# Supporting Information

# Intermolecular Bromoesterification of Conjugated Enynes: An Efficient Synthesis of Bromoallenes

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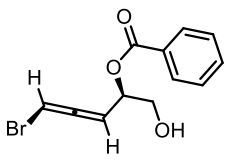
## General remarks

All reactions in non-aqueous media were conducted under a positive pressure of dry argon in glassware that had been oven dried prior to use unless noted otherwise. Anhydrous solutions of reaction mixtures were transferred via an oven dried syringe or cannula. All solvents were dried prior to use unless noted otherwise. Thin layer chromatography was performed using precoated silica gel plates (EMD Chemical Inc. 60, F254). Flash column chromatography was performed with silica gel (Silicycle, 40-63 μm). Infrared spectra (IR) were obtained on a Bruker Equinox 55 Spectrophotometer. $^{1}H$ and $^{13}C$ nuclear magnetic resonance spectra (NMR) were obtained on a Varian Unity-Inova 400 MHz or 500 MHz recorded in ppm (δ) downfield of TMS (δ = 0) in $CDCl_3$ unless noted otherwise. Signal splitting patterns were described as singlet (s), doublet (d), triplet (t), quartet (q), quintet (quint),or multiplet (m), with coupling constants (*J*) in hertz. High resolution mass spectra (HRMS) were performed by Analytical Instrument Center at the School of Pharmacy or Department of Chemistry on an Electron Spray Injection (ESI) mass spectrometer.

## General methods for the preparation of conjugated enynes:

Substrates **3a**, **3c**, **3e**, **3g**, **3h** were prepared according to our previously reported procedures[1] and their spectra are in accordance with literature.[1-4] Substrates **3b**,[5] **3d**,[6] and **3f**[7] were prepared according to known procedures and their spectra are in accordance with literature.

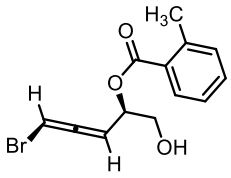
## Characterization data for bromoesterification products:




**2a:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl benzoate

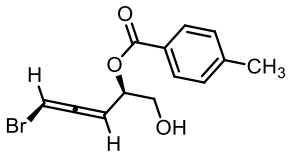
Colorless oil. 21.0 mg, 73% yield. (dr = 10:1, 68% yield for 1mmol scale) $^{1}H$ NMR (400 MHz, $CDCl_3$, TMS): δ 8.07 (d, *J* = 7.2 Hz, 2H), 7.59 (t, *J* = 7.2 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 6.18 – 6.08 (dd, *J* = 5.6,

2.0 Hz, 1H), 5.69 (qd, *J* = 5.2, 2.0 Hz, 1H), 5.58 (t, *J* = 5.6 Hz, 1H), 3.91 (br, s, 2H), 2.10 (br, s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.57, 166.03, 133.54, 129.92, 129.68, 128.61, 97.04, 75.28, 71.57, 64.22. IR (neat) ν 3454, 3061, 2934, 1719, 1265, 1069 cm$^{-1}$. HRMS (ESI) for $C_{12}H_{11}BrO_3$ (M+H), 282.9965 (Calc.), found 282.9967.



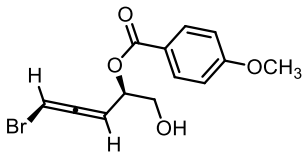

**2b:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl 2-methylbenzoate

Colorless oil. 19.0 mg, 65% yield. $^1$H NMR (500 MHz, $CDCl_3$, TMS): δ 7.96 (d, *J* = 8.0 Hz, 1H), 7.43 (td, *J* = 7.5, 0.5 Hz, 1H), 7.29 – 7.23 (m, 2H), 6.14 (dd, *J* = 5.5, 2.0 Hz, 1H), 5.70 – 5.63 (m, 1H), 5.58 (t, *J* = 5.5 Hz, 1H), 3.98 – 3.86 (m, 2H), 2.61 (s, 3H), 2.03 (s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.63, 166.82, 140.67, 132.57, 131.93, 130.91, 129.02, 125.95, 97.12, 75.30, 71.36, 64.26, 21.95. IR (neat) ν 3425, 3060, 2927, 1719, 1250, 1073 cm$^{-1}$. HRMS (ESI) for $C_{13}H_{13}BrO_3$ (M+$NH_4$), 314.0387 (Calc.), found 314.0384.



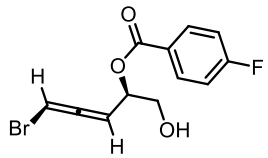

**2c:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl 4-methylbenzoate

Colorless oil. 19.0 mg, 65% yield. $^1$H NMR (500 MHz, $CDCl_3$, TMS): δ 7.95 (d, *J* = 8.4 Hz, 2H), 7.27 (d, *J* = 7.0 Hz, 2H), 6.12 (dd, *J* = 5.6, 2.0 Hz, 1H), 5.68 (m, 1H), 5.56 (t, *J* = 5.6 Hz, 1H), 3.98 – 3.85 (m, 2H), 2.42 (s, 3H), 1.25 (s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.56, 166.10, 144.37, 129.98, 129.34, 126.93, 97.17, 75.26, 71.41, 64.32, 21.86. IR (neat) ν 3440, 3060, 2924, 1719, 1268, 1105 cm$^{-1}$. HRMS (ESI) for $C_{13}H_{13}BrO_3$ (M+H), 297.0121 (Calc.), found 297.0123.



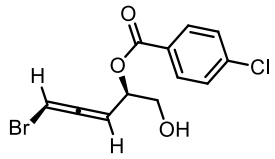

**2d:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl 4-methoxybenzoate.

Colorless oil. 14.0 mg, 45% yield. $^1$H NMR (500 MHz, $CDCl_3$, TMS): δ 8.02 (d, *J* = 9.0 Hz, 2H), 6.93 (d, *J* = 8.5 Hz, 2H), 6.12 (d, *J* = 5.5 Hz, 1H), 5.67 (d, *J* = 5.0 Hz, 1H), 5.58 (t, *J* = 5.5 Hz, 1H), 3.92 (d, *J* = 4.5 Hz, 2H), 3.87 (s, 3H), 2.02 (s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.53, 165.77, 163.89, 132.04, 122.01, 113.89, 97.27, 75.23, 71.31, 64.38, 55.64. IR (neat) ν 3453, 3060, 2923, 1711, 1254, 1101 cm$^{-1}$. HRMS (ESI) for $C_{13}H_{13}BrO_4$ (M+H), 313.0070 (Calc.), found 313.0066.



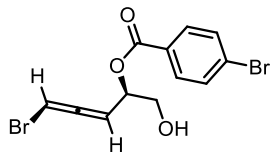
**2e:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl 4-fluorobenzoate.

Colorless oil. 21.0 mg, 70% yield. $^{1}$H NMR (400 MHz, $CDCl_3$, TMS): δ 8.05 – 8.12 (m, 2H), 7.17 – 7.08 (t, *J* = 8.4 Hz, 2H), 6.13 (ddd, *J* = 5.6, 2.0, 0.4 Hz, 1H), 5.72 – 5.64 (m, 1H), 5.57 (td, *J* = 5.6, 0.4 Hz, 1H), 3.98 – 3.88 (m, 2H), 2.00 (s, 1H).$^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.62, 166.17 (d, *J* = 253 Hz), 165.06, 132.54 (d, *J* = 9.3 Hz), 125.95, 115.84 (d, *J* = 21.9 Hz), 96.93, 75.33, 71.69, 64.22. IR (neat) ν 3440, 3061, 2927, 1720, 1265, 1113 cm$^{-1}$. HRMS (ESI) for $C_{12}H_{10}BrFO_3$ (M+Na), 322.9689 (Calc.), found 322.9690.



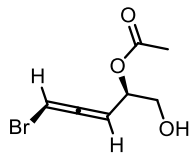
**2f:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl 4-chlorobenzoate.

Colorless oil. 14.0 mg, 45% yield. $^{1}$H NMR (500 MHz, $CDCl_3$, TMS): δ 8.01 (d, *J* = 8.5 Hz, 2H), 7.45 (d, *J* = 8.5 Hz, 2H), 6.13 (dd, *J* = 5.5, 2.0 Hz, 1H), 5.73 – 5.62 (m, 1H), 5.58 (t, *J* = 5.5 Hz, 1H), 3.99 – 3.85 (m, 2H), 2.00 (s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.65, 165.17, 140.09, 131.33, 129.01, 128.15, 96.85, 75.37, 71.79, 64.19. IR (neat) ν 3441, 3060, 2924, 1718, 1265, 1091 cm$^{-1}$. HRMS (ESI) for $C_{12}H_{10}BrO_3$ (M+Na), 338.9394 (Calc.), found 338.9392.



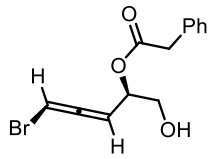
**2g:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl 4-bromobenzoate.

Colorless oil. 16.0 mg, 44% yield. $^{1}$H NMR (400 MHz, $CDCl_3$, TMS): δ 7.93 (d, *J* = 8.4 Hz, 2H), 7.61 (d, *J* = 8.4 Hz, 2H), 6.13 (dd, *J* = 6.0, 0.8 Hz, 1H), 5.72 – 5.65 (m, 1H), 5.57 (t, *J* = 6.0 Hz, 1H), 3.98 – 3.90 (m, 2H), 1.99 (s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.65, 165.31, 132.01, 131.44, 128.78, 128.61, 96.83, 75.38, 71.81, 64.18. IR (neat) ν 3424, 3060, 2923, 1720, 1265, 1116 cm$^{-1}$. HRMS (ESI) for $C_{12}H_{10}Br_2O_3$ (M+Na), 382.8888 (Calc.), found 382.8878.



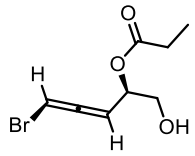
**2h:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl acetate.

Colorless oil. 15.0 mg, 67% yield. $^1$H NMR (500 MHz, $CDCl_3$, TMS): δ 6.17 – 6.11 (m, 1H), 5.47 (t, *J* = 5.5 Hz, 1H), 5.45 – 5.39 (m, 1H), 3.88 – 3.72 (m, 2H), 2.18 – 2.08 (s, 3H), 1.86 (s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.59, 170.40, 96.84, 75.02, 71.14, 64.04, 21.12. IR (neat) ν 3441, 3060, 2924, 1737, 1232, 1044 cm$^{-1}$. HRMS (ESI) for $C_7H_9BrO_3$ (M+$NH_4$), 238.0074 (Calc.), found 238.0078.



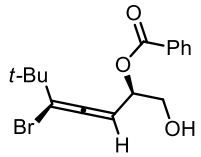

**2i:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl 2-phenylacetate.

Colorless oil. 23.0 mg, 77% yield. $^1$H NMR (400 MHz, $CDCl_3$, TMS): δ 7.38 – 7.27 (m, 5H), 6.03 – 5.95 (m, 1H), 5.47 – 5.37 (m, 2H), 3.77 (m, 2H), 3.69 (s, 2H), 1.71 (s, 1H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.43, 170.97, 133.69, 129.37, 128.83, 127.44, 96.72, 75.23, 71.34, 63.98, 41.45. IR (neat) ν 3454, 3060, 2922, 1734, 1245, 1146 cm$^{-1}$. HRMS (ESI) for $C_{13}H_{13}BrO_3$ (M+$NH_4$), 314.0387 (Calc.), found 314.0395.



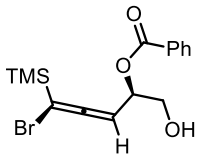

**2j:** 5-bromo-1-hydroxypenta-3,4-dien-2-yl propionate.

Colorless oil. 14.0 mg, 61% yield. $^1$H NMR (400 MHz, $CDCl_3$, TMS): δ 6.14 – 6.10 (m, 1H), 5.50 – 5.40 (m, 2H), 3.87 – 3.75 (m, 2H), 2.40 (q, *J* = 7.6 Hz, 2H), 1.26 (s, 1H), 1.21 – 1.13 (m, 3H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 202.52, 173.88, 97.02, 75.05, 70.87, 64.13, 27.73, 9.26. IR (neat) ν 3455, 3061, 2924, 1737, 1180, 1082 cm$^{-1}$. HRMS (ESI) for $C_8H_{11}BrO_3$ (M+$NH_4$), 252.0230 (Calc.), found 252.0234.



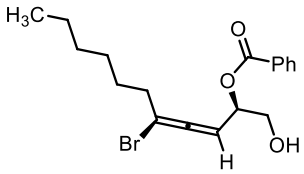

**4a:** 5-bromo-1-hydroxy-6,6-dimethylhepta-3,4-dien-2-yl benzoate.

Colorless oil. 24.0 mg, 71% yield. $^1$H NMR (400 MHz, $CDCl_3$, TMS): δ 8.07 (d, *J* = 7.2 Hz, 2H), 7.58 (td, *J* = 8.0, 1.2 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 5.70 – 5.62 (m, 1H), 5.45 (dd, *J* = 5.2, 1.2 Hz, 1H), 3.95 – 3.88 (m, 2H), 2.09 (s, 1H), 1.07 (s, 9H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 198.20, 166.16, 133.57, 130.03, 129.91, 128.66, 109.10, 94.74, 72.10, 64.40, 37.04, 31.17, 29.12, 28.99. IR (neat) ν 3442, 3063, 2969, 1721, 1267, 1113 cm$^{-1}$. HRMS (ESI) for $C_{16}H_{19}BrO_3$ (M+Na), 361.0410 (Calc.), found 361.0414.




**4b:** 5-bromo-1-hydroxy-5-(trimethylsilyl)penta-3,4-dien-2-yl benzoate.

Colorless oil. 25.0 mg, 71% yield. $^{1}$H NMR (400 MHz, $CDCl_3$, TMS): δ 8.06 (d, *J* = 8.8Hz, 2H), 7.58 (t, *J* = 7.2 Hz, 1H), 7.45 (t, *J* = 7.6 Hz, 2H), 5.70 – 5.62 (m, 1H), 5.31 (d, *J* = 5.2 Hz, 1H), 3.97 – 3.83 (m, 2H), 2.04 (s, 1H), 0.09 (s, 9H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 203.76, 165.99, 133.49, 129.94, 129.83, 128.58, 91.75, 90.05, 71.65, 64.48, -2.05. IR (neat) ν 3440, 3063, 2958, 1721, 1266, 1112 $cm^{-1}$. HRMS (ESI) for $C_{15}H_{19}BrO_3Si$ (M+$NH_4$), 372.0626 (Calc.), found 372.0615.




