Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

Supporting Information

Regiodivergent Hydrosilylation in Nickel(0)-Catalyzed Cyclization of 1,6-Enynes

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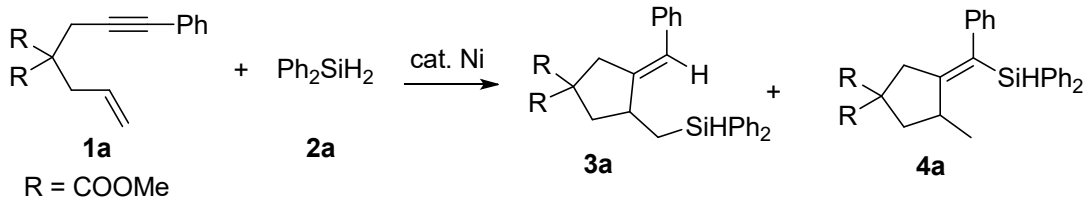
1. General Information

All chemicals were obtained from commercial sources and were used as received unless otherwise noted. All the reactions were carried out in an argon-filled glove box. The ^{1}H NMR spectra were recorded on a 400 MHz or 600 MHz NMR spectrometer. The ^{13}C NMR spectra were recorded at 100 MHz or 150 MHz. The ^{19}F NMR spectra were recorded at 565 MHz. Chemical shifts were expressed in parts per million(δ) downfield from the internal standard tetramethylsilane, and were reported as s (singlet), d (doublet), t (triplet), dd (doublet of doublet), dt (doublet of triplet), m (multiplet), brs (broad singlet), etc. The residual solvent signals were used as references and the chemical shifts were converted to the TMS scale. High resolution mass spectra were obtained on an Agilent Q-TOF 6540 spectrometer. Column chromatography was performed on silica gel (300-400 mesh). Thin layer chromatography was performed on pre-coated glass backed plates and visualized under UV light at 254 nm. Flash column chromatography was performed on silica gel.diphenylsilane were purchased from commercial sources. 1, 6-enyne were prepared according to literature reports.[1]

2. Hydrosilylation/cyclization of 1,6-enynes

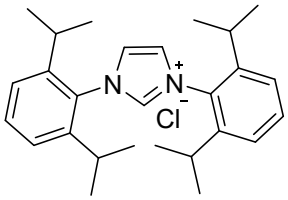
2.1 Table S1. The hydrosilylation/cyclization of **1a** and **2a**. [a]



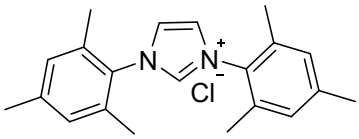
1a R = COOMe **2a** **3a** **4a**

Entry	L	**2a**	Base (20 mol%)	Solvent	T (°C)	Yield (%) **3a**	Yield (%) **4a**
1	--	2eq	--	DMA	30	NR	--
2	--	2eq	--	THF	30	38%	--
3	--	2eq	--	CH_3CN	30	40%	--
4	--	2eq	--	Dioxane	30	48%	--
5	--	2eq	--	MeO^tBu	30	46%	--
6	--	2eq	--	EtOH	30	50%	--
7	--	2eq	--	DME	30	74%	--
8	--	2eq	--	DME	50	76%	--
9	--	2eq	--	DME	80	80%	--
10	--	2eq	--	DME	120	80%	--
11	--	1eq	--	DME	120	48%	--
12[b]	BINAP(10%)	2eq	--	THF	30	28%	--
13[b]	BINAP(20%)	2eq	--	THF	30	33%	--
14[b]	BPY(10%)	2eq	--	THF	30	trace	trace
15[b]	PPh_3(10%)	2eq	--	THF	30	--	--

16[b]	PCy_3(10%)	2eq	--	THF	30	36%	30%
17[b]	PCy_3(20%)	2eq	--	THF	30	14%	32%
18[b]	**L1**(10%)	2eq	CsOAc	THF	30	--	66%
19[b]	**L1**(20%)	2eq	CsOAc	THF	30	--	62%
20[b]	**L2**(10%)	2eq	CsOAc	THF	30	4%	32%
21[b]	**L3**(10%)	2eq	CsOAc	THF	30	7%	33%
22[b]	**L4**(10%)	2eq	CsOAc	THF	30	20%	--
23[b]	**L1**(10%)	2eq	^{t}BuONa	THF	30	--	16%
24[b]	**L1**(10%)	2eq	$CsCO_3$	THF	30	--	30%
25[b]	**L1**(10%)	2eq	K_2CO_3	THF	30	--	57%
26[b]	**L1**(10%)	2eq	NaOEt	THF	30	--	46%
27[b]	**L1**(10%)	2eq	KOAc	THF	30	--	60%
28[b]	**L1**(10%)	2eq	CsOAc	DMA	30	trace	trace
29[b]	**L1**(10%)	2eq	CsOAc	Dioxane	30	--	40%
30[b]	**L1**(10%)	2eq	CsOAc	$PhCF_3$	30	--	52%
31[b]	**L1**(10%)	2eq	CsOAc	DME	30	--	54%
32[b]	**L1**(10%)	2eq	CsOAc	MeOtBu	30	--	60%
33[b]	**L1**(10%)	2eq	CsOAc	CH_3CN	30	--	72%
34[b]	**L1**(10%)	2eq	CsOAc	CH_3CN	50	--	74%
35[b]	**L1**(10%)	2eq	CsOAc	CH_3CN	80	--	82%
36[b]	**L1**(10%)	1eq	CsOAc	CH_3CN	80	--	32%
37[c]	--	2eq	--	DME	120	48%	--
38[c]	**L1**(10%)	2eq	CsOAc	CH_3CN	80	--	--
39[d]	--	2eq	--	DME	120	--	--
40[d]	**L1**(10%)	2eq	CsOAc	CH_3CN	80	--	--
41[e]	--	2eq	--	DME	80	--	80%
42[f]	**L1**(5%)	2eq	CsOAc	CH_3CN	80	82%	--



L1



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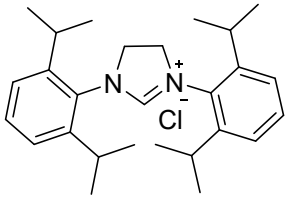
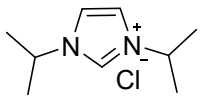


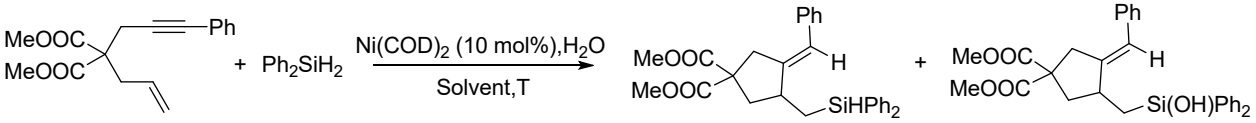
L3



L4

[a] Reaction conditions A: **1a** (0.2 mmol), **2a** (0.4 mmol), $Ni(cod)_2$ (0.02 mmol) in solvent (2.0 mL), 24h, argon.
[b] Reaction conditions B: **1a** (0.2 mmol), **2a** (0.4 mmol), $Ni(cod)_2$ (0.02 mmol), base (0.04 mmol), L1 (0.02 mmol) in solvent (2.0 mL), 24h, argon. [c] In the air. [d] Without $Ni(cod)_2$. [e] $Ni(cod)_2$ (0.01 mmol) , 40h, argon. [f] $Ni(cod)_2$ (0.01 mmol), base (0.02 mmol), L1 (0.01 mmol) , 40h, argon.

2.2 Table S2. Optimization of reaction conditions of the silanol **5a**.[a]



1a **2a** **3a** **5a**

Entry	H_2O(mmol)	Ph_2SiH_2(mmol)	Solvent	T (°C)	Yield (%) **3a**	Yield (%) **5a**
1	0.2	0.2	DME	120	4%	18%
2	0.2	0.4	DME	120	14%	44%
3	0.2	0.5	DME	120	28%	30%
4	0.2	0.6	DME	120	14%	22%
5	0.2	0.4	DME	60	16%	26%
6	0.2	0.4	DME	30	20%	24%
7	0.2	0.4	DME	0	12%	10%
8	0.2	0.4	Toluene	120	18%	28%
9	0.2	0.4	MeO^tBu	120	24%	38%
10	0.2	0.4	CH_3CN	120	10%	--
11	0.2	0.4	Dioxane	120	--	42%
12	0.2	0.4	Dioxane	120	--	60%
13	0.2	0.4	Dioxane	120	--	46%

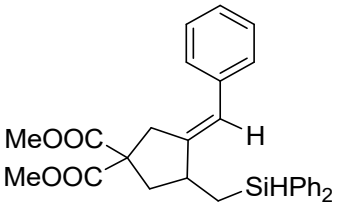
Reaction Conditions: **1a** (0.2 mmol), Ph_2SiH_2 (0.2 mmol), $Ni(cod)_2$ (0.02 mmol) in solvent (2.0 mL), 24 h, isolated yields.

3. General procedure and Characterization

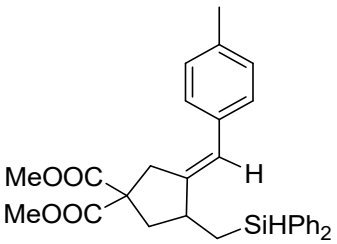
General procedure **A**: $Ni(cod)_2$ (5.6 mg, 0.02 mmol) and diphenylsilane (0.400 mmol, 2.0 equiv) in DME (2.0 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed by addition of 1, 6-enyne **1a** (0.200 mmol, 1.0 equiv). The reaction tube was then sealed and placed into an oil bath at 80 °C. After stirred for 24 h, the reaction mixture was filtered through a pad of celite. The mixture was eluted with ethyl acetate, concentrated, and purified by silica gel chromatography (PE : dioxane = 10:1) to give the indicated product **3a**.

General procedure **B**: $Ni(cod)_2$ (2.8 mg, 0.01 mmol) and IPr.HCl (4.25 mg, 0.01 mmol) and CsOAc (3.8 mg, 0.02 mmol) in CH_3CN (2.0 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed by addition of diphenylsilane (0.400 mmol, 2.0 equiv) and stirred for 30 min at room temperatureα, then **1a** (0.200 mmol, 1.0 equiv) was added. The reaction tube was then sealed and placed into an oil bath at 80 °C. After stirred for 40 h, the reaction mixture was filtered through a pad of celite. The mixture was eluted with ethyl acetate, concentrated, and purified by silica gel chromatography (PE : dioxane = 10:1) to give the indicated product **4a**.

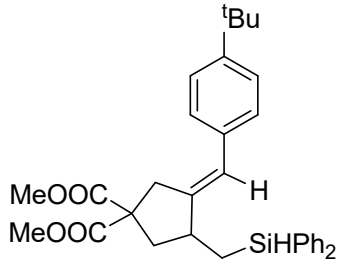
General procedure **C**：$Ni(cod)_2$ (5.6 mg, 0.02 mmol), diphenylsilane (0.400 mmol, 2.0 equiv) and H_2O (5.4mg, 0.3 mmol) in Dioxane (2.0 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed by addition of **1a** (0.200 mmol, 1.0 equiv). The reaction tube was then sealed and placed into an oil bath at 120 °C. After stirred for 24 h, the reaction mixture was filtered through a pad of celite. The mixture was eluted with ethyl acetate, concentrated, and purified by silica gel chromatography (PE : EA = 5:1) to give the indicated product **5a**.



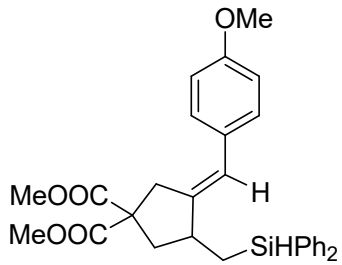
3a[2], General procedure A, yellow oil. 75.3 mg (80% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.61 – 7.57 (m, 4H), 7.40 – 7.34 (m, 6H), 7.32 – 7.29 (m, 2H), 7.25 – 7.23 (m, 2H), 7.19 – 7.16 (m, 1H), 6.32 – 6.29 (m, 1H), 5.01 – 4.99 (m, 1H), 3.69 (s, 3H), 3.61 (s, 3H), 3.34 (d, *J* = 17.6 Hz, 1H), 3.14 (dt, *J* = 17.6, 2.5 Hz, 1H), 2.82 – 2.78 (m, 1H), 2.67 – 2.61 (m, 1H), 1.87 – 1.81 (m, 1H), 1.77 – 1.71 (m, 1H), 1.30 – 1.23 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.2, 146.7, 137.9, 135.3, 135.2, 134.4, 134.0, 129.9, 128.5, 128.4, 128.3, 128.2, 126.4, 122.0, 59.1, 52.9, 52.9, 41.1, 40.9, 38.8, 17.3. HRMS (ESI, m/z): calcd for $C_{29}H_{30}NaO_4Si^+$ $[M + Na]^+$: 493.1806, found 493.1790.



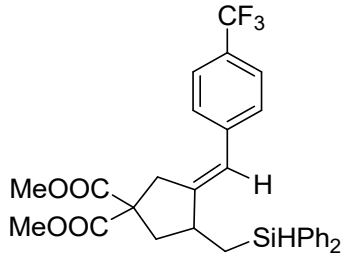
3b, General procedure **A**, yellow oil. 67.9 mg (70% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.64 – 7.61 (m, 4H), 7.43 – 7.39 (m, 6H), 7.19 – 7.14 (m, 4H), 6.31 – 6.30 (m, 1H), 5.04 – 5.03 (m, 1H), 3.72 (s, 3H), 3.64 (s, 3H), 3.37 (d, *J* = 17.5 Hz, 1H), 3.18 – 3.16 (m, 1H), 2.83 – 2.82 (m, 1H), 2.67 (dd, *J* = 12.6, 7.0 Hz, 1H), 2.36 (s, 3H), 1.86 (t, *J* = 12.0 Hz, 1H), 1.78 (dt, *J* = 14.8, 4.6 Hz, 1H), 1.32 – 1.26 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 172.3, 172.2, 145.7, 136.1, 135.3, 135.2, 135.0, 134.4, 134.0, 129.8, 129.1, 128.4, 128.2, 128.2, 121.8, 59.1, 52.9, 52.9, 41.1, 40.9, 38.8, 21.3, 17.2. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_4Si^+$ $[M + Na]^+$: 507.1962, found 507.1955.



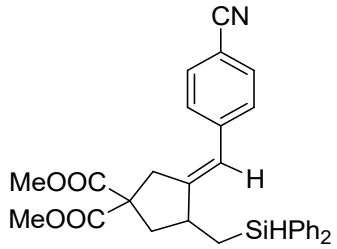
3c, General procedure **A**, yellow oil. 69.5 mg (66% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.62 – 7.58 (m, 4H), 7.41 – 7.33 (m, 8H), 7.20 (d, *J* = 8.4 Hz, 2H), 6.30 – 6.26 (m, 1H), 5.01 (dd, *J* = 5.3, 2.6 Hz, 1H), 3.71 (s, 3H), 3.62 (s, 3H), 3.36 (d, *J* = 17.6 Hz, 1H), 3.16 (dt, *J* = 17.6, 2.4 Hz, 1H), 2.85 – 2.75 (m, 1H), 2.66 – 2.61 (m, 1H), 1.83 (t, *J* = 11.6 Hz, 1H), 1.78 – 1.71 (m, 1H), 1.32 (s, 9H), 1.29 – 1.25 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.2, 149.3, 145.9, 135.3, 135.3, 135.1, 134.5, 134.1, 129.8, 129.8, 128.2, 128.2, 128.2, 125.3, 121.7, 59.2, 52.9, 52.9, 41.1, 40.9, 38.8, 34.6, 31.5, 17.2. HRMS (ESI, m/z): calcd for $C_{33}H_{38}NaO_4Si^+$ $[M + Na]^+$: 549.2432, found 549.2414.



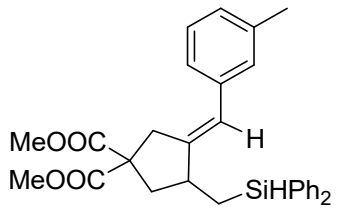
3d, General procedure **A**, yellow oil. 70.1 mg (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.59 (m, 4H), 7.42 – 7.36 (m, 6H), 7.20 (d, *J* = 8.6 Hz, 2H), 6.87 (d, *J* = 8.8 Hz, 2H), 6.26 – 6.25 (m, 1H), 5.03 – 5.01 (m, 1H), 3.81 (s, 3H), 3.71 (s, 3H), 3.63 (s, 3H), 3.34 (d, *J* = 17.4 Hz, 1H), 3.16 – 3.11 (m, 1H), 2.82 – 2.78 (m, 1H), 2.67 – 2.63 (m, 1H), 1.88 – 1.82 (m, 1H), 1.78 – 1.82 (m, 1H), 1.37 – 1.23 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.2, 158.2, 144.5, 135.3, 135.2, 134.5, 134.1, 130.7, 129.8, 129.6, 128.2, 128.2, 121.4, 113.9, 59.2, 55.4, 52.9, 52.9, 41.1, 40.8, 38.7, 17.2. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_5Si^+$ $[M + Na]^+$: 523.1911, found 523.1889.



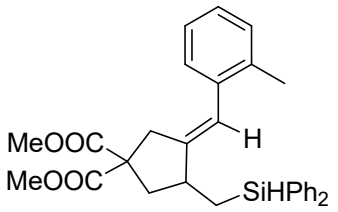
3e, General procedure **A**, colorless oil. 73.2 mg (68% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 – 7.52 (m, 6H), 7.44 – 7.35 (m, 6H), 7.33 (d, *J* = 8.2 Hz, 2H), 6.33 – 6.32 (m, 1H), 5.01 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.72 (s, 3H), 3.63 (s, 3H), 3.33 (d, *J* = 17.6 Hz, 1H), 3.16 – 3.10 (m, 1H), 2.89 – 2.80 (m, 1H), 2.70 – 2.65 (m, 1H), 1.90 – 1.84 (m, 1H), 1.78 – 1.71 (m, 1H), 1.32 – 1.25 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.1, 172.0, 149.7, 141.4, 135.3, 135.2, 134.2, 133.8, 129.9, 128.6, 128.3, 128.3, 128.2(q, *J* = 32.2 Hz), 125.3(q, *J* = 3.8 Hz), 124.4(q, *J* = 271.6 Hz), 121.0, 59.0, 53.0, 53.0, 41.2, 40.9, 38.9, 17.2. ^{19}F NMR (376 MHz, $CDCl_3$) δ -62.37 (s, 3F). HRMS (ESI, m/z): calcd for $C_{30}H_{29}F_3NaO_4Si^+$ $[M + Na]^+$: 561.1679, found 561.1655.



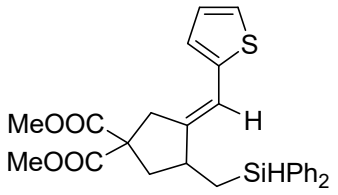
3f, General procedure **A**, colorless oil. 51.5 mg (52% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.61 – 7.57 (m, 6H), 7.40 – 7.35 (m, 6H), 7.30 (d, *J* = 8.4 Hz, 2H), 6.32 – 6.27 (m, 1H), 5.00 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.72 (s, 3H), 3.63 (s, 3H), 3.31 (d, *J* = 17.6 Hz, 1H), 3.12 (dt, *J* = 17.6, 2.6 Hz, 1H), 2.89 – 2.78 (m, 1H), 2.70 – 2.65 (m, 1H), 1.88 (dd, *J* = 12.6, 11.4 Hz, 1H), 1.79 – 1.66 (m, 1H), 1.35 – 1.22 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.9, 171.8, 151.2, 142.4, 135.3, 135.2, 134.1, 133.7, 132.2, 130.0, 128.9, 128.3, 128.3, 120.9, 119.2, 109.7, 59.1, 53.5, 53.0, 53.0, 41.4, 40.8, 39.0, 17.2. HRMS (ESI, m/z): calcd for $C_{30}H_{29}NNaO_4Si^+$ $[M + Na]^+$: 518.1758, found 518.1746.



3g, General procedure **A**, colorless oil 71.7 mg (74% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.58 (m, 4H), 7.42 – 7.35 (m, 6H), 7.21 (t, *J* = 7.6 Hz, 1H), 7.08 – 7.00 (m, 3H), 6.30 – 6.25 (m, 1H), 5.02 – 5.00 (m, 1H), 3.71 (s, 3H), 3.63 (s, 3H), 3.35 (d, *J* = 17.6 Hz, 1H), 3.18 – 3.15 (m, 1H), 2.85 – 2.75 (m, 1H), 2.67 – 2.62 (m, 1H), 2.35 (s, 3H), 1.87 – 1.81 (m, 1H), 1.77 – 1.71 (m, 1H), 1.30 – 1.23 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.2, 146.5, 137.9, 137.9, 135.3, 135.3, 134.4, 134.1, 129.9, 129.3, 128.3, 128.3, 128.2, 127.2, 125.6, 122.1, 59.2, 52.9, 52.9, 41.1, 41.0, 38.8, 21.6, 17.3. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_4Si^+$ [M + Na]$^+$: 507.1962, found 507.1944.

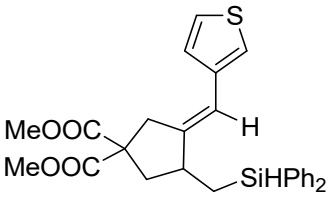


3h, General procedure **A**, 120 °C, colorless oil. 67.9 mg (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.69 – 7.55 (m, 4H), 7.40 – 7.37 (m, 6H), 7.16 – 7.13 (m, 4H), 7.38 – 7.34 (m, 1H), 5.03 – 5.01 (m, 1H), 3.67 (s, 3H), 3.62 (s, 3H), 3.15 (d, *J* = 17.4 Hz, 1H), 3.03 – 2.91 (m, 1H), 2.80 (s, 1H), 2.66 – 2.61 (m, 1H), 2.23 (s, 3H), 1.91 – 1.85 (m, 1H), 1.78 – 1.72 (m, 1H), 1.35 – 1.28 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.3, 147.0, 137.1, 136.3, 135.3, 135.3, 134.4, 134.1, 129.9, 129.9, 128.6, 128.3, 128.3, 126.8, 125.7, 120.5, 58.8, 52.9, 41.4, 40.2, 38.2, 20.1, 17.5. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_4Si^+$ [M + Na]$^+$: 507.1962, found 507.1955.

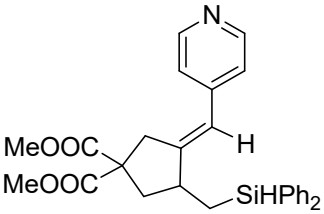


3i, General procedure **A**, 120 °C, yellow oil. 68.6 mg (72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.58 (m, 4H), 7.41 – 7.35 (m, 6H), 7.24 (d, *J* = 5.0 Hz, 1H), 7.02 – 7.00 (m, 1H), 6.90 (d, *J* = 3.4 Hz, 1H), 6.53 – 6.48 (m, 1H), 5.00 (dd, *J* = 5.4, 2.6 Hz, 1H), 3.73 (s, 3H), 3.64 (s, 3H), 3.35 (d, *J* = 17.6 Hz, 1H), 3.16 – 3.10 (m, 1H), 2.83 – 2.77 (m, 1H), 2.69 – 2.64 (m, 1H), 1.87 (t, *J* = 12.2 Hz, 1H), 1.76 – 1.70 (m, 1H), 1.27 – 1.19 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.2, 172.1, 145.3, 141.7, 135.3,

135.2, 134.3, 133.9, 129.9, 128.3, 128.2, 127.2, 125.9, 124.7, 115.3, 59.1, 53.0, 52.9, 41.6, 40.7, 39.3, 16.9. HRMS (ESI, m/z): calcd for $C_{27}H_{28}NaO_4SSi^+$ [M + H]$^+$: 499.1370, found 499.1347.

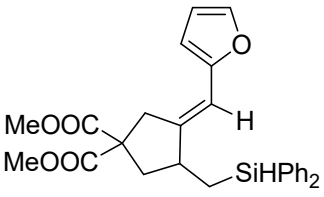


3j, General procedure **A**, yellow oil. 66.7 mg (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 – 7.57 (m, 4H), 7.40 – 7.34 (m, 6H), 7.26 – 7.24 (m, 1H), 7.07 – 7.06 (m, 2H), 6.34 – 6.28 (m, 1H), 4.99 (dd, *J* = 5.4, 2.6 Hz, 1H), 3.71 (s, 3H), 3.62 (s, 3H), 3.32 (d, *J* = 17.6 Hz, 1H), 3.13 – 3.08 (m, 1H), 2.80 – 2.74 (m, 1H), 2.67 – 2.62 (m, 1H), 1.84 (t, *J* = 12.0 Hz, 1H), 1.75 – 1.69 (m, 1H), 1.25 – 1.18 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.2, 172.1, 145.7, 139.2, 135.3, 135.2, 134.4, 134.0, 129.9, 128.4, 128.2, 128.2, 125.1, 121.9, 116.1, 59.0, 53.0, 52.9, 41.3, 40.6, 39.2, 16.9. HRMS (ESI, m/z): calcd for $C_{27}H_{28}NaO_4SSi^+$ [M + Na]$^+$: 499.1370, found 199.1344.

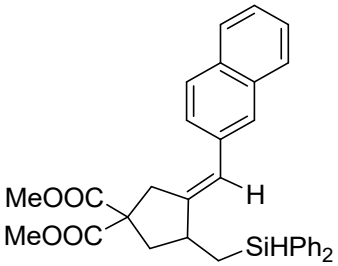


3k, General procedure **A**, 120 °C, colorless oil. 61.3 mg (65% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.52 (d, *J* = 6.0 Hz, 2H), 7.61 – 7.57 (m, 4H) 7.43 – 7.34 (m, 6H), 7.11 (d, *J* = 6.0 Hz, 1H), 6.25 – 6.2 (m, 1H), 5.00 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.72 (s, 3H), 3.63 (s, 3H), 3.35 (d, *J* = 17.8 Hz, 1H), 3.15 (dt, *J* = 17.8, 2.4 Hz, 1H), 2.91 – 2.74 (m, 1H), 2.73 – 2.64 (m, 1H), 1.88 (dd, *J* = 12.6, 11.4 Hz, 1H), 1.78 – 1.68 (m, 1H), 1.33 – 1.22 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 171.7, 153.2, 149.2, 145.7, 135.2, 135.1, 134.0, 133.6, 129.9, 128.3, 128.2, 123.0, 119.9, 59.0, 53.0, 53.0, 41.4, 40.7, 39.1, 17.0.

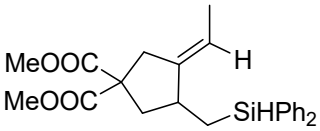
HRMS (ESI, m/z): calcd for $C_{28}H_{30}NO_4Si^+$ [M + H]$^+$: 472.1939, found 472.1923.



3l, General procedure **A**, 120 °C, brown oil. 65.4 mg (71% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 – 7.54 (m, 4H), 7.43 – 7.34 (m, 7H), 6.40 – 6.38 (m, 1H), 6.19 – 6.16 (m, 1H), 5.00 (dd, *J* = 5.4, 2.6 Hz, 1H), 3.73 (s, 3H), 3.64 (s, 3H), 3.41 (d, *J* = 19.4 Hz, 1H), 3.21 – 3.15 (m, 1H), 2.82 – 2.72 (m, 1H), 2.68 – 2.63 (m, 1H), 1.84 (t, *J* = 12.2 Hz, 1H), 1.74 – 1.68 (m, 1H), 1.23 – 1.16 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.2, 153.5, 145.6, 141.4, 135.3, 135.2, 134.2, 133.9, 129.9, 128.2, 128.2, 111.4, 110.7, 107.8, 58.9, 53.0, 52.9, 41.4, 40.5, 39.4, 16.7. HRMS (ESI, m/z): calcd for $C_{27}H_{28}NaO_5Si^+$ [M + Na]$^+$: 483.1598, found 483.1596.

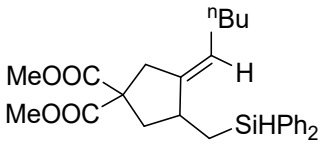


3m, General procedure **A**, yellow oil. 68.7 mg (66% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.81 (dd, *J* = 12.8, 7.2 Hz, 3H), 7.68 – 7.62 (m, 5H), 7.49 – 7.37 (m, 9H), 6.51 – 6.44 (m, 1H), 5.05 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.73 (s, 3H), 3.64 (s, 3H), 3.48 (d, *J* = 18.2 Hz, 1H), 3.27 (dt, *J* = 17.6, 2.4 Hz, 1H), 2.96 – 2.81 (m, 1H), 2.79 – 2.65 (m, 1H), 1.91 (dd, *J* = 12.6, 11.4 Hz, 1H), 1.86 – 1.76 (m, 1H), 1.36-1.31 (m, 1H).. ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.2, 147.3, 135.4, 135.3, 135.2, 134.4, 134.0, 133.6, 132.1, 129.9, 128.3, 128.2, 128.1, 127.8, 127.7, 127.1, 126.2, 125.8, 122.1, 59.2, 53.0, 53.0, 41.1, 41.0, 38.9, 17.3. HRMS (ESI, m/z): calcd for $C_{33}H_{32}NaO_4Si^+$ [M + Na]$^+$: 543.1962, found 543.1943.

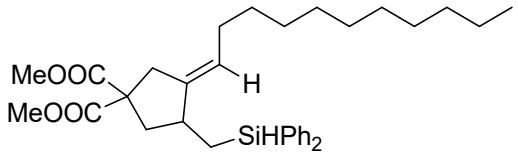


3n, General procedure **A**, colorless oil. 63.7 mg (78% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.58 – 7.55 (m, 4H), 7.42 – 7.34 (m, 6H), 5.33 – 5.28 (m, 1H), 4.95 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.71 (s, 3H), 3.63 (s, 3H), 2.99 (d, *J* = 17.6 Hz, 1H), 2.81 (dd, *J* = 17.2, 1.6 Hz, 1H), 2.61 – 2.57 (m, 2H), 1.82 – 1.75 (m, 1H), 1.63 (dd, *J* = 5.2, 3.8 Hz, 1H), 1.59 (dd, *J* = 6.8, 1.8 Hz, 1H), 1.14 – 1.07 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.4, 144.4, 135.8, 135.3, 135.2, 134.6, 134.3, 129.7, 128.1, 128.1, 115.7, 58.4, 52.8,

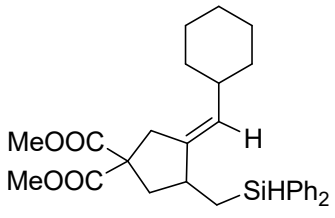
52.8, 42.0, 39.0, 37.0, 16.8, 14.5. HRMS (ESI, m/z): calcd for $C_{24}H_{28}NaO_4Si^+$ [M + Na]$^+$: 431.1649, found 431.1635.



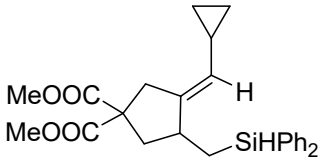
3o, General procedure **A**, colorless oil. 73.9 mg (82% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.56 (m, 4H), 7.40 – 7.34 (m, 6H), 5.25 – 5.21 (m, 1H), 4.96 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.70 (s, 3H), 3.63 (s, 3H), 2.99 (d, *J* = 17.0 Hz, 1H), 2.82 (d, *J* = 17.0 Hz, 1H), 2.60 – 2.55 (m, 1H), 1.98 – 1.96 (m, 1H), 1.81 – 1.74 (m, 1H), 1.64 – 1.58 (m, 1H), 1.33 – 1.27 (m, 4H), 1.14 – 1.07 (m, 1H), δ 0.89 (t, *J* = 6.8 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.4, 143.5, 135.3, 135.2, 134.6, 134.3, 129.7, 128.2, 128.2, 121.8, 58.5, 52.8, 52.8, 41.9, 39.0, 37.1, 31.8, 29.0, 22.5, 17.0, 14.1. HRMS (ESI, m/z): calcd for $C_{27}H_{34}NaO_4Si^+$ [M + Na]$^+$: 473.2119, found 473.2102.



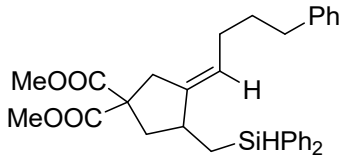
3p, General procedure **A**, colorless oil. 79.2 mg (74% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 – 7.56 (m, 4H), 7.40 – 7.34 (m, 6H), 5.25 – 5.21 (m, 1H), 4.96 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.71 (s, 3H), 3.63 (s, 3H), 2.99 (d, *J* = 17.0 Hz, 1H), 2.82 (d, *J* = 17.0 Hz, 1H), 2.61 – 2.56 (m, 2H), 1.98 – 1.94 (m, 1H), 1.78 (t, *J* = 14.2 Hz, 1H), 1.64 – 1.58 (m, 1H), 1.39 – 1.38 (m, 18H), 1.14 – 1.08 (m, 1H), 0.89 (t, *J* = 6.8 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.4, 143.5, 135.3, 135.2, 134.7, 134.3, 129.7, 128.2, 128.1, 121.8, 58.5, 52.8, 52.8, 41.9, 39.0, 37.1, 32.1, 29.8, 29.7, 29.6, 29.5, 29.5, 29.4, 22.8, 16.9, 14.2. HRMS (ESI, m/z): calcd for $C_{33}H_{46}NaO_4Si^+$ [M + Na]$^+$: 557.3058, found 557.3064.



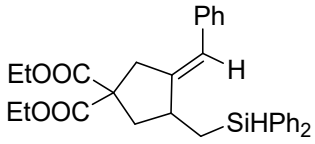
3q, General procedure **A**, yellow oil. 59.1 mg (62% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 – 7.57 (m, 4H), 7.40 – 7.34 (m, 6H), 5.08 (dd, *J* = 9.0, 2.0 Hz, 1H), 4.96 (dd, *J* = 5.4, 2.5 Hz, 1H), 3.71 (s, 3H), 3.64 (s, 3H), 3.01 (d, *J* = 17.0 Hz, 1H), 2.88-2.81 (m, 1H), 2.61 – 2.54 (m, 2H), 2.09 – 1.97 (m, 1H), 1.77 – 1.57 (m, 7H), 1.31 – 0.98 (m, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.4, 141.8, 135.3, 135.2, 134.7, 134.3, 129.7, 128.1, 127.6, 58.5, 52.8, 52.8, 41.8, 38.9, 38.5, 36.9, 33.1, 33.1, 26.3, 26.2, 26.2, 17.0. HRMS (ESI, m/z): calcd for $C_{29}H_{36}NaO_4Si^+$ $[M + Na]^+$: 499.2275, found 499.2250



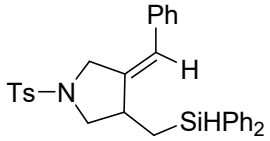
3r, General procedure **A**, colorless oil. 43.5 mg (50% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.57 – 7.54 (m, 4H), 7.39– 7.33 (m, 6H), 4.93 (dd, *J* = 5.4, 2.6 Hz, 1H), 4.63 – 4.61 (m, 1H), 3.71 (s, 3H), 3.63 (s, 3H), 3.13 (dd, *J* = 17.2, 1.8 Hz, 1H), 3.00 – 2.94 (m, 1H), 2.60 – 2.54 (m, 1H), 1.77 (t, *J* = 14.2 Hz, 1H), 1.34 – 1.28 (m, 1H), 1.11 – 1.04 (m, 1H), 0.94 – 0.90 (m, 1H), 0.70 (dd, *J* = 8.0, 2.1 Hz, 2H), 0.28 – 0.25 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.4, 142.3, 135.3, 135.2, 134.6, 134.2, 129.8, 128.2, 125.3, 58.5, 52.9, 52.8, 42.0, 39.1, 37.3, 16.6, 11.3, 6.9, 6.8. HRMS (ESI, m/z): calcd for $C_{26}H_{30}NaO_4Si^+$ $[M + Na]^+$: 3457.1806, found 457.1794.



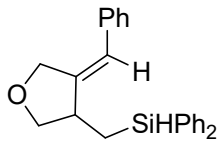
3s, General procedure **A**, colorless oil. 69.7 mg (68% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.49 (m, 4H), 7.40 – 7.32 (m, 6H), 7.24 (dd, *J* = 14.0, 6.7 Hz, 2H), 7.16 – 7.14 (m, 3H), 5.27– 5.21 (m, 1H), 4.95 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.69 (s, 3H), 3.62 (s, 3H), 2.96 (d, *J* = 17.0 Hz, 1H), 2.78 (d, *J* = 17.0 Hz, 1H), 2.60 – 2.54 (m, 4H), 2.03 – 1.98 (m, 2H),.1.78 (t, *J* = 14.2 Hz, 1H), 1.66 – 1.54 (m, 3H)， 1.10-1.06 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 172.3, 144.1, 142.6, 135.3, 135.2, 134.6, 134.2, 129.7, 128.5, 128.4, 128.2, 125.8, 121.3, 58.4, 52.8, 52.8, 41.9, 39.0, 37.1, 35.6, 31.2, 28.9, 16.9. HRMS (ESI, m/z): calcd for $C_{32}H_{36}NaO_4Si^+$ $[M + Na]^+$: 535.2275, found 535.2242.



3t, General procedure **A**, yellow oil. 69.8 mg (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.58 (m, 4H), 7.39 – 7.36 (m, 6H), 7.33 – 7.29 (m, 2H), 7.26 – 7.23 (m, 2H), 7.19 – 7.15 (m, 1H), 6.31 (d, *J* = 2.2 Hz, 1H), 5.02 – 5.00 (m, 1H), 4.18 – 4.13 (m, 2H), 4.11 – 4.05 (m, 2H), 3.33 (d, *J* = 17.4 Hz, 1H), 3.16 – 3.11 (m, 1H), 2.84 – 2.82 (m, 1H), 2.63 (dd, *J* = 12.6, 7.2 Hz, 1H), 1.87 – 1.81 (m, 1H), 1.79 – 1.73 (m, 1H), 1.31 – 1.26 (m, 1H), 1.21 (t, *J* = 7.0 Hz, 3H), 1.13 (t, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 171.7, 147.0, 138.0 135.3, 135.2, 134.5, 134.1, 129.8, 129.8, 128.5, 128.4, 128.2, 128.2, 126.3, 121.9, 61.7, 61.6, 59.2, 41.0, 40.9, 38.6, 17.4, 14.1, 14.0. HRMS (ESI, m/z): calcd for $C_{31}H_{34}NaO_4Si^+$ $[M + H]^+$: 521.2119, found 521.2105.

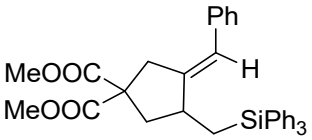


3u [2], General procedure **A**, 120 °C, yellow oil. 73.4 mg (72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (d, *J* = 8.2 Hz, 2H), 7.55 – 7.52 (m, 4H), 7.44 – 7.37 (m, 6H), 7.35 – 7.30 (m, 2H), 7.25 – 7.22 (m, 3H), 7.06 (d, *J* = 7.4 Hz, 1H), 6.26 – 6.25 (m, 1H), 4.92 (dd, *J* = 4.6, 3.2 Hz, 1H), 4.18 – 4.14 (m, 1H), 4.00 – 3.96 (m, 1H), 3.50 – 3.46 (m, 1H), 2.91 – 2.84 (m, 1H), 2.80 – 2.76 (m, 1H), 2.38 (s, 3H), 1.59 (dt, *J* = 15.0, 4.8 Hz, 1H), 1.23 – 1.16 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.7, 142.3, 136.5, 135.2, 133.7, 133.4, 133.0, 130.1, 129.8, 128.7, 128.4, 128.3, 128.3, 127.8, 127.2, 122.6, 53.8, 50.5, 41.1, 21.6, 16.0. HRMS (ESI, m/z): calcd for $C_{31}H_{31}NNaO_2SSi^+$ $[M + Na]^+$: 532.1737, found 532.1723.

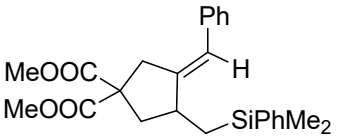


3v[2], General procedure **A**, yellow oil. 39.9 mg (56% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.60 (t, *J* = 7.8 Hz, 4H), 7.41 – 7.36 (m, 6H), 7.32 (t, *J* = 7.6 Hz, 2H), 7.20 (t, *J* = 7.4, 1H), 7.09 (d, *J* = 7.6 Hz, 2H), 6.34 – 6.34 (m, 1H), 4.98 – 4.96 (m, 1H), 4.64 – 4.56 (m, 2H), 3.97 – 3.94 (m, 1H), 3.41 (t, *J* = 8.0 Hz, 1H), 2.98 (s, 1H), 1.70 (dt, *J* = 14.8, 4.6 Hz, 1H), 1.37 – 1.32 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$) δ

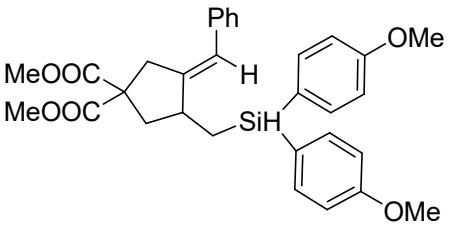
147.0, 137.4, 135.2, 135.2, 134.1, 133.9, 130.0, 130.0, 128.6, 128.3, 128.3, 128.1, 126.7, 120.5, 73.9, 70.1, 41.9, 15.6. HRMS (ESI, m/z): calcd for $C_{24}H_{24}NaOSi^+$ $[M + H]^+$: 379.1489, found 379.1487.



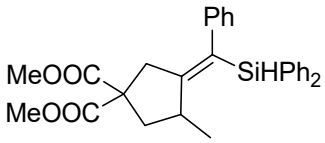
3aa, General procedure **A**, white solid, mp: 92~94 °C. 102.7 mg (94% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.59 – 7.57 (m, 6H), 7.43 – 7.37 (m, 9H), 7.32 – 7.28 (m, 2H), 7.24 (d, *J* = 7.4 Hz, 2H), 7.17 (t, *J* = 7.2 Hz, 1H), 6.31 – 6.30 (m, 1H), 3.63 (s, 3H), 3.59 (s, 3H), 3.32 (d, *J* = 17.6 Hz, 1H), 3.09 (dt, *J* = 17.6, 2.4 Hz, 1H), 2.85 – 2.83 (m, 1H), 2.33 – 2.28 (m, 1H), 2.02 (dd, *J* = 15.0, 3.4 Hz, 1H), 1.67 (t, *J* = 12.6 Hz, 1H), 1.53 – 1.46 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.1, 147.1, 138.0, 135.9, 135.1, 129.7, 128.5, 128.4, 128.1, 126.4, 121.7, 59.0, 52.8, 41.7, 40.7, 38.7, 17.8. HRMS (ESI, m/z): calcd for $C_{35}H_{34}NaO_4Si^+$ $[M + Na]^+$: 569.2119, found 569.2095.



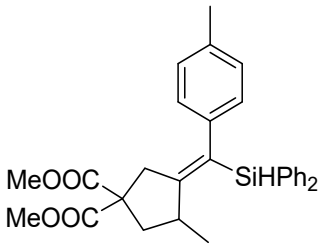
3ab, General procedure **A**, 120 °C, yellow oil. 76.1 mg (90% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.58 – 7.55 (m, 2H), 7.39 – 7.37 (m, 3H), 7.33 – 7.27 (m, 4H), 7.19 (t, *J* = 7.2 Hz, 1H), 6.27 – 6.26 (m, 1H), 3.72 (s, 3H), 3.68 (s, 3H), 3.35 (d, *J* = 17.6 Hz, 1H), 3.18 (dt, *J* = 17.6, 2.4 Hz, 1H), 2.74 – 2.70 (m, 1H), 2.62 – 2.57 (m, 1H), 1.70 (t, *J* = 11.8 Hz, 1H), 1.41 (dd, *J* = 14.6, 3.6 Hz, 1H), 0.88 (dd, *J* = 14.6, 10.8 Hz, 1H), 0.40 (s, 3H), 0.39 (s, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.3, 147.3, 139.3, 138.1, 133.7, 129.1, 128.5, 128.4, 128.0, 126.3, 121.6, 59.2, 52.9, 41.4, 41.0, 38.6, 20.5, -1.70, -2.16. HRMS (ESI, m/z): calcd for $C_{25}H_{30}NaO_4Si^+$ $[M + Na]^+$: 445.1806, found 445.1795.



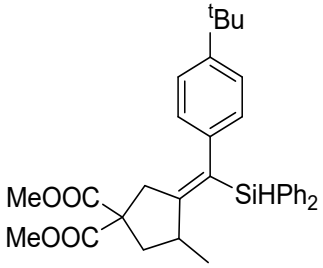
3ac, General procedure **A**, 120 °C, yellow oil. 87.0 mg (82% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (dd, *J* = 8.4, 6.4 Hz, 4H), 7.32 (t, *J* = 7.6 Hz, 2H), 7.26 (t, *J* = 3.6 Hz, 3H), 7.19 (t, *J* = 7.2 Hz, 1H), 6.95 – 6.91 (m, 4H), 6.30 (d, *J* = 2.2 Hz, 1H), 4.98 (dd, *J* = 5.2, 2.6 Hz, 1H), 3.82 (d, *J* = 0.8 Hz, 6H), 3.71 (s, 3H), 3.64 (s, 3H), 3.35 (d, *J* = 18.2 Hz, 1H), 3.16 (dt, *J* = 17.6, 2.4 Hz, 1H), 2.86 – 2.76 (m, 1H), 2.65 (dd, *J* = 12.6, 7.2 Hz, 1H), 1.84 (t, *J* = 12.2 Hz, 1H), 1.69 (dt, *J* = 16.6, 4.6 Hz, 1H), 1.27 – 1.18 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.2, 161.1, 161.1, 146.9, 138.0, 136.8, 136.7, 128.5, 128.4, 126.4, 125.5, 125.2, 121.9, 114.1, 114.0, 59.2, 55.2, 52.9, 52.9, 41.1, 41.0, 38.8, 17.8. HRMS (ESI, m/z): calcd for $C_{31}H_{34}NaO_6Si^+$ $[M + Na]^+$: 553.2017, found 553.2016.



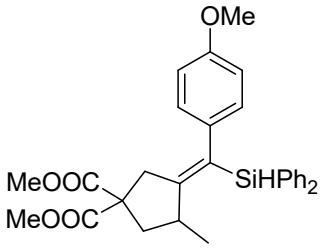
4a, General procedure **B**, colorless oil. 79.1 mg (84% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.38 (m, 4H), 7.37 – 7.24 (m, 6H), 7.14 – 7.05 (m, 3H), 6.80 – 6.78 (m, 2H), 5.41 (s, 1H), 3.69 (s, 3H), 3.66 (s, 3H), 3.22 – 3.14 (m, 1H), 3.02 (dd, *J* = 17.0, 1.2 Hz, 1H), 2.77 – 2.70 (m, 2H), 2.03 (dd, *J* = 13.6, 4.6 Hz, 1H), 1.14 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.3, 161.7, 143.1, 136.0, 136.0, 133.7, 133.2, 130.6, 129.7, 129.7, 128.7, 128.1, 128.0, 127.9, 125.7, 58.8, 52.8, 52.8, 41.4, 40.1, 37.5, 23.0. HRMS (ESI, m/z): calcd for $C_{29}H_{30}NaO_4Si^+$ $[M + Na]^+$: 493.1806, found 493.1789.



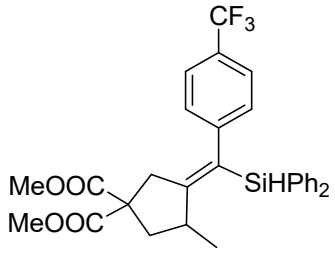
4b, General procedure **B**, white solid, mp: 67~69 °C. 77.5 mg (80% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.46 – 7.42 (m, 4H), 7.39 – 7.24 (m, 6H), 6.94 (d, *J* = 8.0 Hz, 2H), 6.69 (d, *J* = 8.0 Hz, 2H), 5.41 (s, 1H), 3.70 (s, 3H), 3.67 (s, 3H), 3.23 – 3.14 (m, 1H), 3.06 – 6.01 (m, 1H), 2.78 – 2.72 (m, 2H), 2.26 (s, 3H), 2.03 (dd, *J* = 13.6, 4.6 Hz, 1H), 1.14 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.4, 161.7, 140.1, 136.0, 136.0, 135.2, 133.9, 133.3, 130.4, 129.6, 129.6, 128.8, 128.6, 127.9, 127.9, 58.8, 52.8, 52.7, 41.4, 40.1, 37.5, 23.0, 21.16. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_4Si^+$ $[M + Na]^+$: 507.1962, found 507.1956.



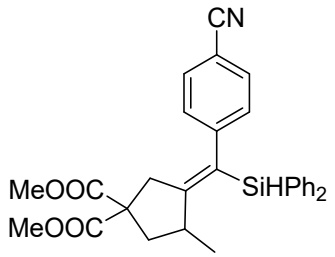
4c, General procedure **B**, yellow solid, mp: 73~75 °C. 81.1 mg (77% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.32 (m, 6H), 7.31 – 7.27 (m, 2H), 7.23 (d, *J* = 7.0 Hz, 2H), 7.11 (d, *J* = 8.4 Hz, 2H), 6.71 – 6.69 (m, 2H), 5.38 (s, 1H), 3.69 (s, 3H), 3.67 (s, 3H), 3.16 – 3.12 (m, 1H), 3.05 – 3.00 (m, 1H), 2.81 – 2.70 (m, 2H), 2.01 (dd, *J* = 13.4, 4.6 Hz, 1H), 1.24 (s, 9H), 1.11 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.4, 161.4, 148.5, 140.0, 136.1, 136.0, 134.5, 134.0, 133.5, 130.3, 129.6, 129.6, 128.26, 127.9, 127.8, 125.0, 58.9, 52.9, 52.8, 41.5, 40.1, 37.6, 34.4, 31.5, 23.0. HRMS (ESI, m/z): calcd for $C_{33}H_{38}NaO_4Si^+$ $[M + Na]^+$: 549.2432, found 549.2418.



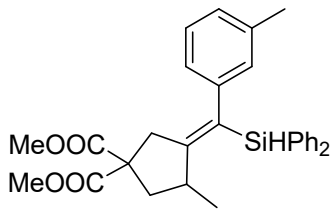
4d, General procedure **B**, white solid, mp: 68~70 °C. 86.1 mg (86% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.40 (m, 4H), 7.36 – 7.24 (m, 6H), 6.71 – 6.65 (m, 4H), 5.40 (s, 1H), 3.72 (s, 3H), 3.69 (s, 3H), 3.66 (s, 3H), 3.22 – 3.14 (m, 1H), 3.02 (dd, *J* = 17.0, 1.2 Hz, 1H), 2.76 – 2.71 (m, 1H), 2.02 (dd, *J* = 13.6, 4.4 Hz, 1H), 1.13 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.4, 162.0, 157.8, 136.0, 136.0, 135.4, 133.9, 133.4, 130.0, 129.8, 129.7, 129.6, 128.0, 127.9, 58.8, 55.3, 52.8, 52.8, 41.4, 40.1, 37.5, 23.1. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_5Si^+$ $[M + Na]^+$: 523.1911, found 523.1882.



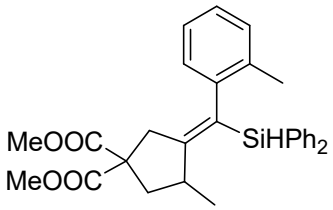
4e, General procedure **B**, colorless oil. 87.3 mg (81% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 – 7.35 (m, 8H), 7.34 – 7.26 (m, 4H), 6.89 (d, *J* = 8.0 Hz, 2H), 5.42 (s, 1H), 3.71 (s, 3H), 3.69 (s, 3H), 3.24 – 3.15 (m, 1H), 2.98 (dd, *J* = 16.8, 1.2 Hz, 1H), 2.74 (dd, *J* = 13.6, 9.0 Hz, 1H), 2.65 (d, *J* = 17.0 Hz, 1H), 2.07 (dd, *J* = 13.6, 4.6 Hz, 1H), 1.17 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.4, 172.2, 162.6, 147.1, 135.9, 135.9, 132.9, 132.5, 130.0, 129.9, 129.8, 129.0, 128.2(q, *J* = 36.4 Hz), 128.1, 128.1, 125.1(q, *J* = 3.8 Hz), 124.5(q, *J* = 272.0 Hz), 58.8, 53.0, 52.9, 41.3, 40.2, 37.6, 23.0. ^{19}F NMR (377 MHz, $CDCl_3$) δ -64.55 (s, 3F). HRMS (ESI, m/z): calcd for $C_{30}H_{29}F_3NaO_4Si^+$ [M + Na]$^+$: 561.1679, found 561.1661.



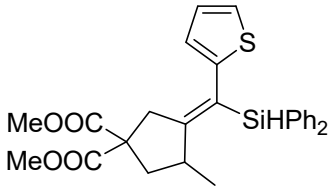
4f, General procedure **B**, white solid, mp: 86~88 °C. 59.5 mg (60% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.42 – 7.37 (m, 7H), 7.35 – 7.26 (m, 4H), 6.89 – 6.87 (m, 2H), 5.43 (s, 1H), 3.71 (s, 3H), 3.69 (s, 3H), 3.22 – 3.14 (m, 1H), 2.96 (dd, *J* = 17.0, 1.4 Hz, 1H), 2.76 – 2.70 (m, 1H), 2.63 (d, *J* = 17.0 Hz, 1H), 2.08 (dd, *J* = 13.6, 4.6 Hz, 1H), 1.17 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.1, 162.9, 148.5, 135.8, 135.8, 132.6, 132.2, 132.0, 130.1, 130.1, 129.8, 129.5, 128.2, 128.1, 119.2, 109.6, 58.7, 53.0, 52.9, 41.2, 40.2, 37.7, 22.9. HRMS (ESI, m/z): calcd for $C_{30}H_{29}NNaO_4Si^+$ [M + Na]$^+$: 518.1758, found 518.1735.



4g, General procedure **B**, colorless oil. 78.5 mg (81% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.40 (m, 4H), 7.36 – 7.24 (m, 6H), 7.01 (t, *J* = 7.6 Hz, 1H), 6.88 (d, *J* = 7.6 Hz, 1H), 6.61 (d, *J* = 7.6 Hz, 1H), 6.53 (s, 1H), 5.39 (s, 1H), 3.69 (s, 3H), 3.66 (s, 3H), 3.20 – 3.12 (m, 1H), 3.03 (dd, *J* = 17.2, 1.4 Hz, 1H), 2.77 – 2.71 (m, 2H), 2.14 (s, 3H), 2.01 (dd, *J* = 13.6, 4.4 Hz, 1H), 1.12 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.4, 161.4, 142.9, 137.9, 136.0, 136.0, 133.9, 133.3, 130.6, 129.7, 129.6, 129.6, 128.0, 127.9, 127.9, 126.4, 125.7, 58.8, 52.8, 52.8, 41.4, 40.1, 37.5, 23.0, 21.4. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_4Si^+$ $[M + Na]^+$: 507.1962, found 507.1942.

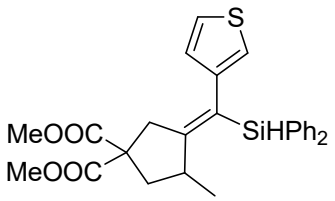


4h, General procedure **B**, 10 mmol% Ni catalysis, 80 °C, yellow oil.54.3 mg (56% yield). dr = 1: 1.7; ^{1}H NMR (400 MHz, $CDCl_3$) δ (mixture of isomers) major: 7.56 – 7.50 (m, 4H), 7.40 6.90 (m, 10H), 6.64 (d, *J* = 7.4 Hz, 1H), 5.42 (s, 1H), 3.70 (s, 3H), 3.69 (s, 3H), 3.21 – 3.15 (m, 1H), 2.87 – 2.77 (m, 2H), 2.61 (d, *J* = 16.8 Hz, 1H), 2.09 – 2.03 (m, 1H), 1.87 (s, 3H), 1.20 (d, *J* = 7.2 Hz, 3H). δ minor: 5.32 (s, 1H), 3.69 (s, 3H), 3.66 (s, 3H), 3.15 – 3.10 (m, 1H), 2.97 (dd, *J* = 17.6, 1.2 Hz, 1H), 2.72 (dd, *J* = 13.2, 8.4 Hz, 1H), 2.01 – 1.98 (m, 1H), 1.75 (s, 3H), 1.13 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ mixture of isomers, 172.7, 172.6, 172.5, 172.4, 161.7, 161.1, 142.5, 142.0, 136.1, 136.0, 135.9, 135.7, 135.0, 134.0, 133.8, 133.4, 132.7, 130.2, 130.0, 129.7, 129.7, 129.7, 129.6, 128.9, 128.1, 127.9, 127.8, 127.7, 126.3, 126.1, 125.8, 125.6, 58.6, 58.3, 52.7, 52.7, 52.6, 42.1, 41.4, 41.1, 39.8, 37.7, 37.3, 22.9, 22.6, 19.5, 19.5. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_4Si^+$ $[M + Na]^+$: 507.1962, found 507.1973.

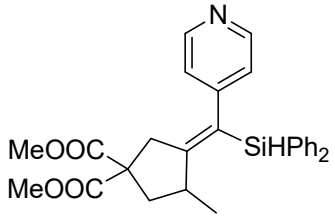


4i, General procedure **B**, white solid, mp: 110~112 °C 65.8 mg (69% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.44 (m, 4H), 7.40 – 7.28 (m, 6H), 7.06 (dd, *J* = 5.2, 1.0 Hz, 1H), 6.81 – 6.79 (m, 1H), 6.38 (dd, *J* = 3.4, 1.0 Hz, 1H), 5.45 (s, 1H), 3.73 (s, 3H), 3.70 (s, 3H), 3.29 – 3.18 (m, 2H), 3.05 (d, *J* = 17.2 Hz,

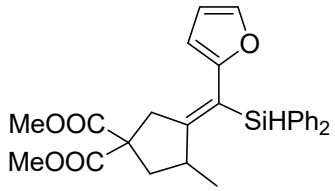
1H), 2.77 (dd, *J* = 13.4, 8.2 Hz, 1H), 2.04 (dd, *J* = 13.6, 4.8 Hz, 1H), 1.16 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 172.2, 165.7, 144.0, 136.0, 135.9, 133.4, 132.8, 129.9, 128.0, 128.0, 126.8, 125.5, 124.4, 123.2, 58.9, 52.9, 52.9, 41.3, 40.7, 37.9, 23.1. HRMS (ESI, m/z): calcd for $C_{27}H_{28}NaO_4SSi^+$ $[M + Na]^+$: 499.1370, found 499.1356.



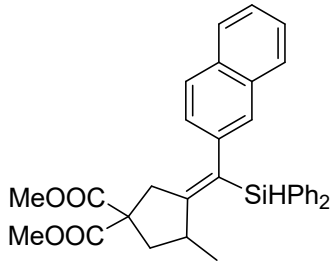
4j, General procedure **B**, white solid, mp: 88~90 °C. 74.3 mg (78% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 – 7.41 (m, 4H), 7.39 – 7.26 (m, 6H), 7.10 (dd, *J* = 5.0, 3.0 Hz, 1H), 6.58 – 6.54 (m, 2H), 5.43 (s, 1H), 3.73 (s, 3H), 3.69 (s, 3H), 3.28 – 3.19 (m, 1H), 3.10 (dd, *J* = 17.0, 1.6 Hz, 1H), 2.88 (d, *J* = 17.0 Hz, 1H), 2.79 – 2.74 (m, 1H), 2.07 – 2.03 (m, 1H), 1.17 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.3, 162.9, 142.6, 135.9, 135.9, 133.8, 133.2, 129.8, 128.9, 128.0, 128.0, 125.3, 124.7, 121.1, 58.9, 52.9, 52.8, 41.4, 40.4, 37.6, 23.2. HRMS (ESI, m/z): calcd for $C_{27}H_{28}NaO_4SSi^+$ $[M + Na]^+$: 499.1370, found 499.1334.



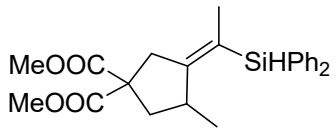
4k, General procedure **B**, yellow oil. 54.7 mg (58% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ8.42 – 8.27 (m, 2H), 7.44 – 7.37 (m, 6H), 7.36 – 7.28 (m, 4H), 6.85 – 6.62 (m, 2H), 5.42 (s, 1H), 3.71 (s, 3H), 3.69 (s, 3H), 3.24 – 3.13 (m, 1H), 2.99 (d, *J* = 17.1 Hz, 1H), 2.73 (dd, *J* = 14.0, 8.0 Hz, 1H), 2.66 (d, *J* = 17.0 Hz, 1H), 2.07 (dd, *J* = 13.6, 4.6 Hz, 1H), 1.16 (d, *J* = 7.1 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 171.8, 171.7, 153.2, 149.2, 145.7, 135.2, 135.1, 134.0, 133.6, 129.9, 128.3, 128.2, 123.0, 119.9, 59.0, 53.0, 53.0, 41.4, 40.7, 39.1, 17.0. HRMS (ESI, m/z): calcd for $C_{28}H_{30}NO_4Si^+$ $[M + H]^+$: 472.1939, found 472.1906.



4l, General procedure **B**, 10 mmol% Ni catalysis 80 °C, yellow oil. 68.2 mg (74% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.56 – 7.50 (m, 4H), 7.39 – 7.29 (m, 6H), 7.21 (d, *J* = 1.4 Hz, 1H), 6.25 (dd, *J* = 3.4, 1.8 Hz, 1H), 5.94 (d, *J* = 3.2 Hz, 1H), 5.46 (s, 1H), 3.76 (s, 3H), 3.70 (s, 3H), 3.50 (d, *J* = 18.0 Hz, 1H), 3.37 – 3.27 (m, 1H), 3.21 (d, *J* = 18.0 Hz, 1H), 2.67 (dd, *J* = 13.4, 8.0 Hz, 1H), 2.12 (dd, *J* = 13.4, 3.6 Hz, 1H), 1.10 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 163.3, 155.1, 140.8, 135.8, 135.8, 134.5, 134.0, 133.3, 129.7, 129.7, 128.0, 118.2, 118.1, 111.0, 108.8, 59.3, 53.0, 53.0, 41.7, 40.9, 39.0, 23.0. HRMS (ESI, m/z): calcd for $C_{27}H_{28}NaO_5Si^+$ $[M + Na]^+$: 483.1598, found 483.1580.

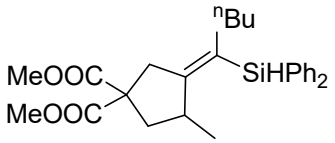


4m, General procedure **B**, yellow oil. 77.1 mg (74% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.73 – 7.71 (m, 1H), 7.62 – 7.55 (m, 2H), 7.46 – 7.43 (m, 4H), 7.38 – 7.19 (m, 9H), 6.97 – 6.95 (m, 1H), 5.48 (s, 1H), 3.67 (s, 3H), 3.64 (s, 3H), 3.29 – 3.19 (m, 1H), 3.06 (d, *J* = 17.0 Hz, 1H), 2.80 – 2.68 (m, 2H), 2.07 – 2.03 (m, 2H), 1.18 (d, *J* = 4.8 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.3, 162.3, 140.7, 136.0, 133.7, 133.5, 133.1, 131.8, 130.6, 129.8, 129.7, 128.0, 127.9, 127.8, 127.8, 127.6, 127.1, 125.8, 125.3, 58.8, 52.8, 52.8, 41.4, 40.3, 37.6, 23.1. HRMS (ESI, m/z): calcd for $C_{33}H_{32}NaO_4Si^+$ $[M + Na]^+$: 543.1962, found 543.1947.

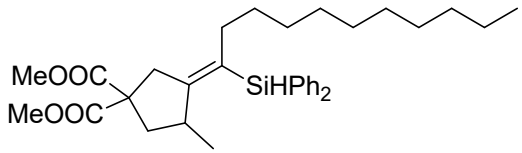


4n, General procedure **B**, 10 mmol% Ni catalysis 80 °C, colorless oil. 65.4 mg (80% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.54 (m, 2H), 7.51 – 7.49 (m, 2H), 7.42 – 7.33 (m, 6H), 5.29 (s, 1H), 3.76 (s, 3H), 3.73 (s, 1H), 3.21 (d, *J* = 17.4 Hz, 1H), 3.13 – 3.00 (m, 2H), 2.63 (dd, *J* = 13.4, 8.2 Hz, 1H), 2.10

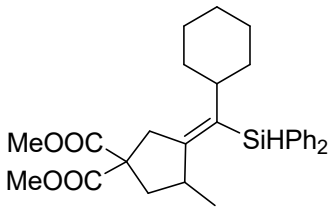
(dd, J = 13.4, 3.8 Hz, 1H), 1.70 (s, 3H), 1.01 (d, J = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.0, 172.7, 160.2, 135.9, 135.8, 133.8, 129.7, 129.7, 128.1, 128.1, 120.7, 58.9, 53.0, 53.0, 41.7, 39.0, 38.0, 23.0, 19.0. HRMS (ESI, m/z): calcd for $C_{24}H_{28}NaO_4Si^+$ $[M + Na]^+$: 431.1649, found 431.1638.



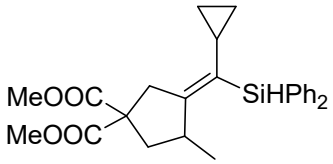
4o, General procedure **B**, 10 mmol% Ni catalysis 80 °C, colorless oil. 64.9 mg (72% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.51 (m, 4H), 7.42 – 7.33 (m, 6H), 5.26 (s, 1H), 3.76 (s, 3H), 3.74 (s, 3H), 3.17 – 3.08 (m, 2H), 2.97 – 2.89 (m, 1H), 2.61 (dd, J = 13.4, 8.0 Hz, 1H), 2.10 – 2.04 (m, 2H), 1.98 (dd, J = 13.4, 4.0 Hz, 1H), 1.11 – 1.00 (m, 4H), 0.96 (d, J = 7.1 Hz, 3H), 0.68 (t, J = 6.9 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.9, 172.6, 159.8, 136.0, 135.9, 134.1, 134.0, 129.62, 128.0, 128.0, 126.4, 58.9, 52.9, 52.9, 41.3, 38.2, 37.9, 33.4, 31.7, 22.9, 22.8, 13.8. HRMS (ESI, m/z): calcd for $C_{27}H_{34}NaO_4Si^+$ $[M + Na]^+$: 473.2119, found 473.2115.



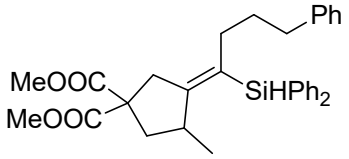
4p, General procedure **B**, 10 mmol% Ni catalysis 80 °C, colorless oil. 79.2 mg (74% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.51 (m, 4H), 7.42 – 7.33 (m, 6H), 5.27 (s, 1H), 3.76 (s, 3H), 3.74 (s, 3H), 3.17 – 3.08 (m, 2H), 2.96 – 2.92 (m, 1H), 2.62 (dd, J = 13.4, 8.0 Hz, 1H), 2.06 (s, 1H), 1.98 (dd, J = 13.4, 4.0 Hz, 1H), 1.30 – 1.13 (m, 16H), 0.97 (d, J = 7.2 Hz, 3H), 0.88 (t, J = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.0, 172.6, 159.8, 136.0, 135.9, 134.2, 134.1, 129.6, 128.0, 128.0, 126.5, 58.9, 52.9, 52.9, 41.3, 38.2, 37.9, 33.8, 32.0, 29.9, 29.7, 29.6, 29.5, 29.43, 29.4, 22.8, 14.2. HRMS (ESI, m/z): calcd for $C_{33}H_{46}NaO_4Si^+$ $[M + Na]^+$: 557.3058, found 557.3048.



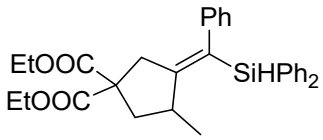
4q, General procedure **B**, yellow oil. 47.7 mg (50% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60 (dd, *J* = 6.6, 1.4 Hz, 4H), 7.43 – 7.32 (m, 6H), 3.76 (s, 3H), 3.76 (s, 3H), 3.15 – 2.99 (m, 2H), 2.96 – 2.86 (m, 1H), 2.71 (dd, *J* = 12.6, 7.0 Hz, 1H), 2.34 – 2.25 (m, 1H), 1.75 (t, *J* = 12.4 Hz, 1H), 1.65 (dd, *J* = 22.8, 7.4 Hz, 2H), 1.54 – 1.50 (m, 2H), 1.46 – 1.33 (m, 2H), 1.23 – 1.05 (m, 3H), 1.01 – 0.78 (m, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.6, 172.4, 141.8, 135.3, 135.2, 134.7, 134.3, 129.7, 128.1, 127.6, 58.5, 52.8, 52.8, 41.8, 38.9, 38.5, 36.9, 33.1, 33.1, 26.3, 26.2, 26.2, 17.0. HRMS (ESI, m/z): calcd for $C_{29}H_{36}NaO_4Si^+$ $[M + Na]^+$: 499.2275, found 499.2261.



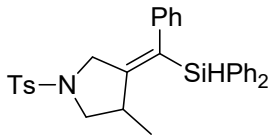
4r, General procedure **B**, yellow oil. 46.9 mg (54% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.57 – 7.54 (m, 4H), 7.42 – 7.33 (m, 6H), 5.26 (s, 1H), 3.77 (s, 3H), 3.75 (s, 3H), 3.31 (s, 1H), 3.04 – 2.96 (m, 1H), 2.62 (dd, *J* = 13.4, 8.2 Hz, 1H), 2.01 (dd, *J* = 13.4, 4.4 Hz, 1H), 1.32 – 1.23 (m, 3H), 0.94 (d, *J* = 7.2 Hz, 3H), 0.62 – 0.56 (m, 1H), 0.49 – 0.43 (m, 0H), 0.37 – 0.31 (m, 1H), 0.27 – 0.22 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 173.0, 172.7, 164.9, 135.9, 135.8, 134.6, 134.4, 129.6, 129.5, 128.0, 126.4, 76.8, 58.9, 52.9, 41.5, 40.0, 37.8, 22.9, 15.4, 7.4, 6.7. HRMS (ESI, m/z): calcd for $C_{26}H_{30}NaO_4Si^+$ $[M + Na]^+$: 457.1806, found 457.1799.



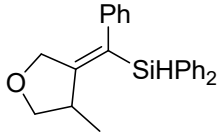
4s, General procedure **B**, colorless oil. 67.7 mg (66% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.54 – 7.49 (m, 4H), 7.42 – 7.33 (m, 6H), 7.21 – 7.10 (m, 3H), 6.93 (d, *J* = 7.0 Hz, 2H), 5.27 (s, 1H), 3.75 (s, 3H), 3.70 (s, 3H), 3.13 – 3.03 (m, 2H), 2.97 – 2.92 (m, 1H), 2.61 (dd, *J* = 13.4, 8.2 Hz, 1H), 2.34 (t, *J* = 7.8 Hz, 2H), 2.15 – 2.10 (m, 2H), 1.98 (dd, *J* = 13.4, 4.2 Hz, 1H), 1.39 – 1.34 (m, 2H), 0.97 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.9, 172.5, 160.2, 142.4, 136.0, 135.9, 133.9, 133.9, 129.7, 128.4, 128.3, 128.1, 128.1, 126.0, 125.7, 58.9, 53.0, 52.9, 41.2, 38.2, 37.9, 36.3, 33.5, 31.4, 22.8. HRMS (ESI, m/z): calcd for $C_{32}H_{36}NaO_4Si^+$ $[M + Na]^+$: 535.2275, found 535.2258.



4t, General procedure **B**, colorless oil. 83.8 mg (84% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.44 – 7.40 (m, 4H), 7.36 – 7.24 (m, 6H), 7.13 – 7.04 (m, 3H), 6.80 – 6.78 (m, 2H), 5.41 (s, 1H), 4.18 – 4.09 (m, 4H), 3.21 – 3.16 (m, 1H), 3.02 (dd, *J* = 17.0, 1.6 Hz, 1H), 2.77 – 2.70 (m, 2H), 1.99 (dd, *J* = 13.4, 4.6 Hz, 1H), 1.21 (t, *J* = 7.2 Hz, 3H), 1.16 (dd, *J* = 13.8, 7.0 Hz, 6H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.2, 171.9, 162.1, 143.2, 136.0, 136.0, 133.8, 133.3, 130.3, 129.7, 129.6, 128.8, 128.1, 127.9, 127.9, 125.7, 61.6, 61.6, 59.0, 41.3, 40.0, 37.6, 23.1, 14.1. HRMS (ESI, m/z): calcd for $C_{31}H_{34}NaO_4Si^+$ $[M + Na]^+$: 521.2119, found 521.2111.

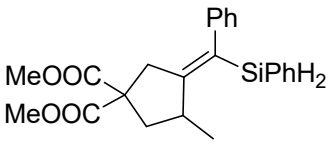


4u, General procedure **B**, 10 mmol% Ni catalysis 80 °C, white solid, mp: 135~137 °C. 78.5 mg (77% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 8.2 Hz, 2H), 7.38 – 7.35 (m, 6H), 7.31 – 7.26 (m, 6H), 7.15 – 7.13 (m, 3H), 6.73 – 6.70 (m, 2H), 5.33 (s, 1H), 3.95 (d, *J* = 15.6 Hz, 1H), 3.49 (d, *J* = 15.6 Hz, 1H), 3.30 (d, *J* = 8.8 Hz, 1H), 3.20 – 3.11 (m, 2H), 2.44 (s, 3H), 1.10 (d, *J* = 6.8 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 156.7, 143.6, 141.7, 135.9, 135.8, 133.3, 132.9, 132.5, 131.3, 130.0, 130.0, 129.7, 128.4, 128.1, 128.1, 128.0, 127.9, 126.4, 55.1, 50.9, 38.1, 21.7, 21.0. HRMS (ESI, m/z): calcd for $C_{31}H_{31}NNaO_2SSi^+$ $[M + Na]^+$: 532.1737, found 532.1713.

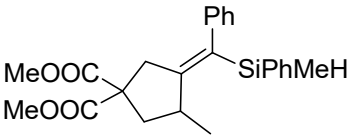


4v, General procedure **B**, 10 mmol% Ni catalysis 80 °C, colorless oil. 57.0 mg (80% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.49 – 7.45 (m, 4H), 7.40 – 7.26 (m, 6H), 7.17 – 7.08 (m, 3H), 6.84 – 6.83 (m, 2H), 5.44 (s, 1H), 4.38 (dd, *J* = 15.0, 1.2 Hz, 1H), 4.05 (d, *J* = 15.0 Hz, 1H), 3.92 (dd, *J* = 8.4, 5.4 Hz, 1H), 3.75 (dd, *J* = 8.4, 1.2 Hz, 1H), 3.16 – 3.10 (m, 1H), 1.23 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 161.9, 142.3, 136.0, 136.0, 133.4, 133.0, 129.9, 129.8, 128.3, 128.2, 128.1, 128.0, 128.0,

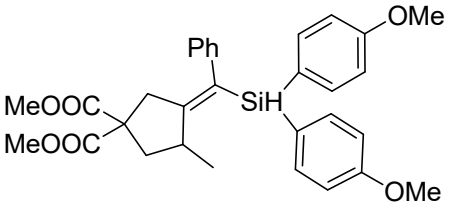
126.1, 75.7, 70.7, 38.8, 20.7. HRMS (ESI, m/z): calcd for $C_{24}H_{24}NaOSi^+$ [M + Na]$^+$: 379.1489, found 379.1470.



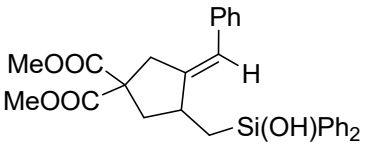
4aa, General procedure **B**, colorless oil. 55.2 mg (70% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (dd, *J* = 7.8, 1.4 Hz, 2H), 7.36 – 7.32 (m, 1H), 7.30 – 7.26 (m, 2H), 7.25 – 7.22 (m, 2H), 7.16 – 7.12 (m, 1H), 6.99 – 6.97 (m, 2H), 4.73 (dd, *J* = 15.6, 6.2 Hz, 2H), 3.70 (s, 3H), 3.65 (s, 3H), 3016 – 3.00 (m, 1H), 3.02 (d, *J* = 17.0 Hz, 1H), 2.77 – 2.71 (m, 2H), 2.01 (dd, *J* = 13.4, 4.8 Hz, 1H), 1.19 (d, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 172.2, 161.7, 143.7, 135.6, 129.7, 128.8, 128.5, 128.3, 128.1, 126.1, 59.1, 52.9, 52.8, 41.4, 40.1, 37.9, 22.9. HRMS (ESI, m/z): calcd for $C_{23}H_{26}NaO_4Si^+$ [M + Na]$^+$: 417.1493, found 417.1476.



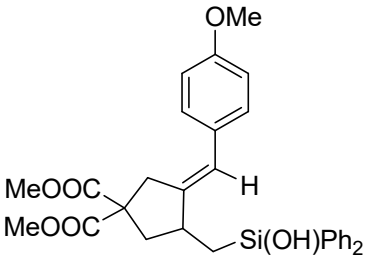
4ab, General procedure **B**, colorless oil. 73.5 mg (90% yield) dr = 7: 1. ^{1}H NMR (400 MHz, $CDCl_3$) δ major :7.47 – 7.45 (m, 2H), 7.39 – 7.30 (m, 3H), 7.15 – 7.11 (m, 2H), 7.15 – 7.11 (m, 1H), 6.82 – 6.80 (m, 2H), 4.93 (q, *J* = 3.8 Hz, 1H), 3.70 (s, 3H), 3.64 (s, 3H), 3.14 – 3.08 (m, 1H), 2.97 (dd, *J* = 16.8, 1.6 Hz, 1H), 2.72 – 2.63 (m, 2H), 2.01 (dd, *J* = 13.4, 4.4 Hz, 1H), 1.21 (d, *J* = 7.0 Hz, 3H), 0.23 (d, *J* = 3.8 Hz, 3H). δ minor : 6.90 – 6.88 (m, 2H), 4.89 (q, *J* = 3.8 Hz, 1H), 2.91 (dd, *J* = 16.8, 1.6 Hz, 1H), 1.14 (d, *J* = 7.0 Hz, 3H), 0.29 (d, *J* = 3.8 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.3, 160.0, 143.3, 135.6, 134.8, 132.0, 129.4, 128.2, 128.0, 125.7, 58.9, 52.9, 52.8, 41.3, 39.9, 37.4, 22.8, -5.3. HRMS (ESI, m/z): calcd for $C_{24}H_{28}NaO_4Si^+$ [M + Na]$^+$: 431.1649, found 431.1659.



4ac, General procedure **B**, 10 mmol% Ni catalysis 80 °C, yellow oil. 57.3 mg (54% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.36 – 7.32 (m, 4H), 7.16 – 7.06 (m, 3H), 6.88 – 6.79 (m, 6H), 5.38 (s, 1H), 3.81 (s, 3H), 3.79 (s, 3H), 3.71 (s, 3H), 3.68 (s, 3H), 3.27 – 3.14 (m, 1H), 3.03 (d, *J* = 20.0 Hz, 1H), 2.79 – 2.70 (m, 2H), 2.03 (dd, *J* = 13.4, 4.4 Hz, 1H), 1.16 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.4, 161.0, 160.9, 143.3, 137.5, 137.4, 131.3, 128.7, 128.1, 125.7, 124.7, 124.2, 113.8, 113.7, 58.8, 55.1, 55.1, 52.8, 52.7, 41.4, 40.1, 37.4, 23.1. HRMS (ESI, m/z): calcd for $C_{31}H_{34}NaO_6Si^+$ $[M + Na]^+$: 553.2017, found 553.2019.

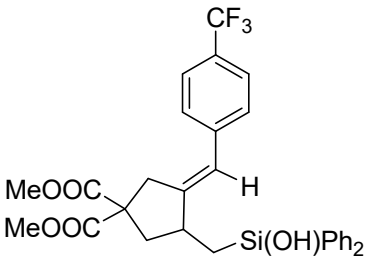


5a, General procedure **C**, colorless oil. 58.4 mg (60% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 – 7.63 (m, 4H), 7.43 – 7.37 (m, 6H), 7.33 – 7.30 (m, 3H), 7.18 (t, *J* = 7.2 Hz, 2H), 6.30 (d, *J* = 2.2 Hz, 1H), 3.69 (s, 3H), 3.62 (s, 3H), 3.33 (d, *J* = 17.6 Hz, 1H), 3.15 (dt, *J* = 17.6, 2.4 Hz, 1H), 2.91 – 2.78 (m, 1H), 2.59 (dd, *J* = 12.8, 7.2 Hz, 2H), 1.88 (dd, *J* = 12.8, 11.0 Hz, 1H), 1.72 (dd, *J* = 15.0, 4.0 Hz, 1H), 1.35 – 1.25 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 172.3, 147.1, 137.9, 136.7, 136.0, 134.3, 134.3, 130.1, 130.1, 128.5, 128.4, 128.2, 126.4, 121.8, 59.3, 53.0, 52.9, 41.2, 40.4, 38.6, 20.1. HRMS (ESI, m/z): calcd for $C_{29}H_{30}NaO_5Si^+$ $[M + Na]^+$: 509.1755, found 509.1759.

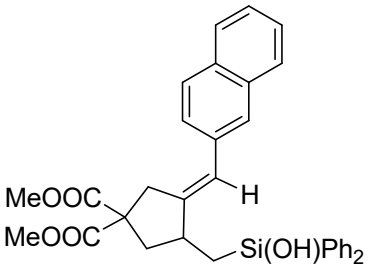


5b, General procedure **C**, yellow oil. 53.6 mg (52% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.67 – 7.64 (m, 4H), 7.43 – 7.37 (m, 6H), 7.19 (d, *J* = 8.7 Hz, 2H), 6.86 (d, *J* = 8.7 Hz, 2H), 6.28 – 6.26 (m, 1H), 3.80 (s, 3H), 3.69 (s, 3H), 3.61 (s, 3H), 3.31 (d, *J* = 17.5 Hz, 1H), 3.13 (dt, *J* = 17.5, 2.3 Hz, 1H), 2.93 – 2.70 (m, 2H), 2.59 (dd, *J* = 12.8, 7.1 Hz, 1H), 1.87 (dd, *J* = 12.7, 11.1 Hz, 1H), 1.71 (dd, *J* = 15.0, 3.9 Hz, 1H), 1.30– 1.24 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 172.3, 158.2, 144.9, 136.7, 136.1, 134.3,

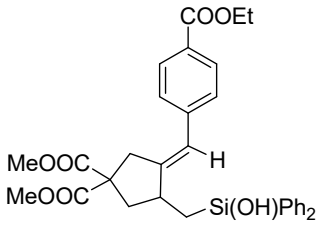
134.23, 130.7, 130.1, 130.0, 129.6, 128.1, 121.1, 113.9, 59.3, 55.4, 52.9, 52.9, 41.8, 40.2, 38.5, 20.1. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_6Si^+$ $[M + Na]^+$: 539.1860, found 539.1837.



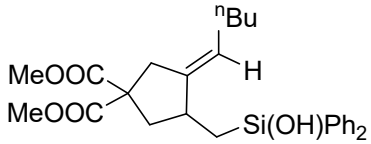
5c, General procedure **C**, yellow oil. 48.8 mg (44% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ7.67 – 7.64 (m, 4H), 7.56 (d, *J* = 8.2 Hz, 2H), 7.44 – 7.38 (m, 6H), 7.33 (d, *J* = 8.1 Hz, 2H), 6.35 – 6.30 (m, 1H), 3.70 (s, 3H), 3.62 (s, 3H), 3.31 (d, *J* = 17.6 Hz, 1H), 3.13 (d, *J* = 17.6 Hz, 1H), 2.93 – 2.81 (m, 1H), 2.71 – 2.52 (m, 2H), 1.95 – 1.86 (m, 1H), 1.71 (dd, *J* = 15.0, 3.8 Hz, 1H), 1.29 (dd, *J* = 15.0, 10.6 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.3, 172.1, 150.1, 141.4, 136.5, 135.9, 134.3, 134.2, 130.2, 130.2, 128.6, 128.3 (q, *J* = 32.4 Hz), 128.2, 125.3 (q, *J* = 3.6 Hz), 124.4 (q, *J* = 271.8 Hz), 120.8, 59.2, 53.0, 53.0, 41.1, 40.6, 38.7, 20.1. ^{19}F NMR (377 MHz, $CDCl_3$) δ -62.4 (s, 3F). HRMS (ESI, m/z): calcd for $C_{30}H_{29}F_3NaO_5Si^+$ $[M + Na]^+$: 577.1629, found 577.1610.



