Electronic Supplementary information

C-H Functionalization of Tertiary Amines by Cross Dehydrogenative Coupling Reactions: Solvent-Free Synthesis of α-Amino Nitriles and β-Nitro Amines under Aerobic Condition

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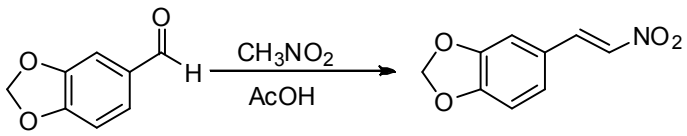
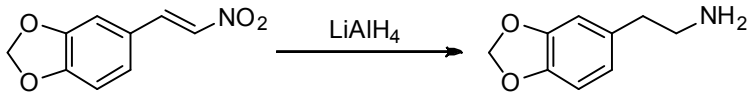
Contents

Typical experimental procedure for the Preparation of Nitroolefin



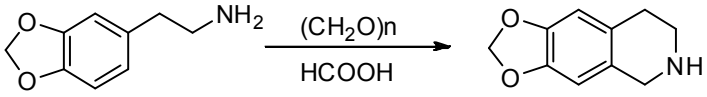
Heliotropin (5 g, 33.3 mmol) and ammonium acetate (2.56 g, 33.3 mmol) were taken into the RB flask. Nitromethane (8.9 mL, 166.5 mmol) and glacial acetic (10 mL) acid were added at room temperature. The reaction mixture was refluxed for 1.5h, and then reaction mixture was cooled in an ice bath, filtered through sintered crucible and washed successively with water, hexane and 1% ethanol in hexane. The crude mixture was concentrated under vacuo.

Typical experimental procedure for the reduction of nitroolefin



The crude nitroolefin (2 g, 10.3 mmol) in dry THF (10 mL) was added drop wise to a stirred solution of $LiAlH_4$ (0.98 g, 25.9 mmol) in THF (20 mL). The reaction mixture was refluxed for 4h and then cooled in ice bath, quenched with saturated solution of Na_2SO_4 until effervescence ceases completely. Then filtered through sintered crucible and washed successively with ethyl acetate and concentrated under vacuo.

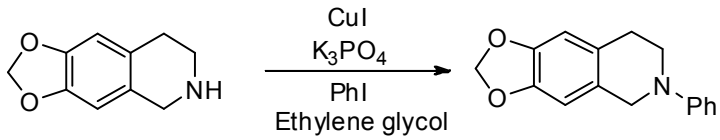
Typical experimental procedure for the preparation of [1, 3]dioxolo[7, 8-g]- 1, 2, 3, 4-tetrahydroisoquinoline



The amine (1.35 g, 8.18 mmol) obtained in previous step was added to formic acid (3.5 mL) at 0 ^oC and stirred for 10 min at same temperature until complete dissolution of amine. Then paraformaldehyde (0.25 g, 8.18 mmol) was added and stirred at 50 ^oC for 24h, added saturated

NaOH solution and extracted with DCM. The combined organic layer was dried over Na_2SO_4 and concentrated under reduced pressure. Then purified by column chromatography on silica gel using MeOH/ $CHCl_3$.

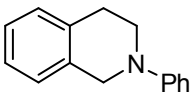
Typical experimental procedure for the preparation of *N*-phenyl Tetrahydroisoquinoline.



Copper (I) iodide (0.21g, 1.13 mmol) and potassium phosphate (4.8 g, 22.6 mmol) were taken into the RB flask filled with nitrogen. 2-Propanol (10 mL), ethylene glycol (1.24 mL, 22.6 mmol), 1,2,3,4-tetrahydro-isoquinoline (2 g, 11.3 mmol) and iodobenzene (1.26 mL, 11.3 mmol) were added successively at room temperature. The reaction mixture was heated at 90 °C for 24 h and then allowed to cool to room temperature. The solvent was removed under vacuo, added water (20 mL) and extracted with dichloromethane (3x 30 mL). The organic layer was dried over sodium sulfate. The solvent was concentrated under reduced pressure and purified by column chromatography on silica gel (hexane/ethyl acetate=95:5), to give the desired product **4a** with 30% isolated yields.

Characterization data for *N*-Aryl Tetrahydroisoquinoline

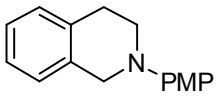
1, 2, 3, 4-Tetrahydro-2-phenylisoquinoline (1a)[1]



1a

Pale yellow solid; Yield - 60%; ***mp***: 44 - 46 °C (lit.[1] 45 °C); R_f (20% EtOAc/Hexane) 0.7; Prepared as shown in general experimental procedure. **IR** (KBr, cm^{-1}): 2824, 1599, 1505, 1388, 1238, 1156, 1034, 934, 873, 749; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.27 (2H, t, J = 7.9Hz), 7.15 (4H, d, J = 3.8Hz), 6.97 (2H, d, J = 8.1Hz), 6.81 (1H, t, J = 7.2Hz), 4.39 (2H, s), 3.54 (2H, t, J = 5.8Hz), 2.96 (2H, t, J = 5.7Hz); **^{13}C NMR** (100MHz, $CDCl_3$): 150.5, 134.8, 134.4, 129.1, 128.4, 126.4, 126.2, 125.9, 118.6, 115.0, 50.6, 46.4, 29.0; **HRESI-MS** *(m/z)*: Calculated for $C_{15}H_{15}N$ (M + H): 210.1283, found (M + H): 210.1286.

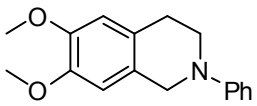
1, 2, 3, 4-Tetrahydro-2- (4-methoxyphenyl)isoquinoline (1b)[1]



1b

Pale yellow solid; Yield - 50%; ***mp***: 93 - 95 °C (lit.[1] 95 °C); R_f (20% EtOAc/Hexane) 0.7; Prepared as shown in general experimental procedure. **IR** (KBr, cm^{-1}): 3456, 1584, 1510, 1459, 1384, 1273, 1242, 1151, 1036, 823, 755; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.11 – 7.18 (4H, m), 6.98 (2H, d, *J* = 8.8Hz), 6.86 (2H, d, *J* = 8.8Hz), 4.29 (2H, s), 3.77 (3H, s), 3.43 (2H, t, *J* = 5.8Hz), 2.98 (2H, t, *J* = 5.7Hz); **^{13}C NMR** (100MHz, $CDCl_3$): 153.4, 145.2, 134.5, 134.4, 128.6, 126.4, 126.2, 125.8, 118.0, 114.5, 55.5, 52.6, 48.4, 29.0; **HRESI-MS** *(m/z)*: Calculated for $C_{16}H_{17}NO$ (M + H): 240.1388, found (M + H): 240.1387.

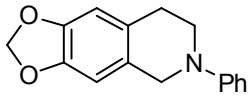
6, 7-dimethoxy-2-phenyl-1, 2, 3, 4-tetrahydroisoquinoline (1c)[2]



1c

Pale yellow solid; Yield - 30%; ***mp***: 91- 93°C; R_f (20% EtOAc/Hexane) 0.7; Prepared as shown in general experimental procedure. **IR** (KBr, cm^{-1}): 3446, 1601, 1519, 1466, 1384, 1271, 1238, 1116, 1025, 861, 761; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.28 (2H, t, *J* = 7.8Hz), 6.98 (2H, d, *J* = 8.2Hz), 6.82 (1H, t, *J* = 7.2Hz), 6.64 (2H, d, *J* = 4.2Hz), 4.33(2H, s), 3.87 (3H, s), 3.86 (3H,s), 3.54 (2H, t, *J* = 5.8Hz), 2.89 (2H, t, *J* = 5.7Hz); **^{13}C NMR** (100MHz, $CDCl_3$): 150.5, 147.5, 147.4, 129.1, 126.6, 126.1, 118.7, 115.3, 111.2, 109.3, 55.94, 55.90, 50.4, 46.7, 28.5; **HRESI-MS** *(m/z)*: Calculated for $C_{17}H_{19}NO_2$ (M + Na): 292.1313, found (M + Na): 292.1314.

[1,3]dioxolo[7, 8-g]-2-phenyl-1, 2, 3, 4-tetrahydroisoquinoline (1d)



1d

Pale yellow solid; Yield - 30%; ***mp***: 65 - 66 °C R_f (20% EtOAc/Hexane) 0.7; Prepared as shown in general experimental procedure. **IR** (KBr, cm^{-1}): 2807, 1583, 1508, 1460, 1385, 1273, 1241,

1207, 1190, 1036, 823, 755; **^{1}H NMR** (400 MHz, $CDCl_3$): δ 7.27 (2H, t, *J* = 7.8Hz), 6.95 (2H, d, *J* = 8.1Hz), 6.82 (1H, t, *J* = 7.2Hz), 6.61 (2H, s), 5.90 (2H, s), 4.29 (2H, s), 3.51 (2H, t, *J* = 5.8Hz), 2.86 (2H, t, *J* = 5.7Hz); **^{13}C NMR** (100MHz, $CDCl_3$): 150.3, 146.1, 145.9, 129.1, 127.8, 127.2, 118.7, 115.2, 108.3, 106.4, 100.6, 50.7, 46.6, 28.9; **HRESI-MS** *(m/z)*: Calculated for $C_{16}H_{15}NO_2$ (M + H): 254.1181, found (M + H): 254.1185.

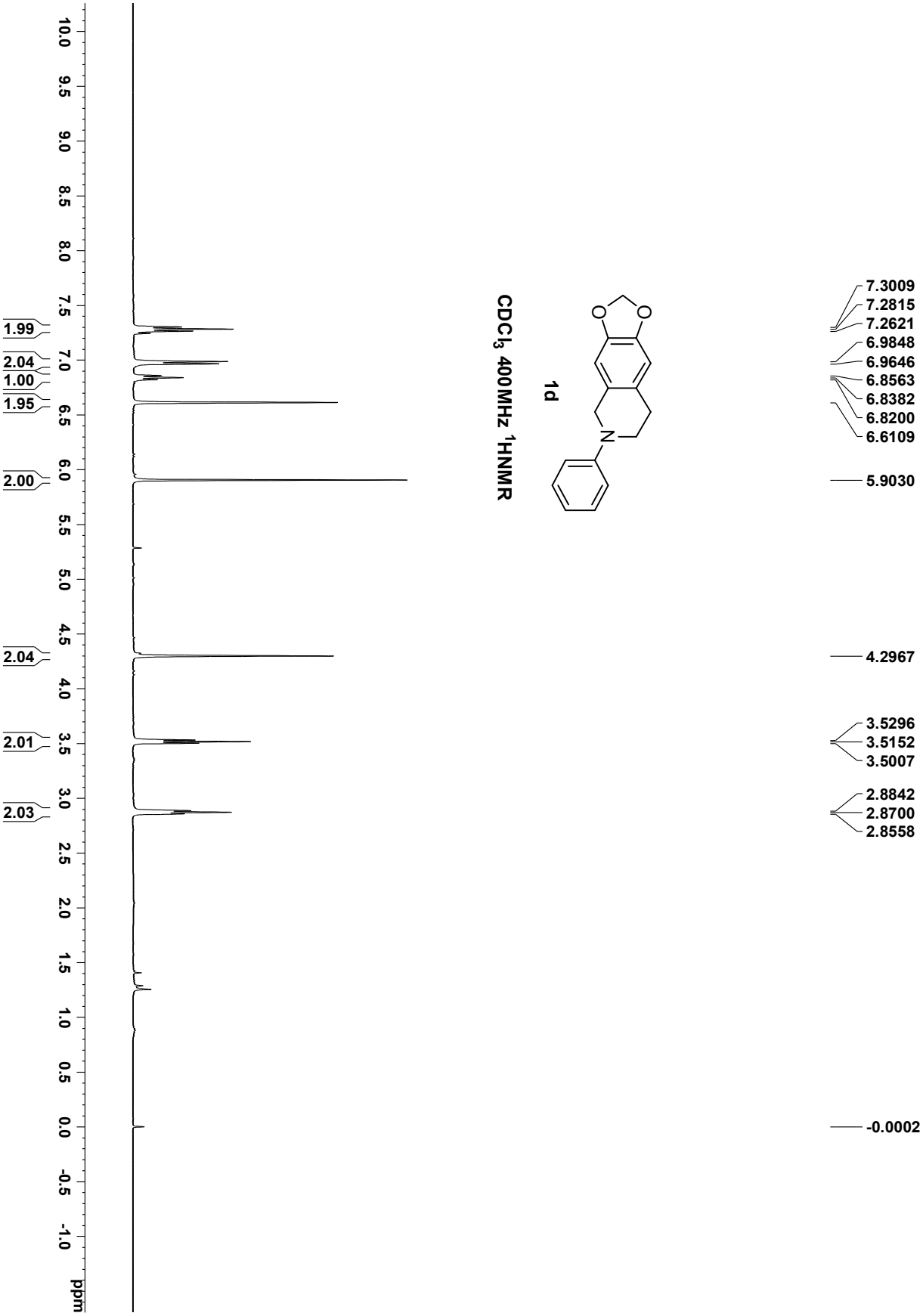
Typical experimental procedure for the synthesis of *α*-Amino nitrile

