Supporting Information

for

Lithium zincate-enabled divergent one-pot dual C–C bond formation in thiophenes

Alexandre Pierret,[a] Kevin Magra,[a] Hugo Lopez,[a] Thomas Kauffmann,[a] Clément Denhez,[b] Ibrahim Abdellah,[c] Christophe Werlé,*[a,d] Alexandre Vasseur*[a]

[a]Université de Lorraine, CNRS, L2CM, F-54000 Nancy, France
[b]Université de Reims Champagne Ardenne, CNRS, ICMR UMR 7312, 51097 Reims, France
[c]Université de Lorraine, CNRS, L2CM, F-57000 Metz, France
[d]Max Planck Institute for Chemical Energy Conversion, Stiftstr. 34−36, 45470 Mülheim an der Ruhr, Germany

Email: christophe.werle@univ-lorraine.fr, christophe.werle@cec.mpg.de, alexandre.vasseur@univ-lorraine.fr

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1) General information

All reactions were conducted under an argon atmosphere using dry, oxygen-free organic solvents and standard Schlenk techniques. Solvents and liquid reagents were transferred with single-use plastic graduated syringes and stainless-steel needles, except for electrophiles **3**, which were handled with Hamilton microsyringes. Tetrahydrofuran (THF, HPLC grade, non-stabilized, BioLab) and toluene were dried using an Mbraun 800 Solvent Purifier System (SPS) equipped with two alumina columns and stored under positive argon pressure (99.9999% purity). Stabilized 2-methyltetrahydrofuran (99+% purity), pre-dried over molecular sieves, was obtained from Fisher Scientific in AcroSeal packaging and used as received.

Reaction progress was monitored *via* analytical thin-layer chromatography (TLC) on silica gel pre-coated aluminum plates with an F254 indicator (Merck 60 F254). Spots were visualized under UV light and/or treated with phosphomolybdic acid followed by heating. For the synthesis of compounds **4** and **6**, crude mixtures were purified by column chromatography on silica gel (40–63 µm) using petroleum ether/diethyl ether mixtures as eluents (100/0 to 80/20, v/v). Exceptions include compounds **6ax**, which was purified by normal-phase HPLC on an Interchim US5SI column using a pentane/isopropanol mixture (20% isocratic, 20 mL/min flow rate, detected at λ = 254 nm), and compounds **6ar** and **6eb**, purified on neutral alumina oxide gel (petroleum ether/Et_2O, 90/10, v/v).

NMR spectra (^1H, ^{13}C, ^{19}F, and ^{31}P) were recorded on a Bruker Advance III 400 spectrometer (400, 100, 375, and 161 MHz, respectively) using $CDCl_3$ as the solvent, with chemical shifts (δ) referenced to TMS. Chemical shifts are reported in ppm, calibrated to the residual peak of $CDCl_3$: δ = 7.26 ppm (s) for ^1H NMR and δ = 77.16 ± 0.06 ppm for ^{13}C NMR. Proton spectra are described as δ (multiplicity, J coupling constant in Hz, number of protons). Multiplicities include: (bs) – broad singlet, (s) – singlet, (d) – doublet, (dd) – doublet of doublets, (ddd) – doublet of doublets of doublets, (dddd) – doublet of doublets of doublets of doublets, (dq) – doublet of quartets, (ddt) – doublet of doublets of triplets, (dt) – doublet of triplets, (h) – hexuplet, (m) – multiplet, (p) – pentuplet, (pd) – pentuplet of doublets, (q) – quartet, (qd) – quartet of doublets, (t) – triplet, (td) – triplet of doublets, and (tt) – triplet of triplets.

Infrared (IR) spectra were recorded on a Shimadzu IRAffinity-1 spectrometer equipped with a PIKE Technologies gladiATR accessory (spectral range: 7500–375 cm^{-1}; resolution: < 3 cm^{-1}). Wavenumbers are reported in cm^{-1}.

Melting points (M.p.) were measured on a Kofler bench and are reported uncorrected in degrees Celsius.

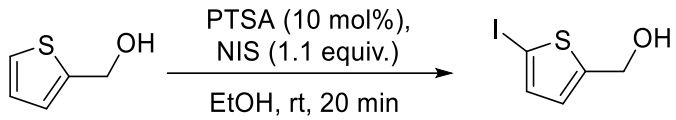
High-resolution mass spectra (HRMS) were obtained using a Waters Xevo G2 ESI/QqTOF apparatus with a Waters Acquity UPLC H-Class PLUS system and an Atmospheric Pressure Ionization (API) source or a Bruker MicrOTOFq ESI/QqTOF apparatus equipped with an API source. Low-resolution mass spectra in electron impact mode (GC-EI) were recorded on a Shimadzu QP2010 instrument equipped with a DB5-MS UI column (30 m length, 0.25 mm internal diameter, 0.25 µm film thickness).
Organolithium reagents were purchased from Aldrich or Fisher Scientific in AcroSeal packaging and routinely titrated under argon using a 1M solution of (-)-menthol in toluene with 1,10-phenanthroline as the indicator.

Anhydrous $ZnCl_2$ (>98% reagent grade) was obtained from Aldrich. Before use, it was dried by heating under vacuum at approximately 140 °C with a heat gun, repeated three times.
Chemicals for the synthesis of starting materials **1** and electrophiles **3** were sourced from commercial suppliers and used as received.

2) Starting materials 1

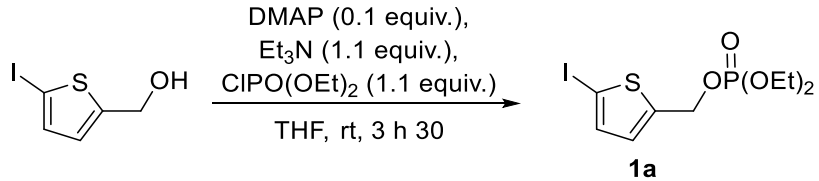
a) Synthesis and characterization data of **1a**

Compound 1a was synthesized *via* a two-step procedure starting from 2-thiophenemethanol.



In the first step, 2-thiophenemethanol (2.283 g, 20 mmol, 1 equiv) was dissolved in ethanol (EtOH, 40 mL) at room temperature (rt). *N*-Iodosuccinimide (4.950 g, 22 mmol, 1.1 equiv) was then added, followed by *p*-toluenesulfonic acid (40 mg, 0.2 mmol, 0.1 equiv). The reaction mixture was stirred for 20 minutes at rt before being quenched with a saturated aqueous solution of sodium thiosulfate ($Na_2S_2O_3$, 20 mL). The resulting mixture was diluted with ethyl acetate (EtOAc, 30 mL), and the organic and aqueous layers were separated. The aqueous phase was extracted twice with EtOAc (2 × 30 mL). The combined organic extracts were washed with a 1 M aqueous solution of sodium carbonate (Na_2CO_3), dried over magnesium sulfate ($MgSO_4$), filtered through cotton, and concentrated under reduced pressure. The crude product was purified by silica gel chromatography (SiO_2) using a petroleum ether/diethyl ether (80/20, v/v) mixture as the eluent. This afforded 5-iodothenyl alcohol as a pure compound in 94% yield.

(5-iodothiophen-2-yl)methanol.[1] Pale yellow oil (4.486 g, yield 94%). R_f 0.31 (Petroleum ether/Et_2O, 8/2, v/v). **^{1}H RMN** (400 MHz, $CDCl_3$) δ 7.11 (d, *J* = 3,6 Hz, 1H), 6.69 (d, *J* = 3,6 Hz, 1H), 4.80 (s, 2H), 1.76 (bs, 1H). **^{13}C RMN** (100 MHz, $CDCl_3$) δ 150.3, 136.8, 127.1, 73.5, 60.1.



1a

In the second step, an oven-dried 100 mL two-neck flask equipped with a Teflon-coated magnetic stir bar, a greased gas inlet adapter with a glass plug, and a rubber septum was charged with DMAP (120 mg, 0.98 mmol, 0.1 equiv) and 5-iodothenyl alcohol (2.342 g, 9.75 mmol, 1 equiv). The flask was connected to a Schlenk line, and the air inside was evacuated. The resulting vacuum was replaced with argon. This "vac-refill" procedure was repeated three times to ensure an inert atmosphere.

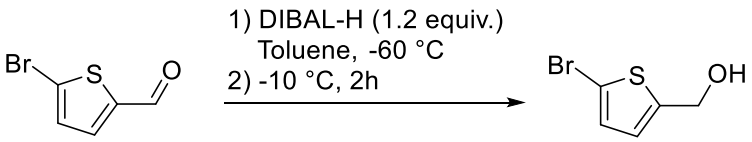
[1] Grolleau, J.; Frère, P.; Gohier, F. Clean and Efficient Iodination of Thiophene Derivatives. *Synthesis* **2015**, *47*, 3901–3906.

Dry tetrahydrofuran (THF, 60 mL) was added, and the mixture was stirred at room temperature (rt) for 5 minutes. Triethylamine (Et_3N, 1.5 mL, 10.73 mmol, 1.1 equiv) was added dropwise *via* syringe, followed by slow addition of diethyl chlorophosphate (1.55 mL, 10.73 mmol, 1.1 equiv) *via* syringe. A white precipitate formed during the addition. The reaction mixture was stirred at rt for 3 hours and 30 minutes before being quenched with a saturated aqueous solution of ammonium chloride (NH_4Cl, 30 mL). The layers were separated, and the aqueous phase was extracted three times with diethyl ether (Et_2O). The combined organic fractions were washed with brine, dried over magnesium sulfate ($MgSO_4$), filtered through cotton, and concentrated under reduced pressure. The crude product was purified by silica gel chromatography (SiO_2, 60–200 µm) using petroleum ether/ethyl acetate (50/50, v/v) as the eluent, affording **compound 1a** as a pure product in 78% yield.

Diethyl ((5-iodothiophen-2-yl)methyl)phosphate (1a). Pale yellow oil (2.866 g, 78%). R_f 0.48 (Petroleum Ether/EtOAc, 50/50, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.12 (d, *J* = 3.7 Hz, 1H), 6.78 (d, *J* = 3.7 Hz, 1H), 5.15 (d, *J* = 8.9 Hz, 2H), 4.14–3.99 (m, 4H), 1.30 (t, *J* = 7.1 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ = 144.5, 136.8, 129.6, 75.3, 64.1, 63.0, 16.2. **^{31}P {1H} NMR** (161 MHz, $CDCl_3$) δ -1.30 (s, 1P). **IR** (ATR) ν_{max}/cm^{-1} 2980, 2904, 1425, 1255, 1165, 962, 794, 499, 459. **HRMS (ESI-TOF)** *m/z* calcd for $C_9H_{14}INaO_4PS$ $[M+Na]^+$ 398.9287, found 398.9294.

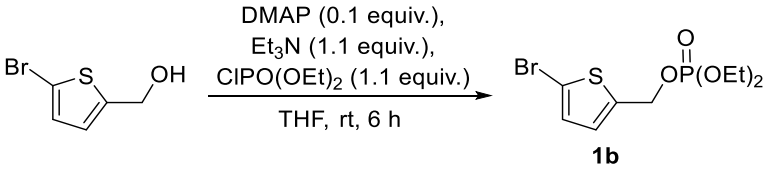
b) Synthesis and characterization data of **1b**

Compound 1b was synthesized in two steps starting from 5-bromo-2-thiophenecarbaldehyde.



Step 1: An oven-dried 250 mL three-neck flask, equipped with a Teflon-coated magnetic stir bar, a greased gas inlet adapter with a glass plug, a low-temperature thermometer with a greased glass adapter, and a dropping funnel with a rubber septum, was charged with 5-bromo-2-thiophenecarbaldehyde (2.38 mL, 20 mmol, 1 equiv). The flask was connected to a Schlenk line, and the air was evacuated. The resulting vacuum was replaced with argon, and this "vac-refill" operation was repeated three times. Anhydrous toluene was added *via* the dropping funnel, and the solution was stirred at 60 °C. A 1 M toluene solution of DIBAL-H (24 mL, 24 mmol, 1.2 equiv) was prepared and diluted with anhydrous toluene (15 mL). This solution was added dropwise to the reaction flask at -60 °C. Once the addition was complete, the mixture was stirred at -10 °C for 2 hours, then quenched by the slow addition of 1 M HCl (20 mL) followed by water (20 mL). The layers were separated, and the aqueous phase was extracted three times with diethyl ether (Et_2O, 3 × 30 mL). The combined organic layers were washed with brine, dried over magnesium sulfate ($MgSO_4$), filtered through cotton, and concentrated under reduced pressure. The crude product was purified by silica gel chromatography (SiO_2) using a petroleum ether/diethyl ether mixture (80/20, v/v), yielding **(5-bromothiophen-2-yl)methanol** as a pure compound in 99% yield.

(5-bromothiophen-2-yl)methanol.[2] Brown oil (4.013mg, 99%). R_f 0.29 (Petroleum Ether/Et_2O, 80/20, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.92 (d, J = 3.7 Hz, 1H), 6.76 (d, J = 3.7 Hz, 1H), 4.74 (s, 2H), 1.81 (bs, 1H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.8, 129.7, 125.8, 112.3, 60.1.



1b

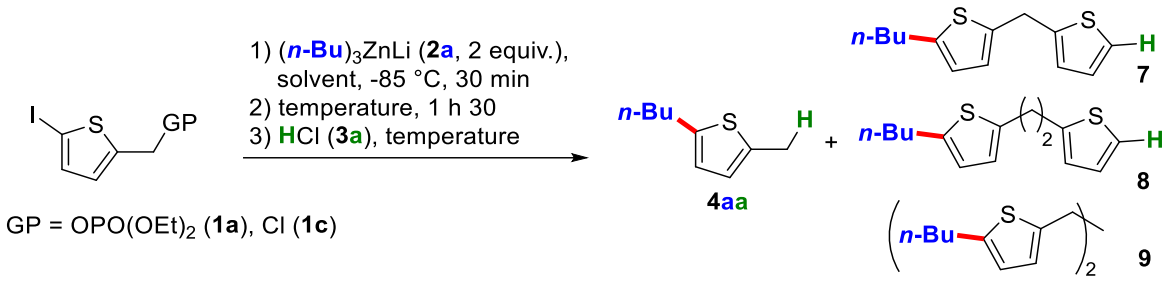
Step 2: An oven-dried 100 mL two-neck flask, equipped with a Teflon-coated magnetic stir bar, a greased gas inlet adapter with a glass plug, and a rubber septum, was charged with DMAP (122 mg, 1.0 mmol, 0.1 equiv) and (5-bromothiophen-2-yl)methanol (1.930 g, 10 mmol, 1 equiv). The flask was connected to a Schlenk line, and the air was evacuated. The vacuum was replaced with argon, and the "vac-refill" operation was repeated three times. Dry tetrahydrofuran (THF, 60 mL) was added, and the mixture was stirred at room temperature (rt) for 5 minutes. Triethylamine (Et_3N, 1.49 mL, 11 mmol, 1.1 equiv) was added dropwise *via* syringe, followed by diethyl chlorophosphate (1.59 mL, 11 mmol, 1.1 equiv) added slowly *via* syringe. A white precipitate formed during the addition. The reaction mixture was stirred at rt for 6 hours before being quenched with a saturated aqueous solution of ammonium chloride (NH_4Cl, 30 mL). The layers were separated, and the aqueous phase was extracted three times with Et_2O (3 × 30 mL). The combined organic layers were washed with brine (80 mL), dried over $MgSO_4$, filtered through cotton, and concentrated under reduced pressure. The crude product was purified by silica gel chromatography (SiO_2, 60–200 µm) using petroleum ether/ethyl acetate (50/50, v/v), yielding **Compound 1b** in 76% yield.

Diethyl ((5-bromothiophen-2-yl)methyl)phosphate (1b). Colorless oil (2.497 g, 76%). R_f 0.47 (Petroleum Ether/EtOAc, 50/50, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.95 (d, J = 3.7 Hz, 1H), 6.86 (d, J = 3.7 Hz, 1H), 5.11 (d, J = 9.0 Hz, 2H), 4.14–4.05 (m, 4H), 1.31 (t, J = 7.1, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 140.1, 129.7, 128.4, 114.0, 64.1, 63.4, 16.1. **^{31}P {1H} NMR** (161 MHz, $CDCl_3$) δ -1.29 (s, 1P). **IR** (ATR) ν_{max}/cm^{-1} 2980, 2906, 1438, 1259, 1165, 974, 794, 501, 460. **HRMS (ESI-TOF)** *m/z* calcd for $C_9H_{14}BrNaO_4PS$ $[M+Na]^+$ 350.9426, found 350.9428.

[2] (a) Lee, J.; Ryu, T.; Park S.; Lee, P. H. Indium Tri(isopropoxide)-Catalyzed Selective Meerwein–Ponndorf–Verley Reduction of Aliphatic and Aromatic Aldehydes. *J. Org. Chem.* **2012**, *77*, 4821−4825. (b) Wei, C.; Zou, J.; Zhang, W.; Huang, J.; Gao, D.; Wang, L.; Liao, Y.; Yu, G. Novel vinylene-bridged donor–acceptor copolymers: synthesis, characterization, properties and effect of cyano substitution. *Mater. Chem. Front.* **2017**, *1*, 2103—2110. (c) Basu, B.; Mandal, B.; Das, S.; Das, P.; Nanda, A. K. Chemoselective reduction of aldehydes by ruthenium trichloride and resin-bound formates. *Beilstein J. Org. Chem.* **2008**, *4*, 53.

3) Optimization of the reaction conditions for *Pathways* 1 and 2

a) Optimization table for the *pathway 1*

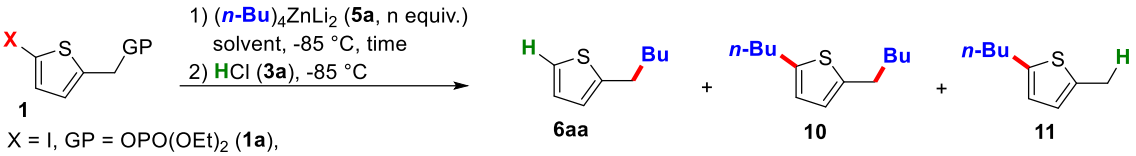


GP = $OPO(OEt)_2$ (**1a**), Cl (**1c**)

Entry	Solvent	Temperature	**1**	**4aa**[b]	**7**, **8**, **9**
1	THF	- 40°C	**1a**	20	80
2	THF	- 40°C	**1c**	Traces	~100
3	2-MeTHF	- 40°C	**1c**	67	33
4	2-MeTHF	- 40°C	**1a**	83	17
5	2-MeTHF	- 85°C	**1c**	80	20
6	2-MeTHF	- 85°C	**1a**	90	10

[a]Conditions : 1) (0.6 mmol), Bu_3ZnLi (1.2 mmol), -85 °C, 30 min, solvent (10 mL); 2) temperature, 1h30; 3) HCl. [b]ratio calculated by GC/MS, values expressed in %.

b) Optimization table for the *Pathway 2*

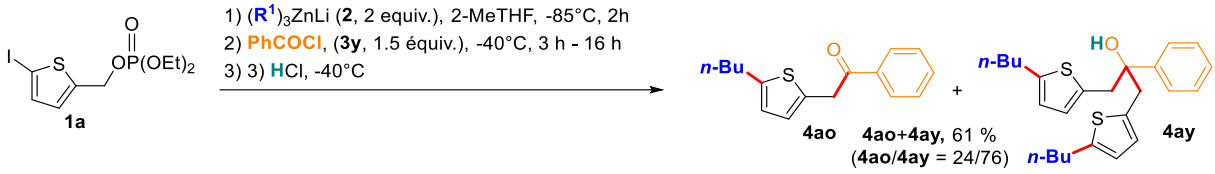


X = I, GP = $OPO(OEt)_2$ (**1a**),
X = Br, GP = $OPO(OEt)_2$ (**1b**)
X = I, GP = Cl (**1c**)

Entry	**1**	Solvent	Equiv.	Time	**6aa**[b]	**10**[b]	**11**[b]
1	**1a**	2-MeTHF	2	2 h	39	61	-
2	**1a**	THF	2	2 h	65	35	-
3	**1a**	THF	2	5, 10, 30, 60 min	66	34	-
4	**1c**	THF	2	30 min	60	40	-
5	**1a**	Et_2O	2	10 min	60	30[c]	8
6	**1a**	Toluene	2	10 min	53[c]	6[c]	6
7	**1a**	2-MeTHF	1,1	2 h	37	21	42
8	**1a**	THF	1,1	2 h	40	15	45
9	**1a**	THF	1,5	2 h	43	19	38
10	**1a**	THF	3	2 h	65	35	-
11[d]	**1b**	THF	2	1 h	83	17	-
12[e]	**1b**	THF	2,2	30 min	100	-	-

[a]Conditions: 1) **1** (0.6 mmol), Bu_4ZnLi_2, -85 °C, time, solvent (10 mL); 2) HCl (2 mL), -85 °C. [b]ratio calculated by GC/MS, values expressed in %. [c]along with other side products. [d]reaction at -60 °C. [e]additional stirring at -60 °C for 1 h.

c) Reactivity of **IIIa** with PhCOCl (**3y**)



4) General procedure for the synthesis of products 4 and 6

a) General procedure for the synthesis of 4

An oven-dried 50 mL three-neck flask, equipped with a Teflon-coated magnetic stir bar, a greased gas inlet adapter with a glass plug, a rubber septum, and a low-temperature thermometer with a greased glass adapter, was charged with anhydrous $ZnCl_2$ (164 mg, 1.2 mmol, 2.0 equiv). The flask was connected to a Schlenk line, and the air was evacuated. $ZnCl_2$ was dried by heating three times under vacuum at ~140 °C using a heat gun. Once cooled to room temperature, the vacuum was replaced with argon, and the "vac-refill" operation was repeated three times. Dry 2-MeTHF (8 mL) was added, and the mixture was stirred at -10 °C for 10 minutes. A solution of the organolithium reagent (3.6 mmol, 6 equiv) was added dropwise under inert conditions while maintaining the temperature below -5 °C. After stirring for 20 minutes at -10 °C, the mixture was cooled to -85 °C. A dry 2-MeTHF solution of diethyl ((5-iodothiophen-2-yl)methyl)phosphate (**1a**) (225.7 mg in 2 mL of 2-MeTHF, 0.6 mmol, 1.0 equiv) was added dropwise, and the reaction was stirred at -85 °C for 2 hours. The mixture was warmed to -40 °C, and the electrophile **3** (0.9 mmol, 1.5 equiv) was added dropwise. The solution was stirred at either -40 °C or -20 °C (depending on the electrophile) for 3–16 hours. The reaction was quenched with 1 M HCl (8 mL) at -40 °C. The layers were separated, and the aqueous phase was extracted with ethyl acetate (EtOAc, 3 × 15 mL). The combined organic layers were washed with brine (30 mL), dried over $MgSO_4$, filtered through cotton, and concentrated under reduced pressure. Pure products **4** were obtained after silica gel chromatography (SiO_2, 40–63 µm) using petroleum ether/diethyl ether (100/0–90/10, v/v).

Modifications for *t*-BuLi Reactions: For reactions involving *t*-BuLi, the addition to $ZnCl_2$ was carried out at -85 °C instead of -10 °C. After 10 minutes of stirring at -85 °C, the reaction mixture was stirred at -20 °C for an additional 20 minutes.

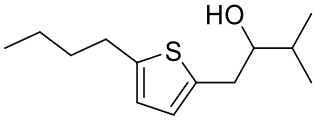
b) General procedure for the synthesis of 6

An oven-dried 50 mL three-neck flask, equipped with a Teflon-coated magnetic stir bar, a greased gas inlet adapter with a glass plug, a rubber septum, and a low-temperature thermometer with a greased glass adapter, was charged with anhydrous $ZnCl_2$ (180 mg, 1.32 mmol, 2.2 equiv). The flask was connected to a Schlenk line, and the air was evacuated. $ZnCl_2$ was dried by heating three times under vacuum at ~140 °C using a heat gun. Once cooled to room temperature, the vacuum was replaced with argon, and the "vac-refill" operation was repeated three times. Dry THF (8 mL) was added, and the

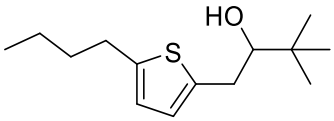
mixture was stirred at -10 °C for 10 minutes. A solution of the organolithium reagent (5.28 mmol, 8.8 equiv) was added dropwise under inert conditions while maintaining the temperature below -5 °C. After stirring for 20 minutes at -10 °C, the mixture was cooled to -85 °C. A dry THF solution of diethyl ((5-bromothiophen-2-yl)methyl)phosphate (**1b**) (197.5 mg in 2 mL of THF, 0.6 mmol, 1.0 equiv) was added dropwise. The reaction was stirred at -85 °C for 30 minutes, then at -60 °C for 1 hour. The mixture was further cooled to -85 °C, and electrophile **3** (1.8 mmol, 3 equiv) was added dropwise. The solution was stirred at -85 °C for 5 minutes, then at -60 °C for 16 hours. The reaction was quenched with 1 M HCl (8 mL) at -60 °C. The layers were separated, and the aqueous phase was extracted with EtOAc (3 × 15 mL). The combined organic layers were washed with brine (30 mL), dried over $MgSO_4$, filtered through cotton, and concentrated under reduced pressure. Pure products **6** were obtained after silica gel chromatography (SiO_2, 40–63 µm) using petroleum ether/diethyl ether (98/2–80/20, v/v). Exceptions: 6ax was purified by normal-phase HPLC on an Interchim US5SI column (pentane/isopropanol, 20%, 20 mL/min, λ = 254 nm), while **6ar** and **6eb** were purified on neutral alumina oxide gel (Al_2O_3, petroleum ether/diethyl ether, 90/10, v/v).

Modifications for *t*-BuLi Reactions: For reactions involving *t*-BuLi, the addition to $ZnCl_2$ was performed at -85 °C. After 10 minutes of stirring at that temperature, the reaction mixture was stirred at -20 °C for an additional 20 minutes.

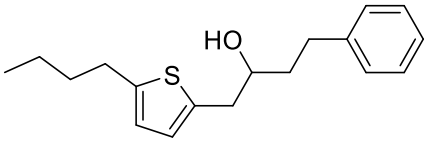
5) Characterisation data of products 4 and 6



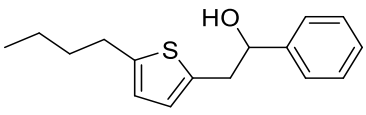
1-(5-butylthiophen-2-yl)-3-methylbutan-2-ol (4ab). Colorless oil (98 mg, 73%). R_f 0.3 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.66 (d, *J* = 3.3 Hz, 1H), 6.60 (d, *J* = 3.3 Hz, 1H), 3.54 (ddt, *J* = 9.1, 5.5, 3.5 Hz, 1H), 2.97 (dd, *J* = 14.7, 3.5 Hz), 2.82–2.73 (m, 3H), 1.75 (pd, *J* = 6.8, 5.5 Hz, 1H), 1.68–1.60 (m, 3H), 1.38 (dt, *J* = 14.7, 7.4 Hz), 0.99 (d, *J* = 6.8 Hz, 6H), 0.93 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 144.9, 138.6, 125.6, 123.8, 77.3, 35.4, 33.9, 33.0, 30.0, 22.4, 19.0, 17.7, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 3381, 2954, 2927, 2870, 1633, 1464, 1039, 993, 790. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_{22}NaOS$ $[M+Na]^+$ 249.1284, found 249.1274.



1-(5-butylthiophen-2-yl)-3,3-dimethylbutan-2-ol (4ac). Colorless oil (93 mg, 65%); R_f 0.77 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.66 (d, *J* = 3.3 Hz, 1H), 6,60 (d, *J* = 3.3 Hz, 1H), 3.41 (dd, *J* = 10.7, 2.0 Hz, 1H, H6), 3.01 (d, *J* = 14.7 Hz, 1H), 2.76 (t, *J* = 7.6 Hz, 2H), 2.67 (dd, *J* = 14.7, 10.7 Hz, 1H), 1.67–1.60 (m, 3H), 1.43–1.34 (m, 2H), 0.98 (s, 9H), 0.93 (t, *J* = 7.3 Hz). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 144.9, 139.7, 125.5, 123.8, 80.4, 34.9, 33.9, 33.2, 30.0, 26.0, 22.3, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 3481, 2953, 2927, 2868, 1477, 1458, 1361, 1066, 1006, 798, 777. **HRMS (ESI-TOF)** *m/z* calcd for $C_{14}H_{24}NaOS$ $[M+Na]^+$ 263.1440, found 263.1415.

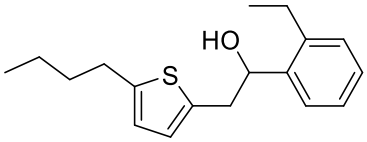


1-(5-butylthiophen-2-yl)-4-phenylbutan-2-ol (4ad). Colorless oil (98 mg, 60%); R_f 0.25 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.31–7.26 (m, 2H), 7.23–7.16 (m, 3H), 6.64 (d, *J* = 3.3 Hz, 1H), 6.60 (d, *J* = 3.3 Hz, 1H), 3.80 (tt, *J* = 8.2, 4.3 Hz, 1H), 2.98 (dd, *J* = 14.7, 3.9 Hz), 2.87–2.68 (m, 5H), 1.84 (dddd, *J* = 9.4, 7.5, 5.4, 3.8 Hz, 2H), 1.67– 1.62 (m, 3H), 1,38 (dt, *J* = 14.6, 7.4 Hz, 2H), 0.93 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.1, 142.1, 137.7, 128.6, 128.5, 126.0, 125.8, 123.9, 71.7, 38.5, 38.2, 33.9, 32.2, 30.0, 22.3, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 3354, 2926, 2854, 1494, 1454, 1049, 796, 744, 696. **HRMS (ESI-TOF)** *m/z* calcd for $C_{18}H_{23}S$ $[M-H_2O+H]^+$ 271.1515, found 271.1515.

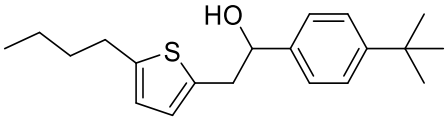


2-(5-butylthiophen-2-yl)-1-phenylethan-1-ol (4ae). Colorless oil (107 mg, 69%); R_f 0.36 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.41–7.33 (m, 4H), 7.31–7.28 (m, 1H), 6.64 (dt, *J* = 3.4, 1.0 Hz, 1H), 6.60 (dt, *J* = 3.4, 1.0 Hz, 1H), 4.87 (dd, *J* = 8.4, 4.6 Hz, 1H), 3.20–3.09 (m, 2H), 2.76 (t, *J*

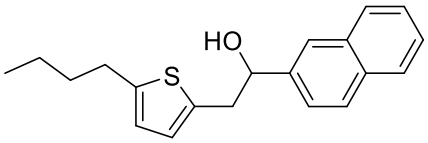
= 7.6 Hz, 2H), 1.67–1.60 (m, 3H), 1.42–1.36 (m, 2H), 0.93 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.2, 143.5, 137.5, 128.6, 127.8, 126.0, 126.0, 123.8, 75.1, 40.6, 33.9, 30.0, 22.3, 13.9. **IR** (ATR) ν_{max}/cm^{-1}: 3365, 2954, 2926, 2854, 1452, 1043, 1026, 794, 756, 698. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{19}S$ $[M\text{-}H_2O+H]^+$ 243.1207, found 243.1213.



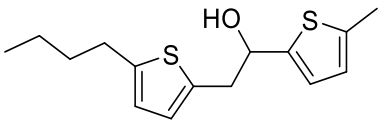
2-(5-butylthiophen-2-yl)-1-(2-ethylphenyl)ethan-1-ol (4af). Colorless oil (70 mg, 41%); R_f 0.33 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.59–7.53 (m, 1H), 7.26–7.17 (m, 3H), 6.68 (d, *J* = 3.3 Hz, 1H), 6.61 (d, *J* = 3.3 Hz, 1H), 5.13 (dd, *J* = 7.4, 5.3 Hz, 1H), 3.15–3.07 (m, 2H), 2.80–2.74 (m, 2H), 2.73–2.63 (m, 2H), 2.08 (bs, 1H), 1.65 (p, *J* = 7.5 Hz, 2H), 1.44–1.36 (m, 2H), 1.24 (t, *J* = 7.6 Hz, 3H), 0.94 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.2, 141.0, 140.8, 138.1, 128.7, 127.8, 126.5, 125.8, 125.6, 123.9, 71.2, 40.2, 33.9, 30.0, 25.4, 22.3, 15.8, 13.9. **IR** (ATR) ν_{max}/cm^{-1}: 3360, 2956, 2926, 2856, 1456, 1028, 794, 752. **HRMS (ESI-TOF)** *m/z* calcd for $C_{18}H_{23}S$ $[M\text{-}H_2O+H]^+$ 271.1515, found 271.1530.



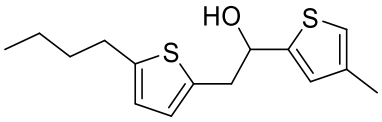
1-(4-(*tert*-butyl)phenyl)-2-(5-butylthiophen-2-yl)ethan-1-ol (4ag). Colorless oil (134 mg, 71%); R_f 0.33 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.42–7.38 (m, 2H), 7.36–7.32 (m, 2H), 6.69 (d, *J* = 3.4 Hz, 1H), 6.62 (t, *J* = 4.1 Hz, 1H), 4.85 (dd, *J* = 8.3, 4.6 Hz, 1H), 3.21–3.09 (m, 2H), 2.78 (q, *J* = 6.6, 5.8 Hz, 2H), 2.17 (bs, 1H), 1.69–1.62 (m, 2H), 1.46–1.37 (m, 2H), 1.34 (d, *J* = 6.7 Hz, 9H), 0.96 (t, *J* = 7.3 Hz, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 150.8, 145.1, 140.5, 137.9, 125.9, 125.7, 125.5, 123.8, 74.9, 40.4, 34.6, 33.9, 31.5, 29.9, 22.3, 13.9. **IR** (ATR) ν_{max}/cm^{-1}: 3354, 2954, 2927, 2868, 1508, 1458, 1361, 1267, 1107, 1045, 1016, 831, 794, 574. **HRMS (ESI-TOF)** *m/z* calcd for $C_{20}H_{27}S$ $[M\text{-}H_2O+H]^+$ 299.1828, found 299.1848.



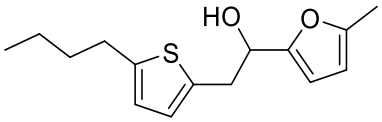
2-(5-butylthiophen-2-yl)-1-(naphtalen-2-yl)ethan-1-ol (4ah). Yellow oil (116 mg, 63%); R_f 0.27 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.86–7.80 (m, 4H), 7.54–7.45 (m, 3H), 6.67 (d, *J* = 3.4 Hz, 1H), 6.60 (d, *J* = 3.4 Hz, 1H), 5.05 (dd, *J* = 8.5, 4.5 Hz, 1H), 3.27 (dd, *J* = 14.8, 4.4 Hz, 1H), 3.20 (dd, *J* = 14.8, 8.5 Hz, 1H), 2.76 (t, *J* = 7.6 Hz, 2H), 1.68–1.59 (m, 3H), 1.42–1.35 (m, 2H), 0.93 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.3, 140.9, 137.4, 133.4, 133.2, 128.4, 128.1, 127.8, 126.3, 126.1, 126.0, 124.8, 124.1, 123.9, 75.2, 40.5, 33.9, 30.0, 22.3, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 3550, 2954, 2926, 2868, 2854, 1055, 864, 817, 808, 779, 738, 472. **HRMS (ESI-TOF)** *m/z* calcd for $C_{20}H_{22}NaOS$ $[M+Na]^+$ 333.1284, found 333.1285.



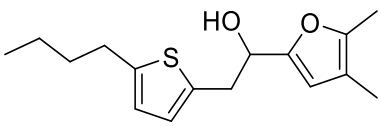
2-(5-butylthiophen-2-yl)-1-(5-methylthiophen-2-yl)ethan-1-ol (4ai). Yellow oil (113 mg, 68%); R_f 0.38 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.77 (d, *J* = 3.5 Hz, 1H), 6.67 (d, *J* = 3.3 Hz, 1H), 6.60 (td, *J* = 3.5, 3.0, 1.8 Hz, 2H), 5.02 (dd, *J* = 7.8, 5.0 Hz, 1H), 3.28–3.18 (m, 2H), 2.75 (t, *J* = 7.6 Hz, 2H), 2.47 (d, *J* = 1.1 Hz, 3H), 1.65–1.60 (m, 2H), 1.41–1.35 (m, 2H), 0.93 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.3, 144.7, 139.5, 137.0, 126.2, 124.8, 124.1, 123.8, 71.2, 40.4, 33.9, 30.0, 22.3, 15.5, 13.9 ppm. **IR** (ATR) ν_{max}/cm^{-1}: 3365, 2953, 2922, 2854, 1456, 1436, 1028, 794, 532. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{19}S_2$ $[M\text{-}H_2O+H]^+$ 263.0923, found 263.0915.



2-(5-butylthiophen-2-yl)-1-(4-methylthiophen-2-yl)ethan-1-ol (4aj). Colorless oil (122 mg, 73%); R_f 0.43 (Petroleum ether/Et_2O, 90:10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.82 (dd, *J* = 6.3, 1.3 Hz, 2H), 6.68 (d, *J* = 3.4 Hz, 1H), 6.61 (d, *J* = 3.4 Hz, 1H), 5.05 (dd, *J* = 8.1, 4.7 Hz, 1H), 3.27 (dd, *J* = 14.8, 4.7 Hz, 1H), 3.21 (dd, *J* = 14.7, 8.2 Hz, 1H), 2.76 (t, *J* = 7.6 Hz, 2H), 2.23 (d, *J* = 0.8 Hz, 3H), 1.63 (tt, *J* = 7.7, 6.4 Hz, 2H), 1.42–1.35 (m, 2H), 0.93 (t, *J* = 7.4 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 146.9, 145.4, 137.4, 136.9, 126.5, 126.2, 123.8, 120.0, 71.1, 40.5, 33.9, 30.0, 22.3, 15.9, 13.9. **IR** (ATR) ν_{max}/cm^{-1}: 3360, 2953, 2924, 2856, 1458, 1436, 1028, 796, 731, 594. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{19}S_2$ $[M\text{-}H_2O+H]^+$ 263.0923, found 263.0920.

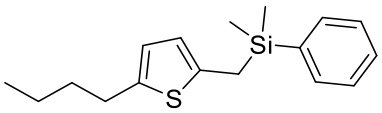


2-(5-butylthiophen-2-yl)-1-(5-methylfuran-2-yl)ethan-1-ol (4ak). Yellow oil (102 mg, 64%); R_f 0.29 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.66 (d, *J* = 3.4 Hz, 1H), 6.59 (d, *J* = 3.4 Hz, 1H), 6.14 (d, *J* = 3.1 Hz, 1H), 5.91 (dd, *J* = 3.1, 1.1 Hz, 1H), 4.82 (dd, *J* = 7.6, 5.5 Hz, 1H), 3.32– 3.22 (m, 2H), 2.75 (t, *J* = 7.6 Hz, 2H), 2.30 (s, 3H), 1.65–1.59 (m, 2H), 1.41–1.34 (m, 2H), 0.93 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 153.6, 152.0, 145.2, 137.0, 126.1, 123.8, 107.6, 106.3, 68.6, 36.8, 33.9, 30.0, 22.3, 13.9, 13.7. **IR** (ATR) ν_{max}/cm^{-1}: 3419, 2954, 2924, 2856, 1558, 1456, 1219, 1056, 1018, 781. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{19}OS$ $[M\text{-}H_2O+H]^+$ 247.1151, found 247.1143.

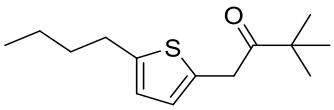


2-(5-butylthiophen-2-yl)-1-(4,5-dimethylfuran-2-yl)ethan-1-ol (4al). Yellow oil (95 mg, 57%); R_f 0.31 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, Toluene-*d8*) δ 6.55–6.49 (m, 1H), 6.46–6.42 (m, 1H), 5.82 (s, 1H), 4.66 (dd, *J* = 7.4, 5.5 Hz, 1H), 3.20 (dd, *J* = 14.7, 5.4 Hz, 1H), 3.14 (dd, *J* = 14.8, 7.5 Hz, 1H), 2.55 (t, *J* = 7.6 Hz, 2H), 1.98 (s, 3H), 1.73 (s, 3H), 1.52–1.44 (m, 2H), 1.21 (dq, *J* = 14.6, 7.4 Hz, 2H),

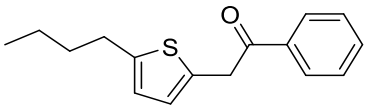
0.81 (t, *J* = 7.4 Hz, 3H ppm). **^{13}C NMR** (100 MHz, $CDCl_3$) δ152.4, 147.1, 145.1, 137.1, 126.0, 123.8, 114.6, 110.0, 68.6, 36.7, 33.9, 29.9, 22.3, 13.9, 11.4, 10.0. **IR** (ATR) ν_{max}/cm^{-1}: 3365, 2954, 2922, 2856, 1456, 1436, 1220, 1029, 796. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{21}OS$ $[M\text{-}H_2O+H]^+$ 261.1308, found 261.1320.



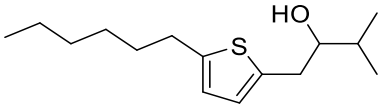
((5-butylthiophen-2-yl)methyl)dimethyl(phenyl)silane (4am). Colorless oil (143 mg, 83%); R_f 0.72 (Petroleum ether).**^{1}H NMR** (400 MHz, $CDCl_3$) δ7.52–7.46 (m, 2H), 7.36 (tt, *J* = 4.1, 2.6 Hz, 3H), 6.51–6.47 (m, 1H), 6.32 (d, *J* = 3.3 Hz, 1H), 2.70 (t, *J* = 7.6 Hz, 2H), 2.43 (s, 2H), 1.63–1.57 (m, 2H), 1.39–1.33 (m, 2H), 0.92 (t, *J* = 7.3 Hz, 3H), 0.31 (s, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ142.1, 138.9, 138.4 133.8, 129.2, 127.9, 123.7, 123.2, 34.0, 29.9, 22.3, 19.8, 14.0, -3.2 ppm. **IR** (ATR) ν_{max}/cm^{-1}: 2954, 2926, 2856, 1425, 1247, 1112, 1066, 829, 813, 794, 725, 696, 464. **HRMS (ESI-TOF)** *m/z* calcd for $C_{17}H_{25}SSi$ $[M+H]^+$ 289.1441, found 289.1430.



1-(5-butylthiophen-2-yl)-3,3-dimethylbutan-2-one (4an). White oil (85 mg, 60%); R_f 0.55 (Petroleum ether/Et_2O, 98/2, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ6.66–6.62 (m, 1H), 6.60 (dt, *J* = 3.3, 1.0 Hz, 1H), 3.93 (s, 2H), 2.76 (t, *J* = 7.6 Hz, 2H), 1.67–1.60 (m, 2H), 1.42–1.35 (m, 2H), 1.20 (s, 9H), 0.92 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ211.7, 145.5, 133.5, 126.1, 123.5, 44.7, 37.6, 33.8, 29.9, 26.5, 22.3, 13.9 ppm. **IR** (ATR) ν_{max}/cm^{-1}: 2956, 2927, 2870, 1712, 1647, 1477, 1458, 1365, 1058, 999, 804, 781. **HRMS (ESI-TOF)** *m/z* calcd for $C_{14}H_{21}S$ $[M\text{-}H_2O+H]^+$ 221.1358, found 221.1351.

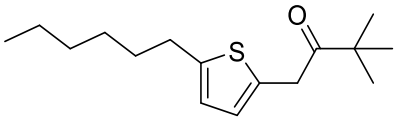


2-(5-butylthiophen-2-yl)-1-phenylethan-1-one (4ao). Yellow oil (102 mg, 70%); R_f 0.42 (Petroleum ether/Et_2O, 98/2, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ8.07–8.02 (m, 2H), 7.65–7.56 (m, 1H), 7.54–7.45 (m, 2H), 6.74 (d, *J* = 3.4 Hz, 1H), 6.64 (d, *J* = 3.4 Hz, 1H), 4.43 (s, 2H), 2.78 (t, *J* = 7.6 Hz, 2H), 1.65 (q, *J* = 7.7 Hz, 2H), 1.44–1.36 (m, 2H), 0.94 (t, *J* = 7.3 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ196.4, 145.9, 136.3, 133.4, 132.9, 128.8, 128.8, 126.5, 123.9, 39.8, 33.8, 29.9, 22.3, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 2924, 2854, 1687, 1593, 1448, 1213, 987, 794, 754, 686, 655, 559, 497. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{17}OS$ $[M\text{-}H_2+H]^+$ 257.0995, found 257.0986.

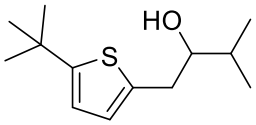


1-(5-hexylthiophen-2-yl)-3-methylbutan-2-ol (4bb). Colorless oil (95 mg, 63%); R_f 0.55 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ6.66 (d, *J* = 3.3 Hz, 1H), 6.60 (d, *J* = 3.3 Hz, 1H), 3.54

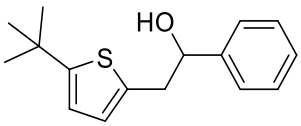
(ddd, *J* = 9.0, 5.5, 3.4 Hz, 1H), 2.97 (dd, *J* = 14.7, 3.2 Hz, 1H), 2.82–2.73 (m, 3H), 1.80–1.71 (m, 1H), 1.64 (dd, *J* = 13.3, 5.5 Hz, 3H), 1.38–1.28 (m, 6H), 0.99 (d, *J* = 6.8 Hz, 6H), 0.92–0.86 (m, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ145.0, 138.6, 125.6, 123.8, 77.3, 35.4, 33.0, 31.8, 31.7, 30.3, 29.0, 22.7, 19.0, 17.7, 14.2. **IR** (ATR) ν_{max}/cm^{-1}: 3387, 2955, 2924, 2854, 1465, 1379, 1365, 1041, 993, 792. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{25}S$ $[M\text{-}H_2O+H]^+$ 237.1671, found 237.1649.



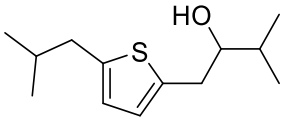
1-(5-hexylthiophen-2-yl)-3,3-dimethylbutan-2-one (4bn). Colorless oil (91 mg, 55%); R_f 0.62 (Petroleum ether/Et_2O, 98/2, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ6.64 (d, *J* = 3.3 Hz, 1H), 6.59 (d, *J* = 3.4 Hz, 1H), 3.93 (s, 2H), 2.75 (t, *J* = 7.7 Hz, 2H), 1.64 (p, *J* = 7.4 Hz, 2H), 1.38–1.27 (m, 6H), 1.20 (s, 9H), 0.90–0.86 (m, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ211.7, 145.6, 133.5, 126.1, 123.5, 44.7, 37.6, 31.7, 30.2, 28.9, 26.5, 22.7, 14.2. **IR** (ATR) ν_{max}/cm^{-1}: 2954, 2926, 2854, 1714, 1475, 1458, 1363, 1058, 999, 781. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{27}OS$ $[M+H]^+$ 267.1777, found 267.1795.



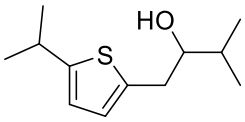
1-(5-(*tert*-butyl)thiophen-2-yl)-3-methylbutan-2-ol (4cb). Colorless oil (81 mg, 60%); R_f 0.5 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ6.67–6.63 (m, 2H), 3.55 (ddd, *J* = 9.1, 5.5, 3.3 Hz, 1H), 2.97 (dd, *J* = 14.7, 3.3 Hz, 1H), 2.78 (dd, *J* = 14.7, 9.1 Hz, 1H), 1.75 (ddd, *J* = 13.6, 6.8, 5.5 Hz, 1H), 1.67 (bs, 1H), 1.36 (s, 9H), 0,99 (d, *J* = 6,8 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ156.5, 138.2, 125.3, 121.1, 77.3, 35.4, 34.6, 33.1, 32.6, 19.0, 17.7. **IR** (ATR) ν_{max}/cm^{-1}: 3385, 2957, 2868, 1460, 1363, 1257, 1043, 993, 794. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_{22}NaOS$ $[M+Na]^+$ 249.1284, found 249.1277.



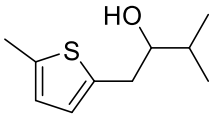
2-(5-(*tert*-butyl)thiophen-2-yl)-1-phenylethan-1-ol (4ce). Colorless oil (90 mg, 58%); R_f 0.36 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ7.41–7.34 (m, 5H), 6.66 (d, *J* = 0.9 Hz, 2H), 4.88 (dd, *J* = 8.8, 4.2 Hz, 1H), 3.20–3.14 (m, 1H), 3.11 (dd, *J* = 14.9, 8.8 Hz, 1H), 2.22 (s, 1H), 1.37 (s, 9H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ156.9, 143.6, 137.2, 128.6, 127.8, 126.0, 125.7, 121.1, 75.1, 40.7, 34.6, 32.6. **IR** (ATR) ν_{max}/cm^{-1}: 3394, 2958, 2900, 2864, 1489, 1456, 1361, 1255, 1043, 1024, 794, 698. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{19}S$ $[M\text{-}H_2O+H]^+$ 243.1202, found 243.1216.



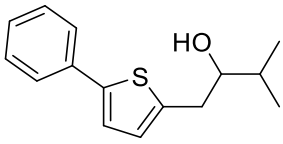
1-(5-isobutylthiophen-2-yl)-3-methylbutan-2-ol (4db). Colorless oil (73 mg, 54%); R_f 0.5 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.66 (d, *J* = 3.3 Hz, 1H), 6.58 (d, *J* = 3.3 Hz, 1H), 3.54 (ddd, *J* = 8.9, 5.5, 3.4 Hz, 1H), 2.97 (dd, *J* = 14.7, 3.1 Hz, 1H), 2.79 (dd, *J* = 14.7, 9.1 Hz, 1H), 2.62 (d, *J* = 7.0 Hz, 2H), 1.86 (dt, *J* = 13.5, 6.8 Hz, 1H), 1.75 (pd, *J* = 6.8, 5.5 Hz, 1H), 1.65 (bs, 1H), 0.99 (d, *J* = 6.8 Hz, 6H), 0.94 (d, *J* = 6.8 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 143.5, 138.9, 125.6, 124.8, 77.3, 39.6, 35.5, 33.1, 30.7, 22.4, 19.0, 17.7. **IR** (ATR) ν_{max}/cm^{-1}: 3381, 2955, 2868, 1463, 1382, 1365, 1039, 993, 790. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_{22}NaOS$ $[M+Na]^+$ 249.1284, found 249.1262.



1-(5-isopropylthiophen-2-yl)-3-methylbutan-2-ol (4eb). Colorless oil (88 mg, 70%); R_f 0.48 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.66 (d, *J* = 3.3 Hz, 1H), 6.63 (dd, *J* = 3.4, 1.0 Hz, 1H), 3.55 (ddd, *J* = 9.0, 5.5, 3.3 Hz, 1H), 3.11 (h, *J* = 6.8 Hz, 1H), 2.97 (dd, *J* = 14.7, 3.2 Hz, 1H), 2.79 (dd, *J* = 14.7, 9.1 Hz, 1H), 1.80–1.72 (m, 1H), 1.71 (bs, *J* = 9.1 Hz, 1H), 1.31 (d, *J* = 6.9 Hz, 6H), 0.99 (d, *J* = 6.8 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 152.4, 138.2, 125.4, 121.7, 77.3, 35.4, 33.1, 30.1, 24.8, 24.8, 19.0, 17.6. **IR** (ATR) ν_{max}/cm^{-1}: 3385, 2958, 2870, 1460, 1382, 1363, 1039, 993, 794. **HRMS (ESI-TOF)** *m/z* calcd for $C_{12}H_{19}S$ $[M-H_2O+H]^+$ 195.1202, found 195.1206.

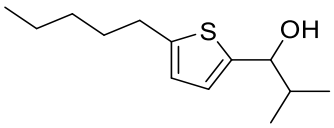


3-Methyl-1-(5-methylthiophen-2-yl)butan-2-ol (4fb). Colorless oil (40 mg, 37%); R_f 0.43 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.64 (d, *J* = 3.3 Hz, 1H), 6.60–6.57 (m, 1H), 3.53 (ddd, *J* = 9.0, 5.5, 3.5 Hz, 1H), 2.96 (dd, *J* = 14.7, 3.5 Hz, 1H), 2.78 (dd, *J* = 14.7, 9.0 Hz, 1H), 2.44 (s, 3H), 1.79–1.71 (m, 1H), 0.98 (d, *J* = 6.8 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 139.0, 138.7, 125.9, 125.0, 77.3, 35.4, 33.0, 19.0, 17.6, 15.4. **IR** (ATR) ν_{max}/cm^{-1}: 3385, 2956, 2918, 2870, 1465, 1365, 1238, 1045, 993, 790. **HRMS (ESI-TOF)** *m/z* calcd for $C_{10}H_{16}NaOS$ $[M+Na]^+$ 207.0814, found 207.0821.

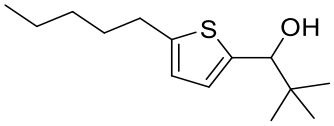


3-Methyl-1-(5-phenylthiophen-2-yl)butan-2-ol (4gb). Colorless oil (90 mg, 60%); R_f 0.21 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ1H NMR (400 MHz, Chloroform-d) δ 7.34–7.28 (m, 2H), 7.27–7.21 (m, 3H), 6.76 (d, *J* = 3.4 Hz, 1H), 6.64 (d, *J* = 3.4 Hz, 1H), 4.51 (dd, *J* = 6.9, 3.3 Hz, 1H), 4.11 (s, 2H), 1.96 (dq, *J* = 13.5, 6.8 Hz, 1H), 1.88 (s, 1H), 1.03 (d, *J* = 6.6 Hz, 3H), 0.86 (d, *J* = 6.8 Hz, 3H). **NMR ^{13}C** (100 MHz, $CDCl_3$) δ 146.2, 143.4, 140.3, 128.7, 128.7, 126.6, 124.5, 124.2, 76.3, 36.5, 35.8,

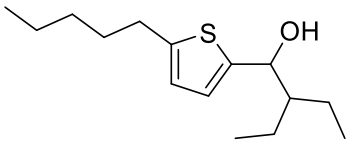
19.1, 18.5. **IR** (ATR) ν_{max}/cm^{-1}: 3381, 2957, 2868,1494, 1452, 1026,1005, 792, 696. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{17}S$ [M-H_2O+H]$^+$ 229.1051, found 229.1049.



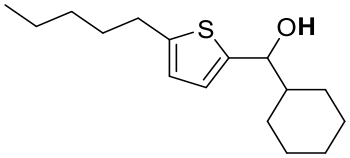
2-Methyl-1-(5-pentylthiophen-2-yl)propan-1-ol (6ab). Colorless oil (95 mg, 69%); R_f 0.42 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ6.74 (d, *J* = 3.4 Hz, 1H), 6.61 (dt, *J* = 3.4, 1.0 Hz, 1H), 4.51 (d, *J* = 7.1 Hz, 1H), 2.77 (t, *J* = 7.7 Hz, 2H), 1.97 (dq, *J* = 13.6, 6.8 Hz, 1H), 1.87 (bs, 1H), 1.70–1.62 (m, 2H), 1.34 (h, *J* = 3.7, 3.2 Hz, 4H), 1,04 (d, *J* = 6.6 Hz, 3H), 0.92–0.85 (m, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ145.4, 144.9, 124.2, 123.3, 76.4, 35.9 31.5 30.3, 22.6, 19.2, 18.6, 14.2. **IR** (ATR) ν_{max}/cm^{-1}: 3354, 2954, 2926, 2856, 1458, 1004, 796. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_{21}S$ [M-H_2O+H]$^+$ 209.1358, found 209.1369.



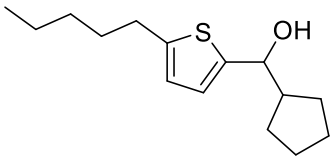
2,2-Dimethyl-1-(5-pentylthiophen-2-yl)propan-1-ol (6ac). Colorless oil (89 mg, 62%); R_f 0.59 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ6.73 (d, *J* = 3.4 Hz, 1H), 6.62 (d, *J* = 3.4 Hz, 1H), 4.56 (s, 1H), 2.76 (t, *J* = 7.7 Hz, 2H), 1.66 (p, *J* = 7.4 Hz, 2H), 1.34 (dq, *J* = 7.2, 3.7 Hz, 4H), 0.98 (s, 9H), 0.92–0.88 (m, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.0, 143.0, 125.1, 123.0, 79.3, 35.7, 31.5, 31.4, 30.2, 26.1, 22.5, 14.1. **IR** (ATR) ν_{max}/cm^{-1}: 3429, 2953, 2926, 2856, 1477, 1458, 1361, 1045, 1001, 800, 759. **HRMS (ESI-TOF)** *m/z* for pour $C_{14}H_{23}S$ [M-H_2O+H]$^+$ 223.1515, found 223.1523.



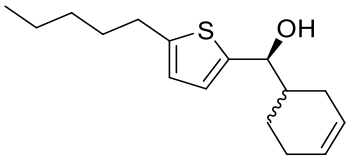
2-Ethyl-1-(5-pentylthiophen-2-yl)butan-1-ol (6ap). Colorless oil (127 mg, 76%); R_f 0.50 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ6.74 (d, *J* = 3.4 Hz, 1H), 6.61 (d, *J* = 3.3 Hz, 1H), 4.78 (d, *J* = 6.5 Hz, 1H), 2.77 (t, *J* = 7.6 Hz, 2H), 1.82 (bs, 1H), 1.73 – 1.62 (m, 2H), 1.58 (ddt, *J* = 11.0, 7.1, 4.0 Hz, 2H), 1.51–1.44 (m, 1H). 1.35 (dt, *J* = 7.3, 3.9 Hz, 5H), 1.23 (dp, *J* = 14.3, 7.3 Hz, 1H), 0.96–0.83 (m, 9H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.4, 145.3 124.0, 123.3, 72.6, 48.3, 31.5, 31.5, 30.3, 22.5, 22.0, 21.2, 14.1, 11.4, 11.0. **IR** (ATR) ν_{max}/cm^{-1}: 2956, 2927, 2870, 1458, 1379, 1053, 1029, 798. **HRMS (ESI-TOF)** *m/z* calcd for $C_{12}H_{25}S$ [M-H_2O+H]$^+$ 237.1677, found 237.1685.



