Stereoselective Synthesis of 2-Deoxy-β-Glycosides Using Anomeric *O*-Alkylation/Arylation

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Supporting Information

General Procedures. All reactions were performed in oven or flame-dried glassware under a positive pressure of argon unless noted otherwise. Flash column chromatography was performed either as described by Still et al. (Still, W. C., Kahn, M.; Mitra, A. *J. Org. Chem.* **1978**, *43*, 2923-2925.) employing E. Merck silica gel 60 (230-400 mesh ASTM) or using pre-packaged FLASH columns on a HPFC Biotage system (Biotage Inc.). Tetrahydrofuran, diethyl ether, methylene chloride, toluene, and dimethylformamide were degassed with argon and passed through a solvent purification system (designed by J.C. Meyer of Glass Contour) utilizing alumina columns. TLC analyses were performed on 250μm Silica Gel $60F_{254}$ plates purchased from EM science.

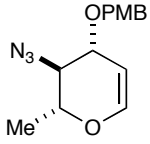
Instrumentation. Infrared spectra were recorded on a Perkin Elmer Spectrum One FT-IR spectrometer. ^{1}H and ^{13}C NMR spectra were recorded on a Varian INOVA600, INOVA500 or Mercury400 spectrometer. Chemical shifts for proton and carbon resonances are reported in ppm (δ) relative to chloroform-d (δ 7.26 ppm, 77.0 ppm respectively). Mass spectra were obtained from the Harvard University Mass Spectrometry Laboratory.

General Procedure for Allylation of Lactols: To a solution of lactol (0.1 mmol) in dioxane (1 ml) at room temperature was added NaH (60% dispersion in mineral oil, 0.2 mmol). The resulting solution was allowed to stir at room temperature for 10 minutes. Allyl bromide (0.25 mmol) was added to the reaction mixture via syringe and the resulting solution was allowed to stir at room temperature for 5 hours. The reaction was quenched by the careful addition of water (1 ml) and transferred to a separatory funnel containing brine (10 ml). The aqueous layer was extracted with EtOAc (3 x 3 ml). The combined organic layers were dried over Na_2SO_4, filtered, and concentrated. The material was purified by flash column chromatography to afford 2-deoxy-β-glycosides **5 & 15**.

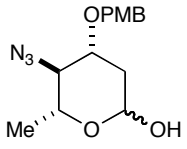
General Procedure for Nucleophilic Aromatic Substitution: To a solution of lactol (0.1 mmol) in dioxane (1 ml) at room temperature was added NaH (60% dispersion in mineral oil, 0.2 mmol). The resulting solution was allowed to stir at room temperature for 10 minutes. 1-halo-2,4-dinitrobenzene (0.25 mmol) was added and the resulting solution was allowed to stir at room temperature for 24 hours. The reaction was quenched by the careful addition of water (1 ml) and transferred to a separatory funnel containing brine (10 ml). The aqueous layer was extracted with EtOAc (3 x 3 ml). The combined organic layers were dried over Na_2SO_4, filtered, and

concentrated. The material was purified by flash column chromatography to afford 2-deoxy-β-glycosides **8, 17, & 20**.

General Procedure for Displacement of Primary Triflates: To a solution of lactol (0.1 mmol) in dioxane (0.8 ml) at room temperature was added NaH (60% dispersion in mineral oil, 0.2 mmol). The resulting solution was allowed to stir at room temperature for 10 minutes. A solution of freshly prepared triflate (**9** or **18**) (see procedure for **2**) (0.25 mmol) in dioxane (0.8 ml) was added via cannula. The resulting solution was allowed to stir at room temperature for 24 hours. The reaction was quenched by the careful addition of water (1 ml) and transferred to a separatory funnel containing brine (10 ml). The aqueous layer was extracted with EtOAc (3x 3 ml). The combined organic layers were dried over Na_2SO_4, filtered, and concentrated. The material was purified by flash column chromatography to afford 2-deoxy-β-glycosides **10, 19, 21, 23, & 25**.



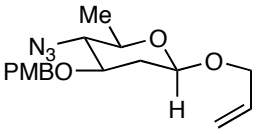
2: To a solution of **1** (500 mg, 1.99 mmol) in CH_2Cl_2 (10 ml) at 0 °C was added pyridine (1.6 ml, 19.9 mmol) followed by trifluoromethanesulfonic anhydride (0.67 ml, 3.98 mmol). The resulting mixture was allowed to stir at 0 °C for 30 minutes at which time the reaction was diluted with water. The aqueous layer was extracted with CH_2Cl_2 (3x 2 ml). The combined organic layers were washed with saturated $CuSO_4$ (3 x 5 ml) and then H_2O (2 x 5 ml). The organic layers were dried over Na_2SO_4, filtered, and concentrated to afford triflate, which was used immediately without further purification. This triflate was dissolved in DMF (10 ml) and NaN_3 (1.3 g, 19.9 mmol) was added in one portion. The mixture was allowed to stir at room temperature for 3 hours. The mixture was diluted with brine and extracted with EtOAc (3 x 5 ml). The combined organic layers were dried over Na_2SO_4, filtered and concentrated. The crude material was purified by flash column chromatography yielding 333 mg (61%) of glycal **2** as colorless oil. R_f = 0.75 (30% ethyl acetate/hexanes); ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.35–7.33 (d, *J* = 8.8 Hz, 2H), 6.93-6.92 (d, *J* = 8.7 Hz, 2H), 6.38-6.37 (dd, *J* = 1.2, 6.1 Hz, 1H), 4.90-4.89 (dd, *J* = 2.3, 6.4 Hz, 1H), 4.65-4.63 (d, A of AB, *J* = 11.2 Hz, 1H), 4.58-4.57 (d, B of AB, *J* = 11.2 Hz, 1H), 4.17-4.16 (m, 1H), 3.84 (s, 3H), 3.83-3.80 (m, 1H), 3.49-3.46 (dd, *J* = 7.9, 10.2 Hz, 1H), 1.42-1.41 (d, *J* = 6.1 Hz, 3H). ^{13}C NMR(100MHz,$CDCl_3$)δ 159.6, 145.1, 130.0, 129.8, 114.1, 100.4, 75.1, 73.5, 70.7, 64.9, 55.5 18.3; HRMS (ESI): Mass calculated for $C_{14}H_{17}N_3O_3$ $[M+Na]^+$, 298.11621. Found 298.11669.



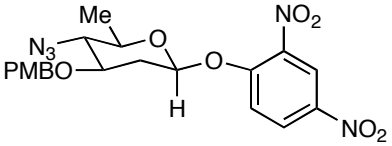
3: To a solution of glycal **2** (300 mg, 1.1 mmol) in CH_2Cl_2 (11 ml) at room temperature was added AcOH (0.19 ml, 3.3 mmol) and Ph_3P•HBr (38 mg, 0.11 mmol). The mixture was stirred at room temperature for 3 hours. The reaction was quenched by the addition of saturated $NaHCO_3$ until gas evolution ceased. The aqueous layer was extracted with EtOAc (3 x 5 ml). The combined organic layers were dried over Na_2SO_4, filtered and concentrated. The crude mixture was purified by flash column chromatography yielding 300 mg (81%) of acetoxy pyran as a mixture of α and β anomers. To a solution of acetoxy pyran (300 mg, 0.89 mmol) in THF (1 ml) at room temperature was added Me_2NH (11 ml, 2M solution in THF). The mixture was stirred at room temperature for 24 hours and then concentrated. The resulting oil was dissolved THF (6 ml) and water (3 ml) and treated with AcOH (1.5 ml) at room temperature for 30 minutes. The mixture was diluted with EtOAc, washed with saturated $NaHCO_3$ and then brine. The combined organic layers were dried over

Na_2SO_4, filtered and concentrated. The crude mixture was purified by flash column chromatography yielding 225 mg (86%) of lactol **3** as a white solid (4:1 mixture of α and β anomers). R_f = 0.25 (40% ethyl acetate/hexanes); IR (film) 3408, 2936, 2106, 1613, 1514, 1249 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.35-7.34 (α, d, *J* = 8.5 Hz, 2H), 7.35-7.33 (β, d, *J* = 8.3 Hz), 6.94-6.92 (β, d, *J* = 8.3 Hz), 6.93-6.92 (α, d, *J* = 8.5 Hz, 2H), 5.38-5.37 (α, d, *J* = 2.7 Hz, 1H), 4.76-4.74 (β, dd, *J* = 1.6, 9.6 Hz), 4.66-4.57 (α, m, 2H), 3.95-3.91 (α, m, 1H), 3.84 (β, s), 3.84 (α, s, 3H), 3.83-3.80 (α, m, 1H), 3.56-3.50 (β, m), 3.26-3.21 (β, m), 3.12-3.09 (α, t, *J* = 9.8 Hz, 1H), 3.12-3.08 (β, t, *J* = 9.8 Hz), 2.56-2.53 (br s, OH), 2.46-2.43 (β, dd, *J* = 1.9, 5.0 Hz), 2.35-2.32 (α, dd, *J* = 1.1, 4.8, 13.0 Hz, 1H), 1.69-1.65 (α, ddd, *J* = 3.6, 11.5, 13.0 Hz, 1H), 1.57-1.51 (β, ddd, *J* = 9.8, 10.5, 11.5 Hz), 1.38-1.37 (β, d, *J* = 6.2 Hz), 1.32-1.31 (α, d, *J* = 6.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) (reflects 4:1 anomeric mixture) δ 159.6, 159.5, 130.2, 129.8, 129.7, 129.6, 128.9, 114.2, 114.1, 108.2, 94.0, 92.1, 74.9, 71.5, 71.2 71.1, 68.6, 67.9, 67.8, 67.6, 66.7, 55.5, 38.2, 35.6, 29.3, 24.1, 18.9;HRMS (ESI): Mass calculated for $C_{14}H_{19}N_3O_4$ $[M+Na]^+$, 316.12678. Found 316.12645.

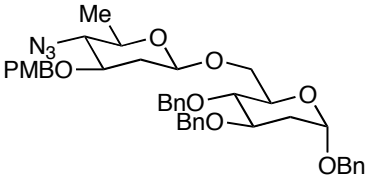
Characterization data for 2-deoxy-β-glycosides:



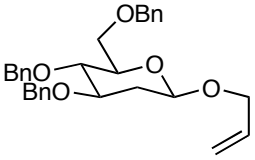
5: Purified with 20% ethyl acetate/hexanes, yielding 30 mg (91%) of **5** as a colorless oil. R_f = 0.55 (30% ethyl acetate/hexanes); IR (film) 2934, 2106, 1613, 1515, 1249, 1092 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.35-7.33 (d, *J* = 8.7 Hz, 2H), 6.93-6.92 (d, *J* = 8.7 Hz, 2H), 5.97-5.91 (ddt, *J* = 17.4, 10.4, 5.2 Hz, 1H), 5.33-5.30 (dd, *J* = 1.5, 17.4 Hz, 1H), 5.24-5.22 (dd, *J* = 1.5, 10.4 Hz, 1H), 4.65-4.63 (d, A of AB, *J* = 11.1 Hz, 1H), 4.58-4.56 (d, B of AB, *J* = 11.1 Hz, 1H), 4.46-4.44 (dd, *J* = 1.7, 9.6 Hz, 1H), 4.39-4.36 (m, 1H), 4.08-4.05 (dd, *J* = 6.1, 12.5 Hz, 1H), 3.84 (s, 3H), 3.55-3.51 (m, 1H), 3.19-3.16 (m, 1H), 3.12-3.09 (t, *J* = 9.3 Hz, 1H), 2.40-2.37 (ddd, *J* = 1.7, 5.0, 12.3 Hz, 1H), 1.67-1.61 (ddd, *J* = 9.6, 12.3, 9.6 Hz, 1H), 1.38-1.37 (d, *J* = 6.2 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 159.6, 134.1, 129.9, 129.7, 117.8, 114.1, 98.7, 77.5, 71.1, 70.9, 69.9, 67.9, 55.5, 36.8, 18.9; HRMS (ESI): Mass calculated for $C_{17}H_{23}N_3O_4$ $[M+Na]^+$, 356.15808. Found 356.15901.



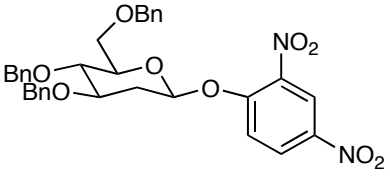
8: Purified with 25% ethyl acetate/hexanes, yielding 40 mg (87%) of **8** as a viscous yellow oil. R_f = 0.45 (35% ethyl acetate/hexanes); IR (film) 2936, 2108, 1609, 1536, 1514, 1275, 1249, 1036 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 8.75-8.74 (d, *J* = 2.7 Hz, 1H), 8.44-8.42 (dd, *J* = 3.0, 9.4 Hz, 1H), 7.39-7.37 (d, *J* = 9.4 Hz, 1H), 7.36-7.34 (d, *J* = 8.2 Hz, 2H), 6.95-6.93 (d, *J* = 8.5 Hz, 2H), 5.26-5.24 (dd, *J* = 1.8, 9.7 Hz, 1H), 4.71-4.69 (d, A of AB, *J* = 11.1 Hz, 1H), 4.62-4.60 (d, B of AB, *J* = 11.1 Hz, 1H), 3.85 (s, 3H), 3.66-3.62 (m, 1H), 3.41-3.37 (m, 1H), 3.25-3.22 (t, *J* = 9.4 Hz, 1H), 2.67-2.64 (ddd, *J* = 1.8, 4.6, 12.3 Hz, 1H), 2.02-1.97 (ddd, *J* = 9.7, 12.3, 9.7 Hz, 1H), 1.44-1.43 (d, *J* = 6.1 Hz, 3H); ^{13}C NMR (100 MHz, $CDCl_3$)δ 159.7, 154.3, 141.7, 140.0, 129.8, 129.3, 128.8, 121.7, 118.2, 114.2, 98.3, 76.5, 71.9, 71.3, 67.0, 55.5, 35.9, 18.9; HRMS (ESI): Mass calculated for $C_{20}H_{21}N_5O_8$ $[M+Na]^+$, 482.12823. Found 482.13106.



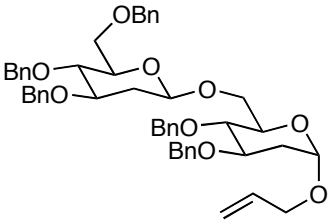
10: Purified with 20% ethyl acetate/hexanes, yielding 64 mg (90%) of **10** as a viscous yellow oil. R_f = 0.60 (40% ethyl acetate/hexanes); IR (film) 2934, 2106, 1722, 1610, 1514, 1454, 1364, 1251, 1027, 736 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.39-7.31 (m, 17H), 6.92-6.91 (d, *J* = 8.5 Hz, 2H), 5.08-5.07 (d, *J* = 3.2 Hz, 1H), 5.00-4.99 (d, A of AB, *J* = 11.4 Hz, 1 H), 4.72-4.64 (m, 4H), 4.63-4.61 (d, A of AB, *J* = 11.1 Hz, 1H), 4.56-4.55 (d, B of AB, *J* = 11.1 Hz, 1H), 4.47-4.45 (d, B of AB, *J* = 12 Hz, 1H), 4.24-4.23 (d, *J* = 9.2 Hz, 1H), 4.13-4.11 (dd, *J* = 1.5, 10.3 Hz, 1H), 4.10-4.07 (m, 1H), 3.88-3.86 (dd, *J* = 2.9, 9.9 Hz, 1H), 3.82 (s, 3H), 3.68-3.65 (dd, *J* = 4.7, 10.3 Hz, 1H), 3.59-3.56 (t, *J* = 9.1 Hz, 1H), 3.49-3.45 (m, 1H), 3.13-3.07 (m, 2H), 2.39-2.36 (dd, *J* = 1.5, 4.6, 12.3 Hz, 1H), 2.28-2.25 (dd, *J* = 4.7, 12.7 Hz, 1H), 1.79-1.74 (ddd, *J* = 3.8, 12.7, 12.9 Hz, 1H), 1.68-1.63 (ddd, *J* = 10.3, 12.3, 10.3 Hz, 1H), 1.36-1.35 (d, *J* = 5.6 Hz, 3H);^{13}C NMR (100 MHz, $CDCl_3$) δ 159.6, 138.9, 138.8, 137.8, 129.9, 129.7, 128.6, 128.6, 128.6 128.2, 128.1, 128.0, 127.9, 127.8, 127.7, 114.1, 100.0, 96.7, 78.2, 78.0, 77.5, 75.0, 71.9, 71.0, 70.9, 70.7, 69.0, 68.2, 67.9, 55.4, 33.6, 35.5, 18.8; HRMS (ESI): Mass calculated for $C_{41}H_{47}N_3O_8$ $[M+Na]^+$, 732.32554. Found 732.32804.