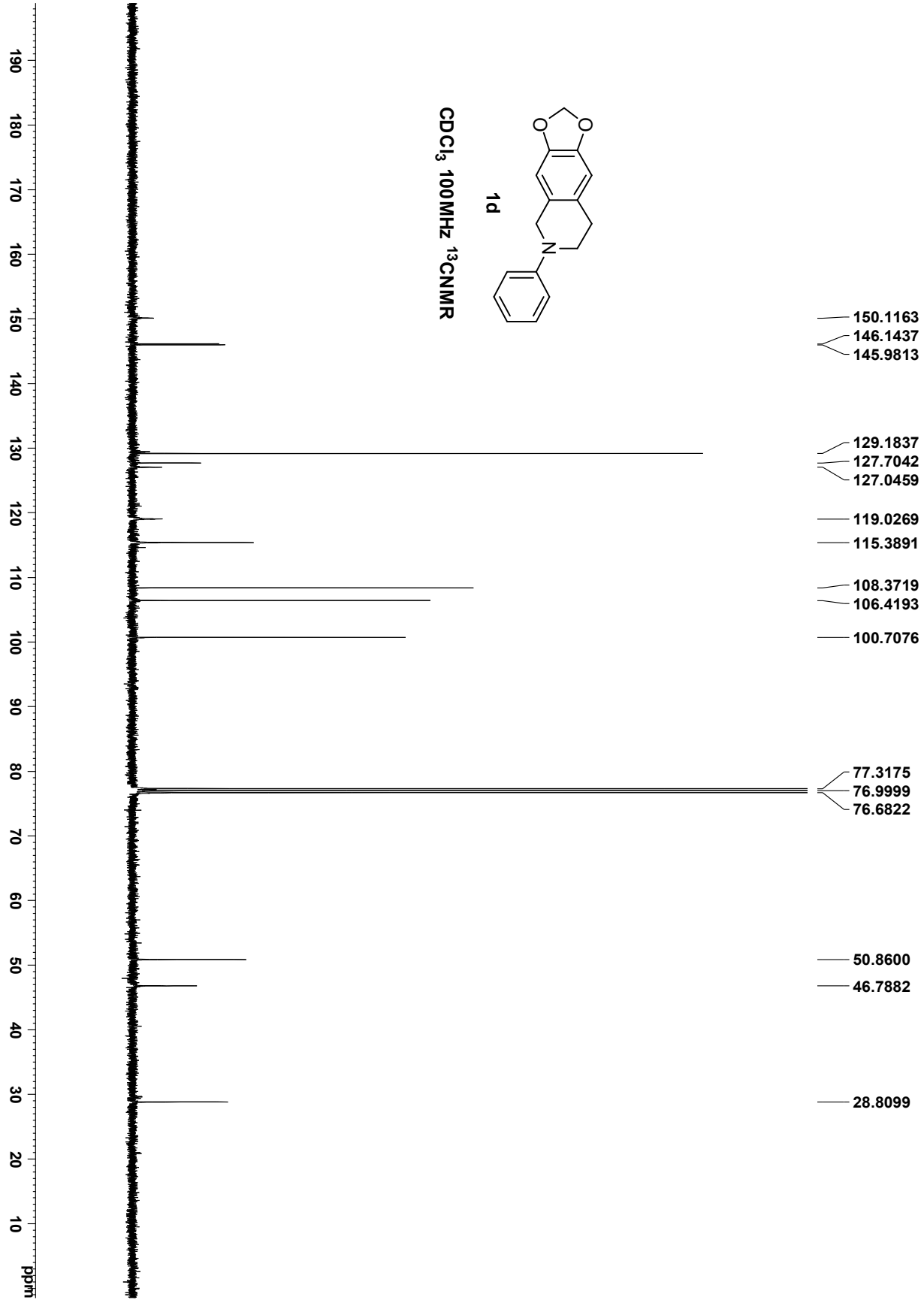
To the 10 mol% of $MoO_2(acac)_2$ (0.05 mmol) and N-phenyltetrahydroisoquinoline (0.5 mmol) was added TMSCN (1.0 mmol). The reaction mixture was stirred at 80 ^{o} C under oxygen atmosphere (oxygen balloon) for 17 h. The reaction mixture was cooled to room temperature, added saturated $NaHCO_3$ solution and extracted with DCM (3 X 10 mL). The combined organic layer was dried over Na_2SO_4 and concentrated under reduced pressure. The crude product was purified by column chromatography on silica gel using Hexane / Ethyl acetate (95 : 5) and furnished pale yellow solid (78%, NMR conversion = 96%).

