Supporting Information for: Palladium-Catalyzed Dynamic Kinetic Asymmetric Transformations of Vinyl Aziridines with Nitrogen Heterocycles: Rapid Access to Biologically Active Pyrroles and Indoles

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Supporting Information

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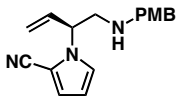
General:

1,2 dichloroethane was distilled from calcium hydride. All other anhydrous solvents were obtained from elution through alumina columns and degassed using the freeze-pump-thaw technique unless stated otherwise. Commercial reagents were used without further purification unless stated otherwise. Reactions were run under nitrogen or argon atmosphere and anhydrous conditions. TLC was performed on precoated glass plates (Merck). Flash chromatography was performed with silica gel 60, 230-400 mesh. ^{1}H-NMR (0 ppm for tetramethylsilane as internal standard) and ^{13}C-NMR (77.5 ppm for $CDCl_3$ as internal standard) spectra were recorded on Varian UI- 600 (600 MHz), UI-500 (500 MHz) or Varian MERC-400 (400 MHz). IR spectra (cm^{-1}) were obtained with a Perkin-Elmer FT-IR Paragon 500 spectrometer or a Thermo Scientific Nicolet IR 100 FT-IR spectrometer using neat sample on a NaCl pad. Enantiomeric excess was determined using chiral HPLC analyses on a Themo Separation Products Spectra Series P-100 or 200 and UV100 (254 nm) using Chiralcel® columns (OD-H, OB-H, AD-H, OJ-H OD, OB, OJ, AD, As, OC, IA, IB or IC) eluting with heptane / *iso*-propanol mixtures indicated. Optical rotations were measured on a Jasco DIP-1000 digital polarimeter using 5 cm cells and the sodium D line (589 nm) at ambient temperature in the solvent and concentration indicated.

General procedure for a pyrrole AAA reaction:

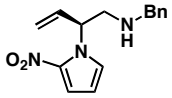
To a flame-dried microwave vial equipped with a magnetic stir bar was added nitrogen heterocycle (0.2 mmol) and vinyl aziridine (0.22 mmol). The system was evacuated and filled with argon (3x) and dry degassed DCE (0.4 mL) was then added. In a separate flame-dried microwave vial equipped with a magnetic stir bar was added $Pd_2(dba)_3$•$CHCl_3$ (4.1 mg, $4.0x10^{-3}$ mmol) and (*R*,*R*)-**L2** (9.5 mg, 0.012 mmol). The system was evacuated and filled with argon (3x), and DCE (0.4 mL) was added. This vial was stirred at rt for 15-20 min until a bright orange color persisted and its contents were then cannulated to the first vial. The reaction mixture was stirred for 48 h at rt, diluted with CH_2Cl_2 (10 mL) and then poured onto water (10 mL). The organic layer was separated, and the aqueous layer was extracted with CH_2Cl_2 (3x10 mL). The

combined organic fractions were dried over anhydrous sodium sulfate, filtered and concentrated *en vacuo*. The crude reaction mixture was purified by flash column chromatography on silica gel.



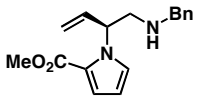
(*S*)-1-(1-(4-methoxybenzylamino)but-3-en-2-yl)-1*H*-pyrrole-2-carbonitrile (3a)

Purified by column chromatography (30% ethyl acetate/petroleum ether) to provide 56 mg of a yellow oil (99% yield, 89 %ee by HPLC, OJ-H column, 9:1 heptane/*i*-propanol, 1.0mL/min, 254 nm, rt = 27.4, 30.2 min). R_f = 0.30 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.20-7.17 (m, 2H), 6.92 (dd, *J* = 2.6, 1.7 Hz, 1H), 6.86-6.84 (m, 2H), 6.82 (dd, *J* = 3.9, 1.6 Hz, 1H), 6.22 (dd, *J* = 3.9, 2.8 Hz, 1H), 5.97 (ddd, *J* = 17.1, 10.5, 5.9 Hz, 1H), 5.28 (ddd, *J* = 10.5, 1.3, 0.7 Hz, 1H), 5.10 (ddd, *J* = 17.2, 1.5, 0.7 Hz, 1H), 4.97-4.92 (m, 1H), 3.79 (s, 3H), 3.72 (q, *J* = 12.2 Hz, 2H), 3.13-3.03 (m, 2H), 1.35 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 159.2, 135.3, 132.2, 129.7, 124.7, 120.5, 119.0, 114.4, 114.3, 110.3, 104.3, 61.5, 55.7, 53.1, 52.5. **IR**(film): 3335, 3123, 2917, 2836, 2214, 1610, 1511, 1457 cm^{-1}. **$[\alpha]_D$** –31.7 (CH_2Cl_2, c 1.00). **HRMS** ($C_{17}H_{19}N_3ONa$): calculated (M + Na): 304.1426, found (M + Na): 304.1428.



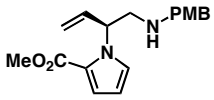
(*S*)-N-benzyl-2-(2-nitro-1H-pyrrol-1-yl)but-3-en-1-amine (3b)

Purified by column chromatography (25% ethyl acetate/petroleum ether) to provide 42 mg of an oil (77% yield, 89% ee by HPLC, OD column, 98:2 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 23.1, 25.3 min). R_f = 0.30 (25% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.32-7.22 (m, 6H), 7.04 (t, *J* = 2.4 Hz, 1H), 6.21 (dd, *J* = 4.2, 3.0 Hz, 1H), 6.03-5.95 (m, 2H), 5.27 (d, *J* = 9.2 Hz, 1H), 5.12-5.06 (m, 1H), 3.81-3.73 (m, 2H), 3.10-3.01 (m, 2H), 1.44 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 140.1, 135.5, 128.9, 128.4, 127.6, 126.9, 119.0, 115.6, 109.4, 59.9, 53.8, 52.6. **IR** (film): 3131, 3025, 2838, 1529, 1500, 1454, 1347, 739 cm^{-1}. **$[\alpha]_D$** –55.2 (CH_2Cl_2, c 1.09). **HRMS** ($C_{15}H_{17}N_3O_2$): calculated (M + H): 272.1399, found (M + H): 272.1387.



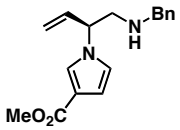
(*S*)-methyl 1-(1-(benzylamino)but-3-en-2-yl)-1H-pyrrole-2-carboxylate (3c)

Purified by column chromatography (25% ethyl acetate/petroleum ether) to provide 43.4 mg of a yellow oil (76 % yield, 96 %ee by HPLC, AD column, 95:5 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 8.3, 9.1 min). R_f = 0.30 (25% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.32-7.21 (m, 5H), 6.99 (ddd, *J* = 5.8, 4.1, 1.7 Hz, 2H), 6.19 (dd, *J* = 3.8, 2.8 Hz, 1H), 6.15-6.10 (m, 1H), 6.00 (ddd, *J* = 16.9, 10.7, 6.0 Hz, 1H), 5.21-5.18 (m, 1H), 5.04 (dt, *J* = 17.1, 1.1 Hz, 1H), 3.82-3.74 (m, 5H), 3.08-3.00 (m, 2H), 1.39 (s, 1H).. **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 162.2, 140.5, 137.0, 128.8, 128.5, 127.4, 125.8, 122.7, 118.6, 117.6, 109.2, 58.5, 53.6, 53.1, 51.5. **IR** (film): 25, 2945, 1702, 1643, 1545, 1456, 1436, 1341, 1234, 1108, 740, 700 cm^{-1}. **$[\alpha]_D$** –12.5 (CH_2Cl_2, c 1.03). **HRMS** ($C_{17}H_{21}N_2O_2$): calculated (M + H): 285.1603, found (M + H): 285.1595.



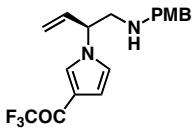
(*S*)-methyl 1-(1-(4-methoxybenzylamino)but-3-en-2-yl)-1*H*-pyrrole-2-carboxylate (3d)

Purified by column chromatography (30% ethyl acetate/petroleum ether) to provide 54 mg of a yellow oil (86% yield, 94%ee by HPLC, OD column, 9:1 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 9.8, 12.4 min). R_f = 0.30 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.19-7.15 (m, 2H), 7.01-6.98 (m, 2H), 6.86-6.82 (m, 2H), 6.19 (dd, *J* = 3.9, 2.7 Hz, 1H), 6.14-6.09 (m, 1H), 6.00 (ddd, *J* = 17.1, 10.4, 5.8 Hz, 1H), 5.19 (dt, *J* = 10.4, 1.2 Hz, 1H), 5.04 (dt, *J* = 17.1, 1.3 Hz, 1H), 3.81 (s, 3H), 3.79 (s, 3H), 3.76-3.68 (m, 2H), 3.07-2.98 (m, 2H), 1.44 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 162.2, 159.1, 137.1, 132.6, 129.7, 125.8, 122.7, 118.6, 117.6, 114.2, 109.2, 58.5, 55.7, 53.0, 51.5. **IR** (film): 2949, 2835, 1703, 1512, 1460, 1438, 1412 cm^{-1}. **$[\alpha]_D$** 0.9 (CH_2Cl_2, c 1.04). **HRMS** ($C_{17}H_{22}N_2O_3Na$): calculated (M + Na): 337.1523, found (M + Na): 337.1528.



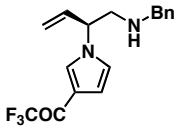
(*S*)-methyl 1-(1-(benzylamino)but-3-en-2-yl)-1H-pyrrole-3-carboxylate (3e)

Purified by column chromatography (35% ethyl acetate/petroleum ether) to provide 41 mg of an oil (72% yield, 89%ee by HPLC, OD column, 9:1 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 17.7, 20.1 min). R_f = 0.30 (40% ethyl acetate/petroleum ether). **^{1}H-NMR** (400 MHz): δ 7.35 (t, *J* = 1.9 Hz, 1H), 7.34-7.23 (m, 5H), 6.65 (t, *J* = 2.6 Hz, 1H), 6.61 (dd, *J* = 2.9, 1.7 Hz, 1H), 5.94 (ddd, *J* = 17.1, 10.6, 6.0 Hz, 1H), 5.25-5.22 (m, 1H), 5.09 (ddd, *J* = 17.2, 1.3, 0.8 Hz, 1H), 4.66-4.61 (m, 1H), 3.80 (s, 3H), 3.77-3.73 (m, 2H), 3.06-2.97 (m, 2H), 1.35 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 165.7, 140.1, 135.9, 128.9, 128.4, 127.6, 125.2, 121.0, 118.4, 116.4, 110.6, 62.9, 53.9, 52.9, 51.5 **IR** (film): 3024, 2945, 2839, 1706, 1539, 1452, 1458, 1360, 1197, 1118 cm^{-1}. **$[\alpha]_D$** –23.0 (CH_2Cl_2, c 1.03). **HRMS** ($C_{17}H_{21}N_2O_2$): calculated (M + H): 285.1603, found (M + H): 285.1598.



(S)-2,2,2-trifluoro-1-(1-(1-((4-methoxybenzyl)amino)but-3-en-2-yl)-1H-pyrrol-3-yl)ethanone (3f)

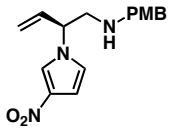
Purified by column chromatography (35% ethyl acetate/petroleum ether) to provide 65 mg of a clear oil (92% yield, 93 % ee by HPLC, OB column, 8:2 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 18.2, 30.9 min). R_f = 0.30 (35% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400MHz): δ 7.57 (d, *J* = 1.0 Hz, 1H), 7.18-7.14 (m, 2H), 6.87-6.84 (m, 2H), 6.77 (d, *J* = 1.0 Hz, 1H), 6.74 (dd, *J* = 3.0, 2.1 Hz, 1H), 5.95 (ddd, *J* = 17.0, 10.7, 6.2 Hz, 1H), 5.32-5.29 (m, 1H), 5.13 (dt, *J* = 17.2, 0.7 Hz, 1H), 4.68-4.63 (m, 1H), 3.80 (s, 3H), 3.75-3.68 (m, 2H), 3.04-3.02 (m, 2H), 1.33 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 159.3, 135.2, 132.0, 129.6, 128.9, 122.6, 119.2, 118.9, 118.3, 116.0, 114.3, 111.4, 63.4, 55.7, 53.4, 52.6. **IR** (film): 3350, 2931, 2835, 1683, 1528, 1512, 1247, 1190, 1143, 880 cm^{-1}. **$[\alpha]_D$** –20.6 (CH_2Cl_2, c 1.29). **HRMS** ($C_{18}H_{20}N_2O_2F_3$): calculated (M + H): 353.1477, found (M + H): 353.1471.



(S)-1-(1-(1-(benzylamino)but-3-en-2-yl)-1H-pyrrol-3-yl)-2,2,2-trifluoroethanone (3g)

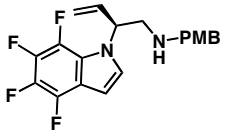
Purified by column chromatography (30% ethyl acetate/petroleum ether) to provide 61 mg of an oil (95% yield, 93 %ee by HPLC, OD-H column, 9:1 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt

= 19.5, 25.2 min). R_f = 0.30 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** (400 MHz): δ 7.58 (d, *J* = 1.0 Hz, 1H), 7.34-7.24 (m, 5H), 6.78-6.77 (m, 1H), 6.75 (dd, *J* = 3.1, 2.1 Hz, 1H), 5.96 (ddd, *J* = 17.1, 10.5, 6.0 Hz, 1H), 5.31 (ddd, *J* = 10.5, 1.3, 0.6 Hz, 1H), 5.13 (ddd, *J* = 17.2, 1.5, 0.6 Hz, 1H), 4.69-4.64 (m, 1H), 3.82-3.74 (m, 2H), 3.06-3.04 (m, 2H), 1.39 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 175.8, 139.9, 135.1, 129.0, 128.4, 127.7, 122.6, 119.2, 118.9, 118.3, 116.0, 111.4, 63.4, 54.0, 52.7. **IR** (film): 2921, 2838, 1684, 1529, 1248, 1191, 1144, 880, 761, 732, 699 cm^{-1}. **[α]$_{D:}$** –22.2 (CH_2Cl_2, c 1.11). **HRMS** ($C_{17}H_{18}N_2O_1F_3$): calculated (M + H): 323.1371, found (M + H): 323.1366.



***(S)*-N-(4-methoxybenzyl)-2-(3-nitro-1H-pyrrol-1-yl)but-3-en-1-amine (3h)**

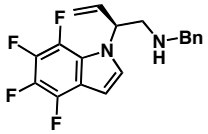
Purified by column chromatography (30% ethyl acetate/petroleum ether) to provide 50.8 mg of a yellow oil (78% yield, 90% ee by HPLC, OD column, 9:1 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 31.3, 34.0 min).. R_f = 0.30 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.58 (t, *J* = 2.1 Hz, 1H), 7.18-7.15 (m, 2H), 6.88-6.84 (m, 2H), 6.73 (dd, *J* = 3.2, 1.8 Hz, 1H), 6.62 (dd, *J* = 3.1, 2.6 Hz, 1H), 5.93 (ddd, *J* = 17.1, 10.5, 6.1 Hz, 1H), 5.31 (dt, *J* = 10.5, 0.7 Hz, 1H), 5.14 (ddd, *J* = 17.2, 1.5, 0.6 Hz, 1H), 4.62-4.57 (m, 1H), 3.80 (s, 3H), 3.72 (d, *J* = 2.2 Hz, 2H), 3.02 (d, *J* = 6.8 Hz, 2H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 159.3, 135.0, 131.9, 129.7, 121.2, 120.9, 119.4, 114.36, 114.36, 106.1, 63.6, 55.7, 53.4, 52.5. **IR**(film): 3138, 2929, 2834, 1619, 1527, 1510, 1485, 1368, 1286, 1246, 1175, 1120, 1032, 810, 751 cm^{-1}. **[α]$_{D:}$** –15.3 (CH_2Cl_2, c 1.02). **HRMS** ($C_{16}H_{20}N_3O_3$): calculated (M + H): 302.1505, found (M + H): 302.1499.



(*S*)-N-(4-methoxybenzyl)-2-(4,5,6,7-tetrafluoro-1H-indol-1-yl)but-3-en-1-amine (4a)

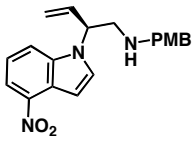
Purified by silica gel flash chromatography. (30% ethyl acetate in petroleum ether) to provide 69 mg of a yellow oil (89% yield, 90% ee by HPLC, AD-H column, 99.5:0.5 heptane/*i*-propanol, 0.8 mL/min, 254 nm, rt = 20.6, 23.9 min.) R_f = 0.3 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.19 (d, *J* = 3.3 Hz, 1H), 7.15-7.11 (m, 2H), 6.84-6.82 (m, 2H),

6.63 (dd, *J* = 3.3, 1.9 Hz, 1H), 6.00 (dddd, *J* = 17.1, 10.5, 5.8, 0.8 Hz, 1H), 5.32 (q, *J* = 6.6 Hz, 1H), 5.25-5.22 (m, 1H), 5.03 (dd, *J* = 17.2, 0.7 Hz, 1H), 3.79 (s, 3H), 3.72 (q, *J* = 10.0 Hz, 2H), 3.13-3.10 (m, 2H), 1.44 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 159.2, 136.0, 132.2, 129.6, 127.81, 127.78, 118.3, 114.2, 99.72, 99.67, 77.5, 60.57, 60.51, 55.7, 53.3, 52.4. **IR** (film): 2933, 2834, 1611, 1538, 1511, 1486, 1341, 1301, 1246, 1177, 1034, 997, 713 cm^{-1}. **$[\alpha]^{22}_D$**: –29.1 (CH_2Cl_2, c 1.10). **HRMS** ($C_{20}H_{19}N_2O_1F_4$): calculated (M + H): 379.1434, found (M + H): 379.1428.



(*S*)-N-benzyl-2-(4,5,6,7-tetrafluoro-1H-indol-1-yl)but-3-en-1-amine (4b)

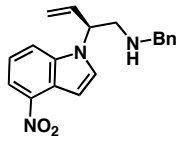
Purified by column chromatography (20% ethyl acetate/petroleum ether) to provide 67 mg of an oil (96% yield, 92%ee by HPLC, OD column, 9:1 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 14.9, 18.8 min). R_f = 0.30 (20% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.31-7.19 (m, 6H), 6.63 (dd, *J* = 3.3, 1.9 Hz, 1H), 6.05-5.96 (m, 1H), 5.36-5.31 (m, 1H), 5.24 (ddd, *J* = 10.5, 1.3, 0.9 Hz, 1H), 5.05-5.01 (m, 1H), 3.82-3.74 (m, 2H), 3.18-3.08 (m, 2H), 1.38 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 140.1, 136.0, 128.9, 128.4, 127.79, 127.76, 127.61, 118.3, 99.75, 99.71, 60.57, 60.51, 53.9, 52.6. **IR** (film): 1538, 1507, 1486, 1341, 997 cm^{-1}. **$[\alpha]^{22}_D$** : –30.0 (CH_2Cl_2, c 1.12). **HRMS** ($C_{19}H_{17}N_2F_4$): calculated (M + H): 349.1328, found (M + H): 349.1322.



(*S*)-*N*-(4-methoxybenzyl)-2-(4-nitro-1*H*-indol-1-yl)but-3-en-1-amine (4c)

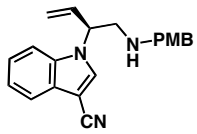
Purified by silica gel flash chromatography (35% ethyl acetate in petroleum ether) to provide 60.2 mg of a yellow oil (86% yield, 93% ee by HPLC, IB column, 75:25 heptane/*i*-propanol, 1.0 mL/min, 254 nm, rt = 10.8, 20.6 min) R_f: 0.3 (40% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 8.13 (dd, *J* = 8.0, 0.7 Hz, 1H), 7.67 (d, *J* = 8.2 Hz, 1H), 7.45 (d, *J* = 3.2 Hz, 1H), 7.30 (dd, *J* = 3.2, 0.7 Hz, 1H), 7.24 (t, *J* = 8.1 Hz, 1H), 7.13-7.10 (m, 2H), 6.84-6.80

(m, 2H), 6.02 (ddd, *J* = 17.2, 10.5, 5.4 Hz, 1H), 5.25 (ddd, *J* = 10.5, 1.6, 0.7 Hz, 1H), 5.13 (dtt, *J* = 7.7, 5.8, 1.7 Hz, 1H), 5.03 (ddd, *J* = 17.2, 1.7, 0.7 Hz, 1H), 3.78 (s, 3H), 3.70 (q, *J* = 10.0 Hz, 2H), 3.23-3.13 (m, 2H), 1.41 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 159.2, 140.9, 138.8, 135.5, 132.1, 130.2, 129.6, 123.1, 120.9, 118.4, 118.1, 117.1, 114.3, 103.1, 59.3, 55.7, 53.4, 52.0. **IR (film):** 3106, 2932, 2834, 1611, 1513, 1463 cm^{-1}. **$[\alpha]_D$:** –12.9 (CH_2Cl_2, c 1.25). **HRMS** ($C_{20}H_{21}N_3O_3Na$): calculated (M + Na): 374.1481, found (M + Na): 374.1476.



(*S*)-N-benzyl-2-(4-nitro-1H-indol-1-yl)but-3-en-1-amine (**4d**)

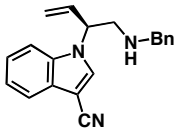
Purified by silica gel flash chromatography (30% ethyl acetate in petroleum ether) to provide 55.3 mg of a yellow oil (86% yield, 86% ee by HPLC, OD-H column, 9:1 heptane/*i*-propanol, 0.8 mL/min, 254 nm, rt = 20.3, 35.0 min) R_f: 0.3 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 8.13 (dd, *J* = 8.0, 0.6 Hz, 1H), 7.67 (d, *J* = 8.2 Hz, 1H), 7.45 (d, *J* = 3.2 Hz, 1H), 7.31-7.19 (m, 7H), 6.02 (ddd, *J* = 17.2, 10.5, 5.4 Hz, 1H), 5.25 (ddd, *J* = 10.5, 1.5, 0.6 Hz, 1H), 5.16-5.11 (m, 1H), 5.04 (ddd, *J* = 17.2, 1.6, 0.6 Hz, 1H), 3.81-3.73 (m, 2H), 3.24-3.14 (m, 2H), 1.47 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 140.9, 140.0, 138.8, 135.4, 130.2, 128.94, 128.90, 128.4, 127.6, 123.1, 120.9, 118.5, 118.13, 118.10, 117.1, 103.1, 59.3, 54.0, 52.1. **IR** (film): 3352, 2919, 2832, 1512, 1496, 1360, 1328, 1301, 1252, 736 cm^{-1}. **$[\alpha]_D$:** –16.1 (CH_2Cl_2, c. 1.05). **HRMS** ($C_{19}H_{20}N_3O_2$): calculated (M + H): 322.3810, found (M + H): 322.1550.



(*S*)-1-(1-(4-methoxybenzylamino)but-3-en-2-yl)-1*H*-indole-3-carbonitrile (**4e**)

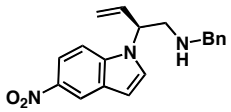
Purified by silica gel flash chromatography. (35% ethyl acetate in petroleum ether) to provide 45 mg of a yellow oil (92% yield, 89% ee by HPLC, IB column, 9:1 heptane/*i*-propanol, 0.8 mL/min, 254 nm, rt = 20.9, 26.2 min.) R_f = 0.3 (40% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 500 MHz): δ 7.77-7.75 (m, 1H), 7.73 (s, 1H), 7.39 (dd, *J* = 6.7, 1.9 Hz, 1H), 7.32-7.27 (m, 2H), 7.14-7.11 (m, 2H), 6.85-6.82 (m, 2H), 5.99 (ddd, *J* = 17.5, 10.5, 5.3 Hz, 1H), 5.30-5.28

(m, 1H), 5.08-5.04 (m, 2H), 3.79 (s, 3H), 3.70 (q, *J* = 10.3 Hz, 2H), 3.15 (qd, *J* = 12.1, 6.5 Hz, 2H), 1.38 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 126 MHz): δ 159.2, 135.9, 134.7, 133.5, 131.9, 129.7, 128.2, 124.2, 122.7, 120.4, 119.1, 116.4, 114.3, 111.4, 86.7, 59.6, 55.7, 53.4, 51.7. **IR** (film): 2835, 2217, 1611, 1528, 1512, 1461 cm^{-1}. **$[\alpha]^{22}_D$**: –26.0 (CH_2Cl_2, c 1.10). **HRMS** ($C_{21}H_{21}N_3ONa$): calculated (M + Na): 354.1584, found (M + Na): 354.1582.



(*S*)-1-(1-(benzylamino)but-3-en-2-yl)-1H-indole-3-carbonitrile (4f)

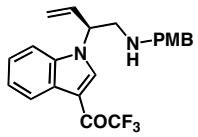
Purified by silica gel flash chromatography. (30% ethyl acetate in petroleum ether) to provide 53 mg of a yellow oil (88% yield, 90% ee by HPLC, OD-H column, 9:1 heptane/*i*-propanol, 0.8 mL/min, 254 nm, rt = 20.6, 27.5 min.) R_f = 0.3 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.77-7.74 (m, 2H), 7.41-7.38 (m, 1H), 7.33-7.20 (m, 6H), 5.99 (ddd, *J* = 17.4, 10.6, 5.4 Hz, 1H), 5.31-5.28 (m, 1H), 5.10-5.04 (m, 2H), 3.80-3.73 (m, 2H), 3.22-3.12 (m, 2H), 1.48 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 139.8, 135.9, 134.7, 133.5, 129.0, 128.5, 128.2, 127.7, 124.2, 122.7, 120.4, 119.2, 116.4, 111.4, 86.7, 59.6, 54.0, 51.8. **IR** (film): 3026, 2920, 2837, 2216, 1527, 1460, 1399, 1356, 1232, 1183, 756 cm^{-1}. **$[\alpha]^{22}_D$**: –24.3 (CH_2Cl_2, c 1.01). **HRMS** ($C_{20}H_{20}N_3$): calculated (M + H): 302.1675, found (M + H): 302.1652.



(*S*)-N-benzyl-2-(5-nitro-1H-indol-1-yl)but-3-en-1-amine (4g)

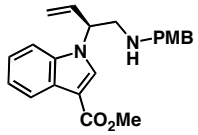
Purified by silica gel flash chromatography. (40% ethyl acetate in petroleum ether) to provide 52 mg of a yellow oil (81% yield, 83% ee by HPLC, AD-H column, 9:1 heptane/*i*-propanol, 0.8 mL/min, 254 nm, rt = 17.7, 20.5 min.) R_f = 0.3 (35% ethyl acetate/petroleum ether). **^{1}H-NMR** (400 MHz): δ 8.58 (d, *J* = 2.2 Hz, 1H), 8.08 (dd, *J* = 9.1, 2.2 Hz, 1H), 7.37-7.19 (m, 8H), 6.73 (d, *J* = 3.3 Hz, 1H), 6.02 (ddd, *J* = 17.2, 10.5, 5.4 Hz, 1H), 5.27 (dt, *J* = 10.5, 0.7 Hz, 1H), 5.14-5.09 (m, 1H), 5.05 (ddd, *J* = 17.2, 1.5, 0.6 Hz, 1H), 3.77 (q, *J* = 10.1 Hz, 2H), 3.24-3.14 (m, 2H), 1.51 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 142.1, 140.0, 139.5, 135.2, 128.9, 128.4, 128.2, 127.7, 118.63, 118.53, 117.6, 110.2, 105.1, 59.4, 54.0, 52.0. **IR** (film): 3083, 3025, 2833, 1609,

1578, 1511, 1468, 1404, 1335, 1197, 1124, 1069, 988, 932, 898, 811, 743, 699, 594 cm^{-1}. **$[\alpha]^{22}_D$**: –31.7 (CH_2Cl_2, c 0.64). **HRMS** ($C_{19}H_{20}N_3O_2$): calculated (M + H): 322.3810, found (M + H): 322.1550.



(*S*)-2,2,2-trifluoro-1-(1-(1-((4-methoxybenzyl)amino)but-3-en-2-yl)-1H-indol-3-yl)ethanone (4h)

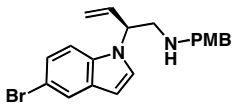
Purified by silica gel flash chromatography. (30% ethyl acetate in petroleum ether) to provide 80 mg of a yellow oil (>99% yield, 81% ee by HPLC, AD column, 9:1 heptane/*i*-propanol, 1.0 mL/min, 254 nm, rt = 9.3, 11.6 min.) R_f = 0.3 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 8.44-8.41 (m, 1H), 8.17 (q, *J* = 1.7 Hz, 1H), 7.40-7.32 (m, 3H), 7.15-7.12 (m, 2H), 6.85-6.81 (m, 2H), 6.05 (ddd, *J* = 17.1, 10.5, 5.7 Hz, 1H), 5.35 (dd, *J* = 10.6, 1.4 Hz, 1H), 5.16-5.08 (m, 2H), 3.79 (s, 3H), 3.73 (s, 2H), 3.29-3.16 (m, 2H), 1.46 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 175.3, 159.3, 137.2, 136.6, 134.4, 131.9, 129.6, 127.4, 124.9, 124.5, 123.2, 119.6, 114.4, 111.3, 110.3, 63.8, 60.0, 55.7, 53.6, 51.6 **IR** (film): 3332, 3120, 2932, 2834, 1666, 1611, 1513, 1461, 1407, 1281, 1246, 1183, 1137, 1034, 877, 752 cm^{-1}. **$[\alpha]^{22}_D$**: –17.9 (CH_2Cl_2, c 1.01). **HRMS** ($C_{22}H_{22}N_2O_2F_3$): calculated (M + H): 403.1633, found (M + H): 403.1628.



(*S*)-methyl 1-(1-(4-methoxybenzylamino)but-3-en-2-yl)-1*H*-indole-3-carboxylate (4i)

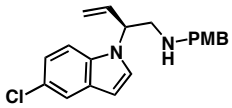
Purified by silica gel flash chromatography (35% ethyl acetate in petroleum ether) to provide 66.0 mg of a clear oil (91% yield, 93% ee by HPLC, IA column, 95:5 heptane/*i*-propanol, 0.8 mL/min, 254 nm, rt = 28.6, 32.8 min.). Rf = 0.3 (45% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 8.21-8.18 (m, 1H), 7.93 (s, 1H), 7.39-7.34 (m, 1H), 7.30-7.23 (m, 2H), 7.13-7.10 (m, 2H), 6.84-6.80 (m, 2H), 6.00 (ddd, *J* = 17.3, 10.6, 5.7 Hz, 1H), 5.27-5.24 (m, 1H), 5.10-5.06 (m, 2H), 3.91 (s, 3H), 3.77 (s, 3H), 3.73-3.66 (m, 2H), 3.16 (qd, *J* = 14.2, 6.8 Hz, 2H),

1.40 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 165.9, 159.2, 137.1, 135.2, 132.5, 132.1, 129.6, 127.0, 123.2, 122.5, 122.2, 118.7, 114.3, 110.8, 108.1, 59.2, 55.7, 53.7, 51.8, 51.5. **IR** (film) 2995, 2948, 2835, 1697, 1612, 1532, 1512, 1460 cm^{-1}. **$[\alpha]_D$**: –19.4 (CH_2Cl_2, c 1.03). **HRMS** ($C_{22}H_{24}N_2O_3Na$): calculated (M + Na): 387.1676, found (M + Na): 387.1685.



