SUPPLEMENTARY INFORMATION FOR

Mild access to planar-chiral *ortho*-condensed aromatic ferrocenes via enantioselective cationic gold(I)-catalyzed cycloisomerization of *ortho*-alkynylaryl ferrocenes

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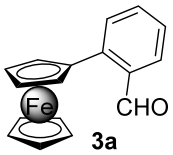
Experimental Procedures

General. Melting points were obtained in open capillary tubes and are uncorrected. ^{1}H- and ^{13}C-NMR spectra were recorded in $CDCl_3$ at 300 and 75 MHz, respectively. All reactions were monitored by thin layer chromatography that was performed on precoated sheets of silica gel 60, and flash column chromatography was done with silica gel 60 (230-400 mesh) of Merck. Eluting solvents are indicated in the text. The apparatus for inert atmosphere experiments was dried by flaming in a stream of dry nitrogen. Ethyl ether, CH_2Cl_2 and THF were dried over 4Å molecular sieves. All other reagent quality solvents were used without purification. For routine workup, extraction was carried out with ethyl acetate, and solvent drying with $MgSO_4$.

General procedure A. Suzuki Coupling

To a mixture of commercially available ferrocenyl boronic acid (**1**) (470 mg, 2 mmol), $Pd(PPh_3)_4$ (107 mg, 0.093 mmol) and K_3PO_4 (690 mg, 3.2 mmol), a solution of the corresponding commercially available 2-bromoaryl aldehydes **2a**-**k** (0.93 mmol) in toluene (15 mL) was added. The resulting suspension was refluxed overnight and filtered through Celite. After solvent evaporation and flash chromatography, the pure 2-formylaryl ferrocenes **3a**-**k** were obtained.

2-Formylphenyl-ferrocene (3a)



3a

Compound **3a** was obtained from 2-bromobenzaldehyde (**2a**) following ***general procedure A*** (eluent heptane/EtOAc 5:1), in 67% yield.

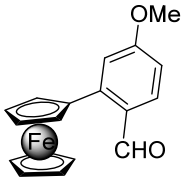
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.33 (s, 1H), 7.76 (d, *J* = 7.9 Hz, 2H), 7.44 (td, *J* = 7.7, 1.4 Hz, 1H), 7.23 (t, *J* = 7.5 Hz, 1H), 4.40 (broad s, 2H), 4.30 (broad s, 2H), 4.04 (s, 5H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 192.5, 143.0, 134.0, 132.9, 131.6, 127.2, 126.3, 83.4, 70.9 (2C), 69.8 (5C), 69.2 (2C).

MS (EI): *m/z* (%) 290 (M^+, 15), 152 (100).

HRMS (EI): Calculated for $C_{17}H_{14}FeO$ (M^+) 290.0394, found 290.0385.

2-Formyl-5-methoxyphenyl-ferrocene (3b)



3b

Compound **3b** was obtained from 2-bromo-4-methoxybenzaldehyde (**2b**) following ***general procedure A***, (eluent hexane/EtOAc, 5:1), in 92% yield.

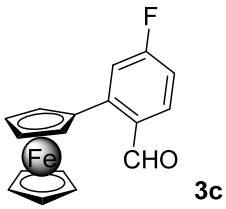
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.36 (s, 1H), 7.90 (d, *J* = 8.7 Hz, 1H), 7.36 (d, *J* = 2.4 Hz, 1H), 6.90 (d, *J* = 8.4 Hz, 1H), 4.55 (broad s, 2H), 4.43 (broad s, 2H), 4.19 (s, 5H), 3.96 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 191.1, 163.1, 145.5, 129.9, 128.0, 116.3, 112.6, 83.7, 71.1 (2C), 69.9 (5C), 69.1 (2C), 55.5.

MS (EI): *m/z* (%) 320 (M^+, 100), 182 (18), 139 (27).

HRMS (EI): Calculated for $C_{18}H_{16}O_2Fe$ (M^+) 320.0500, found 320.0507.

5-Fluoro-2-formylphenyl-ferrocene (3c)



3c

Compound **3c** was obtained from 2-bromo-4-fluorobenzaldehyde (**2c**) following ***general procedure A*** (eluent heptane/EtOAc 5:1), in 57% yield.

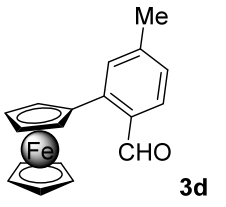
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.34 (s, 1H), 7.87 (dd, *J* = 8.7, 6.2 Hz, 1H), 7.49 (dd, *J* = 10.0, 2.5 Hz, 1H), 7.08 – 6.90 (dt, *J* = 2.4, 11.1 Hz, 1H), 4.52 (broad s, 2H), 4.40 (broad s, 2H), 4.14 (s, 5H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 190.7, 165.1 (d, *J* = 253.5 Hz), 146.4 (d, *J* = 9.6 Hz), 130.6 (d, *J* = 2.5 Hz), 130.3 (d, *J* = 10.0 Hz), 117.6 (d, *J* = 22.3 Hz), 114.0 (d, *J* = 22.2 Hz), 82.1, 70.9 (2C), 69.9 (5C), 69.4 (2C).

MS (EI): *m/z* (%) 308 (M^+, 18), 242 (22), 170 (100).

HRMS (EI): Calculated for $C_{17}H_{13}FFeO$ (M^+) 308.0300, found 308.0292.

2-Formyl-5-methylphenyl-ferrocene (3d)



3d

Compound **3d** was obtained from 2-bromo-4-methylbenzaldehyde (**2d**) following ***general procedure A*** (eluent hexane/EtOAc 5:1), in 98% yield.

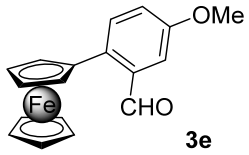
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.36 (s, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.61 (d, *J* = 2.1 Hz, 1H), 7.12 (d, *J* = 8.0 Hz, 1H), 4.24 (broad s, 2H), 4.20 (broad s, 2H), 4.08 (s, 5H), 2.39 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 192.1, 143.6, 142.9, 133.7, 131.9, 128.4, 127.4, 83.5, 70.8 (2C), 69.7 (5C), 69.0 (2C), 21.8.

MS (EI): *m/z* (%) 304 (M^+, 100), 166 (45).

HRMS (EI): Calculated for $C_{18}H_{16}FeO$ (M^+) 304.0551, found 304.0563.

2-Formyl-4-methoxyphenyl-ferrocene (3e)



3e

Compound **3e** was obtained from 2-bromo-5-methoxybenzaldehyde (**2e**) following ***general procedure A,*** (eluent hexane/EtOAc 20:1), in 63% yield.

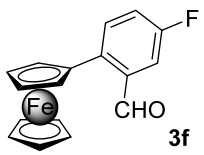
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.40 (s, 1H), 7.78 (d, *J* = 8.6 Hz, 1H), 7.34 (d, *J* = 2.9 Hz, 1H), 7.13 (dd, *J* = 8.6, 2.9 Hz, 1H), 4.49 (broad s, 2H), 4.38 (broad s, 2H), 4.17 (s, 5H), 3.90 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 192.2, 158.0, 135.7, 134.6, 133.0, 121.2, 109.0, 83.5, 70.7 (2C), 69.7 (5C), 68.9 (2C), 55.4.

MS (EI): *m/z* (%) 320 (M^+, 100), 292 (20), 277 (30), 249 (18).

HRMS (EI): Calculated for $C_{18}H_{16}FeO_2$ (M^+) 320.0501, found 320.0500

4-Fluoro-2-formylphenyl-ferrocene (3f)



3f

Compound **3f** was obtained from 2-bromo-5-fluorobenzaldehyde (**2f**) following ***general procedure A*** (eluent hexane/EtOAc 15:1), in 89% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 10.34 (d, *J* = 3.2 Hz, 1H), 7.84 (dd, *J* = 8.7, 5.2 Hz, 1H), 7.51 (dd, *J* = 9.0, 2.9 Hz, 1H), 7.29 – 7.20 (m, 1H), 4.48 (broad s, 2H), 4.39 (broad s, 2H), 4.14 (s, 5H).

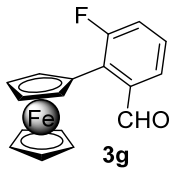
^{13}C NMR (75 MHz, $CDCl_3$): δ 191.2, 161.2 (d, *J* = 246.7 Hz), 139.0, 135.4, 133.7, 120.4 (d, *J* = 21.7 Hz), 113.0 (d, *J* = 21.7 Hz), 82.8, 70.9 (2C), 69.8 (5C), 69.2 (2C).

^{19}F NMR (282 MHz, $CDCl_3$): δ -114.92.

MS (EI): m/z (%) 308 (M^+, 98), 242 (57), 170 (100).

HRMS (EI): Calculated for $C_{17}H_{13}FFeO$ (M^+) 308.0288, found 308.0298.

6-Fluoro-2-formylphenyl-ferrocene (3g)



3g

Compound **3g** was obtained from 2-bromo-3-fluorobenzaldehyde (**2g**) following ***general procedure A*** (eluent heptane/EtOAc 5:1), in 55% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 10.28 (s, 1H), 7.66 (dd, *J* = 8.6, 4.0 Hz, 1H), 7.37 – 7.28 (m, 2H), 4.56 (broad s, 2H), 4.45 (broad s, 2H), 4.15 (s, 5H).

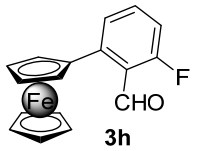
^{13}C NMR (75 MHz, $CDCl_3$): δ 191.8, 160.4 (d, *J* = 249.0 Hz), 136.8, 130.3 (d, *J* = 13.5 Hz), 127.3 (d, *J* = 9.0 Hz), 123.7, 120.3 (d, *J* = 23.2 Hz), 75.4, 71.5 (2C), 69.9 (5C), 69.5 (2C).

^{19}F NMR (282 MHz, $CDCl_3$): δ -106.98.

MS (EI): *m/z* (%) 308 (M^+, 19), 170 (100).

HRMS (EI): Calculated for $C_{17}H_{13}FFeO$ (M^+) 308.0300, found 308.0302.

3-Fluoro-2-formylphenyl-ferrocene (3h)



3h

Compound **3h** was obtained from 2-bromo-6-fluorobenzaldehyde (**2h**) following ***general procedure A***, (eluent hexane/EtOAc 5:1), in 53% yield.

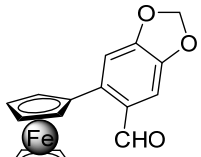
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.23 (s, 1H), 7.66 (d, *J* = 7.9 Hz, 1H), 7.52 – 7.39 (m, 1H), 7.04 – 6.95 (m, 1H), 4.54 (broad s, 2H), 4.42 (broad s, 2H), 4.15 (s, 5H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 189.9, 161.3 (d, *J* = 259.5 Hz), 144.5, 133.4 (d, *J* = 10.7 Hz), 127.2, 123.5, 114.0 (d, *J* = 22.3 Hz), 82.9, 71.0 (2C), 70.0 (5C), 69.5 (2C).

MS (EI): *m/z* (%) 308 (M^+, 48), 170 (100).

HRMS (EI): Calculated for $C_{17}H_{13}FFeO$ (M^+) 308.0300, found 308.0288.

2-Formyl-4,5-(methylenedioxy)phenyl-ferrocene (3i)



3i

Compound **3i** was obtained from 6-bromo-3,4-(methylenedioxy)benzaldehyde (**2i**) following ***general procedure A*** (eluent heptane/EtOAc 5:1), in 89% yield.

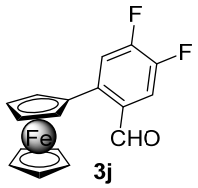
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.17 (s, 1H), 7.30 (broad s, 2H), 6.06 (s, 2H), 4.47 (broad s, 2H), 4.37 (broad s, 2H), 4.17 (s, 5H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 190.4, 151.7, 146.9, 140.5, 129.2, 110.8, 105.8, 101.8, 83.8, 70.9 (2C), 69.7 (5C), 68.9 (2C).

MS (EI): *m/z* (%) 334 (M^+, 98), 269 (57).

HRMS (EI): Calculated for $C_{18}H_{14}FeO_3$ (M^+) 334.0292, found 334.0300.

4,5-Difluoro-2-formylphenyl-ferrocene (3j)



3j

Compound **3j** was obtained from 2-bromo-4,5-difluorobenzaldehyde (**2j**) following ***general procedure A*** (eluent heptane/EtOAc 5:1), in 75% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 10.29 (d, *J* = 3.2 Hz, 1H), 7.70 – 7.58 (m, 2H), 4.50 (broad s, 2H), 4.43 (broad s, 2H), 4.17 (s, 5H).

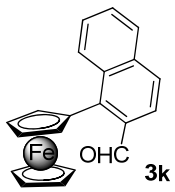
^{13}C NMR (75 MHz, $CDCl_3$): δ 189.7, 153.0 (dd, *J* = 257.3, 13.6 Hz), 149.1 (dd, *J* = 251.3, 13.5 Hz), 141.3 (d, *J* = 11.2 Hz), 130.8, 120.0 (d, *J* = 18.0 Hz), 115.9 (d, *J* = 17.2 Hz), 81.6, 70.9 (2C), 69.9 (5C), 69.5 (2C).

^{19}F NMR (282 MHz, $CDCl_3$): δ -128.99 (d, *J* = 21.8 Hz), -138.90 (d, *J* = 21.8 Hz).

MS (EI): *m/z* (%) 326 (M^+, 18), 260 (20), 188 (100).

HRMS (EI): Calculated for $C_{17}H_{12}F_2FeO$ (M^+) 326.0206, found 326.0207.

2-Formylnaphtyl-ferrocene (3k)



3k

Compound **3k** was obtained from 1-bromo-2-naphthaldehyde (**2k**) following ***general procedure A*** (eluent hexane/EtOAc 5:1), in 79% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 9.55 (d, *J* = 8.3 Hz, 1H), 8.04 – 7.79 (m, 3H), 7.72 – 7.56 (m, 2H), 7.34 (broad s, 1H), 4.65 (broad s, 2H), 4.57 (broad s, 2H), 4.24 (s, 5H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 193.5, 141.8, 135.9, 133.6, 132.0, 128.5, 128.3, 128.1, 127.6, 125.4, 123.1, 81.1, 73.4 (2C), 69.9 (5C), 68.9 (2C).

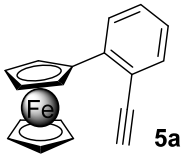
MS (EI): *m/z* (%) 340 (M^+, 100), 252 (20).

HRMS (EI): Calculated for $C_{21}H_{16}FeO$ (M^+) 340.0541, found 340.0551.

General procedure B. Seyferth-Gilbert homologation

The corresponding 2-formylaryl ferrocenes **3a**-**k** (0.550 mmol), dimethyl (1-diazo-2-oxopropyl)-phosphonate (Ohira-Bestmann reagent) (318 mg, 1.65 mmol) and K_2CO_3 (381 mg, 2.76 mmol) were suspended in dry MeOH (5 mL) and stirred for 20 h at r.t. After evaporation of the solvent, the crude was partitioned between CH_2Cl_2 and brine. The combined organic layers were dried (Na_2SO_4), evaporated, and the residue purified by flash chromatography, affording pure 2-alkynylaryl ferrocenes **5a**-**k**.

2-Ethynylphenyl-ferrocene (5a)



5a

Compound **5a** was obtained from 2-formylphenyl-ferrocene (**3a**) following ***general procedure B*** (eluent hexane/EtOAc 5:1), in 98% yield.

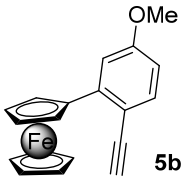
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.60 (d, *J* = 7.8 Hz, 1H), 7.48 (d, *J* = 7.8 Hz, 1H), 7.29 (t, *J* = 7.8 Hz, 1H), 7.15 (t, *J* = 7.8 Hz, 1H), 4.95 (broad s, 2H), 4.32 (broad s, 2H), 4.11 (s, 5H), 3.27 (s, 1H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 141.4, 134.6, 129.0, 128.5, 125.5, 119.5, 84.4, 84.3, 81.1, 69.7 (5C), 69.0 (2C), 68.6 (2C).

MS (EI): *m/z* (%) 286 (M^+, 90), 165 (100).

HRMS (EI): Calculated for $C_{18}H_{24}Fe$ (M^+) 286.0445, found 286.0457.

2-Ethynyl-5-methoxyphenyl-ferrocene (5b)



5b

Compound **5b** was obtained from 2-formyl-5-methoxyferrocene (**3b**) following ***general procedure B***, (eluent hexane to hexane/EtOAc, 5:1), in 44% yield.

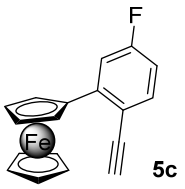
^{1}H NMR δ (300 MHz, $CDCl_3$): 7.35 (d, *J* = 8.6 Hz, 1H), 7.04 (d, *J* = 2.6 Hz, 1H), 6.64 (dd, *J* = 8.6 and 2.7 Hz, 1H), 4.87 (broad s, 2H), 4.25 (broad s, 2H), 4.04 (s, 5H), 3.78 (s, 3H), 3.17 (s, 1H).

^{13}C NMR δ (75 MHz, $CDCl_3$): 159.5, 143.1, 136.1, 114.5, 112.1, 111.4, 84.4, 84.3, 79.8, 69.8 (5C), 69.1 (2C), 68.7 (2C), 55.3

MS (EI): *m/z* (%) 316 (M^+, 100).

HRMS (EI): Calculated for $C_{19}H_{16}OFe$ (M^+) 316.0551, found 316.0561.

2-Ethynyl-5-fluorophenyl-ferrocene (5c)



5c

Compound **5c** was obtained from 5-fluoro-2-formylphenyl-ferrocene (**3c**) following ***general procedure B*** (eluent heptane/EtOAc 5:1), in 64% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.46 (dd, *J* = 8.5, 6.1 Hz, 1H), 7.27 (dd, *J* = 10.5, 2.3 Hz, 1H), 6.86 (td, *J* = 8.2, 2.6 Hz, 1H), 4.96 (broad s, 2H), 4.36 (broad s, 2H), 4.12 (s, 5H), 3.29 (s, 1H).

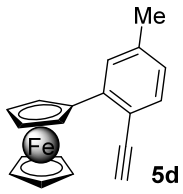
^{13}C NMR (75 MHz, $CDCl_3$): δ 162.4 (d, *J* = 248.7 Hz), 144.5, 144.4, 136.5 (d, *J* = 8.9 Hz), 115.3 (d, *J* = 22.7 Hz), 112.9 (d, *J* = 22.2 Hz), 83.5, 83.2, 80.8, 69.8 (5C), 69.0 (4C).

^{19}F NMR (282 MHz, $CDCl_3$): δ -111.13.

MS (EI): *m/z* (%) 304 (M^+, 100), 246 (20).

HRMS (EI): Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0345.

2-Ethynyl-5-methylphenyl-ferrocene (5d)



5d

Compound **5d** was obtained from 2-formyl-5-methylphenyl-ferrocene (**3d**) following ***general procedure B*** (eluent hexane), in 87% yield.

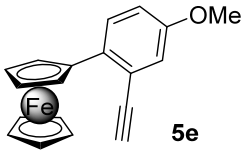
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.38 (m, 2H), 6.97 (d, *J* = 8.0 Hz, 1H), 4.95 (broad s, 2H), 4.32 (broad s, 2H), 4.11 (s, 5H), 3.29 (s, 1H), 2.38 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 141.1, 138.4, 134.6, 129.4, 126.5, 116.6, 84.5, 84.5, 80.6, 69.7 (5C), 68.8 (2C), 68.5 (2C), 21.5.

MS (EI): *m/z* (%) 300 (M^+, 100), 178 (20).

HRMS (EI): Calculated for $C_{19}H_{16}Fe$ (M^+) 300.0601, found 300.0606.

2-Ethynyl-4-methoxyphenyl-ferrocene (5e)



5e

Compound **5e** was obtained from 2-formyl-4-methoxyphenyl-ferrocene (**3e**) following ***general procedure B*** (eluent hexane/EtOAc 10:1), in 85% yield.

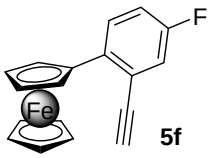
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.54 (d, *J* = 8.6 Hz, 1H), 6.99 (d, *J* = 2.6 Hz, 1H), 6.87 (dd, *J* = 8.6, 2.6 Hz, 1H) 4.90 (broad s, 2H), 4.32 (broad s, 2H), 4.13 (s, 5H), 3.82 (s, 3H), 3.28 (s, 1H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 157.1, 133.7, 130.2, 120.0, 118.2, 115.9, 84.6, 84.1, 80.9, 69.6 (5C), 68.6 (2C), 68.2 (2C), 55.3.

MS (EI): m/z (%) 316 (M^+, 100), 152 (31).

HMRS (EI): Calculated for $C_{19}H_{16}FeO$ (M^+) 316.0551, found 316.0556.

2-Ethynyl-4-fluorophenyl-ferrocene (5f)



5f

Compound **5f** was obtained from 4-fluoro-2-formylphenyl-ferrocene (**3f**) following ***general procedure B*** (eluent hexane), in 86% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.56 (dd, *J* = 8.7, 5.8 Hz, 1H), 7.17 (dd, *J* = 9.1, 2.6 Hz, 1H), 7.01 (td, *J* = 8.5, 2.6 Hz, 1H), 4.89 (broad s, 2H), 4.34 (broad s, 2H), 4.12 (s, 5H), 3.34 (s, 1H).

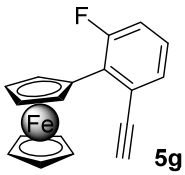
^{13}C NMR (75 MHz, $CDCl_3$): δ 160.2 (d, *J* = 243.7 Hz), 137.6 (d, *J* = 3.0 Hz), 130.6 (d, *J* = 8.3 Hz), 120.9, 120.6 (d, *J* = 23.2 Hz), 116.2 (d, *J* = 21.0 Hz), 83.8, 83.1, 82.0, 69.7 (5C), 68.9 (2C), 68.6 (2C).

^{19}F NMR (282 MHz, $CDCl_3$): δ -117.22.

MS (EI): m/z (%) 304 (M^+, 100).

HMRS (EI): Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0364.

2-Ethynyl-6-fluorophenyl-ferrocene (5g)



5g

Compound **5g** was obtained from 6-fluoro-2-formylphenyl-ferrocene (**3g**) following ***general procedure B*** (eluent heptane/EtOAc 5:1), in 65% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.27 (dd, *J* = 7.6, 1.0 Hz, 1H), 7.20 – 7.05 (m, 2H), 4.96 (broad s, 2H), 4.37 (broad s, 2H), 4.09 (s, 5H), 3.30 (s, 1H).

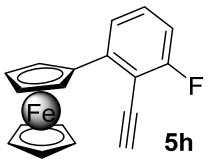
^{13}C NMR (75 MHz, $CDCl_3$): δ 160.1 (d, *J* = 247.5 Hz), 130.7, 129.3, 126.5 (d, *J* = 9.8 Hz), 122.1, 116.5 (d, *J* = 24.0 Hz), 83.7, 83.6, 81.8, 70.3 (2C), 69.7 (5C), 68.5 (2C).

^{19}F NMR (282 MHz, $CDCl_3$): δ -107.82.

MS (EI+): *m/z* (%) 304 (M^+, 100), 183 (26).

HRMS: Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0349.

2-Ethynyl-3-fluorophenyl-ferrocene (5h)



5h

Compound **5h** was obtained from 2-formyl-3-fluorophenyl-ferrocene (**3h**) following ***general procedure B*** (eluent hexane/AcOEt 5:1), in 53% yield.

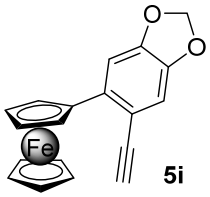
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.29 (d, *J* = 7.9 Hz, 1H), 7.25 - 7.20 (m, 1H), 6.85 (td, *J* = 8.7, 1.1 Hz, 1H), 4.88 (broad s, 2H), 4.28 (broad s, 2H), 4.03 (s, 5H), 3.50 (s, 1H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 165.8 (d, *J* = 250.2 Hz), 144.2, 129.3 (d, *J* = 9.3 Hz), 124.3 (d, *J* = 3.2 Hz), 112.3 (d, *J* = 22.0 Hz), 108.5, 87.0, 86.9, 83.2, 69.8 (5C), 69.1 (2C), 69.00 (2C).

MS (EI): m/z (%) 304 (M^+, 100), 183 (19).

HMRS (EI): Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0356.

2-Ethynyl-4,5-(methylenedioxy)phenyl-ferrocene (5i)



5i

Compound **5i** was obtained from 2-formyl-4,5-(methylenedioxy)phenyl-ferrocene (**3i**) following the ***general procedure B*** (eluent hexane), in 60% yield.

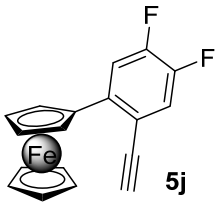
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.09 (s, 1H), 6.90 (s, 1H), 5.99 (s, 2H), 4.85 (broad s, 2H), 4.30 (broad s, 2H), 4.12 (s, 5H), 3.20 (s, 1H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 148.2, 145.5, 136.7, 113.2, 112.4, 109.0, 101.4, 84.8, 84.2, 79.6, 69.6 (5C), 69.1 (2C), 68.3 (2C).

MS (EI): *m/z* (%) 330 (M^+, 100), 216 (15).

HRMS (EI): Calculated for $C_{19}H_{14}FeO_2$ (M^+) 330.0343, found 330.0353.

4,5-Difluoro-2-ethynylphenyl-ferrocene (5j)



5j

Compound **5j** was obtained from 4,5-difluoro-2-formylphenyl-ferrocene (**3j**) following ***general procedure B*** (eluent heptane/EtOAc 5:1), in 79% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.38 (dd, *J* = 11.8, 8.1 Hz, 1H), 7.28 (dd, *J* = 10.6, 8.2 Hz, 1H), 4.91 (broad s, 2H), 4.36 (broad s, 2H), 4.13 (s, 5H), 3.32 (s, 1H).

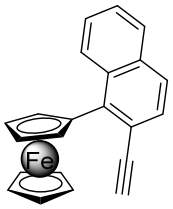
^{13}C NMR (75 MHz, $CDCl_3$): δ 149.2 (dd, *J* = 251.2, 12.9 Hz), 146.6 (dd, *J* = 248.5, 13.4 Hz), 138.5 (dd, *J* = 6.5, 3.6 Hz), 121.7 (dd, *J* = 18.3, 1.1 Hz), 116.3 (d, *J* = 18.3 Hz), 114.6 (dd, *J* = 7.1, 3.5 Hz), 81.6, 81.3, 80.7, 68.7 (5C), 67.9 (2C), 67.9 (2C).

^{19}F NMR (282 MHz, $CDCl_3$): δ -135.38 (d, *J* = 22.2 Hz), -141.01 (d, *J* = 22.2 Hz).

MS (EI+): *m/z* (%) 322 (M^+, 100), 201 (34).

HRMS: Calculated for $C_{18}H_{12}F_2Fe$ (M^+) 322.0256, found 322.0256.

2-Ethynylnaphthyl-ferrocene (5k)



5k

Compound **5k** was obtained from 2-formylnaphthyl-ferrocene (**3k**) following ***general procedure B*** (eluent hexane/AcOEt 5:1), in 61% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 9.43 (d, *J* = 8.3 Hz, 1H), 7.82 (d, *J* = 7.7 Hz, 1H), 7.68 (d, *J* = 8.5 Hz, 1H), 7.60 – 7.47 (m, 3H), 4.98 (broad s, 2H), 4.45 (broad s, 2H), 4.21 (s, 5H), 3.33 (s, 1H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 138.7, 133.7, 131.7, 130.7, 128.3, 127.5, 126.7, 126.4, 125.2, 119.5, 85.7, 83.2, 82.1, 72.1 (2C), 69.8 (5C), 67.8 (2C).

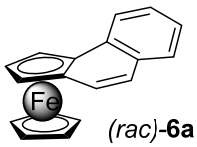
MS (EI): *m/z* (%) 336 (M^+, 100).

HRMS (EI): Calculated for $C_{22}H_{16}Fe$ (M^+) 336.0601, found 336.0806.

General procedure C. $PtCl_2$-catalyzed cycloisomerization

In a high-necked-schlenck flask, a solution of the corresponding alkyne (0.15 mmol) and $PtCl_2$ (4 mg, 0.015 mmol) in dry toluene (2.2 mL), under an argon atmosphere, was heated at 100 °C for the time indicated in each case. The crude mixture was filtered through celite and washed with hexane. After solvent removal, the corresponding *ortho*-condensed aromatic ferrocenes, which didn´t need further purification, were obtained in practically quantitative yield. Pure analytical samples could be obtained by flash chromatography using a short pad of neutralized silica gel eluting with hexane.

***(rac)*-Ferrocene[3]helicene (6a).**



(rac)-**6a**

Compound (*rac*)-**6a** was obtained from 2-ethynylphenyl-ferrocene (**5a**) following ***general procedure C*** (4 h).

^{1}H NMR (500 MHz, $CDCl_3$): δ 8.00 (d, *J* = 7.7 Hz, 1H), 7.64 (d, *J* = 7.6 Hz, 1H), 7.48 (t, *J* = 7.0 Hz, 1H), 7.41 (m, 2H), 7.18 (d, *J* = 9.1 Hz, 1H), 5.27 (broad s, 1H), 4.82 (broad s, 1H), 4.23 (broad s, 1H), 3.74 (s, 5H).

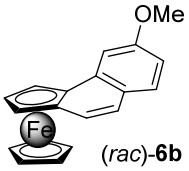
^{13}C NMR (126 MHz, $CDCl_3$): δ 135.1, 131.9, 128.6, 127.5, 126.6, 125.2 (2C), 123.3, 83.9, 83.0, 69.3 (5C), 69.2, 64.0, 61.1.

MS (EI): *m/z* (%) 286 (M^+, 90), 165 (100).

HRMS: Calculated for $C_{18}H_{24}Fe$ (M^+) 286.0445, found 286.0457.

HPLC: *Daicel Chiralpak* IB, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 19.3 min, R_t = 21.6 min, T = 25 °C).

***(rac)*-8-Methoxyferrocene[3]helicene (6b)**



(*rac*)-**6b**

Compound *(rac)*-**6b** was obtained from 2-ethynyl-1-ferrocenyl-5-methoxybenzene (**5b**) following ***general procedure C*** (5 h).

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.55 (d, *J* = 8.4 Hz, 1H), 7.43 (broad s, 1H), 7.22 (d, *J* = 8.9 Hz, 1H), 7.11 (d, *J* = 8.9 Hz, 1H), 7.02 (d, *J* = 7.4 Hz, 1H), 5.19 (broad s, 1H), 4.81 (broad s, 1H), 4.22 (broad s, 1H), 3.98 (s, 3H), 3.74 (s, 5H).

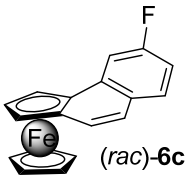
^{13}C NMR (126 MHz, $CDCl_3$): δ 158.5, 136.7, 129.9, 125.9, 124.8, 124.5, 113.0, 106.5, 84.5, 82.6, 69.3 (5C), 69.1, 63.9, 61.0, 55.5.

MS (EI): *m/z* (%) 316 (M^+, 90), 195 (98), 152 (100).

HRMS: Calculated for $C_{19}H_{16}OFe$ (M^+) 316.0551, found 316.0553.

HPLC: *Daicel Chiralpak* IB, hexane / 2-propanol 96:4; 0.4 mL min^{-1}, 254 nm, R_t = 15.2 min, R_t = 40.4 min, T = 25 °C

***(rac)*-8-Fluoroferrocene[3]helicene (6c)**



(*rac*)-**6c**

Compound *(rac)*-**6c** was obtained from 2-ethynyl-1-ferrocenyl-5-fluorobenzene (**5c**) following ***general procedure C*** (3 h).

^{1}H NMR δ (500 MHz, $CDCl_3$): 7.68 – 7.53 (m, 2H), 7.34 (d, *J* = 9.1 Hz, 1H), 7.13 (d, *J* = 8.8 Hz, 2H), 5.20 (broad s, 1H), 4.83 (broad s, 1H), 4.25 (broad s, 1H), 3.75 (s, 5H).

^{13}C NMR δ (126 MHz, $CDCl_3$): 161.6 (d, *J* = 245.6 Hz), 137.2 (d, *J* = 8.8 Hz), 130.3 (d, *J* = 8.9 Hz), 128.3, 126.4, 124.4, 113.1 (d, *J* = 22.9 Hz), 108.9 (d, *J* = 21.8 Hz), 84.2, 82.2, 69.5, 69.4 (5C), 64.3, 61.3.

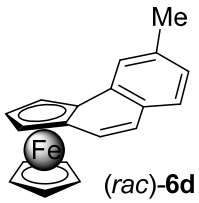
^{19}F NMR δ (282 MHz, $CDCl_3$): -114.17.

MS (EI): *m/z* (%) 304 (M^+, 100), 183 (30).

HRMS: Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0354.

HPLC: *Daicel Chiralpak* IA, CO2 /MeOH 98:2; 1.0 mL min^{-1}, 254 nm, R_t = 41.7 min, R_t = 49.3 min, *T* = 25 °C

***(rac)*-8-Methylferrocene-[3]-helicene (6d)**



(*rac*)-**6d**

Compound *(rac)*-**6d** was obtained from 2-ethynyl-1-ferrocenyl-5-methylbenzene (**5d**) following ***general procedure C*** (6 h).

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.78 (broad s, 1H), 7.55 (d, *J* = 8.4 Hz, 1H), 7.22 (m, 2H), 7.15 (d, *J* = 7.9 Hz, 1H), 5.26 (broad s, 1H), 4.83 (broad s, 1H), 4.22 (broad s, 1H), 3.75 (s, 5H), 2.55 (s, 3H).

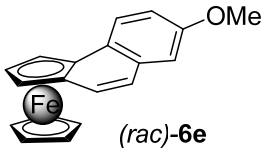
^{13}C NMR (75 MHz, $CDCl_3$): δ 136.4, 135.1, 129.6, 128.4, 126.6, 126.2, 125.1, 123.4, 84.2, 82.9, 69.3 (5C), 69.02, 63.9, 60.9, 21.8.

MS (EI): *m/z* (%) 300 (M^+, 100), 179 (13).

HRMS: Calculated for $C_{19}H_{16}$ (M^+) 300.0601, found 300.0592.

HPLC: *Daicel Chiralpak* IB, hexane / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 15.8 min, R_t = 21.8 min, *T* = 25 ºC.

***(rac)*-7-Methoxyferrocene-[3]-helicene (6e).**



(rac)-**6e**

Compound *(rac)*-**6e** was obtained from 2-ethynyl-4-methoxyphenyl-ferrocene (**5e**) following ***general procedure C*** (10 h).

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.91 (d, *J* = 8.4 Hz, 1H), 7.38 (d, *J* = 9.0 Hz, 1H), 7.11 (m, 3H), 5.20 (broad s, 1H), 4.77 (broad s, 1H), 4.18 (broad s, 1H), 3.92 (s, 3H), 3.73 (s, 5H).

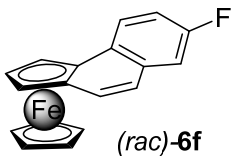
^{13}C NMR (126 MHz, $CDCl_3$): δ 157.5, 133.2, 128.4, 128.1, 124.9, 124.6, 115.2, 111.0, 83.8, 83.0, 69.2 (5C), 68.8, 63.7, 60.6, 55.4.

MS (EI): m/z (%) 316 (M^+, 100), 273 (52), 215 (47),

HRMS: Calculated for $C_{19}H_{16}FeO$ (M^+) 316.0551, found 316.0543.

HPLC: *Daicel Chiralpak* IC, hexane / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 30.4 min, R_t = 33.5 min, *T* = 25 ºC.

***(rac)*-7-Fluoroferrocene-[3]-helicene (6f).**



(rac)-**6f**

Compound *(rac)*-**6f** was obtained from 2-ethynyl-4-fluorophenyl-ferrocene (**5f**) following ***general procedure C*** (5 h).

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.95 (dd, *J* = 8.4, 5.7 Hz, 1H), 7.44 (d, *J* = 9.1 Hz, 1H), 7.30 (dd, *J* = 9.7, 2.1 Hz, 1H), 7.20 (dd, *J* = 8.6, 2.3 Hz, 1H), 7.10 (d, *J* = 9.1 Hz, 1H), 5.24 (broad s, 1H), 4.81 (broad s, 1H), 4.23 (broad s, 1H), 3.74 (s, 5H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 160.8 (d, *J* = 243.0 Hz), 133.4 (d, *J* = 8.3 Hz), 131.1, 129.3, 124.9 (d, *J* = 8.4 Hz), 124.3, 114.5 (d, *J* = 22.9 Hz), 113.7 (d, *J* = 21.0 Hz), 83.2, 83.0, 69.3 (5C), 69.3, 64.1, 61.0.

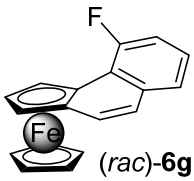
^{19}F NMR (282 MHz, $CDCl_3$): δ -117.21.

MS (EI): *m/z* (%) 304 (M^+, 100), 183 (54).

HRMS: Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0343.

HPLC-SFC: *Daicel Chiralpak* IA, CO_2/MeOH 98:2; 1.0 mL min^{-1}, 254 nm, R_t = 33.1 min, R_t = 36.7 min, *T* = 25 ºC.

***(rac)*-9-Fluoro-ferrocene-[3]helicene (6g)**



(*rac*)-**6g**

Compound *(rac)*-**6g** was obtained from 2-ethynyl-1-ferrocenyl-6-fluorobenzene (**5g**) following ***general procedure C*** (3h).

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.47 – 7.39 (m, 2H), 7.34 (td, *J* = 7.9 and 5.3 Hz, 1H), 7.22 – 7.12 (m, 2H), 5.53 (broad s, 1H), 4.81 (broad s, 1H), 4.25 (broad s, 1H), 3.78 (s, 5H).

^{13}C NMR (126 MHz, $CDCl_3$): δ 159.9 (d, *J* = 248.0 Hz), 134.6 (d, *J* = 5.6 Hz), 129.0, 125.4 (d, *J* = 8.6 Hz), 124.3, 124.1, 123.7, 112.6 (d, *J* = 21.3 Hz), 83.6, 78.4, 70.0, 69.2 (5C), 65.7, 63.9.

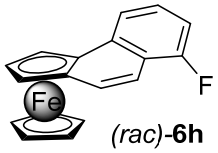
^{19}F NMR δ (282 MHz, $CDCl_3$): -117.13.

MS (EI): *m/z* (%) 304 (M^+, 100), 183 (30).

HRMS: Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0355.

HPLC: *Daicel Chiralpak* IA, CO2/ MeOH 98:2; 1.0 mL min^{-1}, 254 nm, R_t = 37.9 min, R_t = 41.6 min, T = 25 °C

***(rac)*-6-Fluoro-ferrocene-[3]helicene (6h).**



(rac)-**6h**

Compound *(rac)*-**6h** was obtained from 2-ethynyl-1-ferrocenyl-3-fluorobenzene (**5h**) following ***general procedure C*** (15 h).

^{1}H NMR (500 MHz, $CDCl_3$): δ 7.81 (d, J = 7.9 Hz, 1H), 7.54 – 7.38 (m, 3H), 7.14 (dd, J = 9.9, 8.5 Hz, 1H), 5.30 (broad s, 1H), 4.90 (broad s, 1H), 4.31 (broad s, 1H), 3.80 (s, 5H).

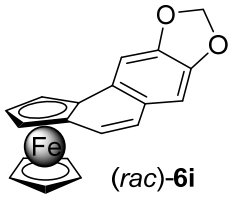
^{13}C NMR (126 MHz, $CDCl_3$): δ 159.6 (d, J = 249.2 Hz), 137.3, 128.3, 127.1 (d, J = 8.9 Hz), 120.6 (d, J = 14.7 Hz), 118.9, 116.5, 110.7 (d, J = 21.3 Hz), 83.8, 82.2, 69.7, 69.4 (5C), 64.4, 61.6.

MS (EI): *m/z* (%) 304 (M^+, 100), 163 (10).

HRMS: Calculated for $C_{18}H_{13}FFe$ (M^+) 304.0351, found 304.0342.

HPLC: *Daicel Chiralpak* IC, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 14.3 min, R_t = 15.3 min, T = 25 °C.

***(rac)*-7,8-(Methylenedioxy)ferrocene-[3]-helicene (6i)**



(*rac*)-**6i**

Compound *(rac)*-**6i** was obtained from 2-ethynyl-4,5-(methylenedioxy)phenyl-ferrocene (**5i**) following ***general procedure C*** (5 h).