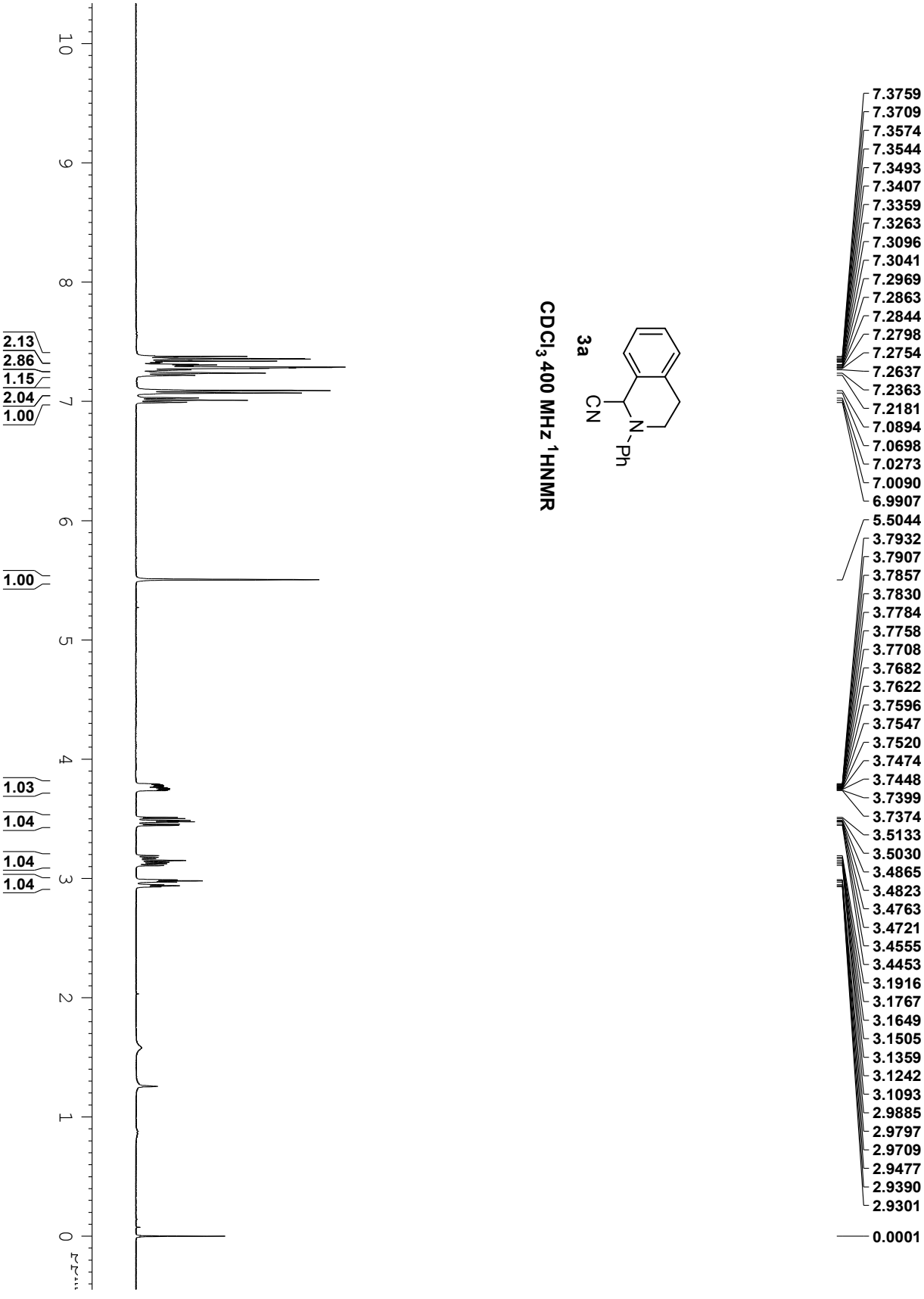
References

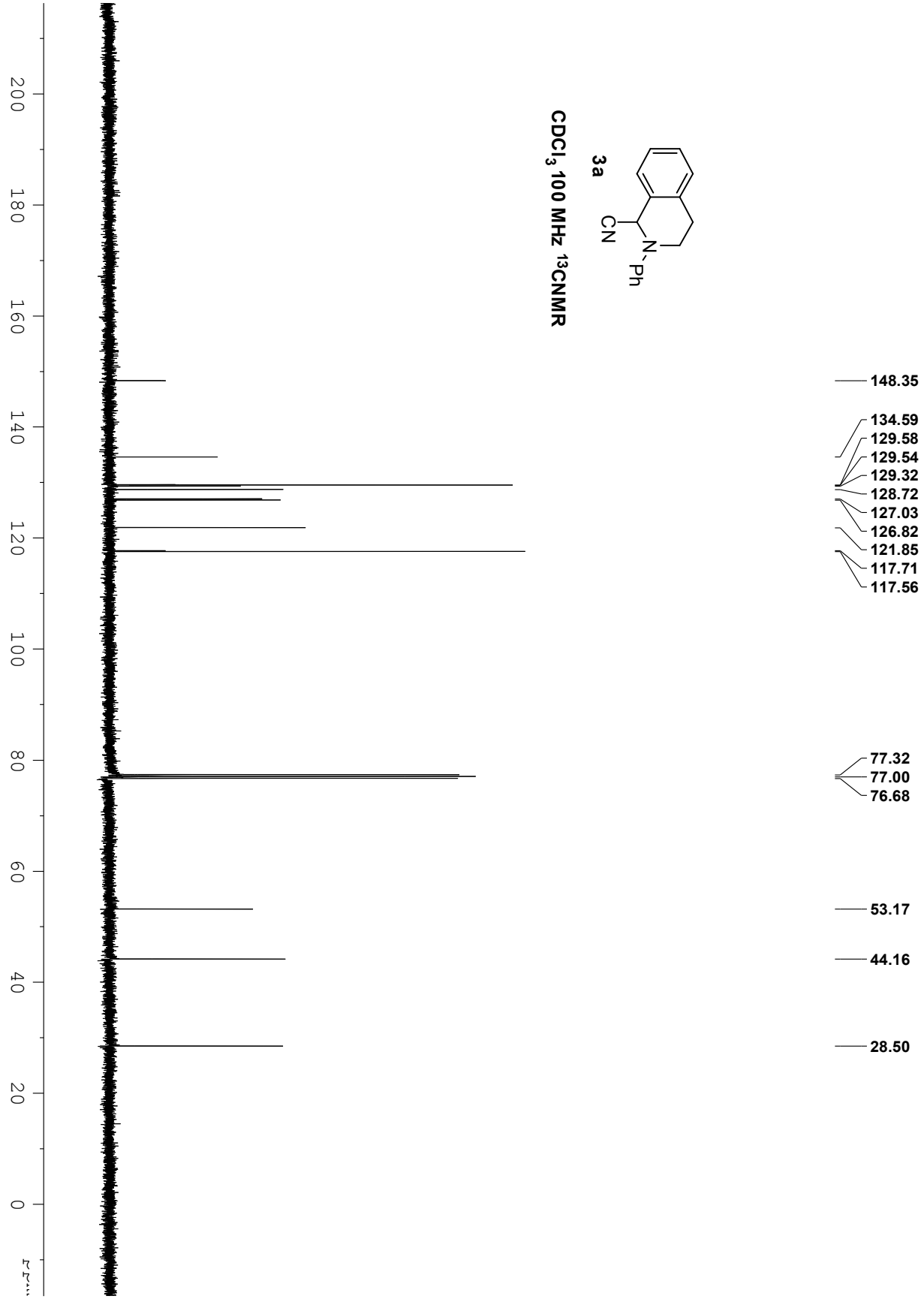
1) M. Jerome, H. Philippe, T. Christophe,G. –R. Sylviane, -P. H. Henri, *Synth. Commun.,* **2001**, *31*, 987–992.

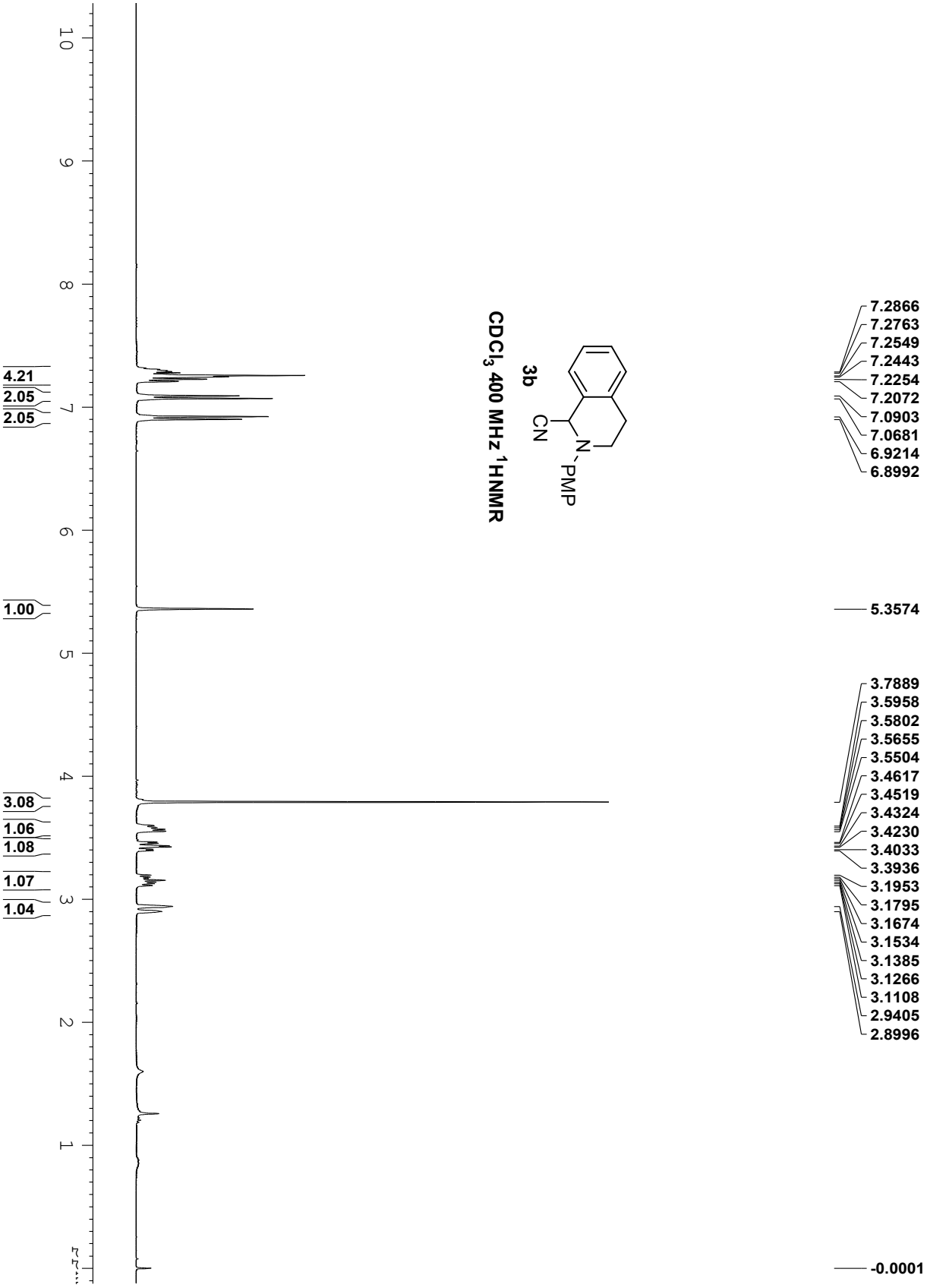
2) A. Sud, D. Sureshkumar, M. Klussmann, *Chem. Commun.* **2009**, 3169