**4c:** 5-bromo-1-hydroxy-undeca-3,4-dien-2-yl benzoate.

Colorless oil. 15.9 mg, 65% yield. $^{1}$H NMR (400 MHz, $CDCl_3$, TMS): δ 8.07 (d, *J* = 8.1 Hz, 2H), 7.59 (t, *J* = 8.0 Hz, 1H), 7.46 (t, *J* = 7.6 Hz, 2H), 5.64 (dt, *J* = 6.1, 4.7 Hz, 1H), 5.46 (dt, *J* = 5.5, 3.0 Hz, 1H), 3.98 – 3.86 (m, 2H), 2.32 (td, *J* = 7.5, 2.9 Hz, 2H), 1.46 – 1.11 (m, 8H), 0.84 (t, *J* = 6.9 Hz, 3H). $^{13}$C NMR (100 MHz, $CDCl_3$): δ 199.73, 166.18, 133.55, 130.00, 129.92, 128.66, 96.83, 94.69, 72.25, 64.42, 37.66, 31.61, 28.43, 27.97, 22.65, 14.24. IR (neat) ν 3442, 3064, 2956, 2928, 2857, 1721, 1268, 1114, 909, 733, 711 $cm^{-1}$. HRMS (ESI) for $C_{18}H_{23}BrO_3$ (M+Na), 389.0722 (Calc.), found 389.0728.

**References:**

(1) W. Zhang, H. Xu, H. Xu, W. Tang. *J. Am. Chem. Soc*. **2009**, *131*, 3832-3833.
(2) B. M. Trost, J. L. Gunzner. *J. Am. Chem. Soc*. **2001**, *123*, 9449-9450.
(3) W. Zhang, S. Zheng, N. Liu, J. B. Werness, I. A. Guzei, W. Tang. *J. Am. Chem. Soc.* **2010**, *132*, 3664-3665.
(4) G. Kim, M. J. Seo. *Bull. Korean Chem. Soc.* **1995**, *16*, 1002-1003.
(5) K. C. Nicolaou, C. A. Veale, S. E. Webber, H. Katerinopoulos. *J. Am. Chem. Soc*. **1985**, *107*, 7515-7518.
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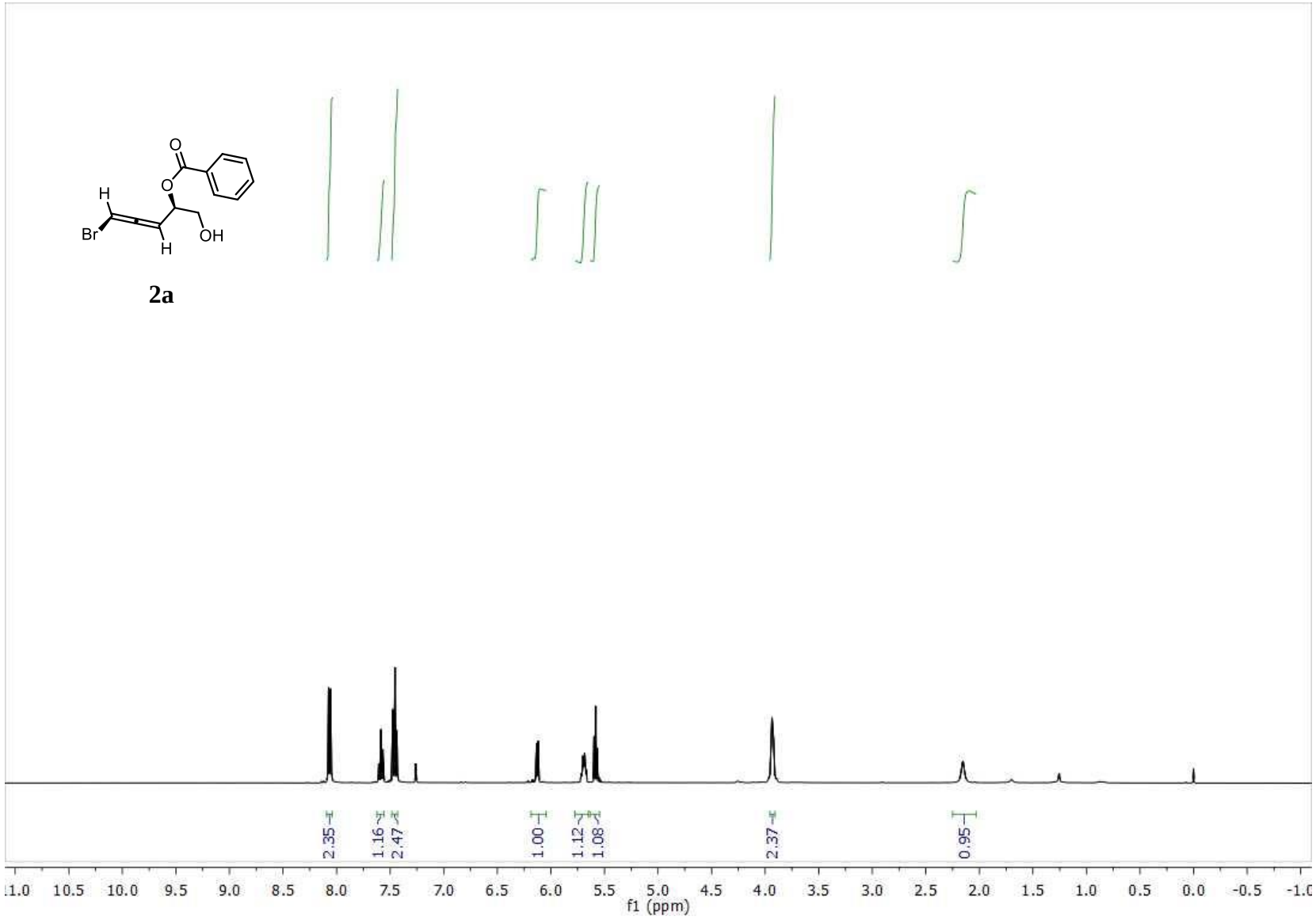
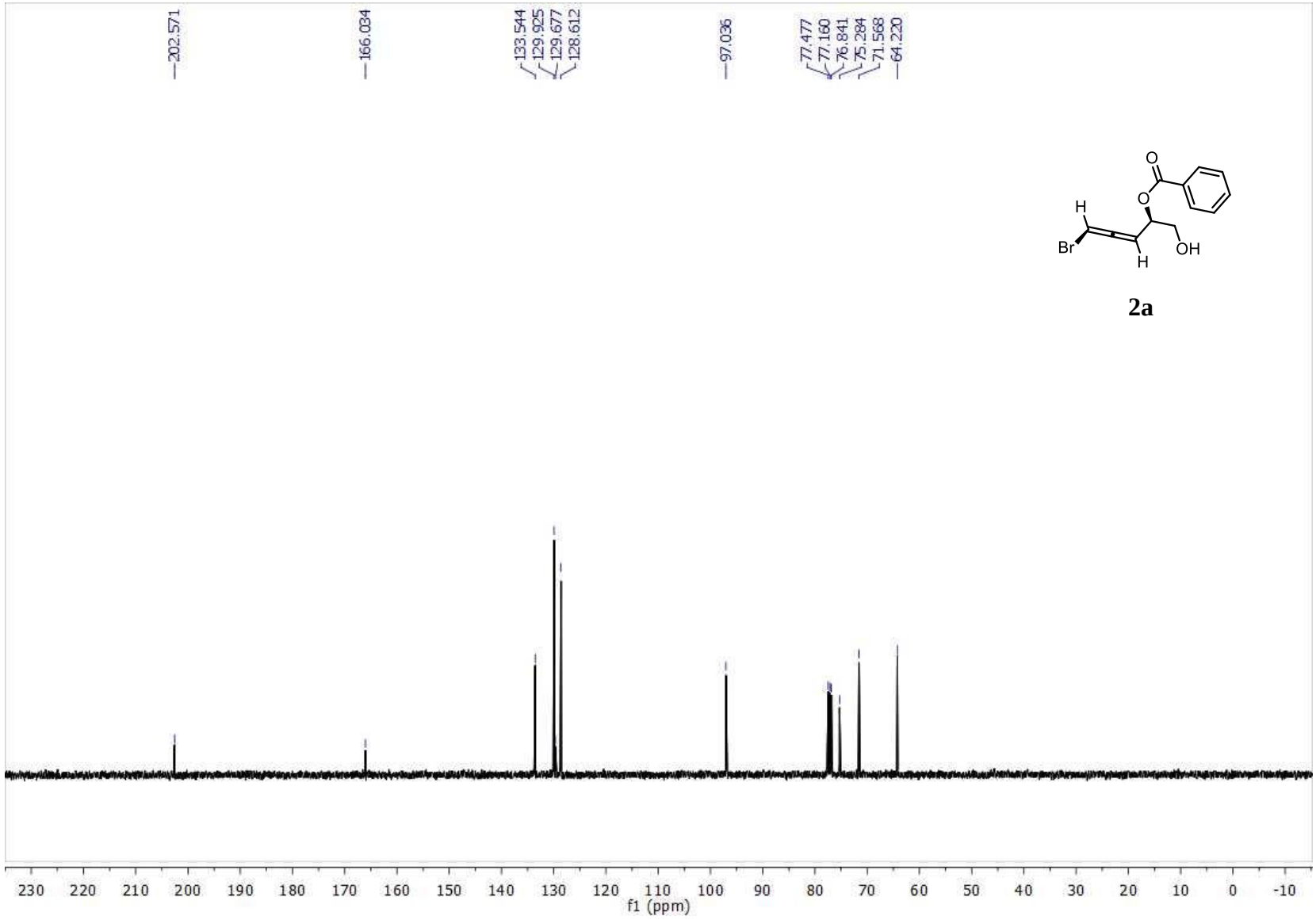
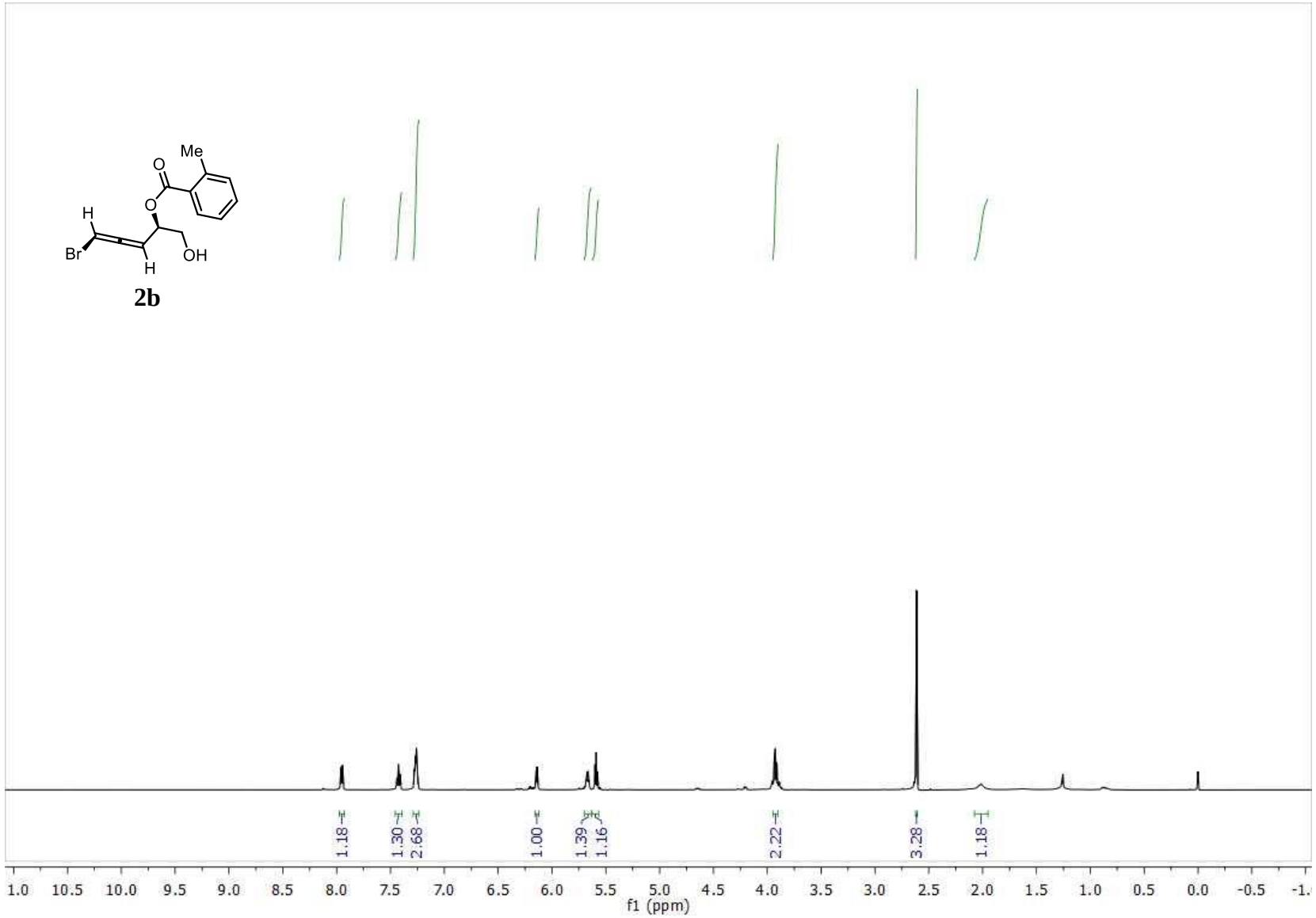
(7) J. K. Stile, J. H. Simpson. *J. Am. Chem. Soc*. **1987**, *109*, 2138-2152



