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Supporting Information

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Stereodivergent Construction of Cyclic Ethers using the Regio- and Enantiospecific Rhodium-Catalyzed Allylic Etherification: Total Synthesis of a Novel Mosquito Deterrent, Guar Acid

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Experimental Procedures and Supplemental Data

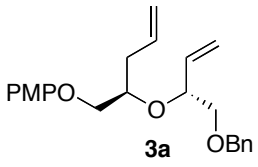
General. The chemical shifts of the ^{1}H-NMR and ^{13}C-NMR spectra were all recorded relative to chloroform, benzene or tetramethylsilane. Multiplicities were determined with the aid of a APT sequence, separating methylene and quaternary carbons = e (even), from methyl and methine = o (odd). GLC and HPLC analysis was carried out using an HP 5890 GC Series 2 and HP 1100 HPLC respectively. All compounds were purified using flash chromatography, and gave spectroscopic data consistent with being ≥95% the assigned structure. Analytical t.l.c. was carried out on pre-coated 0.2 mm thick Merck 60 F_{245} silica plates. Flash chromatography was carried out using Merck Silica Gel 60 (230-400 mesh).

Representative experimental procedure for the rhodium-catalyzed allylic etherification using copper(I) alkoxides: Trimethyl phosphite (12 μL, 0.10 mmol) was added directly to a red suspension of Wilkinson's catalyst (23.1 mg, 0.025 mmol) in anhydrous tetrahydrofuran (1.0 mL) under an atmosphere of argon. The catalyst was allowed to form over *ca.* 15 minutes resulting in a light yellow homogeneous solution. Lithium *bis*(trimethylsilyl)amide (475 μL, 0.475 mmol, 1.0M solution in THF) was added dropwise to a suspension of copper(I) iodide (95.2 mg, 0.5 mmol, previously dried *in vacuo* at 160 °C and freshly pyrolized in the dark), trimethyl phosphite (59 μL, 0.50 mmol), and secondary alcohol (0.50 mmol) in anhydrous

tetrahydrofuran (1.5 mL) under an atmosphere of argon. The anion was allowed to form over *ca.* 2 minutes until a light green homogeneous solution was obtained, and the catalyst and the copper alkoxide solutions were then cooled with stirring to 0 °C, and the former was then added *via* Teflon® cannula to the copper alkoxide solution. The allylic carbonate (0.25 mmol) was then added *via* a tared 500 μL gastight syringe to the catalyst/alkoxide mixture, and the reaction was allowed to slowly warm to room temperature over *ca.* 18 hours (t.l.c. control) resulting in a tan heterogeneous solution. The reaction was quenched with NH_4Cl, partitioned between diethyl ether and saturated aqueous NH_4Cl solution. The organic layers were then combined, washed with saturated aqueous sodium chloride solution, dried (Na_2SO_4), filtered and concentrated *in vacuo* to afford a crude oil. Purification by flash chromatography (eluting with 3% ethyl acetate/hexanes) furnished the *allyl ether*.

Representative experimental procedure for the ruthenium-catalyzed ring-closing metathesis reaction: For n = 0-2: The diene (0.1 mmol) was dissolved in dichloromethane (1.0 ml) with stirring under an atmosphere of argon. Grubbs' catalyst (0.005-0.010 mmol) was added in a single portion, and the resulting reaction mixture was stirred at room temperature for *ca.* 12 hours (t.l.c. control). The reaction mixture was absorbed on to a silica gel column and purified by flash chromatography (eluting with 3-7% ethyl acetate/hexanes) to afford the *cyclic ether*.

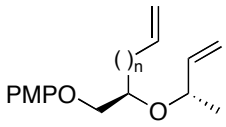
For n = 3: The diene (0.1 mmol) was dissolved in *dichloromethane* (100 ml) and stirred under an atmosphere of argon. Grubbs' *N*-Heterocyclic carbene catalyst (0.005 mmol) was added in a single portion, and the resulting reaction mixture was heated at reflux for *ca*. 12 hours (t.l.c. control). The reaction mixture was absorbed on to a silica gel column and purified by flash chromatography (eluting with 3-7% ethyl acetate/hexanes) to afford the *cyclic ether*.



3a

1-{[(2*R*)-2-({(1*R*)-1-[(Benzyloxy)methyl]prop-2-en-1-yl}oxy)pent-4-en-1-yl]oxy}-4-methoxybenzene 3a.

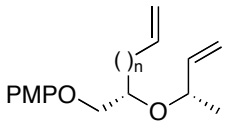
$[\alpha]_D^{24}$ +9.5 (c = 1.24, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* = 48:1, *ds* = ≥99:1; IR (neat) 3074 (w), 3030 (w), 3003 (w), 2979 (w), 2930 (m), 2862 (m), 2835 (w), 1641 (w), 1592 (w), 1507 (s), 1455 (m), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.33-7.24 (m, 5H), 6.80 (s, 4H), 5.89 (ddt, *J* = 17.1, 10.1, 6.9 Hz, 1H), 5.80 (ddd, *J* = 17.1, 10.4, 6.8 Hz, 1H), 5.35 (d, *J* = 17.4 Hz, 1H), 5.21 (d, *J* = 10.4 Hz, 1H), 5.10 (dd, *J* = 17.1, 1.8 Hz, 1H), 5.05 (d, *J* = 10.1, Hz, 1H), 4.59 (d, A of AB, J_{AB} = 12.2 Hz, 1H), 4.54 (d, B of AB, J_{AB} = 12.2 Hz, 1H), 4.17 (q, *J* = 6.0 Hz, 1H), 3.93-3.82 (m, 3H), 3.74 (s, 3H), 3.55 (dd, A of ABX, J_{AB} = 10.2 Hz, J_{AX} = 6.6 Hz, 1H), 3.49 (dd, B of ABX, J_{AB} = 10.2 Hz, J_{BX} = 4.7 Hz, 1H), 2.50-2.36 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.99 (e), 153.23 (e), 138.52 (e), 136.64 (o), 134.50 (o), 128.52 (o), 127.78 (o), 127.72 (o), 117.86 (e), 117.69 (e), 115.71 (o), 114.74 (o), 79.51 (o), 76.15 (o), 73.56 (e), 73.42 (e), 70.60 (e), 55.89 (o), 36.34 (e); HRMS (EI, M^+) calcd for $C_{23}H_{28}O_4$ 368.1988, found 368.1985.



1-Methoxy-4-[((2*R*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}but-3-en-1-yl)oxy]benzene (n = 0).

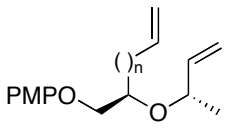
$[\alpha]_D^{25}$ +3.6 (c = 0.92, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* ≥99:1, *ds* = 53:1; IR (neat) 3078 (w), 2979 (m), 2930 (m), 2872 (w), 2834 (w), 1643 (w), 1592 (w), 1509 (s), 1466 (m), 1455 (m), 1443 (m), 1233 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.84-6.77 (m, 4H), 5.79 (ddd, *J* = 17.4, 10.4, 7.0 Hz, 1H), 5.72 (ddd, *J* = 17.4, 10.4, 7.2 Hz, 1H), 5.32 (dt, *J* = 17.4, 1.4 Hz, 1H), 5.28 (d, *J* = 11.6 Hz, 1H), 5.18 (dd, *J* = 17.4, 0.9 Hz, 1H), 5.12 (dd, *J* = 10.3, 0.8 Hz, 1H), 4.17 (q, *J* = 6.2 Hz, 1H), 3.98 (quintet, *J* = 6.6 Hz, 1H), 3.95 (dd, A of ABX, J_{AB} = 9.8 Hz, J_{AX} = 6.4 Hz, 1H), 3.86 (dd, B of ABX, J_{AB} = 9.8 Hz, J_{BX} = 5.2 Hz, 1H), 3.74 (s, 3H), 1.25(d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.07 (e), 153.27

(e), 140.36 (o), 136.13 (o), 118.41 (e), 116.29 (e), 115.97 (o), 114.73 (o), 76.32 (o), 74.56 (o), 71.71 (e), 55.89 (o), 21.99 (o); HRMS (ESI, $M+Na^+$) calcd for $C_{15}H_{20}O_3Na$ 271.1310, found 271.1310.



1-Methoxy-4-[((2*S*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}but-3-en-1-yl)oxy]benzene (n = 0).

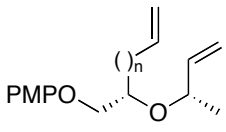
$[\alpha]_D^{24}$ -23.7 (c = 1.52, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* >99:1, *ds* = 50:1; IR (neat) 3079 (w), 2978 (m), 2930 (m), 2870 (w), 2834 (w), 1644 (w), 1592 (w), 1509 (s), 1466 (m), 1455 (m), 1443 (m),1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.85-6.79 (m, 4H), 5.84 (ddd, *J* = 17.2, 10.5, 6.7 Hz, 1H), 5.80 (ddd, *J* = 17.2, 10.4, 6.7 Hz, 1H), 5.35 (dt, *J* = 17.1, 1.4 Hz, 1H), 5.21 (dt, *J* = 10.4, 1.4 Hz, 1H), 5.17 (dt, *J* = 17.1, 1.5 Hz, 1H), 5.07 (d, *J* = 10.4 Hz, 1H), 4.21 (dt, *J* = 6.2, 5.0 Hz, 1H), 4.11 (quintet, *J* = 6.4 Hz, 1H), 3.95 (dd, A of ABX, J_{AB} = 9.9 Hz, J_{AX} = 6.6 Hz, 1H), 3.90 (dd, B of ABX, J_{AB} = 9.8 Hz, J_{BX} = 4.9 Hz, 1H), 3.74 (s, 3H), 1.24 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.09 (e), 153.20 (e), 140.75 (o), 136.41 (o), 117.42 (e), 115.90 (o), 115.40 (e), 114.77 (o), 76.43 (o), 75.82 (o), 71.80 (e), 55.89 (o), 21.05 (o); HRMS (EI, M^+) calcd for $C_{15}H_{20}O_3$ 248.1412, found 248.1409.



1-Methoxy-4-[((2*R*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}pent-4-en-1-yl)oxy]benzene (n = 1).

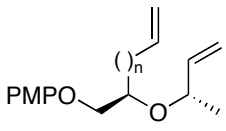
$[\alpha]_D^{24}$ +19.2 (c = 0.96, $CHCl_3$), GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* >99:1, *ds* = 23:1; IR (neat) 3077 (w), 2978 (m), 2930 (m), 2872 (w), 2834 (w), 1642 (w), 1592 (w), 1509 (s), 1466 (m), 1443 (m), 1233 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.82-6.78 (m, 4H), 5.86 (ddt, *J* = 17.1, 10.1, 7.1 Hz, 1H), 5.77 (ddd, *J* = 17.4, 10.4, 7.1 Hz, 1H), 5.18 (dt, *J* = 17.1, 1.2 Hz, 1H), 5.13-5.05 (m, 3H), 4.02 (quintet, *J* = 6.6 Hz, 1H), 3.88 (dd, A of ABX, J_{AB} = 9.7 Hz, J_{AX} = 5.6 Hz, 1H), 3.82 (dd, B of ABX, J_{AB} = 9.5 Hz, J_{BX} = 5.5 Hz, 1H), 3.78-3.72 (m, 1H), 3.74 (s, 3H), 2.44 (ddd, A of

ABMX, J_{AB} = 14.0 Hz, J_{AM} = 6.9 Hz, J_{AX} = 5.9 Hz, 1H), 2.33 (ddd, B of ABMX, J_{AB} = 13.7 Hz, J_{BM} = 7.2 Hz, J_{BX} = 6.3 Hz, 1H), 1.24 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.99 (e), 153.24 (e), 140.91 (o), 134.53 (o), 117.69 (e), 115.74 (e), 115.71 (o), 114.74 (o), 76.31 (o), 74.94 (o), 70.66 (e), 55.91 (o), 36.45 (e), 21.72 (o); HRMS (EI, M^+) calcd for $C_{16}H_{22}O_3$ 262.1569, found 262.1563.



1-Methoxy-4-[((2*S*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}pent-4-en-1-yl)oxy]benzene (n = 1).

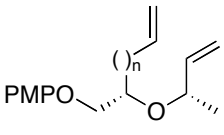
$[\alpha]_D^{24}$ -34.1 (c = 0.99, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* >99:1, *ds* = 23:1; IR (neat) 3077 (w), 2978 (m), 2930 (m), 2870 (w), 2834 (w), 1642 (w), 1592 (w), 1508 (s), 1466 (m), 1443 (w),1232 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.84-6.79 (m, 4H), 5.83 (ddt, *J* = 17.1, 9.9, 7.0 Hz, 1H), 5.73 (ddd, *J* = 17.7, 10.4, 7.3 Hz, 1H), 5.16 (dt, *J* = 17.4, 1.2 Hz, 1H), 5.11-5.02 (m, 3H), 4.09 (quintet, *J* = 6.6 Hz, 1H), 3.88 (d, *J* = 5.2 Hz, 2H), 3.78-3.75 (m, 1H), 3.75 (s, 3H), 2.42-2.28 (m, 2H) 1.23 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.03 (e), 153.29 (e), 140.91 (o), 134.82 (o), 117.41 (e), 115.97 (e), 115.69 (o), 114.78 (o), 76.56 (o), 74.71 (o), 70.83 (e), 55.92 (o), 37.39 (e), 21.89 (o); HRMS (EI, M^+) calcd for $C_{16}H_{22}O_3$ 262.1569, found 262.1564.



1-Methoxy-4-[((2*R*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}hex-5-en-1-yl)oxy]benzene (n = 2).

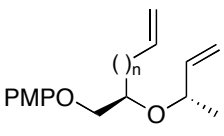
$[\alpha]_D^{24}$ +25.2 (c = 1.40, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* >99:1, *ds* = 27:1; IR (neat) 3077 (w), 2976 (m), 2929 (m), 2870 (w), 2834 (w), 1641 (w), 1592 (w), 1509 (s), 1466 (w), 1456 (m), 1443 (m), 1233 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.80 (s, 4H), 5.83 (ddt, *J* = 16.8, 10.4, 6.7 Hz, 1H), 5.79 (ddd, *J* = 17.4, 10.4, 7.1 Hz, 1H), 5.17 (d, *J* = 17.4 Hz, 1H), 5.06 (d, *J* = 10.1 Hz, 1H), 5.03 (dd, *J* = 17.1, 2.0 Hz, 1H), 4.96 (d, *J* = 10.1 Hz, 1H), 4.01 (quintet, *J* = 6.5 Hz, 1H), 3.90 (dd, A of ABX, J_{AB}

= 9.7 Hz, J_{AX} = 5.3 Hz, 1H), 3.80 (dd, B of ABX, J_{AB} = 9.7 Hz, J_{BX} = 5.6 Hz, 1H), 3.74 (s, 3H), 3.72-3.66 (m, 1H), 2.27-2.09 (m, 2H), 1.79-1.61 (m, 2H), 1.24 (d, J = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.97 (e), 153.26 (e), 141.14, (o), 138.70 (o), 115.63 (o), 115.50 (e), 114.93 (e), 114.75 (o), 76.65 (o), 75.11 (o), 71.16 (e), 55.91 (o), 31.53 (e), 29.65 (e), 21.60 (o); HRMS (EI, M^+) calcd for $C_{17}H_{24}O_3$ 276.1725, found 276.1721.



1-Methoxy-4-[((2*S*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}hex-5-en-1-yl)oxy]benzene (n = 2).

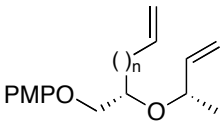
$[\alpha]_D^{24}$ -41.0 (c = 1.05, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* >99:1, *ds* = 26:1; IR (neat) 3077 (w), 2977 (m), 2929 (m), 2868 (w), 2834 (w), 1641 (w), 1592 (w), 1509 (s), 1466 (m), 1456 (m), 1443 (m), 1233 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.86-6.83 (m, 4H), 5.83 (ddt, J = 16.9, 10.2, 6.6 Hz, 1H), 5.74 (ddd, J = 17.7, 10.2, 7.6 Hz, 1H), 5.17 (d, J = 17.5 Hz, 1H), 5.13 (d, J = 10.5 Hz, 1H), 5.04 (dd, J = 17.1, 1.7 Hz, 1H), 4.96 (dd, J = 10.1, 1.3 Hz, 1H), 4.11 (quintet, J = 6.7 Hz, 1H), 3.92 (dd, A of ABX, J_{AB} = 9.7 Hz, J_{AX} = 5.5 Hz, 1H), 3.88 (dd, B of ABX, J_{AB} = 9.7 Hz, J_{BX} = 4.8 Hz, 1H), 3.77 (s, 3H), 3.77-3.70 (m, 1H), 2.29-2.20 (m, 1H), 2.10 (dq, J = 15.1, 7.4 Hz, 1H), 1.73-1.62 (m, 2H), 1.26 (d, J = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.03 (e), 153.30 (e), 140.93 (o), 138.70 (o), 116.27 (e), 115.62 (o), 114.84 (e), 114.80 (o), 76.47 (o), 74.29 (o), 71.39 (e), 55.92 (o), 32.14 (e), 29.97 (e), 22.07 (o); HRMS (EI, M^+) calcd for $C_{17}H_{24}O_3$ 276.1725, found 276.1722.



1-Methoxy-4-[((2*R*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}hept-6-en-1-l)oxy]benzene (n = 3).

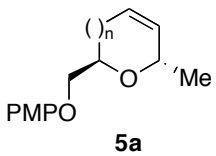
$[\alpha]_D^{29}$ +28.6 (c = 1.05, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* >99:1, *ds* = 29:1; IR (neat) 3077 (m), 2976 (m), 2930 (s), 2865 (m), 2835 (m), 1641 (m), 1592 (w), 1507 (s), 1457 (m), 1443 (m), 1421 (m), 1369 (m), 1307 (m), 1289 (m), 1232

(s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.83 (bs, 4H), 5.88–5.77 (m, 2H), 5.19 (d, *J* = 17.2 Hz, 1H), 5.09 (d, *J* = 10.3 Hz, 1H), 5.03 (dd, *J* = 17.2, 1.7 Hz, 1H), 4.97 (dd, *J* = 10.2, 0.9 Hz, 1H), 4.03 (quintet, *J* = 6.5 Hz, 1H), 3.91 (A of ABX, J_{AB} = 9.5 Hz, J_{AX} = 5.5 Hz, 1H), 3.82 (B of ABX, J_{AB} = 9.5 Hz, J_{BX} = 5.5 Hz, 1H), 3.76 (s, 3H), 3.73–3.68 (m, 1H), 2.10 (q, *J* = 7.0 Hz, 2H), 1.71–1.54 (m, 3H), 1.52–1.42 (m, 1H), 1.26 (d, *J* = 6.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.05 (e), 153.37 (e), 141.25 (o), 138.92 (o), 115.72 (o), 115.44 (e), 114.87 (e), 114.82 (o), 76.55 (o), 75.60 (o), 71.35 (e), 55.96 (o), 34.12 (e), 31.82 (e), 24.82 (e), 21.66 (o); HRMS (CI, M^+) calcd for $C_{18}H_{26}O_3$ 290.1882, found 290.1888.



1-Methoxy-4-[((2*S*)-2-{[(1*S*)-1-methylprop-2-en-1-yl]oxy}hept-6-en-1-l)oxy]benzene (n = 3).

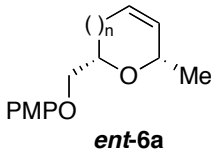
$[\alpha]_D^{27}$ -45.8 (c = 1.05, $CHCl_3$); GLC analysis (HP-1 Methyl Siloxane capillary column) *2°:1°* >99:1, *ds* = 39:1; IR (neat) 3077 (m), 2977 (m), 2930 (s), 2865 (m), 2835 (m), 1641 (m), 1592 (w), 1509 (s), 1457 (m), 1443 (m), 1421 (m), 1369 (m), 1306 (m), 1289 (m), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.87–6.81 (m, 4H), 5.81 (ddt, *J* = 16.8, 10.1, 6.7 Hz, 1H), 5.74 (ddd, *J* = 17.6, 10.2, 7.6 Hz, 1H), 5.16 (d, *J* = 17.6 Hz, 1H), 5.13 (d, *J* = 10.7 Hz, 1H), 5.01 (dd, *J* = 17.2, 1.8 Hz, 1H), 4.95 (dd, *J* = 10.1, 0.9 Hz, 1H), 4.11 (quintet, *J* = 6.7 Hz, 1H), 3.92 (A of ABX, J_{AB} = 9.7 Hz, J_{AX} = 5.6 Hz, 1H), 3.87 (B of ABX, J_{AB} = 9.7 Hz, J_{BX} = 4.7 Hz, 1H), 3.77 (s, 3H), 3.74–3.70 (m, 1H), 2.08 (q, *J* = 6.5 Hz, 2H), 1.64–1.51 (m, 3H), 1.48–1.40 (m, 1H), 1.25 (d, *J* = 6.3 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.98 (e), 153.29 (e), 140.96 (o), 138.87 (o), 116.08 (e), 115.58 (o), 114.75 (o), 114.66 (e), 76.40 (o), 74.61 (o), 71.53 (e), 55.85 (o), 33.88 (e), 32.31(e), 24.99 (e), 21.99 (o); HRMS (CI, M^+) calcd for $C_{18}H_{26}O_3$ 290.1882, found 290.1871.



5a

(2*R*,5*S*)-2-[(4-Methoxyphenoxy)methyl]-5-methyl-2,5-dihydrofuran 5a (n = 0).

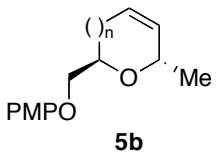
$[\alpha]_D^{26}$ +132.3 (c = 1.08, $CHCl_3$); IR (neat) 3073 (w), 3046 (w), 2969 (m), 2925 (m), 2865 (m), 2835 (m), 1592 (w), 1506 (s), 1466 (m), 1455 (m), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.87-6.80 (m, 4H), 5.93 (dt, *J* = 6.1, 1.7 Hz, 1H), 5.85 (dt, *J* = 6.3, 1.8 Hz, 1H), 5.21-5.16 (m, 1H), 5.04 (triple quintet, *J* = 6.2, 1.7 Hz, 1H), 3.94 (dd, A of ABX, J_{AB} = 9.6 Hz, J_{AX} = 6.0 Hz, 1H), 3.89 (dd, B of ABX, J_{AB} = 9.6 Hz, J_{BX} = 4.4 Hz, 1H), 3.76 (s, 3H), 1.30 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.10 (e), 153.25 (e), 133.85 (o), 126.31 (o), 115.79 (o), 114.72 (o), 84.31 (o), 82.46 (o), 71.57 (e), 55.89 (o), 21.92 (o); HRMS (ESI, M+Na^+) calcd for $C_{13}H_{16}O_3Na$ 243.0997, found 243.0999.



***ent*-6a**

(2*S*,5*S*)-2-[(4-Methoxyphenoxy)methyl]-5-methyl-2,5-dihydrofuran *ent*-6a (n = 0).

$[\alpha]_D^{26}$ -54.2 (c = 1.13, $CHCl_3$); IR (neat) 3073 (w), 3046 (w), 2969 (m), 2925 (m), 2863 (m), 2835 (m), 1592 (w), 1506 (s), 1465 (m), 1455 (m), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.88-6.81 (m, 4H), 5.91 (dt, *J* = 6.3, 1.6 Hz, 1H), 5.85 (dt, *J* = 6.1, 1.5 Hz, 1H), 5.11-5.07 (m, 1H), 5.01-4.96 (m, 1H), 3.97 (dd, A of ABX, J_{AB} = 9.5 Hz, J_{AX} = 5.5 Hz, 1H), 3.91 (dd, B of ABX, J_{AB} = 9.5 Hz, J_{BX} = 4.9 Hz, 1H), 3.76 (s, 3H), 1.31 (d, *J* = 6.4 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.07 (e), 153.26 (e), 133.57 (o), 126.58 (o), 115.75 (o), 114.74 (o), 84.72 (o), 82.78 (o), 72.38 (e), 55.89 (o), 22.95 (o); HRMS (ESI, M+Na^+) calcd for $C_{13}H_{16}O_3Na$ 243.0997, found 243.1000.

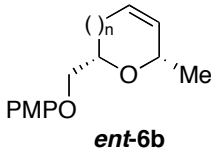


5b

(2*R*,6*S*)-2-[(4-Methoxyphenoxy)methyl]-6-methyl-3,6-dihydro-2*H*-pyran 5b (n = 1).

$[\alpha]_D^{26}$ +96.7 (c = 1.06, $CHCl_3$); IR (neat) 3033 (m), 2969 (s), 2929 (s), 2834 (m), 1592 (m), 1506 (s), 1456 (s),

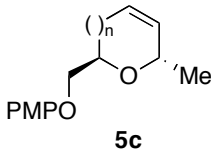
1368 (m), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.91–6.82 (m, 4H), 5.86–5.81 (m, 1H), 5.73 (dq, *J* = 10.2, 2.2 Hz, 1H), 4.47–4.43 (m, 1H), 4.13 (dq, *J* = 7.6, 5.2 Hz, 1H), 4.05 (dd, A of ABX, J_{AB} = 9.7 Hz, J_{AX} = 5.9 Hz, 1H), 3.93 (dd, B of ABX, J_{AB} = 9.7 Hz, J_{BX} = 4.8 Hz, 1H), 3.78 (s, 3H), 2.20–2.07 (m, 2H), 1.31 (d, *J* = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.19 (e), 153.32 (e), 131.21 (o), 123.05 (o), 115.96 (o), 114.81 (o), 71.41 (e), 68.98 (o), 66.40 (o), 55.93 (o), 27.30 (e), 20.19 (o); HRMS (EI, M^+) calcd for $C_{14}H_{18}O_3$ 234.1256, found 234.1247.



***ent*-6b**

(2*S*,6*S*)-2-[(4-Methoxyphenoxy)methyl]-6-methyl-3,6-dihydro-2*H*-pyran *ent*-6b (n = 1).

$[\alpha]_D^{24}$ −12.1 (c = 0.24, $CHCl_3$); IR (neat) 3032 (w), 2974 (w), 2928 (m), 2833 (w), 1592 (w), 1509 (s), 1455 (m), 1370 (w), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.88–6.78 (m, 4H), 5.80 (ddt, *J* = 9.9, 4.8, 2.5 Hz, 1H), 5.63 (ddt, *J* = 10.2, 2.6, 1.3 Hz, 1H), 4.34–4.29 (m, 1H), 4.03 (dd, A of ABX, J_{AB} = 9.4 Hz, J_{AX} = 6.2 Hz, 1H), 4.00–3.94 (m, 1H), 3.86 (dd, B of ABX, J_{AB} = 9.4 Hz, J_{BX} = 4.1 Hz, 1H), 3.74 (s, 3H), 2.16–1.99 (m, 2H), 1.25 (d, *J* = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.20 (e), 153.39 (e), 131.87 (o), 123.64 (o), 116.05 (o), 114.82 (o), 72.78 (o), 72.13 (e), 71.30 (o), 55.96 (o), 27.91 (e), 21.52 (o); HRMS (EI, M^+) calcd for $C_{14}H_{18}O_3$ 234.1256, found 234.1252.

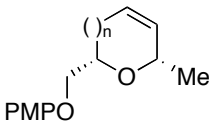


5c

(2*R*,7*S*)-2-[(4-Methoxyphenoxy)methyl]-7-methyl-2,3,4,7-tetrahydrooxepine 5c (n = 2).

$[\alpha]_D^{25}$ +11.3 (c = 0.60, $CHCl_3$); IR (neat) 3044 (w), 3016 (m), 2970 (s), 2930 (s), 2868 (m), 2835 (m), 1727 (w), 1653 (w), 1615 (w), 1592 (m), 1506 (s), 1456 (s), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.87–6.78 (m, 4H), 5.71–5.66 (m, 1H), 5.44 (dq, *J* = 11.2, 1.9 Hz, 1H), 4.67–4.61 (m, 1H), 4.17 (dq, *J* = 10.6, 5.3 Hz, 1H), 3.99 (dd, A of ABX, J_{AB} = 9.8 Hz, J_{AX} = 6.0 Hz, 1H), 3.86 (dd, B

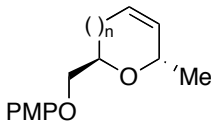
of ABX, J_{AB} = 9.8 Hz, J_{BX} = 5.2 Hz, 1H), 3.75 (s, 3H), 2.40–2.25 (m, 2H), 2.02–1.87 (m, 2H), 1.22 (d, J = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.13 (e), 153.40 (e), 134.49 (o), 130.11 (o), 115.88 (o), 114.85 (o), 74.50 (o), 71.20 (e), 68.49 (o), 55.96 (o), 30.37 (e), 26.31 (e), 22.04 (o); HRMS (EI, M^+) calcd for $C_{15}H_{20}O_3$ 248.1412, found 248.1411.



***ent*-6c**

(2S,7S)-2-[(4-Methoxyphenoxy)methyl]-7-methyl-2,3,4,7-tetrahydrooxepine *ent*-6c (n = 2).