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.38 (s, 1H), 7.24 (s, 1H), 7.03 (m, 2H), 6.03 (m, 2H), 5.11 (broad s, 1H), 4.77 (broad s, 1H), 4.13 (broad s, 1H), 3.70 (s, 5H).

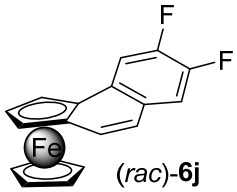
^{13}C NMR (75 MHz, $CDCl_3$): δ 147.2, 146.1, 130.1, 126.9, 125.5, 124.9, 107.3, 102.5, 101.0, 84.1, 83.9, 69.1 (5C), 68.9, 63.4, 60.4.

MS (EI+): *m/z* (%) 330 (M^+, 100), 264 (25), 215 (25).

HRMS: Calculated for $C_{19}H_{14}O_2Fe$ (M^+) 330.0343, found 330.0334.

HPLC: *Daicel Chiralpak* IC, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 22.1 min, R_t = 29.8 min, *T* = 25 ºC.

***(rac)*-7,8-Difluoro-ferrocene-[3]helicene (6j)**



(*rac*)-**6j**

Compound *(rac)*-**6j** was obtained from 2-ethynyl-1-ferrocenyl-4,5-difluorobenzene (**5j**) following ***general procedure C*** (8 h).

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.65 (dd, *J* = 11.1 and 7.8 Hz, 1H), 7.32 (m, 2H), 6.98 (d, *J* = 9.2 Hz, 1H), 5.09 (broad s, 1H), 4.76 (broad s, 1H), 4.17 (broad s, 1H), 3.68 (s, 5H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 149.6 (dd, *J* = 246.7 and 13.5 Hz), 148.6 (dd, *J* = 244.5 and 13.5 Hz), 132.1, 128.5, 128.3, 123.5, 115.9 (d, *J* = 17.0 Hz), 111.0 (d, *J* = 17.7 Hz), 83.5, 82.2, 69.6, 69.4 (5C), 64.3, 61.2.

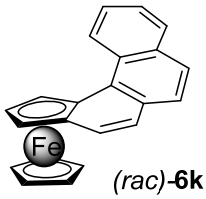
^{19}F NMR δ (282 MHz, $CDCl_3$): -138.21 (d, *J* = 21.4 Hz), -141.25 (d, *J* = 21.5 Hz).

MS (EI): *m/z* (%) 322 (M^+, 100).

HRMS: Calculated for $C_{18}H_{12}F_2Fe$ (M^+) 322.0256, found 322.0255.

HPLC: *Daicel Chiralpak* IA, hexane / 2-propanol 100:0; 0.4 mL min^{-1}, 254 nm, R_t = 17.5 min, R_t = 22.3 min, *T* = 25 °C.

***(rac)*-Ferrocene-[4]helicene (6k).**



(rac)-**6k**

Compound *(rac)*-**6k** was obtained from 2-ethynyl-1-naphthylferrocene (**5k**) following ***general procedure C*** (15 h).

^{1}H NMR δ (500 MHz, $CDCl_3$): 9.17 (d, *J* = 8.6 Hz, 1H), 8.01 (d, *J* = 8.0 Hz, 1H), 7.85 (d, *J* = 8.4 Hz, 1H), 7.78 (t, *J* = 7.7 Hz, 1H), 7.71 (d, *J* = 8.4 Hz, 1H), 7.63 (m, 2H), 7.37 (d, *J* = 8.9 Hz, 1H), 5.79 (broad s, 1H), 5.03 (broad s, 1H), 4.34 (broad s, 1H), 3.76 (s, 5H).

^{13}C NMR δ (126 MHz, $CDCl_3$): 133.2, 131.9, 131.1, 130.9, 128.8, 128.5, 127.9, 126.3, 126.1, 126.1, 125.7, 125.5, 86.7, 82.3, 70.8, 68.9 (5C), 65.6, 64.0.

MS (EI): *m/z* (%) 336 (M^+, 50), 154 (88), 57 (100).

HRMS: Calculated for$C_{22}H_{16}Fe$ (M^+) 336.0601, found 336.0596.

HPLC: *Daicel Chiralpak* IC, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 28.2 min, R_t = 30.2 min, *T* = 25 °C).

Synthesis of chiral gold complex (R)-DTBM-Segphos-$(AuCl)_2$

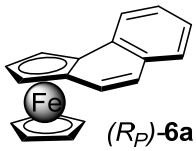
To a solution of commercially available Me_2S·AuCl (40 mg, 0.136 mmol) in CH_2Cl_2 (8.4 mL) cooled to 0 ºC, a solution of commercially available chiral phosphine (*R*)-DTBM-Segphos (80 mg, 0.068 mmol) in CH_2Cl_2 (4.2 mL) was added dropwise. The resulting mixture was allowed to warm to room temperature and stirred overnight. After evaporation of the solvent, the desired gold(I) complex was obtained.

General procedure D. Enantioselective Au(I)-Catalyzed Cycloisomerization

A solution of (*R*)-DTBM-Segphos-$(AuCl)_2$ (14 mg, 0.0089 mmol) and commercially available $AgSbF_6$ (6.5 mg, 0.0178 mmol) in dry toluene (0.2 mL), in the dark and under argon atmosphere, was stirred at room

temperature for 5 min. After cooling to 0 ºC, a solution of the corresponding 2-alkynylaryl ferrocene **5a-k** (0.089 mmol) in toluene (0.5 mL) was slowly added and the resulting mixture stirred at the same temperature for the time indicated in each case. Then, hexane (0.6 mL) was added and the mixture filtered through celite to remove the metal residues. After evaporation of the solvent and flash chromatography using neutralized silica gel (eluent hexane), the corresponding pure enantioenriched *ortho*-condensed aromatic ferrocenes were obtained.

***(R_p)*-Ferrocene[3]helicene (6a).**

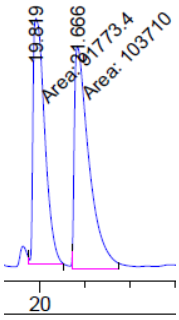


(R_P)-**6a**

Compound (R_p)-**6a** was obtained from 2-ethynylphenyl-ferrocene (**5a**) following ***general procedure D*** (4 h), in 92% yield.

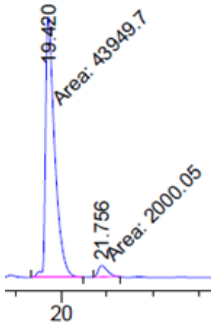
$[\alpha]_D^{20}$ = +932 (*c* = 0.040, $CHCl_2$), 91% *ee.*

HPLC: *Daicel Chiralpak* IB, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 21.2 min, *T* = 25 °C).



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

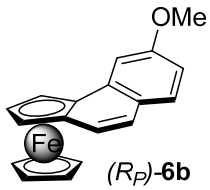
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	19.819	MM	0.6028	9.17734e4	2537.27661	46.9470
2	21.666	MM	0.7520	1.03710e5	2298.63843	53.0530
Totals :				1.95483e5	4835.91504	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	19.420	MM	0.4677	4.39497e4	1566.12512	95.6473
2	21.756	MM	0.4702	2000.05005	70.88730	4.3527
Totals :				4.59497e4	1637.01242	

***(R$_p$)*-8-Methoxyferrocene[3]helicene (6b)**

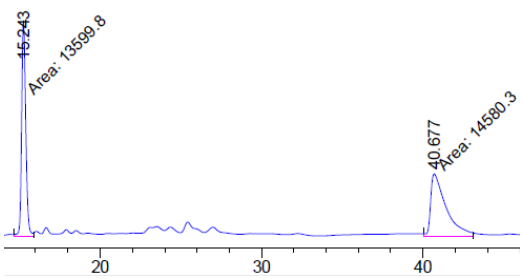


(R$_P$)-**6b**

Compound *(R$_p$)*-**6b** was obtained from 2-ethynyl-1-ferrocenyl-5-methoxybenzene **5b** following ***general procedure D*** (3 h), in 83% yield.

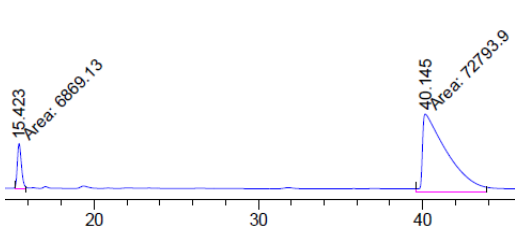
[α]$_D^{20}$ = +2750 (*c* 0.007, CH_2Cl_2), 83% *ee.*

HPLC: *Daicel Chiralpak* IB, hexane / 2-propanol 96:4; 0.4 mL min^{-1}, 254 nm, R_t = 40.1 min, T = 25 °C



Signal 2: DAD1 C, Sig=210,8 Ref=360,100

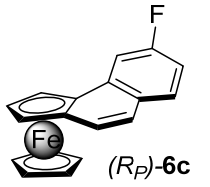
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.243	MM	0.2973	1.35998e4	762.46027	47.5026
2	40.677	MM	1.1031	1.45803e4	220.29704	50.9277
3	63.752	BB	0.9566	449.40881	5.53897	1.5697
Totals :				2.86295e4	988.29628	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.423	MM	0.2884	6869.13184	396.99210	8.6227
2	40.145	MM	1.7547	7.27939e4	691.43701	91.3773
Totals :				7.96630e4	1088.42911	

***(R$_p$)*-8-Fluoroferrocene[3]helicene (6c)**

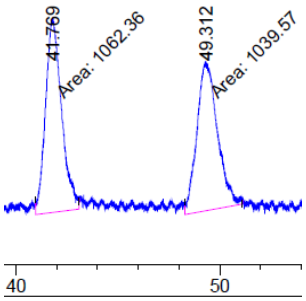


(R$_P$)-**6c**

Compound *(R$_p$)*-**6c** was obtained from 2-ethynyl-1-ferrocenyl-5-fluorobenzene **5c** following ***general procedure D*** (3 h), in 85% yield.

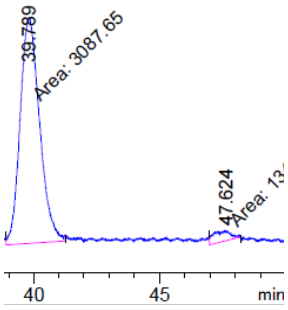
$[\alpha]_D^{20}$ = +3260 (*c* 0.08, CH_2Cl_2), 92% *ee.*

HPLC: *Daicel Chiralpak* IA, CO2 /MeOH 98:2; 1.0 mL min^{-1}, 254 nm, R_t = 39.8 min, *T* = 25 °C



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

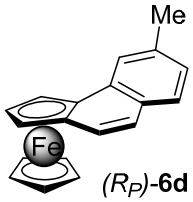
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	41.769	MM	0.9126	1062.35681	19.40245	50.5420
2	49.312	MM	1.1660	1039.57288	14.85958	49.4580
Totals :				2101.92969	34.26203	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	39.789	MM	0.8940	3087.65381	57.56224	95.8298
2	47.624	MM	0.8409	134.36462	2.66326	4.1702
Totals :				3222.01843	60.22549	

***(R_p)*-8-Methylferrocene-[3]-helicene (6d)**

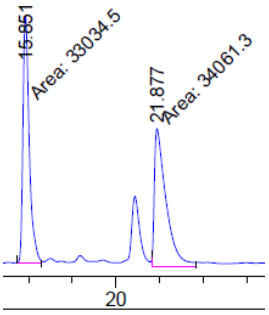


(R_P)-**6d**

Compound *(R_p)*-**6d** was obtained from 2-ethynyl-1-ferrocenyl-5-methylbenzene (**5d**) following ***general procedure D*** (6 h), in 84% yield.

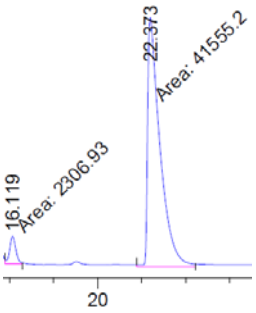
$[\alpha]_D^{20}$ = +980 (*c* = 0.012, $CHCl_2$), 91% *ee.*

HPLC: *Daicel Chiralpak* IB, hexane / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 22.4 min, *T* = 25 ºC.



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

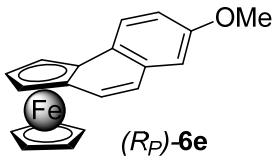
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.851	MM	0.3372	3.30345e4	1632.65222	49.2349
2	21.877	MM	0.6242	3.40613e4	909.45093	50.7651
Totals :				6.70958e4	2542.10315	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	16.119	MM	0.3285	2306.92676	117.05837	5.2595
2	22.373	MM	0.6544	4.15552e4	1058.39600	94.7405
Totals :				4.38621e4	1175.45437	

***(R_P)*-7-methoxyferrocene-[3]-helicene (6e).**

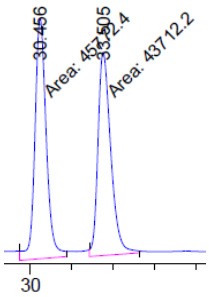


(R_P)-**6e**

Compound *(R_p)*-**6e** was obtained from 2-ethynyl-4-methoxyphenyl-ferrocene (**5e**) following ***general procedure D*** (5 h), in 90% yield.

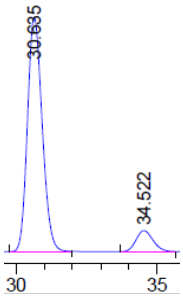
$[\alpha]_D^{20}$ = +1545 (*c* = 0.016, $CHCl_2$), 81% *ee*.

HPLC: *Daicel Chiralpak* IC, hexane / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 30.6 min, *T* = 25 ºC.



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

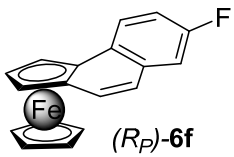
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.456	MM	0.6384	4.57724e4	1194.90332	51.1512
2	33.505	MM	0.7210	4.37122e4	1010.43073	48.8488
Totals :				8.94846e4	2205.33405	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	30.635	BB	0.5647	3.53884e4	976.79785	90.5963
2	34.522	BB	0.6548	3673.22925	87.67911	9.4037
Totals :				3.90616e4	1064.47696	

***(R_P)*-7-Fluoroferrocene-[3]-helicene (6f).**

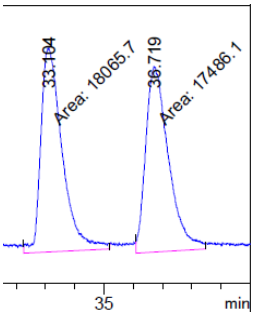


(R_P)-**6f**

Compound *(R_P)*-**6f** was obtained from 2-ethynyl-4-fluorophenyl-ferrocene (**5f**) following ***general procedure D*** (5 h), in 82% yield.

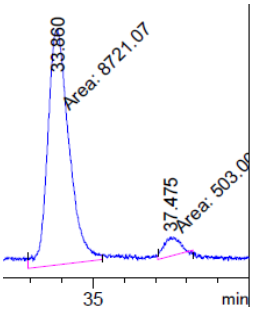
$[\alpha]_D^{20}$ = +432 (*c* = 0.032, $CHCl_2$), 89% *ee.*

HPLC-SFC: *Daicel Chiralpak* IA, CO_2/MeOH 98:2; 1.0 mL min^{-1}, 254 nm, R_t = 33.9 min, *T* = 25 ºC.



Signal 3: DAD1 D, Sig=230,4 Ref=off

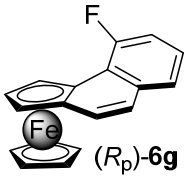
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	33.104	MM	0.8444	1.80657e4	356.57330	50.8151
2	36.719	MM	0.9036	1.74861e4	322.53961	49.1849
Totals :				3.55517e4	679.11292	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	33.860	MM	0.7867	8721.06738	184.75812	94.5468
2	37.475	MM	0.5629	503.00848	14.89272	5.4532
Totals :				9224.07587	199.65084	

9-Fluoro-ferrocene-[3]helicene (6g)

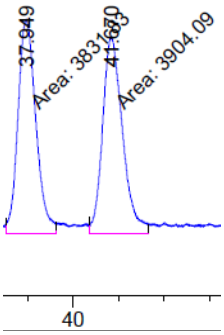


(R_p)-**6g**

Compound *(R_P)*-**6g** was obtained from 2-ethynyl-1-ferrocenyl-6-fluorobenzene **5g** following ***general procedure D*** (3h), in 74% yield.

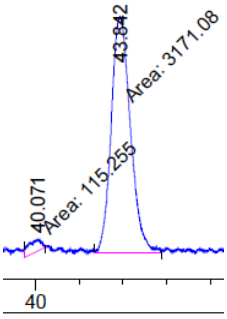
$[\alpha]_D^{20}$ = +2710 (*c* = 0.07, $CHCl_2$), 93% *ee.*

HPLC: *Daicel Chiralpak* IA, CO2/ MeOH 98:2; 1.0 mL min^{-1}, 254 nm, R_t = 43.8 min, *T* = 25 °C.



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

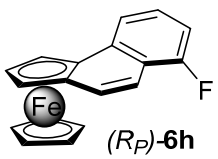
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	37.949	MM	0.9057	3831.83447	70.51444	49.4674
2	41.670	MM	1.0088	3904.09351	64.49864	50.4003
3	59.974	VBA	0.0323	10.24716	4.08341	0.1323
Totals :				7746.17514	139.09649	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	40.071	MM	0.6861	115.25468	2.79957	3.5071
2	43.842	MM	1.0107	3171.07666	52.29097	96.4929
Totals :				3286.33134	55.09054	

***(R_P)*-6-Fluoro-ferrocene-[3]helicene (6h).**

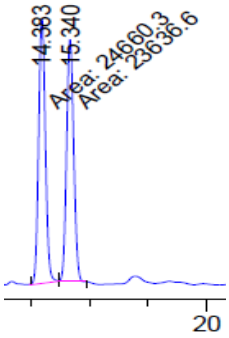


(R_P)-**6h**

Compound *(R_P)*-**6h** was obtained from 2-ethynyl-1-ferrocenyl-3-fluorobenzene **5h** following ***general procedure D*** (15 h), in 79% yield.

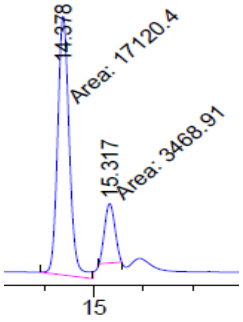
$[\alpha]_D^{20}$ = +660 (*c* 0.055, $CHCl_2$), 68% *ee.*

HPLC: *Daicel Chiralpak* IC, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 14.4 min, *T* = 25 °C.



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

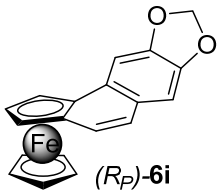
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.383	MM	0.2668	2.46603e4	1540.64343	51.0598
2	15.340	MM	0.2805	2.36366e4	1404.24182	48.9402
Totals :				4.82968e4	2944.88525	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	14.366	MM	0.2615	5496.23340	350.27203	83.6724
2	15.301	MM	0.2290	1072.52002	78.07485	16.3276
Totals :				6568.75342	428.34689	

***(R_p)*-7,8-(Methylenedioxy)ferrocene-[3]-helicene (6i)**

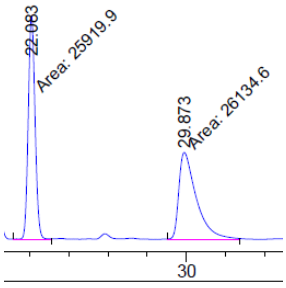


(R_P)-**6i**

Compound *(R_p)*-**6i** was obtained from 2-ethynyl-4,5-(methylenedioxy)phenyl-ferrocene (**5i**) following ***general procedure D*** (5 h), in 85% yield.

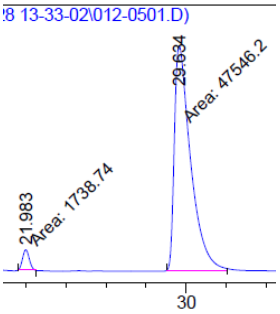
$[\alpha]_D^{20}$ = +2444 (*c* = 0.037, CH_2Cl_2), 93% *ee*.

HPLC: *Daicel Chiralpak* IC, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 29.6 min, *T* = 25 ºC.



Signal 3: DAD1 D, Sig=230,16 Ref=360,100

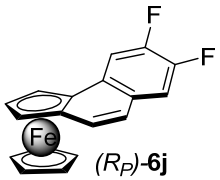
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	22.083	MM	0.4059	2.59199e4	1064.33252	49.7937
2	29.873	MM	1.0479	2.61346e4	415.65436	50.2063
Totals :				5.20545e4	1479.98688	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.983	MM	0.3818	1738.73926	75.90256	3.5279
2	29.634	MM	0.9373	4.75462e4	845.46295	96.4721
Totals :				4.92849e4	921.36551	

***(R_p)*-7,8-Difluoro-ferrocene-[3]helicene (6j).**

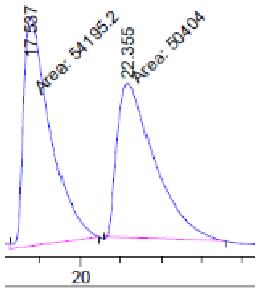


(R_P)-**6j**

Compound *(R_P)*-**6j** was obtained from 2-ethynyl-1-ferrocenyl-4,5-difluorobenzene **5j** following ***general procedure D*** (4 h), in 83% yield.

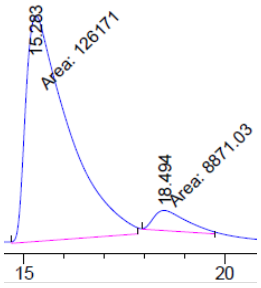
$[\alpha]_D^{20}$ = +2774 (*c* 0.042, CH_2Cl_2), 87% *ee.*

HPLC: *Daicel Chiralpak* IA, hexane / 2-propanol 100:0; 0.4 mL min^{-1}, 254 nm, R_t = 15.3 min, *T* = 25 °C



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

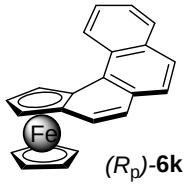
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	17.537	MM	1.5453	5.41952e4	584.52600	51.8122
2	22.355	MM	2.1539	5.04040e4	390.01868	48.1878
Totals :				1.04599e5	974.54468	



Signal 2: DAD1 C, Sig=210,8 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	15.283	MM	1.2391	1.26171e5	1697.06177	93.4309
2	18.494	MM	0.9695	8871.03223	152.49930	6.5691
Totals :				1.35042e5	1849.56107	

(*R*$_P$)-Ferrocene-[4]helicene (6k).

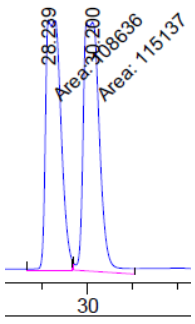


(*R*$_p$)-**6k**

Compound (*R*$_p$)-**6k** was obtained from (*R*$_P$)-2-ethynyl-1-naphthylferrocene **5k** following ***general procedure D*** (15 h), in 88% yield.

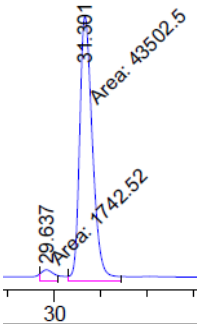
[α]$_D^{20}$ = +1974 (*c* 0.017, CH_2Cl_2), 93% *ee*.

HPLC: *Daicel Chiralpak* IC, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 31.3 min, *T* = 25 °C).



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

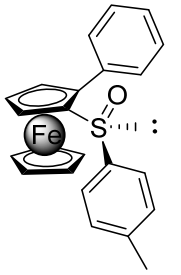
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	28.239	MM	0.7834	1.08636e5	2311.23120	48.5475
2	30.200	MM	0.8326	1.15137e5	2304.80396	51.4525
Totals :				2.23773e5	4616.03516	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	29.637	MM	0.6077	1742.52478	47.79377	3.8513
2	31.301	MM	0.6472	4.35025e4	1120.30798	96.1487
Totals :				4.52450e4	1168.10175	

(S_S,S_p)-2-Phenyl-1-(*p*-tolylsulfinyl)ferrocene (9).[1]

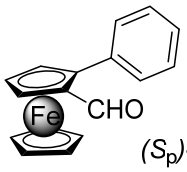


(S_S,S_p)-**9**

To a mixture of (S_S,S_p)-2-(*p*-tolylsulfinyl)ferrocenyl boronic acid (**7**) (94 mg, 0.25 mmol), $PdCl_2$(dppf) (11 mg, 0.015 mmol) and NaOH (39 mg, 1 mmol), iodobencene (101 µL, 0.9 mmol), toluene (3.3 mL) and water (0.6 mL) were added. The resulting suspension was refluxed overnight. After workup and flash chromatography (eluent hexane/EtOAc/CH_2Cl_2 79:22:8), pure compound (S_S,S_p)-**9** was obtained, as an orange solid, in 79% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ 7.74 (d, *J* = 8.1 Hz, 2H), 7.64 (d, *J* = 8.1 Hz, 2H), 7.32 – 7.19 (m, 5H), 4.66 (broad s, 1H), 4.34 (broad s, 1H), 4.07 (s, 5H), 4.05 (broad s, 1H), 2.36 (s, 3H).

(S_p)-1-Formyl-2-phenylferrocene (10).[2]



(S_p)-**10**

(1) V. E. Albrow, A. J. Blake, R. Fryatt, C. Wilson, S. Woodward, *Eur. J. Org. Chem.* **2006**, 2549.
(2) M. R. Buchmeiser, N. Schuler, G. Kaltenhauser, K. -H. Ongania, I. Lagoja, K. Wurst, H. Schottenberger, *Macromolecules* **1998**, *31*, 3175.

To a solution of the sulfoxide *(S_S,S_p)*-**9** (376 mg, 0.94 mmol) in THF (9.8 mL) at -78 °C, *tert*-BuLi (0.82 mL, 1.4 mmol, 1.7 M in pentane) was added dropwise during 10 min. The resulting solution was stirred for 10 min at the same temperature before addition of dry *N*,*N*-dimethyl formamide (DMF) (0.82 mL, 10.4 mmol). After stirring at -78 °C for 2 h, the solution was quenched with water. After workup, the residue was concentrated *in vacuo* and purified by flash chromatography (eluent hexane/EtOAc 5:1) affording the pure aldehyde (S_p)-**10**, as orange oil, in 64% yield.

$[\alpha]_D^{20}$ = -697 (*c* = 0.070, CH_2Cl_2).

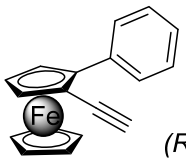
^{1}H NMR (300 MHz, $CDCl_3$): δ 10.21 (s, 1H), 7.53 (d, *J* = 7.8, Hz, 2H), 7.41 – 7.29 (m, 3H), 5.00 (broad s, 1H), 4.84 (broad s, 1H), 4.71 (broad s, 1H), 4.26 (s, 5H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 193.1, 136.0, 129.7 (2C), 128.3 (2C), 127.3, 92.7, 75.07, 72.0, 71.1 (5C), 70.0, 68.5.

MS (FAB+): *m/z* (%) 290 (M^+, 43), 57 (30).

HRMS: Calculated for $C_{17}H_{14}FeO$ (M^+) 290.0394, found 290.0397.

(R_P)-2-Ethynyl-1-phenylferrocene (11).[3]



(R_p)-**11**

A solution of PPh_3 (390 mg, 1.5 mmol) and CBr_4 (250 mg, 0.75 mmol) in CH_2Cl_2 (15 mL) was stirred for 10 min at 0 °C. Then, a solution of (S_p)-1-formyl-2-phenylferrocene (**10**) (174 mg, 0.60 mmol) in CH_2Cl_2 (15 mL) was added, and the reaction mixture was stirred for 2 h at this temperature. After filtration over silica gel and solvent elimination, Et_2O (20 mL) and THF (10 mL) were added under nitrogen. The solution was cooled at -78 °C and *n*-BuLi 2.5 M (0.86 mL, 2.09 mmol) was added dropwise. After 30 min, the mixture was allowed to warm to room temperature, stirred for 1 h and hydrolyzed with water. After workup and solvent elimination, the crude was purified by flash chromatography (eluent hexane) affording pure ethynyl compound (R_p)-**11**, in 60% yield.

(3) H. Lehner, K. Schoegl, *Monatsh. Chem.* **1970**, *101*, 895

$[\alpha]_D^{20}$ = -434 (*c* = 0.08, CH_2Cl_2).

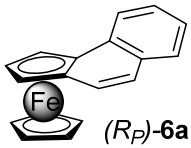
^{1}H NMR (300 MHz, $CDCl_3$): δ 7.81 (d, *J* = 7.3 Hz, 2H), 7.33 (m, 3H), 4.62 (broad s, 2H), 4.33 (broad s, 1H), 4.16 (s, 5H), 2.90 (s, 1H).

^{13}C NMR (75 MHz, $CDCl_3$): δ 137.6, 128.0 (2C), 127.8 (2C), 126.6, 88.0, 82.6, 76.3, 73.2, 71.6 (5C), 70.3, 68.6, 68.4.

MS (EI): *m/z* (%) 286 (M^+, 100), 121 (15).

HRMS: Calculated for $C_{18}H_{14}Fe$ (M^+) 286.0445, found 286.0435.

***(R_p)*-Ferrocene[3]helicene (6a).**

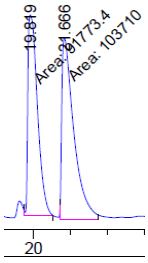


(R_P)-**6a**

Compound *(R_p)*-**6a** was obtained from (R_p)-2-ethynyl-1-phenylferrocene (**11**) following ***general procedure C*** (1.5 h).

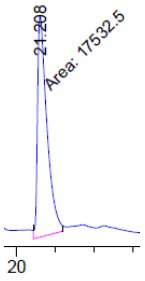
$[\alpha]_D^{20}$ = +1037 (*c* = 0.013, CH_2Cl_2), >98% *ee.*

HPLC: *Daicel Chiralpak* IB, hexano / 2-propanol 97:3; 0.3 mL min^{-1}, 254 nm, R_t = 21.2 min, *T* = 25 °C).



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	19.819	MM	0.6028	9.17734e4	2537.27661	46.9470
2	21.666	MM	0.7520	1.03710e5	2298.63843	53.0530
Totals :				1.95483e5	4835.91504	



Signal 1: DAD1 A, Sig=254,4 Ref=360,100

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	21.208	MM	0.5643	1.75325e4	517.83704	100.0000
Totals :				1.75325e4	517.83704	

X-Ray Crystallography for (*rac*)-6a (CCDC-1469767)

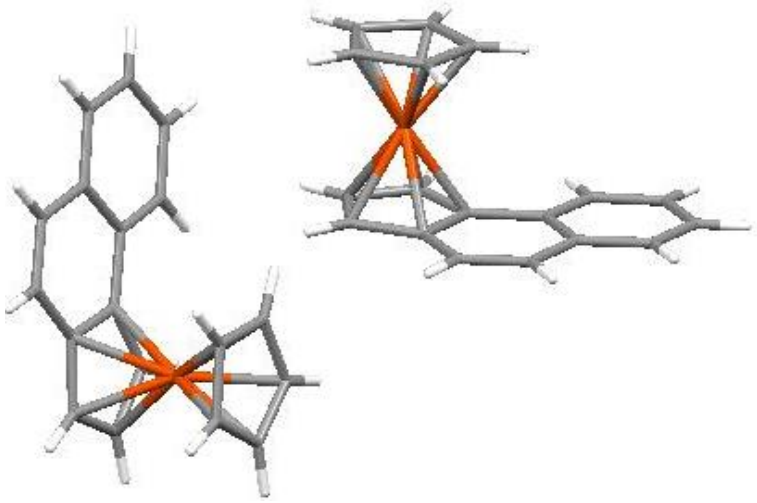


Table. Crystal data and structure refinement for (*rac*)-6a.

Identification code	(*rac*)-6a	
Chemical formula	$C_{18}H_{14}Fe$	
Formula weight	286.14	
Temperature	200(2) K	
Wavelength	0.71073 Å	
Crystal size	0.04 x 0.20 x 0.32 mm	
Crystal habit	clear dark orange plate	
Crystal system	monoclinic	
Space group	P 1 21/c 1	
Unit cell dimensions	a = 13.4447(4) Å	α = 90°
	b = 19.4178(11) Å	β = 91.4960(10)°
	c = 9.8391(6) Å	γ = 90°
Volume	2567.8(2) $Å^3$	
Z	8	
Density (calculated)	1.480 Mg/cm^3	
Absorption coefficient	1.155 mm^{-1}	
F(000)	1184	

Theta range for data collection	1.84 to 25.37°	
Index ranges	-16<=h<=14, -23<=k<=23, -11<=l<=11	
Reflections collected	32723	
Independent reflections	4683 [R(int) = 0.0521]	
Coverage of independent reflections	99.5%	
Absorption correction	multi-scan	
Max. and min. transmission	0.9553 and 0.7089	
Structure solution technique	direct methods	
Structure solution program	SHELXS-97 (Sheldrick, 2008)	
Refinement method	Full-matrix least-squares on F^2	
Refinement program	SHELXL-97 (Sheldrick, 2008)	
Function minimized	$\Sigma w(F_o^2 - F_c^2)^2$	
Data / restraints / parameters	4683 / 0 / 343	
Goodness-of-fit on F^2	1.034	
Δ/σ_{max}	0.001	
Final R indices	3631 data; I>2σ(I)	R1 = 0.0308, wR2 = 0.0699
	all data	R1 = 0.0469, wR2 = 0.0777
Weighting scheme	$w=1/[\sigma^2(F_o^2)+(0.0371P)^2+0.3877P]$ where $P=(F_o^2+2F_c^2)/3$	
Largest diff. peak and hole	0.301 and -0.243 eÅ^{-3}	
R.M.S. deviation from mean	0.049 eÅ^{-3}	

X-Ray Crystallography for (R_p)-6e (CCDC-1469768)

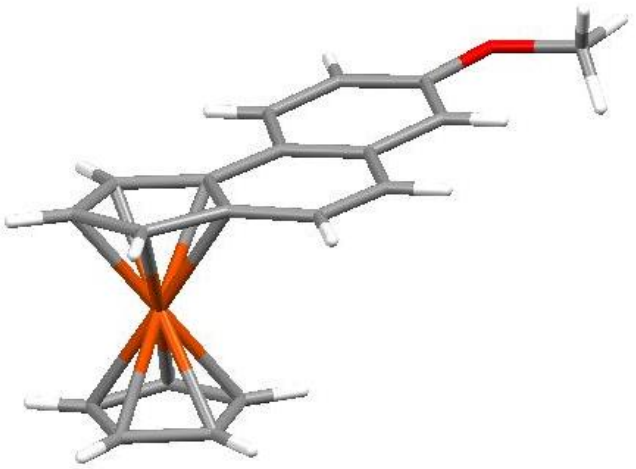
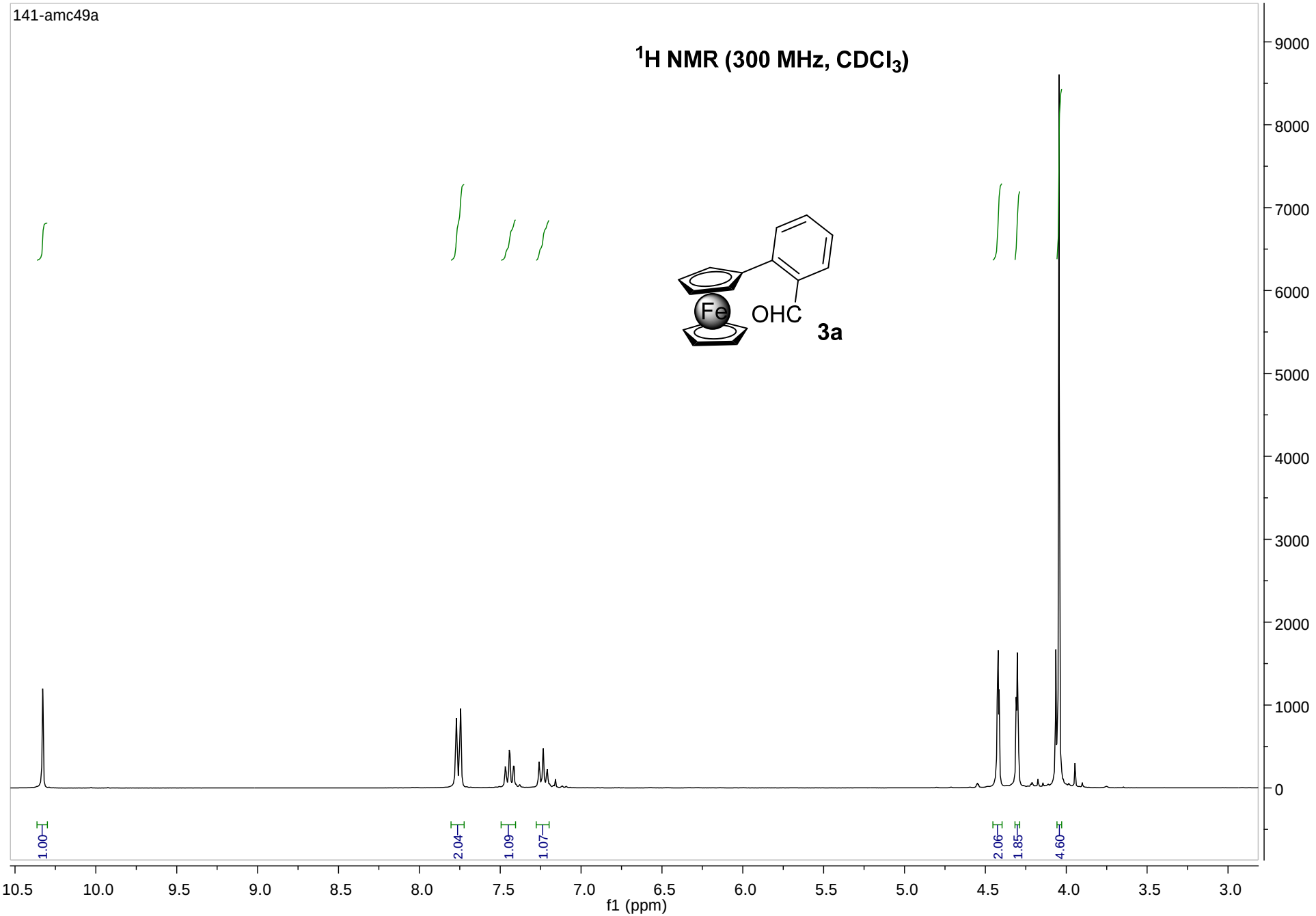
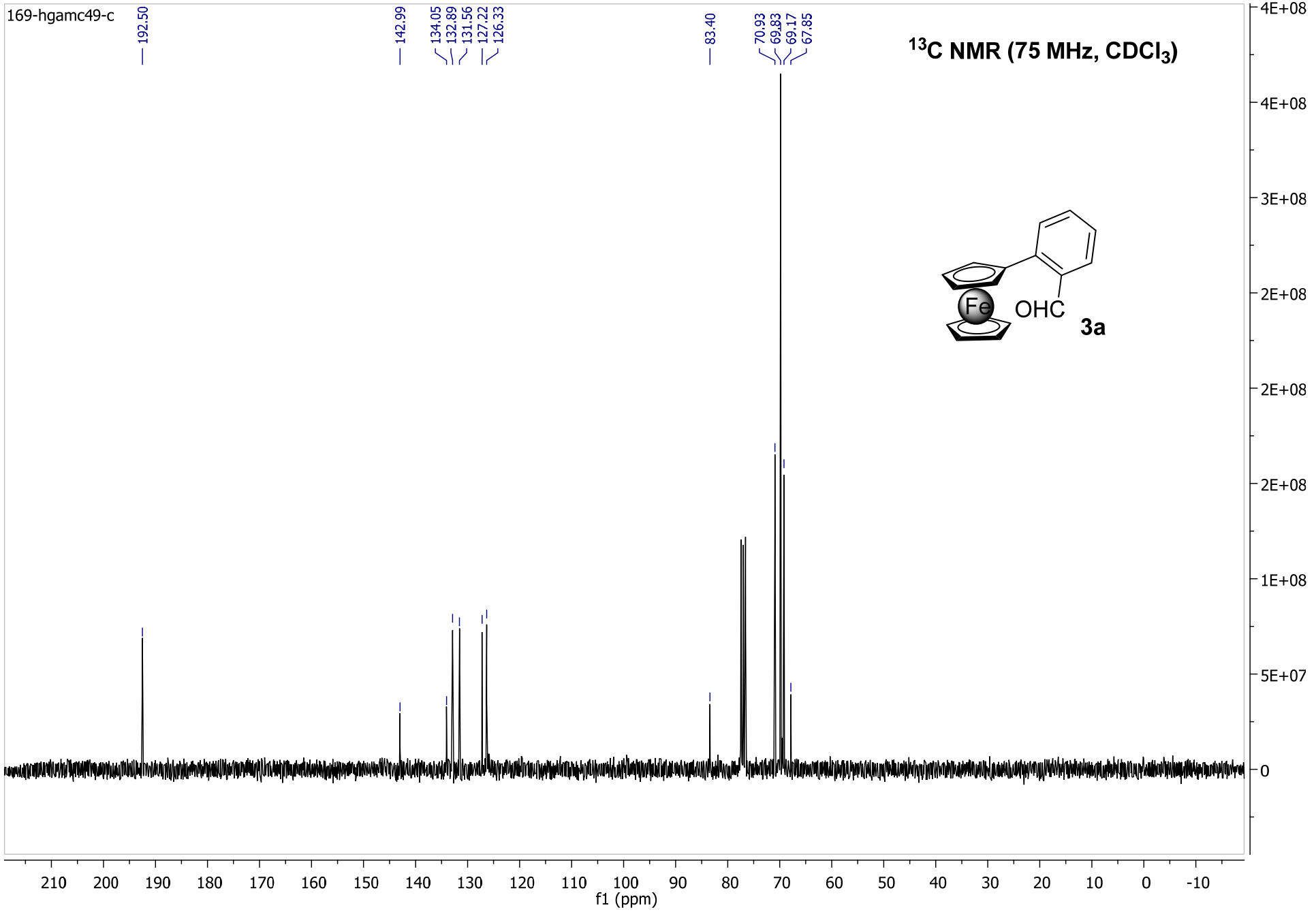


Table. Crystal data and structure refinement for (R_p)-6e.