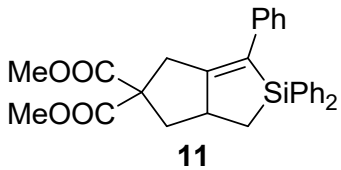
5d, General procedure **C**, yellow oil. 51.3 mg (48% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 – 7.78 (m, 3H), 7.71 – 7.67 (m, 5H), 7.47 – 7.39 (m, 9H), 6.51 – 6.45 (m, 1H), 3.70 (s, 3H), 3.63 (s, 3H), 3.46 (d, *J* = 17.6 Hz, 2H), 3.26 (dt, *J* = 17.6, 2.4 Hz, 2H), 2.99 – 2.76 (m, 2H), 2.66 (dd, *J* = 12.8, 7.2 Hz, 1H), 1.94 (dd, *J* = 12.8, 11.0 Hz, 1H), 1.79 (dd, *J* = 15.0, 4.0 Hz, 1H), 1.38 – 1.29 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 172.3, 147.7, 136.7, 136.1, 135.5, 134.3, 134.3, 133.6, 132.2, 130.1, 130.1, 128.1, 128.1, 127.8, 127.7, 127.1, 126.2, 125.7, 121.9, 59.3, 53.0, 52.9, 41.2, 40.5, 38.7, 20.1. HRMS (ESI, m/z): calcd for $C_{33}H_{32}NaO_5Si^+$ $[M + Na]^+$: 559.1911, found 559.1891



5e, General procedure **C**, yellow oil. 43.6 mg (40% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, *J* = 8.2 Hz, 2H), 7.58 (d, *J* = 6.4 Hz, 4H), 7.42 – 7.36 (m, 8H), 6.32 (s, 1H), 4.37 (q, J = 7.2 Hz, 2H), 3.65 (s, 3H), 3.60 (s, 3H), 3.32 (d, *J* = 17.6 Hz, 1H), 3.09 (d, *J* = 17.6 Hz, 1H), 2.93 – 2.79 (m, 1H), 2.32 (dd, *J* = 13.0, 6.8 Hz, 1H), 2.00 (dd, *J* = 15.0, 3.4 Hz, 1H), 1.69 (t, *J* = 12.3 Hz, 1H), 1.39 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.4, 172.2, 166.8, 162.3, 148.4, 135.9, 135.9, 133.1, 132.6, 130.3, 129.9, 129.9, 129.50, 128.7, 128.1, 128.0, 60.9, 58.8, 52.9, 52.8, 41.3, 40.2, 37.6, 23.0, 14.4. HRMS (ESI, m/z): calcd for $C_{30}H_{32}NaO_6Si^+$ $[M + Na]^+$: 539.1860, found 539.1837.



5f, General procedure **C**, yellow oil. 42.5mg (46% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 – 7.57 (m, 4H), 7.45 – 7.33 (m, 6H), 5.26 – 5.17 (m, 1H), 3.69 (s, 3H), 3.62 (s, 3H), 2.96 (d, *J* = 16.8 Hz, 1H), 2.88 – 2.74 (m, 1H), 2.62 – 2.47 (m, 2H), 2.01 – 1.91 (m, 1H), 1.80 (t, *J* = 10.8 Hz, 1H), 1.58 (d, *J* = 15.0 Hz, 1H), 1.37 – 1.23 (m, 5H), 1.15 – 1.09 (m, 1H), δ 0.87 (t, *J* = 11.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.5, 143.9, 136.8, 136.2, 134.3, 134.2, 130.0, 130.0, 128.1, 121.5, 58.6, 52.8, 52.8, 42.1, 38.4, 36.9, 31.8, 29.0, 22.5, 19.7, 14.1. HRMS (ESI, m/z): calcd for $C_{27}H_{34}NaO_5Si^+$ $[M + Na]^+$: 489.2068, found 489.2058.

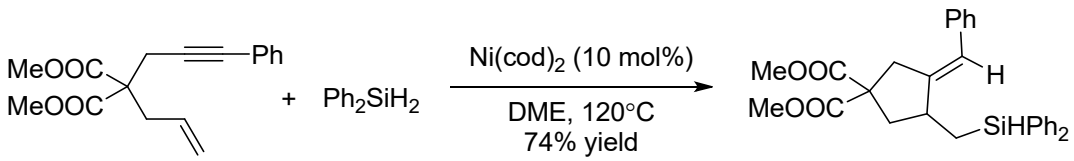


11

11, General procedure **B**, yellow oil.^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.50 (m, 4H), 7.43 – 7.31 (m, 6H), 7.22 – 7.18 (m, 2H), 7.14 – 7.11 (m, 2H), 3.78 (s, 3H), 3.73 (s, 3H), 3.40 (d, *J* = 18.6 Hz, 1H), 3.20 – 3.08 (m, 2H), 2.79 (dd, *J* = 12.8, 7.2 Hz, 1H), 1.89 (t, *J* = 12.6 Hz, 1H), 1.65 (dd, *J* = 14.6, 7.4 Hz, 1H),

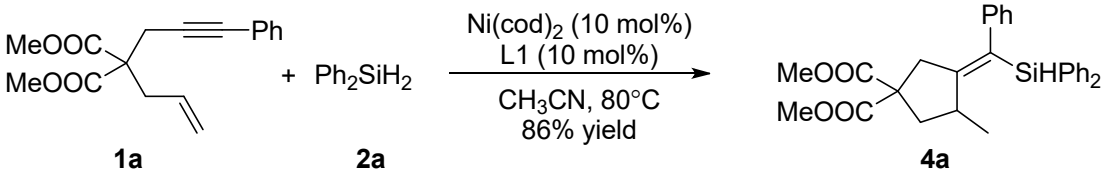
1.10 (dd, J = 14.6, 8.0 Hz, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.8, 172.3, 164.9, 139.8, 136.4, 135.4, 135.2, 135.2, 132.1, 129.9, 129.7, 128.5, 128.4, 128.2, 128.1, 126.1, 60.8, 53.1, 53.0, 47.7, 42.2, 36.8, 16.8. HRMS (ESI, m/z): calcd for $C_{29}H_{28}NaO_4Si^+$ $[M + Na]^+$: 491.1649, found 491.1652.

4. Large-scale Synthesis



1a 2.0 mmol | **2a** 4.0 mmol | **3a** 1.5 mmol

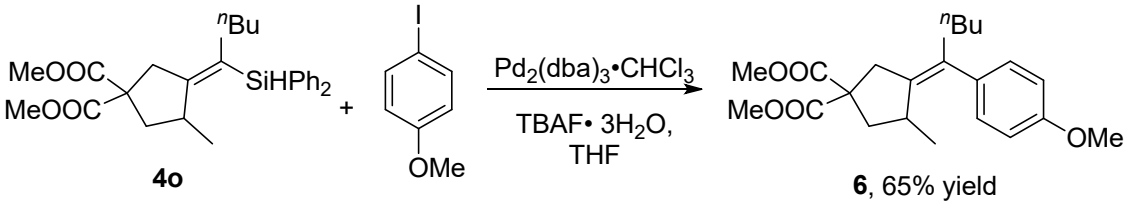
The mixture of **1a** (2.0 mmol, 1.0 equiv), diphenylsilane **2a** (4.0 mmol, 1 equiv), $Ni(cod)_2$ (10 mol %) in DME (20.0 mL) was stirred at 120 °C in the oil bath for 30 h under argon atmosphere. The reaction vial was removed from the oil bath and cooled to ambient temperature. The reaction mixture was filtered through a pad of celite. The mixture was eluted with ethyl acetate, concentrated, and purified by silica gel chromatography (PE : Dioxane = 10:1) to give the indicated product **3a** (696mg, 74% yield).



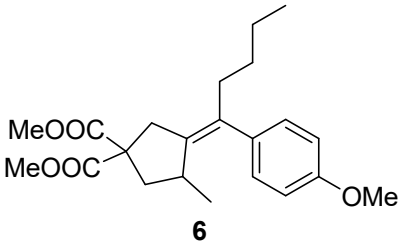
1a 2.0 mmol | **2a** 4.0 mmol | **4a** 1.7 mmol

The mixture of **1a** (2 mmol, 1.0 equiv), diphenylsilane **2a** (4 mmol, 1 equiv), $Ni(cod)_2$ (10 mol %) and L1 (10 mol %) in CH_3CN (20.0 mL) was stirred at 80 °C in the oil bath for 30 h under argon atmosphere. The reaction vial was removed from the oil bath and cooled to ambient temperature. The reaction vial was removed from the oil bath and cooled to ambient temperature. The reaction mixture was filtered through a pad of celite. The mixture was eluted with ethyl acetate, concentrated, and purified by silica gel chromatography (PE : Dioxane = 10:1) to give the indicated product **4a** (809mg, 86% yield).

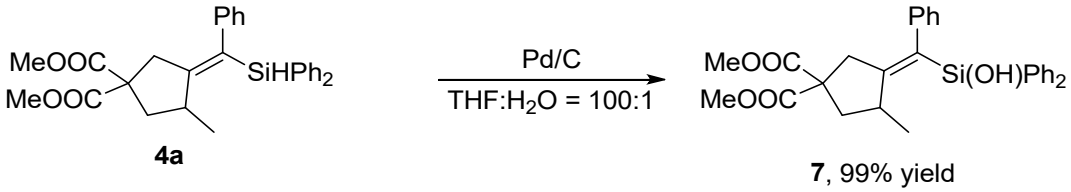
5. Derivatization Reactions



Alkylidenylsilane **4o** (90.1 mg, 0.22 mmol,1.1 equiv) a 10-mL round-bottomed flask with a magnetic stir bar, then a solution of TBAF·$3H_2O$ (1.0 M in THF, 0.4 mL,0.4 mmol, 2.0 equiv) was added and the resulting light-yellow solution was stirred at room temperature under argon for 3 min. Then Methyl 4-iodobenzoate (46.8 mg, 0.2 mmol, 1.0 equiv) and Pd(dba) • $CHCl_3$; (5.1 mg, 0.005 mmol, 2.5 mol %) were added to the solution sequentially. The flask was purged with argon, and the reaction mixture was stirred at 35 °C under Ar atmosphere for 24 h.

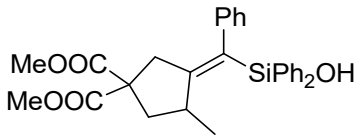


6, 57.7 mg (65% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.02 – 6.98 (m, 2H), 6.84 – 6.81 (m, 2H), 3.80 (s, 3H), 3.75 (s, 3H), 3.74 (s, 3H), 3.09 – 3.00 (m, 2H), 2.85 – 2.76 (m, 1H), 2.57 (ddd, *J* = 13.0, 8.0, 1.0 Hz, 1H), 2.35 – 2.28 (m, 1H), 2.22 – 2.17 (m, 1H), 1.76 (dd, *J* = 13.0, 7.2 Hz, 1H), 1.31 – 1.17 (m, 4H), 0.84 (t, *J* = 6.8 Hz, 3H), 0.61 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.7, 172.5, 158.1, 139.4, 135.2, 134.8, 129.6, 113.6, 59.2, 55.3, 52.8, 52.8, 42.2, 38.6, 36.1, 35.5, 30.0, 22.6, 20.3, 14.2. HRMS (ESI, m/z): calcd for $C_{22}H_{30}NaO_5^+$ $[M + Na]^+$: 397.1985, found 397.1988.



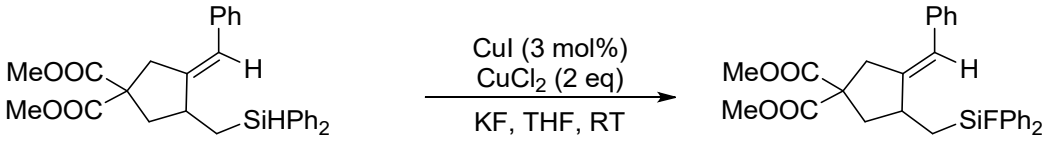
4a (84.2 mg, 0.2 mmol) and THF (2.0 mL, containing 1% v/v H_2O) was added to a flame dried schlenk tube under argon, the Pd/C·(15.0 mg,10 wt%)was added and stirred at room temperature. After the reaction was complete (10 min), DCM (5.0 mL) was added and dried·by Na_2SO_4, then the reaction

mixture was filtered through a pad of celite, eluted with ethyl acetate, concentrated in vacuo and purified by silica gel chromatography (PE:EA = 10:1) to give the product **7** (97.3 mg. yield 99%).



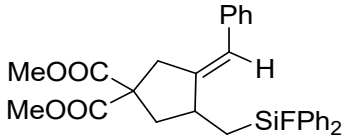
7

7, 97.3 mg (99% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.59 (m, 4H), 7.44 – 7.33 (m, 6H), 7.23-7.21 (m, 2H), 7.17 – 7.08 (m, 1H), 6.97 (d, *J* = 7.0 Hz, 2H), 3.69 (s, 3H), 3.67 (s, 3H), 3.02 (dd, *J* = 17.0, 1.2 Hz, 1H), 2.87 – 2.80 (m, 1H), 2.69 (d, *J* = 17.0 Hz, 1H), 2.59 (dd, *J* = 13.6, 8.0 Hz, 1H), 2.17 (s, 1H) 1.96 (dd, *J* = 13.6, 3.4 Hz, 1H), 0.76 (d, *J* = 7.0 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.8, 172.6, 161.8, 143.1, 136.2, 135.5, 135.3, 135.1, 131.8, 130.1, 130.1, 128.7, 128.5, 127.9, 127.9, 125.9, 58.0, 52.9, 52.8, 41.1, 39.7, 37.7, 22.1. HRMS (ESI, m/z): calcd for $C_{29}H_{30}NaO_5Si^+$ $[M + Na]^+$: 509.1755, found 509.1758.



3a **8**, 60% yield

3a(0.10 mmol, 42.5mg), $CuCl_2$(27.1 mg, 0.2 mmol, 2.0 equiv), CuI (1.6mg,0.009 mmol, 9 mol%), KF(7.1 mg, 0.12mmol, 1.2 equiv.) and 1.0 mL (1.0 M) of THF was charged inTHF and stirred for 12h at room temperature. After 12 h, the resulting solution was added 5 mL of EA and filtered through a pad of silica gel. The combined filtrates were concentrated and purified by flash column chromatography using EA/Hexane(1:10)as the eluent to give product as a colorless oil.



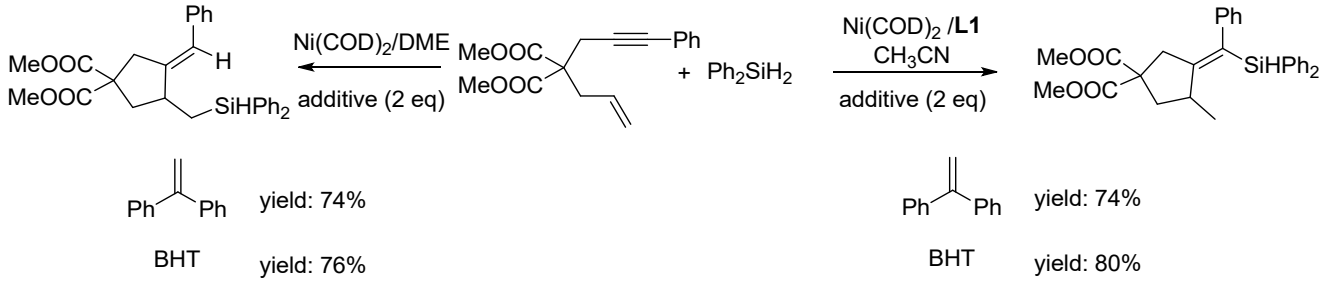
8

8, 31.2 mg (60% yield), ^{1}H NMR (400 MHz, $CDCl_3$) δ7.67 – 7.63 (m, 4H), 7.47 – 7.41 (m, 6H), 7.33 – 7.29 (m, 2H), 7.25 – 7.23 (m, 2H), 7.18 (dd, *J* = 9.0, 6.2 Hz, 1H), 6.28 (d, *J* = 2.6 Hz, 1H), 3.69 (s, 3H),

3.60 (s, 3H), 3.32 (d, J = 17.6 Hz, 1H), 3.14-3.12 (m, 1H), 2.93 – 2.79 (m, 1H), 2.68 – 2.53 (m, 1H), 1.90 – 1.81 (m, 1H), 1.74 (ddd, J = 18.8, 10.8, 3.6 Hz, 1H), 1.43 – 1.23 (m, 1H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 172.5, 172.3, 147.1, 137.9, 136.7, 136.1, 134.3, 134.2, 130.1, 130.1, 128.5, 128.4, 128.1, 126.4, 121.8, 59.2, 52.9, 52.9, 41.2, 40.3, 38.6, 20.1. ^{19}F NMR (377 MHz, $CDCl_3$) δ -169.00 (s, 1F). HRMS (ESI, m/z): calcd for$C_{29}H_{29}FNaO_4Si^+$ $[M + Na]^+$: 511.1711, found 511.1715.

6. Mechanistic Studies

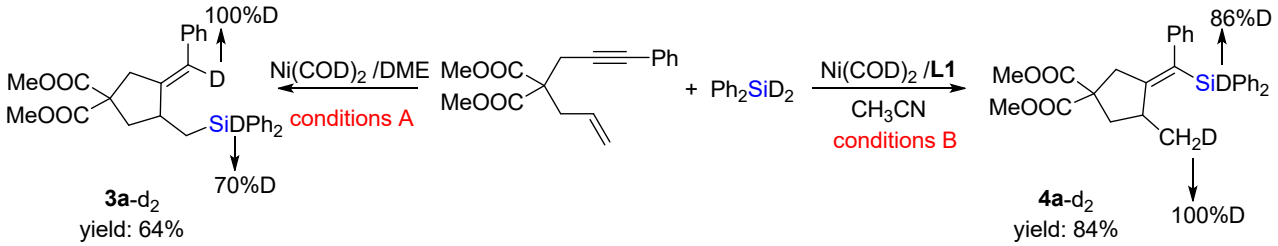
a) Radical-probe experiments



Condition A: $Ni(cod)_2$:(5.6 mg, 0.002 mmol) and diphenylsilane **2a** (0.4 mmol, 1 equiv), in DME (2 mL) were charged into a 25 mL pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed **1a** (0.2 mmol, 1.0 equiv) and ethene-1.1-diyldibenzene (0.60 mmol) or BHT (0.6 mmol) . The reaction tube was then sealed and placed in an oil bath at 120 °C. After the reaction was complete (24 h).the reaction mixture was filtered through a pad of celite. eluted with ethyl acetate, concentrated. and purified by silica gel chromatography(PE:Dioxane =.10:1) to give the indicated product **3a** (69.6 mg, yield 74% with ethene-1.1-diyldibenzene) or (71.5 mg, yield 76% with BHT).

Condition B: $Ni(cod)_2$ (1.4 mg, 0.002 mmol) and IPr • HCl (8.5 mg, 0.02 mmol) and CH_3COOCs (7.6 mg, 0.04 mmol) in CH_3CN (2.0 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed by addition of diphenylsilane (0.4 mmol, 2.0 equiv) and then stirred for 30 min at room temperature, followed by addition of **1a** (0.2 mmol, 1.0 equiv).and ethene-1.1-diyldibenzene (0.6 mmol) or BHT(0.6 mmol). The reaction tube was then sealed and placed in an oil bath at 80 °C. After the reaction was complete (24 h). the reaction mixture was filtered through a pad of celite. eluted with ethyl acetate, concentrated. and purified by silica gel chromatography(PE: Dioxane =.10:1) to give the indicated product 4a (66.8 mg, yield 71%) or (75.3 mg, yield 80%).

b) Deuterium labeling experiments

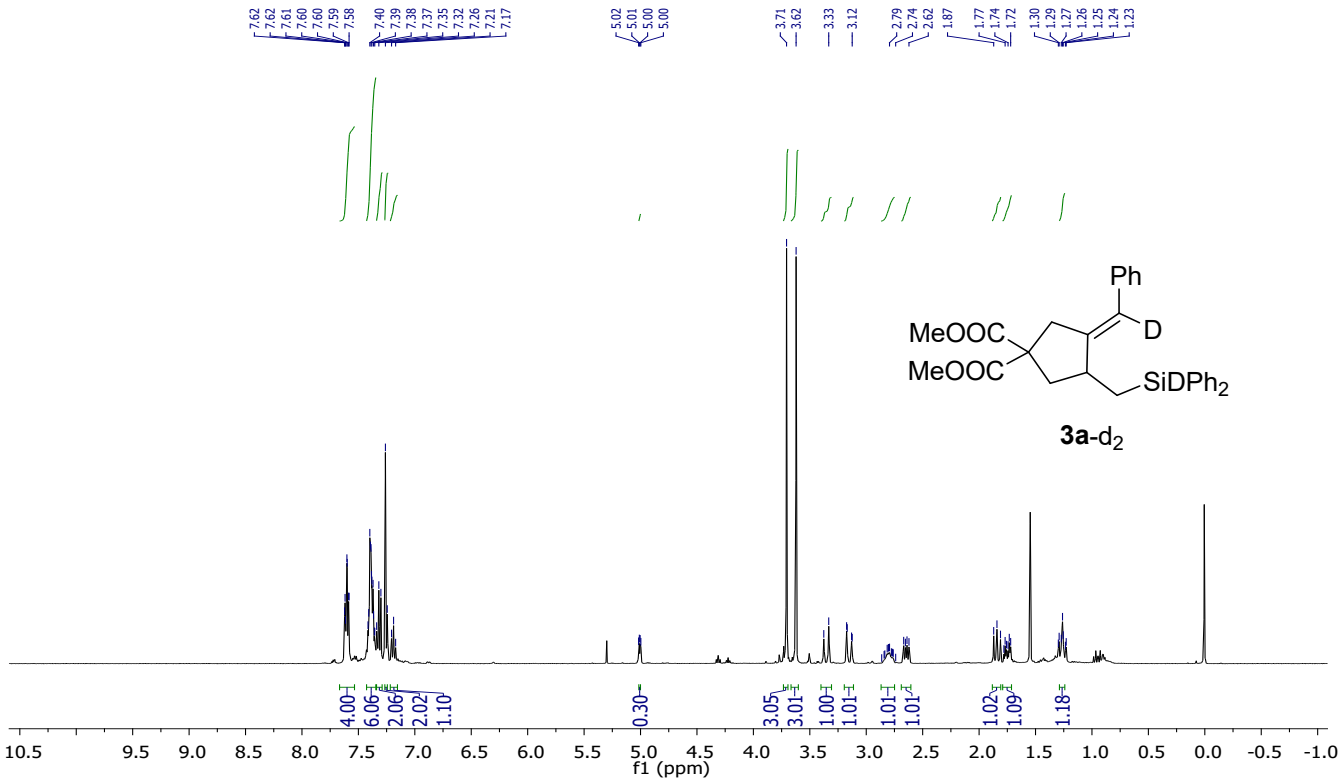


Co

ndition A: $Ni(cod)_2$:(5.6 mg, 0.02 mmol) and Ph_2SiD_2 (0.4 mmol, 1 equiv), in DME (2 mL) were charged into a 25 mL pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed **1a** (0.2 mmol, 1.0 equiv). The reaction tube was then sealed and placed in an oil bath at 120 °C. After the reaction was complete (24 h).the reaction mixture was filtered through a pad of celite. eluted with ethyl acetate, concentrated. and purified by silica gel chromatography(PE:Dioxane =.10:1) to give the indicated product **3a**-d_2 (66.1 mg, yield 70%). **3a**-d_2: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.62 – 7.58 (m, 4H), 7.41 – 7.35 (m, 6H), 7.34 – 7.30 (m, 2H), 7.25 (d, J = 6.5 Hz, 2H), 7.20 – 7.17 (m, 1H), 5.01 (dd, J = 5.4, 2.6 Hz, 0.3H), 3.71 (s, 3H), 3.62 (s, 3H), 3.35 (d, J = 17.5 Hz, 1H), 3.15 (dd, J = 17.6, 2.3 Hz, 1H), 2.81 – 2.74 (m, 1H), 2.65 (dd, J = 12.2, 6.5 Hz, 1H), 1.87 – 1.81 (m, 1H), 1.78 – 1.72 (m, 1H), 1.27-1.25 (m, 1H).

Condition B: $Ni(cod)_2$ (5.6 mg, 0.02 mmol) and IPr • HCl (8.5 mg, 0.02 mmol) and CH_3COOCs (7.6 mg,

0.04 mmol) in CH_3CN (2.0 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed by addition of Ph_2SiD_2 (0.4 mmol, 2.0 equiv) and then stirred for 30 min at room temperature, followed by addition of **1a** (0.2 mmol, 1.0 equiv). The reaction tube was then sealed and placed in an oil bath at 80 °C. After the reaction was complete (24 h).the reaction mixture was filtered through a pad of celite. eluted with ethyl acetate, concentrated. and purified by silica gel chromatography(PE:Dioxane =.10:1) to give the indicated product **4a**-d_2 (79.3 mg, yield 84%). **4a**-d_2: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.43 (td, J = 8.1, 1.3 Hz, 3H), 7.38 – 7.35 (m, 2H), 7.30 (ddd, J = 16.0, 6.0, 1.7 Hz, 3H), 6.81 – 6.79 (m, 2H), 5.42 (s, 0.14H), 3.71 (s, 3H), 3.68 (s, 3H), 3.20 – 3.17 (m, 1H), 3.06 – 3.01 (m, 1H), 2.79 – 2.71 (m, 2H), 2.04 (dd, J = 13.6, 4.6 Hz, 1H), 1.14 (d, J = 7.2 Hz, 2H).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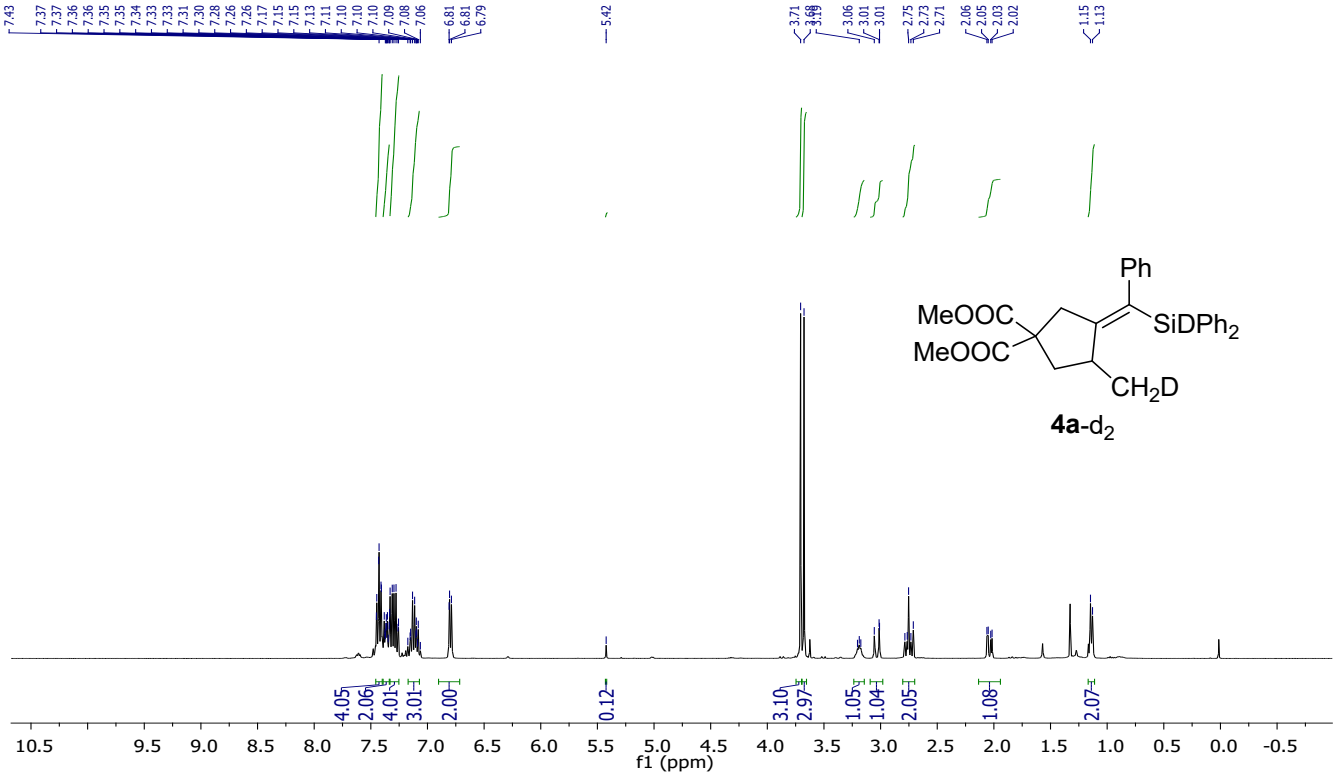
MeOOC
D
SiDPh2
3a-d2
f1 (ppm)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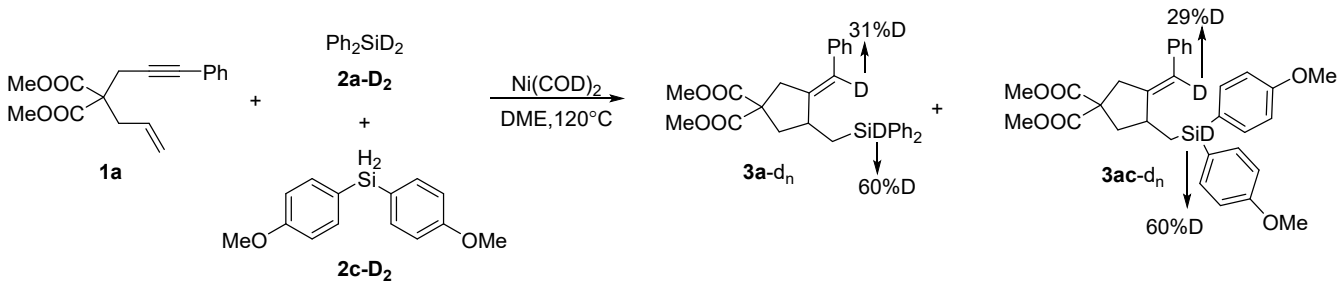
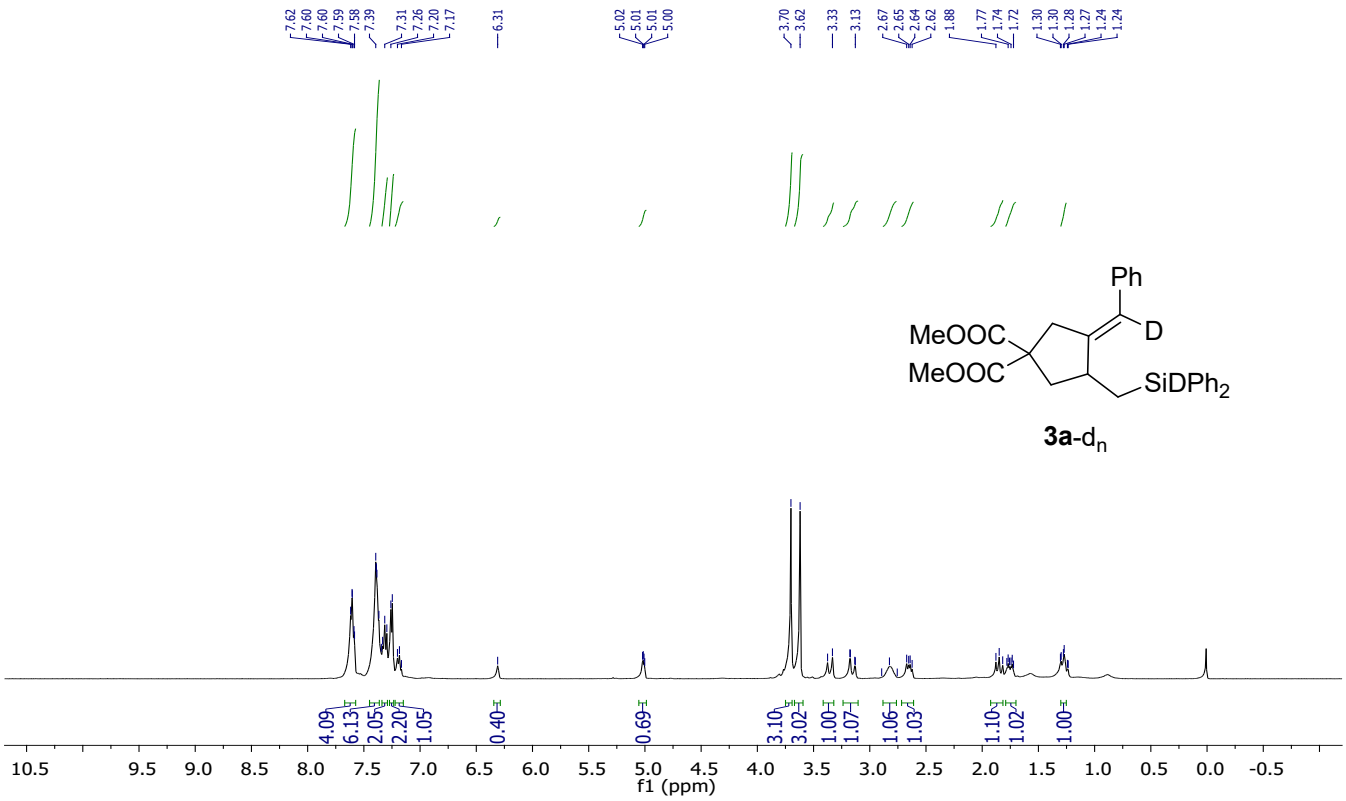
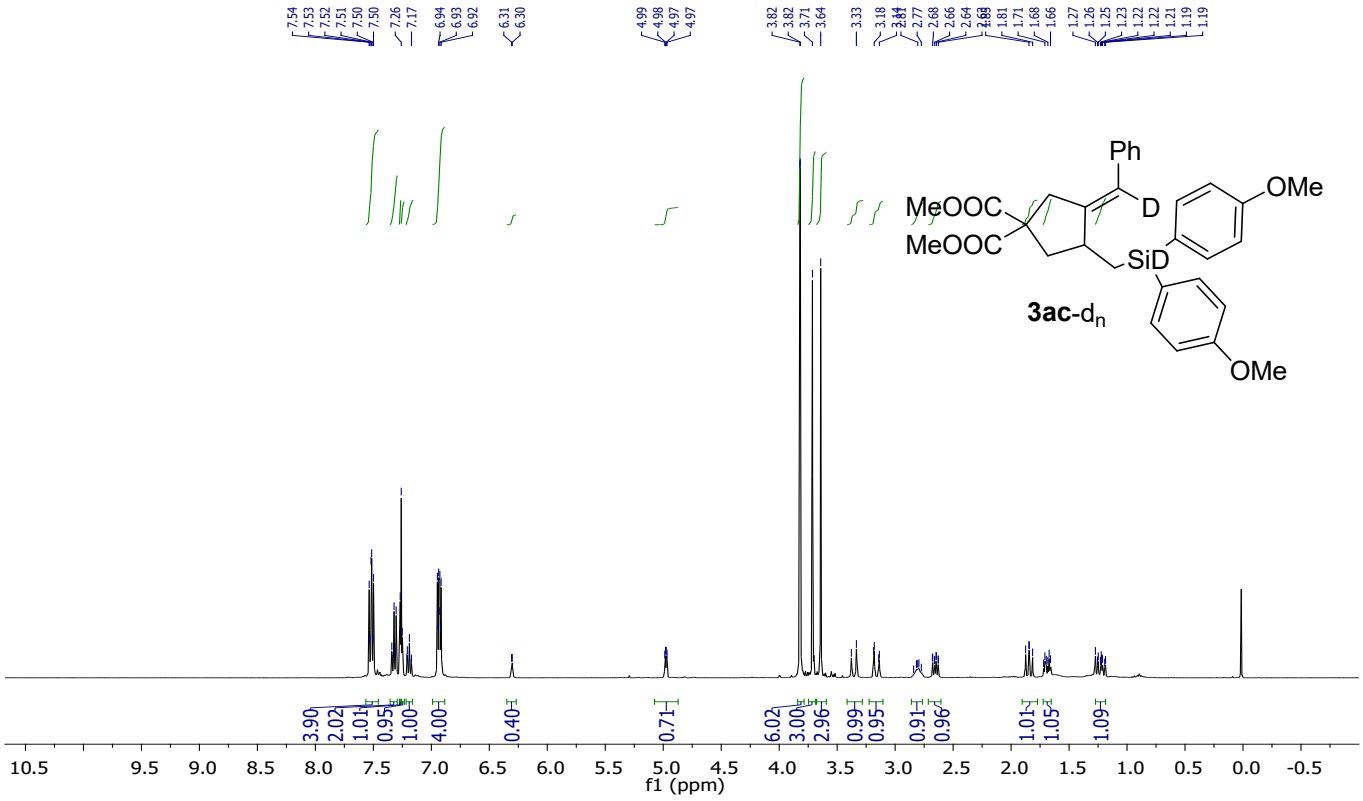
MeOOC
SiDPh2
CH2D
4a-d2
f1 (ppm)

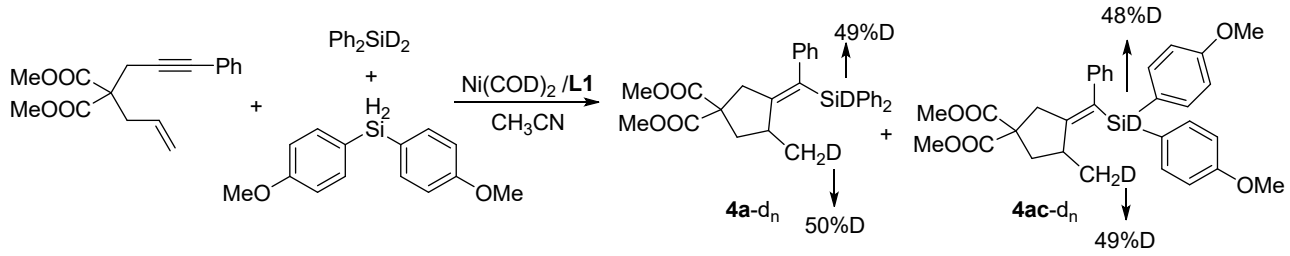


$Ni(cod)_2$ (5.6 mg, 0.01 mmol) and **2a-D_2** (36.8mg, 0.2 mmol) and **2c-D_2** (48.8mg, 0.2 mmol) in CH_3CN (2 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature. Then **1a** (0.2 mmol, 1.0 equiv.) were added sequentially to the reaction mixture. The reaction tube was then sealed and placed in an oil bath at 120 °C. After the reaction was complete (24 h), the reaction mixture was filtered through a pad of celite, eluted with ethyl acetate, concentrated. and purified by silica gel chromatography (PE : EA = 8:1) to give the indicated product **3a-**d_n . and **3ac-**d_n.

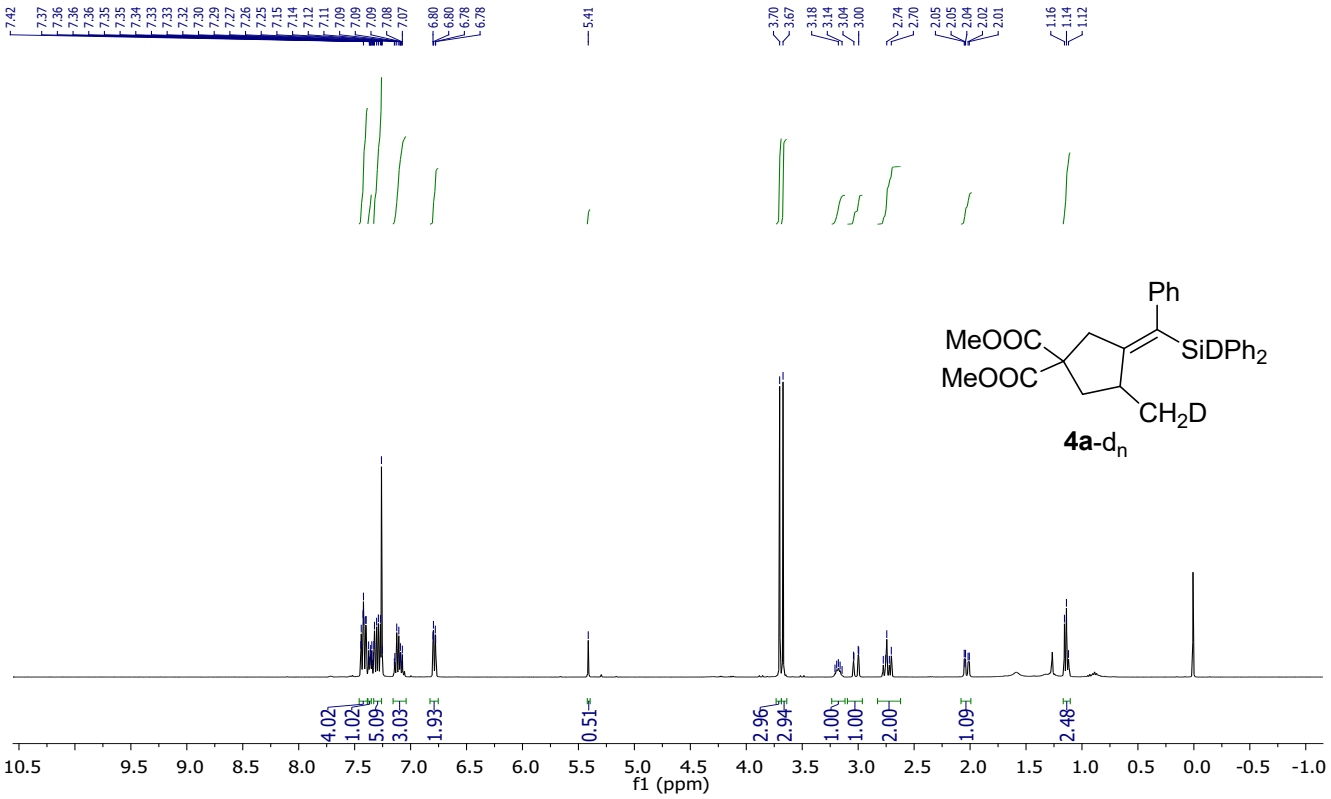




c) H/D exchange experiments



$Ni(cod)_2$ (5.6 mg, 0.01 mmol) and L1 (8.5 mg, 0.01 mmol) in CH_3CN (2 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed by addition of **2a-D** (36.8mg, 0.2 mmol) and **2c-D2** (48.8mg, 0.2 mmol) was added and stirred for 30 min. Then **1a** (0.2 mmol, 1.0 equiv.) were added sequentially to the reaction mixture. The reaction tube was then sealed and placed in an oil bath at 80 °C. After the reaction was complete (24 h), the reaction mixture was filtered through a pad of celite, eluted with ethyl acetate, concentrated. and purified by silica gel chromatography (PE : EA = 8:1) to give the indicated product **4a-**d_n and **4ac-**d_n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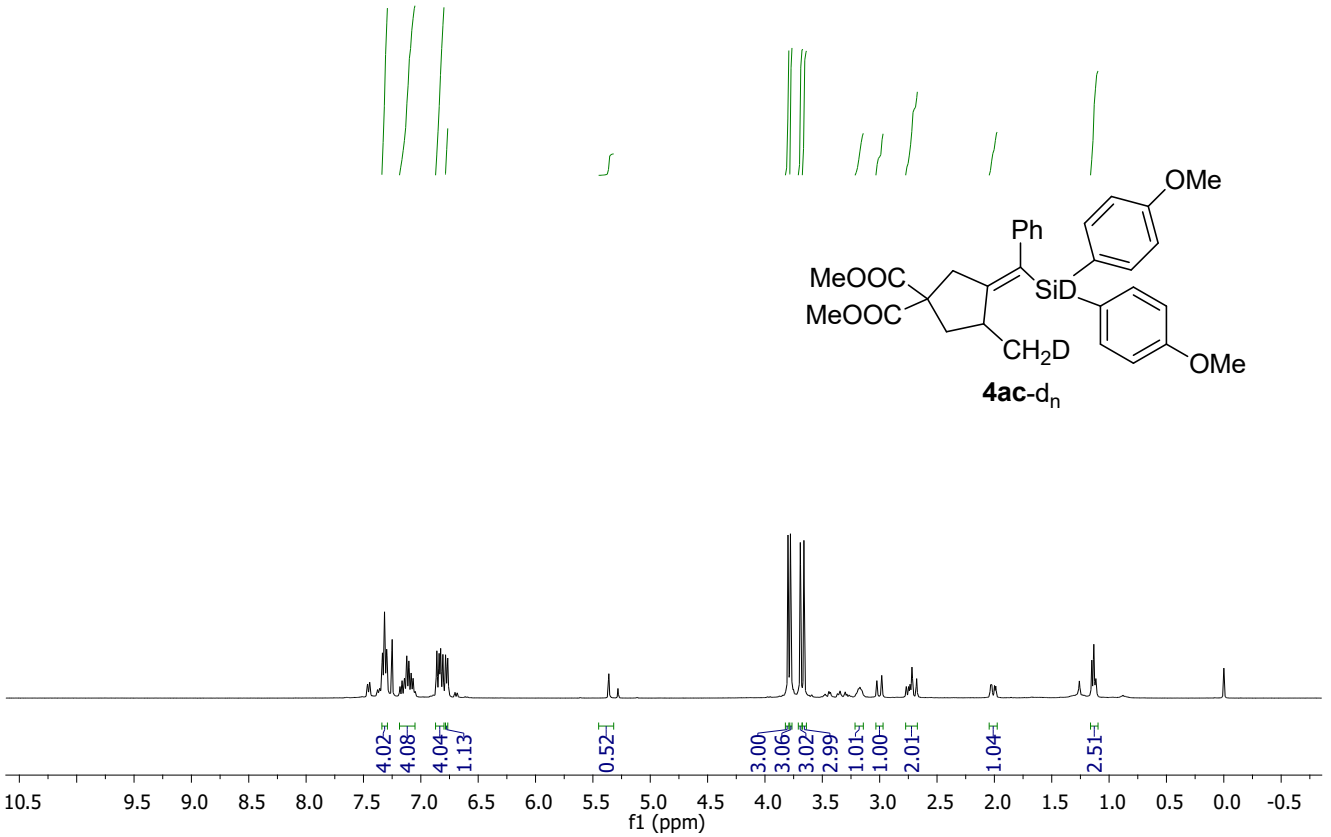
MeOOC
SiDPh2
CH2D
4a-dn
f1 (ppm)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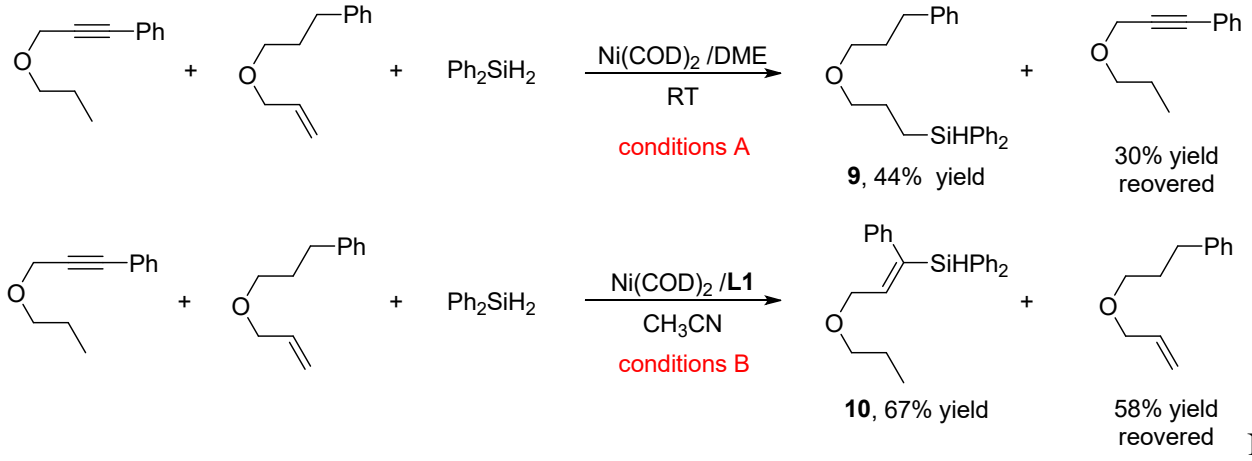
Ph
MeOOC
MeOOC
SiD
CH2D
OMe
4ac-dn
f1 (ppm)

d) Control experiments



Ni(cod)$_2$ (5.6 mg, 0.02 mmol) and **2** (36.8mg, 0.2 mmol) in DME (2 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature. Then alkyne (0.2 mmol, 1.0 equiv.) and alkene (0.2 mmol, 1.0 equiv.) were added sequentially to the reaction mixture. The reaction tube was then sealed and placed in an oil bath at room temperature. After the reaction was complete (24 h), the reaction mixture was filtered through a pad of celite, eluted with ethyl acetate, concentrated. and purified by silica gel chromatography (PE : Dioxane = 10:1) to give the indicated product **9. 9：** ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.49 – 7.47 (m, 4H), 7.29 – 7.24 (m, 6H), 7.19 – 7.16 (m, 2H), 7.10 – 7.06 (m, 3H), 4.80 (t, *J* = 3.7 Hz, 1H), 3.31-3.30 (m, 4H), 2.64 – 2.52 (m, 2H), 1.78 (dq, *J* = 9.0, 6.4 Hz, 2H), 1.66-1.65 (m, 2H), 1.13 – 1.08 (m, 2H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 142.2, 135.3, 134.5, 129.7, 128.6, 128.4, 128.1, 125.9, 73.2, 70.0, 32.5, 31.5, 24.8, 8.6. HRMS (ESI, m/z): calcd for $C_{24}H_{28}NaOSi^+$ $[M + Na]^+$: 383.1802, found 383.1777.

Ni(cod)$_2$ (5.6 mg, 0.02 mmol) and L1 (8.5 mg, 0.02 mmol) in CH_3CN (2 mL) were charged into a pressure tube under argon. The mixture was stirred for 30 min at room temperature, followed by addition of **2** was added and stirred for 30 min. Then alkyne (0.2 mmol, 1.0 equiv.) and alkene (0.2 mmol, 1.0 equiv.) were added sequentially to the reaction mixture. The reaction tube was then sealed and placed in an oil bath at room temperature. After the reaction was complete (24 h), the reaction mixture was filtered through a pad of celite, eluted with ethyl acetate, concentrated. and purified by silica gel chromatography (PE : Dioxane = 10:1) to give the indicated product **10**[2]**. 10**: ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54-7.52 (m, 4H), 7.43 – 7.30 (m, 6H), 7.25 – 7.12 (m, 3H), 7.06 – 6.93 (m, 2H), 6.34 (t, *J* = 5.8 Hz, 1H), 5.23 (s, 1H), 4.02 (d, *J* = 5.9 Hz, 2H), 3.30 (t, *J* = 6.6 Hz, 2H), 1.54 (dd, *J* = 14.2, 7.2

Hz, 2H), 0.88 (t, J = 7.4 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 143.9, 140.9, 140.7, 135.9, 133.1, 129.9, 128.3, 128.1, 126.5, 72.46, 68.7, 23.0, 10.7. $C_{24}H_{28}NaOSi^+$ [M + Na]$^+$: 381.1645, found 381.1657.

7. Crystal structure details

Crystal structure details for **4j** (CDCC 2177517), Thermal ellipsoids are shown at 50 % probability level (hydrogen atoms were omitted).

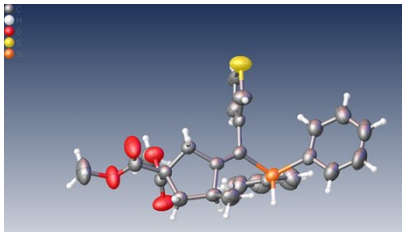


Table 1 Crystal data and structure refinement for **4j**.

Identification code	**4j**
Empirical formula	$C_{27}H_{28}O_4SSi$
Formula weight	476.64
Temperature/K	293(2)
Crystal system	monoclinic
Space group	$P2_1/n$
a/Å	11.1642(5)
b/Å	19.7847(10)
c/Å	11.8671(5)
α /°	90
β /°	101.346(4)
γ /°	90
Volume/Å^3	2570.0(2)
Z	4
ρ_{calc}g/cm^3	1.232
μ /mm^{-1}	1.806
F(000)	1008.0
Crystal size/mm^3	0.02 × 0.01 × 0.01
Radiation	Cu K α (λ = 1.54184)
2Θ range for data collection/°	8.816 to 142.778
Index ranges	-13 ⩽ h ⩽ 13, -19 ⩽ k ⩽ 23, -11 ⩽ l ⩽ 14

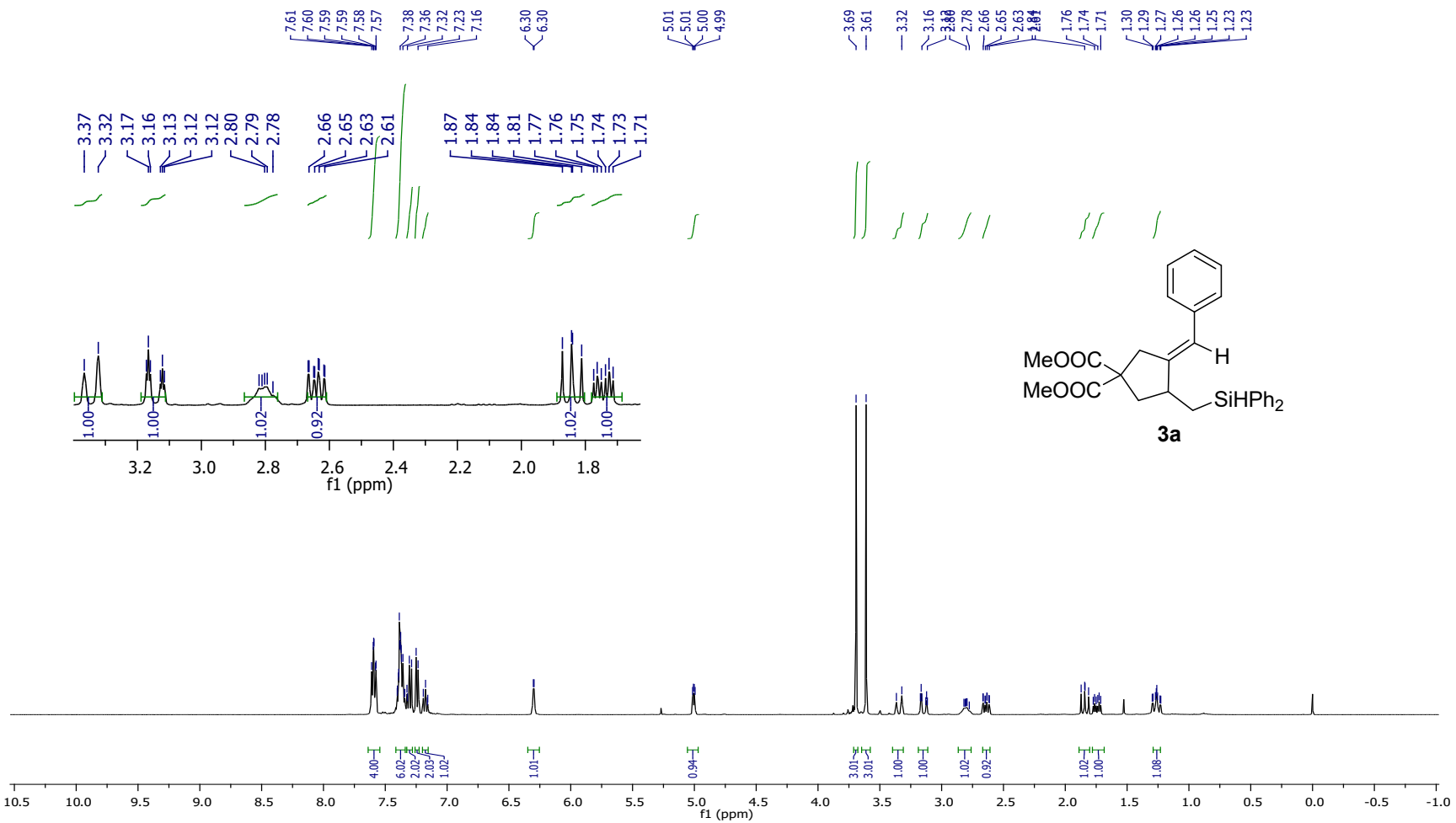
Reflections collected	11571
Independent reflections	4844 [R_{int} = 0.0326, R_{sigma} = 0.0358]
Data/restraints/parameters	4844/3/309
Goodness-of-fit on F^2	1.081
Final R indexes [I>=2 σ (I)]	R_1 = 0.0725, wR_2 = 0.2006
Final R indexes [all data]	R_1 = 0.0886, wR_2 = 0.2160
Largest diff. peak/hole / e $Å^{-3}$	0.72/-0.49

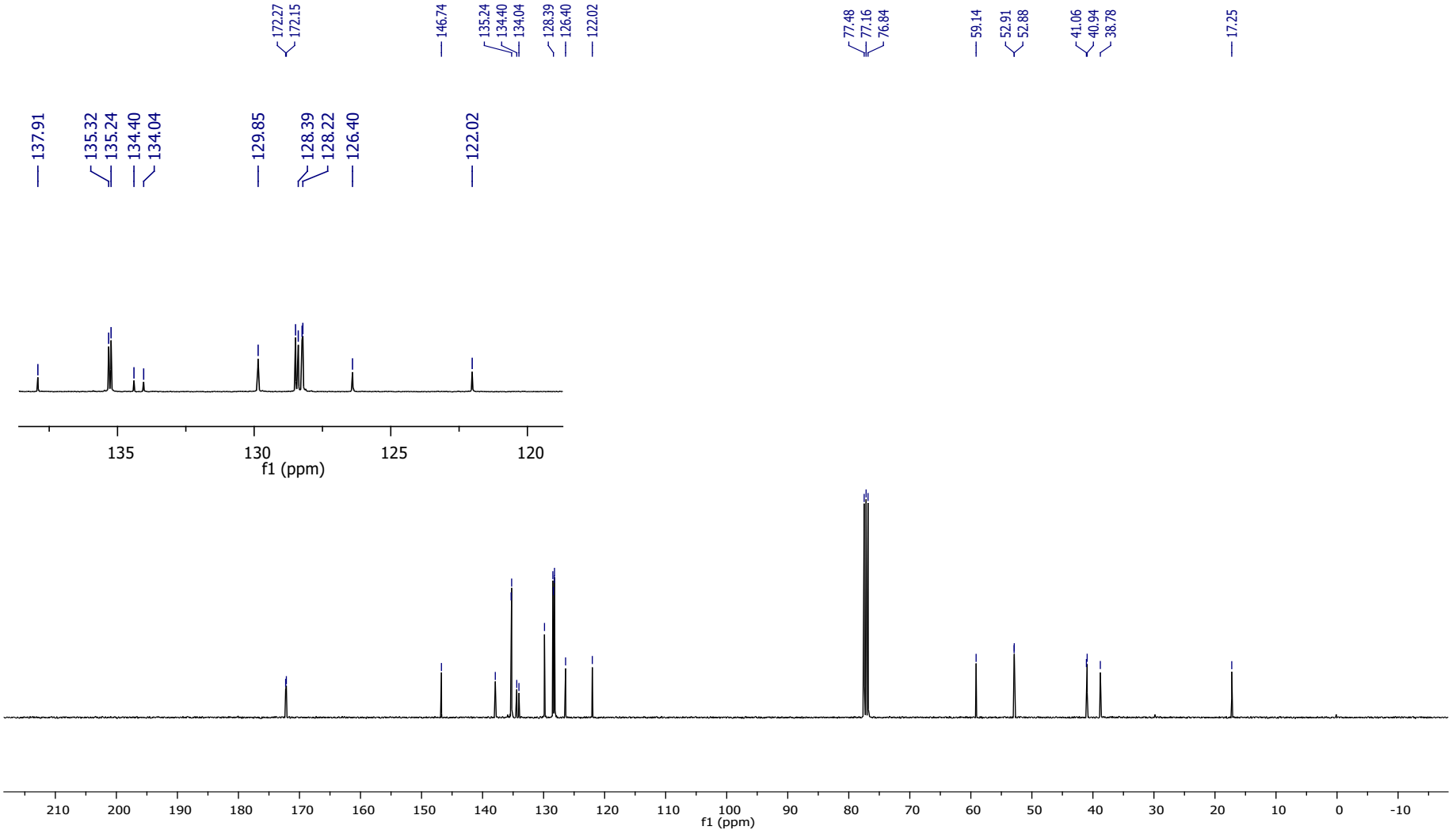
8. References

[1] N. C. Lobera, M. T. Quiros, W. W. Brennessel, M. L. Neidig, E. Buñuel and D. J. Cardenas. *Org. Letters.* **2019**, *21*, 6552-6556.

[2] Y. Q. You and S. Z. Ge. *Angew. Chem. Int. Ed*, **2021**, *60*, 12046-12052.

9. NMR Spectra

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59.14
52.91
52.88
41.06
40.94
38.78
17.25
137.91
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135.24
134.40
134.04
129.85
128.39
128.22
126.40
122.02
135
130
125
120
f1 (ppm)
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200
190
180
170
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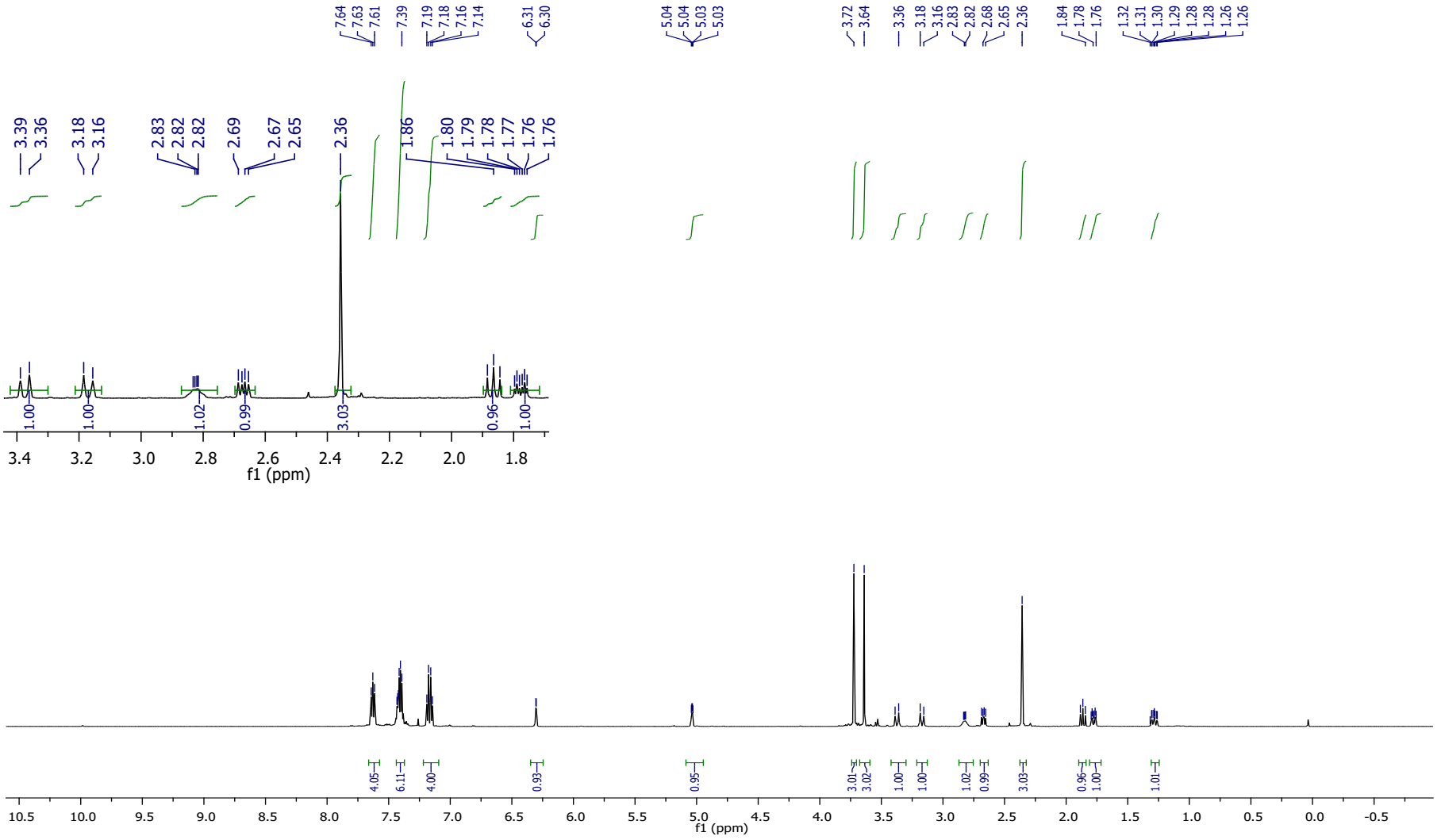
f1 (ppm)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5.03
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3.16
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2.65
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1.80
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1.78
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1.76
1.76
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1.00
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2.6
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2.2
2.0
1.8
f1 (ppm)
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4.00
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0.95
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3.02
1.00
1.00
1.02
0.99
3.03
0.96
1.00
1.01
10.5
10.0
9.5
9.0
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8.0
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7.0
6.5
6.0
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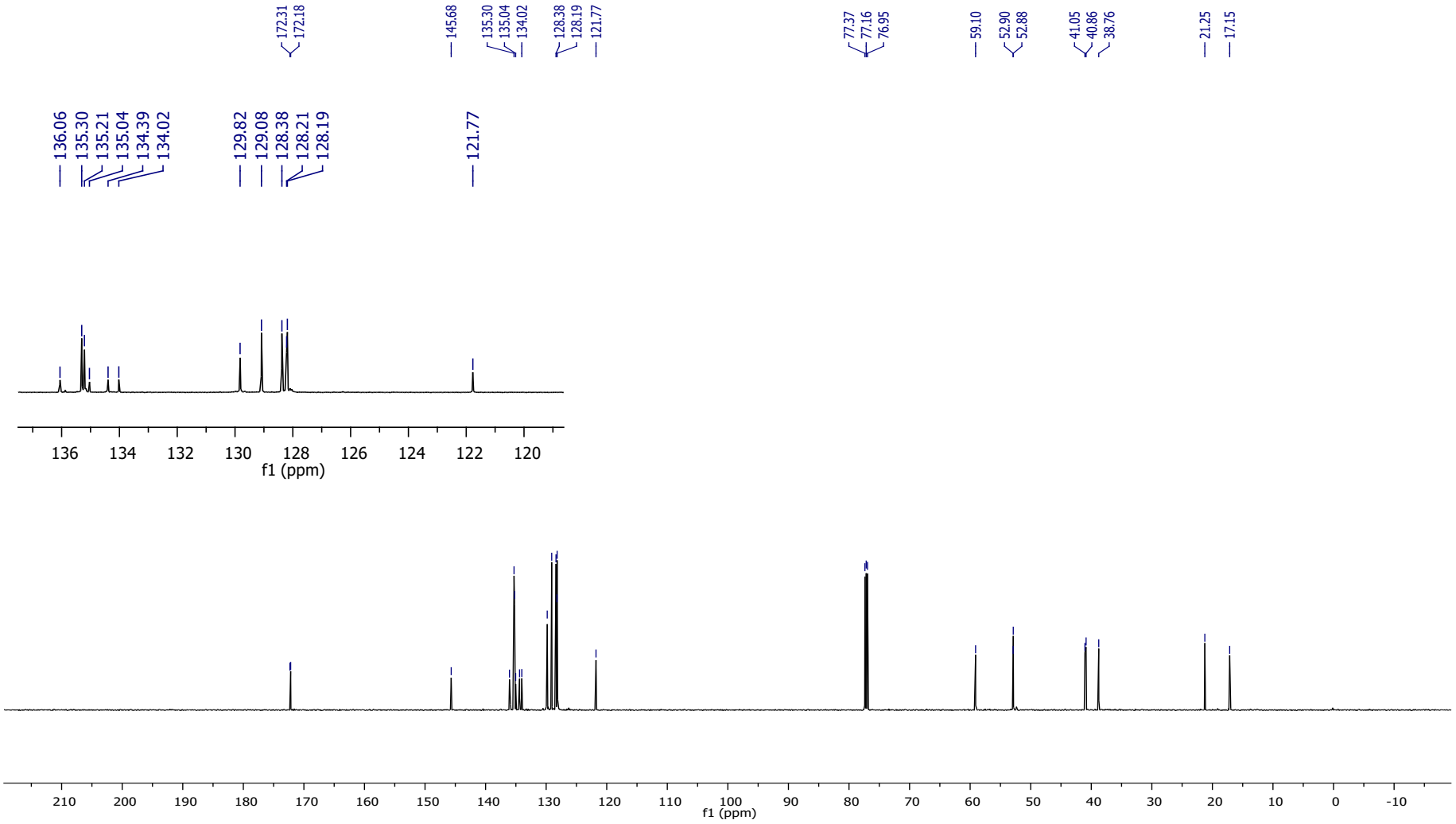
f1 (ppm)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21.25
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129.08
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f1 (ppm)
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180
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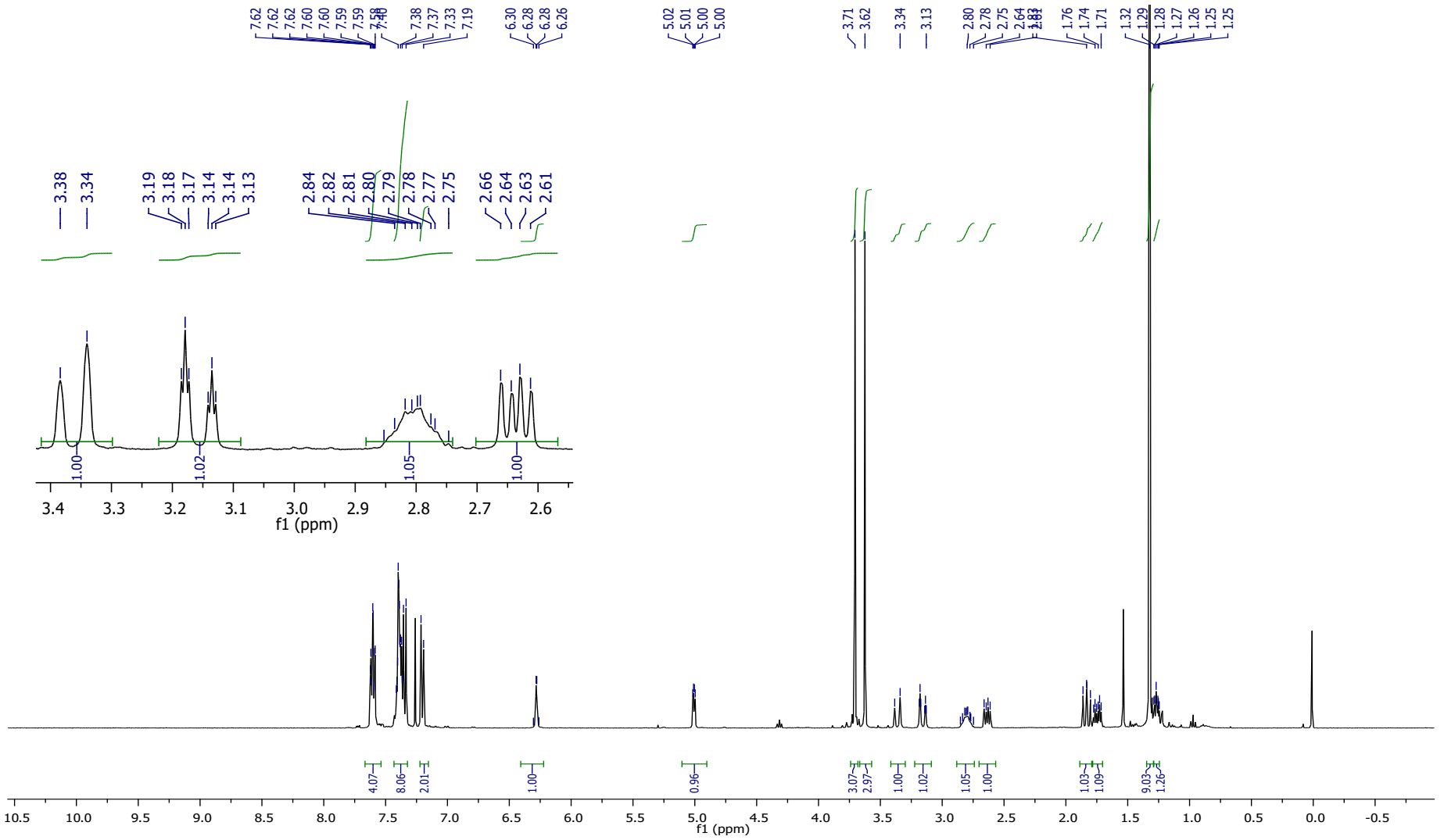
f1 (ppm)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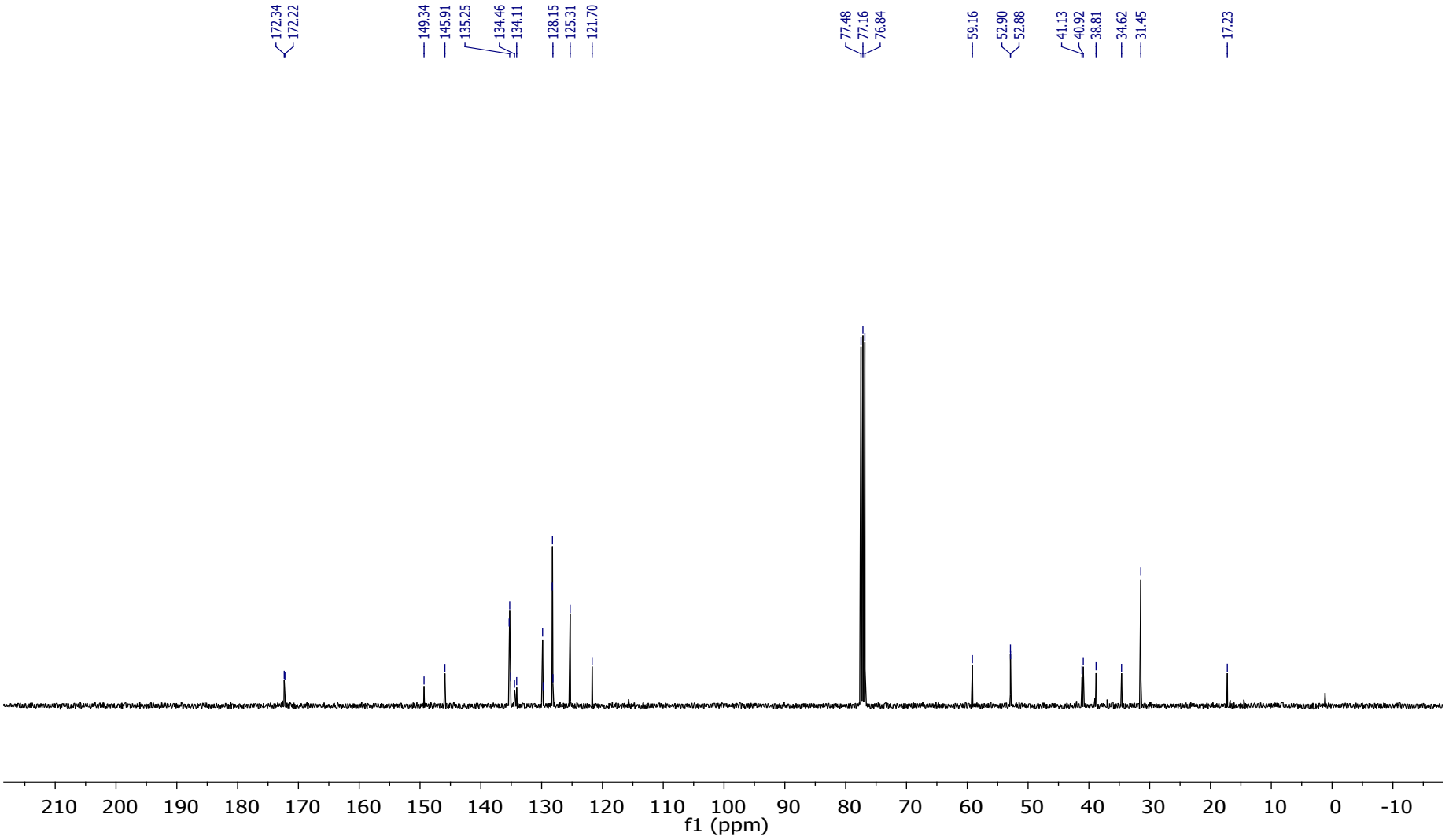
5.02 5.01 5.00 5.00
3.71 3.62
3.34
3.13
2.80 2.78 2.75 2.64
1.76 1.74 1.71
1.32 1.29 1.28 1.27 1.26 1.25 1.25
3.38 3.34
3.19 3.18 3.17 3.14 3.14 3.13
2.84 2.82 2.81 2.80 2.79 2.78 2.77 2.75
2.66 2.64 2.63 2.61
1.00 1.02 1.05 1.00
3.4 3.3 3.2 3.1 3.0 2.9 2.8 2.7 2.6
f1 (ppm)
4.07 8.06 2.01 1.00 0.96 3.07 2.97 1.00 1.02 1.05 1.00 1.03 1.09 9.03 1.26
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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52.90
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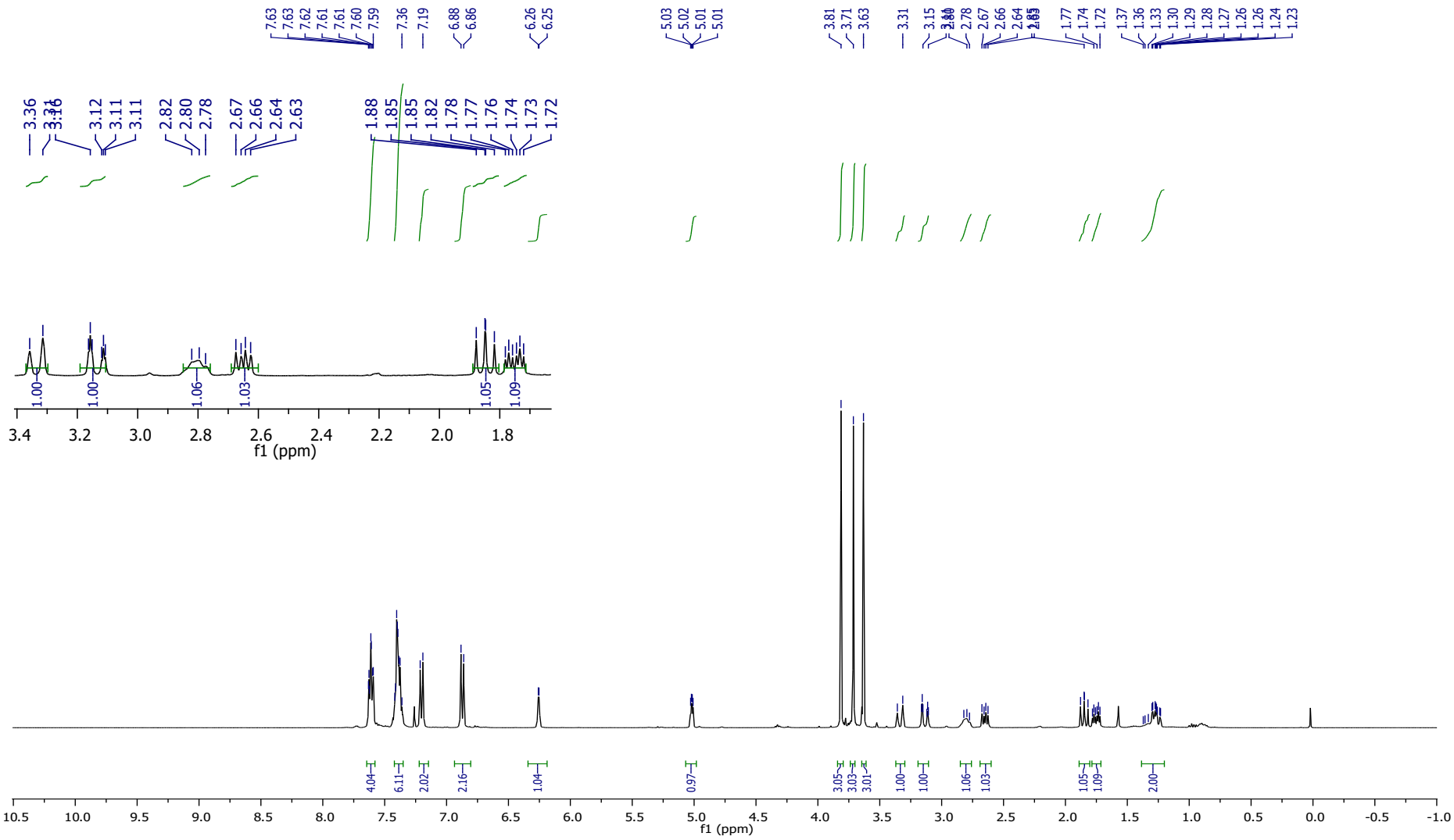
f1 (ppm)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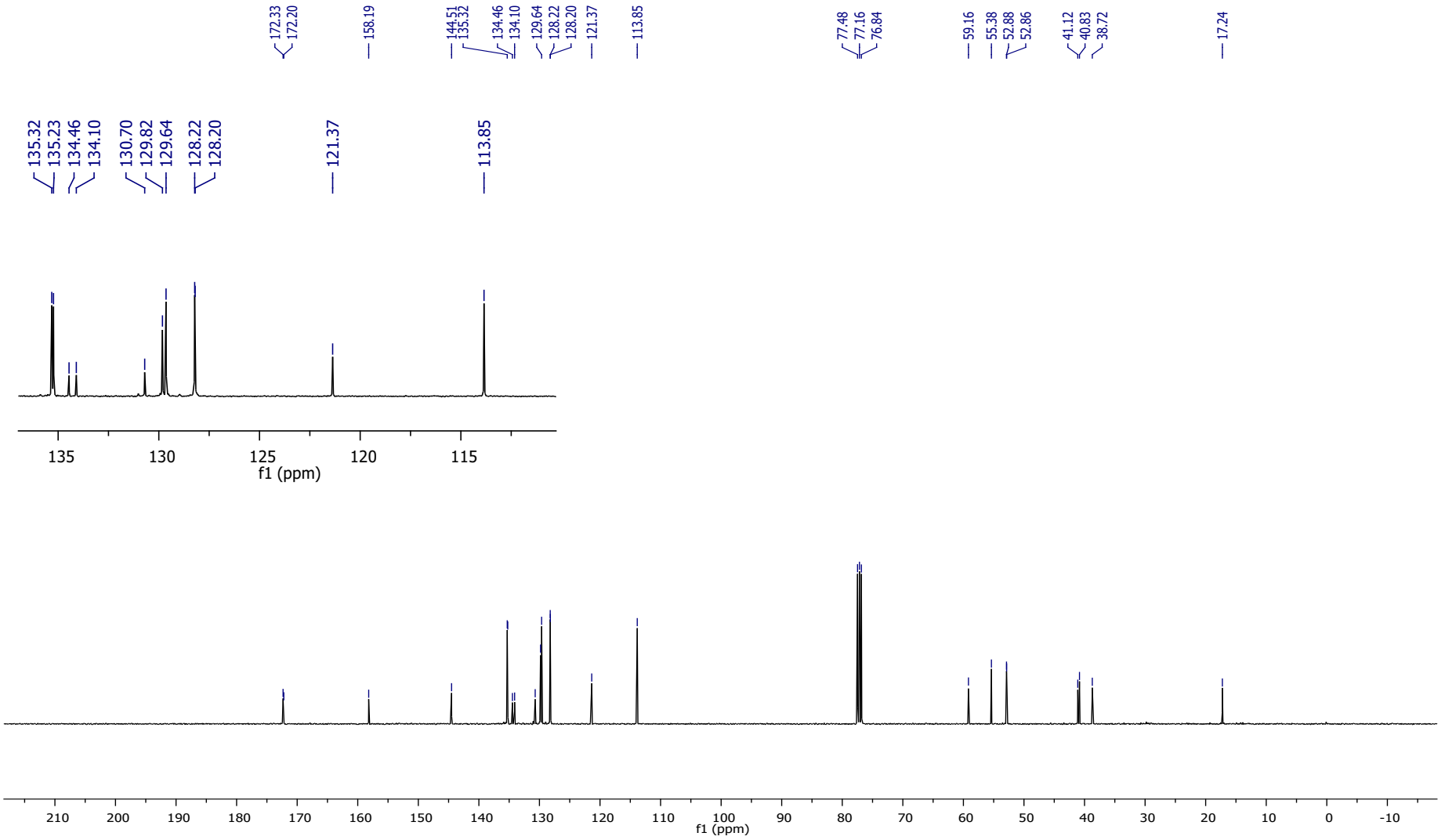
5.03 5.02 5.01 5.01
3.81 3.71 3.63 3.31 3.15 2.78 2.67 2.66 2.64 1.77 1.74 1.72 1.37 1.36 1.33 1.30 1.29 1.28 1.27 1.26 1.26 1.24 1.23
3.36 3.12 3.11 3.11 2.82 2.80 2.78 2.67 2.66 2.64 2.63
1.88 1.85 1.85 1.82 1.78 1.77 1.76 1.74 1.73 1.72
1.00 1.00 1.06 1.03 1.05 1.09
3.4 3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8
f1 (ppm)
4.04 6.11 2.02 2.16 1.04 0.97 3.05 3.03 3.01 1.00 1.00 1.06 1.03 1.05 1.09 2.00
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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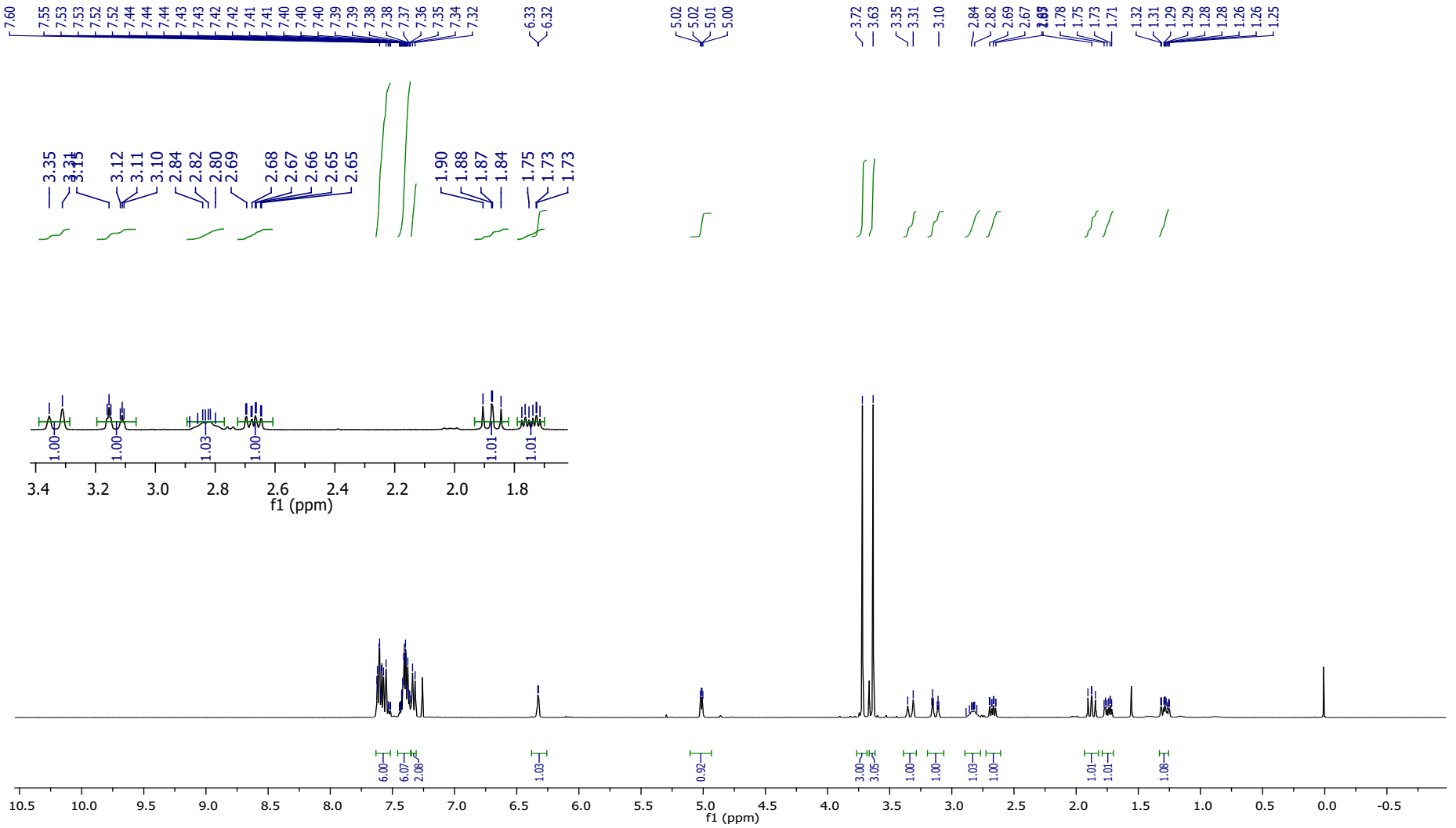
f1 (ppm)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5.02 5.02 5.01 5.00
3.72 3.63 3.35 3.31 3.10 2.84 2.82 2.69 2.67 1.78 1.75 1.73 1.71 1.32 1.31 1.29 1.29 1.28 1.28 1.26 1.26 1.25
3.35 3.31 3.12 3.11 3.10 2.84 2.82 2.80 2.69 2.68 2.67 2.66 2.65 2.65 1.90 1.88 1.87 1.84 1.75 1.73 1.73
1.00 1.00 1.03 1.00 1.01 1.01
3.4 3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8
f1 (ppm)
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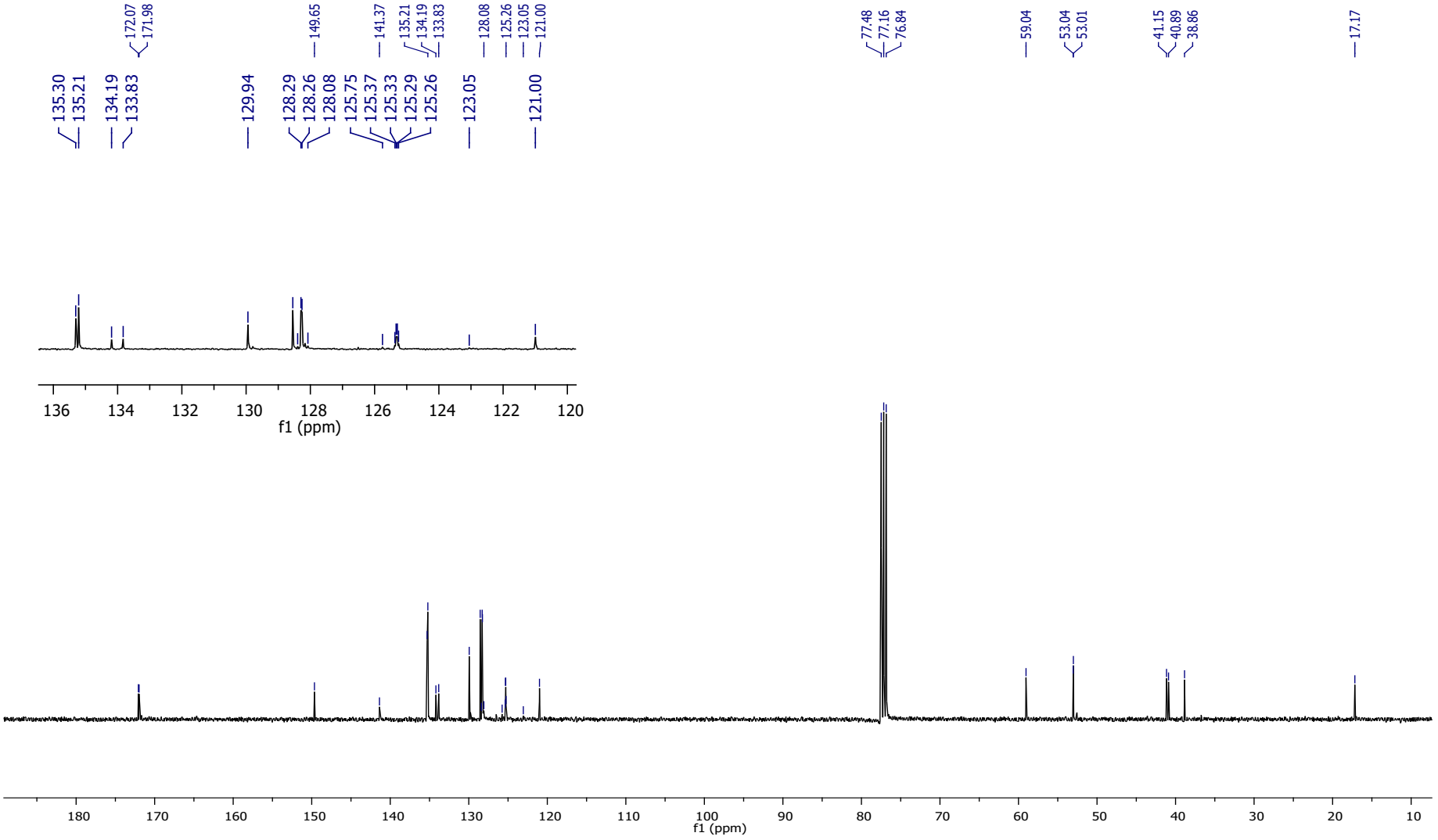
10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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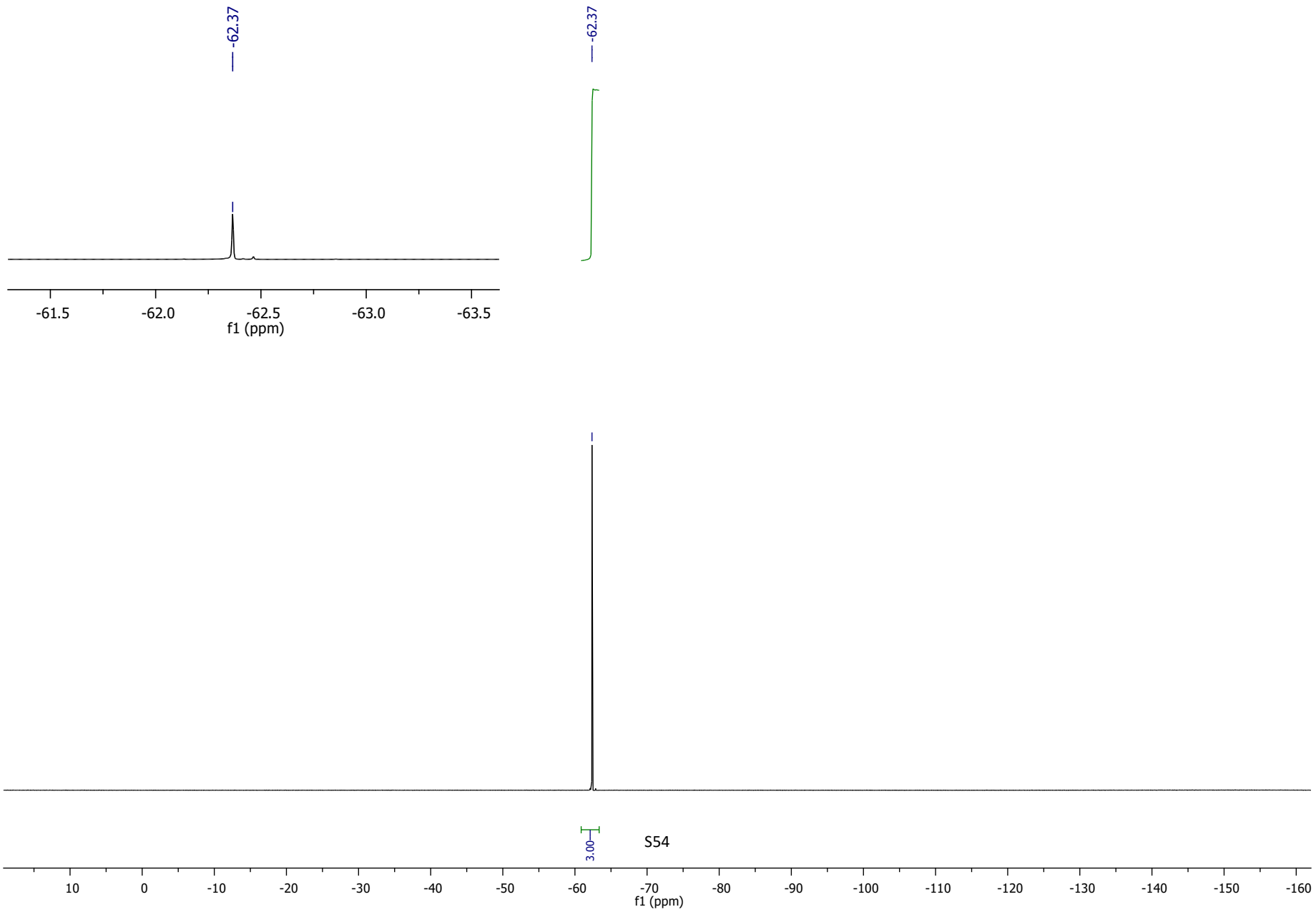
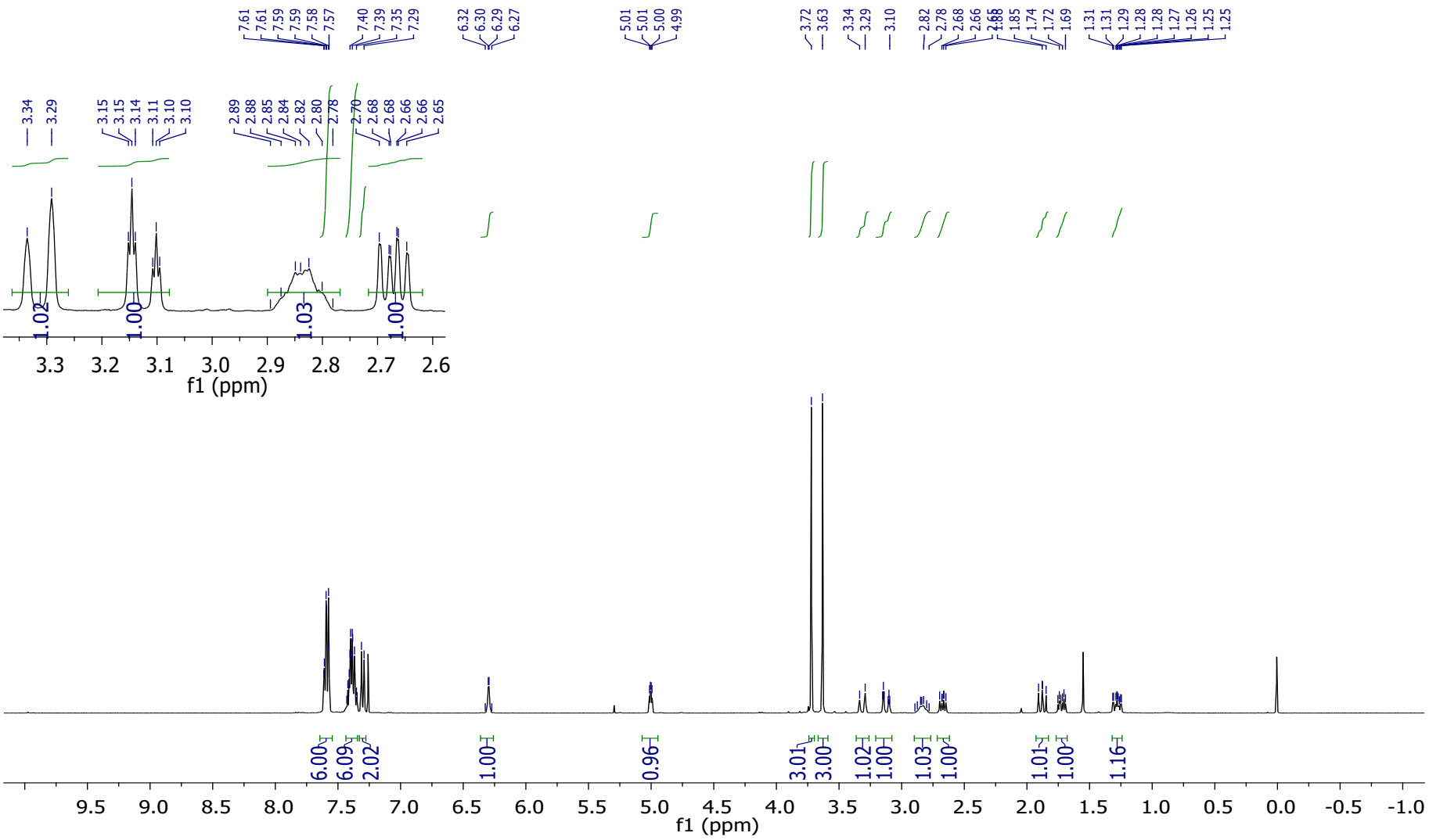
128.08
125.26
123.05
121.00
77.48
77.16
76.84
59.04
53.04
53.01
41.15
40.89
38.86
17.17
135.30
135.21
134.19
133.83
129.94
128.29
128.26
128.08
125.75
125.37
125.33
125.29
125.26
123.05
121.00
136
134
132
130
128
126
124
122
120
f1 (ppm)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


