Total Synthesis of Narbonolide and Biotransformation to Pikromycin

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General Procedures. All commercial reagents were used as provided unless otherwise indicated. The Dess–Martin periodinane[1] was synthesized according to the modified method of Ireland.[2] THF, Et_2O, and CH_2Cl_2 were purified by passage through alumina columns. All reactions were performed under an inert atmosphere of dry N_2 in oven-dried (150 °C) glassware. Optical rotations were determined on a polarimeter using the sodium D line (λ = 589 nm) at the temperature indicated and are reported as follows: $[\alpha]_D^{temp}$, concentration (c = g/100 mL), and solvent. Proton chemical shifts are reported in ppm from an internal standard of residual chloroform (7.26 ppm), and carbon chemical shifts are reported using an internal standard of residual chloroform (77.0 ppm). Proton chemical data are reported as follows: chemical shift, multiplicity (ovlp = overlapping, s = singlet, d = doublet, t = triplet, q = quartet, p = pentet, m = multiplet, br = broad), coupling constant, and integration. High resolution mass spectra were obtained by ESI-TOF/MS using either PEG or PPG standards as high resolution calibrants. HPLC analyses were performed with a diode array and multiple wavelength detector. LC-MS data were obtained with a UV6000L diode array detector and an electrospray-ion trap mass spectrometer for ESI.

(*R*)-3-((2*S*,3*S*,4*S*,6*R*)-3-Hydroxy-2,4,6-trimethyl-7-(triisopropylsilyloxy)heptanoyl)-4-benzyloxazolin-2-one (5). To a solution of *R*-4-benzyl-3-propionyl-2-oxazolidinone (2.33 g, 10 mmol, 1.0 equiv) in CH_2Cl_2 at –78 ºC was added freshly distilled Bu_2BOTf (3.0 mL, 12 mmol, 1.2 equiv). After 15 min, distilled *i*-Pr_2NEt (2.3 mL, 13.0 mmol, 1.3 equiv) was added, and the temperature was raised to 0 ºC and stirred for 1 h. The mixture was cooled back to –78 ºC and a solution of aldehyde **4**[3] (2.84 g, 10.0 mmol, 1.0 equiv) in CH_2Cl_2 (10 mL) was added. The reaction mixture was stirred at –78 ºC for 30 min, followed by stirring at –10 ºC for 2 h. The reaction was quenched by the addition of pH 7 phosphate buffer (1 M, 10 mL) and MeOH (25 mL). The mixture was treated with a solution of 30% H_2O_2 (9 mL) and MeOH (17 mL) and extracted with Et_2O (5 × 15 mL). Purification by flash chromatography (20% EtOAc/hexanes) afforded the title compound (4.07 g, 78% yield) as a colorless oil. R_f = 0.46 (20% EtOAc/hexanes); $[\alpha]_D^{23}$ = -40.56 (c = 0.53, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.24–7.37 (m, 3H), 7.19–7.22 (m, 2H), 4.64–4.72 (m, 1H), 4.15–4.24 (m, 2H), 3.96 (dq, J = 2.1, 6.9 Hz,

1H), 3.55–3.62 (m, 2H), 3.44 (dd, *J* = 5.7, 9.3 Hz, 1H), 3.27 (dd, *J* = 3.6, 13.5 Hz, 1H), 2.77 (dd, *J* = 9.3, 13.5 Hz, 2H), 1.64–1.84 (ovlp, 4H), 1.21 (d, *J* = 6.9 Hz, 3H), 1.03–1.16 (ovlp, 21H), 0.95 (d, *J* = 6.3 Hz, 3H), 0.90 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 177.7, 153.1, 135.3, 129.6, 129.2, 127.6, 76.4, 68.5, 66.4, 55.6, 40.1, 38.2, 38.1, 34.4, 34.0, 19.4, 18.5, 16.6, 12.4, 9.9; HRMS calcd for ($C_{29}H_{49}NO_5Si + Na^+$): 542.3278, found 542.3275.

(2*S*,3*S*,4*S*,6*R*)-2,4,6-Trimethyl-7-(triisopropylsilyloxy)heptane-1,3-diol (6). To a solution of aldol adduct **5** (3.63 g, 7.0 mmol) in THF (35 mL) at 0 ºC was added MeOH (0.27 mL) and $LiBH_4$ (2 M solution in THF, 3.5 mL, 7.0 mmol, 1.0 equiv), and the reaction was stirred for 45 min. The reaction was quenched by the addition of saturated aqueous sodium potassium tartrate (35 mL) and stirred vigorously as it was warmed to room temperature. The reaction mixture was extracted with CH_2Cl_2 (3 × 50 mL). The combined organic extracts were washed with saturated aqueous NaCl (20 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. Purification by flash chromatography (30% EtOAc/hexanes) afforded the title compound (2.13 g, 88% yield) as a colorless oil. R_f = 0.43 (30% EtOAc/hexanes); $[\alpha]_D^{23}$ = +10.53 (*c* = 0.94, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 3.77 (dd, *J* = 3.6, 10.5 Hz, 1H), 3.68 (dd, *J* = 5.4, 10.5 Hz,1H), 3.46–3.58 (ovlp, 3H), 2.27 (br s, 2H), 1.58–1.88 (m, 4H), 1.03–1.14 (ovlp, 21H), 0.89–1.02 (ovlp, 7H), 0.84 (d, *J* = 7.2 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 80.3, 68.5, 68.4, 38.6, 36.3, 35.2, 34.3, 19.4, 18.4, 17.4, 12.4, 9.3; HRMS calcd for ($C_{19}H_{42}O_3Si + Na^+$): 369.2801, found 369.2804.

(2*R*,4*S*)-4-((2'*R*,4'*S*,5'*S*)-2'-(4-Methoxyphenyl)-5'-methyl-1',3'-dioxan-4-yl)-2-methyl-1-(triisopropylsilyloxy)pentane (7). To a solution of diol **6** (2.13 g, 6.16 mmol) in CH_2Cl_2 (40 mL) at room temperature was added *p*-anisaldehyde dimethylacetal (1.35 g, 7.4 mmol, 1.2 equiv) and CSA (0.07 g, 0.31 mmol, 0.05 equiv) and the reaction was stirred for 12h. The reaction was quenched by the addition of saturated aqueous $NaHCO_3$ (15 mL). The layers were separated and the aqueous layer was extracted with CH_2Cl_2 (3 × 20 mL). The combined organic layers were washed with saturated aqueous NaCl (20 mL), dried ($MgSO_4$), filtered and concentrated under reduced pressure. Purification by flash

chromatography (15% EtOAc/hexanes) afforded the title compound (2.64 g, 92% yield) as a colorless oil whose spectral data corresponded to those reported.[4]

(2*S*,3*S*,4*S*,6*R*)-3-(4-Methoxybenzyloxy)-2,4,6-trimethyl-7-(triisopropylsilyloxy)heptan-1-ol (8). A solution of cyclic acetal **7** (1.86 g, 4.0 mmol) in toluene (20 mL) at 0 ºC was treated dropwise with DIBAL-H (1.0 M solution in toluene, 12 mL, 12 mmol, 3.0 equiv) and stirred for 1 h. The reaction was quenched by the addition of EtOAc (12 mL) and saturated aqueous sodium potassium tartrate (12 mL). The mixture was warmed to room temperature and stirred vigorously for 6 h. The mixture was extracted with Et_2O (3 × 30 mL), and the combined organic layers were washed with saturated aqueous NaCl (10 mL), dried ($MgSO_4$), filtered, and concentrated under reduced pressure. Purification by flash chromatography (20% EtOAc/hexanes) afforded the title compound (1.75 g, 94% yield) as a colorless oil whose spectral data corresponded to those reported.[4]

(2*S*,3*S*,4*S*,6*R*)-3-(4-Methoxybenzyloxy)-2,4,6-trimethyl-7-(triisopropylsilyloxy)heptanal (9). To solution of $(COCl)_2$ (0.50 mL, 5.7 mmol, 1.5 equiv) in CH_2Cl_2 (15 mL) at –78 ºC was added dropwise a solution of DMSO (0.81 mL, 11.4 mmol, 3.0 equiv) in CH_2Cl_2 (5 mL). After 15 min the cloudy solution was treated with a solution of alcohol **8** (1.77 g, 3.8 mmol) in CH_2Cl_2 (25 mL). The reaction was stirred for 15 min at –78 ºC, then treated with *i*-Pr_2NEt (3.3 mL, 19.0 mmol, 5.0 equiv). After stirring for 30 min at –78 ºC, the reaction mixture was warmed to 0 ºC and stirred for 1 h. The reaction was quenched by the addition of saturated aqueous NH_4Cl (20 mL) and the mixture was slowly warmed to room temperature. The layers were separated and the aqueous layer was extracted with CH_2Cl_2 (3 × 30 mL). The combined organic layers were washed with saturated aqueous NaCl (15 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. Purification by flash chromatography (10% EtOAc/hexanes) afforded the title compound (1.52 g, 86% yield) as a colorless oil. R_f = 0.53 (10% EtOAc/hexanes); $[\alpha]_D^{23}$ = -16.59 (*c* = 0.91, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 9.72 (s, 1H), 7.20 (d, *J* = 8.7 Hz, 2H), 6.84 (d, *J* = 8.7 Hz, 2H), 4.38 (AB system, *J* = 10.8 Hz, ν_{AB} = 23.4, 2H), 3.79 (s, 3H), 3.66 (dd, *J* = 3.6, 6.3 Hz, 1H), 3.53 (dd, *J* = 5.1, 6.3 Hz, 1H), 3.42 (dd, *J* = 6.3, 9.3 Hz, 1H), 2.53–

2.62 (m, 1H), 1.95 (m, 1H), 1.52–1.75 (ovlp, 2H), 1.16 (d, *J* = 6.9 Hz, 3H), 1.02–1.09 (ovlp, 22H), 0.94 (d, *J* = 6.6 Hz, 3H), 0.93 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 204.9, 159.3, 130.7, 129.4, 113.9, 82.0, 73.1, 68.3, 55.6, 49.1, 37.5, 33.9, 18.9, 18.5, 18.1, 17.2, 12.4, 8.9; HRMS calcd for ($C_{27}H_{48}O_4Si + Na^+$): 487.3220, found 487.3218.

(2*R*,3*S*,4*S*,5*S*,6*S*,8*R*)-3-Hydroxy-5-(4-methoxybenzyloxy)-2,4,6,8-tetramethyl-9-(triisopropylsilyloxy)nonanoic acid (11). To a solution of oxazolidinone **10** (1.05 g, 1.5 mmol) in THF (16 mL) and H_2O (4 mL) at 0 ºC was added 30% aqueous H_2O_2 (1.7 mL, 15.0 mmol, 10.0 equiv) and aqueous LiOH (1 M, 4.5 mL, 4.5 mmol, 3.0 equiv). After 1 h the solution was warmed to room temperature and stirred for an additional 6 h. The solution was cooled to 0 ºC and treated with aqueous Na_2SO_3 (1.5 M, 10 mL). After 10 min, the mixture was diluted with EtOAc (20 mL) and acidified to pH 1 with 1 M HCl. The layers were separated and the aqueous layer was extracted with EtOAc (3 × 20 mL). The combined organic layers were washed with saturated aqueous NaCl (10 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. Purification by flash chromatography (5% MeOH/CH_2Cl_2) afforded the title compound (0.66 g, 82% yield) as a colorless oil. R_f = 0.35 (5% MeOH/CH_2Cl_2); $[\alpha]_D^{23}$ = + 5.78 (*c* = 1.80, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.26 (d, *J* = 8.7 Hz, 2H), 6.87 (d, *J* = 8.7 Hz, 2H), 4.52 (AB system, *J* = 10.7 Hz, ν_{AB} 75.3, 2H), 3.93 (dd, *J* = 2.4, 8.4 Hz, 1H), 3.80 (s, 3H), 3.57 (dd, *J* = 5.1, 9.6 Hz, 1H), 3.47 (dd, *J* = 5.7, 9.6 Hz, 1H), 3.36 (dd, *J* = 2.4, 6.6 Hz, 1H), 2.67 (pent, *J* = 7.2 Hz, 1H), 2.07–2.14 (m, 1H), 1.87–1.94 (m, 1H), 1.70–1.78 (m, 1H), 1.58–1.67 (m, 1H), 1.25 (d, *J* = 6.9 Hz, 3H), 1.01–1.19 (ovlp, 23H), 0.97 (d, *J* = 7.2 Hz, 3H), 0.96 (d, *J* = 6.3 Hz, 3H), 0.95 (d, *J* = 6.6 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 180.5, 159.4, 130.4, 129.6, 114.1, 87.9, 76.7, 73.2, 68.3, 55.6, 43.3, 37.6, 37.0, 33.8, 33.3, 19.1, 18.5, 16.8, 13.8, 12.4, 8.1; HRMS calcd for ($C_{30}H_{54}O_6Si + Na^+$): 561.3587, found 561.3593.

(2*R*,3*S*,4*S*,5*S*,6*S*,8*R*)-((3*R*,4*R*,5*E*)-6-Iodo-4-methylhex-5-en-3-yl) 3-hydroxy-5-(4-methoxybenzyloxy)-2,4,6,8-tetramethyl-9-(triisopropylsilyloxy)nonanoate (13). To a solution of acid **11** (0.81 g, 1.50 mmol) in THF (15 mL) at room temperature was added 2,4,6-

trichlorobenzoylchloride (0.25 mL, 1.65 mmol, 1.1 equiv) and Et_3N (0.22 mL, 1.58 mmol, 1.05 equiv). After stirring for 3 h, the solids were filtered and washed with hexanes. The solvents were removed under reduced pressure and the residue was dissolved in benzene (20 mL). To this solution was added vinyliodide **12**[4] (0.43 g, 1.80 mmol, 1.20 equiv) in benzene (10 mL) and DMAP (0.25 g, 2.03 mmol, 1.35 equiv), and the reaction was stirred at room temperature for 24 h. The reaction was diluted with Et_2O (100 mL), washed with saturated aqueous $NaHCO_3$ (15 mL) and saturated aqueous NaCl (10 mL), dried ($MgSO_4$), filtered, and concentrated under reduced pressure. Purification by flash chromatography (20% EtOAc/hexanes) afforded the title compound (0.69 g, 61% yield) as a colorless oil. R_f = 0.41 (20% EtOAc/hexanes); $[\alpha]_D^{23}$ = + 28.80 (*c* = 1.00, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.25 (d, *J* = 8.4 Hz, 2H), 6.87 (d, *J* = 8.7 Hz, 2H), 6,43 (dd, *J* = 7.8, 14.7 Hz, 1H), 6.08 (dd, *J* = 0.9, 14.7 Hz, 1H), 4.69–4.76 (m, 1H), 4.52 (AB system, *J* = 10.5 Hz, ν_{AB} 66.3, 2H), 3.88 (dd, *J* = 2.4, 8.7 Hz, 1H), 3.79 (s, 3H), 3.58 (dd, *J* = 4.8, 9.6 Hz, 1H), 3.45 (dd, *J* = 6.3, 9.6 Hz, 1H), 3.36 (dd, *J* = 2.4, 6.9 Hz, 1H), 2.59–2.69 (m, 1H), 2.42–2.48 (m, 1H), 2.03–2.10 (m, 1H), 1.44–1.82 (ovlp, 6H), 1.27 (d, *J* = 6.9 Hz, 3H), 1.03–1.11 (ovlp, 22H), 0.96–1.01 (ovlp, 6H), 0.95 (d, *J* = 6.6 Hz, 3H), 0.92 (d, *J* = 7.2 Hz, 3H), 0.86 (t, *J* = 7.5 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 175.1, 159.3, 147.4, 130.4, 129.4, 114.1, 88.4, 77.2, 77.1, 76.4, 72.9, 68.1, 55.6, 44.3, 43.9, 37.7, 37.2, 33.7, 33.3, 24.6, 19.2, 18.5, 16.5, 15.2, 14.8, 12.4, 10.3, 7.9; HRMS calcd for ($C_{37}H_{65}IO_6Si + Na^+$): 783.3493, found 783.3513.

(2*R*,3*S*,4*S*,5*S*,6*S*,8*R*)-((3*R*,4*R*,5*E*)-6-Iodo-4-methylhex-5-en-3-yl) 3,9-dihydroxy-5-(4-methoxybenzyloxy)-2,4,6,8-tetramethylnonanoate (14). To a solution of silyl ether **13** (0.27 g, 0.355 mmol) in pyridine (1.00 mL) and THF (15 mL) was added HF•pyridine (70% HF in pyridine, 2.00 mL). The reaction was stirred for 48 h at room temperature, diluted with Et_2O (50 mL), washed with H_2O (2 × 5 mL), saturated aqueous NaCl (5 mL), dried ($MgSO_4$), filtered, and concentrated under reduced pressure. Purification by flash chromatography (40% EtOAc/hexanes) afforded the title compound (0.17 g, 79% yield) as a colorless oil. R_f = 0.51 (40% EtOAc/hexanes); $[\alpha]_D^{23}$ = +40.63 (*c* = 0.48, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.24 (d, *J* = 8.4 Hz, 2H), 6.84 (d, *J* = 8.4 Hz, 2H), 6.47 (dd, *J* = 8.1, 14.4 Hz,

1H), 6.06 (d, *J* = 14.4 Hz, 1H), 4.73–4.79 (m, 1H), 4.55 (s, 2H), 4.07 (dd, *J* = 2.7, 9.3 Hz, 1H), 3.77 (s, 3H), 3.49 (dd, *J* = 4.5, 10.5 Hz, 1H), 3.31–3.40 (ovlp, 2H), 2.57–2.65 (m, 1H), 2.46 (sext, *J* = 6.6 Hz, 1H), 1.41–1.91 (m, 8H), 1.12 (d, *J* = 7.2 Hz, 3H), 1.03 (d, *J* = 6.6 Hz, 3H), 0.99 (d, *J* = 6.9 Hz, 3H), 0.97–0.99 (m, 1H), 0.94 (d, *J* = 6.6 Hz, 3H), 0.83–0.84 (ovlp, 6H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 175.3, 159.4, 147.7, 130.2, 129.7, 114.1, 89.7, 77.4, 76.2, 74.9, 74.6, 67.7, 55.6, 44.3, 42.6, 38.4, 35.9, 34.5, 33.7, 24.5, 18.8, 15.5, 15.4, 10.3, 9.1; HRMS calcd for ($C_{28}H_{45}IO_6$ + Na^+): 627.2159, found 627.2183.