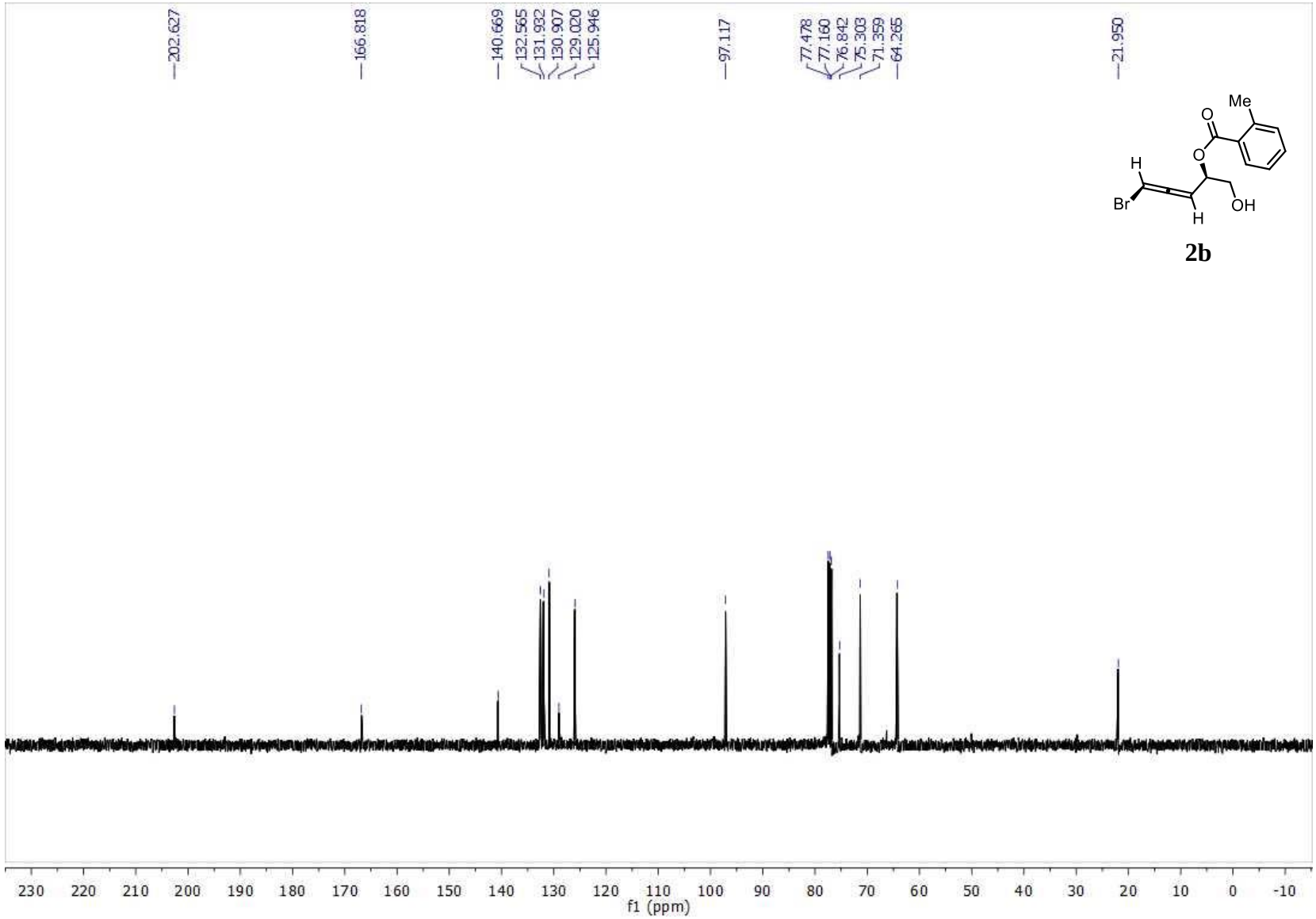

**2a**


202.571
166.034
133.544
129.925
129.677
128.612
97.036
77.477
77.160
76.841
75.284
71.568
64.220
O
O
H
Br
H
OH
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

**2a**




**2b**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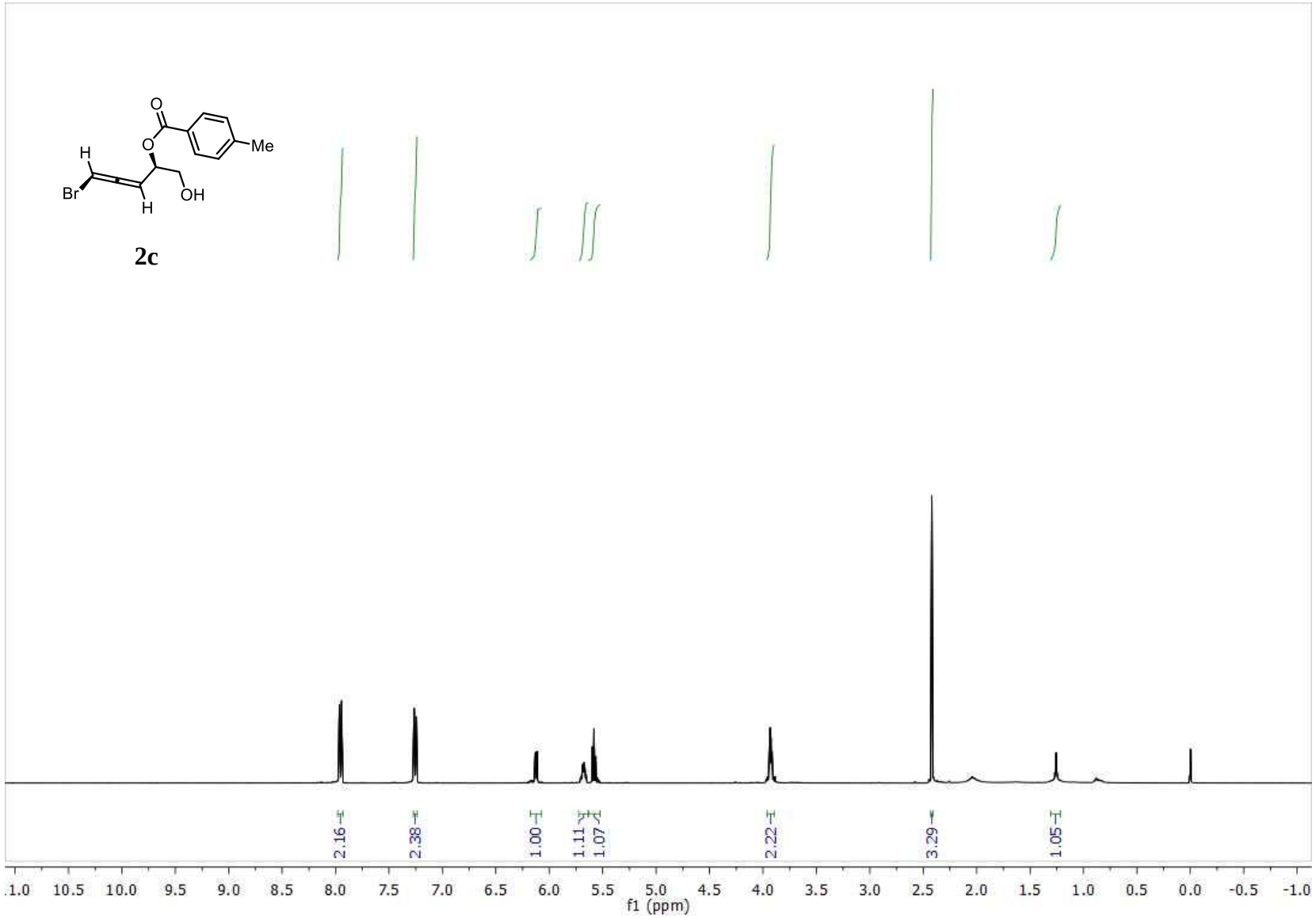
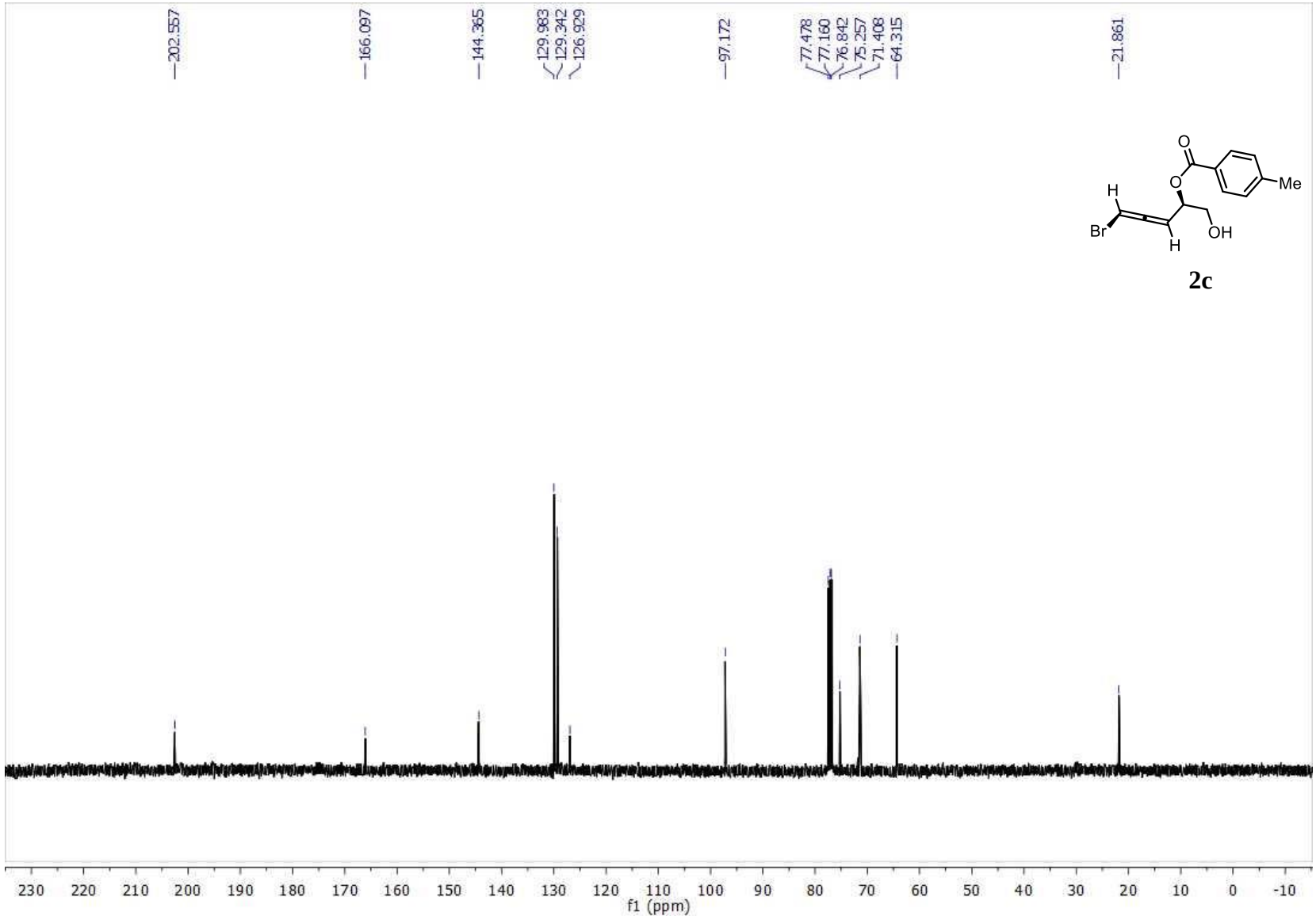
132.565
131.932
130.907
129.020
125.946
97.117
77.478
77.160
76.842
75.303
71.359
64.265
21.950
Me
O
O
H
Br
H
OH
2b
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