$[\alpha]_D^{26}$ −4.0 (c = 1.04, $CHCl_3$); IR (neat) 3045 (m), 3017 (m), 2971 (s), 2931 (s), 2869 (s), 2835 (s), 1729 (w), 1651 (w), 1615 (w), 1592 (m), 1506 (s), 1469 (s), 1456 (s), 1443 (s), 1232 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.85–6.78 (m, 4H), 5.77 (ddt, J = 11.3, 5.6, 2.1 Hz, 1H), 5.53 (dt, J = 11.3, 1.4 Hz, 1H), 4.29–4.25 (m, 1H), 4.00–3.93 (m, 2H), 3.82–3.77 (m, 1H), 3.74 (s, 3H), 2.49–2.41 (m, 1H), 2.18–2.09 (m, 1H), 2.02–1.95 (m, 1H), 1.71–1.62 (m, 1H), 1.28 (d, J = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.05 (e), 153.29 (e), 135.73 (o), 130.83 (o), 115.92 (o), 114.77 (o), 78.85 (o), 74.88 (o), 71.77 (e), 55.92 (o), 30.72 (e), 25.07 (e), 22.59 (o); HRMS (EI, M^+) calcd for $C_{15}H_{20}O_3$ 248.1412, found 248.1412.

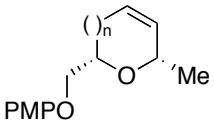


5d

(2*R*,8*S*)-2-[(4-Methoxyphenoxy)methyl]-8-methyl-3,4,5,8-tetrahydro-2*H*-oxocine 5d (n = 3).

$[\alpha]_D^{26}$ +12.6 (c = 0.88, $CHCl_3$); IR (neat) 3045 (w), 3011 (m), 2930 (s), 2834 (m), 1592 (w), 1507 (s), 1456 (m), 1402 (w), 1374 (m), 1352 (w), 1289 (m), 1232 (s) cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.86–6.80 (m, 4H), 5.81 (ddt, J = 11.0, 8.2, 1.7 Hz, 1H), 5.32 (dd, J = 10.9, 5.6 Hz, 1H), 4.55 (quintet, J = 5.9 Hz, 1H), 4.06–4.00 (m, 1H), 3.95 (dd, J = 9.2, 5.4 Hz, 1H), 3.78–3.74 (m, 1H), 3.77 (s, 3H), 2.42–2.28 (m, 2H), 1.90–1.65 (m, 3H), 1.50–1.39 (m, 1H), 1.28 (d, J = 6.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.99 (e), 153.34 (e), 132.24 (o), 131.65 (o), 115.78 (o), 114.74 (o), 73.66

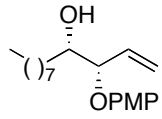
(o), 72.29 (e), 68.18 (o), 55.88 (o), 30.06 (e), 26.20 (e), 26.08 (e), 21.80 (o); HRMS (CI, M^+) calcd for $C_{16}H_{22}O_3$ 262.1569, found 262.1569.



***ent*-6d**

(2*S*,8*S*)-2-[(4-Methoxyphenoxy)methyl]-8-methyl-3,4,5,8-tetrahydro-2*H*-oxocine *ent*-6d (n = 3).

$[\alpha]_D^{26}$ +40.2 (c = 0.84, $CHCl_3$); IR (neat) 3045 (w), 3008 (m), 2929 (s), 2861 (m), 2834 (m), 1592 (w), 1506 (s), 1455 (m), 1398 (w), 1367 (m), 1307 (m), 1289 (m), 1232 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.87–6.81 (m, 4H), 5.64 (dt, *J* = 10.9, 8.8 Hz, 1H), 5.42 (ddd, *J* = 11.5, 3.6, 1.3 Hz, 1H), 4.28–4.22 (m, 1H), 3.97–3.93 (m, 2H), 3.84–3.79 (m, 1H), 3.77 (s, 3H), 2.77 (dq, *J* = 10.3, 1.4 Hz, 1H), 2.08–2.00 (m, 1H), 1.89–1.81 (m, 2H), 1.63–1.54 (m, 1H), 1.50–1.39 (m, 1H), 1.29 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.96 (e), 153.40 (e), 133.61 (o), 128.91 (o), 115.71 (o), 114.74 (o), 77.36 (o), 75.98 (o), 72.26 (e), 55.88 (o), 30.31 (e), 25.52 (e), 25.30 (e), 21.98 (o); HRMS (CI, M^+) calcd for $C_{16}H_{22}O_3$ 262.1569, found 262.1567.

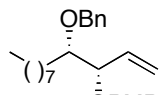


9

(3*S*,4*S*)-3-(4-Methoxyphenoxy)dodec-1-en-4-ol 9.

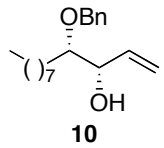
Heptyllithium (1.7 mL, 0.75 mmol, 0.44 M solution in 3:2 mixture of hexanes/diethyl ether) was added directly to a suspension of copper(I) cyanide (4.1 mg, 0.05 mmol, dried *in vacuo* at 160 °C) in anhydrous diethyl ether that was previously cooled to -78 °C under an atmosphere of argon. The resulting suspension was stirred *ca*. 10 minutes followed by addition of epoxide **8** (51.0 mg, 0.25 mmol, *ee* = 99%) *via* a tared 500 μL gastight syringe. The resulting yellow mixture was allowed to stir for *ca.* 2.5 hours at -78 °C (t.l.c. control) then quenched at -78 °C with a saturated aqueous NH_4Cl solution (0.5 mL). The reaction mixture was allowed to warm to room temperature and partitioned between diethyl ether and saturated aqueous NH_4Cl solution. The combined organic layers were

dried ($MgSO_4$), filtered, and concentrated *in vacuo* to afford a crude solid. Purification by flash chromatography (eluting with 7% ethyl acetate/hexanes) furnished the alcohol **9** (54.1 mg, 71%) as a white solid: $[\alpha]_D^{25}$ +10.9 (c = 1.06, $CHCl_3$); IR (neat) 3428 (bm), 3053 (m), 2988 (m), 2921 (s), 2854 (s), 1645 (w), 1608 (w), 1592 (w), 1506 (s), 1464 (s), 1226 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 6.89-6.78 (m, 4H), 5.86-5.78 (m, 1H), 5.32-5.28 (m, 2H), 4.32 (t, *J* = 6.7 Hz, 1H), 3.76 (s, 3H), 3.73-3.66 (m, 1H), 2.55 (bs, 1H), 1.62-1.27 (m, 14H), 0.88 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.49 (e), 152.13 (e), 135.02 (o), 119.64 (e), 117.97 (o), 114.66 (o), 84.45 (o), 73.82 (o), 55.83 (o), 32.59 (e), 32.08 (e), 29.86 (e), 29.73 (e), 29.49 (e), 25.75 (e), 22.87 (e), 14.32 (o); HRMS (ESI, M+Na^+) calcd for $C_{19}H_{30}O_3Na$ 329.2093, found 329.2091.



1-({(1*S*)-1-[(1*S*)-1-(Benzyloxy)nonyl]prop-2-en-1-yl}oxy)-4-methoxybenzene. Sodium hydride (0.23 g, 5.63 mmol, 60% in oil) was suspended in anhydrous *N*,*N*-dimethylformamide (15 mL) and cooled to 0 °C under an atmosphere of nitrogen. The secondary alcohol **9** (1.15 g, 3.75 mmol) was then added in anhydrous THF (3 mL) and stirred for *ca.* 15 minutes at 0 °C. The reaction mixture was the warmed to room temperature until homogeneous (*ca.* 1 hour). The reaction was then re-cooled to 0 °C, and benzyl bromide (0.67 mL, 5.63 mmol) was added, and the reaction mixture stirred for *ca.* 15 minutes at 0 °C, before being warmed to room temperature and stirred overnight. The reaction was quenched by the addition of water (*ca.* 2 mL), and partitioned between diethyl ether and saturated aqueous NH_4Cl solution. The organic layers were combined, dried ($MgSO_4$), filtered, and concentrated *in vacuo* to afford a crude yellow oil. Purification by flash chromatography (eluting with 0-5% ethyl acetate/hexanes) furnished the benzyl protected alcohol (1.47 g, 99%) as a yellow oil: $[\alpha]_D^{26}$ -22.8 (c = 1.06, $CHCl_3$); IR (neat) 3065 (m), 3031 (m), 2926 (s),

2856 (s), 1644 (w), 1608 (w), 1591 (w), 1506 (s), 1464 (s), 1456 (s), 1442 (m), 1228 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.38-7.26 (m, 5H), 6.88-6.79 (m, 4H), 5.92 (ddd, *J* = 16.9, 10.4, 6.3 Hz, 1H), 5.32 (d, *J* = 17.4 Hz, 1H), 5.28 (d, *J* = 10.7 Hz, 1H), 4.77 (d, A of AB, J_{AB} = 11.6 Hz, 1H), 4.63 (d, B of AB, J_{AB} = 11.6 Hz, 1H), 4.59 (dd, *J* = 11.0, 5.2 Hz, 1H), 3.77 (s, 3H), 3.60 (ddd, *J* = 8.9, 5.3, 3.7 Hz, 1H), 1.68-1.61 (m, 1H), 1.57-1.47 (m, 2H), 1.30-1.26 (m, 11H), 0.89 (t, *J* = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.20 (e), 152.66 (e), 138.92 (e), 135.07 (o), 128.52 (o), 128.30 (o), 127.81 (o), 118.17 (e), 117.61 (o), 114.66 (o), 82.29 (o), 81.25 (o), 73.57 (e), 55.88 (o), 32.09 (e), 30.91 (e), 29.89 (e), 29.75 (e), 29.49 (e), 25.90 (e), 22.90 (e), 14.34 (o); HRMS (ESI, $M+Na^+$) calcd for $C_{26}H_{36}O_3Na$ 419.2562, found 419.2542.

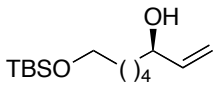


10

(3*S*,4*S*)-4-(Benzyloxy)dodec-1-en-3-ol 10.

Ceric ammonium nitrate (3.79 g, 6.9 mmol) was added *via* a dry vial in one portion to a solution of the benzyl protected alcohol (1.37 g, 3.46 mmol) in acetonitrile/water (13.5 mL/ 3.5 mL), that was previously cooled to 0 °C. The resulting red solution was allowed to warm to room temperature and stirred for *ca*. 3 hours (t.l.c. control) before being quenched by the addition of saturated aqueous NH_4Cl solution (1 mL). The reaction mixture was partitioned between diethyl ether and saturated aqueous NH_4Cl solution. The organic layers were combined, washed with 2M potassium hydroxide, dried ($MgSO_4$), filtered, and concentrated *in vacuo* to a crude orange oil. Purification by flash chromatography (eluting with 0-5% ethyl acetate/hexanes) afforded the alcohol **10** as an orange oil. The orange oil was taken up in dichloromethane (20 mL), treated with triethylamine (4 mL), and stirred overnight. Solvent was remove *in vacuo*, and the residue was purified by flash chromatography (eluting with 0-5% ethyl acetate/hexanes) furnishing the allylic alcohol **10** (0.77 g, 77%) as a light yellow oil. The oil was freshly distilled

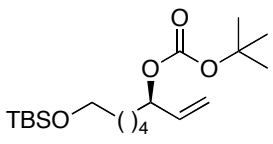
under high vacuum prior to use in the etherification reaction: $[\alpha]_D^{26}$ +2.4 (c = 1.11, $CHCl_3$); IR (neat) 3450 (bm), 3088 (m), 3066 (m), 3031(m), 2926 (s), 2855 (s), 1644 (w), 1607 (w), 1587 (w), 1497 (m), 1455 (m) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.36-7.30 (m, 5H), 5.89 (ddd, *J* = 17.0, 10.5, 6.3 Hz, 1H), 5.37 (dt, *J* = 17.4, 1.4 Hz, 1H), 5.23 (dt, *J* = 10.4, 1.3 Hz, 1H), 4.65 (d, A of AB, J_{AB} = 11.3 Hz, 1H), 4.55 (d, B of AB, J_{AB} = 11.3 Hz, 1H), 4.08 (t, *J* = 6.1 Hz, 1H), 3.36 (q, *J* = 5.8 Hz, 1H), 2.49 (bs, 1H), 1.67-1.51 (m, 2H), 1.40-1.27 (m, 12H), 0.89 (t, *J* = 6.9 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.49 (e), 137.88 (o), 128.69 (o), 128.08 (o), 128.02 (o), 117.02 (e), 82.53 (o), 74.62 (o), 72.81 (e), 32.07 (e), 30.59 (e), 30.05 (e), 29.71 (e), 29.46 (e), 25.26 (e), 22.88 (e), 14.33 (o); HRMS (ESI, M+Na^+) calcd for $C_{19}H_{30}O_2Na$ 313.2144, found 313.2136.



(*R*)-11

(*R*)-8-(*tert*-Butyldimethylsilyloxy)oct-1-en-3-ol (*R*)-11. Titanium(IV) isopropoxide (405 μl, 1.36 mmol) was added to a –23 °C solution of (+)-dicyclohexyl-L-tartrate (641.3 mg, 2.04 mmol) and crushed 4Å molecular sieves (1.054 g, 30 weight %, dried *in vacuo* at 160 °C for *ca*. 12 hours prior to addition) in dichloromethane(54 ml, 0.25 M in substrate) stirred under an atmosphere of nitrogen at –23 °C for 30 minutes. The reaction was then treated with *tert*-butyl hydroperoxide (3.0 ml, 15.0 mmol, 5-6M solution in decane, dried with 4Å molecular sieves for *ca*. 3 hours prior to addition) followed by ***rac*-11** (3.516 g, 13.6 mmol). The reaction mixture was stirred under an atmosphere of nitrogen at –23 °C (maintained by a constant temperature bath using a NesLab Cryocool) until the enantiomeric excess was ≥95% (9 days, monitored by ^1H NMR after conversion to the (*R*)-Mosher's ester). The reaction was then warmed to 0 °C and poured into a freshly prepared aqueous solution of ferrous sulfate heptahydrate (6.0 g, 22 mmol), and tartaric acid (1.8 g, 11 mmol) in deionized water (18 ml) at 0 °C. The two-phase mixture was stirred for 10 minutes, filtered through

Celite, the phases separated and the aqueous phase extracted with diethyl ether. The combined organic layers were treated with a pre-cooled (0 °C) solution of 30% aqueous solution of sodium hydroxide (w/v) in saturated brine. The two-phase mixture was stirred vigorously for 1 hour at 0 °C then filtered through a pad of Celite, before being transferred to a separatory funnel and diluted with water. The phases were separated and the aqueous layer was extracted with diethyl ether. The organic layers were then combined, dried ($MgSO_4$), filtered, and concentrated *in vacuo* to afford a crude oil. Purification by flash chromatography (eluting with 10-20% ethyl acetate/hexanes) furnished the enantiomerically enriched allylic alcohol **(*R*)-11** (1.1042 g, 31%) as a colorless oil: $[\alpha]_D^{26}$ -3.1 (c = 1.29, $CHCl_3$); IR (neat) 3360 (bs), 2931 (s), 2858 (s), 1644 (m), 1472 (m), 1463 (m) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 5.84 (ddd, *J* = 17.1, 10.4, 6.4 Hz, 1H), 5.19 (dt, *J* = 17.4, 1.4 Hz, 1H), 5.07 (dt, *J* = 10.2, 1.2 Hz, 1H), 4.07 (q, *J* = 6.0 Hz, 1H), 3.57 (t, *J* = 6.4 Hz, 2H), 1.58-1.21 (m, 9H), 0.86 (s, 9H), 0.02 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.51 (o), 114.78 (e), 73.42 (o), 63.37 (e), 37.25 (e), 32.99 (e), 26.20 (o), 25.98 (e), 25.35 (e), 18.58 (e), -5.06 (o); HRMS (EI, $M-H^+$) calcd for $C_{14}H_{29}O_2Si$ 257.1937, found 257.1938.

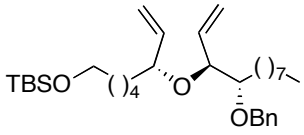


12

***tert*-Butyl(1*R*)-1-(5-{[*tert*-Butyldimethylsilyl]oxy }pentyl)prop-2-en-1-yl carbonate 12.**

The allylic alcohol **(*R*)-11** (1.024 g, 4.0 mmol) was dissolved in anhydrous tetrahydrofuran (40 mL) and cooled with stirring to 0 °C. Lithium *bis*(trimethylsilyl)amide (4.0 mL, 1.0 eq, 1.0M solution in THF) was added dropwise, keeping the temperature <5 °C, followed by the addition of BOC-ON (1.97g, 2.0 eq.) in a single portion from a weighing vial. The reaction was stirred until the allylic alcohol was consumed (t.l.c. control), then the reaction was then quenched by addition of saturated NH_4Cl solution with rapid stirring for *ca*. 12 hours. The reaction mixture was

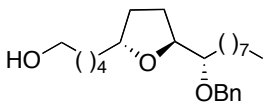
partitioned between diethyl ether and saturated aqueous NH_4Cl solution, the organic layers were combined, washed with saturated aqueous sodium chloride solution, dried (Na_2SO_4), filtered and concentrated *in vacuo* to afford a crude oil. Purification by flash chromatography (eluting with a 2% ethyl acetate/hexane) furnished the desired allylic carbonate **12** (82%, 1.162g): $[\alpha]_D^{27}$ +2.6 (c = 1.01, $CHCl_3$); IR (neat) 3087 (w), 2934 (s), 2859 (s), 1743 (s), 1648 (w), 1473 (m), 1463 (m), 1277 (s), 1255 (s) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 5.78 (ddd, *J* = 17.2, 10.5, 6.7 Hz, 1H), 5.26 (d, *J* = 17.4 Hz, 1H), 5.18 (d, *J* = 10.4 Hz, 1H), 4.97 (q, *J* = 6.7 Hz, 1H), 3.58 (t, *J* = 6.6 Hz, 2H), 1.71-1.30 (m, 8H), 1.48 (s, 9H), 0.88 (s, 9H), 0.03 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 153.26 (e), 136.66 (o), 117.23 (e), 82.11 (e), 78.26 (o), 63.32 (e), 34.50 (e), 32.91 (e), 28.03 (o), 26.19 (o), 25.83 (e), 25.12 (e), 18.58 (e), -5.07 (o); HRMS (ESI, $M+Na^+$) calcd for $C_{19}H_{38}O_4SiNa$ 381.2437, found 381.2434.



13

(3*S*,4*S*,6*R*)-13,13,14,14-Tetramethyl-3-octyl-1-phenyl-4,6-divinyl-2,5,12-trioxa-13-silapentadecane 13. Trimethyl phosphite (35 μL, 0.30 mmol) was added directly to a red suspension of Wilkinson's catalyst (69.4 mg, 0.075 mmol) in anhydrous THF (1.5 mL) under an atmosphere of argon. The catalyst was allowed to form over *ca*. 15 minutes resulting in a light yellow homogeneous solution. Lithium *bis*(trimethylsilyl)amide (475 μL, 0.475 mmol, 1.0M solution in THF) was added dropwise to a suspension of copper(I) iodide (95.2 mg, 0.5 mmol, previously dried *in vacuo* at 160 °C freshly pyrolized in the dark), trimethyl phosphite (59 μL, 0.50 mmol), and the alcohol **10** (145.2 mg, 0.50 mmol) in anhydrous THF (1.0 mL) under an atmosphere of argon. The anion was allowed to form over *ca.* 2 minutes until a light green homogeneous solution was obtained. The catalyst and the alkoxide solutions were then cooled with stirring to 0 °C, and the former was then added *via* Teflon® cannula to the copper alkoxide

solution. The allylic carbonate **12** (90.8 mg, 0.25 mmol) was then added *via* a tared 500 μL gastight syringe to the catalyst/alkoxide mixture, and the reaction was allowed to slowly warm to room temperature over *ca.* 18 hours resulting in a tan heterogeneous solution (t.l.c. control). The reaction was quenched with NH_4Cl, partitioned between diethyl ether and saturated aqueous NH_4Cl solution. The organic layers were then combined, washed with saturated aqueous sodium chloride solution, dried (Na_2SO_4), filtered and concentrated *in vacuo* to afford a crude oil. Purification by flash chromatography (eluting with 2-4% ethyl acetate/hexanes) furnished the allyl ether **13** (93.5 mg, 69%): $[\alpha]_D^{27}$ -10.1 (c = 1.02, $CHCl_3$); IR (neat) 3076 (w), 3030 (w), 2929 (s), 2857 (s), 1642 (w), 1497 (w), 1463 (m), 1255 (m) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.34-7.22 (m, 5H), 5.69 (ddd, *J* = 17.7, 10.5, 7.5 Hz, 1H), 5.60 (ddd, *J* = 17.5, 10.5, 7.6 Hz, 1H), 5.22 (dd, *J* = 10.4, 1.5 Hz, 1H), 5.17 (d, *J* = 17.4 Hz, 1H), 5.13 (dd, *J* = 10.7, 1.8 Hz, 1H), 5.09 (dd, *J* = 17.1, 1.4 Hz, 1H), 4.71 (d, A of AB, J_{AB} = 11.6 Hz, 1H), 4.52 (d, B of AB, J_{AB} = 11.6 Hz, 1H), 3.91 (t, *J* = 6.6 Hz, 1H), 3.70 (q, *J* = 6.8 Hz, 1H), 3.57 (t, *J* = 6.6 Hz, 2H), 3.37-3.32 (m, 1H), 1.59-1.21 (m, 22H), 0.87 (s, 9H), 0.86 (t, *J* = 7.0 Hz, 3H), 0.02 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.66 (o), 139.29 (e), 136.23 (o), 128.42 (o), 128.25 (o), 127.61 (o), 118.29 (e), 117.12 (e), 81.54 (o), 79.67 (o), 78.26 (o), 73.27 (e), 63.47 (e), 35.98 (e), 33.05 (e), 32.10 (e), 30.91 (e), 29.90 (e), 29.79 (e), 29.50 (e), 26.20 (o), 26.01 (e), 25.39 (e), 22.90 (e), 18.58 (e), 14.34 (o), -5.05 (o); HRMS (ESI, $M+Na^+$) calcd for $C_{33}H_{58}O_3SiNa$ 553.4053, found 553.4038.

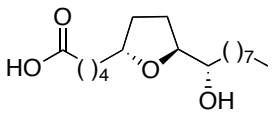


14

5-{(2*R*,5*S*)-5-[(1*S*)-1-(Benzyloxy)nonyl]tetrahydrofuran-2-yl}pentan-1-ol 14.

The diene **13** (69.4 mg, 0.13 mmol) was dissolved in anhydrous dichloroethane (1.3 ml) and stirred under an atmosphere of argon. Grubbs' *N*-heterocyclic carbene catalyst (11.0

mg, 0.013 mmol) was added in a single portion, and the resulting reaction mixture was heated at 40 °C for *ca.* 13 hours (t.l.c. control). The atmosphere was exchanged with hydrogen and the reaction mixture was stirred at 70 °C for *ca.* 6 hours (t.l.c. control). The reaction mixture was then cooled to room temperature, the reaction was diluted with methanol and hydrogen chloride (5 drops) added *via* pipet and the reaction was stirred at room temperature for *ca.* 1 hour. The reaction mixture was then cooled to 0 °C, and quenched by addition of saturated sodium hydrogen carbonate solution with rapid stirring. The reaction was partitioned between ethyl acetate and saturated aqueous sodium hydrogen carbonate solution. The organic layers were combined, washed with saturated aqueous sodium chloride solution, dried (Na_2SO_4), filtered and concentrated *in vacuo* to afford a crude oil. Purification by flash chromatography (eluting with a 5-20% ethyl acetate/hexane gradient) furnished the alcohol **14** (38.2 mg, 75%) as a colorless oil: $[\alpha]_D^{27}$ -15.9 (c = 1.08, $CHCl_3$); IR (neat) 3419 (bm), 3089 (m), 3064 (m), 3030 (m), 2925 (s), 1605 (w), 1497 (m), 1456 (s), 1207 (m) cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.36-7.22 (m, 5H), 4.73 (d, A of AB, J_{AB} = 11.5 Hz, 1H), 4.59 (d, B of AB, J_{AB} = 11.5 Hz, 1H), 4.03 (dt, *J* = 8.4, 6.4 Hz, 1H), 3.93-3.87 (m, 1H), 3.61 (t, *J* = 6.6 Hz, 2H), 3.29 (q, *J* = 5.9 Hz, 1H), 2.08-1.87 (m, 2H), 1.67-1.23 (m, 25H), 0.86 (t, *J* = 6.8 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.47 (e), 128.40 (o), 128.14 (o), 127.54 (o), 81.77 (o), 81.22 (o), 79.44 (o), 73.01 (e), 63.11 (e), 35.99 (e), 32.93 (e), 32.43 (e), 32.08 (e), 31.04 (e), 30.00 (e), 29.78 (e), 29.49 (e), 28.72 (e), 26.38 (e), 26.01 (e), 25.95 (e), 22.88 (e), 14.32 (o); HRMS (ESI, M+Na^+) calcd for $C_{25}H_{42}O_3Na$ 413.3032, found 413.3031.

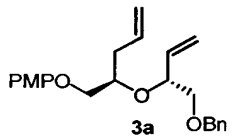


Guar Acid **7**

5-{(2*R*,5*S*)-5-[(1*S*)-1-hydroxynonyl]tetrahydrofuran-2-yl}pentanoic acid 7.