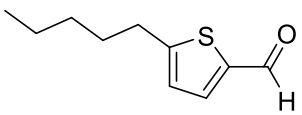
Cyclohexyl(5-pentylthiophen-2-yl)methanol (6aq). Colorless oil (150 mg, 87%); R_f 0.43 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.73 (d, *J* = 3.3 Hz, 1H), 6.61 (d, *J* = 3.3 Hz, 1H), 4.52 (d, *J* = 7.5 Hz, 1H), 2.76 (t, J = 7.7 Hz, 2H), 2.05 (d, J = 12.7 Hz, 1H), 1.87 (bs, 1H), 1.74–1.58 (m, 5H), 1.57–1.45 (m, 2H), 1.40–1.31 (m, 4H), 1.30–0.91 (m, 5H), 0.94–0.86 (m, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ145.2, 144.9, 124.1, 123.2, 75.4, 45.4, 31.4, 31.4, 30.3, 29.4, 29.1, 26.5, 26.1, 26.0, 22.5, 14.1. **IR** (ATR) ν_{max}/cm^{-1}: 3473, 2953, 2924, 2848, 1448, 1041, 1028, 794. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{25}S$ [M-H_2O+H]$^+$ 249.1677, found 249.1678.



Cyclopentyl(5-pentylthiophen-2-yl)methanol (6ar). Colorless oil (125 mg, 80%); R_f 0.38 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ6.76 (d, *J* = 3.4 Hz, 1H), 6.60 (d, *J* = 3.0 Hz, 1H), 4.57 (d, *J* = 8.5 Hz, 1H), 2.77 (t, *J* = 7.7 Hz, 2H), 2.27 (h, J = 8.2 Hz, 1H), 1.91 (dt, *J* = 12.8, 7.2 Hz, 2H), 1.72–1.61 (m, 3H), 1.61–1.49 (m, 5H), 1.40–1.29 (m, 4H), 1.25–1.16 (m, 1H), 0.95–0.84 (m, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ145.7, 144.4, 123.9, 123.2, 75.0, 47.9, 31.4, 31.4, 30.3, 29.8, 29.7, 25.9, 25.7, 22.5, 14.1 ppm. **IR** (ATR) ν_{max}/cm^{-1}: 3363, 2951, 2926, 2856, 1450, 1022, 796. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{23}S$ [M-H_2O+H]$^+$ 235.1520, found 253.1528.

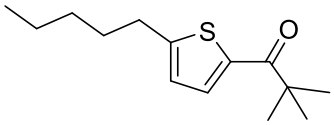


Cyclohex-3-en-1-yl(5-pentylthiophen-2-yl)methanol (6as). Colorless oil (107 mg, 66%); *dr* = 60:40; R_f 0.51 (Petroleum ether/Et_2O, 80/20, v/v). *Only the major diastereomer is described:* **^{1}H NMR** (400 MHz, $CDCl_3$) δ6.77 (d, *J* = 3.4 Hz, 1H), 6.61 (d, *J* = 3.2 Hz, 1H), 5.65 (d, *J* = 30.9 Hz, 2H), 4.64 (d, *J* = 7.1 Hz, 1H), 2.77 (t, *J* = 7.7 Hz, 2H), 2.40–1.84 (m, 6H), 1.64 (dt, *J* = 22.0, 9.9 Hz, 3H), 1.35 (dt, *J* = 6.9, 3.7 Hz, 4H), 0.90 (t, *J* = 6.9 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ145.5, 144.7, 127.0, 126.2, 124.4, 123.3, 74.8, 41.5, 31.4, 30.3, 28.3, 27.9, 25.3, 25.0, 22.5, 14.1. **IR** (ATR) ν_{max}/cm^{-1}: 3379, 3020, 2922, 2854, 1456, 1435, 1024, 798, 650. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{23}S$ [M-H_2O+H]$^+$ 247.1520, found 247.1526.

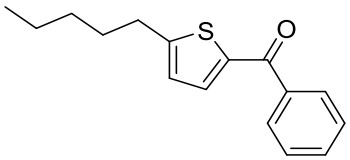


5-pentylthiophene-2-carbaldehyde (6at). Colorless oil (67 mg; 61%); R_f 0.40 (Petroleum ether/Et_2O, 90:10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ9.82 (s, 1H), 7.60 (d, *J* = 3.7 Hz, 1H), 6.90 (d, *J* = 3.7 Hz, 1H), 2.87 (t, *J* = 7.6 Hz, 2H), 1.71 (p, *J* = 7.4 Hz, 2H), 1.40–1.30 (m, 4H), 0.90 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz,

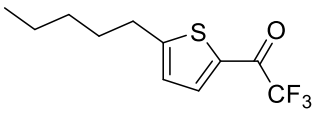
$CDCl_3$) δ 182.8, 157.9, 141.8, 137.1, 126.0, 31.3, 31.1, 31.0, 22.5, 14.1. **IR** (ATR) ν_{max}/cm^{-1}: 2956, 2924, 2854, 1662, 1454, 1224, 1037, 806, 669. **HRMS (ESI-TOF)** *m/z* calcd for $C_{10}H_{15}OS$ $[M+H]^+$ 183.0844, found 183.0846.



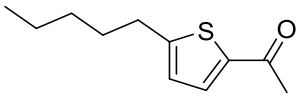
(5-pentylthiophen-2-yl)(tert-butyl)methanone (6an). Colorless oil (66 mg, 47%) ; R_f 0.56 (Petroleum ether/Et_2O, 98/2, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 3.8 Hz, 1H), 6.78 (dt, *J* = 3.8, 0.8 Hz, 1H), 2.81 (t, *J* = 7.6 Hz, 2H), 1.70 (p, *J* = 7.4 Hz, 2H), 1.38 (s, 9H), 1.37–1.31 (m, 4H), 0.90 (t, *J* = 7.1 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 198.8, 154.3, 140.1, 132.4, 125.2, 43.8, 31.4, 31.2, 30.5, 28.4, 22.5, 14.1. **IR** (ATR) ν_{max}/cm^{-1}: 2956, 2929, 2858, 1643, 1448, 1282, 1180, 894, 800, 746. **HRMS (ESI-TOF)** *m/z* calcd for $C_{14}H_{23}OS$ $[M+H]^+$ 239.1470, found 239.1474.



(5-pentylthiophen-2-yl)(phenyl)methanone (6ao). Colorless oil (88 mg, 62%); R_f 0.53 (Petroleum ether/Et_2O, 95/5, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.89–7.80 (m, 2H), 7,56 (m, 1H), 7.52–7.44 (m, 3H), 6,85 (d, *J* = 3.8 Hz, 1H), 2,88 (t, *J* = 7.6 Hz, 2H), 1,73 (p, *J* = 7.4 Hz, 2H), 1.46–1.30 (m, 4H), 0,91 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 188.0, 156.6, 141.1, 138.4, 135.5, 132.0, 129.1, 128.4, 125.6, 31.3, 31.1, 30.7, 22.4, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 2953, 2926, 2854, 1625, 1450, 1288, 1043, 1024, 860, 812, 711, 698, 640. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{19}OS$ $[M+H]^+$ 259.1157, found 259.1166.

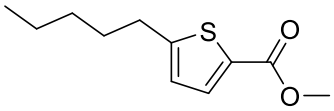


2,2,2-Trifluoro-1-(5-pentylthiophen-2-yl)ethan-1-one (6au). Colorless oil (98 mg, 64%); R_f 0.90 (Petroleum ether/Et_2O, 95/5, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.81 (dd, *J* = 3.7, 1.5 Hz, 1H), 6.93 (d, *J* = 4.0 Hz, 1H), 2.90 (t, *J* = 7.6 Hz, 2H), 1.73 (p, *J* = 7.4 Hz, 2H), 1.41–1.30 (m, 4H), 0.91 (t, *J* = 7.0 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 173.2, 161.4, 137.3, 133.9, 127.0, 116.8, 31.3, 31.0, 30.9, 22.4, 14.0. **^{19}F NMR** (375 MHz, $CDCl_3$) δ -72.05 (S, 3F). **IR** (ATR) ν_{max}/cm^{-1}: 2957, 2929, 2914, 1681, 1444, 1203, 1176, 1139, 1053, 867, 750, 731. **HRMS (ESI-TOF)** *m/z* calcd for $C_{11}H_{14}F_3OS$ $[M+H]^+$ 251.0717, found 251.0717.

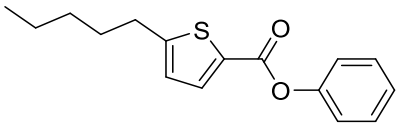


1-(5-pentylthiophen-2-yl)ethan-1-one (6av). Colorless oil (64 mg, 56%); R_f 0.68 (Petroleum ether/Et_2O, 95/5, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 3.8 Hz, 1H), 6,81 (d, *J* = 3.8 Hz, 1H), 2,83 (t, *J* = 7.6 Hz, 2H), 2.51 (s, 3H), 1.70 (p, *J* = 7.4 Hz, 2H), 1,35 (dq, *J* = 7.1, 3.6 Hz, 4H), 0.95–0.85 (m, 3H). **^{13}C NMR** (100

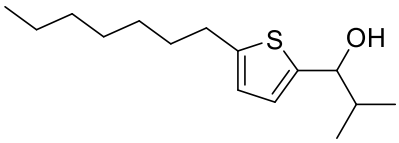
MHz, $CDCl_3$) δ 190.5, 156.1, 142.1, 132.9, 125.6, 31.3, 31.1, 30.7, 26.6, 22.4, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 2957, 2926, 2854, 1654, 1452, 1355, 1274, 1028, 925, 806, 607, 561. **HRMS (ESI-TOF)** *m/z* calcd $C_{11}H_{17}OS$ for $[M+H]^+$ 197.1000, found 197.1004.



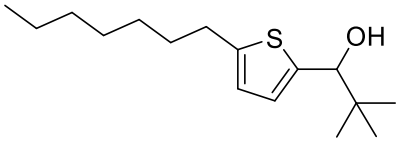
Methyl 5-pentylthiophene-2-carboxylate (6aw). Colorless oil (84 mg, 65%); R_f 0.63 (Petroleum ether/ Et_2O, 95/5, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.62 (d, *J* = 3.7 Hz, 1H), 6.77 (d, *J* = 3.7 Hz, 1H), 3.85 (s, 3H), 2.81 (t, *J* = 7.6 Hz, 2H), 1.68 (p, *J* = 7.3 Hz, 2H), 1.33 (h, *J* = 3.8 Hz, 4H), 0.93–0.84 (m, 3H).**^{13}C NMR** (100 MHz, $CDCl_3$) δ 162.9, 154.2, 133.8, 130.6, 125.2, 52.0, 31.3, 31.2, 30.5, 22.4, 14.0. **IR** (ATR) ν_{max}/cm^{-1}: 2953, 2926, 2854, 1707, 1458, 1444, 1286, 1255, 1190, 1091, 812, 748. **HRMS (ESI-TOF)** *m/z* calcd for $C_{11}H_{17}OS$ $[M+H]^+$ 213.0949, found 213.0953.



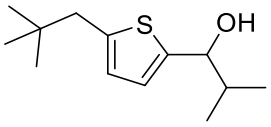
Phenyl 5-pentylthiophene-2-carboxylate (6ax). Colorless oil (126 mg, 76%); R_f 0.44 (Petroleum ether/ Et_2O, 98/2, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.81 (d, *J* = 3.7 Hz, 1H), 7.41 (t, *J* = 7.9 Hz, 2H), 7.26 (t, *J* = 3.7 Hz, 1H), 7.21 (d, *J* = 8.0 Hz, 2H), 6.86 (d, *J* = 3.8 Hz, 1H), 2.88 (t, *J* = 7.6 Hz, 2H), 1.73 (p, *J* = 7.3 Hz, 2H), 1.40–1.34 (m, 4H), 0.92 (t, *J* = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 160.8, 155.6, 150.9, 135.1, 130.0, 129.6, 126.0, 125.6, 121.8, 31.3, 31.3, 30.7, 22.5, 14.1. **IR** (ATR) ν_{max}/cm^{-1}: 2956, 2926, 2854, 1724, 1490, 1456, 1269, 1247, 1190, 1056, 736, 686. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{19}O_2S$ $[M+H]^+$ 275.1106, found 275.1105.



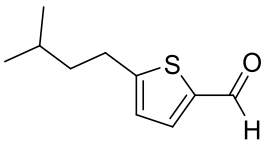
1-(5-heptylthiophen-2-yl)-2-methylpropan-1-ol (6bb). Colorless oil (102 mg, 67%); R_f 0.54 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.74 (d, *J* = 3.4 Hz, 1H), 6.61 (d, *J* = 3.4 Hz, 1H), 4.51(d, *J* = 7.2 Hz, 1H), 2.76 (t, *J* = 7.6 Hz, 2H), 1.97 (dq, *J* = 13.5, 6.8 Hz, 1H), 1.65 (p, *J* =7.7 Hz, 2H), 1.40–1.22 (m, 8H), 1.04 (d, *J* = 6.7 Hz, 3H), 0.93–0.84 (m, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.4, 144.9, 124.2, 123.3, 76.4, 35.9, 31.9, 31.8, 30.3, 29.2, 29.2, 22.8, 19.2, 18.6, 14,2. **IR** (ATR) ν_{max}/cm^{-1}: 3385, 2954, 2922, 2852, 1465, 1458, 1049, 1022, 794. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{25}S$ $[M-H_2O+H]^+$ 237.1677, found 237.1685.



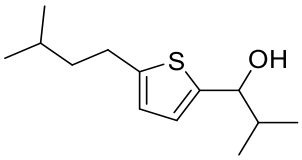
1-(5-heptylthiophen-2-yl)-2,2-dimethylpropan-1-ol (6bc). Yellow oil (107 mg, 59%); R_f 0.30 (Petroleum ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.73 (d, *J* = 3.4 Hz, 1H), 6.62 (dt, *J* = 3.4, 0.8 Hz 1H), 4.56 (s, 1H), 2.76 (t, *J* = 7.7 Hz, 2H), 1.96 (bs, 1H), 1.66 (p, *J* = 7.4 Hz, 2H), 1.43–1.21 (m, 9H), 0.98 (s, 9H), 0.94–0.85 (m, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.1, 143.1, 125.1, 123.0, 79.3, 35.8, 31.9, 31.8, 30.3, 29.2, 29.2, 26.1, 22.8, 14.2. **IR** (ATR) ν_{max}/cm^{-1}: 3442, 2953, 2924, 2852, 1460, 1361, 1043, 1001, 800, 759. **HRMS (ESI-TOF)** *m/z* calcd for $C_{16}H_{27}S$ $[M\text{-}H_2O+H]^+$ 251.1833, found 251.1836.



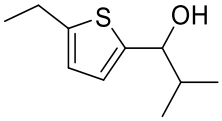
1-(5-neopentylthiophen-2-yl)-2-methylpropan-1-ol (6cb). Colorless oil (97 mg, 72%); R_f 0.30 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.77 (d, *J* = 3.4 Hz, 1H), 6.59 (d, *J* = 3.4 Hz, 1H), 4.52 (d, *J* = 7.1 Hz, 1H), 2.65 (s, 2H), 1.98 (dq, *J* = 13.6, 6.8 Hz, 1H), 1.88 (bs, 1H), 1.04 (d, *J* = 6.6 Hz, 3H), 0.95 (s, *J* = 7.2 Hz, 9H), 0.86 (d, *J* = 6.7 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.5, 141.2, 125.9, 124.0, 76.3, 44.5, 35.9, 31.7, 29.4, 19.2, 18.6. **IR** (ATR) ν_{max}/cm^{-1}: 2951, 2902, 2866, 1465, 1363, 1051, 798. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_{21}S$ $[M\text{-}H_2O+H]^+$ 209.1364, found 209.1362.



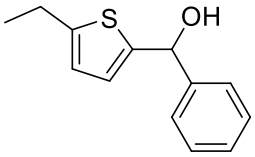
5-isopentylthiophene-2-carbaldehyde (6dt). Colorless oil (63 mg, 69%); R_f 0.42 (Petroleum ether/ Et_2O, 90/10, v/v). **^{1}H** (400 MHz, $CDCl_3$) δ 9.81 (s, 1H), 7.60 (d, *J* = 3.7 Hz, 1H), 6.90 (d, *J* = 3.7 Hz, 1H), 2.87 (t, *J* = 7.4 Hz, 2H), 1.77–1.43 (m, 3H), 0.94 (d, *J* = 6.2 Hz, 6H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 182.7, 158.0, 141.7, 137.1, 125.8, 40.4, 28.9, 27.6, 22.4. **IR** (ATR) ν_{max}/cm^{-1}: 2954, 2870, 2360, 1660, 1456, 1220, 1039, 864, 754, 669. **HRMS (ESI-TOF)** *m/z* calcd for $C_{10}H_{15}OS$ $[M+H]^+$ 183.0844, found 183.0843.



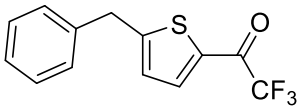
1-(5-isopentylthiophen-2-yl)-2-methylpropan-1-ol (6db). Colorless oil (73 mg, 54%); R_f 0.55 (Petroleum Ether/Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.74 (d, *J* = 3.4 Hz, 1H), 6.61 (d, *J* = 3.5 Hz, 1H), 4.51 (d, *J* = 6.8 Hz, 1H), 2.78 (t, *J* = 7.7 Hz, 2H), 1.97 (dq, *J* = 13.5, 6.8 Hz, 1H), 1.88 (s, 1H), 1.67–1.52 (m, 3H), 1.04 (d, *J* = 6.6 Hz, 3H), 0.93 (d, *J* = 6.4 Hz, 6H), 0.87 (d, *J* = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 145.5, 144.9, 124.2, 123.2, 76.4, 40.9, 35.9, 28.2, 27.7, 22.6, 22.5, 19.2, 18.6. **IR** (ATR) ν_{max}/cm^{-1}: 3383, 2954, 2926, 2870, 1465, 1365, 1004, 796. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_{21}S$ $[M\text{-}H_2O+H]^+$ 209.1364, found 209.1368.



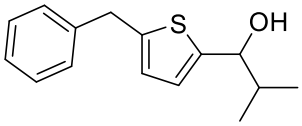
1-(5-ethylthiophen-2-yl)-2-methylpropan-1-ol (6eb). Colorless oil (72 mg, 65%); R_f 0.32 (Petroleum ether/Et_2O, 90/10, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 6.75 (d, *J* = 3.4 Hz, 1H), 6.63 (d, *J* = 3.4 Hz, 1H), 4.51 (d, *J* = 7.1 Hz, 1H), 2.82 (q, *J* = 7.5 Hz, 2H), 1.97 (td, *J* = 13.5, 6.7 Hz, 1H), 1.44 (s, 1H), 1.30 (t, *J* = 7.5 Hz, 3H), 1.05 (d, *J* = 6.7 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 146.8, 144.8, 124.2, 122.6, 76.3, 35.8, 23.6, 19.1, 18.6, 16.0. **IR** (ATR) ν_{max}/cm^{-1}: 3365, 2960, 2926, 2872, 1456, 1018, 1002, 800, 698. **HRMS (ESI-TOF)** *m/z* calcd for $C_{10}H_{15}S$ $[M\text{-}H_2O+H]^+$ 167.0894, found 167.0892.



(5-ethylthiophen-2-yl)(phenyl)methanol (6ee). Colorless oil (64 mg, 49%); R_f 0.35 (Petroleum ether/ Et_2O, 90/10, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.50–7.42 (m, 2H), 7.42–7.28 (m, 3H), 6.70 (d, *J* = 3.3 Hz, 1H), 6.61 (dt, *J* = 3.4, 1.1 Hz, 1H), 5.99 (s, 1H), 2.79 (q, *J* = 7.5 Hz, 2H), 1.27 (t, *J* = 7.5 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 148.0, 145.3, 143.3, 128.6, 128.0, 126.3, 124.9, 122.8, 72.6, 23.6, 15.9. **IR** (ATR) ν_{max}/cm^{-1}: 3392, 2962, 2924, 1490, 1450, 1024, 906, 796, 729, 696. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_{13}S$ $[M\text{-}H_2O+H]^+$ 201.0732, found 201.0746.

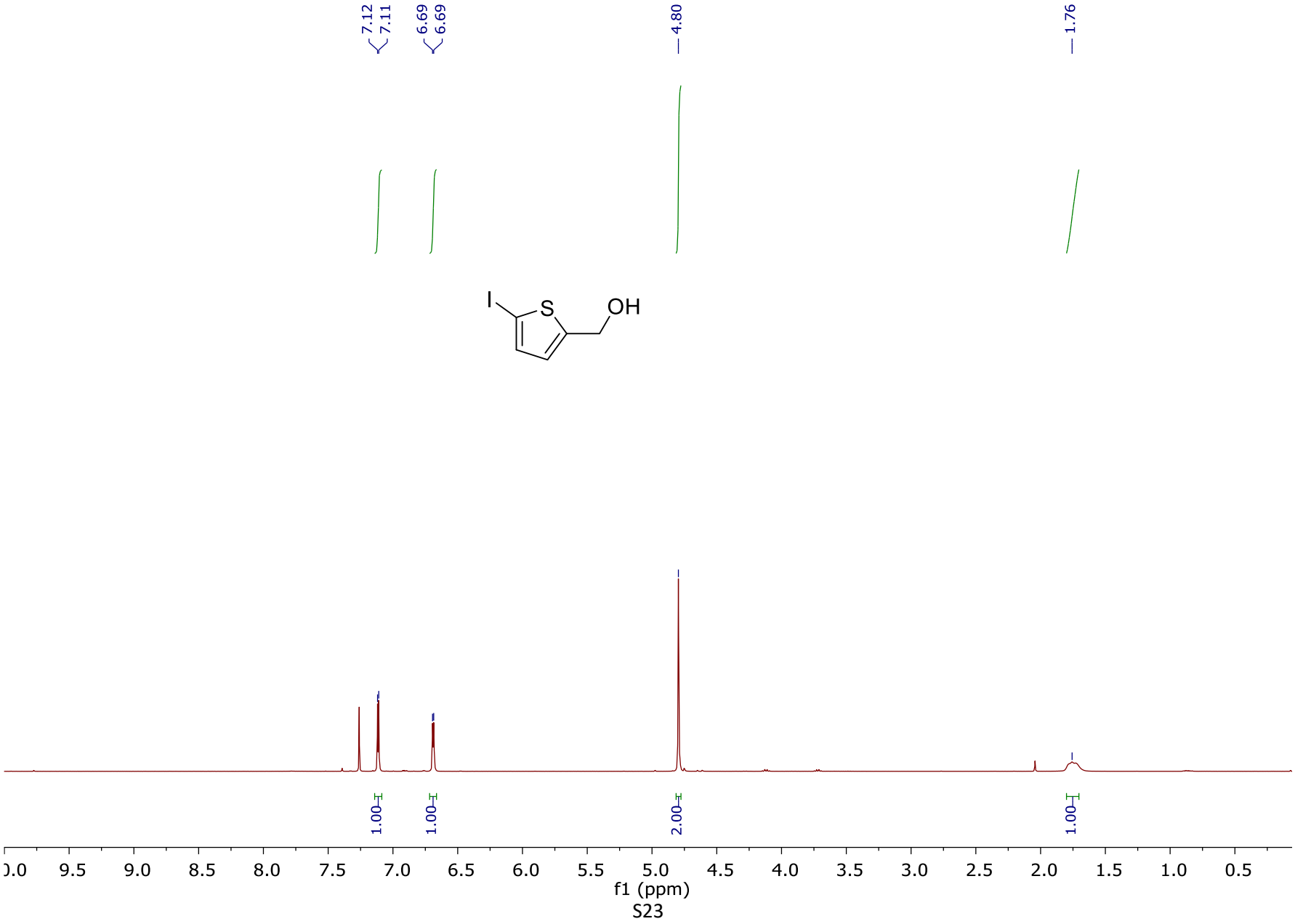


1-(5-benzylthiophen-2-yl)-2,2,2-trifluoroethan-1-one (6fu). Yellow oil (71 mg, 58%); R_f 0.24 (Petroleum ether/Et_2O, 95/5, v/v).**^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.81 (dd, *J* = 3.7, 1.5 Hz, 1H), 7.37–7.32 (m, 2H), 7.32–7.28 (m, 1H), 7.27–7.23 (m, 2H), 6.94 (d, *J* = 4.0 Hz, 2H), 4.21 (s, 1H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 173.4, 159.4, 138.3, 137.2, 134.8, 129.1, 128.8, 127.7, 127.4, 116.6, 37.0. **^{19}F NMR** (375 MHz, $CDCl_3$) δ - 72,12 (s, 3F). **IR** (ATR) ν_{max}/cm^{-1}: 3030, 1681, 1440, 1174, 1139, 1055, 867, 731, 696. **HRMS (ESI-TOF)** *m/z* calcd for $C_{13}H_9F_3OS$ $[M+H]^+$ 271.0404; found 271.0407.



1-(5-benzylthiophen-2-yl)-2-methylpropan-1-ol (6fb). Colorless oil (71 mg, 50%); R_f 0.24 (Petroleum ether/Et_2O, 95/5, v/v). **^{1}H NMR** (400 MHz, $CDCl_3$) δ 7.35–7.29 (m, 2H), 7.28–7.20 (m, 3H), 6.76 (d, *J* = 3.4 Hz, 1H), 6.64 (d, *J* = 3.4 Hz, 1H), 4.51 (d, *J* = 6.9 Hz, 1H), 4.11 (s, 2H), 1.96 (dq, *J* = 13.5, 6.7 Hz, 1H), 1.90 (s, 1H), 1.03 (d, *J* = 6.7 Hz, 3H), 0.87 (d, *J* = 6.8 Hz, 3H). **^{13}C NMR** (100 MHz, $CDCl_3$) δ 146.2, 143.4, 140.3, 128.7, 128.6, 126.6, 124.5, 124.2, 76.3, 36.5, 35.8, 19.1, 18.5. **IR** (ATR) ν_{max}/cm^{-1}: 3381, 3061, 3026, 2956, 2868, 1492, 1452, 1002, 792, 696. **HRMS (ESI-TOF)** *m/z* calcd for $C_{15}H_{17}S$ $[M\text{-}H_2O+H]^+$ 229.1051, found 229.1055.

NMR spectra related to substrates 1 and products 4 and 6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6.69
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S
OH
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2.00
1.00
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6.5
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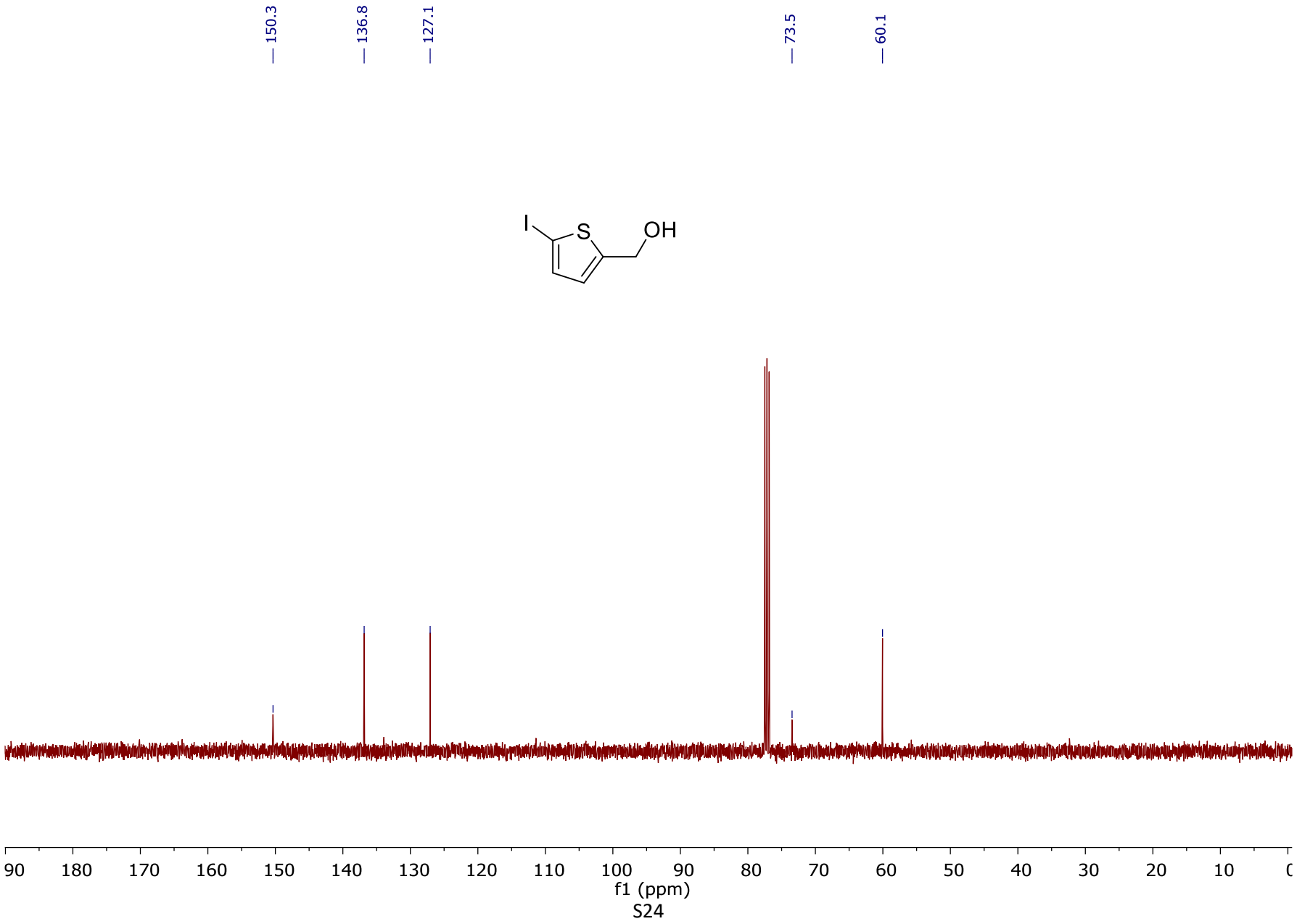
f1 (ppm)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OH
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160
150
140
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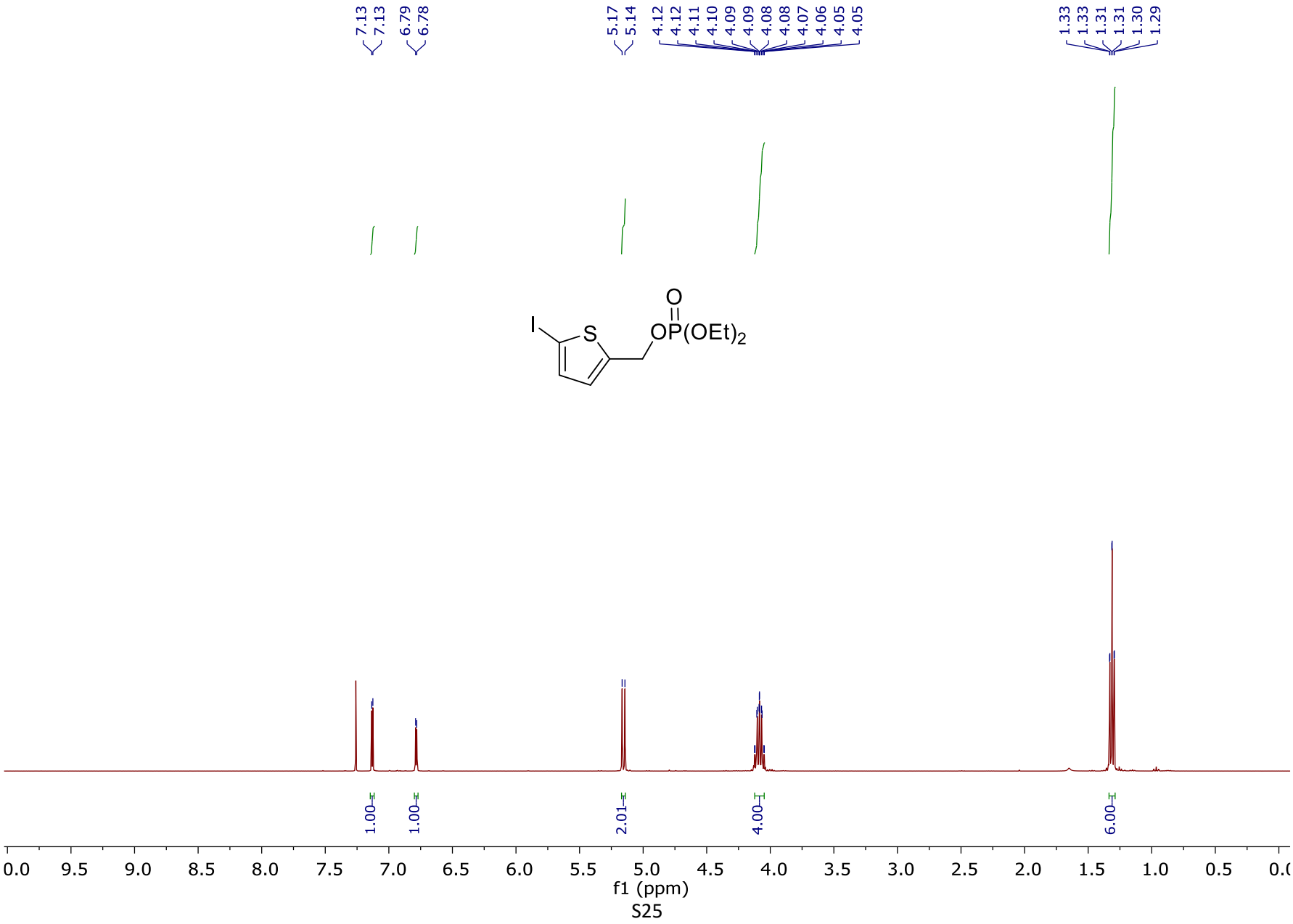
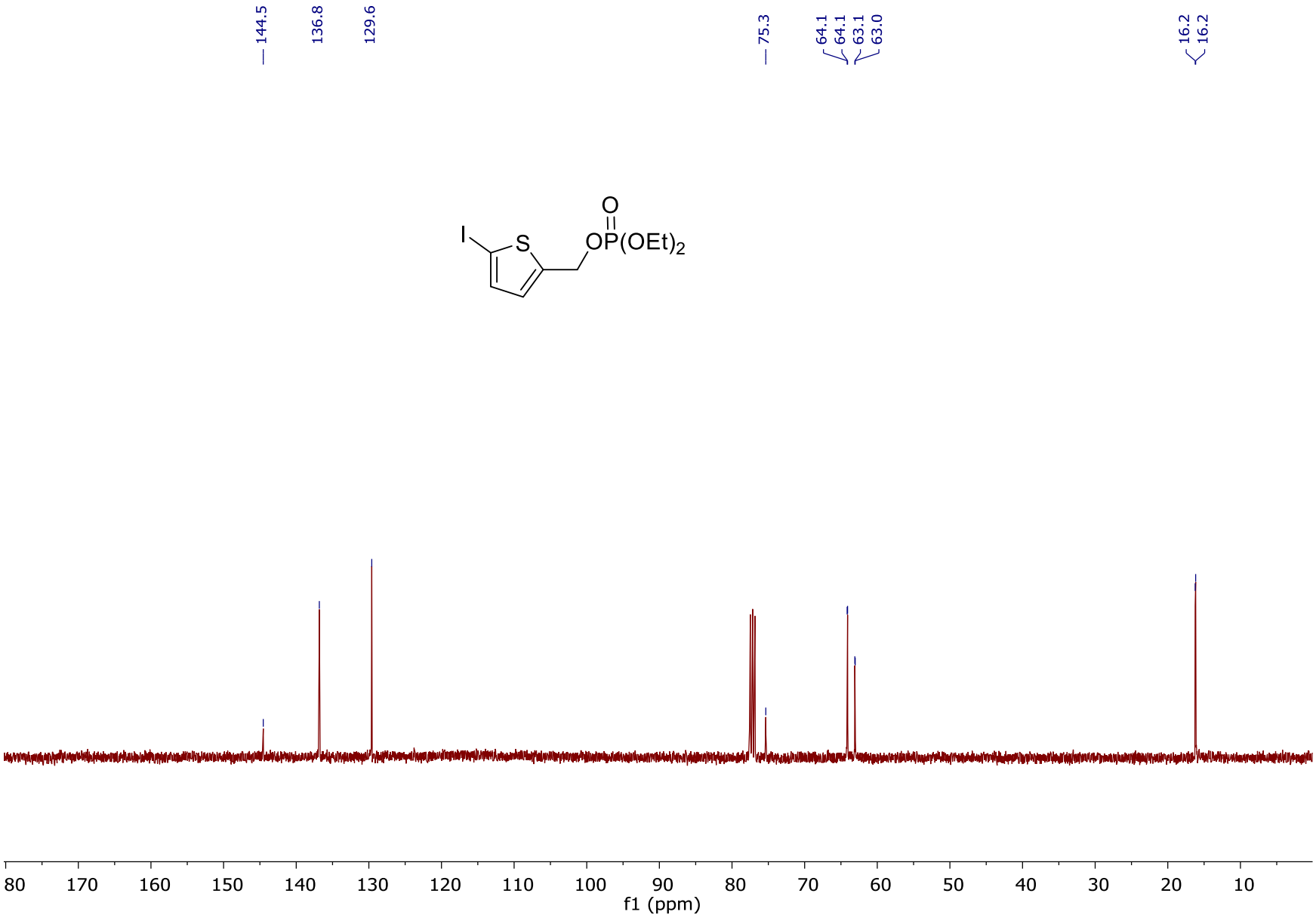
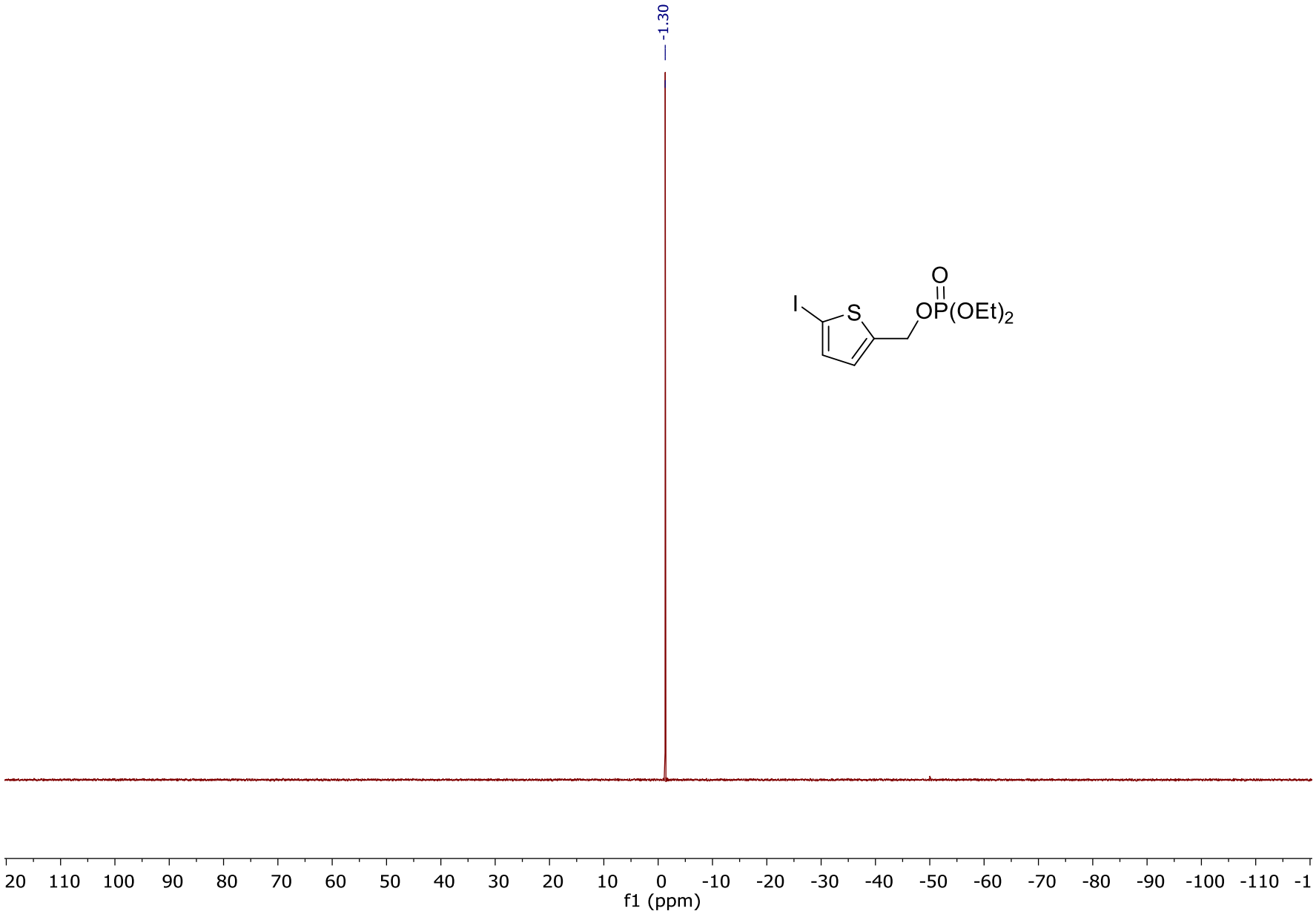
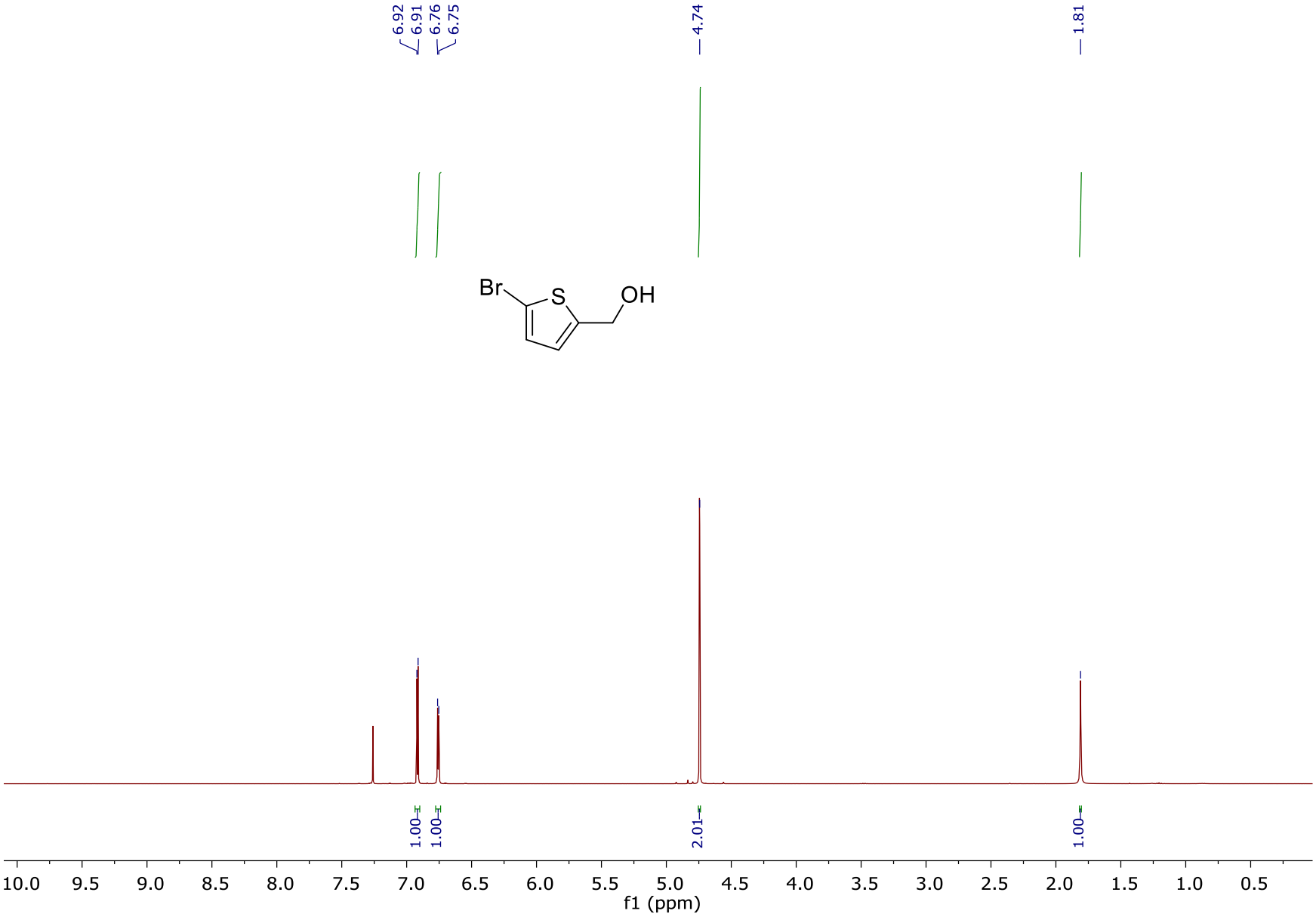
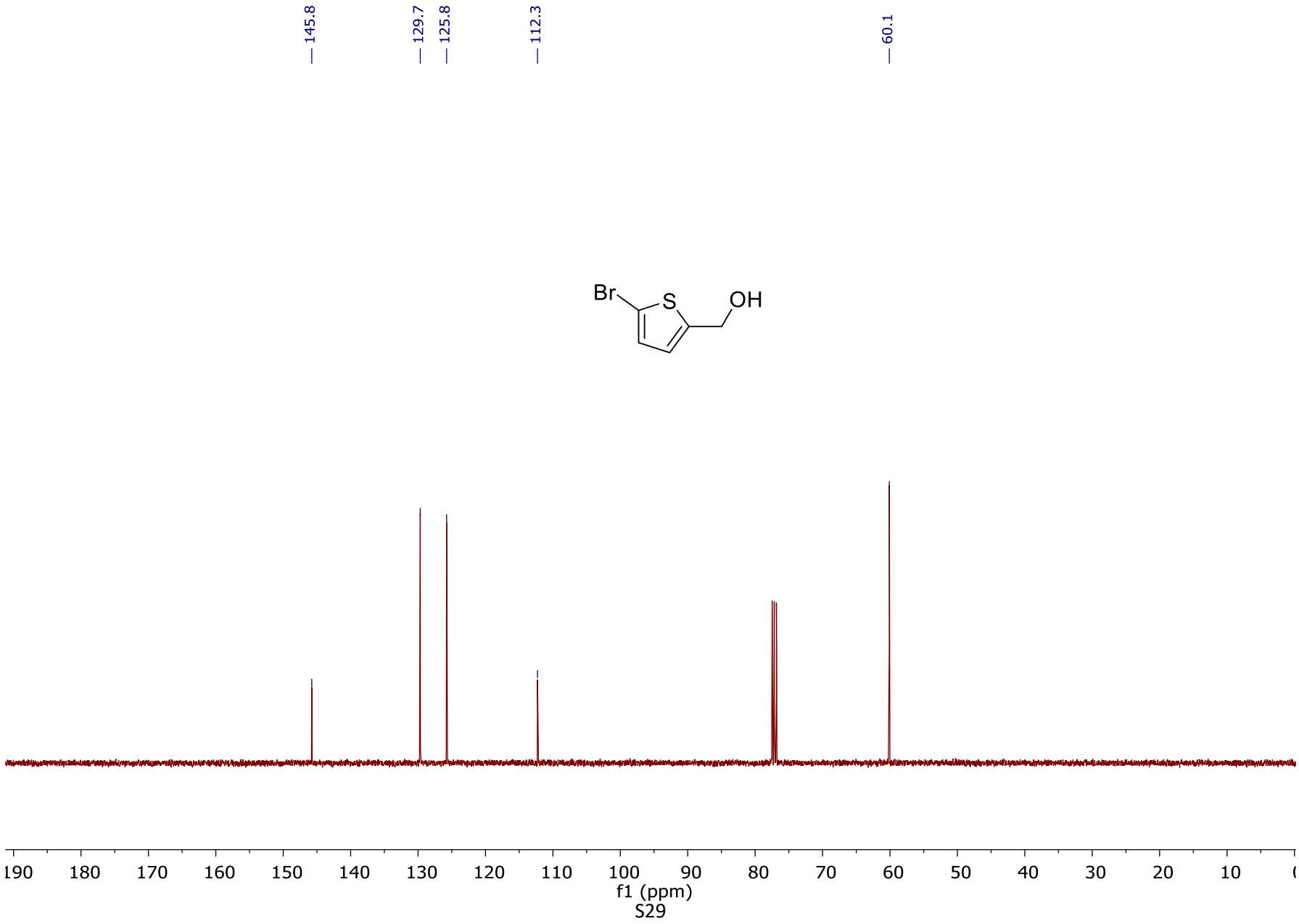
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

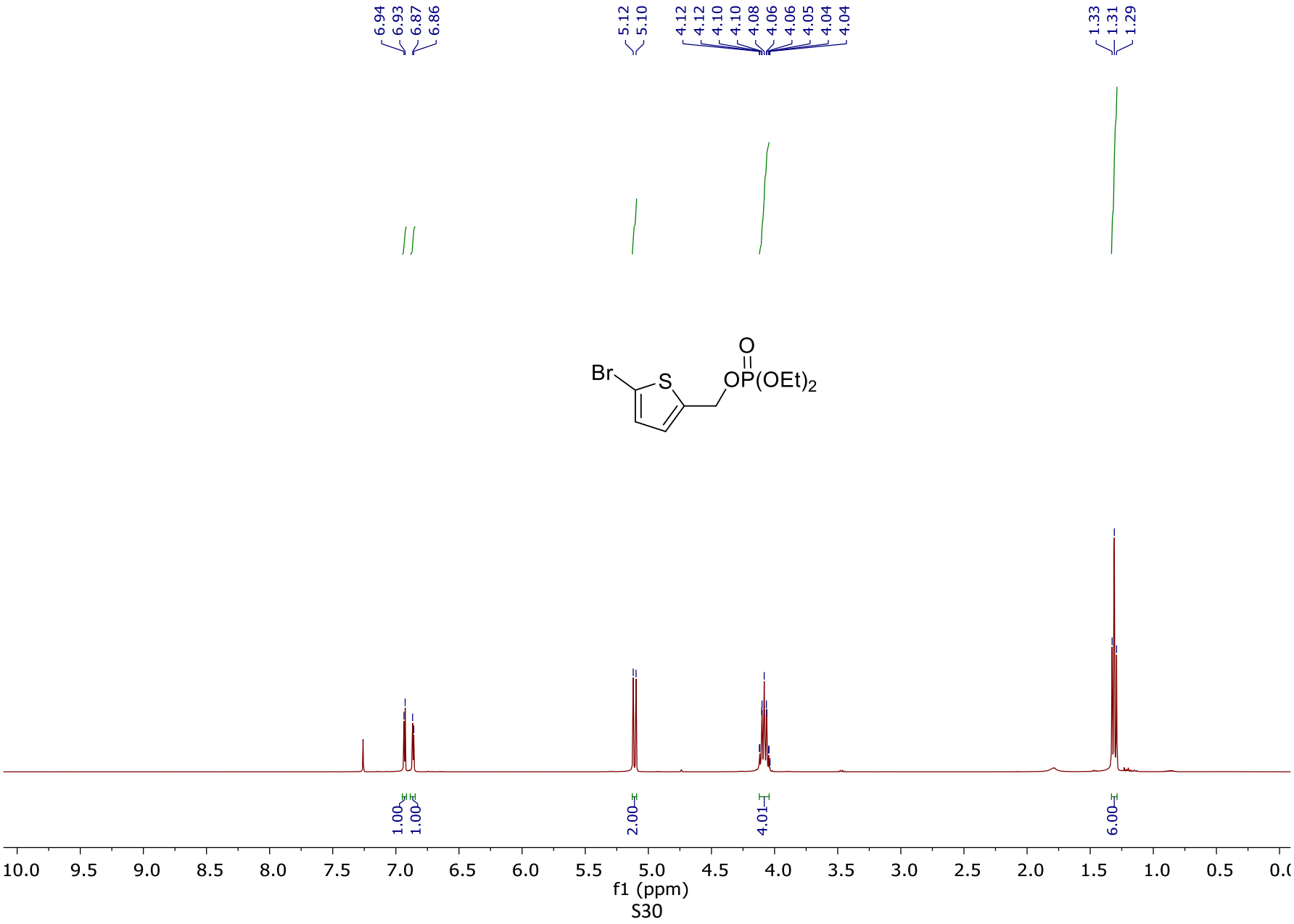

7.13
7.13
6.79
6.78
5.17
5.14
4.12
4.12
4.11
4.10
4.09
4.09
4.08
4.08
4.07
4.06
4.05
4.05
1.33
1.33
1.31
1.31
1.30
1.29
I
S
O
OP(OEt)2
1.00
1.00
2.01
4.00
6.00
0.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

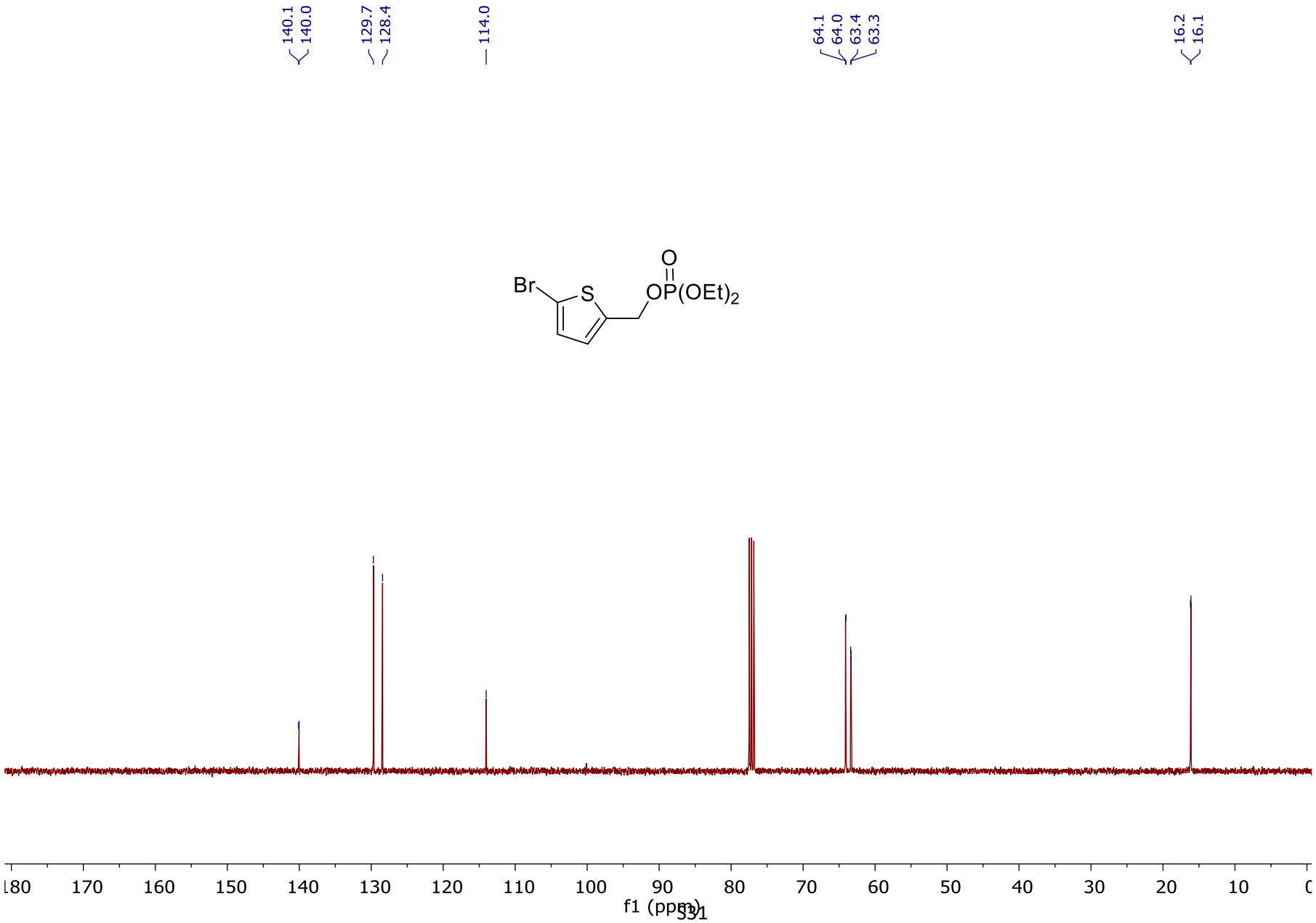

144.5
136.8
129.6
75.3
64.1
64.1
63.1
63.0
16.2
16.2
I
S
O
OP(OEt)2
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

