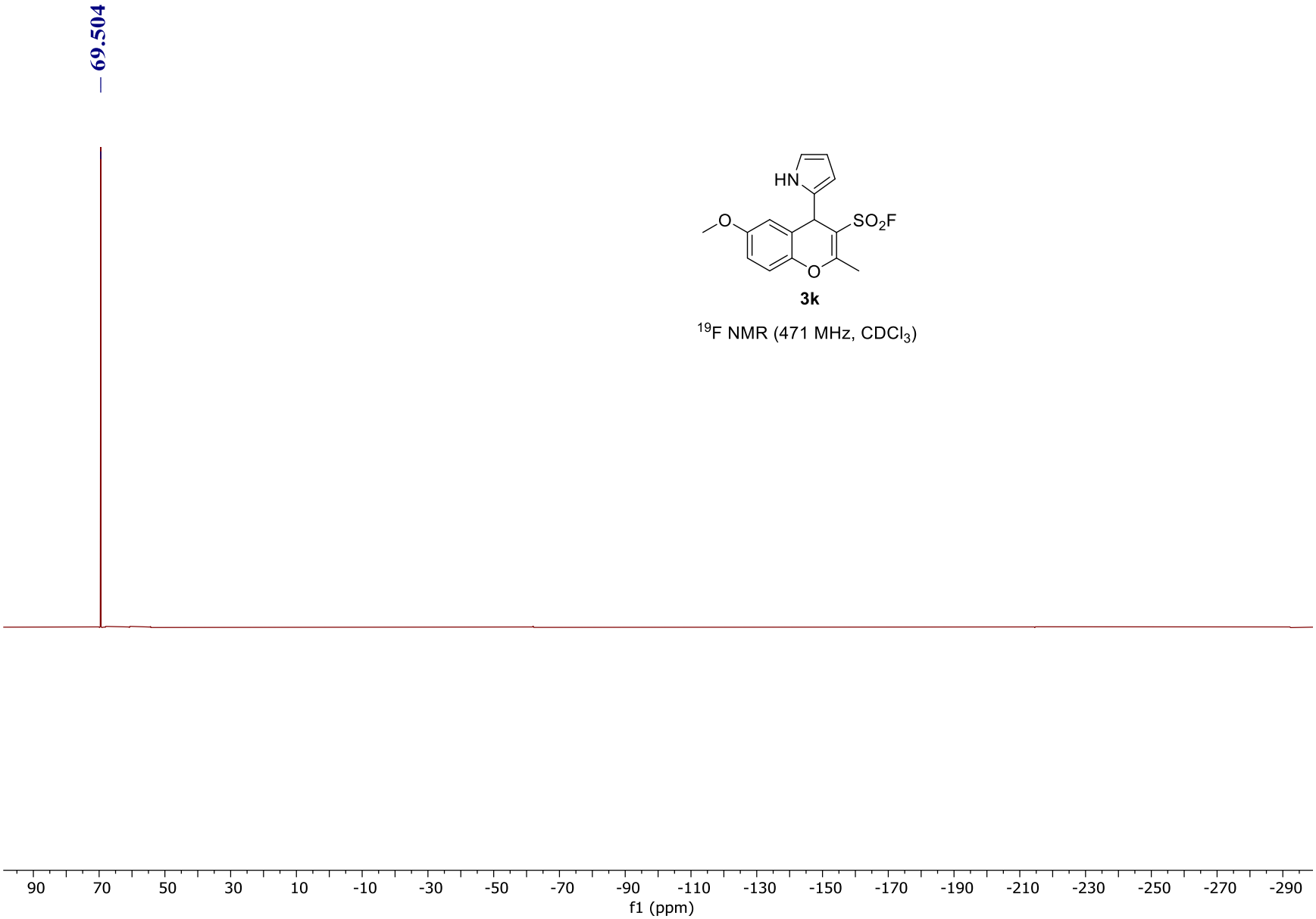

164.452
149.280
139.260
133.393
129.098
127.043
118.702
118.075
116.892
109.755
109.598
108.661
107.129
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
34.956
21.220
19.871
HN
SO2F
O
3i
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

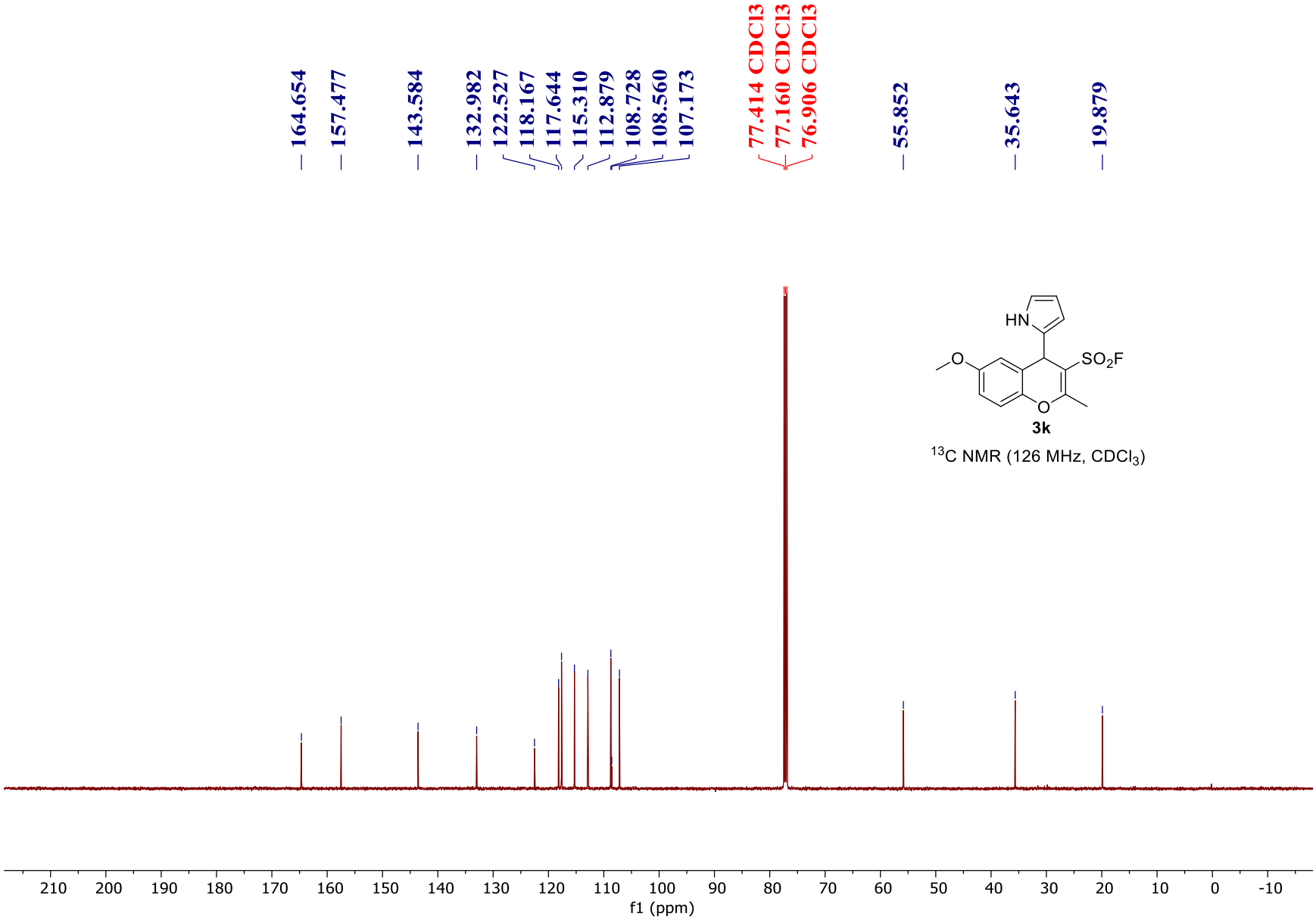

8.357
7.264 CDCl3
7.126
7.110
7.094
6.880
6.877
6.863
6.861
6.781
6.779
6.765
6.763
6.689
6.684
6.679
6.675
6.076
6.070
6.064
6.058
5.734
5.730
5.726
5.721
5.718
5.165
3.925
2.528
HN
SO2F
O
O
3j
1H NMR (500 MHz, CDCl3)
0.87
1.01
1.01
1.01
1.00
0.99
0.99
0.99
3.09
3.00
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)

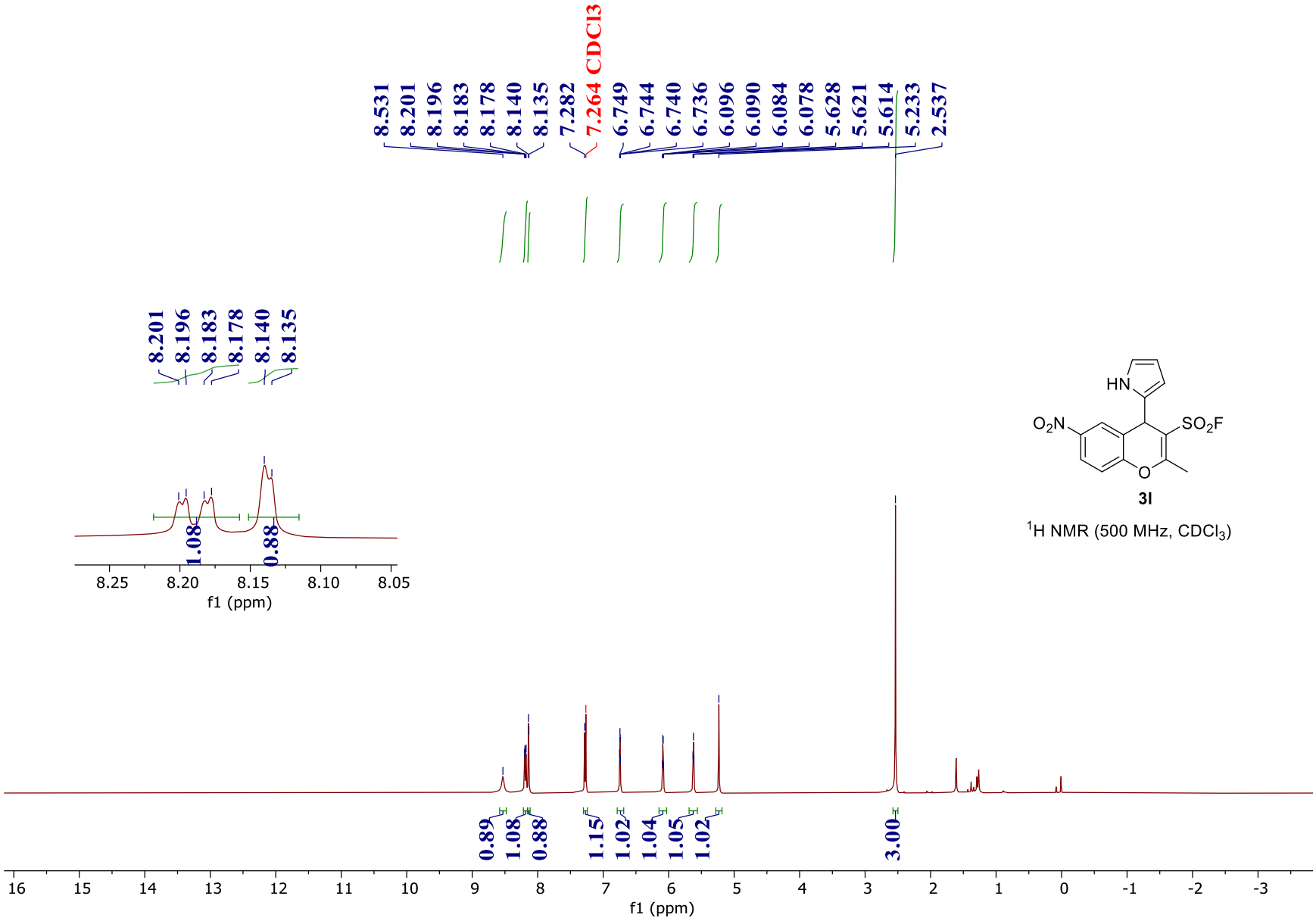

69.349
HN
SO2F
O
O
3j
19F NMR (471 MHz, CDCl3)
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
f1 (ppm)

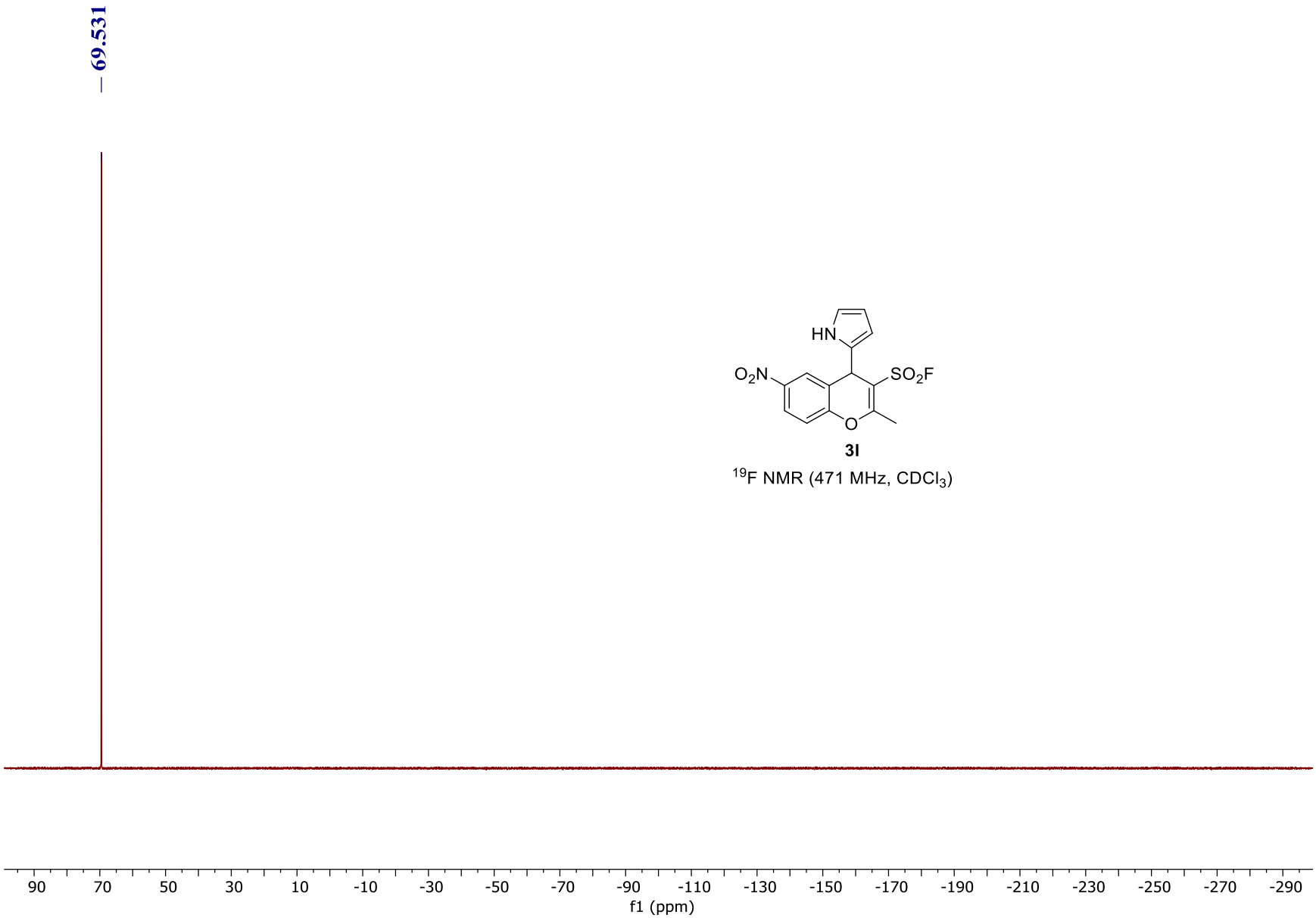

164.259
147.852
139.112
132.973
126.012
122.961
120.520
118.130
110.952
109.768
109.609
108.767
107.200
77.414 CDCl3
77.160 CDCl3
76.907 CDCl3
56.229
35.272
19.772
HN
SO2F
O
O
3j
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.404
7.264 CDCl3
7.081
7.063
6.862
6.856
6.844
6.838
6.701
6.695
6.690
6.684
6.092
6.086
6.080
6.074
5.739
5.736
5.733
5.730
5.727
5.724
5.159
3.759
2.481
HN
O
SO2F
O
3k
1H NMR (500 MHz, CDCl3)
0.86
0.99
1.03
2.06
1.03
1.02
1.04
3.13
3.00
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)


−69.504
HN
O
SO2F
O
3k
19F NMR (471 MHz, CDCl3)
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
f1 (ppm)

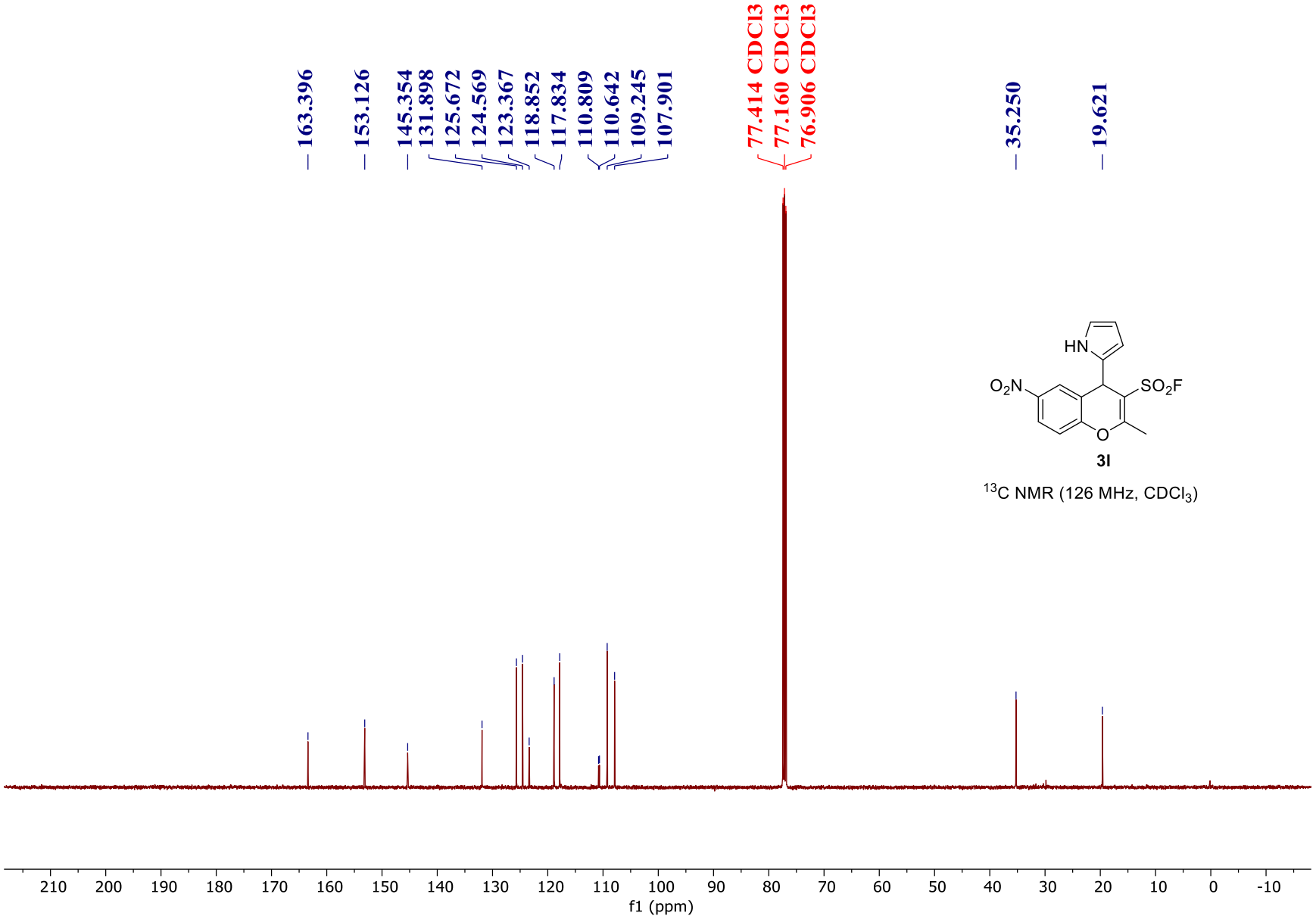

164.654
157.477
143.584
132.982
122.527
118.167
117.644
115.310
112.879
108.728
108.560
107.173
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
55.852
35.643
19.879
HN
O
SO2F
O
3k
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

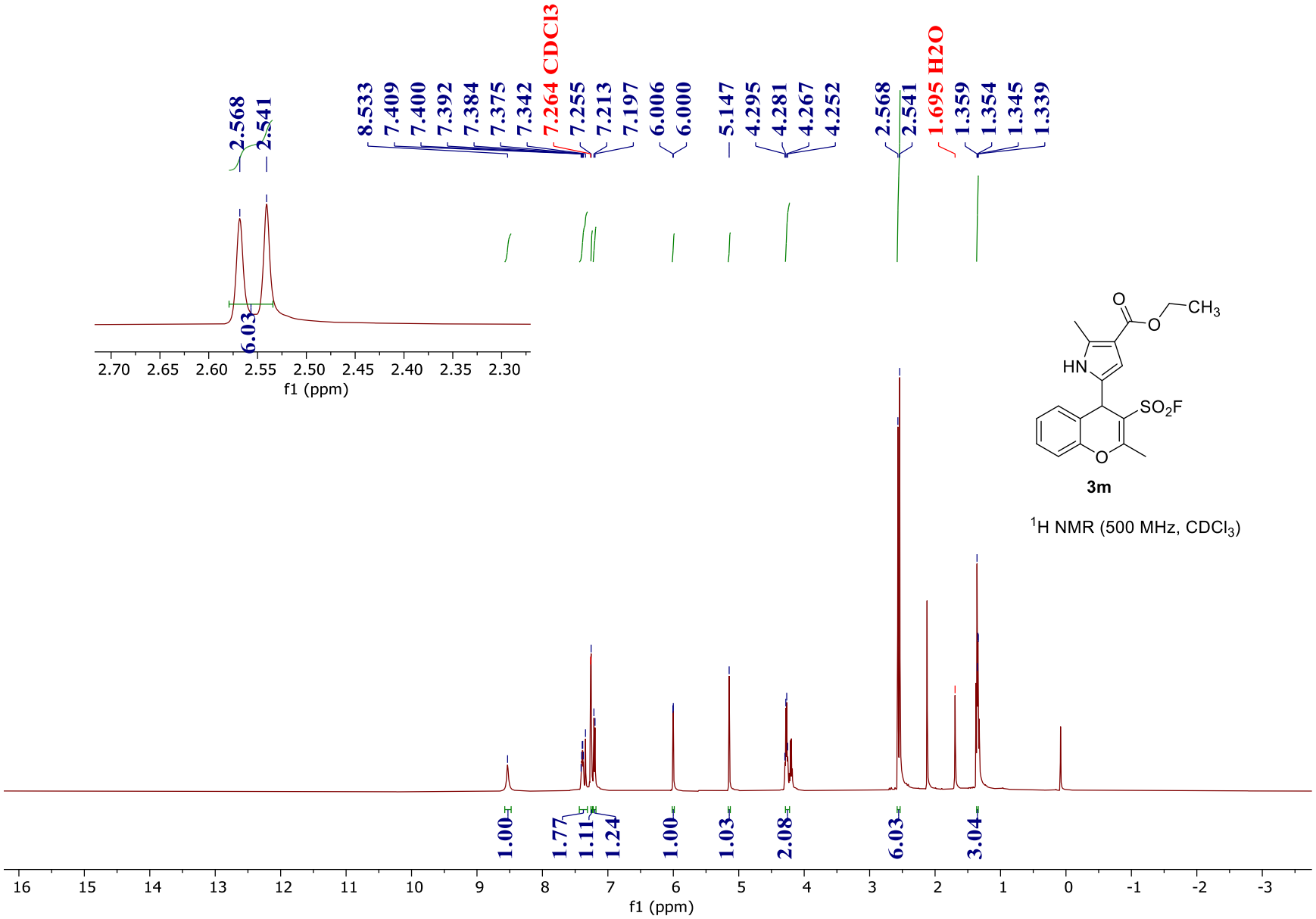

8.531
8.201
8.196
8.183
8.178
8.140
8.135
7.282
7.264 CDCl3
6.749
6.744
6.740
6.736
6.096
6.090
6.084
6.078
5.628
5.621
5.614
5.233
2.537
1.08
0.88
f1 (ppm)
HN
O2N
SO2F
O
3l
1H NMR (500 MHz, CDCl3)
0.89
1.08
0.88
1.15
1.02
1.04
1.05
1.02
3.00
f1 (ppm)

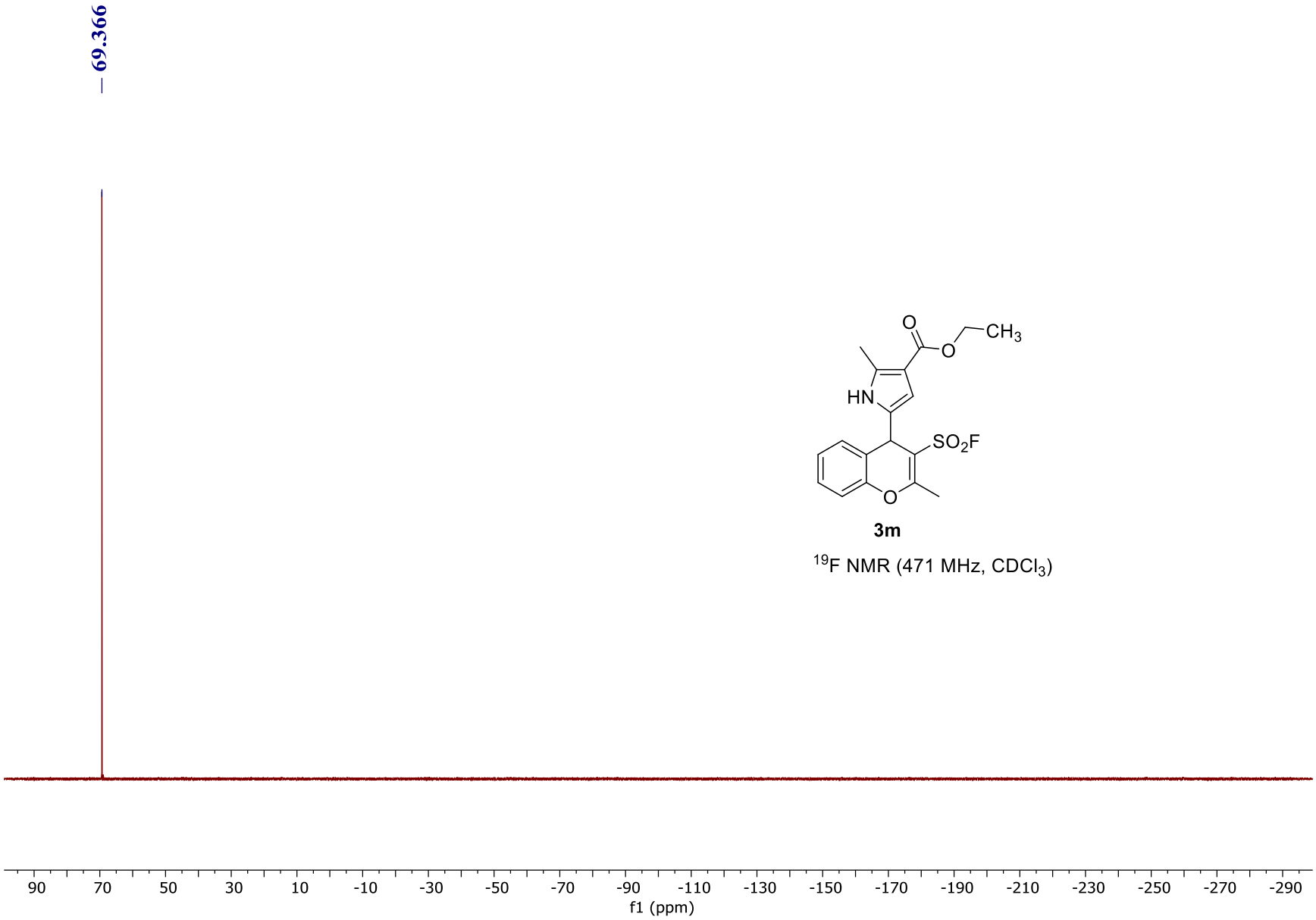


3l

^{19}F NMR (471 MHz, $CDCl_3$)

