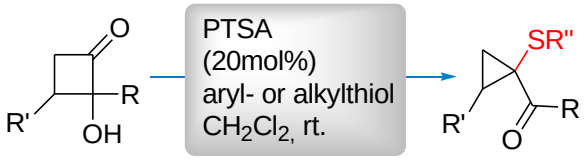
Supporting Information

One-pot acid catalyzed synthesis of functionalized arylthio-cyclopropane carbaldehydes and ketones.



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1. Materials and Methods

Unless stated otherwise, respectively the synthesis of compounds **3a-v** were performed at room temperature in a glass vial with a screw cap and equipped with a stirring bar. Synthesis of compounds **3x-y** and **6a** were performed at room temperature in a glass vial with a screw cap and equipped with a stirring bar.

Commercially available reagents were used as received unless otherwise noted. The acids used in this work were purchased from Sigma Aldrich (PTSA, MSA, CSA) or Alfa-Aesar (TFA, BF_3-OEt_2) and used as received. ^{18}O-water (97%) was purchased from Sigma Aldrich.

Hexane-3,4-dione, hex-3-ynyloxymethyl-benzene, but-3-yn-1-ol, hex-3-yn-1-ol were purchased from Sigma Aldrich. Pent-1-ynyl-benzene, but-1-ynyl-benzene, hept-3-ynyloxymethyl-benzene were prepared following the corresponding literature.

^{1}H NMR spectra were recorded on 400 and 500 MHz Varian spectrometers at 27° C using $CDCl_3$ (ref. 7.27 ppm), or DMSO-*d6* as a solvent. ^{13}C NMR were recorded at 101 MHz (ref. $CDCl_3$ 77.00 ppm) and 126 MHz at 27°C using $CDCl_3$, as solvent. Chemical shifts (δ) are given in ppm. Coupling constants (*J*) are reported in Hz. Infrared spectra were recorded on a FT-IR Bruker Equinox-55 spectrophotometer and are reported in wavenumbers.

Low Mass Spectra Analysis were recorded on an Agilent-HP GC-MS (E.I. 70eV). High Resolution Mass Spectra (HRMS) were obtained using a Bruker High Resolution Mass Spectrometer in fast atom bombardment (FAB+) ionization mode or acquired using an Bruker micrOTOF-Q II 10027.

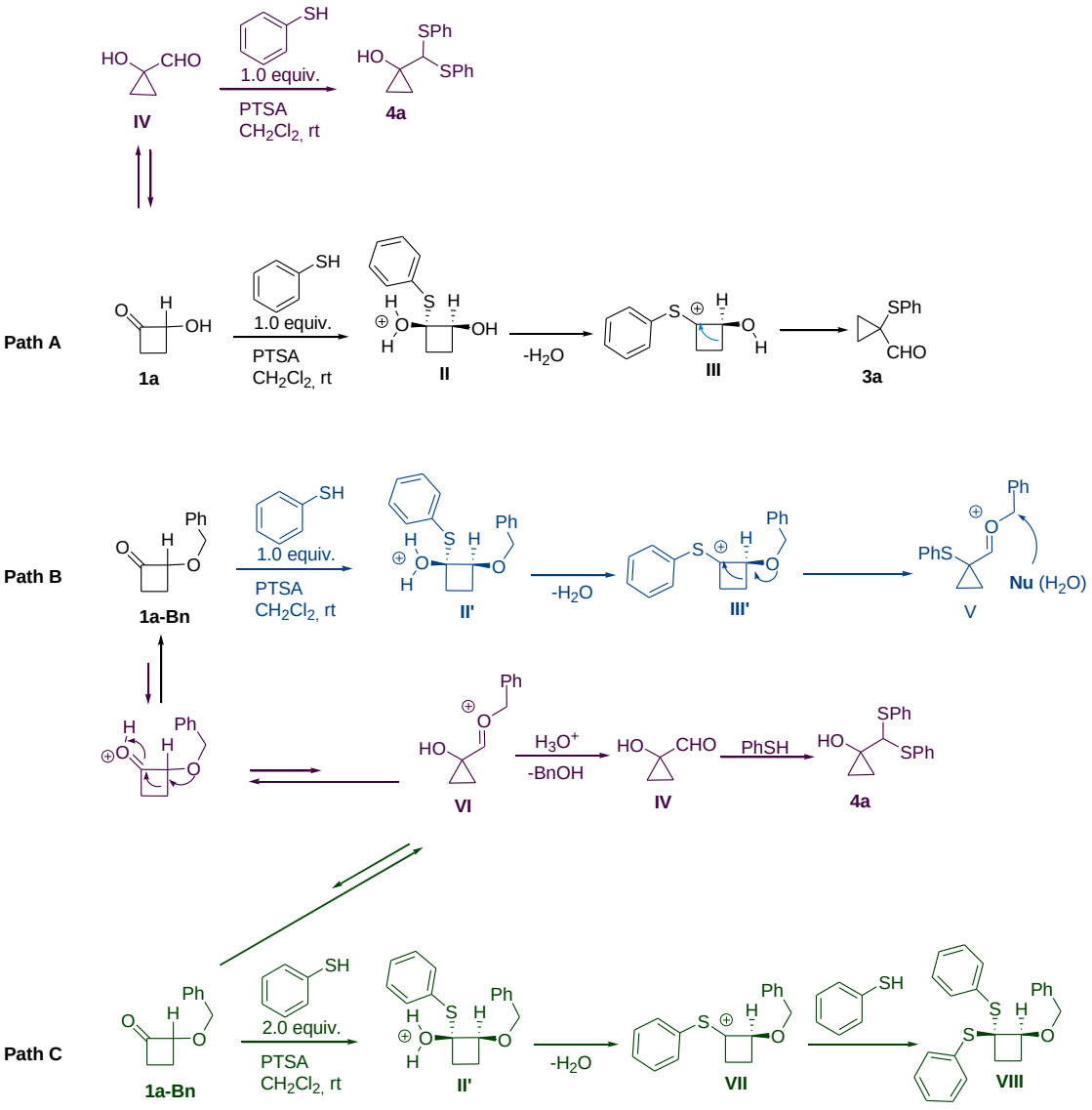
Melting points were determined with a Büchi M-560.

Analytical thin layer chromatography was performed using 0.25 mm Aldrich silica gel 60-F plates. Flash chromatography was performed using Merk 70-200 mesh silica gel. Yields refer to chromatography and spectroscopically pure materials.

Chiral HPLC analysis was performed using an Perkin Elmer HPLC System Flexar, with a Flexar UV/Vis detector. Chiral column: Phenomenex Lux-5u (Cellulose-1), 25 cm×4.6 mm I.D.

2. Mechanistic investigations and ^{1}H, ^{13}C NMR and HRMS-analysis of derivatives 3a, 4a and VIII.

The reaction mechanism between **1a** and thiophenol **2a** has been hypothesized by observing the results of the following experiments (scheme 1). In path A, **1a**, is protonate by the acid (PTSA, 20 mol %) promoting the attack of thiophenol **2a** (1.0 equiv) and the formation of the intermediate **II**. This adduct evolves forming the cyclobutylthionium carbocation **III** by lose of water, thus favouring the four-membered ring contraction and affording the aldehyde **3a**. The formation of compound **4a** was rationalized taking in account the ring contraction equilibriums between the cyclobutanone **1a** and the corresponding aldehyde **VI**[1] which would be able to react with thiophenol affording the cyclopropanol **4a**.



Scheme S1. Mechanistic investigations on the synthesis of compounds **3** and **4**.

To value other possible reaction mechanisms, the hydroxyl-group of cyclobutanone **1a** was protected as benzyloxy derivative (**1a-Bn**).[2] In Path B, **1a-Bn** was reacted with thiophenol **2a** (1.0 equiv) in the presence of PTSA (20 mol %). After 8h reaction, cyclopropanol **4a** was isolated in 55% yield accompanied by the cyclobutane thioketal **VIII** (17%). However, carbaldehyde **3a** was

isolated in 26% yield, probably obtained through the intermediacy of **V**. In order to rationalize this result, we suggest that an acid catalysed C4-C3 ring contraction of **1a-Bn** would allow to generate the intermediate **VI** which would be able to undergo thioketalization by reaction with thiophenol **2a**. On the other hand, the formation of the cyclobuylthionium **III'** has been evoked in order to rationalize the isolation of the compounds **3a** and **VIII**. Similar reactions carried-out with **1a-Bn** and thiophenol **2a** (2.0 equiv) in acid conditions (Path C) hallowed to isolate the compound **4a** in 42 % accompanied by the starting material **1a-Bn** (10%) and **VIII** (50%). In these conditions, the formation of thioketal **VIII** results faster than the C4-C3 cyclobutylthionium **III'** ring contraction. Moreover, the aldehyde **3a** was observed just in traces. It is important to note that using other thiols such as **2i** or **2o** we obtained similar results (figure 1, 2 and 3). In summary, this set of experiments allowed us to assume that 1) the first determining step of this reaction consists in the formation of the cyclobutylthionium carbocation **III/III'** than can be captured by using 2 equivalents of thiophenol. 2) The acid catalysed synthesis of carbaldehydes **3a-s,v,w** from **1a** is thwarted by the protection of the hdroxy-group. However the compound **3a** can be still isolated in moderate yields 3) We believe that compound **4a** can be achieved not just through the intermediacy of the **1a** ring contraction product **IV** but also by the formation of a transient oxonium ion **VI**.

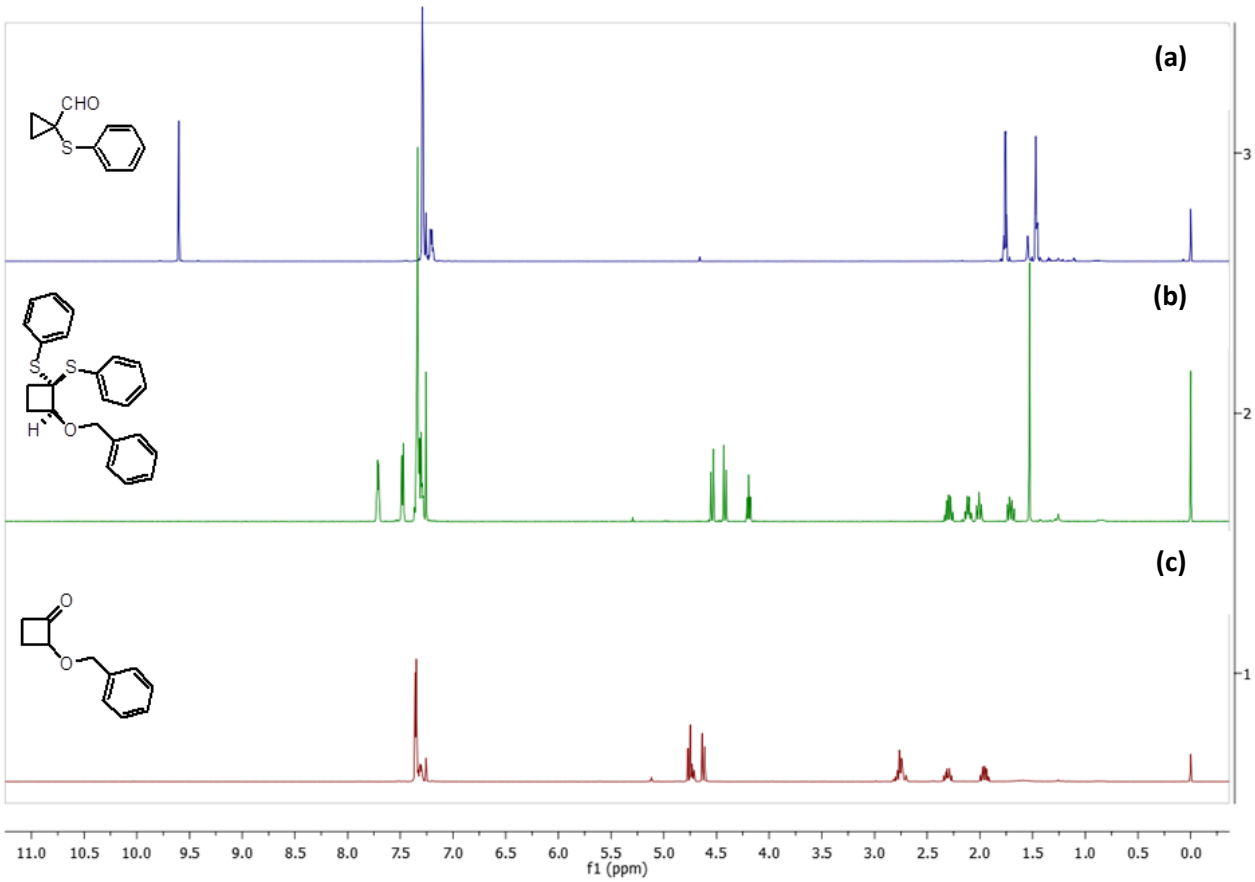
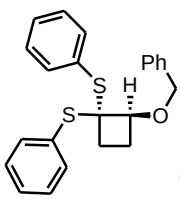


Figure S1. Reaction of cyclobutanone 1a-Bn with thiophenol 2a (1.0 equiv.) a) pure carbaldehyde **3a**; b) pure cyclobutane thioketal **IX-a**; pure benzyloxycyclobutanone **1a-Bn**.



Thioketal VIII-a. Colourless oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.71 (dd, *J* = 6.5, 3.0 Hz, 2H), 7.48 (dd, *J* = 7.8, 1.2 Hz, 2H), 7.41-7.26 (m, 11H), 4.54 (d, *J* = 11.9 Hz, 1H), 4.42 (d, *J*

= 11.9 Hz, 1H), 4.19 (t, *J* = 8.0 Hz, 1H), 2.35-2.23 (m, 1H), 2.11 (ddd, *J* = 10.7, 9.3, 2.2 Hz, 1H), 2.01 (t, *J* = 11.1 Hz, 1H), 1.71 (dt, *J* = 12.2, 9.5 Hz, 1H); ^{13}C NMR (126 MHz, CDC_3) δ: 137.8, 135.8, 135.0, 132.8, 132.0, 128.7, 128.5, 128.3, 128.1, 127.7, 107.4, 107.3, 79.7, 77.2, 76.9, 76.7, 71.6, 71.5, 67.9, 26.4, 26.0; HRMS (ESI): calcd for $C_{23}H_{22}NaOS_2$: 401.1010. (M+Na), found: 401.1007.

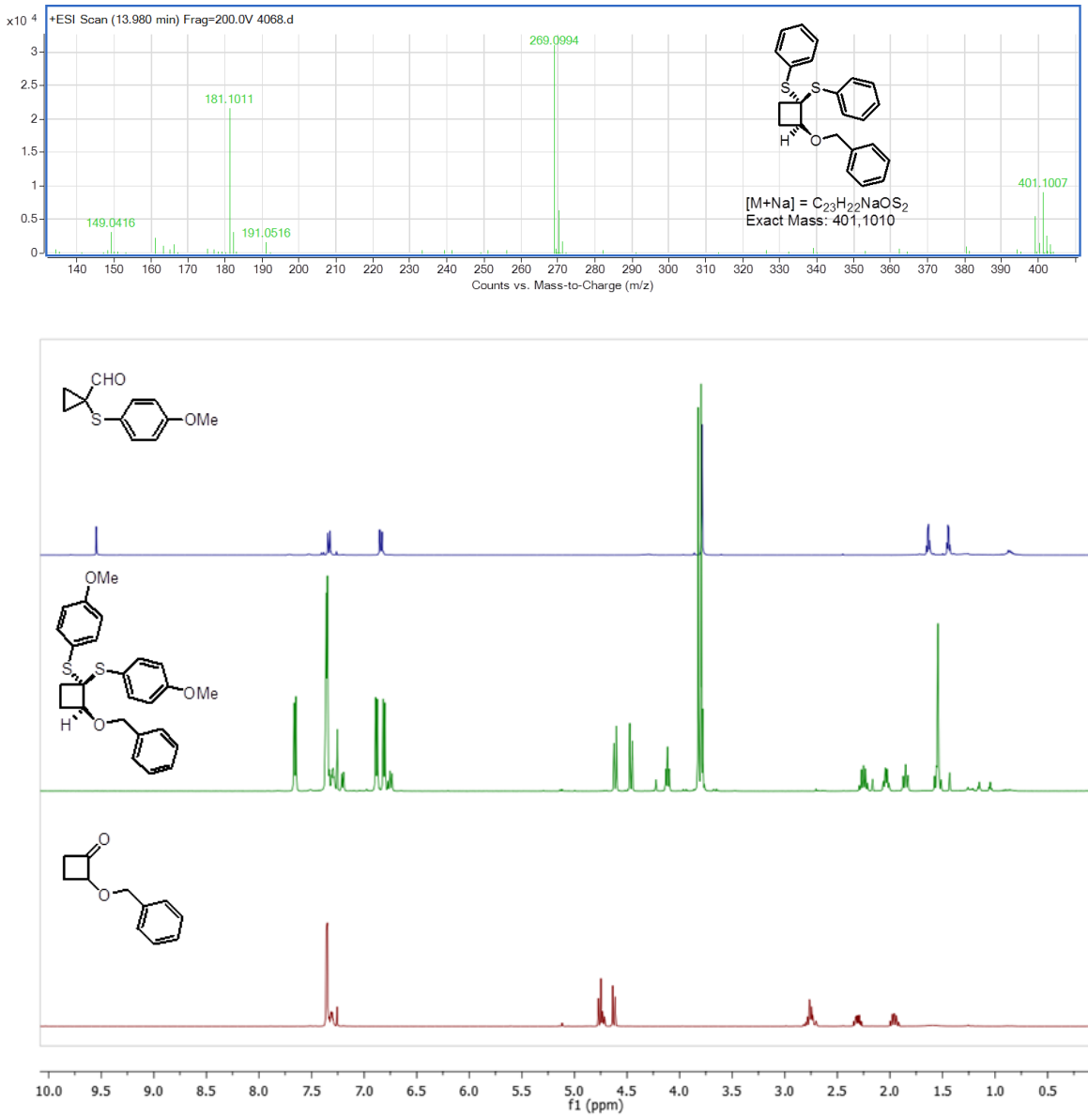
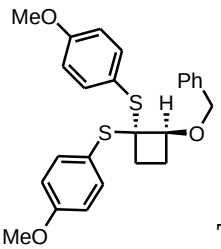


Figure S2. reaction of **1a-Bn** with thiophenol **2i** (2 equiv.) a) pure carbaldehyde **3i**; b) pure cyclobutane thioketal **VIII-h**; pure benzyloxycyclobutanone **1a-Bn**.



Thioketal VIII-i. Colourless oil. ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.66 (d, *J* = 8.8 Hz, 2H), 7.40-7.32 (m, 7H), 6.88 (d, *J* = 8.8 Hz, 2H), 6.81 (d, *J* = 8.7 Hz, 2H), 4.61 (d, *J* = 11.9 Hz, 1H), 4.46 (d, *J* = 11.9 Hz, 1H), 4.11 (t, *J* = 8.0 Hz, 1H), 3.82 (s, 3H), 3.79 (s, 3H), 2.32-2.18 (m, 1H), 2.03 (td, *J* = 10.3, 2.0 Hz, 1H), 1.85 (t, *J* = 10.8 Hz, 1H), 1.61-1.47 (m, 1H); ^{13}C NMR (126

MHz, $CDCl_3$) δ: 160.3, 160.2, 138.0, 138.0, 137.9, 128.3, 127.8, 127.6, 123.6, 122.0, 114.3, 114.3, 114.1, 107.3, 78.6, 71.4, 68.4, 55.2, 25.6, 25.4; HRMS (ESI): calcd for $C_{25}H_{26}NaOS_2$: 461.1221 (M+Na), found: 461.1233.

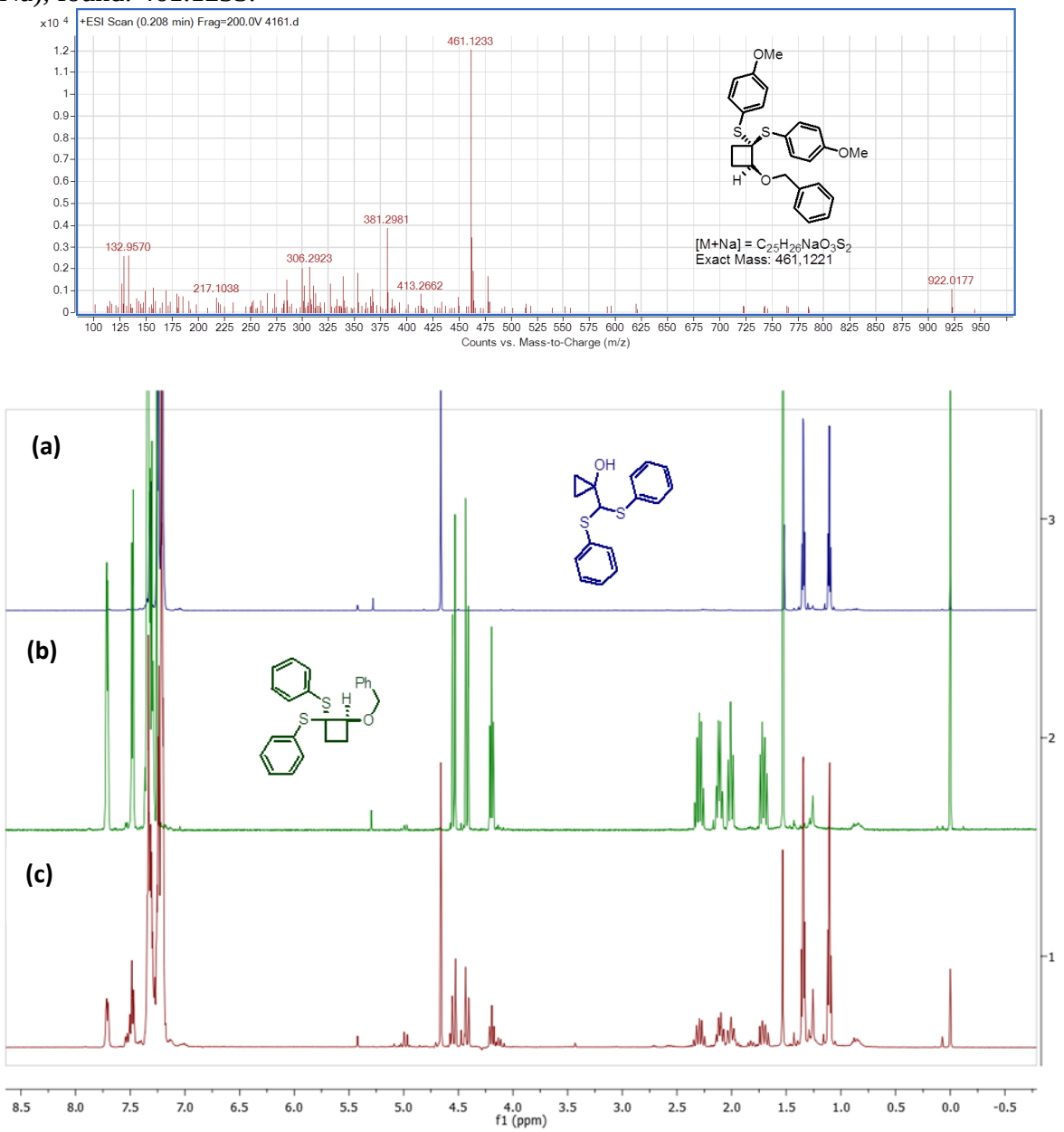
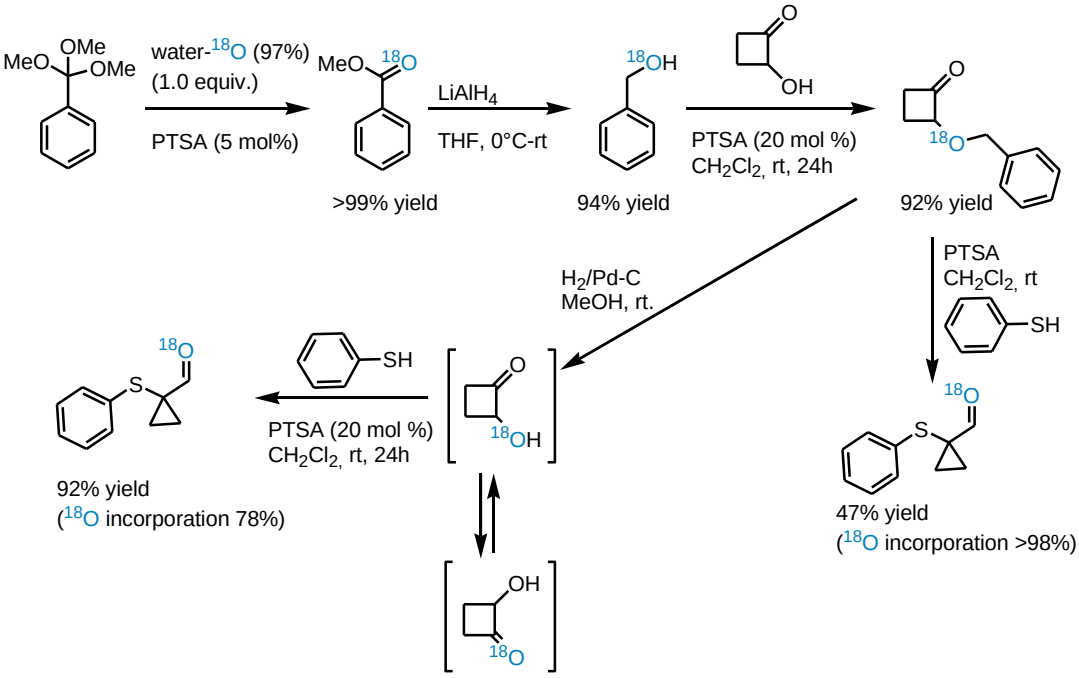


Figure S3. reaction of **1a-Bn** with thiophenol **2a** (2 equiv.) a) pure compound **4a**; b) pure compound **VIII**; crude reaction mixture after 8h reaction.

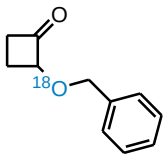
2.1 ^{18}O-incorporation and mechanistic investigations in the acid-catalyzed 2-synthesis of arylthio carbaldehydes.

With the aim to demonstrate the acid catalysed ring contraction of 1-hydroxycyclobutanol **1a** and the formation of the aldehyde **3a**, ^{18}O-labeled compounds were prepared as reported in the scheme **S2**. For this purpose, phenylortobenzoate (9.1g, 0.05 mol) was reacted with ^{18}O-water (1.0 g, 0.05 mol, ^{18}O 97%) and PTSA (5 mol %) at room temperature for 16h. the resulting solution was concentrated in vacuum and the crude product was reduced with

$LiAlH_4$ (3.79g, 0.1 mol) in dry THF (70 mL). ^{18}O-benzylic alcohol was isolated in 94% yield and ^{18}O-incorporation was determined by GC-MS analysis.[2]

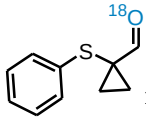


Scheme S2. ^{18}O-incorporation and synthesis of compounds **^{18}O-1aBn** and **^{18}O-3a.**



^{18}O-1aBn was prepared as follow: To a solution of ^{18}O-benzyl alcohol (127 mg, 1.16 mmol) and 2-hydroxycyclobutanone**1a** (100 mg, 1.16 mmol) in CH_2Cl_2, (1 mL), *p*-toluenesulfonic acid (44 mg, 0.23 mmol) was added. The reaction mixture was stirred at 40 °C for 24 h and checked by GC-MS analysis until completion. The reaction solution was charged on a silica gel column and chromatographed (flash chromatography, 90 : 10 hexanes/diethyl ether). **^{18}O-1aBn** was isolated in 92% yield (192 mg ^{18}O > 98%). Colourless oil, ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.46-7.25 (m, 5H), 4.83-4.67 (m, 2H), 4.62 (d, *J* = 11.7 Hz, 1H), 2.87-2.62 (m, 2H), 2.31 (ddd, *J* = 20.6, 9.8, 5.4 Hz, 1H), 1.96 (qd, *J* = 10.6, 8.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 206.5, 137.1, 128.4, 128.0, 86.9, 72.1, 39.3, 19.6. Spectroscopic data are in accordance with those previously reported.[3]

Method A. Synthesis of ^{18}O-3a from ^{18}O-1aBn.



^{18}O-3a was prepared as follow: In a 5 mL glass vial, **^{18}O-1aBn** (120 mg, 0.67 mmol) thiophenol **2a** (73 mg, 0.67 mmol) and *p*-toluenesulfonic acid (25 mg, 0.13 mmol) in 2.0 mL of CH_2Cl_2 were gently stirred for 12h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by flash chromatography (hexanes-diethyl ether 10:1-5:1).Yellow oil, 47% yield (56 mg); ^{1}H

NMR (500 MHz, $CDCl_3$) δ: 9.61 (s, 1H), 7.29-7.19 (m, 5H), 1.75 (dd, *J* = 4.5, 7.9 Hz, 2H), 1.54 (s, 1H), 1.46 (dd, *J* = 5.0, 7.6 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.6, 129.0, 128.1, 126.3, 107.3, 20.8. Spectroscopic data are in accordance with those previously reported for the compound **3a**.[4]

Method B. Synthesis of ^{18}O-3a from ^{18}O-1a

In a 25 mL round bottom flask, a MeOH solution (3 mL) of **^{18}O-1aBn** (120 mg, 0.67 mmol) was added to a suspension of Pd-C (0.07 mmol) in MeOH (7 mL). The resulting mixture was degassed and loaded with a H_2 balloon. The reaction was stirred for 12 h and followed by GC-MS **^{18}O-1aBn** disappeared, the reaction mixture was filtered on Celite® and the filtrate washed with 2x20 mL of MeOH. The organic phase was concentrated under reduced pressure and the resulting crude oil was loaded in a 5 mL glass vial containing *p*-toluenesulfonic acid (25 mg, 0.13 mmol) and thiophenol **2a** (73 mg, 0.67 mmol). The reaction mixture was stirred for 2h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by flash chromatography (hexanes-diethyl ether 10:1-5:1) affording ^{18}O-**3a** in 92% yield (110 mg) as a 78:22 mixture of **^{18}O-1a/^{16}O-1a**.

2.2 GC-MS alaysis of ^{18}O-labelled compounds ^{18}O-methyl benzoate, ^{18}O-benzylic alcohol, ^{18}O-1aBn, ^{18}O-3a from ^{18}O-1a

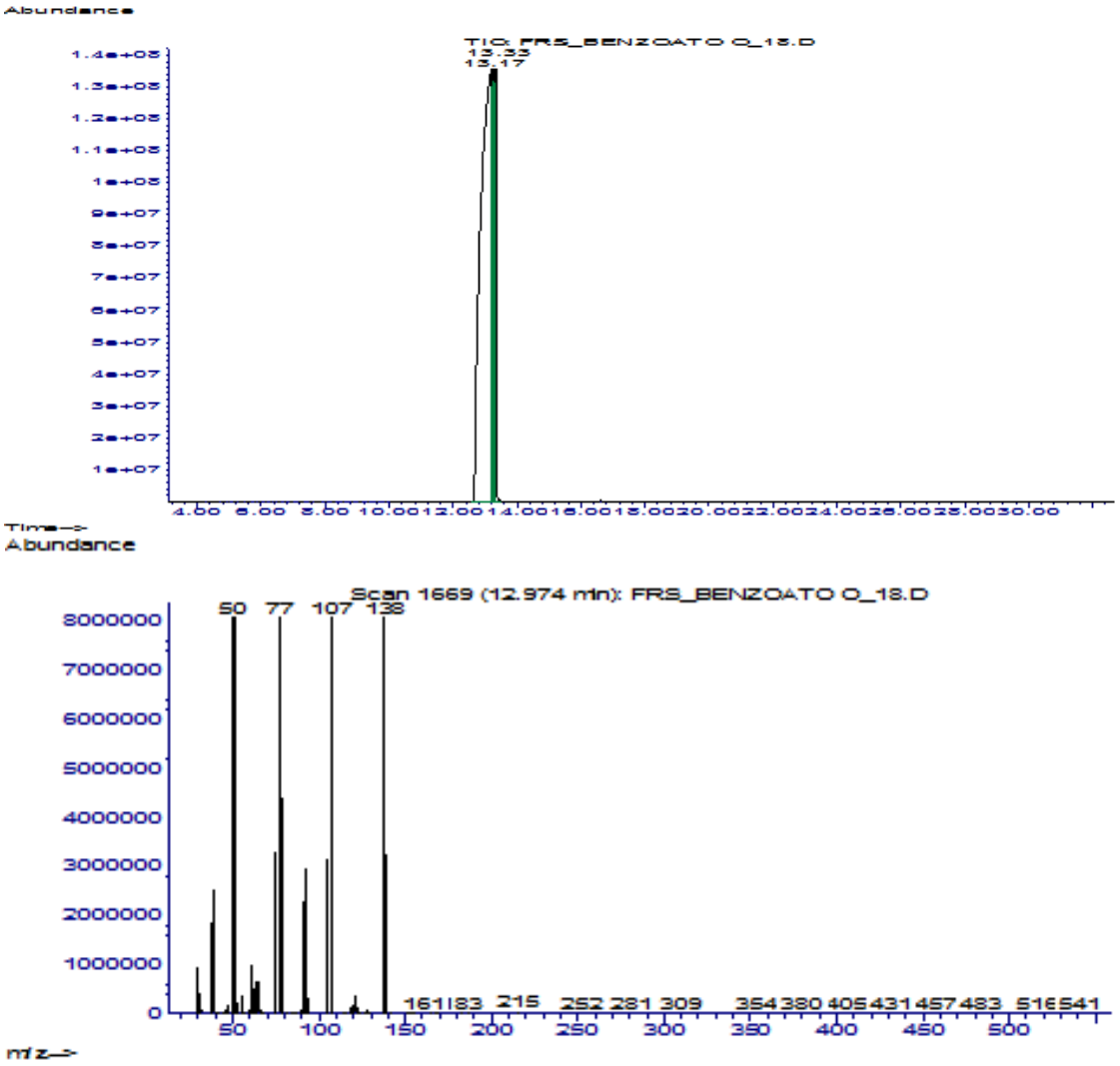
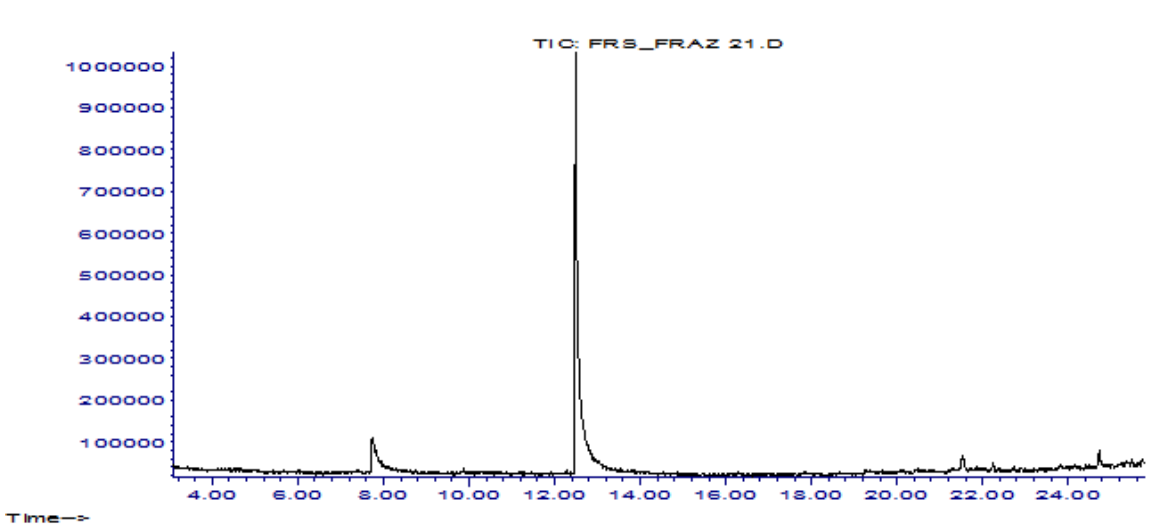


Figure S4 low resolution GC-MS analysis of ^{18}O-methylbenzoate.



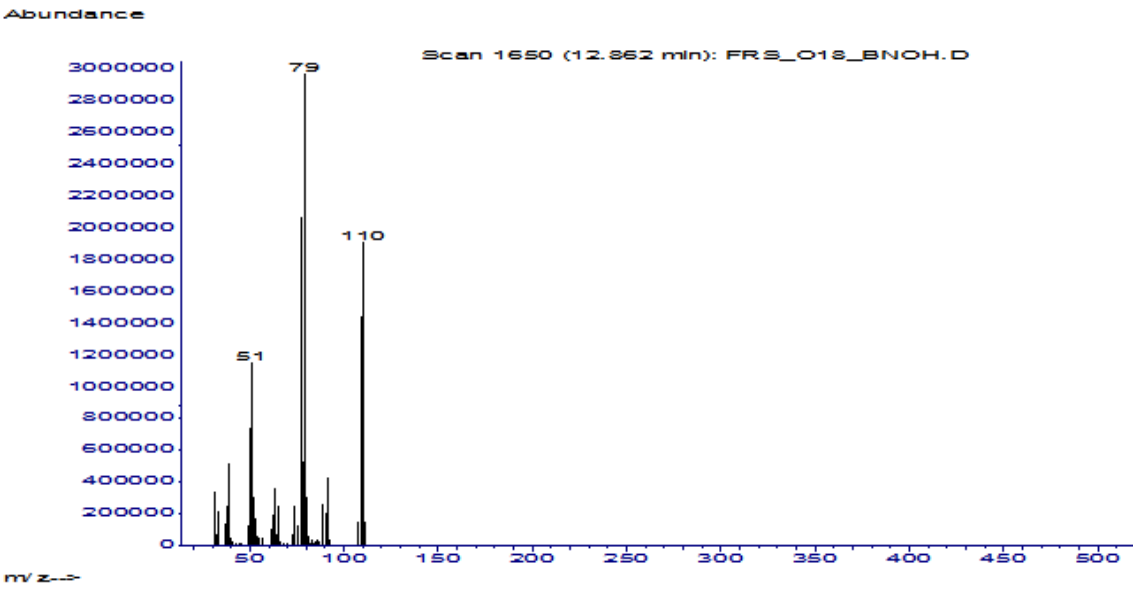


Figure S5 low resolution GC-MS analysis of ^{18}O-benzylic alcohol.

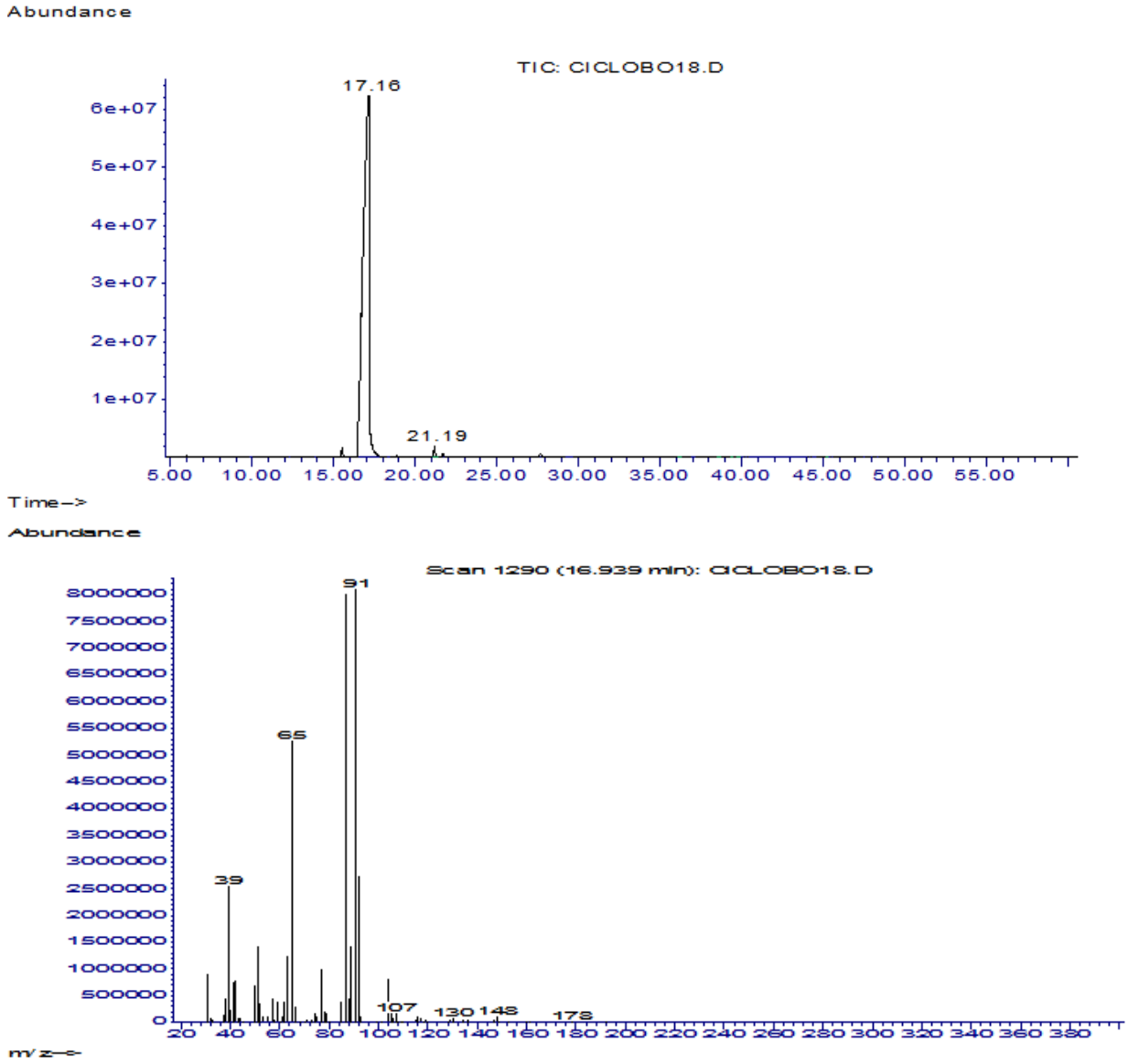


Figure S6 low resolution GC-MS analysis of **^{18}O-1aBn**.

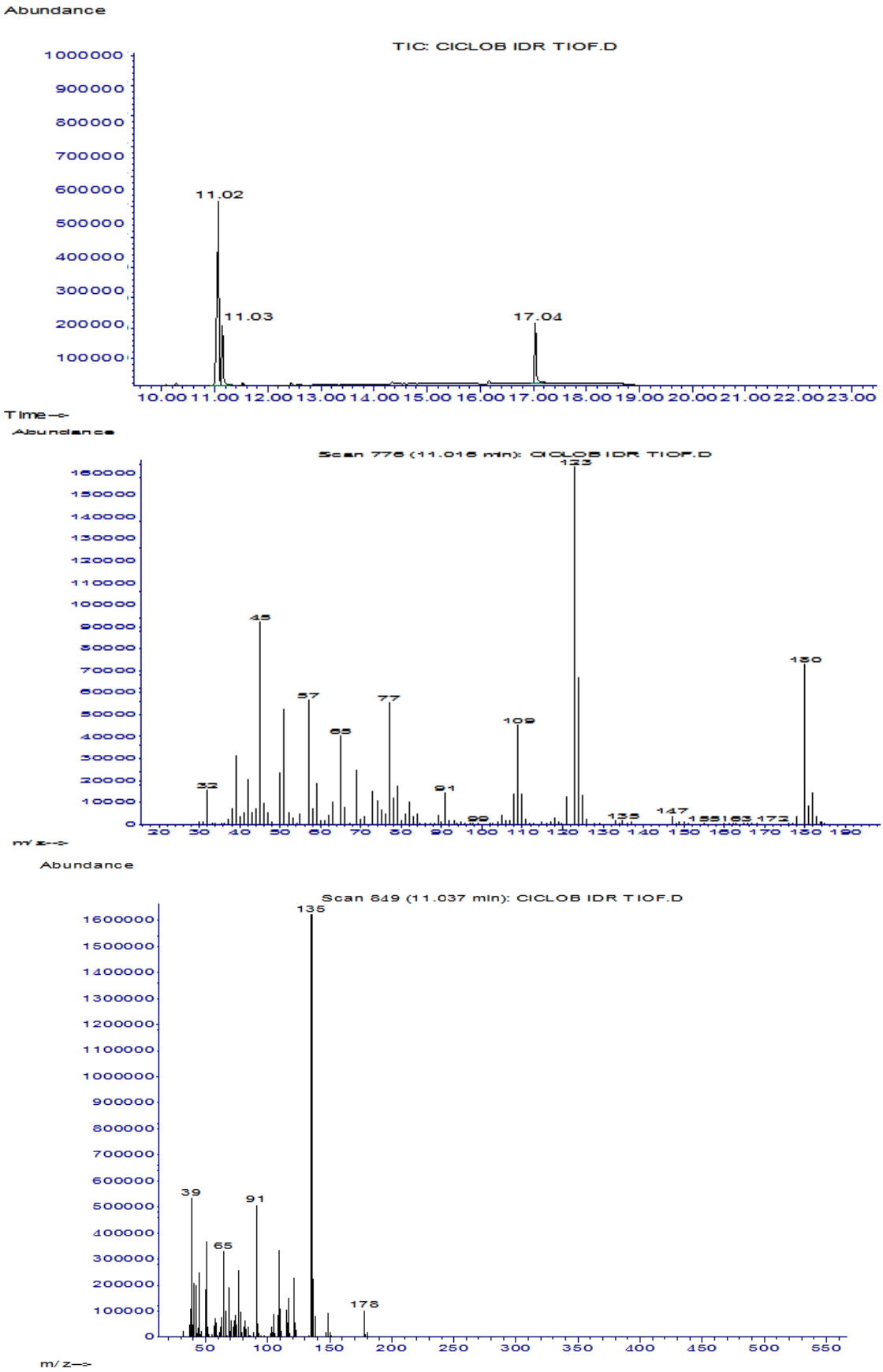
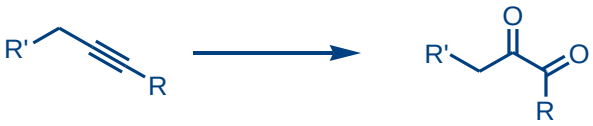


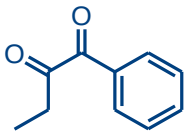
Figure S7 low resolution GC-MS analysis of **^{18}O-3a** (a) and **^{16}O-3a** (b).

3. General procedure for the synthesis of 2-hydroxycyclobutanones 1b-f

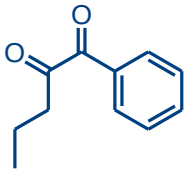
3.1 synthesis of diones A1-4.



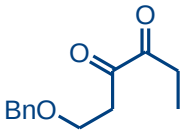
In a 2 L Erlenmeyer flask, alkyne **A** (17.8 mmol) was dissolved in 670 mL of acetone and cooled to 0° C. To this vigorous stirred solution $MgSO_4$ (4.2 g, 34.4 mmol) and $NaHCO_3$ (0.9 g, 10.7 mmol) were added in water (390 mL) followed by finely grounded $KMnO_4$ (10.9 g, 69.2 mmol). After 4 h reaction, $NaNO_2$ (6.0 g, 86.9 mmol) was added portionwise. Further a H_2SO_4 water solution (50 mL, 0.1M) and 0.7 mL of H_2SO_4 conc. were added. After 20 minutes, NaCl (100g) was loaded to the reaction favouring the formation of two phases which were separated in a glass funnel. The water media was further extracted with Et_2O/hexane (1:1). The organic phase was washed with a NaOH solution (50 mL, 0.1M), dried on Na_2SO_4, filtered and concentrated under reduced pressure. Flash chromatography (petroleum ether/Et_2O 95:5) allowed to isolate the corresponding dione as a pure product.



1-Phenyl-butane-1,2-dione A2. But-1-ynyl-benzene (1.3 g, 10 mmol), acetone (370 mL), $MgSO_4$ (2.3 g, 19 mmol), $NaHCO_3$ (0.5 g, 6 mmol), H_2O (220 mL), $KMnO_4$ (6.1 g, 38.8 mmol), $NaNO_2$ (3.3 g, 48.8 mmol). Flash chromatography (petroleum ether/Et_2O 95:5-90:10). Yellow oil, 76% yield (1.23 g); ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.97 (d, *J* = 8.0 Hz, 2H), 7.63 (d, *J* = 8.0 Hz, 1H), 7.48 (t, *J* = 8.0 Hz, 2H), 2.90 (q, *J* = 7.3 Hz, 2H), 1.18 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 203.8, 192.4, 132.0, 130.0, 128.7, 32.0, 6.8. Spectral data are in agreement with the literature.[5]

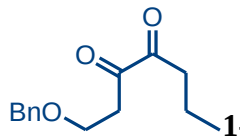


1-Phenyl-pentane-1,2-dione A3. Pent-1-ynyl-benzene (1.4 g, 10 mmol), acetone (370 mL), $MgSO_4$ (2.3 g, 19 mmol), $NaHCO_3$ (0.5 g, 6 mmol), H_2O (220 mL), $KMnO_4$ (6.1 g, 38.8 mmol), $NaNO_2$ (3.3 g, 48.8 mmol). Flash chromatography (petroleum ether/Et_2O 95:5-90:10). Yellow oil, 78% yield (1.37 g). ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.97 (d, *J* = 6.8 Hz, 2H), 7.65-7.60 (m, 1H), 7.51-7.46 (m, 2H), 2.85 (t, *J* = 7.2 Hz, 2H), 1.77-1.68 (m, 2H), 1.00 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (CDCl3, 100 MHz): δ 203.4, 192.5, 134.5, 131.9, 130.1, 128.8, 40.6, 16.4, 13.6. Spectral data are in agreement with the literature.[6]



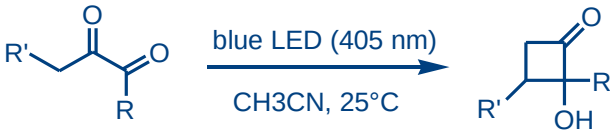
1-(benzyloxy)hexane-3,4-dione A4. Hex-3-ynyloxymethyl-benzene (1.8 g, 10 mmol), acetone (370 mL), $MgSO_4$ (2.3 g, 19 mmol), $NaHCO_3$ (0.5 g, 6 mmol), H_2O (220 mL), $KMnO_4$ (6.1 g, 38.8 mmol), $NaNO_2$ (3.3 g, 48.8 mmol). Flash chromatography (petroleum ether/Et_2O 95:5-80:20). Yellow oil, 53% yield (1.21 g); FTIR (film), $cm^{-1}\nu$: 3067, 3030, 2955,

2934, 2861, 1724, 1452, 1274, 1123, 1023, 757, 702; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.47-7.17 (m, 5H), 4.50 (s, 2H), 3.78 (t, *J* = 6.1 Hz, 2H), 3.03 (t, *J* = 6.1 Hz, 1H), 2.75 (q, *J* = 7.2 Hz, 2H), 1.07 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 202.6, 200.8, 140.5, 131.0, 130.3, 130.3, 75.8, 67.3, 39.4, 32.0, 9.4; HRMS (ESI): calcd for $C_{13}H_{16}NaO_3$: 243,0997 [M+Na], found: 243,0999. Spectral data are in agreement with the literature.[7]

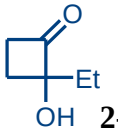


1-Benzyloxy-heptane-3,4-dione A5. Hept-3-ynyloxymethyl-benzene (2.02 g, 10 mmol), acetone (370 mL), $MgSO_4$ (2.3 g, 19 mmol), $NaHCO_3$ (0.5 g, 6 mmol), H_2O (220 mL), $KMnO_4$ (6.1 g, 38.8 mmol), $NaNO_2$ (3.3 g, 48.8 mmol). Flash chromatography (petroleum ether/Et_2O 95:5-90:10). Yellow oil, 71% yield (1.66 g). FTIR (film), cm^{-1} ν: 3067, 3030, 2955, 2934, 2861, 1724, 1452, 1274, 1123, 1023, 757, 702; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.71-7.07 (m, 5H), 4.50 (s, 2H), 3.78 (t, *J* = 6.1 Hz, 2H), 3.03 (t, *J* = 6.1 Hz, 1H), 2.70 (t, *J* = 7.2 Hz, 2H), 1.60 (dd, *J* = 14.7, 7.3 Hz, 2H), 0.92 (t, *J* = 7.4 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 199.7, 198.4, 138.0, 129.7, 128.5, 127.8, 77.1, 73.3, 64.8, 37.9, 36.9, 16.5, 13.7; HRMS (ESI): calcd for $C_{14}H_{18}NaO_3$: 257,1154 [M+Na], found: 257,1156.

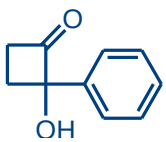
3.2 Synthesis of hydroxycyclobutanones 1b-f.



In a 50 mL round bottom two neck flask, diones **A2-5** (4.4 mol) were dissolved in CH_3CN (10 mL) and irradiated at 405 nm (blue LED) for 2-16h (25° C) and followed by GC-MS. The organic solutions were evaporated under reduced pressure and purified by flash chromatography (*n*-hexane/Et_2O, 10:1-5:1-3:1) without previous work-up.

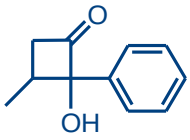


2-Ethyl-2-hydroxy-cyclobutanone. Compound **1b** was synthetized as described above. Hexane-3,4-dione **A1** (501 mg, 4.4 mol), CH_3CN (10 mL). Flash chromatography (*n*-hexane/Et_2O, 3:1). Colourless oil, 90% yield (450 mg); *Rf* = 0.6; FTIR (film), cm^{-1} ν: 3431, 2974, 2941, 2879, 1783, 1713, 1462, 1400, 1380, 1277, 1203, 1174, 1116, 1067, 1013; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 3.35 (br. s, 1H), 2.94-2.83 (m, 1H), 2.84-2.72 (m, 1H), 2.18 (td, *J* = 11.3, 5.1 Hz, 1H), 2.00 (dd, *J* = 21.1, 10.5 Hz, 1H), 1.83-1.68 (m, 2H), 1.02 (td, *J* = 7.4, 3.1 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 212.2, 91.6, 39.6, 28.4, 26.1, 7.6; HRMS (ESI): calcd for $C_6H_{11}O_2$: 115,0759 [M+H], found: 115,0760. Spectral data are in agreement with the literature.[8]



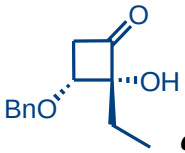
2-Hydroxy-2-phenyl-cyclobutanone 1c. Compound **1c** was synthetized as described above. 1-Phenyl-butane-1,2-dione **A2** (712 mg, 4.4 mol), CH_3CN (10 mL). Flash chromatography (*n*-hexane/Et_2O, 5:1). Colourless oil, 35% yield (249 mg); *Rf* = 0.6; FTIR (film), cm^{-1} ν: 3407, 2923, 2842, 1781, 1494, 1452, 1070, 1005, 757, 702; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.65-7.22 (m, 5H), 3.66 (s, 1H), 3.02-2.91 (m, 2H), 2.74-2.63 (m, 1H), 2.36 (dd, *J* = 22.1, 10.2 Hz, 1H); ^{13}C NMR

(126 MHz, $CDCl_3$) δ: 209.2, 138.8, 129.0, 128.8, 126.1, 92.6, 41.0, 28.0; HRMS (ESI): calcd for $C_{10}H_{11}O_2$: 163,0759 [M+H], found: 163,0760. Spectral data are in agreement with the literature.[9]

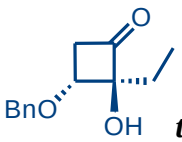


2-Hydroxy-3-methyl-2-phenyl-cyclobutanone 1d. Compound **1d** was synthetized as described above. 1-Phenyl-pentane-1,2-dione **A3** (774 mg, 4.4 mol), CH_3CN (10 mL). Flash chromatography (*n*-hexane/Et_2O, 5:1). (inseparable 70:30 mixture of diastereoisomers). Colourless oil, 38% yield (294 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 3409, 2967, 2930, 1777, 1495, 935, 755, 695, 625; (Major isomer): ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.52-6.96 (m, 5H), 3.88 (br. s, 1H), 3.12 (dd, *J* = 16.6, 8.8 Hz, 1H), 2.66-2.58 (m, 1H), 2.57-2.54 (m, 1H), 0.88 (d, *J* = 6.7 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 213.7, 140.3, 131.5, 131.0, 129.3, 97.0, 51.7, 37.6, 19.5. (Minor isomer): ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.52-7.00 (m, 5H), 3.88 (br. s, 1H), 3.00-2.68 (m, 1H), 2.61 (dd, *J* = 14.6, 7.1 Hz, 1H), 2.46 (dd, *J* = 14.6, 4.8 Hz, 1H), 1.27 (d, *J* = 7.1 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 212.2, 142.5, 131.5, 131.0, 128.7, 94.8, 51.6, 34.8, 16.8. HRMS (ESI): calcd for $C_{11}H_{13}O_2$: 177,0916 [M+H], found: 177,0917.