(*S*)-2-(5-bromo-1*H*-indol-1-yl)-*N*-(4-methoxybenzyl)but-3-en-1-amine (4j)

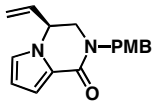
Purified by column chromatography (30% ethyl acetate/petroleum ether) to provide 44 mg of a clear oil (57% yield, 73 %ee by HPLC, OD-H column, 98:2 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 26.3, 30.0 min). R_f = 0.30 (35% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.74 (d, *J* = 1.8 Hz, 1H), 7.26-7.20 (m, 2H), 7.16 (d, *J* = 3.2 Hz, 1H), 7.11-7.09 (m, 2H), 6.83-6.80 (m, 2H), 6.48 (dd, *J* = 3.2, 0.4 Hz, 1H), 5.98 (ddd, *J* = 17.2, 10.5, 5.5 Hz, 1H), 5.20 (ddd, *J* = 10.5, 1.4, 0.8 Hz, 1H), 5.06-4.98 (m, 2H), 3.78 (s, 3H), 3.68 (q, *J* = 10.7 Hz, 2H), 3.12 (qd, *J* = 14.2, 7.0 Hz, 2H), 1.25 (s, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 159.2, 135.8, 135.3, 132.2, 130.7, 129.67, 129.61, 126.86, 126.82, 124.8, 123.9, 118.0, 114.3, 113.3, 111.8, 102.1, 59.0, 55.7, 53.4, 52.0. **IR**(film): 3081, 2999, 2929, 2832, 1610, 1510, 1460, 1300, 1246, 1176, 1034 754, 719 cm^{-1}. **$[\alpha]_D$**: –24.9 (CH_2Cl_2, c 1.14). **HRMS** ($C_{20}H_{22}N_2O_1Br$): calculated (M + H): 385.0837, found (M + H): 385.0910.



(*S*)-2-(5-chloro-1*H*-indol-1-yl)-*N*-(4-methoxybenzyl)but-3-en-1-amine (4k)

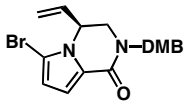
Purified by column chromatography (30% ethyl acetate/petroleum ether) to provide 37.2 mg of a clear oil (60% yield, 73 %ee by HPLC, OD-H column, 98:2 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 25.0, 29.2 min). R_f = 0.30 (35% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.59-7.58 (m, 1H), 7.26 (s,), 7.24 (d, *J* = 1.2 Hz, 1H), 7.18 (d, *J* = 3.2 Hz, 1H), 7.13 (d, *J* = 2.0 Hz, 1H), 7.12-7.09 (m, 2H), 6.83-6.80 (m, 2H), 6.48 (dd, *J* = 3.2, 0.7 Hz, 1H), 5.99 (ddd, *J* = 17.2, 10.5, 5.5 Hz, 1H), 5.20 (ddd, *J* = 10.5, 1.4, 0.8 Hz, 1H), 5.05-4.99 (m, 2H), 3.78 (s, 3H), 3.68 (q, *J* = 10.9 Hz, 2H), 3.13 (qd, *J* = 14.4, 7.0 Hz, 2H), 1.32 (s, 1H). **^{13}C-NMR** ($CDCl_3$,

101 MHz): δ 159.2, 135.9, 135.0, 132.2, 130.0, 129.6, 126.9, 125.7, 122.3, 120.8, 117.9, 114.3, 111.3, 102.2, 59.0, 55.7, 53.4, 52.0. **IR** (film): 3341, 3000, 2929, 2832, 1610, 1511, 1460, 1300, 1246, 1197, 1176, 1064, 1034, 818, 793, 754, 720 cm^{-1}. **[α]**$_D$: –28.3 (CH_2Cl_2, c 1.02). **HRMS** ($C_{20}H_{22}N_2O_1Cl$): calculated (M + H): 341.1342, found (M + H): 341.1415.



(*S*)-2-(4-methoxybenzyl)-4-vinyl-3,4-dihydropyrrolo[1,2-a]pyrazin-1(2H)-one (**5a**)

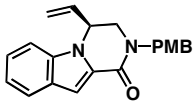
Purified by column chromatography (30% ethyl acetate/petroleum ether) to provide 55 mg of a clear oil (97% yield, 90 %ee by HPLC, AD column, 9:1 heptane/*i*-propanol, 0.8mL/min, 254 nm, rt = 39.2, 48.1 min). R_f = 0.30 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 500 MHz): δ 7.25-7.22 (m, 2H), 7.01 (dd, *J* = 3.8, 1.6 Hz, 1H), 6.86-6.83 (m, 2H), 6.71 (dd, *J* = 2.5, 1.6 Hz, 1H), 6.24 (dd, *J* = 3.8, 2.6 Hz, 1H), 5.76 (ddd, *J* = 17.0, 10.2, 6.9 Hz, 1H), 5.33 (dt, *J* = 10.2, 0.8 Hz, 1H), 5.11 (dt, *J* = 17.0, 1.0 Hz, 1H), 4.72-4.60 (m, 4H), 3.79 (s, 3H), 3.46 (ddd, *J* = 67.4, 12.7, 6.0 Hz, 2H). **^{13}C-NMR** ($CDCl_3$, 126 MHz): δ 159.6, 134.1, 130.1, 129.4, 124.8, 122.4, 121.2, 114.4, 110.4, 57.1, 55.7, 50.3, 48.9. **IR**(film): 3468, 2927, 1641, 1545, 1512, 1475, 1462 cm^{-1}. **[α]**$_D$: –1.7 (CH_2Cl_2, c 1.10). **HRMS** ($C_{17}H_{18}N_2O_2Na$): calculated (M + Na): 305.1266, found (M + Na): 305.1252.



(*S*)-6-Bromo-2-(2,4-dimethoxy-benzyl)-4-vinyl-3,4-dihydro-2H-pyrrolo[1,2a] pyrazin-1-one (**5b**)

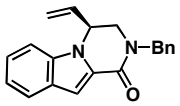
A solution of $[Pd(C_3H_5)Cl]_2$ (0.92 mg, 0.0025 mmol) and (*R*,*R*)-**L1** (5.2 mg, 0.0075 mmol) in 0.5 ml degassed CH_2Cl_2 which had been stirring at rt for 10 min, was added to a solution of compound methyl 5-bromo-1*H*-pyrrole-2-carboxylate (20.4 mg, 0.1 mmol) and vinyl aziridine **1c** (22 mg, 0.1 mmol) in CH_2Cl_2 (0.5 ml) under Ar. The mixture was stirred at rt for 16 hr, and then the solvent was removed under vacuum. Compound **5b** with some uncyclized product were isolated via silica gel flash column chromatography (petroleum ether / ethyl acetate = 4/1, then 3/2) as a light yellow oil. After two days at rt under vacuum, the uncyclized intermediate was

automatically converted to the cyclized compound as a light yellow foam. (28 mg, 72%, 95% ee by HPLC OD column, 90:10 heptane/*i*-propanol, 0.8 ml/min): R_f: 0.35 (petroleum ether / ethyl acetate = 3/2); **[α]$_D$**: –21.12 (CH_2Cl_2, c 0.1); **^{1}H NMR** ($CDCl_3$, 500 MHz) δ 7.25 (m, 1H), 6.95 (d, *J* = 4.0 Hz, 1H), 6.43 (m, 2H), 6.26 (d, *J* = 4.0 Hz, 1H), 5.64 (ddd, *J* = 17, 10.5, 5.0 Hz, 1H), 5.10 (dd, *J* = 10.5, 1.5 Hz, 1H), 4.75 (m, 2H), 4.60(d, *J* = 17 Hz, 1H), 4.50 (d, *J* = 14.5 Hz, 1H), 3.88 (dd, *J* = 13, 4.5 Hz, 1H), 3.79 (s, 6H), 3.48 (dd, *J* = 13, 1.5 Hz, 1H); **^{13}C-NMR** ($CDCl_3$, 125 MHz) δ 160.5, 158.7, 158.5, 133.8, 131.7, 125.6, 118.0, 117.2, 114.1, 112.4, 104.7, 104.2, 98.3, 55.5, 55.4, 54.6, 49.5, 43.7; **IR** (film) 2936, 1645, 1614, 1418, 1209 cm^{-1}; **HRMS** ($C_{18}H_{19}BrN_2O_3$): Calc'd. 392.055858 (M^+), Found 392.056840.



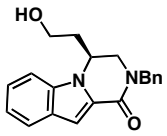
(*S*)-methyl 1-(1-(4-methoxybenzylamino)but-3-en-2-yl)-1*H*-indole-2-carboxylate (5c)

Purified by silica gel flash chromatography (25% ethyl acetate in petroleum ether) to provide 44 mg of a yellow oil (66% yield, 93% ee by HPLC, IA column, 9:1 heptane/*i*-propanol, 1.0 mL/min, 254 nm, rt = 42.7, 52.7 min.) R_f = 0.3 (25% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 500 MHz): δ 7.72 (dt, *J* = 8.1, 0.9 Hz, 1H), 7.34 (d, *J* = 0.7 Hz, 1H), 7.29 (ddd, *J* = 8.2, 6.9, 1.2 Hz, 1H), 7.25-7.23 (m, 2H), 7.15 (ddd, *J* = 8.0, 6.8, 1.2 Hz, 1H), 6.87-6.84 (m, 2H), 5.72 (ddd, *J* = 17.0, 10.3, 5.3 Hz, 1H), 5.08 (dd, *J* = 10.3, 0.9 Hz, 1H), 4.96 (ddt, *J* = 4.8, 3.2, 1.7 Hz, 1H), 4.89 (d, *J* = 14.6 Hz, 1H), 4.61 (ddd, *J* = 17.0, 1.5, 0.5 Hz, 1H), 4.54 (d, *J* = 14.6 Hz, 1H), 3.91 (dd, *J* = 12.8, 4.7 Hz, 1H), 3.79 (s, 3H), 3.44 (dd, *J* = 12.8, 2.2 Hz, 1H). **^{13}C-NMR** ($CDCl_3$, 126 MHz): δ 160.3, 159.6, 136.6, 134.3, 130.3, 129.2, 128.8, 127.9, 125.0, 123.2, 121.2, 118.5, 114.4, 110.5, 107.0, 55.7, 53.4, 50.0, 49.3. **IR** (film): 1647, 1548, 1512, 1452, 1432, 1355, 1246 cm^{-1}. **[α]$_D$**: –1.8 (CH_2Cl_2, c 1.00). **HRMS** ($C_{21}H_{20}N_2O_2Na$): calculated (M + Na): 355.1422, found (M + Na): 355.1422.



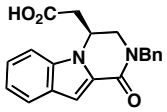
(*S*)-2-benzyl-4-vinyl-3,4-dihydropyrazino[1,2-a]indol-1(2H)-one (5d)

Purified by silica gel flash chromatography. (25% ethyl acetate in petroleum ether) to provide 1.17 g of an orange oil (97% yield, 95% ee by HPLC, OD column, 8:2 heptane/*i*-propanol, 0.8 mL/min, 254 nm, rt = 21.6, 32.6 min.) R_f = 0.3 (25% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.73 (dt, *J* = 8.1, 0.9 Hz, 1H), 7.36 (d, *J* = 0.7 Hz, 1H), 7.34-7.24 (m, 6H), 7.16 (ddd, *J* = 8.0, 6.7, 1.3 Hz, 1H), 5.74 (ddd, *J* = 17.0, 10.3, 5.3 Hz, 1H), 5.09 (dd, *J* = 10.3, 0.9 Hz, 1H), 4.99-4.93 (m, 2H), 4.65-4.60 (m, 2H), 3.95 (dd, *J* = 12.8, 4.7 Hz, 1H), 3.45 (dd, *J* = 12.8, 2.2 Hz, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 160.4, 136.84, 136.65, 134.3, 129.12, 129.00, 128.2, 127.9, 125.1, 123.2, 121.3, 118.6, 110.5, 107.2, 53.4, 50.3, 50.0. **IR** (film): 3057, 3028, 2917, 1647, 1548, 1451, 1426, 1355, 1317, 1244, 744 cm^{-1}. **$[\alpha]^{22}_D$**: 6.82 (CH_2Cl_2, c 1.66). **HRMS** ($C_{20}H_{19}N_2O_1$): calculated (M + H): 303.1497, found (M + H): 303.1490.



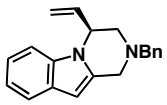
(*S*)-2-benzyl-4-(2-hydroxyethyl)-3,4-dihydropyrazino[1,2-a]indol-1(2H)-one (6)

To a solution of olefin **5d** (91 mg, 0.3 mmol) in THF (3 mL, 0.1M) is added solid, freshly prepared dicyclohexylborane (160 mg, 0.9 mmol). The reaction is stirred overnight and a solution of NaOH (1 mL, 1M) is added followed by a solution of H_2O_2 (1 mL, 30%). The reaction mixture is stirred at rt for 1h and extracted into ethyl acetate (3x 30 mL). The combined organic extracts are dried over magnesium sulfate and concentrated *en vacuo*. The crude reaction mixture is purified using column chromatography (50% ethyl acetate/petroleum ether) to provide the desired product as a white foam (82 mg, 85%). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.68-7.66 (m, 1H), 7.43 (dd, *J* = 8.4, 0.8 Hz, 1H), 7.31-7.21 (m, 7H), 7.11 (ddd, *J* = 8.0, 7.0, 0.9 Hz, 1H), 5.05 (d, *J* = 14.4 Hz, 1H), 4.74 (q, *J* = 5.4 Hz, 1H), 4.43 (d, *J* = 14.5 Hz, 1H), 3.86 (dd, *J* = 12.9, 4.2 Hz, 1H), 3.46 (dd, *J* = 12.9, 1.2 Hz, 1H), 3.34 (dtt, *J* = 11.6, 7.6, 4.0 Hz, 2H), 2.63-2.59 (m, 1H), 1.82 (dtd, *J* = 14.0, 6.8, 4.5 Hz, 1H), 1.70-1.63 (m, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 160.5, 136.9, 136.5, 129.16, 129.13, 128.34, 128.30, 127.6, 125.0, 123.0, 121.1, 110.4, 107.0, 58.9, 49.9, 49.0, 48.0, 35.5. **IR** (film): 3384, 2919, 1629, 1547, 1449, 1430, 1356, 1319, 1250, 1139, 1057, 743, 700 cm^{-1}. **$[\alpha]^{22}_D$**: – 25.0 (CH_2Cl_2, c 1.00). **HRMS** ($C_{20}H_{21}N_2O_2$): calculated (M + H): 321.1603, found (M + H): 321.1598.



(*S*)-2-(2-benzyl-1-oxo-1,2,3,4-tetrahydropyrazino[1,2-a]indol-4-yl)acetic acid (**7**)

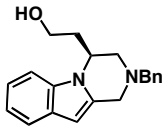
To a solution of alcohol **6** (32 mg, 0.1 mmol) in dichloromethane (0.5 mL, 0.2M) is added sodium bicarbonate (34 mg, 0.4 mmol), iodobenzene diacetate (81 mg, 0.25 mmol), and TEMPO (2 mg, 0.01 mmol). The reaction mixture is stirred at rt for 10h, and poured onto a concetrated solution of $Na_2S_2O_3$ (50 mL). The biphasic mixture is stirred for 0.5h and extracted into ethyl acetate (3x 30 mL). The combined organic extracts are treated with 1M NaOH until a pH of 11-13 is achieved. The desired carboxylate is extracted into the aqueous layer with sodium hydroxide (3x 30 mL 1M). The combined aqueous extracts are treated with 1M HCl until a pH of 1-3 is achieved. The desired acid is extracted from into ethyl acetate (3x 30mL). The combined organic layers are dried over magnesium sulfate and concentrated *en vacuo* to afford the desired product as a white foam (27 mg, 81%). ^{1}**H-NMR** ($CDCl_3$, 500 MHz): δ 7.72 (d, *J* = 8.1 Hz, 1H), 7.35-7.32 (m, 7H), 7.30-7.27 (m, 1H), 7.19-7.16 (m, 1H), 5.06 (d, *J* = 14.5 Hz, 1H), 4.92-4.89 (m, 1H), 4.54 (d, *J* = 14.5 Hz, 1H), 3.98 (dd, *J* = 13.2, 3.6 Hz, 1H), 3.65-3.62 (m, 1H), 2.67-2.54 (m, 2H). **^{13}C-NMR** ($CDCl_3$, 126 MHz): δ 177.6, 160.3, 136.4, 135.5, 129.2, 129.0, 128.3, 127.97, 127.93, 125.3, 123.3, 121.4, 109.8, 107.9, 50.0, 48.6, 47.2, 35.8, 30.0. **IR** (film): 3057, 2916, 2848, 1724, 1616, 1548, 1468, 1451, 1432, 1356, 1320, 1250, 1225, 1168, 1140, 743, 701. **$[\alpha]^{22}_D$**: –22.6 ($CHCl_3$, c 1.01).



(*S*)-2-benzyl-4-vinyl-1,2,3,4-tetrahydropyrazino[1,2-a]indole (**8**)

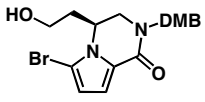
To a solution of olefin **5d** (302 mg, 1.0 mmol) in THF (10 mL, 0.1M) at 0 ºC is added $LiAlH_4$ (76 mg, 2.0 mmol). The reaction mixture is stirred for 4h while allowing to warm to rt. The reaction is cooled back down to 0 ºC, and sodium sulfate decahydrate (500 mg) is added portion-wise to destroy unreacted hydride. After several hours, the reaction mixture is filtered through celite and concentrated *en vacuo*. The crude reaction mixture is purified using column chromatography (10% ethyl ether/petroleum ether) to provide the desired product as a yellow oil

(206 mg, 72%) R_f = 0.5 (10% diethyl ether/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.54-7.52 (m, 1H), 7.39-7.27 (m, 6H), 7.11-7.05 (m, 2H), 6.18 (q, *J* = 1.0 Hz, 1H), 6.02 (ddd, *J* = 17.2, 10.2, 7.4 Hz, 1H), 5.24-5.17 (m, 2H), 4.82-4.79 (m, 1H), 3.98-3.95 (m, 1H), 3.75-3.64 (m, 3H), 2.93 (qdd, *J* = 11.9, 4.7, 0.9 Hz, 2H). **^{13}C-NMR** ($CDCl_3$, 126 MHz): δ 138.2, 137.9, 136.3, 134.8, 129.4, 129.05, 128.89, 127.8, 120.9, 120.5, 120.2, 117.5, 111.0, 97.2, 62.5, 57.1, 56.6, 52.1. **$[\alpha]^{22}_D$**: 20.6 (CH_2Cl_2, c 1.78). **IR (film)**: 3557, 3025, 2799, 2751, 1456, 1216, 1361, 1331, 746, 698 cm^{-1}.



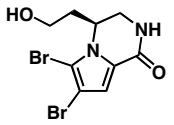
(*S*)-2-(2-benzyl-1,2,3,4-tetrahydropyrazino[1,2-a]indol-4-yl)ethanol (**9**)

To a solution of olefin **8** (100 mg, 0.33 mmol) in THF (3.5 mL, 0.1M) at rt is added solid, freshly prepared dicyclohexylborane (178 mg, 1.0 mmol). The reaction is stirred overnight and a solution of NaOH (1 mL, 1M) followed by a solution of H_2O_2 (1 mL, 30%). The reaction mixture is stirred at rt for 1h and extracted into ethyl acetate (3x 30 mL). The combined organic extracts are dried over magnesium sulfate and concentrated *en vacuo*. The crude reaction mixture is purified using column chromatography (40% ethyl acetate/petroleum ether) to provide the desired product as a yellow oil (99 mg, 93%). **R_f** = 0.3 (30% ethyl acetate/petroleum ether). **^{1}H-NMR** ($CDCl_3$, 400 MHz): δ 7.53 (d, *J* = 7.4 Hz, 1H), 7.41-7.32 (m, 5H), 7.25-7.22 (m, 1H), 7.15-7.06 (m, 2H), 6.31 (s, 1H), 6.14 (s, 1H), 4.75 (d, *J* = 1.1 Hz, 1H), 4.12 (dd, *J* = 14.6, 1.4 Hz, 1H), 3.88 (d, *J* = 12.4 Hz, 1H), 3.58 (d, *J* = 12.4 Hz, 1H), 3.38 (dd, *J* = 14.5, 1.3 Hz, 1H), 3.27-3.18 (m, 2H), 2.85 (dd, *J* = 12.0, 4.6 Hz, 1H), 2.57-2.48 (m, 2H), 1.90 (dddd, *J* = 14.8, 11.4, 3.3, 1.4 Hz, 1H). **^{13}C-NMR** ($CDCl_3$, 101 MHz): δ 135.8, 135.1, 133.9, 130.1, 129.20, 129.07, 128.5, 121.2, 120.9, 120.4, 110.2, 97.4, 63.5, 56.7, 56.3, 51.14, 50.98, 36.9. **IR** (film): 3377, 3055, 2923, 1456, 1421, 1360, 1332, 1059, 748, 699 cm^{-1}. **$[\alpha]^{22}_D$**: 90.9 (CH_2Cl_2, c 1.20).



(*S*)-6-Bromo-2-(2,4-dimethoxy-benzyl)-4-(2-hydroxy-ethyl)-3,4-dihydro-2H-pyrrolo[1,2-a]pyrazin-1-one (**10**)

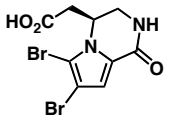
9-BBN (99 mg, 0.40 mmol) was added to a solution of **5b** (105 mg, 0.27 mmol) in THF (2 ml) at 0 ºC under N_2. The resulting solution was stirred at rt for 3 h, before it was quenched with $NaBO_3 \cdot H_2O$ (81mg, 0.81 mmol) and H_2O (1 ml). The mixture was stirred at rt for 12h before it was extracted with ethyl acetate (20 ml x 3). The combined organic fraction was dried over $MgSO_4$. Compound **2.21** was purified via silica gel flash column chromatography (5% MeOH in CH_2Cl_2) to give a white foam (90 mg, with 7.7 mg starting material recovered, 82%, brsm 88%): $\mathbf{R}_f$: 0.40 (10% MeOH in CH_2Cl_2); $[\alpha]_D$: –31.64 (c 0.35, CH_2Cl_2); **^{1}H NMR** ($CDCl_3$, 500 MHz): δ 7.28 (m, 1H), 6.92 (d, *J* = 4.0 Hz, 1H), 6.45 (m, 2H), 6.23 (d, *J* = 4.0 Hz, 1H), 5.00 (d, *J* = 14.5 Hz, 1H), 4.42 (m, 1H), 4.35 (d, *J* = 14 Hz, 1H), 3.81 (s, 3H), 3.81 (s, 3H), 3.77 (m, 1H), 3.56 (dd, *J* = 13, 1.5 Hz, 1H), 3.47 (m, 1H), 3.33 (m, 1H), 1.72 (m, 2H); **^{13}C-NMR** ($CDCl_3$, 126 MHz) δ 160.7, 158.8, 158.4, 132.3, 125.2, 117.4, 114.2, 112.3, 104.4, 103.7, 98.5, 59.1, 55.5, 50.2, 47.6, 43.2, 35.0, 30.4; **IR** (film) 3383 (br), 2923, 2851, 1660, 1615, 1417, 1209 cm^{-1}; **HRMS** ($C_{18}H_{21}BrN_2O_4$): Calc'd. 410.066422 (M^+), Found 410.068069.



(*S*)-6,7-Dibromo-4-(2-hydroxy-ethyl)-3,4-dihydro-2H-pyrrolo[1,2-a]pyrazin-1-one (**11**)

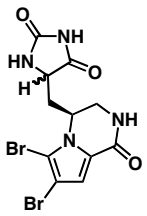
TFA (0.6 ml) was added to a solution of **10** (58 mg, 0.14 mmol), tetrahydrothiophene (59.4 mg, 0.68 mmol) in CH_2Cl_2 (0.6 ml) at rt. The resulting brown solution was stirred at 50 ºC for 20 hr, before poured into pre-cooled sat. $NaHCO_3$ solution. The mixture was extracted with ethyl acetate (20 ml x 3), and the combined organic fraction was dried over Na_2SO_4. The products, as a ca. 2:1 mixture (mono-bromo-product and debromo-product) were purified via silica gel flash column chromatography (10% MeOH/CH_2Cl_2). The mixture was then dissolved with THF (1 ml) and MeOH (0.5 ml). At 0 ºC, NBS (37 mg, 0.21 mmol) was added portionwisely to the above solution. The resulting solution was stirred at rt for 0.5 hr before the solvents were removed under vacuum. Compound **11** was purified via silica gel flash column chromatography (5% MeOH in CH_2Cl_2) to give a white foam (46.1 mg, 96% over two steps): $\mathbf{R}_f$: 0.50 (10% MeOH in ethyl acetate); **$[\alpha]_D$**: –27.3 (c 0.6, MeOH); **^{1}H NMR** (CD_3OD, 400 MHz): δ 6.92 (s, 1H), 4.60 (m, 1H), 3.80 (dd, *J* = 13.6, 4.0 Hz, 1H), 3.69-3.64 (m, 3H), 2.00 (m, 1H), 1.85 (m, 1H); **^{13}C-NMR** (CD_3OD, 101 MHz) δ 161.1, 126.1, 116.4, 108.1, 101.3, 59.3, 53.3, 43.4, 35.5; **IR** (film)

3308 (br), 2927, 2882, 1652, 1550, 1465, 1429, 1338 cm^{-1}; **HRMS** ($C_9H_{10}Br_2N_2O_2$): Calc'd. 335.910900 (M^+), Found 335.910485.



Longamide B: (*S*)-2-(6,7-dibromo-1-oxo-1,2,3,4-tetrahydropyrrolo[1,2-*a*]pyrazin-4-yl)acetic acid (**12**)

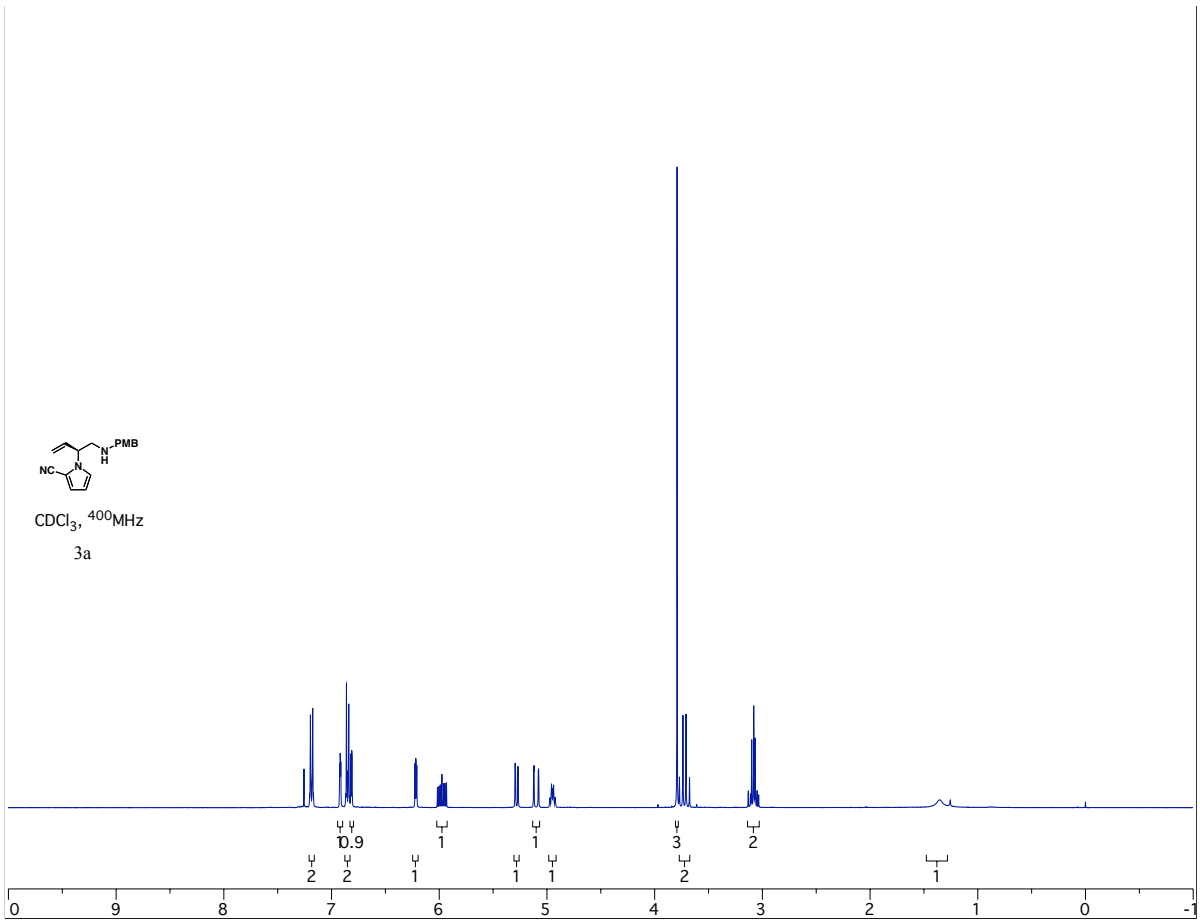
TEMPO (0.44 mg, 0.0028 mmol) was added to a mixture of compound **11** (9.5 mg, 0.028 mmol), $PhI(OAc)_2$ (22.7 mg, 0.0705 mmol) and $NaHCO_3$ (9.4 mg, 0.112 mmol) in CH_2Cl_2 (0.15 ml) at rt under air. The resulting solution was stirred at rt for 3 hr, before quenched with sat. $Na_2S_2O_3$ and sat. $NaHCO_3$. The mixture was diluted with ethyl acetate, and longamide B (**12**) was further purified via a classical acid-base treatment as a white powder (9.3 mg, 95%). **mp** 203-204 ºC (decomposed to black tar); $[\alpha]_D$: –8.21 (c 0.52, MeOH); **^{1}H NMR** (CD_3OD, 500 MHz): δ 6.94 (s, 1H), 4.81 (m, 1H), 3.89 (ddd, *J* = 13.5, 4.5, 1.5 Hz, 1H), 3.66 (dd, *J* = 13.5, 1.5 Hz, 1H), 2.86 (dd, *J* = 16.5, 11 Hz, 1H), 2.55 (ddd, *J* = 16.5, 3.5, 1.5 Hz, 1H); IR: 3282, 3203, 2924, 1715, 1645, 1558, 1428 cm^{-1}; **HRMS** ($C_9H_8Br_2N_2O_3$): Calc'd. 349.890164 (M^+), Found 349.889306.