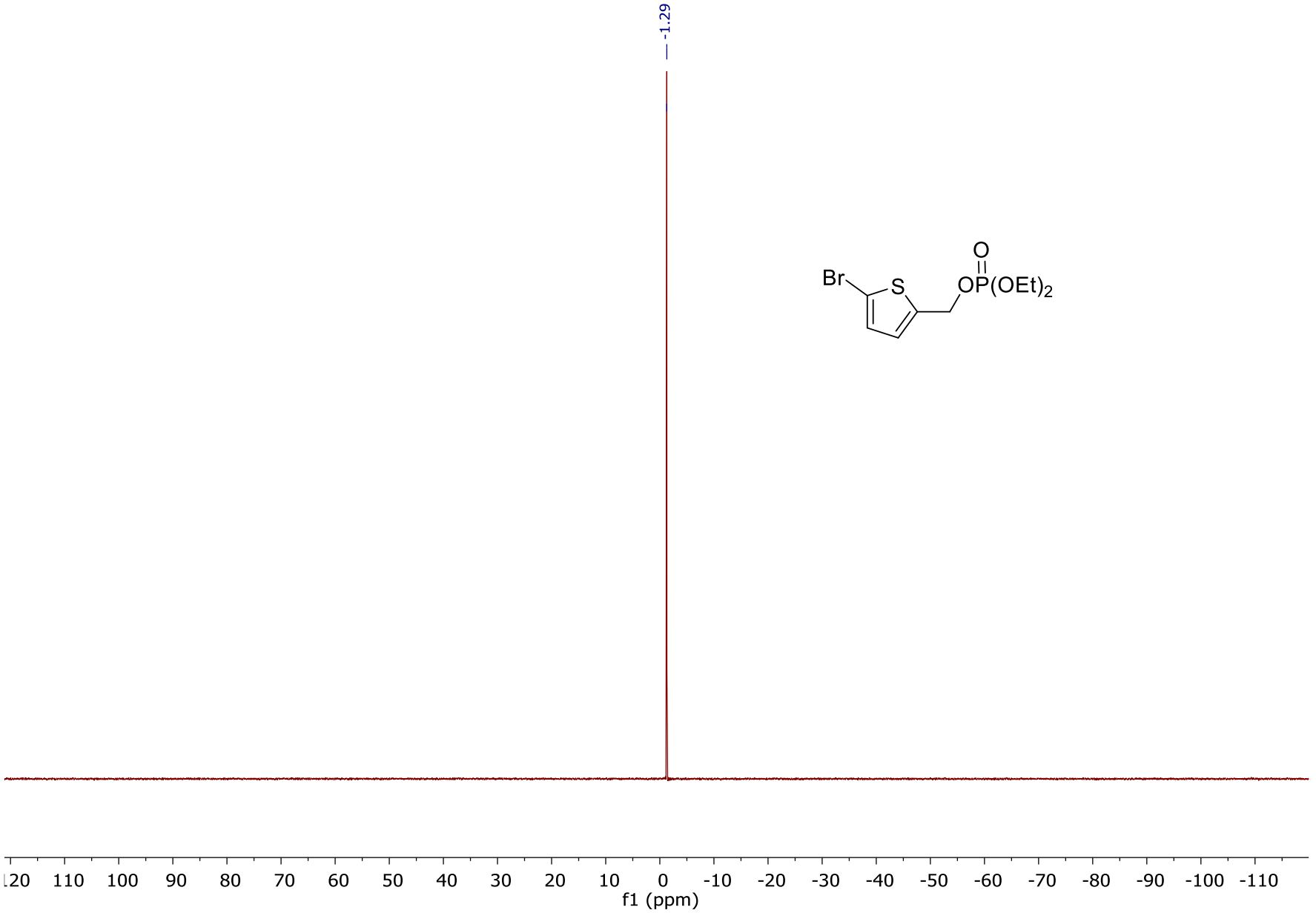

-1.30
I
S
O
OP(OEt)2
20 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110 -1
f1 (ppm)

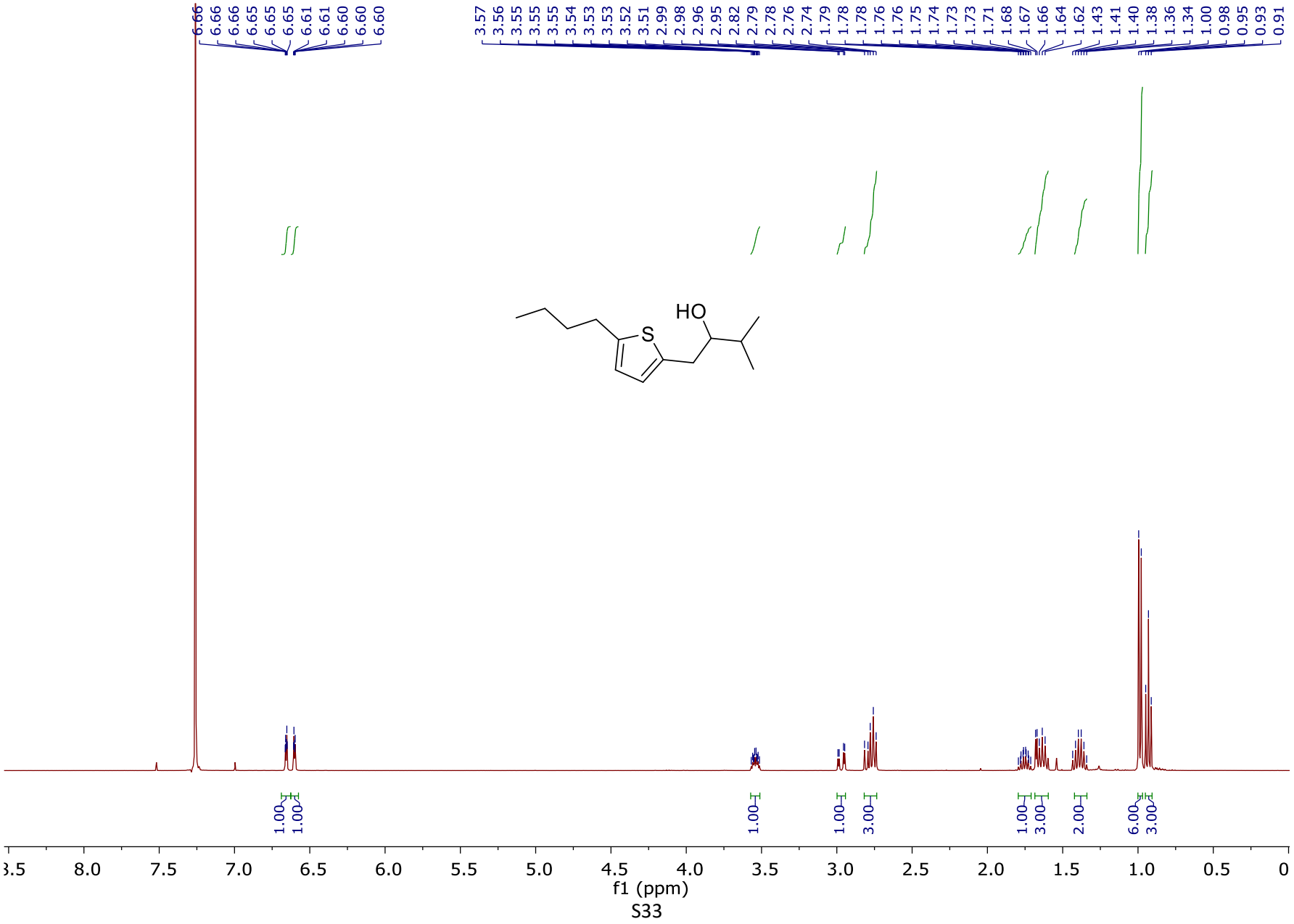

6.92
6.91
6.76
6.75
4.74
1.81
Br
S
OH
1.00
1.00
2.01
1.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


145.8
129.7
125.8
112.3
60.1
Br
S
OH
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

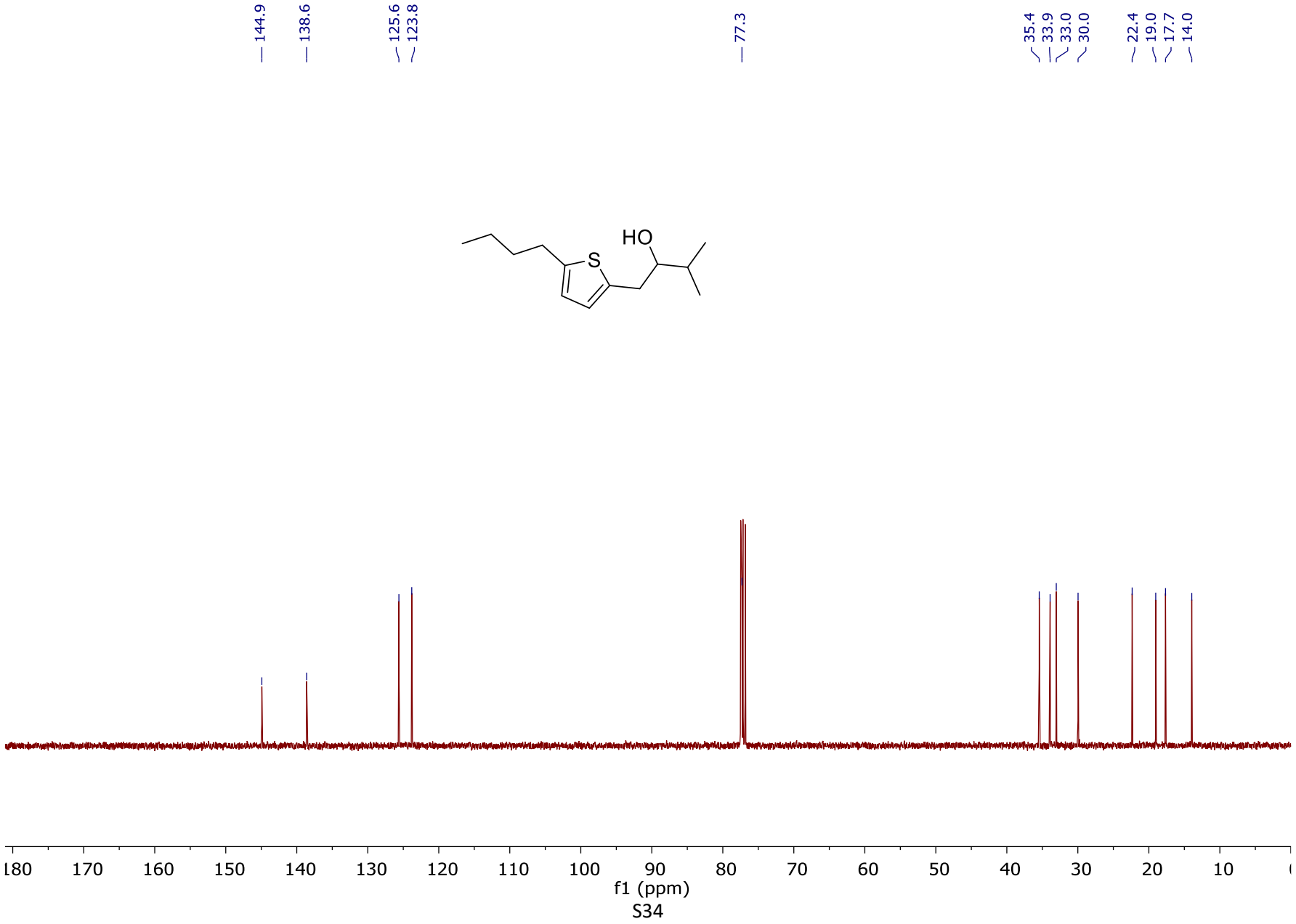

6.94
6.93
6.87
6.86
5.12
5.10
4.12
4.12
4.10
4.10
4.08
4.06
4.06
4.05
4.04
4.04
1.33
1.31
1.29
Br
S
O
OP(OEt)2
1.00
1.00
2.00
4.01
6.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

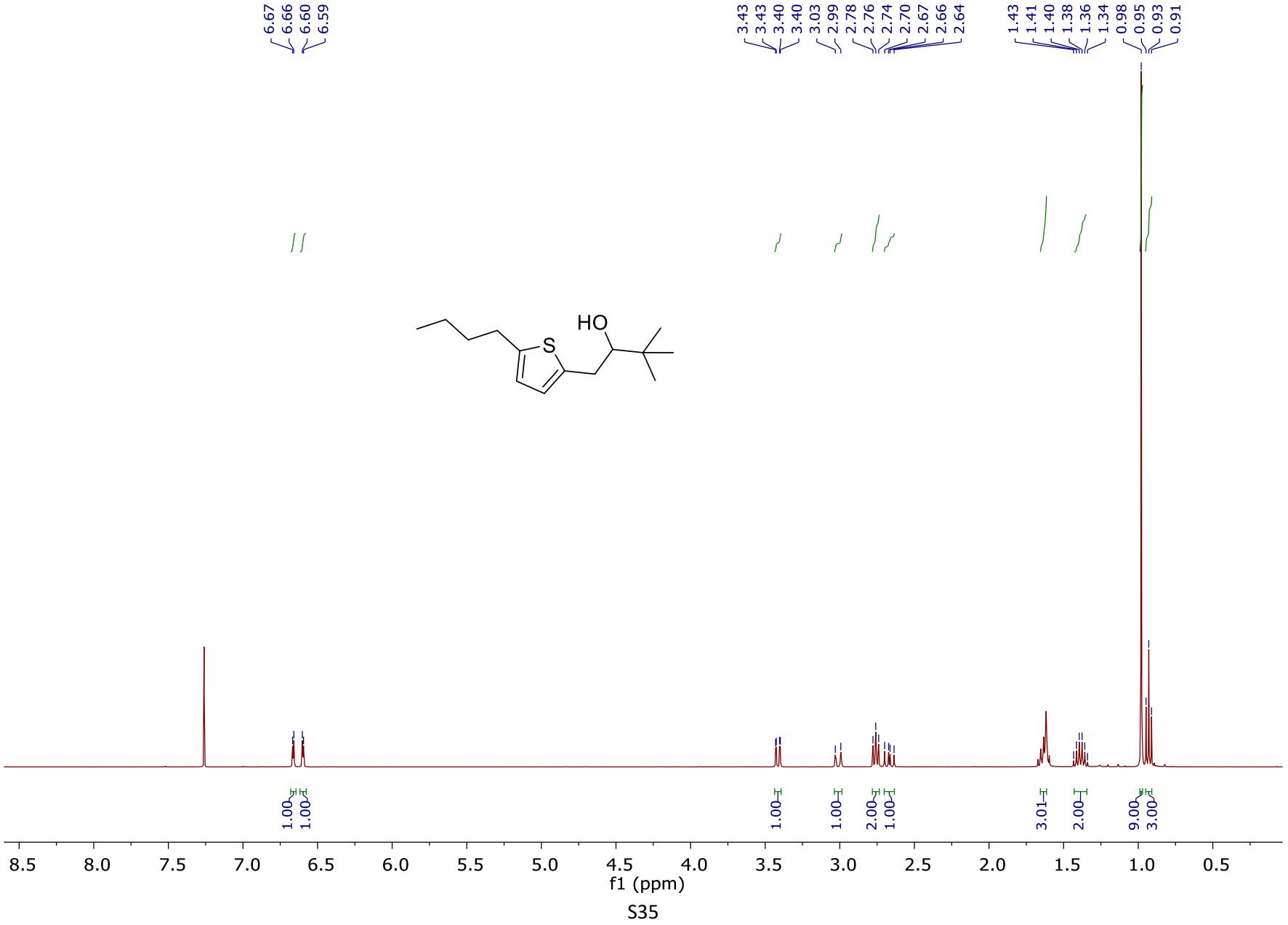

140.1
140.0
129.7
128.4
114.0
64.1
64.0
63.4
63.3
16.2
16.1
Br
S
O
OP(OEt)2
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

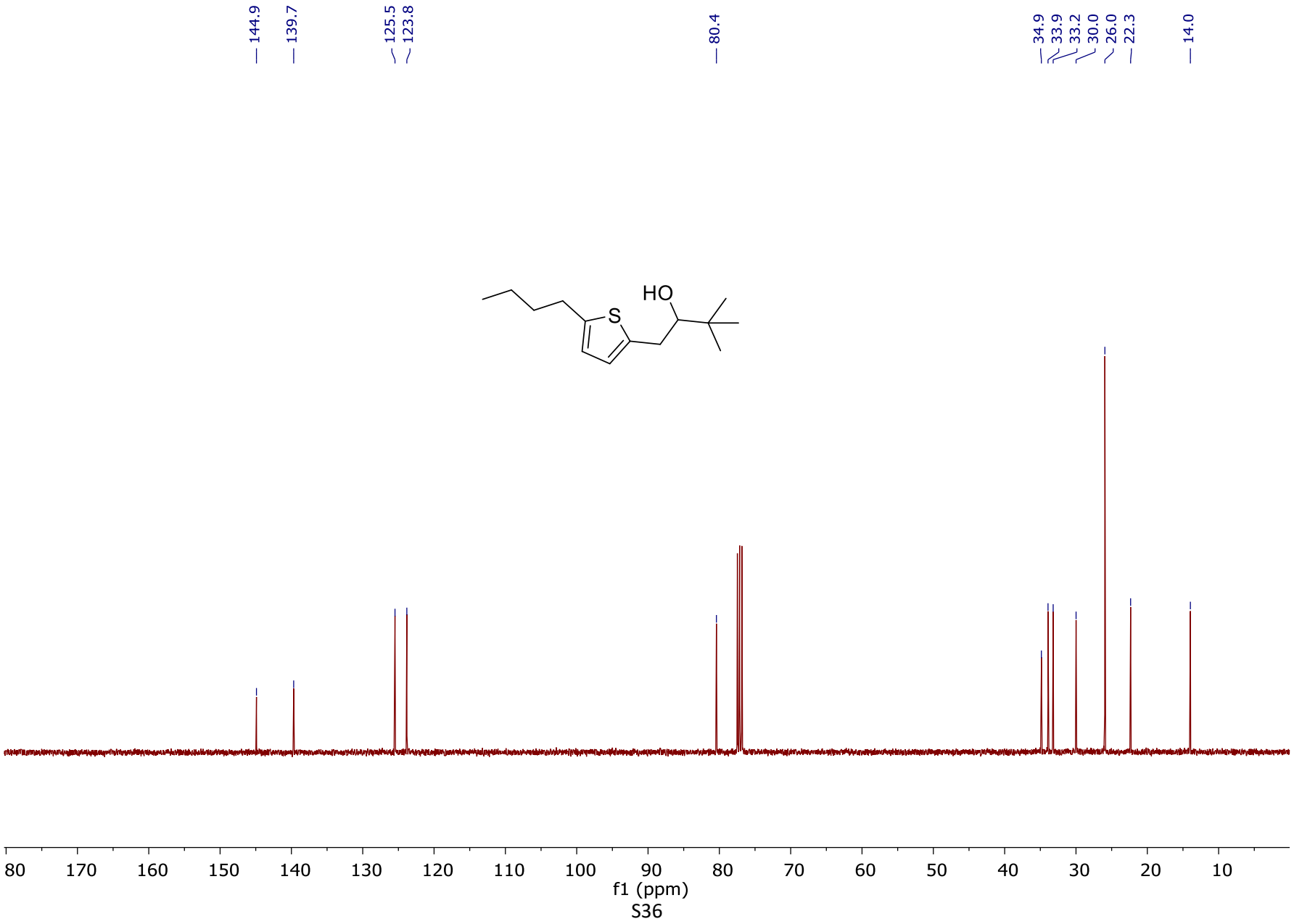

-1.29
Br
S
O
OP(OEt)2
120 110 100 90 80 70 60 50 40 30 20 10 0 -10 -20 -30 -40 -50 -60 -70 -80 -90 -100 -110
f1 (ppm)

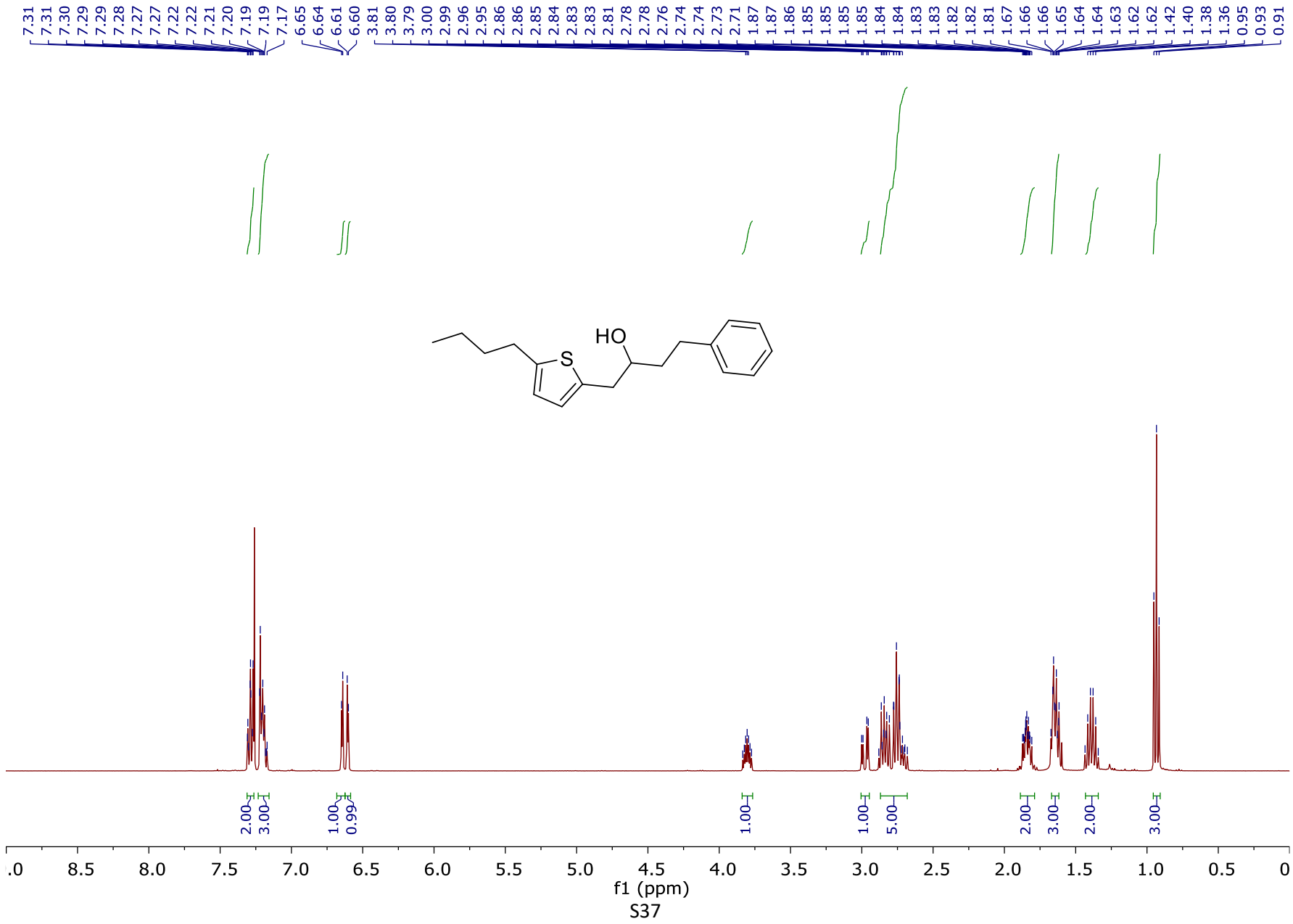

6.66 6.66 6.66 6.65 6.65 6.65 6.61 6.61 6.60 6.60 6.60
3.57 3.56 3.55 3.55 3.55 3.54 3.53 3.53 3.52 3.51 2.99 2.98 2.96 2.95 2.82 2.79 2.78 2.76 2.74 1.79 1.78 1.78 1.76 1.76 1.75 1.74 1.73 1.73 1.71 1.68 1.67 1.66 1.64 1.62 1.43 1.41 1.40 1.38 1.36 1.34 1.00 0.98 0.95 0.93 0.91
HO
S
1.00 1.00 1.00 1.00 3.00 1.00 3.00 2.00 6.00 3.00
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
f1 (ppm)

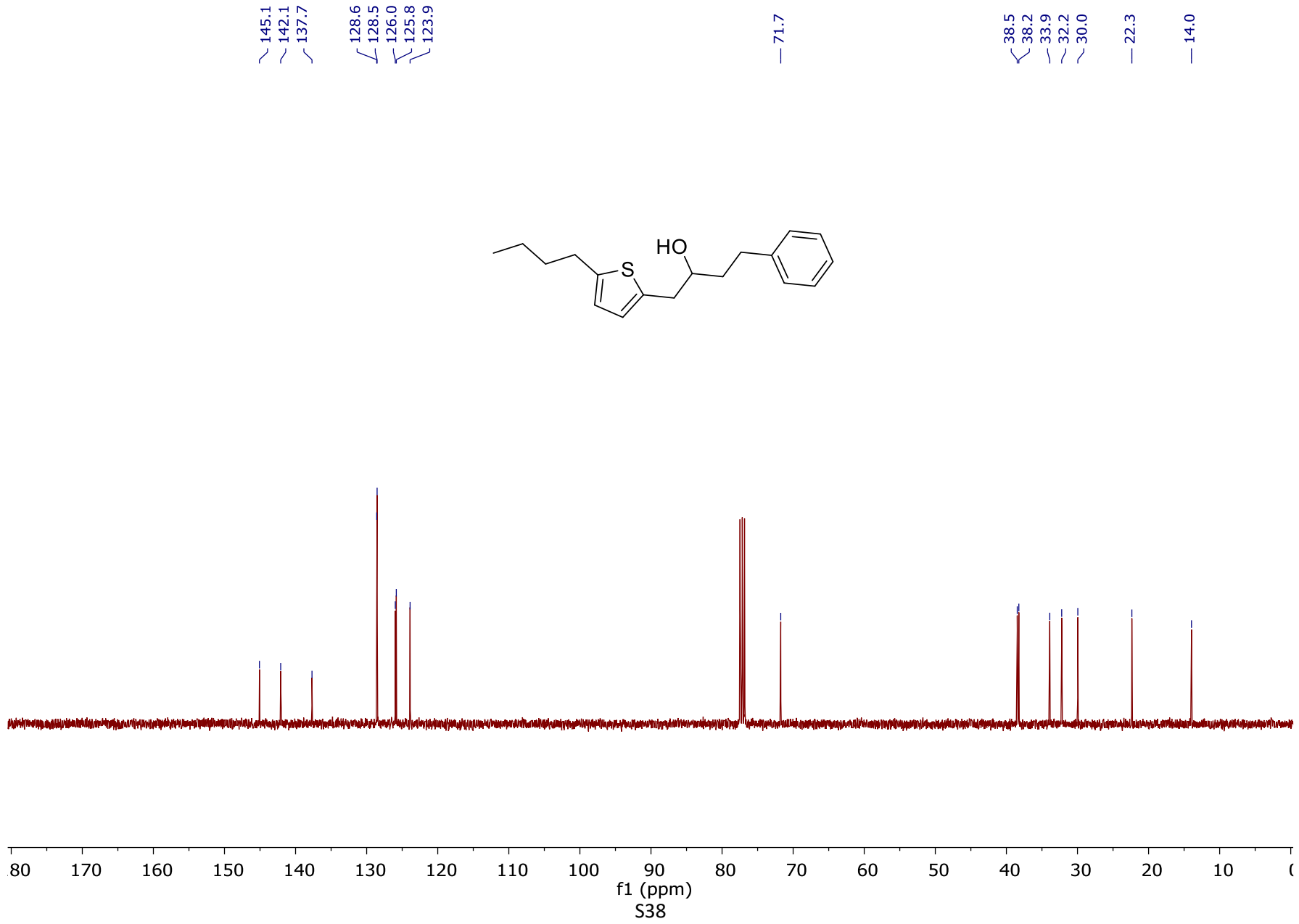
S33

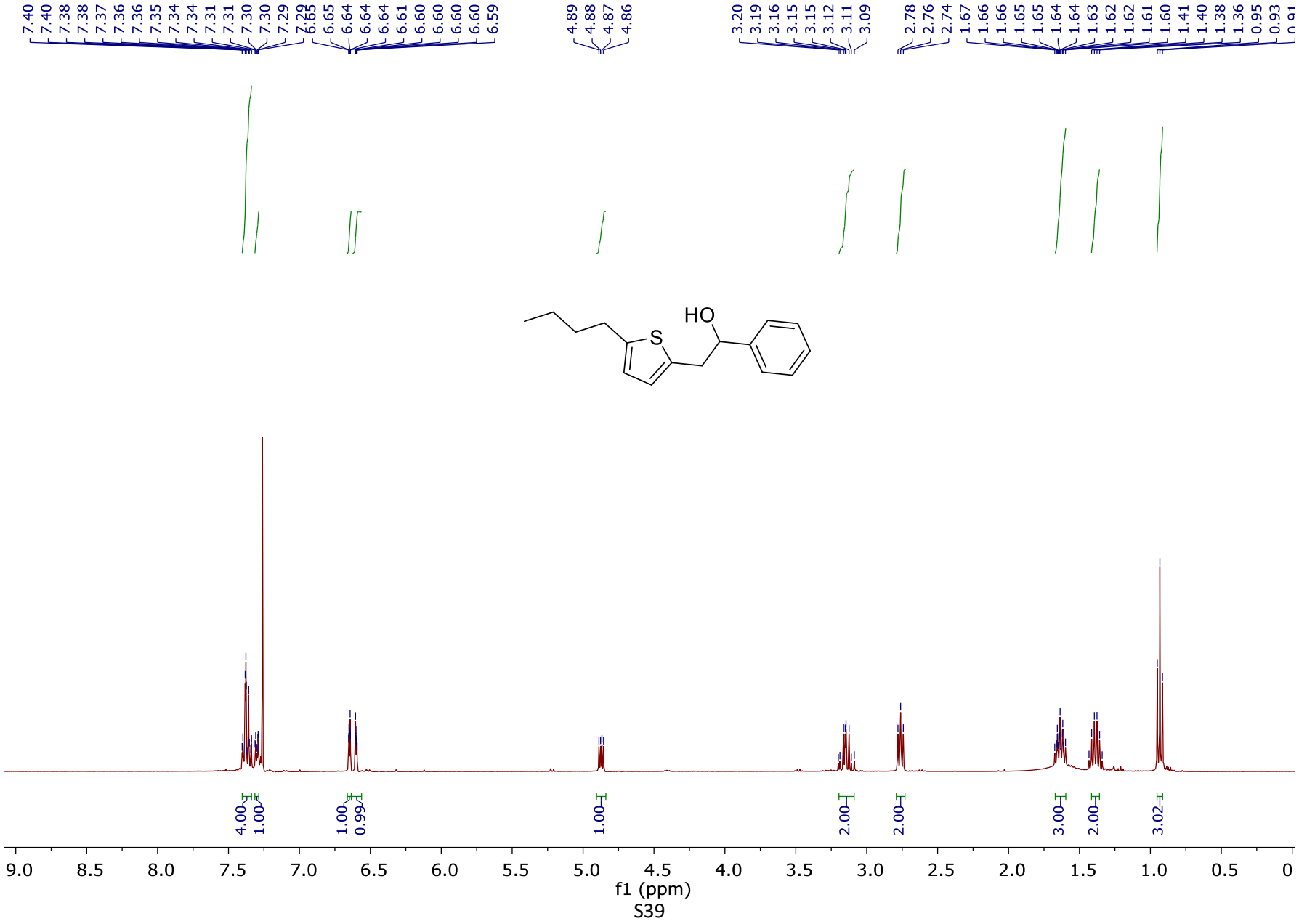

144.9
138.6
125.6
123.8
77.3
35.4
33.9
33.0
30.0
22.4
19.0
17.7
14.0
HO
S
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

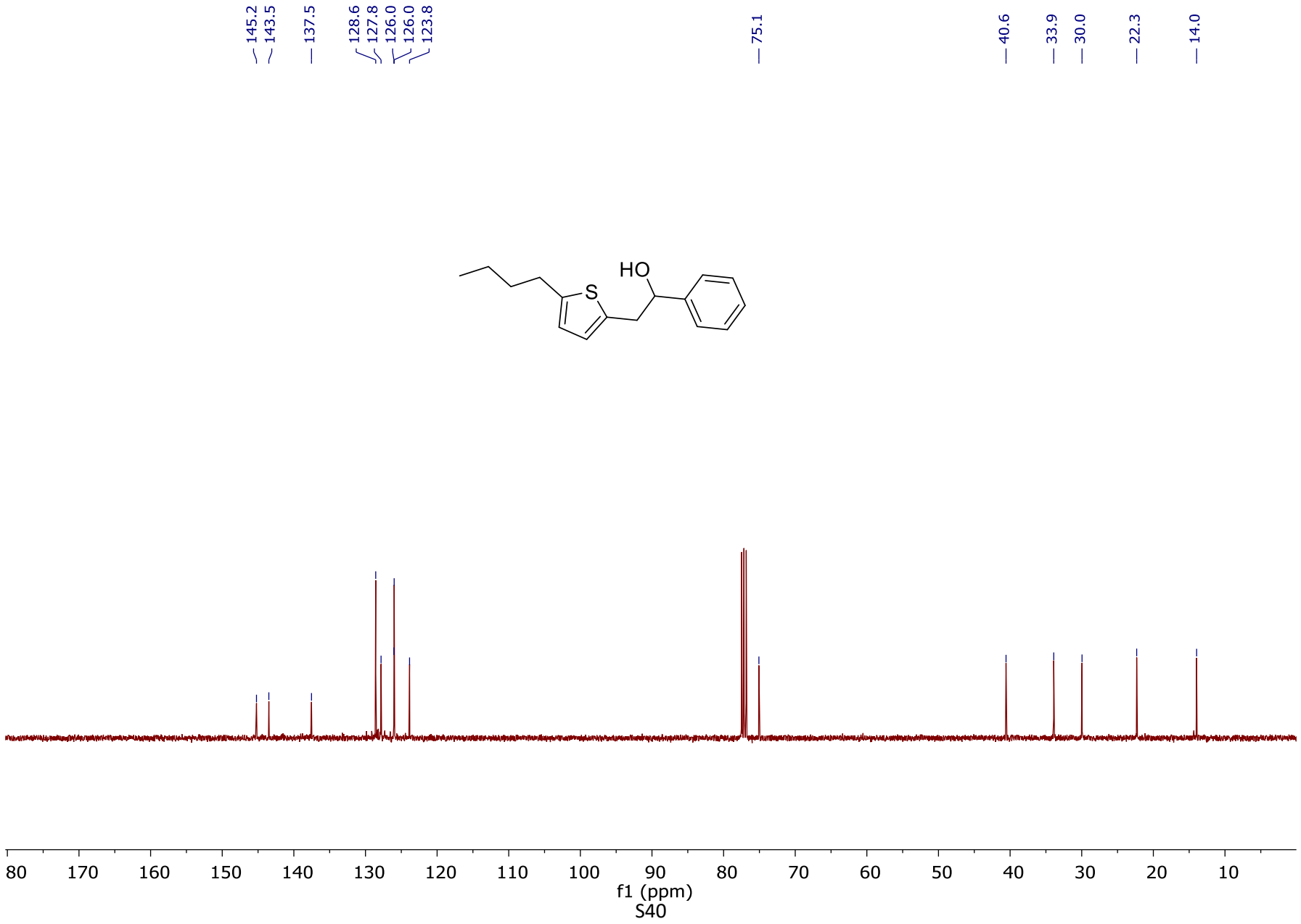

6.67
6.66
6.60
6.59
3.43
3.43
3.40
3.40
3.03
2.99
2.78
2.76
2.74
2.70
2.67
2.66
2.64
1.43
1.41
1.40
1.38
1.36
1.34
0.98
0.95
0.93
0.91
HO
S
1.00
1.00
1.00
1.00
2.00
1.00
3.01
2.00
9.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

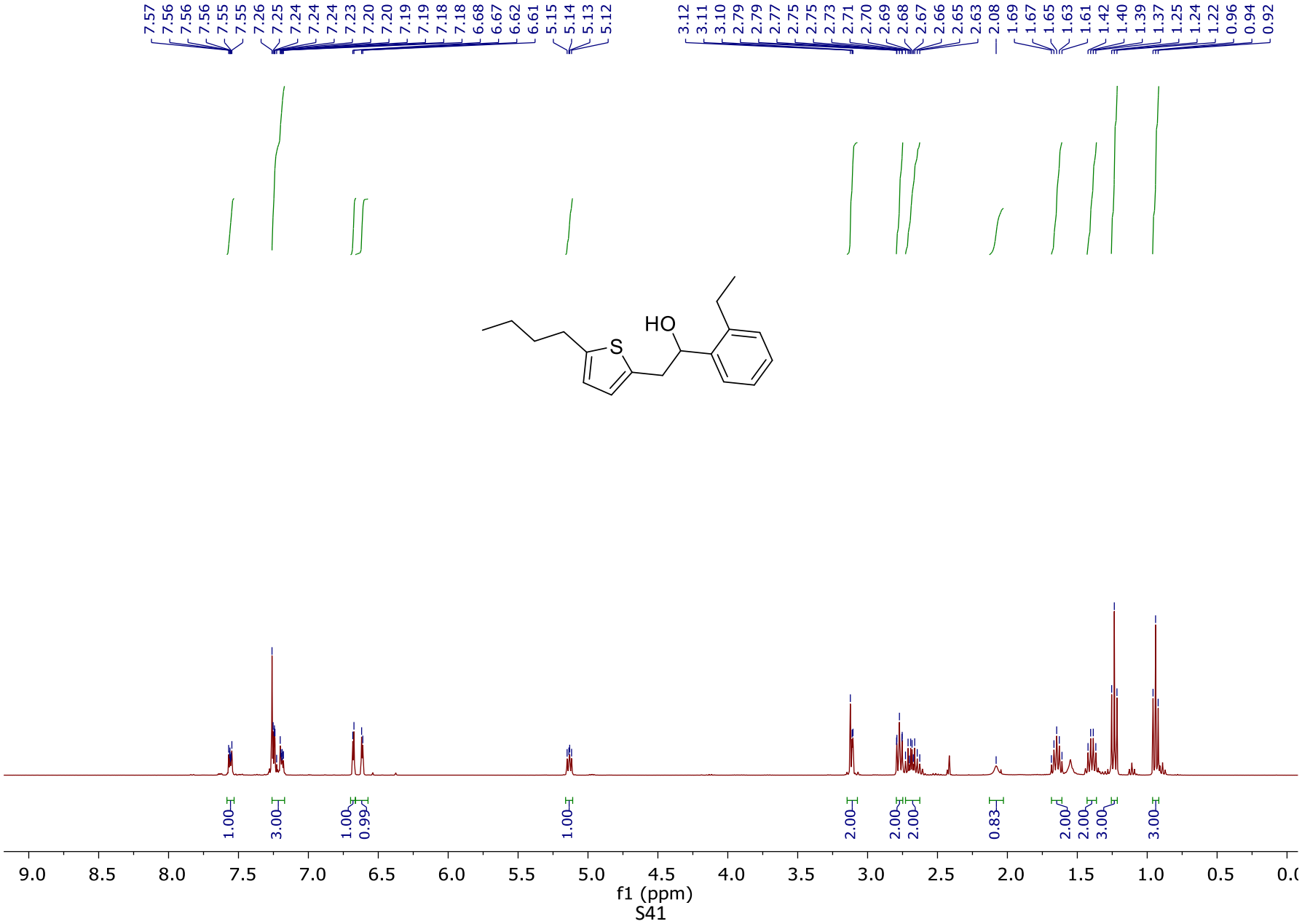

144.9
139.7
125.5
123.8
80.4
34.9
33.9
33.2
30.0
26.0
22.3
14.0
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

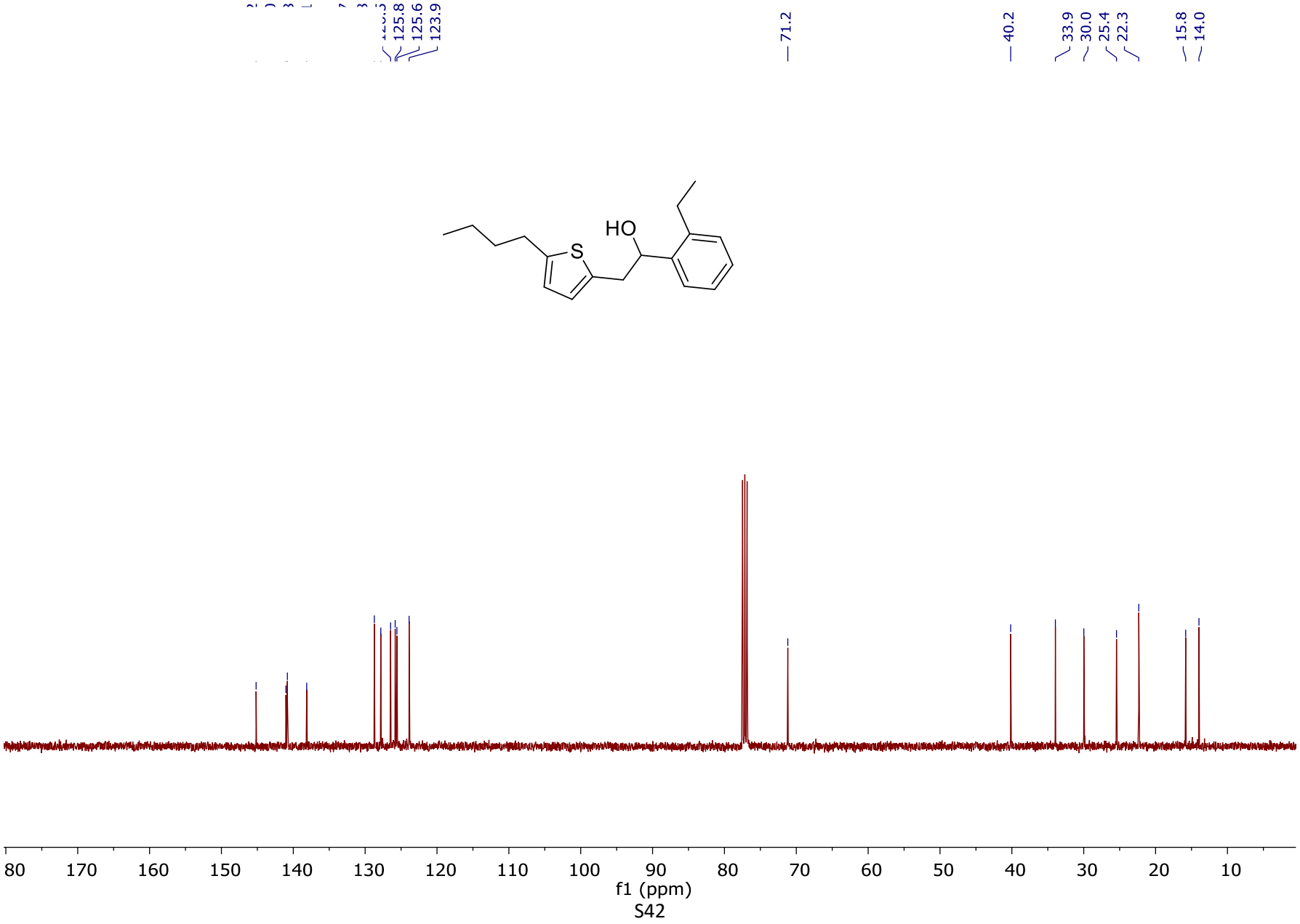

7.31 7.31 7.30 7.29 7.29 7.28 7.27 7.27 7.22 7.22 7.21 7.20 7.19 7.19 7.17 6.65 6.64 6.61 6.60 3.81 3.80 3.79 3.00 2.99 2.96 2.95 2.86 2.86 2.85 2.84 2.83 2.83 2.81 2.78 2.78 2.76 2.74 2.74 2.73 2.71 1.87 1.87 1.86 1.85 1.85 1.85 1.85 1.84 1.84 1.83 1.83 1.82 1.82 1.81 1.67 1.66 1.66 1.65 1.64 1.64 1.63 1.62 1.62 1.42 1.40 1.38 1.36 0.95 0.93 0.91
HO
S
2.00 3.00 1.00 0.99 1.00 1.00 5.00 2.00 3.00 2.00 3.00
.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
f1 (ppm)

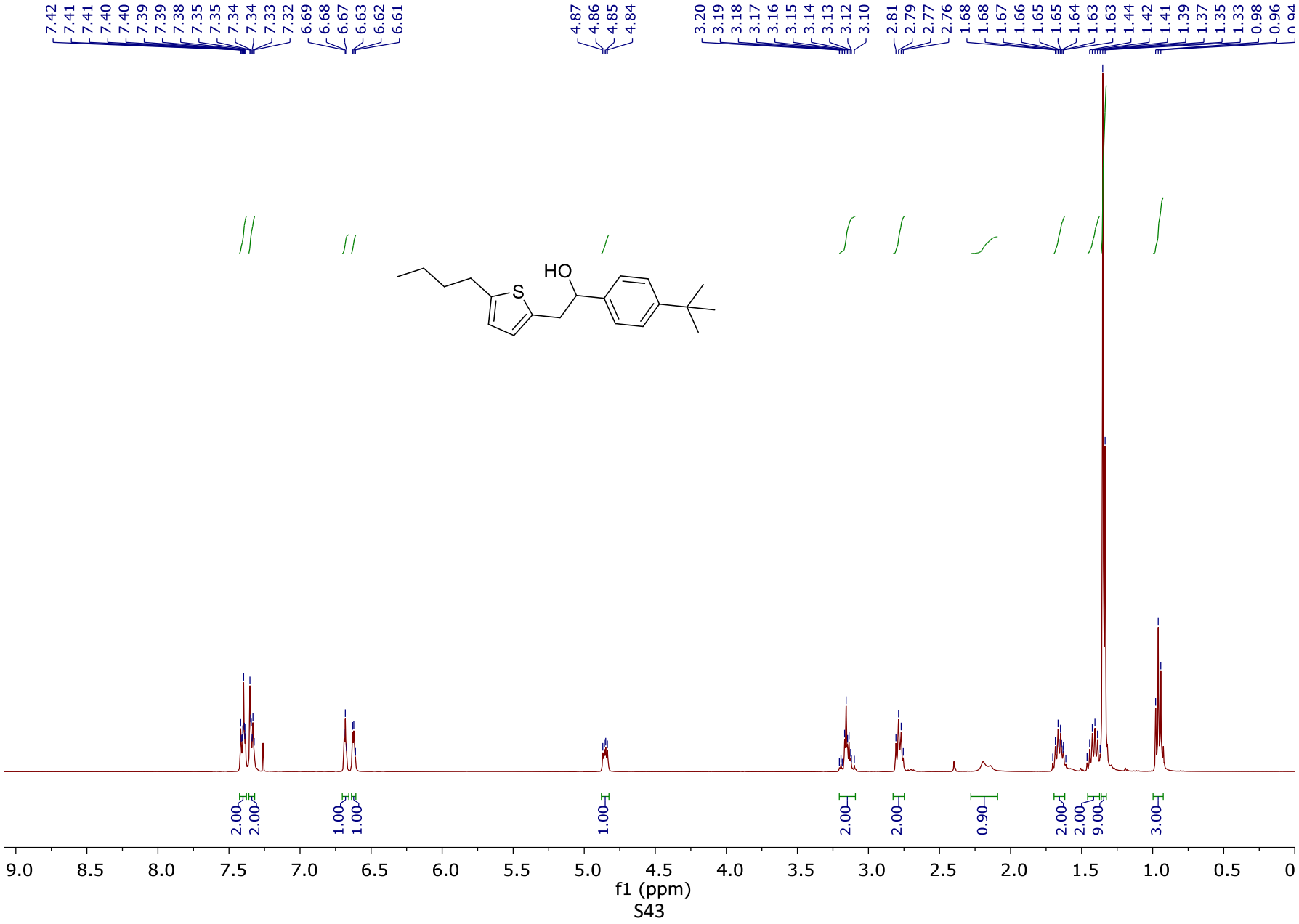

145.1
142.1
137.7
128.6
128.5
126.0
125.8
123.9
71.7
38.5
38.2
33.9
32.2
30.0
22.3
14.0
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

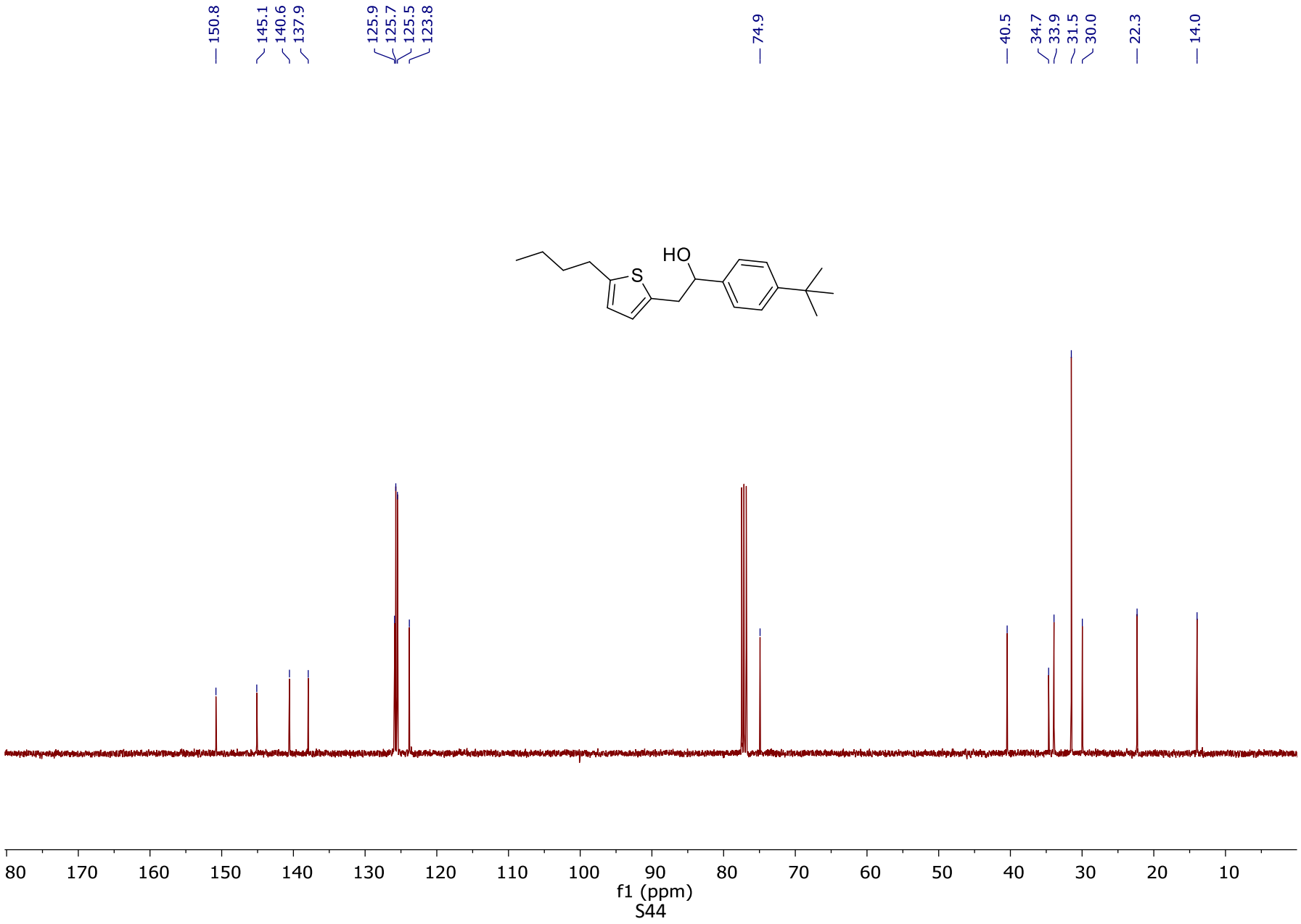

7.40 7.40 7.38 7.38 7.37 7.36 7.36 7.35 7.34 7.34 7.31 7.31 7.30 7.30 7.29 7.29 6.65 6.65 6.64 6.64 6.64 6.61 6.60 6.60 6.60 6.60 6.59
4.89 4.88 4.87 4.86
3.20 3.19 3.16 3.15 3.15 3.12 3.11 3.09
2.78 2.76 2.74
1.67 1.66 1.66 1.65 1.65 1.64 1.64 1.63 1.62 1.62 1.61 1.60 1.41 1.40 1.38 1.36 0.95 0.93
HO
S
4.00 1.00 1.00 0.99 1.00 2.00 2.00 3.00 2.00 3.02
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
f1 (ppm)


145.2
143.5
137.5
128.6
127.8
126.0
126.0
123.8
75.1
40.6
33.9
30.0
22.3
14.0
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.57 7.56 7.56 7.56 7.55 7.55 7.26 7.25 7.24 7.24 7.24 7.23 7.20 7.20 7.19 7.19 7.18 7.18 6.68 6.67 6.62 6.61 5.15 5.14 5.13 5.12
3.12 3.11 3.10 2.79 2.79 2.77 2.75 2.75 2.73 2.71 2.70 2.69 2.68 2.67 2.66 2.65 2.63 2.08 1.69 1.67 1.65 1.63 1.61 1.42 1.40 1.39 1.37 1.25 1.24 1.22 0.96 0.94 0.92
HO
S
1.00 3.00 1.00 0.99 1.00 2.00 2.00 2.00 0.83 2.00 2.00 3.00 3.00
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)