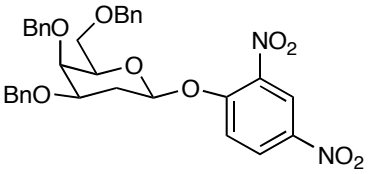
15: Purified with 10% ethyl acetate/hexanes, yielding 33 mg (70%) of **15** as a colorless oil. R_f = 0.60 (40% ethyl acetate/hexanes); IR (film) 3030, 2927, 2864, 1496, 1454, 1362, 1027, 736 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.40-7.24 (m, 15 H), 6.00-5.94 (ddt, *J* = 17.2, 12.5, 4.9 Hz, 1H), 5.35-5.31 (dd, *J* = 1.7, 17.2 Hz 1H), 5.24-5.22 (dd, *J* = 1.4, 12.5 Hz, 1H), 4.95-4.93 (d, A of AB, *J* = 10.9 Hz, 1H), 4.74, 4.58 (m, 5H), 4.54-4.52 (dd, *J* = 1.7, 9.6 Hz, 1H), 4.45-4.41 (ddt, *J* = 1.4, 5.2, 12.8 Hz, 1H), 4.11-4.08 (ddt, *J* = 1.2, 6.1, 12.8 Hz, 1H), 3.82-3.80 (dd, *J* = 2.0, 10.8 Hz, 1H), 3.77-3.74 (dd, *J* = 5.0, 10.8 Hz, 1H), 3.73-3.69 (m, 1H), 3.57-3.54 (t, *J* = 9.7 Hz, 1H), 3.47-3.44 (ddd, *J* = 2.1, 5.0, 9.6 Hz, 1H), 2.42-2.39 (ddd, *J* = 1.7, 5.0, 12.3 Hz, 1H), 1.76-1.70 (ddd, *J* = 9.7, 11.7, 12.2 Hz, 1H) ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.6, 138.5, 134.3, 128.6, 128.5, 128.5 128.4, 128.2, 128.0, 127.9, 127.8, 127.7, 127.6, 117.6, 99.1, 79.6, 78.3, 75.4, 75.2, 73.7, 71.6, 69.9, 69.6, 36.9; HRMS (ESI): Mass calculated for $C_{30}H_{34}O_5$ $[M+Na]^+$, 497.22985. Found 497.24161.



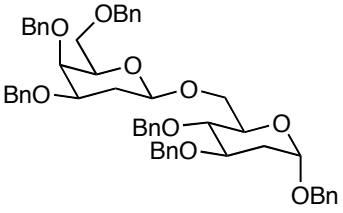
17: Purified with 15% ethyl acetate/hexanes, yielding 51 mg (85%) of **17** as a viscous yellow oil. R_f = 0.40 (40% ethyl acetate/hexanes); IR (film) 2868, 1608, 1536, 1277, 1074, 742 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 8.71-8.70 (d, *J* = 2.9 Hz, 1H), 8.27-8.25 (dd, *J* = 2.9, 9.1 Hz, 1H), 7.50-7.49 (d, *J* = 9.1 Hz, 1H), 7.40-7.28 (m, 15H), 5.34-5.32 (dd, *J* = 2.3, 9.1 Hz, 1H), 4.96-4.94 (d, A of AB, *J* = 10.9 Hz, 1H), 4.79-4.77 (d, A of AB, *J* = 11.7 Hz, 1H), 4.68-4.66 (d, B of AB, *J* = 11.7 Hz, 1H), 4.64-4.62 (d, B of AB, *J* = 10.9 Hz, 1H), 4.57-4.55 (d, A of AB, *J* = 12 Hz, 1H), 4.51-4.49 (d, B of AB, *J* = 12.7 Hz, 1H), 3.84-3.80 (m, 2H), 3.73 (m, 2H), 3.65-3.62 (m, 1H), 2.67-2.64 (ddd, *J* = 2.3, 5.0, 12.6 Hz, 1H), 2.13-2.07 (ddd, *J* = 9.1, 10.9, 12.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.6, 141.4, 139.8, 138.1, 138.0, 137.9, 128.8, 128.7, 128.6, 128.5, 128.2, 128.1, 128.0, 127.9, 127.8, 127.7, 121.4, 118.4, 98.5, 78.0, 77.0, 76.0, 75.1, 73.6, 71.8, 69.4, 35.4; HRMS (ESI): Mass calculated for $C_{33}H_{32}N_2O_9$ $[M+Na]^+$, 623.2030. Found 623.20029.



19: Purified with 10% ethyl acetate/hexanes, yielding 60 mg (75%) of **19** as a viscous yellow oil. R_f = 0.65 (30% ethyl acetate/hexanes); IR (film) 2930, 1496, 1454, 1364, 1028, 697 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.41-7.25 (m, 25H), 5.96-5.90, (ddt, *J* = 5.1, 10.4, 12.5 Hz, 1H), 5.32-5.29 (dq, *J* = 1.6, 17.1, 1H), 5.22-5.20 (dq, *J* = 1.4, 10.3 Hz, 1H), 5.04-5.03 (d, *J* = 2.7 Hz, 1H), 4.99-4.97 (d, *J* = 11.2 Hz, 1H), 4.94-4.92 (d, *J* = 10.6 Hz, 1H), 4.72-4.58 (m, 8H), 4.30-4.28 (dd, *J* = 1.8, 9.7 Hz, 1H), 4.18-4.14 (m, 2H), 4.10-4.06 (m, 1H), 3.97-3.93 (ddt, *J* = 1.3, 6.2, 12.8 Hz, 1H), 3.84-3.81 (ddd, *J* = 1.9, 4.2, 9.8 Hz, 1H), 3.80-3.78 (dd, *J* = 1.9, 10.8 Hz, 1H), 3.75-3.72 (dd, *J* = 5.3, 10.8 Hz, 1H), 3.70-3.68 (dd, *J* = 4.5, 10.7 Hz, 1H), 3.66-3.62 (m, 1H), 3.60-3.57 (t, *J* = 9.1 Hz, 1H), 3.51-3.48 (t, *J* = 9.5 Hz, 1H), 3.42-3.40 (ddd, *J* = 1.9, 5.1, 9.6 Hz, 1H), 2.37-2.34 (ddd, *J* = 1.1, 5.1, 13.0 Hz, 1H), 2.27-2.24 (ddd, *J* = 1.9, 4.9, 12.4 Hz, 1H), 1.78-1.68 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.9, 138.8, 138.6, 138.5, 138.4, 134.3, 128.6, 128.6 128.5, 128.4, 128.3, 128.2, 128.1, 127.9, 127.9, 127.8, 127.7, 127.6, 127.6, 127.5, 127.4, 127.1, 117.4, 100.4, 96.7, 79.5, 78.4, 78.1, 78.0, 75.5, 75.2, 74.9, 73.6, 71.9, 70.6, 69.7, 68.2, 67.9, 36.7, 35.5; HRMS (ESI): Mass calculated for $C_{50}H_{56}O_9$ $[M+Na]^+$, 823.38165. Found 823.38230.

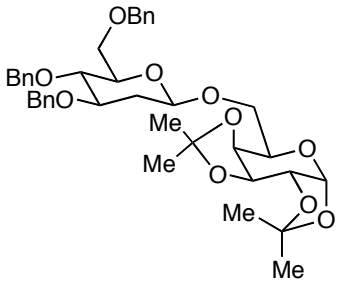


20: Purified with 15% ethyl acetate/hexanes, yielding 54 mg (90%) of **20** as a viscous yellow oil. R_f = 0.40 (40% ethyl acetate/hexanes); IR (film) 2921, 2869, 1607, 1538, 1496, 1454, 1346, 1043, 741 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 8.71-8.70 (d, *J* = 2.9 Hz, 1H), 8.22-8.20 (dd, *J* = 2.7, 9.4 Hz, 1H), 7.53-7.51(d, *J* = 9.4 Hz, 1H), 7.42-7.28 (m, 15H), 5.29-5.27 (dd, *J* = 2.6, 9.7 Hz, 1H), 5.01-4.99 (d, *J* = 11.4 Hz, 1H), 4.72-4.64 (m, 4H), 4.47 (s, 2H), 3.91-3.90 (d, *J* = 2Hz, 1H), 3.75-3.70 (m, 2H), 3.63-3.60 (dd, *J* = 8.2, 12.6 Hz, 1H), 2.56-2.50 (ddd, *J* = 9.7, 10.0, 12.3 Hz, 1H), 2.42-2.38 (dt, *J* = 2.6, 12.3 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.5, 141.4, 139.8, 138.4, 137.9, 137.8, 128.8, 128.7, 128.5, 128.4, 128.2, 128.1, 128.0, 127.9, 127.8, 127.6, 121.5, 118.7, 99.1, 76.3, 75.6, 74.4, 73.9, 71.5, 70.7, 69.7, 31.9; HRMS (ESI): Mass calculated for $C_{33}H_{32}N_2O_9$ $[M+Na]^+$, 623.2000. Found 623.20021.

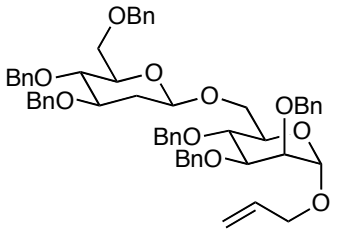


21: Purified with 10% ethyl acetate/hexanes, yielding 68 mg (80%) of **21** as a viscous yellow oil. R_f = 0.55 (40% ethyl acetate/hexanes); IR (film) 2918, 1496, 1454, 1364, 1099, 1064, 697 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.44-7.24 (m, 30H), 5.04-5.03 (d, *J* = 3.2 Hz, 1H), 4.96-4.94 (d, *J* = 11.7 Hz, 1H), 4.95-4.93 (d, *J* = 11.1 Hz, 1H), 4.74-4.61 (m, 7H), 4.48-4.42 (m, 3H), 4.36-4.34 (dd, *J* = 2.1, 9.7 Hz, 1H), 4.18-4.16 (dd, *J* = 1.8, 10.9 Hz, 1H), 4.09-4.04 (ddd, *J* = 5.0, 8.7, 11.1 Hz, 1H), 3.91-3.88 (ddd, *J* = 1.7, 5.2, 9.6 Hz, 1H), 3.86 (br s, 1H), 3.70-3.66 (m, 2H), 3.61-3.59 (dd, *J* = 5.5, 9.0 Hz, 1H), 3.54-3.50 (m, 2H), 3.47-3.45 (t, *J* = 6.2 Hz, 1H), 2.36-2.33 (dd, *J* = 4.9, 12.6 Hz, 1H), 2.22-2.16 (ddd, *J* = 9.7, 10.2, 12.5 Hz, 1H), 2.05-2.03 (m, 1H), 1.77-1.72 (ddd, *J* = 3.1, 12.6, 13.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$ 139.2, 138.8, 138.2, 137.8, 128.8, 128.6, 128.5, 128.4, 128.4 128.3, 128.2, 128.1, 128.1 128.0, 128.0, 127.9, 127.8, 127.7, 127.7 127.6, 127.5, 127.4, 127.3,

127.2, 101.2, 96.5, 78.6, 78.0, 75.0, 74.4, 74.2, 73.7, 72.0, 71.9, 70.9, 70.3, 69.3, 68.9, 68.2, 65.6, 35.5, 32.8; HRMS (ESI): Mass calculated for $C_{54}H_{58}O_9$ $[M+Na]^+$, 873.39730. Found 873.39709.



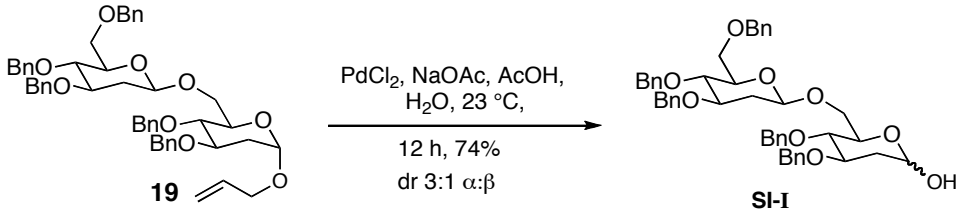
23: Purified with 10% ethyl acetate/hexanes, yielding 42 mg (61%) of **23** as a viscous yellow oil. R_f = 0.55 (30% ethyl acetate/hexanes); IR (film) 2930, 1496, 1454, 1364, 1028, 697 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.37-7.18 (m, 15H), 5.55-5.54, (d, *J* = 4.8, 1H), 4.90-4.88 (d, *J* = 10.8, 1H), 4.70-4.49 (m, 6H), 4.31-4.30 (dd, J = 2.4, 4.8 Hz, 1H), 4.22-4.20 (dd, J = 1.4, 7.7 Hz, 1H), 4.10-4.07 (dd, *J* = 3.4, 11.2 Hz, 1H), 4.00-3.99 (m, 1H), 3.75-3.70 (m, 3H), 3.67-3.62 (m, 2H), 3.55-3.51 (t, *J* = 9.3 Hz, 1H), 3.41-3.37 (m, 1H), 2.47-2.44 (ddd, *J* = 1.4, 4.8, 12.2 Hz, 1H), 1.69-1.62 (m, 1H) 1.54 (s, 3H), 1.44 (s, 3H), 1.33(s,3H),1.32(s,3H);^{13}C NMR (125 MHz, $CDCl_3$)δ 138.6, 138.5, 128.8, 128.6, 128.5, 128.2, 128.0, 127.9, 127.8, 127.7, 127.2, 109.5, 108.8, 100.6, 96.5, 79.6, 78.2, 75.3, 75.1, 73.6, 71.7, 71.4, 70.9, 70.6, 69.3, 69.0, 67.9, 65.6, 36.7, 26.9, 26.2, 25.2, 24.6; HRMS (ESI): Mass calculated for $C_{39}H_{48}O_{10}$ $[M+Na]^+$, 699.32470. Found 699.31453.