***cis/trans*-3-Benzyloxy-2-ethyl-2-hydroxy-cyclobutanone**. In a 50 mL round bottom two neck flask, diones **A4** (968 mg, 4.4 mol) were dissolved in CH_3CN (10 mL) and irradiated at 405 nm (blue LED) for 2-16h (25° C) and followed by GC-MS. The organic solutions were evaporated under reduced pressure and purified by flash chromatography without previous work-up. (Flash chromatography (*n*-hexane/Et_2O, 10:1-5:1)) yielding the corresponding ***cis*-1e** and ***trans*-1e** diastereoisomers as pure products.

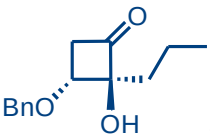


***cis*-3-Benzyloxy-2-ethyl-2-hydroxy-cyclobutanone *cis*-1e.** Colourless oil, 36% yield (348 mg); *Rf* = 0.5; FTIR (film), cm^{-1} ν: 3417, 2921, 2853, 2398, 1716, 1604, 1496, 1455, 1407, 1358, 1264, 1180, 1107, 1026, 801, 741, 699; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.43-7.29 (m, 5H), 4.64 (d, *J* = 3.1 Hz, 2H), 4.05 (dd, *J* = 6.5, 2.4 Hz, 1H), 3.37 (s, 1H), 3.10 (dd, *J* = 18.1, 6.5 Hz, 1H), 2.73 (dd, *J* = 18.1, 2.4 Hz, 1H), 1.86-1.62 (m, 2H), 1.02 (t, *J* = 7.4 Hz, 3H); HRMS (ESI): calcd for $C_{13}H_{17}O_3$: 221,1178 [M+H], found: 221,1179.

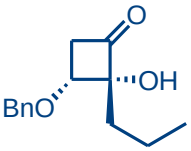


***trans*-3-Benzyloxy-2-ethyl-2-hydroxy-cyclobutanone *trans*-1e.** Colourless oil, 54% yield (522 mg); *Rf* = 0.4; FTIR (film), cm^{-1} ν: 3417, 2921, 2853, 2398, 1716, 1604, 1496, 1455, 1407, 1358, 1264, 1180, 1107, 1026, 801, 741, 699; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.49-7.31 (m, 5H), 4.63 (dd, *J* = 30.2, 11.8 Hz, 2H), 4.17 (t, *J* = 8.0 Hz, 1H), 2.98 (dd, *J* = 8.0, 1.3 Hz, 1H), 1.96 (ddt, *J* = 30.2, 14.9, 7.5 Hz, 2H), 1.43 (br. s, 1H), 1.04 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 212.5, 137.6, 128.7, 128.1, 128.0, 107.5, 93.4, 72.9, 47.1, 24.2, 7.9; HRMS (ESI): calcd for $C_{13}H_{17}O_3$: 221,1178 [M+H], found: 221,1178.

***cis/trans*-3-Benzyloxy-2-hydroxy-2-propyl-cyclobutanone**. In a 50 mL round bottom two neck flask, diones **A5** (1.03 g, 4.4 mol) were dissolved in CH_3CN (10 mL) and irradiated at 405 nm (blue LED) for 2-16h (25° C) and followed by GC-MS. The organic solutions were evaporated under reduced pressure and purified by flash chromatography without previous work-up. (Flash chromatography (*n*-hexane/Et_2O, 10:1-5:1)) yielding the corresponding ***cis*-1e** and ***trans*-1e** diastereoisomers as pure products.



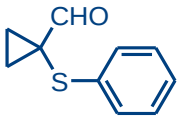
***cis*-3-Benzyloxy-2-hydroxy-2-propyl-cyclobutanone *cis*-1f.** Colourless oil, 43% yield (442 mg); *Rf* = 0.6; FTIR (film), cm^{-1} ν: 3438, 2981, 1718, 1452, 1277, 1115, 1029, 715, 699; ^1H NMR (500 MHz, $CDCl_3$) δ: 7.53-7.15 (m, 5H), 4.63 (dd, *J* = 36.9, 11.8 Hz, 2H), 4.13 (t, *J* = 8.0 Hz, 1H), 3.10-2.80 (m, 2H), 1.89 (td, *J* = 10.9, 5.2 Hz, 2H), 1.57 (ddd, *J* = 18.2, 11.8, 5.2 Hz, 1H), 1.46-1.34 (m, 1H), 0.96 (t, *J* = 7.3 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 208.4, 137.5, 128.6, 128.1, 127.8, 93.2, 74.6, 72.8, 46.9, 46.9, 33.2, 17.0, 14.5, 14.5; HRMS (ESI): calcd for $C_{14}H_{19}O_3$: 235,1334 [M+H], found: 235,1335.



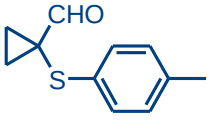
***trans*-3-Benzyloxy-2-hydroxy-2-propyl-cyclobutanone *trans*-1f.** Colourless oil, (extrapolated from the 60:40 mixture of *cis-/trans*-isomers), 53% yield. FTIR (film), cm^{-1} ν: 3440, 2985, 1719, 1450, 1279, 1115, 1029; ^1H NMR (500 MHz, $CDCl_3$) δ: 7.49-7.22 (m, 5H), 4.66 (ABq, *J* = 12.4 Hz, 2H), 4.15 (t, *J* = 8.0 Hz, 1H), 4.07 (dd, *J* = 6.5, 2.4 Hz, 1H), 4.07 (dd, *J* = 6.5, 2.4 Hz, 1H), 3.43 (br. s, 1H), 3.14 (dd, *J* = 18.1, 6.5 Hz, 1H), 2.75 (dd, *J* = 18.1, 2.4 Hz, 1H), 1.76-1.36 (m, 4H), 0.97 (t, *J* = 7.5 Hz, 3H); HRMS (ESI): calcd for $C_{14}H_{19}O_3$: 235,1334 [M+H], found: 235,1337.

4. Synthesis of cyclopropylphenylthio and cyclopropylphenylselenyl carbaldehydes 3a-w and cyclobutanones 5x,y

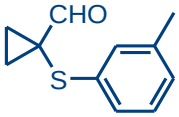
In a 5 mL glass vial, 2-hydroxycyclobutanone **1a** (50 mg, 0.58 mmol) arylthiols **2a-y** (1.0 equiv.) and PTSA (20 mol%) in 2.0 mL of CH_2Cl_2 were gently stirred for 2-16h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by flash chromatograpy (hexanes-diethyl ether 10:1-5:1).



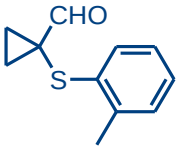
1-Phenylsulfanyl-cyclopropanecarbaldehyde 3a. Compound **3a** was synthetized as described above. (50 mg, 0.58 mmol), **2a** (63 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 93% yield (96 mg); *Rf* = 0.9; FTIR neat (KBr), cm^{-1} ν: 2961, 2707, 1710, 1496, 1263, 1113, 960; ^1H NMR (500 MHz, $CDCl_3$) δ: 9.60 (s, 1H), 7.29-7.19 (m, 5H), 1.75 (dd, *J* = 4.5, 7.9 Hz, 2H), 1.54 (s, 1H), 1.46 (dd, *J* = 5.0, 7.6 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.6, 129.0, 128.1, 126.3, 107.3, 20.8; HRMS (ESI): calcd for $C_{10}H_{11}OS$: 179,0531 $[M+H]^+$, found: 179,0544. Spectral data are in agreement with the literature.[10]



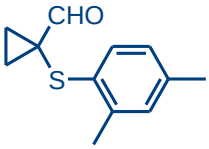
1-*p*-Tolylsulfanyl-cyclopropanecarbaldehyde 3b. Compound **3b** was synthetized as described above. (50 mg, 0.58 mmol), **2b** (72 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 92% yield (102 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3230, 2910, 2814, 2571, 1827, 1670, 1588, 1342, 1140, 863; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.59 (s, 1H), 7.22 (d, *J* = 8.2 Hz, 3H), 7.10 (d, *J* = 8.2 Hz, 3H), 2.32 (s, 3H), 1.71 (q, *J* = 4.3 Hz, 2H), 1.45 (q, *J* = 4.3 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.7, 136.7, 132.9, 129.8, 129.0, 54.6, 20.9, 20.7; HRMS (ESI): calcd for $C_{11}H_{13}OS$: 193.0687 ($M-H^+$), found: 193.0680.



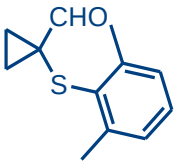
1-*m*-Tolylsulfanyl-cyclopropanecarbaldehyde 3c. Compound **3c** was synthetized as described above. (50 mg, 0.58 mmol), **2c** (72 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 92% yield (103 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 3020, 2910, 2817, 2570, 1825, 1668, 1588, 1343, 1140, 874; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.61 (s, 1H), 7.17 (t, *J* = 7.6 Hz, 1H), 7.11 – 7.06 (m, 2H), 7.00 (d, *J* = 7.3 Hz, 1H), 2.31 (s, 3H), 1.75 (q, *J* = 4.3 Hz, 2H), 1.45 (q, *J* = 4.3 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.7, 138.9, 135.4, 128.9, 128.6, 127.2, 125.1, 34.3, 21.3, 20.8; calcd for $C_{11}H_{13}OS$: 193.0687 ($M-H^+$), found, found: 193.0679.



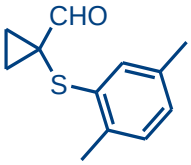
1-*o*-Tolylsulfanyl-cyclopropanecarbaldehyde 3d. Compound **3d** was synthetized as described above. (50 mg, 0.58 mmol), **2d** (72 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 96% yield (106 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3012, 2989, 2818, 1827, 1669, 1586, 1345, 1129, 870; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.58 (s, 1H), 7.62-7.43 (m, 2H), 7.11 (ddd, *J* = 10.6, 6.1, 1.7 Hz, 2H), 2.32 (s, 3H), 1.80 (q, *J* = 4.3 Hz, 2H), 1.43 (q, *J* = 4.3 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.8, 137.3, 135.4, 130.2, 128.6, 127.2, 126.6, 125.6, 32.9, 20.8, 19.9; HRMS (ESI): calcd for $C_{11}H_{13}OS$: 193,0687 ($M-H^+$), found: 193.0710.



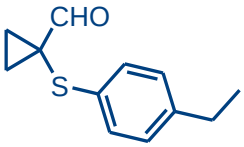
1-(2,4-Dimethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3e. Compound **3e** was synthetized as described above. (50 mg, 0.58 mmol), **2e** (80 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 92% yield (110 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3104, 3043, 2968, 2739, 2578, 1984, 1601, 1270, 1212, 993; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.60 (s, 1H), 7.08 (d, *J* = 7.9 Hz, 1H), 7.01-6.86 (m, 2H), 2.31 (s, 3H), 2.27 (s, 3H), 1.77 (q, *J* = 4.3 Hz, 2H), 1.43 (q, *J* = 4.3 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 201.1, 135.6, 131.6, 131.2, 130.5, 127.3, 126.6, 33.5, 20.9, 20.7, 20.0; HRMS (ESI): calcd for $C_{12}H_{15}OS$: 207.0844 ($M-H^+$), found: 207.0840.



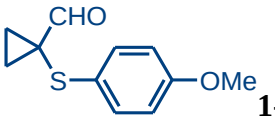
1-(2,6-Dimethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3f. Compound **3f** was synthetized as described above. (50 mg, 0.58 mmol), **2f** (80 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 92% yield (109 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 3100, 3040, 2967, 2735, 1980, 1604, 1270, 1203, 998; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 9.71 (s, 1H), 7.17-6.97 (m, 3H), 2.46 (s, 6H), 1.53 (q, *J* = 4.4 Hz, 2H), 1.22 (q, *J* = 4.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.9, 143.0, 131.8, 128.7, 128.3, 127.8, 36.8, 22.8, 21.6; HRMS (ESI): calcd for $C_{12}H_{15}OS$: 207.0844 ($M+H^+$), found: 207.0831.



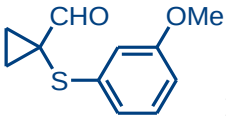
1-(2,5-Dimethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3g. Compound **3g** was synthetized as described above. (50 mg, 0.58 mmol), **2g** (80 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 96% yield (114 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 2931, 2820, 2714, 1707, 1482, 1263, 996; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.26 (s, 1H), 7.04 (d, *J* = 7.6 Hz, 1H), 6.96 (s, 1H), 6.90 (d, *J* = 7.6 Hz, 1H), 2.29 (s, 3H), 2.28 (s, 3H), 1.82 (q, *J* = 4.3 Hz, 2H), 1.48-1.42 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 201.2, 136.2, 135.0, 132.5, 130.1, 126.5, 33.0, 21.2, 21.0, 19.5; HRMS (ESI): calcd for $C_{12}H_{15}OS$: 207.0844 ($M+H^+$), found: 207.0835 .



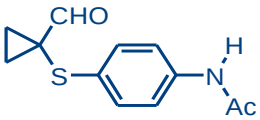
1-(4-Ethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3h. Compound **3h** was synthetized as described above. (50 mg, 0.58 mmol), **2h** (80 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Colourless oil, 92% yield (109 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3053, 1715, 1415, 1293, 1121, 1066, 857; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 9.61 (s, 1H), 7.24 (d, *J* = 8.2 Hz, 2H), 7.12 (d, *J* = 8.3 Hz, 2H), 2.61 (q, *J* = 7.6 Hz, 2H), 1.72 (q, *J* = 4.3 Hz, 2H), 1.45 (q, *J* = 4.4 Hz, 2H), 1.21 (t, *J* = 7.6 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 200.8, 143.0, 132.1, 129.0, 128.6, 109.9, 34.9, 28.3, 20.8, 15.4; HRMS (ESI): calcd for $C_{12}H_{15}OS$: 207.0844 ($M+H^+$), found: 207.0836.



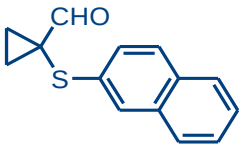
1-(4-Methoxy-phenylsulfanyl)-cyclopropanecarbaldehyde 3i. Compound **3i** was synthetized as described above. (50 mg, 0.58 mmol), **2i** (81 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 93% yield (96 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 3173, 2923, 2438, 2134, 1946, 1690, 1128, 802; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 9.55 (s, 1H), 7.33 (d, *J* = 8.8 Hz, 2H), 6.84 (d, *J* = 8.8 Hz, 2H), 3.79 (s, 3H), 1.63 (t, *J* = 3.7 Hz, 2H), 1.44 (q, *J* = 4.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.5, 159.3, 132.5, 125.4, 114.6, 55.3, 36.4, 20.4; HRMS (ESI): calcd for $C_{11}H_{13}O_2S$: 209.0636 ($M+H^+$), found: 209.0629. Spectral data are in agreement with the literature.[4]



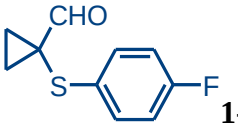
1-(3-Methoxy-phenylsulfanyl)-cyclopropanecarbaldehyde 3j. Compound **3j** was synthetized as described above. (50 mg, 0.58 mmol), **2j** (81 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 95% yield (98 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 3070, 2974, 2800, 2650, 2394, 2938, 1724, 1656, 1557, 1181, 1037; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 9.59 (s, 1H), 7.19 (t, *J* = 8.0 Hz, 1H), 6.90-6.78 (m, 2H), 6.73 (ddd, *J* = 8.3, 2.4, 0.7 Hz, 1H), 3.78 (s, 3H), 1.76 (q, *J* = 4.3 Hz, 2H), 1.46 (q, *J* = 4.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.5, 159.9, 137.1, 129.9, 120.0, 113.4, 111.9, 55.2, 34.2, 20.8; HRMS (ESI); calcd for $C_{11}H_{13}O_2S$: 209.0636 ($M+H^+$), found: 209.0632.



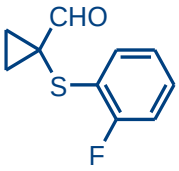
***N*-[4-(1-Formyl-cyclopropylsulfanyl)-phenyl]-acetamide 3k.** Compound **3k** was synthetized as described above. (50 mg, 0.58 mmol), **2k** (97 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 92% yield (125 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 3315, 3103, 2910, 2850, 1784, 1711, 1593, 1527, 1471, 1404, 1310, 1257, 964; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 9.50 (s, 1H), 7.53 (s, 1H), 7.43 (d, *J* = 8.6 Hz, 2H), 7.27 (d, *J* = 6.3 Hz, 2H), 2.15 (s, 3H), 1.79-1.62 (m, 2H), 1.46 (dt, *J* = 14.2, 6.9 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 200.3, 168.4, 136.9, 130.3, 130.0, 120.5, 38.9, 24.4, 20.5; HRMS (ESI): calcd for $C_{12}H_{14}NO_2S$: 236.0745 ($M+H^+$), found: 236.0789.



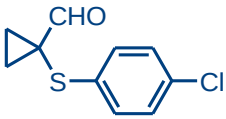
1-(Naphthalen-2-ylsulfanyl)-cyclopropanecarbaldehyde 3l. Compound **3k** was synthetized as described above. (50 mg, 0.58 mmol), **2k** (93 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). White solid Mp = 49-50 °C, 87% yield (115 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3050, 2817, 2712, 1707, 1587, 1496, 1260; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 9.62 (s, 1H), 7.74 (dd, *J* = 11.6, 8.8 Hz, 1H), 7.68 (d, *J* = 6.7 Hz, 1H), 7.47-7.38 (m, 2H), 7.34 (dd, *J* = 8.6, 1.8 Hz, 1H), 1.78 (q, *J* = 4.4 Hz, 2H), 1.49 (q, *J* = 4.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.6, 133.6, 133.2, 131.9, 128.7, 127.7, 127.1, 126.7, 126.2, 126.1, 125.9, 34.5, 20.9; HRMS (ESI): calcd for $C_{14}H_{13}OS$: 229,0687 ($M+H^+$), found: 229.0695.



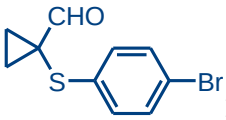
1-(4-Fluoro-phenylsulfanyl)-cyclopropanecarbaldehyde 3m. Compound **3m** was synthetized as described above. (50 mg, 0.58 mmol), **2m** (74 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Colorless oil, 87% yield (102 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 3012, 2899, 2816, 1716, 1227, 1128, 867; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 9.48 (s, 1H), 7.36-7.28 (m, 2H), 7.03-6.96 (m, 2H), 1.71 (q, *J* = 4.4 Hz, 2H), 1.46 (q, *J* = 4.5 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 199.8, 162.0 (d, *J* = 247.0 Hz), 131.4 (d, *J* = 8.0 Hz), 130.4 (d, *J* = 3.4 Hz), 116.1 (dd, *J* = 22.0, 8.8 Hz), 35.6, 20.3; HRMS (ESI): calcd for $C_{10}H_{10}FOS$: 197,0436 [M+H], found: 197.0430.



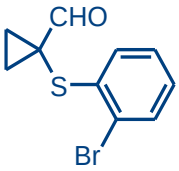
1-(2-Fluoro-phenylsulfanyl)-cyclopropanecarbaldehyde 3n. Compound **3n** was synthetized as described above. (50 mg, 0.58 mmol), **2n** (74 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Colorless oil, 92% yield (104 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3237, 2906, 2816, 2564, 2045, 1716, 1587, 1137, 870; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.67 (s, 1H), 7.38-7.25 (m, 2H), 7.26-7.17 (m, 1H), 7.16-7.00 (m, 1H), 1.73 (q, *J* = 4.4 Hz, 2H), 1.47 (q, *J* = 4.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.5, 160.55 (d, *J* = 245.2 Hz), 134.6, 131.0, 128.6 (d, *J* = 7.7 Hz), 124.6 (d, *J* = 3.0 Hz), 115.8 (d, *J* = 22.1 Hz), 34.1, 21.0; HRMS (ESI): calcd for $C_{10}H_{10}FOS$: 197,0436 [M+H], found: 197.0423.



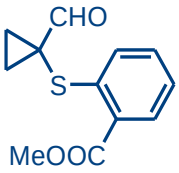
1-(4-Chloro-phenylsulfanyl)-cyclopropanecarbaldehyde 3o. Compound **3o** was synthetized as described above. (50 mg, 0.58 mmol), **2o** (84 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 91% yield (112 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3521, 2674, 2334, 2277, 1799, 1739, 1584, 1427, 1345; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.48 (s, 1H), 7.27-7.24 (m, 2H), 7.24-7.20 (m, 2H), 1.75 (q, *J* = 4.5 Hz, 2H), 1.47 (q, *J* = 4.5 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 199.7, 134.2, 132.5, 129.5, 129.1, 34.7, 20.4; HRMS (ESI): calcd for $C_{10}H_{10}ClOS$: 213,0141 [M+H], found: 213,0154.



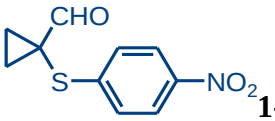
1-(4-Bromo-phenylsulfanyl)-cyclopropanecarbaldehyde 3p. Compound **3p** was synthetized as described above. (50 mg, 0.58 mmol), **2p** (109 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 96% yield (142 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 3095, 2950, 2820, 2714, 1710, 1476, 1257, 1090, 969; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.43 (d, *J* = 1.0 Hz, 1H), 7.35 (dd, *J* = 6.9, 1.6 Hz, 2H), 7.15-7.04 (m, 2H), 1.76-1.62 (m, 2H), 1.49-1.32 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 199.7, 134.9, 132.0, 129.6, 120.3, 34.5, 20.4; HRMS (ESI): calcd for $C_{10}H_{10}BrOS$: 258,9615 [M+H], found: 258.9610.



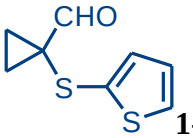
1-(2-Bromo-phenylsulfanyl)-cyclopropanecarbaldehyde 3q. Compound **3q** was synthetized as described above. (50 mg, 0.58 mmol), **2q** (109 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 92% yield (136 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 3053, 2814, 2714, 1707, 1443, 1254, 1018; ^1H NMR (400 MHz, $CDCl_3$) δ: 9.56 (s, 1H), 7.49 (dd, *J* = 7.9, 1.2 Hz, 1H), 7.21 (ddd, *J* = 8.6, 7.0, 1.3 Hz, 1H), 7.12 (dd, *J* = 8.0, 1.5 Hz, 1H), 7.00 (td, *J* = 7.8, 1.5 Hz, 1H), 1.83 (q, *J* = 4.4 Hz, 2H), 1.46 (q, *J* = 4.4 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 200.3, 137.7, 133.0, 127.9, 126.6, 126.4, 120.9, 33.2, 20.7; HRMS (ESI): calcd for $C_{10}H_{10}BrOS$: 258,9615 [M+H], found: 258.9604.



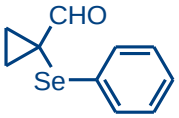
2-(1-Formyl-cyclopropylsulfanyl)-benzoic acid methyl ester 3r. Compound **3r** was synthetized as described above. (50 mg, 0.58 mmol), **2r** (97 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Colourless oil, 78% yield (108 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 3459, 2086, 1977, 1730, 1700, 1215, 1389; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 9.52 (s, 1H), 7.96 (d, *J* = 7.8 Hz, 1H), 7.39-7.31 (m, 1H), 7.25 (d, *J* = 8.1 Hz, 1H), 7.12 (t, *J* = 7.6 Hz, 1H), 3.85 (s, 3H), 1.90-1.71 (m, 2H), 1.50-1.28 (m, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 201.2, 166.8, 141.7, 132.9, 131.9, 126.6, 125.7, 124.7, 52.3, 32.8, 21.0; HRMS (ESI): calcd for $C_{12}H_{13}O_3S$: 237,0585 [M+H], found: 237,0591.



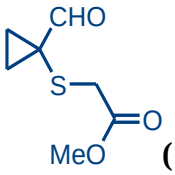
1-(4-Nitro-phenylsulfanyl)-cyclopropanecarbaldehyde 3s. Compound **3s** was synthetized as described above. (50 mg, 0.58 mmol), **2s** (90 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Yellow oil, 84% yield (108 mg); *Rf* = 0.6; FTIR (film), cm^{-1} ν: 3106, 3011, 2853, 1790, 1710, 1604, 1524, 1349, 1152, 855; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 9.34 (s, 1H), 8.06 (t, *J* = 2.0 Hz), 7.25 (t, *J* = 2.0 Hz, 2H), 1.83 (dd, *J* = 7.5, 4.5 Hz, 2H), 1.46 (dd, *J* = 7.5, 3.5 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 198.3, 146.1, 145.6, 126.0, 124.1, 33.2, 20.1; HRMS (ESI): calcd for $C_{10}H_{10}NO_3S$: 224,0381 [M+H], found: 224.0419.



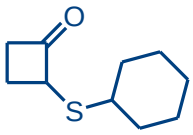
1-(Thiophen-2-ylsulfanyl)-cyclopropanecarbaldehyde 3u. Compound **3u** was synthetized as described above. (50 mg, 0.58 mmol), **2u** (67 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Pale yellow oil, 93 % yield (99 mg); *Rf* = 0.9; FTIR (film), cm^{-1} ν: 3004, 2879, 1717, 1439, 1276, 1129, 1028; ^{1}H NMR (500 MHz, cdcl$_3$) δ: 9.48 (s, 1H), 7.31-7.30 (m, 1H), 7.30-7.29 (m, 1H), 7.14-7.11 (m, 1H), 6.94-6.90 (m, 1H), 1.54-1.50 (m, 2H), 1.44 (dd, *J* = 7.7, 4.5 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 199.6, 136.8, 134.1, 130.0, 127.6, 38.6, 20.4; HRMS (ESI): calcd for $C_8H_9OS_2$: 185,0095[M+H], found: 185,0099.



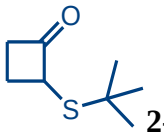
1-Phenylselanyl-cyclopropanecarbaldehyde 3v. Compound **3v** was synthetized as described above. (50 mg, 0.58 mmol), **2v** (92 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Pale yellow oil, 68% yield (89 mg); *Rf* = 0.9; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 9.45 (s, 1H), 7.55-7.38 (m, 2H), 7.37-7.18 (m, 3H), 1.73 (q, *J* = 4.5 Hz, 2H), 1.48 (q, *J* = 4.5 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 200.3, 132.0, 131.5, 129.2, 127.3, 30.5, 19.4. HRMS (ESI): calcd for $C_{10}H_{11}OSe$: 226.9975 [M+H], found: 226.9963. Spectral data are in agreement with the literature.[10]



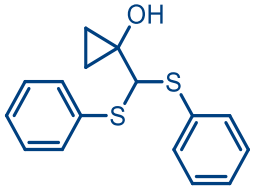
(1-Formyl-cyclopropylsulfanyl)-acetic acid methyl ester 3w. Compound **3w** was synthetized as described above. (50 mg, 0.58 mmol), **2w** (61 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Colourless oil, 72 % yield (72 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 2931, 2723, 1785, 1737, 1712, 1438, 1280, 1135, 1074, 1010; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 9.33 (s, 1H), 3.73 (s, 3H), 3.34 (s, 2H), 1.44-1.41 (m, 2H), 1.63-1.60 (m, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 199.3, 170.4, 52.4, 34.4, 19.7; HRMS (ESI): calcd for $C_7H_{11}O_3S$: 175,0429 [M+H], found: 175.0430.



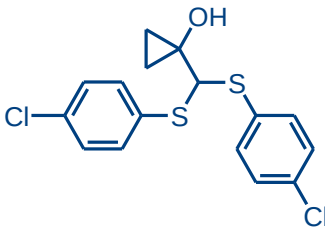
2-Cyclohexylsulfanyl-cyclobutanone 5x. Compound **3x** was synthetized as described above. (50 mg, 0.58 mmol), **2x** (67 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Colourless oil, 92% yield (98 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 2913, 2853, 1785, 1449, 1393, 1343, 1266, 1241, 1179, 1071, 999, 888; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 4.22 (ddt, *J* = 9.5, 6.6, 2.7 Hz, 1H), 3.24-3.13 (m, 1H), 3.07 (dddd, *J* = 17.7, 10.2, 7.4, 2.9 Hz, 1H), 2.94-2.83 (m, 1H), 2.46 (dtd, *J* = 11.7, 9.9, 6.2 Hz, 1H), 2.05-1.91 (m, 2H), 1.90-1.79 (m, 1H), 1.75 (dd, *J* = 7.1, 3.1 Hz, 2H), 1.60 (dd, *J* = 11.1, 3.6 Hz, 2H), 1.44-1.16 (m, 3H); ^{13}C NMR (101 MHz, $CDCl_3$) δ 206.2, 55.8, 44.8, 43.8, 33.8, 33.7, 25.9, 25.8, 25.5, 19.4; HRMS (ESI): calcd for $C_{10}H_{17}OS$: 185.1000 [M+H], found: 185.0985.



2-tert-Butylsulfanyl-cyclobutanone 5y. Compound **3y** was synthetized as described above. (50 mg, 0.58 mmol), **2y** (52 mg, 0.58 mmol), PTSA (22 mg, 0.12 mmol), CH_2Cl_2 (2.0 mL). Flash chromatograpy (hexanes-diethyl ether 10:1). Colourless oil, 74% yield (67 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 2975, 1789, 1516, 1398, 1218, 1070; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 4.21 (dd, *J* = 12.0, 9.0 Hz, 1H), 3.02 (t, *J* = 12.0, Hz, 2H), 2.48-2.37 (m, 1H), 1.82-1.78 (m, 1H), 1.28 (s, 9H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 206.8, 55.9, 45.1, 43.9, 31.5, 21.1; HRMS (ESI): calcd for $C_8H_{15}OS$: 159.0844 [M+H], found: 159.0678.

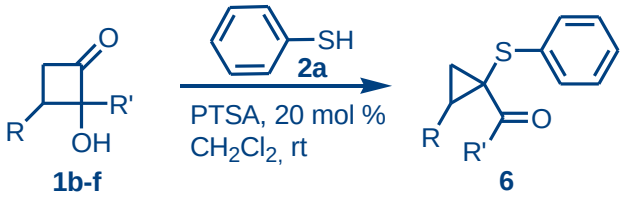


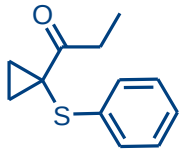
1-(bis(phenylthio)methyl)cyclopropanol 4a. White solid, Mp = 128 °C, 5% yield (8 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 3220, 3007, 2998, 1560, 1232, 1068 ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.34-7.30 (m, 2H), 7.27-7.23 (m, 3H), 7.23-7.19 (m, 5H), 4.66 (s, 1H), 1.35 (dd, *J* = 6.8, 5.1 Hz, 2H), 1.11 (q, *J* = 5.1 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 135.4, 135.2, 131.6, 130.8, 128.9, 128.8, 127.3, 126.8, 65.1, 31.2, 15.0; HRMS (ESI): calcd for $C_{16}H_{15}S_2$: 271,0615 (M+H – H_2O), found: 271,0617.



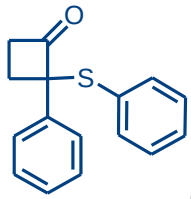
1-[(3-Chloro-phenylsulfanyl)-(4-chloro-phenylsulfanyl)-methyl] cyclopropanol 4o. Yellow oil, 4% yield (8 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 3350, 3000, 2989, 1491, 1210, 1022, 634; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 7.27 (m, 8H), 4.41(s, 1H), 1.27 (d, *J* = 8.0 Hz, 2H), 1.11 (d, *J* = 8.0 Hz, 2H); ^{13}C NMR (101 MHz, $CDCl_3$) δ: 134.0, 133.4, 133.3, 132.1, 130.1, 129.1, 129.0, 66.7, 31.6, 15.4; HRMS (ESI): calcd for $C_{16}H_{13}Cl_2S_2$: 338.9836 [M+H – H_2O), found: 338.9824.

5. Synthesis of 1-(1-Phenylsulfanyl-cyclopropyl)-propan-1-ones 6a-f

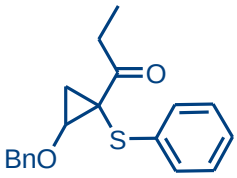




1-(1-Phenylsulfanyl-cyclopropyl)-propan-1-one 6b. As reported above for the synthesis of copounds **3a-w**, in a 5 mL glass vial, 2-hydroxycyclobutanone **1b** (68 mg, 0.58 mmol) arylthiol **2a** (1.0 equiv.) and PTSA (20 mol%) in 2.0 mL of CH_2Cl_2 were gently stirred for 8 h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by flash chromatography (hexanes-diethyl ether 10:1-5:1). Colourless oil, 90% yield (123 mg); *Rf* = 0.8; FTIR (film), cm^{-1} ν: 2976, 2918, 2849, 1697, 1584, 1479, 1439, 1249, 1118, 1025, 739; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.28 (t, *J* = 7.5 Hz, 2H), 7.20 (d, *J* = 8.2 Hz, 2H), 7.14 (td, *J* = 7.4, 1.0 Hz, 1H), 2.91 (tt, *J* = 7.1, 3.6 Hz, 2H), 1.89-1.72 (m, 2H), 1.37-1.20 (m, 2H), 1.00 (td, *J* = 7.2, 0.9 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 210.3, 137.2, 129.0, 125.8, 125.3, 33.4, 32.2, 22.0, 8.3; HRMS (ESI): calcd for $C_{12}H_{15}OS$: 207,0844 [M+H], found: 207,0845.

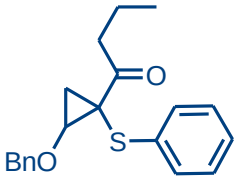


2-Phenyl-2-phenylsulfanyl-cyclobutanone 6c'. In a 5 mL glass vial, 2-hydroxycyclobutanone **1g** (100 mg, 0.61 mmol) arylthiol **2a** (1.0 equiv.) and PTSA (20 mol%) in 2.0 mL of CH_2Cl_2 were gently stirred for 8 h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by flash chromatography (hexanes-diethyl ether 10:1-5:1). Yellow oil, 73% yield (155 mg); *Rf* = 0.8; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 7.45 (m, 2H), 7.38 (t, *J* = 7.2 Hz, 2H), 7.34 (t, *J* = 7.2 Hz, 1H), 2.96 (dd, *J* = 9.8, 8.5 Hz, 2H), 2.72-2.62 (m, 1H), 2.36 (dt, *J* = 11.8, 10.2 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 204.10 (s), 138.15 (s), 136.27 (s), 131.03 (s), 129.3, 129.3, 128.8, 128.5, 128.2, 128.0, 127.7, 127.5, 127.2, 72.6, 42.9, 25.7, 17.1; HRMS (ESI): calcd for $C_{16}H_{14}NaOS$: 277,0663 [M+Na], found: 277,0664.



***trans*-1-(2-(benzyloxy)-1-(phenylthio)cyclopropyl)propan-1-one 6e (PTSA cat.).** In a 5 mL glass vial, 2-hydroxycyclobutanone **1e** (100 mg, 0.45 mmol) arylthiol **2a** (1.0 equiv.) and PTSA (20 mol%) in 2.0 mL of CH_2Cl_2 were gently stirred for 8 h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by Flash chromatography (hexanes-diethyl ether 10:1-5:1). Colourless oil, 90% yield (126 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 3477, 3038, 1708, 1446, 1028, 753; ^1H NMR (500 MHz, $CDCl_3$) δ: 7.55 (dd, *J* = 7.9, 1.5 Hz, 1H), 7.39 (dd, *J* = 18.6, 17.7 Hz, 1H), 7.33 (ddd, *J* = 25.0, 20.2, 2.5 Hz, 4H), 4.76 (dd, *J* = 10.0, 4.1 Hz, 1H), 4.56 (ddd, *J* = 9.6, 5.0, 2.5 Hz, 1H), 3.54 (d, *J* = 5.0 Hz, 1H), 2.43 (dddd, *J* = 25.0, 17.7, 10.4, 7.3 Hz, 1H), 2.19 (ddd, *J* = 14.2, 10.4, 2.5 Hz, 1H), 1.99 (ddd, *J* = 14.2, 10.0, 4.1 Hz, 1H), 1.10 (t, *J* = 7.3 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 212.2, 91.6, 39.6, 28.4, 26.1, 7.6; HRMS (ESI): calcd for $C_{19}H_{20}NaO_2S$: 335,1082 [M+Na], found: 335,1085; Chiral HPLC analysis (λ = 254 nm): I enantiomer t_R (13.52 min), II enantiomer t_R (17.41 min), Column: Phenomenex Lux 5u Cellulose-1; *i*-PrOH/*n*-hexane 5:95.

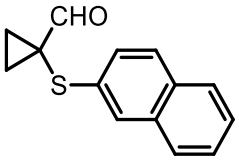
***trans*-1-(2-(benzyloxy)-1-(phenylthio)cyclopropyl)propan-1-one 6e (CSA cat.).** In a 5 mL glass vial, 2-hydroxycyclobutanone **1e** (100 mg, 0.45 mmol) arylthiol **2a** (1.0 equiv.) and CSA (20 mg 0.09 mmol) in 2.0 mL of CH_2Cl_2 were gently stirred for 8 h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by Flash chromatography (hexanes-diethyl ether 10:1-5:1). Colourless oil, 88% yield (123 mg); *Rf* = 0.7; Chiral HPLC analysis (λ = 254 nm): I enantiomer t_R (12.80 min), II enantiomer t_R (16.56 min), Column: Phenomenex Lux-5u Cellulose-1; *i*-PrOH/*n*-hexane 5:95.



***trans*-1-(2-Benzyloxy-1-phenylsulfanyl-cyclopropyl)-butan-1-one 6f.** In a 5 mL glass vial, 2-hydroxycyclobutanone **1f** (100 mg, 0.45 mmol) arylthiol **2a** (1.0 equiv.) and PTSA (20 mol%) in 2.0 mL of CH_2Cl_2 were gently stirred for 8 h at room temperature and followed by GC-MS. the solution was loaded in a silica gel column without further manipulations and purified by Flash chromatography (hexanes-diethyl ether 10:1-5:1). Colourless oil, 90% yield (128 mg); *Rf* = 0.7; FTIR (film), cm^{-1} ν: 3475, 3062, 1708, 1441, 1026, 752, 691; ^1H NMR (500 MHz, $CDCl_3$) δ: 7.57 (d, *J* = 1.4 Hz, 1H), 7.55 (s, 1H), 7.42 (d, *J* = 1.4 Hz, 1H), 7.40 (s, 1H), 4.77 (dd, *J* = 10.4, 3.9 Hz, 1H), 4.57-4.53 (m, 1H), 3.54 (d, *J* = 5.1 Hz, 1H), 2.43-2.30 (m, 3H), 2.22-2.19 (m, 1H), 2.20-2.17 (m, 1H), 2.16 (d, *J* = 2.6 Hz, 1H), 1.97 (ddd, *J* = 14.1, 10.1, 5.1 Hz, 2H), 1.68-1.58 (m, 3H), 0.91 (t, *J* = 7.4 Hz, 3H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 213.3, 135.0, 134.2, 131.1, 130.1, 129.8, 76.2, 56.5, 42.3, 41.9, 19.3, 15.8; HRMS (ESI): calcd for $C_{20}H_{22}NaO_2S$: 349,1238 [M+Na], found: 349,1239.

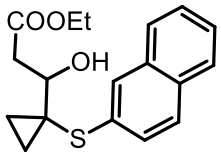
6. Formal synthesis of the anti-inflammatory bradykinin B-1 receptor antagonist intermediate 10

Synthesis of the acid **10** was achieved as reported below:



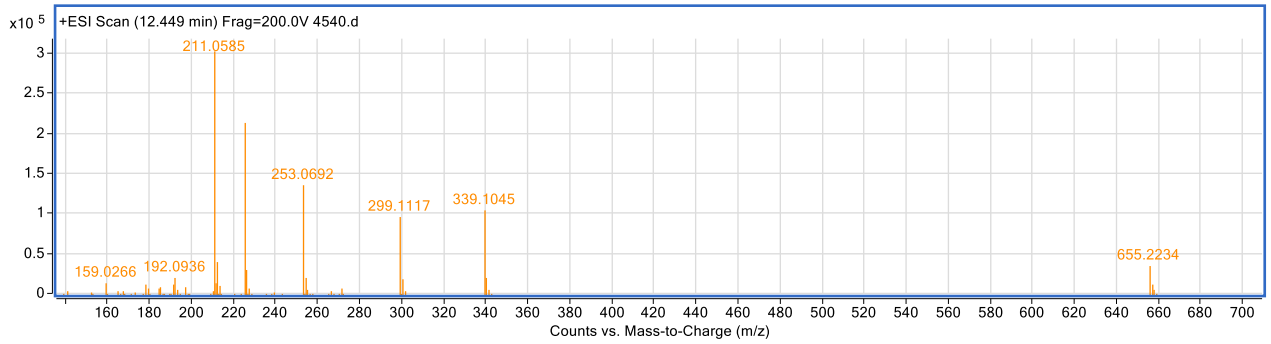
Synthesis of carbaldehyde 3l (2g scale).

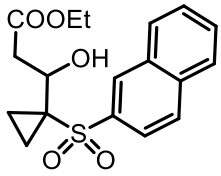
To a solution of 2-hydroxycyclobutanone **1a** (2.0 g, 0.024 mol) in CH_2Cl_2 (60 mL) and naphthylthiol **2l** (3.68 g, 0.024 mol), PTSA (0.88 g, 20 mol %) was added over 5 minutes. The reaction mixture, was gently stirred for 6h at 25°C and followed by GC-MS. The solution was evaporated under reduced pressure and the crude product was purified by flash chromatography (hexanes-diethyl ether 10:1) without further work-up to yield the corresponding naphthylthio carbaldehyde **3l** in 90% yield (4.72g).



Synthesis of ethyl 3-hydroxy-3-(1-(naphthalen-2-ylthio)cyclopropyl)-propanoate 7.

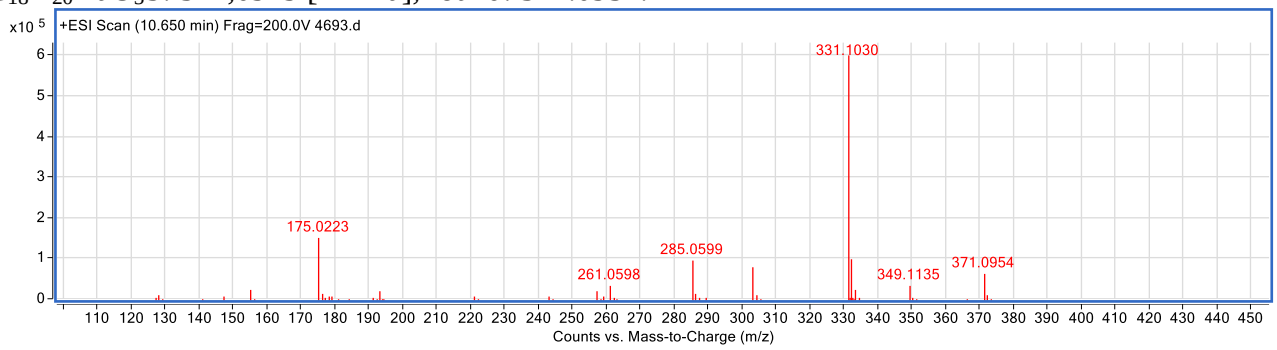
In a round-bottomed flask, *n*-BuLi (1.6 M in *n*-hexane, 1.25 mL, 2.0 mmol) was added to a solution of diisopropylamine (5.6 mL, 2.0 mmol) in dry THF (30 mL) at 0 °C under argon atmosphere. After stirring for 15 min at 0 °C, the resulting solution was cooled to -78 °C. Ethyl acetate (2.8 mL, 2.0 mmol) was then added to the solution, and the reaction mixture was stirred for 30 min at the same temperature. After addition of aldehyde **3l** (456 mg, 2.0 mmol) at -78 °C, the reaction mixture was warmed to room temperature and stirred for 2 h. The resulting solution was then poured into aq. NH_4Cl (15%, 30 mL) and extracted with AcOEt (30 mL×3). The combined organic phase was washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Compound **8** was isolated by column chromatography (silica gel, hexane/EtOAc) in 79% (500 mg) yield as a colourless oil. FTIR (film), cm^{-1} ν: 2919, 2857, 1730, 1560, 1304, 1131, 1126; ^1H NMR (500 MHz, $CDCl_3$) δ: 7.91 (s, 1H), 7.75 (dd, *J* = 18.1, 8.8 Hz, 3H), 7.51 (dd, *J* = 8.6, 1.7 Hz, 1H), 7.49 -7.36 (m, 2H), 4.13 (q, *J* = 7.1 Hz, 2H), 3.99 (dt, *J* = 9.2, 3.2 Hz, 1H), 3.14 (d, *J* = 4.3 Hz, 1H), 2.90 (dd, *J* = 16.3, 2.8 Hz, 1H), 2.67 (dd, *J* = 16.3, 9.6 Hz, 1H), 1.32 (ddd, *J* = 9.5, 6.2, 4.2 Hz, 1H), 1.24 (t, *J* = 7.1 Hz, 3H), 1.19-1.12 (m, 1H), 1.12-1.07 (m, 1H), 1.04-0.99 (m, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 172.9, 133.7, 131.7, 128.2, 127.6, 127.1, 126.7, 126.6, 126.4, 125.5, 71.3, 60.8, 39.7, 29.5, 14.1, 14.0, 12.6; HRMS (ESI): calcd for $C_{18}H_{20}NaO_3S$: 339,1031 [M+Na], found: 339.1045.

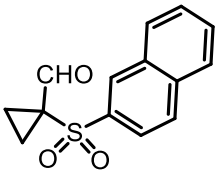




Synthesis of Ethyl 3-hydroxy-3-(1-(naphthalen-2-ylsulfonyl)cyclopropyl)propanoate 8.

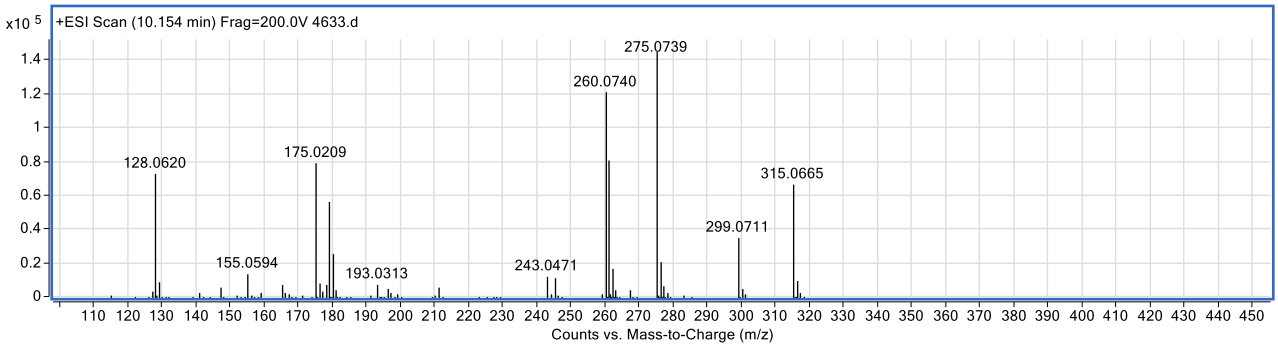
In a round-bottomed flask, *n*-BuLi (1.6 M in *n*-hexane, 1.56 mL, 2.5 mmol) was added to a solution of diisopropylamine (7.0 mL, 2.5 mmol) in dry THF (40 mL) at 0 °C under argon atmosphere. After stirring for 15 min at 0 °C, the resulting solution was cooled to -78 °C. Ethyl acetate (3.5 mL, 2.5 mmol) was then added to the solution, and the reaction mixture was stirred for 30 min at the same temperature. After addition of aldehyde **9** (650 mg, 2.5 mmol) at -78 °C, the reaction mixture was warmed to room temperature and stirred for 2 h. The resulting solution was then poured into aq. NH_4Cl (15%, 30 mL) and extracted with AcOEt (40 mL×3). The combined organic phase was washed with brine, dried over Na_2SO_4, filtered, and concentrated under reduced pressure. Compound **8** was isolated by column chromatography (silica gel, hexane/EtOAc 10:1-5:1) in 82% yield as a colourless oil, 82% yield (714 mg). FTIR (film), cm^{-1} ν: 3060, 2363, 1732, 1713, 1627, 1572, 1304, 1202, 1126, 926; ^{1}H NMR (500 MHz, CDC_3) δ: 8.47 (s, 1H), 8.06-7.96 (m, 2H), 7.93 (d, *J* = 8.2 Hz, 1H), 7.85 (dd, *J* = 8.7, 1.8 Hz, 1H), 7.74-7.56 (m, 2H), 4.39 (d, *J* = 7.0 Hz, 1H), 4.06 (q, *J* = 7.1 Hz, 2H), 3.29 (s, 1H), 2.74 (dd, *J* = 16.6, 3.3 Hz, 1H), 2.54 (dd, *J* = 16.6, 9.5 Hz, 1H), 1.78-1.56 (m, 2H), 1.28 (ddd, *J* = 9.9, 6.7, 4.8 Hz, 1H), 1.17 (t, *J* = 7.1 Hz, 3H), 1.09 (ddd, *J* = 9.1, 6.6, 4.9 Hz, 1H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 172.0, 136.0, 135.2, 132.1, 130.4, 129.4, 129.3, 129.2, 127.9, 127.6, 123.4, 65.9, 60.9, 45.3, 39.1, 13.9, 10.3, 9.5; HRMS (ESI): calcd for $C_{18}H_{20}NaO_5S$: 371,0929 [M+Na], found: 371.0954.

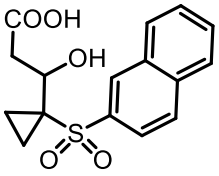




1-(Naphthalen-2-ylsulfonyl)cyclopropanecarbaldehyde 9. To a solution of aldehyde **3l** (2.0 g, 0.008 mol) in CH_2Cl_2 (100 mL) and cooled at 0° C, *m*-CPBA (ca. 72%) was added over 10 minutes (4.06 g, 0.017 mol). The reaction mixture, was gently stirred for 8h and followed by TLC. The resulting suspension was filtrated on a celite pad and the recovered solution was washed (2x30 mL) with $Na_2S_2O_{3acq}$ 20% and (2x30 mL) $NaHCO_{3acq}$ (20%). The organic layer was separated and concentrated under reduced pressure. The resulting crude product was purified by flash chromatography (hexanes-diethyl ether 10:1-5:1) to yield the corresponding naphthylsulfone **9** in 94% yield (1.95g). White solid Mp = 120-124° C; FTIR (film), cm^{-1} ν: 3108, 3061, 2919, 2859, 1705, 1564, 1315, 1276, 1200, 1147, 1121, 1074, 985; ^{1}H NMR (500 MHz, $CDCl_3$) δ: 9.92 (s, 1H), 8.54 (d, *J* = 1.1 Hz, 1H), 8.03 (d, *J* = 2.2 Hz, 1H), 8.02 (m, 1H), 7.95 (d, *J* = 8.1 Hz, 1H), 7.87 (dd, *J* = 8.7, 1.8 Hz, 1H), 7.68 (dtd, *J* = 16.2, 7.0, 1.2 Hz, 2H), 2.05 (q, *J* = 4.4 Hz, 2H), 1.69 (q, *J* = 4.5 Hz, 2H); ^{13}C NMR (126 MHz, $CDCl_3$) δ: 192.9, 136.4, 135.4, 132.2, 130.0,

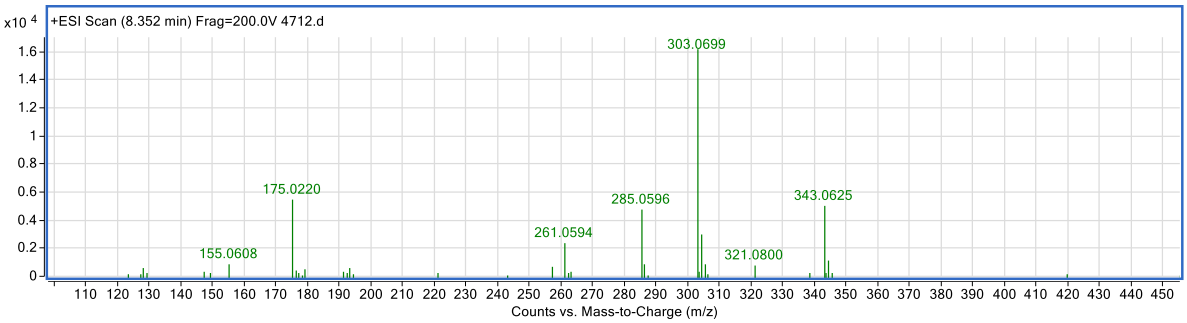
129.9, 129.6, 129.5, 128.0, 127.9, 122.5, 29.6, 18.4; HRMS (ESI): calcd for $C_{14}H_{12}O_3S$: 260,0507 [M], found: 260.0740. Spectral data are in agreement with the literature.[11]





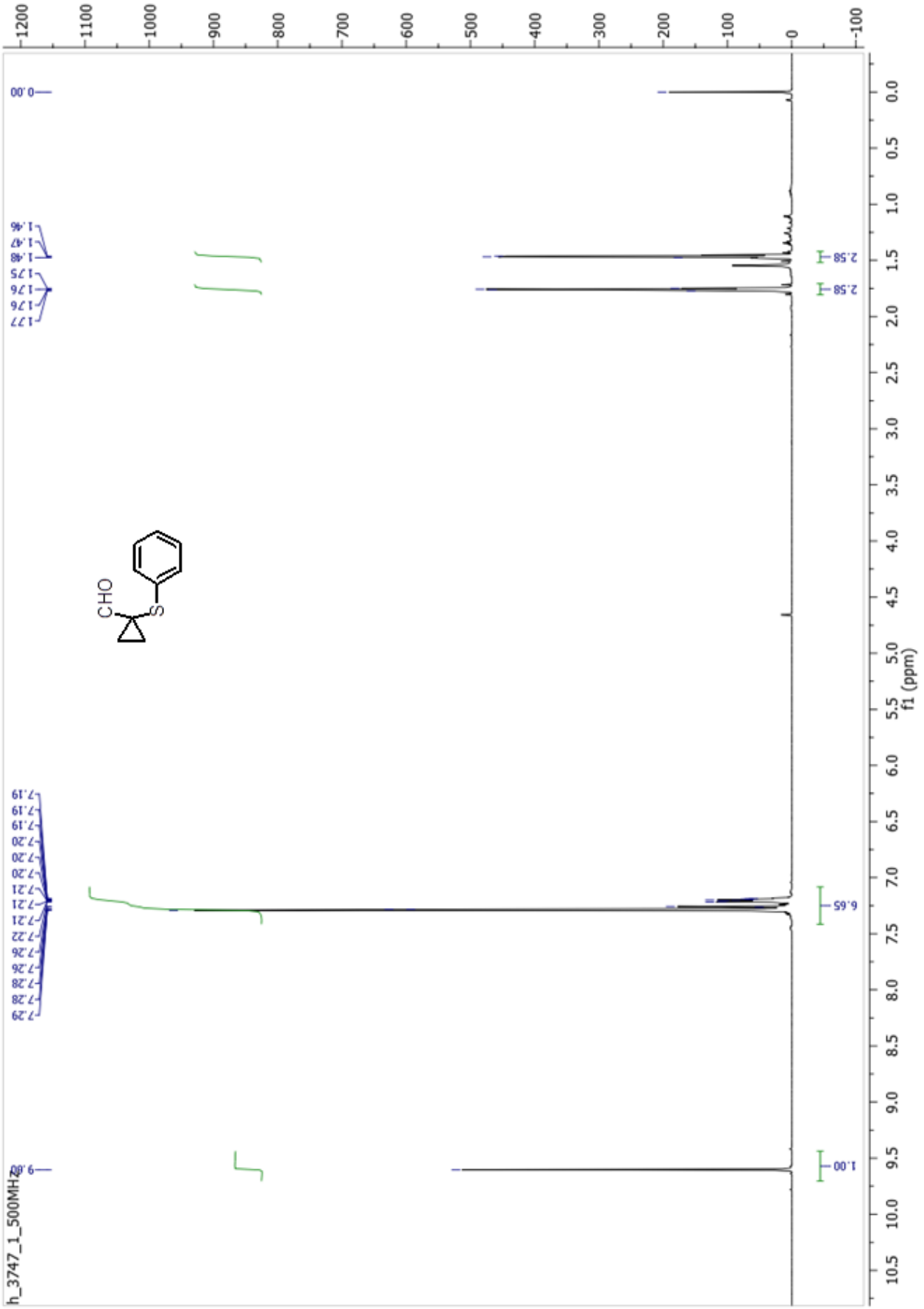
3-Hydroxy-3-(1-(naphthalen-2-ylsulfonyl)cyclopropyl)propanoic acid 10.