-62.37
-62.37
-61.5
-62.0
-62.5
-63.0
-63.5
f1 (ppm)
3.00
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
f1 (ppm)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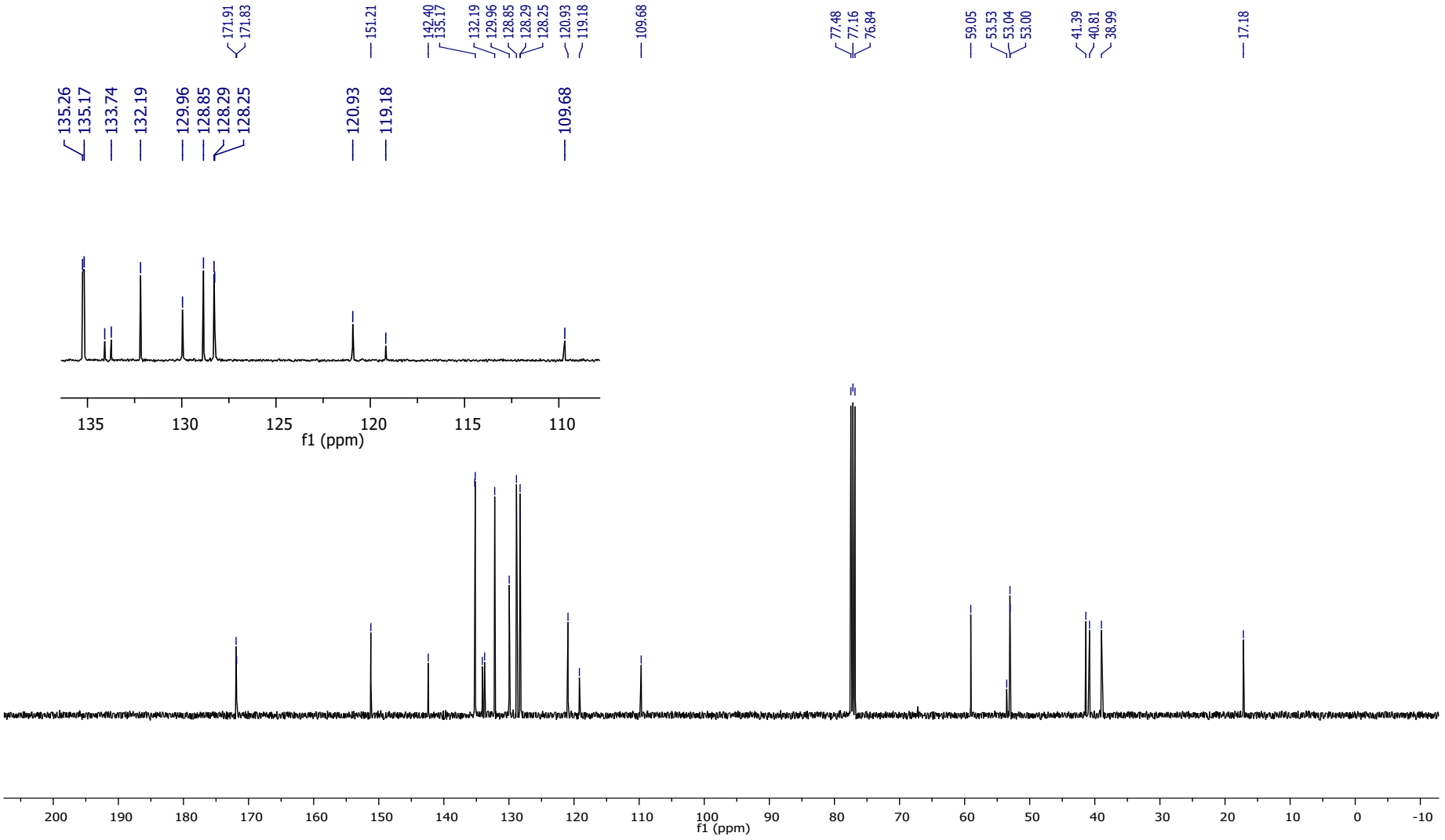
3.34 3.29 3.15 3.15 3.14 3.11 3.10 3.10 2.89 2.88 2.85 2.84 2.82 2.80 2.78 2.70 2.68 2.68 2.66 2.66 2.65
1.02 1.00 1.03 1.00
3.3 3.2 3.1 3.0 2.9 2.8 2.7 2.6
f1 (ppm)
6.00 6.09 2.02 1.00 0.96 3.01 3.00 1.02 1.00 1.03 1.00 1.01 1.00 1.16
9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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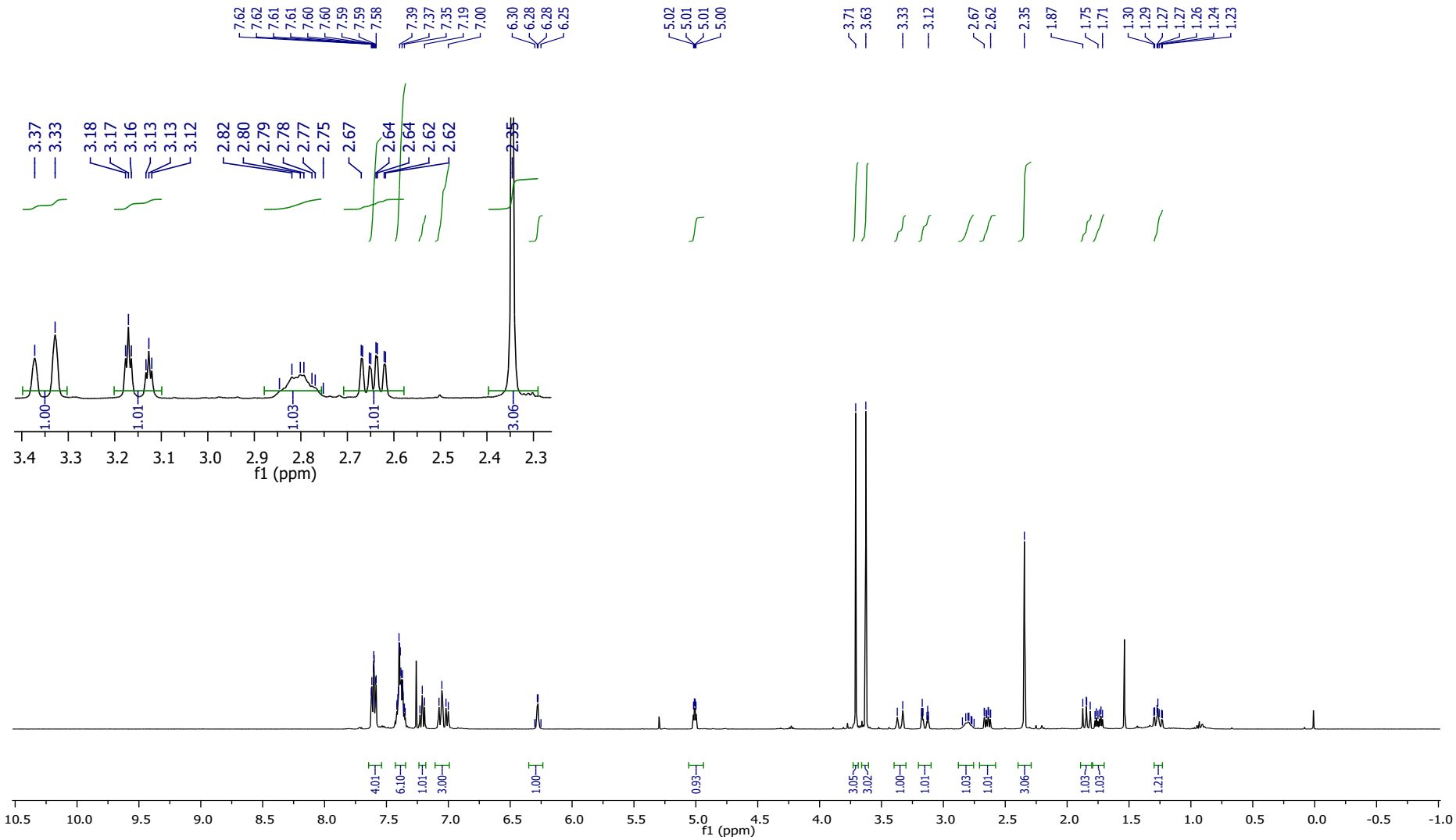
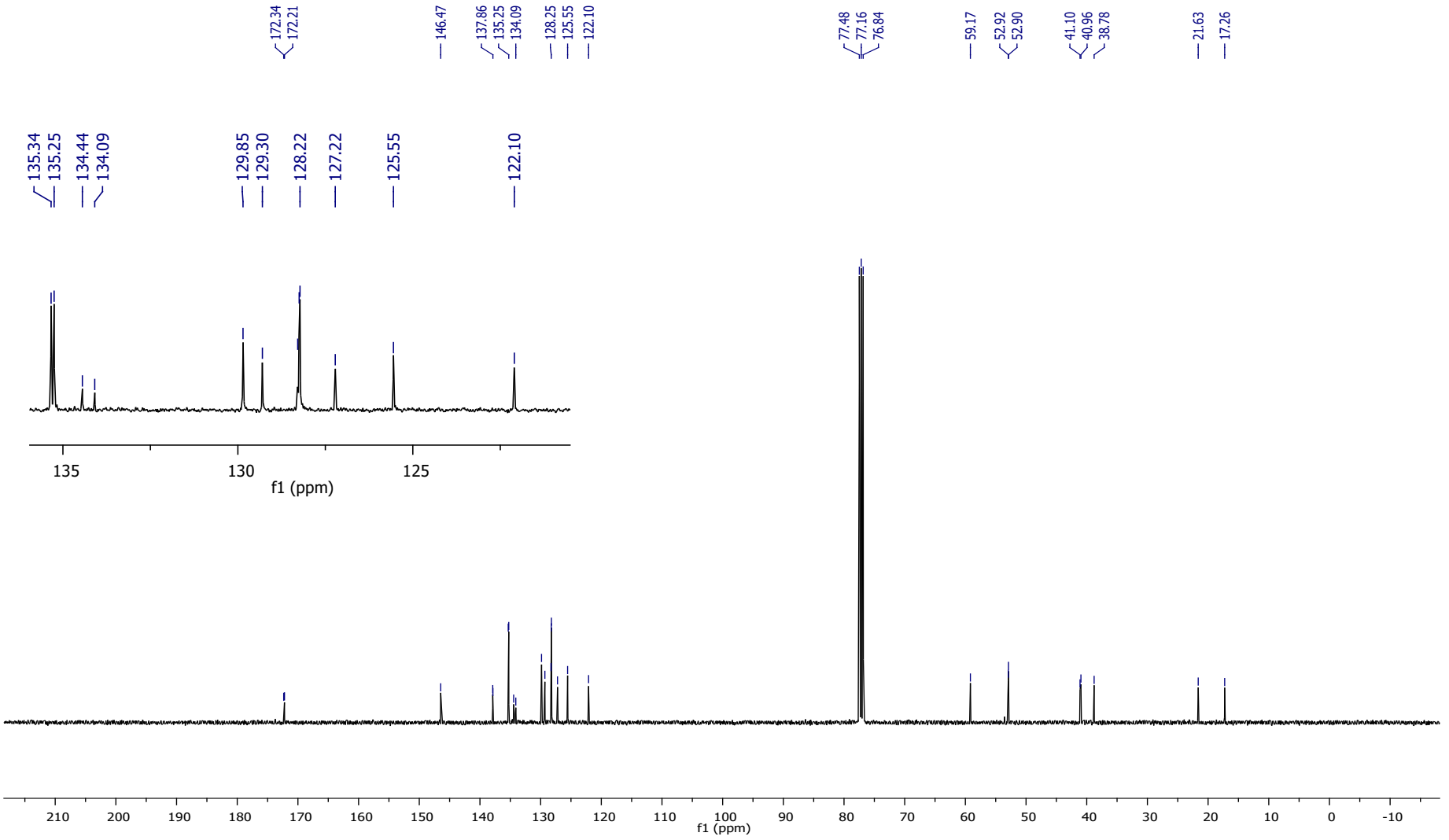
171.83
151.21
142.40
135.17
132.19
129.96
128.85
128.29
128.25
120.93
119.18
109.68
77.48
77.16
76.84
59.05
53.53
53.04
53.00
41.39
40.81
38.99
17.18
135.26
135.17
133.74
132.19
129.96
128.85
128.29
128.25
120.93
119.18
109.68
135
130
125
120
115
110
f1 (ppm)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.62 7.62 7.61 7.61 7.60 7.60 7.59 7.59 7.58 7.39 7.37 7.35 7.19 7.00 6.30 6.28 6.28 6.25
5.02 5.01 5.01 5.00
3.71 3.63 3.33 3.12 2.67 2.62 2.35 1.87 1.75 1.71 1.30 1.29 1.27 1.27 1.26 1.24 1.23
3.37 3.33 3.18 3.17 3.16 3.13 3.13 3.12 2.82 2.80 2.79 2.78 2.77 2.75 2.67 2.64 2.64 2.62 2.62 2.35
1.00 1.01 1.03 1.01 3.06
3.4 3.3 3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3
f1 (ppm)
4.01 6.10 1.01 3.00 1.00 0.93 3.05 3.02 1.00 1.01 1.03 1.01 3.06 1.03 1.03 1.21
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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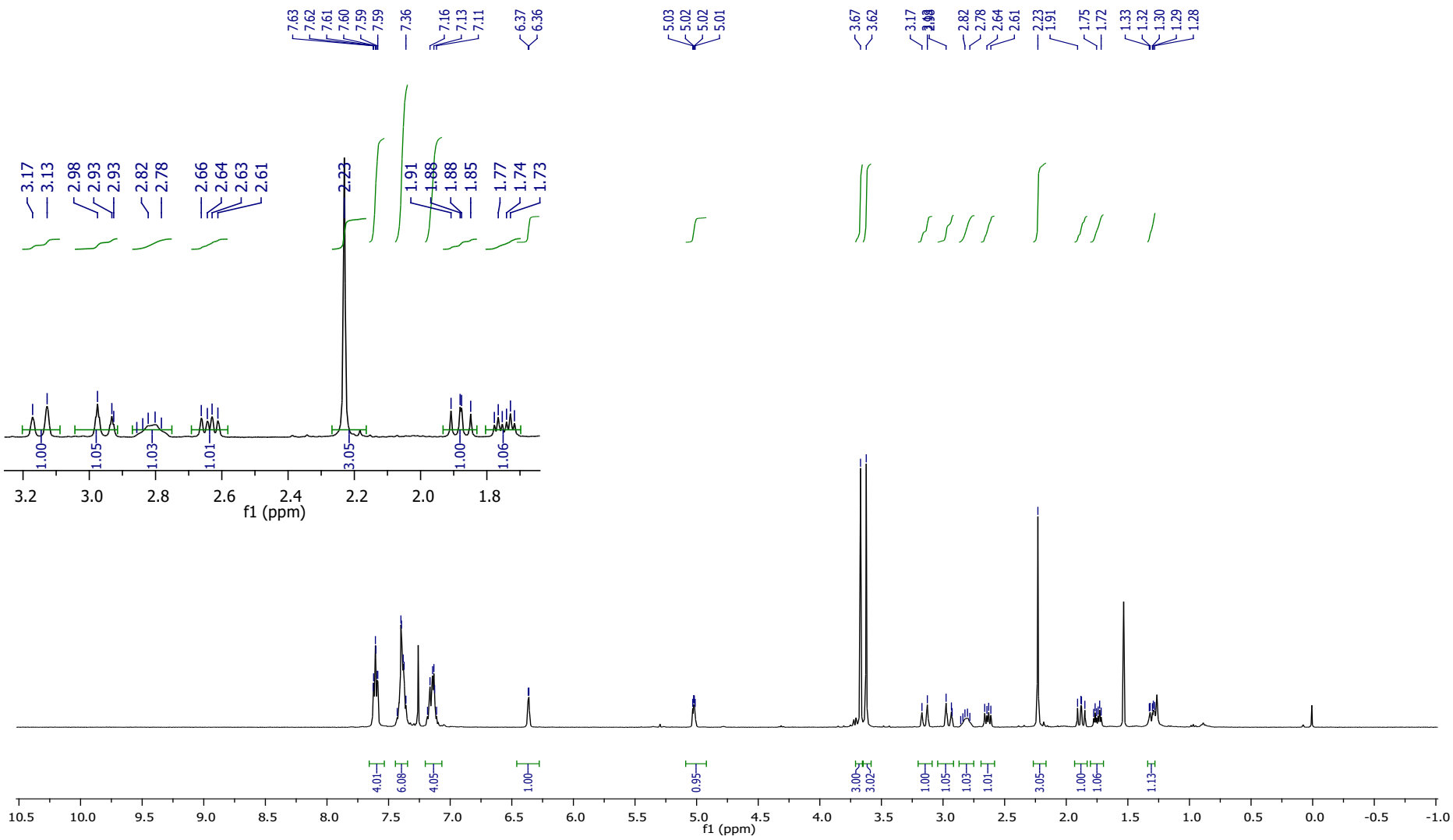
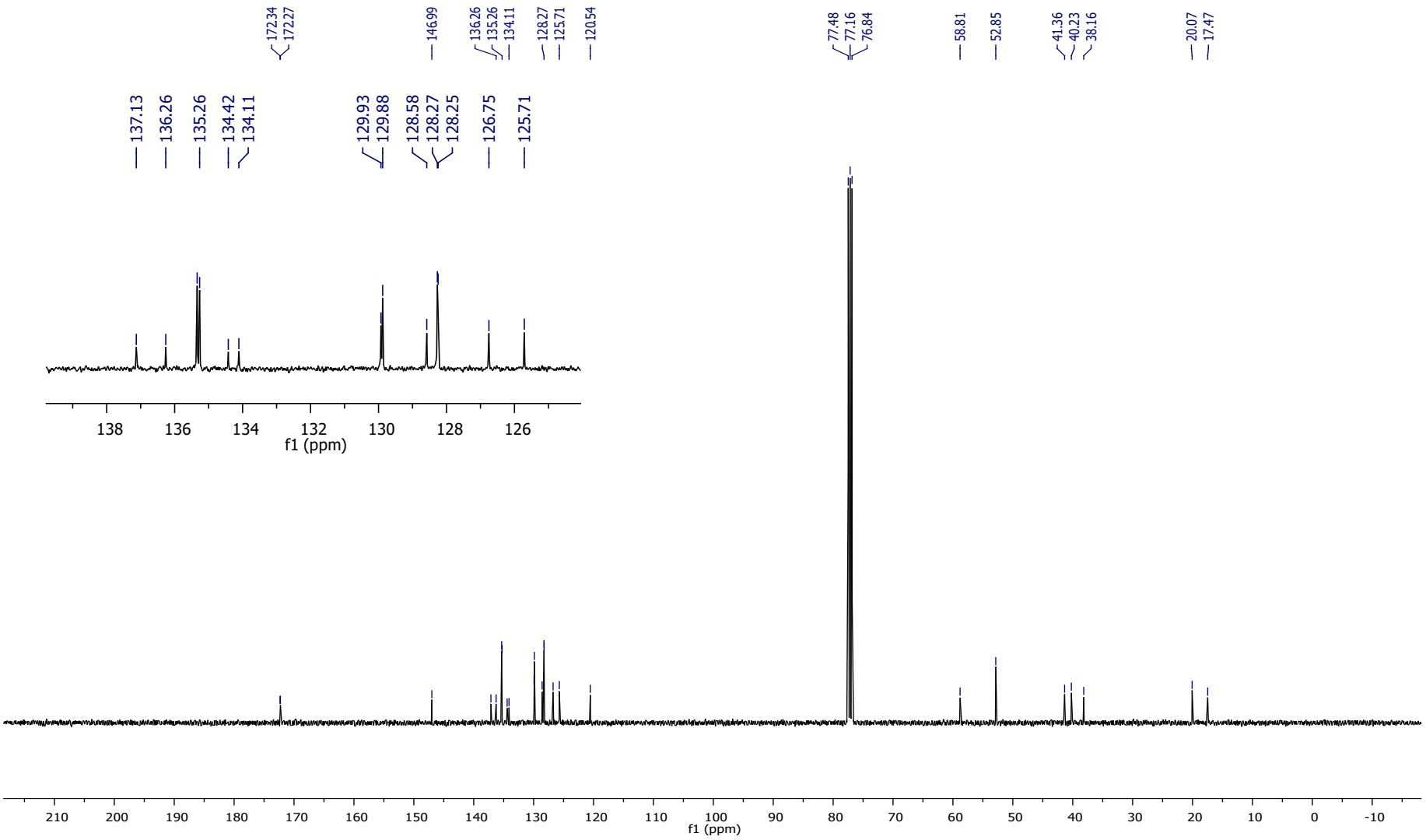
172.21
146.47
137.86
135.25
134.09
128.25
125.55
122.10
77.48
77.16
76.84
59.17
52.92
52.90
41.10
40.96
38.78
21.63
17.26
135.34
135.25
134.44
134.09
129.85
129.30
128.22
127.22
125.55
122.10
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.63
7.62
7.61
7.60
7.59
7.59
7.36
7.16
7.13
7.11
6.37
6.36
5.03
5.02
5.02
5.01
3.67
3.62
3.17
2.82
2.78
2.64
2.61
2.23
1.91
1.75
1.72
1.33
1.32
1.30
1.29
1.28
3.17
3.13
2.98
2.93
2.93
2.82
2.78
2.66
2.64
2.63
2.61
2.23
1.91
1.88
1.88
1.85
1.77
1.74
1.73
1.00
1.05
1.03
1.01
3.05
1.00
1.06
3.2
3.0
2.8
2.6
2.4
2.2
2.0
1.8
f1 (ppm)
4.01
6.08
4.05
1.00
0.95
3.00
3.02
1.00
1.05
1.03
1.01
3.05
1.00
1.06
1.13
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)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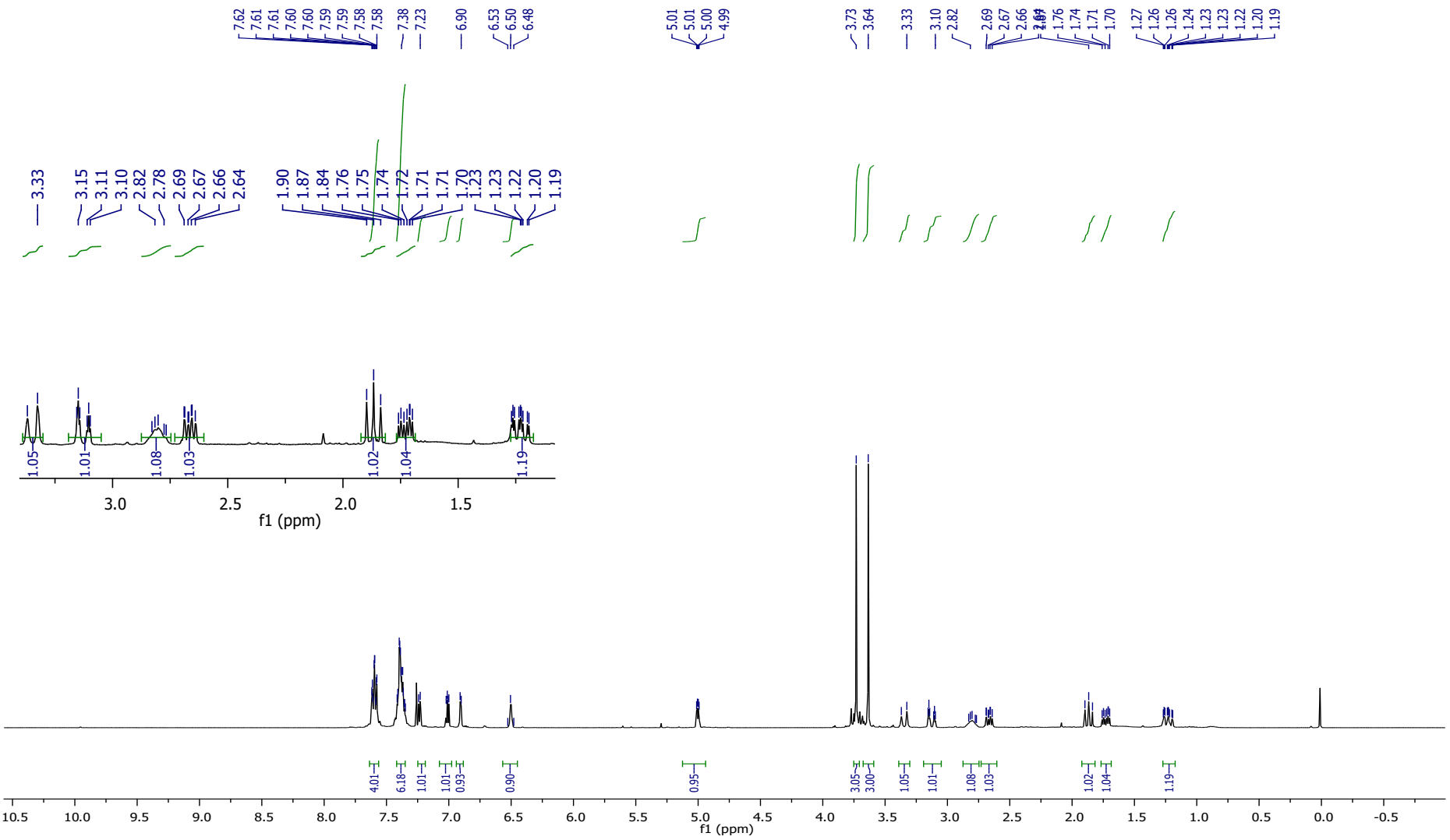
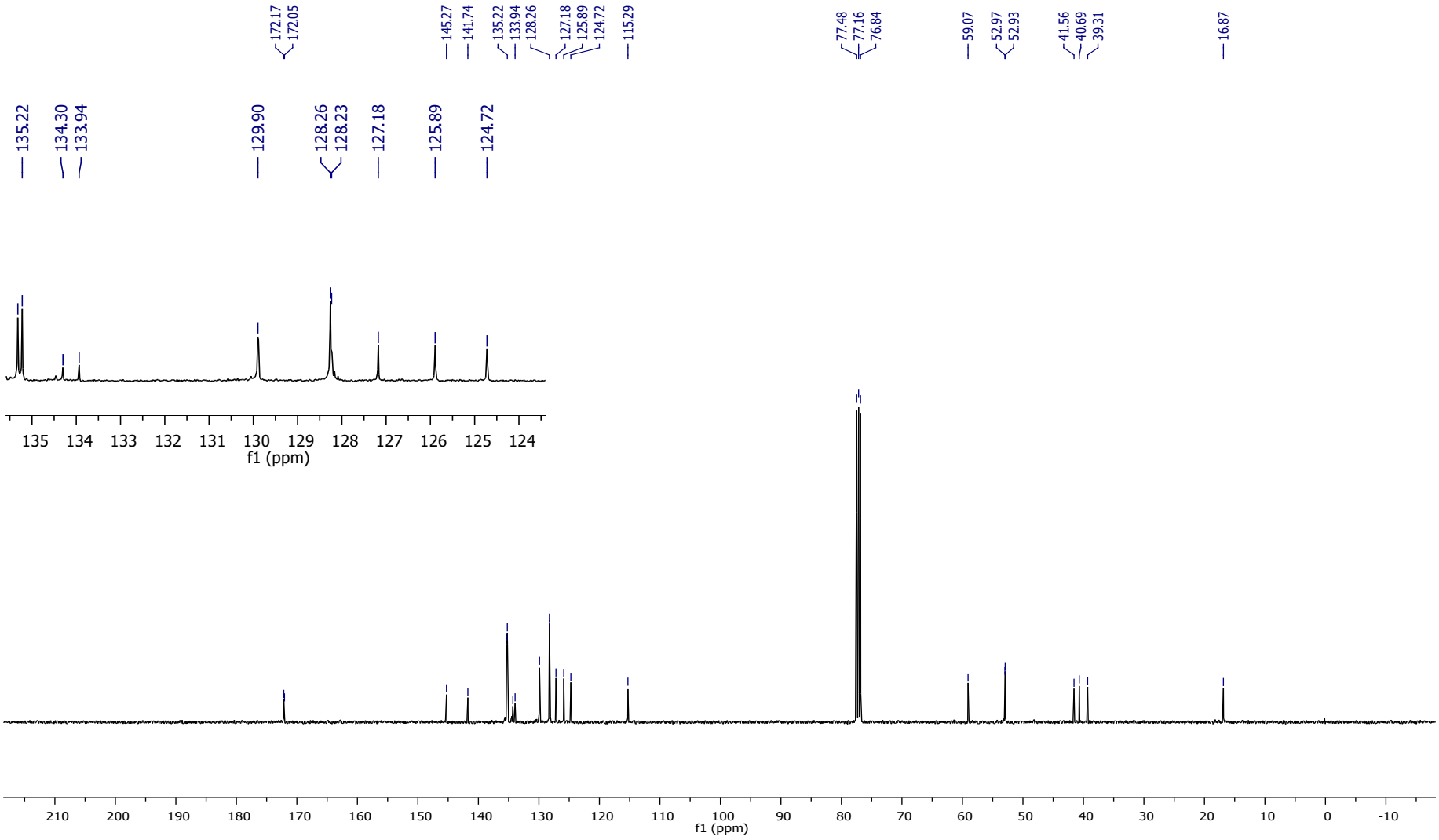
172.27
146.99
136.26
135.26
134.11
128.27
125.71
120.54
77.48
77.16
76.84
58.81
52.85
41.36
40.23
38.16
20.07
17.47
137.13
136.26
135.26
134.42
134.11
129.93
129.88
128.58
128.27
128.25
126.75
125.71
138
136
134
132
130
128
126
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.62 7.61 7.61 7.60 7.60 7.59 7.59 7.58 7.58 7.38 7.23 6.90 6.53 6.50 6.48
5.01 5.01 5.00 4.99
3.73 3.64 3.33 3.10 2.82 2.69 2.67 2.66 1.76 1.74 1.71 1.70 1.27 1.26 1.26 1.24 1.23 1.23 1.22 1.20 1.19
3.33 3.15 3.11 3.10 2.82 2.78 2.69 2.67 2.66 2.64 1.90 1.87 1.84 1.76 1.75 1.74 1.72 1.71 1.71 1.70 1.23 1.23 1.22 1.20 1.19
1.05 1.01 1.08 1.03 1.02 1.04 1.19
3.0 2.5 2.0 1.5
f1 (ppm)
4.01 6.18 1.01 1.01 0.93 0.90 0.95 3.05 3.00 1.05 1.01 1.08 1.03 1.02 1.04 1.19
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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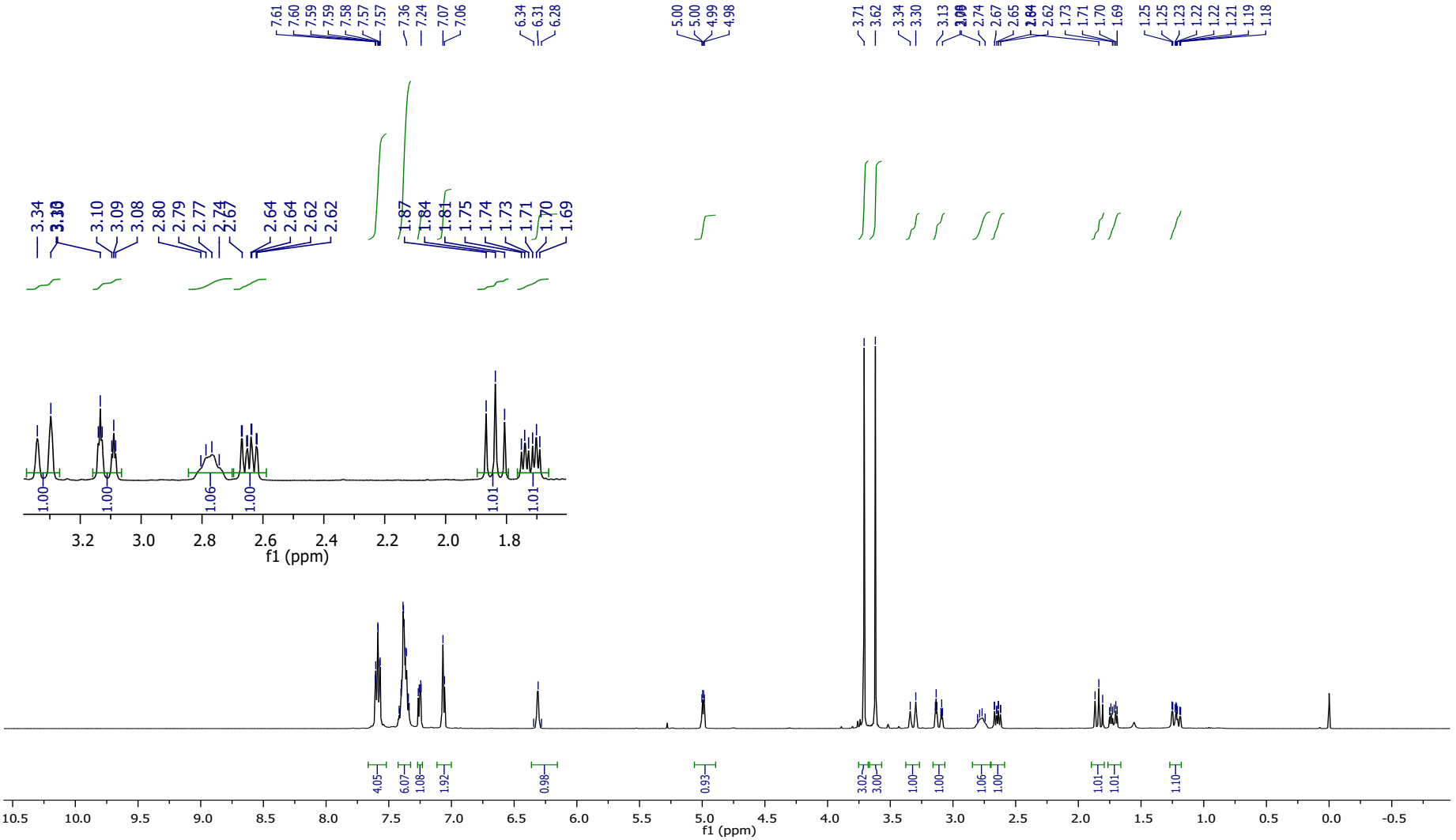
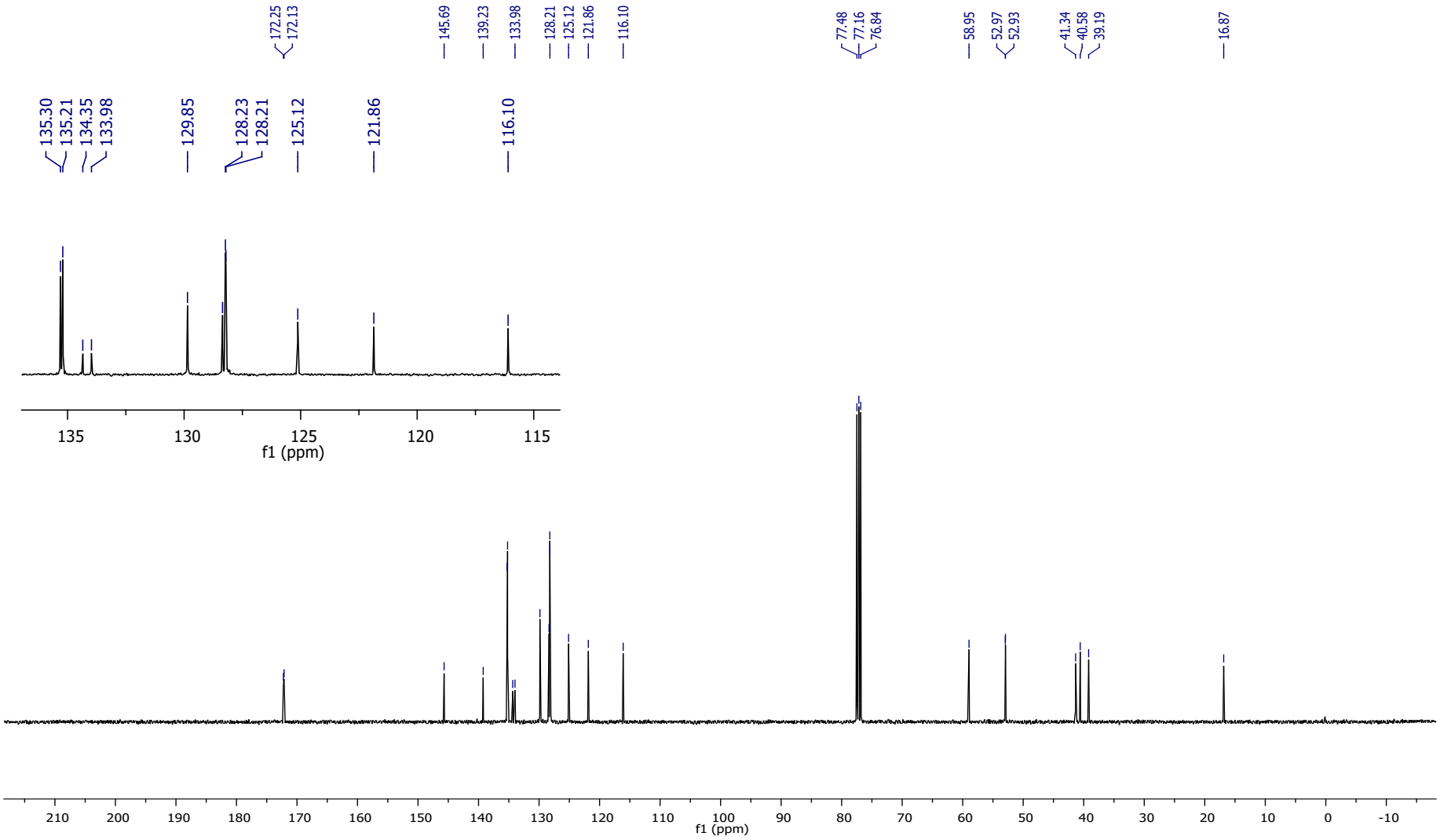
141.74
135.22
133.94
128.26
127.18
125.89
124.72
115.29
77.48
77.16
76.84
59.07
52.97
52.93
41.56
40.69
39.31
16.87
135.22
134.30
133.94
129.90
128.26
128.23
127.18
125.89
124.72
135 134 133 132 131 130 129 128 127 126 125 124
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.61 7.60 7.59 7.59 7.58 7.57 7.57 7.36 7.24 7.07 7.06 6.34 6.31 6.28
5.00 5.00 4.99 4.98
3.71 3.62 3.34 3.30 3.13 2.74 2.67 2.65 2.62 1.73 1.71 1.70 1.69
1.25 1.25 1.23 1.22 1.22 1.21 1.19 1.18
3.34 3.10 3.09 3.08 2.80 2.79 2.77 2.64 2.64 2.62 2.62 1.87 1.84 1.81 1.75 1.74 1.73 1.71 1.70 1.69
1.00 1.00 1.06 1.00 1.01 1.01
3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8
f1 (ppm)
4.05 6.07 1.08 1.92 0.98 0.93 3.02 3.00 1.00 1.00 1.06 1.00 1.01 1.01 1.10
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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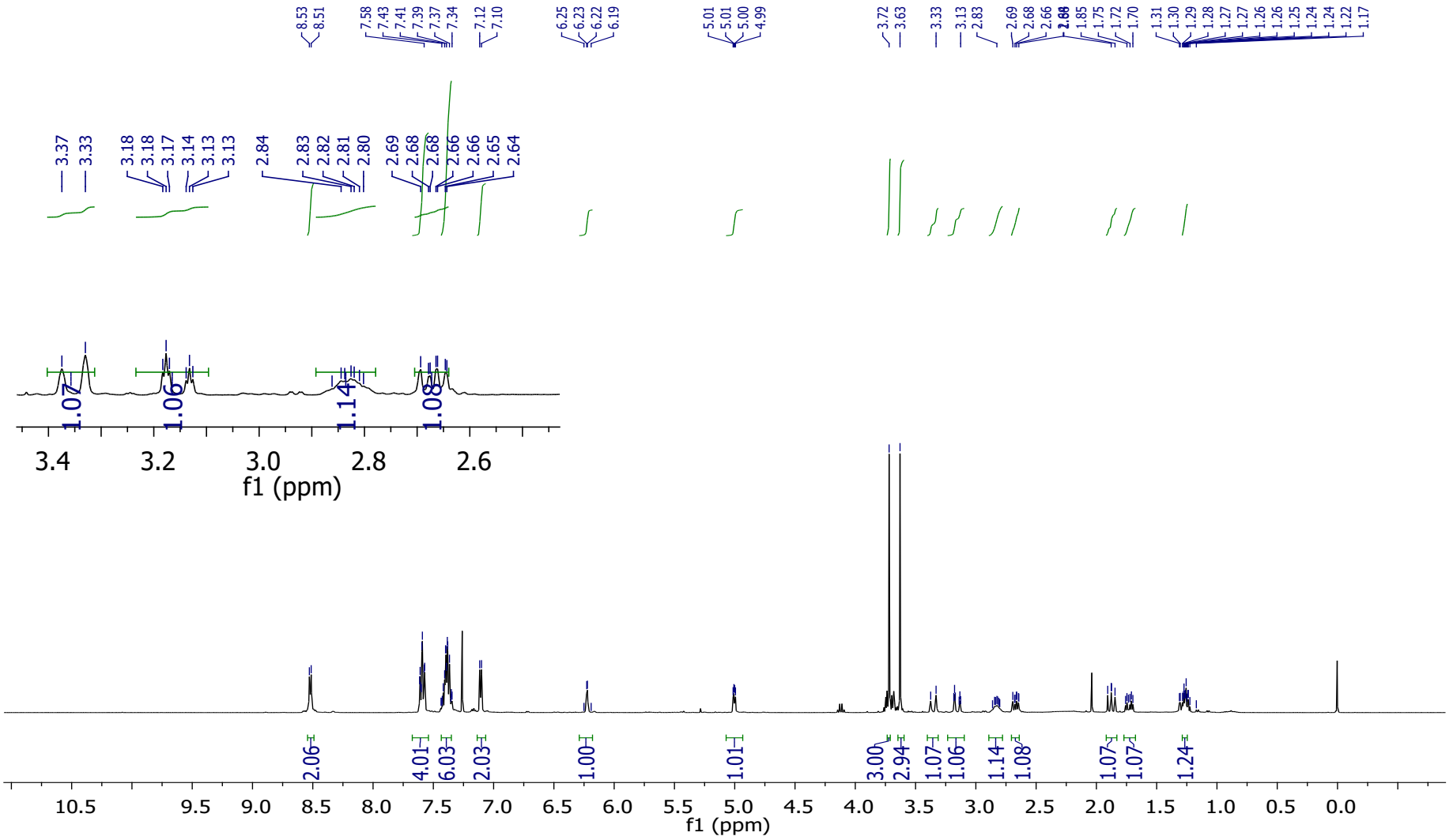
172.13
145.69
139.23
133.98
128.21
125.12
121.86
116.10
77.48
77.16
76.84
58.95
52.97
52.93
41.34
40.58
39.19
16.87
135.30
135.21
134.35
133.98
129.85
128.23
128.21
125.12
121.86
116.10
135
130
125
120
115
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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7.39
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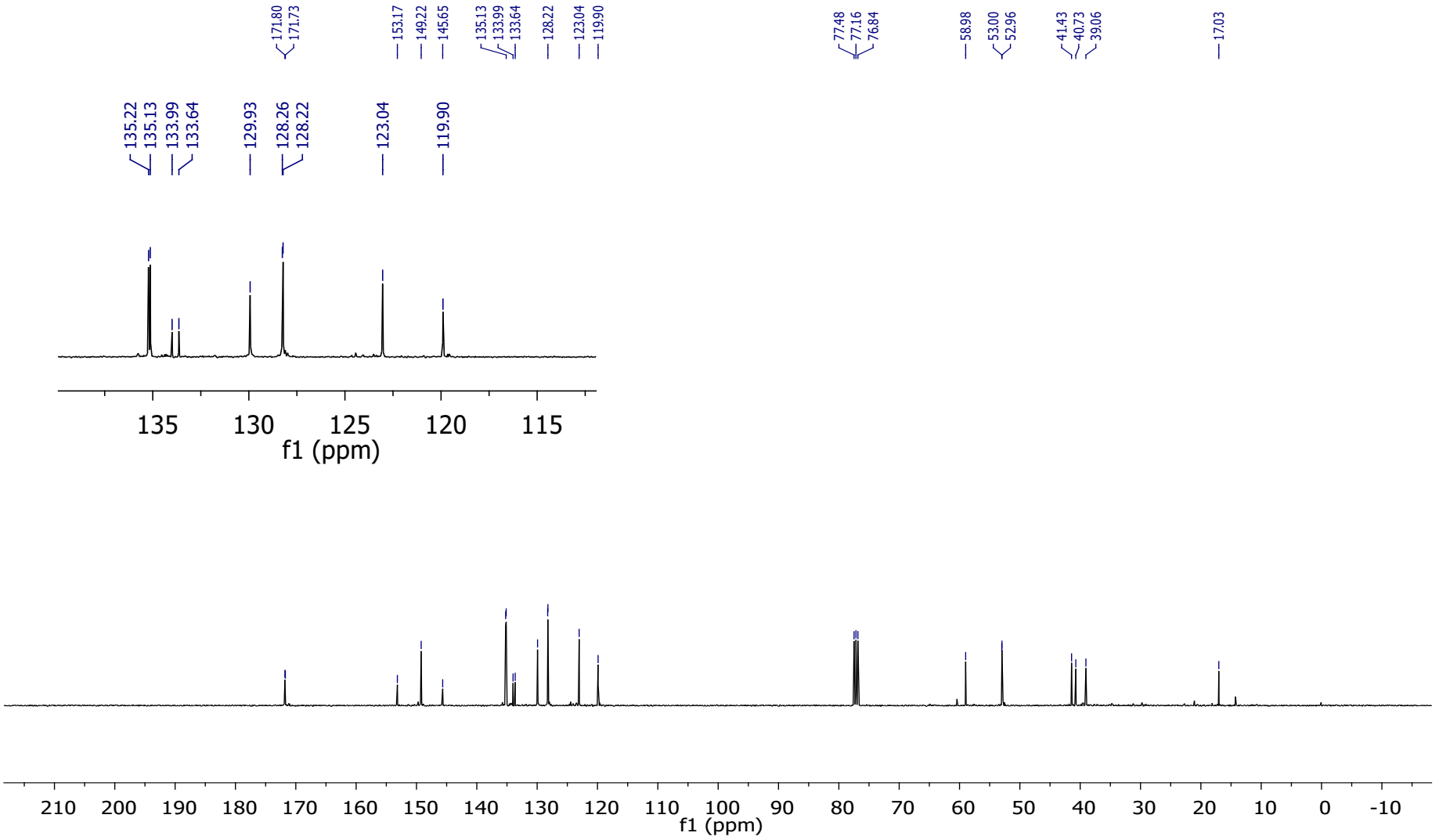
7.34
7.12
7.10
6.25
6.23
6.22
6.19
5.01
5.01
5.00
4.99
3.72
3.63
3.33
3.13
2.83
2.69
2.68
2.66
1.85
1.75
1.72
1.70
1.31
1.30
1.29
1.28
1.27
1.27
1.26
1.26
1.25
1.24
1.24
1.22
1.17
3.37
3.33
3.18
3.18
3.17
3.14
3.13
3.13
2.84
2.83
2.82
2.81
2.80
2.69
2.68
2.68
2.66
2.66
2.65
2.64
1.07
1.06
1.14
1.08
3.4
3.2
3.0
2.8
2.6
f1 (ppm)
2.06
4.01
6.03
2.03
1.00
1.01
3.00
2.94
1.07
1.06
1.14
1.08
1.07
1.07
1.24
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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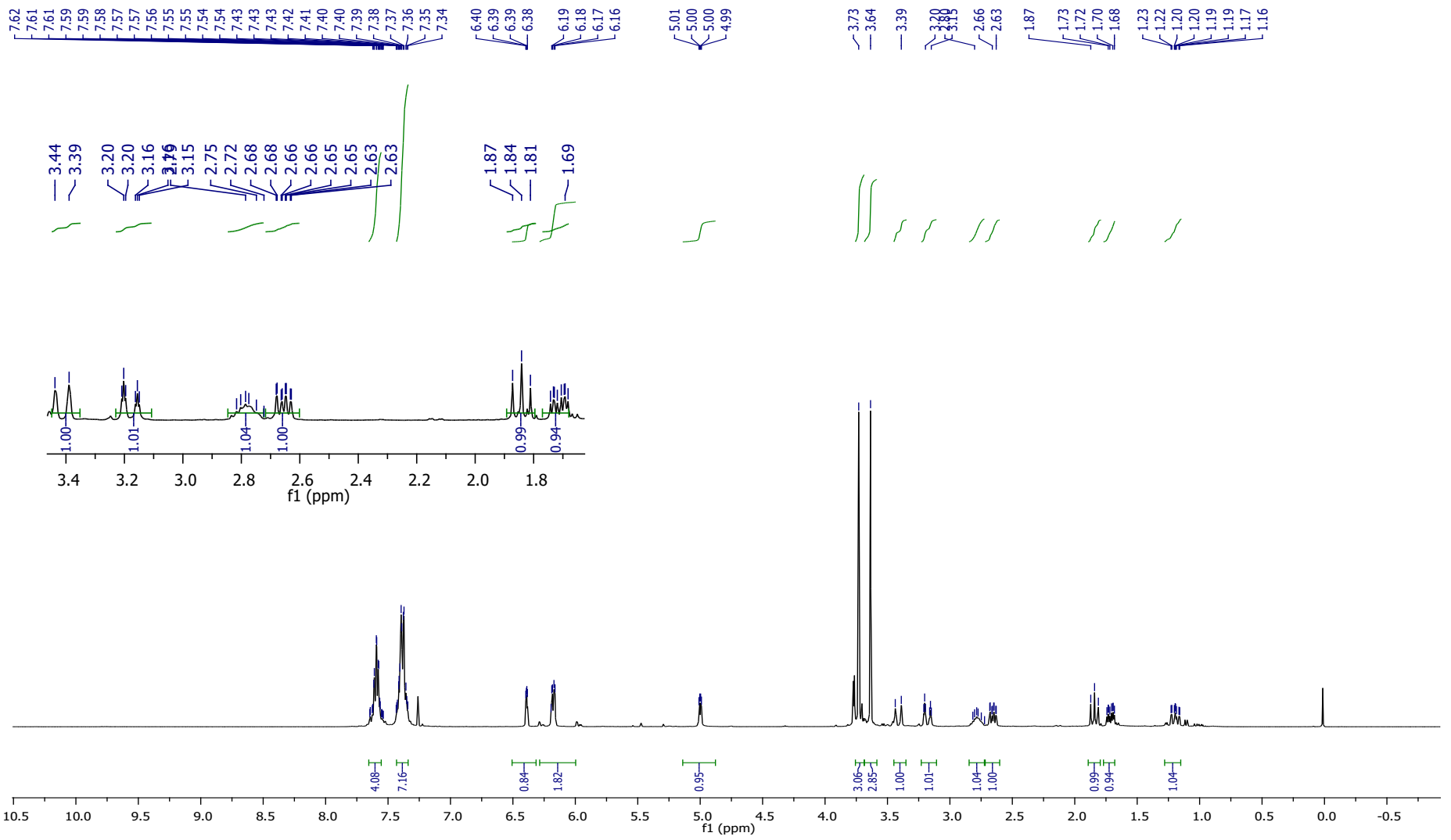
145.65
135.13
133.99
133.64
128.22
123.04
119.90
77.48
77.16
76.84
58.98
53.00
52.96
41.43
40.73
39.06
17.03
135.22
135.13
133.99
133.64
129.93
128.26
128.22
123.04
119.90
135
130
125
120
115
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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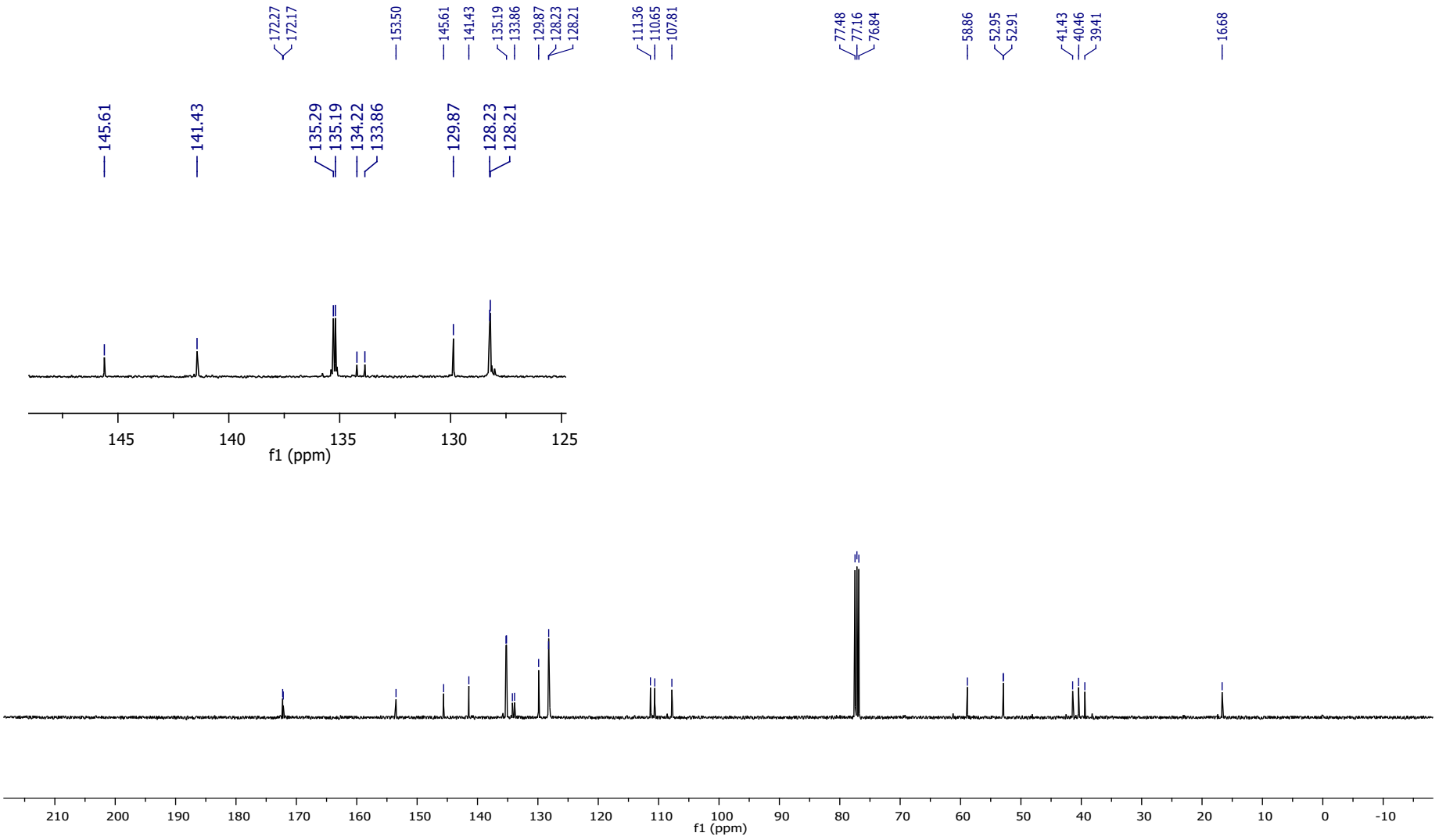
6.40 6.39 6.39 6.38 6.19 6.18 6.17 6.16
5.01 5.00 5.00 4.99
3.73 3.64 3.39 3.20 3.15 2.66 2.63 1.87 1.73 1.72 1.70 1.68 1.23 1.22 1.20 1.20 1.19 1.19 1.17 1.16
3.44 3.39 3.20 3.20 3.16 3.15 2.75 2.72 2.68 2.68 2.66 2.66 2.65 2.65 2.63 2.63 1.87 1.84 1.81 1.69
1.00 1.01 1.04 1.00 0.99 0.94
3.4 3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8
f1 (ppm)
4.08 7.16 0.84 1.82 0.95 3.06 2.85 1.00 1.01 1.04 1.00 0.99 0.94 1.04
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)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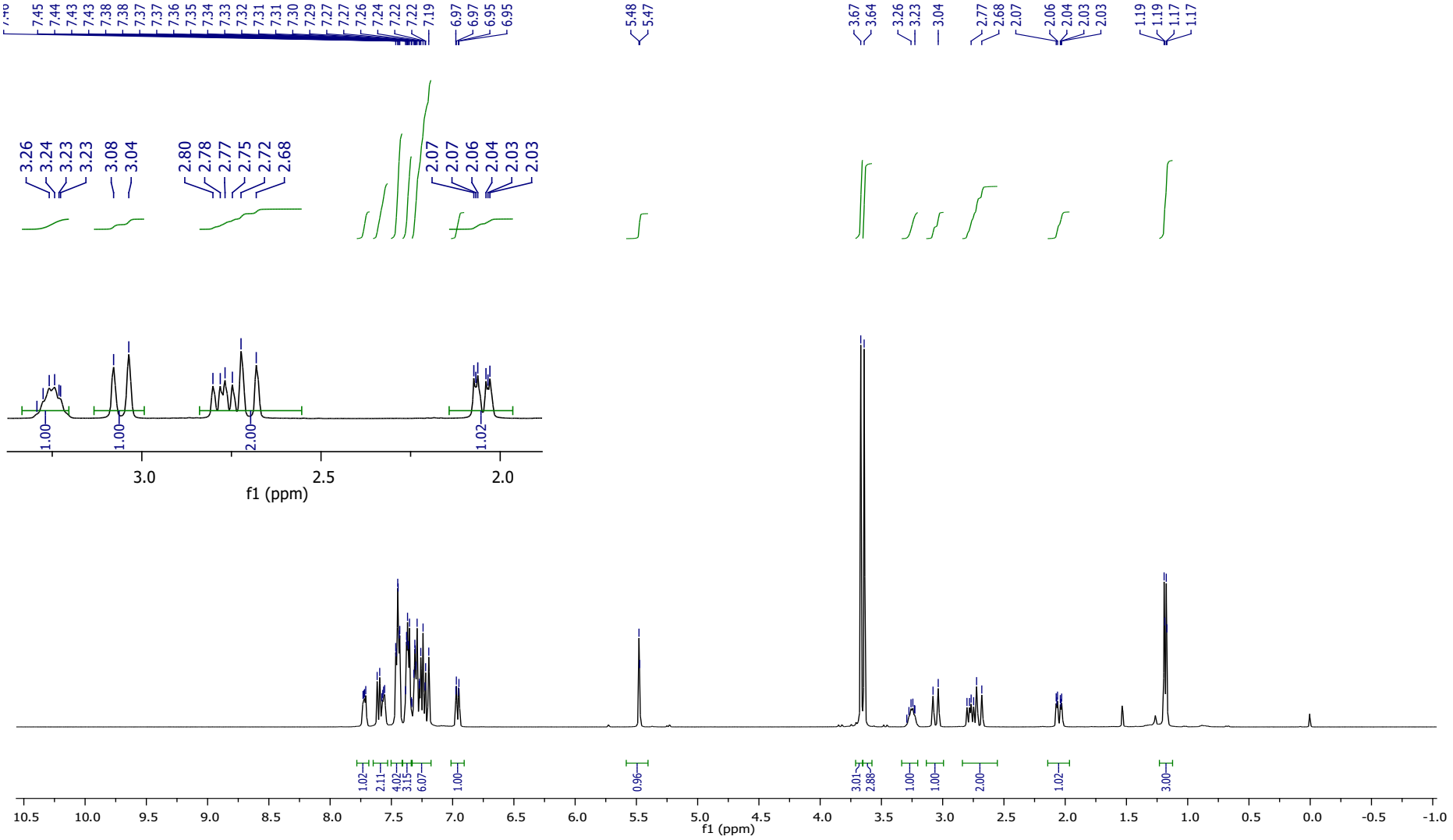
141.43
135.19
133.86
129.87
128.23
128.21
111.36
110.65
107.81
77.48
77.16
76.84
58.86
52.95
52.91
41.43
40.46
39.41
16.68
145.61
141.43
135.29
135.19
134.22
133.86
129.87
128.23
128.21
145
140
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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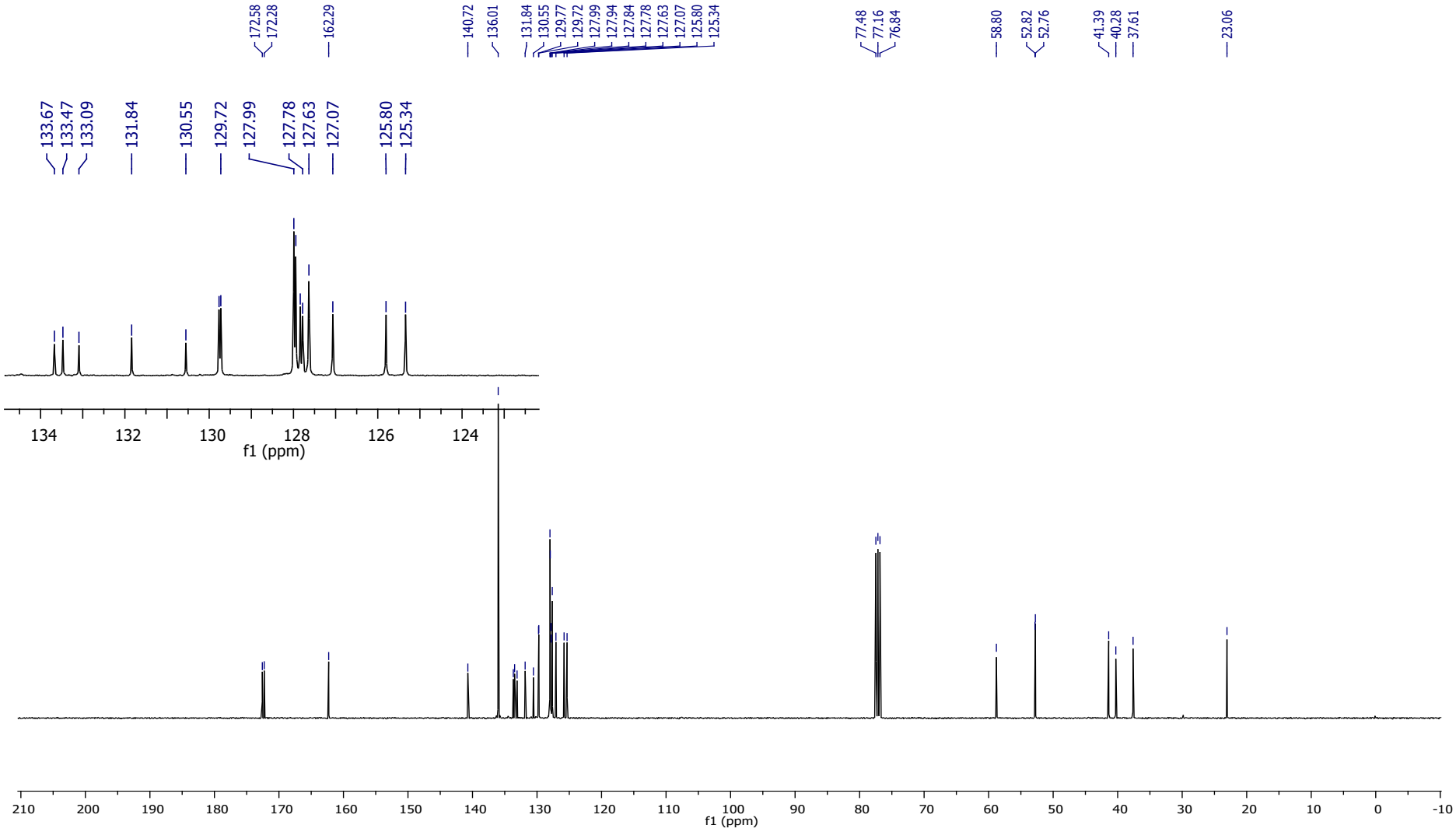
7.44
7.43
7.43
7.38
7.38
7.37
7.37
7.36
7.35
7.34
7.33
7.32
7.31
7.31
7.30
7.29
7.27
7.27
7.26
7.24
7.22
7.22
7.19
6.97
6.97
6.95
6.95
5.48
5.47
3.67
3.64
3.26
3.23
3.04
2.77
2.68
2.07
2.06
2.04
2.03
2.03
1.19
1.19
1.17
1.17
3.26
3.24
3.23
3.23
3.08
3.04
2.80
2.78
2.77
2.75
2.72
2.68
2.07
2.07
2.06
2.04
2.03
2.03
1.00
1.00
2.00
1.02
3.0
2.5
2.0
f1 (ppm)
1.02
2.11
4.02
3.15
6.07
1.00
0.96
3.01
2.88
1.00
1.00
2.00
1.02
3.00
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)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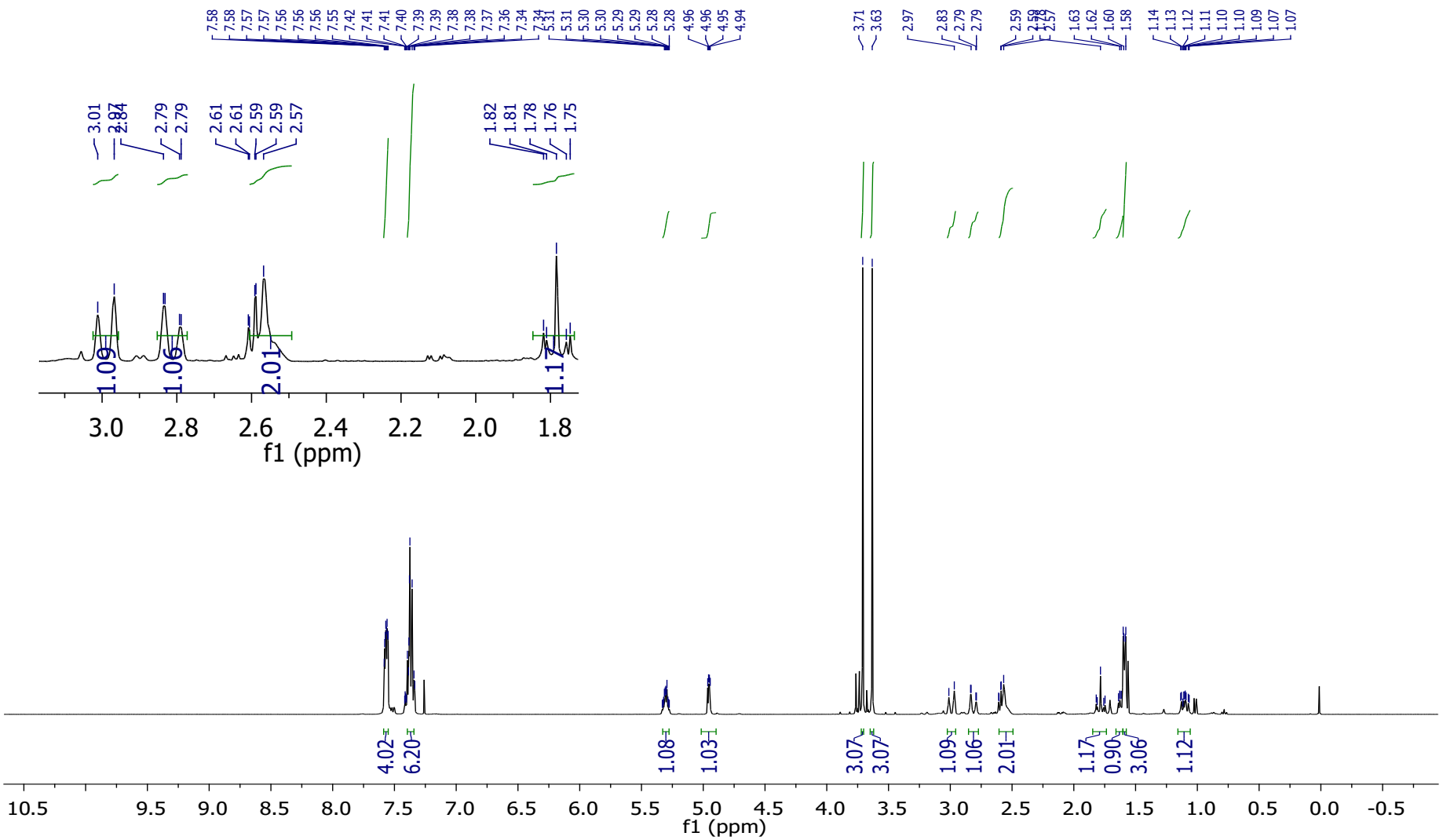
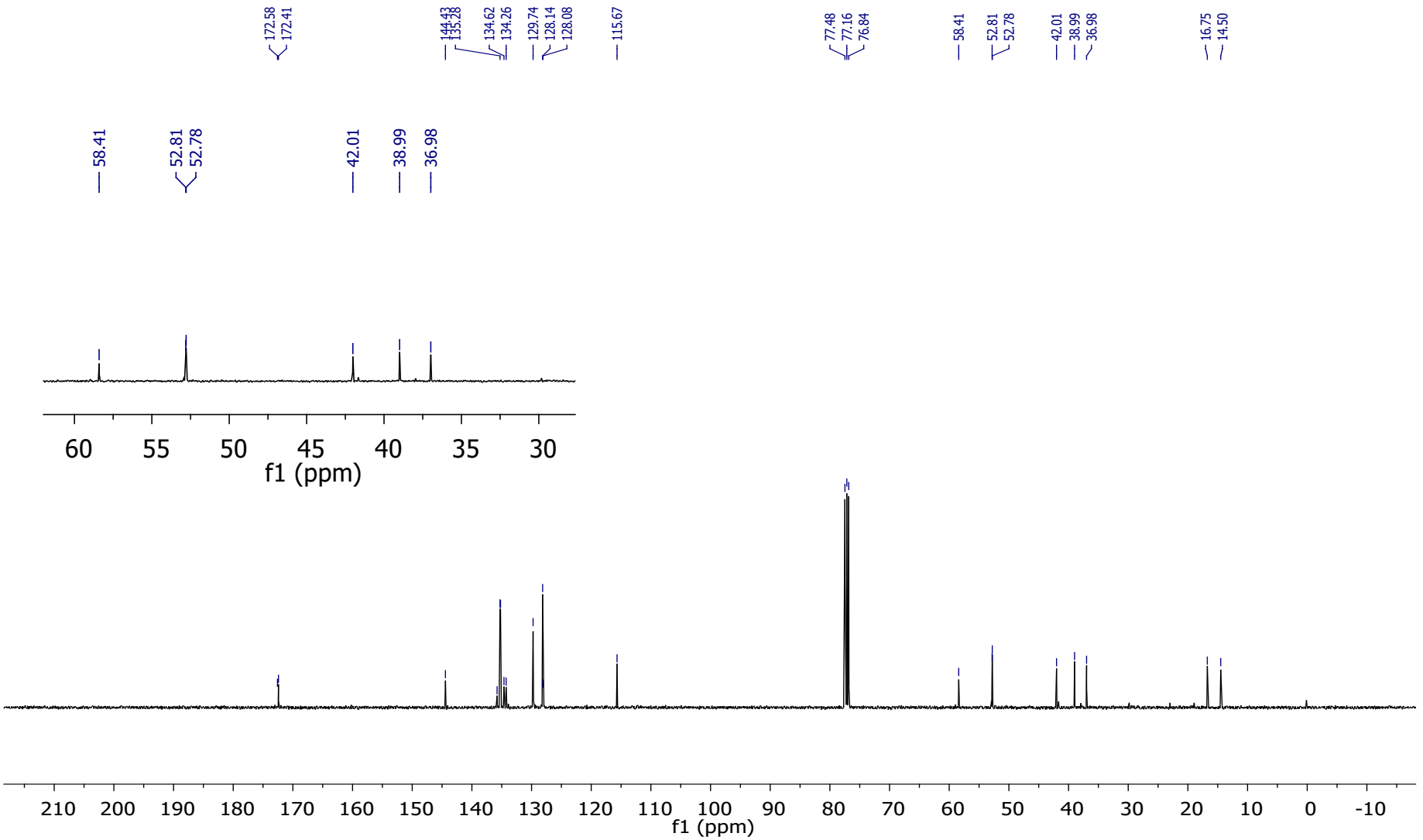
172.28
162.29
140.72
136.01
131.84
130.55
129.77
129.72
127.99
127.94
127.84
127.78
127.63
127.07
125.80
125.34
77.48
77.16
76.84
58.80
52.82
52.76
41.39
40.28
37.61
23.06
133.67
133.47
133.09
131.84
130.55
129.72
127.99
127.78
127.63
127.07
125.80
125.34
134
132
130
128
126
124
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.58 7.58 7.57 7.57 7.56 7.56 7.56 7.55 7.42 7.41 7.41 7.40 7.39 7.39 7.38 7.38 7.37 7.36 7.34 7.34 5.31 5.30 5.30 5.29 5.29 5.28 5.28 4.96 4.96 4.95 4.94
3.71 3.63 2.97 2.83 2.79 2.79 2.59 1.63 1.62 1.60 1.58 1.14 1.13 1.12 1.11 1.10 1.10 1.09 1.07 1.07
3.01 2.84 2.79 2.79 2.61 2.61 2.59 2.59 2.57 1.82 1.81 1.78 1.76 1.75
1.09 1.06 2.01 1.17
3.0 2.8 2.6 2.4 2.2 2.0 1.8
f1 (ppm)
4.02 6.20 1.08 1.03 3.07 3.07 1.09 1.06 2.01 1.17 0.90 3.06 1.12
10.5 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
f1 (ppm)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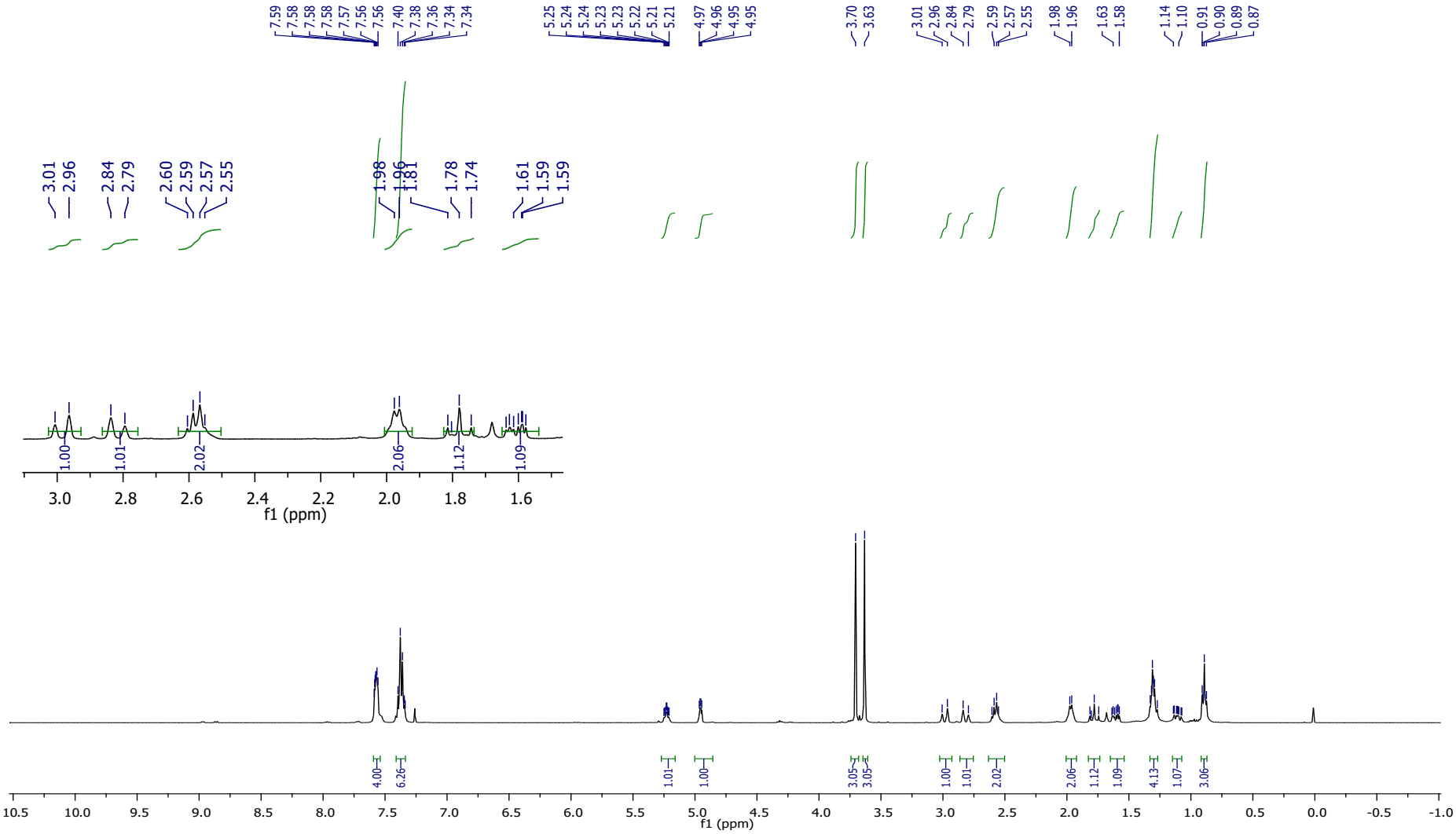
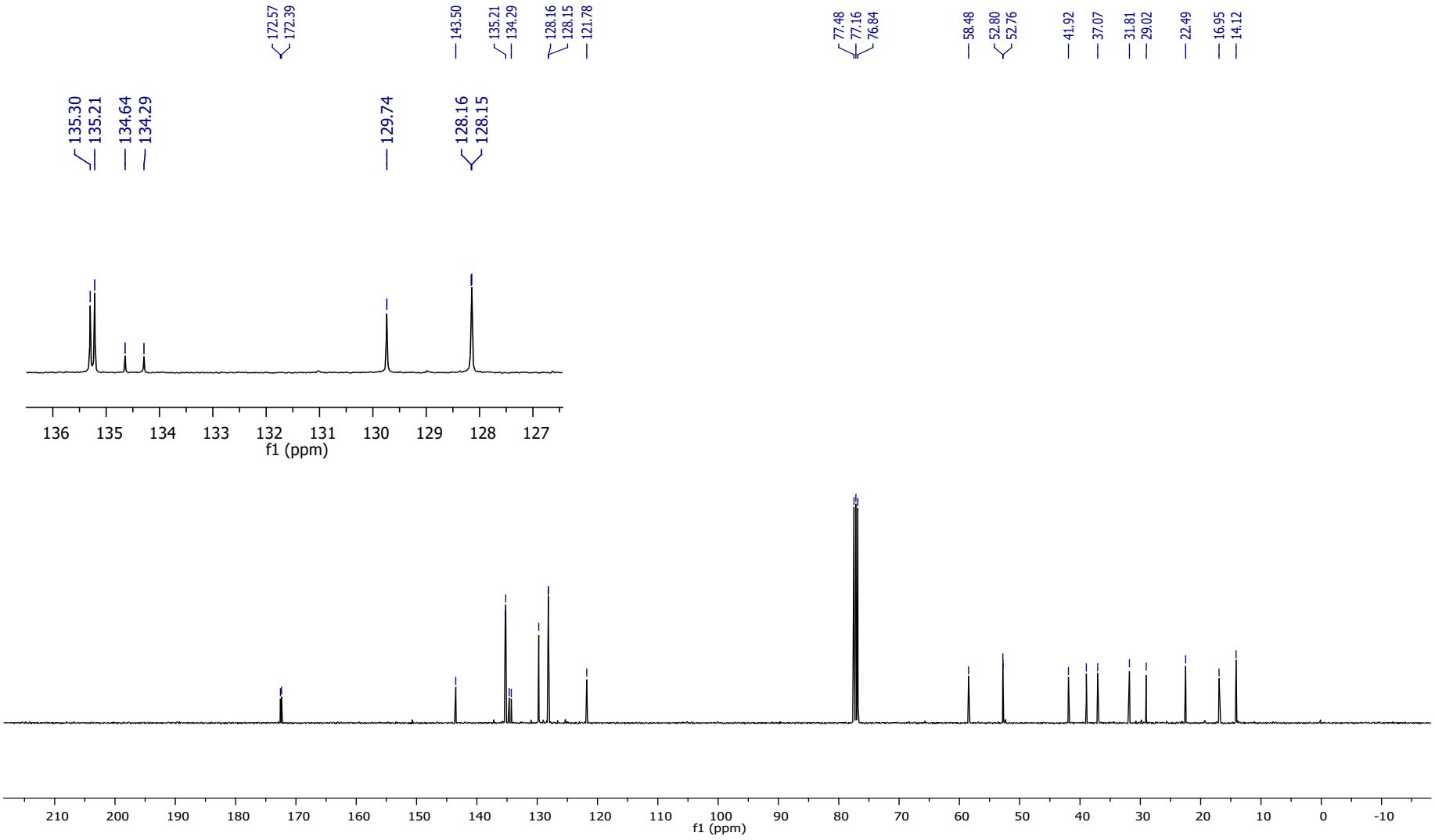
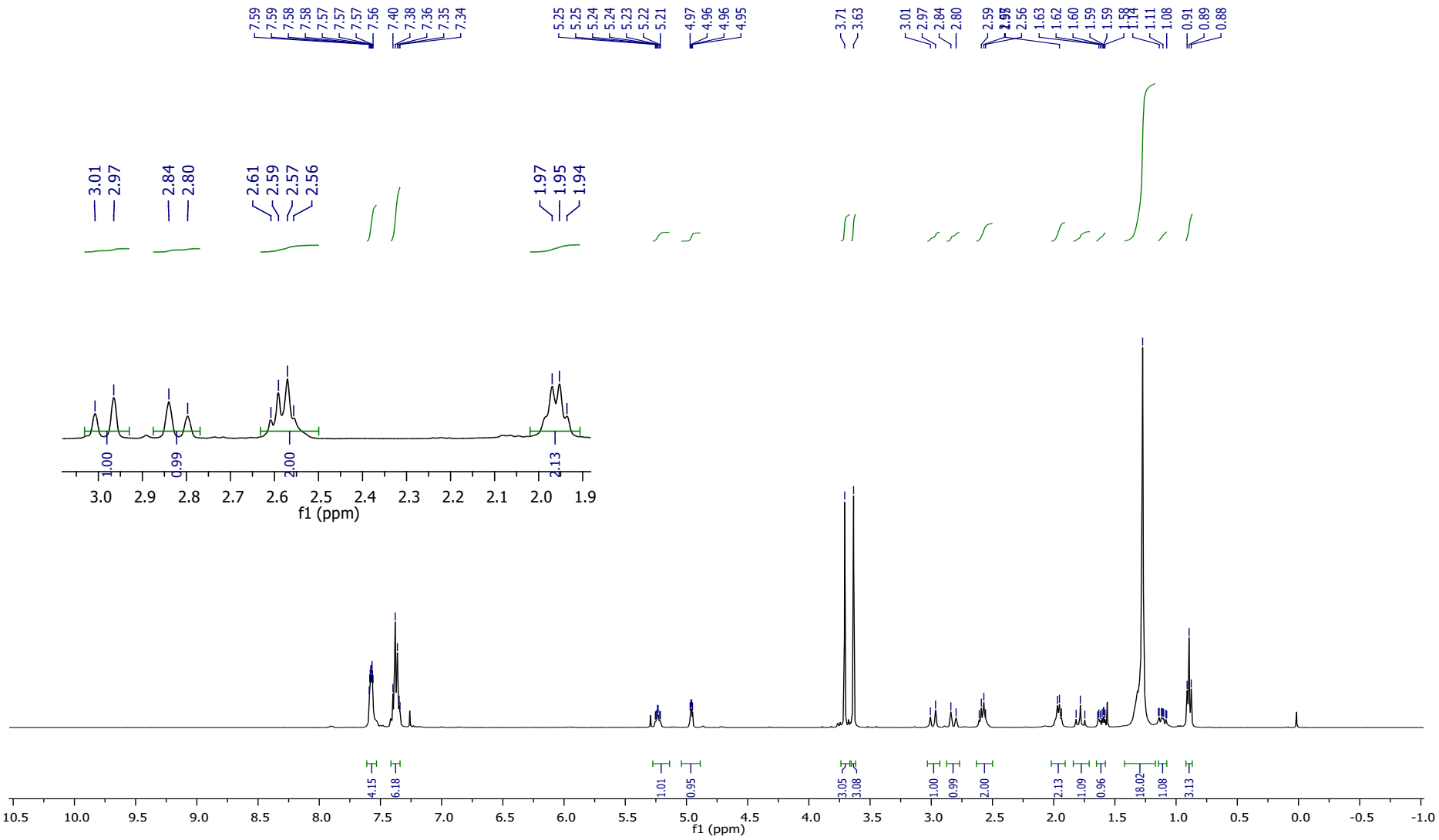
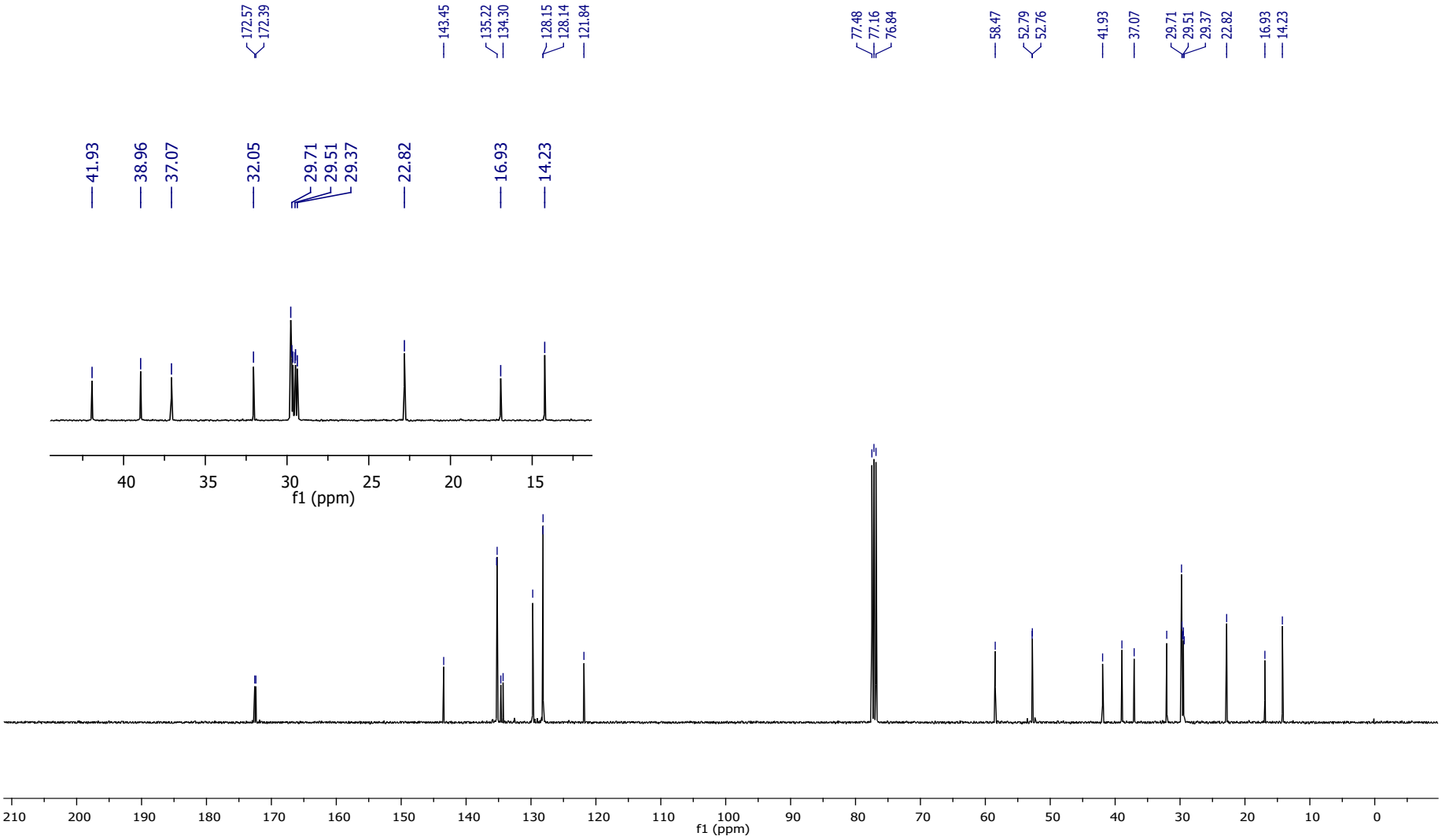
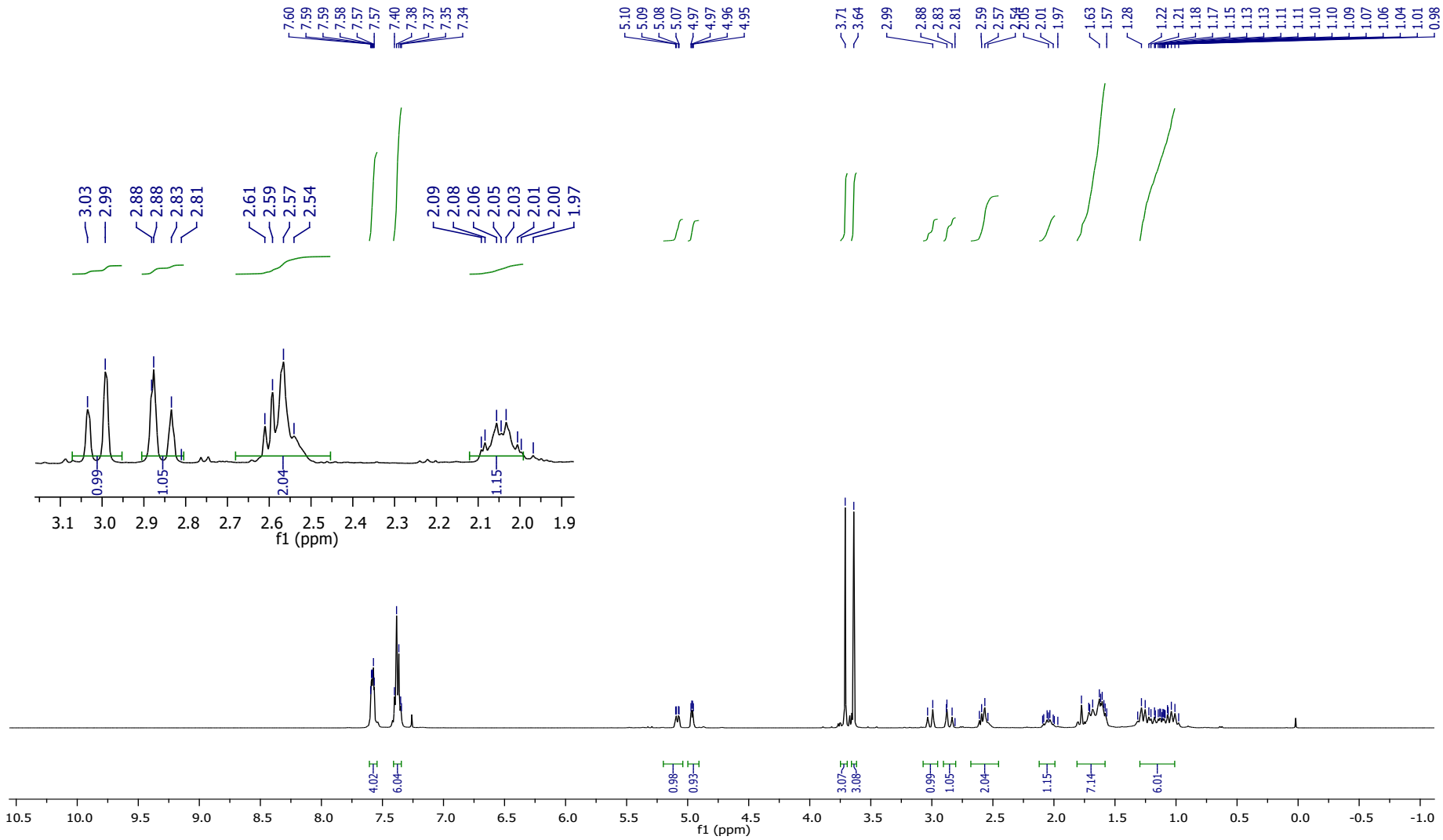
172.41
144.43
135.28
134.62
134.26
129.74
128.14
128.08
115.67
77.48
77.16
76.84
58.41
52.81
52.78
42.01
38.99
36.98
16.75
14.50
58.41
52.81
52.78
42.01
38.99
36.98
60 55 50 45 40 35 30
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