The alcohol **14** (7.6 mg, 0.02 mmol) was dissolved in

anhydrous *N,N*-dimethylformamide (200 μL) and stirred under an atmosphere of nitrogen. Pyridinium dichromate (52.7 mg, 0.14 mmol) was added in a single portion, and the resulting reaction mixture was stirred at room temperature for *ca.* 12 hours (t.l.c. control). The reaction was quenched by addition of water with rapid stirring. The reaction mixture was partitioned between diethyl ether and water, the organic layers were combined, washed with saturated aqueous sodium chloride solution, dried (Na_2SO_4), filtered and concentrated *in vacuo* to afford the crude acid **15**. The crude acid **15** was dissolved in ethyl acetate, (200 μL) and stirred under an atmosphere of nitrogen. Palladium hydroxide (1.4 mg, 0.002 mmol) was added in a single portion, then the atmosphere was exchanged with hydrogen and the resulting reaction mixture was stirred at room temperature for *ca.* 2 hours (t.l.c. control). The reaction was filtered through Celite, rinsing with ethyl acetate and concentrated *in vacuo* to afford a crude acid. Purification by flash chromatography (eluting with a 50% ethyl acetate/hexanes then 5% methanol/ethyl acetate) furnished guar acid **7** (4.8 mg, 79%) as a colorless oil: $[\alpha]_D^{25}$ -7.5 (c = 1.06, $CHCl_3$); IR (neat) 3445 (bm), 2923 (bs), 1715 (s), 1464 (s), 1410 (m), 1378 (m), 1236 (m) 1079 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 3.91–3.84 (m, 1H), 3.77 (q, *J* = 6.9 Hz, 1H), 3.36–3.35 (m, 1H), 2.36–2.32 (m, 2H), 2.03–1.91 (m, 2H), 1.65–1.24 (m, 24H), 0.85 (t, *J* = 6.7 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 179.18 (e), 82.31 (o), 79.20 (o), 74.36 (o), 35.35 (e), 33.49 (e), 32.63 (e), 32.09 (e), 29.94 (e), 29.76 (e), 29.50 (e), 28.62 (e), 25.90 (e), 25.84 (e), 24.91 (e), 22.88 (e), 14.33 (o); HRMS (ESI, $M+Na^+$) calcd for $C_{18}H_{34}O_4Na$ 337.2355, found 337.2355.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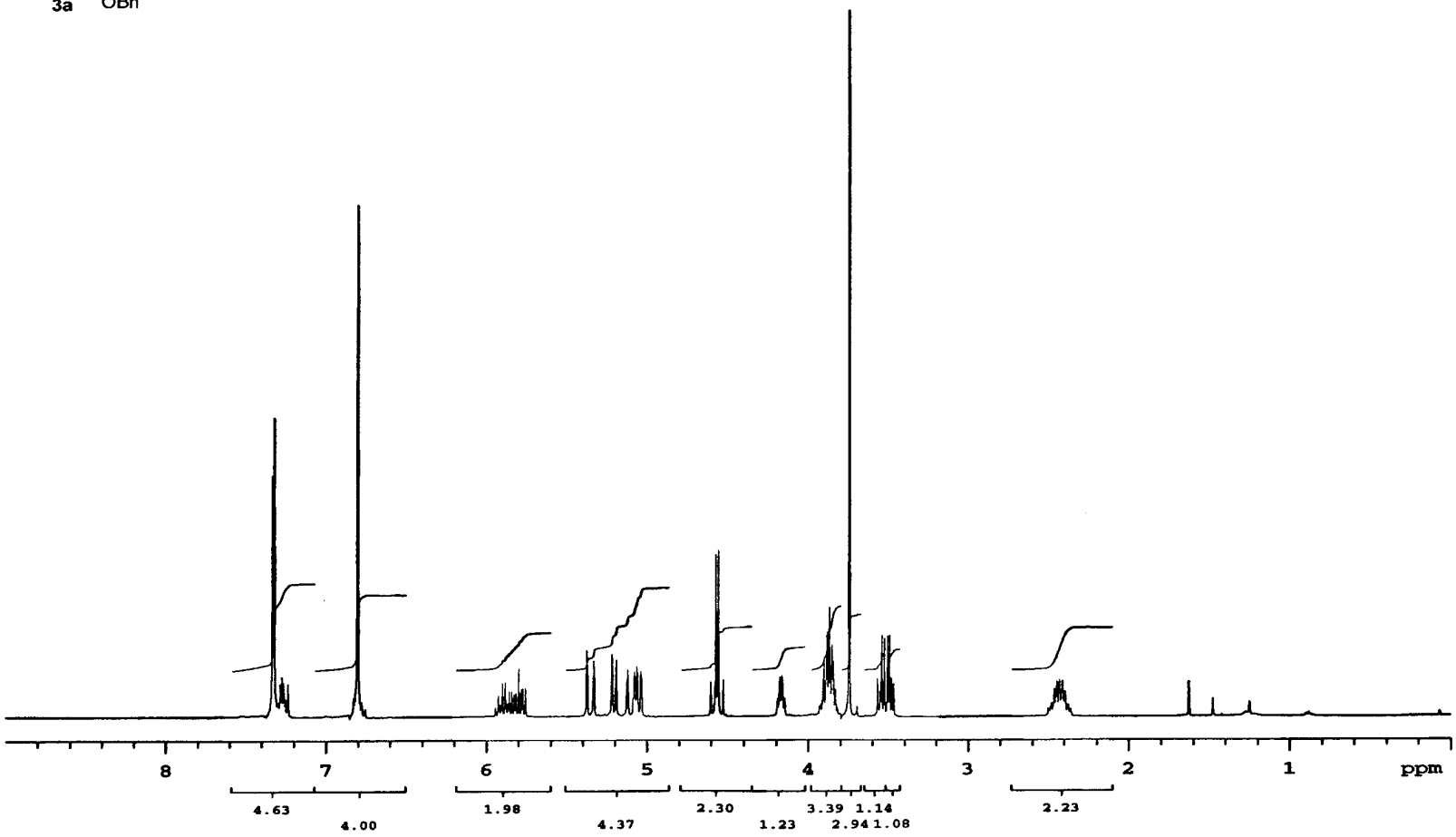
