Supporting information

Selective ligand-free cobalt catalysed hydrosilylation of esters to aldehydes or alcohols.

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I) General remarks.

All solvents were dried using standard methods and stored over molecular sieves (4 Å). All sensitive salts were weighted in a glovebox. All reactions were carried out under a dry nitrogen atmosphere and were repeated at least twice. Analytical thin layer chromatography (TLC) was performed on Merck pre-coated 0.20 mm silica gel Alugram Sil 60 G/UV$_{254}$ plates. Flash chromatography was carried out with Macherey silica gel (Kielselgel 60). ^{1}H (300 MHz), ^{13}C (75 or 125 MHz) NMR spectra were acquired on Bruker Avance spectrometers. Chemical shifts (δ) are reported downfield of Me_4Si in ppm and coupling constants are expressed in Hz. Infra-red analyses were acquired by Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS) on a ThermoScientific-Nicolet 6700 spectrometer. X-ray diffraction analyses were performed in reflexion mode using a Bruker D8 Advance diffractometer and in transmission mode using a Rigaku Smartlab diffractometer. XPS measurements were acquired on a XPS KRATOS, AXIS UltraDLD (2009). Ester substrates were purchased and used as received. Alternatively, ester reagents **3a**, **3b**, **3c**, **3d**, **3e**, **3f**, **3g**, **3h**, **3k**, **3l**, **3m**, **3n**, **3p**, **3q** were prepared from the corresponding carboxylic acids following the general procedure (vide infra). Cobalt salts were purchased and used as received, dry compounds being manipulated in a glovebox: $CoCl_2$ [anhydrous, 99+% Strem, Lot 26235300], $CoCl_2$ [anhydrous, 99.998%, AlfaAesar, Lot Q21D126], $Co(acac)_2$ [99% Acros, Lot A0273018], $Co(OAc)_2$ .4 H_2O [reagent grade, Aldrich], $Co(OAc)_2$ [anhydrous, 99.995%, Aldrich, Lot MKBW0775V], $Co(BF_4)_2$.4 H_2O [96%, AlfaAesar, Lot T11D001].

II) General procedures.

1) General procedure for the synthesis of esters.

In a round bottom flask, carboxylic acid (1 eq.), sulfuric acid (5 mol%) and ethanol (solvent of reaction) were added and refluxed during one night under stirring. The ethanol was then evaporated under vacuum through the use of a rotary evaporator. The crude product was subsequently dissolved with dichloromethane and washed three times with NaOH 1M. The organic layer was then dried with magnesium sulfate and evaporated to dryness under vacuum. All esters were obtained without any further purification.

2) General procedure for the catalysis using $Co(OAc)_2$, e.g. cat. A:

$Co(OAc)_2.4\ H_2O$ (3.8 mg, 5 mol%, 0.015 mmol) was introduced into a Schlenk tube and dried under vacuum during 15 minutes. Under nitrogen, dry DME (2 mL) was transferred and the resulting solution was stirred at 60 °C. After 15 minutes, $NaBHEt_3$ (30 µL, 1M in toluene, 10 mol%, 0.03 mmol) was added. After 5 minutes of additional stirring, $PhSiH_3$ (74 µL, 2 eq., 0.6 mmol) was added followed by the ester (0.3 mmol, 1 eq.). The reaction mixture was then heated at 25 °C under stirring during 15 hours. Reactions proceeded also on a 3 mmol scale of ester.

General procedure for the catalysis using $CoCl_2$, e.g. cat. B:

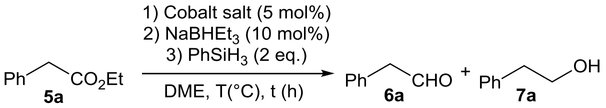
In a glovebox, $CoCl_2$ (1.95 mg, 5 mol%, 0.015 mmol), KO*t*Bu (3.36 mg, 10 mol%, 0.03 mmol) were introduced into a Schlenk tube. Under nitrogen, dry dioxane (2 mL) was transferred and the resulting mixture was heated at 60°C. After 15 minutes, $NaBHEt_3$ (30 µL, 1M in toluene, 10 mol%, 0.03 mmol) and water (2.7 µL, 50 mol%, 0.15 mmol) were added. After 5 additional minutes of stirring, $PhSiH_3$ (74 µL, 2 eq., 0.6 mmol) was added followed by the ester (0.30 mmol, 1 eq.). The reaction mixture was then heated at 60°C under stirring during 15 hours. Reactions proceeded also on a 3 mmol scale of ester.

To monitor the progress of the reactions, aliquots (0.1 mL) were taken at defined times, filtered through Celite with a CH_2Cl_2 wash (3 mL), and analysed by GC. At the end of each reaction, the crude product was filtered through Celite with a CH_2Cl_2 wash (3 mL) then purified by flash chromatography or preparative TLC.

Volatile aldehyde products were isolated as 2,4-dinitrophenylhydrazoneadducts as follows. After reaction, the resulting crude mixture was dried over $MgSO_4$ and diluted with ethanol (1 mL). The resulting solution was treated with 0.5 mL of Brady’s reagent [solution of 2,4-dinitrophenylhydrazine (0.3 g), H_2O (1.5 mL), ethanol (5 mL) and H_2SO_4 conc. (1 mL)] for 30 min with vigorous stirring. The resulting orange precipitate was isolated by filtration through filter paper, washed and triturated with ethanol (10 mL) and finally dried under vacuum.

III) Optimization of the reaction conditions: additional experimental data.

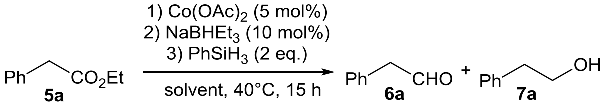
Table S1. Screening of cobalt salts for cat. A



Entry	Cobalt salt	T (°C)	Time (h)	Yield (%)[a]	Selectivity (%)[a] 6a	7a
1	$Co(OAc)_2 .4 H_2O$	25	0.5	9	100	-
2	$Co(OAc)_2 .4 H_2O$	25	5	89	100	-
3	$Co(OAc)_2$ 99.995%	25	0.5	9	100	-
4	$Co(OAc)_2$ 99.995%	25	5	93	100	-
5	$Co(acac)_2$	25	15	78	100	-
6	$CoCl_2$ 99+%	25	15	0	-	-
7	$CoCl_2$ 99+%	60	15	0	-	-
8	$Co(BF_4)_2 .4 H_2O$ 96%	60	15	2	traces	traces
9[b]	$Co(OAc)_2 .4 H_2O$	25	15	100	100	-
10	none	25	15	75	-	100

a) determined by GC. b) on a 3 mmol scale (instead 0.3 mmol).

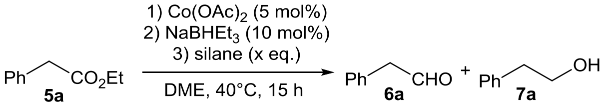
Table S2. Screening of solvents for cat. A.



Entry	Solvent	Yield (%)[a]	Selectivity (%)[a] 6a	7a
1	THF	100	81	19
2	Dioxane	78	100	0
3	TBME	100	10	-
4	DBE	100	6	-
5	Anisole	0	-	-
6	CPME	0	-	
7	DME	100	100	-

a) determined by GC.

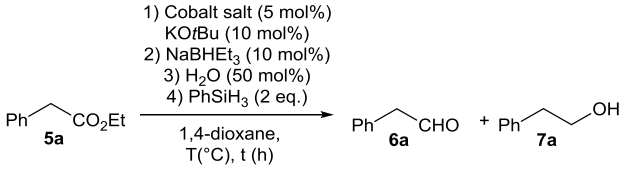
Table S3. Screening of silanes for cat. A.



Entry	Silane	Yield (%)[a]	Selectivity (%)[a] 6a	7a
1	$PhSiH_3$	100	100	-
2	Ph_2SiH_2	0	-	-
3	Ph_3SiH	0	-	-
4	$PhMe_2SiH$	0	-	
5	Et_3SiH	0	-	-
6	TMDS	0	-	-
7	PMHS	0	-	-
8	Hexylsilane	100	100	-

a) determined by GC.

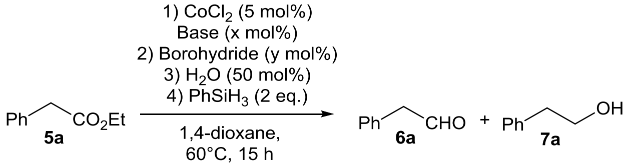
Table S4. Screening of cobalt salts for cat. B.



Entry	Cobalt salt	T (°C)	Time (h)	Yield (%)[a]	Selectivity (%)[a]	
					6a	7a
1	$CoCl_2$ 99+%	25	5	46	2	98
2	$CoCl_2$ 99+%	25	15	95	6	94
3	$CoCl_2$ 99+%	60	5	99	-	100
4	$CoCl_2$ 99+%	60	15	100	-	100
5	$CoCl_2$ 99.99%	60	5	100	-	100
6	$Co(OAc)_2 .4 H_2O$	60	5	100	2	98
7	$Co(acac)_2$	60	15	88	80	20
8	$Co(BF_4)_2 .4 H_2O$	60	15	83	-	100
9[b]	$CoCl_2$ 99+%	60	15	100	-	100
10[c]	none	60	5	39	-	100

a) determined by GC. b) on a 3 mmol scale (instead 0.3 mmol).
c) reaction without $CoCl_2$ and base.

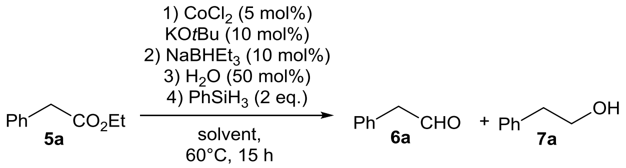
Table S5. Screening of bases and hydrides for cat. B.



Entry	Base (mol%)	Borohydride (mol%)	Yield (%)[a]	Selectivity (%)[a]	
				6a	7a
1	KO*t*Bu (10)	$NaBHEt_3$ (10)	100	-	100
2	KO*t*Bu (5)	$NaBHEt_3$ (10)	85	-	100
3	KO*t*Bu (10)	$NaBHEt_3$ (5)	81	-	100
4	KO*t*Bu (10)	-	0	-	-
5[b]	KO*t*Bu (10)	-	0	-	-
6[c]	none	$NaBHEt_3$ (10)	73	-	100
7	KO*t*Bu (10)	$NaBH_4$ (10)	0		
8	KO*t*Bu (10)	DIBAl-H (10)	0		
9	KHMDS (10)	$NaBHEt_3$ (10)	98	-	100
10	K_2CO_3 (10)	$NaBHEt_3$ (10)	0	-	-
11	Cs_2CO_3 (10)	$NaBHEt_3$ (10)	100	38	62
12	KOH (10)	$NaBHEt_3$ (10)	93	28	72
13	KOAc (10)	$NaBHEt_3$ (10)	25	-	100

a) determined by GC. b) only KO*t*Bu used with **5a**, no other reagents implied.
c) reaction without $CoCl_2$ and base.

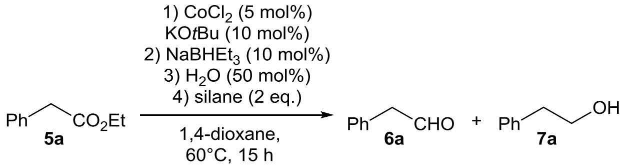
Table S6. Screening of solvents for cat. B.



Entry	Solvent	Yield (%)[a]	Selectivity (%)[a]	
			6a	**7a**
1	DME	71	-	100
2	CPME	98	-	34 + by-products
3	THF	100	54	46
4	TBME	7	36	64
5	DBE	92	3	97
6	1,4-dioxane	100	-	100
7	anisole	0	-	

a) determined by GC.

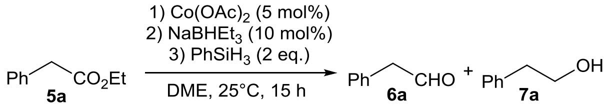
Table S7. Screening of silanes for cat. B.



Entry	Silane	Yield (%)[a]	Selectivity (%)[a]	
			6a	**7a**
1	$PhSiH_3$	100	-	100
2	Ph_2SiH_2	0	-	-
3	Ph_3SiH	0	-	-
4	Me_2PhSiH	0	-	-
5	Et_3SiH	0	-	-
6	TMDS	0	-	-
7	PMHS	0	-	-
8	Hexylsilane	100	**-**	100

a) determined by GC.

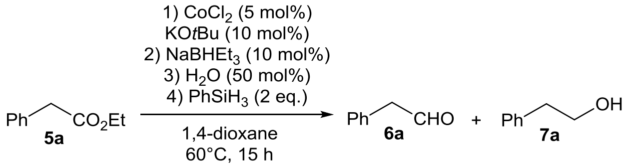
Table S8: recycling tests for catalyst A.



Cycle[a]	Yield[b]	Selectivity (%)[b] 6a	 7a
1	Quant.	100	-
2	Quant.	78	21
3	92	76	24
4	93	77	23

a) After a cycle, all volatiles were evaporated under vacuum and condensed in a side trap cooled by liquid nitrogen. Afterwards, the reaction vessel was filled with solvent under nitrogen gas and $NaBHEt_3$ (10 mol%) was subsequently added followed by phenylsilane (2 eq.). The new reaction cycle was then started for 15 h. b) Determined by GC.

Table S9: recycling tests for catalyst B.



Cycle[a]	Yield[b]	Selectivity (%)[b] 6a	 7a
1	Quant.	-	100
2	Quant.	-	100
3	Quant.	3	97
4	Quant.	3	97

a) After a cycle, all volatiles were evaporated under vacuum and condensed in a side trap cooled by liquid nitrogen. Afterwards, the reaction vessel was filled with solvent under nitrogen gas and $NaBHEt_3$ (10 mol%) was subsequently added followed by phenylsilane (2 eq.). The new reaction cycle was then started for 15 h. b) Determined by GC.

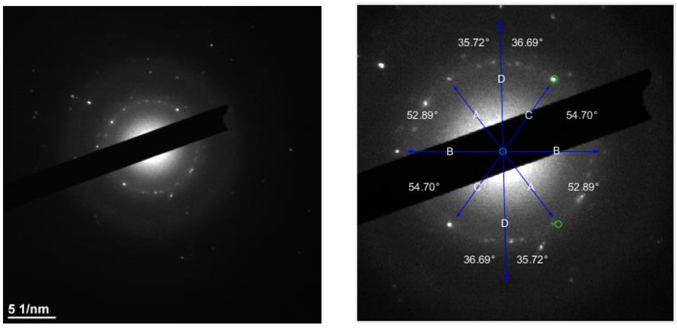
IV) TEM analyses.

All samples were handled in a glovebox. They were ground in a mortar before being deposited as solids (no solvent used) on Copper grids compatible with MET analyses. Each prepared grid was then stored in an object holder under argon and later under vacuum before the analyses. The machine used was a transmission electron microscope JEOL JEM-2100F. This field emission microscope allowed the user to work under the following modes:
- TEM, HRTEM: conventional microscopy, high resolution and micro-diffraction
- EDS: microanalysis by energy dispersion of the photons emitted by the sample under the impact effect of the incident electrons.

Main characteristics:
- Field emission source
- Acceleration voltage: 200 kV
- Resolution: 2.3 Å
- EDX analysis: SDD Bruker (XFlash 5030, 127 eV resolution)

Help for indexation was provided by CaRInE, JEEMS and CrysTool softwares in order to rebuild and verify all orientations.[S1]

Regarding catalyst **A** resulting from the reaction of $Co(OAc)_2$ with $NaBHEt_3$ and phenylsilane, nanoparticles appeared crystallised as plans and diffraction patterns were observed at HRTEM (ie >400kx) (see manuscript Figure 1d and Figure S1). However, indexation was not completely fitting with NaOAc (which was observed by DRX) as the diffraction data were few in number and of average quality. Other possible but not obvious indexations would be for: Co in (-5,-3,7) or in (-13,-4, 16), or $CoFe_2O_4$ in (-4,-3,-16) or CoO in (9,-7,6).



d spacing [nm]	
A	0.205
B	0.176
C	0.210
D	0.129

Figure S1. Diffraction patterns of catalyst **A** nanoparticles observed in Figure 1d.

The EDX analysis of the nanoparticles observed in Figure 1d showed piles were made of Co, Fe, Ti traces and Cu which was likely coming from the TEM grid on which the solid was deposited (Figure S2).

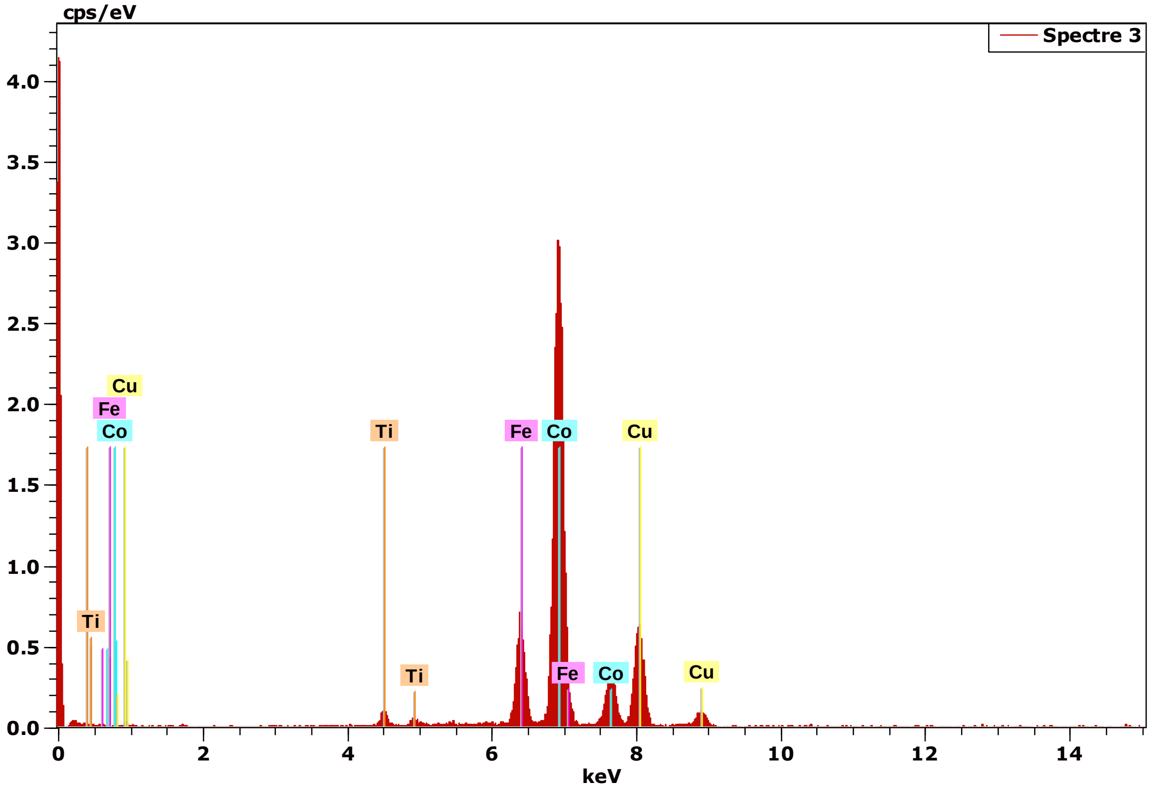


Figure S2. EDX analysis of catalyst **A** nanoparticles observed in Figure 1d.

The dispersion of the nanoparticules was studied by STEM EDS elemental mapping without quantification and sizing (Figures 1e-f, S3). The nanoparticles appearing as dark piles on the electronic picture were predominantly appearing as green piles of Co on the mapping.

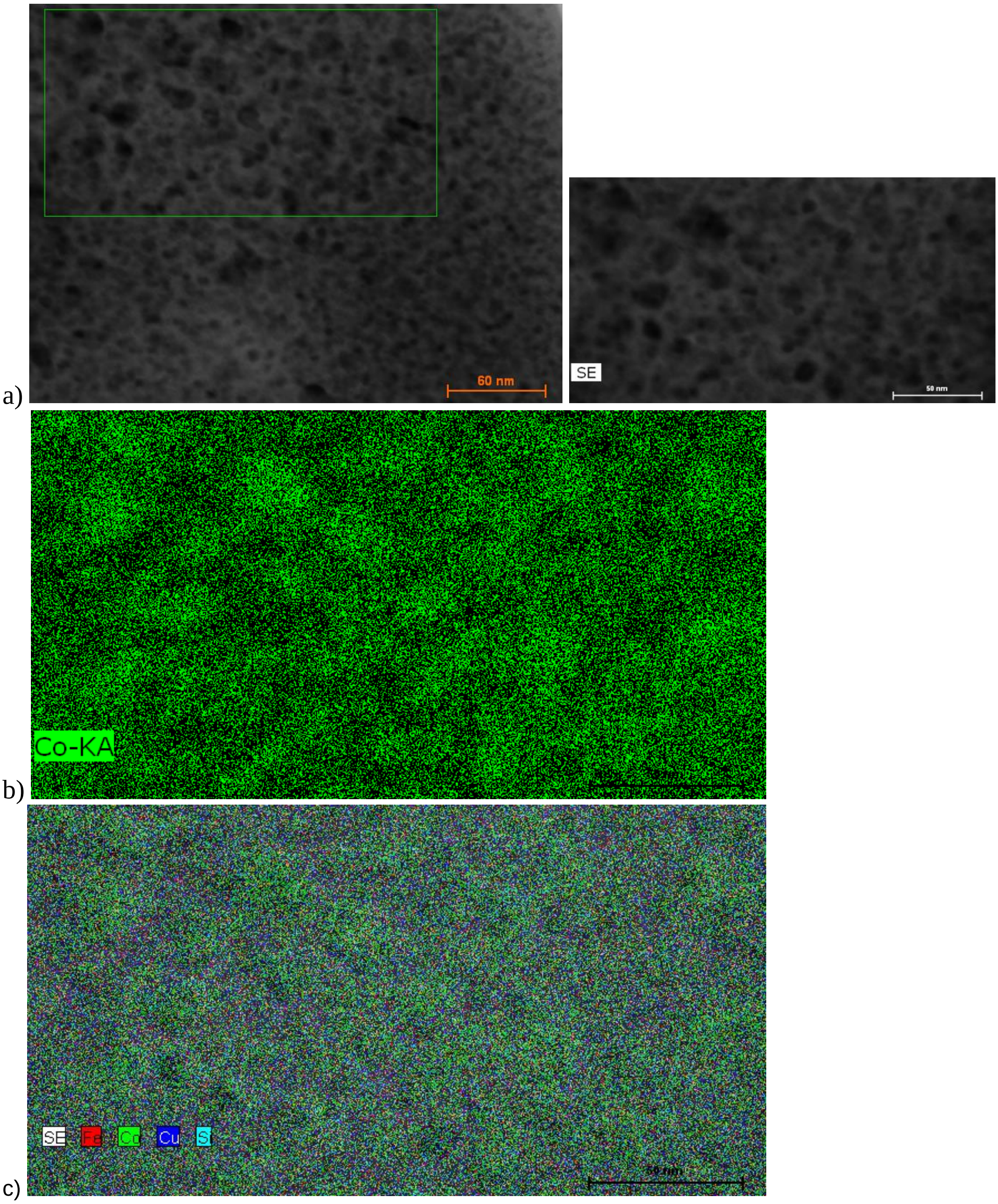
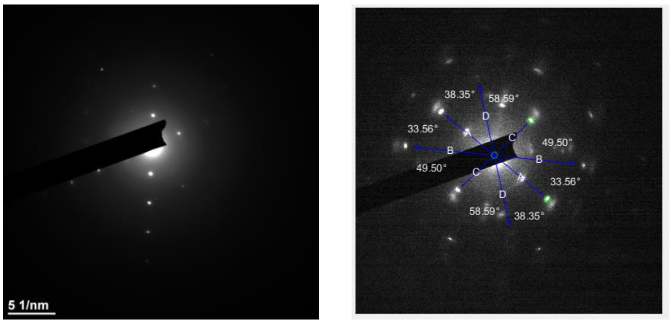


Figure S3. STEM EDS elemental mapping of catalyst **A** nanoparticles observed in Figure 1d. a) Electronic picture of the mapping area; the green area (SE, secondary electron) was scanned. b) Elemental mapping area for Co (K-alpha ray @6.925keV). c) Elemental mapping area for Fe, Co, Cu, Si.

Regarding catalyst **B** resulting from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$, water and phenylsilane, nanoparticles appeared crystallised by diffraction or at HRTEM (Figures 1h as well as 1i-1j) and the observed diffraction patterns (Figures S4-S6) could be indexed for $Co(OH)_2$. Distances fitted with the cif file of $Co(OH)_2$. This was also verified by using VESTA software and a possible indexation was found for (-1, 4, 2) with small differences.



	d spacing [nm]
A	0.134
B	0.103
C	0.185
D	0.116

Figure S4. Diffraction patterns of catalyst **B** nanoparticles observed in Figure 1h.

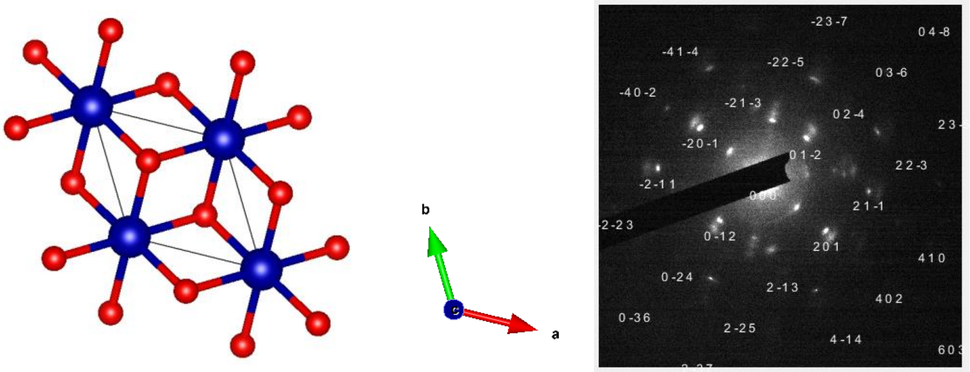


Figure S5. Possible indexation of diffraction patterns of catalyst **B** nanoparticles observed in Figure 1h.

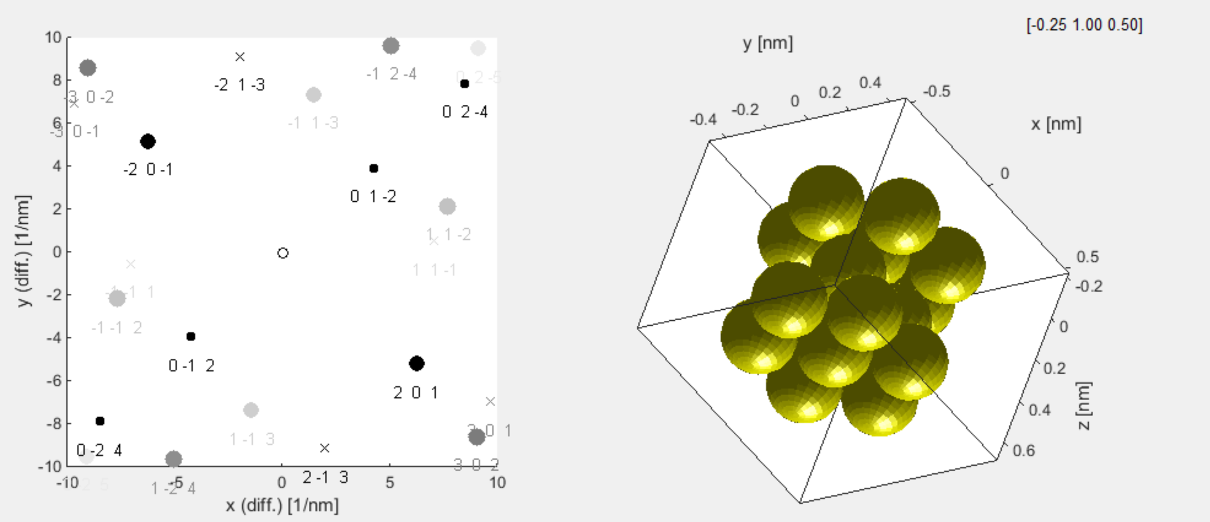


Figure S6. Possible indexation of diffraction patterns of catalyst **B** nanoparticles observed in Figure 1h.

However, sample was not stable enough to allow any STEM-EDS analysis as nanoparticles were rapidly becoming amorphous or even melting upon effect of the 200kV beam (Figure S7).

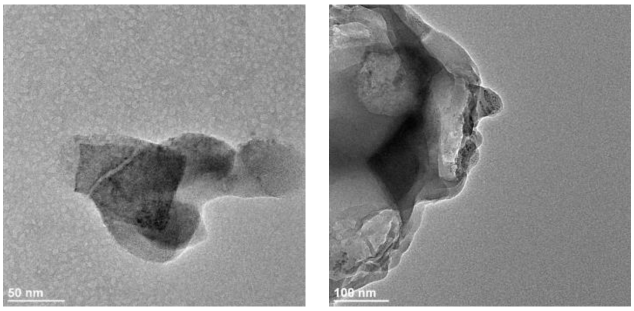


Figure S7. TEM images of catalyst **B** nanoparticles - negative effect of the 200kV beam.

EDX analysis of the nanoparticles observed in Figure 1h (see manuscript) showed the piles were composed of Co, Fe, Si, K and Cl with the presence of Ti traces and Cu from the TEM grid holding the sample (Figure S8).

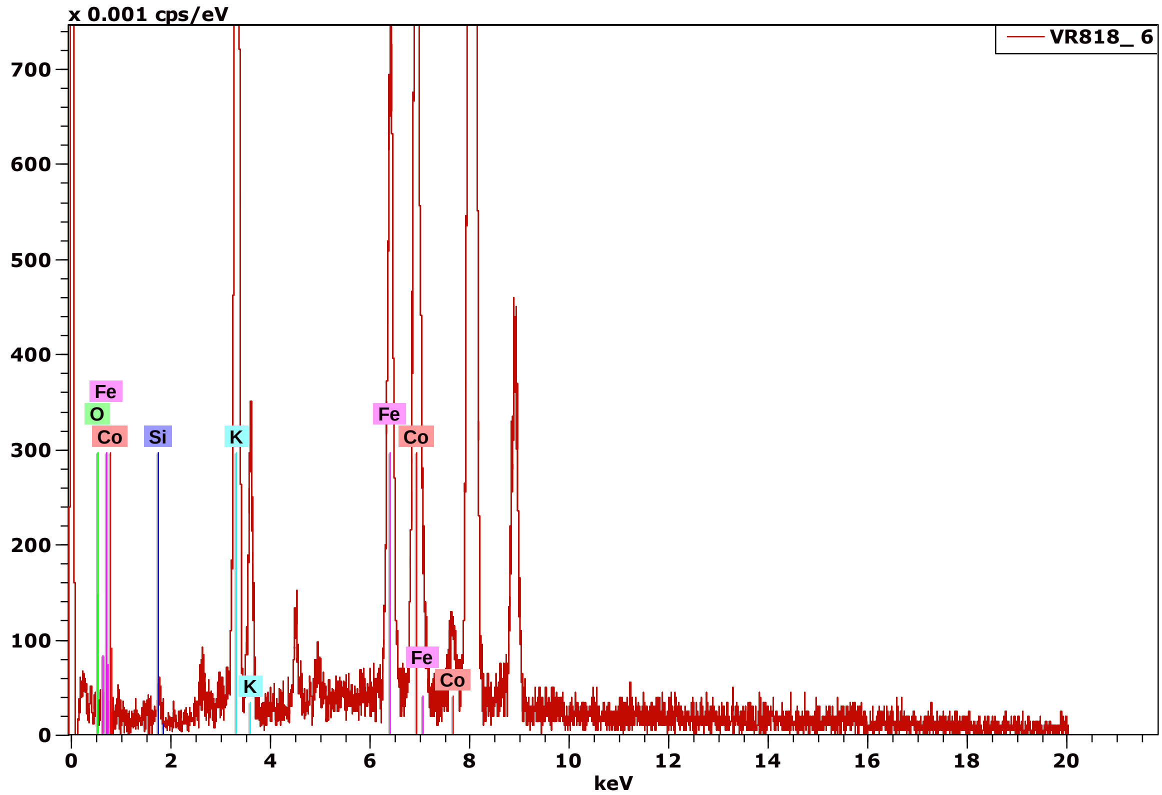


Figure S8. EDX analysis of catalyst **B** nanoparticles observed in Figure 1h.

When catalyst **A** was prepared without silane, from the reaction of $Co(OAc)_2$ with $NaBHEt_3$, piles of various sizes and thicknesses were also observed with various kinds of shapes, some area being crystalline (Figure S9).

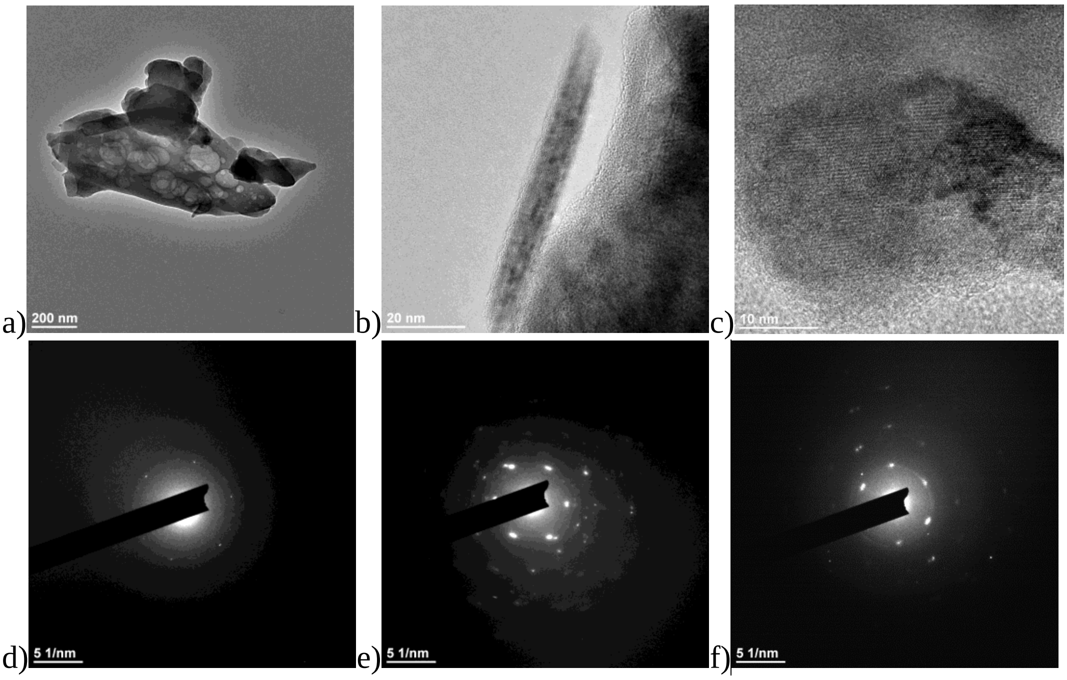


Figure S9. TEM images and diffraction patterns of nanoparticles of catalyst **A** prepared without silane (correlations between a and d, b and e, c and f).

If nanoparticles appeared crystallised at HRTEM, indexations of the diffraction patterns were not obvious because of other orientation. Indexation for $CoFe_2O_4$ (-1,-3,1) was possible (Figure S10) but not for Co alone.

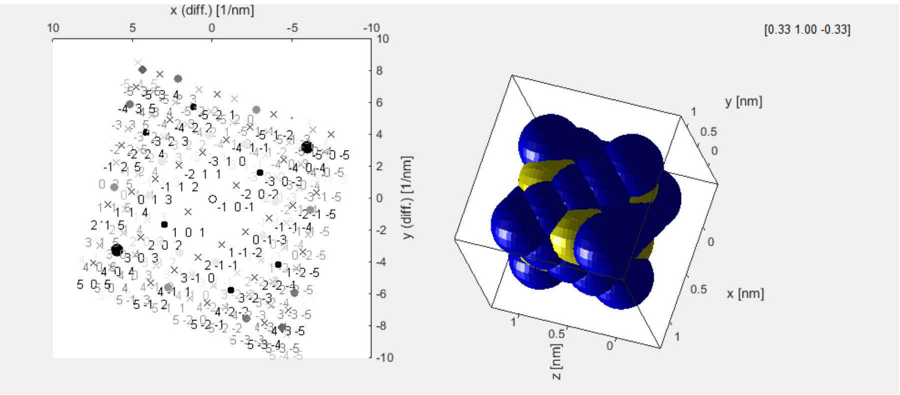


Figure S10. Possible indexation for $CoFe_2O_4$ (-1,-3,1) of diffraction patterns of nanoparticles observed in Figure S8 of catalyst **A** prepared without silane.

An indexation for CoO (-1, 4,2) was also possible (Figure S11).

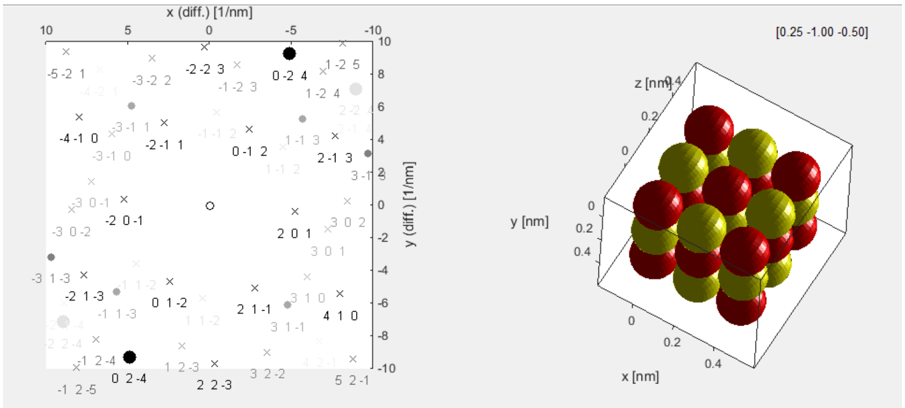


Figure S11. Possible indexation for CoO (-1, 4,2) of diffraction patterns of nanoparticles observed in Figure S8 of catalyst **A** prepared without silane.

When catalyst **B** was prepared without silane, from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$ and water, piles of various sizes and thicknesses were also observed at low magnification with various kinds of shapes. In most cases, crystalline piles (Figure S12a), needles (Figure S12b) and sheets (Figure S12c) were observed.

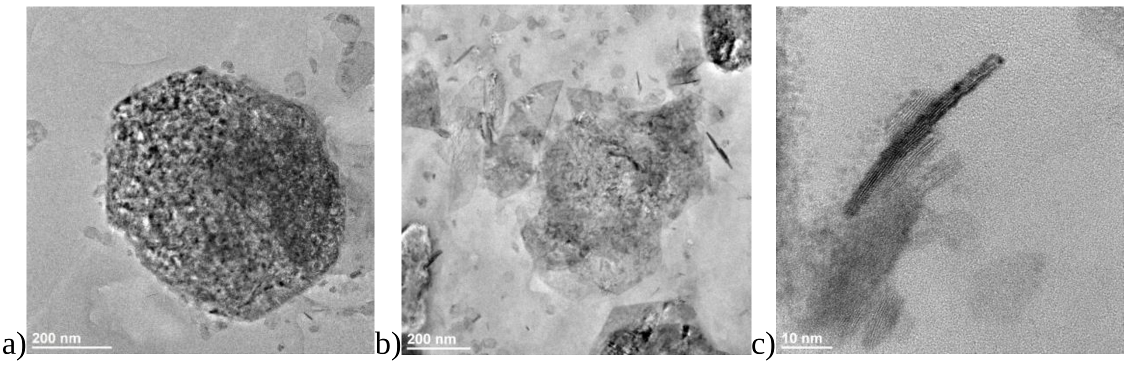


Figure S12. TEM images of nanoparticles of catalyst **B** prepared without silane.

If piles and needles were formed of various but randomly orientated crystals, sheets were rather big areas with 1 to 3 orientations. It was difficult to define the crystals composition as EDX spectra showed the presence of various elements (Co, Cl, Fe, K, Na, Si…) with different ratios depending on the analysed areas. While magnifying, the crystalline aspect was confirmed by the appearance of fringes and atomic arrangements on the different piles, sheets and needles (Figure S13). Nanoparticles appeared also crystallised by diffraction (Figure S14). Quality of the diffractions was highly dependent of the sample orientation. Modification of the later was only possible along the X axis due to the type of sample holder that was used. Because of the presence of many elements according EDX analyses, these well-defined diffraction patterns were not allowing to retrieve the crystals orientation. Possible indexations were found for Co (0,0,1) (Figure S15) and for $CoCl_2$ (-4,-5,0) (Figure S16).