(2*R*/*S*,3*S*,4*S*,5*S*,6*S*,8*R*)-((3*R*,4*R*,*E*)-6-Iodo-4-methylhex-5-en-3-yl) 3-hydroxy-5-(4-methoxybenzyloxy)-2,4,6,8-tetramethyl-9-oxononanoate (15). To a solution of alcohol **14** (0.17 g, 0.282 mmol) in CH_2Cl_2 (30 mL) at room temperature was added the Dess–Martin periodinane (0.48 g, 1.126 mmol, 4.0 equiv) and pyridine (1.25 mL). The reaction was stirred for 12 h and diluted with EtOAc (100 mL). The mixture was washed with saturated aqueous $NaHCO_3$ (20 mL), 1 M aqueous Na_2SO_3 (20 mL), and saturated aqueous NaCl (20 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. Purification by flash chromatography (15% EtOAc/hexanes) afforded the title compound (0.131 g, 77% yield) as a colorless oil. R_f = 0.51 (15% EtOAc/hexanes); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 9.56 (s, 1H), 7.14 (d, *J* = 8.4 Hz, 2H), 6.82 (d, *J* = 8.7 Hz, 2H), 6.39 (dd, *J* = 8.4, 14.7 Hz, 1H), 6.07 (d, *J* = 14.1 Hz, 1H), 4.72–4.78 (m ,1H), 4.32 (AB system, *J* = 10.8 Hz, ν_{AB} 49.2, 2H), 3.78 (s, 3H), 3.66–3.71 (m, 1H), 3.52 (dd, *J* = 1.5, 9.6 Hz, 1H), 3.04–3.15 (m, 1H), 2.42–2.51 (m, 2H), 1.72–1.88 (m, 2H), 1.29–1.63 (ovlp, 3H), 1.20 (d, *J* = 6.9 Hz, 3H), 1.12 (d, *J* = 7.2 Hz, 3H), 1.05 (d, *J* = 6.6 Hz, 3H), 1.04 (d, *J* = 6.6 Hz, 3H), 0.98 (d, *J* = 6.9 Hz, 3H), 0.85 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 209.3, 204.9, 170.6, 159.3, 147.1, 130.7, 129.4, 113.9, 87.1, 78.4, 76.7, 74.9, 55.6, 54.7, 48.4, 44.4, 44.2, 44.0, 33.1, 32.1, 24.4, 18.1, 15.5, 15.2, 14.7, 12.8, 10.3; HRMS calcd for ($C_{28}H_{41}IO_6$ + Na^+): 623.1846, found 623.1829.

(2*R*/*S*,9*R*/*S*)-9-Dihydro-5-(4-methoxybenzyloxy)narbonolide (16). To a solution of aldehyde **15** (130 mg, 0.2167 mmol) in DMSO (87 mL) at room temperature was added $CrCl_2$ (266 mg, 2.1670 mmol, 10 equiv) and $NiCl_2$ (2.7 mg, 0.0217 mmol, 0.1 equiv). The reaction was stirred for 12 h, then

quenched by the addition of H_2O (40 mL). The mixture was diluted with EtOAc (500 mL) and the layers were separated. The organic layer was washed with H_2O (3 × 50 mL) and saturated aqueous NaCl (20 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. Purification by flash chromatography (30% EtOAc/hexanes) afforded the title compound (91.0 mg, 89% yield) as a moist solid. R_f = 0.38 (30% EtOAc/hexanes); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.11 (d, *J* = 8.1 Hz, 2H), 6.83 (d, *J* = 8.4 Hz, 2H), 5.62–5.79 (m, 2H), 4.94–4.99 (m, 1H), 4.27 (AB system, *J* = 10.5 Hz, ν_{AB} 42.3, 2H), 4.04–4.06 (m, 1H), 3.78 (s, 3H), 3.51 (q, *J* = 6.6 Hz, 1H), 3.31–3.34 (m, 1H), 2.82–2.92 (m ,1H), 2.55 (br s, 1H), 1.47–1.81 (ovlp, 7H), 1.19 (d, *J* = 6.9 Hz, 3H), 1.11 (d, *J* = 6.9 Hz, 3H), 1.09 (d, *J* = 7.2 Hz, 3H), 1.07 (d, *J* = 6.9 Hz, 3H), 1.01 (d, *J* = 6.6 Hz, 3H), 0.89 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 208.9, 208.7, 170.0, 169.9, 159.2, 135.3, 133.2, 133.1, 131.1, 131.0, 130.7, 129.5, 113.9, 80.6, 80.5, 79.5, 79.1, 78.5, 75.3, 73.1, 72.5, 55.6, 54.1, 52.1, 51.4, 47.7, 46.8, 40.1, 39.2, 36.8, 36.6, 34.8, 33.8, 31.9, 29.6, 22.3, 21.2, 17.5, 17.2, 17.1, 16.9, 16.7, 15.6, 14.9, 14.4, 14.3, 11.4, 11.2; HRMS calcd for ($C_{28}H_{42}O_6$ + Na^+): 497.2879, found 497.2853.

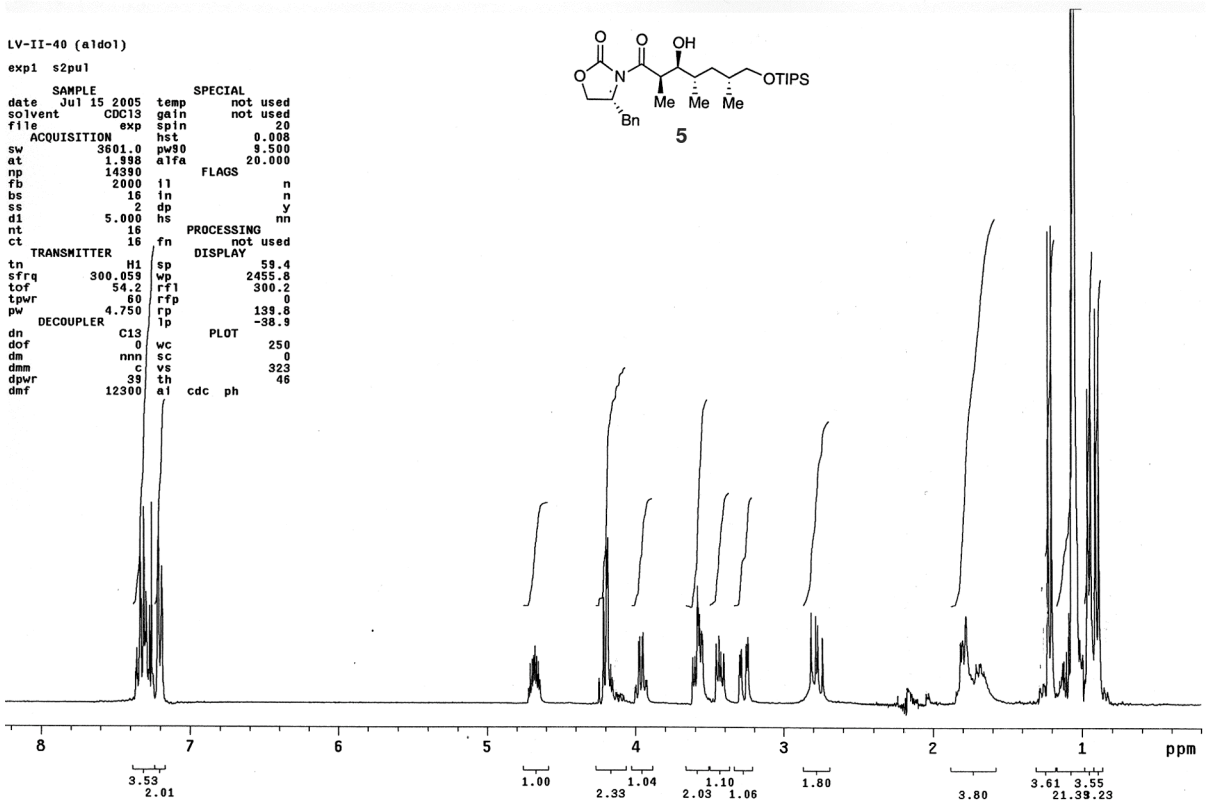
5-(4-Methoxybenzyloxy)narbonolide (17). To a solution of allylic alcohol **16** (28 mg, 0.059 mmol) in CH_2Cl_2 (5 mL) at room temperature was added the Dess–Martin periodinane (75 mg, 0.177 mmol, 4.0 equiv) and pyridine (0.15 mL). The reaction was stirred for 18 h and diluted with EtOAc (40 mL). The mixture was washed with saturated aqueous $NaHCO_3$ (5 mL), 1M aqueous Na_2SO_3 (5 mL), and saturated aqueous NaCl (5 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. Purification by flash chromatography (20% EtOAc/hexanes) afforded the title compound (24.7 mg, 88% yield) as a moist solid. R_f = 0.56 (20% EtOAc/hexanes); $[\alpha]_D^{23}$ = + 86.44 (*c* = 0.59, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 7.27 (d, *J* = 8.4 Hz, 2H), 6.87 (d, *J* = 8.1 Hz, 2H), 6.74 (dd, *J* = 6.0, 15.6 Hz, 1H), 6.13 (d, *J* = 15.9 Hz, 1H), 4.91–4.94 (m, 1H), 4.48 (s, 2H), 3.89 (d, *J* = 6.3 Hz, 1H), 3.79–3.82 (ovlp, 4H), 2.84 (pent, *J* = 7.2 Hz, 1H), 2.58–2.69 (m, 2H), 1.48–1.66 (ovlp, 4H), 1.35 (d, *J* = 7.2 Hz, 3H), 1.28 (d, *J* = 7.2 Hz, 3H), 1.12–1.24 (m, 1H), 1.10 (d, *J* = 7.5 Hz, 3H), 1.07 (d, *J* = 6.9, 3H), 1.01 (d, *J* = 6.6 Hz, 3H), 0.90 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 208.2, 203.2, 169.6, 159.3, 147.8,

130.9, 129.5, 127.1, 113.9, 79.8, 78.7, 74.0, 55.6, 51.0, 49.6, 43.3, 38.8, 36.2, 23.6, 18.2, 16.4, 14.9, 14.7, 12.5, 10.9; HRMS calcd for ($C_{28}H_{40}O_6$ + Na^+): 495.2723, found 495.2727.

(2*R*,3*S*,4*S*,5*S*,6*S*,8*R*)-((3*R*,4*R*,*E*)-6-Iodo-4-methylhex-5-en-3-yl) 3-hydroxy-5-(4-methoxybenzyloxy)-2,4,6,8-tetramethyl-9-oxononanoate (18). To a solution of diol **14** (30.2 mg, 0.05 mmol) in CH_2Cl_2 (5 mL) was added saturated aqueous $NaHCO_3$ (2 mL) and a catalytic amount of KBr. The mixture was cooled to 0 ºC, a catalytic amount of TEMPO was added, and was stirred vigorously and treated with aqueous NaOCl (0.25 M, 0.22 mL, 0.055 mmol, 1.1 equiv) and stirred for 20 min. The reaction was quenched by the addition of saturated aqueous Na_2SO_3 (1 mL) and saturated aqueous $NaHCO_3$ (10 mL). The mixture was extracted with EtOAc (3 × 10 mL) and the combined organic layers were dried ($MgSO_4$), filtered, and concentrated under reduced pressure. Purification by flash chromatography (30% EtOAc/hexanes) afforded the title compound (28 mg, 93% yield) as a colorless oil. R_f = 0.61 (30% EtOAc/hexanes); $[\alpha]_D^{23}$ = +40.42 (*c* = 0.48, CH_2Cl_2); ^{1}H NMR ($CDCl_3$, 300 MHz) δ 9.54 (s, 1H), 7.26 (d, *J* = 8.4 Hz, 2H), 6.87 (d, *J* = 8.4 Hz, 2H), 6.43 (dd, *J* = 4.8, 14.4 Hz, 1H), 6.09 (d, *J* = 14.4 Hz, 1H), 4.70–4.76 (m, 1H), 4.53 (AB system, *J* = 10.5 Hz, ν_{AB} 30.3, 2H) 3.86–3.89 (m, 1H), 3.80 (s, 3H), 3.36 (dd, *J* = 3.0, 6.0 Hz, 1H), 3.03 (s, 1H), 2.66 (pent, *J* = 6.9 Hz, 1H), 2.39–2.52 (m, 2H), 1.75–2.07 (m, 3H), 1.42–1.66 (ovlp, 2H), 1.27 (d, *J* = 7.2 Hz, 3H), 1.15–1.22 (m, 1H), 1.11 (d, *J* = 6.9 Hz, 3H), 0.99 (d, *J* = 6.9 Hz, 3H), 0.98 (d, *J* = 7.2 Hz, 3H), 0.94 (d, *J* = 6.9 Hz, 3H), 0.86 (t, *J* = 7.2 Hz, 3H); ^{13}C NMR ($CDCl_3$, 75 MHz) δ 205.2, 175.2, 159.4, 147.4, 130.2, 129.5, 114.2, 87.6, 77.3, 76.5, 76.4, 73.6, 55.6, 44.4, 44.1, 37.6, 34.5, 33.5, 24.6, 16.7, 15.3, 15.2, 14.8, 10.3, 8.1; HRMS calcd for ($C_{28}H_{43}IO_6$ + Na^+): 625.2002, found 625.2010.

5-(4-Methoxybenzyloxy)narbonolide (17). To a solution of diol **19** (20.0 mg, 0.042 mmol) in CH_2Cl_2 (8 mL) at room temperature was added the Dess–Martin periodinane (71.2 mg, 0.168 mmol, 4.0 equiv). The reaction was stirred for 4 h and diluted with EtOAc (40 mL). The mixture was washed with saturated aqueous $NaHCO_3$ (5 mL), 1 M Na_2SO_3 (5 mL), and saturated aqueous NaCl (5 mL), dried (Na_2SO_4), filtered, and concentrated under reduced pressure. Purification by flash chromatography (20%