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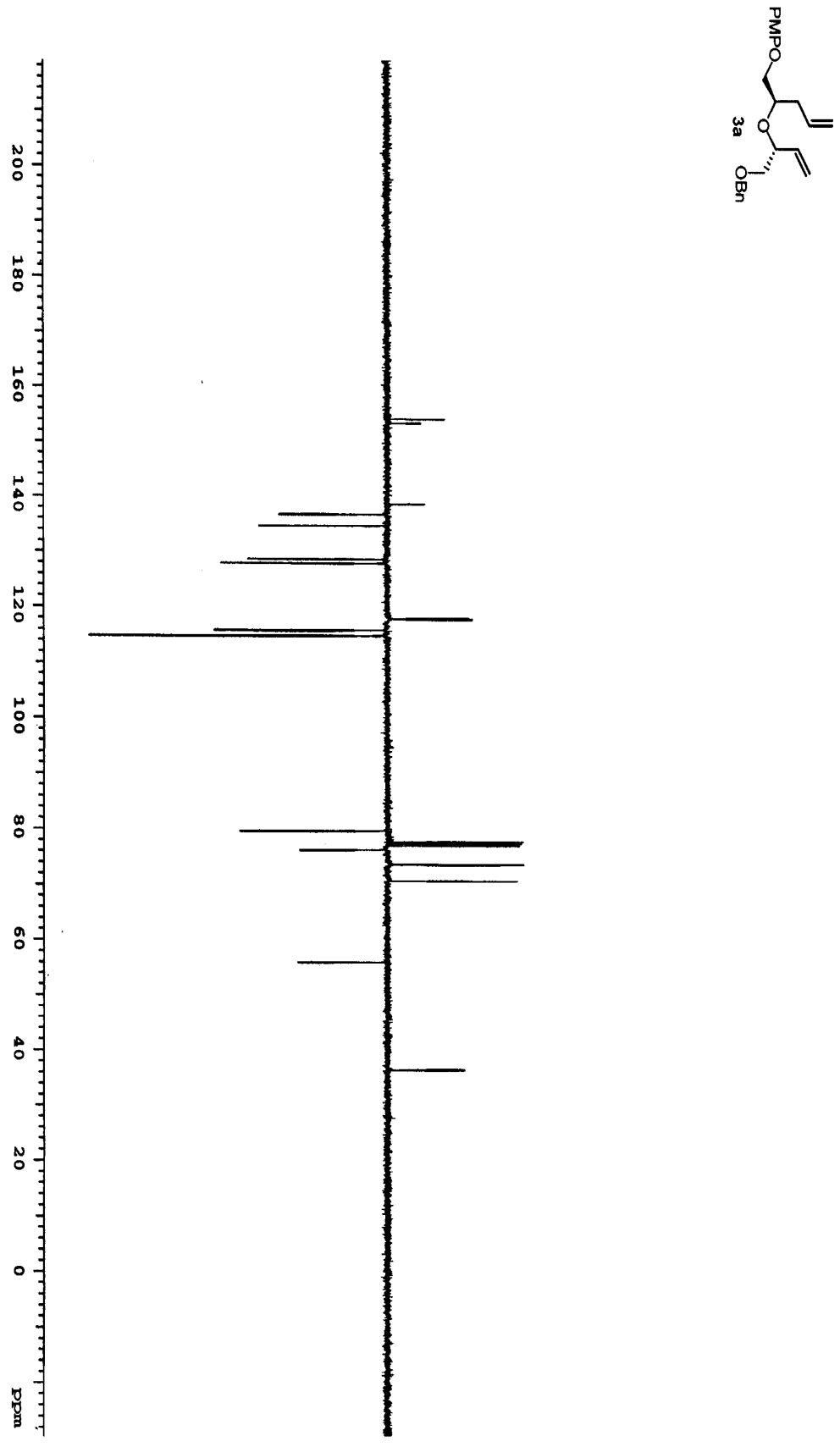
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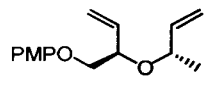
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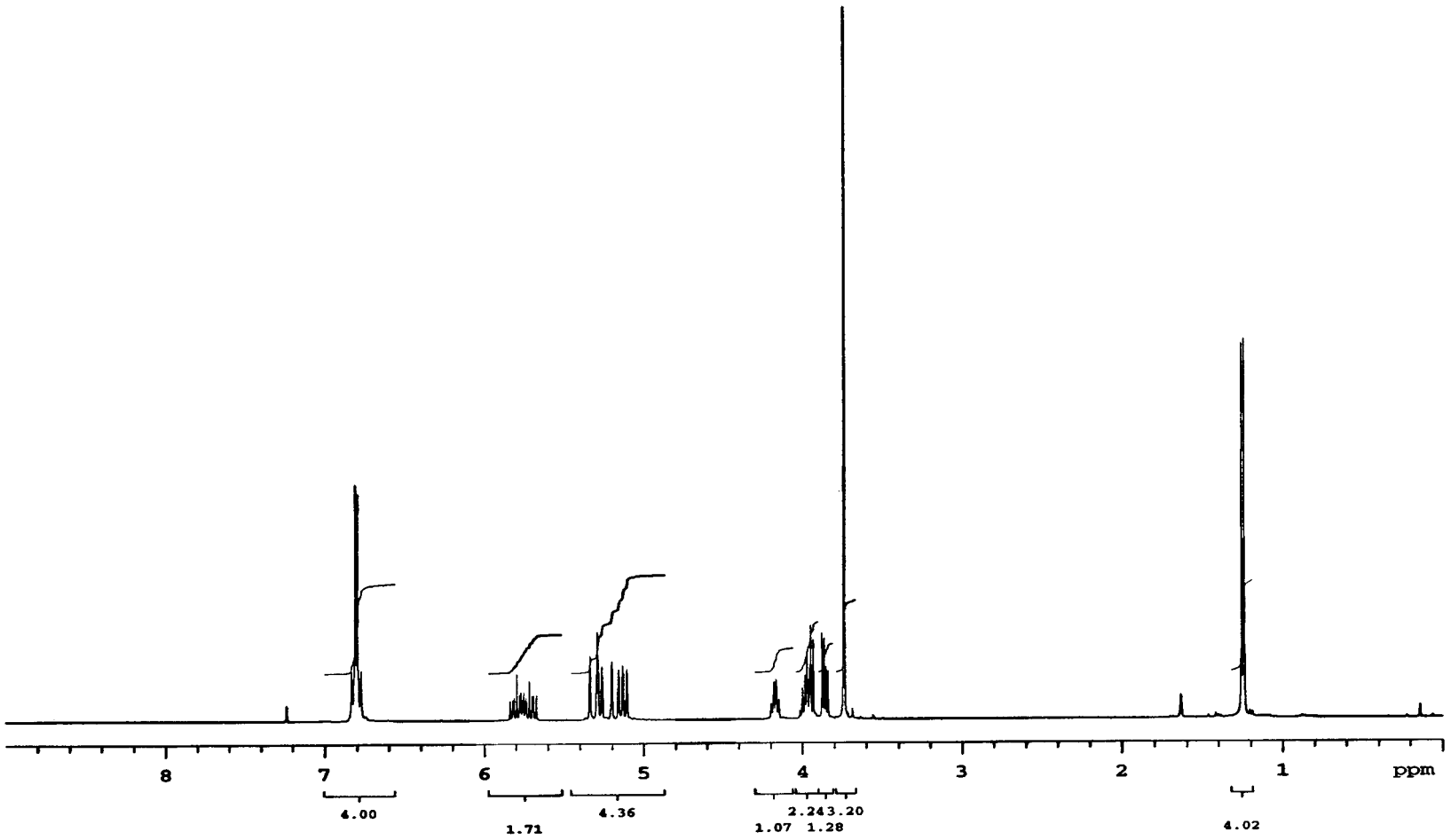
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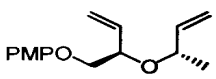
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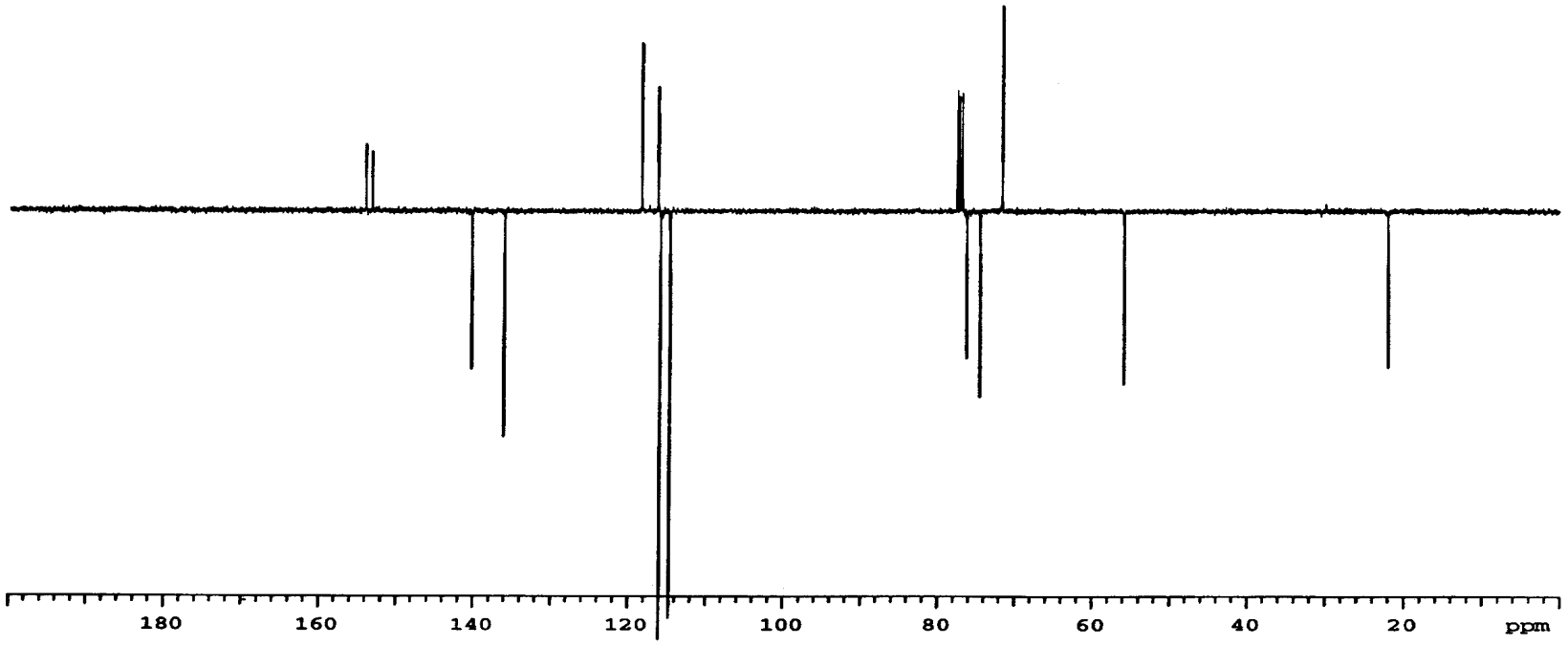
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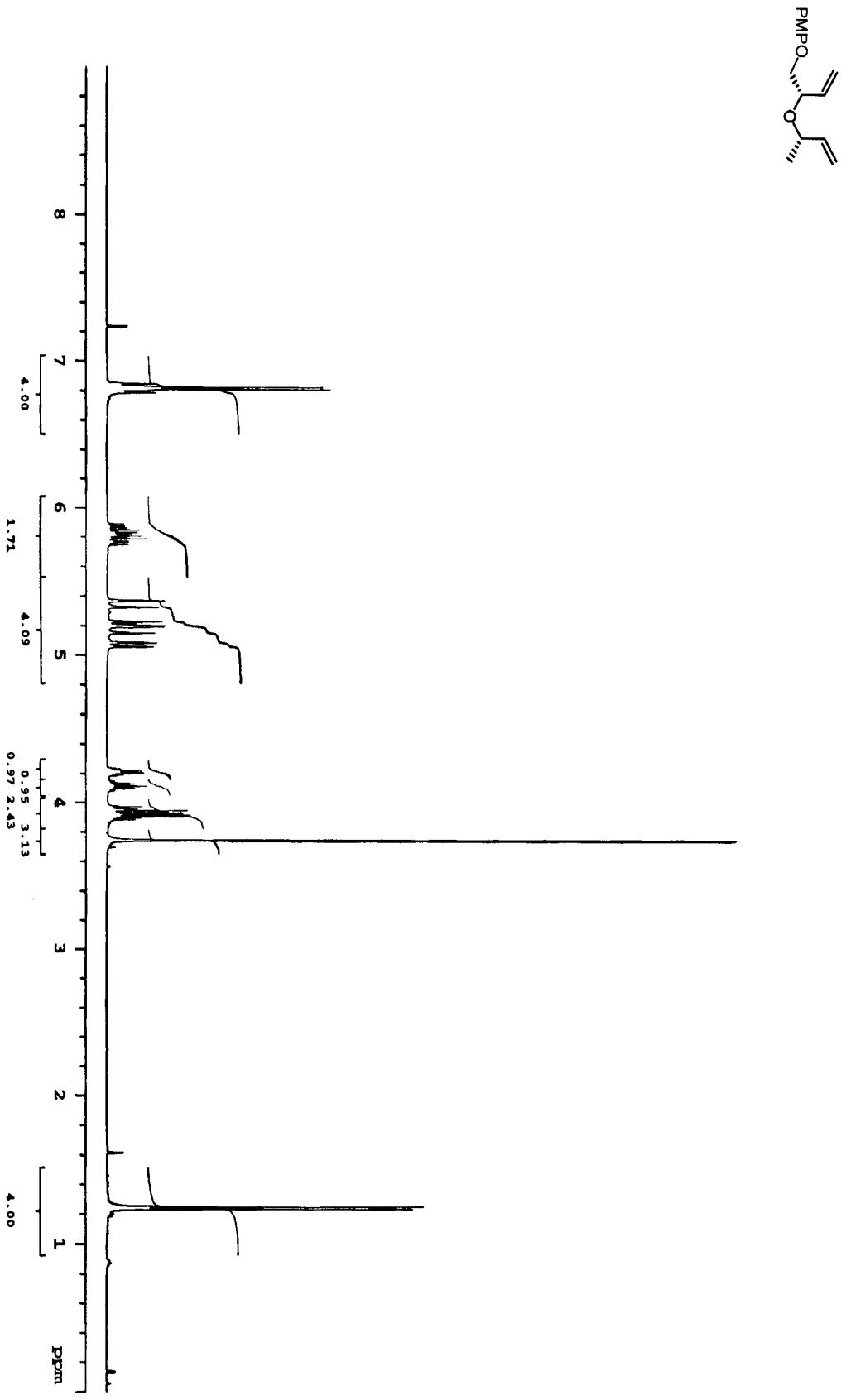
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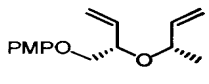
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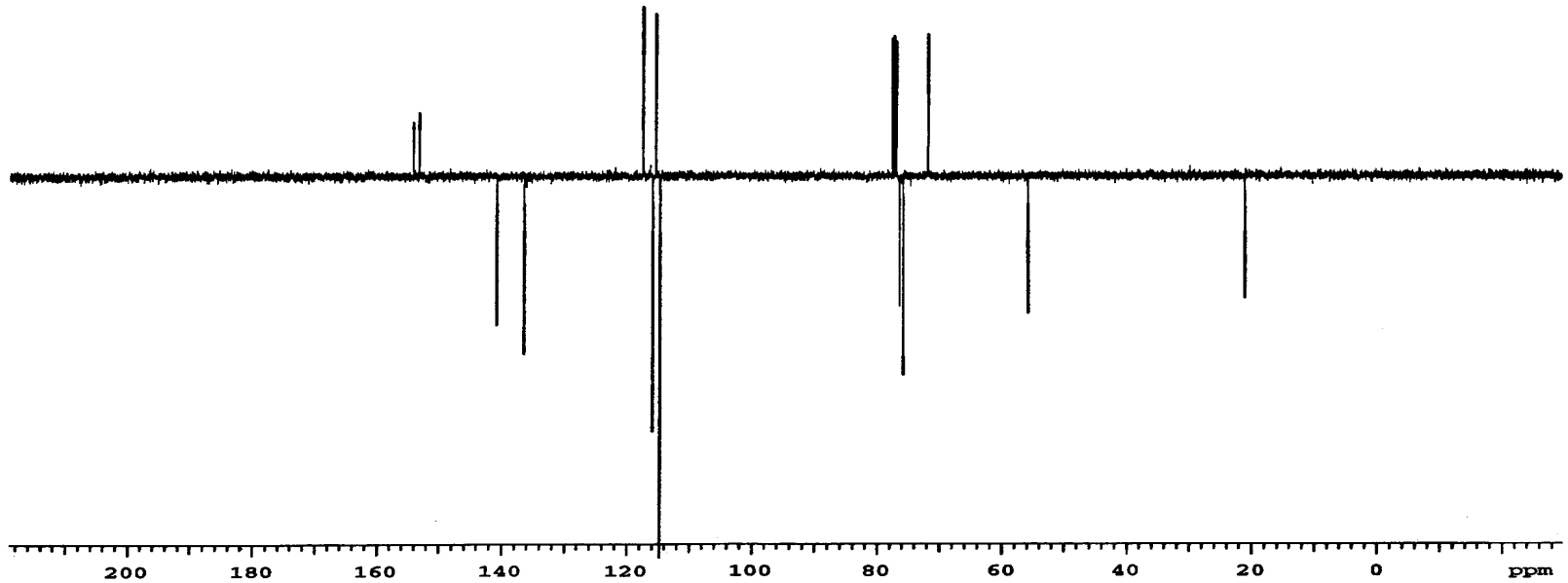
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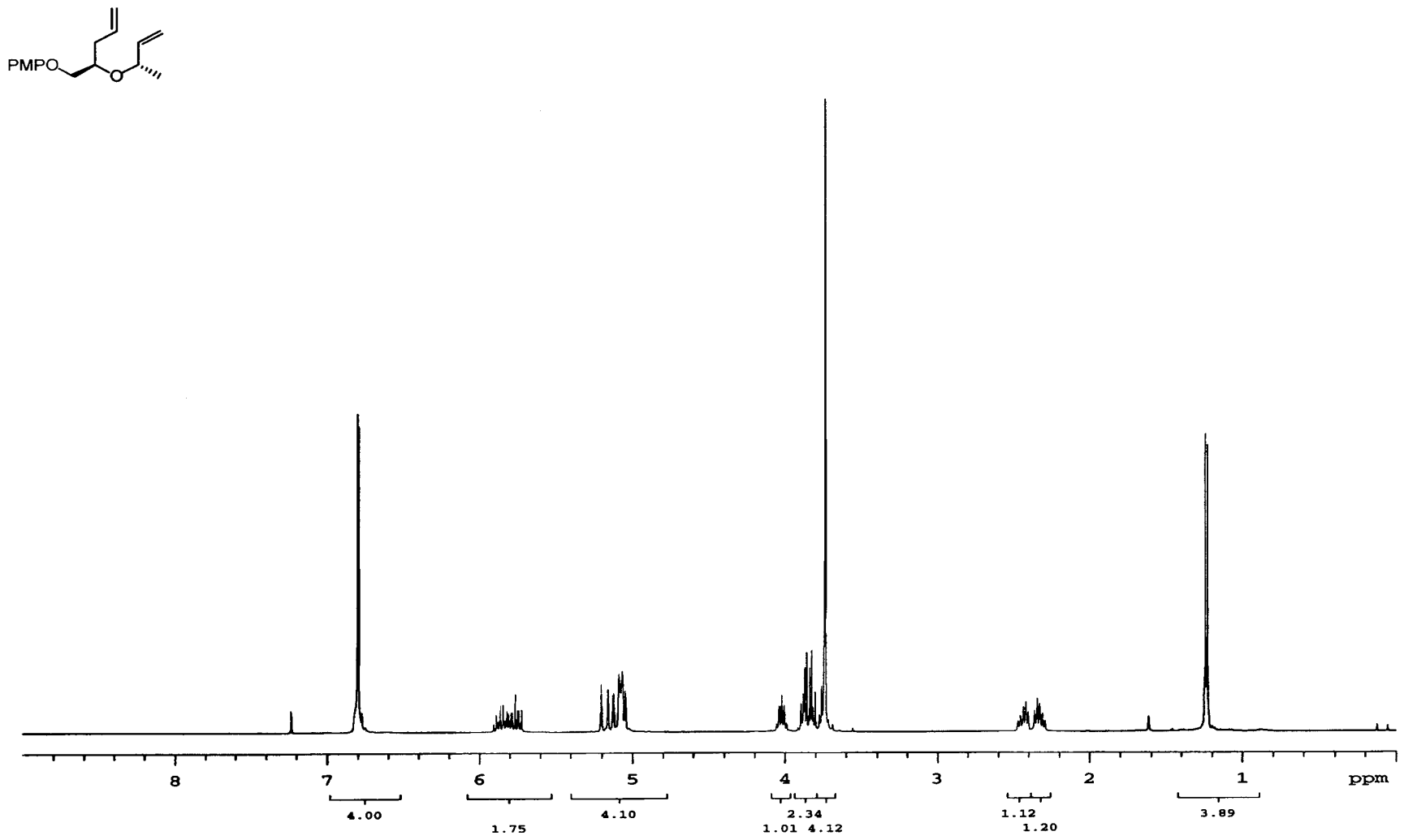
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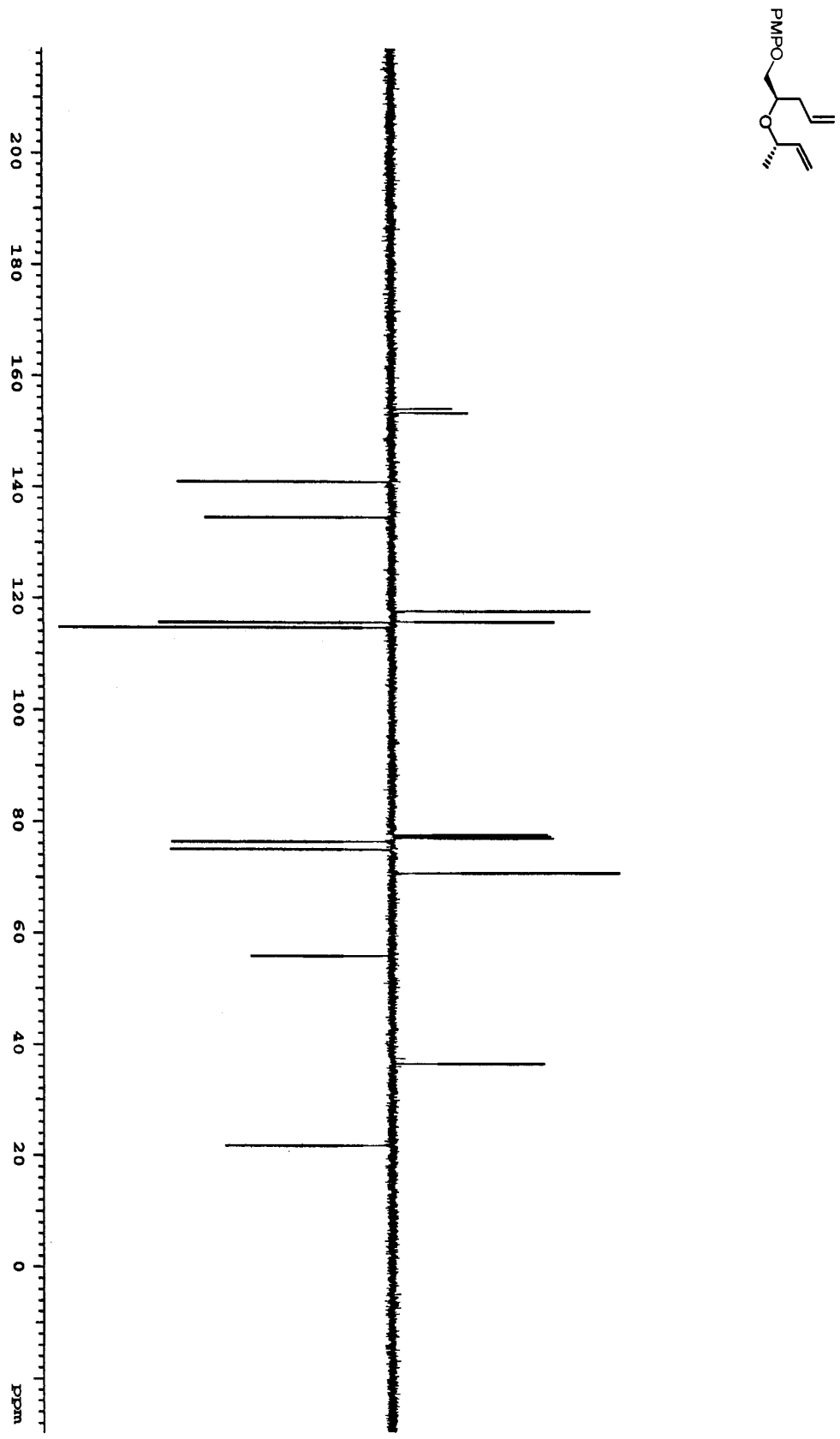
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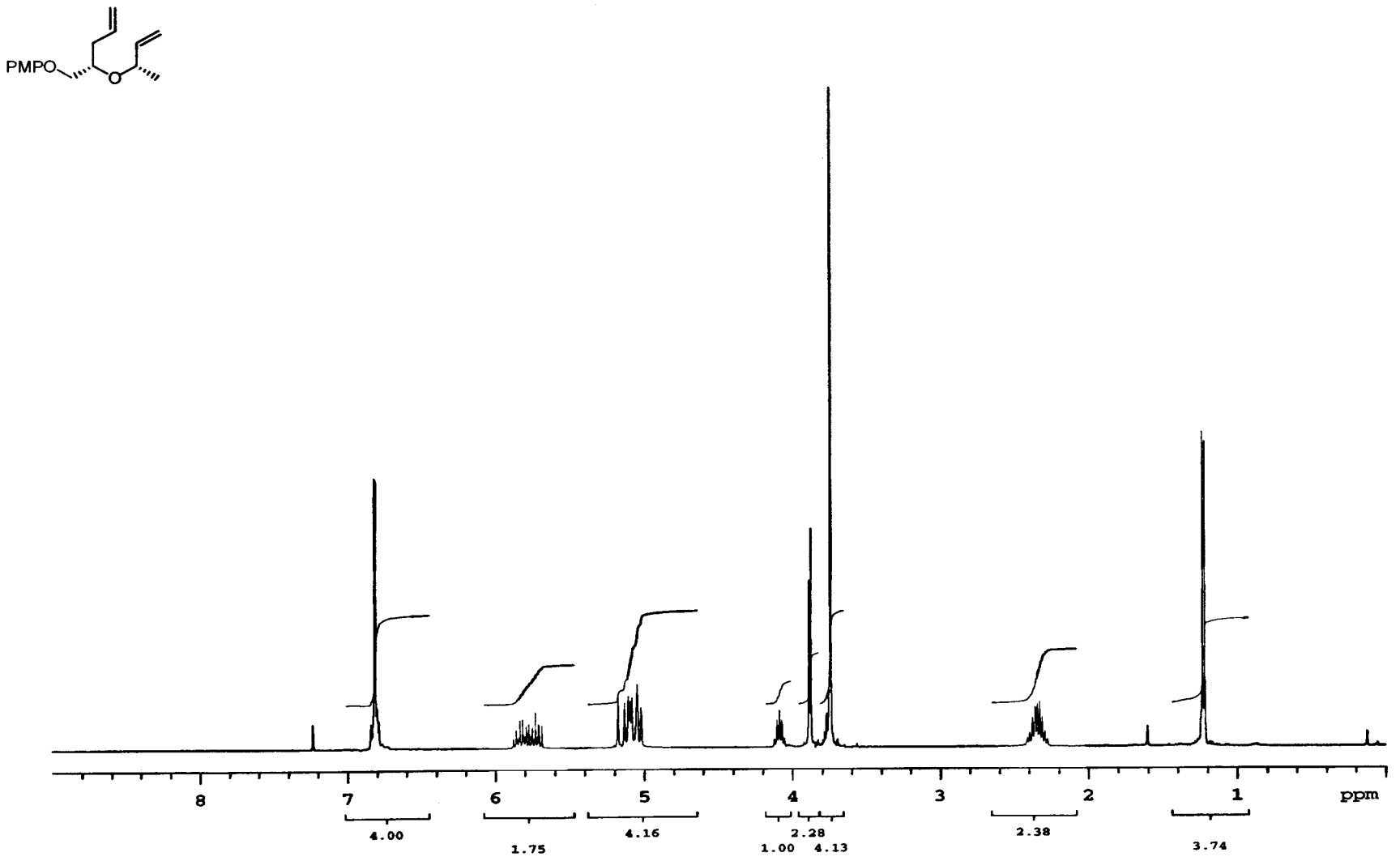
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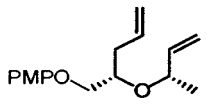
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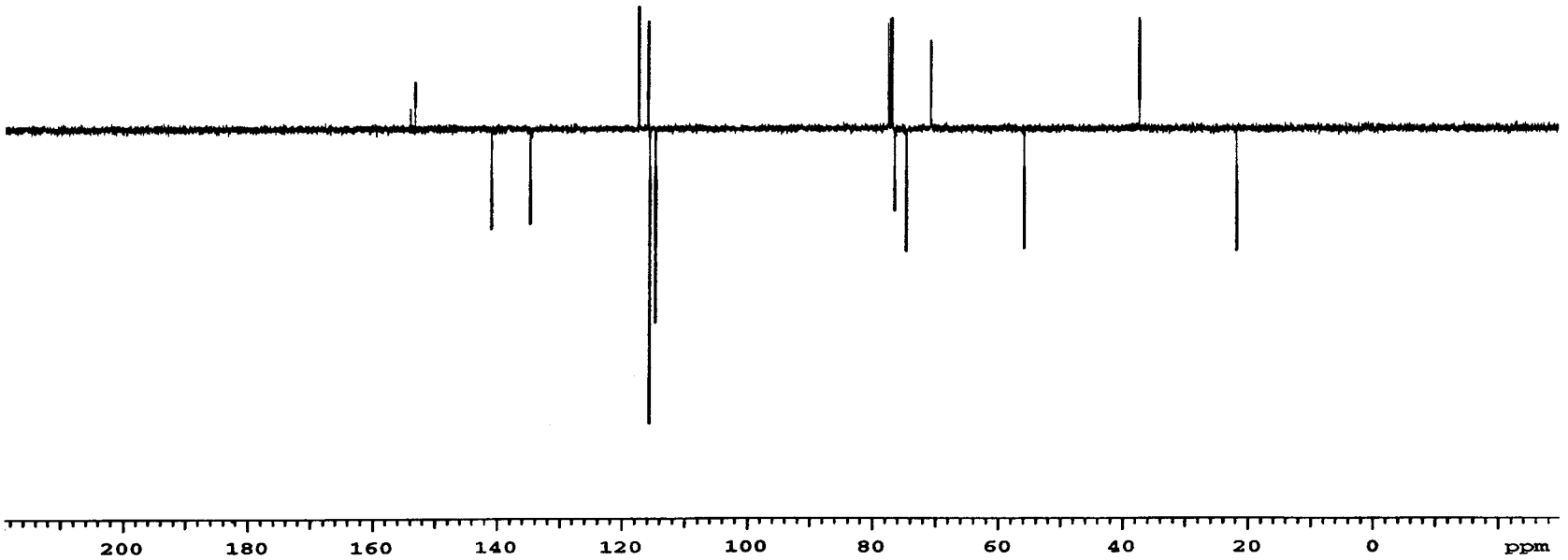
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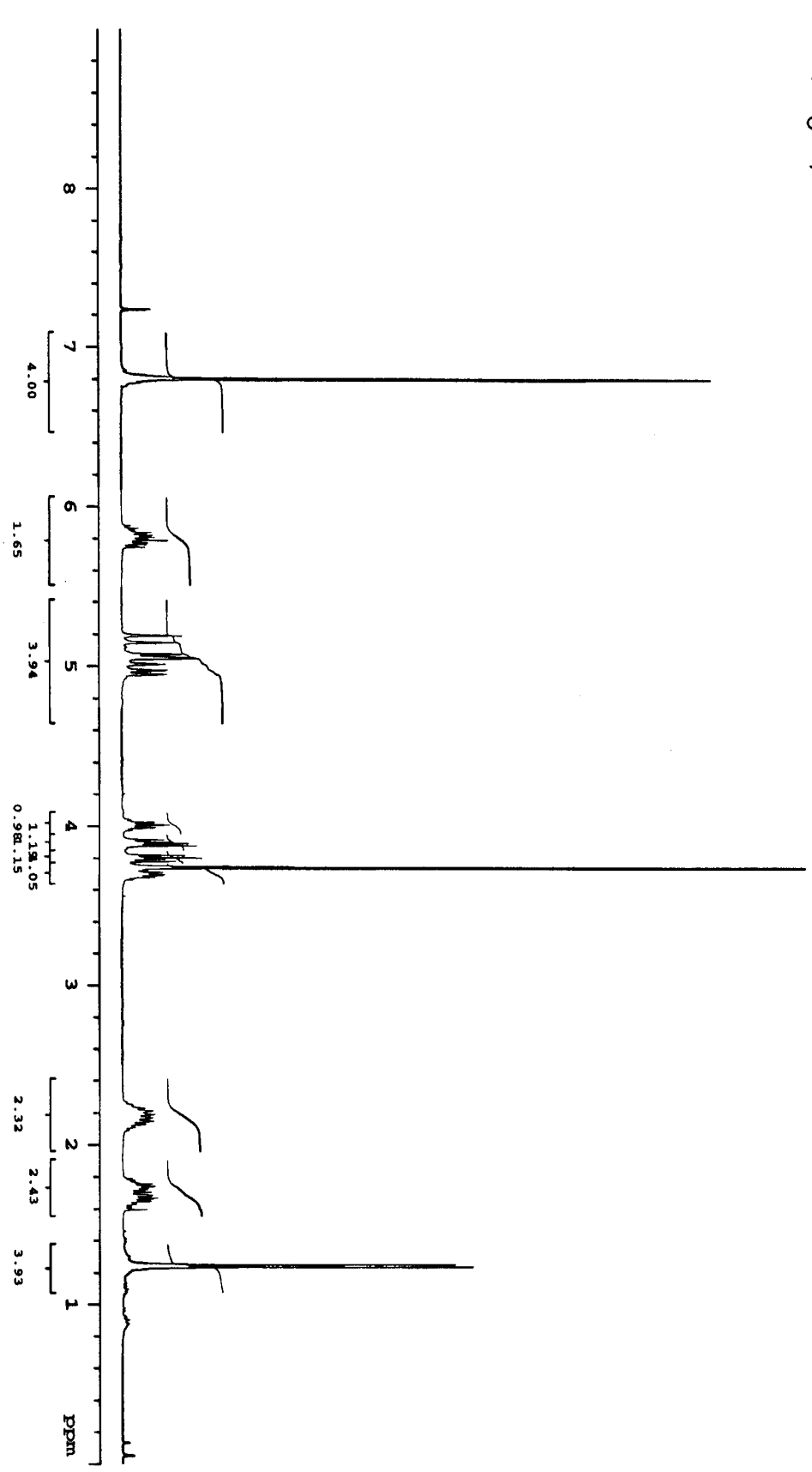
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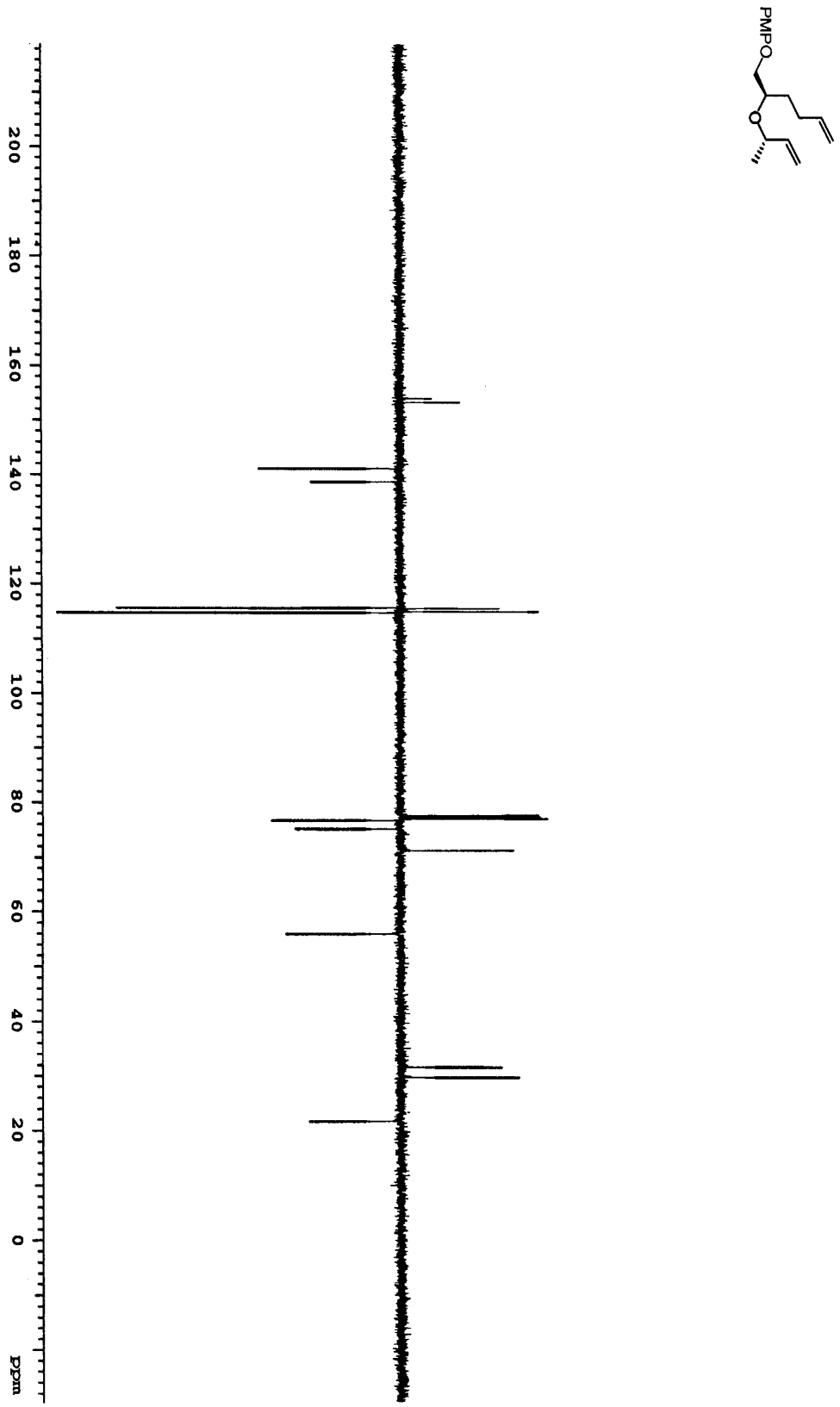
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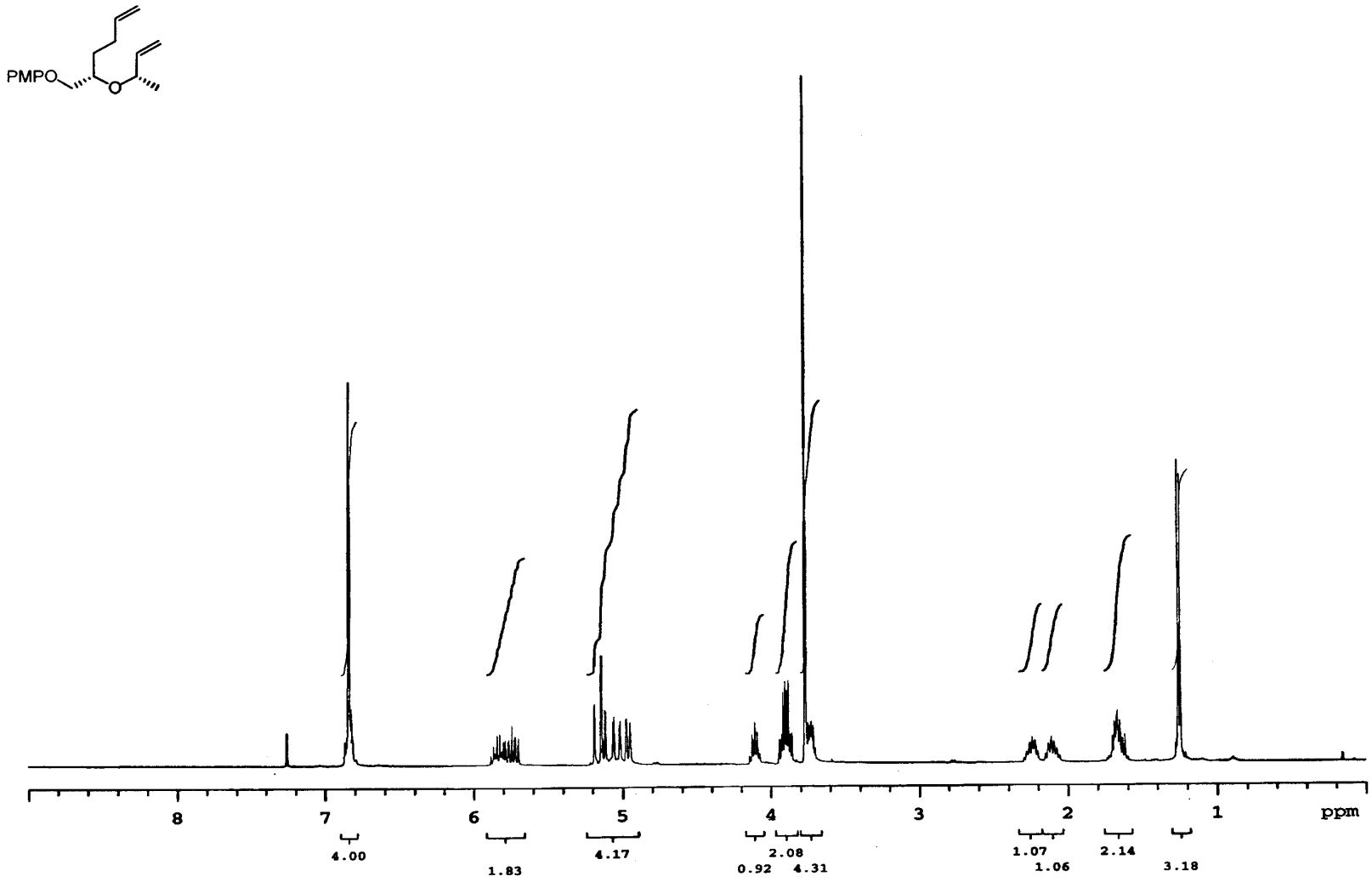
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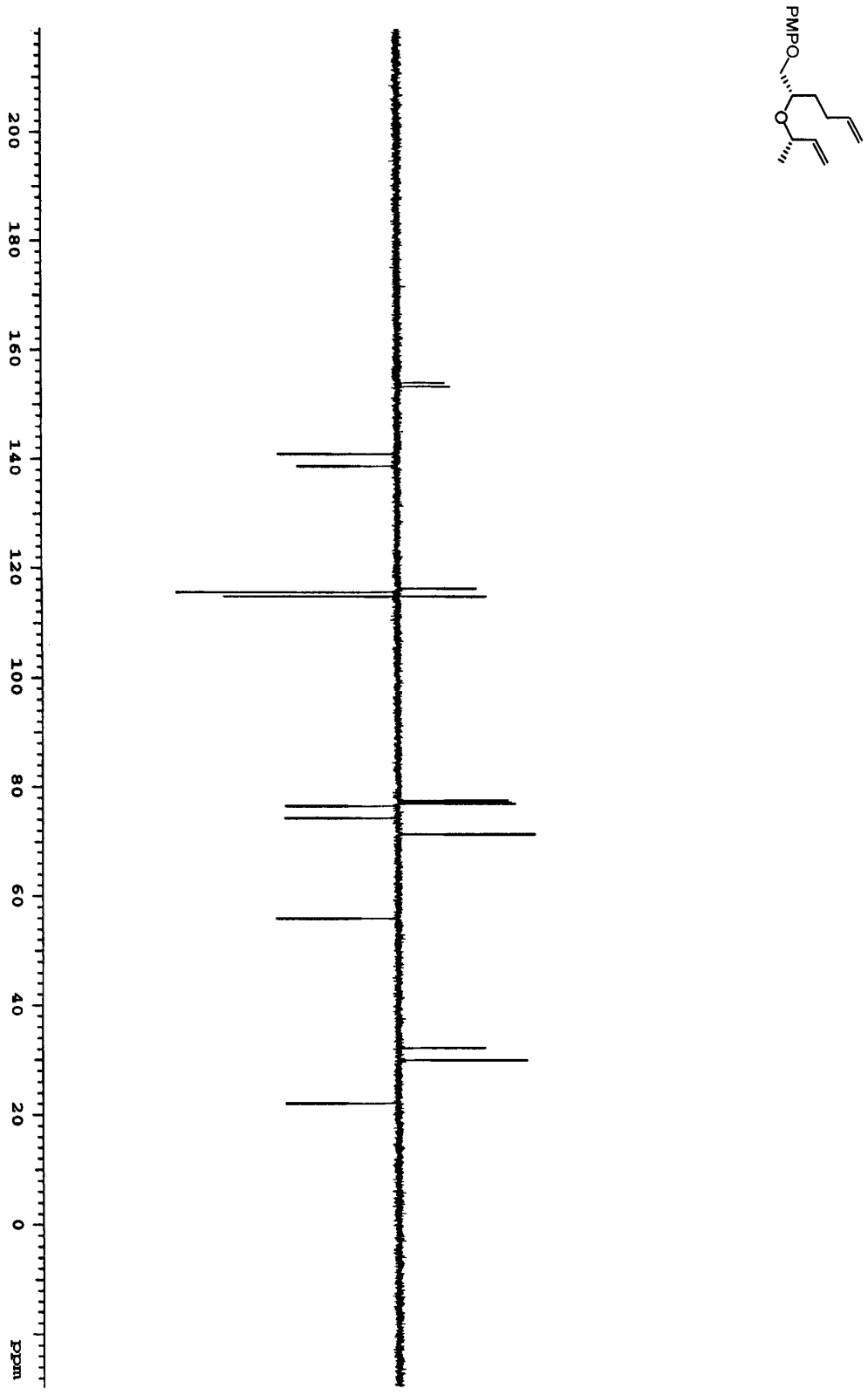
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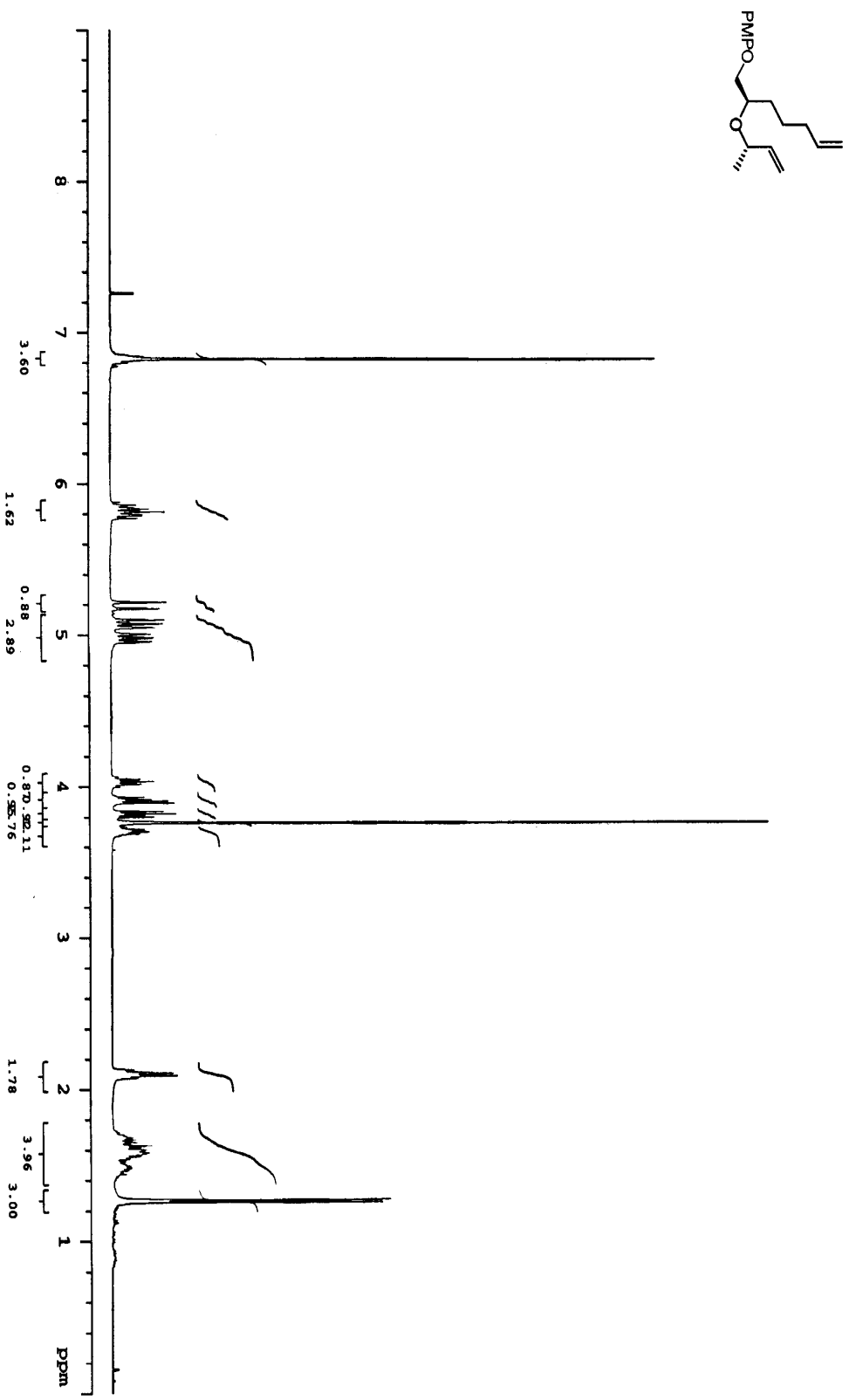
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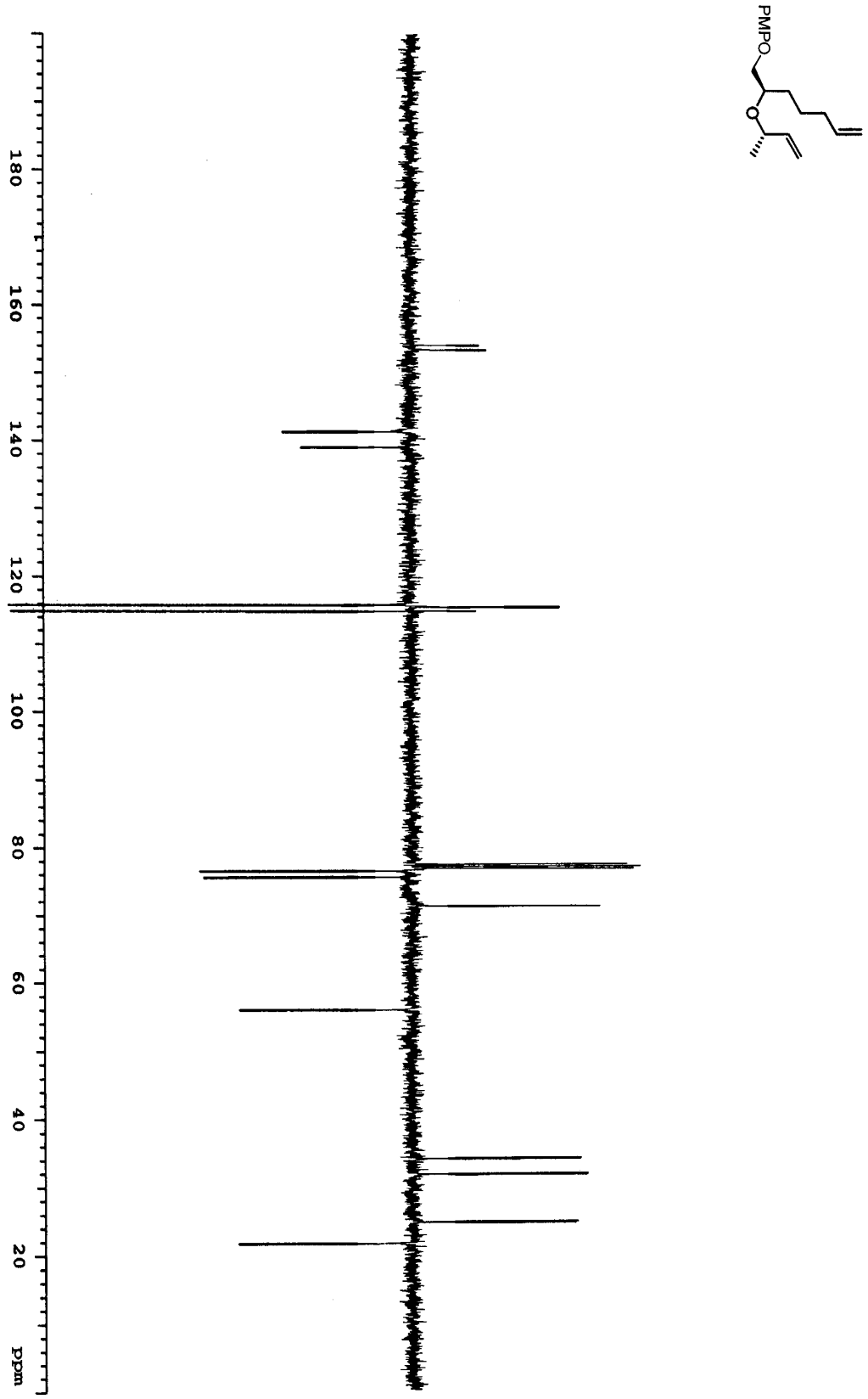
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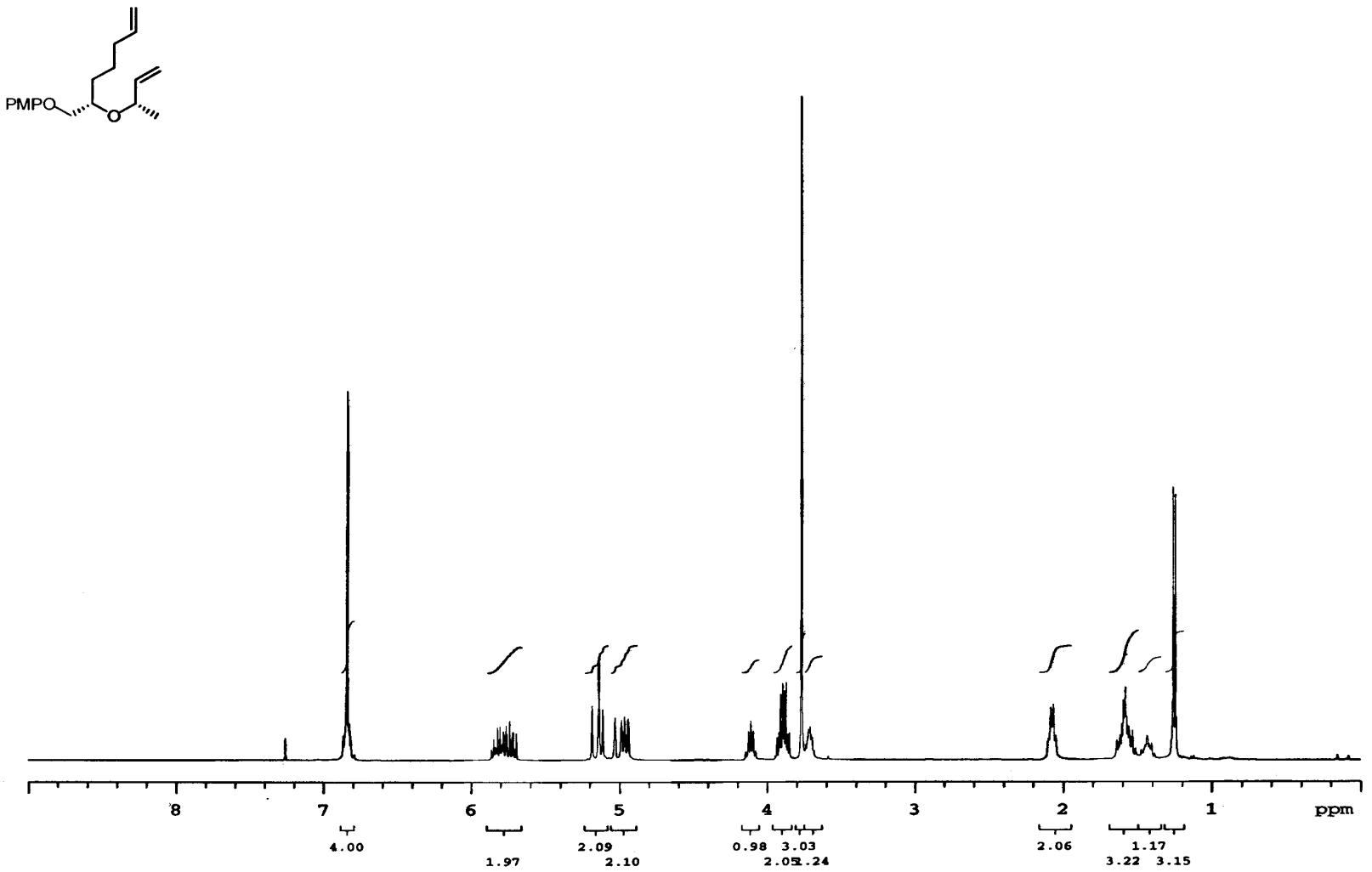
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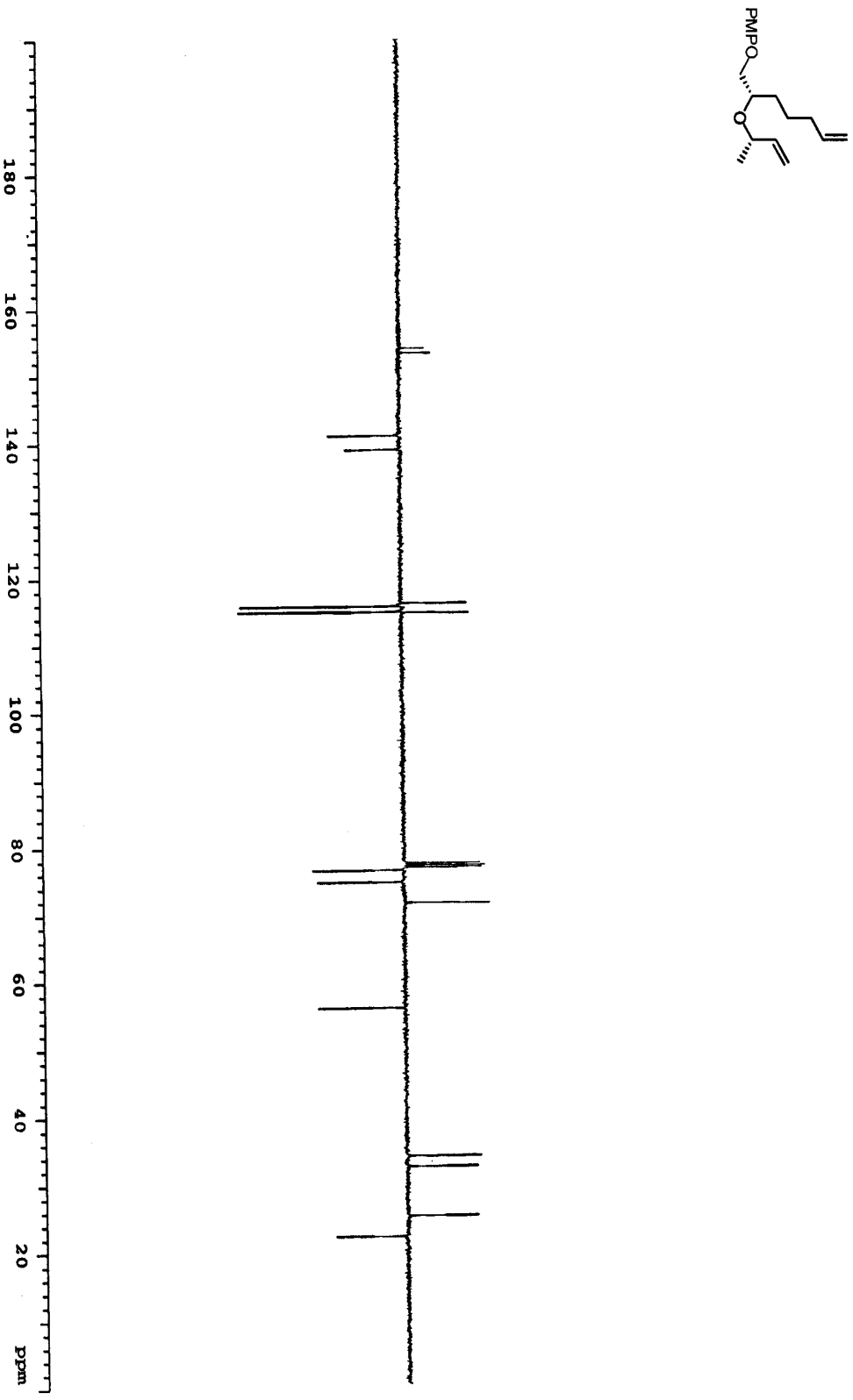
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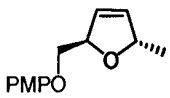