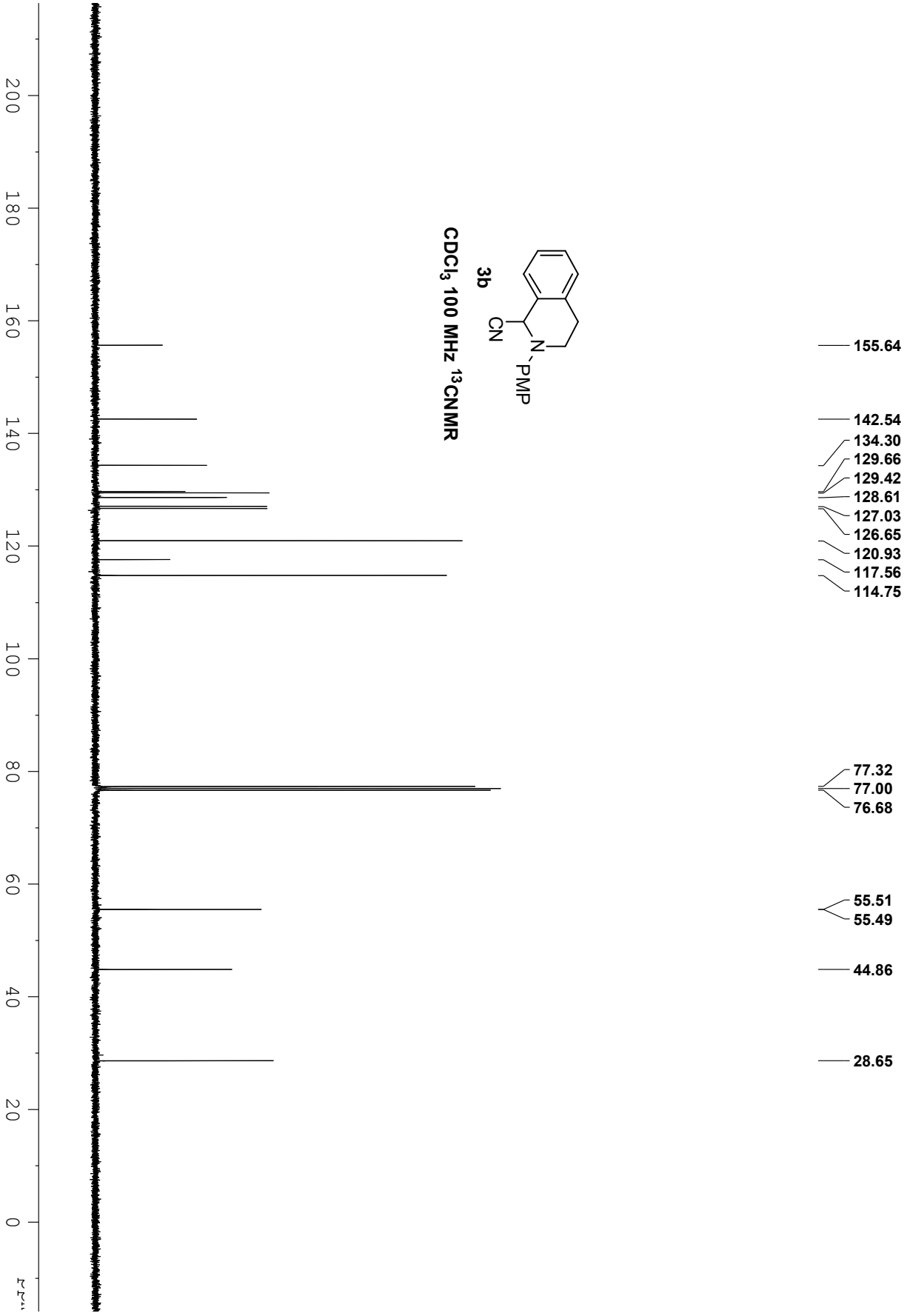


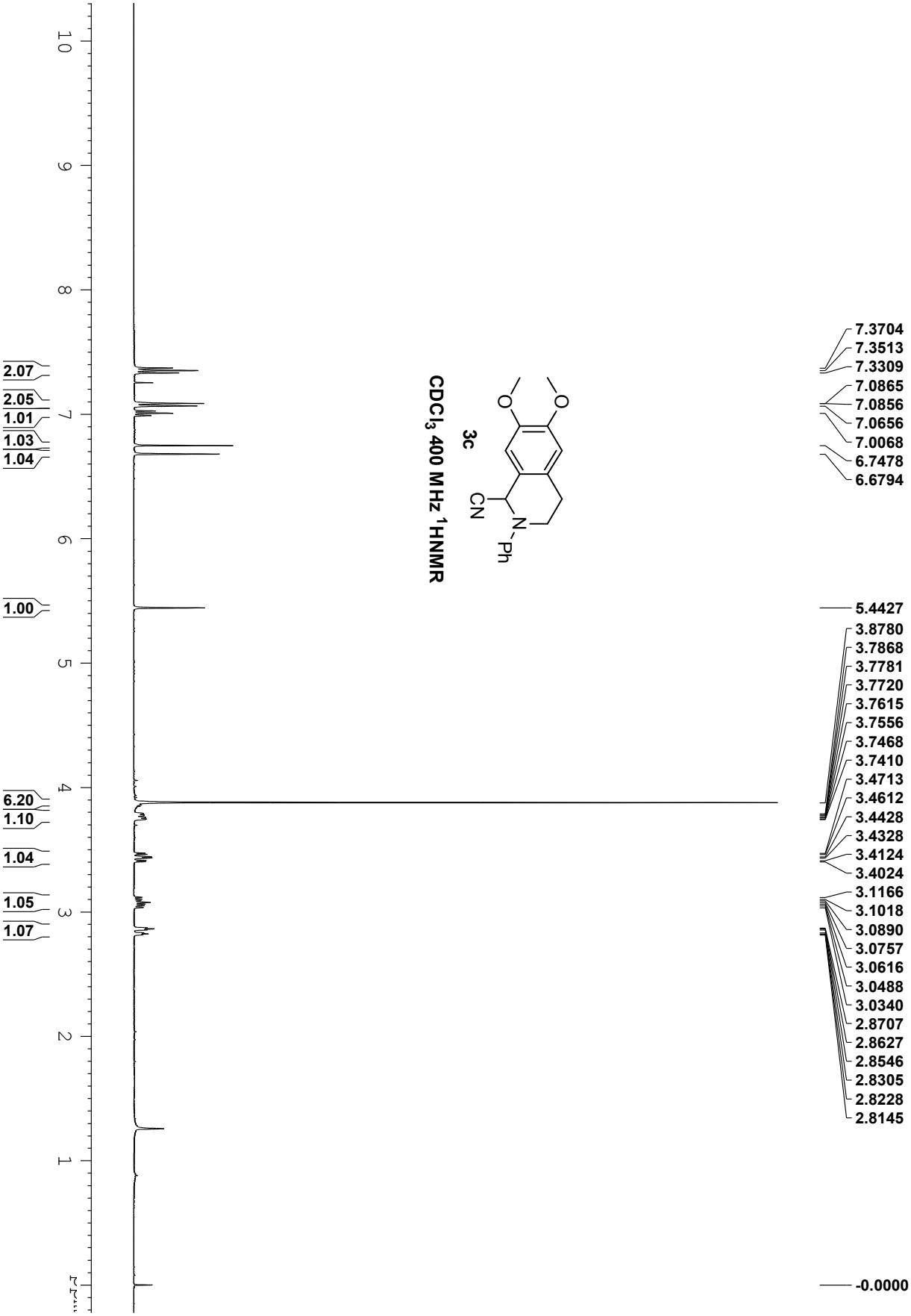


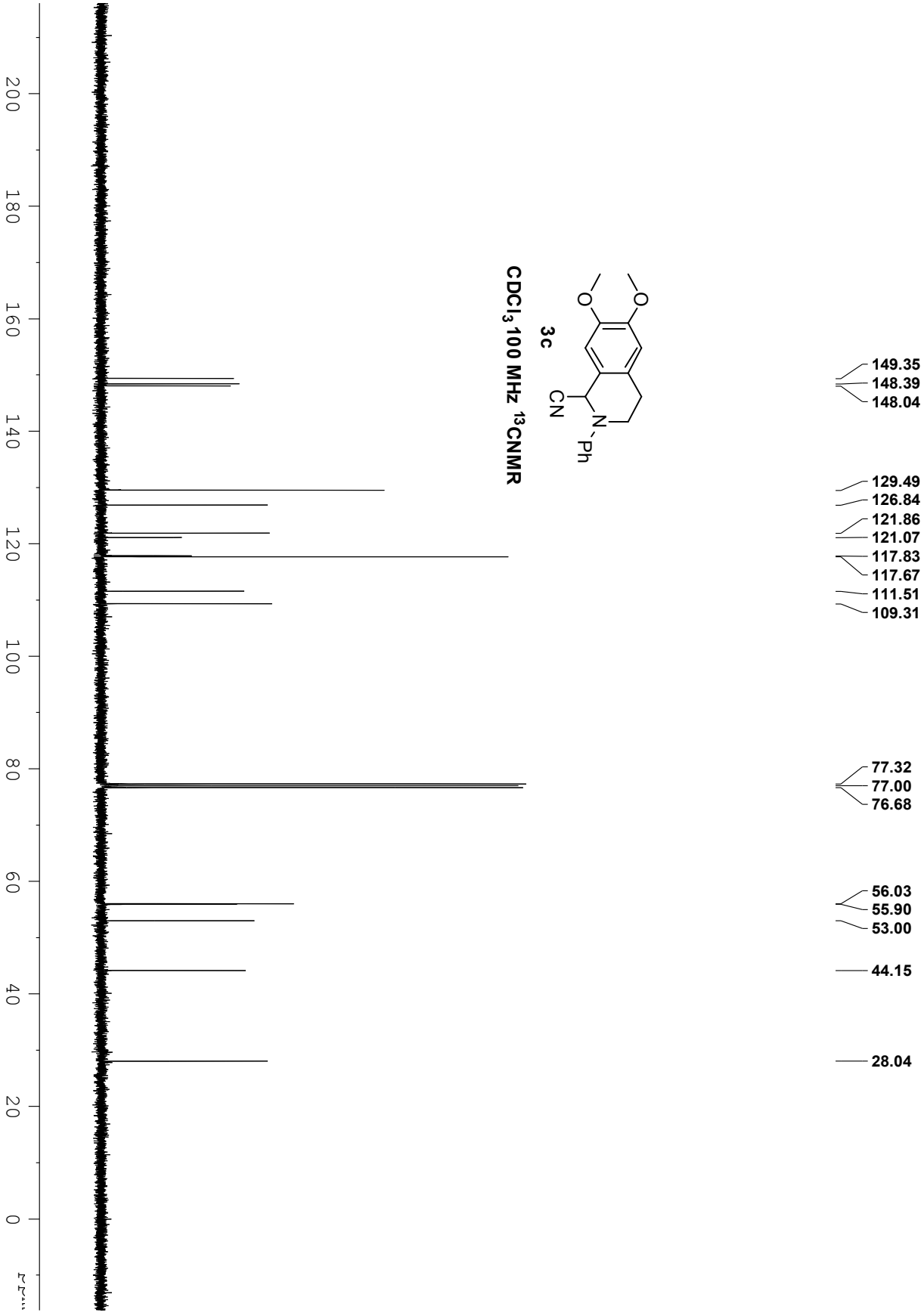