EtOAc/hexanes) afforded the title compound (17.6 mg, 88% yield) as a moist solid whose spectral data corresponded to those reported above.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date Jul 15 2005
solvent CDCl3
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at 1.998
np 14390
fb 2000
bs 16
ss 2
d1 5.000
nt 16
ct 16
TRANSMITTER
tn H1
sfrq 300.059
tof 54.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 39
dmf 12300
SPECIAL
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gain not used
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hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
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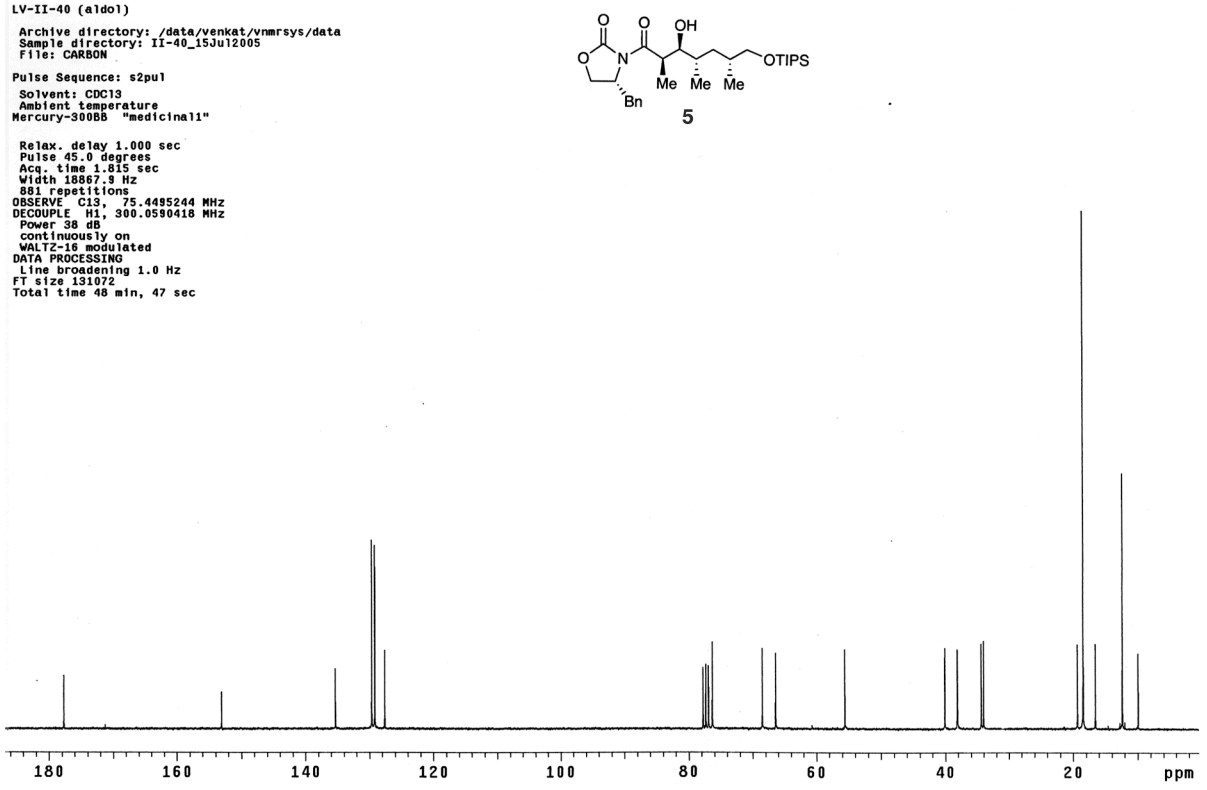
wp 2455.8
rfl 300.2
rfp 0
rp 139.8
lp -38.9
PLOT
wc 250
sc 0
vs 323
th 46
al cdc ph
OH
OTIPS
Me Me Me
Bn
5
8
7
6
5
4
3
2
1
ppm
3.53
2.01
1.00
2.33
1.04
2.03
1.10
1.06
1.80
3.80
3.61
3.55
21.39
3.23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Sample directory: II-40_15Jul2005
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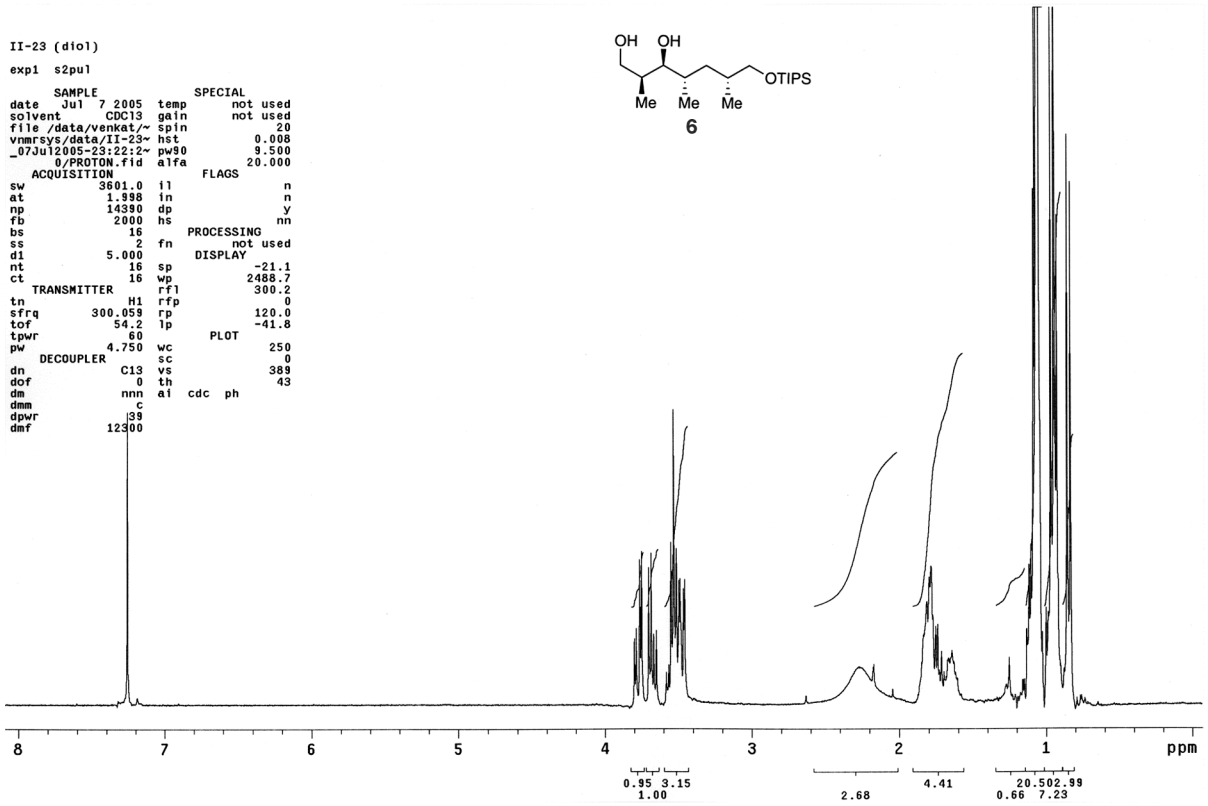
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
881 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 48 min, 47 sec
OH
OTIPS
Me Me Me
Bn
5
180
160
140
120
100
80
60
40
20
ppm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date Jul 7 2005
solvent CDCl3
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vnmrsys/data/II-23~
_07Jul2005-23:22:2~
0/PROTON.fid
ACQUISITION
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at 1.998
np 14390
fb 2000
bs 16
ss 2
d1 5.000
nt 16
ct 16
TRANSMITTER
tn H1
sfrq 300.059
tof 54.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 39
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp -21.1
wp 2488.7
rfl 300.2
rfp 0
rp 120.0
lp -41.8
PLOT
wc 250
sc 0
vs 389
th 43
ai cdc ph
OH OH
OTIPS
Me Me Me
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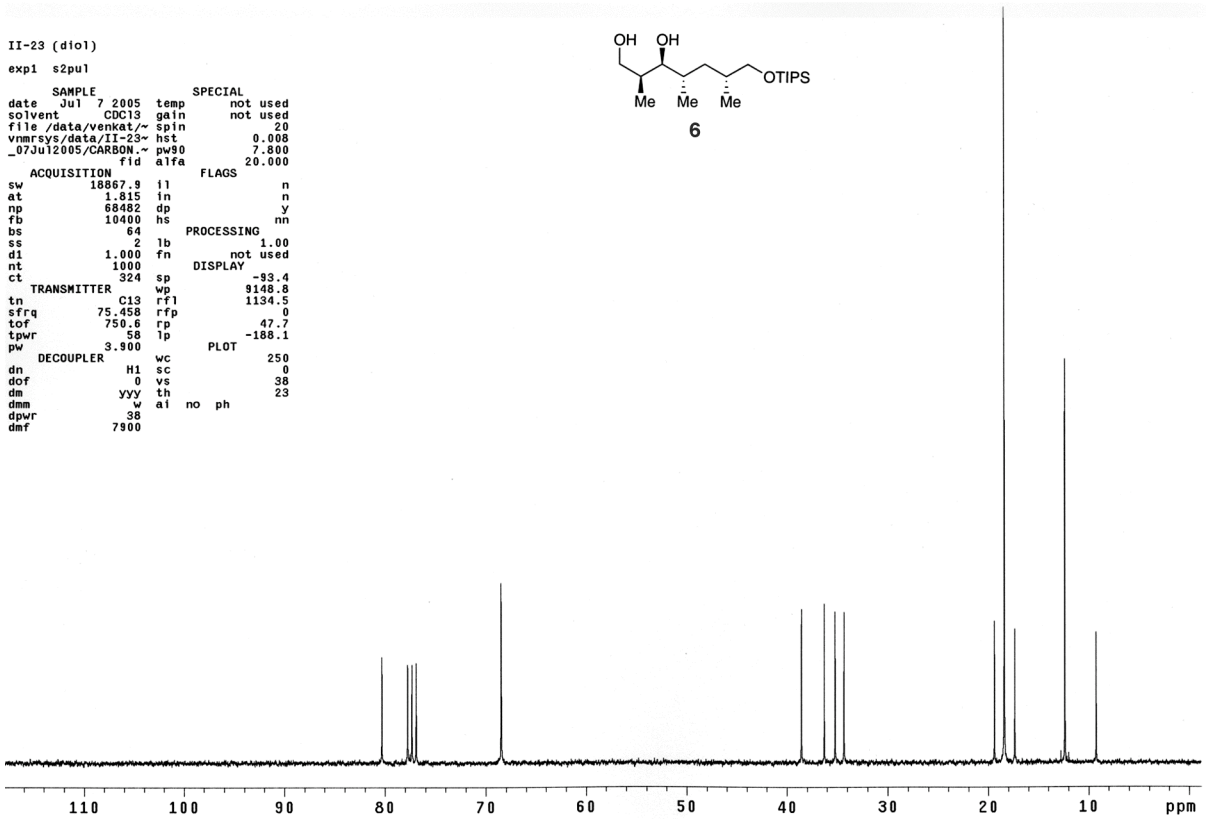
0.95 3.15
1.00
2.68
4.41
20.50 2.99
0.66 7.23


II-23 (diol)
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SAMPLE
date Jul 7 2005
solvent CDCl3
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_07Jul2005/CARBON.~
fid
ACQUISITION
sw 18867.9
at 1.815
np 68482
fb 10400
bs 64
ss 2
d1 1.000
nt 1000
ct 324
TRANSMITTER
tn C13
sfrq 75.458
tof 750.6
tpwr 58
pw 3.900
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 38
dmf 7900
SPECIAL
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gain not used
spin 20
hst 0.008
pw90 7.800
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 1.00
fn not used
DISPLAY
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wp 9148.8
rfl 1134.5
rfp 0
rp 47.7
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sc 0
vs 38
th 23
ai no ph
OH OH
OTIPS
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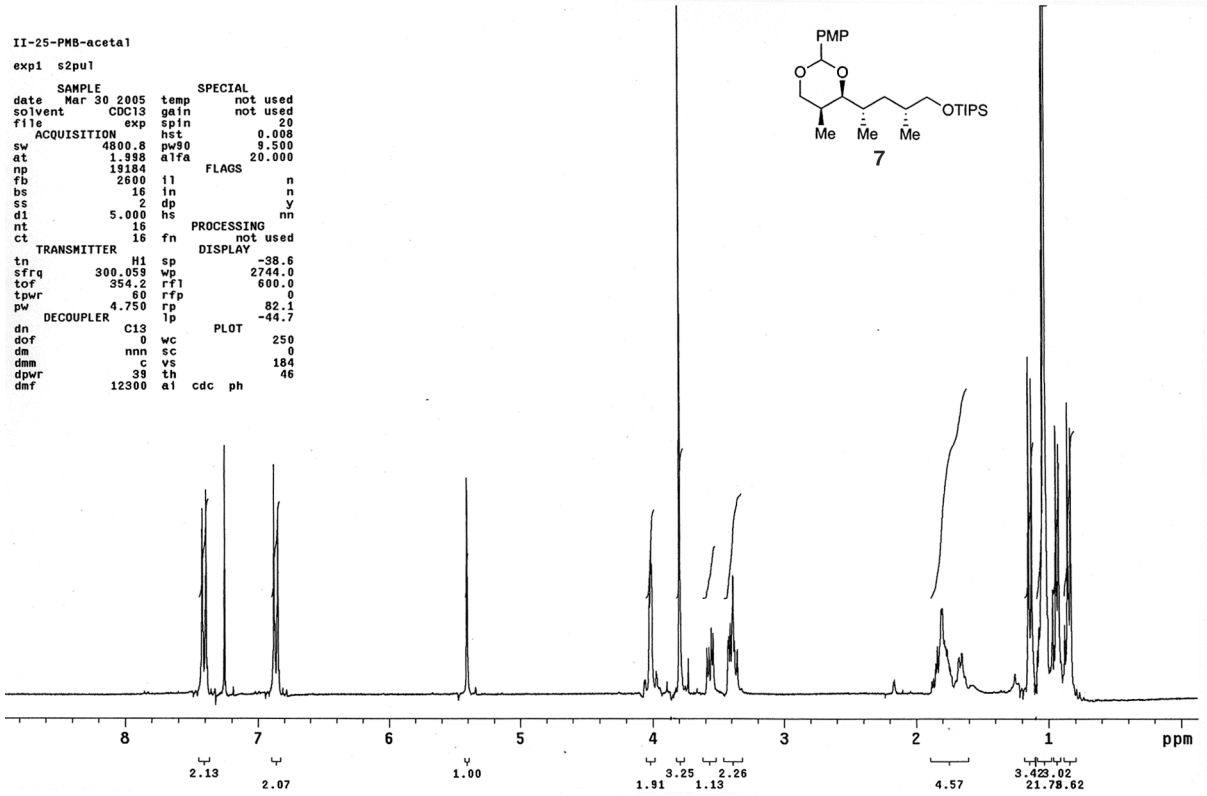
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exp1 s2pul
SAMPLE
date Mar 30 2005
solvent CDCl3
file exp
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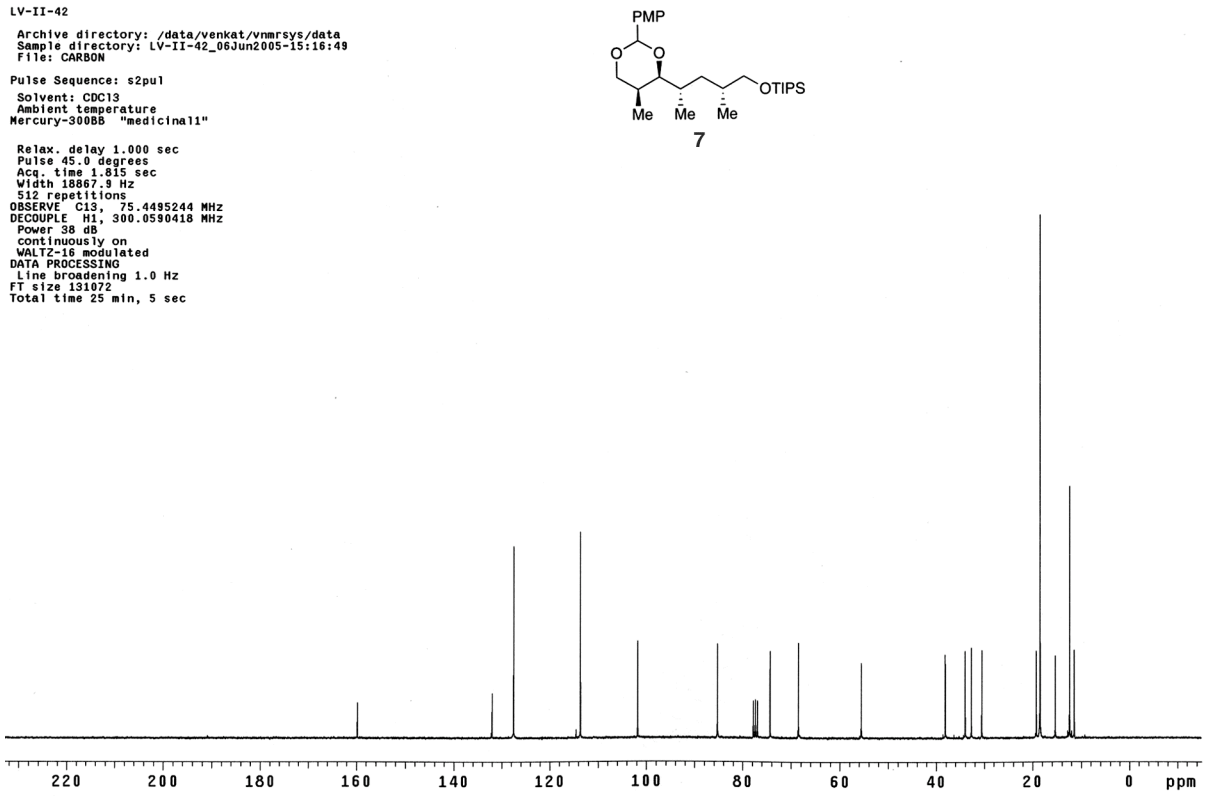
sw 4800.8
at 1.998
np 19184
fb 2600
bs 16
ss 2
d1 5.000
nt 16
ct 16
TRANSMITTER
tn H1
sfrq 300.059
tof 354.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 39
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp -38.6
wp 2744.0
rfl 600.0
rfp 0
rp 82.1
lp -44.7
PLOT
wc 250
sc 0
vs 184
th 46
ai cdc ph
PMP
OTIPS
Me Me Me
7
8 7 6 5 4 3 2 1 ppm
2.13 2.07 1.00 1.91 3.25 1.13 2.26 4.57 3.42 3.02 21.78.62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Sample directory: LV-II-42_06Jun2005-15:16:49
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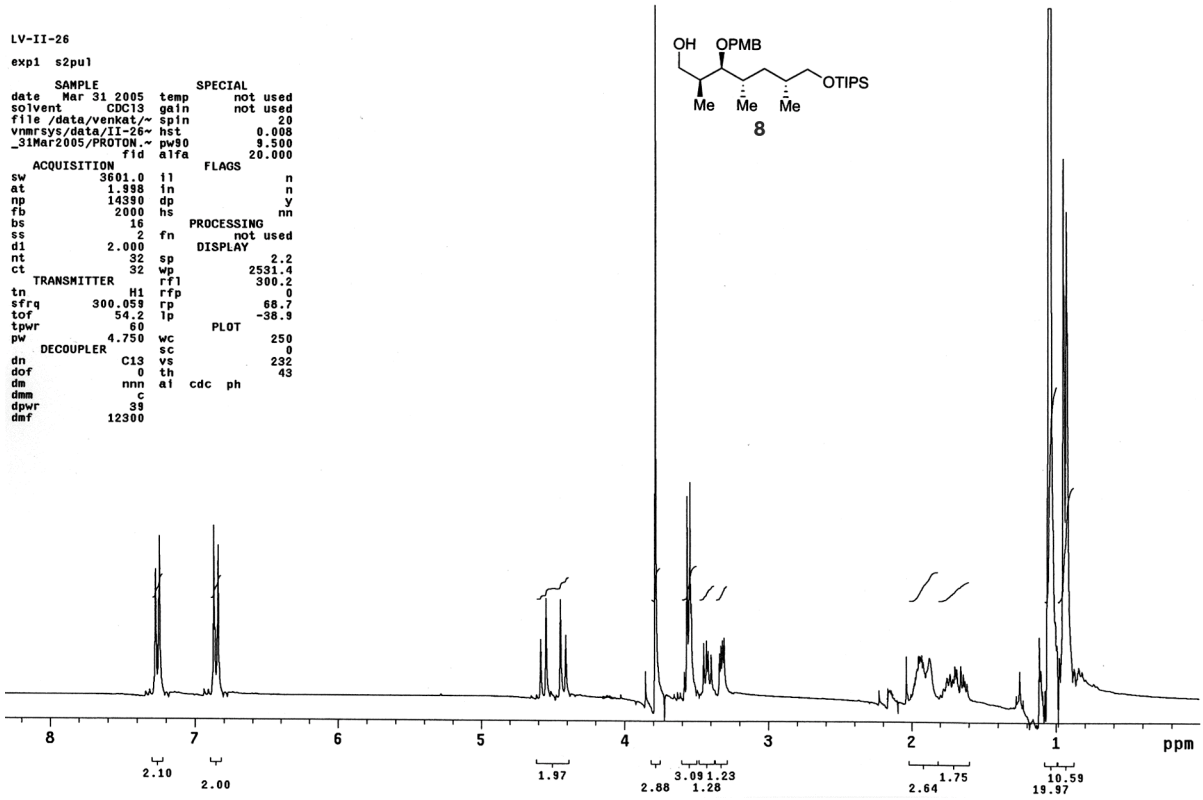
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
512 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 25 min, 5 sec
PMP
OTIPS
Me Me Me
7
220 200 180 160 140 120 100 80 60 40 20 0 ppm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SAMPLE
date Mar 31 2005
solvent CDCl3
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vnmrsys/data/II-26~
_31Mar2005/PROTON.~
fid
ACQUISITION
sw 3601.0
at 1.998
np 14390
fb 2000
bs 16
ss 2
d1 2.000
nt 32
ct 32
TRANSMITTER
tn H1
sfrq 300.059
tof 54.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp 2.2
wp 2531.4
rfl 300.2
rfp 0
rp 68.7
lp -38.9
PLOT
wc 250
sc 0
vs 232
th 43
ai cdc ph
OH
OPMB
OTIPS
Me
Me
Me
8
8
7
6
5
4
3
2
1
ppm
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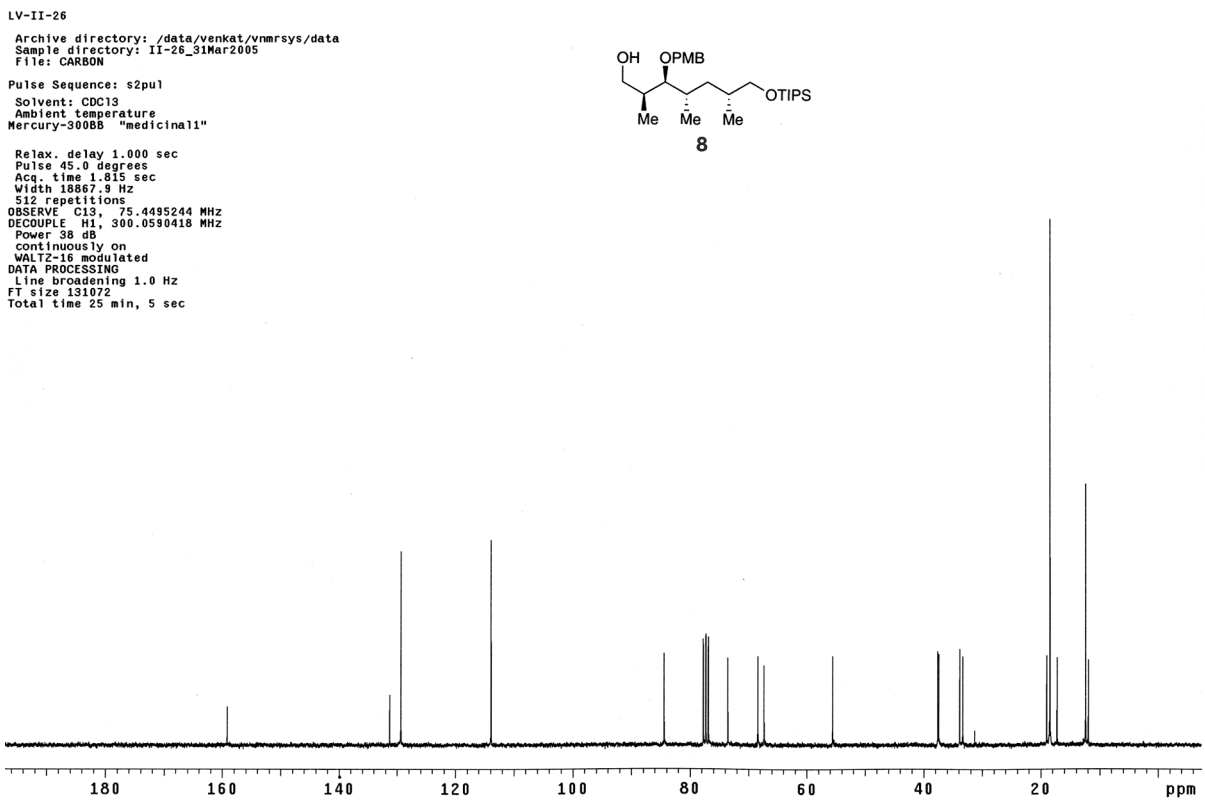
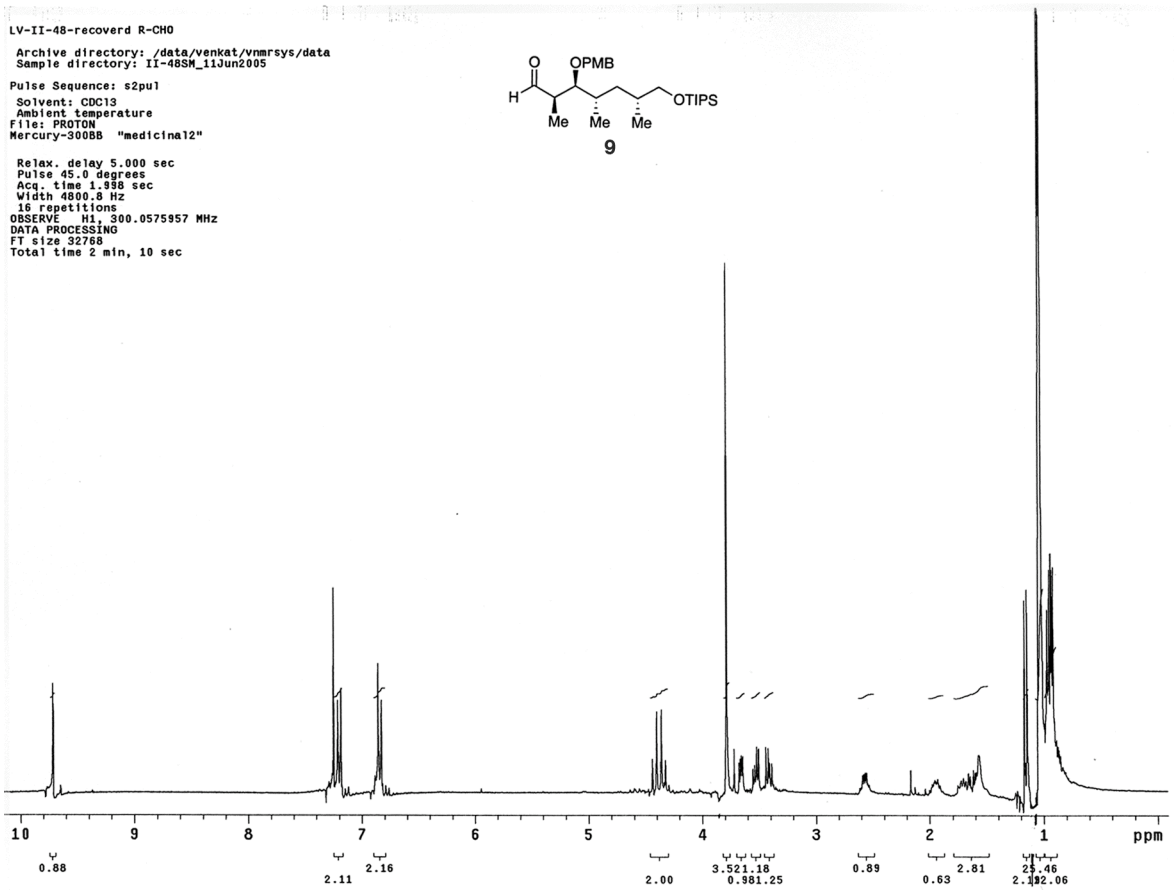
1.23
1.28
2.64
1.75
10.59
19.97