Agesamides A and B: (4S)-6,7-dibromo-4-((2-imino-5-oxoimidazolidin-4-yl)methyl)-3,4-dihydropyrrolo[1,2-a]pyrazin-1(2H)-one (**15** and **16**)

Dess–Martin periodane (34.3 mg, 0.081 mmol) was added to a mixture of compound **11** (16.5 mg, 0.040 mmol), $NaHCO_3$ (10.1 mg, 0.12 mmol) in CH_2Cl_2 (0.4 ml) at 0 ºC. The resulting suspension was stirred at rt for 0.5 hr, before quenched with sat. $Na_2S_2O_3$ and sat. $NaHCO_3$. The mixture was extracted with ethyl acetate (10 ml x 3), and the combined organic fraction was dried over Na_2SO_4. The solvent was removed, and the resultant aldehyde with $(NH_4)_2CO_3$ (8.8 mg, 0.1125 mmol) and KCN (3.0 mg, 0.045 mmol) was then dissolved in EtOH/H_2O (1:1, 0.4 ml). The resulting solution was stirred vigorously at 60 ºC overnight. The solvents were

removed under vacuum, and agesamides A and B (**15** and **16**) was purified via preparative silica gel TLC (10% MeOH in ethyl acetate) as a white solid (1:1 mixture, 17.5 mg, 100 % over two steps): $\mathbf{R}_f$: 0.35 (10% MeOH in ethyl acetate); **^{1}H NMR** (DMSO-d_6, 400 MHz): δ 10.80 (br, 1H), 8.18 (s, 1H), 8.04 (s, 1H), 7.89-7.88 (2H), 6.85 (s, 2H), 4.65 (m, 1H), 4.53 (d, J = 11.2 Hz, 1H), 4.20 (ddd, J = 11, 3.0, 1.5 Hz, 1H), 4.13 (m, 1H), 3.78-3.70 (2H), 3.54-3.46 (2H), 2.12 (ddd, J = 14, 11.5, 3.5 Hz, 1H), 2.04 (ddd, J = 14.0, 9.0, 7.0 Hz, 1H), 1.79 (m, 1H), 1.53 (m, 1H); **^{13}C-NMR** (DMSO-d_6, 101 MHz) δ 175.2, 174.9, 157.53, 157.46, 157.2, 157.1, 125.5, 114.0, 113.9, 105.71, 105.67, 99.3, 54.6, 54.3, 50.6, 41.7, 40.2, 33.8, 33.5; **IR**: 3228 (br), 2926, 2854, 1724, 1646, 1550, 1429, 1338 cm^{-1}; **HRMS** ($C_{11}H_{10}Br_2N_4O_3$): Calc'd. 403.911963 (M^+), Found 403.910347.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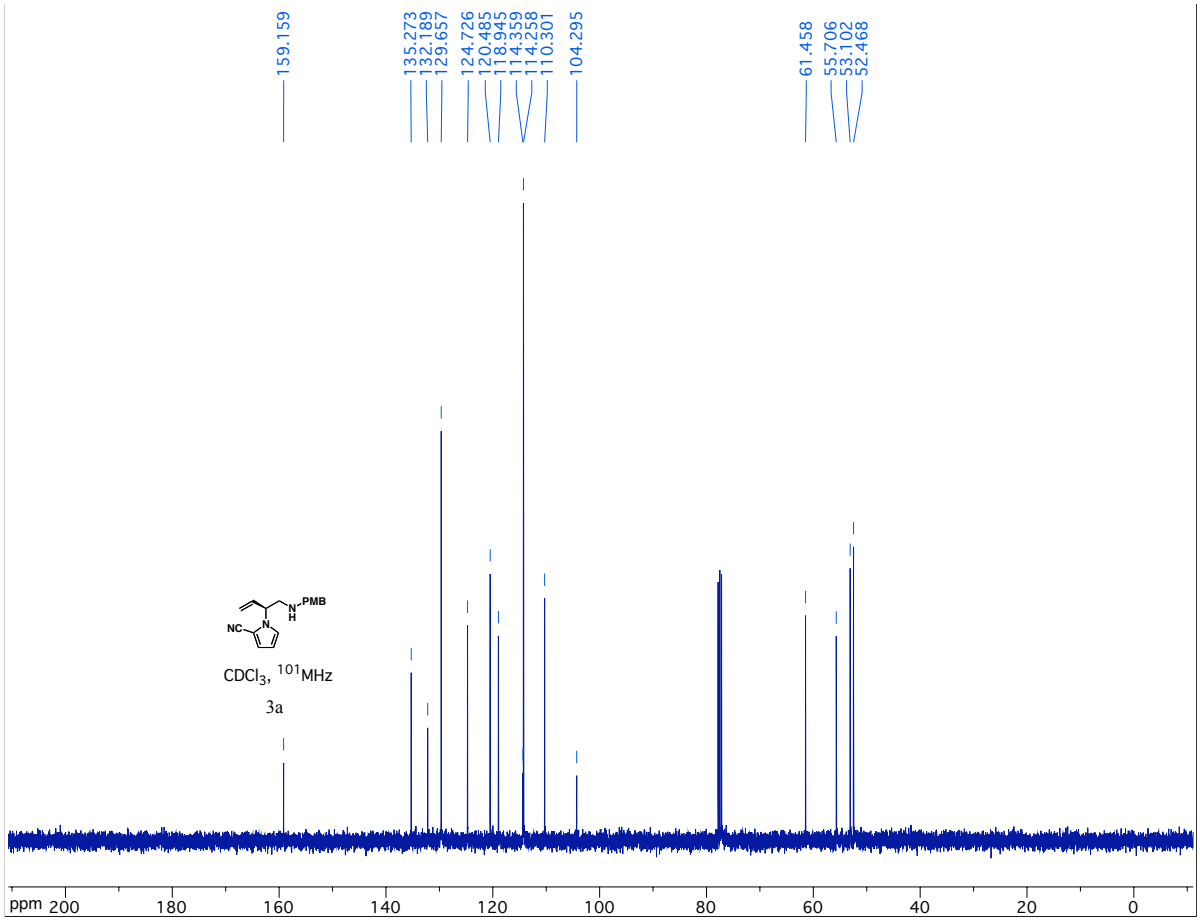
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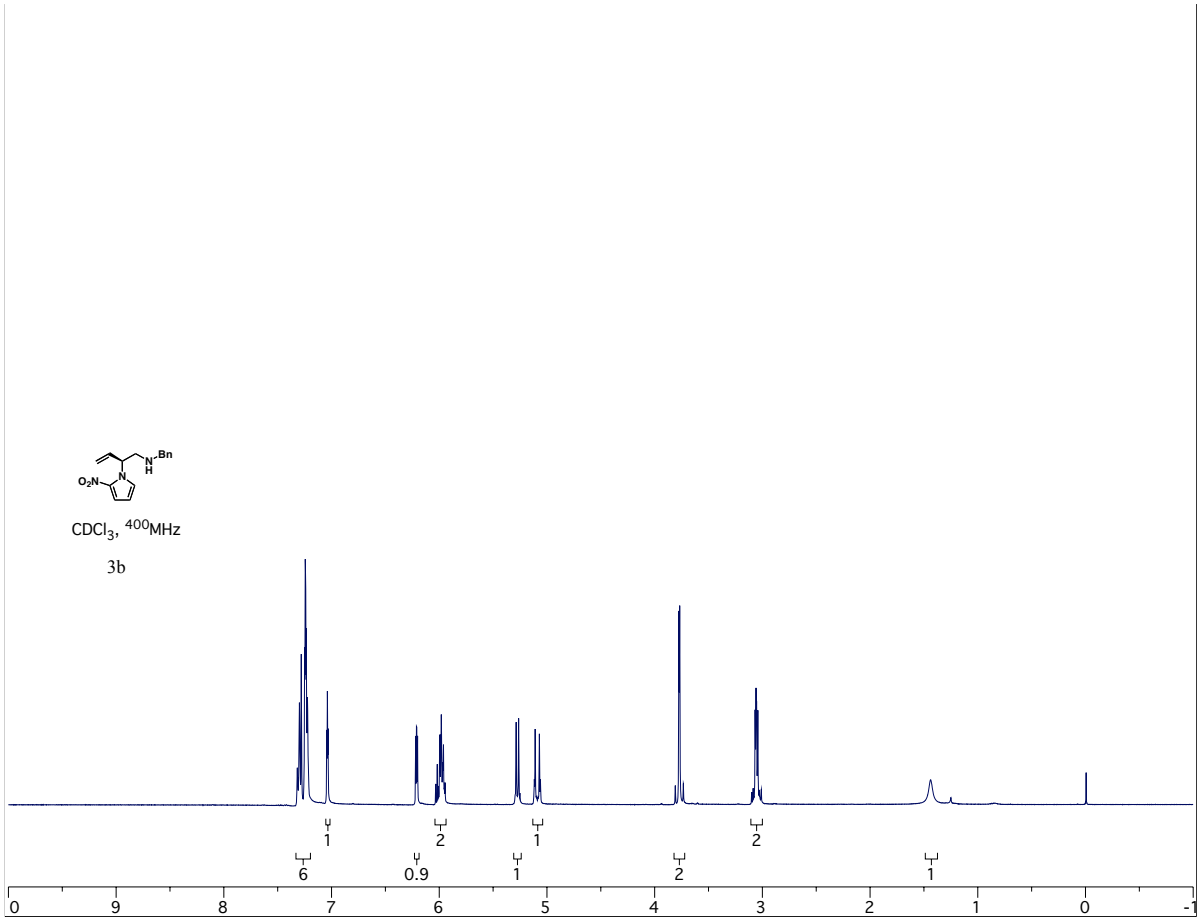
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8
7
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5
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2
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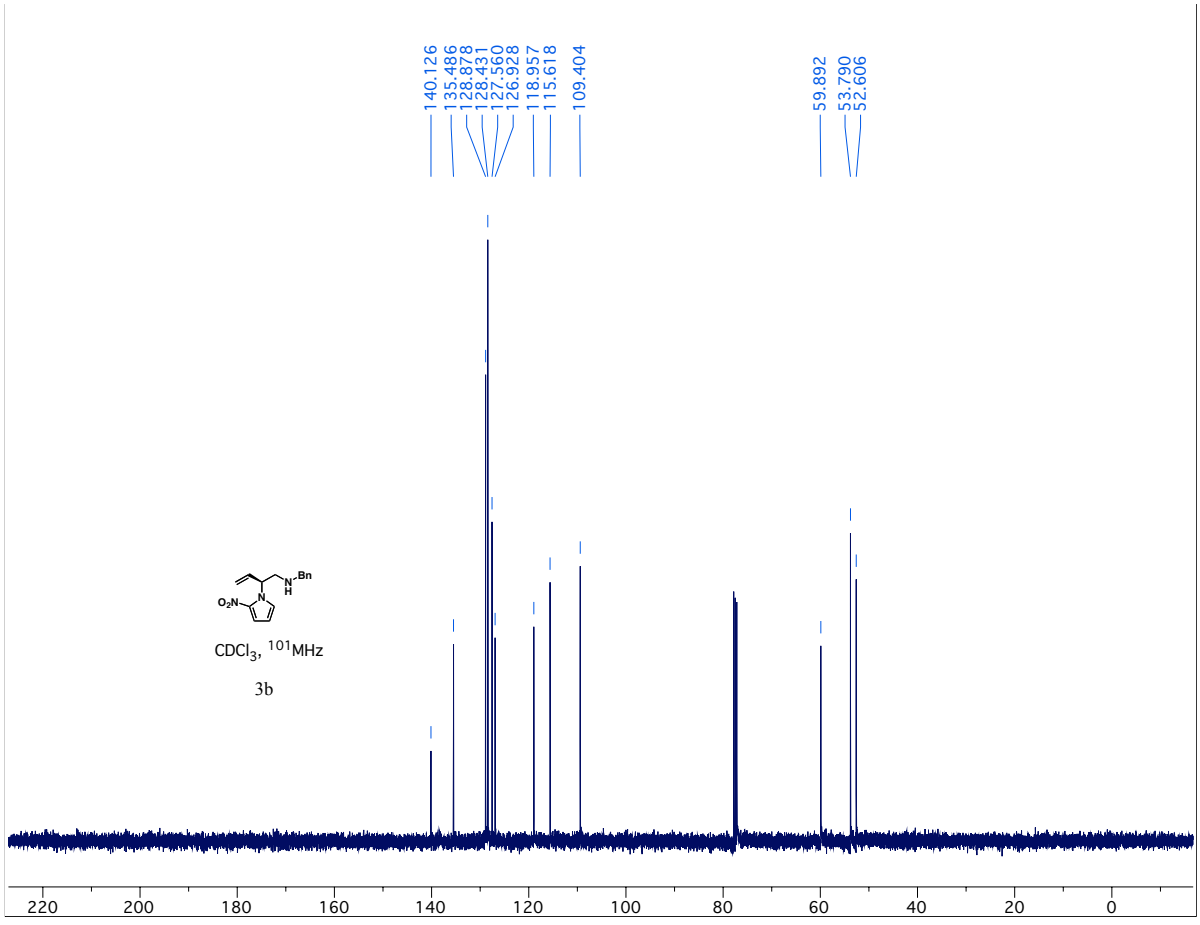
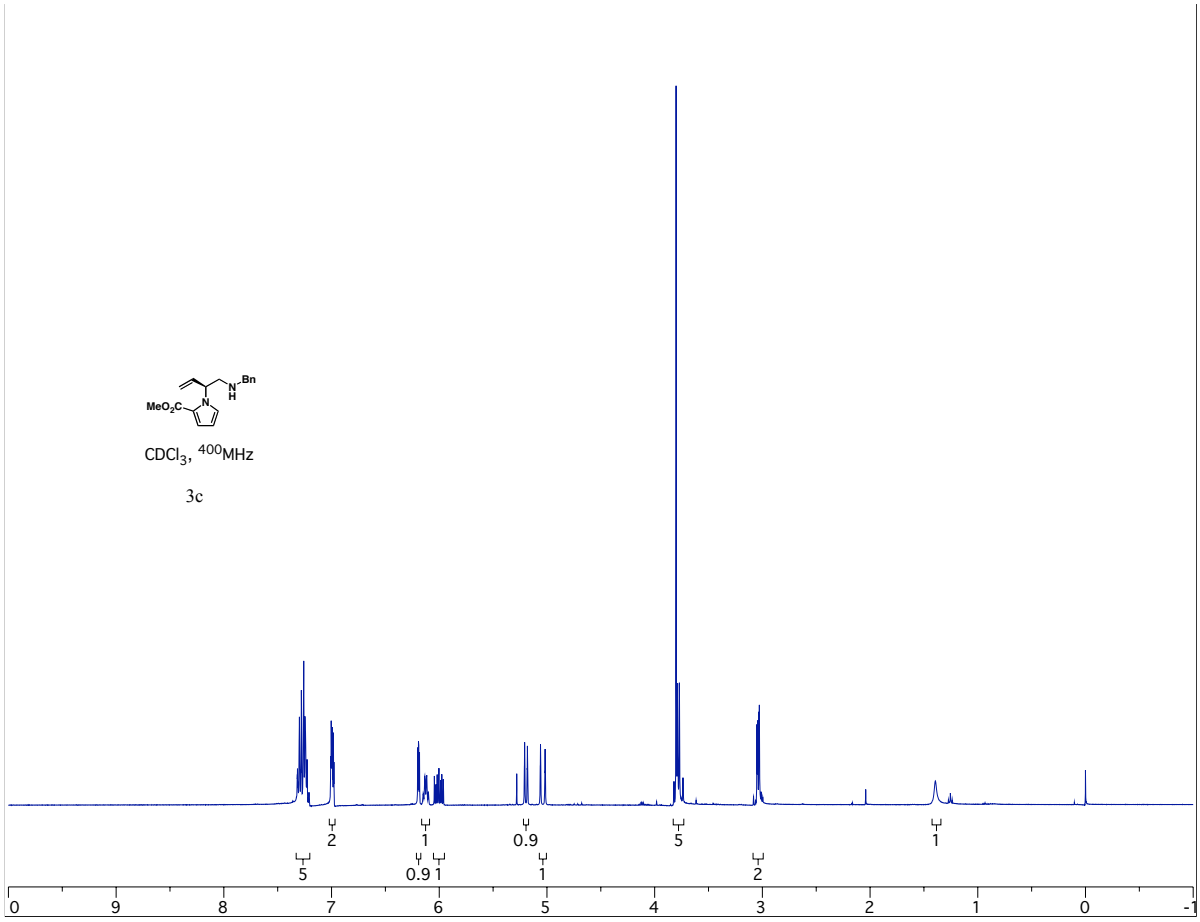
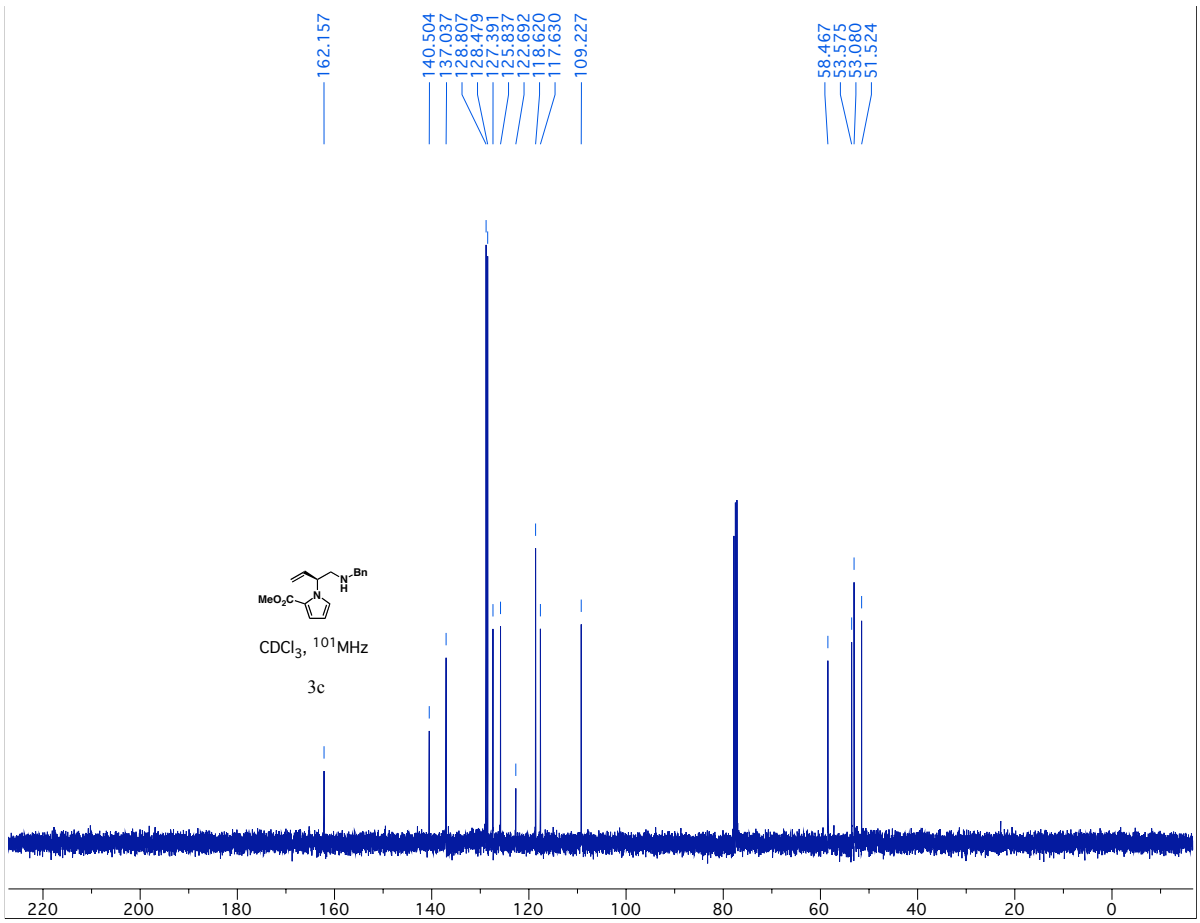
0
-1


140.126
135.486
128.878
128.431
127.560
126.928
118.957
115.618
109.404
59.892
53.790
52.606
CDCl3, 101MHz
3b
220
200
180
160
140
120
100
80
60
40
20
0


MeO2C
N
H
Bn
CDCl3, 400MHz
3c
2
1
0.9
5
1
5
0.9
1
1
2
0
9
8
7
6
5
4
3
2
1
0
-1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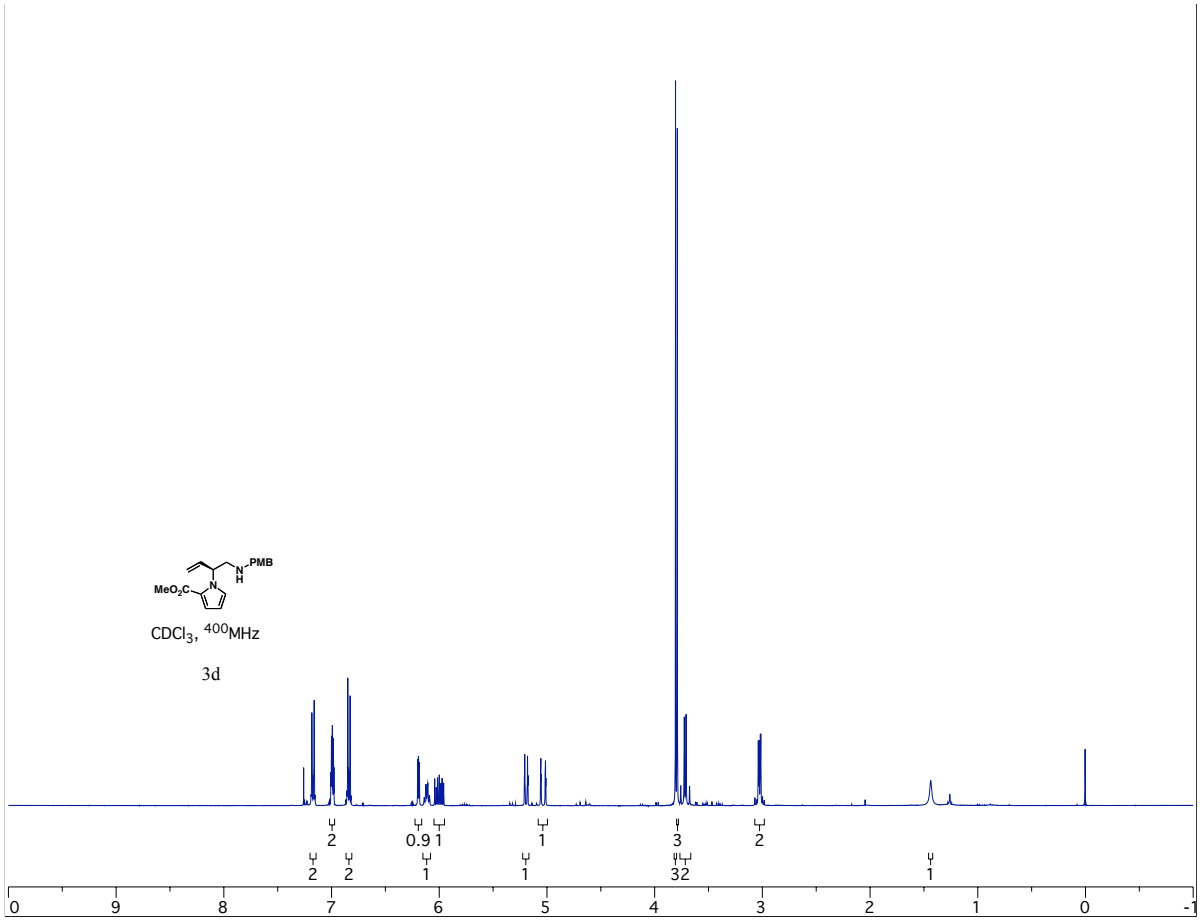
140.504
137.037
128.807
128.479
127.391
125.837
122.692
118.620
117.630
109.227
58.467
53.575
53.080
51.524
MeO2C
N
H
Bn
CDCl3, 101MHz
3c
220
200
180
160
140
120
100
80
60
40
20
0