O
O
Me
H
Br
H
OH
2c
2.16
2.38
1.00
1.11
1.07
2.22
3.29
1.05
f1 (ppm)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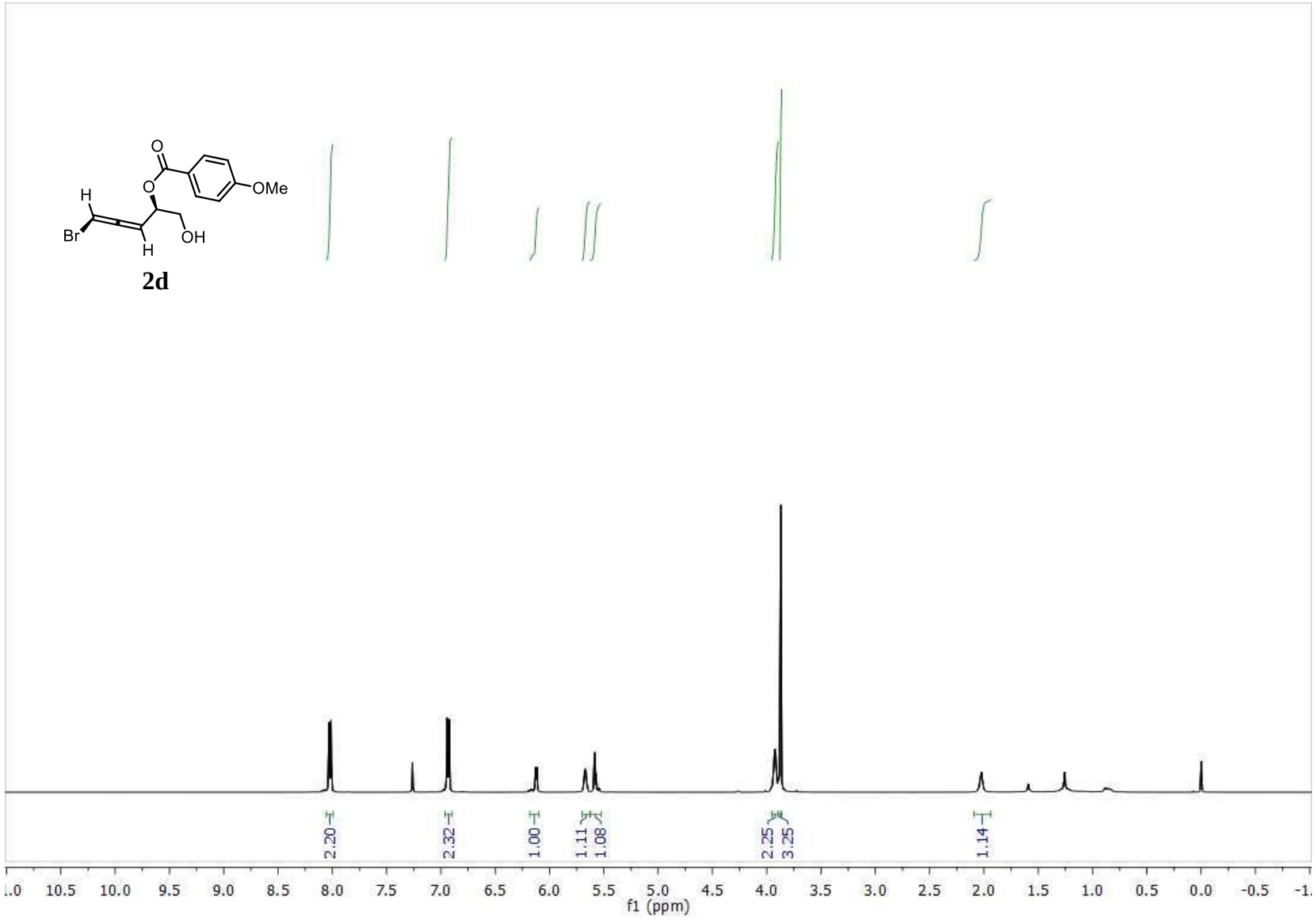
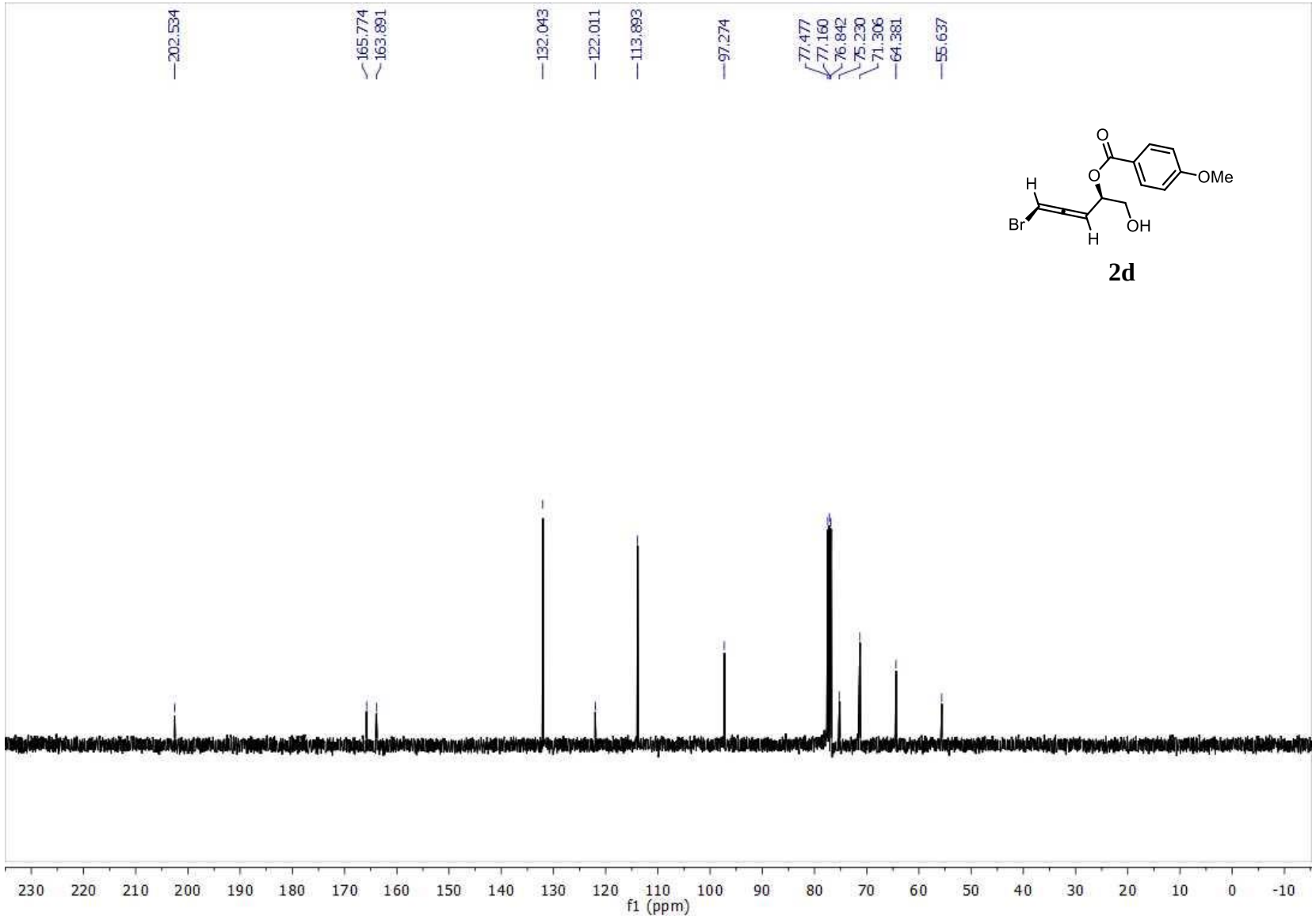
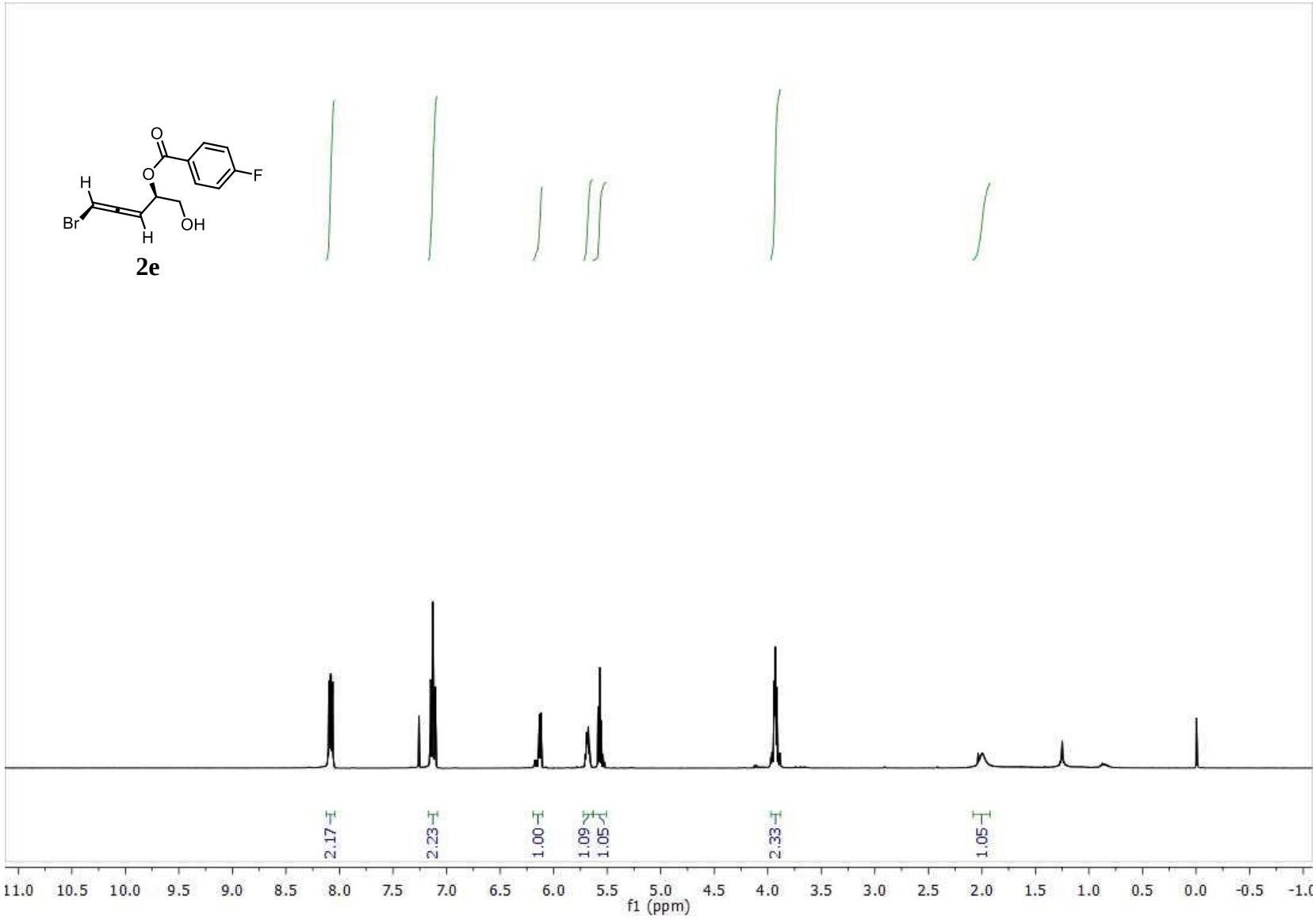
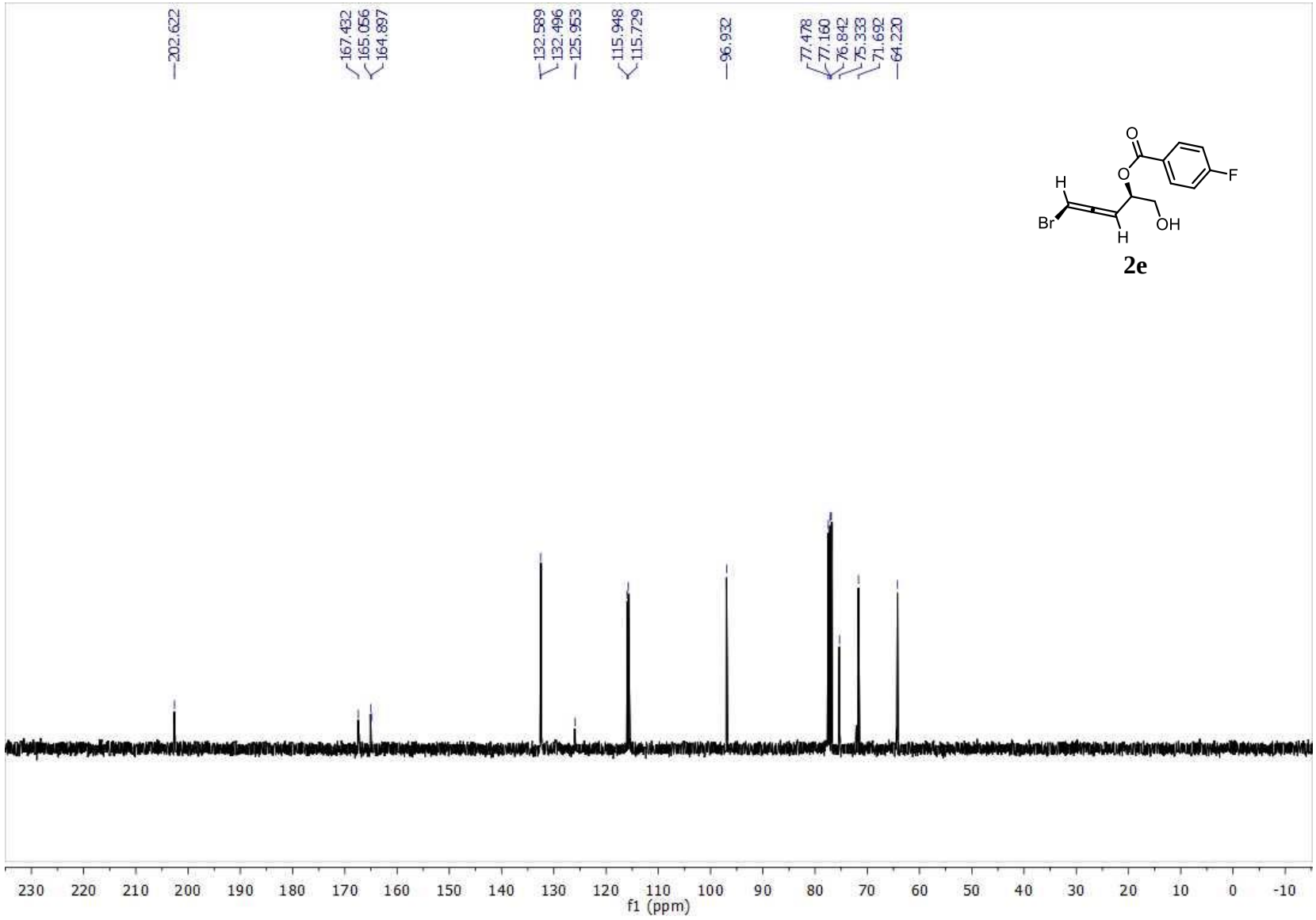
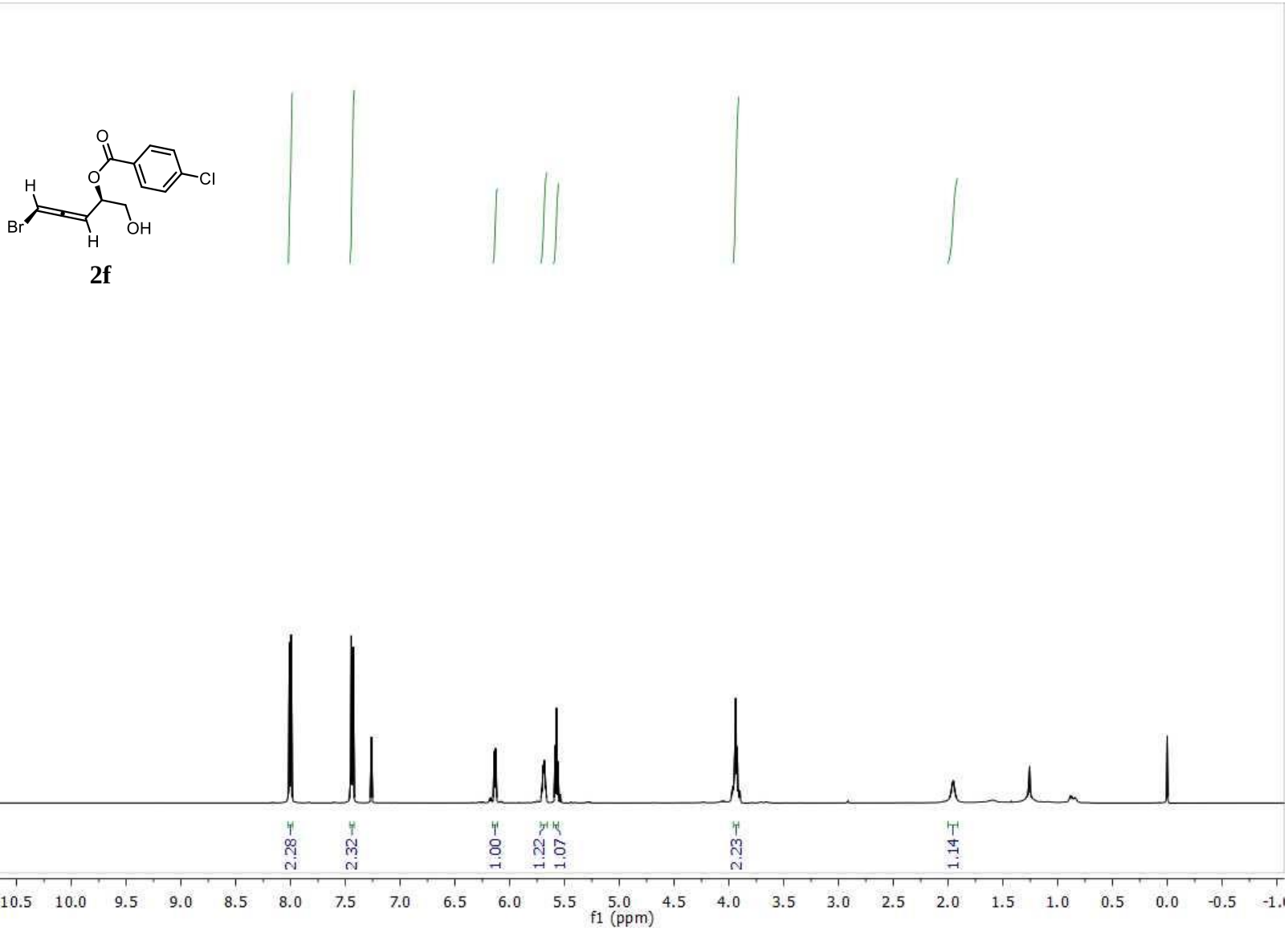
71.408
64.315
21.861
O
O
Me
H
Br
H
OH
2c
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