Identification code	(R_p)-6e	
Chemical formula	$C_{19}H_{16}FeO$	
Formula weight	316.17	
Temperature	200(2) K	
Wavelength	0.71073 Å	
Crystal size	0.02 x 0.14 x 0.18 mm	
Crystal habit	clear light red plate	
Crystal system	tetragonal	
Space group	P 41 21 2	
Unit cell dimensions	a = 7.8273(13) Å	α = 90°
	b = 7.8273(13) Å	β = 90°
	c = 47.227(9) Å	γ = 90°
Volume	2893.4(9) $Å^3$	
Z	8	
Density (calculated)	1.452 Mg/cm^3	
Absorption coefficient	1.037 mm^{-1}	
F(000)	1312	

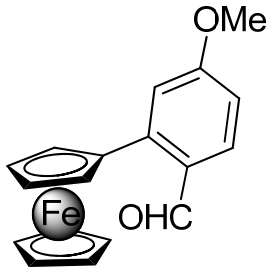
Theta range for data collection	1.72 to 25.45°	
Index ranges	-7<=h<=7, -9<=k<=8, -48<=l<=57	
Reflections collected	10547	
Independent reflections	2679 [R(int) = 0.1009]	
Coverage of independent reflections	99.9%	
Absorption correction	multi-scan	
Max. and min. transmission	0.9796 and 0.8353	
Structure solution technique	direct methods	
Structure solution program	SHELXS-97 (Sheldrick, 2008)	
Refinement method	Full-matrix least-squares on F^2	
Refinement program	SHELXL-97 (Sheldrick, 2008)	
Function minimized	$\Sigma\, w(F_o^2 - F_c^2)^2$	
Data / restraints / parameters	2679 / 0 / 191	
Goodness-of-fit on F^2	1.031	
Δ/σ_{max}	0.001	
Final R indices	1829 data; I>2σ(I)	R1 = 0.0751, wR2 = 0.1647
	all data	R1 = 0.1172, wR2 = 0.1839
Weighting scheme	$w=1/[\sigma^2(F_o^2)+(0.1000P)^2+0.0000P]$ where $P=(F_o^2+2F_c^2)/3$	
Absolute structure parameter	-0.0(1)	
Largest diff. peak and hole	0.335 and -0.441 eÅ^{-3}	
R.M.S. deviation from mean	0.083 eÅ^{-3}	


141-amc49a
1H NMR (300 MHz, CDCl3)
Fe
OHC
3a
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
1.00
2.04
1.09
1.07
2.06
1.85
4.60
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
f1 (ppm)


169-hgamc49-c
192.50
142.99
134.05
132.89
131.56
127.22
126.33
83.40
70.93
69.83
69.17
67.85
^{13}C NMR (75 MHz, CDCl$_3$)
Fe
OHC
3a
4E+08
4E+08
3E+08
2E+08
2E+08
2E+08
1E+08
5E+07
0
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)

hgc1_09

^{1}H NMR (300 MHz, $CDCl_3$)

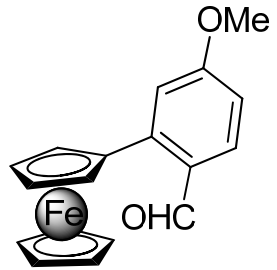


3b

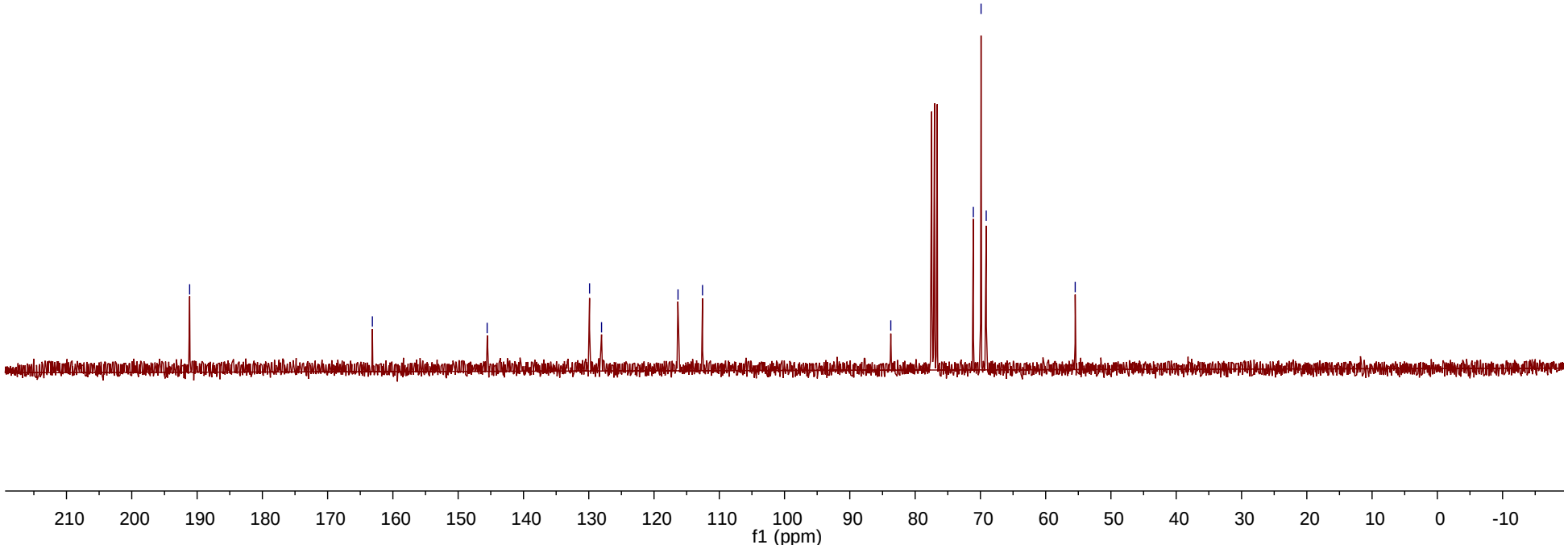
hgc1_09

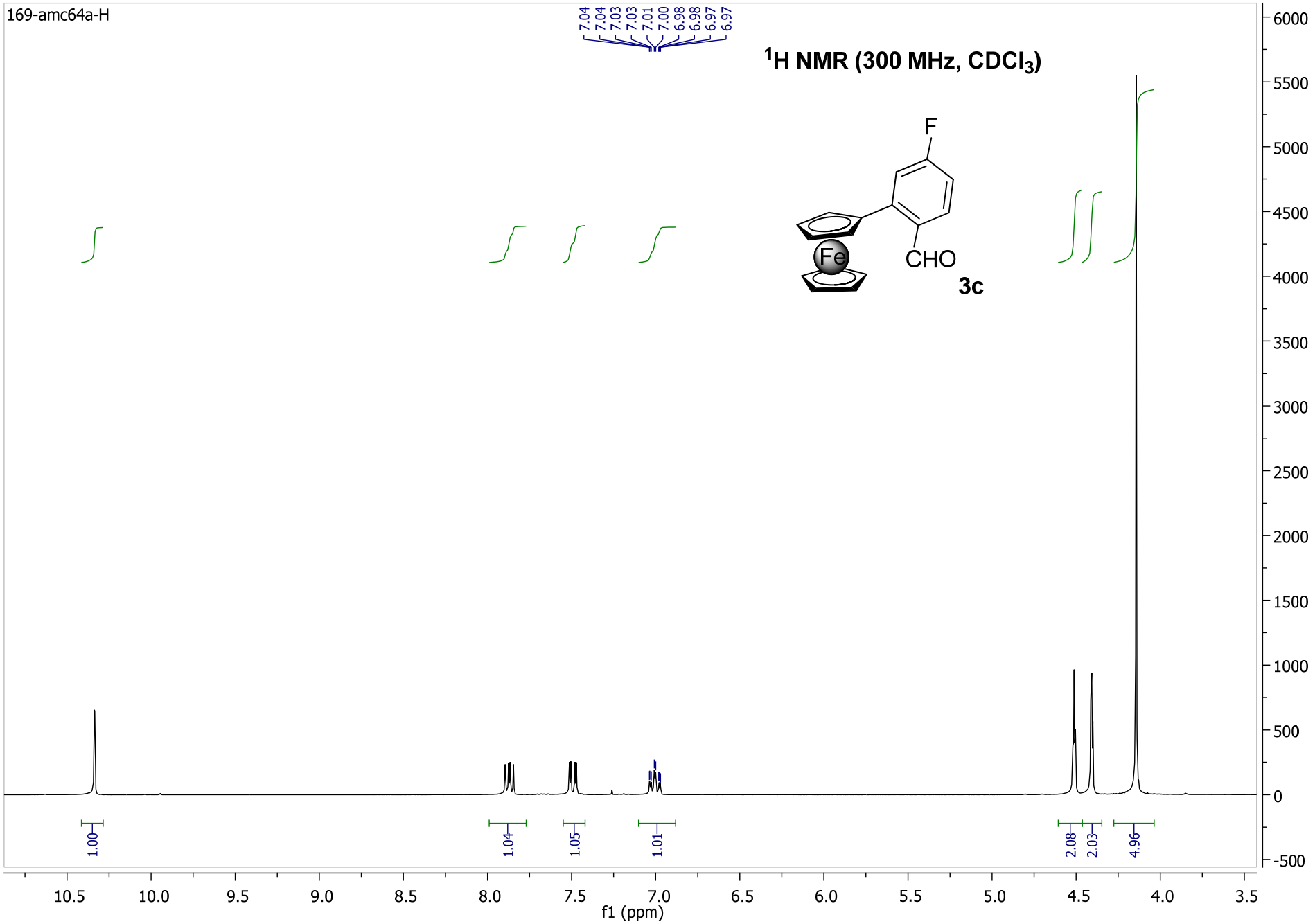
191.13 163.15 145.55 129.89 128.04 116.33 112.56 83.72 71.09 69.90 69.11 55.48

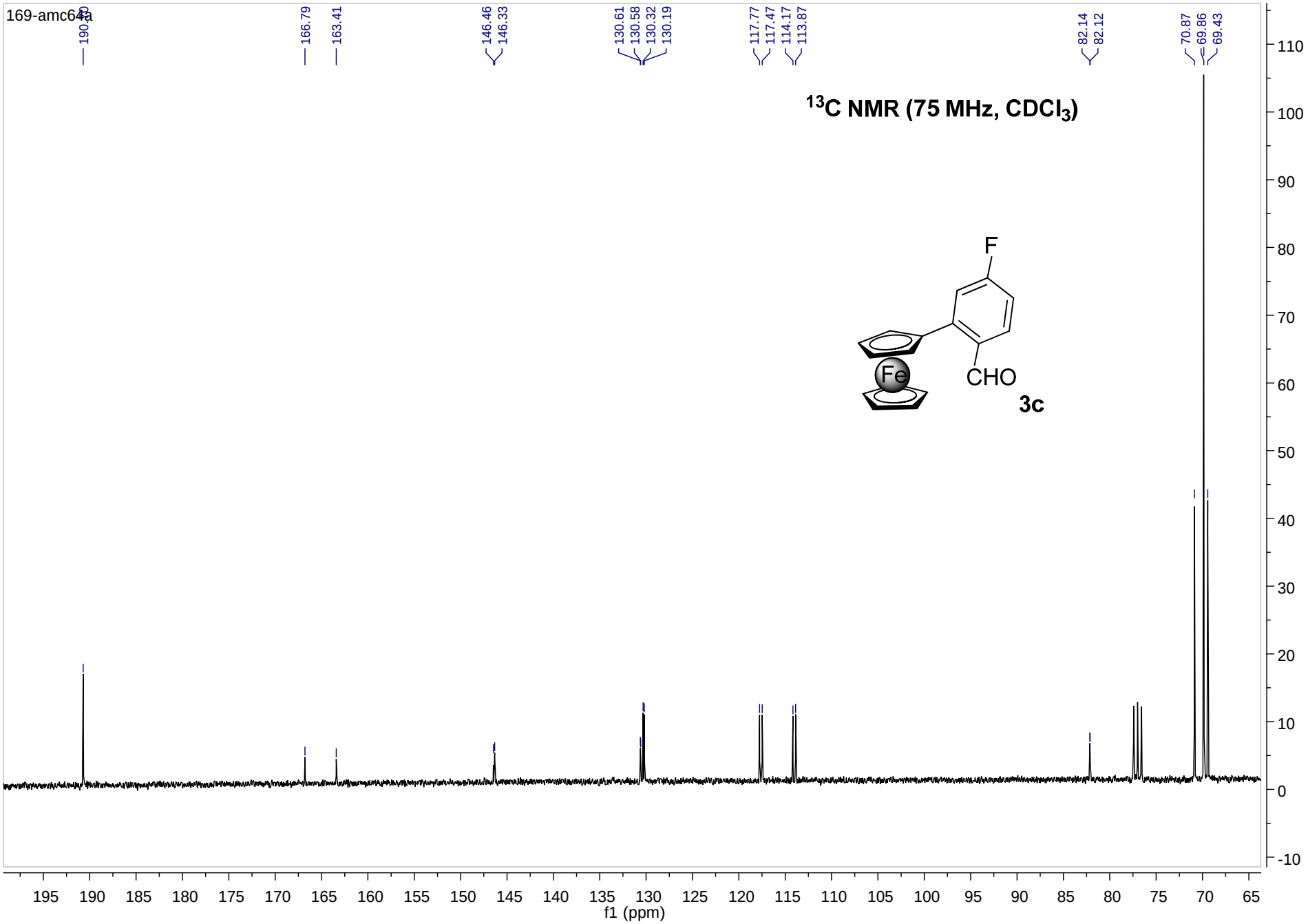
^{13}C NMR (75 MHz, $CDCl_3$)

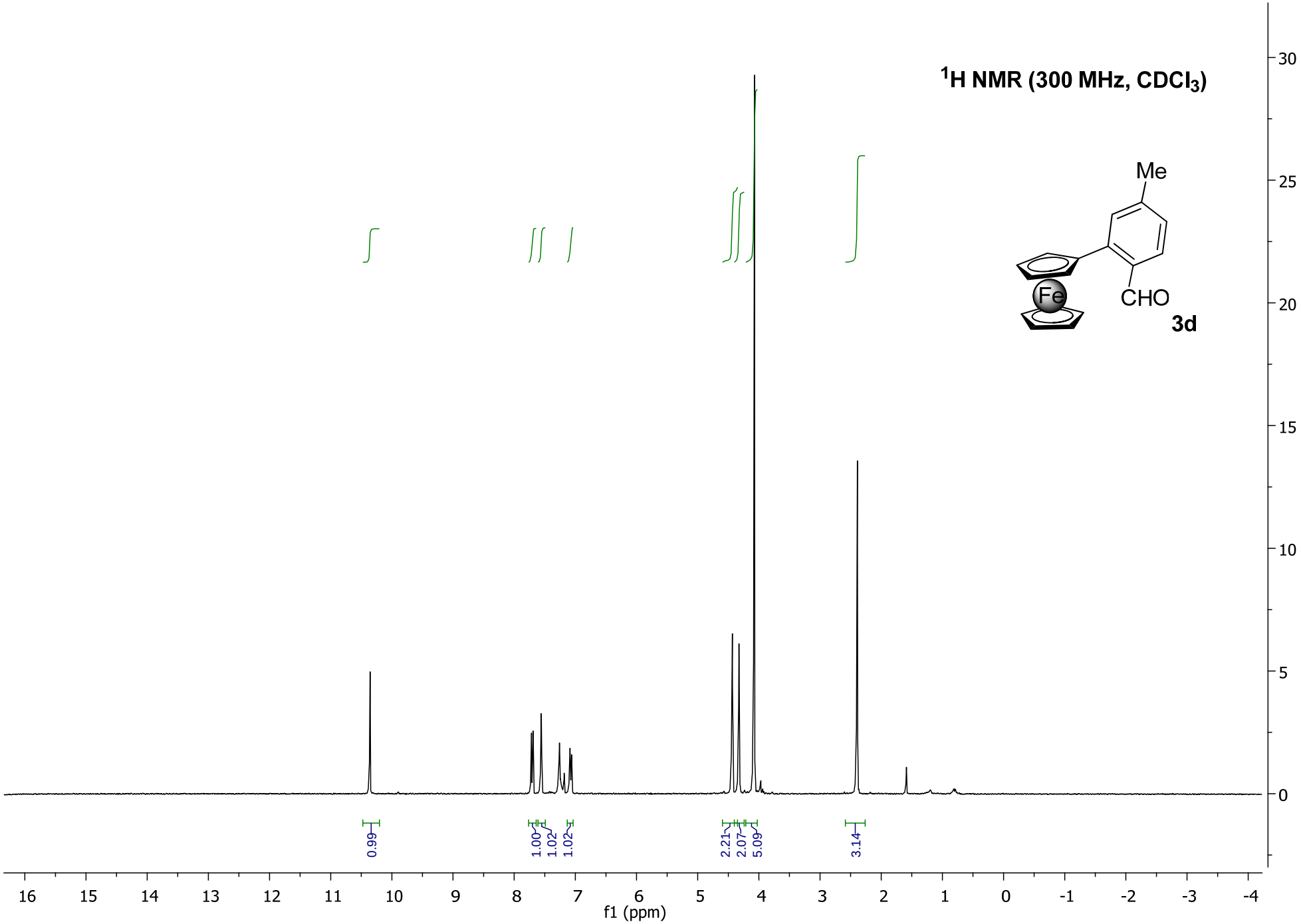


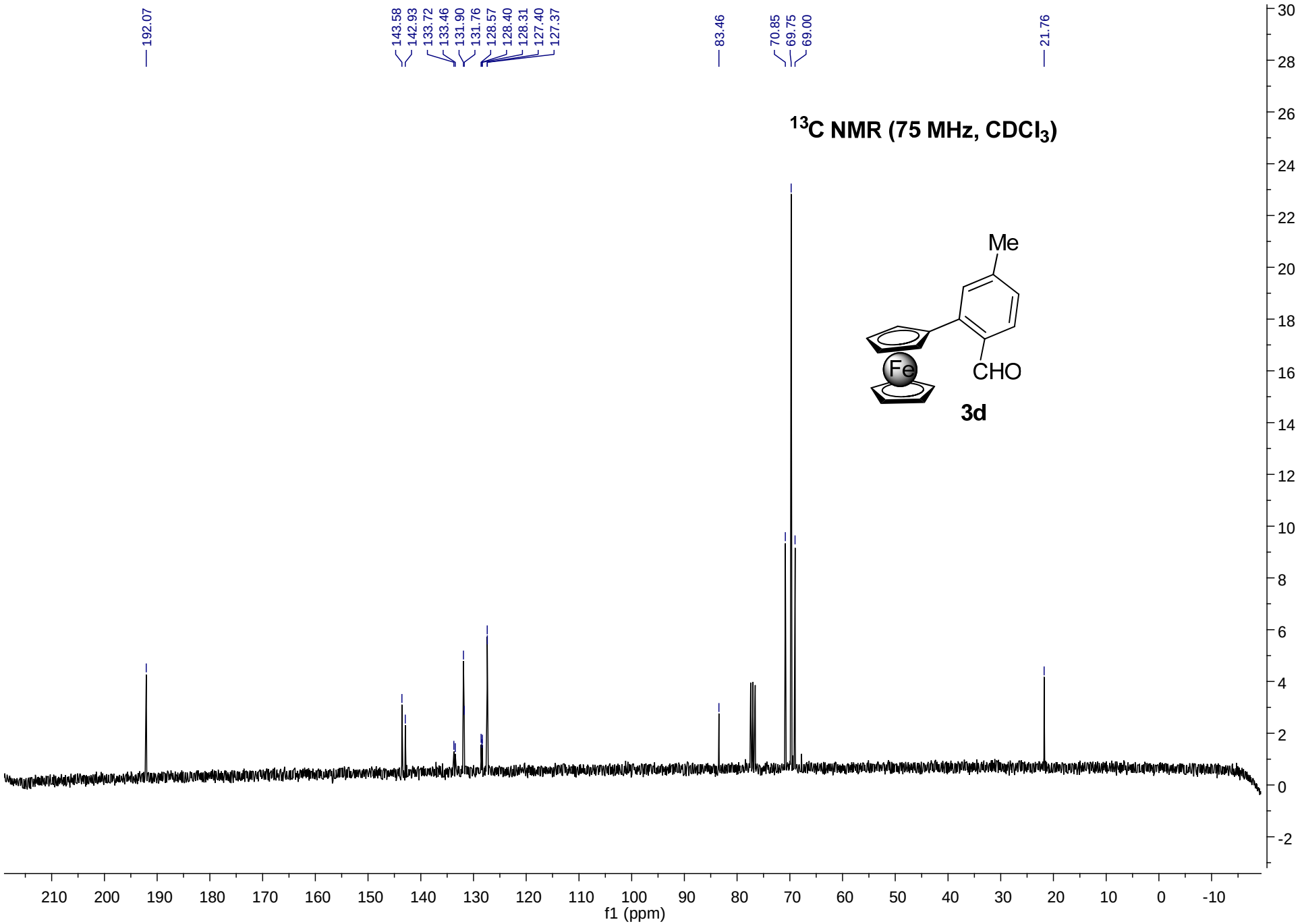
3b

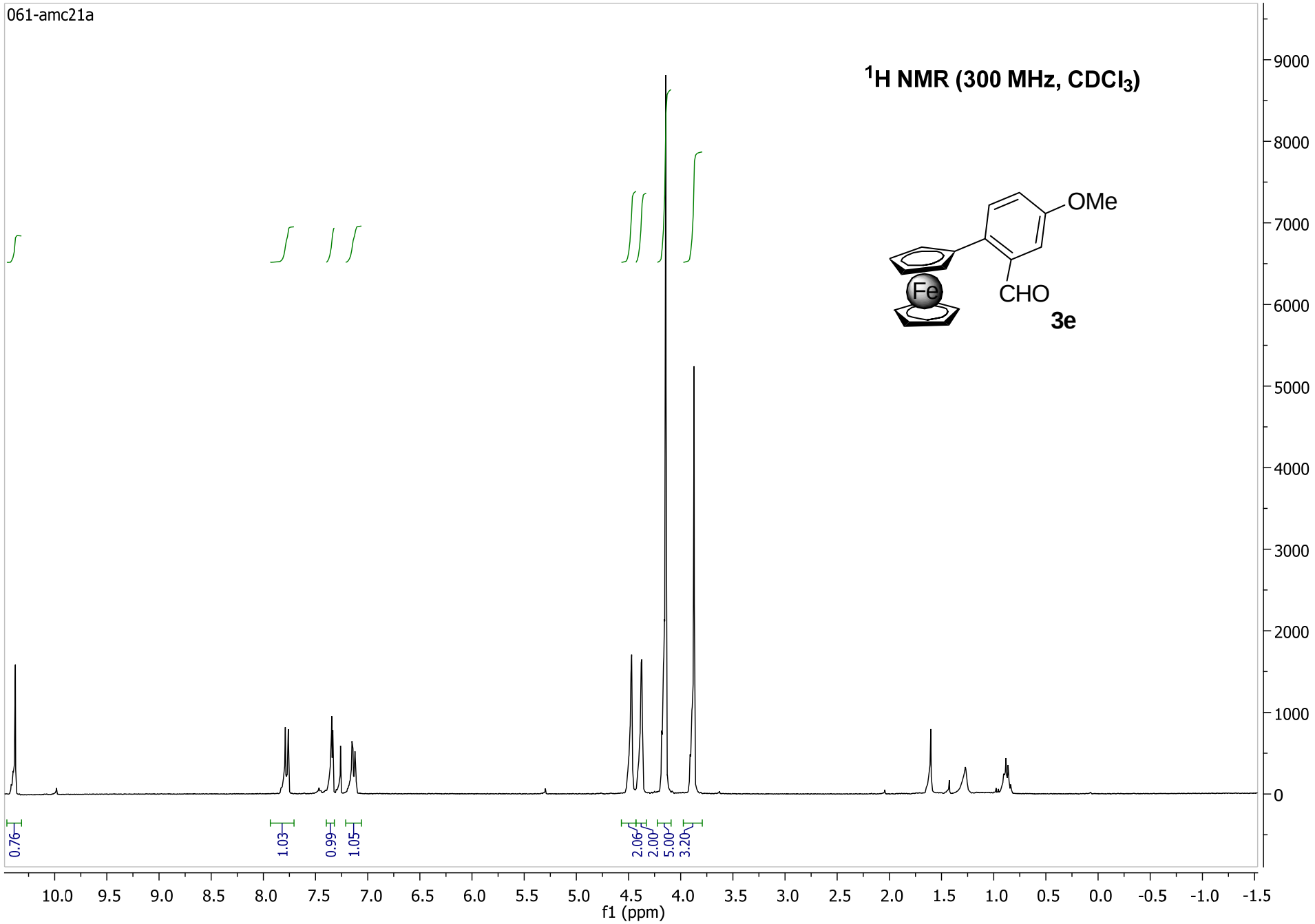


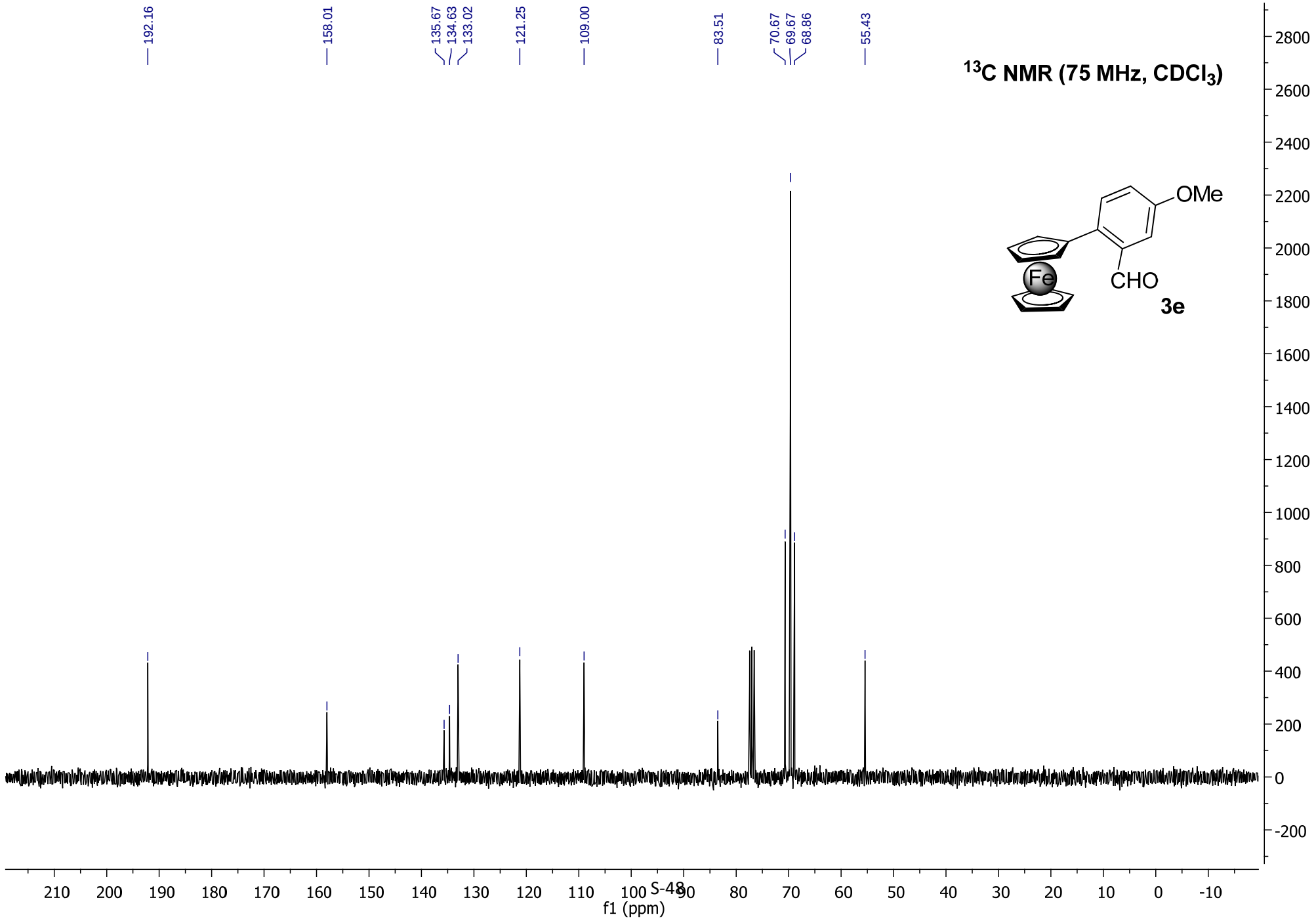

169-amc64a-H
7.04
7.04
7.03
7.03
7.01
7.00
6.98
6.98
6.97
6.97
^{1}H NMR (300 MHz, CDCl$_3$)
F
Fe
CHO
3c
1.00
1.04
1.05
1.01
2.08
2.03
4.96
f1 (ppm)

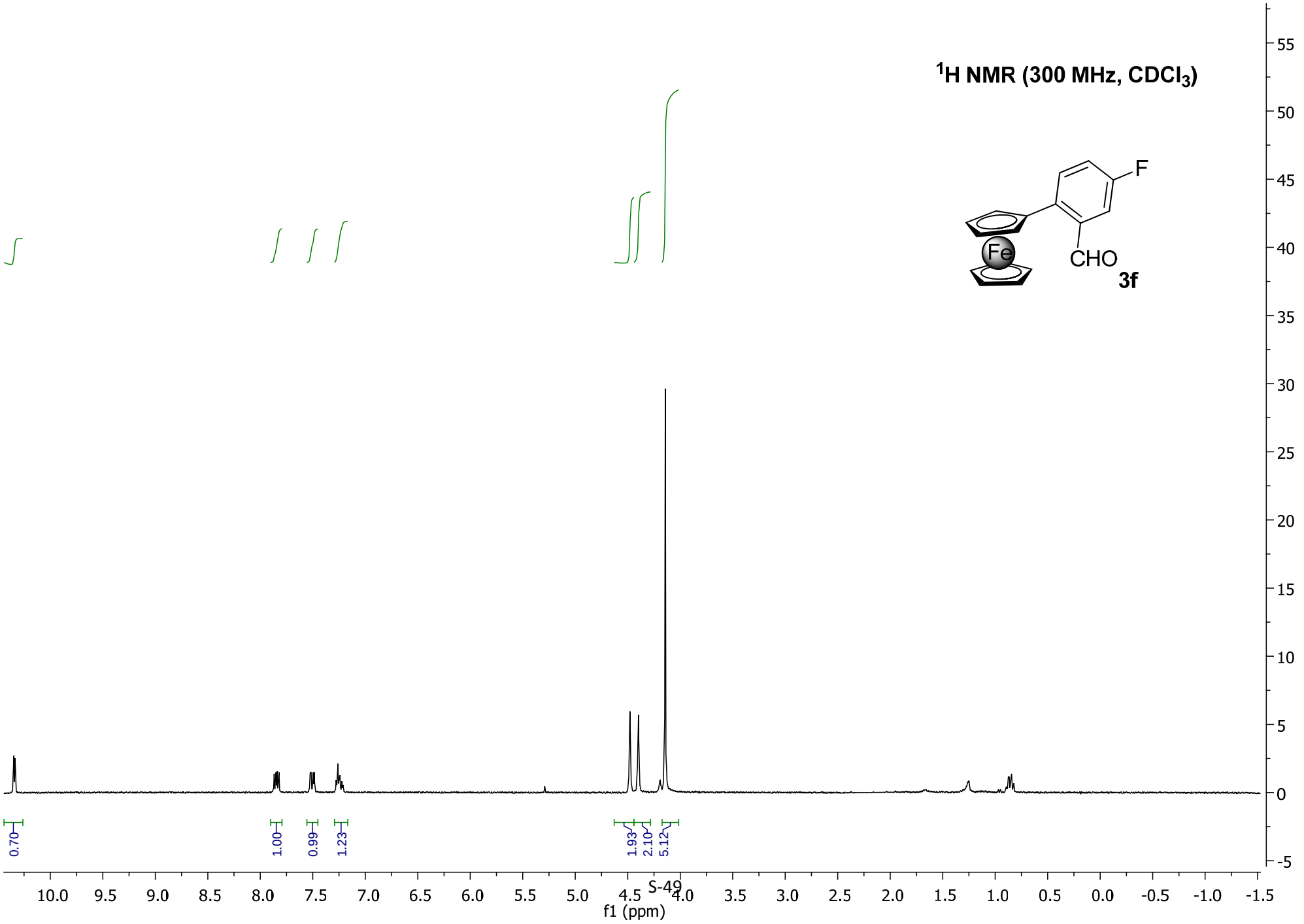

169-amc64a
190.42
166.79
163.41
146.46
146.33
130.61
130.58
130.32
130.19
117.77
117.47
114.17
113.87
82.14
82.12
70.87
69.86
69.43
13C NMR (75 MHz, CDCl3)
F
Fe
CHO
3c
110
100
90
80
70
60
50
40
30
20
10
0
-10
195 190 185 180 175 170 165 160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65
f1 (ppm)

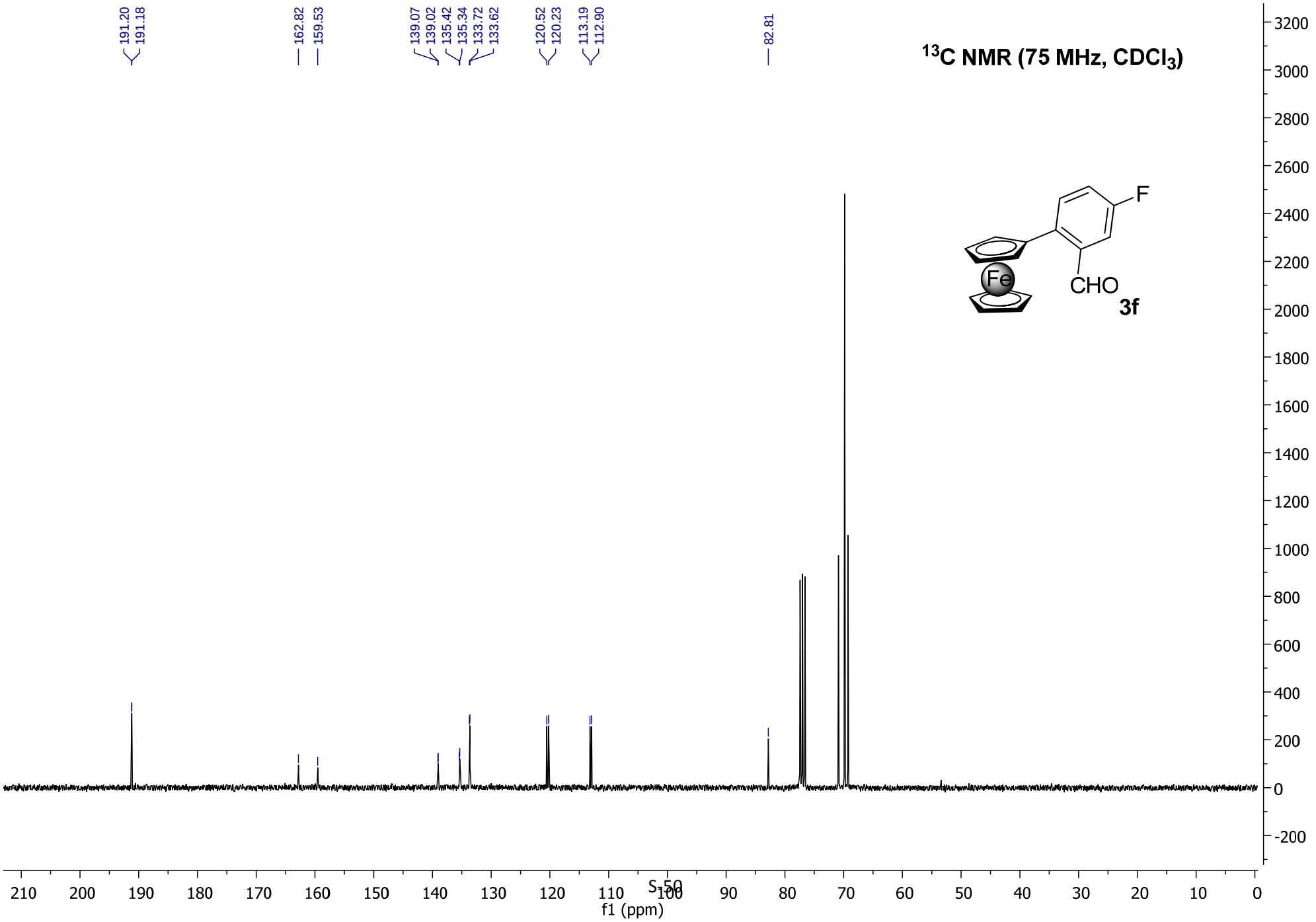

^{1}H NMR (300 MHz, $CDCl_3$)
Me
Fe
CHO
3d
0.99
1.00
1.02
1.02
2.21
2.07
5.09
3.14
f1 (ppm)

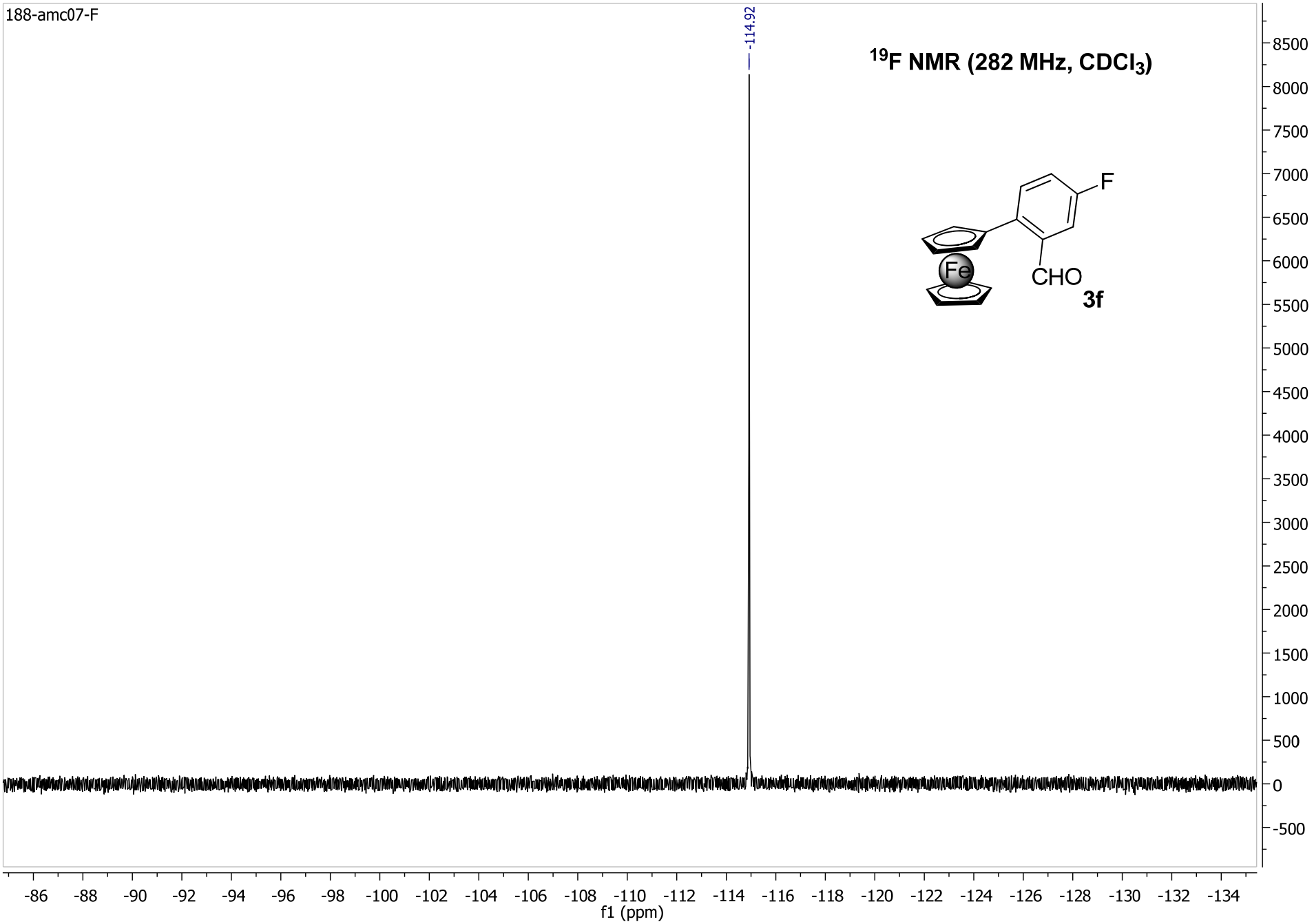

192.07
143.58
142.93
133.72
133.46
131.90
131.76
128.57
128.40
128.31
127.40
127.37
83.46
70.85
69.75
69.00
21.76
13C NMR (75 MHz, CDCl3)
Me
Fe
CHO
3d
f1 (ppm)