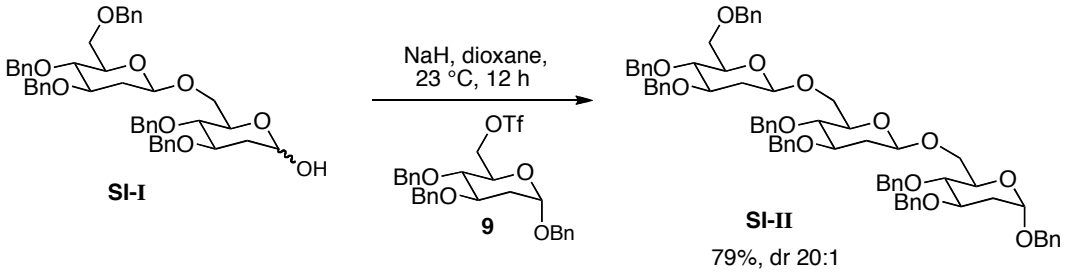
25: Purified with 10% ethyl acetate/hexanes, yielding 69 mg (77%) of **25** as a viscous yellow oil. R_f = 0.70 (30% ethyl acetate/hexanes); IR (film) 2930, 1496, 1454, 1364, 1028, 697 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.40-7.24 (m, 30H), 5.91-5.85, (ddt, *J* = 5.1, 10.4, 12.5 Hz, 1H), 5.26-5.23 (dq, *J* = 1.5, 17.2, 1H), 5.20-5.18 (dq, *J* = 1.3, 10.3 Hz, 1H), 4.96-4.92 (m, 3H), 4.76-4.56 (m, 10H), 4.42-4.40 (dd, *J* = 1.6, 9.7 Hz, 1H), 4.23-4.21 (dd, *J* = 1.8, 11.0 Hz, 1H), 4.19-4.16 (m, 1H), 3.97-3.94 (m, 2H), 3.89-3.83 (m, 3H), 3.79-3.73 (m, 2H), 3.71-3.68 (dd, *J* = 6.1, 11.0 Hz, 1H), 3.67-3.63 (m, 1H), 3.55-3.52 (t, *J* = 9.2 Hz, 1H), 3.43-3.40 (m, 1H), 2.35-2.32 (ddd, *J* = 1.7, 5.0, 12.4 Hz, 1H), 1.74-1.68 (m, 1H); ^{13}C NMR (125 MHz, $CDCl_3$) δ 138.8, 138.7, 138.6, 138.5, 138.4, 134.0, 128.6, 128.5, 128.4, 128.3, 128.2, 128.1, 128.0, 128.0, 127.9, 127.9, 127.8, 127.8, 127.7, 127.6, 127.5, 127.3, 127.3, 127.2, 127.1, 127.0, 117.6, 100.5, 97.1, 80.5, 79.6, 78.4, 75.4, 75.3, 75.2, 74.8, 73.7, 72.8, 72.3, 71.8, 71.6, 69.6, 68.7, 67.9, 36.8; HRMS (ESI): Mass calculated for $C_{57}H_{62}O_{10}$ $[M+Na]^+$, 929.43430. Found 929.42316.

Competition Experiment: A 10 mL round bottom flask was charged with **3** (29 mg, 0.1 mmol), and trans-4-*tert*-butylcyclohexanol (16 mg, 0.1 mmol). Dioxane (1.5 ml) was added followed by NaH (9 mg, 0.21 mmol) at room temperature. The mixture was allowed to stir at room temperature for 10 minutes. Allyl bromide (9 µl, 0.105 mmol) was added via syringe and the resulting solution was allowed to stir for 6 hours. The reaction was quenched by the careful addition of water (1 ml) and transferred to a separatory funnel containing brine (10 ml). The aqueous layer was extracted with EtOAc (3 x 2 ml). The combined organic layers were dried over Na_2SO_4, filtered, and concentrated. The material was purified by flash column chromatography to afford 2-deoxy-β-glycoside **5** (26 mg, 81%) and unreacted trans-4-*tert*-butylcyclohexanol (16 mg, quantitative recovery).

Iterative Anomeric *O*-Alkylation:



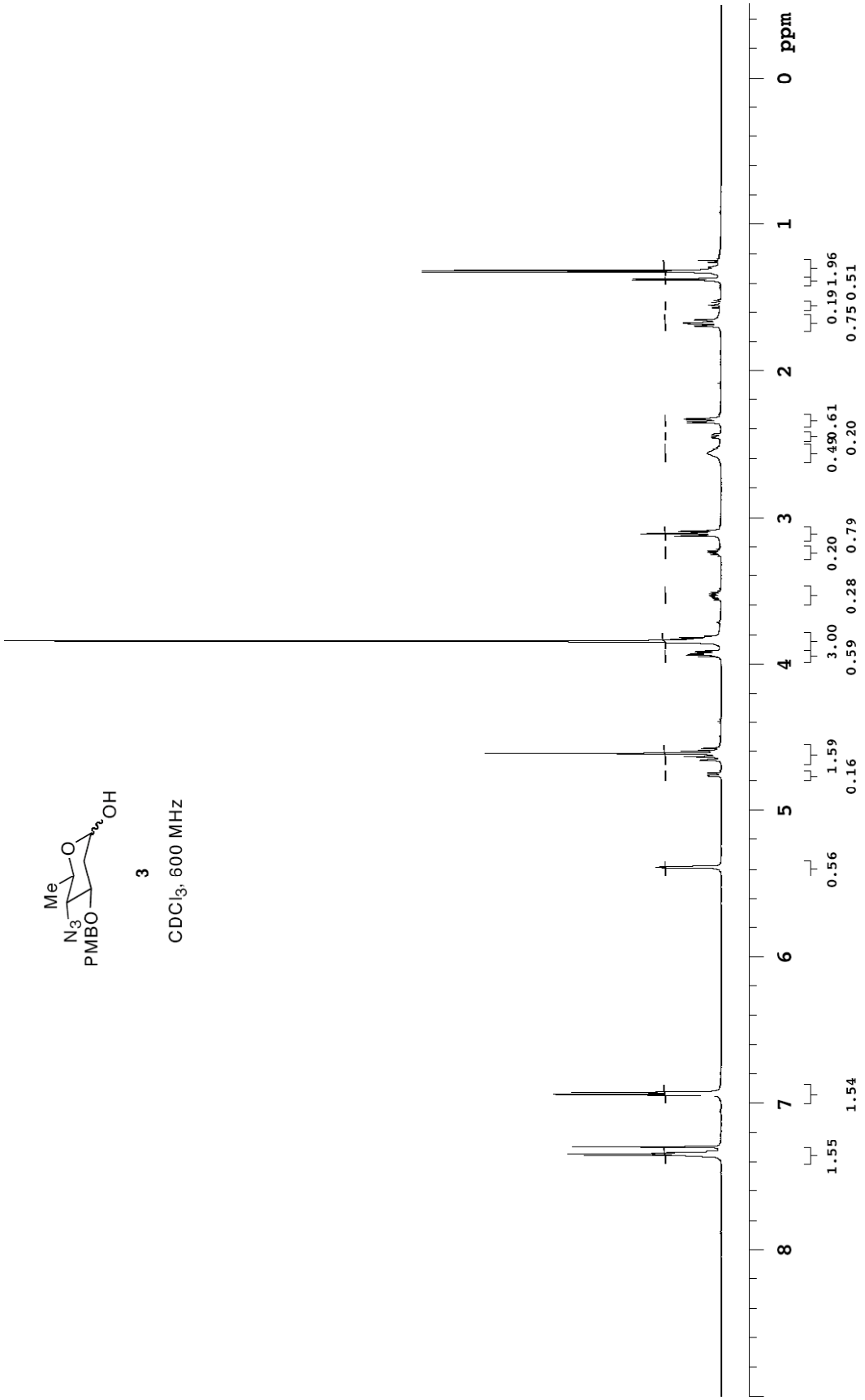
Deallylation of 19: To a solution of 2-deoxy-β-glycoside **19** (50 mg, 0.006 mmol) in AcOH (3 ml) and water (1.5 ml) was added NaOAc (76 mg, 0.94 mmol) and $PdCl_2$ (78 mg, 0.44 mmol). The resulting solution was allowed to stir for 15 hours at 23 °C. The mixture was diluted with EtOAc (10 ml) and washed with water (5 ml), saturated $NaHCO_3$ (5 ml) and brine (5 ml). The combined organic layers were dried over Na_2SO_4, filtered and concentrated. The crude mixture was purified by flash column chromatography yielding 34 mg (74%) of lactol as a white solid (3:1 mixture of α and β anomers). R_f = 0.10 (30% ethyl acetate/hexanes); IR (film) 3399, 2929, 1735, 1453, 1363, 1094, 696 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) (α anomer reported) δ 7.40-7.21 (m, 25 H), 5.4 (s, 1H), 4.99-4.97 (d, *J* = 11.2 Hz, 1H), 4.92-4.90 (d, *J* = 10.8 Hz, 1H), 4.73-4.54 (m, 8H), 4.35-4.33 (dd, *J* = 1.9, 9.8 Hz, 1H), 4.18-4.10 (m, 2H), 3.79-3.62 (m, 5H), 3.49-3.44 (m, 2H), 3.42-3.40 (ddd, *J* = 1.9, 5.0, 9.6 Hz, 1H), 3.09 (br s, OH), 2.36-2.33 (ddd, *J* = 1.1, 5.0, 13.0 Hz, 1H), 2.30-2.27 (ddd, *J* = 1.7, 4.9, 12.4 Hz, 1H), 1.74-1.68 (m, 2H). ^{13}C NMR (100 MHz,$CDCl_3$)δ 138.8, 138.7, 138.6, 138.5, 138.3, 128.8, 128.7, 128.6, 128.5, 128.2, 128.1, 128.0 , 127.9, 127.8, 127.7, 100.7, 100.4, 97.4, 97.2, 94.2, 92.2, 79.5, 78.9, 78.3, 77.9, 75.2, 75.1, 74.9, 73.7, 73.6, 71.9, 71.6, 70.2, 69.5, 69.4, 36.7, 35.6. HRMS (ESI): Mass calculated for $C_{47}H_{52}O_9$ $[M+Na]^+$, 783.35035. Found 783.50960.



Anomeric *O*-alkylation of disaccharide Sl-I: **See General Proceudre for Displacement of Primary Triflates**: Purified with 50% Et_2O/hexanes, yielding 41 mg (79%) as a viscous yellow oil. R_f = 0.40 (50% diethyl ether/hexanes); IR (film) 3030, 2930, 1735, 1496, 1454, 1364, 1098, 735 cm^{-1}; ^1H NMR (600 MHz, $CDCl_3$) δ 7.44-7.21 (m, 40H), 5.06-5.05 (d, J = 2.7 Hz, 1H), 5.00-4.95 (m, 3H), 4.91-4.89 (d, J = 10.9 Hz, 1H), 4.74-4.61(m, 7H), 4.58-4.53 (m, 3H), 4.49-4.43 (m, 2H), 4.39-4.38 (dd, J = 1.6, 9.7 Hz, 1H), 4.33-4.31 (dd, J = 1.8, 9.7 Hz, 1H), 4.23-4.21 (dd, J = 1.9, 11.0 Hz, 1H), 4.14-4.07 (m, 2H), 3.88-3.85 (m, 1H), 3.83-3.81(m, 2H), 3.79-3.74 (m, 2H), 3.72-3.69 (m, 1H), 3.65-3.52 (m, 4H), 3.46-3.43 (ddd, J = 1.9, 9.7, 11.5 Hz, 1H), 3.40-3.37 (m, 1H), 2.40-2.31 (m, 2H), 2.29-2.24 (m, 1H), 1.78-1.65 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$)

138.8, 138.7, 138.6, 138.5, 138.2, 138.1, 137.8, 137.7, 128.9, 128.8, 128.7, 128.6, 128.6, 128.5, 128.4, 128.3, 128.2, 128.1, 128.0, 128.0, 127.9, 127.9, 127.8, 127.8, 127.7, 127.6, 127.6, 127.5, 127.4, 127.2, 127.1, 127.0, 100.6, 100.3, 96.9, 79.7, 78.5, 78.4, 78.3, 78.1, 77.7, 75.4, 75.3, 75.2, 75.1, 73.7, 72.0, 71.9, 71.7, 71.6, 71.5, 70.8, 69.2, 68.9, 62.4, 36.7, 35.8, 35.5; HRMS (ESI): Mass calculated for $C_{74}H_{80}O_{13}$ $[M+Na]^+$, 1199.54911. Found 1199.54786.