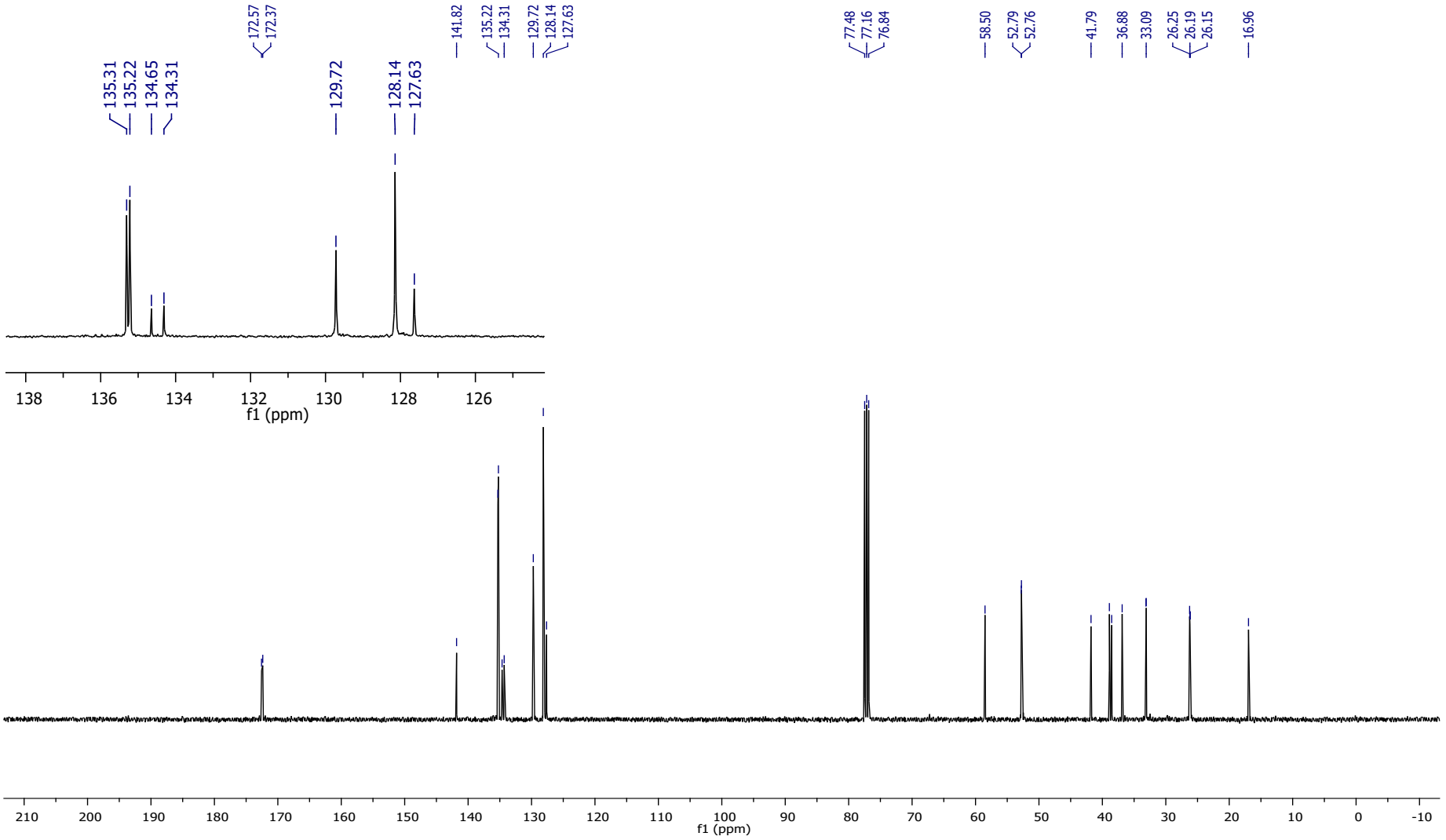

7.59
7.58
7.58
7.58
7.57
7.56
7.56
7.40
7.38
7.36
7.34
7.34
5.25
5.24
5.24
5.23
5.23
5.22
5.21
5.21
4.97
4.96
4.95
4.95
3.70
3.63
3.01
2.96
2.84
2.79
2.59
2.57
2.55
1.98
1.96
1.63
1.58
1.14
1.10
0.91
0.90
0.89
0.87
3.01
2.96
2.84
2.79
2.60
2.59
2.57
2.55
1.98
1.96
1.81
1.78
1.74
1.61
1.59
1.59
1.00
1.01
2.02
2.06
1.12
1.09
3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
f1 (ppm)
4.00
6.26
1.01
1.00
3.05
3.05
1.00
1.01
2.02
2.06
1.12
1.09
4.13
1.07
3.06
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

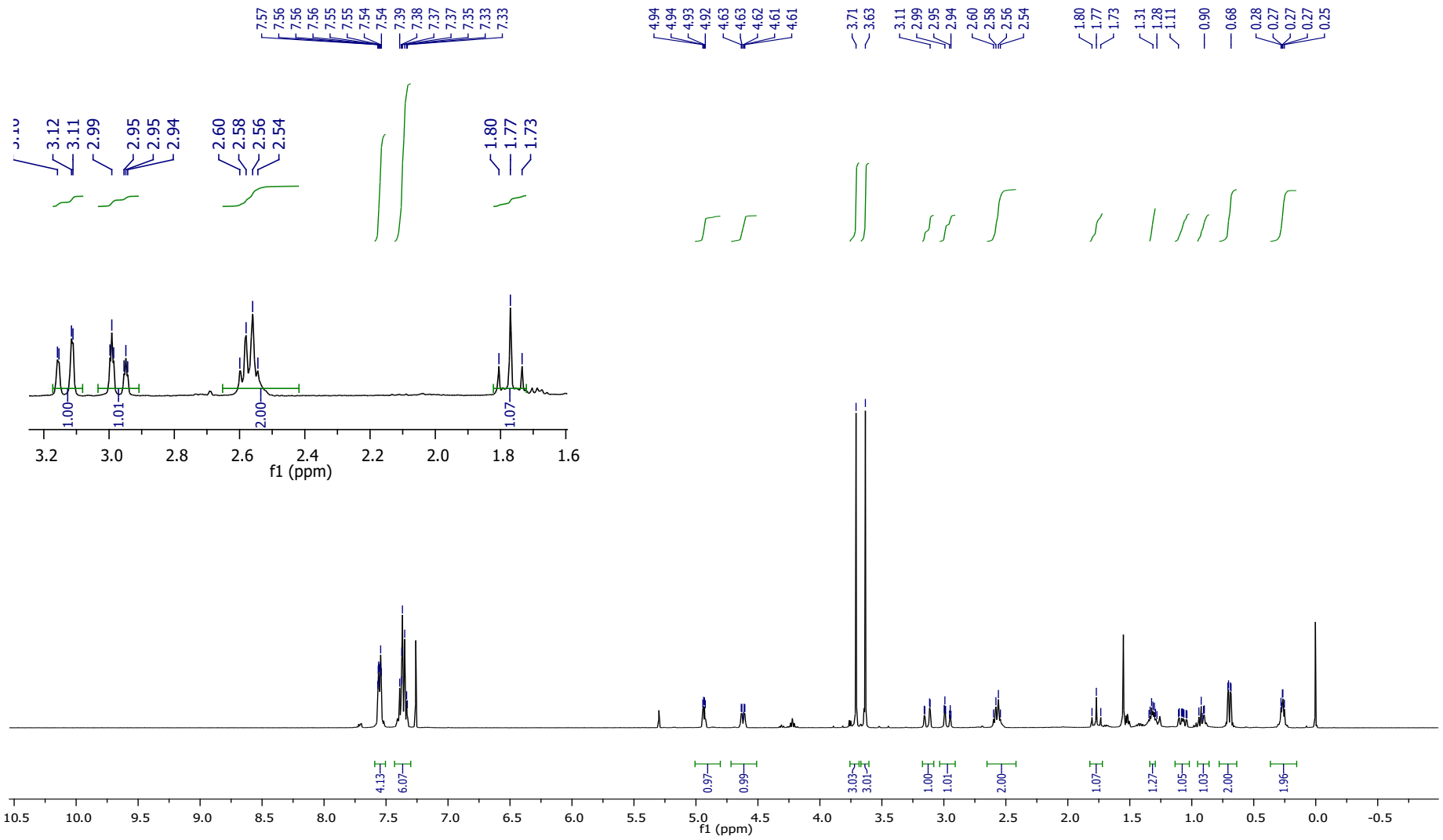

172.57
172.39
143.50
135.21
134.29
128.16
128.15
121.78
77.48
77.16
76.84
58.48
52.80
52.76
41.92
37.07
31.81
29.02
22.49
16.95
14.12
135.30
135.21
134.64
134.29
129.74
128.16
128.15
136 135 134 133 132 131 130 129 128 127
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

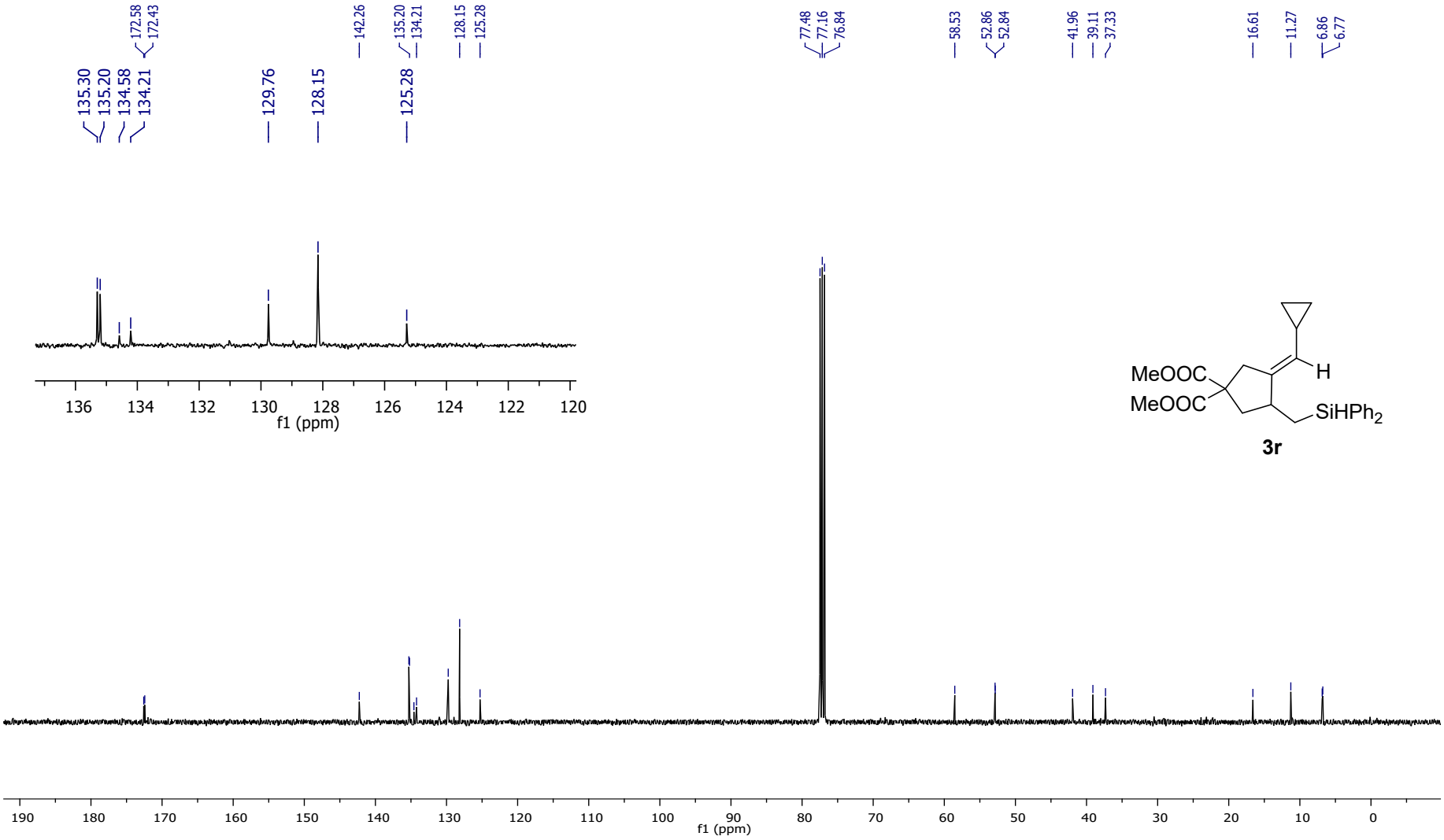

7.59 7.59 7.58 7.58 7.57 7.57 7.57 7.56 7.40 7.38 7.36 7.35 7.34
5.25 5.25 5.24 5.24 5.23 5.22 5.21 4.97 4.96 4.96 4.95
3.71 3.63
3.01 2.97 2.84 2.80 2.59 2.56 1.63 1.62 1.60 1.59 1.59 1.14 1.11 1.08 0.91 0.89 0.88
3.01 2.97 2.84 2.80 2.61 2.59 2.57 2.56 1.97 1.95 1.94
1.00 0.99 2.00 2.13
3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9
f1 (ppm)
4.15 6.18 1.01 0.95 3.05 3.08 1.00 0.99 2.00 2.13 1.09 0.96 18.02 1.08 3.13
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

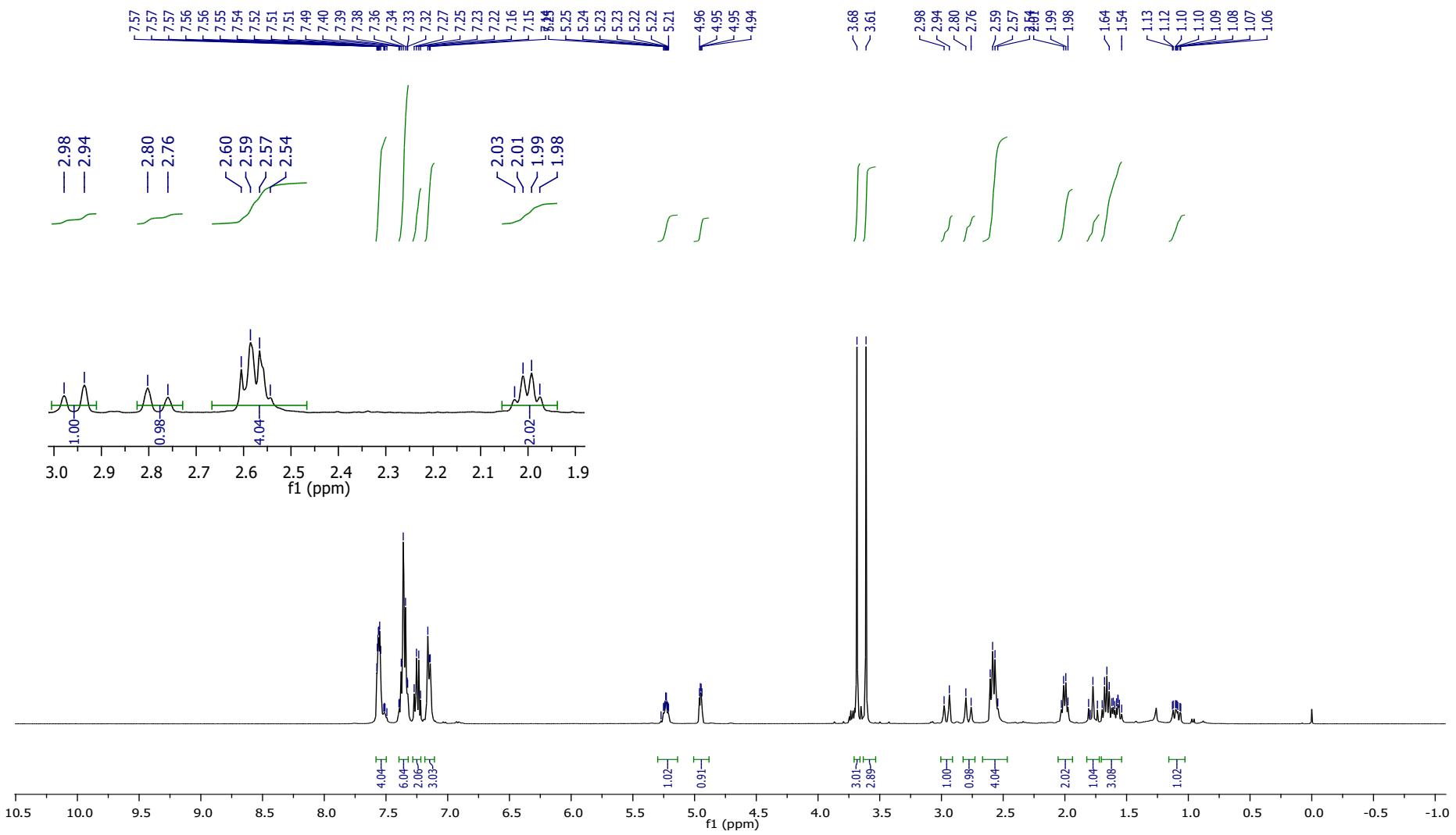

172.57
172.39
143.45
135.22
134.30
128.15
128.14
121.84
77.48
77.16
76.84
58.47
52.79
52.76
41.93
37.07
29.71
29.51
29.37
22.82
16.93
14.23
41.93
38.96
37.07
32.05
29.71
29.51
29.37
22.82
16.93
14.23
40
35
30
25
20
15
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

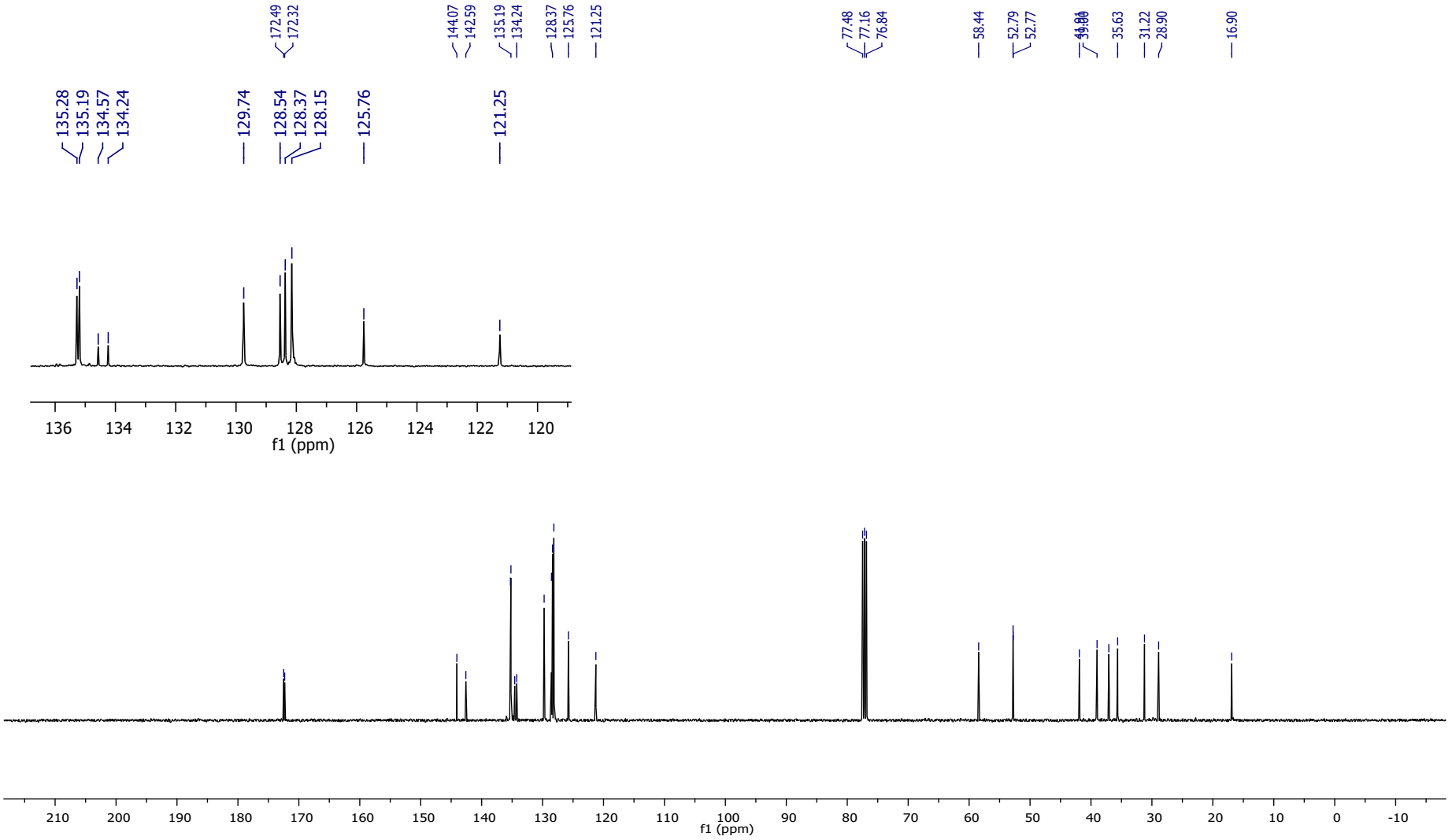

7.60 7.59 7.59 7.58 7.57 7.57 7.40 7.38 7.37 7.35 7.34
5.10 5.09 5.08 5.07 4.97 4.97 4.96 4.95
3.71 3.64 2.99 2.88 2.83 2.81 2.59 2.57 2.54 2.05 2.01 1.97 1.63 1.57 1.28 1.22 1.21 1.18 1.17 1.15 1.13 1.13 1.11 1.11 1.10 1.10 1.09 1.07 1.06 1.04 1.01 0.98
3.03 2.99 2.88 2.88 2.83 2.81 2.61 2.59 2.57 2.54 2.09 2.08 2.06 2.05 2.03 2.01 2.00 1.97
0.99 1.05 2.04 1.15
3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9
f1 (ppm)
4.02 6.04 0.98 0.93 3.07 3.08 0.99 1.05 2.04 1.15 7.14 6.01
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

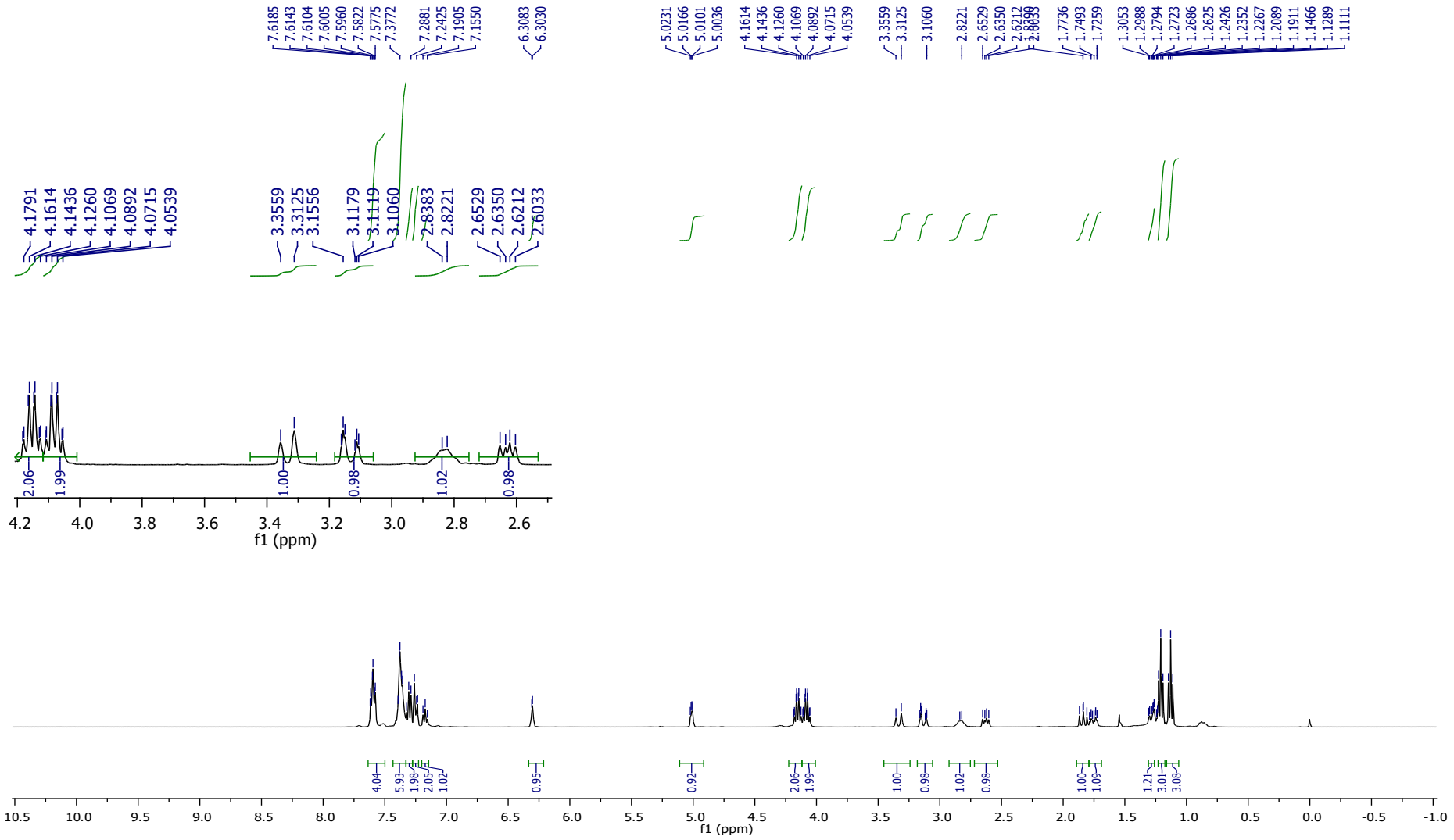

172.57
172.37
141.82
135.22
134.31
129.72
128.14
127.63
77.48
77.16
76.84
58.50
52.79
52.76
41.79
36.88
33.09
26.25
26.19
26.15
16.96
135.31
135.22
134.65
134.31
129.72
128.14
127.63
138
136
134
132
130
128
126
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.57 7.56 7.56 7.56 7.55 7.55 7.54 7.54 7.39 7.38 7.37 7.37 7.35 7.33 7.33
4.94 4.94 4.93 4.92 4.63 4.63 4.62 4.61 4.61
3.71 3.63
3.11 2.99 2.95 2.94
2.60 2.58 2.56 2.54
1.80 1.77 1.73
1.31 1.28 1.11
0.90
0.68
0.28 0.27 0.27 0.27 0.25
3.12 3.11 2.99 2.95 2.95 2.94 2.60 2.58 2.56 2.54 1.80 1.77 1.73
1.00 1.01 2.00 1.07
3.2 3.0 2.8 2.6 2.4 2.2 2.0 1.8 1.6
f1 (ppm)
4.13 6.07 0.97 0.99 3.03 3.01 1.00 1.01 2.00 1.07 1.27 1.05 1.03 2.00 1.96
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)


135.30
135.20
134.58
134.21
172.58
172.43
129.76
128.15
142.26
125.28
135.20
134.21
128.15
125.28
77.48
77.16
76.84
58.53
52.86
52.84
41.96
39.11
37.33
16.61
11.27
6.86
6.77
f1 (ppm)
MeOOC
MeOOC
H
SiHPh2
3r


7.57 7.57 7.57 7.56 7.56 7.55 7.54 7.52 7.51 7.51 7.49 7.40 7.39 7.38 7.36 7.34 7.33 7.32 7.27 7.25 7.23 7.22 7.16 7.15 5.25 5.24 5.23 5.23 5.22 5.22 5.21 4.96 4.95 4.95 4.94 3.68 3.61 2.98 2.94 2.80 2.76 2.59 2.57 1.99 1.98 1.64 1.54 1.13 1.12 1.10 1.10 1.09 1.08 1.07 1.06
2.98 2.94 2.80 2.76 2.60 2.59 2.57 2.54 2.03 2.01 1.99 1.98
1.00 0.98 4.04 2.02
3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0 1.9
f1 (ppm)
4.04 6.04 2.06 3.03 1.02 0.91 3.01 2.89 1.00 0.98 4.04 2.02 1.04 3.08 1.02
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


172.49
172.32
144.07
142.59
135.19
134.24
128.37
125.76
121.25
77.48
77.16
76.84
58.44
52.79
52.77
35.63
31.22
28.90
16.90
135.28
135.19
134.57
134.24
129.74
128.54
128.37
128.15
125.76
121.25
136
134
132
130
128
126
124
122
120
f1 (ppm)
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)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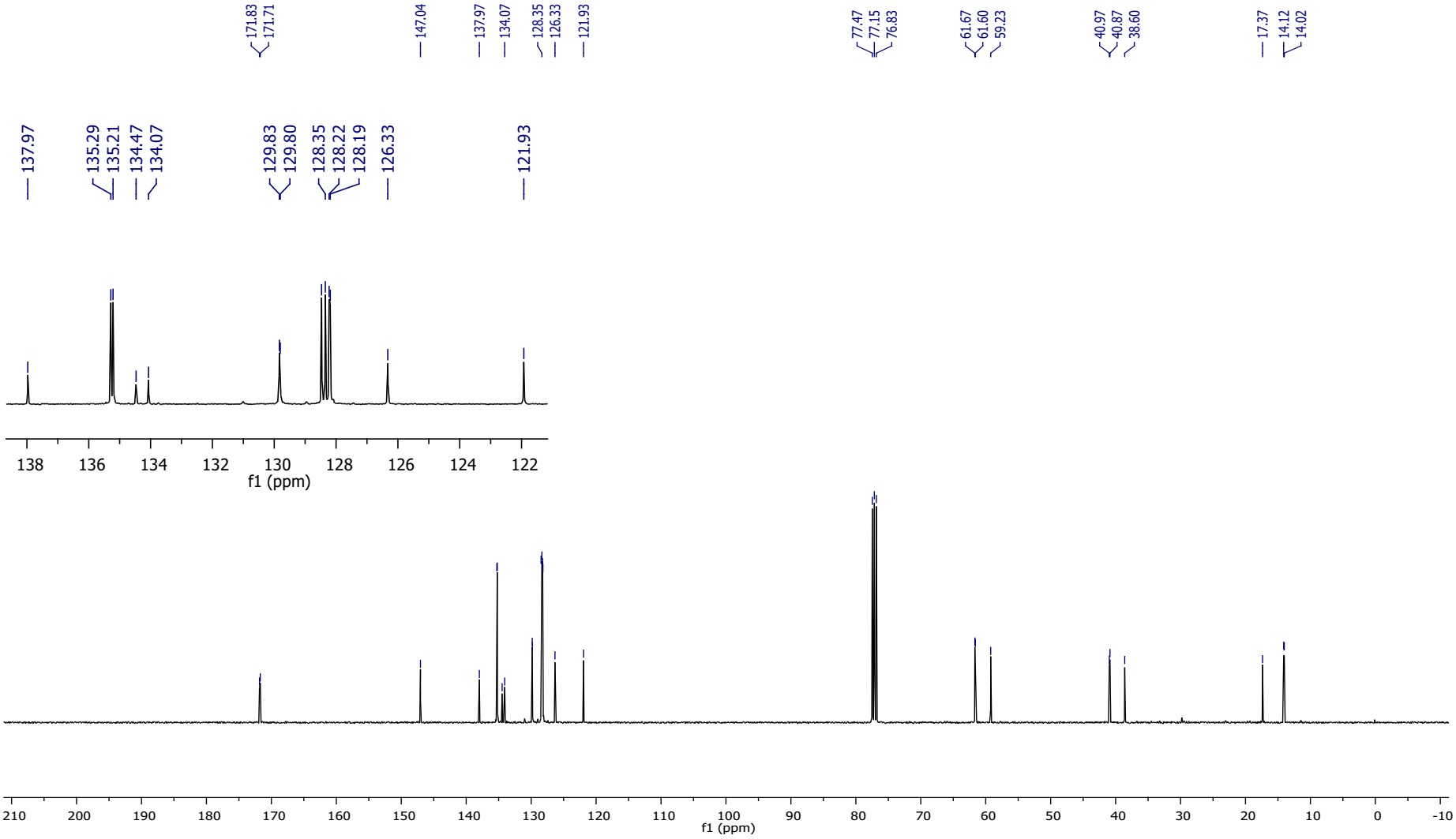
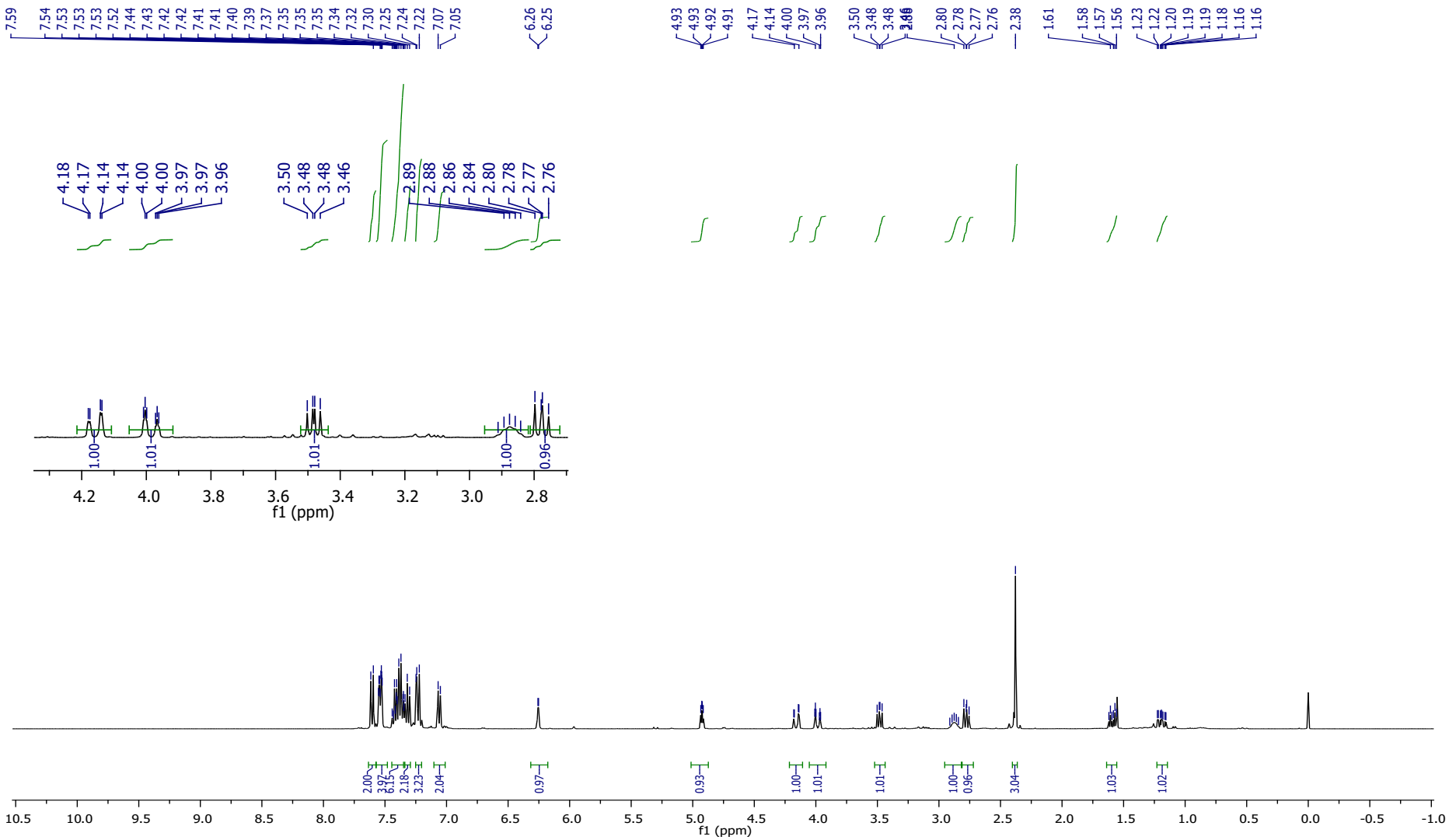
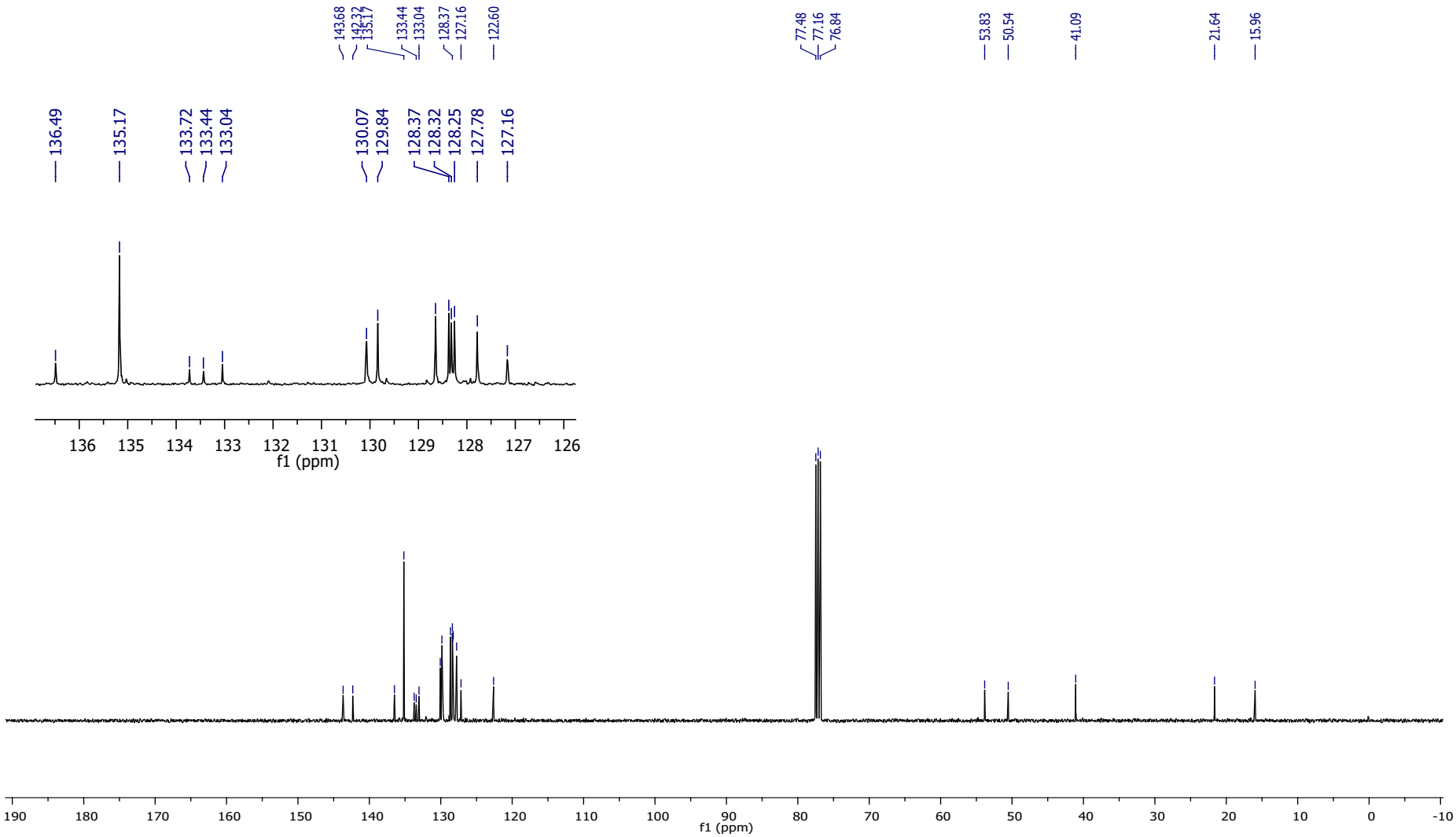
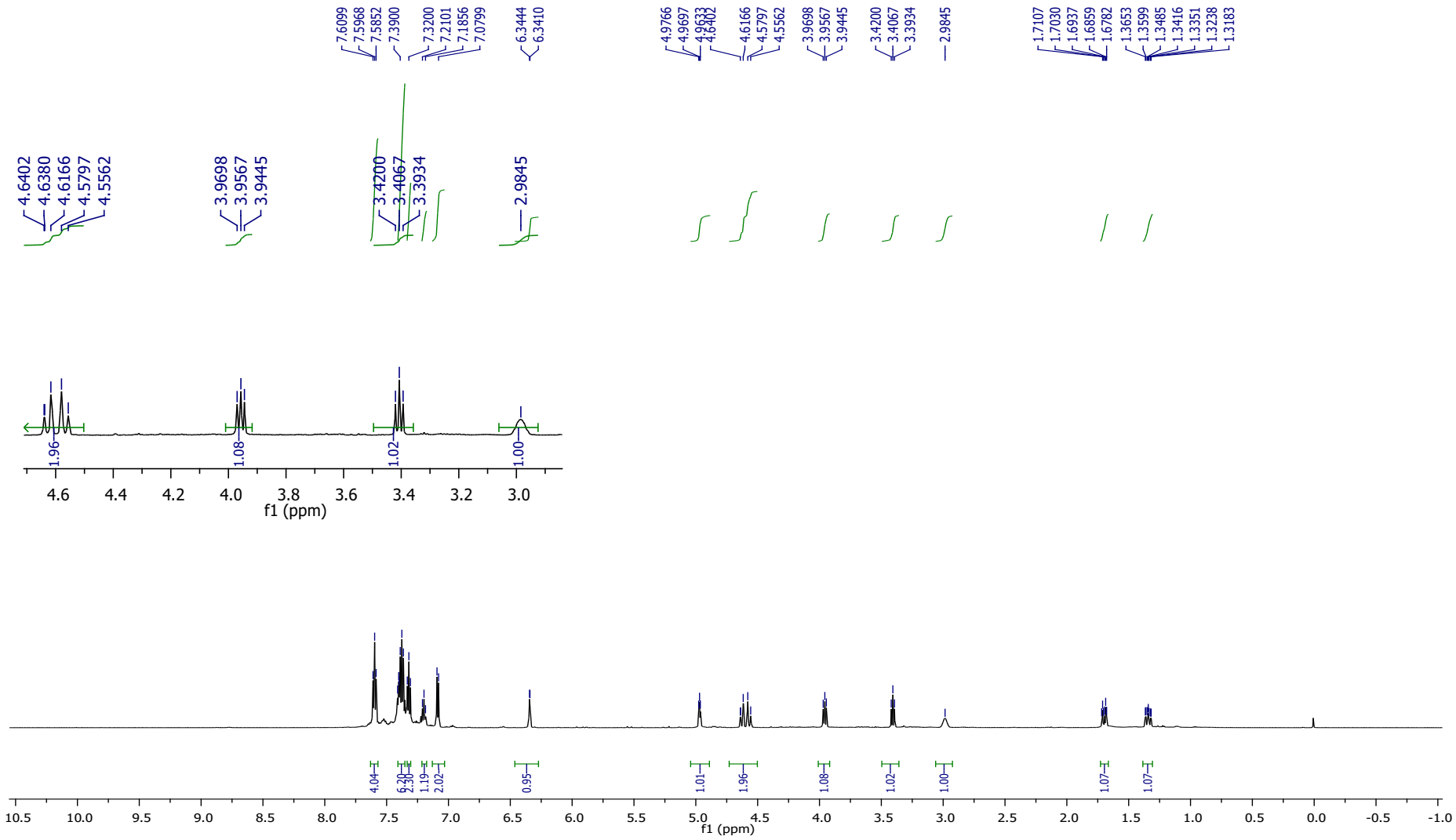
7.6143
7.6104
7.6005
7.5960
7.5822
7.5775
7.3772
7.2881
7.2425
7.1905
7.1550
6.3083
6.3030
5.0231
5.0166
5.0101
5.0036
4.1614
4.1436
4.1260
4.1069
4.0892
4.0715
4.0539
3.3559
3.3125
3.1060
2.8221
2.6529
2.6350
2.6212
1.7736
1.7493
1.7259
1.3053
1.2988
1.2794
1.2723
1.2686
1.2625
1.2426
1.2352
1.2267
1.2089
1.1911
1.1466
1.1289
1.1111
4.1791
4.1614
4.1436
4.1260
4.1069
4.0892
4.0715
4.0539
3.3559
3.3125
3.1556
3.1179
3.1119
3.1060
2.8383
2.8221
2.6529
2.6350
2.6212
2.6033
2.06
1.99
1.00
0.98
1.02
0.98
4.2
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
f1 (ppm)
4.04
5.93
1.98
2.05
1.02
0.95
0.92
2.06
1.99
1.00
0.98
1.02
0.98
1.00
1.09
1.21
3.01
3.08
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


171.83
171.71
147.04
137.97
134.07
128.35
126.33
121.93
77.47
77.15
76.83
61.67
61.60
59.23
40.97
40.87
38.60
17.37
14.12
14.02
137.97
135.29
135.21
134.47
134.07
129.83
129.80
128.35
128.22
128.19
126.33
121.93
138
136
134
132
130
128
126
124
122
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.59 7.54 7.53 7.53 7.53 7.52 7.44 7.43 7.42 7.42 7.41 7.41 7.40 7.39 7.37 7.35 7.35 7.35 7.34 7.32 7.30 7.25 7.24 7.22 7.07 7.05 6.26 6.25
4.93 4.93 4.92 4.91 4.17 4.14 4.00 3.97 3.96 3.50 3.48 3.48 2.80 2.78 2.77 2.76 2.38 1.61 1.58 1.57 1.56 1.23 1.22 1.20 1.19 1.19 1.18 1.16 1.16
4.18 4.17 4.14 4.14 4.00 4.00 3.97 3.97 3.96 3.50 3.48 3.48 3.46 2.89 2.88 2.86 2.84 2.80 2.78 2.77 2.76
1.00 1.01 1.01 1.00 0.96
4.2 4.0 3.8 3.6 3.4 3.2 3.0 2.8
f1 (ppm)
2.00 3.97 6.15 2.18 3.23 2.04 0.97 0.93 1.00 1.01 1.01 1.00 0.96 3.04 1.03 1.02
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


143.68
142.32
135.17
133.44
133.04
128.37
127.16
122.60
77.48
77.16
76.84
53.83
50.54
41.09
21.64
15.96
136.49
135.17
133.72
133.44
133.04
130.07
129.84
128.37
128.32
128.25
127.78
127.16
136 135 134 133 132 131 130 129 128 127 126
f1 (ppm)
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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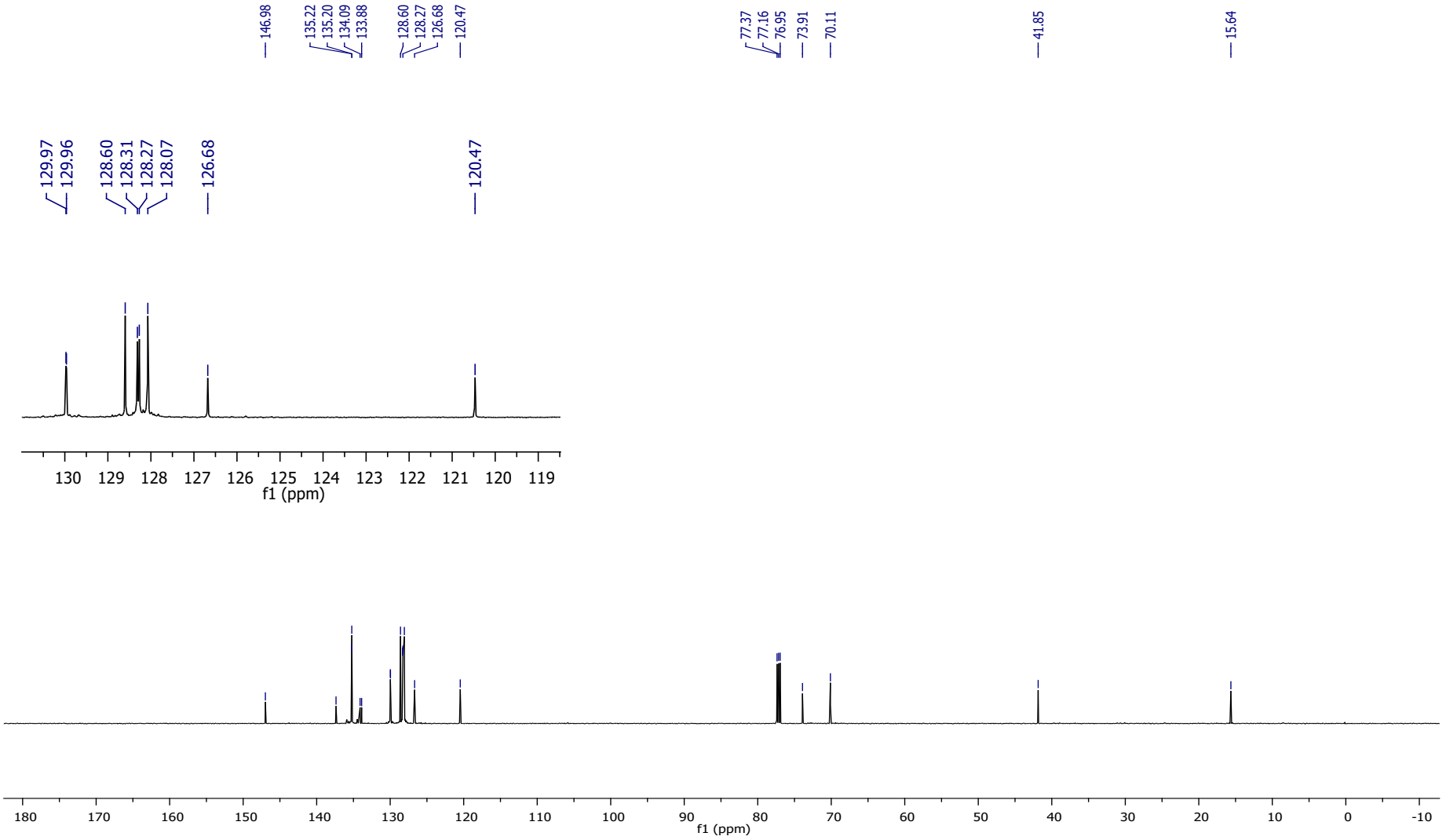
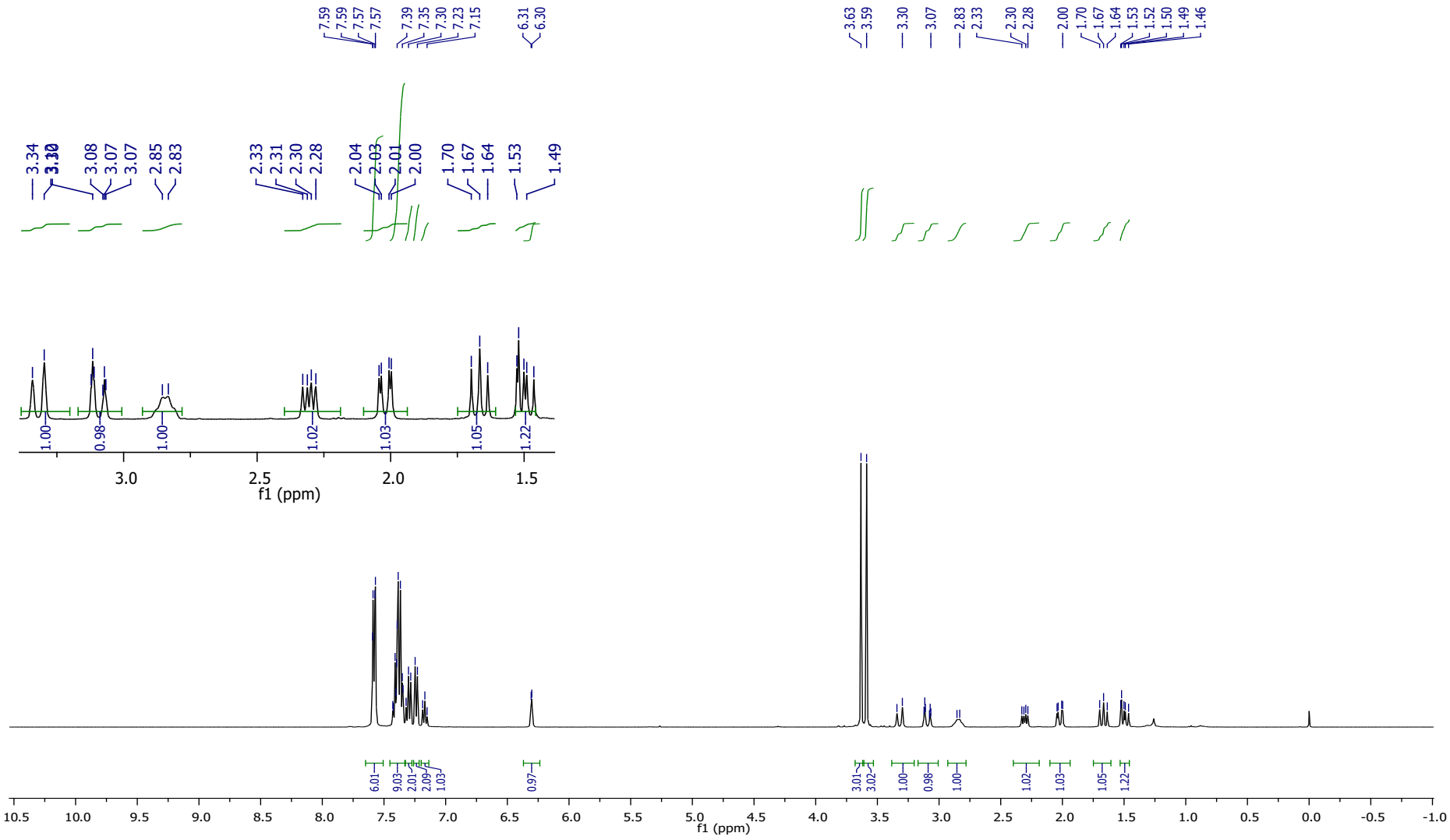
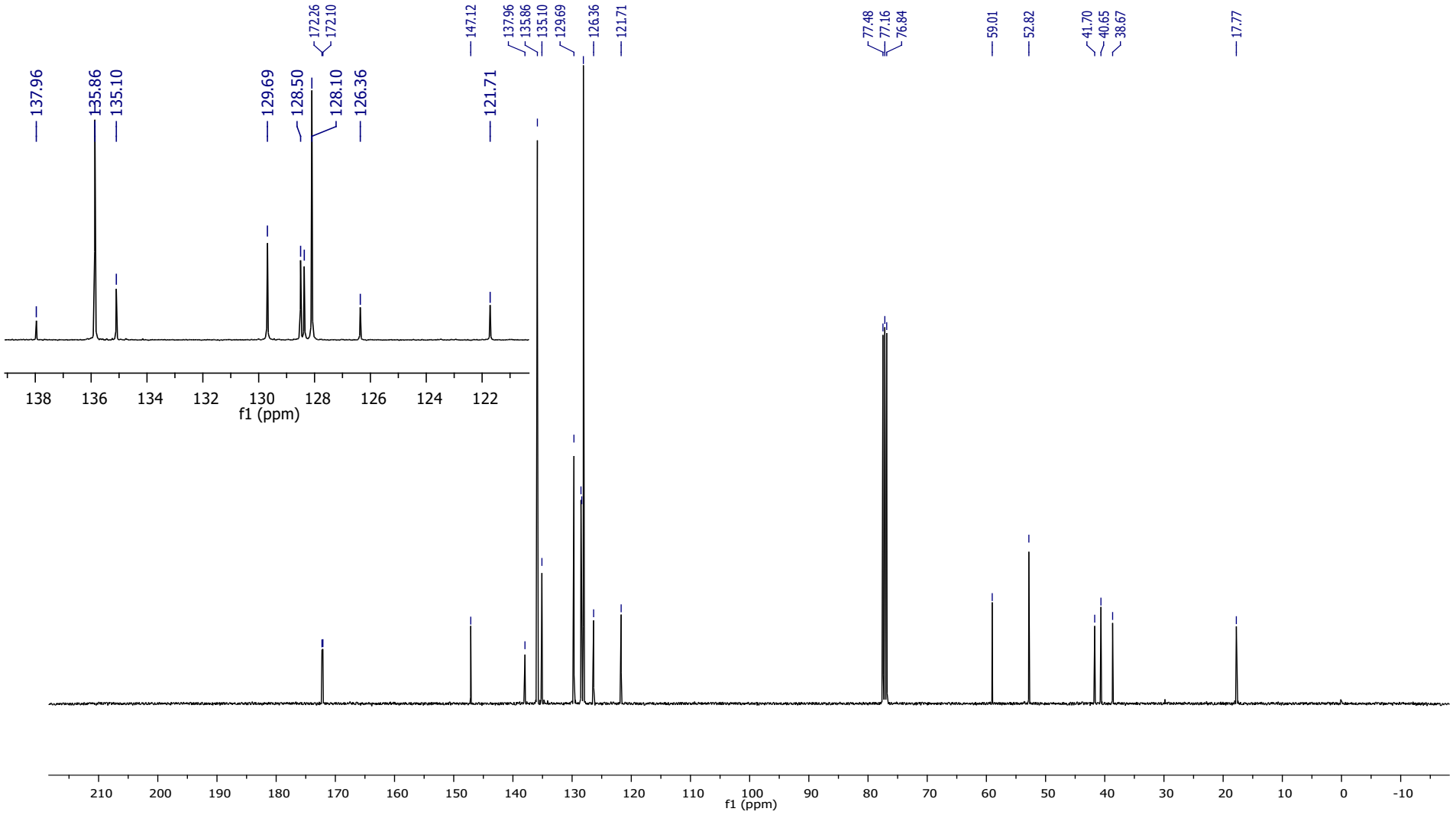
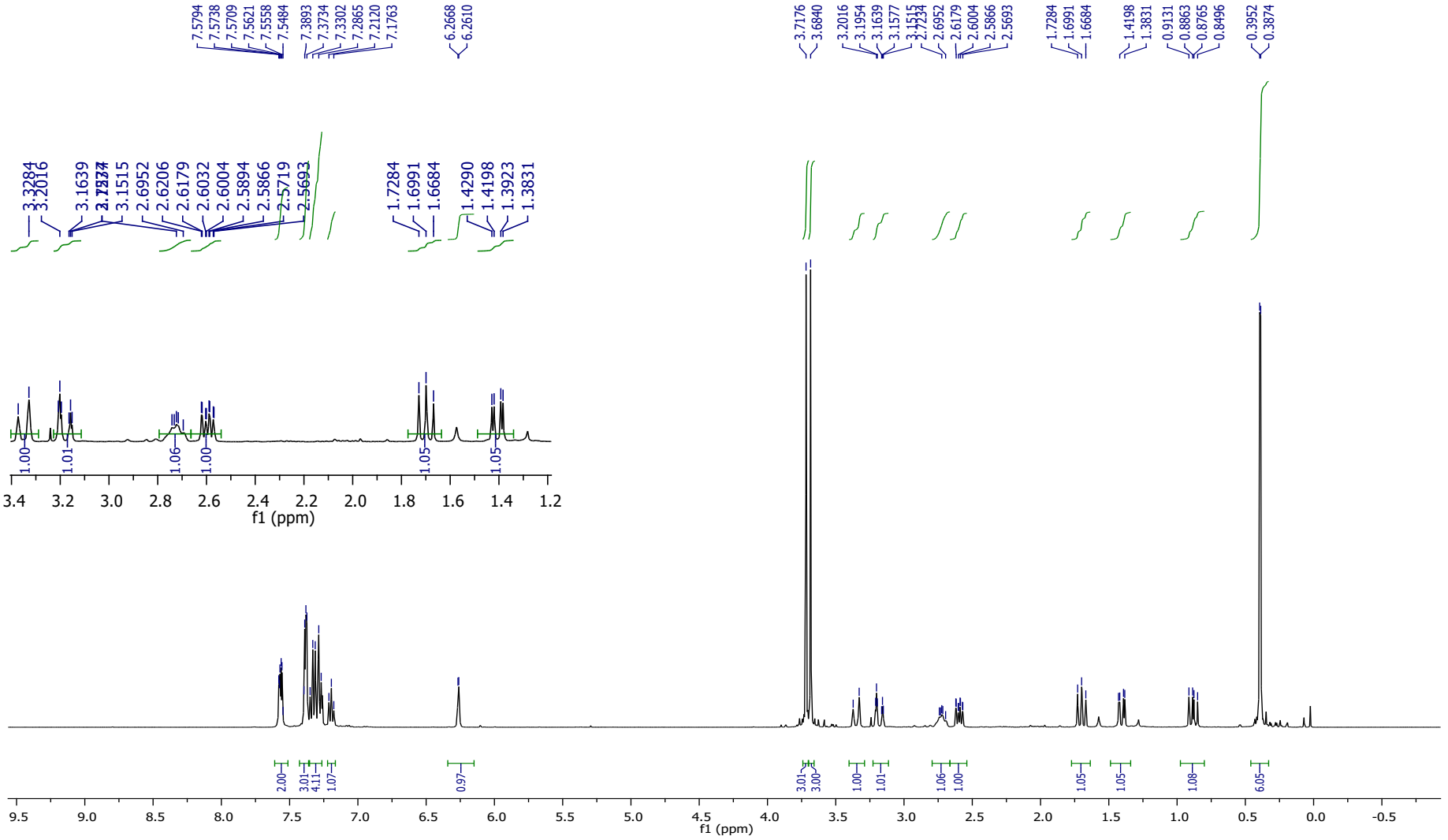
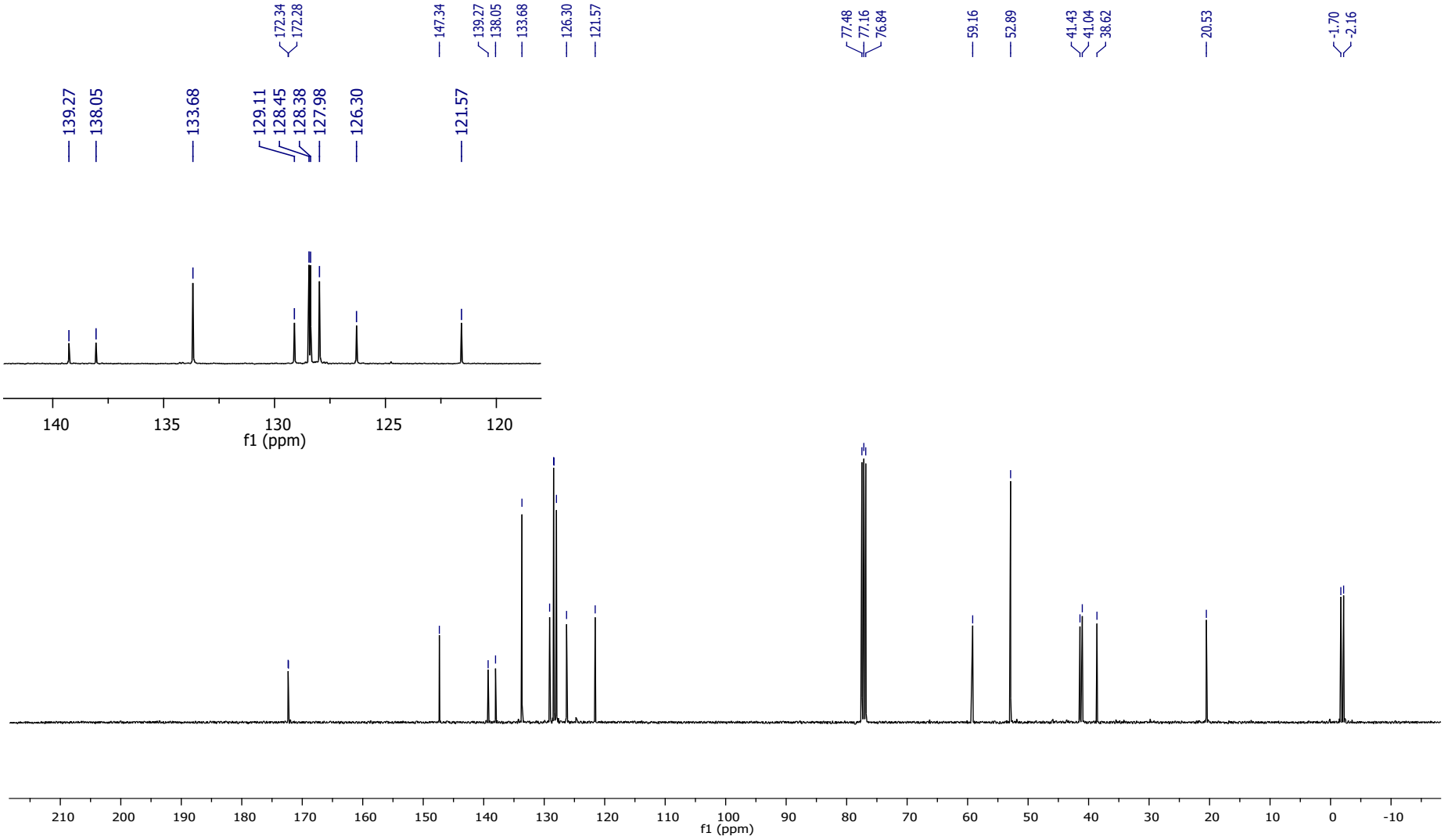
7.5852
7.3900
7.3200
7.2101
7.1856
7.0799
6.3444
6.3410
4.9766
4.9697
4.9633
4.6402
4.6166
4.5797
4.5562
3.9698
3.9567
3.9445
3.4200
3.4067
3.3934
2.9845
1.7107
1.7030
1.6937
1.6859
1.6782
1.3653
1.3599
1.3485
1.3416
1.3351
1.3238
1.3183
4.6402
4.6380
4.6166
4.5797
4.5562
3.9698
3.9567
3.9445
3.4200
3.4067
3.3934
2.9845
1.96
1.08
1.02
1.00
4.6
4.4
4.2
4.0
3.8
3.6
3.4
3.2
3.0
f1 (ppm)
4.04
6.20
2.30
1.19
2.02
0.95
1.01
1.96
1.08
1.02
1.00
1.07
1.07
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