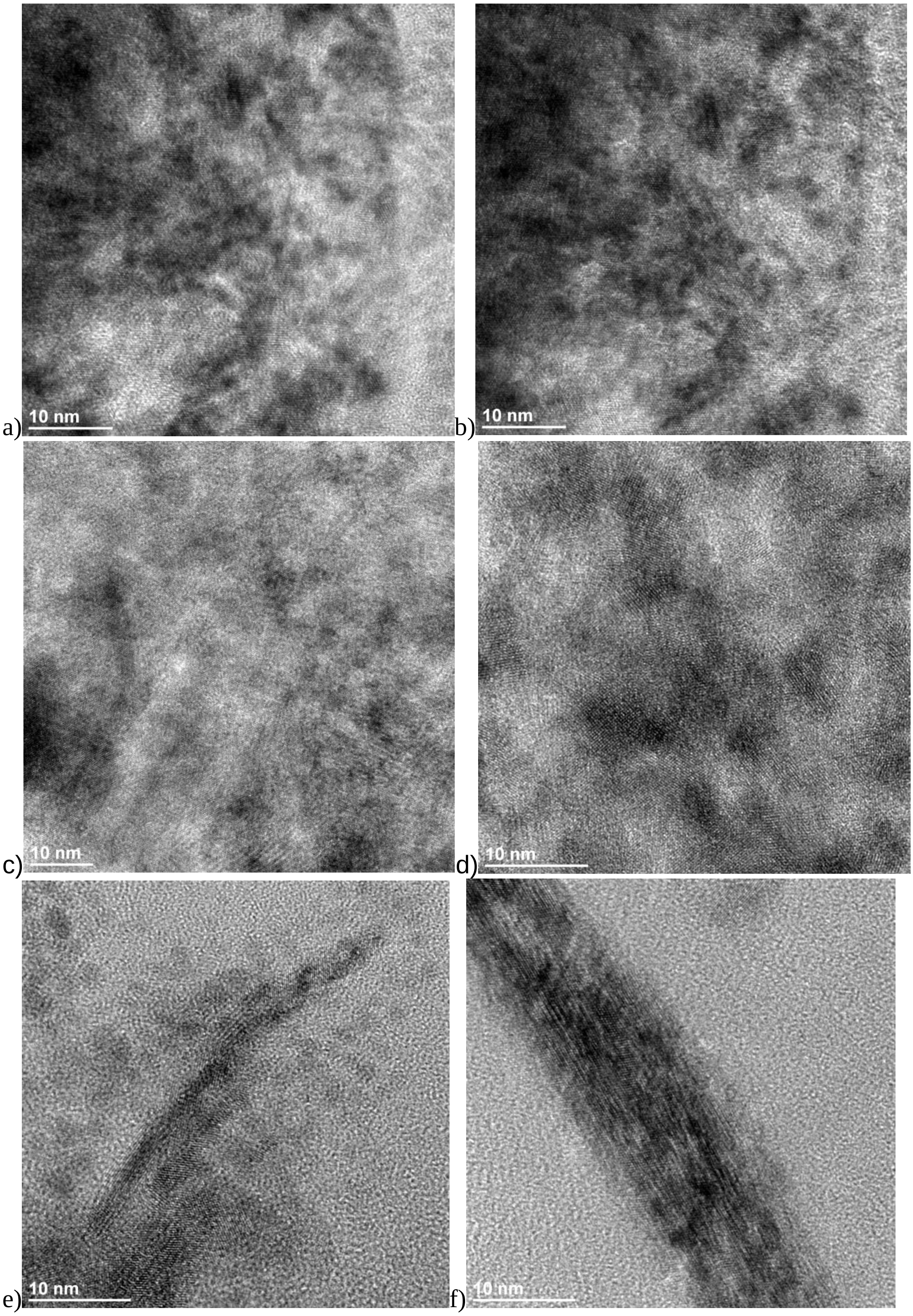


Figure S13. TEM images of nanoparticles of catalyst **B** prepared without silane (images a) and b) for piles, c) and d) for sheets, e) and f) for needles).

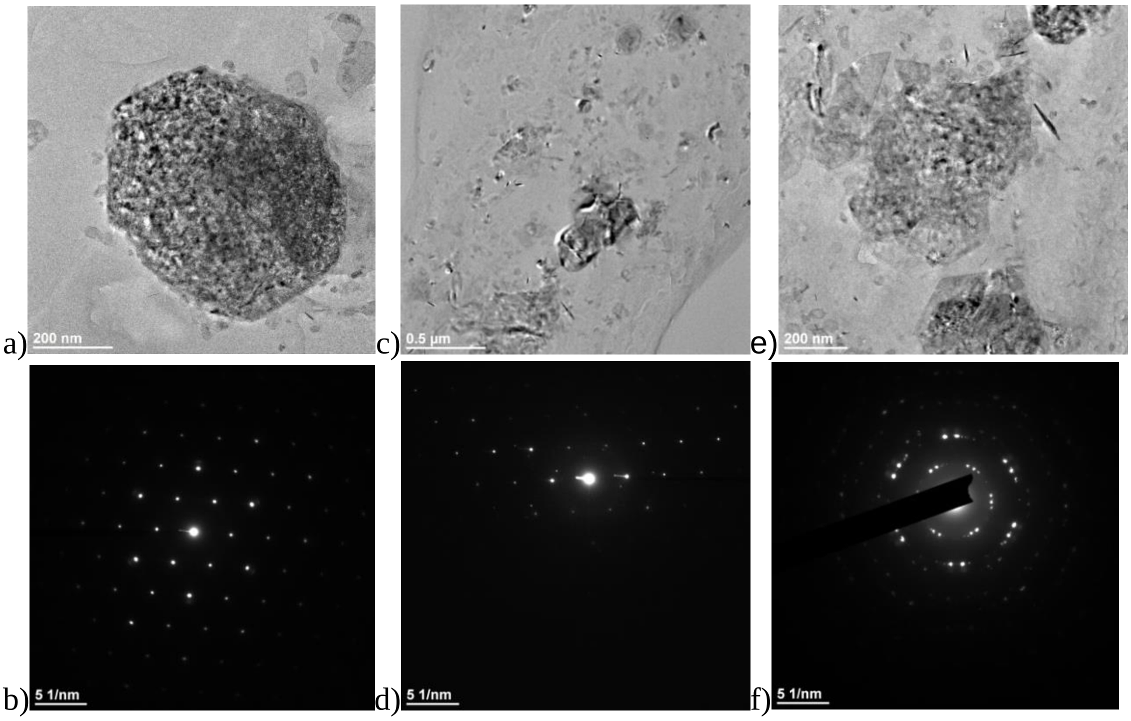


Figure S14. TEM images and diffraction patterns of nanoparticles of catalyst **B** prepared without silane (correlations between a and b, c and d, e and f).

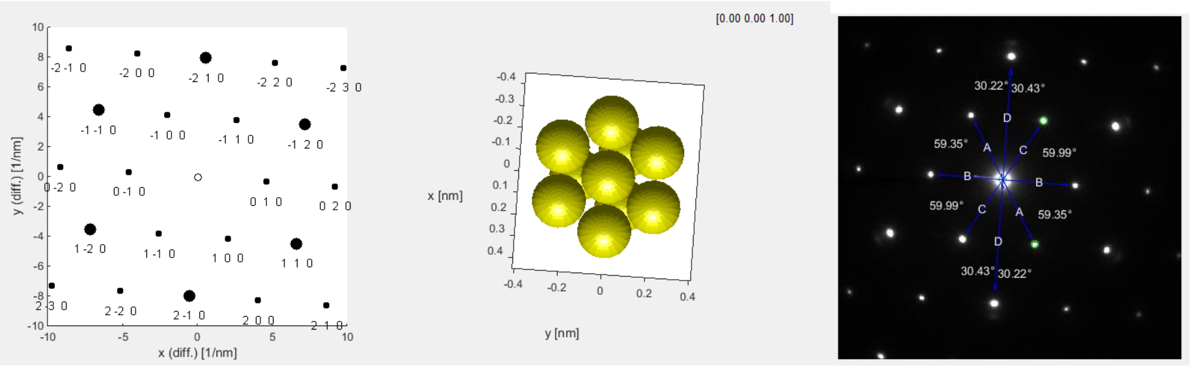


Figure S15. Possible indexation for Co (0,0,1) of diffraction patterns of nanoparticles observed for catalyst **B** prepared without silane.

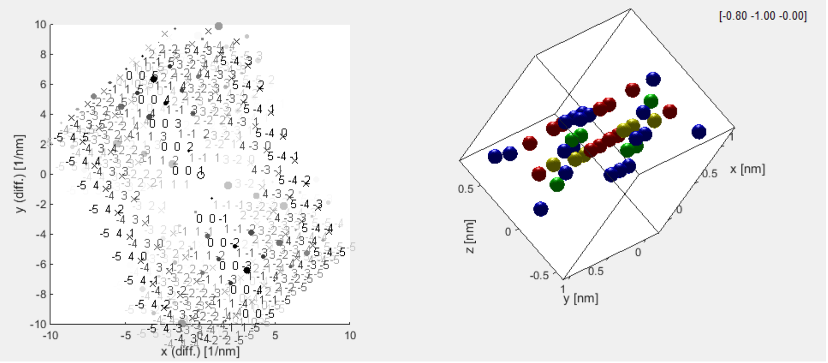
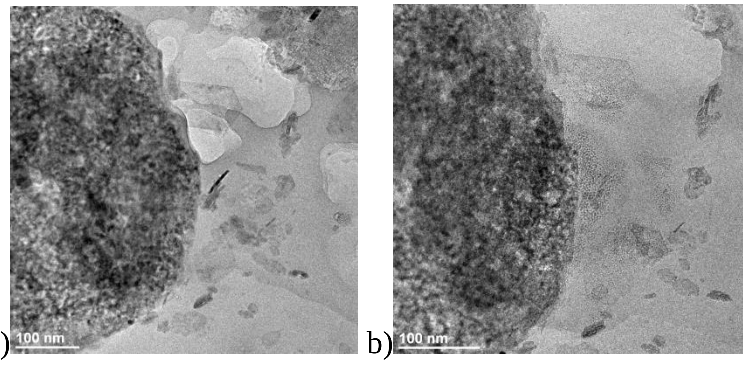


Figure S16. Possible indexation for $CoCl_2$ (-4,-5,0) of diffraction patterns of nanoparticles observed for catalyst **B** prepared without silane.

It was worth to note sample was not stable enough as nanoparticles were rapidly becoming amorphous or even melting upon effect of the 200kV beam (Figure S17a before analysis and S17b after analysis).

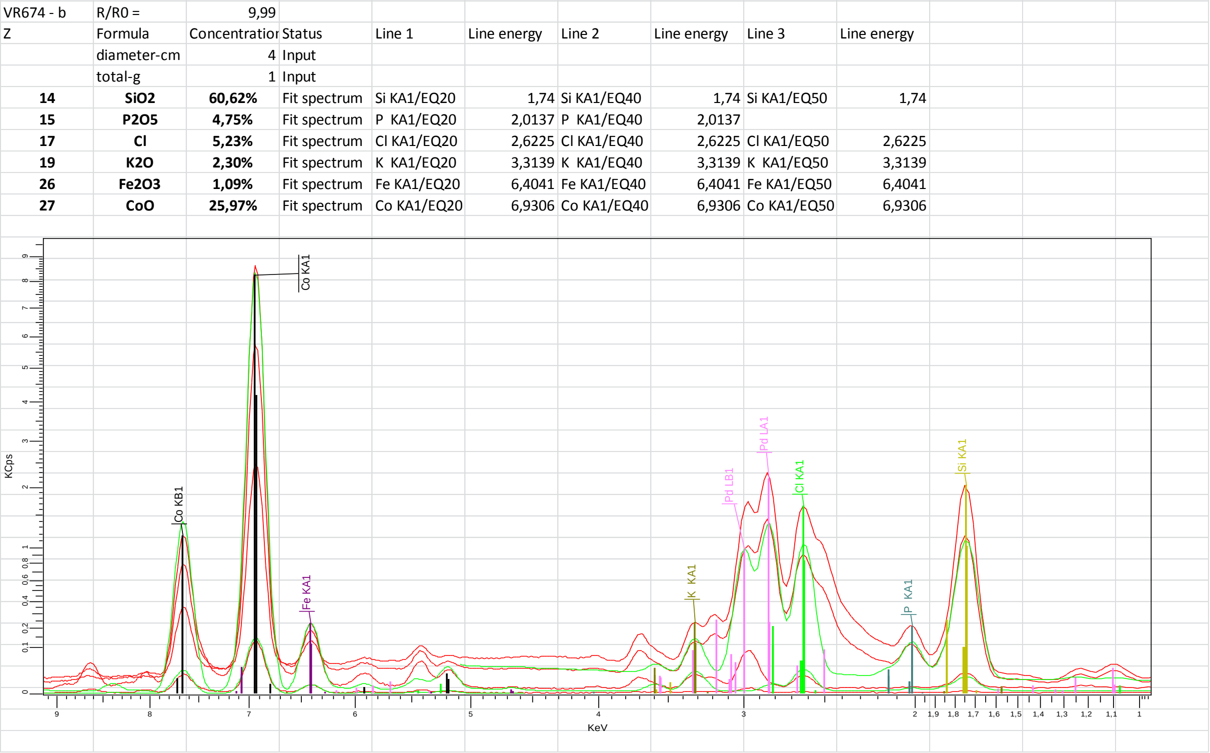


a) b)

Figure S17. Negative effect of the 200kV beam on nanoparticles observed for catalyst **B** prepared without silane.

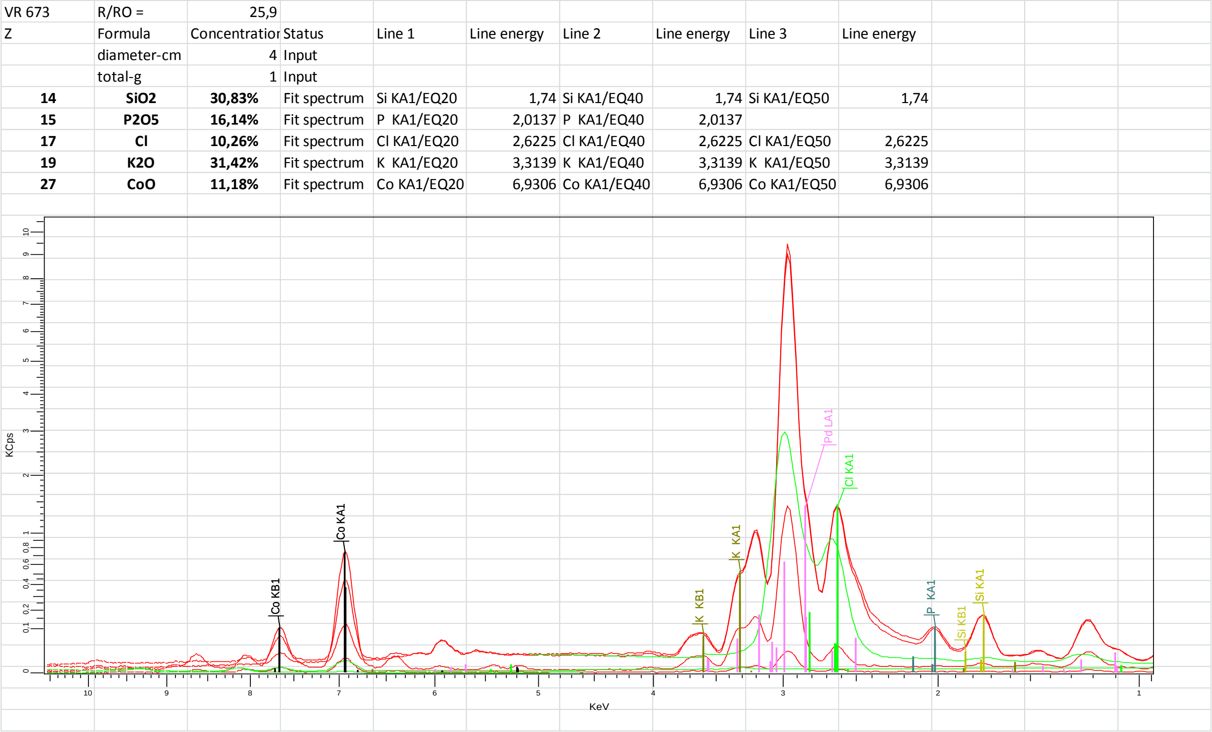
V) X-ray fluorescence analyses.

The presence of Co and Si elements as well as Fe, P and Cl impurities was also detected by X-ray fluorescence analyses of catalysts **A** and **B** (Figure S18). It was worth to note K element value was not reliable here. Indeed, the signal was shifting at the same value as one peak of the spectrometer's Pd anode.



VR674 - b	R/R0 =	9,99							
Z	Formula	Concentratior	Status	Line 1	Line energy	Line 2	Line energy	Line 3	Line energy
	diameter-cm	4	Input						
	total-g	1	Input						
14	**SiO2**	**60,62%**	Fit spectrum	Si KA1/EQ20	1,74	Si KA1/EQ40	1,74	Si KA1/EQ50	1,74
15	**P2O5**	**4,75%**	Fit spectrum	P KA1/EQ20	2,0137	P KA1/EQ40	2,0137		
17	**Cl**	**5,23%**	Fit spectrum	Cl KA1/EQ20	2,6225	Cl KA1/EQ40	2,6225	Cl KA1/EQ50	2,6225
19	**K2O**	**2,30%**	Fit spectrum	K KA1/EQ20	3,3139	K KA1/EQ40	3,3139	K KA1/EQ50	3,3139
26	**Fe2O3**	**1,09%**	Fit spectrum	Fe KA1/EQ20	6,4041	Fe KA1/EQ40	6,4041	Fe KA1/EQ50	6,4041
27	**CoO**	**25,97%**	Fit spectrum	Co KA1/EQ20	6,9306	Co KA1/EQ40	6,9306	Co KA1/EQ50	6,9306

a)



VR 673	R/RO =	25,9							
Z	Formula	Concentratior	Status	Line 1	Line energy	Line 2	Line energy	Line 3	Line energy
	diameter-cm	4	Input						
	total-g	1	Input						
14	**SiO2**	**30,83%**	Fit spectrum	Si KA1/EQ20	1,74	Si KA1/EQ40	1,74	Si KA1/EQ50	1,74
15	**P2O5**	**16,14%**	Fit spectrum	P KA1/EQ20	2,0137	P KA1/EQ40	2,0137		
17	**Cl**	**10,26%**	Fit spectrum	Cl KA1/EQ20	2,6225	Cl KA1/EQ40	2,6225	Cl KA1/EQ50	2,6225
19	**K2O**	**31,42%**	Fit spectrum	K KA1/EQ20	3,3139	K KA1/EQ40	3,3139	K KA1/EQ50	3,3139
27	**CoO**	**11,18%**	Fit spectrum	Co KA1/EQ20	6,9306	Co KA1/EQ40	6,9306	Co KA1/EQ50	6,9306

b)

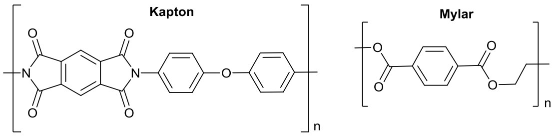
Figure S18. a) X-ray fluorescence analyses of **cat. A** based on $Co(OAc)_2$, $NaBHEt_3$ and phenylsilane; b) X-ray fluorescence analyses of **cat. B** based on $CoCl_2$, KO*t*Bu, $NaBHEt_3$, water and phenylsilane.

VI) X-ray diffraction analyses.

Two samples were first analysed:

- Catalyst **A** resulting from the reaction of $Co(OAc)_2$ with $NaBHEt_3$ and phenylsilane.
- Catalyst **B** resulting from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$, water and phenylsilane

Analyses were first performed in reflexion mode by protecting sample powders from oxygen and water of air using Mylar^{TM} and Kapton^{TM} films (Scheme S1).



Scheme S1.

Absorbance of the Mylar^{TM} film was too important while measuring the catalyst **B** based on $CoCl_2$ (Figure S19).

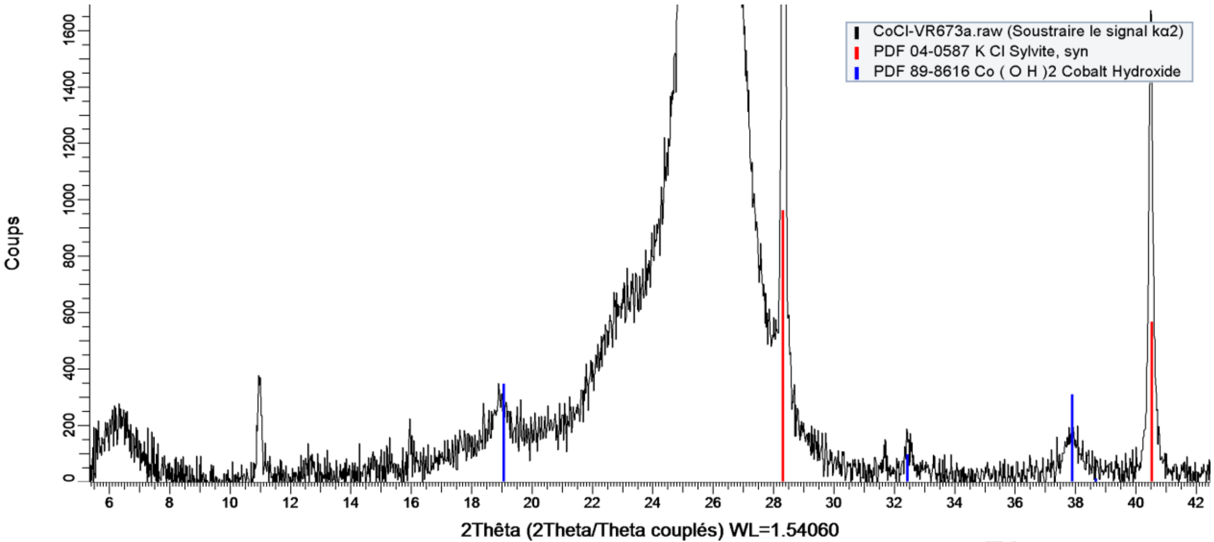


Figure S19. Diffraction by reflexion of catalyst **B** based on $CoCl_2$ using a Mylar^{TM} film.

The use of a Kapton^{TM} film proved to reduce significantly the absorbance but the diffraction patterns remained unclear between 10 to 30 2θ (Figure S20).

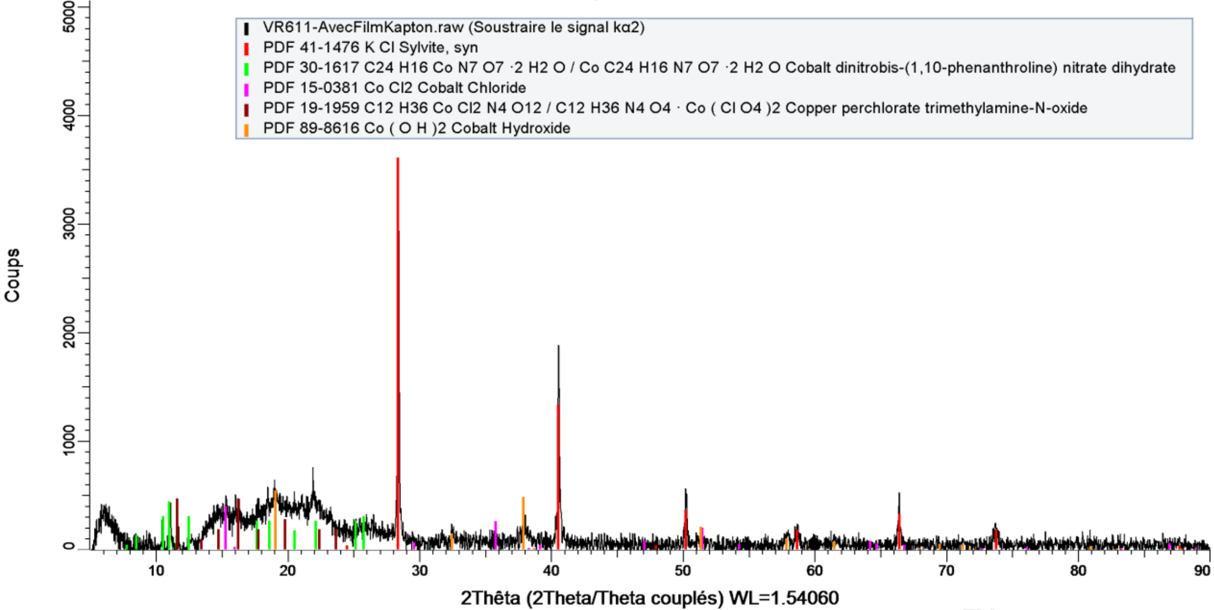


Figure S20. Diffraction by reflexion of catalyst **B** based on $CoCl_2$ using a Kapton^{TM} film.

Finally, without any film, the diffraction analysis by reflexion of catalyst **B** proved to be better resolved without any significant decomposition of the sample (Figure S21). Diffraction patterns were better identified and likely to be ascribed to KCl, $Co(OH)_2$ and $CoCl_2$.

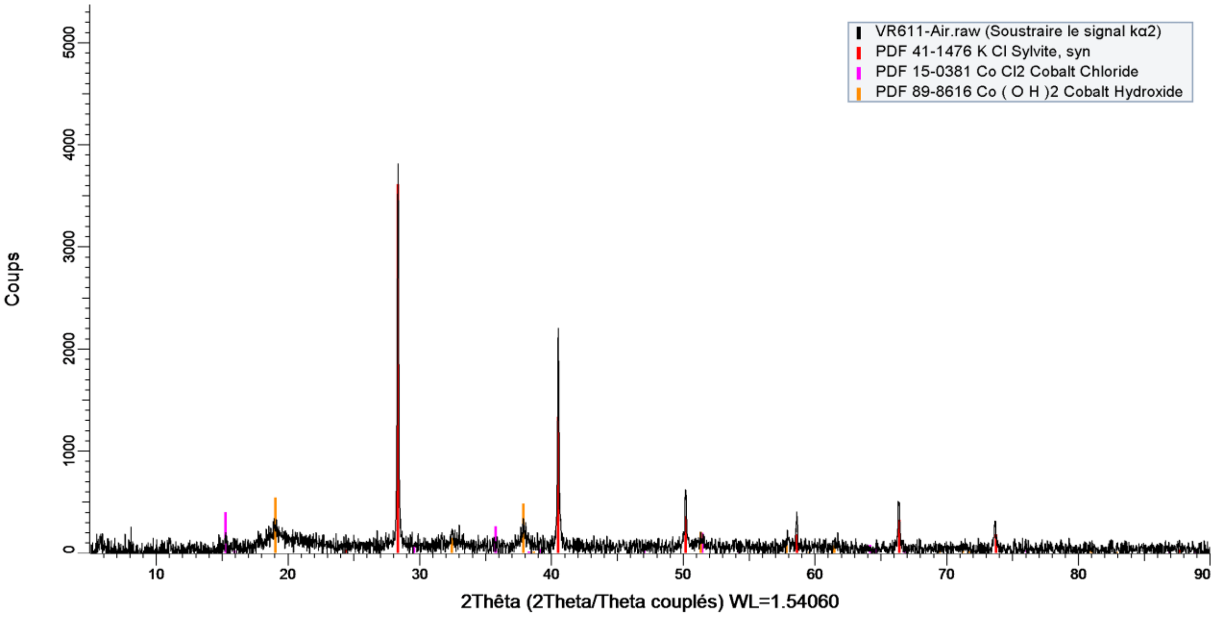


Figure S21. Diffraction by reflexion of catalyst **B** based on $CoCl_2$ using no film.

In the case of catalyst **A** based on $Co(OAc)_2$, the diffraction analysis by reflexion showed only diffraction patterns of poor intensity that were likely to be ascribed to sodium acetate (Figure S22).

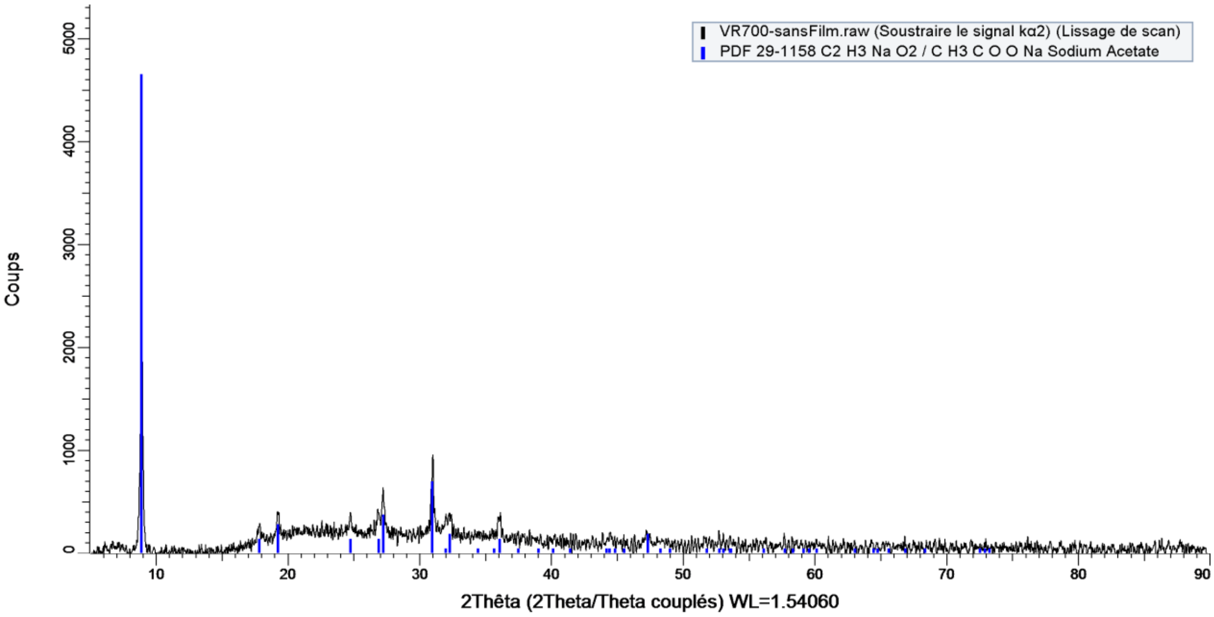


Figure S22. Diffraction by reflexion of catalyst **A** based on $Co(OAc)_2$ using no film.

A better resolution was obtained for both samples using another diffractometer operating by transmission mode (see manuscript Figures 2a and 2b). Samples were prepared in a glovebox by deposition of the catalyst powders in degassed mineral oil between two sheets of Kapton^{TM} film.

Two other samples were then analysed by transmission mode:

- Catalyst **A** resulting from the reaction of $Co(OAc)_2$ with $NaBHEt_3$ but no phenylsilane (Figure S23).
- Catalyst **B** resulting from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$ and water but no phenylsilane (Figure S24).

The observed diffraction patterns were similar to the catalysts **A** and **B** prepared with phenylsilane.

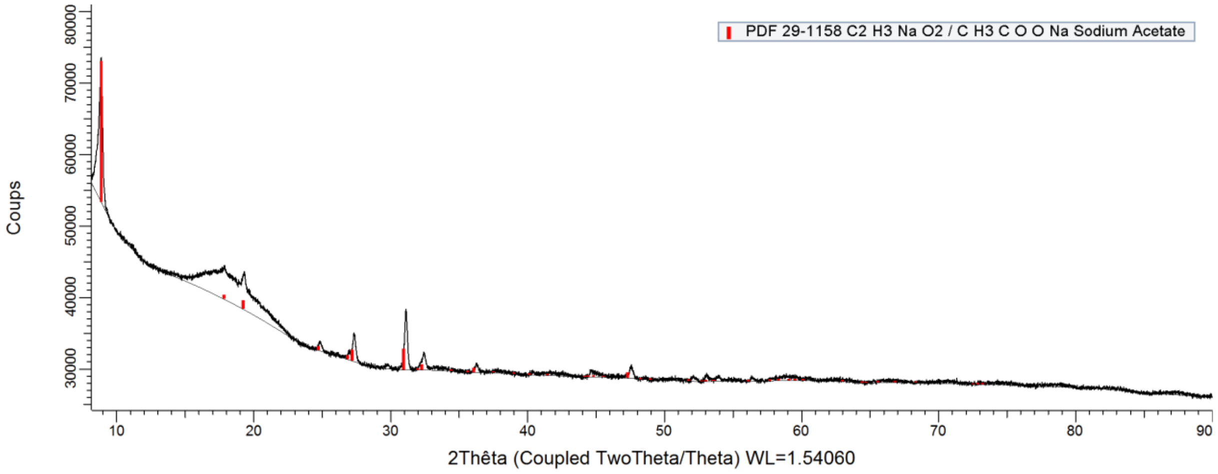


Figure S23. Diffraction by transmission of catalyst **A** based on $Co(OAc)_2$ prepared without silane.

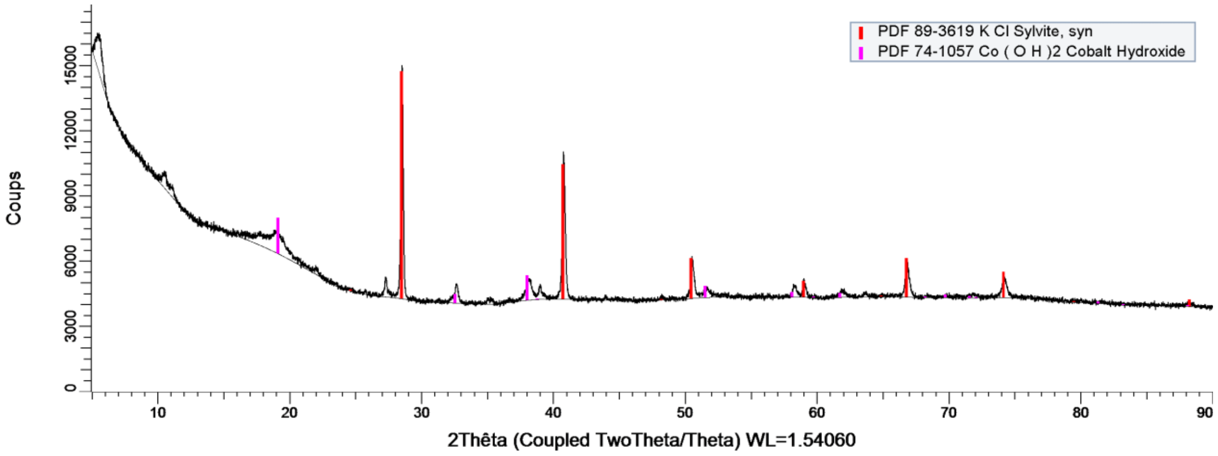


Figure S24. Diffraction by transmission of catalyst **B** based on $CoCl_2$ prepared without silane.

VII) Infra-red analyses.

Infra-red analyses were realised by Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS). In the case of the catalyst **B** resulting from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$, water and phenylsilane, a strong band is observed at 3631 cm^{-1} corresponding to the stretches of O-H bonds from $Co(OH)_2$ (Figure S25). Stretches of aromatic and aliphatic C-H bonds were observed between 3100 and 2800 cm^{-1}**.**

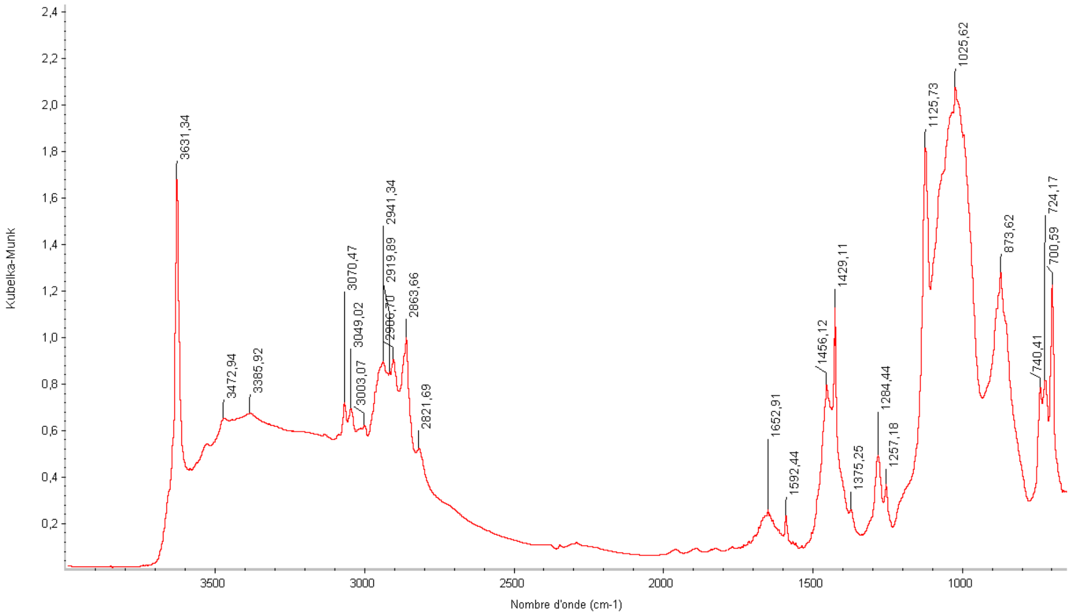


Figure S25. DRIFTS spectrum of the catalyst **B** resulting from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$, water and phenylsilane

In the case of the catalyst **A** resulting from the reaction of $Co(OAc)_2$ with $NaBHEt_3$ and phenylsilane, stretches of aromatic and aliphatic C-H bonds were observed between 3100 and 2800 cm^{-1} (Figure S26)**.** Carbonyl stretches from the acetate were observed at 1578 cm^{-1}.

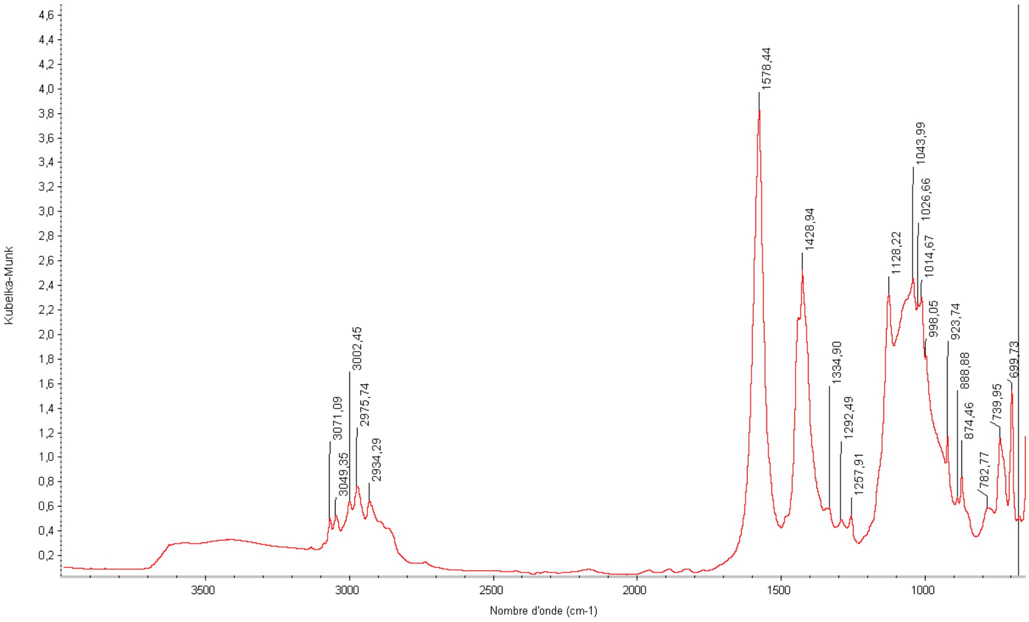


Figure S26. DRIFTS spectrum of the catalyst **A** resulting from the reaction of $Co(OAc)_2$ with $NaBHEt_3$ and phenylsilane.

VIII) XPS analyses.

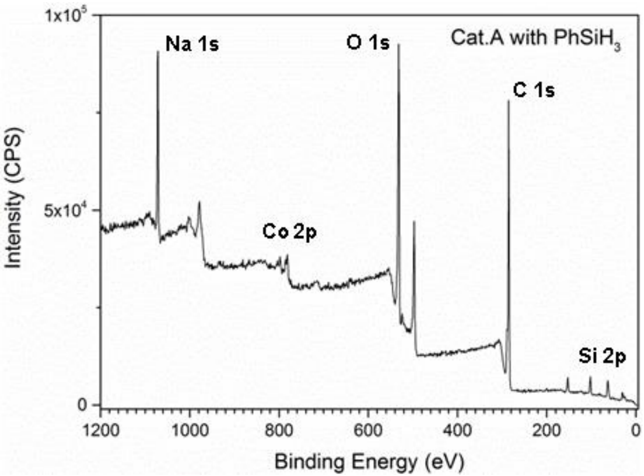


Figure S27. XPS full-scan spectrum of the catalyst **A** resulting from the reaction of $Co(OAc)_2$ with $NaBHEt_3$ and phenylsilane.