Selected NMR Spectra: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1.59
0.16
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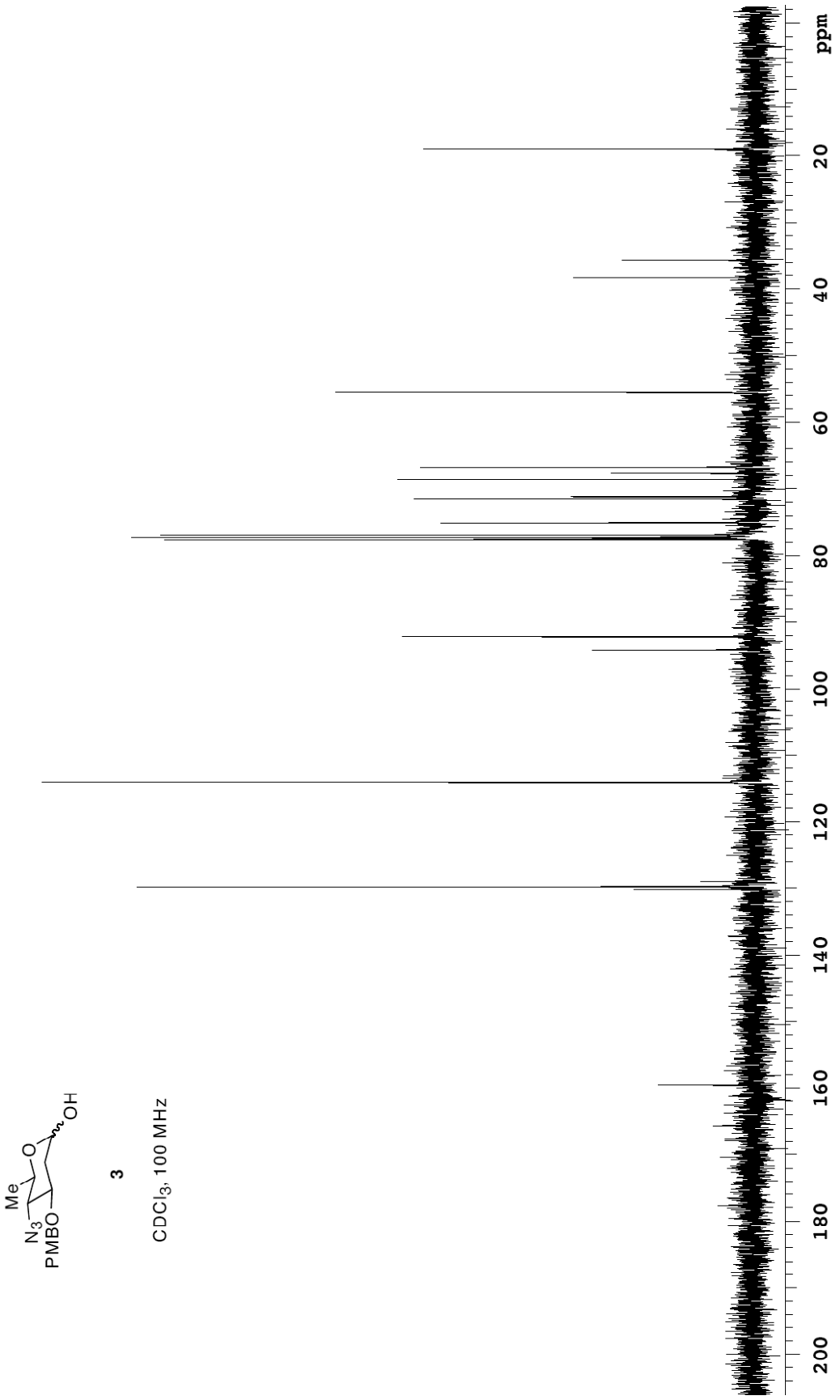
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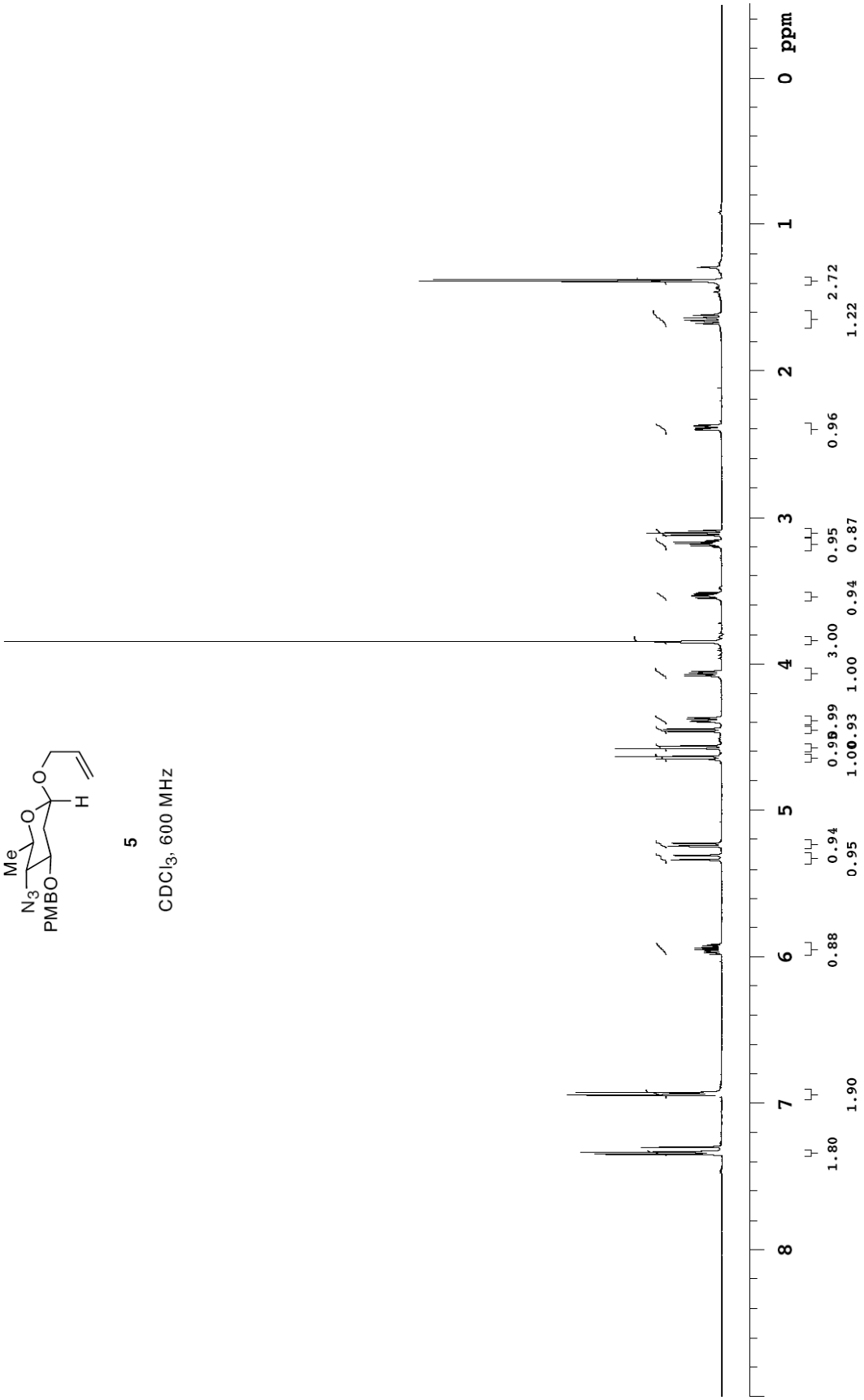
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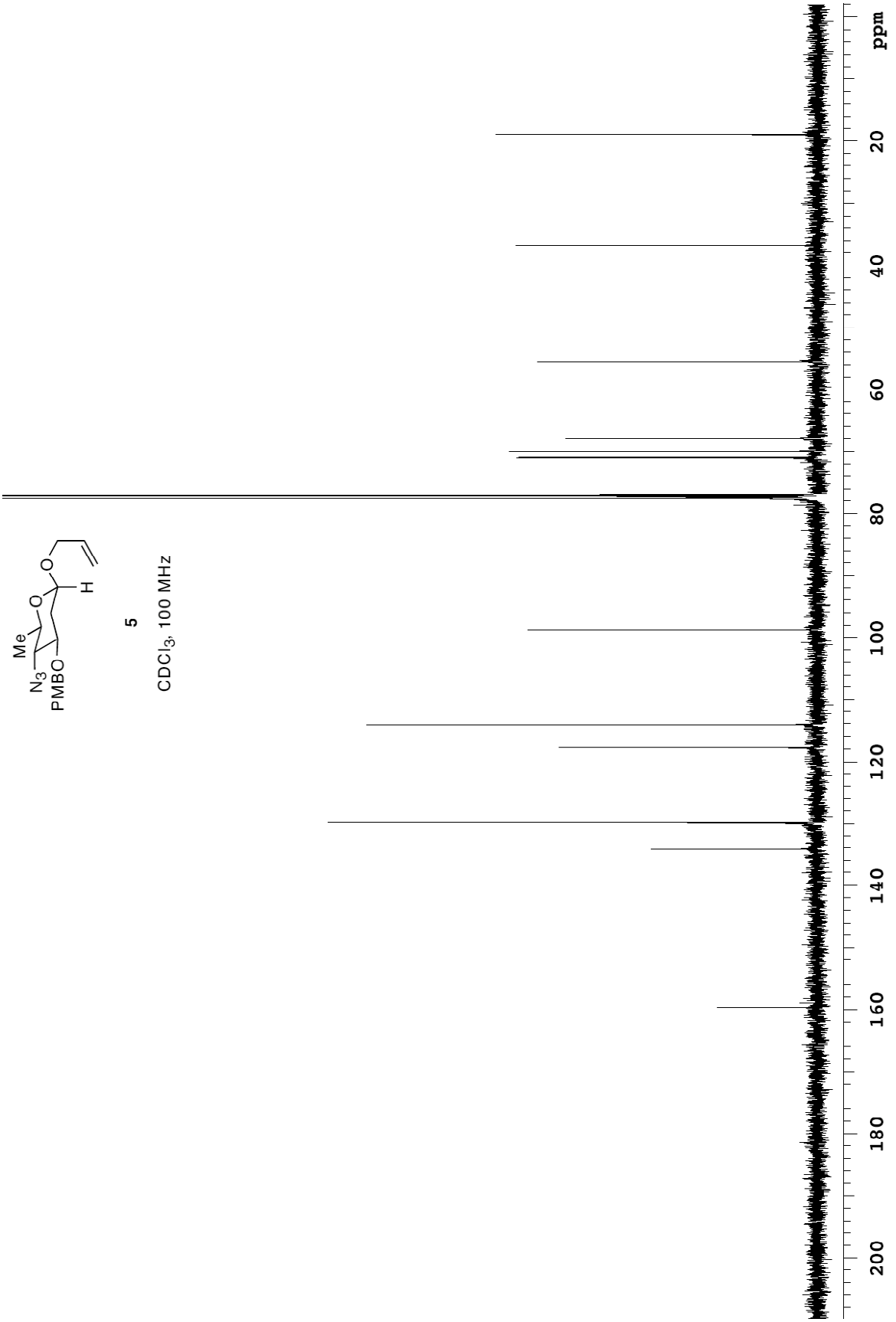
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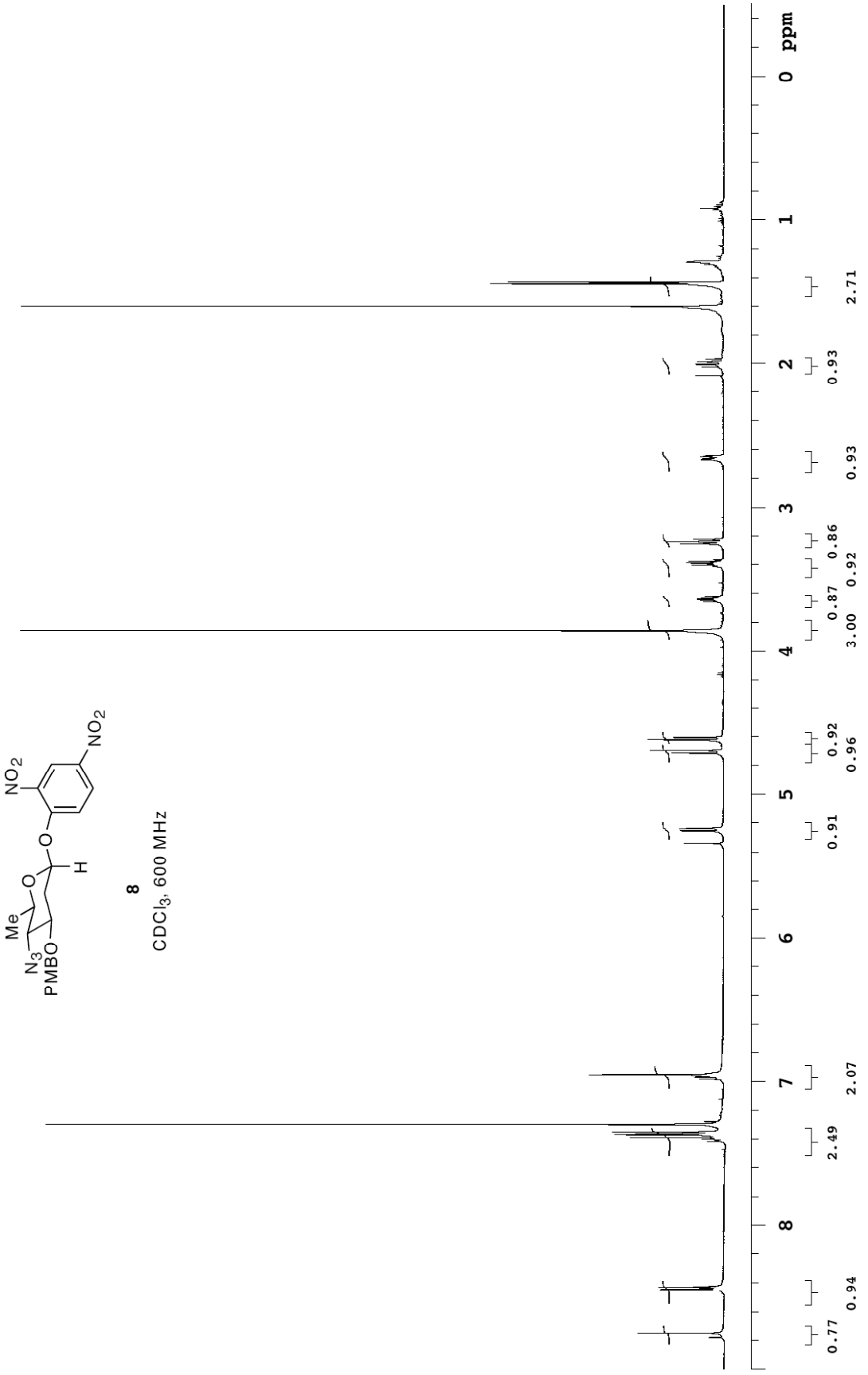
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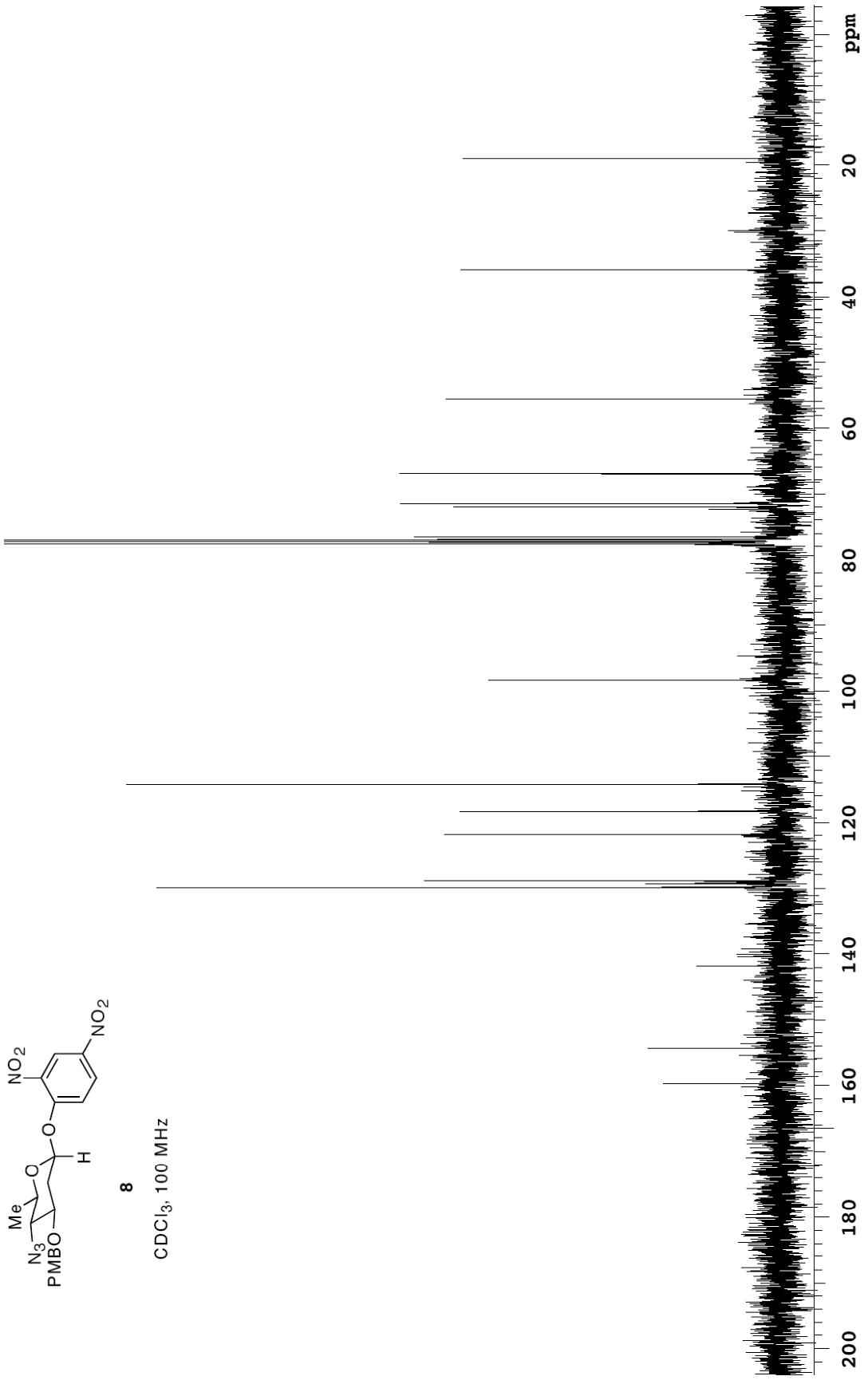
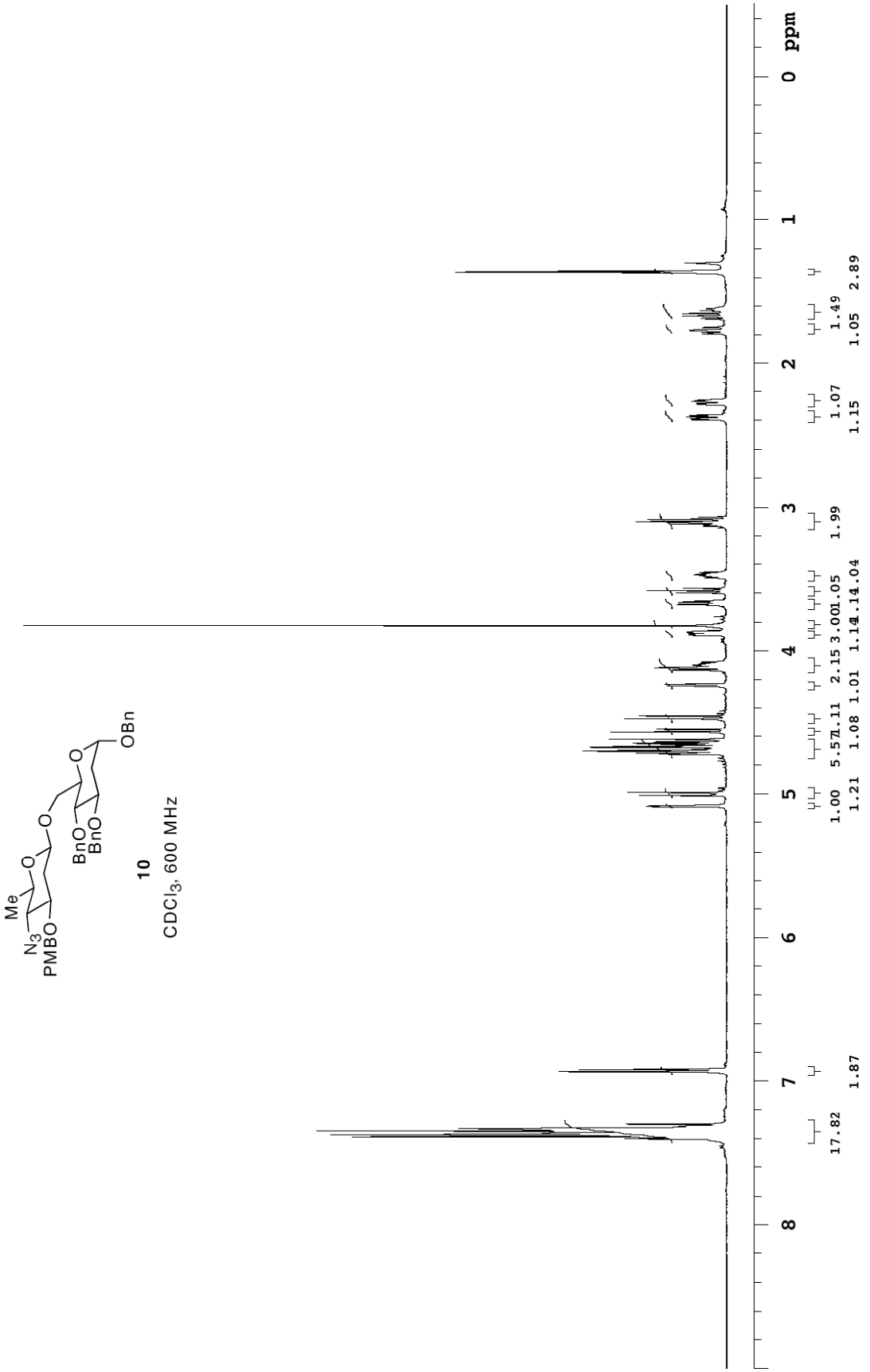


