Supporting Information

Gold-Catalyzed Addition of Sulfonic Acids to Alkyns to Form Vinyl Sulfonates

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Contents

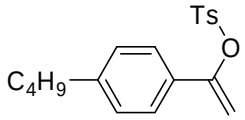
General Information.

Under otherwise noted, materials were obtained from commercial suppliers and used without further purification. Thin layer chromatography (TLC) was performed using silica gel 60 F_{254} and visualized using UV light. Column chromatography was performed with silica gel (mesh 300-400). ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker Avance 500 MHz spectrometer in $CDCl_3$ with Me_4Si as an internal standard. Data were reported as follows: chemical shift in ppm (δ), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, br = broad and m = multiplet), coupling constant in Herts (Hz) and integration. Infrared spectra (IR) were obtained on 370 FT-IR spectrometer; absorptions were reported in cm^{-1}. Mass spectra (MS) and high resolution mass spectra (HRMS) were obtained from the Zhejiang University of Technology Mass Spectrometry Facility.

General procedure

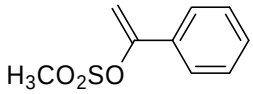
To a reactor containing alkyne (1.0 mmol), phthalimide (2.9 mg, 0.02 mmol), PPh_3AuNO_3 (5.2 mg, 0.01 mmol), and dichlorethane (2 mL) was added sulfonic acid (0.5 mmol) under nitrogen. The mixture was then sealed and stirred at 100℃ for 4 hours. It was quenched with saturated solution of $NaHCO_3$ and then extracted with ethyl acetate (3 x 10 mL). The organic layer was washed with brine, dried over Na_2SO_4 and concentrated *in vacuo*. The residue was purified by flash chromatography to give the pure product.

(1) 1-(4-butylphenyl)vinyl 4-methylbenzenesulfonate (**3a**): a yellow oil. TLC (SiO_2; Petroleum-Ethyl acetate = 20 : 1): R_f = 0.35.



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.78 (d, J = 8.5 Hz, 2H), 7.32 (d, J = 8.0 Hz, 2H), 7.25 (d, J = 8.0 Hz, 2H), 7.07 (d, J = 8.5 Hz, 2H), 5.33 (d, J = 3.0 Hz, 1H), 5.01 (d, J = 3.0 Hz, 1H), 2.56 (t, J = 7.5 Hz, 2H), 2.39 (s, 3H), 1.51-1.57 (m, 2H), 1.28-1.35 (m, 2H), 0.91 (t, J = 7.5 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 152.9, 145.0, 144.3, 133.0, 130.7, 129.5, 128.4, 128.3, 125.3, 102.0, 35.2, 33.4, 22.2, 21.6, 13.9 ppm; IR (KBr) 2956, 2858, 1681, 1634, 1606, 1510, 1456, 1374, 1177, 1085, 941, 732 cm^{-1}. HRMS (EI) for $C_{19}H_{22}O_3S$: calcd. 330.1290, found 330.1298.

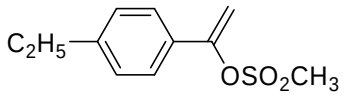
(2) 1-phenylvinyl methanesulfonate (**3b**): a pale yellow oil. TLC (SiO_2; Petroleum-Ethyl acetate = 5 : 1): R_f = 0.35.



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.58-7.56 (m, 2H), 7.39-7.38 (m, 3H), 5.54 (d, J = 3.0 Hz, 1H), 5.37 (d, J = 3.0 Hz, 1H), 3.09 (s, 3H) ppm; ^{13}C NMR (125MHz, $CDCl_3$) δ 152.4, 133.2, 129.8, 128.8, 125.4, 103.3, 38.2 ppm; IR (KBr): 2938, 1637, 1577, 1493, 1447, 1364, 1177, 1074, 940 cm^{-1}. HRMS (EI) for $C_9H_{10}O_3S$: calcd. 198.0351, found 198.0352.

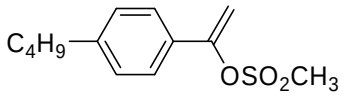
(3) 1-(4-ethylphenyl)vinyl methanesulfonate (**3c**): a pale yellow oil. TLC (SiO_2; Petroleum--

Ethyl acetate = 5 : 1): R_f = 0.5.



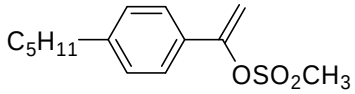
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, J = 8.0 Hz, 2H), 7.21 (d, J = 8.0 Hz, 2H), 5.48 (d, J = 3.0 Hz, 1H), 5.31 (d, J = 3.0 Hz, 1H), 3.08 (s, 3H), 2.65 (q, J = 7.5 Hz, 2H), 1.23 (t, J = 7.5 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 152.6, 146.2, 130.7, 128.2, 125.5, 102.4, 38.1, 28.6, 15.3 ppm; IR (KBr) 2967, 2931, 1680, 1606, 1568, 1496, 1361, 1177, 1085, 941, 779 cm^{-1}. HRMS (EI) for $C_{11}H_{14}O_3S$: calcd. 226.0664, found 226.0657.

(4) 1-(4-butylphenyl)vinyl methanesulfonate (**3d**) : a pale yellow oil. TLC (SiO_2; Petroleum-Ethyl acetate = 5 : 1): R_f = 0.37.



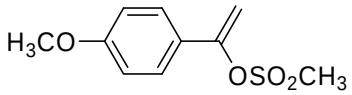
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 (d, J = 8.5 Hz, 2H), 7.19 (d, J = 8.5 Hz, 2H), 5.48 (d, J = 3.0 Hz, 1H), 5.32 (d, J = 3.0 Hz, 1H), 3.08 (s, 3H), 2.61 (t, J = 7.5 Hz, 2H), 1.62-1.57 (m, 2H), 1.38-1.31 (m, 2H), 0.92 (t, J = 7.0 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 152.6, 144.9, 130.6, 128.8, 125.4, 102.4, 38.1, 35.4, 33.4, 22.4, 14.0 ppm; IR (KBr) 3030, 2956, 2931, 2858, 1635, 1611, 1510, 1465, 1365, 1176, 1087, 941 cm^{-1}. HRMS (EI) for $C_{13}H_{18}O_3S$: calcd. 254.0977, found 254.0984.

(5) 1-(4-pentylphenyl)vinyl methanesulfonate (**3e**): a pale yellow oil. TLC (SiO_2; Petroleum--Ethyl acetate = 10 : 1): R_f = 0.40.



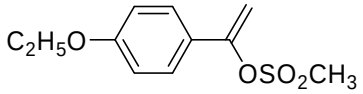
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.48 (d, J = 8.5 Hz, 2H), 7.20 (d, J = 8.0 Hz, 2H), 5.49 (d, J = 3.0 Hz, 1H), 5.33 (d, J = 3.0 Hz, 1H), 3.10 (s, 3H), 2.61 (t, J = 7.5 Hz, 2H), 1.61-1.56 (m, 2H), 1.33-1.31 (m, 4H), 0.89 (t, J = 7.0 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 152.6, 145.0, 130.6, 128.8, 125.4, 102.3, 38.1, 35.7, 31.5, 30.9, 22.5, 14.0 ppm; IR (KBr) 2930, 2857, 1636, 1558, 1457, 1366, 1176, 1081, 941, 669 cm^{-1}. HRMS (APCI) for $C_{14}H_{20}O_3S$: calcd. 268.1133, found 268.1133.

(6) 1-(4-methoxyphenyl)vinyl methanesulfonate (**3f**): a buffy oil (instability). TLC (SiO_2; Petroleum-Ethyl acetate = 5 : 1): R_f = 0.19.



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.51 (d, J = 9.0 Hz, 2H), 6.90 (d, J = 9.0 Hz, 2H), 5.40 (d, J = 3.0 Hz, 1H), 5.26 (d, J = 3.0 Hz, 1H), 3.82 (s, 3H), 3.10 (s, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 160.7, 152.3, 127.0, 125.7, 114.1, 101.4, 55.4, 38.1; IR (KBr) 2924, 2852, 1632, 1604, 1511, 1449, 1344, 1166, 1087, 944, 844 cm^{-1}. HRMS (EI) for $C_{10}H_{12}O_4S$: calcd. 228.0456, found 228.0458

(7) 1-(4-ethoxyphenyl)vinyl methanesulfonate (**3g**): a buffy oil. TLC (SiO_2; Petroleum-Ether acetate = 5 : 1): R_f = 0.29.

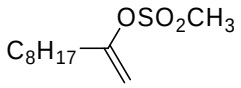


^{1}H NMR (500 MHz, $CDCl_3$) δ 7.49 (d, J = 7.5 Hz，2H), 6.88(d, J = 7.5 Hz, 2H), 5.39 (d, J = 3.0 Hz，1H), 5.25 (d, J = 3.0 Hz, 1H), 4.05 (q, J = 7.0 Hz，2H), 3.09 (s, 3H), 1.42 (t, J = 7.0 Hz, 3H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 160.1, 152.4, 127.0, 125.6, 114.6, 101.2, 63.6, 38.1, 14.7; IR (KBr) 2981, 2936, 1635, 1608, 1575, 1477, 1384, 1172, 1083, 938, 733 cm^{-1}. HRMS (EI) for $C_{11}H_{14}O_4S$: calcd. 242.0613, found 242.0617

(8) (Z)-3-fluorostyryl methanesulfonate (**4h**) : a pale yellow oil. TLC (SiO_2; Petroleum-Ethyl acetate = 5 : 1): R_f = 0.3.

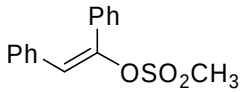
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.35-7.28 (m, 3H), 7.02-6.98 (m, 1H), 6.76 (d, J = 7.0 Hz, 1H), 5.86 (d, J = 7.0, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 162.72 (d, J = 243.8 Hz), 134.72, 134.33 (d, J = 8.4 Hz), 130.07 (d, J = 7.5 Hz), 124.98 (d, J = 3.8Hz), 115.81 (d, J = 22.5 Hz), 115.15 (d, J = 21.3 Hz), 114.61 (d, J = 2.5 Hz); IR (KBr) 1637, 1384, 1177, 949 cm^{-1}. HRMS (EI) for $C_9H_9O_3FS$: calcd. 216.0256, found 216.0258

(9) dec-1-en-2-yl methanesulfonate (**3i**): a colorless oil. TLC (SiO_2; Petroleum-Ethyl acetate = 20 : 1): R_f = 0.38.



^{1}H NMR (500 MHz, $CDCl_3$) δ 5.01 (d, J = 2.5 Hz, 1H), 4.79 (d, J = 2.5 Hz, 1H), 3.11 (s, 3H), 2.82 (t, J = 7.5 Hz, 2H), 1.55-1.49 (m, 2H), 1.31-1.26 (m, 10H), 0.88 (t, J = 7.0 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.2, 120.6, 101.7, 37.8, 34.3, 31.8, 29.2, 28.8, 26.3, 20.4, 14.1 ppm; IR(KBr) 2927, 2856, 1661, 1465, 1364, 1175, 1103, 949, 894 cm^{-1}. HRMS (EI) for $C_{11}H_{22}O_3S$: calcd. 234.1290, found 234.1291.

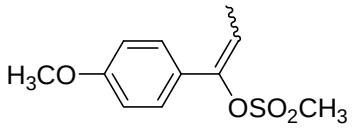
(10) (E)-1,2-diphenylvinyl methanesulfonate (**3j**): a pale yellow oil. TLC (SiO_2; Petroleum--Ethyl acetate = 20 : 1): R_f = 0.16.



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.46-7.44 (m, 2H), 7.44-7.32 (m, 3H), 7.19-7.17 (m, 3H), 7.11-7.09 (m, 2H), 6.80 (s, 1H), 2.89 (s, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 146.5, 133.3, 133.2, 129.8, 129.4, 129.1, 128.8, 128.4, 127.9, 123.0, 39.1 ppm; IR (KBr) 2929, 2853, 1649, 1495, 1362, 1168, 1079, 966, 802, 694 cm^{-1}. HRMS (EI) for $C_{15}H_{14}O_3S$: calcd.

274.0664, found 274.0665.

(11) (*Z*)-1-(4-methoxyphenyl)prop-1-enyl methanesulfonate (**3k1**) and (*E*)-1-(4-methoxyphenyl)prop-1-enyl methanesulfonate (**3k2**)): a buffy oil. TLC (SiO_2; Petroleum-Ethyl acetate = 5 : 1): R_f = 0.29.

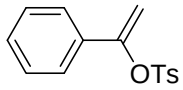


3k1, 3k2

^{1}HNMR (500 MHz, $CDCl_3$) δ 7.39 (d, J = 9.0 Hz，2H), 6.93 (d, J = 9.0 Hz，2H), 5.84 (q, J = 7.5 Hz, 1H), 3.83 (s, 3H), 2.84 (s, 3H), 1.81(d, J = 7.5 Hz，3H); ^{13}CNMR（125 MHz，$CDCl_3$）：δ 160.0, 146.1, 130.1, 125.0, 117.2, 113.9, 55.3, 38.6, 13.1.

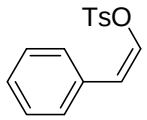
^{1}HNMR (500 MHz, $CDCl_3$) δ 7.41 (d, J = 9.0 Hz，2H), 6.88 (d, J = 9.0 Hz，2H), 5.75 (q, J = 7.5 Hz, 1H), 3.81(s, 3H), 2.95 (s, 3H), 1.80(d, J = 7.5 Hz，3H); ^{13}CNMR (125 MHz, $CDCl_3$) δ 160.0, 146.8, 127.1, 123.5, 114.0115.9, 55.3, 39.4, 12.4; IR (KBr) 2937, 2839, 1667, 1608, 1511, 1463, 1361, 1170, 1031, 955 cm^{-1}. HRMS (EI) for $C_{11}H_{14}O_4S$: calcd. 242.0613, found 242.0621.

(12) 1-phenylvinyl 4-methylbenzenesulfonate (**3l**)[1)] and (*E*)-styryl 4-methylbenzenesulfonate（4**l**）: a pale yellow oil. TLC (SiO_2; Petroleum-Ethyl acetate = 20 : 1): R_f = 0.22.



3l

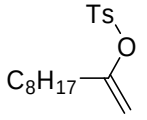
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, J = 8.5 Hz, 2H), 7.44-7.41 (m, 2H), 7.29-7.25 (m, 5H), 5.39 (d, J = 3.0 Hz, 1H), 5.08 (d, J = 3.0 Hz, 1H), 2.40 (s, 3H) ppm.



4l

^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, J = 8.5 Hz, 2H), 7.44-7.41 (m, 2H), 7.29-7.25 (m, 5H), 6.62 (d, J = 7.0 Hz, 1H), 5.73 (d, J = 7.0 Hz, 1H), 2.39 (s, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 152.8, 145.3, 134.1, 133.4, 133.0, 129.7, 129.3, 128.4, 125.4, 103.0, 21.7 ppm; IR (KBr) 2923, 1636, 1493, 1446, 1366, 1177, 1086, 947, 775 cm^{-1}. HRMS (EI) for $C_{15}H_{14}O_3S$: calcd. 274.0664, found 274.0660.

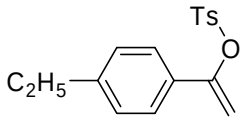
(13) dec-1-en-2-yl 4-methylbenzenesulfonate (**3m**): a pale yellow oil. TLC (SiO_2; Petroleum--Ethyl acetate = 20 : 1): R_f = 0.39.



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.81 (d, J = 8.0 Hz, 2H), 7.34 (d, J = 8.0 Hz, 2H), 4.73 (d, J =

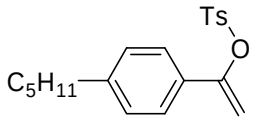
2.5 Hz, 1H), 4.63 (d, *J* = 2.5 Hz, 1H), 2.45 (s, 3H), 2.10 (t, *J* = 7.5 Hz, 2H), 1.42-1.36 (m, 2H), 1.30-1.21 (m, 10H), 0.87 (t, *J* = 7.0 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 156.3, 145.0, 133.4, 129.7, 128.3, 102.2, 34.1, 31.8, 29.2, 29.1, 28.7, 26.1, 22.6, 21.7, 14.1 ppm; IR (KBr) 2927, 2855, 1659, 1598, 1465, 1370, 1177, 1093, 949, 889, 814, 710 cm^{-1}. HRMS (EI) for $C_{17}H_{26}O_3S$: calcd. 310.1603, found 310.1616.

(14) 1-(4-ethylphenyl)vinyl 4-methylbenzenesulfonate (**3n**)：a pale yellow oil. TLC (SiO_2; Petroleum-Ethyl acetate = 20 : 1): R_f = 0.36.



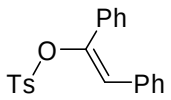
^{1}H NMR (500 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.0 Hz, 2H), 7.34 (d, *J* = 8.0 Hz, 2H), 7.27 (d, *J* = 8.0 Hz, 2H), 7.09 (d, *J* = 8.0 Hz, 2H), 5.33 (d, *J* = 2.5 Hz, 1H), 5.01 (d, *J* = 2.5 Hz, 1H), 2.61 (q, *J* = 7.5 Hz, 2H), 2.40 (s, 3H), 1.20 (t, *J* = 7.5 Hz, 3H) ppm; ^{13}C NMR（125 MHz，$CDCl_3$）δ 153.0, 145.7, 145.1, 133.2, 130.9, 129.6, 128.4, 127.9, 125.5, 102.1, 28.6, 21.6, 15.4 ppm; IR (KBr) 2924, 1667, 1633, 1601, 1574, 1453, 1378, 1154, 1076, 913, 750 cm^{-1}. HRMS (EI) for $C_{17}H_{18}O_3S$+1: calcd. 303.1055, found 303.1075.

(15) 1-(4-pentylphenyl)vinyl 4-methylbenzenesulfonate (3**o**): a pale yellow oil. TLC (SiO_2; Petroleum-Ethyl acetate = 20 : 1): R_f = 0.35.



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.80 (d, *J* = 8.0 Hz, 2H), 7.33 (d, *J* = 7.5 Hz, 2H), 7.27 (d, *J* = 7.5 Hz, 2H), 7.07 (d, *J* = 8.0 Hz, 2H), 5.33 (d, *J* = 3.0 Hz, 1H), 5.02 (d, *J* = 3.0 Hz, 1H), 2.56 (t, *J* = 7.5 Hz, 2H), 2.41 (s, 2H), 1.56-1.57 (m, 2H), 1.26-1.32 (m, 4H), 0.91 (t, *J* = 7.5 Hz, 3H)ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 153.0, 145.0, 144.4, 133.2, 130.8, 129.6, 128.4, 128.3, 125.4, 102.0, 35.6, 31.4, 30.9, 22.5, 21.6, 14.0 ppm; IR (KBr) 2930, 2858, 1733, 1634, 1607, 1558, 1456, 1373, 1177, 1079, 940, 779 cm^{-1}. HRMS (EI) for $C_{20}H_{24}O_3S$+1: calcd. 345.1524, found 345.1523.

(16) (E)-1,2-diphenylvinyl 4-methylbenzenesulfonate (**3p**)[2)]: a colorless crystal, mp. 99-100 ℃. TLC (SiO_2; Petroleum-Ethyl acetate = 20 : 1): R_f = 0.26.