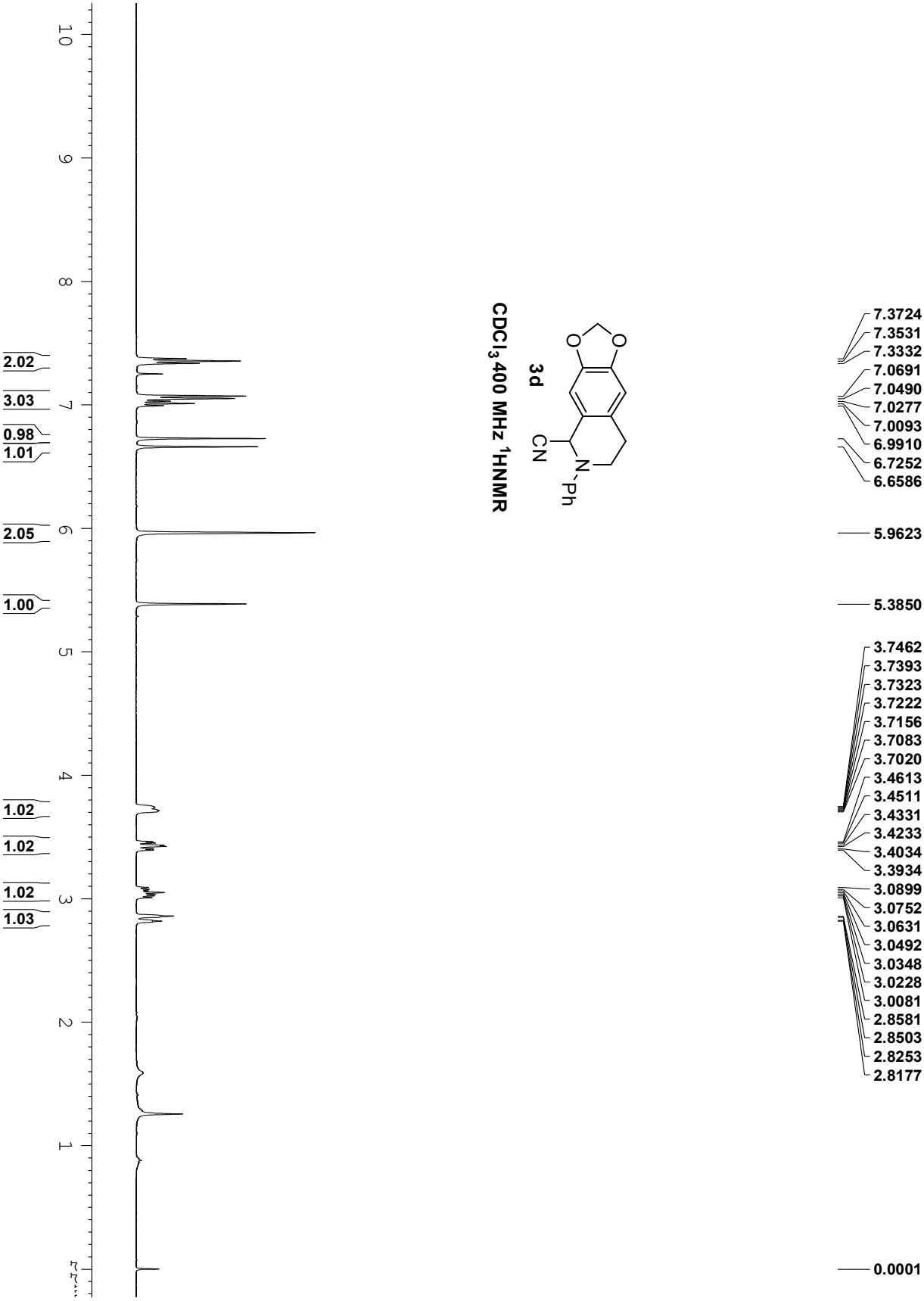


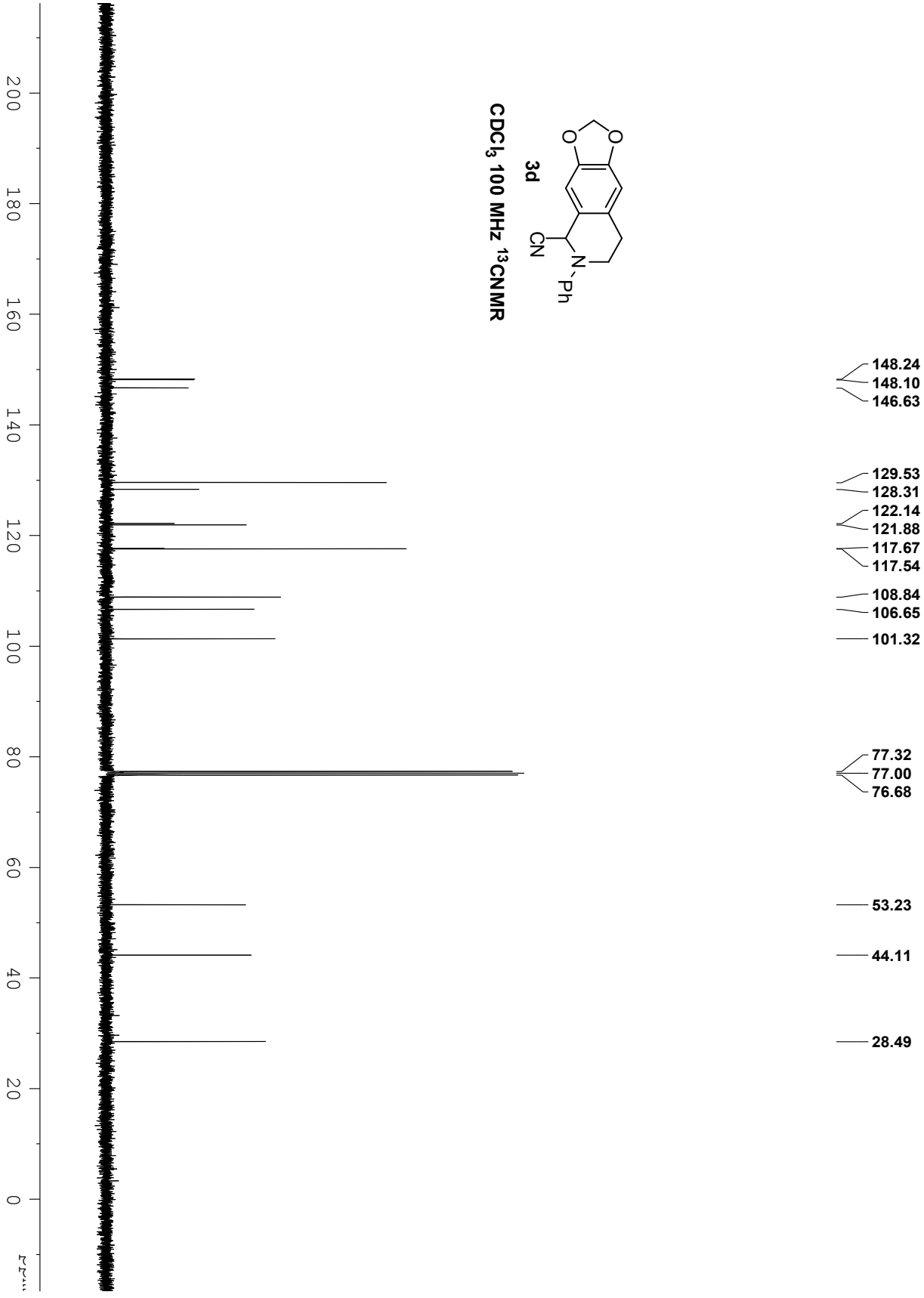


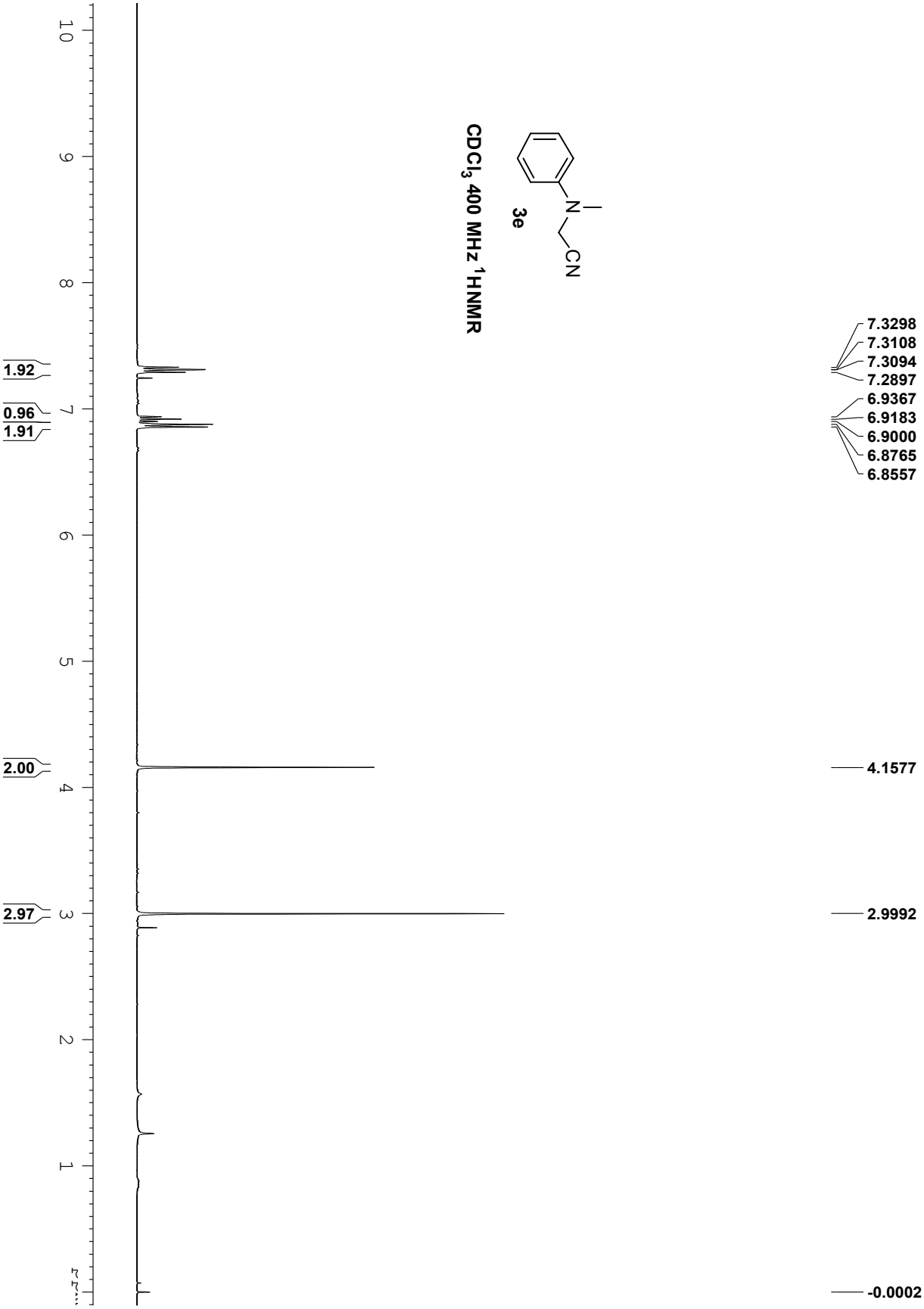