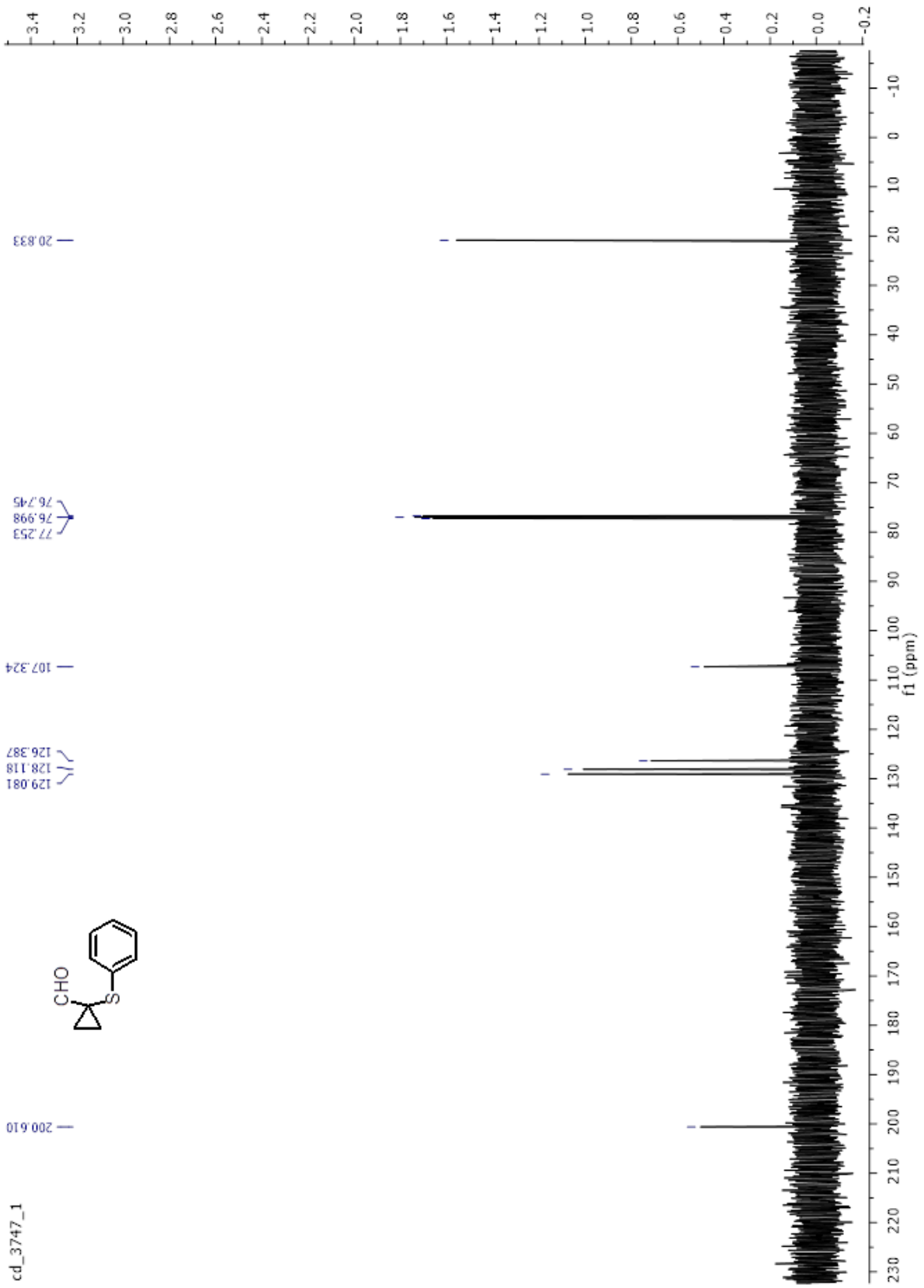
In a round bottom flask, ester **8** (600 mg, 1.72 mmol) was added to a KOH solution (20 mL, 0.3M) and stirred at 40° C for 7 h. The resulting solution was acidified with HCl (6M) and extracted with dichloromethane. The resulting solid was recrystallized from EtOAc/n-hexane to yield the carboxylic acid **10** in 88% yield (498 mg) as a white solid. Mp = 158-162° C; FTIR (film), cm^{-1} ν: 3012, 2956, 2925, 2554, 1726, 1622, 1572, 1475, 1325, 1218, 937; ^{1}H NMR (500 MHz, DMSO-*d6*) δ: 12.12 (s, 1H), 8.60 (s, 1H), 8.26 (d, *J* = 8.1 Hz, 1H), 8.22 (d, *J* = 8.7 Hz, 1H), 8.13 (d, *J* = 8.2 Hz, 1H), 7.91 (dd, *J* = 8.7, 1.7 Hz, 1H), 7.79 (dd, *J* = 11.0, 4.0 Hz, 1H), 7.74 (dd, *J* = 10.9, 4.0 Hz, 1H), 4.23 (dd, *J* = 10.0, 2.2 Hz, 1H), 3.36 (br. s, 2H), 2.77 (dd, *J* = 15.7, 2.4 Hz, 1H), 2.33 (dd, *J* = 15.7, 10.1 Hz, 1H), 1.57-1.50 (m, 1H), 1.50-1.44 (m, 1H), 1.23 (ddd, *J* = 11.1, 6.5, 4.5 Hz, 1H), 1.12 (ddd, *J* = 9.2, 6.8, 4.6 Hz, 1H); ^{13}C NMR (126 MHz, DMSO-*d6*) δ: 173.1, 137.4, 135.6, 132.6, 130.8, 130.3, 130.1, 130.0, 128.7, 128.5, 124.4, 107.7, 65.4, 46.3, 41.6, 10.6, 9.1; HRMS (ESI): calcd for $C_{16}H_{16}NaO_5S$: 343,0616 [M+Na], found: 343.0625. Spectral data are in agreement with the literature.[11]



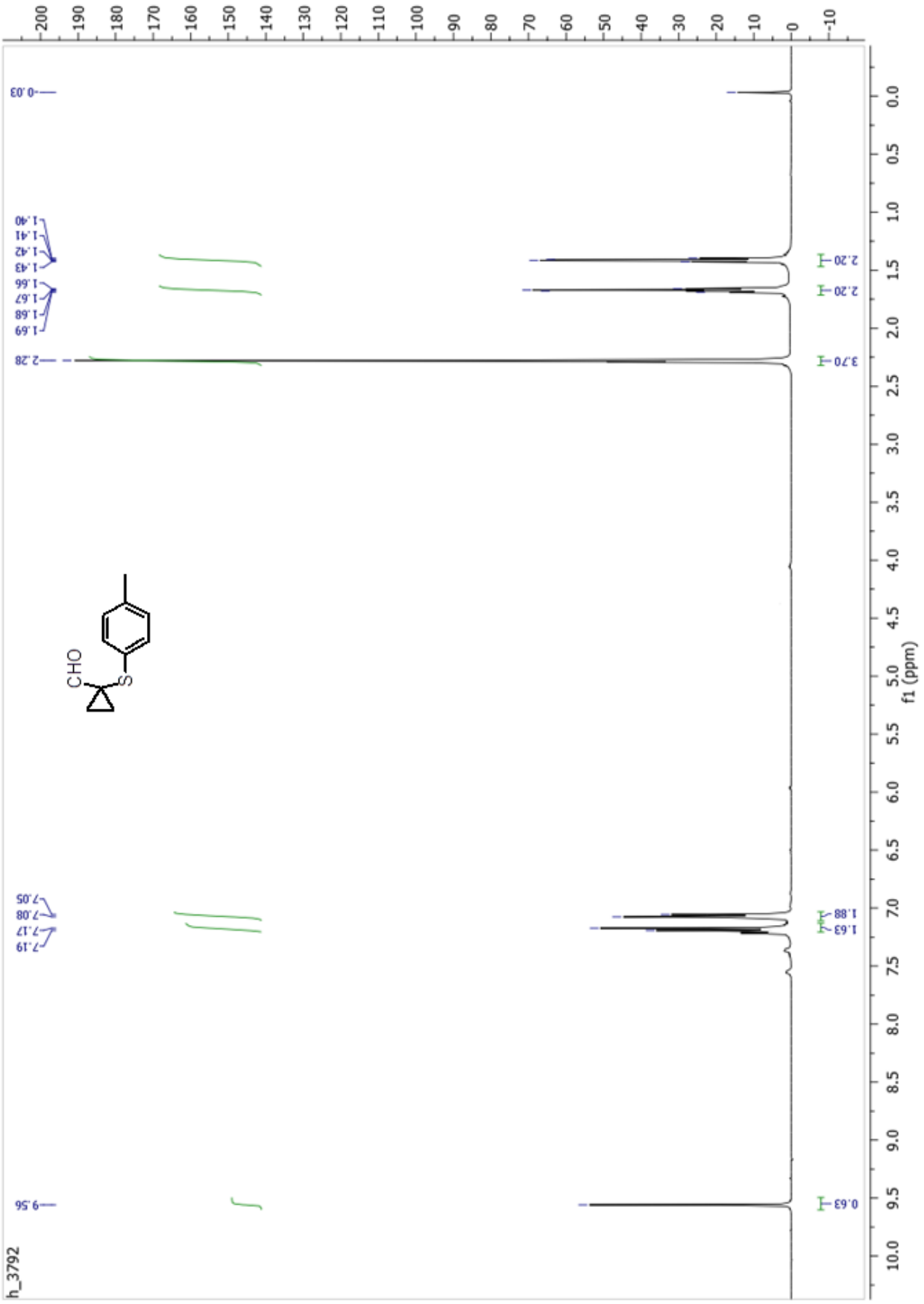
7. ^{1}H and ^{13}C NMR spectra of carbaldehydes 3a-s,v,w and cyclobutanons 5x,y

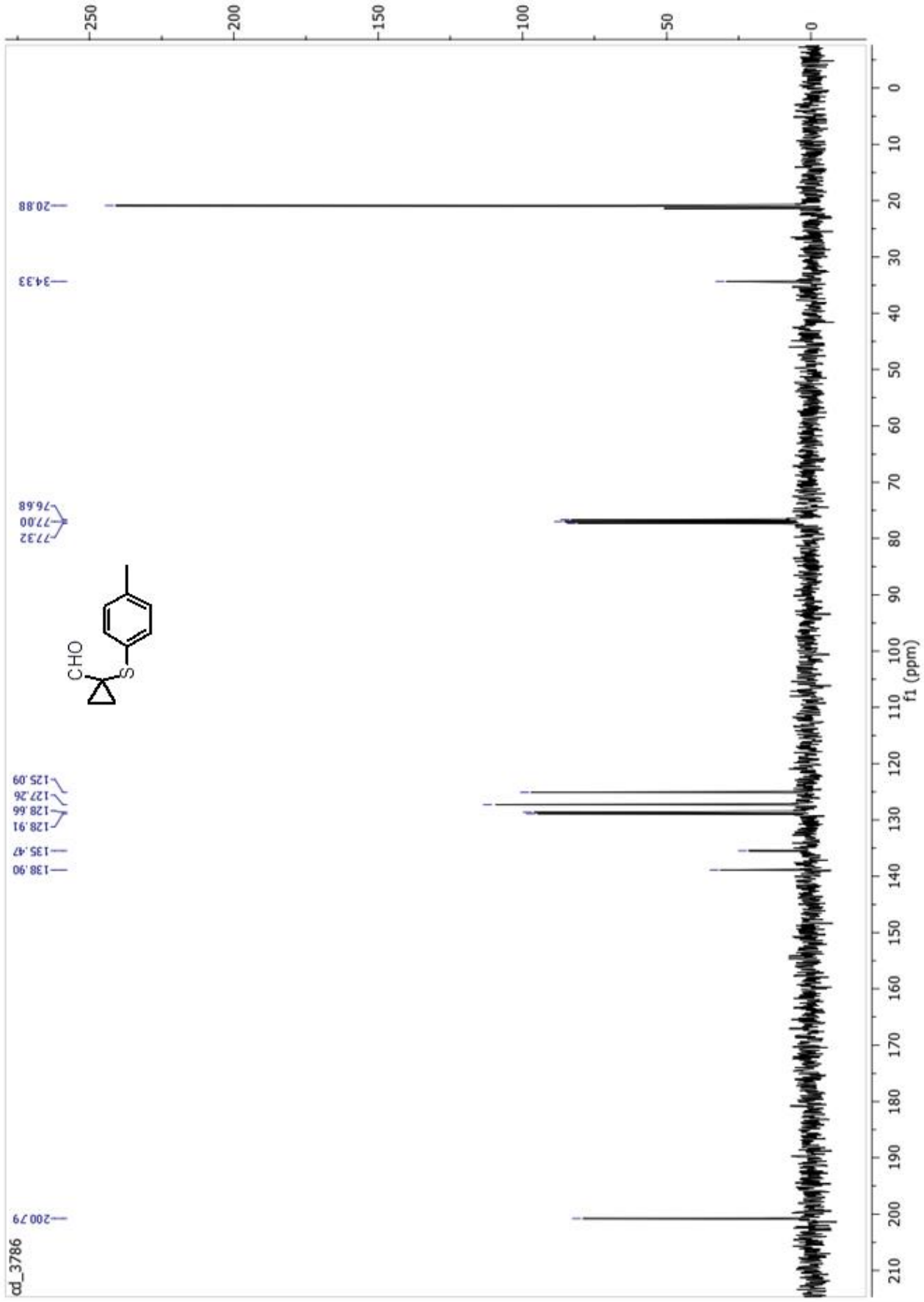
1-Phenylsulfanyl-cyclopropanecarbaldehyde 3a



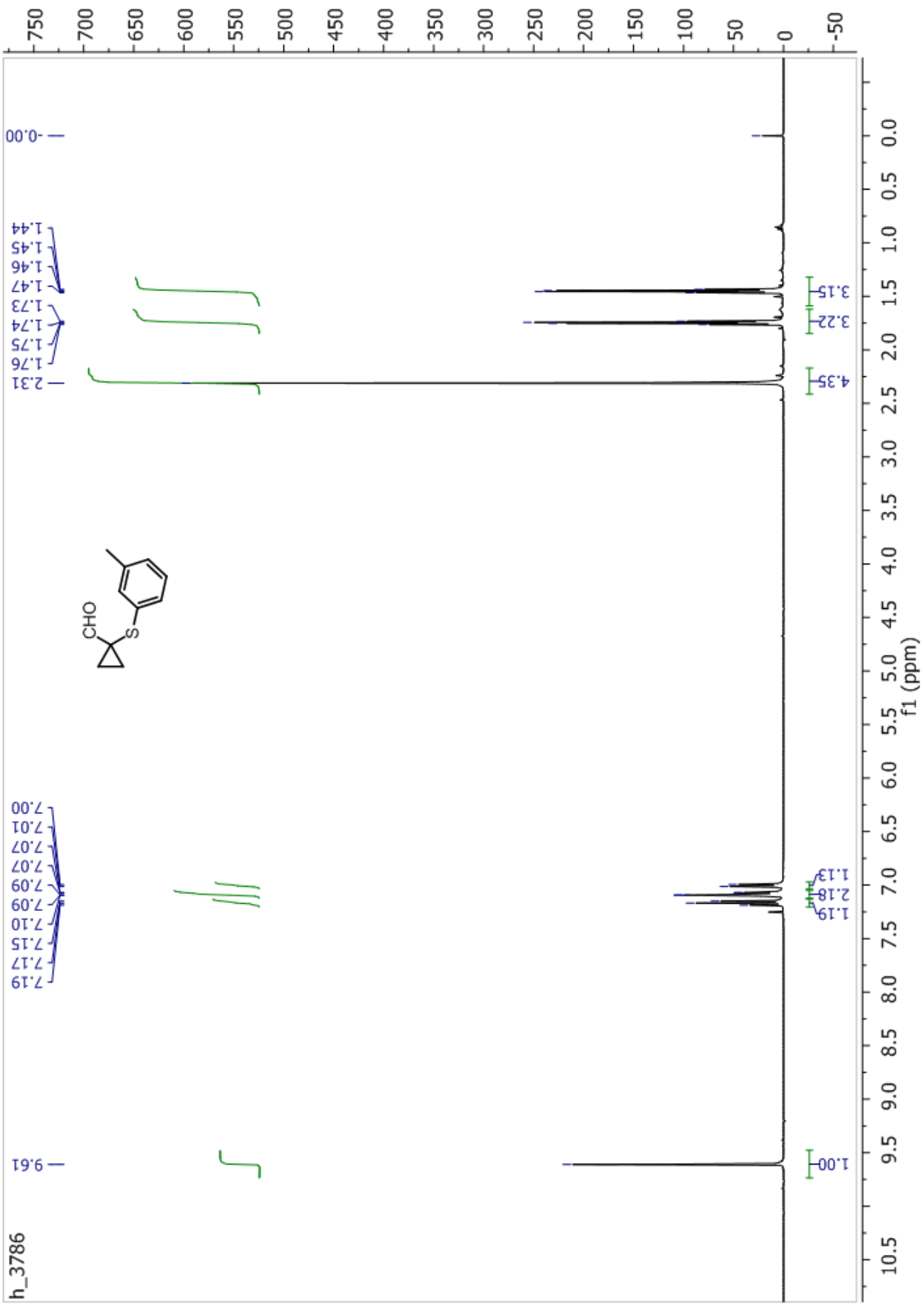

cd_3747_1
200.610
129.081
128.118
126.387
107.324
77.253
76.998
76.745
20.833
CHO
S
f1 (ppm)

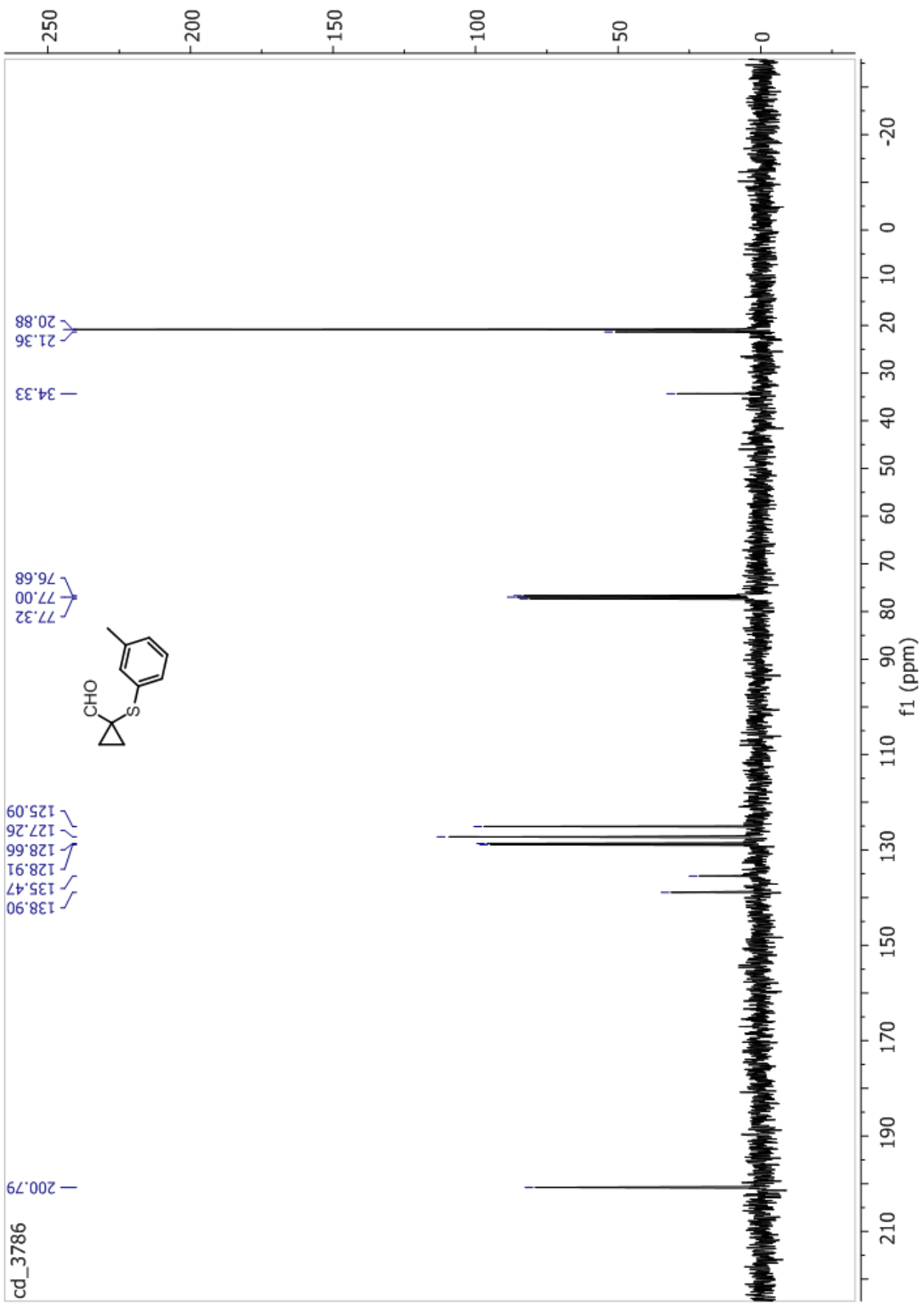
1-4-Tolylsulfanyl-cyclopropanecarbaldehyde 3b



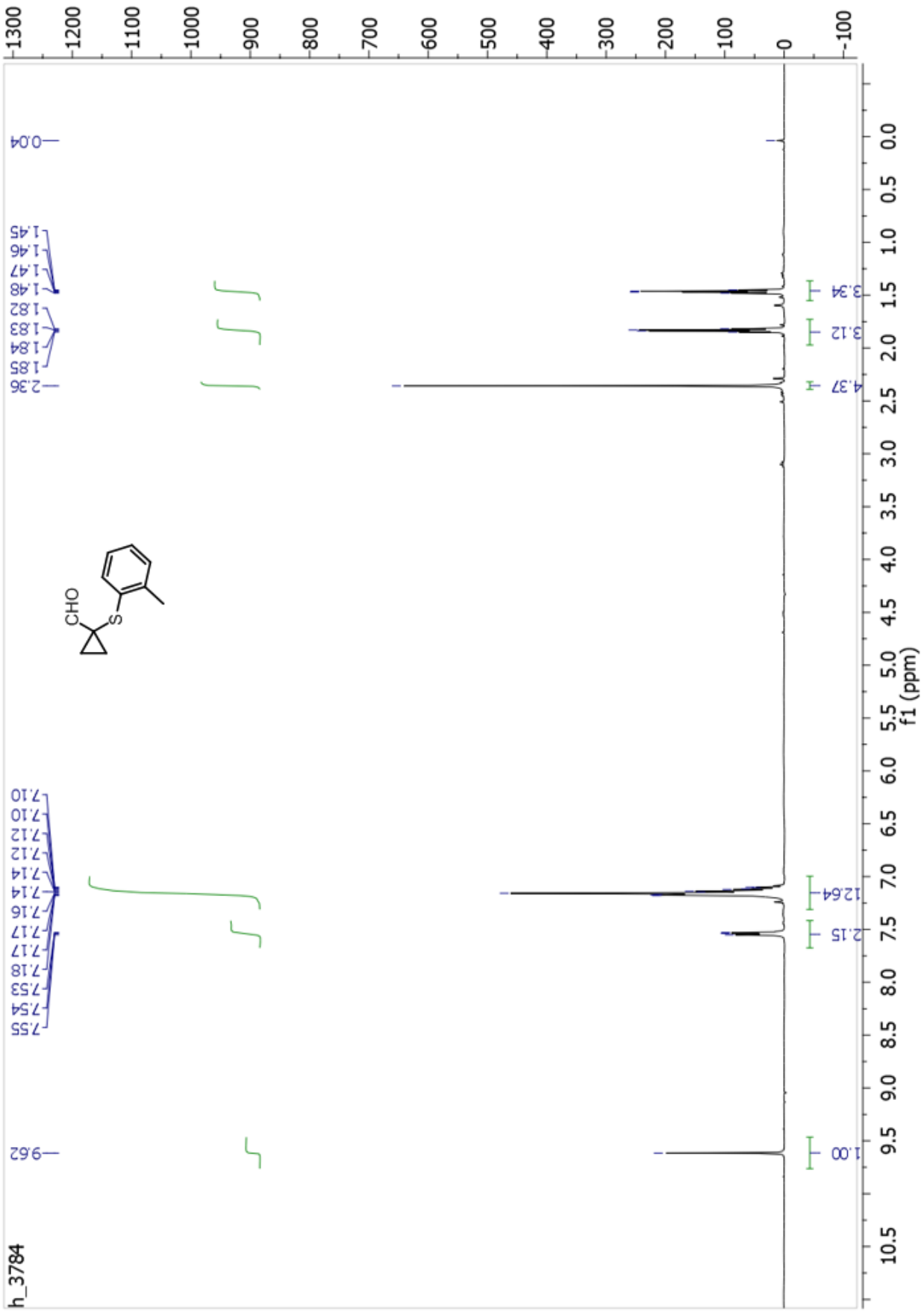

20.88
34.33
76.68
77.00
77.32
125.09
127.26
128.66
128.91
135.47
138.90
200.79
CHO
S
od_3786
f1 (ppm)

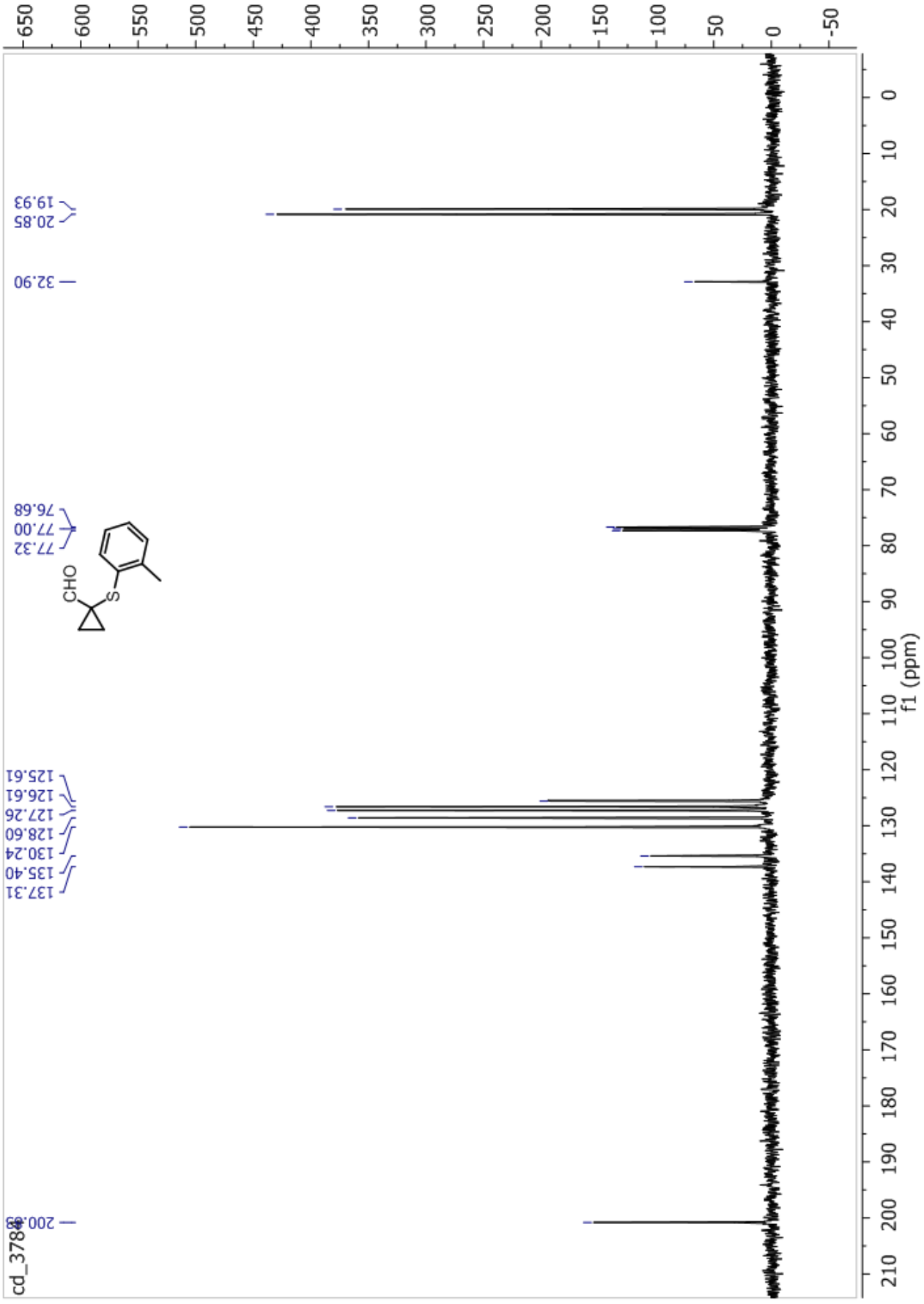
1-3-Tolylsulfanyl-cyclopropanecarbaldehyde 3c



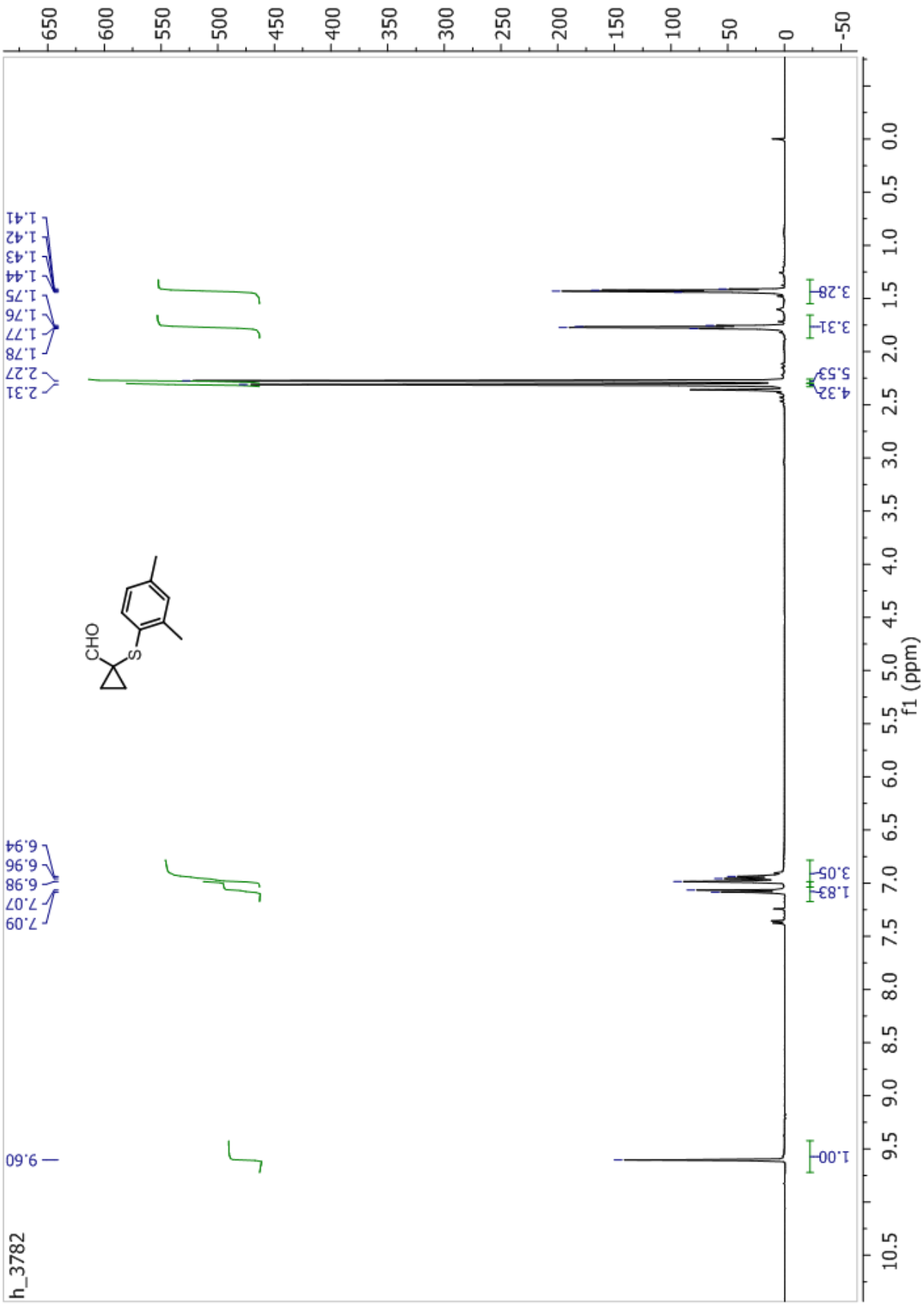

cd_3786
200.79
138.90
135.47
128.91
128.66
127.26
125.09
77.32
77.00
76.68
34.33
21.36
20.88
CHO
S
f1 (ppm)

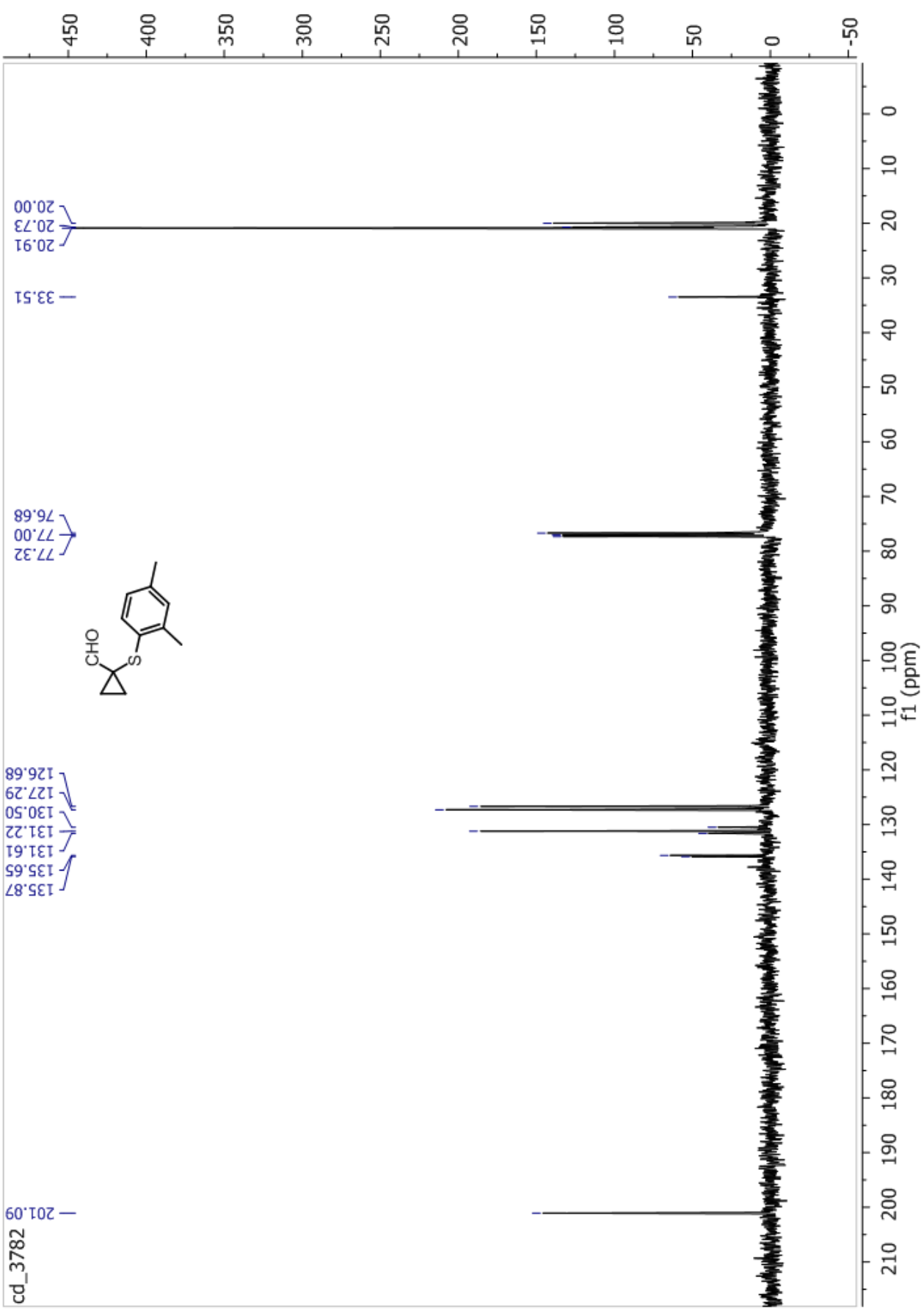
1-2-Tolylsulfanyl-cyclopropanecarbaldehyde 3d



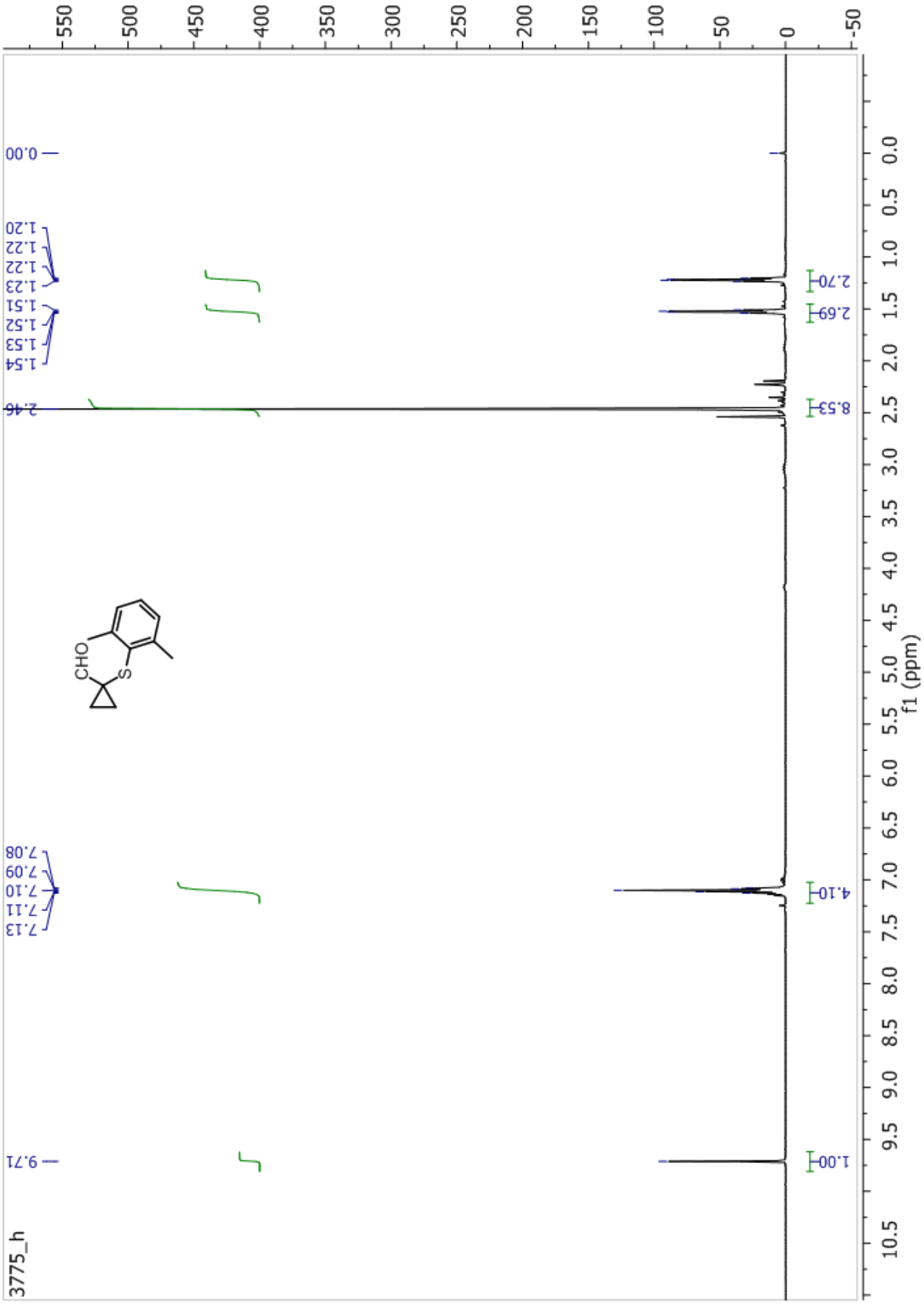

cd_3784
200.89
137.31
135.40
130.24
128.60
127.26
126.61
125.61
77.32
77.00
76.68
32.90
20.85
19.93
CHO
S
f1 (ppm)

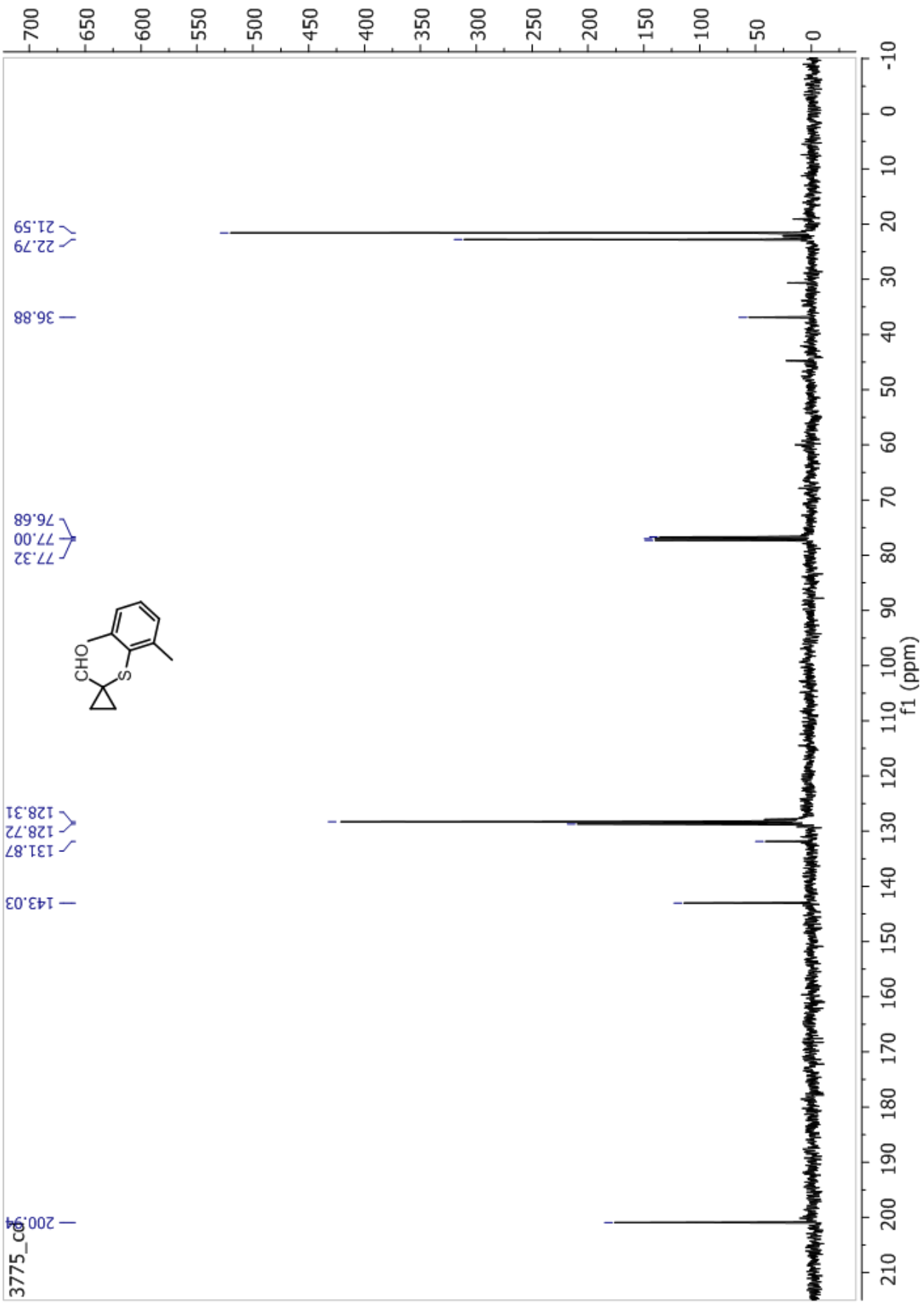
1-(2,4-Dimethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3e



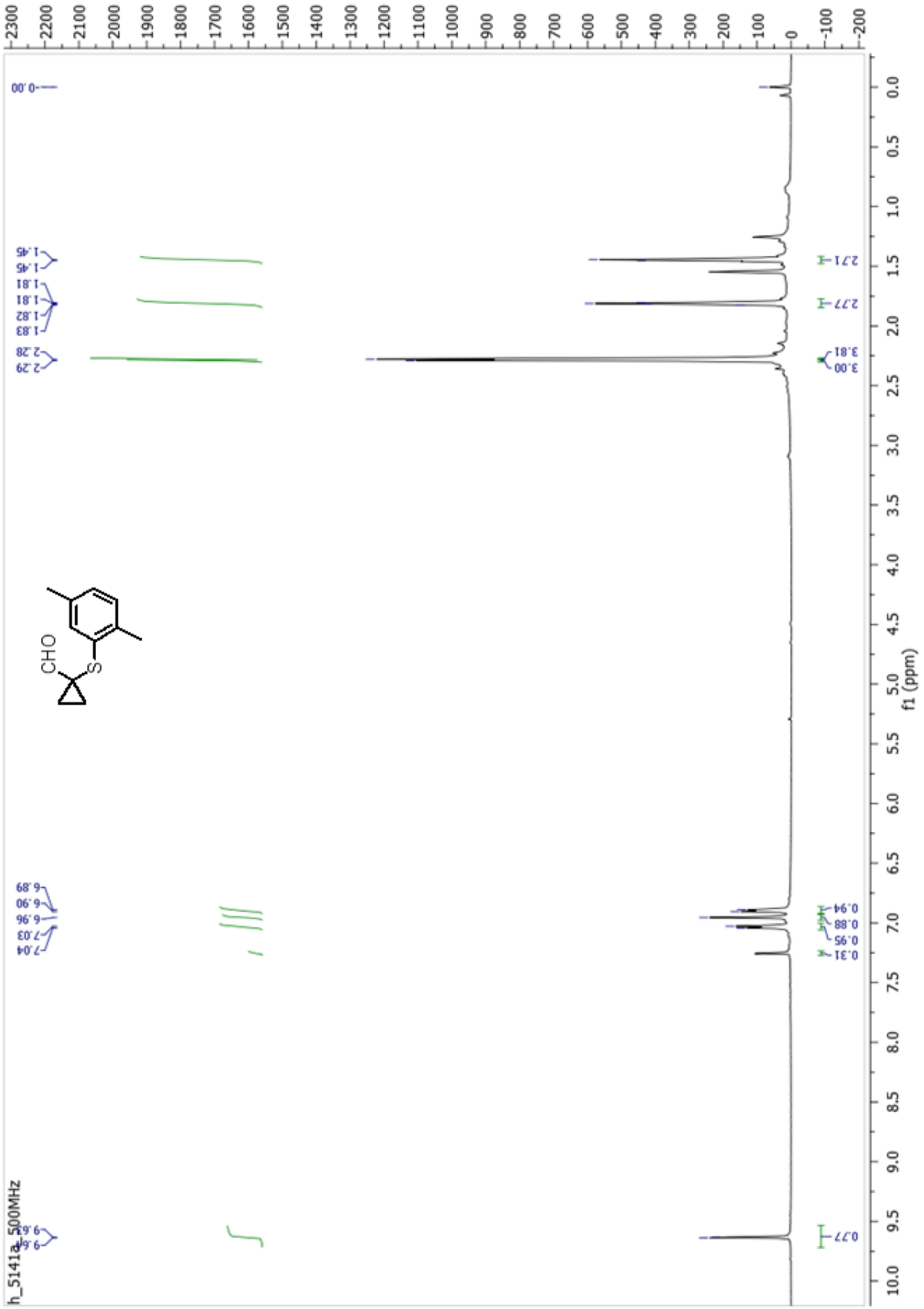

cd_3782
201.09
135.87
135.65
131.61
131.22
130.50
127.29
126.68
77.32
77.00
76.68
33.51
20.91
20.73
20.00
CHO
S
f1 (ppm)

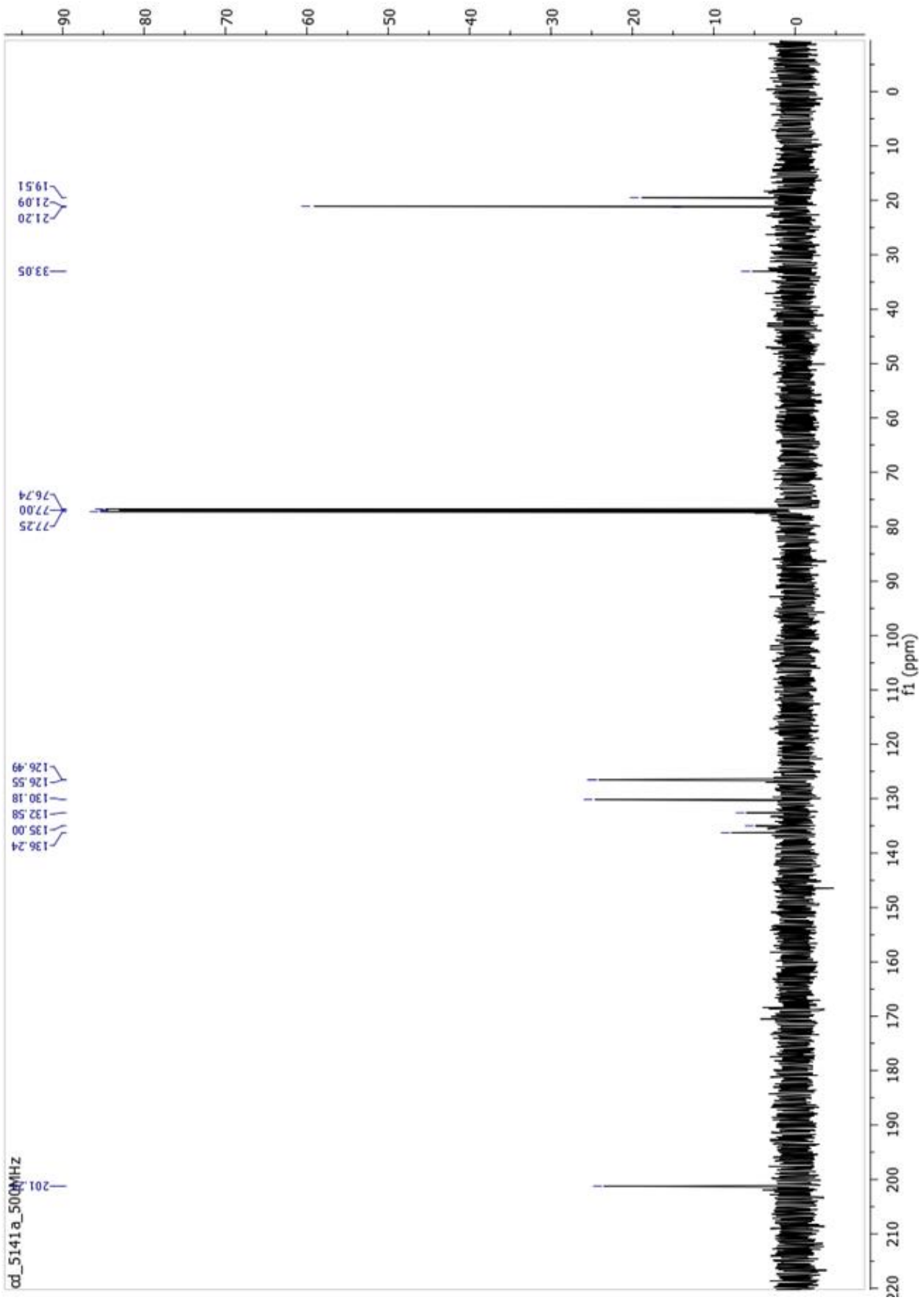
1-(2,6-Dimethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3f