MeO2C
N
H
PMB
CDCl3, 400MHz
3d
2
2
0.9
1
1
1
3
32
2
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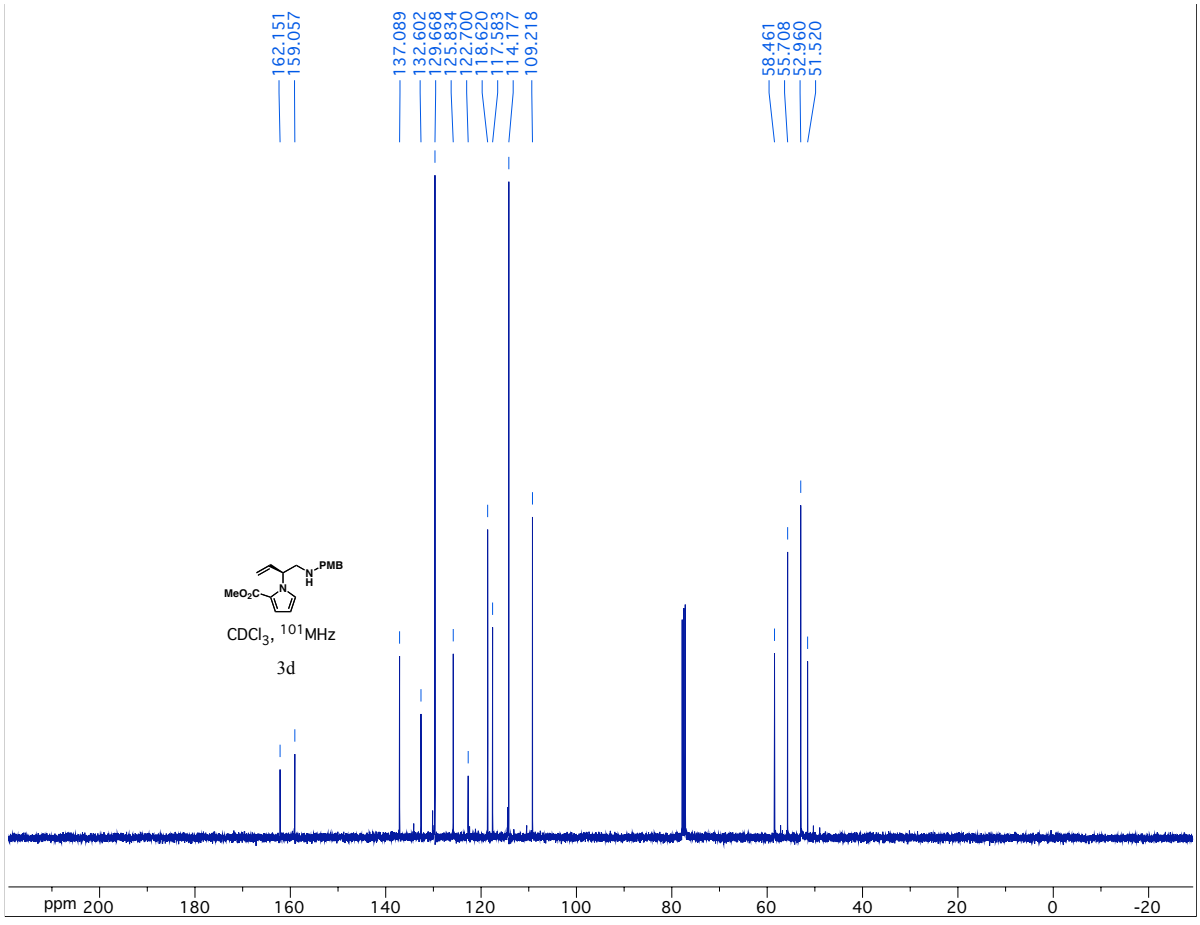
0
9
8
7
6
5
4
3
2
1
0
-1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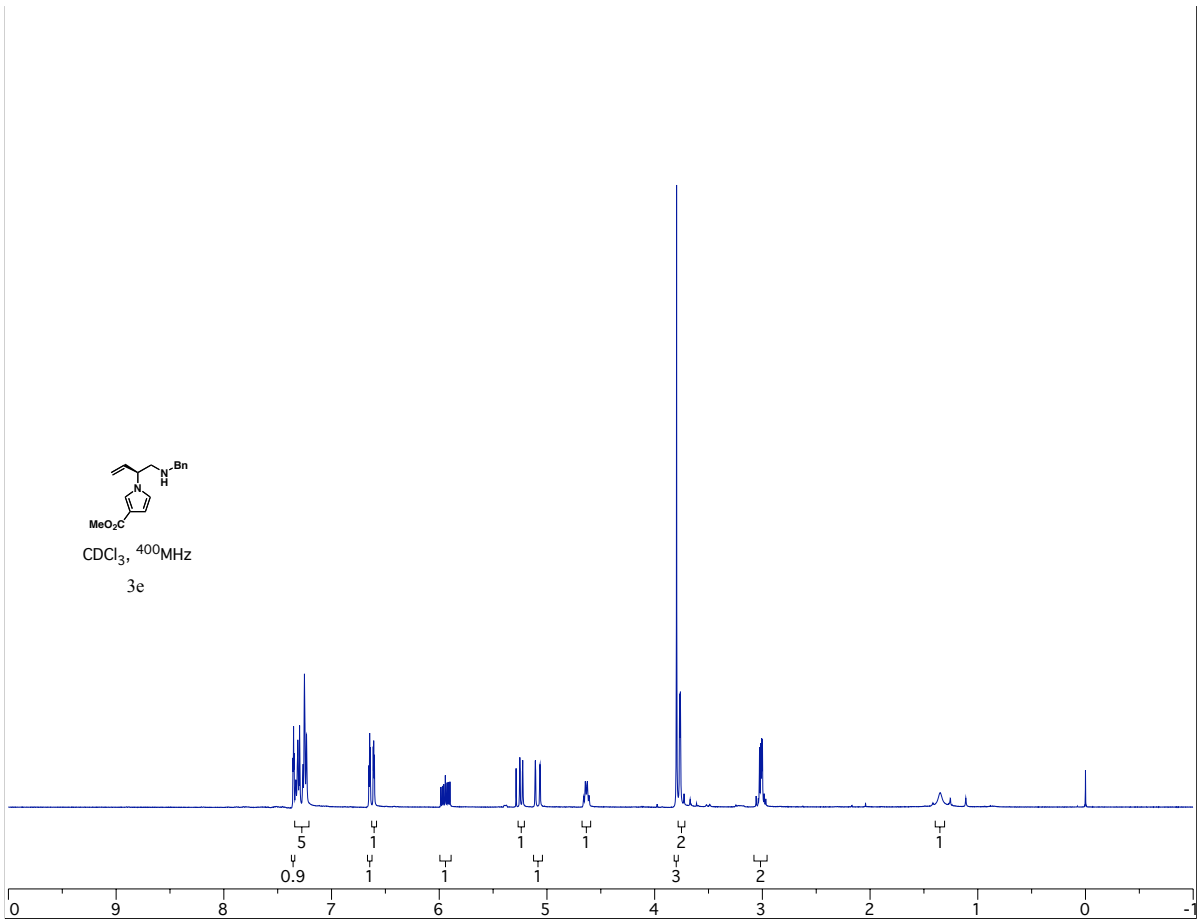
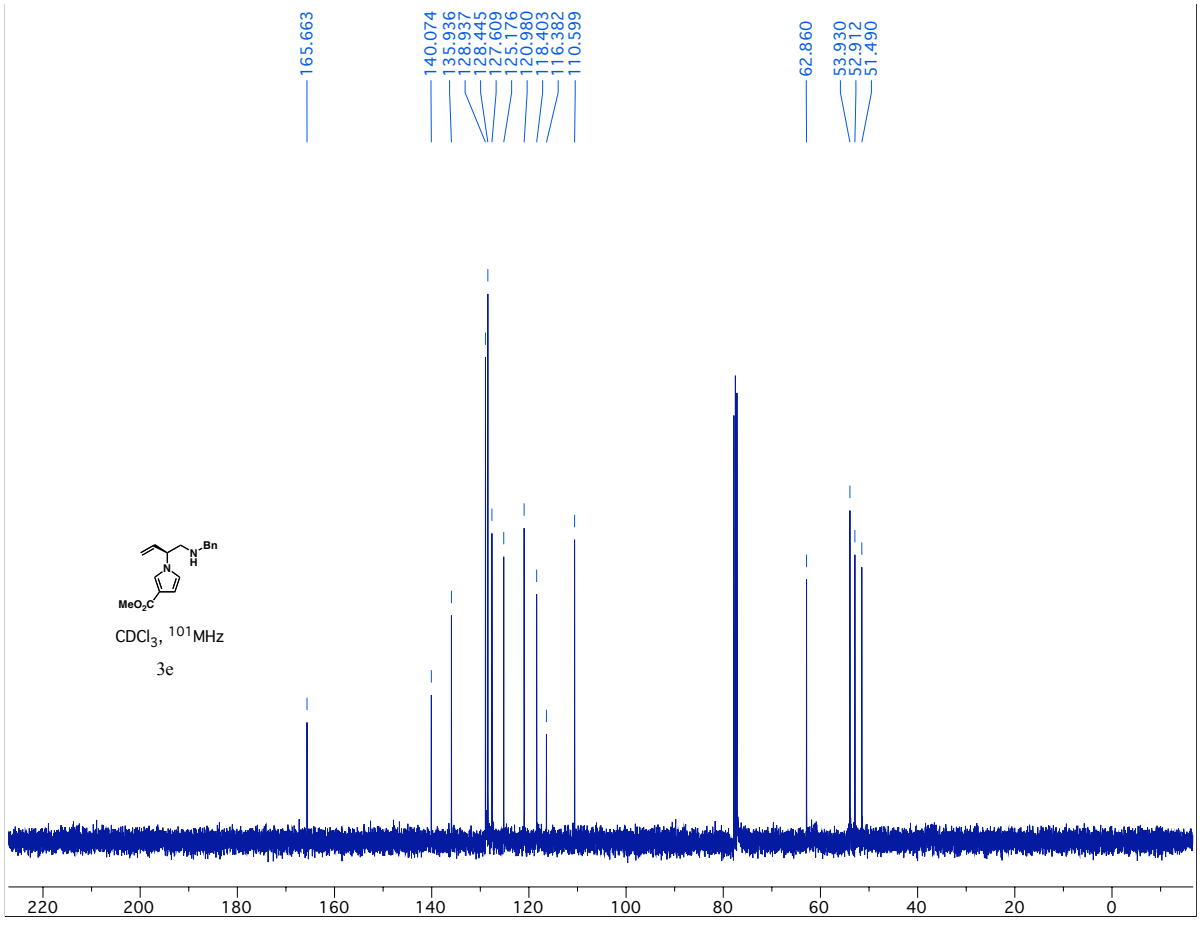
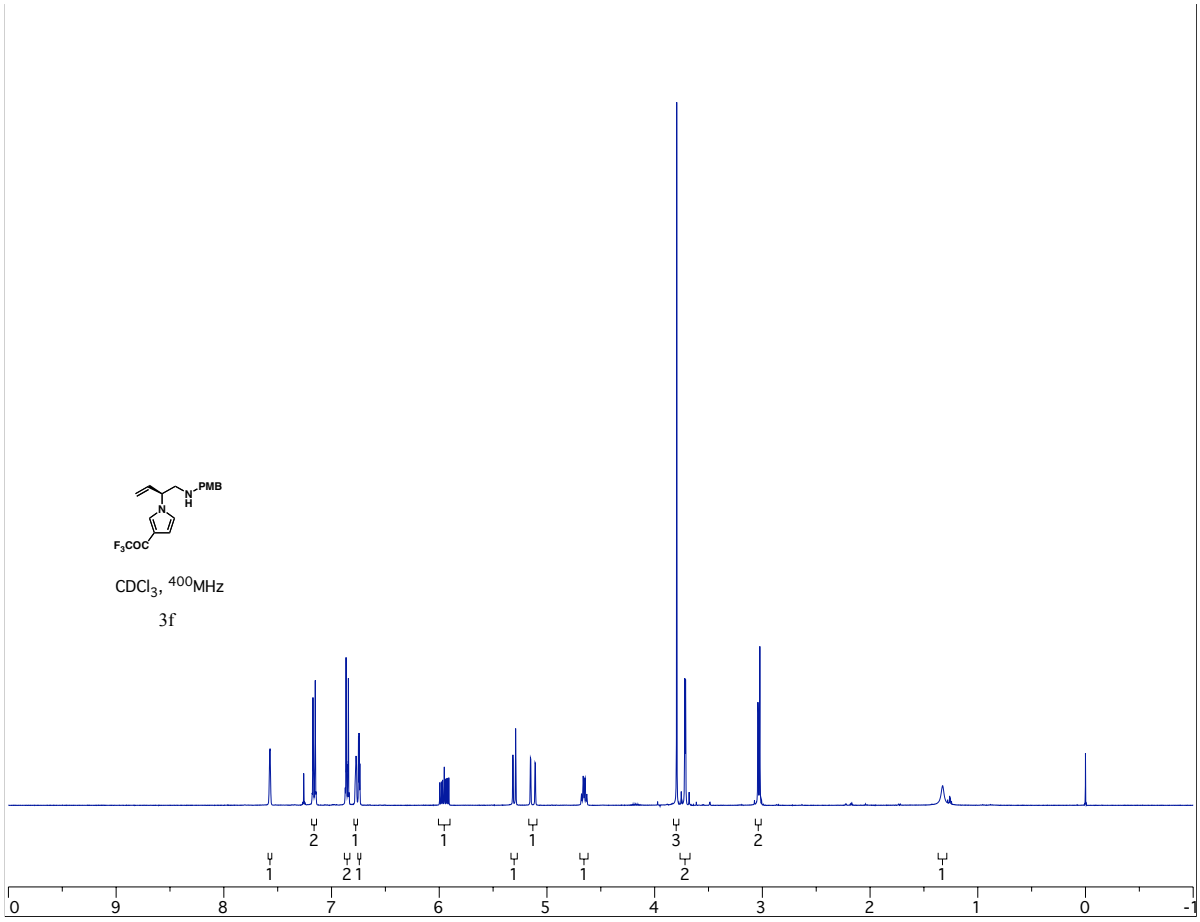
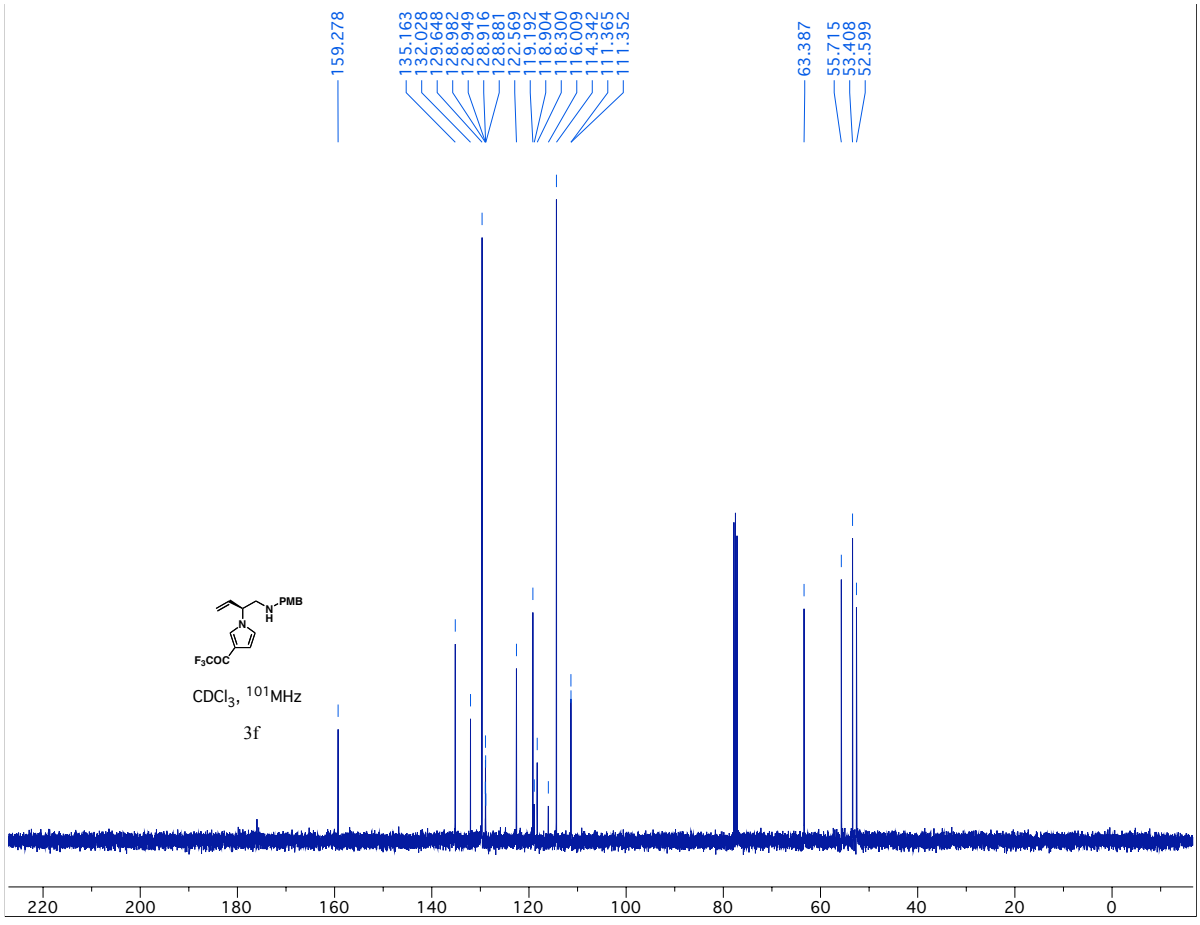
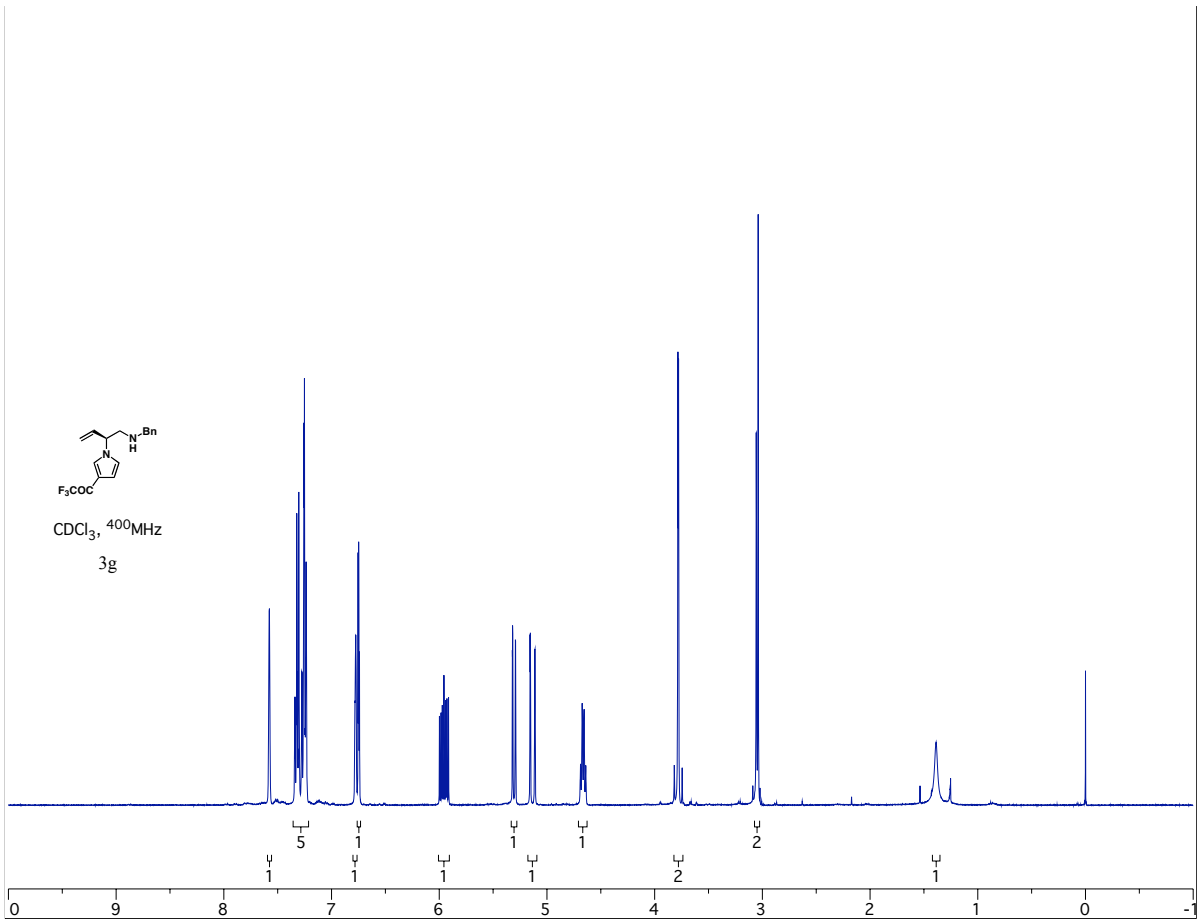
159.057
137.089
132.602
129.668
125.834
122.700
118.620
117.583
114.177
109.218
58.461
55.708
52.960
51.520
MeO2C
N
H
PMB
CDCl3, 101MHz
3d
ppm
200
180
160
140
120
100
80
60
40
20
0
-20

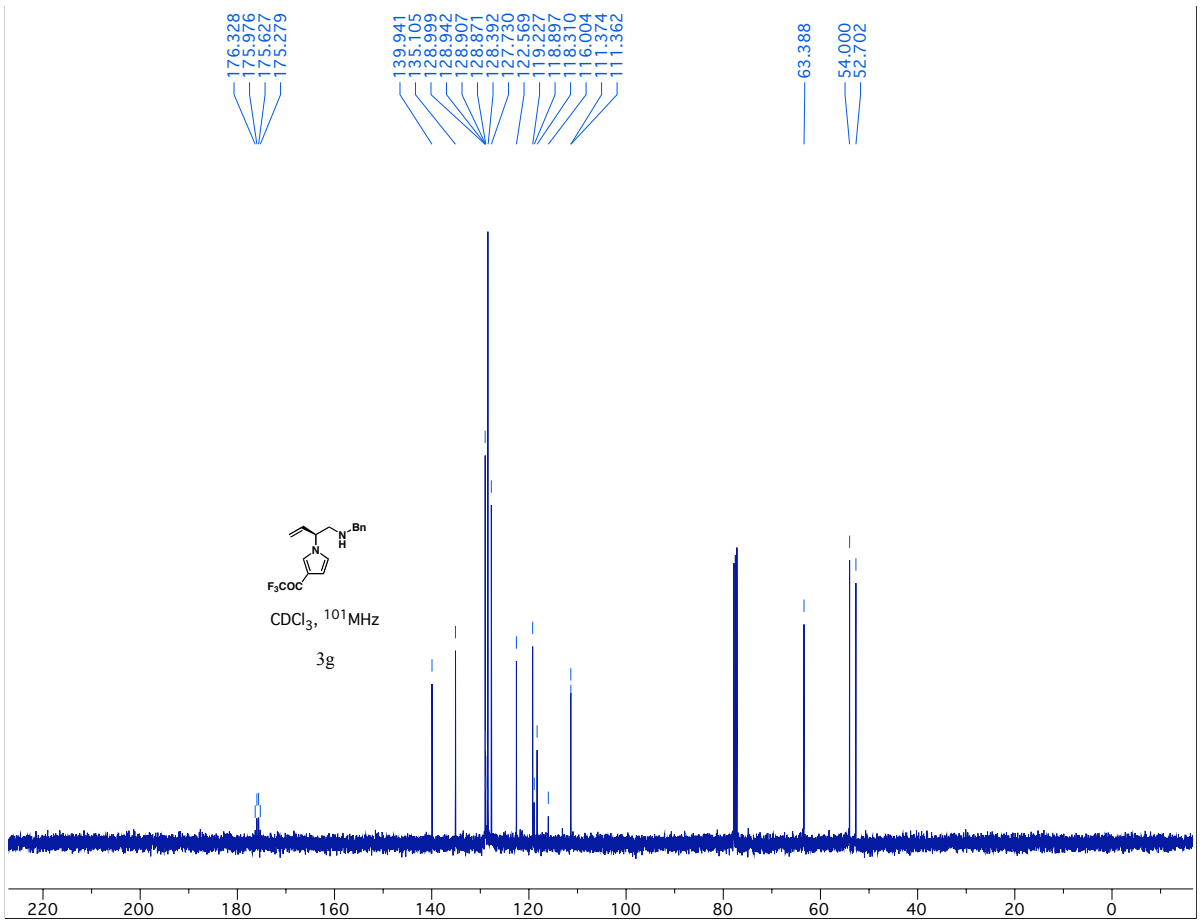

CDCl3, 400MHz
3e

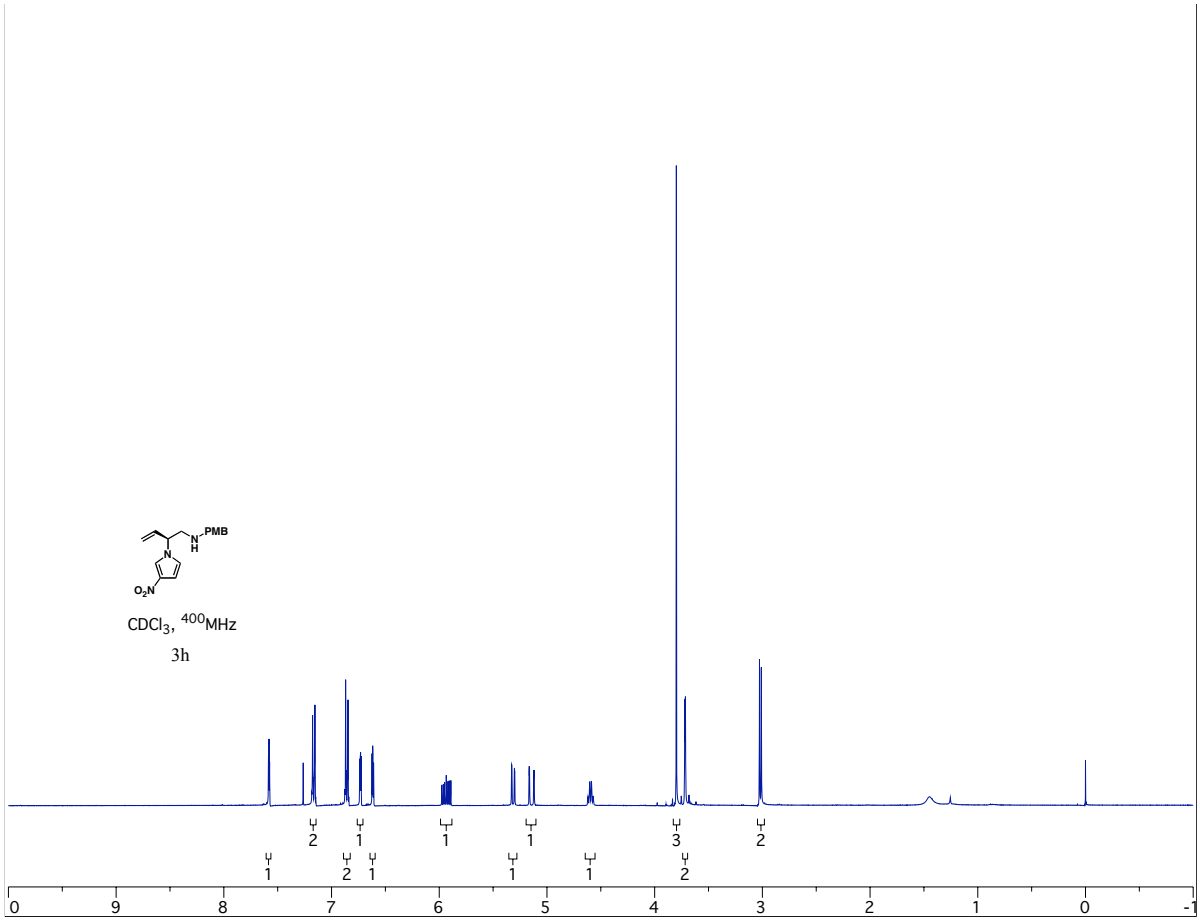

165.663
140.074
135.936
128.937
128.445
127.609
125.176
120.980
118.403
116.382
110.599
62.860
53.930
52.912
51.490
CDCl3, 101MHz
3e

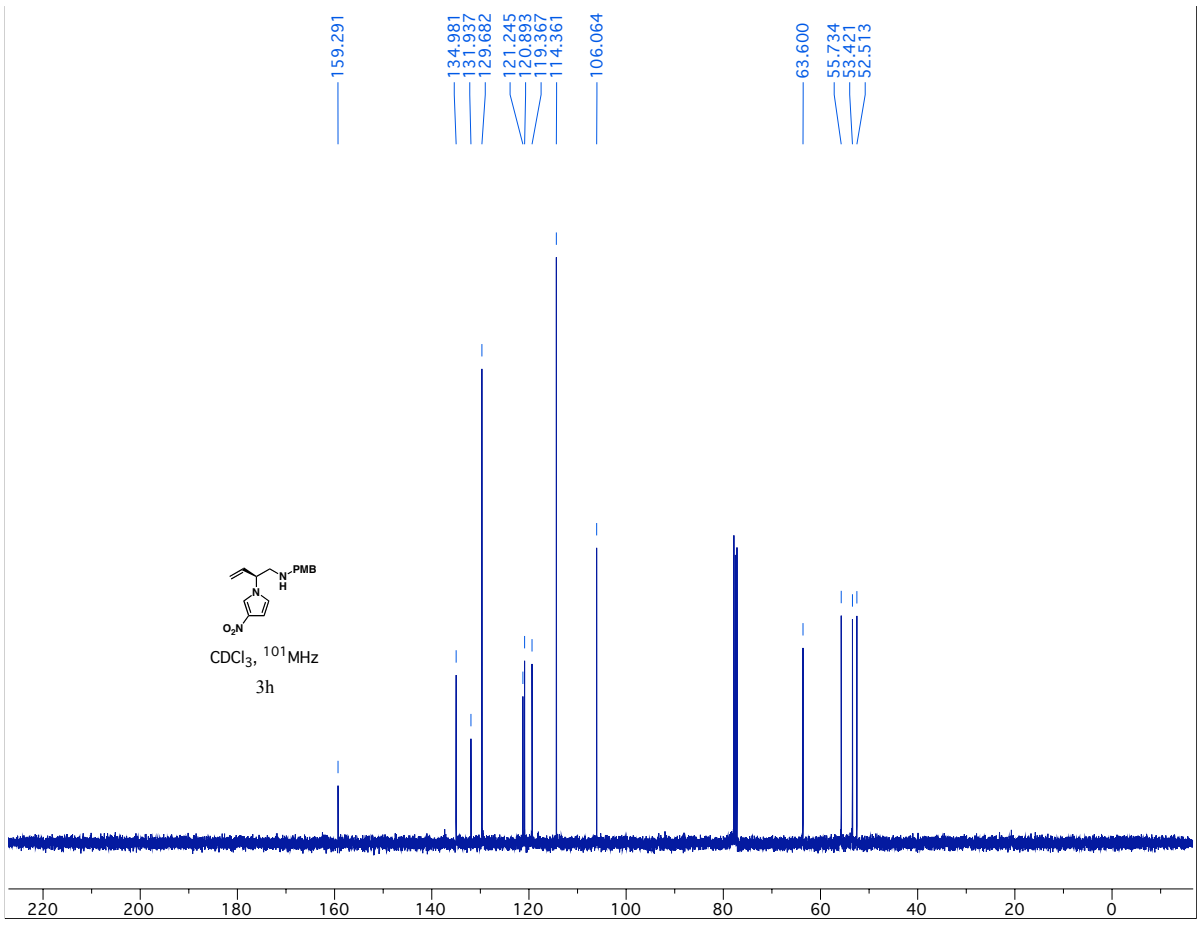

PMB
N
H
N
F3COC
CDCl3, 400MHz
3f
2
1
1
1
3
2
1
2 1
1
1
2
1
0
9
8
7
6
5
4
3
2
1
0
-1

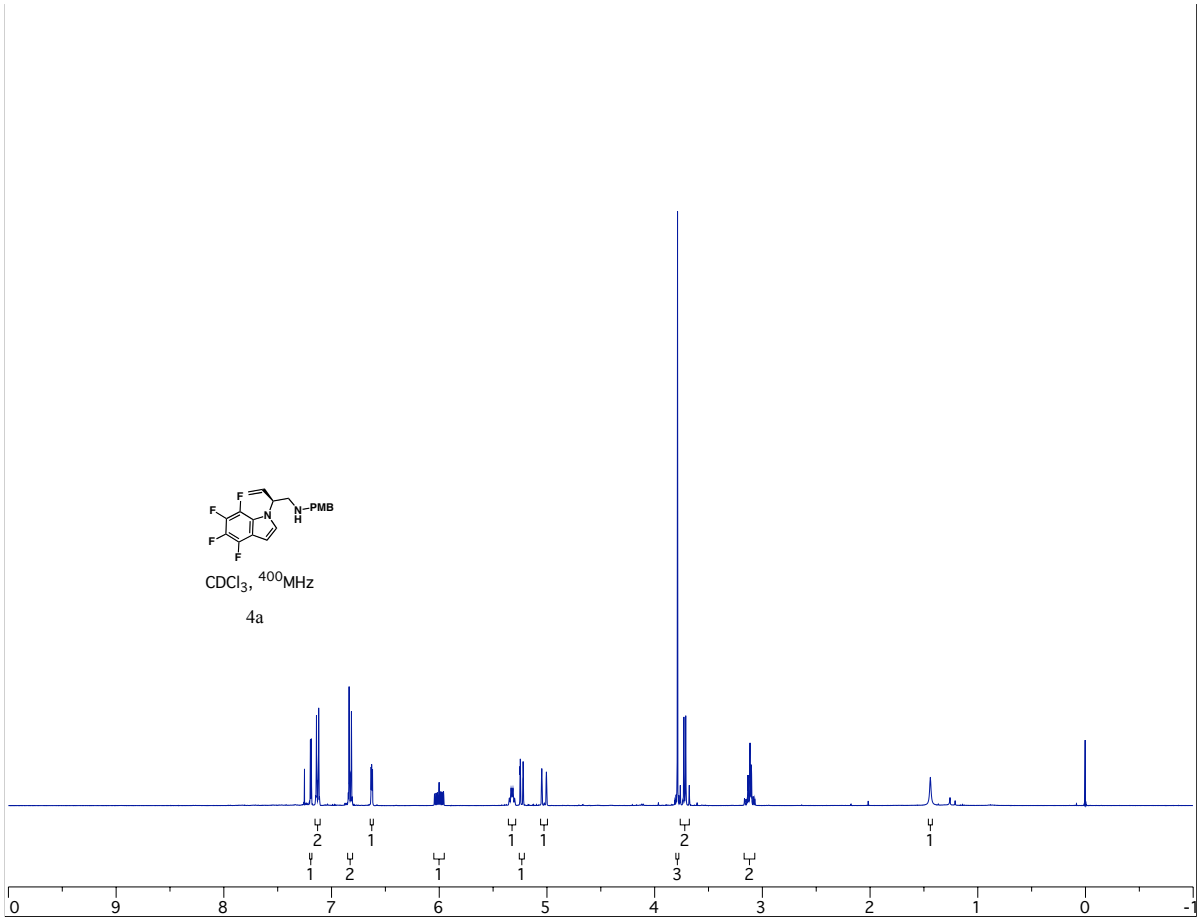

159.278
135.163
132.028
129.648
128.982
128.949
128.916
128.881
122.569
119.192
118.904
118.300
116.009
114.342
111.365
111.352
63.387
55.715
53.408
52.599
PMB
N
H
N
F3COC
CDCl3, 101MHz
3f
220
200
180
160
140
120
100
80
60
40
20
0