^{1}H NMR (500 MHz, $CDCl_3$) δ 7.68 (d, *J* = 8.5 Hz, 2H), 7.26-7.19 (m, 5H), 7.16-7.13 (m, 5H), 7.01-7.00 (m, 2H), 6.57 (s, 1H), 2.40 (s, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$) δ 147.2, 144.9, 133.6, 133.4, 133.2, 129.5, 129.3, 129.2, 128.9, 128.4, 128.3, 128.2, 127.8, 122.5, 21.7 ppm; IR (KBr) 2924, 2853, 1658, 1596, 1445, 1367, 1169, 1093, 1002, 881, 782, 699 cm^{-1}.

References:

1) Cox R. A.; McAllister M.; Roberts K. A. *J. Org. Chem*. **1989**, *54*, 4899.
2) Frydman N.; Mazur Y. *J. Am. Chem. Soc*. **1970**, *92*, 3203.

X-ray data for product **3p**

Crystal data

$C_{21}H_{18}O_3S$

$M_r = 350.43$

Monoclinic, $P2_1/c$

Hall synbol: -P 2ybc

$a = 19.8000\ (7)$ Å

$b = 5.8289\ (2)$ Å

$c = 15.5228\ (7)$ Å

$\beta = 97.2226\ (12)°$

$V = 1777.31\ (12)$ Å^3

$Z = 4$

$F_{000} = 736.00$

$D_x = 1.310$ Mg m^{-3}

Mo $K\alpha$ rediation

$\lambda = 0.71075$ Å

Cell parameters from 11320 reflenctions

$\theta = 3.1\text{-}27.4°$

$\mu = 0.20$ mm^{-1}

$T = 296\ (1)$ K

Plat, colourless

0.50 x 0.50 x 0.20 mmm

Data collection

Riguku R-AXIS RAPID diffractometer

Detector resolution: 10.00 pixels mm^{-1}

ω scans

Absorption correction: multi-scan (ABSCOR; Higashi, 1995)

$T_{min} = 0.879$, $T_{max} = 0.961$

16497 measured reflections

4064 independent reflections

2454 reflections with $I > 2\sigma\ (I)$

$R_{int} = 0.037$

$\theta_{max} = 27.5°$

$h = -25 \rightarrow 25$

$k = -6 \rightarrow 7$

$l = -20 \rightarrow 20$

Refinement

Refinement on F^2

$R[F^2 > 2\sigma(F^2)] = 0.035$

$wR(F^2) = 0.115$

$S = 1.01$

4064 reflections

245 parameters

H-atom parameters constrained

$W = 1/[0.0007F_o+\sigma(F_o^2)]/(4F_o^2)$

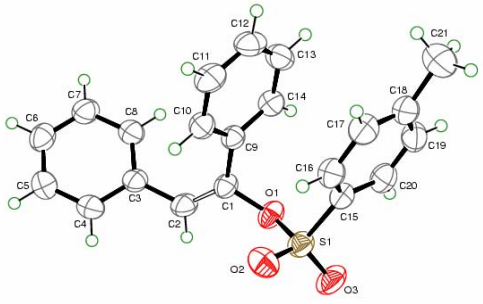
$(\triangle/\sigma)_{max} < 0.001$

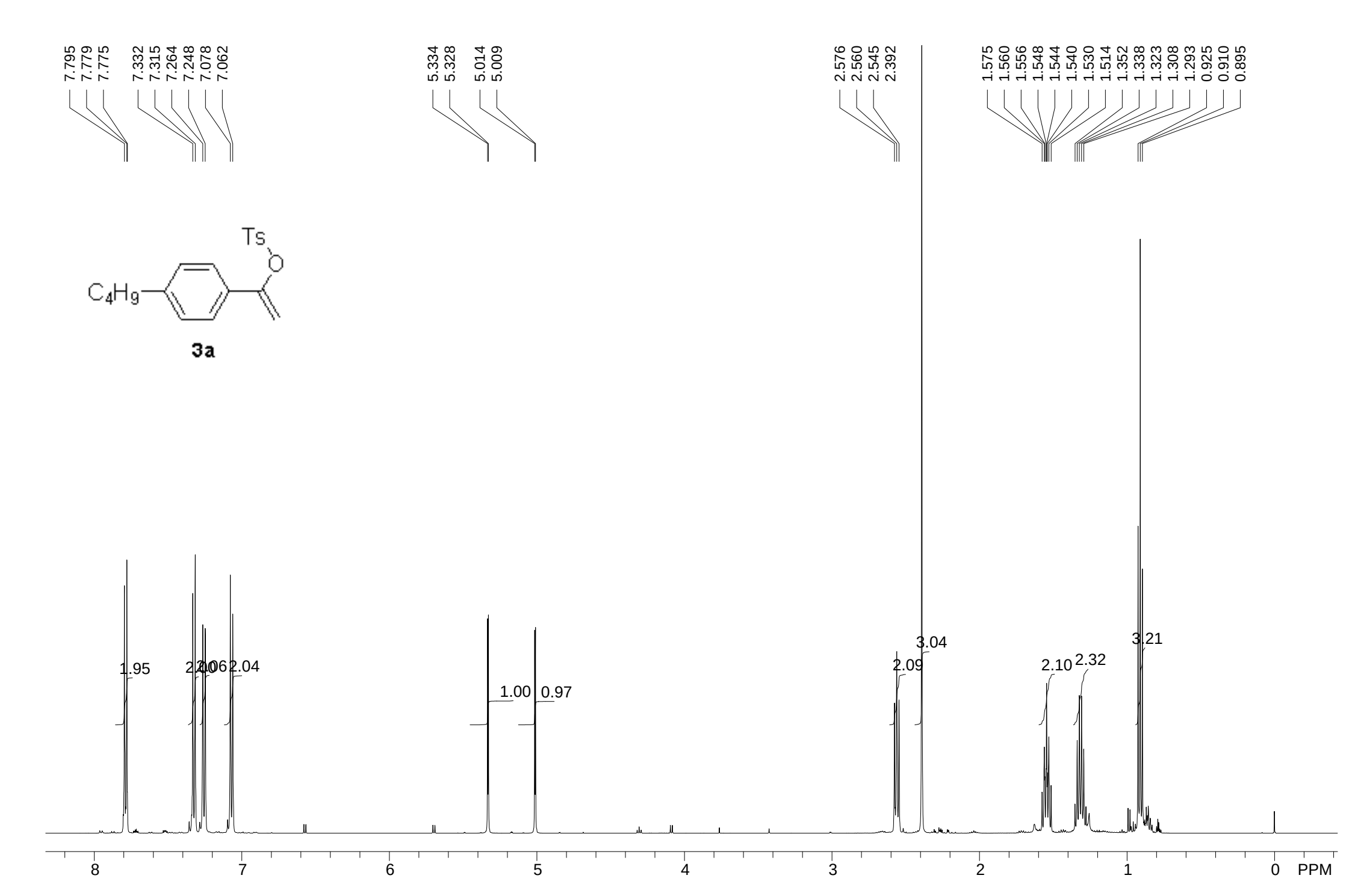
$\triangle\rho_{max} = 0.32$ e Å^{-3}

$\triangle\rho_{mix} = -0.37$ e Å^{-3}

Extinction correction: Larson (1970)

Extinction correction: 704 (41)

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7.062
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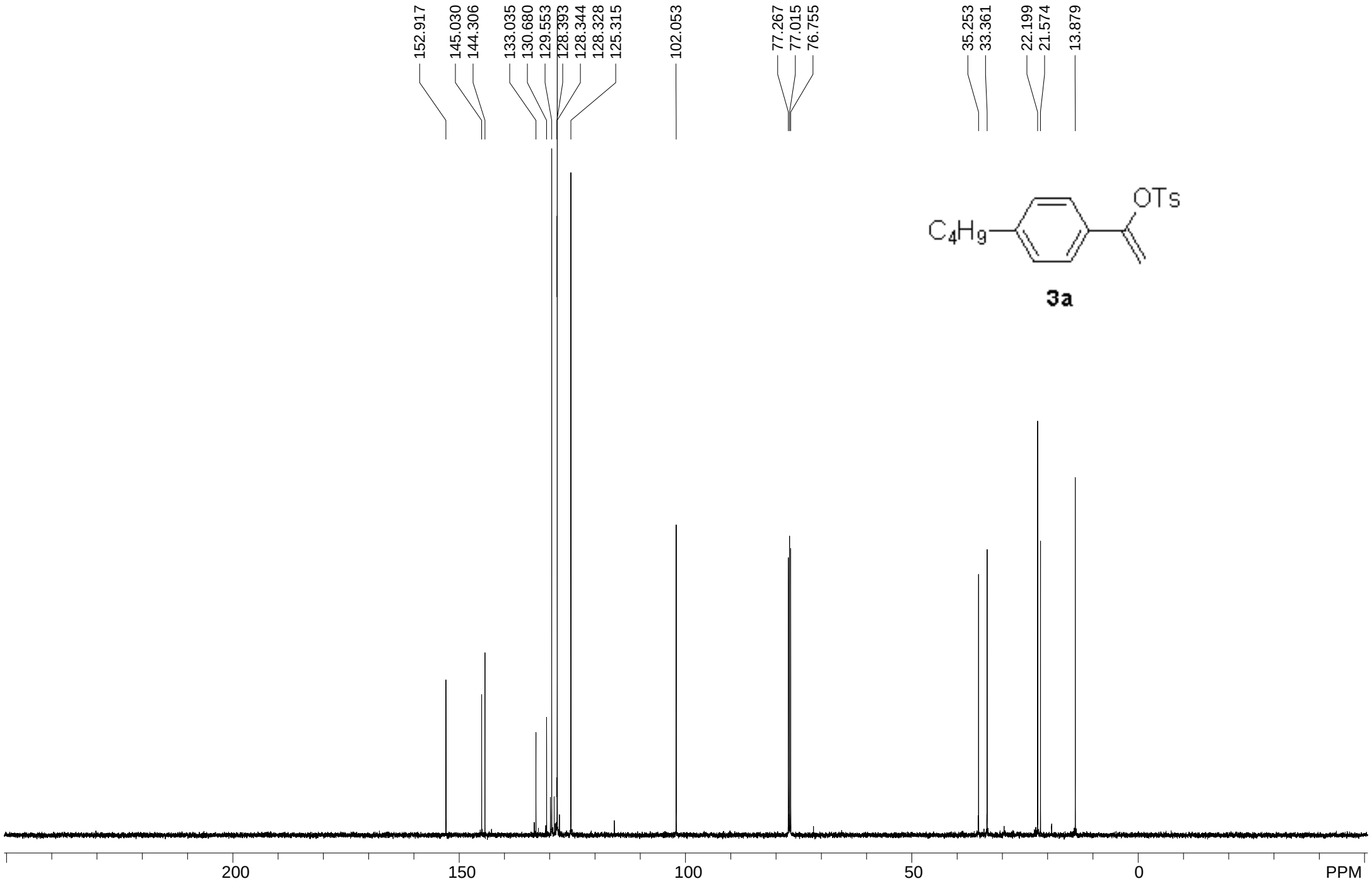
5.328
5.014
5.009
2.576
2.560
2.545
2.392
1.575
1.560
1.556
1.548
1.544
1.540
1.530
1.514
1.352
1.338
1.323
1.308
1.293
0.925
0.910
0.895
Ts
O
C4H9
3a
1.95
2.00
2.06
2.04
1.00
0.97
3.04
2.09
2.10
2.32
3.21
8
7
6
5
4
3
2
1
0
PPM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144.306
133.035
130.680
129.553
128.393
128.344
128.328
125.315
102.053
77.267
77.015
76.755
35.253
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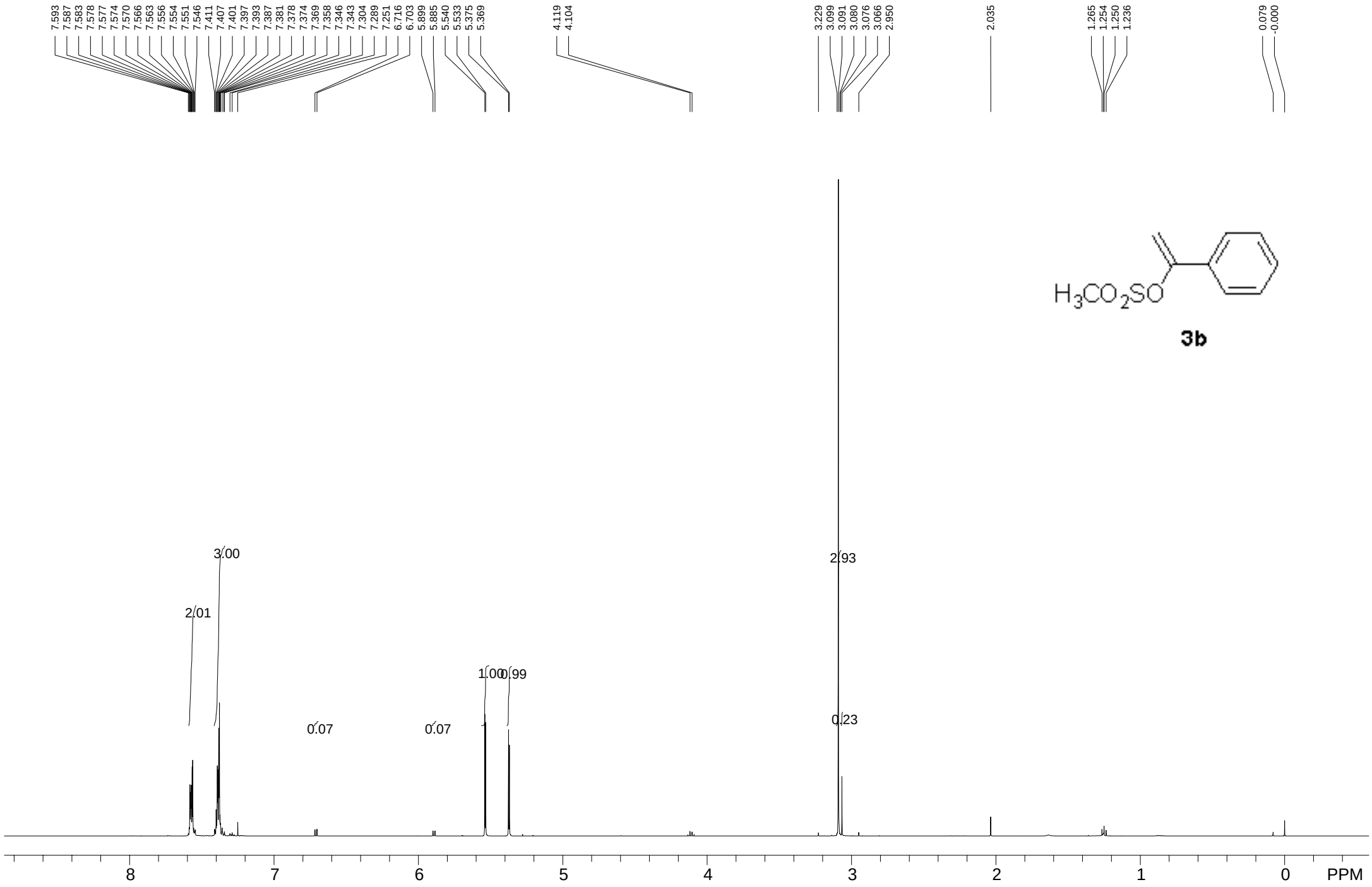
22.199
21.574
13.879
OTs
C4H9
3a
200
150
100
50
0
PPM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7.556
7.554
7.551
7.546
7.411
7.407
7.401
7.397
7.393
7.387
7.381
7.378
7.374
7.369
7.358
7.346
7.343
7.304
7.289
7.251
6.716
6.703
5.899
5.885
5.540
5.533
5.375
5.369
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4.104
3.229
3.099
3.091
3.080
3.076
3.066
2.950
2.035
1.265
1.254
1.250
1.236
0.079
-0.000
H3CO2SO
3b
3.00
2.01
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4
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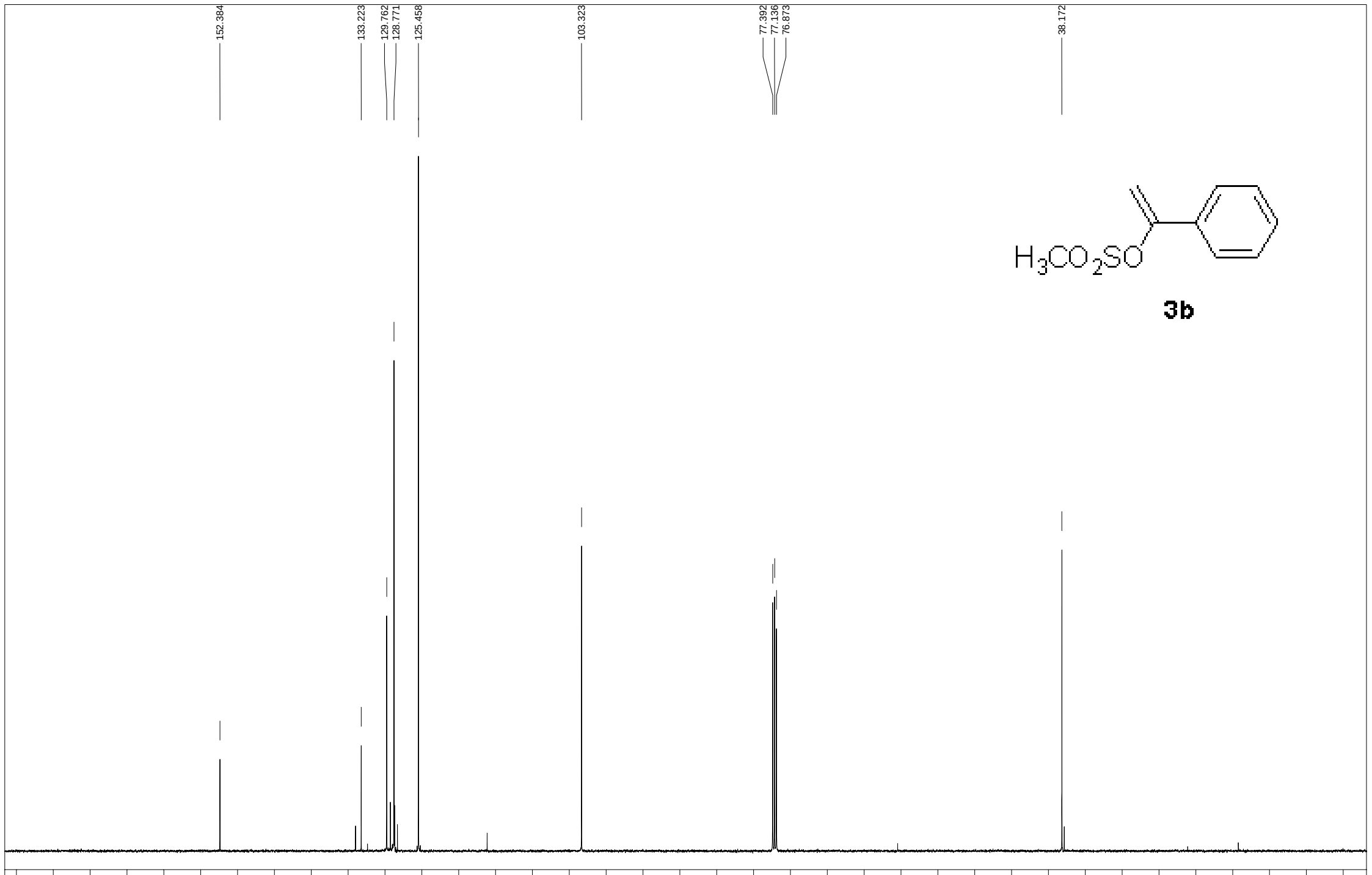
PPM