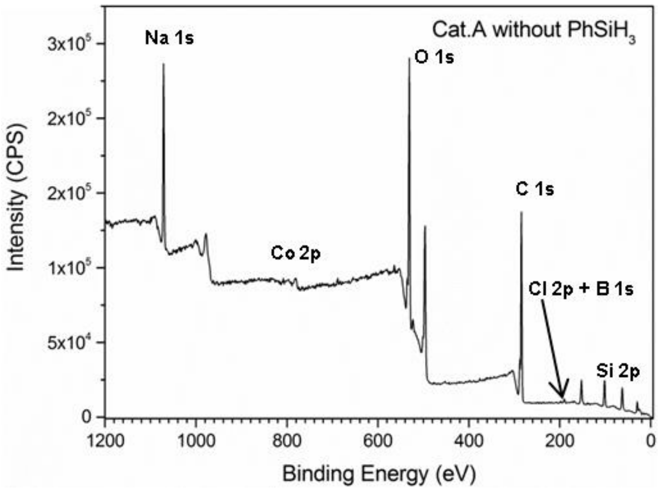


Figure S28. XPS full-scan spectrum of the catalyst **A** resulting from the reaction of $Co(OAc)_2$ with $NaBHEt_3$ but without phenylsilane.

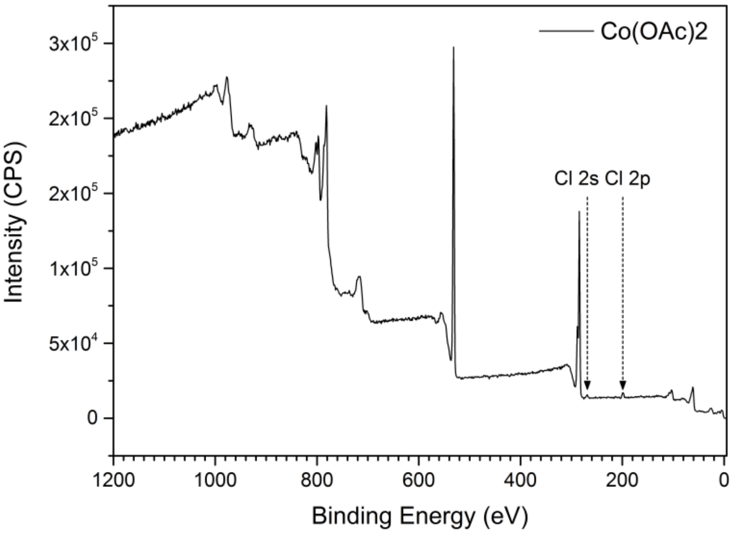


Figure S29. Pollution of $Co(OAc)_2$ (reagent grade) used in the catalysis by chloride

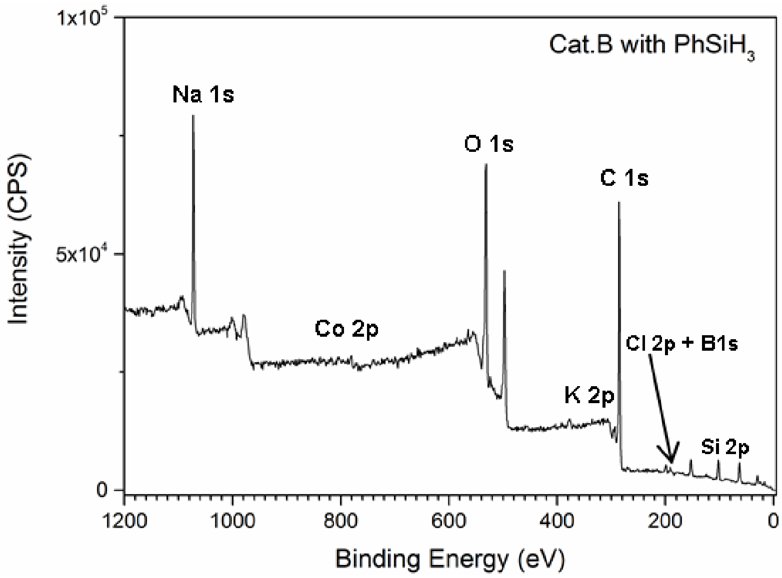


Figure S30. XPS full-scan spectrum of the catalyst **B** resulting from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$, water and phenylsilane.

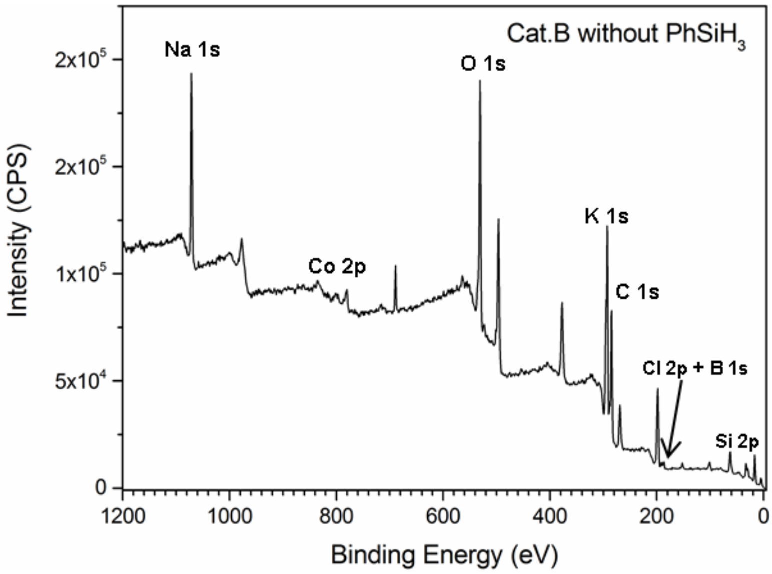
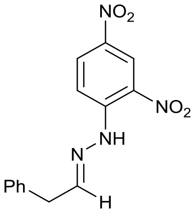


Figure S31. XPS full-scan spectrum of the catalyst **B** resulting from the reaction of $CoCl_2$ with KO*t*Bu, $NaBHEt_3$, water and without phenylsilane.

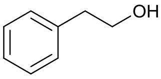
IX) Characterization of compounds.

6a (*E*)-1-(2,4-dinitrophenyl)-2-(2-phenylethylidene)hydrazine CAS [2074-04-6][S2]



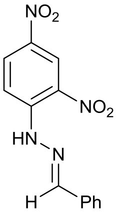
Isolated as the 2,4-dinitrophenylhydrazone adduct by precipitation, 92% yield.
^{1}H NMR (300 MHz, CDCl$_3$): δ= 11.05 (s, 1H, NH), 9.11 (d, *J*= 1.0 Hz, 1H$_{Ar}$), 8.31 (ddd, *J*= 9.6, 2.6, 0.7 Hz, 1H$_{Ar}$), 7.99 (d, *J*= 9.6 Hz, 1H$_{Ar}$), 7.60 (td, *J*= 5.8, 0.6 Hz, 1H$_{Ar}$), 7.33 (m, 4H$_{Ar}$), 3.76 (d, *J*= 5.8 Hz, 2H). ^{13}C NMR (75 MHz, CDCl$_3$): δ= 150.4 (CH), 145.3 (C), 138.1 (C), 135.6 (C), 133.4 (C), 130.1 (CH$_{Ar}$), 129.2 (2CH$_{Ar}$), 129.1 (2CH$_{Ar}$), 127.4 (CH$_{Ar}$), 123.6 (CH$_{Ar}$), 116.7 (CH$_{Ar}$), 39.2 (CH$_2$).

7a 2-Phenylethan-1-ol CAS [60-12-8][S3]



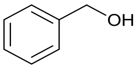
Isolated as a colorless oil after flash chromatography on silica gel using a (85/15) petroleum ether and diethyl ether mixture (Rf = 0.75), 94% yield.
^{1}H NMR (300 MHz, CDCl$_3$): δ= 7.40 (m, 2H$_{Ar}$), 7.32 (m, 3H$_{Ar}$), 3.87 (t, *J*= 6.8 Hz, 2H), 2.92 (t, *J*= 6.8 Hz, 2H), 2.73 (s, 1H). ^{13}C NMR (75 MHz, CDCl$_3$): δ= 138.6 (C), 129.0 (2CH), 128.5 (2CH), 126.4 (CH), 63.5 (CH$_2$), 39.1 (CH$_2$).

6e (*E*)-1-benzylidene-2-(2,4-dinitrophenyl)hydrazine CAS [1157-84-2][S4]



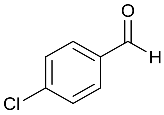
Isolated as the 2,4-dinitrophenylhydrazone adduct by precipitation, 95% yield.
^{1}H NMR (300 MHz, DMSO): δ= 11.68 (s, 1H, NH), 8.89 (d, *J*= 2.6 Hz, 1H), 8.72 (s, 1H$_{Ar}$), 8.37 (dd, *J*= 9.6, 2.7 Hz, 1H$_{Ar}$), 8.13 (s, *J*= 9.6 Hz, 1H$_{Ar}$), 7.81 (dd, *J*= 7.7, 5.1 Hz, 2H$_{Ar}$), 7.51 (dd, *J*= 5.2, 1.7 Hz, 3H$_{Ar}$). ^{13}C NMR (75 MHz, DMSO): δ= 149.4 (CH), 144.6 (C), 137.0 (C), 133.8 (C), 130.5 (CH$_{Ar}$), 129.7 (CH$_{Ar}$), 129.53 (C), 128.9 (2CH$_{Ar}$), 127.3 (2CH$_{Ar}$), 123.0 (CH$_{Ar}$), 116.8 (CH$_{Ar}$).

7e Phenylmethanol CAS [100-51-6][S5]



Isolated as a colorless oil after flash chromatography on silica gel using a (9/1) dichloromethane and diethylether mixture (Rf = 0,6), 96% yield.
^{1}H NMR (300 MHz, CDCl$_3$): δ= 7.40 (m, 5H$_{Ar}$), 4.64 (d, *J*= 5.5 Hz, 2H), 3.48 (m, 1H). ^{13}C NMR (75 MHz, CDCl$_3$): δ= 140.9 (C), 128.4 (2CH), 127.4 (CH), 127.0 (2CH), 64.8 (CH$_2$).

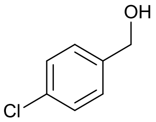
6g 4-chlorobenzaldehyde CAS [104-88-1][S6]



Isolated as a colorless oil after flash chromatography on silica gel using a (25/75) petroleum ether and dichloromethane mixture (Rf = 0.6), 84% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ= 9.96 (d, J= 1.0 Hz, 1H, CHO), 7.79 (m, 2H), 7.48 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 190.9 (CHO), 141.0 (C), 134.8 (C), 131.0 (2CH), 129.5 (2CH).

7g (4-chlorophenyl)methanol CAS [873-76-7][S7]

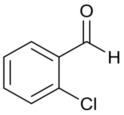


Isolated as a colorless oil after flash chromatography on silica gel using dichloromethane (Rf = 0.4), 98% yield.

RMN ^{1}H ($CDCl_3$, 300 MHz): δ = 1.66 (bs, 1H, OH), 4.67 (s, 2H, CH_2), 7.31 (m, 4H_{Ar}).

RMN ^{13}C ($CDCl_3$, 75 MHz): δ = 64.6 (CH_2), 128.4 (2 CH), 128.8 (2 CH), 133.4 (C), 139.3 (C).

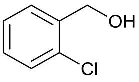
6h 2-chlorobenzaldehyde CAS [89-98-5][S6]



Isolated as a colorless oil after flash chromatography on silica gel using a (25/75) petroleum ether and dichloromethane mixture (Rf = 0.5), 49% yield.

^{1}H NMR (300 MHz, $CDCl_3$): δ= 10.37 (s, 1H, CHO), 7.81 (d, J= 7.7 Hz, 1H_{Ar}), 7.44 (m, 1H_{Ar}), 7.32 (m, 2H_{Ar}). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 189.3 (CHO), 137.6 (C), 134.9 (CH), 132.3 (C), 130.4 (CH), 129.1 (CH), 127.1 (CH).

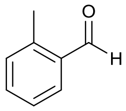
7h (2-Chlorophenyl)methanol CAS [17849-38-6][S8]



Isolated as a white solid after flash chromatography on silica gel using a (85/15) petroleum ether and diethylether mixture (Rf = 0.5), 97% yield.

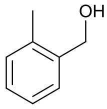
^{1}H NMR (300 MHz, $CDCl_3$): δ= 7.34 (dd, J= 7.0, 2.3 Hz, 1H), 7.23 (dd, J= 7.3, 1.7 Hz, 1H), 7.13 (m, 2H), 4.62 (s, 2H), 2.67 (s, 1H). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 138.3 (C), 132.7 (C), 129.4 (CH), 128.8 (CH), 128.7 (CH), 127.0 (CH), 62.7 (CH_2).

6i 2-methylbenzaldehyde CAS [529-20-4][S6]



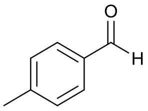
Isolated as a colorless oil after flash chromatography on silica gel using a (9/1) petroleum ether and diethyl ether mixture (Rf = 0.65), 89% yield.
^{1}H NMR (300 MHz, $CDCl_3$): δ= 10.27 (s, 1H, CHO), 7.80 (dd, *J*= 7.6-1.4 Hz, $1H_{Ar}$), 7.47 (td, *J*=7.5-1.5 Hz, $1H_{Ar}$), 7.35 (t, *J*= 7.5 Hz, $1H_{Ar}$), 7.25 (d, *J*= 3.3 Hz, $1H_{Ar}$), 2.67 (s, 3H, CH_3). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 192.9 (CHO), 140.7 (C), 134.5 (C), 133.9 (CH), 132.3 (CH), 132.1 (CH), 126.6 (CH), 19.7 (CH_3).

7i *o*-tolylméthanol CAS [89-95-2][S9]



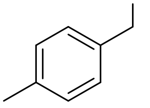
Isolated as a colorless oil after flash chromatography on silica gel using a (9/1) dichloromethane and diethylether mixture (Rf = 0.5), 92% yield.
RMN ^{1}H ($CDCl_3$, 300 MHz): δ = 1.65 (bs, 1H, OH), 2.37 (s, 3H), 4.70 (s, 2H), 7.23 (m, 3H), 7.35 (m, 1H).
RMN ^{13}C ($CDCl_3$, 75 MHz): δ = 18.8 (CH_3), 63.7 (CH_2), 126.2 (CH), 127.7 (CH), 127.9 (CH), 130.5 (CH), 136.3 (C), 138.8 (C).

6j 4-methylbenzaldehyde CAS [104-87-0][S10]



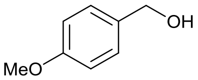
Isolated as a colorless oil after flash chromatography on silica gel using a (9/1) petroleum ether and diethyl ether mixture (Rf = 0.7), 92% yield.
^{1}H NMR (300 MHz, $CDCl_3$): δ= 9.96 (s, 1H, CHO), 7.78 (d, *J*= 8.1 Hz, $2H_{Ar}$), 7.32 (d, *J*= 8.1, $2H_{Ar}$), 2.43 (s, 3H, CH_3). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 192.1 (CHO), 145.7 (C), 134.6 (C), 130.0 (4CH), 22.0 (CH_3).

7j p-tolylméthanol CAS [589-18-4][S11]



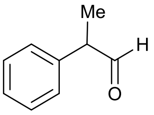
Isolated as a colorless oil after flash chromatography on silica gel using a (9/1) petroleum ether and diethyl ether mixture (Rf = 0.4), 86% yield.
RMN ^{1}H ($CDCl_3$, 300 MHz): δ = 1.62 (bs, 1H, OH), 2.35 (s, 3H), 4.65 (s, 2H), 7.18 (d, *J*= 7.2 Hz, 2H), 7.27 (d, *J*= 8.0 Hz, 2H).
RMN ^{13}C ($CDCl_3$, 75 MHz): δ = 21.3 (CH_3), 65.4 (CH_2), 127.3 (2CH), 129.4 (2CH), 137.6 (C), 138.1 (C).

7k 4-Methoxyphenylmethanol CAS [105-13-5][S5]



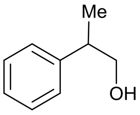
Isolated as a white solid after flash chromatography on silica gel using a (3/7) petroleum ether and dichloromethane (Rf = 0.7), 83% yield.
^{1}H NMR (300 MHz, CDCl$_3$): δ= 7.20 (m, 2H$_{Ar}$), 6.80 (m, 2H$_{Ar}$), 4.52 (s, 2H), 3.72 (s, 3H), 1.80 (s, 1H). ^{13}C NMR (75 MHz, CDCl$_3$): δ= 159.3 (C), 133.2 (C), 128.8 (2CH), 114.0 (2CH), 65.1 (CH$_2$), 55.4 (CH$_3$).

6m 2-Phenylpropionaldehyde CAS [93-53-8][S12]



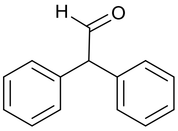
Isolated as a white solid after flash chromatography on silica gel using a (9/1) petroleum ether and diethyl ether mixture (Rf = 0.2), 83% yield
^{1}H NMR (300 MHz, CDCl$_3$): δ= 9.74 (d, J= 1.4 Hz, 1H, CHO), 7.40 (m, 3H$_{Ar}$), 7.27 (m, 2H$_{Ar}$), 3.69 (dq, J= 7.1, 1.3 Hz, 1H), 1.50 (d, J= 7.1 Hz, 3H). ^{13}C NMR (75 MHz, CDCl$_3$): δ= 201.0 (CHO), 137.8 (C), 129.1 (2CH), 128.4 (2CH), 127.5 (CH), 53.0 (CH), 14.6 (CH$_3$).

7m 2-Phenylpropionaldehyde CAS [93-53-8][S13]



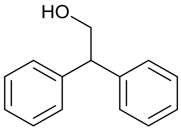
Isolated as a white solid after flash chromatography on silica gel using a (6/4) petroleum ether and diethyl ether mixture (Rf = 0.5), 92% yield
^{1}H NMR (300 MHz, CDCl$_3$): δ= 7.40 (m, 2H, 2CH$_{Ar}$), 7.31 (m, 3H$_{Ar}$), 3.72 (m, 2H), 2.98 (q, J= 6.9 Hz, 1H), 2.66 (s broad, OH), 1.35 (d, J= 7.0 Hz, 3H). ^{13}C NMR (75 MHz, CDCl$_3$): δ= 143.9 (C), 128.5 (2CH), 127.5 (2CH), 126.5 (CH), 68.5(CH$_2$), 42.3 (CH), 17.6 (CH$_3$).

6n 2,2-Diphenylacetaldehyde CAS [947-91-1][S14]



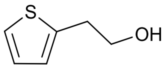
Isolated as a white solid after flash chromatography on silica gel using a (95/5) petroleum ether and dichloromethane mixture (Rf = 0.5), 90% yield.
^{1}H NMR (300 MHz, CDCl$_3$): δ= 10.04 (m, 1H, CHO), 7.45 (m, 6H$_{Ar}$), 7.33 (m, 4H$_{Ar}$), 4.99 (b, 1H). ^{13}C NMR (75 MHz, CDCl$_3$): δ= 198.6 (CHO), 136.5 (C), 129.3 (4CH), 129.1 (4CH), 127.7 (2CH), 64.17 (CH).

7n 2,2-diphenylethanol CAS [1883-32-5][S15]



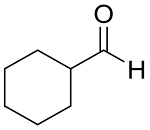
Isolated as a colorless oil after flash chromatography on silica gel using a (60/40) petroleum ether and diethylique ether mixture (Rf = 0.5), 51% yield ^{1}H NMR (300 MHz, $CDCl_3$): δ= 7.38 (m, 10H$_{Ar}$), 4.30 (m, 1H), 4.22 (m, 2H). ^{13}C NMR (75 MHz, $CDCl_3$): $\boldsymbol{\delta}$**=** 141.6 (C), 128.7 (4CH), 128.4(4CH), 126.8 (2CH), 66.0 (CH_2), 53.6(CH).

7o 2-Thiophenethanol CAS [5402-55-1][S16]



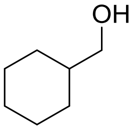
Isolated as a colorless oil after flash chromatography on silica gel using a (6/4) petroleum ether and diethyl ether mixture (Rf = 0.5), 92% yield.
^{1}H NMR (300 MHz, $CDCl_3$): δ= 7.18 (dd, *J*= 5.1, 1.2 Hz, 1H$_{Ar}$), 6.96 (dd, *J*= 5.1, 3.3 Hz, 1H$_{Ar}$), 6.88 (m, 1H$_{Ar}$), 3.87 (t, *J*= 6.3 Hz, 2H), 3.09 (dt, *J*= 6.3, 0.8 Hz, 2H), 2.10 (b, 1H). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 140.9 (C), 127.2 (CH), 125.8 (CH), 124.2 (CH), 63.7 (CH_2), 33.5 (CH_2).

6p Cyclohexanecarbaldehyde CAS [2043-61-0][S17]



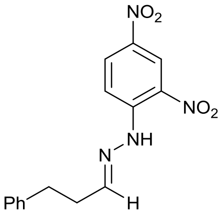
Isolated as a colorless oil after flash chromatography on silica gel using a (6/4) petroleum spirit and dichloromethane mixture (Rf = 0.4), 82 % yield.
^{1}H NMR (300 MHz, $CDCl_3$): δ= 9.52 (s, 1H, CHO), 2.12 (m, 1H), 1.68 (m, 6H), 1.23 (m, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 204.7 (CHO), 49.8 (CH), 25.9 (2CH_2), 25.9 (CH_2), 24.95 (2CH_2).

7p Cyclohexylmethanol CAS [100-49-2][S18]



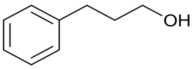
Isolated as a colorless oil after flash chromatography on silica gel using a (8/2) petroleum ether and diethyl ether mixture (Rf = 0.8), 84% yield.
RMN ^{1}H ($CDCl_3$, 300 MHz): δ = 0.94 (m, 2H), 1.21 (m, 3H), 1.48 (m, 2H), 1.71 (m, 5H), 3.43 (d, *J*= 6.4 Hz, 2H).
RMN ^{13}C ($CDCl_3$, 75 MHz): δ = 26.0 (2CH_2), 26.7 (CH_2), 29.7 (2CH_2), 40.6 (CH), 68.9 (CH_2).

6q (*E*)-1-(2,4-dinitrophenyl)-2-(3-phenylpropylidene)hydrazine CAS [1237-68-9][S19]



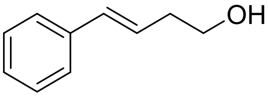
Isolated as the 2,4-dinitrophenylhydrazone adduct by precipitation, 92% yield.
^{1}H NMR (300 MHz, $CDCl_3$): δ= 11.00 (s, 1H, NH), 9.11 (d, *J*= 2.6 Hz, 1H), 8.29 (ddd, *J*= 9.6, 2.6, 0.6 Hz, $1H_{Ar}$), 7.90 (d, *J*= 9.6 Hz, $1H_{Ar}$), 7.56 (t, *J*= 4.9 Hz, $1H_{Ar}$), 7.34 (m, $2H_{Ar}$), 7.24 (m, $4H_{Ar}$), 2.97 (t, *J*= 4.5 Hz, 2H), 2.79 (m, 2H).
RMN ^{13}C (75 MHz, $CDCl_3$): δ= 151.4 (CH), 145.2 (C), 140.4 (C), 138.1 (C), 130.1 (CH_{Ar}), 129.1 (C), 128.8 ($2CH_{Ar}$), 128.5 ($2CH_{Ar}$), 126.6 (CH_{Ar}), 123.6 (CH_{Ar}), 34.1 (CH_2), 32.6 (CH_2).

7q 3-Phenylpropan-1-ol CAS [122-97-4][S20]



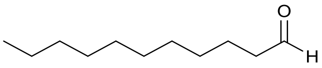
Isolated as a colorless oil after flash chromatography on silica gel using a (85/15) petroleum ether and diethyl ether mixture (Rf = 0.8), 93% yield.
^{1}H NMR (300 MHz, $CDCl_3$): δ= 7.22 (m, $2H_{Ar}$), 7.12 (m, $3H_{Ar}$), 3.58 (t, *J*= 6.5 Hz, 2H), 2.62 (t, *J*= 7.7 Hz, 2H), 1.81 (m, 2H), 1.70 (s, 1H). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 141.9 (C), 128.6 (2CH), 128.5 (2CH), 126.0 (CH), 62.3 (CH_2), 34.3 (CH_2), 32.2 (CH_2).

7r (3E)-4-Phenyl-3-buten-1-ol CAS [770-36-5][S21]



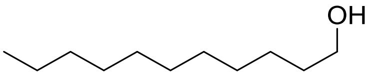
Isolated as a colorless oil after flash chromatography on silica gel using a (6/4) petroleum ether and diethyl ether mixture (Rf = 0.5), 92% yield
^{1}H NMR (300 MHz, $CDCl_3$): δ= 7.22 (m, $5H_{Ar}$), 6.43 (d, *J*= 15.9 Hz, 1H), 6.13 (dt, *J*= 15.9, 7.1 Hz, 1H), 3.68 (t, *J*= 6.3 Hz, 2H), 2.42 (ddt, *J*= 7.1, 6.3, 1.3 Hz, 2H), 1.48 (s, 1H). ^{13}C NMR (75 MHz $CDCl_3$): δ= 137.4 (C), 132.9 (CH), 128.7 ($2CH_{Ar}$), 127.4 (CH_{Ar}), 126.5 (CH), 126.2 ($2CH_{Ar}$), 62.2 (CH_2), 36.5 (CH_2).

6s Undecanal CAS [112-44-7][S22]



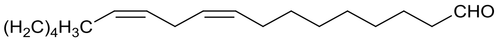
Isolated as a colorless oil after flash chromatography on silica gel using a (7/3) petroleum ether and diethyl ether mixture (Rf = 0.5), 90% yield.
^{1}H NMR (300 MHz, $CDCl_3$): δ= 9.76 (t, *J*= 1.9 Hz, 1H, CHO), 2.41 (td, *J*= 7.3, 1.9 Hz, 2H), 1.63 (m, 2H), 1.29 (m, 14H), 0.88 (t, *J*= 1.3 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 203.1 (CHO), 44.1 (CH_2), 32.0 (CH_2), 29.7 (CH_2), 29.6 (CH_2), 29.5 (CH_2), 29.4 (CH_2), 29.3 (CH_2), 22.8 (CH_2), 22.3 (CH_2), 14.2 (CH_3).

7s Undecan-1-ol CAS [112-42-5][S23]



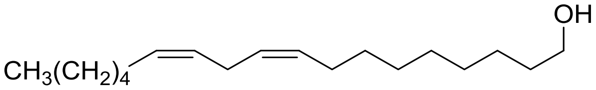
Isolated as a colorless oil after flash chromatography on silica gel using a (7/3) petroleum ether and diethyl ether mixture (Rf = 0.3), 92% yield.
RMN ^1H ($CDCl_3$, 300 MHz): δ = 0.81 (t, J= 6.5 Hz, 3H), 1.19 (m, 16H), 1.58 (m, 2H), 2.91 (bs, 1H, OH), 3.56 (t, J= 6.7 Hz, 2H, CH_2O).
RMN ^{13}C ($CDCl_3$, 75 MHz): δ = 14.3 (CH_3), 22.9 (CH_2), 25.9 (CH_2), 29.5 (CH_2), 29.6 (CH_2), 29.8 ($3CH_2$), 32.1 (CH_2), 33.0 (CH_2), 63.2 (CH_2-OH).

6t (9*Z*,12*Z*)-octadeca-9,12-dienal 4s CAS [2541-61-9][S24]



Isolated as a colorless oil after flash chromatography on silica gel using a (9/1) dichloromethane and diethyl ether mixture (Rf = 0.6), 98% yield.
^1H NMR (300 MHz, $CDCl_3$): δ= 9.77 (t, J= 1.9 Hz, 1H, CHO), 5.35 (m, 4H), 2.77 (t, J= 6.2 Hz, 2H), 2.42 (td, J= 7.3, 1.9 Hz, 2H), 2.05 (m, 4CH), 1.63 (m, 2H), 1.33 (m, 14H), 0.89 (t, J= 1.4 Hz, 3H). ^{13}C NMR (75 MHz, $CDCl_3$): δ= 203.0 (CHO), 130.4 (CH), 130.1 (CH), 128.3 (CH), 128.1 (CH), 44.1 (CH_2), 31.7 (CH_2), 29.7 (CH_2), 29.5 (CH_2), 29.4 (CH_2), 29.3 (CH_2), 29.2 (CH_2), 27.4 (CH_2), 27.3 (CH_2), 25.8 (CH_2), 22.7 (CH_2), 22.2 (CH_2), 14.2 (CH_3).

7t (9*Z*,12*Z*)-octadeca-9,12-dien-1-ol CAS [506-43-4][S25]



Isolated as a colorless oil after flash chromatography on silica gel using a (9/1) dichloromethane and diethyl ether mixture (Rf = 0.3), 70% yield.
RMN ^1H ($CDCl_3$, 300 MHz): δ = 0.89 (m, 3H), 1.26 (m, 16H), 1.54 (m, 2H, -CH_2-CH_2OH), 2.06 (m, 4H, =CH-CH_2-), 2.77 (t, J= 5.9 Hz, 2H, =CH-CH_2-CH=), 3.64 (t, J= 6.6 Hz, 2H, -CH_2-OH), 5.36 (m, 4H, =CH-).
RMN ^{13}C ($CDCl_3$, 75 MHz): δ = 14.2 (CH_3), 22.7 (CH_2), 25.8 (CH_2), 25.9 (CH_2), 27.4 (CH_2), 29.3 (CH_2), 29.4 (CH_2), 29.5 (CH_2), 29.6 (CH_2), 29.7 (CH_2), 29.8 (CH_2), 31.7 (CH_2), 33.0 (CH_2), 63.3 (CH_2), 128.1 (CH), 128.2 (CH), 130.3 (CH), 130.4 (CH).

X) References.

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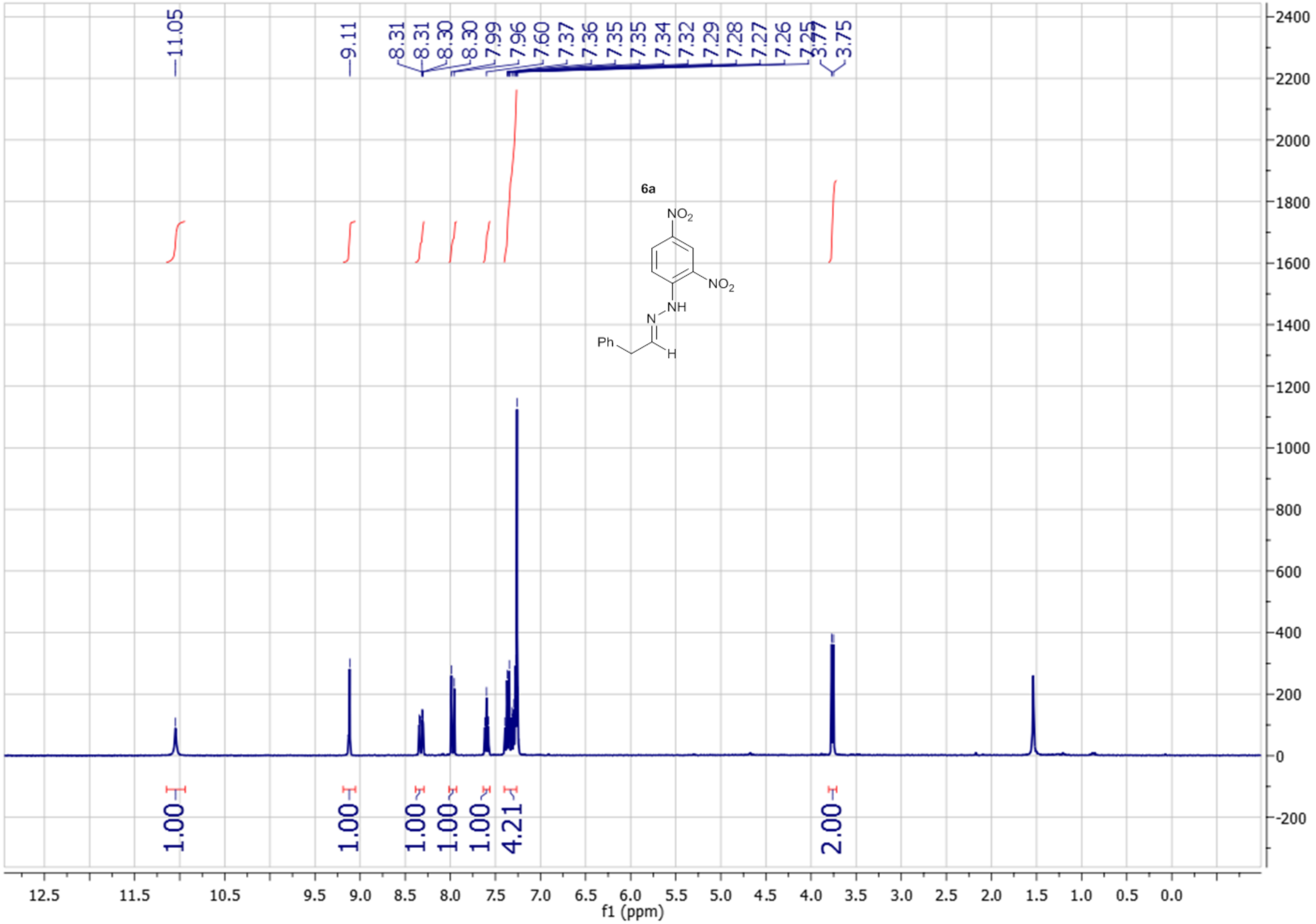
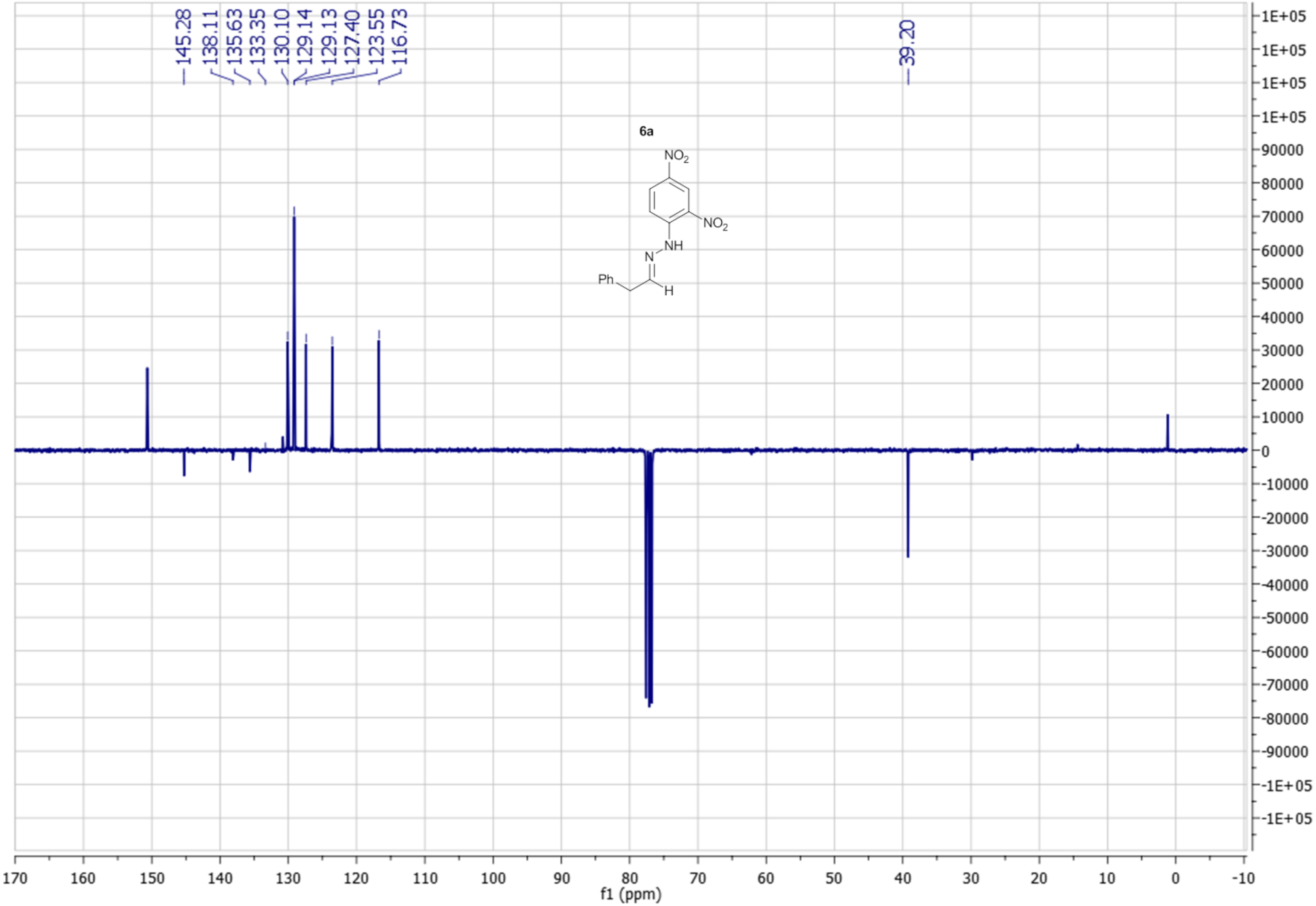
XI) ^{1}H, ^{13}C NMR spectra of isolated compounds.