8

$CDCl_3$, 100 MHz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1.05
1.99
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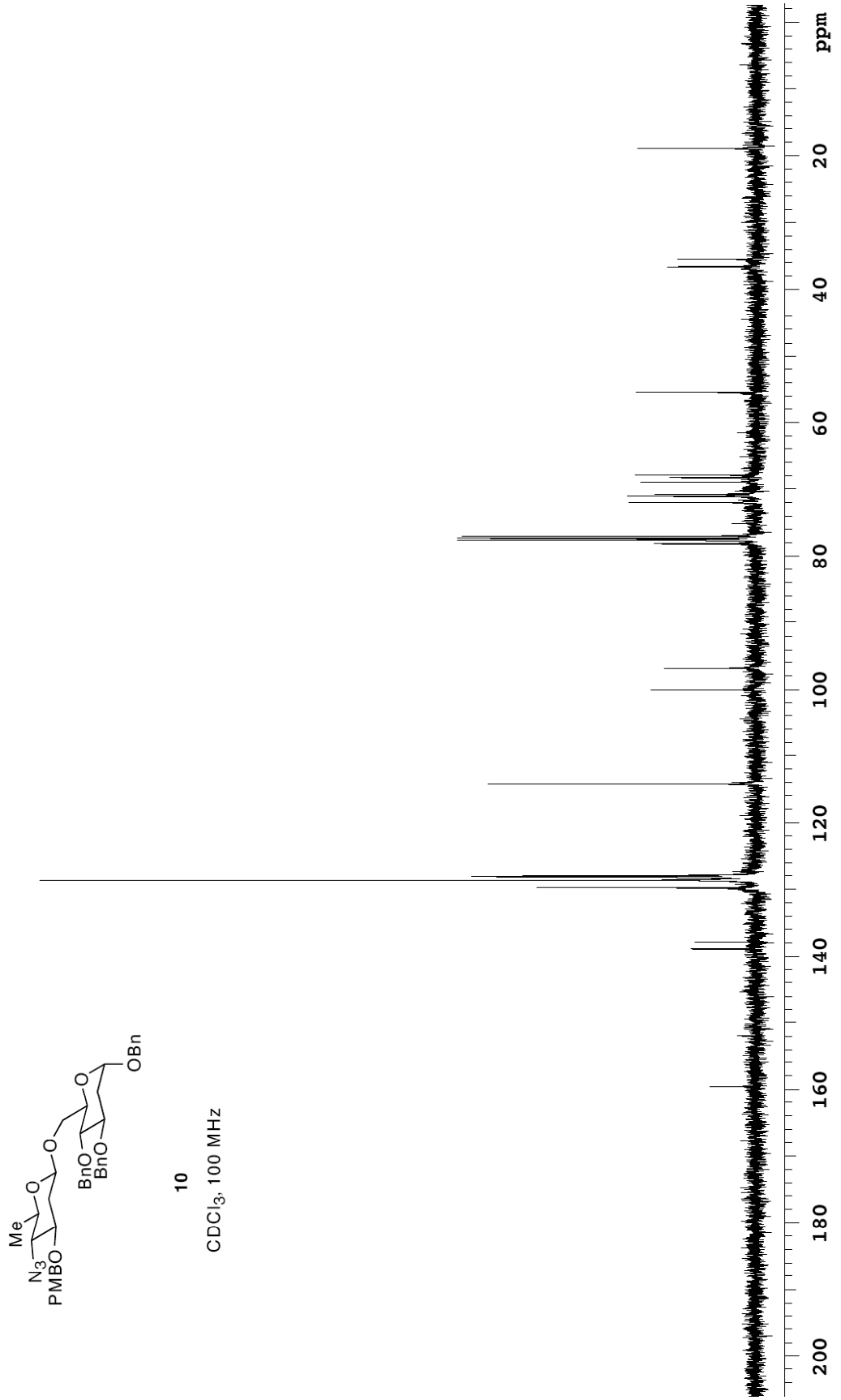
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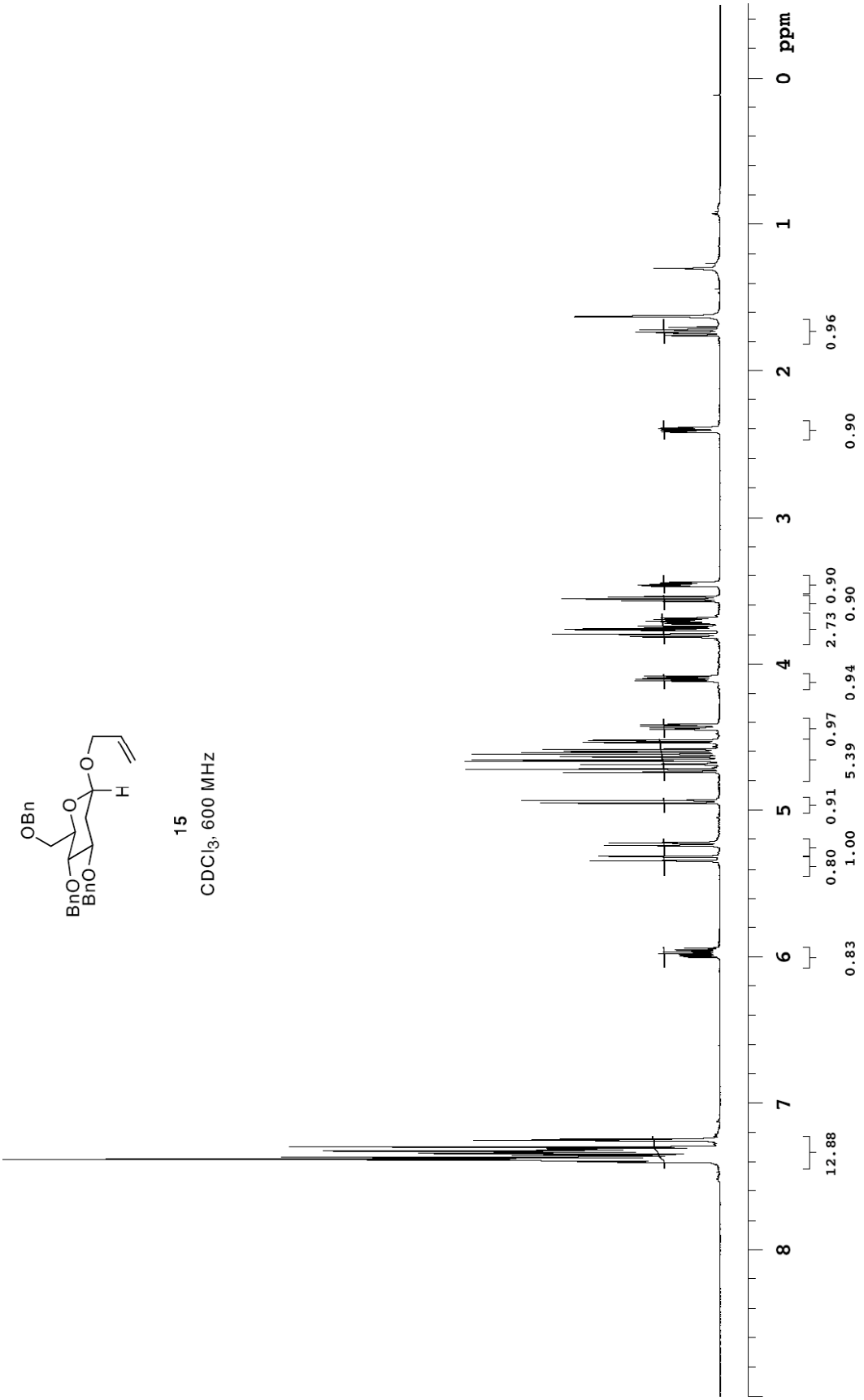
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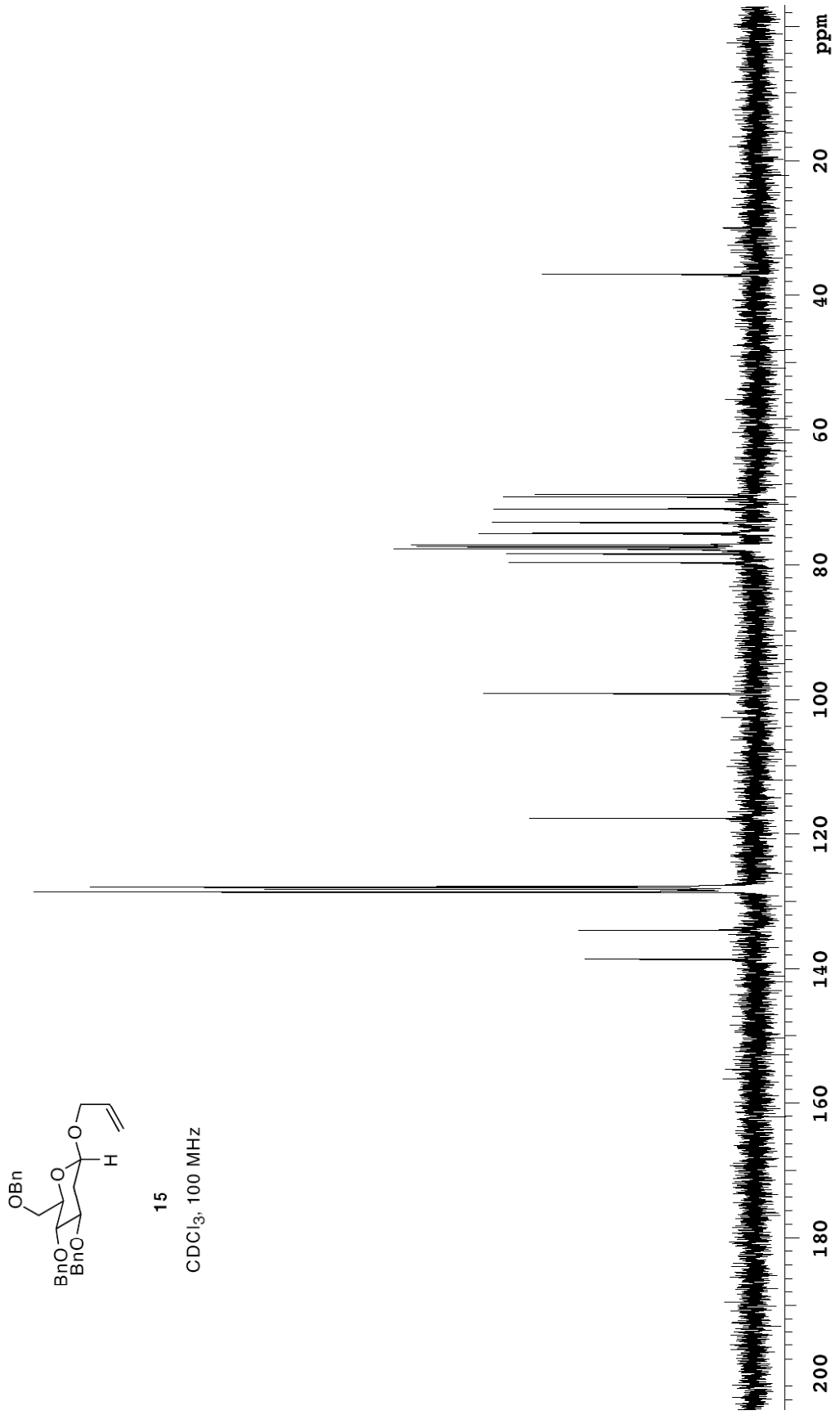