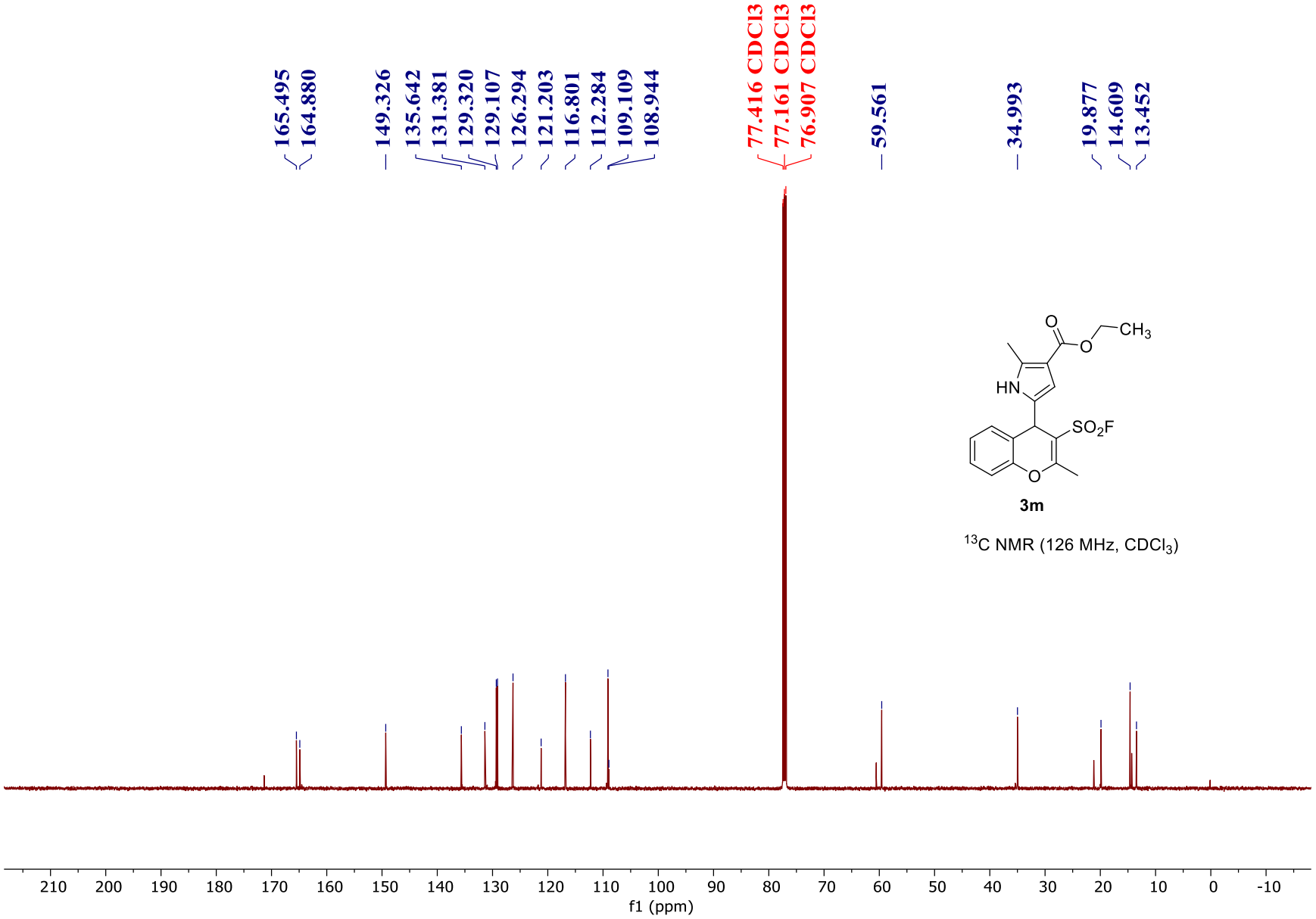

163.396
153.126
145.354
131.898
125.672
124.569
123.367
118.852
117.834
110.809
110.642
109.245
107.901
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
35.250
19.621
HN
O2N
SO2F
O
3l
13C NMR (126 MHz, CDCl3)
f1 (ppm)

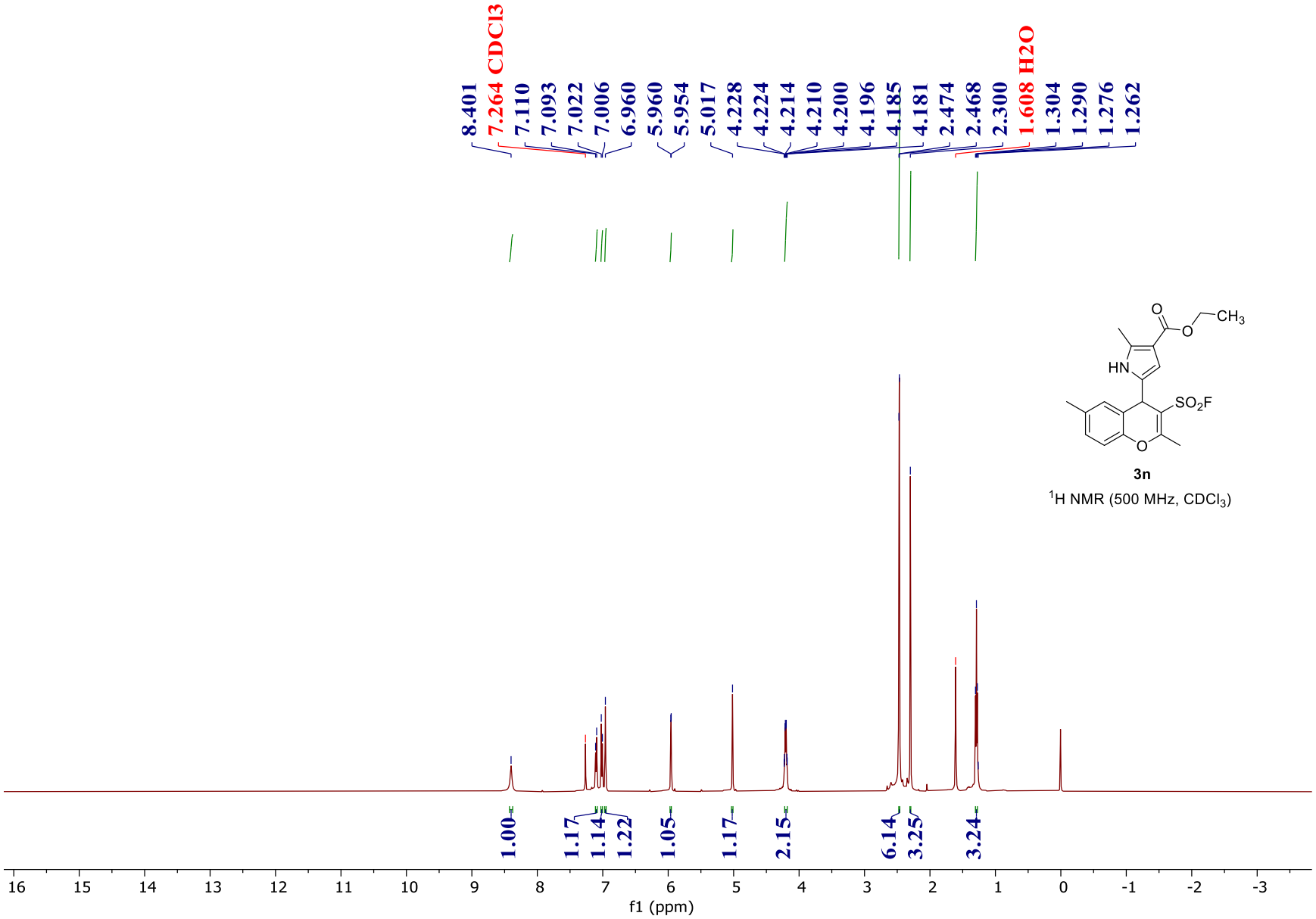

8.533
7.409
7.400
7.392
7.384
7.375
7.342
7.264 CDCl3
7.255
7.213
7.197
6.006
6.000
5.147
4.295
4.281
4.267
4.252
2.568
2.541
1.695 H2O
1.359
1.354
1.345
1.339
2.568
2.541
6.03
2.70 2.65 2.60 2.55 2.50 2.45 2.40 2.35 2.30
f1 (ppm)
1.00
1.77
1.11
1.24
1.00
1.03
2.08
6.03
3.04
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)
O
O
CH3
HN
SO2F
O
3m
1H NMR (500 MHz, CDCl3)

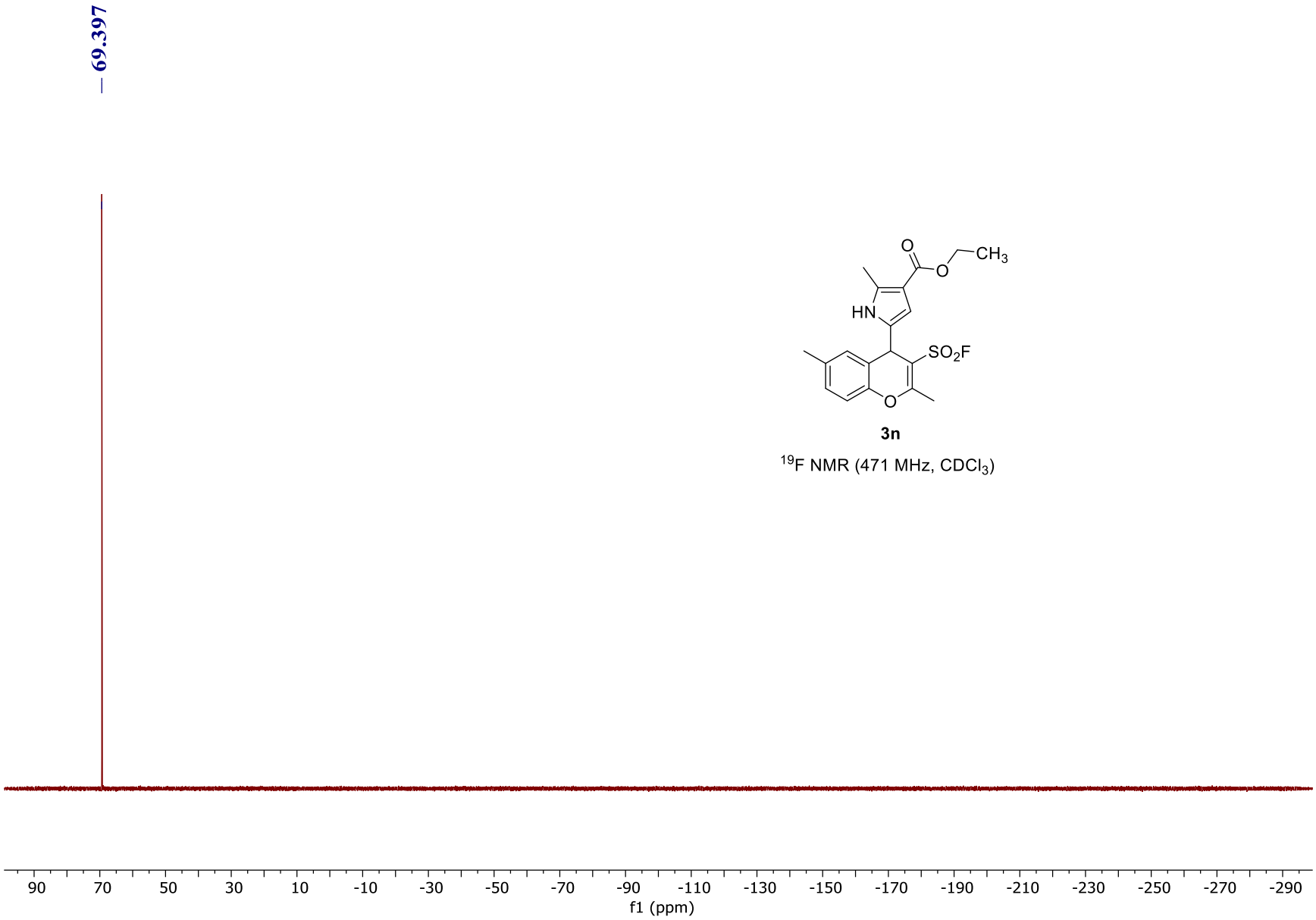


3m

^{19}F NMR (471 MHz, $CDCl_3$)

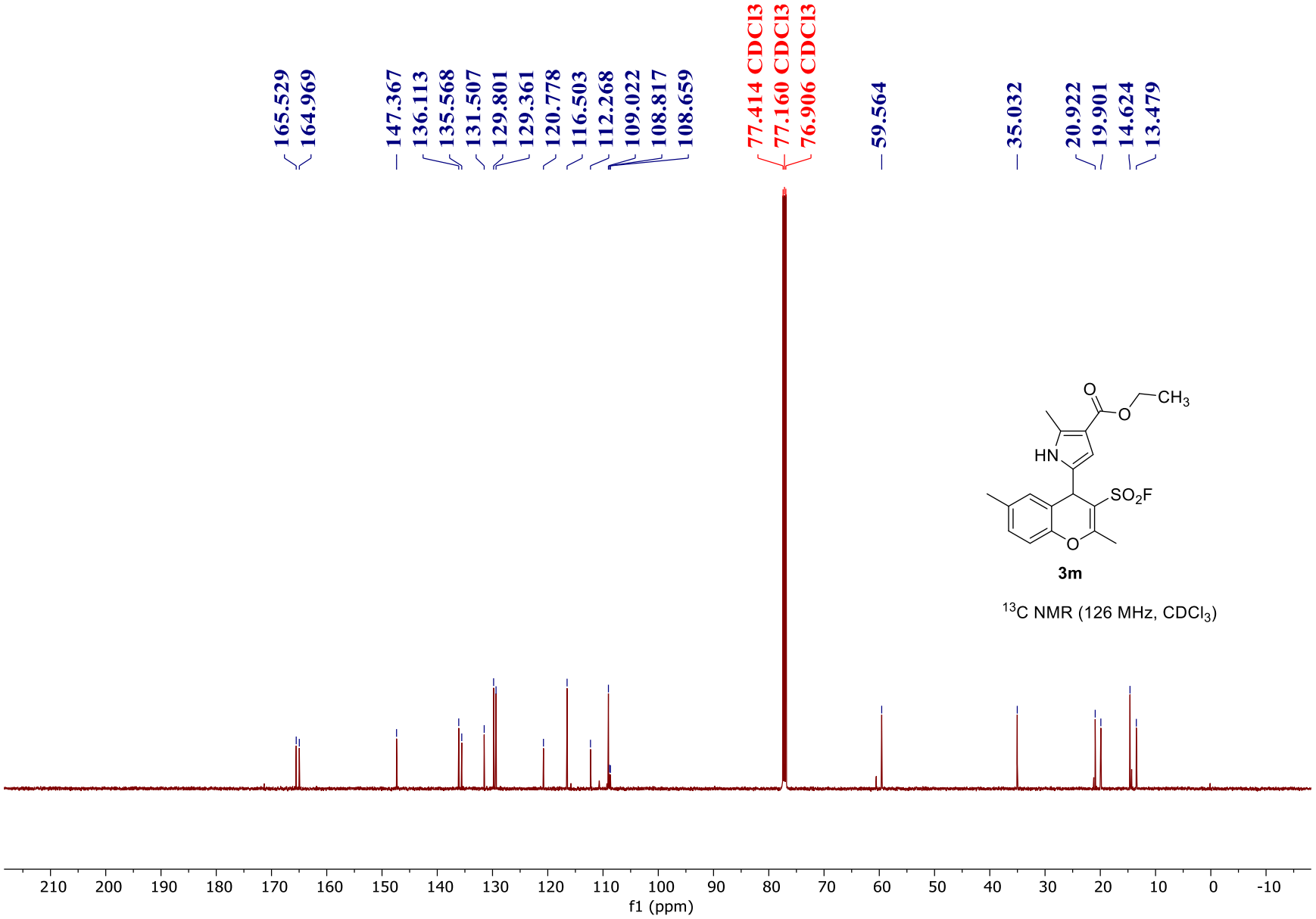

165.495
164.880
149.326
135.642
131.381
129.320
129.107
126.294
121.203
116.801
112.284
109.109
108.944
77.416 CDCl3
77.161 CDCl3
76.907 CDCl3
59.561
34.993
19.877
14.609
13.452
O
O
CH3
HN
SO2F
O
3m
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

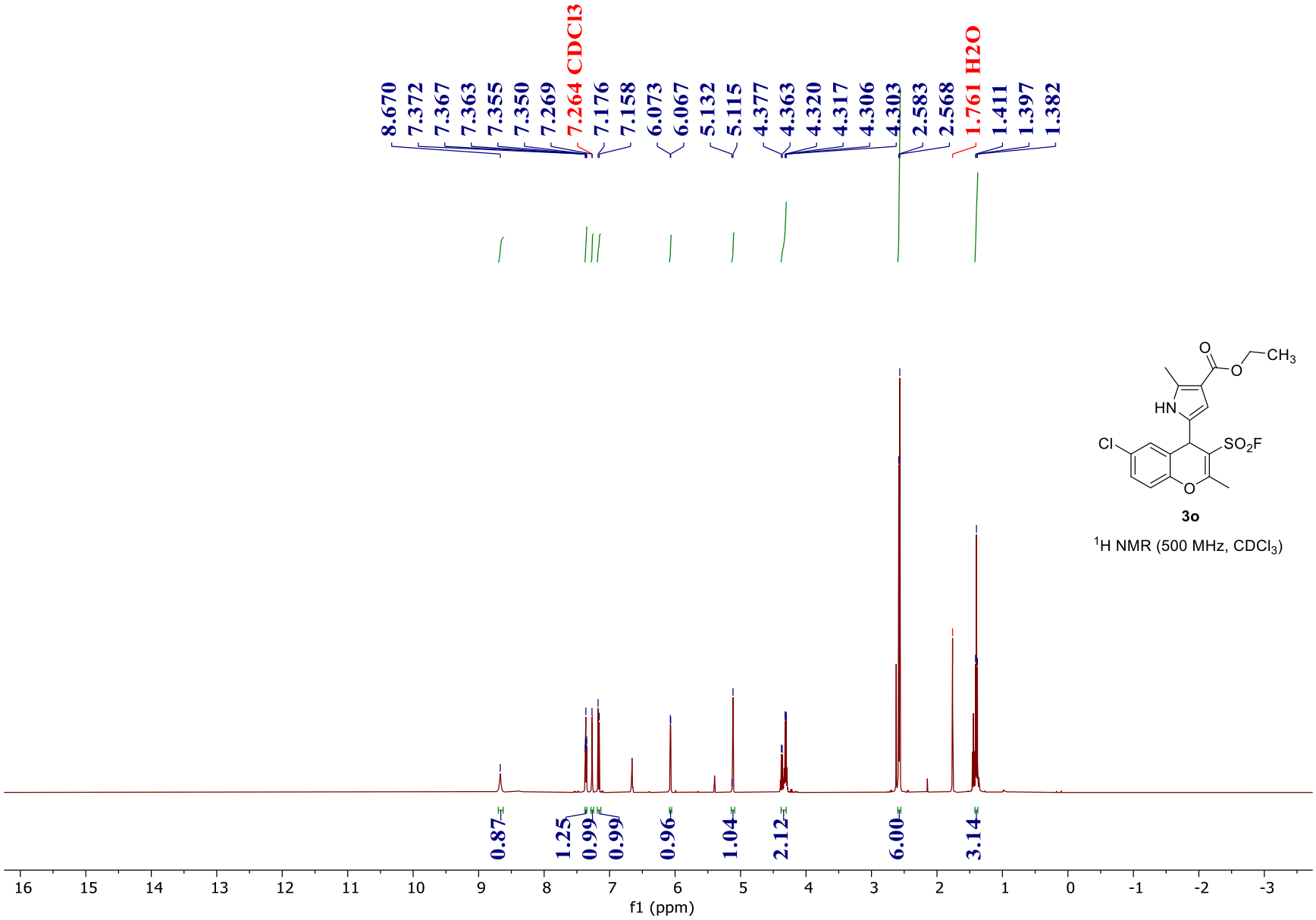

8.401
7.264 CDCl3
7.110
7.093
7.022
7.006
6.960
5.960
5.954
5.017
4.228
4.224
4.214
4.210
4.200
4.196
4.185
4.181
2.474
2.468
2.300
1.608 H2O
1.304
1.290
1.276
1.262
1.00
1.17
1.14
1.22
1.05
1.17
2.15
6.14
3.25
3.24
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)
O
O
CH3
HN
SO2F
O
3n
1H NMR (500 MHz, CDCl3)

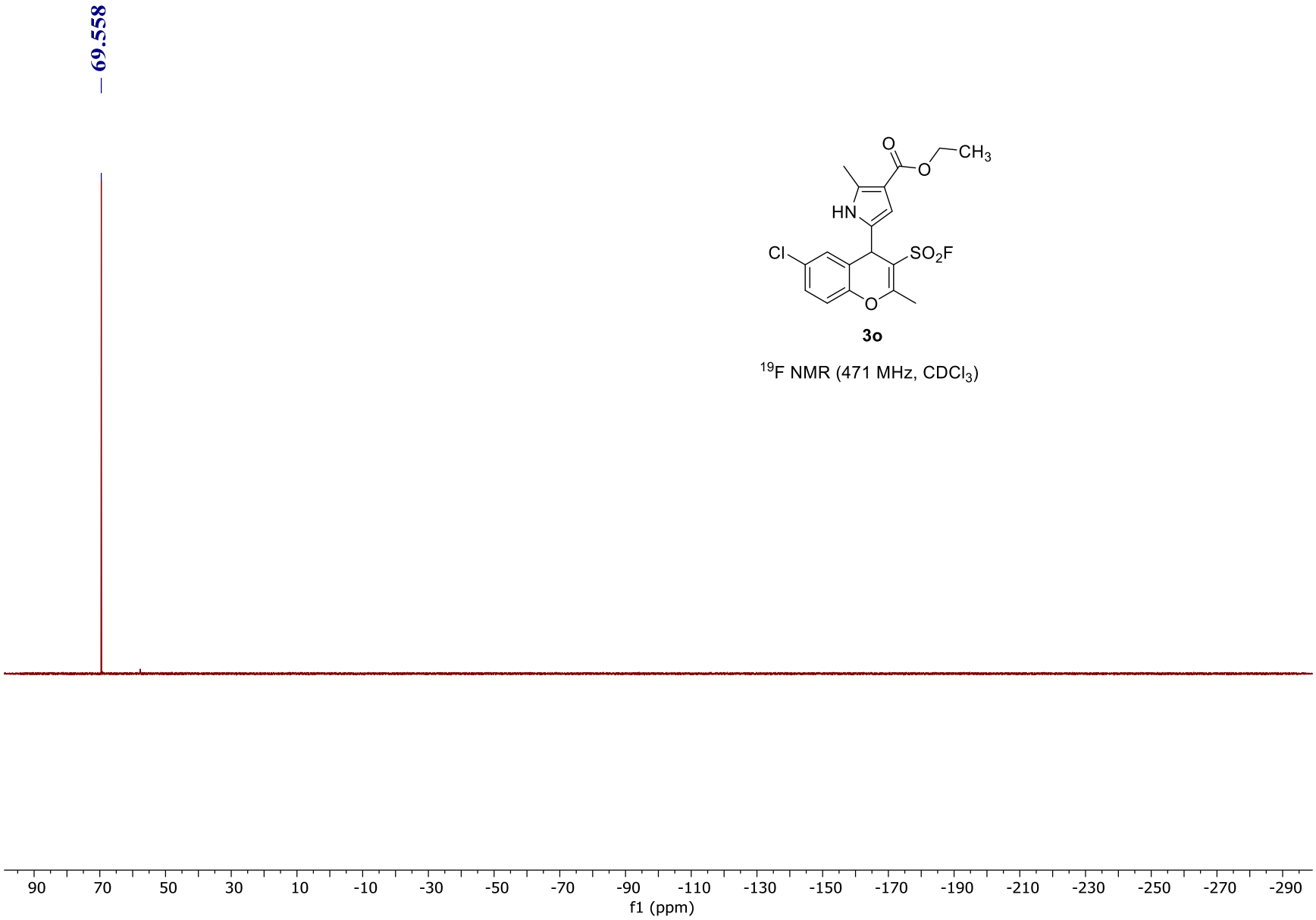


3n

^{19}F NMR (471 MHz, $CDCl_3$)

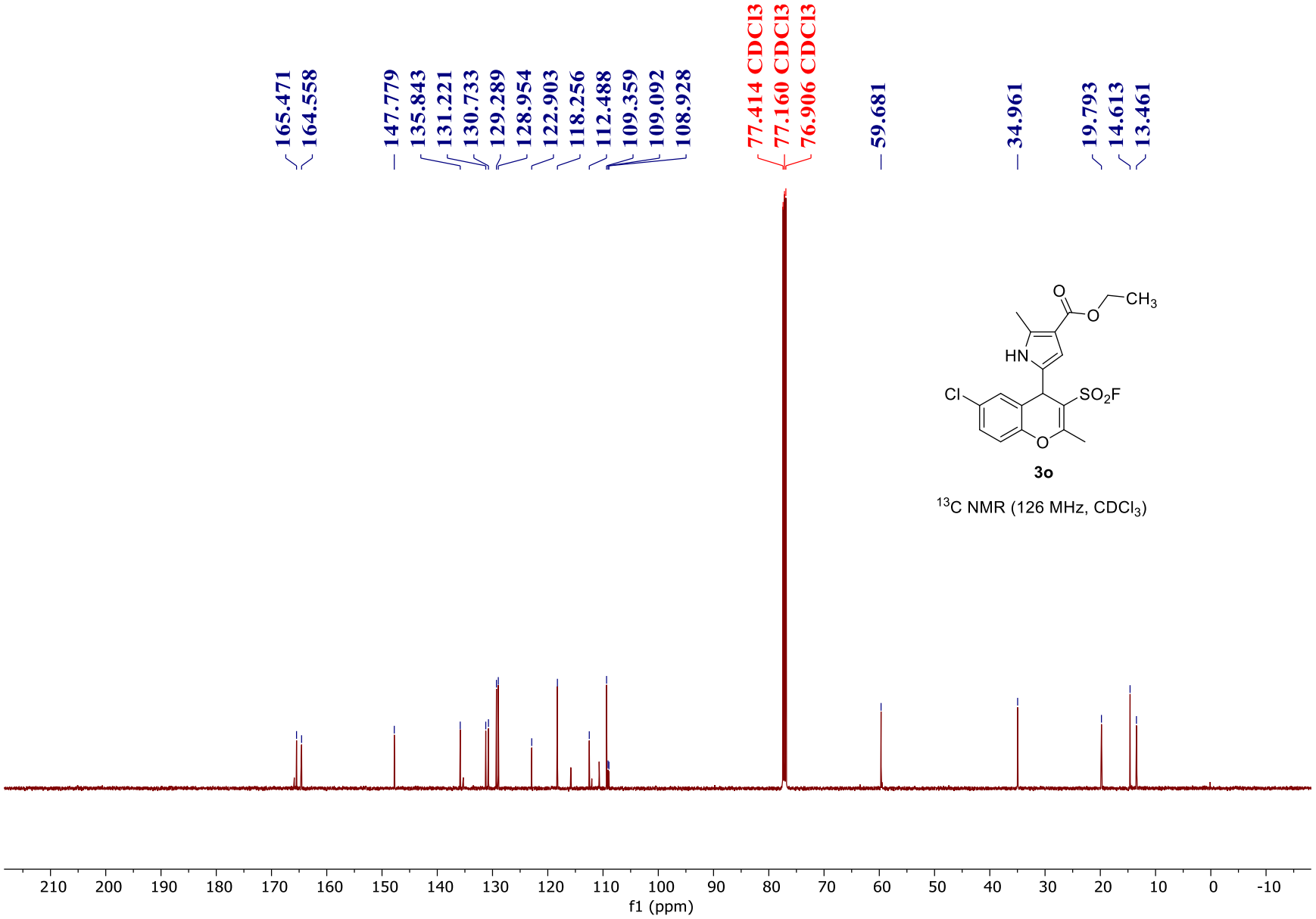

165.529
164.969
147.367
136.113
135.568
131.507
129.801
129.361
120.778
116.503
112.268
109.022
108.817
108.659
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
59.564
35.032
20.922
19.901
14.624
13.479
O
O
CH3
HN
SO2F
O
3m
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