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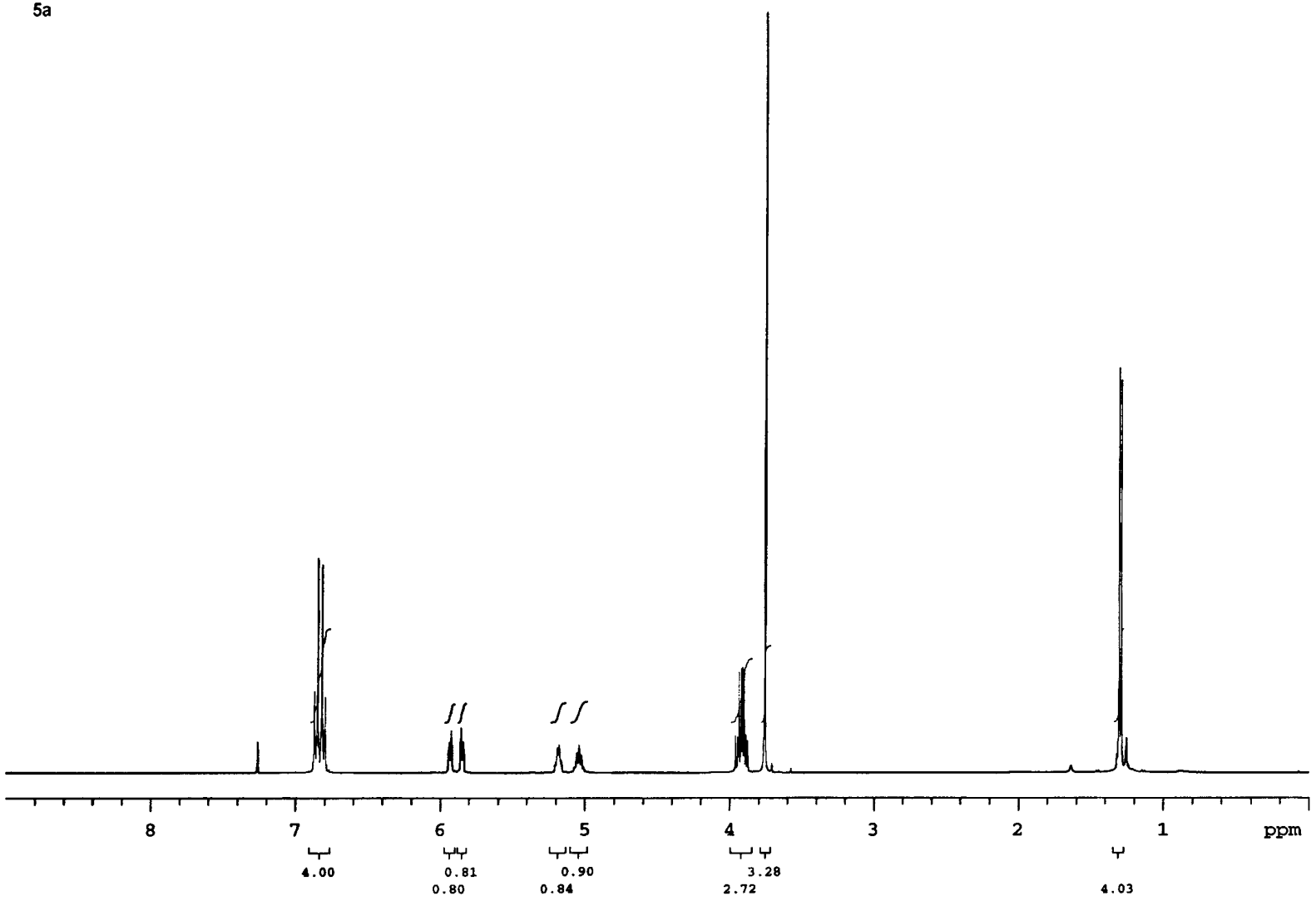

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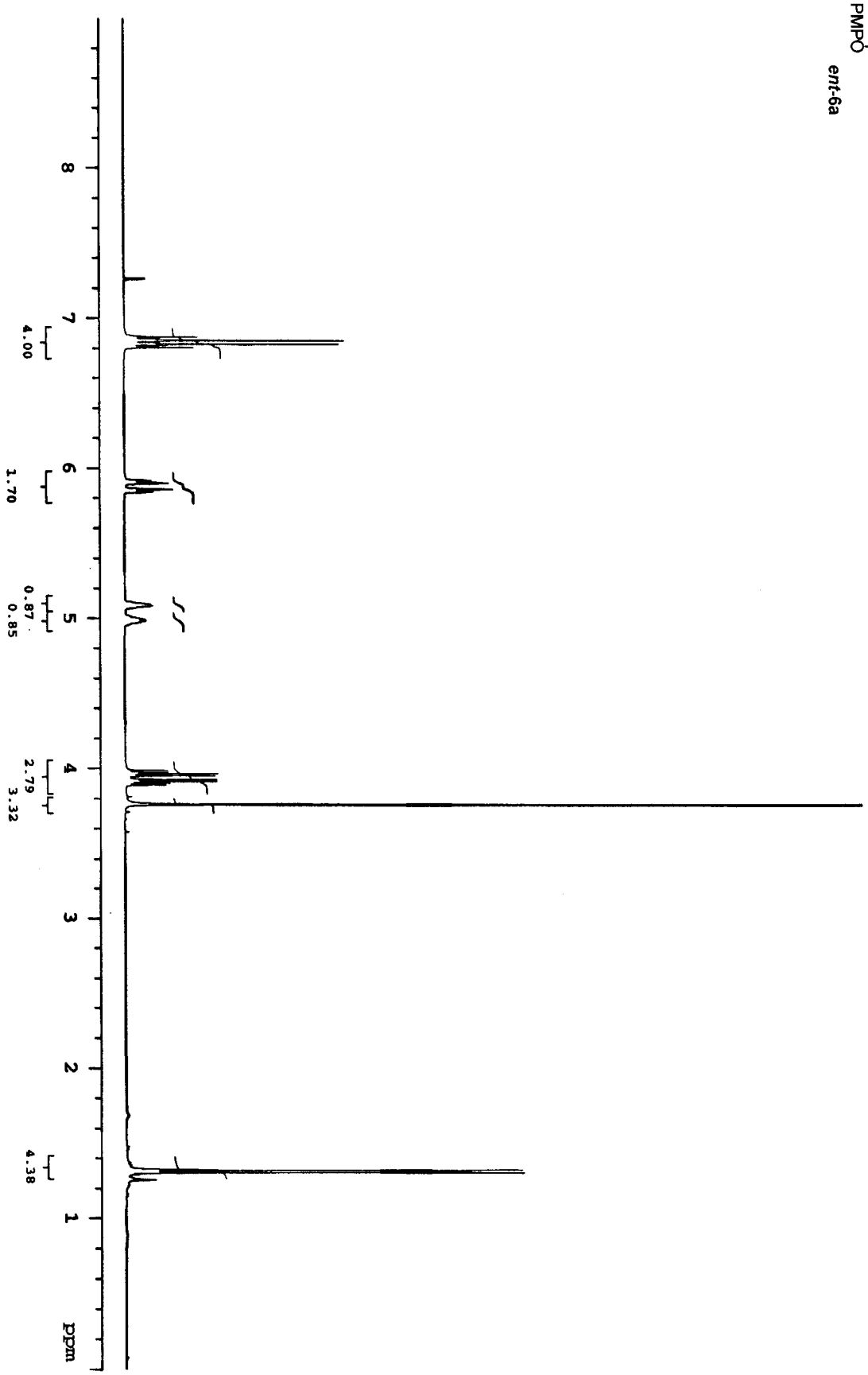
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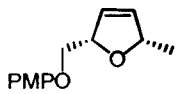

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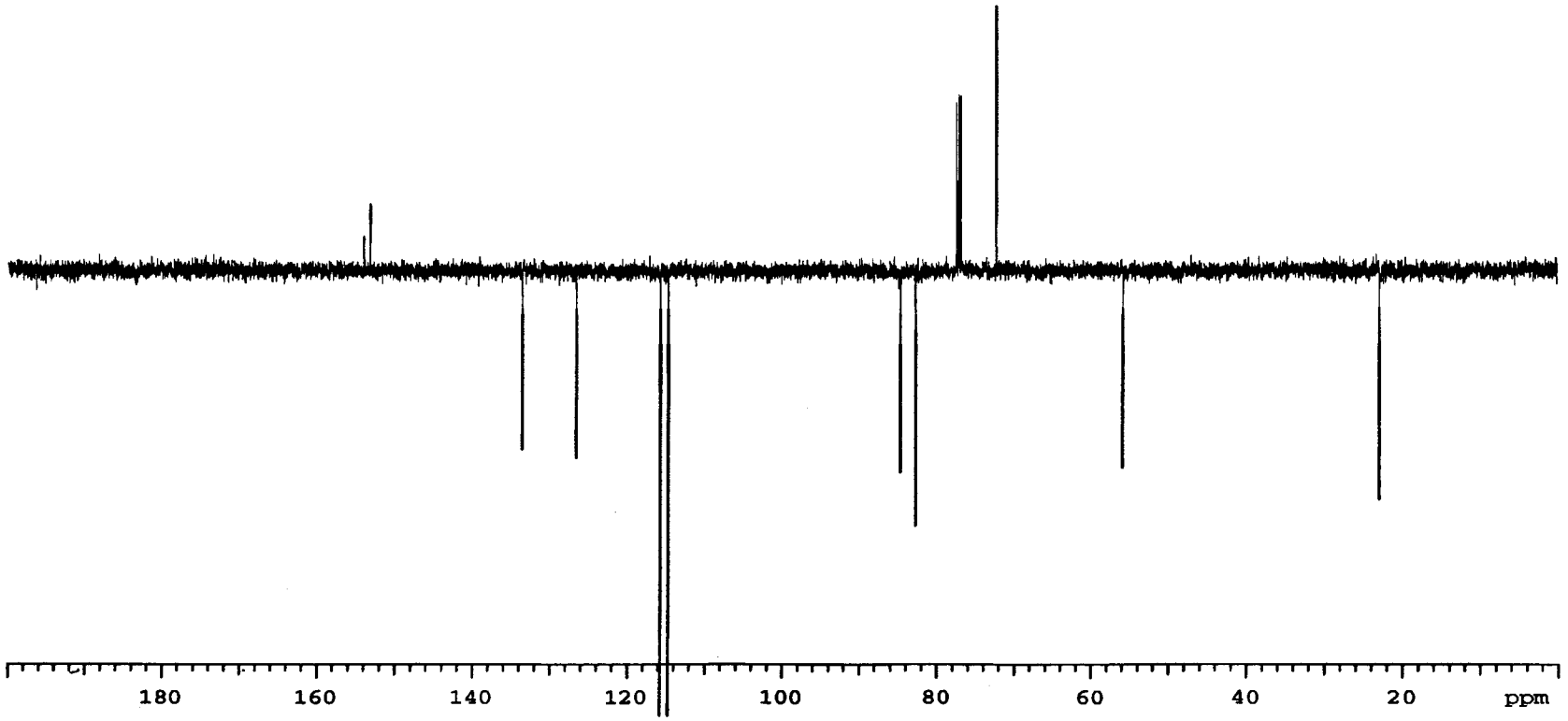

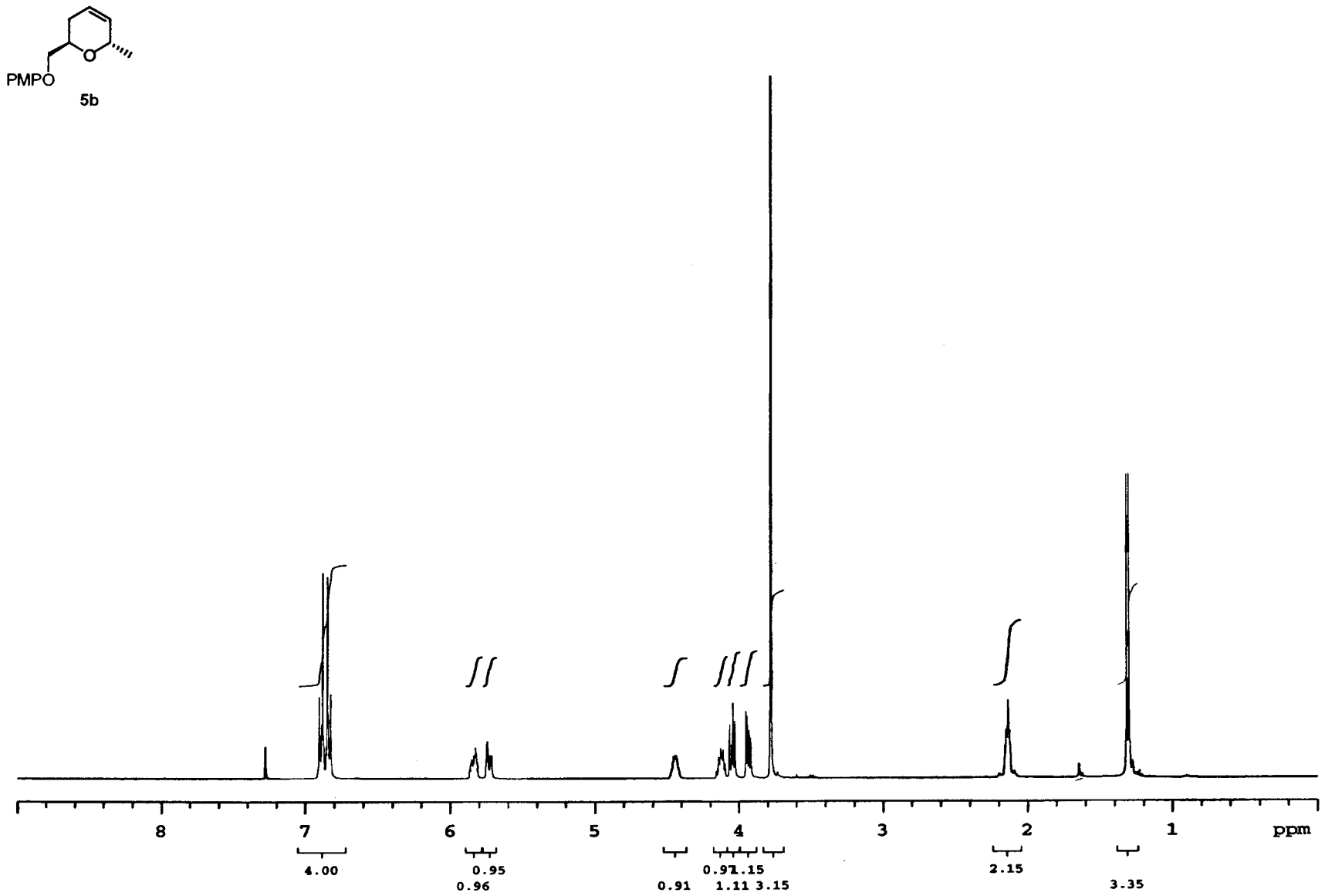
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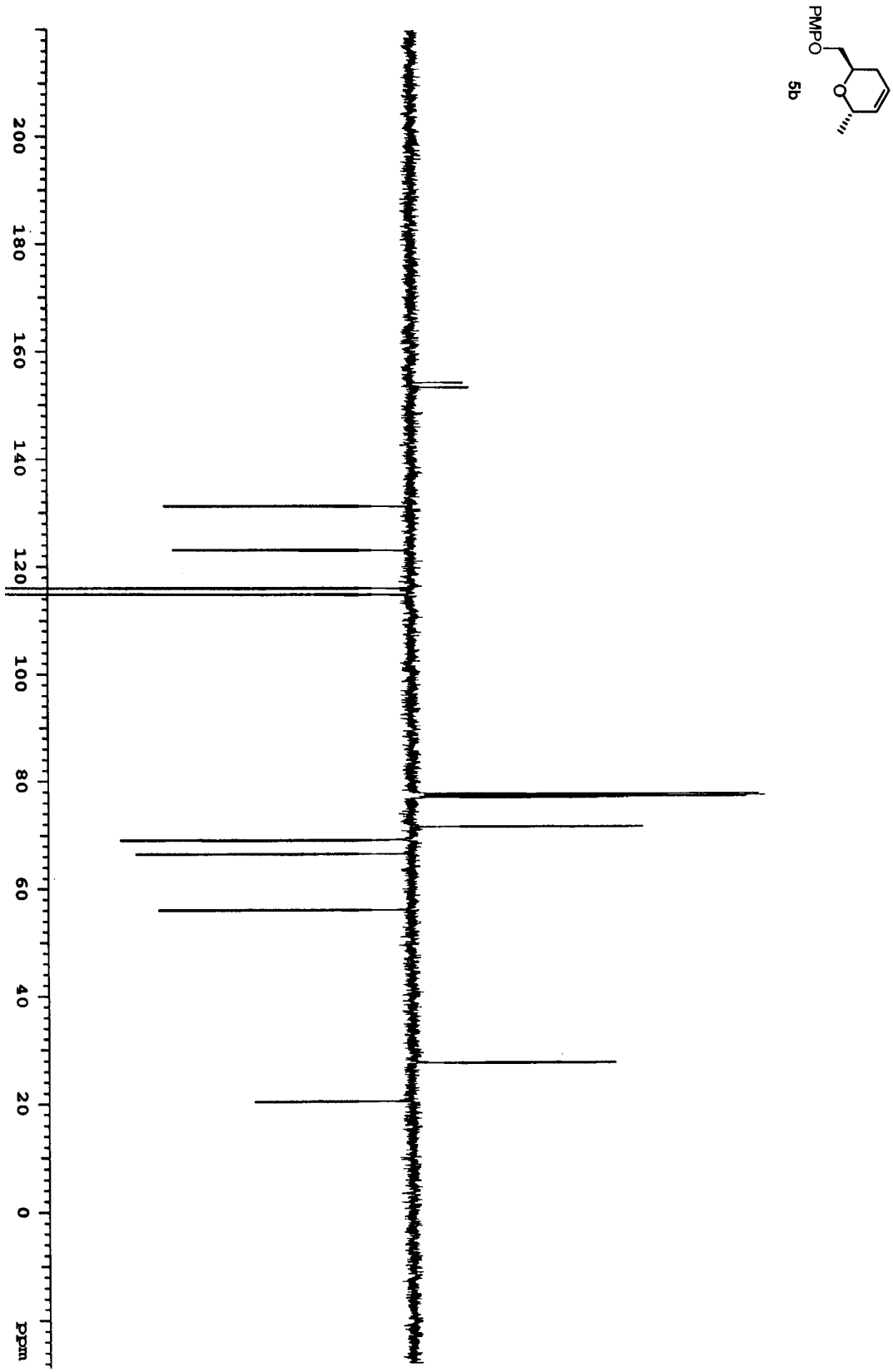
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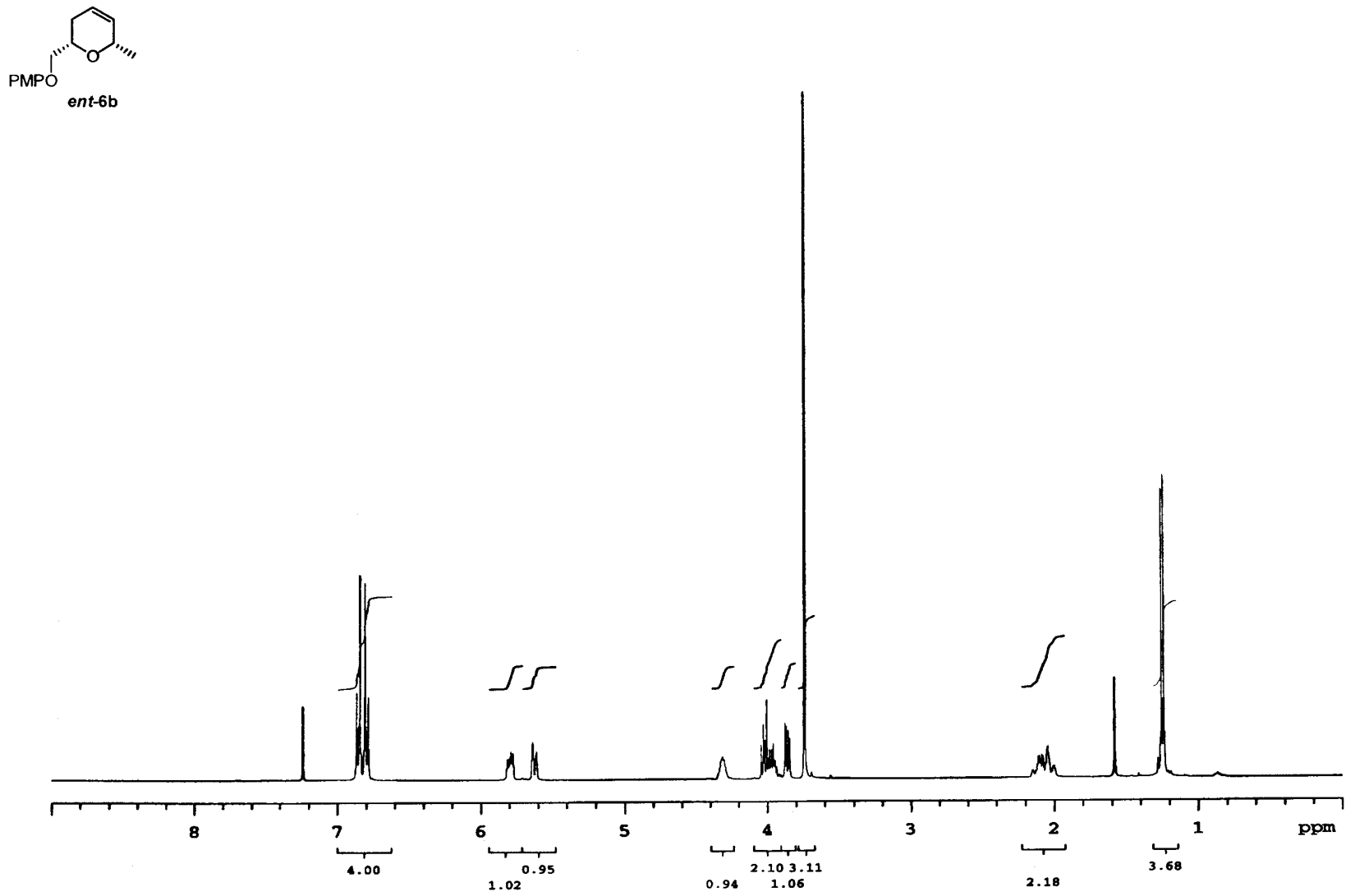
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O
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ppm
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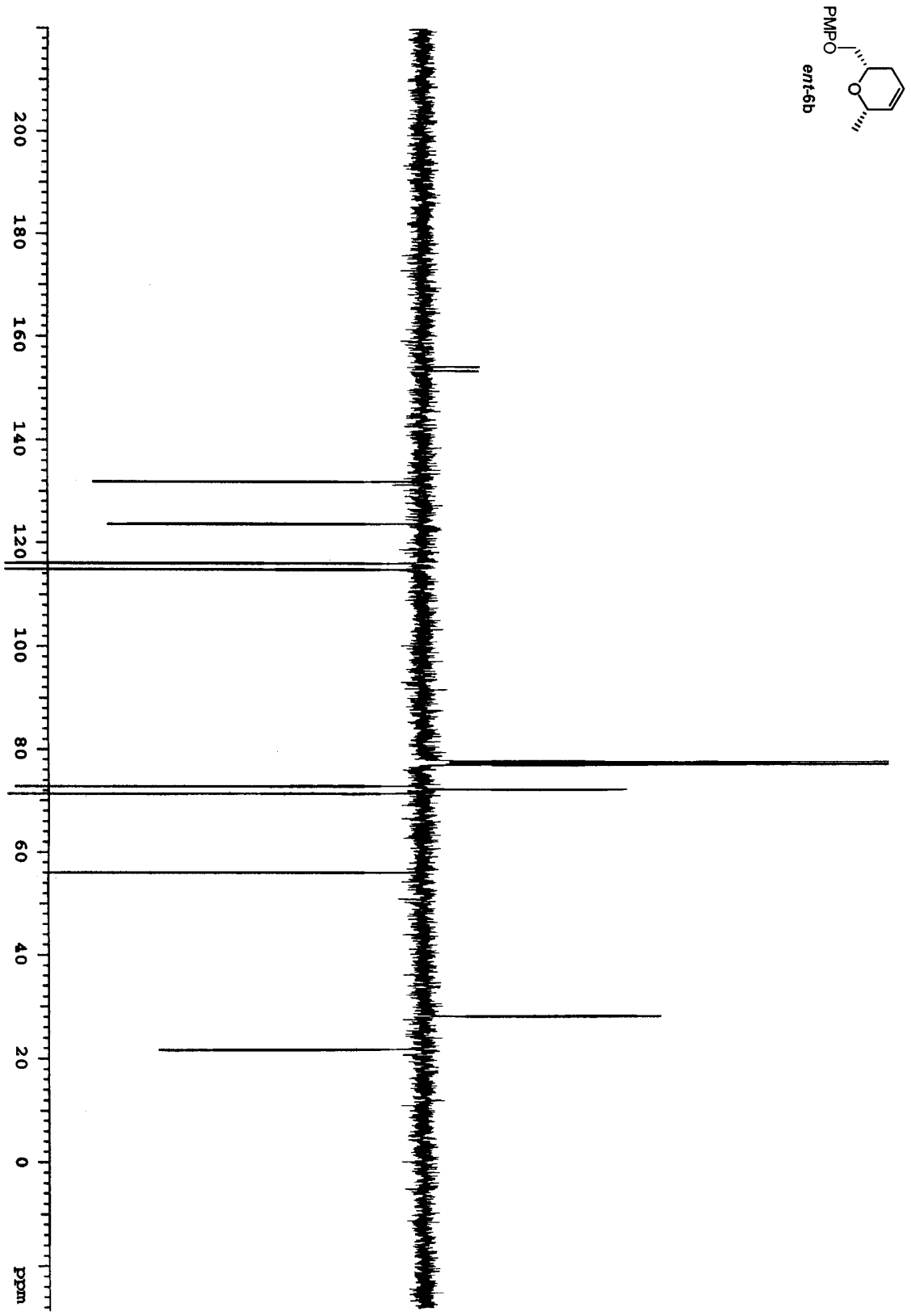
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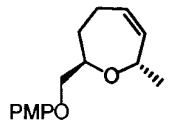