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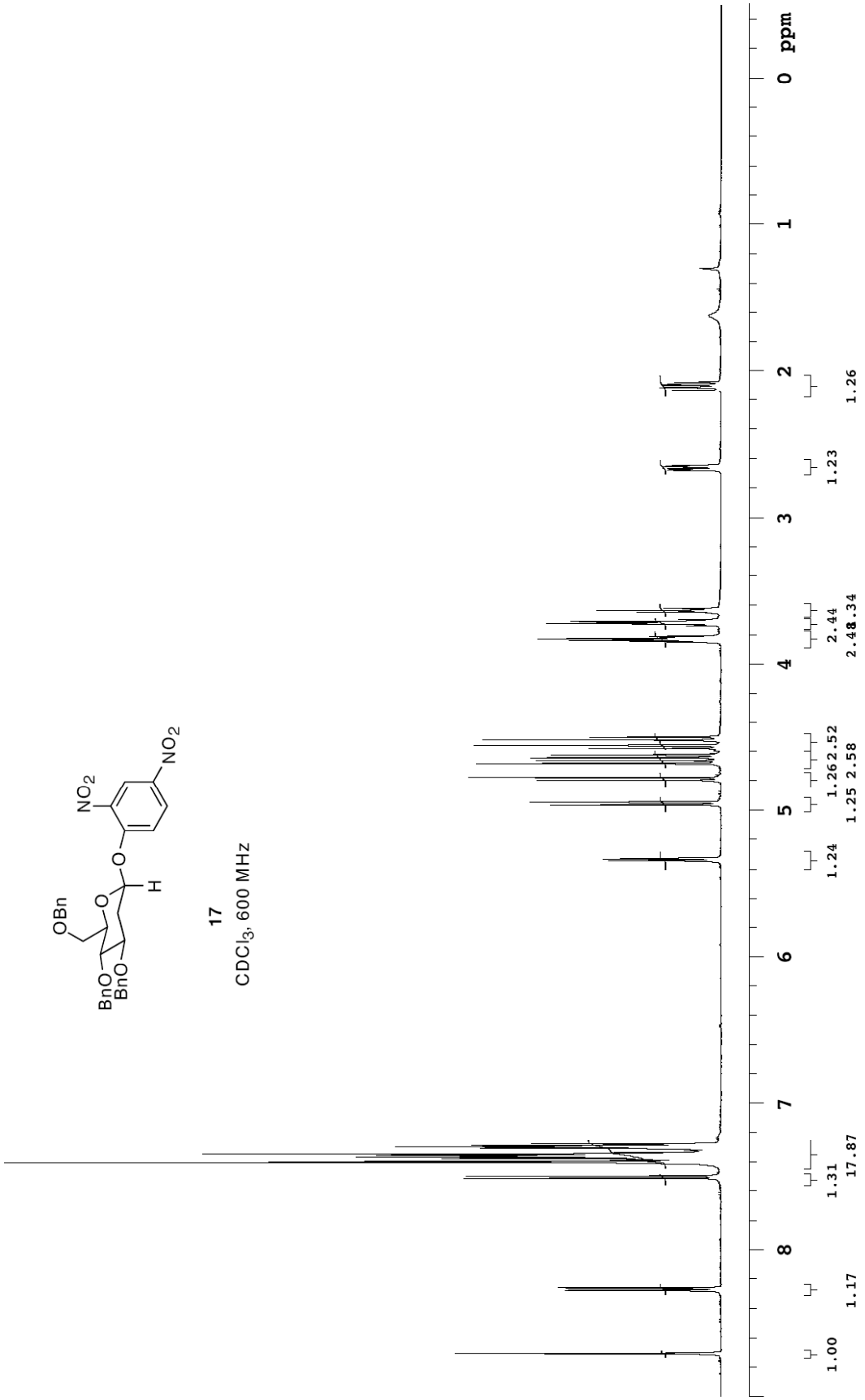
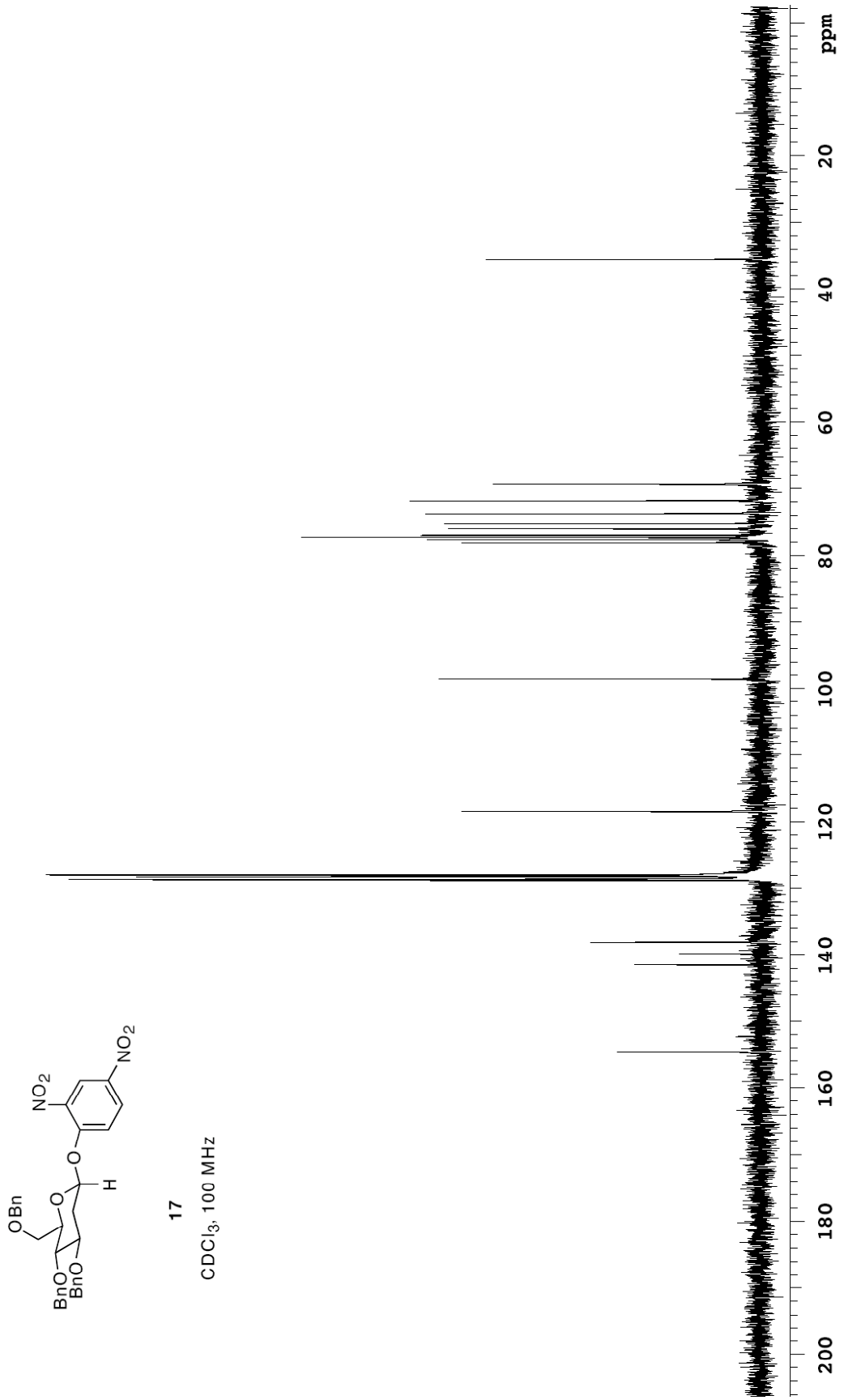
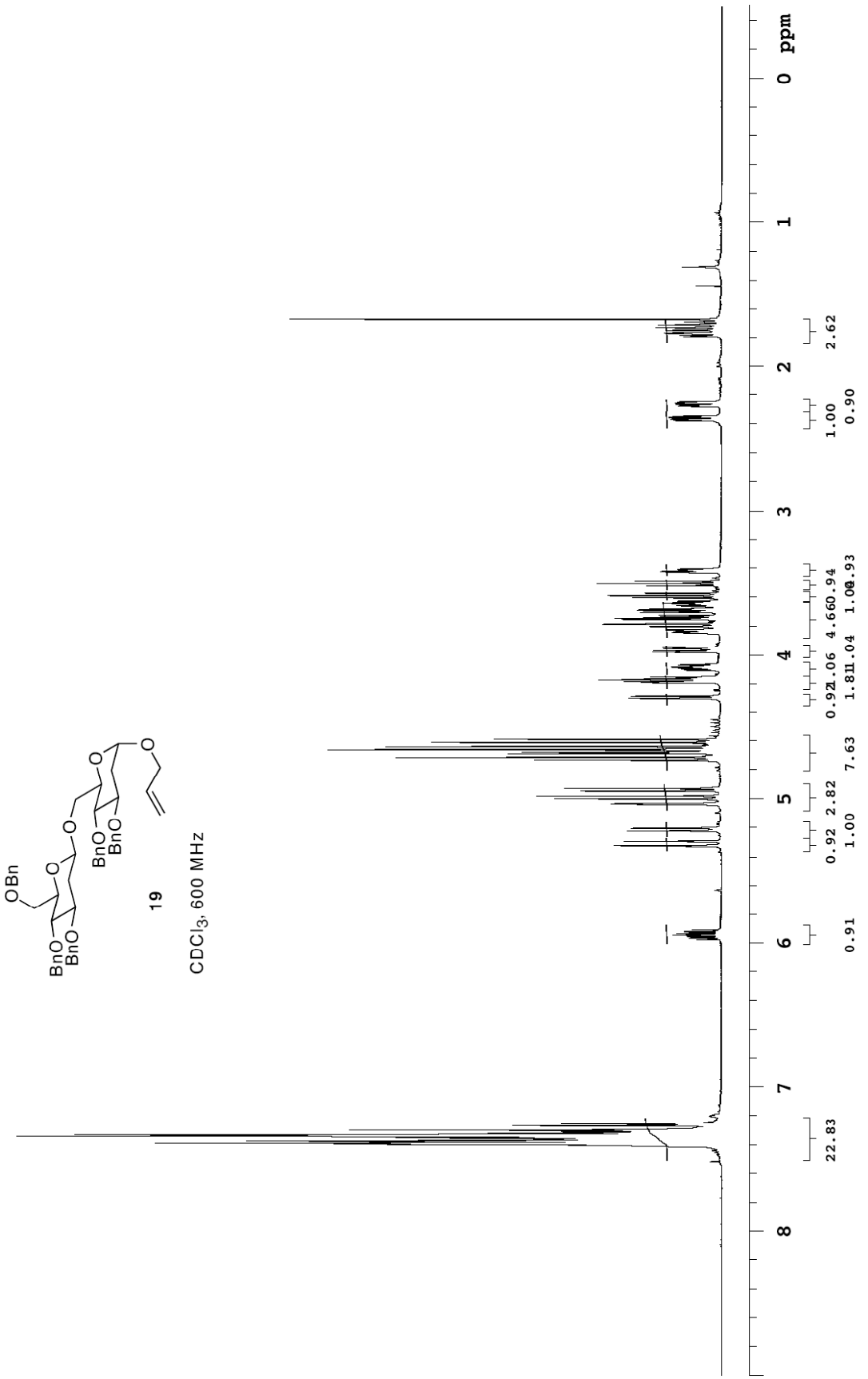
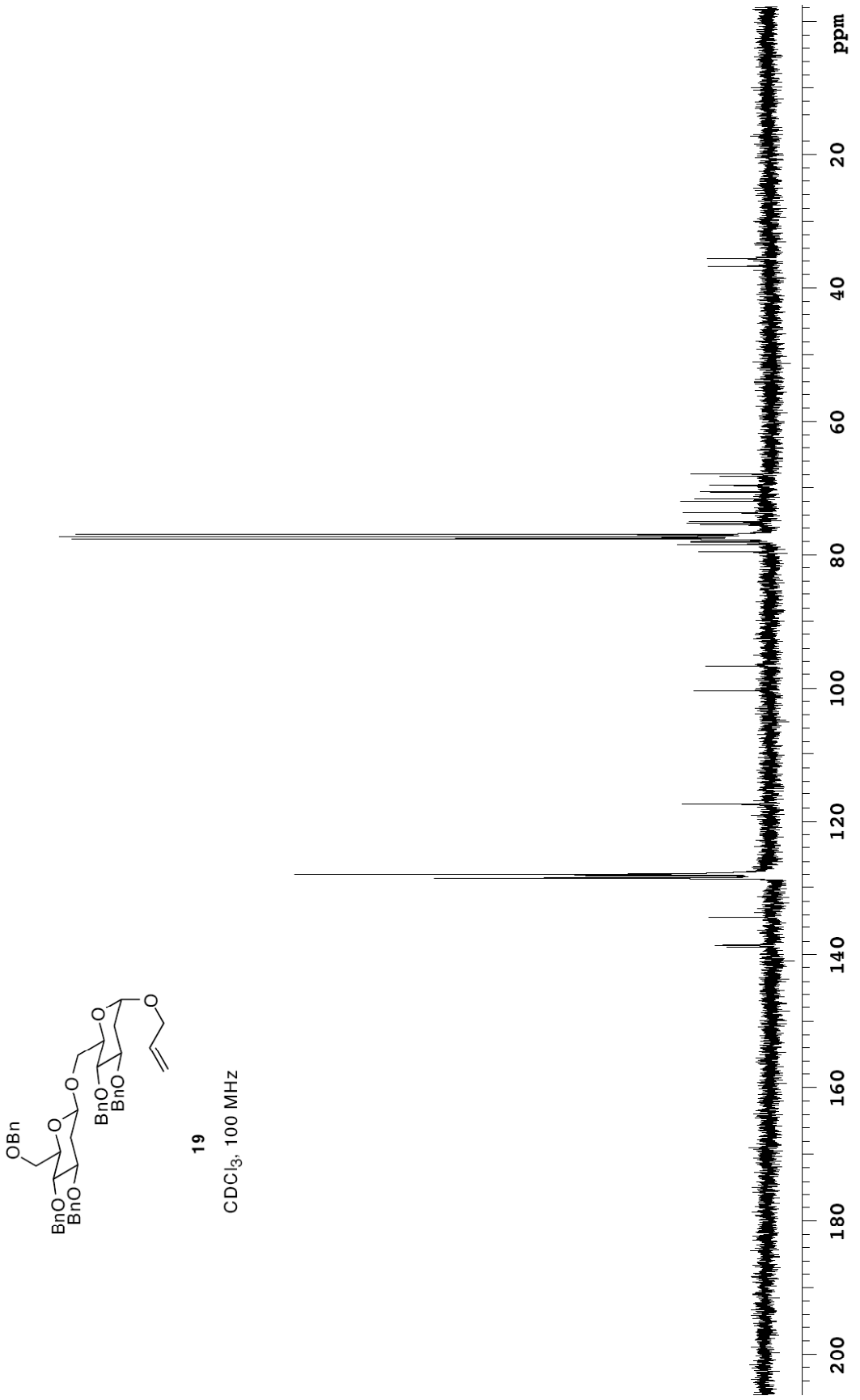
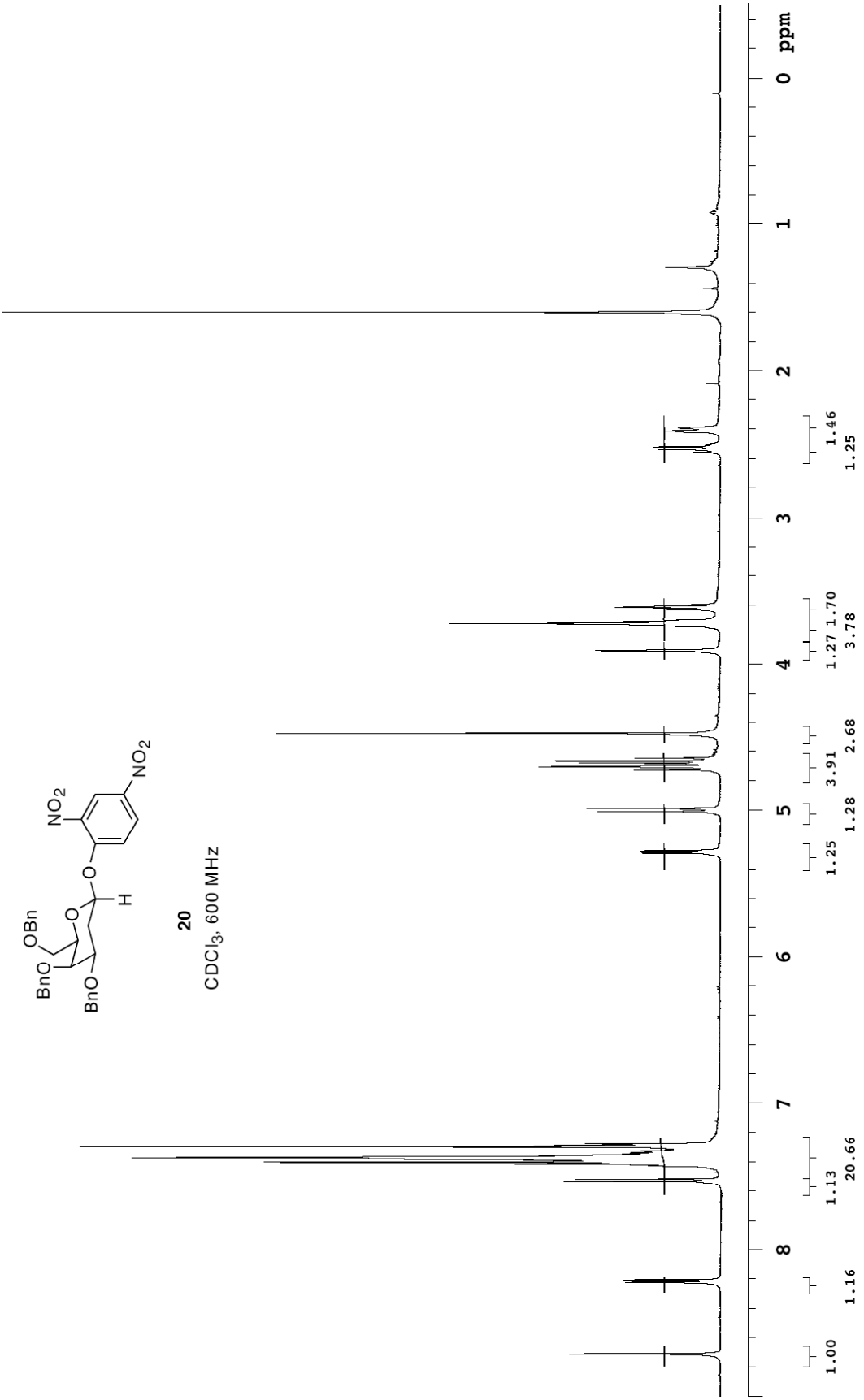
O
O
H
15
$CDCl_3$, 100 MHz