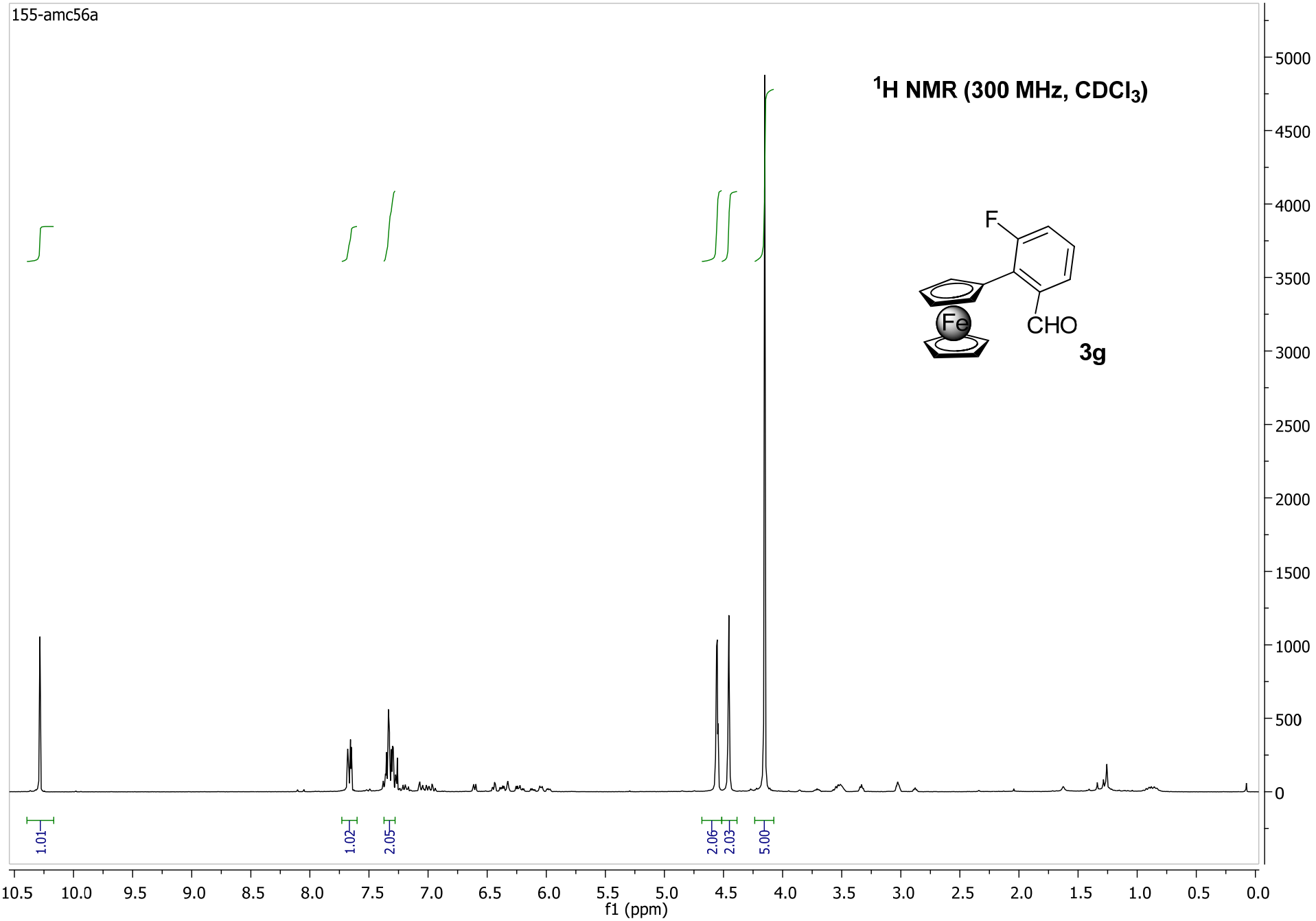

061-amc21a
^{1}H NMR (300 MHz, CDCl$_3$)
OMe
Fe
CHO
3e
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0.76
1.03
0.99
1.05
2.06
2.00
5.00
3.20
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0 -1.5
f1 (ppm)

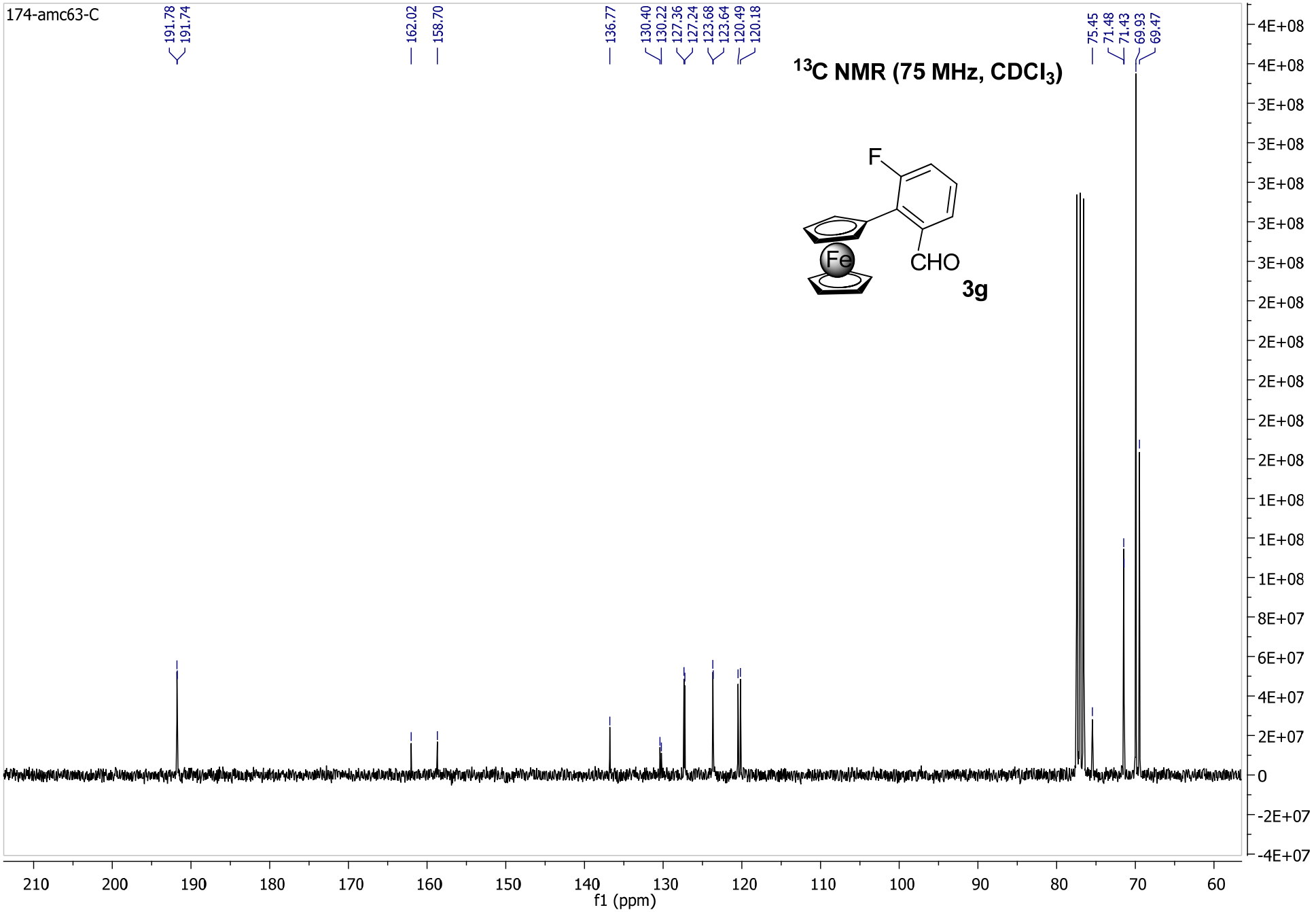

192.16
158.01
135.67
134.63
133.02
121.25
109.00
83.51
70.67
69.67
68.86
55.43
13C NMR (75 MHz, CDCl3)
OMe
Fe
CHO
3e
f1 (ppm)

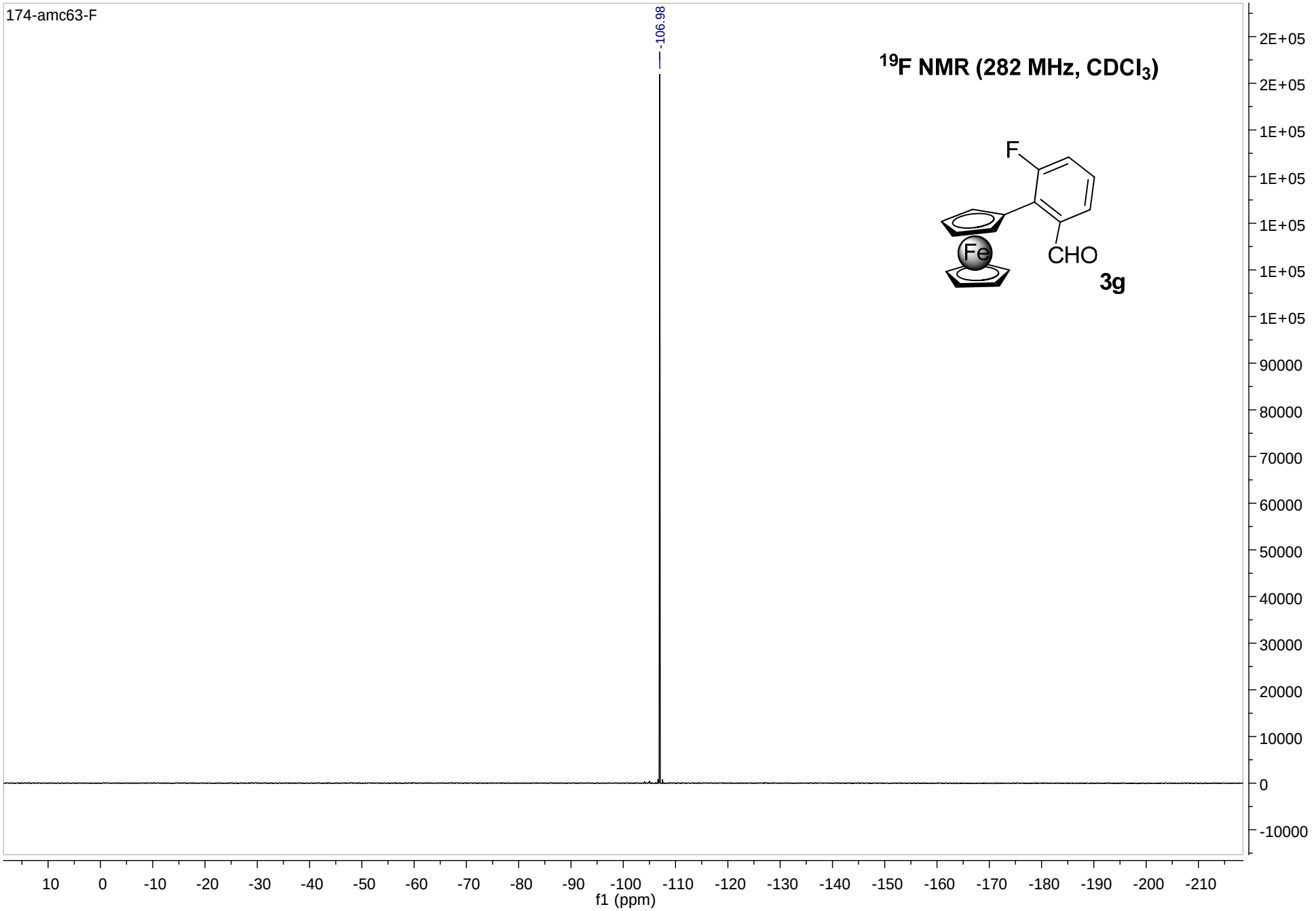

^{1}H NMR (300 MHz, $CDCl_3$)
F
Fe
CHO
3f
0.70
1.00
0.99
1.23
1.93
2.10
5.12
f1 (ppm)

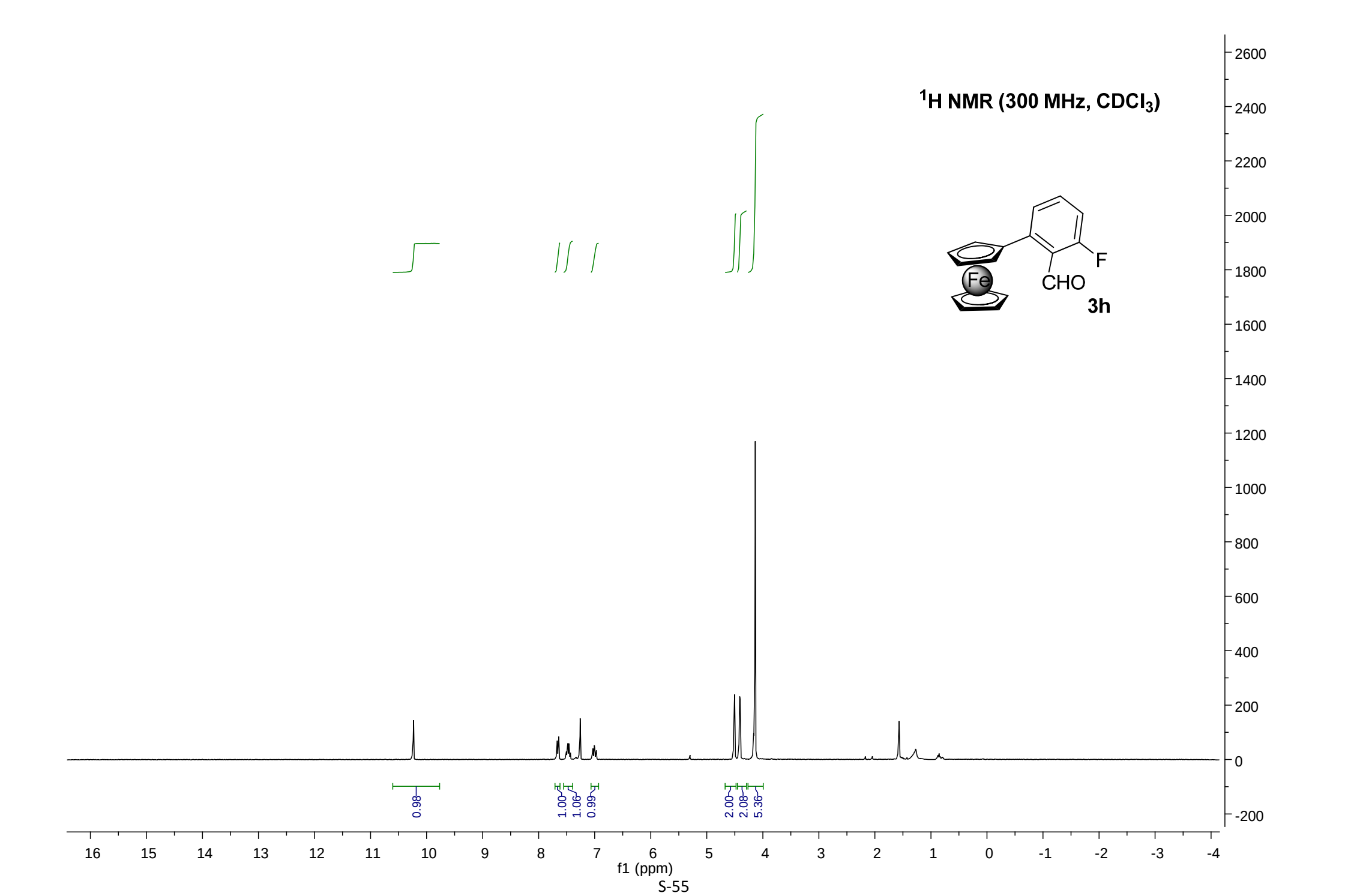

191.20
191.18
162.82
159.53
139.07
139.02
135.42
135.34
133.72
133.62
120.52
120.23
113.19
112.90
82.81
13C NMR (75 MHz, CDCl3)
F
Fe
CHO
3f
f1 (ppm)

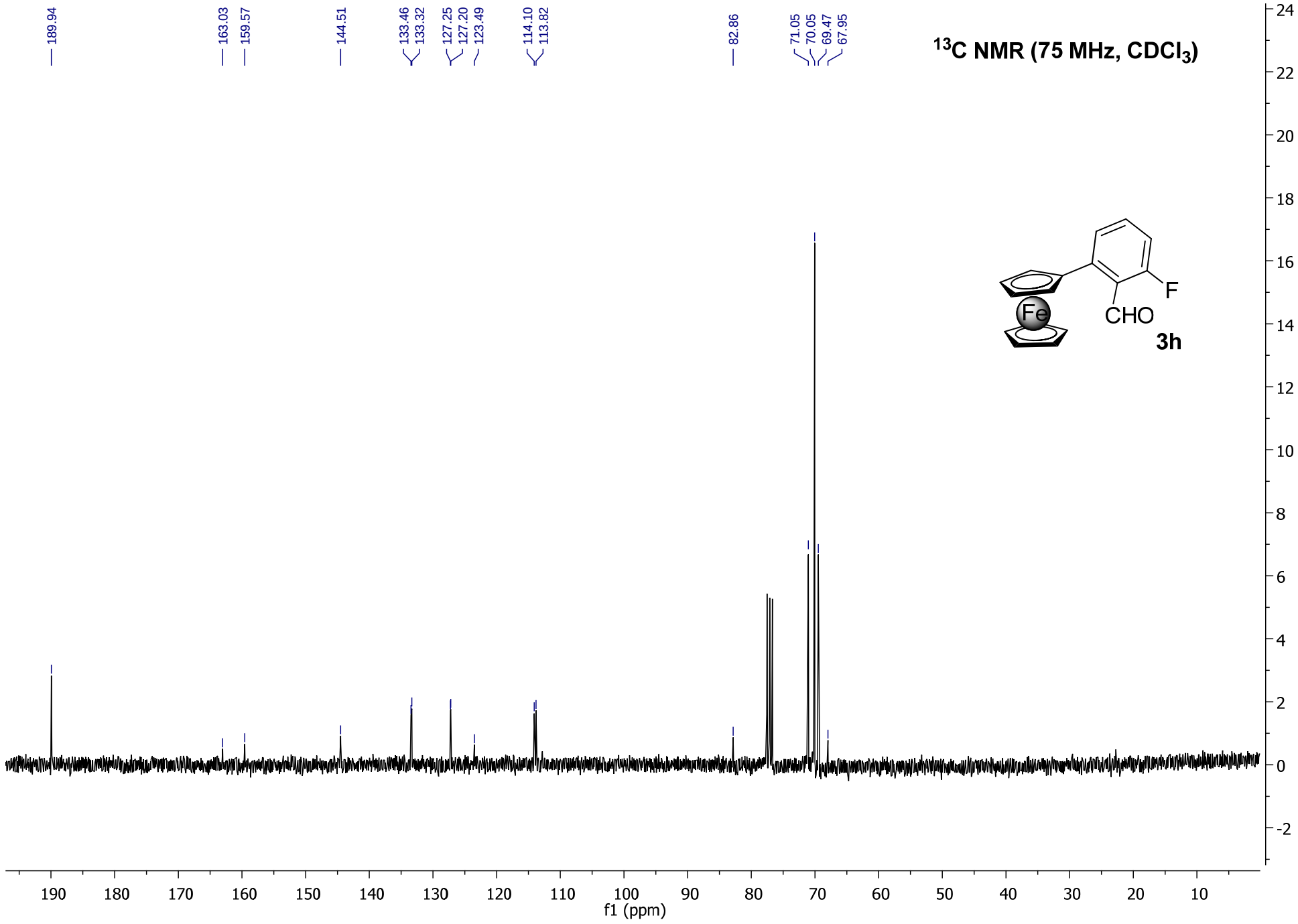

188-amc07-F
-114.92
19F NMR (282 MHz, CDCl3)
F
Fe
CHO
3f
8500
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
-86 -88 -90 -92 -94 -96 -98 -100 -102 -104 -106 -108 -110 -112 -114 -116 -118 -120 -122 -124 -126 -128 -130 -132 -134
f1 (ppm)

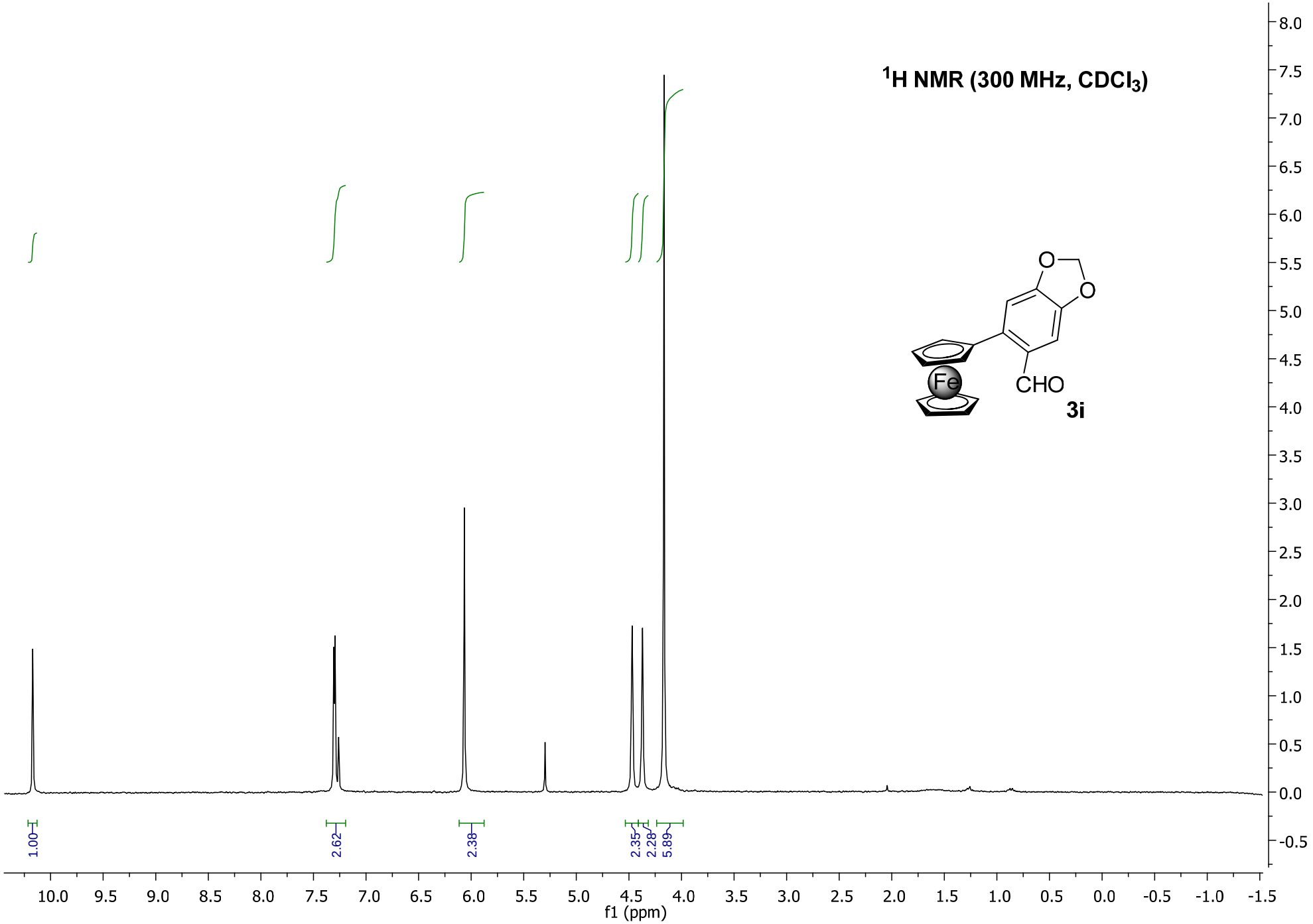

155-amc56a
^{1}H NMR (300 MHz, CDCl$_3$)
F
Fe
CHO
3g
1.01
1.02
2.05
2.06
2.03
5.00
f1 (ppm)

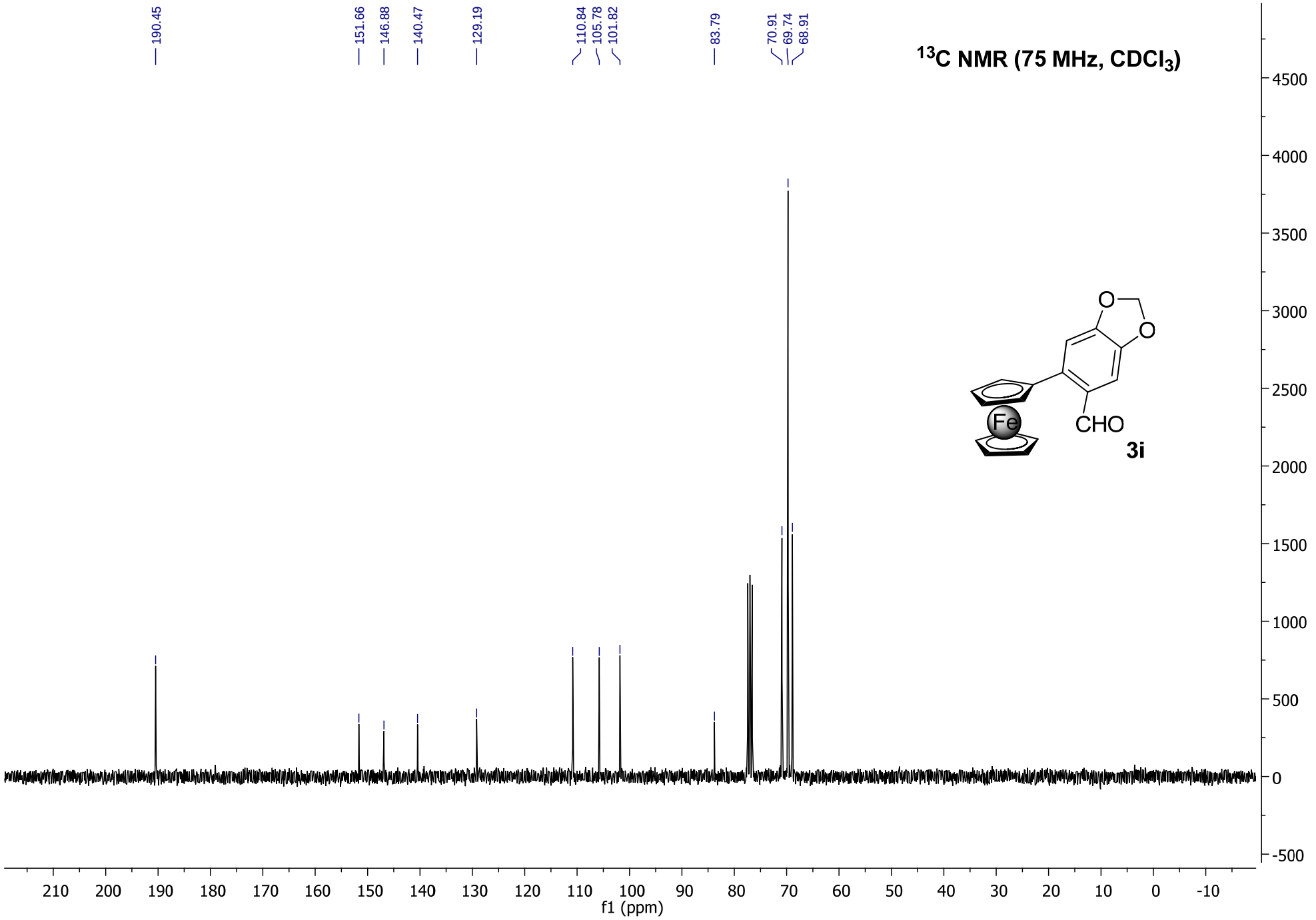

174-amc63-C
191.78
191.74
162.02
158.70
136.77
130.40
130.22
127.36
127.24
123.68
123.64
120.49
120.18
75.45
71.48
71.43
69.93
69.47
^{13}C NMR (75 MHz, CDCl$_3$)
F
Fe
CHO
3g
4E+08
4E+08
3E+08
3E+08
3E+08
3E+08
3E+08
3E+08
2E+08
2E+08
2E+08
2E+08
2E+08
2E+08
1E+08
1E+08
1E+08
1E+08
8E+07
6E+07
4E+07
2E+07
0
-2E+07
-4E+07
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
f1 (ppm)

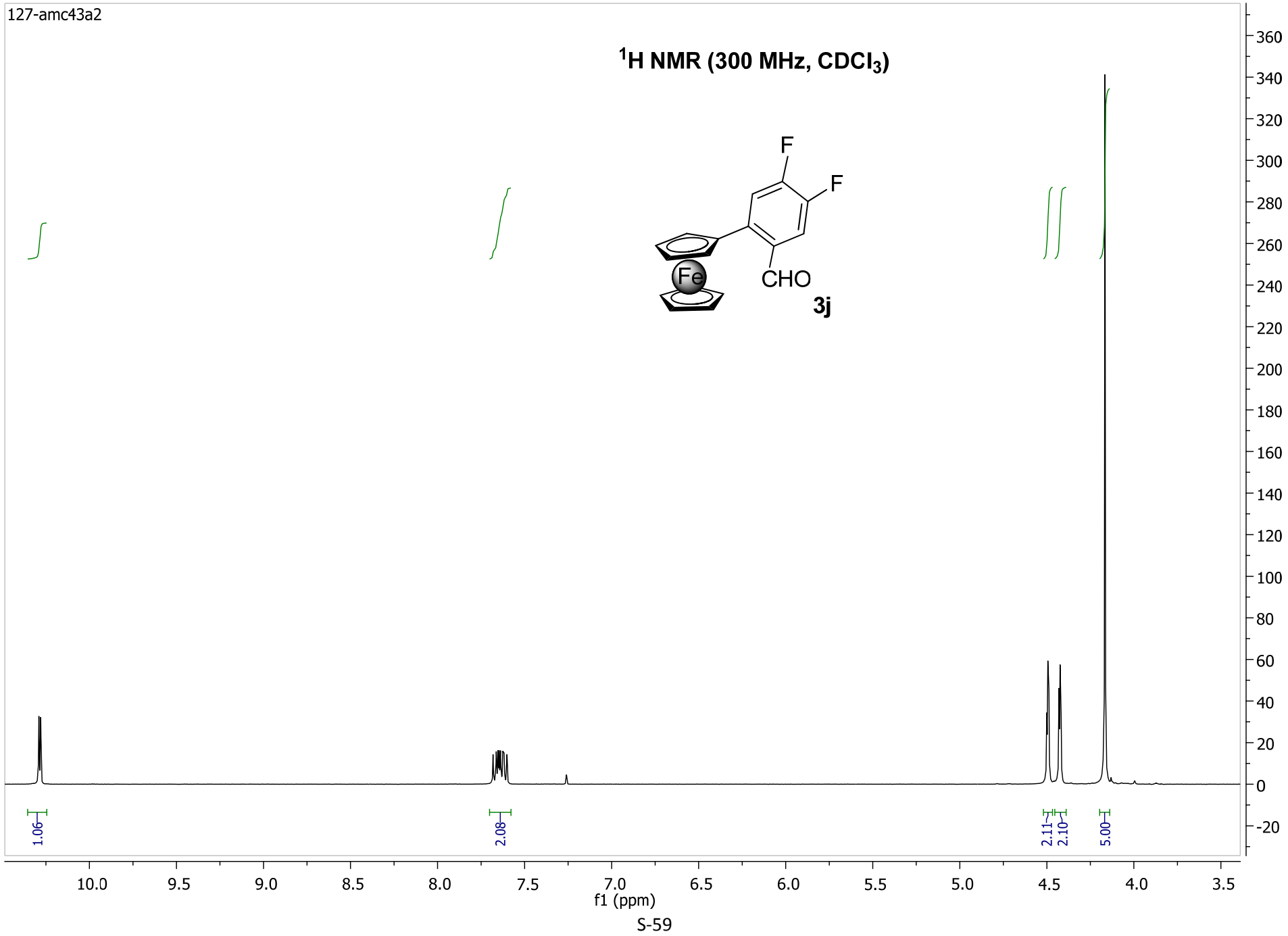

174-amc63-F
-106.98
19F NMR (282 MHz, CDCl3)
F
Fe
CHO
3g
2E+05
2E+05
1E+05
1E+05
1E+05
1E+05
1E+05
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
f1 (ppm)

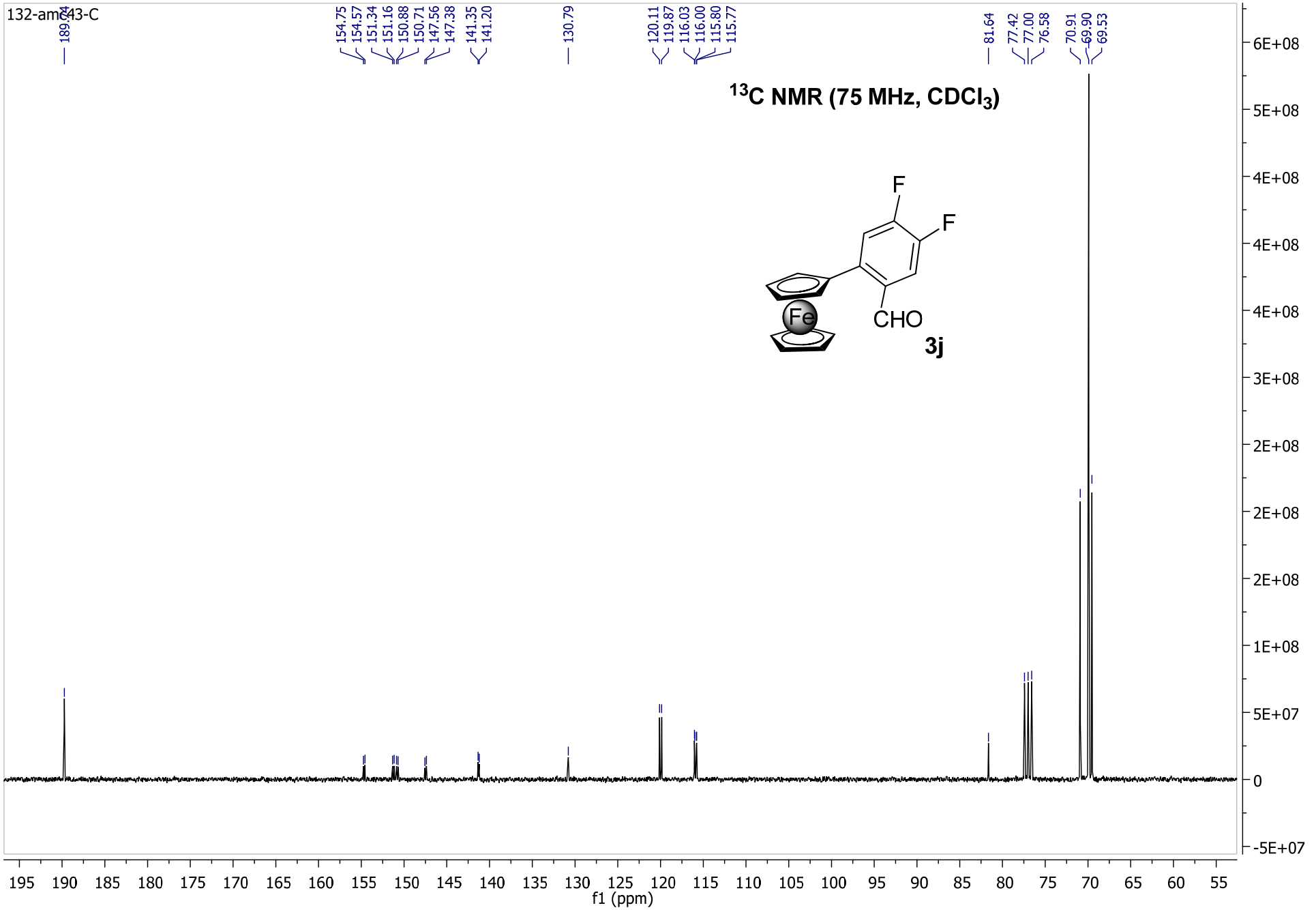

^{1}H NMR (300 MHz, $CDCl_3$)
Fe
F
CHO
3h
0.98
1.00
1.06
0.99
2.00
2.08
5.38
f1 (ppm)

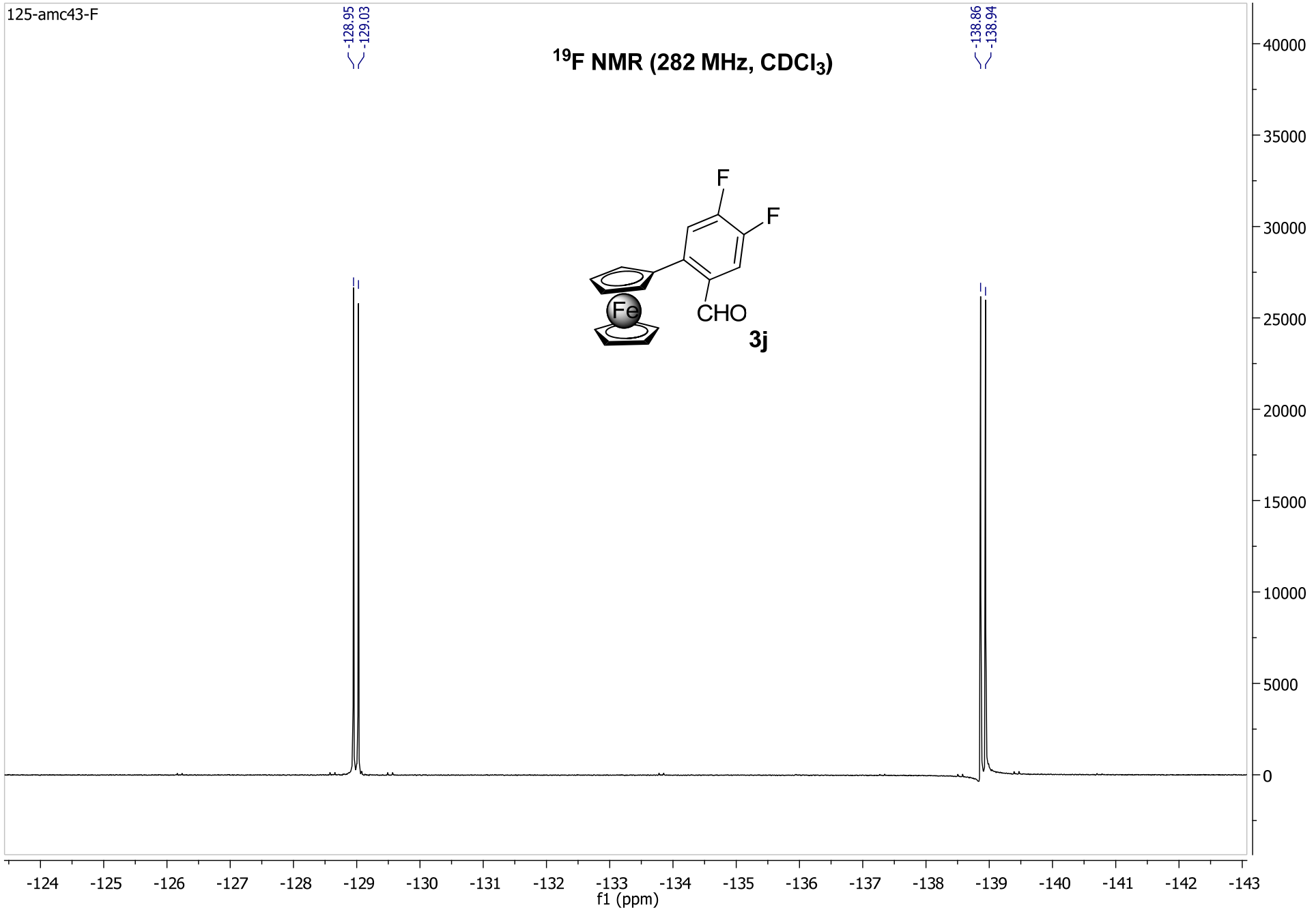

189.94
163.03
159.57
144.51
133.46
133.32
127.25
127.20
123.49
114.10
113.82
82.86
71.05
70.05
69.47
67.95
13C NMR (75 MHz, CDCl3)
Fe
F
CHO
3h
f1 (ppm)