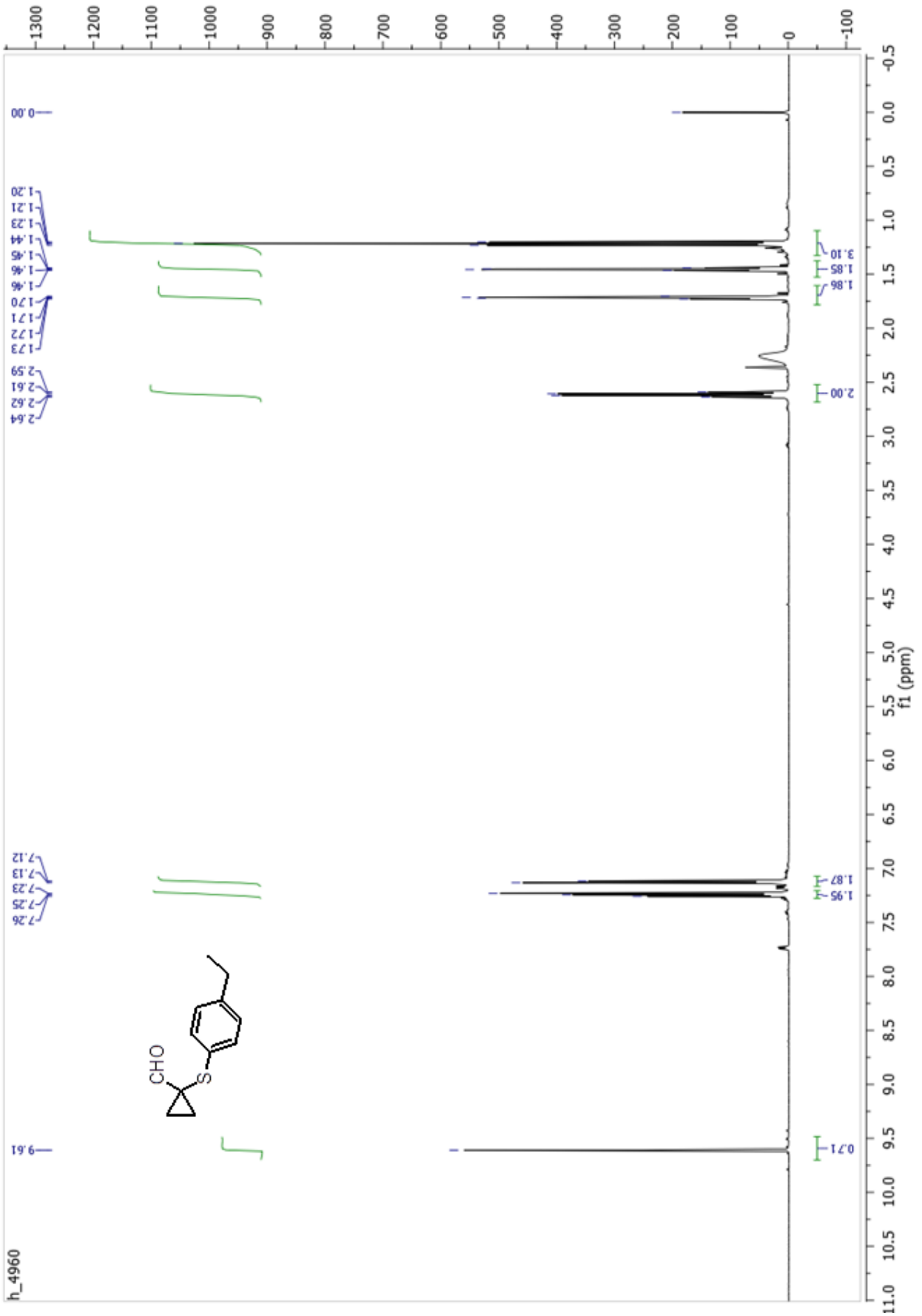

3775_c
200.94
143.03
131.87
128.72
128.31
77.32
77.00
76.68
36.88
22.79
21.59
CHO
S
f1 (ppm)

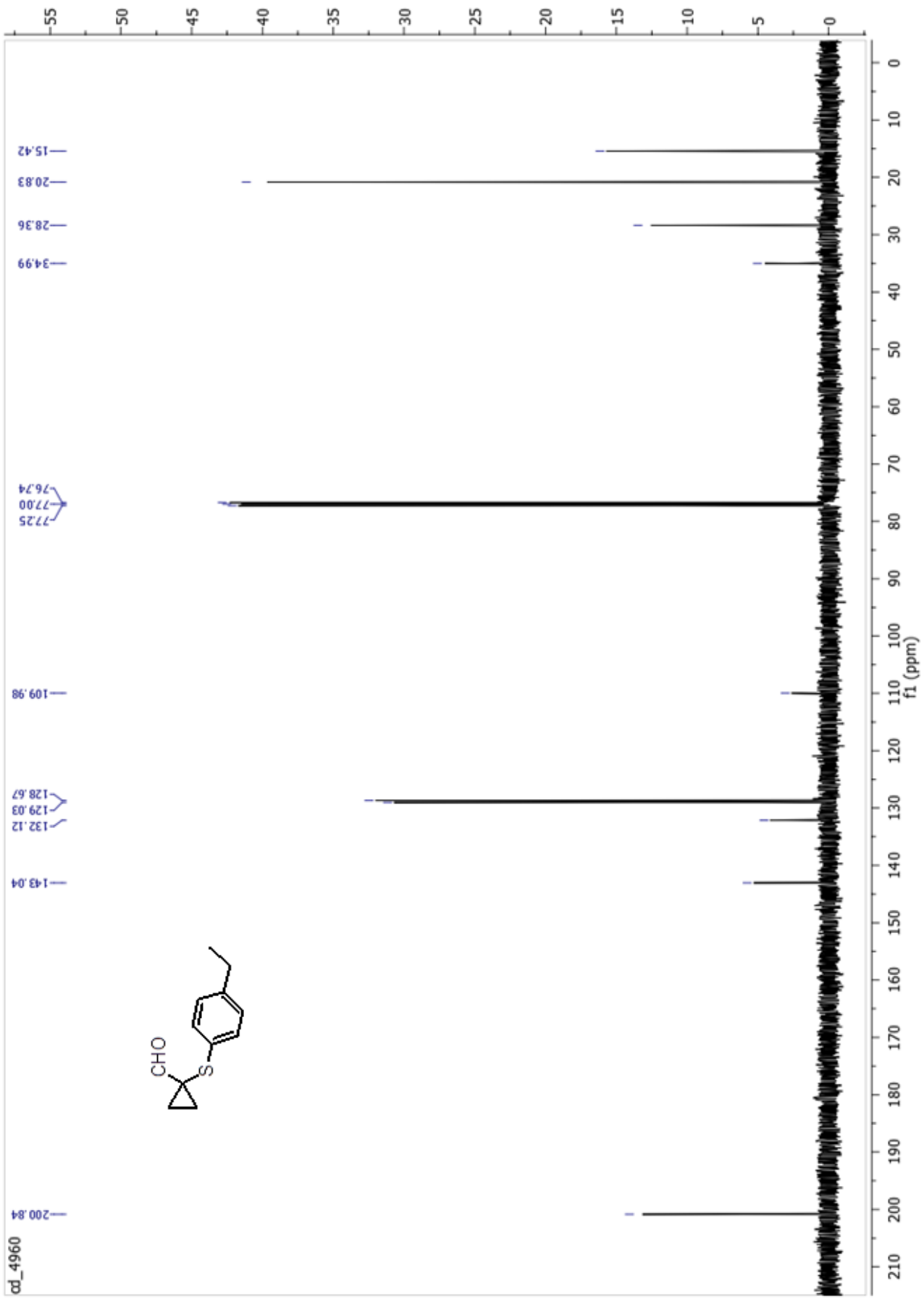
1-(2,5-Dimethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3g



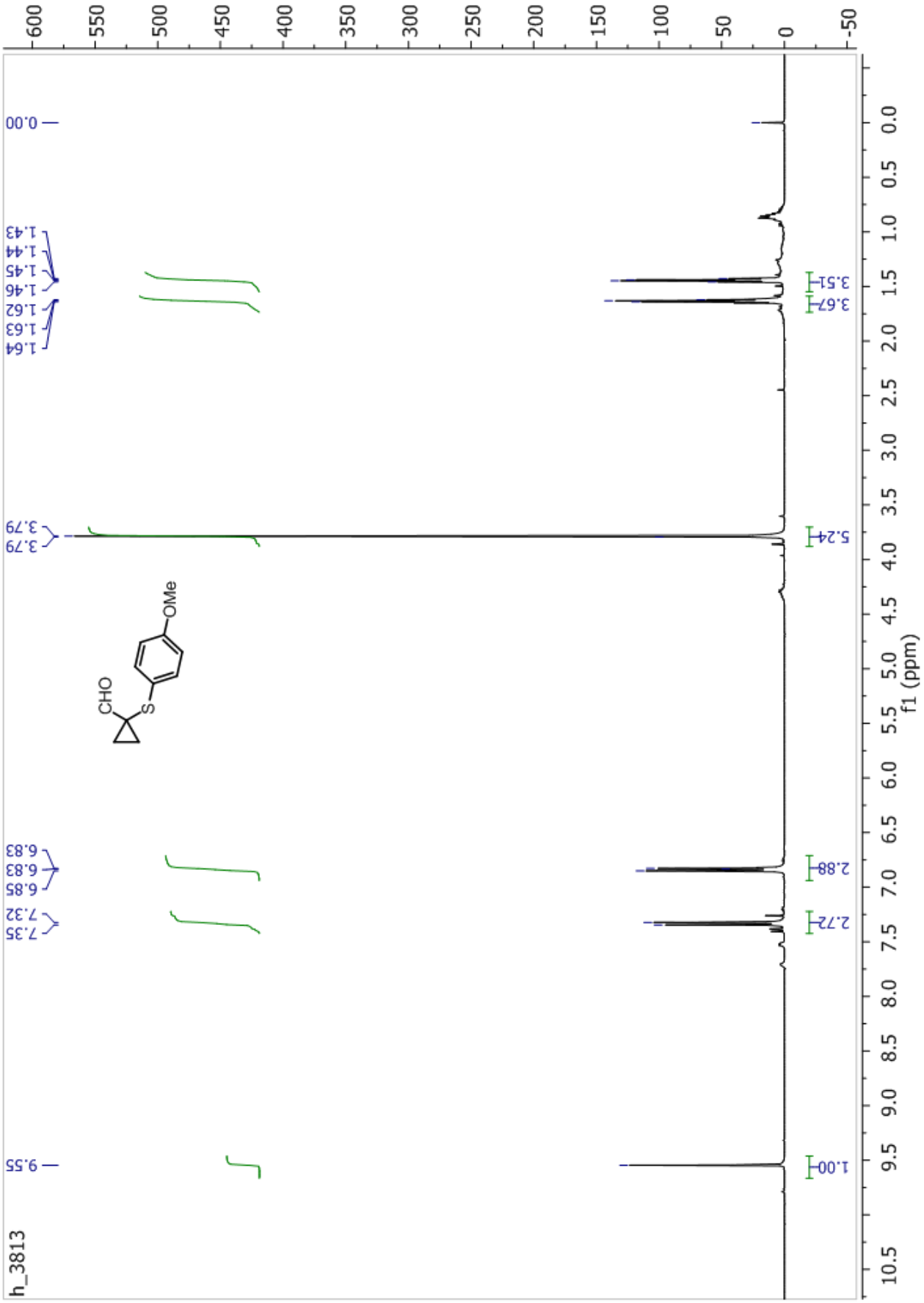

19.51
21.09
21.20
33.05
76.74
77.00
77.25
126.49
126.55
130.18
132.58
135.00
136.24
201.47
f1 (ppm)

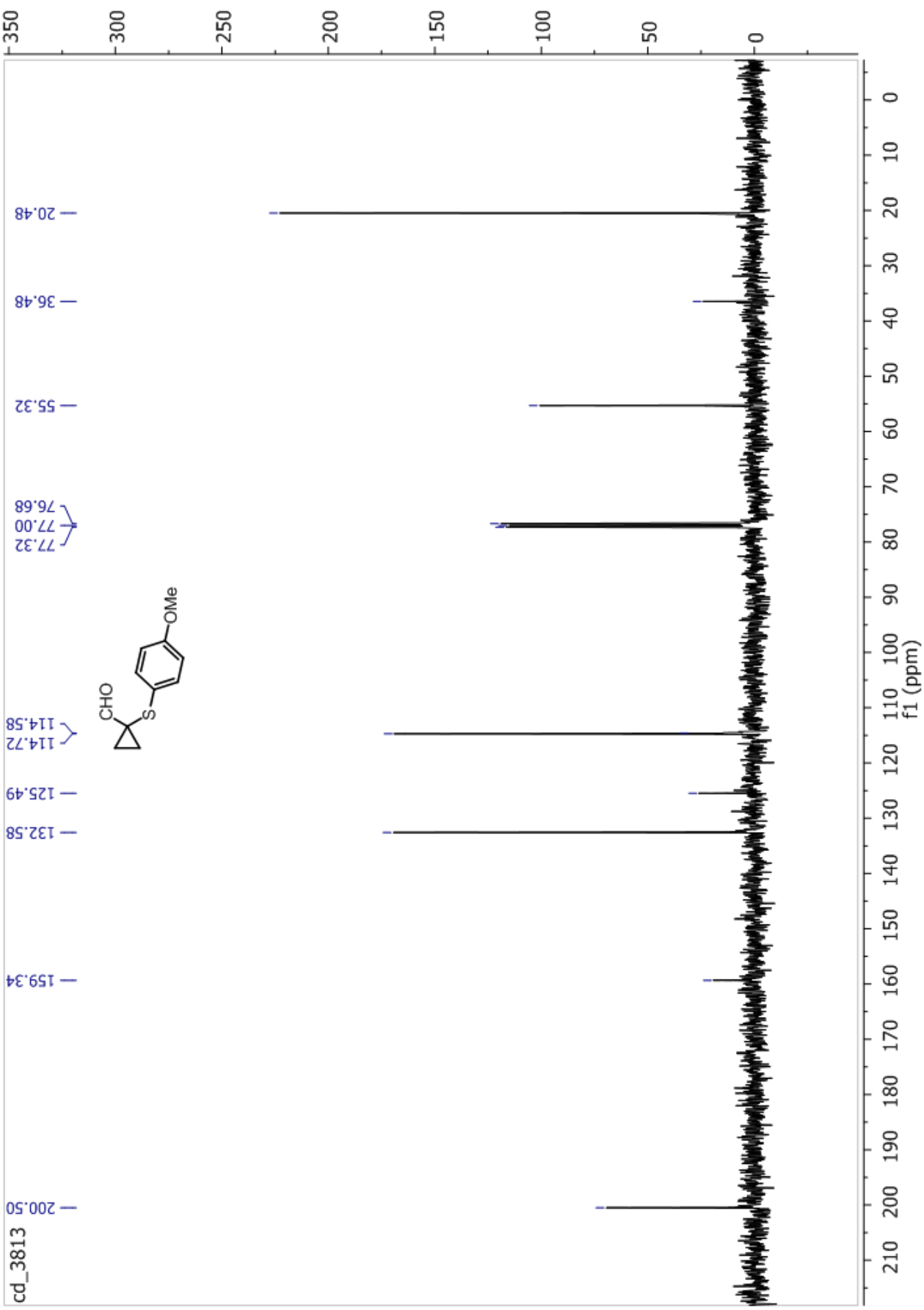
1-(4-Ethyl-phenylsulfanyl)-cyclopropanecarbaldehyde 3h



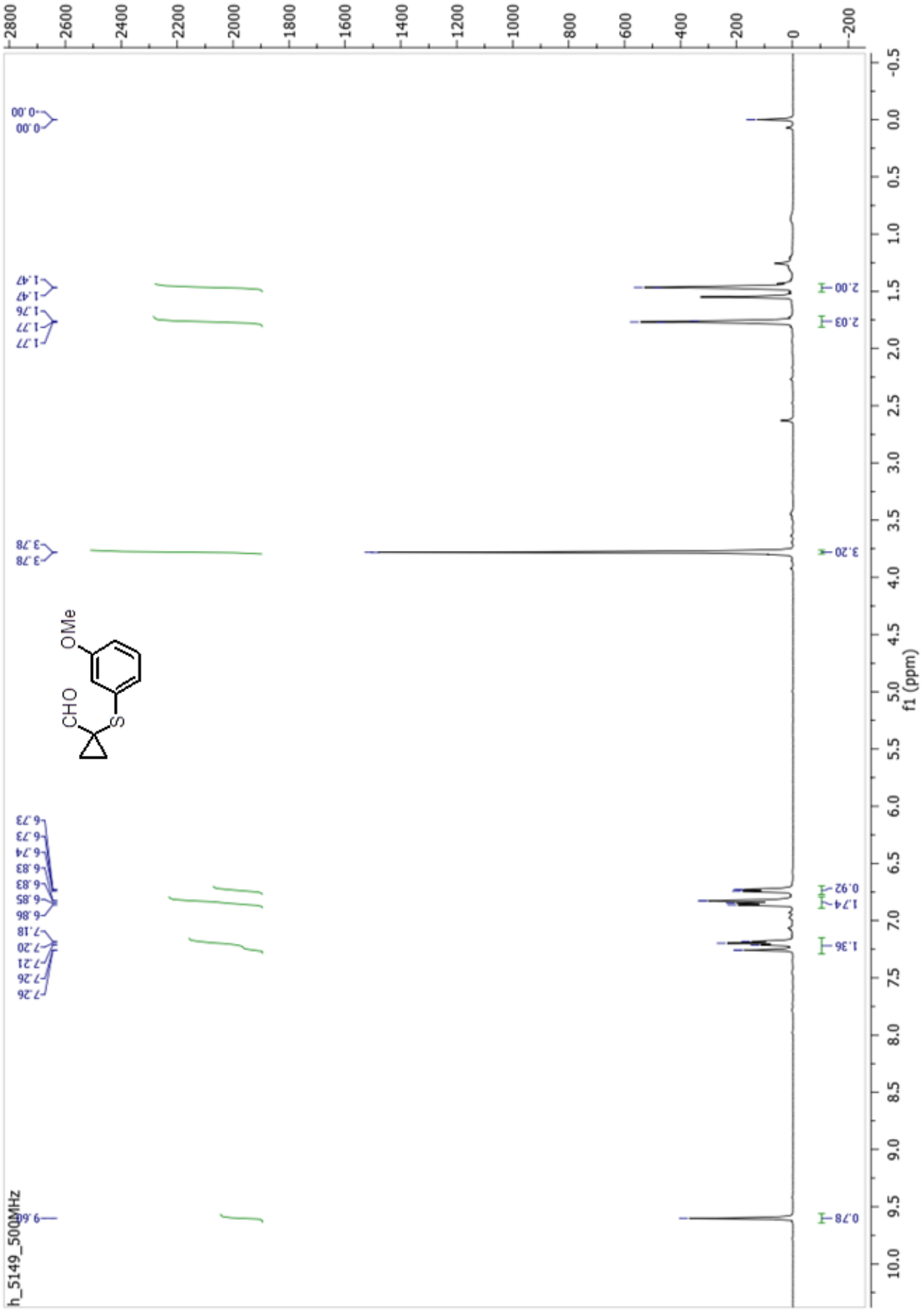

15.42
20.83
28.36
34.99
76.74
77.00
77.25
109.98
128.67
129.03
132.12
143.04
200.84
CHO
S
f1 (ppm)
ad_4960

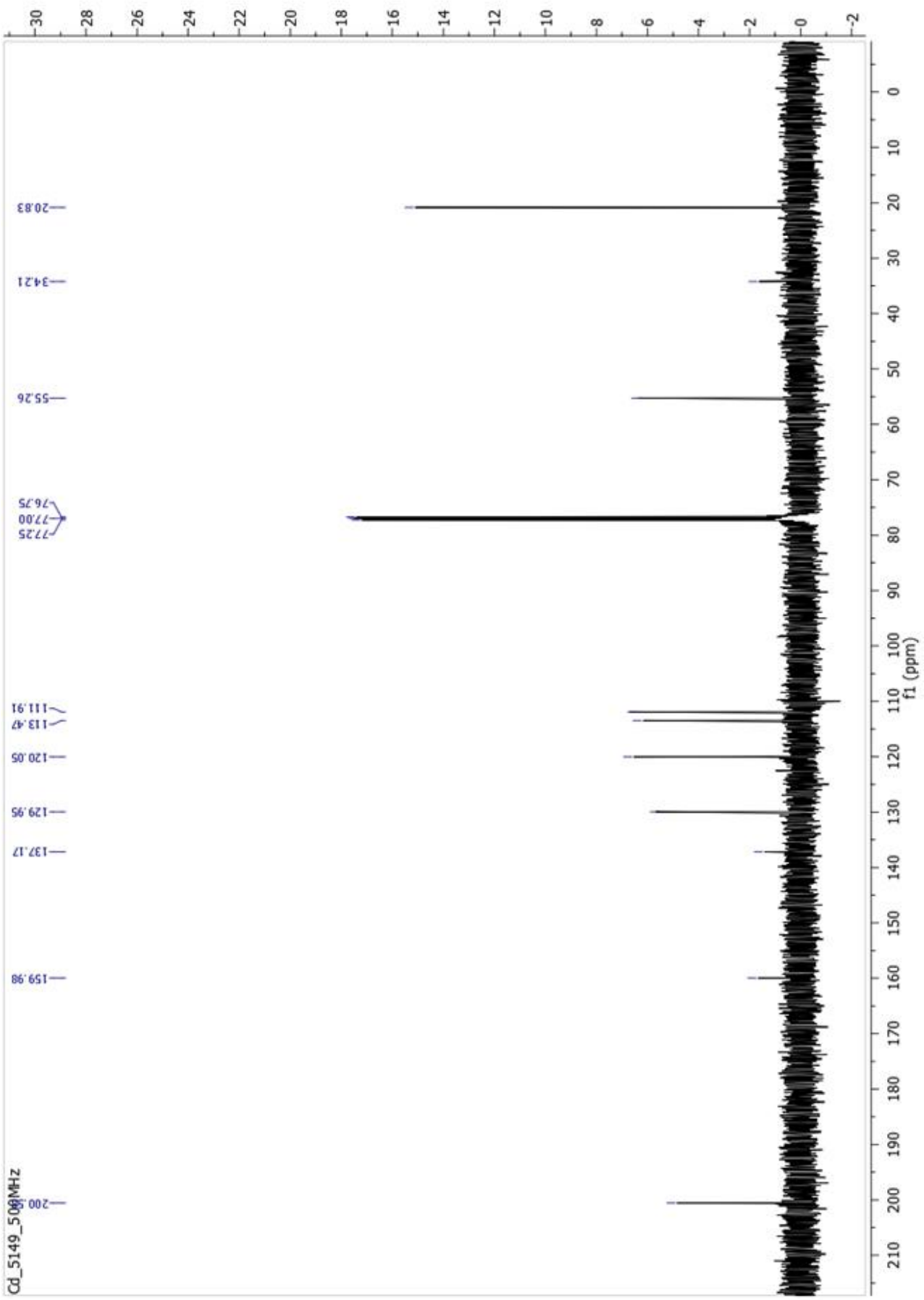
1-(4-Methoxy-phenylsulfanyl)-cyclopropanecarbaldehyde 3i



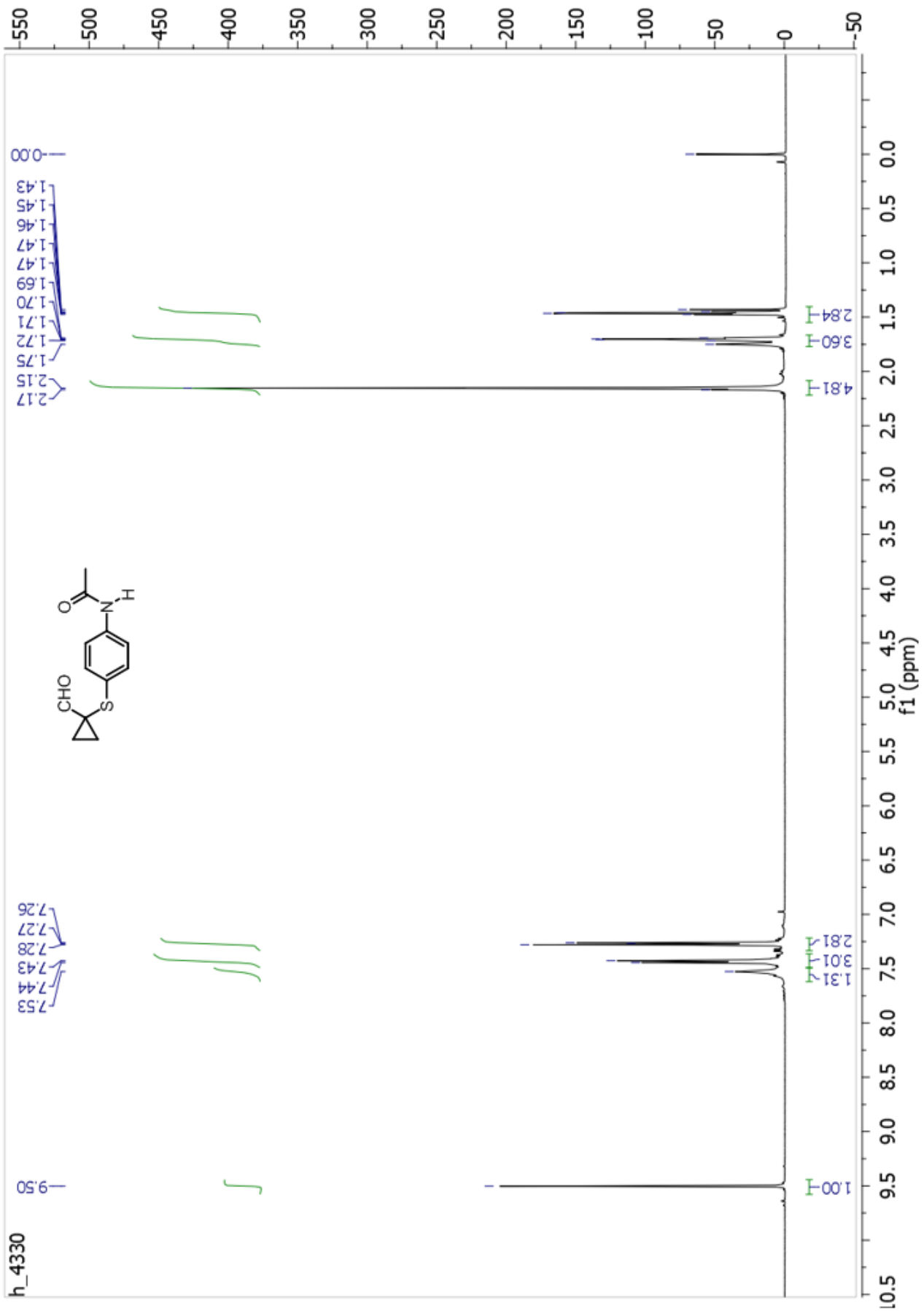

cd_3813
200.50
159.34
132.58
125.49
114.72
114.58
77.32
77.00
76.68
55.32
36.48
20.48
CHO
S
OMe
f1 (ppm)

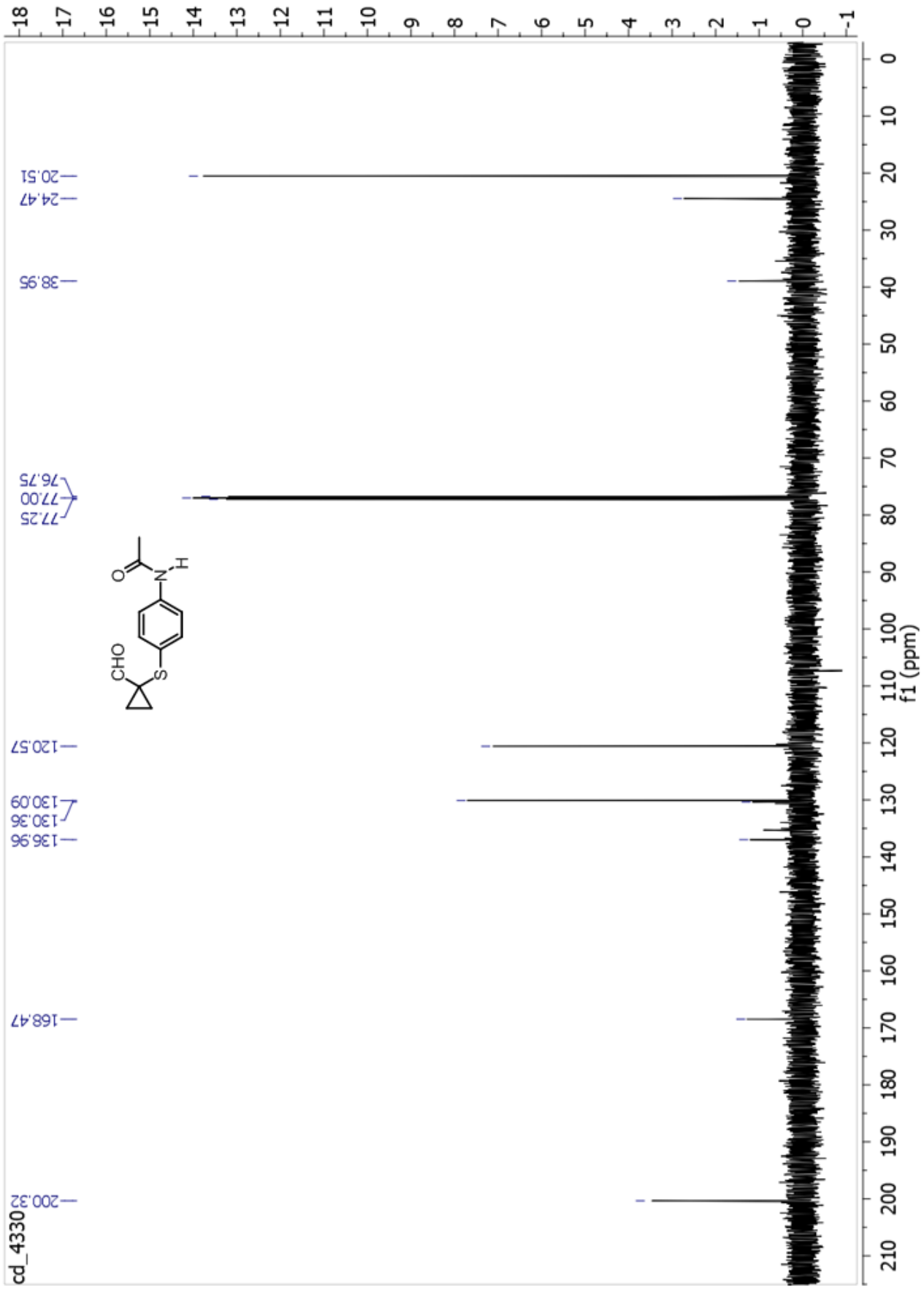
1-(4-Methoxy-phenylsulfanyl)-cyclopropanecarbaldehyde 3j



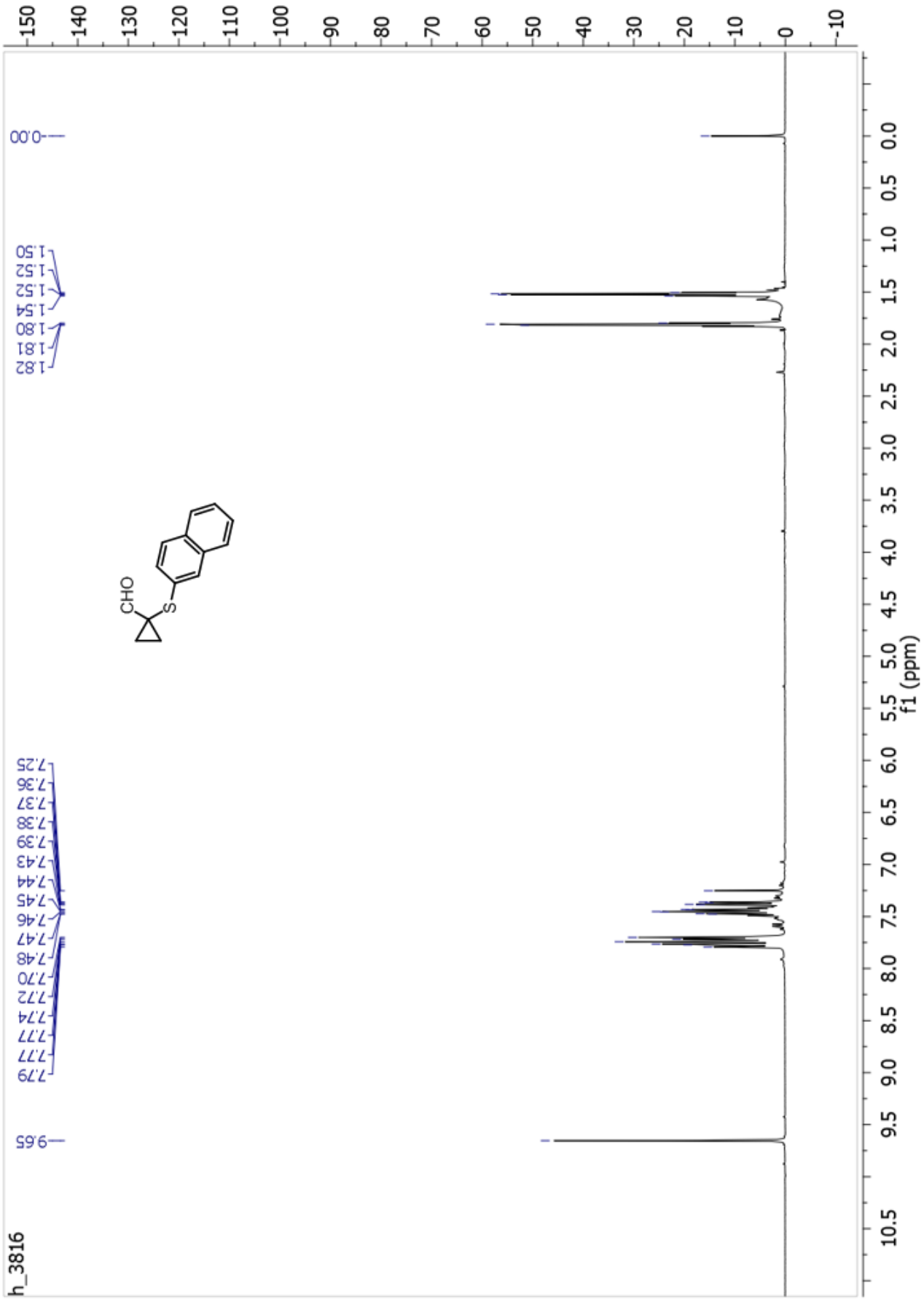

Cd_5149_500MHz
200.83
159.98
137.17
129.95
120.05
113.47
111.91
77.25
77.00
76.75
55.26
34.21
f1 (ppm)

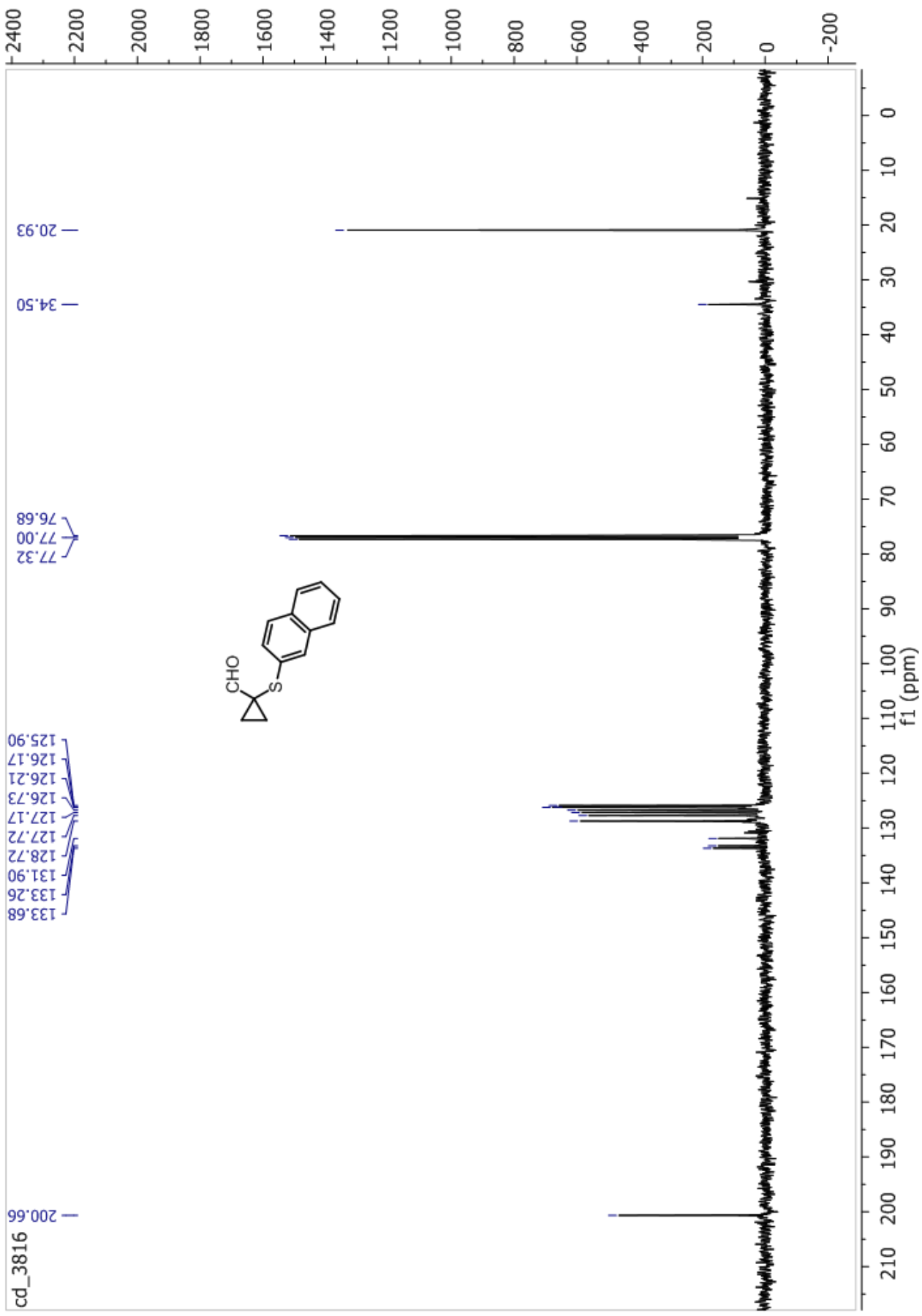
***N*-[4-(1-Formyl-cyclopropylsulfanyl)-phenyl]-acetamide 3k**



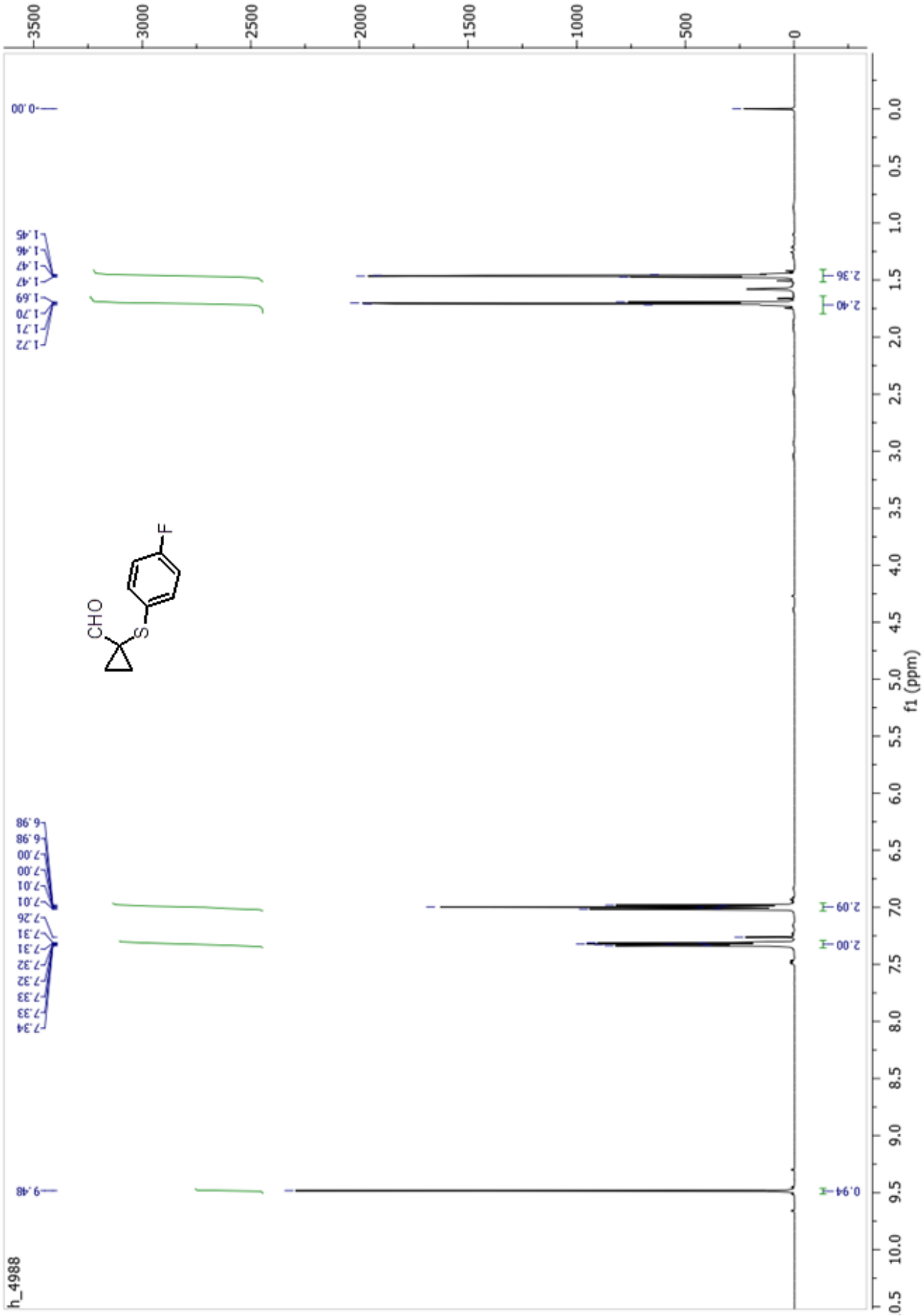

cd_4330
200.32
168.47
136.96
130.36
130.09
120.57
77.25
77.00
76.75
38.95
24.47
20.51
CHO
S
N
H
O
f1 (ppm)

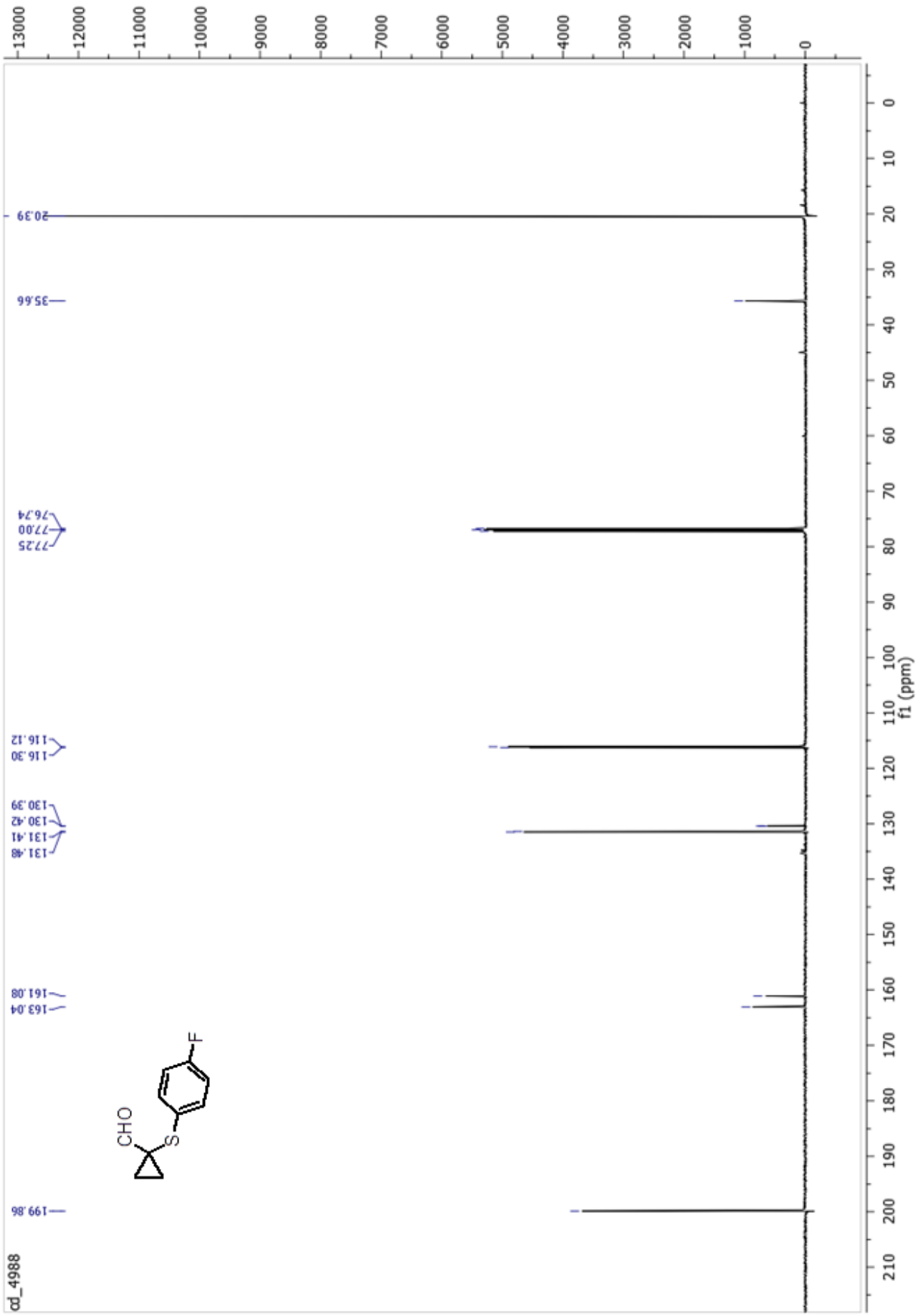
1-(Naphthalen-2-ylsulfanyl)-cyclopropanecarbaldehyde 3l



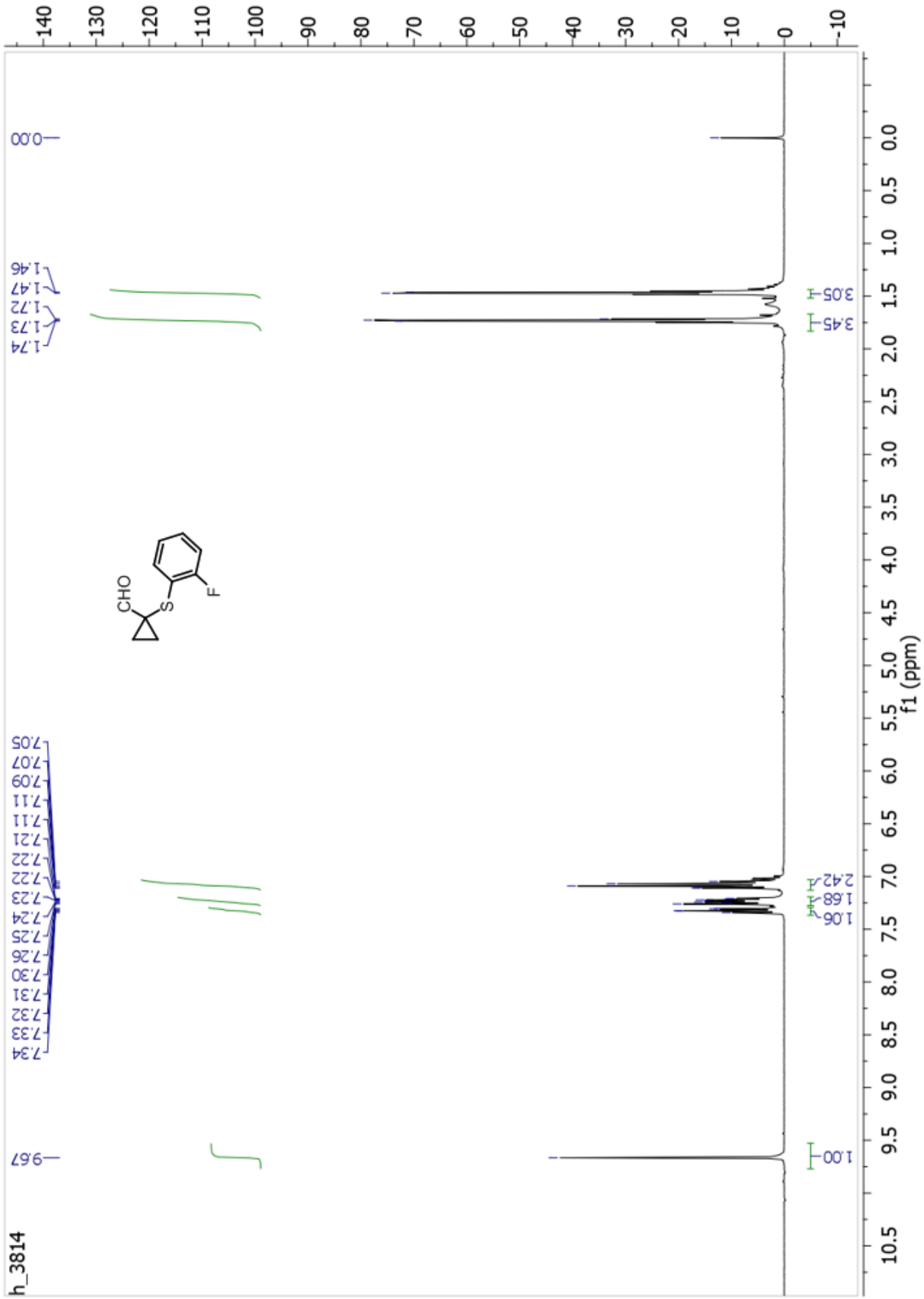

cd_3816
200.66
133.68
133.26
131.90
128.72
127.72
127.17
126.73
126.21
126.17
125.90
77.32
77.00
76.68
34.50
20.93
CHO
S
f1 (ppm)

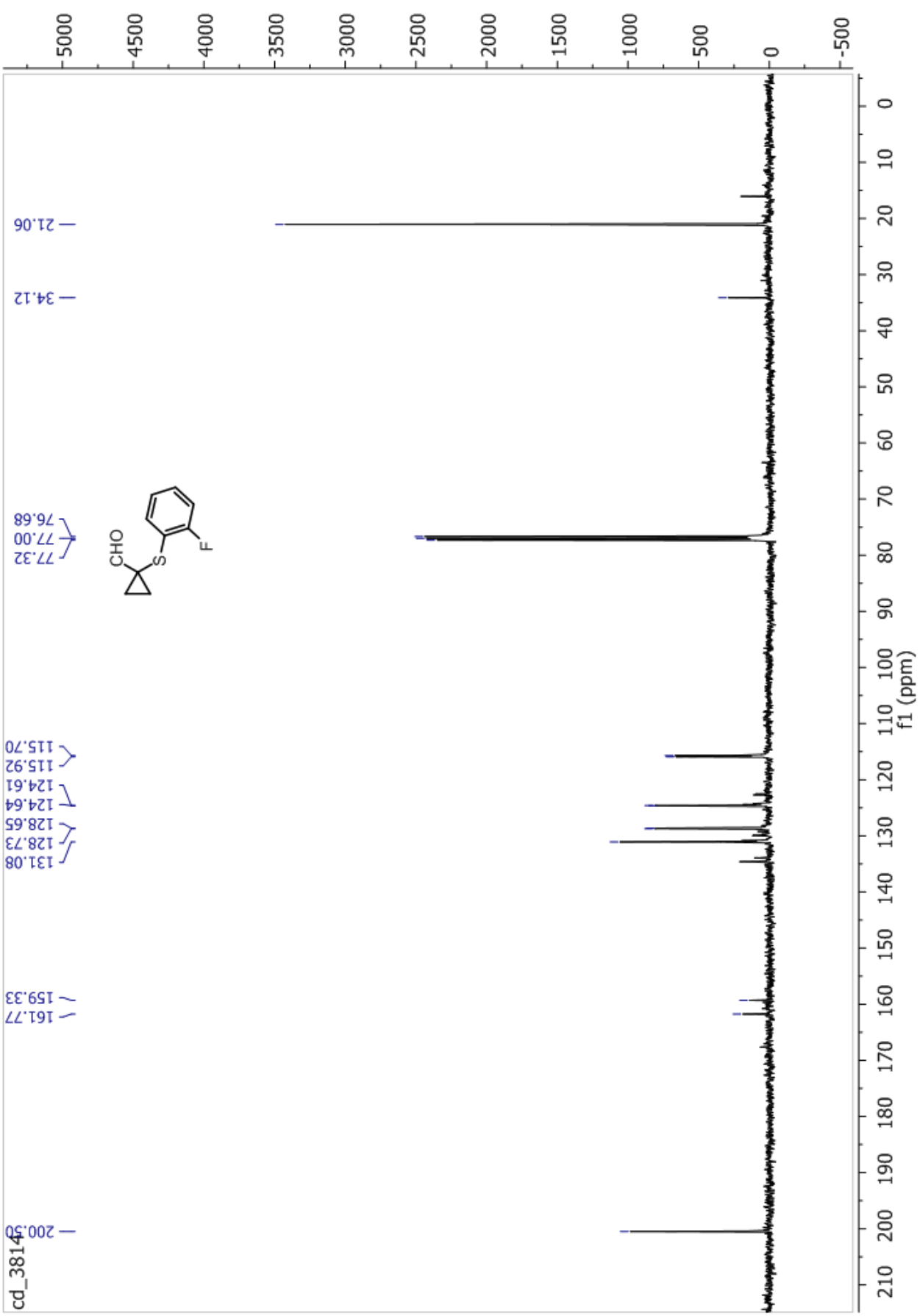
1-(4-Fluoro-phenylsulfanyl)-cyclopropanecarbaldehyde 3m



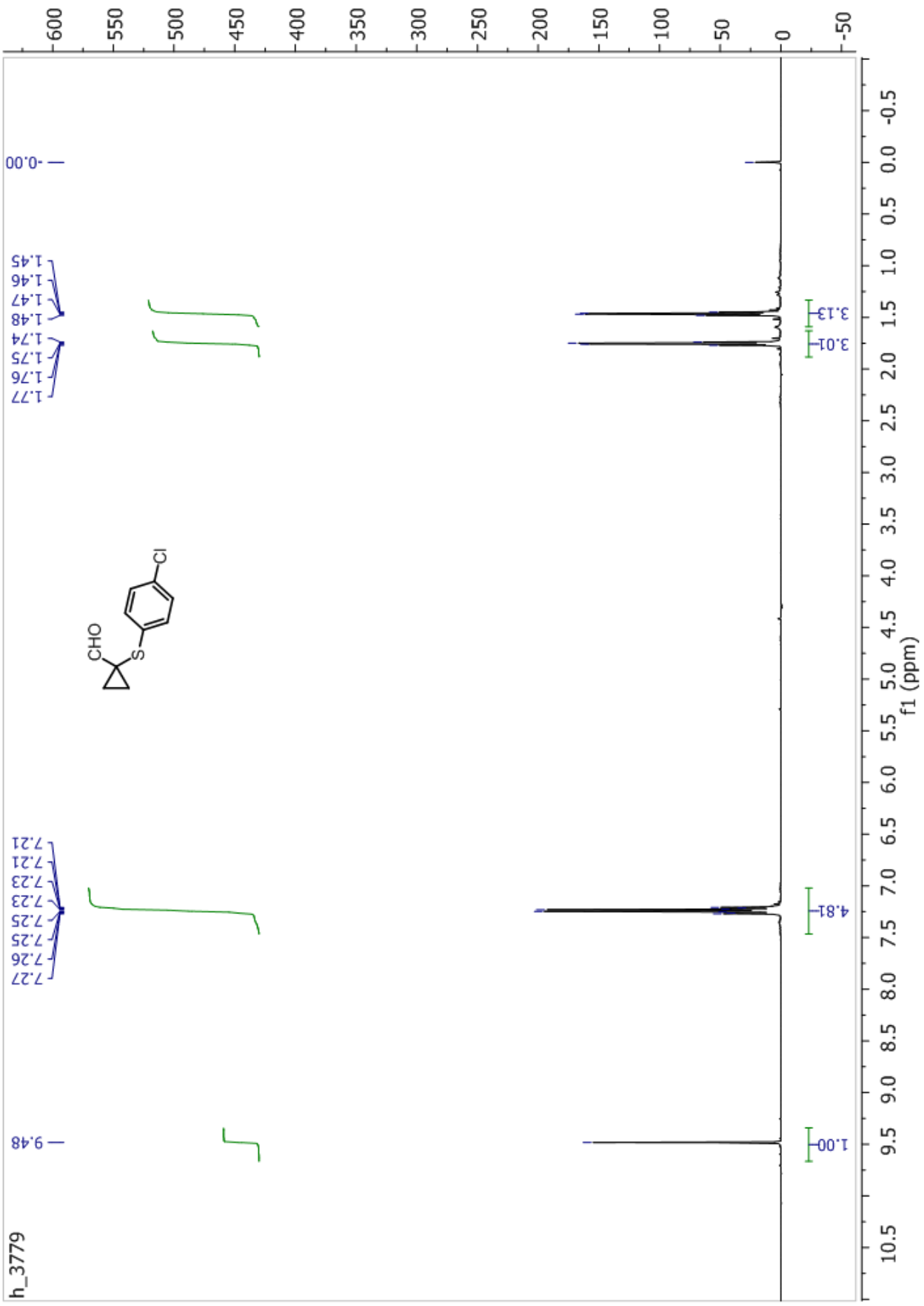

199.86
163.04
161.08
131.48
131.41
130.42
130.39
116.30
116.12
77.25
77.00
76.74
35.66
20.39
CHO
S
F
f1 (ppm)
cd_4988