125.8
125.6
123.9
71.2
40.2
33.9
30.0
25.4
22.3
15.8
14.0
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.42 7.41 7.41 7.40 7.40 7.39 7.39 7.38 7.35 7.35 7.34 7.34 7.33 7.32
6.69 6.68 6.67 6.63 6.62 6.61
4.87 4.86 4.85 4.84
3.20 3.19 3.18 3.17 3.16 3.15 3.14 3.13 3.12 3.10
2.81 2.79 2.77 2.76
1.68 1.68 1.67 1.66 1.65 1.65 1.64 1.63 1.63 1.44 1.42 1.41 1.39 1.37 1.35 1.33 0.98 0.96
HO
S
2.00 2.00 1.00 1.00 1.00 2.00 2.00 0.90 2.00 2.00 9.00 3.00
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
f1 (ppm)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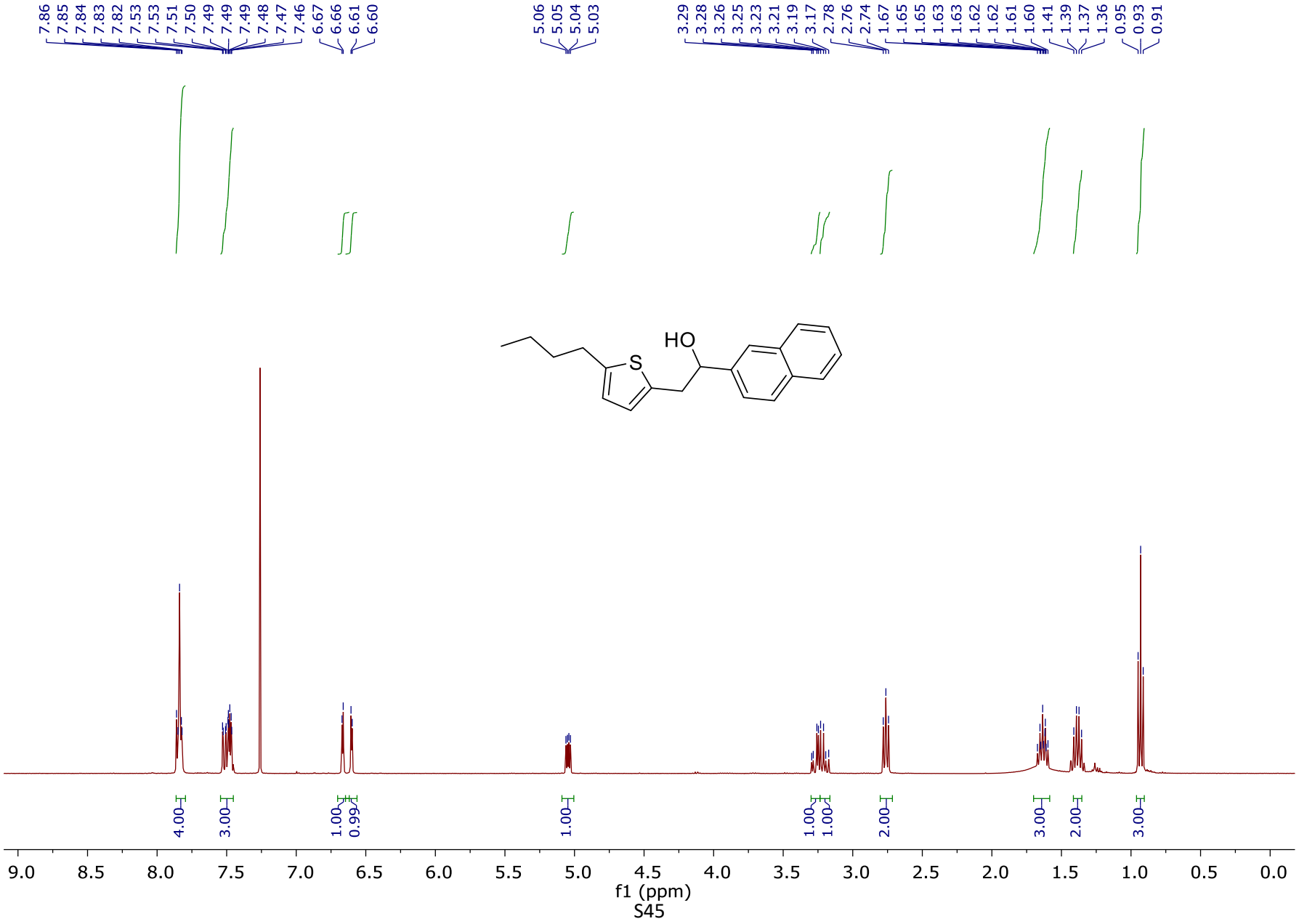
137.9
125.9
125.7
125.5
123.8
74.9
40.5
34.7
33.9
31.5
30.0
22.3
14.0
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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7.85
7.84
7.83
7.82
7.53
7.53
7.51
7.50
7.49
7.49
7.49
7.48
7.47
7.46
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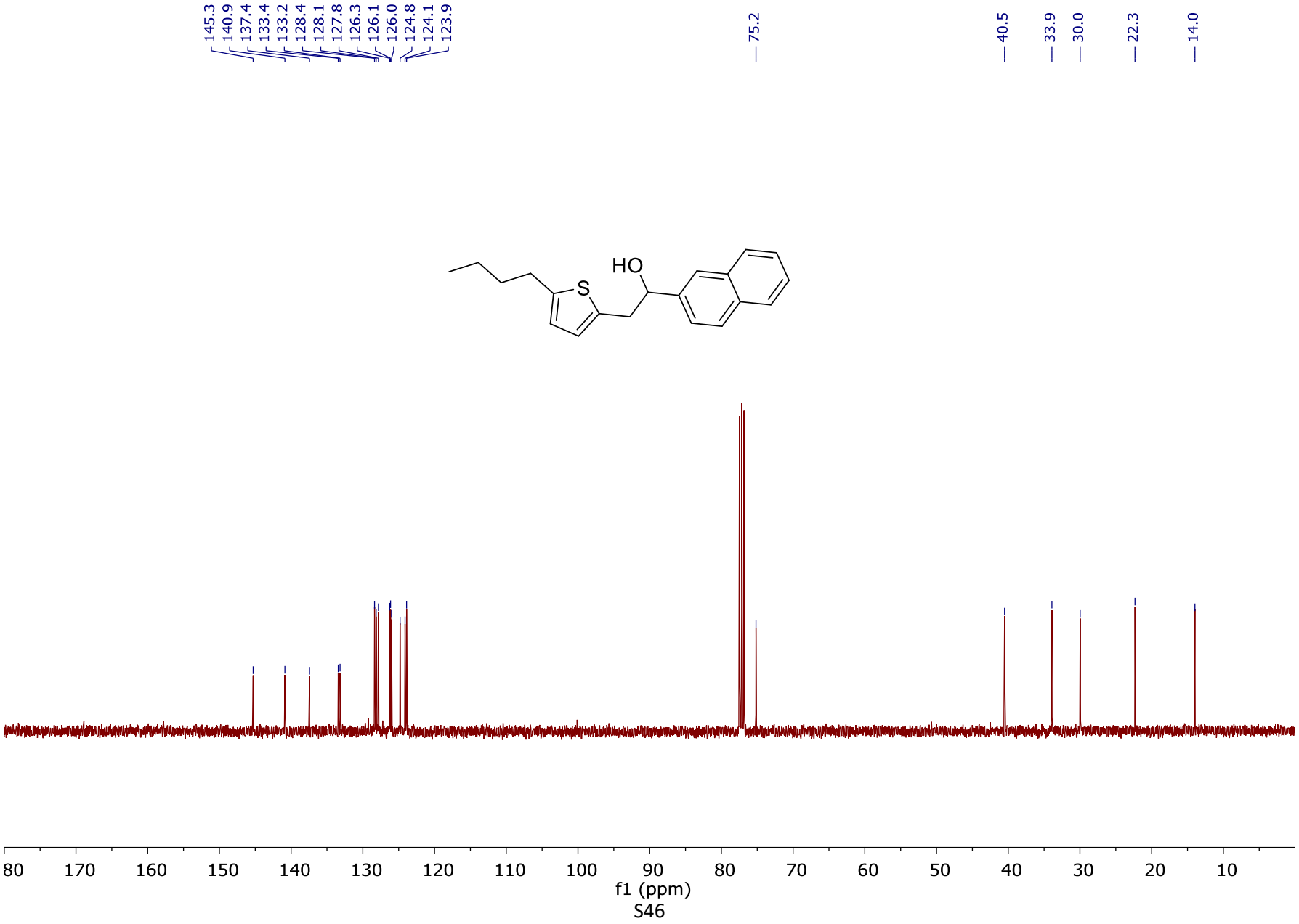
6.66
6.61
6.60
5.06
5.05
5.04
5.03
3.29
3.28
3.26
3.25
3.23
3.21
3.19
3.17
2.78
2.76
2.74
1.67
1.65
1.65
1.63
1.63
1.62
1.62
1.61
1.60
1.41
1.39
1.37
1.36
0.95
0.93
0.91
HO
S
4.00
3.00
1.00
0.99
1.00
1.00
1.00
2.00
3.00
2.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)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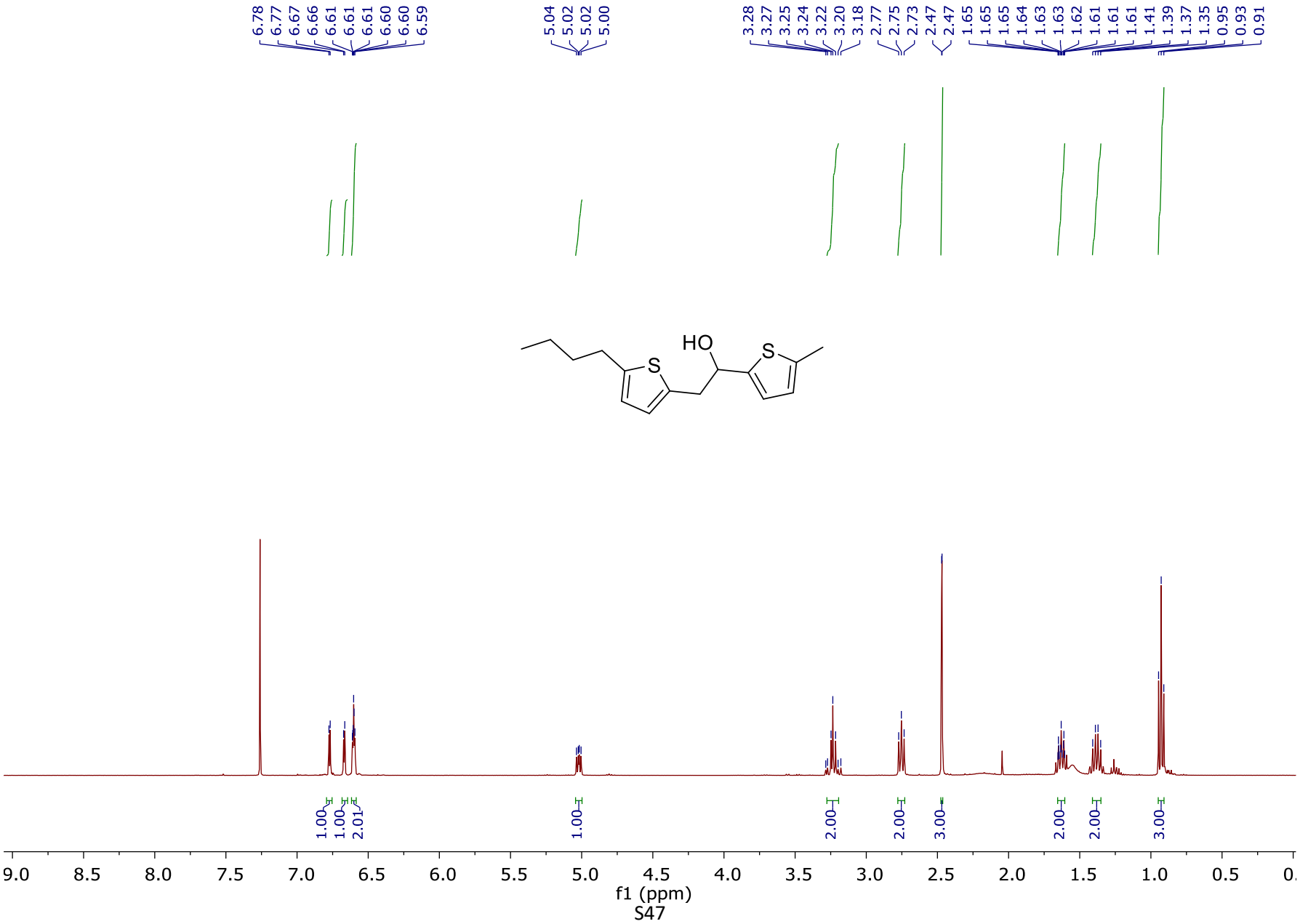
140.9
137.4
133.4
133.2
128.4
128.1
127.8
126.3
126.1
126.0
124.8
124.1
123.9
75.2
40.5
33.9
30.0
22.3
14.0
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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6.77
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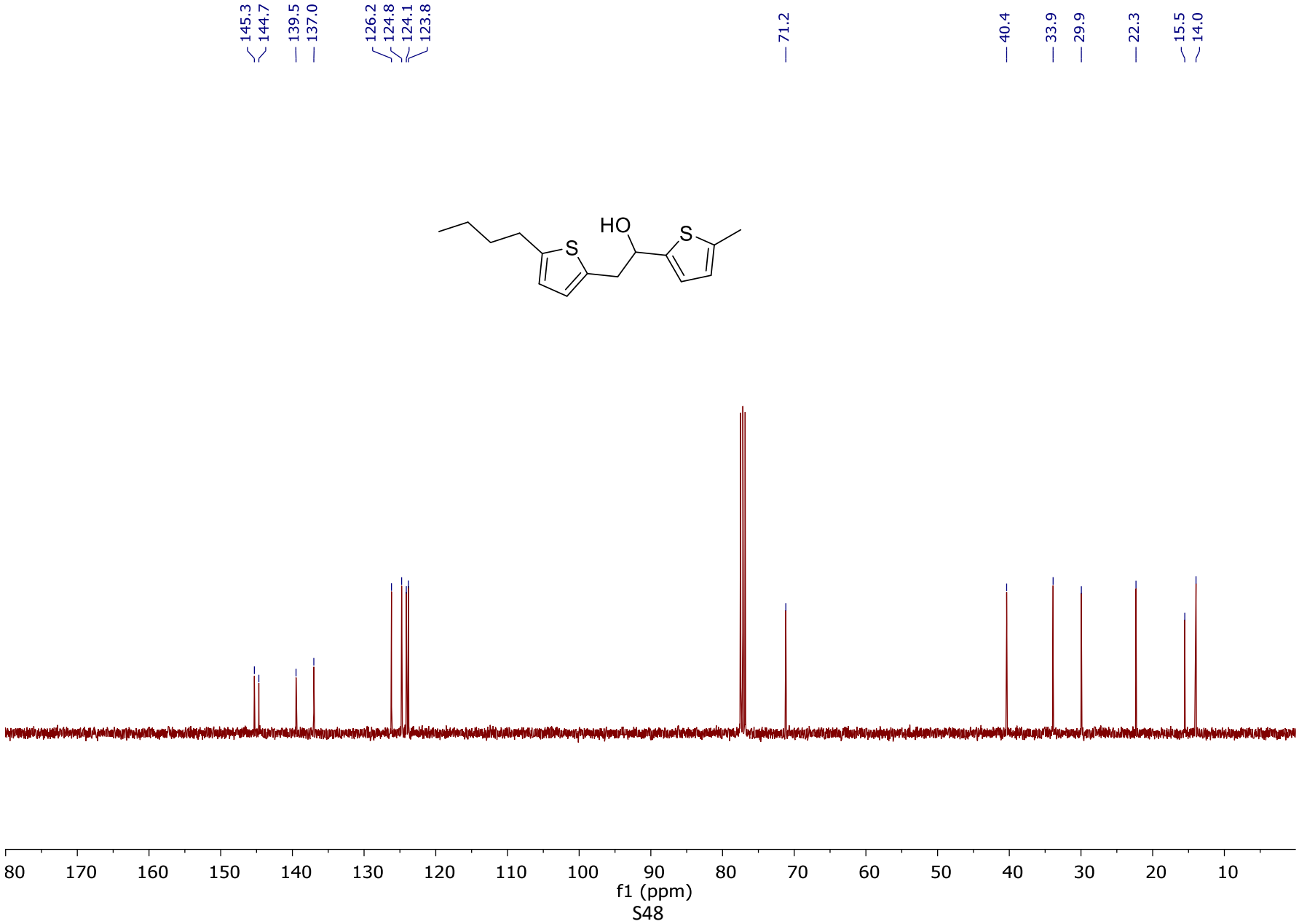
6.66
6.61
6.61
6.61
6.60
6.60
6.59
5.04
5.02
5.02
5.00
3.28
3.27
3.25
3.24
3.22
3.20
3.18
2.77
2.75
2.73
2.47
2.47
1.65
1.65
1.65
1.64
1.63
1.63
1.62
1.61
1.61
1.61
1.41
1.39
1.37
1.35
0.95
0.93
0.91
HO
S
S
1.00
1.00
2.01
1.00
2.00
2.00
3.00
2.00
2.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


145.3
144.7
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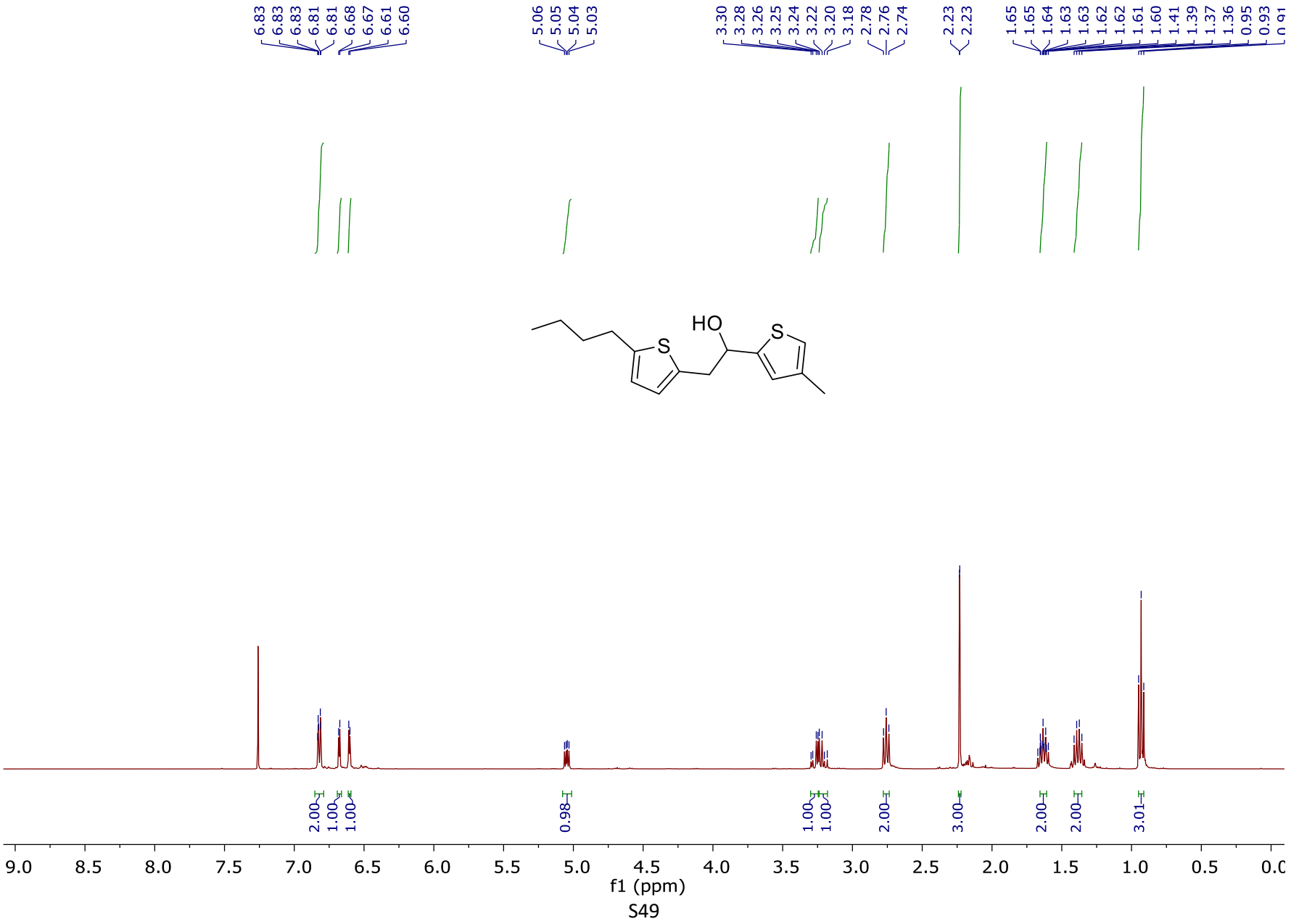
137.0
126.2
124.8
124.1
123.8
71.2
40.4
33.9
29.9
22.3
15.5
14.0
HO
S
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


6.83
6.83
6.83
6.81
6.81
6.68
6.67
6.61
6.60
5.06
5.05
5.04
5.03
3.30
3.28
3.26
3.25
3.24
3.22
3.20
3.18
2.78
2.76
2.74
2.23
2.23
1.65
1.65
1.64
1.63
1.63
1.62
1.62
1.61
1.60
1.41
1.39
1.37
1.36
0.95
0.93
HO
S
S
2.00
1.00
1.00
0.98
1.00
1.00
2.00
3.00
2.00
2.00
3.01
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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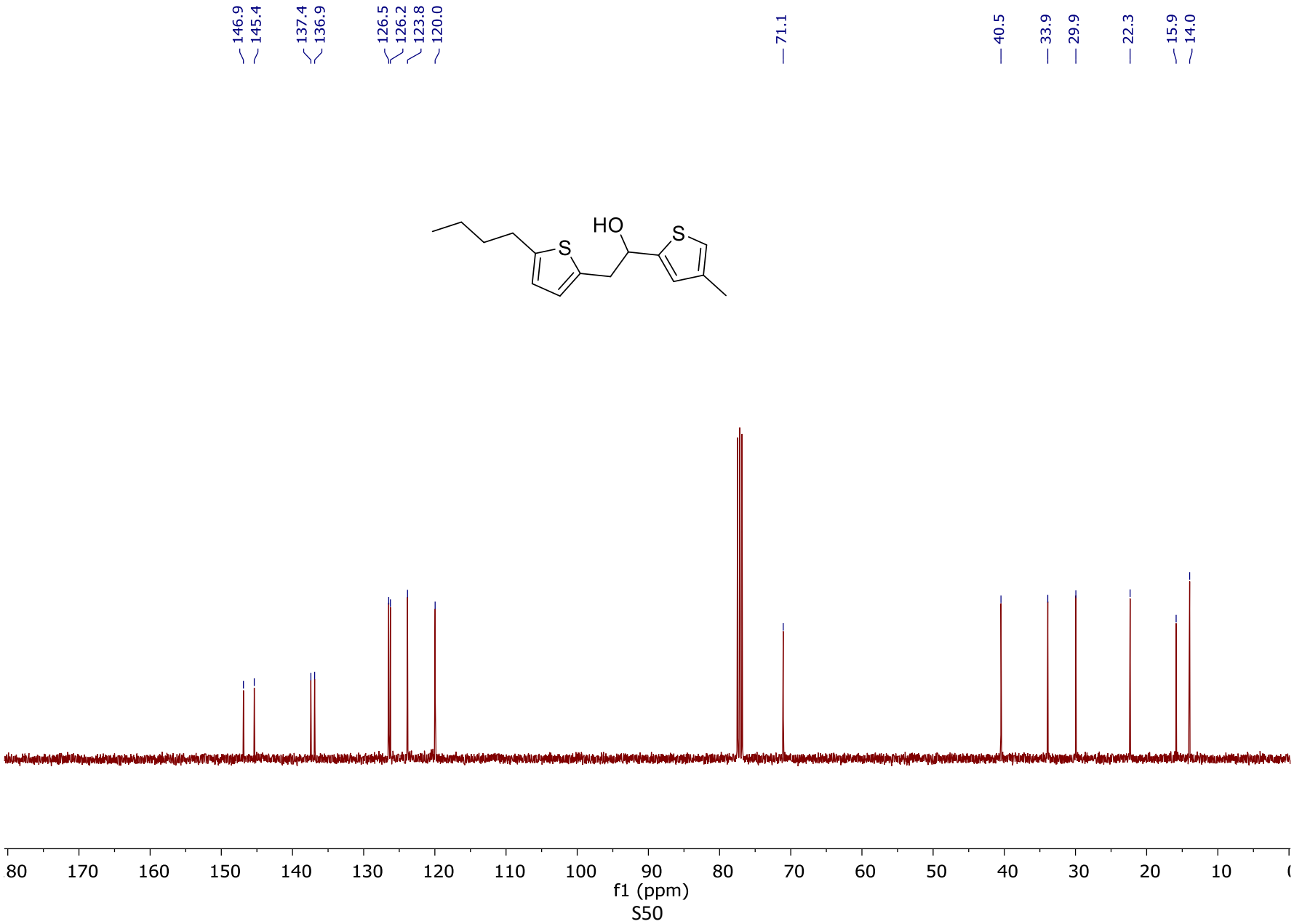
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)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137.4
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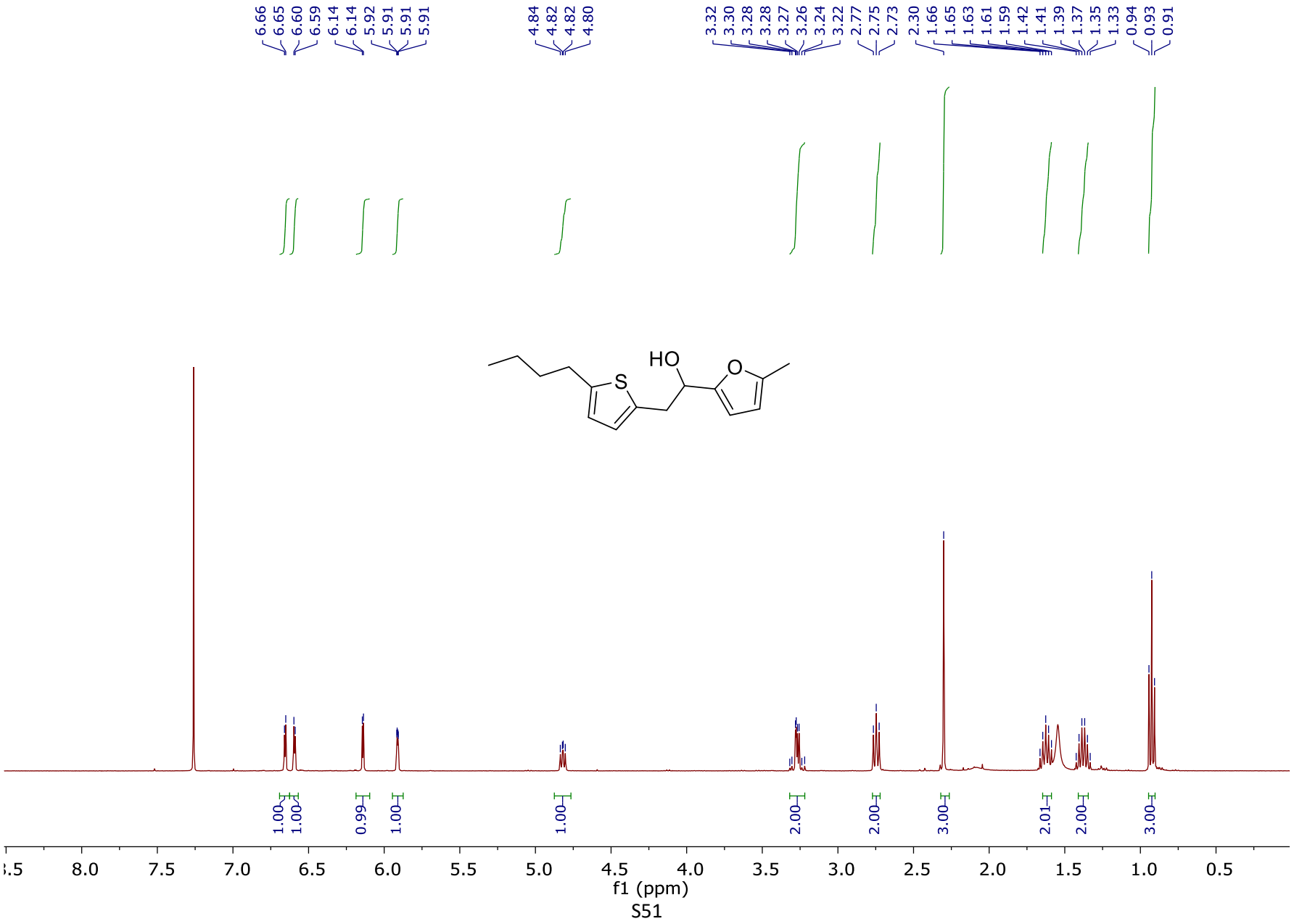
126.2
123.8
120.0
71.1
40.5
33.9
29.9
22.3
15.9
14.0
HO
S
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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5.91
4.84
4.82
4.82
4.80
3.32
3.30
3.28
3.28
3.27
3.26
3.24
3.22
2.77
2.75
2.73
2.30
1.66
1.65
1.63
1.61
1.59
1.42
1.41
1.39
1.37
1.35
1.33
0.94
0.93
0.91
HO
S
O
1.00
1.00
0.99
1.00
1.00
2.00
2.00
3.00
2.01
2.00
3.00
8.0
7.5
7.0
6.5
6.0
5.5
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4.0
3.5
3.0
2.5
2.0
1.5
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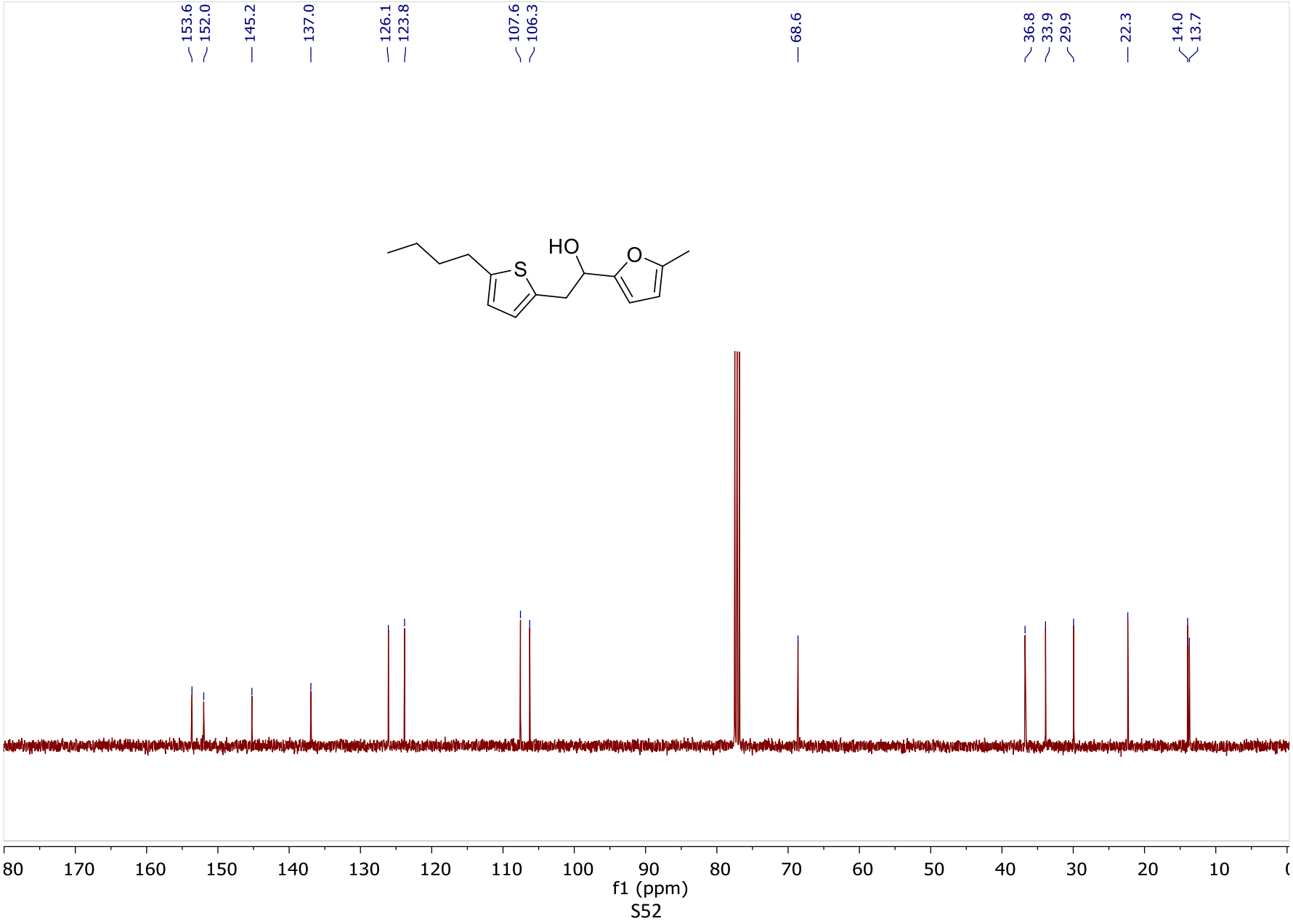
0.5
f1 (ppm)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123.8
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106.3
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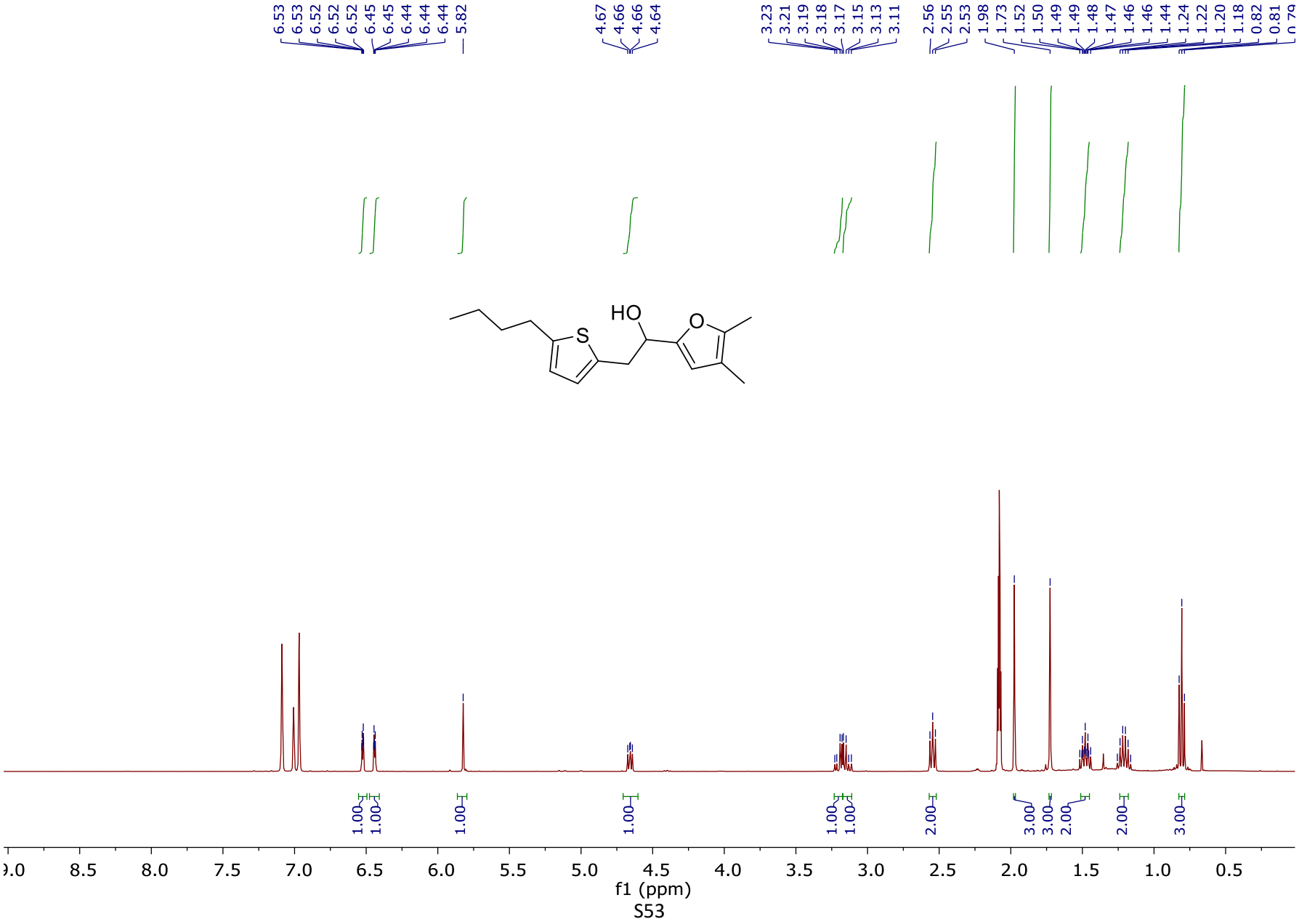
36.8
33.9
29.9
22.3
14.0
13.7
HO
S
O
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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6.52
6.45
6.45
6.44
6.44
6.44
5.82
4.67
4.66
4.66
4.64
3.23
3.21
3.19
3.18
3.17
3.15
3.13
3.11
2.56
2.55
2.53
1.98
1.73
1.52
1.50
1.49
1.49
1.48
1.47
1.46
1.46
1.44
1.24
1.22
1.20
1.18
0.82
0.81
HO
O
S
1.00
1.00
1.00
1.00
1.00
1.00
2.00
3.00
3.00
2.00
2.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
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3.0
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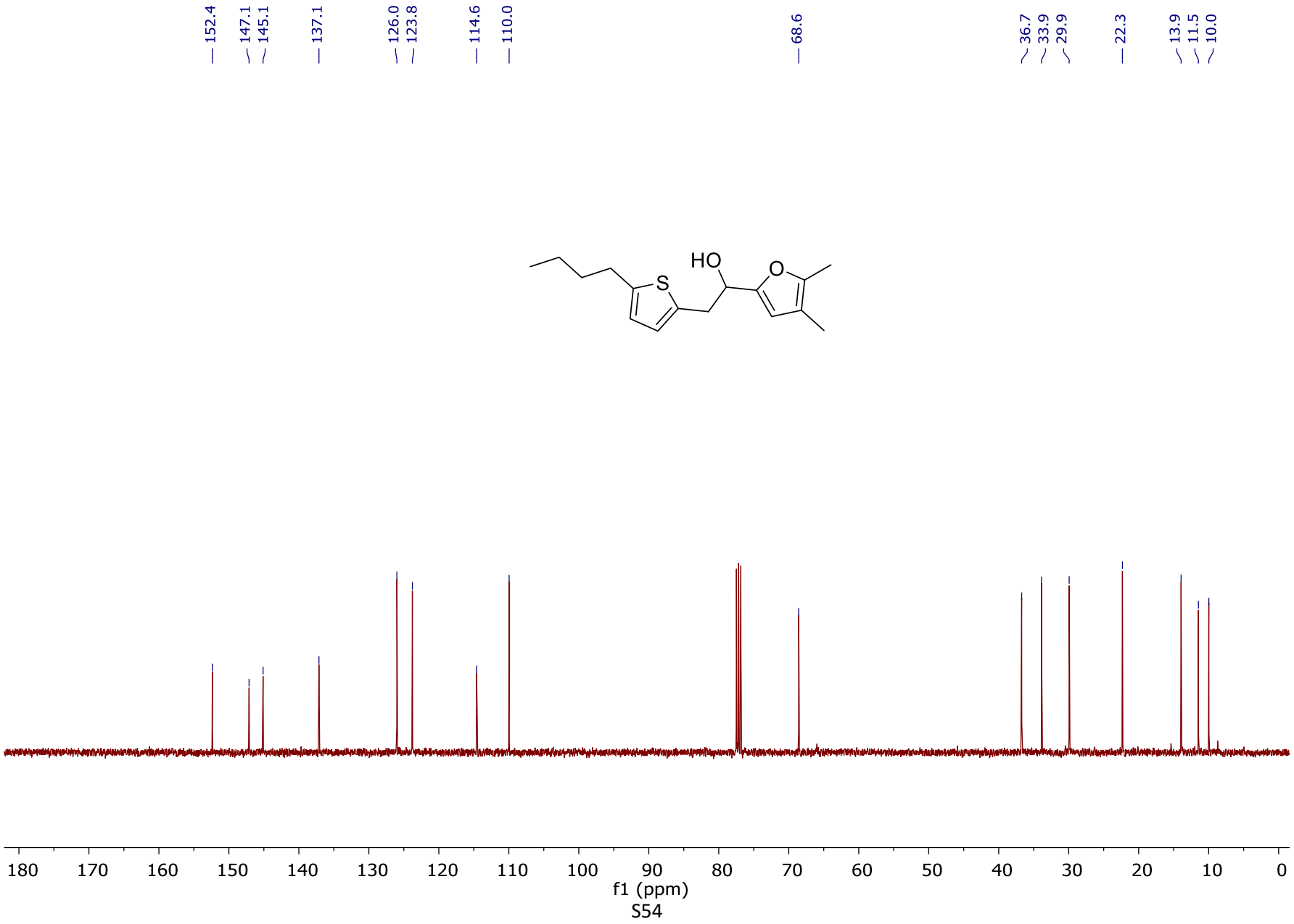
1.5
1.0
0.5
f1 (ppm)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145.1
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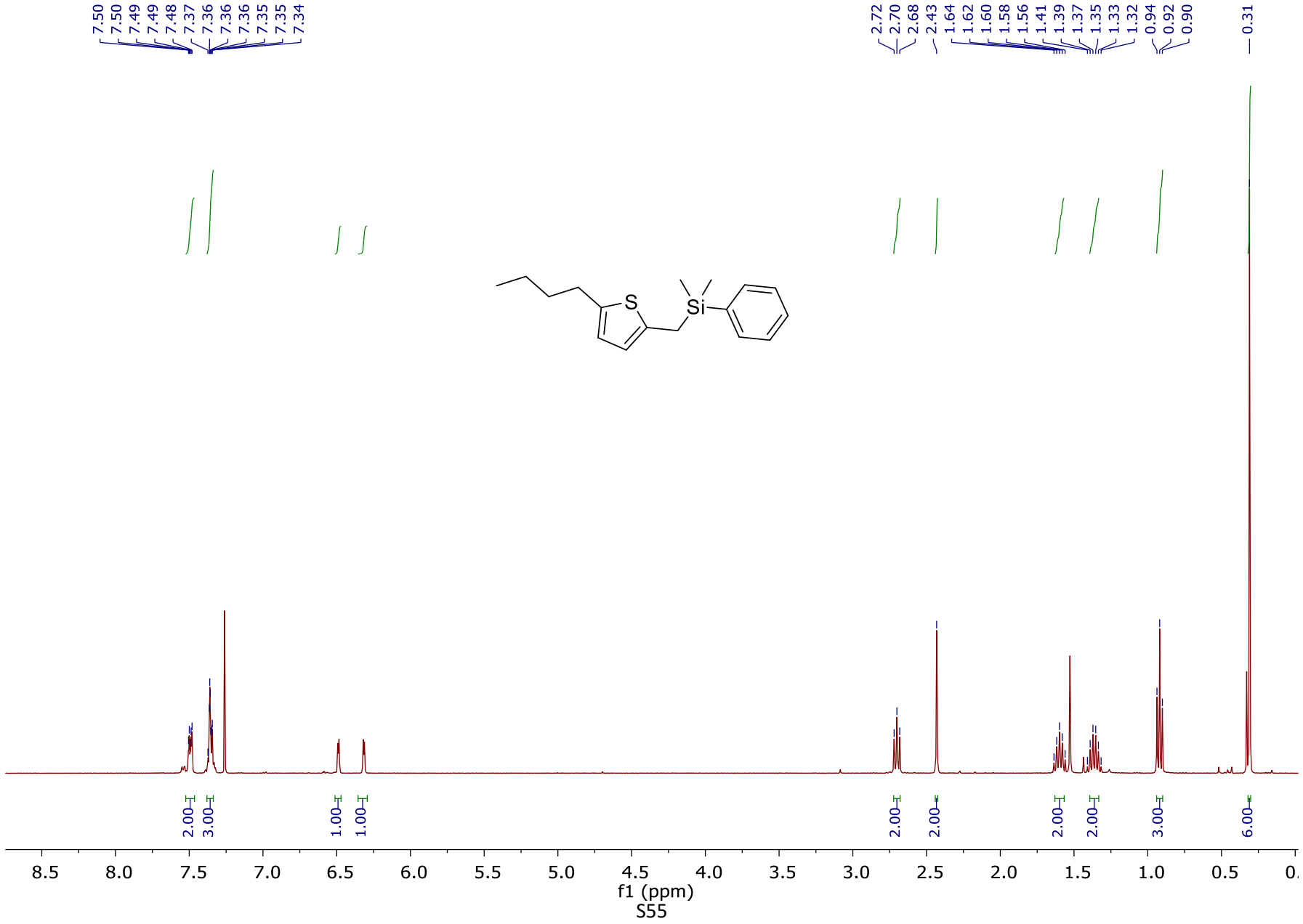
114.6
110.0
68.6
36.7
33.9
29.9
22.3
13.9
11.5
10.0
HO
S
O
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


7.50
7.50
7.49
7.49
7.48
7.37
7.36
7.36
7.36
7.35
7.35
7.34
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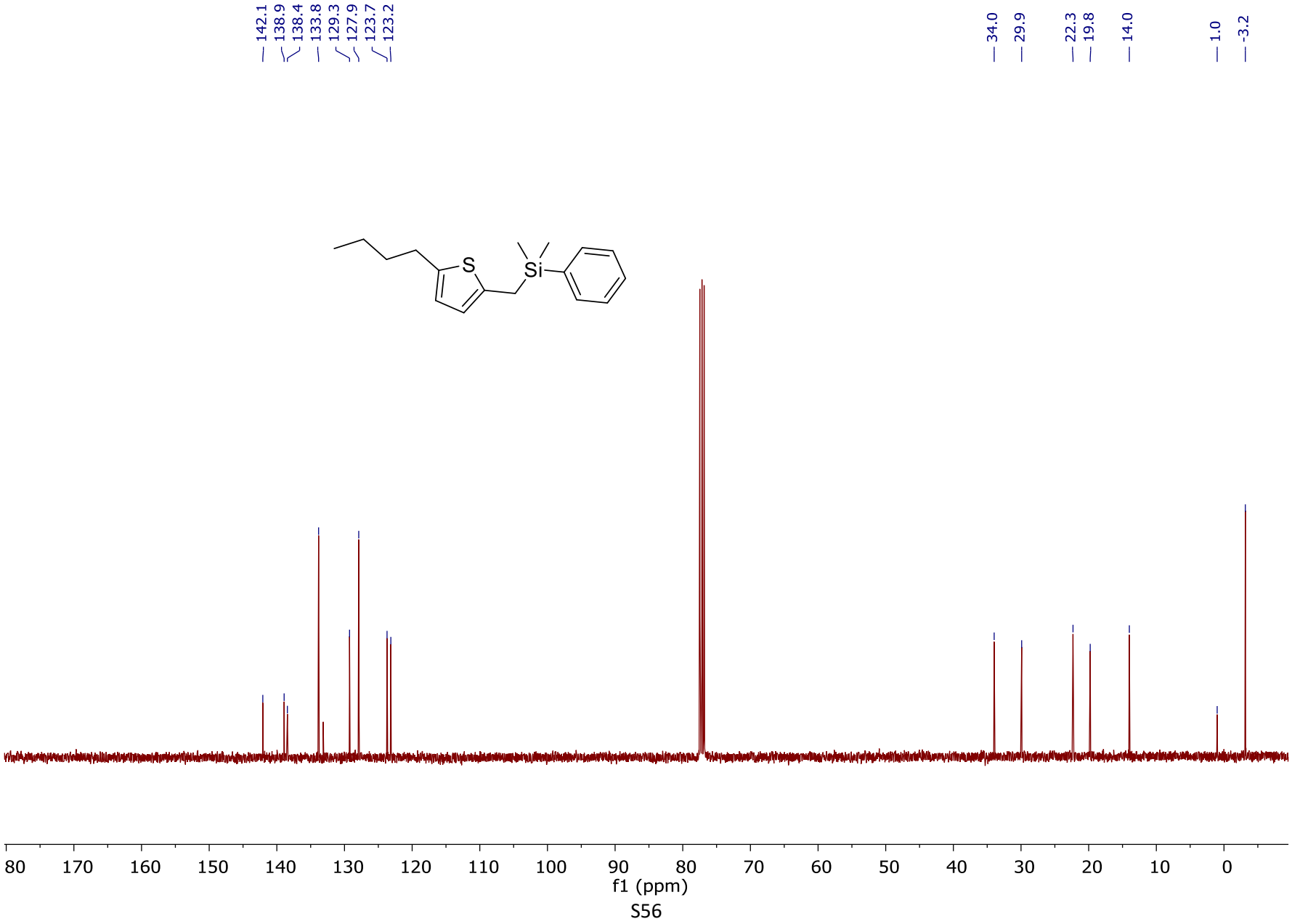
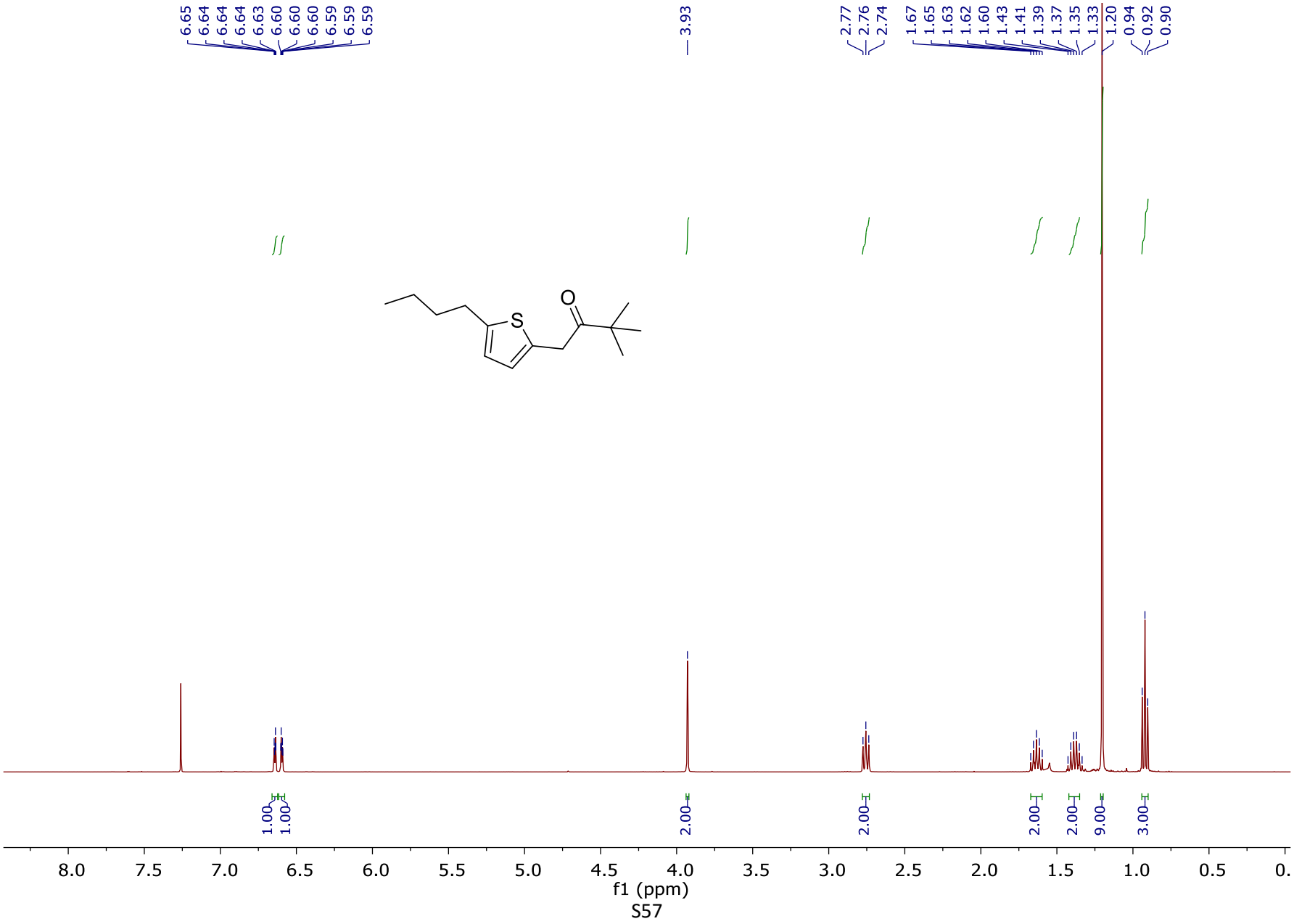
2.70
2.68
2.43
1.64
1.62
1.60
1.58
1.56
1.41
1.39
1.37
1.35
1.33
1.32
0.94
0.92
0.90
0.31
S
Si
2.00
3.00
1.00
1.00
2.00
2.00
2.00
2.00
3.00
6.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

S55


142.1
138.9
138.4
133.8
129.3
127.9
123.7
123.2
34.0
29.9
22.3
19.8
14.0
1.0
-3.2
S
Si
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)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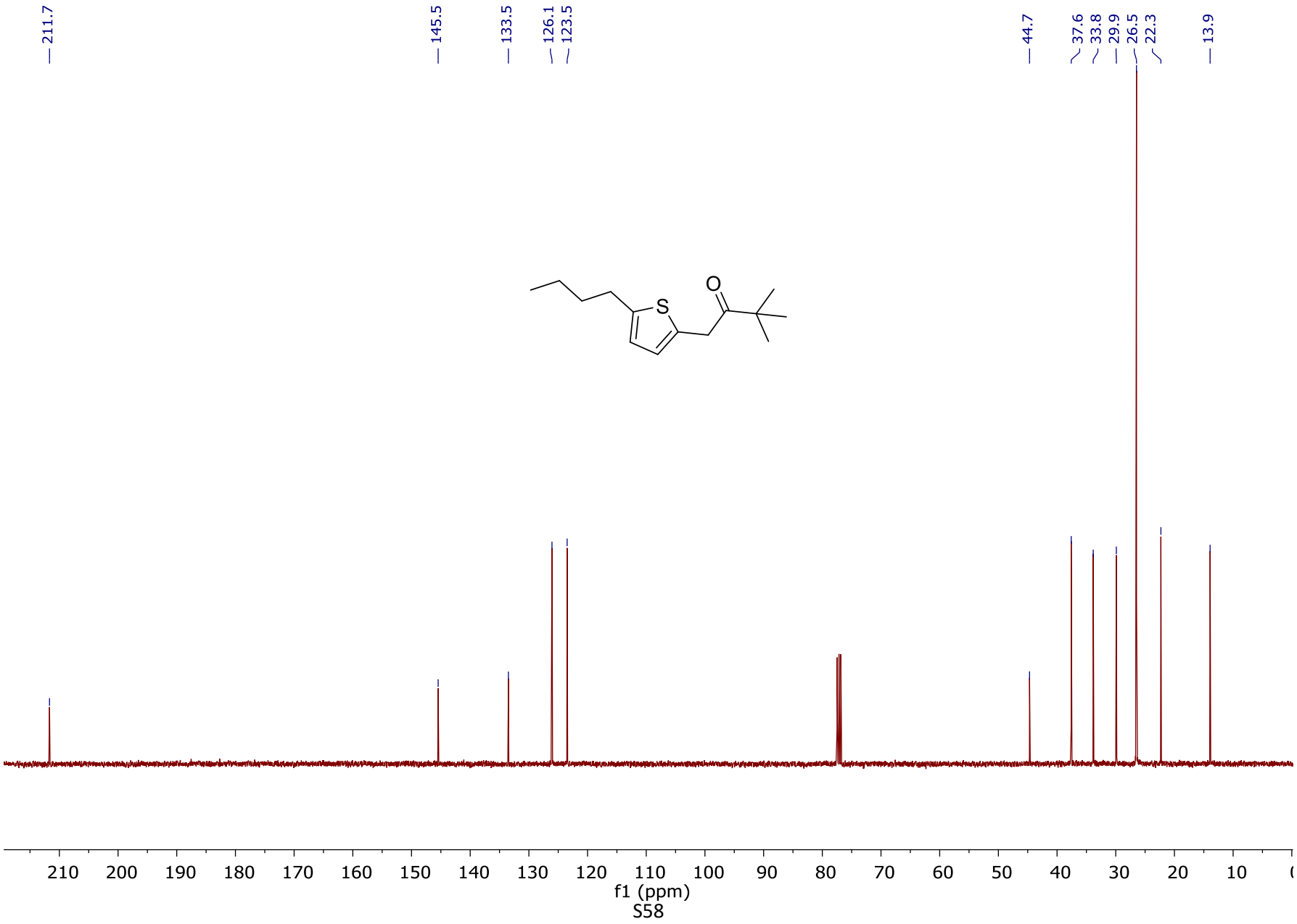
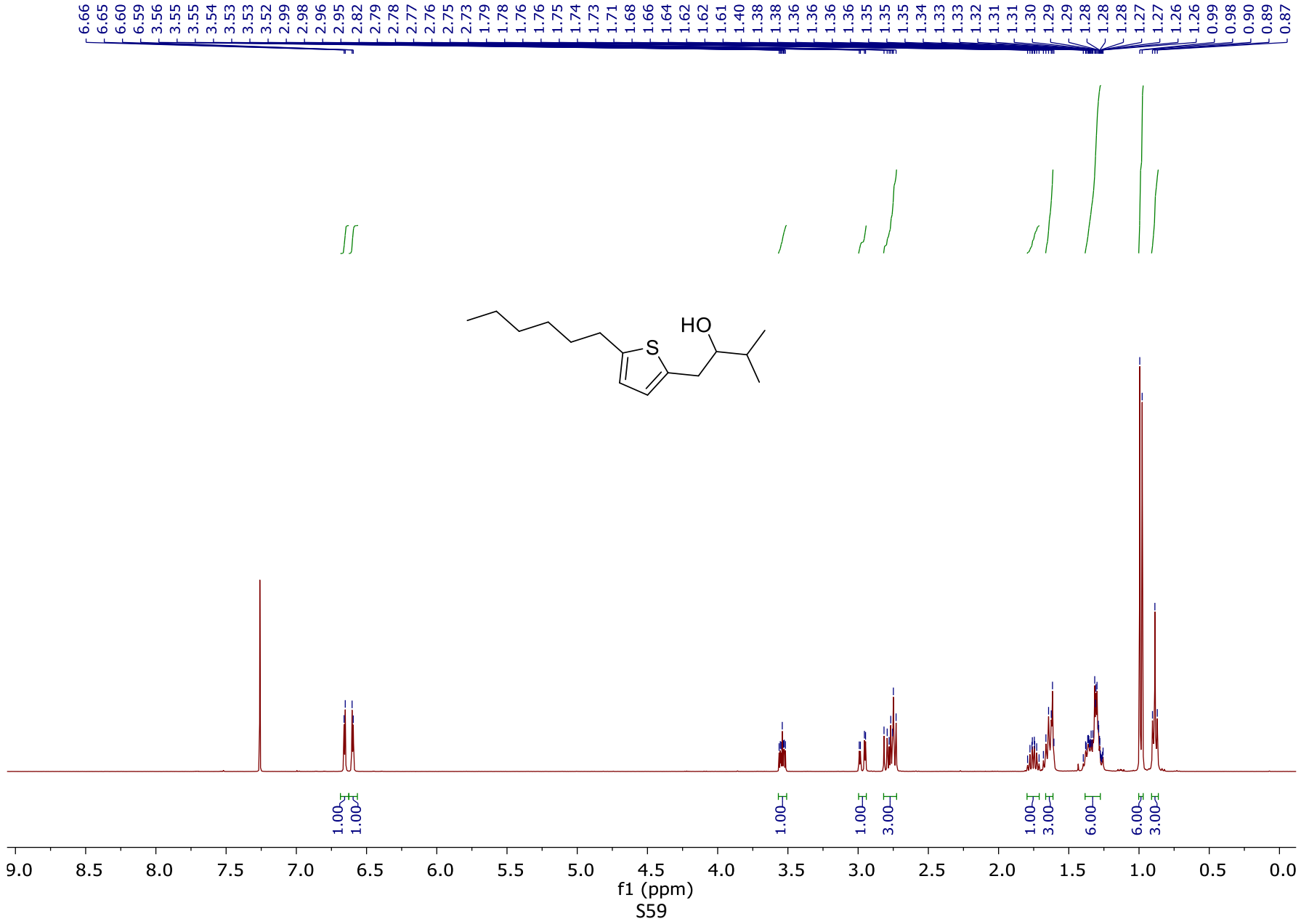
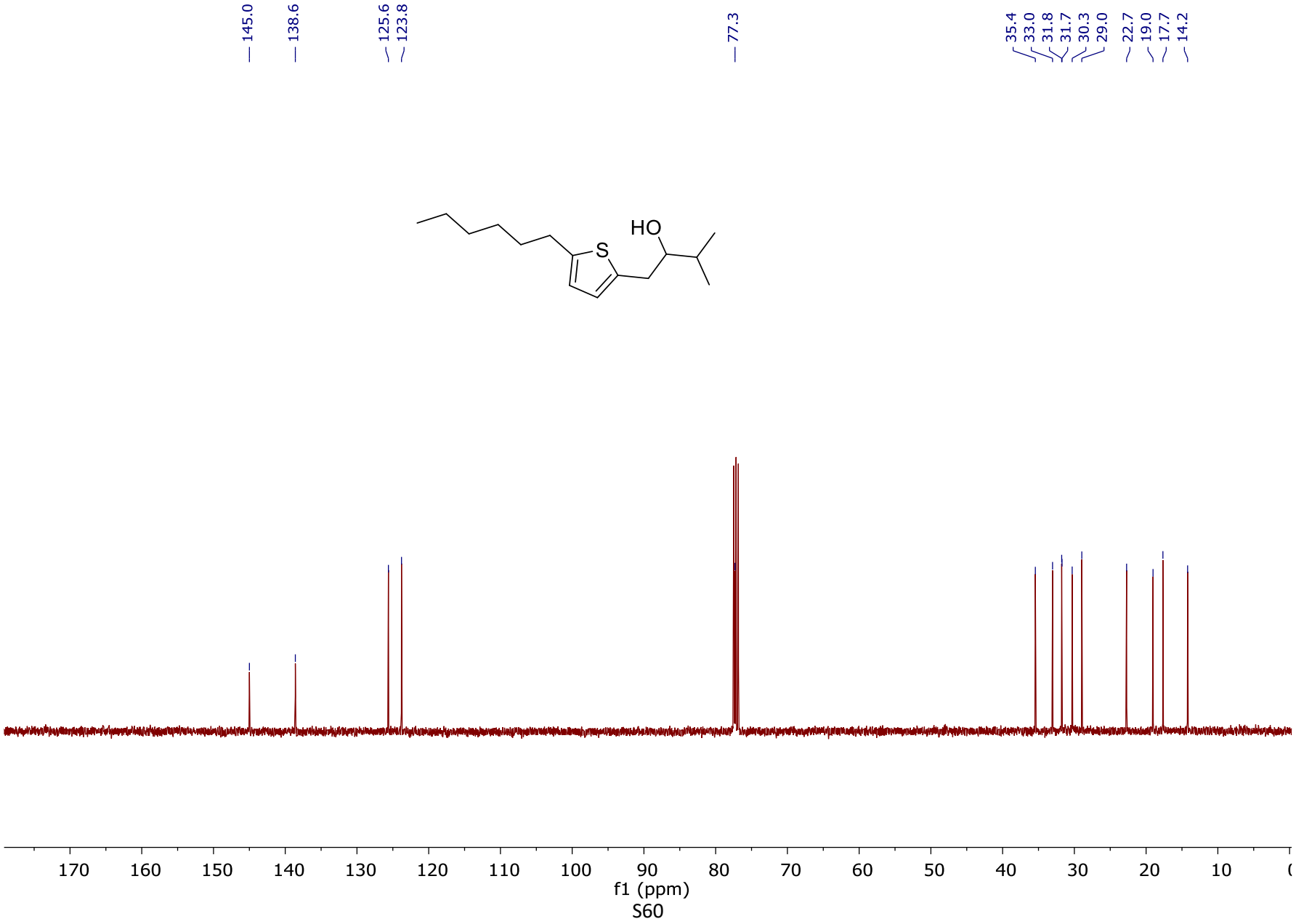
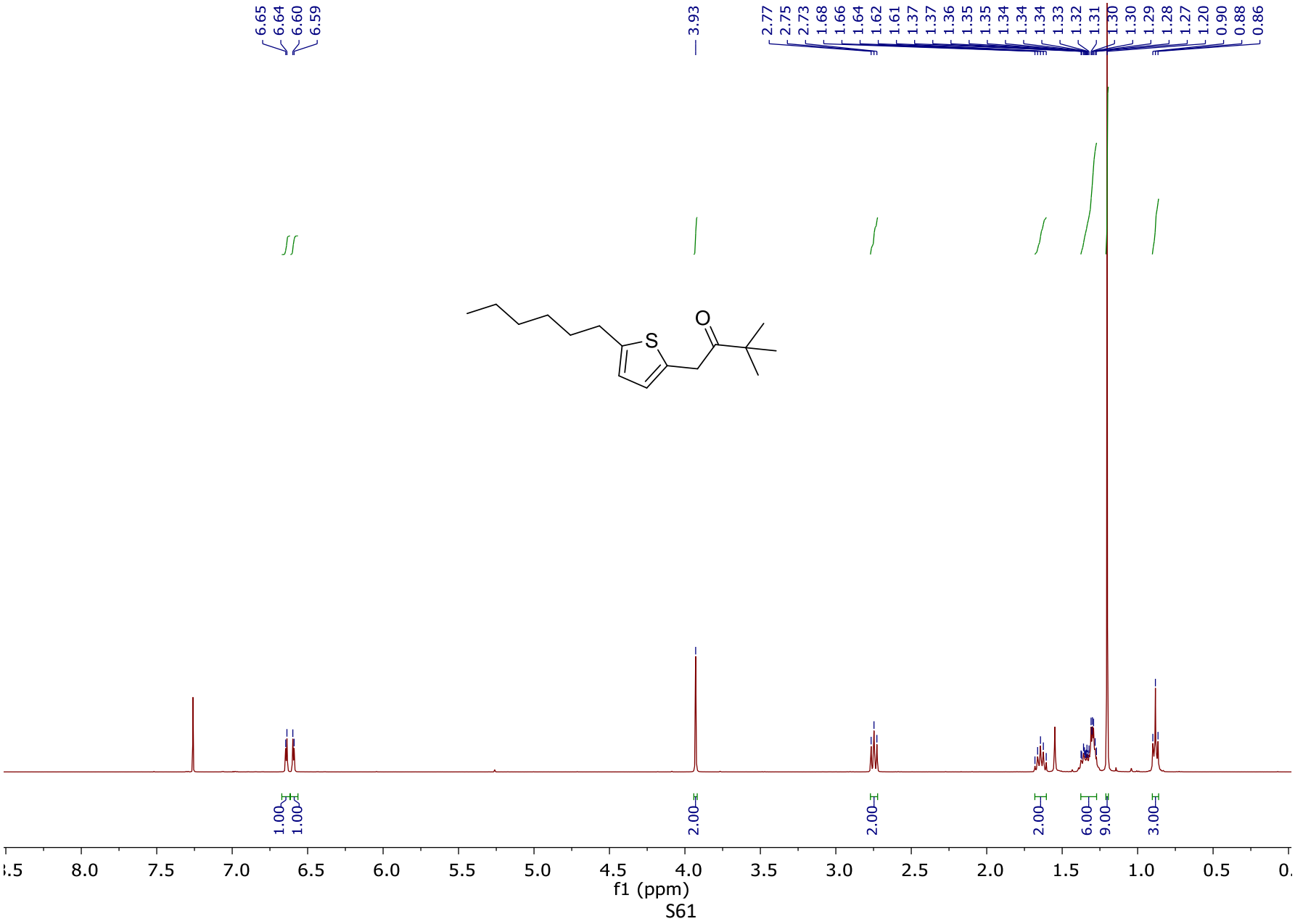
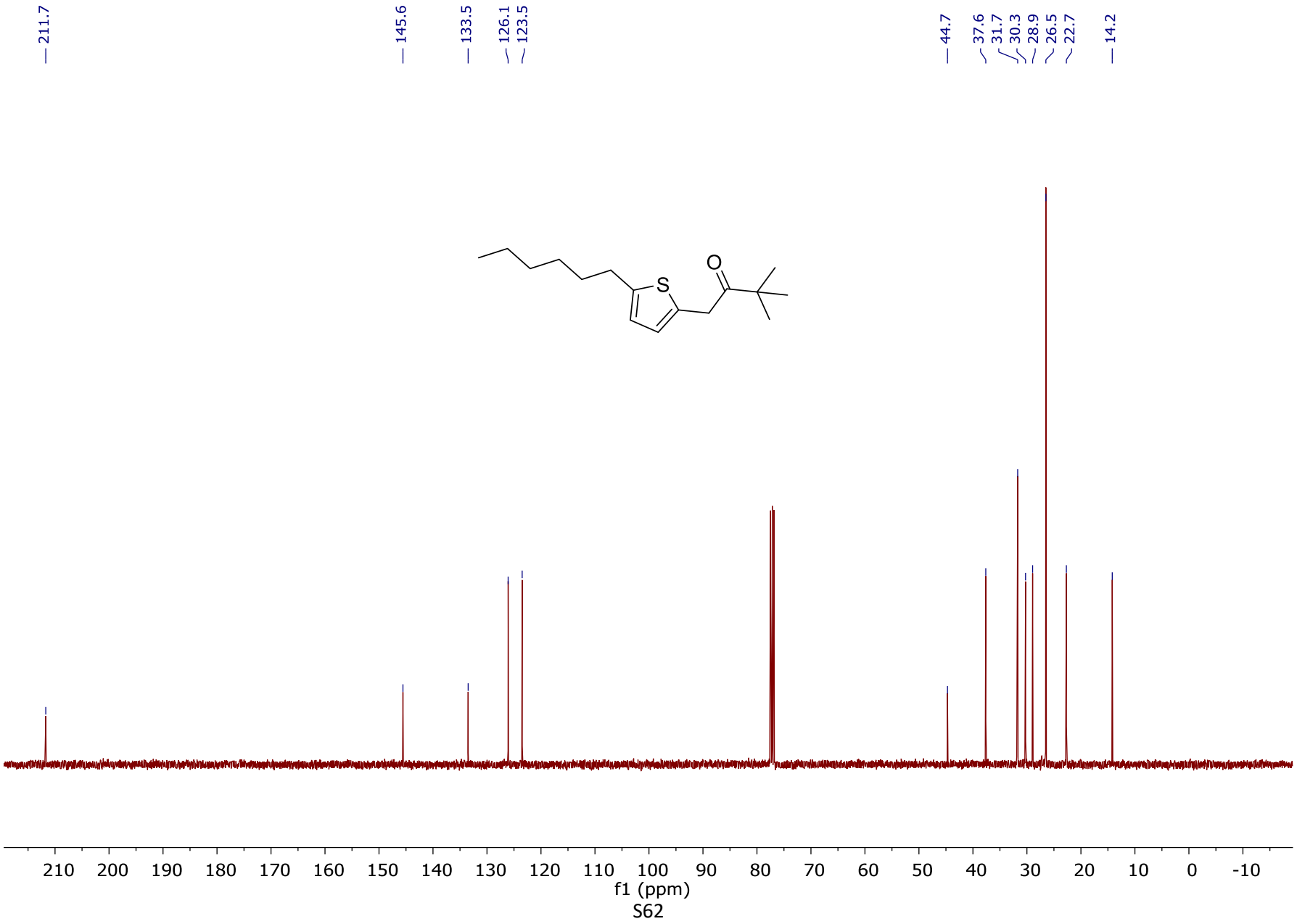
6.64
6.64
6.64
6.63
6.60
6.60
6.60
6.59
6.59
6.59
3.93
2.77
2.76
2.74
1.67
1.65
1.63
1.62
1.60
1.43
1.41
1.39
1.37
1.35
1.33
1.20
0.94
0.92
0.90
S
O
1.00
1.00
2.00
2.00
2.00
2.00
9.00
3.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