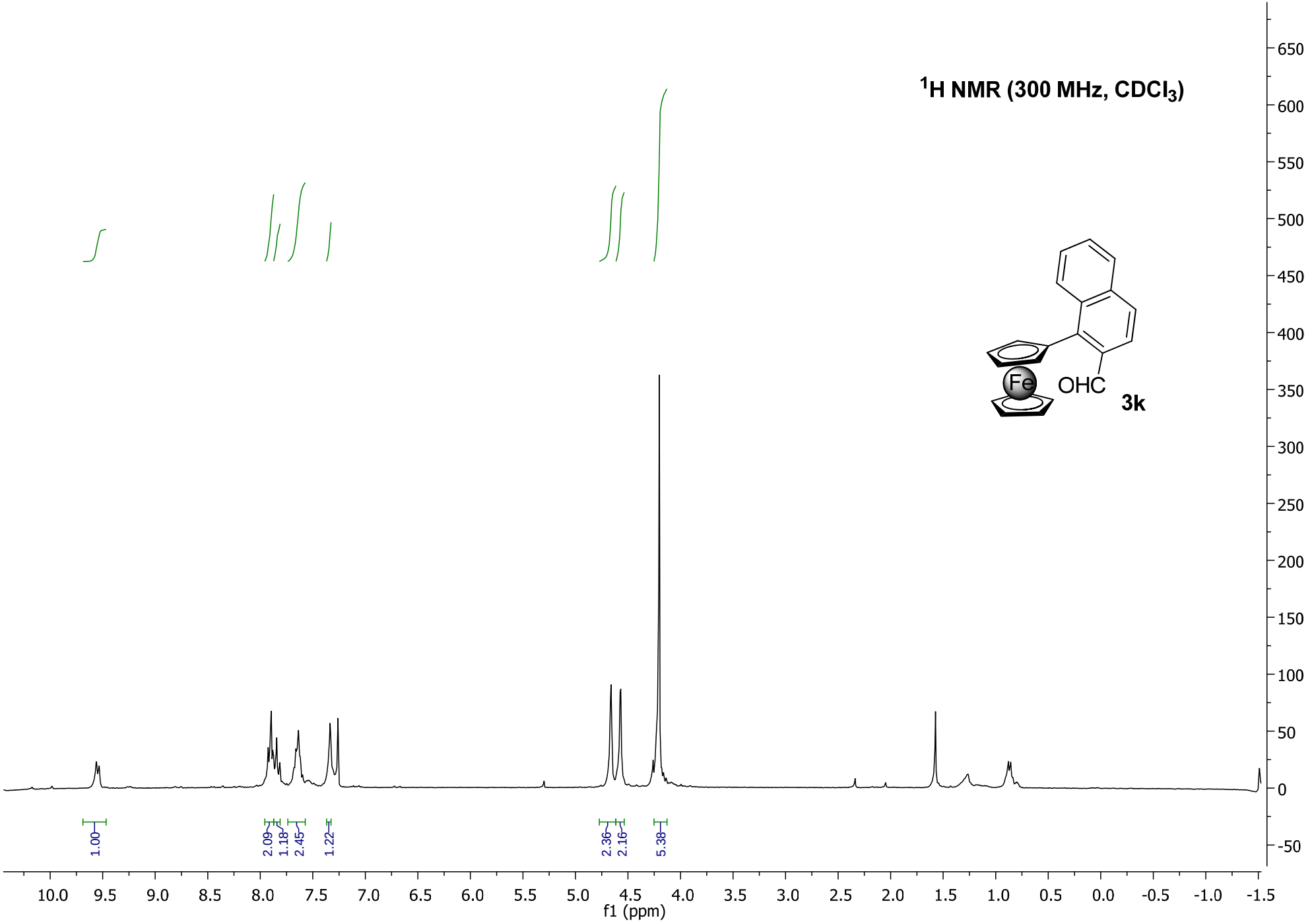

^{1}H NMR (300 MHz, $CDCl_3$)
O
O
Fe
CHO
3i
1.00
2.62
2.38
2.35
2.28
5.89
f1 (ppm)

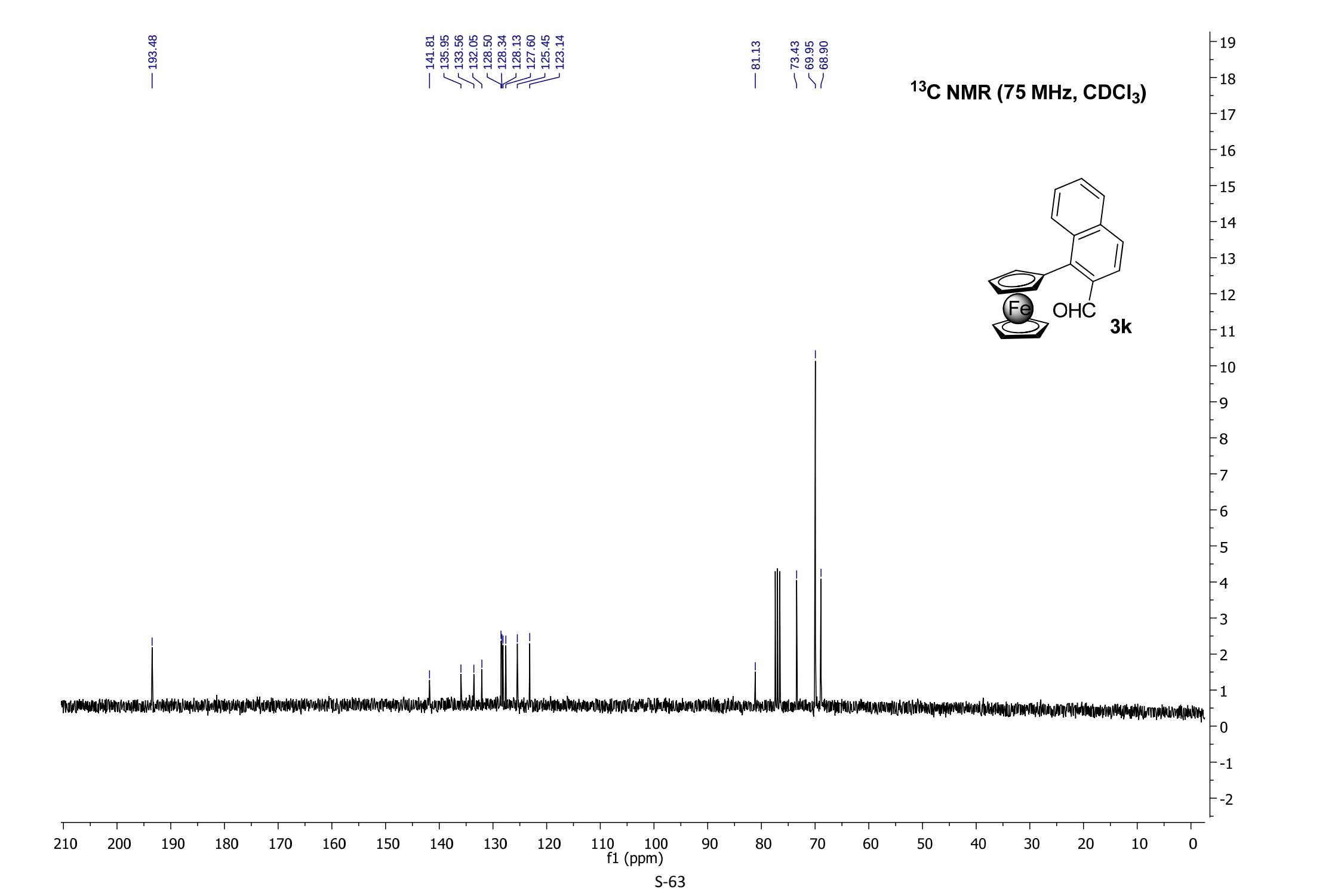

190.45
151.66
146.88
140.47
129.19
110.84
105.78
101.82
83.79
70.91
69.74
68.91
13C NMR (75 MHz, CDCl3)
O
O
Fe
CHO
3i
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

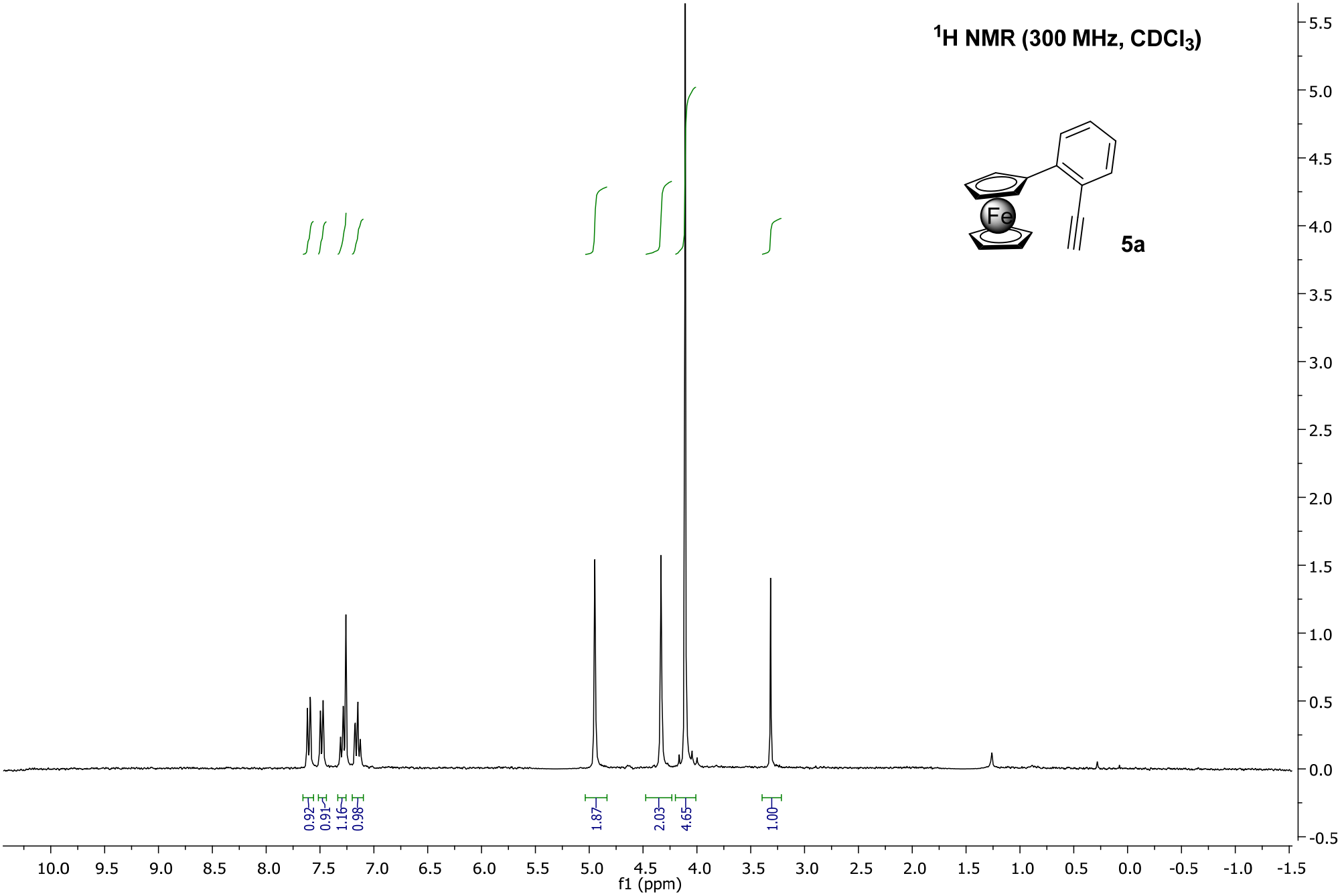

127-amc43a2
^{1}H NMR (300 MHz, CDCl$_3$)
F
F
Fe
CHO
3j
1.06
2.08
2.11
2.10
5.00
f1 (ppm)

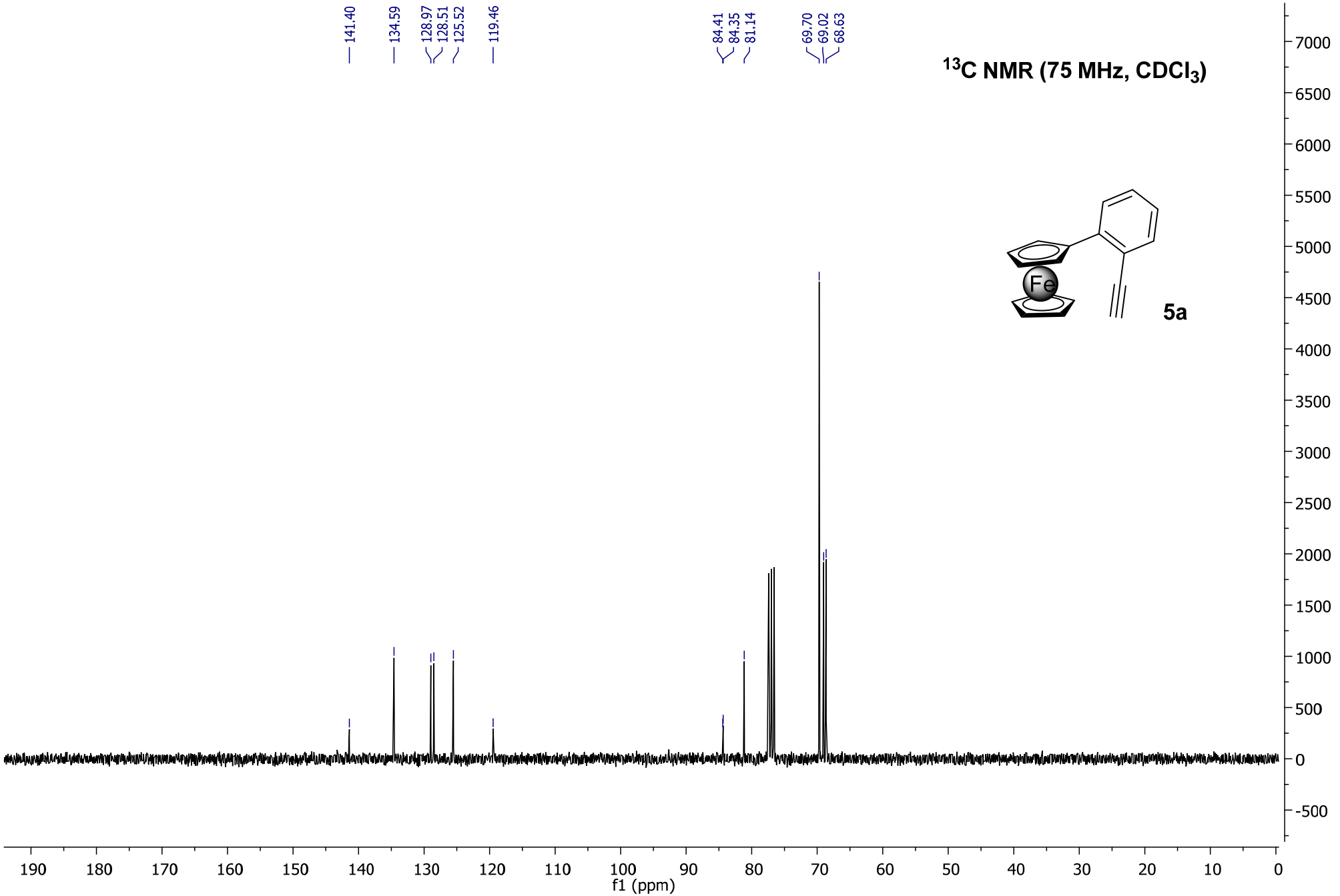

132-amc43-C
189.74
154.75
154.57
151.34
151.16
150.88
150.71
147.56
147.38
141.35
141.20
130.79
120.11
119.87
116.03
116.00
115.80
115.77
81.64
77.42
77.00
76.58
70.91
69.90
69.53
13C NMR (75 MHz, CDCl3)
F
F
Fe
CHO
3j
6E+08
5E+08
4E+08
4E+08
4E+08
3E+08
2E+08
2E+08
2E+08
1E+08
5E+07
0
-5E+07
195 190 185 180 175 170 165 160 155 150 145 140 135 130 125 120 115 110 105 100 95 90 85 80 75 70 65 60 55
f1 (ppm)


125-amc43-F
-128.95
-129.03
-138.86
-138.94
^{19}F NMR (282 MHz, CDCl$_3$)
F
F
Fe
CHO
3j
40000
35000
30000
25000
20000
15000
10000
5000
0
-124
-125
-126
-127
-128
-129
-130
-131
-132
-133
-134
-135
-136
-137
-138
-139
-140
-141
-142
-143
f1 (ppm)


^{1}H NMR (300 MHz, $CDCl_3$)
Fe
OHC
3k
1.00
2.09
1.18
2.45
1.22
2.36
2.16
5.38
f1 (ppm)

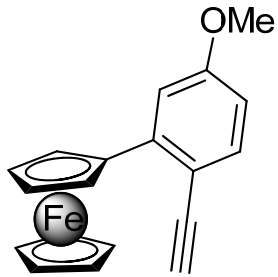

193.48
141.81
135.95
133.56
132.05
128.50
128.34
128.13
127.60
125.45
123.14
81.13
73.43
69.95
68.90
^{13}C NMR (75 MHz, CDCl$_3$)
Fe
OHC
3k
f1 (ppm)


^{1}H NMR (300 MHz, $CDCl_3$)
Fe
5a
0.92
0.91
1.16
0.98
1.87
2.03
4.65
1.00
f1 (ppm)


141.40
134.59
128.97
128.51
125.52
119.46
84.41
84.35
81.14
69.70
69.02
68.63
^{13}C NMR (75 MHz, CDCl$_3$)
Fe
5a
f1 (ppm)

hg01_13

^{1}H NMR (300 MHz, $CDCl_3$)

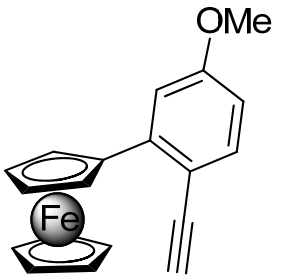


5b

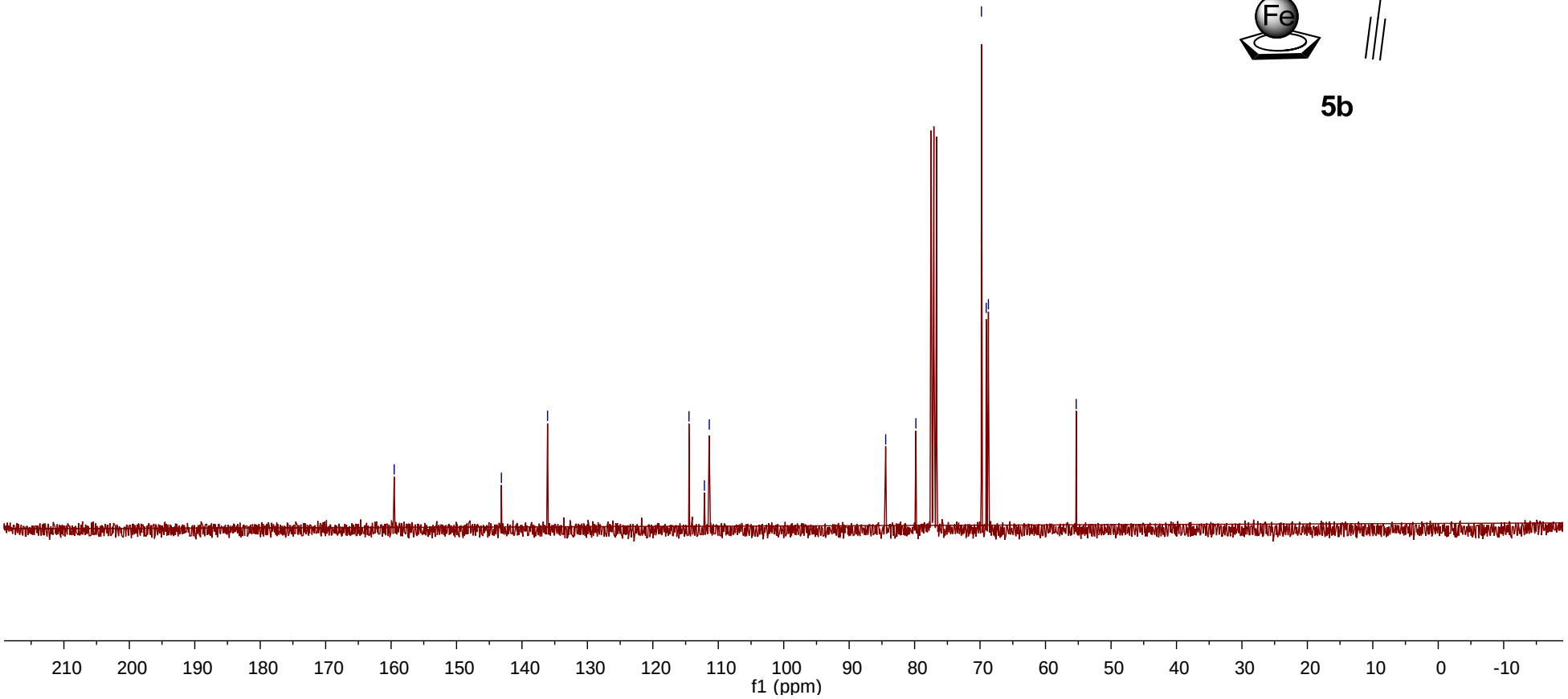
hg01_13

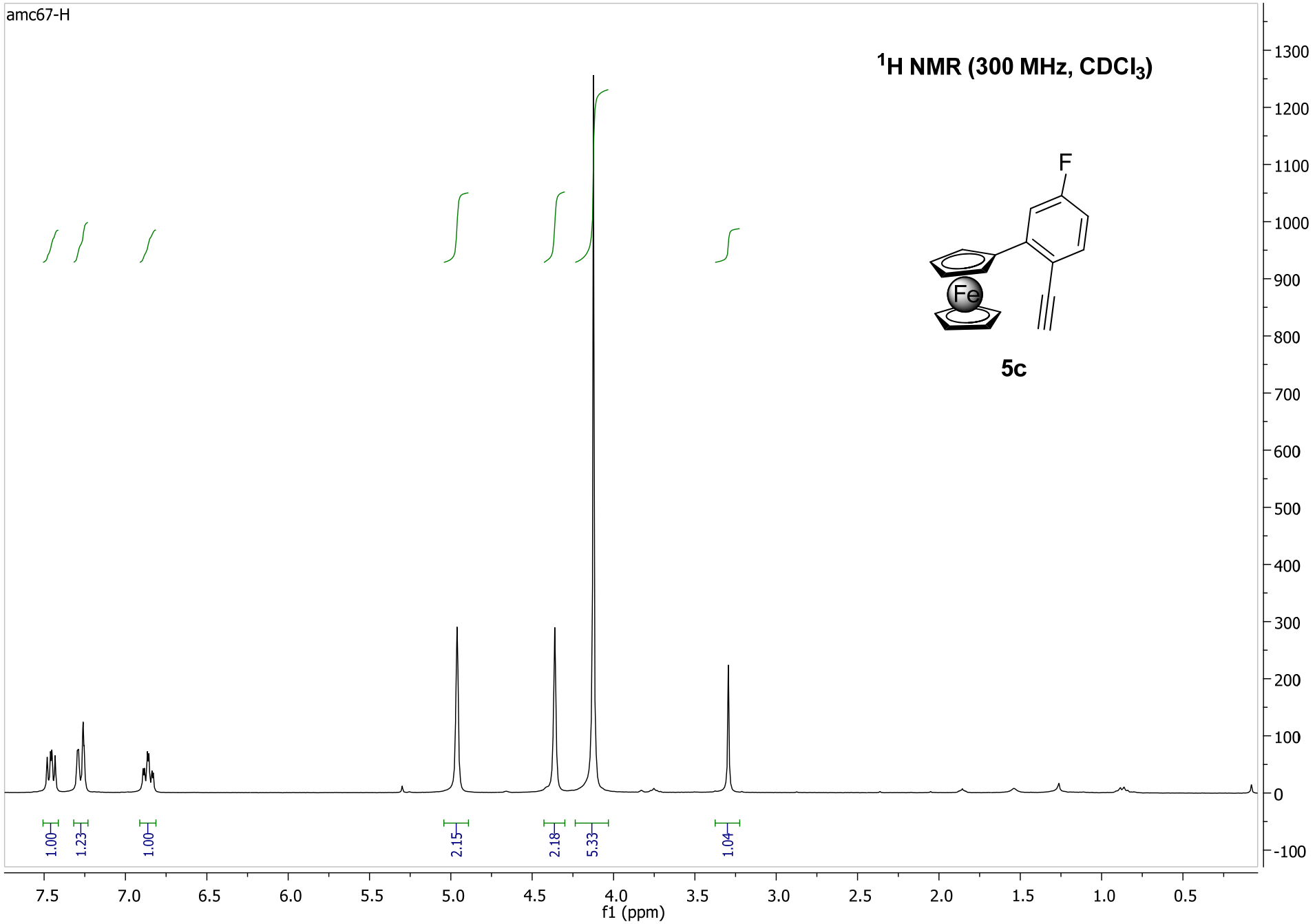
159.52
143.14
136.09
114.48
112.12
111.39
84.42
79.82
69.79
69.06
68.73
55.31

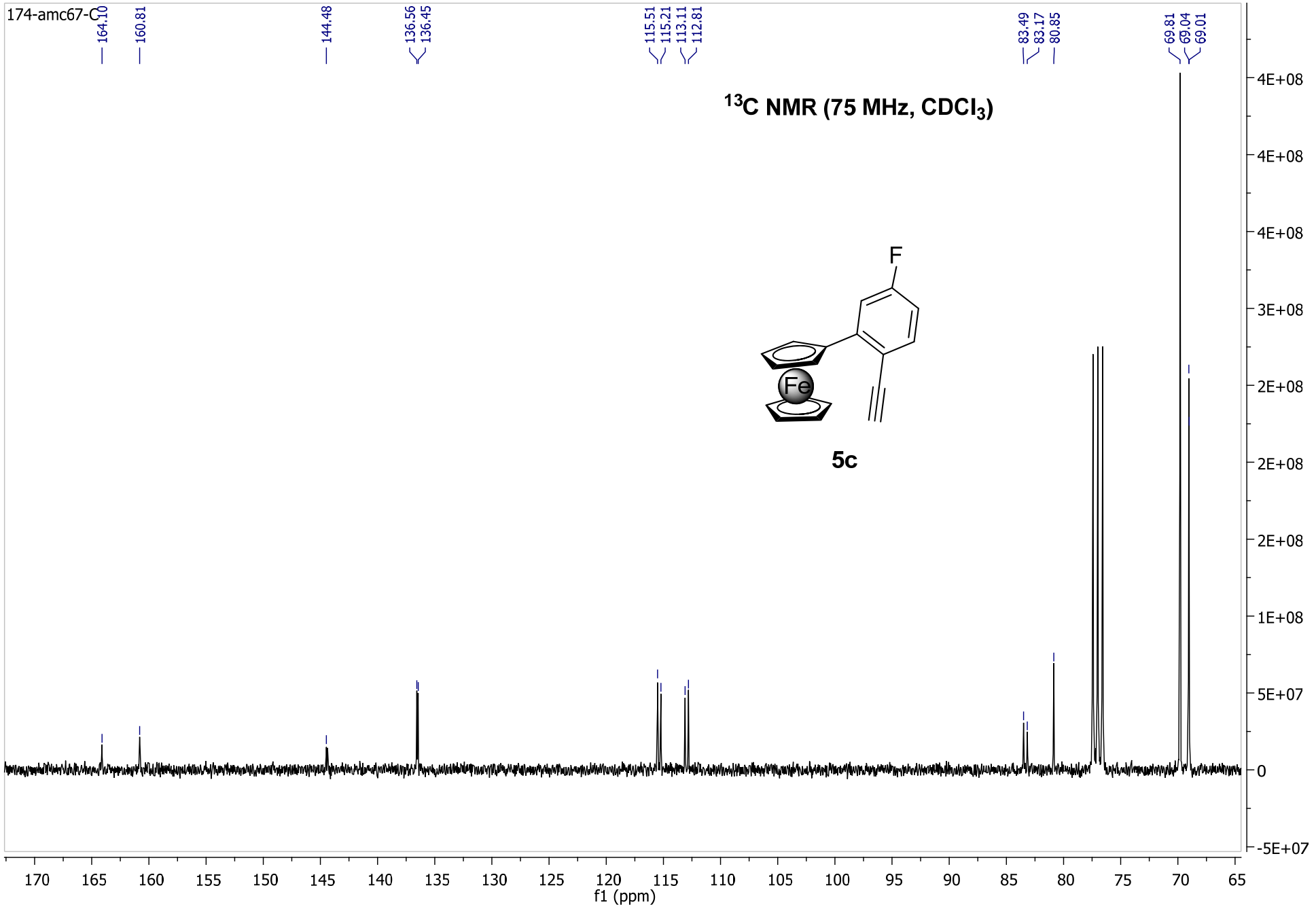
^{13}C NMR (75 MHz, $CDCl_3$)

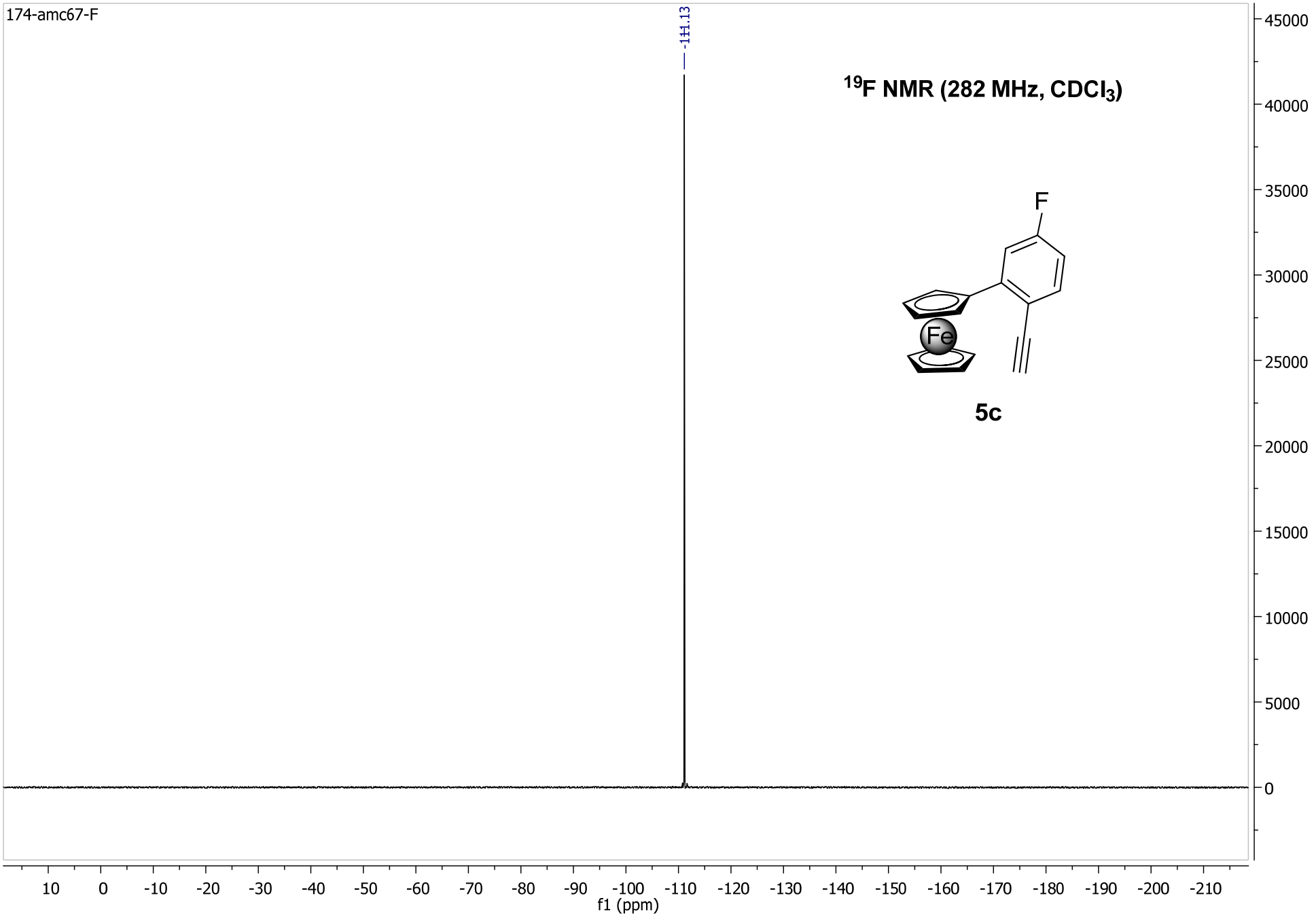


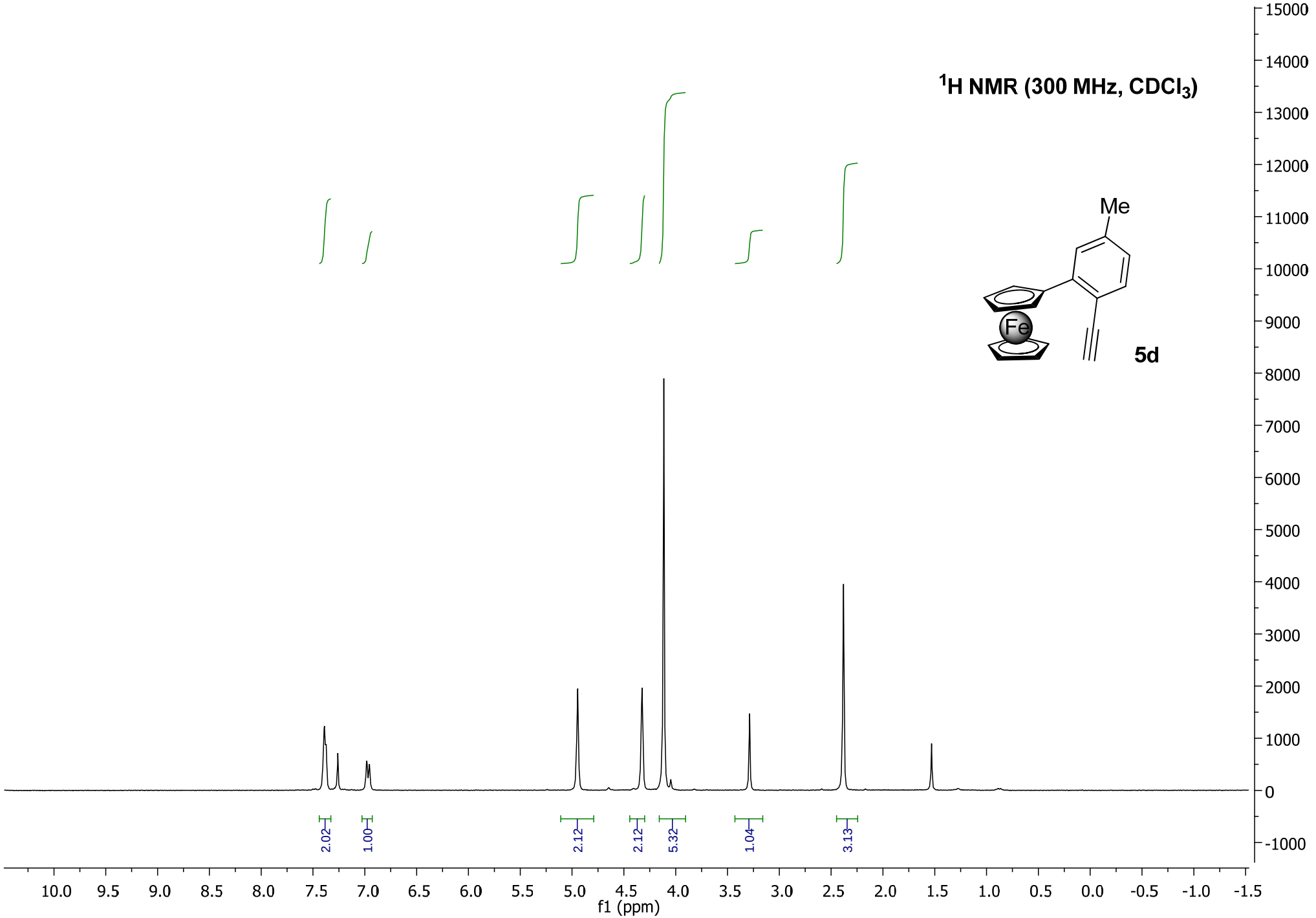
5b



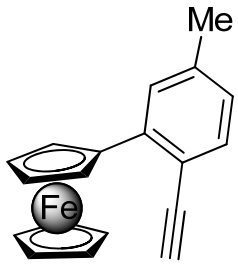

amc67-H
1H NMR (300 MHz, CDCl3)
F
Fe
5c
1.00
1.23
1.00
2.15
2.18
5.33
1.04
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100


174-amc67-C
164.10
160.81
144.48
136.56
136.45
115.51
115.21
113.11
112.81
83.49
83.17
80.85
69.81
69.04
69.01
^{13}C NMR (75 MHz, CDCl$_3$)
F
Fe
5c
4E+08
4E+08
4E+08
3E+08
2E+08
2E+08
2E+08
1E+08
5E+07
0
-5E+07
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
f1 (ppm)

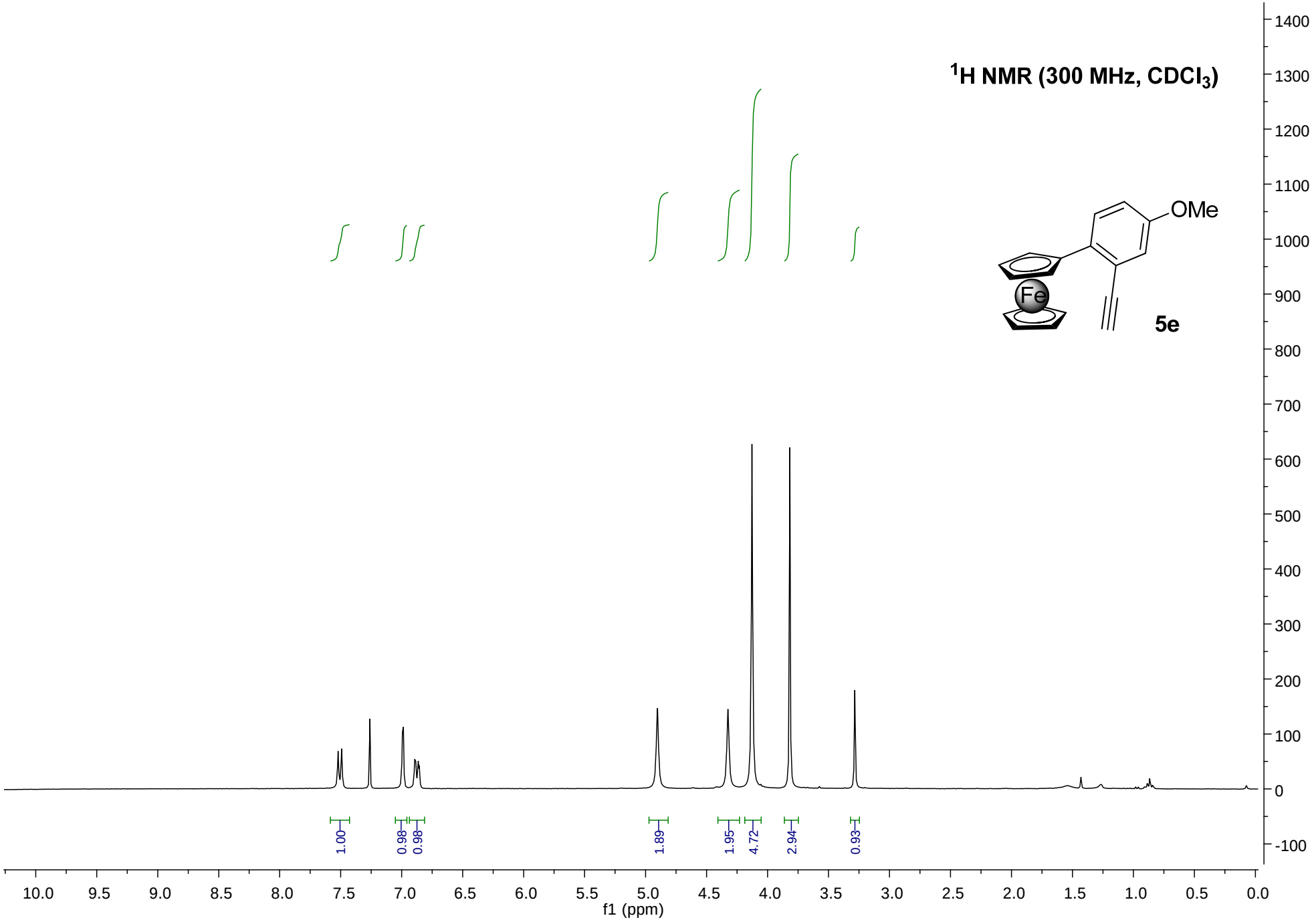

174-amc67-F
-111.13
19F NMR (282 MHz, CDCl3)
F
Fe
5c
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