spect, CDCl3,

USER: nmr -- DATE: Fri Feb 01 09:47:57 2008

F1: 125.770	SW1: 37879		OF1: 12578.5		PTS1d: 32768
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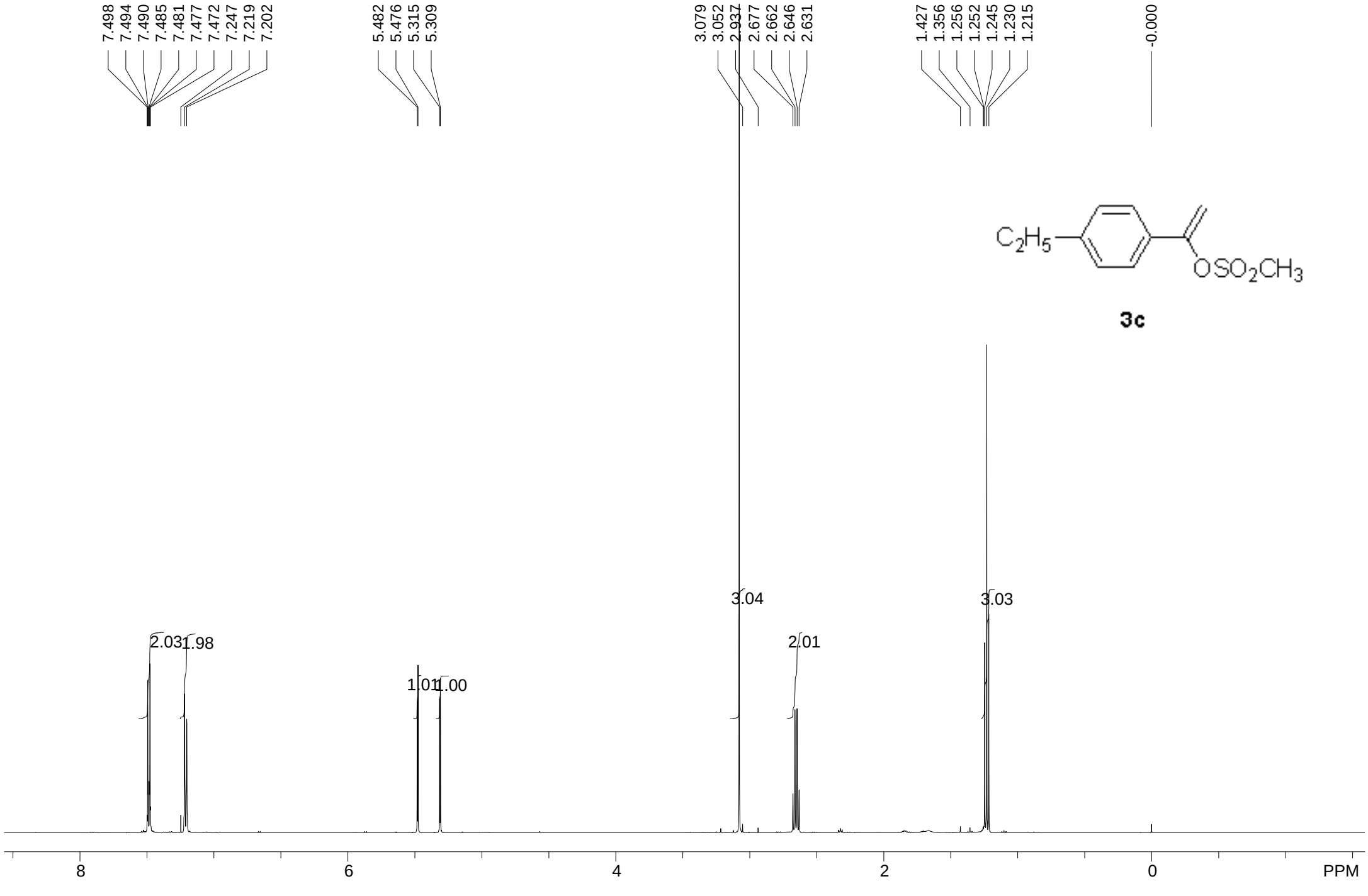
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7.490
7.485
7.481
7.477
7.472
7.247
7.219
7.202
5.482
5.476
5.315
5.309
3.079
3.052
2.937
2.677
2.662
2.646
2.631
1.427
1.356
1.256
1.252
1.245
1.230
1.215
-0.000
C2H5
OSO2CH3
3c
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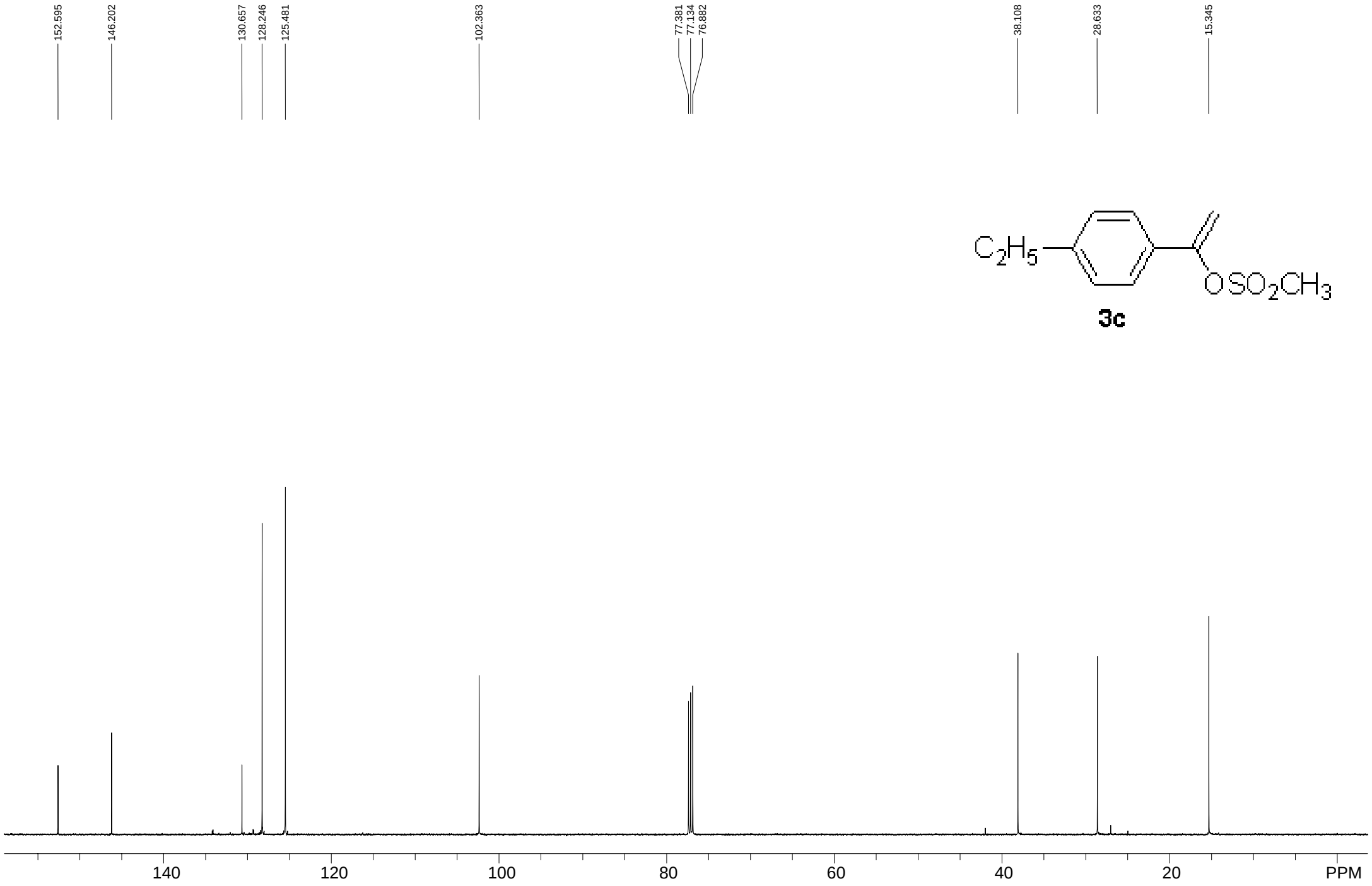
1.98
1.01
1.00
3.04
2.01
3.03
8
6
4
2
0
PPM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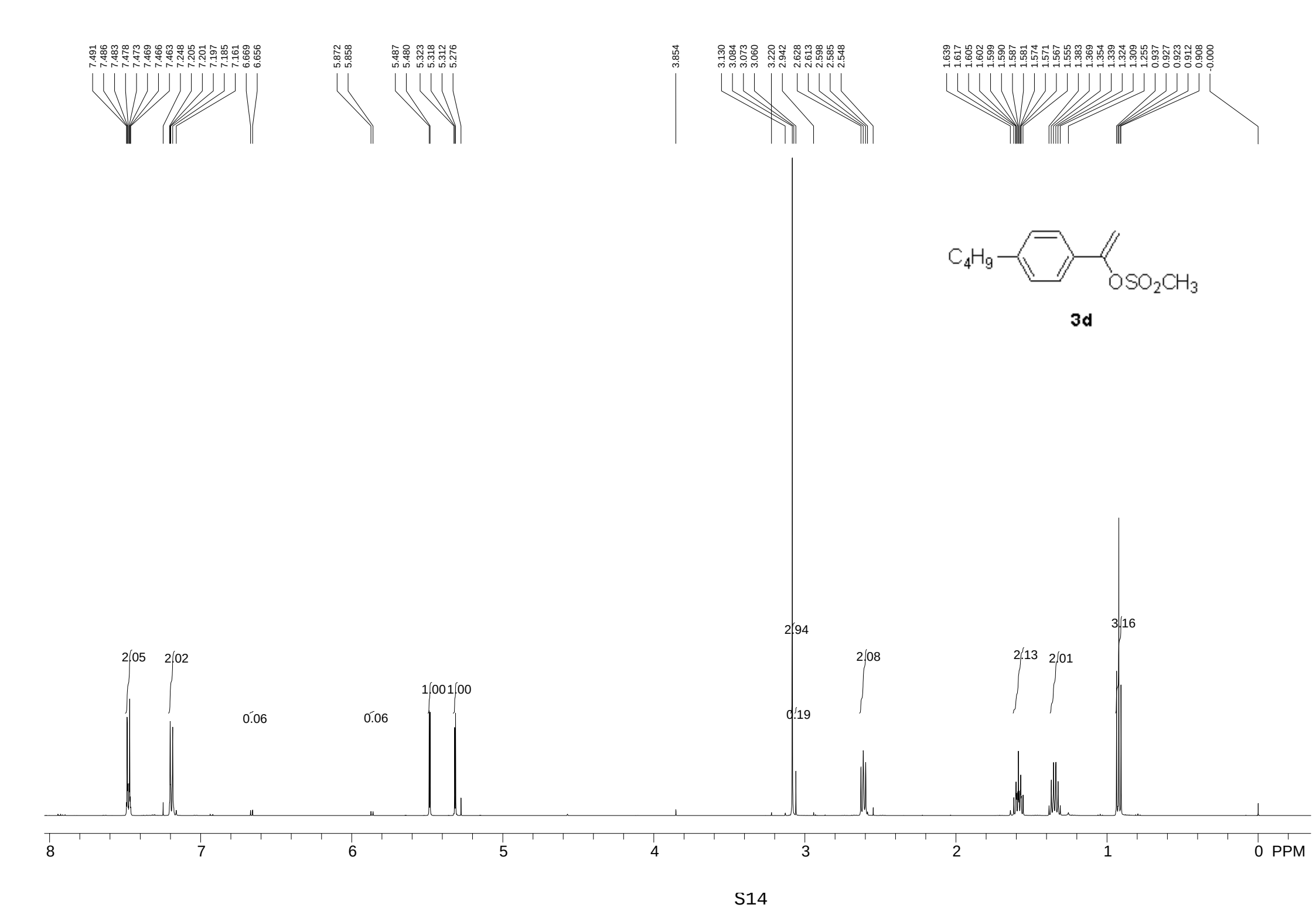
130.657
128.246
125.481
102.363
77.381
77.134
76.882
38.108
28.633
15.345
C2H5
OSO2CH3
3c
140
120
100
80
60
40
20
PPM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7.473
7.469
7.466
7.463
7.248
7.205
7.201
7.197
7.185
7.161
6.669
6.656
5.872
5.858
5.487
5.480
5.323
5.318
5.312
5.276
3.854
3.130
3.084
3.073
3.060
3.220
2.942
2.628
2.613
2.598
2.585
2.548
1.639
1.617
1.605
1.602
1.599
1.590
1.587
1.581
1.574
1.571
1.567
1.555
1.383
1.369
1.354
1.339
1.324
1.309
1.255
0.937
0.927
0.923
0.912
0.908
-0.000
C4H9
OSO2CH3
3d
2.05
2.02
0.06
0.06
1.00
1.00
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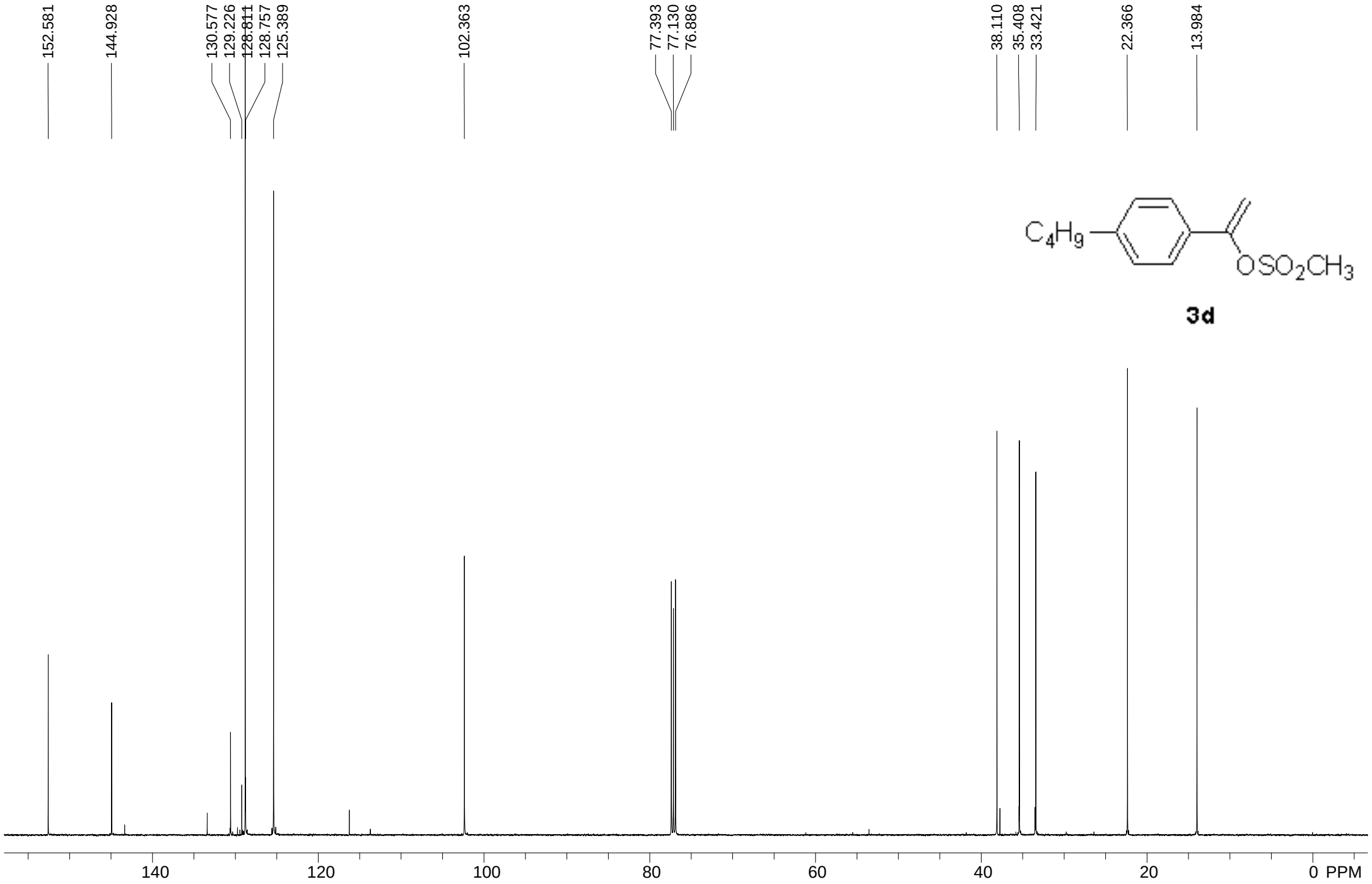
2.08
2.13
2.01
3.16
8
7
6
5
4
3
2
1
0 PPM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128.757
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102.363
77.393
77.130
76.886
38.110
35.408
33.421
22.366
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C_4H_9
OSO_2CH_3
3d
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120
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80
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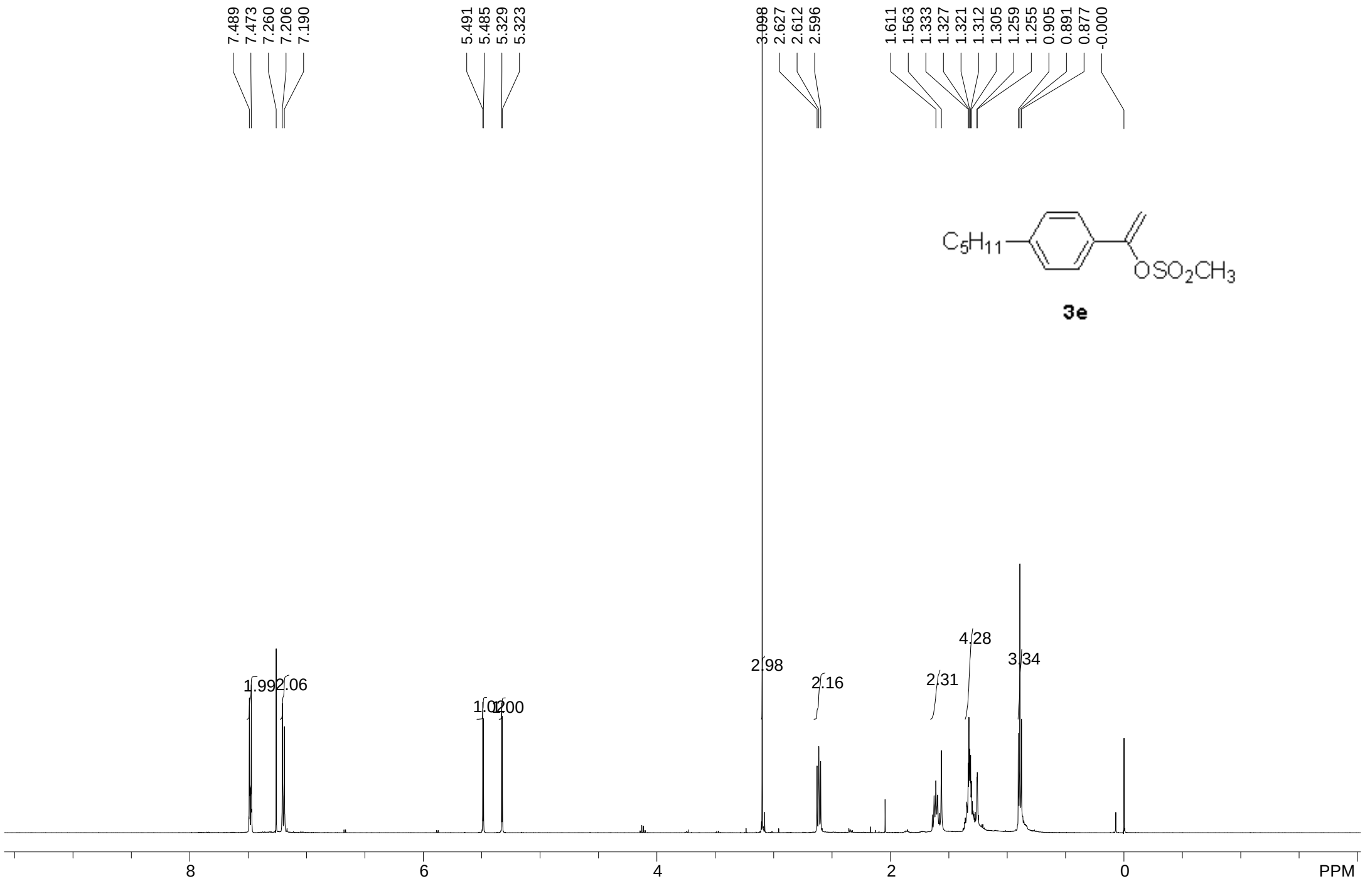
40
20
0 PPM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7.190
5.491
5.485
5.329
5.323
3.098
2.627
2.612
2.596
1.611
1.563
1.333
1.327
1.321
1.312
1.305
1.259
1.255
0.905
0.891
0.877
-0.000
C5H11
OSO2CH3
3e
1.99