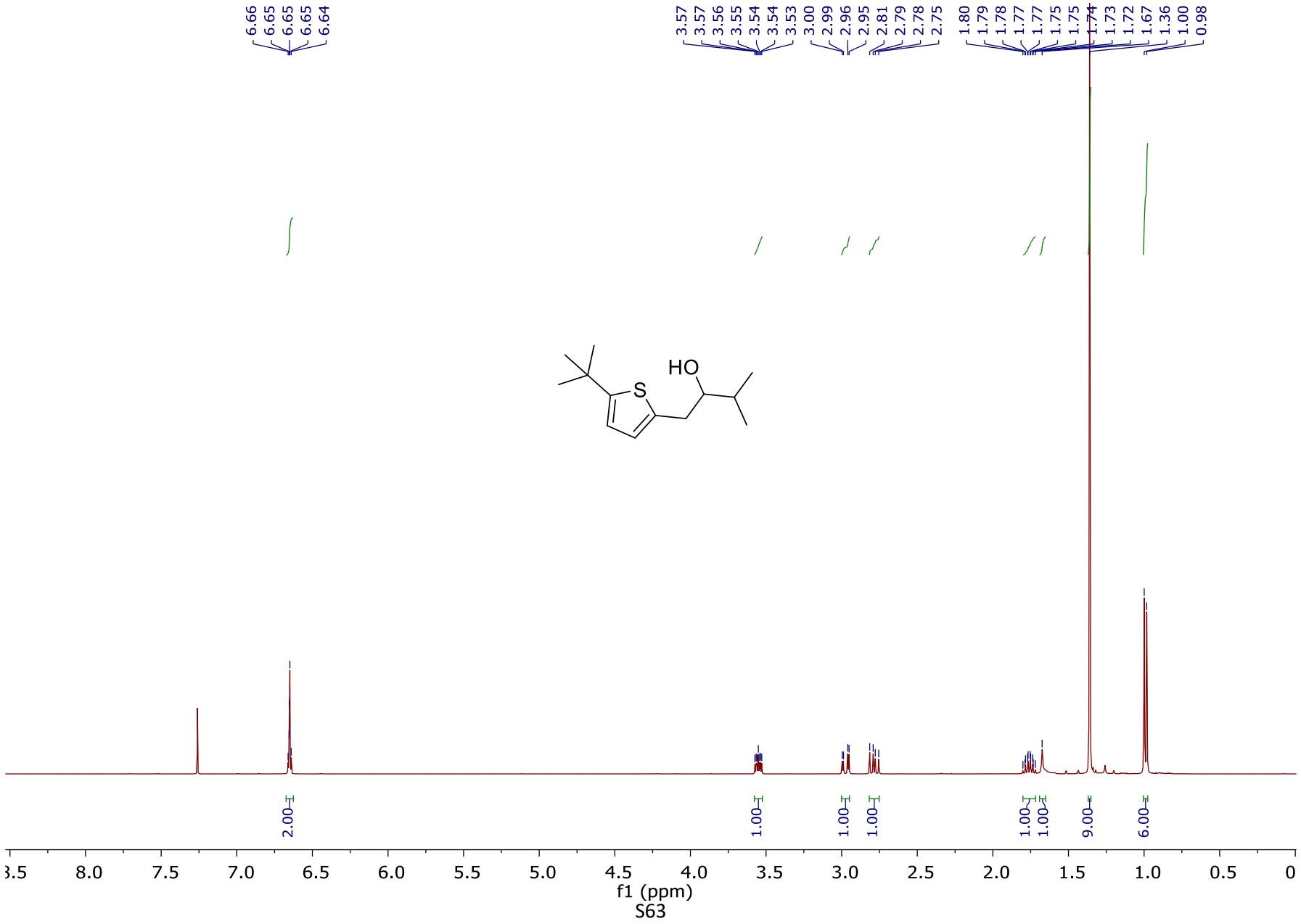

211.7
145.5
133.5
126.1
123.5
44.7
37.6
33.8
29.9
26.5
22.3
13.9
O
S
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


6.66 6.65 6.60 6.59 3.56 3.55 3.55 3.54 3.53 3.53 3.52 2.99 2.98 2.96 2.95 2.82 2.79 2.78 2.77 2.76 2.75 2.73 1.79 1.78 1.76 1.76 1.75 1.74 1.73 1.71 1.68 1.66 1.64 1.62 1.62 1.61 1.40 1.38 1.38 1.36 1.36 1.36 1.36 1.35 1.35 1.35 1.34 1.33 1.33 1.32 1.31 1.31 1.30 1.29 1.29 1.28 1.28 1.28 1.27 1.27 1.26 1.26 0.99 0.98 0.90 0.89 0.87
HO
S
1.00 1.00 1.00 1.00 3.00 1.00 3.00 6.00 6.00 3.00
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)


145.0
138.6
125.6
123.8
77.3
35.4
33.0
31.8
31.7
30.3
29.0
22.7
19.0
17.7
14.2
HO
S
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)
S60


6.65
6.64
6.60
6.59
3.93
2.77
2.75
2.73
1.68
1.66
1.64
1.62
1.61
1.37
1.37
1.36
1.35
1.35
1.34
1.34
1.34
1.33
1.32
1.31
1.30
1.30
1.29
1.28
1.27
1.20
0.90
0.88
0.86
O
S
1.00
1.00
2.00
2.00
2.00
6.00
9.00
3.00
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
f1 (ppm)


211.7
145.6
133.5
126.1
123.5
44.7
37.6
31.7
30.3
28.9
26.5
22.7
14.2
O
S
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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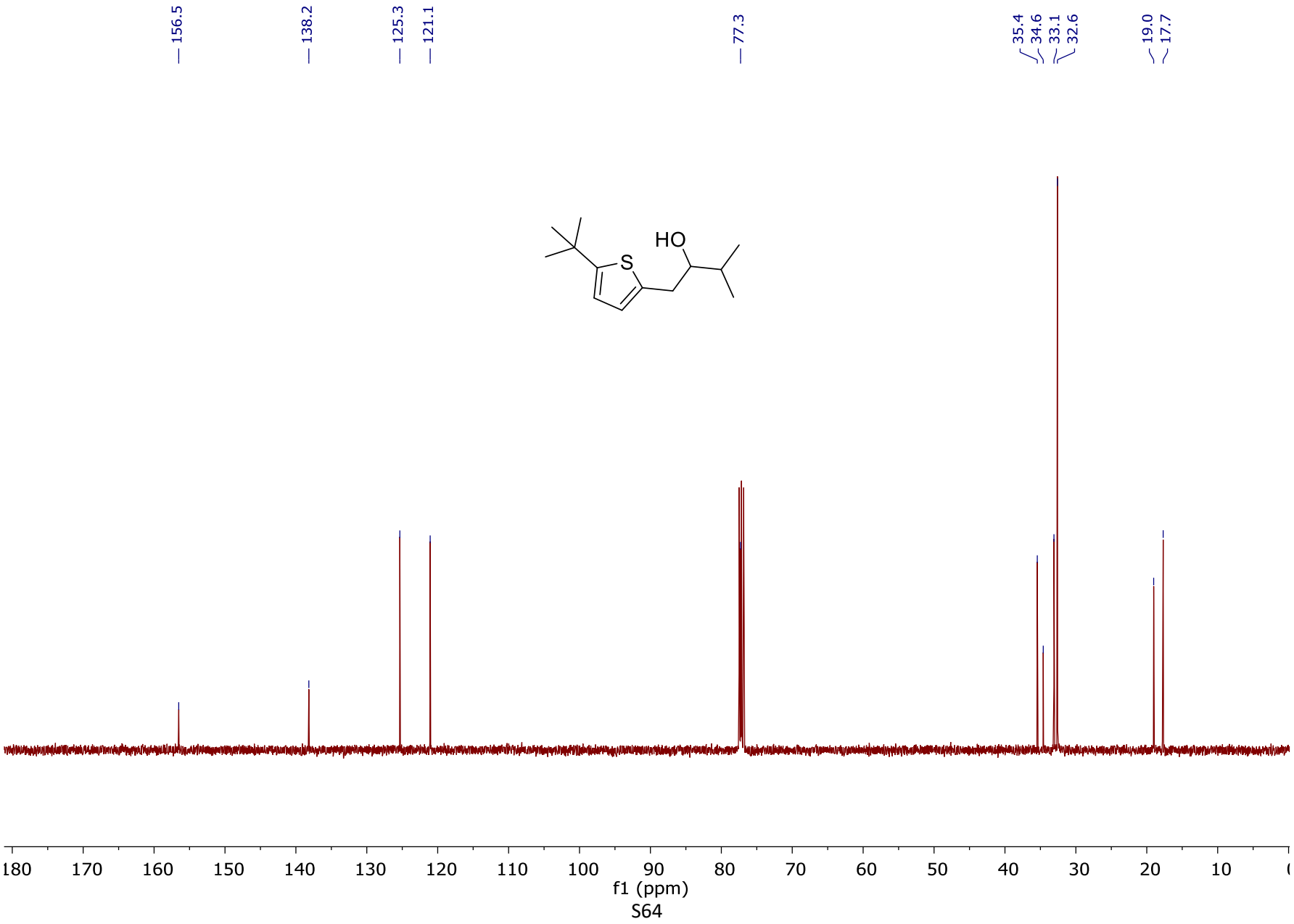
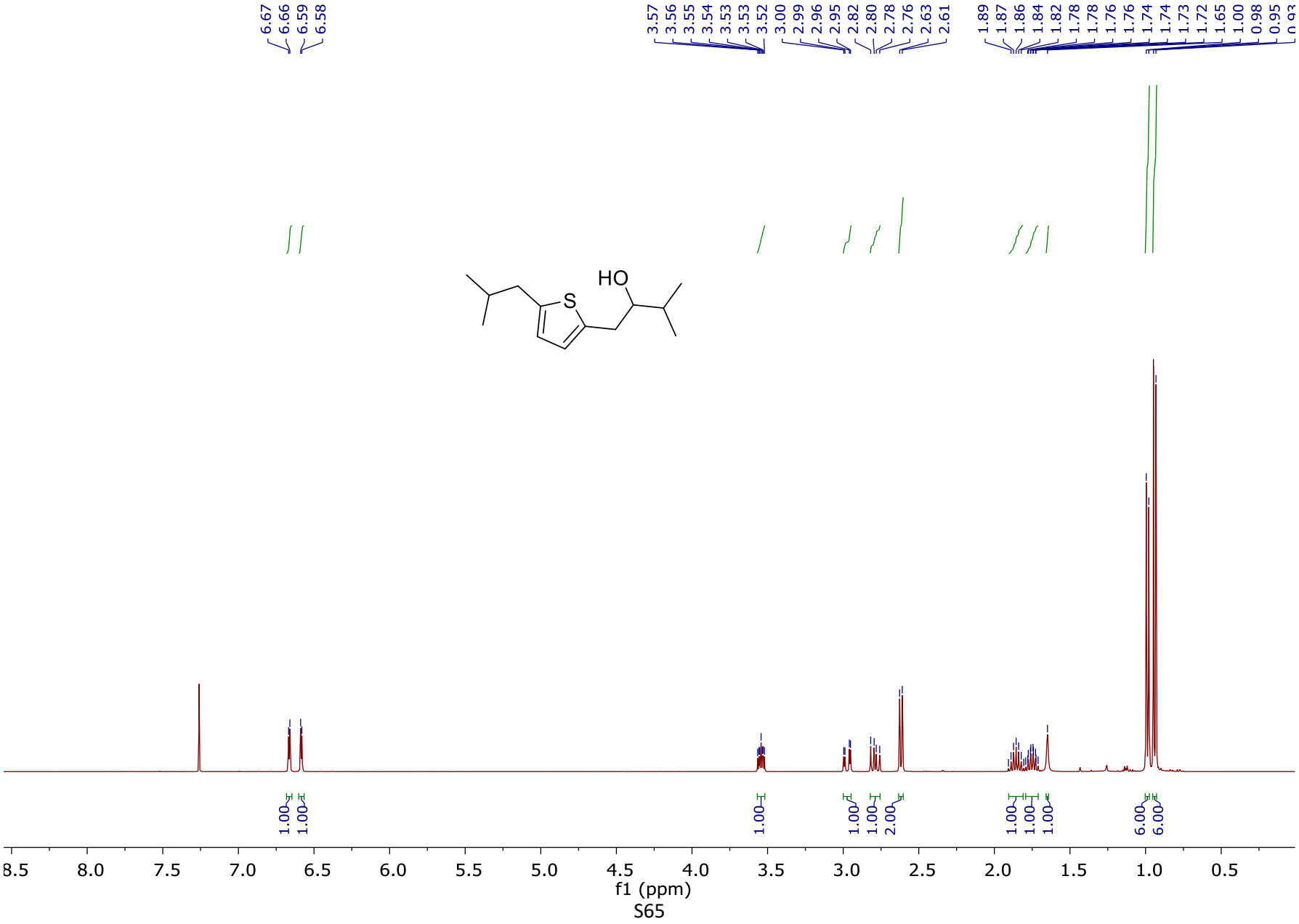
6.65
6.65
6.65
6.64
3.57
3.57
3.56
3.55
3.54
3.54
3.53
3.00
2.99
2.96
2.95
2.81
2.79
2.78
2.75
1.80
1.79
1.78
1.77
1.77
1.75
1.75
1.74
1.73
1.72
1.67
1.36
1.00
0.98
HO
S
2.00
1.00
1.00
1.00
1.00
1.00
9.00
6.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
f1 (ppm)


156.5
138.2
125.3
121.1
77.3
35.4
34.6
33.1
32.6
19.0
17.7
HO
S
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


6.67
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6.59
6.58
3.57
3.56
3.55
3.54
3.53
3.53
3.52
3.00
2.99
2.96
2.95
2.82
2.80
2.78
2.76
2.63
2.61
1.89
1.87
1.86
1.84
1.82
1.78
1.78
1.76
1.76
1.74
1.74
1.73
1.72
1.65
1.00
0.98
0.95
HO
S
1.00
1.00
1.00
1.00
1.00
2.00
1.00
1.00
1.00
6.00
6.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
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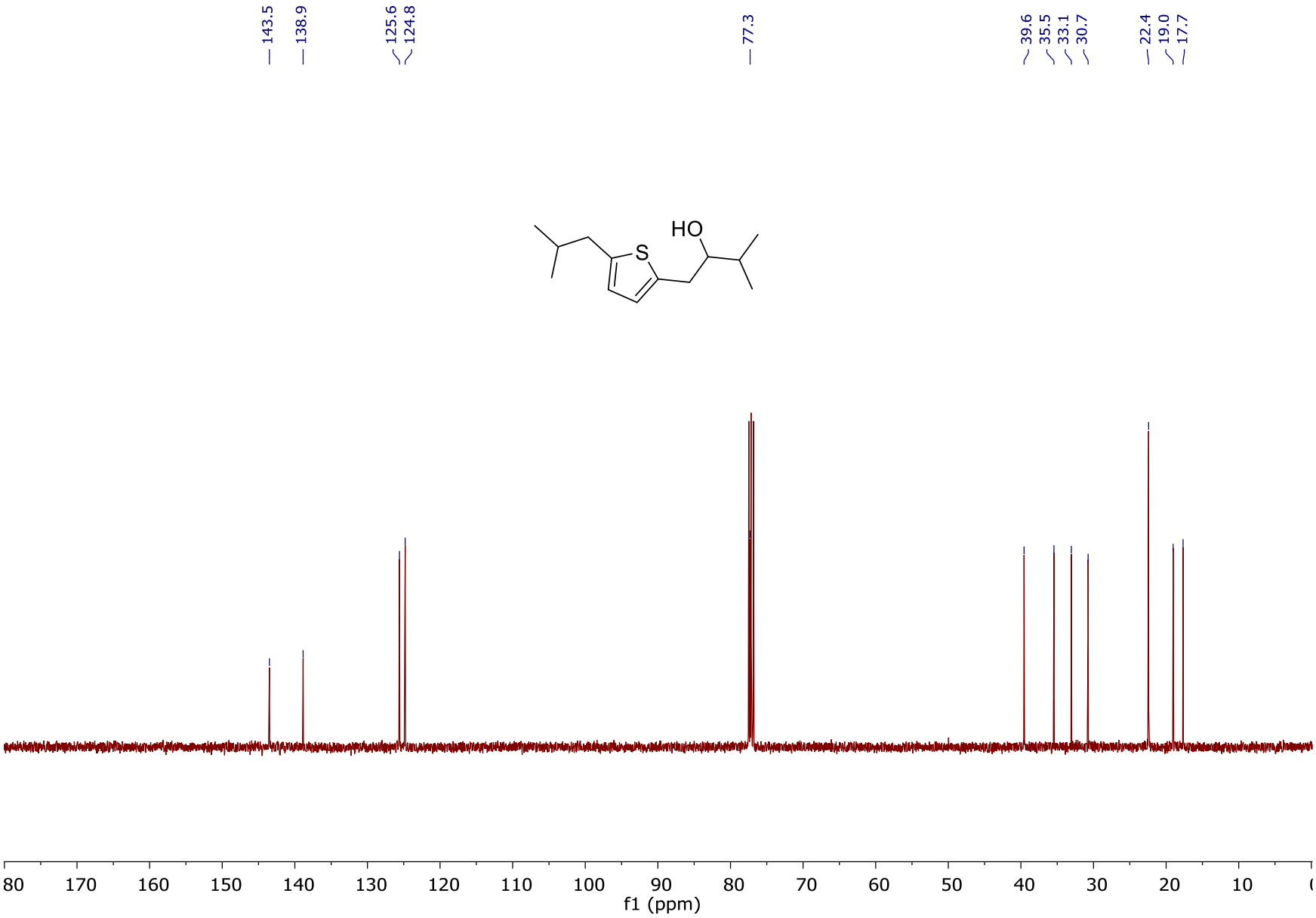
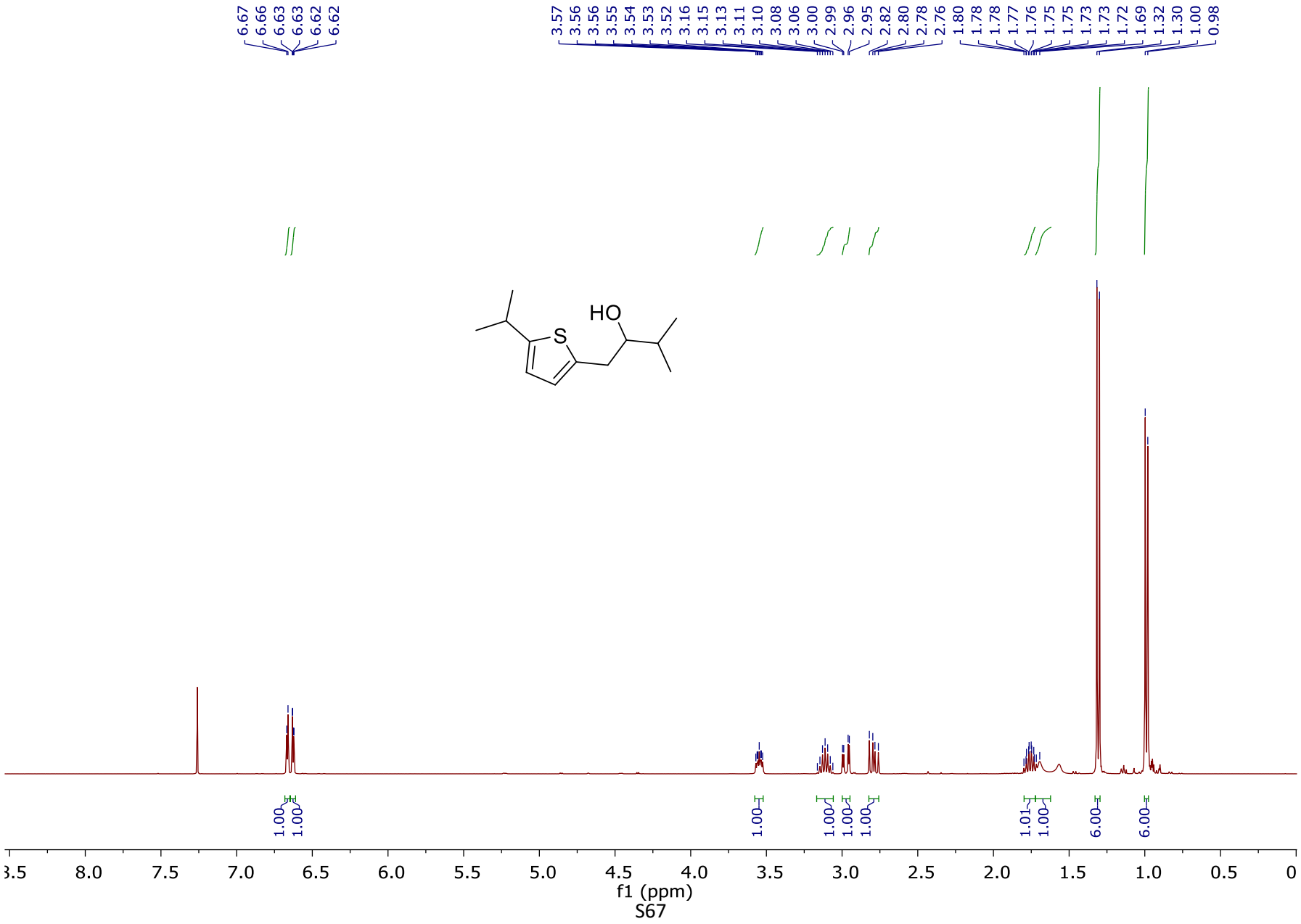
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

S65


143.5
138.9
125.6
124.8
77.3
39.6
35.5
33.1
30.7
22.4
19.0
17.7
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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6.66
6.63
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6.62
3.57
3.56
3.56
3.55
3.54
3.53
3.52
3.16
3.15
3.13
3.11
3.10
3.08
3.06
3.00
2.99
2.96
2.95
2.82
2.80
2.78
2.76
1.80
1.78
1.78
1.77
1.76
1.75
1.75
1.73
1.73
1.72
1.69
1.32
1.30
1.00
0.98
HO
S
1.00
1.00
1.00
1.00
1.00
1.00
1.01
1.00
6.00
6.00
8.0
7.5
7.0
6.5
6.0
5.5
5.0
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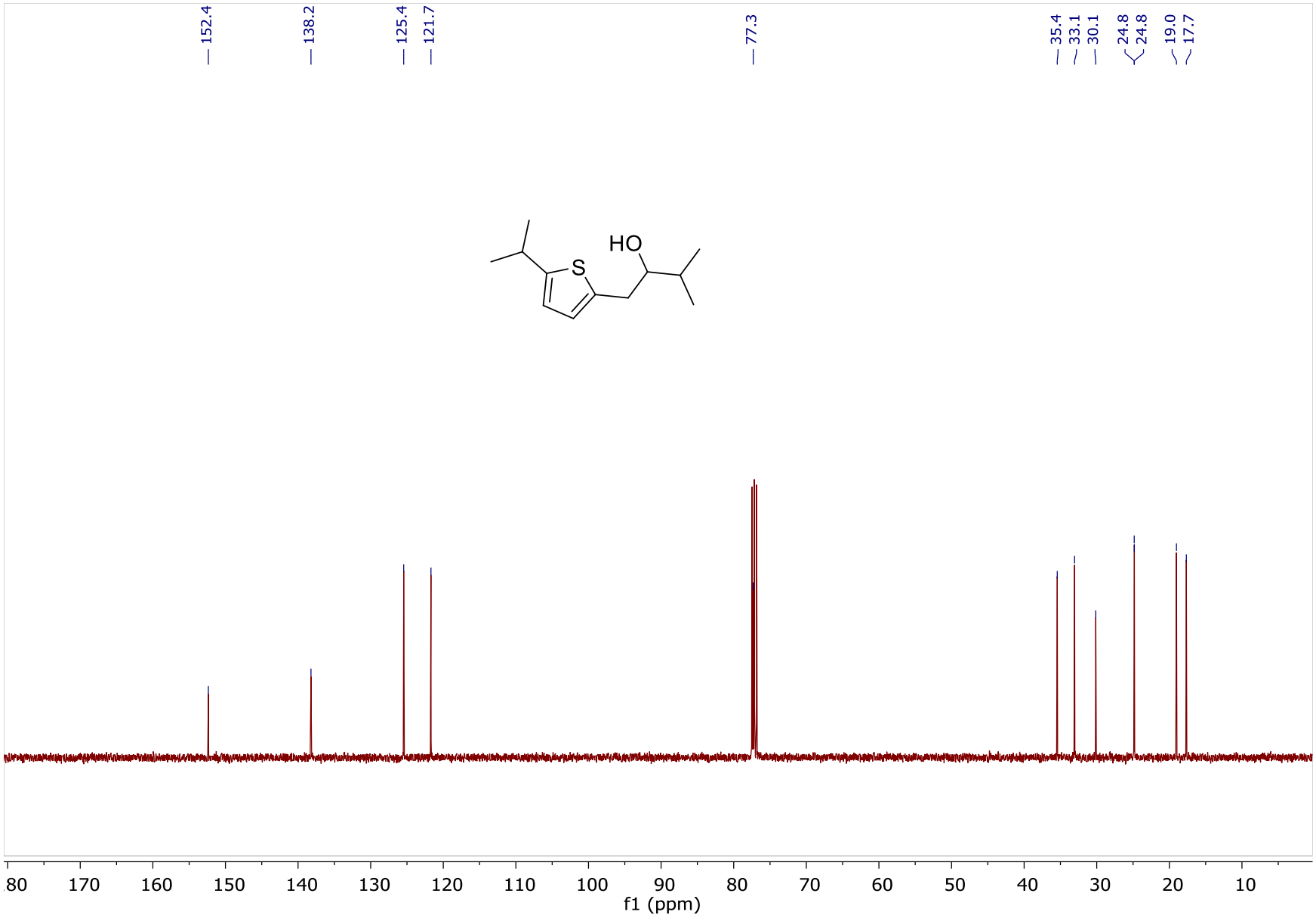
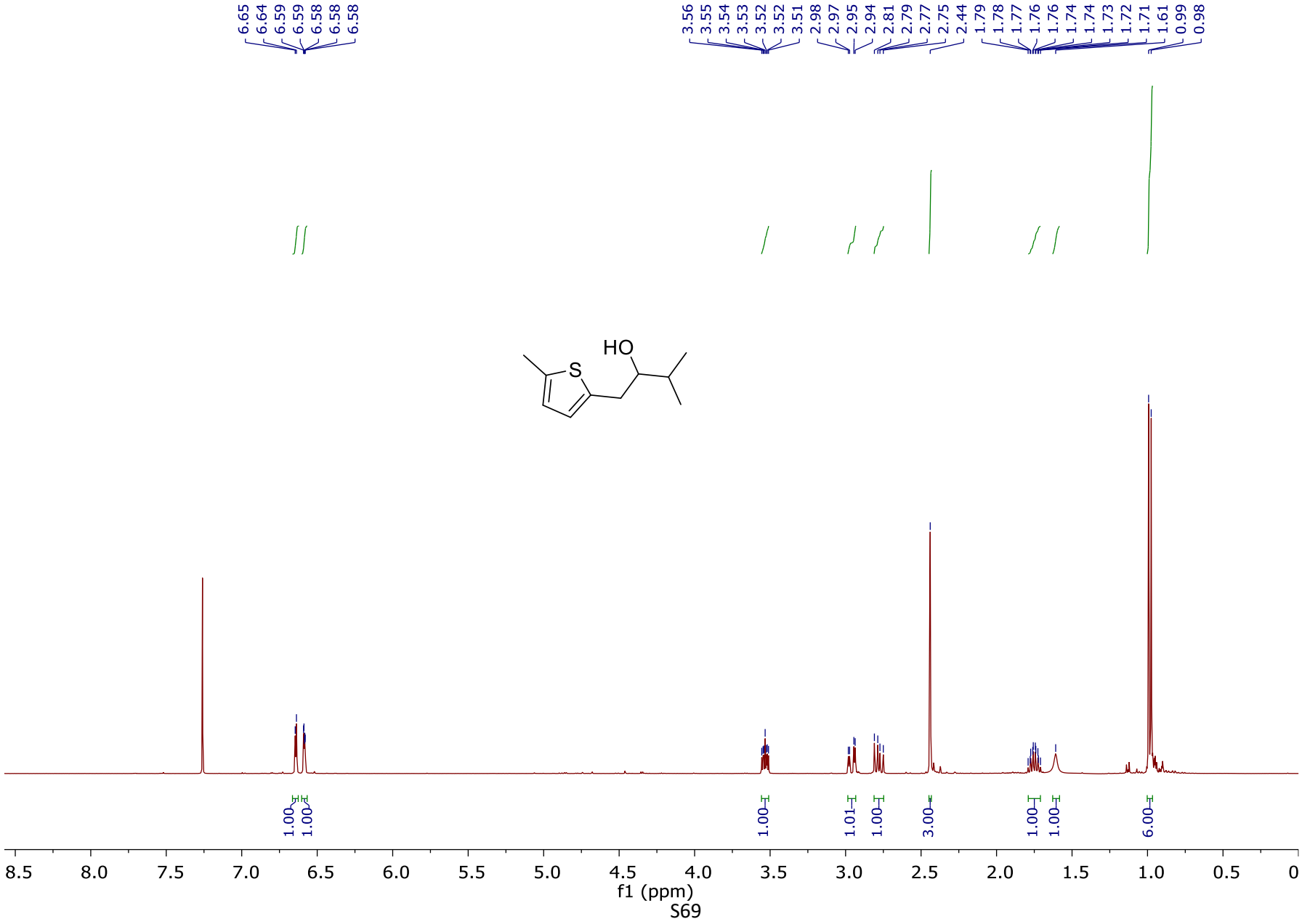
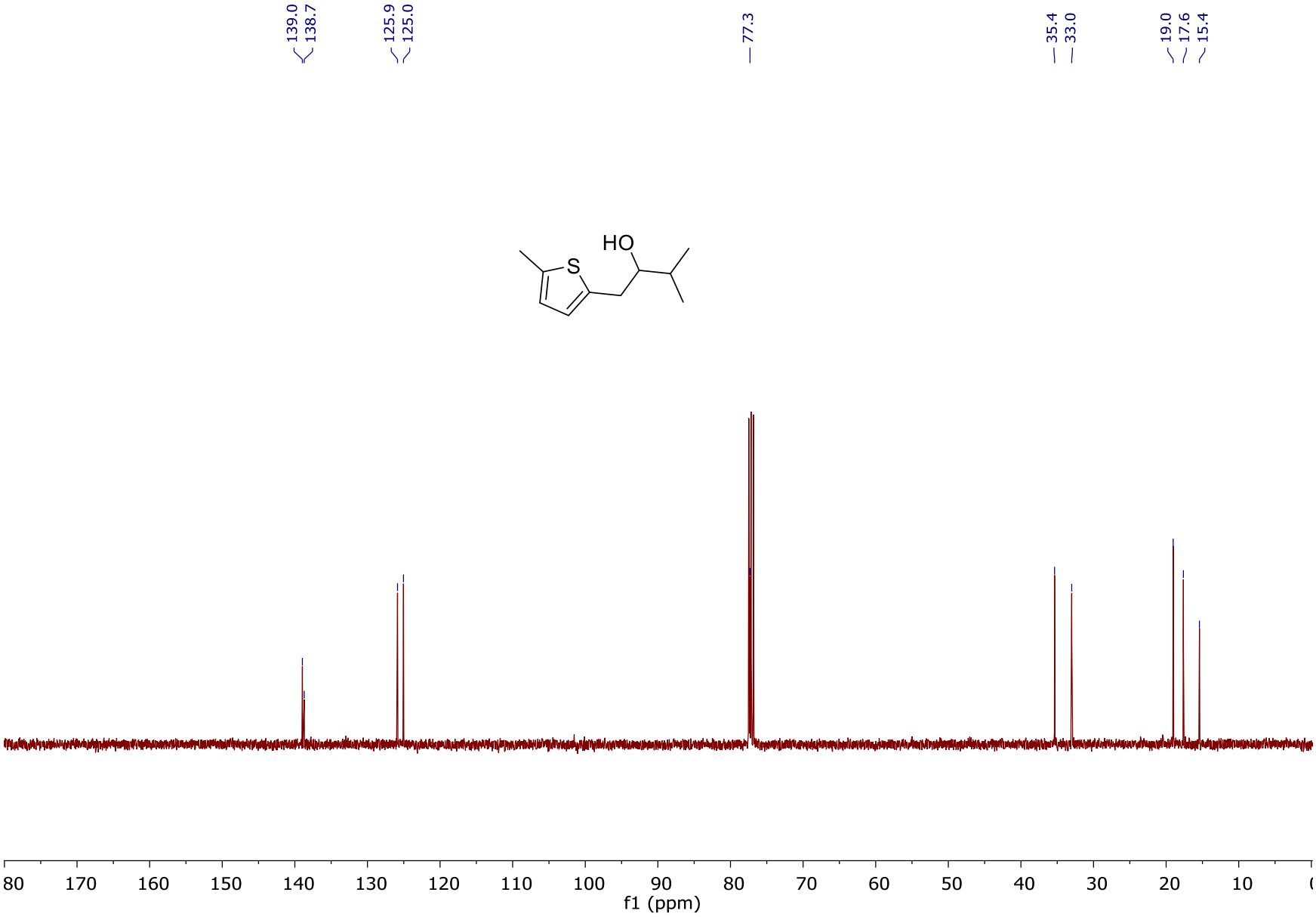
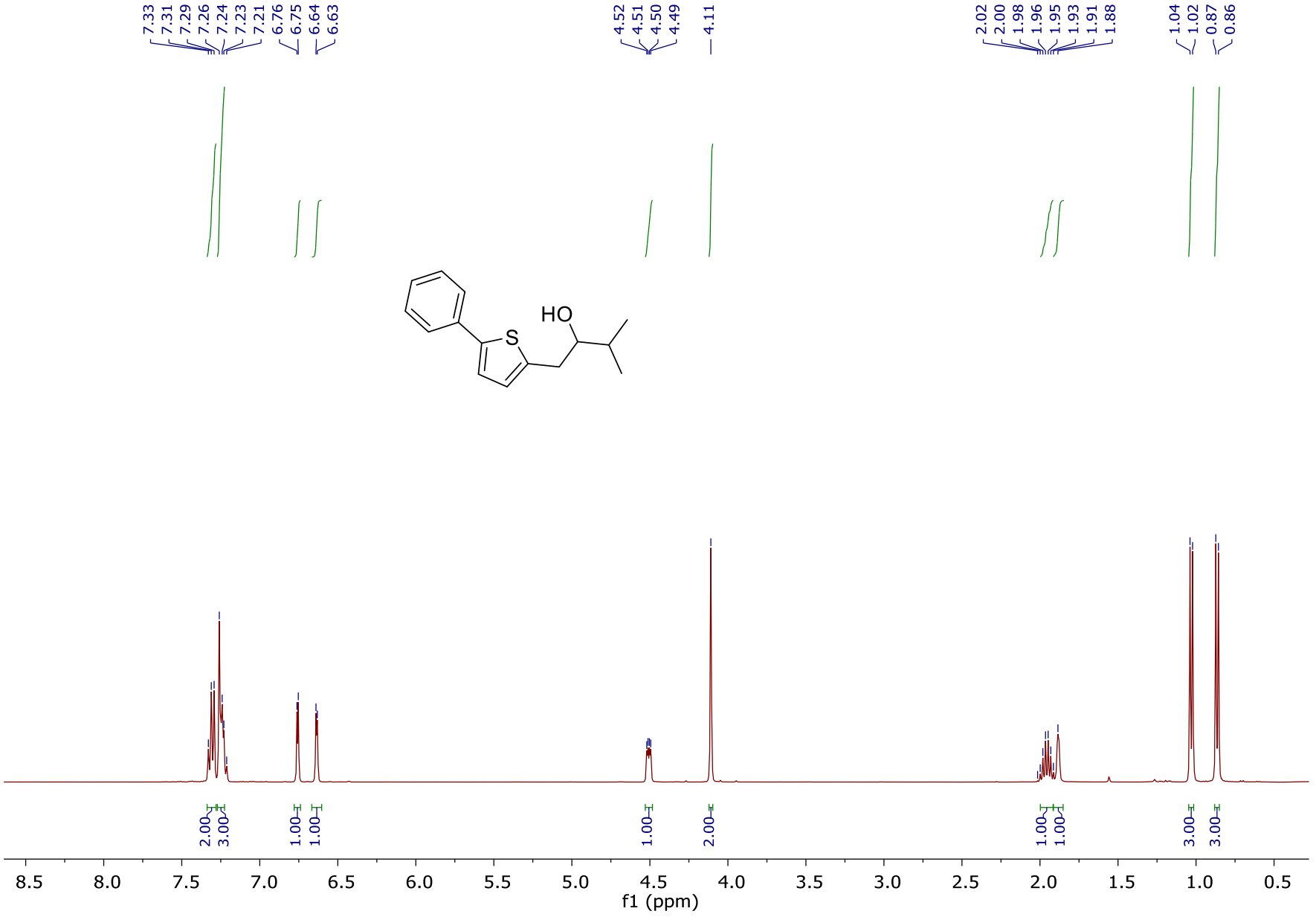
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
f1 (ppm)
S67


152.4
138.2
125.4
121.7
77.3
35.4
33.1
30.1
24.8
24.8
19.0
17.7
HO
S
f1 (ppm)


6.65
6.64
6.59
6.59
6.58
6.58
6.58
3.56
3.55
3.54
3.53
3.52
3.52
3.51
2.98
2.97
2.95
2.94
2.81
2.79
2.77
2.75
2.44
1.79
1.78
1.77
1.76
1.76
1.74
1.74
1.73
1.72
1.71
1.61
0.99
0.98
HO
S
1.00
1.00
1.00
1.01
1.00
3.00
1.00
1.00
6.00
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
f1 (ppm)


139.0
138.7
125.9
125.0
77.3
35.4
33.0
19.0
17.6
15.4
HO
S
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.33
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7.29
7.26
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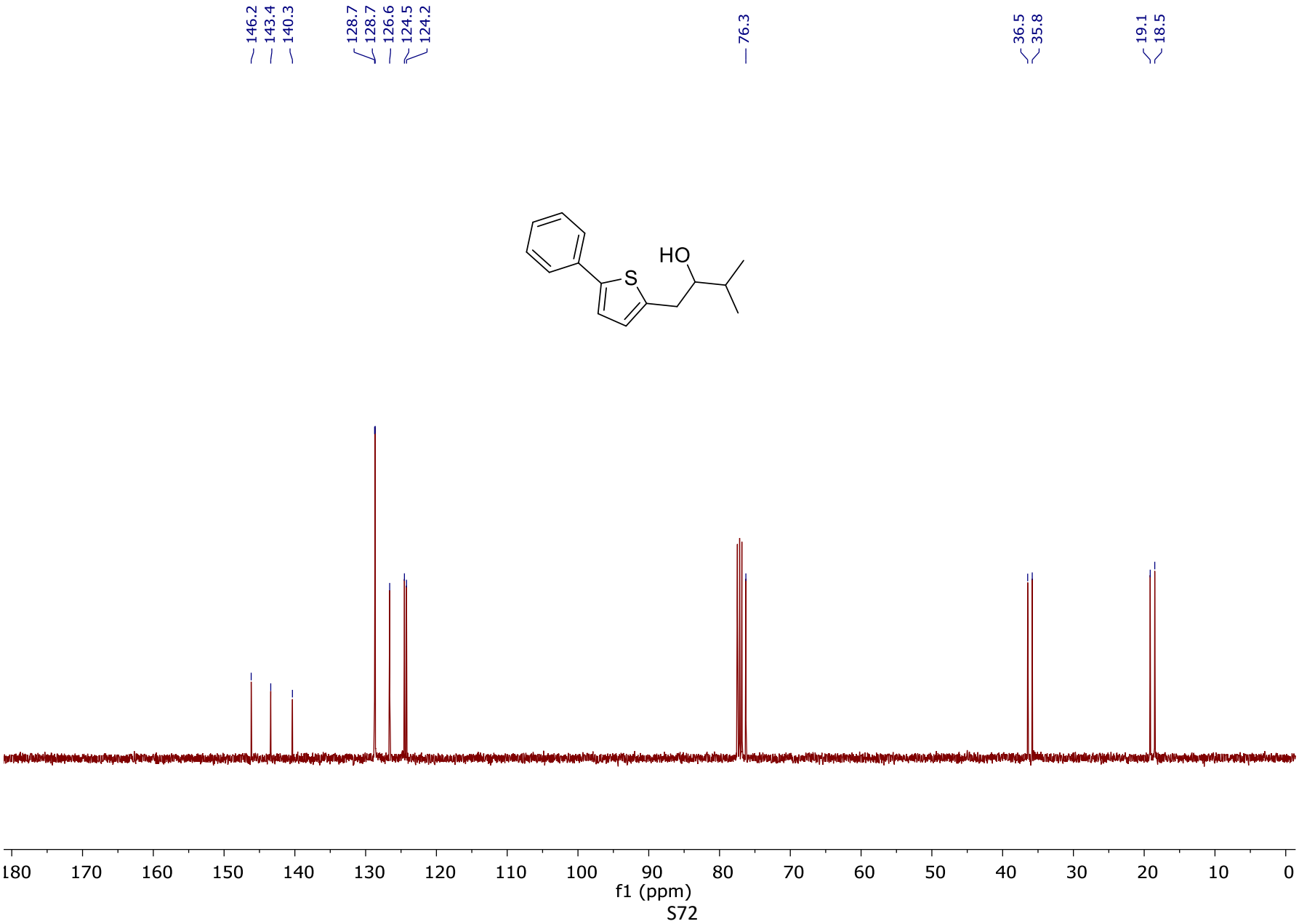
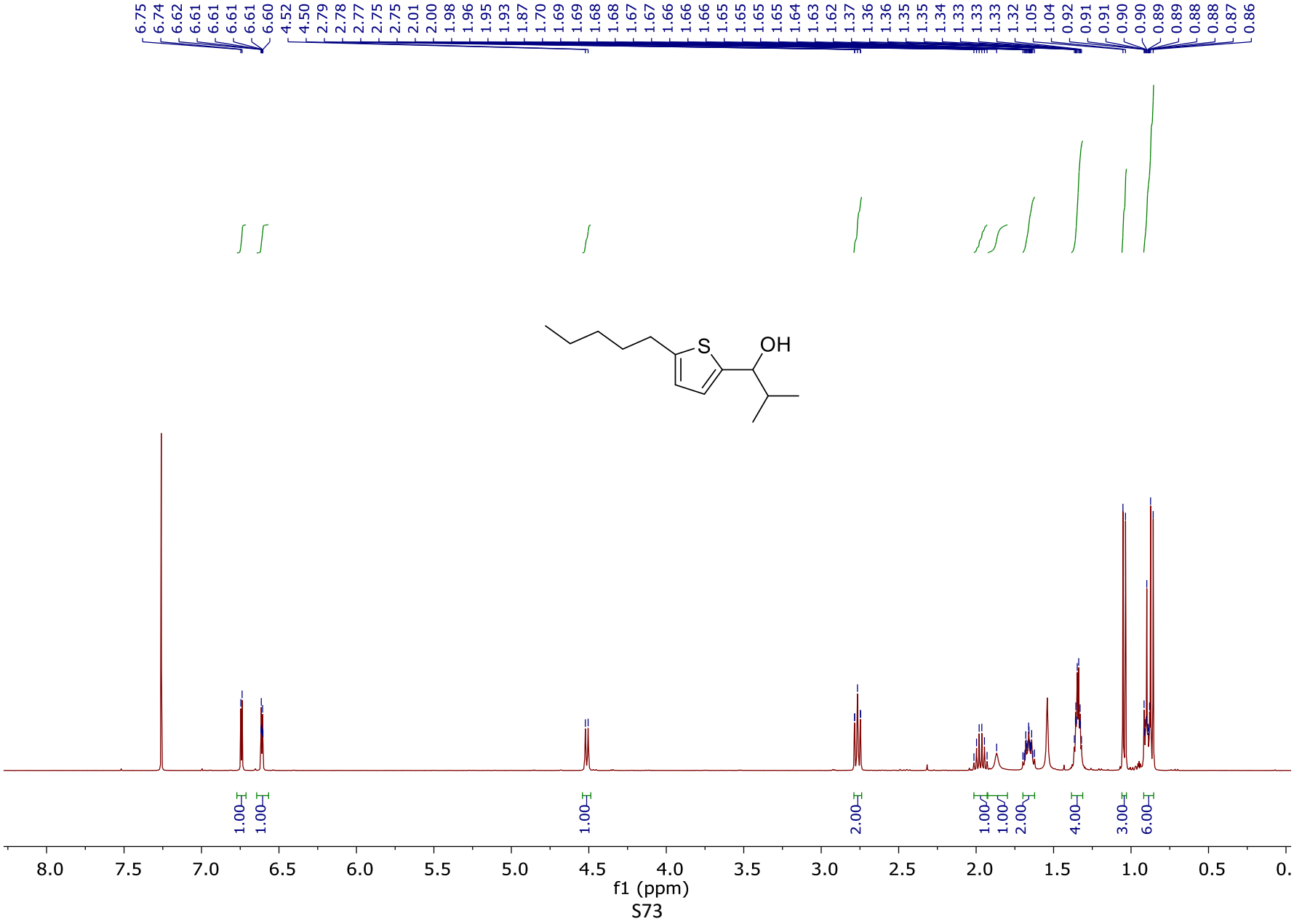
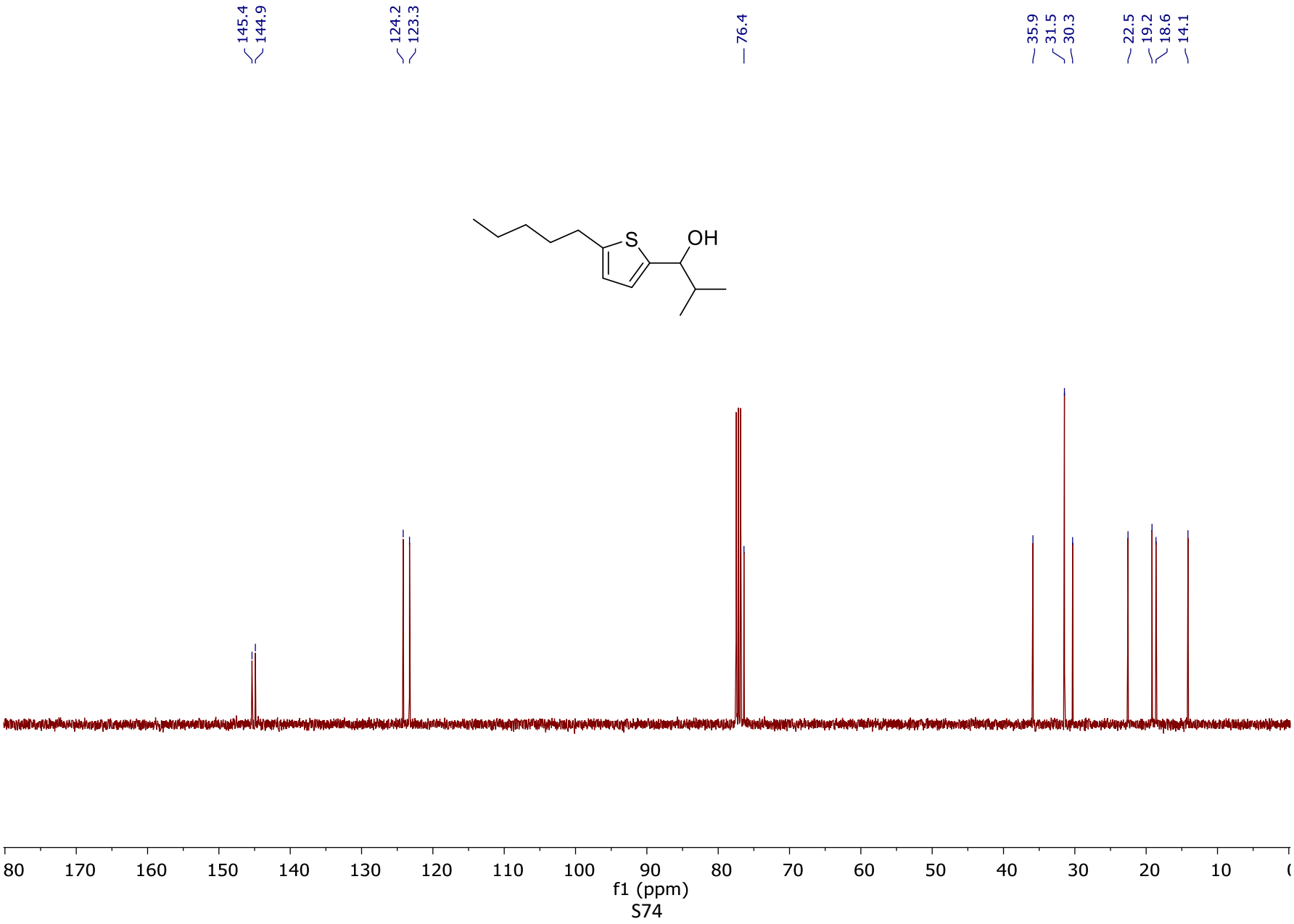
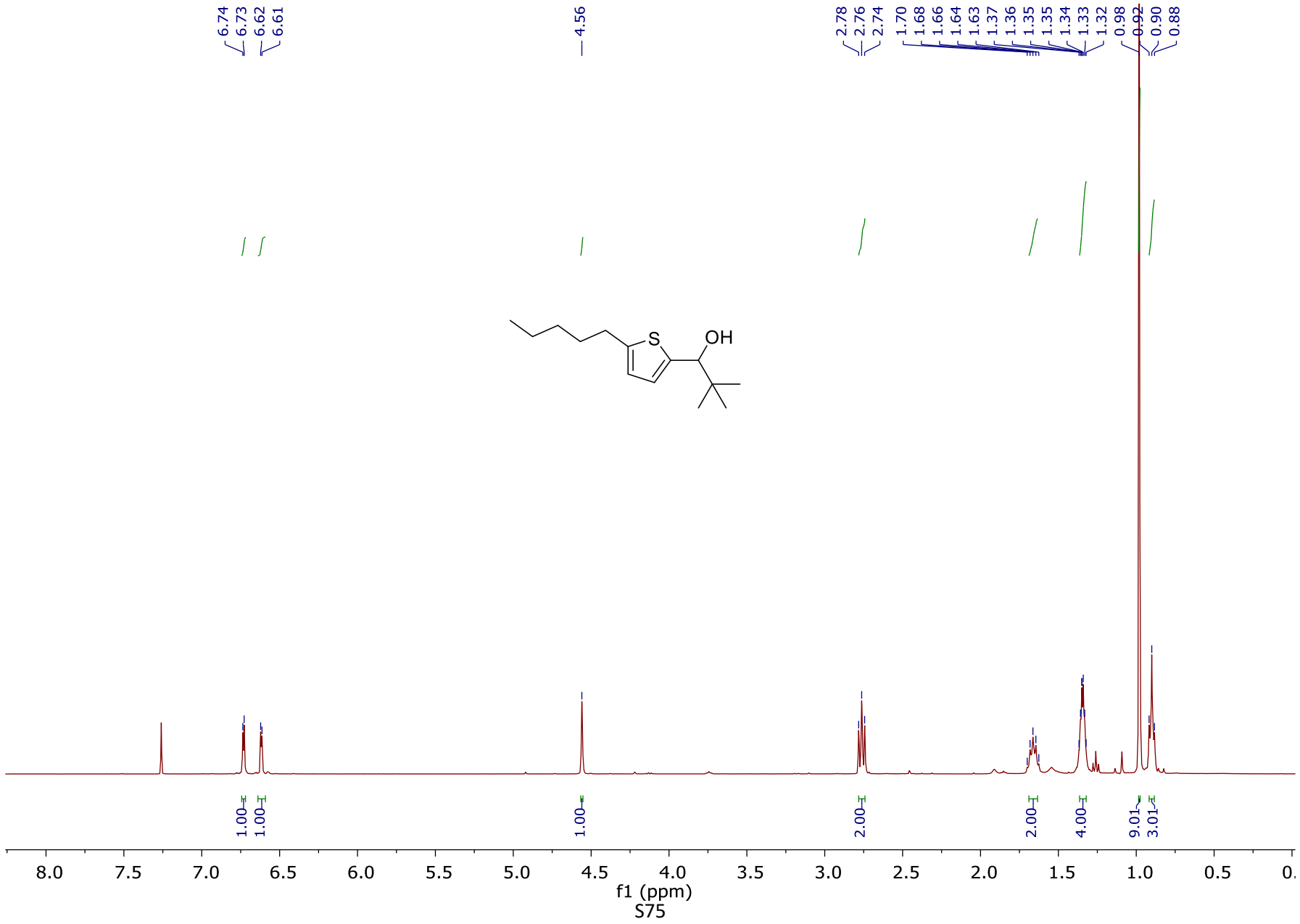
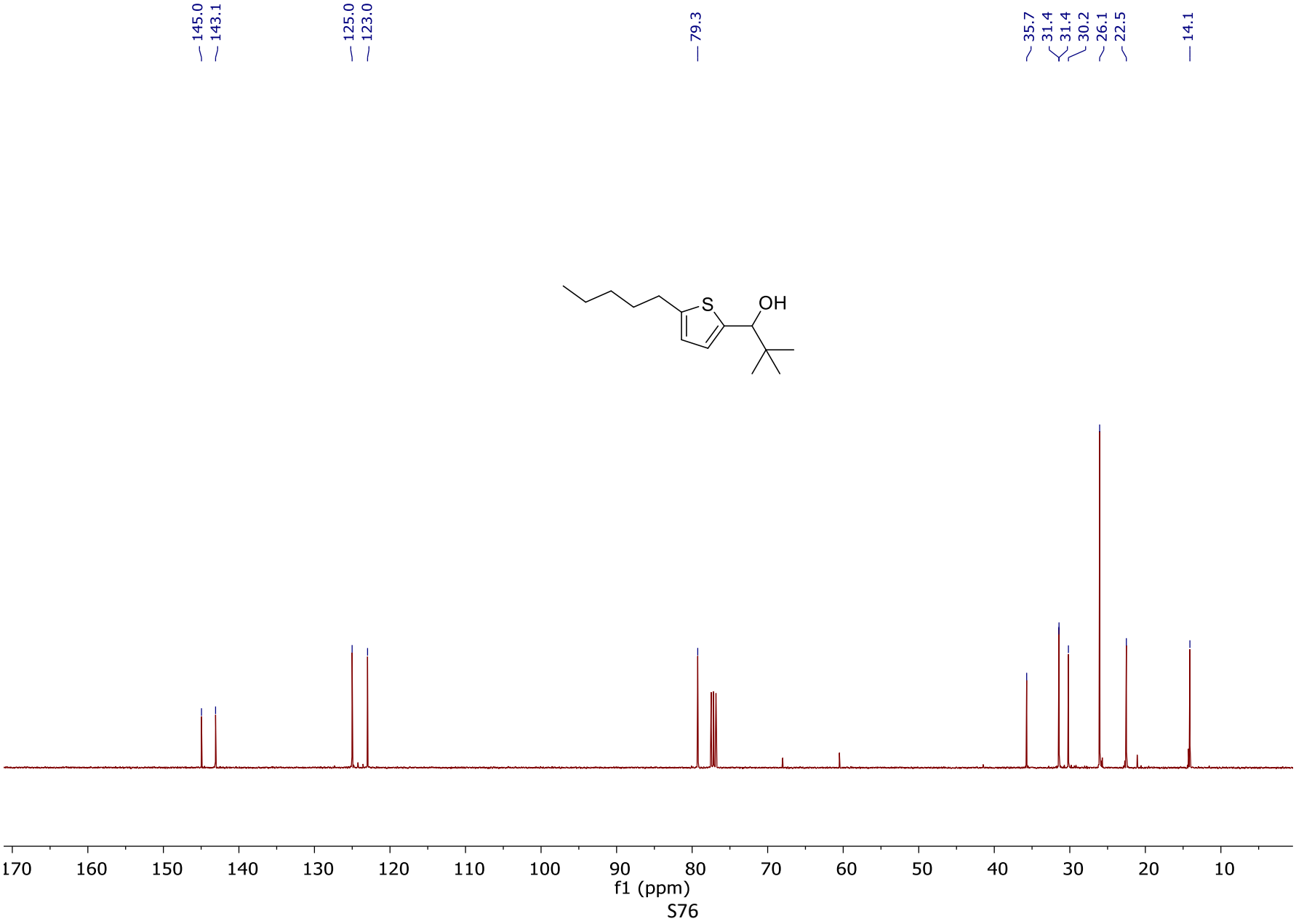
7.23
7.21
6.76
6.75
6.64
6.63
4.52
4.51
4.50
4.49
4.11
2.02
2.00
1.98
1.96
1.95
1.93
1.91
1.88
1.04
1.02
0.87
0.86
HO
S
2.00
3.00
1.00
1.00
1.00
2.00
1.00
1.00
3.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