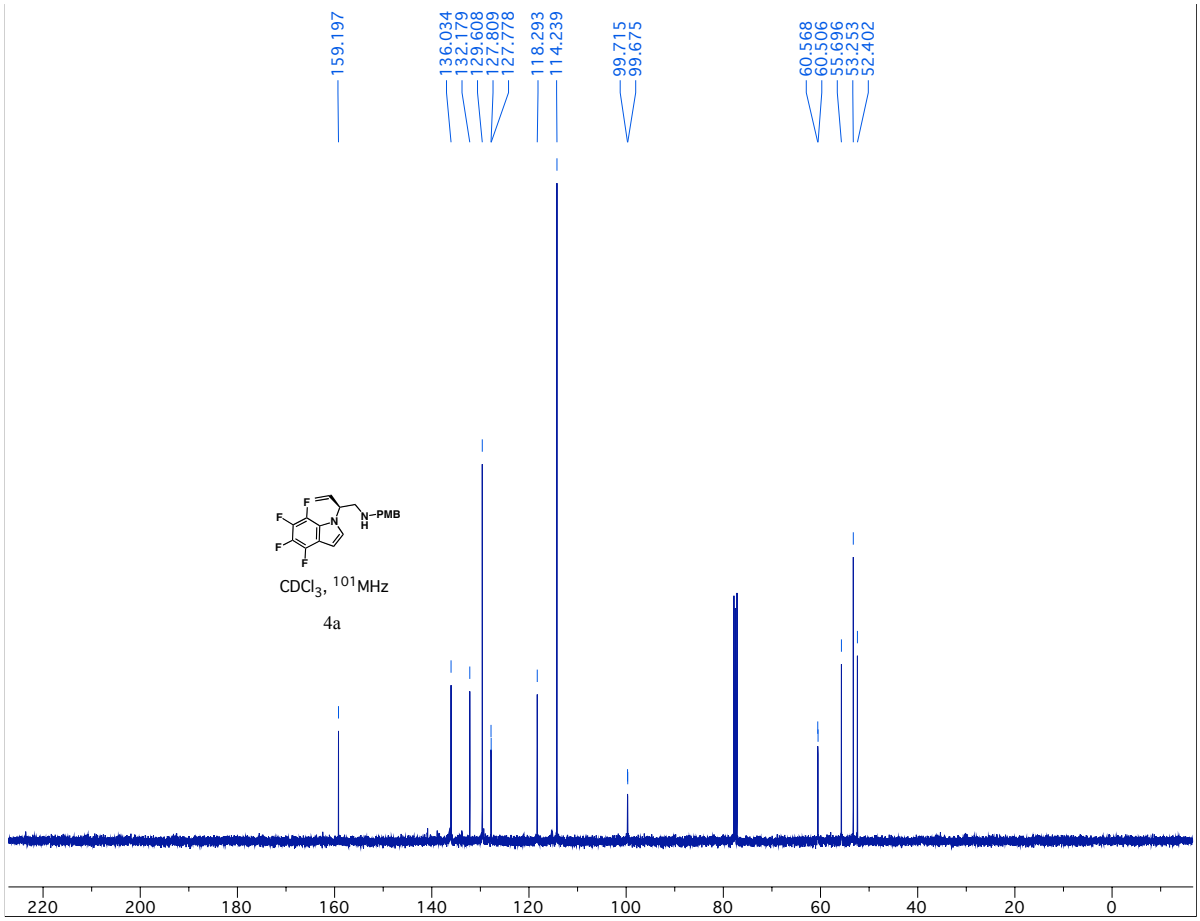

CDCl3, 400MHz
3g

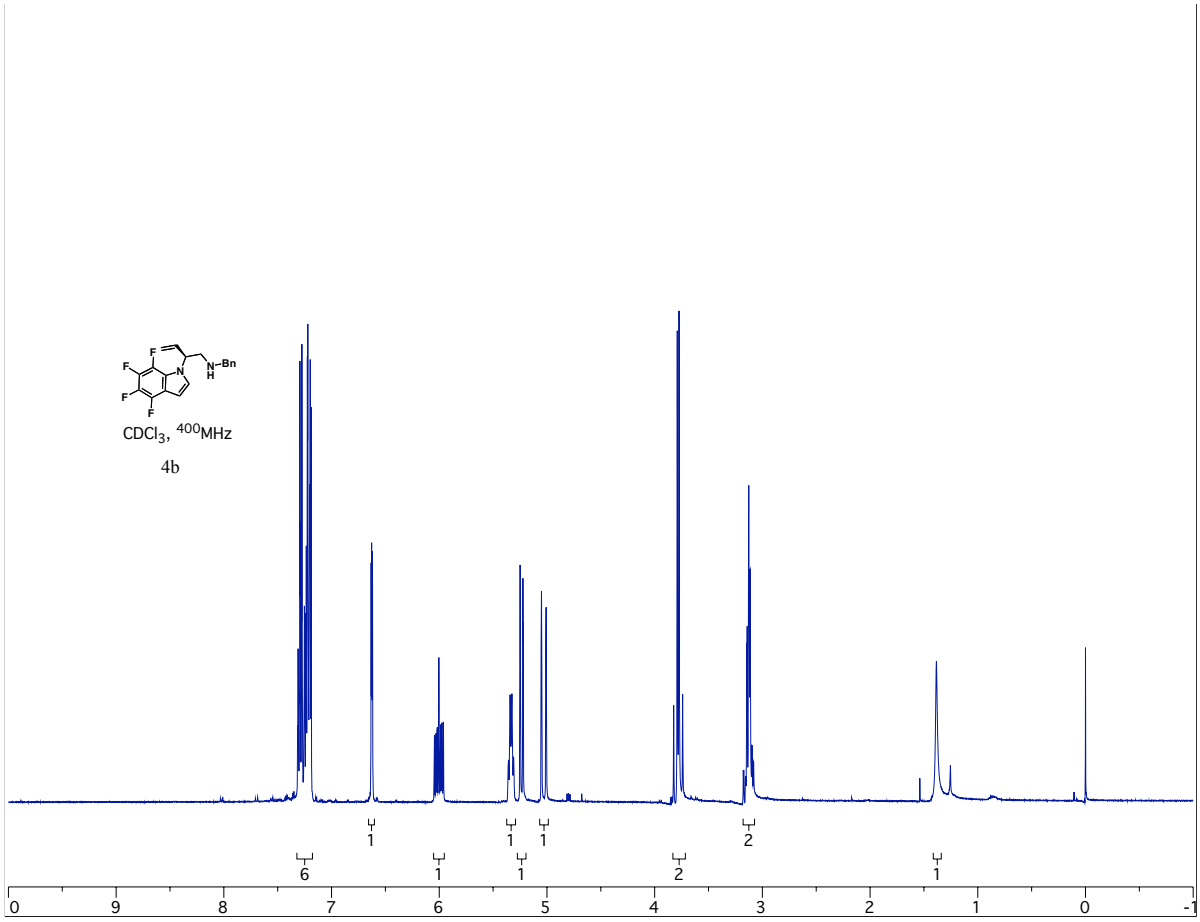

176.328
175.976
175.627
175.279
139.941
135.105
128.999
128.942
128.907
128.871
128.392
127.730
122.569
119.227
118.897
118.310
116.004
111.374
111.362
63.388
54.000
52.702
CDCl3, 101MHz
3g

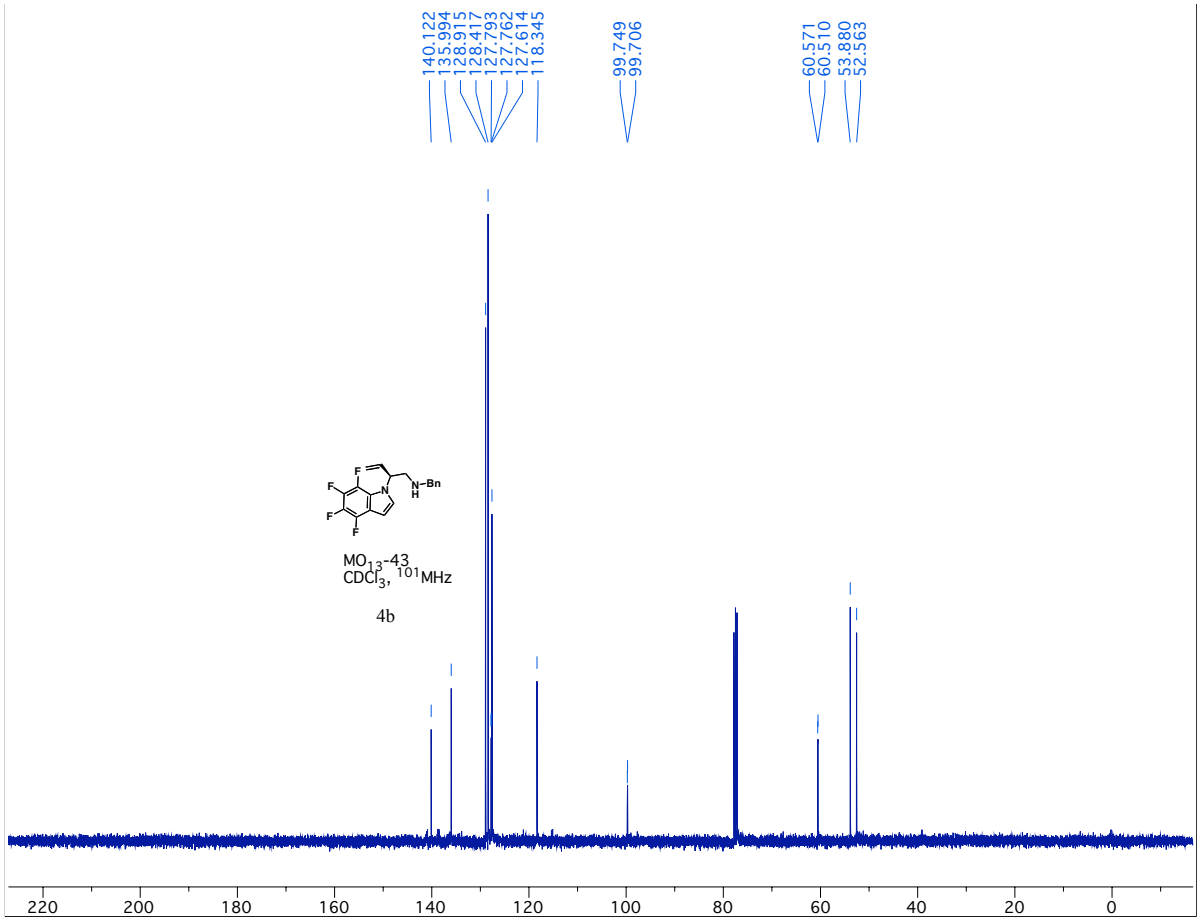

PMB
N
H
O2N
CDCl3, 400MHz
3h
2
1
1
1
3
2
1
2
1
1
1
1
2
0
9
8
7
6
5
4
3
2
1
0
-1

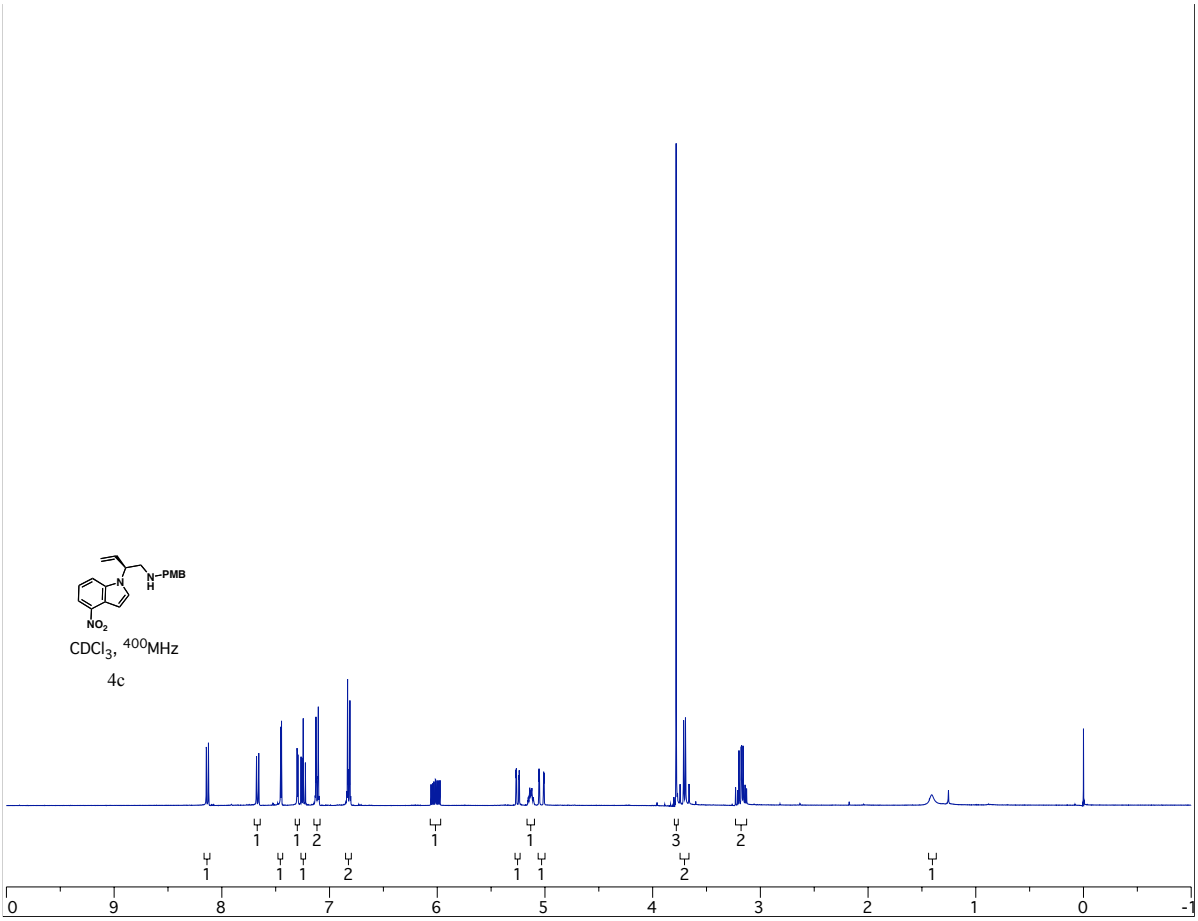

159.291
134.981
131.937
129.682
121.245
120.893
119.367
114.361
106.064
63.600
55.734
53.421
52.513
PMB
N
H
O2N
CDCl3, 101MHz
3h
220
200
180
160
140
120
100
80
60
40
20
0

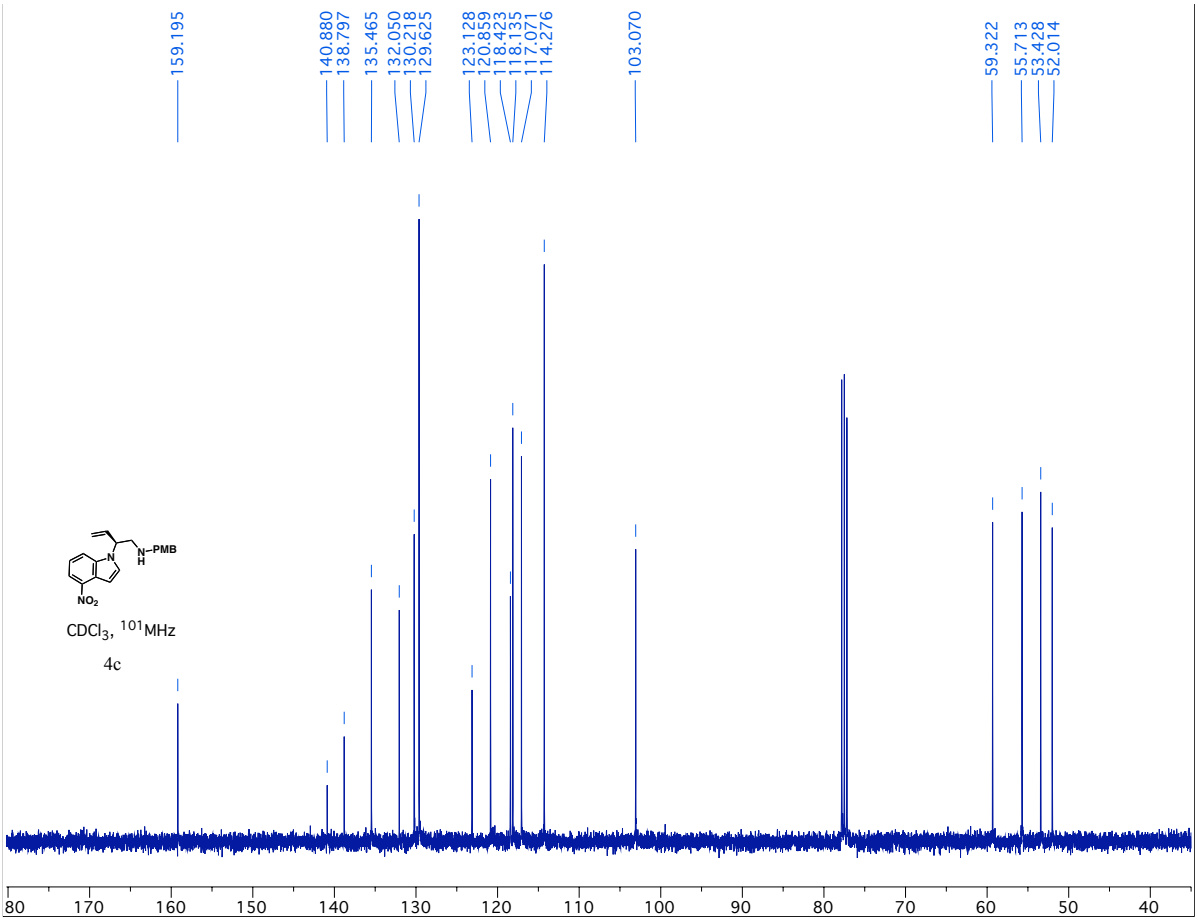

CDCl3, 400MHz
4a

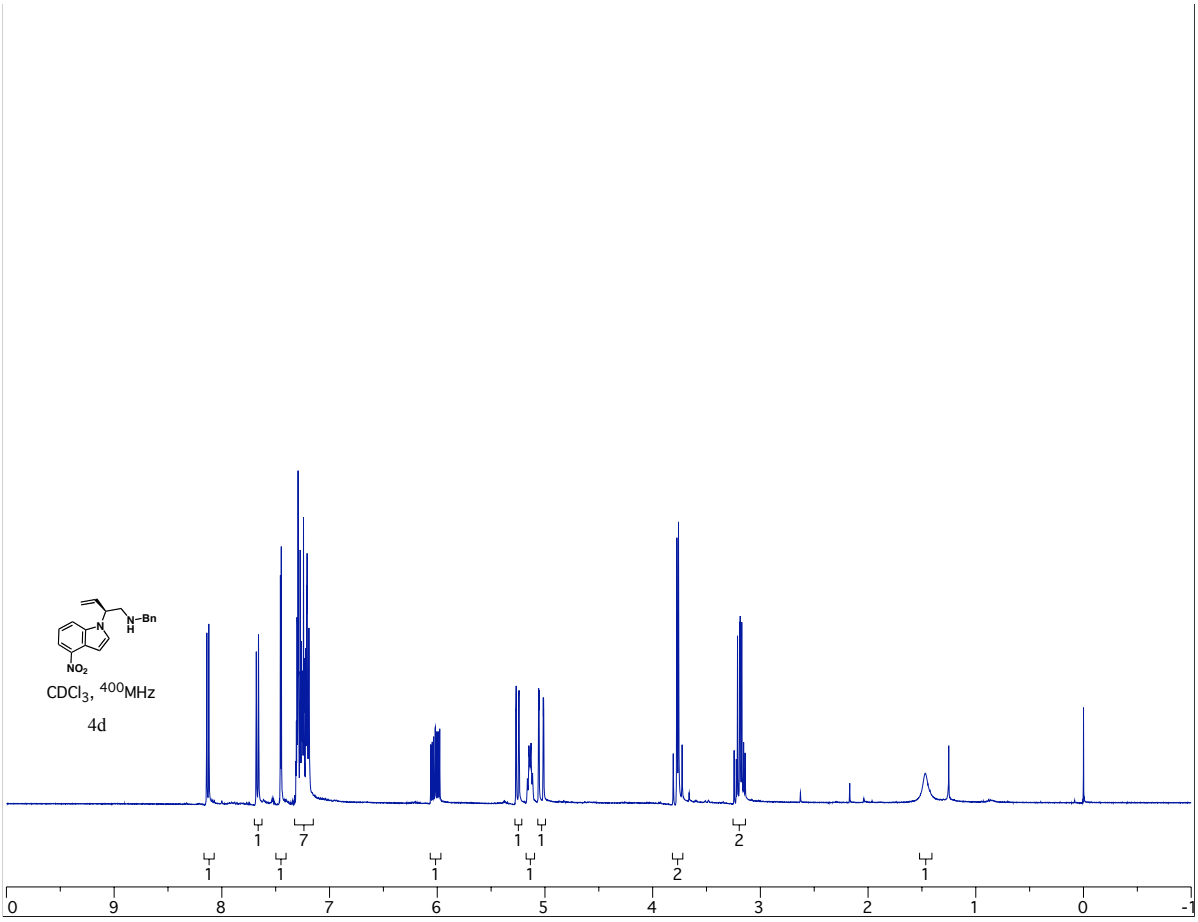

159.197
136.034
132.179
129.608
127.809
127.778
118.293
114.239
99.715
99.675
60.568
60.506
55.696
53.253
52.402
CDCl3, 101MHz
4a

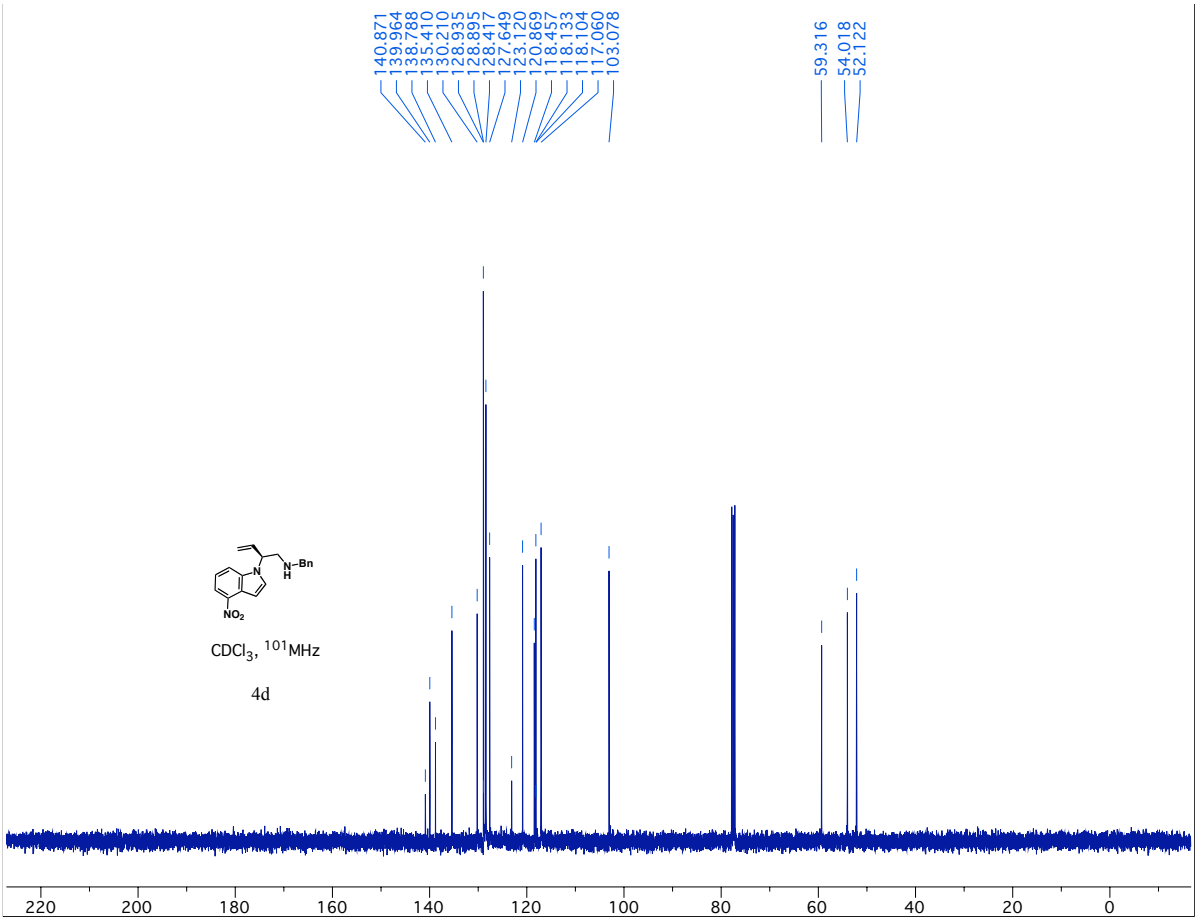

CDCl3, 400MHz
4b

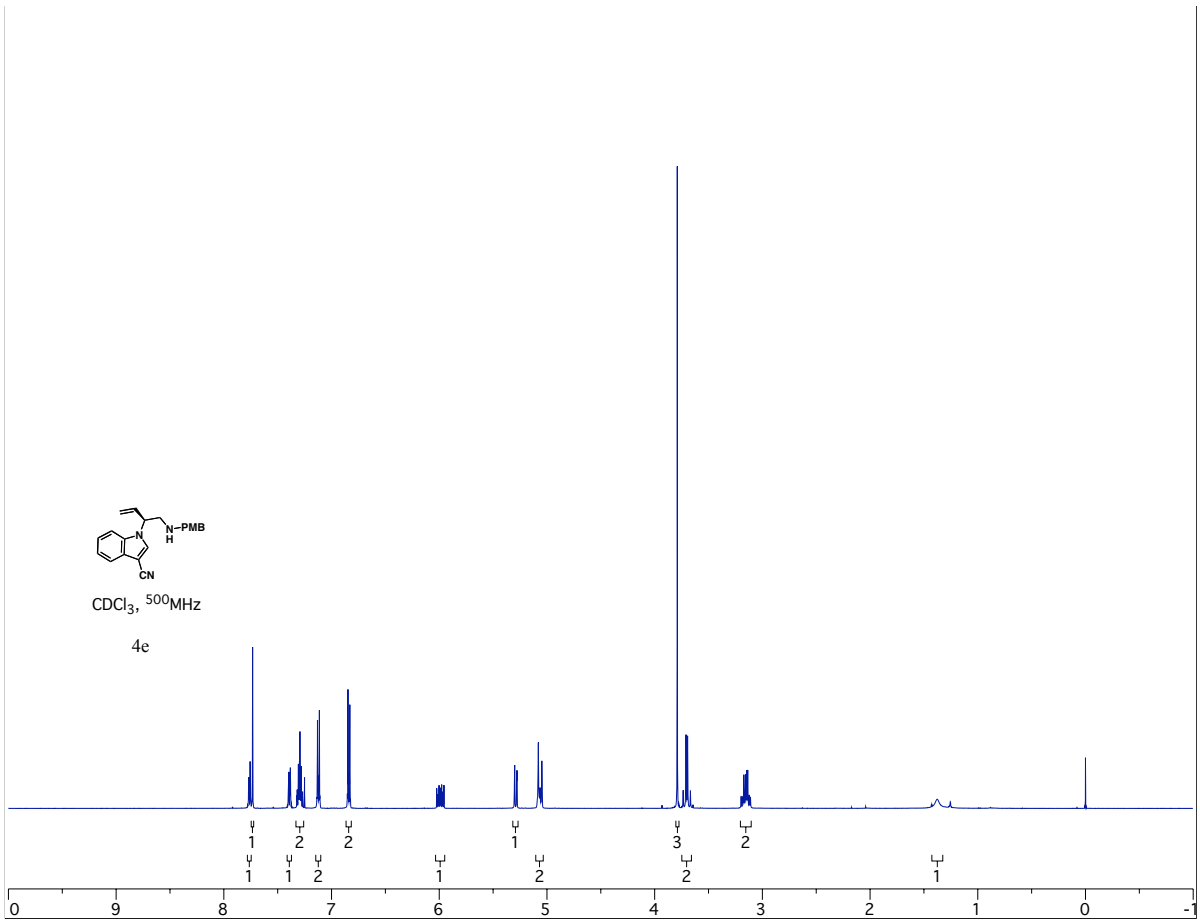

140.122
135.994
128.915
128.417
127.793
127.762
127.614
118.345
99.749
99.706
60.571
60.510
53.880
52.563
MO13-43
CDCl3, 101MHz
4b

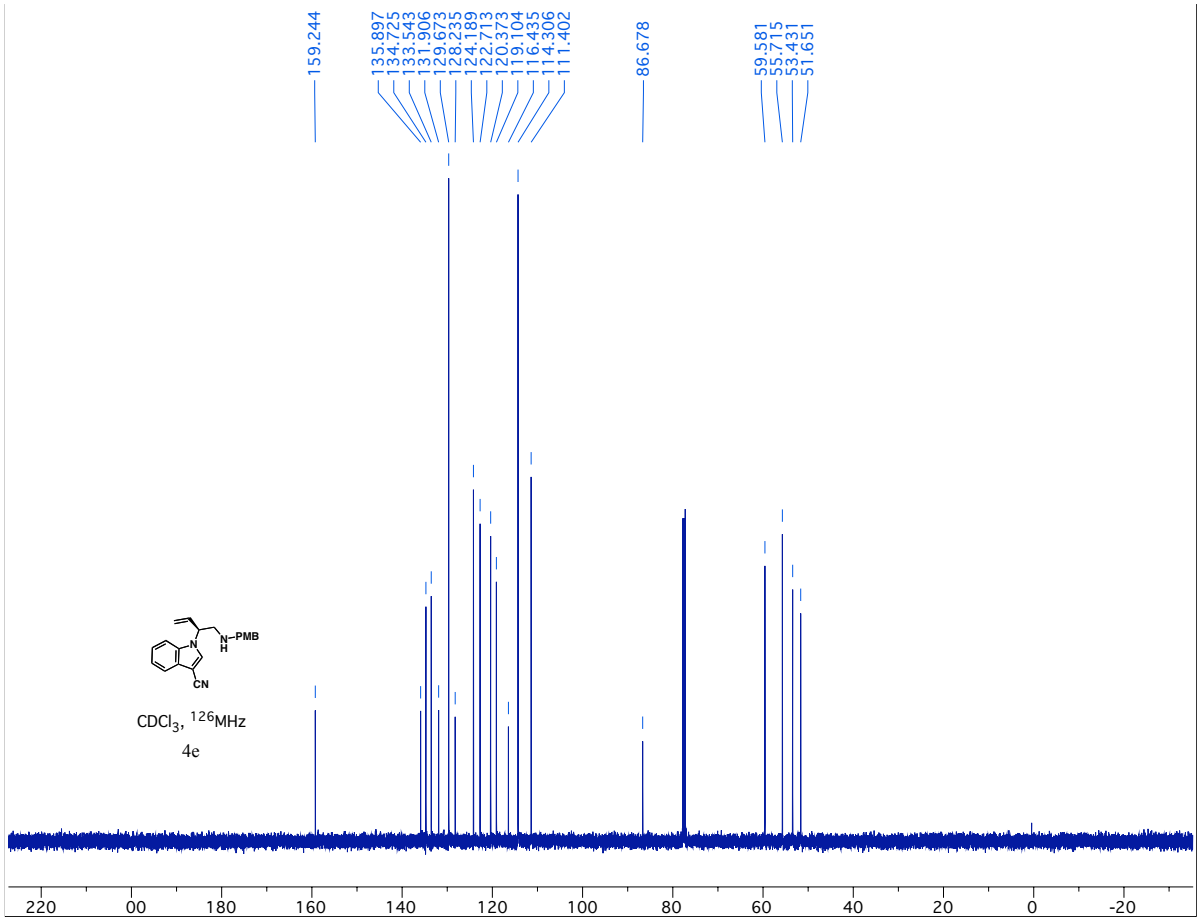

N–PMB
H
NO2
CDCl3, 400MHz
4c

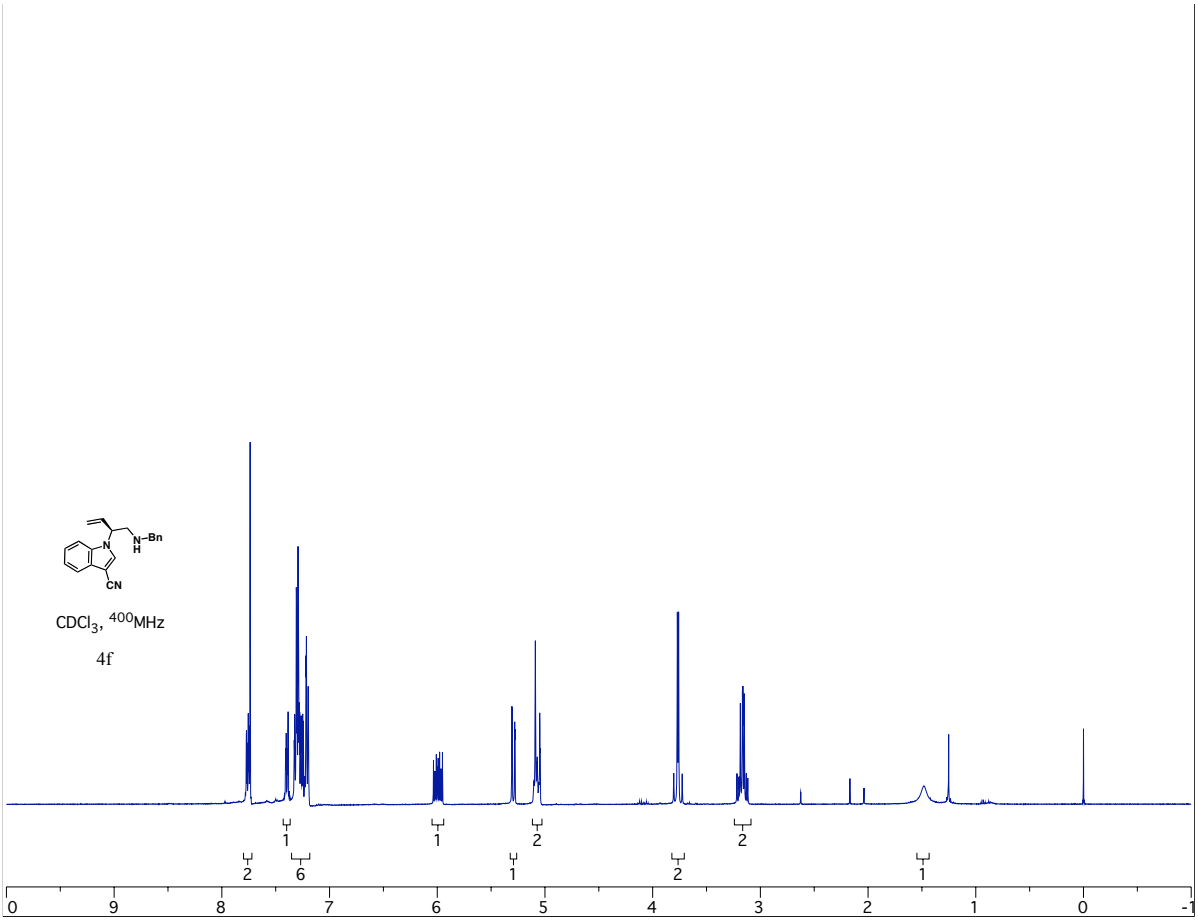

159.195
140.880
138.797
135.465
132.050
130.218
129.625
123.128
120.859
118.423
118.135
117.071
114.276
103.070
59.322
55.713
53.428
52.014
N–PMB
H
NO2
CDCl3, 101MHz
4c