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1.00
2.98
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2.31
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3.34
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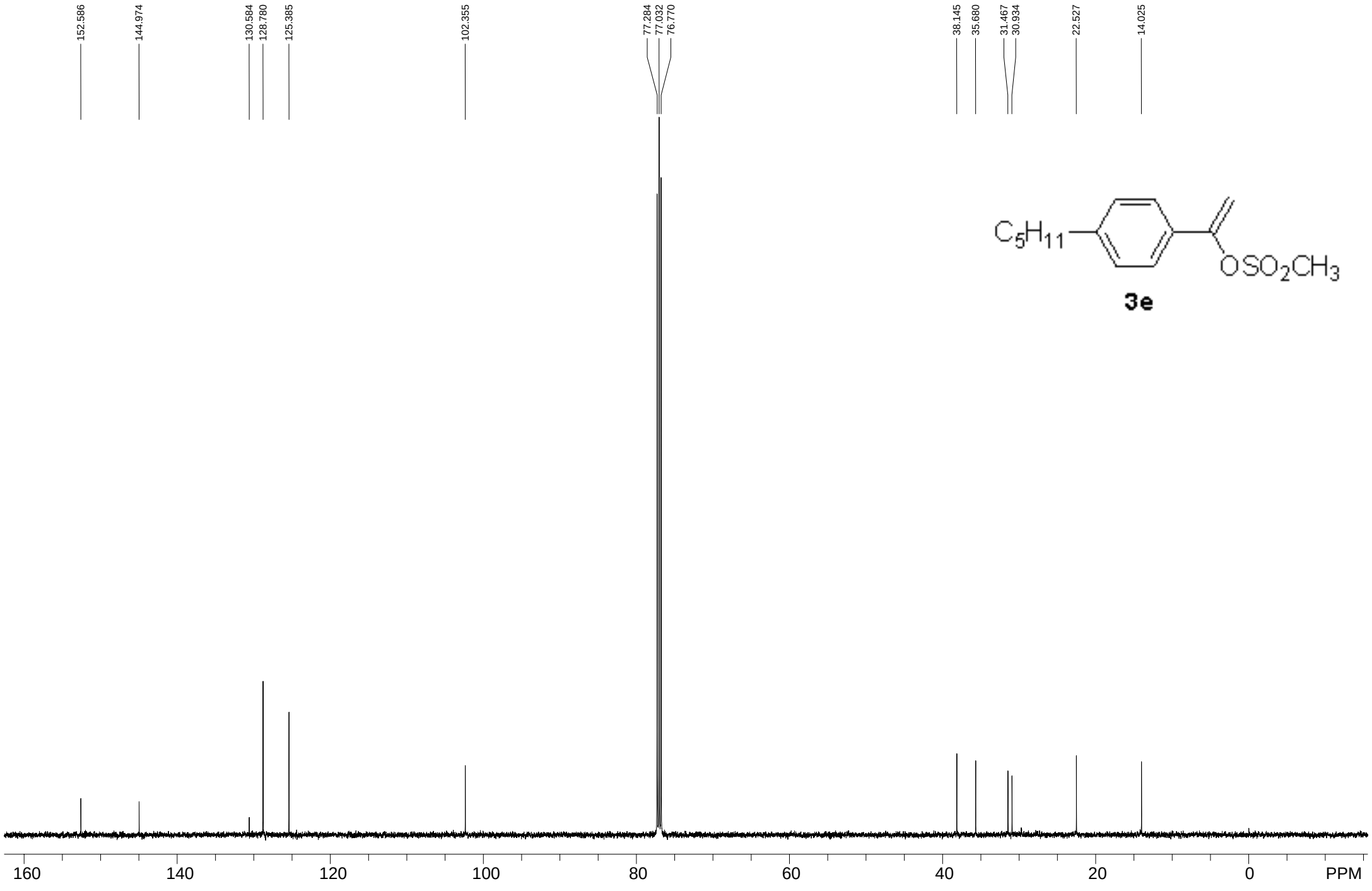
6
4
2
0
PPM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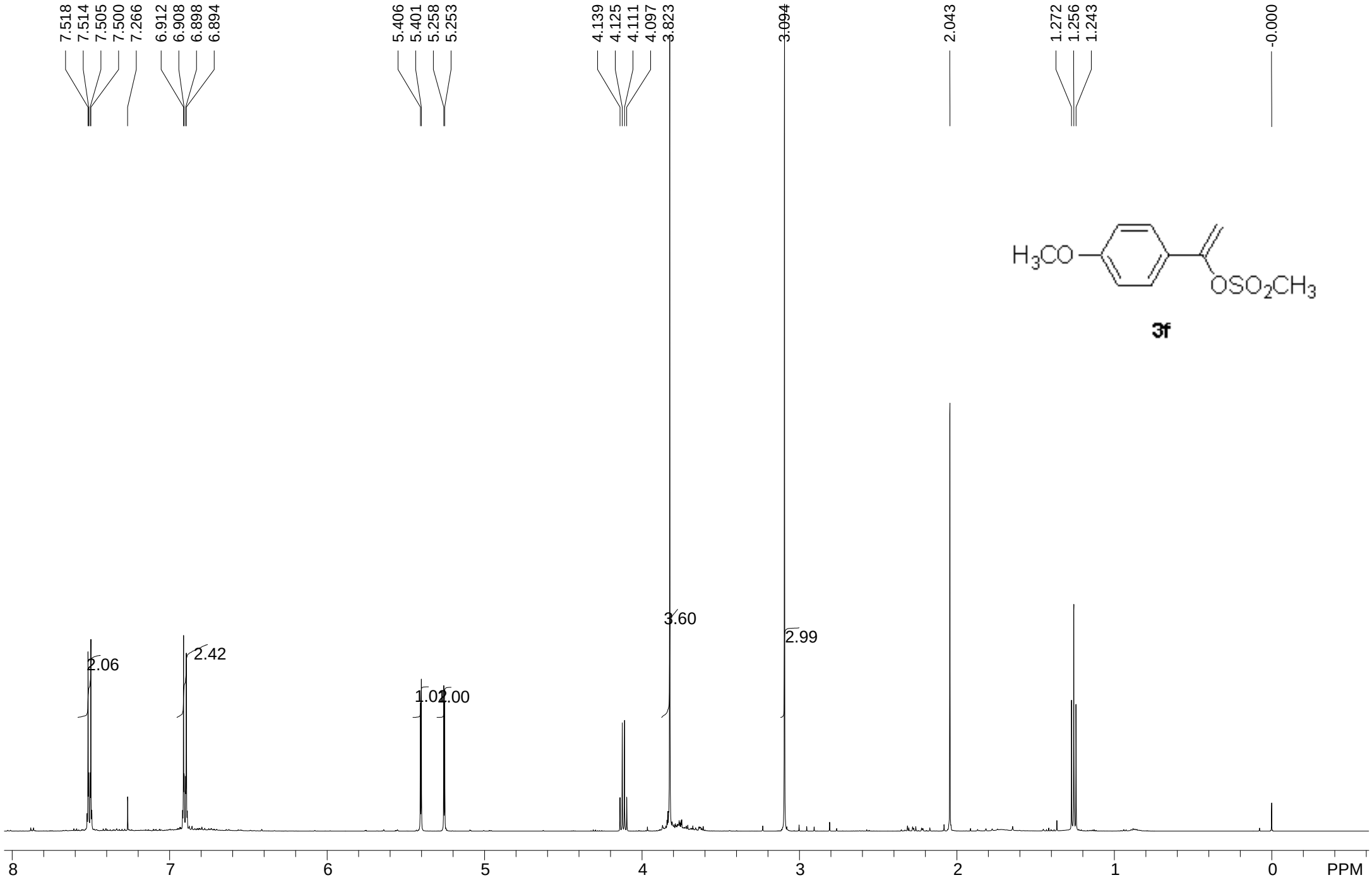
31.467
30.934
22.527
14.025
C5H11
OSO2CH3
3e
160
140
120
100
80
60
40
20
0
PPM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7.505
7.500
7.266
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6.898
6.894
5.406
5.401
5.258
5.253
4.139
4.125
4.111
4.097
3.823
3.094
2.043
1.272
1.256
1.243
-0.000
H3CO
OSO2CH3
3f
2.06
2.42
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2.00
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2.99
8
7
6
5
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3
2
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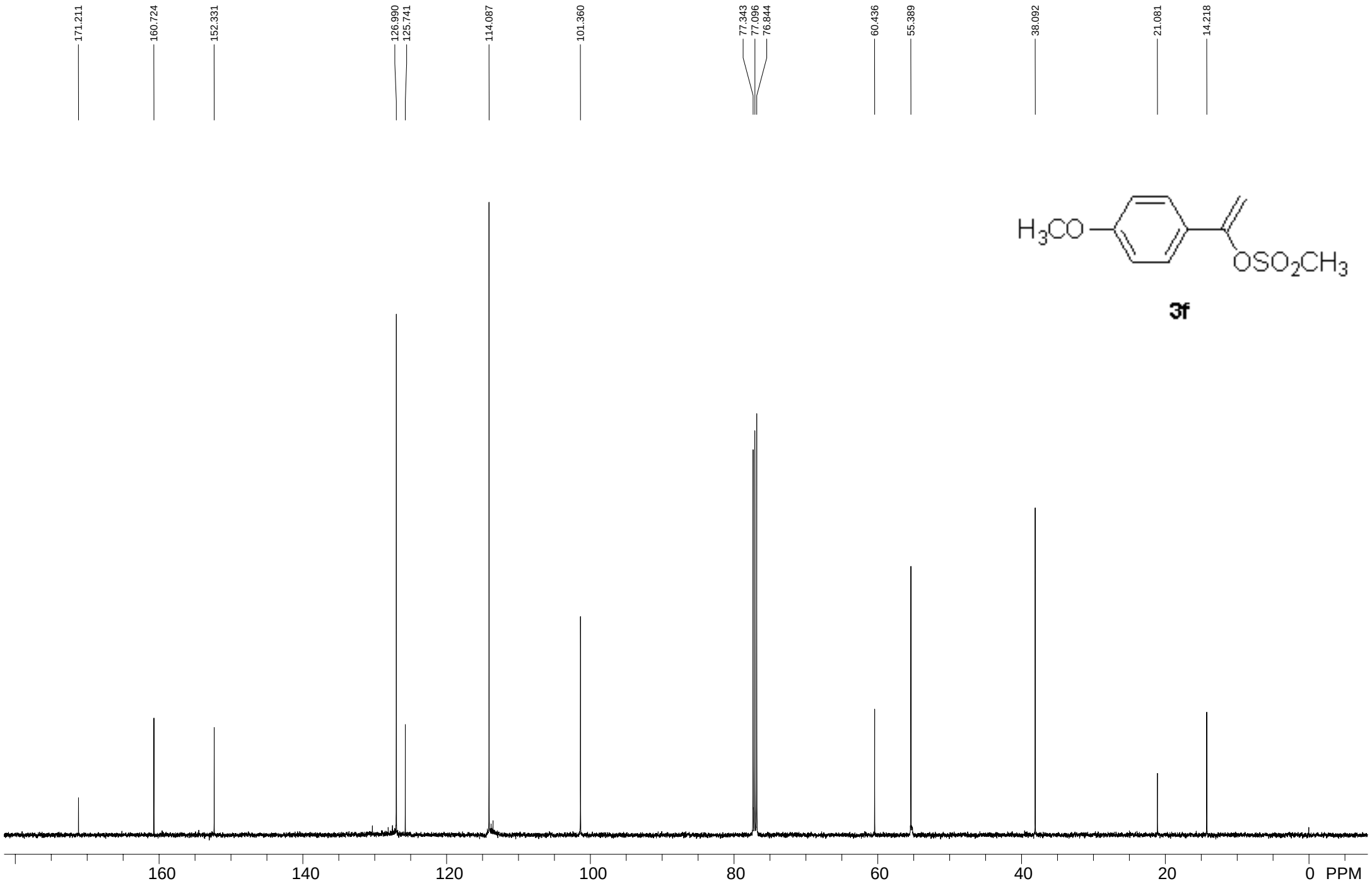
PPM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114.087
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77.343
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76.844
60.436
55.389
38.092
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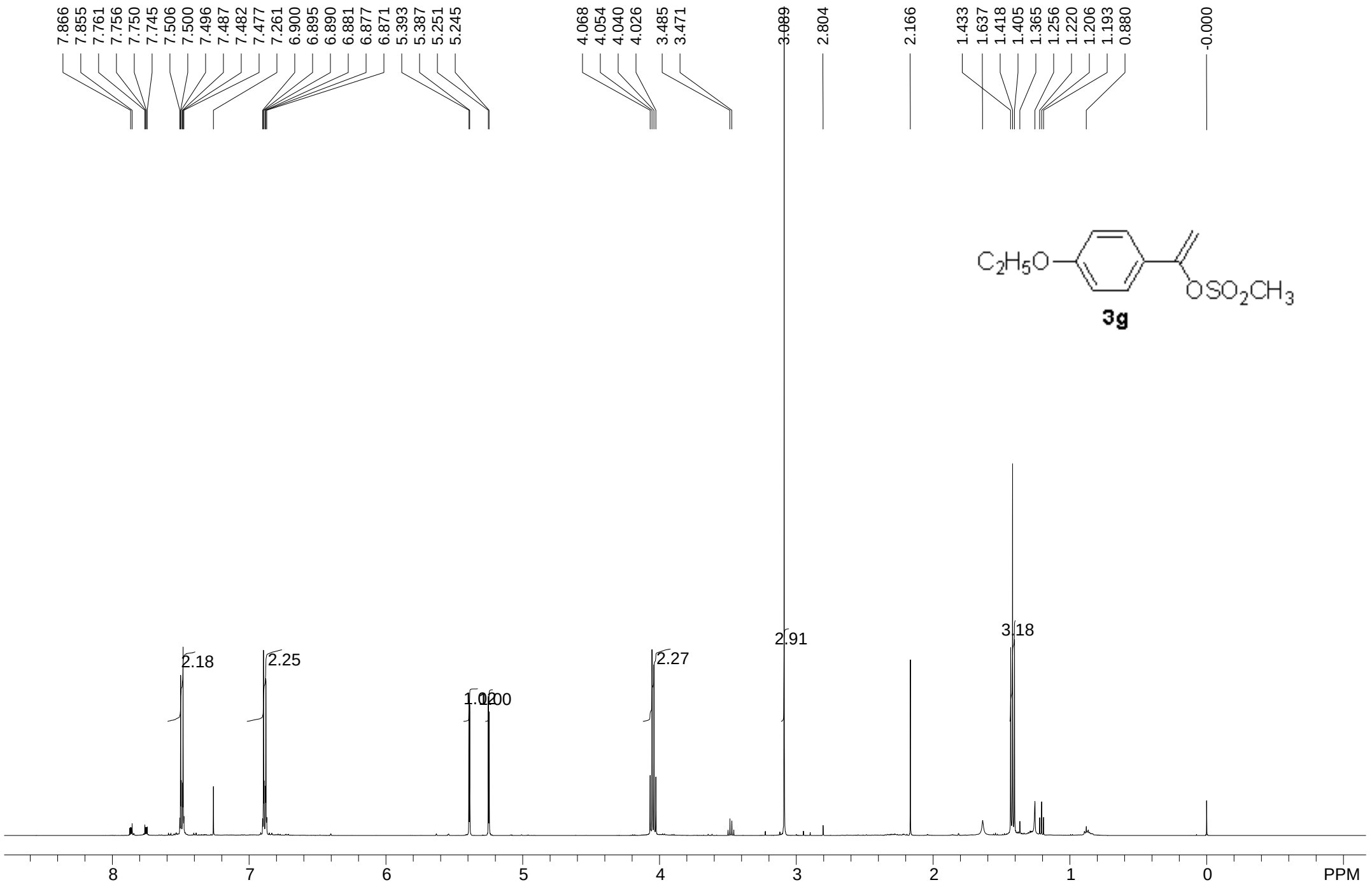
14.218
H3CO
OSO2CH3
3f
160
140
120
100
80
60
40
20
0 PPM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7.761
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7.496
7.487
7.482
7.477
7.261
6.900
6.895
6.890
6.881
6.877
6.871
5.393
5.387
5.251
5.245
4.068
4.054
4.040
4.026
3.485
3.471
3.089
2.804
2.166
1.433
1.637
1.418
1.405
1.365
1.256
1.220
1.206
1.193
0.880
-0.000
C2H5O
OSO2CH3
3g
2.18
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1.00
1.00
2.27
2.91
3.18
8
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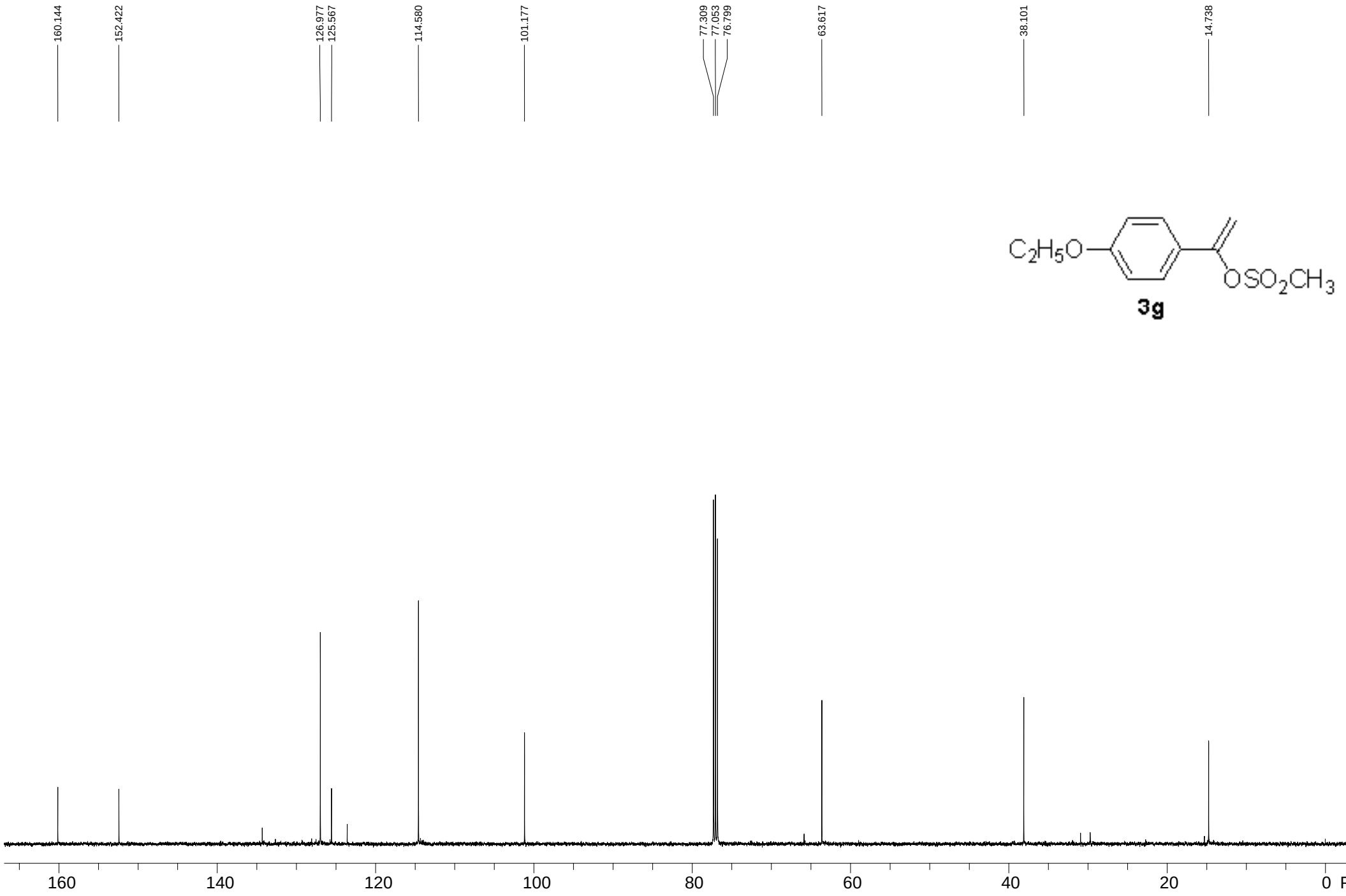
PPM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77.053
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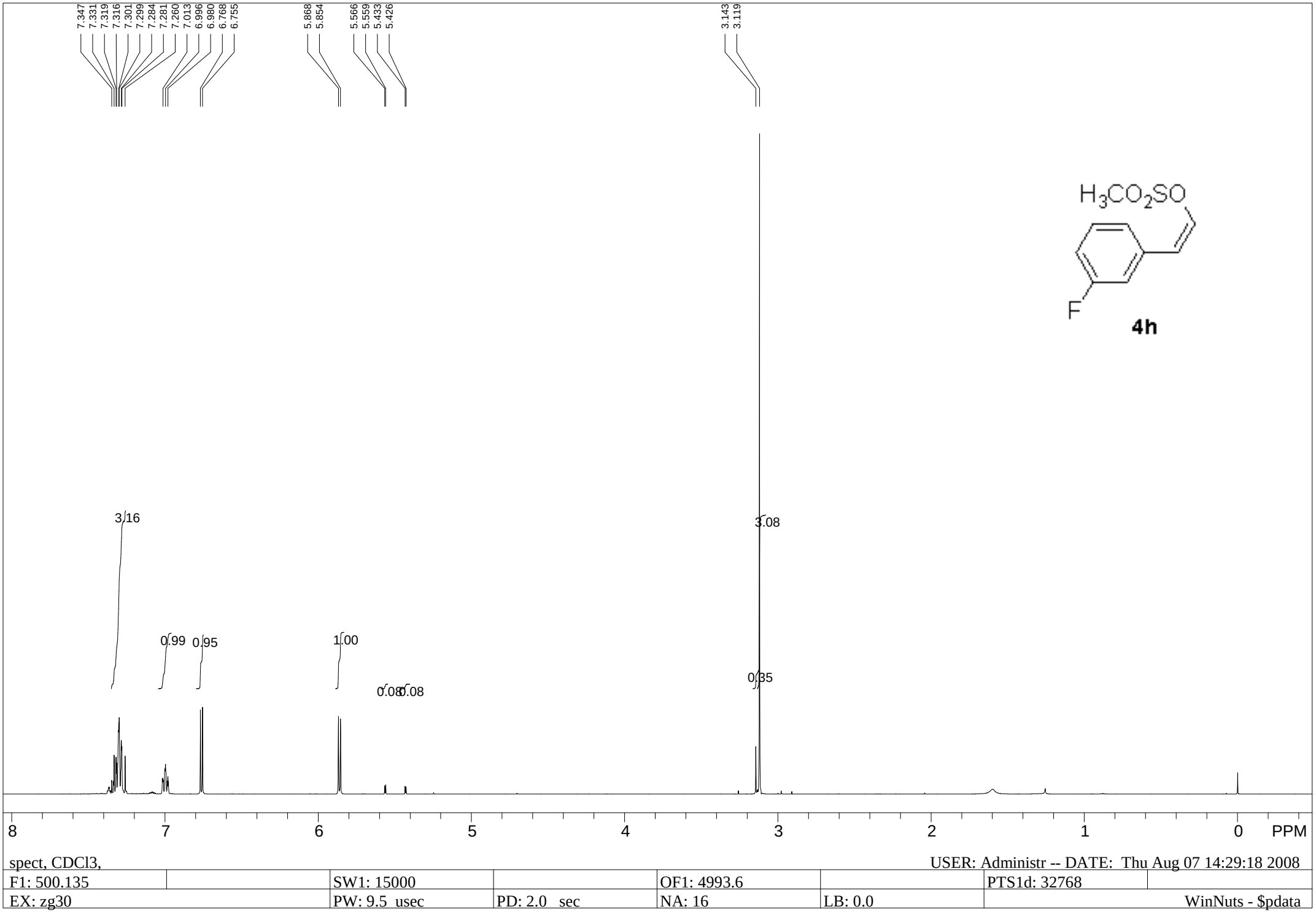
C2H5O
OSO2CH3
3g
160
140
120
100
80
60
40
20
0 PPM