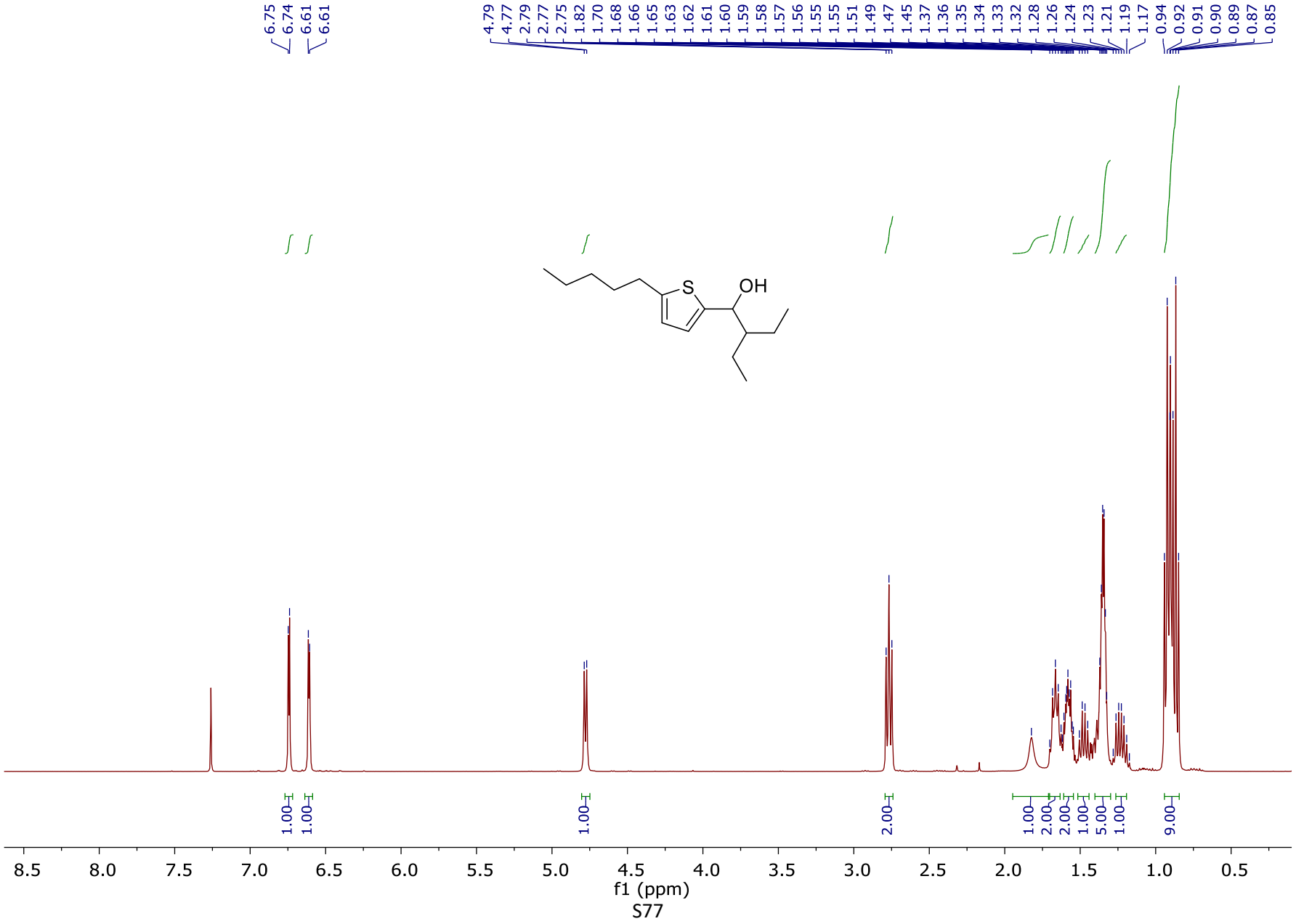

146.2
143.4
140.3
128.7
128.7
126.6
124.5
124.2
76.3
36.5
35.8
19.1
18.5
HO
S
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)


6.75 6.74 6.62 6.61 6.61 6.61 6.61 6.60 4.52 4.50 2.79 2.78 2.77 2.75 2.75 2.01 2.00 1.98 1.96 1.95 1.93 1.87 1.70 1.69 1.69 1.68 1.68 1.67 1.67 1.66 1.66 1.66 1.65 1.65 1.65 1.65 1.64 1.63 1.62 1.37 1.36 1.36 1.35 1.35 1.34 1.33 1.33 1.33 1.32 1.05 1.04 0.92 0.91 0.91 0.90 0.90 0.89 0.89 0.88 0.88 0.87 0.86
S
OH
1.00 1.00 1.00 2.00 1.00 1.00 2.00 4.00 3.00 6.00
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.
f1 (ppm)

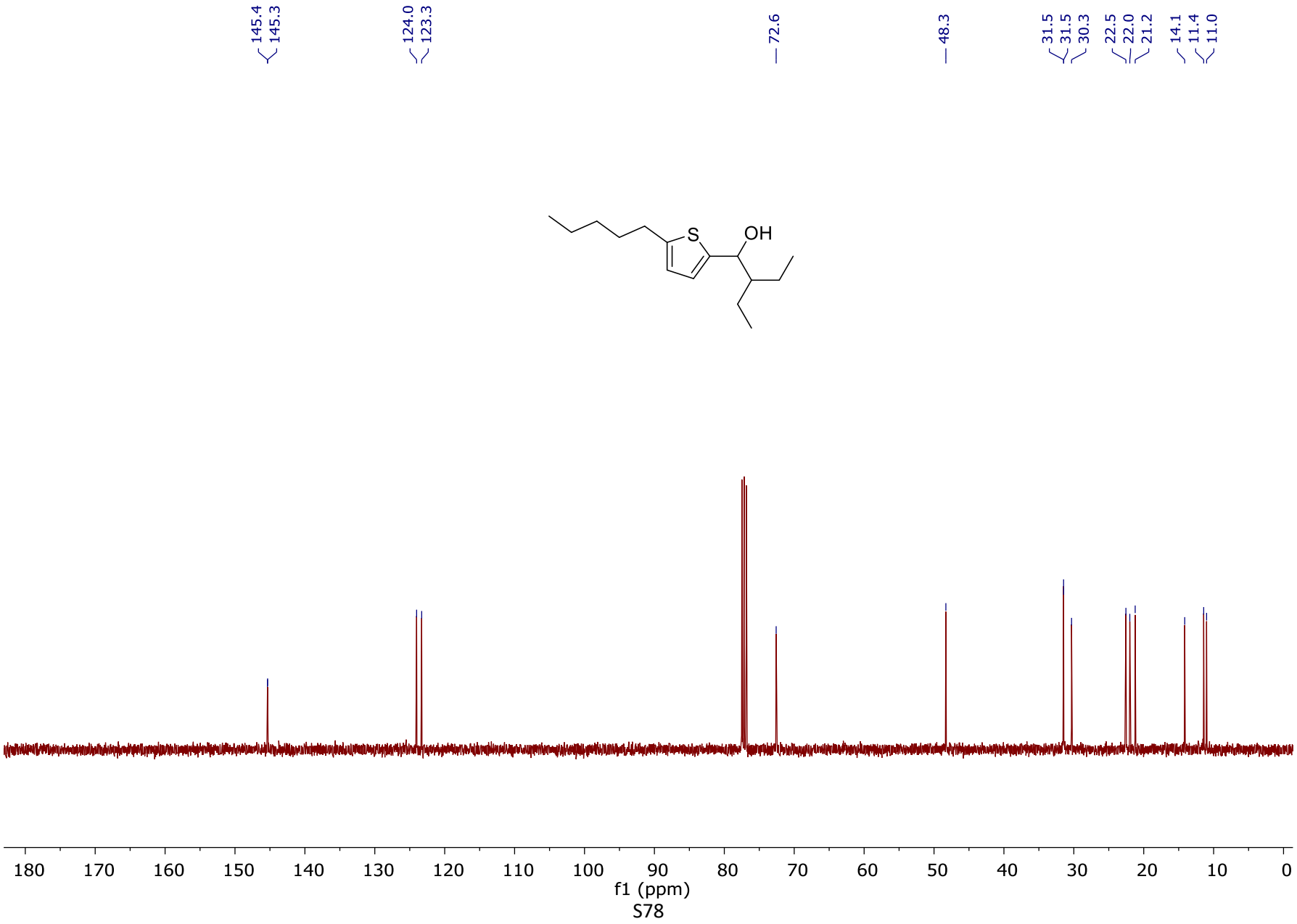

145.4
144.9
124.2
123.3
76.4
35.9
31.5
30.3
22.5
19.2
18.6
14.1
S
OH
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

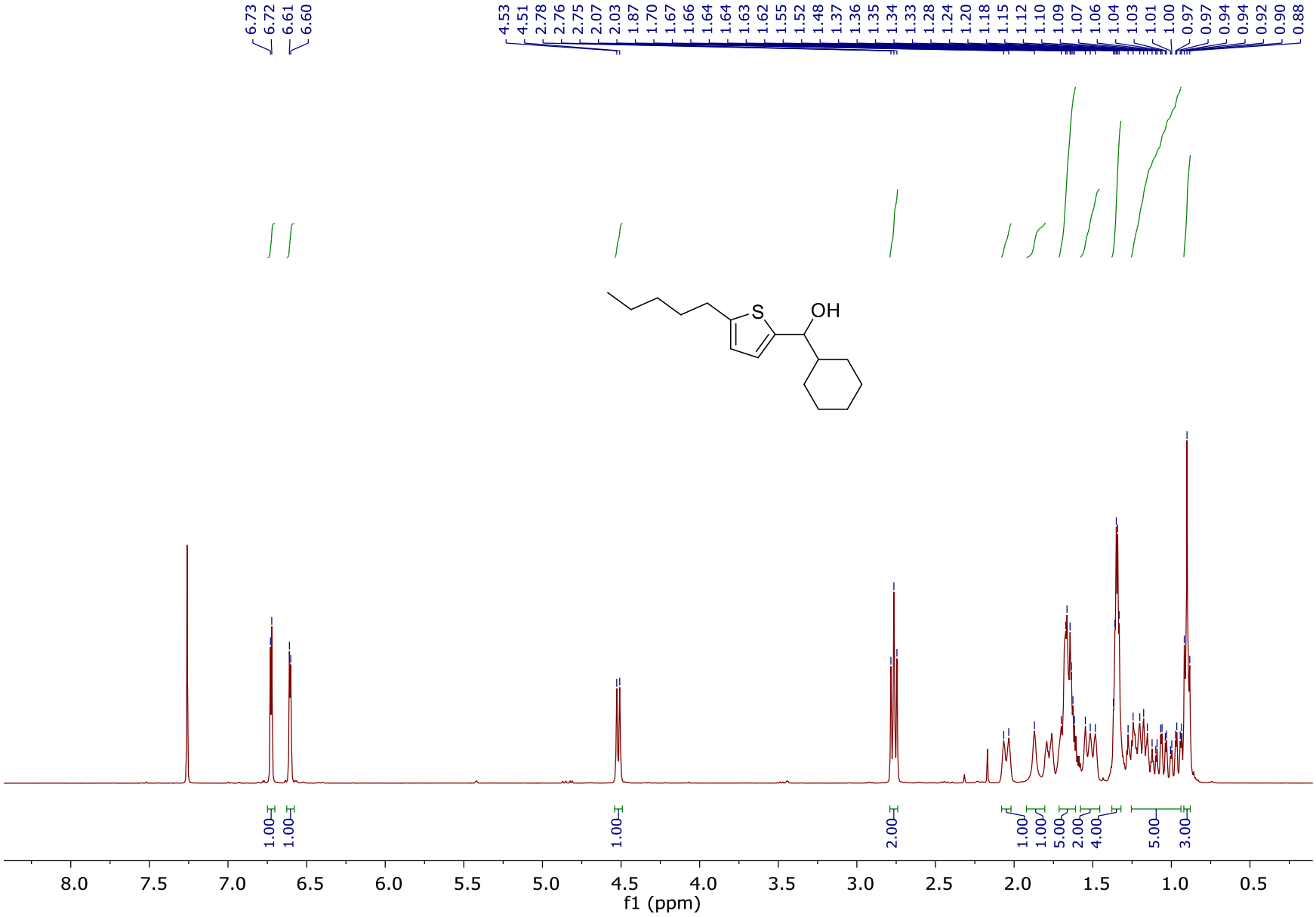

6.74
6.73
6.62
6.61
4.56
2.78
2.76
2.74
1.70
1.68
1.66
1.64
1.63
1.37
1.36
1.35
1.35
1.34
1.33
1.32
0.98
0.92
0.90
0.88
S
OH
1.00
1.00
1.00
2.00
2.00
4.00
9.01
3.01
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

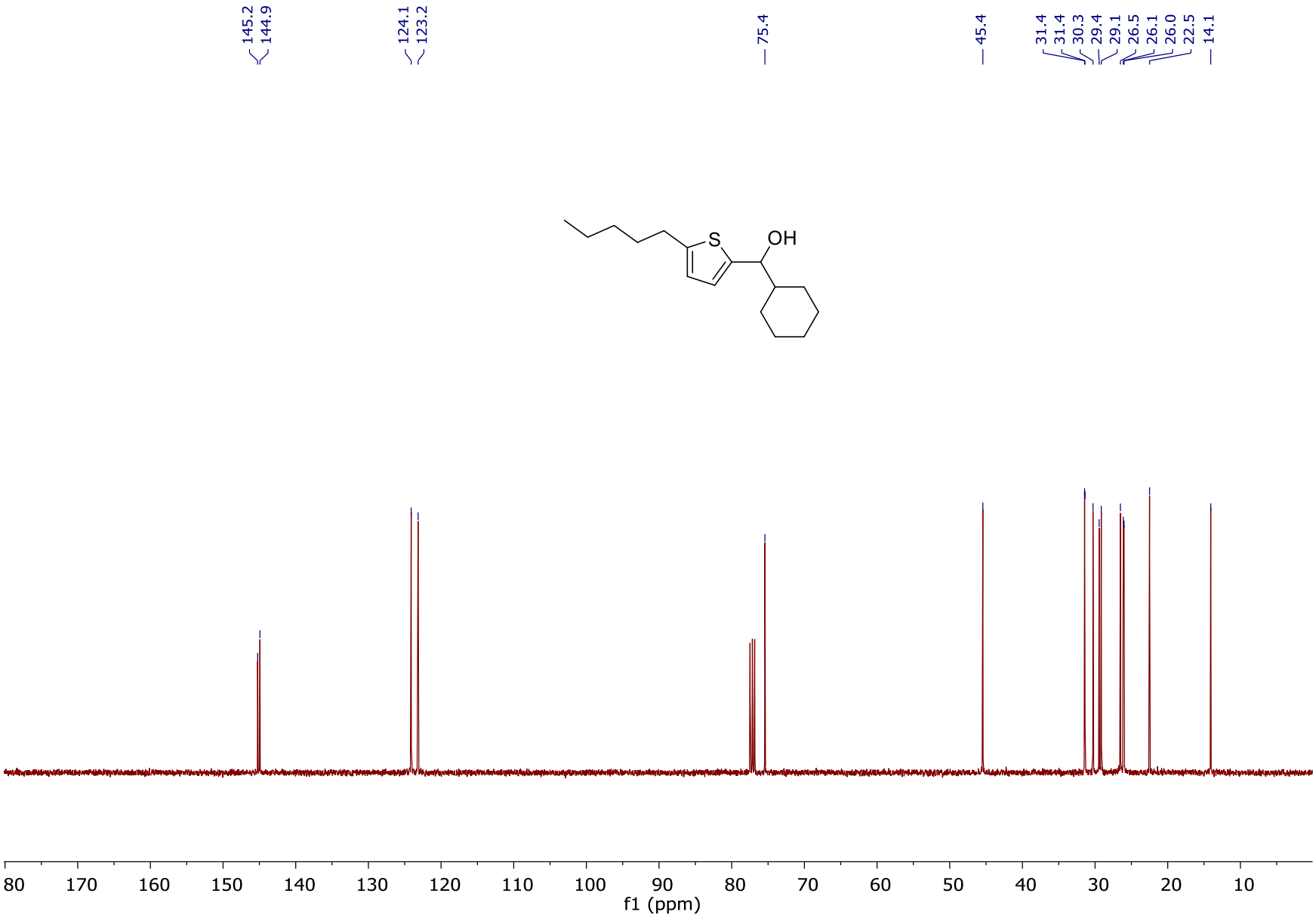

145.0
143.1
125.0
123.0
79.3
35.7
31.4
31.4
30.2
26.1
22.5
14.1
S
OH
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

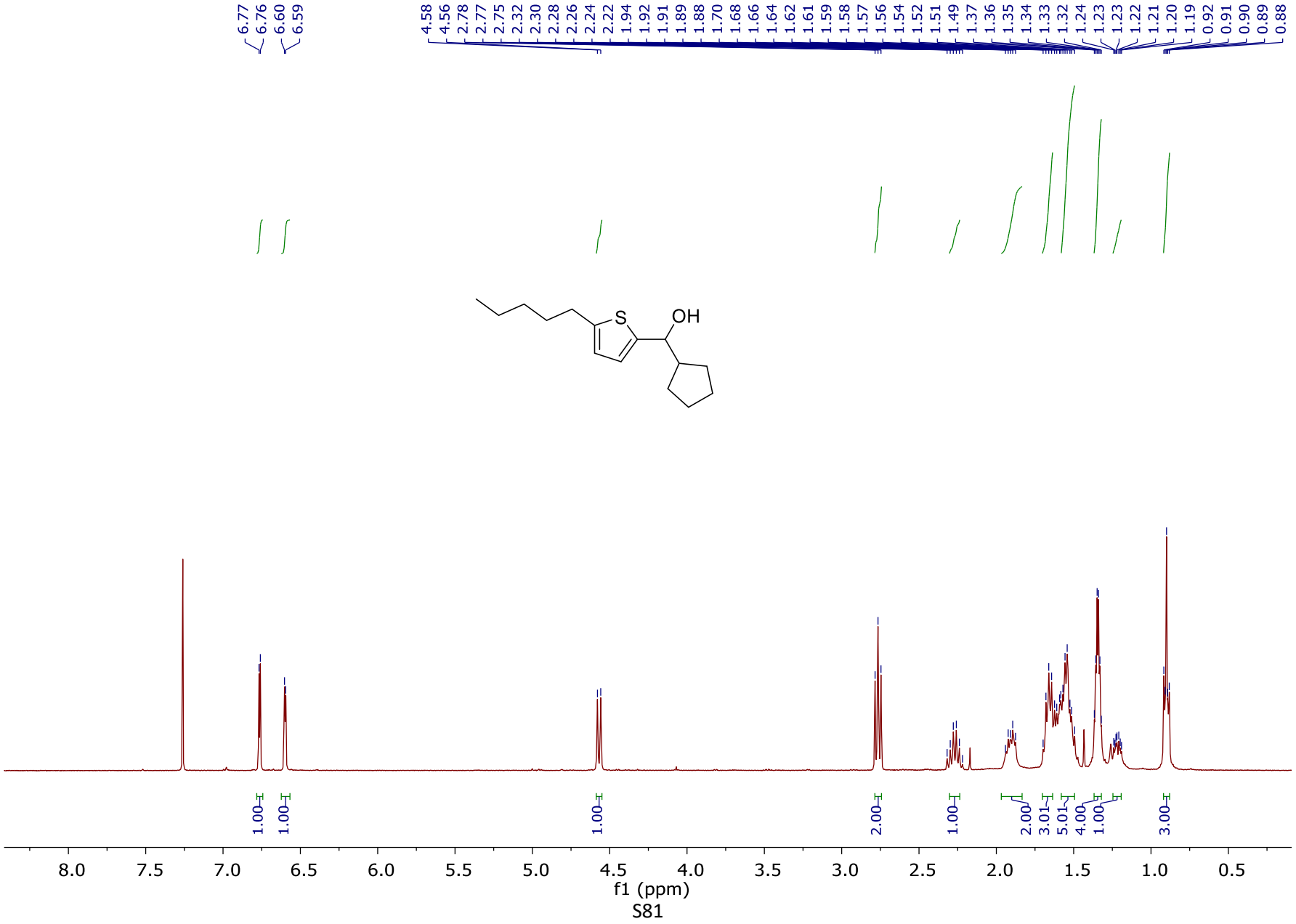

6.75
6.74
6.61
6.61
4.79
4.77
2.79
2.77
2.75
1.82
1.70
1.68
1.66
1.65
1.63
1.62
1.61
1.60
1.59
1.58
1.57
1.56
1.55
1.55
1.51
1.49
1.47
1.45
1.37
1.36
1.35
1.34
1.33
1.32
1.28
1.26
1.24
1.23
1.21
1.19
1.17
0.94
0.92
0.91
0.90
0.89
0.87
0.85
S
OH
1.00
1.00
1.00
2.00
1.00
2.00
2.00
1.00
5.00
1.00
9.00
8.5
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
f1 (ppm)

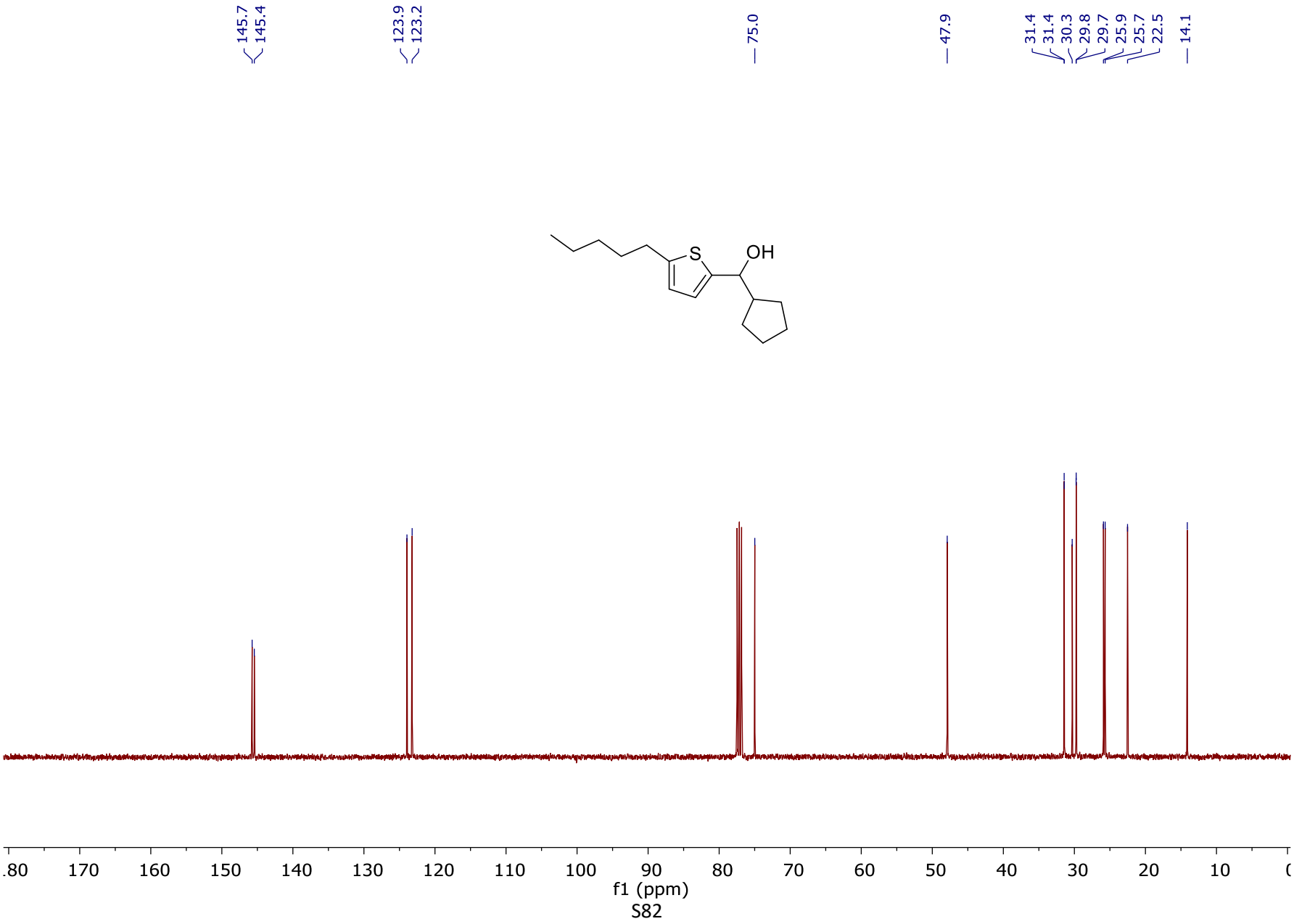
S77

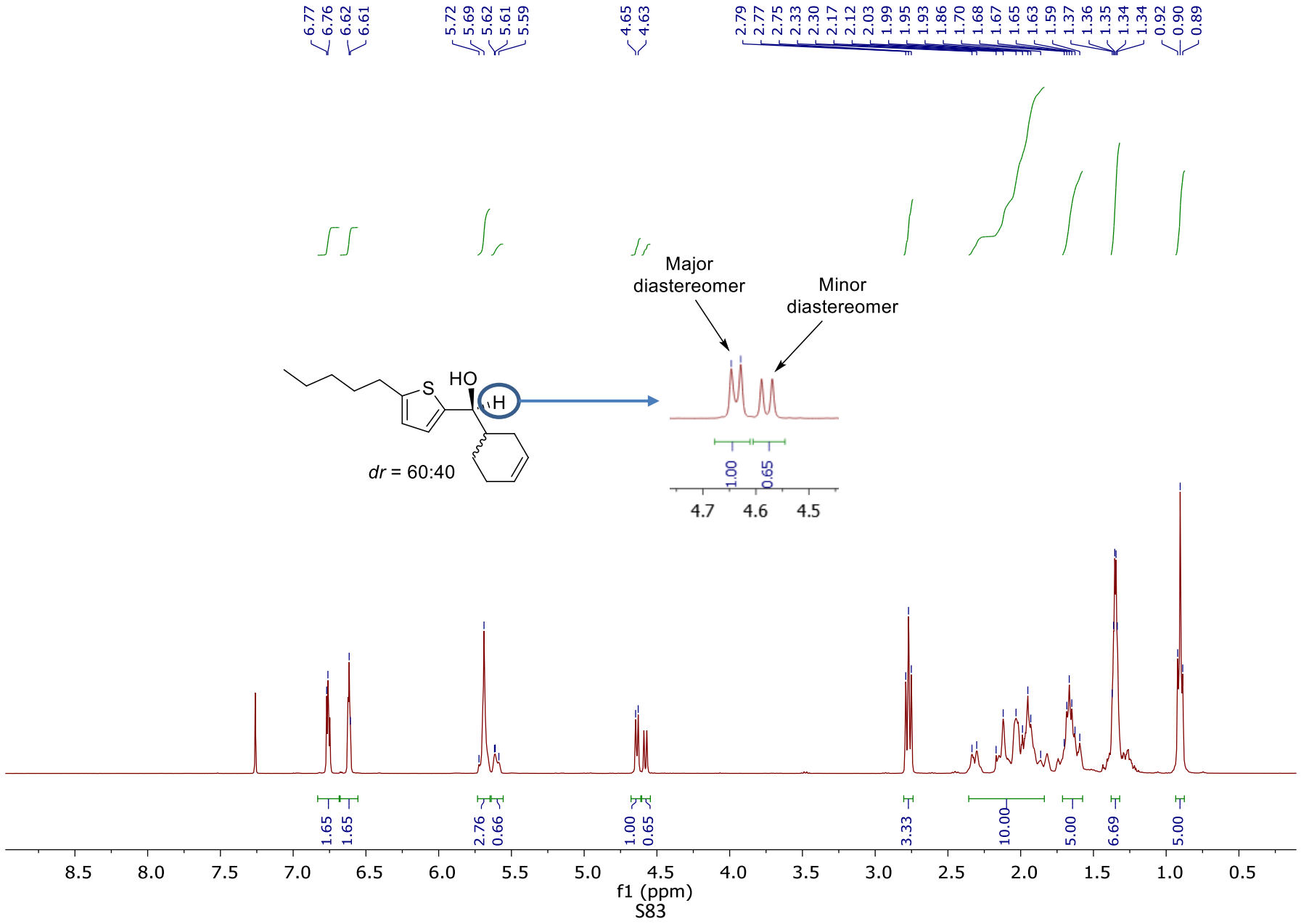

145.4
145.3
124.0
123.3
72.6
48.3
31.5
31.5
30.3
22.5
22.0
21.2
14.1
11.4
11.0
S
OH
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

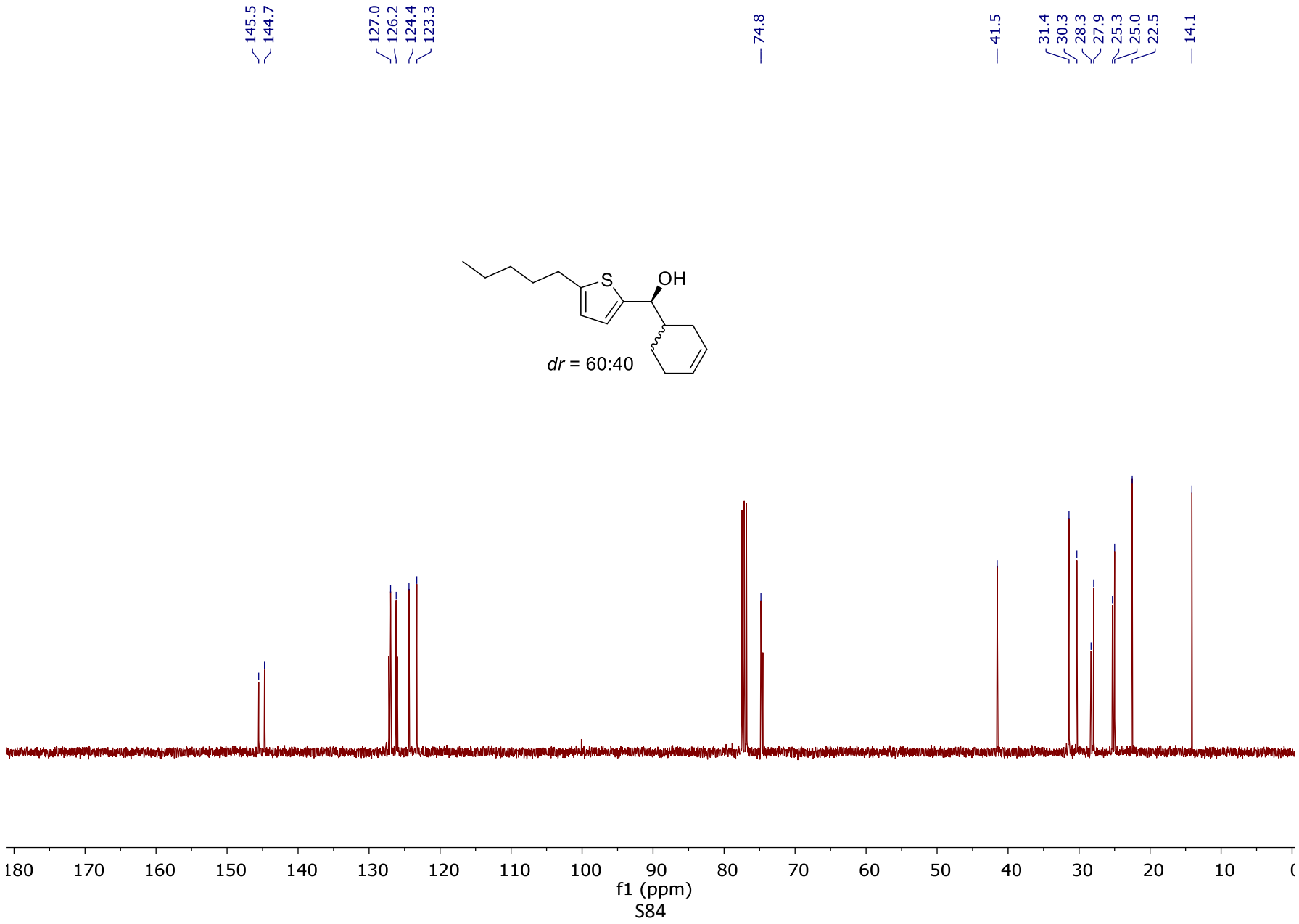

6.73
6.72
6.61
6.60
4.53
4.51
2.78
2.76
2.75
2.07
2.03
1.87
1.70
1.67
1.66
1.64
1.64
1.63
1.62
1.55
1.52
1.48
1.37
1.36
1.35
1.34
1.33
1.28
1.24
1.20
1.18
1.15
1.12
1.10
1.09
1.07
1.06
1.04
1.03
1.01
1.00
0.97
0.97
0.94
0.94
0.92
0.90
0.88
S
OH
1.00
1.00
1.00
2.00
1.00
1.00
5.00
2.00
4.00
5.00
3.00
8.0
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
f1 (ppm)

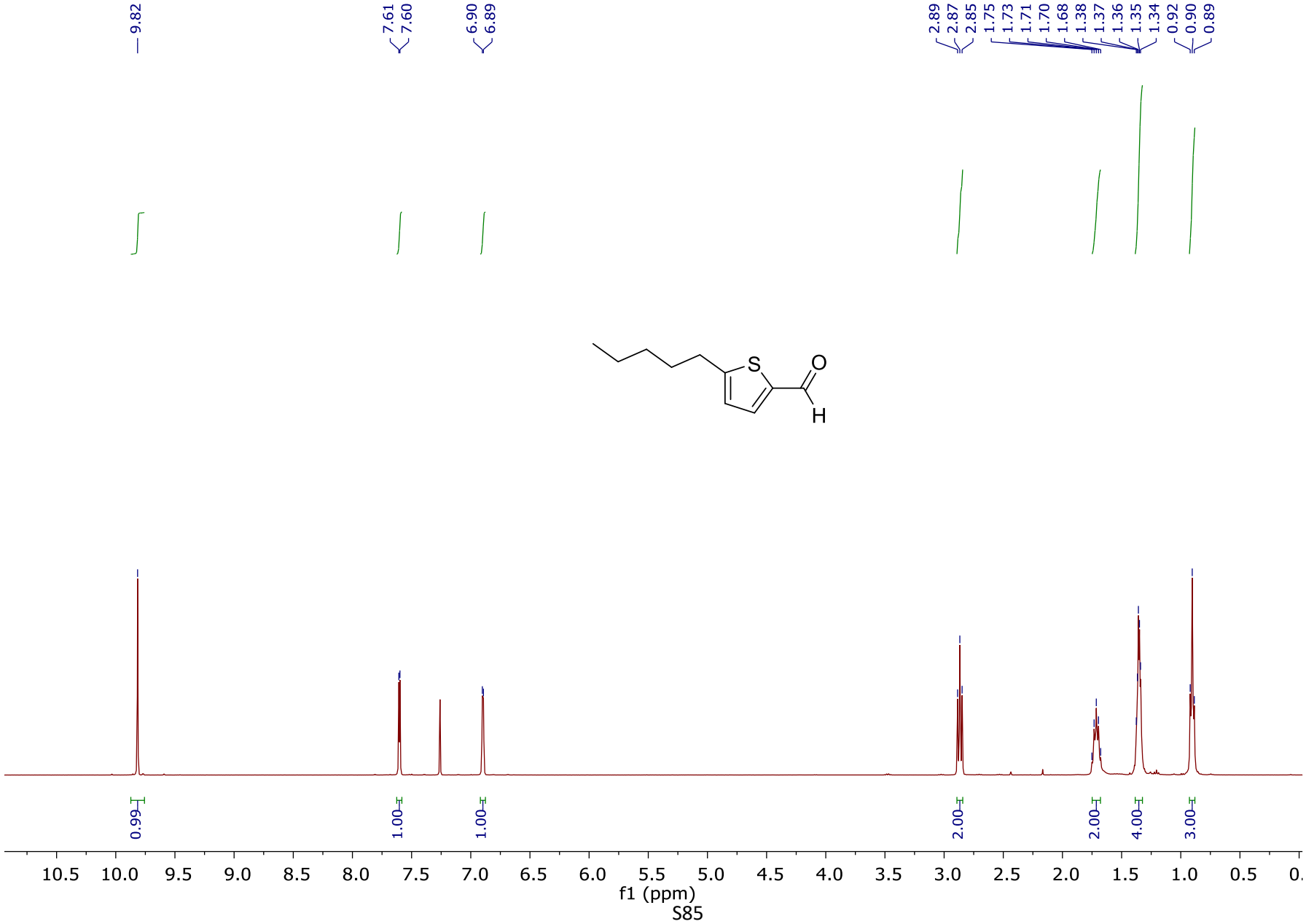

145.2
144.9
124.1
123.2
75.4
45.4
31.4
31.4
30.3
29.4
29.1
26.5
26.1
26.0
22.5
14.1
S
OH
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

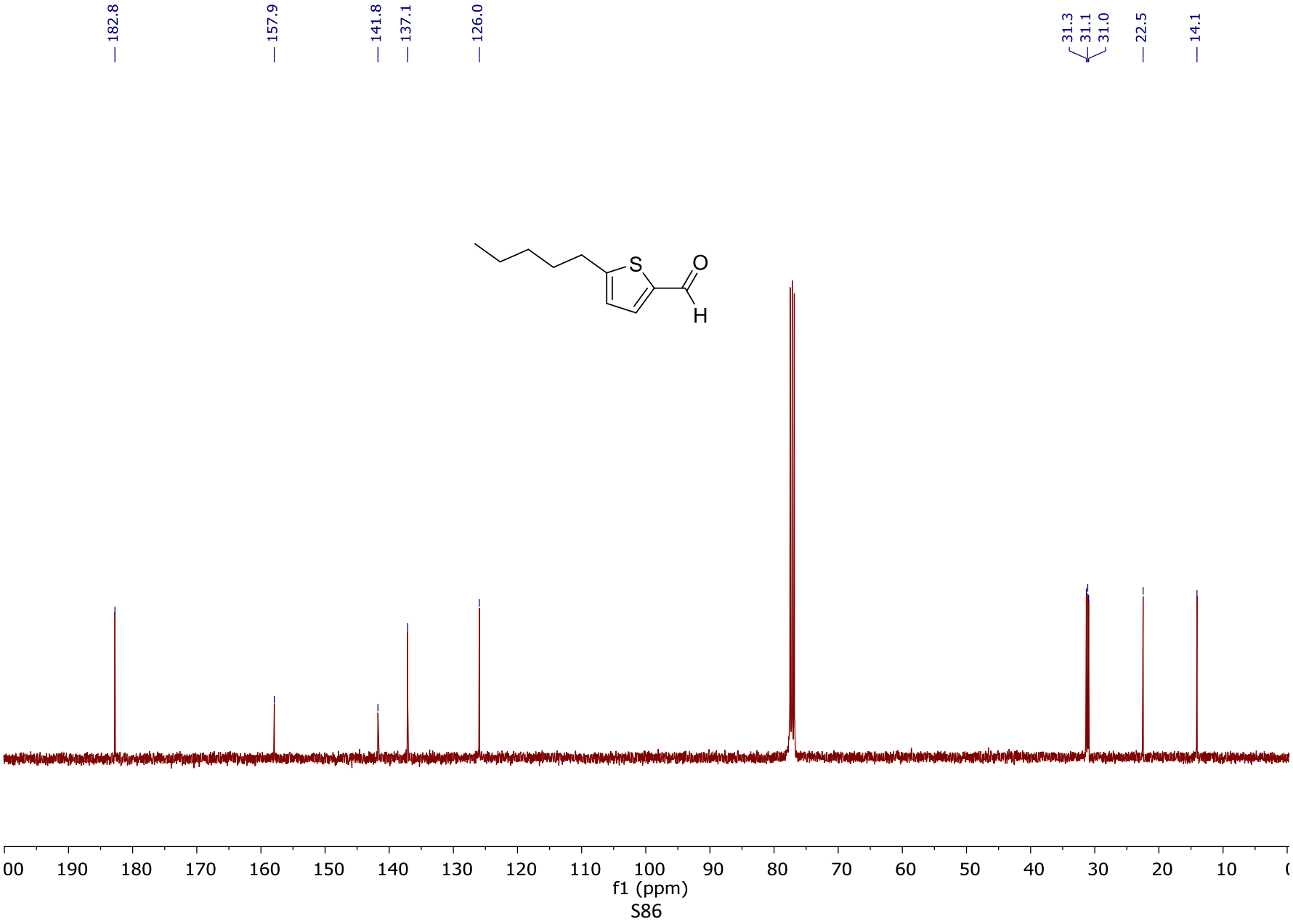

6.77
6.76
6.60
6.59
4.58
4.56
2.78
2.77
2.75
2.32
2.30
2.28
2.26
2.24
2.22
1.94
1.92
1.91
1.89
1.88
1.70
1.68
1.66
1.64
1.62
1.61
1.59
1.58
1.57
1.56
1.54
1.52
1.51
1.49
1.37
1.36
1.35
1.34
1.33
1.32
1.24
1.23
1.23
1.22
1.21
1.20
1.19
0.92
0.91
0.90
0.89
0.88
S
OH
1.00
1.00
1.00
2.00
1.00
2.00
3.01
5.01
4.00
1.00
3.00
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
f1 (ppm)

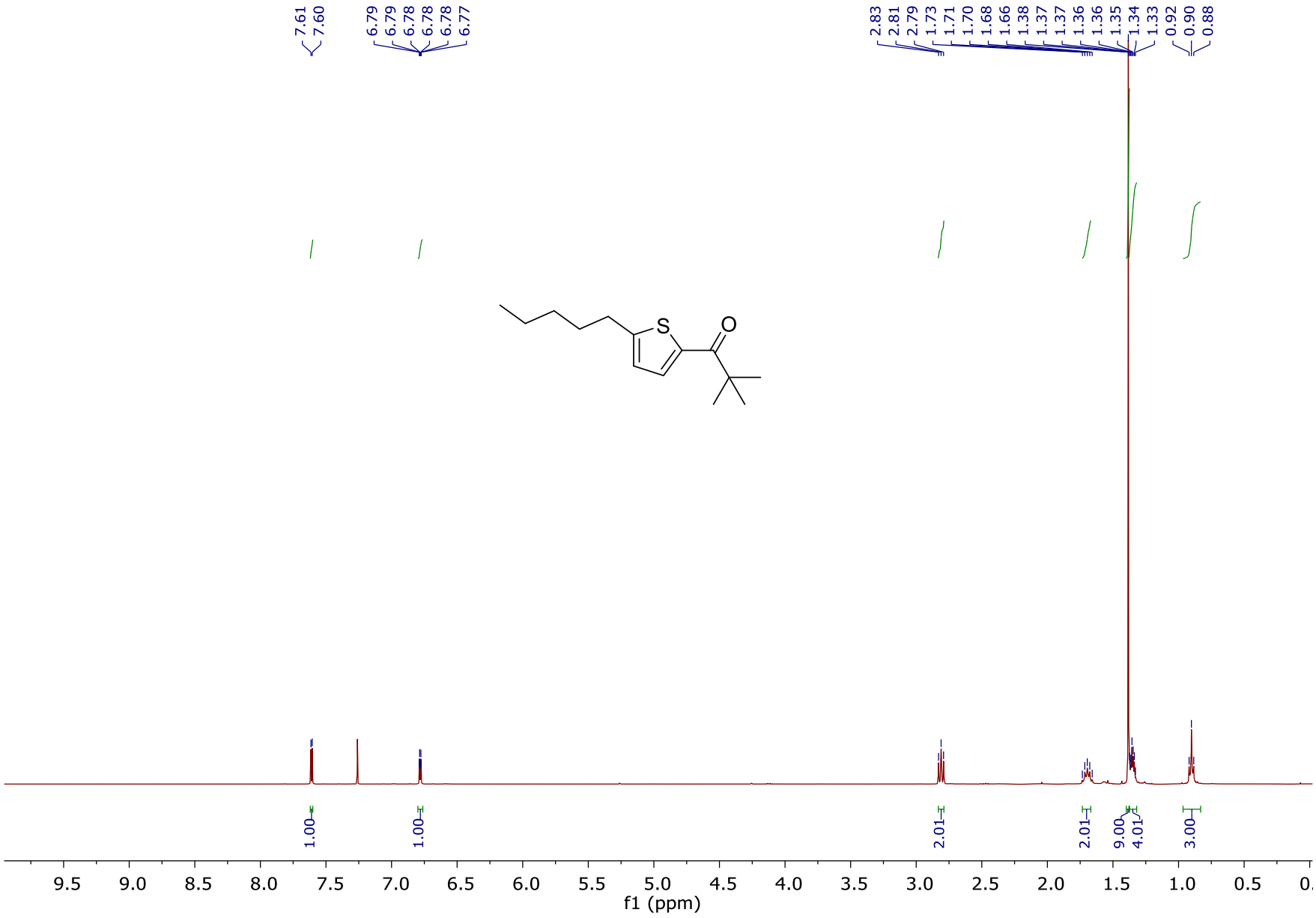

145.7
145.4
123.9
123.2
75.0
47.9
31.4
31.4
30.3
29.8
29.7
25.9
25.7
22.5
14.1
S
OH
.80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

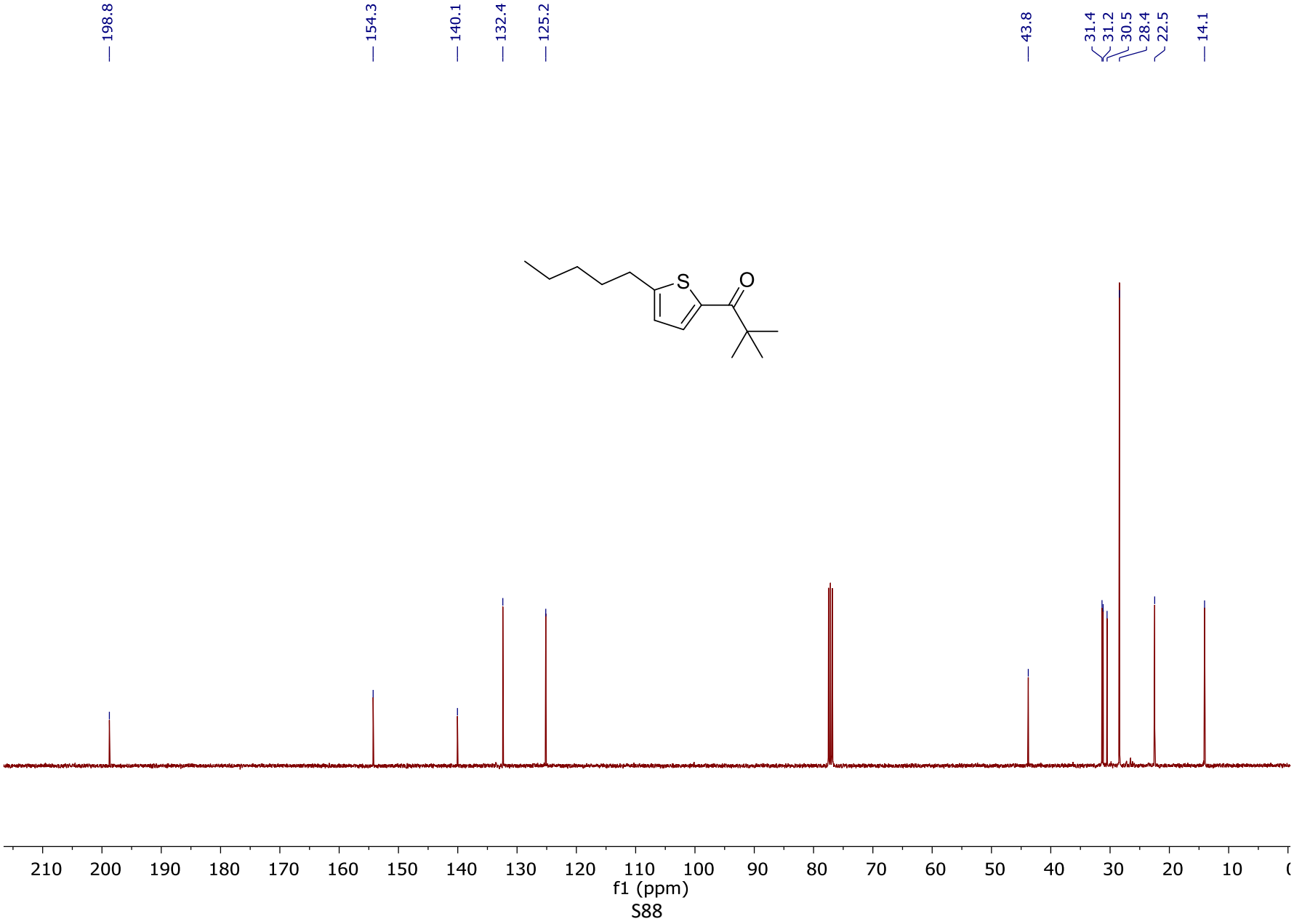

6.77
6.76
6.62
6.61
5.72
5.69
5.62
5.61
5.59
4.65
4.63
2.79
2.77
2.75
2.33
2.30
2.17
2.12
2.03
1.99
1.95
1.93
1.86
1.70
1.68
1.67
1.65
1.63
1.59
1.37
1.36
1.35
1.34
1.34
0.92
0.90
0.89
Major diastereomer
Minor diastereomer
HO
S
H
dr = 60:40
1.00
0.65
4.7
4.6
4.5
1.65
1.65
2.76
0.66
1.00
0.65
3.33
10.00
5.00
6.69
5.00
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
f1 (ppm)

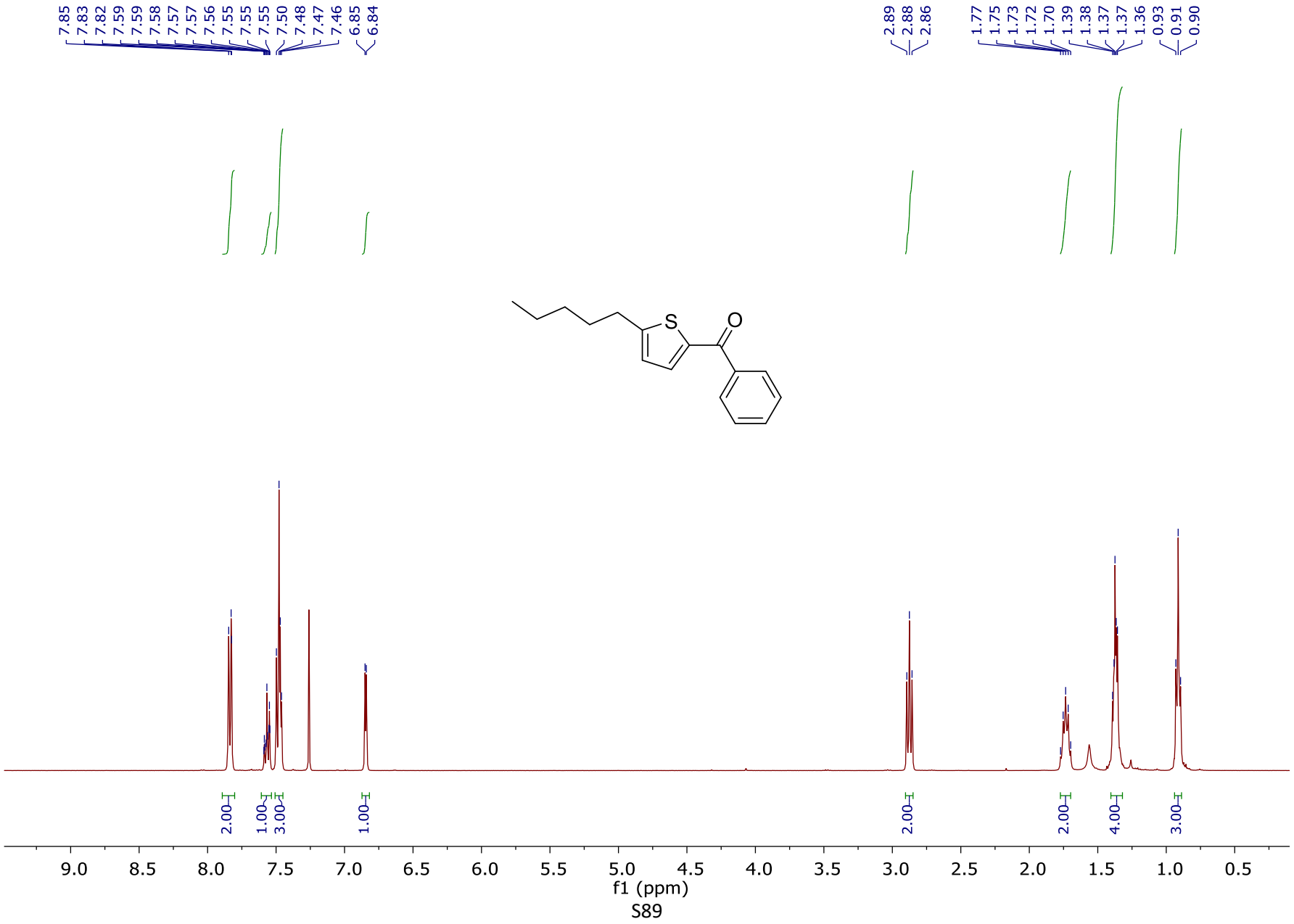

145.5
144.7
127.0
126.2
124.4
123.3
74.8
41.5
31.4
30.3
28.3
27.9
25.3
25.0
22.5
14.1
S
OH
dr = 60:40
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