LV-II-26
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-26_31Mar2005
File: CARBON
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
512 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 25 min, 5 sec
OH
OPMB
OTIPS
Me
Me
Me
8
180
160
140
120
100
80
60
40
20
ppm


LV-II-48-recoverd R-CHO
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-48SM_11Jun2005
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: PROTON
Mercury-300BB "medicinal2"
Relax. delay 5.000 sec
Pulse 45.0 degrees
Acq. time 1.998 sec
Width 4800.8 Hz
16 repetitions
OBSERVE H1, 300.0575957 MHz
DATA PROCESSING
FT size 32768
Total time 2 min, 10 sec
O
OPMB
H
OTIPS
Me
Me
Me
9
10
9
8
7
6
5
4
3
2
1
ppm
0.88
2.11
2.16
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1.18
0.98
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0.89
0.63
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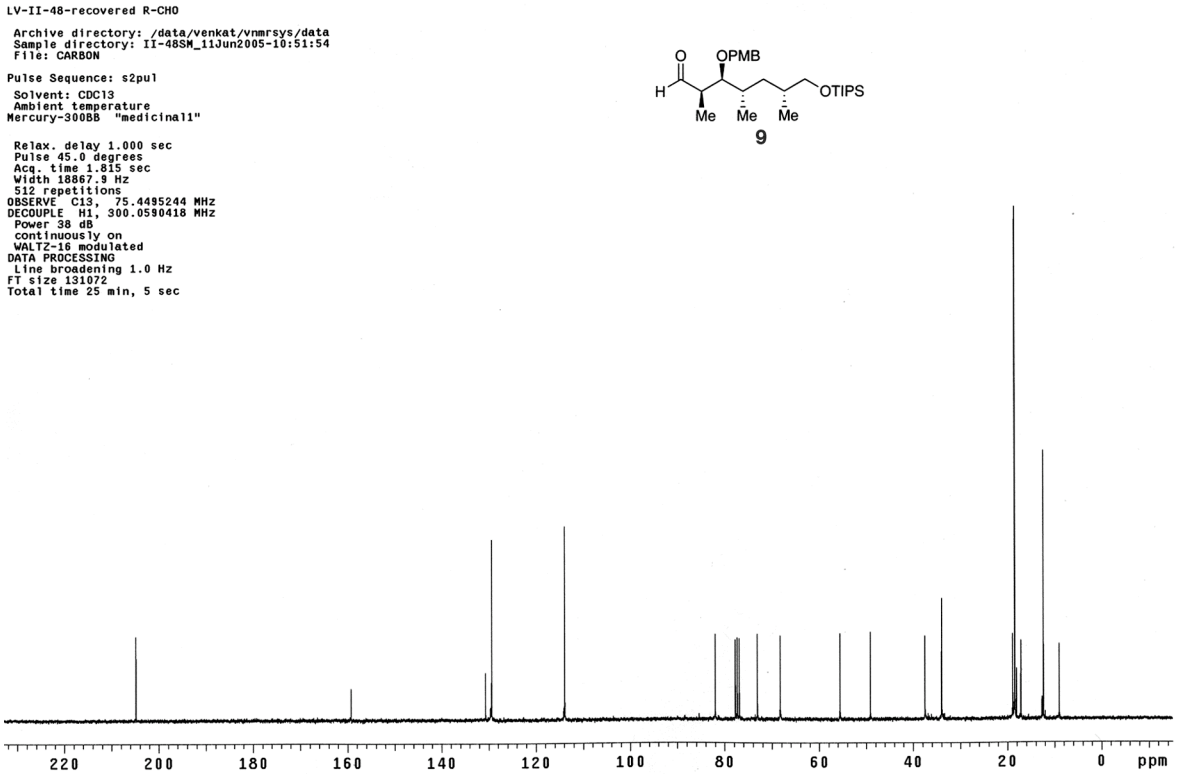
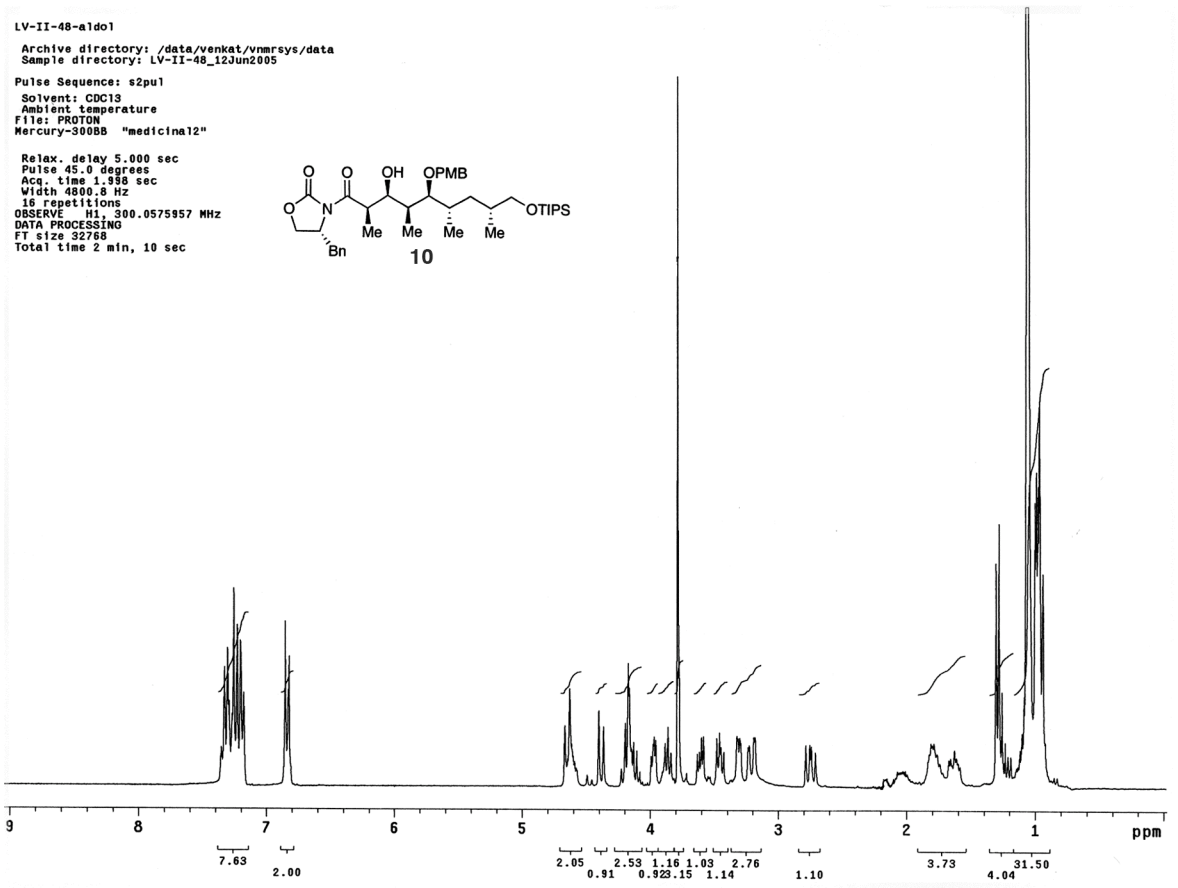
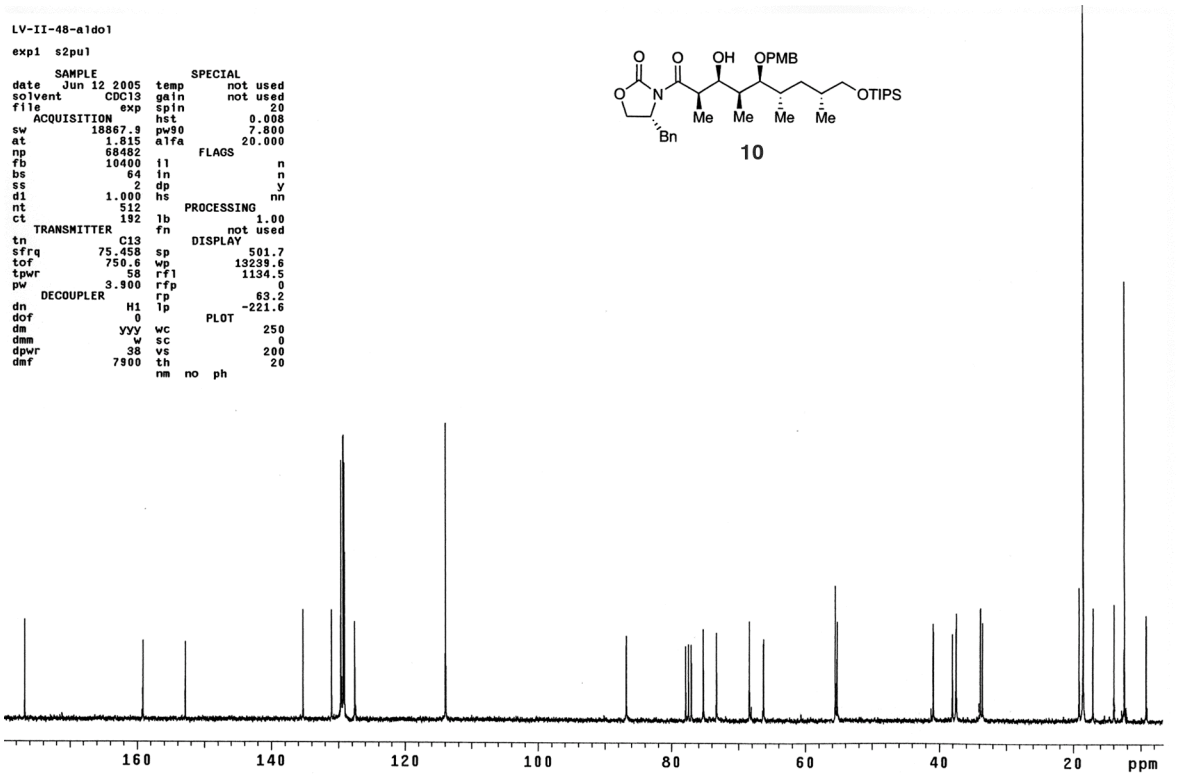
2.46
2.12
2.06


LV-II-48-recovered R-CHO
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-48SM_11Jun2005-10:51:54
File: CARBON
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
512 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 25 min, 5 sec
O
OPMB
H
OTIPS
Me
Me
Me
9
220
200
180
160
140
120
100
80
60
40
20
0
ppm