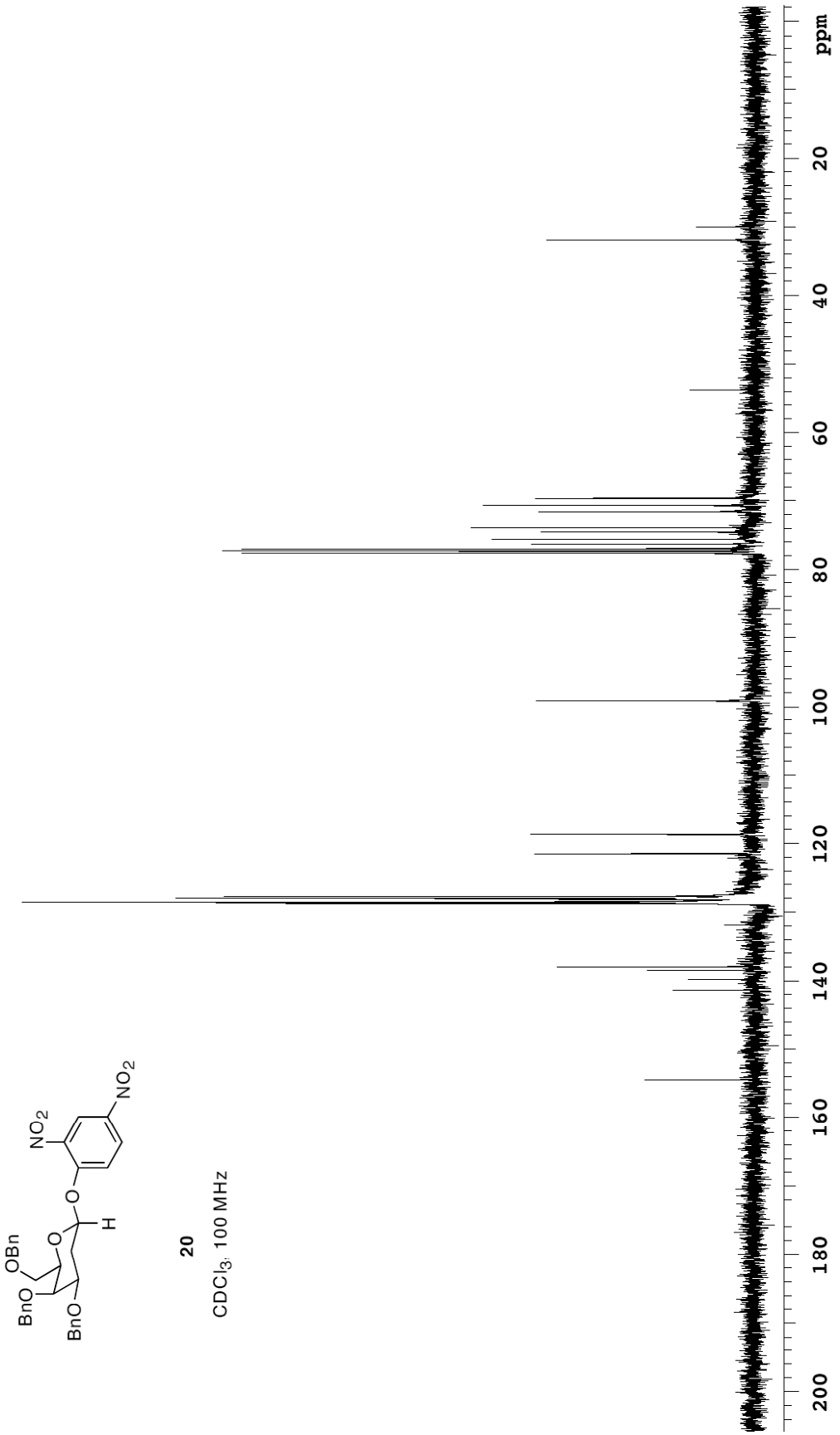

17
CDCl3, 600 MHz
NO2
NO2
O
H
OBn
O
BnO
BnO
ppm
0
1
2
3
4
5
6
7
8
1.00
1.17
1.31
17.87
1.24
1.25
1.26
2.52
2.58
2.44
2.48
4.34
1.23
1.26

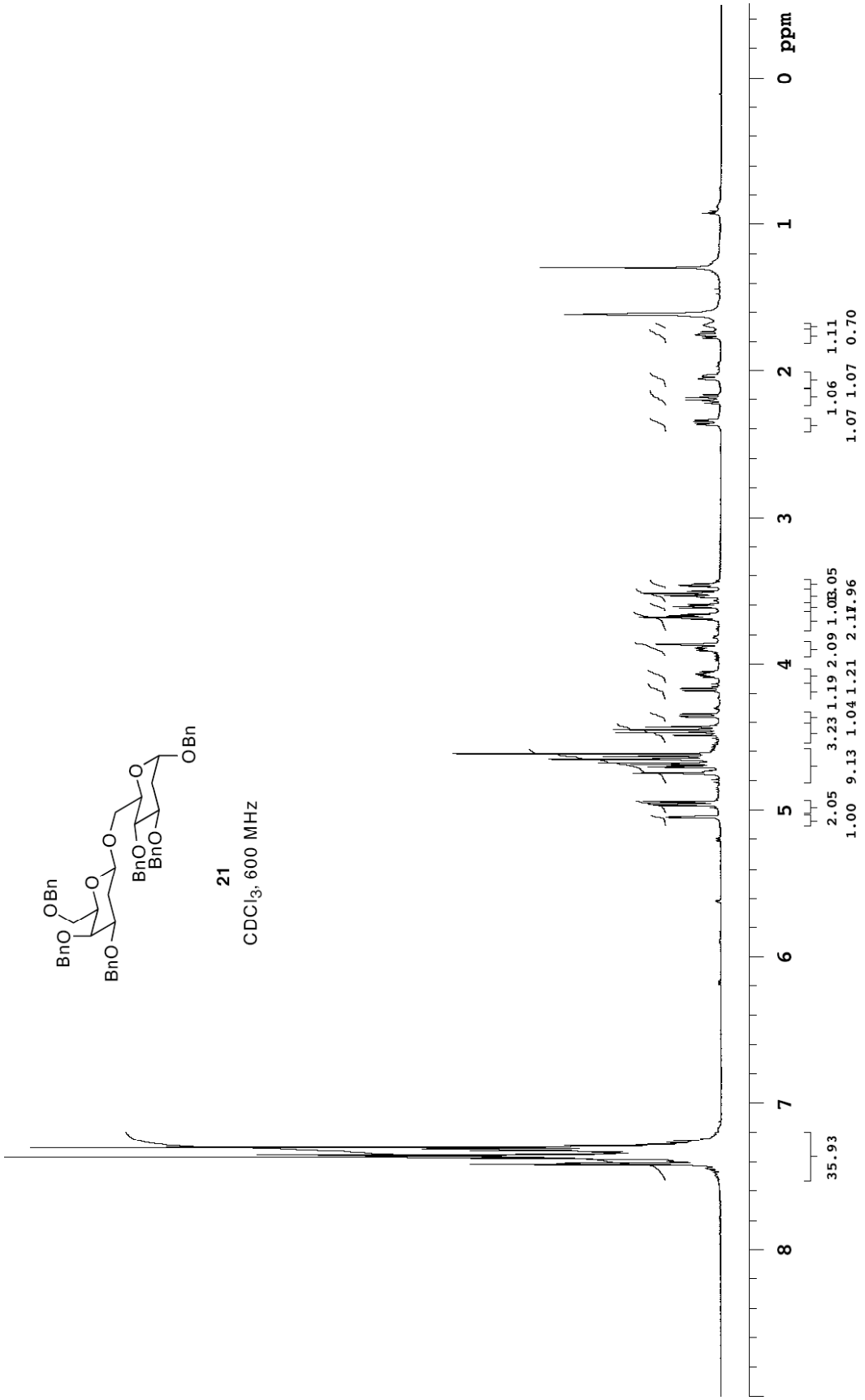

ppm
20
40
60
80
100
120
140
160
180
200
NO2
NO2
O
H
OBn
BnO
BnO
O
17
CDCl3, 100 MHz

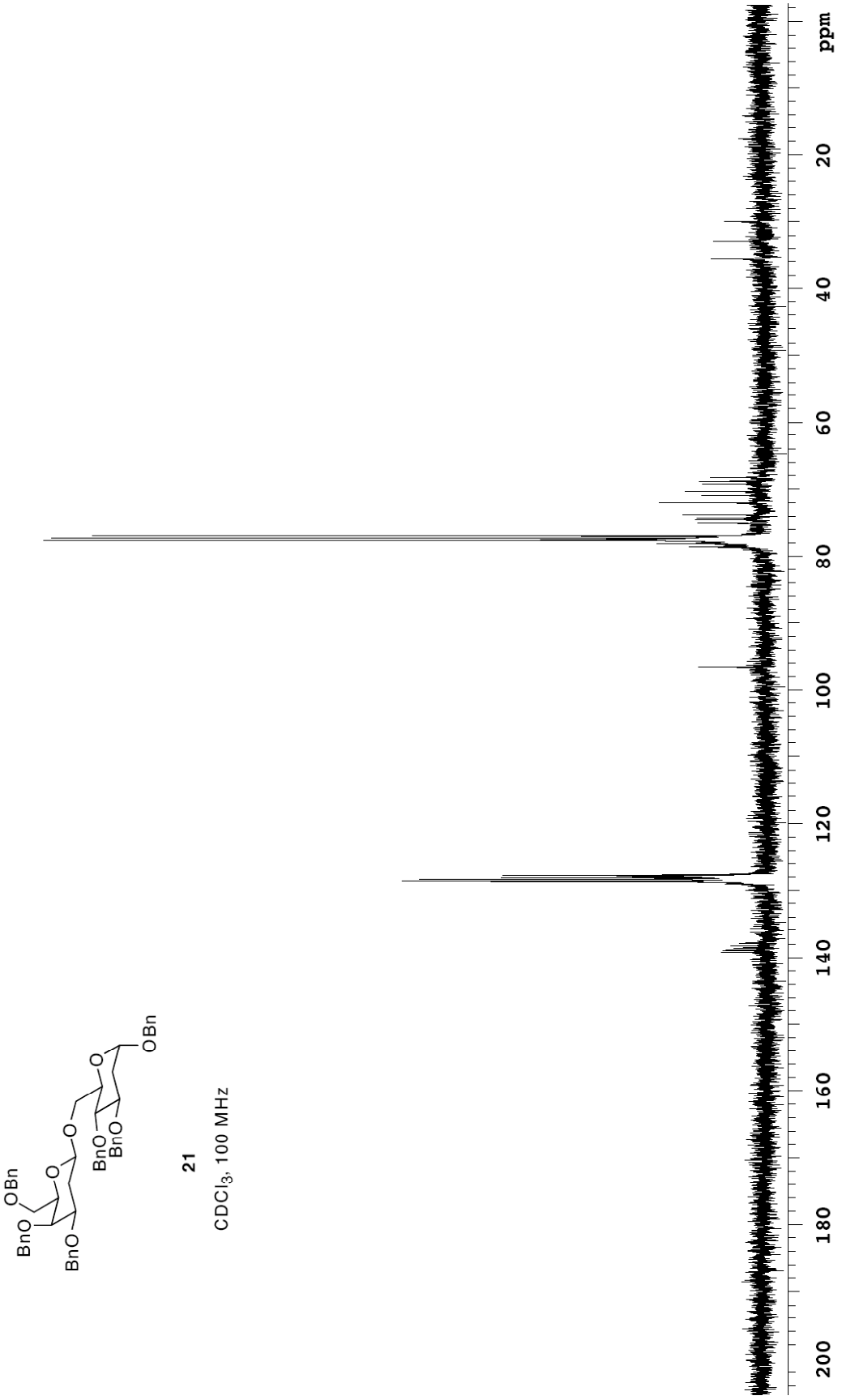

OBn
BnO
BnO
BnO
BnO
O
O
O
O
19
$CDCl_3$, 600 MHz
ppm
0
1
2
3
4
5
6
7
8
22.83
0.91
0.92
2.82
1.00
7.63
0.92
1.06
1.81
1.04
4.66
0.94
1.00
0.93
1.00
2.62
1.00
0.90