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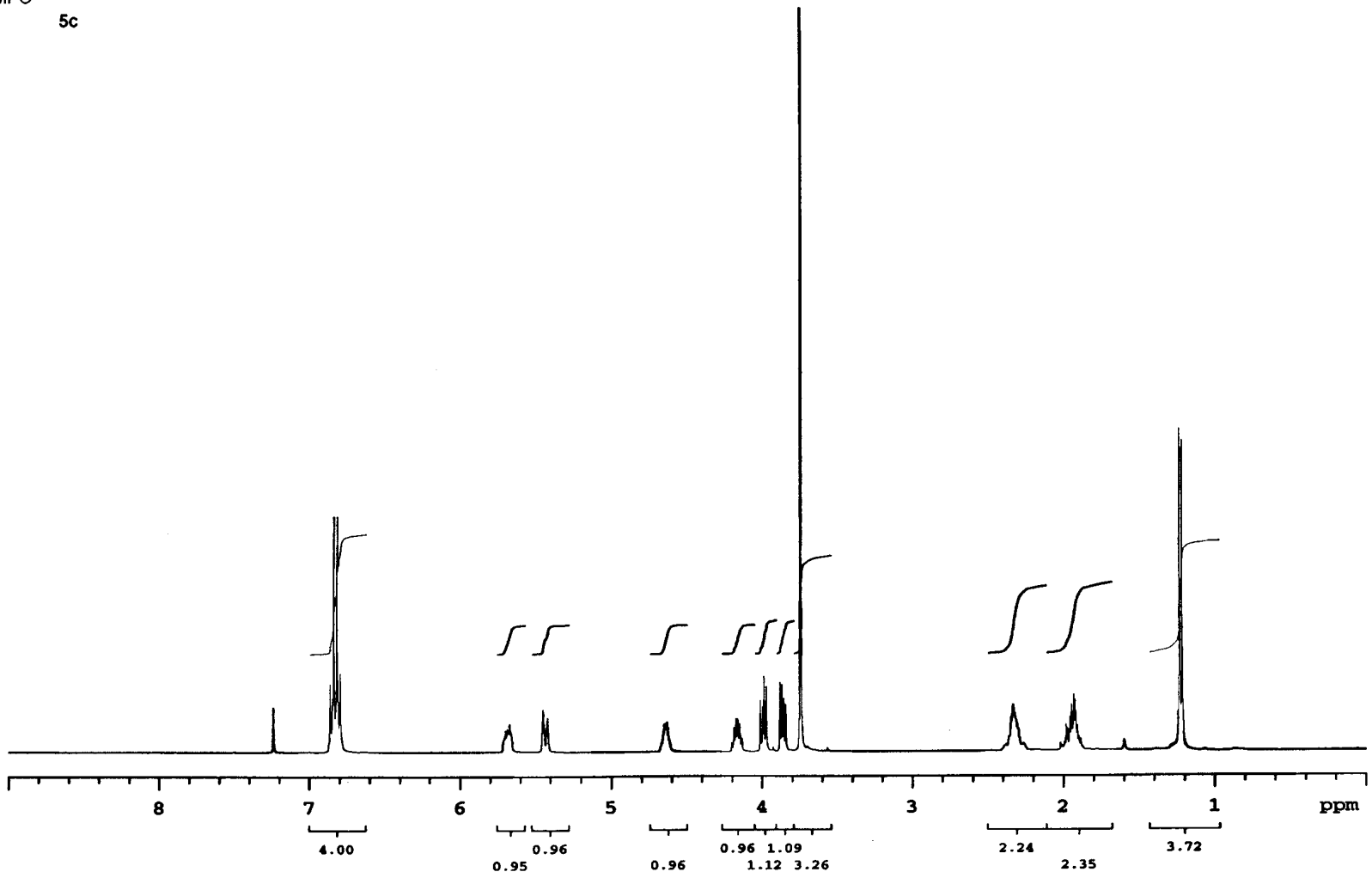

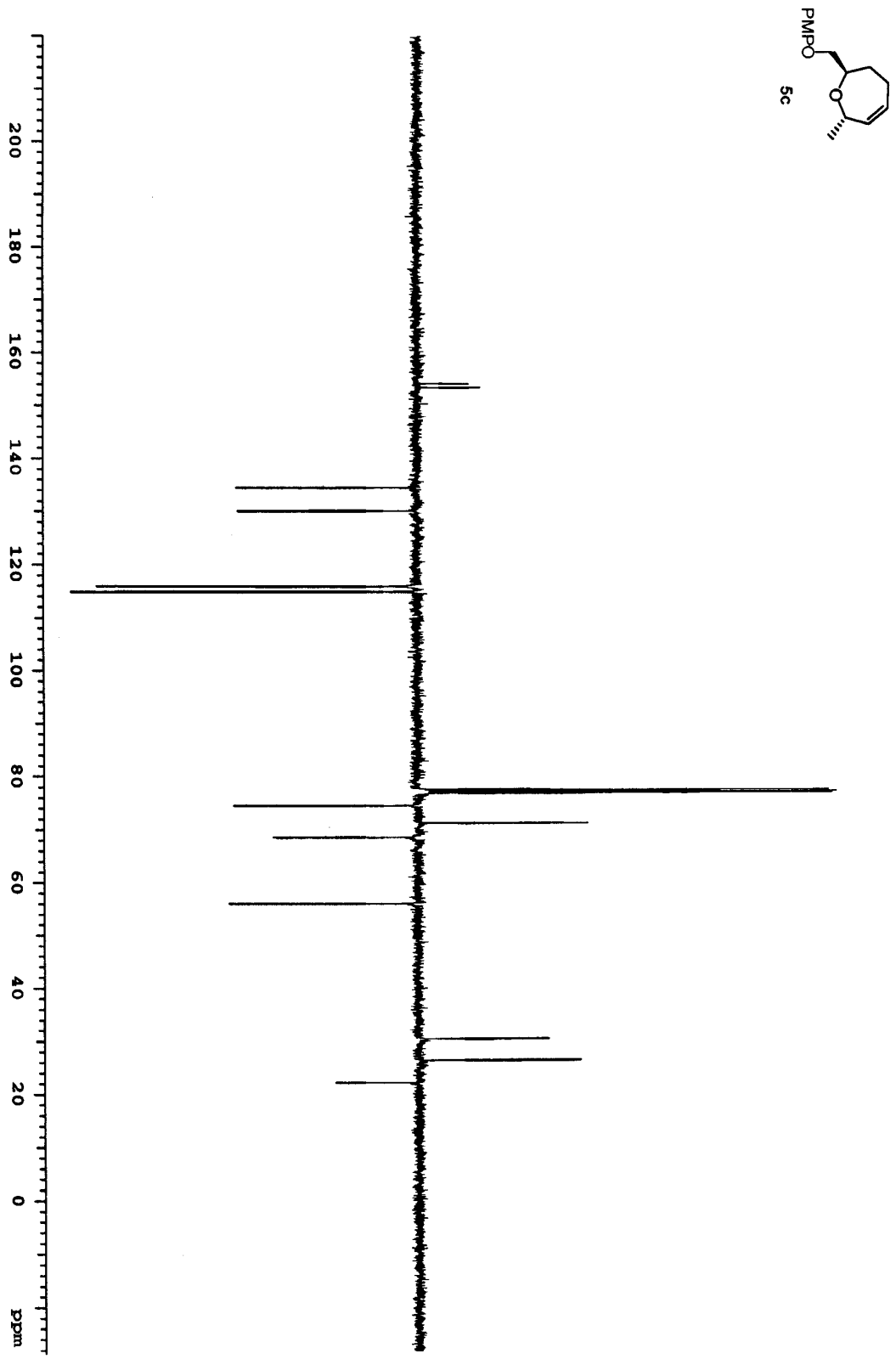
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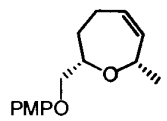

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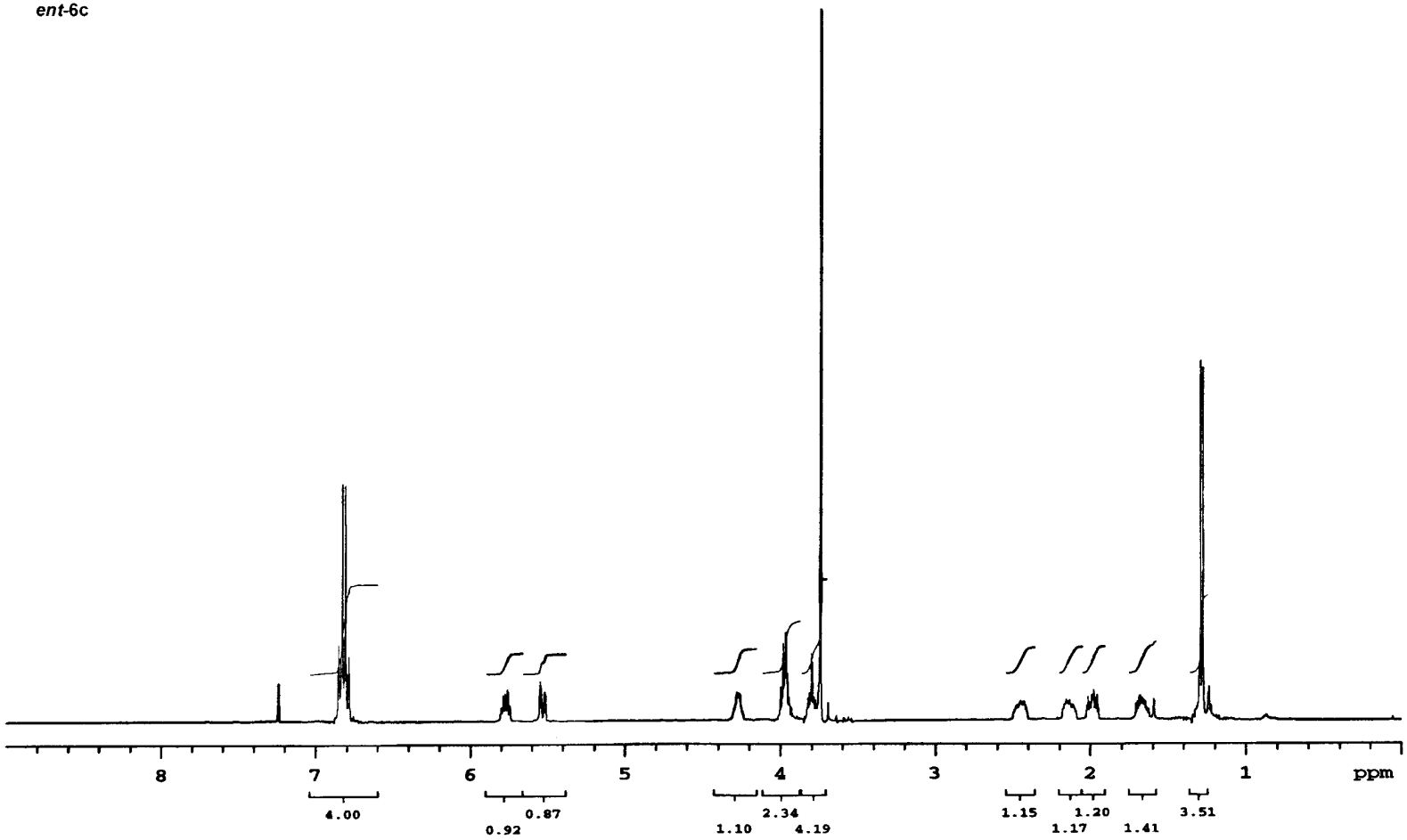

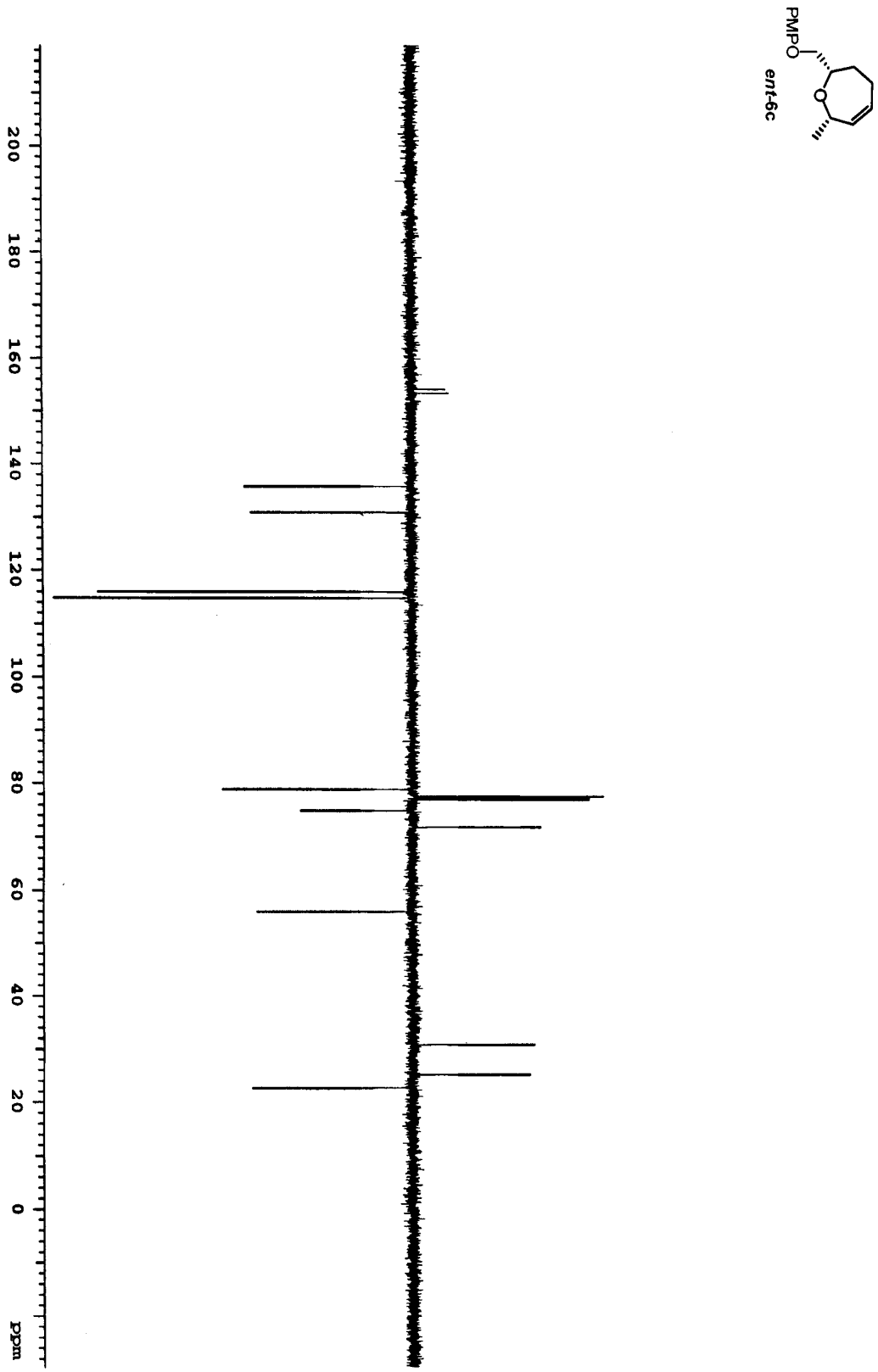
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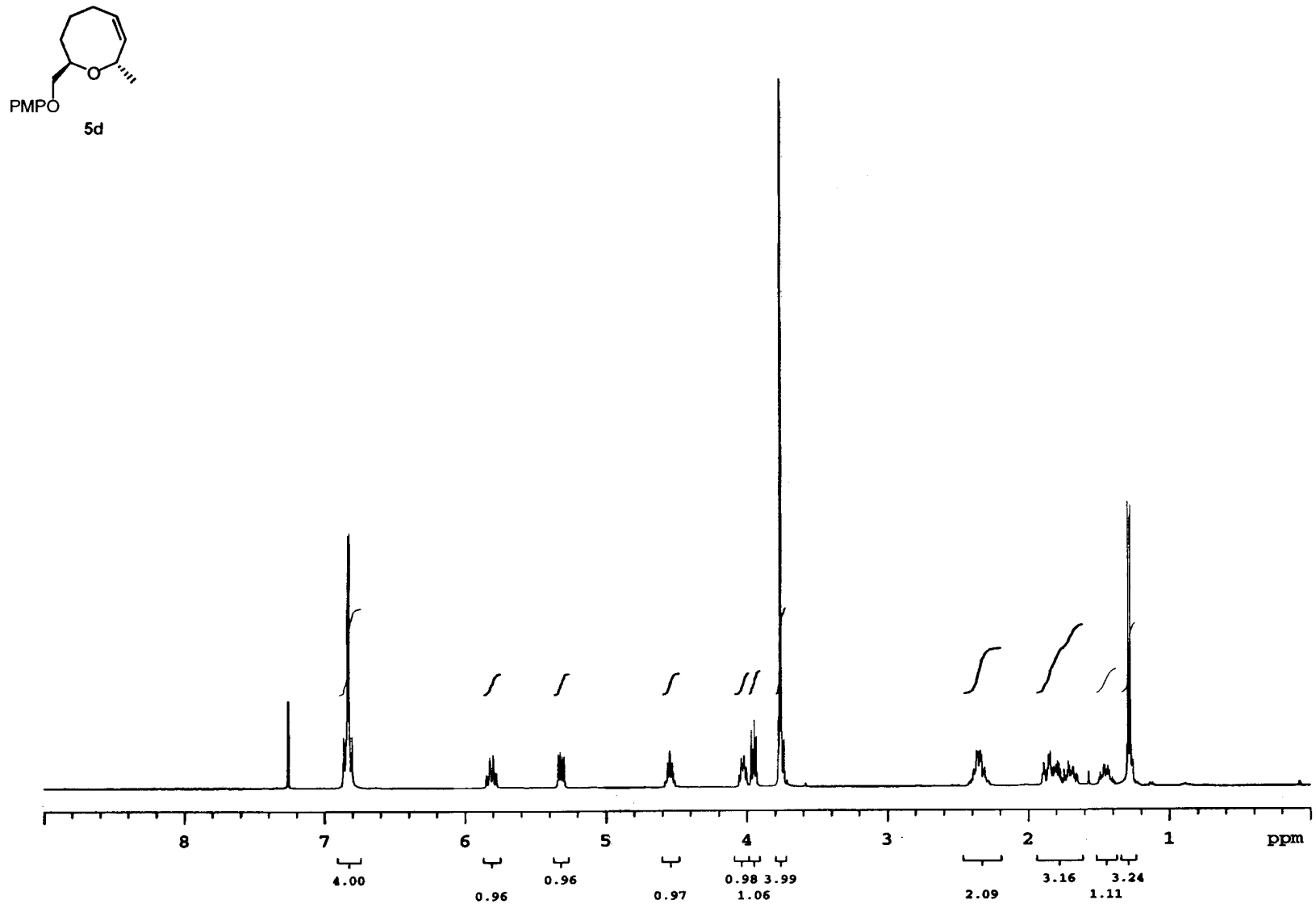
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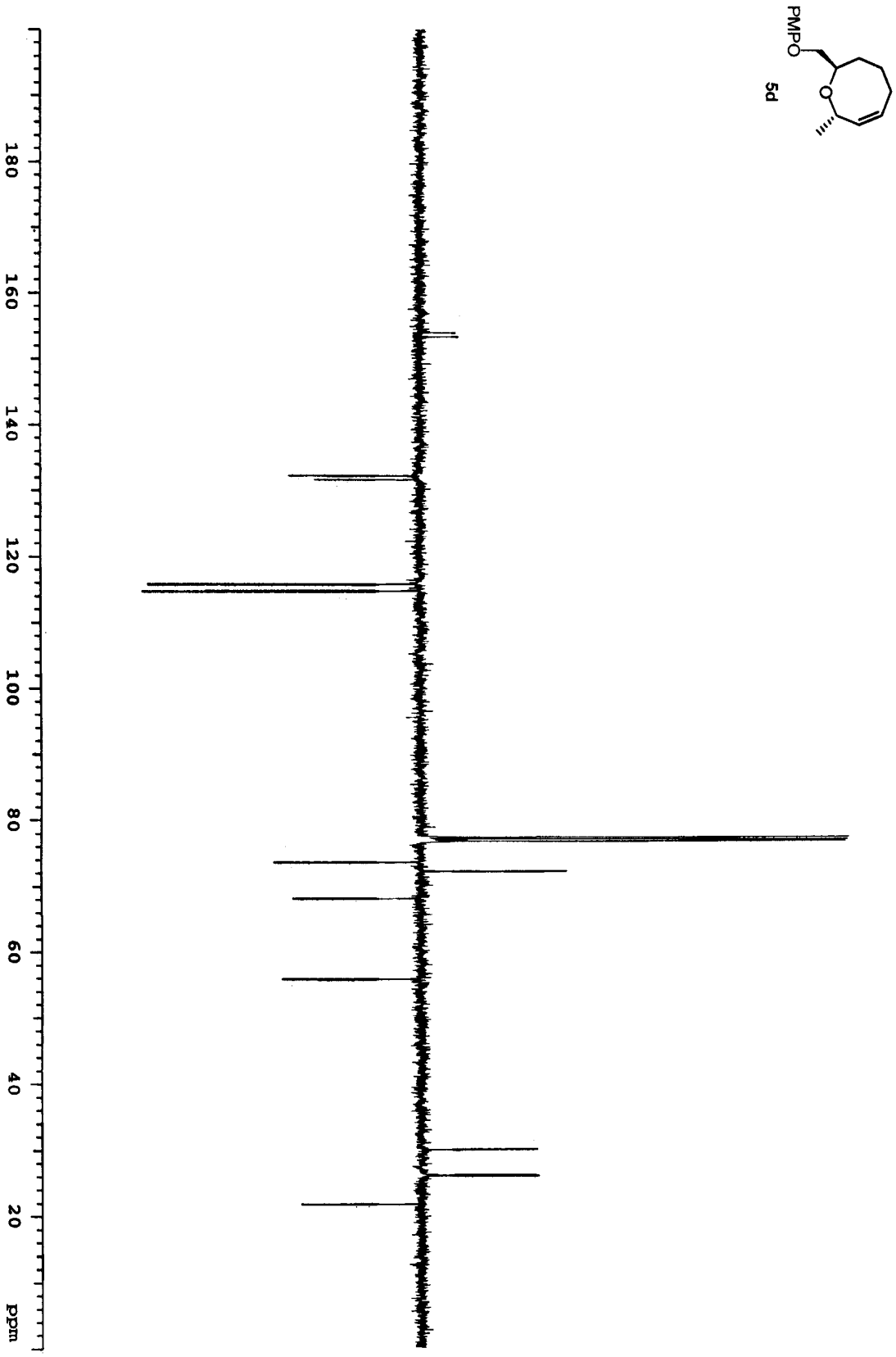
3.24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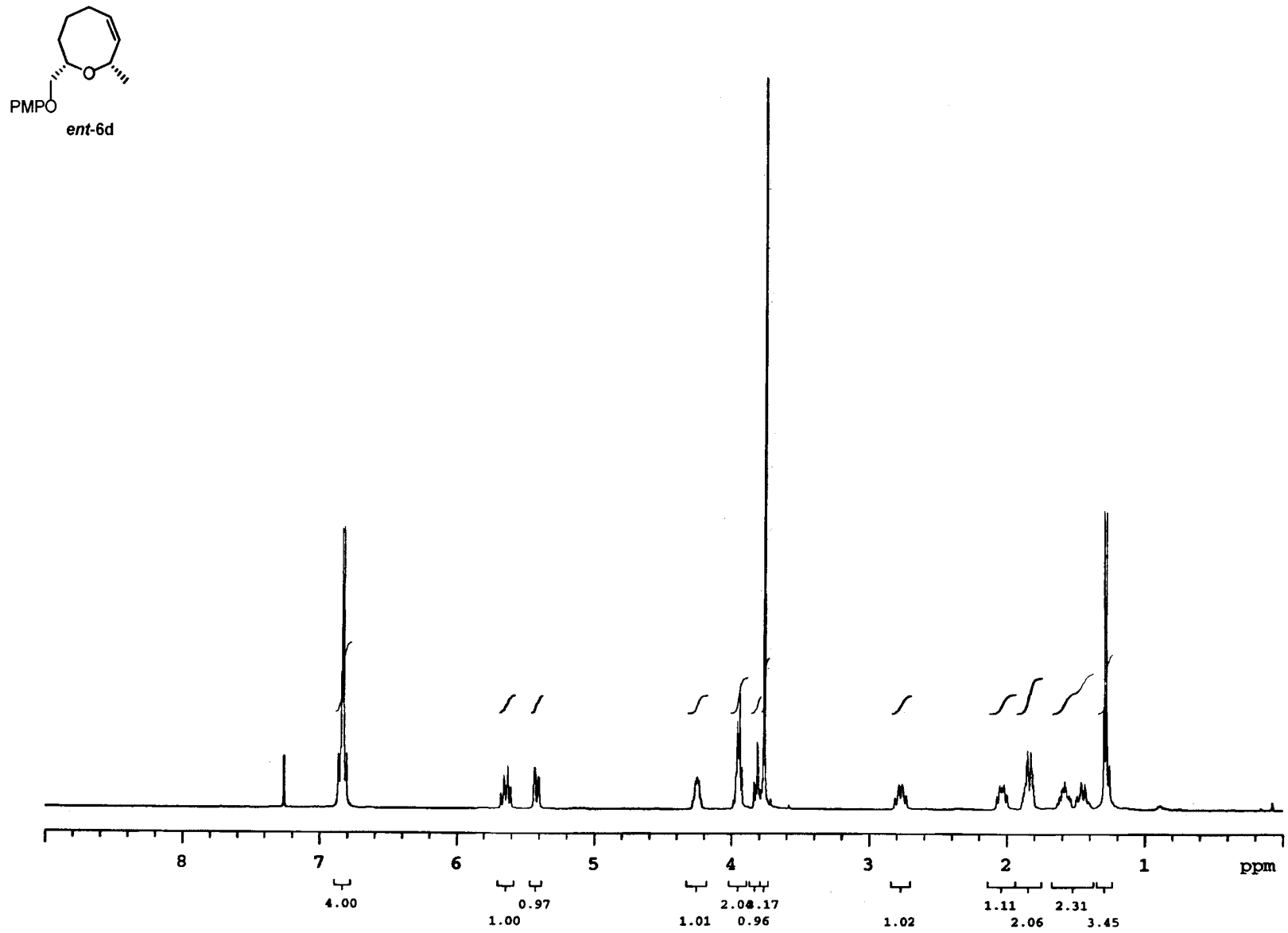
ppm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1.11
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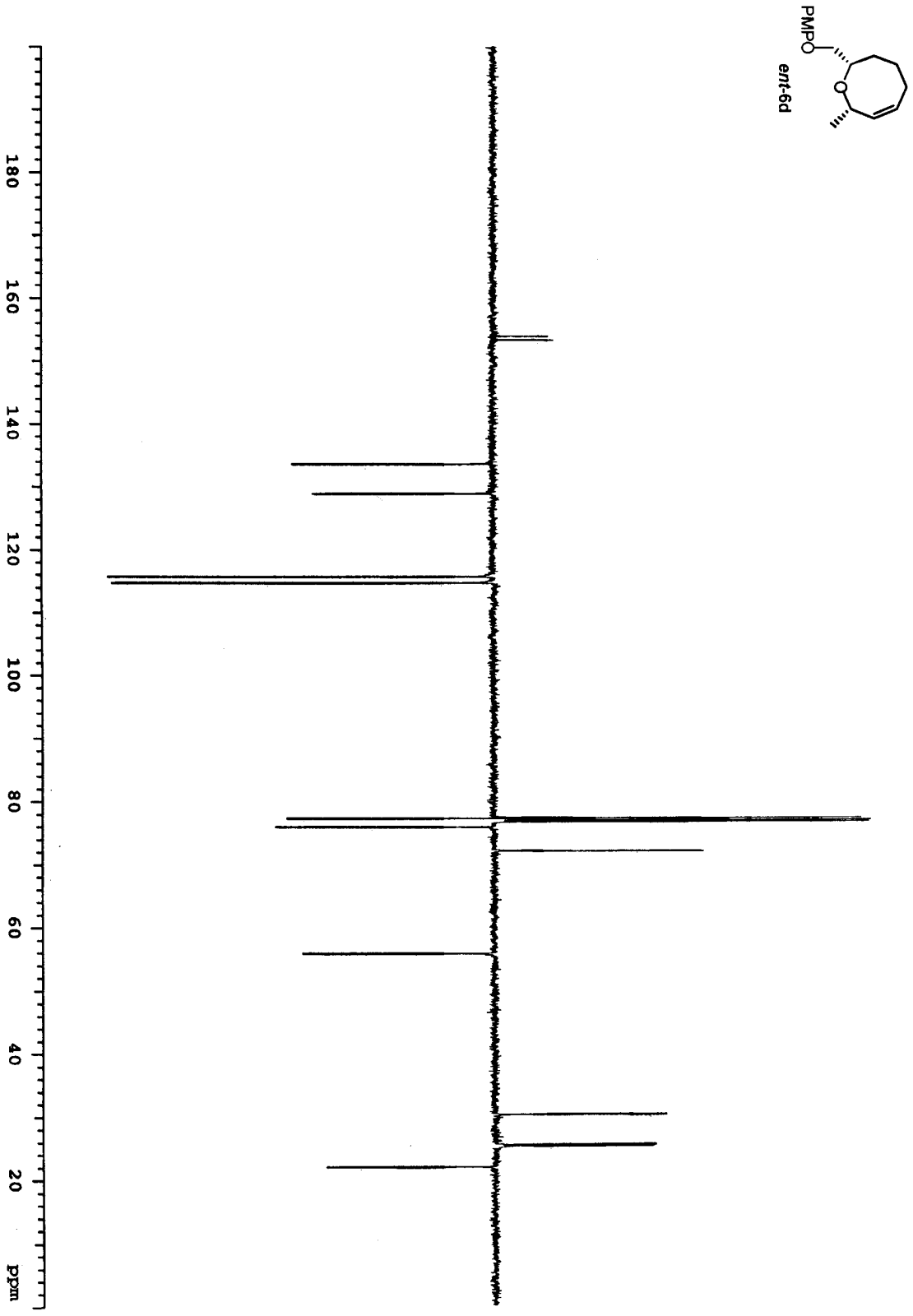
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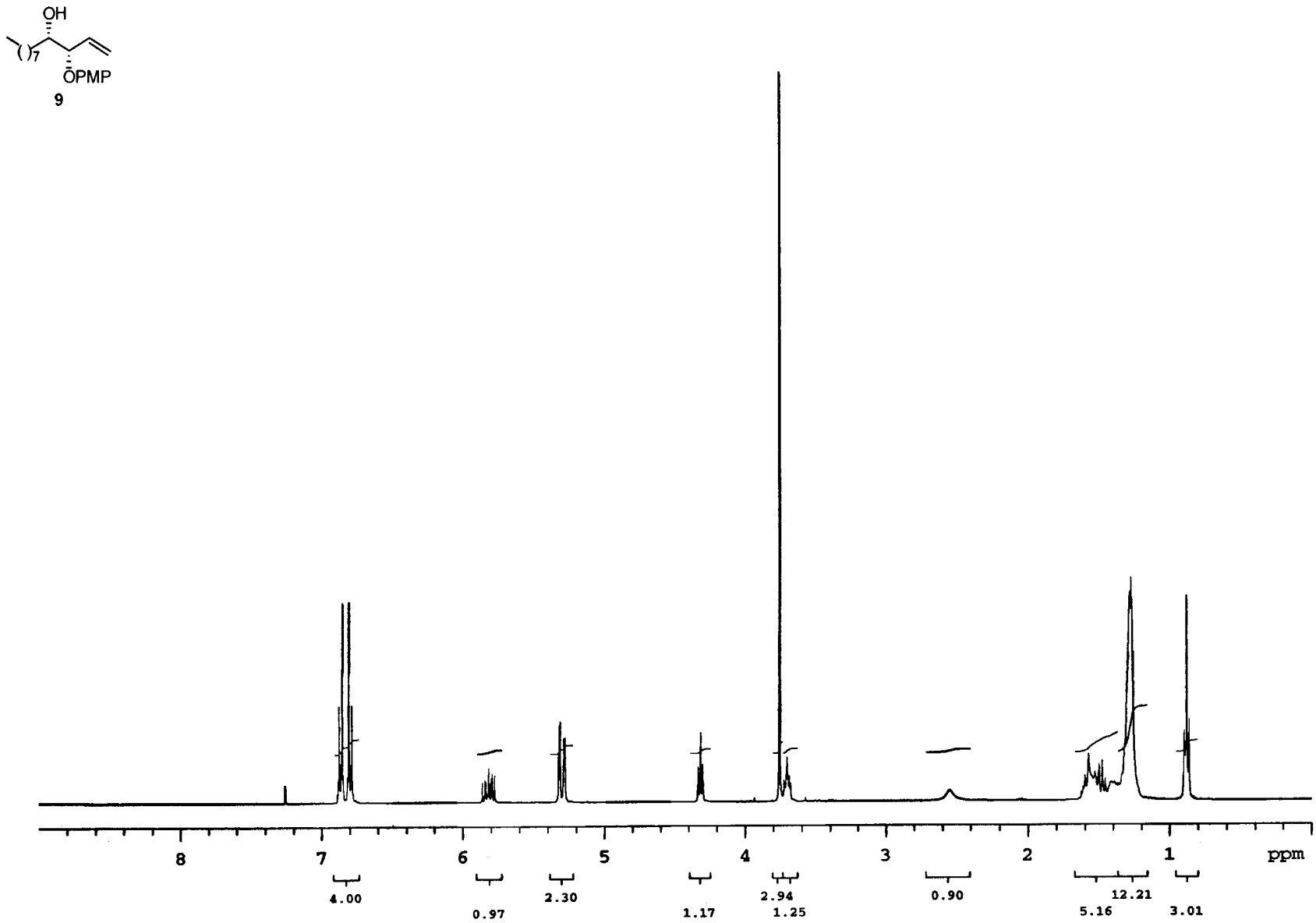
20
ppm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12.21
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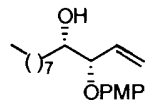