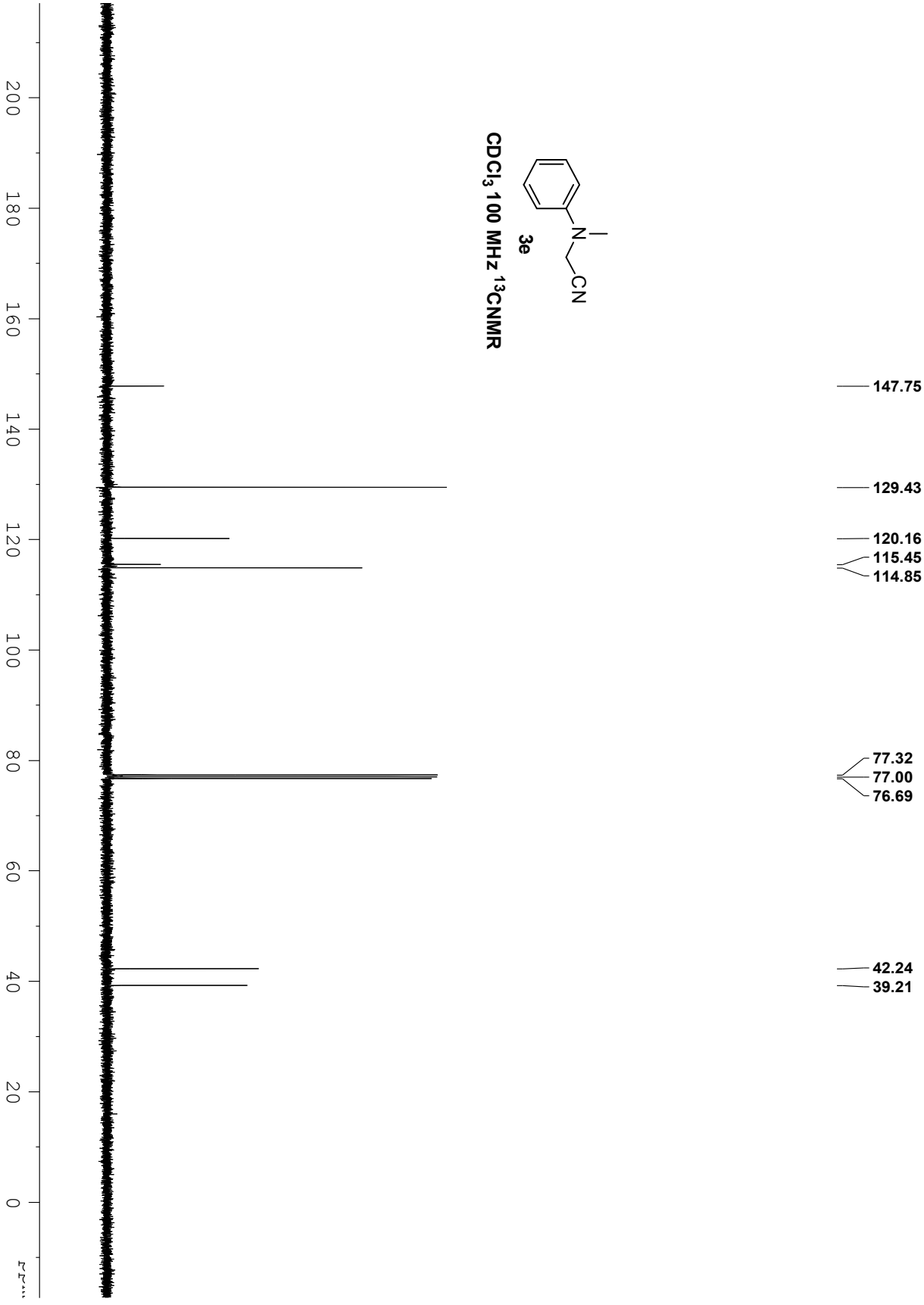


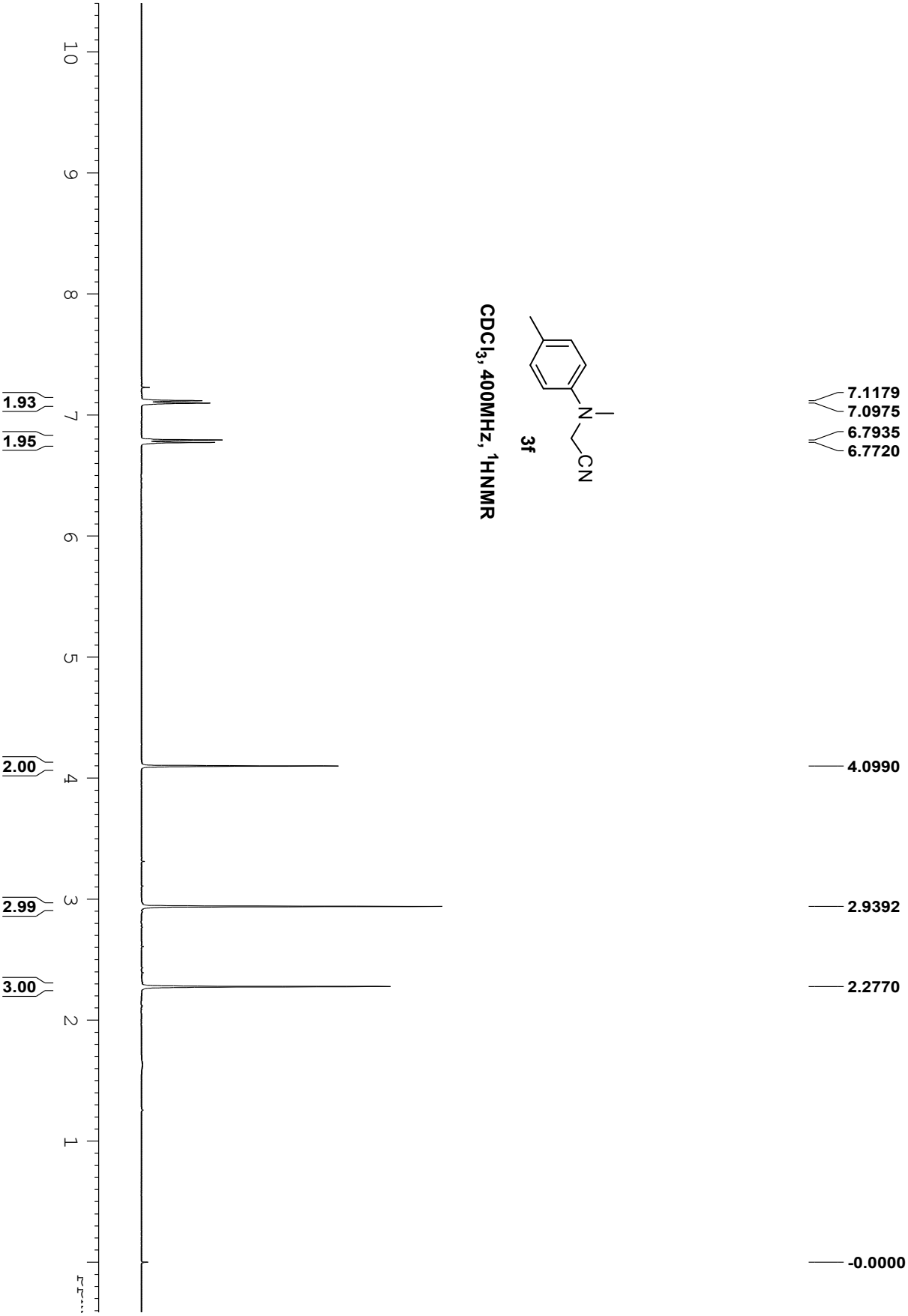


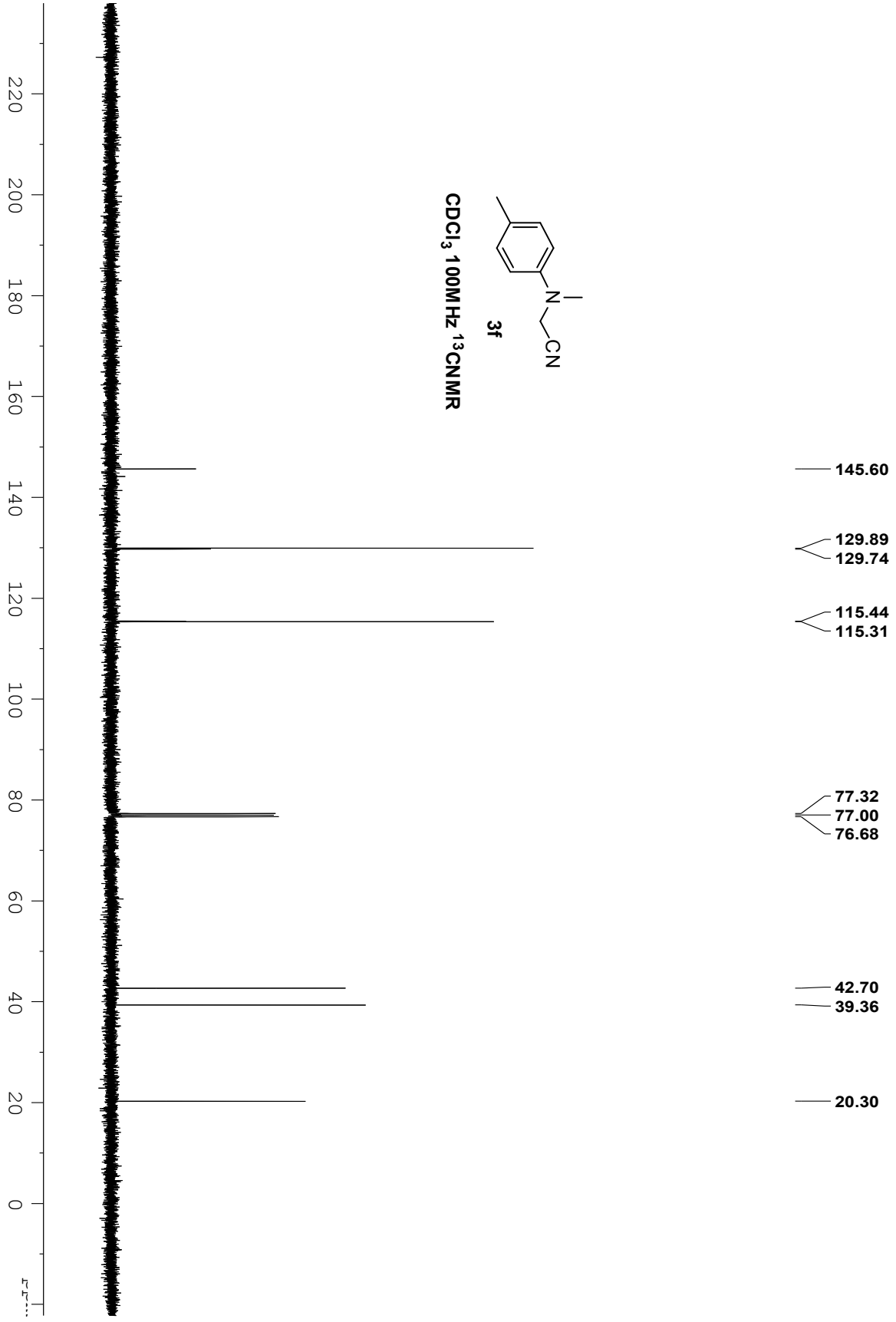