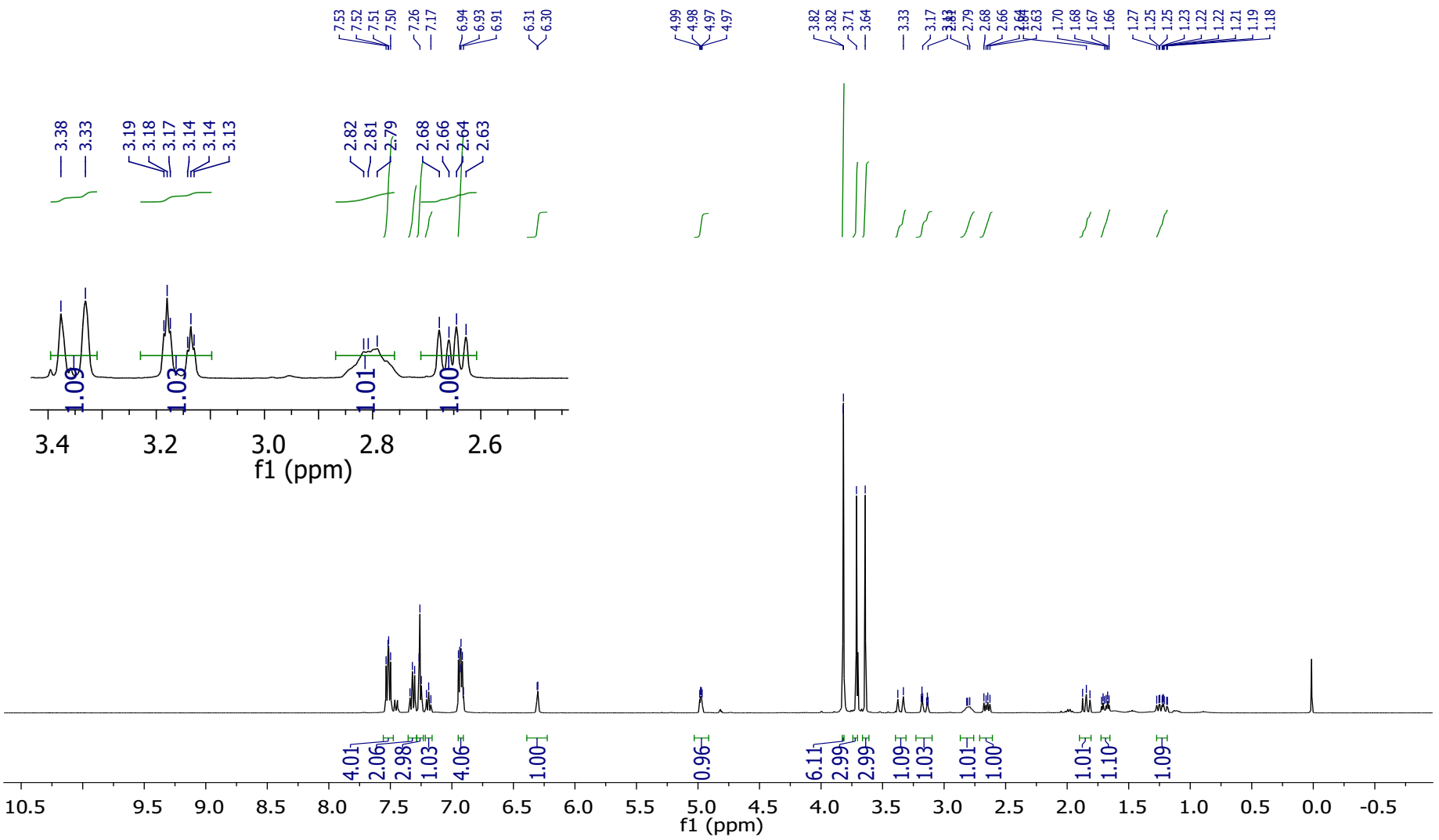

146.98
135.22
135.20
134.09
133.88
128.60
128.27
126.68
120.47
77.37
77.16
76.95
73.91
70.11
41.85
15.64
129.97
129.96
128.60
128.31
128.27
128.07
126.68
120.47
130 129 128 127 126 125 124 123 122 121 120 119
f1 (ppm)
180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

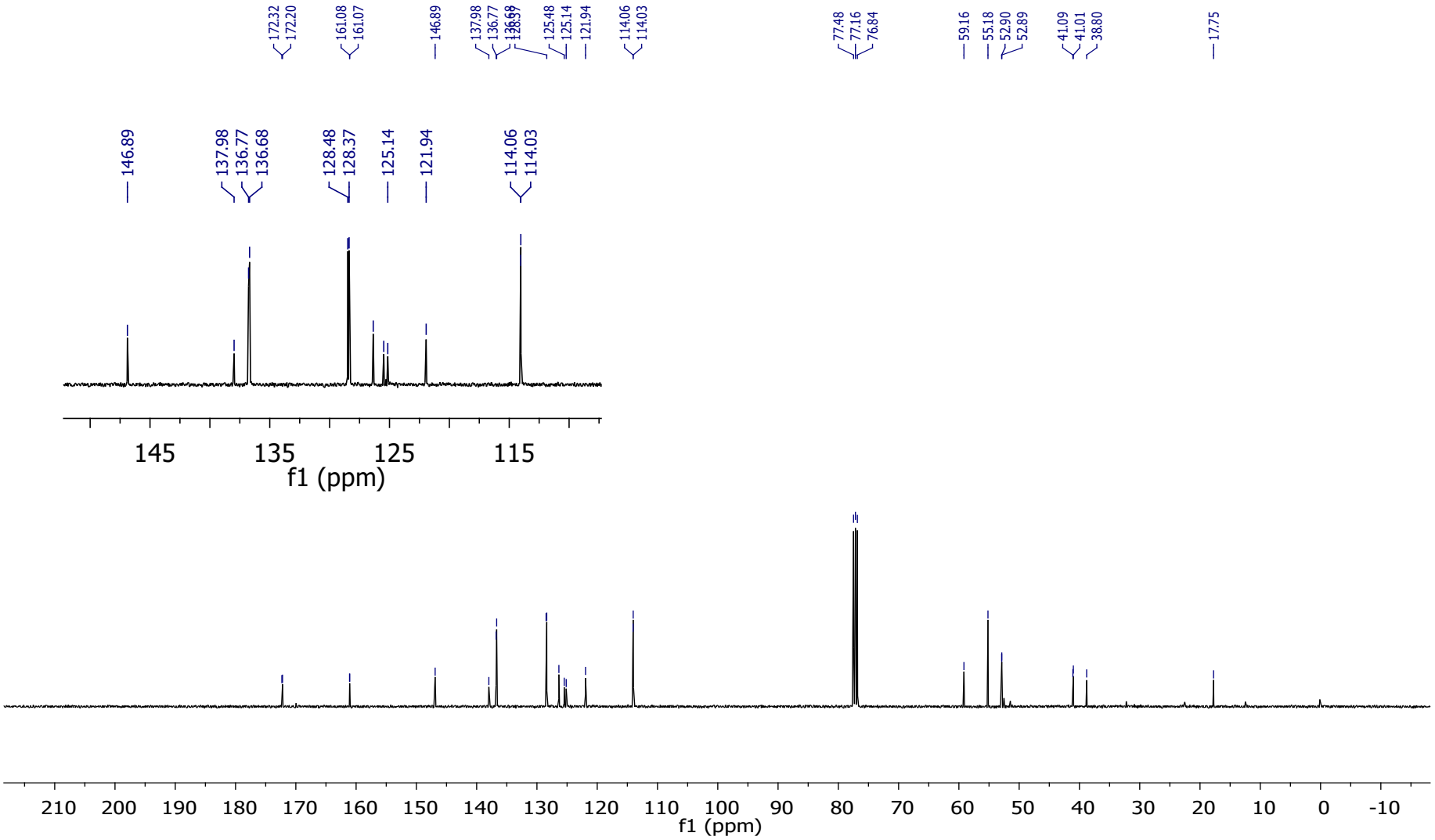

7.59
7.59
7.57
7.57
7.39
7.35
7.30
7.23
7.15
6.31
6.30
3.63
3.59
3.30
3.07
2.83
2.33
2.30
2.28
2.00
1.70
1.67
1.64
1.53
1.52
1.50
1.49
1.46
3.34
3.08
3.07
3.07
2.85
2.83
2.33
2.31
2.30
2.28
2.04
2.03
2.01
2.00
1.70
1.67
1.64
1.53
1.49
1.00
0.98
1.00
1.02
1.03
1.05
1.22
3.0
2.5
2.0
1.5
f1 (ppm)
6.01
9.03
2.01
2.09
1.03
0.97
3.01
3.02
1.00
0.98
1.00
1.02
1.03
1.05
1.22
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

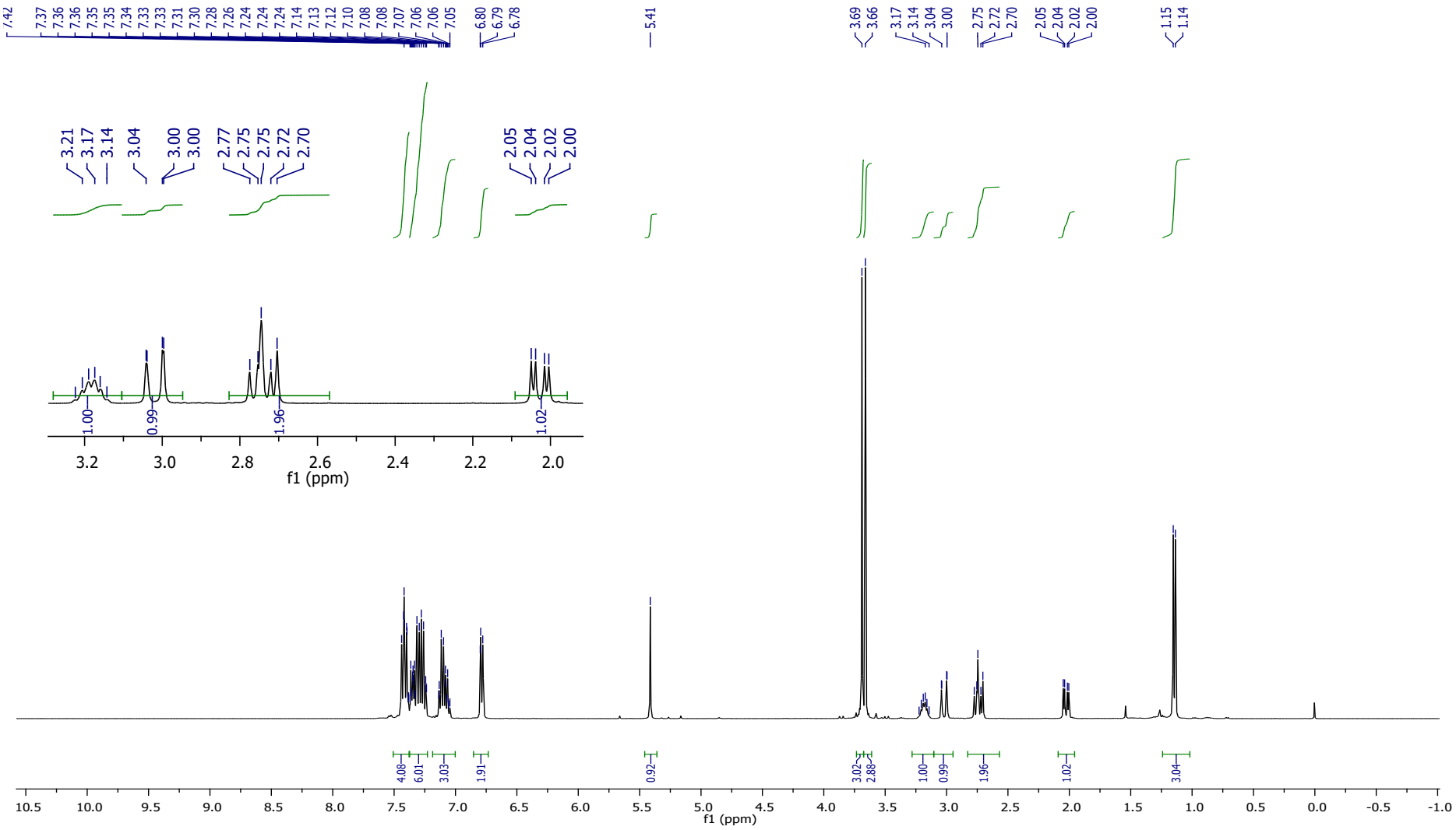

172.26
172.10
147.12
137.96
135.86
135.10
129.69
126.36
121.71
77.48
77.16
76.84
59.01
52.82
41.70
40.65
38.67
17.77
137.96
135.86
135.10
129.69
128.50
128.10
126.36
121.71
138
136
134
132
130
128
126
124
122
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

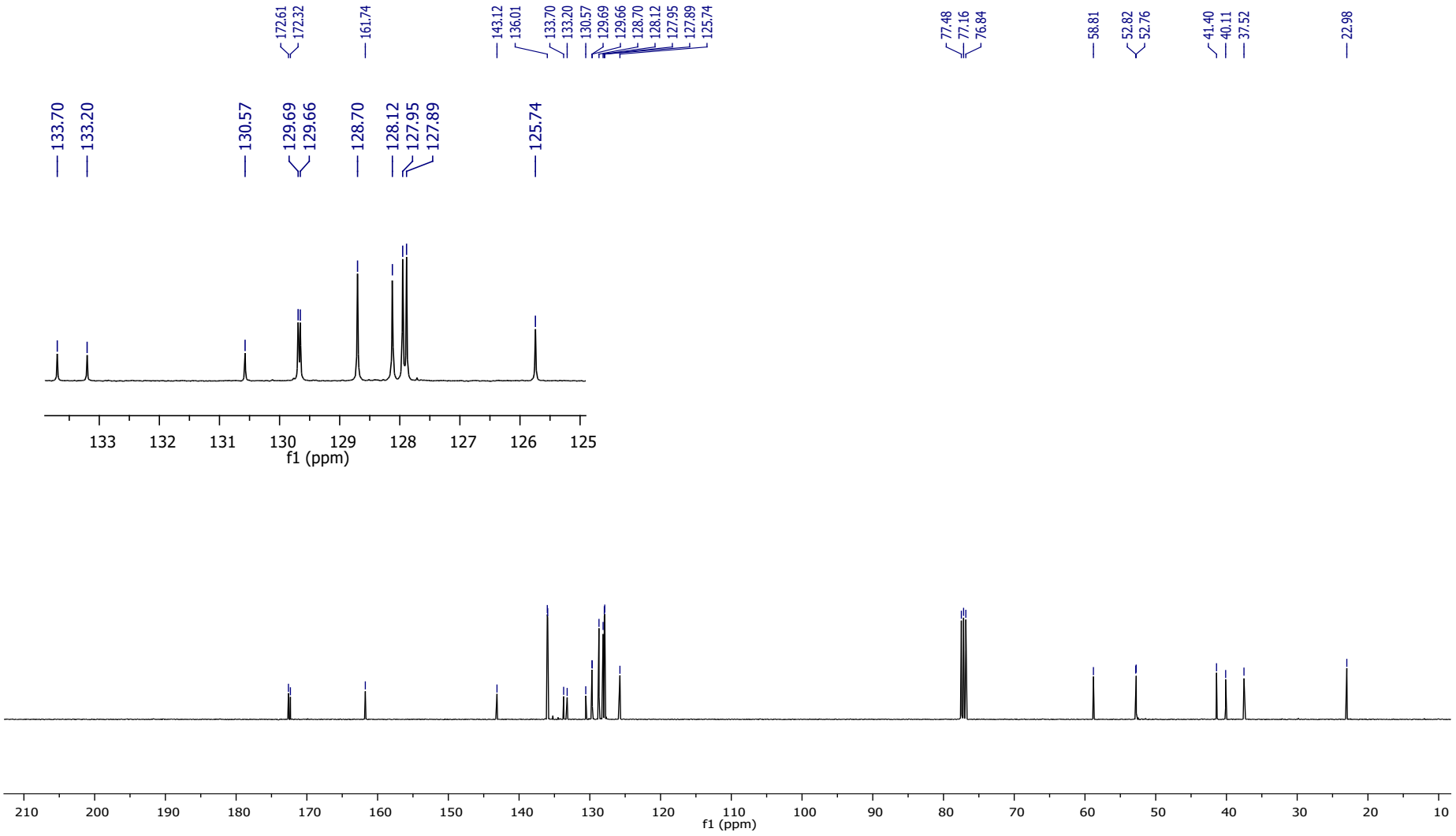

7.5794
7.5738
7.5709
7.5621
7.5558
7.5484
7.3893
7.3734
7.3302
7.2865
7.2120
7.1763
6.2668
6.2610
3.7176
3.6840
3.2016
3.1954
3.1639
3.1577
3.1515
2.6952
2.6179
2.6004
2.5866
2.5693
1.7284
1.6991
1.6684
1.4198
1.3831
0.9131
0.8863
0.8765
0.8496
0.3952
0.3874
f1 (ppm)

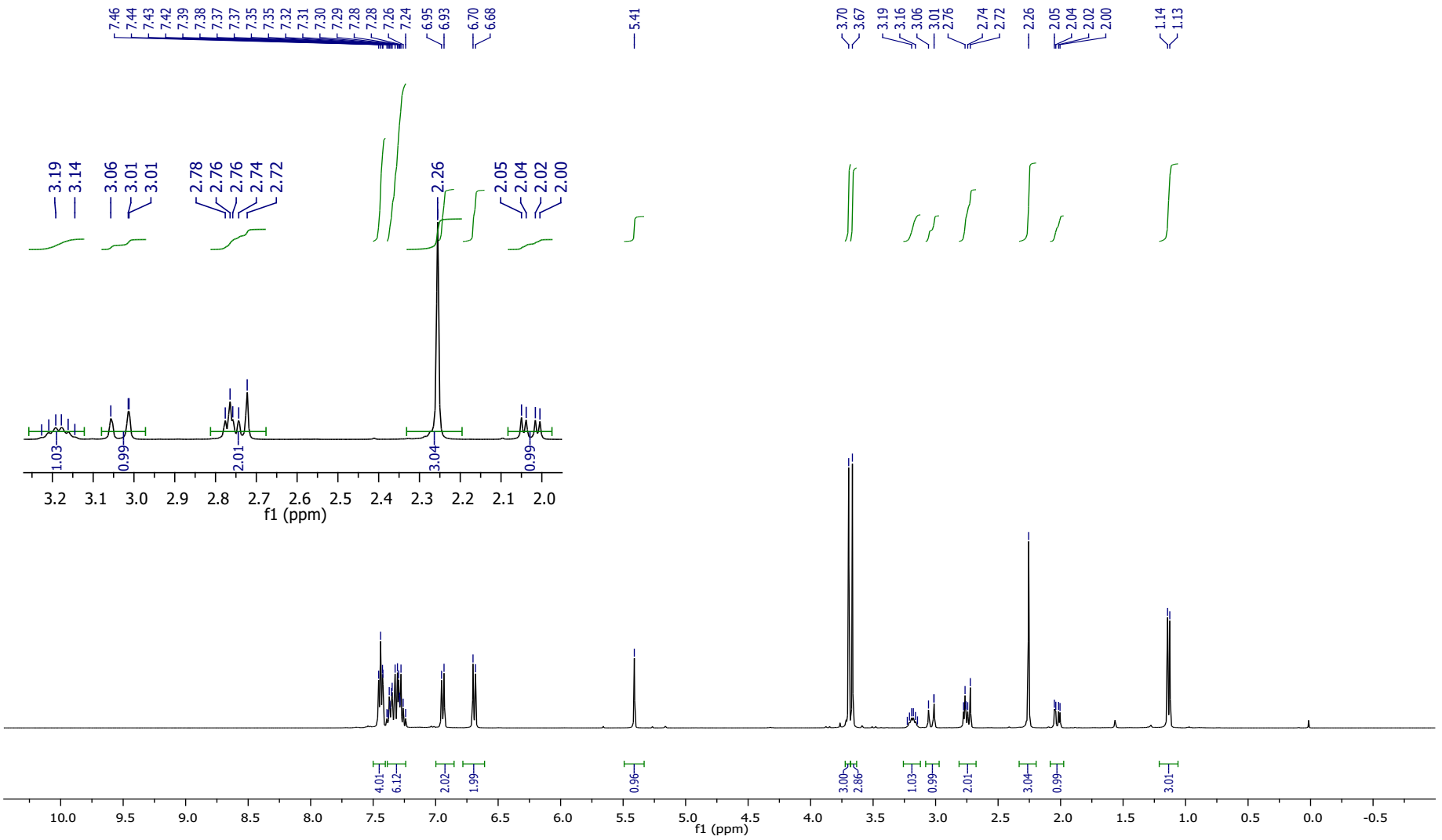

172.34
172.28
147.34
139.27
138.05
133.68
126.30
121.57
77.48
77.16
76.84
59.16
52.89
41.43
41.04
38.62
20.53
-1.70
-2.16
139.27
138.05
133.68
129.11
128.45
128.38
127.98
126.30
121.57
140
135
130
125
120
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

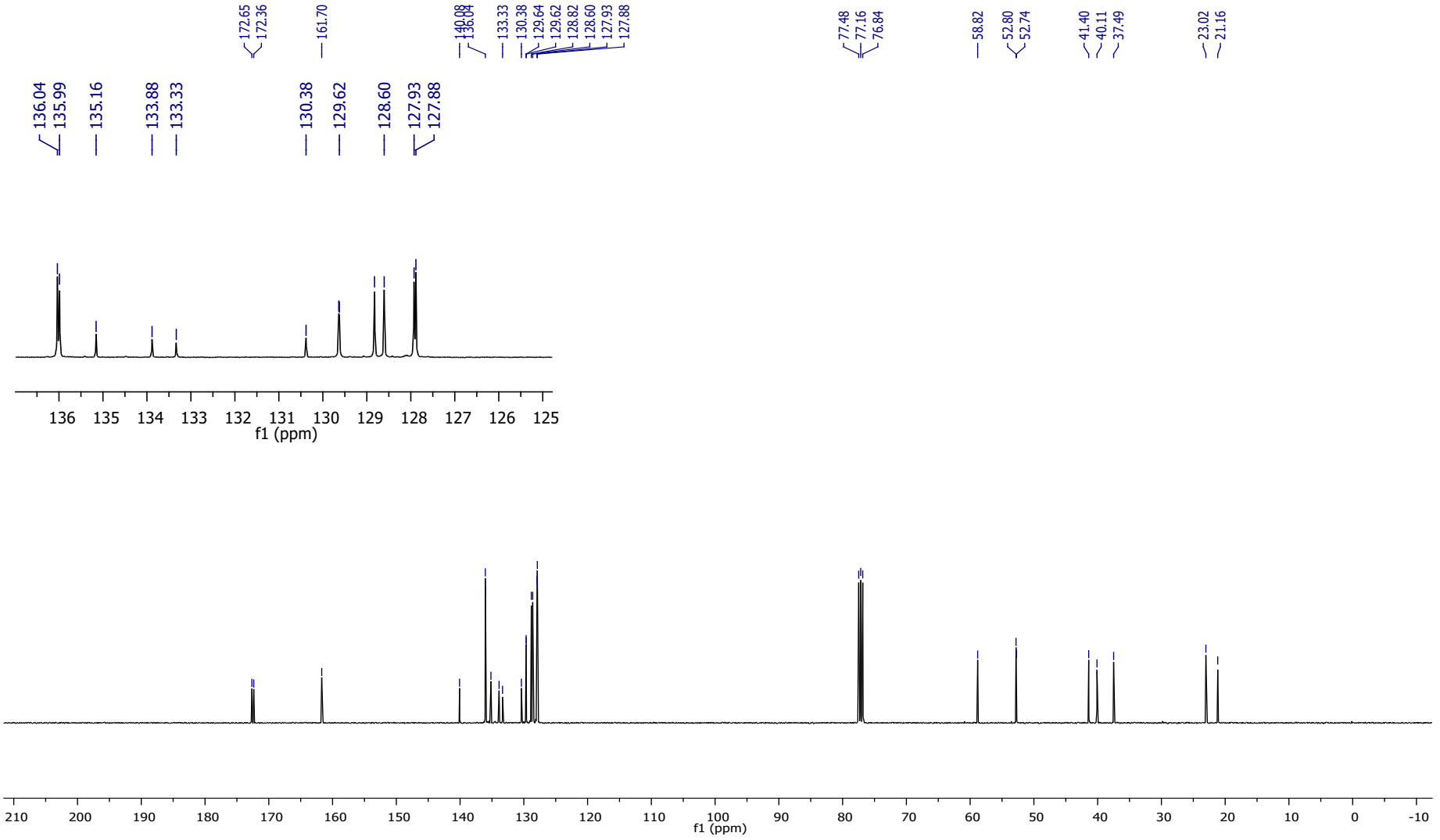

7.53
7.52
7.51
7.50
7.26
7.17
6.94
6.93
6.91
6.31
6.30
4.99
4.98
4.97
4.97
3.82
3.82
3.71
3.64
3.33
3.17
2.79
2.68
2.66
2.63
1.70
1.68
1.67
1.66
1.27
1.25
1.25
1.23
1.22
1.22
1.21
1.19
1.18
3.38
3.33
3.19
3.18
3.17
3.14
3.14
3.13
2.82
2.81
2.79
2.68
2.66
2.64
2.63
1.09
1.03
1.01
1.00
3.4
3.2
3.0
2.8
2.6
f1 (ppm)
4.01
2.06
2.98
1.03
4.06
1.00
0.96
6.11
2.99
2.99
1.09
1.03
1.01
1.00
1.01
1.10
1.09
10.5
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
f1 (ppm)

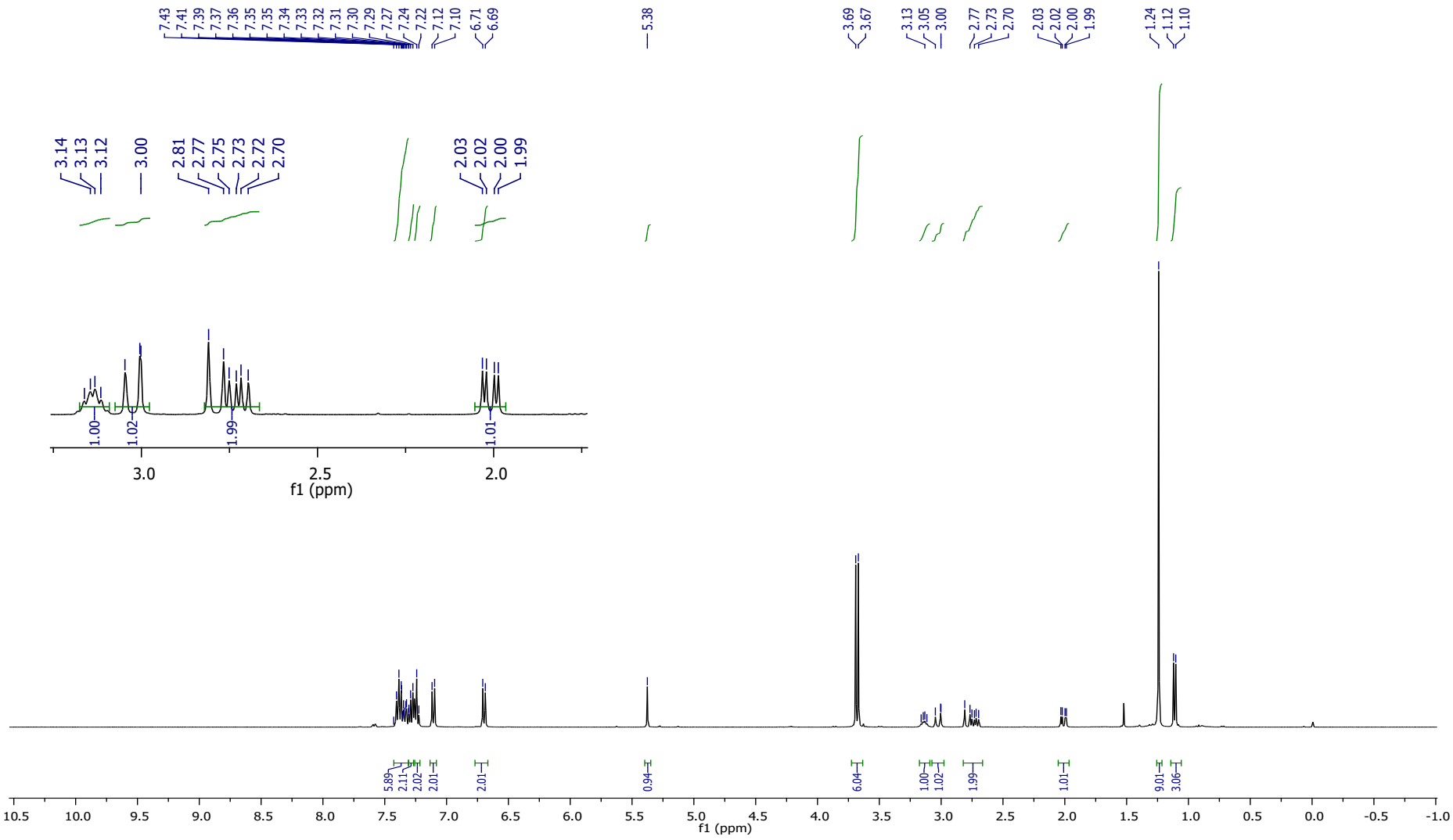

172.32
172.20
161.08
161.07
146.89
137.98
136.77
125.48
125.14
121.94
114.06
114.03
77.48
77.16
76.84
59.16
55.18
52.90
52.89
41.09
41.01
38.80
17.75
146.89
137.98
136.77
136.68
128.48
128.37
125.14
121.94
114.06
114.03
145
135
125
115
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

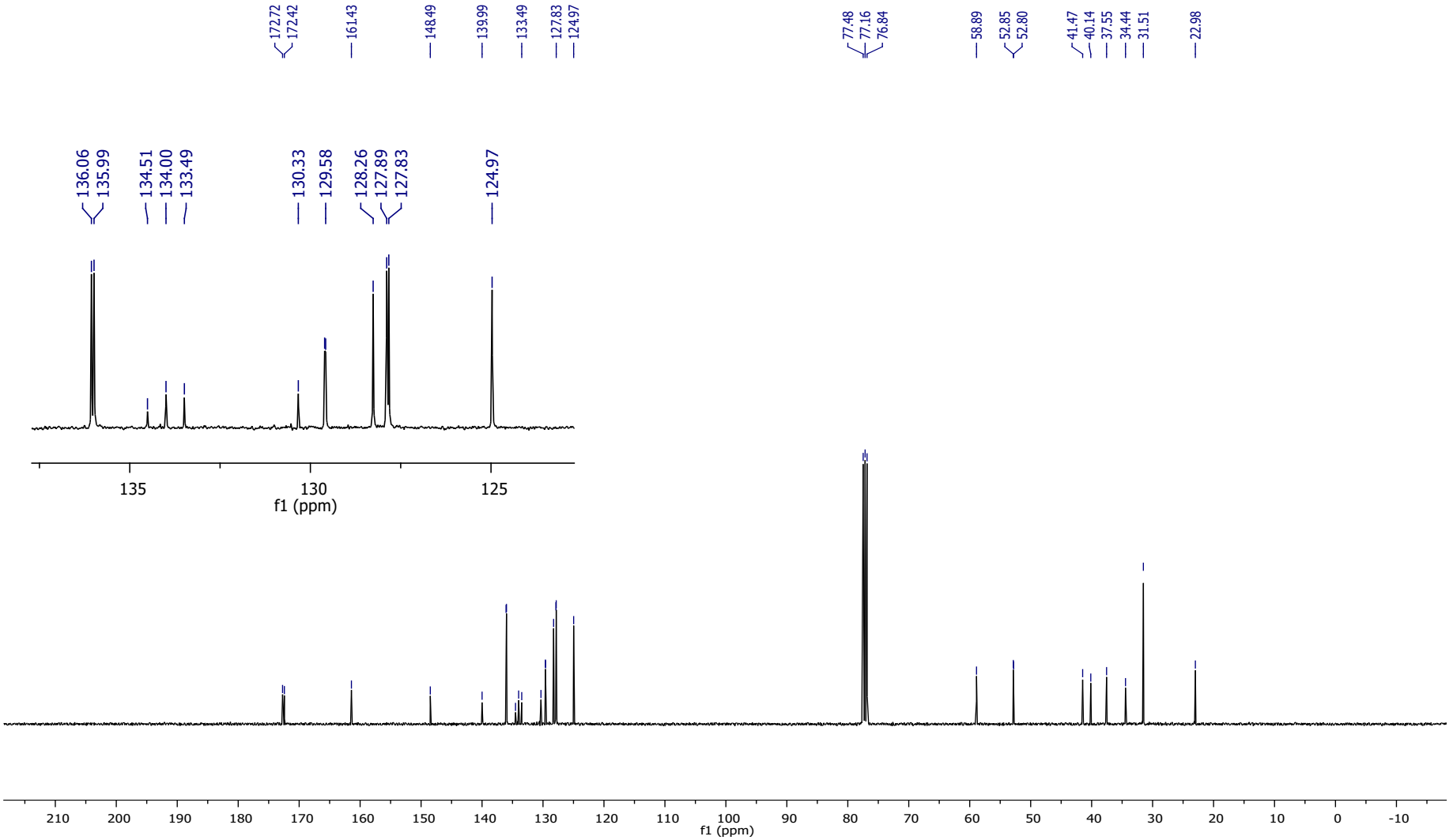

7.42 7.37 7.36 7.36 7.35 7.35 7.34 7.33 7.33 7.31 7.30 7.28 7.26 7.24 7.24 7.24 7.14 7.13 7.12 7.10 7.08 7.08 7.07 7.06 7.06 7.05 6.80 6.79 6.78
5.41
3.69 3.66 3.17 3.14 3.04 3.00 2.75 2.72 2.70 2.05 2.04 2.02 2.00 1.15 1.14
3.21 3.17 3.14 3.04 3.00 3.00 2.77 2.75 2.75 2.72 2.70 2.05 2.04 2.02 2.00
1.00 0.99 1.96 1.02
3.2 3.0 2.8 2.6 2.4 2.2 2.0
f1 (ppm)
4.08 6.01 3.03 1.91 0.92 3.02 2.88 1.00 0.99 1.96 1.02 3.04
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

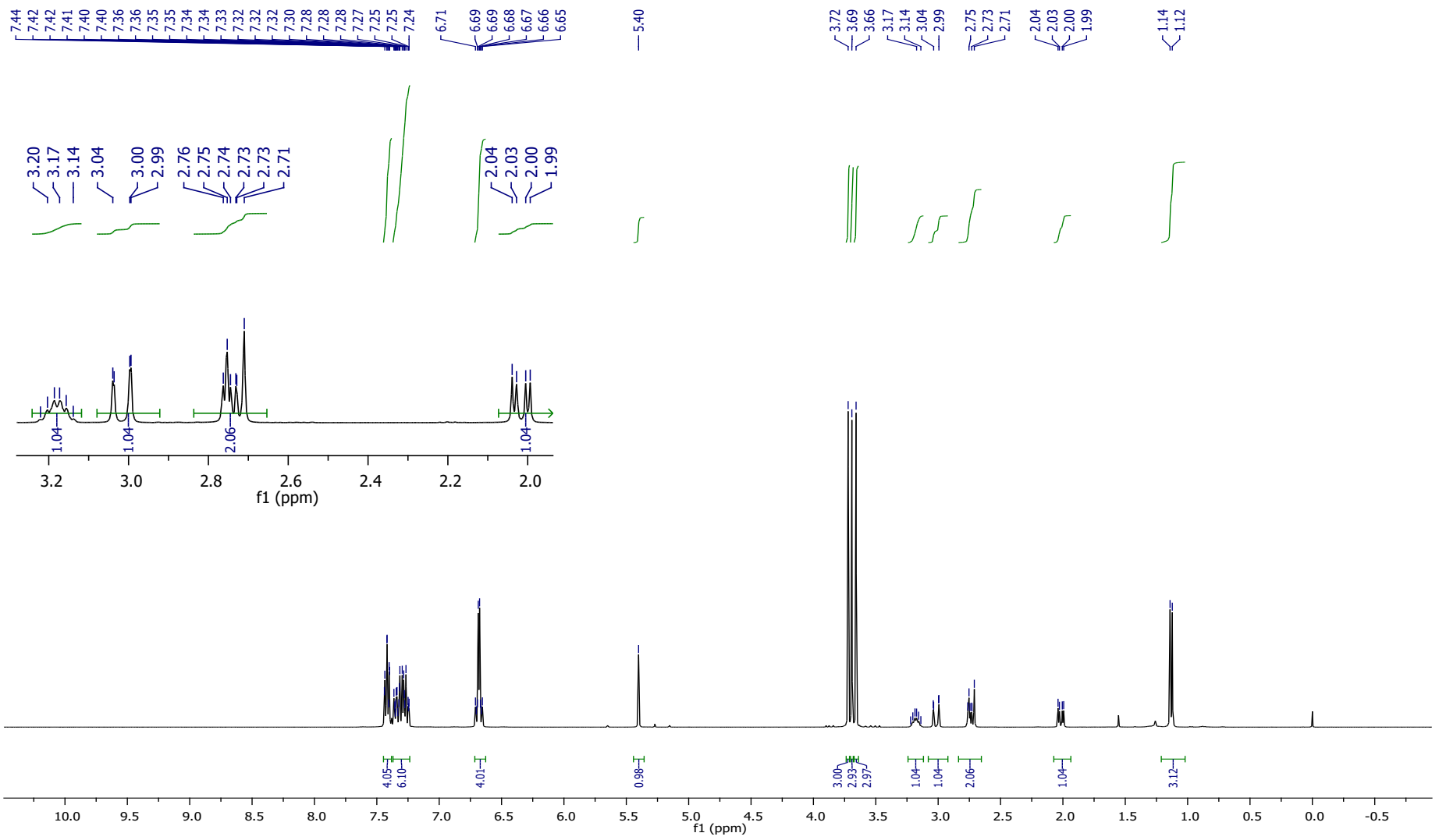

172.61
172.32
161.74
143.12
136.01
133.70
133.20
130.57
129.69
129.66
128.70
128.12
127.95
127.89
125.74
77.48
77.16
76.84
58.81
52.82
52.76
41.40
40.11
37.52
22.98
133.70
133.20
130.57
129.69
129.66
128.70
128.12
127.95
127.89
125.74
133
132
131
130
129
128
127
126
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

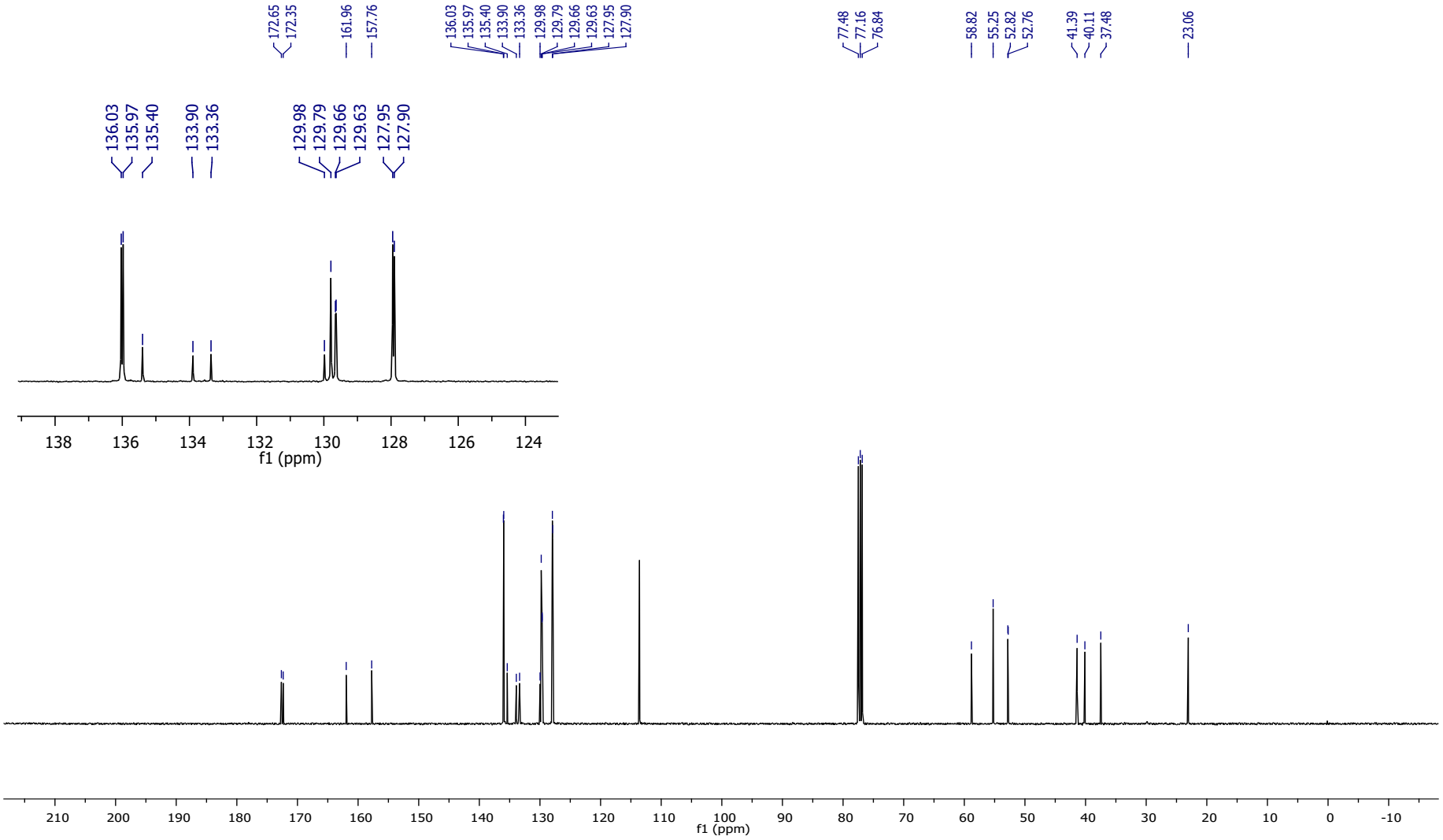

7.46
7.44
7.43
7.42
7.39
7.38
7.37
7.37
7.35
7.35
7.32
7.31
7.30
7.29
7.28
7.28
7.26
7.24
6.95
6.93
6.70
6.68
5.41
3.70
3.67
3.19
3.16
3.06
3.01
2.76
2.74
2.72
2.26
2.05
2.04
2.02
2.00
1.14
1.13
3.19
3.14
3.06
3.01
3.01
2.78
2.76
2.76
2.74
2.72
2.26
2.05
2.04
2.02
2.00
1.03
0.99
2.01
3.04
0.99
3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0
f1 (ppm)
4.01
6.12
2.02
1.99
0.96
3.00
2.86
1.03
0.99
2.01
3.04
0.99
3.01
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
f1 (ppm)

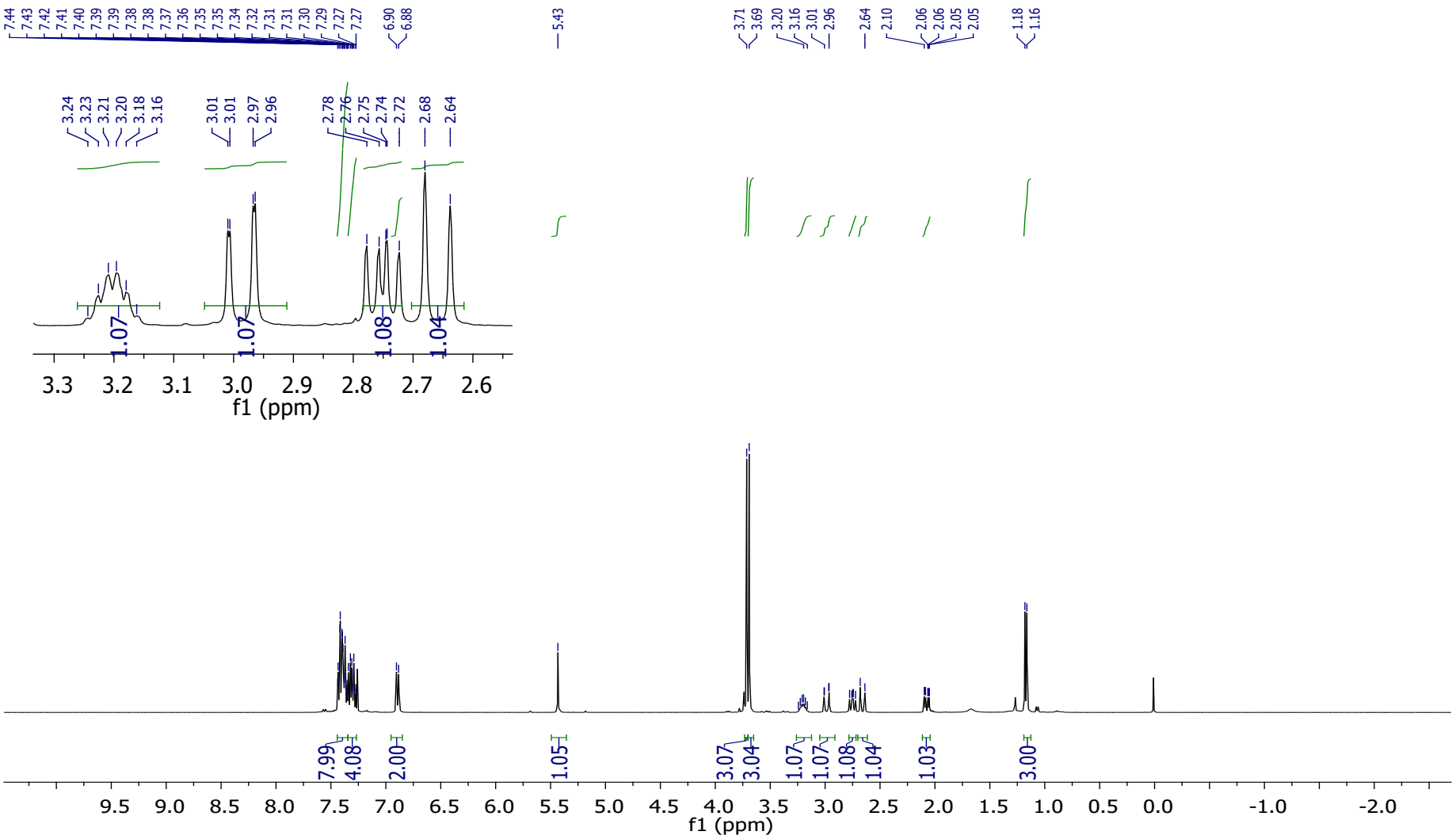

172.65
172.36
161.70
140.08
136.04
133.33
130.38
129.64
129.62
128.82
128.60
127.93
127.88
77.48
77.16
76.84
58.82
52.80
52.74
41.40
40.11
37.49
23.02
21.16
136.04
135.99
135.16
133.88
133.33
130.38
129.62
128.60
127.93
127.88
136 135 134 133 132 131 130 129 128 127 126 125
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

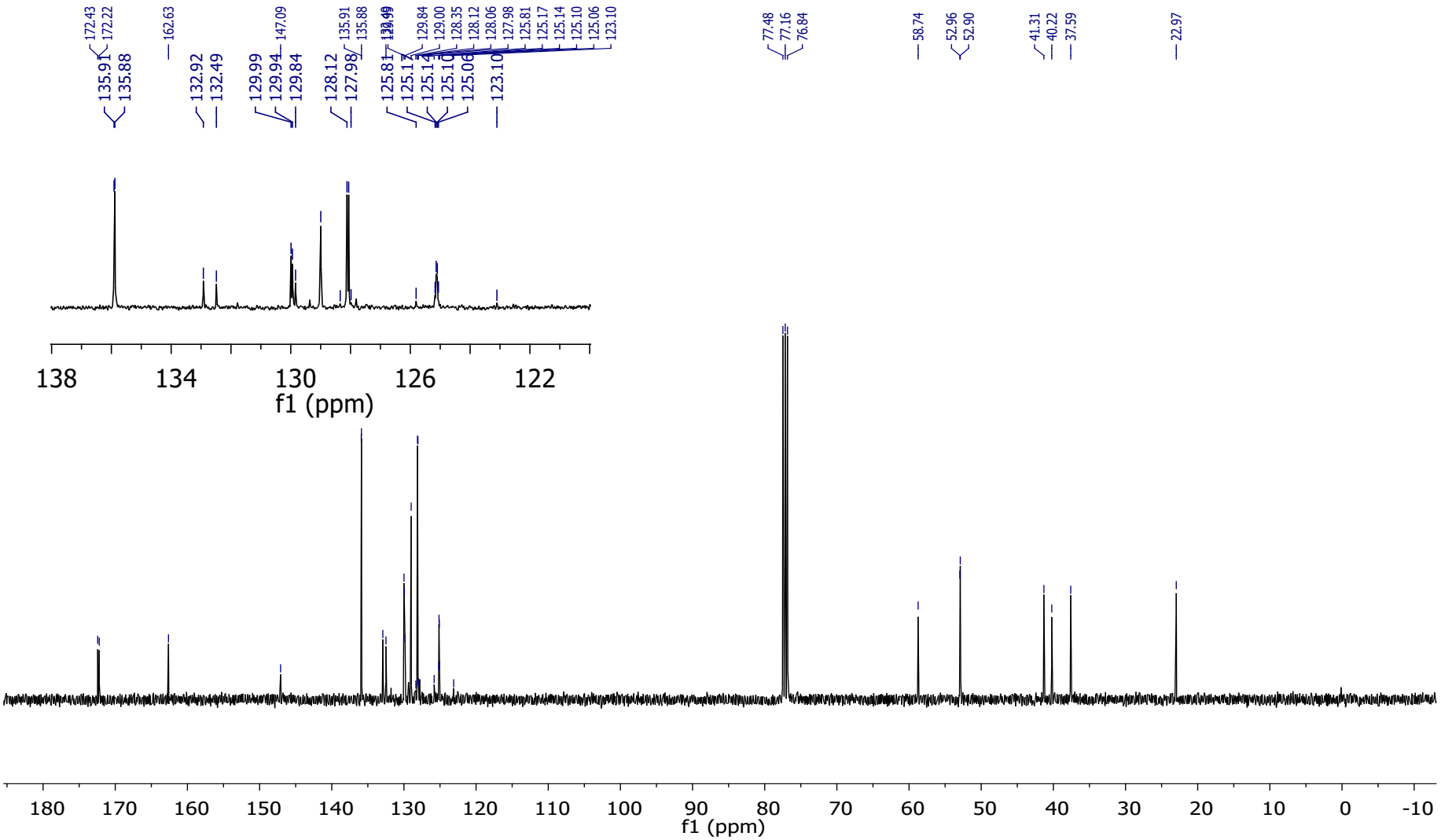

7.43
7.41
7.39
7.37
7.36
7.35
7.35
7.34
7.33
7.32
7.31
7.30
7.29
7.27
7.24
7.22
7.12
7.10
6.71
6.69
5.38
3.69
3.67
3.13
3.05
3.00
2.77
2.73
2.70
2.03
2.02
2.00
1.99
1.24
1.12
1.10
3.14
3.13
3.12
3.00
2.81
2.77
2.75
2.73
2.72
2.70
2.03
2.02
2.00
1.99
1.00
1.02
1.99
1.01
3.0
2.5
2.0
f1 (ppm)
5.89
2.11
2.02
2.01
2.01
0.94
6.04
1.00
1.02
1.99
1.01
9.01
3.06
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

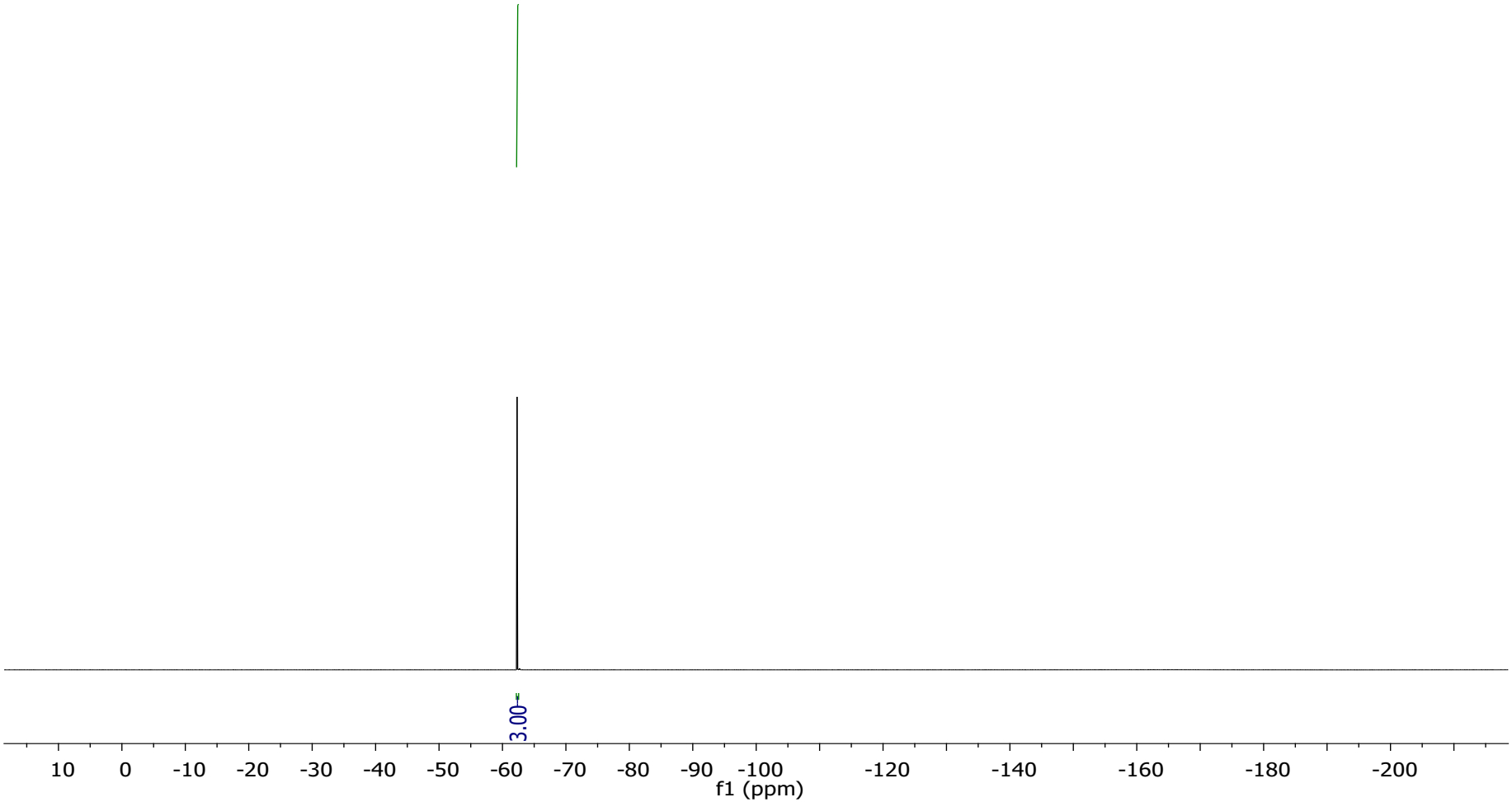

172.72
172.42
161.43
148.49
139.99
133.49
127.83
124.97
77.48
77.16
76.84
58.89
52.85
52.80
41.47
40.14
37.55
34.44
31.51
22.98
136.06
135.99
134.51
134.00
133.49
130.33
129.58
128.26
127.89
127.83
124.97
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

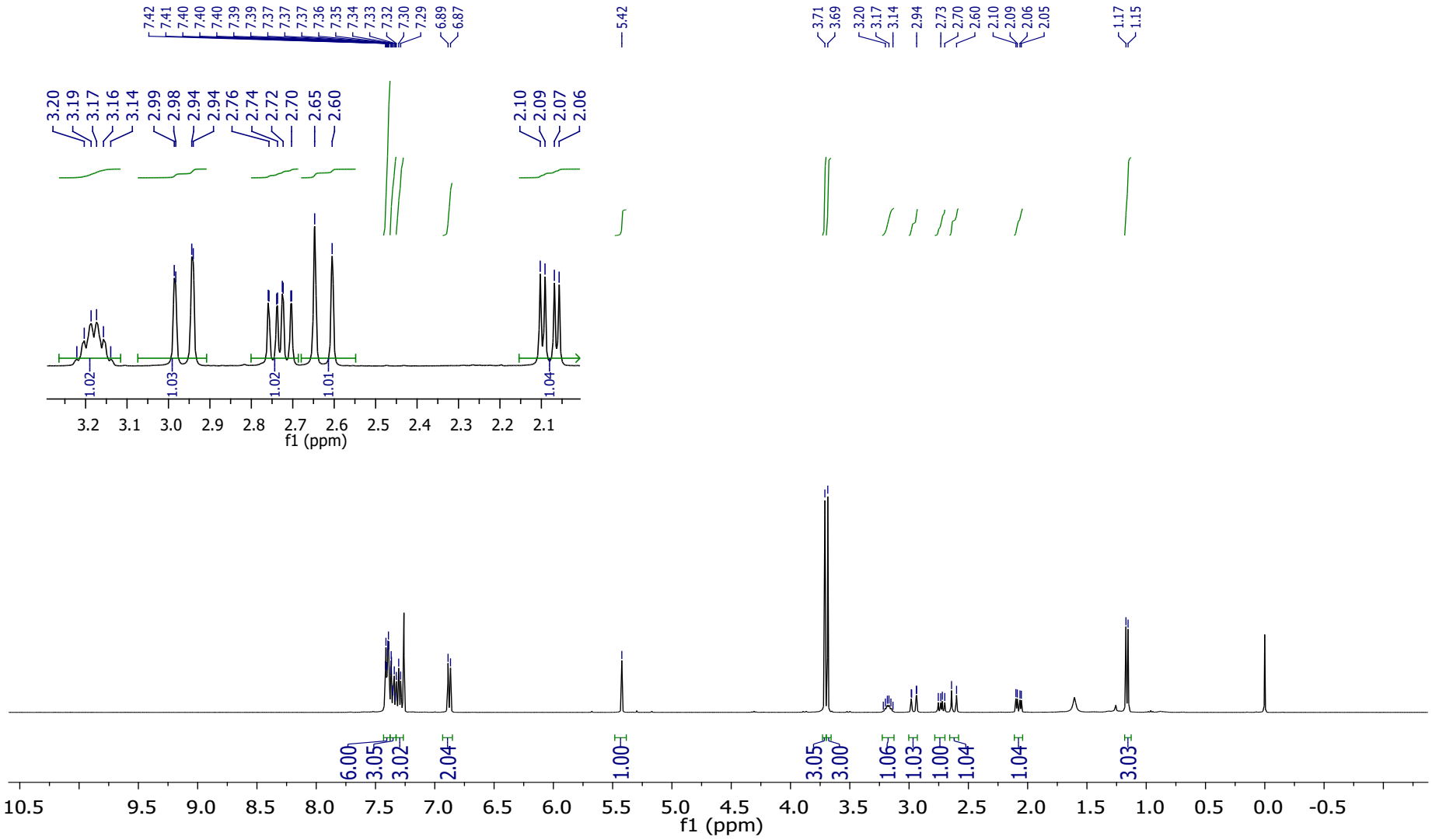

7.44 7.42 7.42 7.41 7.40 7.40 7.36 7.36 7.35 7.35 7.34 7.34 7.33 7.32 7.32 7.32 7.30 7.28 7.28 7.28 7.27 7.25 7.25 7.24
6.71 6.69 6.69 6.68 6.67 6.66 6.65
5.40
3.72 3.69 3.66
3.17 3.14 3.04 2.99
2.75 2.73 2.71
2.04 2.03 2.00 1.99
1.14 1.12
3.20 3.17 3.14 3.04 3.00 2.99 2.76 2.75 2.74 2.73 2.73 2.71
2.04 2.03 2.00 1.99
1.04 1.04 2.06 1.04
3.2 3.0 2.8 2.6 2.4 2.2 2.0
f1 (ppm)
4.05 6.10 4.01 0.98 3.00 2.93 2.97 1.04 1.04 2.06 1.04 3.12
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
f1 (ppm)

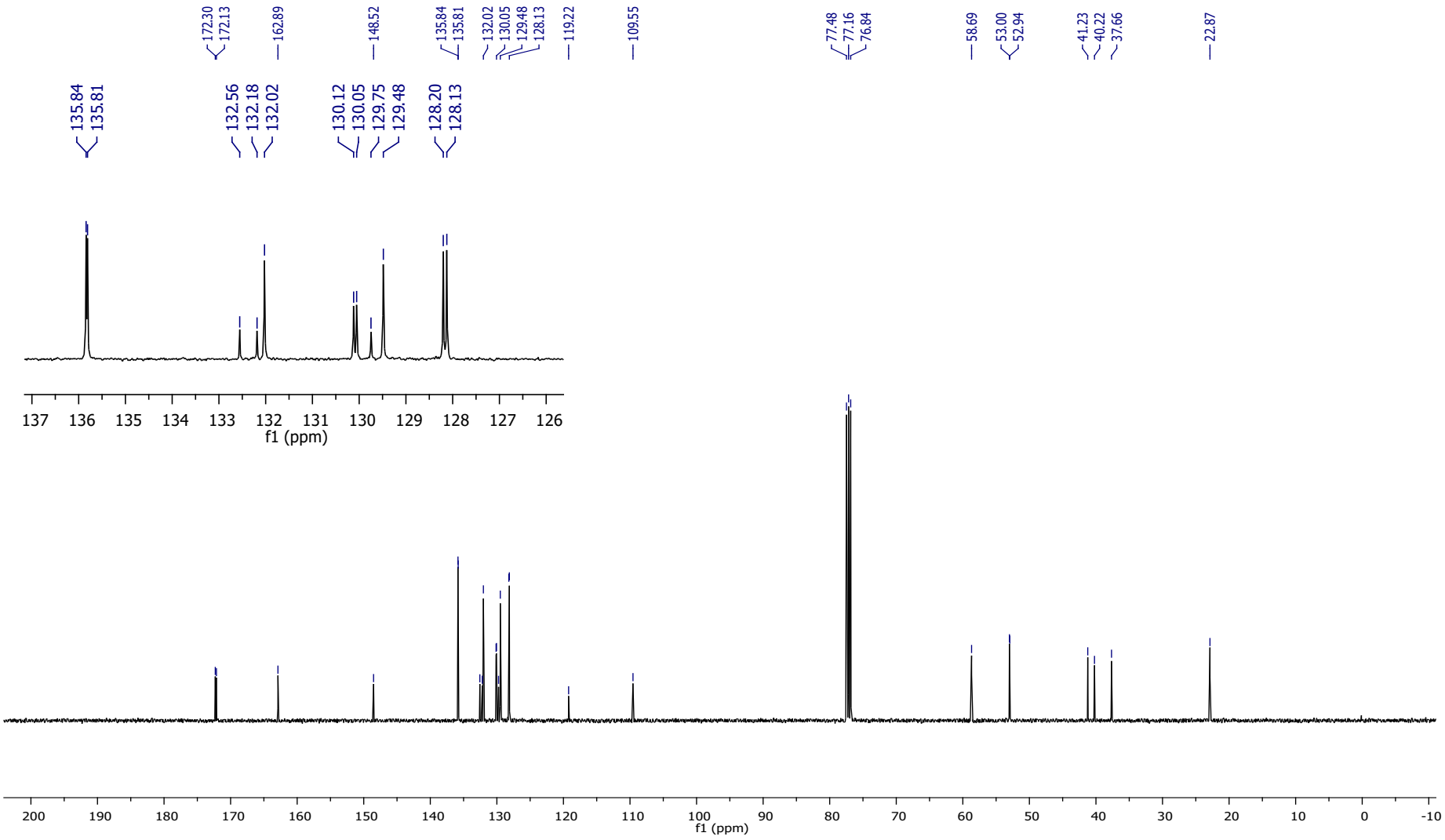

172.65
172.35
161.96
157.76
136.03
135.97
135.40
133.90
133.36
129.98
129.79
129.66
129.63
127.95
127.90
77.48
77.16
76.84
58.82
55.25
52.82
52.76
41.39
40.11
37.48
23.06
f1 (ppm)
f1 (ppm)

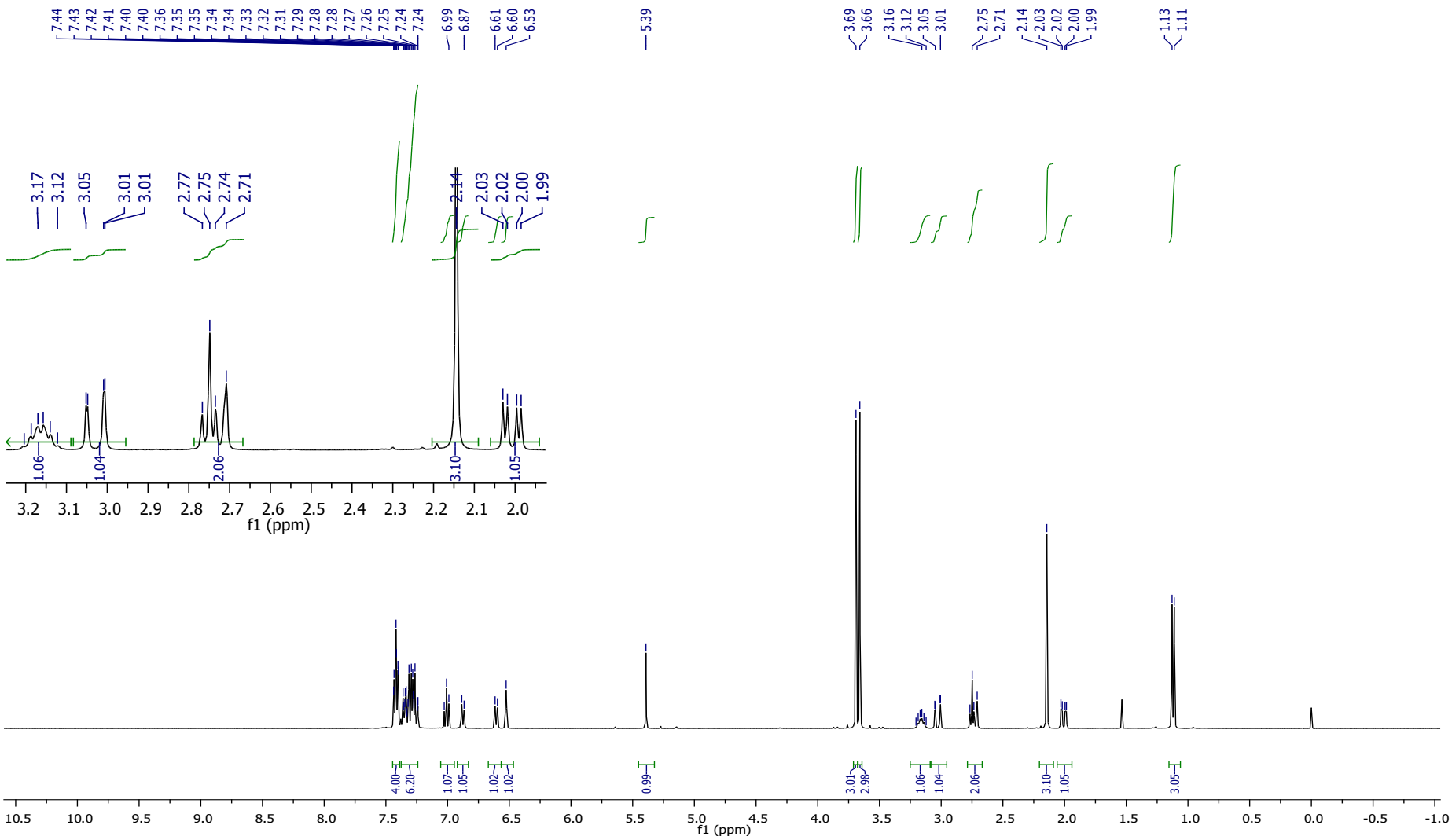

7.44 7.43 7.42 7.41 7.40 7.39 7.39 7.38 7.38 7.37 7.36 7.35 7.35 7.34 7.32 7.31 7.31 7.30 7.29 7.27 7.27
6.90 6.88
5.43
3.71 3.69 3.20 3.16 3.01 2.96
2.64
2.10
2.06 2.06 2.05 2.05
1.18 1.16
3.24 3.23 3.21 3.20 3.18 3.16
3.01 3.01 2.97 2.96
2.78 2.76 2.75 2.74 2.72
2.68
2.64
1.07 1.07 1.08 1.04
3.3 3.2 3.1 3.0 2.9 2.8 2.7 2.6
f1 (ppm)
7.99 4.08 2.00 1.05 3.07 3.04 1.07 1.07 1.08 1.04 1.03 3.00
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 -1.0 -2.0
f1 (ppm)

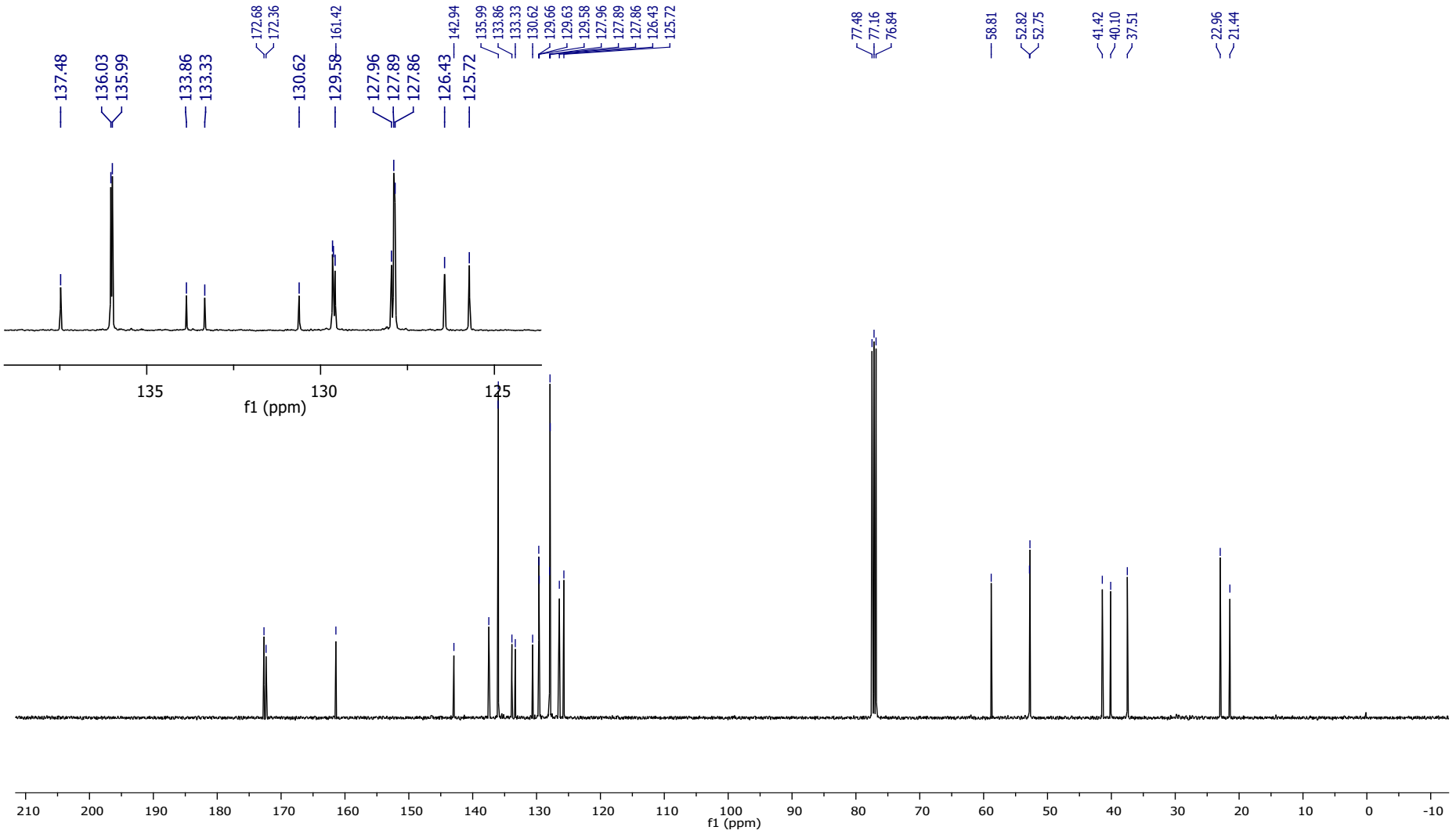

172.43
172.22
135.91
135.88
162.63
132.92
132.49
129.99
129.94
147.09
129.84
128.12
127.98
135.91
135.88
129.84
129.00
128.35
128.12
128.06
127.98
125.81
125.17
125.14
125.10
125.06
123.10
77.48
77.16
76.84
58.74
52.96
52.90
41.31
40.22
37.59
22.97
138
134
130
126
122
f1 (ppm)
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

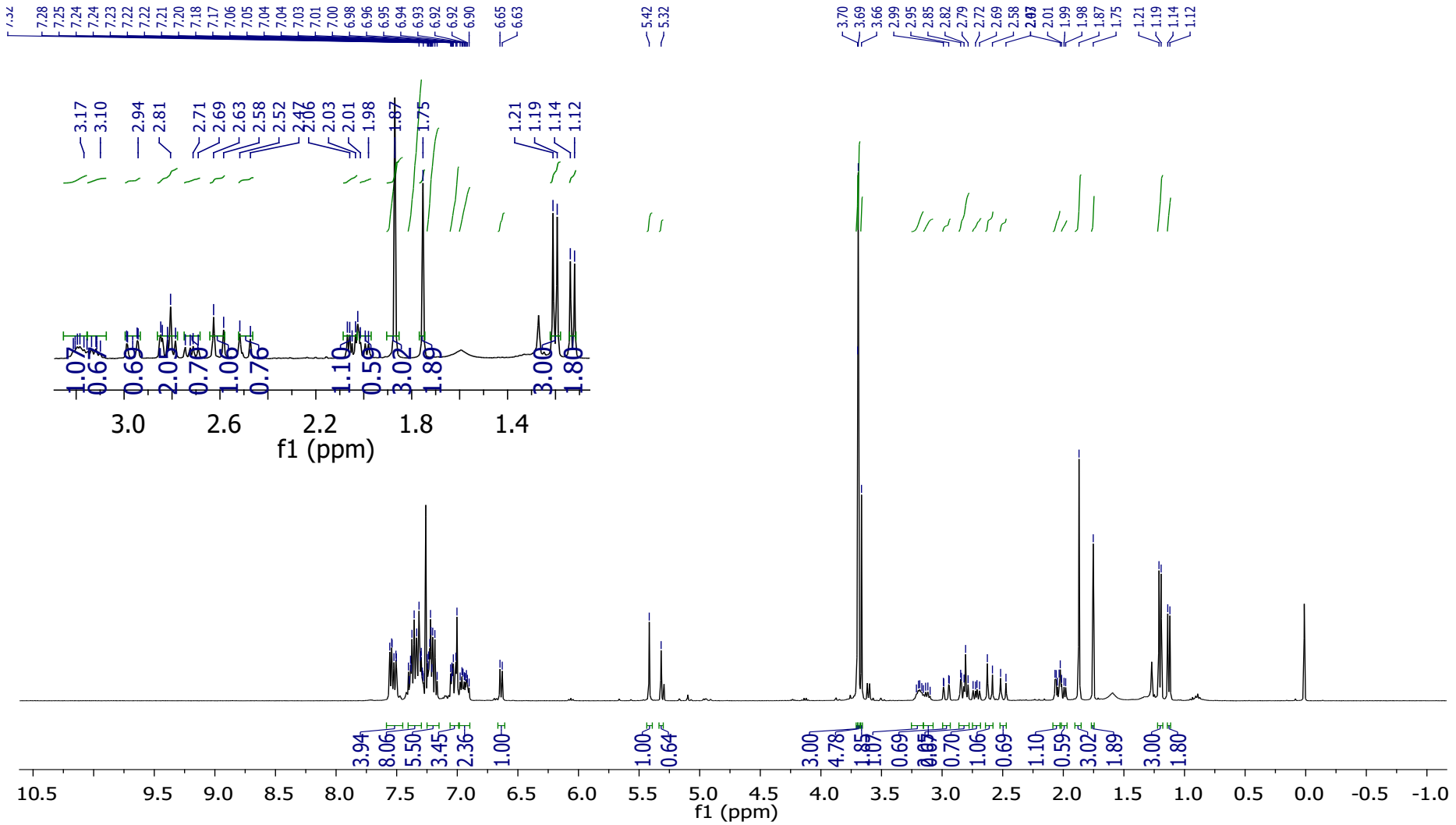

3.00
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-120
-140
-160
-180
-200
f1 (ppm)

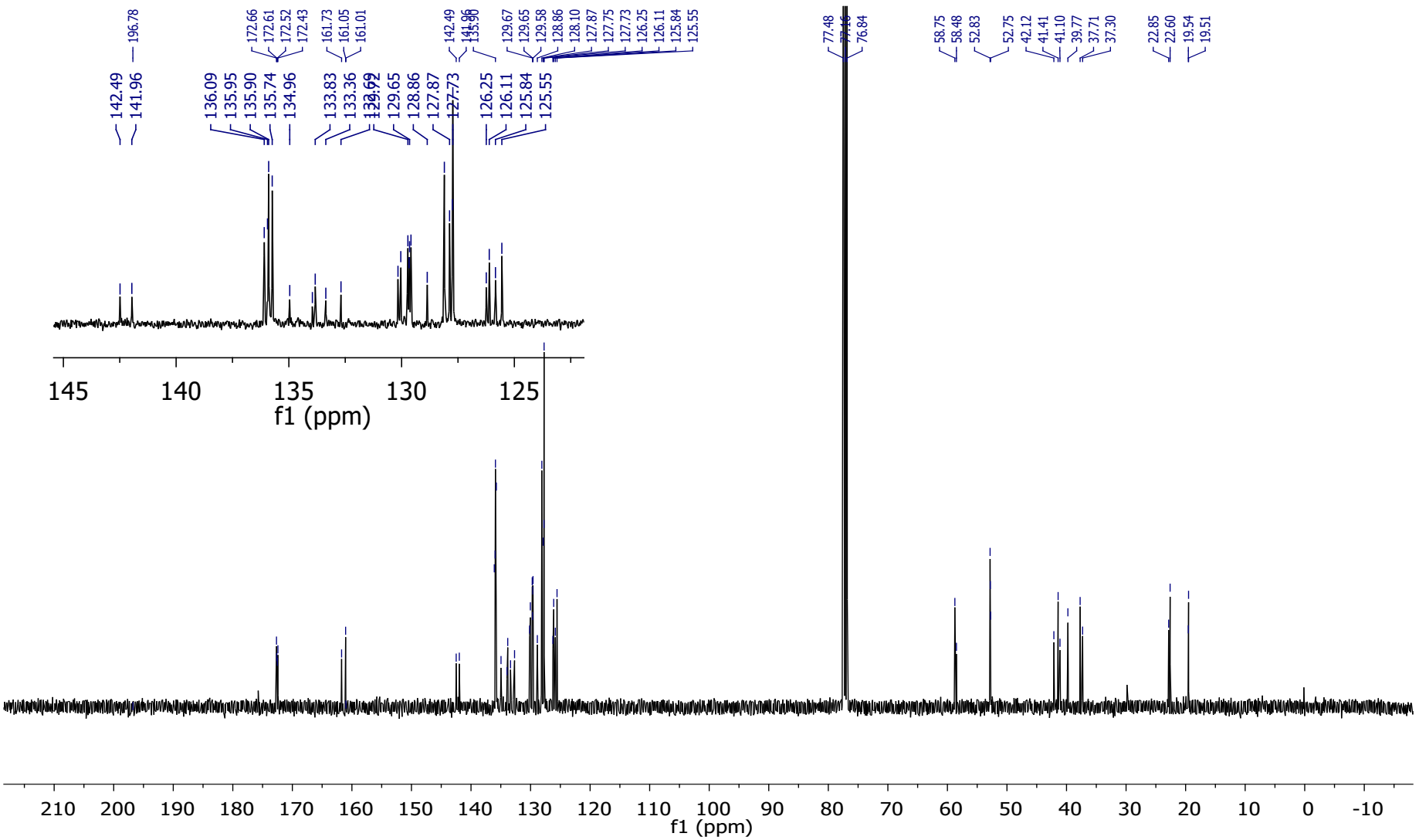

7.42 7.41 7.40 7.40 7.40 7.39 7.39 7.37 7.37 7.37 7.36 7.35 7.34 7.33 7.32 7.30 7.29 6.89 6.87
5.42
3.71 3.69 3.20 3.17 3.14 2.94 2.73 2.70 2.60 2.10 2.09 2.06 2.05 1.17 1.15
3.20 3.19 3.17 3.16 3.14 2.99 2.98 2.94 2.94 2.76 2.74 2.72 2.70 2.65 2.60 2.10 2.09 2.07 2.06
1.02 1.03 1.02 1.01 1.04
3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1
f1 (ppm)
6.00 3.05 3.02 2.04 1.00 3.05 3.00 1.06 1.03 1.00 1.04 1.04 3.03
10.5 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
f1 (ppm)