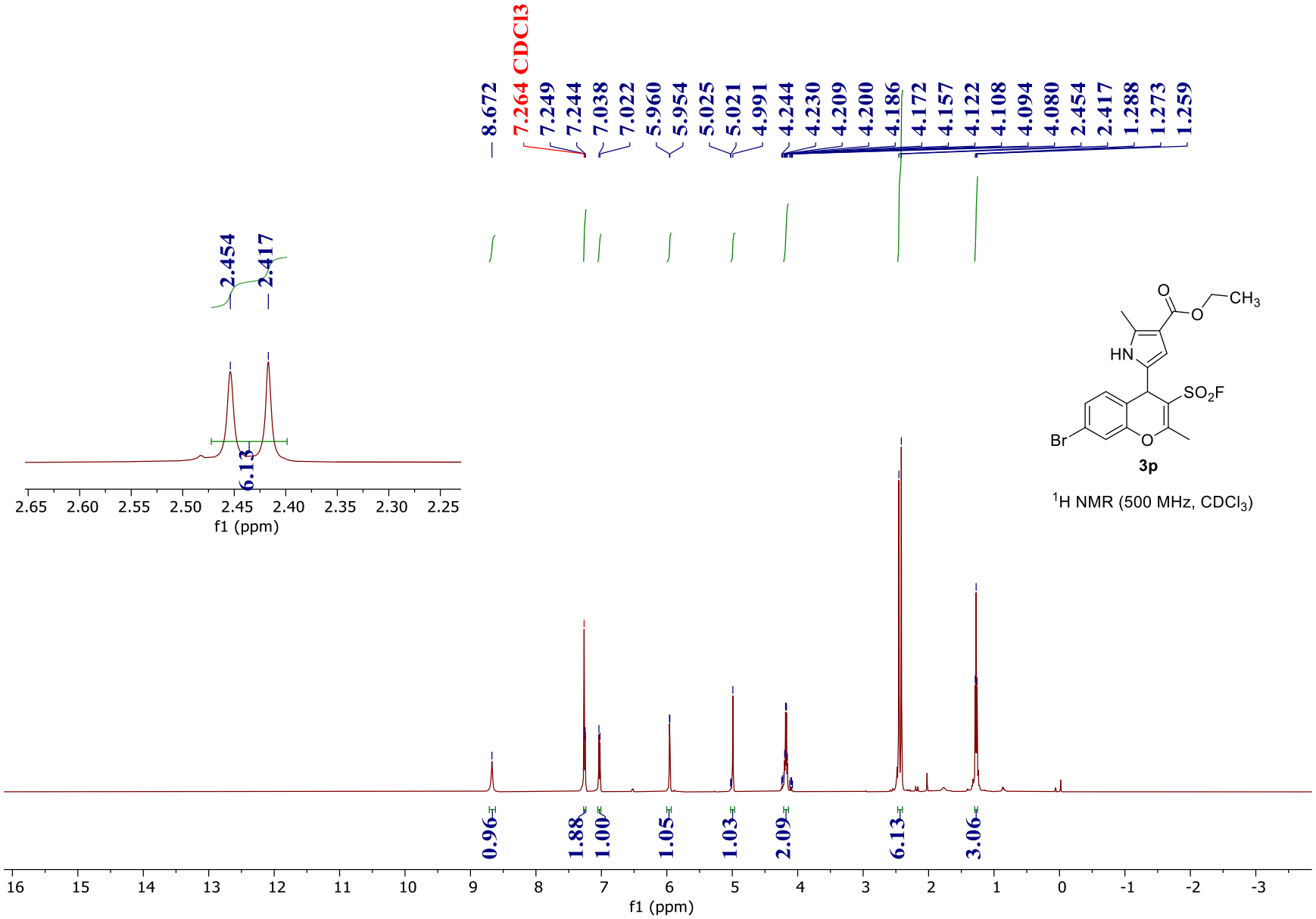

8.670
7.372
7.367
7.363
7.355
7.350
7.269
7.264 CDCl3
7.176
7.158
6.073
6.067
5.132
5.115
4.377
4.363
4.320
4.317
4.306
4.303
2.583
2.568
1.761 H2O
1.411
1.397
1.382
0.87
1.25
0.99
0.99
0.96
1.04
2.12
6.00
3.14
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)
O
O
CH3
HN
Cl
SO2F
O
3o
1H NMR (500 MHz, CDCl3)

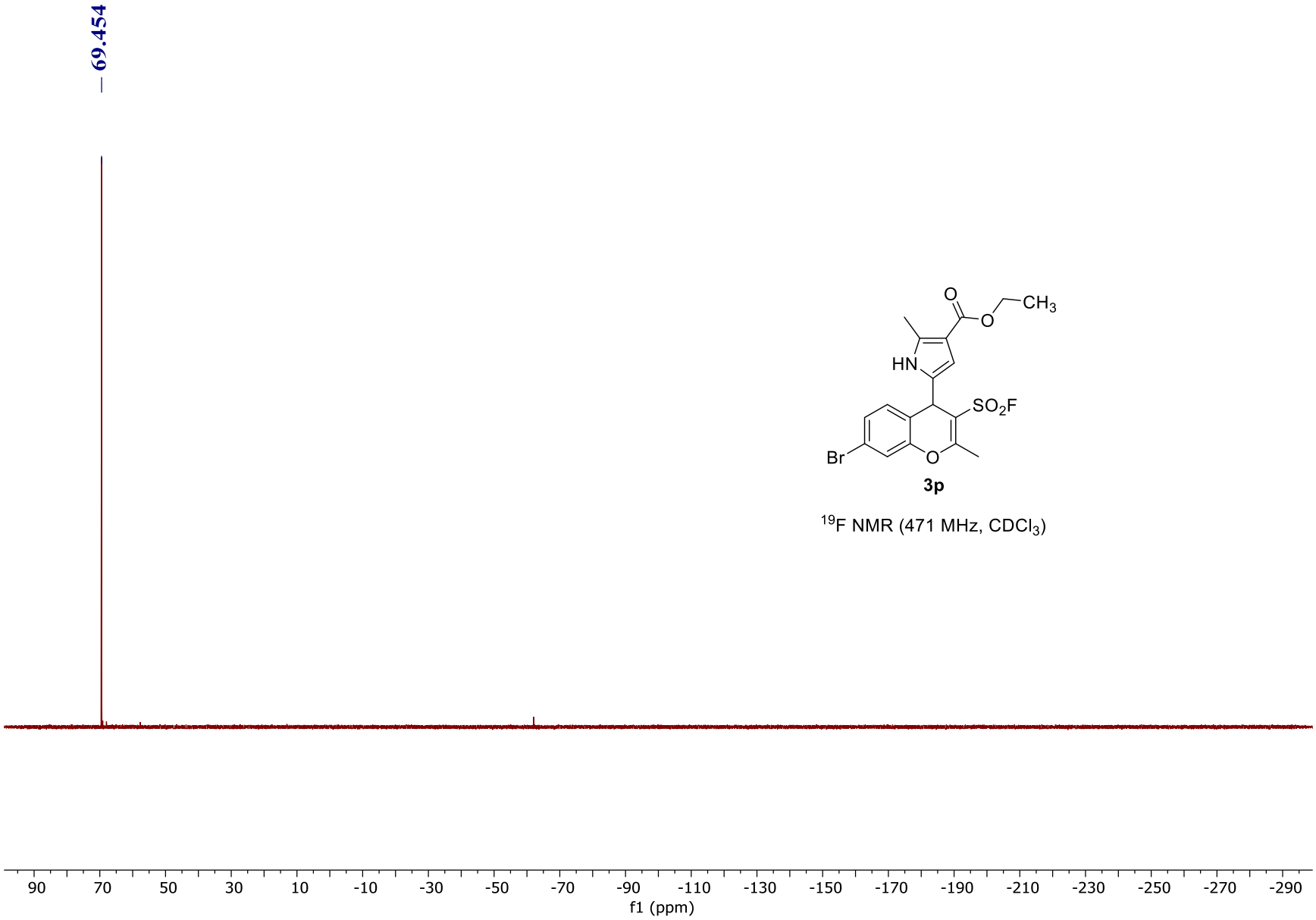


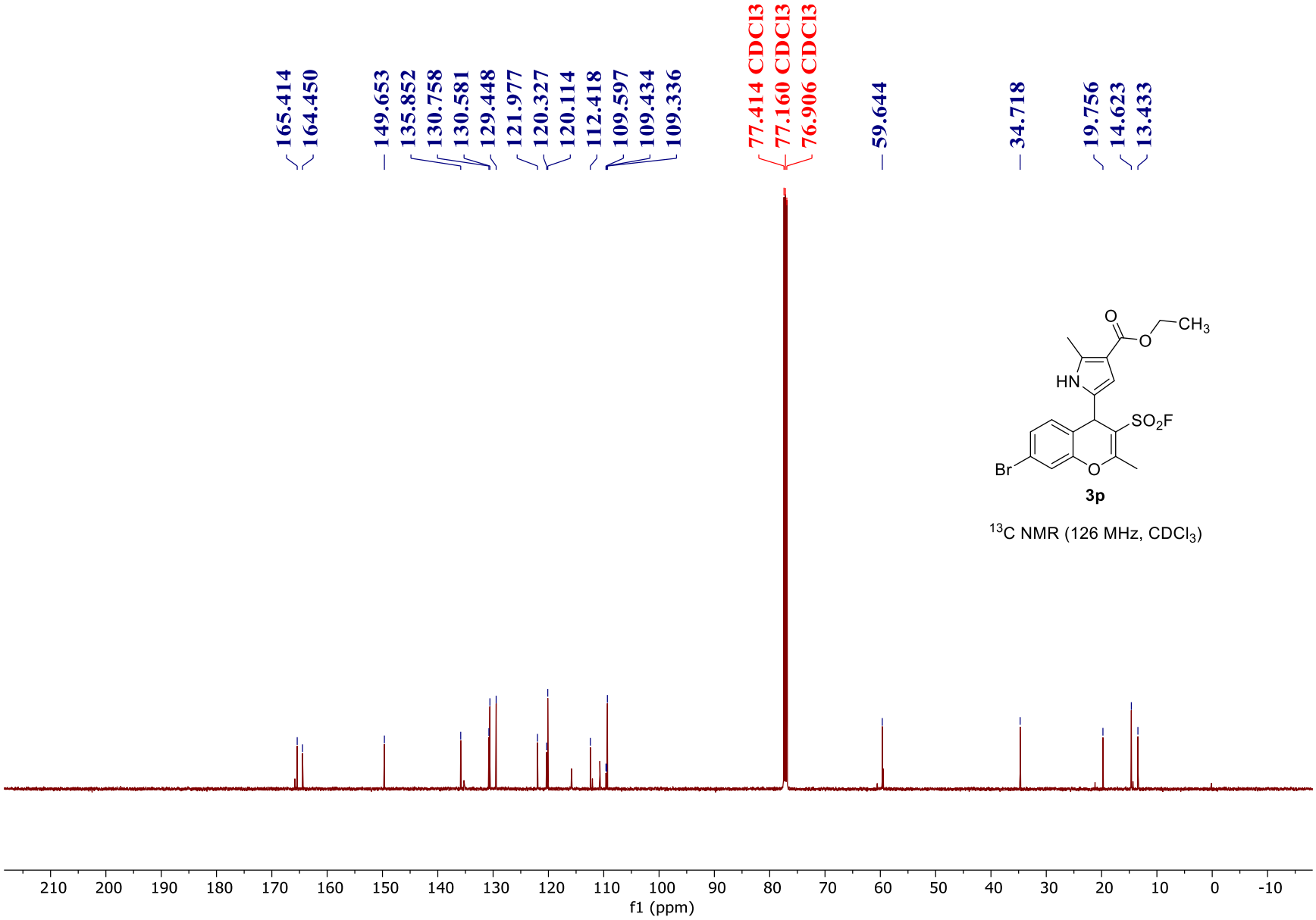
3o

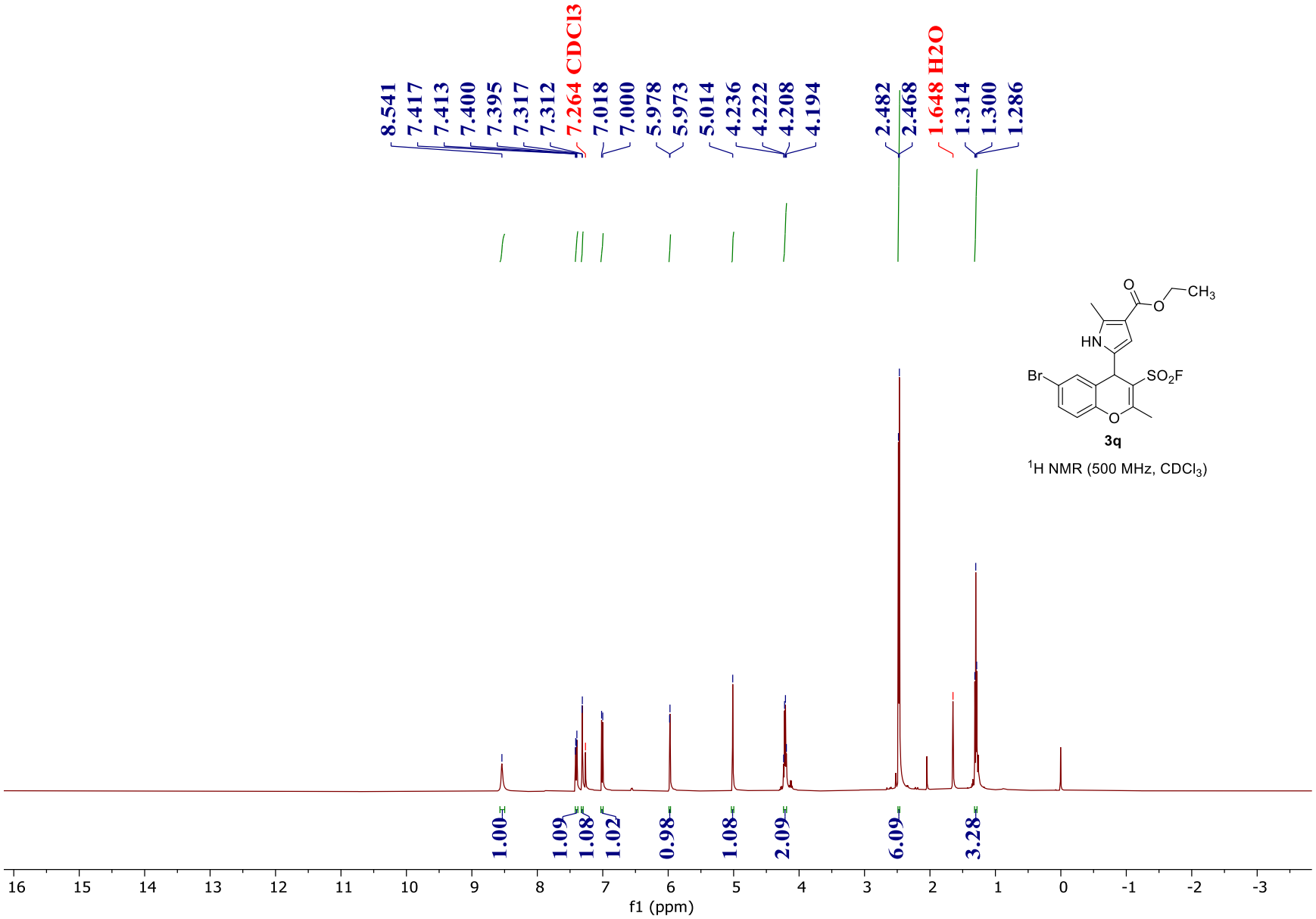
^{19}F NMR (471 MHz, $CDCl_3$)

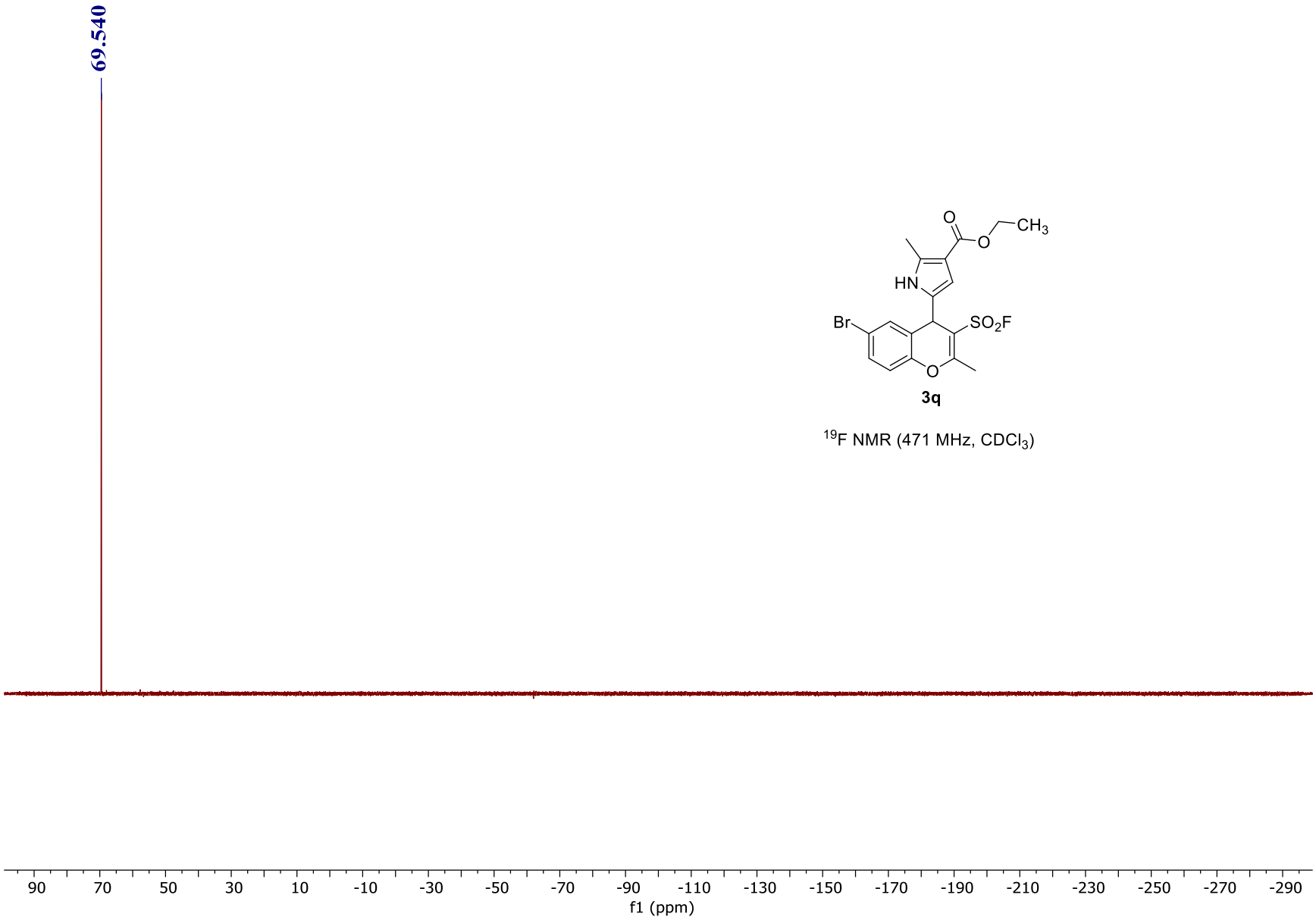

165.471
164.558
147.779
135.843
131.221
130.733
129.289
128.954
122.903
118.256
112.488
109.359
109.092
108.928
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
59.681
34.961
19.793
14.613
13.461
O
O
CH3
HN
Cl
SO2F
O
3o
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


8.672
7.264 CDCl3
7.249
7.244
7.038
7.022
5.960
5.954
5.025
5.021
4.991
4.244
4.230
4.209
4.200
4.186
4.172
4.157
4.122
4.108
4.094
4.080
2.454
2.417
1.288
1.273
1.259
2.454
2.417
6.13
2.65 2.60 2.55 2.50 2.45 2.40 2.35 2.30 2.25
f1 (ppm)
O
O
CH3
HN
SO2F
Br
O
3p
1H NMR (500 MHz, CDCl3)
0.96
1.88
1.00
1.05
1.03
2.09
6.13
3.06
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)


— 69.454
O
O
CH3
HN
SO2F
Br
O
3p
19F NMR (471 MHz, CDCl3)
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
f1 (ppm)

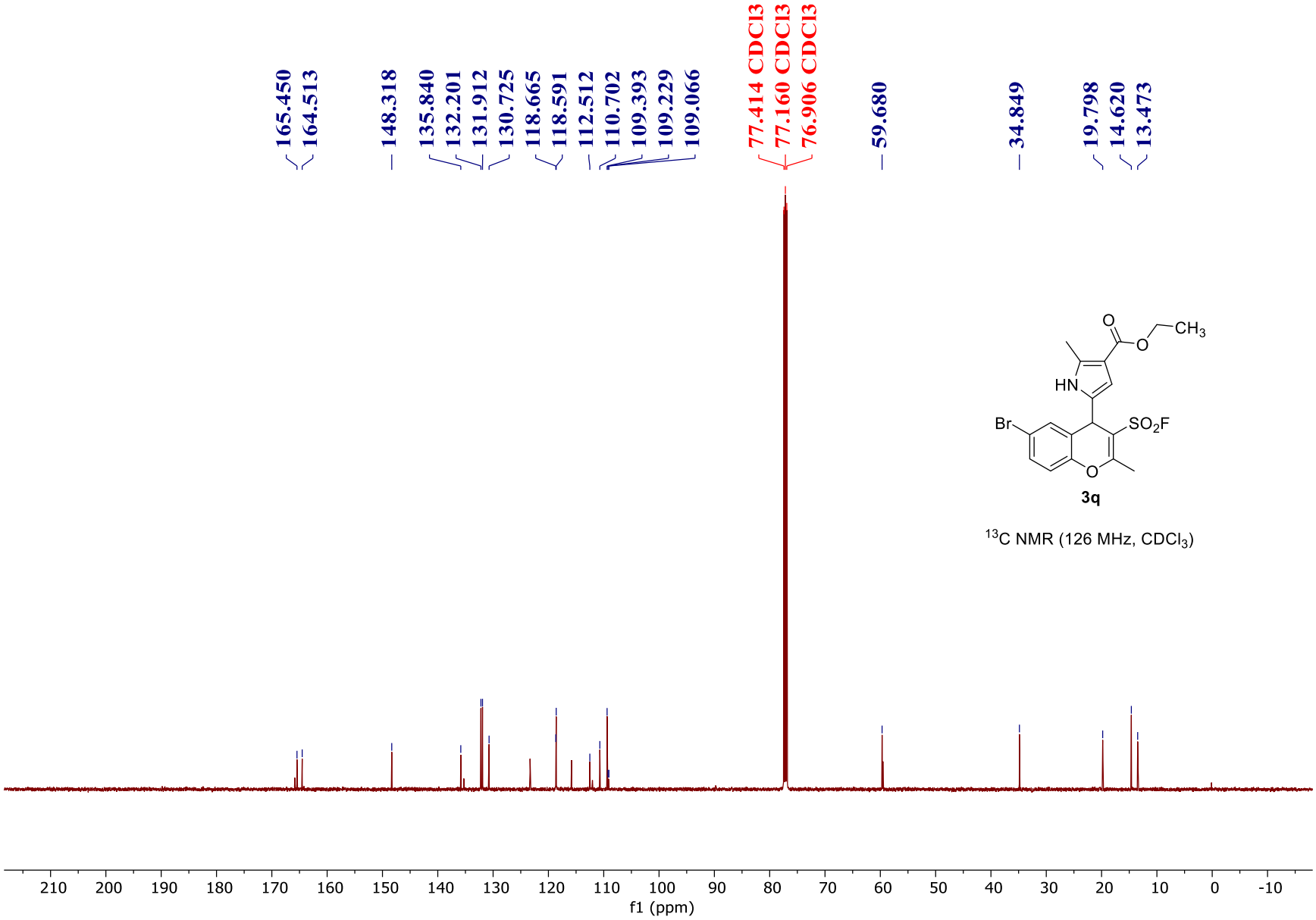

165.414
164.450
149.653
135.852
130.758
130.581
129.448
121.977
120.327
120.114
112.418
109.597
109.434
109.336
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
59.644
34.718
19.756
14.623
13.433
O
O
CH3
HN
SO2F
Br
O
3p
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

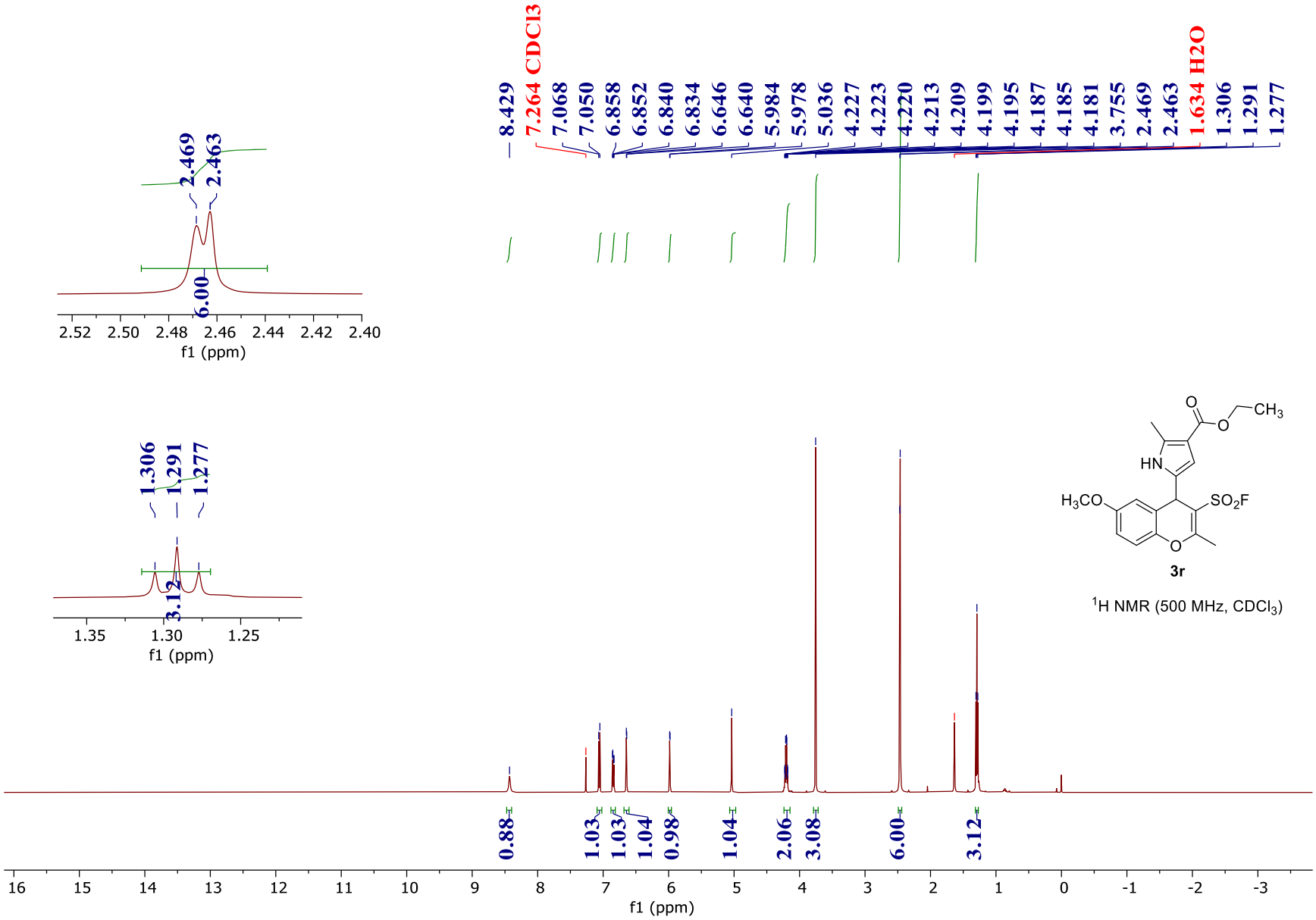

8.541
7.417
7.413
7.400
7.395
7.317
7.312
7.264 CDCl3
7.018
7.000
5.978
5.973
5.014
4.236
4.222
4.208
4.194
2.482
2.468
1.648 H2O
1.314
1.300
1.286
1.00
1.09
1.08
1.02
0.98
1.08
2.09
6.09
3.28
f1 (ppm)
3q
1H NMR (500 MHz, CDCl3)