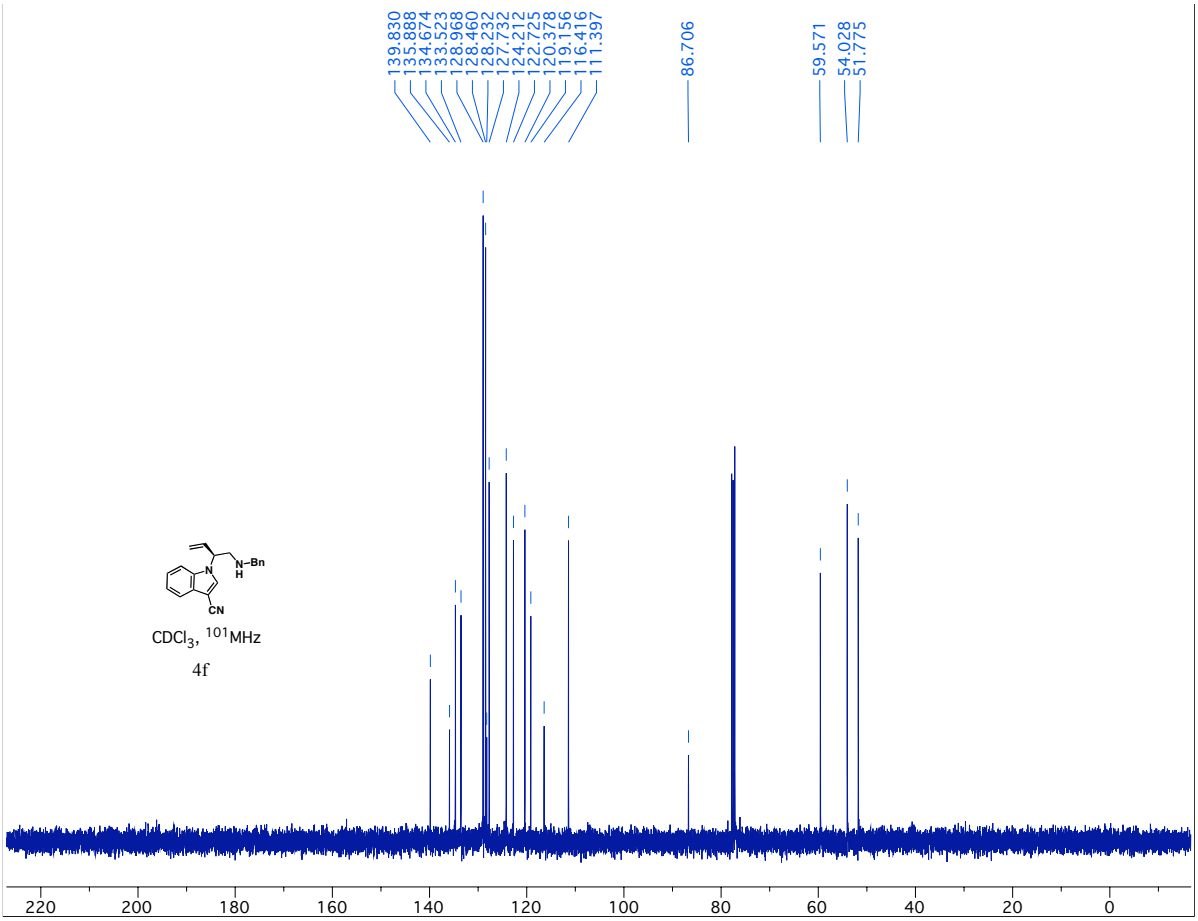

CDCl3, 400MHz
4d

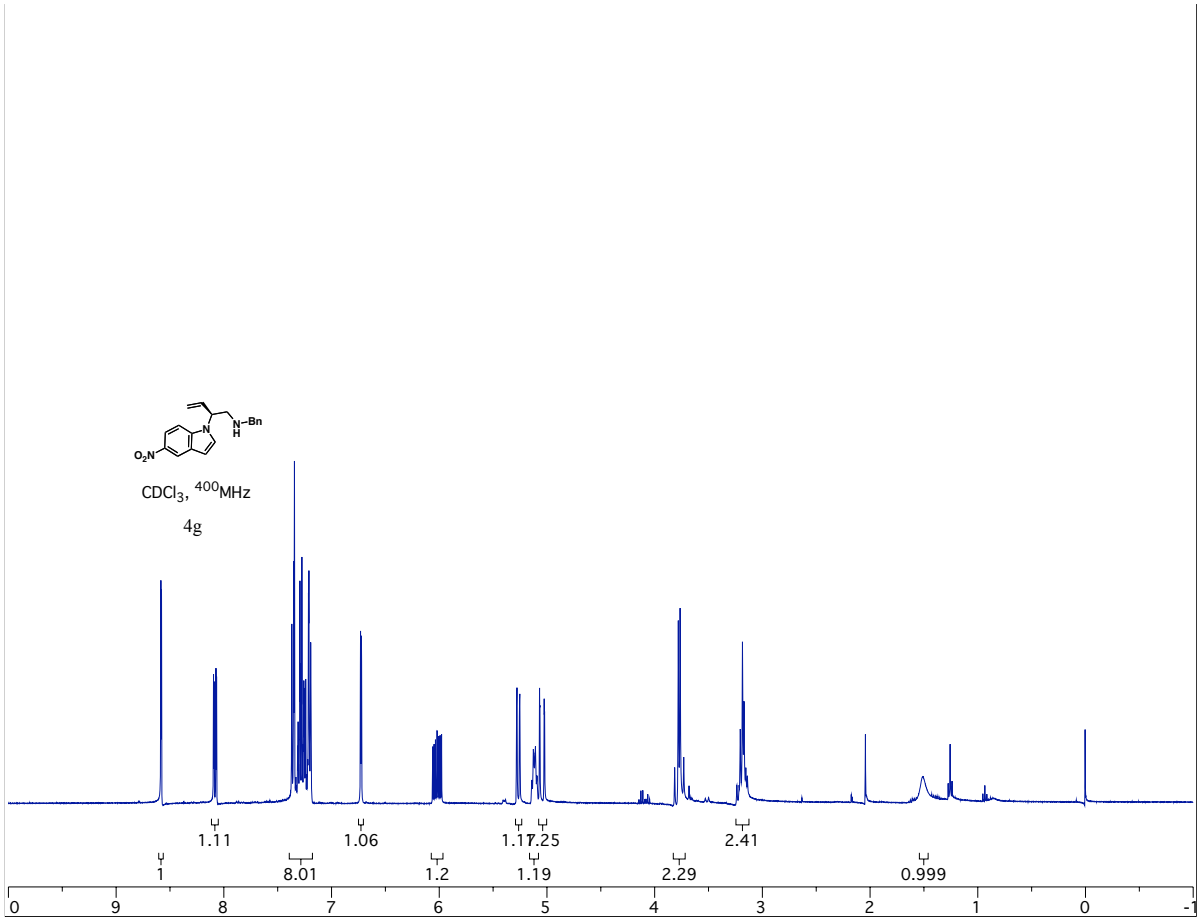

140.871
139.964
138.788
135.410
130.210
128.935
128.895
128.417
127.649
123.120
120.869
118.457
118.133
118.104
117.060
103.078
59.316
54.018
52.122
CDCl3, 101MHz
4d

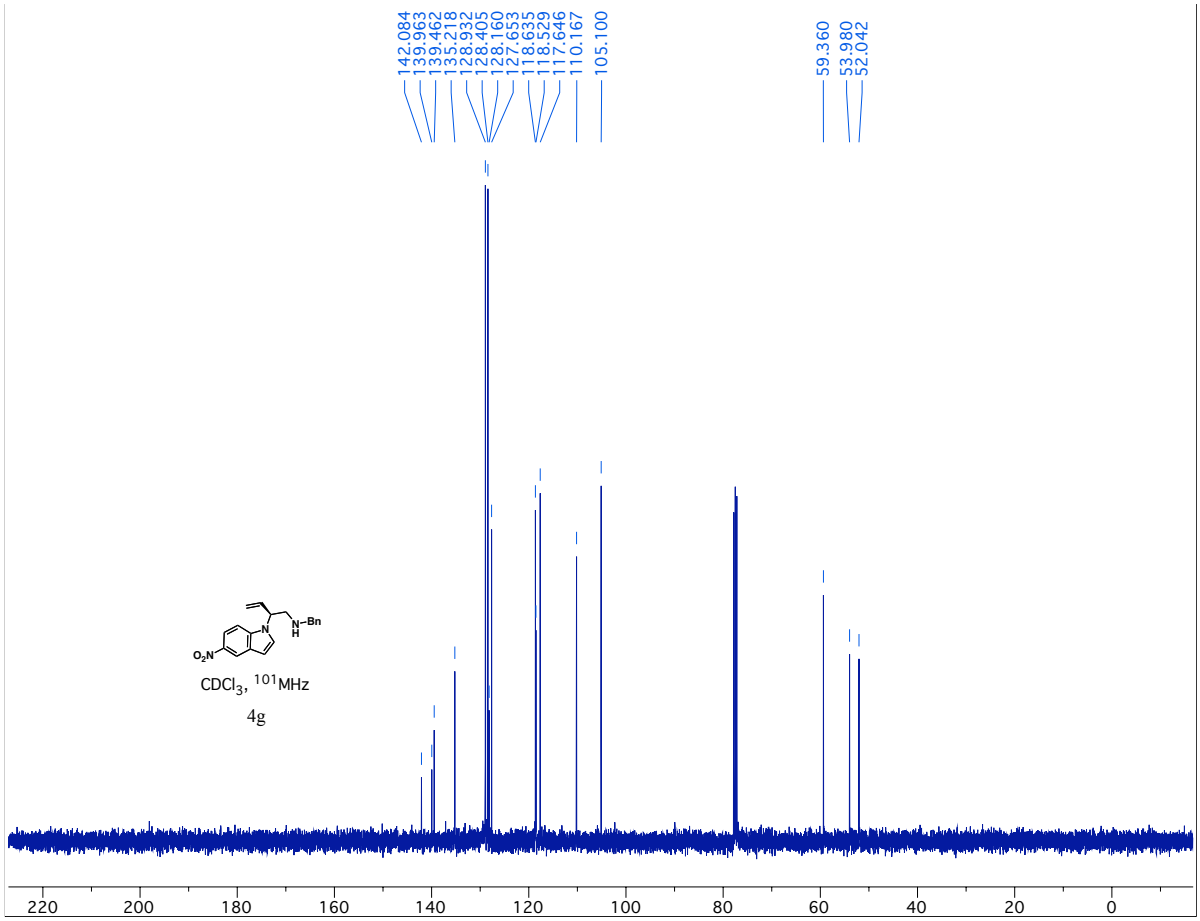

N–PMB
H
CN
CDCl3, 500MHz
4e
1
2
2
1
3
2
1
1
2
1
2
2
1
0
9
8
7
6
5
4
3
2
1
0
-1

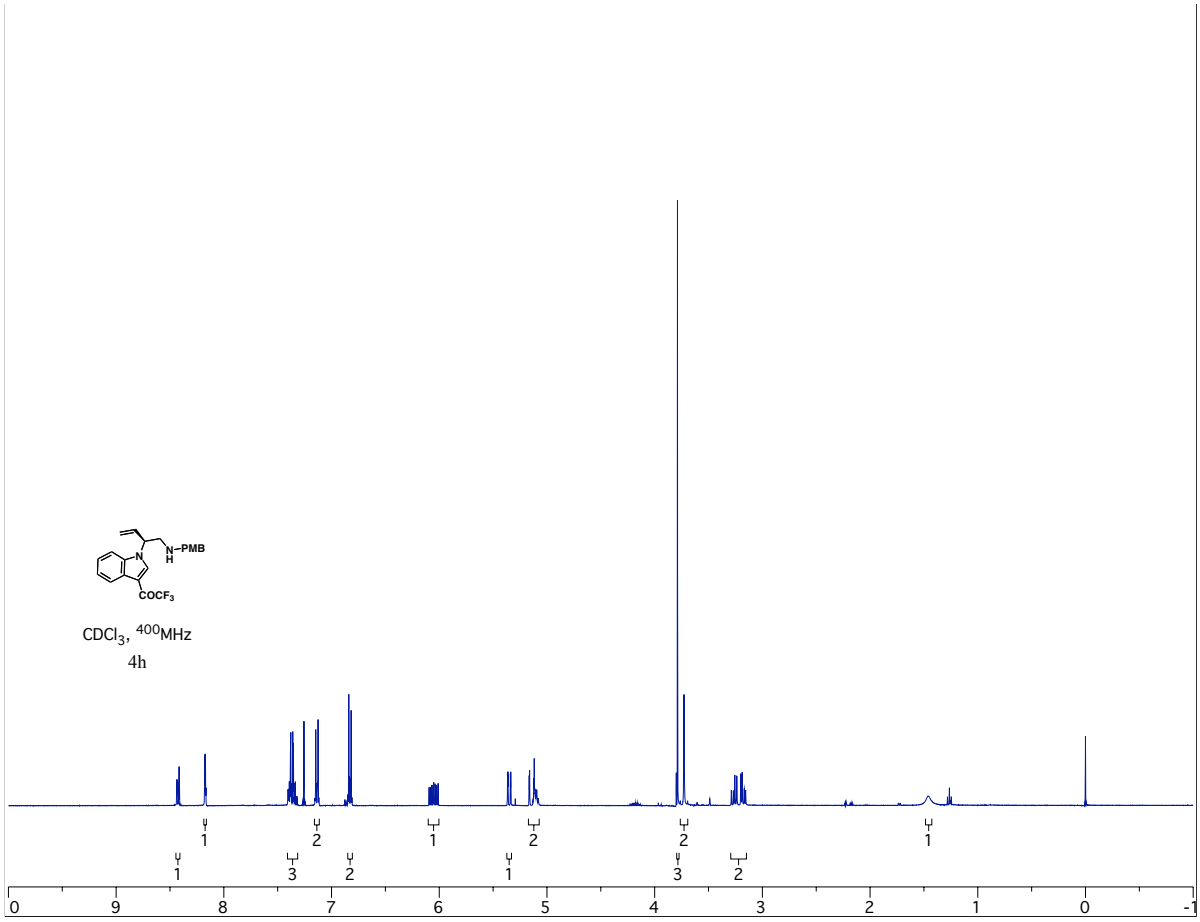

159.244
135.897
134.725
133.543
131.906
129.673
128.235
124.189
122.713
120.373
119.104
116.435
114.306
111.402
86.678
59.581
55.715
53.431
51.651
N–PMB
H
CN
CDCl3, 126MHz
4e
220
00
180
160
140
120
100
80
60
40
20
0
-20

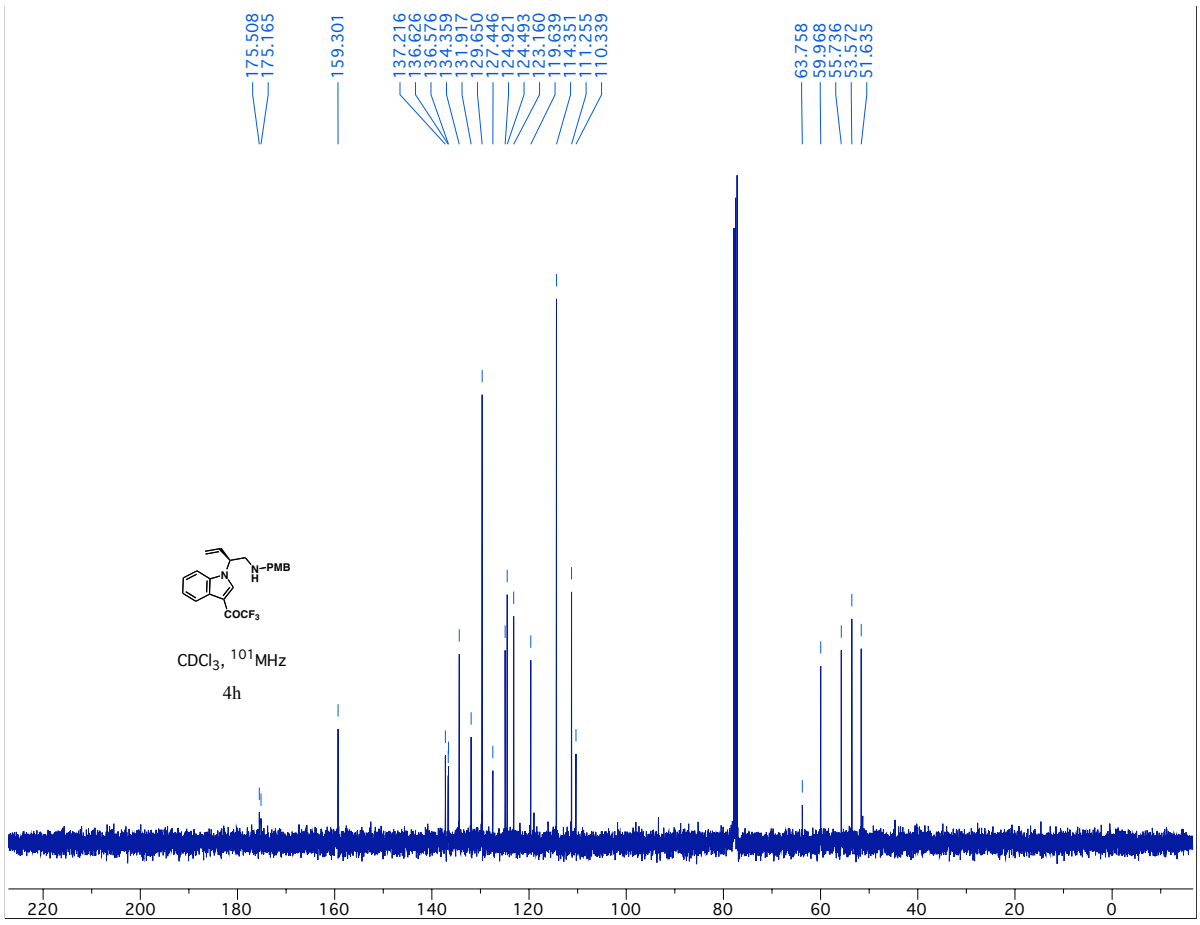

CDCl3, 400MHz
4f
2
6
1
1
2
1
2
1
0
9
8
7
6
5
4
3
2
1
0
-1

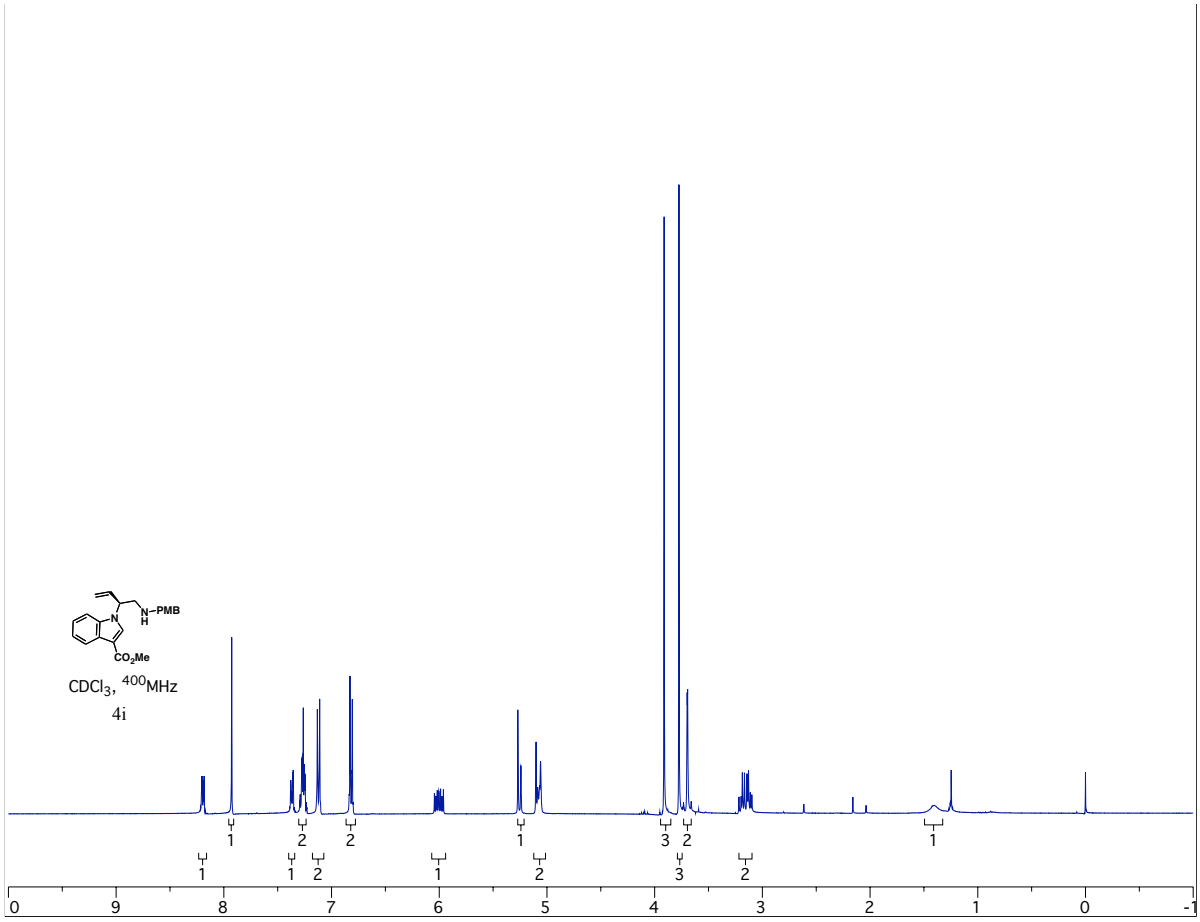

139.830
135.888
134.674
133.523
128.968
128.460
128.232
127.732
124.215
122.725
120.378
119.156
116.416
111.397
86.706
59.571
54.028
51.775
CDCl3, 101MHz
4f
220
200
180
160
140
120
100
80
60
40
20
0

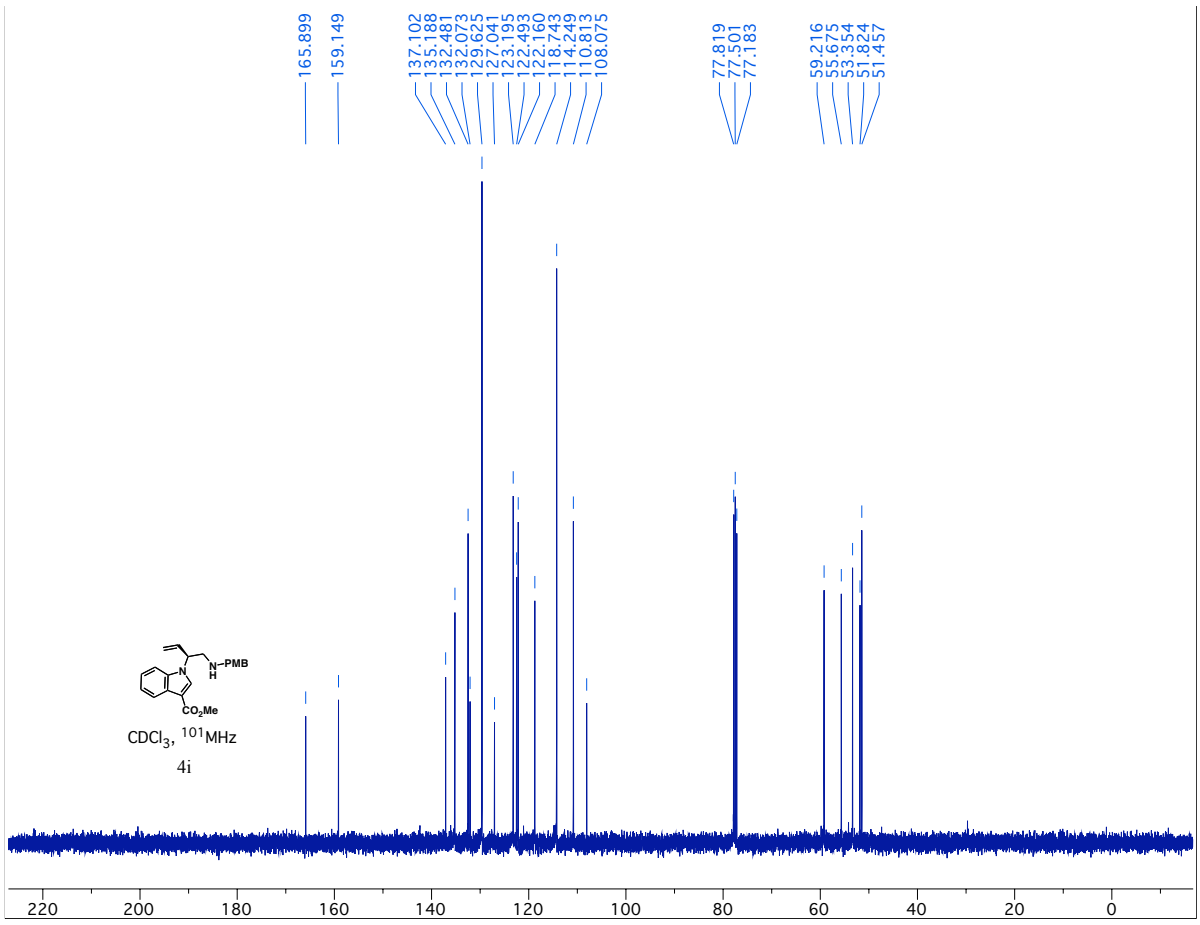

CDCl3, 400MHz
4g
1.11
1.06
1.17
1.25
2.41
1
8.01
1.2
1.19
2.29
0.999

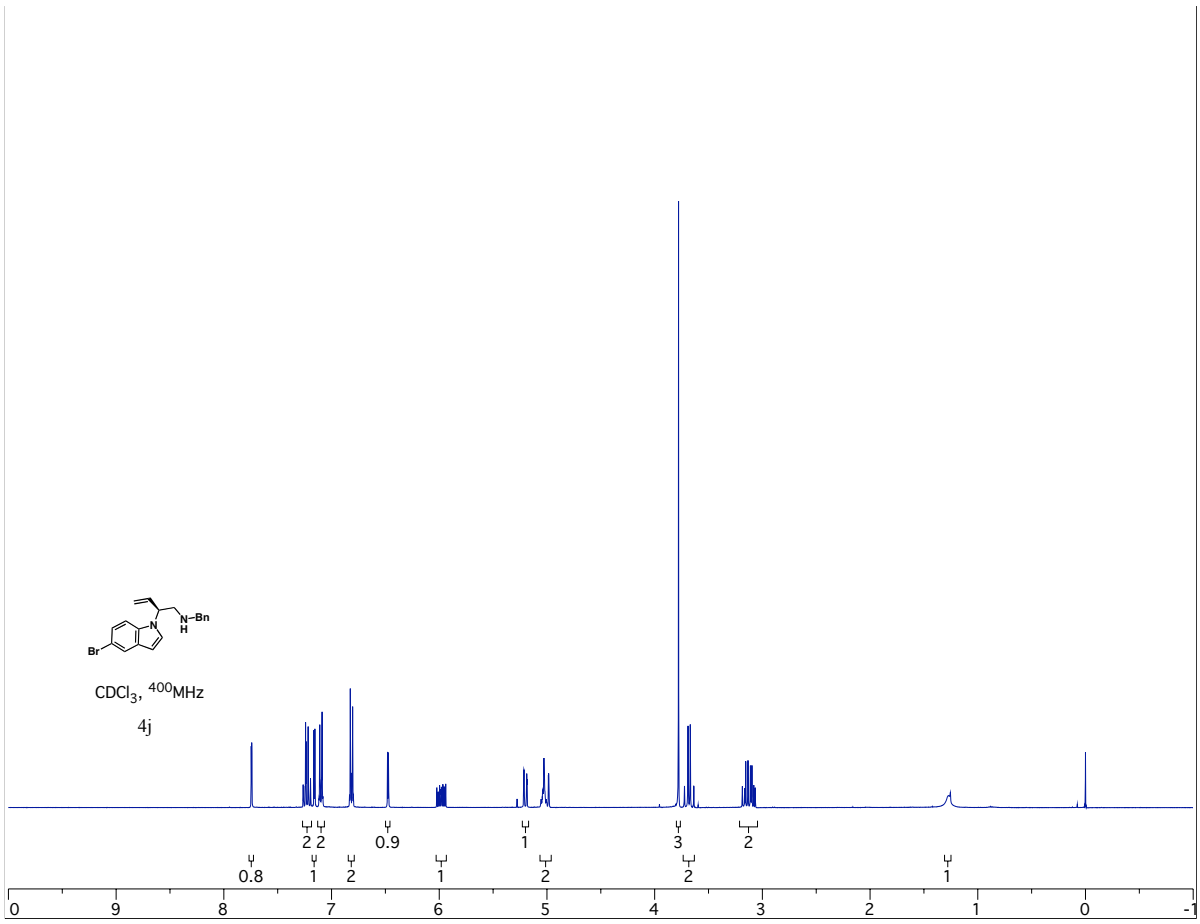

142.084
139.963
139.462
135.218
128.932
128.405
128.160
127.653
118.635
118.529
117.646
110.167
105.100
59.360
53.980
52.042
CDCl3, 101MHz
4g