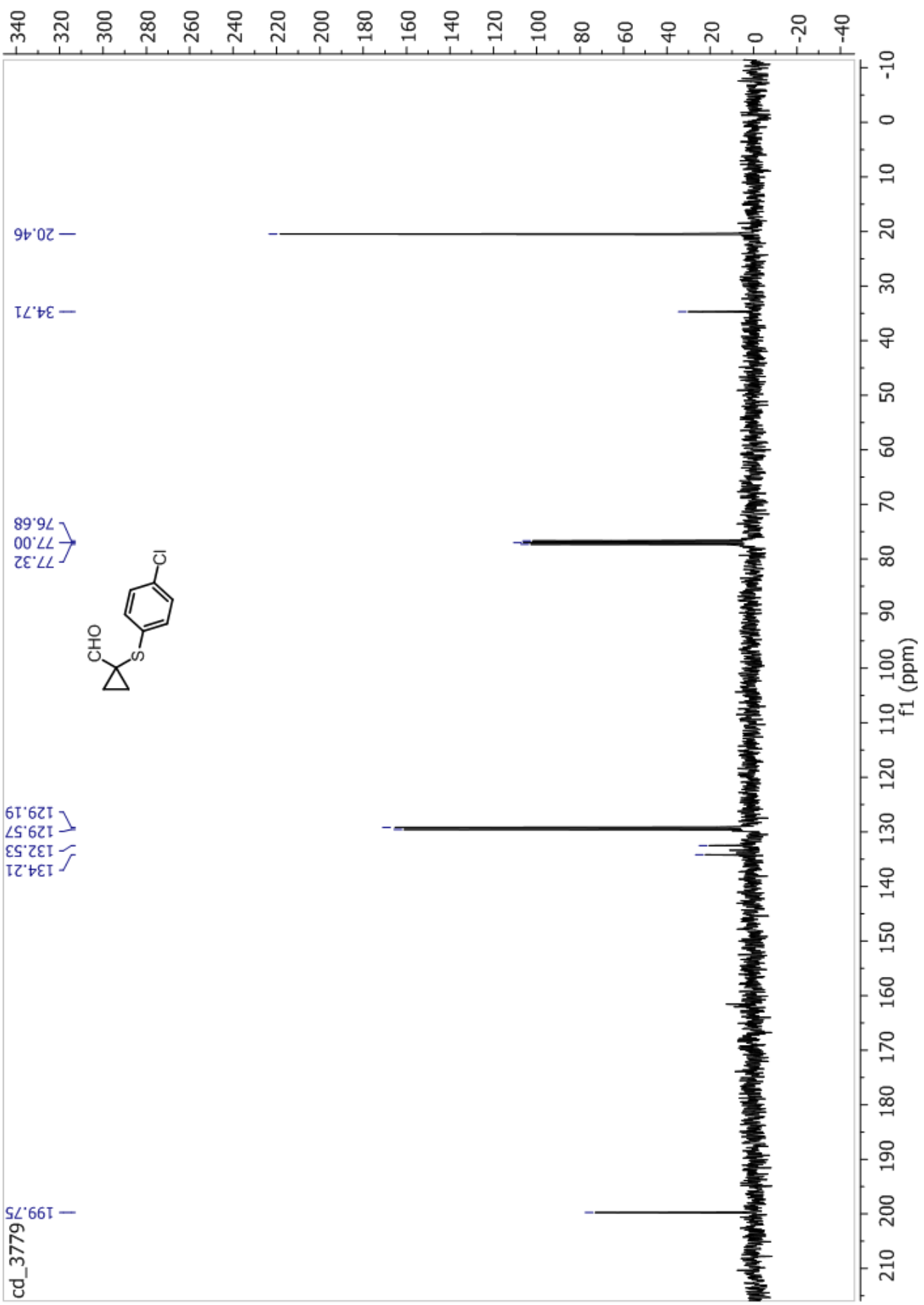
1-(2-Fluoro-phenylsulfanyl)-cyclopropanecarbaldehyde 3n



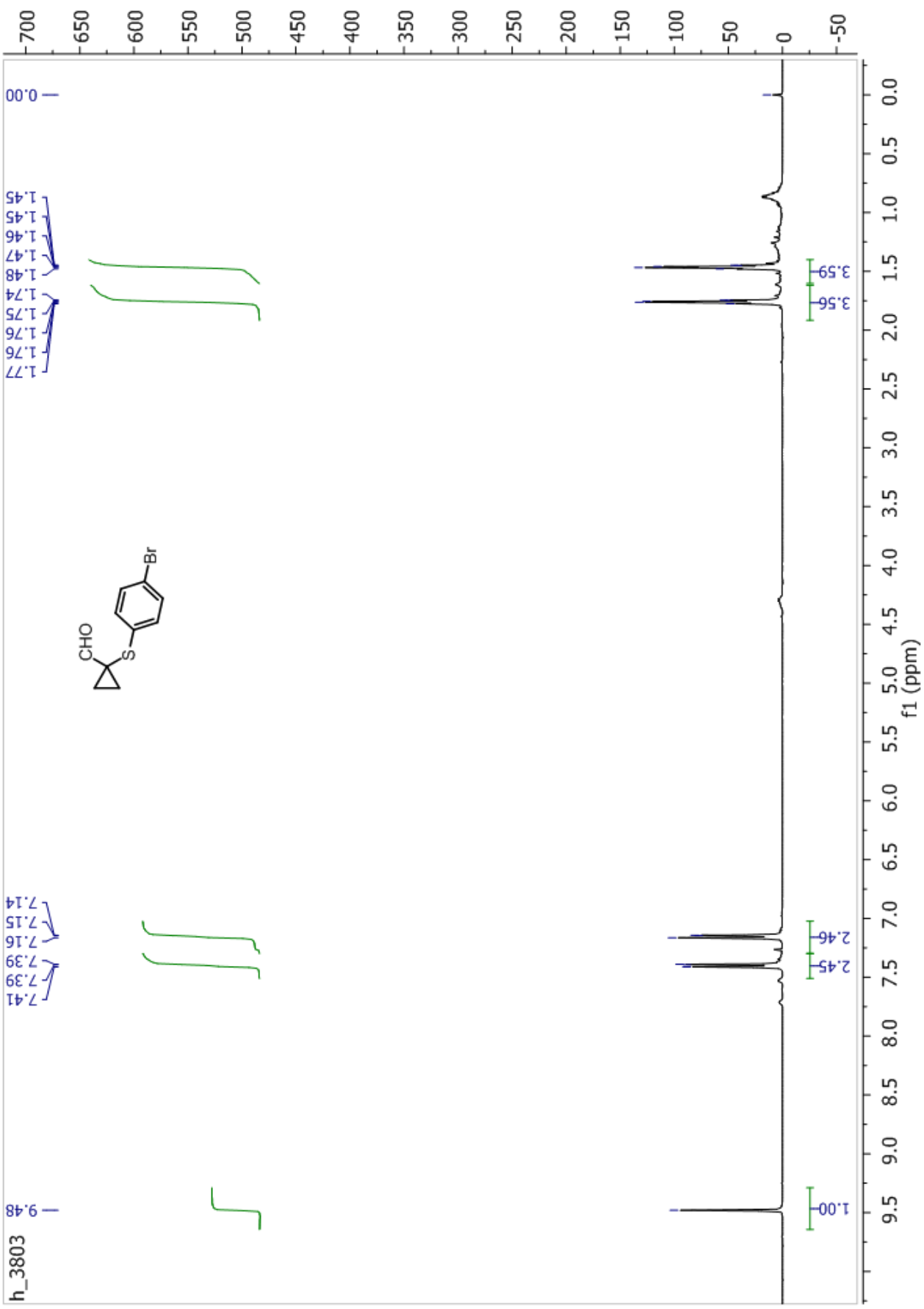

cd_38144
200.50
161.77
159.33
131.08
128.73
128.65
124.64
124.61
115.92
115.70
77.32
77.00
76.68
34.12
21.06
CHO
S
F
f1 (ppm)

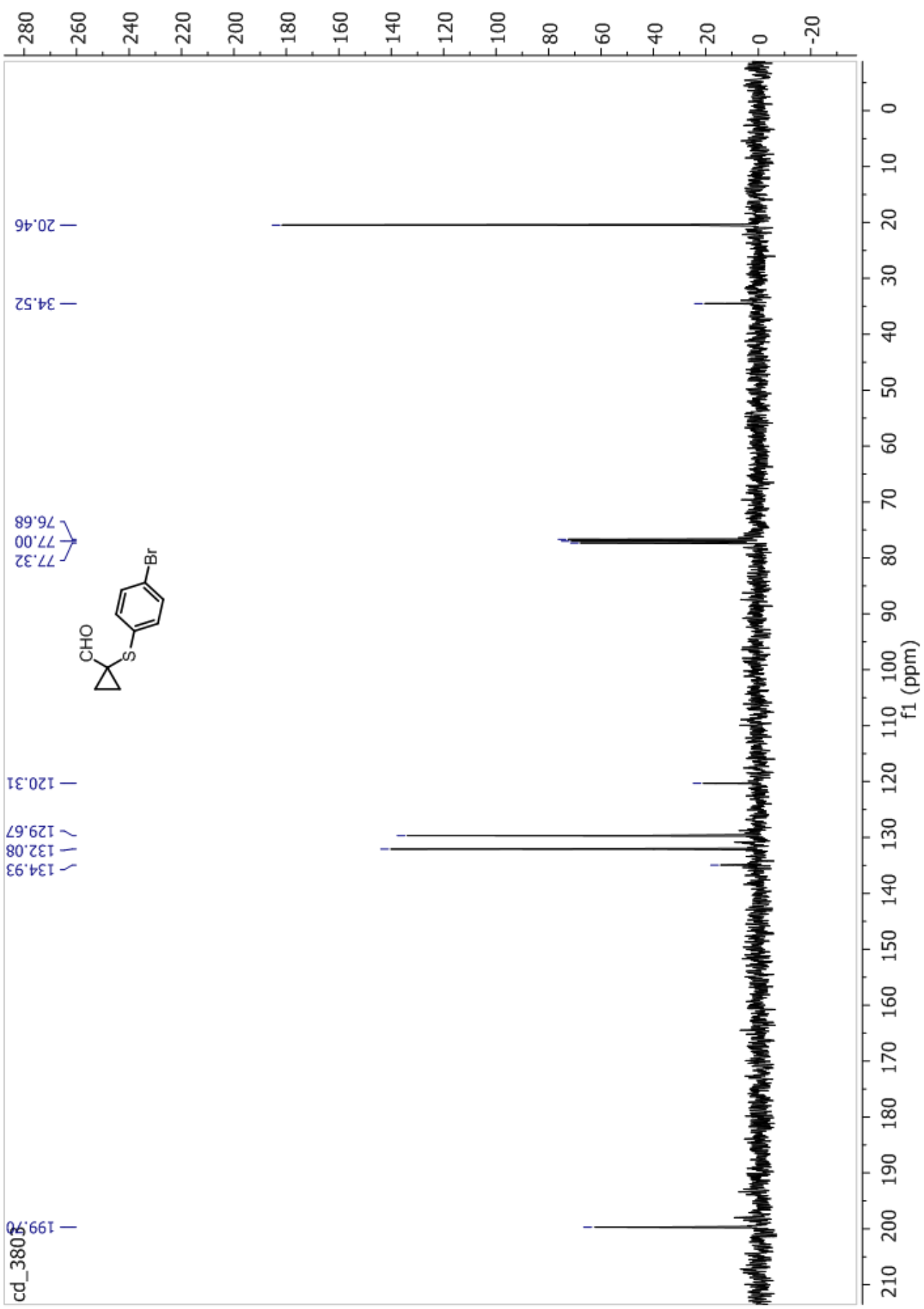
1-(4-Chloro-phenylsulfanyl)-cyclopropanecarbaldehyde 3o



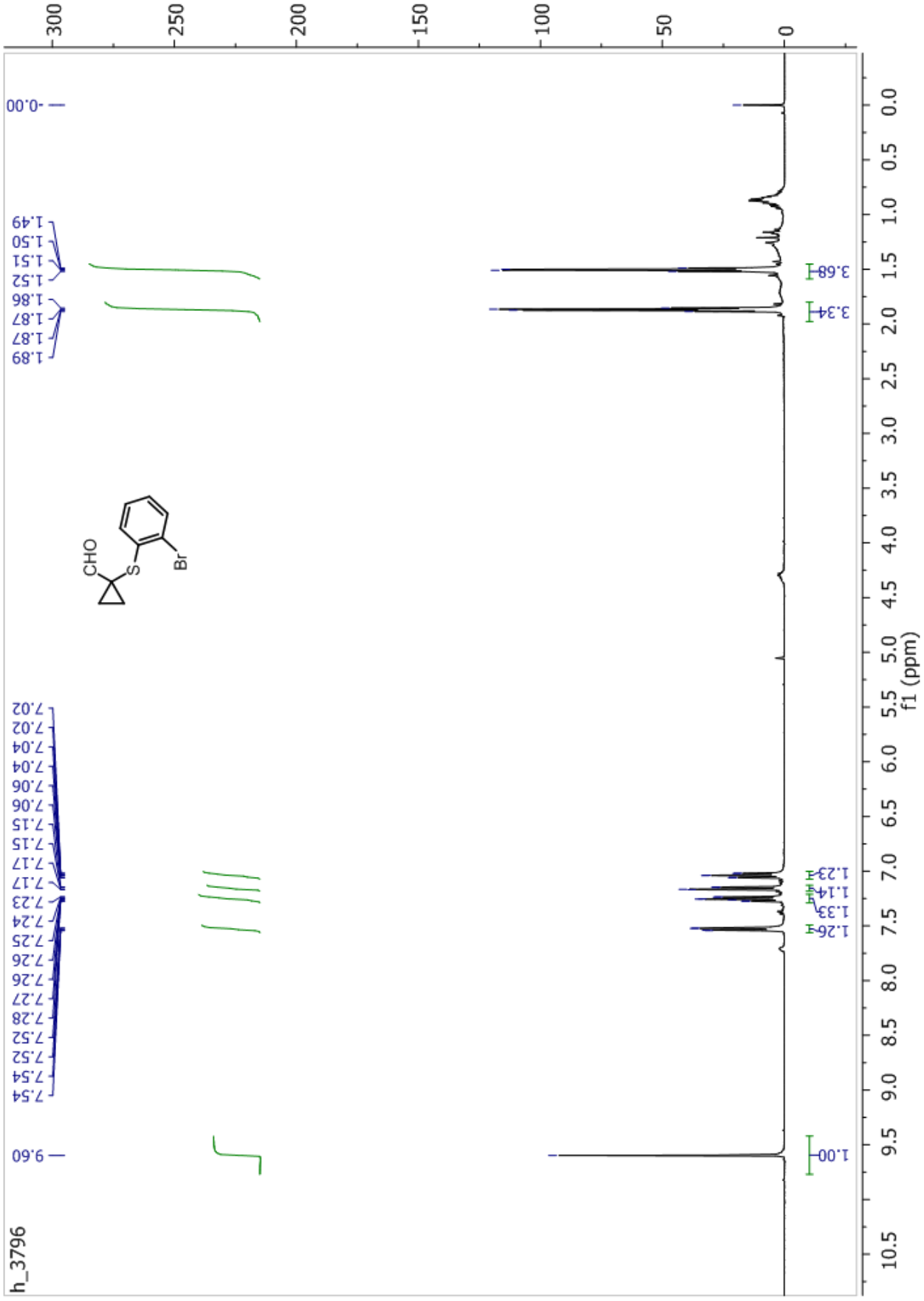

cd_3779
199.75
134.21
132.53
129.57
129.19
77.32
77.00
76.68
34.71
20.46
CHO
S
Cl
f1 (ppm)

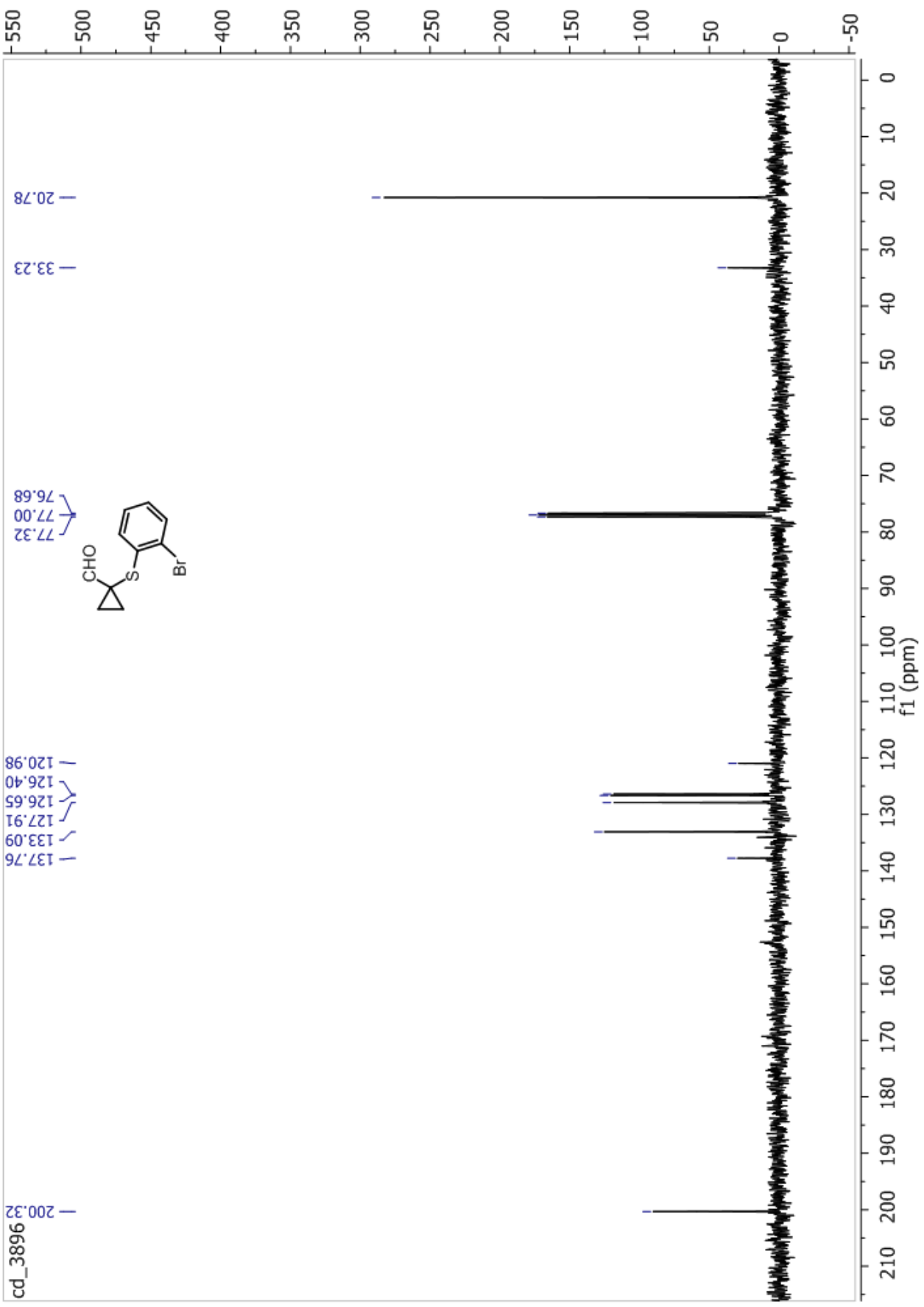
1-(4-Bromo-phenylsulfanyl)-cyclopropanecarbaldehyde 3p



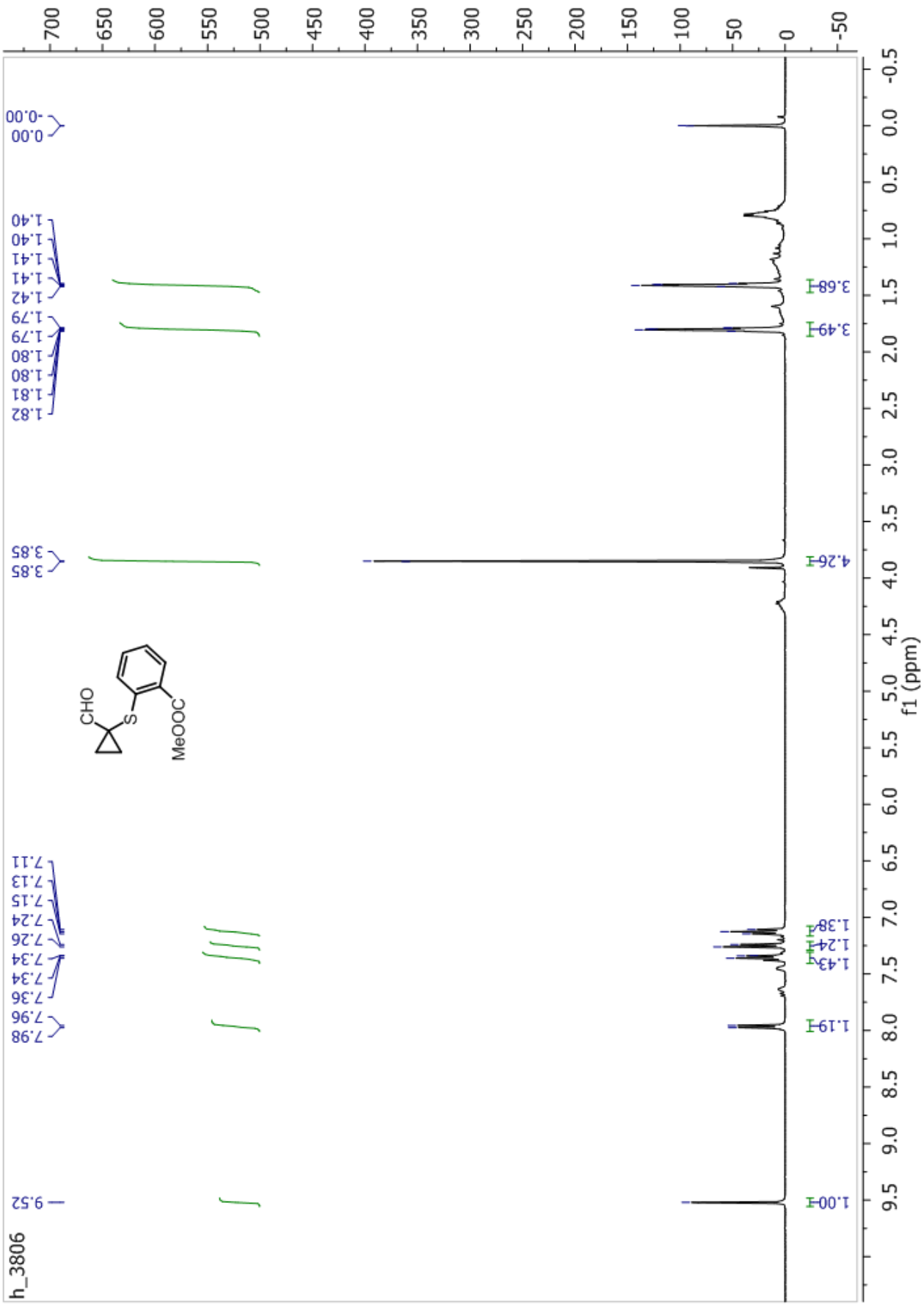

20.46
34.52
76.68
77.00
77.32
120.31
129.67
132.08
134.93
199.90
CHO
S
Br
f1 (ppm)

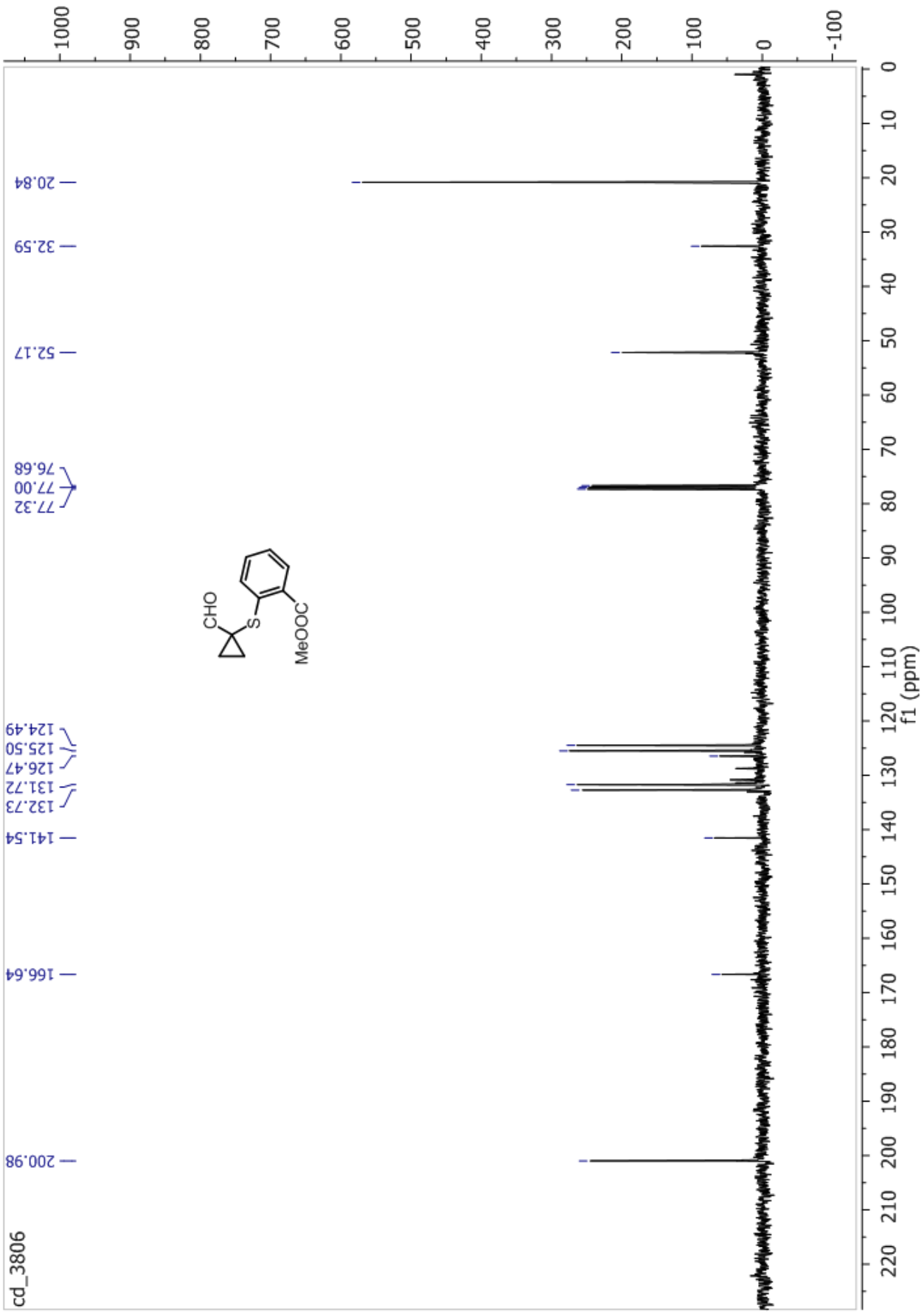
1-(2-Bromo-phenylsulfanyl)-cyclopropanecarbaldehyde 3q



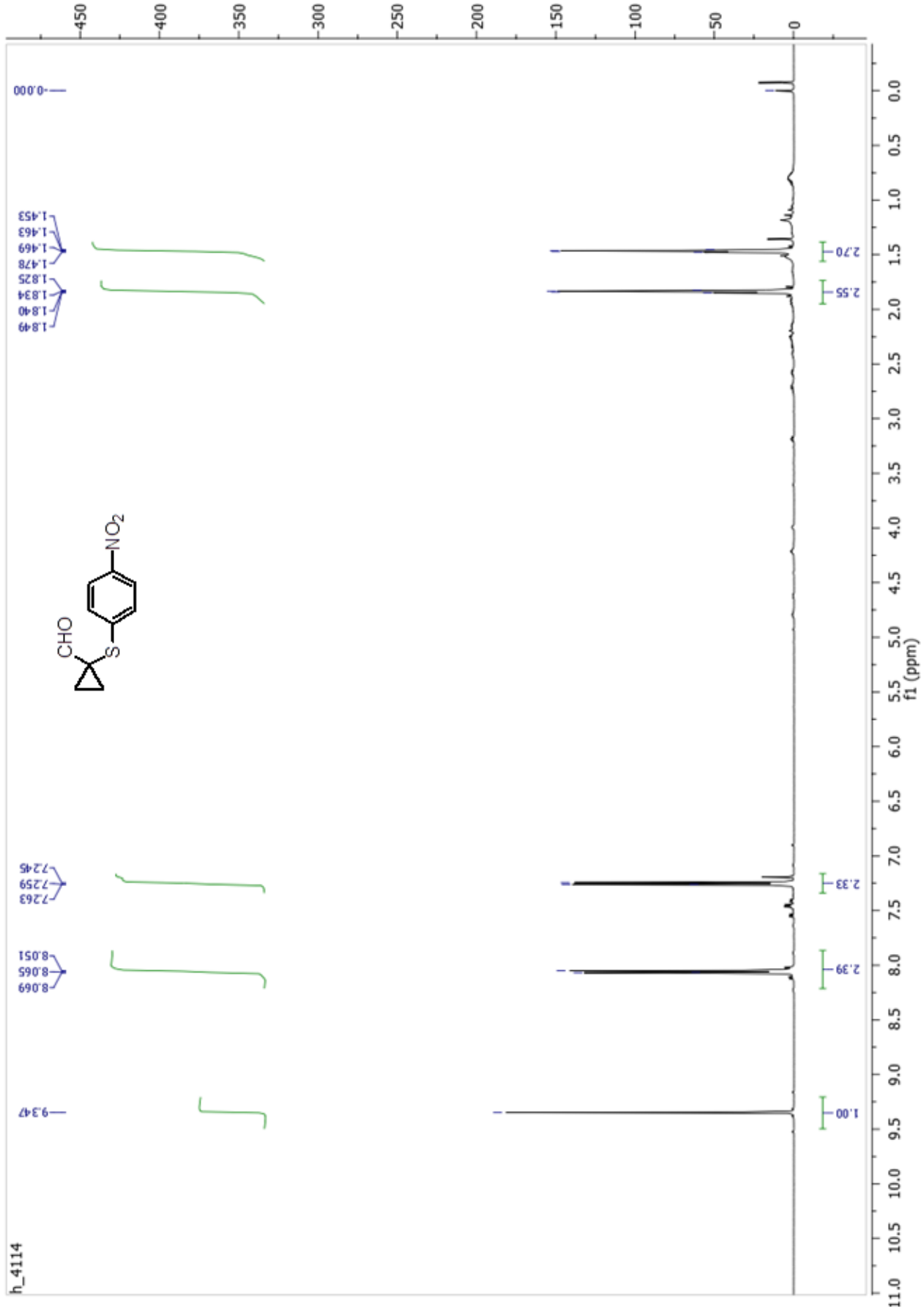

cd_3896
200.32
137.76
133.09
127.91
126.65
126.40
120.98
77.32
77.00
76.68
33.23
20.78
CHO
S
Br
f1 (ppm)

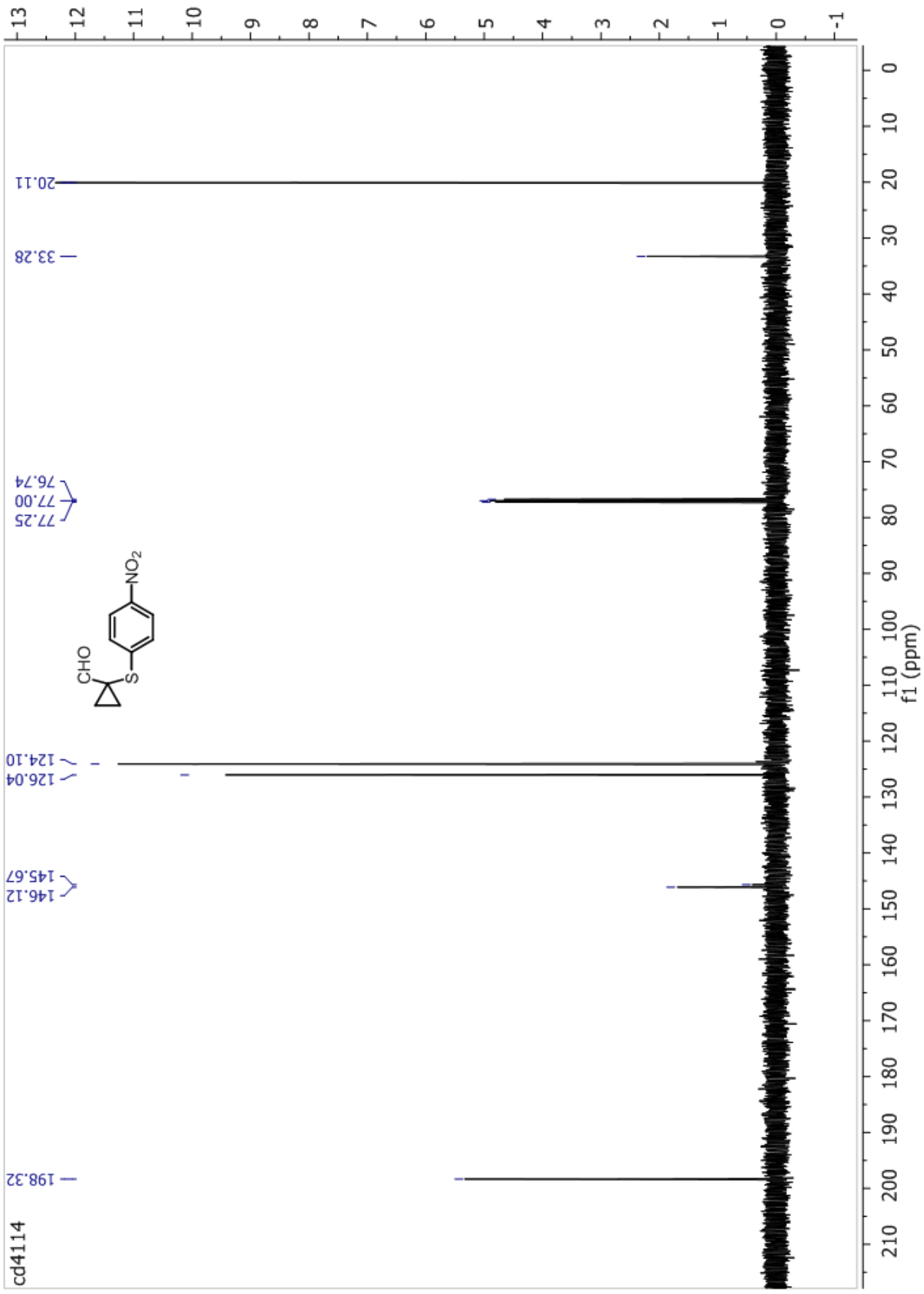
2-(1-Formyl-cyclopropylsulfanyl)-benzoic acid methyl ester 3r



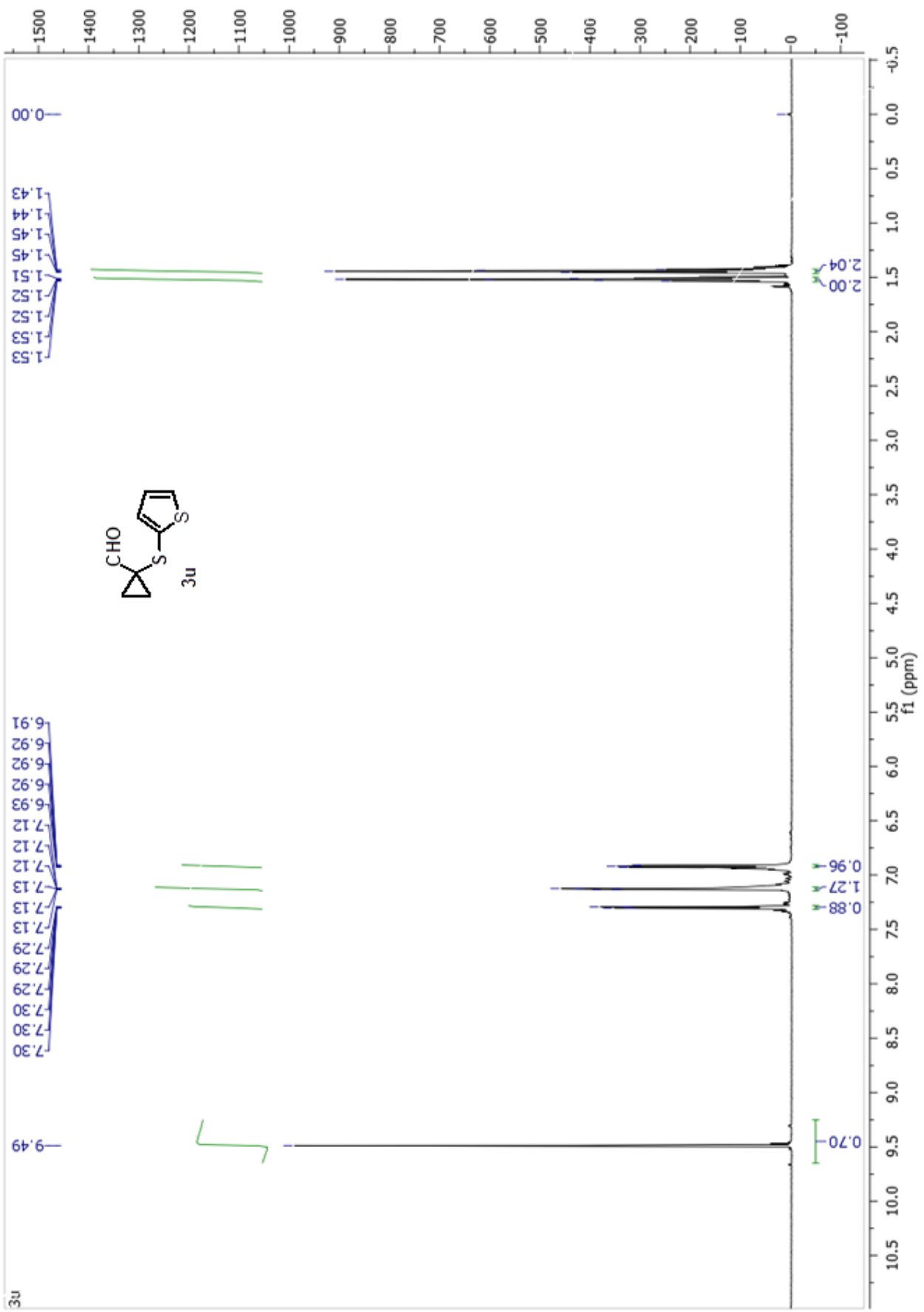

cd_3806
200.98
166.64
141.54
132.73
131.72
126.47
125.50
124.49
77.32
77.00
76.68
52.17
32.59
20.84
CHO
S
MeOOC
f1 (ppm)

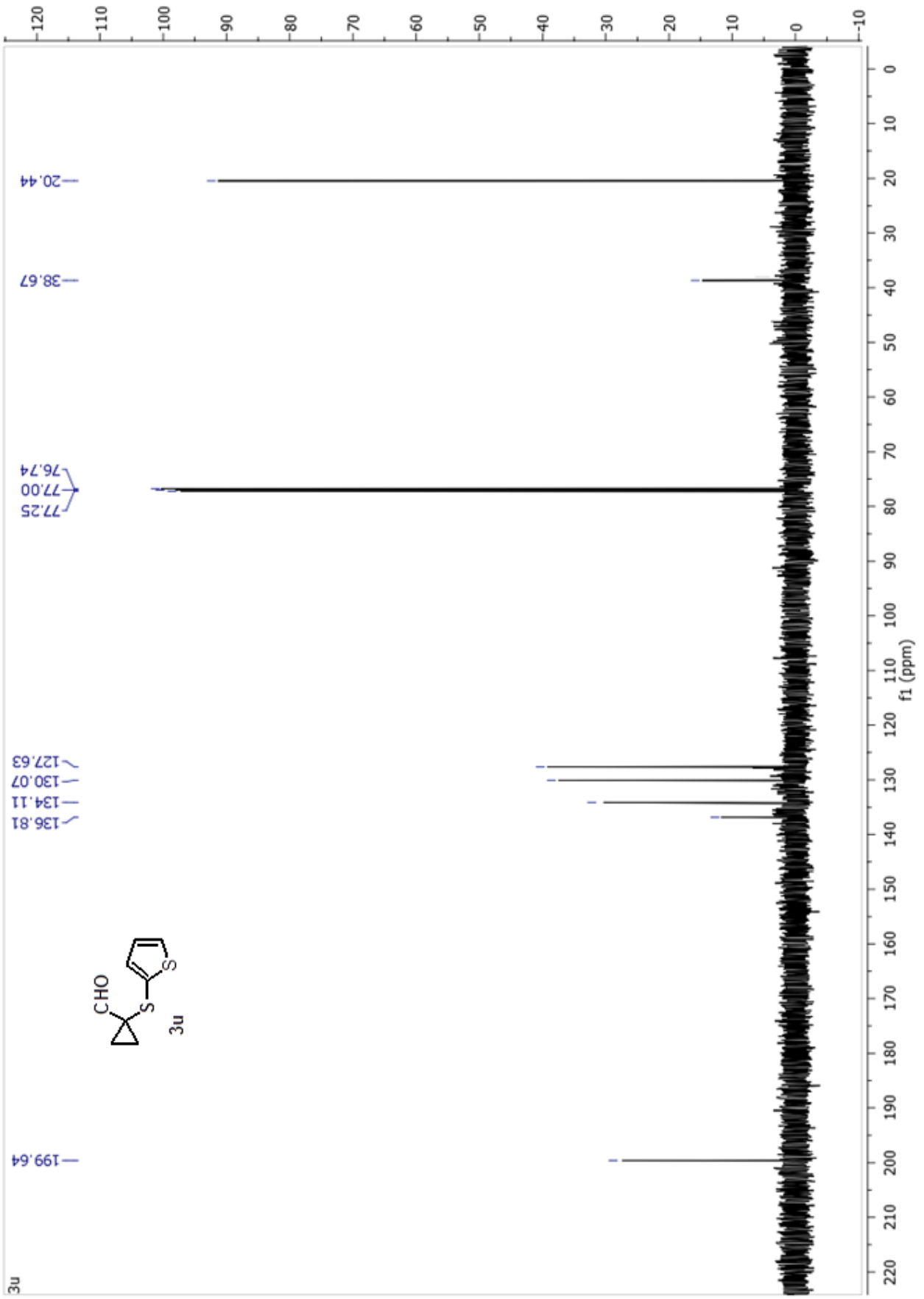
1-(4-Nitro-phenylsulfanyl)-cyclopropanecarbaldehyde 3s



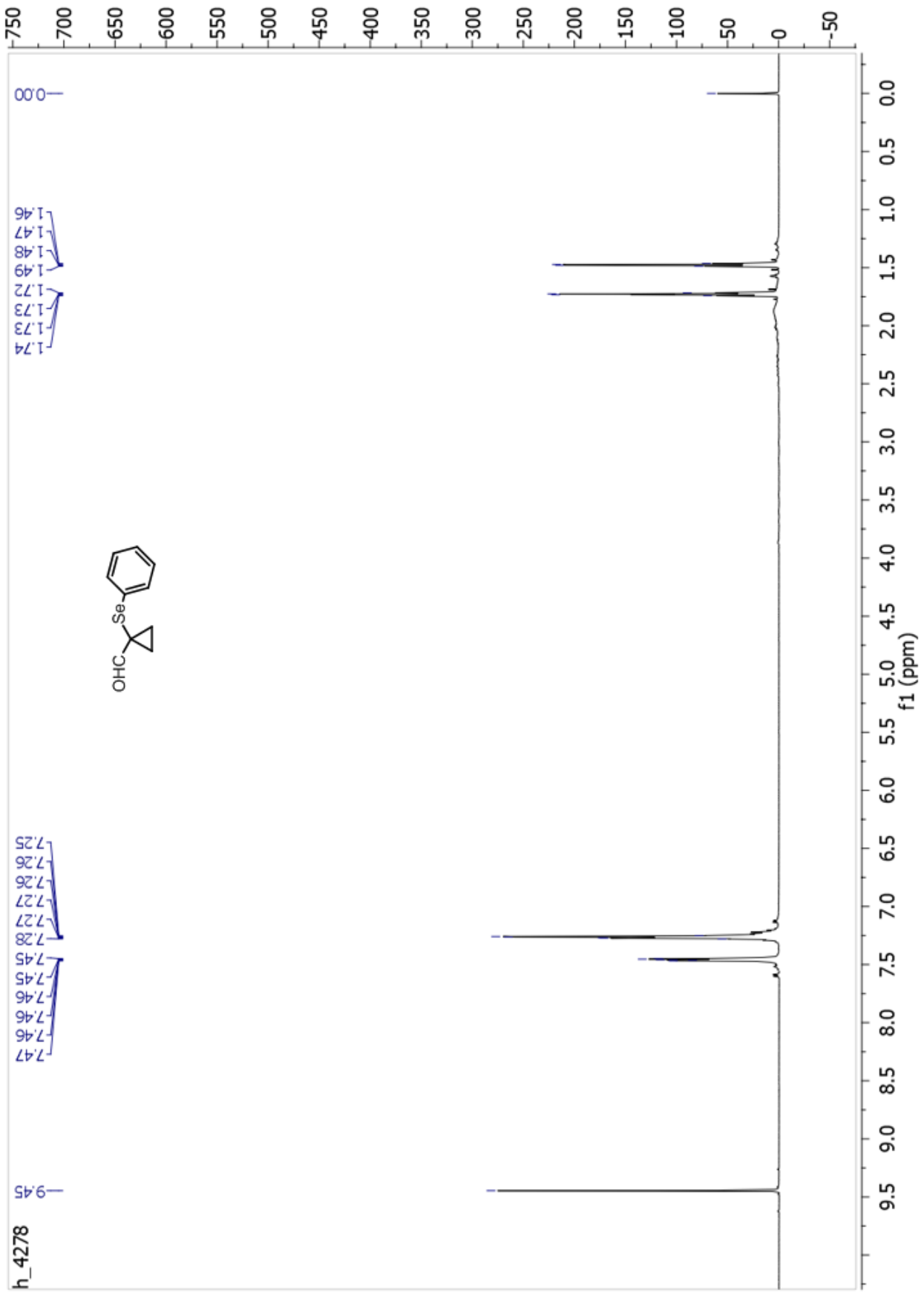

cd4114
198.32
146.12
145.67
126.04
124.10
77.25
77.00
76.74
33.28
20.11
CHO
S
NO2
f1 (ppm)

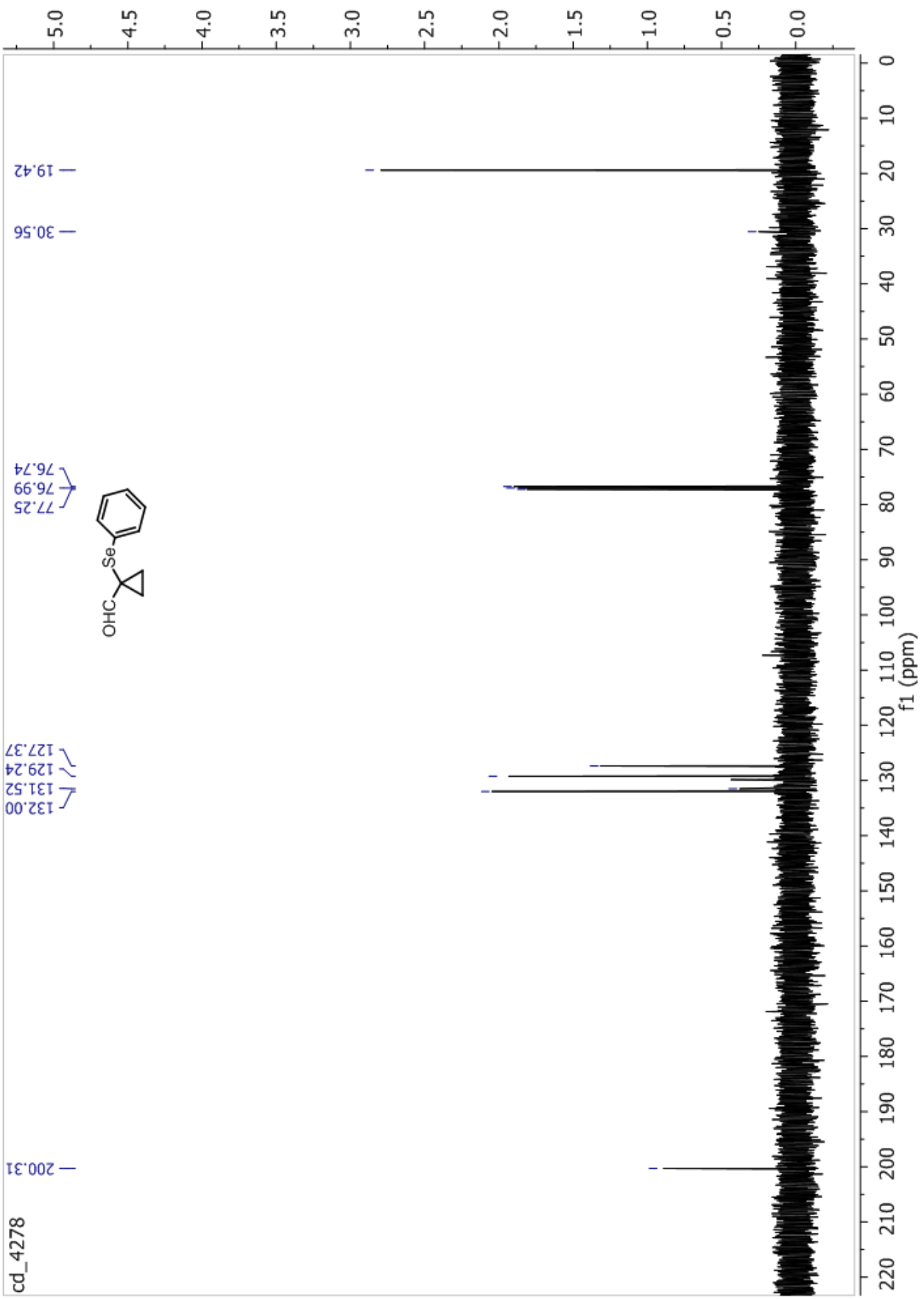
1-(Thiophen-2-ylsulfanyl)-cyclopropanecarbaldehyde 3u



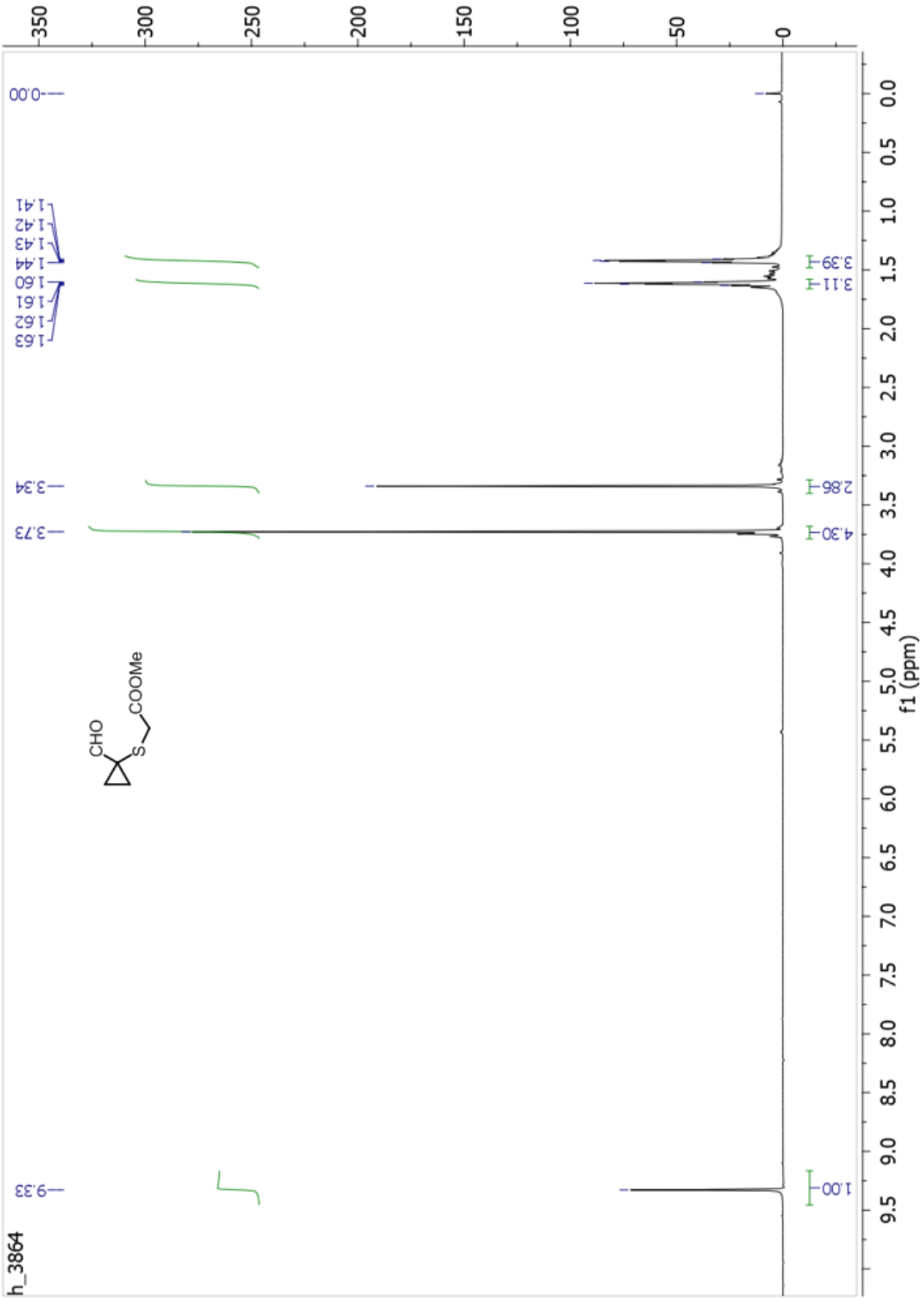

3u
199.64
136.81
134.11
130.07
127.63
77.25
77.00
76.74
38.67
20.44
CHO
S
S
3u
f1 (ppm)