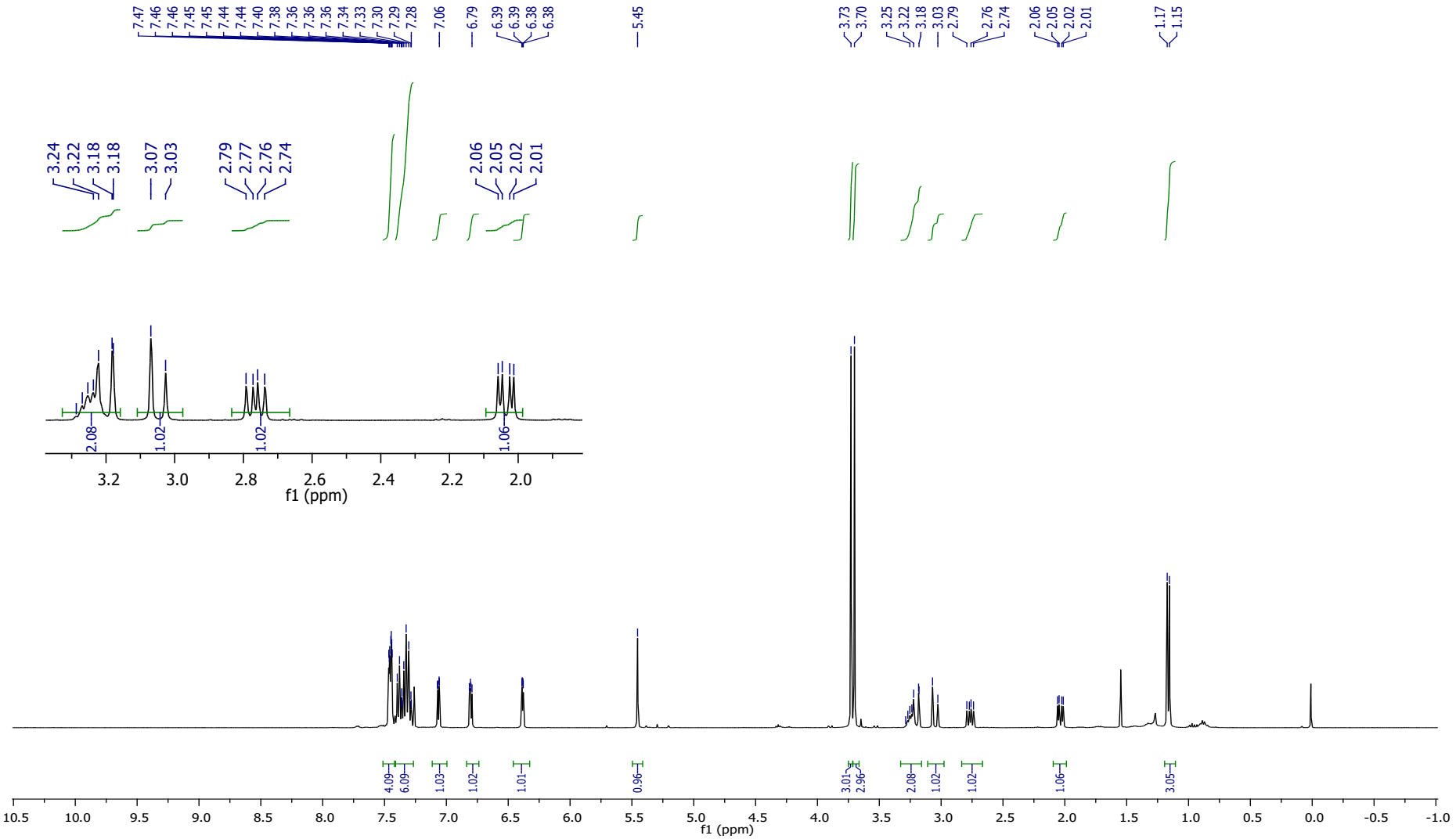

172.30
172.13
162.89
148.52
135.84
135.81
132.02
130.05
129.48
128.13
119.22
109.55
77.48
77.16
76.84
58.69
53.00
52.94
41.23
40.22
37.66
22.87
135.84
135.81
132.56
132.18
132.02
130.12
130.05
129.75
129.48
128.20
128.13
137 136 135 134 133 132 131 130 129 128 127 126
f1 (ppm)
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

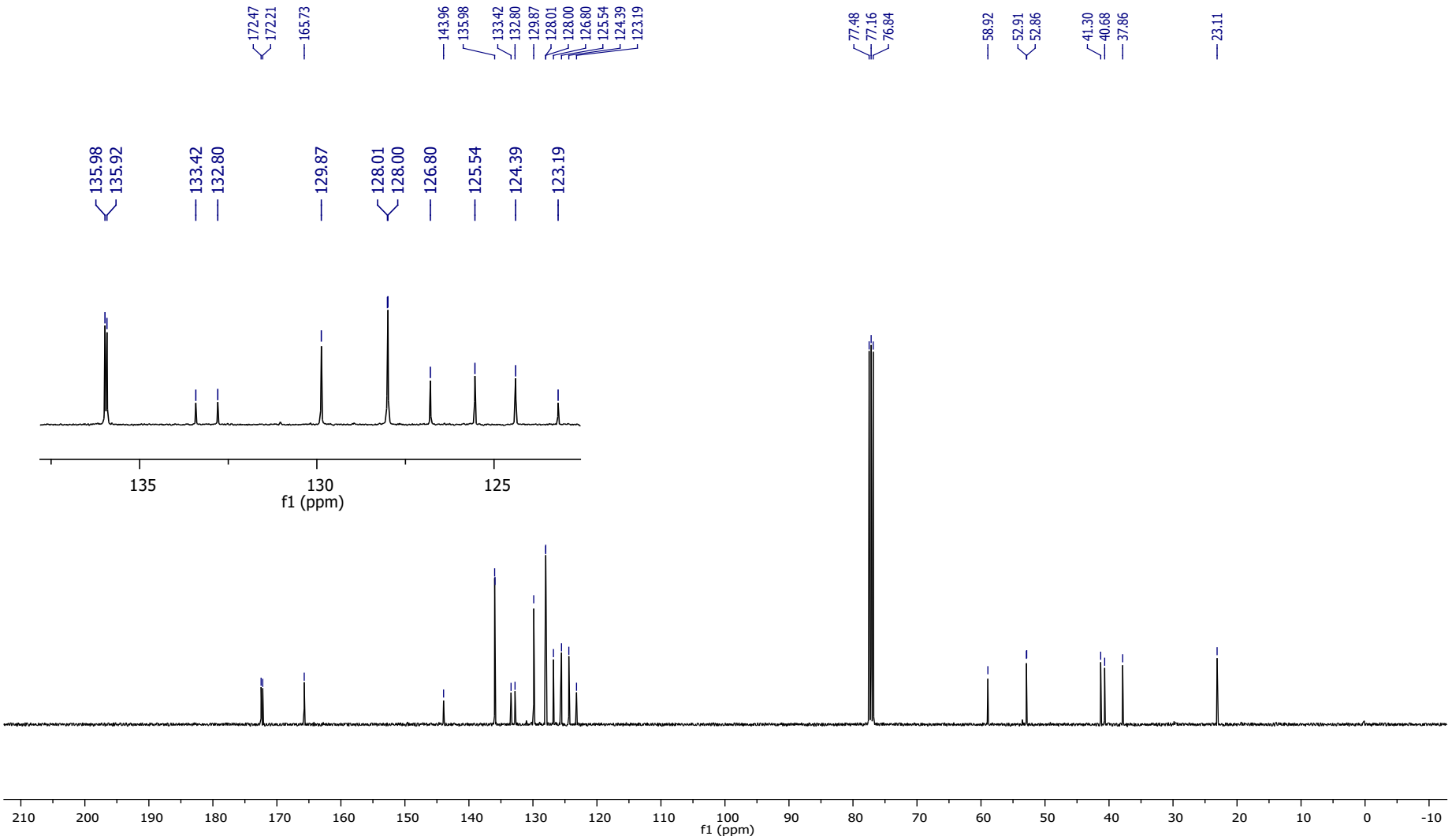

7.44 7.43 7.42 7.41 7.40 7.40 7.36 7.35 7.35 7.34 7.34 7.33 7.32 7.31 7.29 7.28 7.28 7.27 7.26 7.25 7.24 7.24
6.99 6.87
6.61 6.60 6.53
5.39
3.69 3.66
3.16 3.12 3.05 3.01
2.75 2.71
2.14 2.03 2.02 2.00 1.99
1.13 1.11
3.17 3.12 3.05 3.01 3.01 2.77 2.75 2.74 2.71 2.14 2.03 2.02 2.00 1.99
1.06 1.04 2.06 3.10 1.05
3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0
f1 (ppm)
4.00 6.20 1.07 1.05 1.02 1.02 0.99 3.01 2.98 1.06 1.04 2.06 3.10 1.05 3.05
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

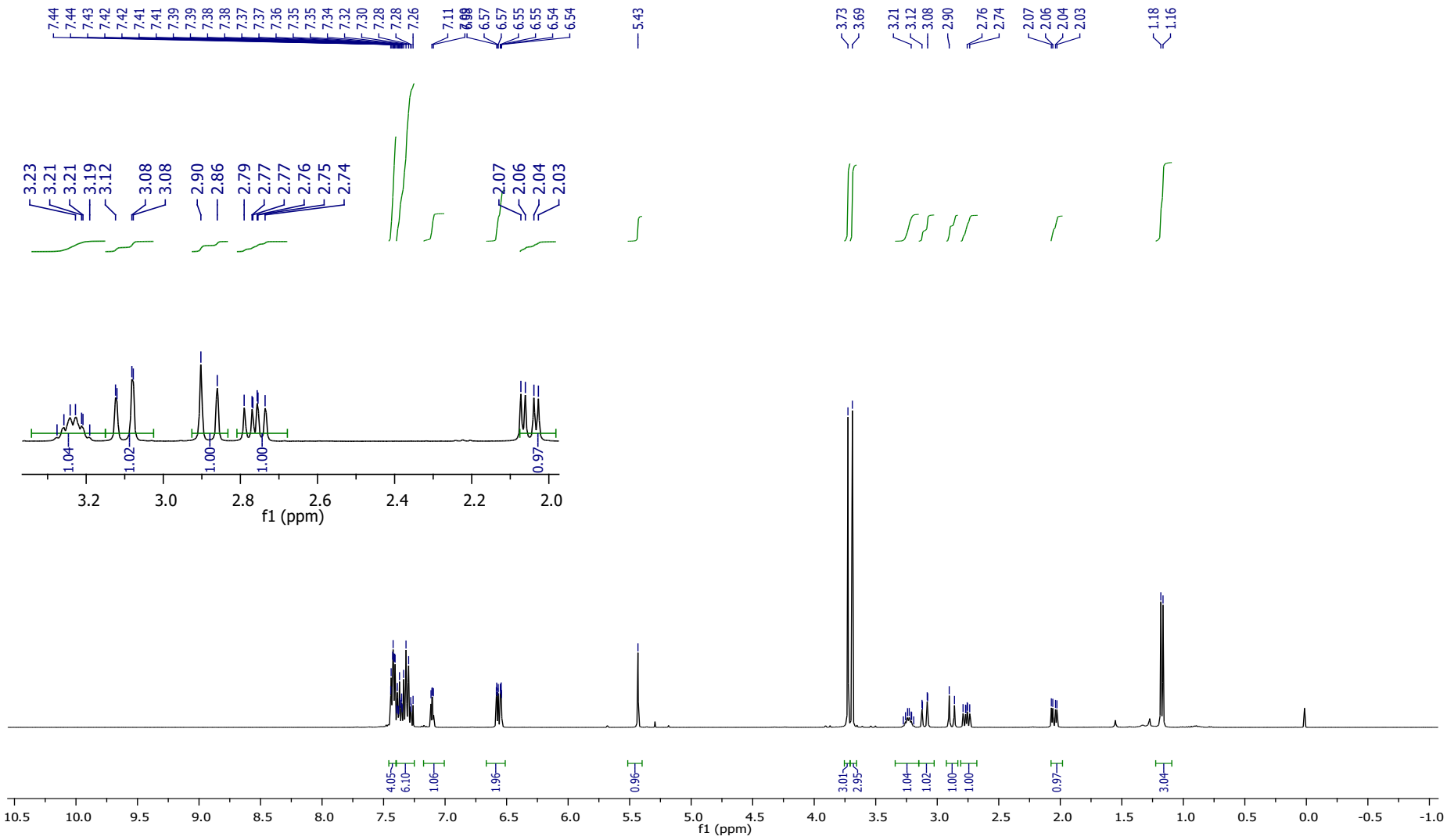

137.48
136.03
135.99
133.86
133.33
172.68
172.36
130.62
129.58
161.42
127.96
127.89
127.86
126.43
142.94
125.72
135.99
133.86
133.33
130.62
129.66
129.63
129.58
127.96
127.89
127.86
126.43
125.72
77.48
77.16
76.84
58.81
52.82
52.75
41.42
40.10
37.51
22.96
21.44
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

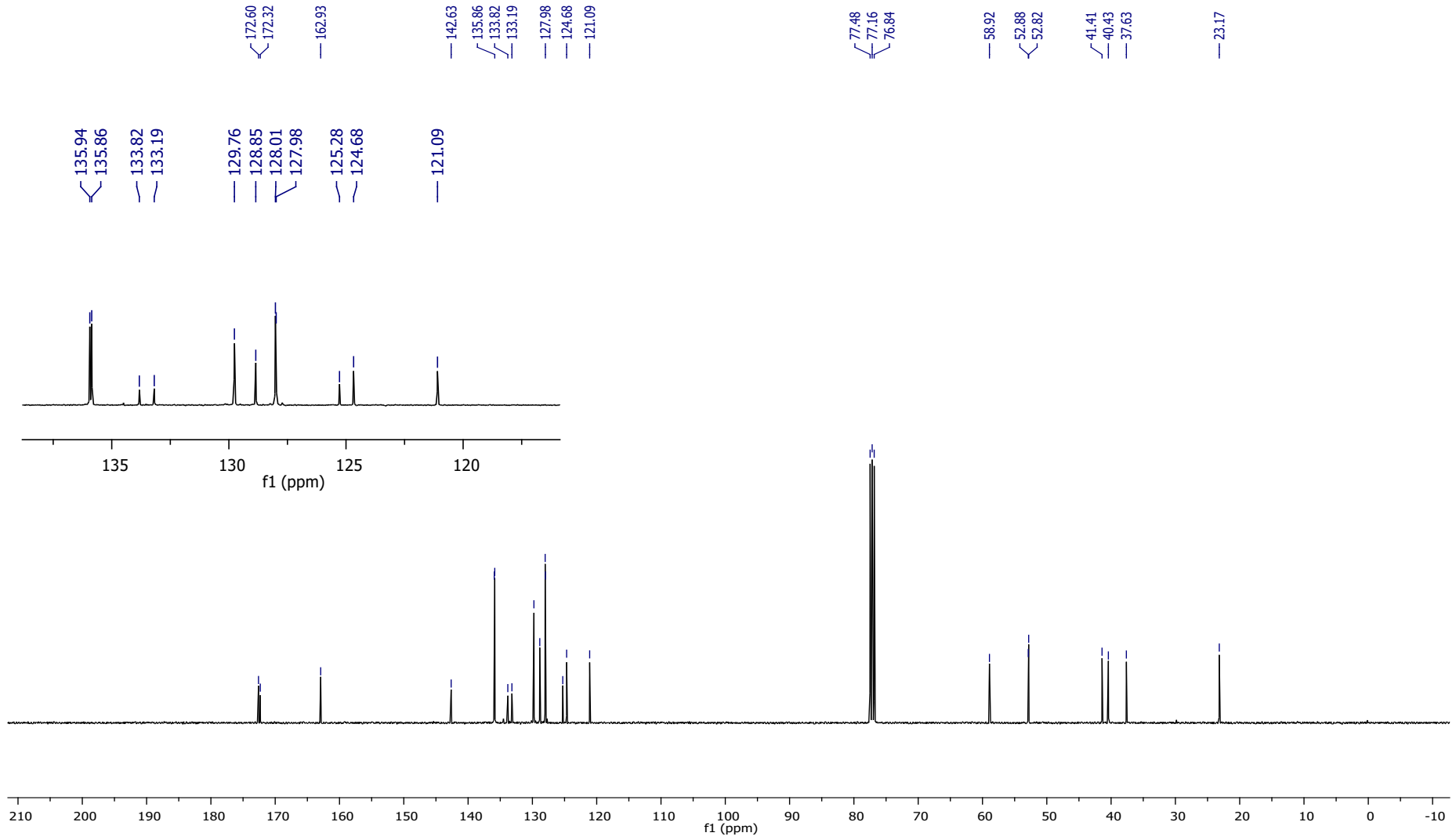

f1 (ppm)
f1 (ppm)

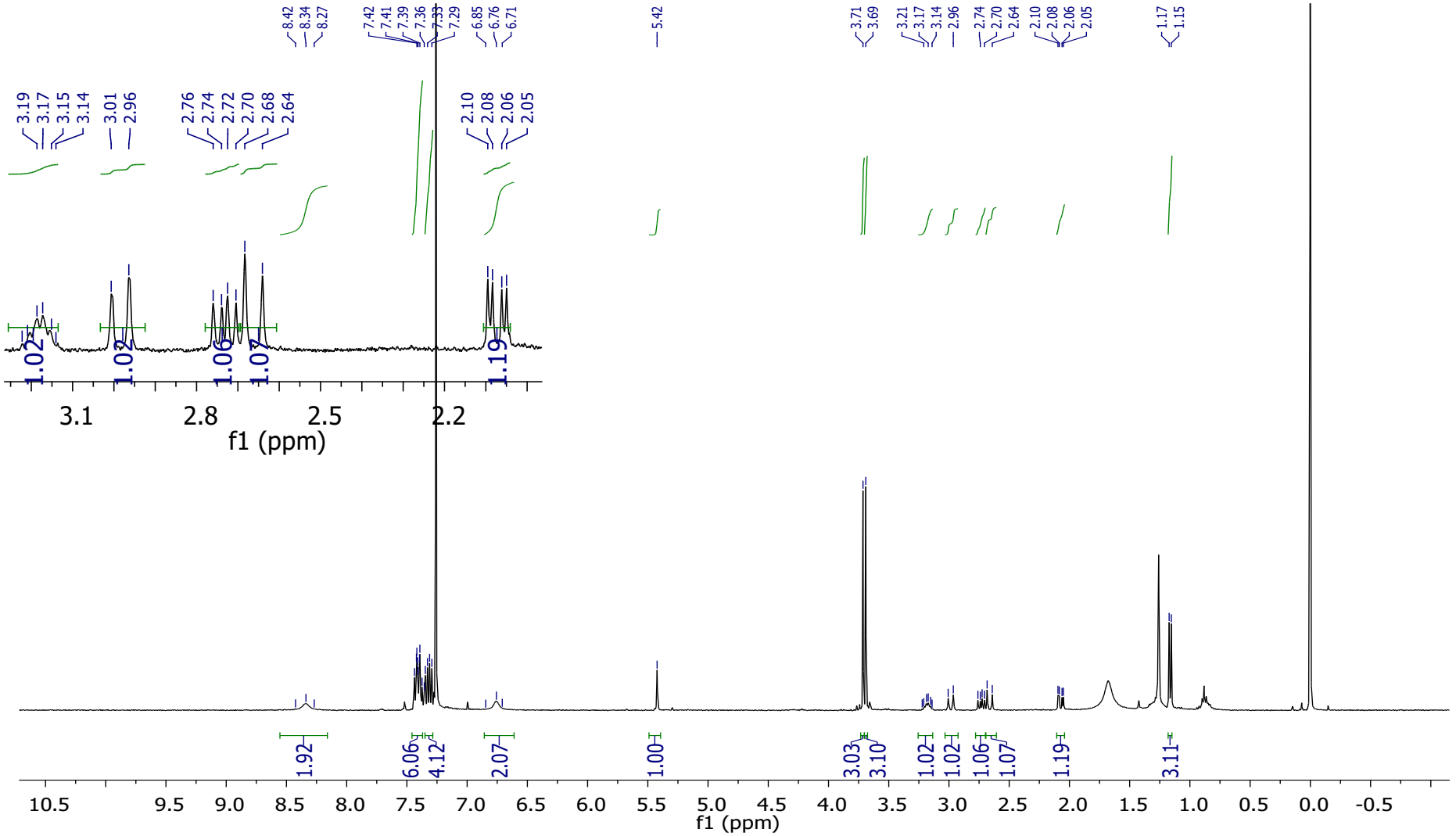

196.78
172.66
172.61
172.52
172.43
161.73
161.05
161.01
142.49
141.96
135.90
129.67
129.65
129.58
128.86
128.10
127.87
127.75
127.73
126.25
126.11
125.84
125.55
77.48
77.16
76.84
58.75
58.48
52.83
52.75
42.12
41.41
41.10
39.77
37.71
37.30
22.85
22.60
19.54
19.51
142.49
141.96
136.09
135.95
135.90
135.74
134.96
133.83
133.36
129.65
128.86
127.87
127.73
126.25
126.11
125.84
125.55
145
140
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

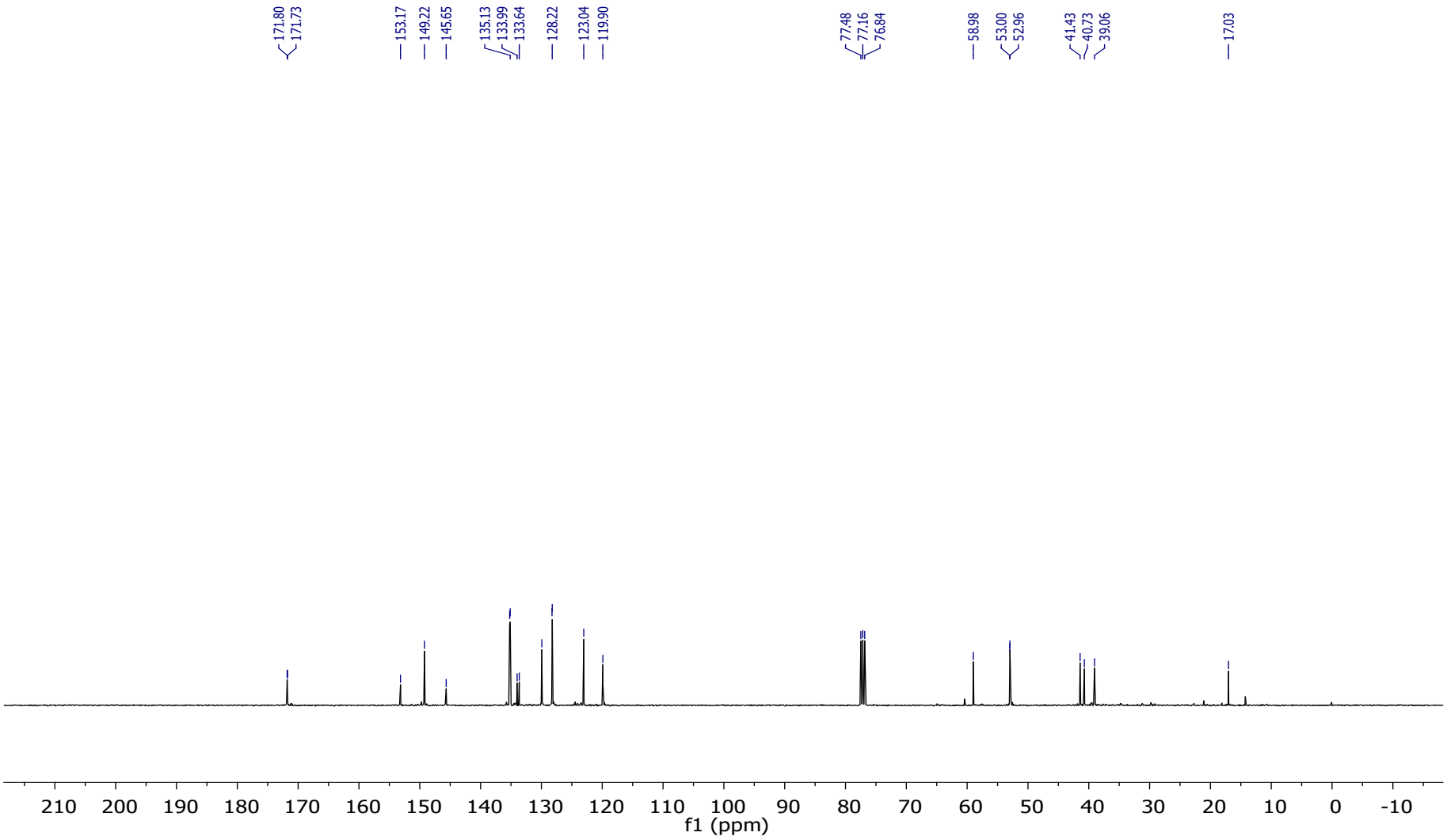

7.47
7.46
7.46
7.45
7.45
7.44
7.44
7.40
7.38
7.36
7.36
7.36
7.34
7.33
7.30
7.29
7.28
7.06
6.79
6.39
6.39
6.38
6.38
5.45
3.73
3.70
3.25
3.22
3.18
3.03
2.79
2.76
2.74
2.06
2.05
2.02
2.01
1.17
1.15
3.24
3.22
3.18
3.18
3.07
3.03
2.79
2.77
2.76
2.74
2.06
2.05
2.02
2.01
2.08
1.02
1.02
1.06
3.2
3.0
2.8
2.6
2.4
2.2
2.0
f1 (ppm)
4.09
6.09
1.03
1.02
1.01
0.96
3.01
2.96
2.08
1.02
1.02
1.06
3.05
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

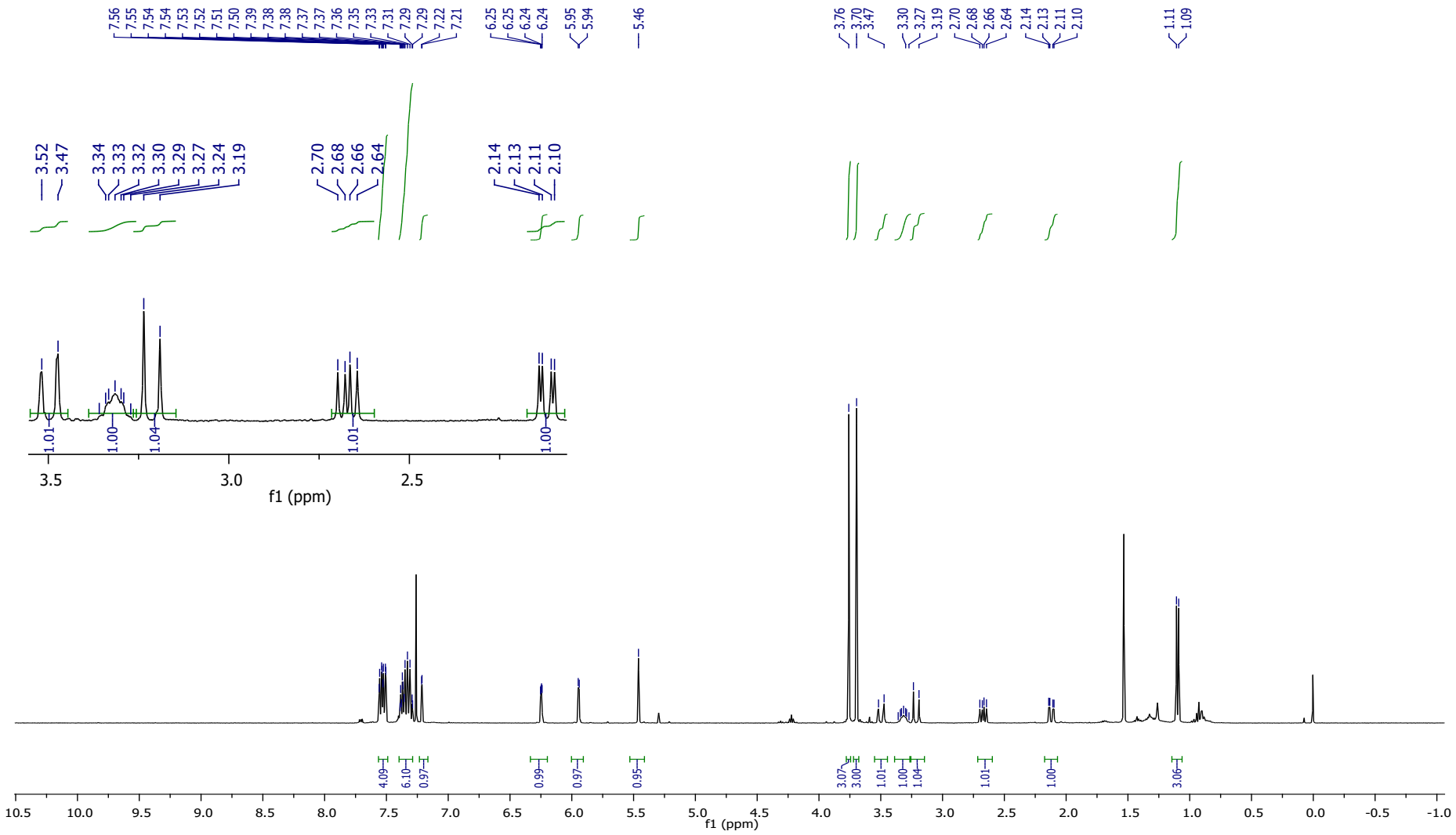

172.47
172.21
165.73
143.96
135.98
133.42
132.80
129.87
128.01
128.00
126.80
125.54
124.39
123.19
77.48
77.16
76.84
58.92
52.91
52.86
41.30
40.68
37.86
23.11
135.98
135.92
133.42
132.80
129.87
128.01
128.00
126.80
125.54
124.39
123.19
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

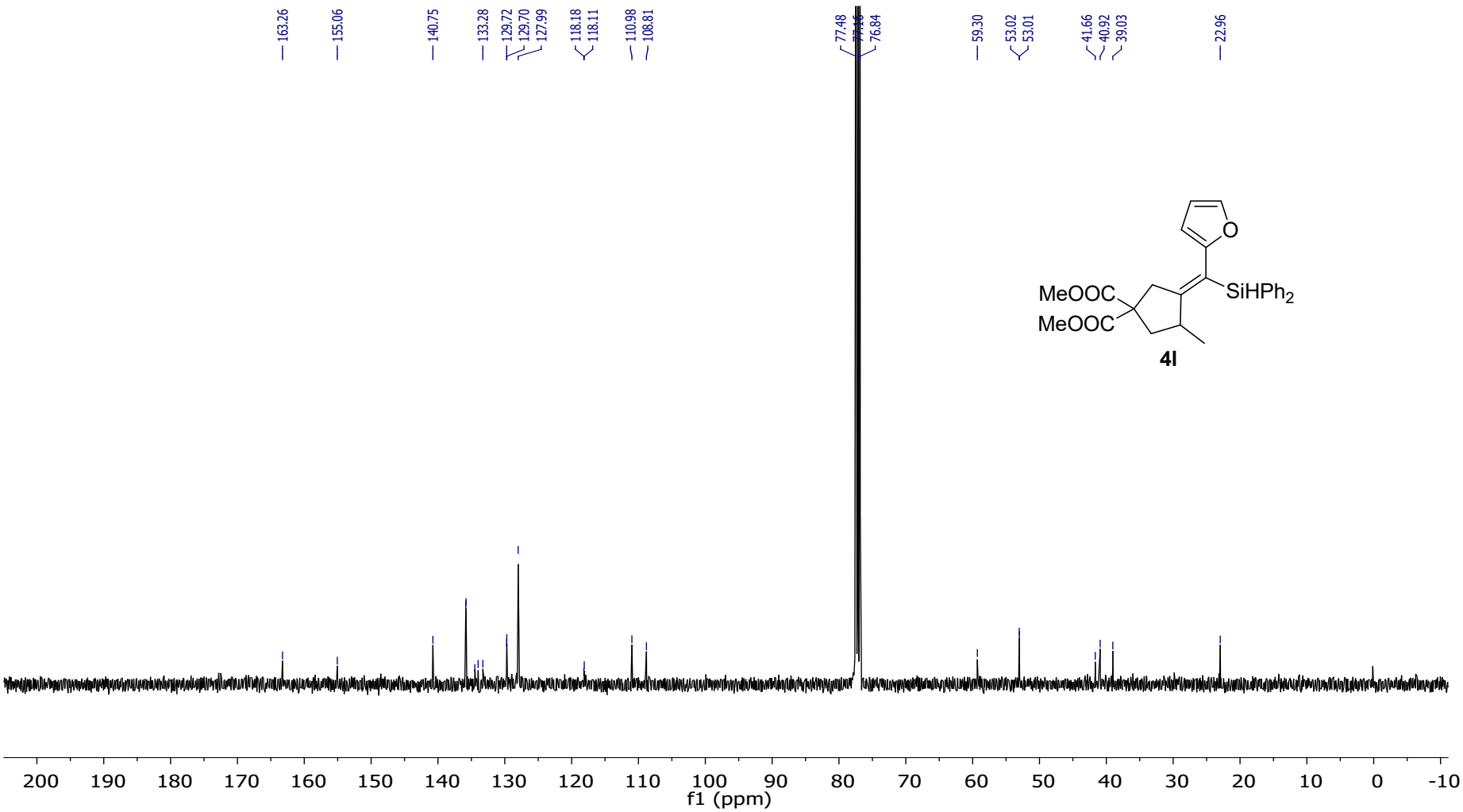

7.44 7.44 7.43 7.42 7.42 7.41 7.41 7.39 7.39 7.38 7.38 7.37 7.37 7.36 7.35 7.34 7.32 7.30 7.28 7.26 7.11 6.57 6.57 6.55 6.55 6.54 6.54
5.43
3.73 3.69
3.21 3.12 3.08 2.90
2.76 2.74
2.07 2.06 2.04 2.03
1.18 1.16
3.23 3.21 3.21 3.19 3.12 3.08 3.08 2.90 2.86 2.79 2.77 2.77 2.76 2.75 2.74 2.07 2.06 2.04 2.03
1.04 1.02 1.00 1.00 0.97
3.2 3.0 2.8 2.6 2.4 2.2 2.0
f1 (ppm)
4.05 6.10 1.06 1.96 0.96 3.01 2.95 1.04 1.02 1.00 1.00 0.97 3.04
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

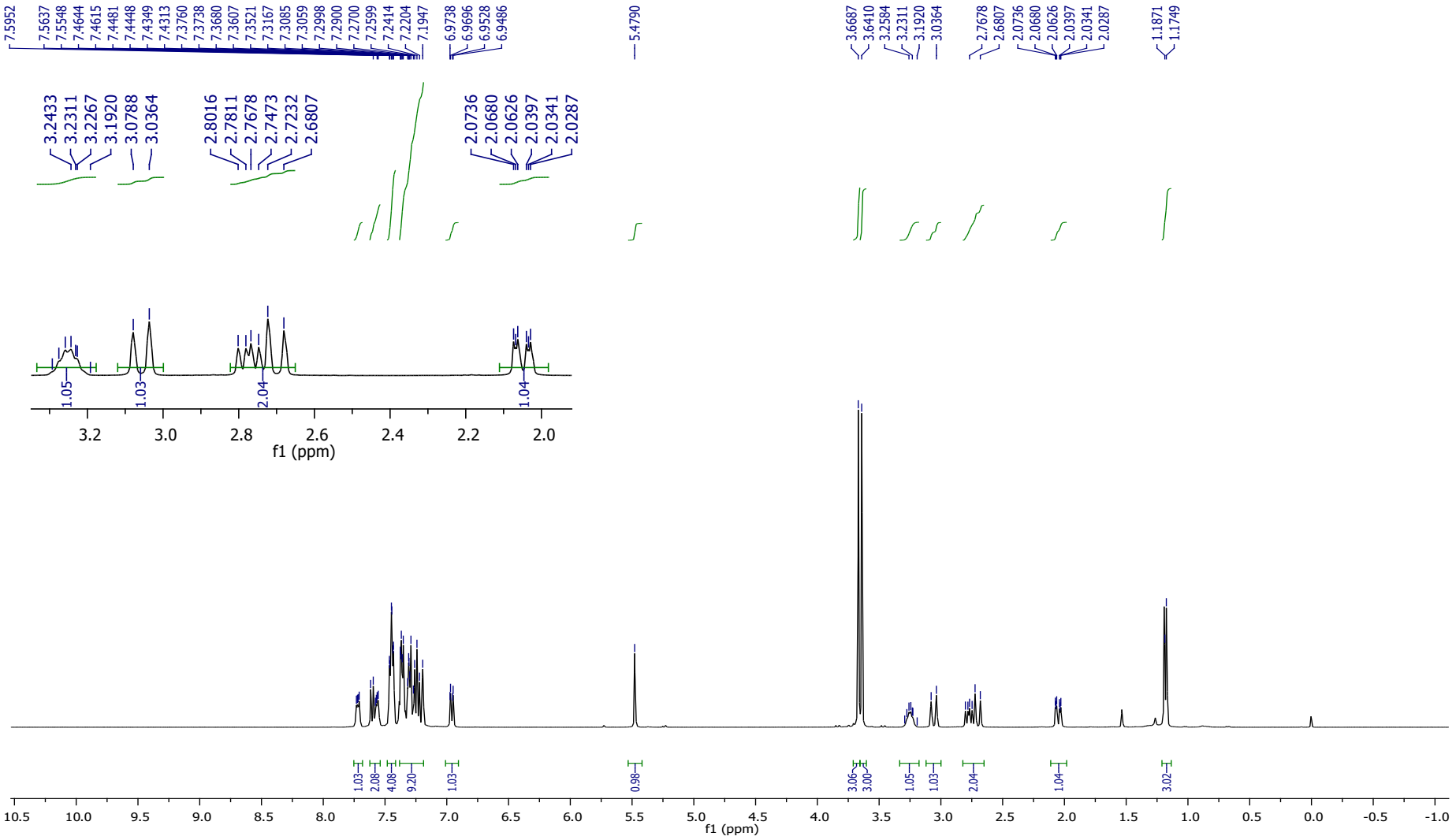

172.60
172.32
162.93
142.63
135.86
133.82
133.19
127.98
124.68
121.09
77.48
77.16
76.84
58.92
52.88
52.82
41.41
40.43
37.63
23.17
135.94
135.86
133.82
133.19
129.76
128.85
128.01
127.98
125.28
124.68
121.09
135
130
125
120
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


8.42
8.34
8.27
7.42
7.41
7.39
7.36
7.33
7.29
6.85
6.76
6.71
5.42
3.71
3.69
3.21
3.17
3.14
2.96
2.74
2.70
2.64
2.10
2.08
2.06
2.05
1.17
1.15
3.19
3.17
3.15
3.14
3.01
2.96
2.76
2.74
2.72
2.70
2.68
2.64
2.10
2.08
2.06
2.05
1.02
1.03
1.06
1.07
1.19
3.1
2.8
2.5
2.2
f1 (ppm)
1.92
6.06
4.12
2.07
1.00
3.03
3.10
1.02
1.02
1.06
1.07
1.19
3.11
10.5
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
f1 (ppm)


171.80
171.73
153.17
149.22
145.65
135.13
133.99
133.64
128.22
123.04
119.90
77.48
77.16
76.84
58.98
53.00
52.96
41.43
40.73
39.06
17.03
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.56 7.55 7.54 7.54 7.53 7.52 7.51 7.50 7.39 7.38 7.38 7.37 7.37 7.36 7.35 7.33 7.31 7.29 7.29 7.22 7.21
6.25 6.25 6.24 6.24
5.95 5.94
5.46
3.76 3.70 3.47
3.30 3.27 3.19
2.70 2.68 2.66 2.64
2.14 2.13 2.11 2.10
1.11 1.09
3.52 3.47
3.34 3.33 3.32 3.30 3.29 3.27 3.24 3.19
2.70 2.68 2.66 2.64
2.14 2.13 2.11 2.10
1.01 1.00 1.04 1.01 1.00
3.5 3.0 2.5
f1 (ppm)
4.09 6.10 0.97 0.99 0.97 0.95 3.07 3.00 1.01 1.00 1.04 1.01 1.00 3.06
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


163.26
155.06
140.75
133.28
129.72
129.70
127.99
118.18
118.11
110.98
108.81
77.48
77.16
76.84
59.30
53.02
53.01
41.66
40.92
39.03
22.96
O
MeOOC
MeOOC
SiHPh2
4l
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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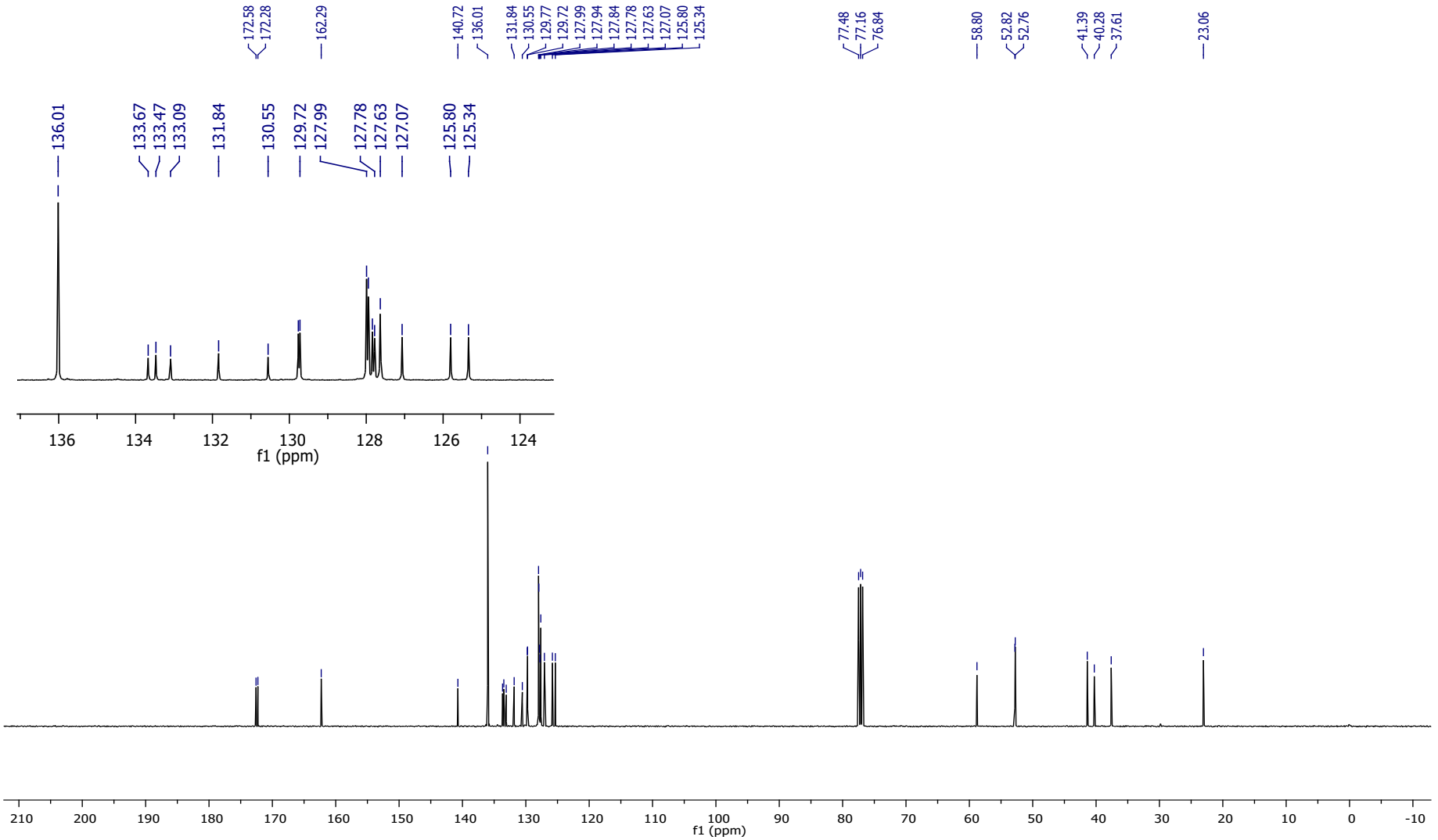
7.4313
7.3760
7.3738
7.3680
7.3607
7.3521
7.3167
7.3085
7.3059
7.2998
7.2900
7.2700
7.2599
7.2414
7.2204
7.1947
6.9738
6.9696
6.9528
6.9486
5.4790
3.6687
3.6410
3.2584
3.2311
3.1920
3.0364
2.7678
2.6807
2.0736
2.0680
2.0626
2.0397
2.0341
2.0287
1.1871
1.1749
3.2433
3.2311
3.2267
3.1920
3.0788
3.0364
2.8016
2.7811
2.7678
2.7473
2.7232
2.6807
2.0736
2.0680
2.0626
2.0397
2.0341
2.0287
1.05
1.03
2.04
1.04
3.2
3.0
2.8
2.6
2.4
2.2
2.0
f1 (ppm)
1.03
2.08
4.08
9.20
1.03
0.98
3.06
3.00
1.05
1.03
2.04
1.04
3.02
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
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)


172.58
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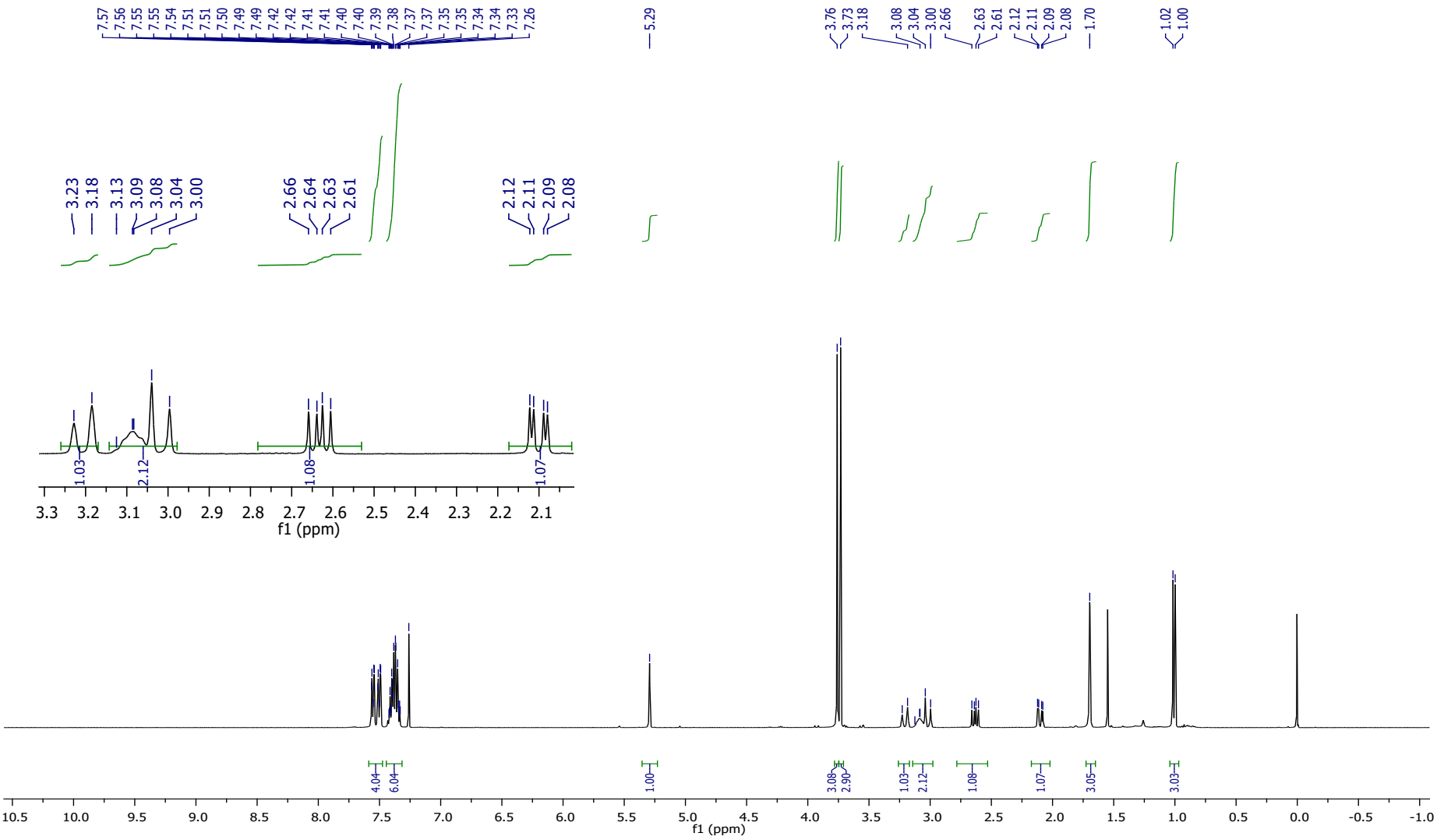
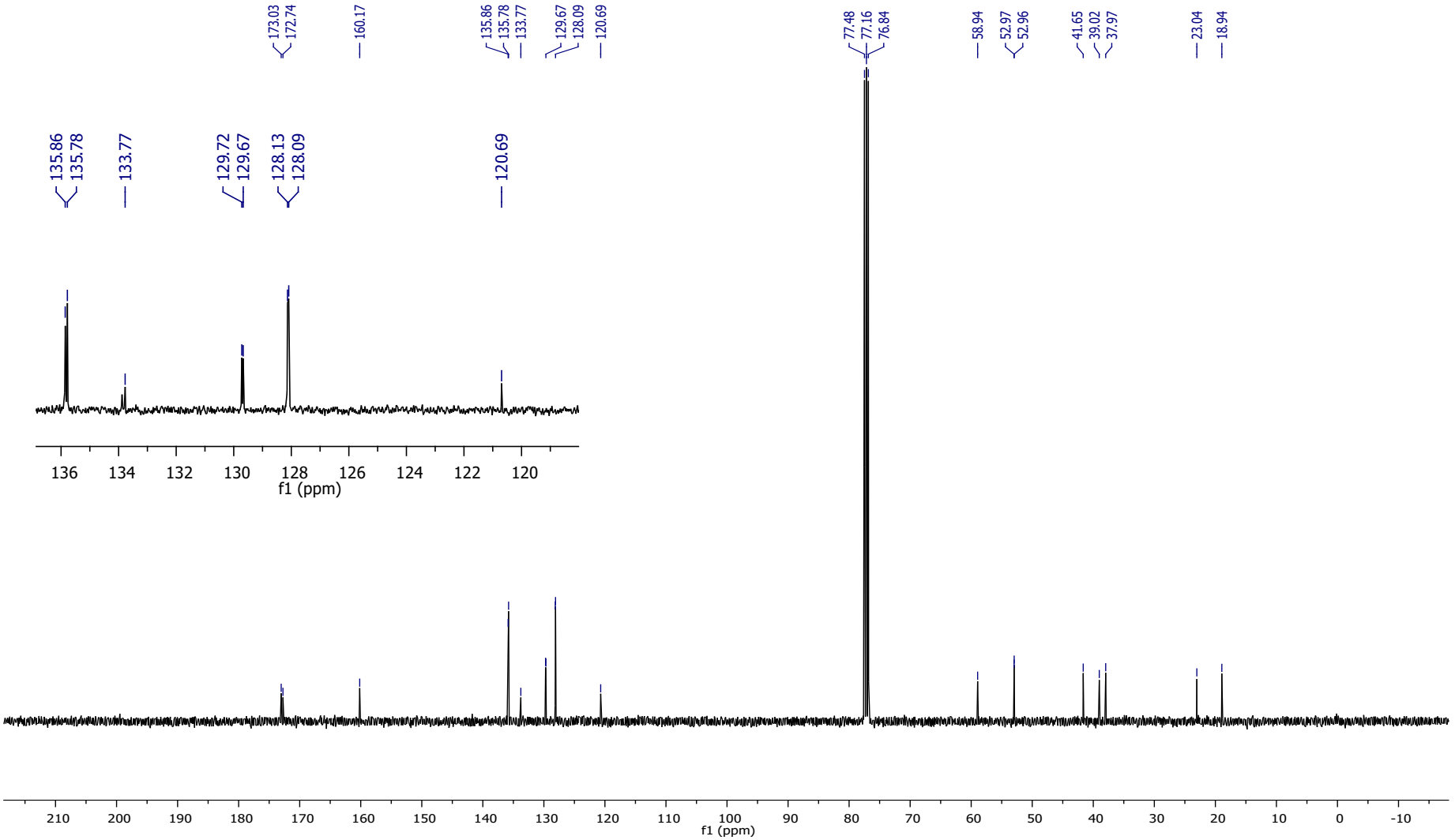
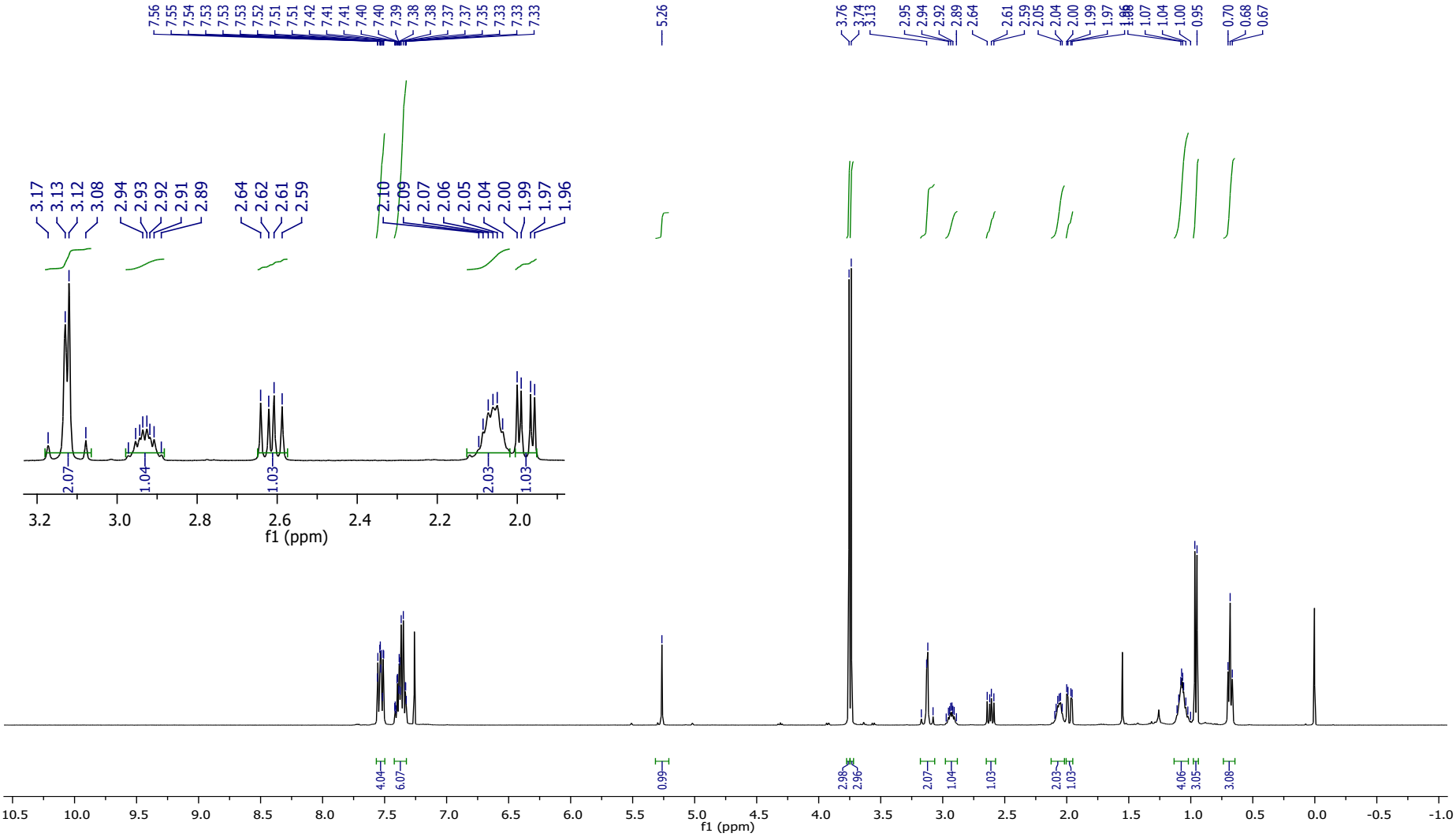
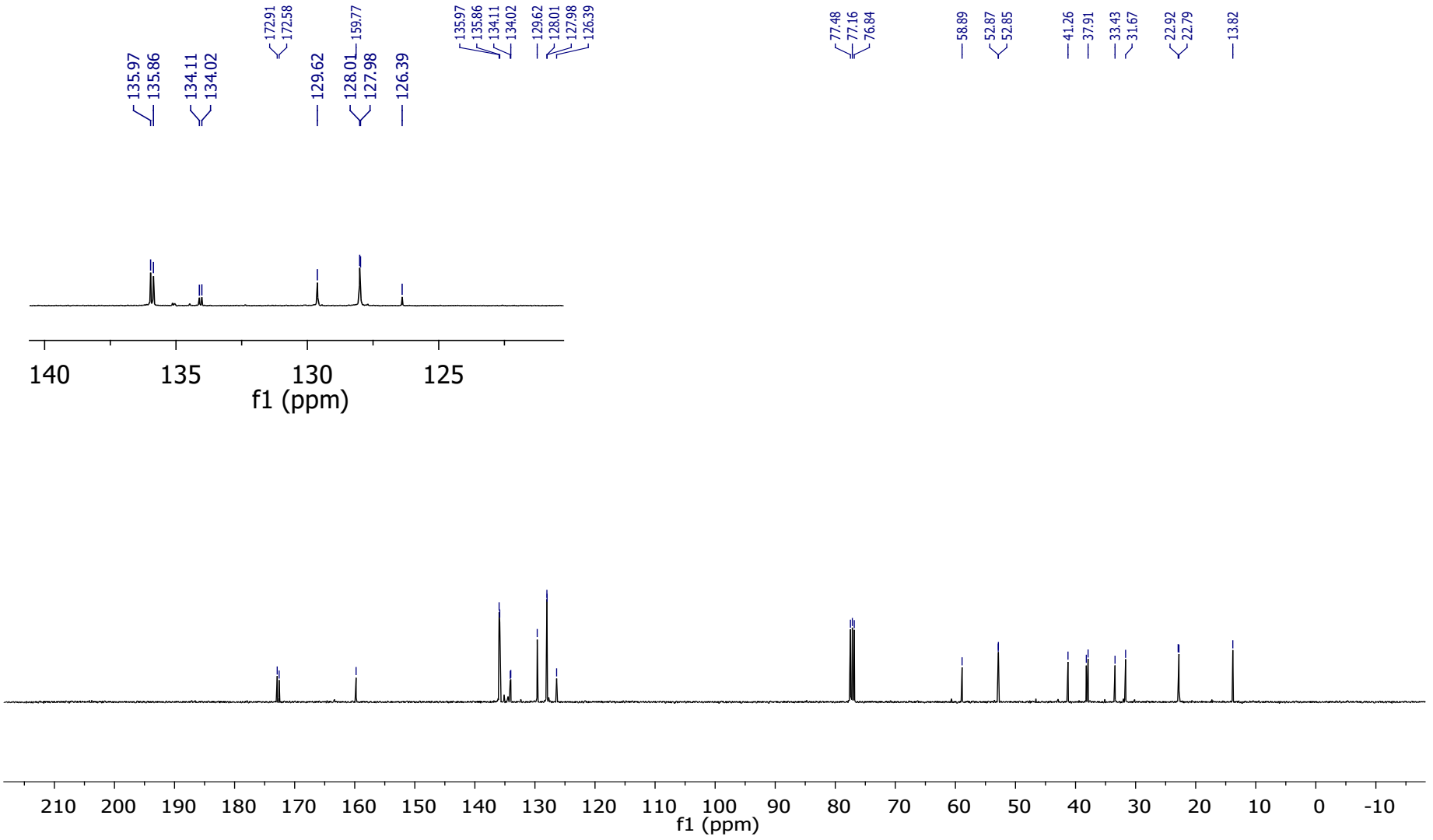
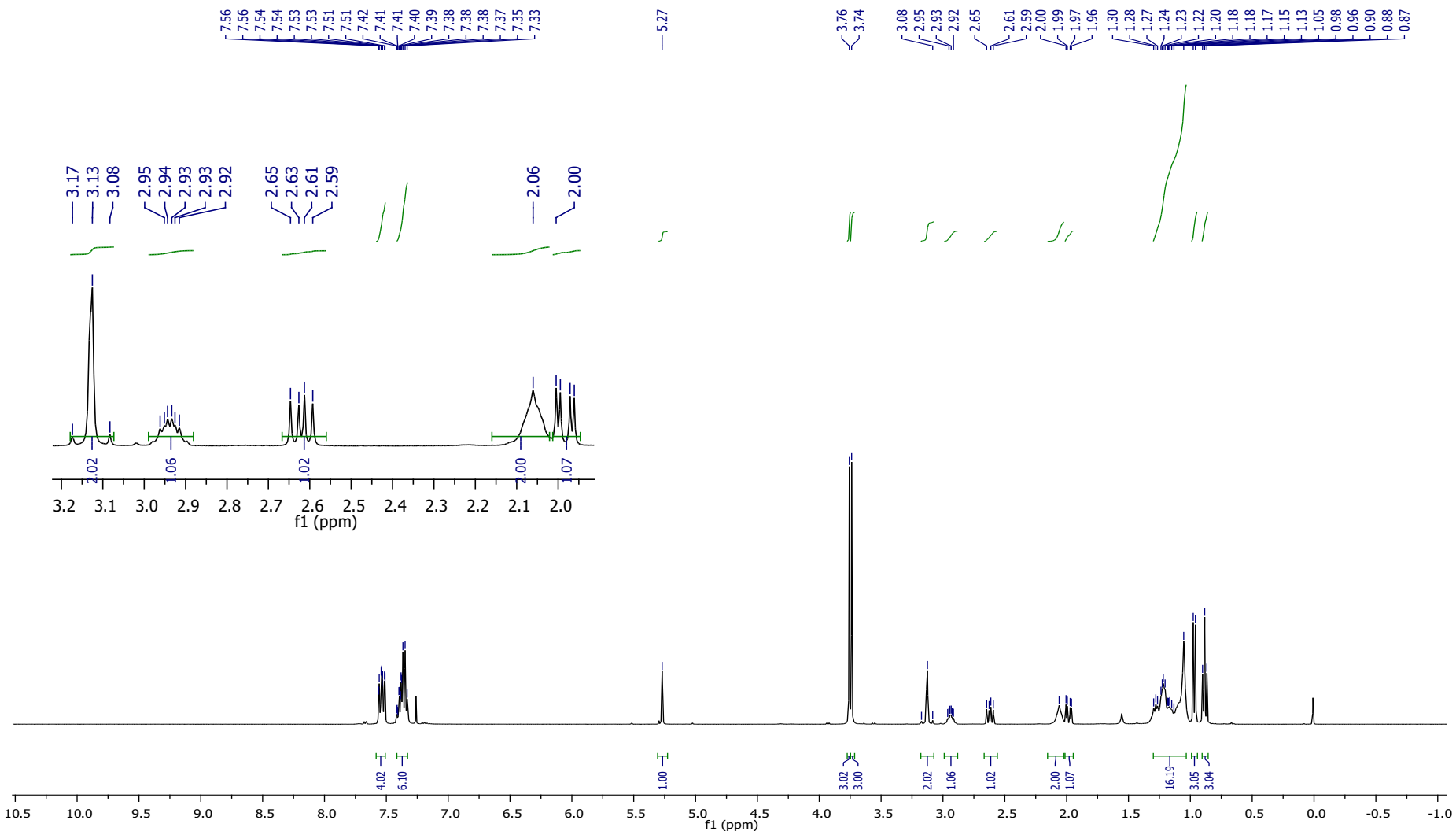
140.72
136.01
131.84
130.55
129.77
129.72
127.99
127.94
127.84
127.78
127.63
127.07
125.80
125.34
77.48
77.16
76.84
58.80
52.82
52.76
41.39
40.28
37.61
23.06
136.01
133.67
133.47
133.09
131.84
130.55
129.72
127.99
127.78
127.63
127.07
125.80
125.34
136
134
132
130
128
126
124
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

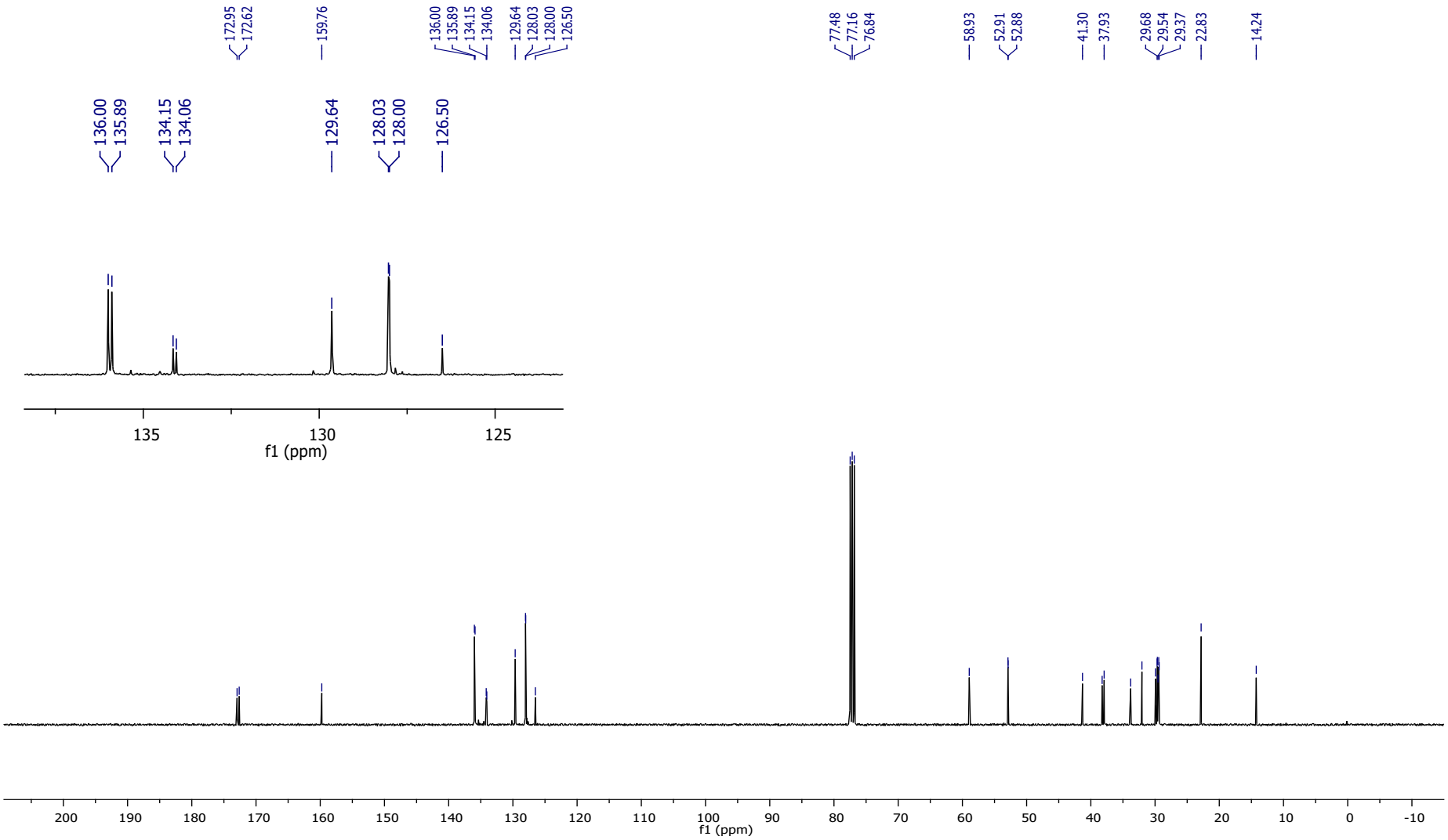

7.57 7.56 7.55 7.55 7.54 7.51 7.51 7.50 7.49 7.49 7.42 7.42 7.41 7.41 7.40 7.40 7.39 7.38 7.37 7.37 7.35 7.35 7.34 7.34 7.33 7.26
5.29
3.76 3.73 3.18 3.08 3.04 3.00 2.66 2.63 2.61 2.12 2.11 2.09 2.08 1.70 1.02 1.00
3.23 3.18 3.13 3.09 3.08 3.04 3.00
2.66 2.64 2.63 2.61
2.12 2.11 2.09 2.08
1.03 2.12 1.08 1.07
3.3 3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1
f1 (ppm)
4.04 6.04 1.00 3.08 2.90 1.03 2.12 1.08 1.07 3.05 3.03
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


173.03
172.74
160.17
135.86
135.78
133.77
129.67
128.09
120.69
77.48
77.16
76.84
58.94
52.97
52.96
41.65
39.02
37.97
23.04
18.94
135.86
135.78
133.77
129.72
129.67
128.13
128.09
120.69
136
134
132
130
128
126
124
122
120
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.56 7.55 7.54 7.53 7.53 7.53 7.52 7.51 7.51 7.42 7.41 7.41 7.40 7.40 7.39 7.38 7.38 7.37 7.37 7.35 7.33 7.33 7.33
5.26
3.76 3.74 3.13 2.95 2.94 2.92 2.89 2.64 2.61 2.59 2.05 2.04 2.00 1.99 1.97 1.07 1.04 1.00 0.95 0.70 0.68 0.67
3.17 3.13 3.12 3.08 2.94 2.93 2.92 2.91 2.89 2.64 2.62 2.61 2.59 2.10 2.09 2.07 2.06 2.05 2.04 2.00 1.99 1.97 1.96
2.07 1.04 1.03 2.03 1.03
3.2 3.0 2.8 2.6 2.4 2.2 2.0
f1 (ppm)
4.04 6.07 0.99 2.98 2.96 2.07 1.04 1.03 2.03 1.03 4.06 3.05 3.08
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


135.97
135.86
134.11
134.02
172.91
172.58
129.62
128.01
127.98
159.77
126.39
135.97
135.86
134.11
134.02
129.62
128.01
127.98
126.39
77.48
77.16
76.84
58.89
52.87
52.85
41.26
37.91
33.43
31.67
22.92
22.79
13.82
140
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.56 7.56 7.54 7.54 7.53 7.53 7.51 7.51 7.42 7.41 7.41 7.40 7.39 7.38 7.38 7.37 7.35 7.33
5.27
3.76 3.74
3.08 2.95 2.93 2.92
2.65
2.61 2.59
2.00 1.99 1.97 1.96
1.30 1.28 1.27 1.24 1.23 1.22 1.20 1.18 1.18 1.17 1.15 1.13 1.05 0.98 0.96 0.90 0.88 0.87
3.17 3.13 3.08
2.95 2.94 2.93 2.93 2.92
2.65 2.63 2.61 2.59
2.06 2.00
2.02 1.06 1.02 2.00 1.07
3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0
f1 (ppm)
4.02 6.10 1.00 3.02 3.00 2.02 1.06 1.02 2.00 1.07 16.19 3.05 3.04
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)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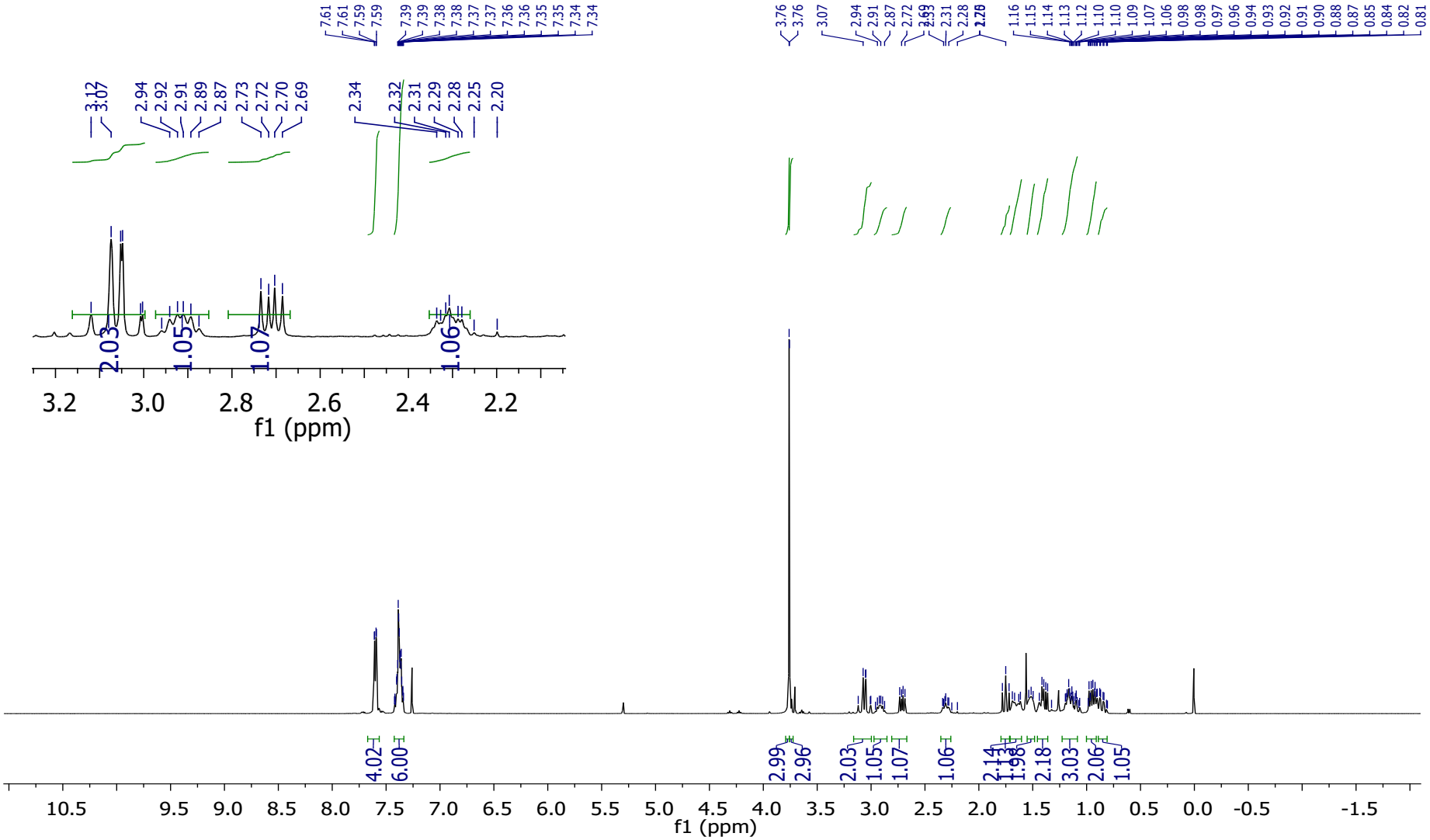
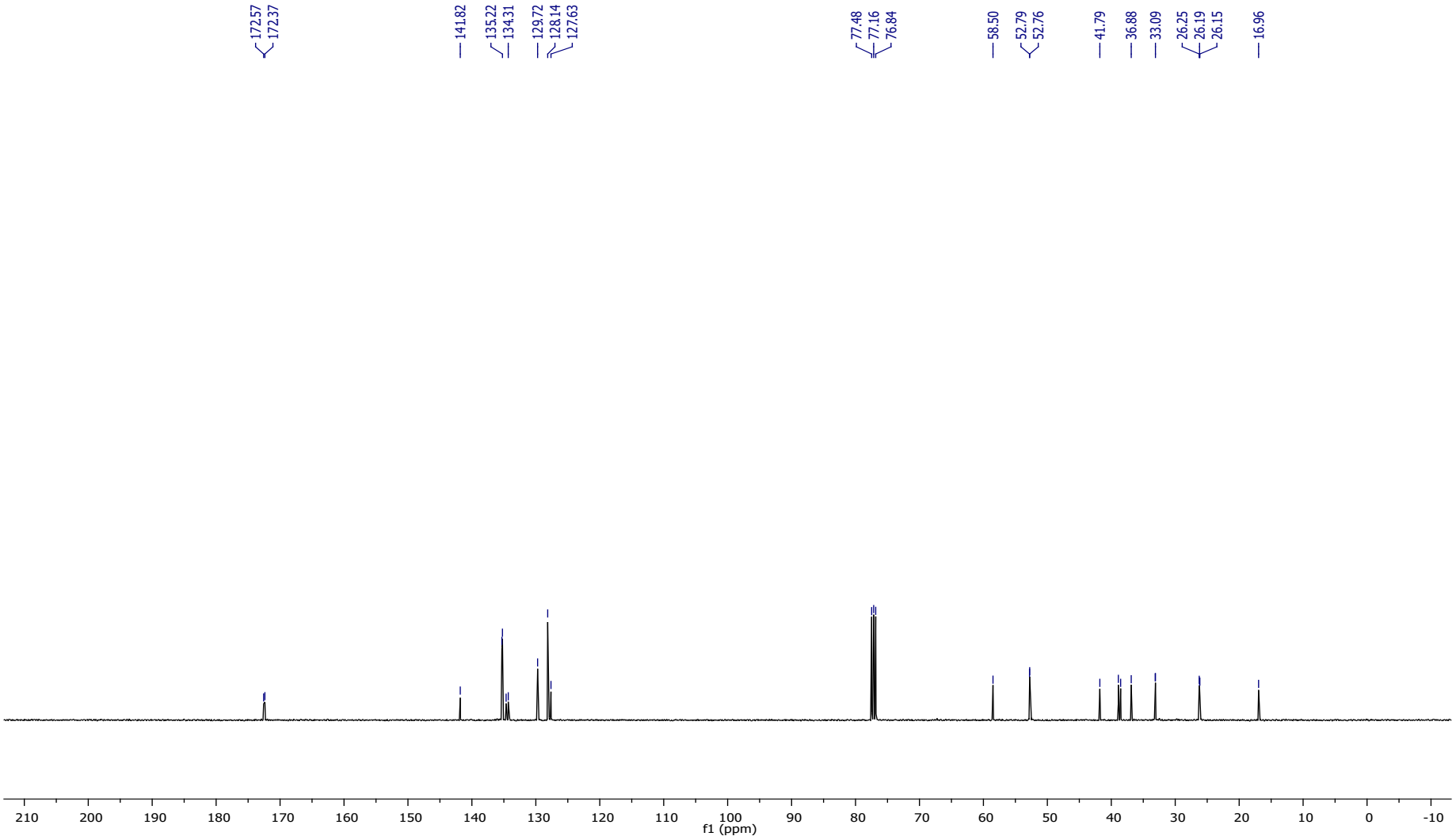
172.62
159.76
136.00
135.89
134.15
134.06
129.64
128.03
128.00
126.50
77.48
77.16
76.84
58.93
52.91
52.88
41.30
37.93
29.68
29.54
29.37
22.83
14.24
f1 (ppm)
f1 (ppm)