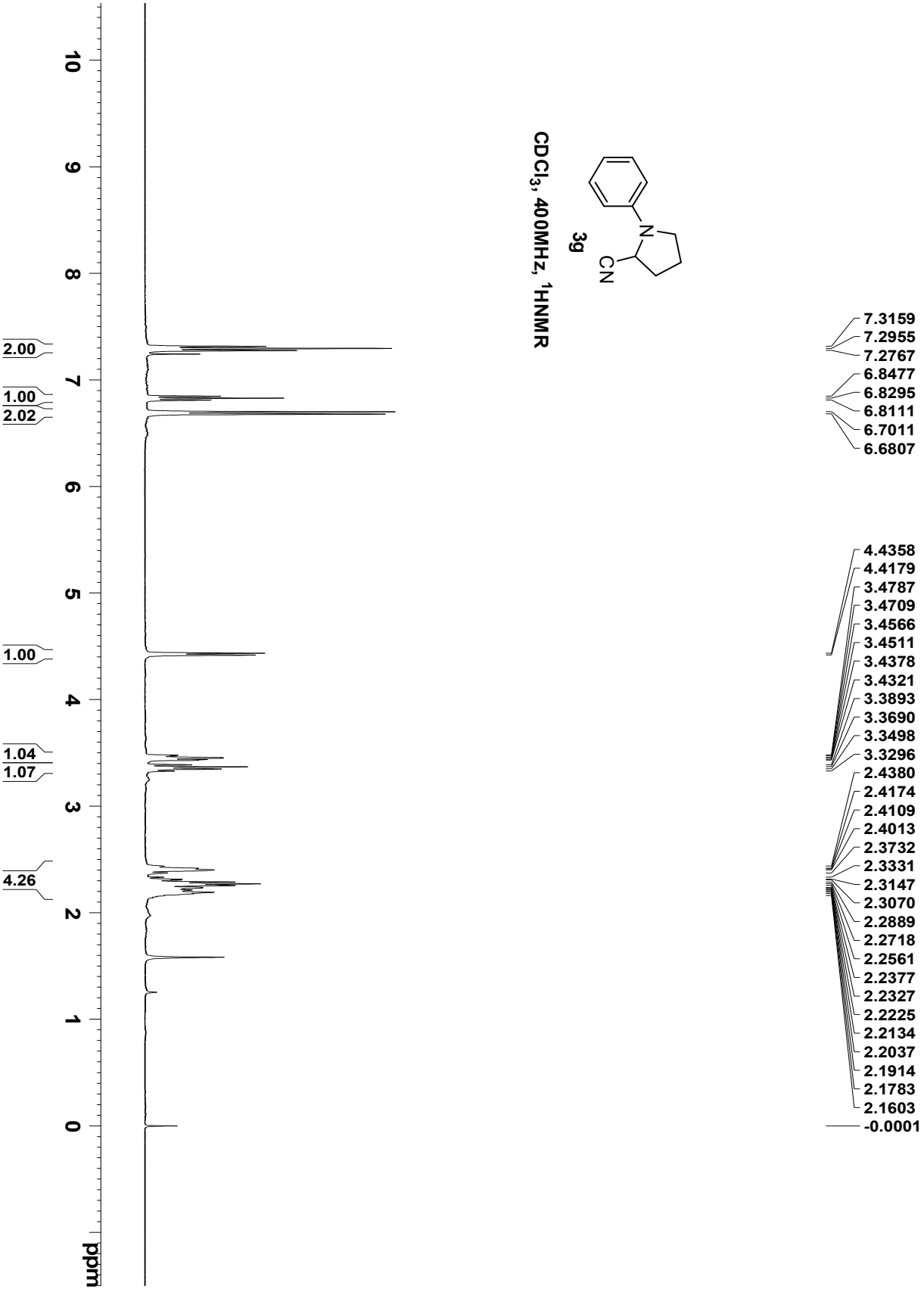








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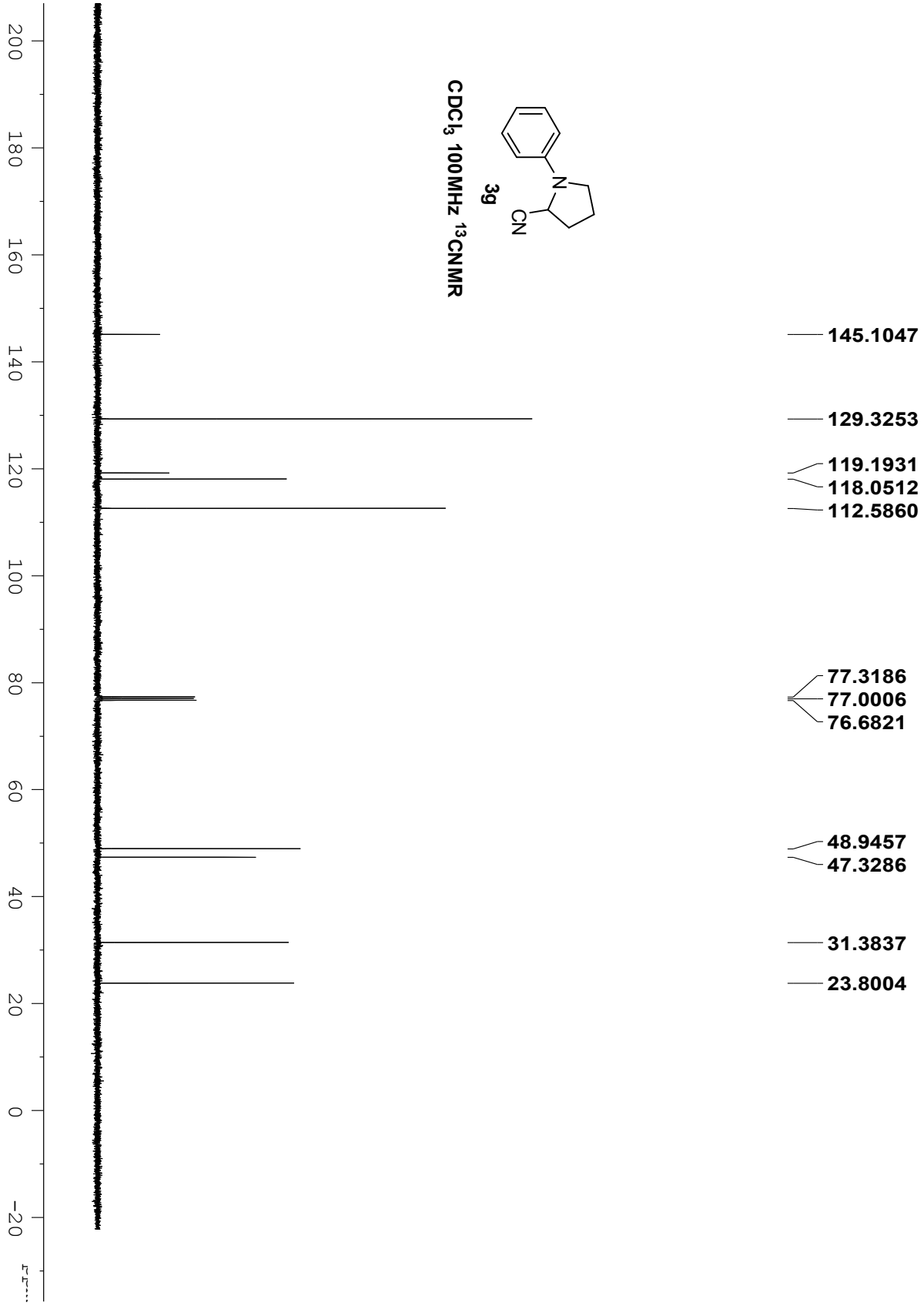