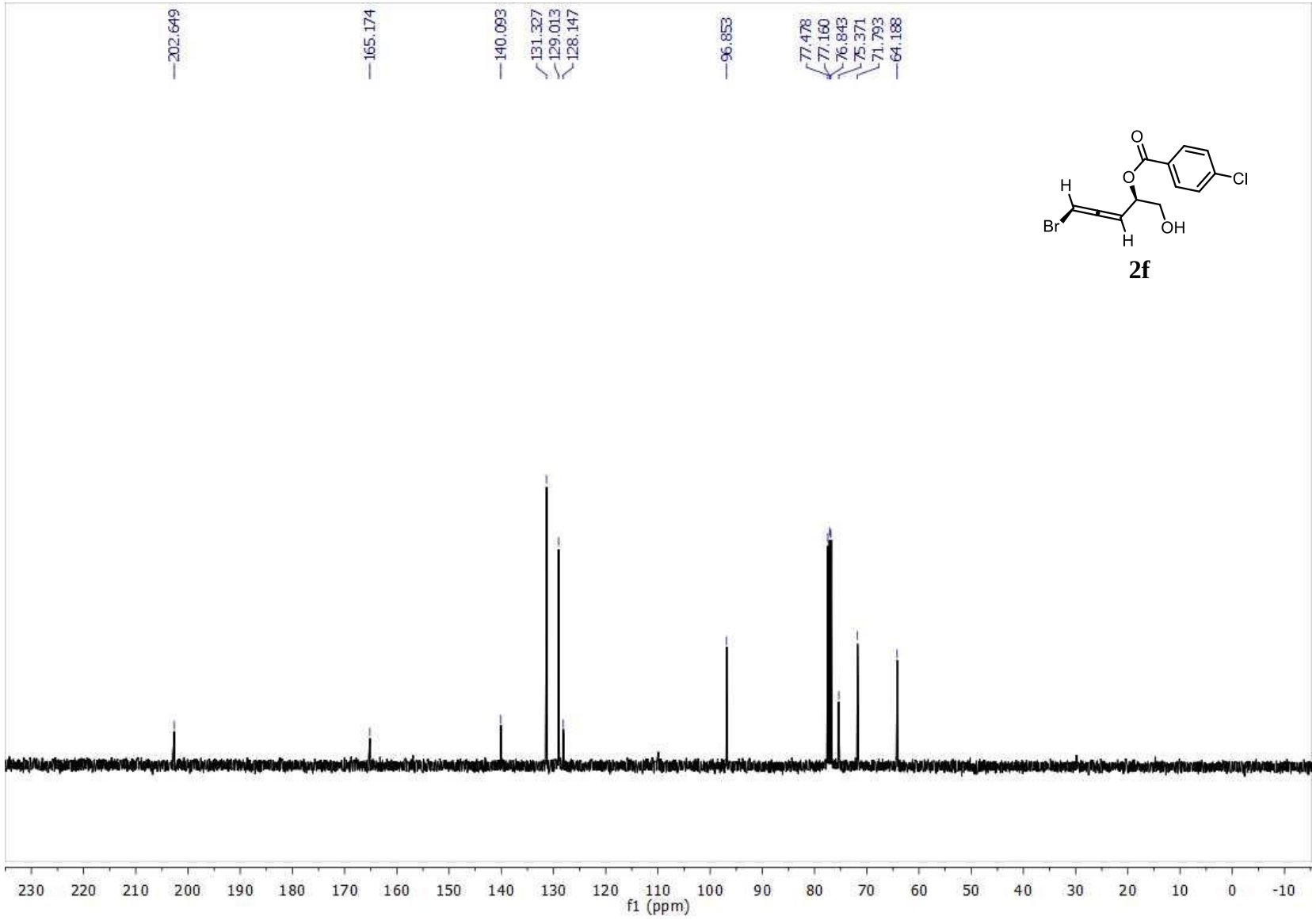

O
O
OMe
H
Br
H
OH
2d
2.20
2.32
1.00
1.11
1.08
2.25
3.25
1.14
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

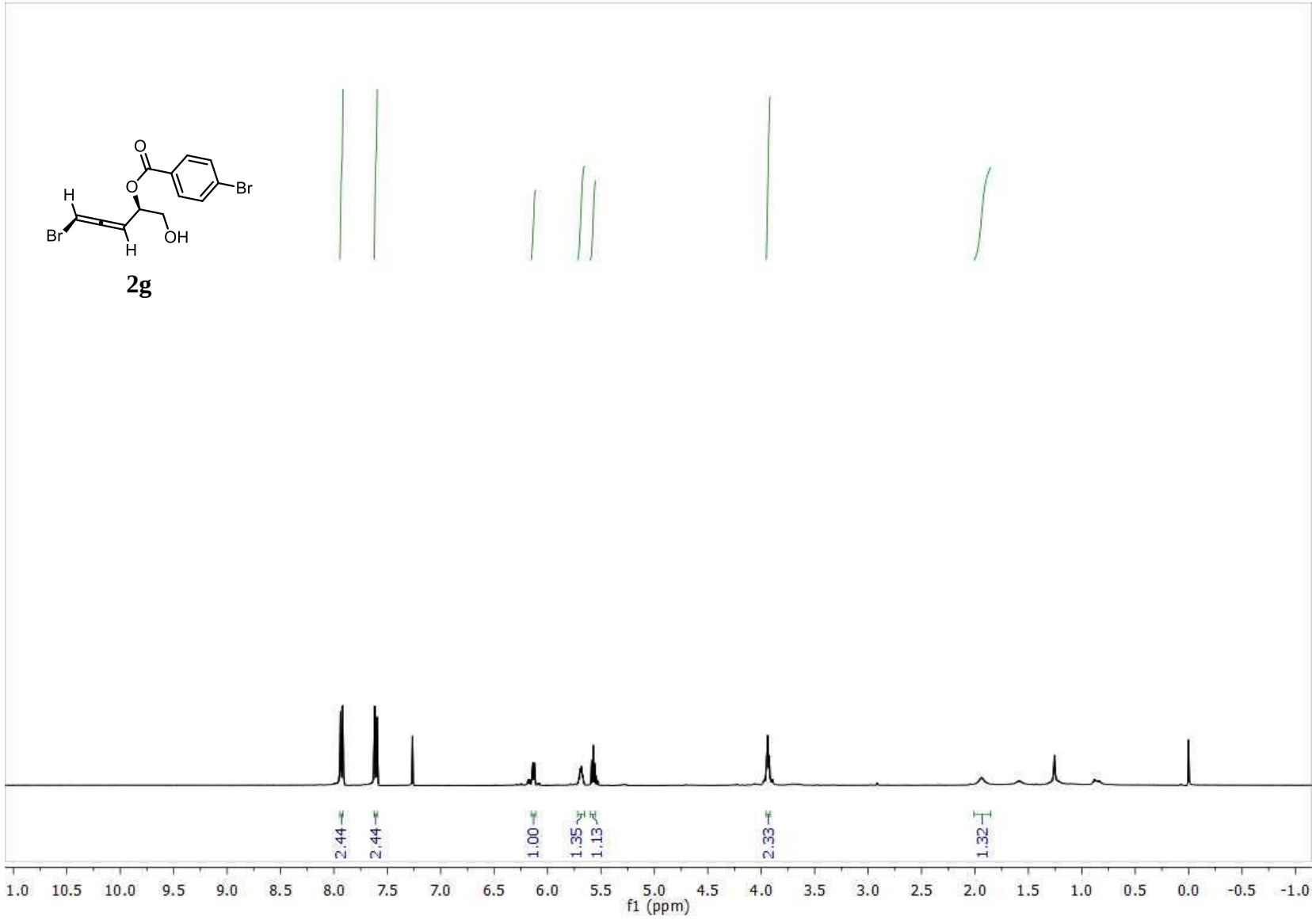

202.534
165.774
163.891
132.043
122.011
113.893
97.274
77.477
77.160
76.842
75.230
71.306
64.381
55.637
O
O
OMe
H
Br
OH
H
2d
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

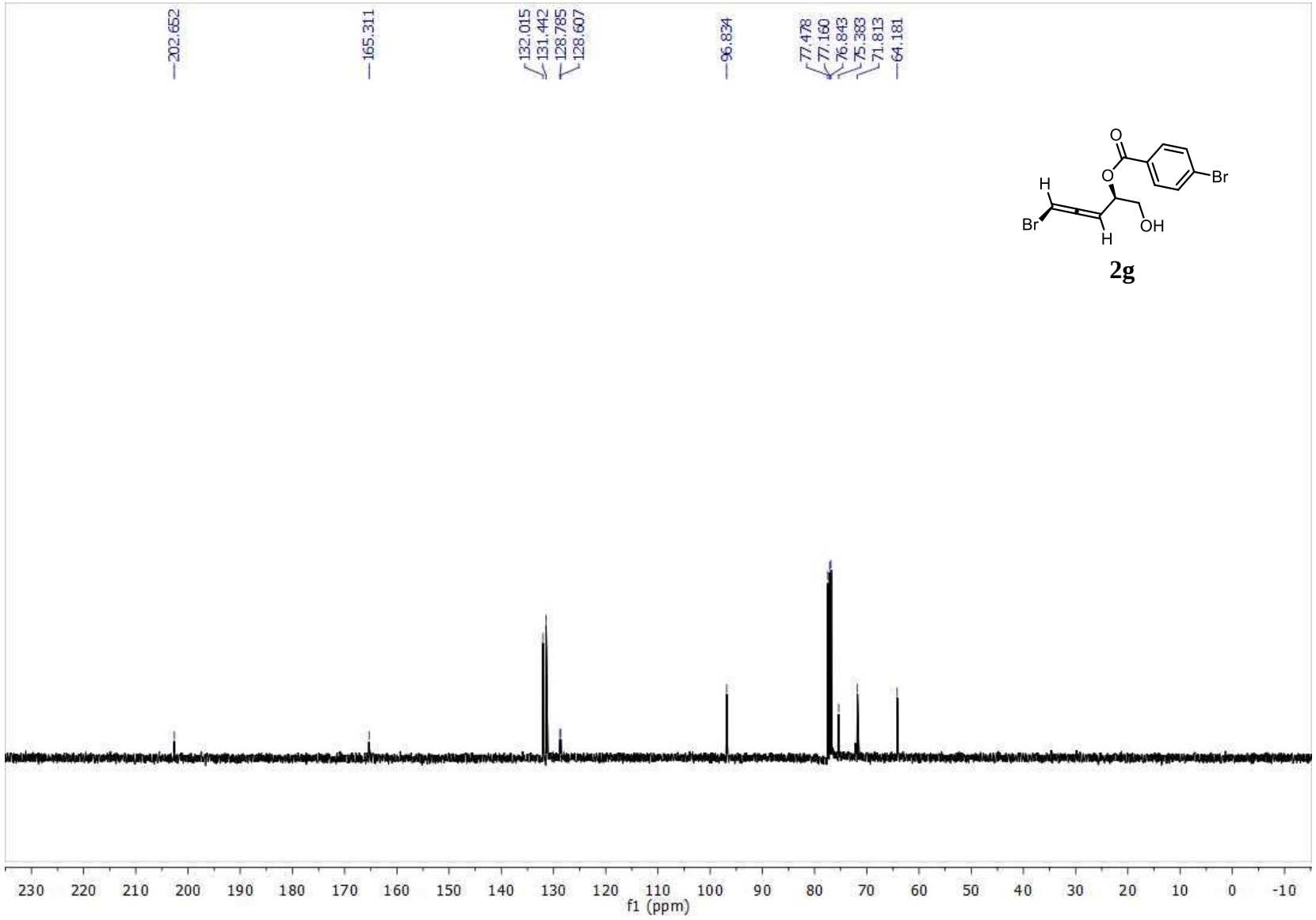

O
O
F
H
Br
H
OH
2e
2.17
2.23
1.00
1.09
1.05
2.33
1.05
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

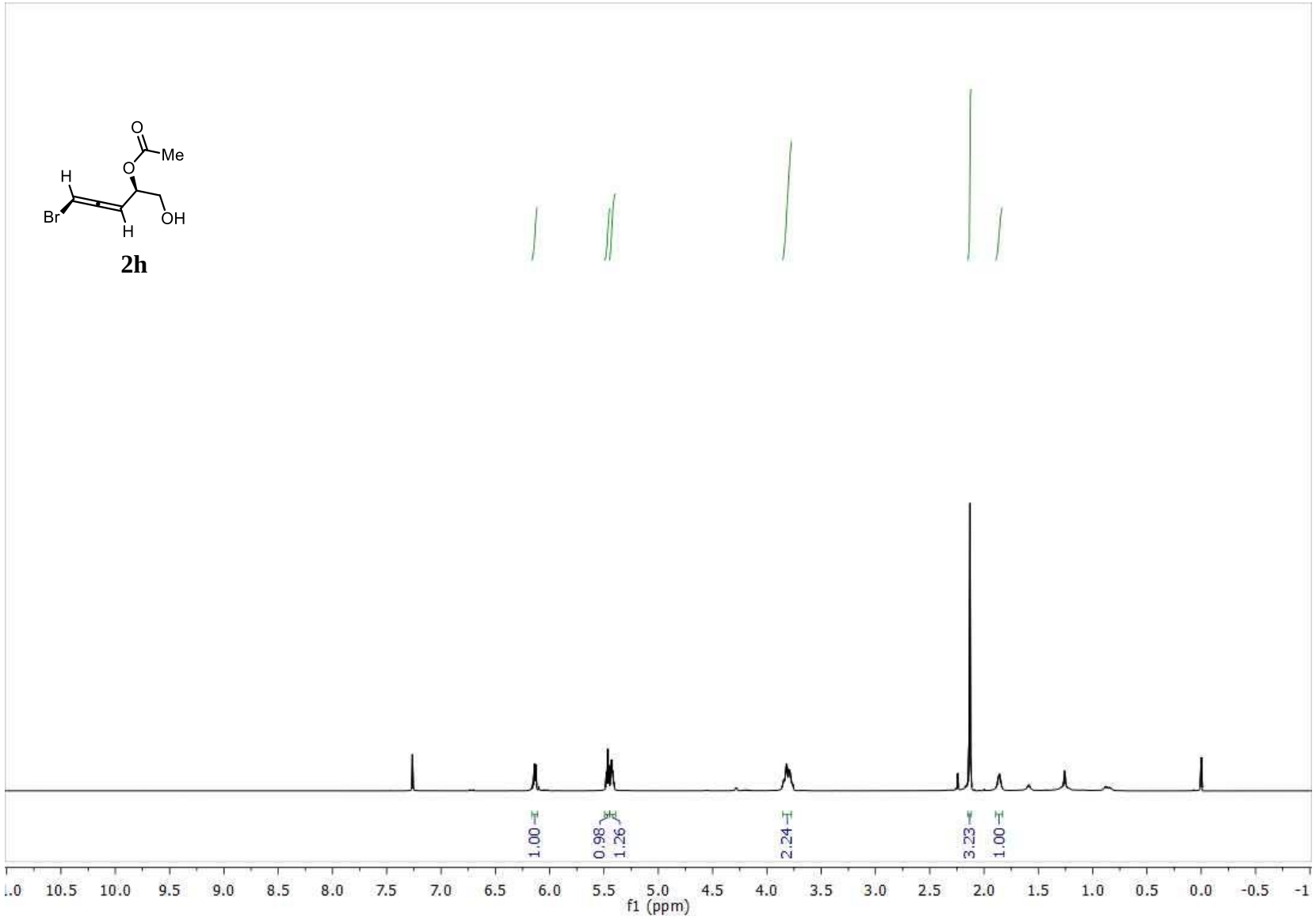

202.622
167.432
165.056
164.897
132.589
132.496
125.953
115.948
115.729
96.932
77.478
77.160
76.842
75.333
71.692
64.220
O
O
F
H
Br
H
OH
2e
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