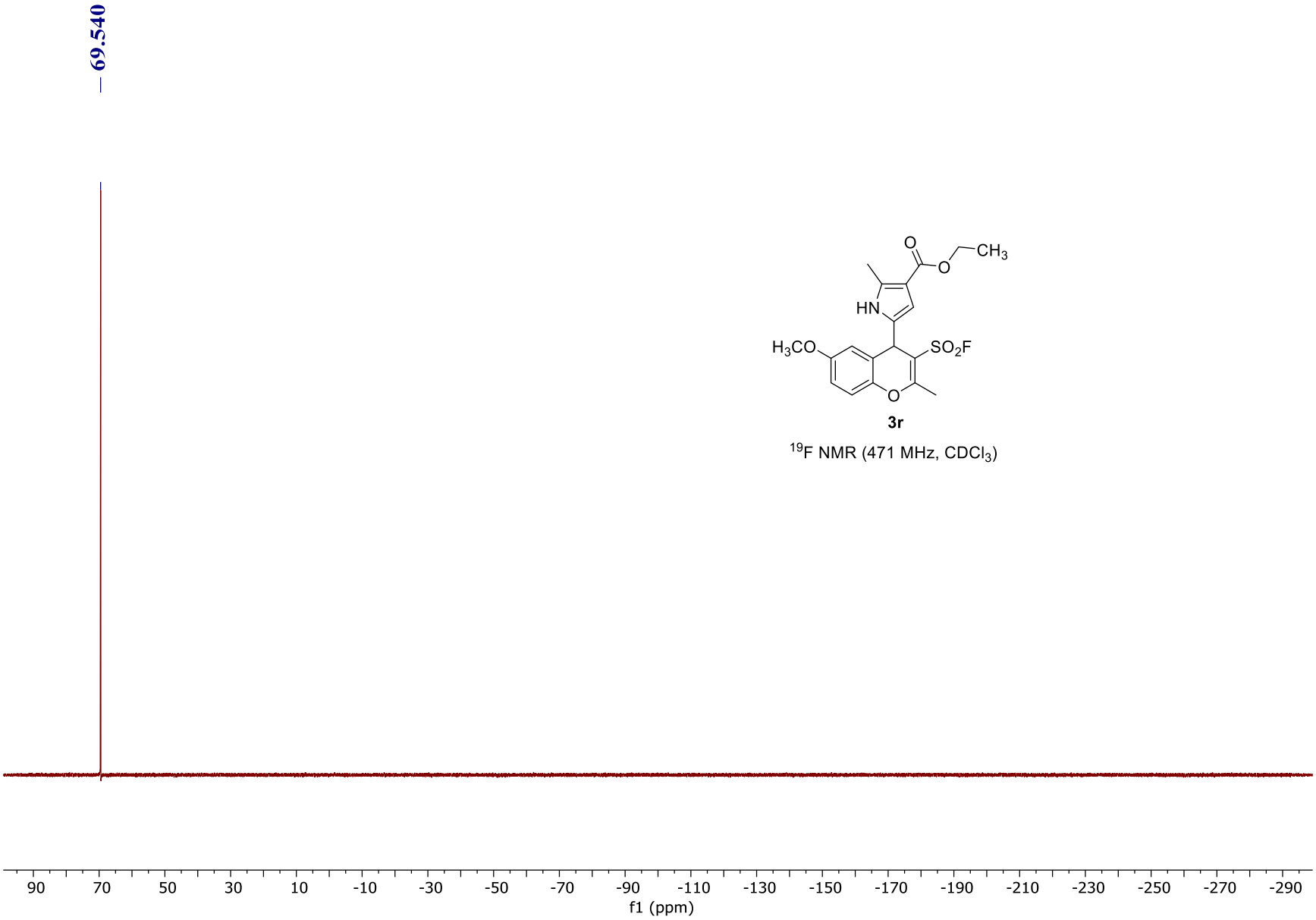


3q

^{19}F NMR (471 MHz, $CDCl_3$)

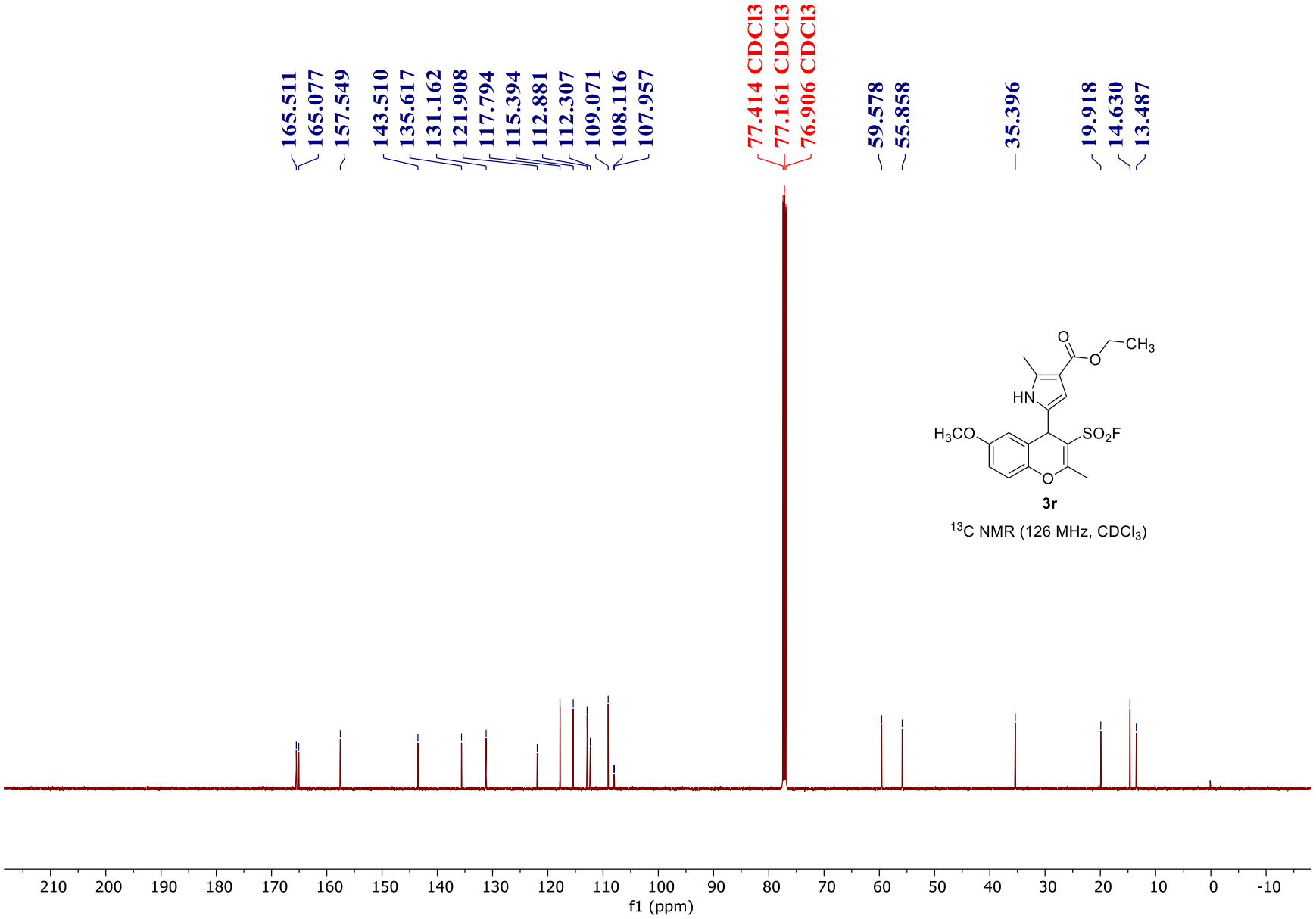

165.450
164.513
148.318
135.840
132.201
131.912
130.725
118.665
118.591
112.512
110.702
109.393
109.229
109.066
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
59.680
34.849
19.798
14.620
13.473
O
O
CH3
HN
Br
SO2F
O
3q
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

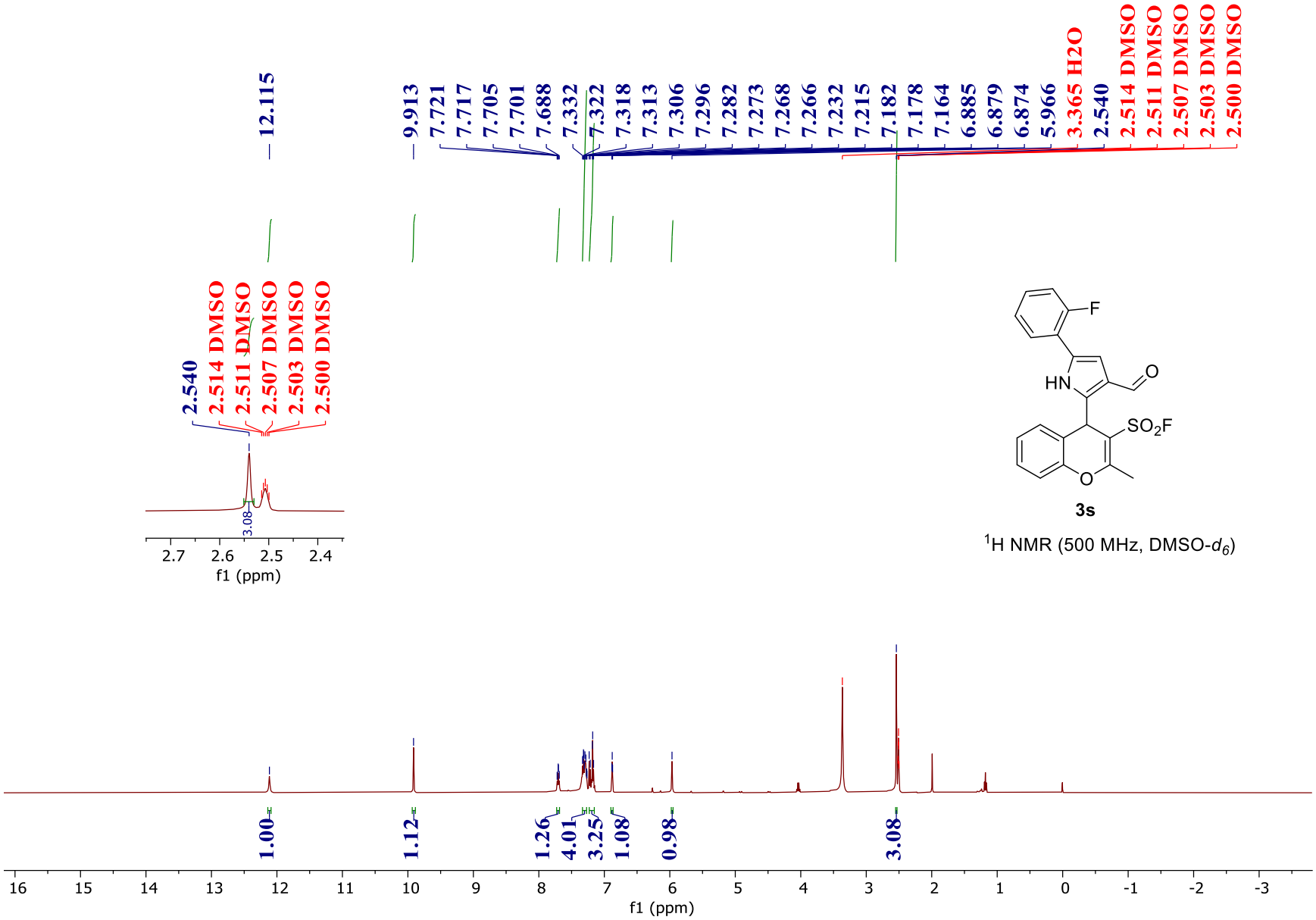

8.429
7.264 CDCl3
7.068
7.050
6.858
6.852
6.840
6.834
6.646
6.640
5.984
5.978
5.036
4.227
4.223
4.220
4.213
4.209
4.199
4.195
4.187
4.185
4.181
3.755
2.469
2.463
1.634 H2O
1.306
1.291
1.277
2.469
2.463
6.00
2.52 2.50 2.48 2.46 2.44 2.42 2.40
f1 (ppm)
1.306
1.291
1.277
3.12
1.35 1.30 1.25
f1 (ppm)
O
O
CH3
HN
H3CO
SO2F
O
3r
1H NMR (500 MHz, CDCl3)
0.88
1.03
1.03
1.04
0.98
1.04
2.06
3.08
6.00
3.12
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)

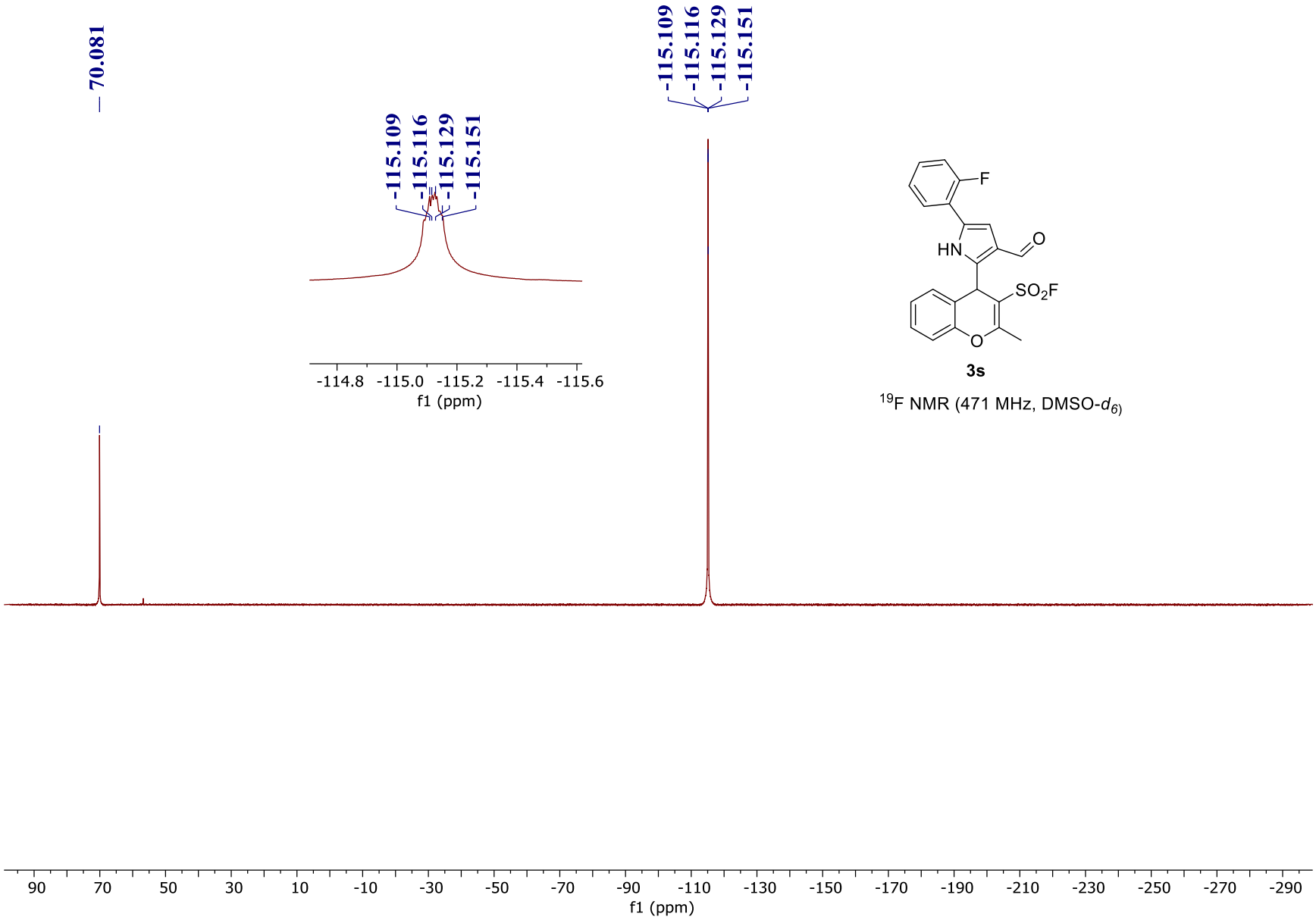


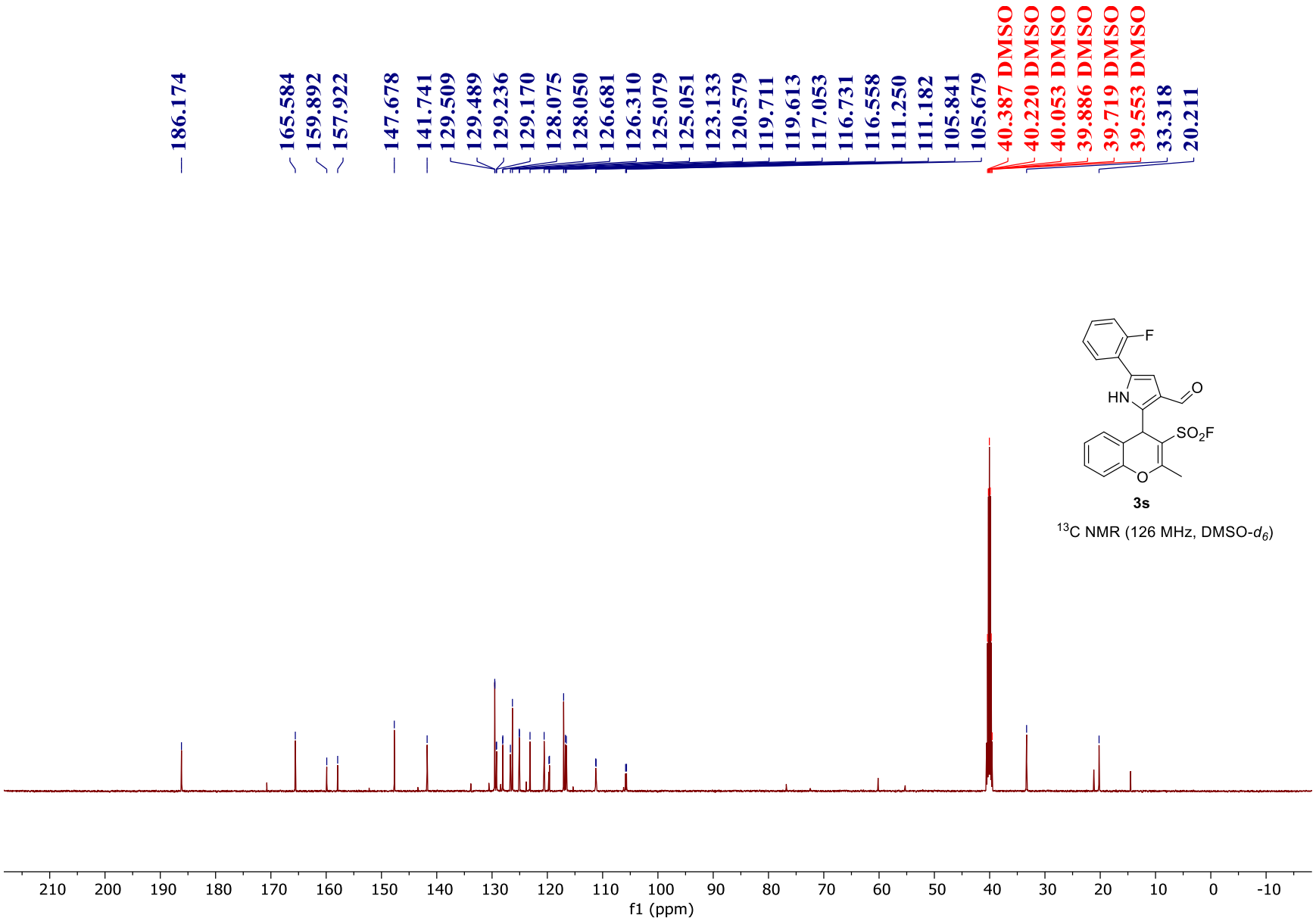
3r

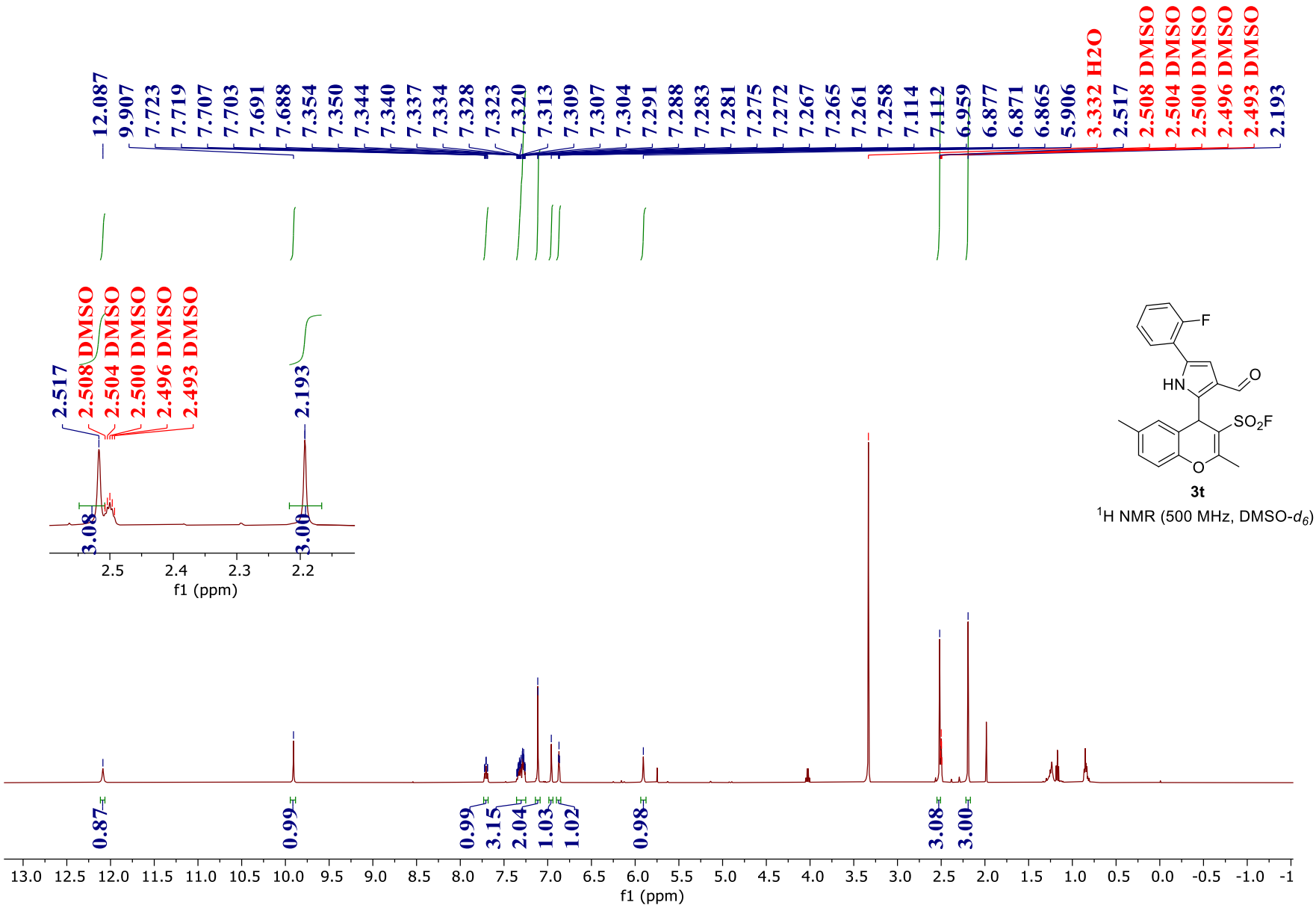
^{19}F NMR (471 MHz, $CDCl_3$)

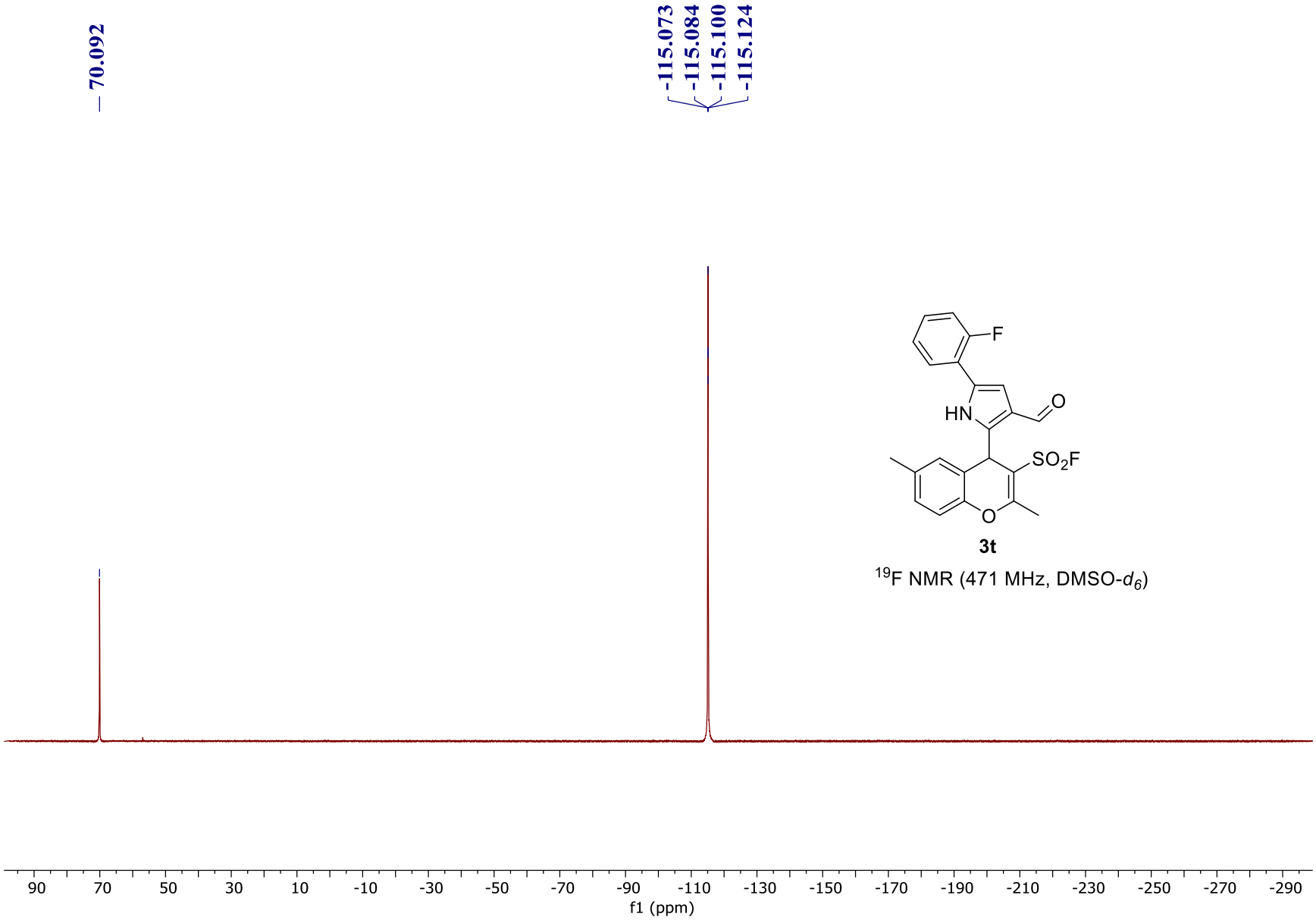

165.511
165.077
157.549
143.510
135.617
131.162
121.908
117.794
115.394
112.881
112.307
109.071
108.116
107.957
77.414 CDCl3
77.161 CDCl3
76.906 CDCl3
59.578
55.858
35.396
19.918
14.630
13.487
O
O
CH3
HN
H3CO
SO2F
O
3r
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


12.115
9.913
7.721
7.717
7.705
7.701
7.688
7.332
7.322
7.318
7.313
7.306
7.296
7.282
7.273
7.268
7.266
7.232
7.215
7.182
7.178
7.164
6.885
6.879
6.874
5.966
3.365 H2O
2.540
2.514 DMSO
2.511 DMSO
2.507 DMSO
2.503 DMSO
2.500 DMSO
3.08
2.7
2.6
2.5
2.4
f1 (ppm)
F
HN
O
SO2F
O
3s
1H NMR (500 MHz, DMSO-d6)
1.00
1.12
1.26
4.01
3.25
1.08
0.98
3.08
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)


-70.081
-115.109
-115.116
-115.129
-115.151
-115.109
-115.116
-115.129
-115.151
-114.8 -115.0 -115.2 -115.4 -115.6
f1 (ppm)
F
HN
O
SO2F
O
3s
19F NMR (471 MHz, DMSO-d6)
90 70 50 30 10 -10 -30 -50 -70 -90 -110 -130 -150 -170 -190 -210 -230 -250 -270 -290
f1 (ppm)