spect, CDCl3, USER: Administr -- DATE: Thu Aug 07 14:29:18 2008

F1: 500.135	SW1: 15000		OF1: 4993.6		PTS1d: 32768
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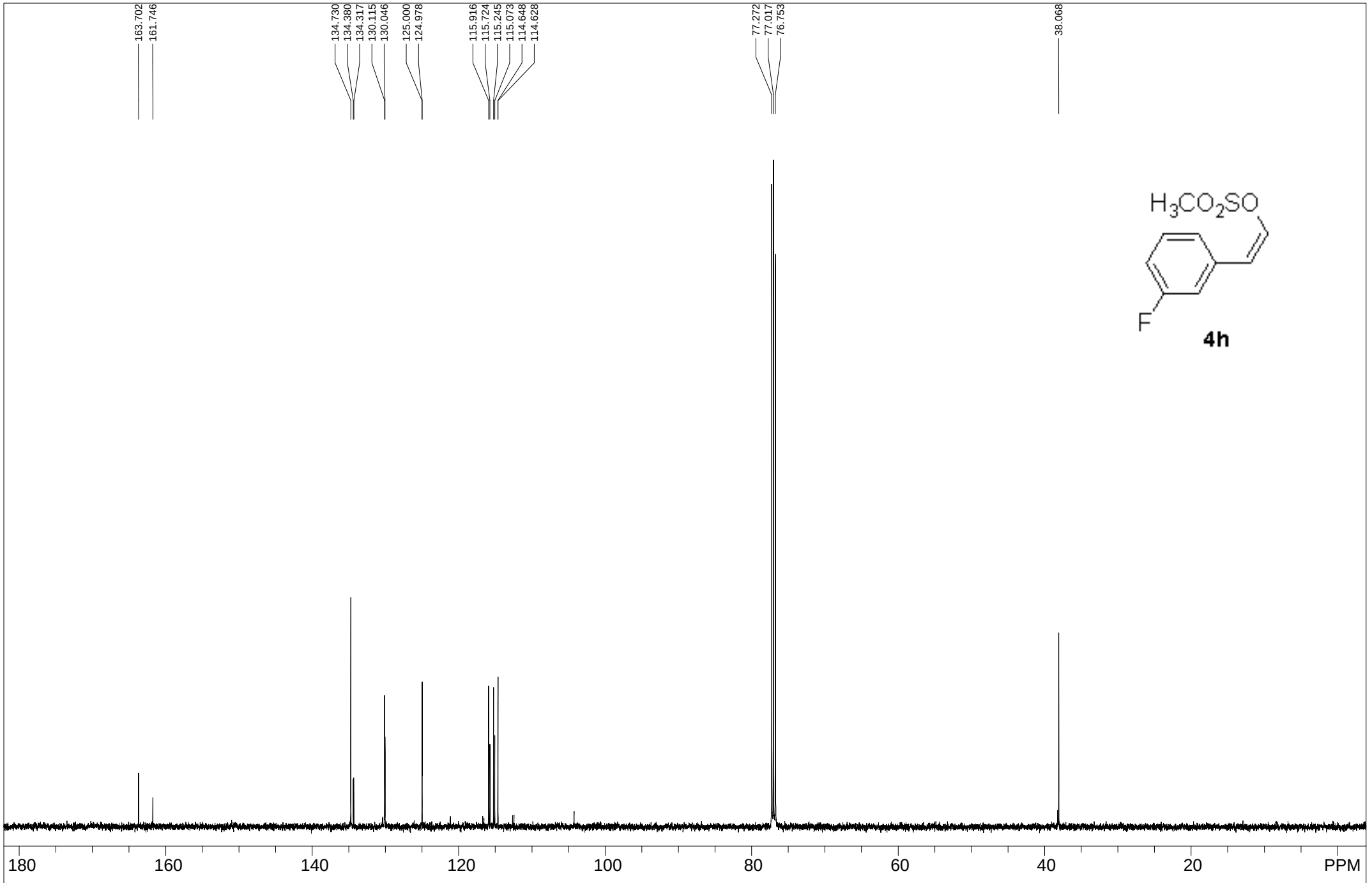

spect, CDCl3, USER: Administr -- DATE: Thu Aug 07 14:42:05 2008

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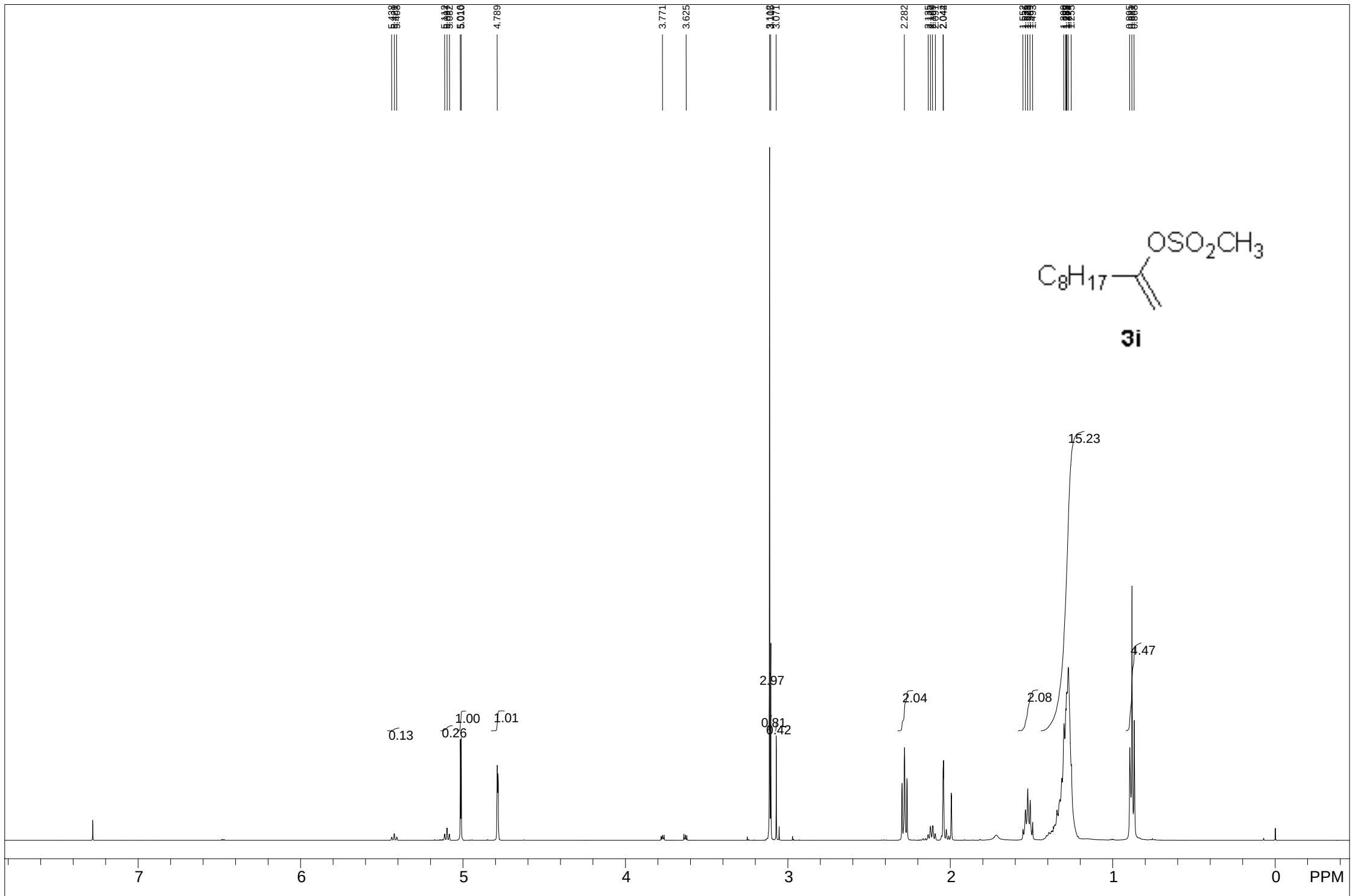

spect, CDCl3, USER: nmr -- DATE: Fri Mar 14 09:22:50 2008

F1: 500.135	SW1: 15000		OF1: 5003.0		PTS1d: 32768
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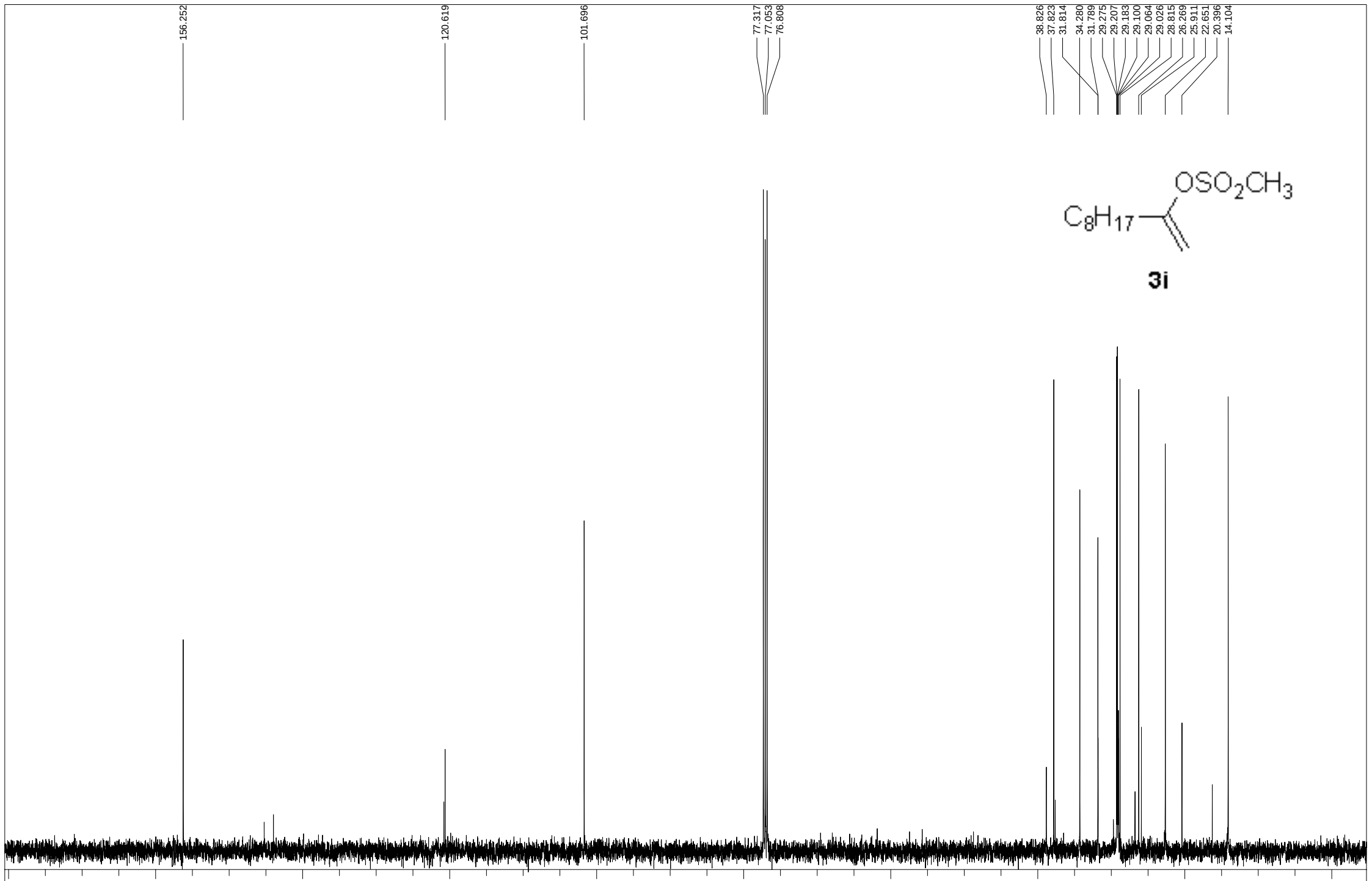