LV-II-48-aldol
Archive directory: /data/venkat/vnmrsys/data
Sample directory: LV-II-48_12Jun2005
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: PROTON
Mercury-300BB "medicinal2"
Relax. delay 5.000 sec
Pulse 45.0 degrees
Acq. time 1.998 sec
Width 4800.8 Hz
16 repetitions
OBSERVE H1, 300.0575957 MHz
DATA PROCESSING
FT size 32768
Total time 2 min, 10 sec
OH
OPMB
OTIPS
Me
Me
Me
Me
Bn
10
9
8
7
6
5
4
3
2
1
ppm
7.63
2.00
2.05
0.91
2.53
0.92
1.16
3.15
1.03
1.14
2.76
1.10
3.73
31.50
4.04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date Jun 12 2005
solvent CDCl3
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np 68482
fb 10400
bs 64
ss 2
d1 1.000
nt 512
ct 192
TRANSMITTER
tn C13
sfrq 75.458
tof 750.6
tpwr 58
pw 3.900
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 38
dmf 7900
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 7.800
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 1.00
fn not used
DISPLAY
sp 501.7
wp 13239.6
rfl 1134.5
rfp 0
rp 63.2
lp -221.6
PLOT
wc 250
sc 0
vs 200
th 20
nm no ph
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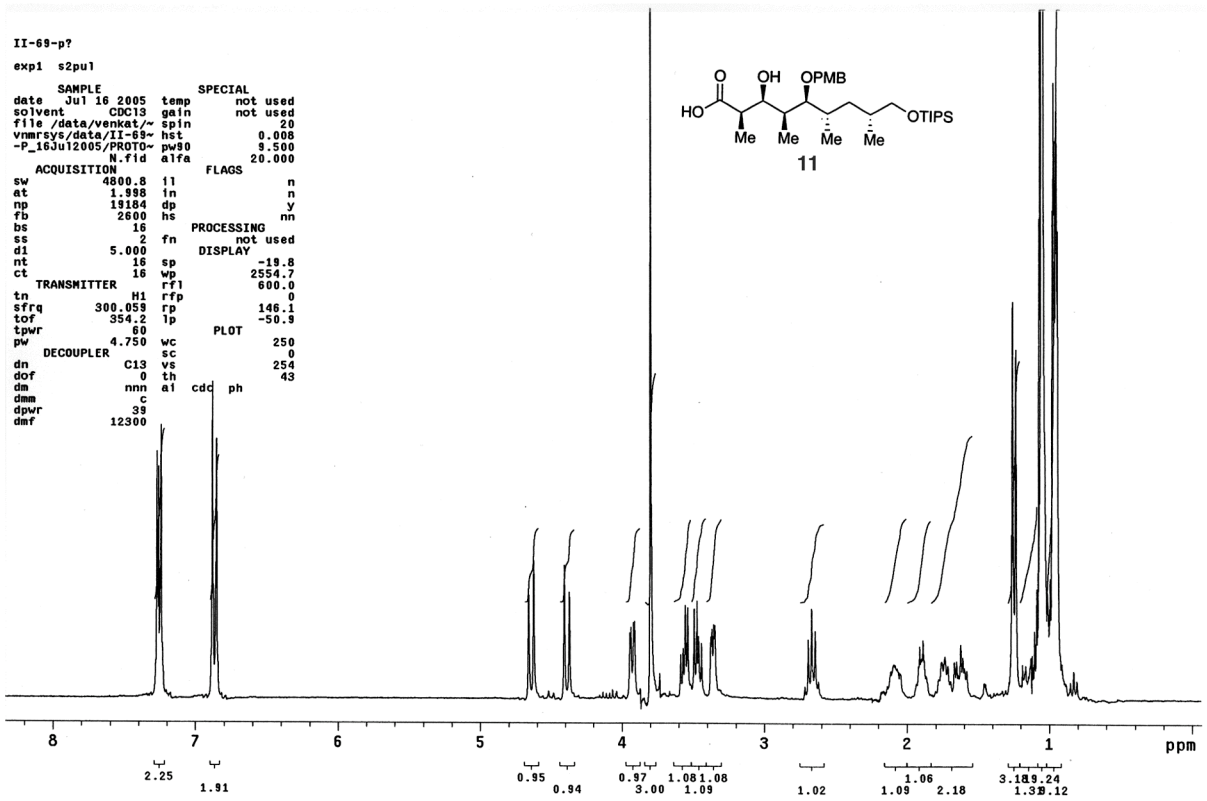
OPMB
OTIPS
Me
Me
Me
Me
Bn
10
160
140
120
100
80
60
40
20
ppm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date Jul 16 2005
solvent CDCl3
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-P_16Jul2005/PROTO~
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ACQUISITION
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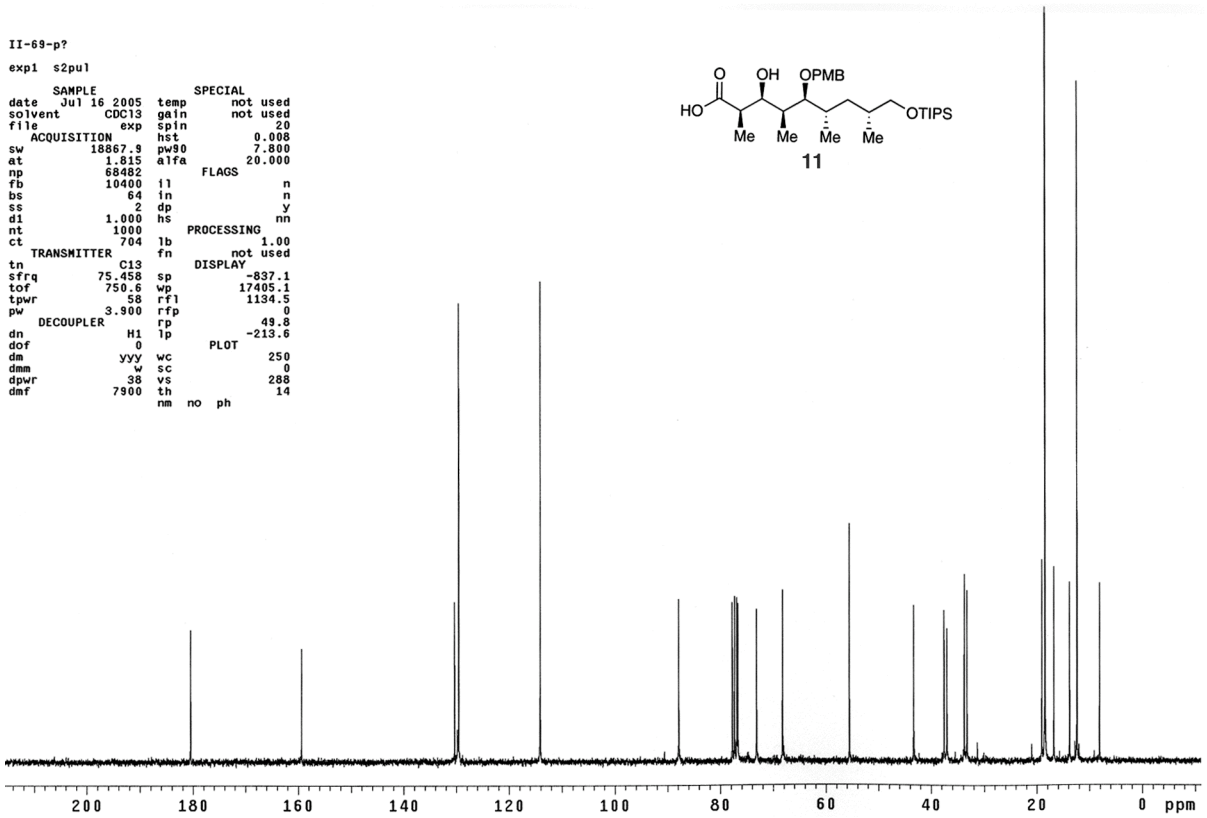
at 1.998
np 19184
fb 2600
bs 16
ss 2
d1 5.000
nt 16
ct 16
TRANSMITTER
tn H1
sfrq 300.059
tof 354.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 39
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp -19.8
wp 2554.7
rfl 600.0
rfp 0
rp 146.1
lp -50.9
PLOT
wc 250
sc 0
vs 254
th 43
ai cdc ph
O
OH
OPMB
HO
Me
Me
Me
Me
OTIPS
11
8
7
6
5
4
3
2
1
ppm
2.25
1.91
0.95
0.94
0.97
3.00
1.08
1.08
1.09
1.02
1.09
2.18
1.06
3.18
1.32
9.24
3.12


II-69-p?
exp1 s2pul
SAMPLE
date Jul 16 2005
solvent CDCl3
file exp
ACQUISITION
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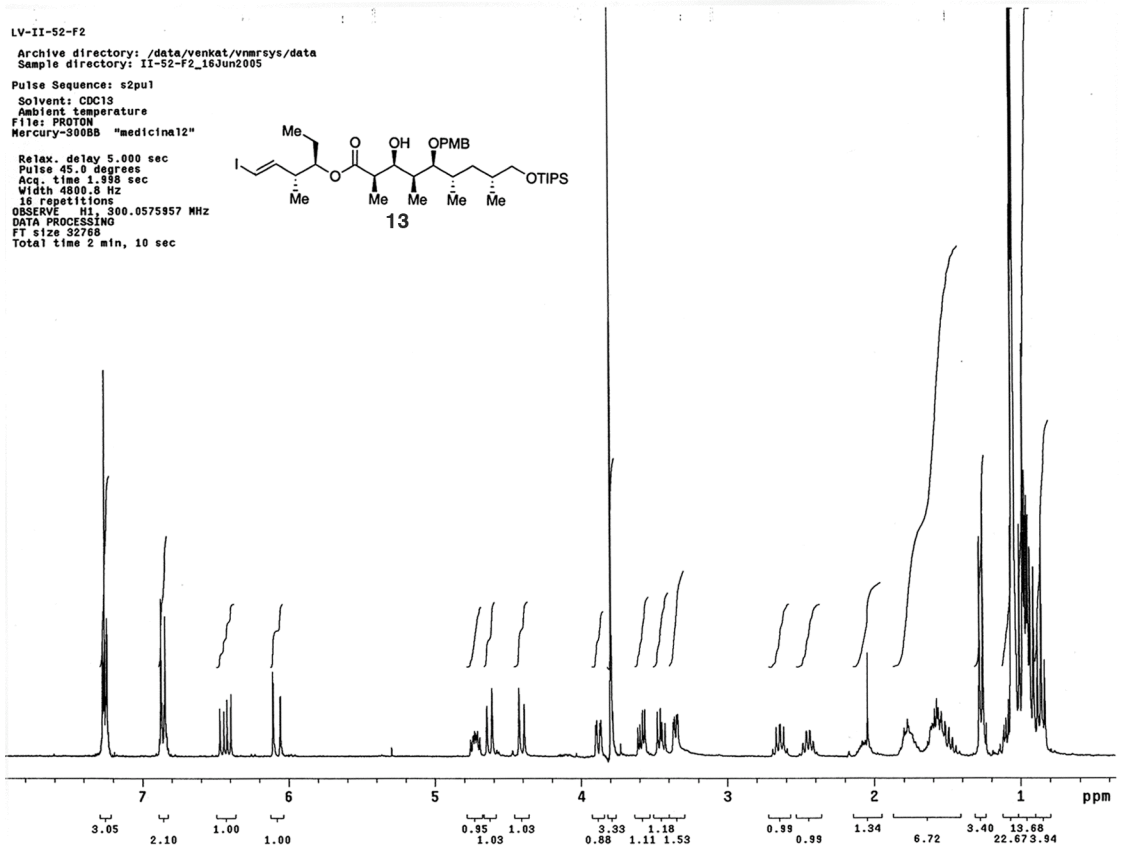
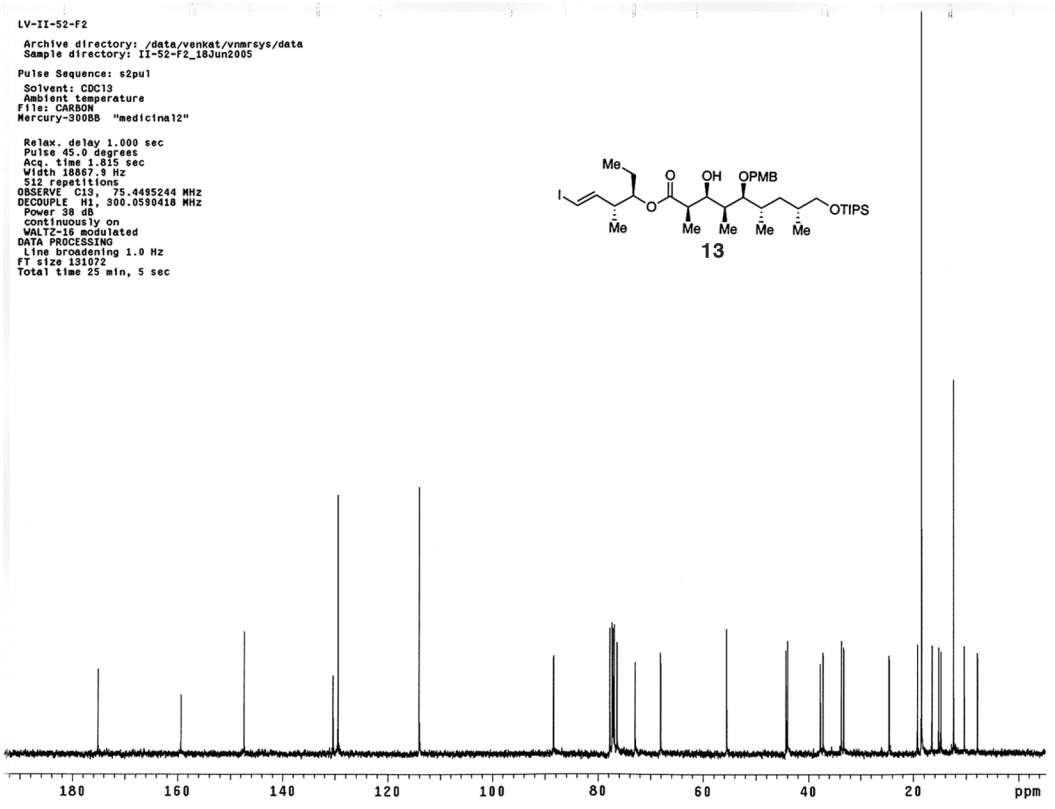
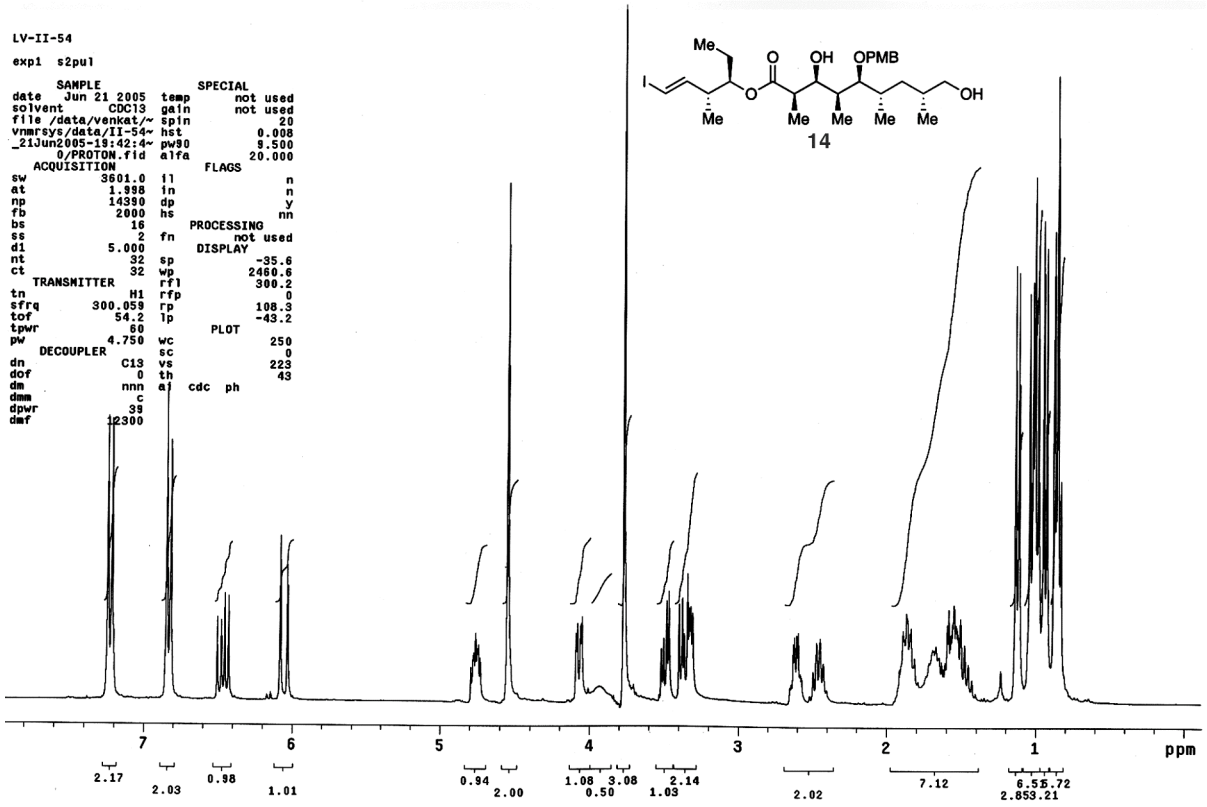
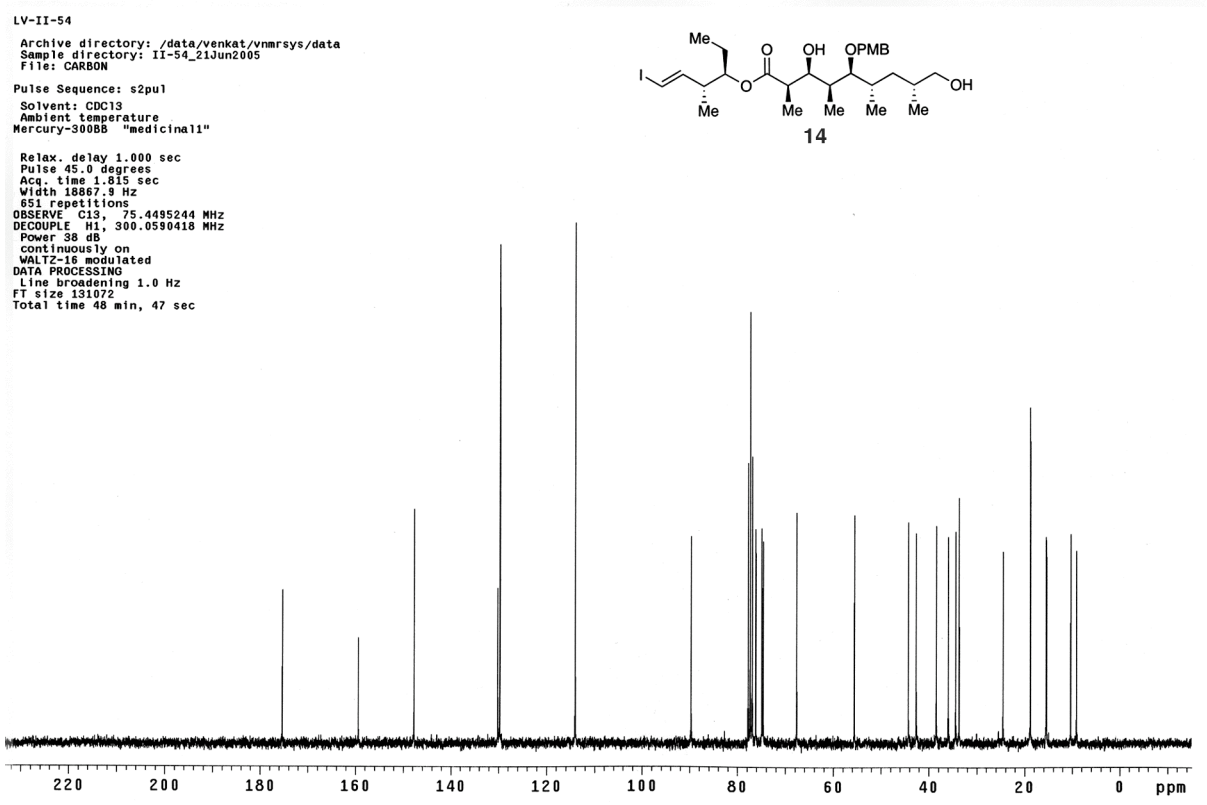
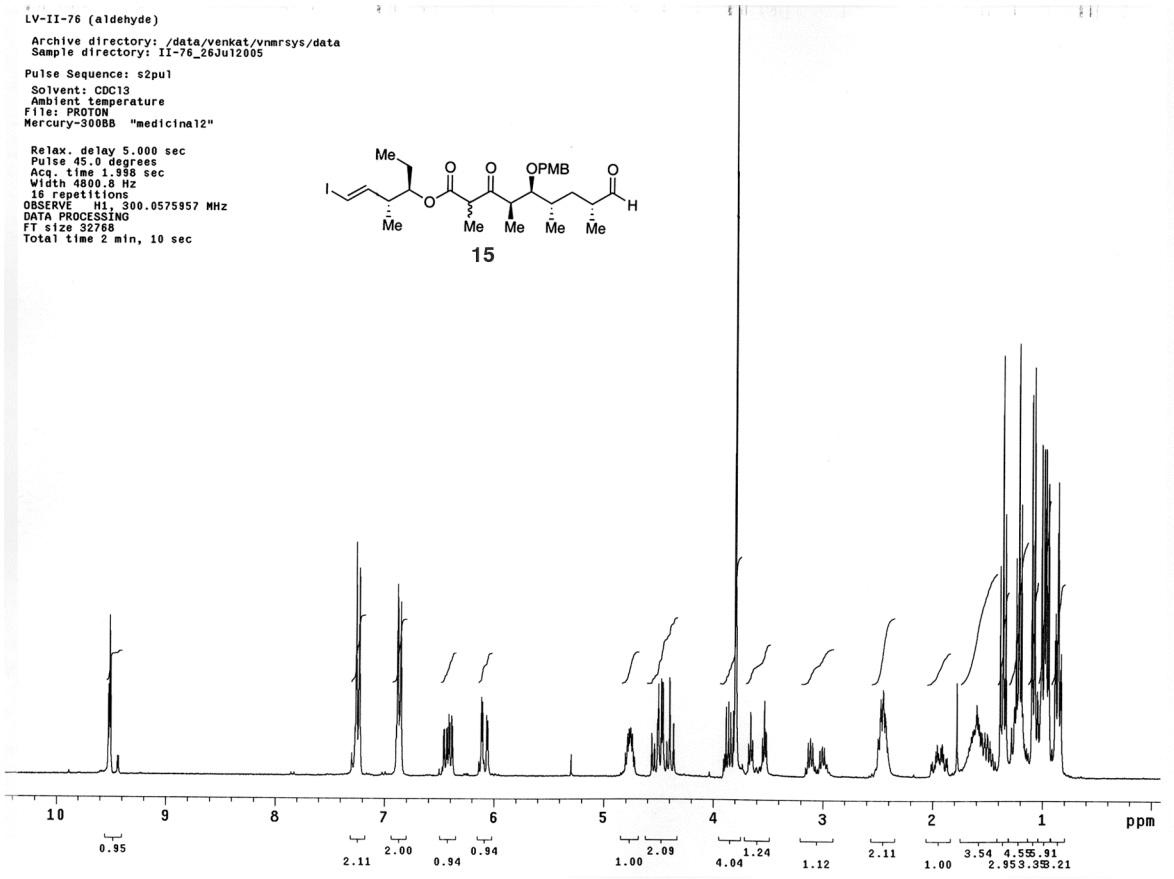
at 1.815
np 68482
fb 10400
bs 64
ss 2
d1 1.000
nt 1000
ct 704
TRANSMITTER
tn C13
sfrq 75.458
tof 750.6
tpwr 58
pw 3.900
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 38
dmf 7900
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 7.800
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 1.00
fn not used
DISPLAY
sp -837.1
wp 17405.1
rfl 1134.5
rfp 0
rp 49.8
lp -213.6
PLOT
wc 250
sc 0
vs 288
th 14
nm no ph
O
OH
OPMB
HO
Me
Me
Me
Me
OTIPS
11
200
180
160
140
120
100
80
60
40
20
0
ppm