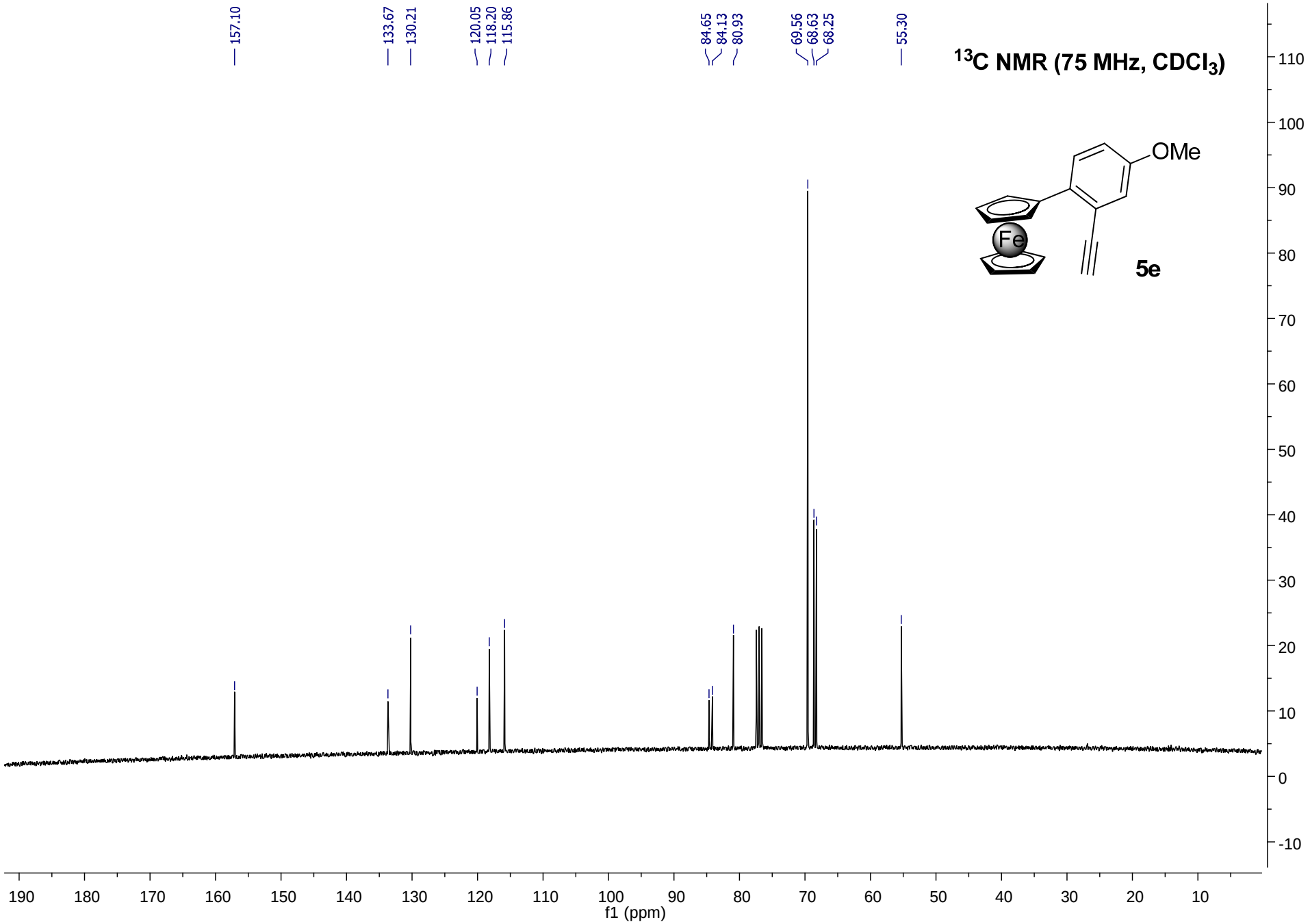

^{1}H NMR (300 MHz, $CDCl_3$)
Me
Fe
5d
2.02
1.00
2.12
2.12
5.32
1.04
3.13
f1 (ppm)

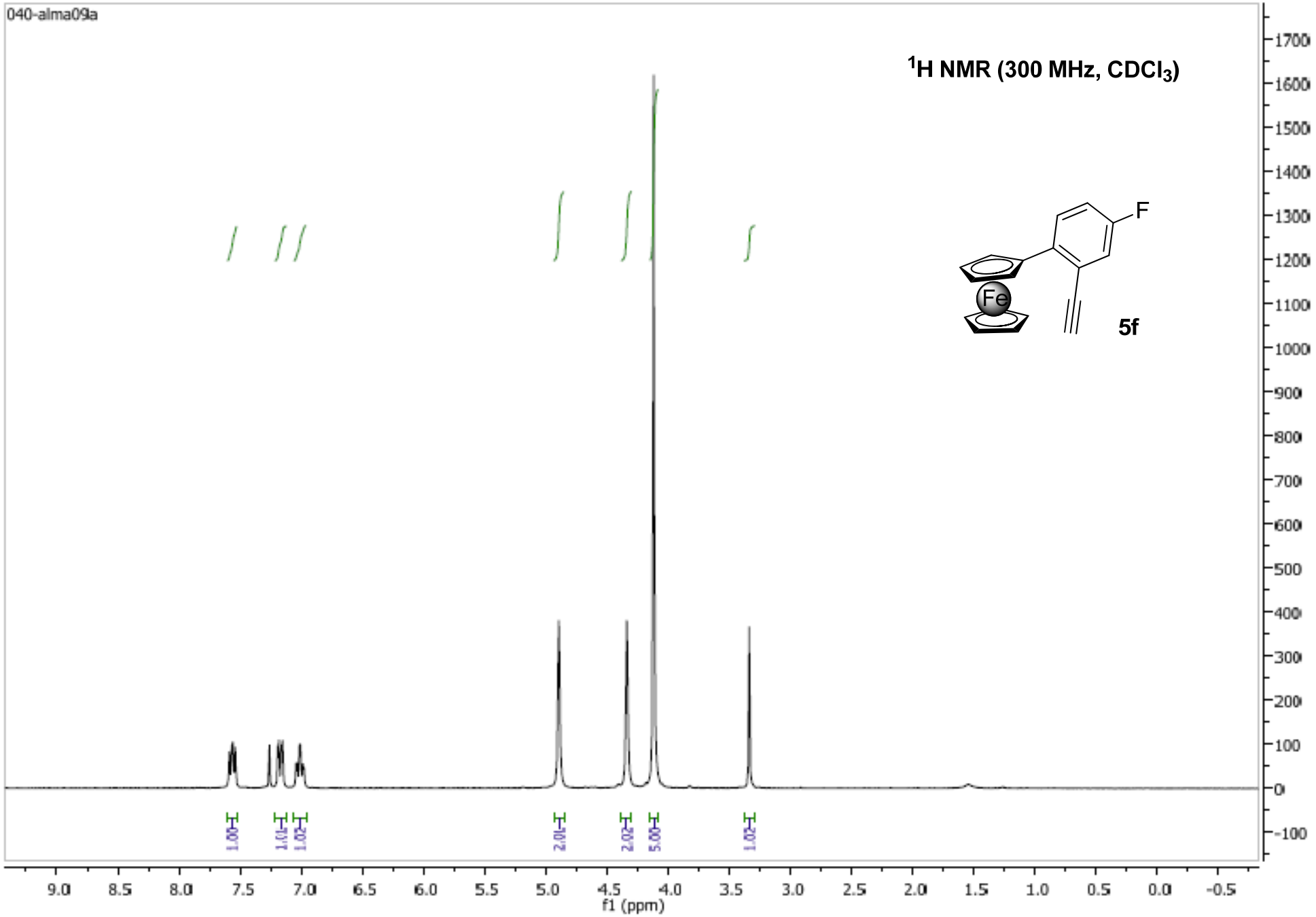
^{13}C NMR (75 MHz, $CDCl_3$)

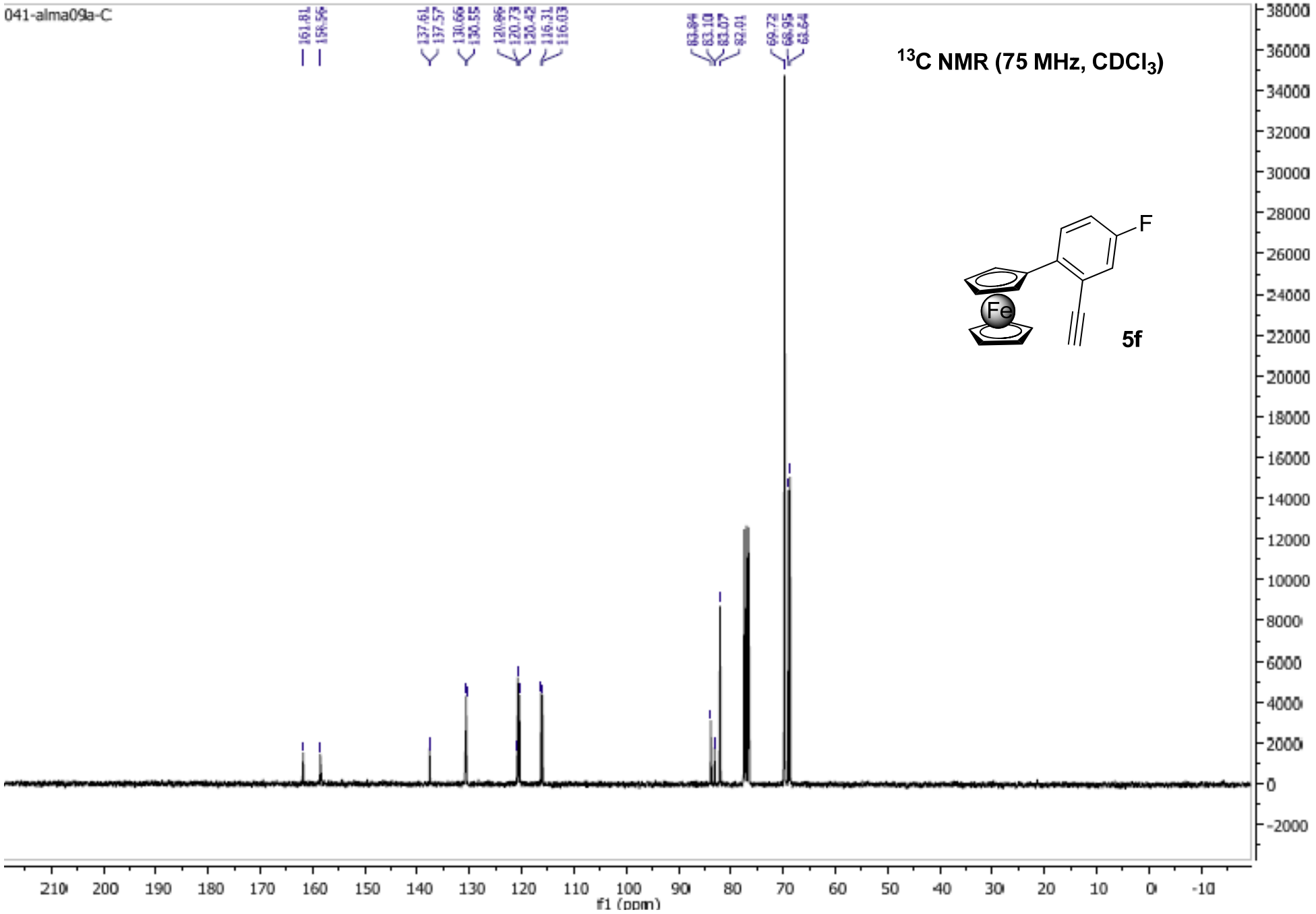


5d

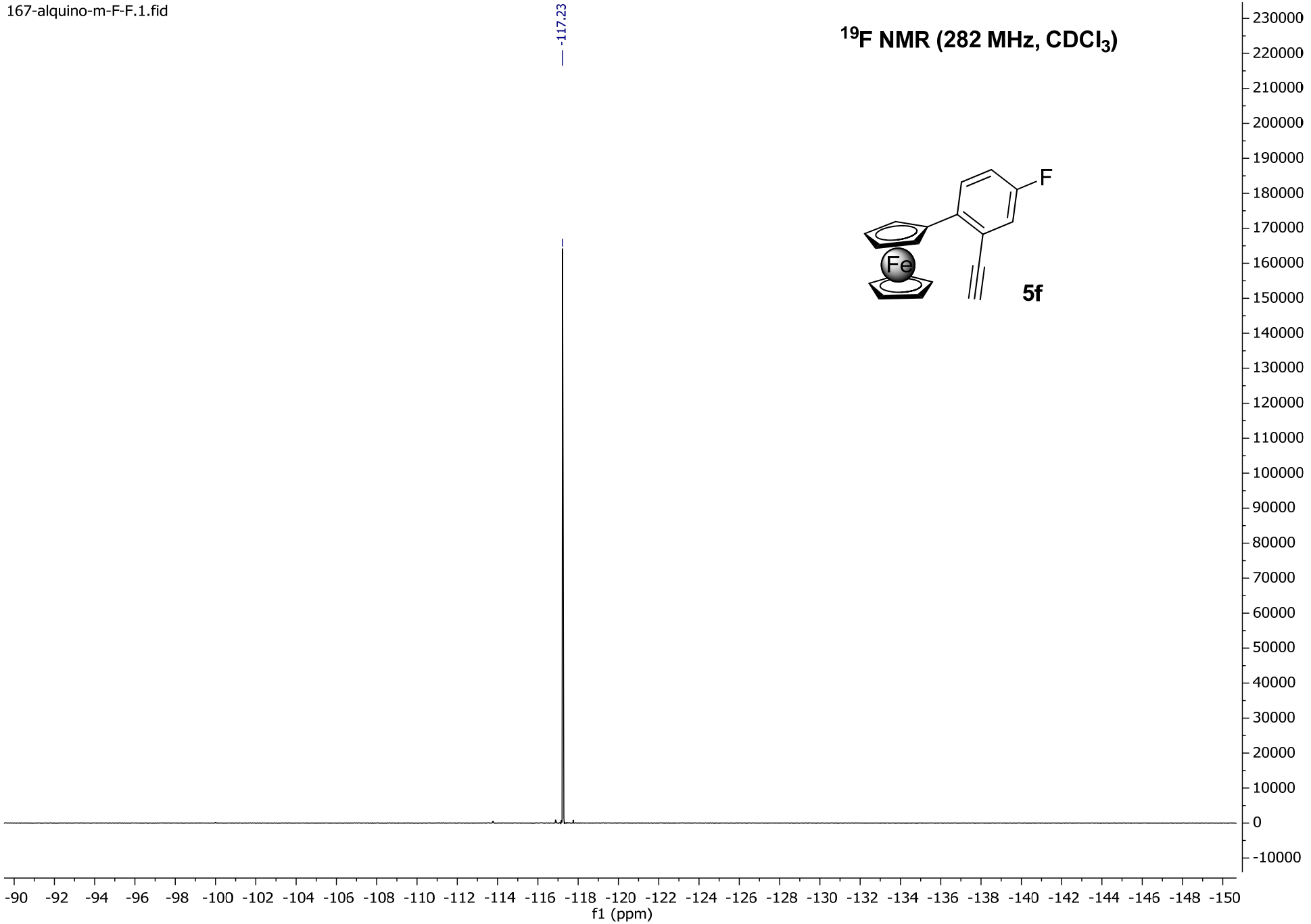

^{1}H NMR (300 MHz, CDCl$_3$)
OMe
Fe
5e
1.00
0.98
0.98
1.89
1.95
4.72
2.94
0.93
f1 (ppm)

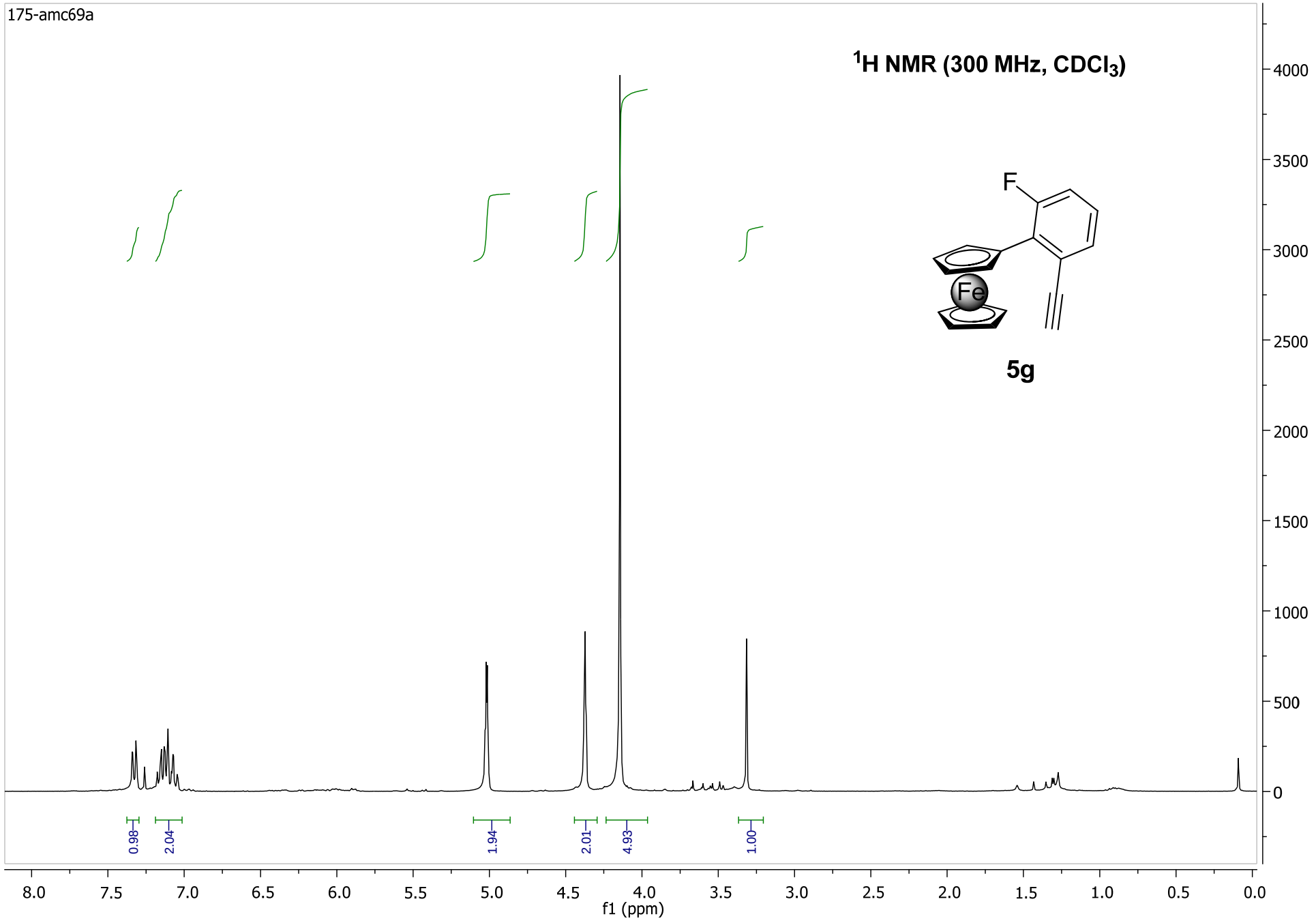

157.10
133.67
130.21
120.05
118.20
115.86
84.65
84.13
80.93
69.56
68.63
68.25
55.30
^{13}C NMR (75 MHz, CDCl$_3$)
OMe
Fe
5e
f1 (ppm)

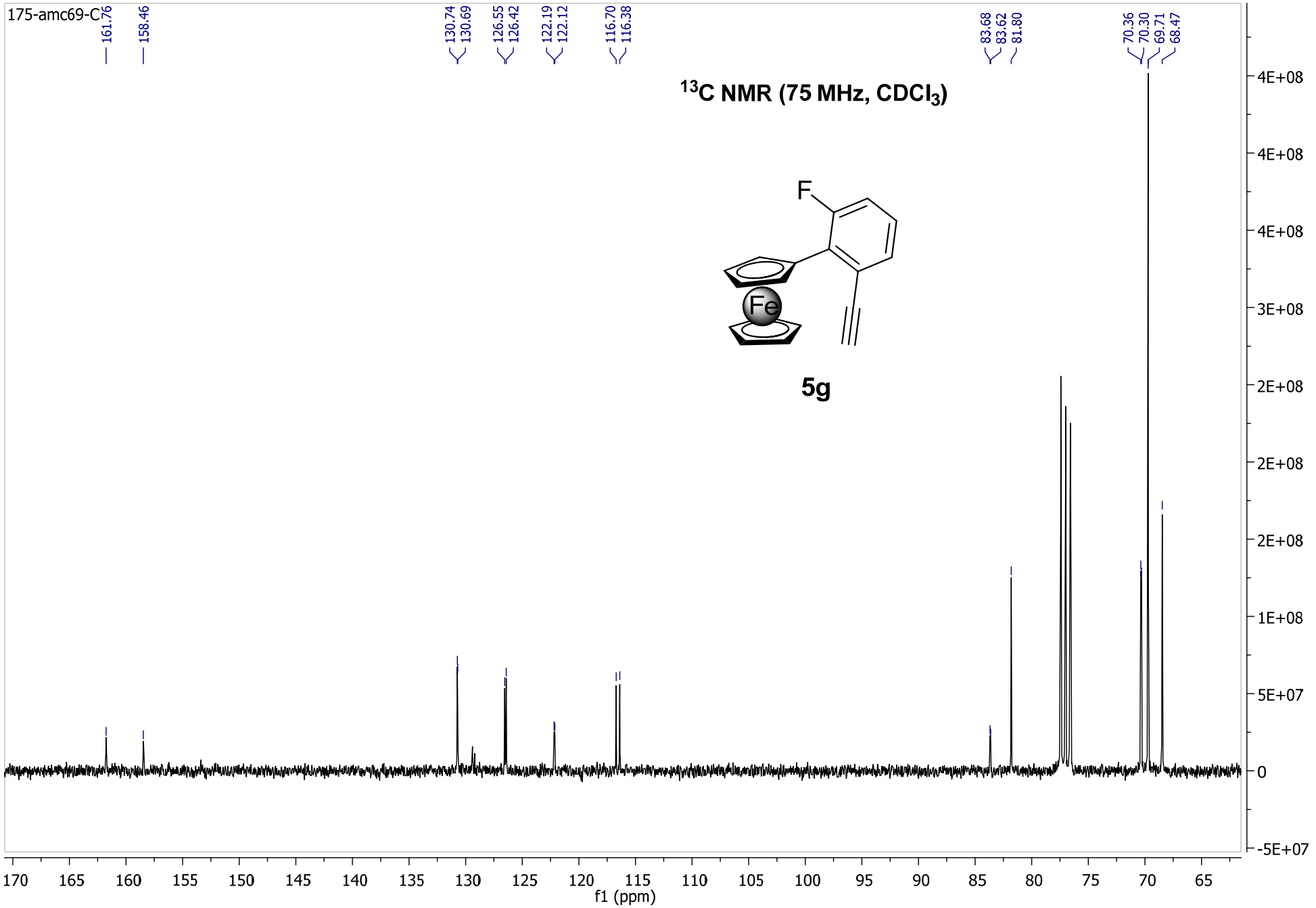

040-alma09a
^{1}H NMR (300 MHz, $CDCl_3$)
F
Fe
5f
1.00
1.01
2.01
2.01
2.02
5.00
1.03
f1 (ppm)

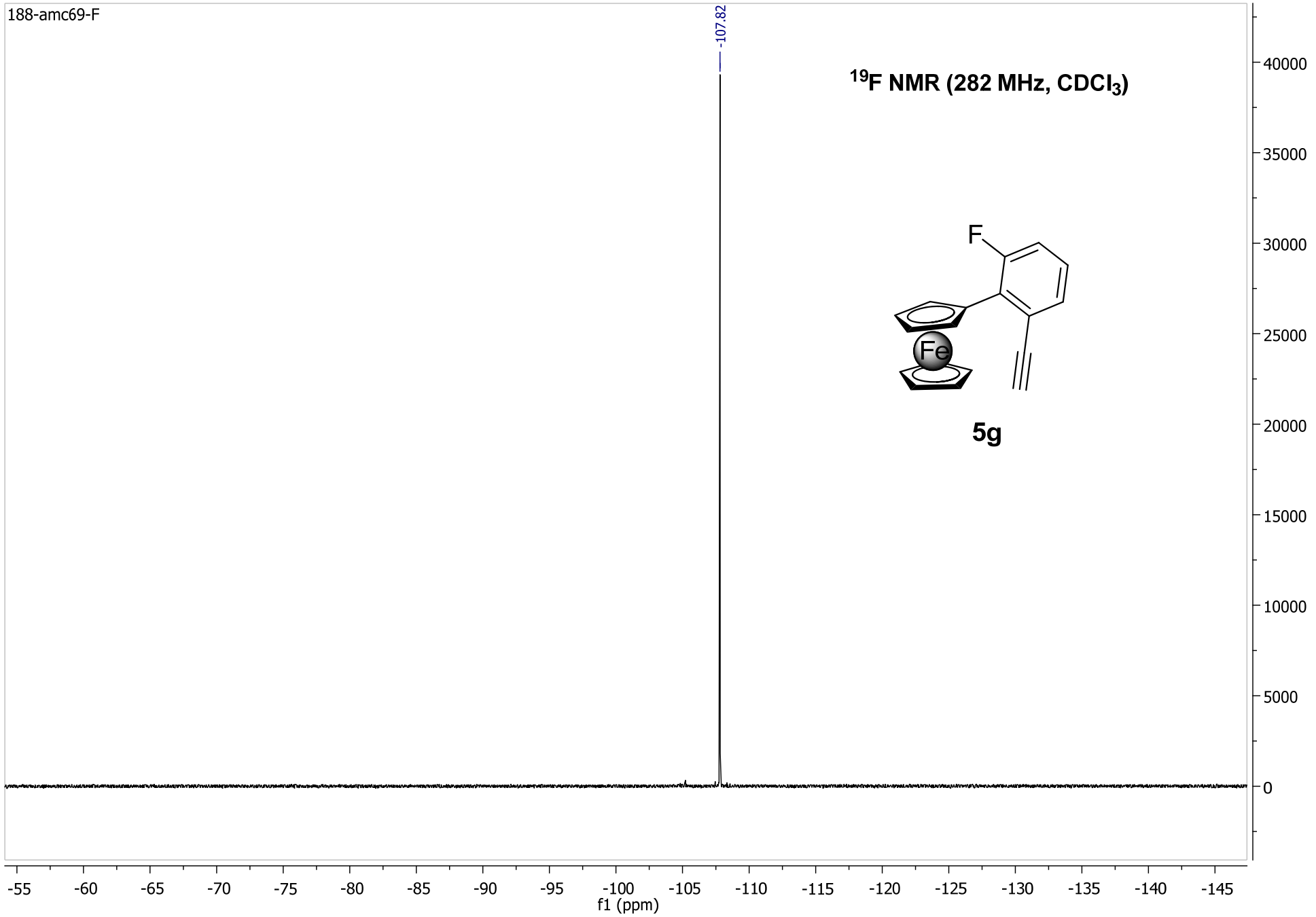

041-alma09a-C
161.81
158.56
137.61
137.57
130.66
130.55
120.86
120.73
120.42
116.31
116.03
83.84
83.10
83.07
82.01
69.72
68.95
61.64
^{13}C NMR (75 MHz, CDCl$_3$)
F
Fe
5f
f1 (ppm)

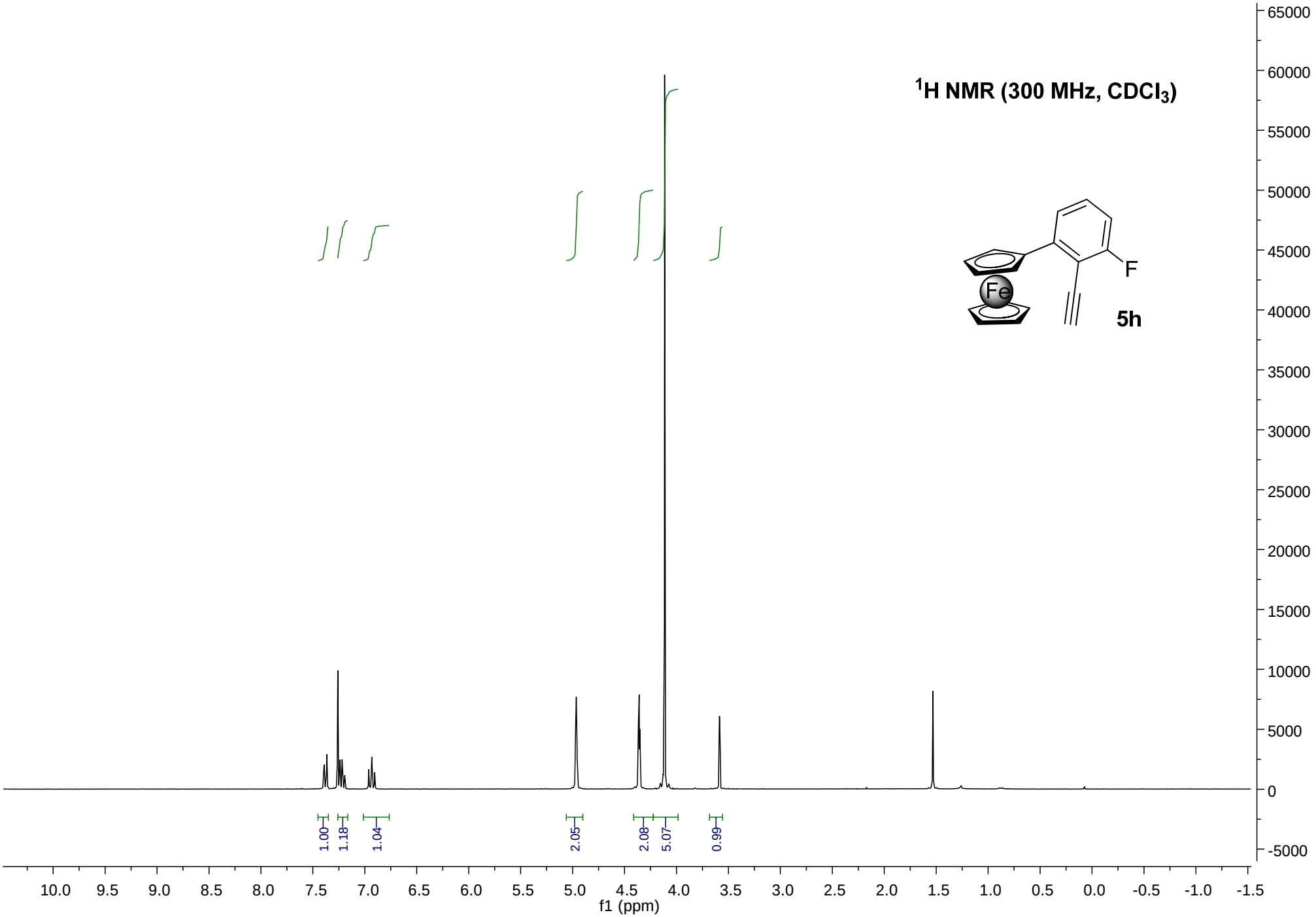
167-alquino-m-F-F.1.fid

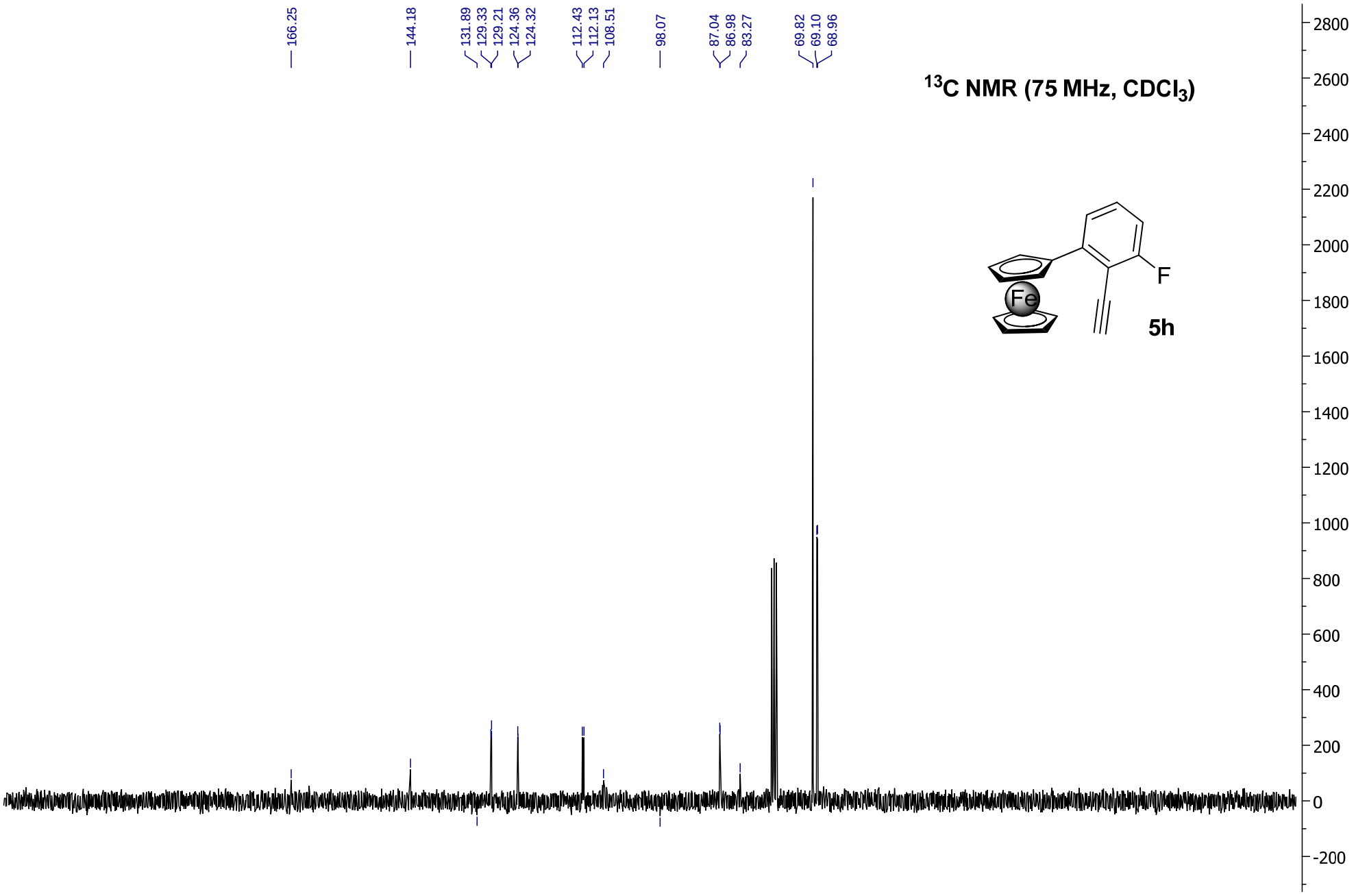


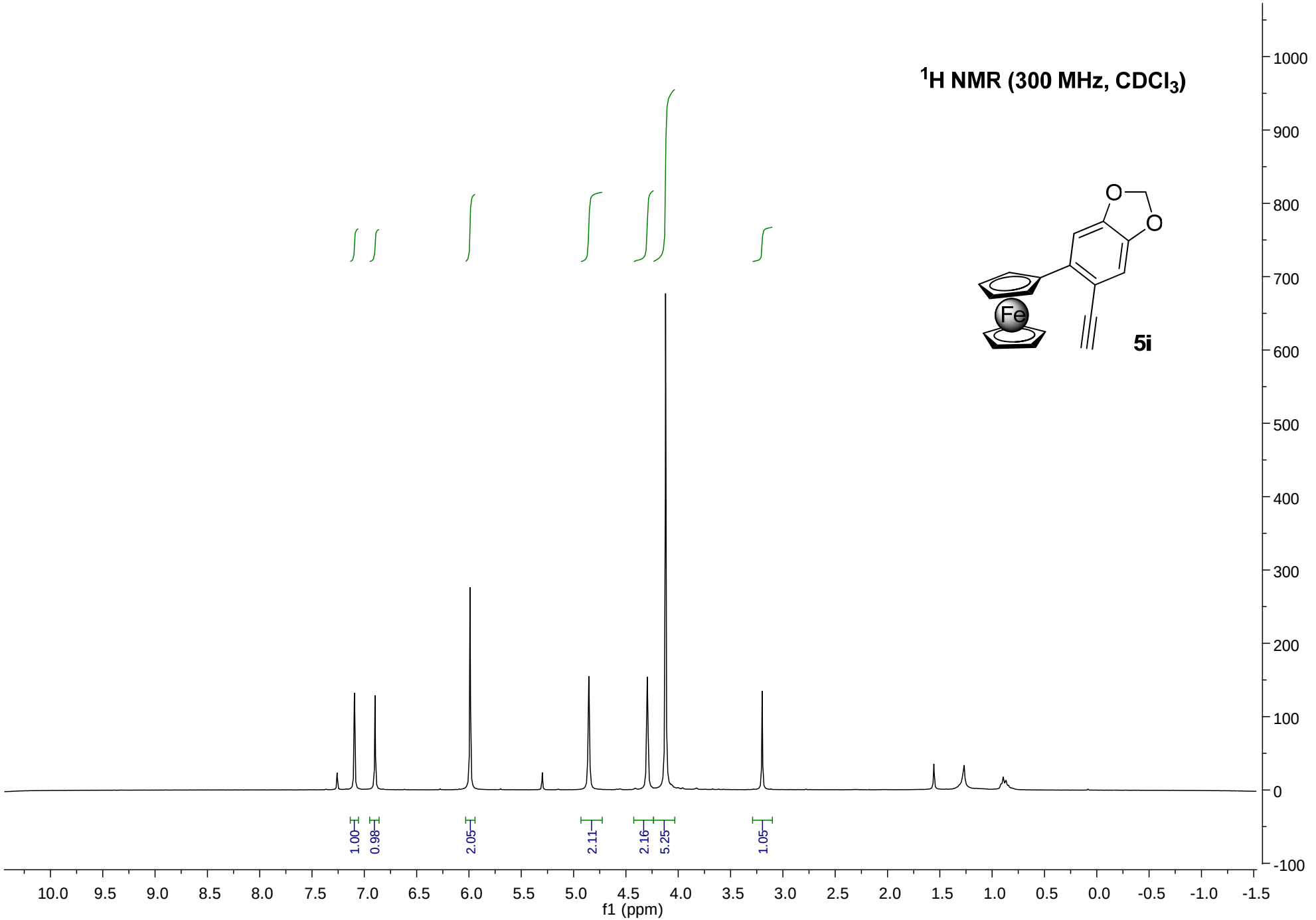

175-amc69a
^{1}H NMR (300 MHz, $CDCl_3$)
F
Fe
5g
0.98
2.04
1.94
2.01
4.93
1.00
f1 (ppm)