7.61 7.61 7.59 7.59 7.39 7.39 7.38 7.38 7.37 7.37 7.36 7.36 7.35 7.35 7.34 7.34
3.76 3.76 3.07 2.94 2.91 2.87 2.72 2.31 2.28 1.16 1.15 1.14 1.13 1.12 1.10 1.10 1.09 1.07 1.06 0.98 0.98 0.97 0.96 0.94 0.93 0.92 0.91 0.90 0.88 0.87 0.85 0.84 0.82 0.81
3.12 3.07 2.94 2.92 2.91 2.89 2.87 2.73 2.72 2.70 2.69 2.34 2.32 2.31 2.29 2.28 2.25 2.20
2.03 1.05 1.07 1.06
3.2 3.0 2.8 2.6 2.4 2.2
f1 (ppm)
4.02 6.00 2.99 2.96 2.03 1.05 1.07 1.06 2.14 1.13 1.98 2.18 3.03 2.06 1.05
10.5 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 -1.5
f1 (ppm)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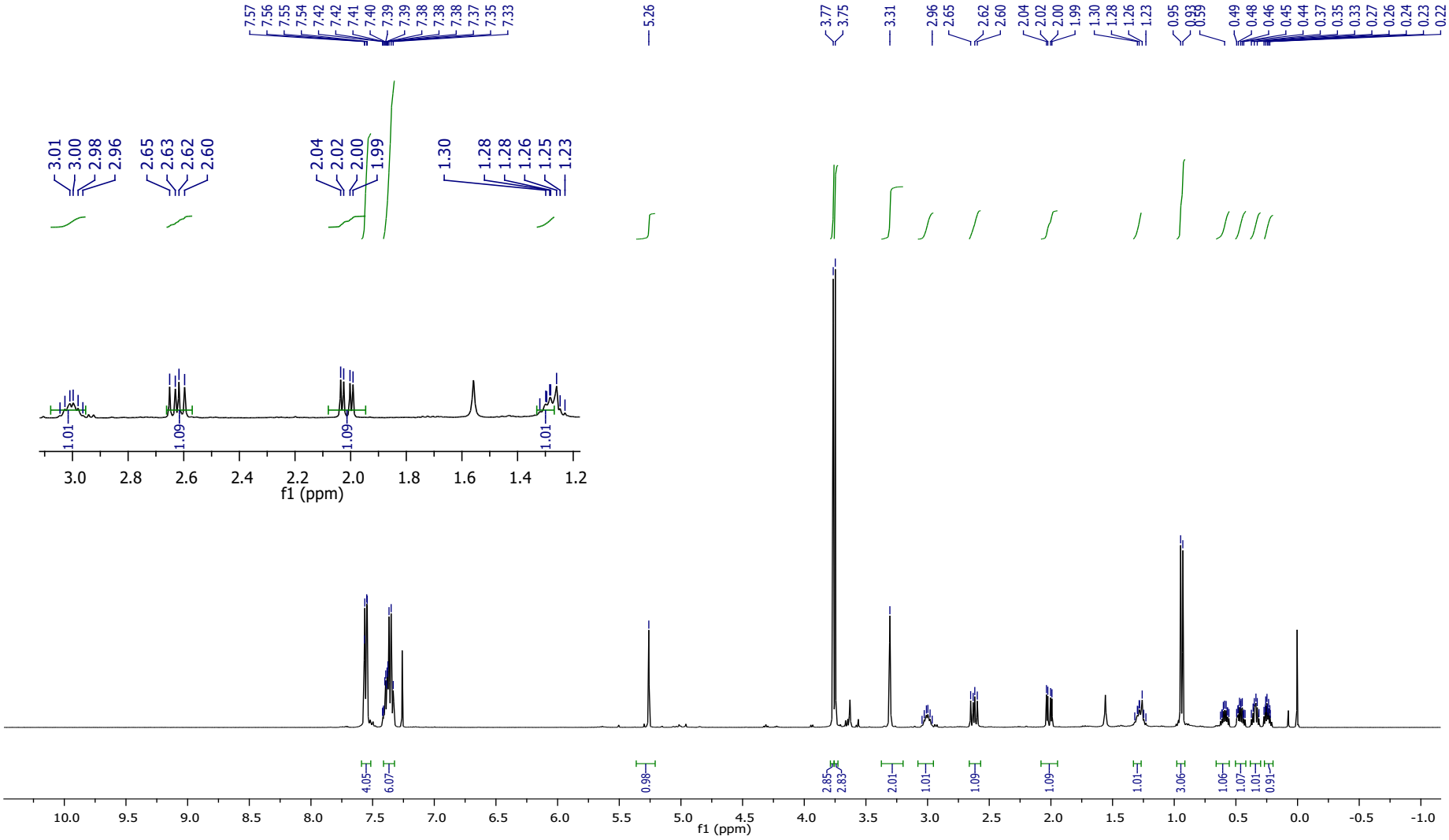
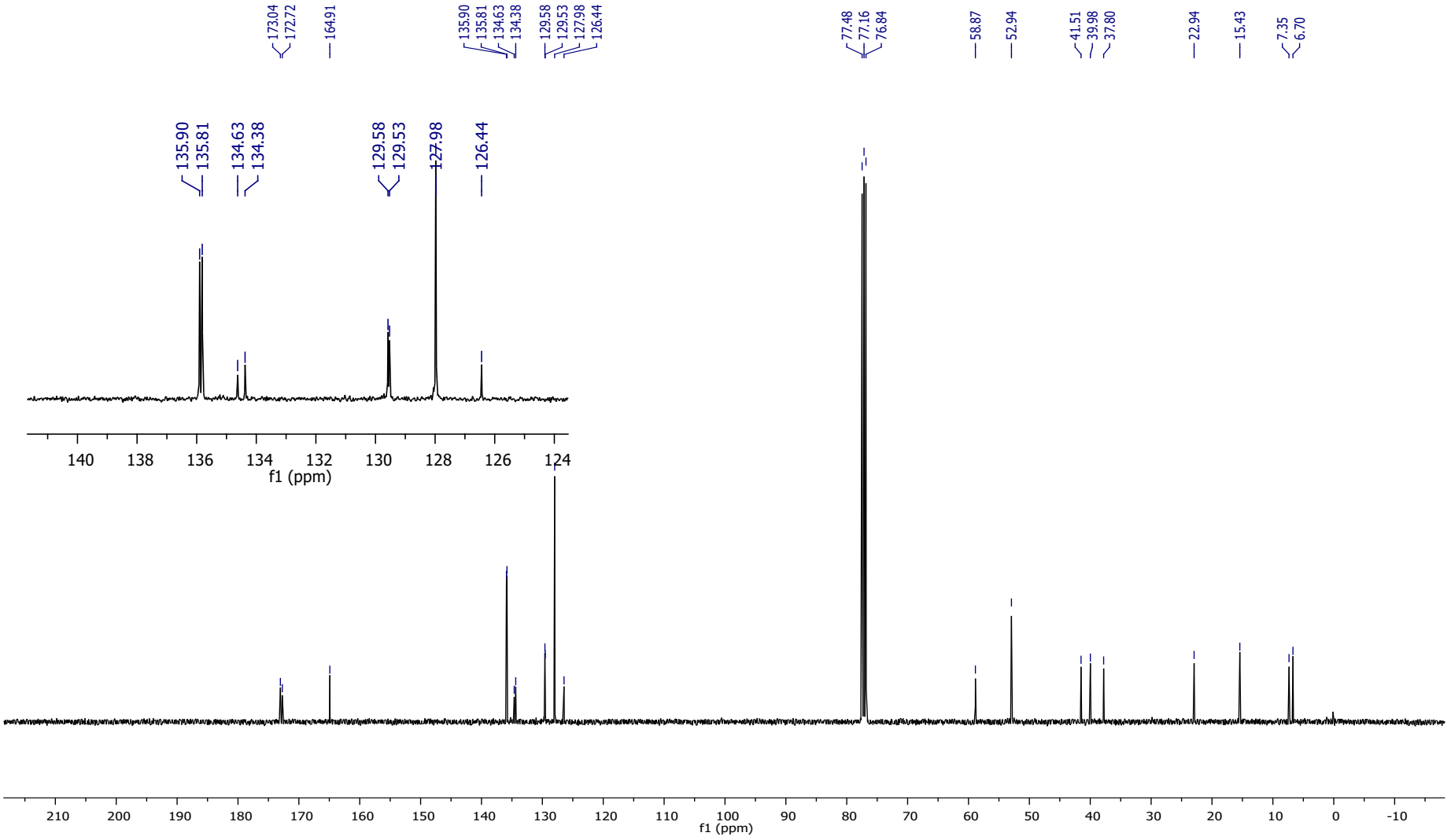
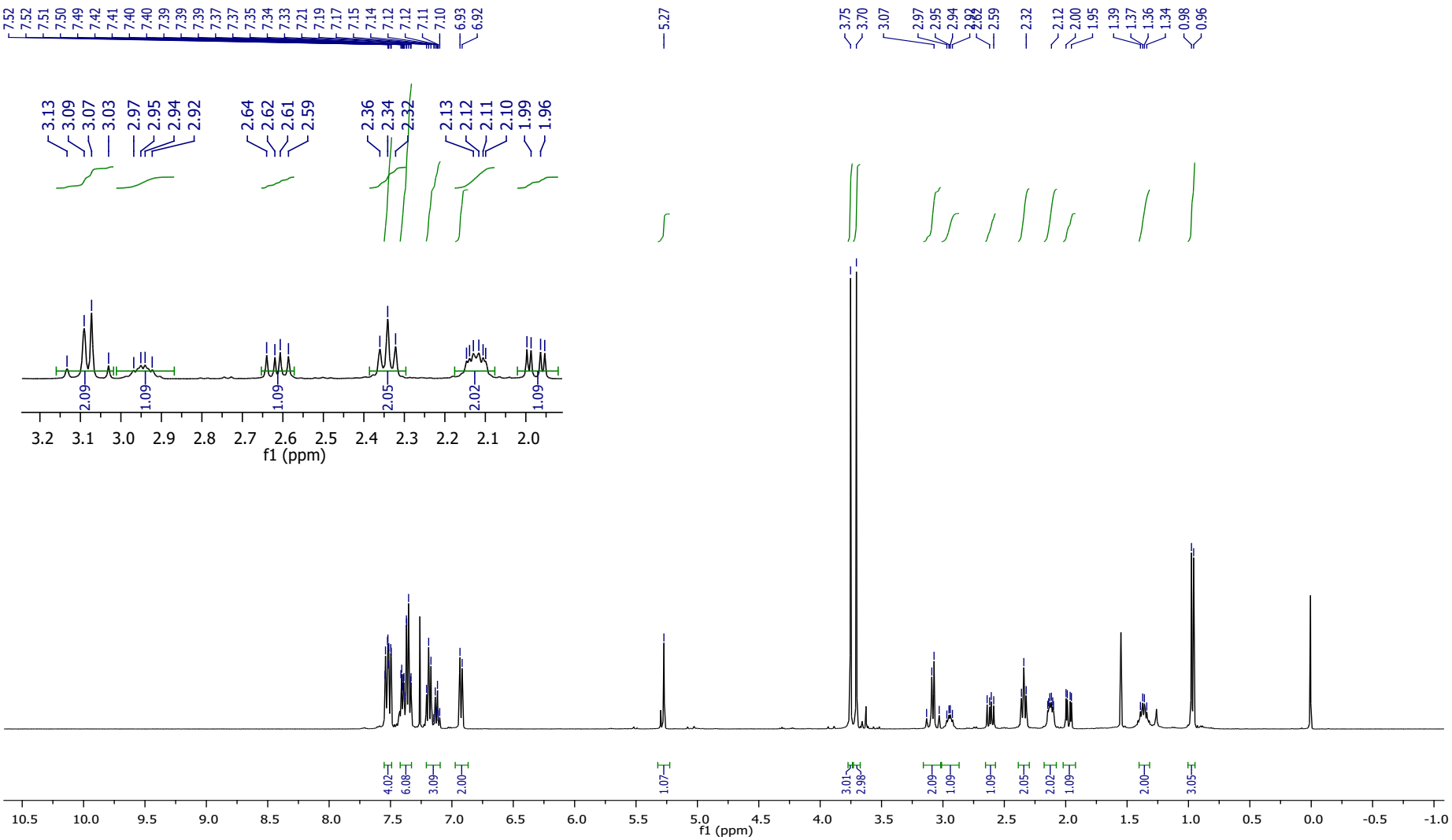
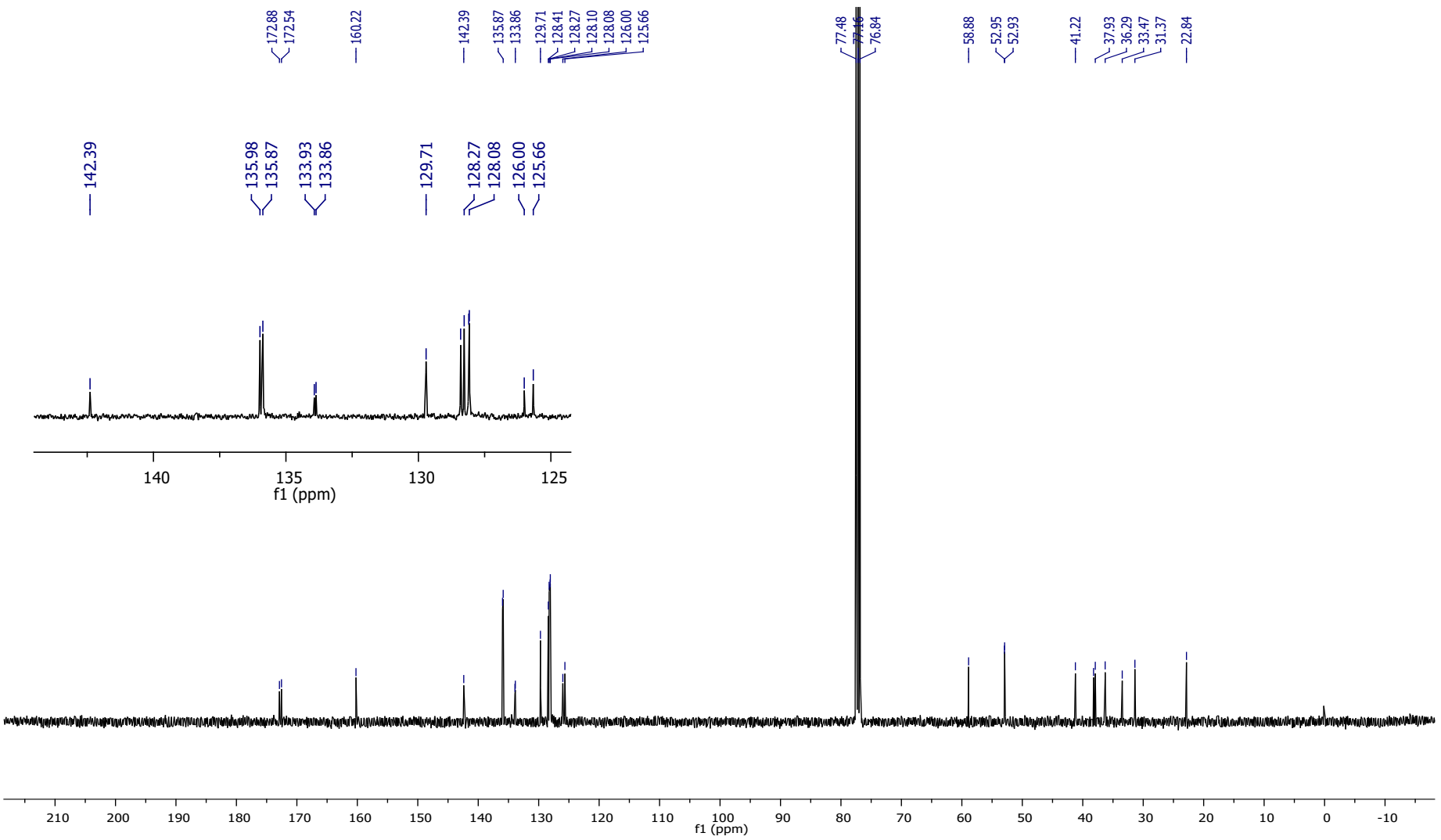
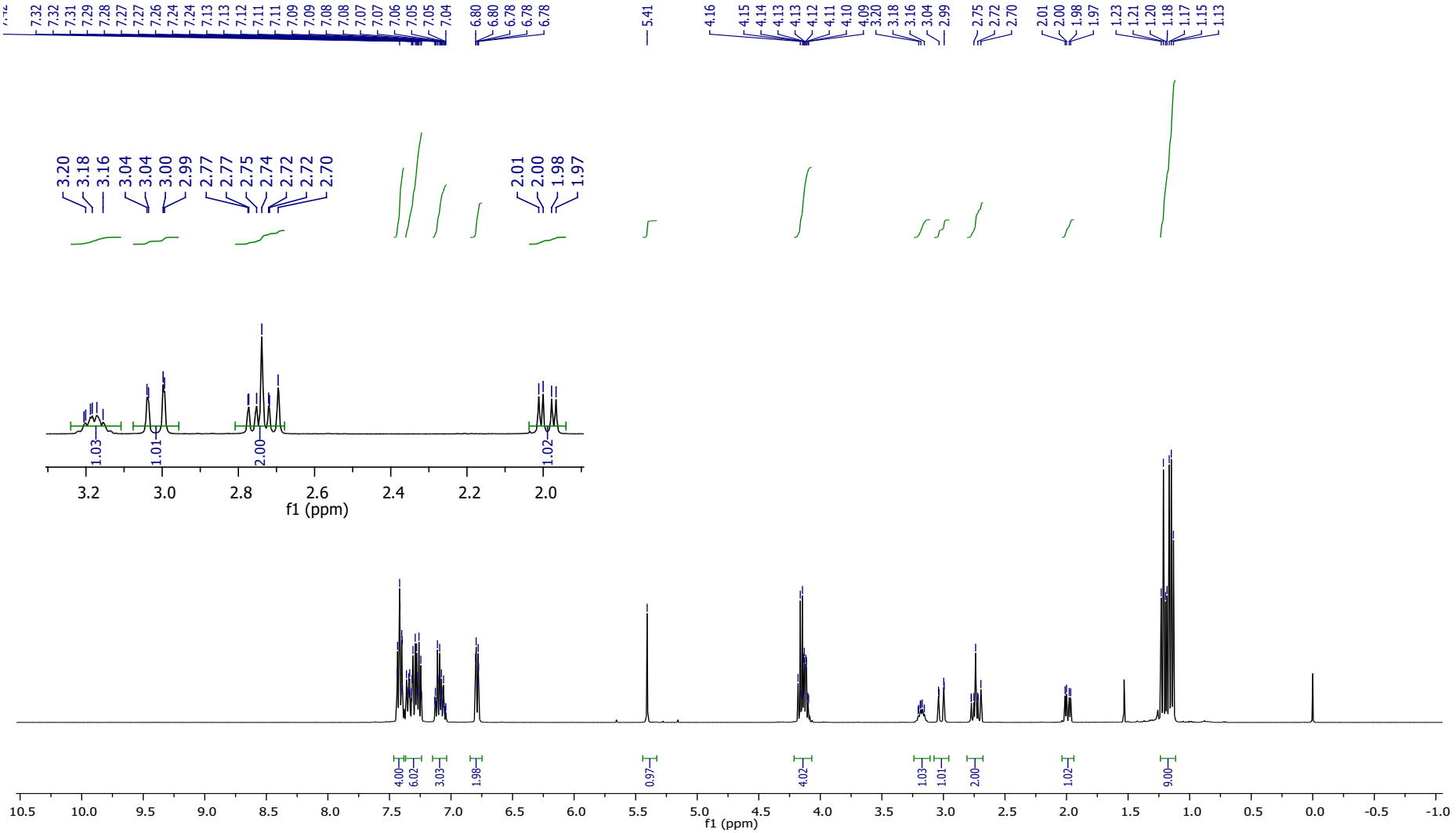
172.37
141.82
135.22
134.31
129.72
128.14
127.63
77.48
77.16
76.84
58.50
52.79
52.76
41.79
36.88
33.09
26.25
26.19
26.15
16.96
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

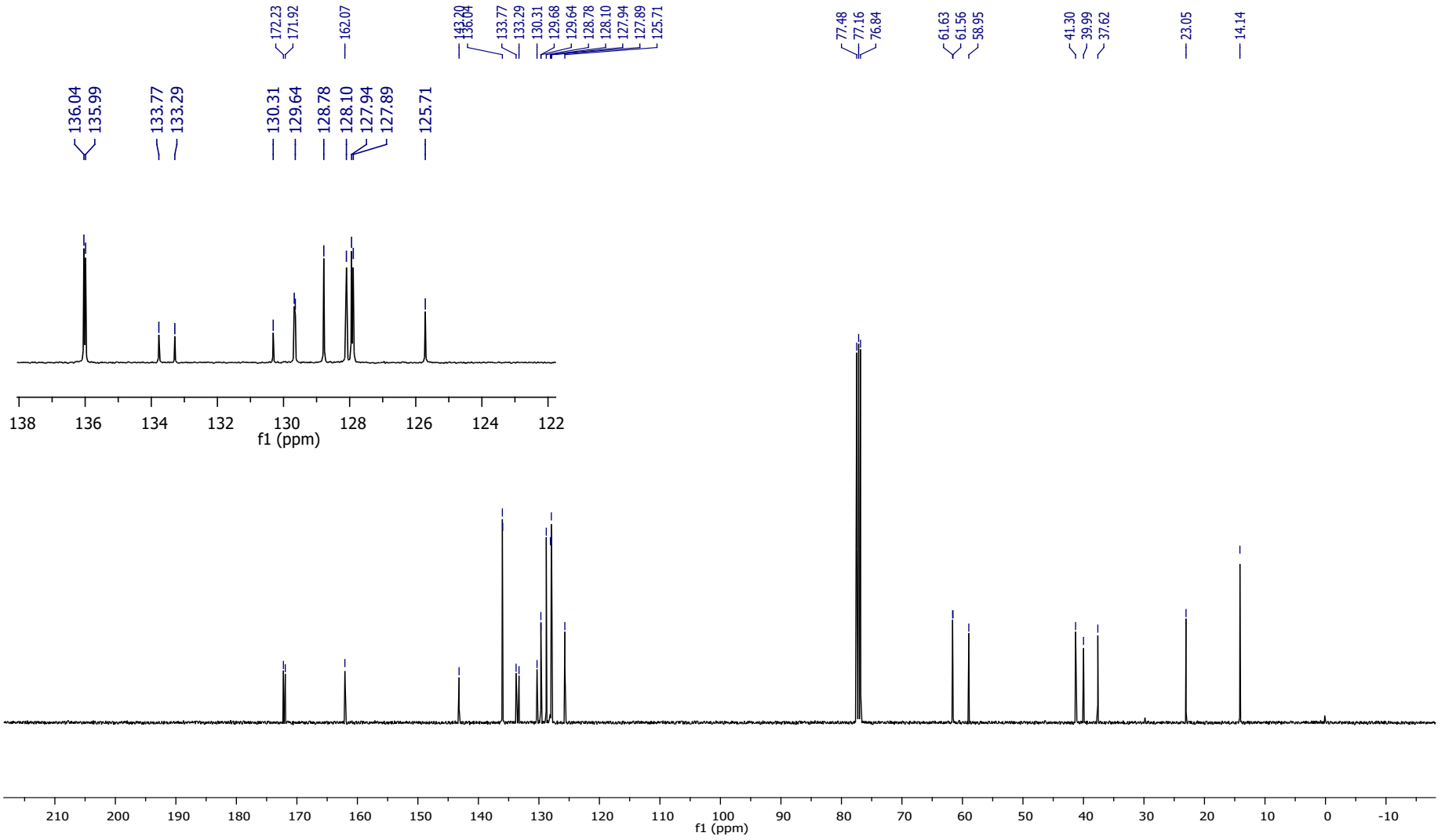

7.57 7.56 7.55 7.54 7.42 7.42 7.41 7.40 7.39 7.39 7.38 7.38 7.38 7.37 7.35 7.33
5.26
3.77 3.75
3.31
2.96 2.65
2.62 2.60
2.04 2.02 2.00 1.99
1.30 1.28 1.26 1.23
0.95 0.93 0.59
0.49 0.48 0.46 0.45 0.44 0.37 0.35 0.33 0.27 0.26 0.24 0.23 0.22
3.01 3.00 2.98 2.96
2.65 2.63 2.62 2.60
2.04 2.02 2.00 1.99
1.30 1.28 1.28 1.26 1.25 1.23
1.01 1.09 1.09 1.01
3.0 2.8 2.6 2.4 2.2 2.0 1.8 1.6 1.4 1.2
f1 (ppm)
4.05 6.07 0.98 2.85 2.83 2.01 1.01 1.09 1.09 1.01 3.06 1.06 1.07 1.01 0.91
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
f1 (ppm)

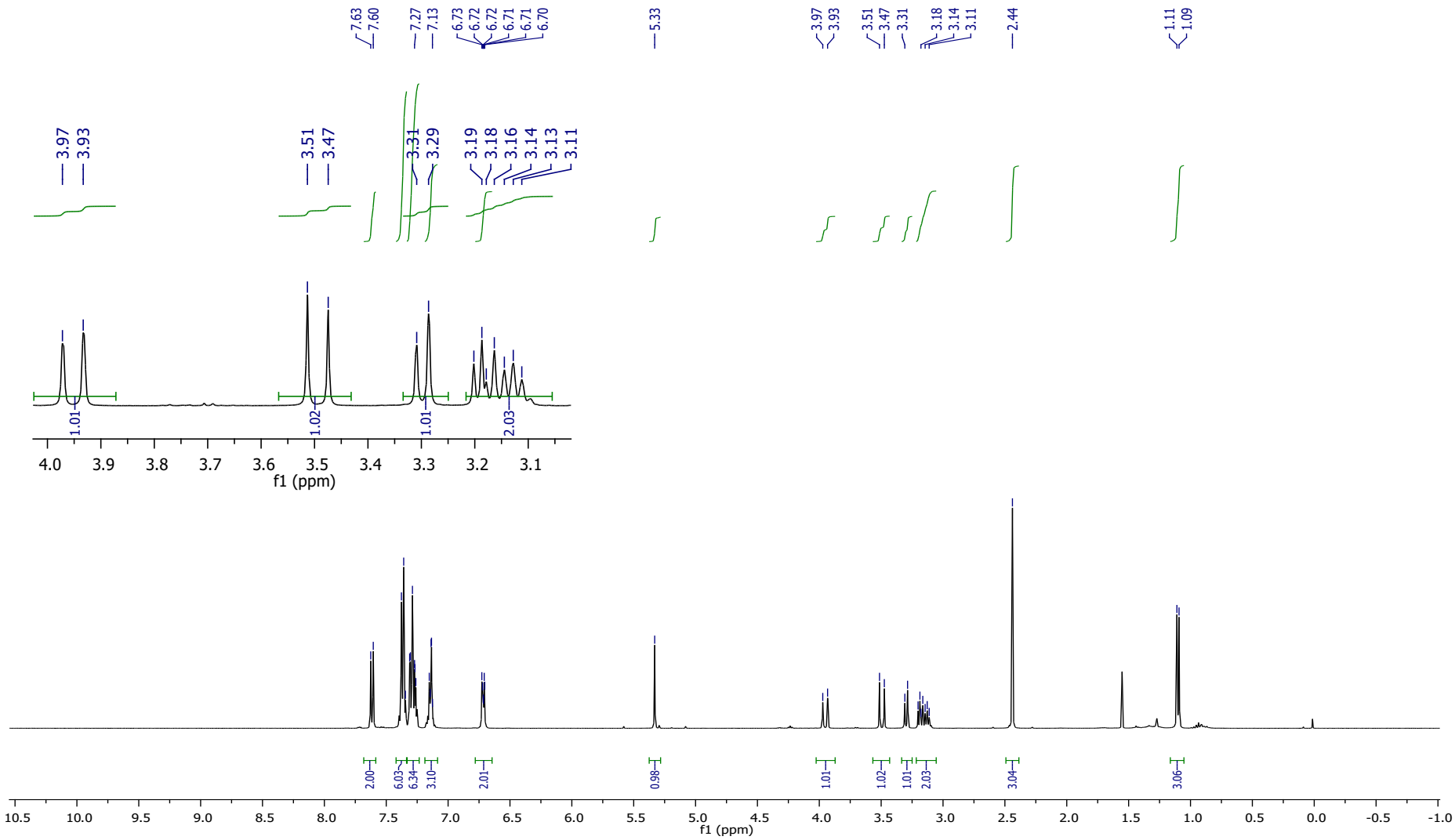

173.04
172.72
164.91
135.90
135.81
134.63
134.38
129.58
129.53
127.98
126.44
77.48
77.16
76.84
58.87
52.94
41.51
39.98
37.80
22.94
15.43
7.35
6.70
f1 (ppm)
f1 (ppm)

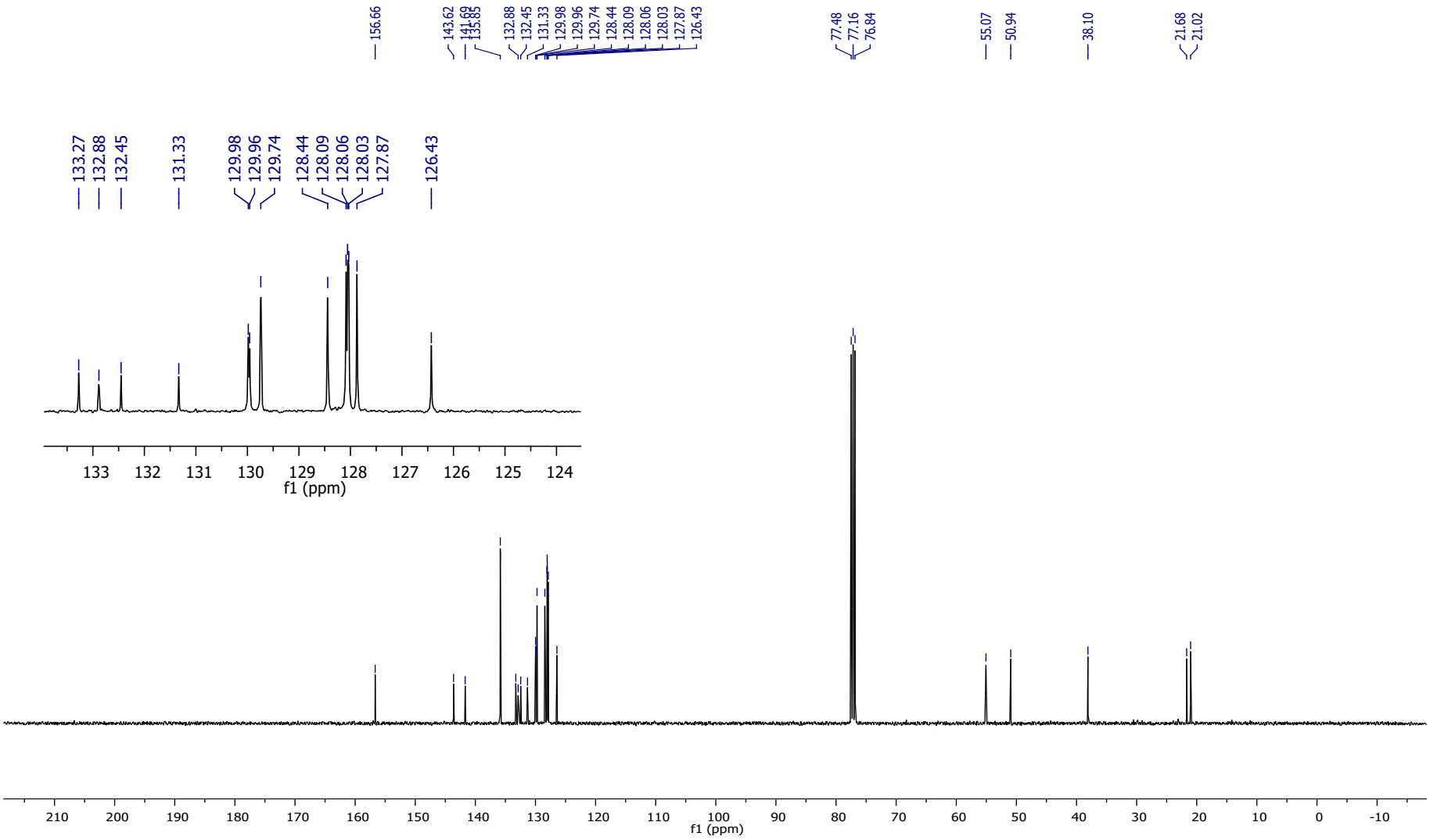

7.52 7.52 7.51 7.50 7.49 7.42 7.41 7.40 7.40 7.39 7.39 7.39 7.37 7.37 7.35 7.34 7.33 7.21 7.19 7.17 7.15 7.14 7.12 7.12 7.11 7.10 6.93 6.92
5.27
3.75 3.70 3.07 2.97 2.95 2.94 2.59 2.32 2.12 2.00 1.95 1.39 1.37 1.36 1.34 0.98 0.96
3.13 3.09 3.07 3.03 2.97 2.95 2.94 2.92 2.64 2.62 2.61 2.59 2.36 2.34 2.32 2.13 2.12 2.11 2.10 1.99 1.96
2.09 1.09 1.09 2.05 2.02 1.09
3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4 2.3 2.2 2.1 2.0
f1 (ppm)
4.02 6.08 3.09 2.00 1.07 3.01 2.98 2.09 1.09 1.09 2.05 2.02 1.09 2.00 3.05
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

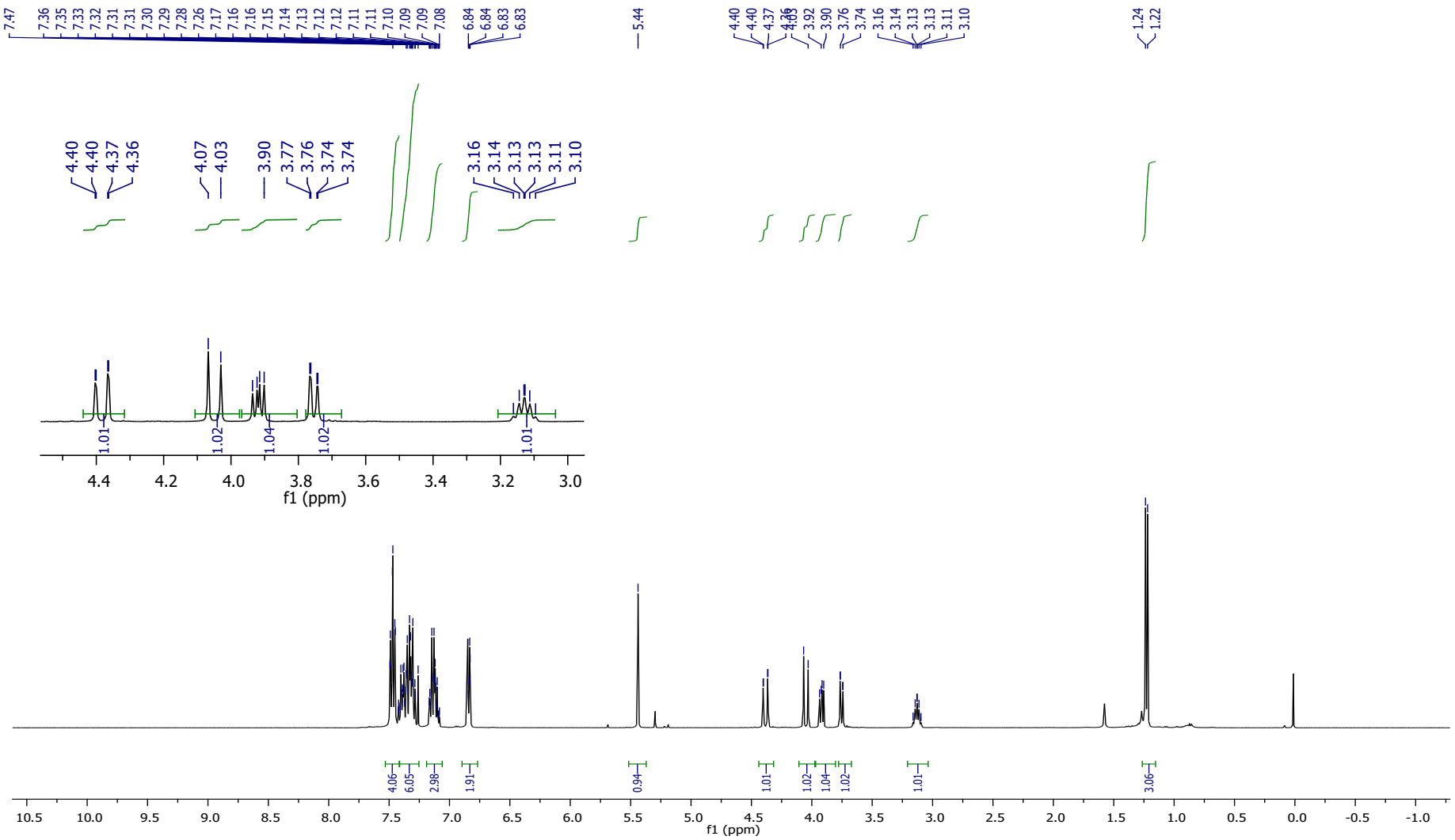

172.88
172.54
160.22
142.39
135.87
133.86
129.71
128.41
128.27
128.10
128.08
126.00
125.66
77.48
77.16
76.84
58.88
52.95
52.93
41.22
37.93
36.29
33.47
31.37
22.84
142.39
135.98
135.87
133.93
133.86
129.71
128.27
128.08
126.00
125.66
140
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

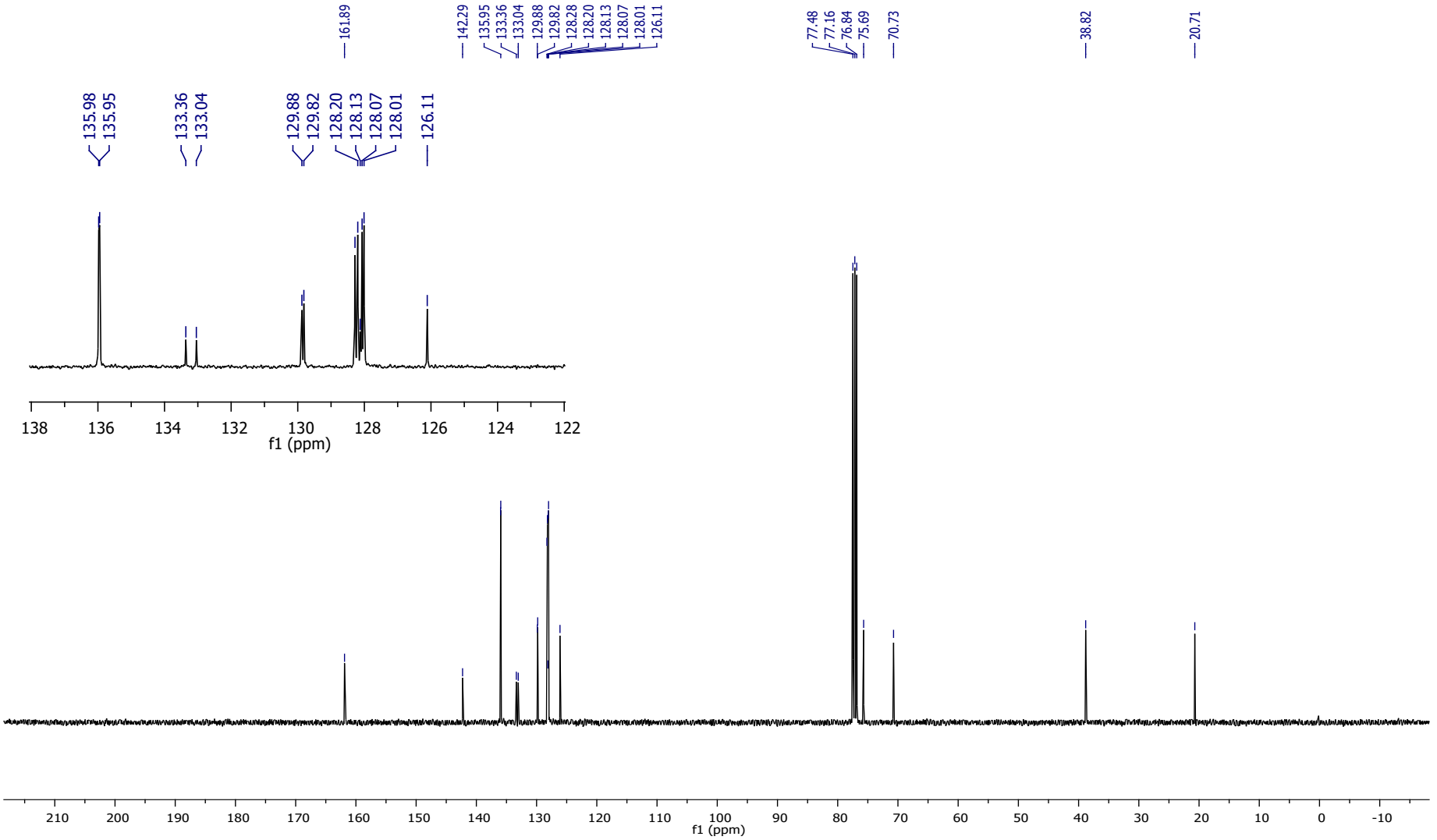

7.32 7.32 7.31 7.29 7.28 7.27 7.27 7.26 7.24 7.24 7.13 7.13 7.12 7.11 7.11 7.09 7.09 7.08 7.08 7.07 7.07 7.06 7.05 7.05 7.04
6.80 6.80 6.78 6.78 6.78
5.41
4.16 4.15 4.14 4.13 4.13 4.12 4.11 4.10 4.09 3.20 3.18 3.16 3.04 2.99
2.75 2.72 2.70
2.01 2.00 1.98 1.97
1.23 1.21 1.20 1.18 1.17 1.15 1.13
3.20 3.18 3.16 3.04 3.04 3.00 2.99 2.77 2.77 2.75 2.74 2.72 2.72 2.70
2.01 2.00 1.98 1.97
1.03 1.01 2.00 1.02
3.2 3.0 2.8 2.6 2.4 2.2 2.0
f1 (ppm)
4.00 6.02 3.03 1.98 0.97 4.02 1.03 1.01 2.00 1.02 9.00
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

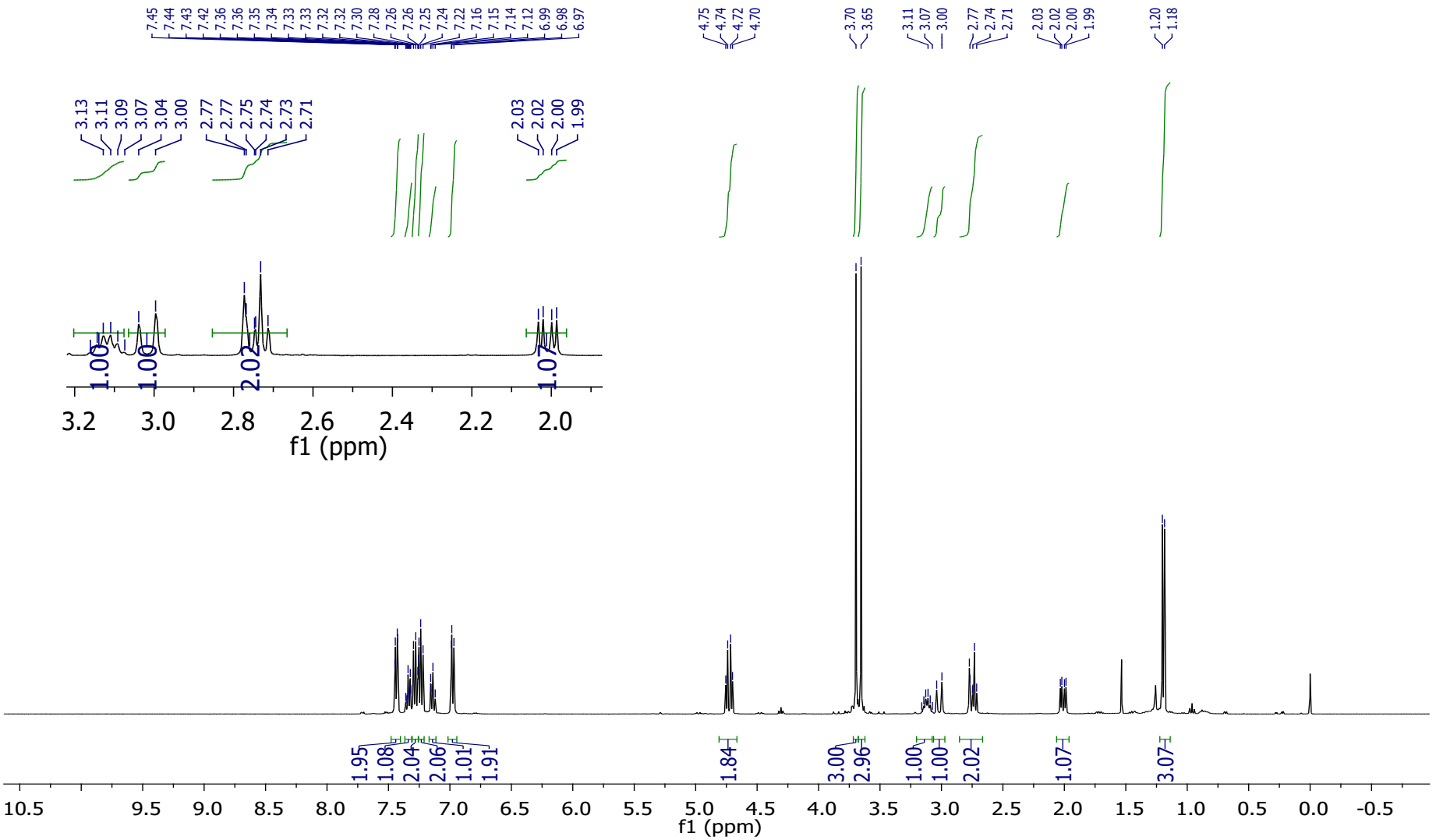

172.23
171.92
162.07
143.20
136.04
133.77
133.29
130.31
129.68
129.64
128.78
128.10
127.94
127.89
125.71
77.48
77.16
76.84
61.63
61.56
58.95
41.30
39.99
37.62
23.05
14.14
136.04
135.99
133.77
133.29
130.31
129.64
128.78
128.10
127.94
127.89
125.71
138
136
134
132
130
128
126
124
122
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

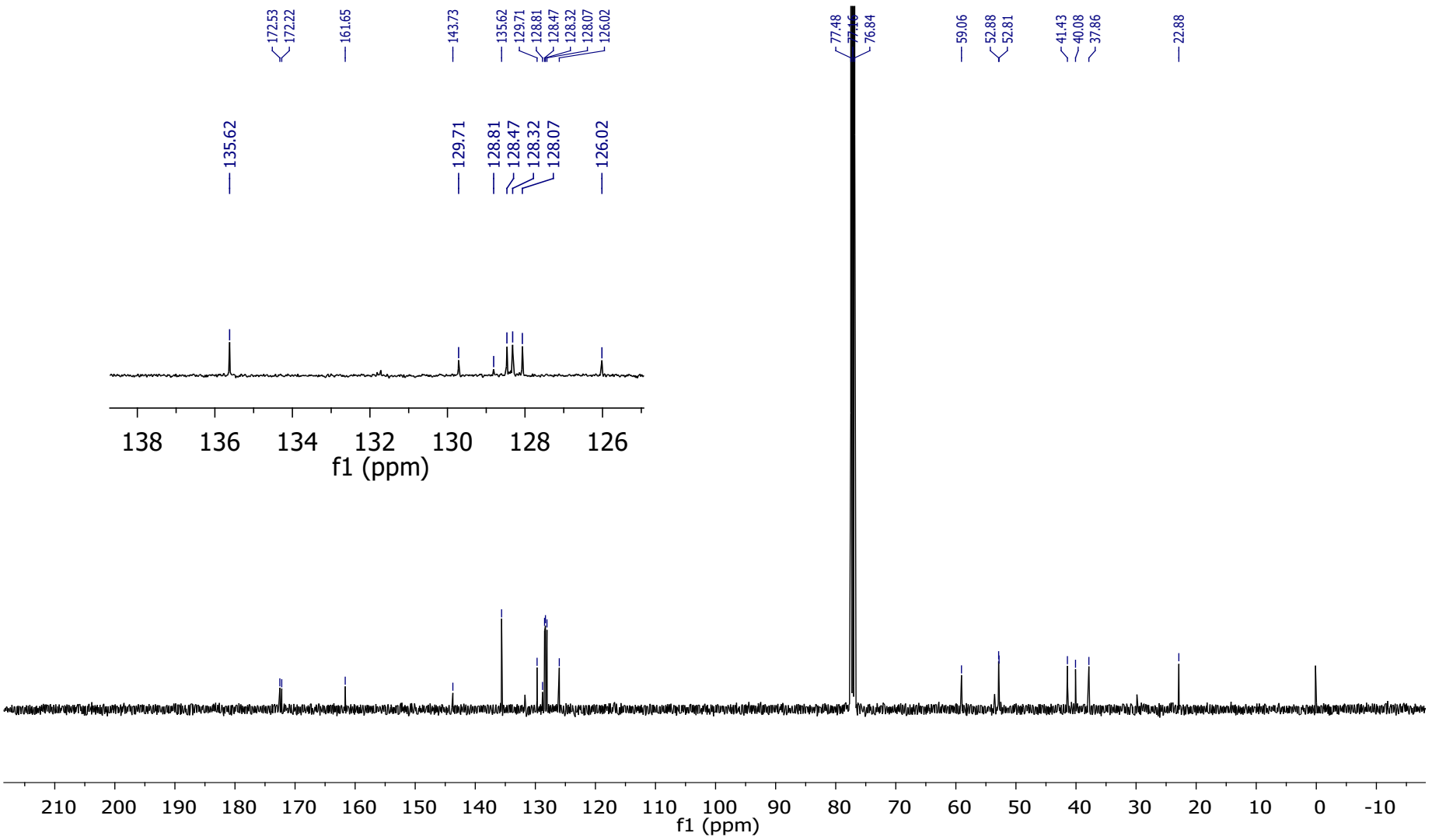

7.63
7.60
7.27
7.13
6.73
6.72
6.72
6.71
6.71
6.70
5.33
3.97
3.93
3.51
3.47
3.31
3.18
3.14
3.11
2.44
1.11
1.09
3.97
3.93
3.51
3.47
3.31
3.29
3.19
3.18
3.16
3.14
3.13
3.11
1.01
1.02
1.01
2.03
4.0 3.9 3.8 3.7 3.6 3.5 3.4 3.3 3.2 3.1
f1 (ppm)
2.00
6.03
6.34
3.10
2.01
0.98
1.01
1.02
1.01
2.03
3.04
3.06
10.5 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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

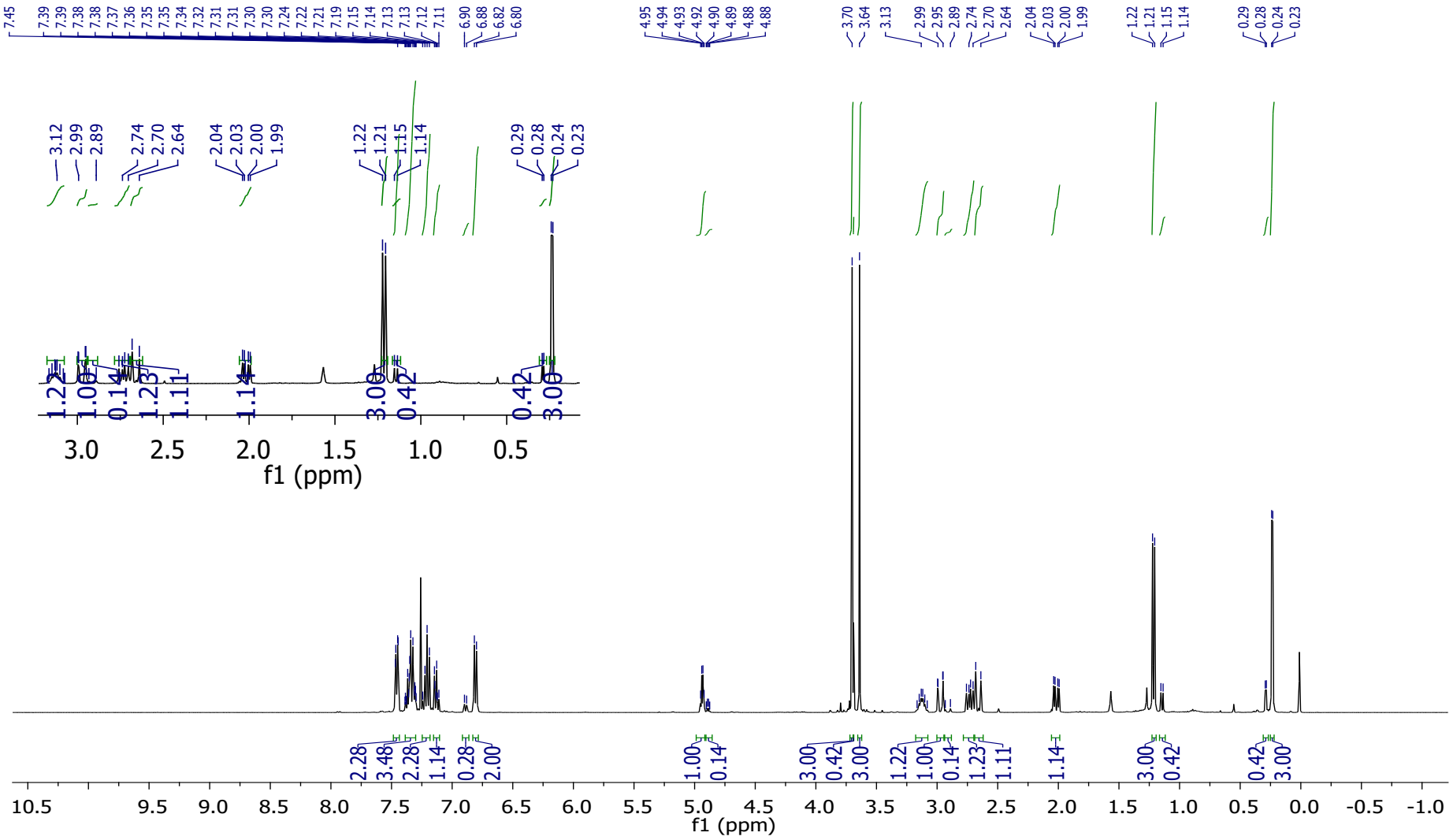

156.66
143.62
141.69
135.85
132.88
132.45
131.33
129.98
129.96
129.74
128.44
128.09
128.06
128.03
127.87
126.43
77.48
77.16
76.84
55.07
50.94
38.10
21.68
21.02
133.27
132.88
132.45
131.33
129.98
129.96
129.74
128.44
128.09
128.06
128.03
127.87
126.43
133 132 131 130 129 128 127 126 125 124
f1 (ppm)
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

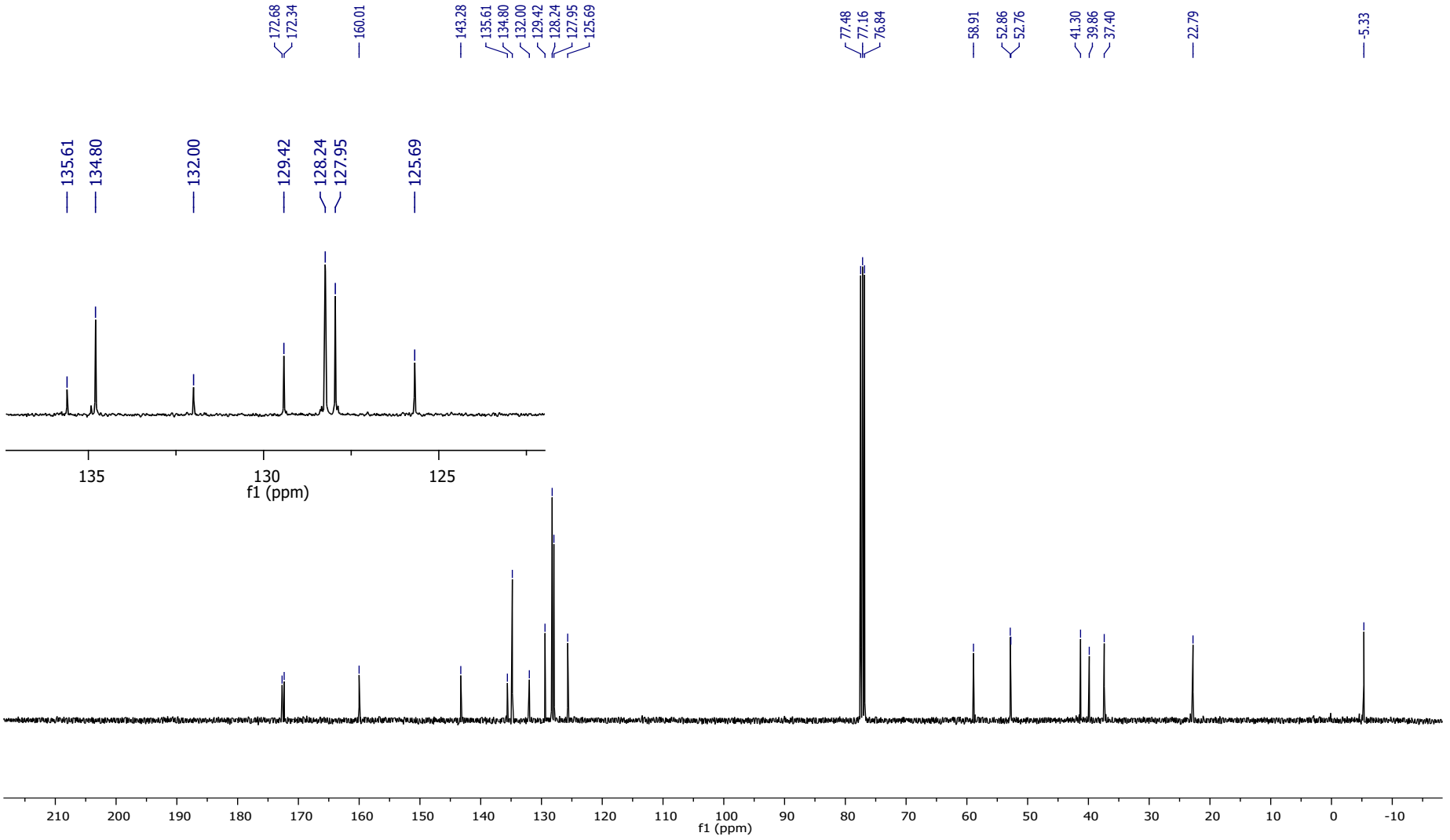

7.47 7.36 7.35 7.33 7.32 7.31 7.31 7.30 7.29 7.28 7.26 7.17 7.16 7.16 7.15 7.14 7.13 7.12 7.12 7.11 7.11 7.10 7.09 7.09 7.08
6.84 6.84 6.83 6.83
5.44
4.40 4.40 4.37 4.36 4.07 4.03 3.90 3.77 3.76 3.74 3.74 3.16 3.14 3.13 3.13 3.11 3.10
4.40 4.40 4.37 4.36 4.07 4.03 3.92 3.90 3.76 3.74 3.16 3.14 3.13 3.13 3.11 3.10
1.24 1.22
1.01 1.02 1.04 1.02 1.01
4.4 4.2 4.0 3.8 3.6 3.4 3.2 3.0
f1 (ppm)
4.06 6.05 2.98 1.91 0.94 1.01 1.02 1.04 1.02 1.01 3.06
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


161.89
142.29
135.95
133.36
133.04
129.88
129.82
128.28
128.20
128.13
128.07
128.01
126.11
77.48
77.16
76.84
75.69
70.73
38.82
20.71
135.98
135.95
133.36
133.04
129.88
129.82
128.20
128.13
128.07
128.01
126.11
138
136
134
132
130
128
126
124
122
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.45 7.44 7.43 7.42 7.36 7.36 7.35 7.34 7.33 7.33 7.32 7.32 7.30 7.28 7.26 7.26 7.25 7.24 7.22 7.16 7.15 7.14 7.12 6.99 6.98 6.97
4.75 4.74 4.72 4.70
3.70 3.65
3.11 3.07 3.00
2.77 2.74 2.71
2.03 2.02 2.00 1.99
1.20 1.18
3.13 3.11 3.09 3.07 3.04 3.00
2.77 2.77 2.75 2.74 2.73 2.71
2.03 2.02 2.00 1.99
1.00 1.00 2.02 1.07
3.2 3.0 2.8 2.6 2.4 2.2 2.0
f1 (ppm)
1.95 1.08 2.04 2.06 1.01 1.91
1.84
3.00 2.96
1.00 1.00
2.02
1.07
3.07
10.5 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
f1 (ppm)


172.53
172.22
161.65
143.73
135.62
129.71
128.81
128.47
128.32
128.07
126.02
77.48
76.84
59.06
52.88
52.81
41.43
40.08
37.86
22.88
135.62
129.71
128.81
128.47
128.32
128.07
126.02
138
136
134
132
130
128
126
f1 (ppm)
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)


f1 (ppm)
f1 (ppm)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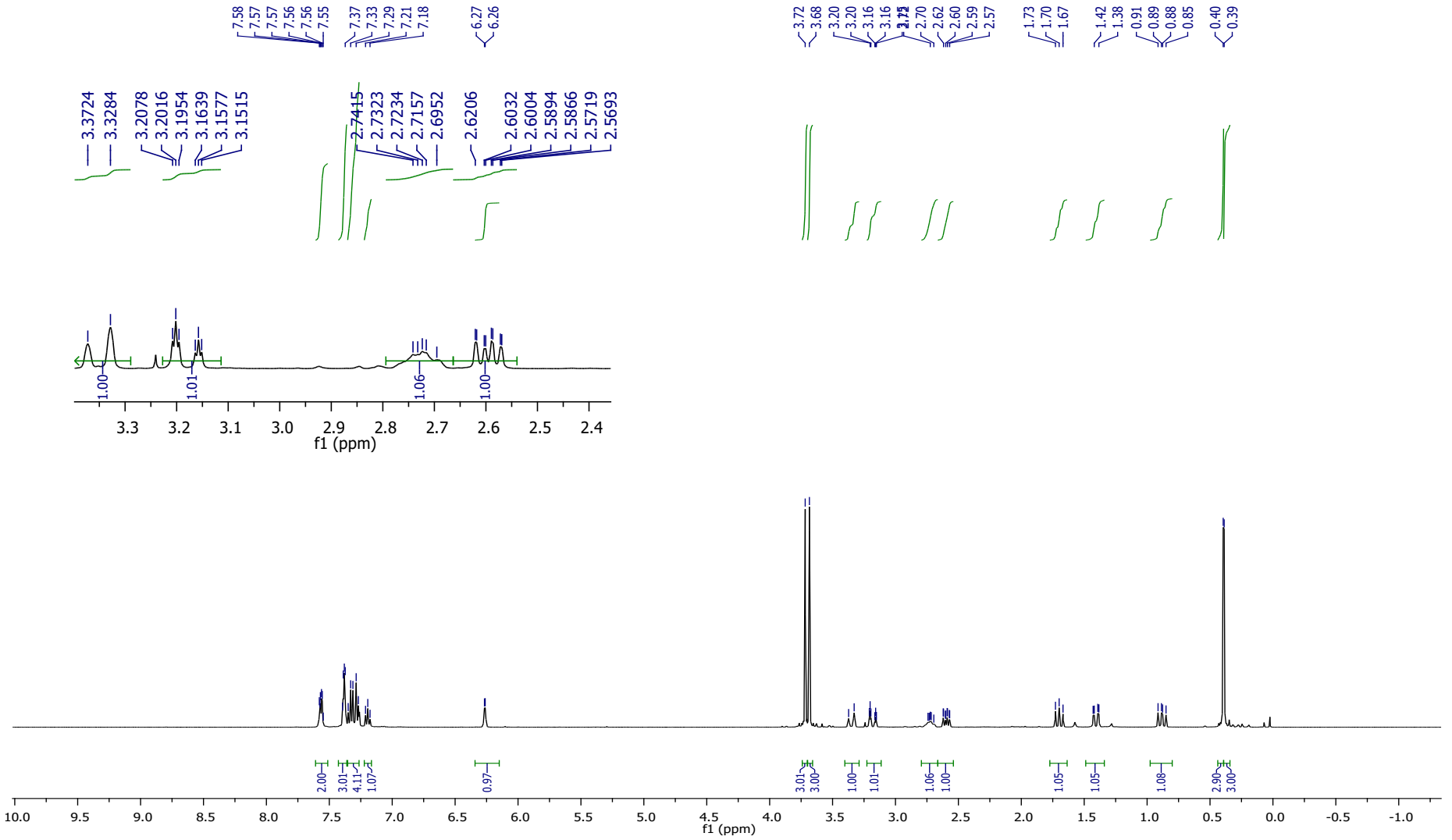
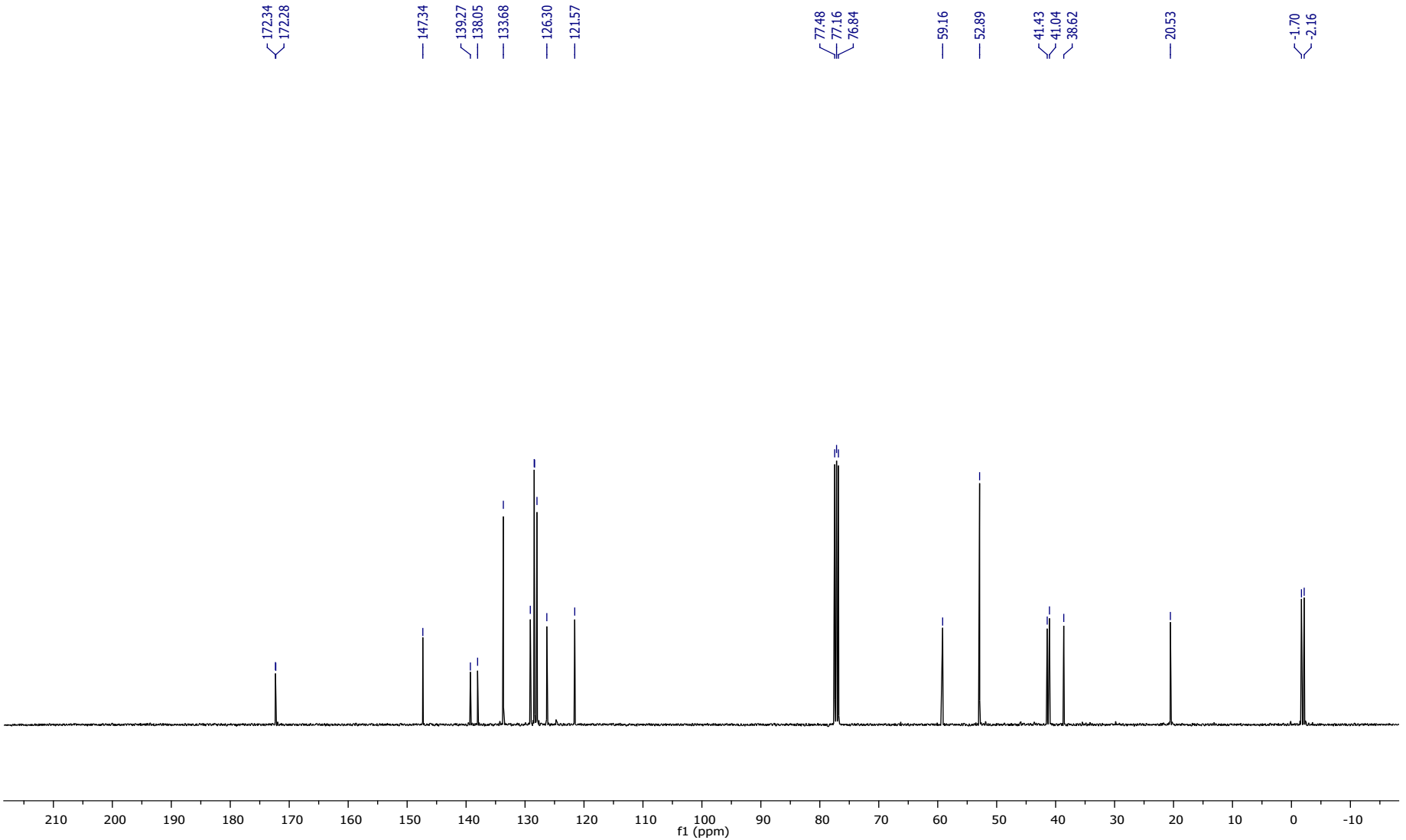
160.01
143.28
135.61
134.80
132.00
129.42
128.24
127.95
125.69
77.48
77.16
76.84
58.91
52.86
52.76
41.30
39.86
37.40
22.79
-5.33
135.61
134.80
132.00
129.42
128.24
127.95
125.69
135
130
125
f1 (ppm)
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.58
7.57
7.57
7.56
7.56
7.55
7.37
7.33
7.29
7.21
7.18
6.27
6.26
3.72
3.68
3.20
3.20
3.16
3.16
2.70
2.62
2.60
2.59
2.57
1.73
1.70
1.67
1.42
1.38
0.91
0.89
0.88
0.85
0.40
0.39
3.3724
3.3284
3.2078
3.2016
3.1954
3.1639
3.1577
3.1515
2.7415
2.7323
2.7234
2.7157
2.6952
2.6206
2.6032
2.6004
2.5894
2.5866
2.5719
2.5693
1.00
1.01
1.06
1.00
3.3 3.2 3.1 3.0 2.9 2.8 2.7 2.6 2.5 2.4
f1 (ppm)
2.00
3.01
4.11
1.07
0.97
3.01
3.00
1.00
1.01
1.06
1.00
1.05
1.05
1.08
2.90
3.00
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
f1 (ppm)


172.34
172.28
147.34
139.27
138.05
133.68
126.30
121.57
77.48
77.16
76.84
59.16
52.89
41.43
41.04
38.62
20.53
-1.70
-2.16
210
200
190
180
170
160
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140
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120
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100
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80
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40
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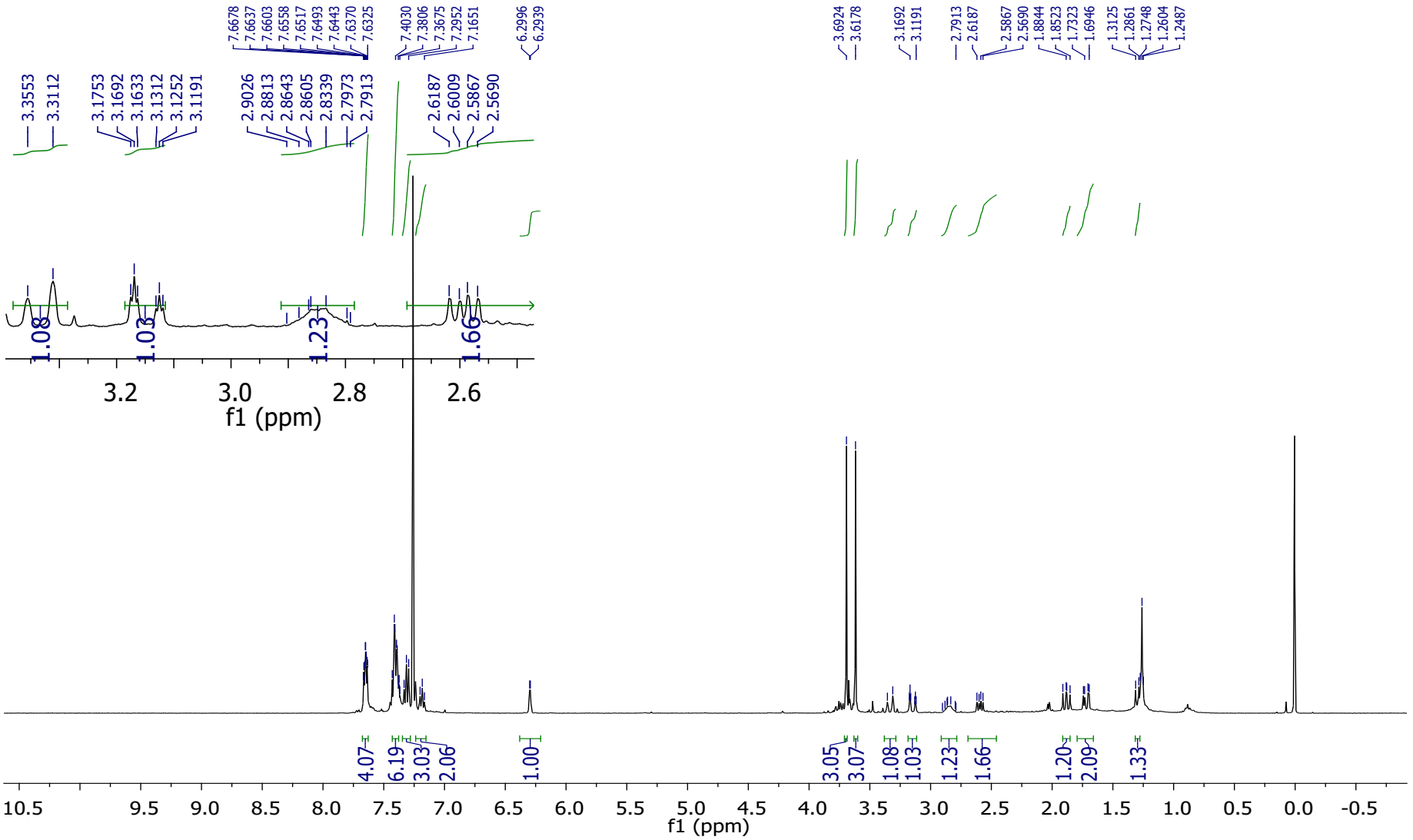
-10
f1 (ppm)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7.6443
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7.4030
7.3806
7.3675
7.2952
7.1651
6.2996
6.2939
3.6924
3.6178
3.1692
3.1191
2.7913
2.6187
2.5867
2.5690
1.8844
1.8523
1.7323
1.6946
1.3125
1.2861
1.2748
1.2604
1.2487
3.3553
3.3112
3.1753
3.1692
3.1633
3.1312
3.1252
3.1191
2.9026
2.8813
2.8643
2.8605
2.8339
2.7973
2.7913
2.6187
2.6009
2.5867
2.5690
1.08
1.03
1.23
1.66
3.2
3.0
2.8
2.6
f1 (ppm)
4.07
6.19
3.03
2.06
1.00
3.05
3.07
1.08
1.03
1.23
1.66
1.20
2.09
1.33
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
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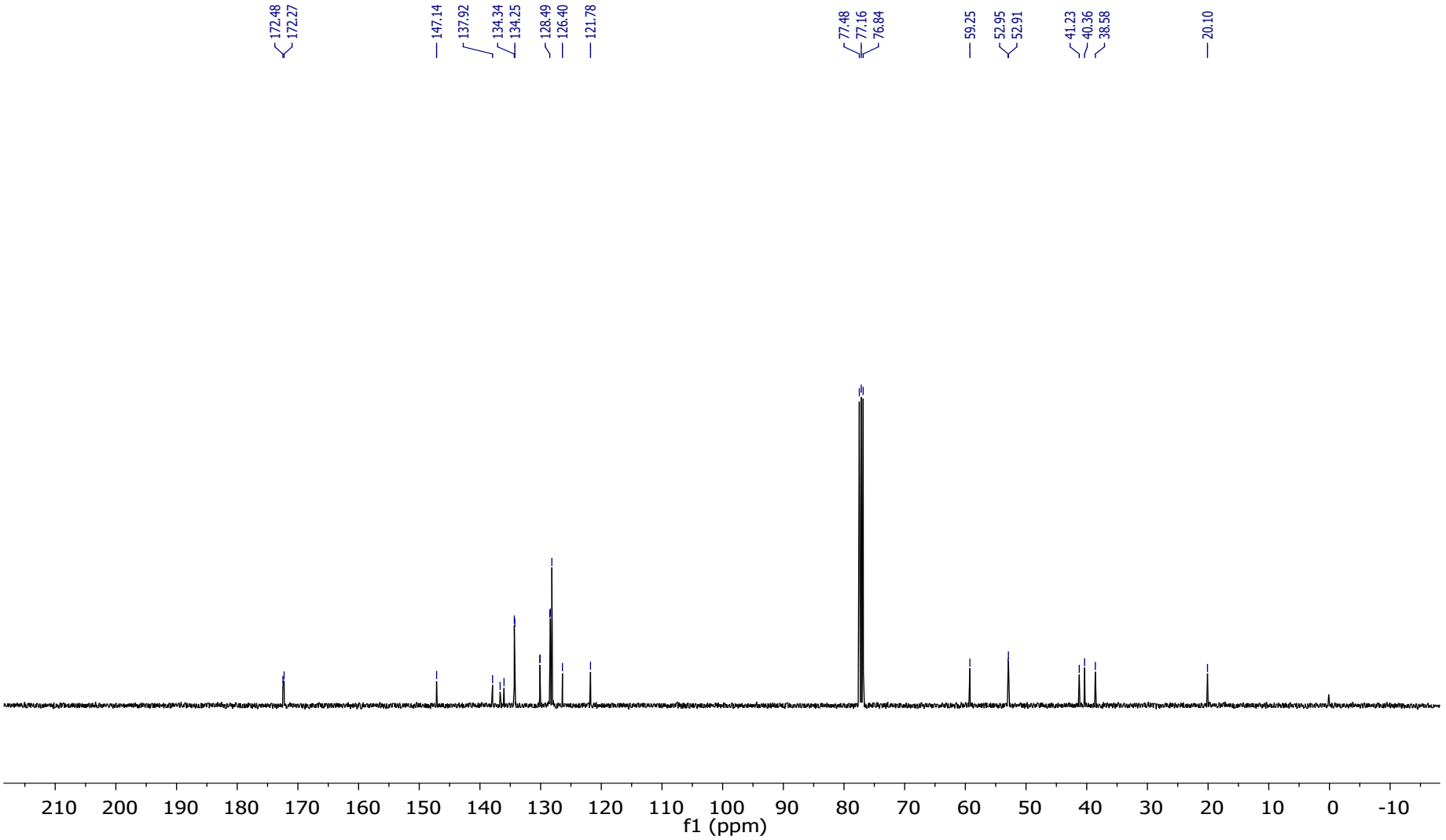
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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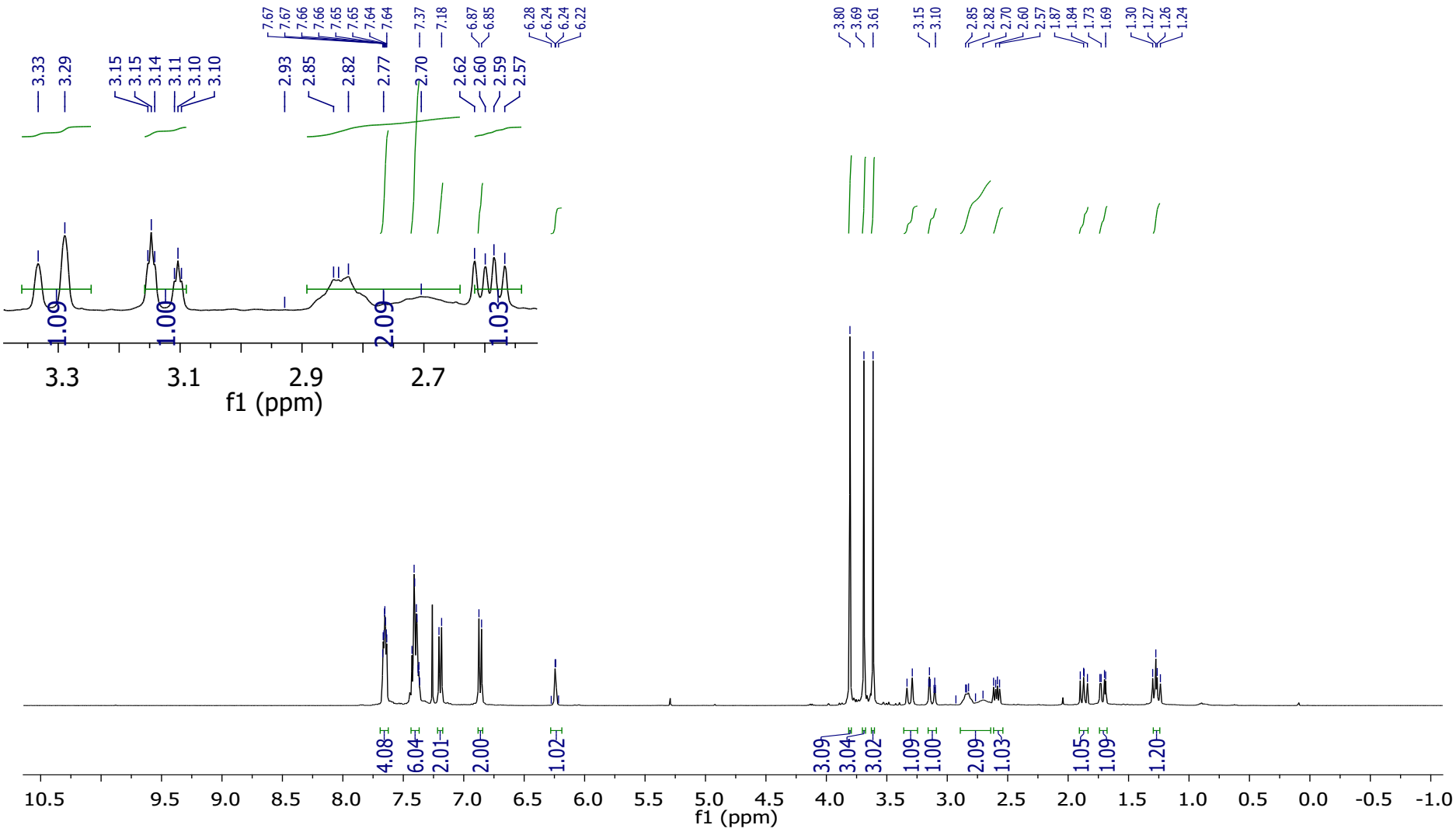
172.27
147.14
137.92
134.34
134.25
128.49
126.40
121.78
77.48
77.16
76.84
59.25
52.95
52.91
41.23
40.36
38.58
20.10
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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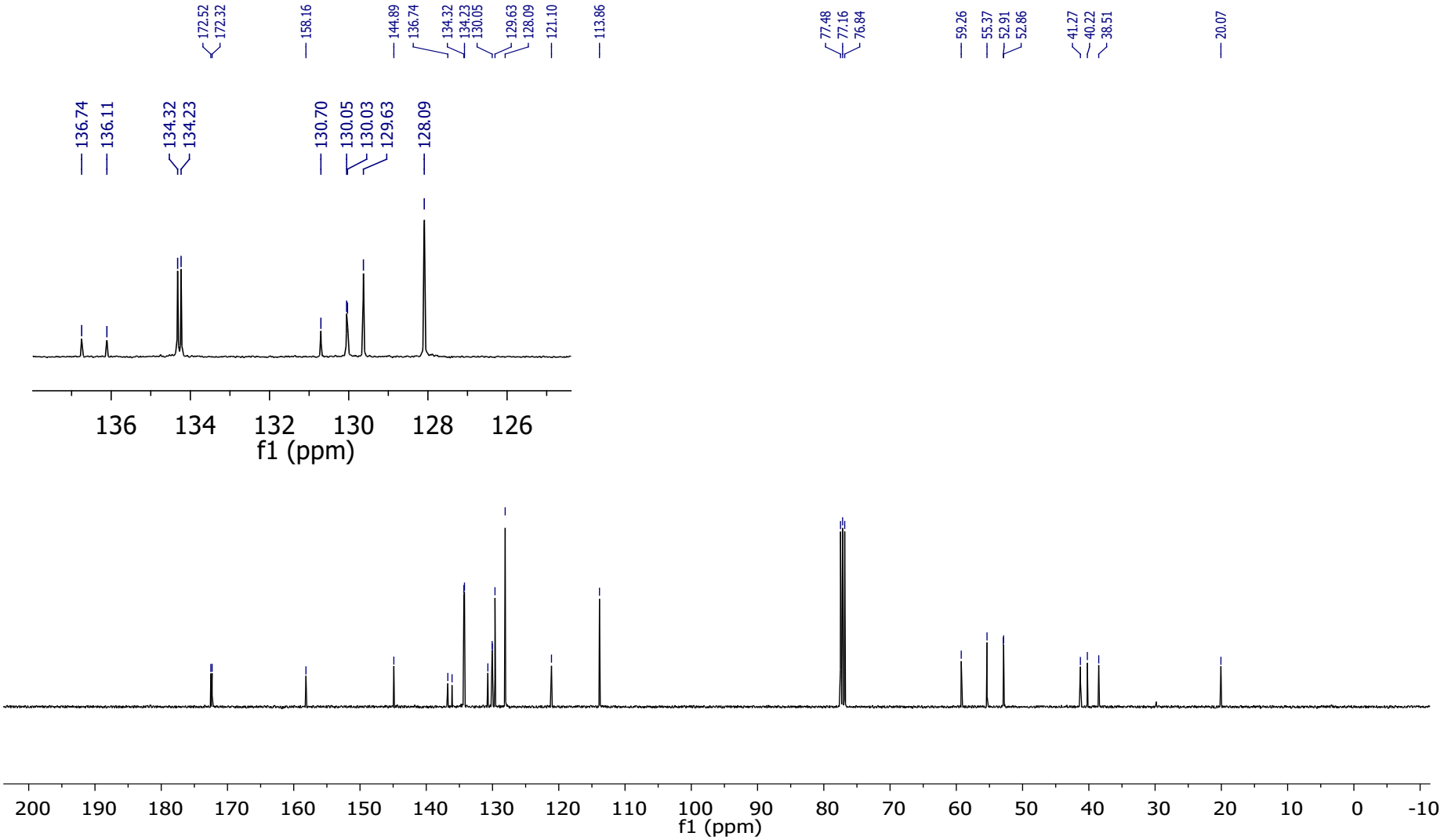
7.67
7.66
7.66
7.65
7.65
7.64
7.64
7.37
7.18
6.87
6.85
6.28
6.24
6.24
6.22
3.80
3.69
3.61
3.15
3.10
2.85
2.82
2.70
2.60
2.57
1.87
1.84
1.73
1.69
1.30
1.27
1.26
1.24
3.33
3.29
3.15
3.15
3.14
3.11
3.10
3.10
2.93
2.85
2.82
2.77
2.70
2.62
2.60
2.59
2.57
1.09
1.00
2.09
1.03
3.3
3.1
2.9
2.7
f1 (ppm)
4.08
6.04
2.01
2.00
1.02
3.09
3.04
3.02
1.09
1.00
2.09
1.03
1.05
1.09
1.20
10.5
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
f1 (ppm)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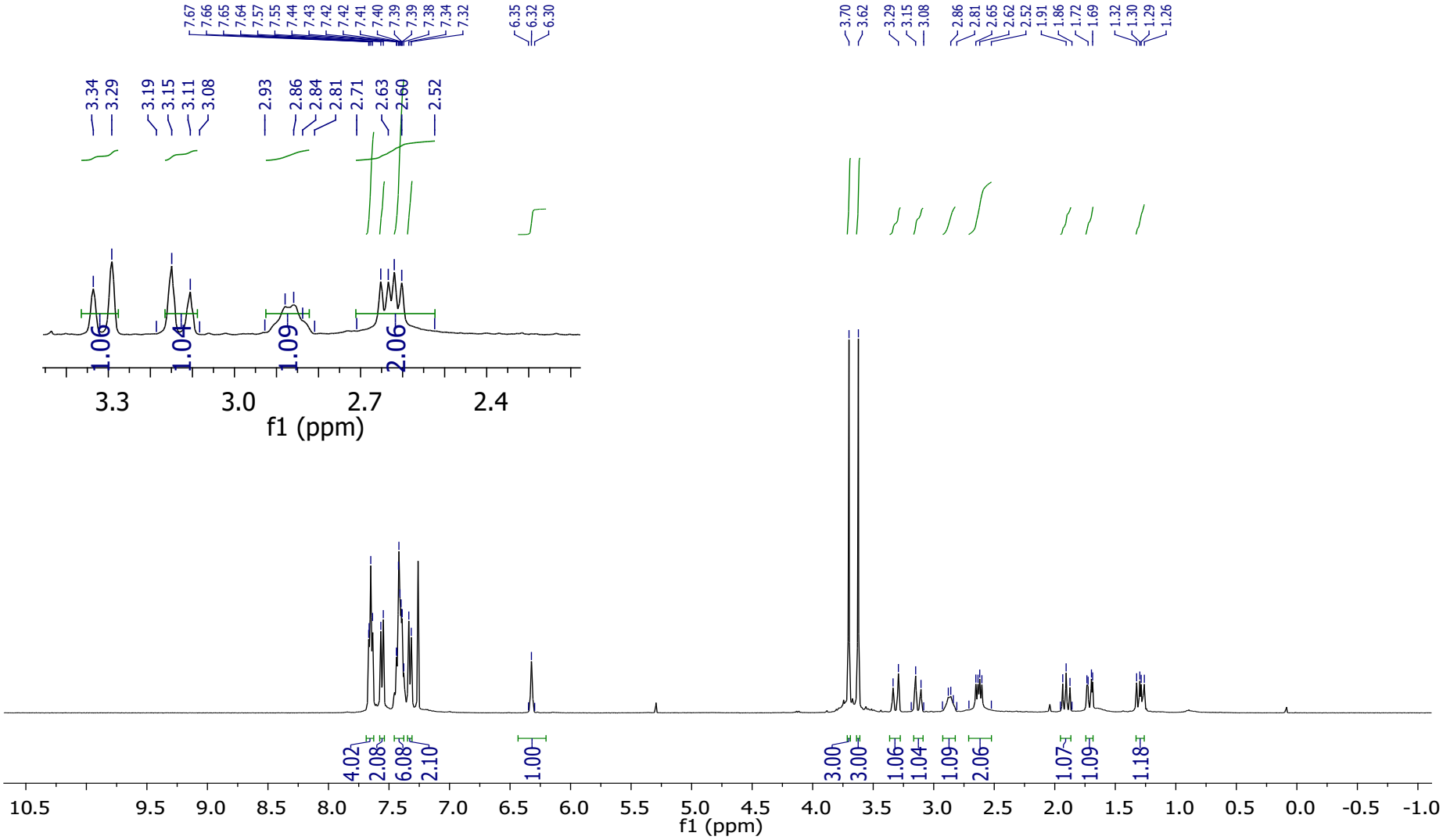
172.32
158.16
144.89
136.74
134.32
134.23
130.05
129.63
128.09
121.10
113.86
77.48
77.16
76.84
59.26
55.37
52.91
52.86
41.27
40.22
38.51
20.07
136.74
136.11
134.32
134.23
130.70
130.05
130.03
129.63
128.09
136
134
132
130
128
126
f1 (ppm)
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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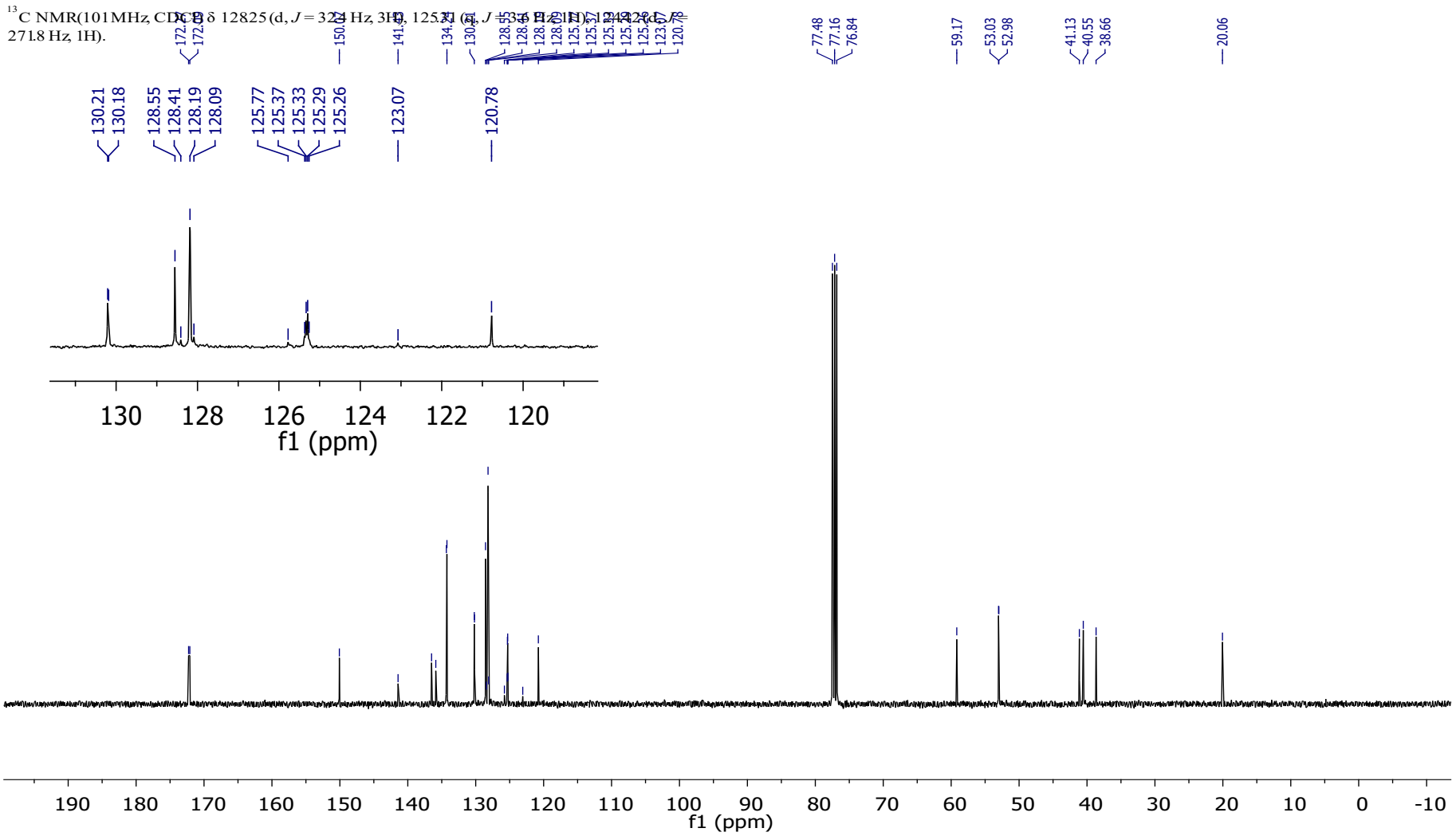
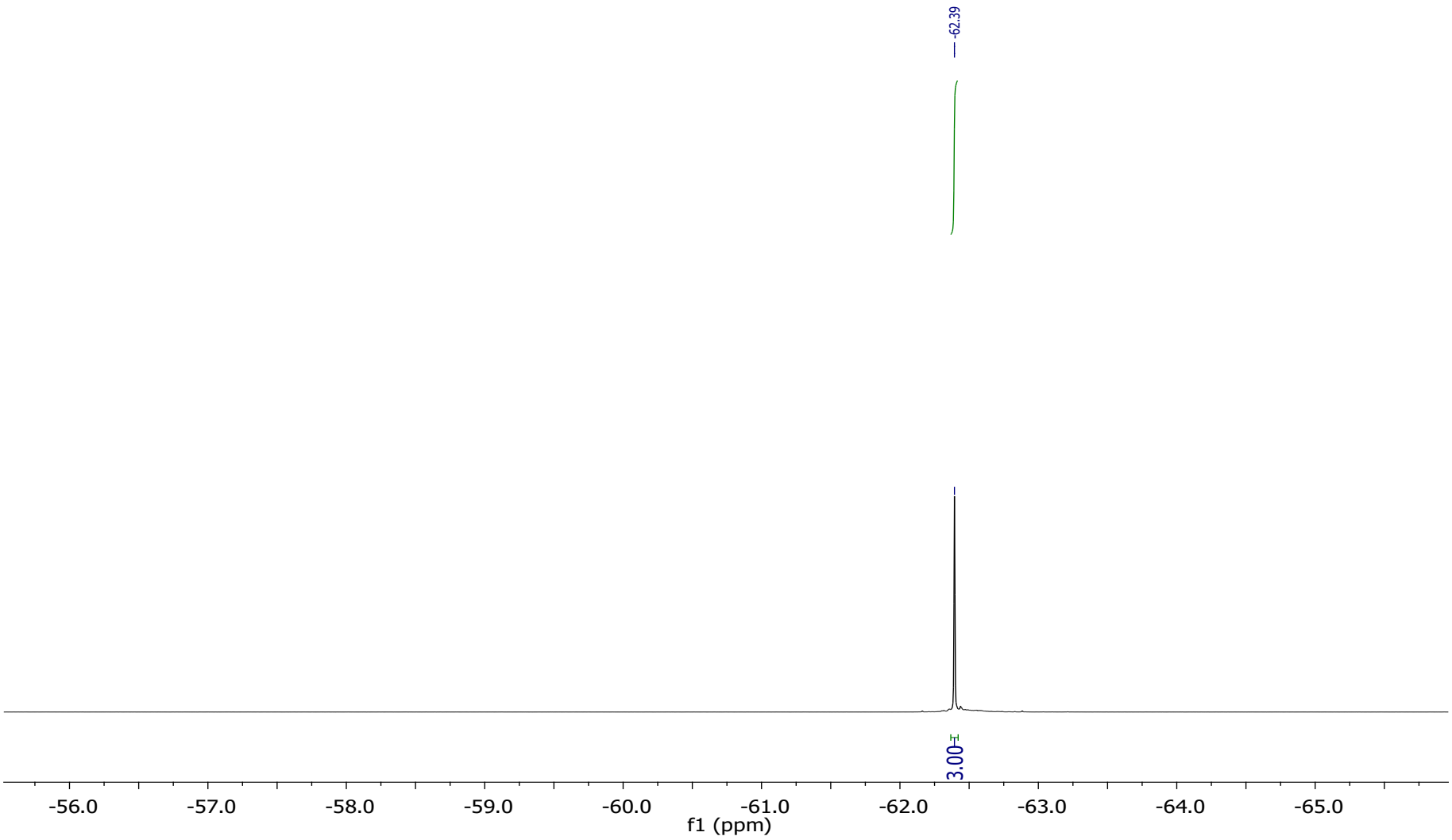
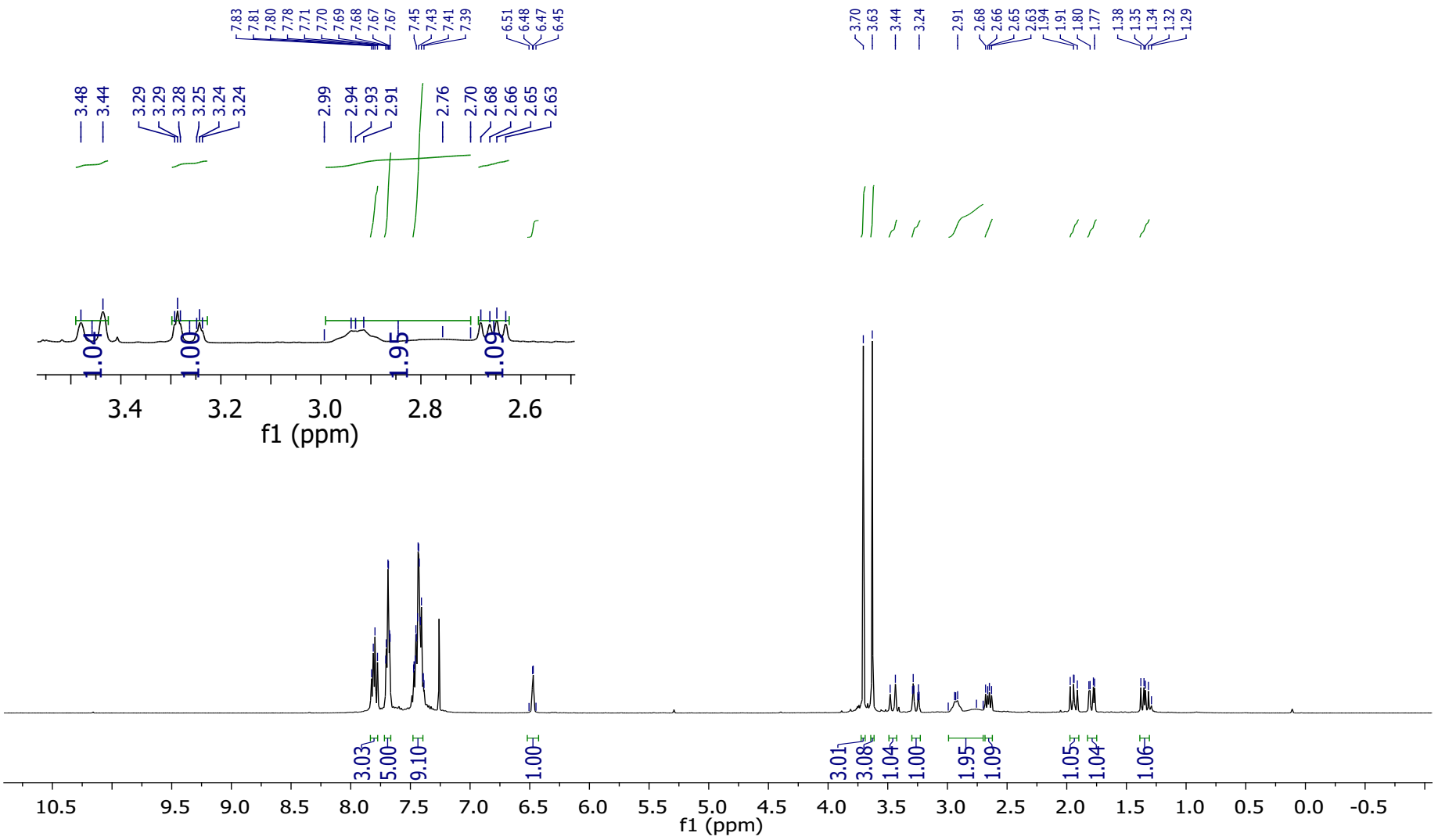
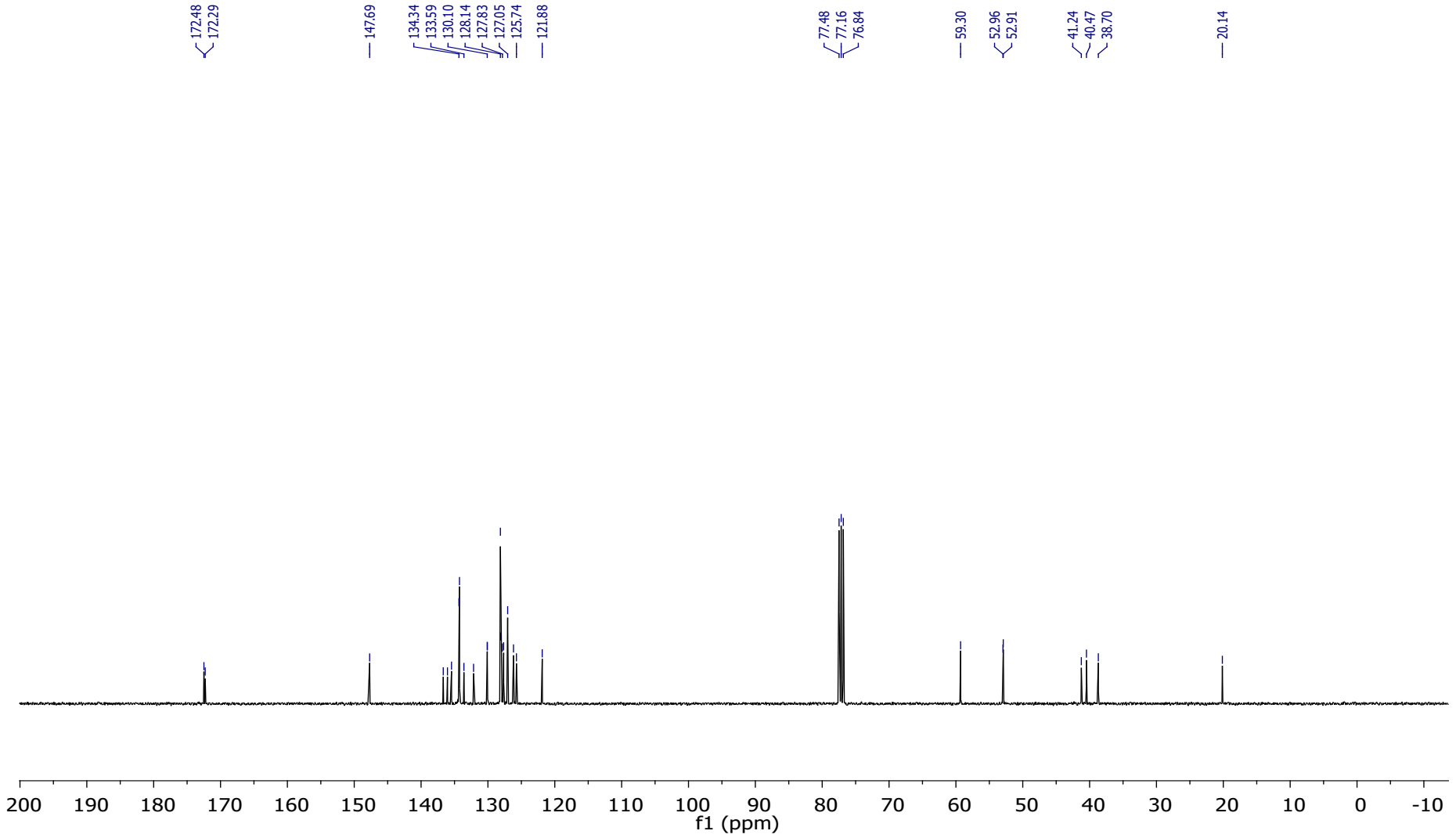
7.66
7.65
7.64
7.57
7.55
7.44
7.43
7.42
7.42
7.41
7.40
7.39
7.39
7.38
7.34
7.32
6.35
6.32
6.30
3.70
3.62
3.29
3.15
3.08
2.86
2.81
2.65
2.62
2.52
1.91
1.86
1.72
1.69
1.32
1.30
1.29
1.26
3.34
3.29
3.19
3.15
3.11
3.08
2.93
2.86
2.84
2.81
2.71
2.63
2.60
2.52
1.06
1.04
1.09
2.06
3.3
3.0
2.7
2.4
f1 (ppm)
4.02
2.08
6.08
2.10
1.00
3.00
3.00
1.06
1.04
1.09
2.06
1.07
1.09
1.18
10.5
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
f1 (ppm)