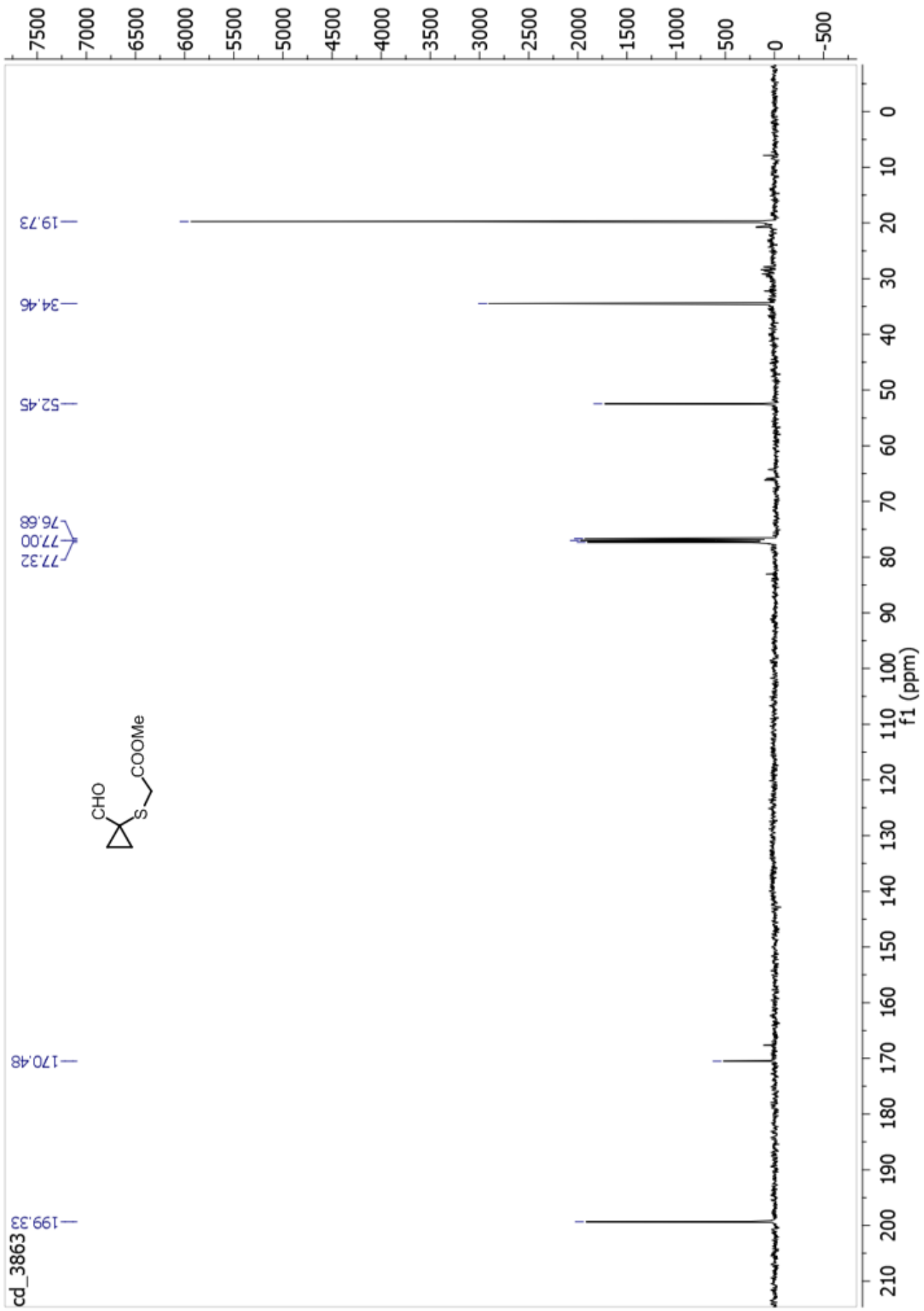
1-Phenylselanyl-cyclopropanecarbaldehyde 3v



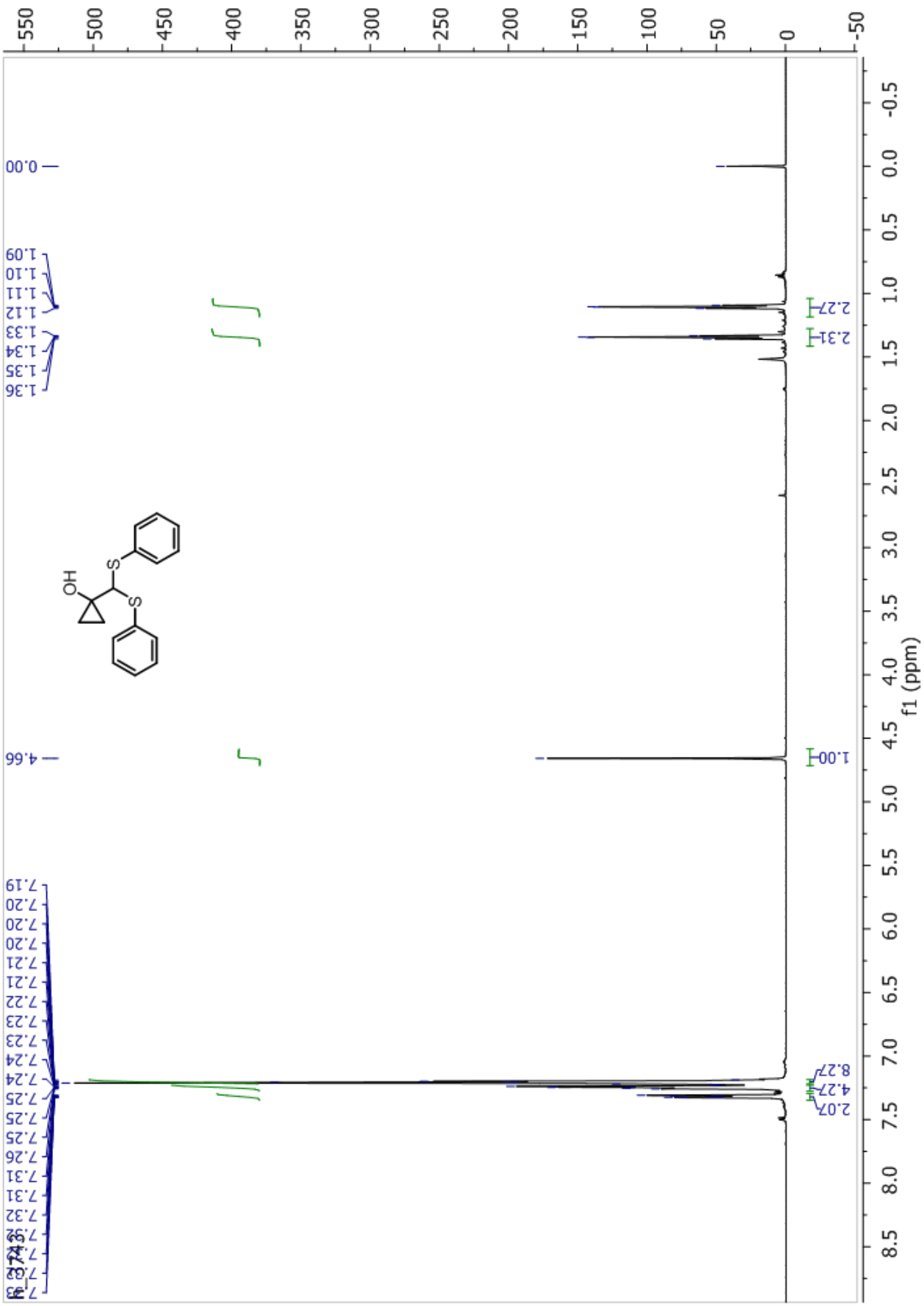

cd_4278
200.31
132.00
131.52
129.24
127.37
77.25
76.99
76.74
30.56
19.42
OHC
Se
f1 (ppm)

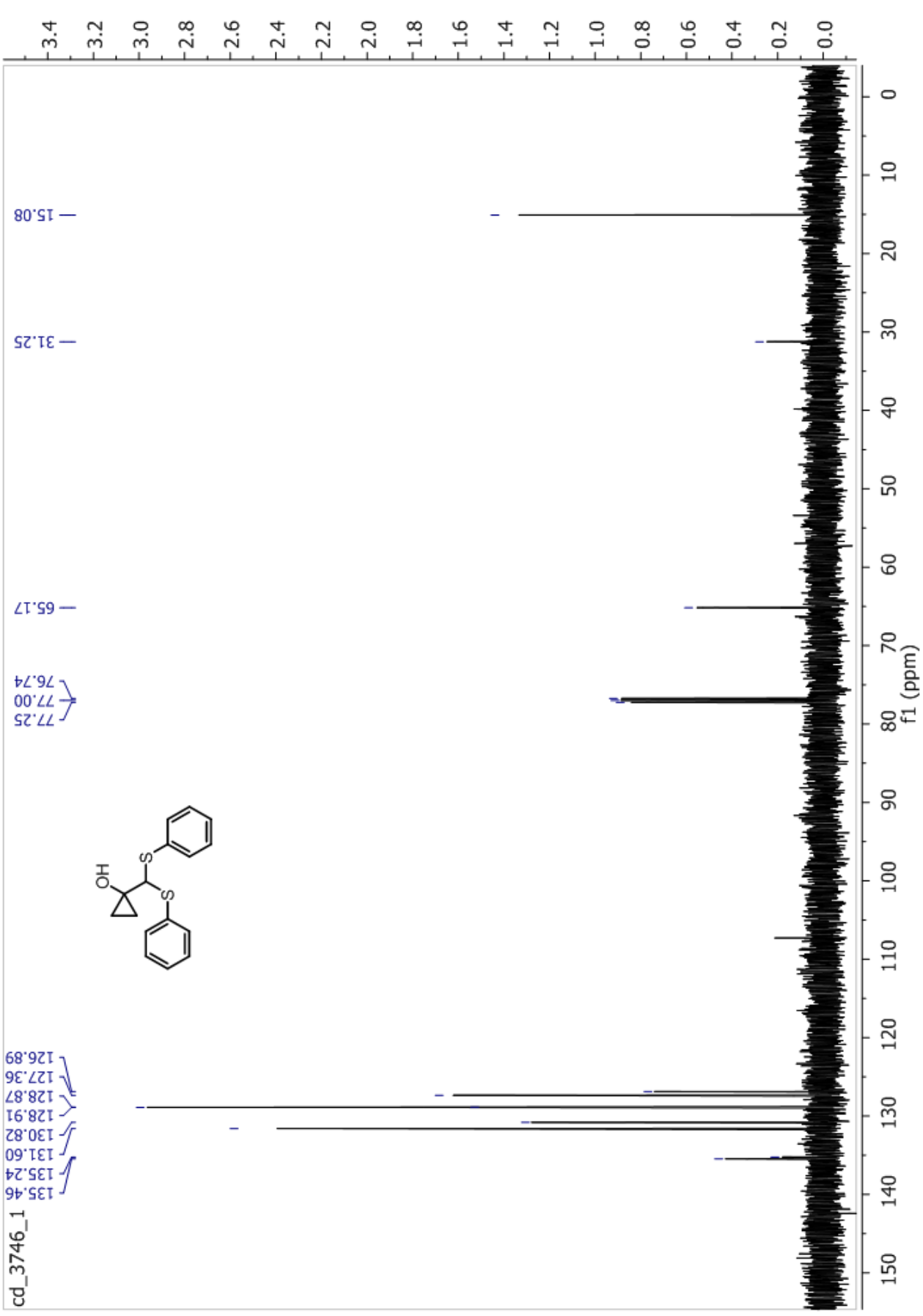
(1-Formyl-cyclopropylsulfanyl)-acetic acid methyl ester 3w



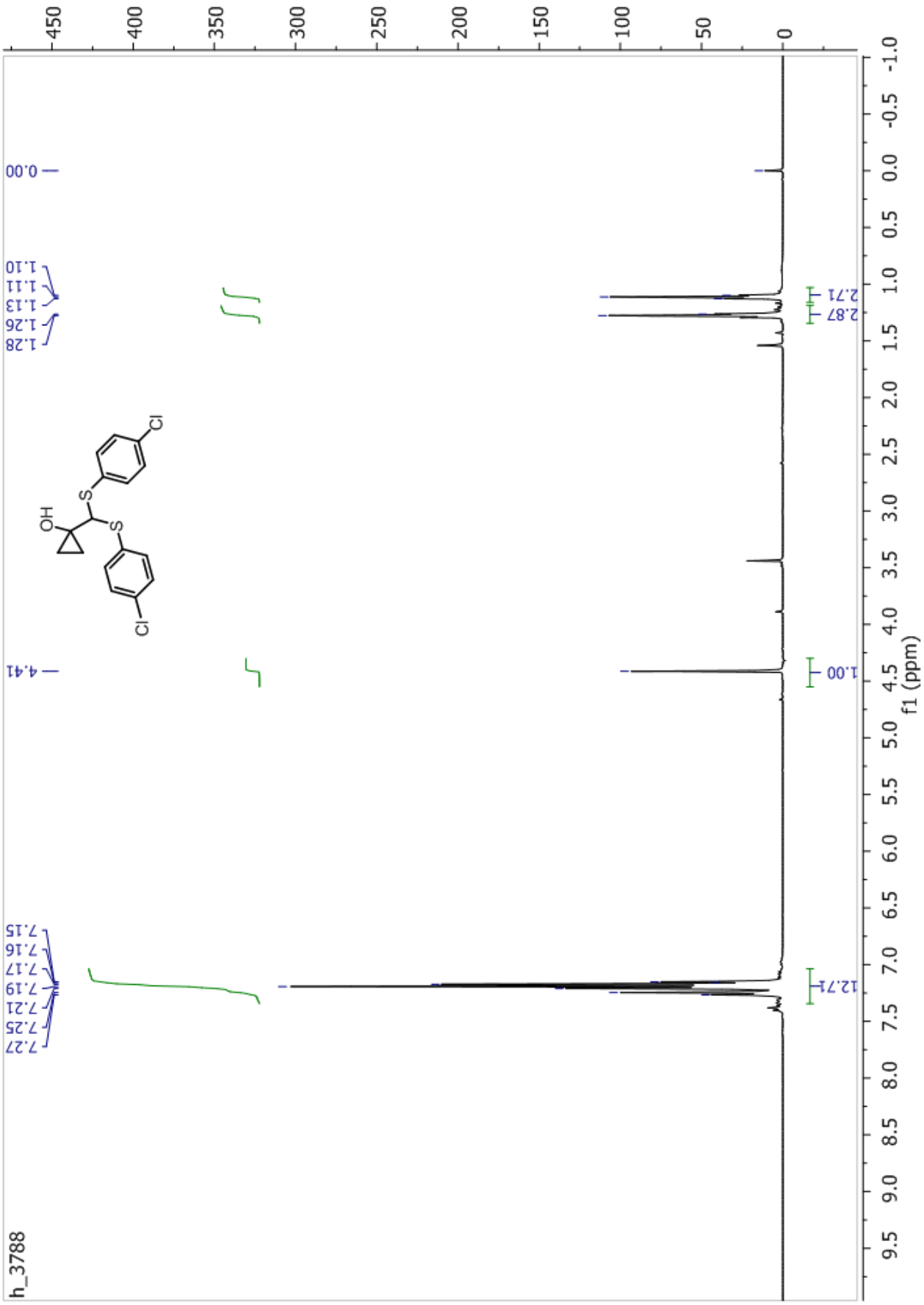

cd_3863
199.33
170.48
77.32
77.00
76.68
52.45
34.46
19.73
CHO
S
COOMe
f1 (ppm)

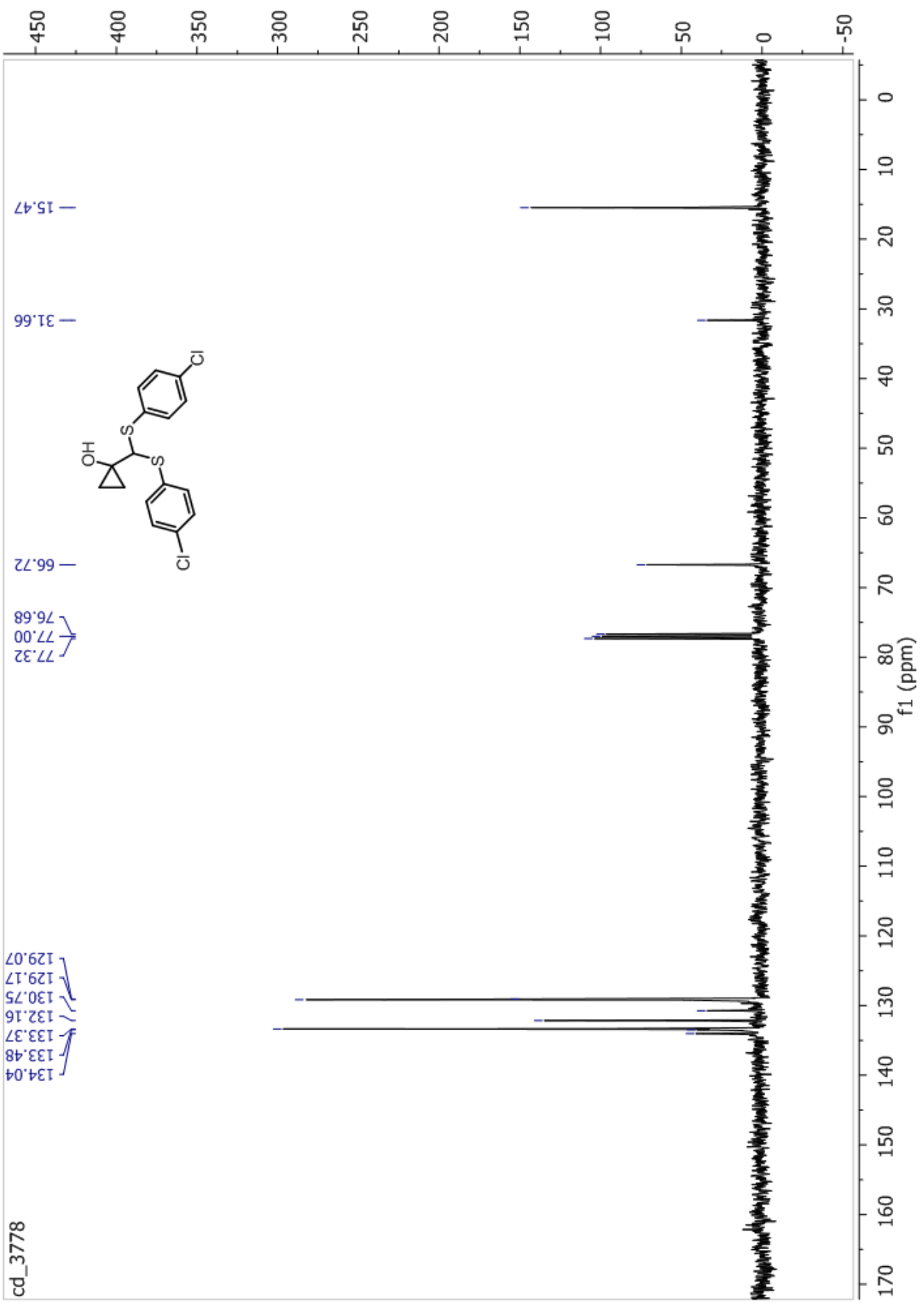
1-(bis(phenylthio)methyl)cyclopropanol 4a



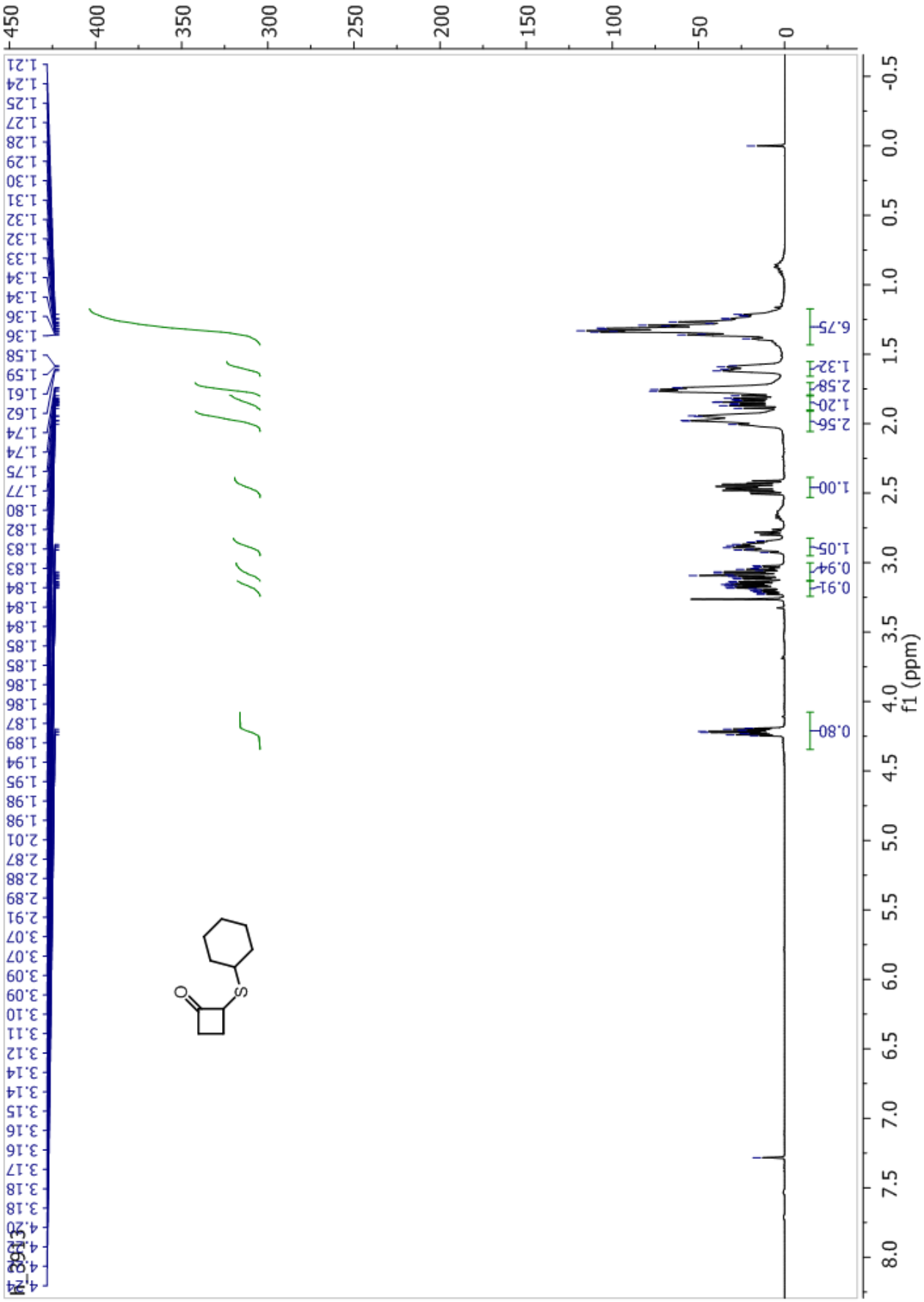

cd_3746_1
135.46
135.24
131.60
130.82
128.91
128.87
127.36
126.89
77.25
77.00
76.74
65.17
31.25
15.08
OH
S
S
f1 (ppm)

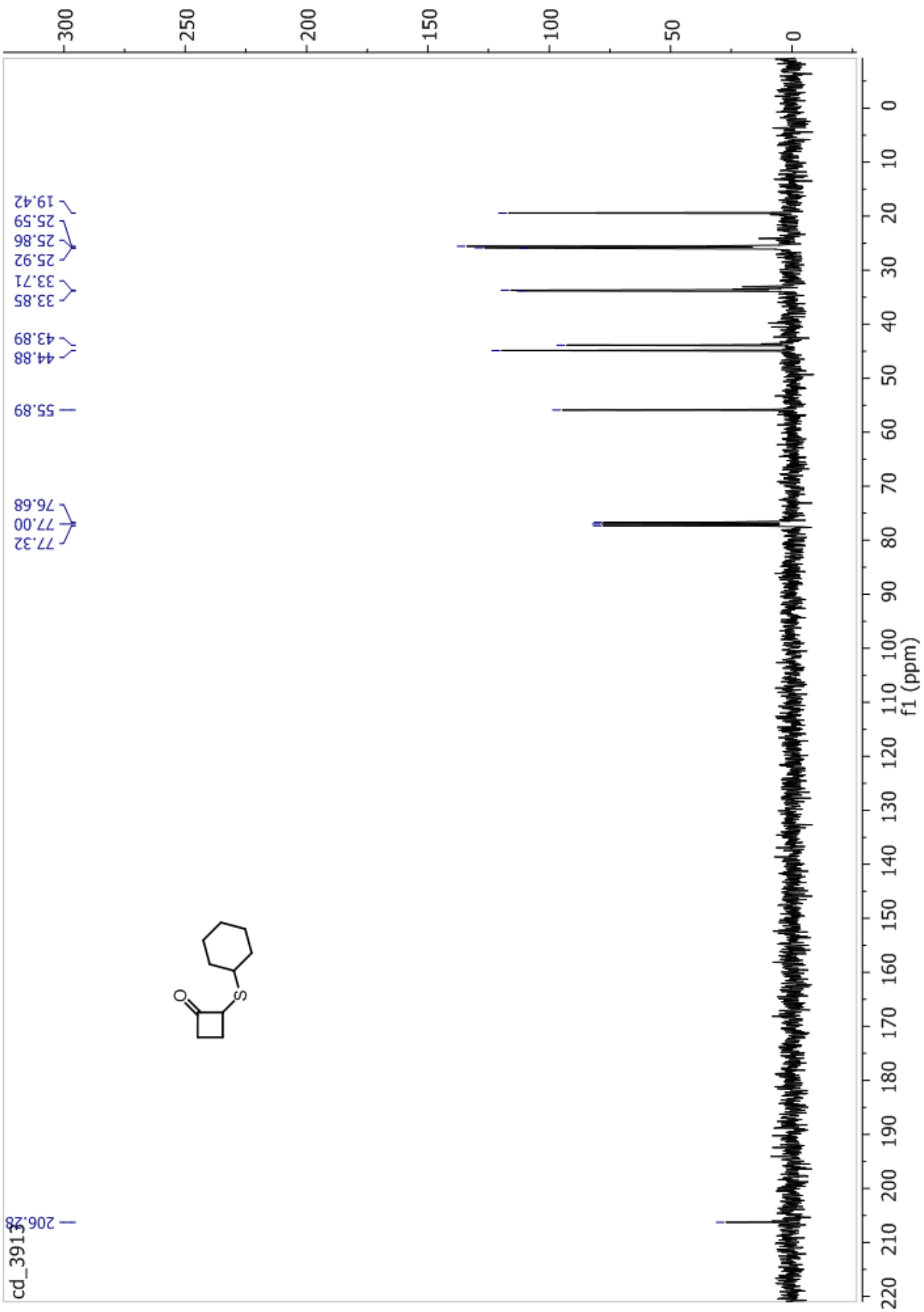
1-[(3-Chloro-phenylsulfanyl)-(4-chloro-phenylsulfanyl)-methyl] cyclopropanol 4o



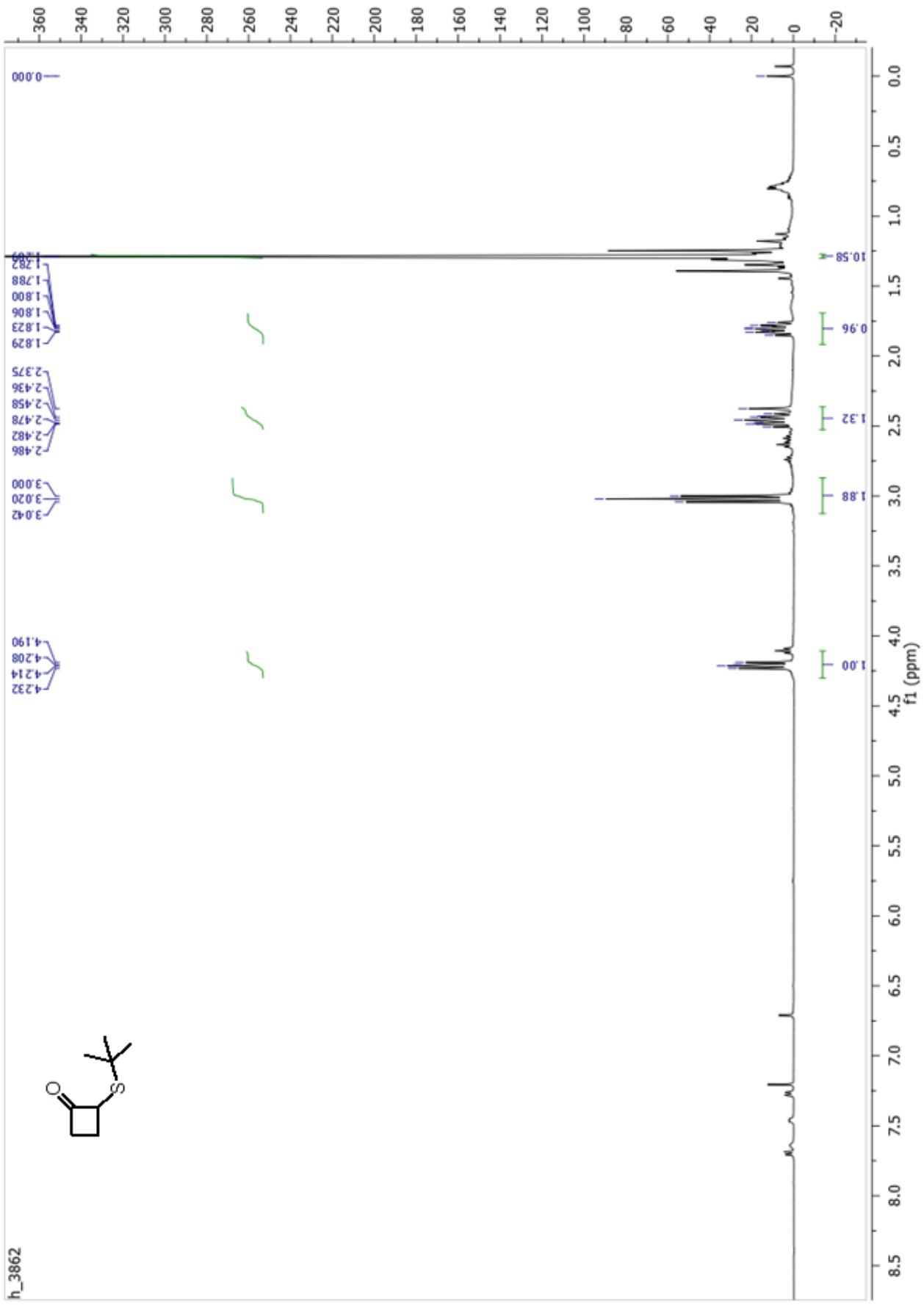

cd_3778
15.47
31.66
66.72
76.68
77.00
77.32
129.07
129.17
130.75
132.16
133.37
133.48
134.04
OH
S
S
Cl
Cl
f1 (ppm)

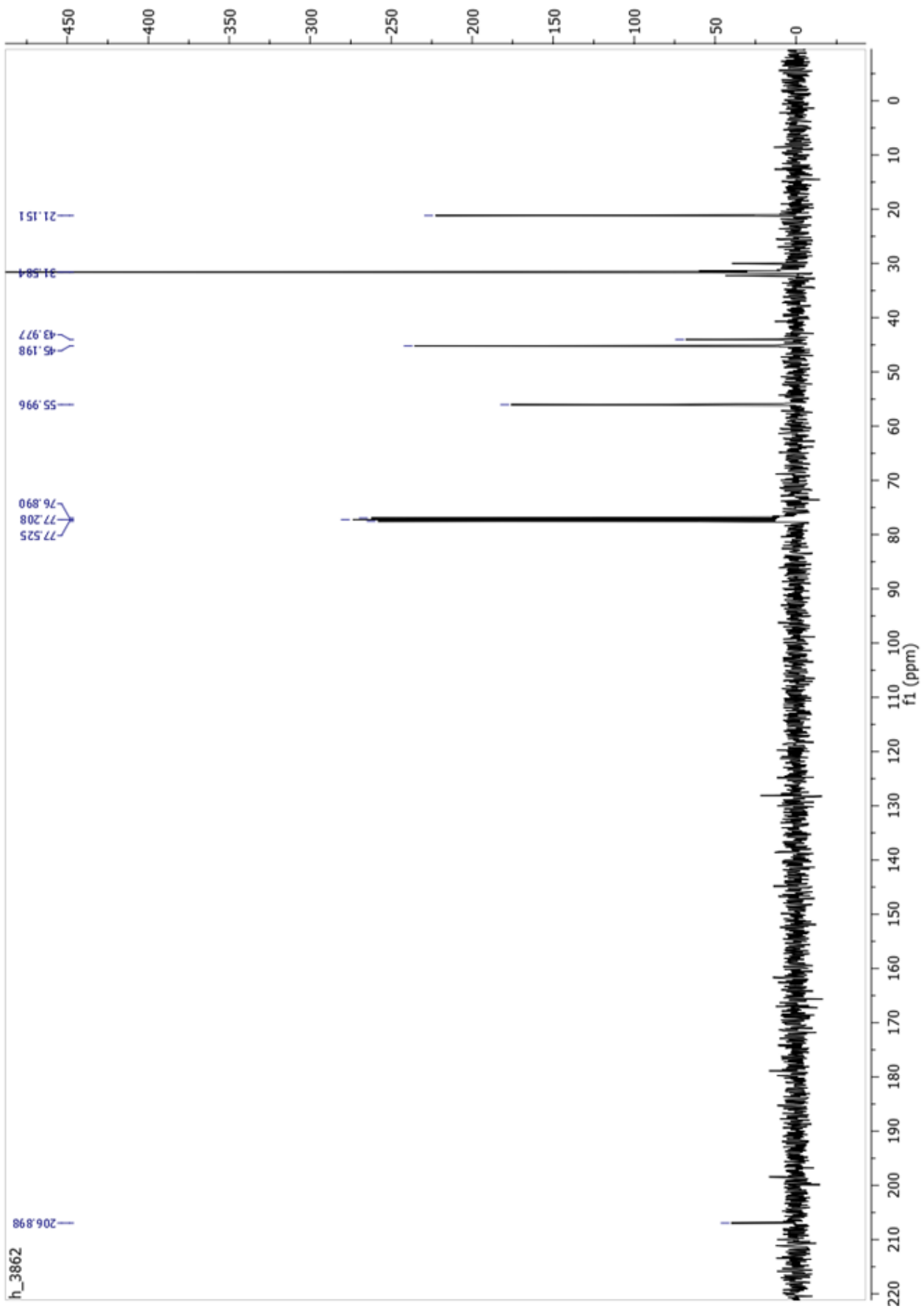
2-Cyclohexylsulfanyl-cyclobutanone 5x




cd_39135
206.28
77.32
77.00
76.68
55.89
44.88
43.89
33.85
33.71
25.92
25.86
25.59
19.42
O
S
f1 (ppm)

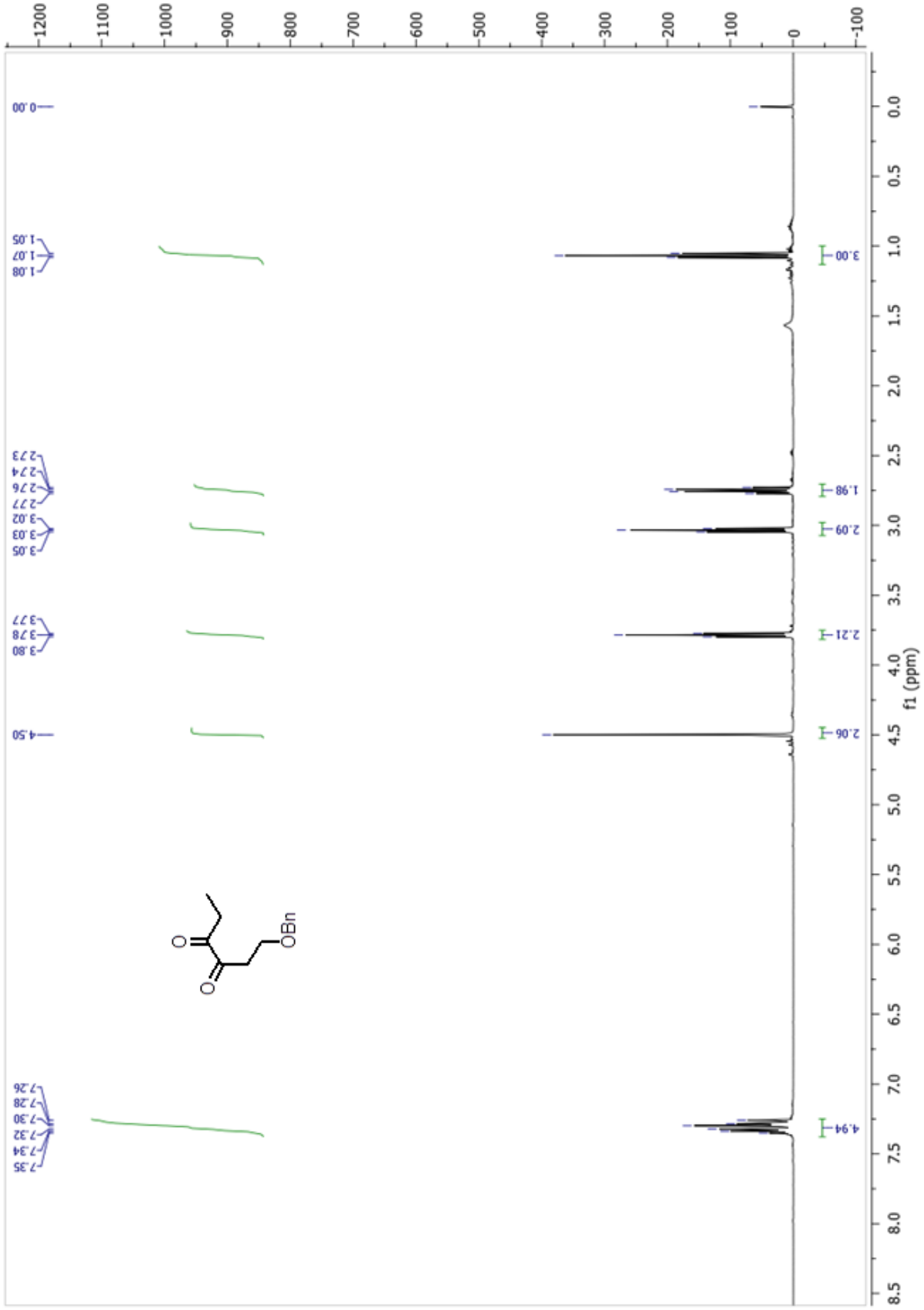
2-*tert*-Butylsulfanyl-cyclobutanone 5y

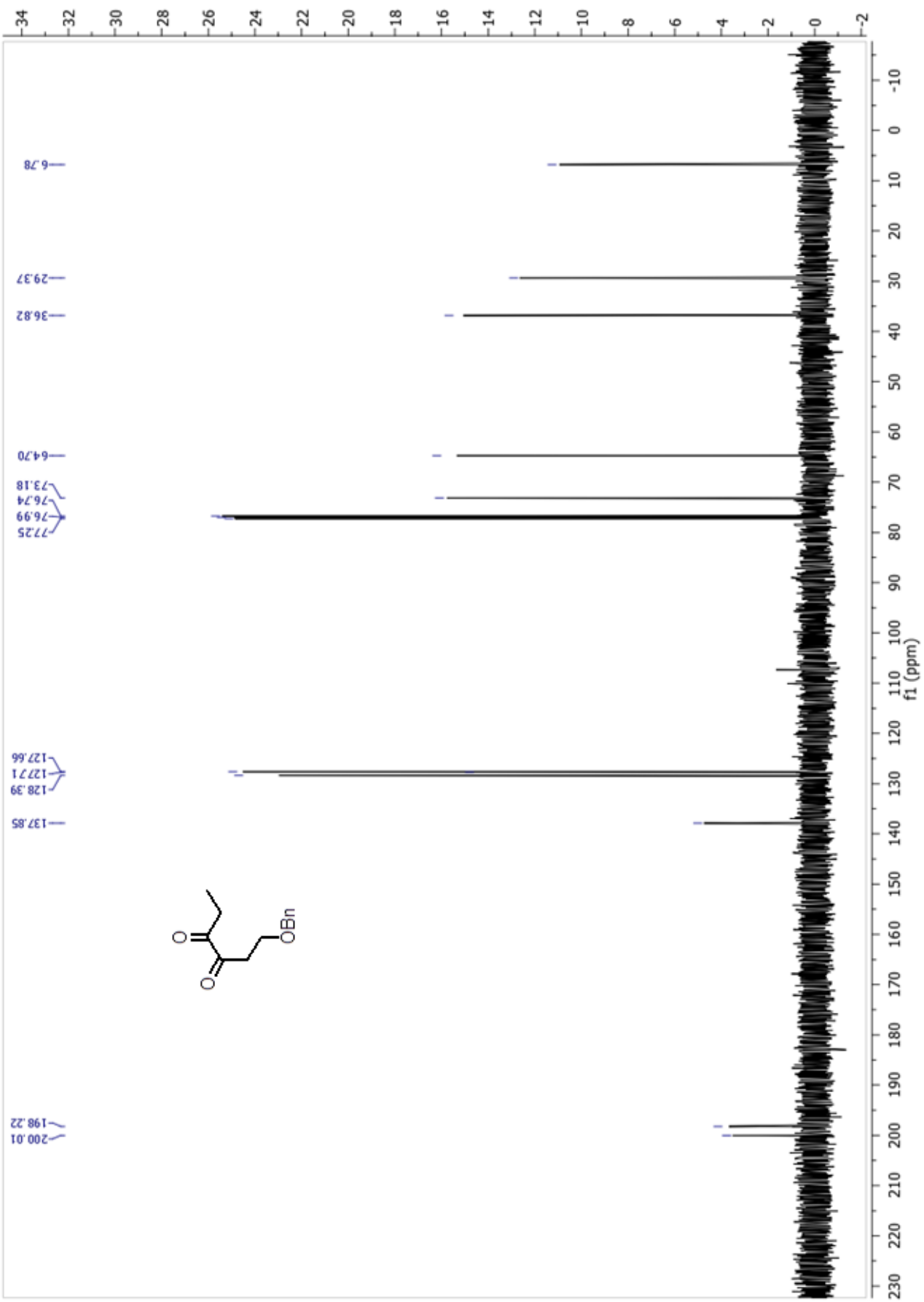



h_3862
206.898
77.525
77.208
76.890
55.996
45.198
43.977
31.584
21.151
f1 (ppm)

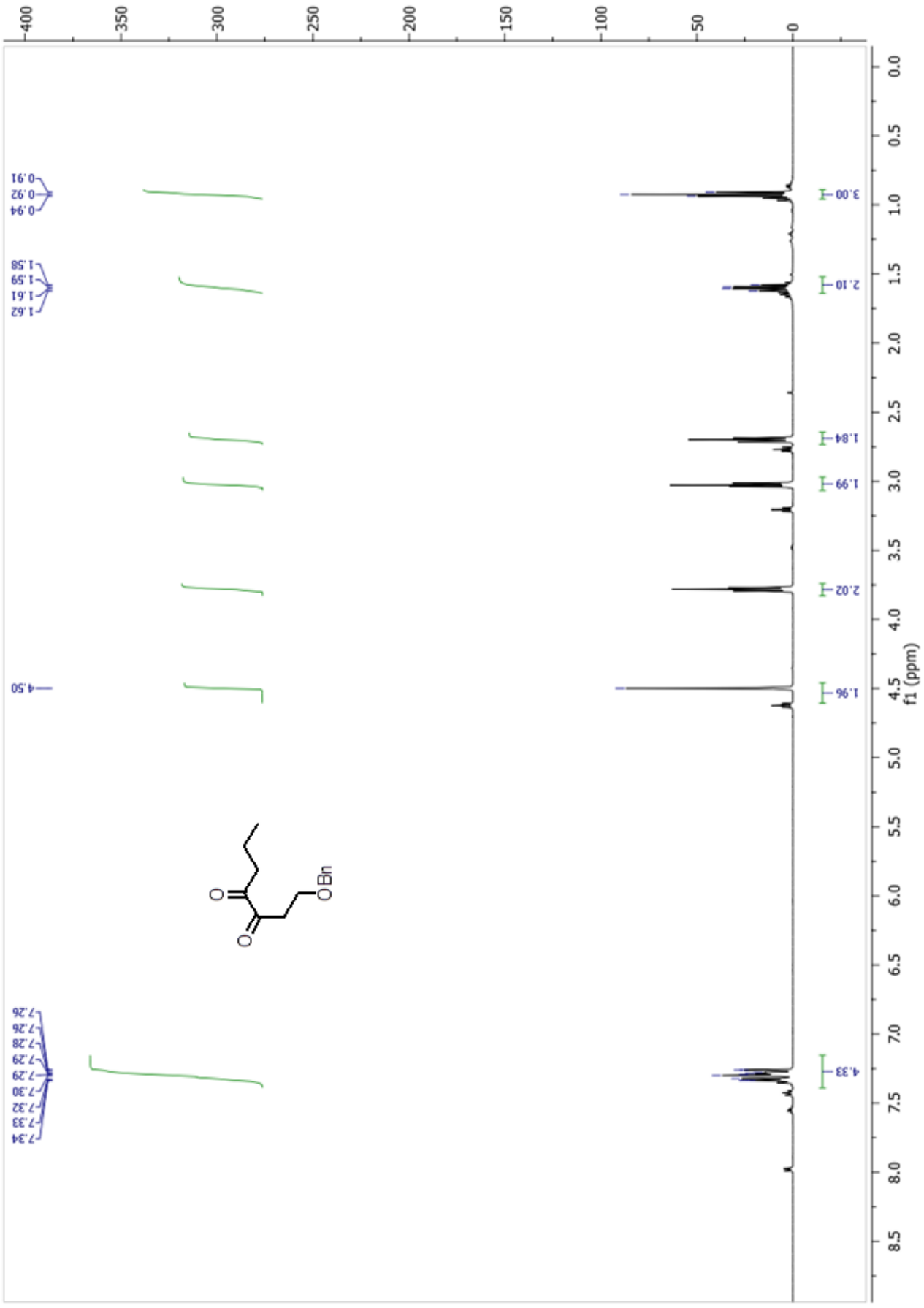
8. ^{1}H and ^{13}C NMR spectra of diones A3-4.

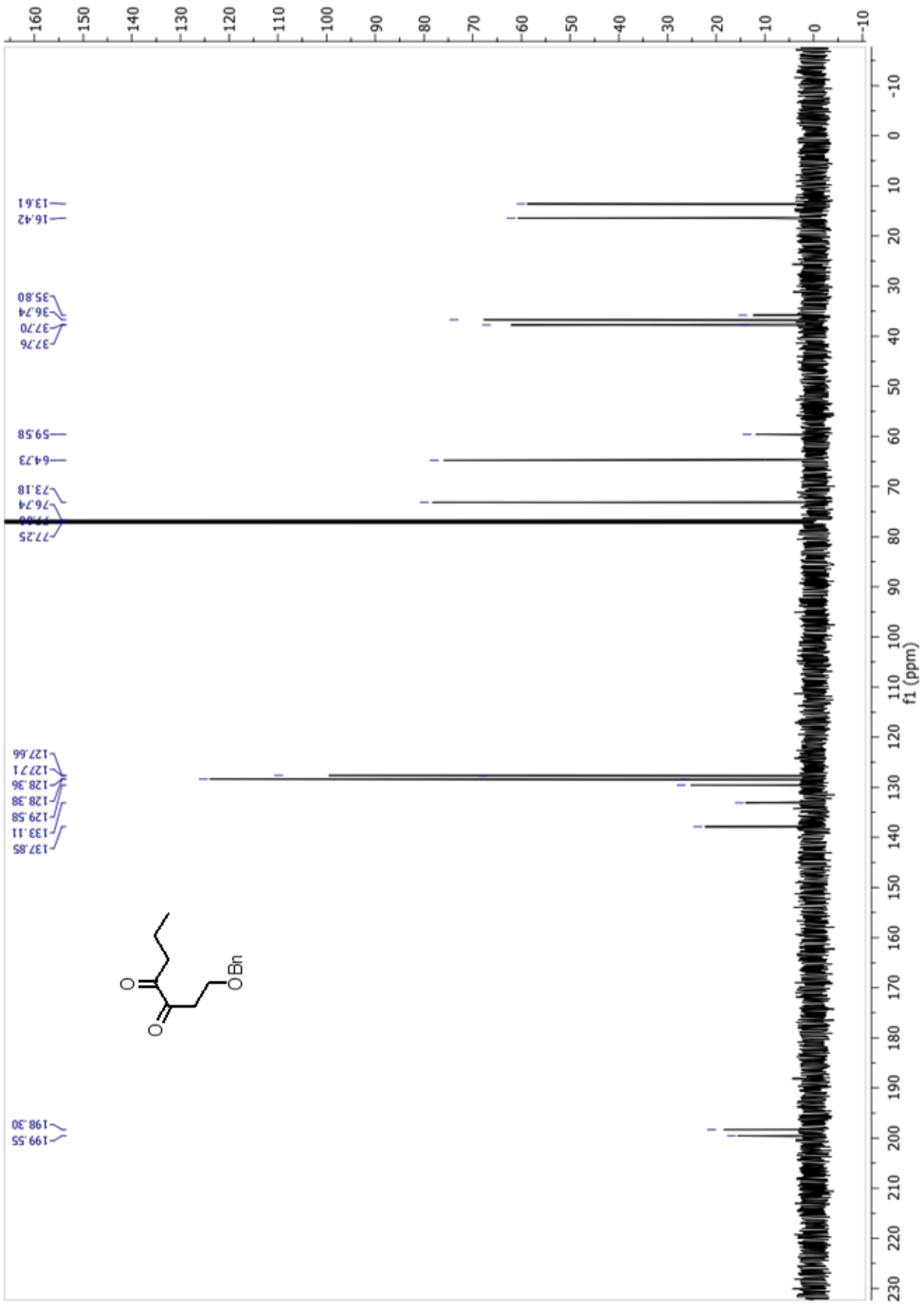
1-Benzyloxy-hexane-3,4-dione A3




6.78
29.37
36.82
64.70
73.18
76.74
76.99
77.25
127.66
127.71
128.39
137.85
198.22
200.01
O
O
OBn
f1 (ppm)

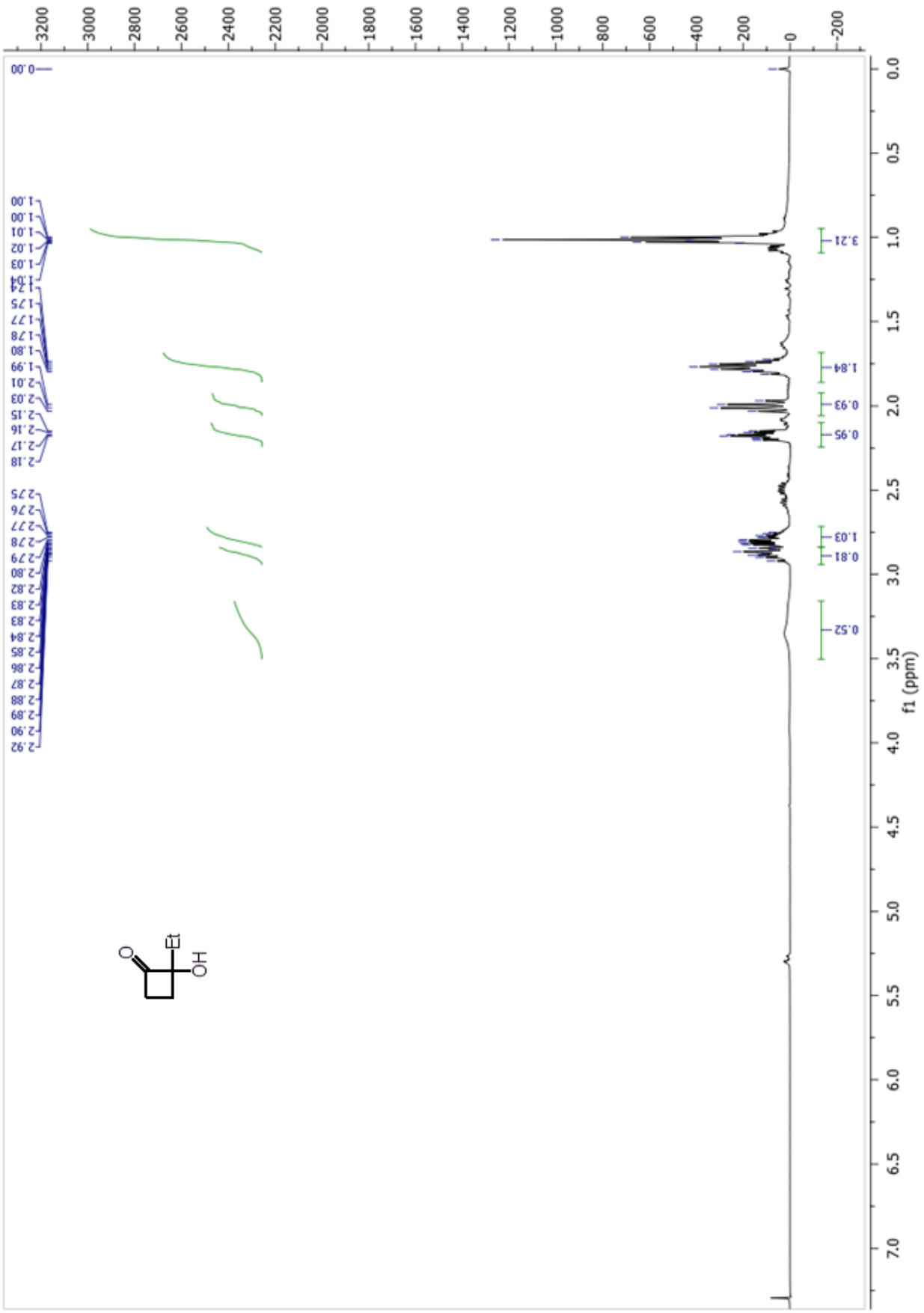
1-Benzyloxy-heptane-3,4-dione A4

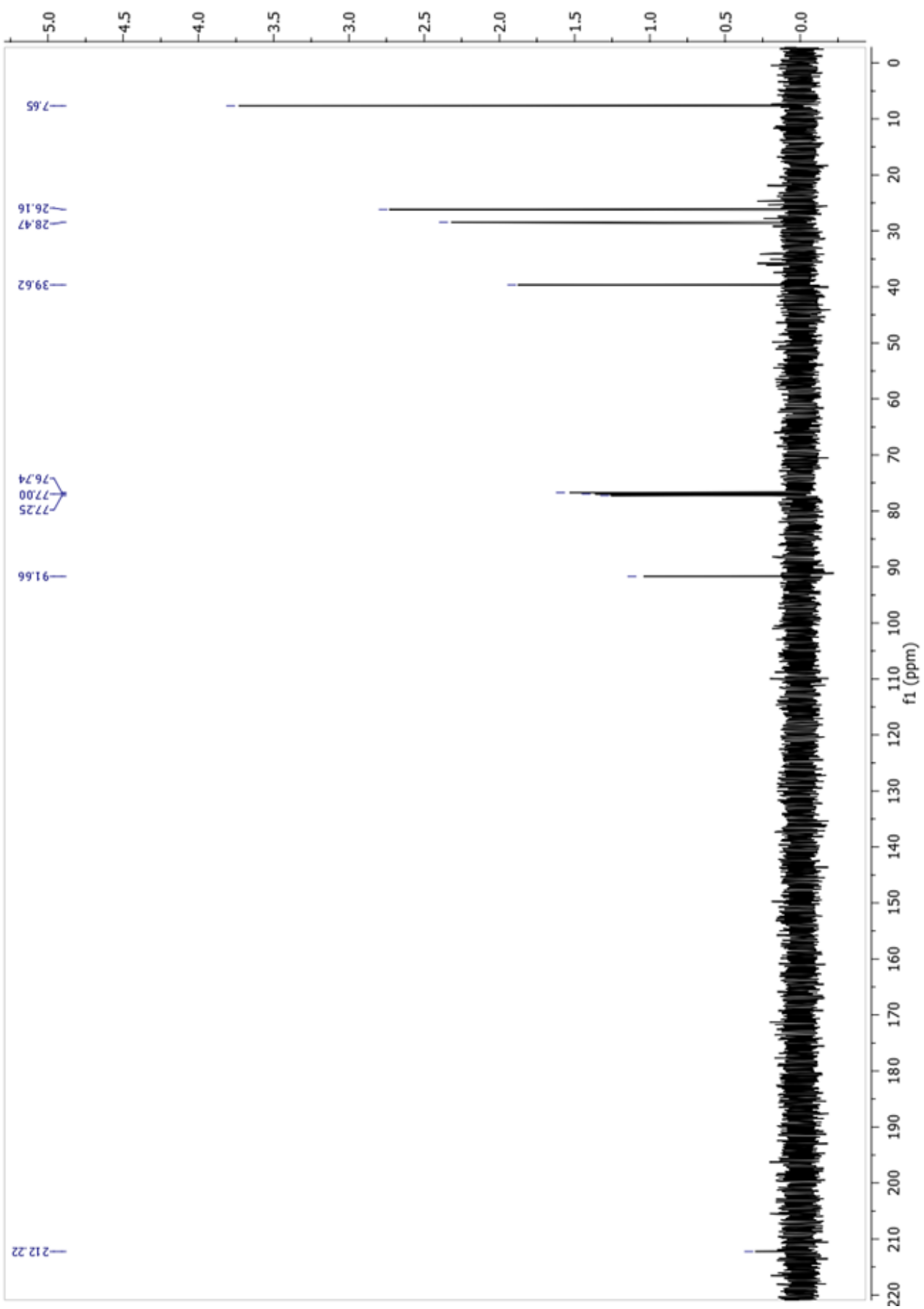



199.55
198.30
137.85
133.11
129.58
128.38
128.36
127.71
127.66
77.25
76.74
73.18
64.73
59.58
37.76
37.70
36.74
35.80
16.42
13.61
O
O
OBn
f1 (ppm)

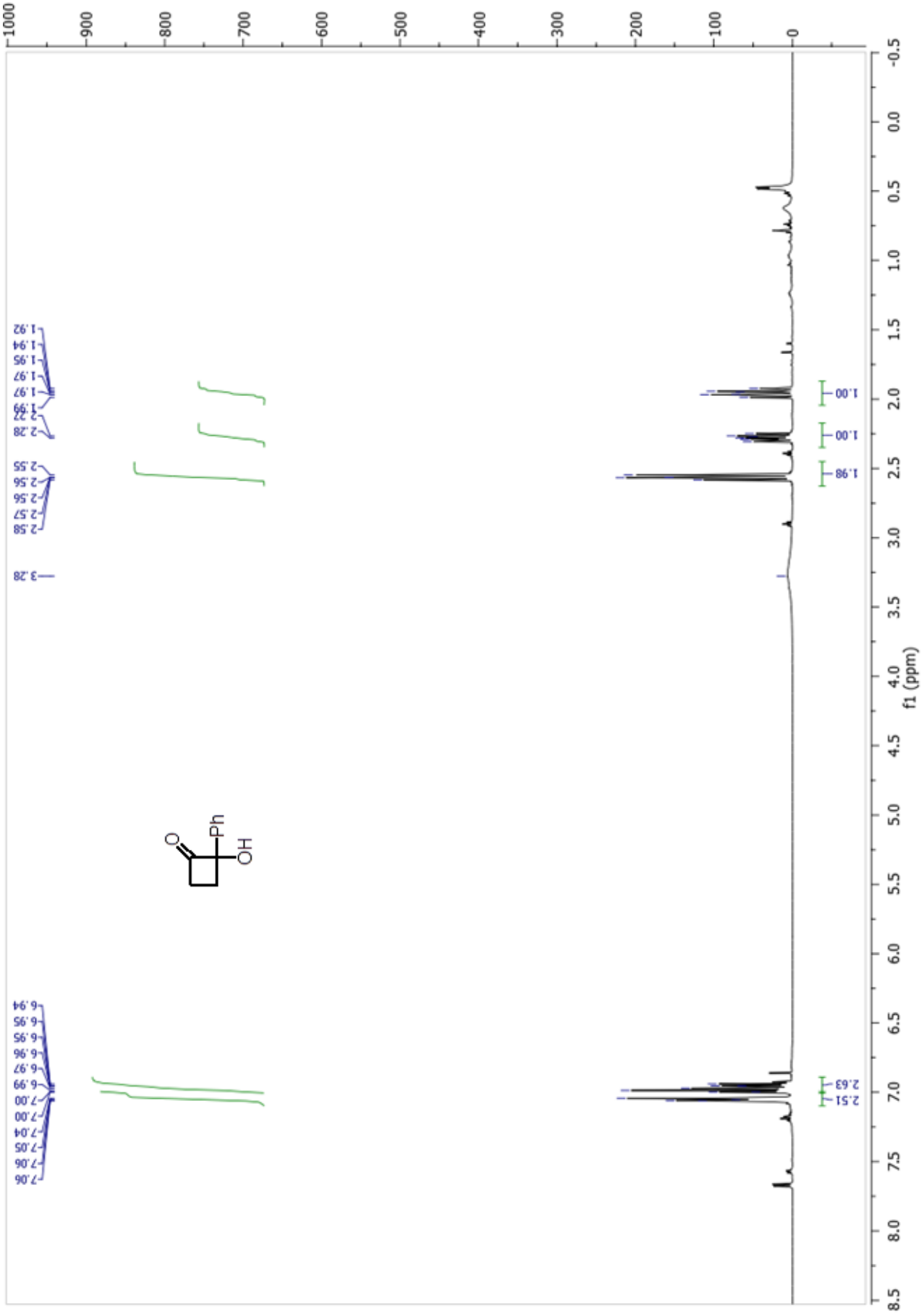
9. ^{1}H and ^{13}C NMR spectra of compounds 1b-f.