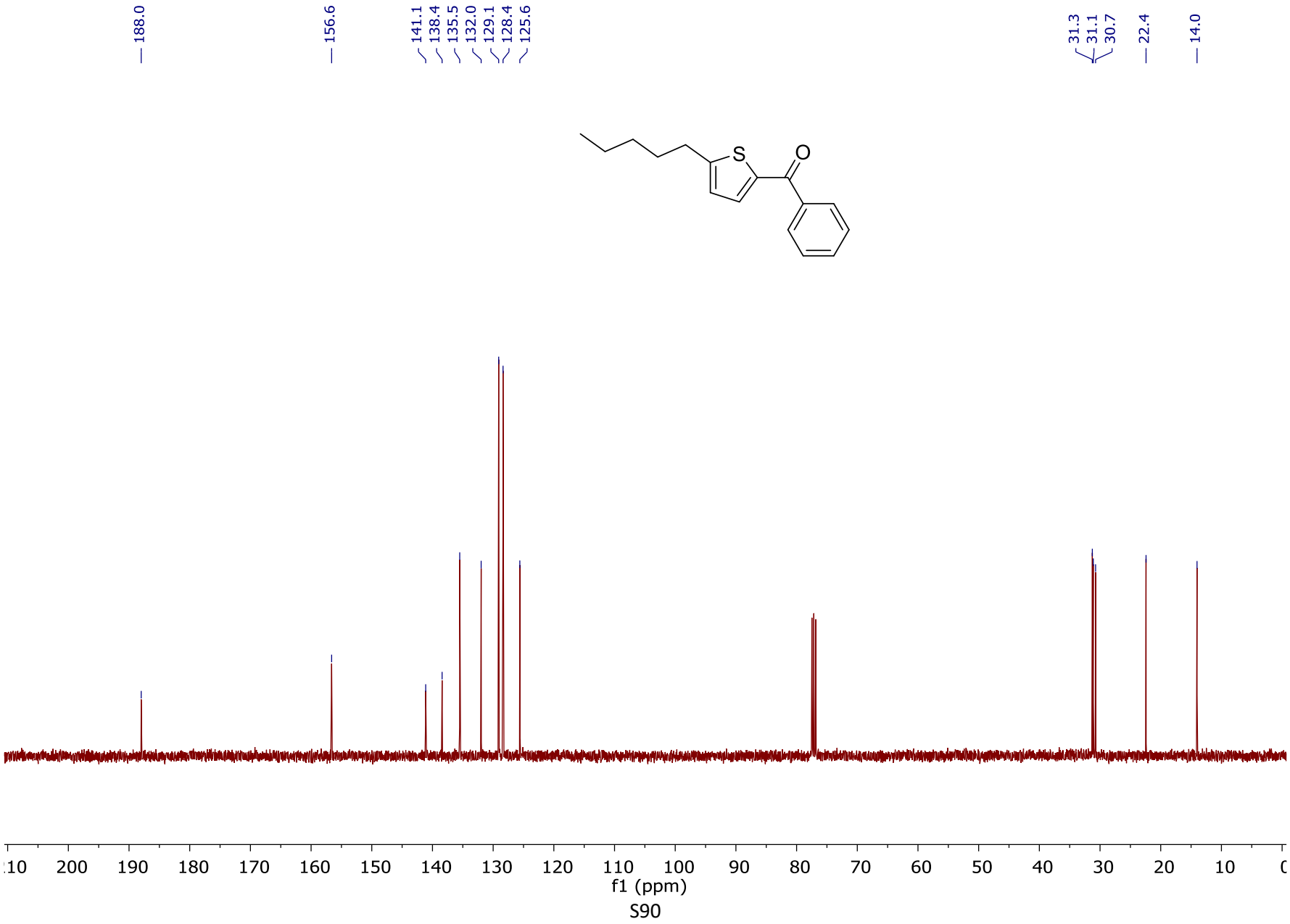

9.82
7.61
7.60
6.90
6.89
2.89
2.87
2.85
1.75
1.73
1.71
1.70
1.68
1.38
1.37
1.36
1.35
1.34
0.92
0.90
0.89
S
O
H
0.99
1.00
1.00
2.00
2.00
4.00
3.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

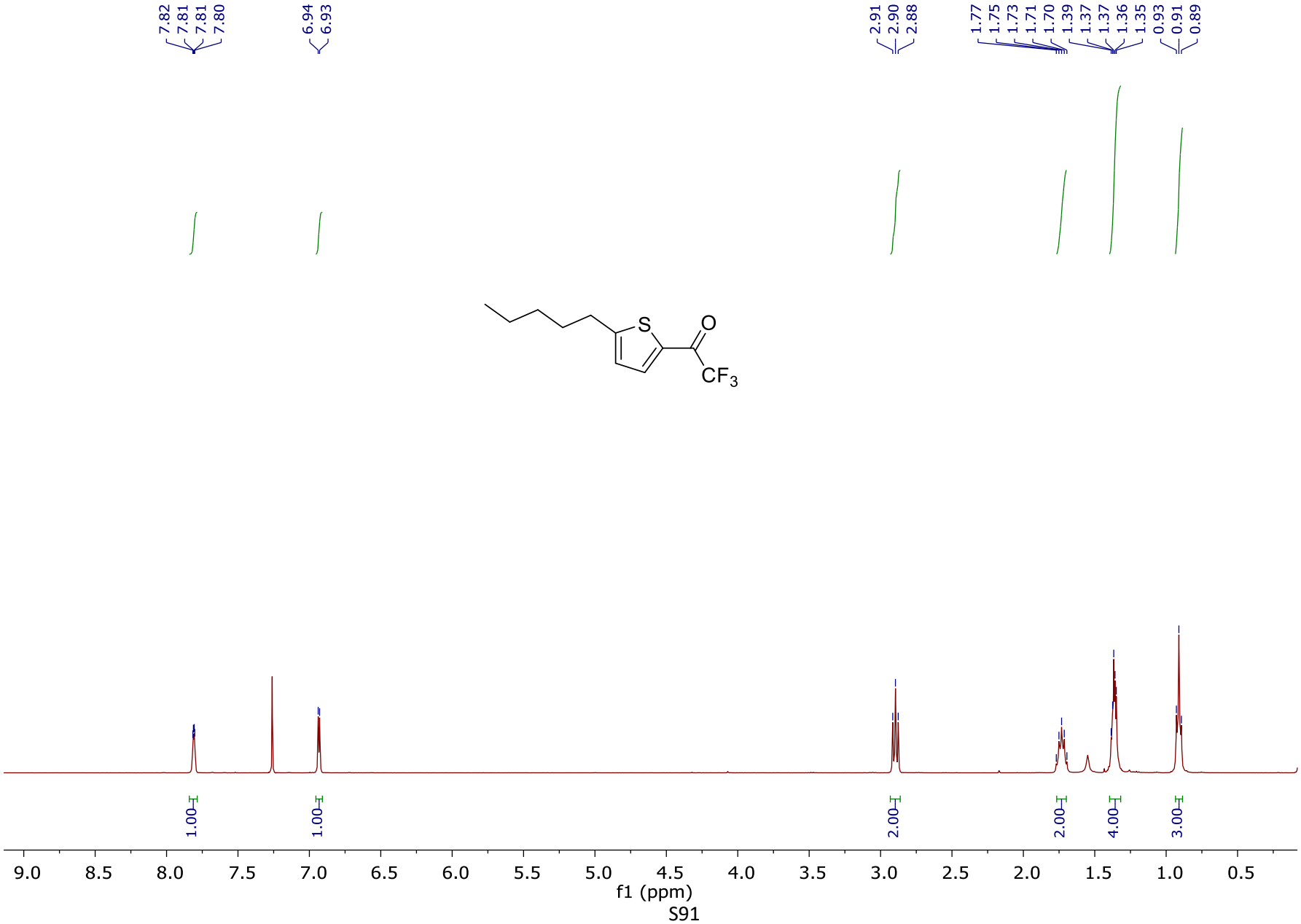

182.8
157.9
141.8
137.1
126.0
31.3
31.1
31.0
22.5
14.1
S
O
H
00
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

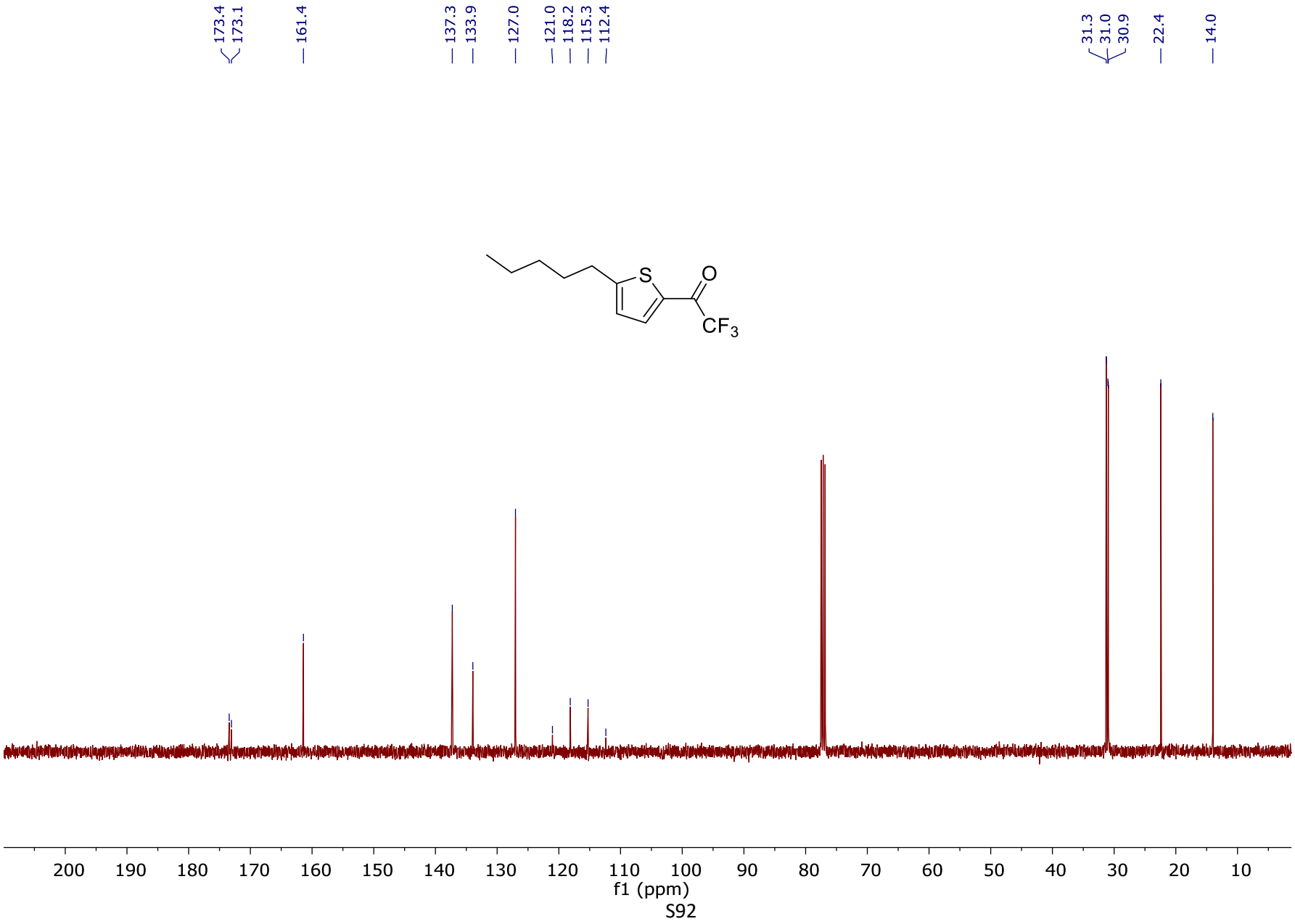

7.61
7.60
6.79
6.79
6.78
6.78
6.78
6.77
2.83
2.81
2.79
1.73
1.71
1.70
1.68
1.66
1.38
1.37
1.37
1.36
1.36
1.35
1.34
1.33
0.92
0.90
0.88
S
O
1.00
1.00
2.01
2.01
9.00
4.01
3.00
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

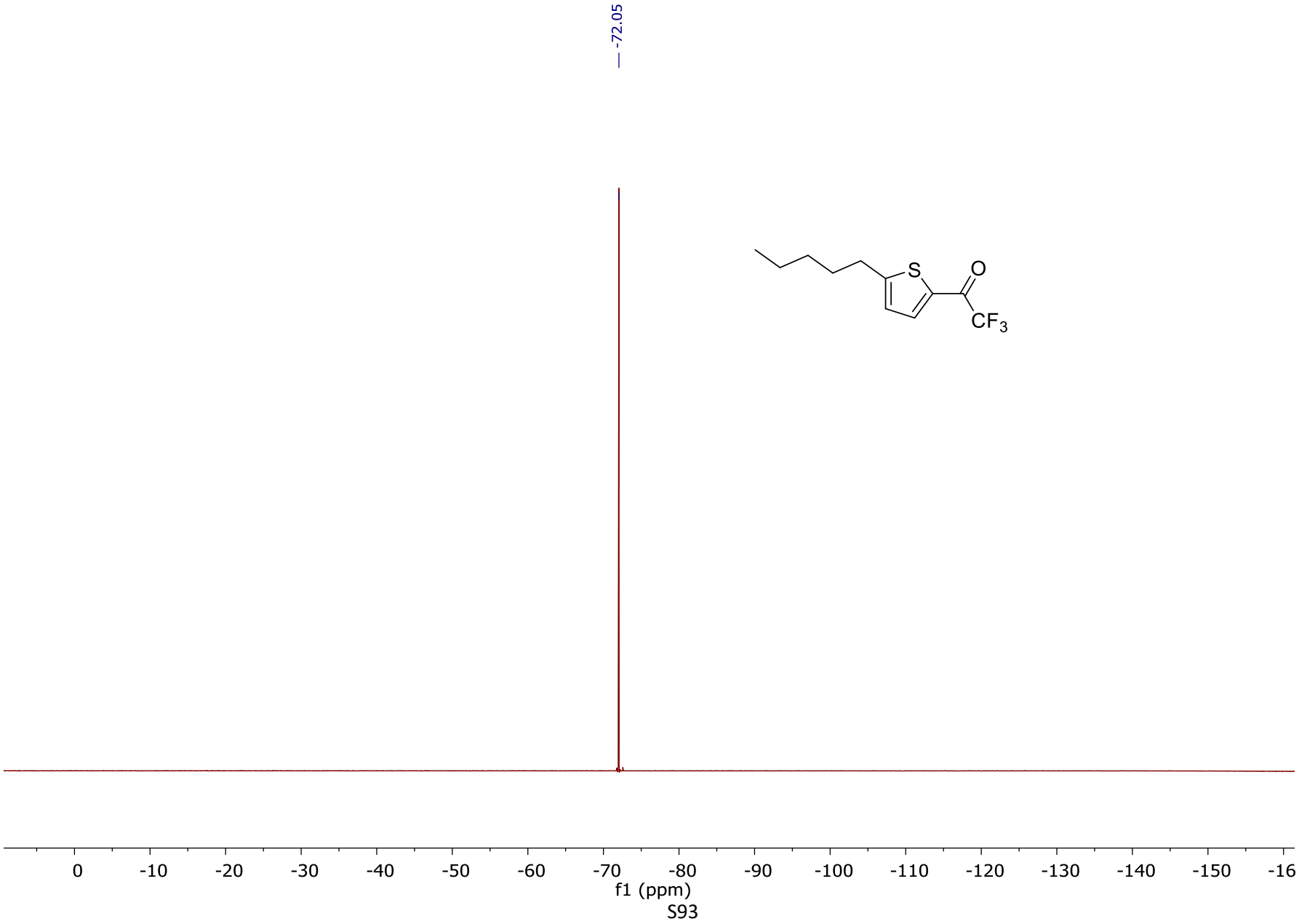

198.8
154.3
140.1
132.4
125.2
43.8
31.4
31.2
30.5
28.4
22.5
14.1
S
O
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

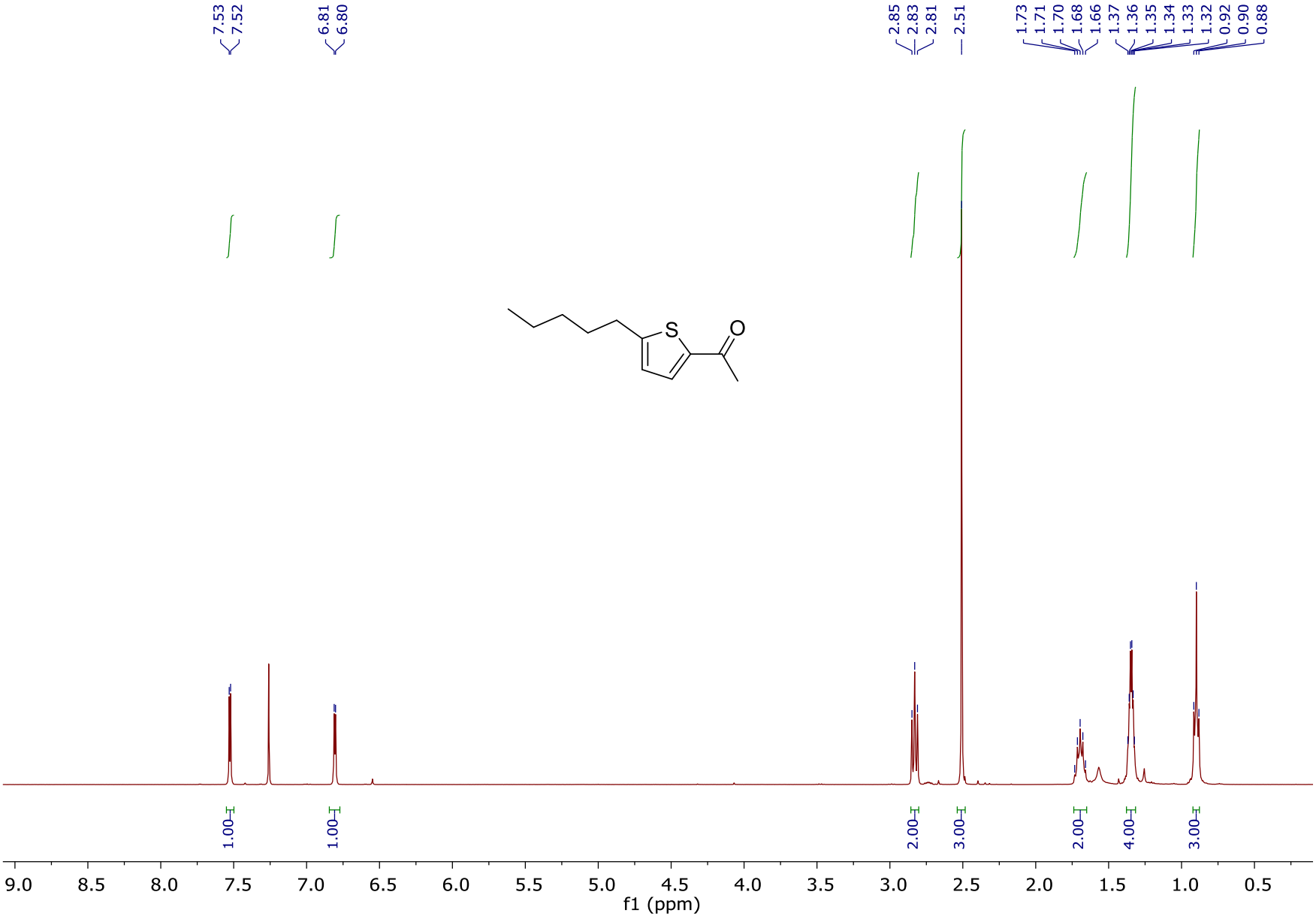

7.85
7.83
7.82
7.59
7.59
7.58
7.57
7.57
7.56
7.55
7.55
7.55
7.50
7.48
7.47
7.46
6.85
6.84
2.89
2.88
2.86
1.77
1.75
1.73
1.72
1.70
1.39
1.38
1.37
1.37
1.36
0.93
0.91
0.90
S
O
2.00
1.00
3.00
1.00
2.00
2.00
4.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

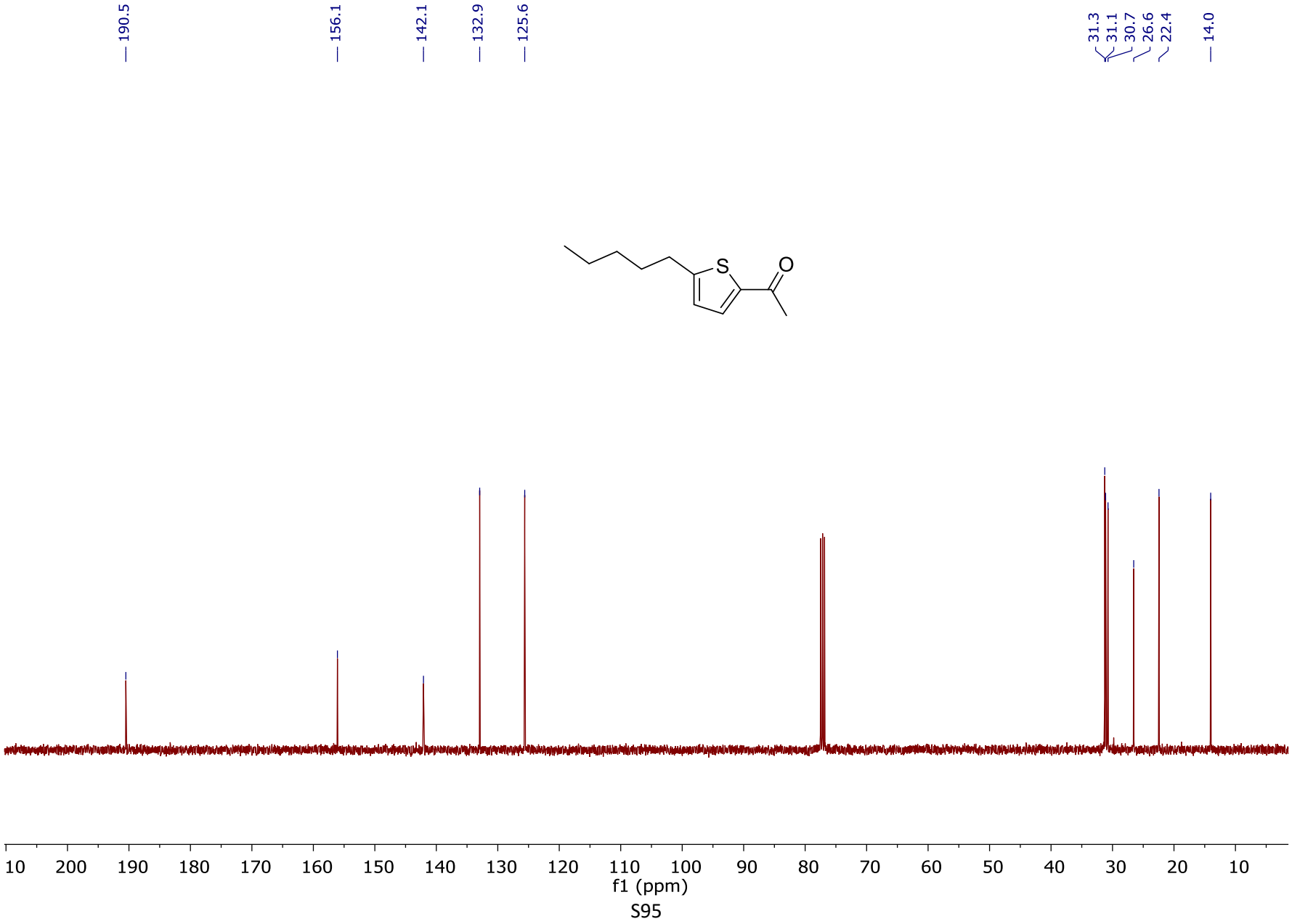

188.0
156.6
141.1
138.4
135.5
132.0
129.1
128.4
125.6
31.3
31.1
30.7
22.4
14.0
S
O
f1 (ppm)

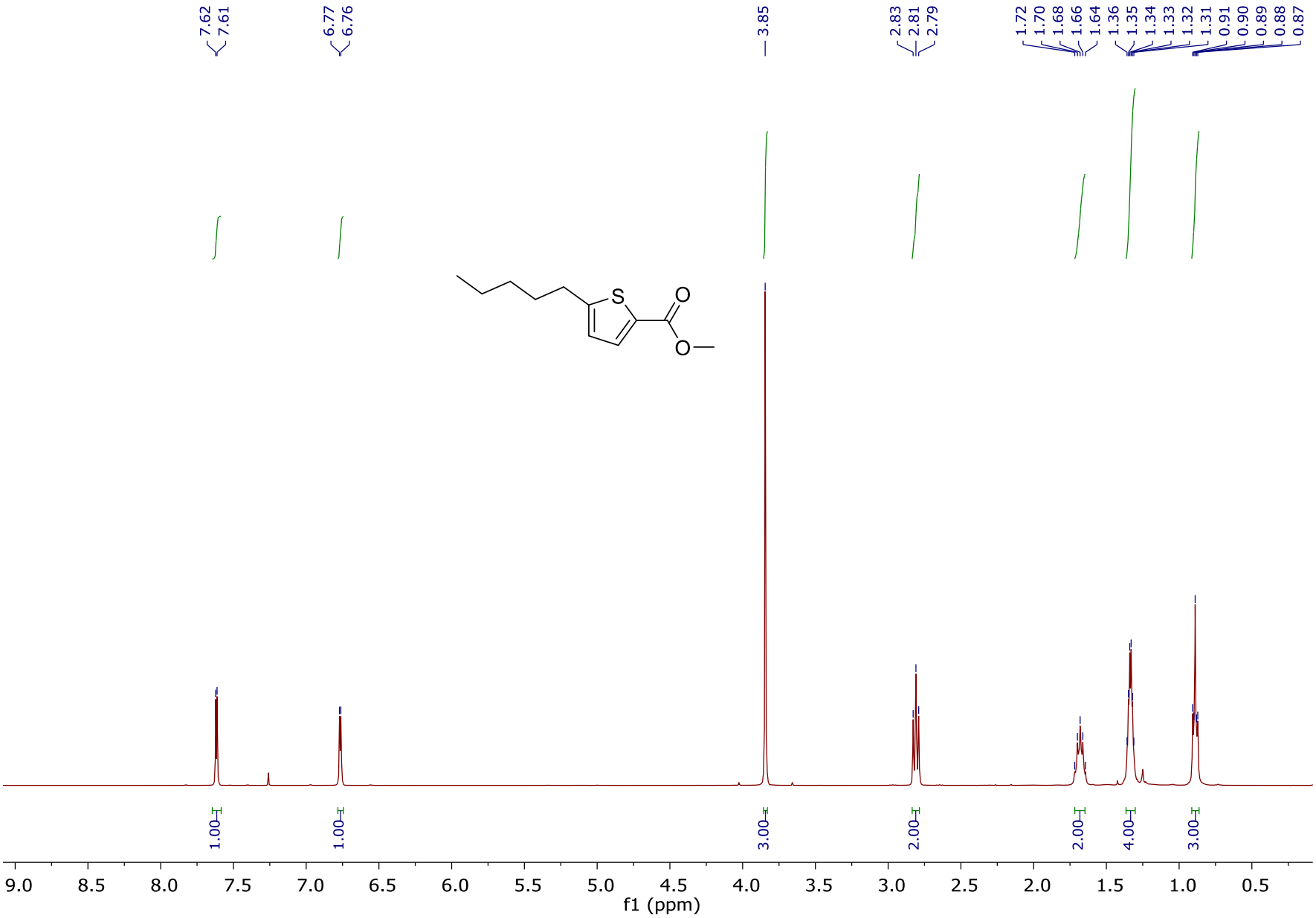

7.82
7.81
7.81
7.80
6.94
6.93
2.91
2.90
2.88
1.77
1.75
1.73
1.71
1.70
1.39
1.37
1.37
1.36
1.35
0.93
0.91
0.89
S
O
CF3
1.00
1.00
2.00
2.00
4.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

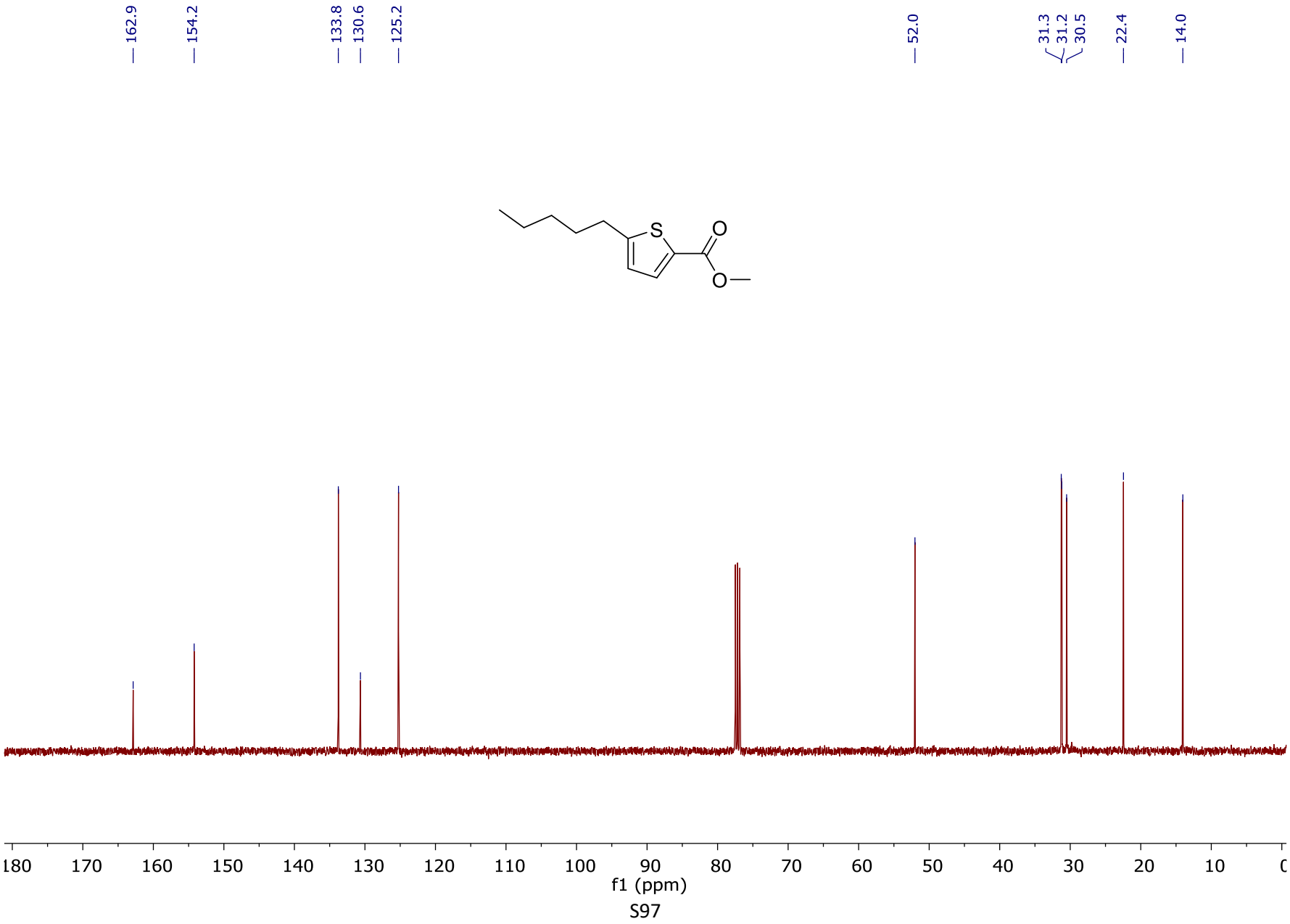

173.4
173.1
161.4
137.3
133.9
127.0
121.0
118.2
115.3
112.4
31.3
31.0
30.9
22.4
14.0
S
O
CF3
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

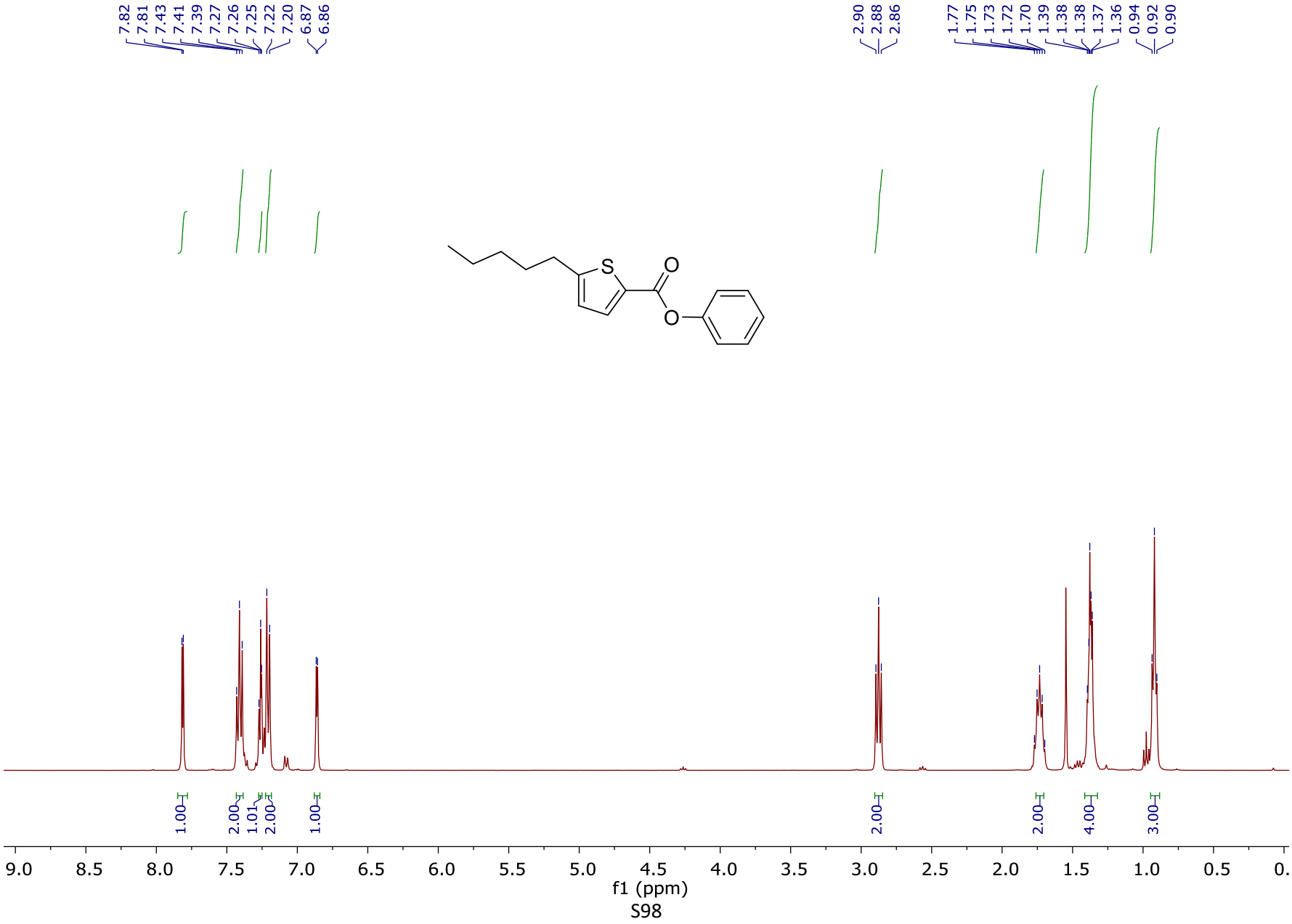

-72.05
S
O
CF3
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
-16
f1 (ppm)

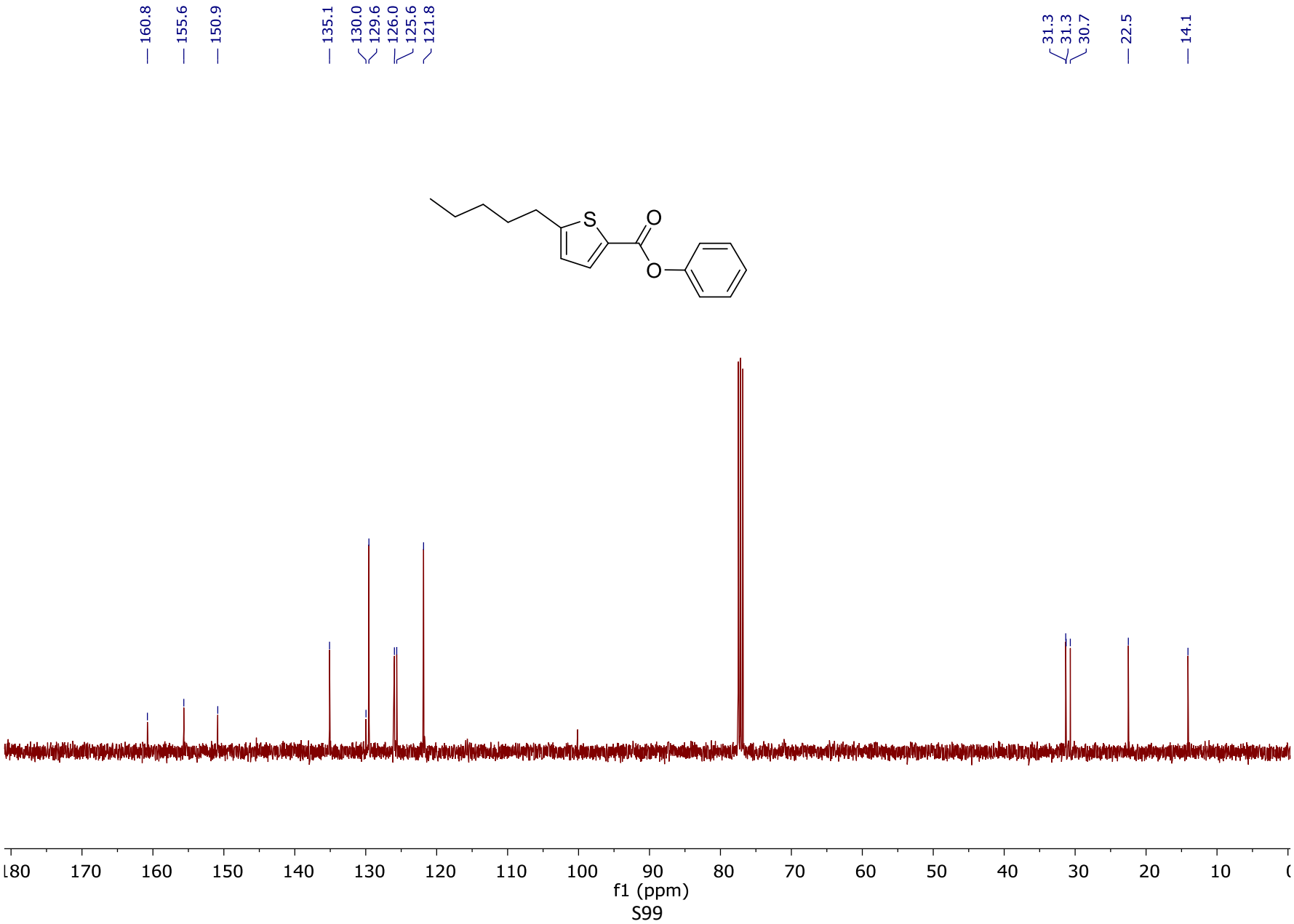

7.53
7.52
6.81
6.80
2.85
2.83
2.81
2.51
1.73
1.71
1.70
1.68
1.66
1.37
1.36
1.35
1.34
1.33
1.32
0.92
0.90
0.88
S
O
1.00
1.00
2.00
3.00
2.00
4.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

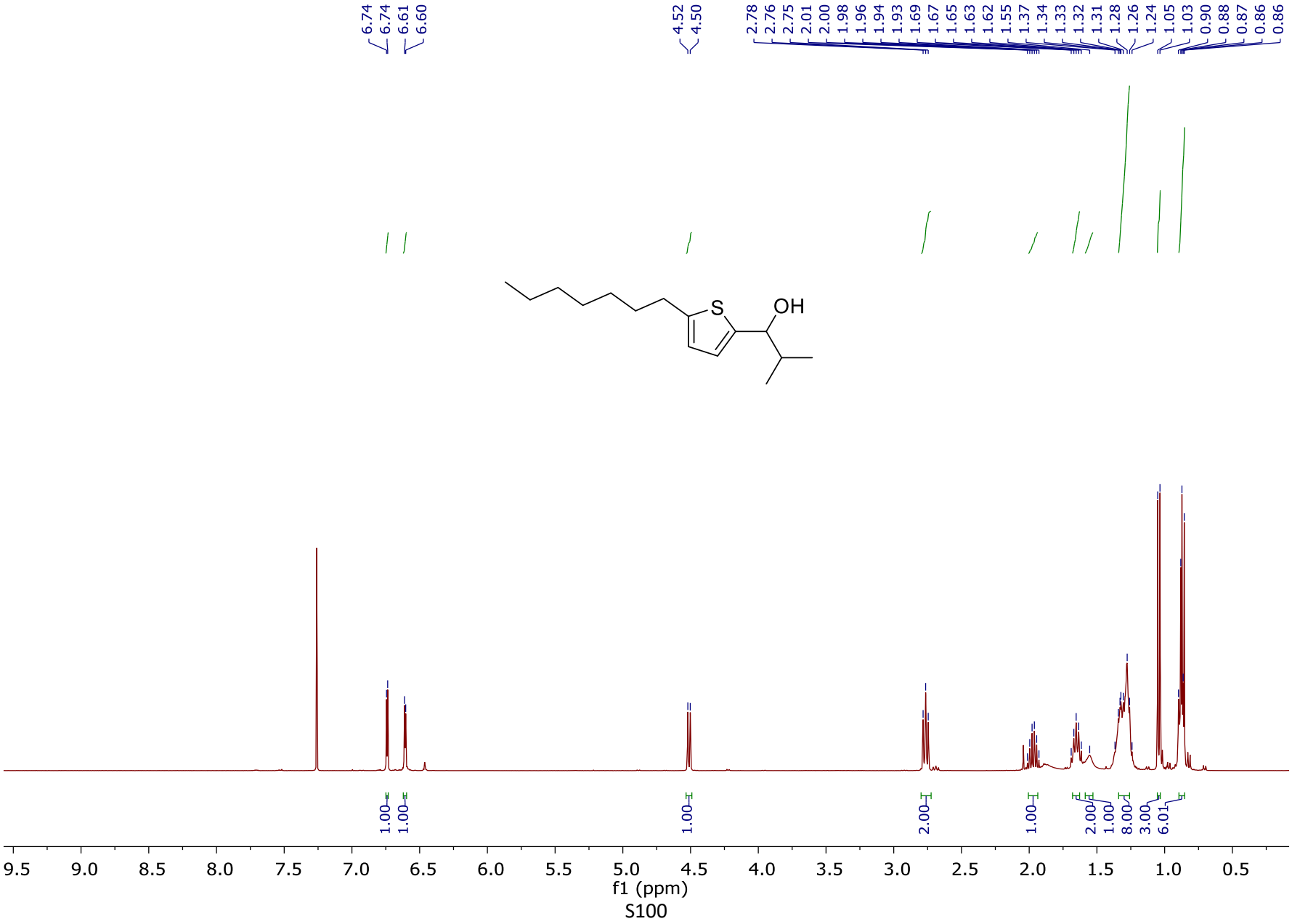

190.5
156.1
142.1
132.9
125.6
31.3
31.1
30.7
26.6
22.4
14.0
S
O
10
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

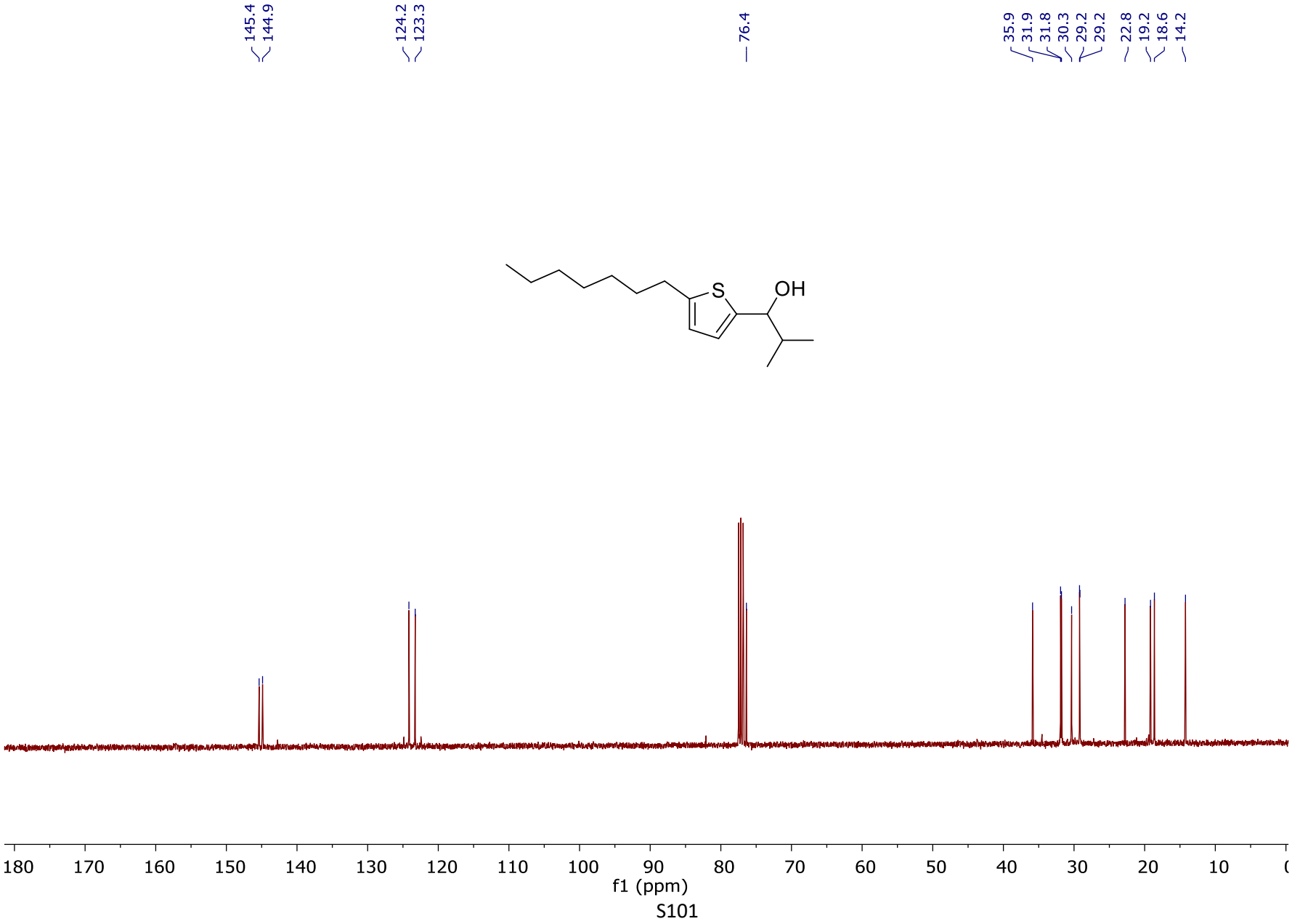

7.62
7.61
6.77
6.76
3.85
2.83
2.81
2.79
1.72
1.70
1.68
1.66
1.64
1.36
1.35
1.34
1.33
1.32
1.31
0.91
0.90
0.89
0.88
0.87
S
O
O
1.00
1.00
3.00
2.00
2.00
4.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

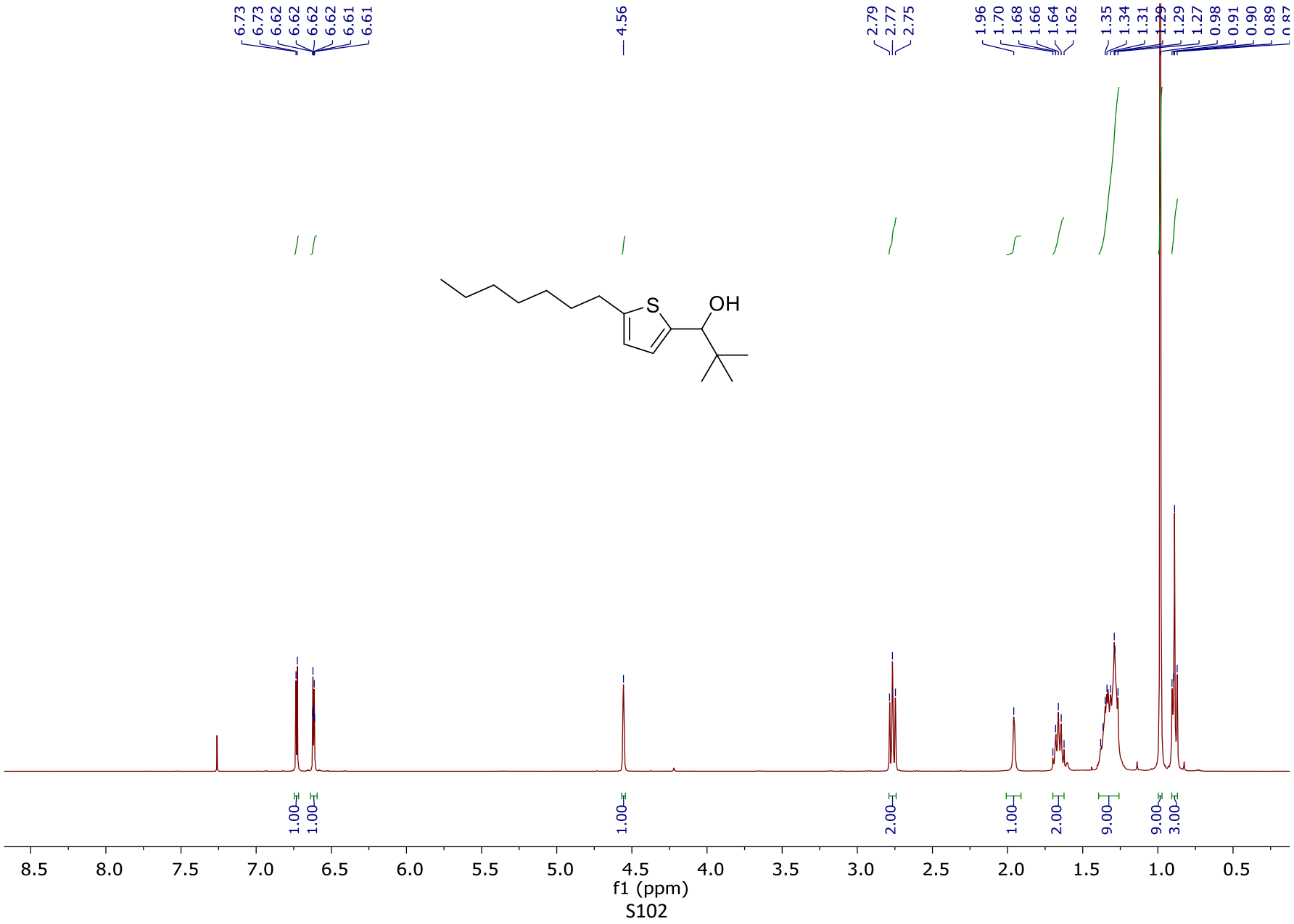

162.9
154.2
133.8
130.6
125.2
52.0
31.3
31.2
30.5
22.4
14.0
S
O
O
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


7.82
7.81
7.43
7.41
7.39
7.27
7.26
7.25
7.22
7.20
6.87
6.86
2.90
2.88
2.86
1.77
1.75
1.73
1.72
1.70
1.39
1.38
1.38
1.37
1.36
0.94
0.92
0.90
S
O
O
1.00
2.00
1.01
2.00
1.00
2.00
2.00
4.00
3.00
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.
f1 (ppm)

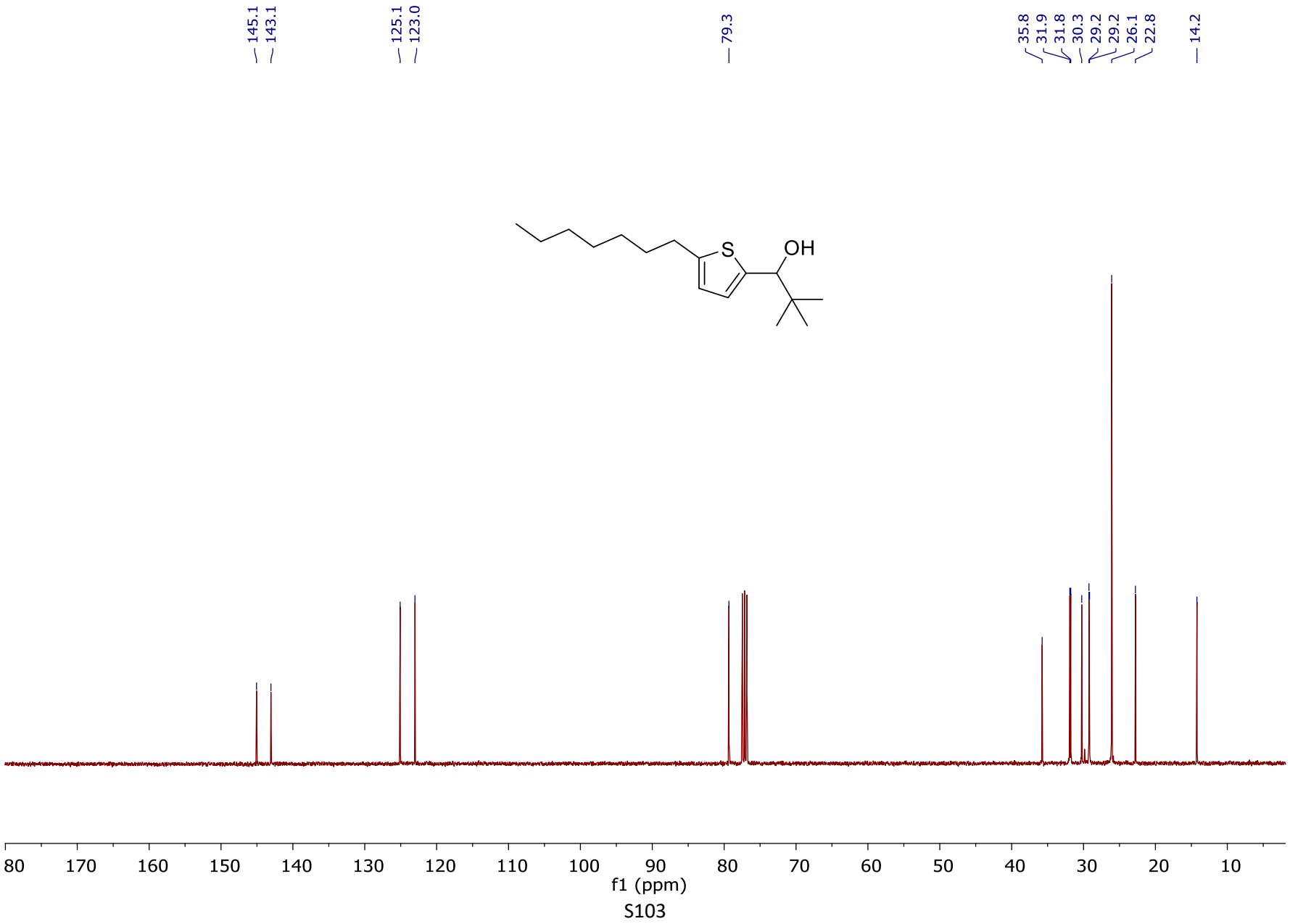

160.8
155.6
150.9
135.1
130.0
129.6
126.0
125.6
121.8
31.3
31.3
30.7
22.5
14.1
S
O
O
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)
S99

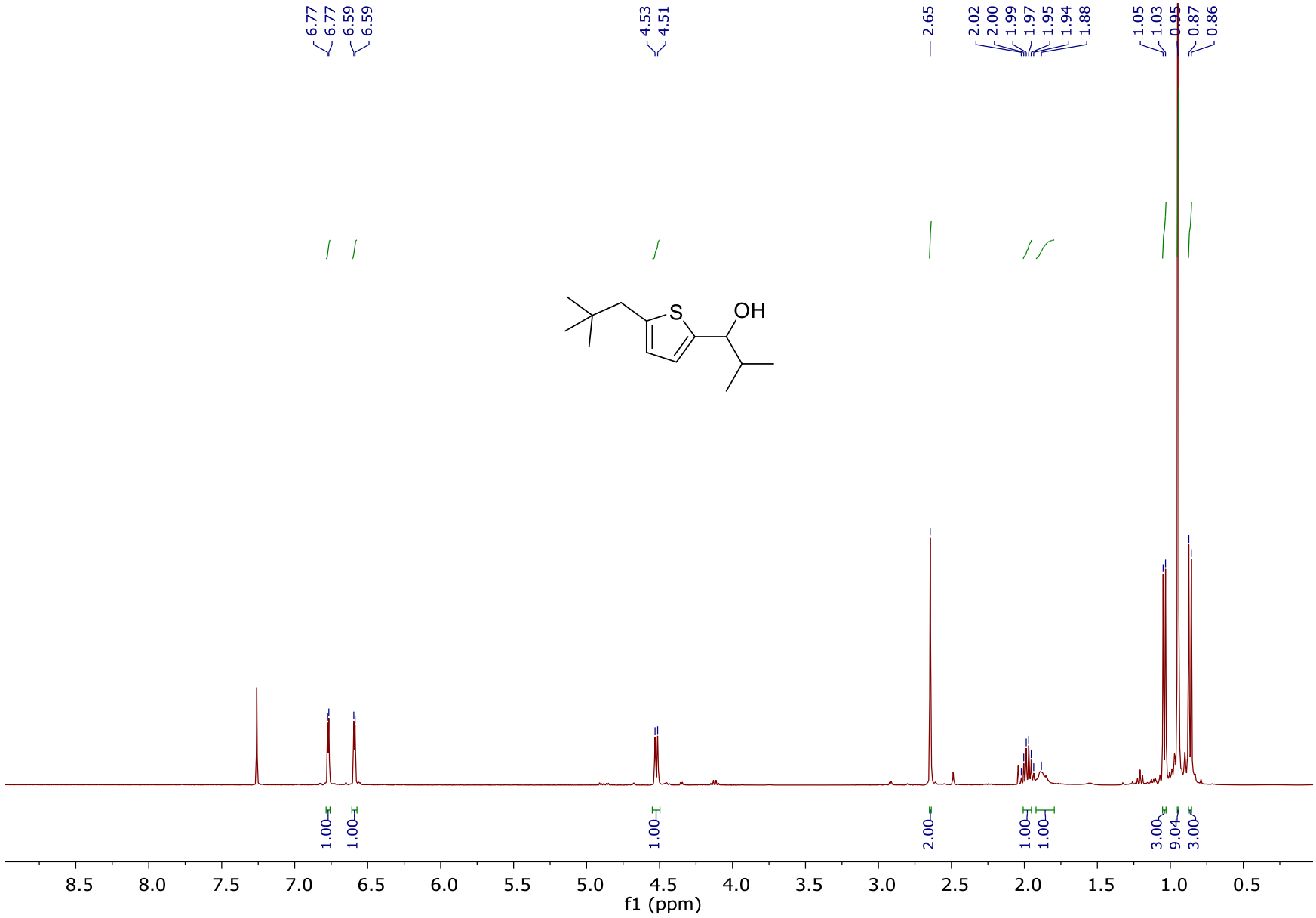

6.74
6.74
6.61
6.60
4.52
4.50
2.78
2.76
2.75
2.01
2.00
1.98
1.96
1.94
1.93
1.69
1.67
1.65
1.63
1.62
1.55
1.37
1.34
1.33
1.32
1.31
1.28
1.26
1.24
1.05
1.03
0.90
0.88
0.87
0.86
0.86
S
OH
1.00
1.00
1.00
2.00
1.00
2.00
1.00
8.00
3.00
6.01
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