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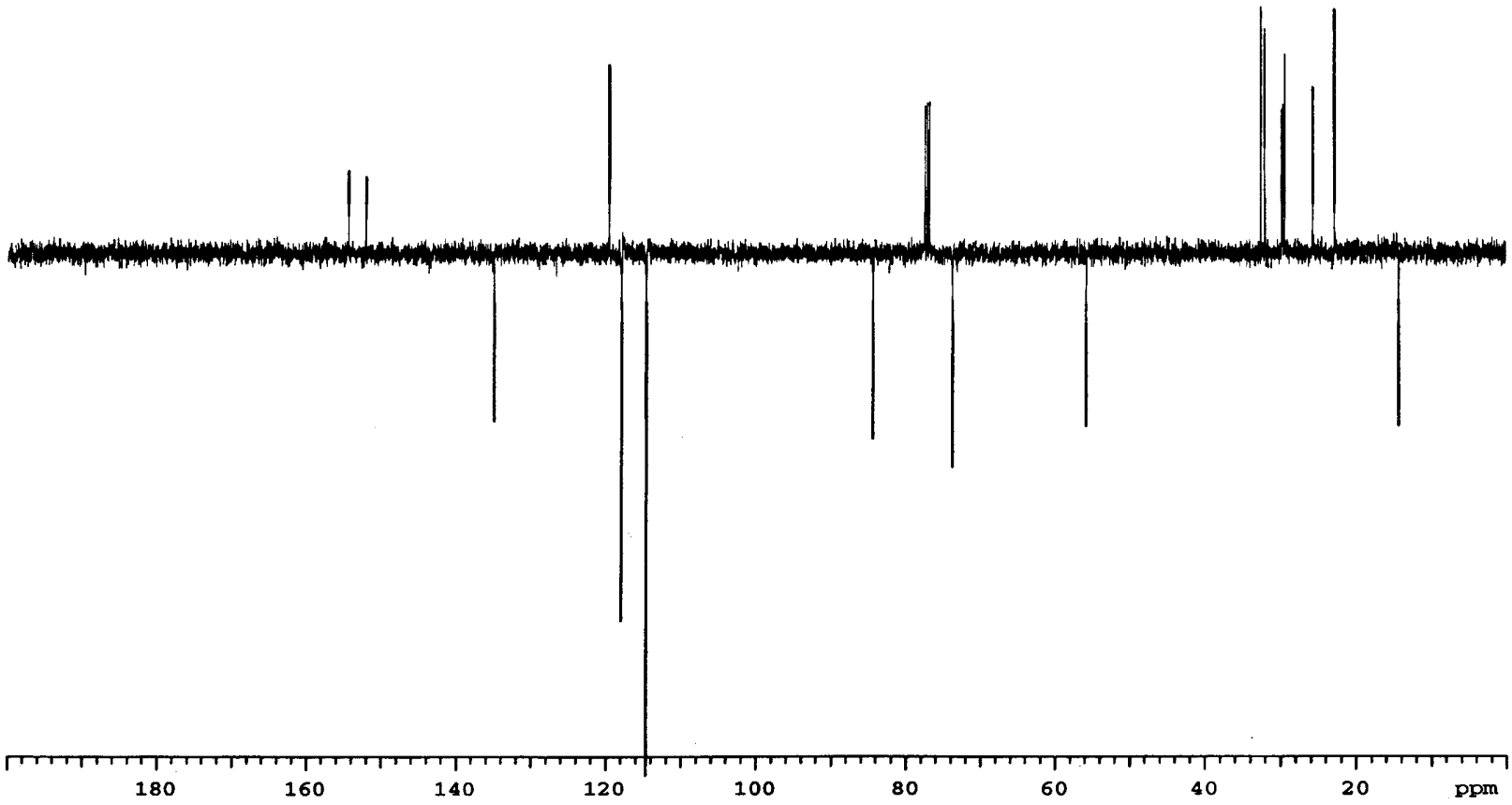

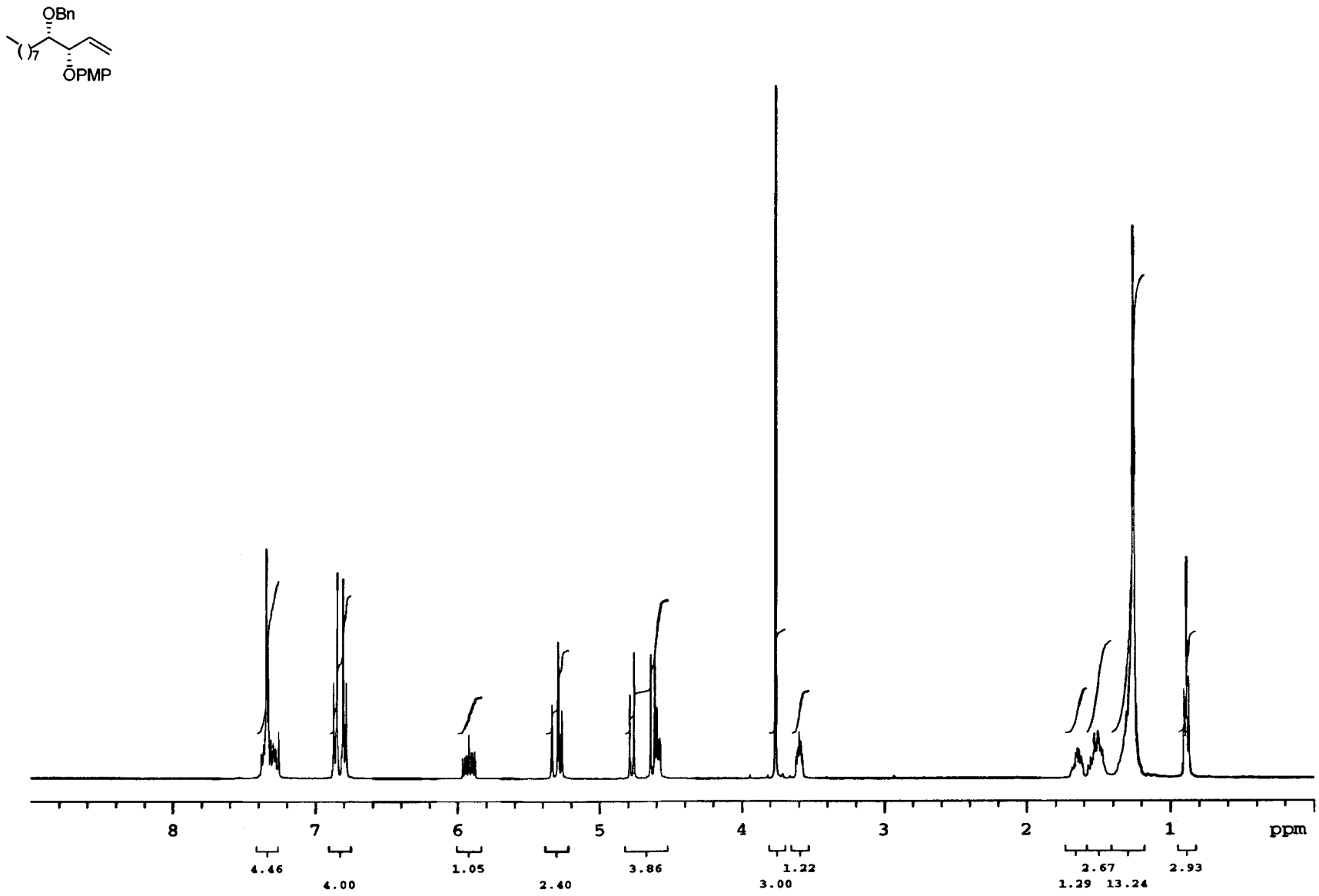
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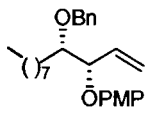
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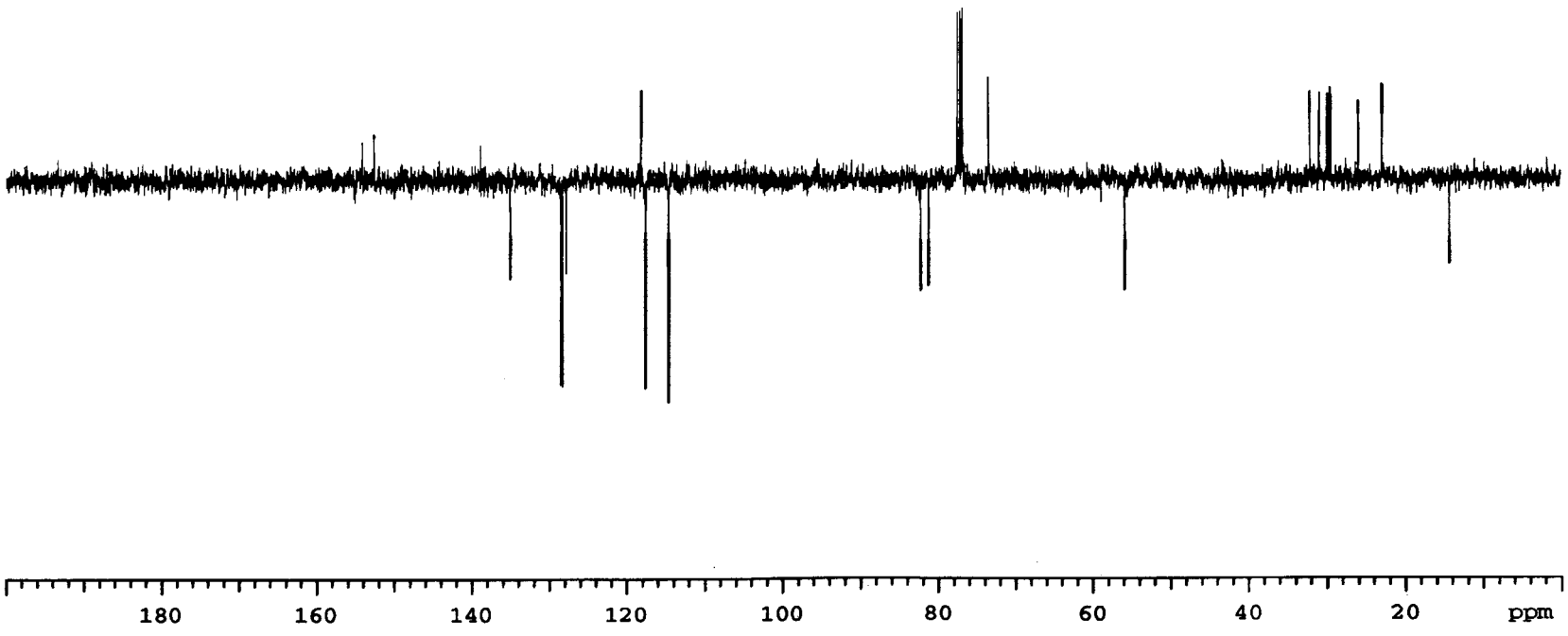
OPMP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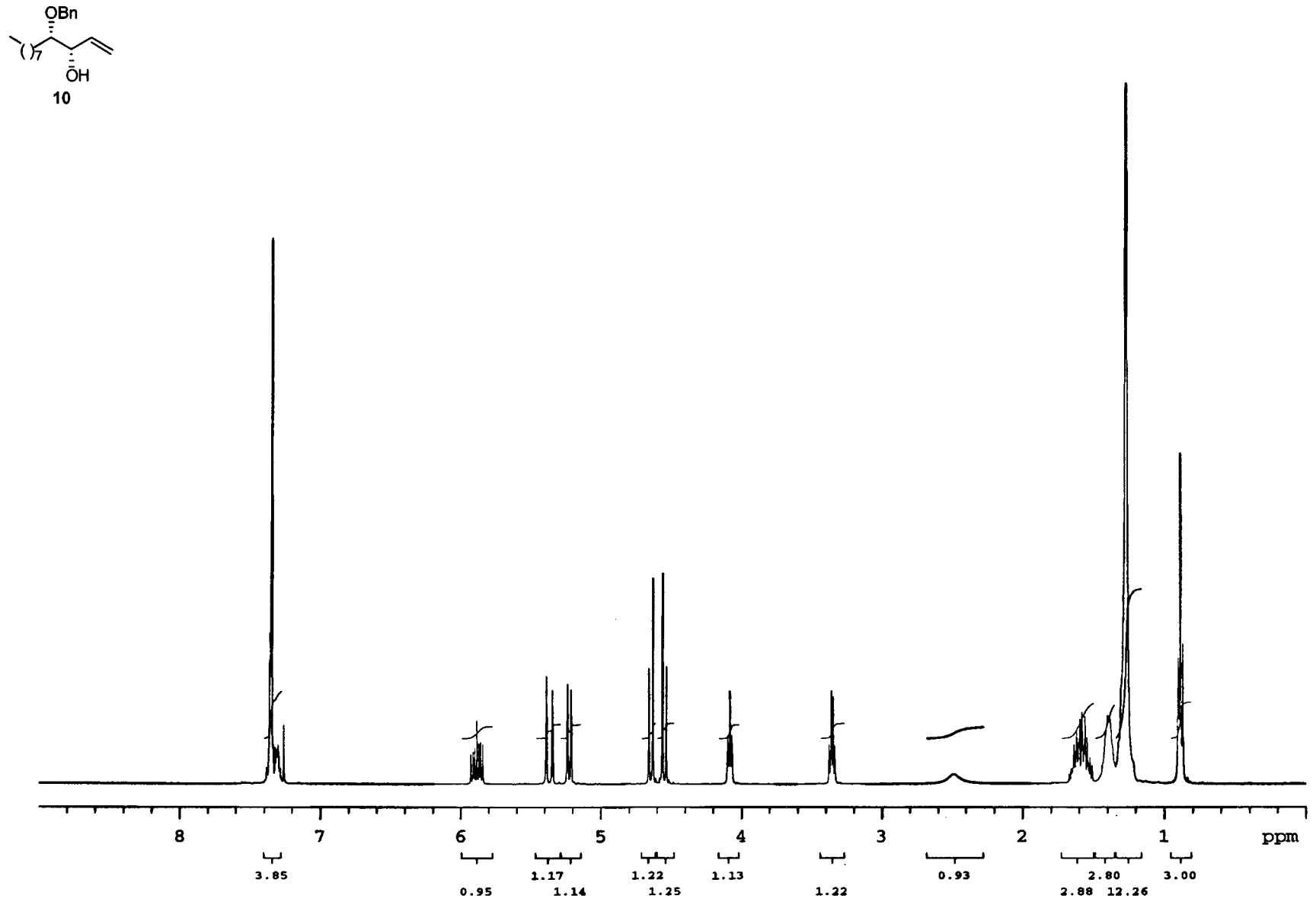
ppm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1.13
1.22
0.93
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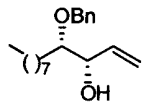
2.88
12.26
3.00



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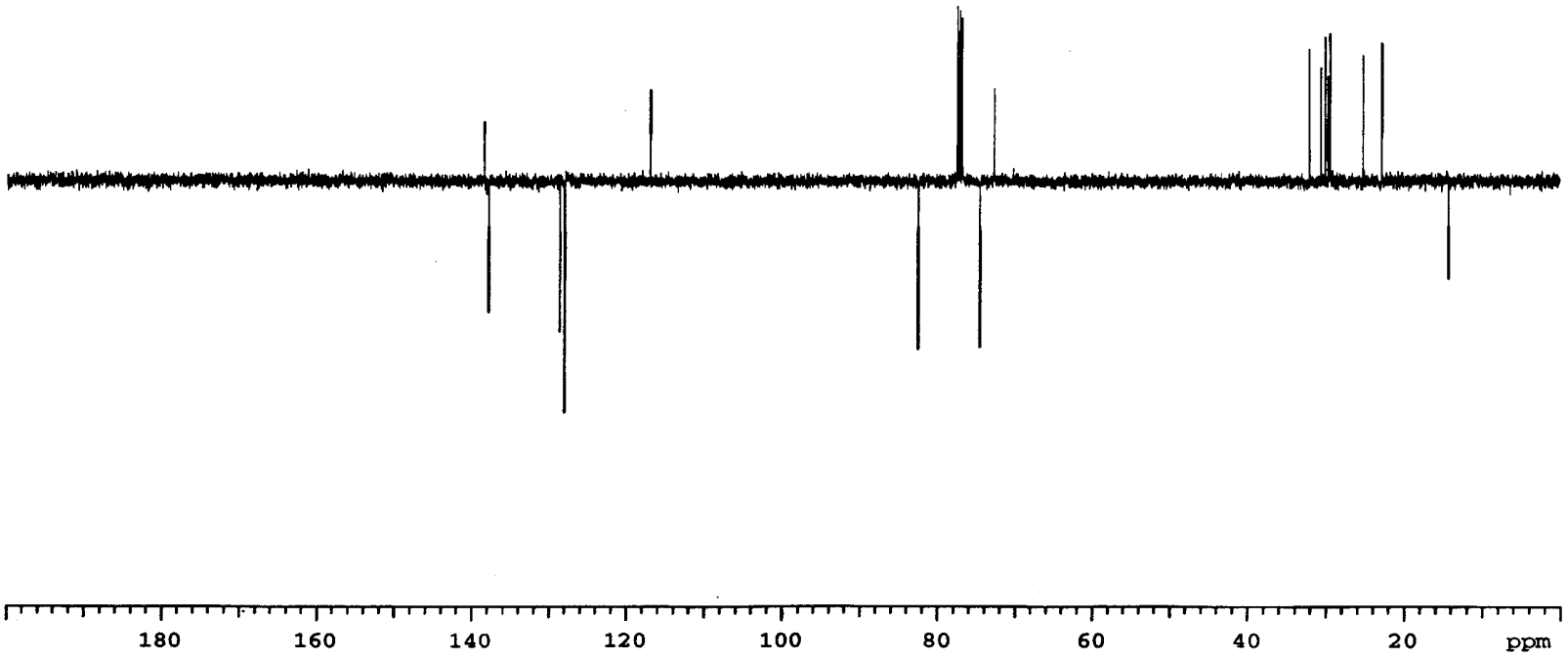
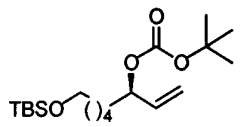
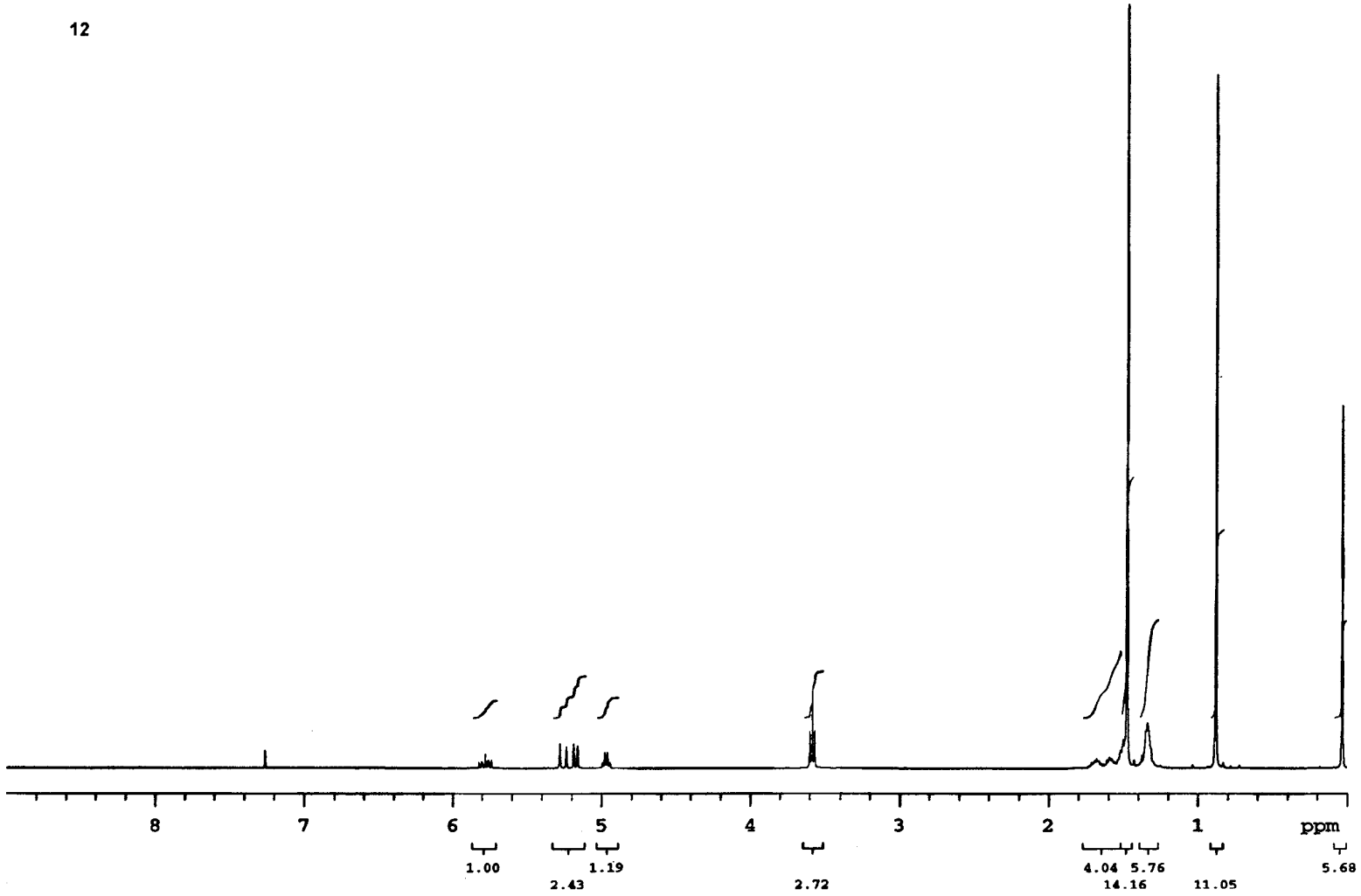
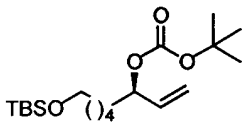