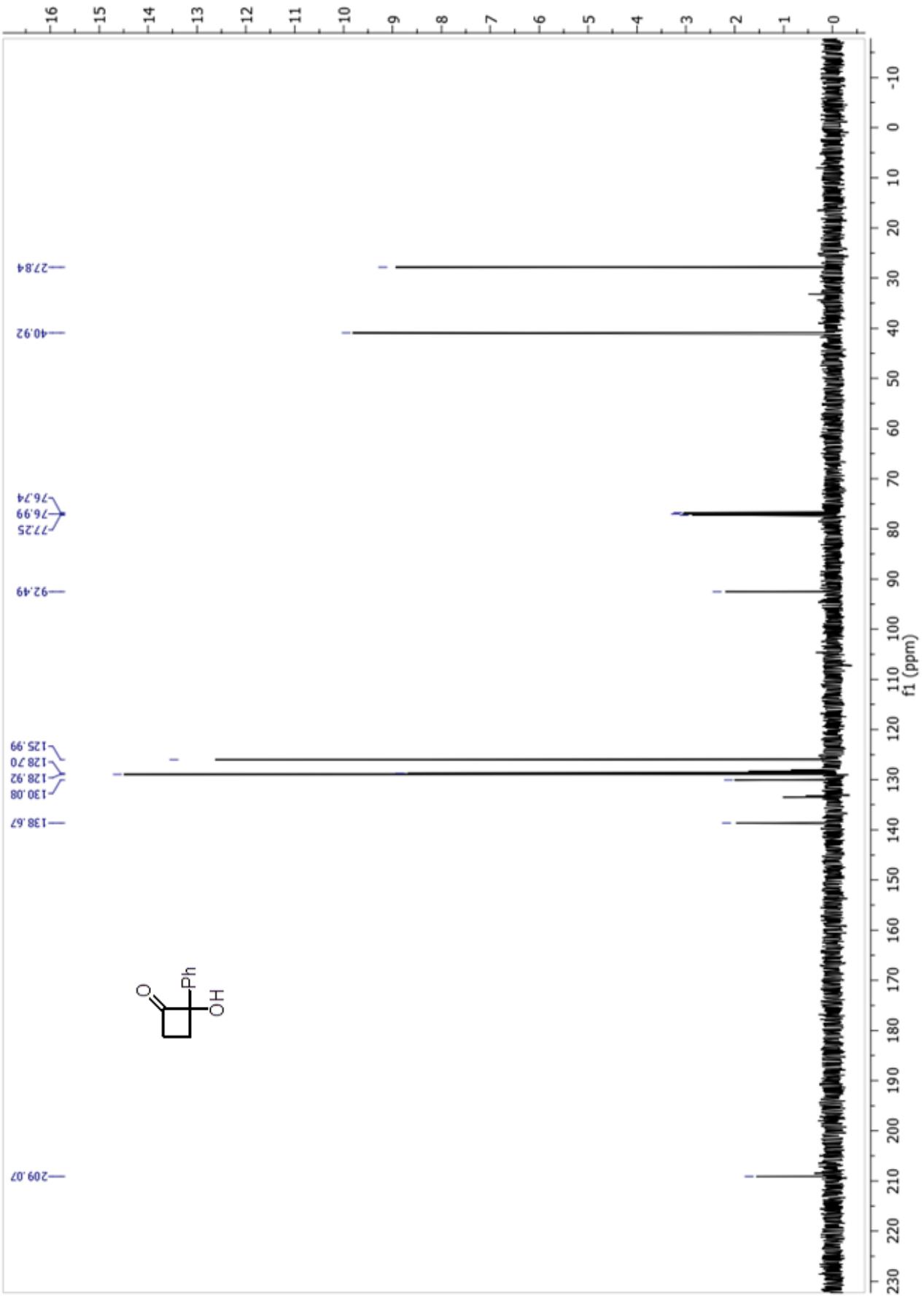
2-Ethyl-2-hydroxy-cyclobutanone 1b



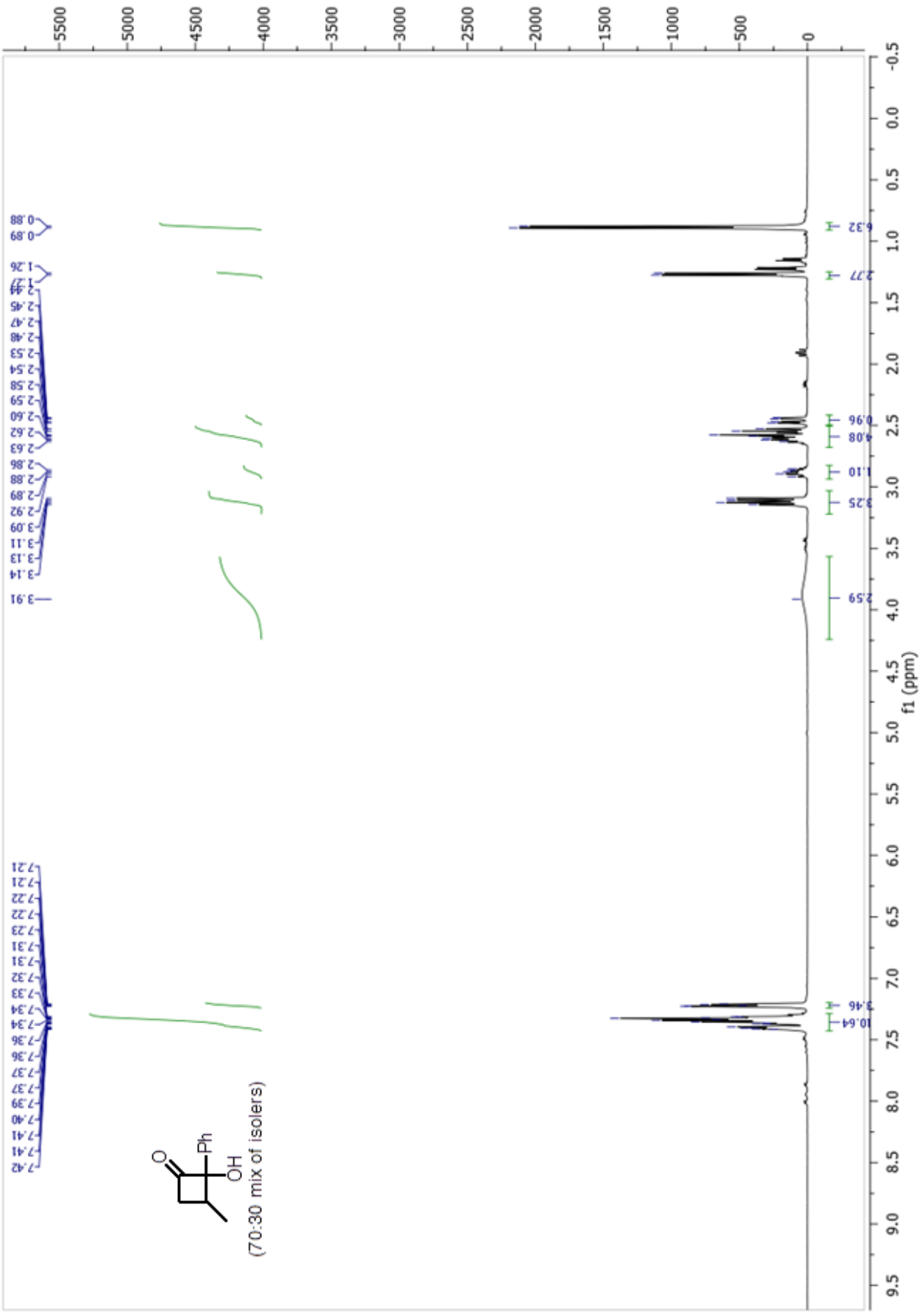

7.65
26.16
28.47
39.62
76.74
77.00
77.25
91.66
212.22
f1 (ppm)

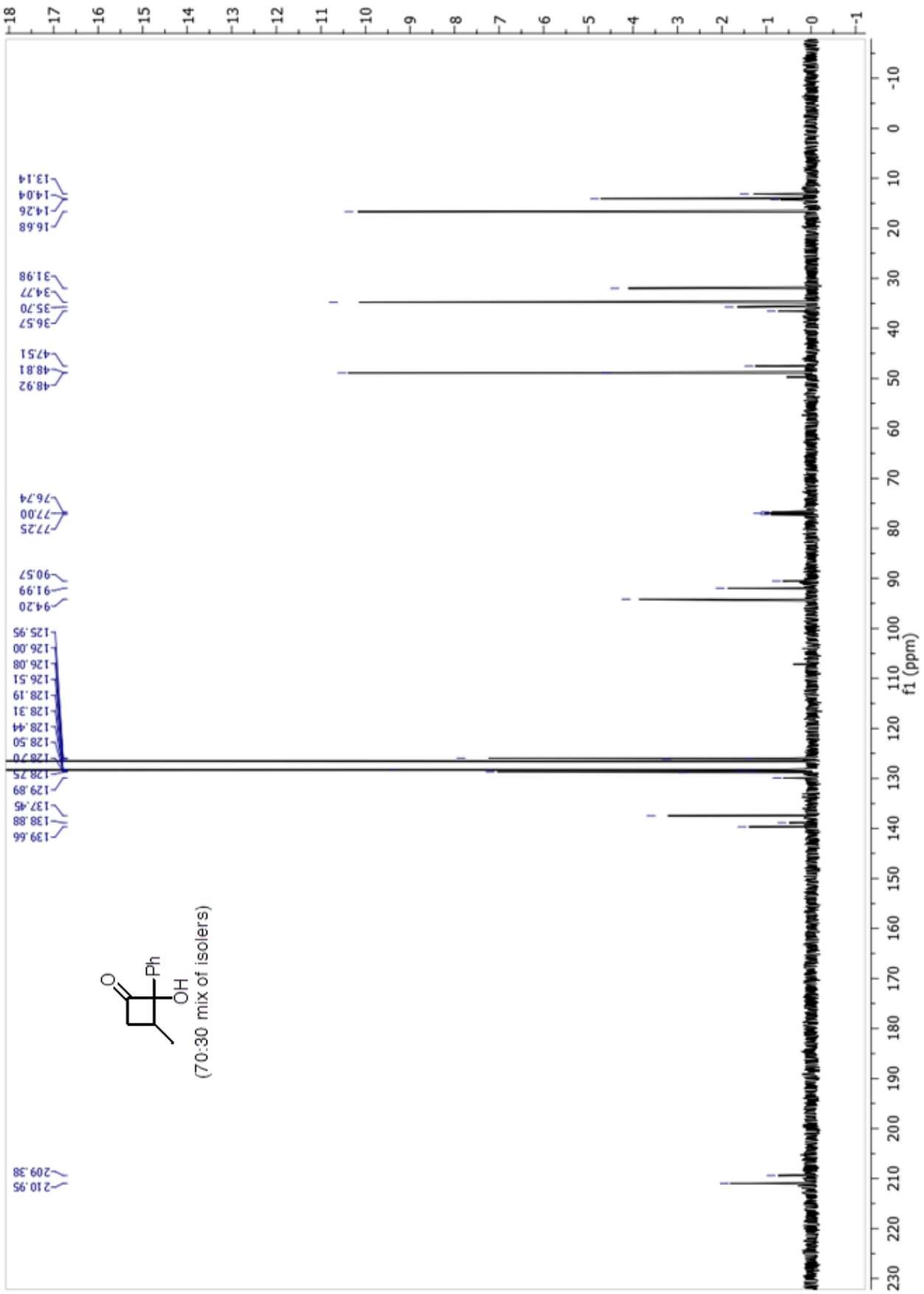
2-Hydroxy-2-phenyl-cyclobutanone 1c



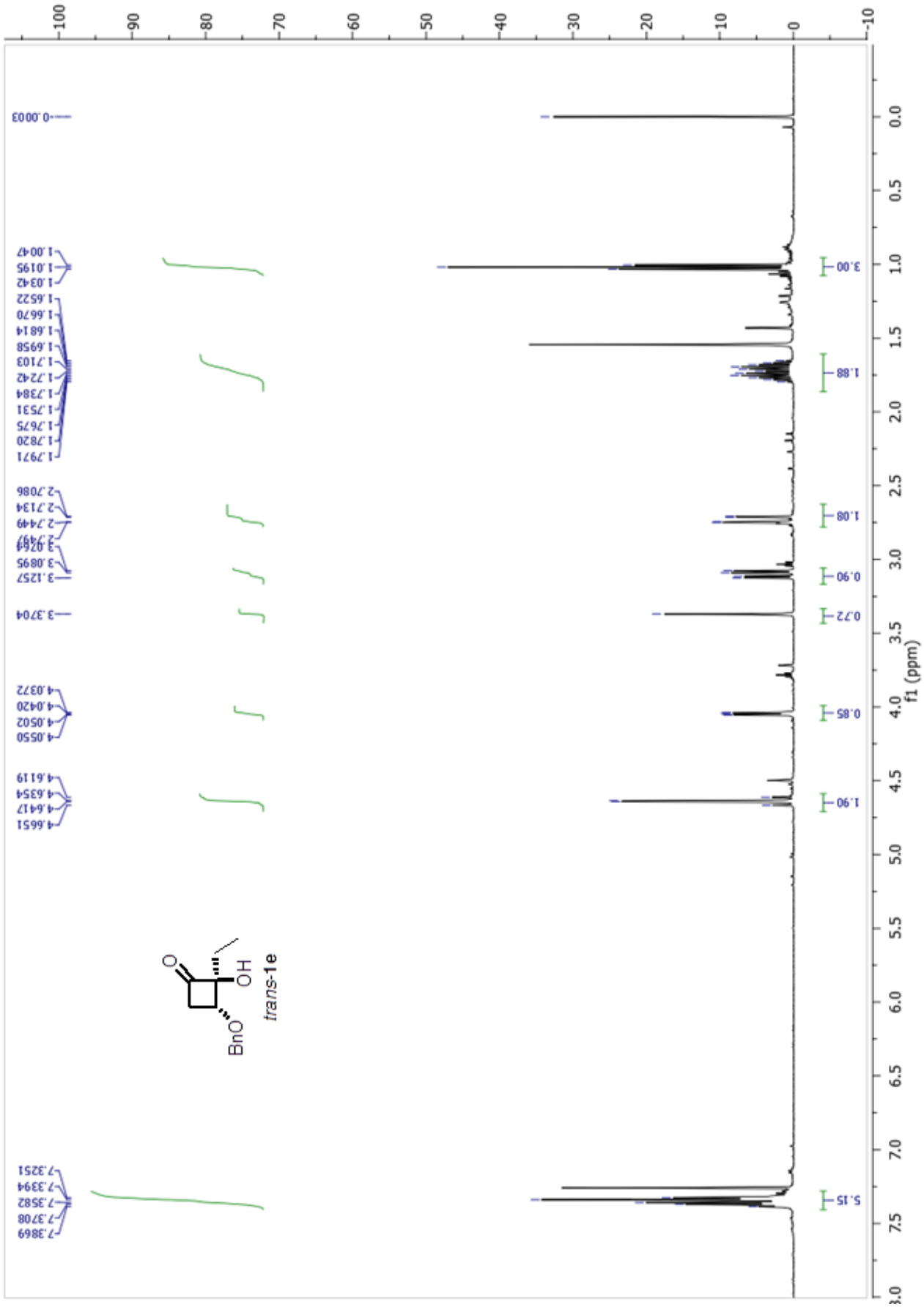

209.07
138.67
130.08
128.92
128.70
125.99
92.49
77.25
76.99
76.74
40.92
27.84
f1 (ppm)
O
Ph
OH

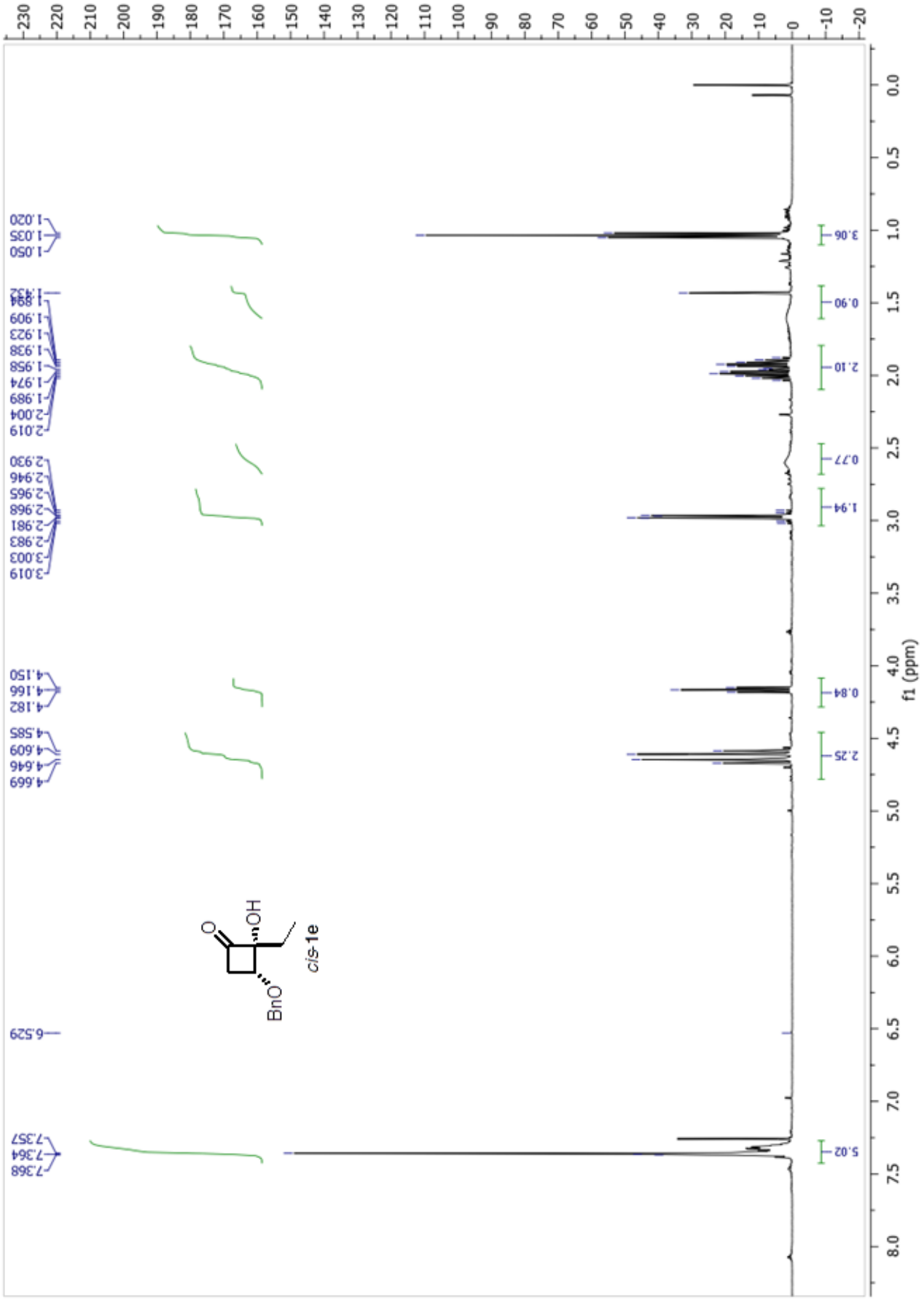
2-Hydroxy-3-methyl-2-phenyl-cyclobutanone 1d

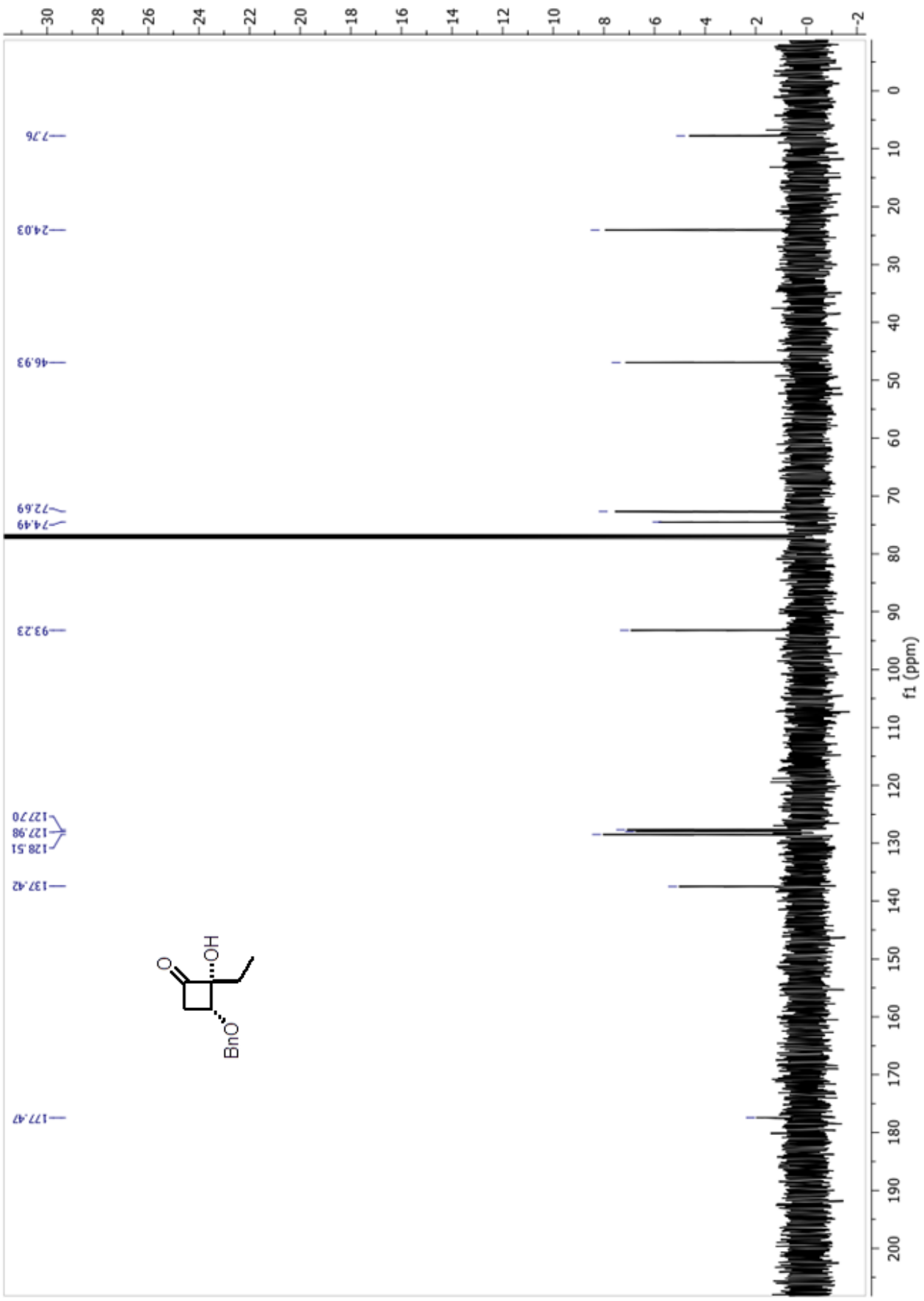



O
Ph
OH
(70:30 mix of isolers)
f1 (ppm)

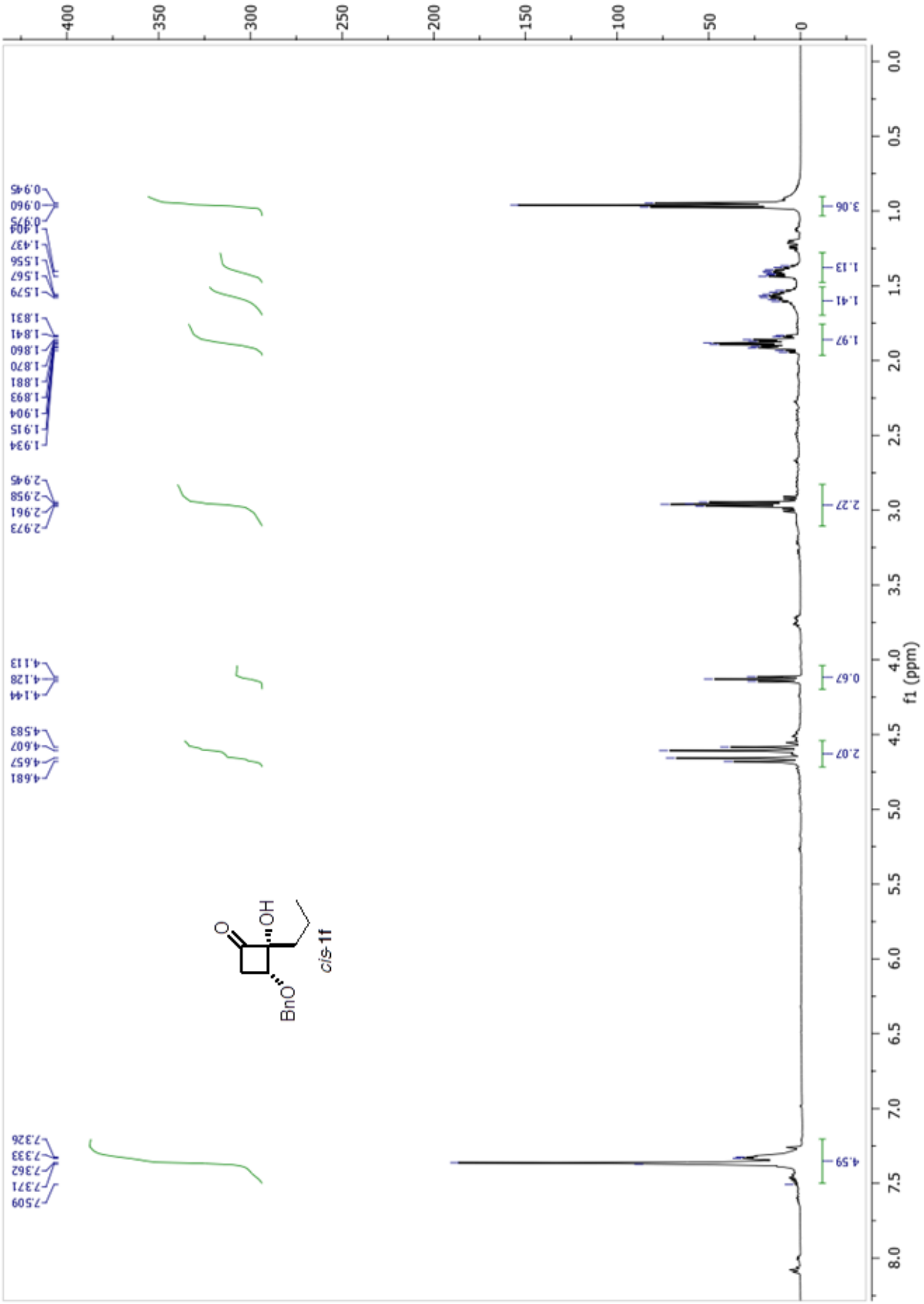
3-Benzyloxy-2-ethyl-2-hydroxy-cyclobutanone 1e

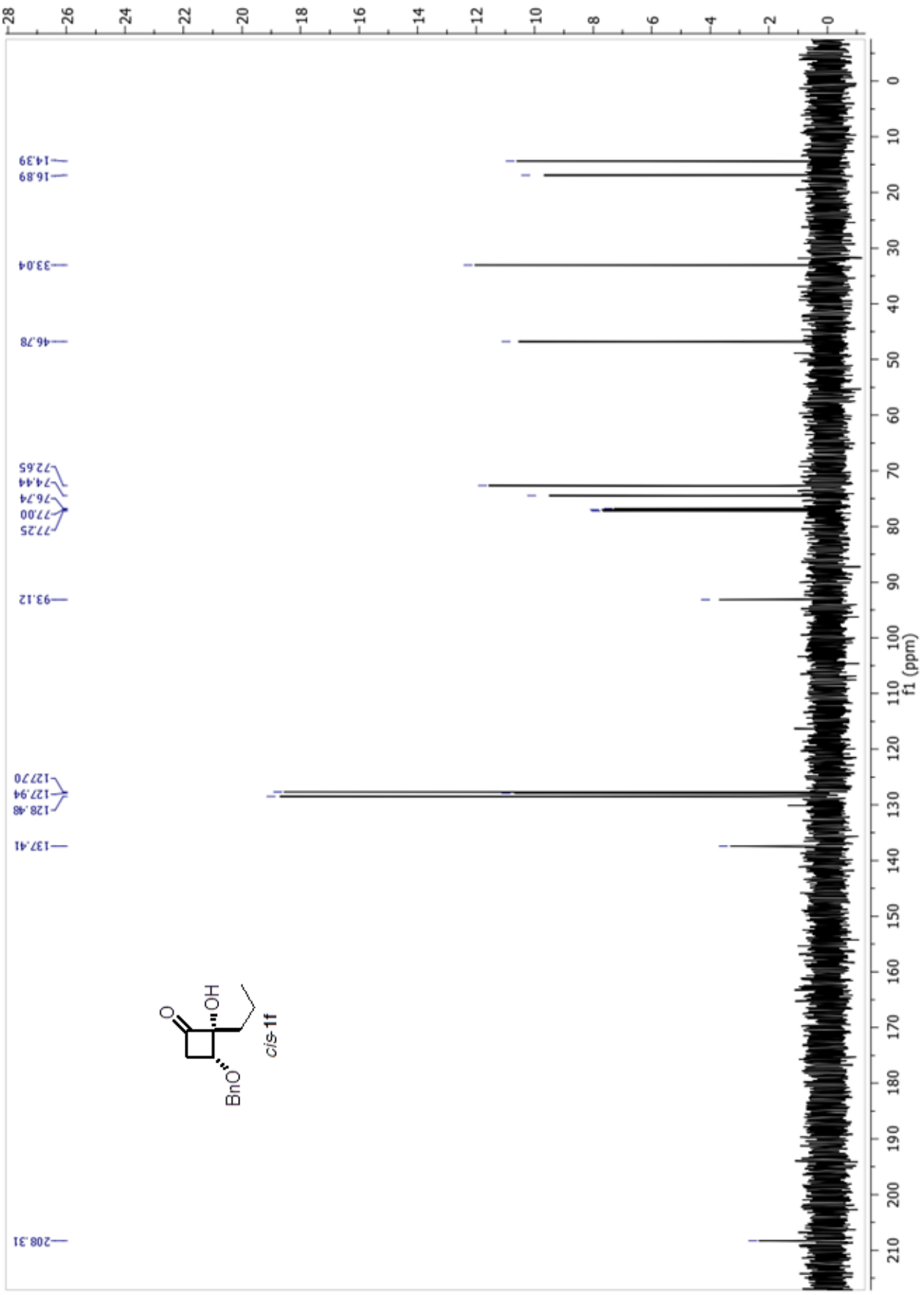



OH
O
BnO
cis-1e
f1 (ppm)


177.47
137.42
128.51
127.98
127.70
93.23
74.49
72.69
46.93
24.03
7.76
OH
O
BnO
f1 (ppm)

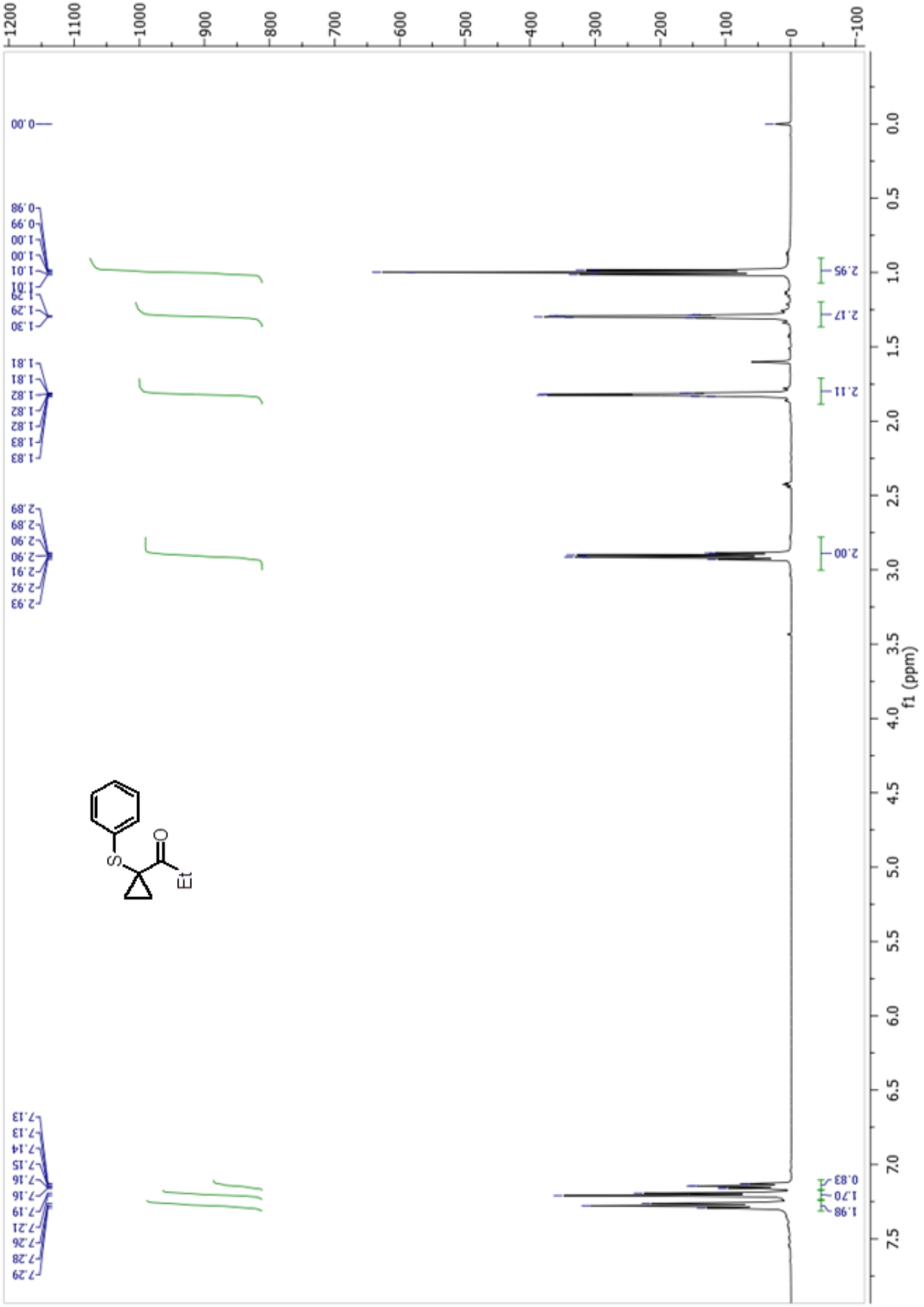
3-Benzyloxy-2-hydroxy-2-propyl-cyclobutanone 1f

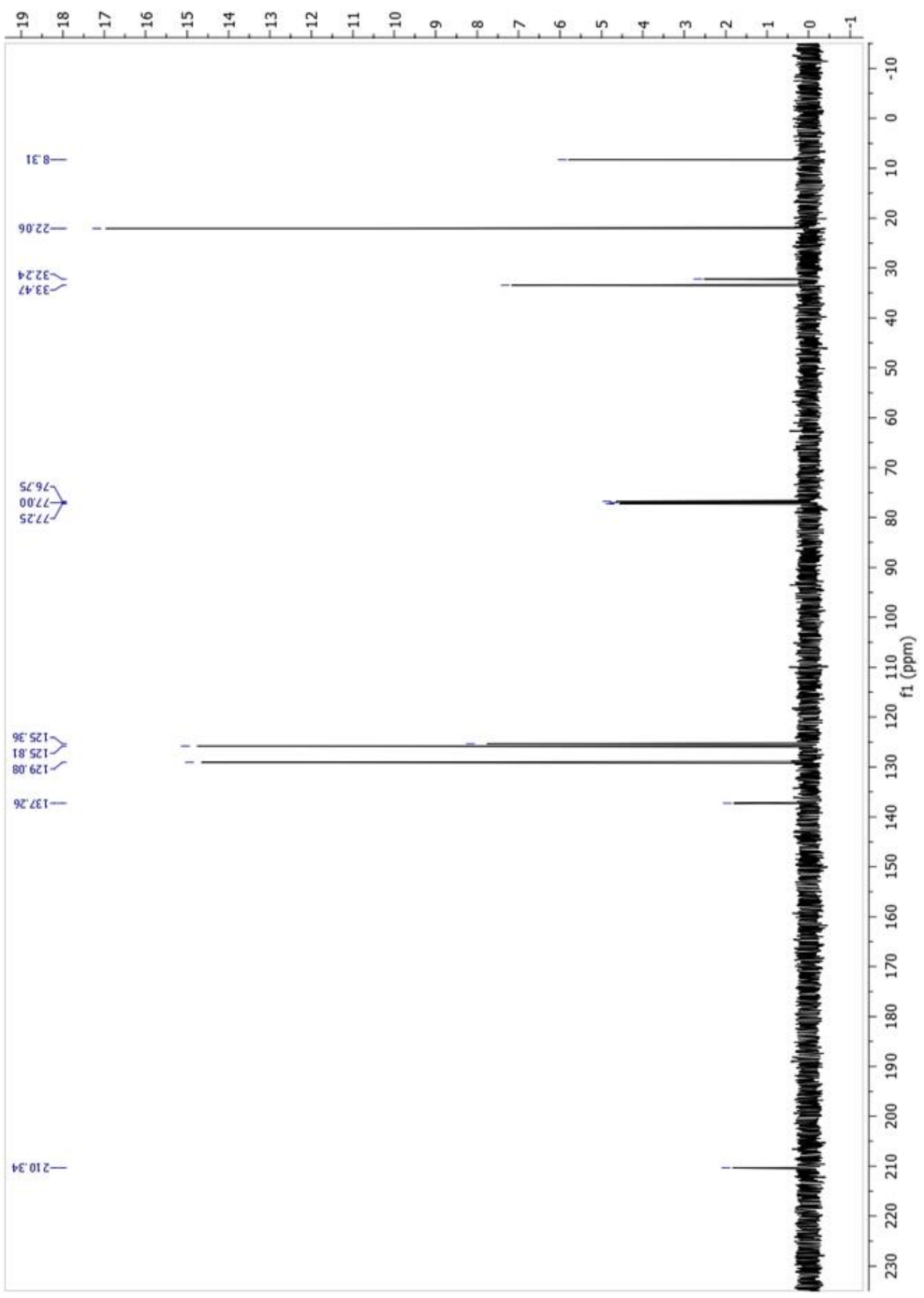



208.31
137.41
128.48
127.94
127.70
93.12
77.25
77.00
76.74
74.44
72.65
46.78
33.04
16.89
14.39
f1 (ppm)
OH
O
BnO
cis-1f

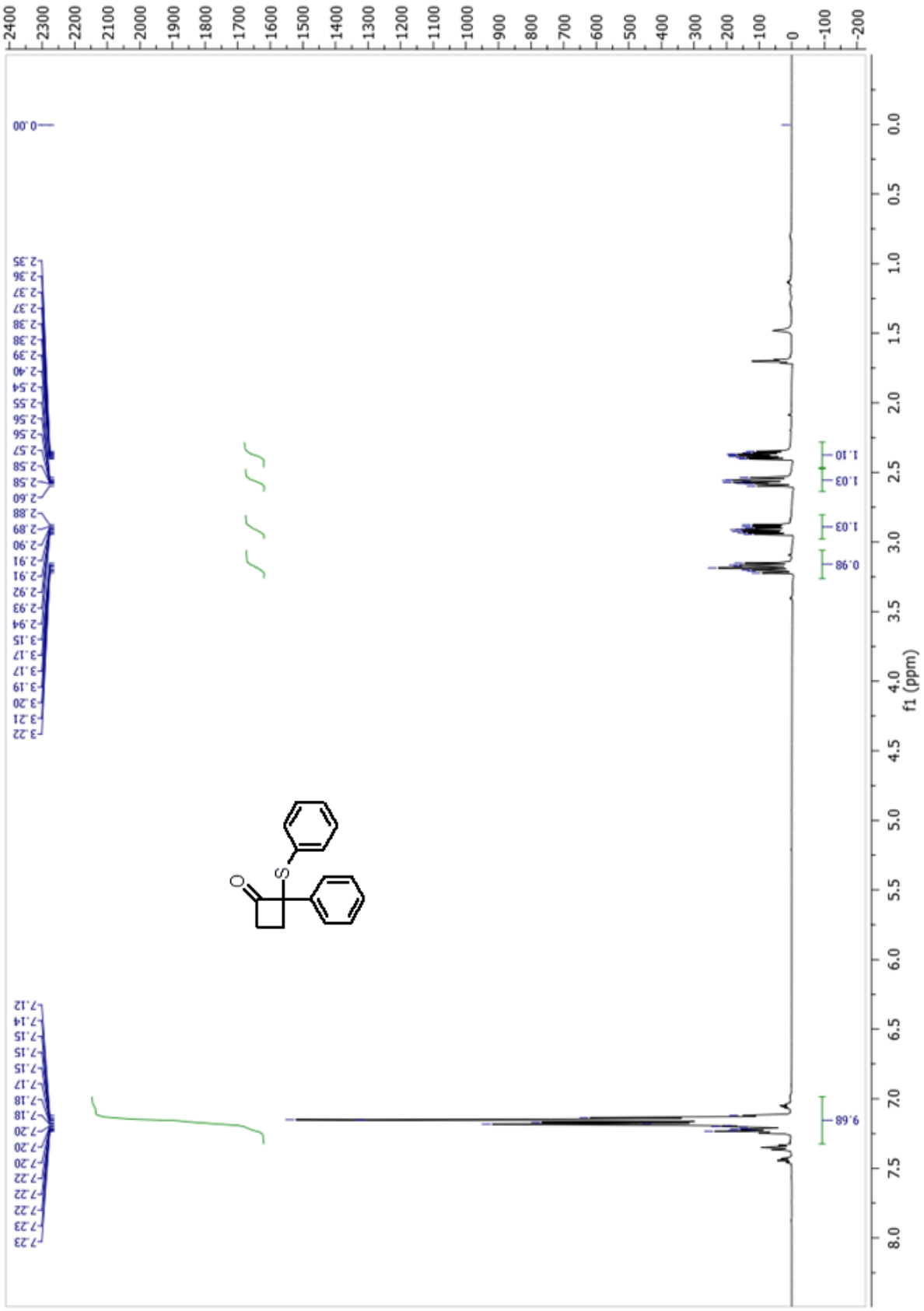
10. ^{1}H and ^{13}C NMR spectra of compounds 6b-f

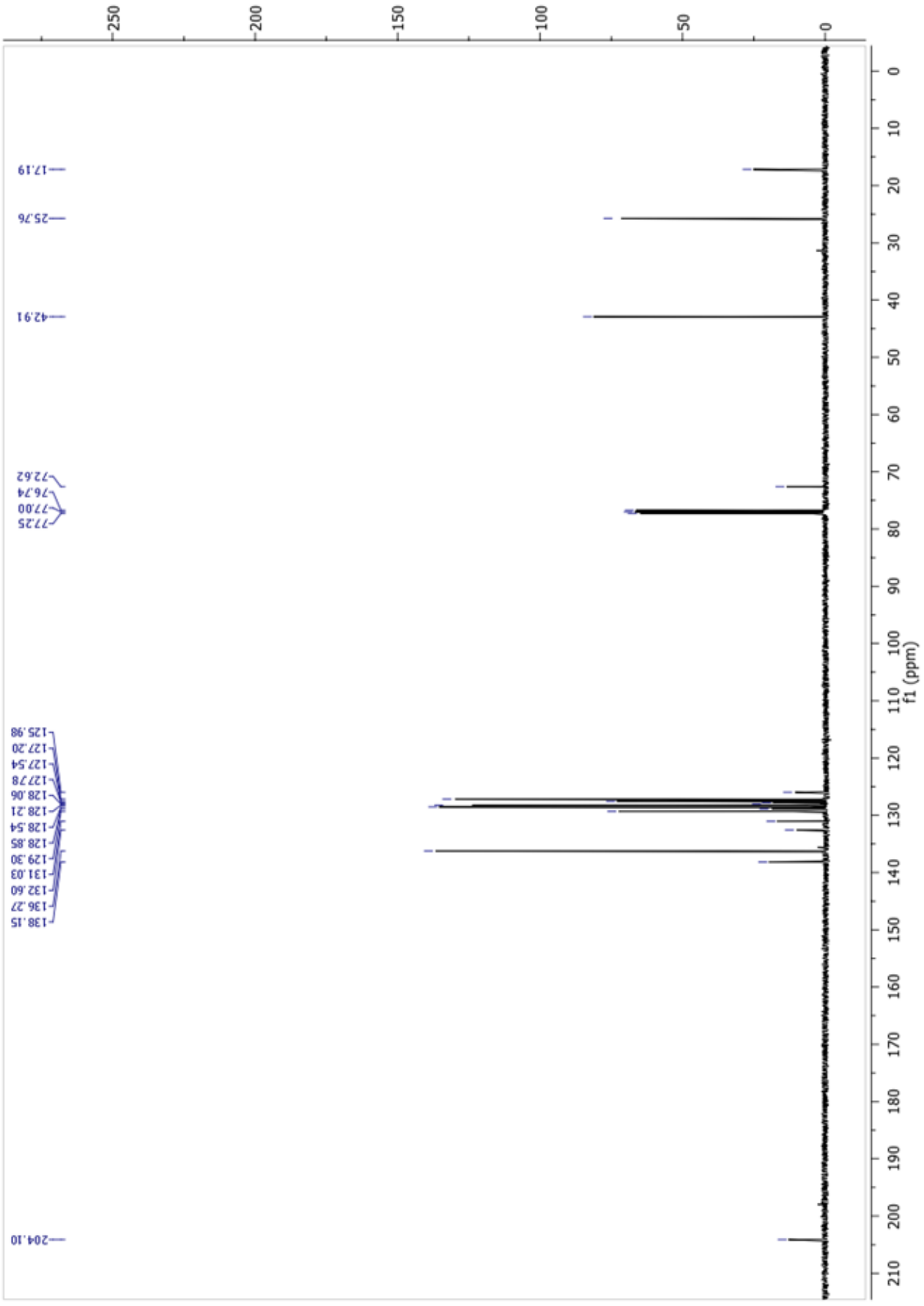
1-(1-Phenylsulfanyl-cyclopropyl)-propan-1-one 6a



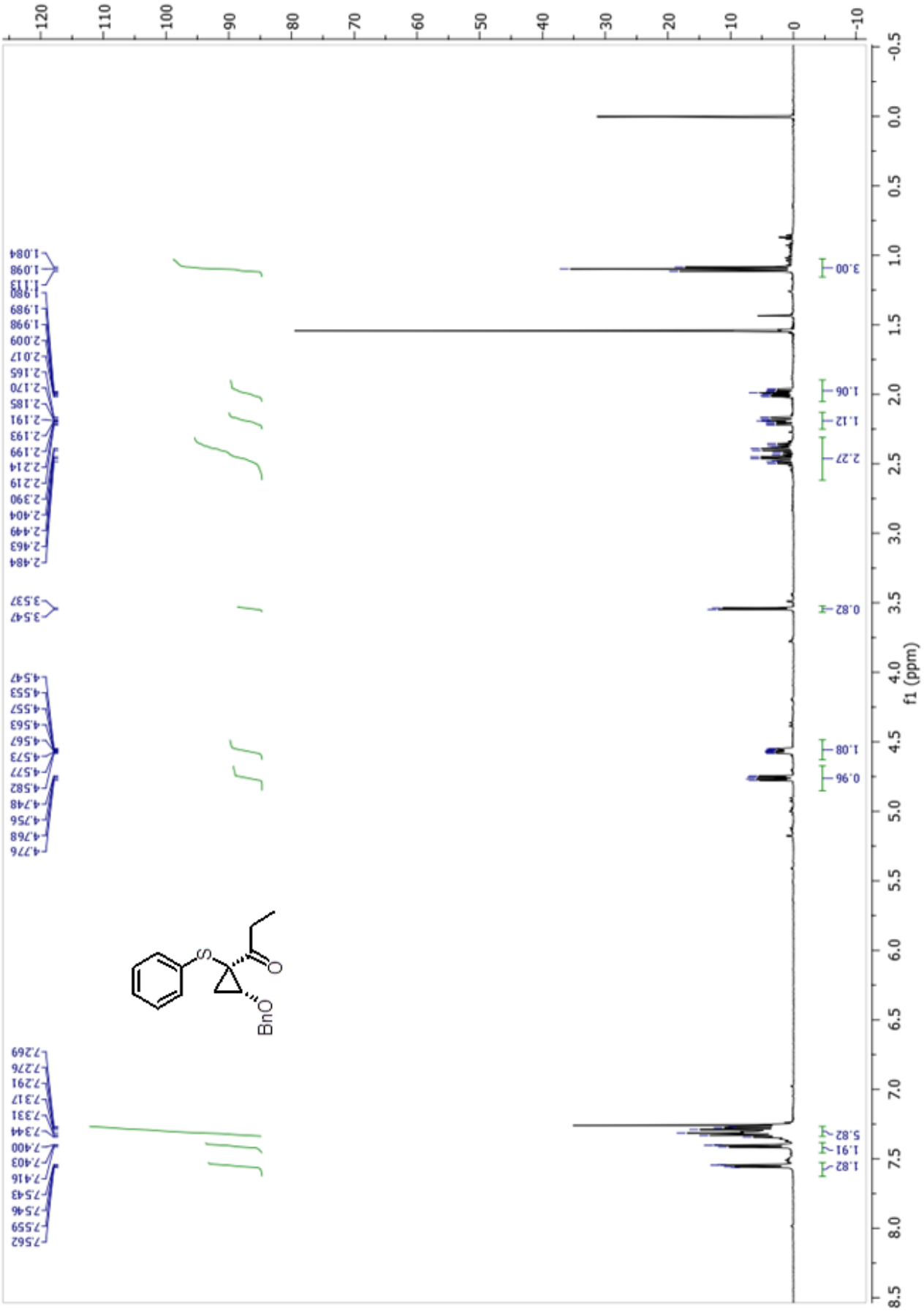

8.31
22.06
32.24
33.47
76.75
77.00
77.25
125.36
125.81
129.08
137.26
210.34
f1 (ppm)