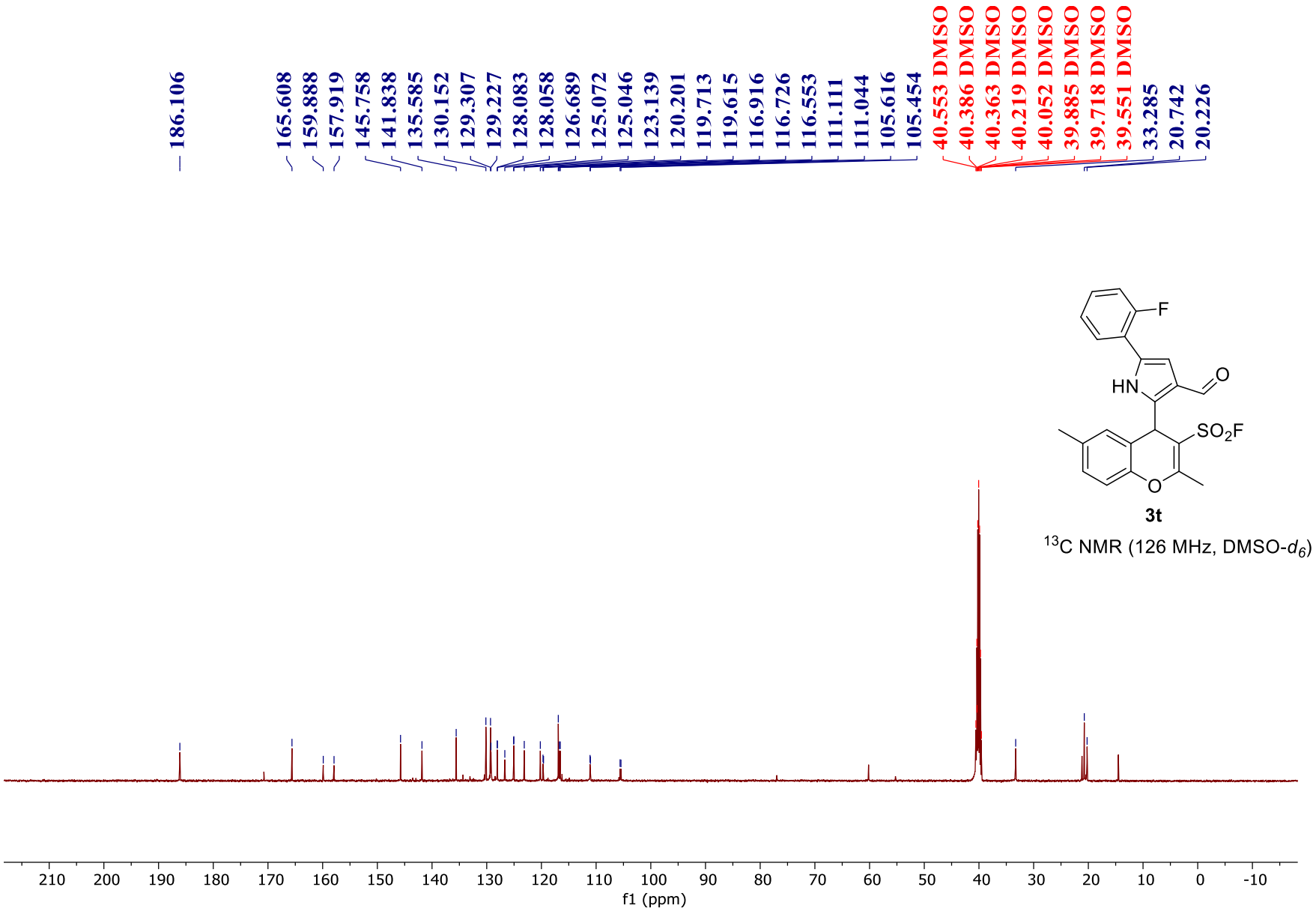

186.174
165.584
159.892
157.922
147.678
141.741
129.509
129.489
129.236
129.170
128.075
128.050
126.681
126.310
125.079
125.051
123.133
120.579
119.711
119.613
117.053
116.731
116.558
111.250
111.182
105.841
105.679
40.387 DMSO
40.220 DMSO
40.053 DMSO
39.886 DMSO
39.719 DMSO
39.553 DMSO
33.318
20.211
F
HN
O
SO2F
O
3s
13C NMR (126 MHz, DMSO-d6)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

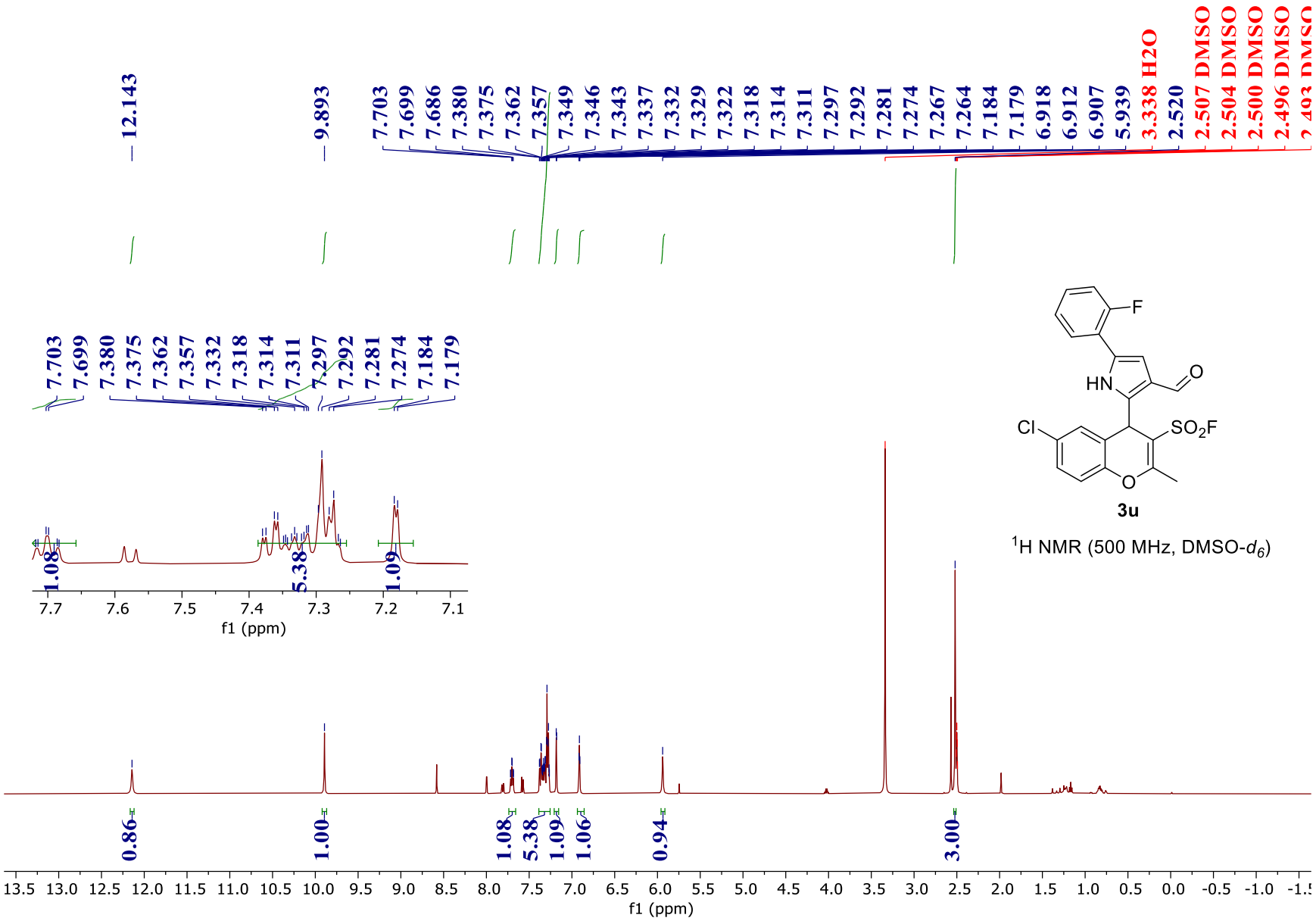

12.087
9.907
7.723
7.719
7.707
7.703
7.691
7.688
7.354
7.350
7.344
7.340
7.337
7.334
7.328
7.323
7.320
7.313
7.309
7.307
7.304
7.291
7.288
7.283
7.281
7.275
7.272
7.267
7.265
7.261
7.258
7.114
7.112
6.959
6.877
6.871
6.865
5.906
3.332 H2O
2.517
2.508 DMSO
2.504 DMSO
2.500 DMSO
2.496 DMSO
2.493 DMSO
2.193
0.87
0.99
0.99
3.15
2.04
1.03
1.02
0.98
3.08
3.00
f1 (ppm)
F
HN
O
SO2F
O
3t
1H NMR (500 MHz, DMSO-d6)

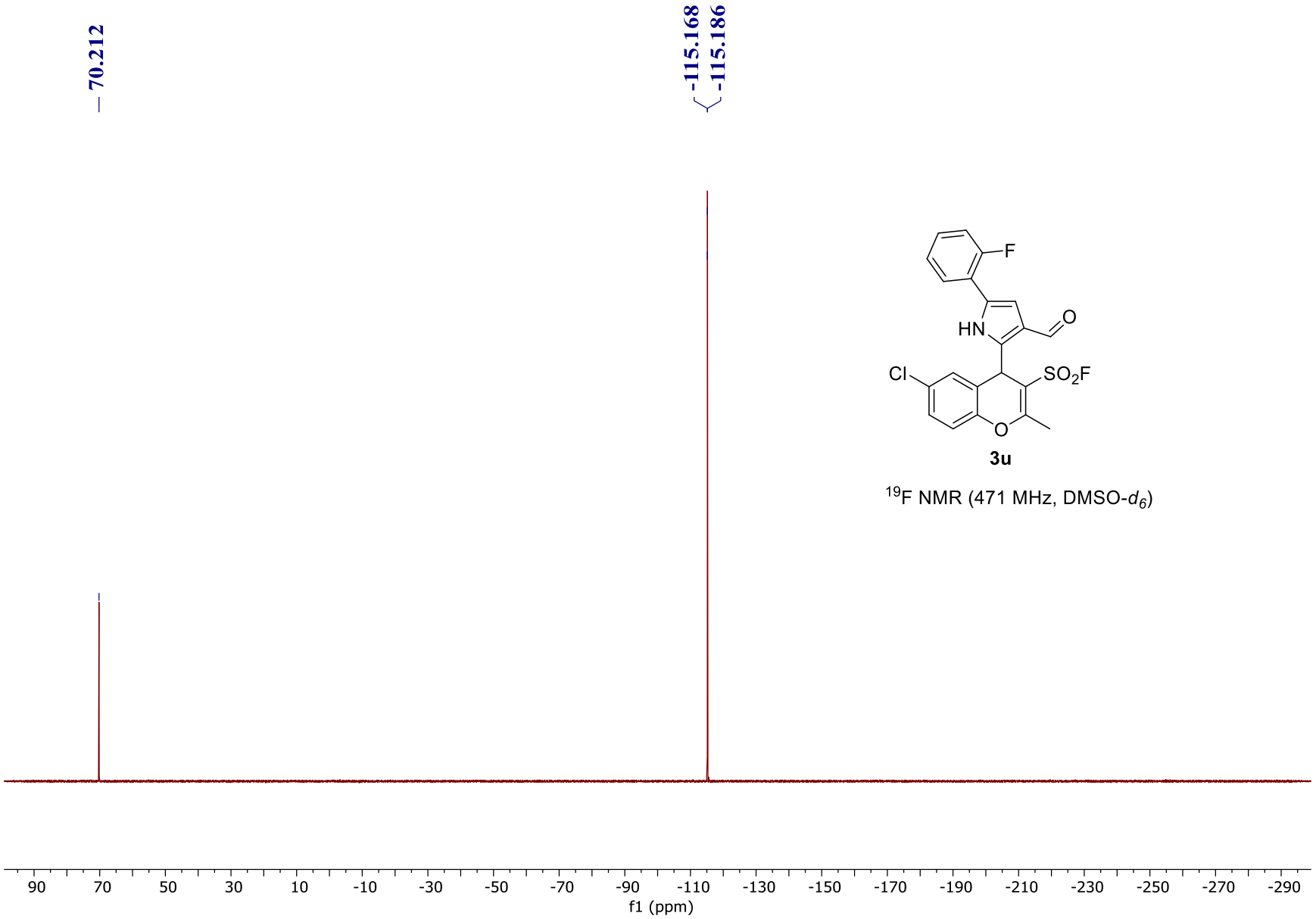


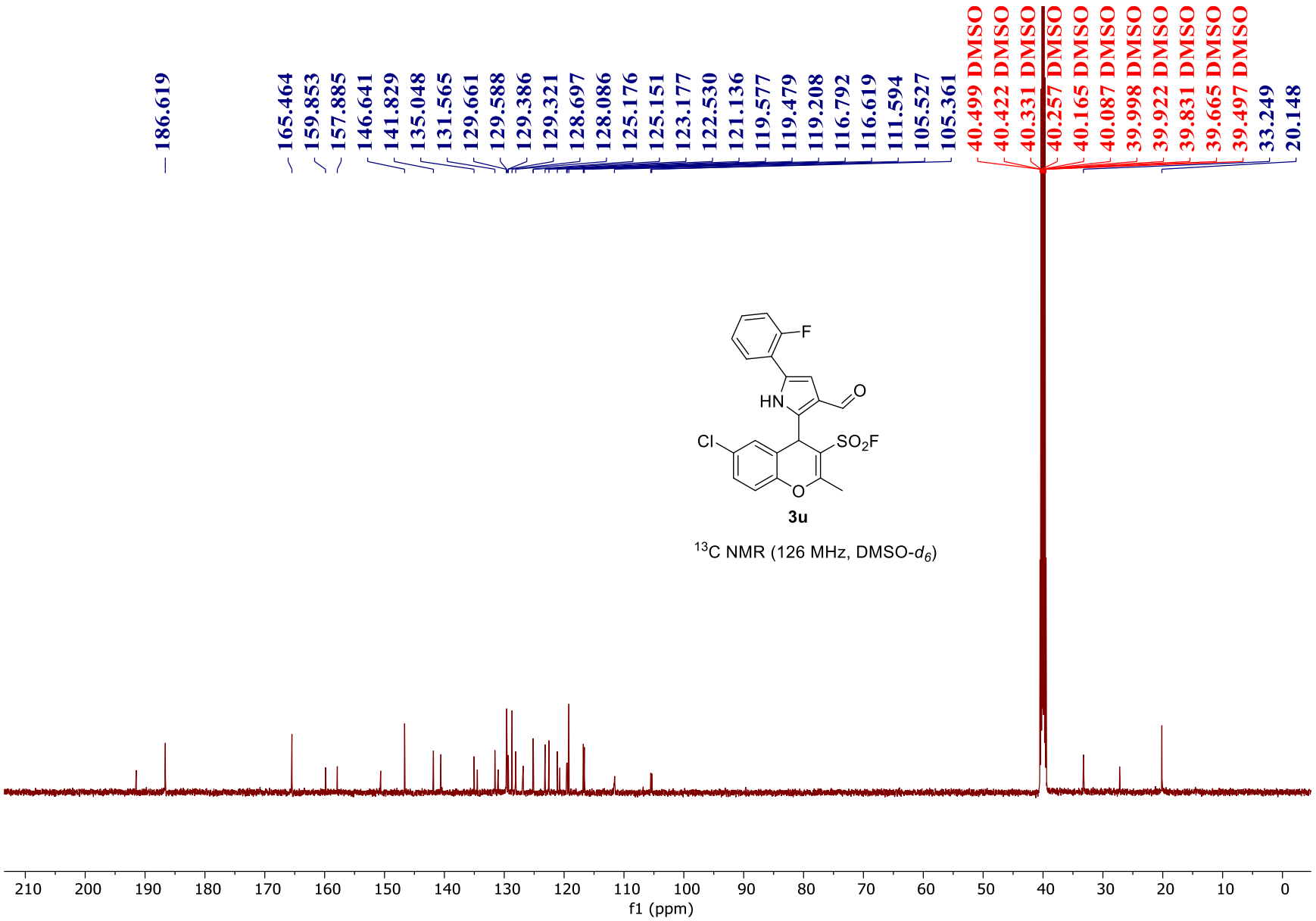
3t

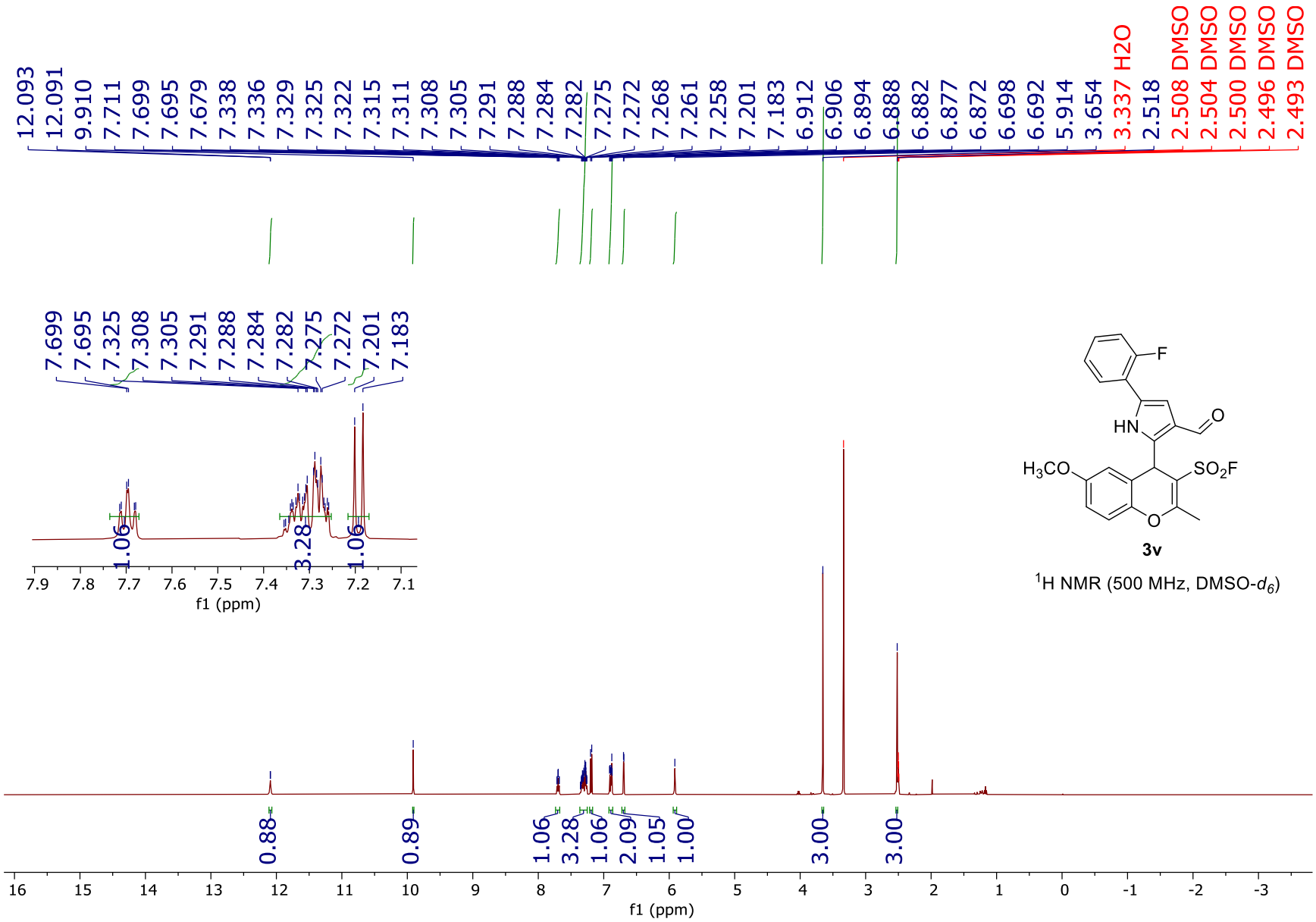
^{19}F NMR (471 MHz, DMSO-d_6)

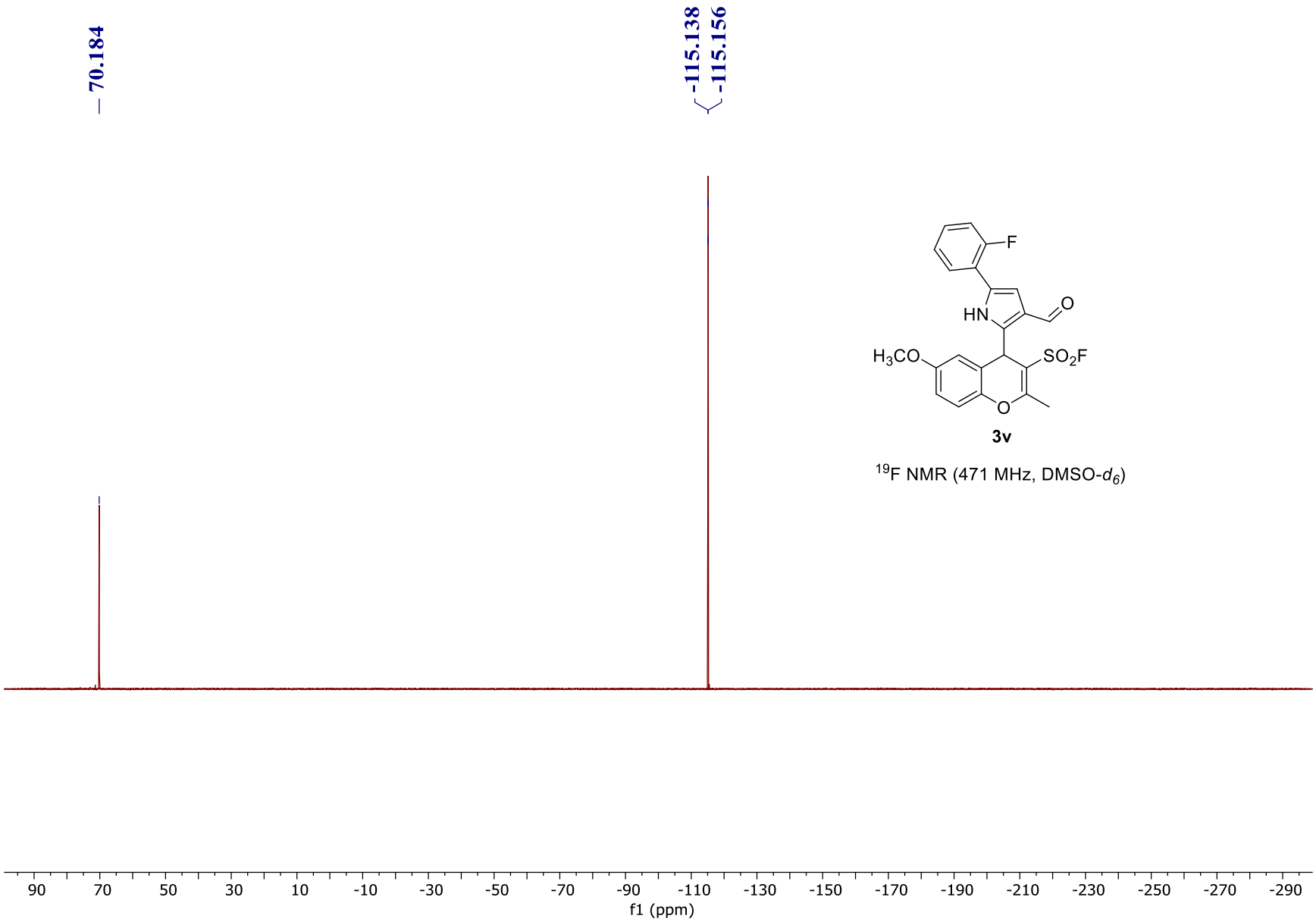

186.106
165.608
159.888
157.919
145.758
141.838
135.585
130.152
129.307
129.227
128.083
128.058
126.689
125.072
125.046
123.139
120.201
119.713
119.615
116.916
116.726
116.553
111.111
111.044
105.616
105.454
40.553 DMSO
40.386 DMSO
40.363 DMSO
40.219 DMSO
40.052 DMSO
39.885 DMSO
39.718 DMSO
39.551 DMSO
33.285
20.742
20.226
F
HN
O
SO2F
O
3t
13C NMR (126 MHz, DMSO-d6)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

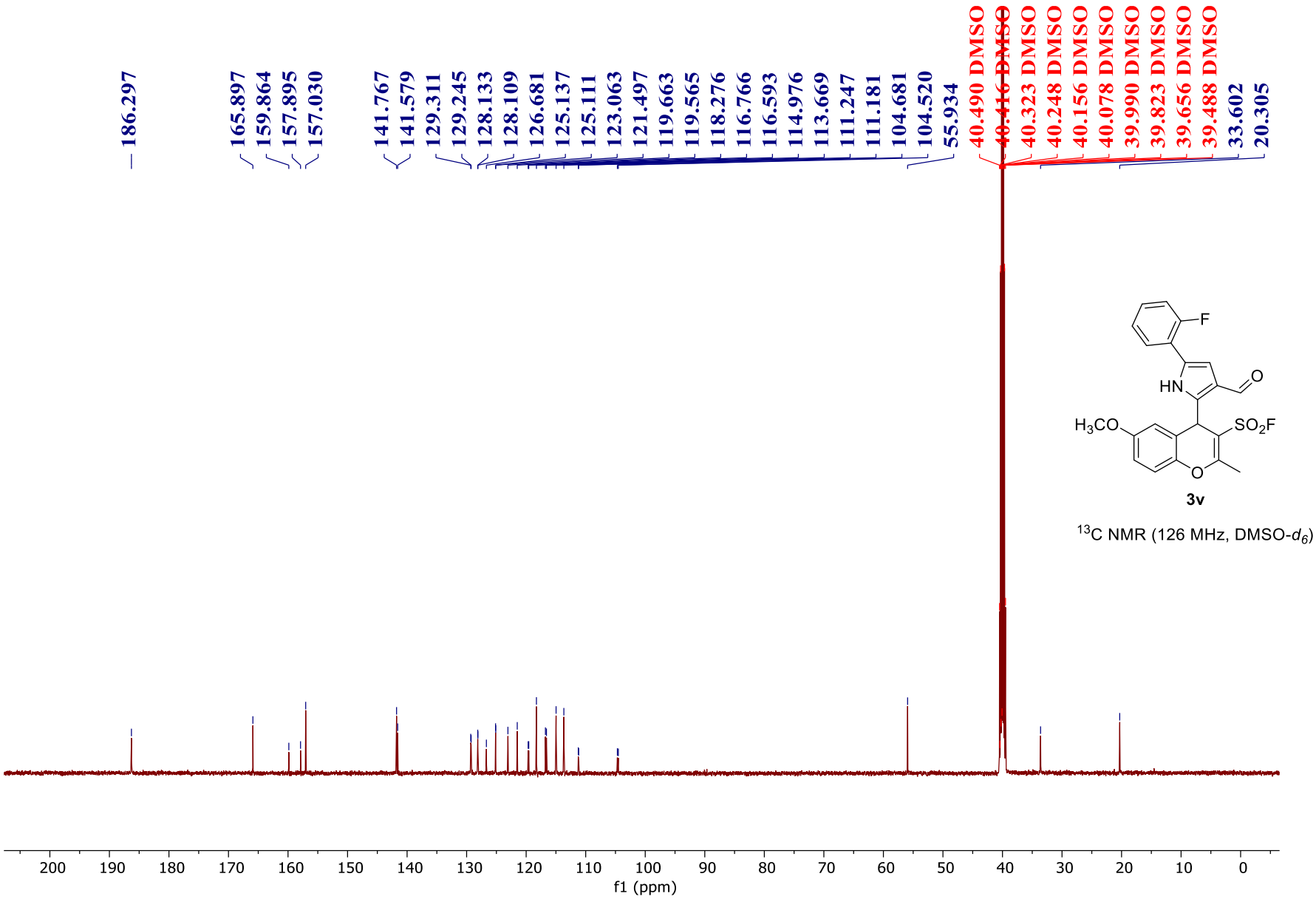

12.143
9.893
7.703
7.699
7.686
7.380
7.375
7.362
7.357
7.349
7.346
7.343
7.337
7.332
7.329
7.322
7.318
7.314
7.311
7.297
7.292
7.281
7.274
7.267
7.264
7.184
7.179
6.918
6.912
6.907
5.939
3.338 H2O
2.520
2.507 DMSO
2.504 DMSO
2.500 DMSO
2.496 DMSO
F
HN
O
Cl
SO2F
O
3u
1H NMR (500 MHz, DMSO-d6)
1.08
5.38
1.09
f1 (ppm)
0.86
1.00
1.08
5.38
1.09
1.06
0.94
3.00
f1 (ppm)