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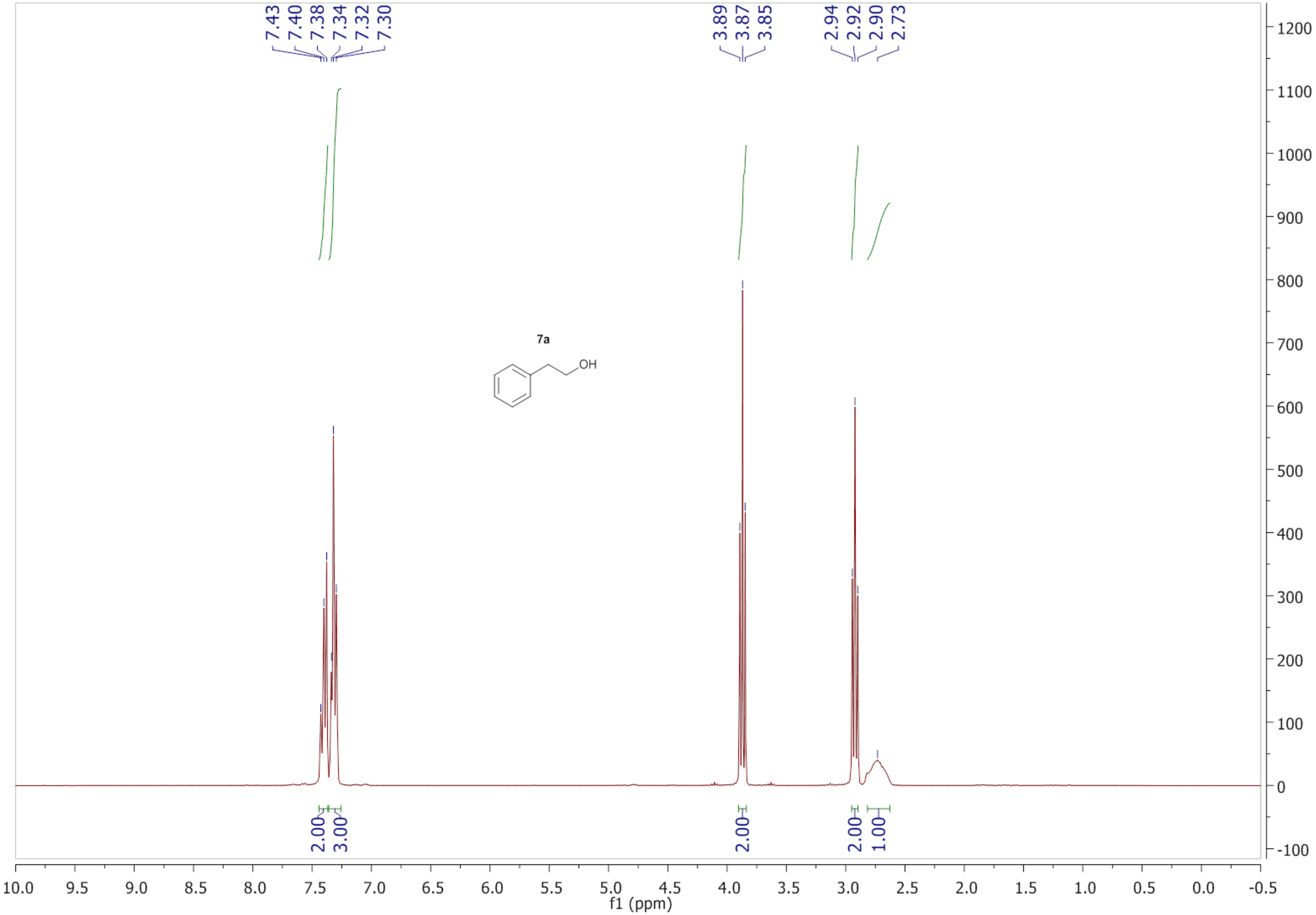
f1 (ppm)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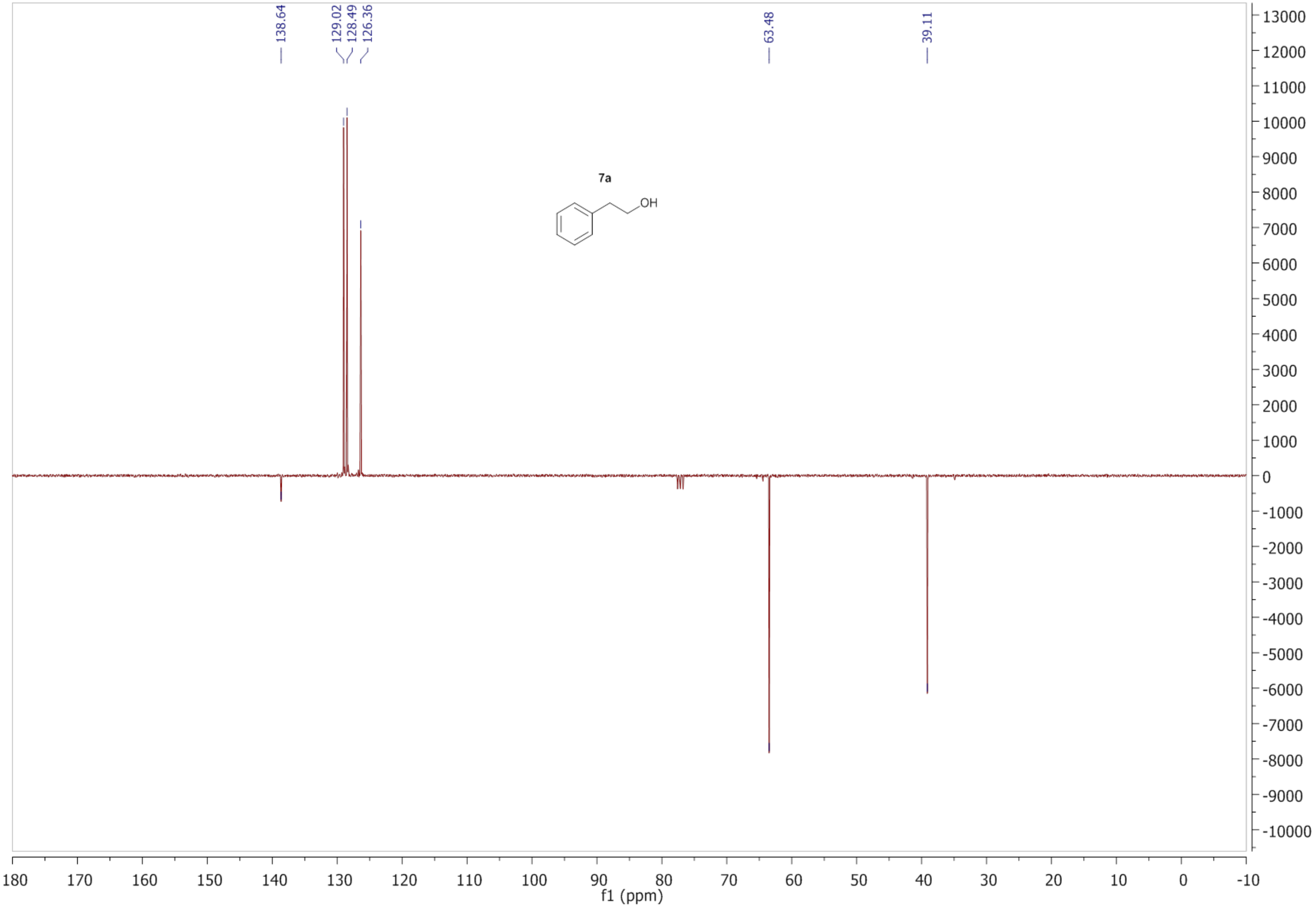
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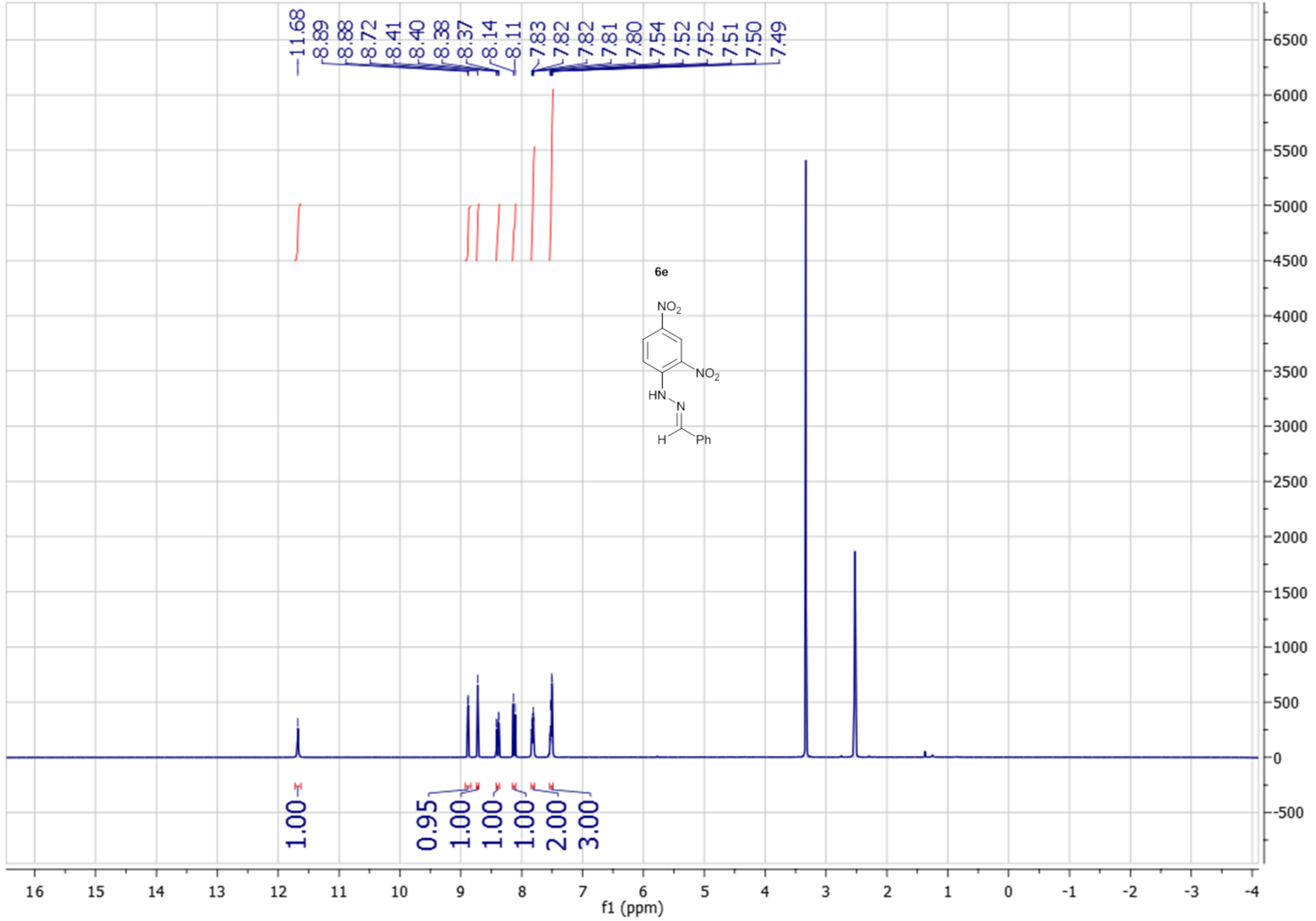
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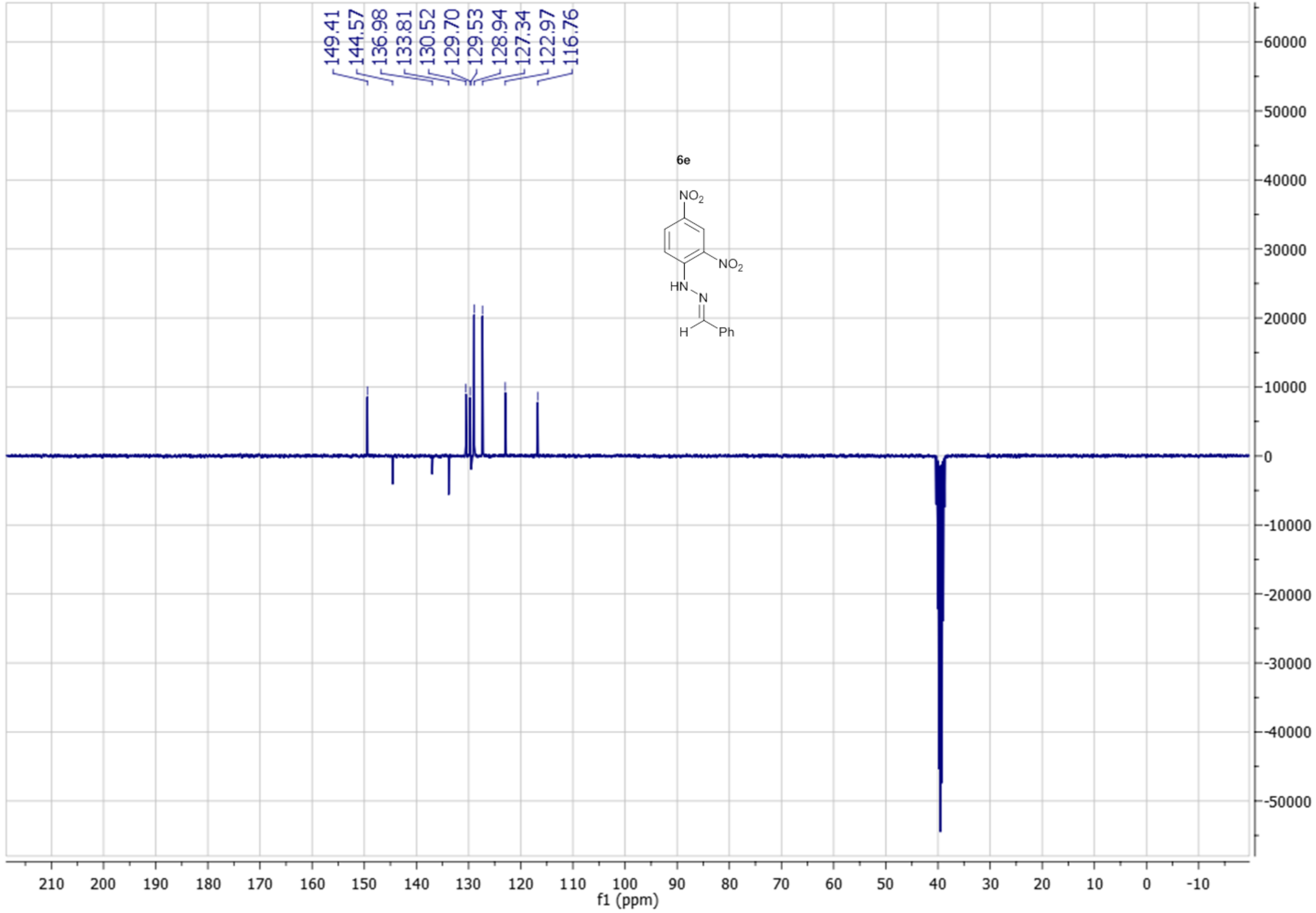
f1 (ppm)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144.57
136.98
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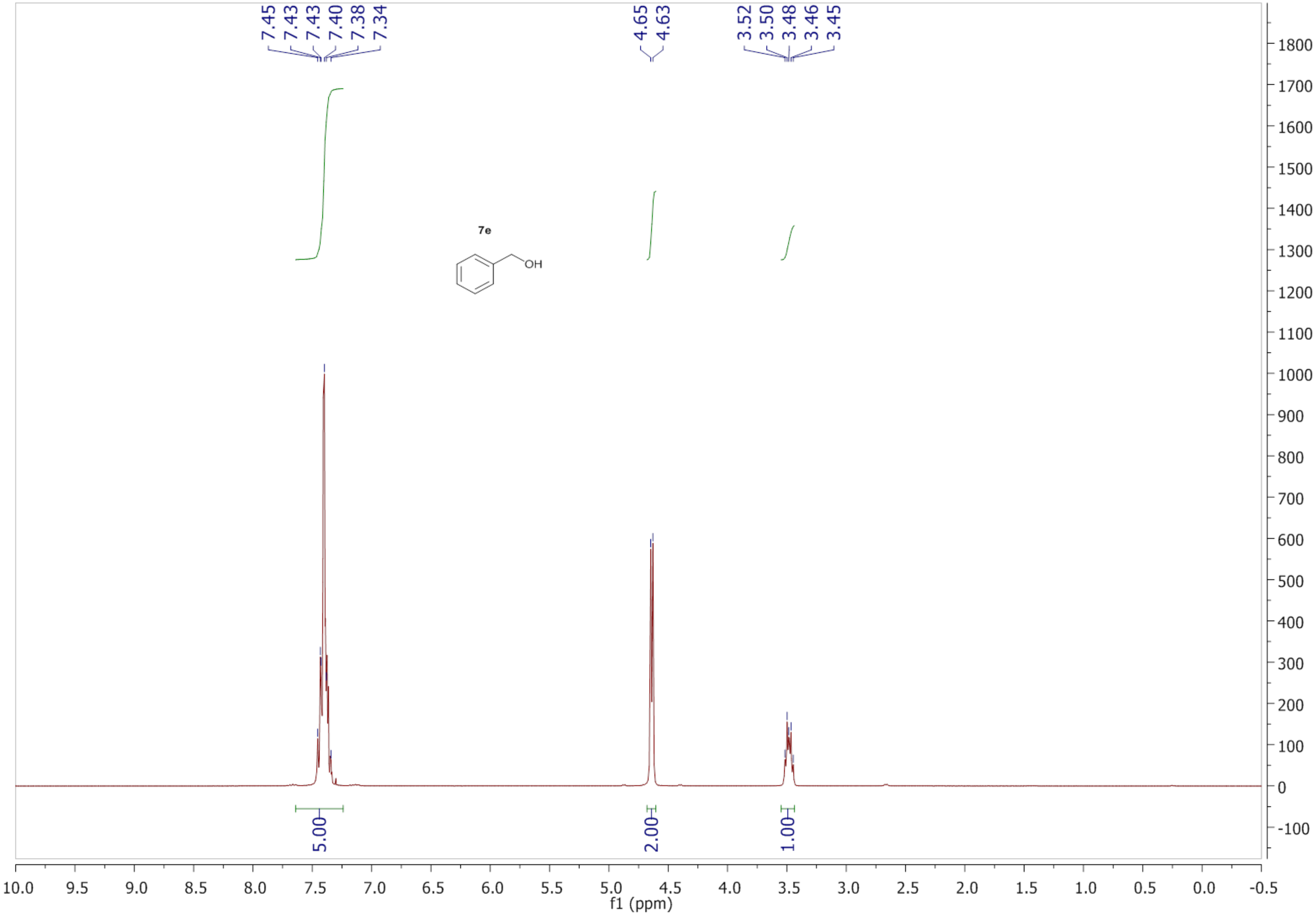
130.52
129.70
129.53
128.94
127.34
122.97
116.76
6e
NO2
NO2
HN
N
H
Ph
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)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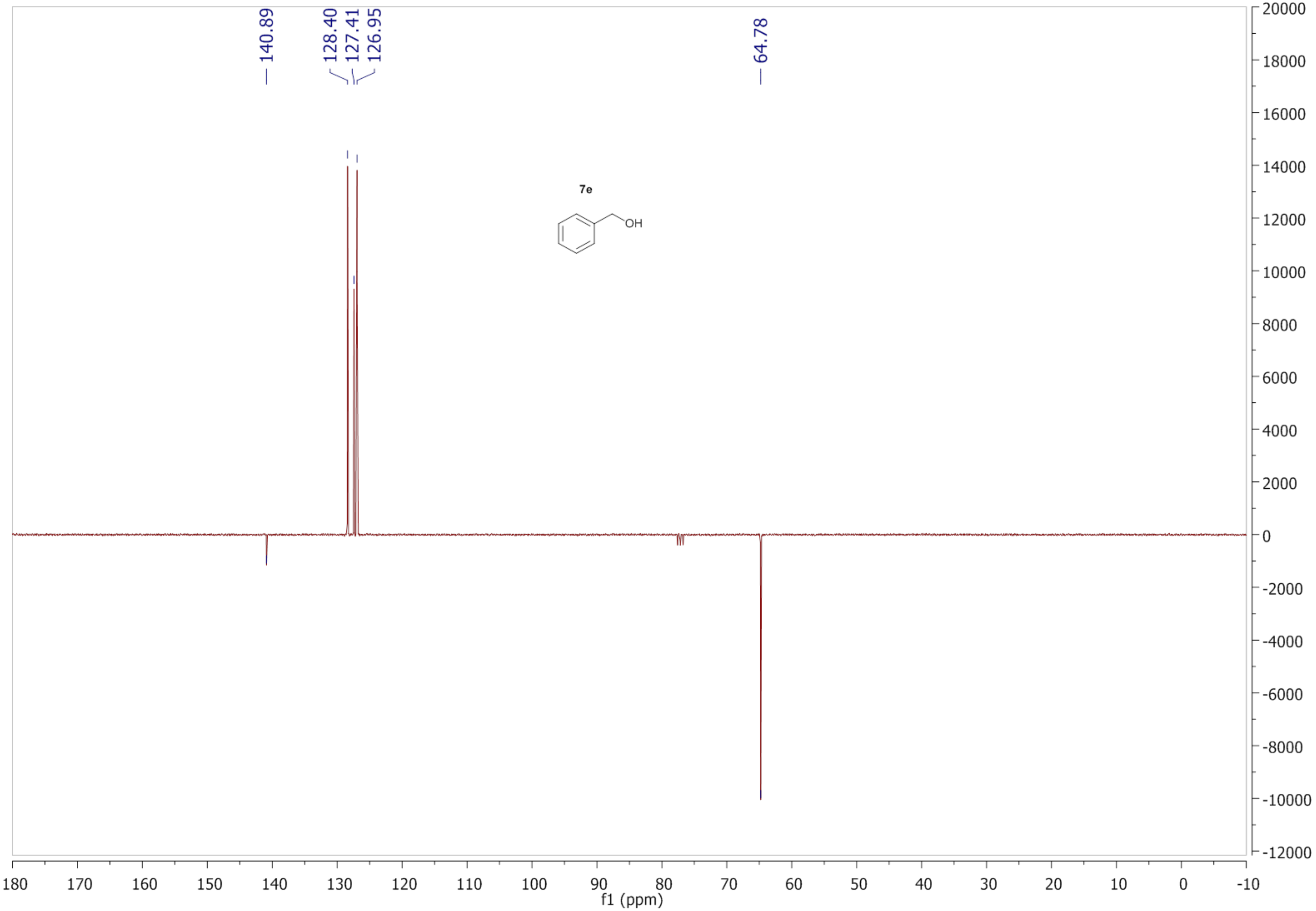
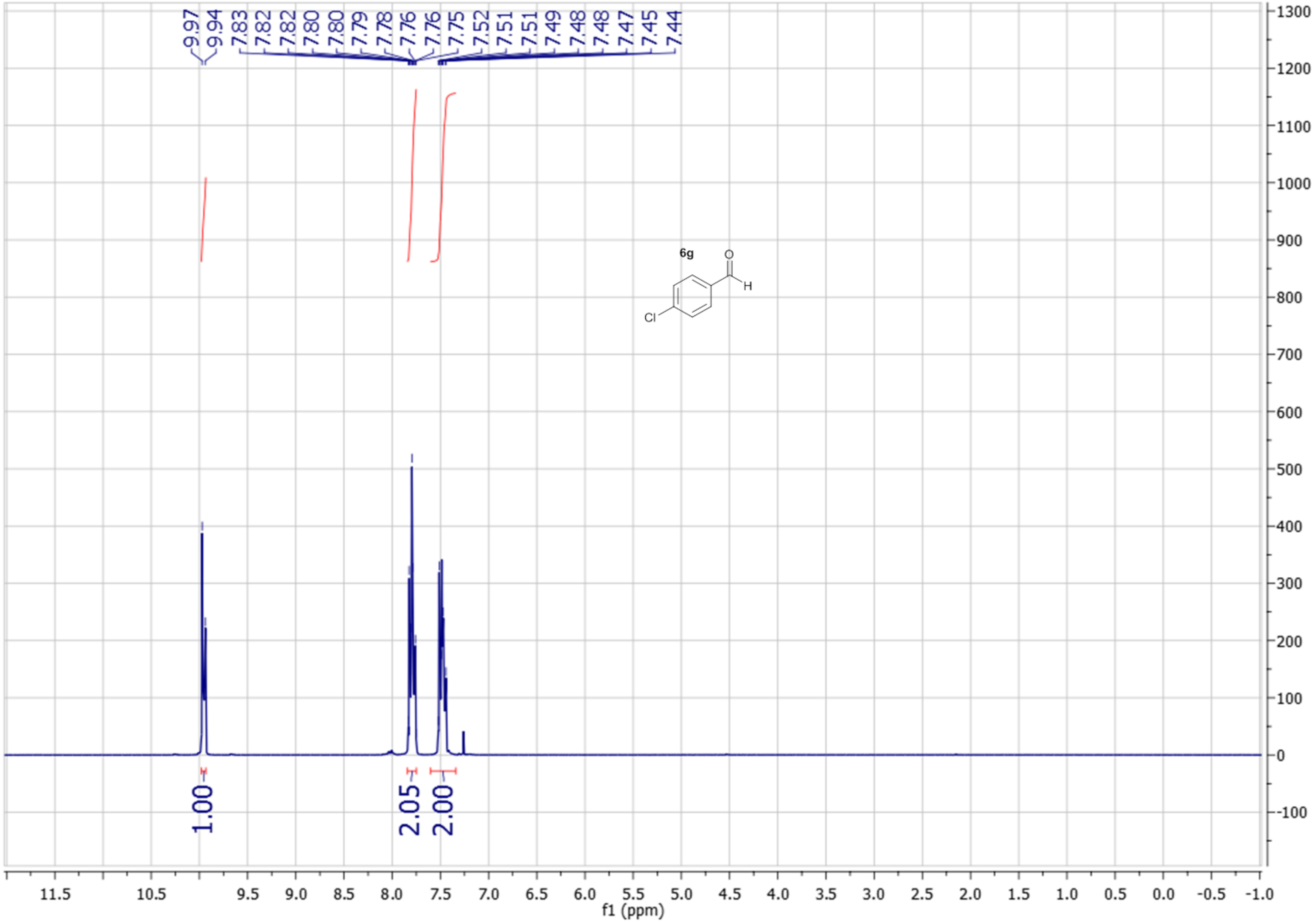
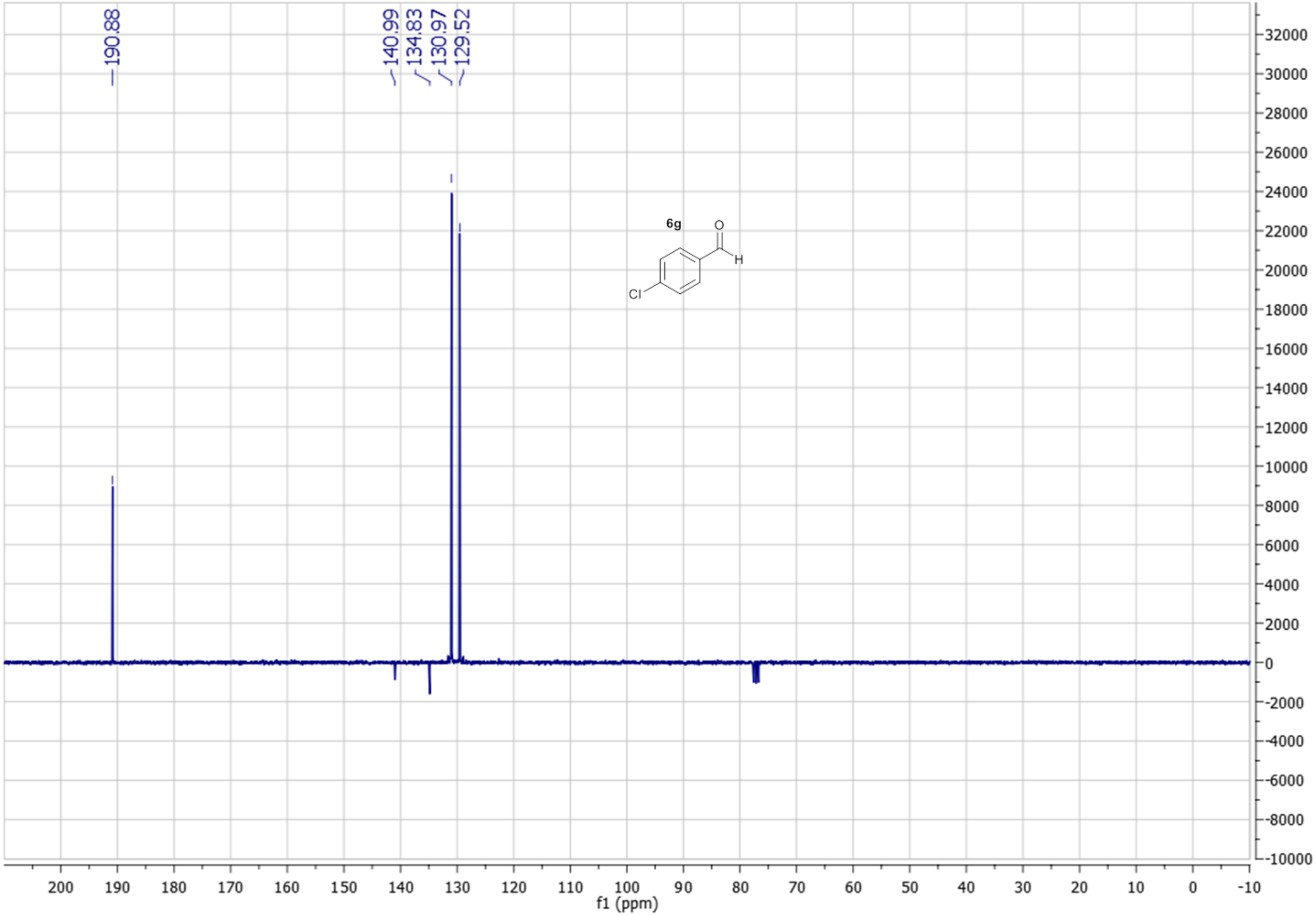
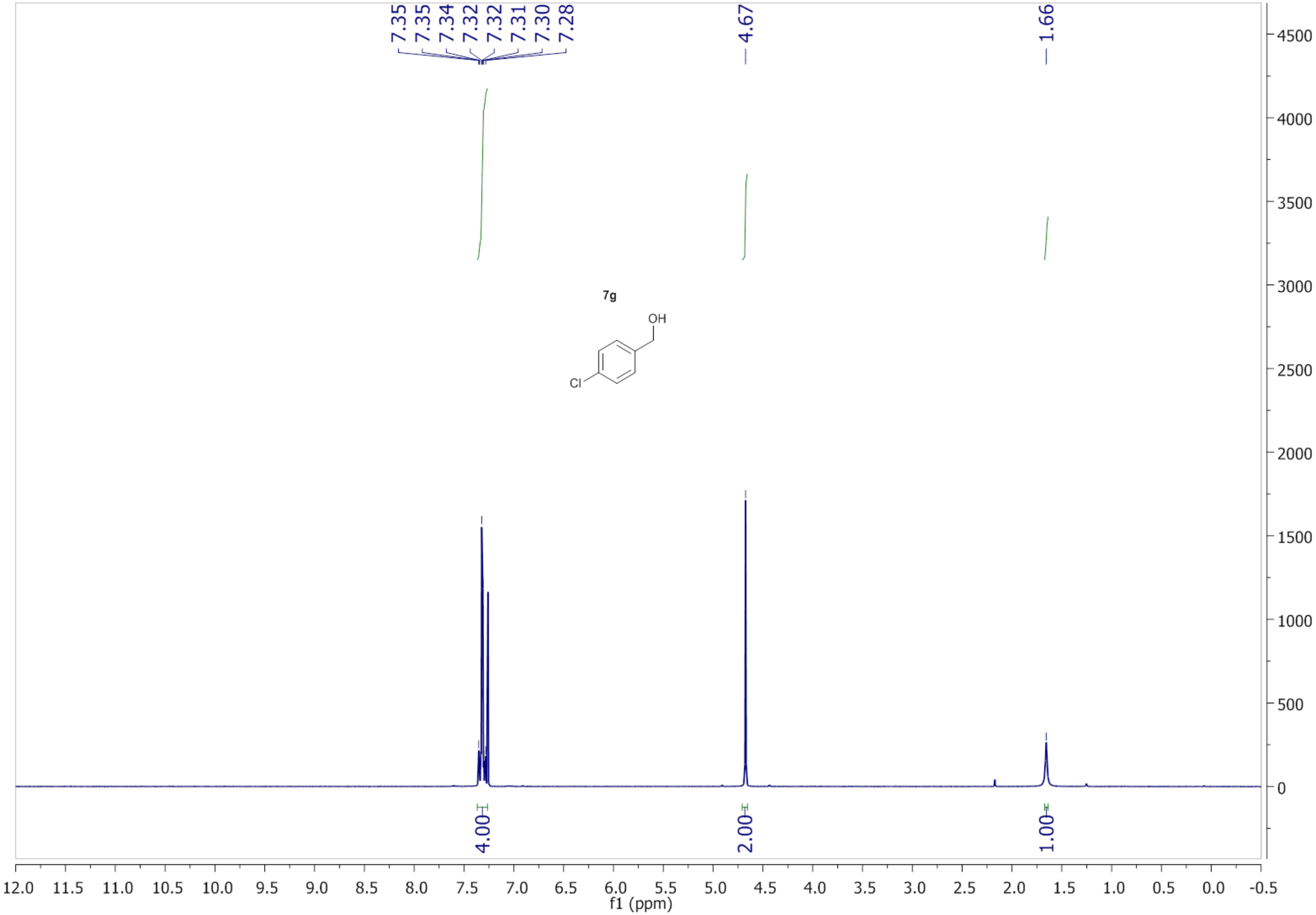
7.43
7.43
7.40
7.38
7.34
4.65
4.63
3.52
3.50
3.48
3.46
3.45
7e
OH
5.00
2.00
1.00
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


140.89
128.40
127.41
126.95
64.78
7e
OH
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


9.97
9.94
7.83
7.82
7.82
7.80
7.80
7.79
7.78
7.76
7.76
7.75
7.52
7.51
7.51
7.49
7.48
7.48
7.47
7.45
7.44
6g
O
H
Cl
1.00
2.05
2.00
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
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
-0.5
-1.0
f1 (ppm)


190.88
140.99
134.83
130.97
129.52
6g
O
H
Cl
32000
30000
28000
26000
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.35
7.35
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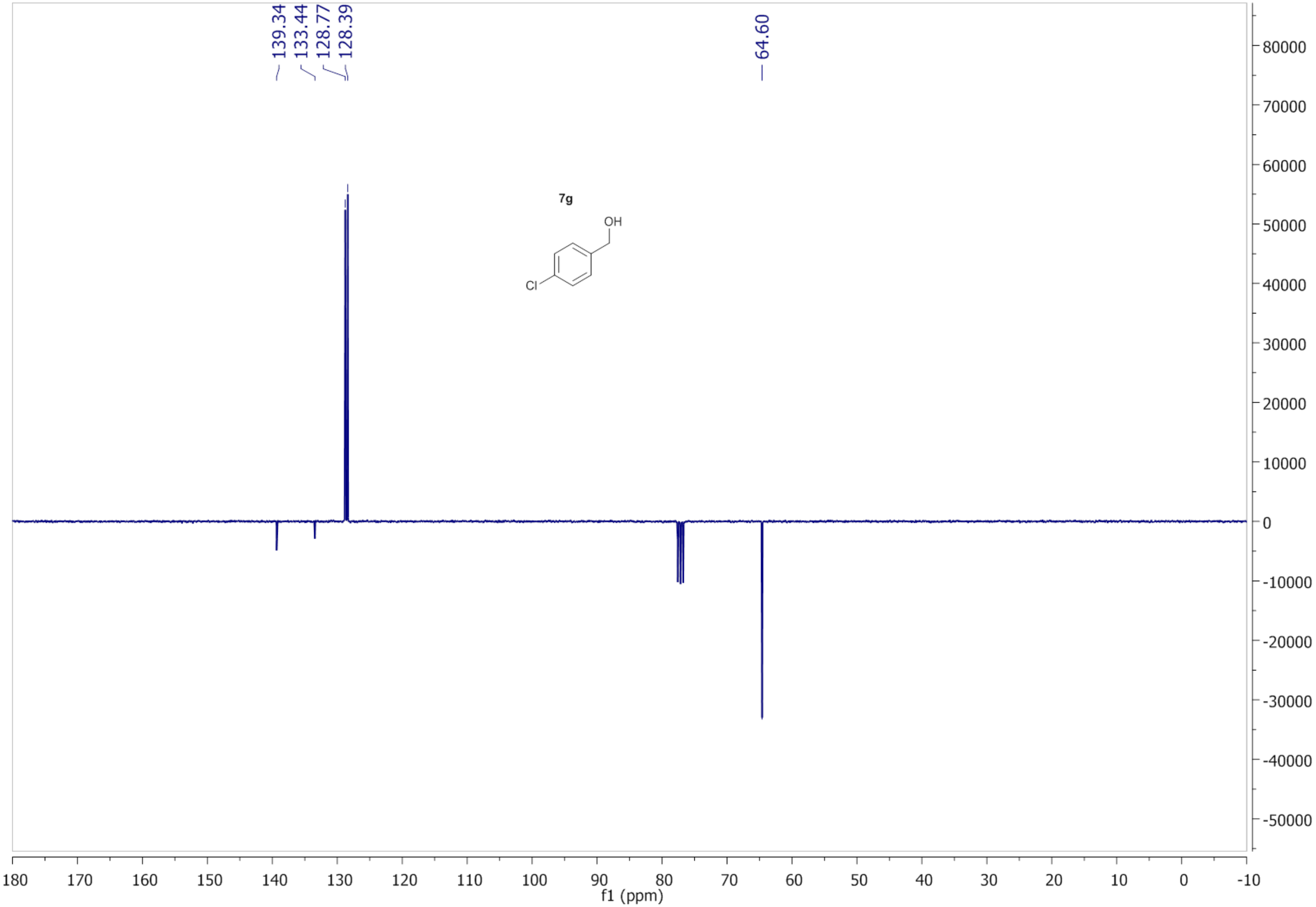
7.32
7.32
7.31
7.30
7.28
4.67
1.66
7g
OH
Cl
4.00
2.00
1.00
4500
4000
3500
3000
2500
2000
1500
1000
500
0
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)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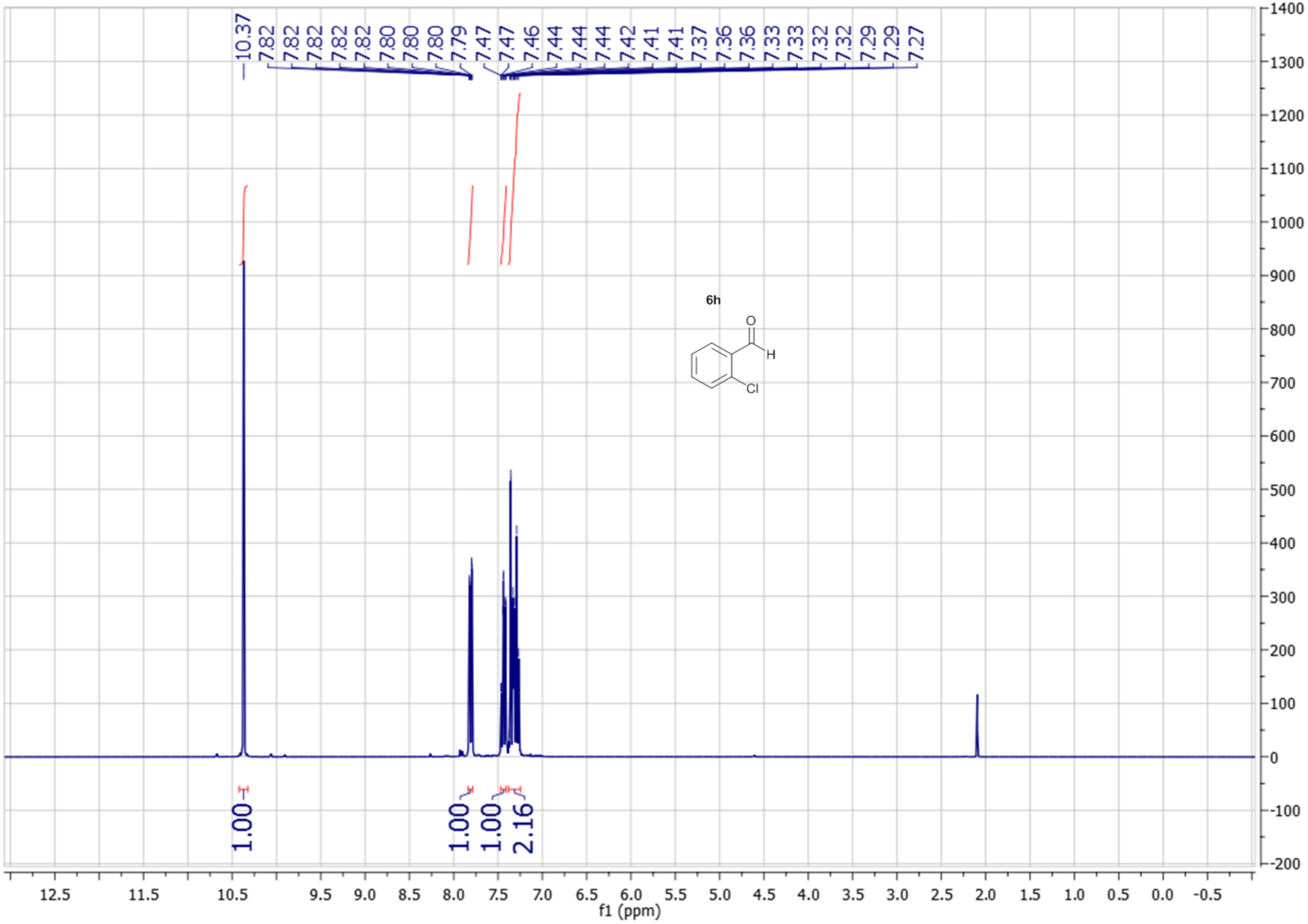
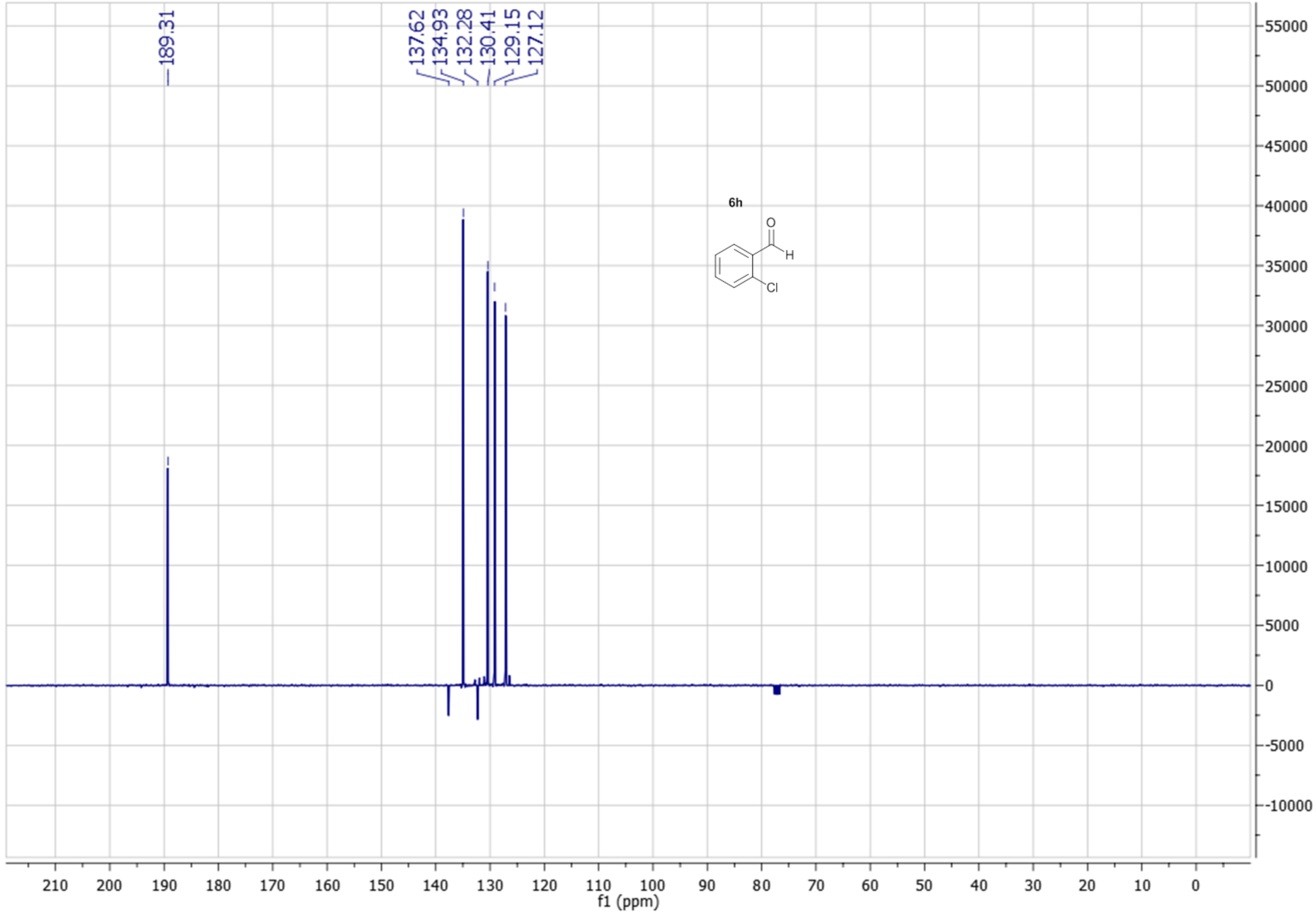
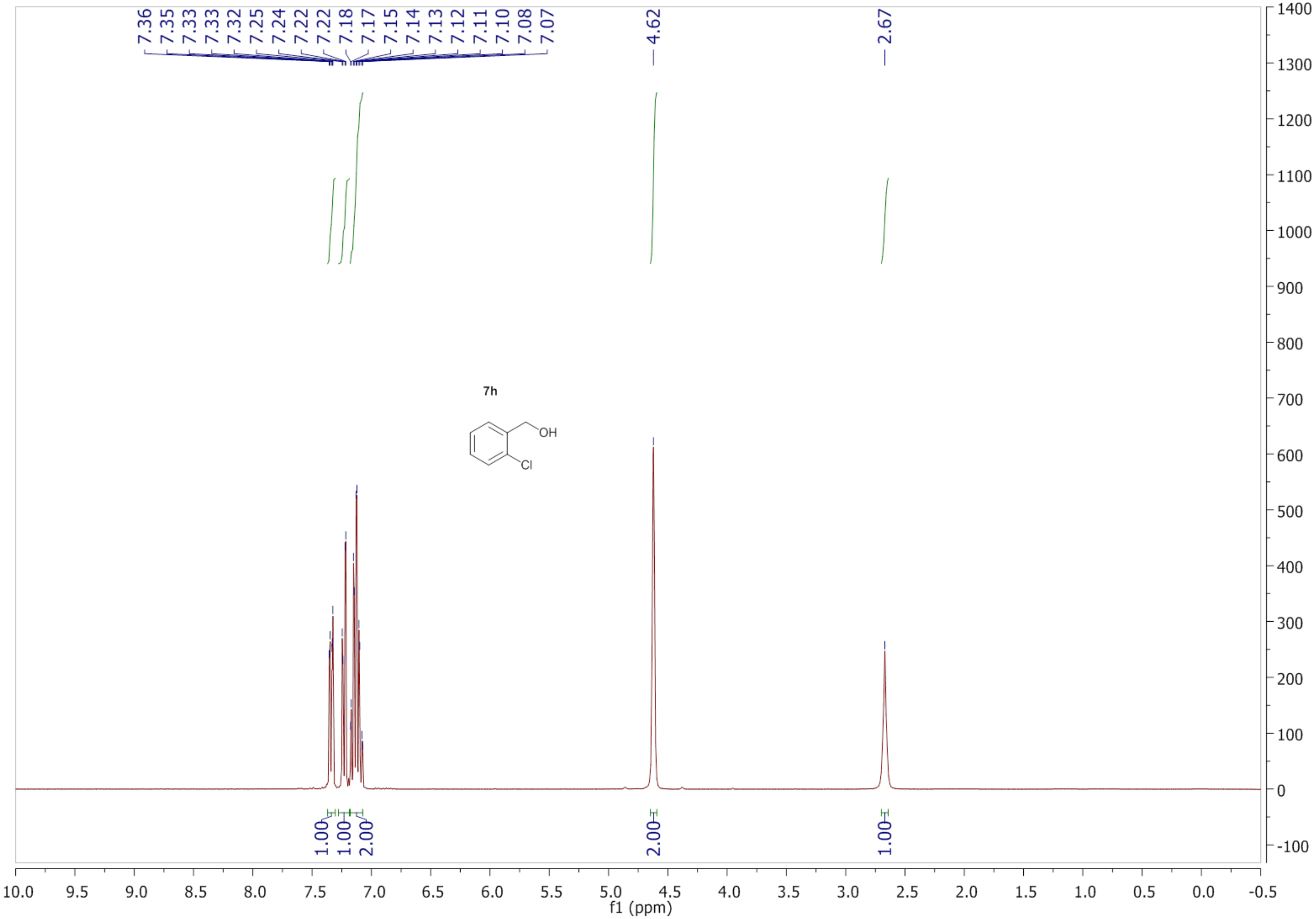
133.44
128.77
128.39
64.60
7g
OH
Cl
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