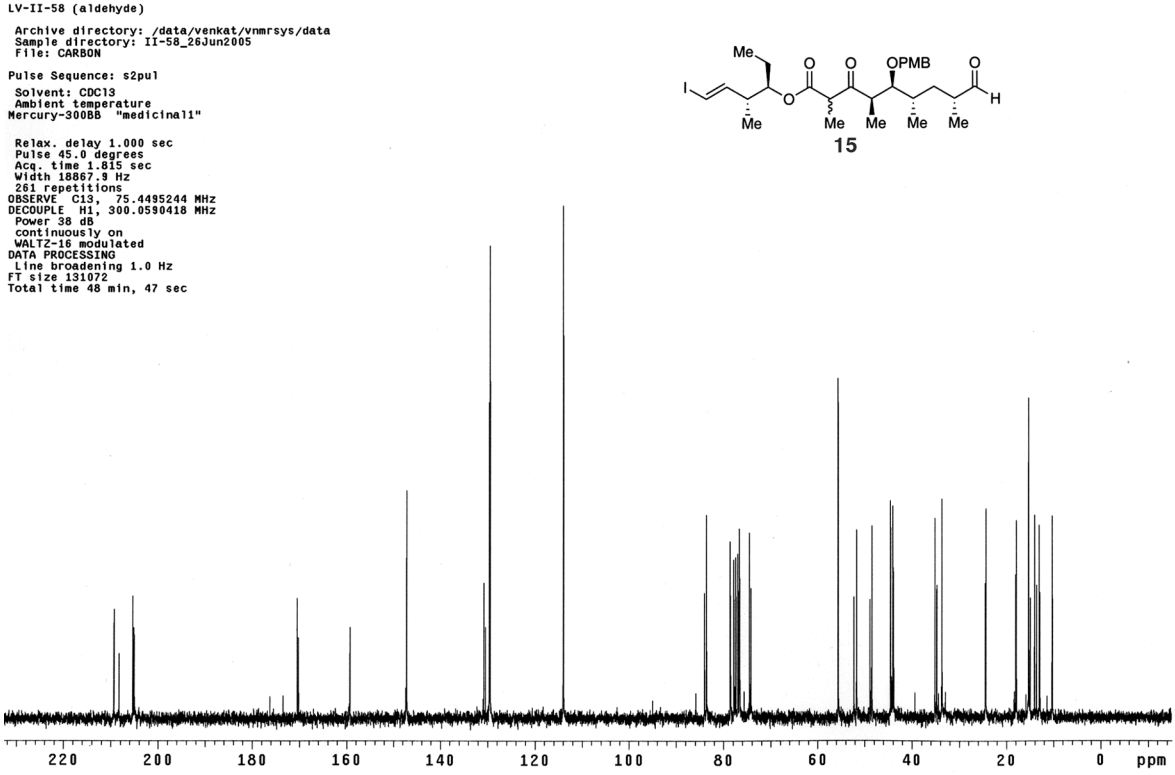

LV-II-52-F2
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-52-F2_16Jun2005
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: PROTON
Mercury-300BB "medicinal2"
Relax. delay 5.000 sec
Pulse 45.0 degrees
Acq. time 1.998 sec
Width 4800.8 Hz
16 repetitions
OBSERVE H1, 300.0575957 MHz
DATA PROCESSING
FT size 32768
Total time 2 min, 10 sec
Me
O
OH
OPMB
I
O
OTIPS
Me
Me
Me
Me
Me
13
7
6
5
4
3
2
1
ppm
3.05
2.10
1.00
1.00
0.95
1.03
1.03
3.33
0.88
1.18
1.11
1.53
0.99
0.99
1.34
6.72
3.40
13.68
22.67
3.94

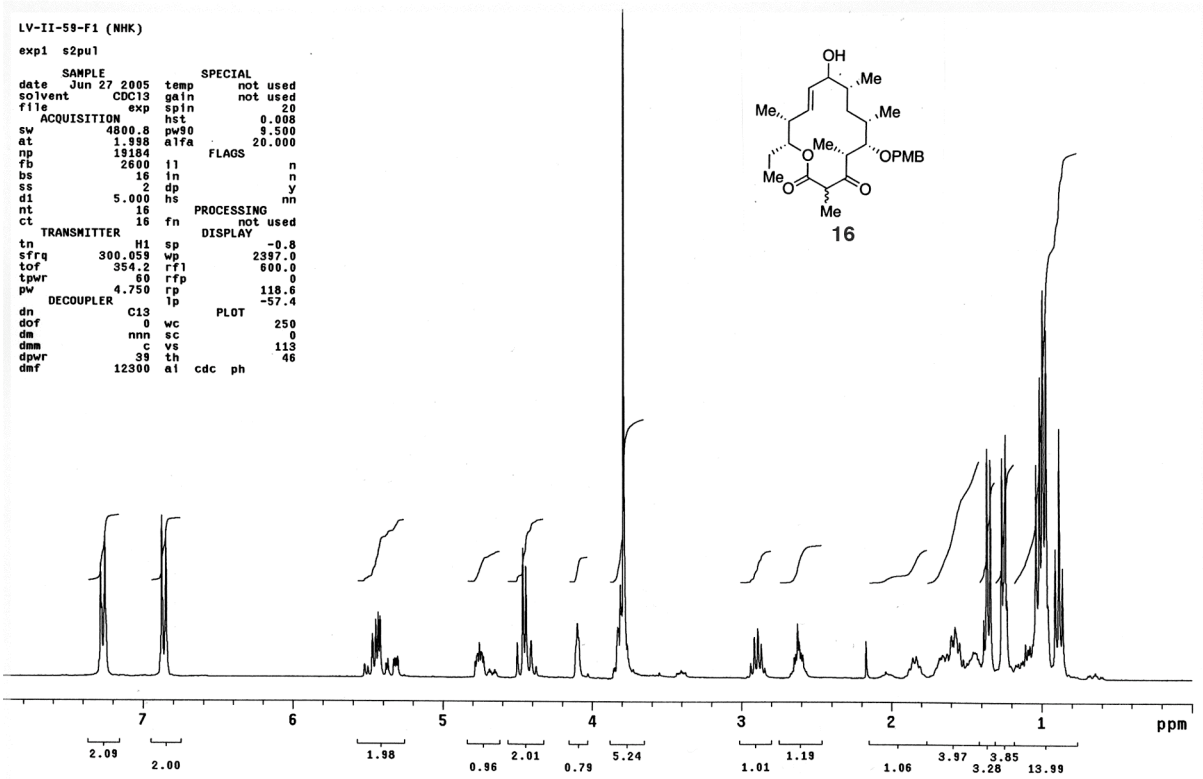

LV-II-52-F2
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-52-F2_18Jun2005
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: CARBON
Mercury-300BB "medicinal2"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
512 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 25 min, 5 sec
Me
O
OH
OPMB
I
O
OTIPS
Me
Me
Me
Me
Me
13
180
160
140
120
100
80
60
40
20
ppm

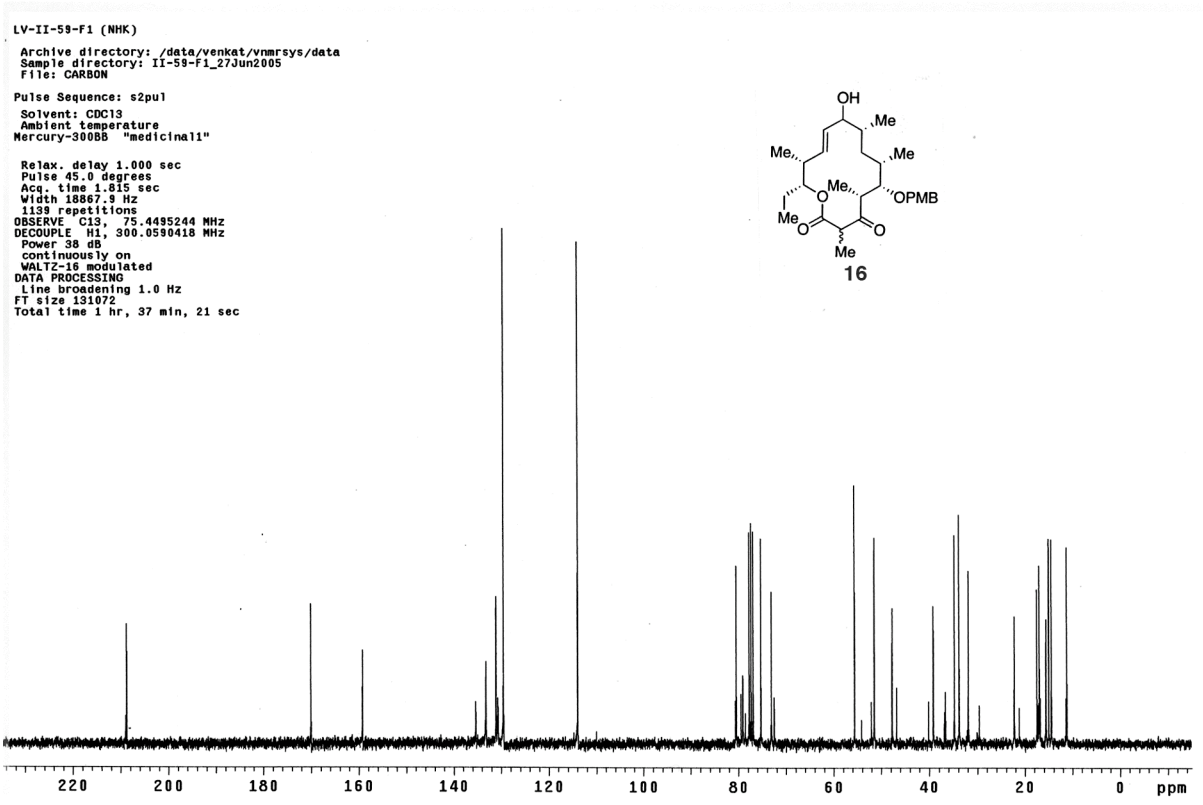

LV-II-54
exp1 s2pul
SAMPLE
date Jun 21 2005
solvent CDCl3
file /data/venkat/~
vnmrsys/data/II-54~
_21Jun2005-19:42:4~
0/PROTON.fid
ACQUISITION
sw 3601.0
at 1.998
np 14390
fb 2000
bs 16
ss 2
d1 5.000
nt 32
ct 32
TRANSMITTER
tn H1
sfrq 300.059
tof 54.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp -35.6
wp 2460.6
rfl 300.2
rfp 0
rp 108.3
lp -43.2
PLOT
wc 250
sc 0
vs 223
th 43
ai cdc ph
Me
O
OH
OPMB
I
OH
Me
Me
Me
Me
Me
14
7
6
5
4
3
2
1
ppm
2.17
2.03
0.98
1.01
0.94
2.00
1.08
3.08
0.50
2.14
1.03
2.02
7.12
6.55
5.72
2.85
3.21

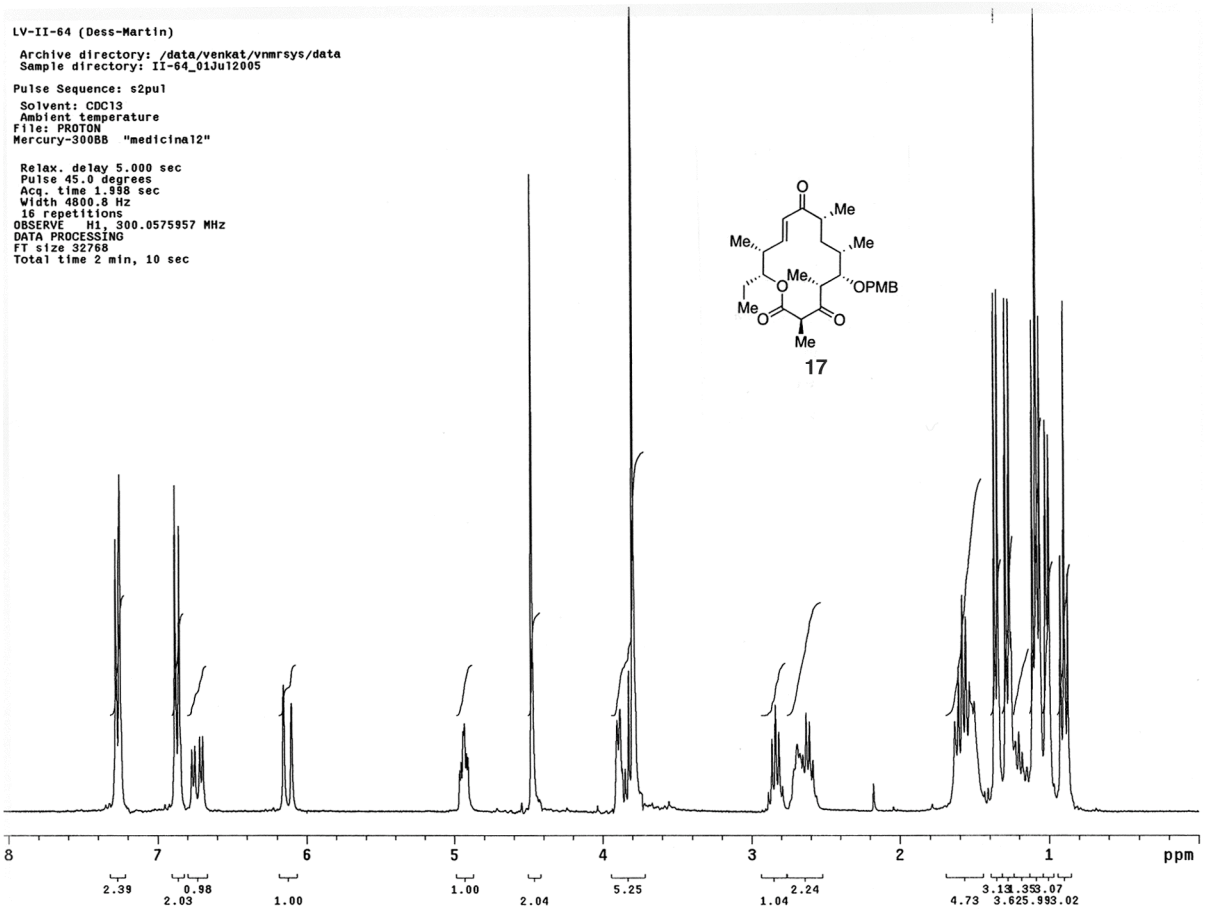

LV-II-54
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-54_21Jun2005
File: CARBON
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
651 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 48 min, 47 sec
Me
O
OH
OPMB
I
OH
Me
Me
Me
Me
Me
14
220
200
180
160
140
120
100
80
60
40
20
0
ppm