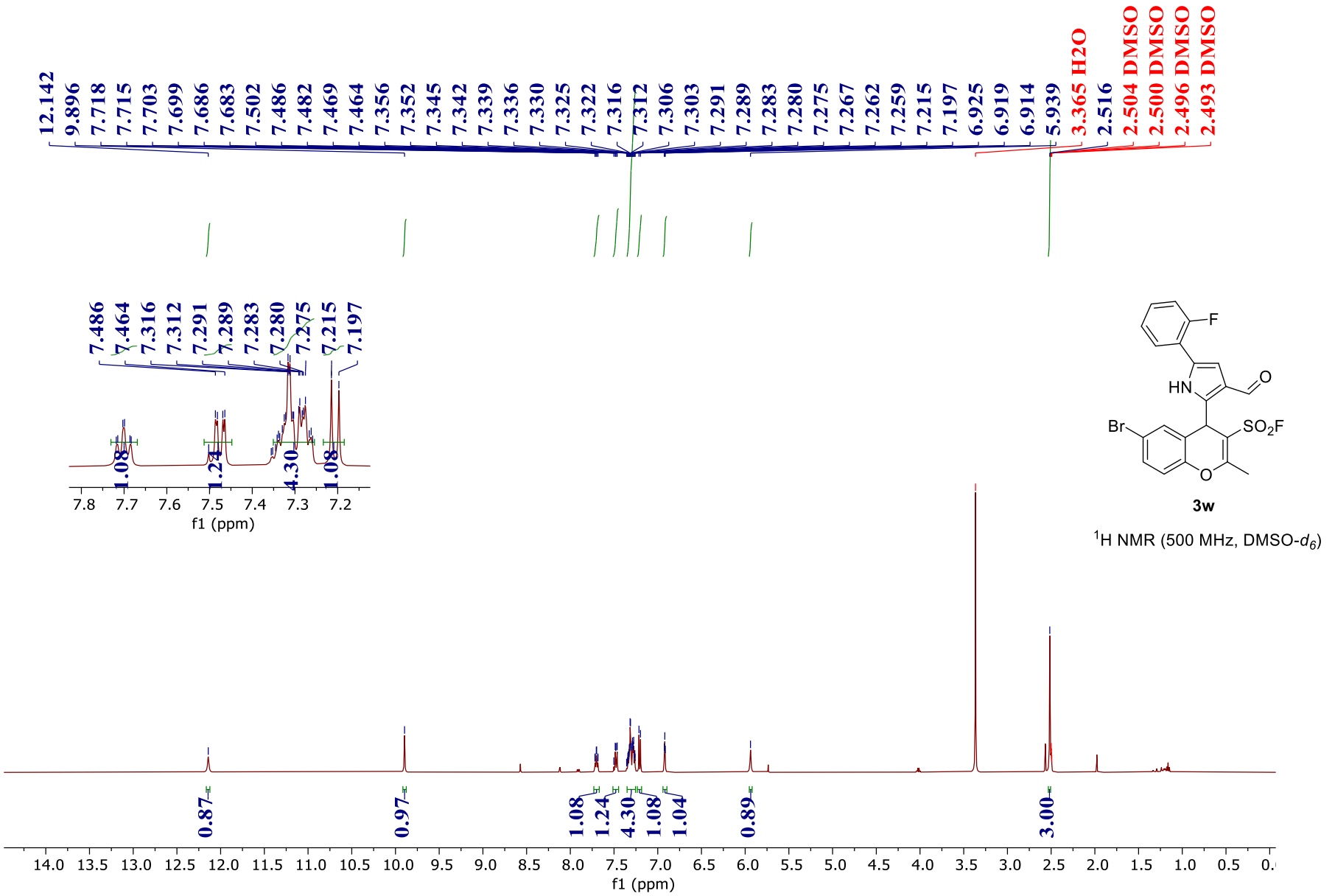

70.212
-115.168
-115.186
F
HN
O
Cl
SO2F
O
3u
19F NMR (471 MHz, DMSO-d6)
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
f1 (ppm)

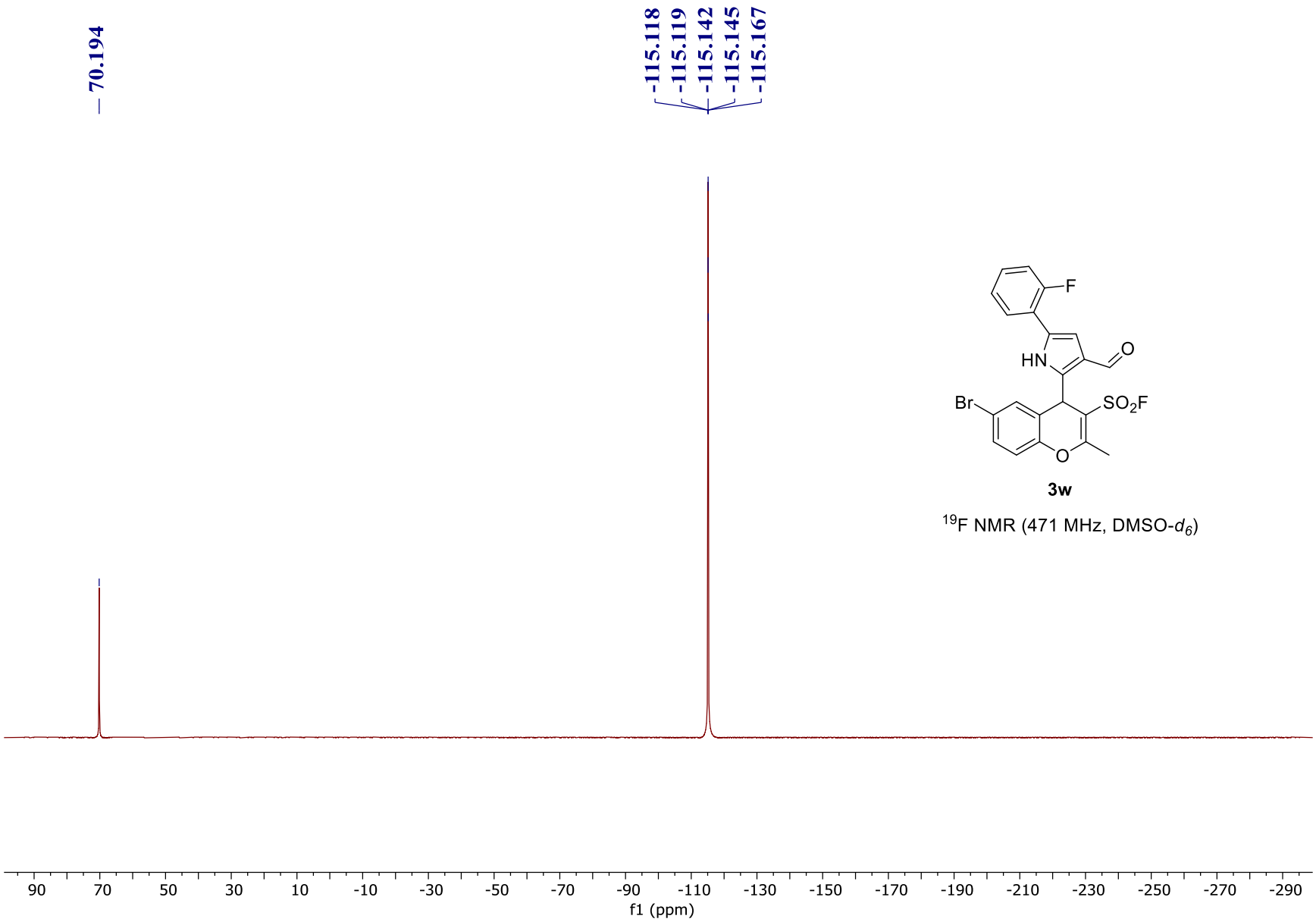

186.619
165.464
159.853
157.885
146.641
141.829
135.048
131.565
129.661
129.588
129.386
129.321
128.697
128.086
125.176
125.151
123.177
122.530
121.136
119.577
119.479
119.208
116.792
116.619
111.594
105.527
105.361
40.499 DMSO
40.422 DMSO
40.331 DMSO
40.257 DMSO
40.165 DMSO
40.087 DMSO
39.998 DMSO
39.922 DMSO
39.831 DMSO
39.665 DMSO
39.497 DMSO
33.249
20.148
F
HN
O
Cl
SO2F
O
3u
13C NMR (126 MHz, DMSO-d6)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


12.093
12.091
9.910
7.711
7.699
7.695
7.679
7.338
7.336
7.329
7.325
7.322
7.315
7.311
7.308
7.305
7.291
7.288
7.284
7.282
7.275
7.272
7.268
7.261
7.258
7.201
7.183
6.912
6.906
6.894
6.888
6.882
6.877
6.872
6.698
6.692
5.914
3.654
3.337 H2O
2.518
2.508 DMSO
2.504 DMSO
2.500 DMSO
2.496 DMSO
2.493 DMSO
7.699
7.695
7.325
7.308
7.305
7.291
7.288
7.284
7.282
7.275
7.272
7.201
7.183
1.06
3.28
1.06
7.9 7.8 7.7 7.6 7.5 7.4 7.3 7.2 7.1
f1 (ppm)
F
HN
O
H3CO
SO2F
O
3v
1H NMR (500 MHz, DMSO-d6)
0.88
0.89
1.06
3.28
1.06
2.09
1.05
1.00
3.00
3.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)


-70.184
-115.138
-115.156
F
HN
O
H3CO
SO2F
O
3v
19F NMR (471 MHz, DMSO-d6)
90
70
50
30
10
-10
-30
-50
-70
-90
-110
-130
-150
-170
-190
-210
-230
-250
-270
-290
f1 (ppm)

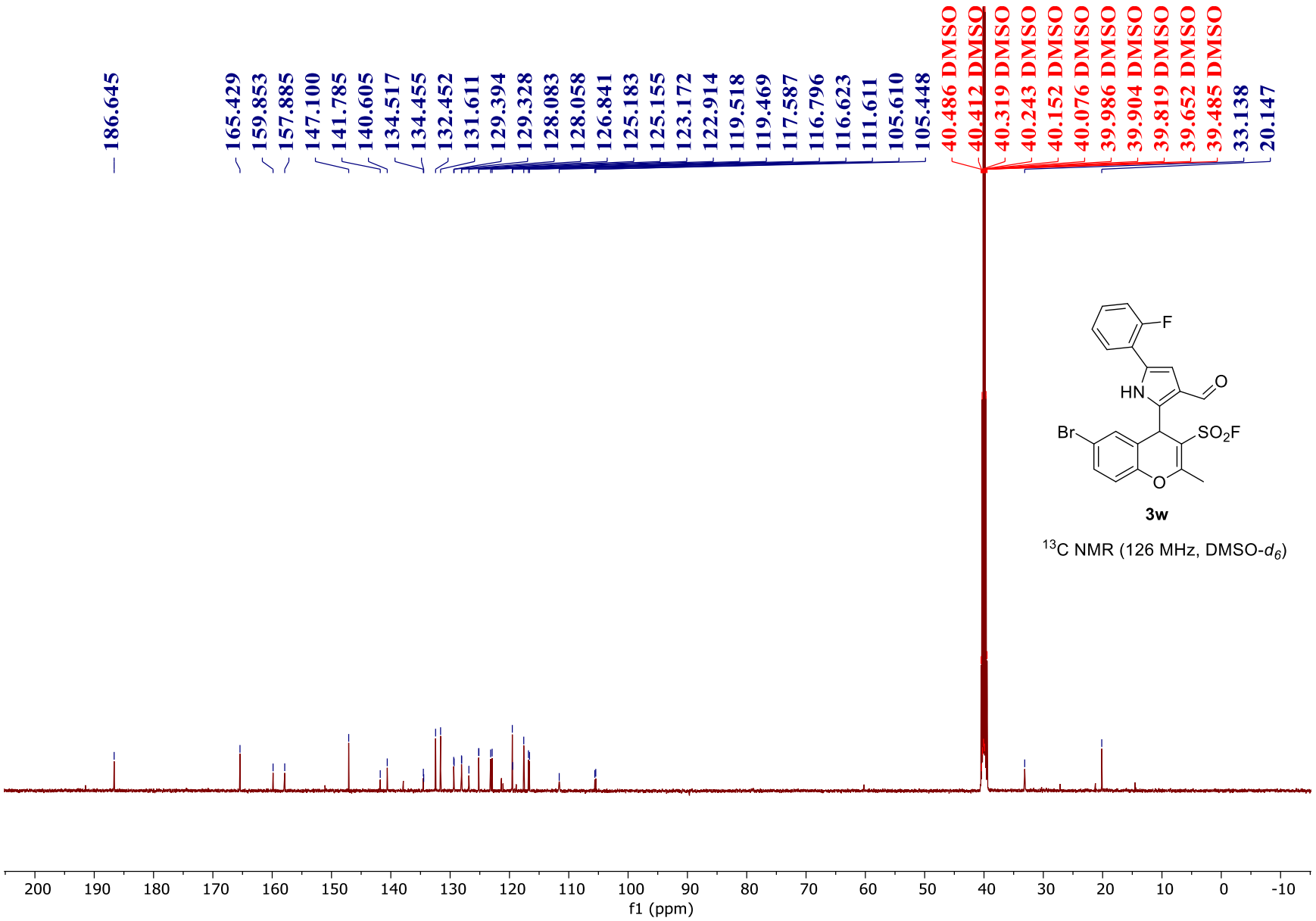

186.297
165.897
159.864
157.895
157.030
141.767
141.579
129.311
129.245
128.133
128.109
126.681
125.137
125.111
123.063
121.497
119.663
119.565
118.276
116.766
116.593
114.976
113.669
111.247
111.181
104.681
104.520
55.934
40.490 DMSO
40.416 DMSO
40.323 DMSO
40.248 DMSO
40.156 DMSO
40.078 DMSO
39.990 DMSO
39.823 DMSO
39.656 DMSO
39.488 DMSO
33.602
20.305
F
HN
O
H3CO
SO2F
O
3v
13C NMR (126 MHz, DMSO-d6)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

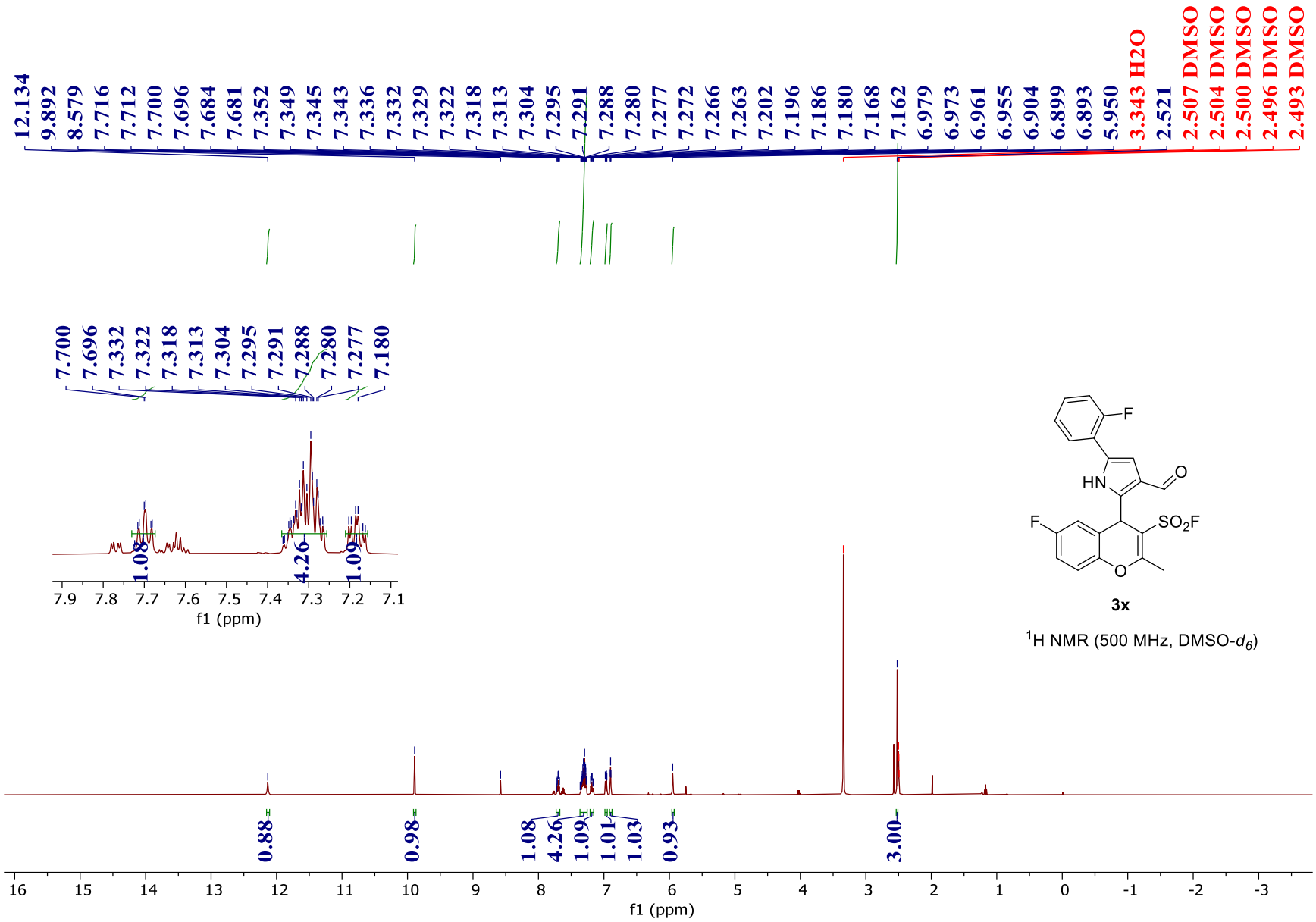

12.142
9.896
7.718
7.715
7.703
7.699
7.686
7.683
7.502
7.486
7.482
7.469
7.464
7.356
7.352
7.345
7.342
7.339
7.336
7.330
7.325
7.322
7.316
7.312
7.306
7.303
7.291
7.289
7.283
7.280
7.275
7.267
7.262
7.259
7.215
7.197
6.925
6.919
6.914
5.939
3.365 H2O
2.516
2.504 DMSO
2.500 DMSO
2.496 DMSO
2.493 DMSO
1.08
1.24
4.30
1.08
f1 (ppm)
F
HN
O
Br
SO2F
O
3w
1H NMR (500 MHz, DMSO-d6)
0.87
0.97
1.08
1.24
4.30
1.08
1.04
0.89
3.00
f1 (ppm)

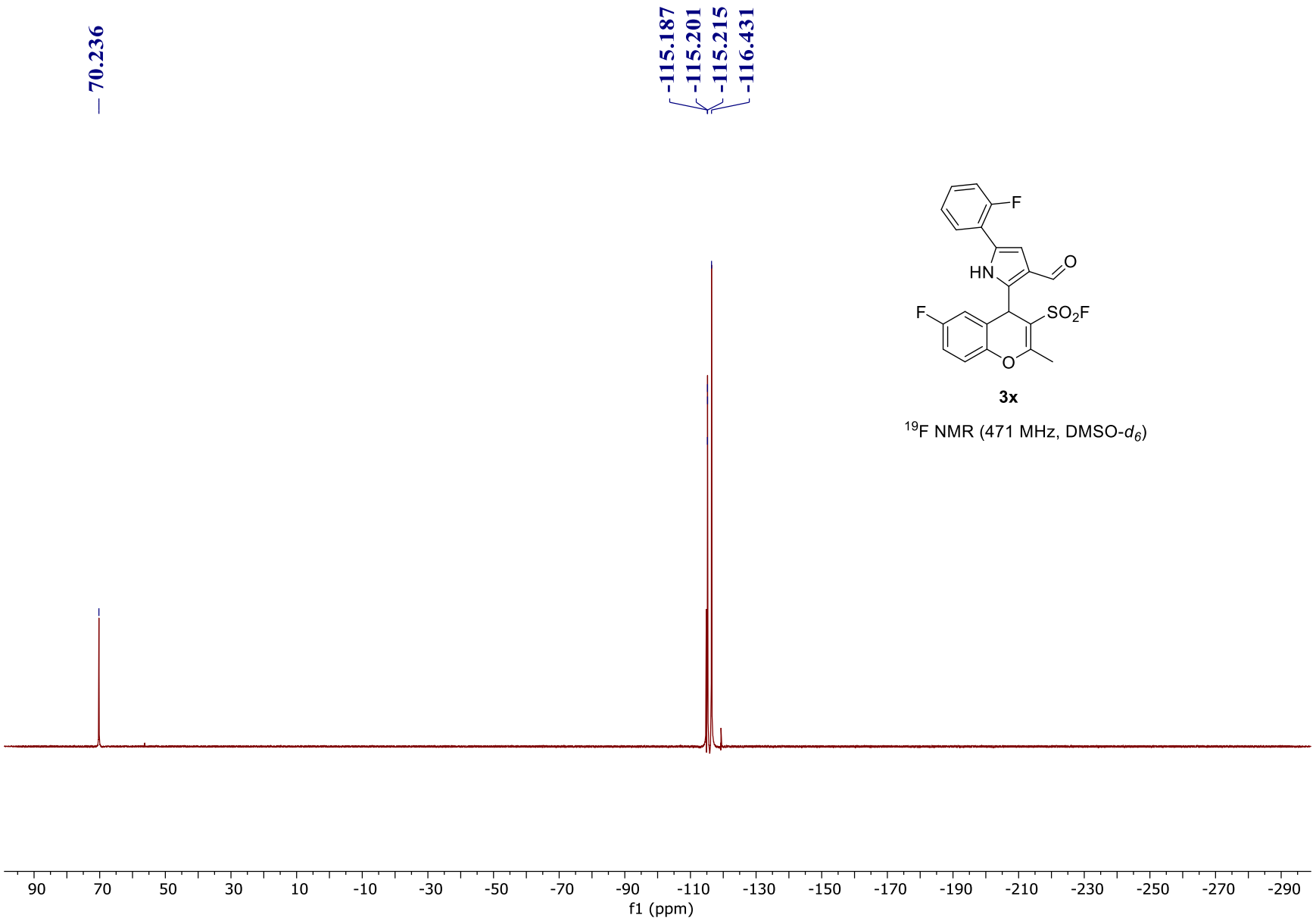


3w

^{19}F NMR (471 MHz, DMSO-d_6)

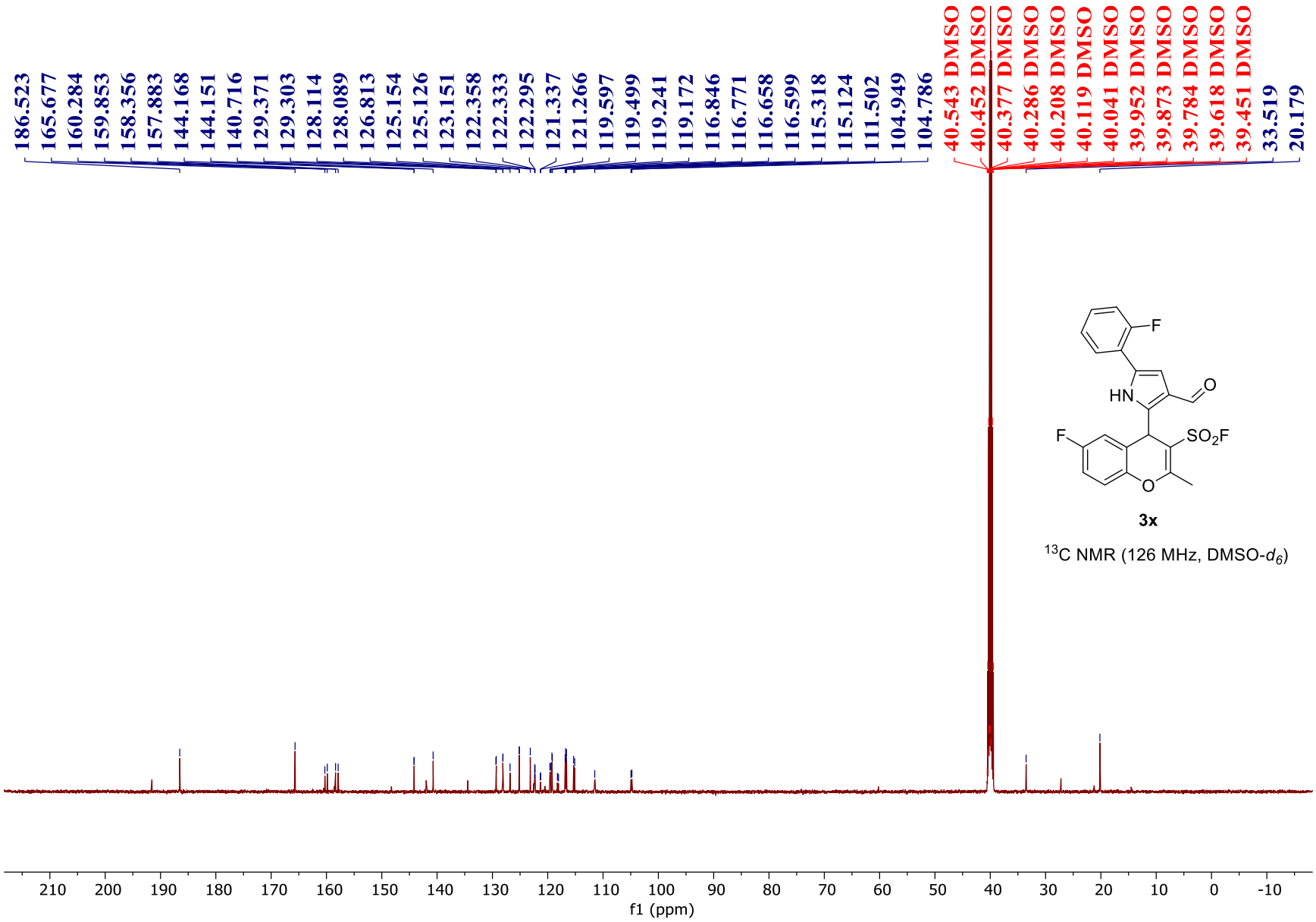

186.645
165.429
159.853
157.885
147.100
141.785
140.605
134.517
134.455
132.452
131.611
129.394
129.328
128.083
128.058
126.841
125.183
125.155
123.172
122.914
119.518
119.469
117.587
116.796
116.623
111.611
105.610
105.448
40.486 DMSO
40.412 DMSO
40.319 DMSO
40.243 DMSO
40.152 DMSO
40.076 DMSO
39.986 DMSO
39.904 DMSO
39.819 DMSO
39.652 DMSO
39.485 DMSO
33.138
20.147
F
HN
O
Br
SO2F
O
3w
13C NMR (126 MHz, DMSO-d6)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

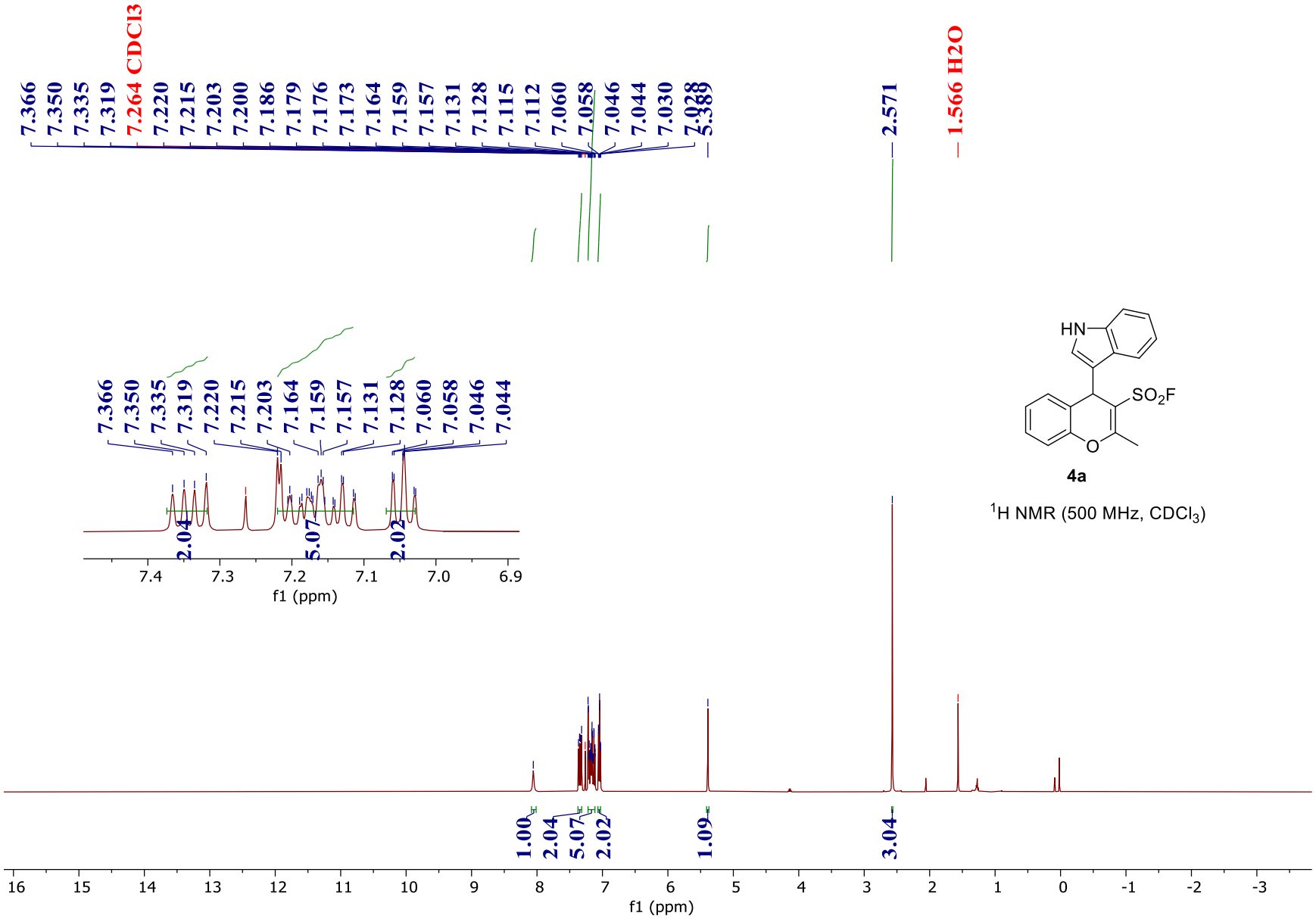

12.134
9.892
8.579
7.716
7.712
7.700
7.696
7.684
7.681
7.352
7.349
7.345
7.343
7.336
7.332
7.329
7.322
7.318
7.313
7.304
7.295
7.291
7.288
7.280
7.277
7.272
7.266
7.263
7.202
7.196
7.186
7.180
7.168
7.162
6.979
6.973
6.961
6.955
6.904
6.899
6.893
5.950
3.343 H2O
2.521
2.507 DMSO
2.504 DMSO
2.500 DMSO
2.496 DMSO
2.493 DMSO
1.08
4.26
1.09
f1 (ppm)
F
HN
O
F
SO2F
O
3x
1H NMR (500 MHz, DMSO-d6)
0.88
0.98
1.08
4.26
1.09
1.01
1.03
0.93
3.00
f1 (ppm)