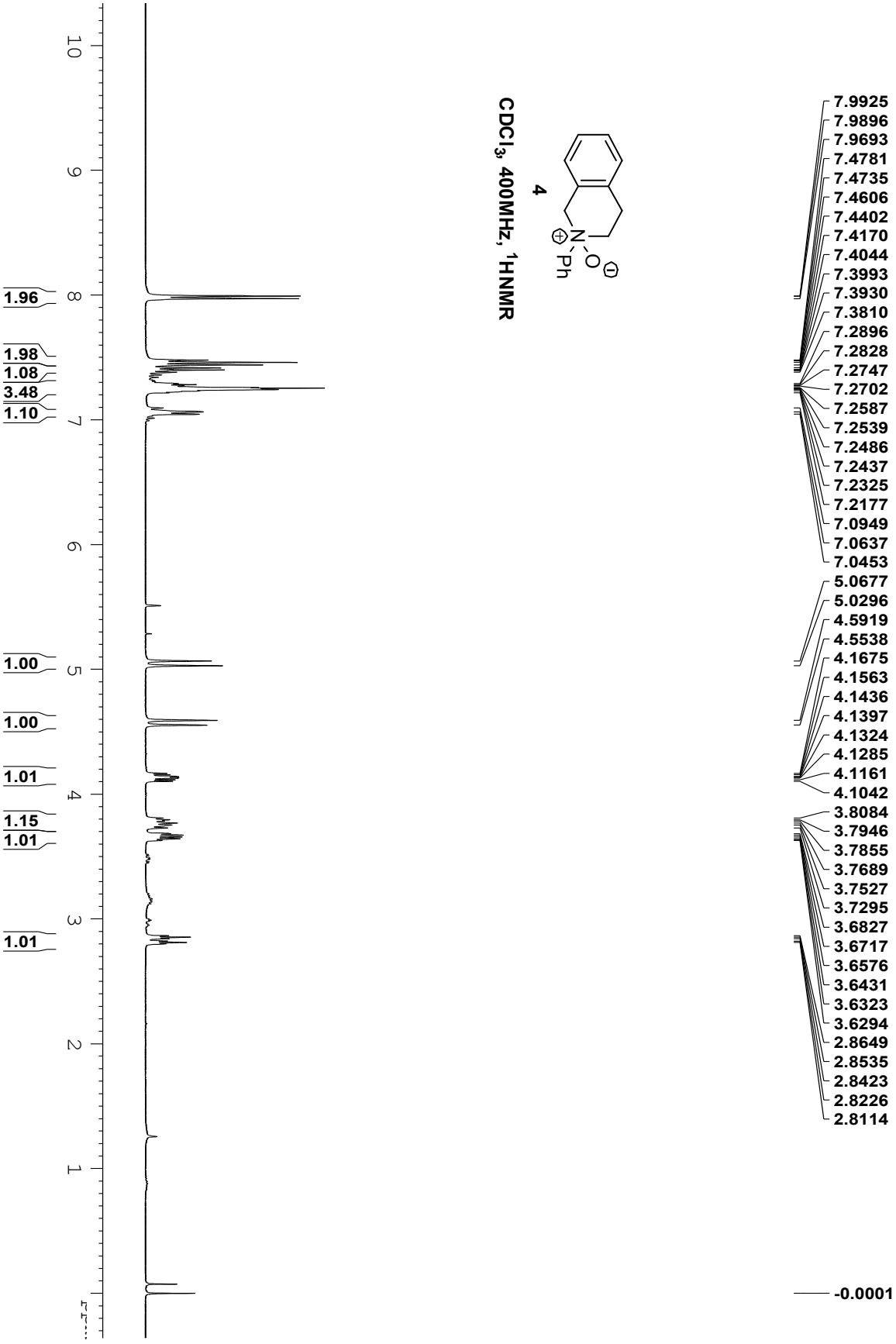

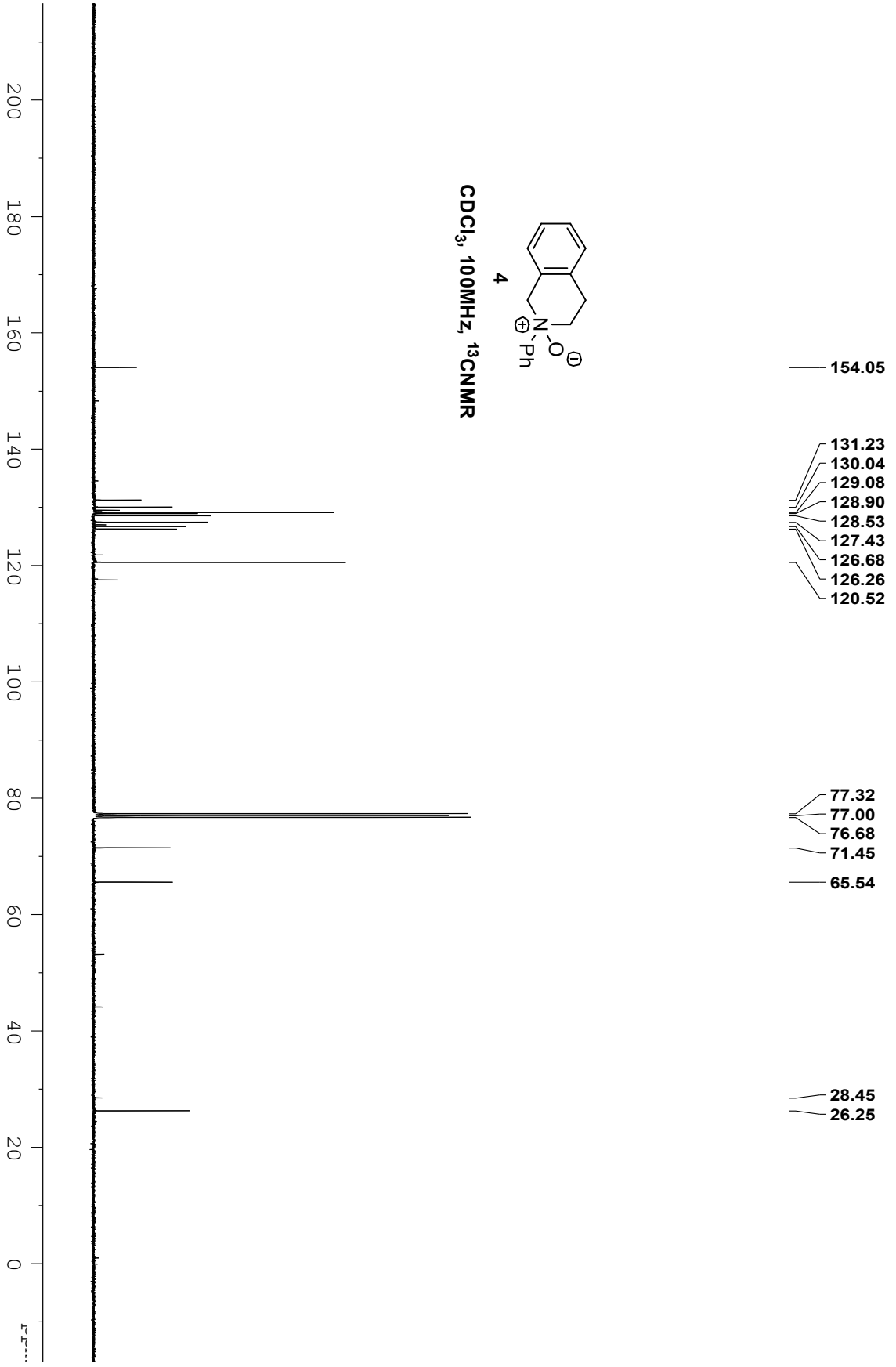

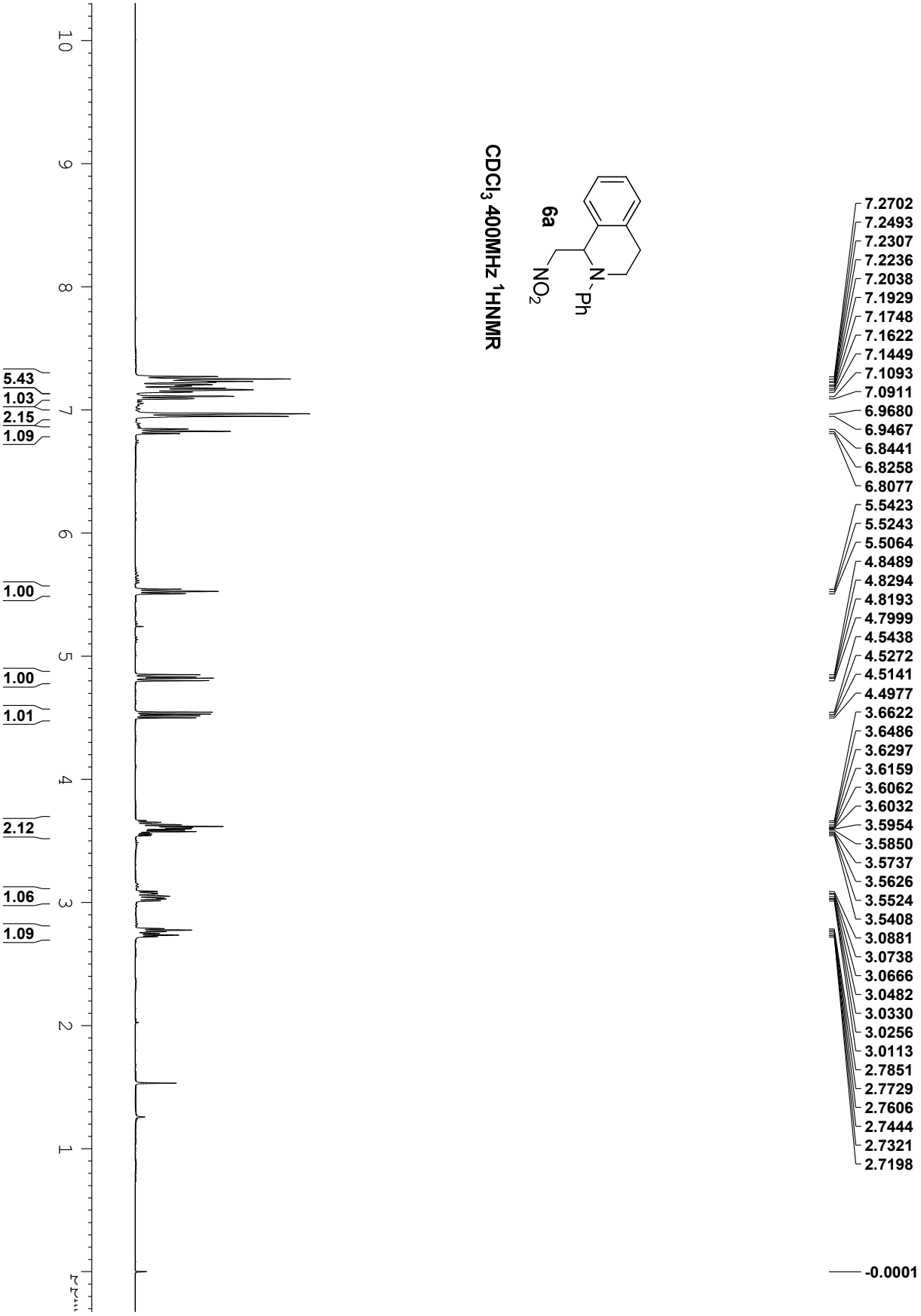

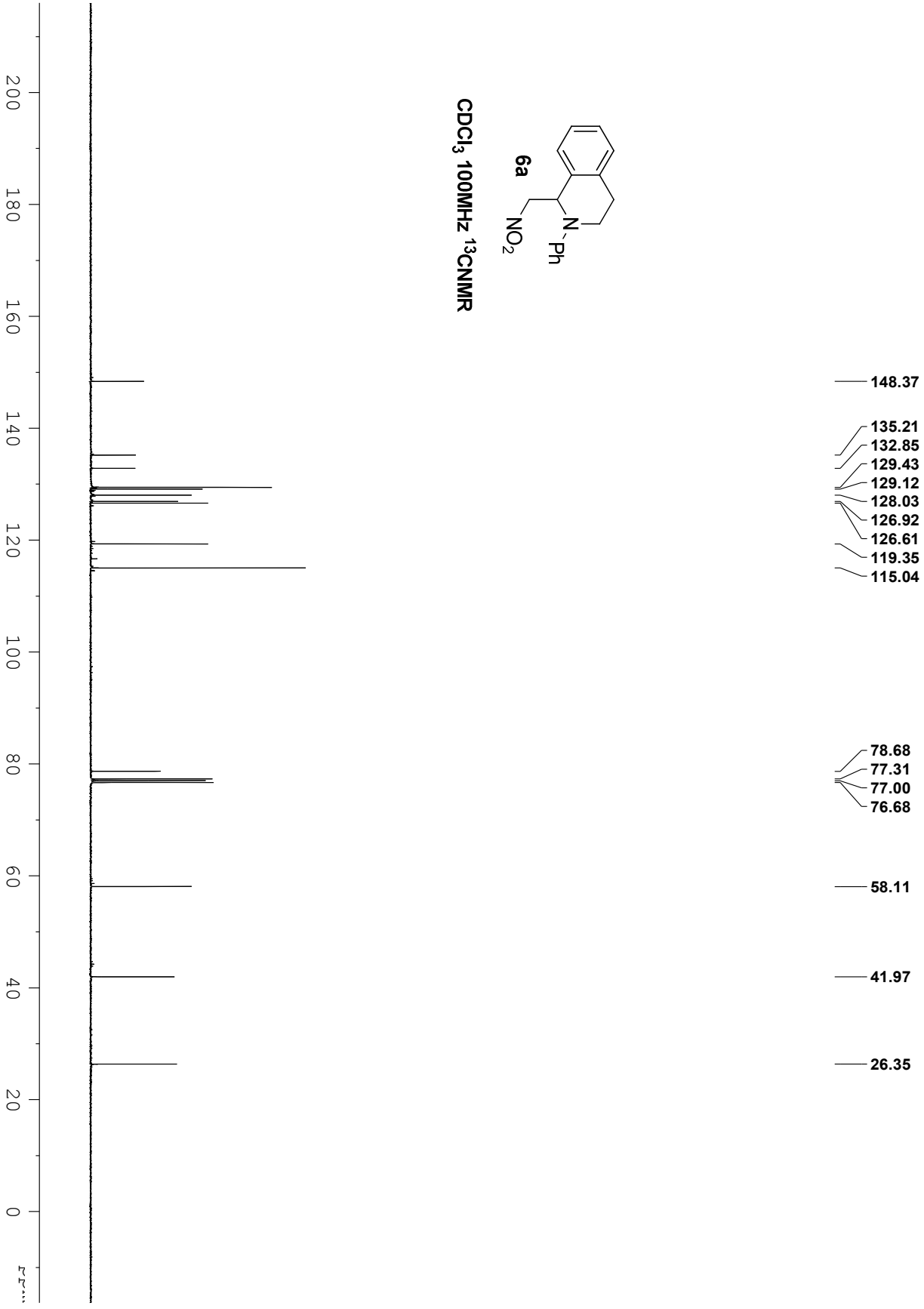

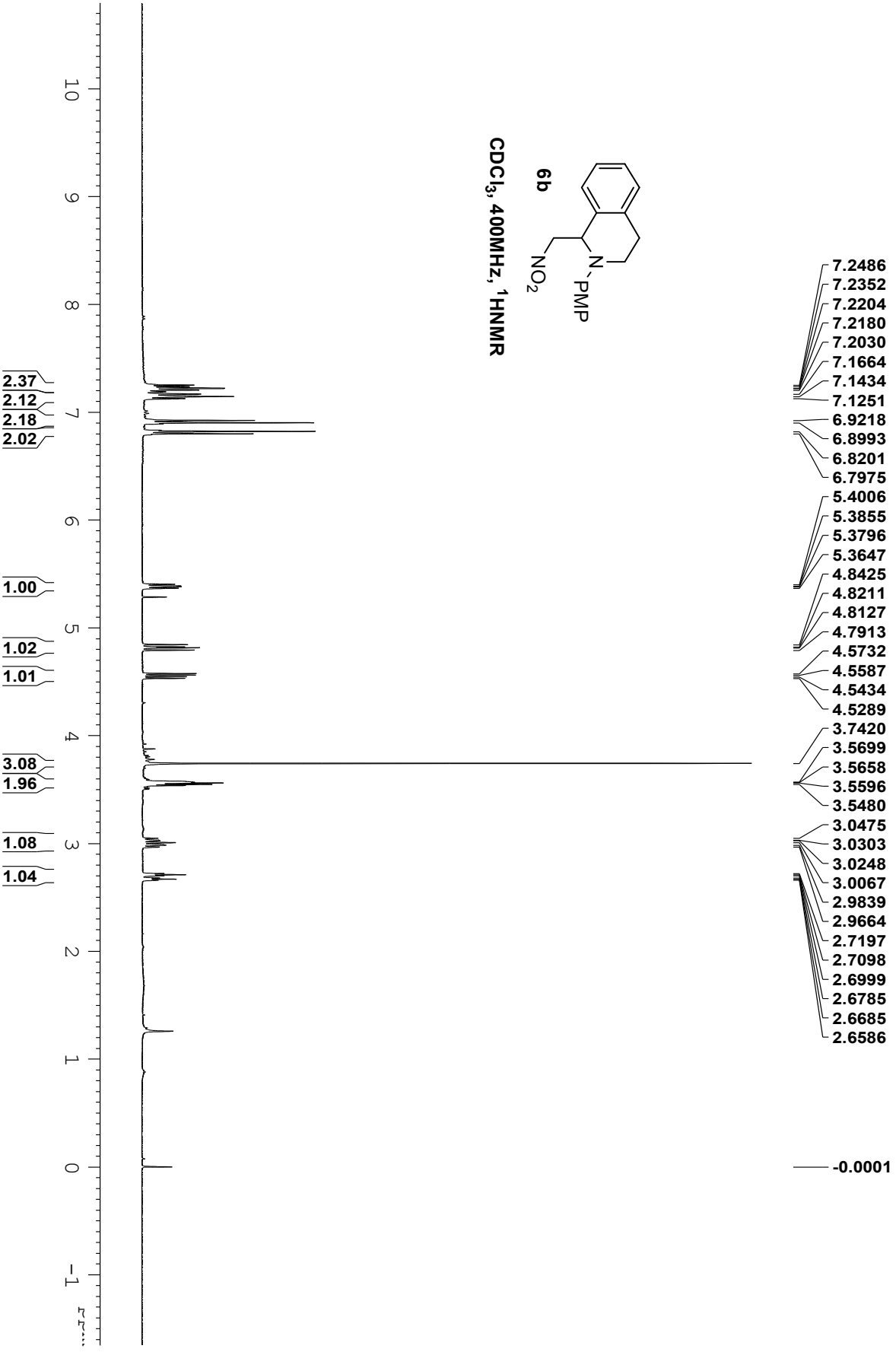
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