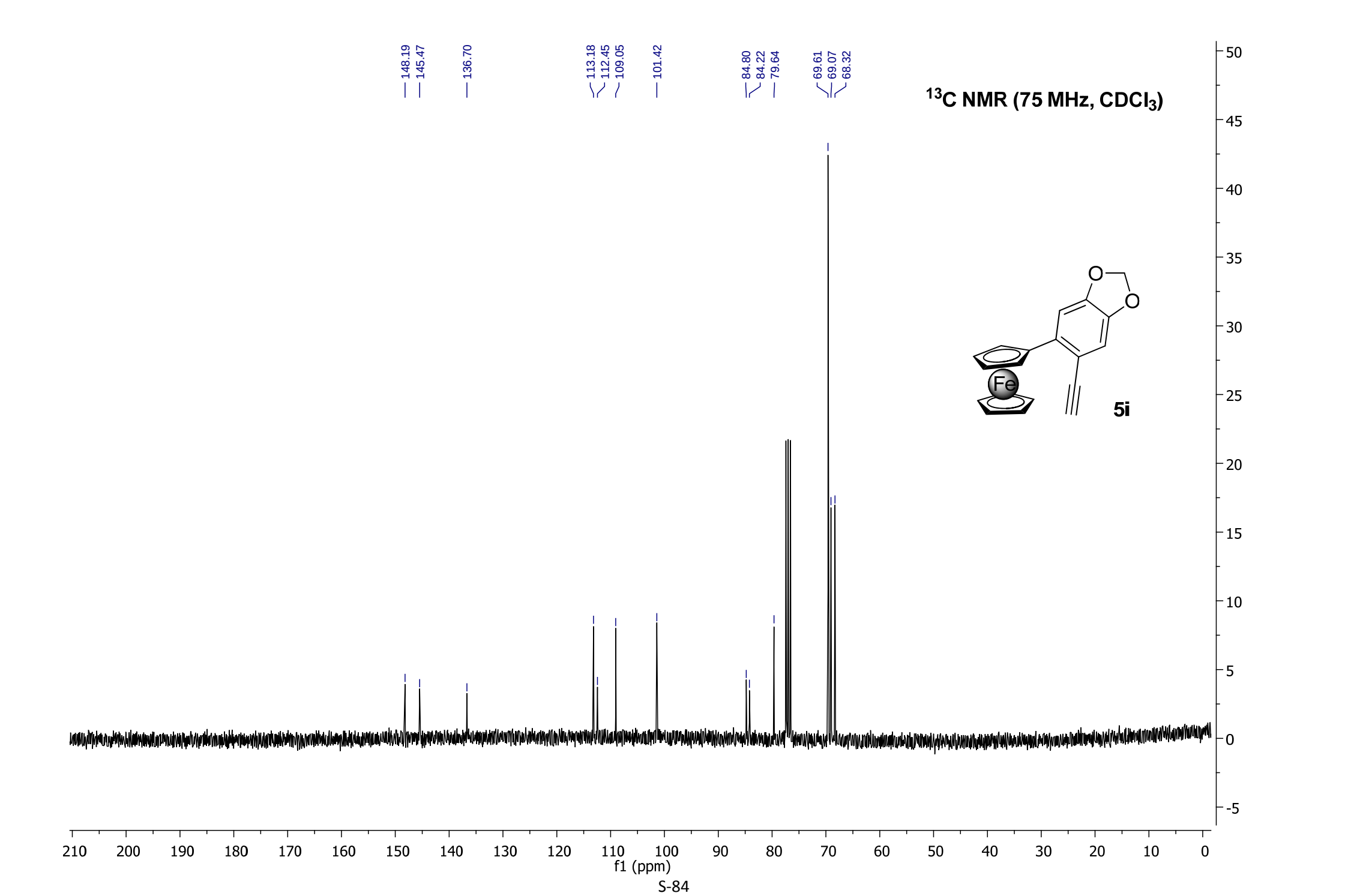

175-amc69-C
161.76
158.46
130.74
130.69
126.55
126.42
122.19
122.12
116.70
116.38
83.68
83.62
81.80
70.36
70.30
69.71
68.47
13C NMR (75 MHz, CDCl3)
F
Fe
5g
4E+08
4E+08
4E+08
3E+08
2E+08
2E+08
2E+08
1E+08
5E+07
0
-5E+07
170
165
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
f1 (ppm)

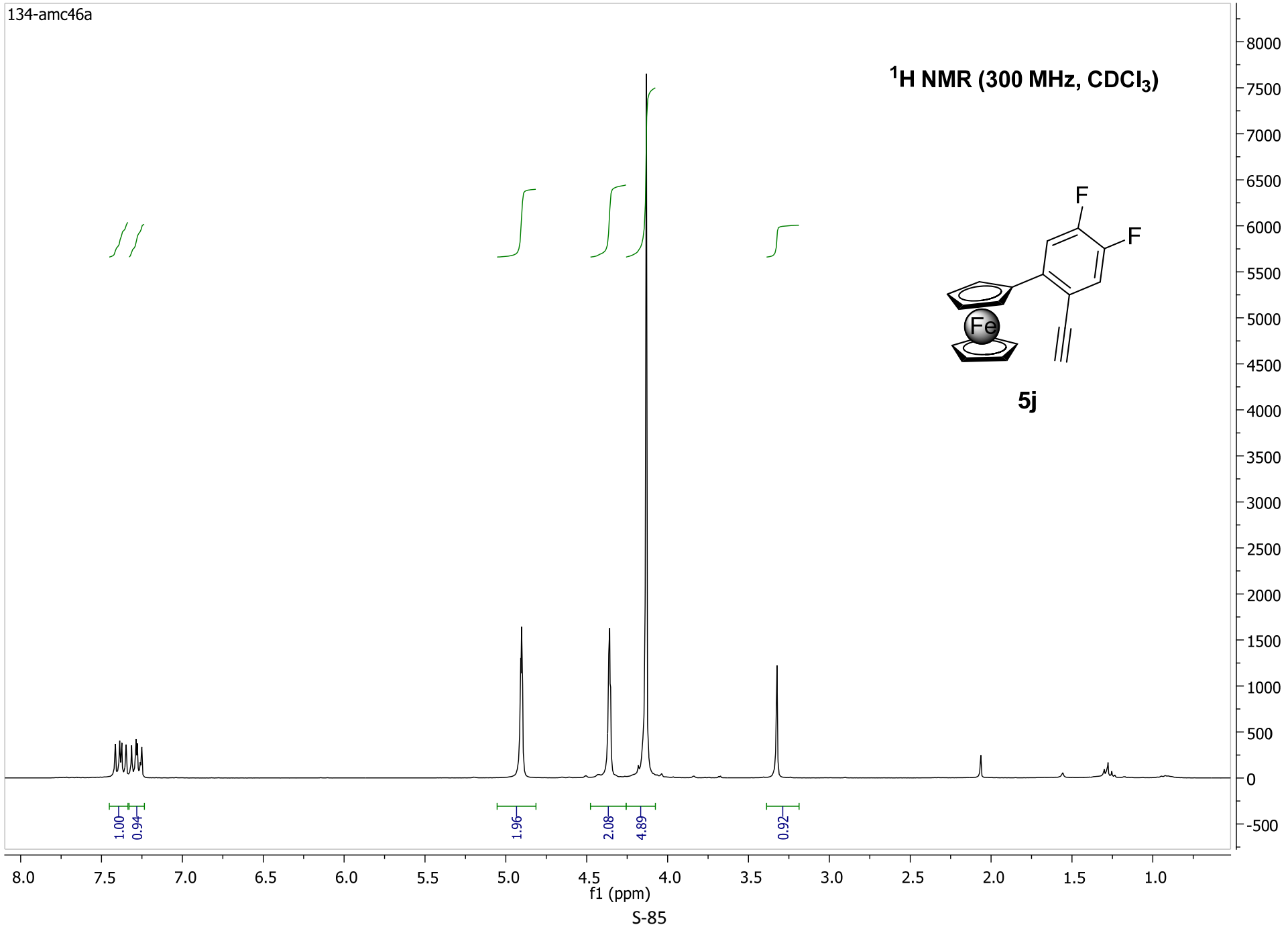

188-amc69-F
-107.82
^{19}F NMR (282 MHz, CDCl$_3$)
F
Fe
5g
40000
35000
30000
25000
20000
15000
10000
5000
0
-55
-60
-65
-70
-75
-80
-85
-90
-95
-100
-105
-110
-115
-120
-125
-130
-135
-140
-145
f1 (ppm)

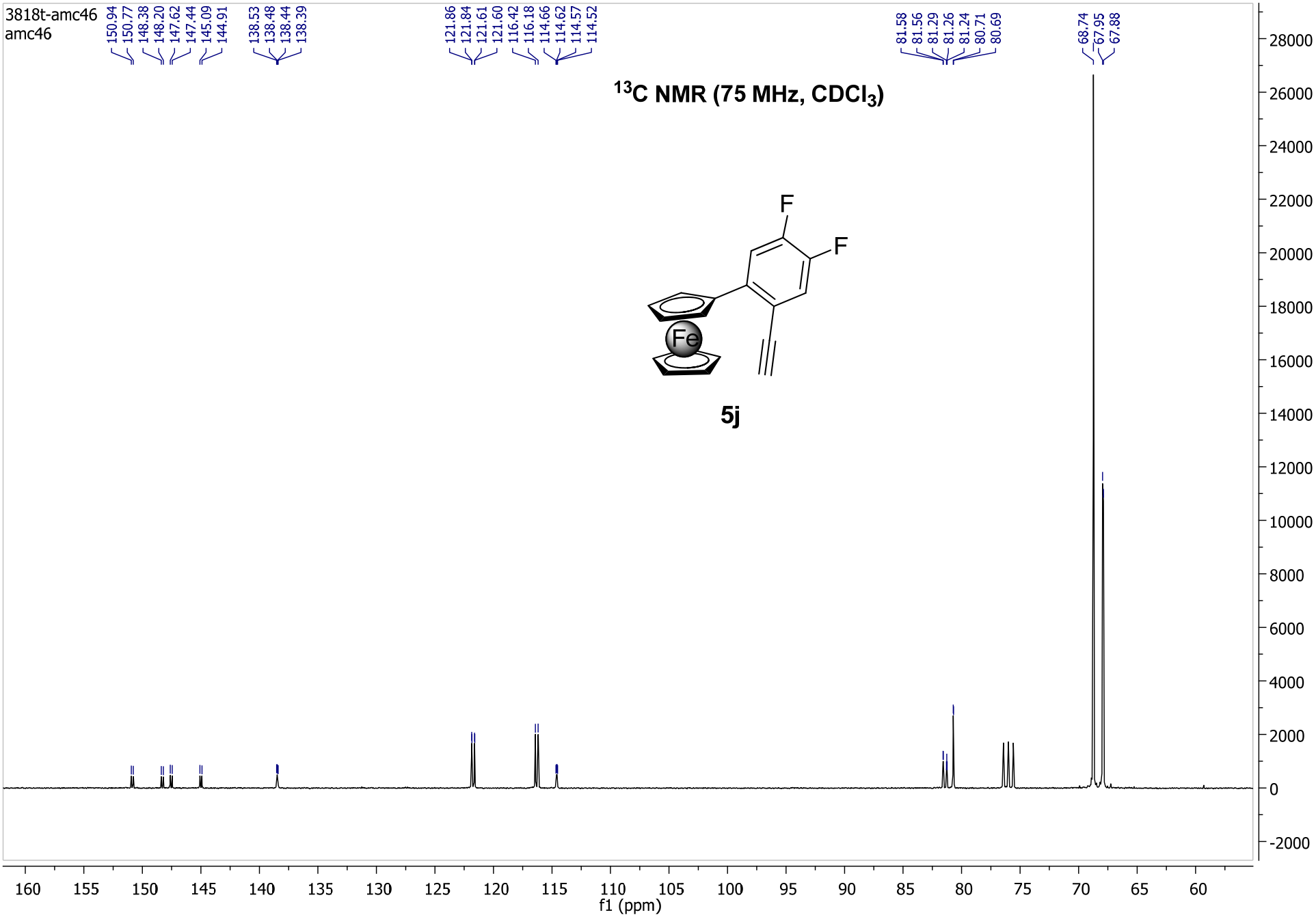

^{1}H NMR (300 MHz, $CDCl_3$)
F
Fe
5h
1.00
1.18
1.04
2.05
2.08
5.07
0.99
f1 (ppm)

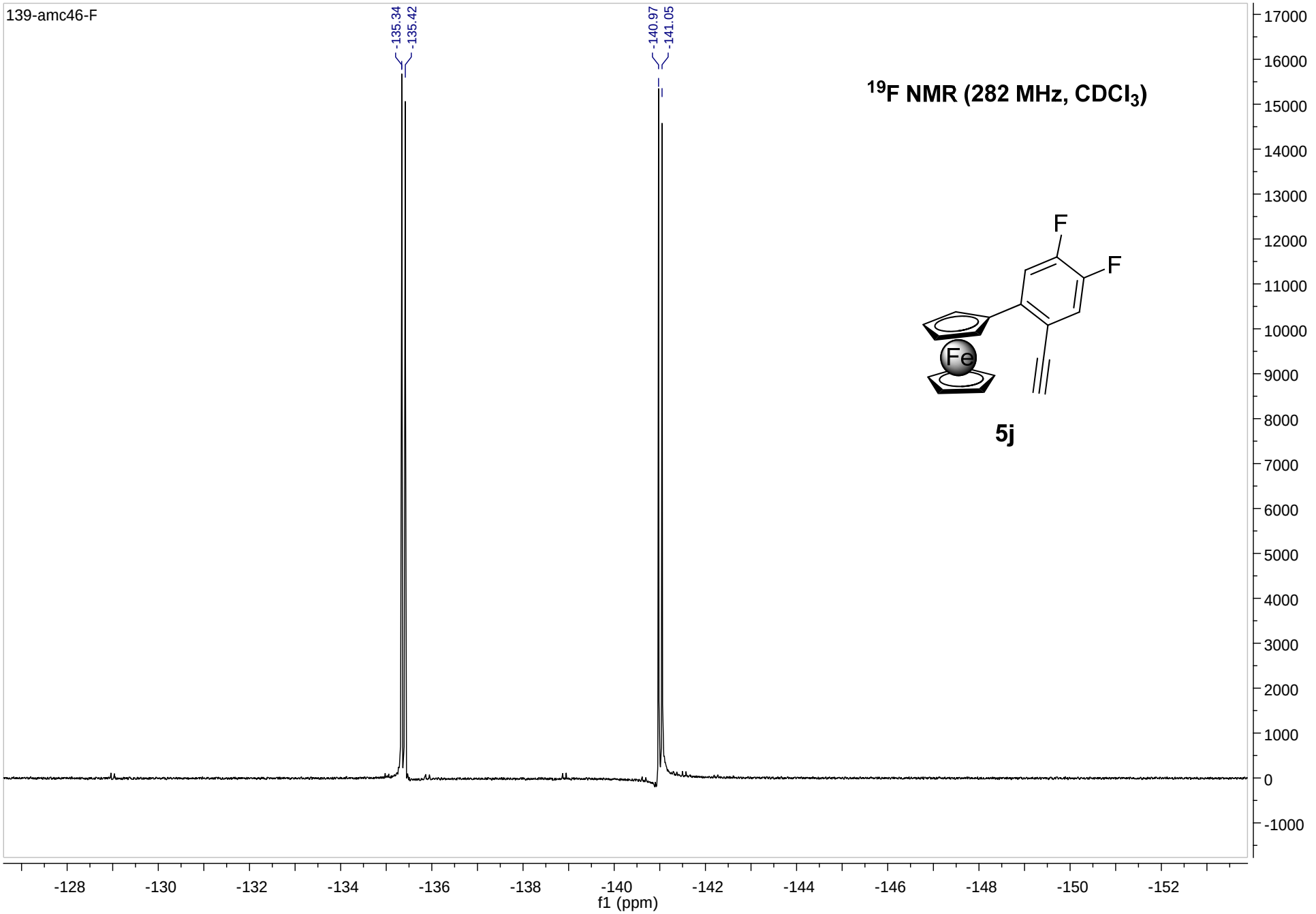

166.25
144.18
131.89
129.33
129.21
124.36
124.32
112.43
112.13
108.51
98.07
87.04
86.98
83.27
69.82
69.10
68.96
13C NMR (75 MHz, CDCl3)
Fe
F
5h
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

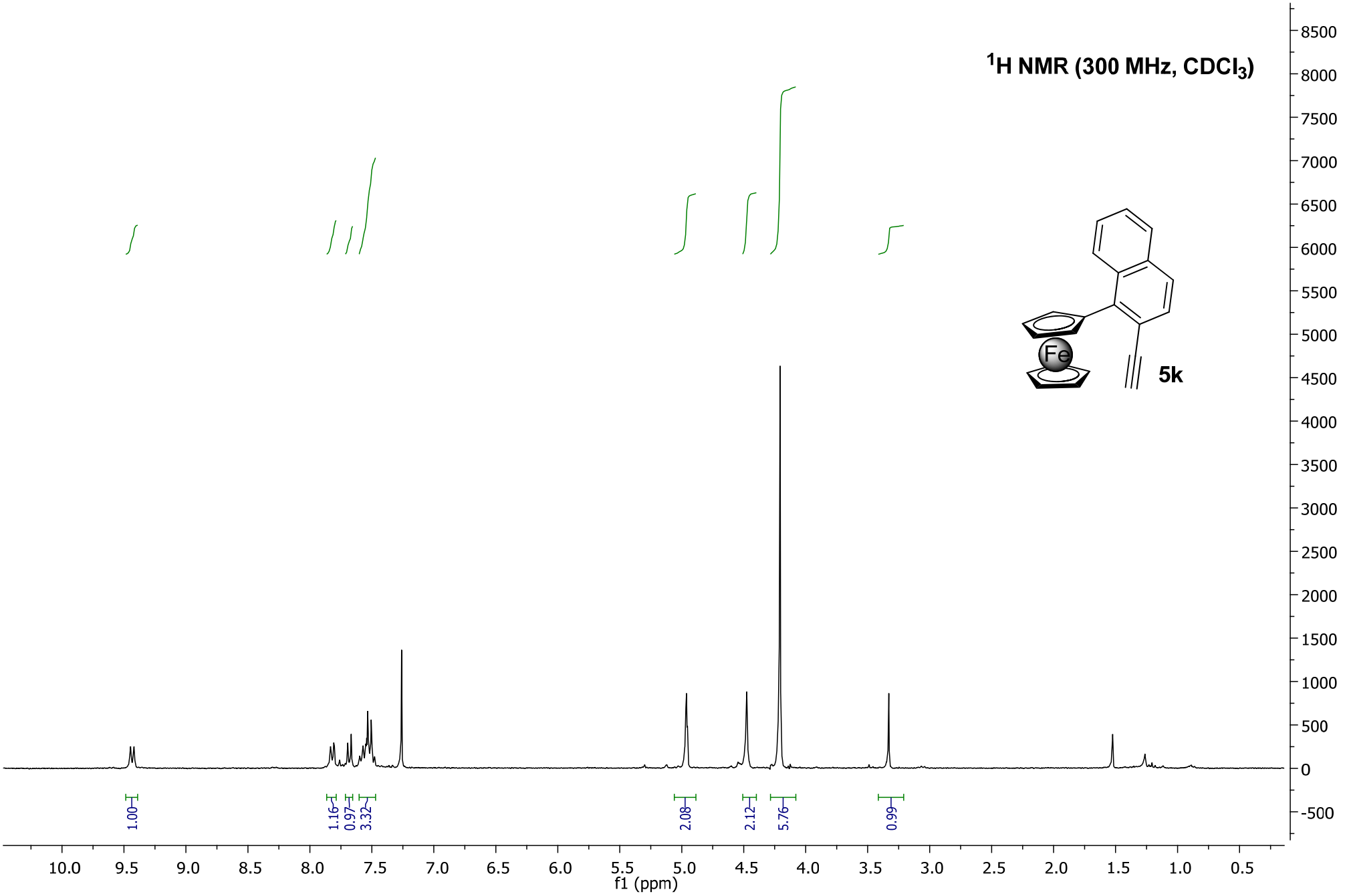

^{1}H NMR (300 MHz, $CDCl_3$)
O
O
Fe
5i
1.00
0.98
2.05
2.11
2.16
5.25
1.05
f1 (ppm)

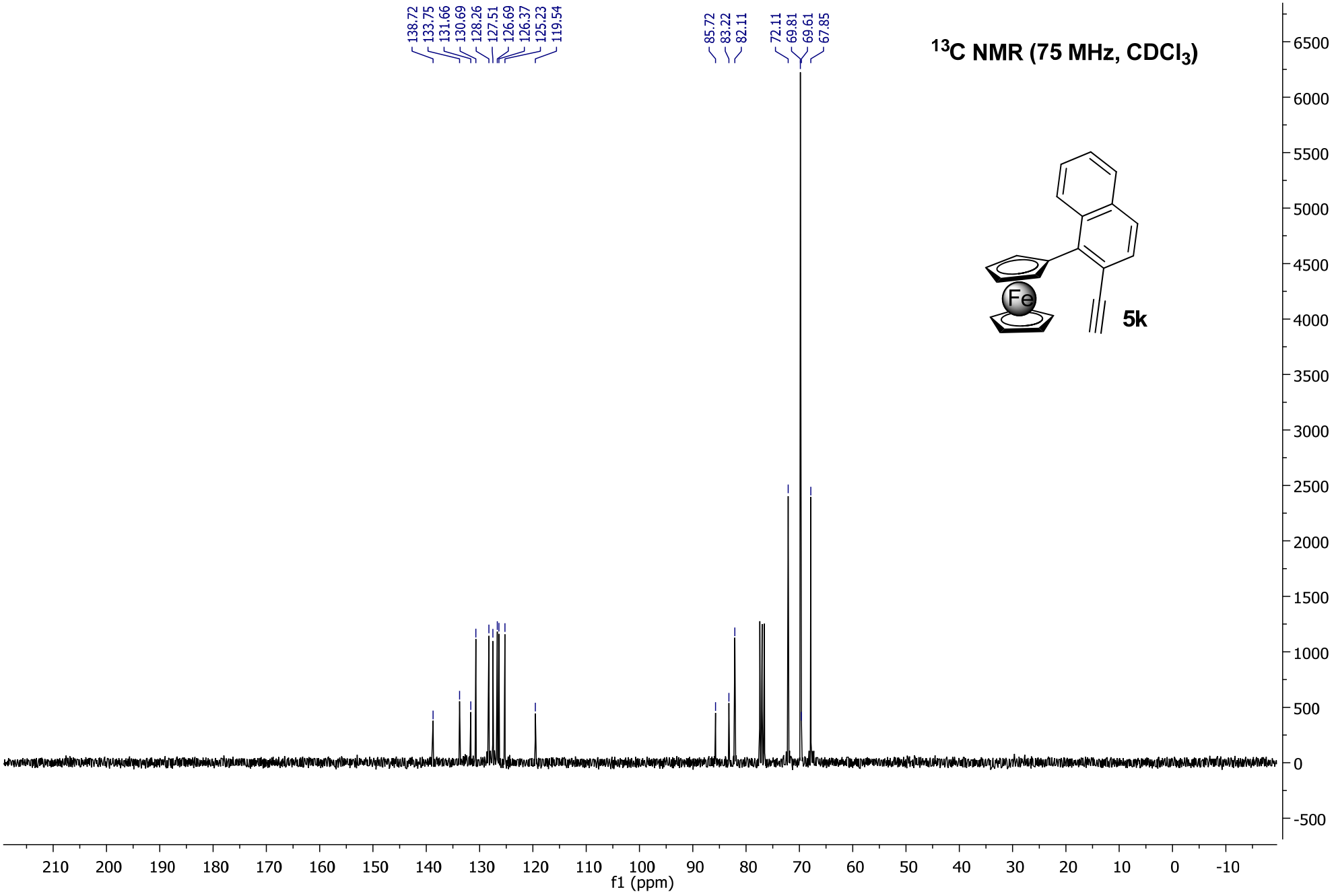

148.19
145.47
136.70
113.18
112.45
109.05
101.42
84.80
84.22
79.64
69.61
69.07
68.32
13C NMR (75 MHz, CDCl3)
O
O
Fe
5i
50
45
40
35
30
25
20
15
10
5
0
-5
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


134-amc46a
^{1}H NMR (300 MHz, $CDCl_3$)
F
F
Fe
5j
1.00
0.94
1.96
2.08
4.89
0.92
f1 (ppm)


3818t-amc46
amc46
150.94
150.77
148.38
148.20
147.62
147.44
145.09
144.91
138.53
138.48
138.44
138.39
121.86
121.84
121.61
121.60
116.42
116.18
114.66
114.62
114.57
114.52
81.58
81.56
81.29
81.26
81.24
80.71
80.69
68.74
67.95
67.88
^{13}C NMR (75 MHz, CDCl$_3$)
F
F
Fe
5j
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
160
155
150
145
140
135
130
125
120
115
110
105
100
95
90
85
80
75
70
65
60
f1 (ppm)

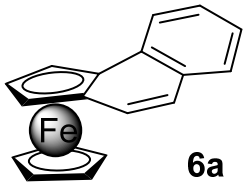

139-amc46-F
-135.34
-135.42
-140.97
-141.05
^{19}F NMR (282 MHz, $CDCl_3$)
F
F
Fe
5j
17000
16000
15000
14000
13000
12000
11000
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
-1000
-128
-130
-132
-134
-136
-138
-140
-142
-144
-146
-148
-150
-152
f1 (ppm)


^{1}H NMR (300 MHz, $CDCl_3$)
Fe
5k
1.00
1.16
0.97
3.32
2.08
2.12
5.76
0.99
f1 (ppm)


138.72
133.75
131.66
130.69
128.26
127.51
126.69
126.37
125.23
119.54
85.72
83.22
82.11
72.11
69.81
69.61
67.85
^{13}C NMR (75 MHz, CDCl$_3$)
Fe
5k
f1 (ppm)

11104q-hgh3p2
hgH[3]_P2
PROTON CDCl3 C:\\ sidi 2

^{1}H NMR (300 MHz, $CDCl_3$)

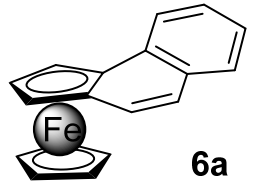


6a

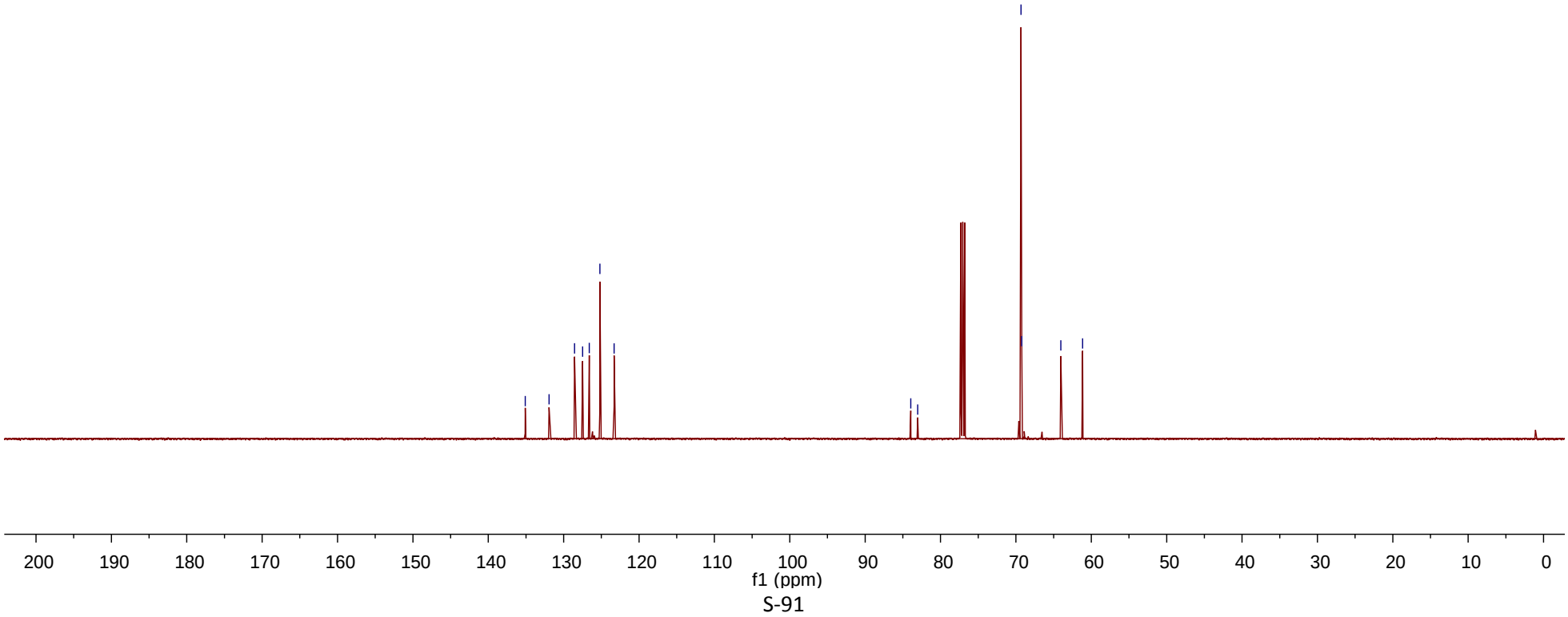
11104q-hgh3p2
hgH[3]_P2
C13CPD CDCl3 C:\\ sidi 2

135.09
131.93
128.56
127.49
126.60
125.20
123.30
83.95
83.04
69.32
69.21
64.04
61.15

^{13}C NMR (75 MHz, $CDCl_3$)

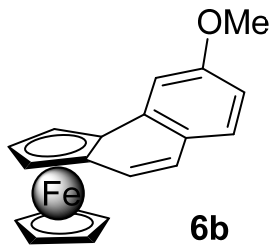


6a



11088q-hg0119
hg01_19

^{1}H NMR (300 MHz, $CDCl_3$)

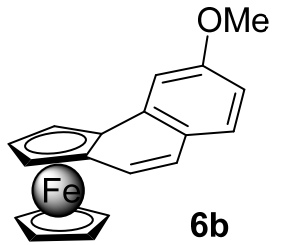


6b

11088q-hg0119
hg01_19

158.54
136.71
129.90
125.88
124.85
124.46
113.05
106.48
84.55
82.64
69.33
69.10
63.96
60.97
55.51

^{13}C NMR (75 MHz, $CDCl_3$)

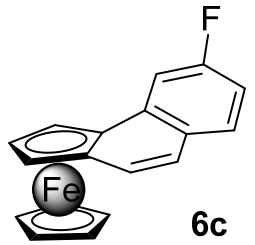


6b

f1 (ppm)

11092q-hg0138
hg01_38
PROTON CDCl3 C:\\ sidi 3

^{1}H NMR (300 MHz, $CDCl_3$)

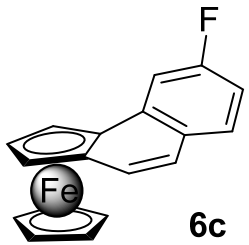


6c

11092q-hg0138
hg01_38
C13CPD CDCl3 C:\\ sidi 3

162.62
160.67
137.26
137.19
130.36
130.28
126.46
126.44
124.41
124.41
113.24
113.06
108.99
108.82
84.16
82.22
82.19
69.55
69.40
64.28
61.34

^{13}C NMR (75 MHz, $CDCl_3$)

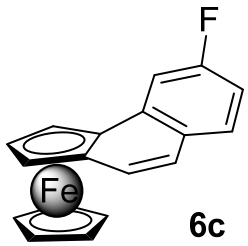


6c

hg01_38-F

-114.17

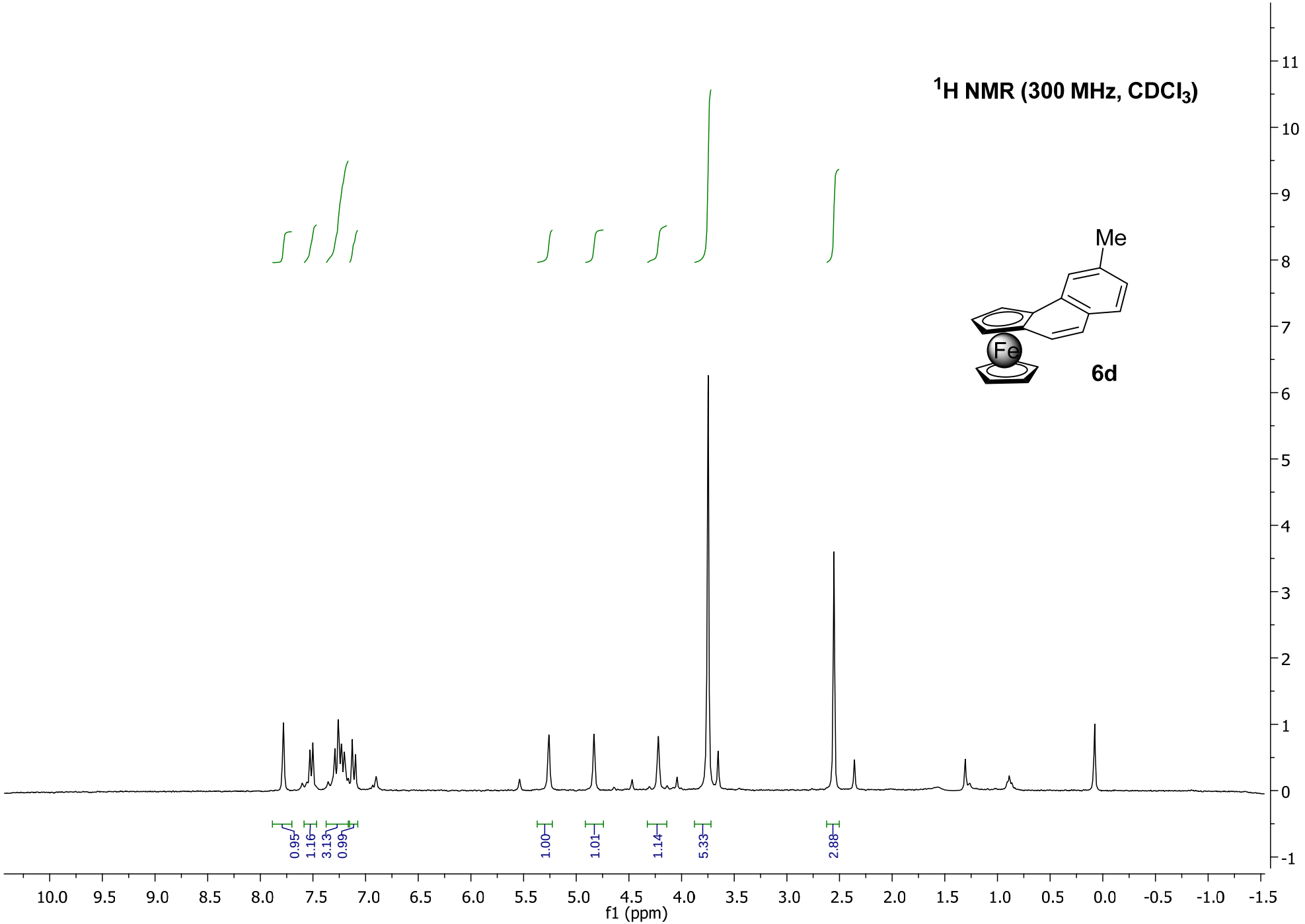
^{19}F NMR (282 MHz, $CDCl_3$)



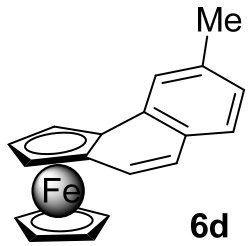
6c

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

f1 (ppm)


^{1}H NMR (300 MHz, $CDCl_3$)
Me
Fe
6d
0.95
1.16
3.13
0.99
1.00
1.01
1.14
5.33
2.88
f1 (ppm)

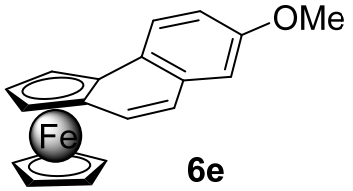
^{13}C NMR (75 MHz, $CDCl_3$)



6d

11105q-hgmomep3
hgmOMe_P3
PROTON CDCl3 C:\\ sidi 3

^{1}H NMR (300 MHz, $CDCl_3$)

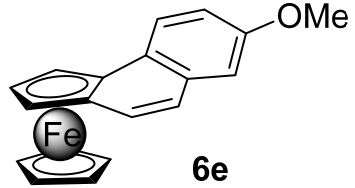


6e

11105q-hgmomep3
hgmOMe_P3
C13CPD CDCl3 C:\\ sidi 3

157.50
133.17
128.39
128.07
124.94
124.57
115.18
110.99
83.84
83.00
69.22
68.82
63.69
60.58
55.40

^{13}C NMR (75 MHz, $CDCl_3$)

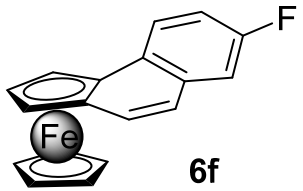


6e

10 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -1
f1 (ppm)

11108q-hgmfp6
hgmF_P6
PROTON CDCl3 C:\\ sidi 6

^{1}H NMR (300 MHz, $CDCl_3$)

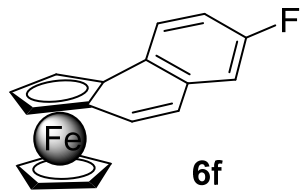


6f

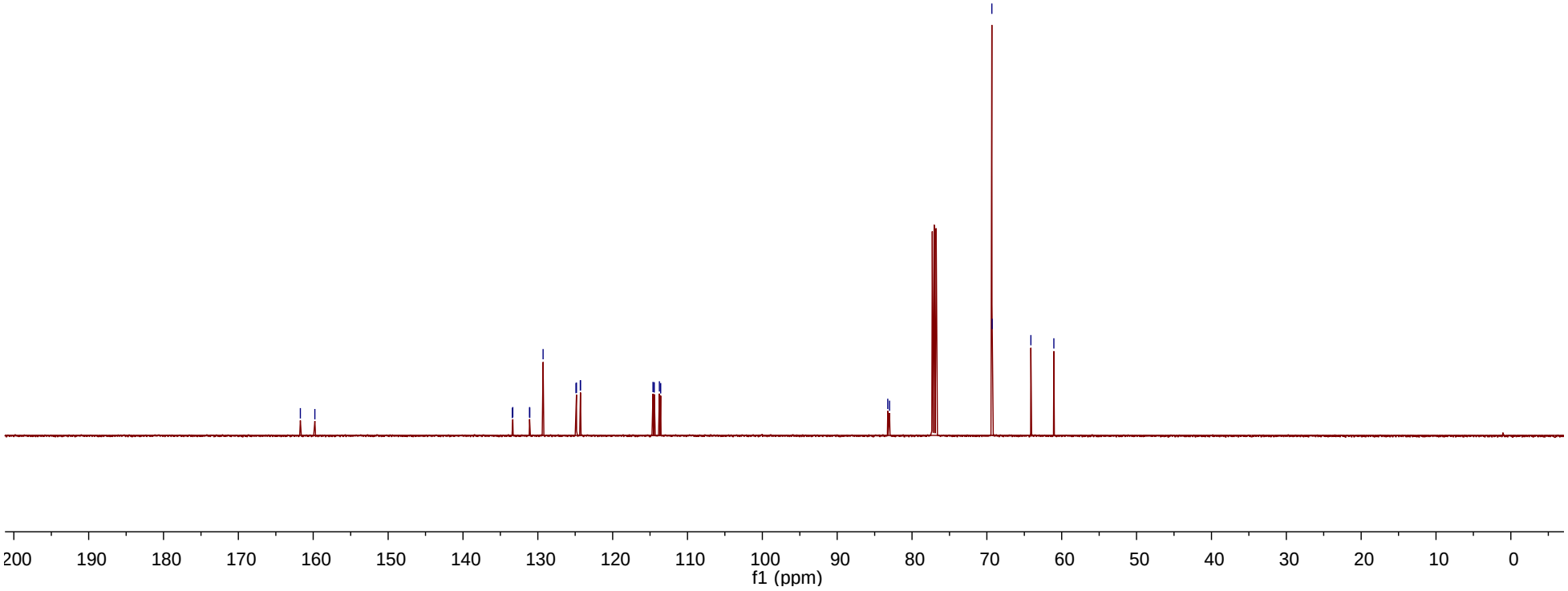
11108q-hgmfp6
hgmF_P6
C13CPD CDCl3 C:\\ sidi 6