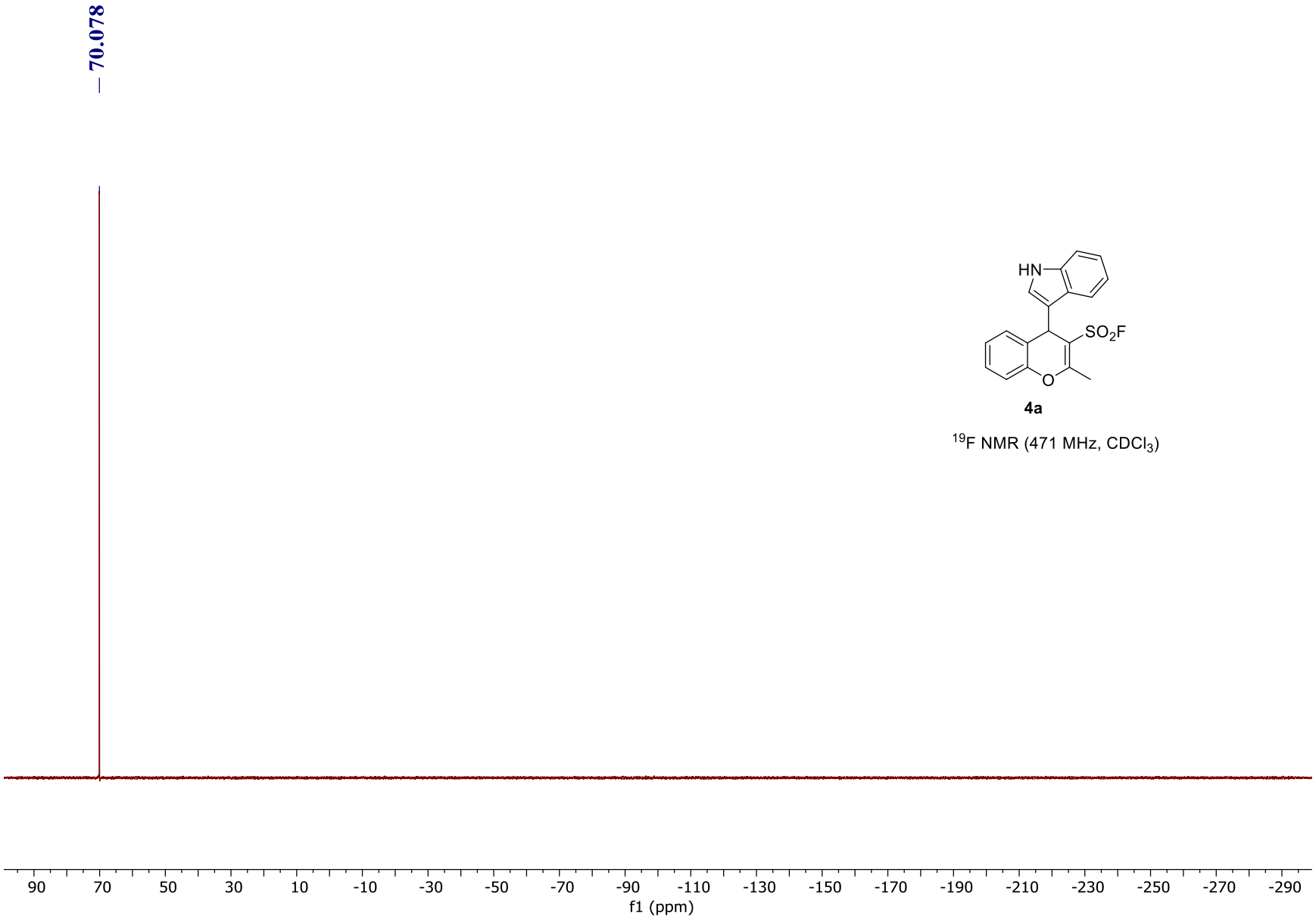


3x

^{19}F NMR (471 MHz, DMSO-d_6)

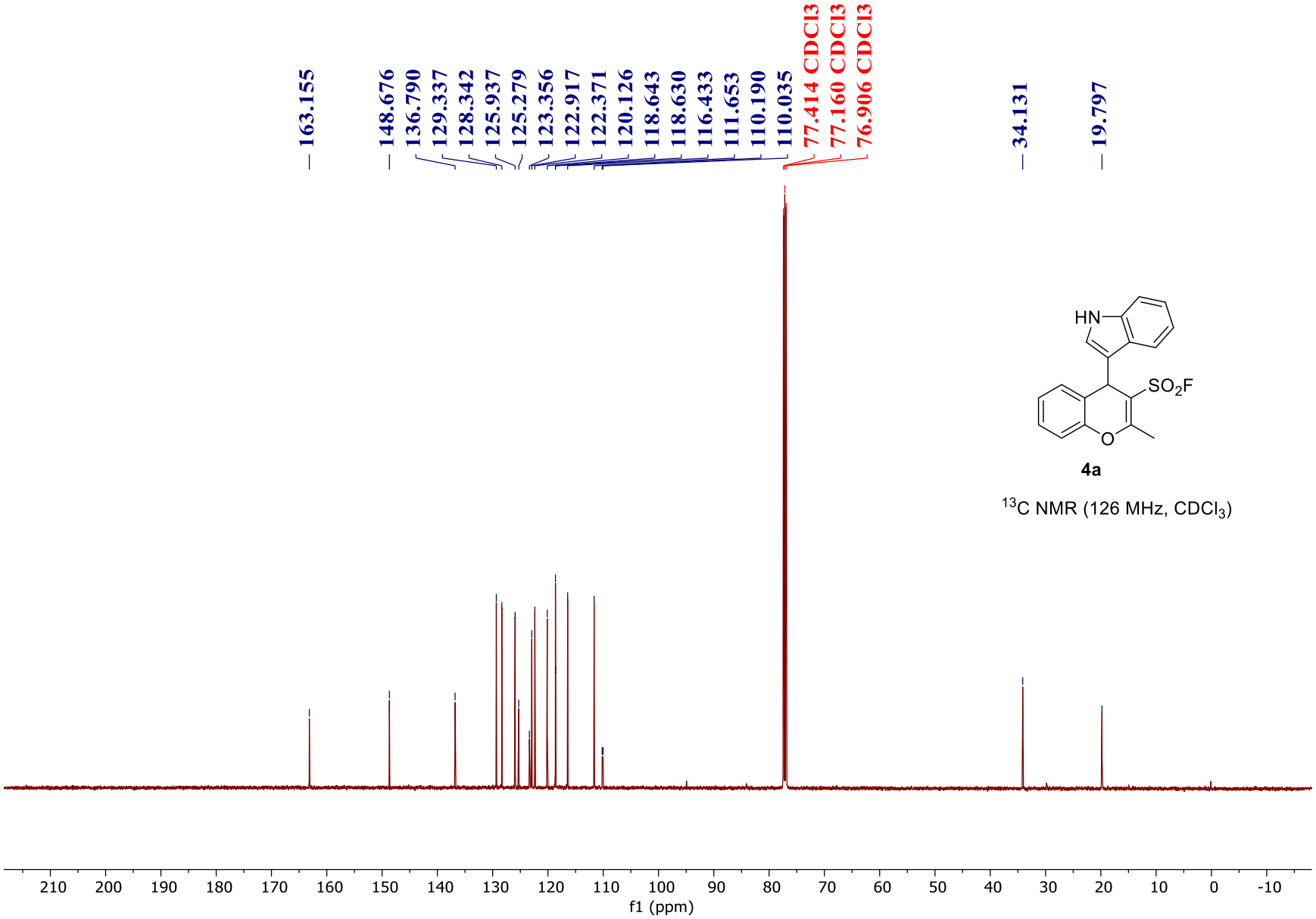

186.523
165.677
160.284
159.853
158.356
157.883
144.168
144.151
140.716
129.371
129.303
128.114
128.089
126.813
125.154
125.126
123.151
122.358
122.333
122.295
121.337
121.266
119.597
119.499
119.241
119.172
116.846
116.771
116.658
116.599
115.318
115.124
111.502
104.949
104.786
40.543 DMSO
40.452 DMSO
40.377 DMSO
40.286 DMSO
40.208 DMSO
40.119 DMSO
40.041 DMSO
39.952 DMSO
39.873 DMSO
39.784 DMSO
39.618 DMSO
39.451 DMSO
33.519
20.179
F
HN
O
F
SO2F
O
3x
13C NMR (126 MHz, DMSO-d6)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

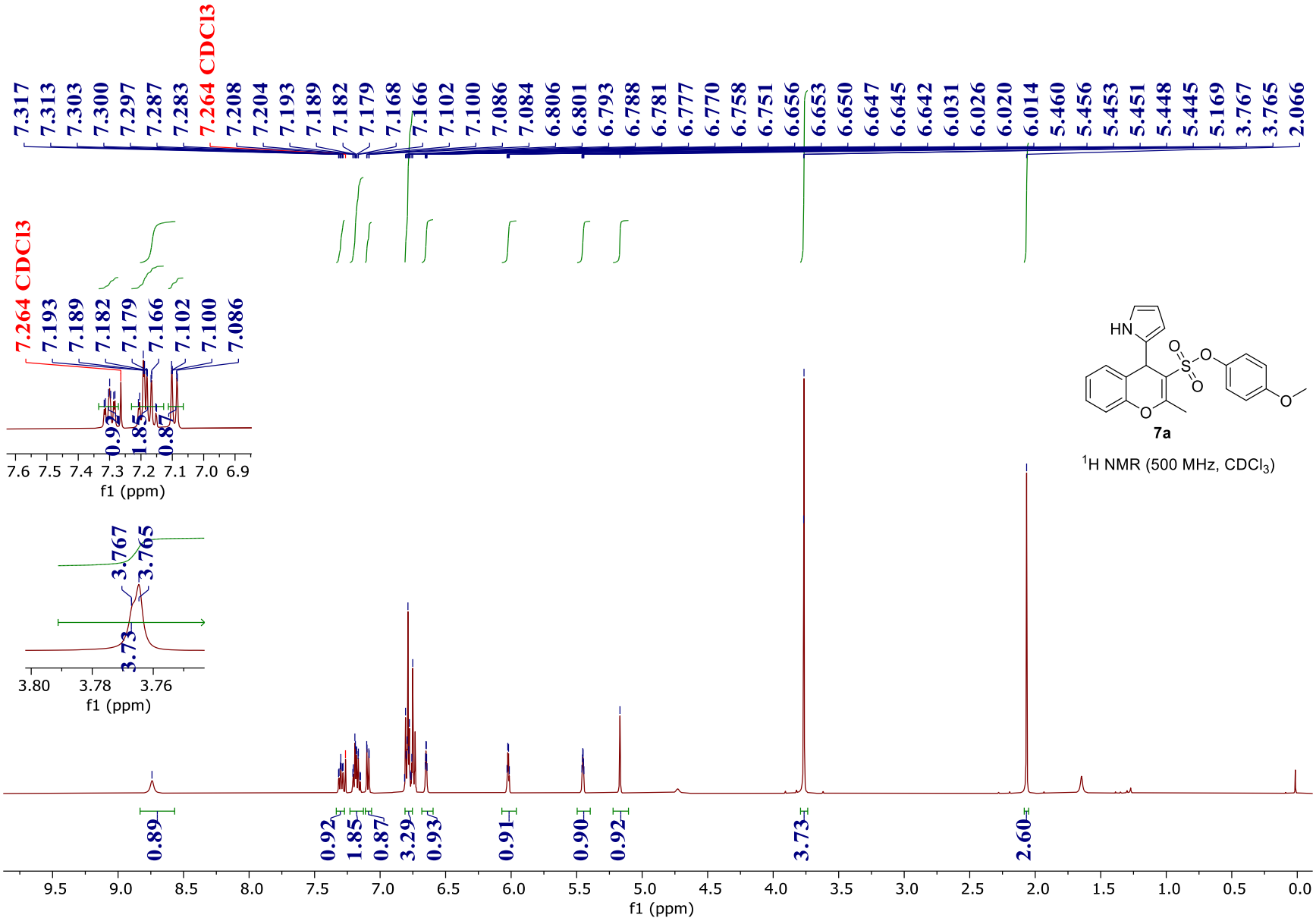

7.366
7.350
7.335
7.319
7.264 CDCl3
7.220
7.215
7.203
7.200
7.186
7.179
7.176
7.173
7.164
7.159
7.157
7.131
7.128
7.115
7.112
7.060
7.058
7.046
7.044
7.030
2.571
1.566 H2O
HN
SO2F
O
4a
1H NMR (500 MHz, CDCl3)
2.04
5.07
2.02
f1 (ppm)
1.00
2.04
5.07
2.02
1.09
3.04
f1 (ppm)

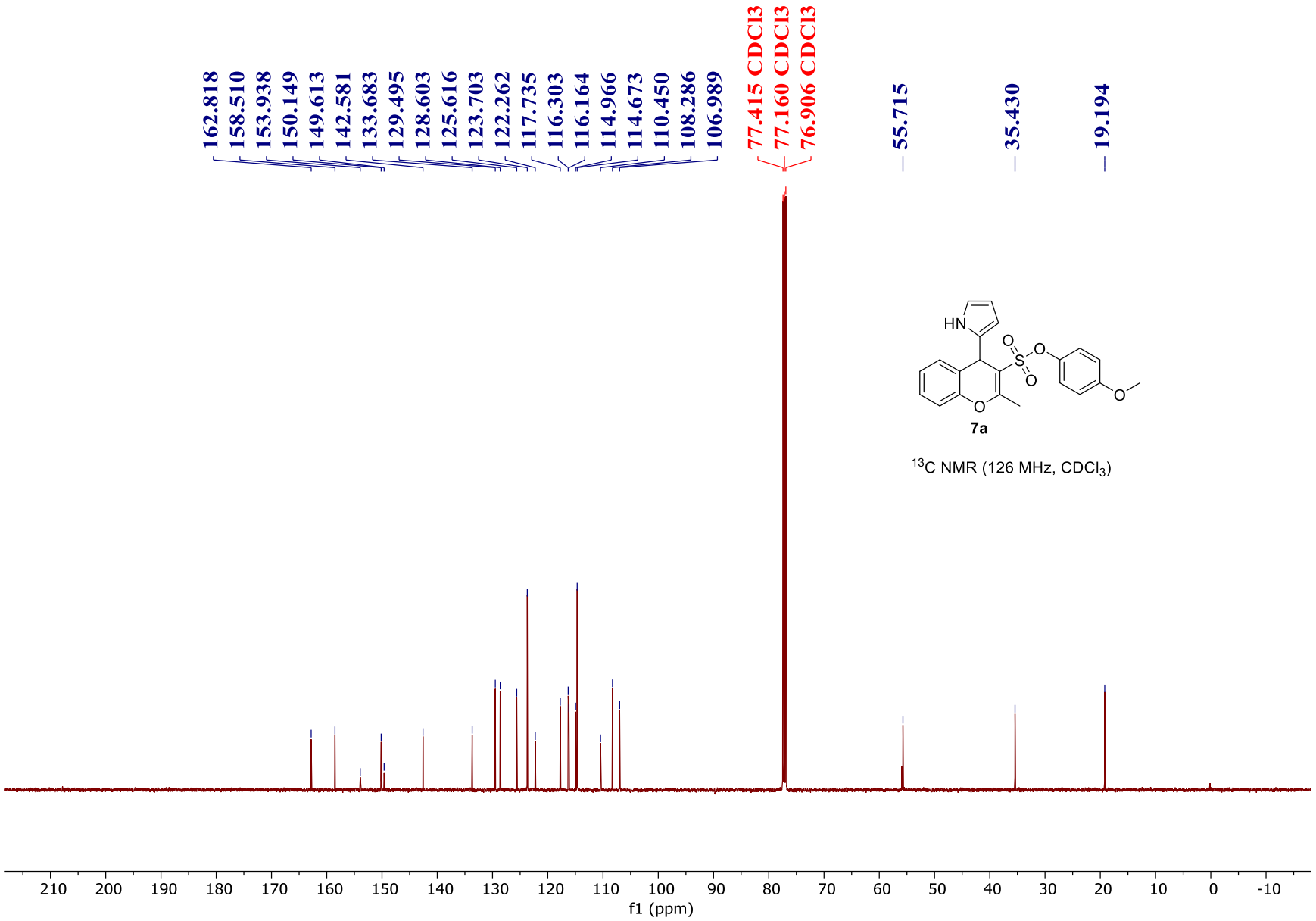


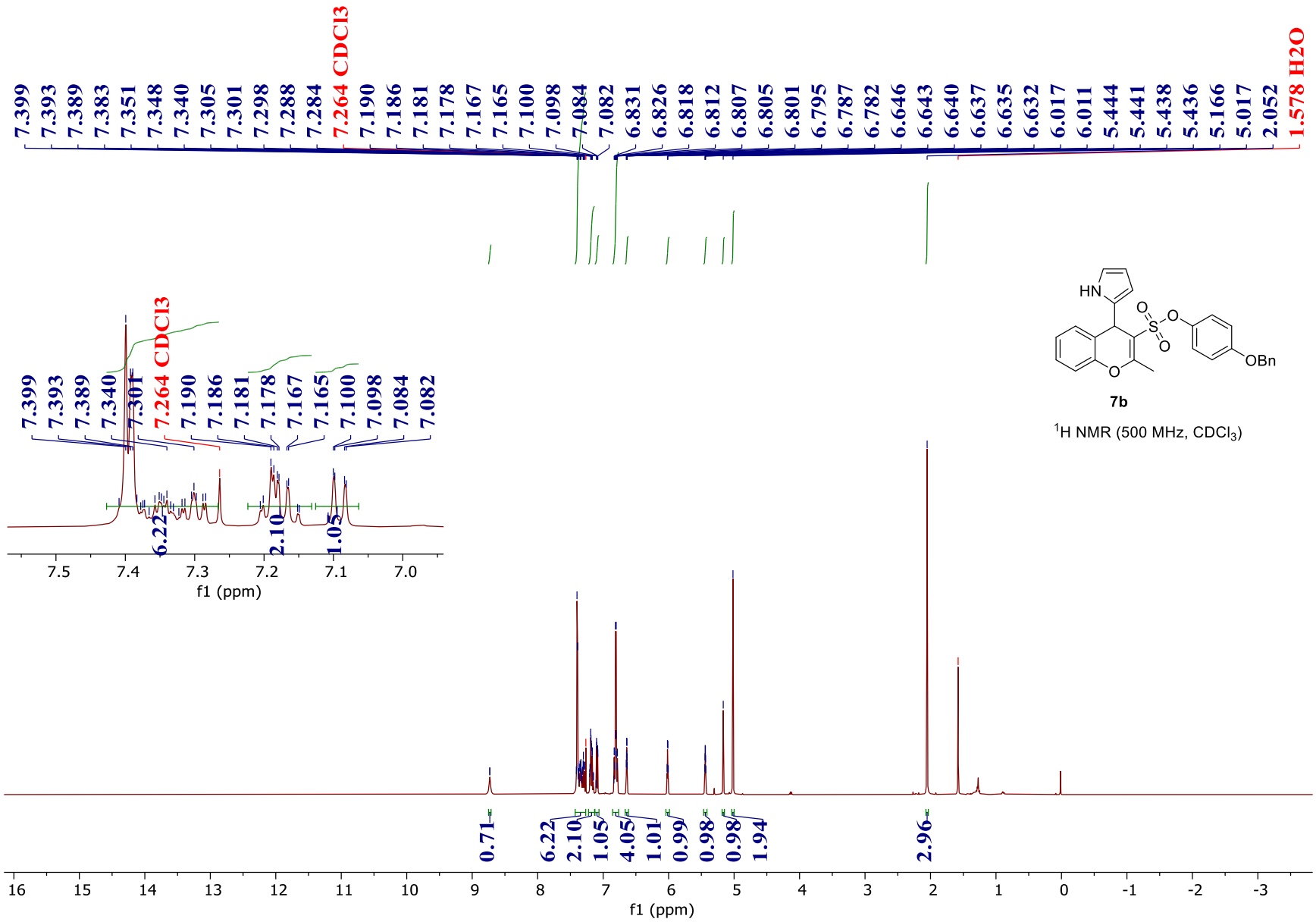
4a

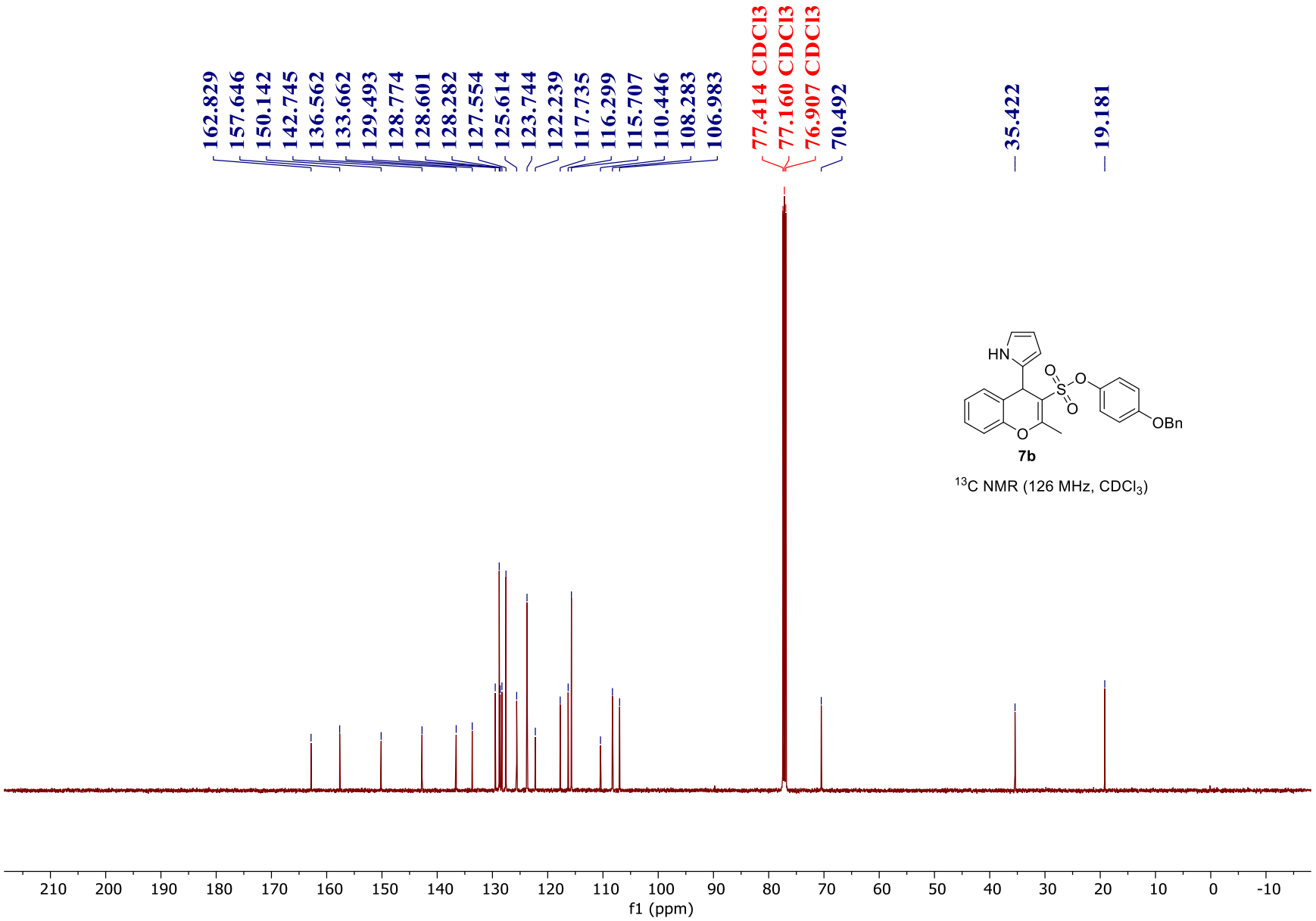
^{19}F NMR (471 MHz, $CDCl_3$)

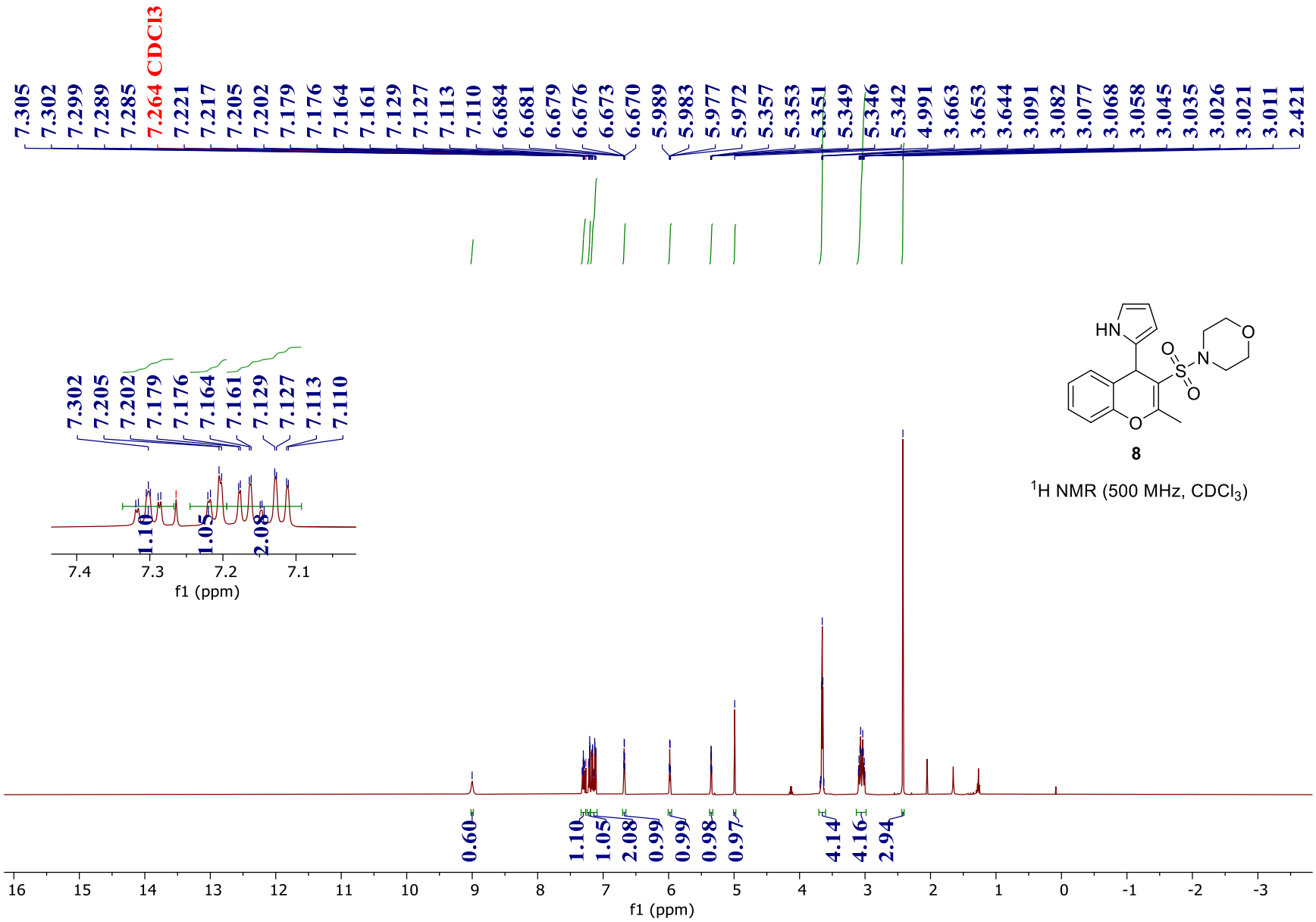

163.155
148.676
136.790
129.337
128.342
125.937
125.279
123.356
122.917
122.371
120.126
118.643
118.630
116.433
111.653
110.190
110.035
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
34.131
19.797
HN
SO2F
O
4a
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