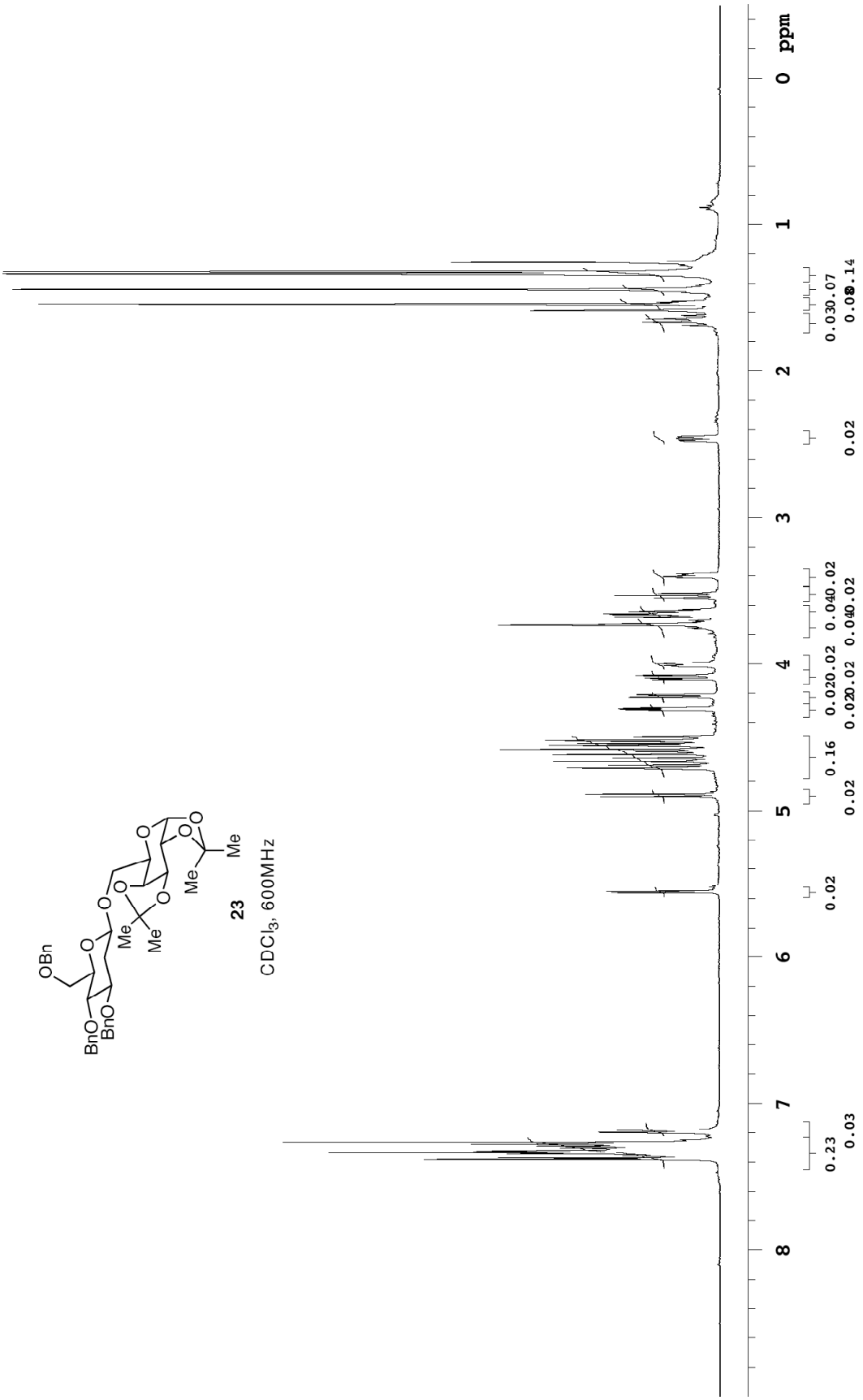

OBn
BnO
BnO
BnO
BnO
O
O
O
O
O
19
$CDCl_3$, 100 MHz
ppm
20
40
60
80
100
120
140
160
180
200

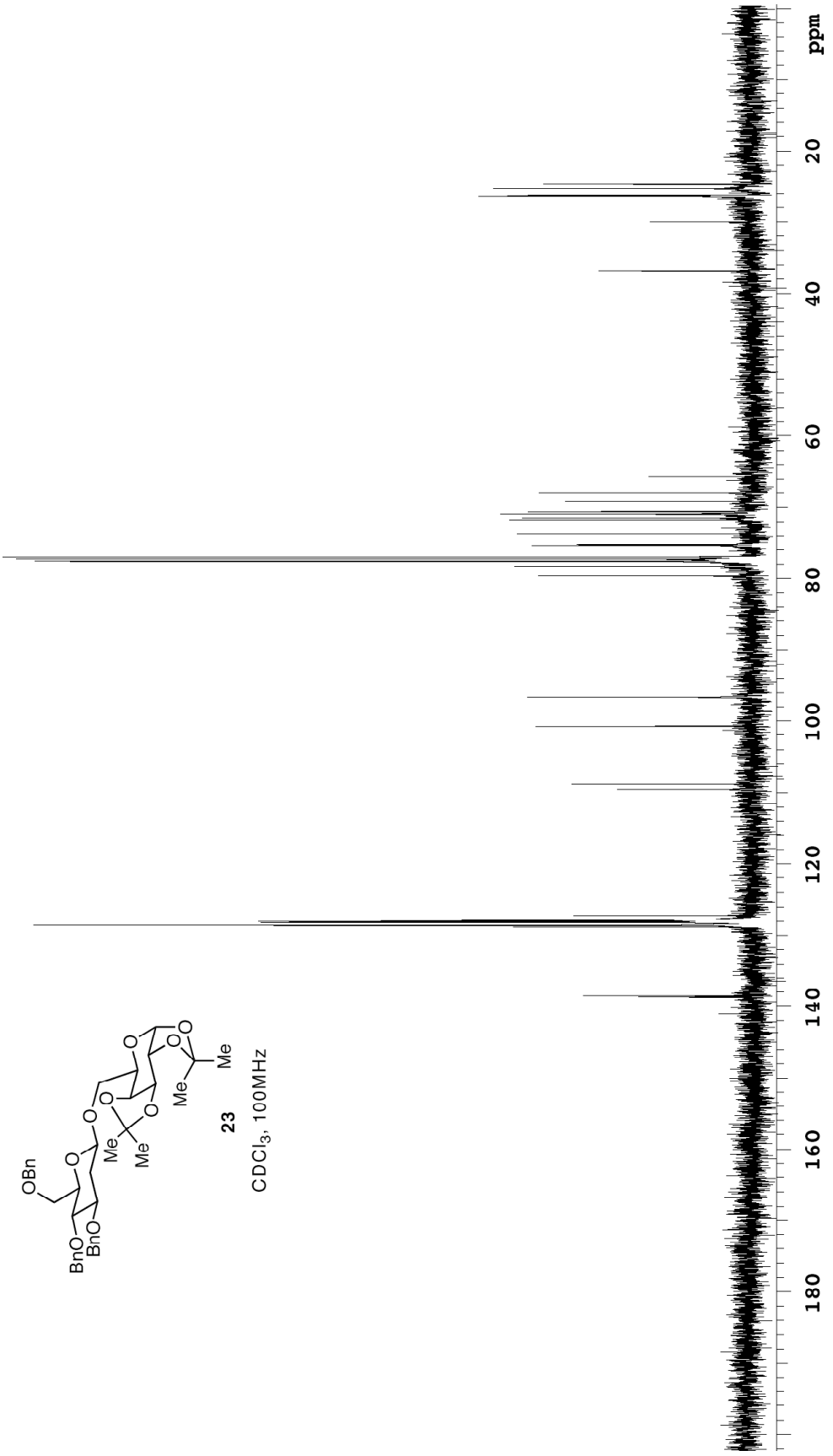

20
$CDCl_3$, 600 MHz
ppm
0
1
2
3
4
5
6
7
8
1.00
1.16
1.13
20.66
1.25
1.28
3.91
2.68
1.27
1.70
3.78
1.46
1.25

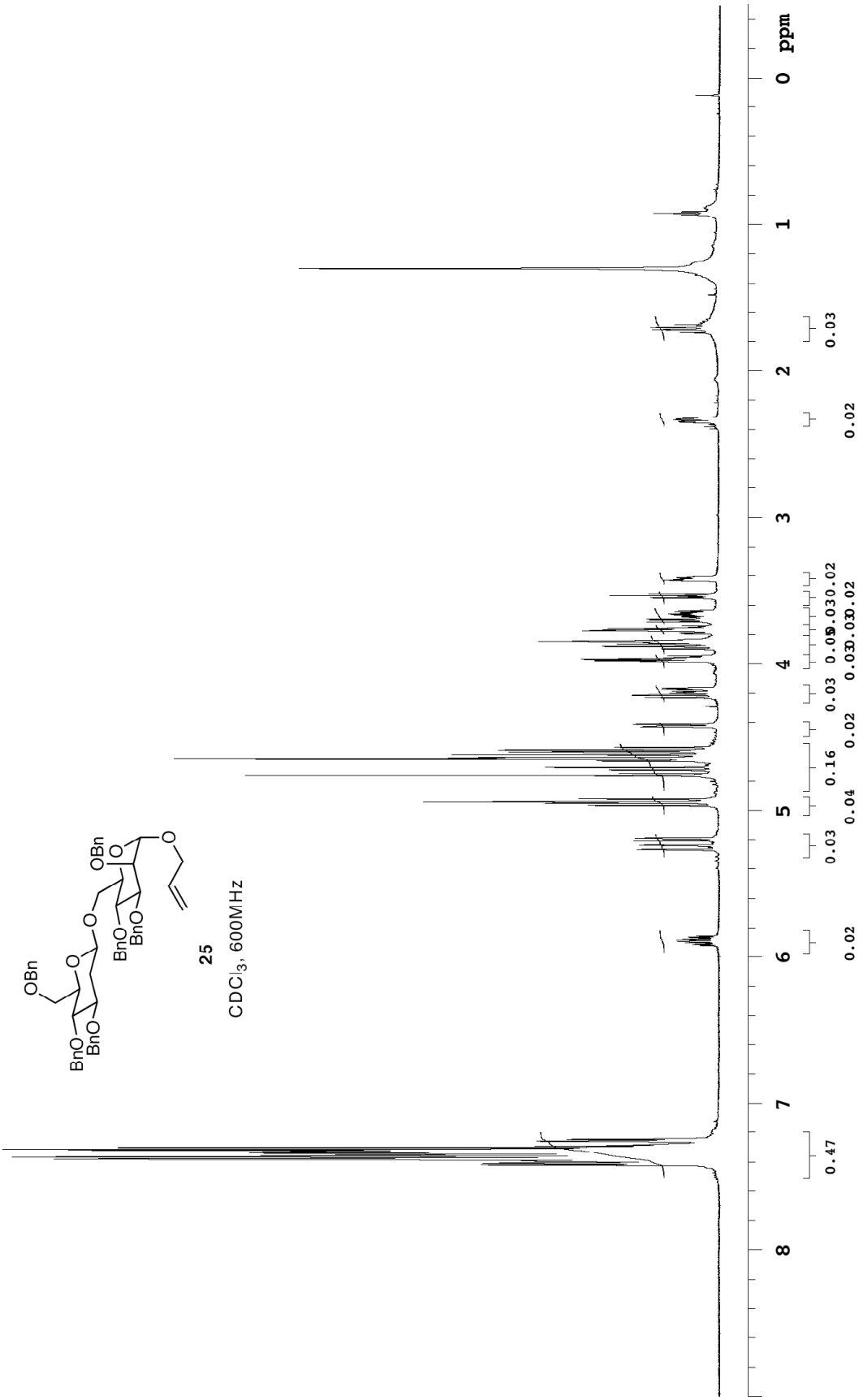

ppm
20
40
60
80
100
120
140
160
180
200
NO2
NO2
O
H
OBn
O
BnO
BnO
20
CDCl3, 100 MHz

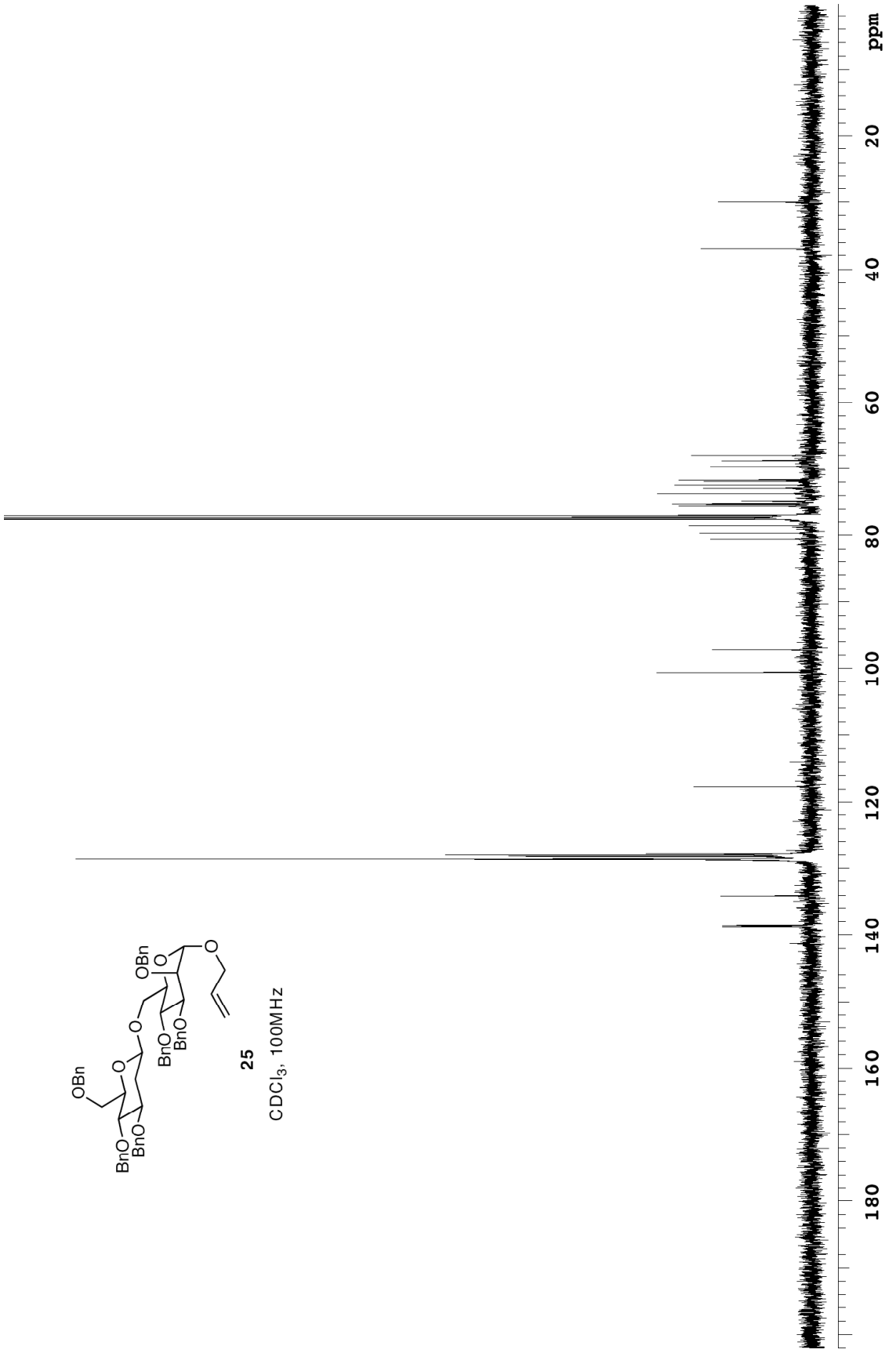

OBn
BnO
O
O
BnO
BnO
O
O
OBn
21
CDCl3, 600 MHz
ppm
0
1
2
3
4
5
6
7
8
35.93
2.05
3.23
1.19
2.09
1.03
3.05
1.00
9.13
1.04
1.21
2.11
7.96
1.06
1.11
1.07
1.07
0.70


ppm
20
40
60
80
100
120
140
160
180
200
OBn
BnO
BnO
O
O
O
BnO
BnO
O
OBn
21
CDCl3, 100 MHz


OBn
BnO
BnO
Me
Me
Me
Me
23
$CDCl_3$, 600MHz
ppm
0
1
2
3
4
5
6
7
8
0.23
0.03
0.02
0.16
0.02
0.02
0.02
0.02
0.04
0.02
0.04
0.02
0.02
0.03
0.07
0.08
0.14


ppm
20
40
60
80
100
120
140
160
180
OBn
BnO
BnO
Me
Me
Me
Me
Me
23
$CDCl_3$, 100MHz


25
$CDCl_3$, 600MHz
ppm


ppm
20
40
60
80
100
120
140
160
180
OBn
O
BnO
BnO
O
O
OBn
O
BnO
BnO
O
25
$CDCl_3$, 100MHz