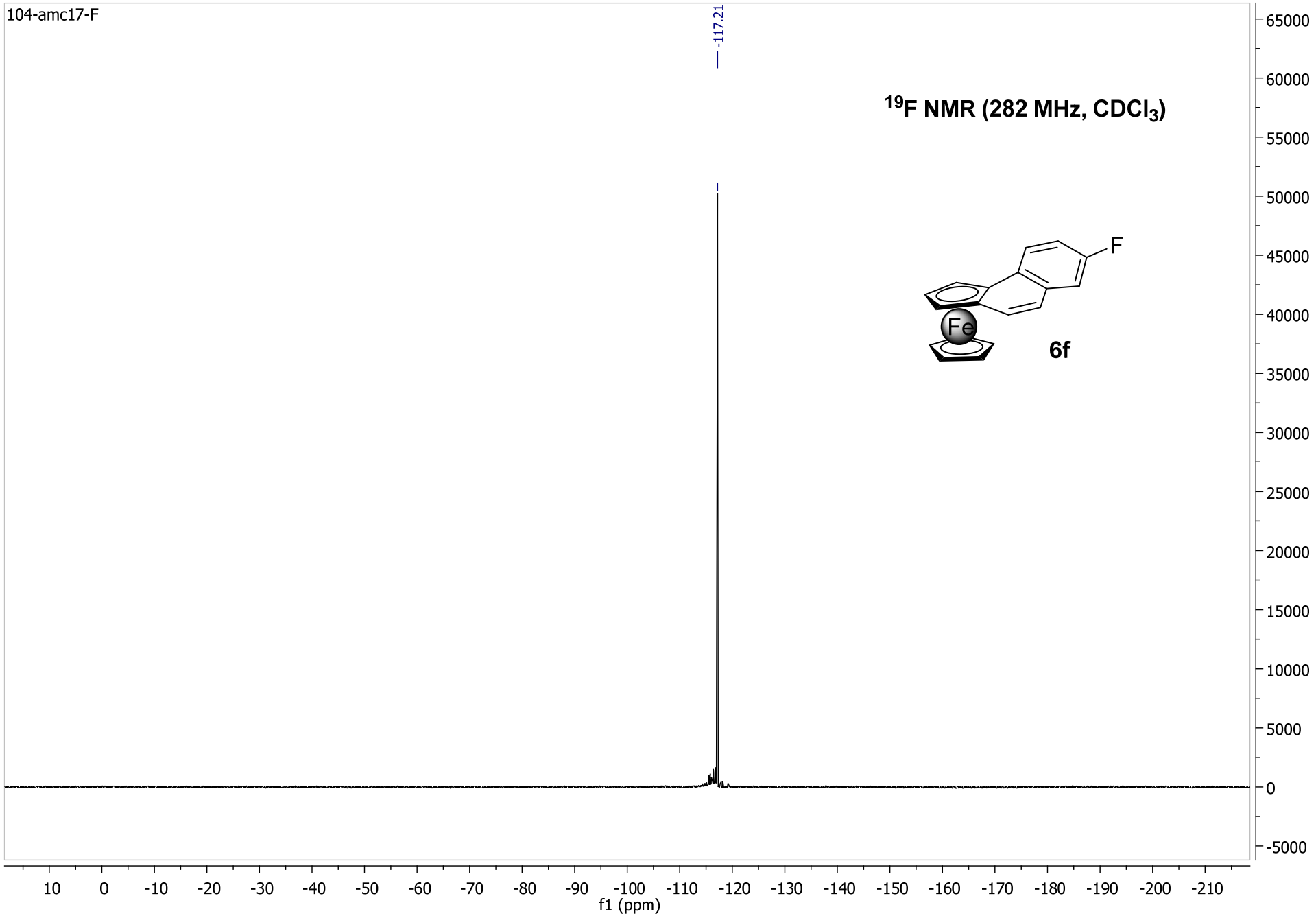
161.72
159.79
133.41
133.35
131.09
131.07
129.29
124.91
124.84
124.32
124.29
114.62
114.44
113.75
113.59
83.25
83.01
69.33
69.30
64.12
61.05

^{13}C NMR (75 MHz, $CDCl_3$)

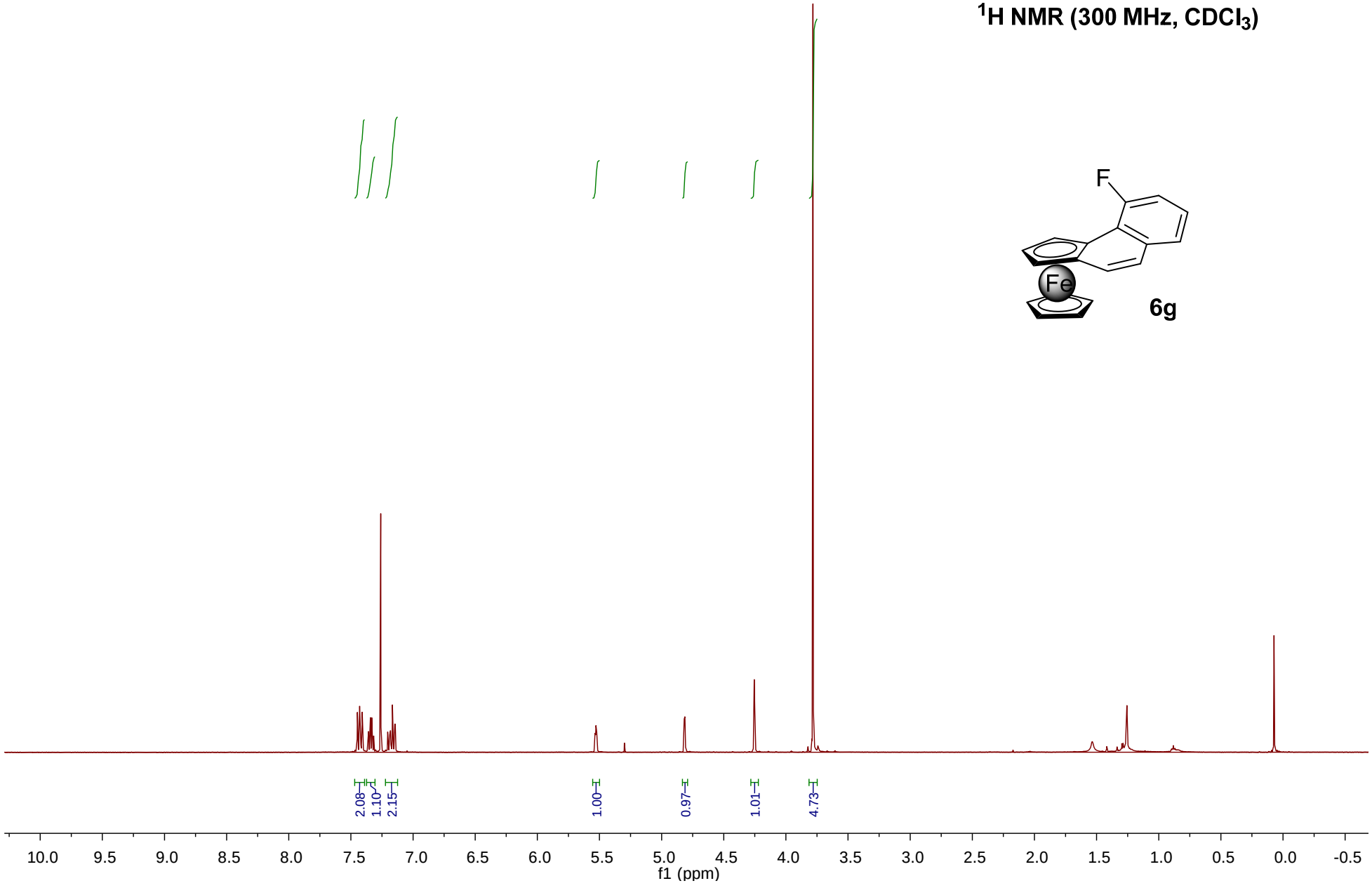


6f




104-amc17-F
-117.21
^{19}F NMR (282 MHz, CDCl$_3$)
F
Fe
6f
65000
60000
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -120 -130 -140 -150 -160 -170 -180 -190 -200 -210
f1 (ppm)

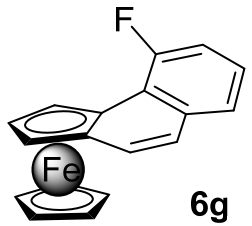
11113q-hg0160
hg01_60
PROTON CDCl3 C:\\ sidi 1



11113q-hg0160
hg01_60
C13CPD CDCl3 C:\\ sidi 1

160.88
158.91
134.58
134.53
129.03
125.37
124.33
124.30
124.13
112.54
83.64
78.41
70.01
69.99
69.25
65.71
65.63
63.93

^{13}C NMR (75 MHz, $CDCl_3$)



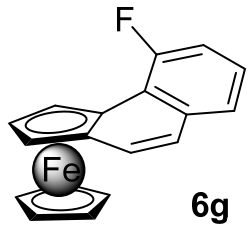
6g

f1 (ppm)

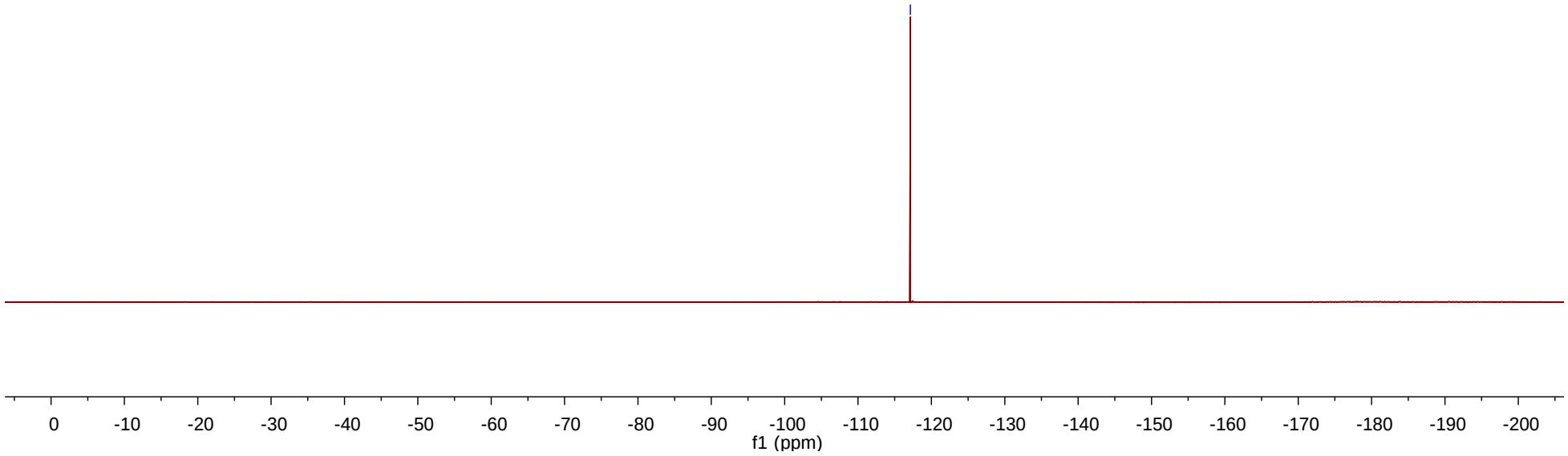
11113q-hg0160
hg01_60
F19CPD CDCl3 C:\\ sidi 1

-117.13

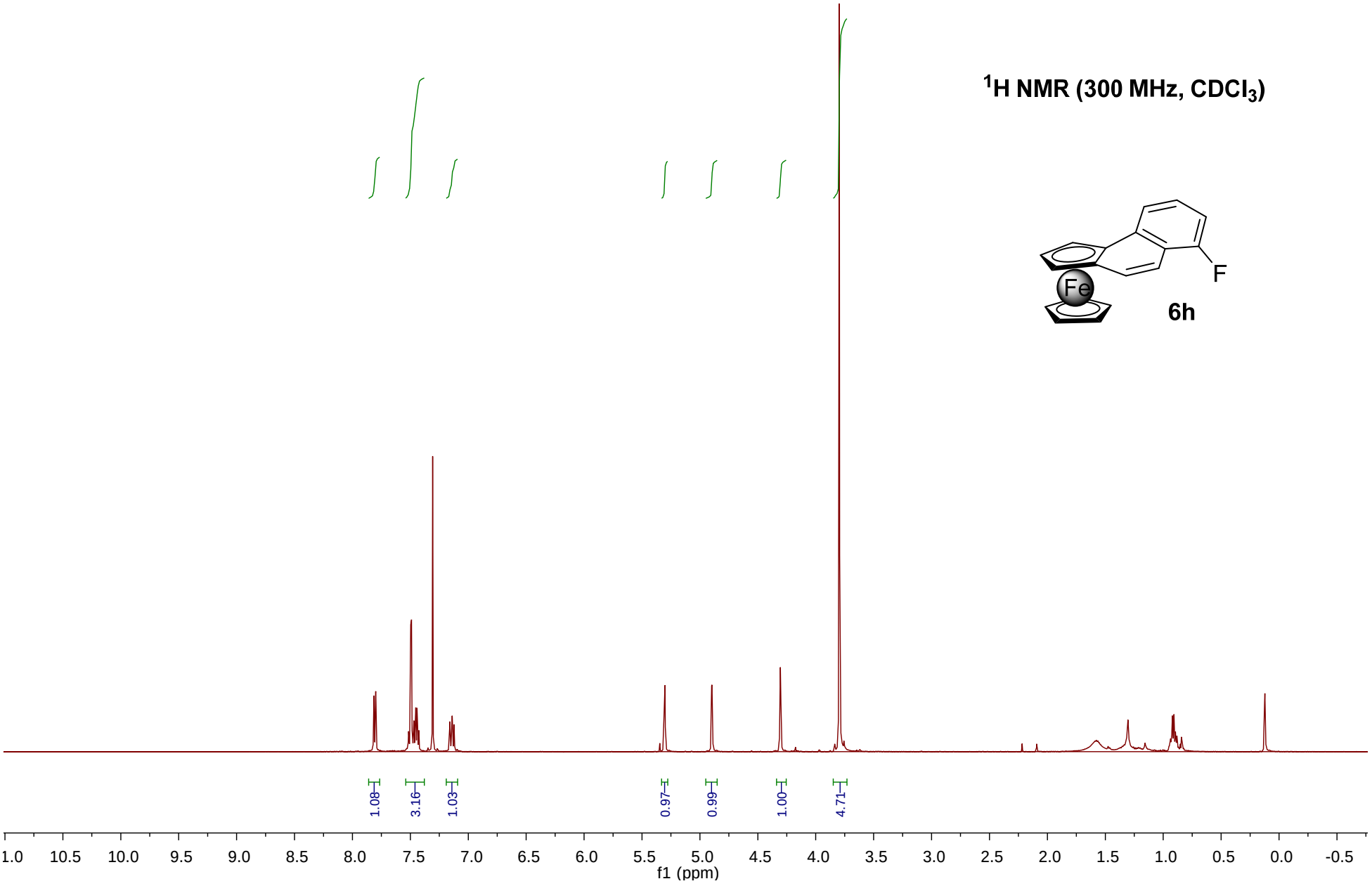
^{19}F NMR (282 MHz, $CDCl_3$)



6g



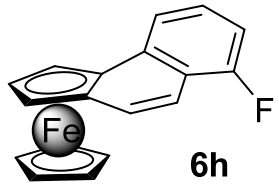
11106q-hgofp4
hgoF_P4
PROTON CDCl3 C:\\ sidi 4



11106q-hgofp4
hgoF_P4
C13CPD CDCl3 C:\\ sidi 4

160.60
158.62
137.33
128.26
127.14
127.07
118.99
118.96
116.57
116.52
116.45
110.59
83.84
82.17
69.68
69.39
64.45
61.57

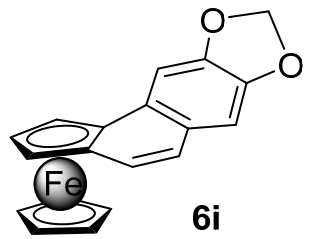
^{13}C NMR (75 MHz, $CDCl_3$)



6h

11109q-hgmdioxop7
hgmdioxo_P7
PROTON CDCl3 C:\\ sidi 7

^{1}H NMR (300 MHz, $CDCl_3$)

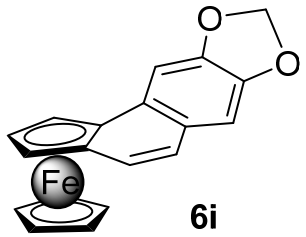


6i

11109q-hgmdioxop7
hgmdioxo_P7
C13CPD CDCl3 C:\\ sidi 7

147.23
146.11
130.14
126.90
125.54
124.94
107.33
102.54
101.03
84.07
83.91
69.13
68.90
63.44
60.41

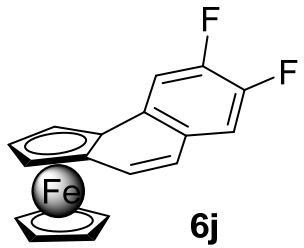
^{13}C NMR (75 MHz, $CDCl_3$)



6i

hg01_02

^{1}H NMR (300 MHz, $CDCl_3$)

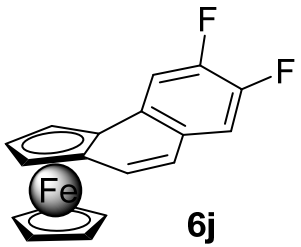


6j

hg01_02-C

151.34
151.16
150.36
150.18
148.05
147.87
147.10
146.91
132.10
128.49
128.32
128.28
123.55
123.52
115.99
115.77
111.10
110.87
83.49
82.18
69.60
69.37
64.34
61.17

^{13}C NMR (75 MHz, $CDCl_3$)



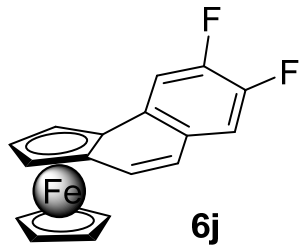
6j

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)

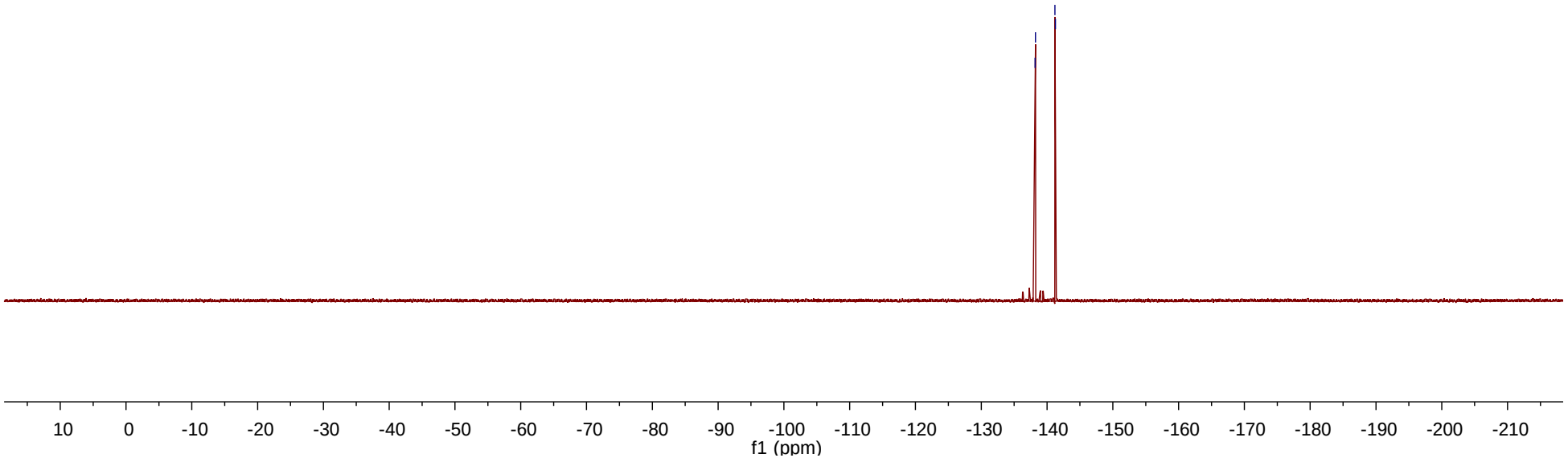
hg01_02-F

-138.18
-138.25
-141.21
-141.28

^{19}F NMR (282 MHz, $CDCl_3$)

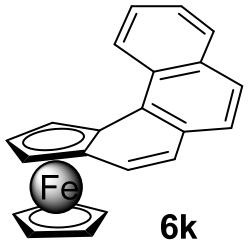


6j



11103q-hgh4p1
hgH[4]_P1
PROTON CDCl3 C:\\ sidi 1

^{1}H NMR (300 MHz, $CDCl_3$)

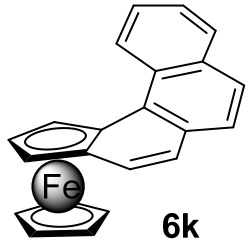


6k

11103q-hgh4p1
hgH[4]_P1
C13CPD CDCl3 C:\\ sidi 1

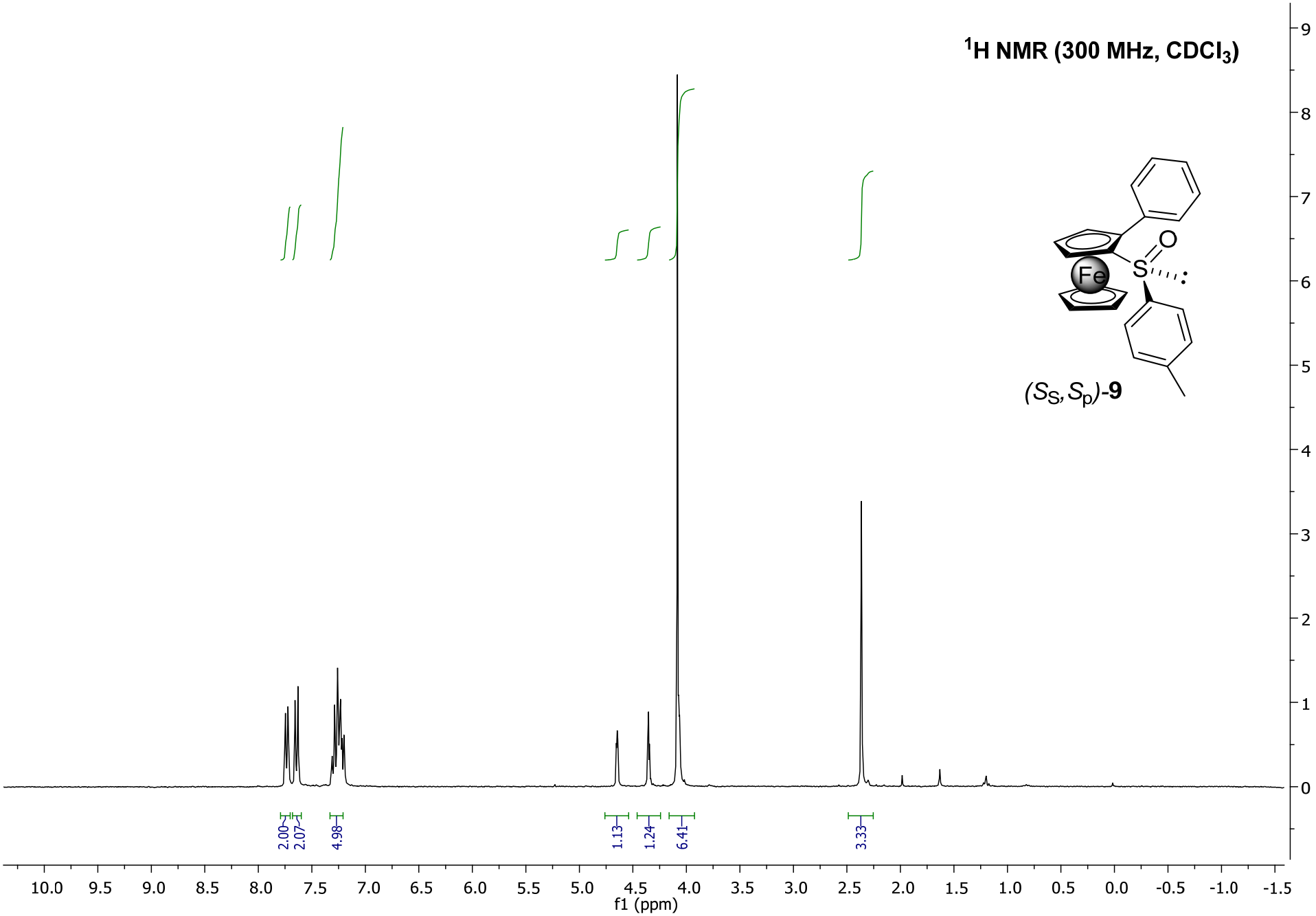
133.16
131.91
131.14
130.89
128.82
128.49
127.87
126.34
126.10
126.08
125.69
125.46
86.66
82.30
70.77
68.86
65.65
64.00

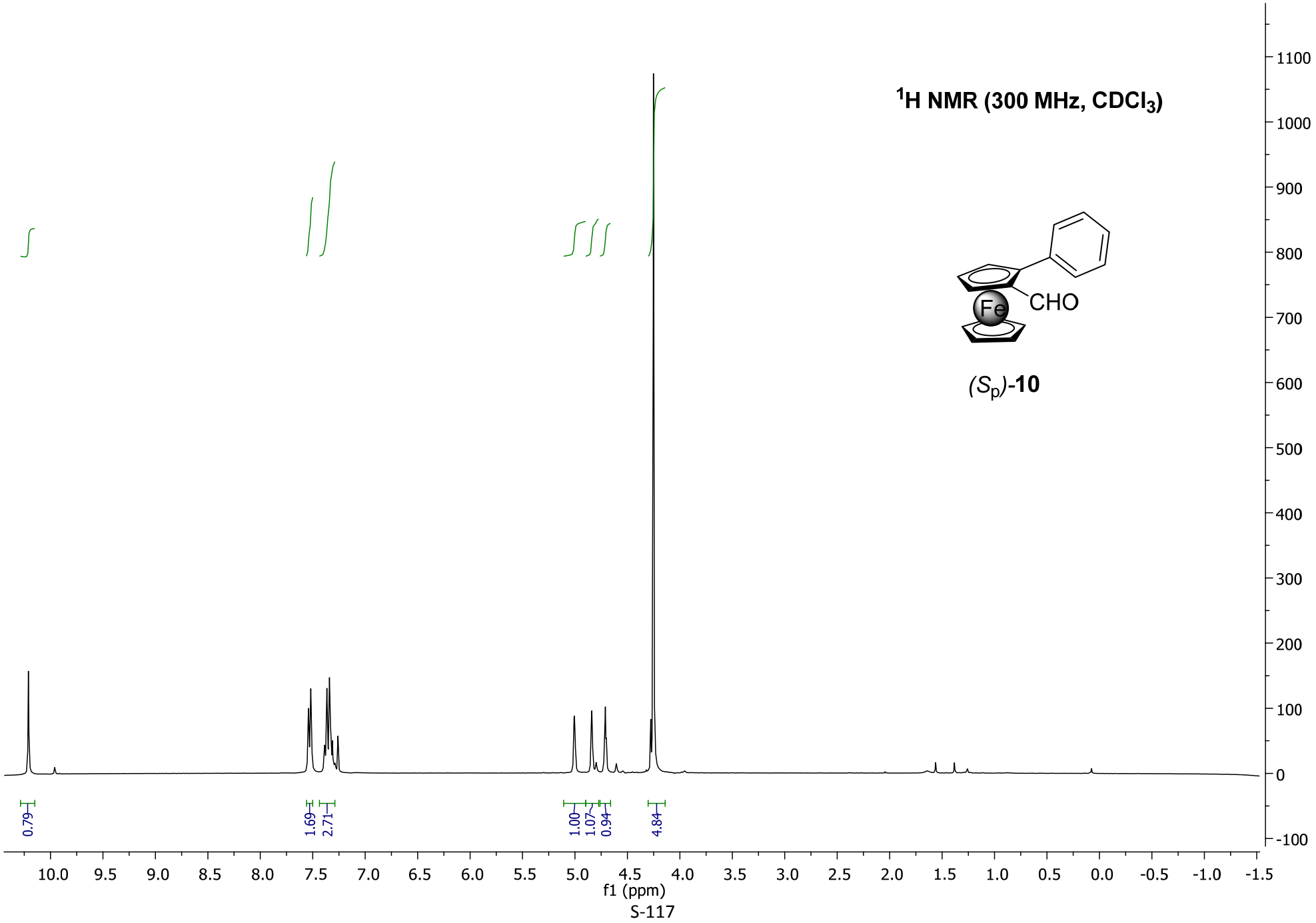
^{13}C NMR (75 MHz, $CDCl_3$)

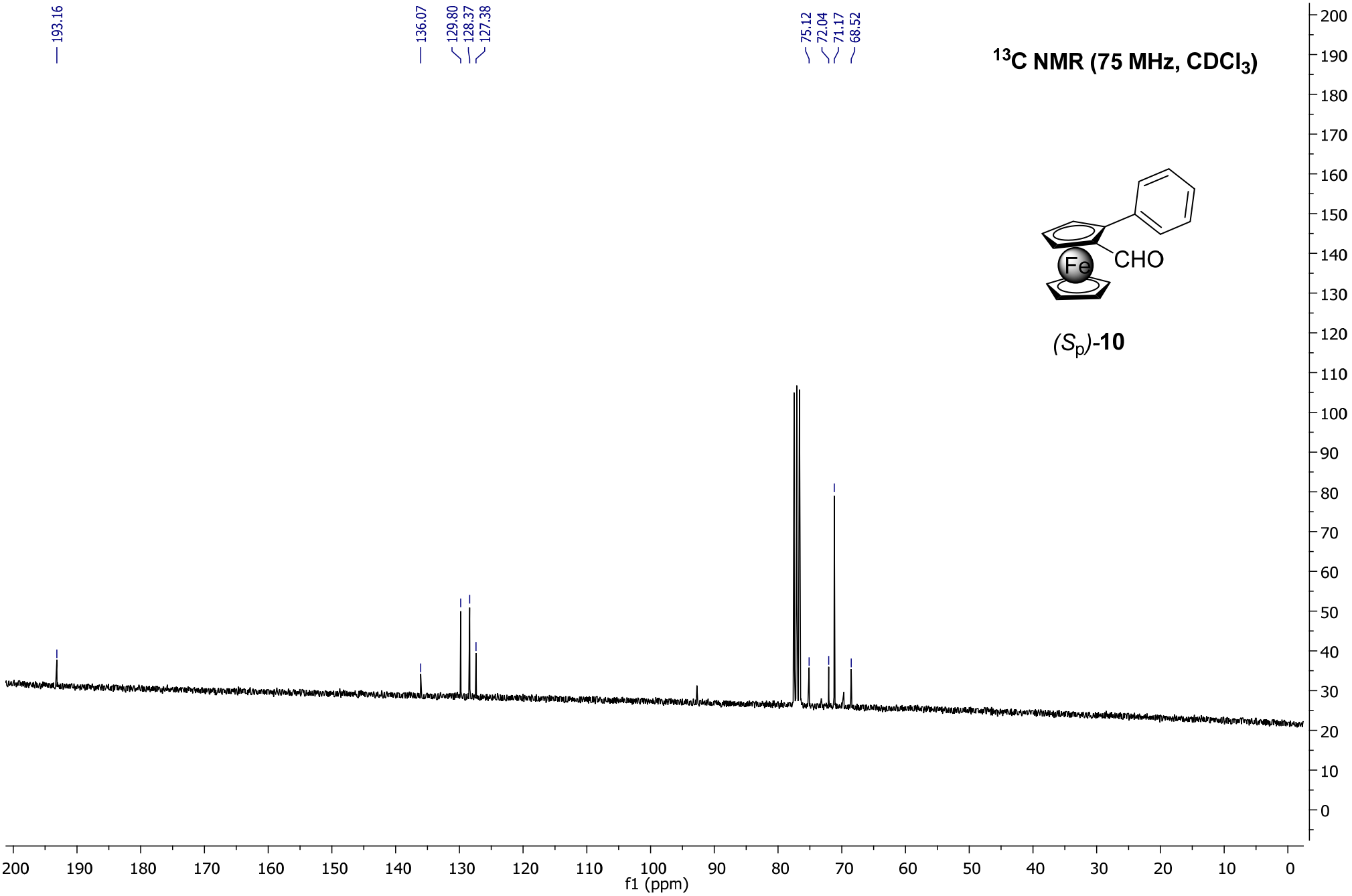


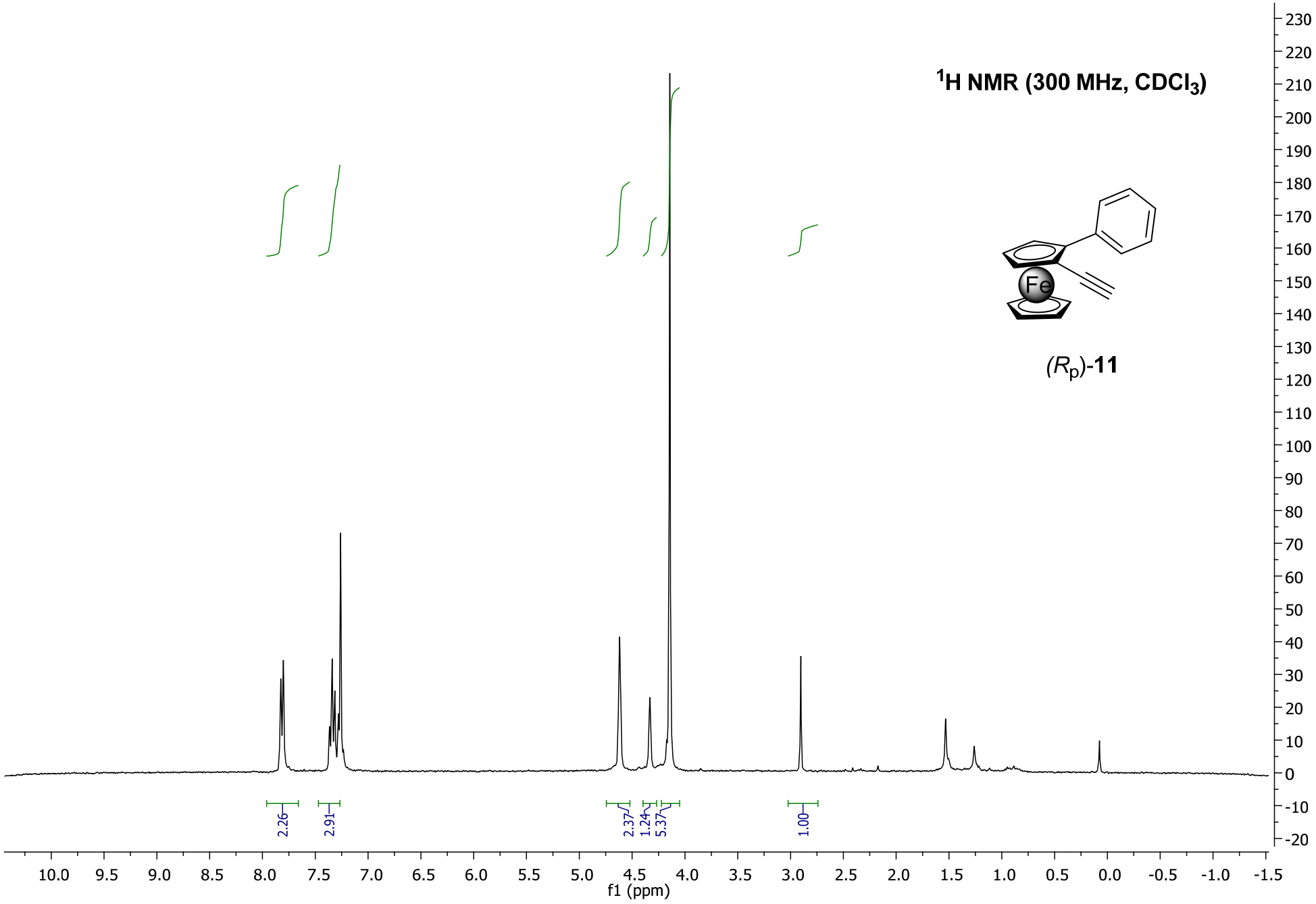
6k

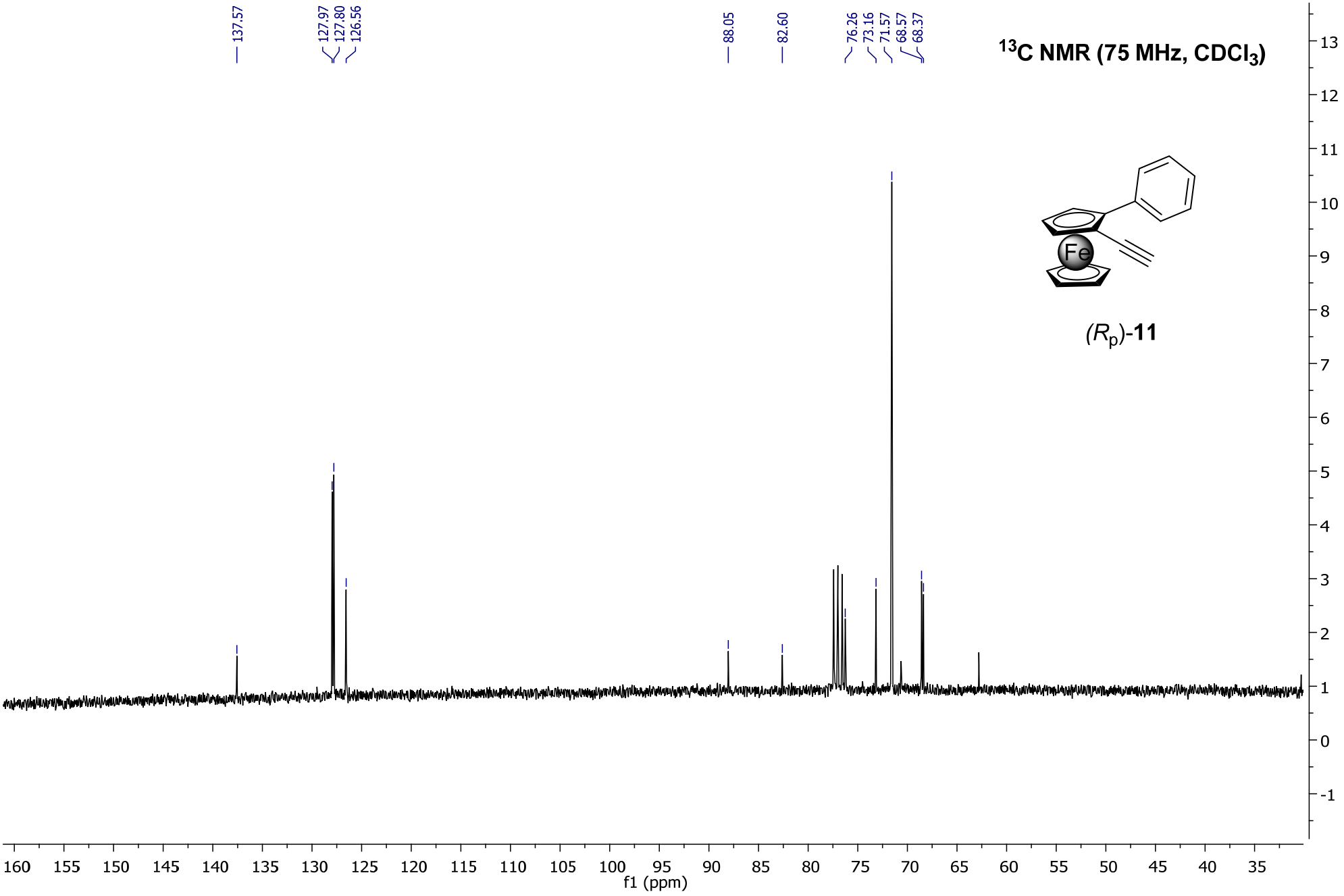
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


^{1}H NMR (300 MHz, $CDCl_3$)
O
S
Fe
(S_S,S_p)-9
2.00
2.07
4.98
1.13
1.24
6.41
3.33
f1 (ppm)


^{1}H NMR (300 MHz, $CDCl_3$)
Fe
CHO
(S_p)-10
0.79
1.69
2.71
1.00
1.07
0.94
4.84
f1 (ppm)


193.16
136.07
129.80
128.37
127.38
75.12
72.04
71.17
68.52
^{13}C NMR (75 MHz, CDCl$_3$)
Fe
CHO
(S_p)-10
f1 (ppm)


^{1}H NMR (300 MHz, $CDCl_3$)
Fe
(R_p)-11
2.26
2.91
2.37
1.24
5.37
1.00
f1 (ppm)


137.57
127.97
127.80
126.56
88.05
82.60
76.26
73.16
71.57
68.57
68.37
^{13}C NMR (75 MHz, CDCl$_3$)
Fe
(R_p)-11
f1 (ppm)