spect, CDCl3,

USER: nmr -- DATE: Thu Apr 10 16:28:15 2008

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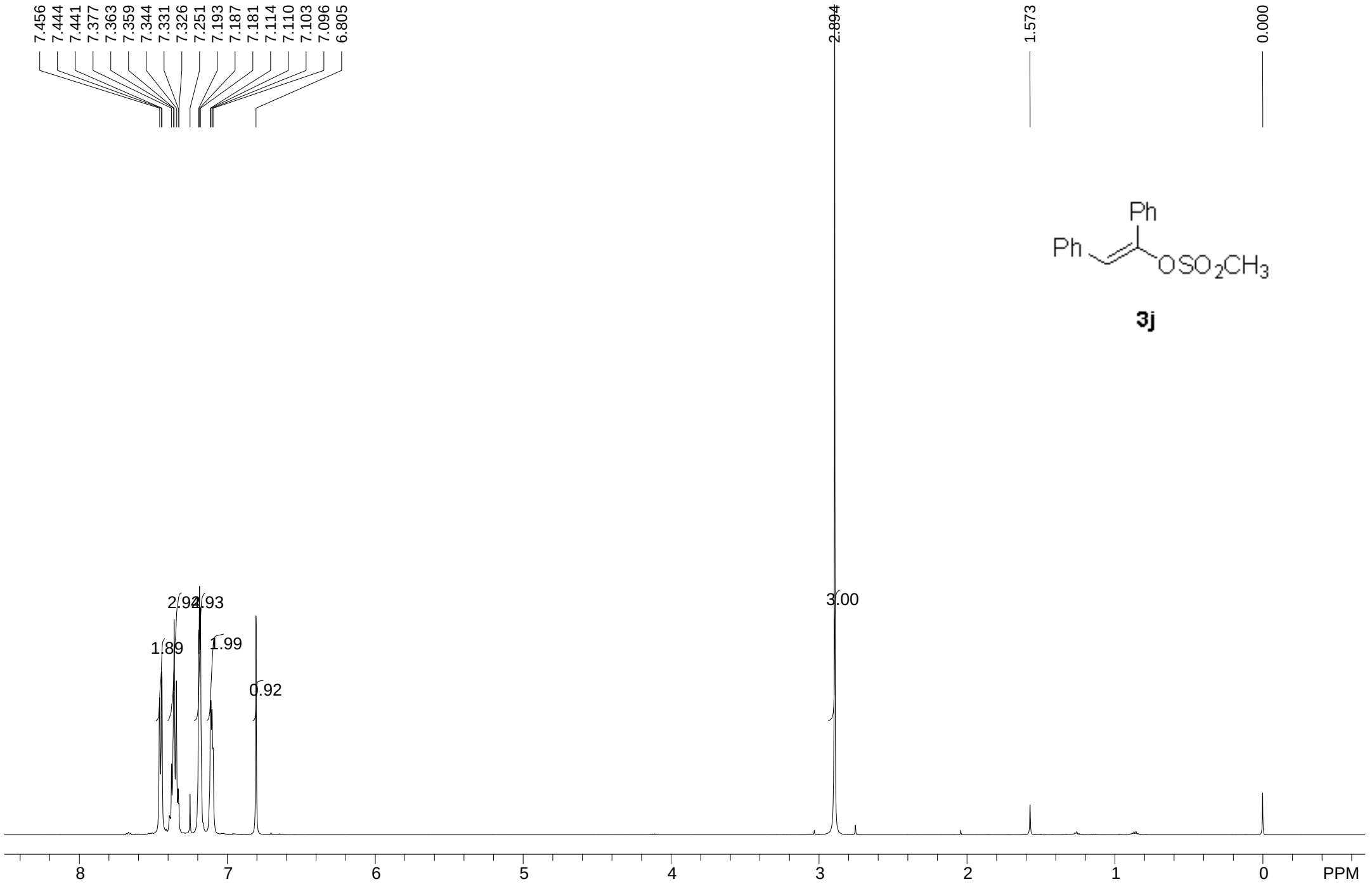
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7.181
7.114
7.110
7.103
7.096
6.805
2.894
1.573
0.000
Ph
Ph
OSO2CH3
3j
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2.93
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0.92
3.00
8
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6
5
4
3
2
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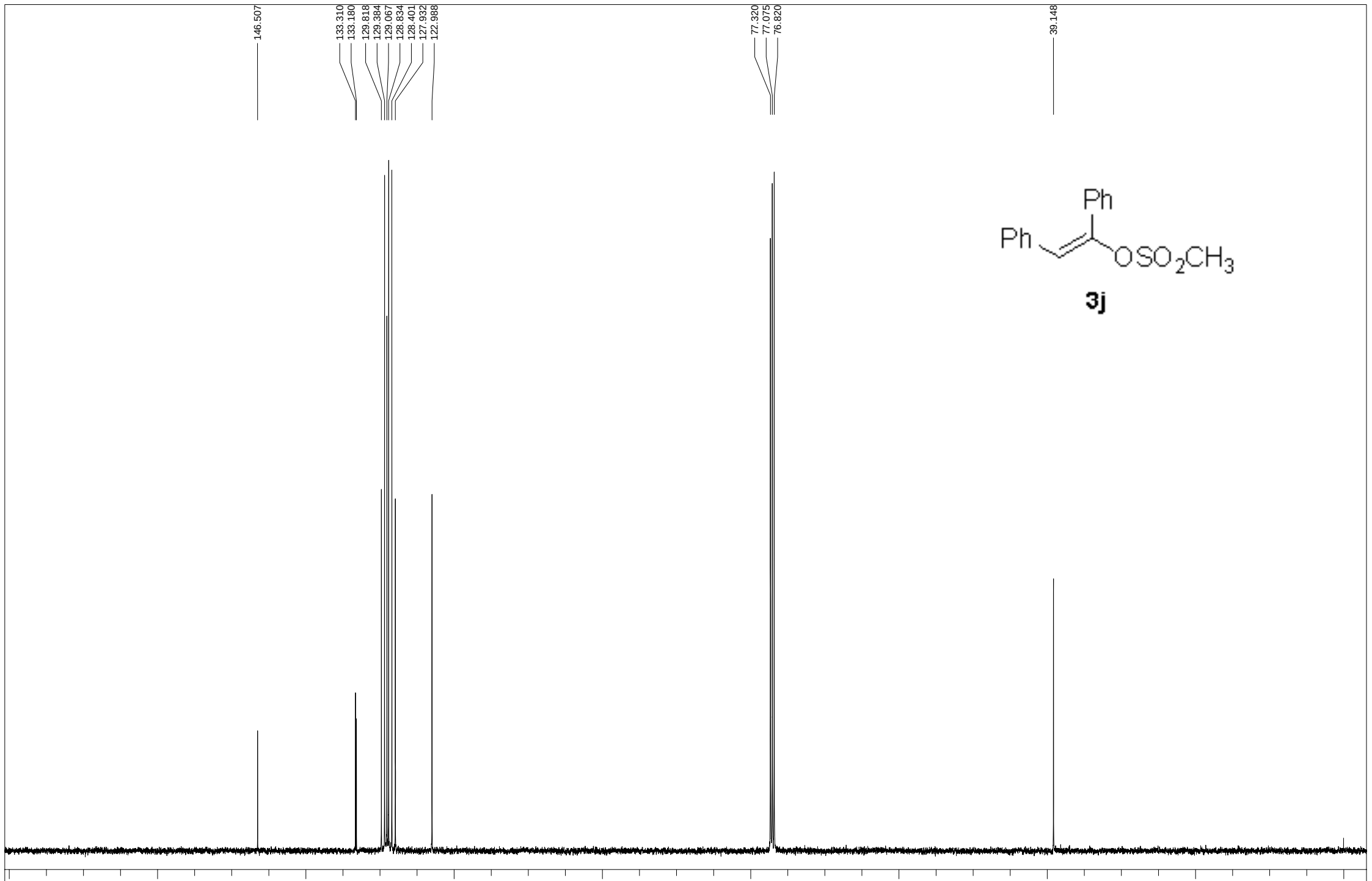