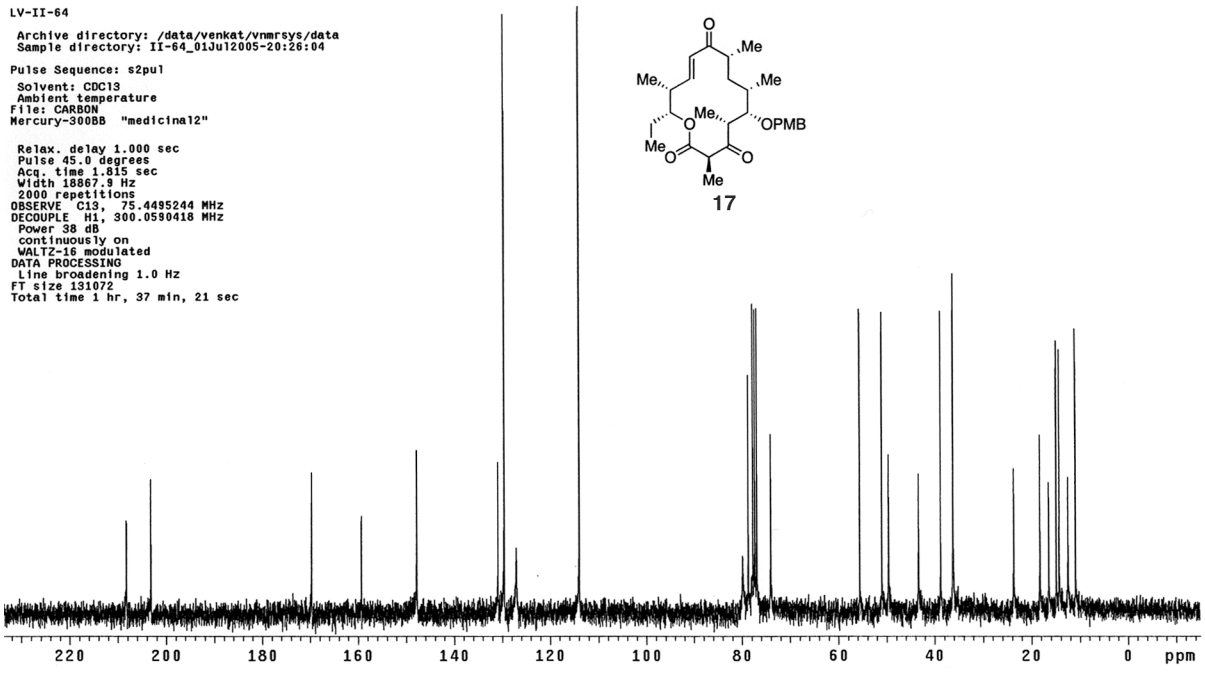

LV-II-76 (aldehyde)
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-76_26Jul2005
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: PROTON
Mercury-300BB "medicinal2"
Relax. delay 5.000 sec
Pulse 45.0 degrees
Acq. time 1.988 sec
Width 4800.8 Hz
16 repetitions
OBSERVE H1, 300.0575957 MHz
DATA PROCESSING
FT size 32768
Total time 2 min, 10 sec
Me
I
O
O
O
OPMB
O
H
Me
Me
Me
Me
Me
15
10
9
8
7
6
5
4
3
2
1
ppm
0.95
2.11
2.00
0.94
0.94
1.00
2.09
4.04
1.24
1.12
2.11
1.00
3.54
4.55
5.91
2.95
3.35
8.21

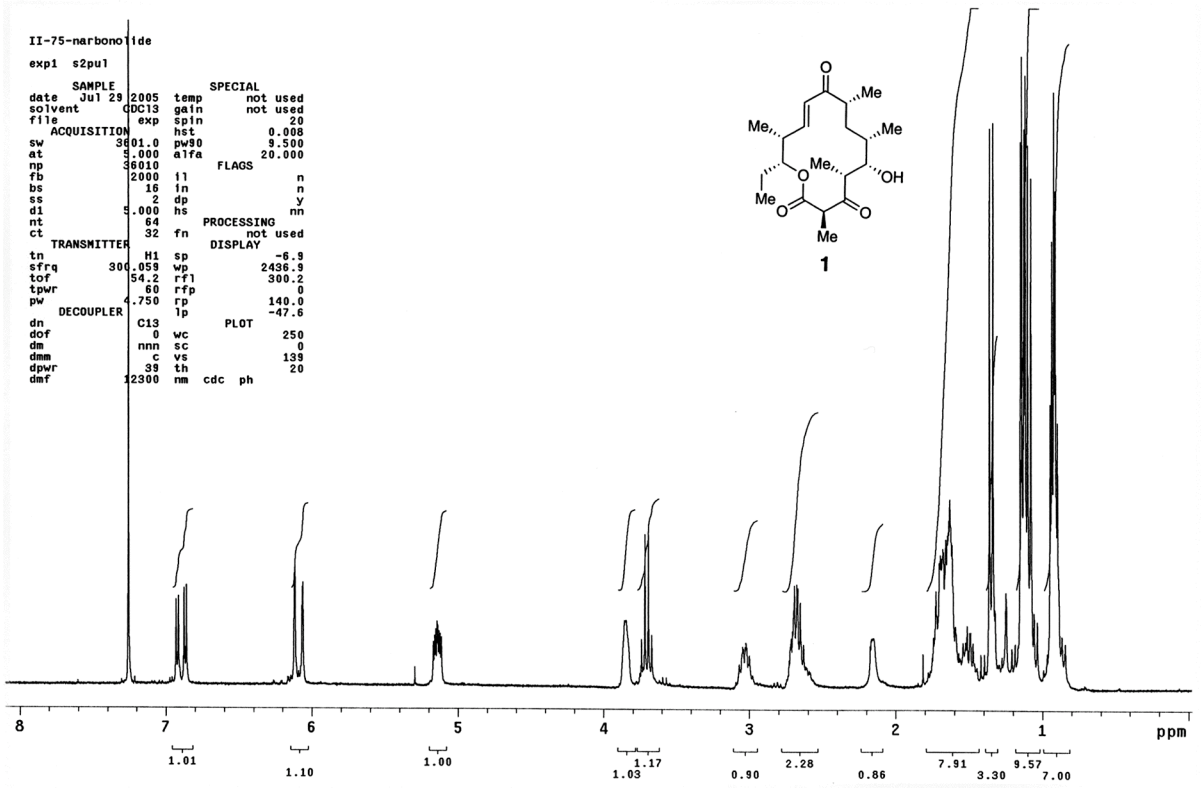

LV-II-58 (aldehyde)
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-58_26Jun2005
File: CARBON
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
261 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 48 min, 47 sec
Me
I
O
O
O
OPMB
O
H
Me
Me
Me
Me
Me
15
220
200
180
160
140
120
100
80
60
40
20
0
ppm

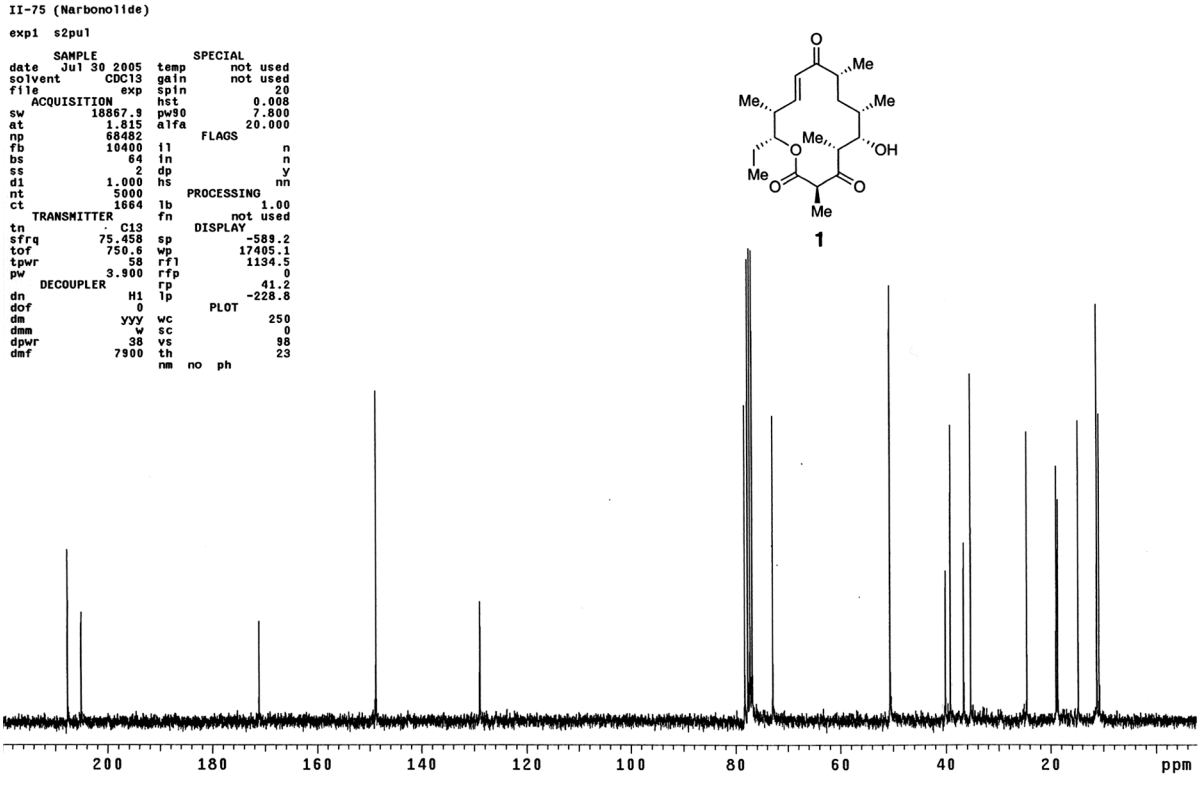

LV-II-59-F1 (NHK)
exp1 s2pul
SAMPLE
date Jun 27 2005
solvent CDCl3
file exp
ACQUISITION
sw 4800.8
at 1.998
np 19184
fb 2600
bs 16
ss 2
d1 5.000
nt 16
ct 16
TRANSMITTER
tn H1
sfrq 300.059
tof 354.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 39
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp -0.8
wp 2397.0
rfl 600.0
rfp 0
rp 118.6
lp -57.4
PLOT
wc 250
sc 0
vs 113
th 46
ai cdc ph
OH
Me
Me
Me
O
Me
OPMB
Me
O
O
Me
16
7
6
5
4
3
2
1
ppm
2.09
2.00
1.98
0.96
2.01
0.79
5.24
1.01
1.19
1.06
3.97
3.85
3.28
13.99

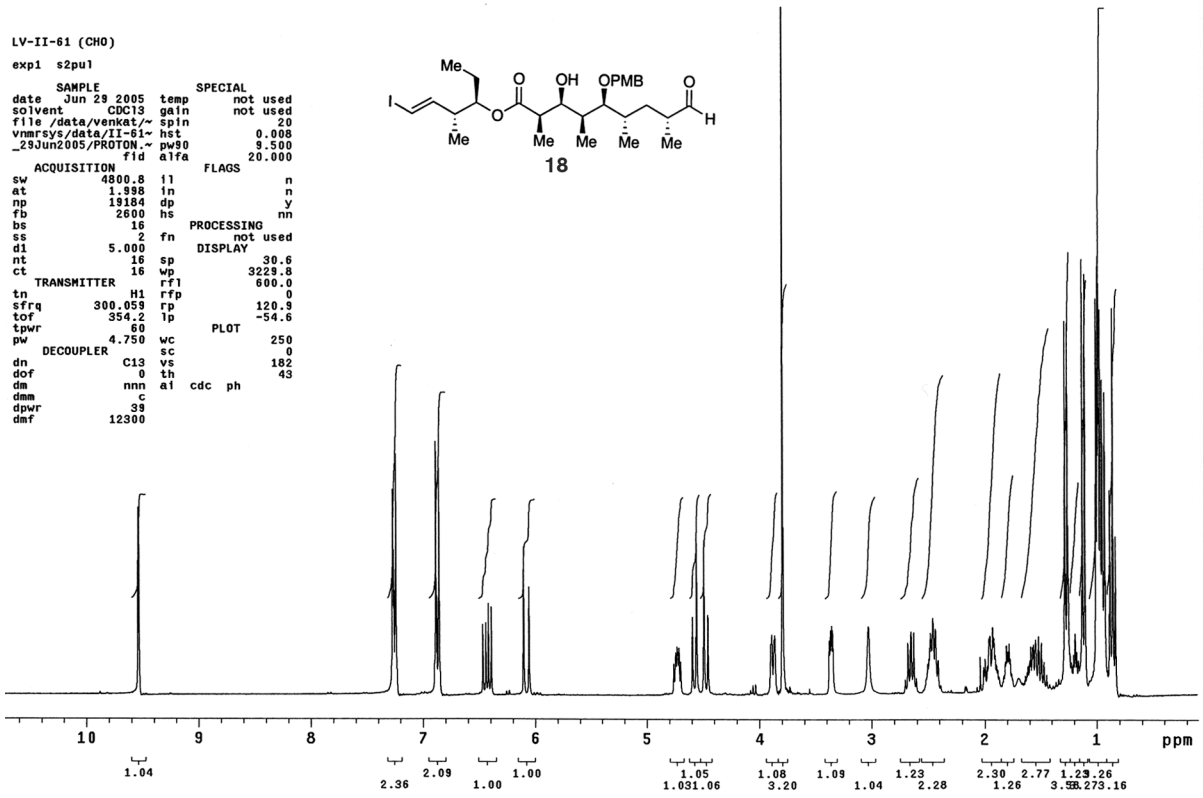

LV-II-59-F1 (NHK)
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-59-F1_27Jun2005
File: CARBON
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
1139 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 1 hr, 37 min, 21 sec
OH
Me
Me
Me
O
Me
OPMB
Me
O
O
Me
16
220
200
180
160
140
120
100
80
60
40
20
0
ppm

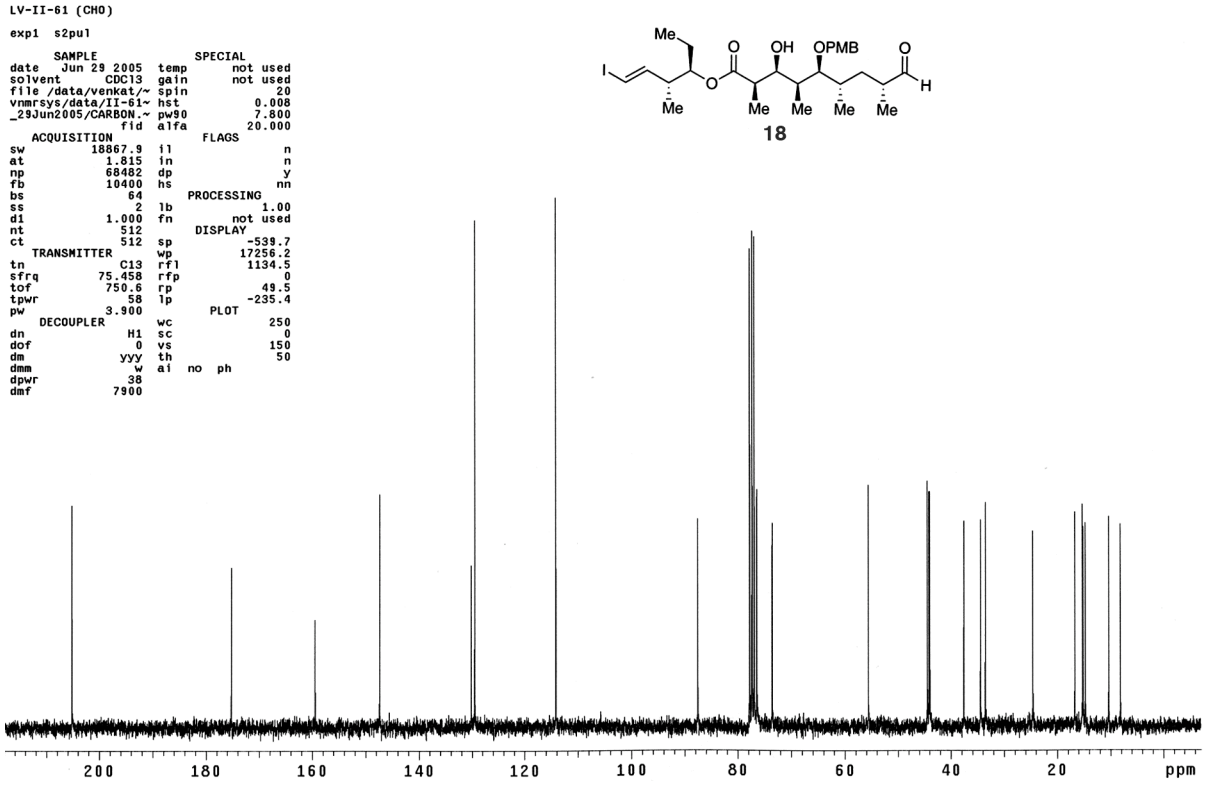

LV-II-64 (Dess-Martin)
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-64_01Jul2005
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: PROTON
Mercury-300BB "medicinal2"
Relax. delay 5.000 sec
Pulse 45.0 degrees
Acq. time 1.998 sec
Width 4800.8 Hz
16 repetitions
OBSERVE H1, 300.0575957 MHz
DATA PROCESSING
FT size 32768
Total time 2 min, 10 sec
Me
Me
Me
Me
O
OPMB
Me
O
O
Me
17
8
7
6
5
4
3
2
1
ppm
2.39
0.98
2.03
1.00
1.00
2.04
5.25
2.24
1.04
4.73
3.62
5.99
3.02