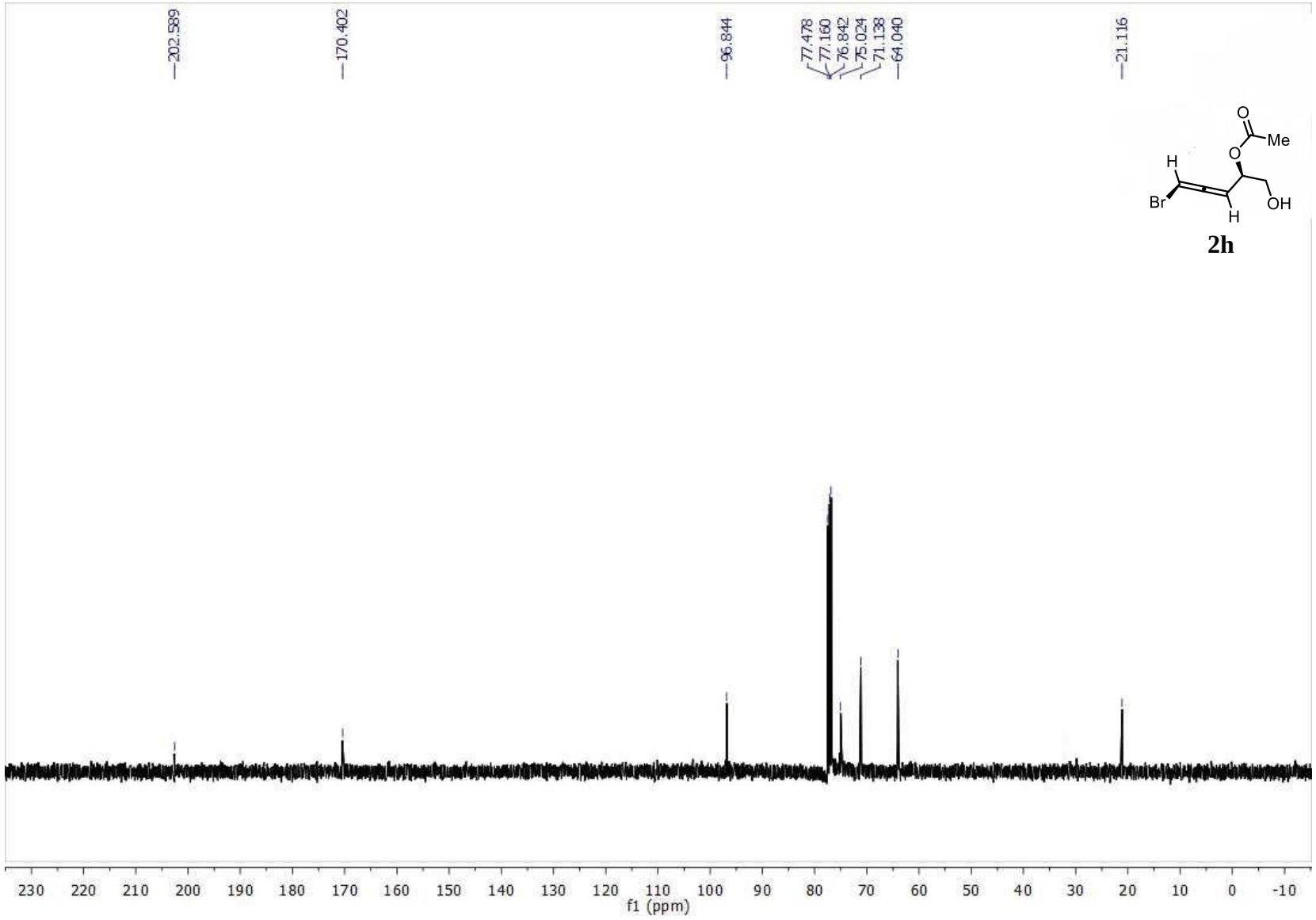

O
O
Cl
H
Br
OH
H
2f
2.28
2.32
1.00
1.22
1.07
2.23
1.14
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

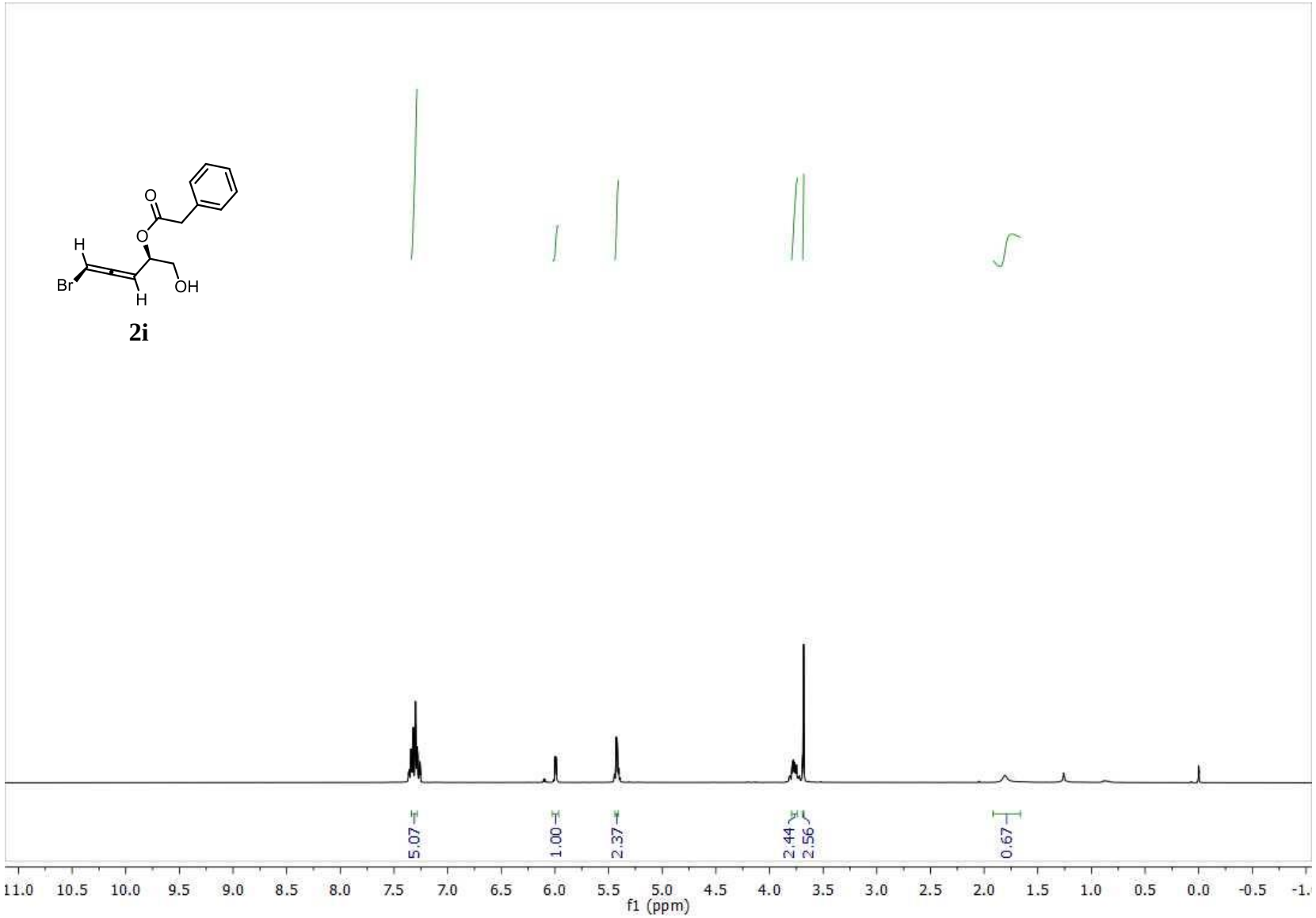

202.649
165.174
140.093
131.327
129.013
128.147
96.853
77.478
77.160
76.843
75.371
71.793
64.188
O
O
Cl
H
Br
OH
H
2f
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


O
O
Br
H
Br
OH
H
2g
2.44
2.44
1.00
1.35
1.13
2.33
1.32
1.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

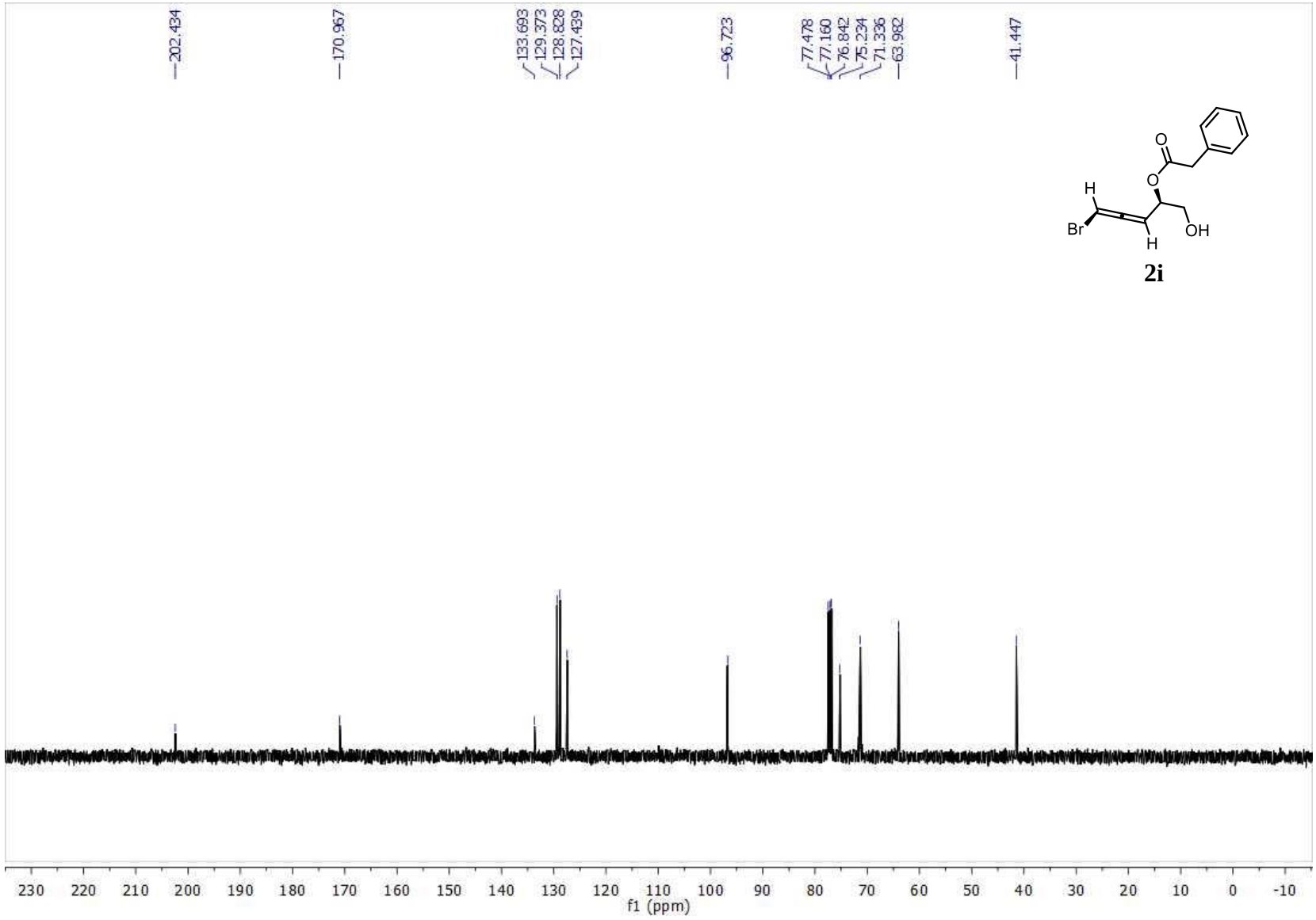

202.652
165.311
132.015
131.442
128.785
128.607
96.834
77.478
77.160
76.843
75.383
71.813
64.181
O
O
Br
H
Br
OH
H
2g
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

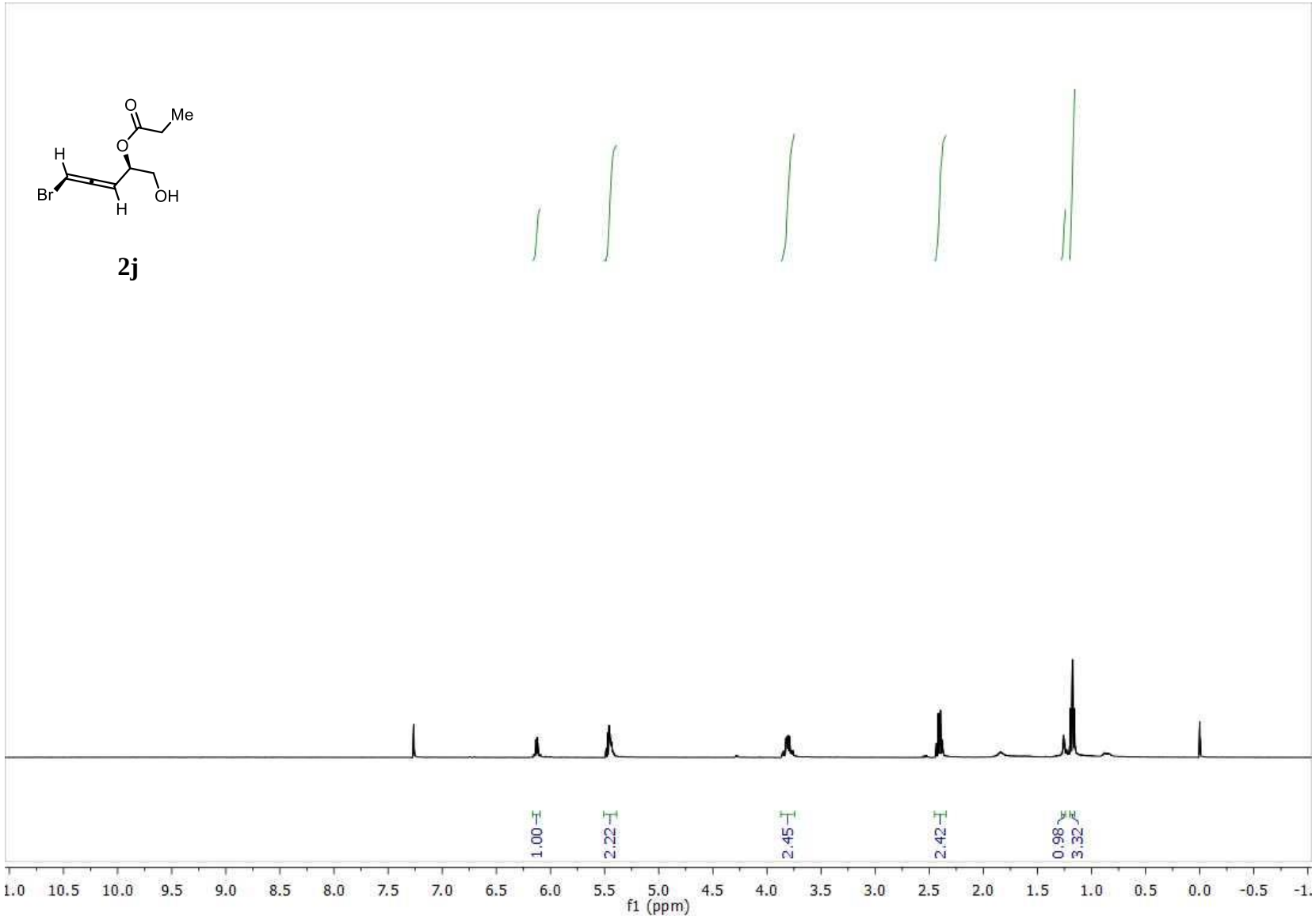

O
Me
O
H
Br
H
OH
2h
1.00
0.98
1.26
2.24
3.23
1.00
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1
f1 (ppm)