spect, CDCl3, USER: nmr -- DATE: Thu Apr 17 16:26:41 2008

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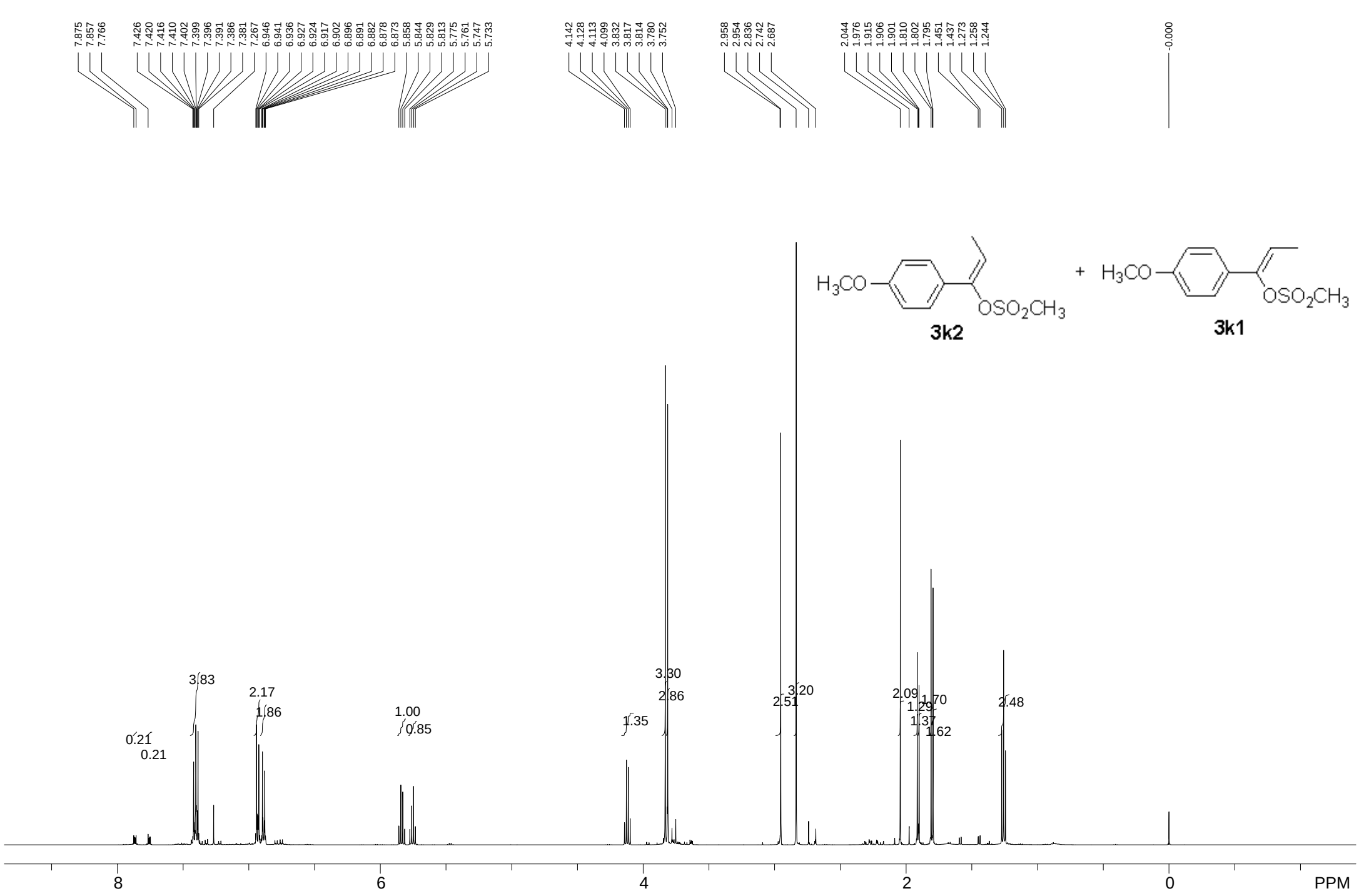
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6.946
6.941
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6.927
6.924
6.917
6.902
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6.891
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5.829
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1.901
1.810
1.802
1.795
1.451
1.437
1.273
1.258
1.244
-0.000
H3CO
OSO2CH3
3k2
+
H3CO
OSO2CH3
3k1
0.21
0.21
3.83
2.17
1.86
1.00
0.85
1.35
3.30
2.86
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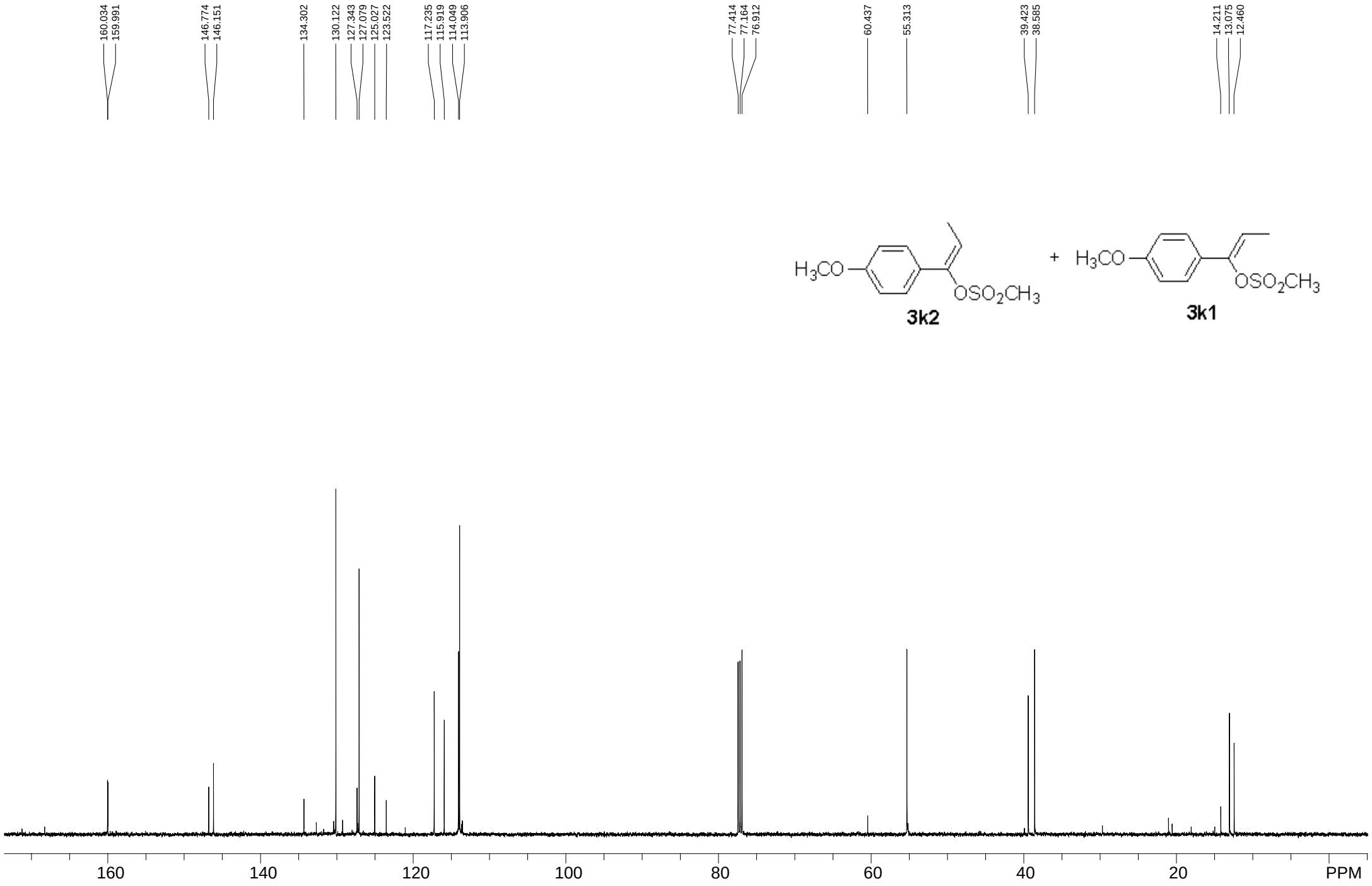
PPM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159.991
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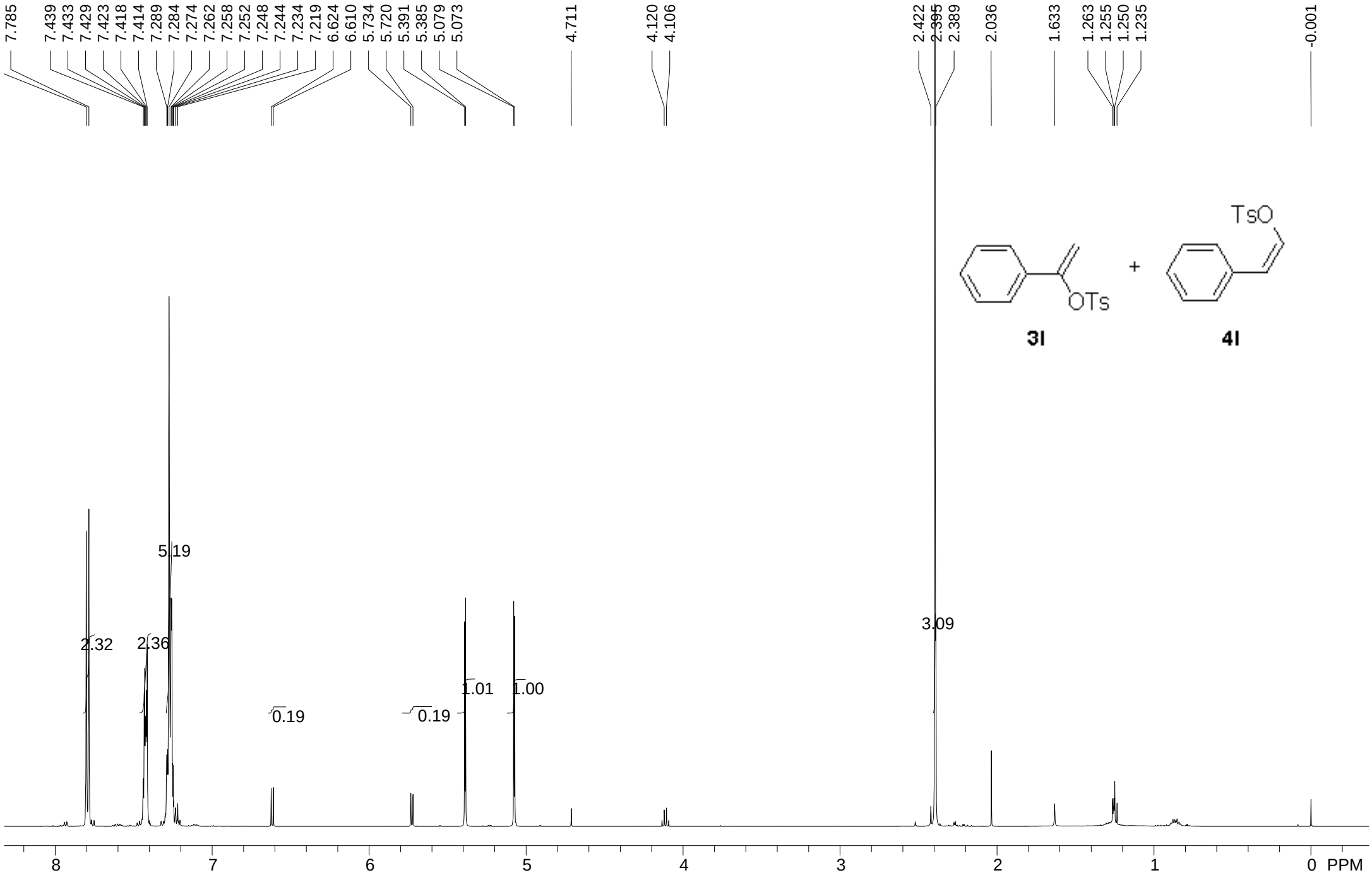
125.027
123.522
117.235
115.919
114.049
113.906
77.414
77.164
76.912
60.437
55.313
39.423
38.585
14.211
13.075
12.460
H3CO
OSO2CH3
3k2
+
H3CO
OSO2CH3
3k1
160
140
120
100
80
60
40
20
PPM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7.289
7.284
7.274
7.262
7.258
7.252
7.248
7.244
7.234
7.219
6.624
6.610
5.734
5.720
5.391
5.385
5.079
5.073
4.711
4.120
4.106
2.422
2.395
2.389
2.036
1.633
1.263
1.255
1.250
1.235
-0.001
TsO
OTs
3l
4l
+
5.19
2.32
2.36
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1.01
1.00
3.09
8
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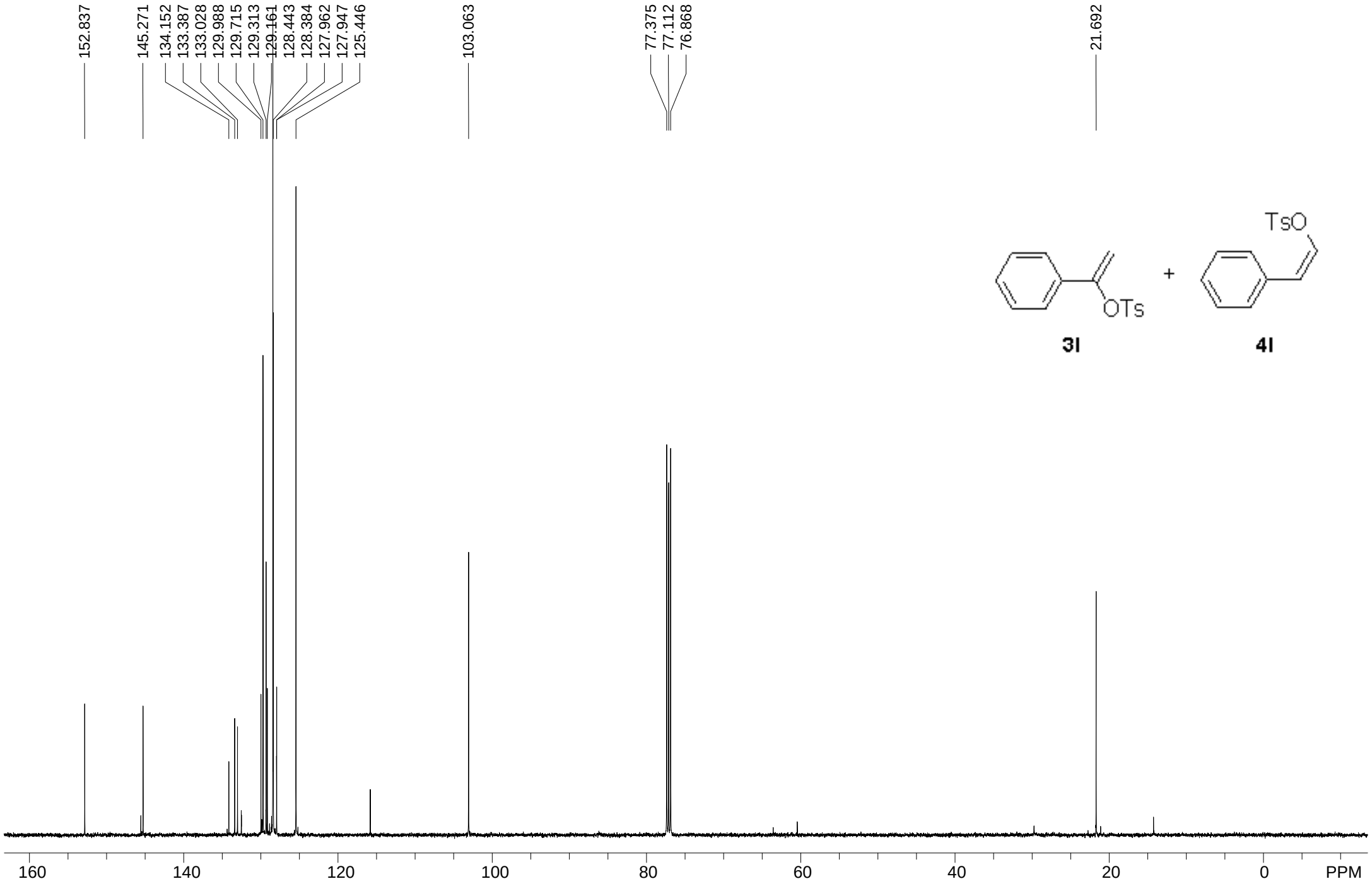
6
5
4
3
2
1
0
PPM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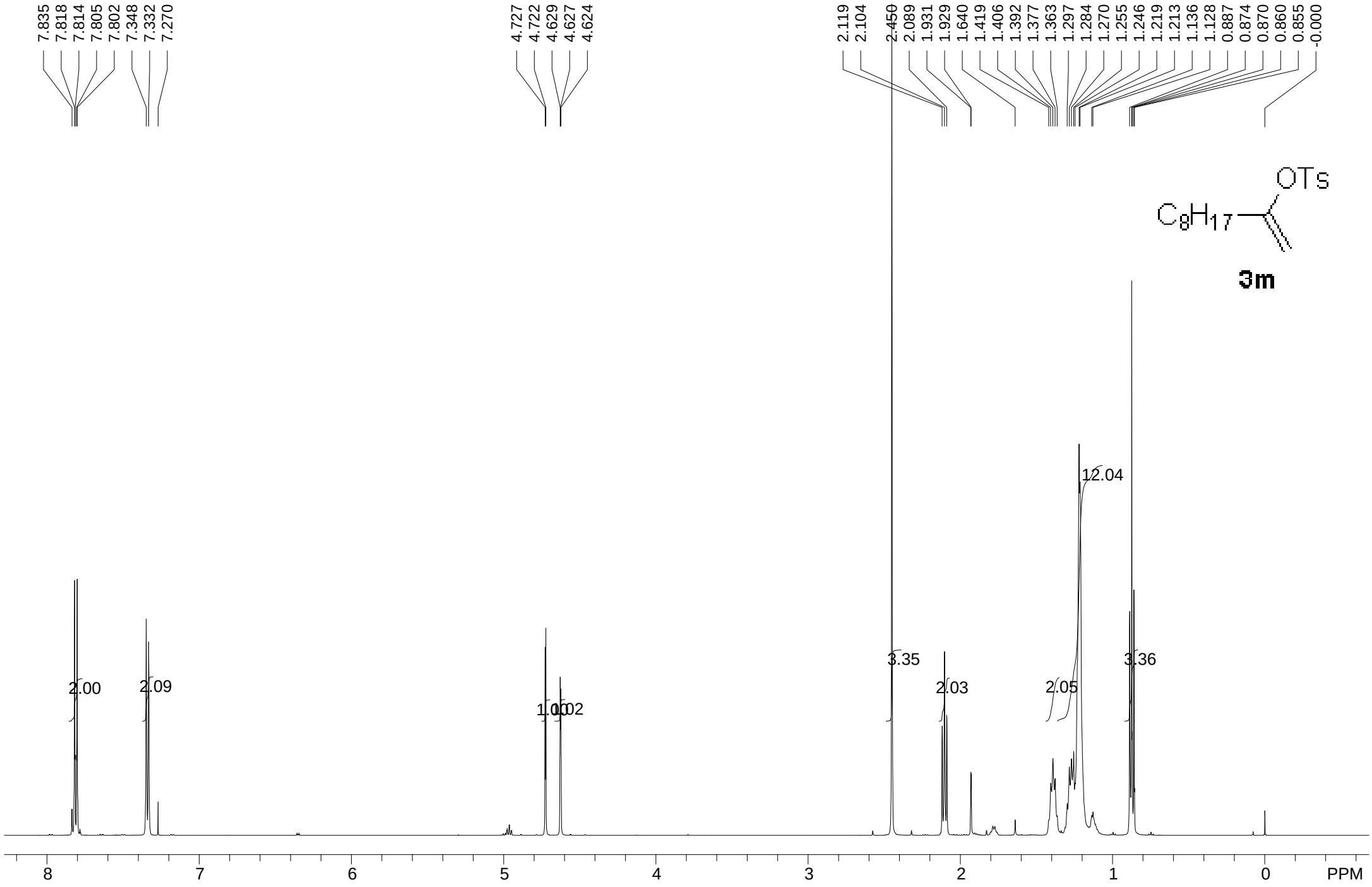
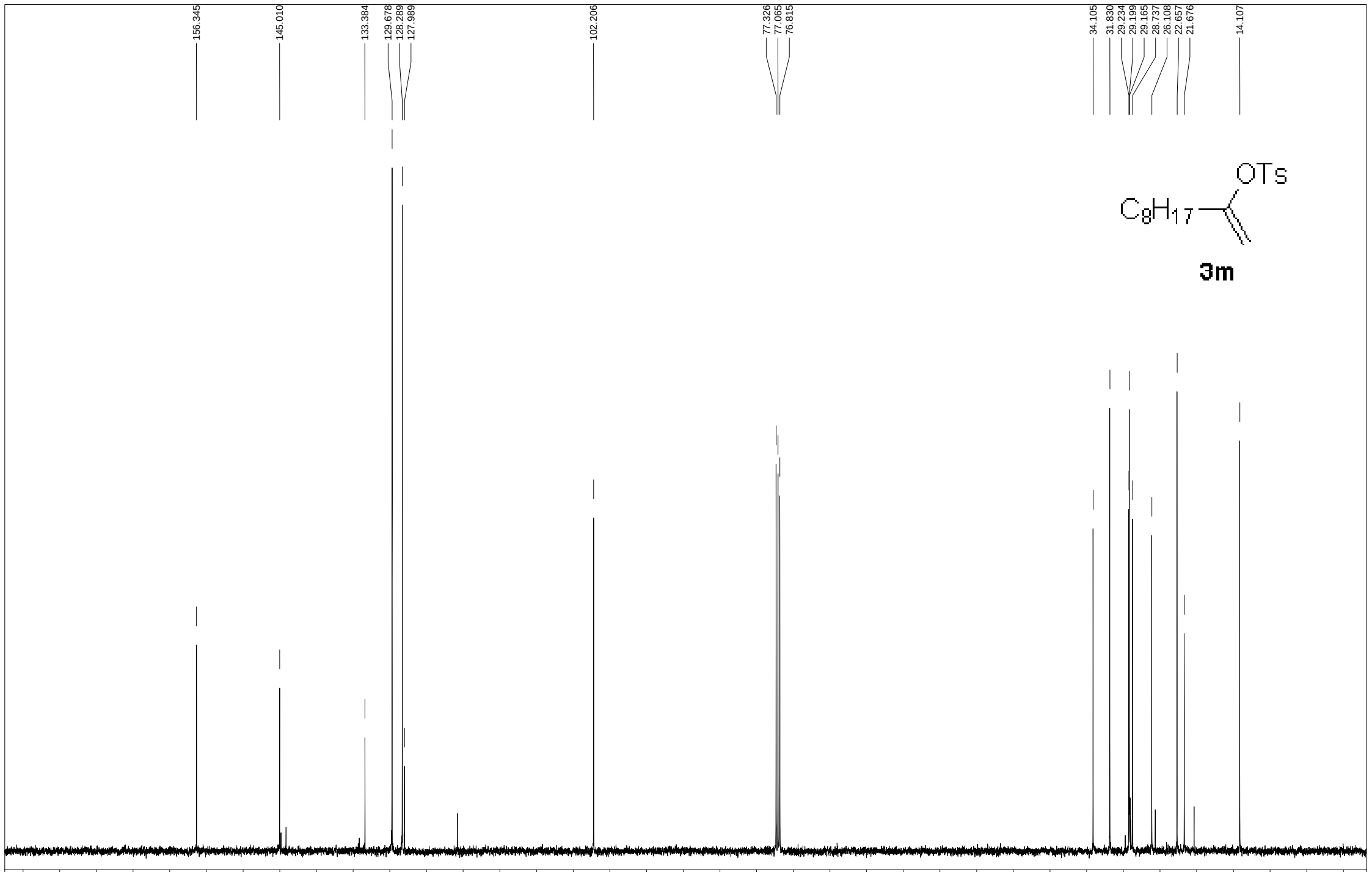
145.271
134.152
133.387
133.028
129.988
129.715
129.313
129.161
128.443
128.384
127.962
127.947
125.446
103.063
77.375
77.112
76.868
21.692
TsO
OTs
+
3l
4l
160
140
120
100
80
60
40
20
0
PPM

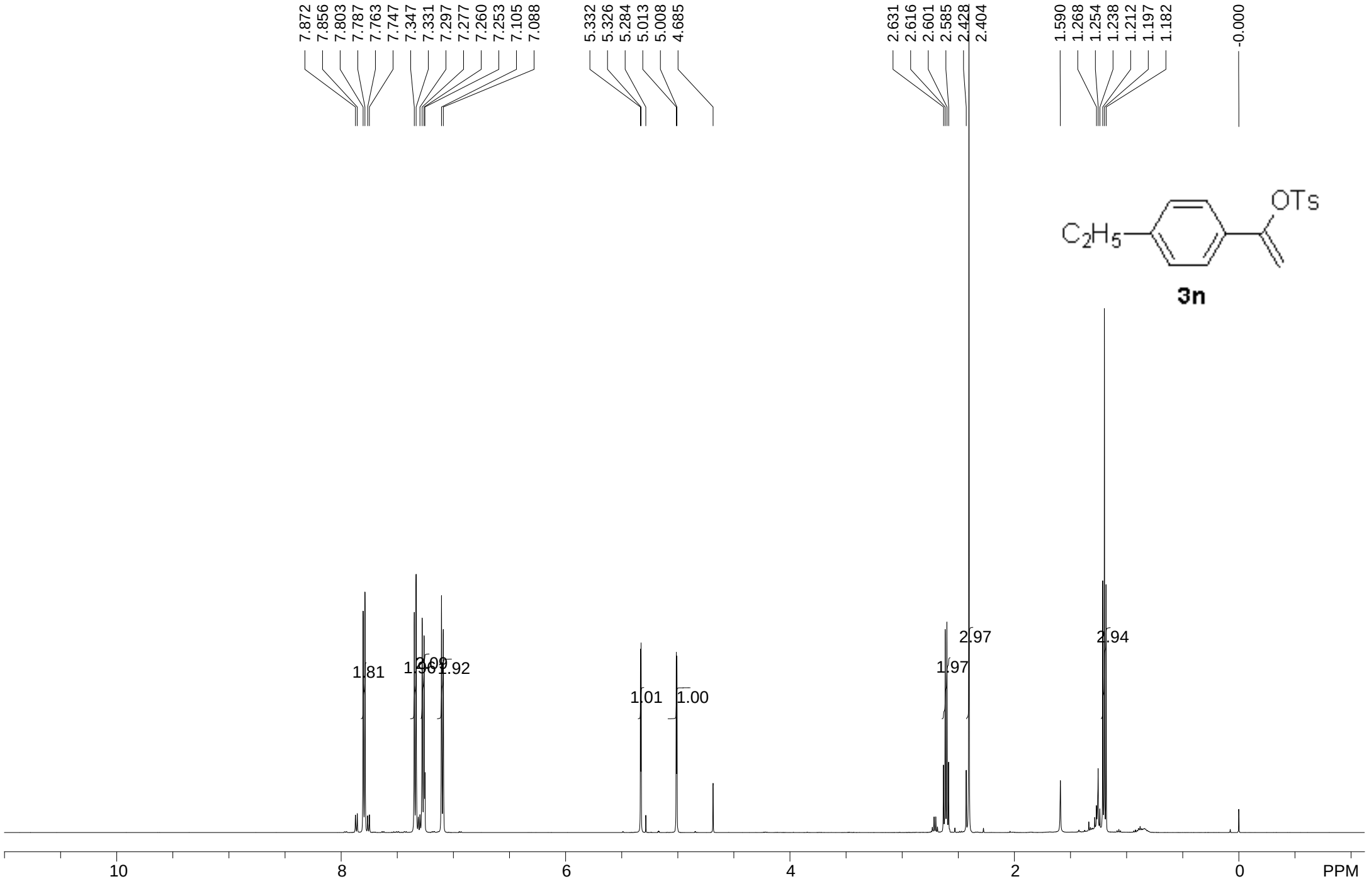

7.835
7.818
7.814
7.805
7.802
7.348
7.332
7.270
4.727
4.722
4.629
4.627
4.624
2.119
2.104
2.450
2.089
1.931
1.929
1.640
1.419
1.406
1.392
1.377
1.363
1.297
1.284
1.270
1.255
1.246
1.219
1.213
1.136
1.128
0.887
0.874
0.870
0.860
0.855
-0.000
OTs
C8H17
3m
2.00
2.09
1.00
1.02
3.35
2.03
12.04
2.05
3.36
8
7
6
5
4
3
2
1
0
PPM