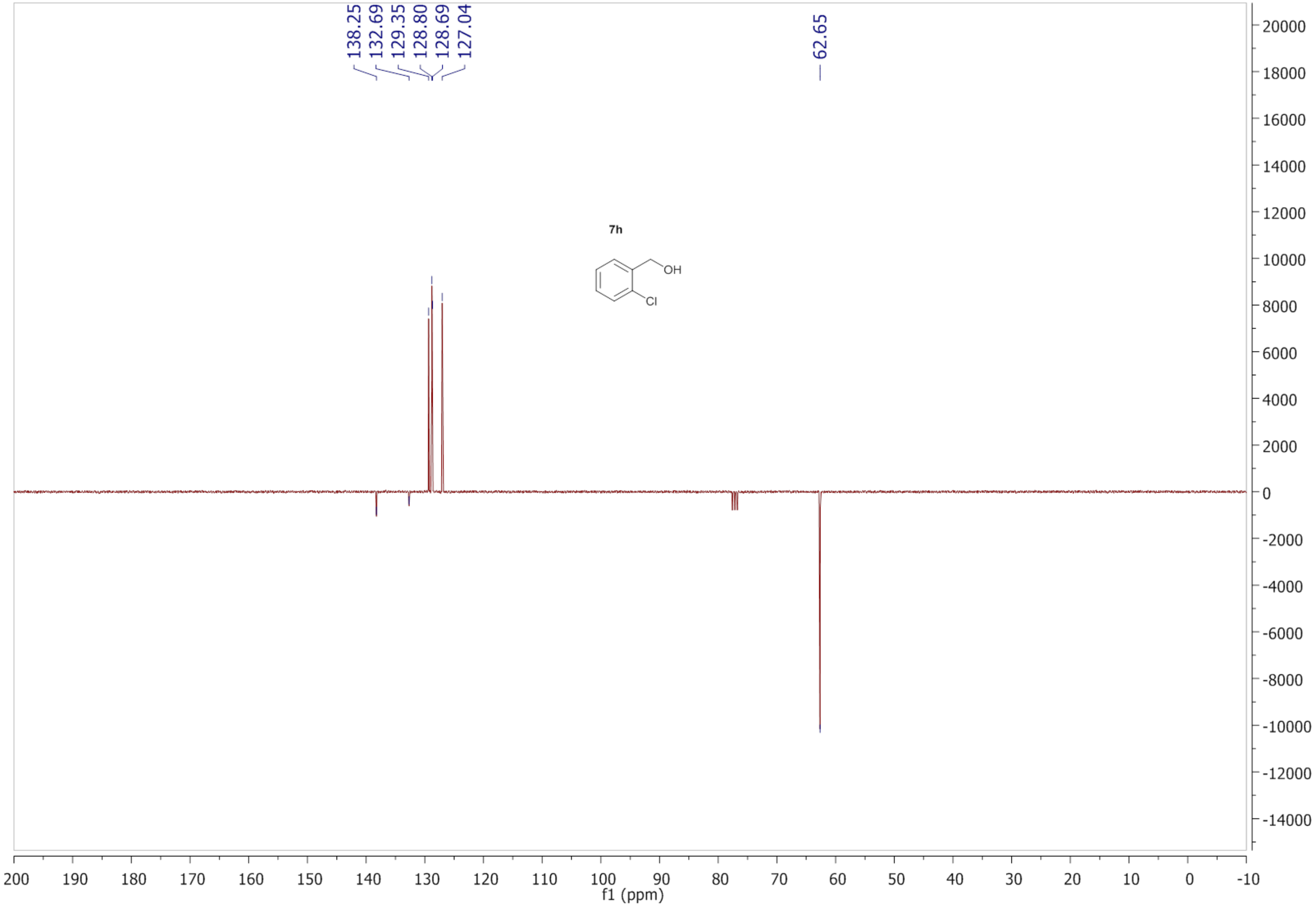

10.37
7.82
7.82
7.82
7.82
7.82
7.80
7.80
7.80
7.79
7.47
7.47
7.46
7.44
7.44
7.44
7.42
7.41
7.41
7.37
7.36
7.36
7.33
7.33
7.32
7.32
7.29
7.29
7.27
6h
O
H
Cl
1.00
1.00
1.00
2.16
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200


189.31
137.62
134.93
132.28
130.41
129.15
127.12
6h
O
H
Cl
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)



7h

7.36
7.35
7.33
7.33
7.32
7.25
7.24
7.22
7.22
7.18
7.17
7.15
7.14
7.13
7.12
7.11
7.10
7.08
7.07
4.62
2.67
OH
Cl
1.00
1.00
2.00
2.00
1.00
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
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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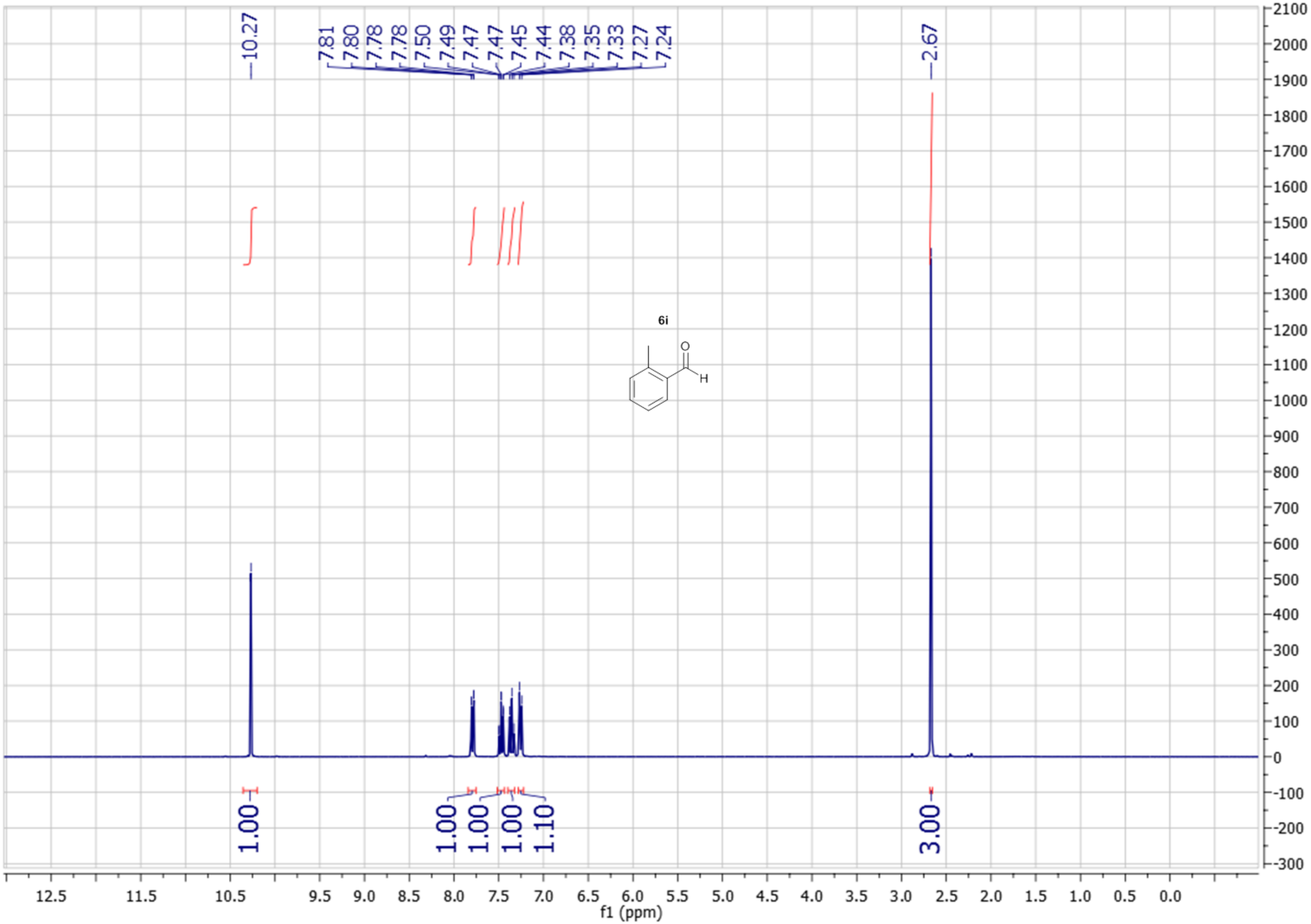
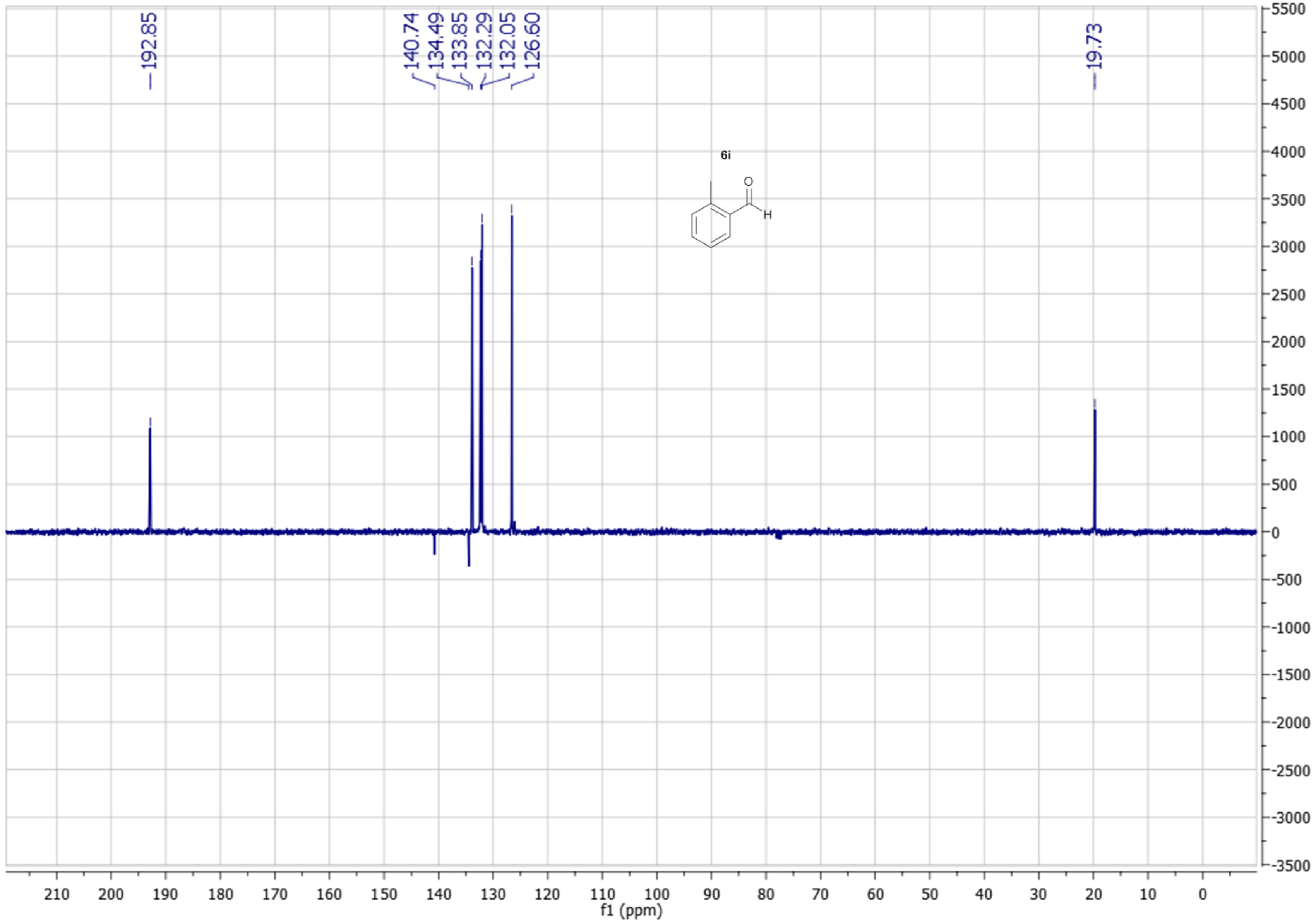
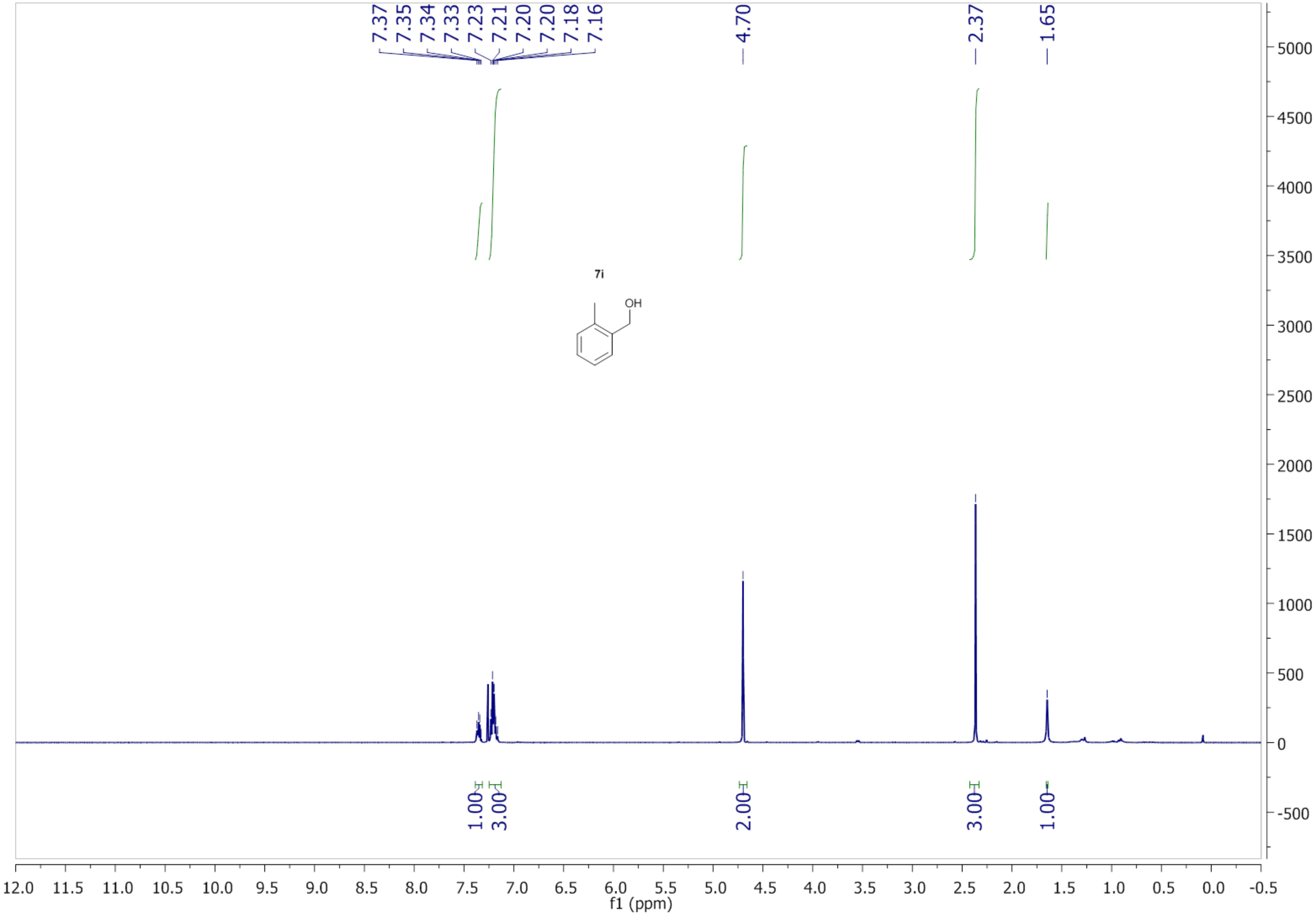
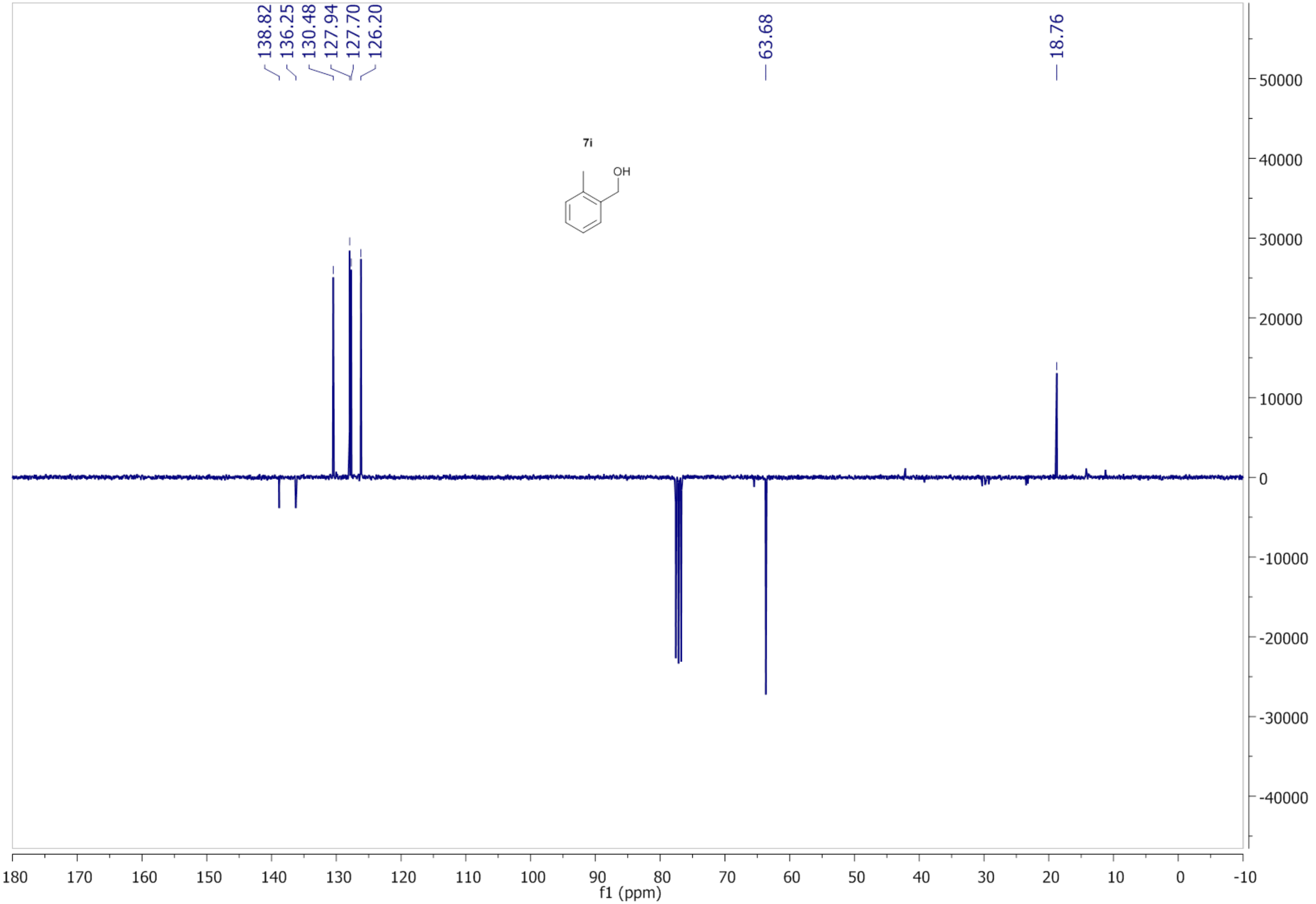
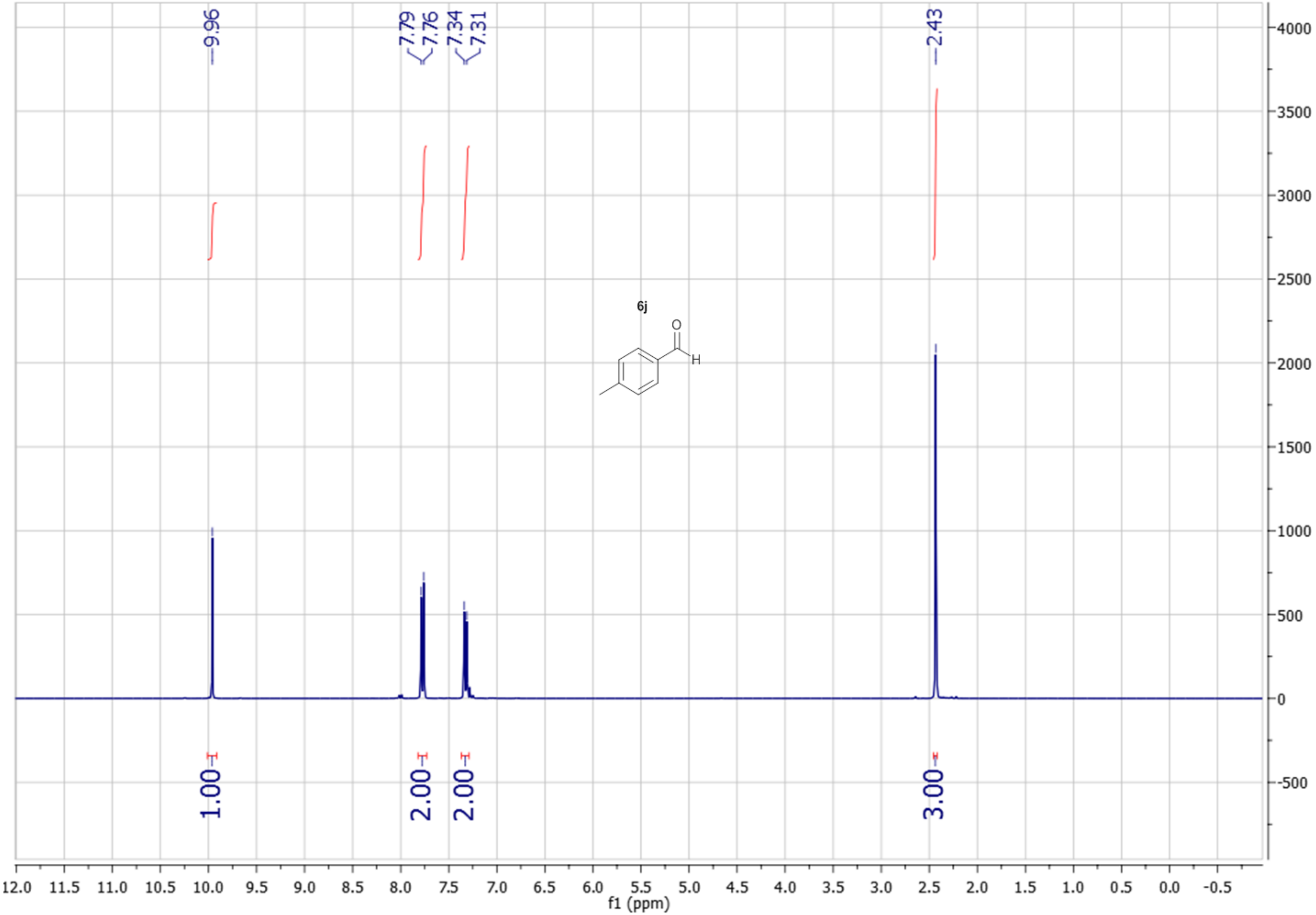
132.69
129.35
128.80
128.69
127.04
62.65
7h
OH
Cl
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
-14000
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

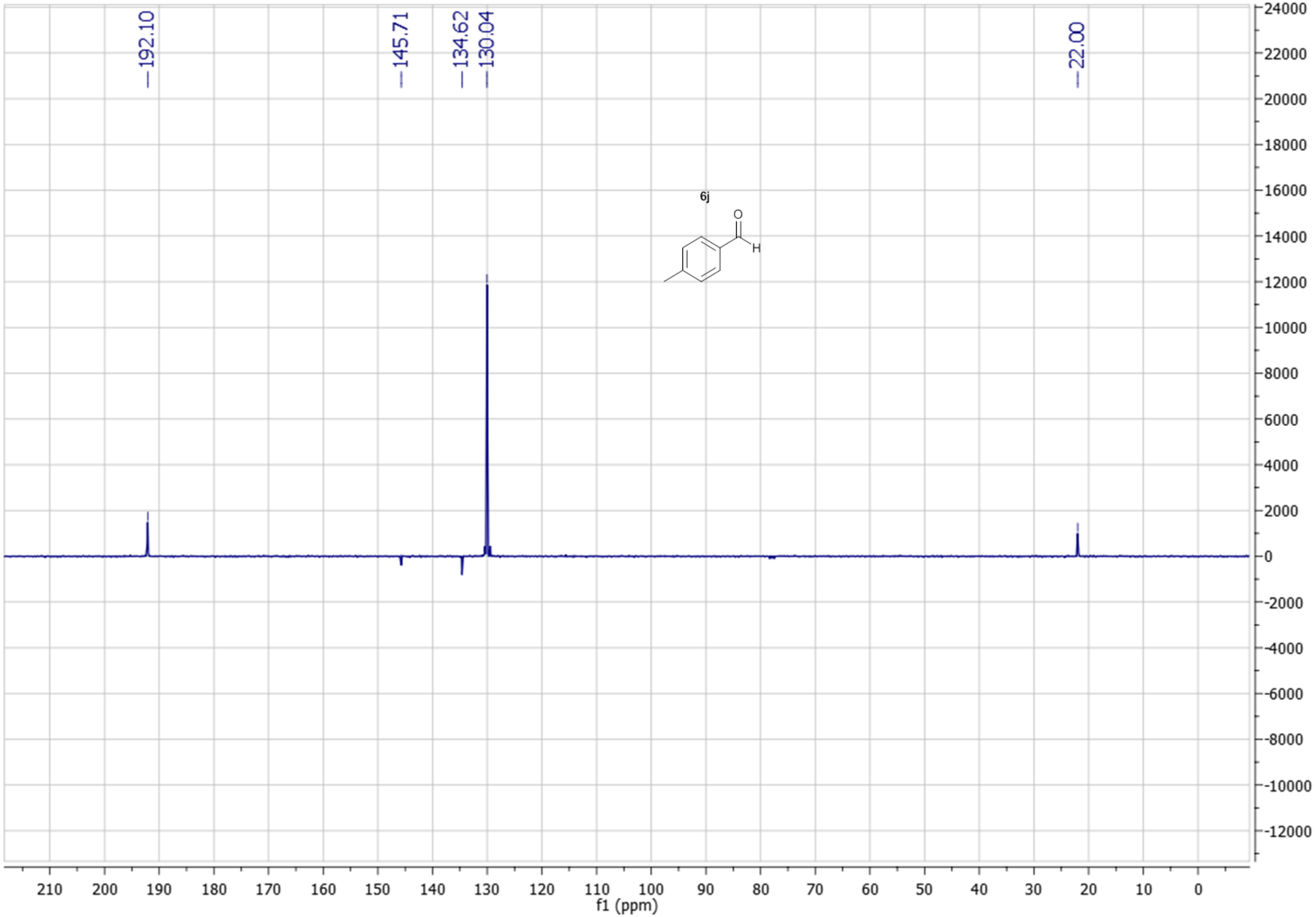

10.27
7.81
7.80
7.78
7.78
7.50
7.49
7.47
7.47
7.45
7.44
7.38
7.35
7.33
7.27
7.24
2.67
6i
O
H
1.00
1.00
1.00
1.00
1.10
3.00
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200
-300

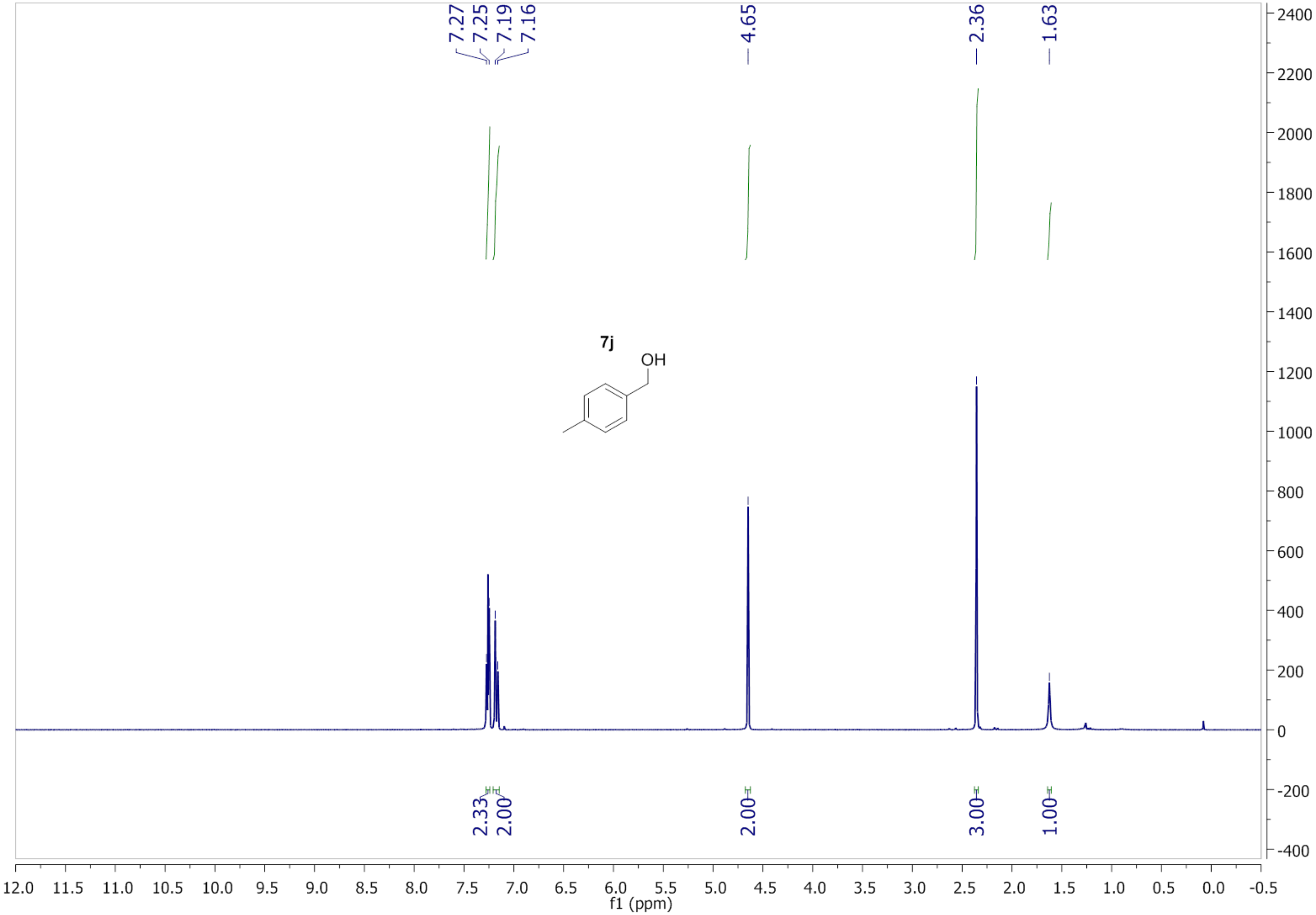

192.85
140.74
134.49
133.85
132.29
132.05
126.60
19.73
6i
O
H
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000
-3500
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

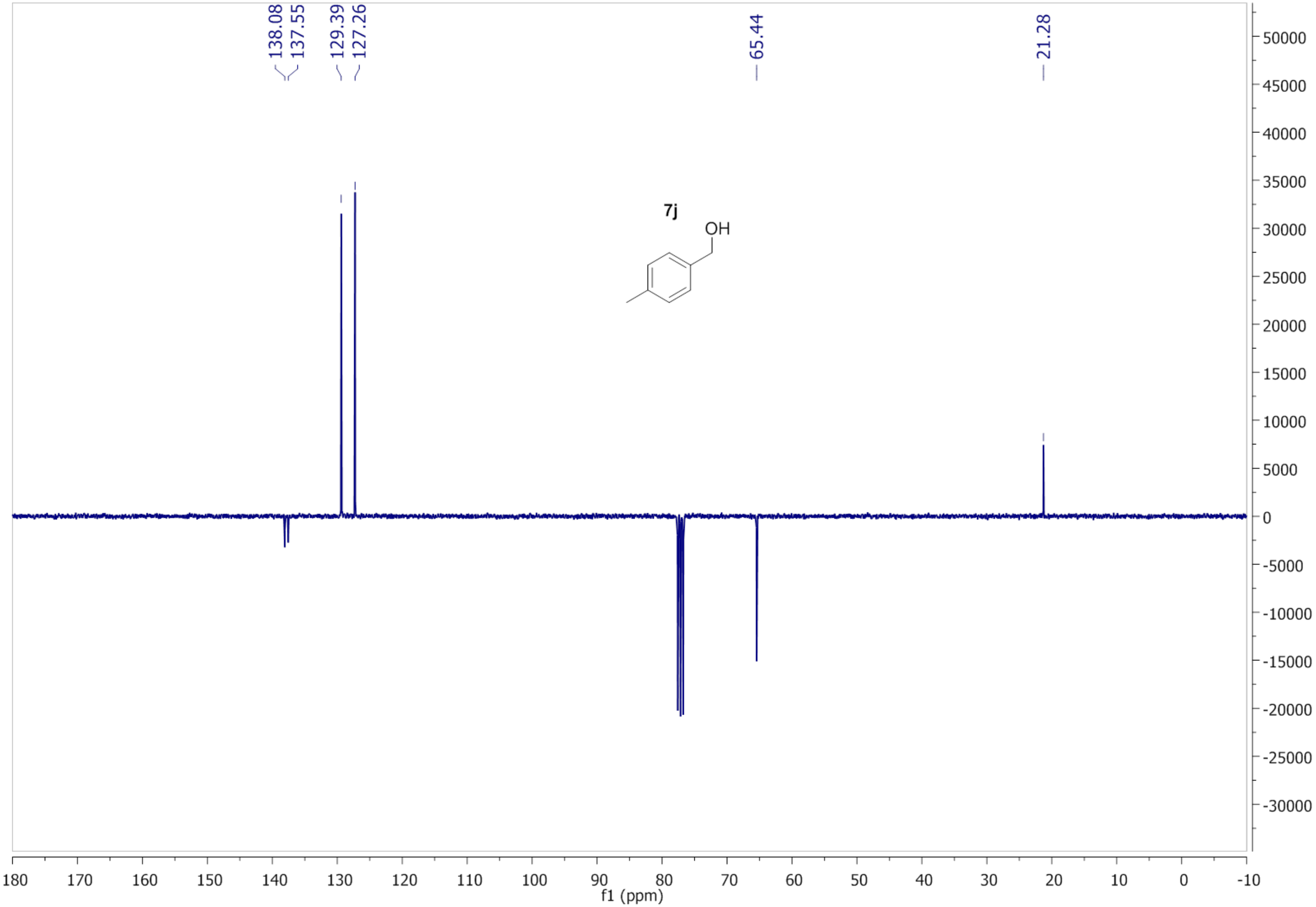

7.37
7.35
7.34
7.33
7.23
7.21
7.20
7.20
7.18
7.16
4.70
2.37
1.65
7i
OH
1.00
3.00
2.00
3.00
1.00
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