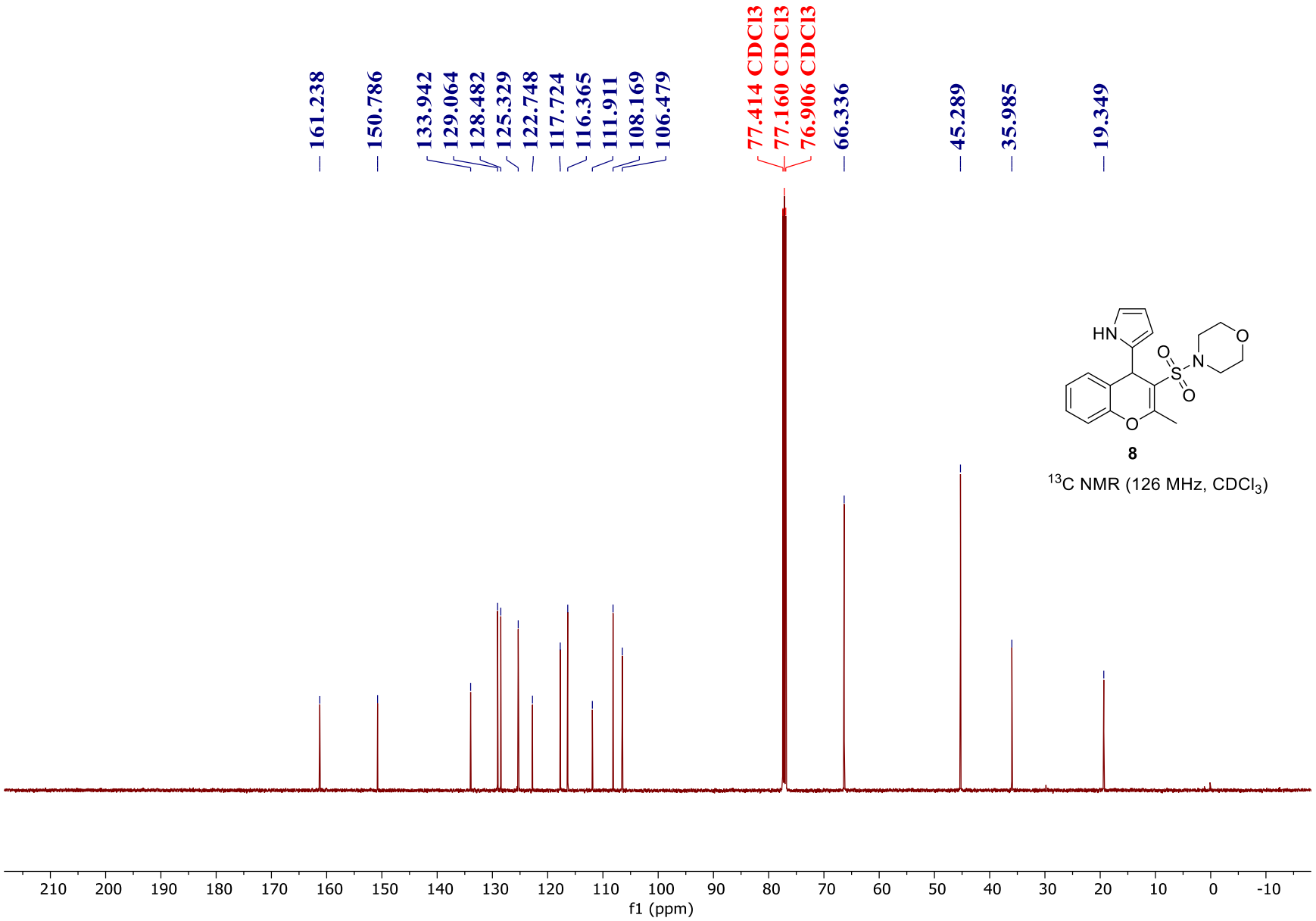

7.317
7.313
7.303
7.300
7.297
7.287
7.283
7.264 CDCl3
7.208
7.204
7.193
7.189
7.182
7.179
7.168
7.166
7.102
7.100
7.086
7.084
6.806
6.801
6.793
6.788
6.781
6.777
6.770
6.758
6.751
6.656
6.653
6.650
6.647
6.645
6.642
6.031
6.026
6.020
6.014
5.460
5.456
5.453
5.451
5.448
5.445
5.169
3.767
3.765
2.066
7.264 CDCl3
7.193
7.189
7.182
7.179
7.166
7.102
7.100
7.086
0.92
1.85
0.87
7.6 7.5 7.4 7.3 7.2 7.1 7.0 6.9
f1 (ppm)
3.767
3.765
3.73
3.80 3.78 3.76
f1 (ppm)
HN
O
S
O
O
O
O
7a
1H NMR (500 MHz, CDCl3)
0.89
0.92
1.85
0.87
3.29
0.93
0.91
0.90
0.92
3.73
2.60
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)

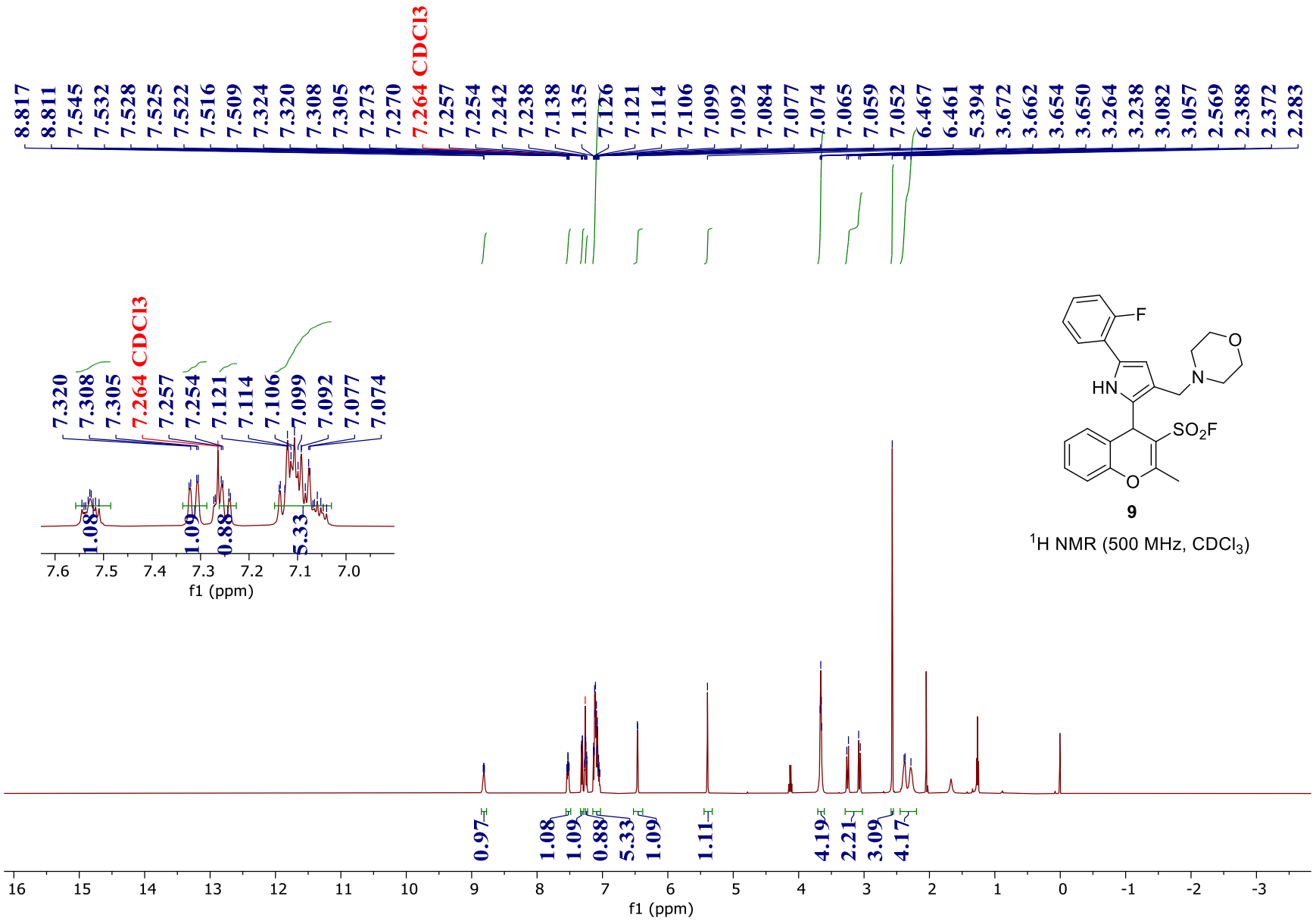

162.818
158.510
153.938
150.149
149.613
142.581
133.683
129.495
128.603
125.616
123.703
122.262
117.735
116.303
116.164
114.966
114.673
110.450
108.286
106.989
77.415 CDCl3
77.160 CDCl3
76.906 CDCl3
55.715
35.430
19.194
HN
O
S
O
O
O
O
7a
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

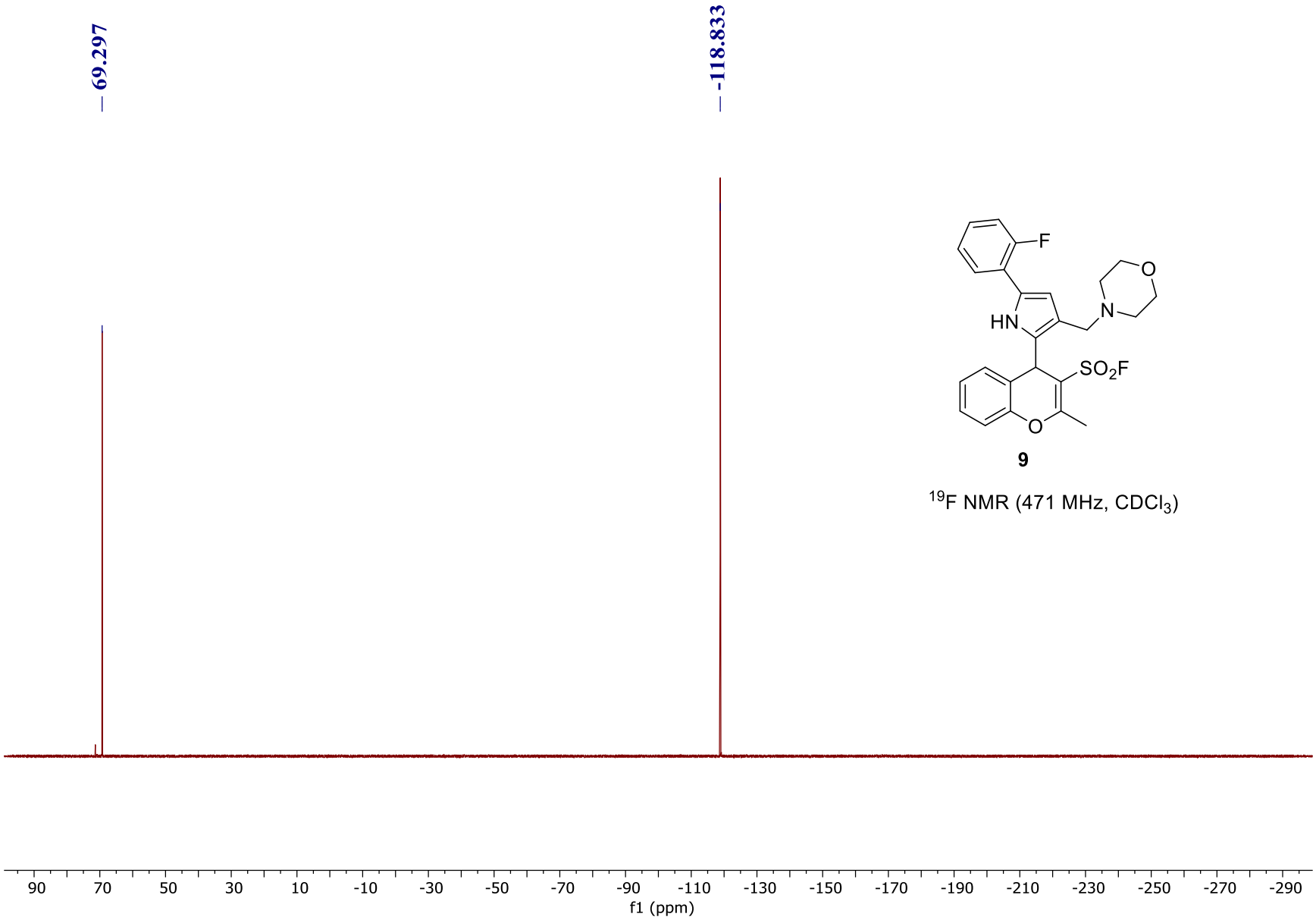

7.399
7.393
7.389
7.383
7.351
7.348
7.340
7.305
7.301
7.298
7.288
7.284
7.264 CDCl3
7.190
7.186
7.181
7.178
7.167
7.165
7.100
7.098
7.084
7.082
6.831
6.826
6.818
6.812
6.807
6.805
6.801
6.795
6.787
6.782
6.646
6.643
6.640
6.637
6.635
6.632
6.017
6.011
5.444
5.441
5.438
5.436
5.166
5.017
2.052
1.578 H2O
HN
O
S
O
O
O
OBn
7b
1H NMR (500 MHz, CDCl3)
6.22
2.10
1.05
0.71
4.05
1.01
0.99
0.98
0.98
1.94
2.96
f1 (ppm)


162.829
157.646
150.142
142.745
136.562
133.662
129.493
128.774
128.601
128.282
127.554
125.614
123.744
122.239
117.735
116.299
115.707
110.446
108.283
106.983
77.414 CDCl3
77.160 CDCl3
76.907 CDCl3
70.492
35.422
19.181
HN
O
S
O
O
O
OBn
7b
13C NMR (126 MHz, CDCl3)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.305
7.302
7.299
7.289
7.285
7.264 CDCl3
7.221
7.217
7.205
7.202
7.179
7.176
7.164
7.161
7.129
7.127
7.113
7.110
6.684
6.681
6.679
6.676
6.673
6.670
5.989
5.983
5.977
5.972
5.357
5.353
5.351
5.349
5.346
5.342
4.991
3.663
3.653
3.644
3.091
3.082
3.077
3.068
3.058
3.045
3.035
3.026
3.021
3.011
2.421
HN
O
O
S
N
O
O
8
1H NMR (500 MHz, CDCl3)
7.302
7.205
7.202
7.179
7.176
7.164
7.161
7.129
7.127
7.113
7.110
1.10
1.05
2.08
7.4
7.3
7.2
7.1
f1 (ppm)
0.60
1.10
1.05
2.08
0.99
0.99
0.98
0.97
4.14
4.16
2.94
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)

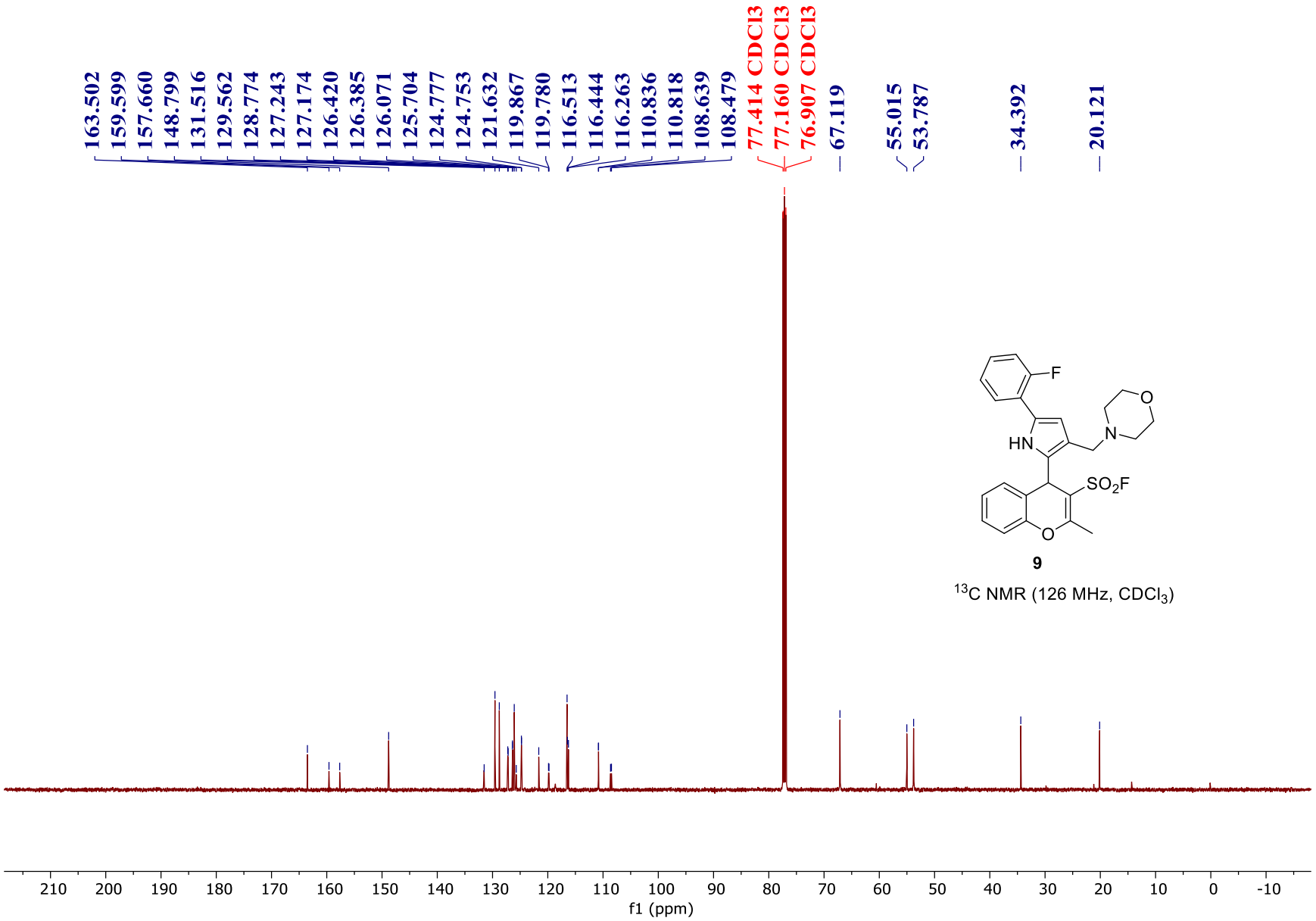

161.238
150.786
133.942
129.064
128.482
125.329
122.748
117.724
116.365
111.911
108.169
106.479
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
66.336
45.289
35.985
19.349
HN
O
O
S
N
O
O
8
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

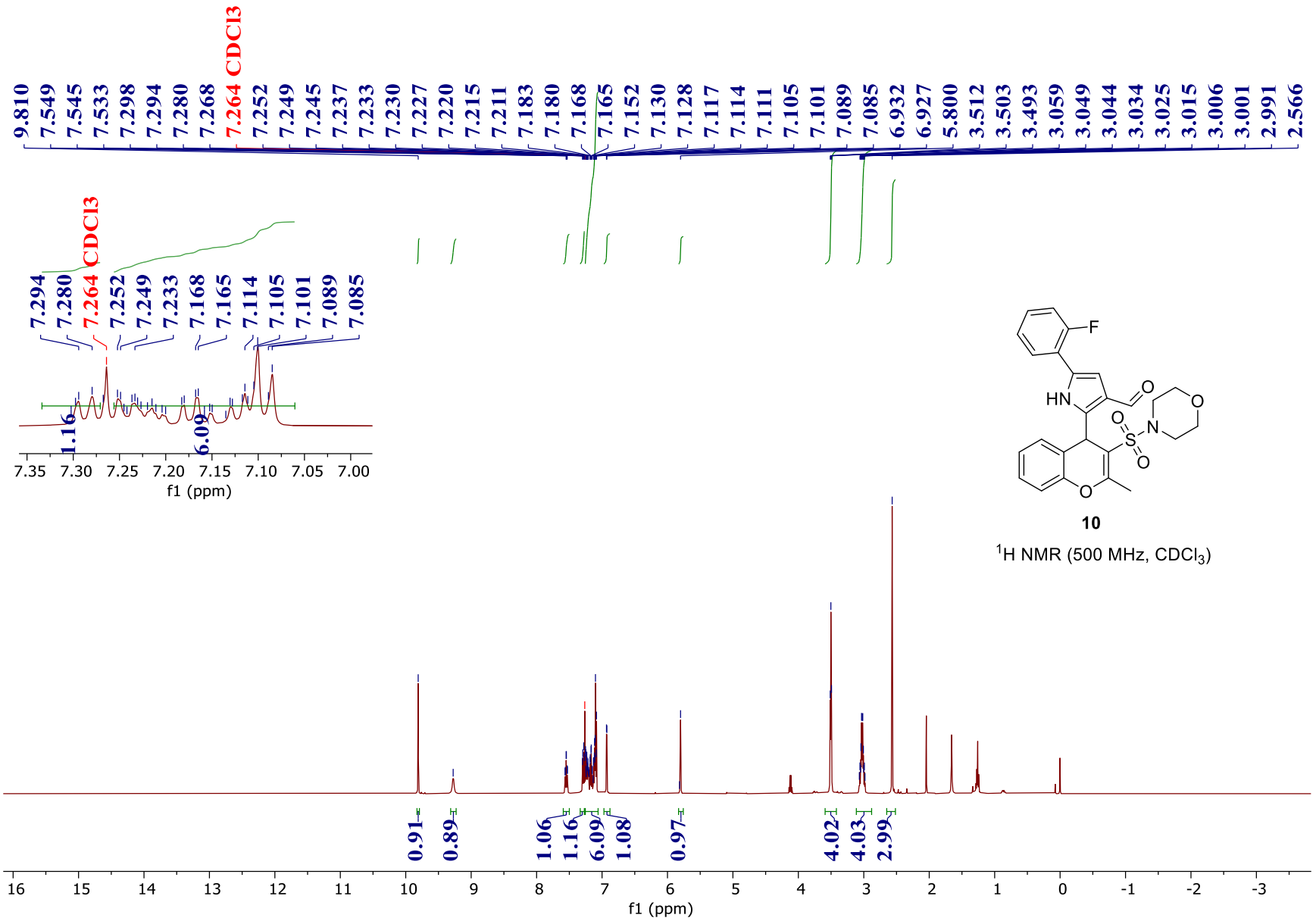

8.817
8.811
7.545
7.532
7.528
7.525
7.522
7.516
7.509
7.324
7.320
7.308
7.305
7.273
7.270
7.264 CDCl3
7.257
7.254
7.242
7.238
7.138
7.135
7.126
7.121
7.114
7.106
7.099
7.092
7.084
7.077
7.074
7.065
7.059
7.052
6.467
6.461
5.394
3.672
3.662
3.654
3.650
3.264
3.238
3.082
3.057
2.569
2.388
2.372
2.283
7.320
7.308
7.305
7.264 CDCl3
7.257
7.254
7.121
7.114
7.106
7.099
7.092
7.077
7.074
1.08
1.09
0.88
5.33
7.6
7.5
7.4
7.3
7.2
7.1
7.0
f1 (ppm)
F
O
N
HN
SO2F
O
9
1H NMR (500 MHz, CDCl3)
0.97
1.08
1.09
0.88
5.33
1.09
1.11
4.19
2.21
3.09
4.17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
-1
-2
-3
f1 (ppm)

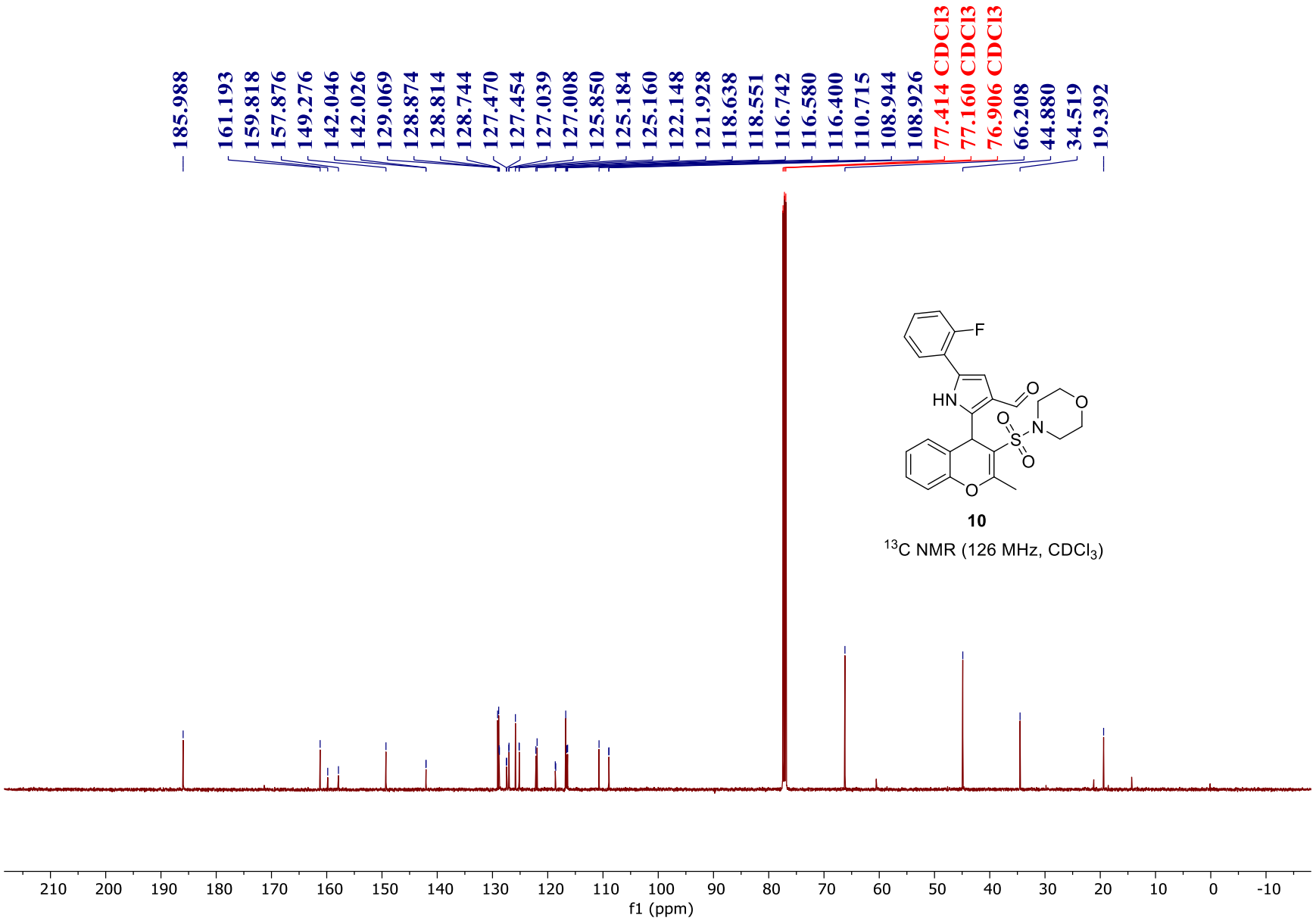


9

^{19}F NMR (471 MHz, $CDCl_3$)


163.502
159.599
157.660
148.799
131.516
129.562
128.774
127.243
127.174
126.420
126.385
126.071
125.704
124.777
124.753
121.632
119.867
119.780
116.513
116.444
116.263
110.836
110.818
108.639
108.479
77.414 CDCl3
77.160 CDCl3
76.907 CDCl3
67.119
55.015
53.787
34.392
20.121
F
O
N
HN
SO2F
O
9
13C NMR (126 MHz, CDCl3)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


9.810
7.549
7.545
7.533
7.298
7.294
7.280
7.268
7.264 CDCl3
7.252
7.249
7.245
7.237
7.233
7.230
7.227
7.220
7.215
7.211
7.183
7.180
7.168
7.165
7.152
7.130
7.128
7.117
7.114
7.111
7.105
7.101
7.089
7.085
6.932
6.927
5.800
3.512
3.503
3.493
3.059
3.049
3.044
3.034
3.025
3.015
3.006
3.001
2.991
2.566
7.294
7.280
7.264 CDCl3
7.252
7.249
7.233
7.168
7.165
7.114
7.105
7.101
7.089
7.085
1.16
6.09
7.35 7.30 7.25 7.20 7.15 7.10 7.05 7.00
f1 (ppm)
F
HN
O
O
N
S
O
O
O
10
1H NMR (500 MHz, CDCl3)
0.91
0.89
1.06
1.16
6.09
1.08
0.97
4.02
4.03
2.99
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)


185.988
161.193
159.818
157.876
149.276
142.046
142.026
129.069
128.874
128.814
128.744
127.470
127.454
127.039
127.008
125.850
125.184
125.160
122.148
121.928
118.638
118.551
116.742
116.580
116.400
110.715
108.944
108.926
77.414 CDCl3
77.160 CDCl3
76.906 CDCl3
66.208
44.880
34.519
19.392
F
HN
O
O
N
O
S
O
O
10
13C NMR (126 MHz, CDCl3)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)