2-Phenyl-2-phenylsulfanyl-cyclobutanone 6c'

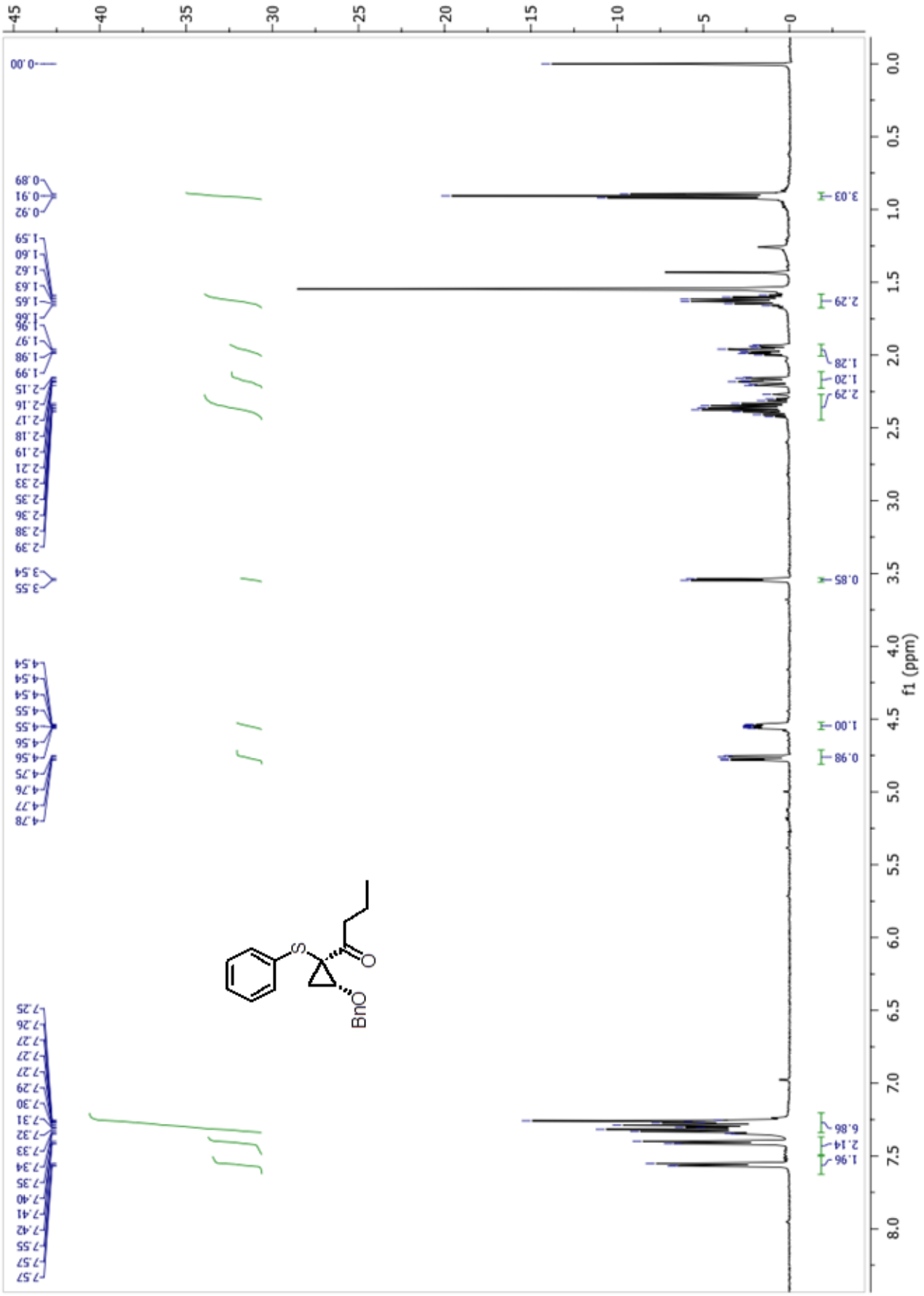


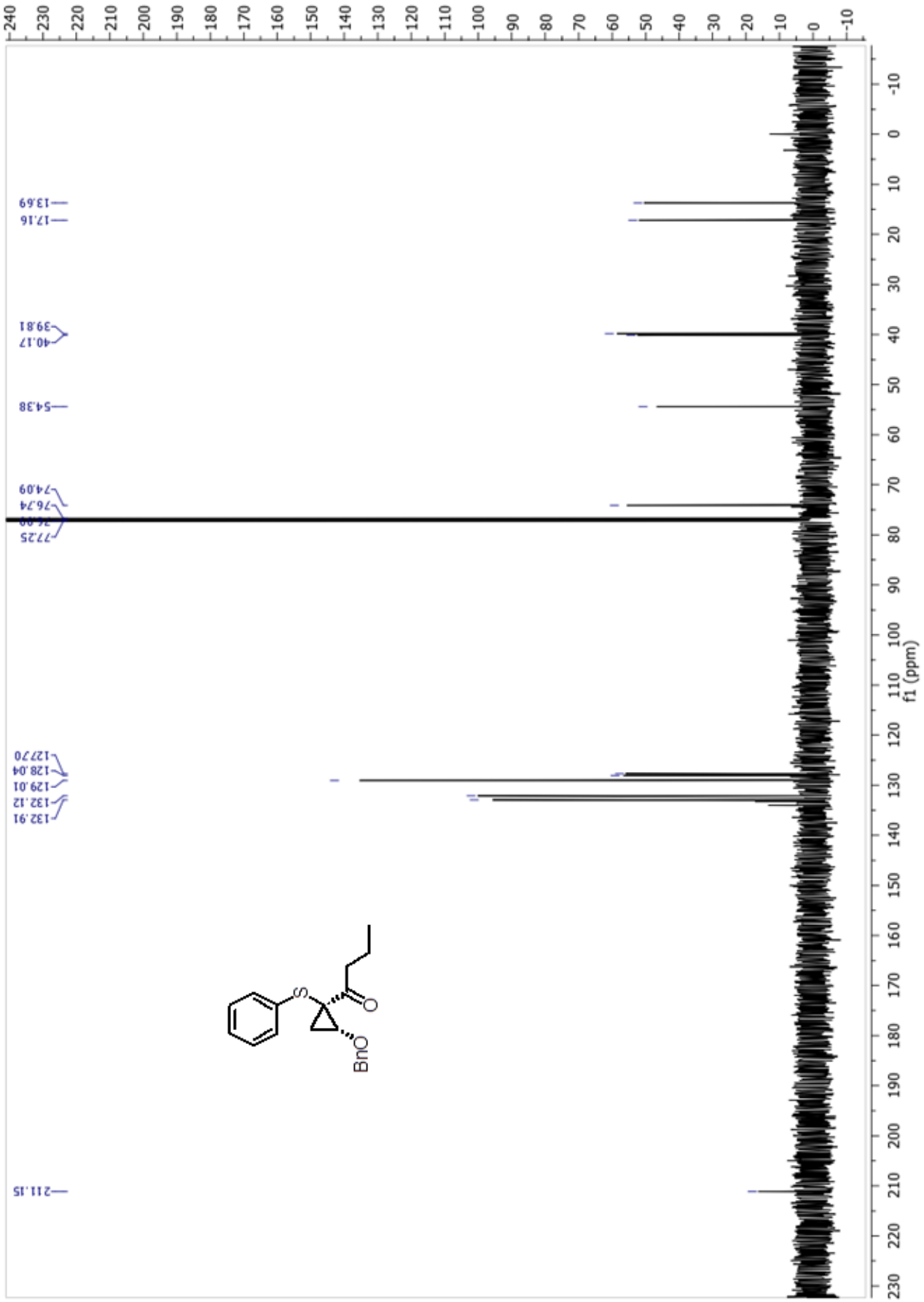

204.10
138.15
136.27
132.60
131.03
129.30
128.85
128.54
128.21
128.06
127.78
127.54
127.20
125.98
77.25
77.00
76.74
72.62
42.91
25.76
17.19
f1 (ppm)

3-Methyl-2-phenyl-2-phenylsulfanyl-cyclobutanone 6e

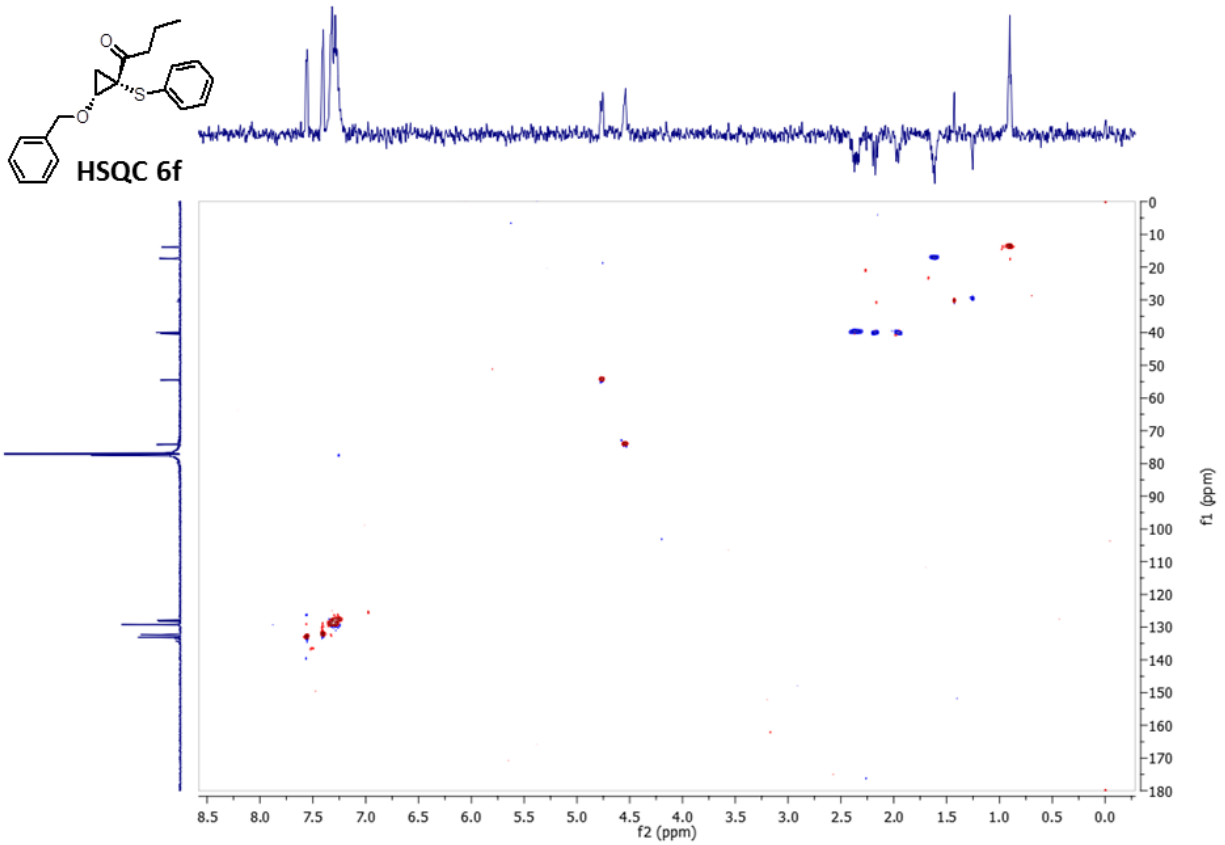


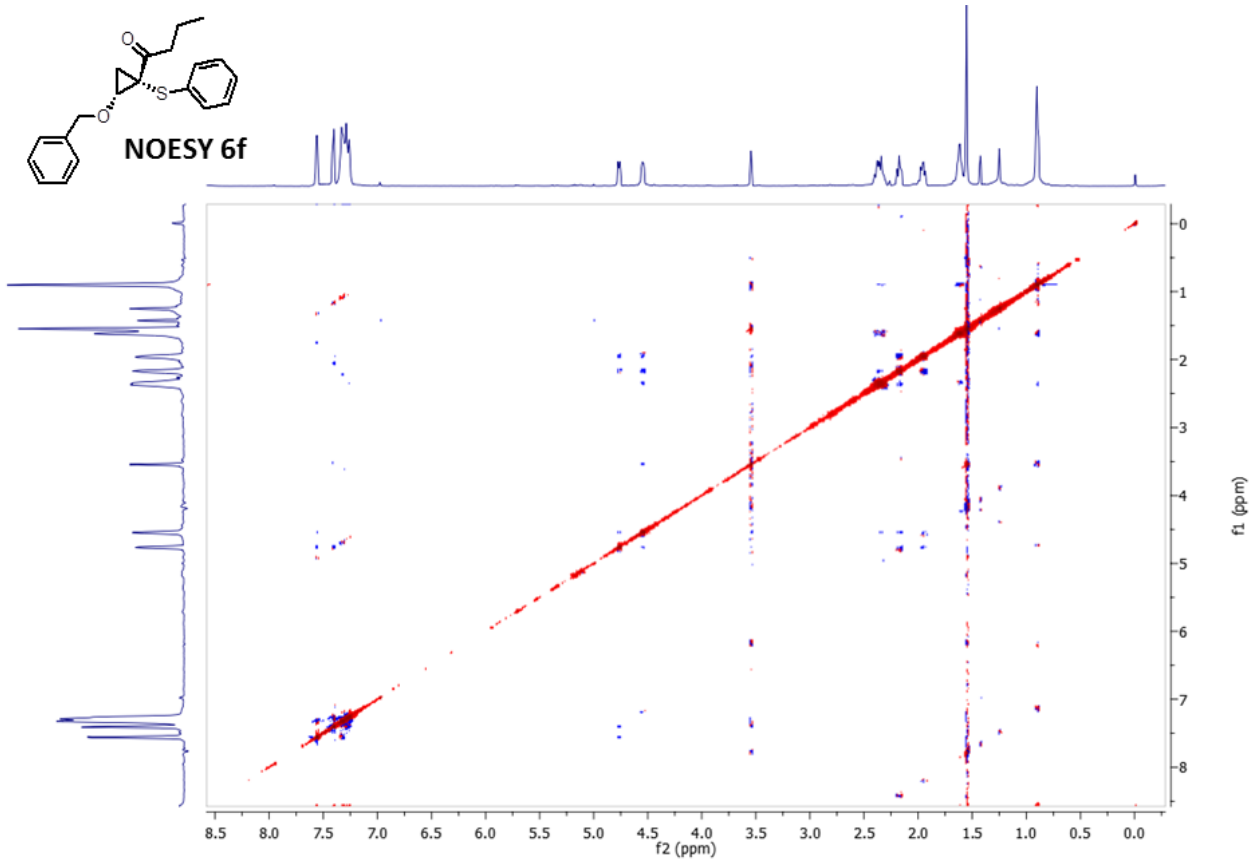
1-(2-Benzyloxy-1-phenylsulfanyl-cyclopropyl)-butan-1-one 1f




211.15
132.91
132.12
129.01
128.04
127.70
77.25
76.99
76.74
74.09
54.38
40.17
39.81
17.16
13.69
f1 (ppm)
S
O
BnO

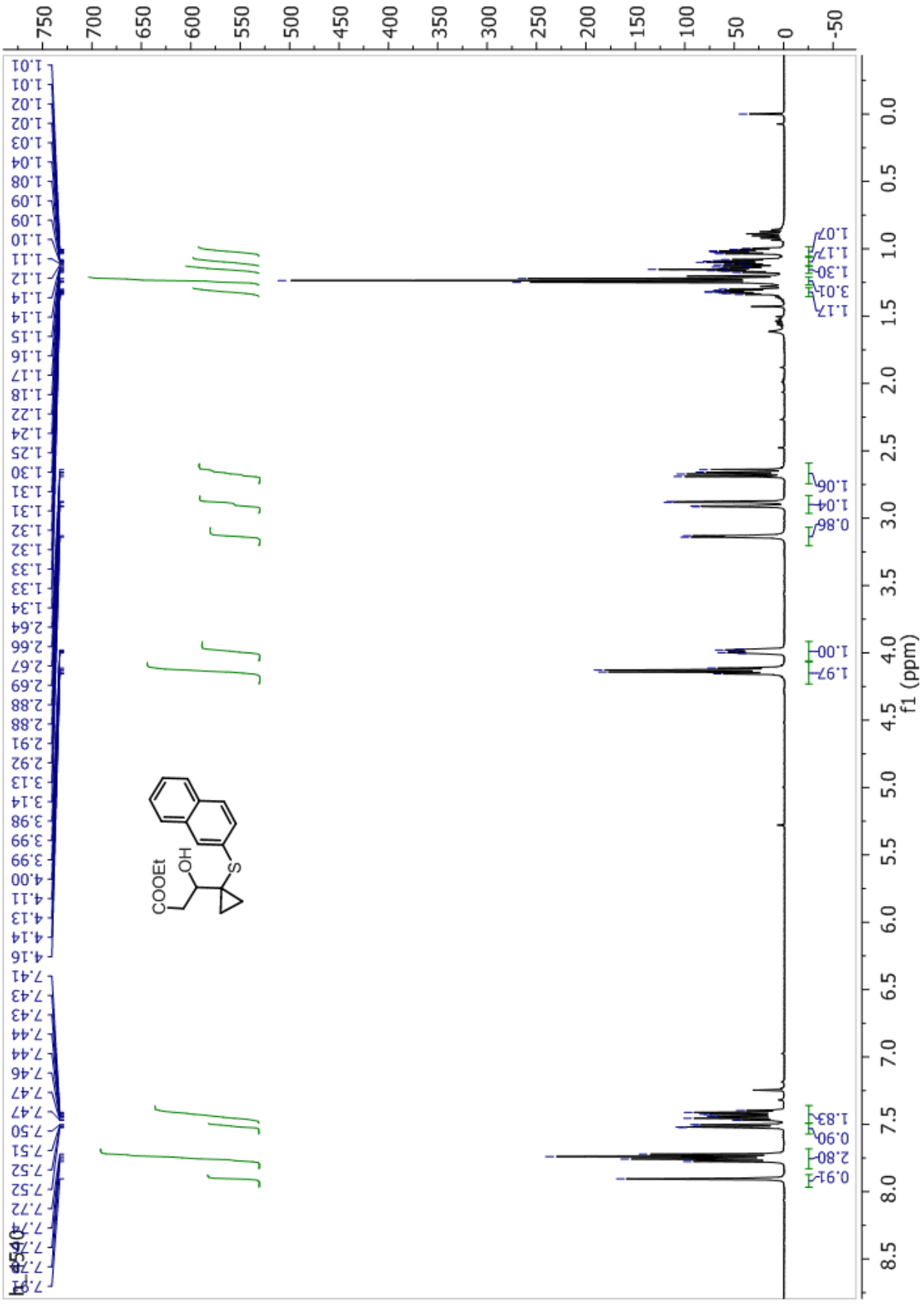
11. HSQC and NOESY NMR analysis of compound 6f.

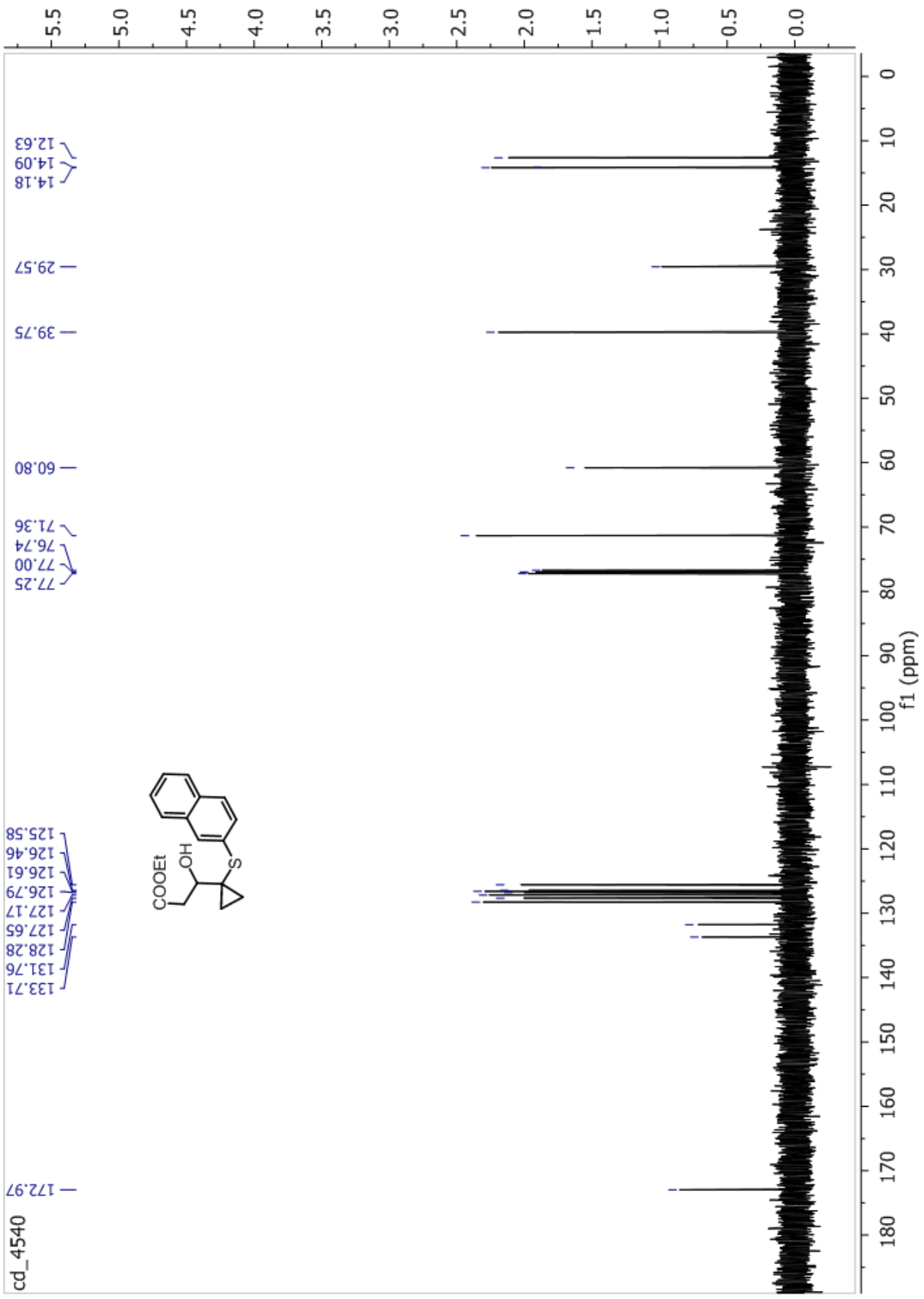




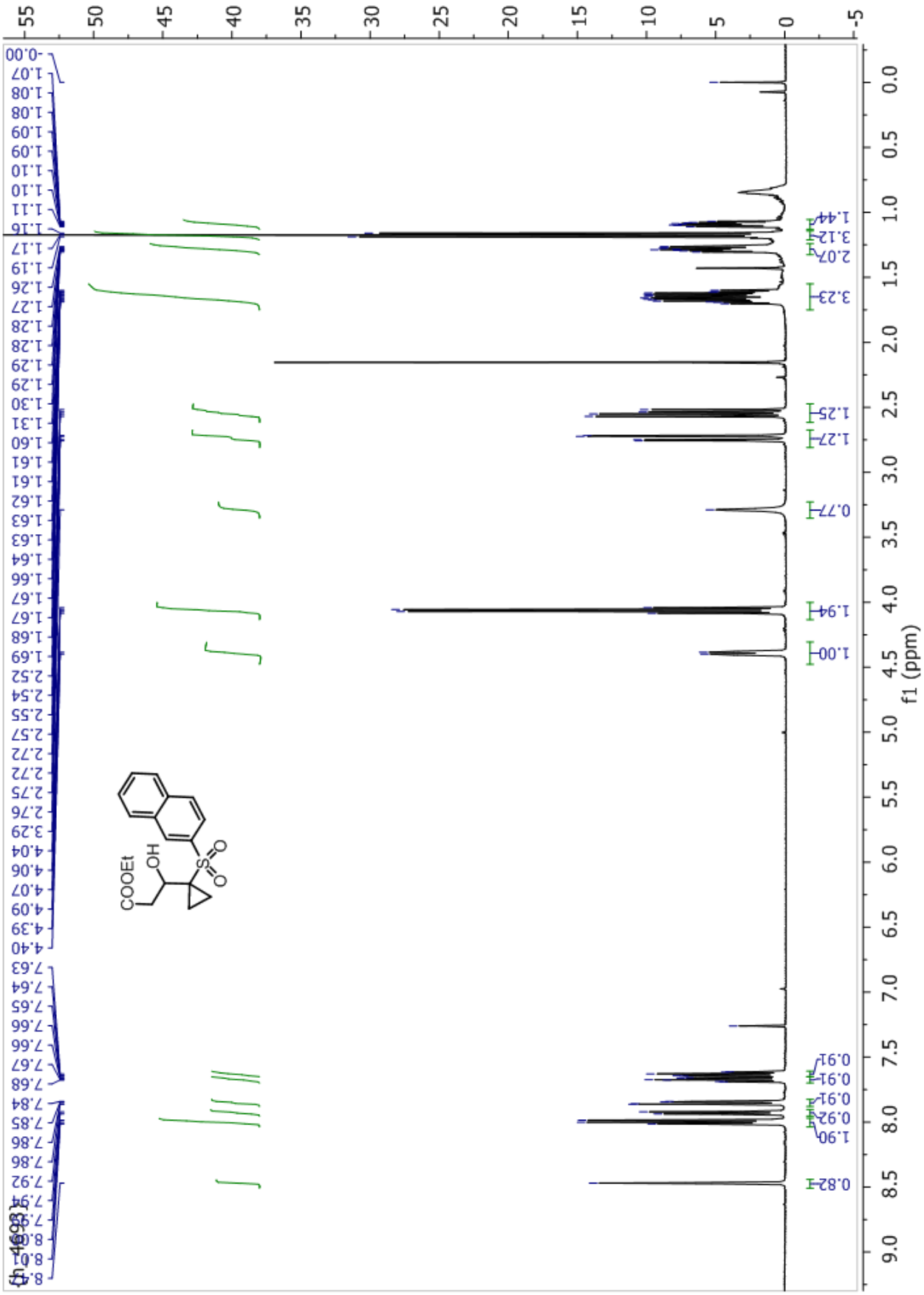
12. ^{1}H and ^{13}C NMR spectra of compounds 7-10. Formal synthesis of the B1-receptor antagonist intermediate 10

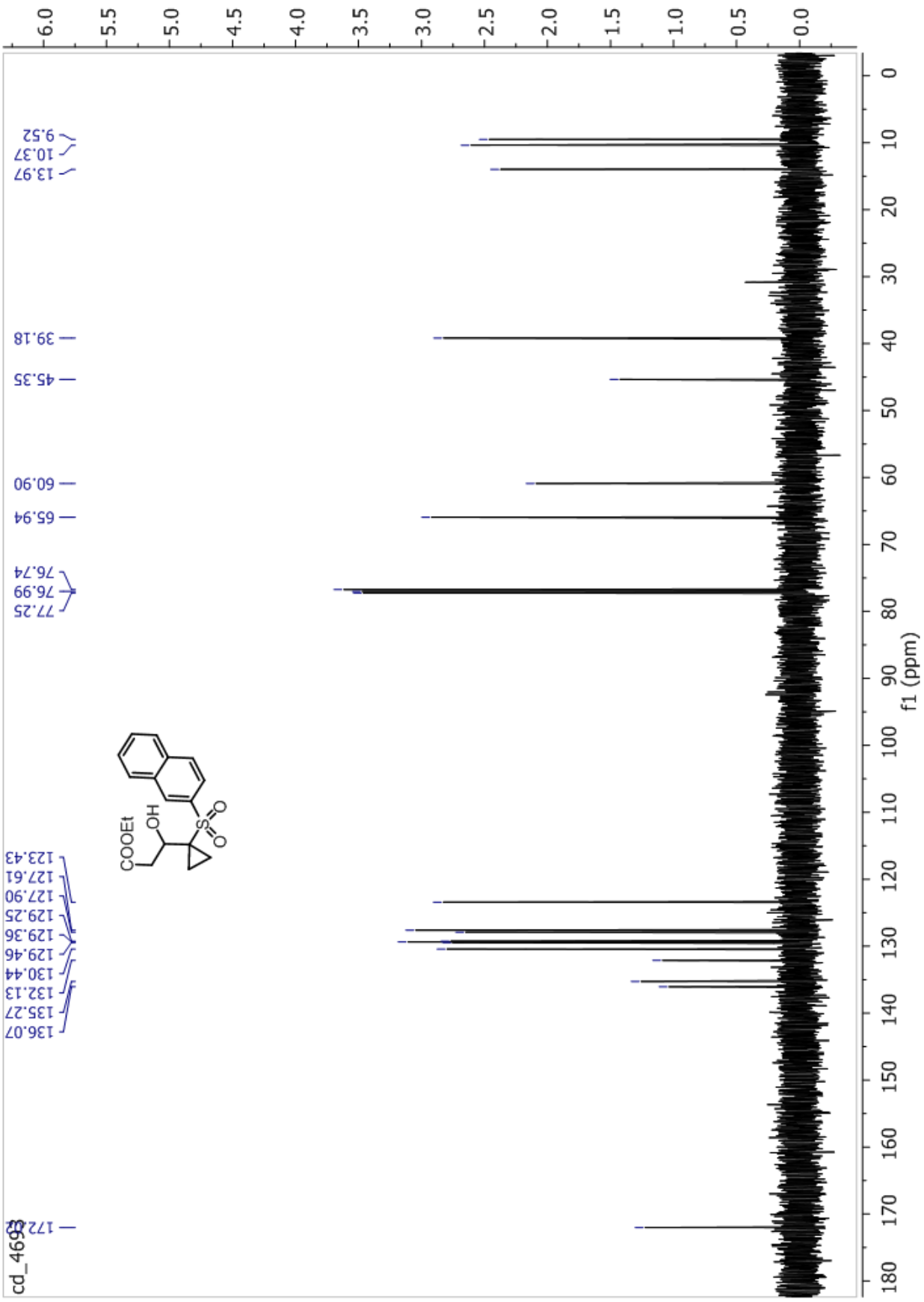
3-hydroxy-3-(1-(naphthalen-2-ylthio)cyclopropyl)propanoate 7



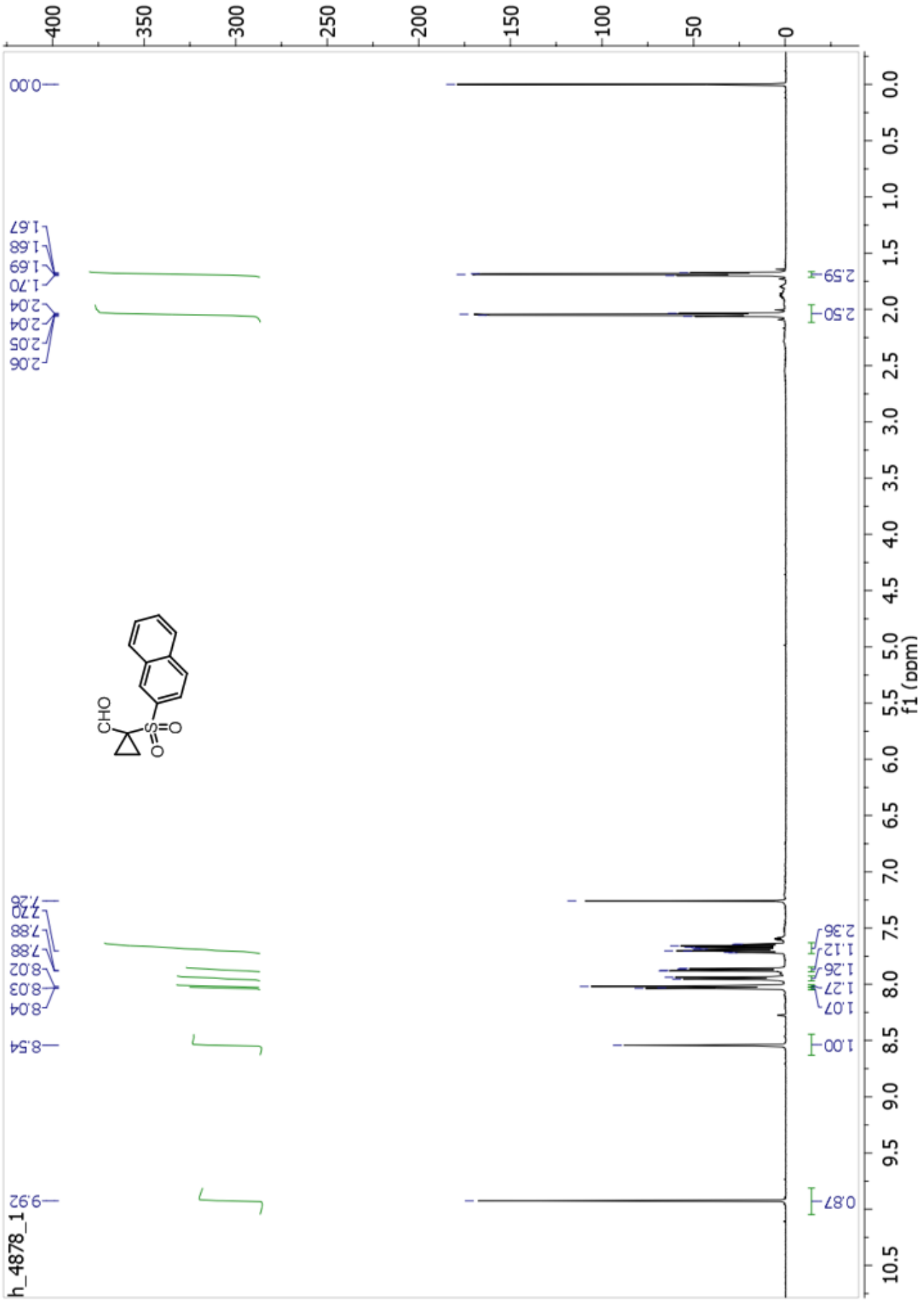

cd_4540
172.97
133.71
131.76
128.28
127.65
127.17
126.79
126.61
126.46
125.58
77.25
77.00
76.74
71.36
60.80
39.75
29.57
14.18
14.09
12.63
COOEt
OH
S
f1 (ppm)

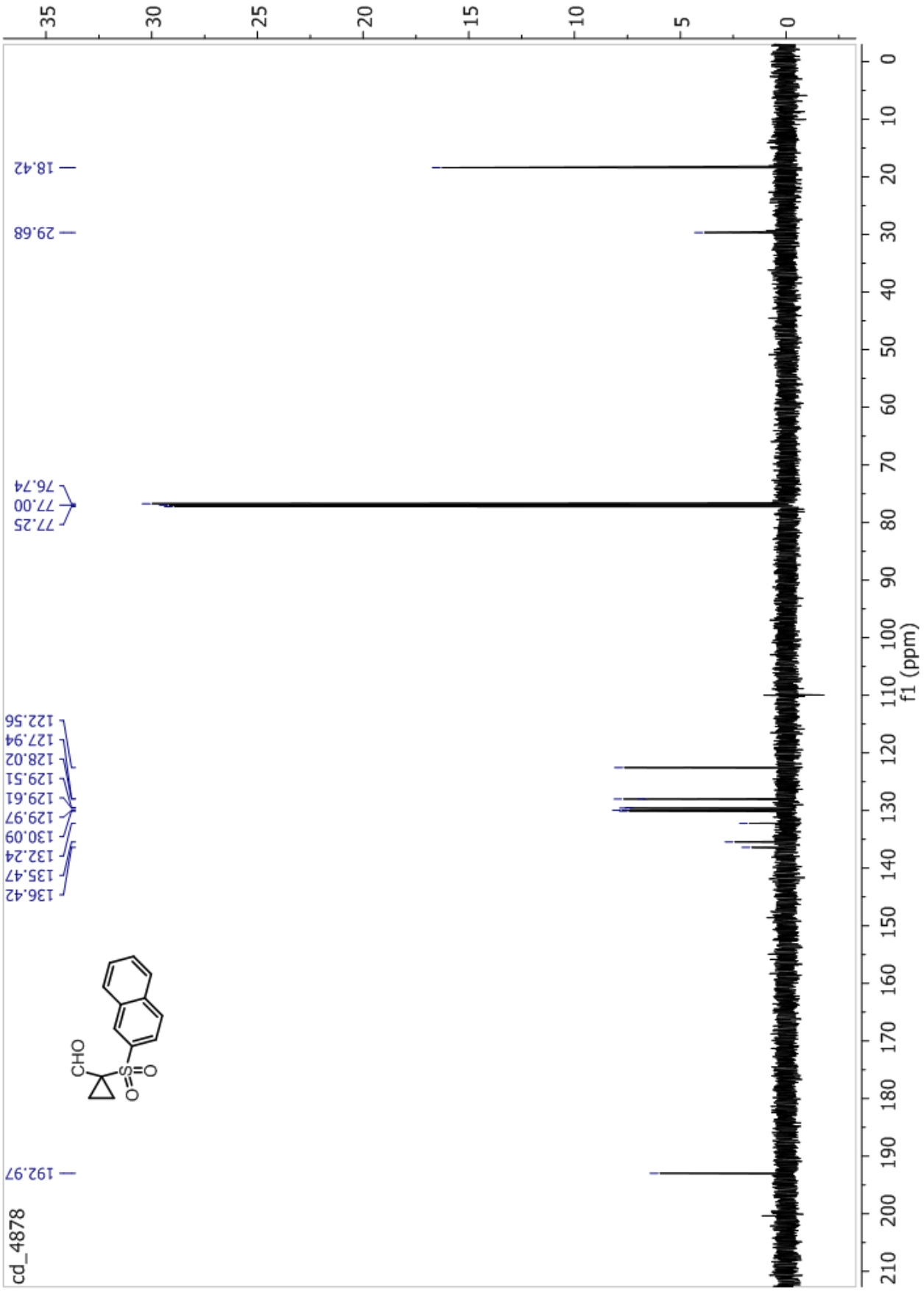
Ethyl 3-hydroxy-3-(1-(naphthalen-2-ylsulfonyl)cyclopropyl)propanoate 8



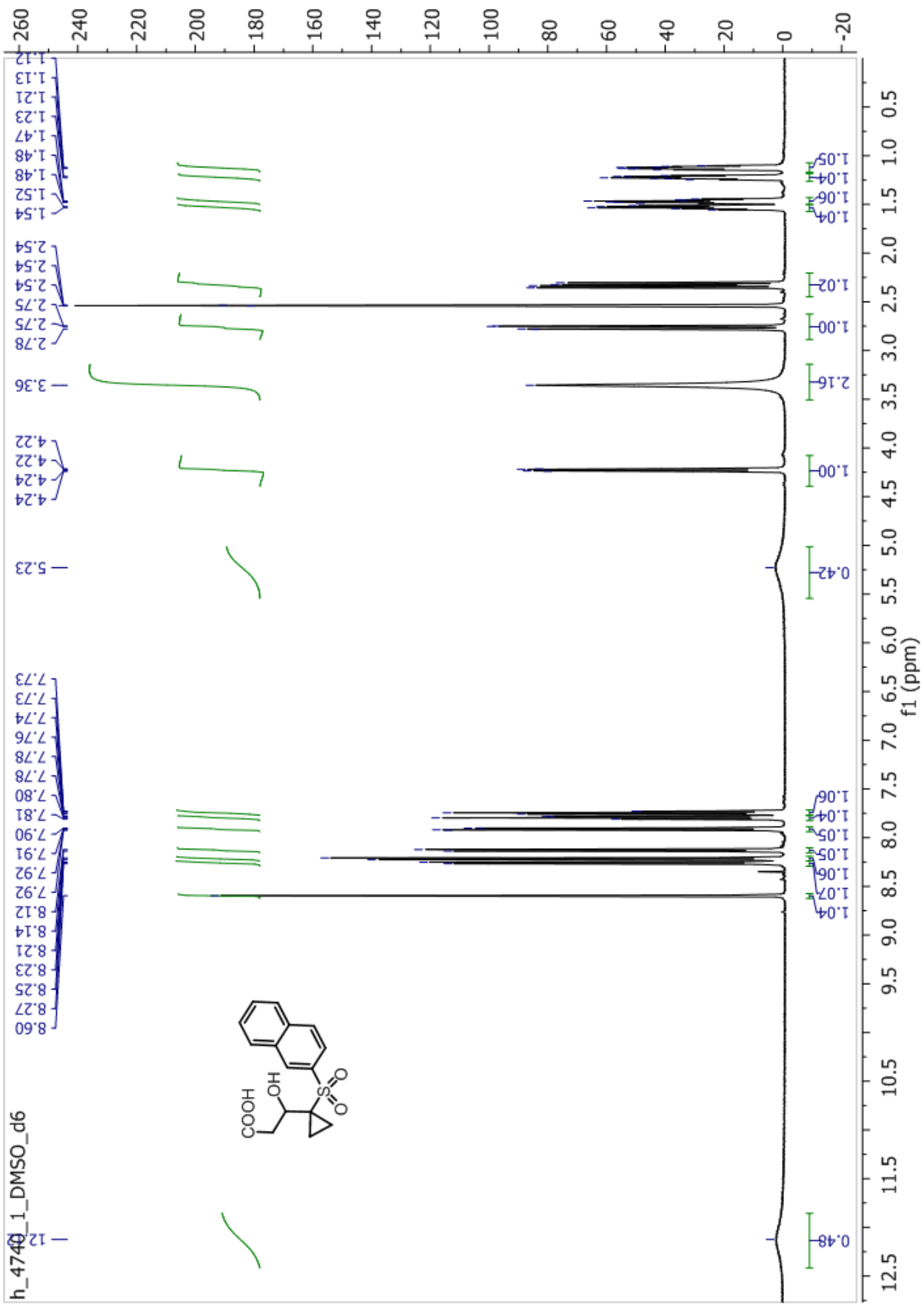

9.52
10.37
13.97
39.18
45.35
60.90
65.94
76.74
76.99
77.25
123.43
127.61
127.90
129.25
129.36
129.46
130.44
132.13
135.27
136.07
172.22
COOEt
OH
S
O
O
cd_4693
f1 (ppm)

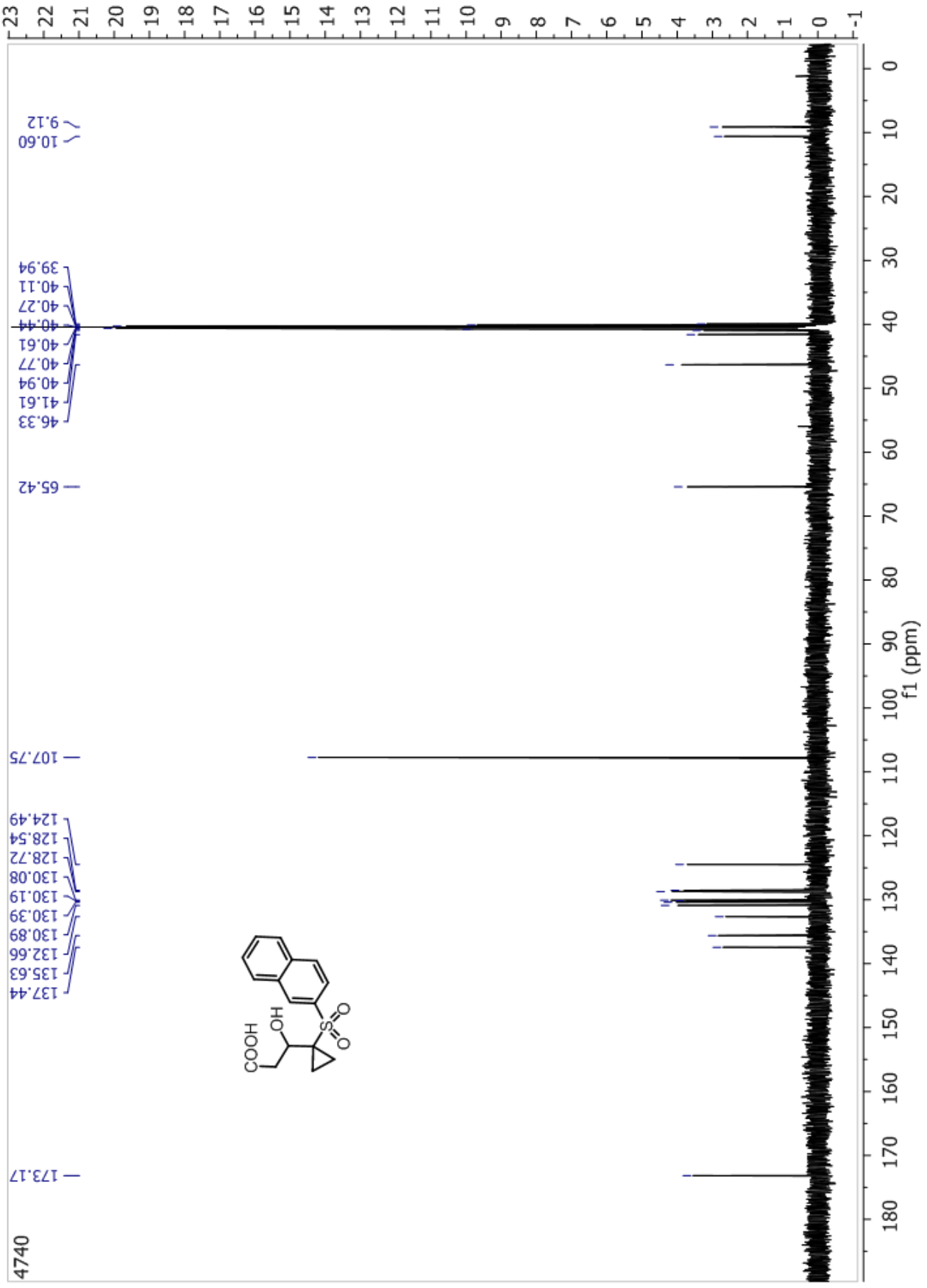
1-(Naphthalen-2-ylsulfonyl)cyclopropanecarbaldehyde 9




cd_4878
192.97
136.42
135.47
132.24
130.09
129.97
129.61
129.51
128.02
127.94
122.56
77.25
77.00
76.74
29.68
18.42
CHO
O
O
f1 (ppm)

3-Hydroxy-3-(1-(naphthalen-2-ylsulfonyl)cyclopropyl)propanoic acid 10




4740
173.17
137.44
135.63
132.66
130.89
130.39
130.19
130.08
128.72
128.54
124.49
107.75
65.42
46.33
41.61
40.94
40.77
40.61
40.44
40.27
40.11
39.94
10.60
9.12
COOH
OH
S
O
O
f1 (ppm)

13. X-Ray analysis of 3-Hydroxy-3-[1-(naphthalene-2-sulfonyl)-cyclopropyl]-propionic acid 10

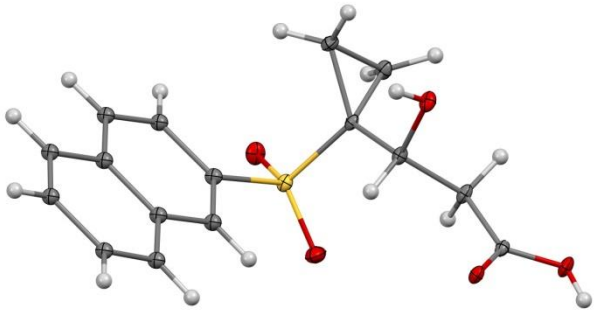


Figure 4. An ORTEP drawing of compound **10**. Thermal ellipsoids are shown at the 30% level.

X-ray diffraction data for compound **10** were collected by using a VENTURE PHOTON100 CMOS Bruker diffractometer with Micro-focus IμS source MoKα radiation. Crystal was mounted on a CryoLoop (Hampton Research) with Paratone-N (Hampton Research) as cryoprotectant and then flashfrozen in a nitrogen-gas stream at 100 K. For compounds, the temperature of the crystal was maintained at the selected value by means of a N-HeliX from Oxford Cryosystems cooling device to within an accuracy of ±1K. The data were corrected for Lorentz polarization, and absorption effects. The structures were solved by direct methods using SHELXS-97[12] and refined against F^2 by full-matrix least-squares techniques using SHELXL-2017[13] with anisotropic displacement parameters for all non-hydrogen atoms. Hydrogen atoms were located on a difference Fourier map and introduced into the calculations as a riding model with isotropic thermal parameters. All calculations were performed by using the Crystal Structure crystallographic software package WINGX.[14]

The crystal data collection and refinement parameters are given in Table S1.

CCDC 1575152 contains the supplementary crystallographic data for this paper. These data can be obtained free of charge from the Cambridge Crystallographic Data Centre via http://www.ccdc.cam.ac.uk/Community/Requestastructure.

Table S1. Crystallographic data and structure refinement details.

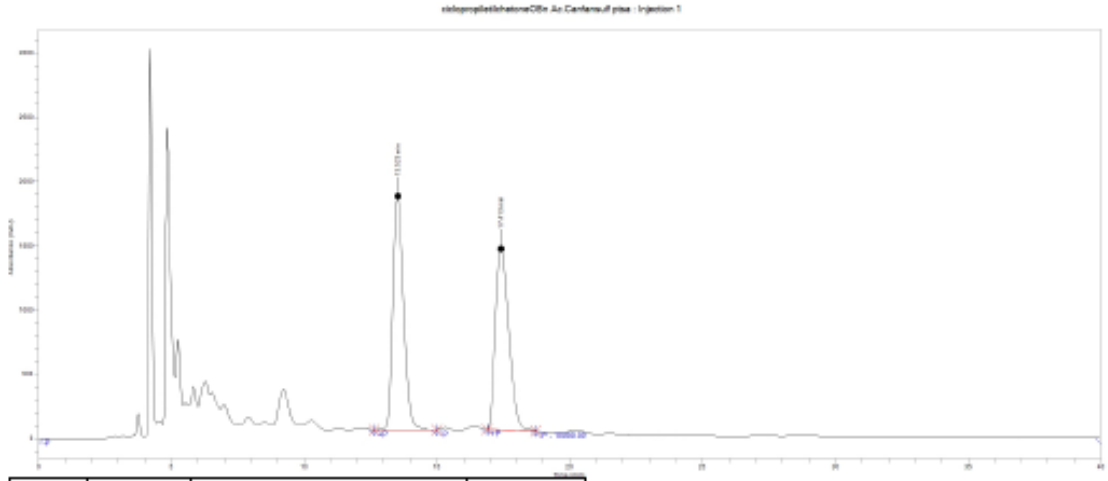
Compound	**10**
Empirical Formula	$C_{16}\,H_{16}\,O_5\,S$
M_r	320.35
Crystal size, mm^3	0.080 x 0.060 x 0.030
Crystal system	triclinic
Space group	*P -1*
a, Å	8.1570(5)
b, Å	9.8595(7)
c, Å	10.2239(8)
α, °	63.734(3)
β, °	75.835(2)
γ, °	85.625(2)
Cell volume, $Å^3$	714.45(9)
Z ; Z'	2 ; 1
T, K	100(1)
Radiation type ; wavelength Å	MoKα ; 0.71073
F_{000}	336
μ, mm^{-1}	0.249
θ range, °	2.286 - 30.583
Reflection collected	33 879
Reflections unique	4 395
R_{int}	0.0705
GOF	1.046
Refl. obs. (I>2σ(I))	3 377
Parameters	184
wR_2 (all data)	0.1123
R value (I>2σ(I))	0.0481
Largest diff. peak and hole (e-.$Å^{-3}$)	0.582 ; -0.623

14. HPLC analysis of cyclopropylketone 6e

HPLC Analysis: [Phenomenex Lux 5u Cellulose-1 column, 25cm × 4.6 mm I.D., Hexanes:*i*PrOH = 95:5, 1.0 mL/min, 250 nm], λ = 254 nm

Sample Report - Single Channel

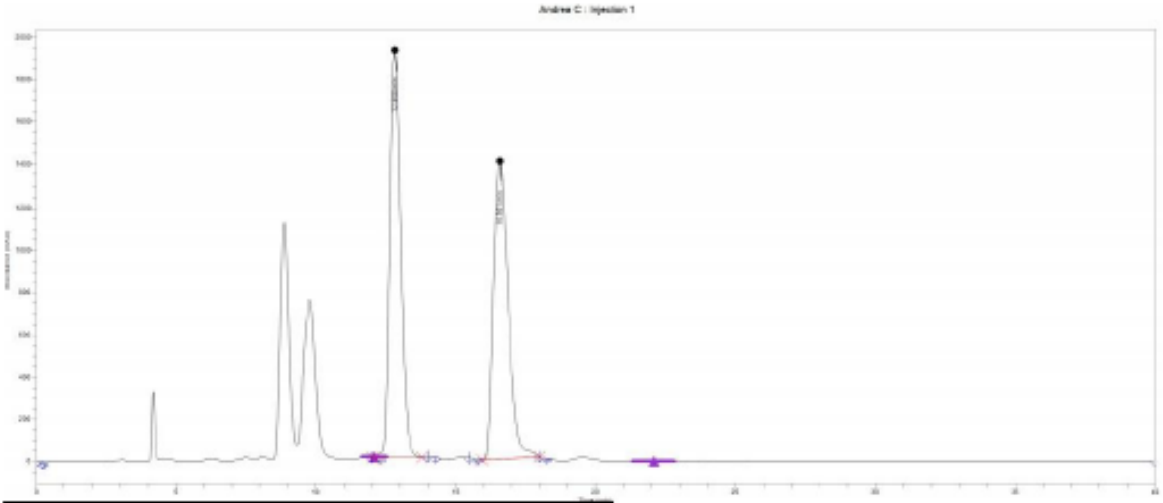
Sample Name	ciclopropiletilchetoneOBn Ac.Canfansulf ptsa		
Batch Group/Name	Hplc/Andrea C		
Acquisition Method	Andrea C		
Processing Method	Andrea C		
Instrument Name	Flexar Pump	Channel Name	FXUVDet-2 1
Vial Number		Injection Number	1
Operator	hplc	Chromera Version	4.1.2.6410
Acquisition Date/Time	10/24/2018 9:28:20 PM		



Peak #	RT (min)	Component Name	Area %
1	13.523		50.74
2	17.413		49.26
Total			100.00

Sample Report - Single Channel

Sample Name	Andrea C		
Batch Group/Name	Hplc/Andrea C		
Acquisition Method	Andrea C		
Processing Method	Andrea C		
Instrument Name	Flexar Pump	Channel Name	FXUVDet-2 1
Vial Number		Injection Number	1
Operator	hplc	Chromera Version	4.1.2.6410
Acquisition Date/Time	10/24/2018 8:43:28 PM		



Peak #	RT (min)	Component Name	Area %
1	12.808		50.49
2	16.561		49.51
Total			100.00

15. References and notes

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