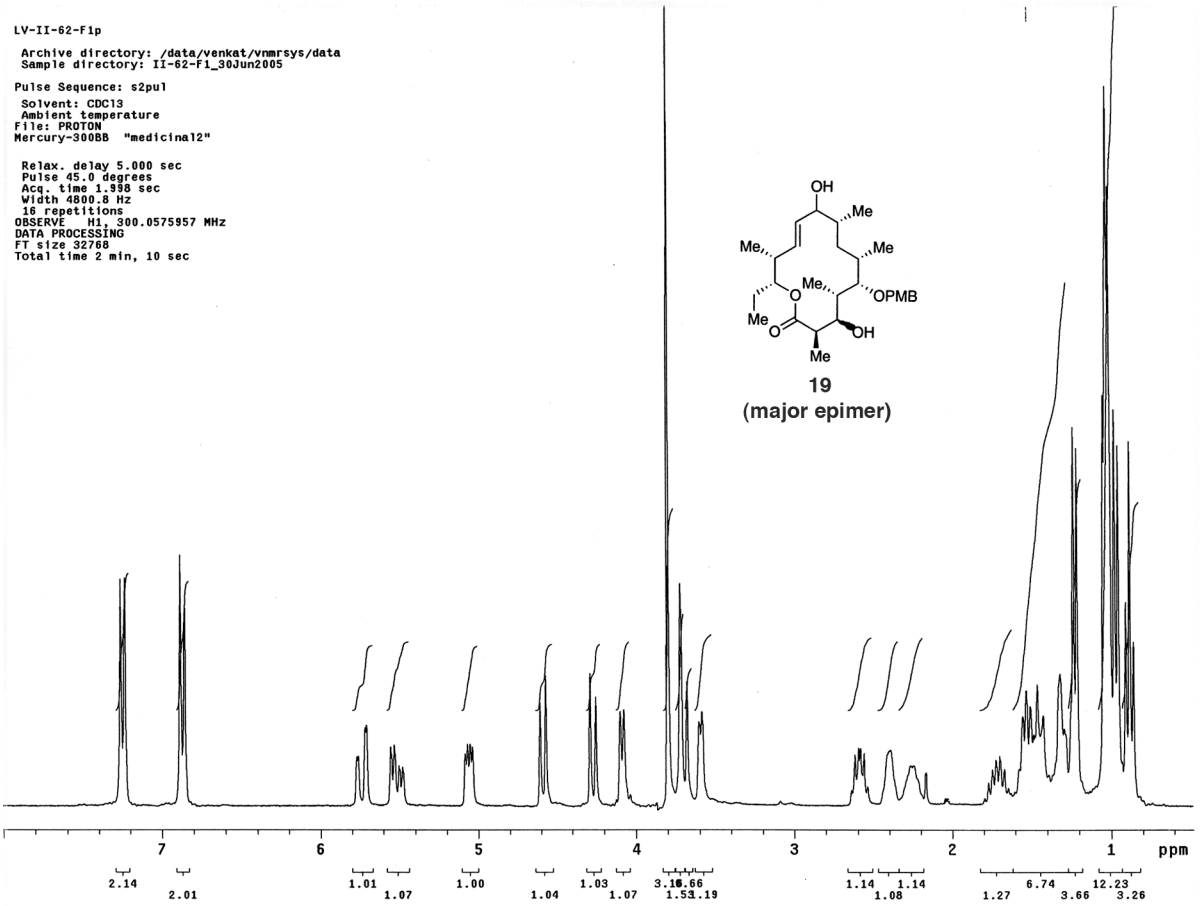

LV-II-64
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-64_01Jul2005-20:26:04
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: CARBON
Mercury-300BB "medicinal2"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
2000 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 1 hr, 37 min, 21 sec
Me
Me
Me
Me
O
OPMB
Me
O
O
Me
17
220
200
180
160
140
120
100
80
60
40
20
0
ppm

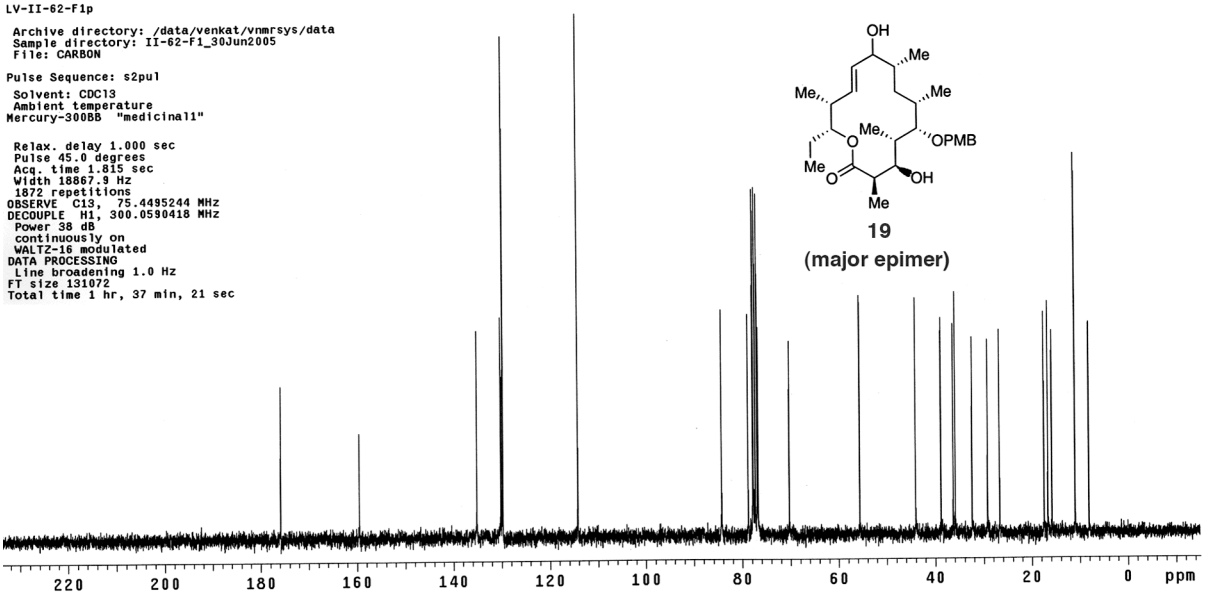

II-75-narbonolide
exp1 s2pul
SAMPLE
date Jul 29 2005
solvent CDCl3
file exp
ACQUISITION
sw 3601.0
at 5.000
np 36010
fb 2000
bs 16
ss 2
di 5.000
nt 64
ct 32
TRANSMITTER
tn H1
sfrq 300.059
tof 54.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 39
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp -6.9
wp 2436.9
rfl 300.2
rfp 0
rp 140.0
lp -47.6
PLOT
wc 250
sc 0
vs 139
th 20
nm cdc ph
Me
Me
Me
Me
Me
OH
O
O
O
1
8
7
6
5
4
3
2
1
ppm
1.01
1.10
1.00
1.03
1.17
0.90
2.28
0.86
7.91
3.30
9.57
7.00

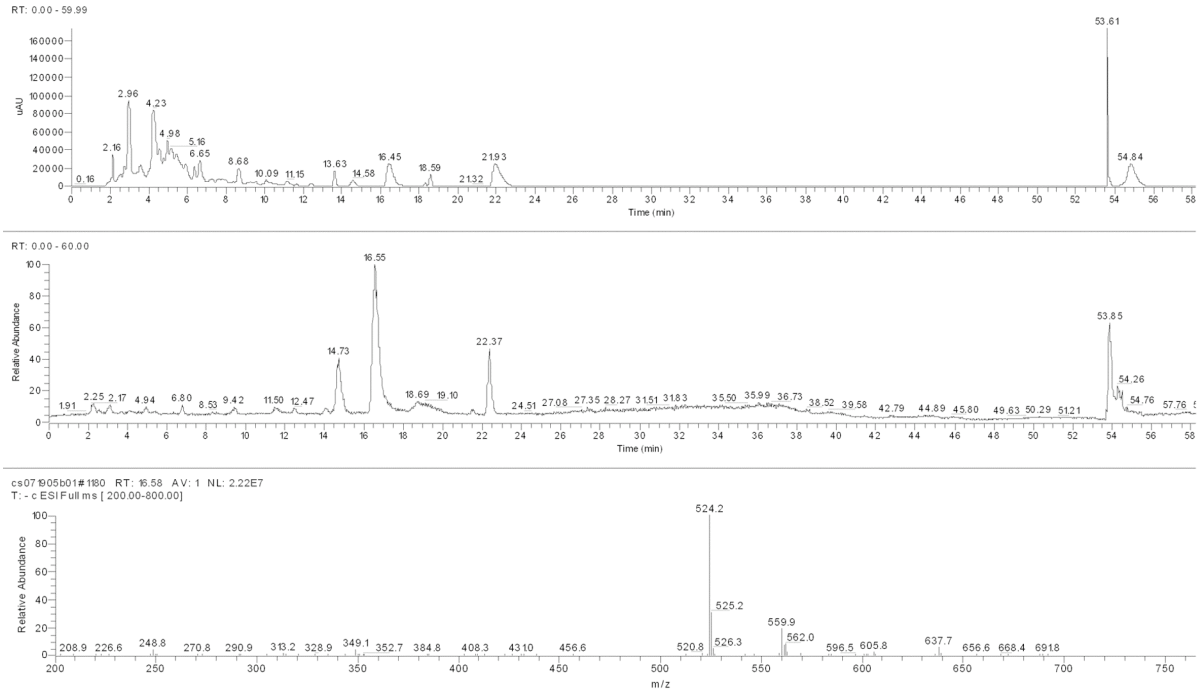

II-75 (Narbonolide)
exp1 s2pul
SAMPLE
date Jul 30 2005
solvent CDCl3
file exp
ACQUISITION
sw 18867.9
at 1.815
np 68482
fb 10400
bs 64
ss 2
di 1.000
nt 5000
ct 1664
TRANSMITTER
tn C13
sfrq 75.458
tof 750.6
tpwr 58
pw 3.900
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 38
dmf 7900
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 7.800
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 1.00
fn not used
DISPLAY
sp -589.2
wp 17405.1
rfl 1134.5
rfp 0
rp 41.2
lp -228.8
PLOT
wc 250
sc 0
vs 98
th 23
nm no ph
Me
Me
Me
Me
Me
OH
O
O
O
1
200
180
160
140
120
100
80
60
40
20
ppm


LV-II-61 (CHO)
exp1 s2pul
SAMPLE
date Jun 29 2005
solvent CDCl3
file /data/venkat/~
vnmrsys/data/II-61~
_29Jun2005/PROTON.~
fid
ACQUISITION
sw 4800.8
at 1.998
np 19184
fb 2600
bs 16
ss 2
d1 5.000
nt 16
ct 16
TRANSMITTER
tn H1
sfrq 300.059
tof 354.2
tpwr 60
pw 4.750
DECOUPLER
dn C13
dof 0
dm nnn
dmm c
dpwr 38
dmf 12300
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 9.500
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
fn not used
DISPLAY
sp 30.6
wp 3229.8
rfl 600.0
rfp 0
rp 120.9
lp -54.6
PLOT
wc 250
sc 0
vs 182
th 43
ai cdc ph
Me
I
O
OH
OPMB
O
H
Me
Me
Me
Me
Me
18
10
9
8
7
6
5
4
3
2
1
ppm
1.04
2.36
2.09
1.00
1.00
1.05
1.03
1.06
1.08
3.20
1.09
1.04
1.23
2.28
2.30
1.26
2.77
1.23
3.26
3.55
3.27
3.16

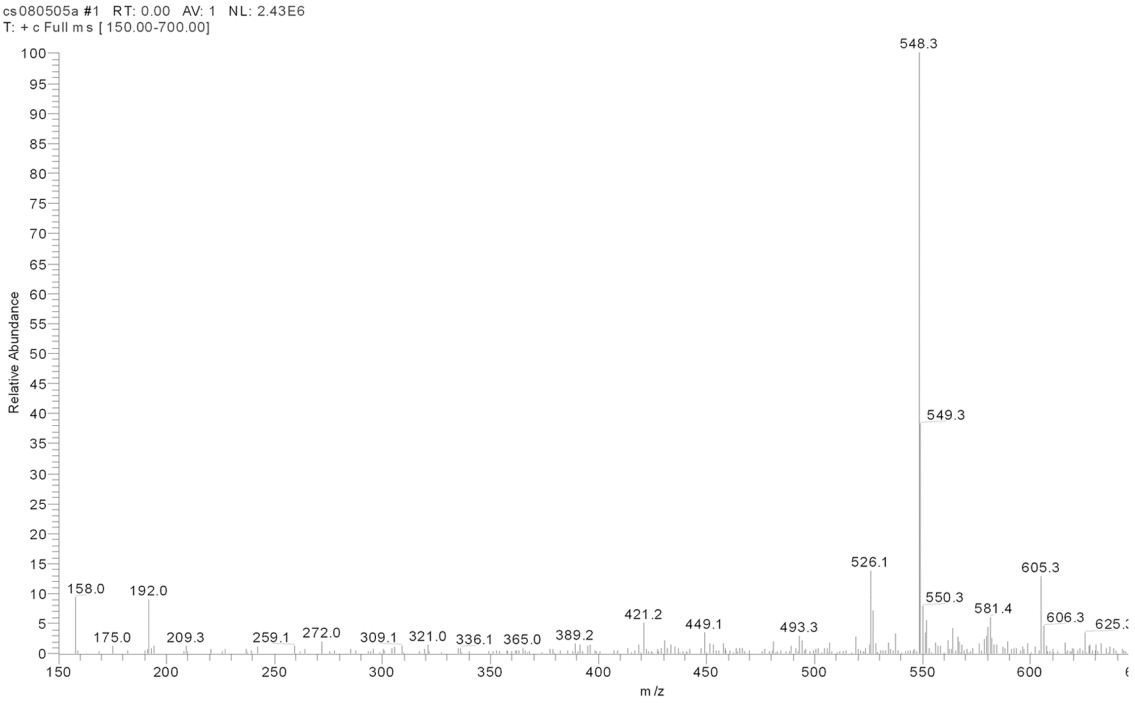

LV-II-61 (CHO)
exp1 s2pul
SAMPLE
date Jun 29 2005
solvent CDCl3
file /data/venkat/~
vnmrsys/data/II-61~
_29Jun2005/CARBON.~
fid
ACQUISITION
sw 18867.9
at 1.815
np 68482
fb 10400
bs 64
ss 2
d1 1.000
nt 512
ct 512
TRANSMITTER
tn C13
sfrq 75.458
tof 750.6
tpwr 58
pw 3.900
DECOUPLER
dn H1
dof 0
dm yyy
dmm w
dpwr 38
dmf 7900
SPECIAL
temp not used
gain not used
spin 20
hst 0.008
pw90 7.800
alfa 20.000
FLAGS
il n
in n
dp y
hs nn
PROCESSING
lb 1.00
fn not used
DISPLAY
sp -539.7
wp 17256.2
rfl 1134.5
rfp 0
rp 49.5
lp -235.4
PLOT
wc 250
sc 0
vs 150
th 50
ai no ph
Me
I
O
OH
OPMB
O
H
Me
Me
Me
Me
Me
18
200
180
160
140
120
100
80
60
40
20
ppm


LV-II-62-F1p
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-62-F1_30Jun2005
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
File: PROTON
Mercury-300BB "medicinal2"
Relax. delay 5.000 sec
Pulse 45.0 degrees
Acq. time 1.998 sec
Width 4800.8 Hz
16 repetitions
OBSERVE H1, 300.0575957 MHz
DATA PROCESSING
FT size 32768
Total time 2 min, 10 sec
OH
Me
Me
Me
Me
O
OPMB
Me
O
OH
Me
19
(major epimer)
7
6
5
4
3
2
1
ppm
2.14
2.01
1.01
1.07
1.00
1.04
1.03
1.07
1.14
1.08
1.14
1.27
6.74
3.66
12.23
3.26


LV-II-62-F1p
Archive directory: /data/venkat/vnmrsys/data
Sample directory: II-62-F1_30Jun2005
File: CARBON
Pulse Sequence: s2pul
Solvent: CDCl3
Ambient temperature
Mercury-300BB "medicinal1"
Relax. delay 1.000 sec
Pulse 45.0 degrees
Acq. time 1.815 sec
Width 18867.9 Hz
1872 repetitions
OBSERVE C13, 75.4495244 MHz
DECOUPLE H1, 300.0590418 MHz
Power 38 dB
continuously on
WALTZ-16 modulated
DATA PROCESSING
Line broadening 1.0 Hz
FT size 131072
Total time 1 hr, 37 min, 21 sec
OH
Me
Me
Me
Me
O
OPMB
Me
O
OH
Me
19
(major epimer)
220
200
180
160
140
120
100
80
60
40
20
0
ppm



LC-MS trace of EtOAc extract from the crude fermentation broth after incubation of narbonolide with *S. venezuelae pikAI* deletion mutant BB138. LC peak at 16.45 min (top frame) corresponds to MS (ESI +) chromatogram peak at 16.55 (middle frame), with an extracted ion mass of 524 ($M–H^+$) (bottom frame).



MS (ESI –) of pikromycin peak (10.4 min) collected from HPLC purification of narbonolide biotransformation: 548 (M^+ + Na), 526 ($M^+ + H^+$).

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