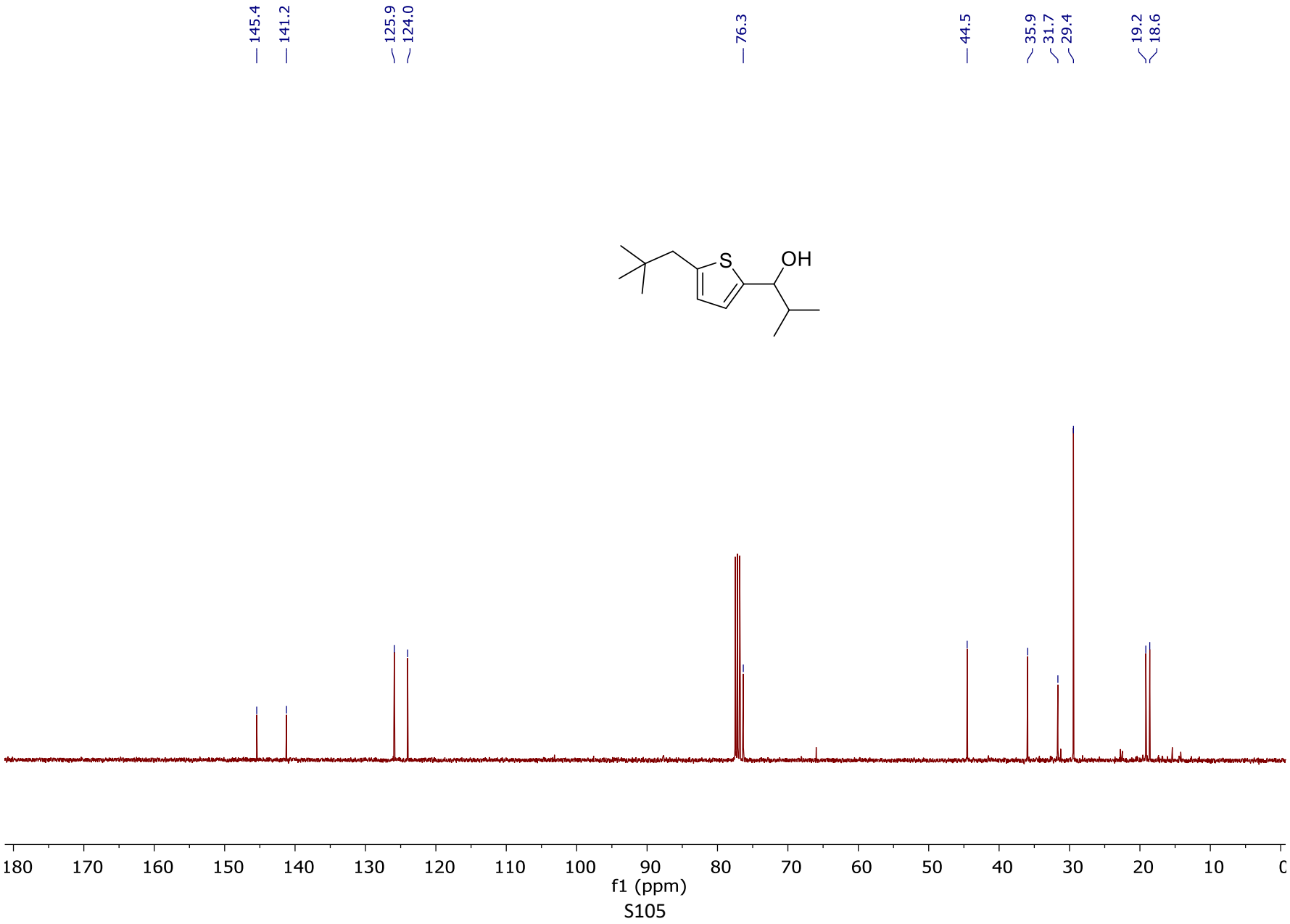

145.4
144.9
124.2
123.3
76.4
35.9
31.9
31.8
30.3
29.2
29.2
22.8
19.2
18.6
14.2
S
OH
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

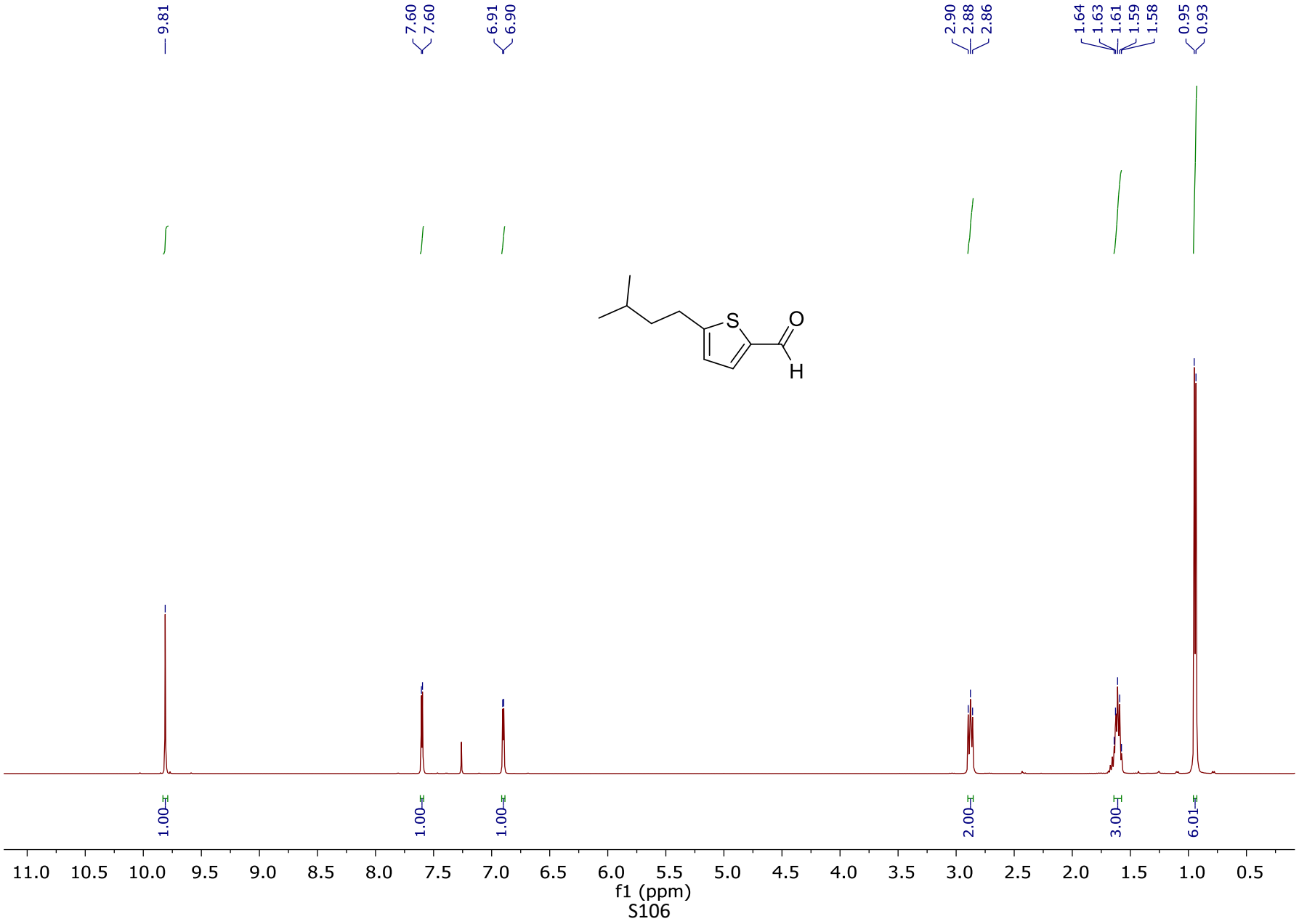

6.73
6.73
6.62
6.62
6.62
6.62
6.61
6.61
4.56
2.79
2.77
2.75
1.96
1.70
1.68
1.66
1.64
1.62
1.35
1.34
1.31
1.29
1.29
1.27
0.98
0.91
0.90
0.89
S
OH
1.00
1.00
1.00
2.00
1.00
2.00
9.00
9.00
3.00
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

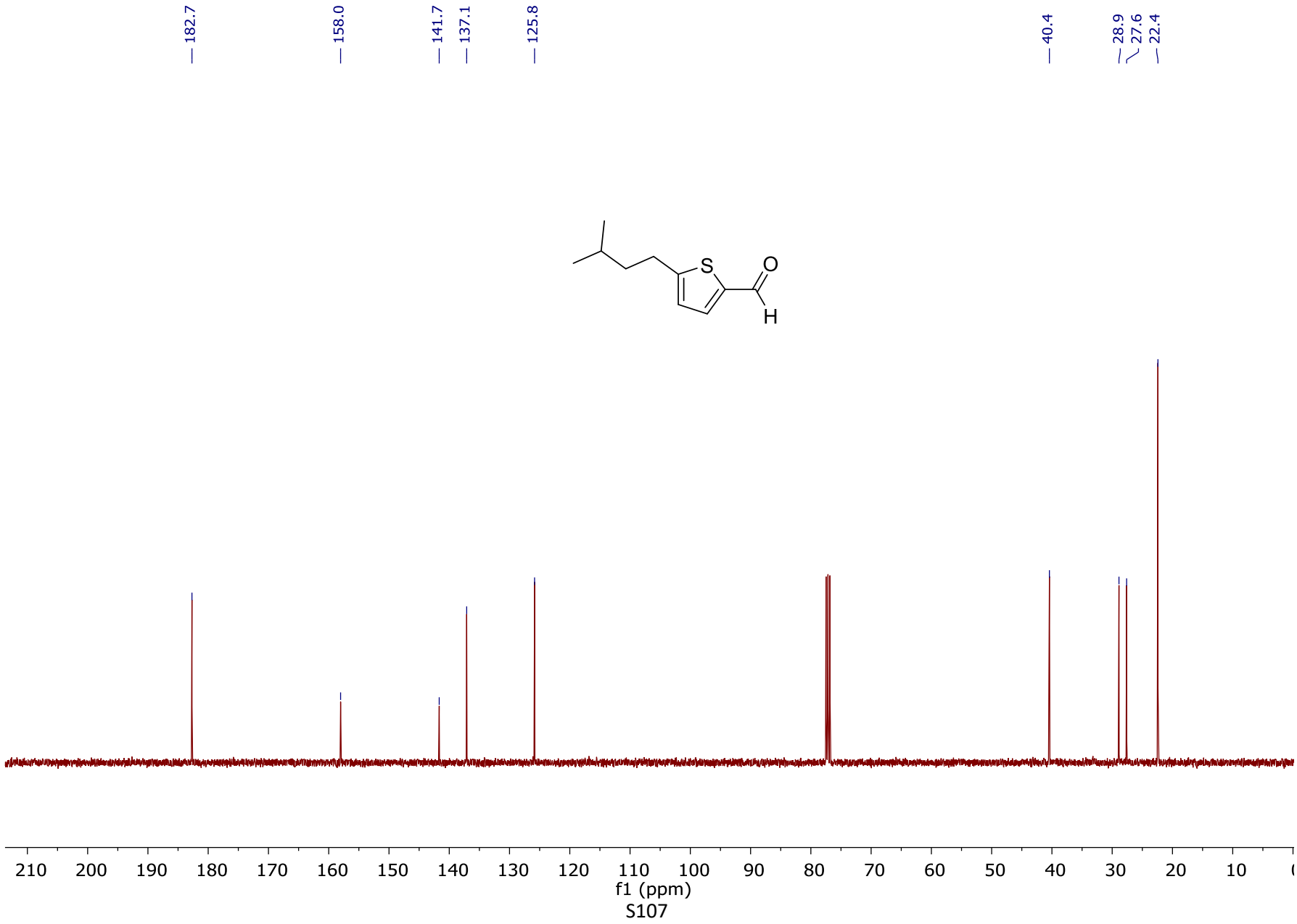
S102

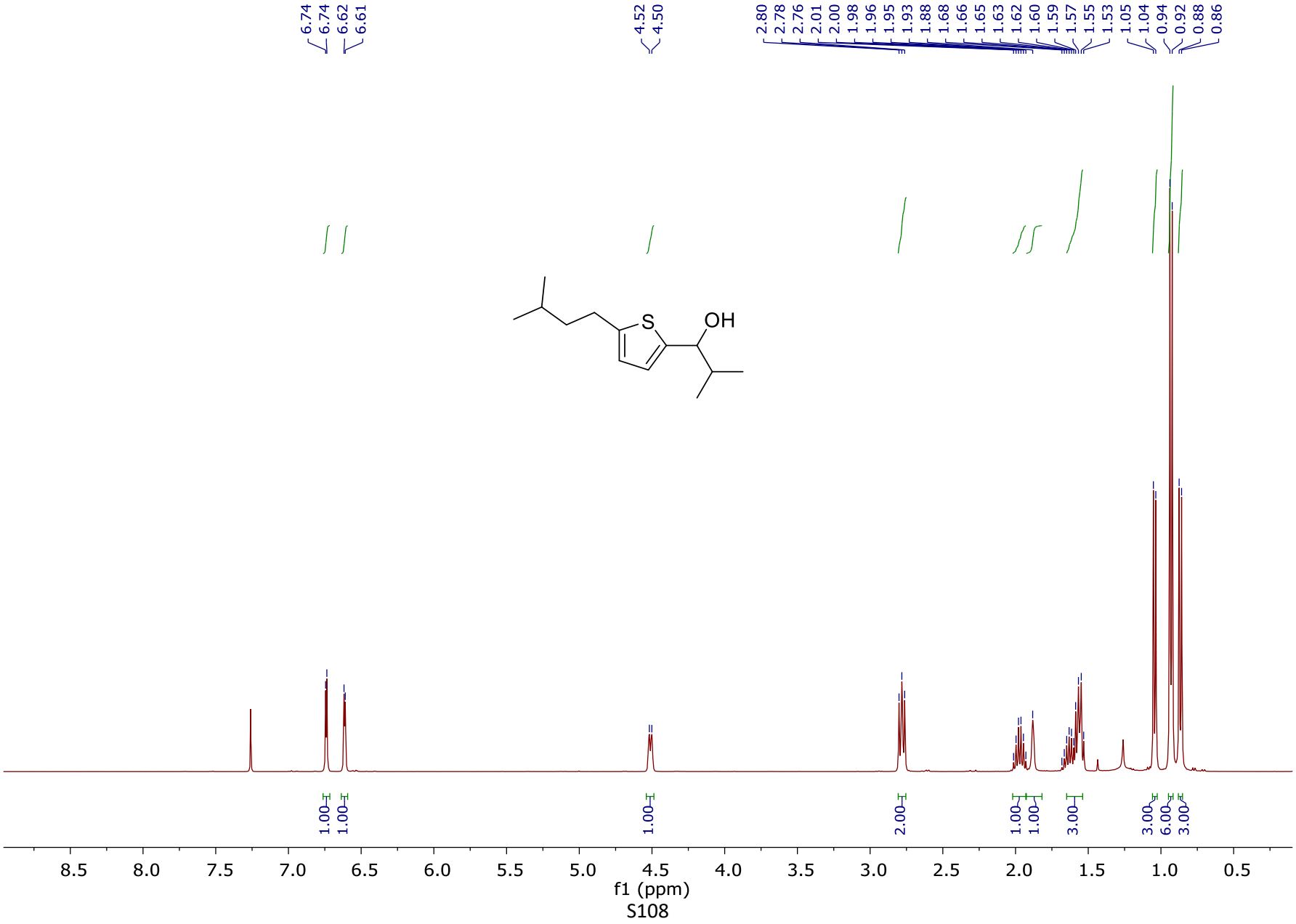

145.1
143.1
125.1
123.0
79.3
35.8
31.9
31.8
30.3
29.2
29.2
26.1
22.8
14.2
S
OH
80
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


6.77
6.77
6.59
6.59
4.53
4.51
2.65
2.02
2.00
1.99
1.97
1.95
1.94
1.88
1.05
1.03
0.95
0.87
0.86
S
OH
1.00
1.00
1.00
2.00
1.00
1.00
3.00
9.04
3.00
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
f1 (ppm)

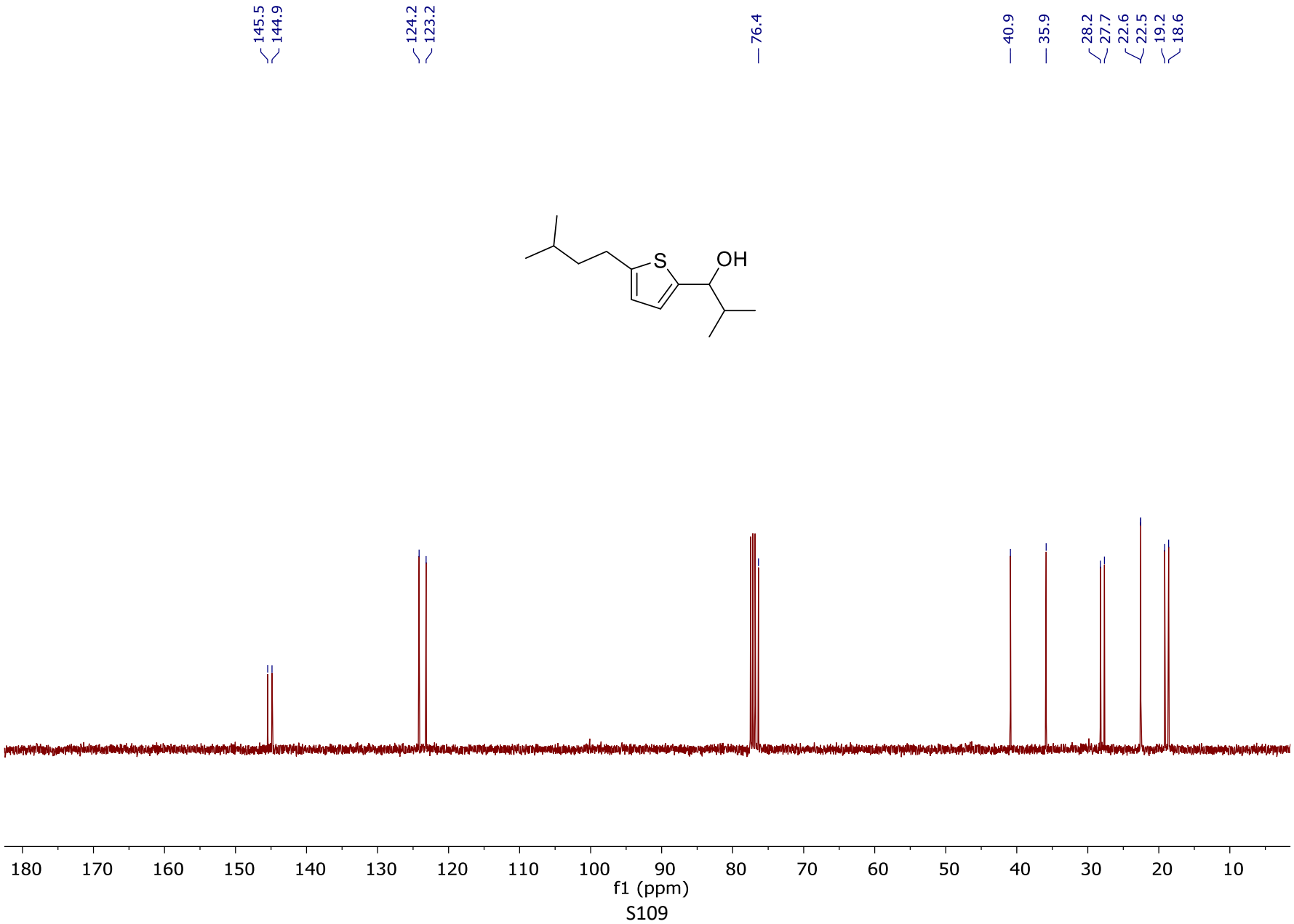

145.4
141.2
125.9
124.0
76.3
44.5
35.9
31.7
29.4
19.2
18.6
S
OH
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

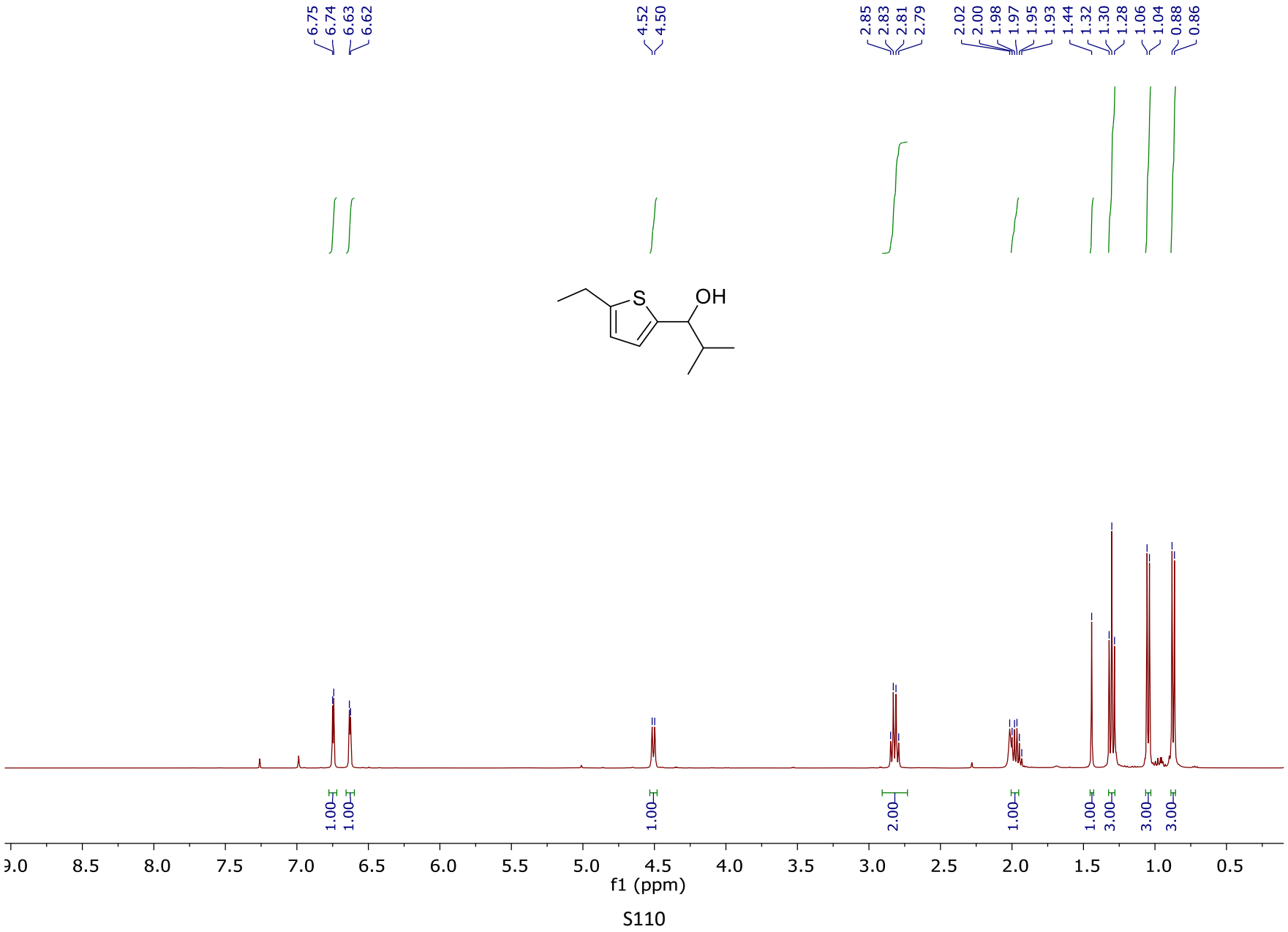

9.81
7.60
7.60
6.91
6.90
2.90
2.88
2.86
1.64
1.63
1.61
1.59
1.58
0.95
0.93
S
O
H
1.00
1.00
1.00
2.00
3.00
6.01
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)


182.7
158.0
141.7
137.1
125.8
40.4
28.9
27.6
22.4
S
O
H
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


6.74
6.74
6.62
6.61
4.52
4.50
2.80
2.78
2.76
2.01
2.00
1.98
1.96
1.95
1.93
1.88
1.68
1.66
1.65
1.63
1.62
1.60
1.59
1.57
1.55
1.53
1.05
1.04
0.94
0.92
0.88
0.86
S
OH
1.00
1.00
1.00
2.00
1.00
1.00
3.00
3.00
6.00
3.00
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
f1 (ppm)

S108


145.5
144.9
124.2
123.2
76.4
40.9
35.9
28.2
27.7
22.6
22.5
19.2
18.6
S
OH
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)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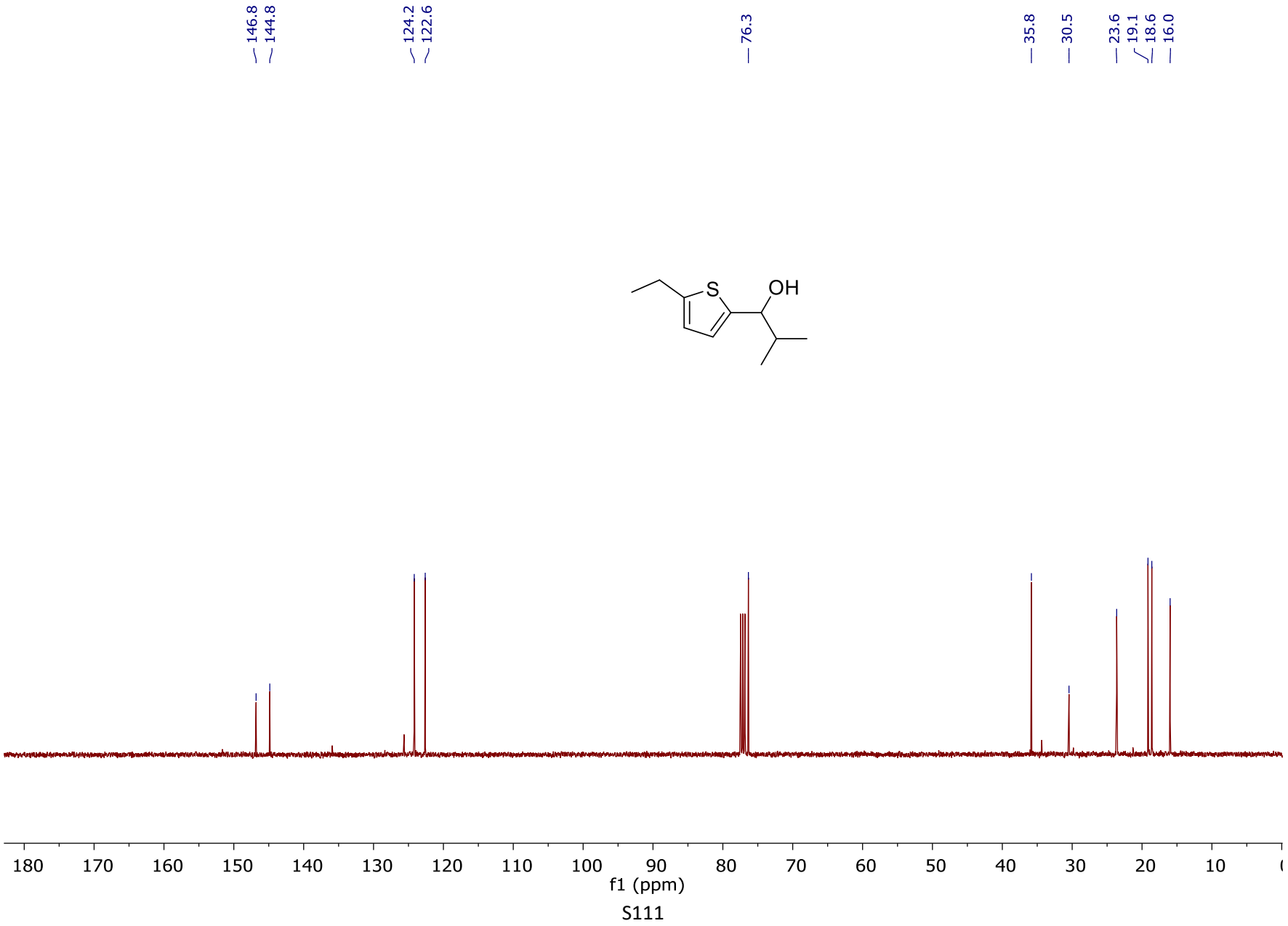
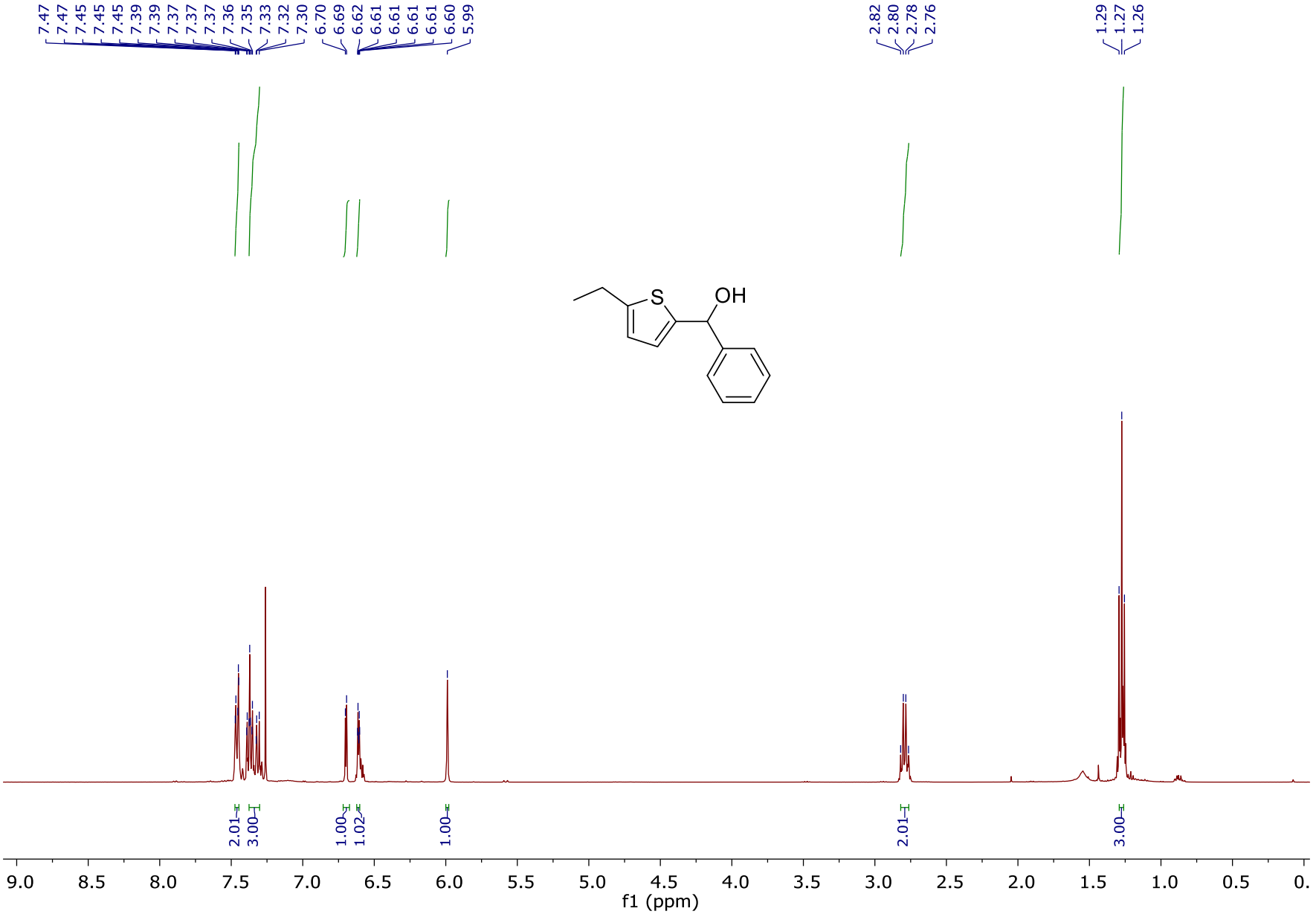
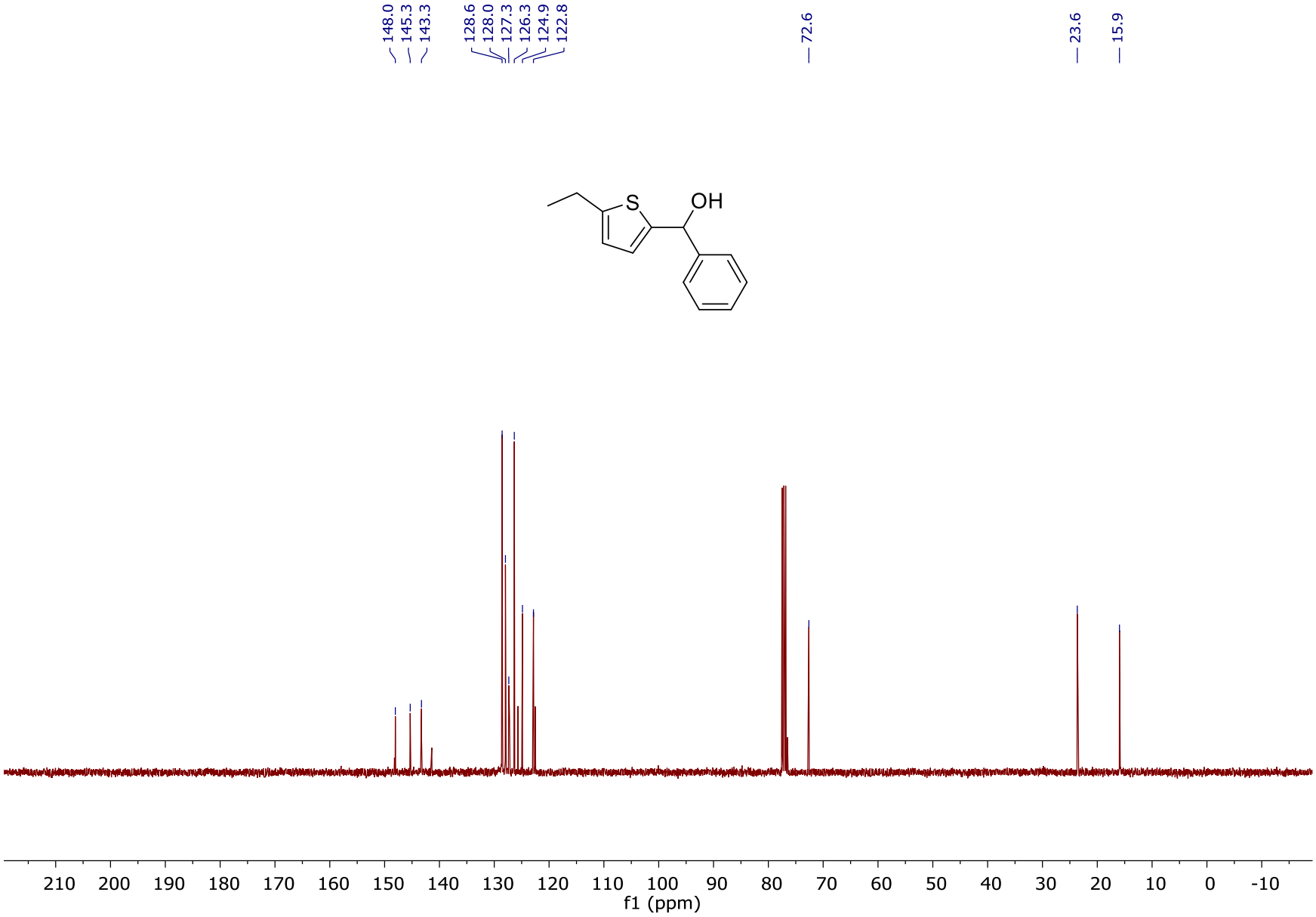
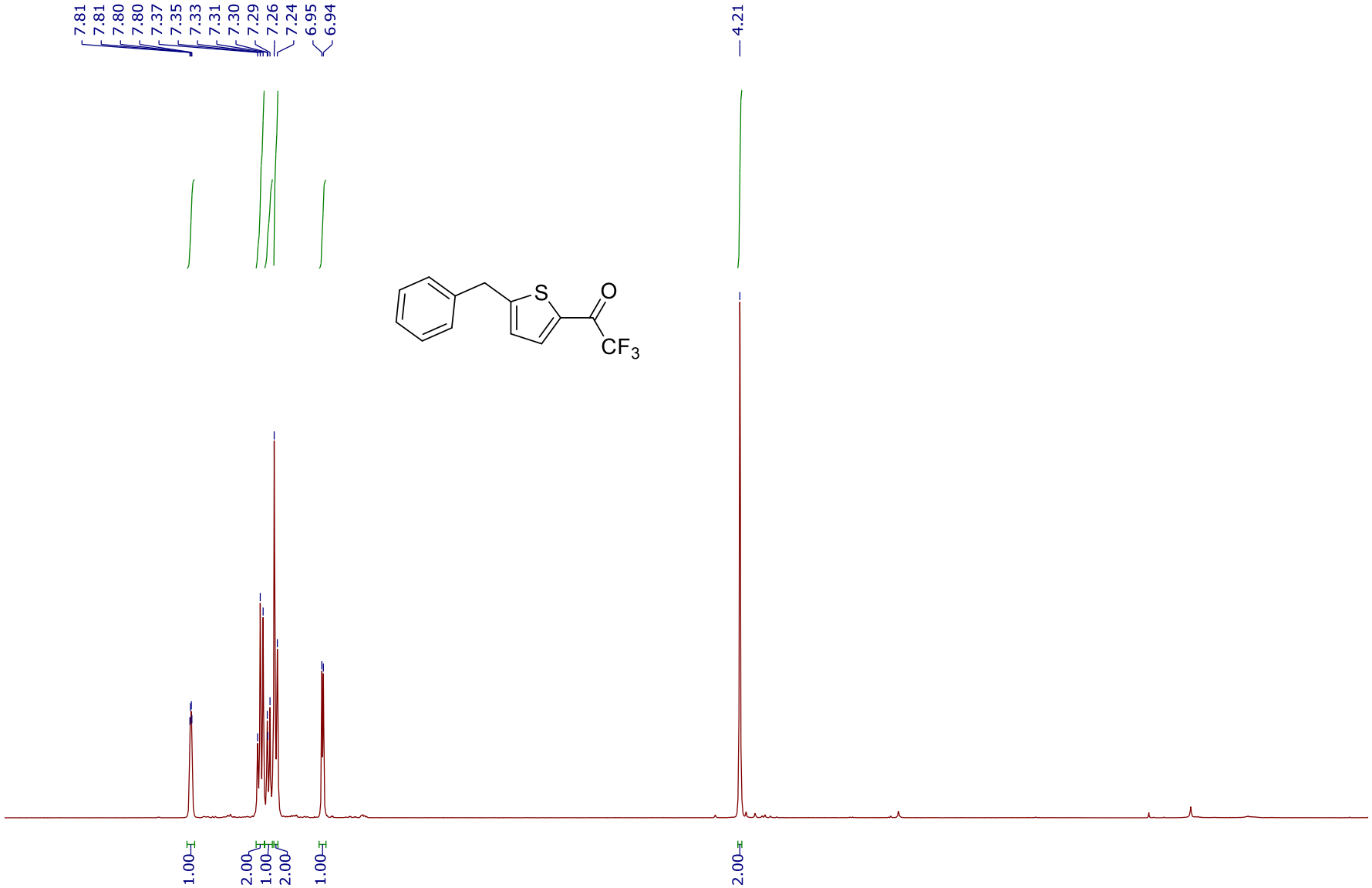
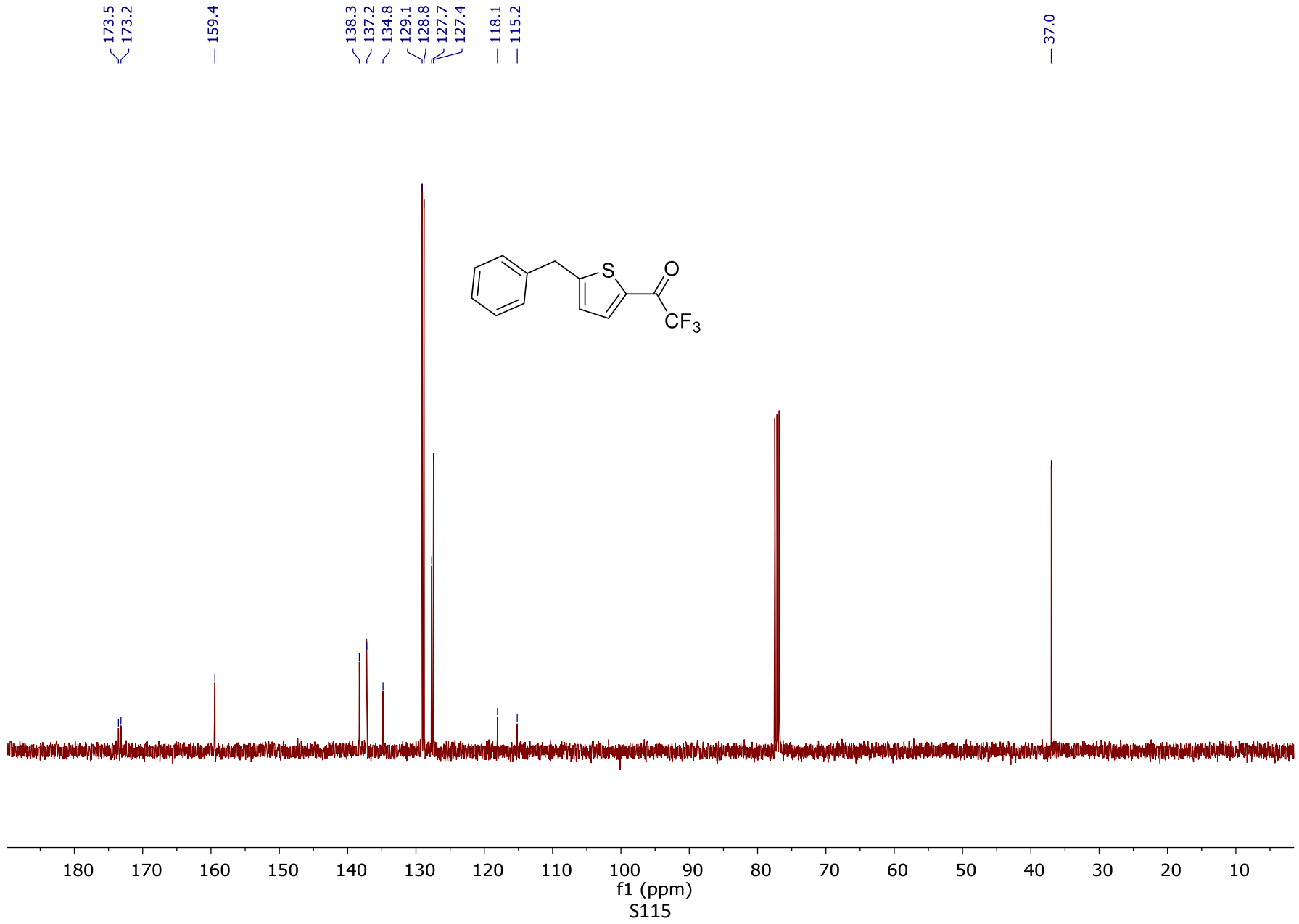
6.74
6.63
6.62
4.52
4.50
2.85
2.83
2.81
2.79
2.02
2.00
1.98
1.97
1.95
1.93
1.44
1.32
1.30
1.28
1.06
1.04
0.88
0.86
S
OH
1.00
1.00
1.00
2.00
1.00
1.00
3.00
3.00
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
f1 (ppm)

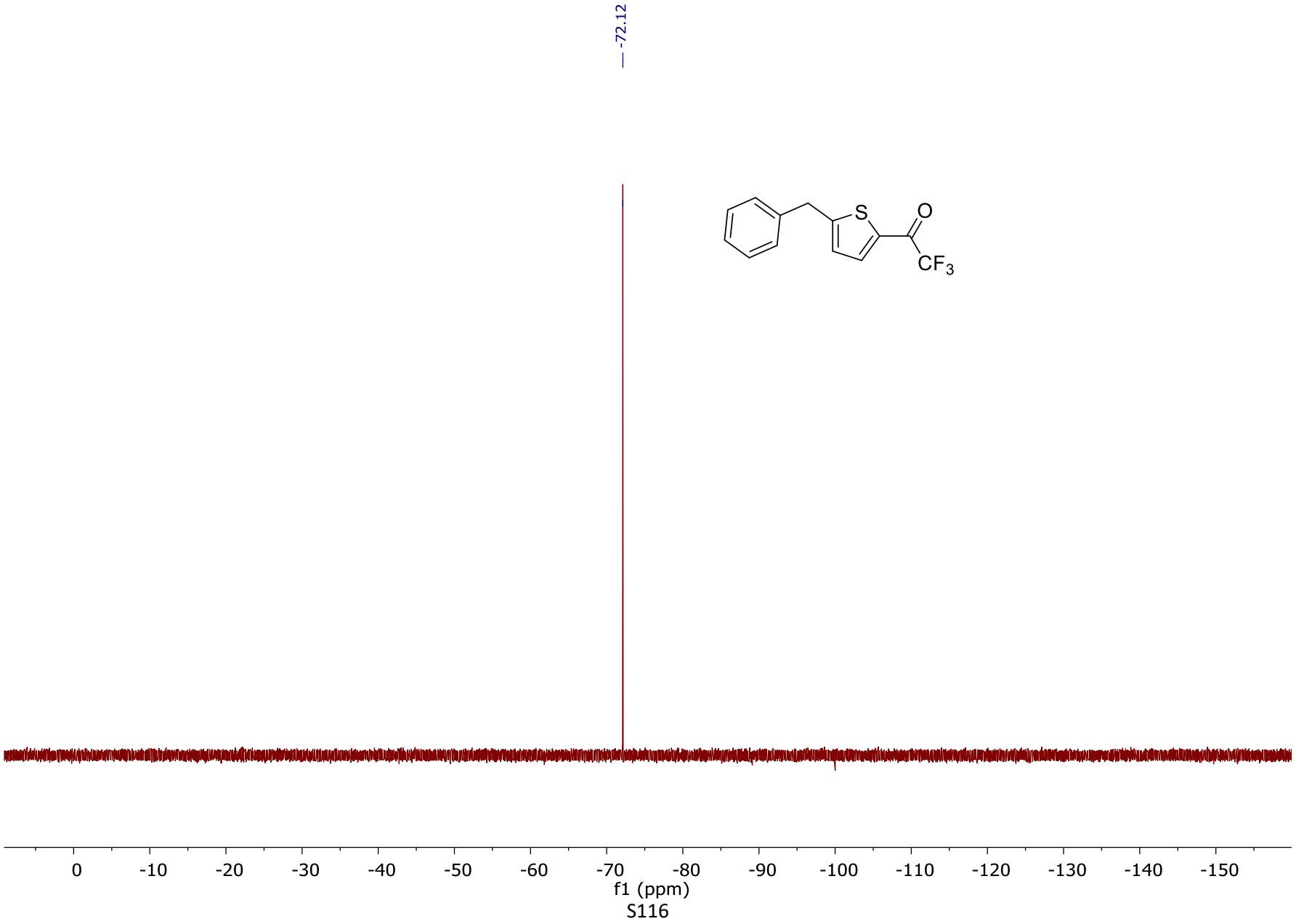

146.8
144.8
124.2
122.6
76.3
35.8
30.5
23.6
19.1
18.6
16.0
S
OH
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)

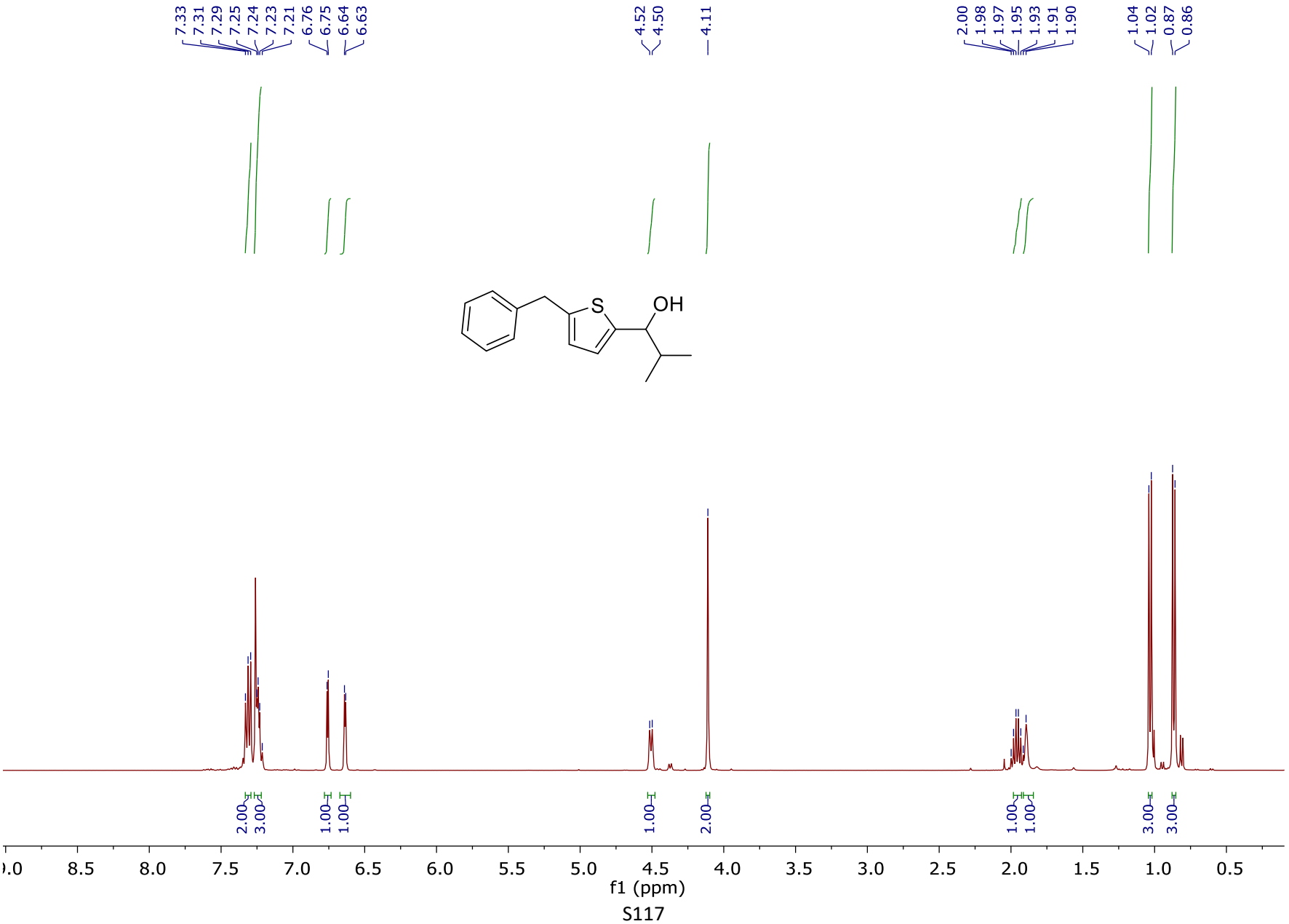

7.47
7.47
7.45
7.45
7.45
7.39
7.39
7.37
7.37
7.37
7.36
7.35
7.33
7.32
7.30
6.70
6.69
6.62
6.61
6.61
6.61
6.61
6.60
5.99
2.82
2.80
2.78
2.76
1.29
1.27
1.26
S
OH
2.01
3.00
1.00
1.02
1.00
2.01
3.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.
f1 (ppm)

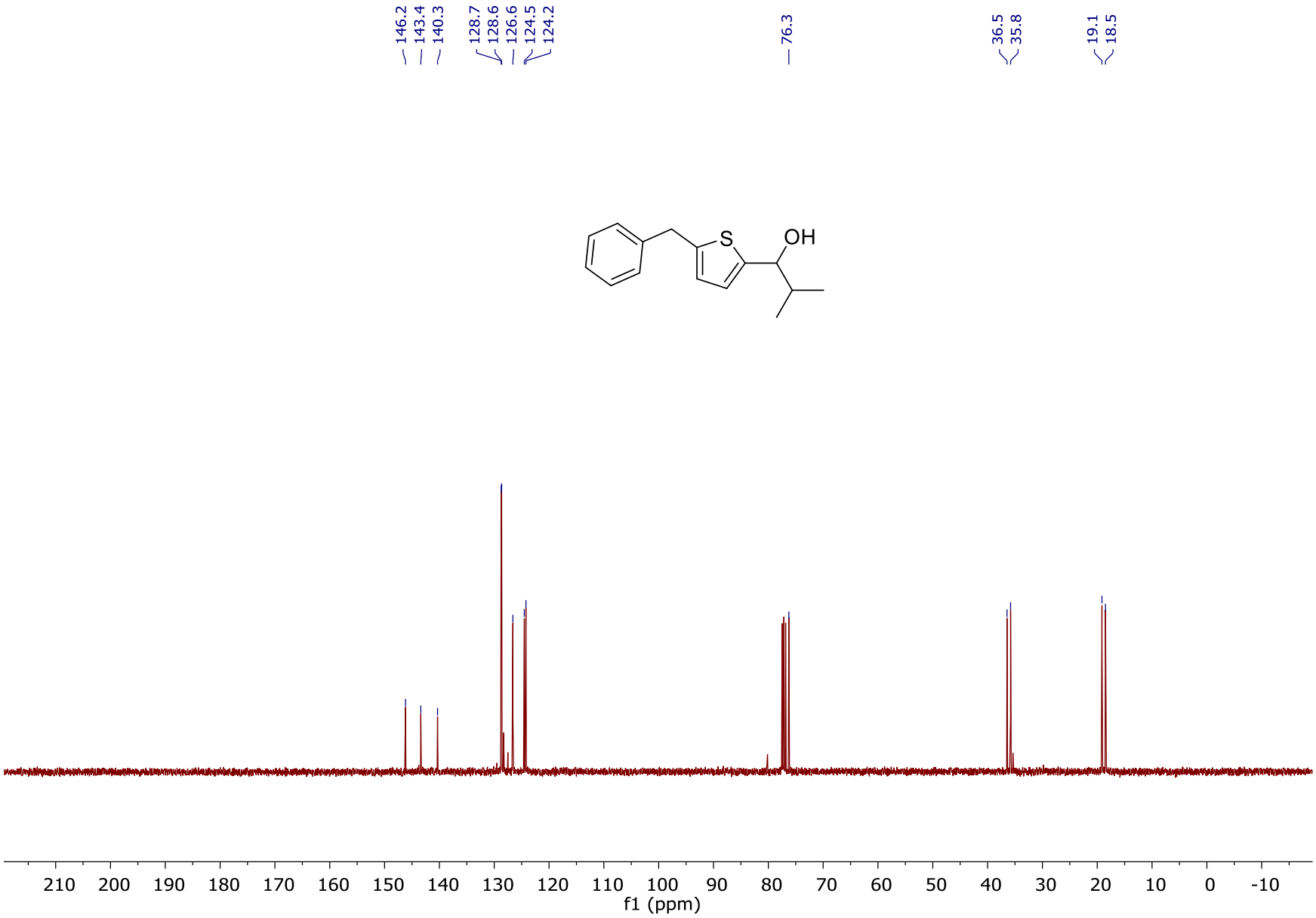

148.0
145.3
143.3
128.6
128.0
127.3
126.3
124.9
122.8
72.6
23.6
15.9
S
OH
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


7.81
7.81
7.80
7.80
7.37
7.35
7.33
7.31
7.30
7.29
7.26
7.24
6.95
6.94
4.21
S
O
CF3
1.00
2.00
1.00
2.00
1.00
2.00
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
f1 (ppm)


173.5
173.2
159.4
138.3
137.2
134.8
129.1
128.8
127.7
127.4
118.1
115.2
37.0
S
O
CF3
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
f1 (ppm)


-72.12
S
O
CF3
0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
-110
-120
-130
-140
-150
f1 (ppm)


7.33
7.31
7.29
7.25
7.24
7.23
7.21
6.76
6.75
6.64
6.63
4.52
4.50
4.11
2.00
1.98
1.97
1.95
1.93
1.91
1.90
1.04
1.02
0.87
0.86
S
OH
2.00
3.00
1.00
1.00
1.00
2.00
1.00
1.00
3.00
3.00
f1 (ppm)


146.2
143.4
140.3
128.7
128.6
126.6
124.5
124.2
76.3
36.5
35.8
19.1
18.5
S
OH
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)