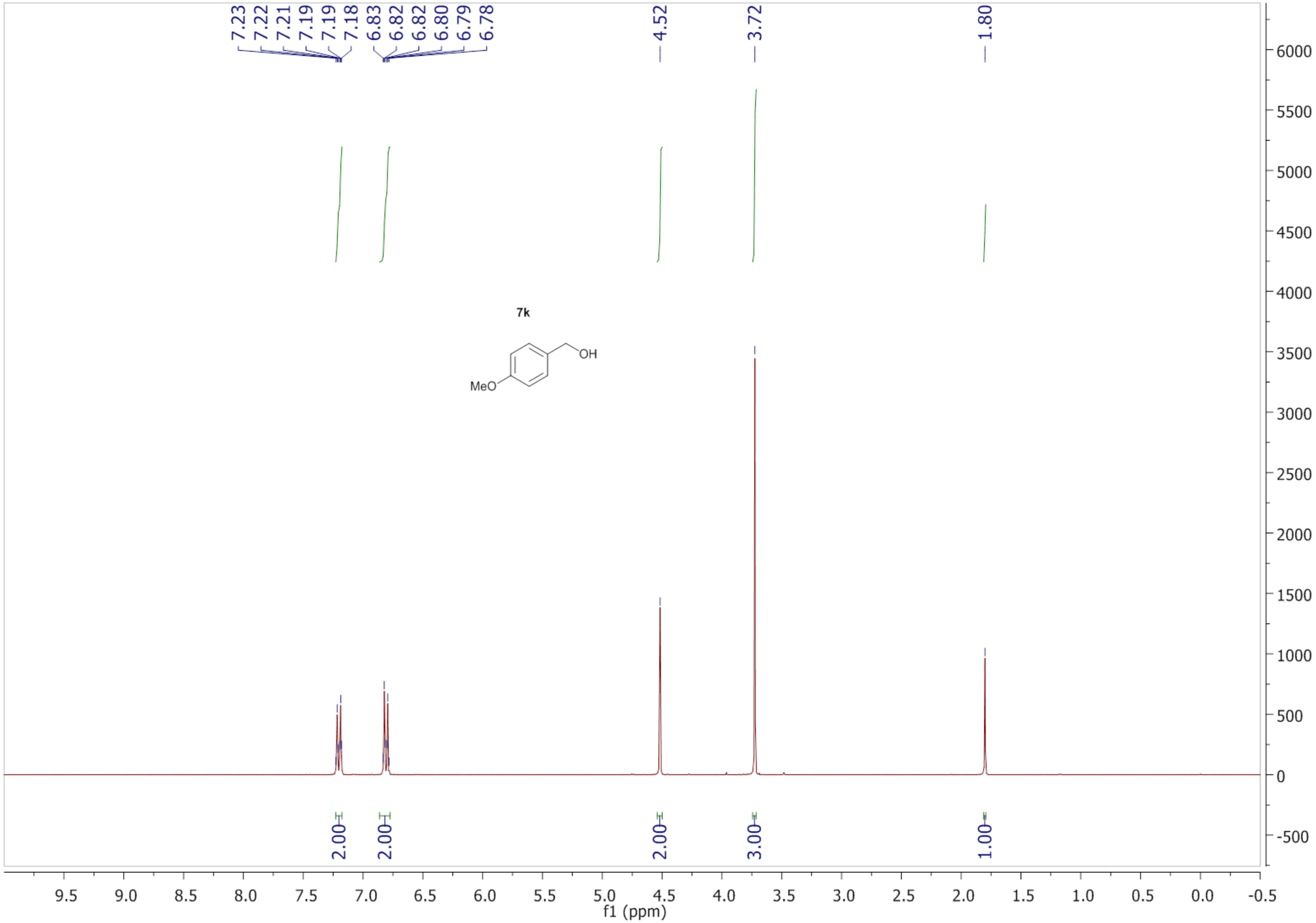

138.82
136.25
130.48
127.94
127.70
126.20
63.68
18.76
7i
OH
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


9.96
7.79
7.76
7.34
7.31
2.43
6j
O
H
1.00
2.00
2.00
3.00
4000
3500
3000
2500
2000
1500
1000
500
0
-500
12.0 11.5 11.0 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)

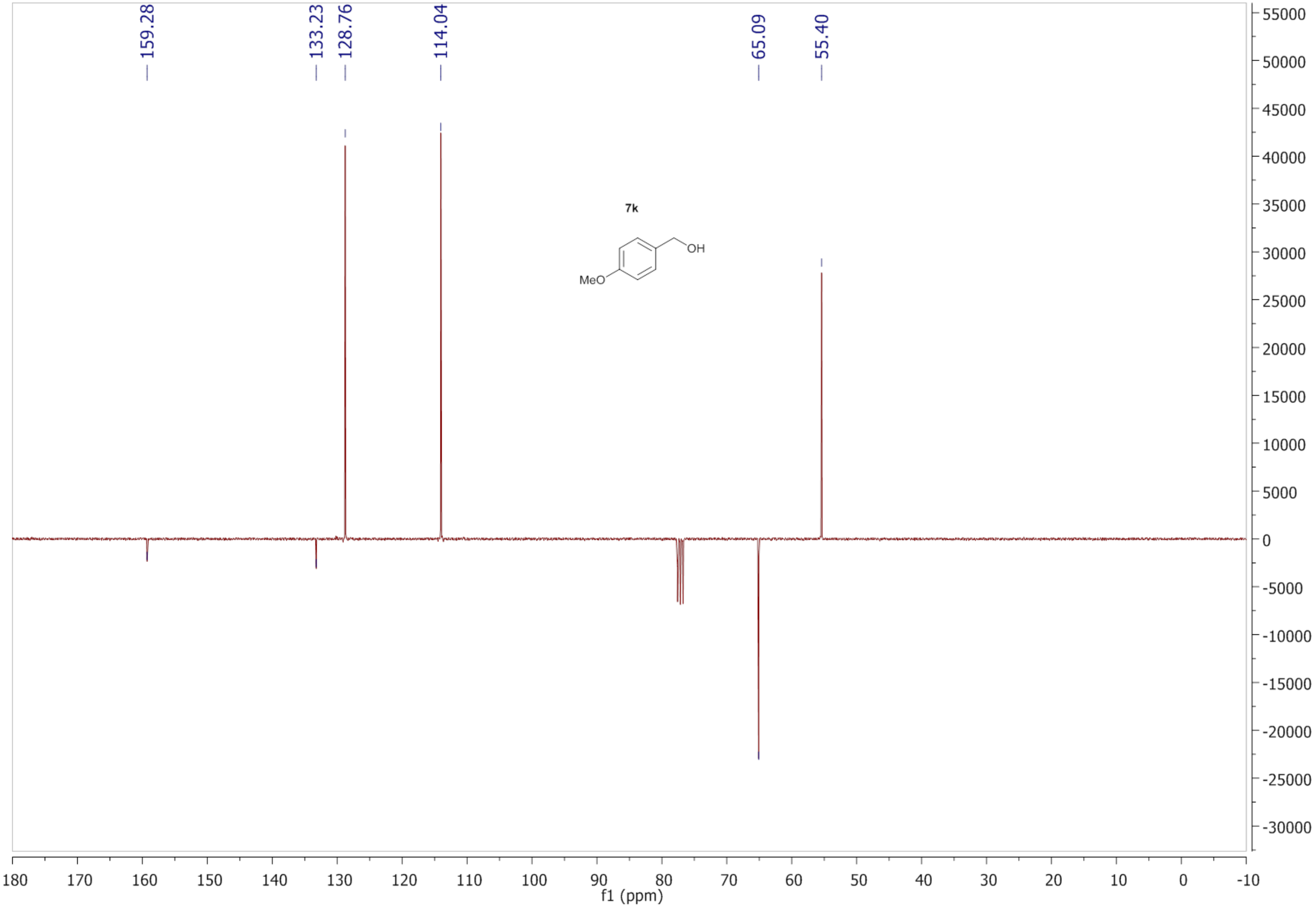

192.10
145.71
134.62
130.04
22.00
6j
O
H
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.27
7.25
7.19
7.16
4.65
2.36
1.63
7j
OH
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
-400
2.33
2.00
2.00
3.00
1.00
12.0
11.5
11.0
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)


138.08
137.55
129.39
127.26
65.44
21.28
7j
OH
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7k

7.23
7.22
7.21
7.19
7.19
7.18
6.83
6.82
6.82
6.80
6.79
6.78
4.52
3.72
1.80
MeO
OH
2.00
2.00
2.00
3.00
1.00
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
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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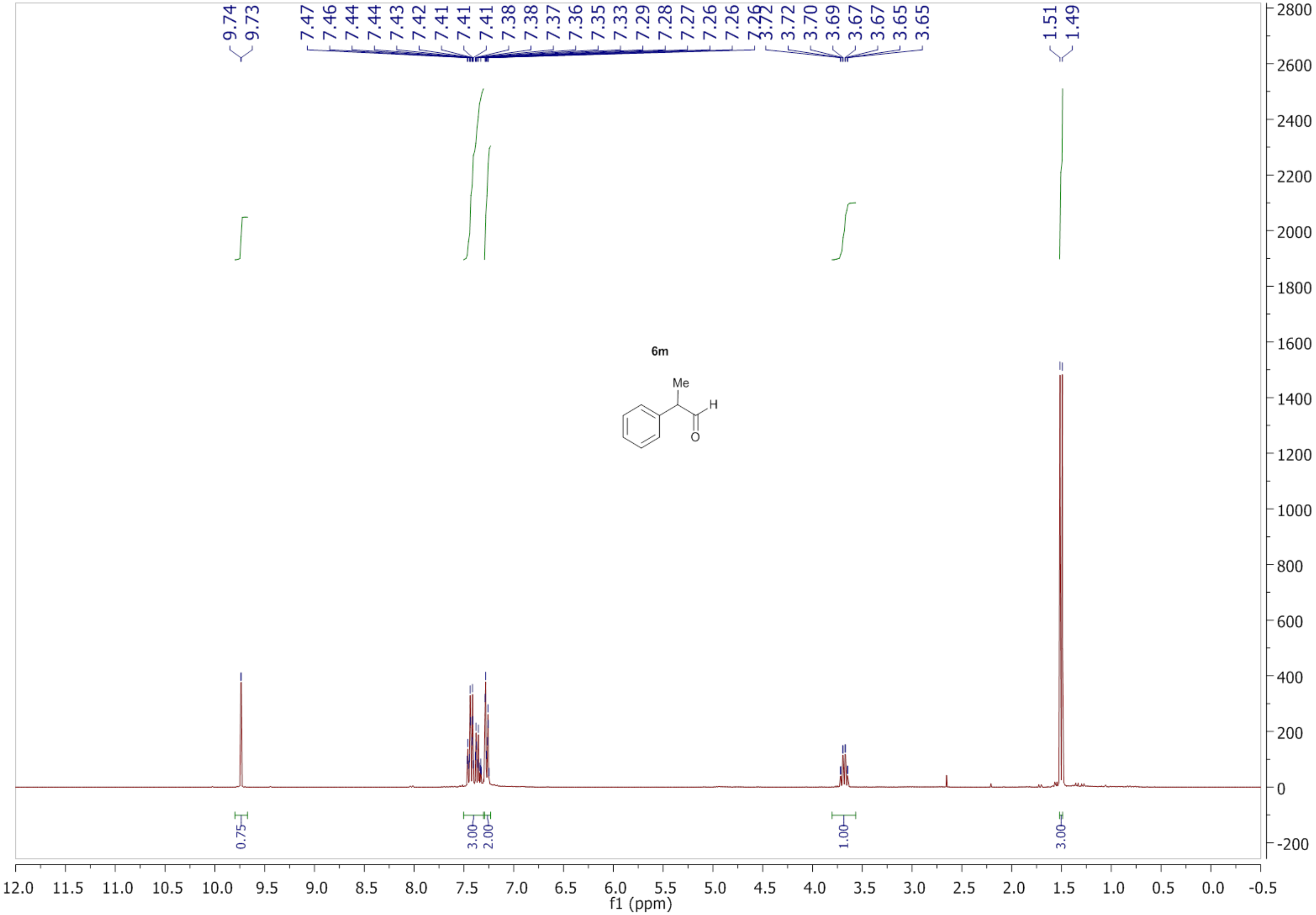
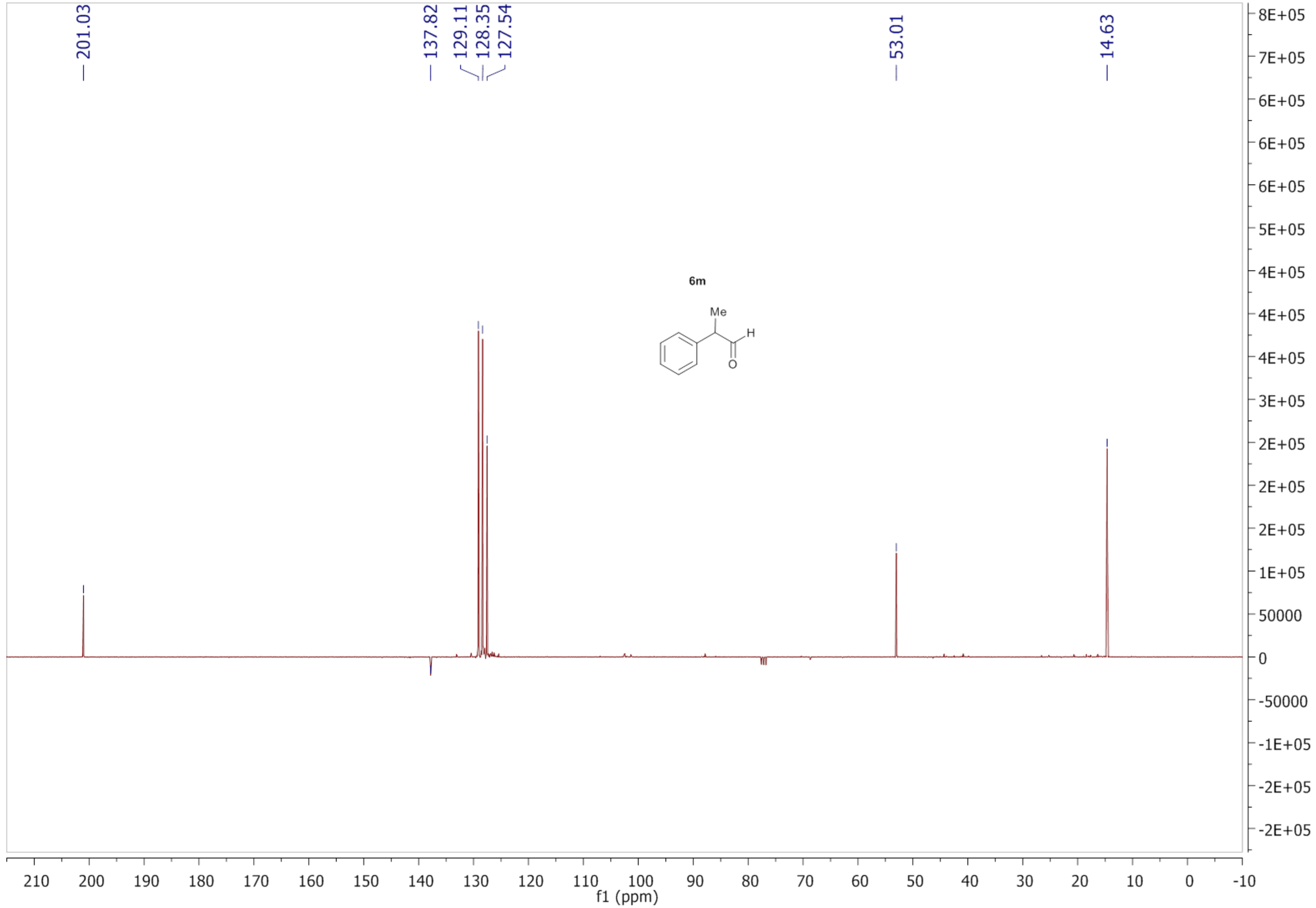
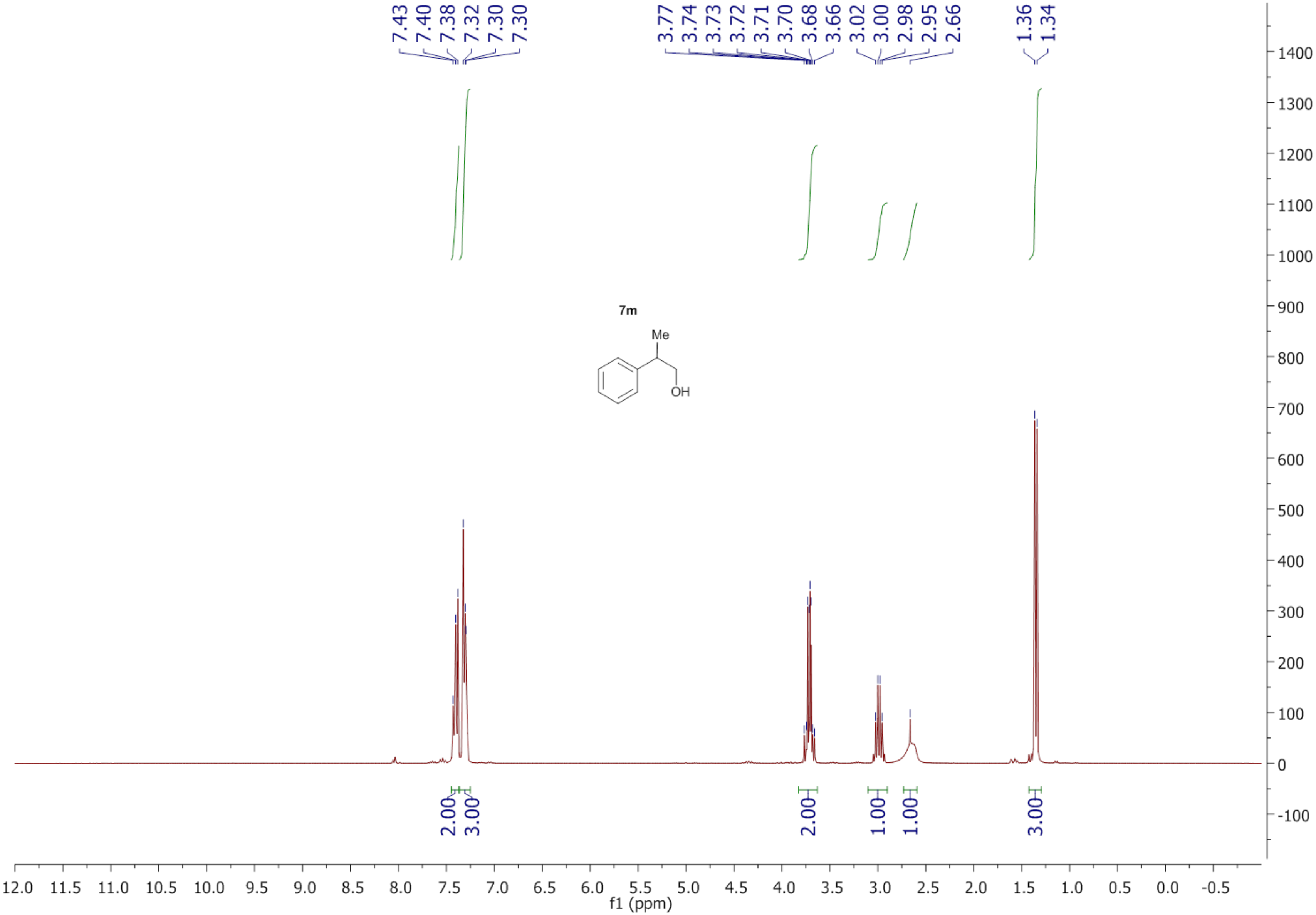
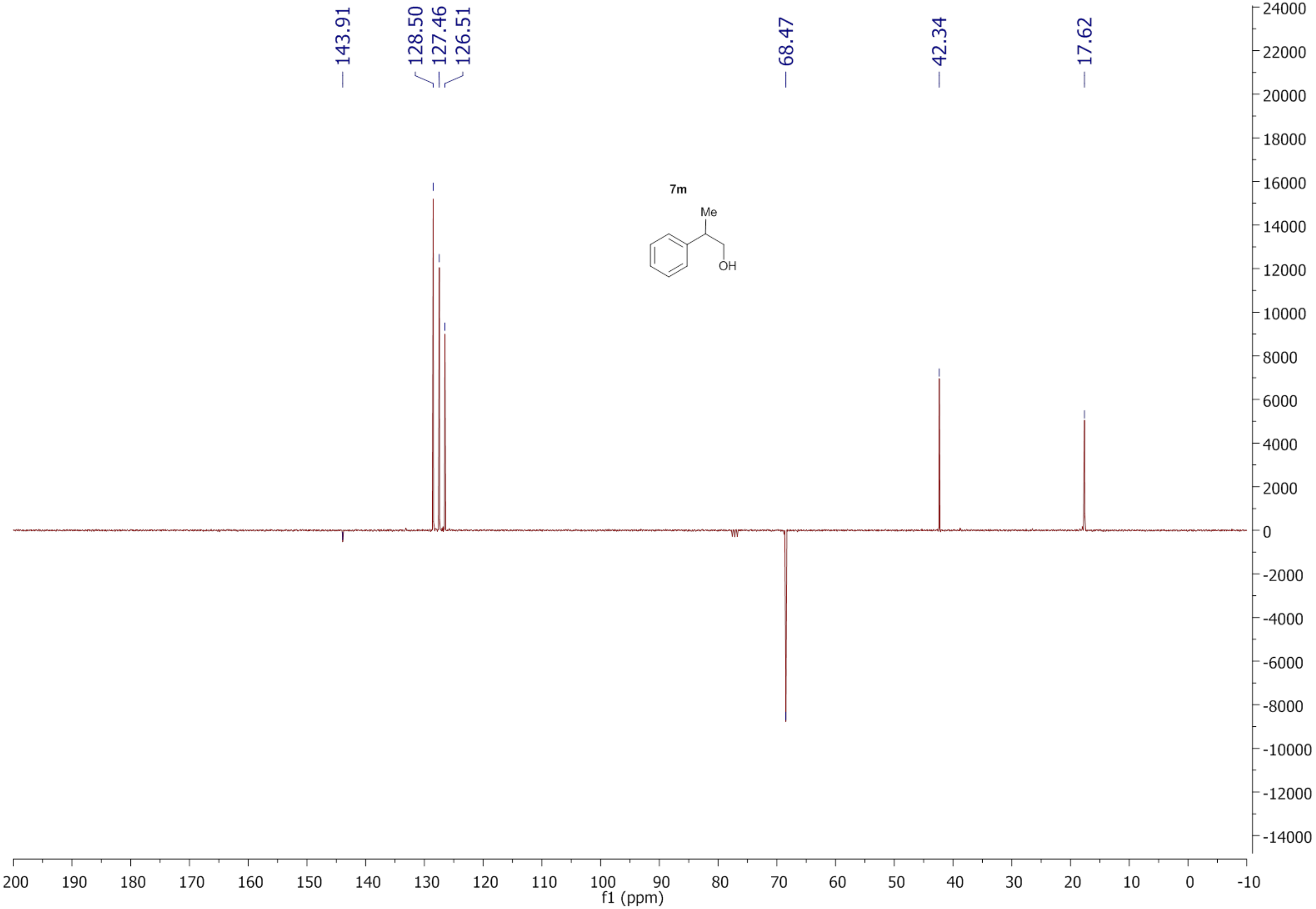
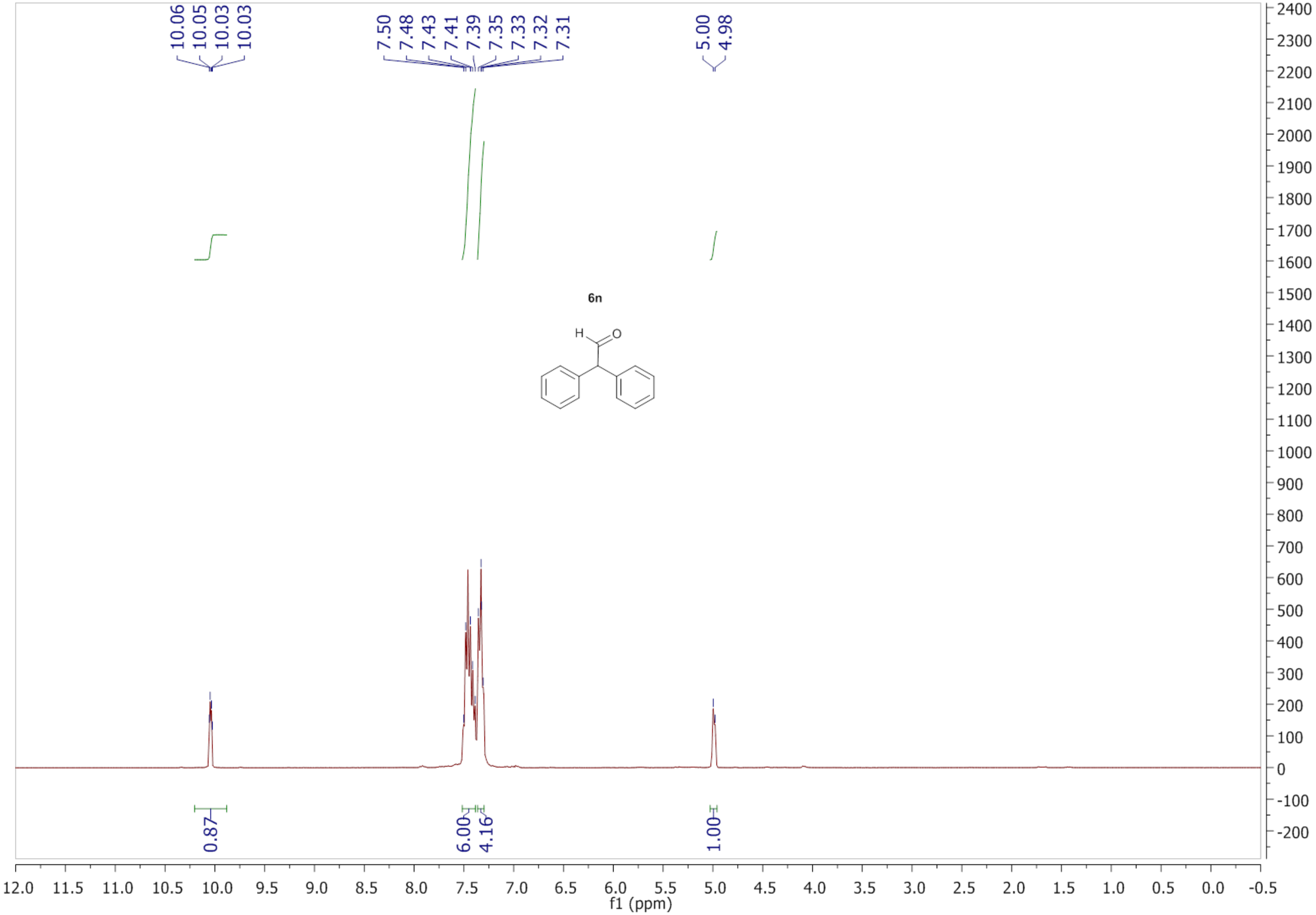
133.23
128.76
114.04
65.09
55.40
7k
MeO
OH
55000
50000
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

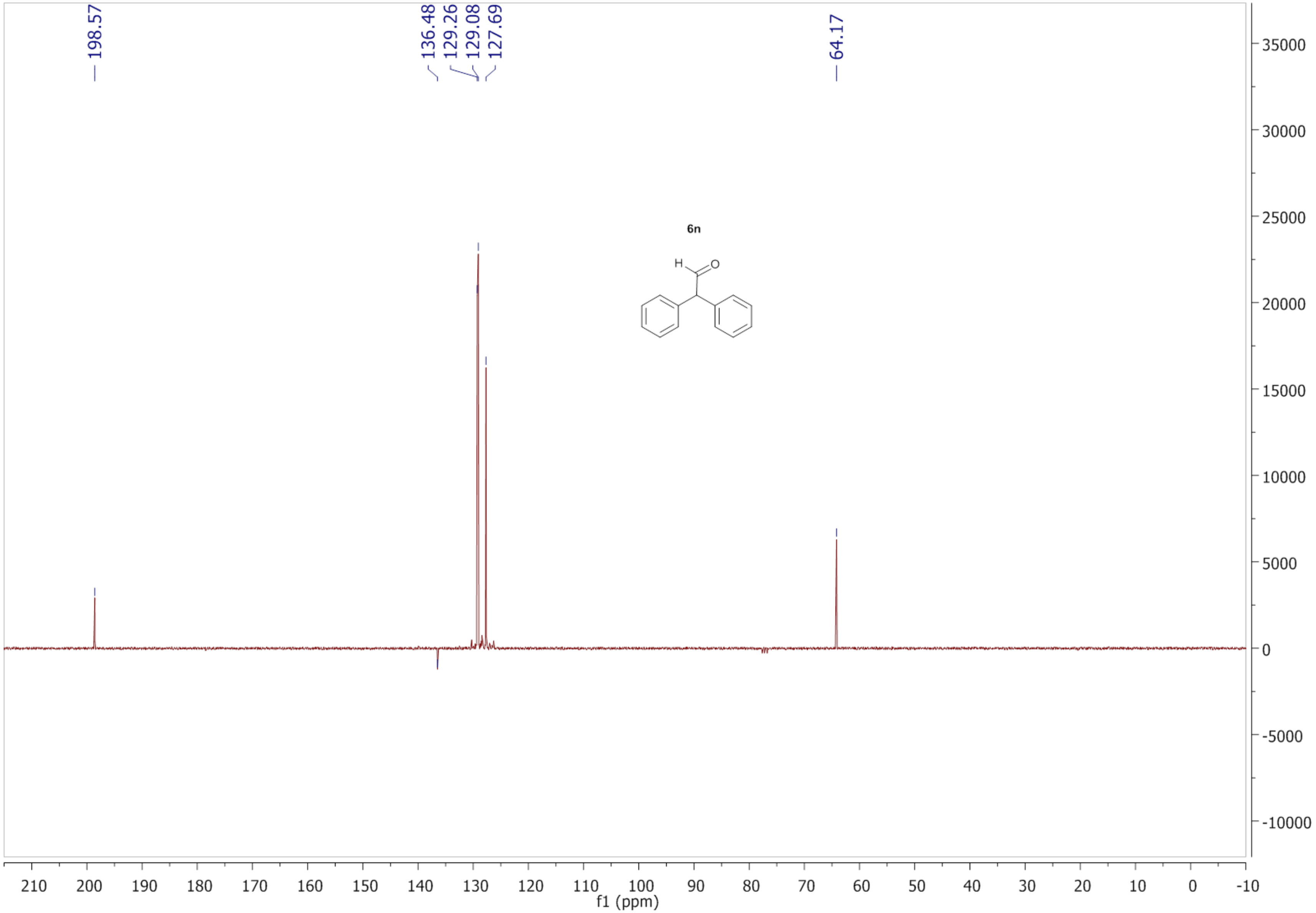

9.74
9.73
7.47
7.46
7.44
7.44
7.43
7.42
7.41
7.41
7.41
7.38
7.38
7.37
7.36
7.35
7.33
7.29
7.28
7.27
7.26
7.26
7.26
3.72
3.72
3.70
3.69
3.67
3.67
3.65
3.65
1.51
1.49
6m
Me
H
O
0.75
3.00
2.00
1.00
3.00
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
200
0
-200
12.0
11.5
11.0
10.5
10.0
9.5
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)

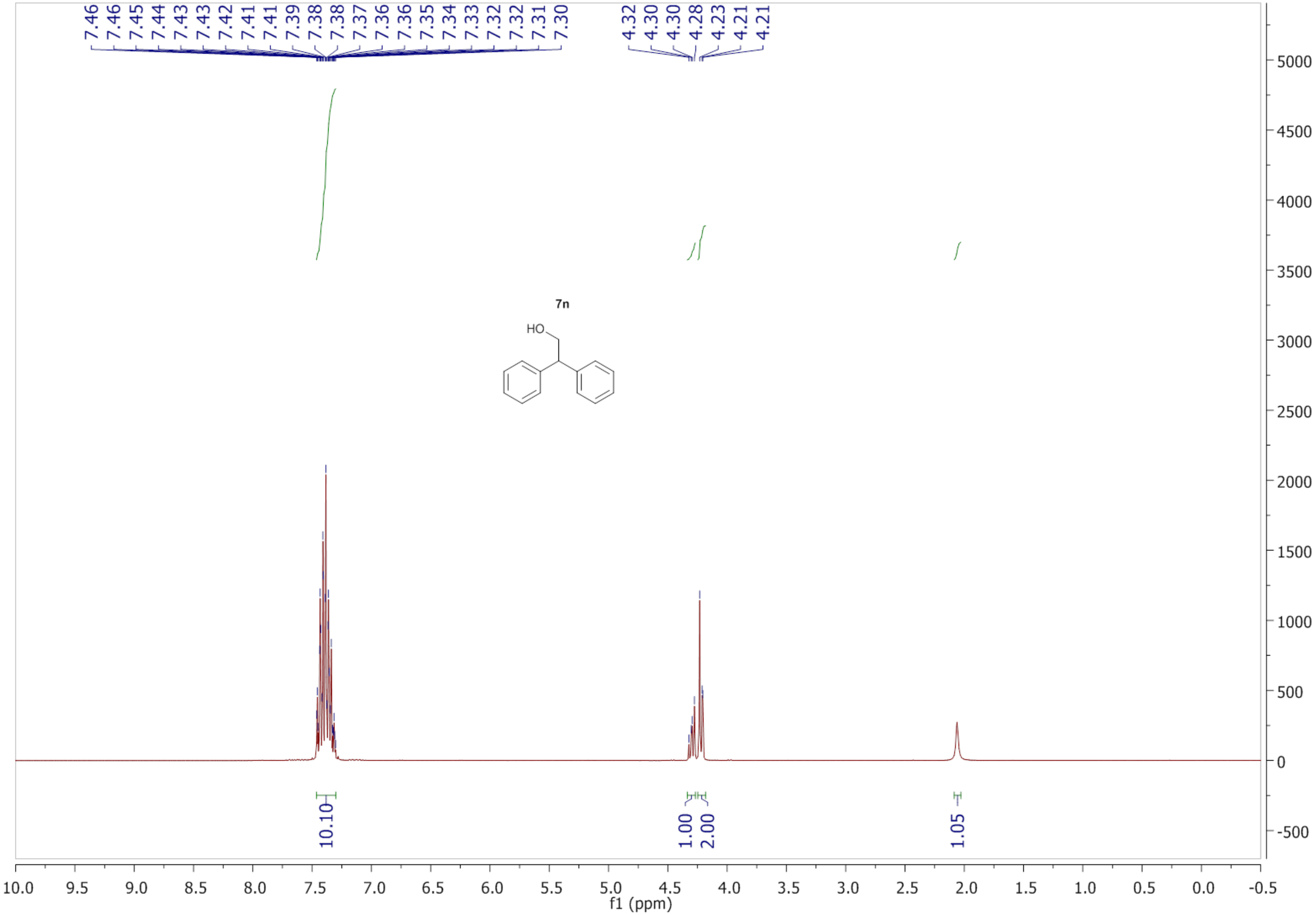

201.03
137.82
129.11
128.35
127.54
53.01
14.63
6m
Me
H
O
8E+05
7E+05
6E+05
6E+05
6E+05
5E+05
4E+05
4E+05
4E+05
3E+05
2E+05
2E+05
2E+05
1E+05
50000
0
-50000
-1E+05
-2E+05
-2E+05
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

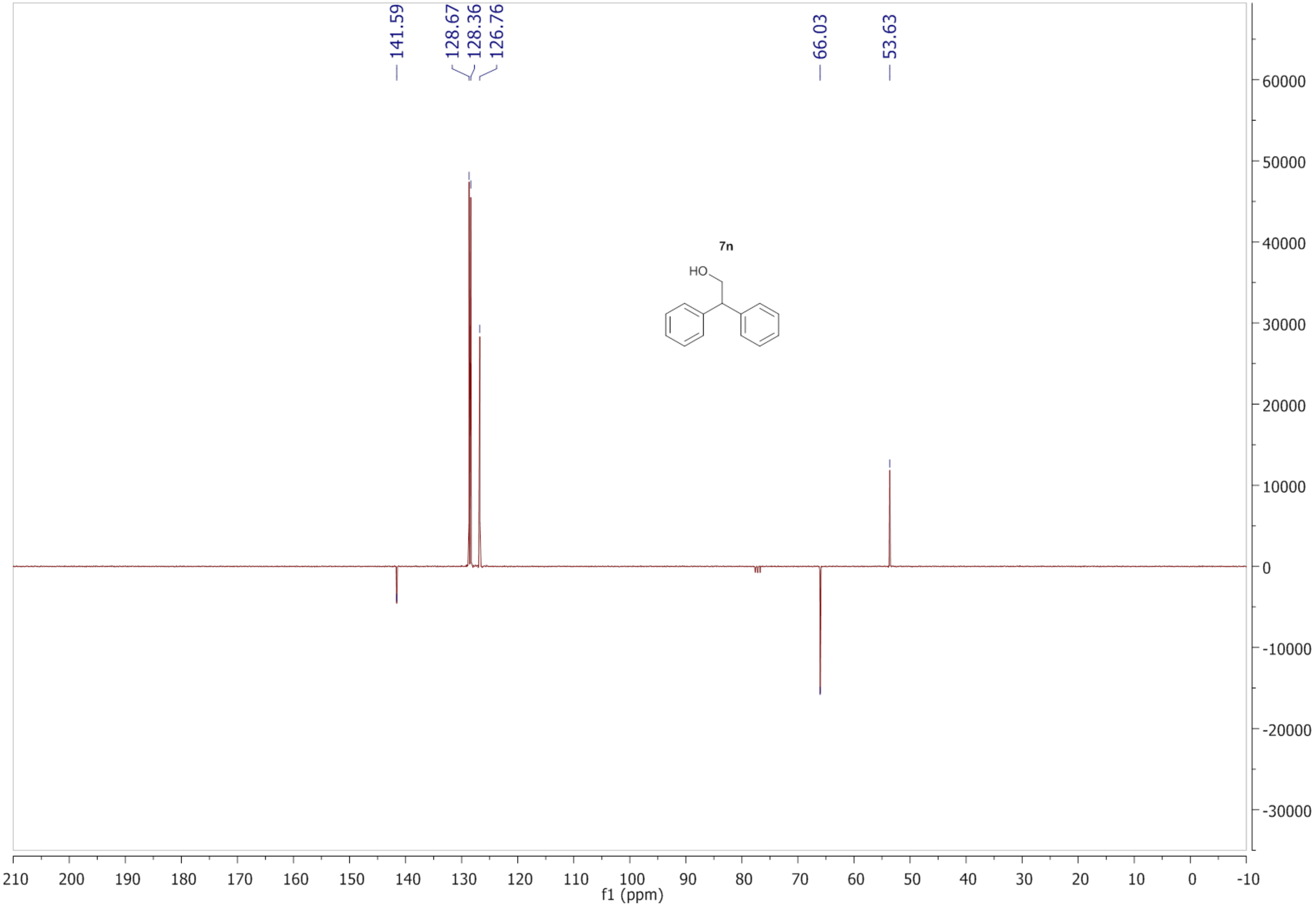

7.43
7.40
7.38
7.32
7.30
7.30
3.77
3.74
3.73
3.72
3.71
3.70
3.68
3.66
3.02
3.00
2.98
2.95
2.66
1.36
1.34
7m
Me
OH
2.00
3.00
2.00
1.00
1.00
3.00
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