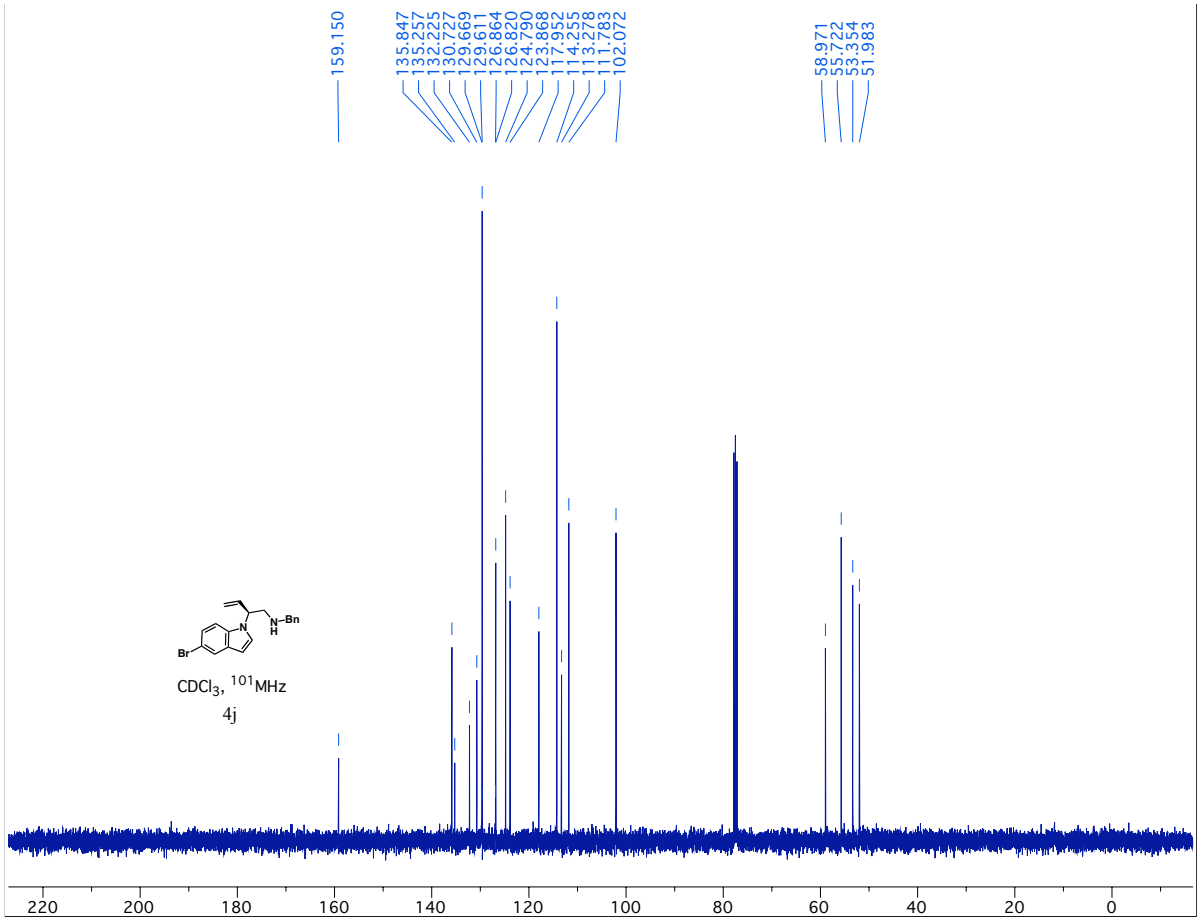

N–PMB
H
COCF3
CDCl3, 400MHz
4h
1
2
1
2
2
1
1
3
2
1
3
2
0
9
8
7
6
5
4
3
2
1
0
-1

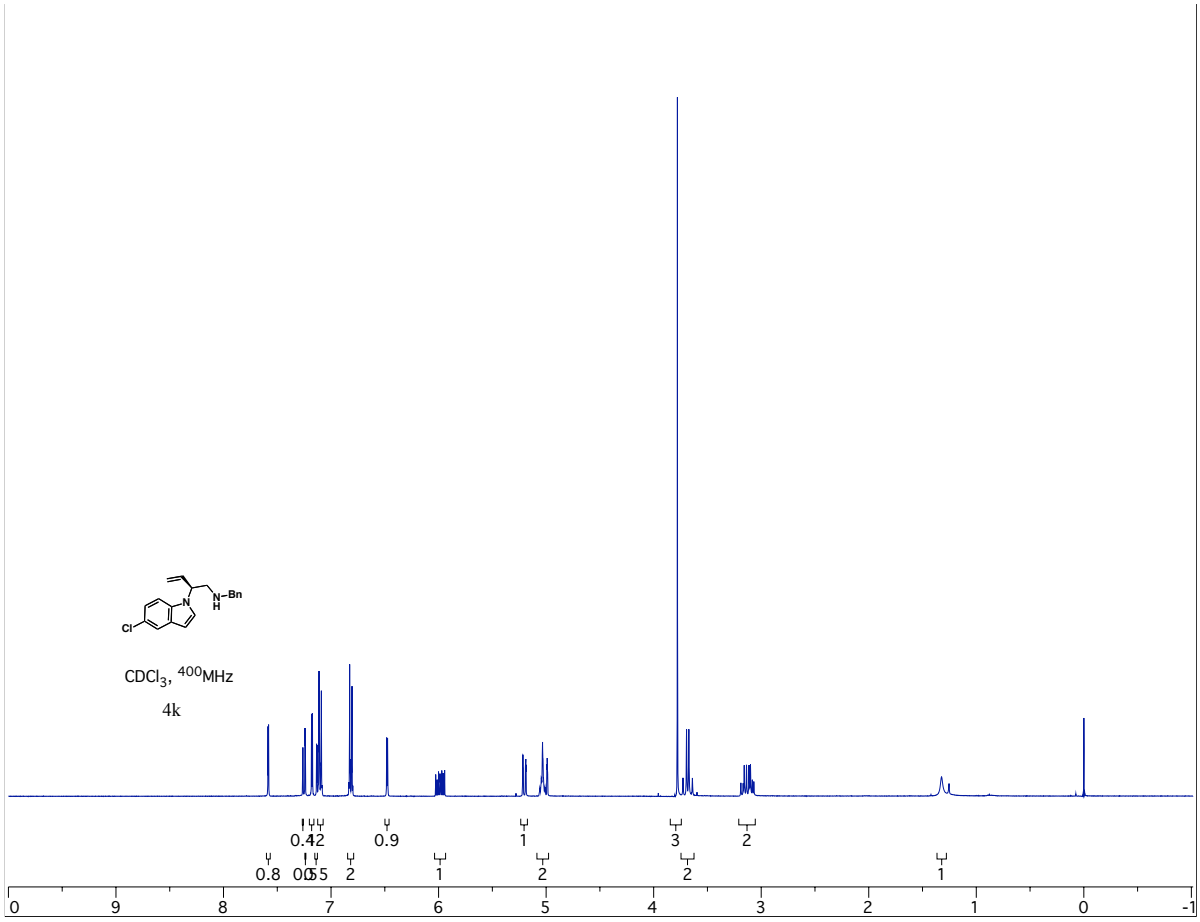

175.508
175.165
159.301
137.216
136.626
136.576
134.359
131.917
129.650
127.446
124.921
124.493
123.160
119.639
114.351
111.255
110.339
63.758
59.968
55.736
53.572
51.635
N–PMB
H
COCF3
CDCl3, 101MHz
4h
220
200
180
160
140
120
100
80
60
40
20
0

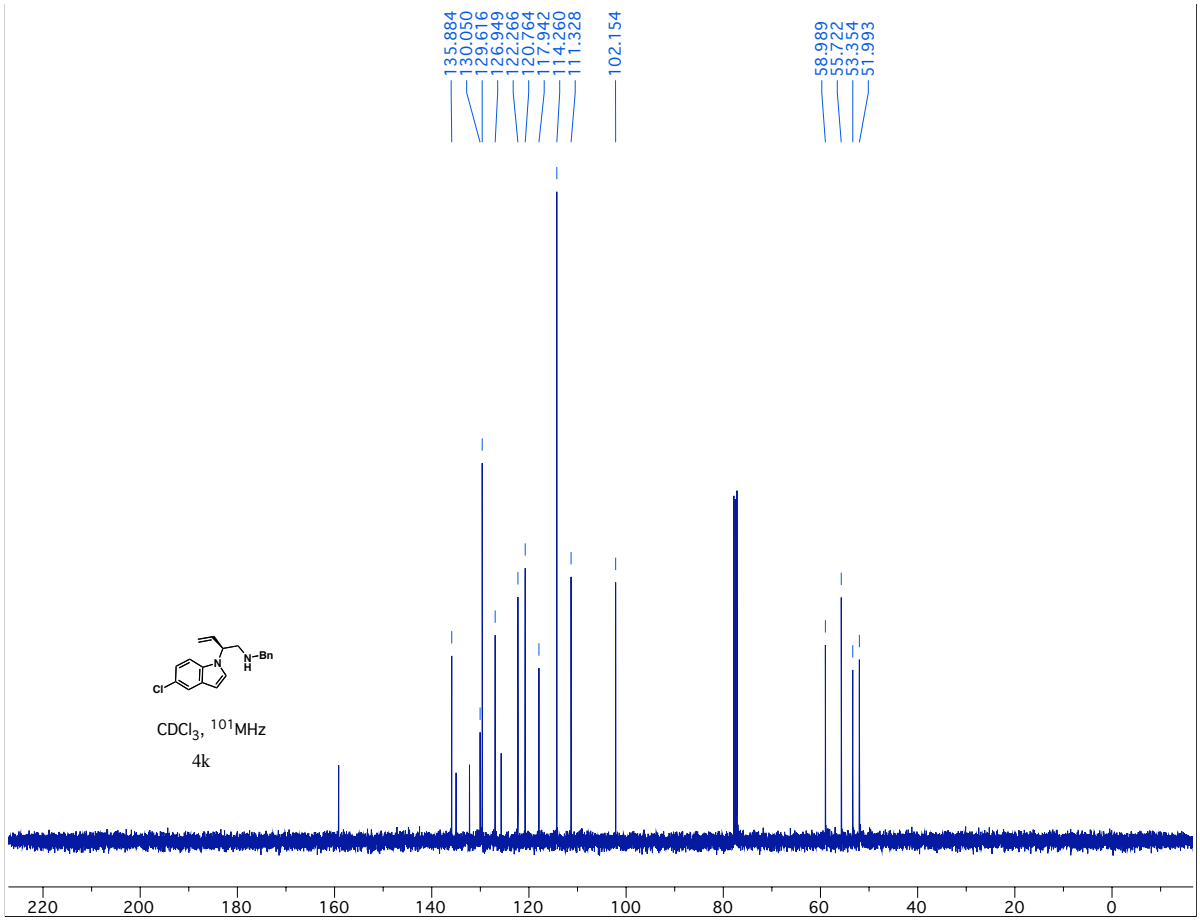

CDCl3, 400MHz
4i

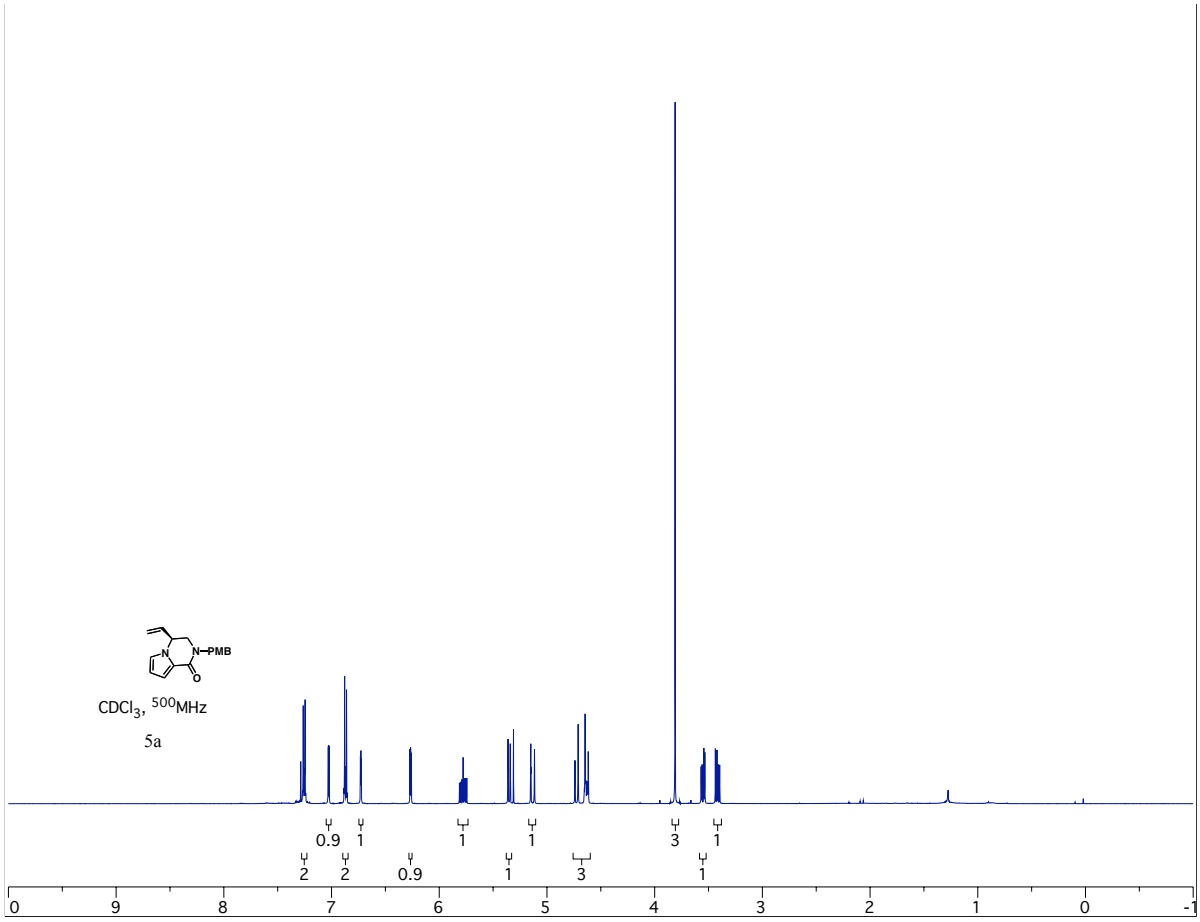

165.899
159.149
137.102
135.188
132.481
132.073
129.625
127.041
123.195
122.493
122.160
118.743
114.249
110.813
108.075
77.819
77.501
77.183
59.216
55.675
53.354
51.824
51.457
CDCl3, 101MHz
4i

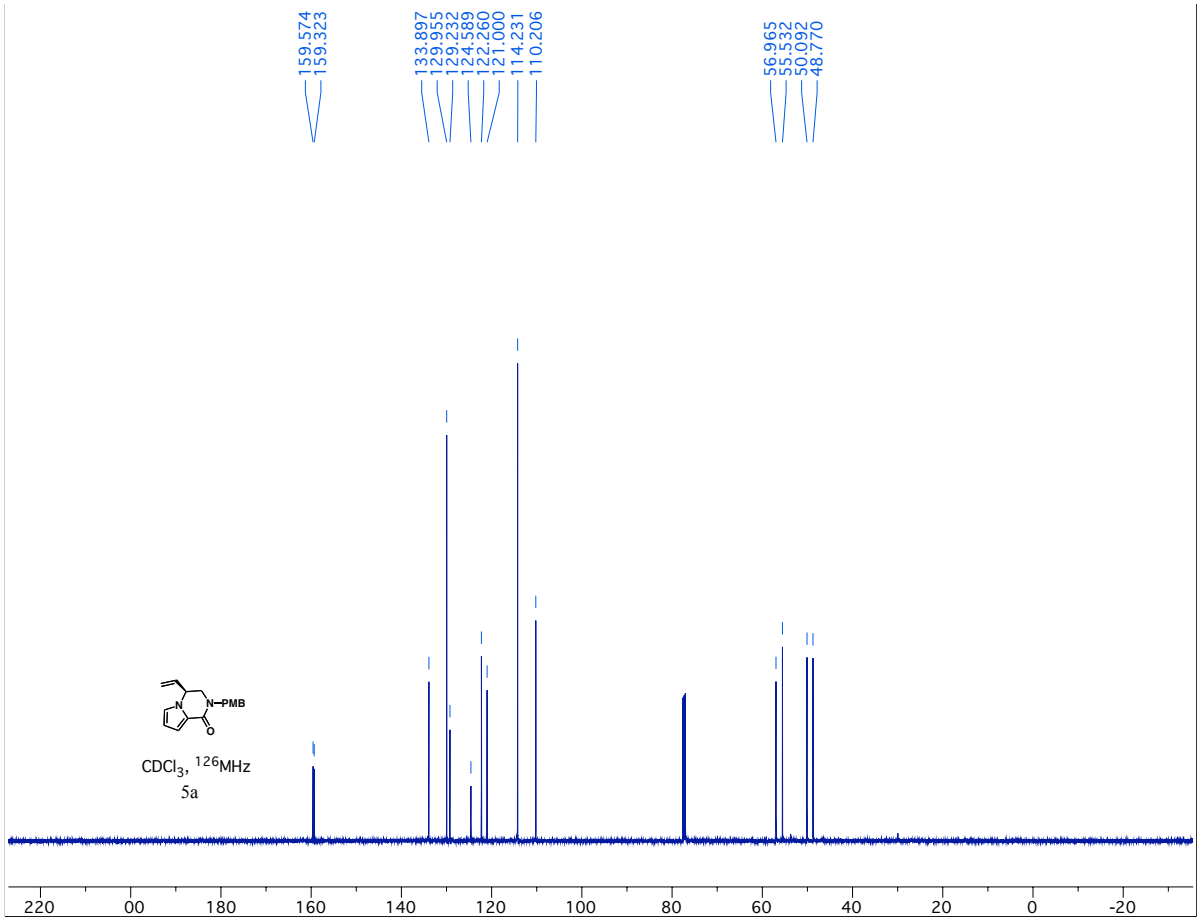

CDCl3, 400MHz
4j
2 2
0.9
0.8
1
2
1
2
1
2
3
2
1

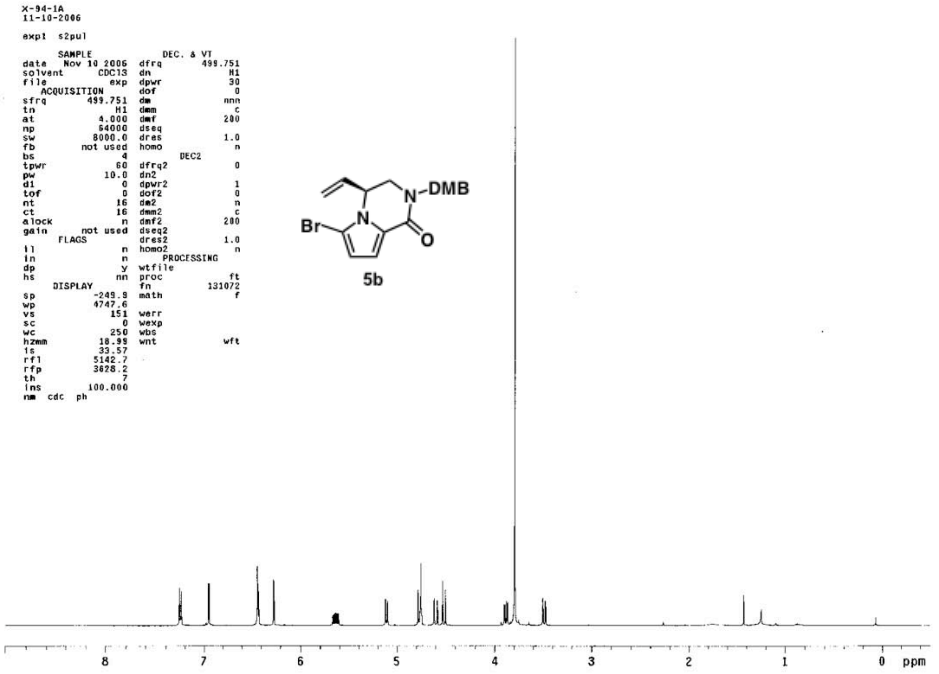

159.150
135.847
135.257
132.225
130.727
129.669
129.611
126.864
126.820
124.790
123.868
117.952
114.255
113.278
111.783
102.072
58.971
55.722
53.354
51.983
CDCl3, 101MHz
4j

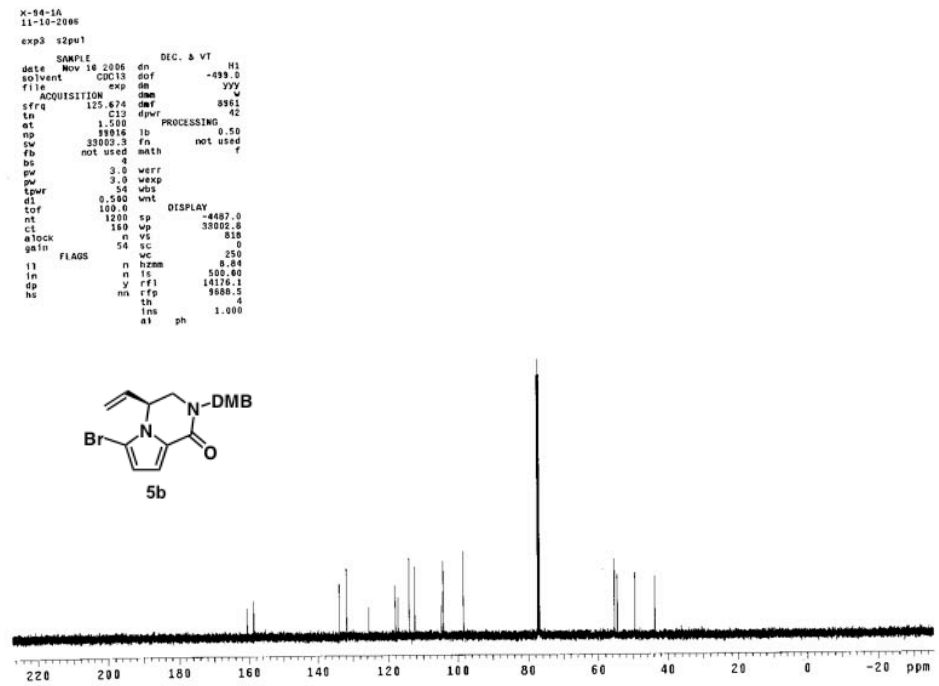

CDCl3, 400MHz
4k
0.4
2
0.9
1
3
2
0.8
2
1
2
2
1

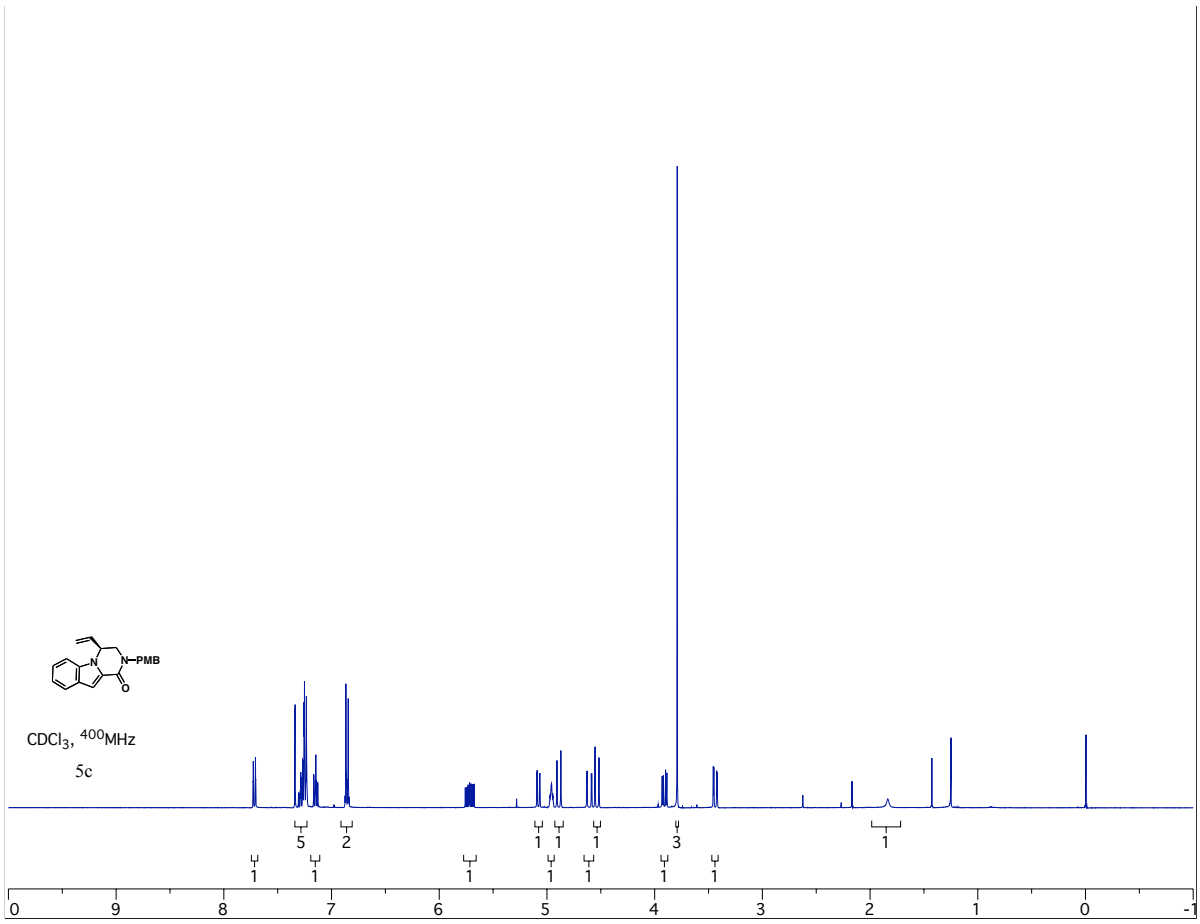

135.884
130.050
129.616
126.949
122.266
120.764
117.942
114.260
111.328
102.154
58.989
55.722
53.354
51.993
CDCl3, 101MHz
4k

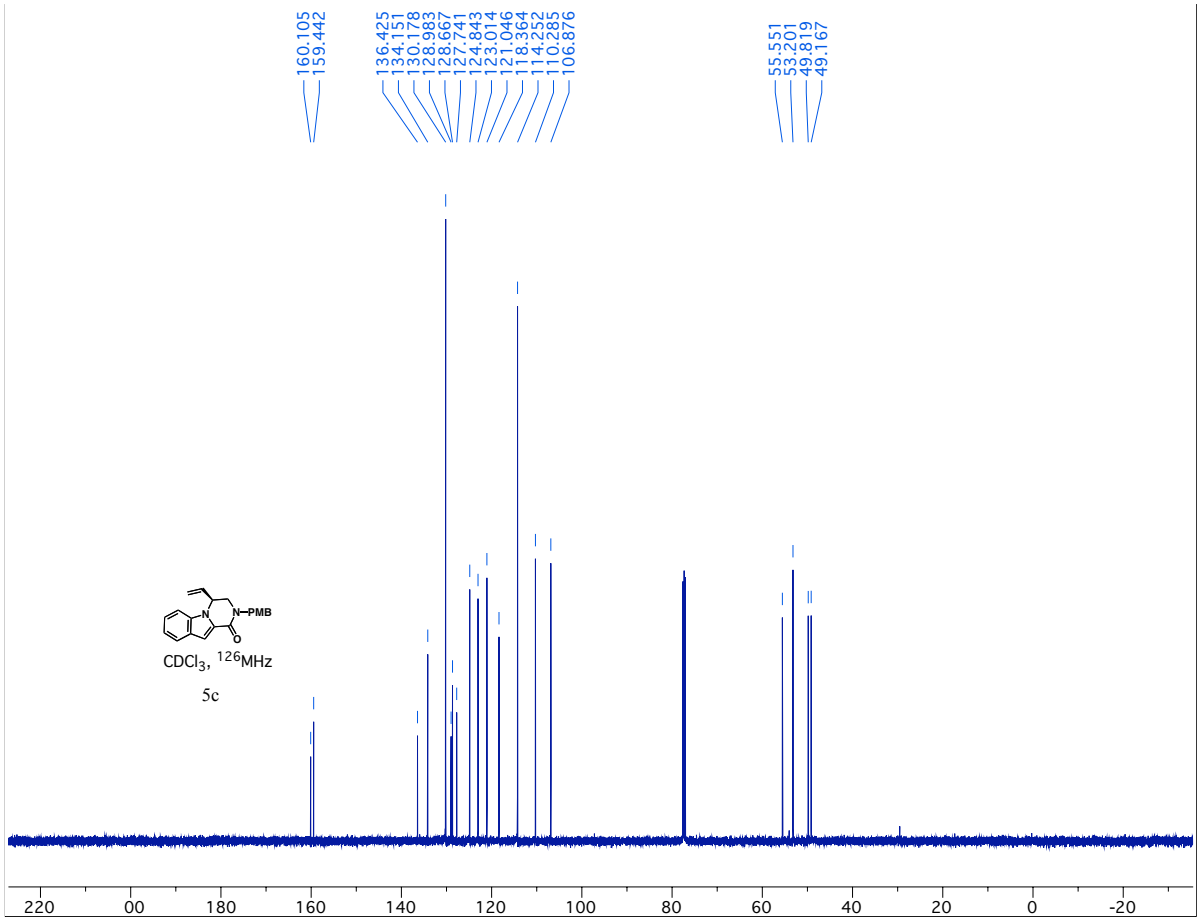

CDCl3, 500MHz
5a
0.9
1
1
1
3
1
2
2
0.9
1
3
1

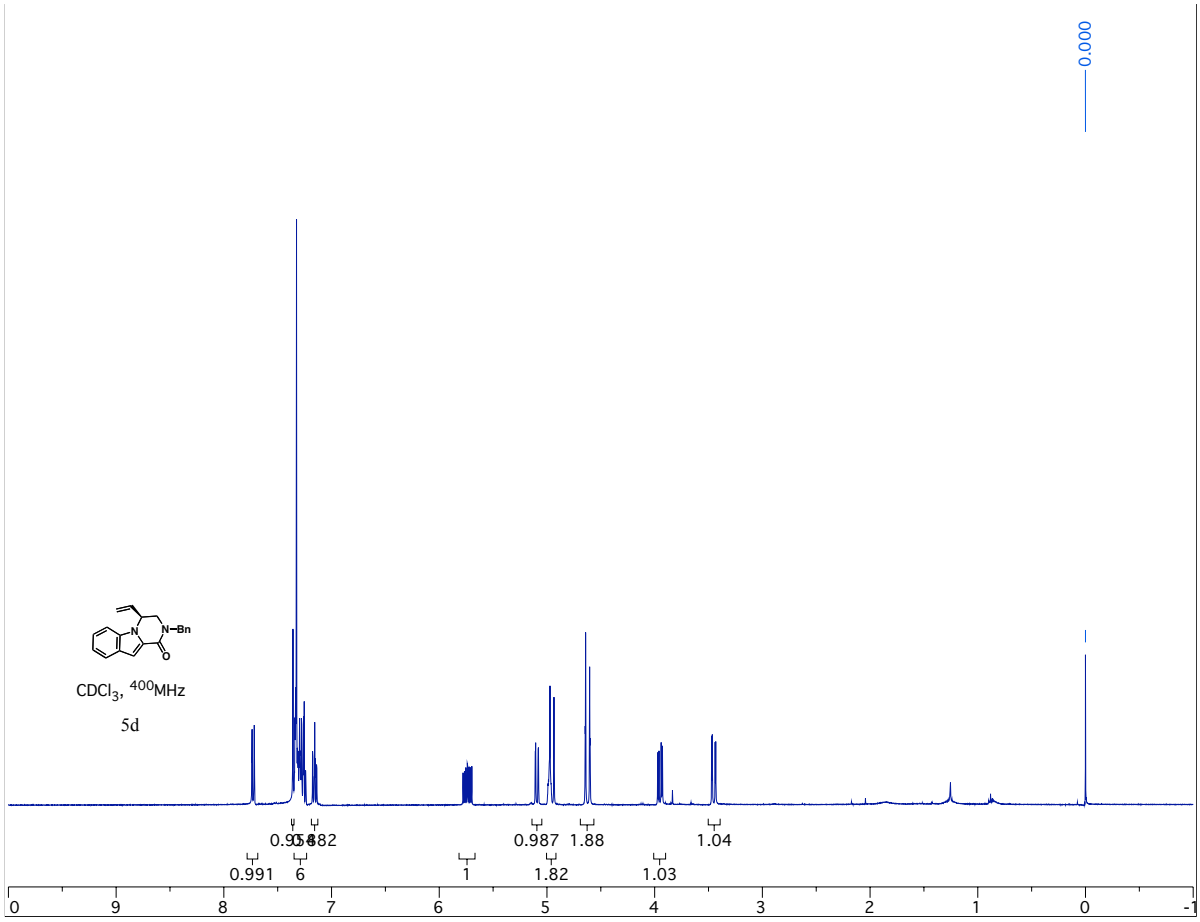

159.574
159.323
133.897
129.955
129.232
124.589
122.260
121.000
114.231
110.206
56.965
55.532
50.092
48.770
CDCl3, 126MHz
5a