12





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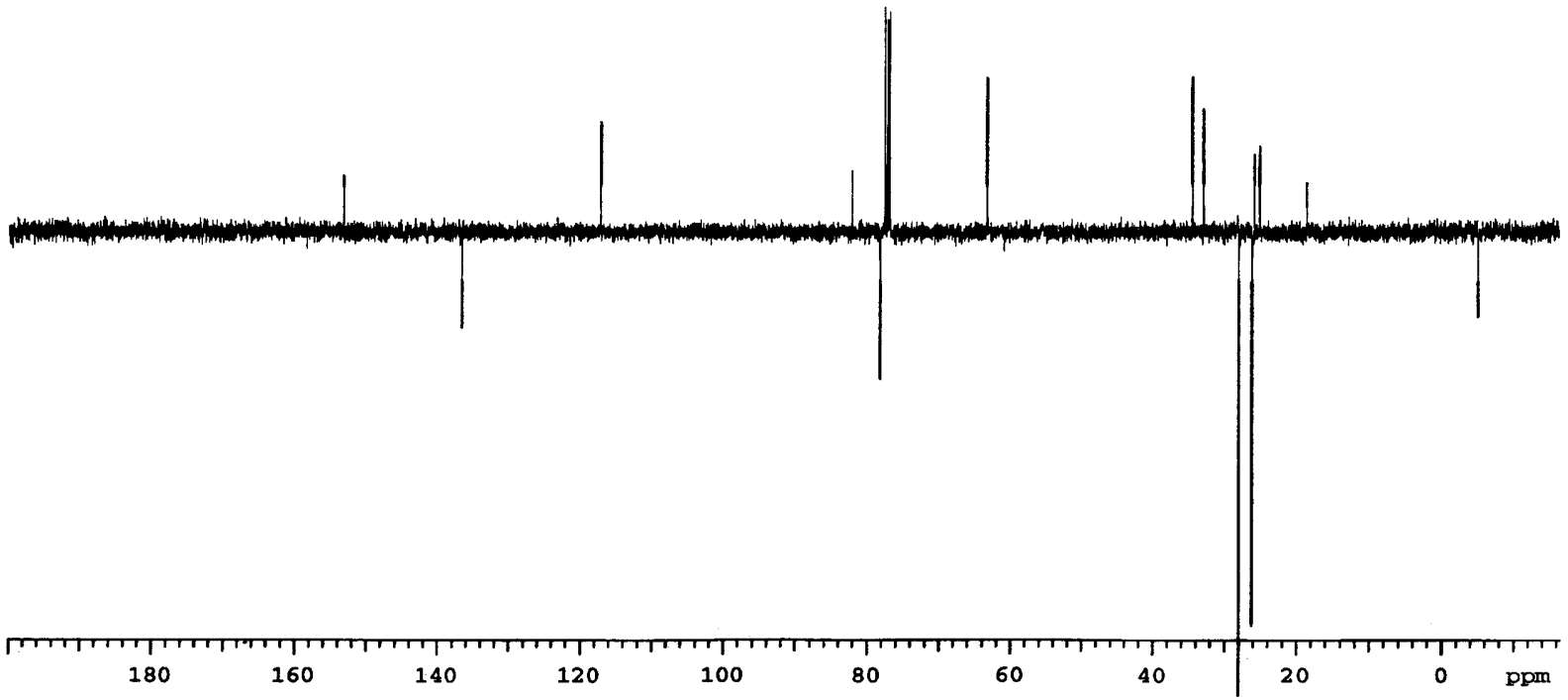
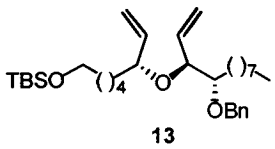
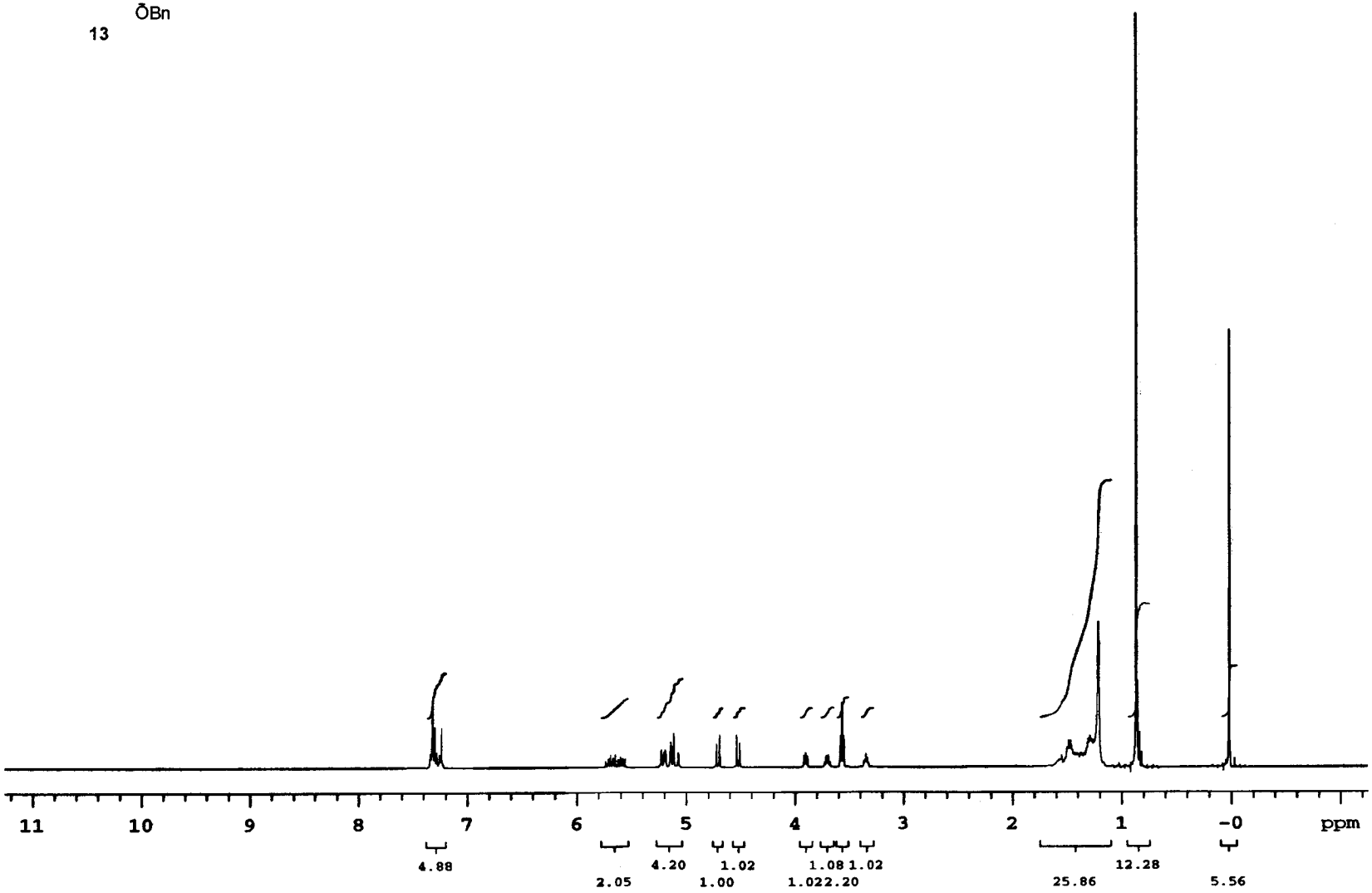



TBSO
OBn

13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1.02
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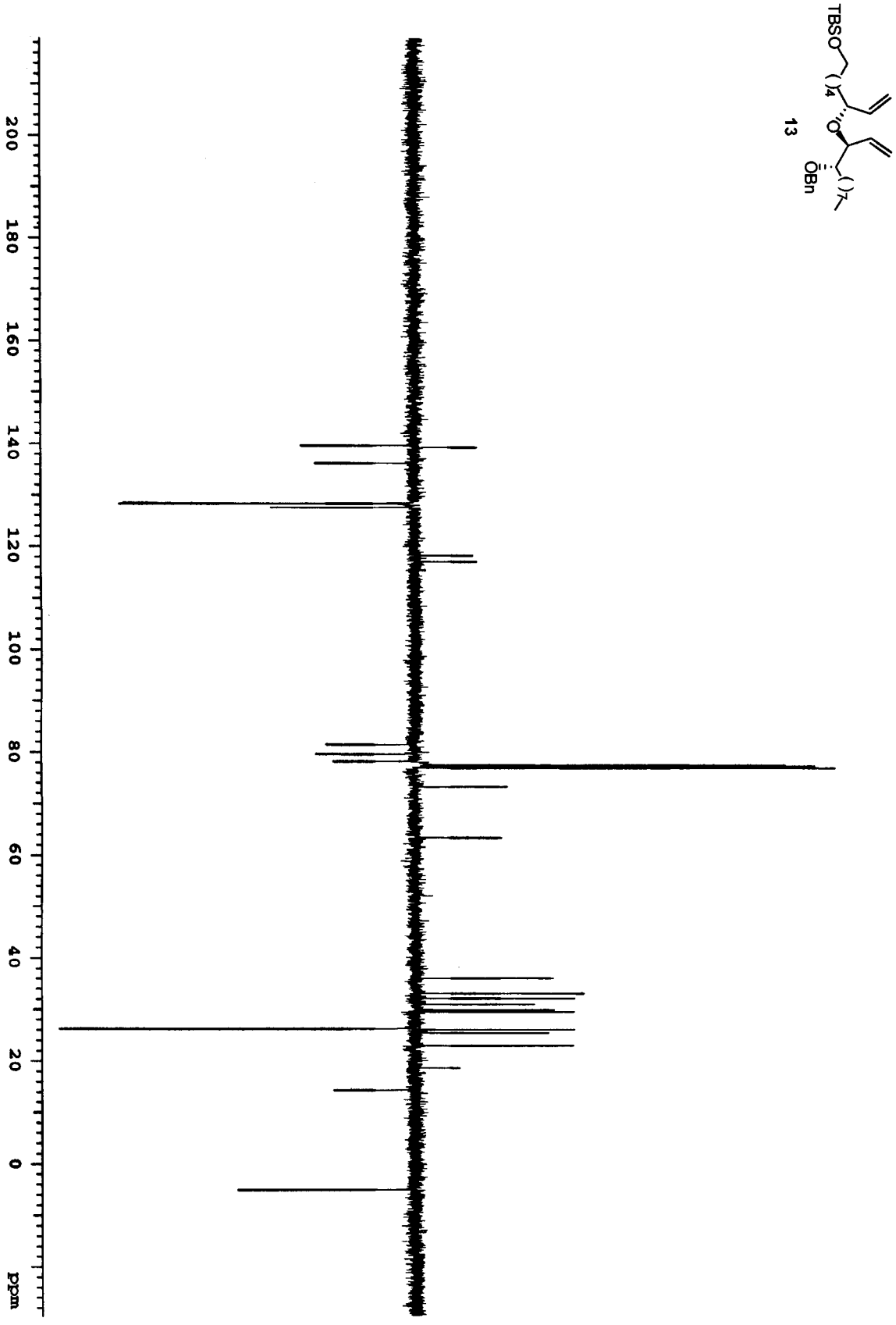
12.28
5.56


TBSO
OBn
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40
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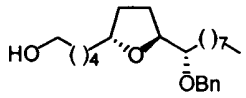
ppm



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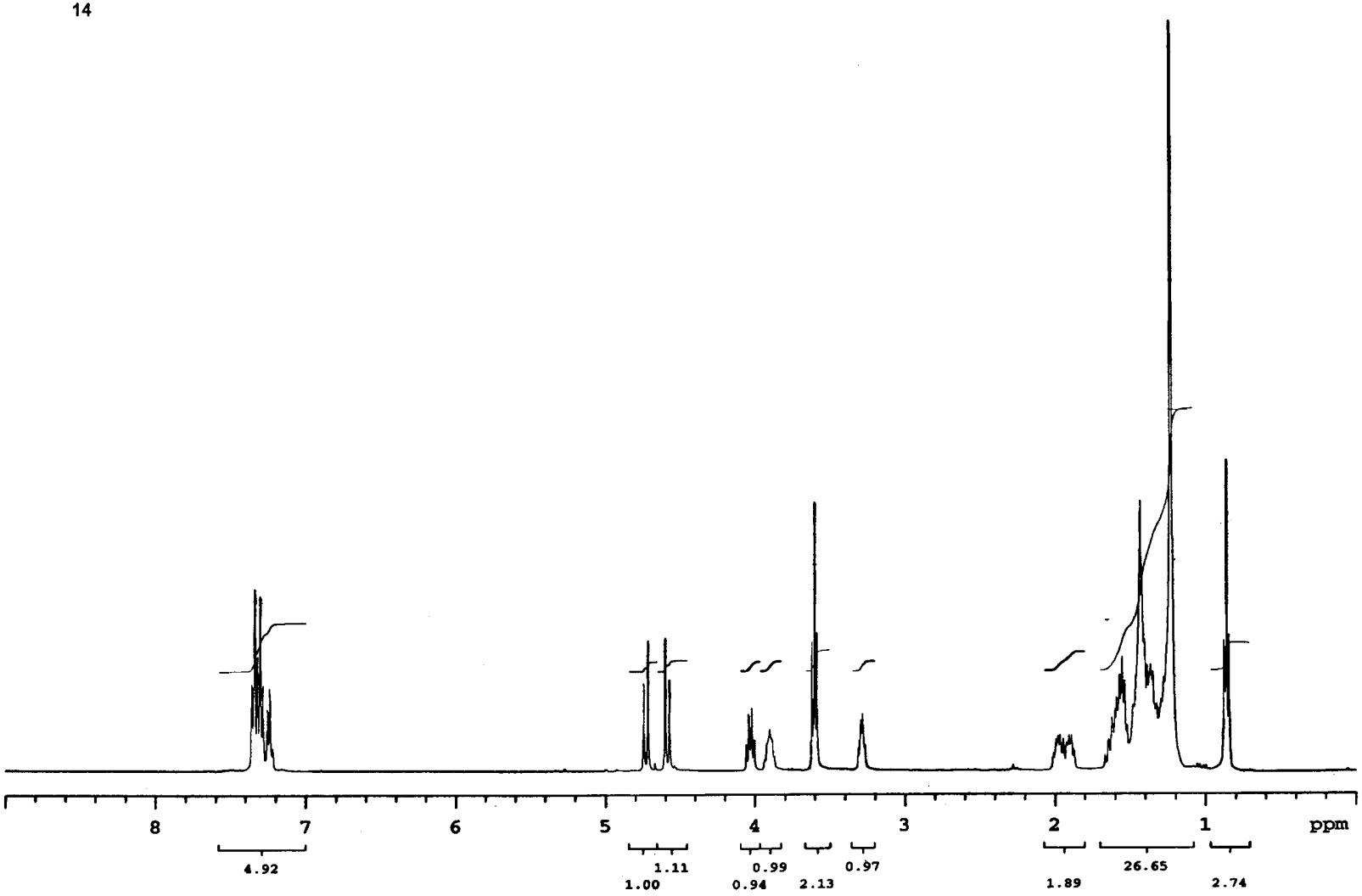

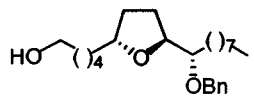

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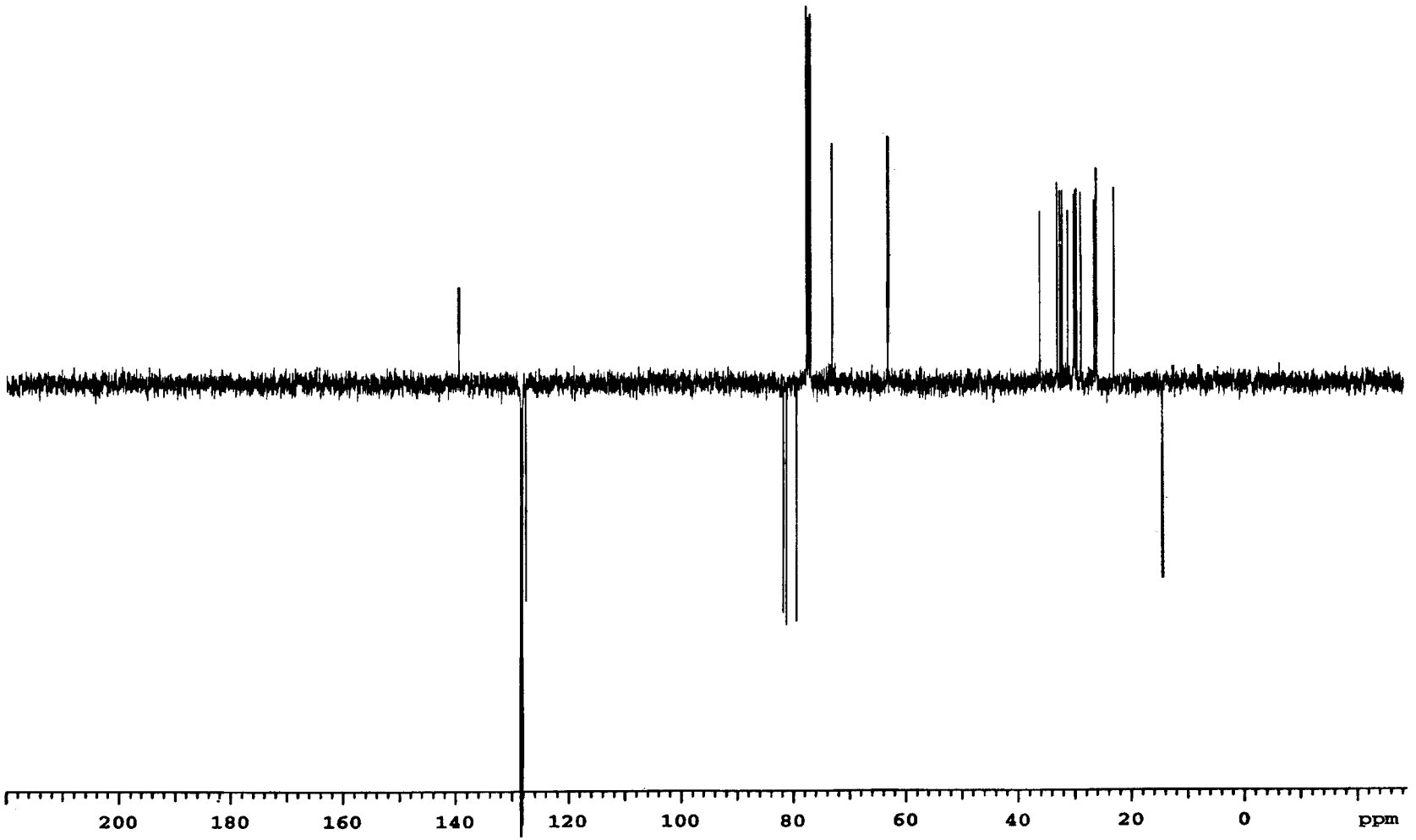
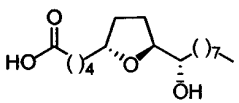
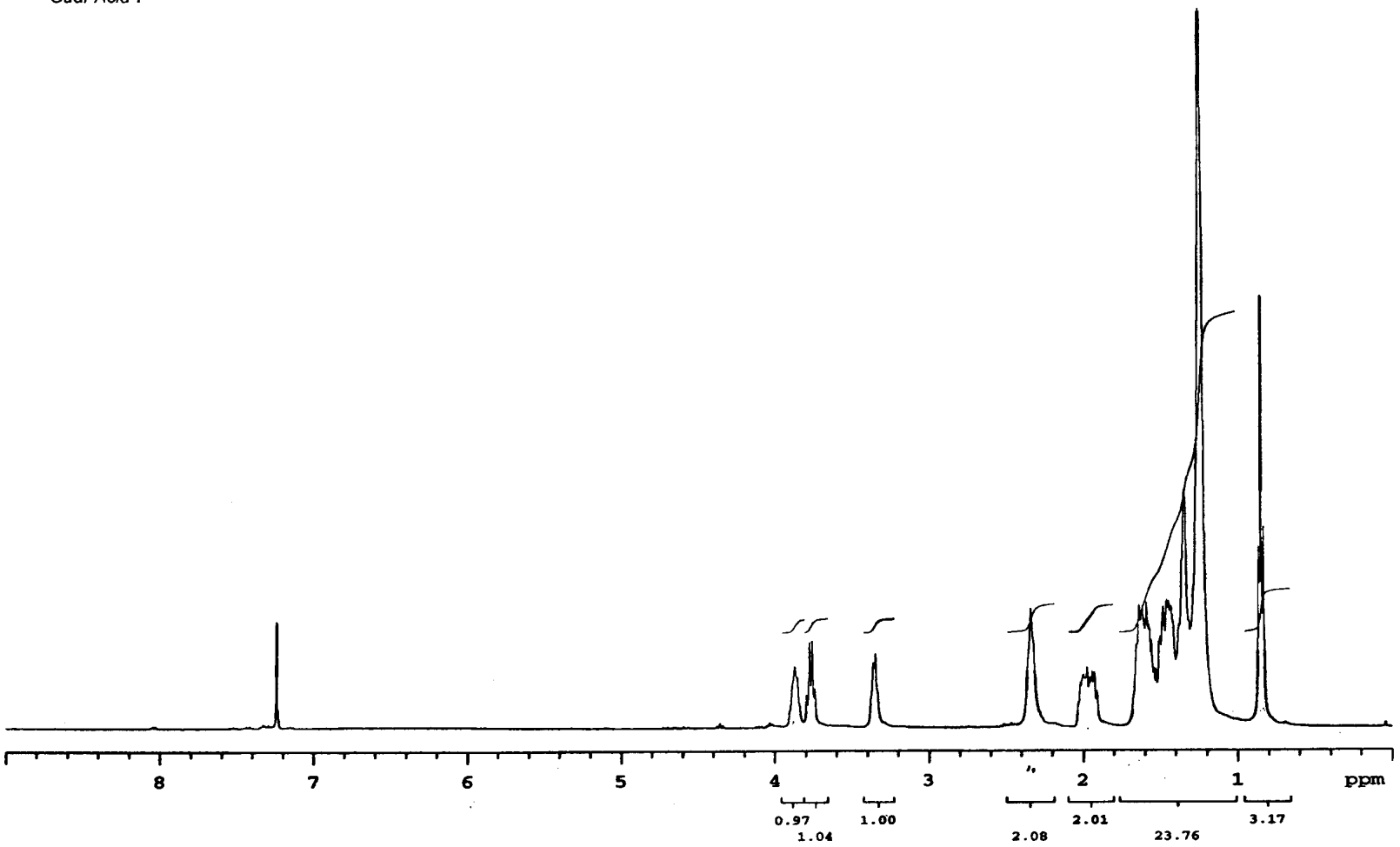
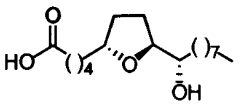


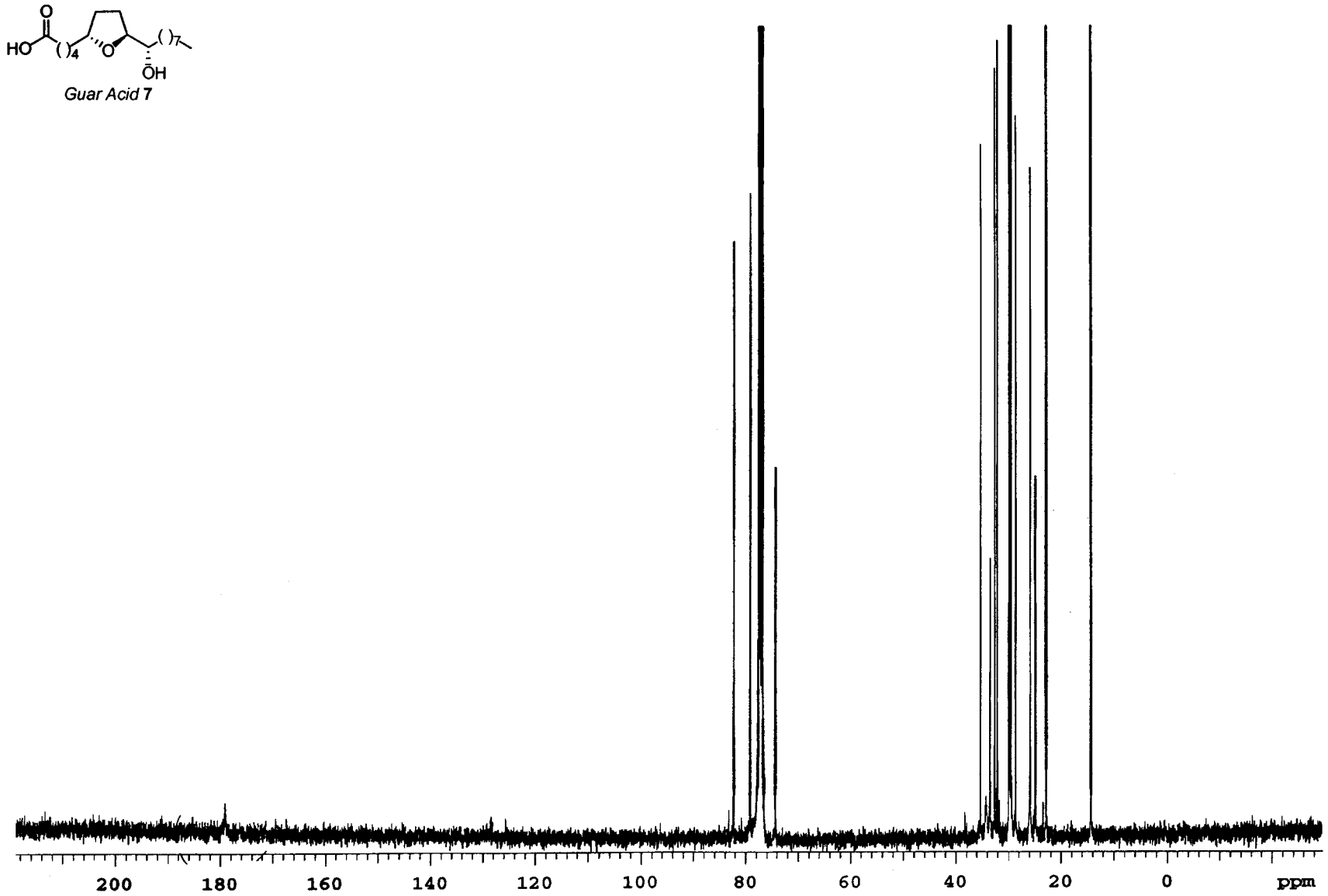


Guar Acid 7





Guar Acid **7**



Guar Acid **7**