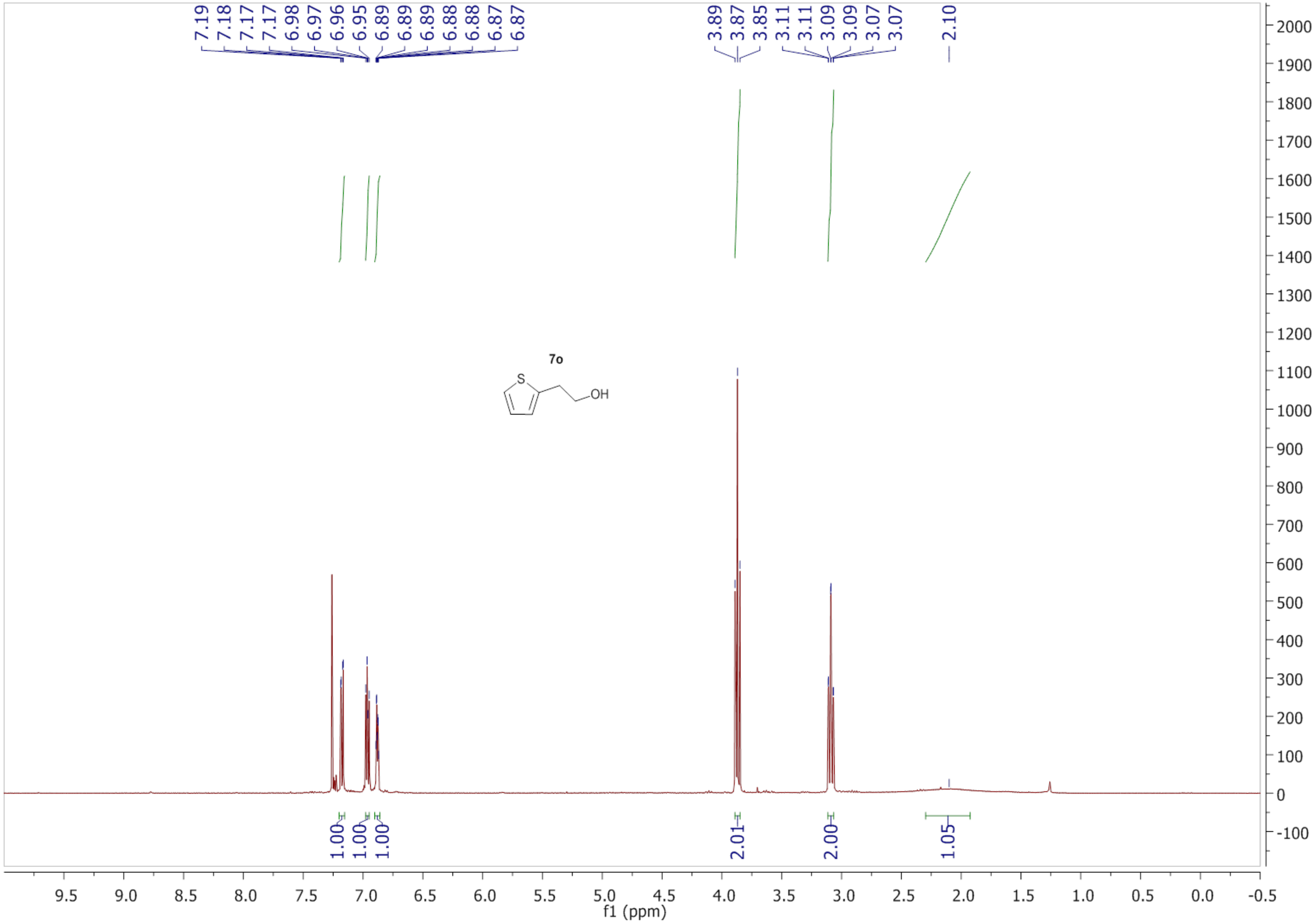

143.91
128.50
127.46
126.51
68.47
42.34
17.62
7m
Me
OH
24000
22000
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
-14000
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

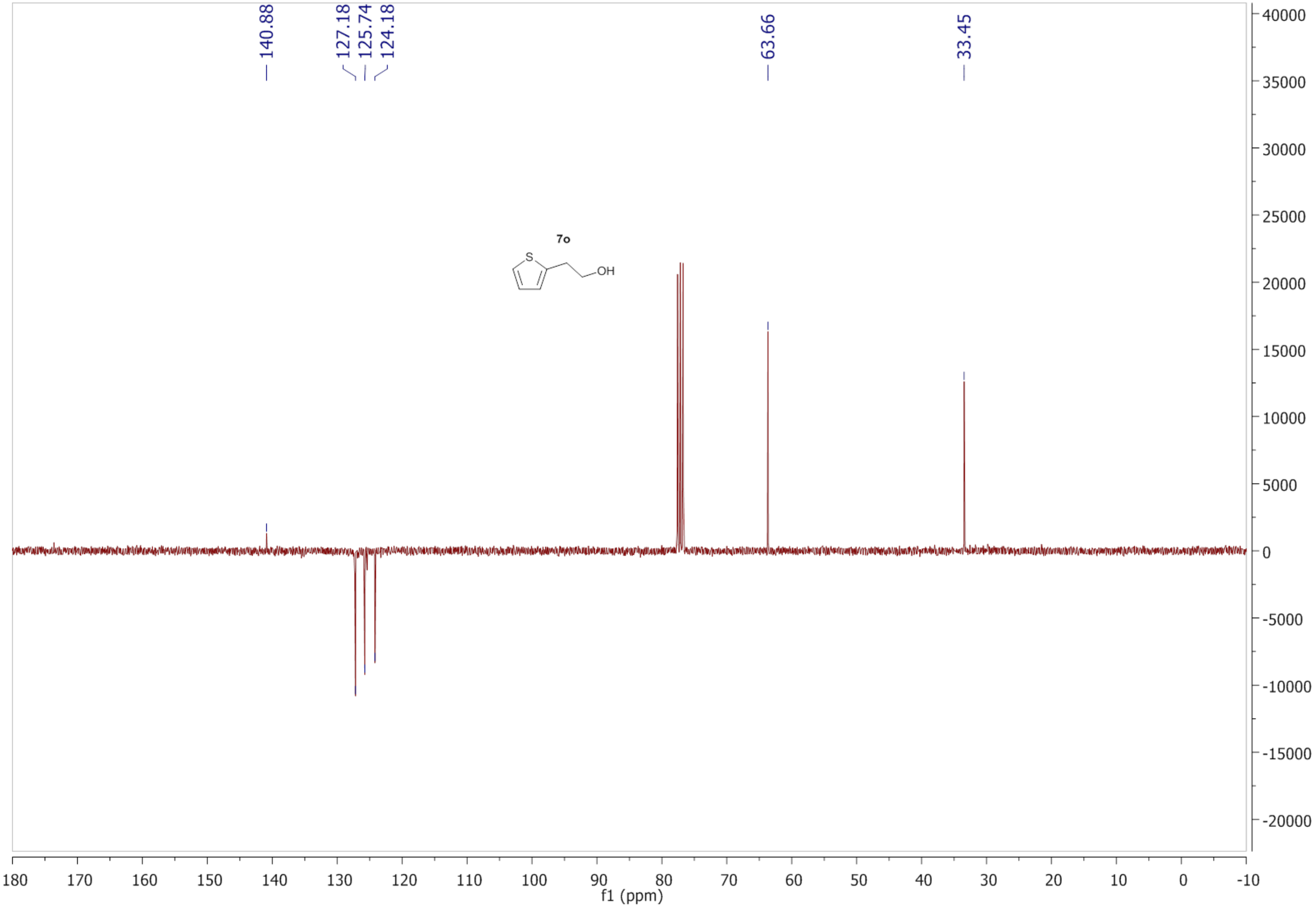

10.06
10.05
10.03
10.03
7.50
7.48
7.43
7.41
7.39
7.35
7.33
7.32
7.31
5.00
4.98
6n
H
O
0.87
6.00
4.16
1.00
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
-200

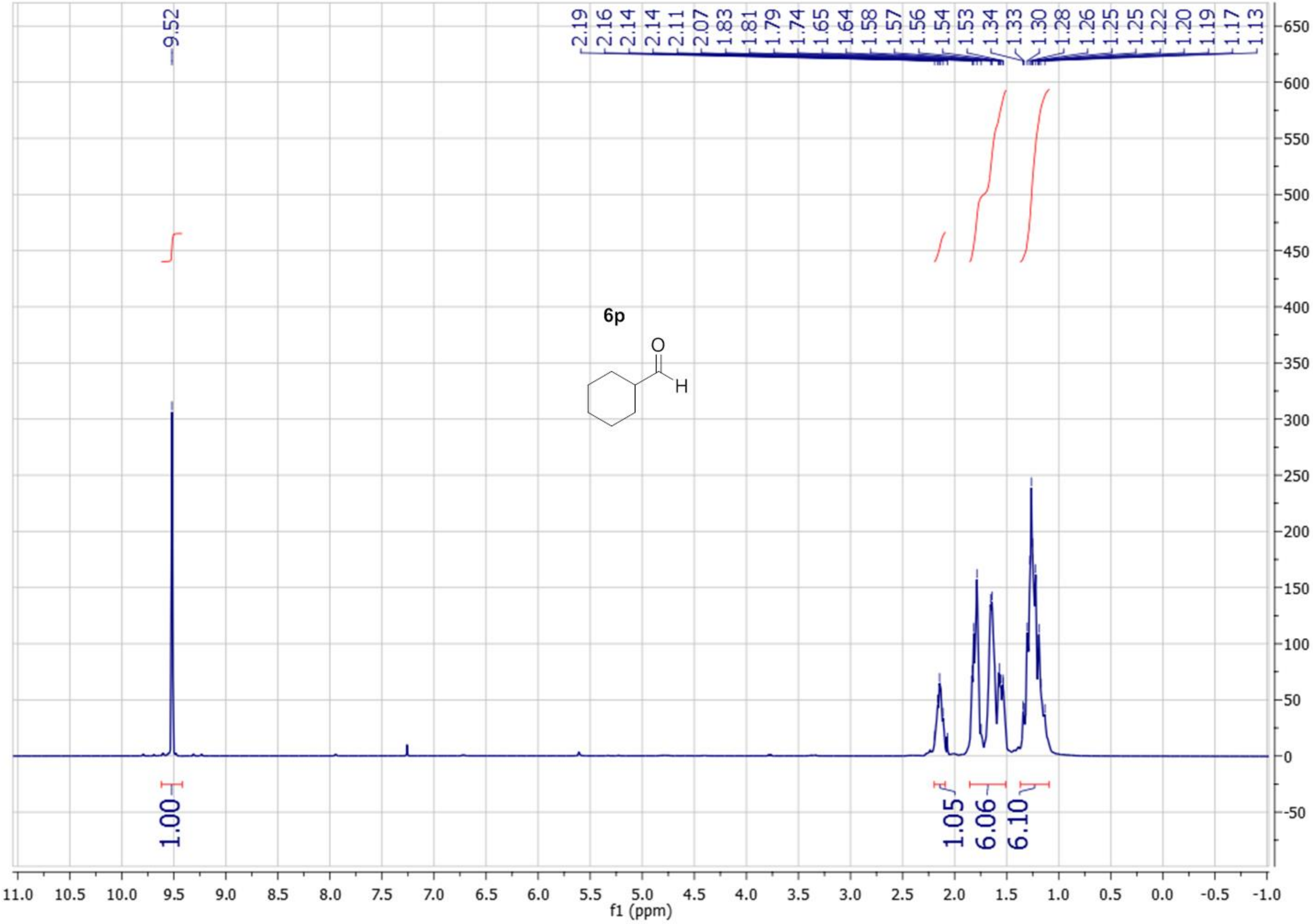

198.57
136.48
129.26
129.08
127.69
64.17
6n
H
O
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

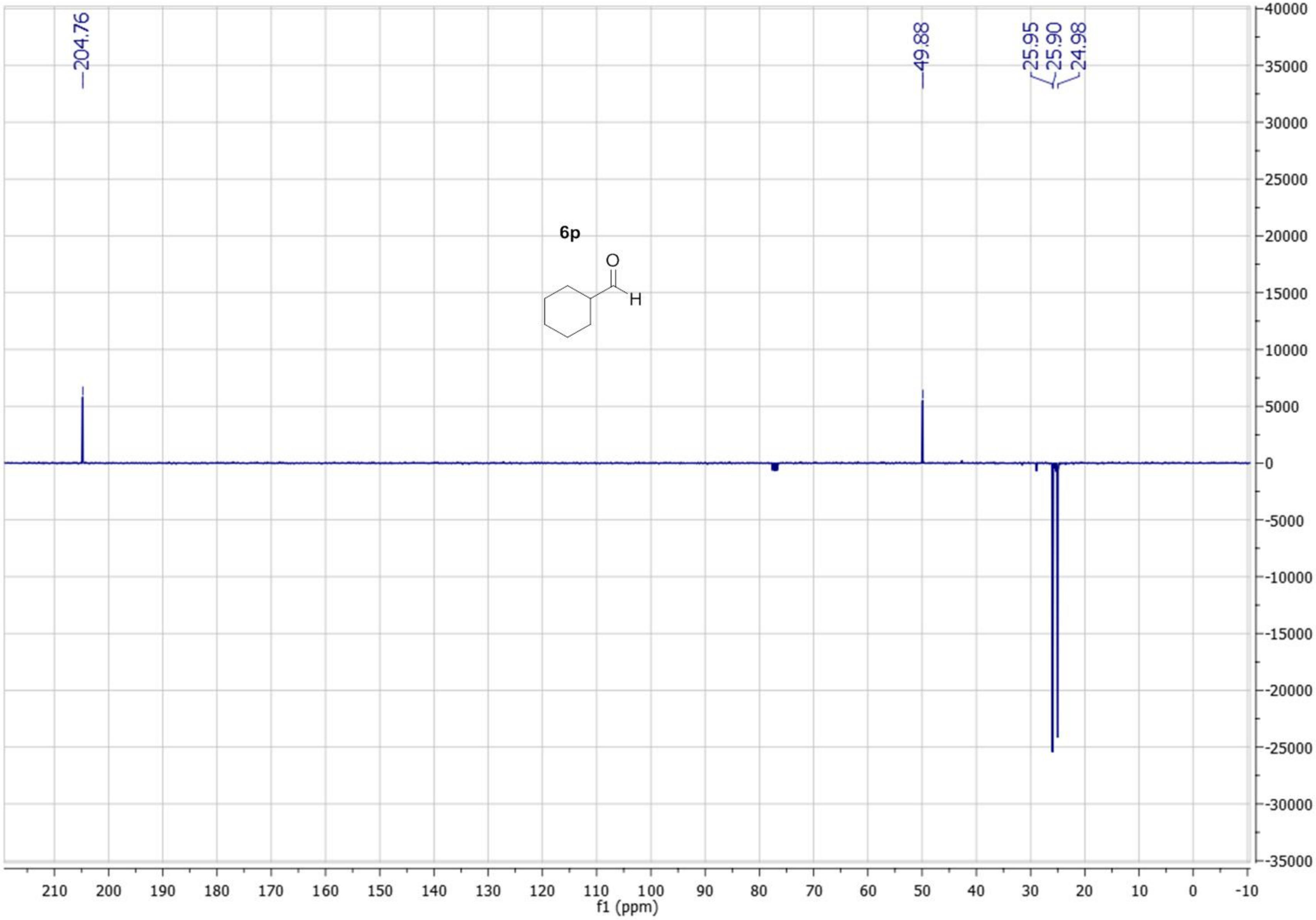

7.46
7.46
7.45
7.44
7.43
7.43
7.42
7.41
7.41
7.39
7.38
7.38
7.37
7.36
7.36
7.35
7.34
7.33
7.32
7.32
7.31
7.30
4.32
4.30
4.30
4.28
4.23
4.21
4.21
7n
HO
10.10
1.00
2.00
1.05
f1 (ppm)
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500

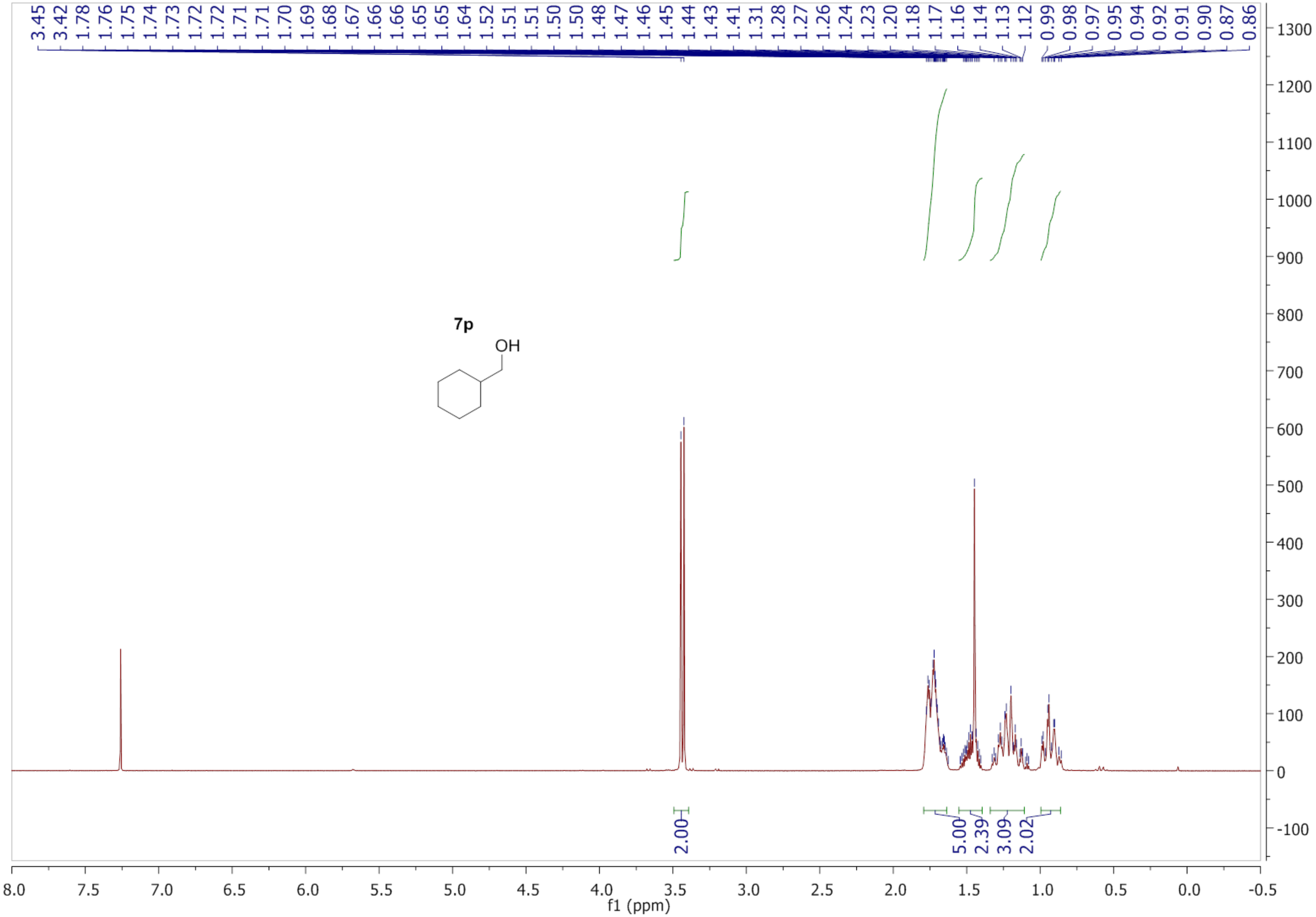

141.59
128.67
128.36
126.76
66.03
53.63
7n
HO
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

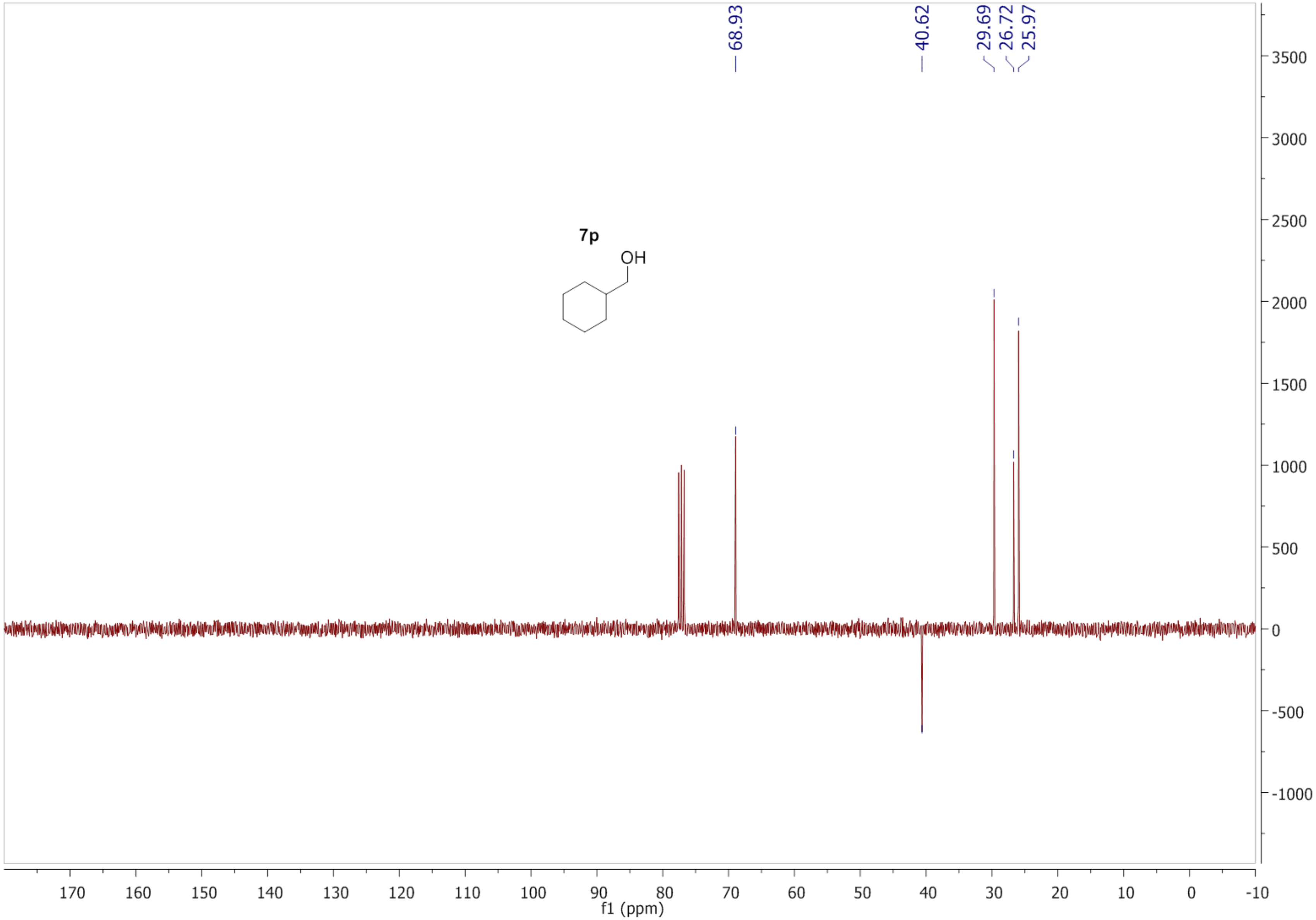

7.19
7.18
7.17
7.17
6.98
6.97
6.96
6.95
6.89
6.89
6.89
6.88
6.88
6.87
6.87
3.89
3.87
3.85
3.11
3.11
3.09
3.09
3.07
3.07
2.10
7o
S
OH
1.00
1.00
1.00
2.01
2.00
1.05
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100

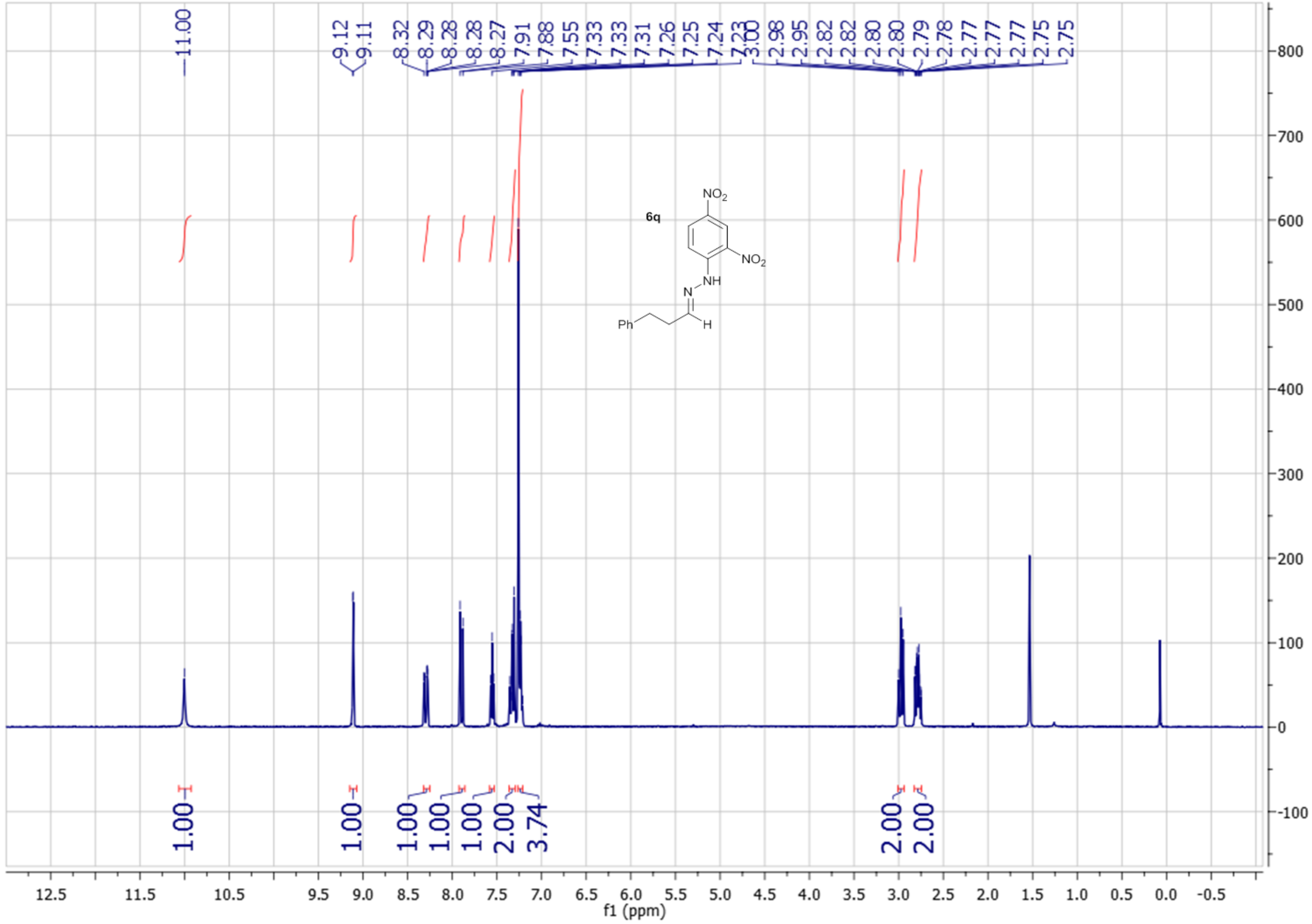

140.88
127.18
125.74
124.18
63.66
33.45
7o
S
OH
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

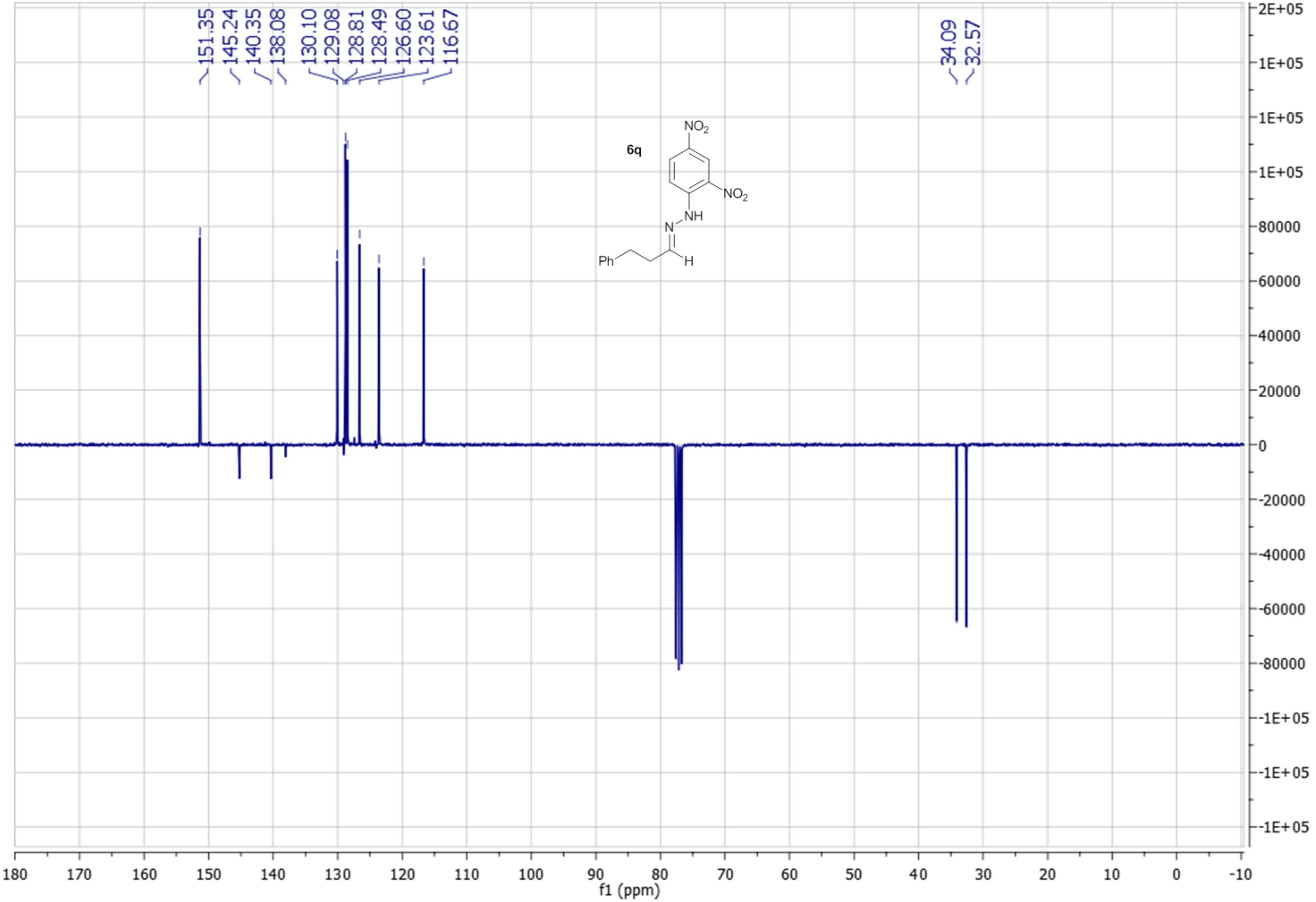

6p
O
H
9.52
2.19
2.16
2.14
2.14
2.11
2.07
1.83
1.81
1.79
1.74
1.65
1.64
1.58
1.57
1.56
1.54
1.53
1.34
1.33
1.30
1.28
1.26
1.25
1.25
1.22
1.20
1.19
1.17
1.13
1.00
1.05
6.06
6.10
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

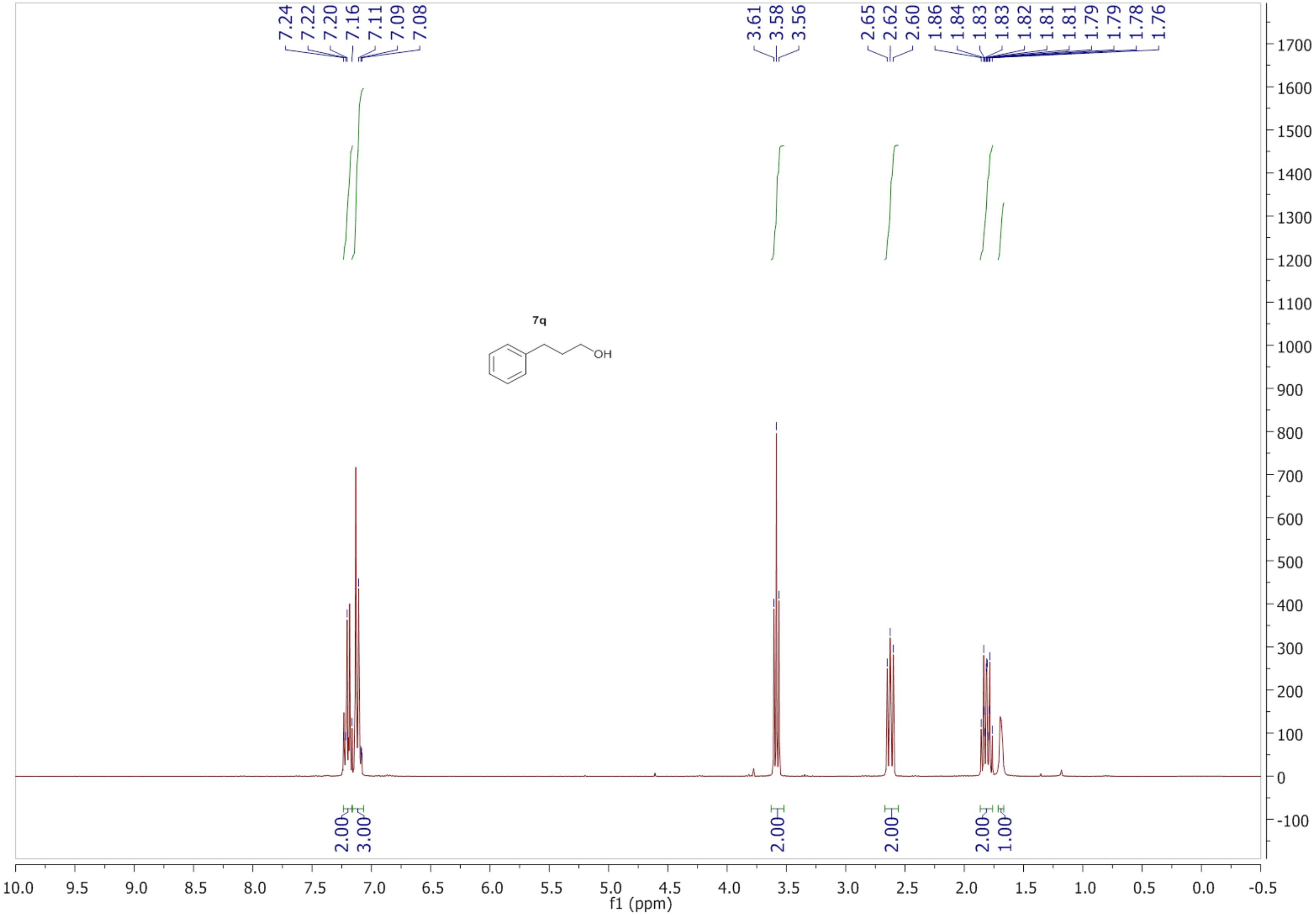

204.76
49.88
25.95
25.90
24.98
6p
O
H
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

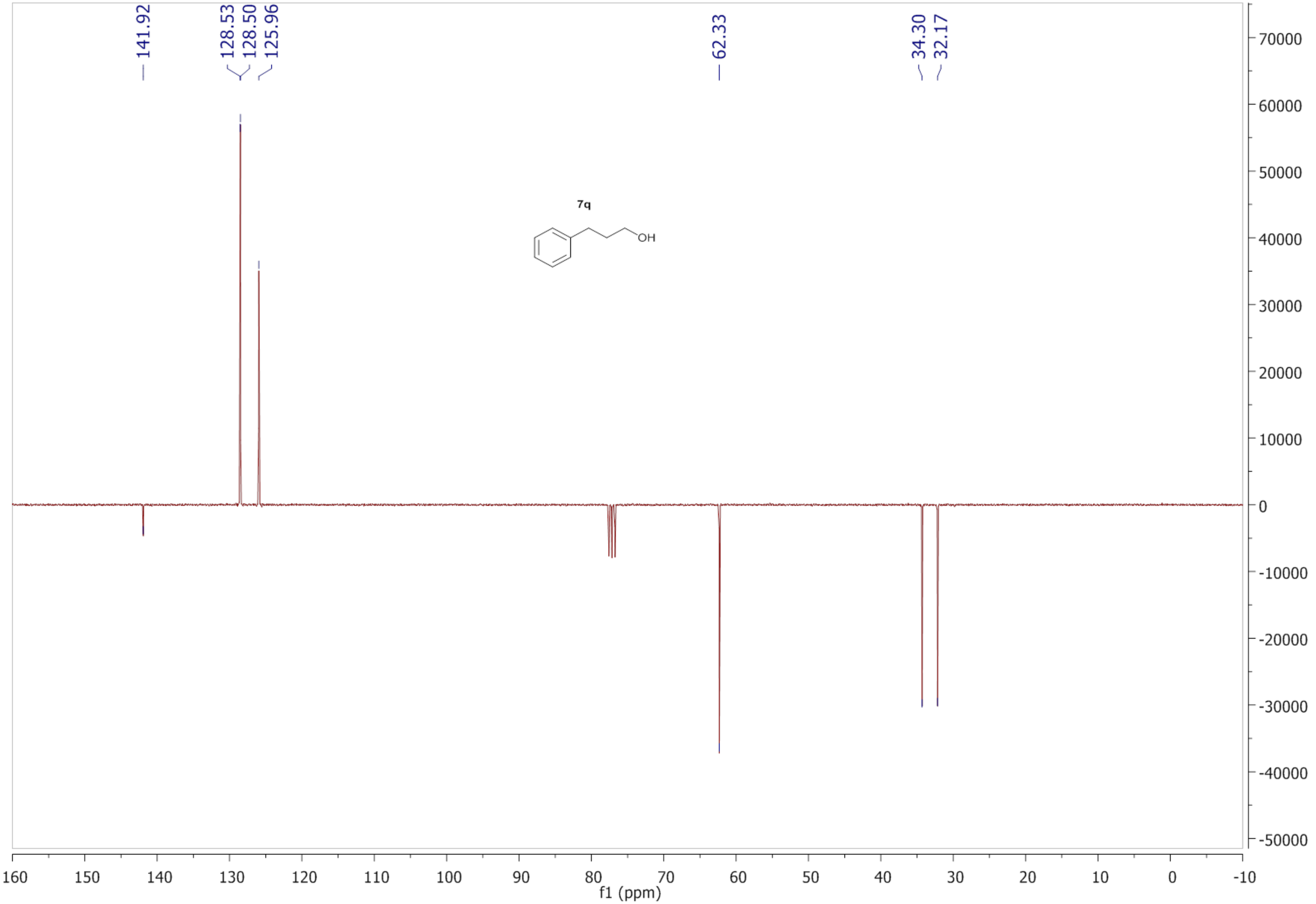

3.45
3.42
1.78
1.76
1.75
1.74
1.73
1.72
1.72
1.71
1.71
1.70
1.69
1.68
1.67
1.66
1.66
1.65
1.65
1.64
1.52
1.51
1.51
1.50
1.50
1.48
1.47
1.46
1.45
1.44
1.43
1.41
1.31
1.28
1.27
1.26
1.24
1.23
1.20
1.18
1.17
1.16
1.14
1.13
1.12
0.99
0.98
0.97
0.95
0.94
0.92
0.91
0.90
0.87
0.86
7p
OH
2.00
5.00
2.39
3.09
2.02
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)
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100