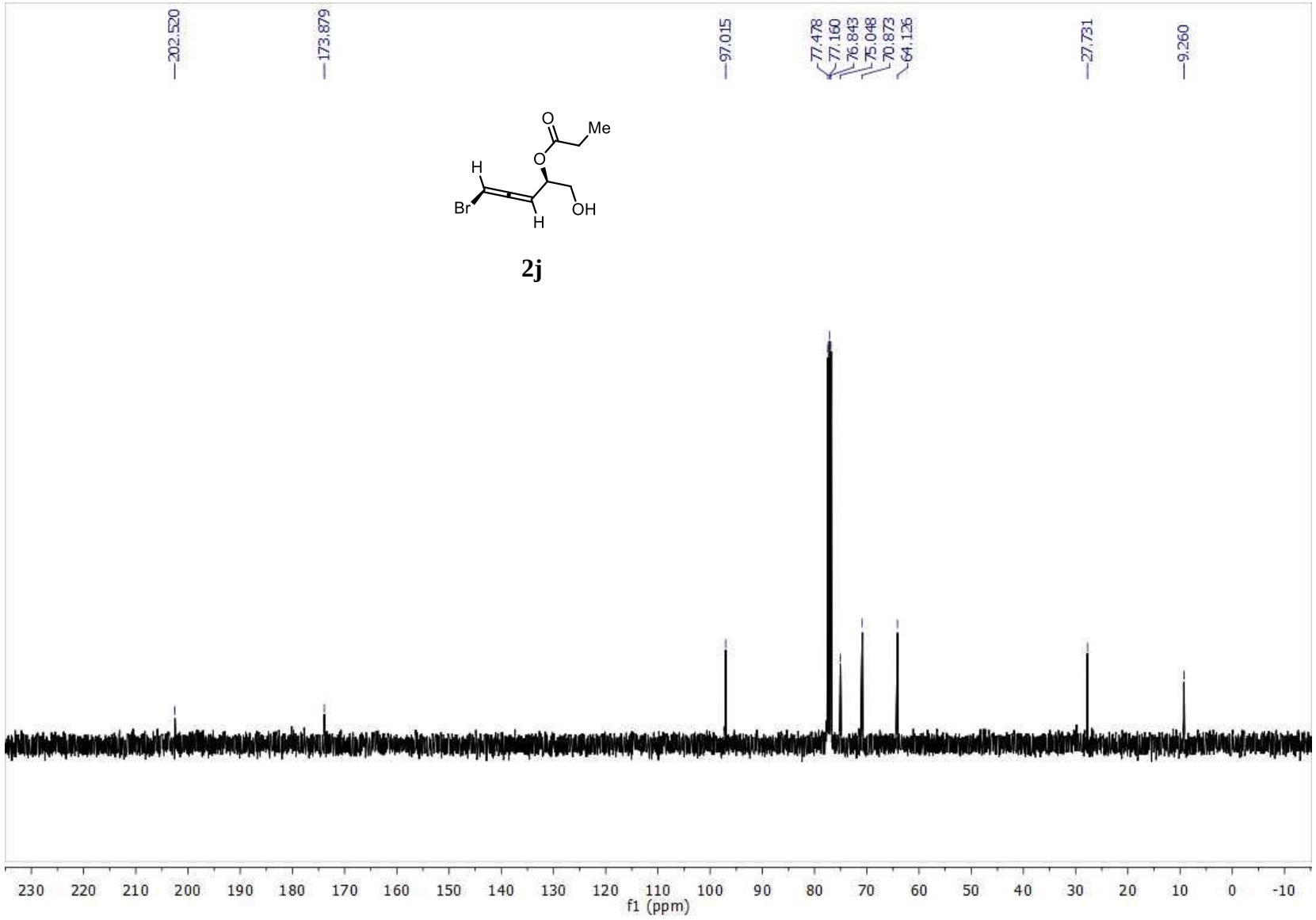

202.589
170.402
96.844
77.478
77.160
76.842
75.024
71.138
64.040
21.116
O
Me
O
H
Br
H
OH
2h
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


O
O
H
Br
H
OH
5.07
1.00
2.37
2.44
2.56
0.67
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
f1 (ppm)

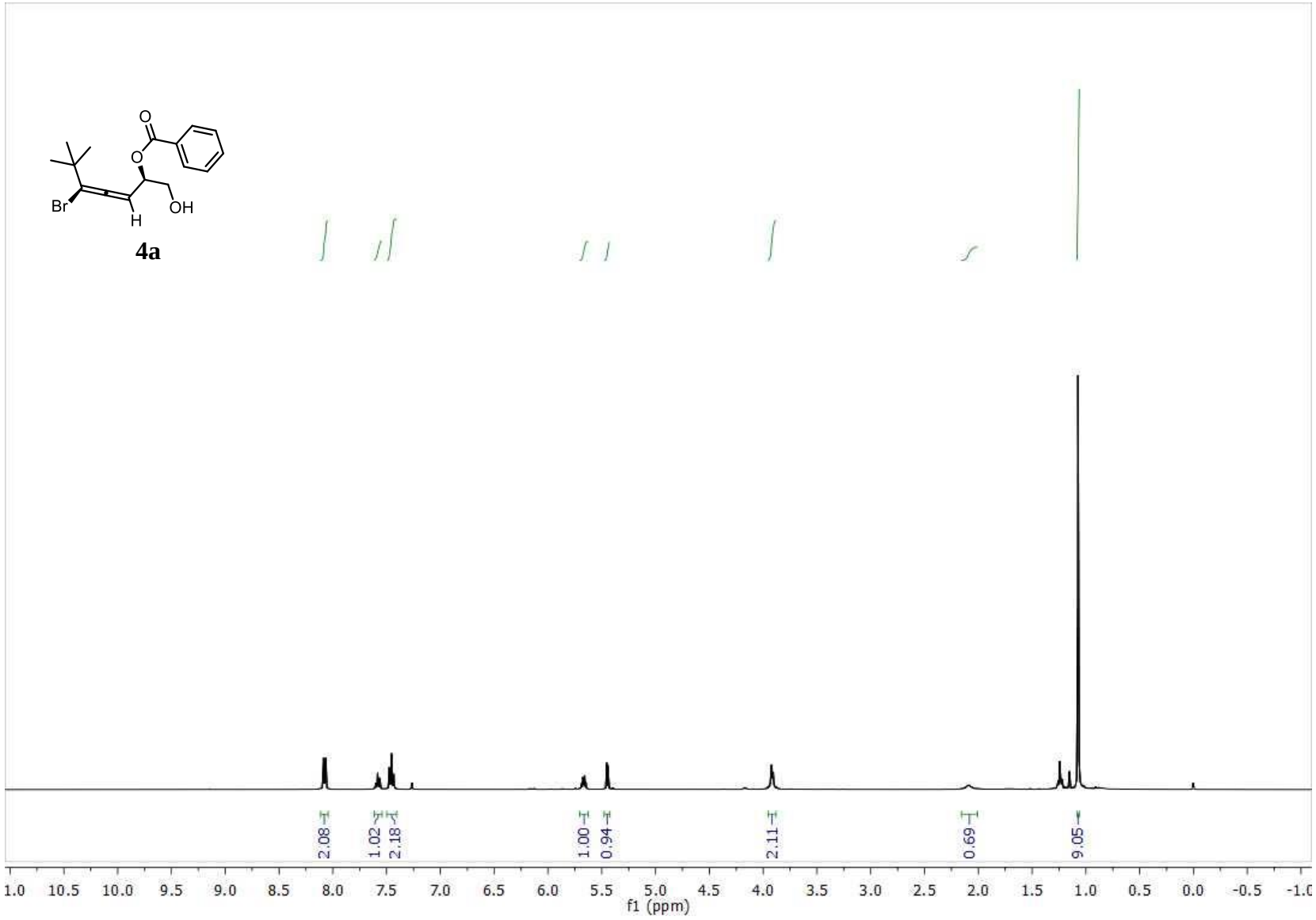
**2i**


202.434
170.967
133.693
129.373
128.828
127.439
96.723
77.478
77.160
76.842
75.234
71.336
63.982
41.447
O
O
H
Br
H
OH
2i
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

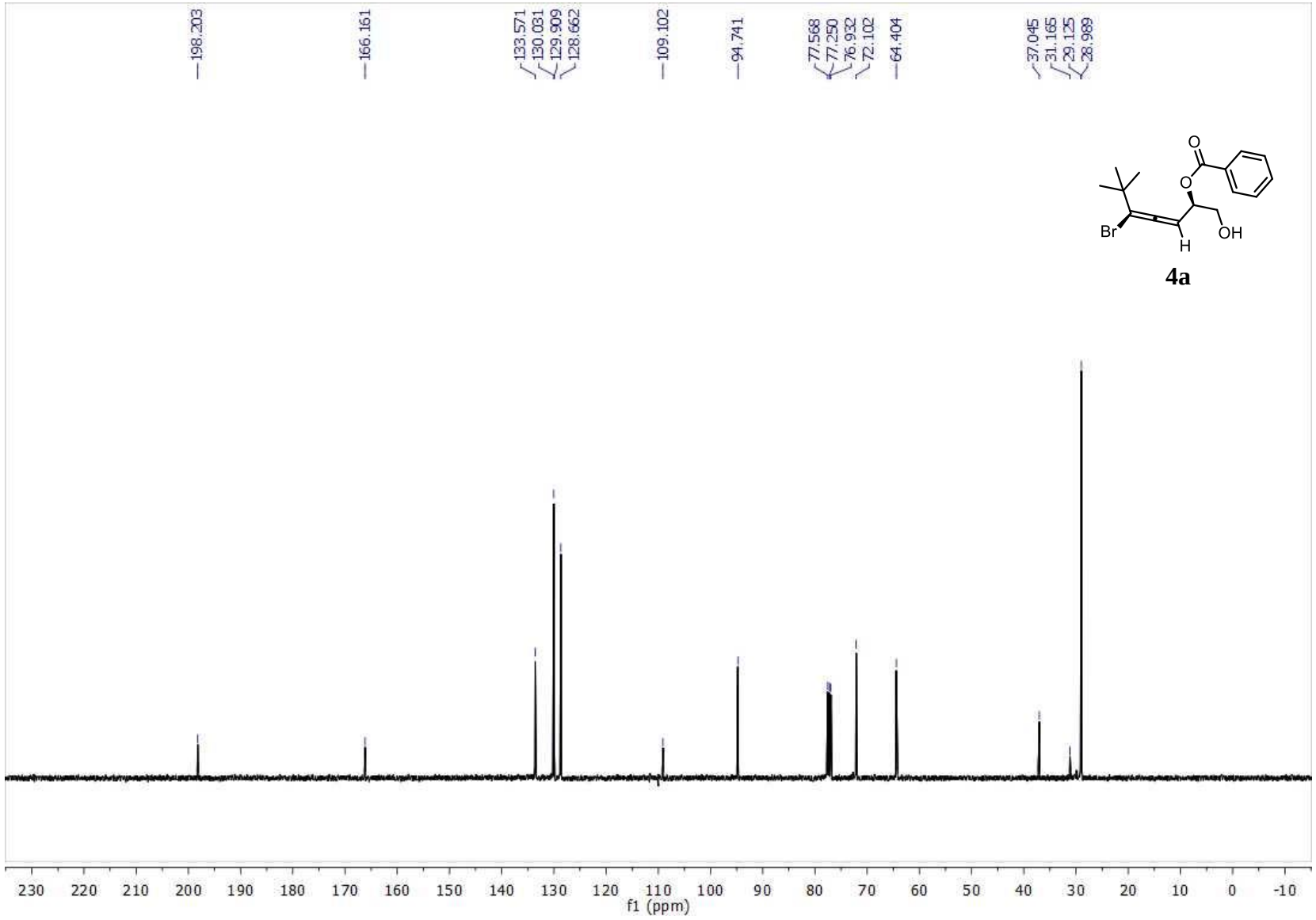

O
Me
O
H
Br
H
OH
2j
1.00
2.22
2.45
2.42
0.98
3.32
f1 (ppm)