^{13}C NMR(101MHz, CDCl$_3$) δ 128.25 (d, J = 32.4 Hz, 3H), 125.31 (q, J = 3.6 Hz, 1H), 124.22 (d, J = 271.8 Hz, 1H).




-62.39
3.00
-56.0
-57.0
-58.0
-59.0
-60.0
-61.0
-62.0
-63.0
-64.0
-65.0
f1 (ppm)


7.83
7.81
7.80
7.78
7.71
7.70
7.69
7.68
7.67
7.67
7.45
7.43
7.41
7.39
6.51
6.48
6.47
6.45
3.70
3.63
3.44
3.24
2.91
2.68
2.66
2.65
2.63
1.94
1.91
1.80
1.77
1.38
1.35
1.34
1.32
1.29
3.48
3.44
3.29
3.29
3.28
3.25
3.24
3.24
2.99
2.94
2.93
2.91
2.76
2.70
2.68
2.66
2.65
2.63
1.04
1.00
1.95
1.09
3.4
3.2
3.0
2.8
2.6
f1 (ppm)
3.03
5.00
9.10
1.00
3.01
3.08
1.04
1.00
1.95
1.09
1.05
1.04
1.06
10.5
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
f1 (ppm)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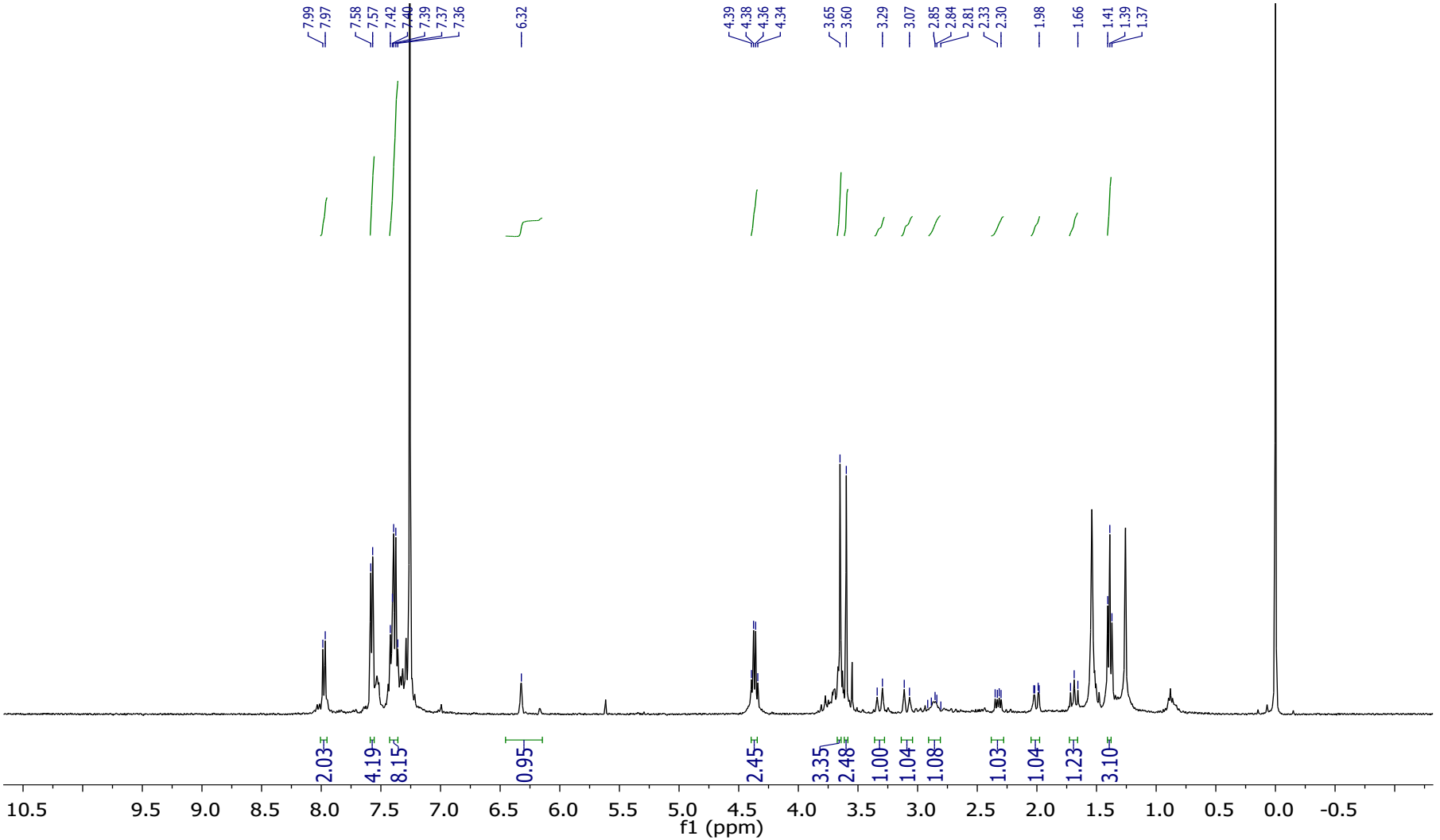
147.69
134.34
133.59
130.10
128.14
127.83
127.05
125.74
121.88
77.48
77.16
76.84
59.30
52.96
52.91
41.24
40.47
38.70
20.14
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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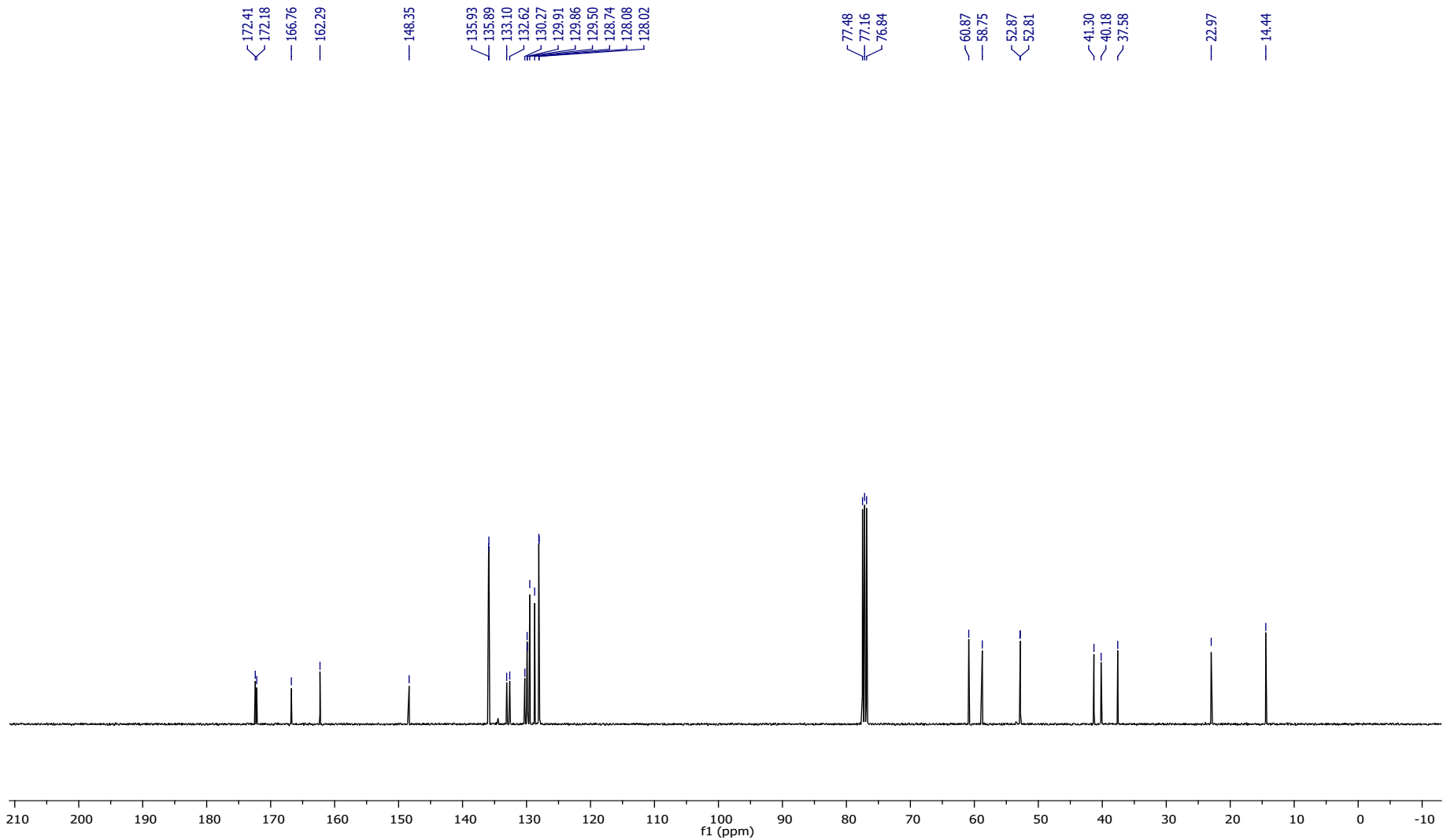
7.42
7.40
7.39
7.37
7.36
6.32
4.39
4.38
4.36
4.34
3.65
3.60
3.29
3.07
2.85
2.84
2.81
2.33
2.30
1.98
1.66
1.41
1.39
1.37
2.03
4.19
8.15
0.95
2.45
3.35
2.48
1.00
1.04
1.08
1.03
1.04
1.23
3.10
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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148.35
135.93
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129.86
129.50
128.74
128.08
128.02
77.48
77.16
76.84
60.87
58.75
52.87
52.81
41.30
40.18
37.58
22.97
14.44
210
200
190
180
170
160
150
140
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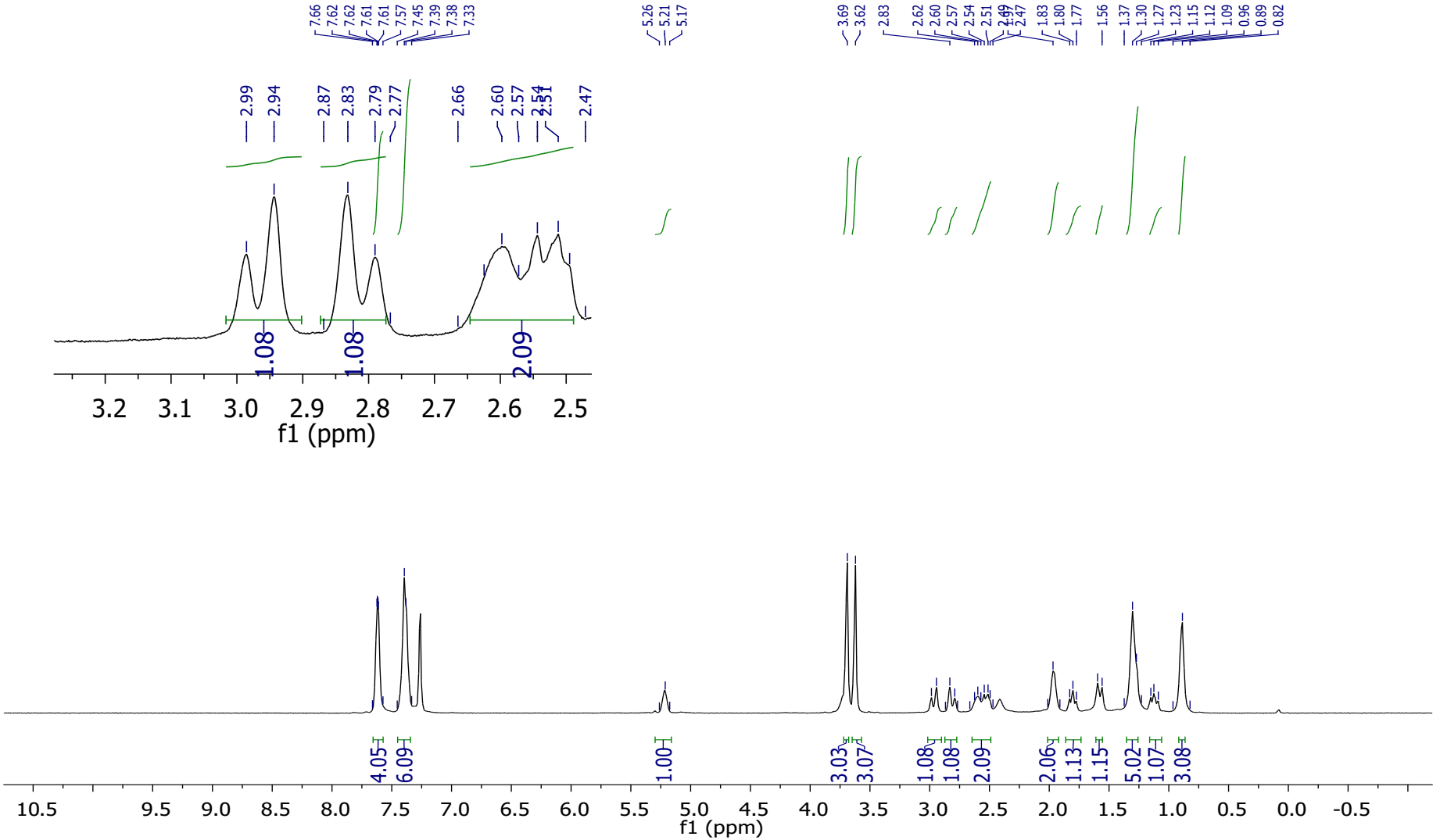
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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7.62
7.61
7.61
7.57
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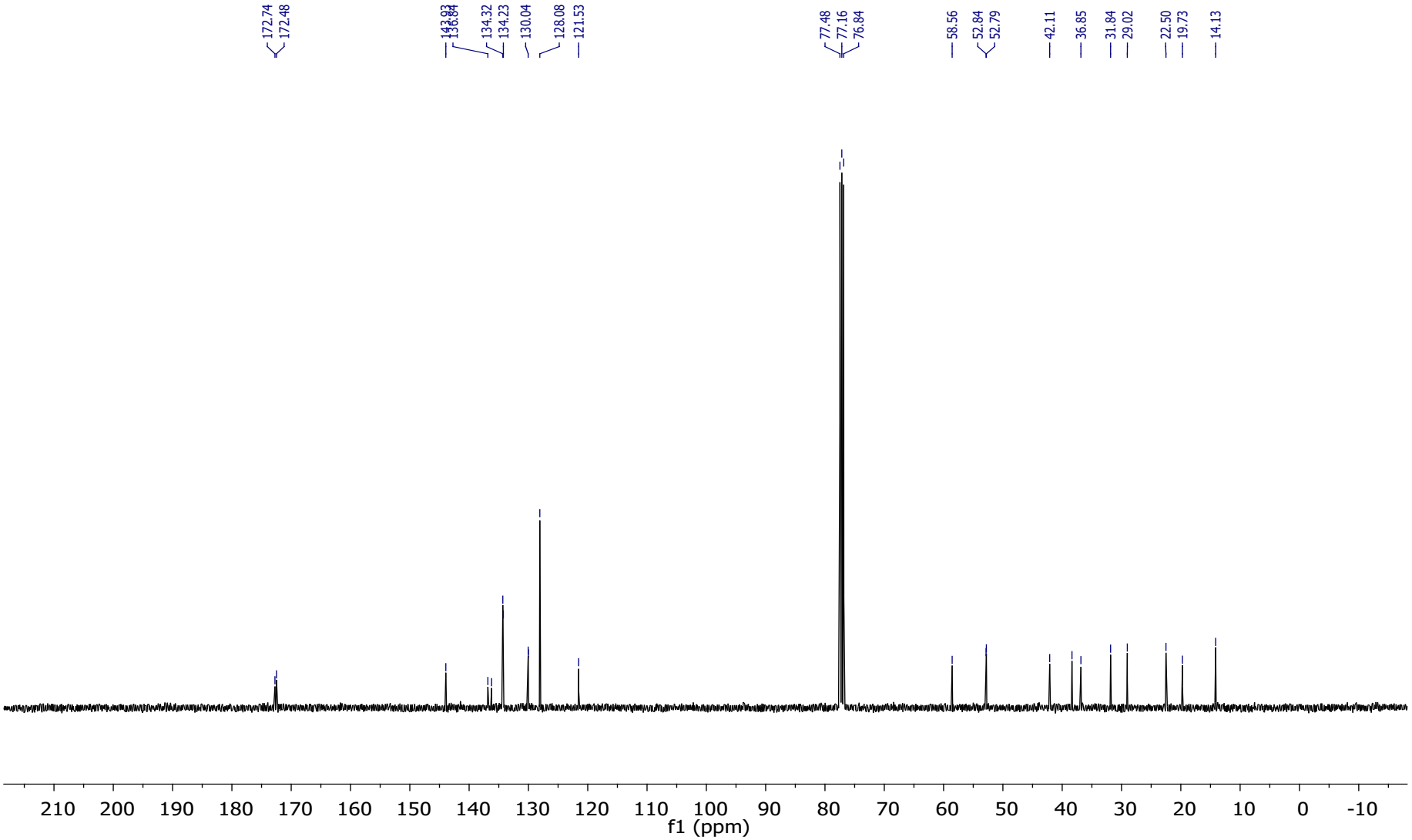
7.39
7.38
7.33
5.26
5.21
5.17
3.69
3.62
2.83
2.62
2.60
2.57
2.54
2.51
2.47
1.83
1.80
1.77
1.56
1.37
1.30
1.27
1.23
1.15
1.12
1.09
0.96
0.89
0.82
2.99
2.94
2.87
2.83
2.79
2.77
2.66
2.60
2.57
2.47
1.08
1.08
2.09
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
f1 (ppm)
4.05
6.09
1.00
3.03
3.07
1.08
1.08
2.09
2.06
1.13
1.15
5.02
1.07
3.08
10.5
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
f1 (ppm)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130.04
128.08
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77.16
76.84
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52.84
52.79
42.11
36.85
31.84
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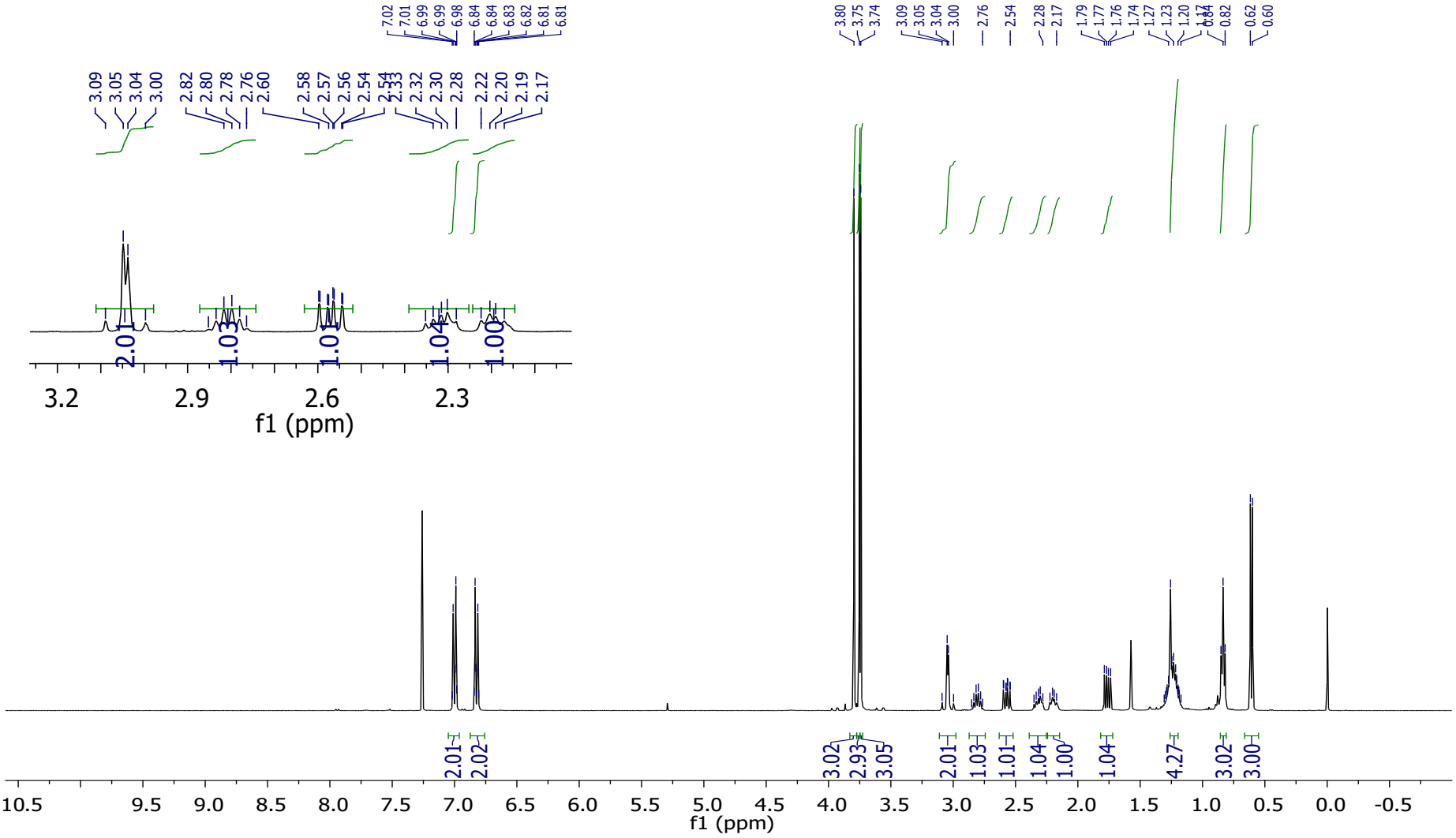
22.50
19.73
14.13
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)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7.01
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6.99
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6.81
6.81
3.80
3.75
3.74
3.09
3.05
3.04
3.00
2.76
2.54
2.28
2.17
1.79
1.77
1.76
1.74
1.27
1.23
1.20
0.82
0.62
0.60
3.09
3.05
3.04
3.00
2.82
2.80
2.78
2.76
2.60
2.58
2.57
2.56
2.54
2.32
2.30
2.28
2.22
2.20
2.19
2.17
2.01
1.03
1.01
1.04
1.00
3.2
2.9
2.6
2.3
f1 (ppm)
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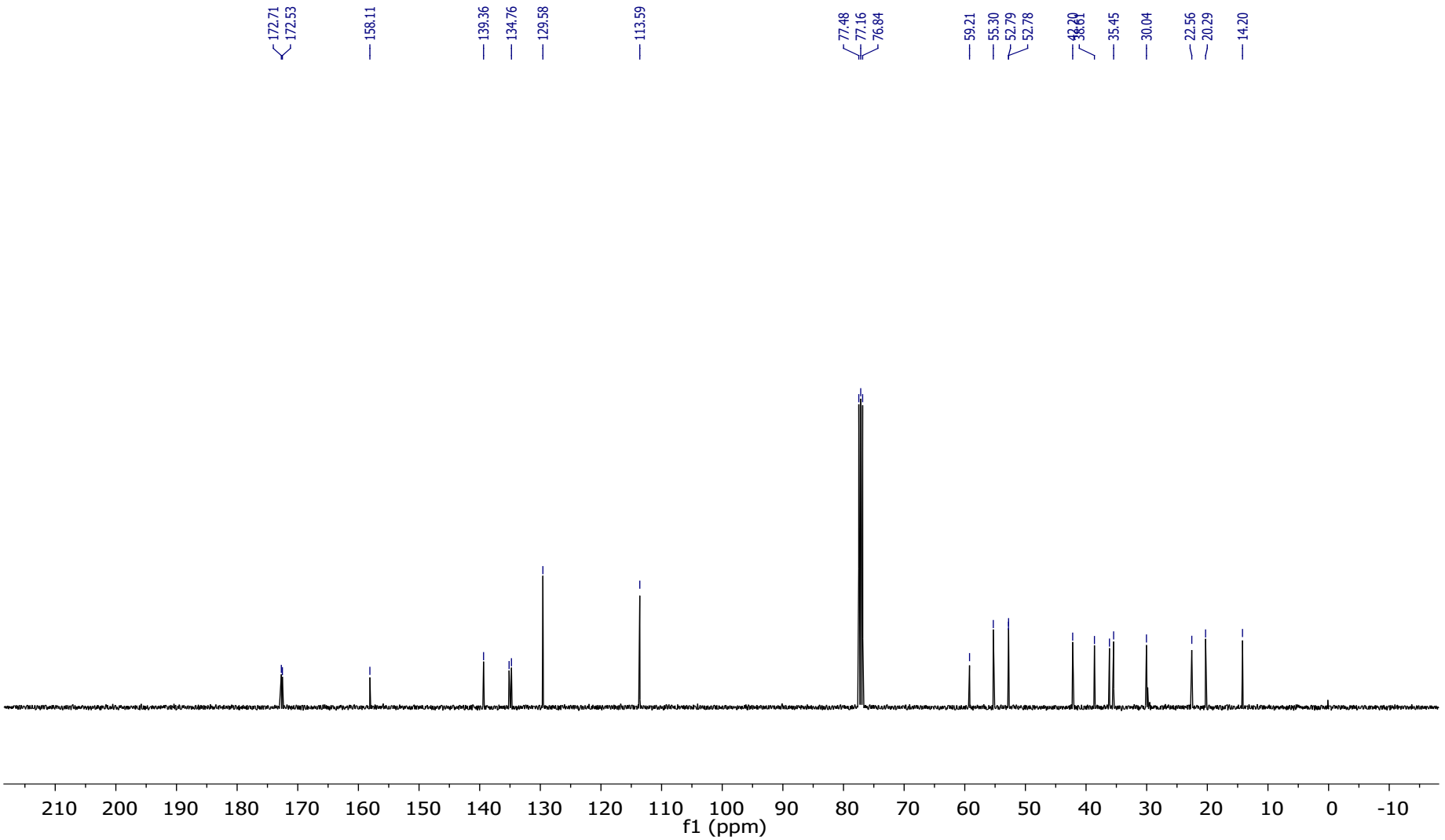
2.02
3.02
2.93
3.05
2.01
1.03
1.01
1.04
1.00
1.04
4.27
3.02
3.00
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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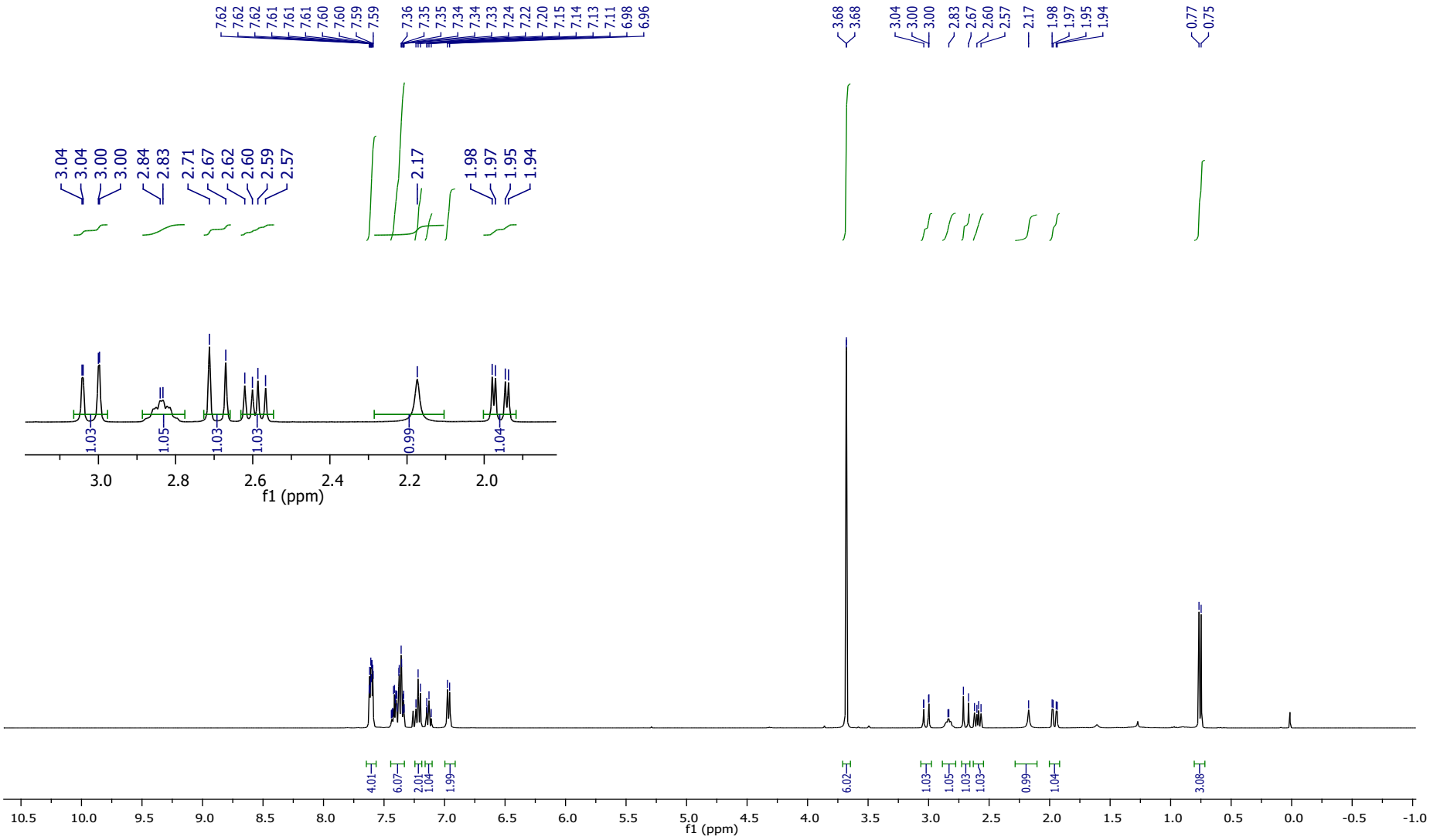
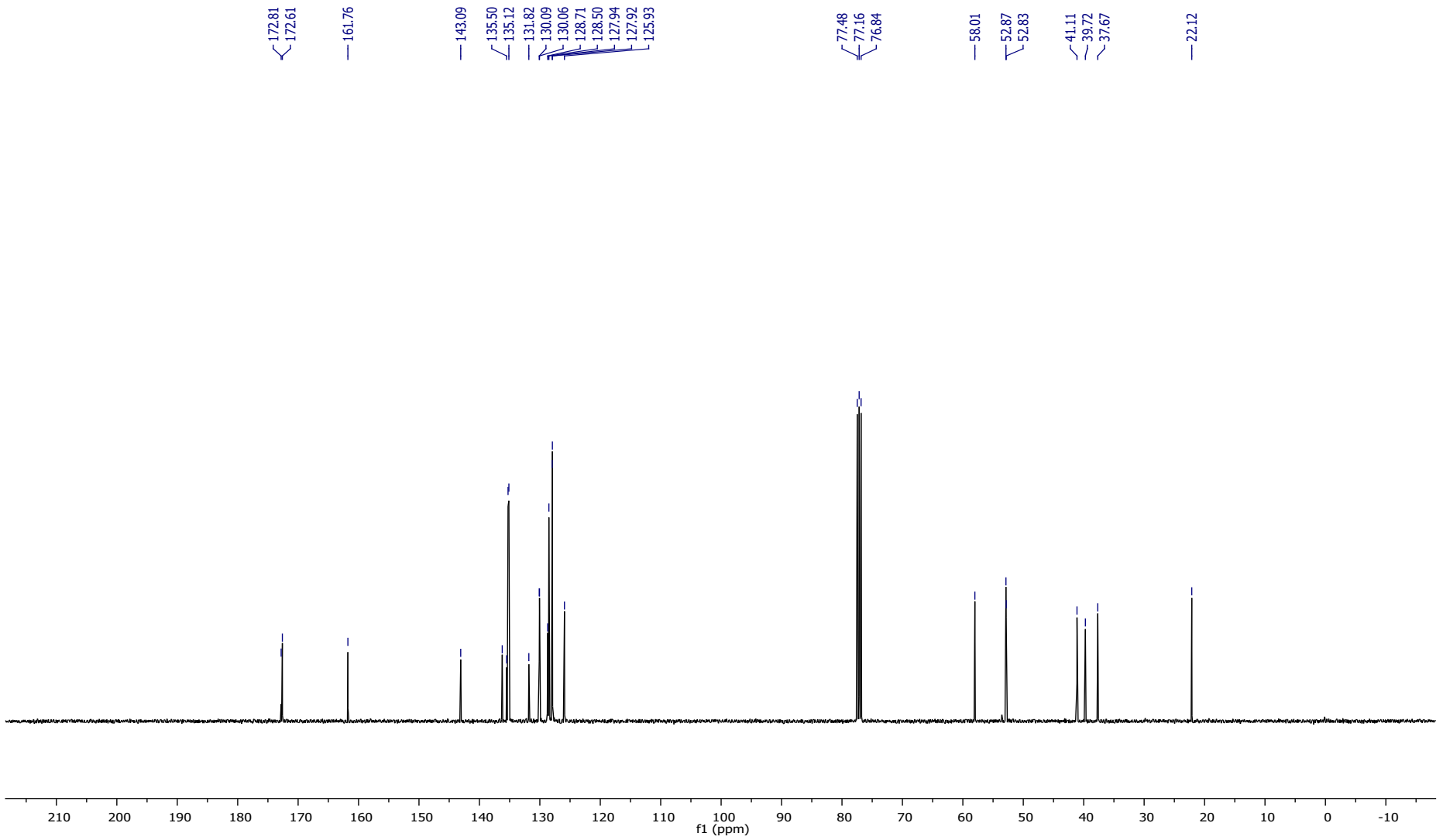
134.76
129.58
113.59
77.48
77.16
76.84
59.21
55.30
52.79
52.78
42.20
38.61
35.45
30.04
22.56
20.29
14.20
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.62 7.62 7.62 7.61 7.61 7.61 7.60 7.60 7.59 7.59
7.36 7.35 7.35 7.34 7.34 7.33 7.24 7.22 7.20 7.15 7.14 7.13 7.11 6.98 6.96
3.68 3.68
3.04 3.00 3.00
2.83 2.67 2.60 2.57
2.17
1.98 1.97 1.95 1.94
0.77 0.75
3.04 3.04 3.00 3.00 2.84 2.83 2.71 2.67 2.62 2.60 2.59 2.57 2.17 1.98 1.97 1.95 1.94
1.03 1.05 1.03 1.03 0.99 1.04
3.0 2.8 2.6 2.4 2.2 2.0
f1 (ppm)
4.01 6.07 2.01 1.04 1.99 6.02 1.03 1.05 1.03 1.03 0.99 1.04 3.08
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 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)


172.81
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161.76
143.09
135.50
135.12
131.82
130.09
130.06
128.71
128.50
127.94
127.92
125.93
77.48
77.16
76.84
58.01
52.87
52.83
41.11
39.72
37.67
22.12
210
200
190
180
170
160
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120
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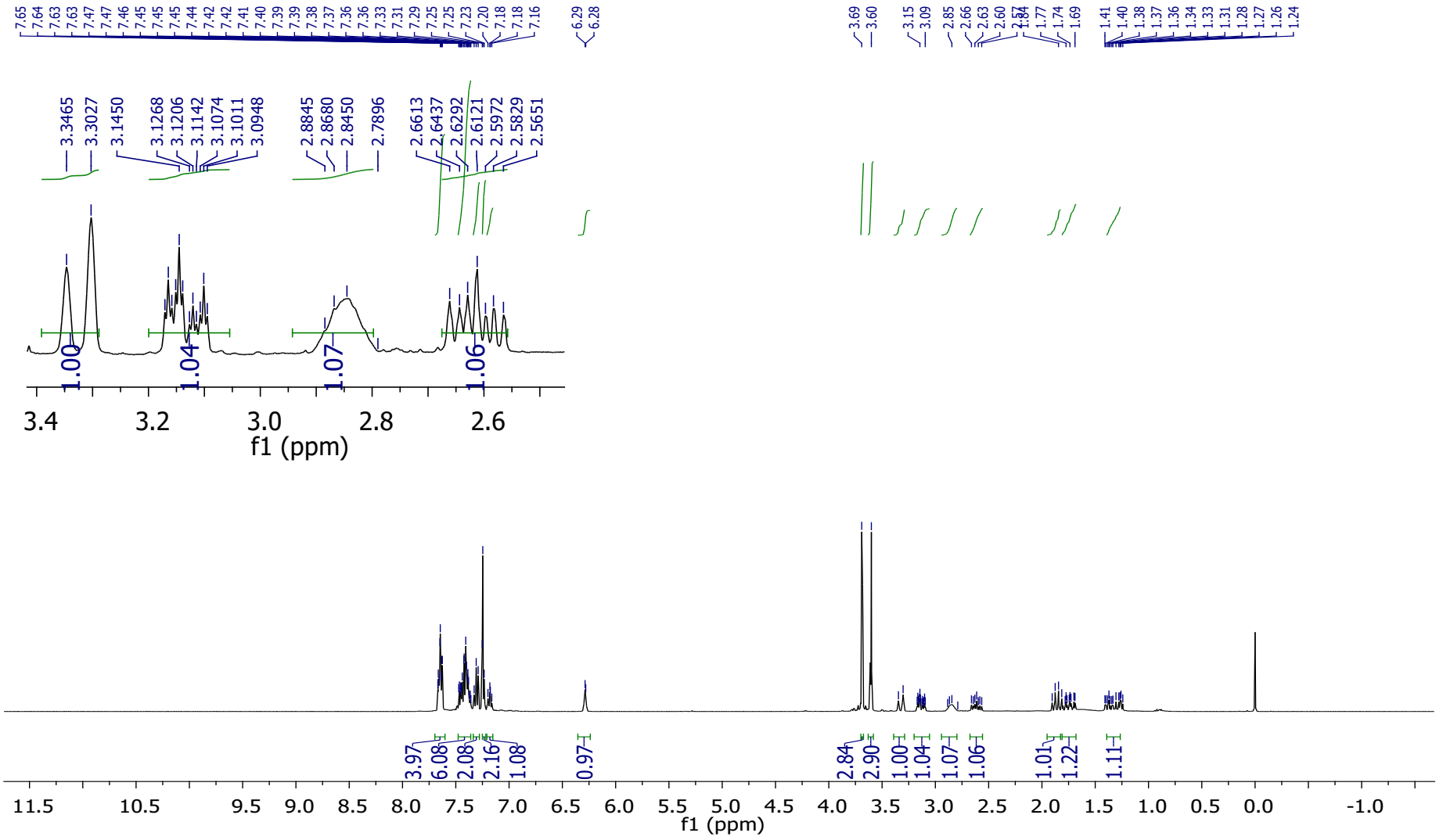
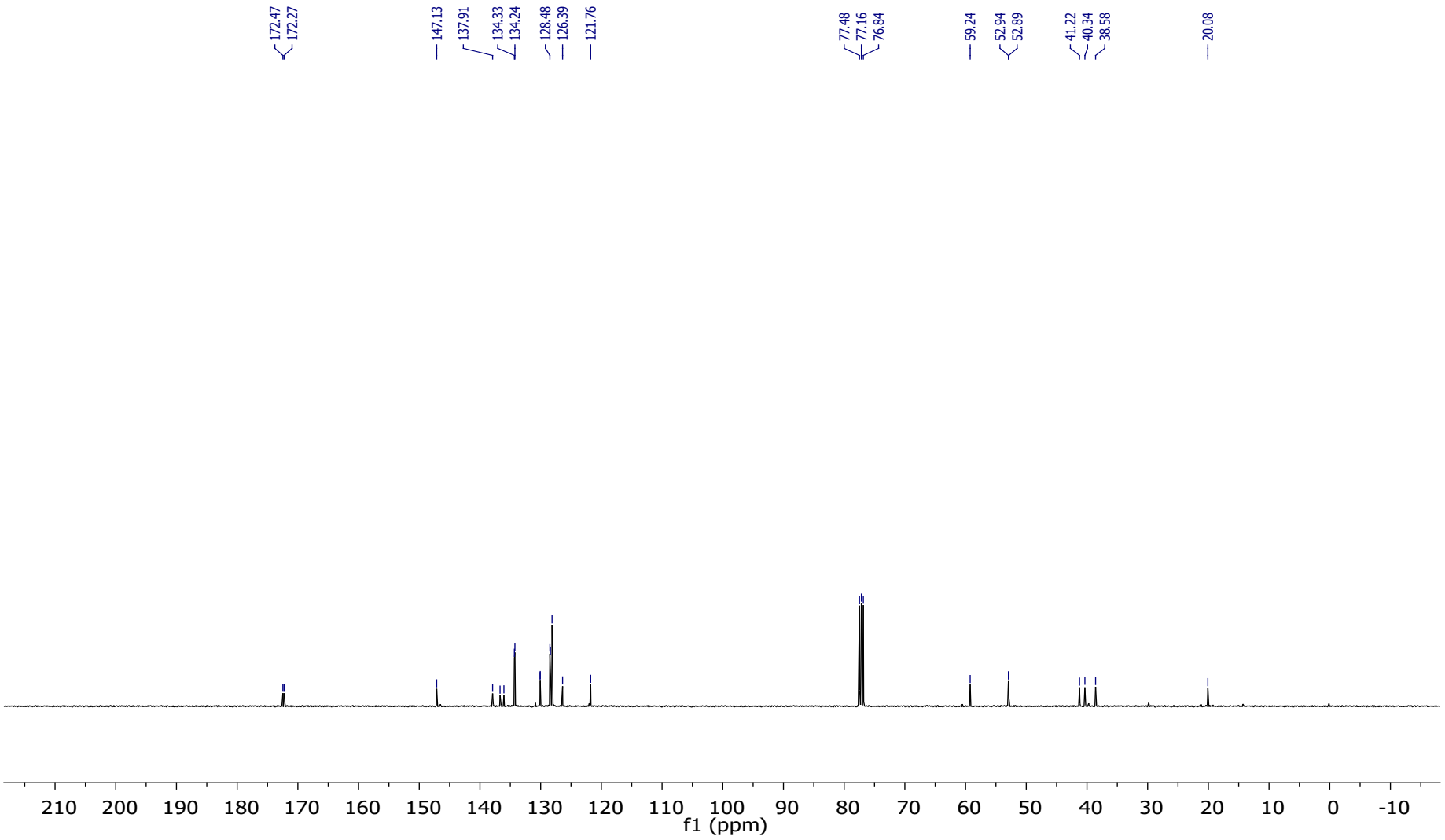
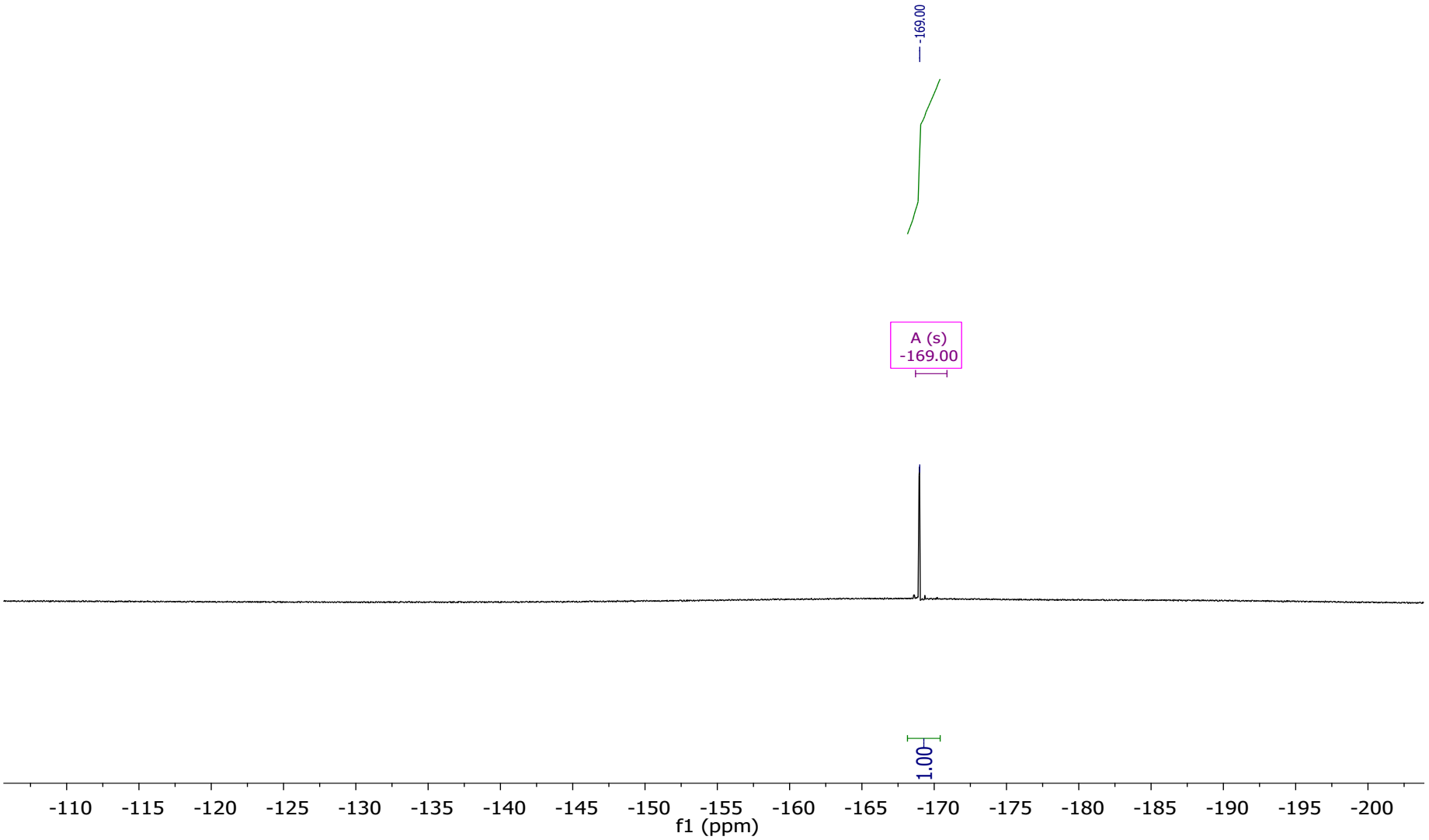
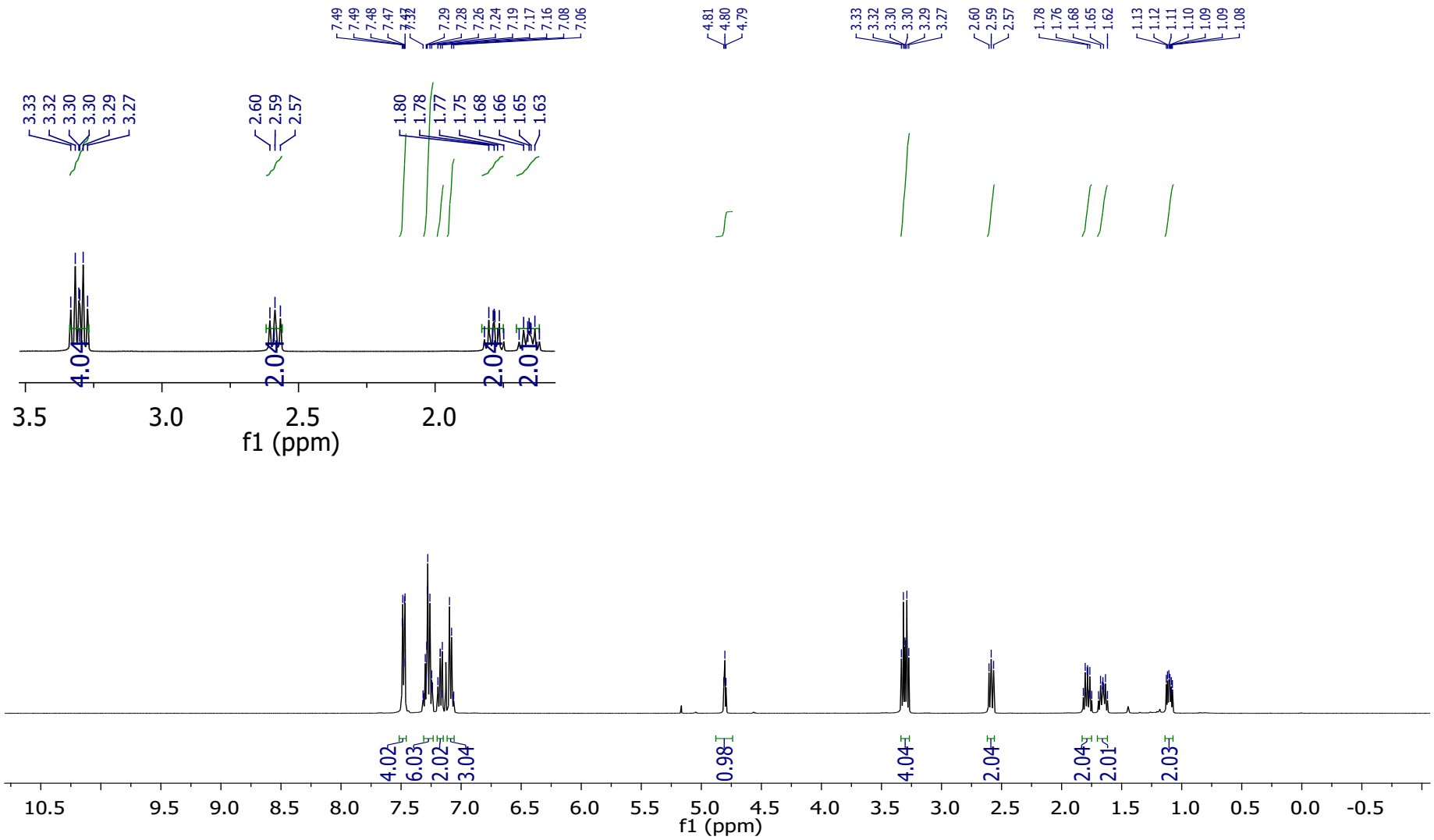
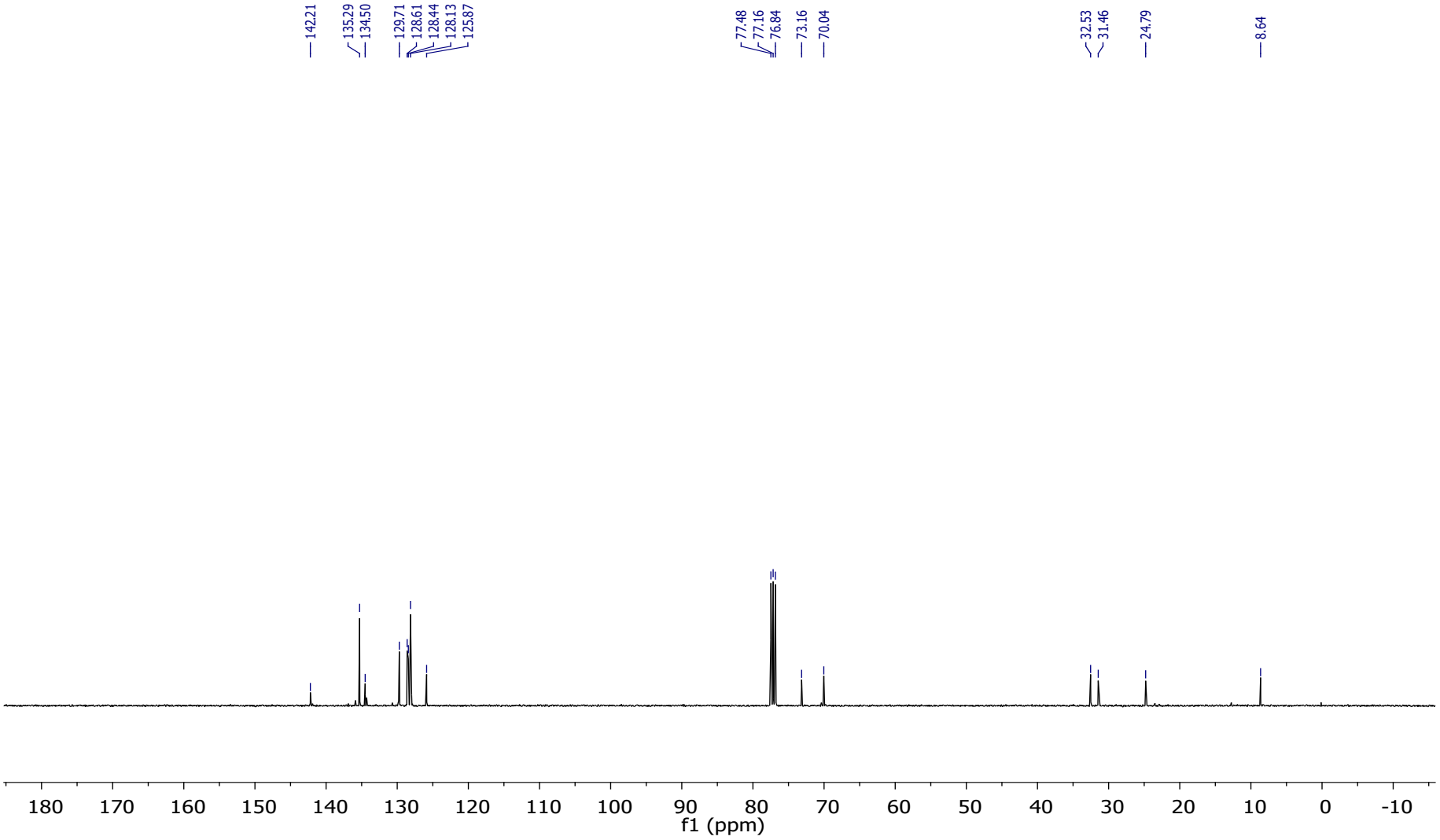
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

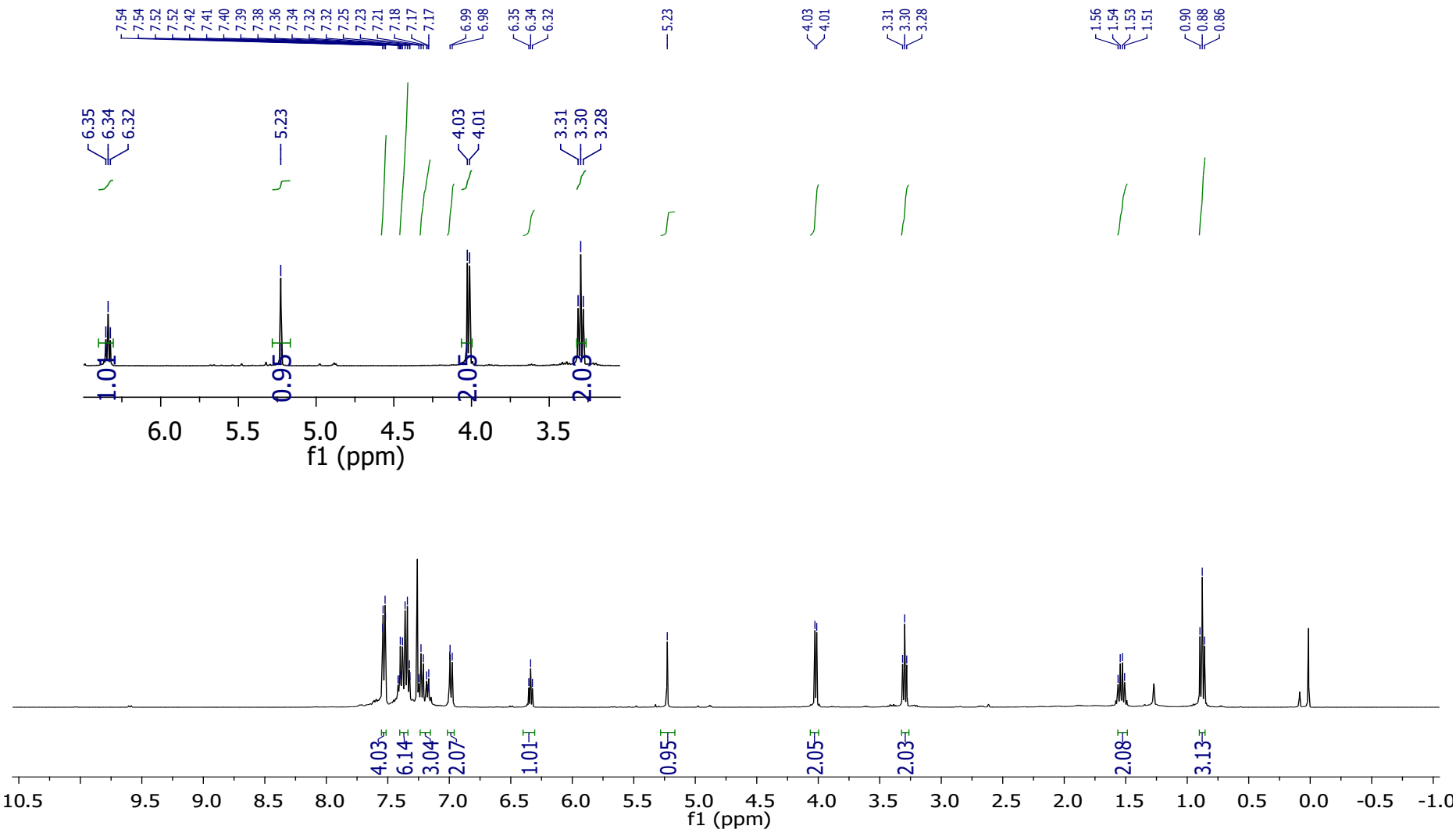

7.65 7.64 7.63 7.63 7.47 7.47 7.46 7.45 7.45 7.45 7.44 7.42 7.42 7.41 7.40 7.39 7.39 7.38 7.37 7.36 7.36 7.33 7.31 7.29 7.25 7.25 7.23 7.20 7.18 7.18 7.16 6.29 6.28
3.69 3.60 3.15 3.09 2.85 2.66 2.63 2.60 1.77 1.74 1.69 1.41 1.40 1.38 1.37 1.36 1.34 1.33 1.31 1.28 1.27 1.26 1.24
3.3465 3.3027 3.1450 3.1268 3.1206 3.1142 3.1074 3.1011 3.0948 2.8845 2.8680 2.8450 2.7896 2.6613 2.6437 2.6292 2.6121 2.5972 2.5829 2.5651
1.00 1.04 1.07 1.06
3.4 3.2 3.0 2.8 2.6
f1 (ppm)
3.97 6.08 2.08 2.16 1.08 0.97 2.84 2.90 1.00 1.04 1.07 1.06 1.01 1.22 1.11
11.5 10.5 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 -1.0
f1 (ppm)

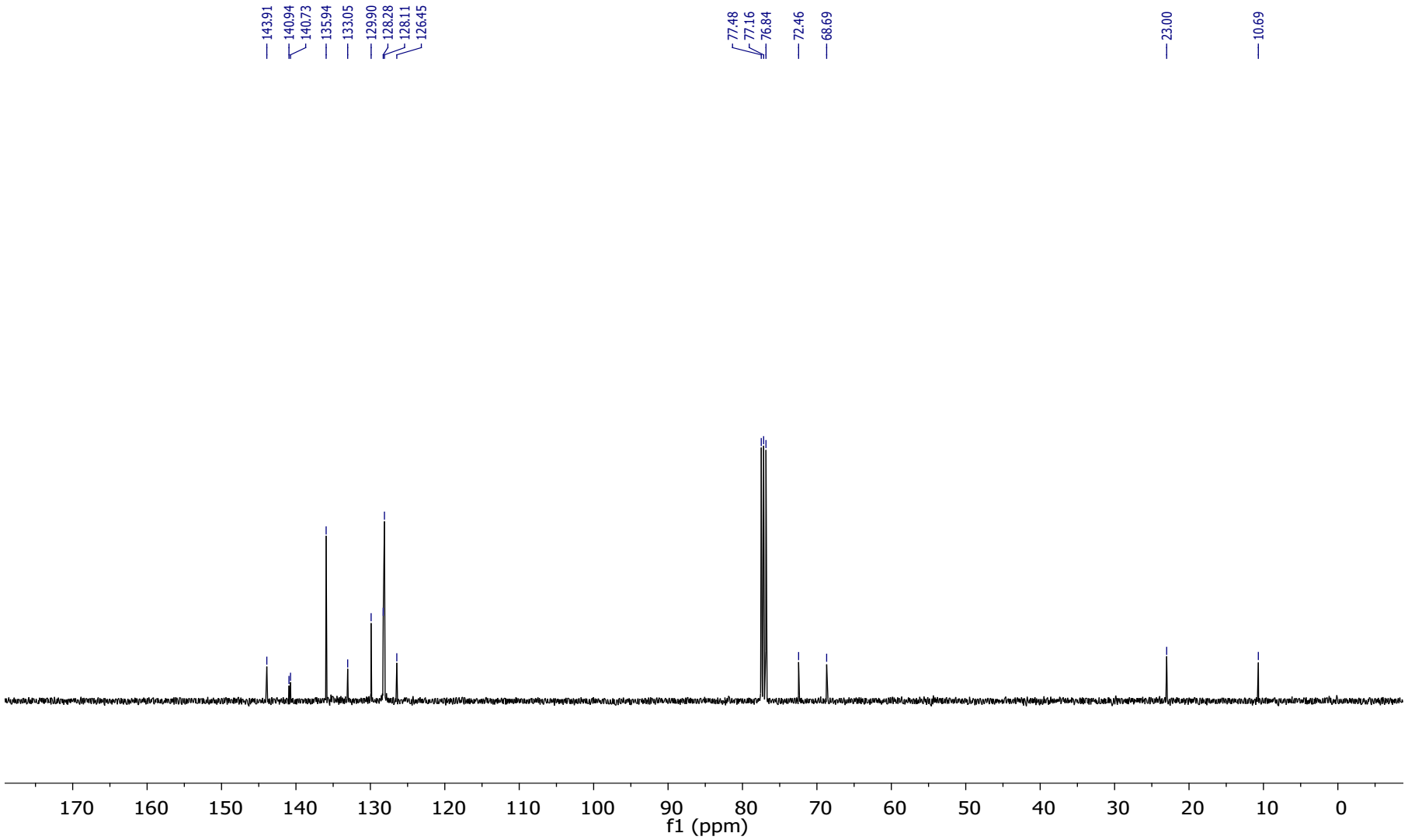

172.47
172.27
147.13
137.91
134.33
134.24
128.48
126.39
121.76
77.48
77.16
76.84
59.24
52.94
52.89
41.22
40.34
38.58
20.08
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

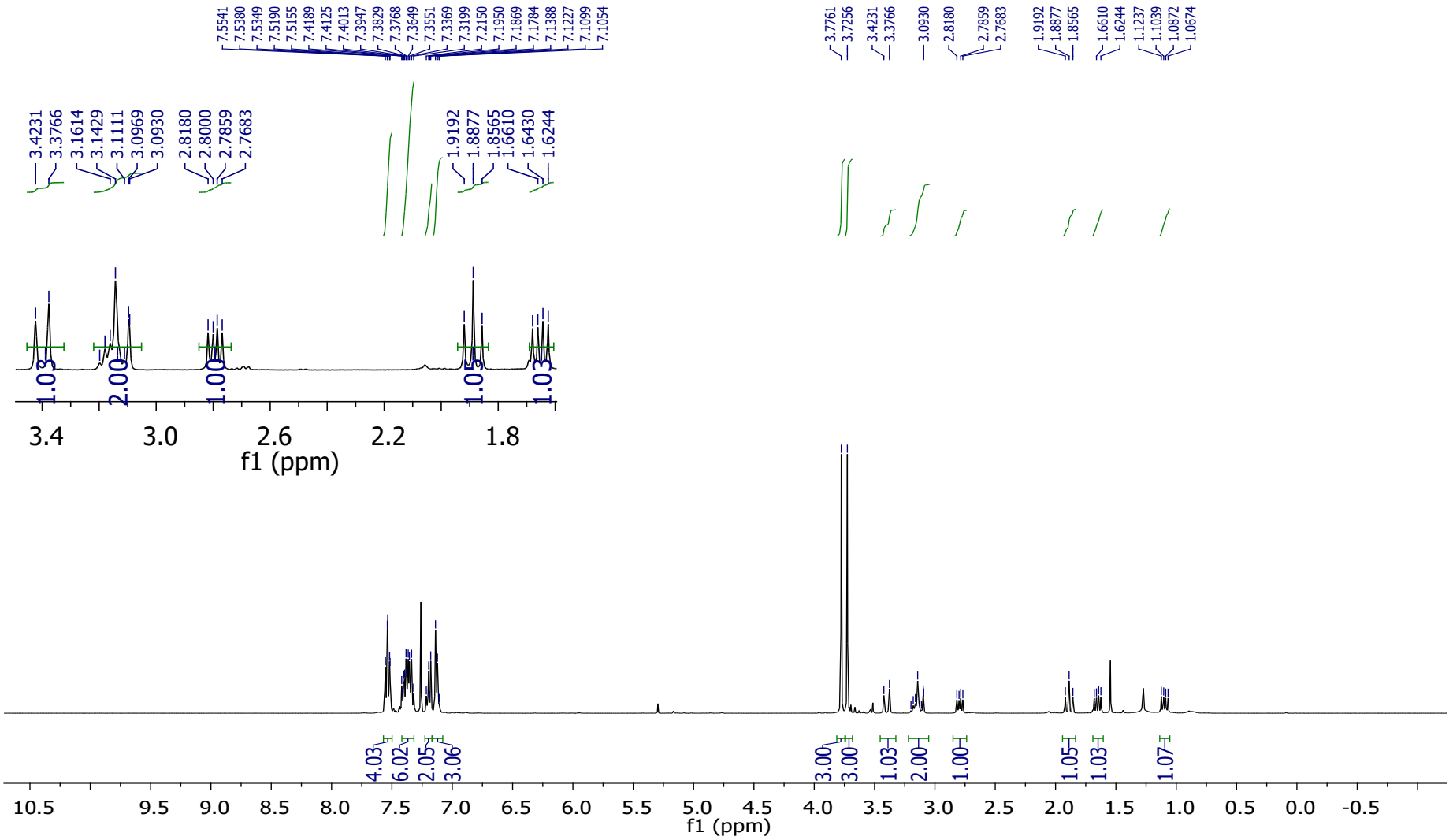

-169.00
A (s)
-169.00
1.00
-110 -115 -120 -125 -130 -135 -140 -145 -150 -155 -160 -165 -170 -175 -180 -185 -190 -195 -200
f1 (ppm)

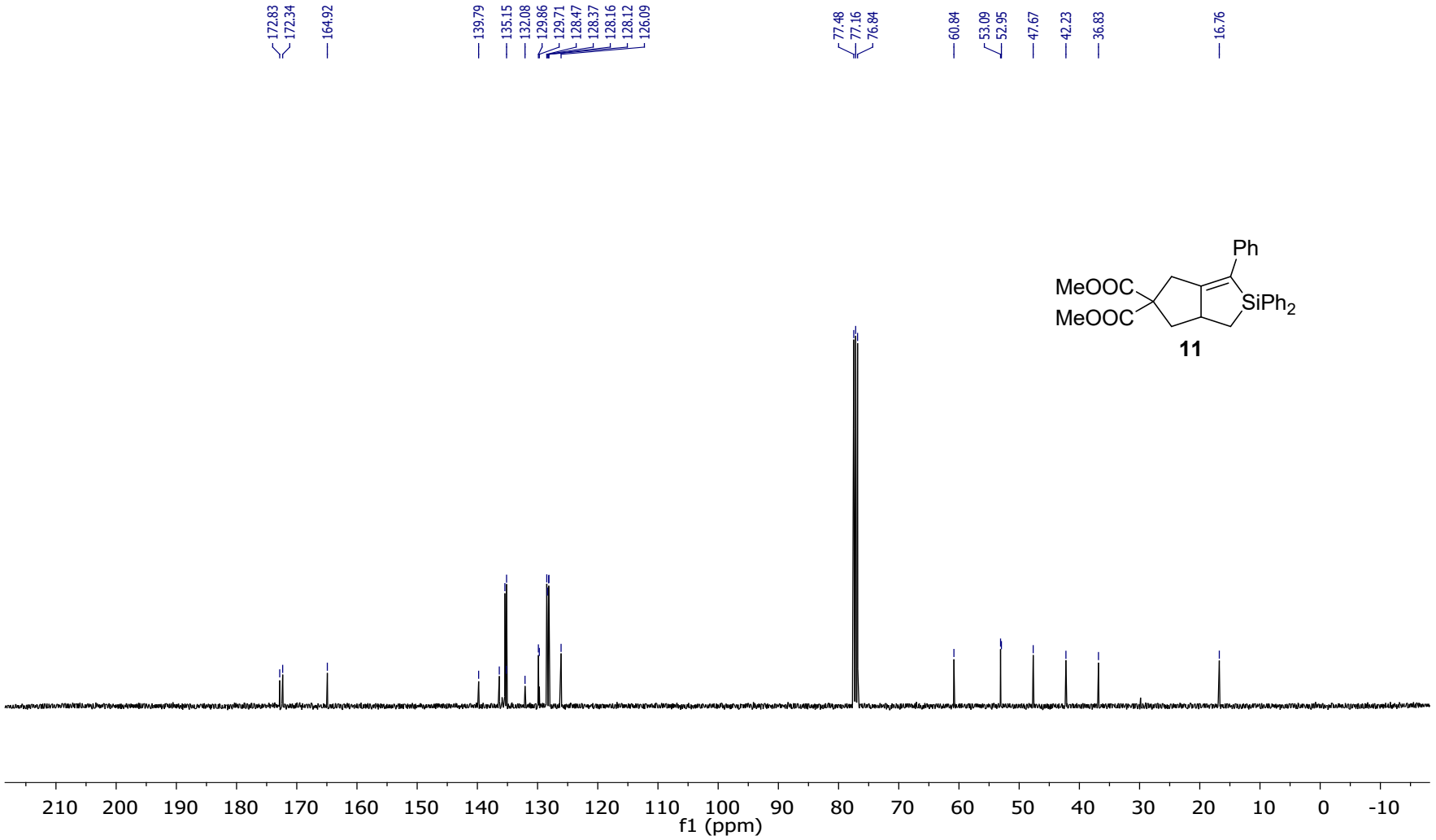

7.49
7.49
7.48
7.47
7.29
7.28
7.26
7.24
7.19
7.17
7.16
7.08
7.06
4.81
4.80
4.79
3.33
3.32
3.30
3.30
3.29
3.27
2.60
2.59
2.57
1.78
1.76
1.68
1.65
1.62
1.13
1.12
1.11
1.10
1.09
1.09
1.08
1.80
1.78
1.77
1.75
1.68
1.66
1.65
1.63
4.04
2.04
2.04
2.01
3.5
3.0
2.5
2.0
f1 (ppm)
4.02
6.03
2.02
3.04
0.98
4.04
2.04
2.04
2.01
2.03
10.5
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
f1 (ppm)


142.21
135.29
134.50
129.71
128.61
128.44
128.13
125.87
77.48
77.16
76.84
73.16
70.04
32.53
31.46
24.79
8.64
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.54
7.54
7.52
7.52
7.42
7.41
7.40
7.39
7.38
7.36
7.34
7.32
7.32
7.25
7.23
7.21
7.18
7.17
7.17
6.99
6.98
6.35
6.34
6.32
5.23
4.03
4.01
3.31
3.30
3.28
1.56
1.54
1.53
1.51
0.90
0.88
0.86
1.01
0.95
2.05
2.03
6.0
5.5
5.0
4.5
4.0
3.5
f1 (ppm)
4.03
6.14
3.04
2.07
1.01
0.95
2.05
2.03
2.08
3.13
10.5
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
f1 (ppm)


143.91
140.94
140.73
135.94
133.05
129.90
128.28
128.11
126.45
77.48
77.16
76.84
72.46
68.69
23.00
10.69
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.5541
7.5380
7.5349
7.5190
7.5155
7.4189
7.4125
7.4013
7.3947
7.3829
7.3768
7.3649
7.3551
7.3369
7.3199
7.2150
7.1950
7.1869
7.1784
7.1388
7.1227
7.1099
7.1054
3.7761
3.7256
3.4231
3.3766
3.0930
2.8180
2.7859
2.7683
1.9192
1.8877
1.8565
1.6610
1.6244
1.1237
1.1039
1.0872
1.0674
3.4231
3.3766
3.1614
3.1429
3.1111
3.0969
3.0930
2.8180
2.8000
2.7859
2.7683
1.9192
1.8877
1.8565
1.6610
1.6430
1.6244
1.03
2.00
1.00
1.03
1.03
3.4
3.0
2.6
2.2
1.8
f1 (ppm)
4.03
6.02
2.05
3.06
3.00
3.00
1.03
2.00
1.00
1.05
1.03
1.07
10.5
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
f1 (ppm)


172.83
172.34
164.92
139.79
135.15
132.08
129.86
129.71
128.47
128.37
128.16
128.12
126.09
77.48
77.16
76.84
60.84
53.09
52.95
47.67
42.23
36.83
16.76
Ph
MeOOC
MeOOC
SiPh2
11
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)