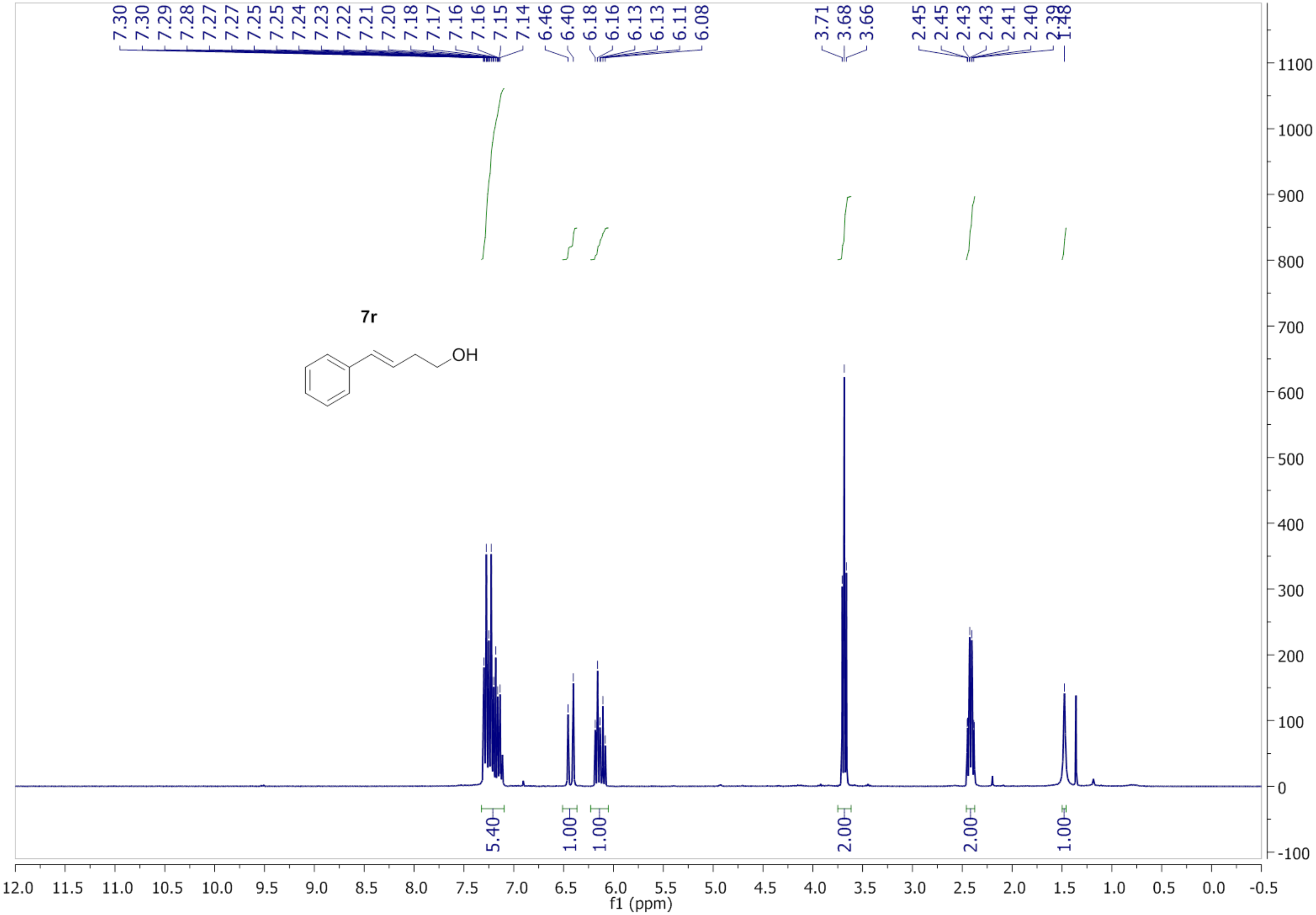

68.93
40.62
29.69
26.72
25.97
7p
OH
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

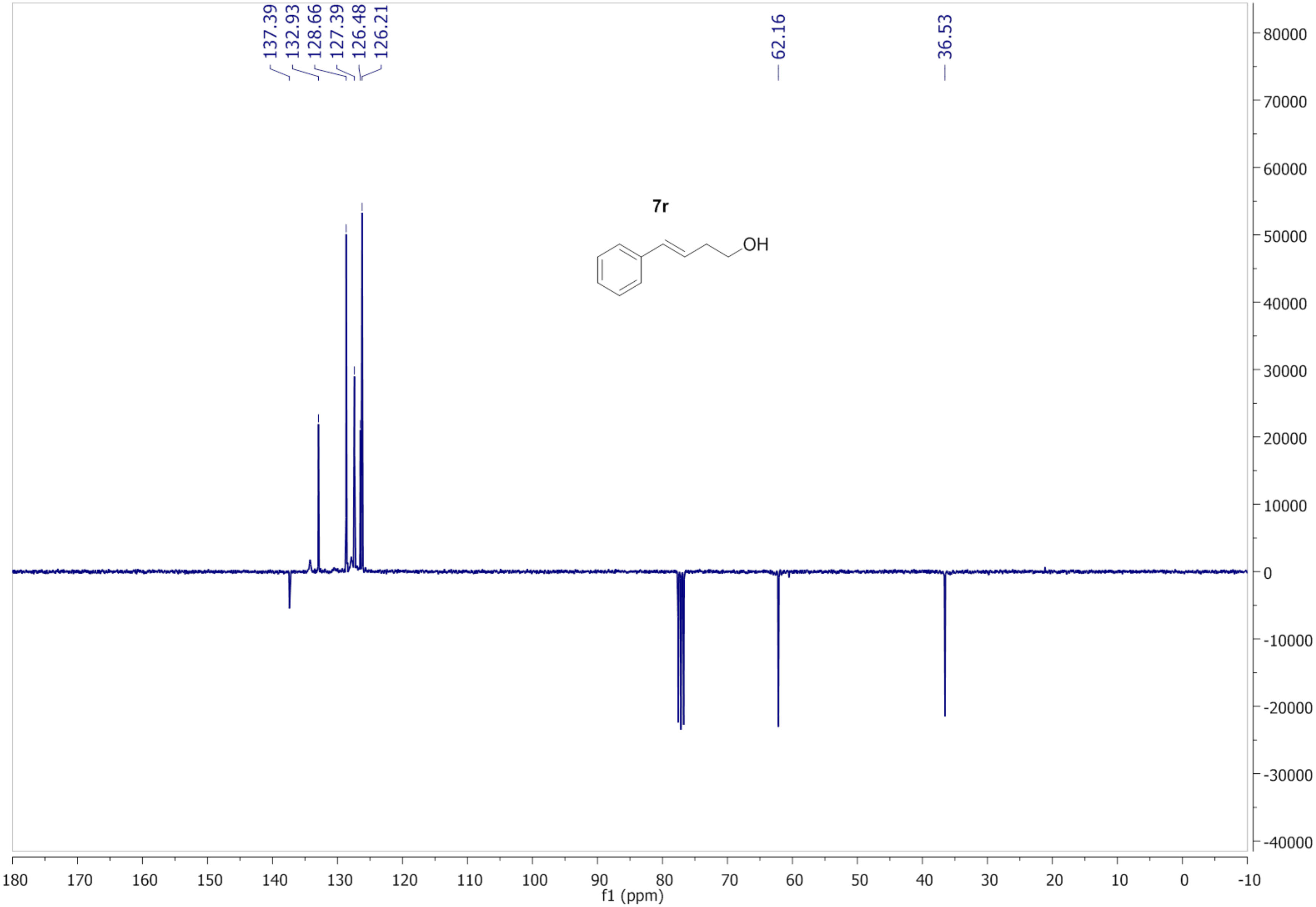

6q
NO2
NO2
NH
N
Ph
H
11.00
9.12
9.11
8.32
8.29
8.28
8.28
8.27
7.91
7.88
7.55
7.33
7.33
7.31
7.26
7.25
7.24
7.23
3.00
2.98
2.95
2.82
2.82
2.80
2.80
2.79
2.78
2.77
2.77
2.77
2.75
2.75
1.00
1.00
1.00
1.00
1.00
2.00
3.74
2.00
2.00
800
700
600
500
400
300
200
100
0
-100
12.5
11.5
10.5
9.5
9.0
8.5
8.0
7.5
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
-0.5
f1 (ppm)


151.35
145.24
140.35
138.08
130.10
129.08
128.81
128.49
126.60
123.61
116.67
34.09
32.57
6q
NO2
NO2
NH
N
Ph
H
2E+05
1E+05
1E+05
1E+05
80000
60000
40000
20000
0
-20000
-40000
-60000
-80000
-1E+05
-1E+05
-1E+05
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


7.24
7.22
7.20
7.16
7.11
7.09
7.08
3.61
3.58
3.56
2.65
2.62
2.60
1.86
1.84
1.83
1.83
1.82
1.81
1.81
1.79
1.79
1.78
1.76
7q
OH
2.00
3.00
2.00
2.00
2.00
1.00
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100
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)

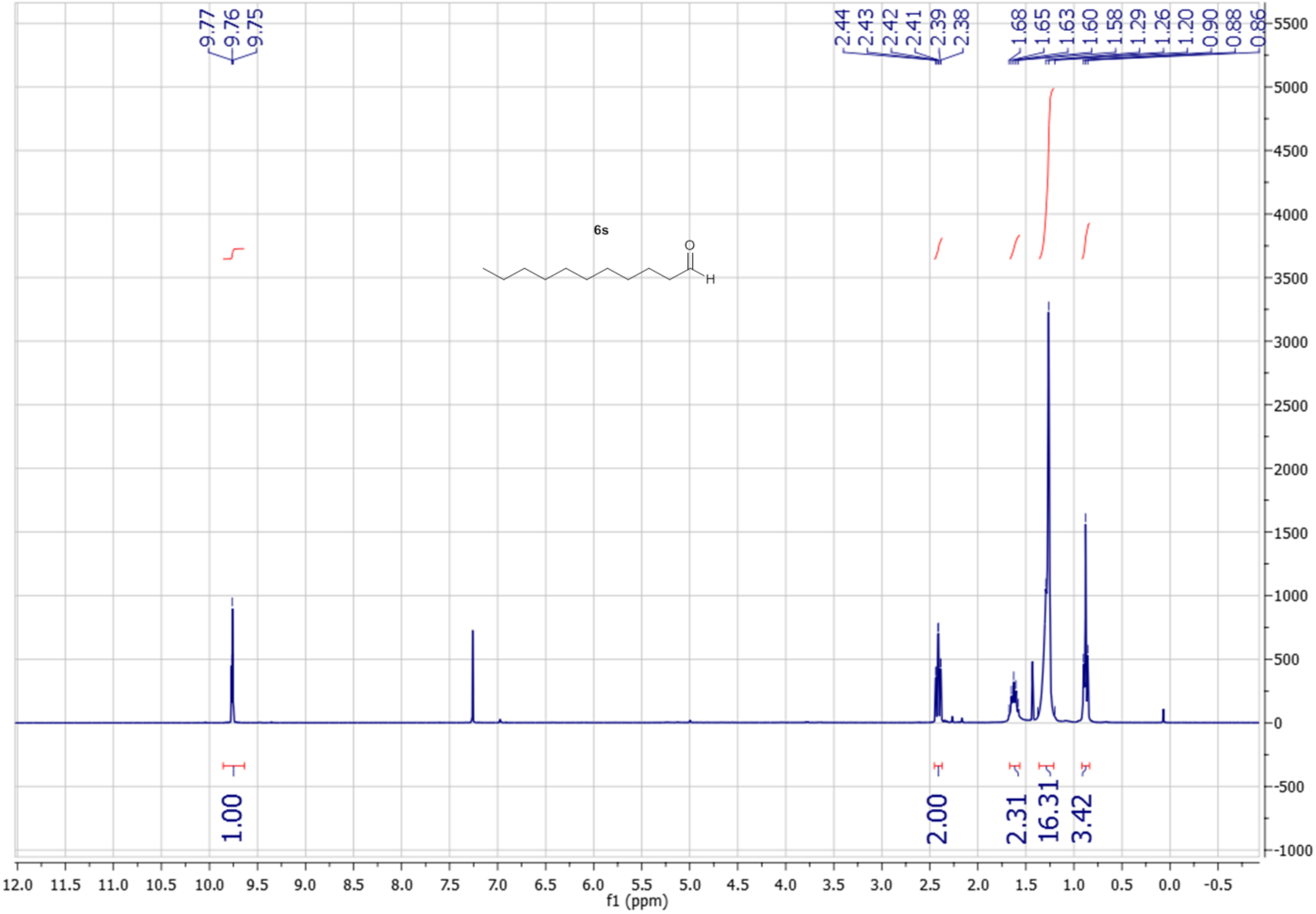

141.92
128.53
128.50
125.96
62.33
34.30
32.17
7q
OH
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
-50000
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

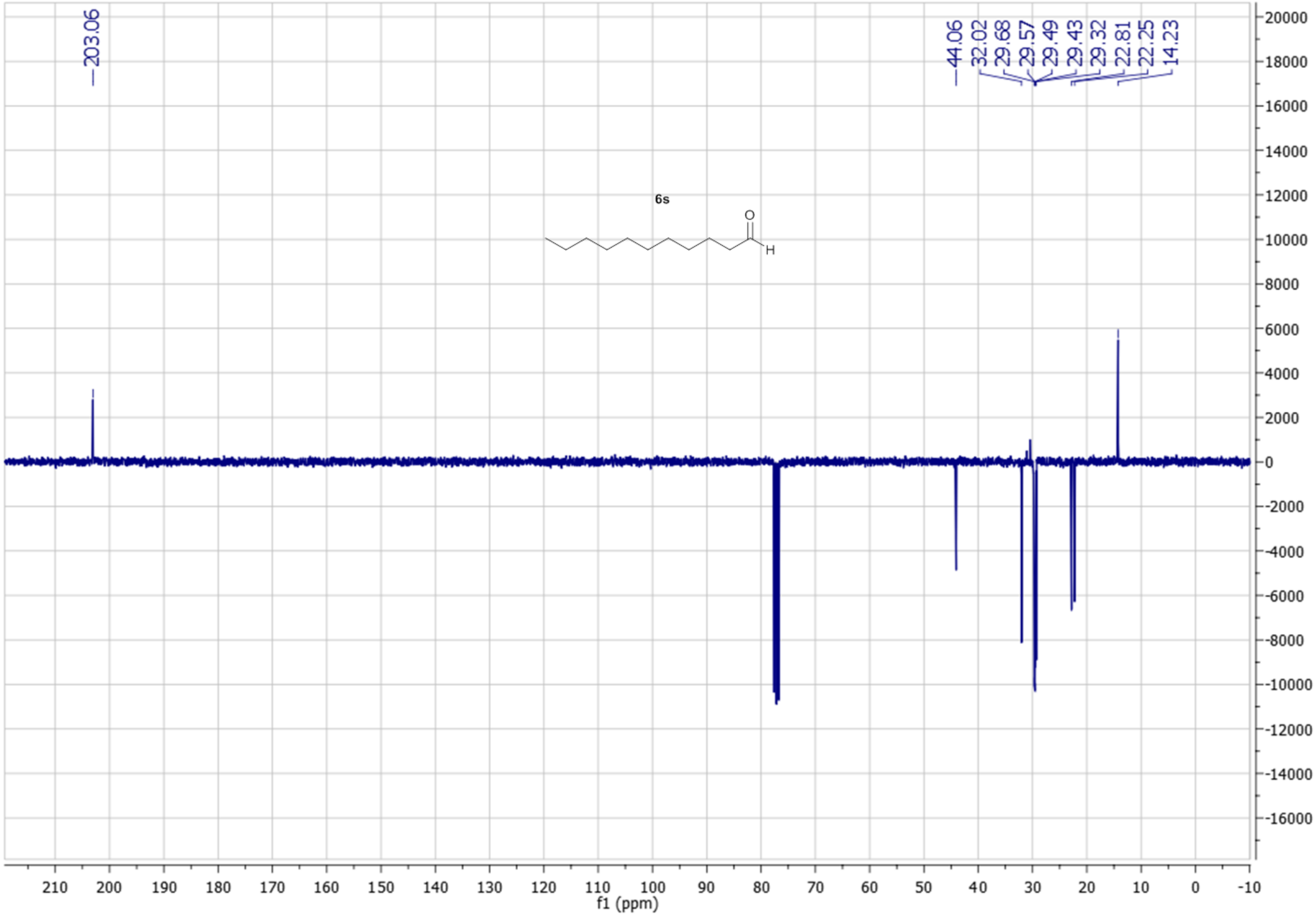

7.30
7.30
7.29
7.28
7.27
7.27
7.25
7.25
7.24
7.23
7.22
7.21
7.20
7.18
7.17
7.16
7.16
7.15
7.14
6.46
6.40
6.18
6.16
6.13
6.13
6.11
6.08
3.71
3.68
3.66
2.45
2.45
2.43
2.43
2.41
2.40
2.39
1.48
7r
OH
5.40
1.00
1.00
2.00
2.00
1.00
12.0
11.5
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)
1100
1000
900
800
700
600
500
400
300
200
100
0
-100

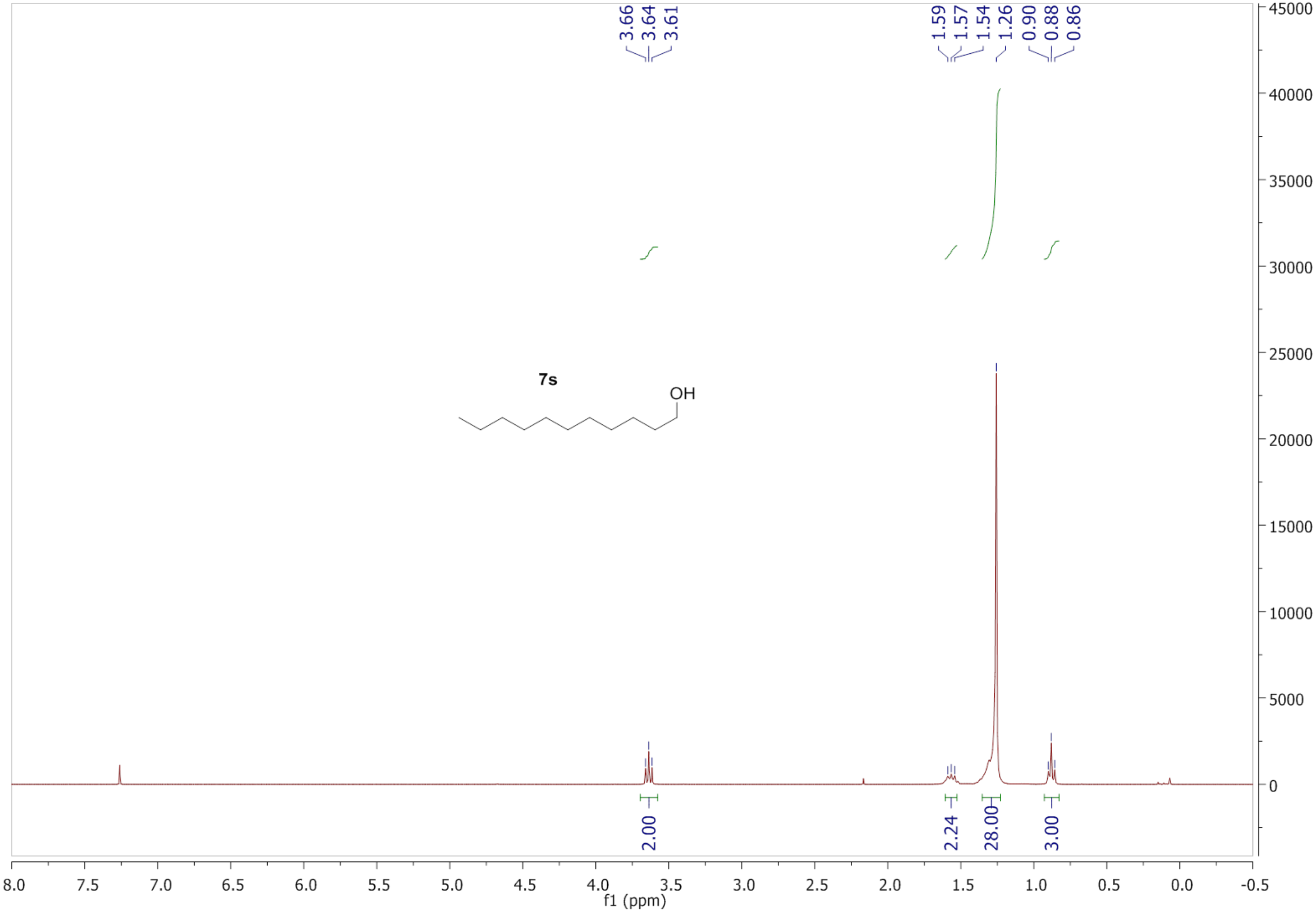


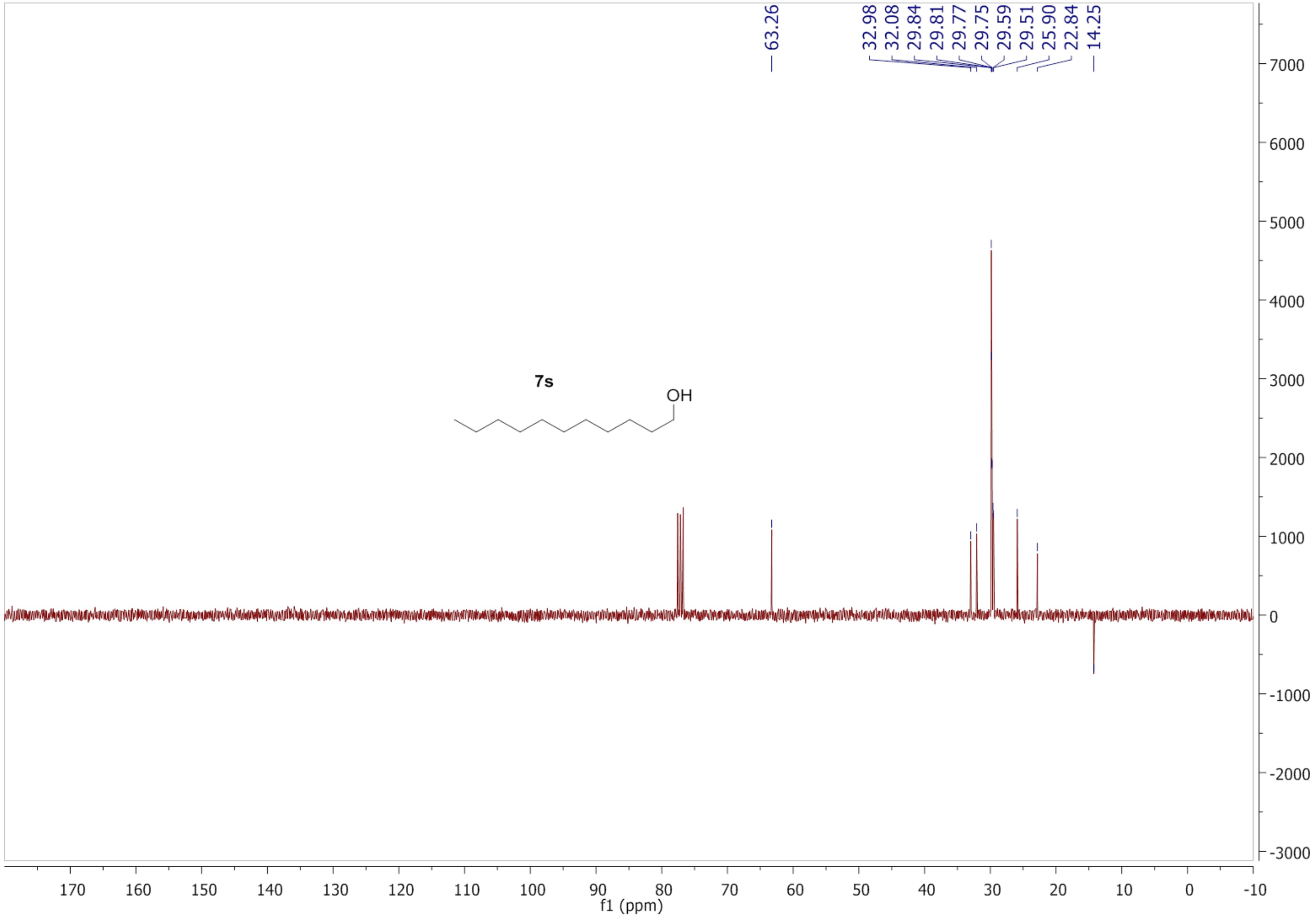
7r

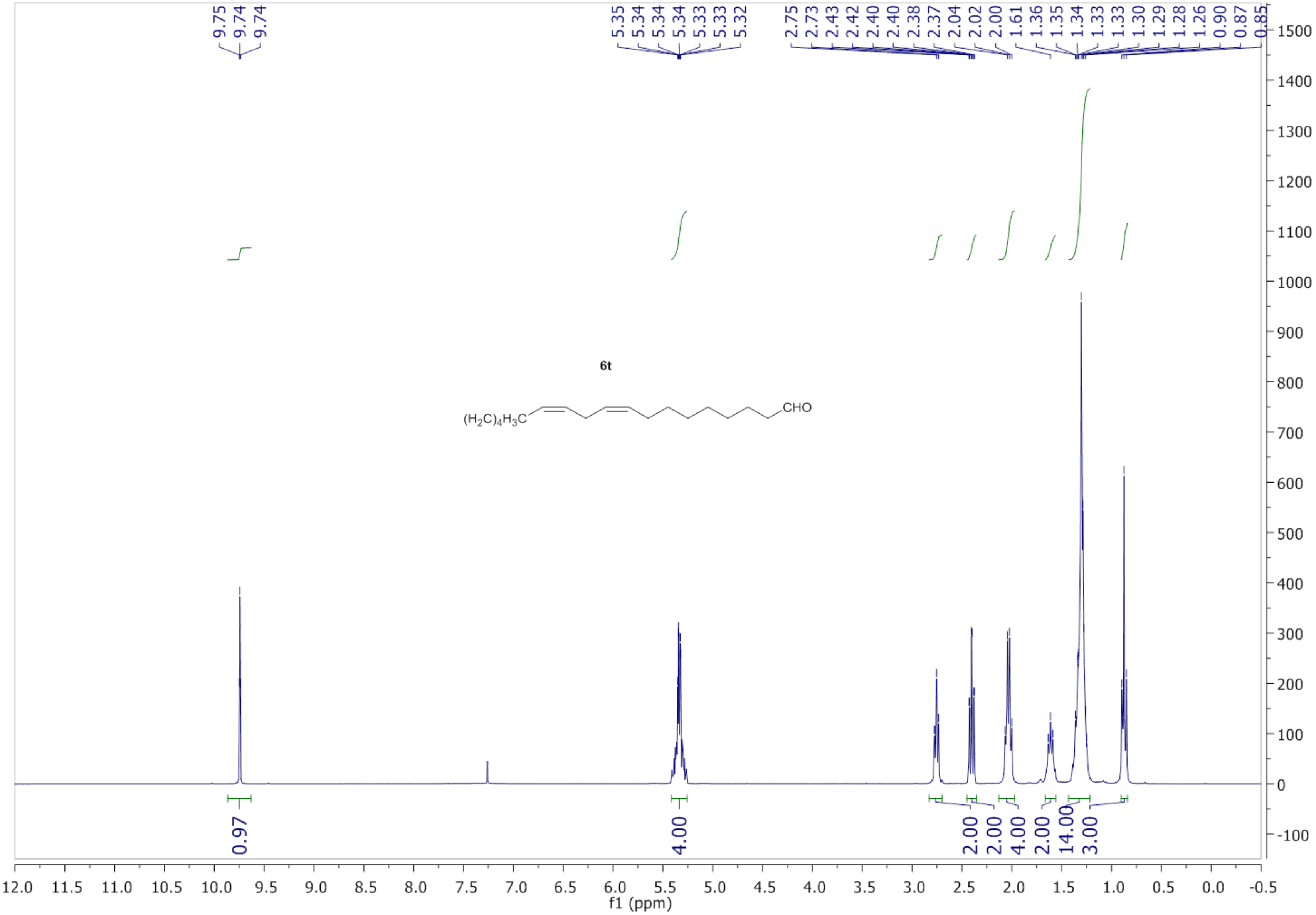
137.39
132.93
128.66
127.39
126.48
126.21
62.16
36.53
OH
80000
70000
60000
50000
40000
30000
20000
10000
0
-10000
-20000
-30000
-40000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

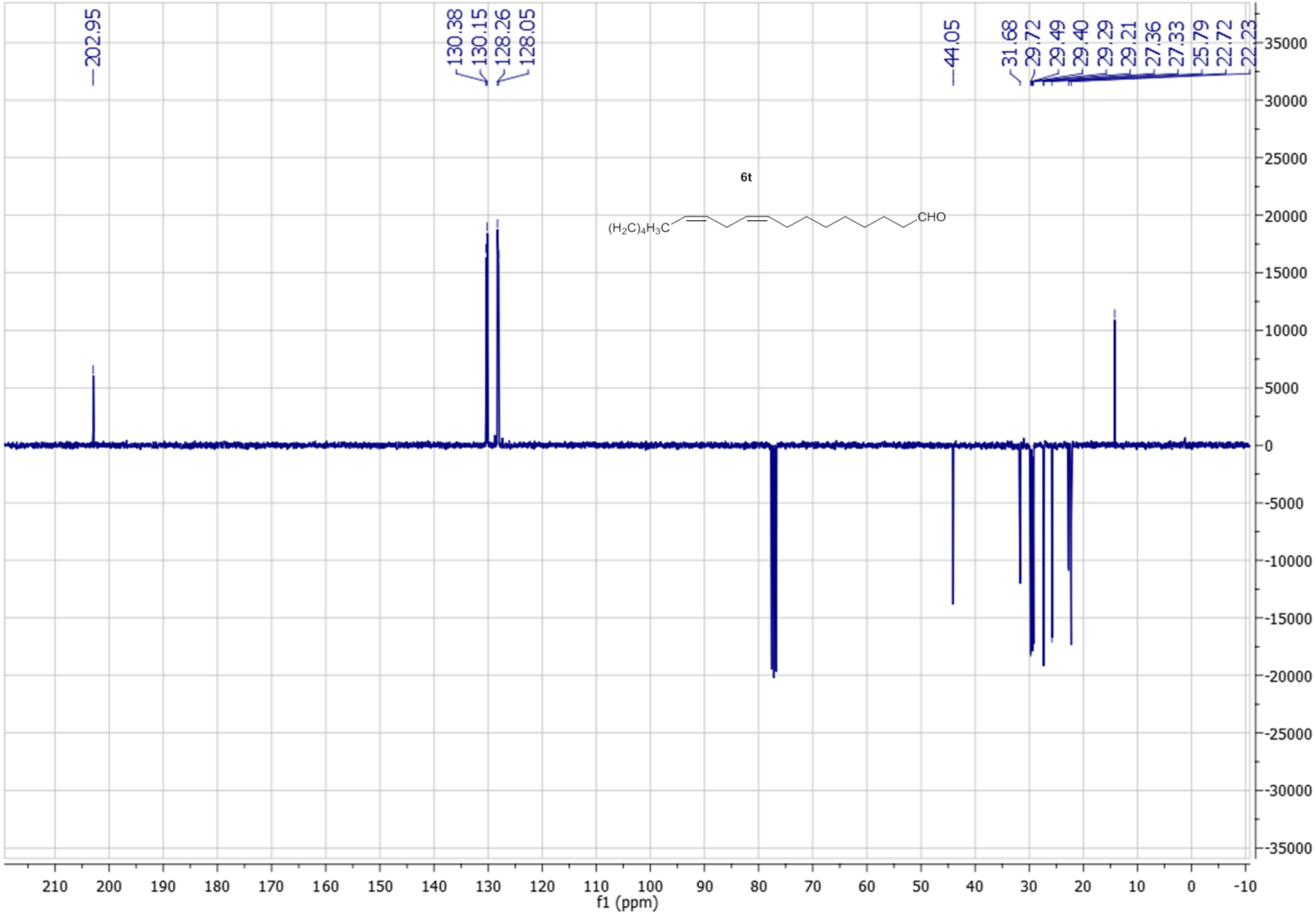

6s
O
H
9.77
9.76
9.75
2.44
2.43
2.42
2.41
2.39
2.38
1.68
1.65
1.63
1.60
1.58
1.29
1.26
1.20
0.90
0.88
0.86
1.00
2.00
2.31
16.31
3.42
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
12.0 11.5 11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5
f1 (ppm)

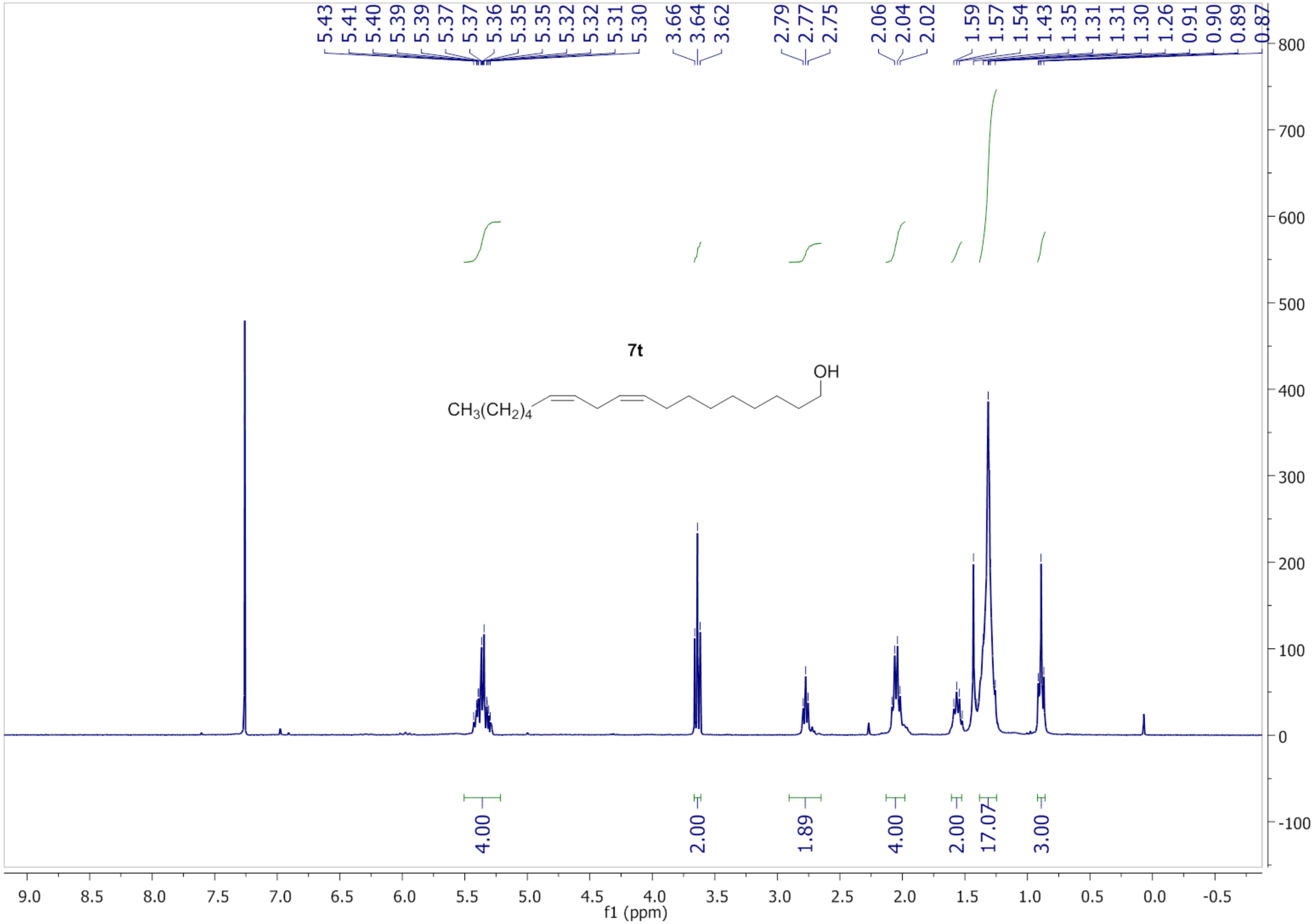

203.06
44.06
32.02
29.68
29.57
29.49
29.43
29.32
22.81
22.25
14.23
6s
O
H
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
-2000
-4000
-6000
-8000
-10000
-12000
-14000
-16000
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


3.66
3.64
3.61
1.59
1.57
1.54
1.26
0.90
0.88
0.86
7s
OH
2.00
2.24
28.00
3.00
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
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)


63.26
32.98
32.08
29.84
29.81
29.77
29.75
29.59
29.51
25.90
22.84
14.25
7s
OH
7000
6000
5000
4000
3000
2000
1000
0
-1000
-2000
-3000
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)


9.75
9.74
9.74
5.35
5.34
5.34
5.34
5.33
5.33
5.32
2.75
2.73
2.43
2.42
2.40
2.40
2.38
2.37
2.04
2.02
2.00
1.61
1.36
1.35
1.34
1.33
1.33
1.30
1.29
1.28
1.26
0.90
0.87
0.85
6t
(H2C)4H3C
CHO
0.97
4.00
2.00
2.00
4.00
2.00
14.00
3.00
12.0
11.5
11.0
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)
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
-100


202.95
130.38
130.15
128.26
128.05
44.05
31.68
29.72
29.49
29.40
29.29
29.21
27.36
27.33
25.79
22.72
22.23
6t
(H2C)4H3C
CHO
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
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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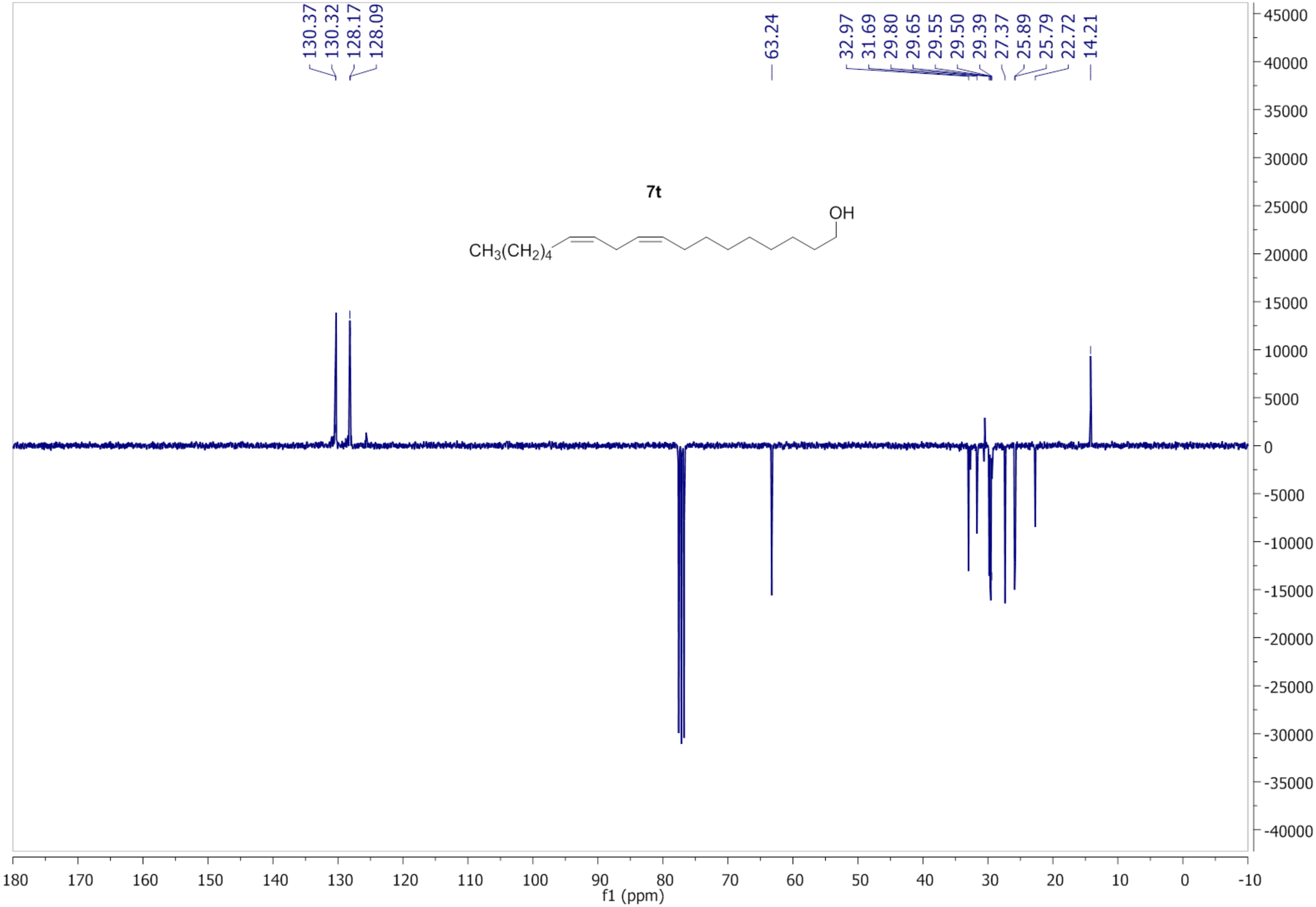
5.41
5.40
5.39
5.39
5.37
5.37
5.36
5.35
5.35
5.32
5.32
5.31
5.30
3.66
3.64
3.62
2.79
2.77
2.75
2.06
2.04
2.02
1.59
1.57
1.54
1.43
1.35
1.31
1.31
1.30
1.26
0.91
0.90
0.89
0.87
7t
OH
CH3(CH2)4
4.00
2.00
1.89
4.00
2.00
17.07
3.00
800
700
600
500
400
300
200
100
0
-100
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)


130.37
130.32
128.17
128.09
63.24
32.97
31.69
29.80
29.65
29.55
29.50
29.39
27.37
25.89
25.79
22.72
14.21
7t
OH
CH3(CH2)4
45000
40000
35000
30000
25000
20000
15000
10000
5000
0
-5000
-10000
-15000
-20000
-25000
-30000
-35000
-40000
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)