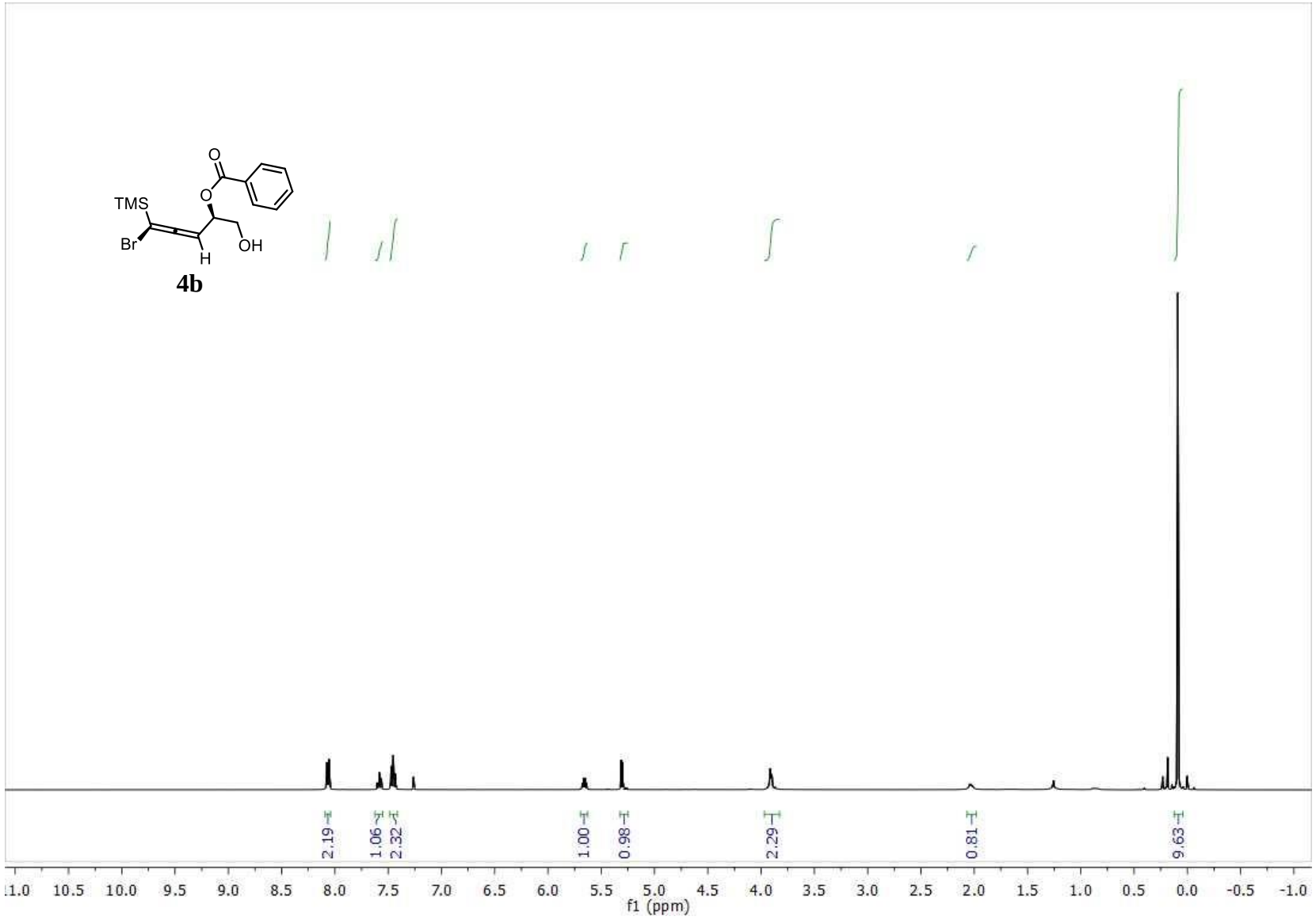

202.520
173.879
97.015
77.478
77.160
76.843
75.048
70.873
64.126
27.731
9.260
O
Me
O
H
Br
H
OH
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

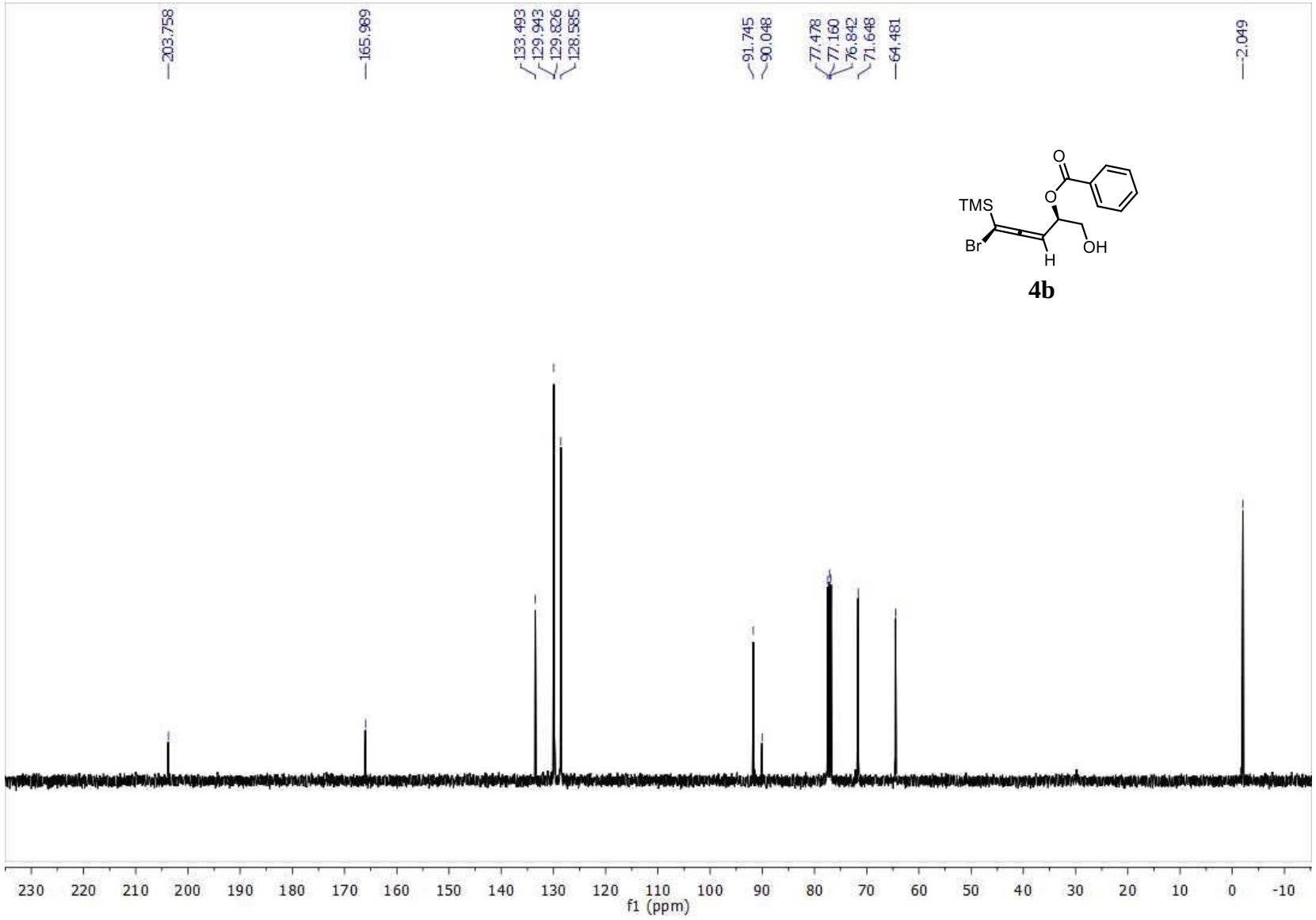
**2j**

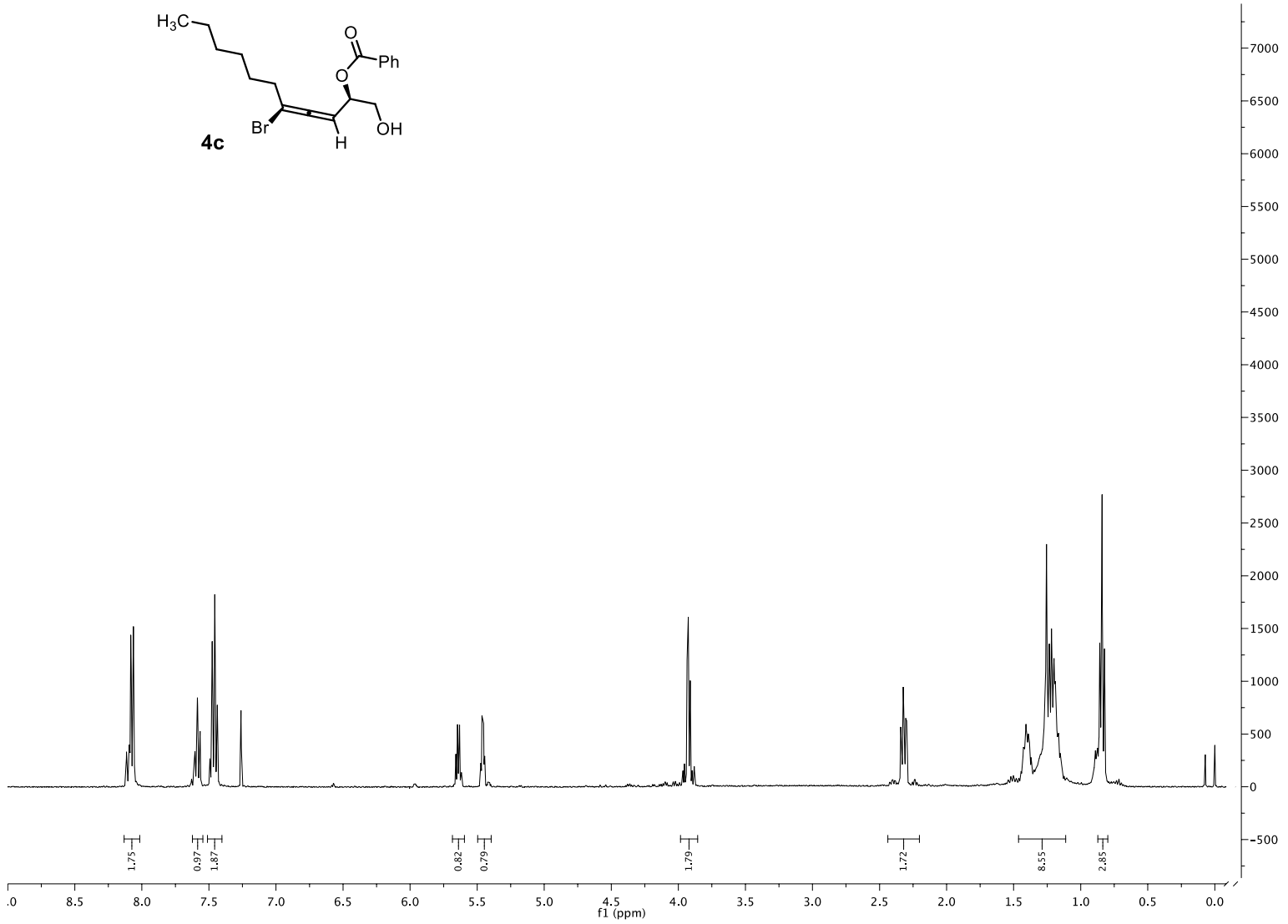

O
O
Br
H
OH
2.08
1.02
2.18
1.00
0.94
2.11
0.69
9.05
1.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
f1 (ppm)

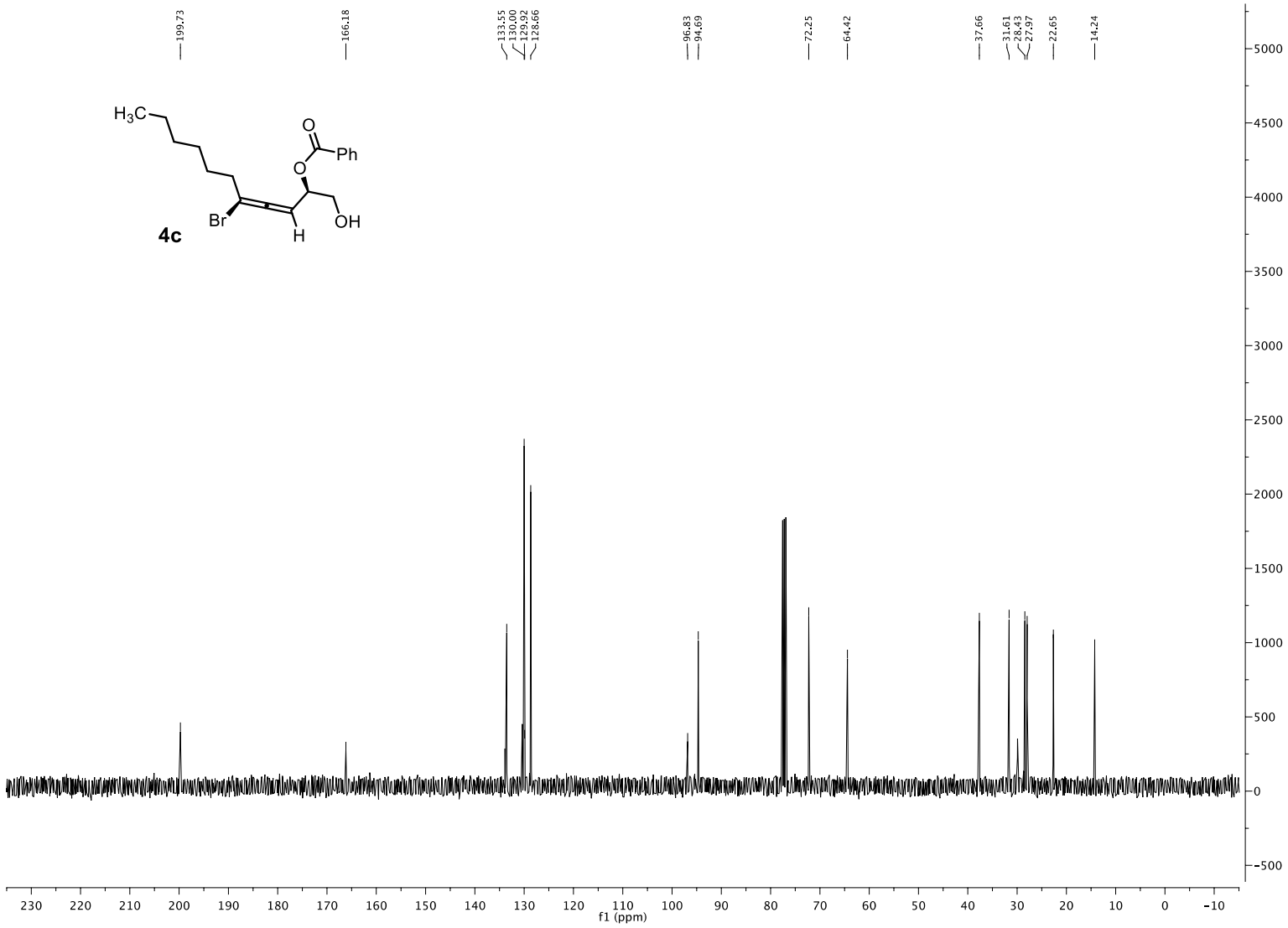
**4a**


198.203
166.161
133.571
130.031
129.909
128.662
109.102
94.741
77.568
77.250
76.932
72.102
64.404
37.045
31.165
29.125
28.989
O
O
Br
H
OH
4a
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


TMS
Br
H
O
O
OH
4b
2.19
1.06
2.32
1.00
0.98
2.29
0.81
9.63
f1 (ppm)


203.758
165.989
133.493
129.943
129.826
128.585
91.745
90.048
77.478
77.160
76.842
71.648
64.481
2.049
TMS
Br
H
OH
O
O
4b
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)


H3C
O
Ph
O
Br
H
OH
4c
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
1.75
0.97
1.87
0.82
0.79
1.79
1.72
8.55
2.85
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


199.73
166.18
133.55
130.00
129.92
128.66
96.83
94.69
72.25
64.42
37.66
31.61
28.43
27.97
22.65
14.24
H3C
O
Ph
O
Br
OH
H
4c
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
-500
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)