spect, CDCl3,

USER: nmr -- DATE: Fri Feb 29 10:46:11 2008

F1: 125.772	SW1: 37879		OF1: 13837.0		PTS1d: 32768
EX: zgpg30	PW: 9.0 usec	PD: 2.0 sec	NA: 98	LB: 0.0	WinNuts - $pdata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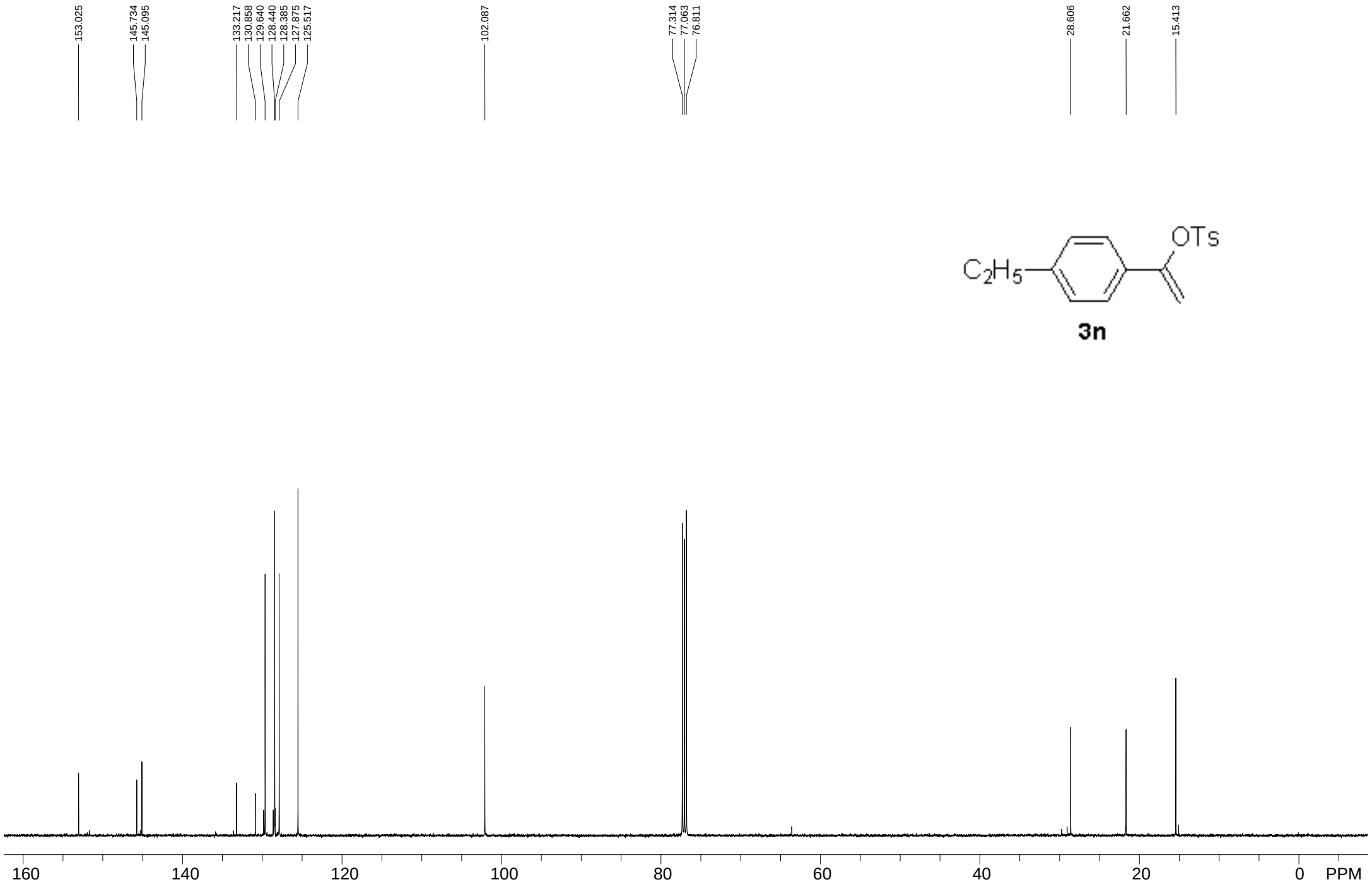
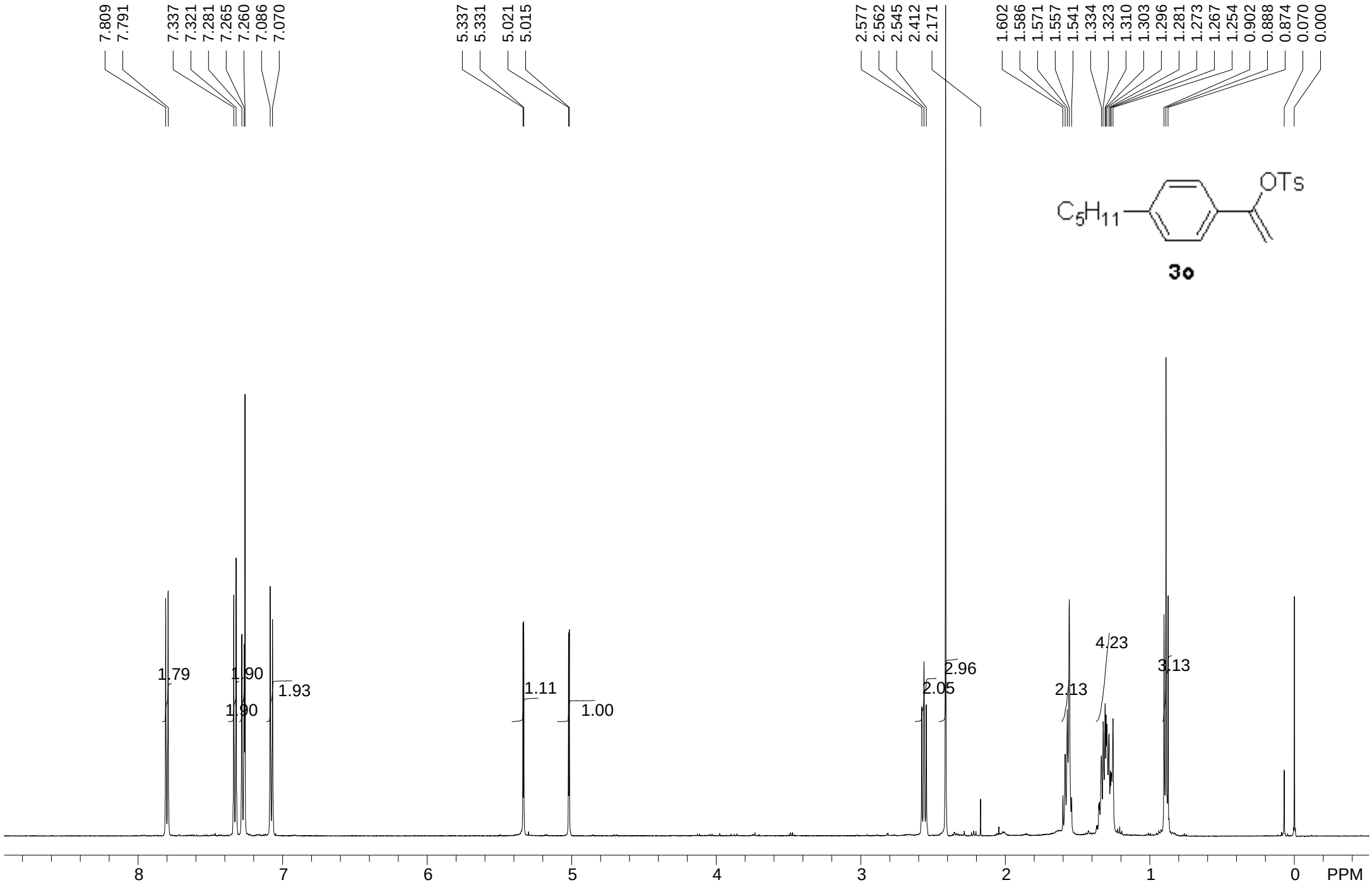
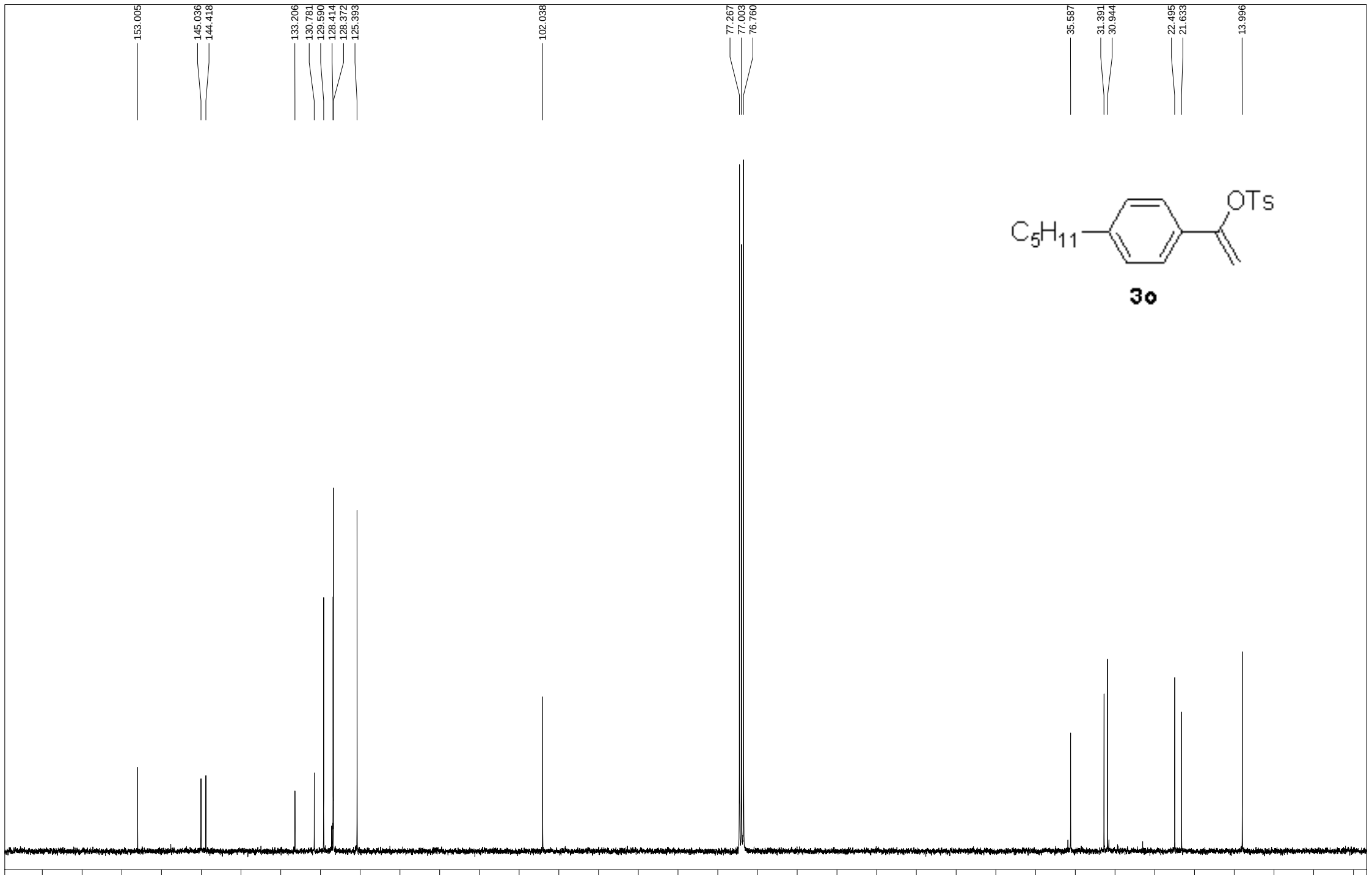
7.803
7.787
7.763
7.747
7.347
7.331
7.297
7.277
7.260
7.253
7.105
7.088
5.332
5.326
5.284
5.013
5.008
4.685
2.631
2.616
2.601
2.585
2.428
2.404
1.590
1.268
1.254
1.238
1.212
1.197
1.182
-0.000
OTs
C2H5
3n
1.81
2.09
1.92
1.01
1.00
1.97
2.97
2.94
10
8
6
4
2
0
PPM

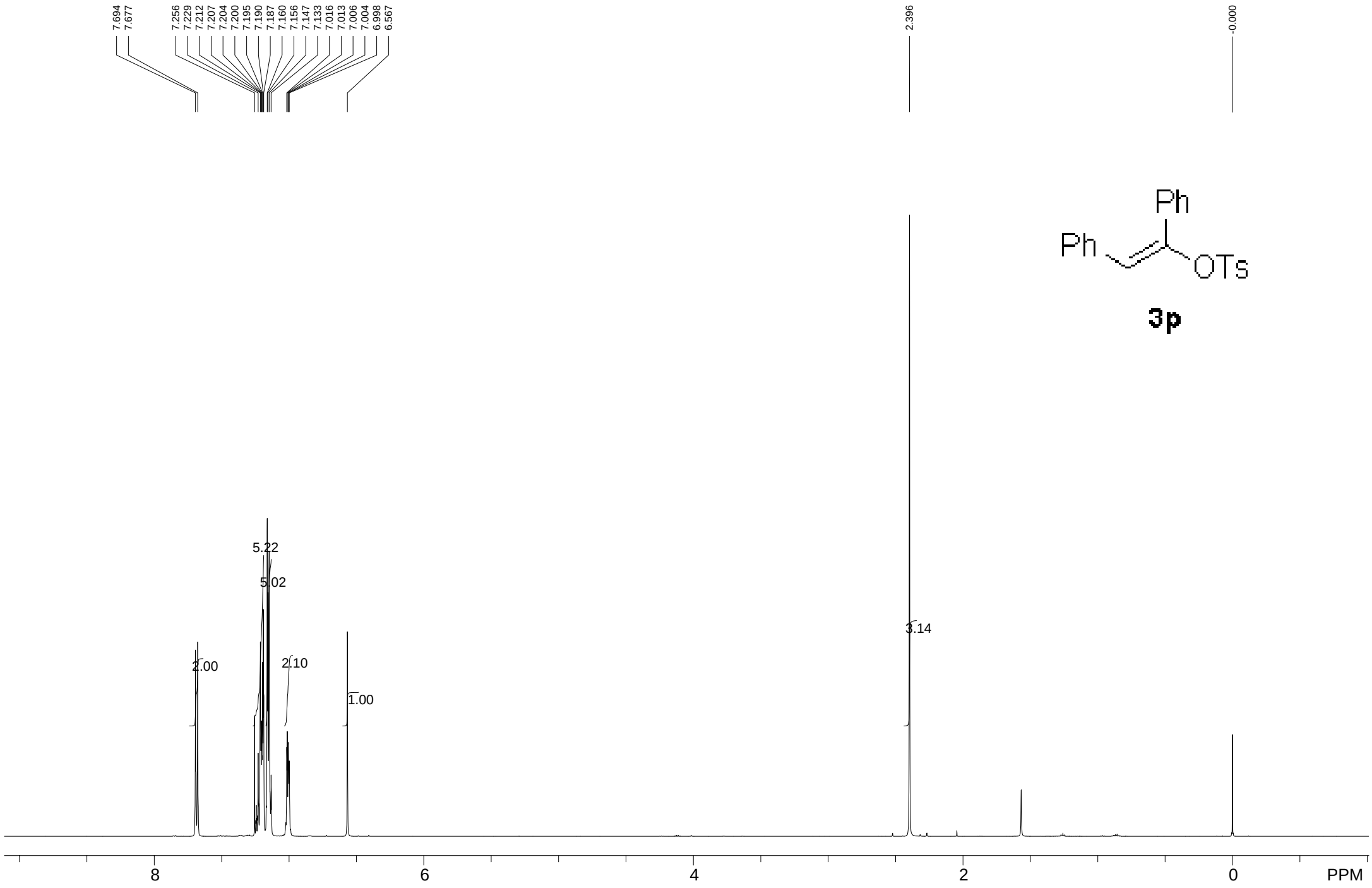

153.025
145.734
145.095
133.217
130.858
129.640
128.440
128.385
127.875
125.517
102.087
77.314
77.063
76.811
28.606
21.662
15.413
OTs
C2H5
3n
160
140
120
100
80
60
40
20
0
PPM

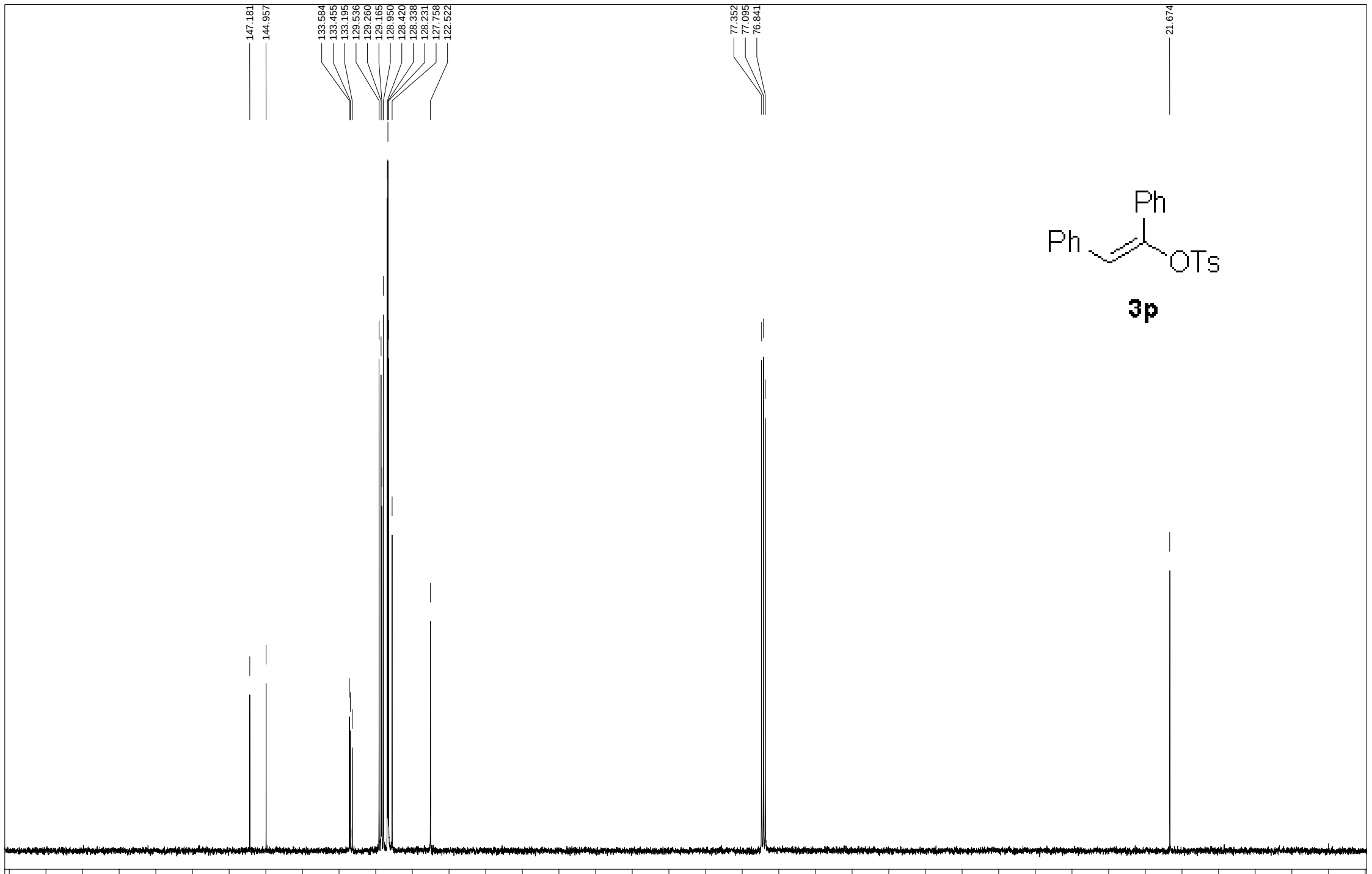

7.809
7.791
7.337
7.321
7.281
7.265
7.260
7.086
7.070
5.337
5.331
5.021
5.015
2.577
2.562
2.545
2.412
2.171
1.602
1.586
1.571
1.557
1.541
1.334
1.323
1.310
1.303
1.296
1.281
1.273
1.267
1.254
0.902
0.888
0.874
0.070
0.000
OTs
C5H11
3o
1.79
1.90
1.90
1.93
1.11
1.00
2.96
2.05
2.13
4.23
3.13
8
7
6
5
4
3
2
1
0
PPM



spect, CDCl3, USER: nmr -- DATE: Thu Jun 12 08:04:05 2008

F1: 125.770	SW1: 37879		OF1: 12575.2		PTS1d: 32768
EX: zgpg30	PW: 9.0 usec	PD: 2.0 sec	NA: 446	LB: 0.0	WinNuts - $pdata


7.694
7.677
7.256
7.229
7.212
7.207
7.204
7.200
7.195
7.190
7.187
7.160
7.156
7.147
7.133
7.016
7.013
7.006
7.004
6.998
6.567
2.396
-0.000
Ph
Ph
OTs
3p
5.22
5.02
2.00
2.10
1.00
3.14
8
6
4
2
0
PPM



spect, CDCl3,

USER: nmr -- DATE: Fri Mar 28 12:10:46 2008

F1: 125.772		SW1: 37879		OF1: 13837.0		PTS1d: 32768	
EX: zgpg30		PW: 9.0 usec	PD: 2.0 sec	NA: 181	LB: 0.0		WinNuts - $pdata