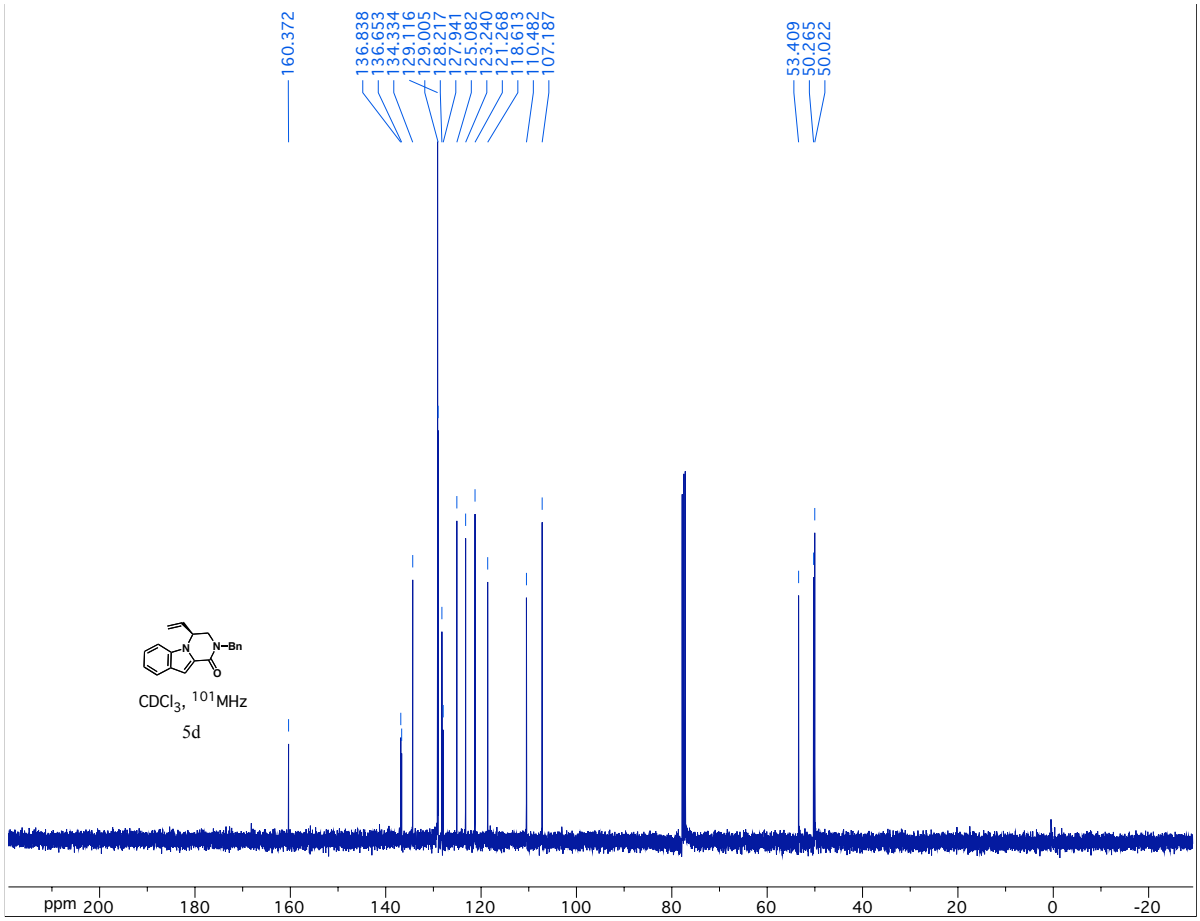

X-94-1A
11-10-2006
expt s2pul
SAMPLE
date Nov 10 2006
solvent CDCl3
file exp
ACQUISITION
sfrq 499.751
tn H1
at 4.000
np 64000
sw 8000.0
fb not used
bs 4
tpwr 60
pw 10.0
d1 0
tof 0
nt 16
ct 16
alock n
gain not used
FLAGS
ll n
in n
dp y
hs nn
DISPLAY
sp -249.8
wp 4747.6
vs 151
sc 0
wc 250
hzmm 18.99
is 33.57
rfl 5142.7
rfp 3628.2
th 7
lns 100.000
nm cdc ph
DEC. & VT
dfrq 499.751
dn H1
dpwr 30
dof 0
dm nnn
dmm c
dmf 280
dseq
dres 1.0
homo n
DEC2
dfrq2 0
dn2
dpwr2 1
dof2 0
dm2 n
dmm2 c
dmf2 280
dseq2
dres2 1.0
homo2 n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt wft
N-DMB
Br
N
O
5b
8
7
6
5
4
3
2
1
0 ppm

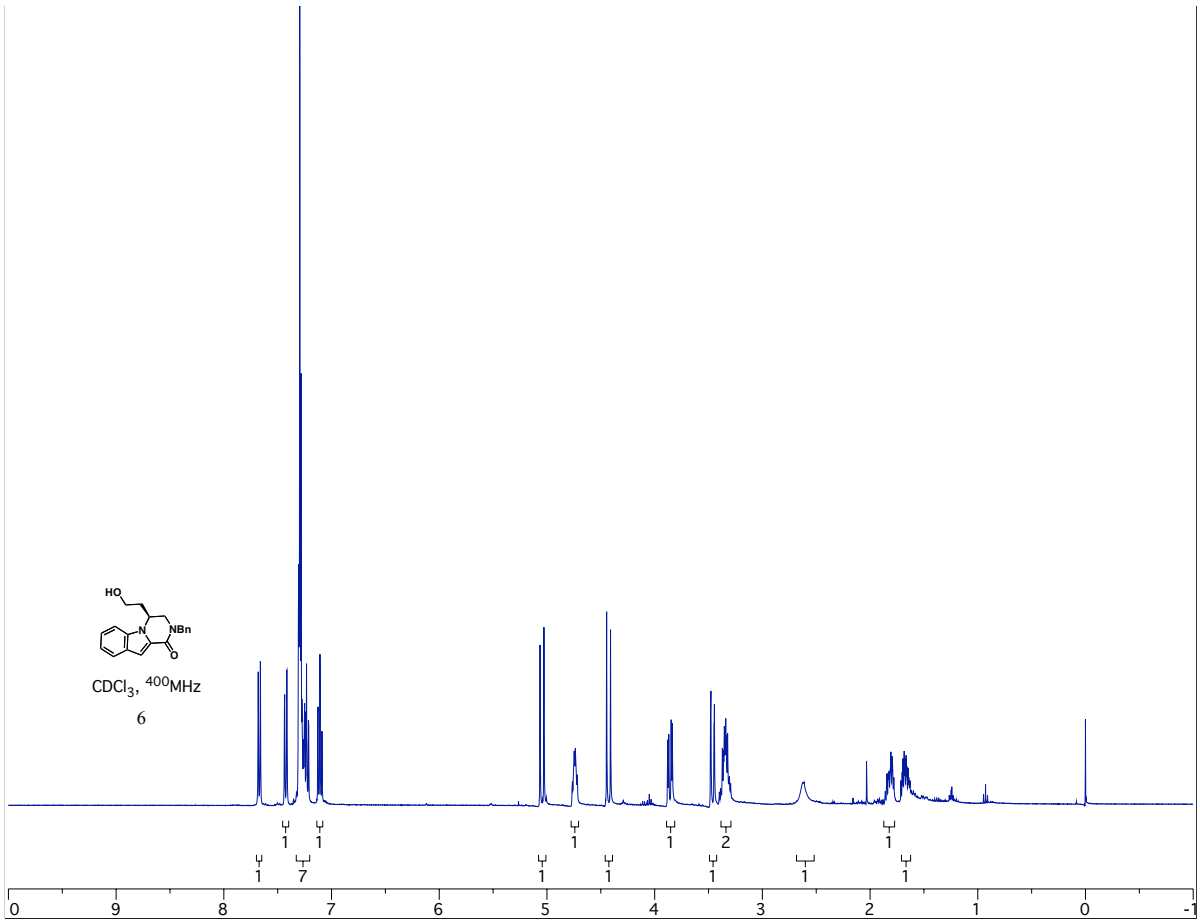

X-94-1A
11-10-2006
exp3 s2pul
SAMPLE
date Nov 10 2006
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 99016
sw 33003.3
fb not used
bs 8
pw 3.0
pw 3.0
tpwr 54
d1 0.500
tof 100.0
nt 1200
ct 160
alock n
gain 54
FLAGS
ll n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 8961
dpwr 42
PROCESSING
lb 0.50
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -4487.0
wp 33002.8
vs 818
sc 0
wc 250
hzmm 8.84
is 500.80
rfl 14176.1
rfp 9688.5
th 4
lns 1.000
al ph
N-DMB
Br
N
O
5b
220
200
180
160
140
120
100
80
60
40
20
0
-20 ppm

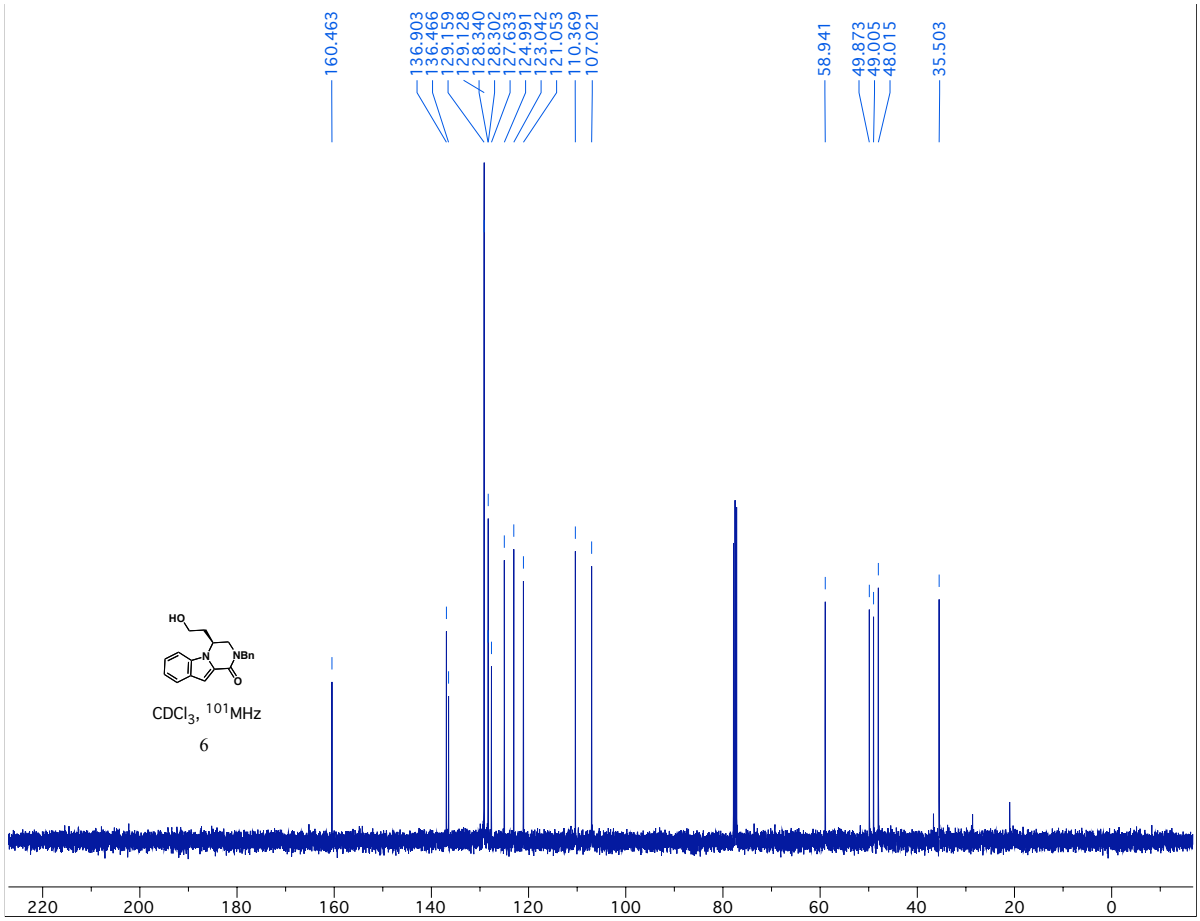

N–PMB
O
CDCl3, 400MHz
5c
5
2
1 1 1
3
1
1 1 1 1 1 1
0 9 8 7 6 5 4 3 2 1 0 -1

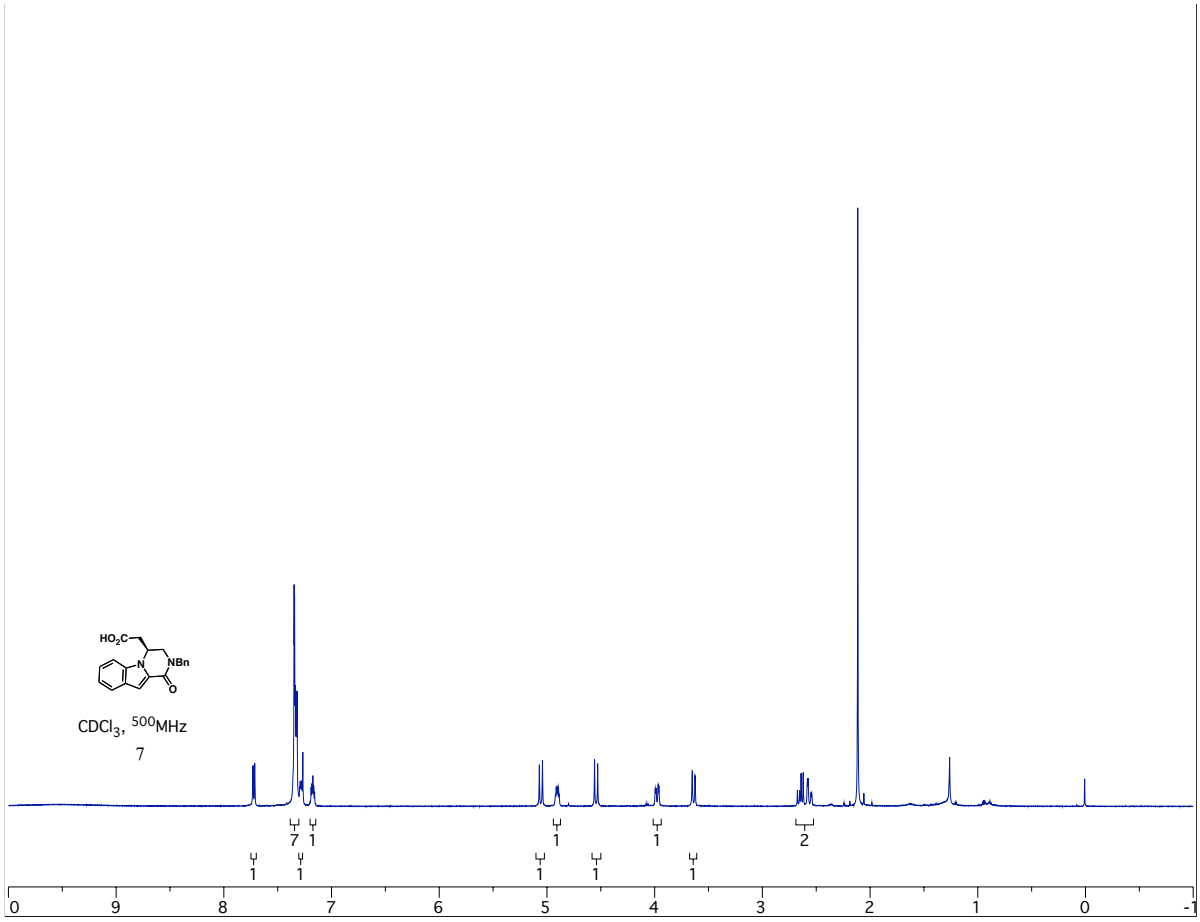

160.105
159.442
136.425
134.151
130.178
128.983
128.667
127.741
124.843
123.014
121.046
118.364
114.252
110.285
106.876
55.551
53.201
49.819
49.167
N–PMB
O
CDCl3, 126MHz
5c
220 00 180 160 140 120 100 80 60 40 20 0 -20

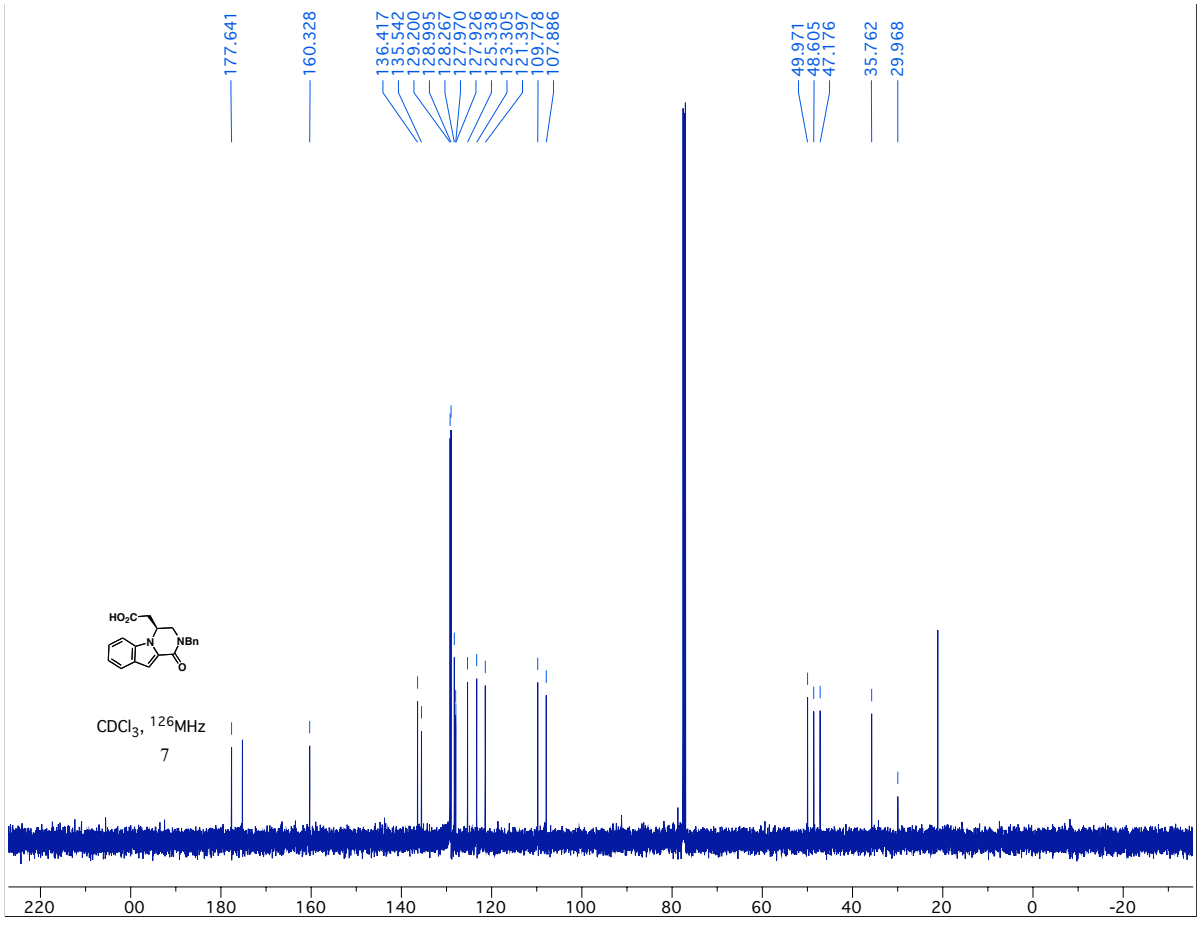

0.000
CDCl3, 400MHz
5d
0.991
6
1
1.82
1.03
0.987
1.88
1.04

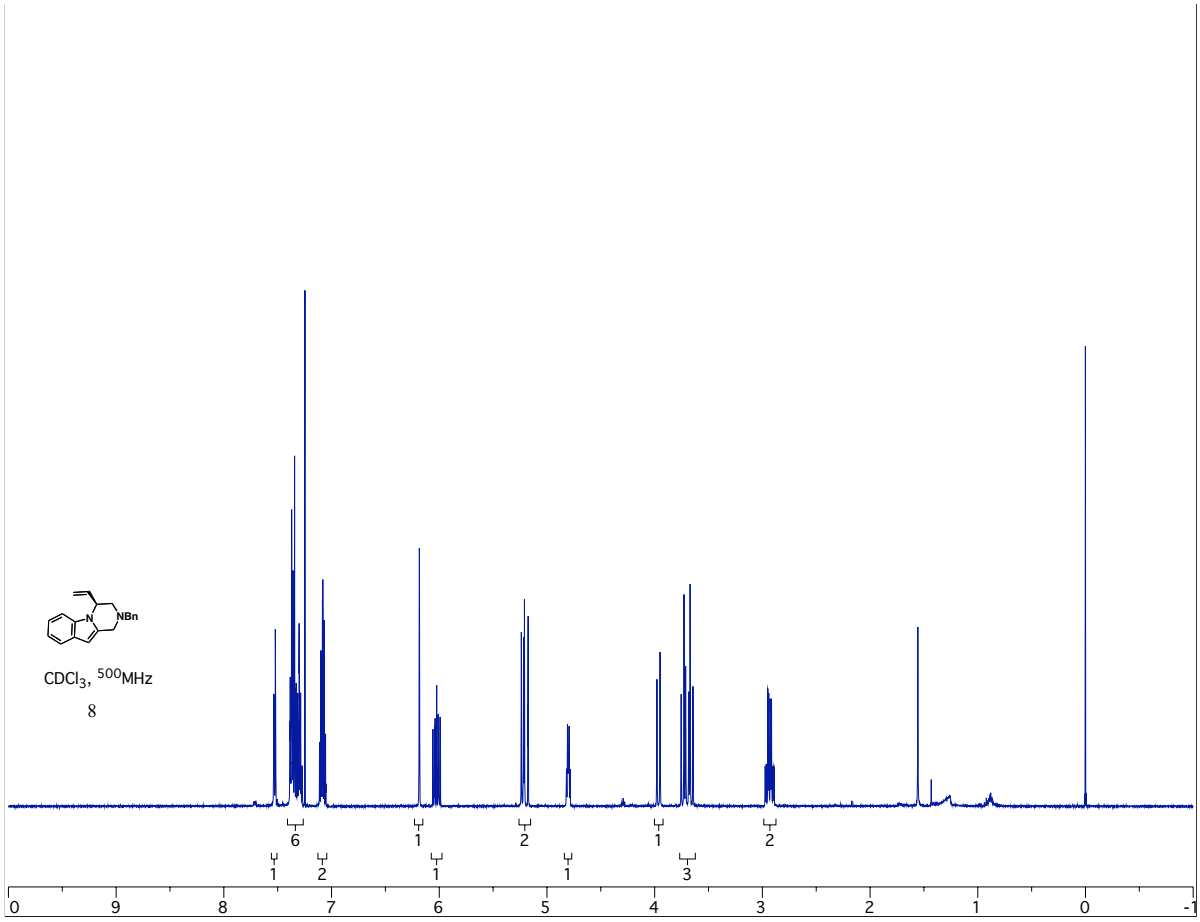

160.372
136.838
136.653
134.334
129.116
129.005
128.217
127.941
125.082
123.240
121.268
118.613
110.482
107.187
53.409
50.265
50.022
CDCl3, 101MHz
5d
ppm

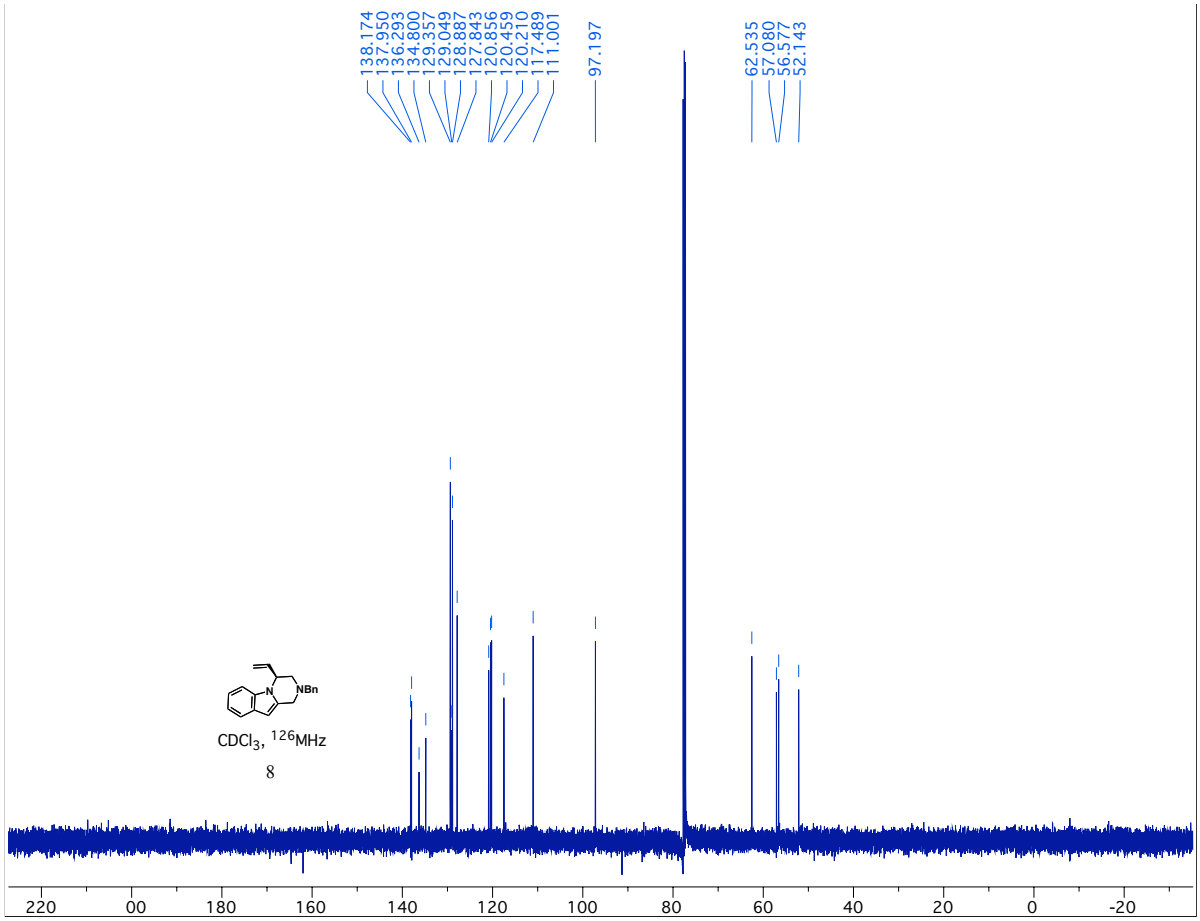

HO
NBn
O
CDCl3, 400MHz
6
1 1 1 7 1 1 1 1 2 1 1
0 9 8 7 6 5 4 3 2 1 0 -1

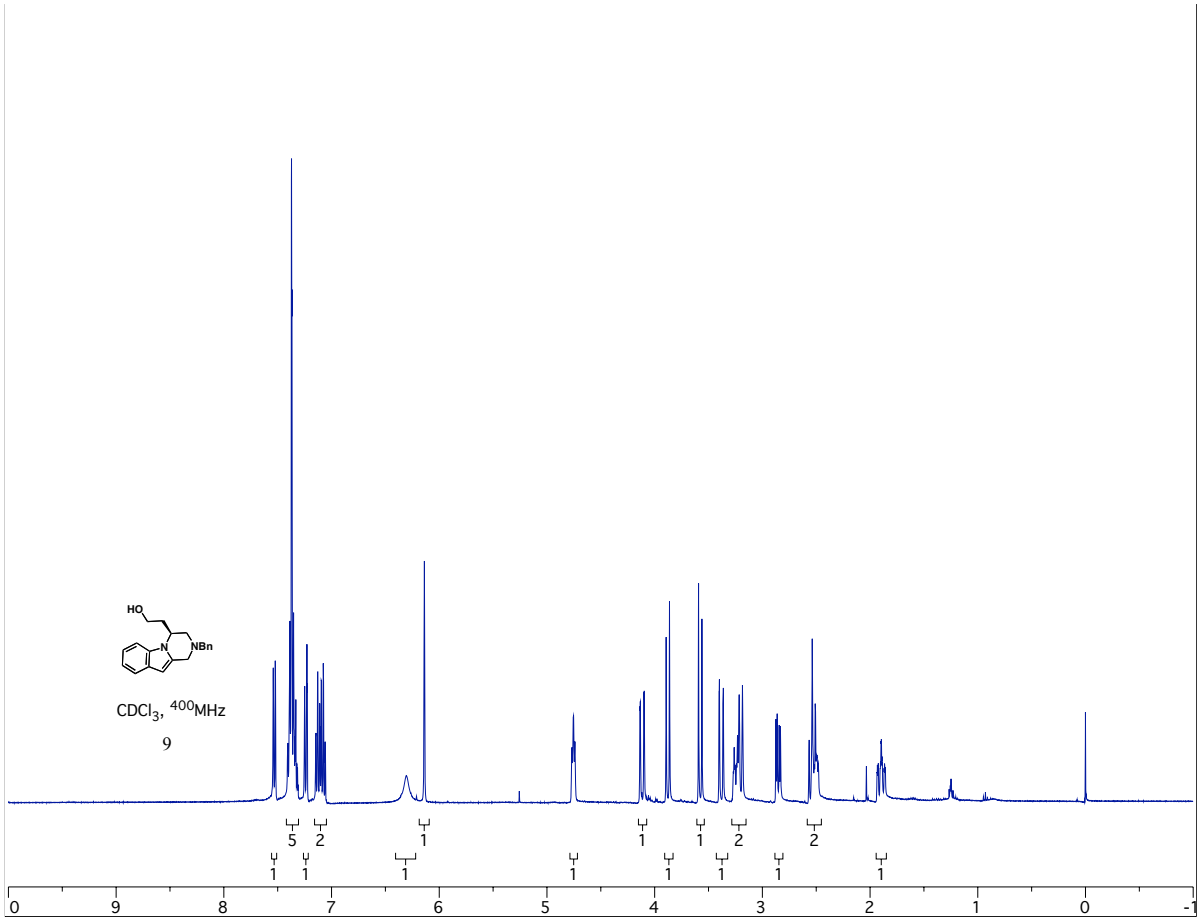

160.463
136.903
136.466
129.159
129.128
128.340
128.302
127.633
124.991
123.042
121.053
110.369
107.021
58.941
49.873
49.005
48.015
35.503
HO
NBn
O
CDCl3, 101MHz
6
220 200 180 160 140 120 100 80 60 40 20 0

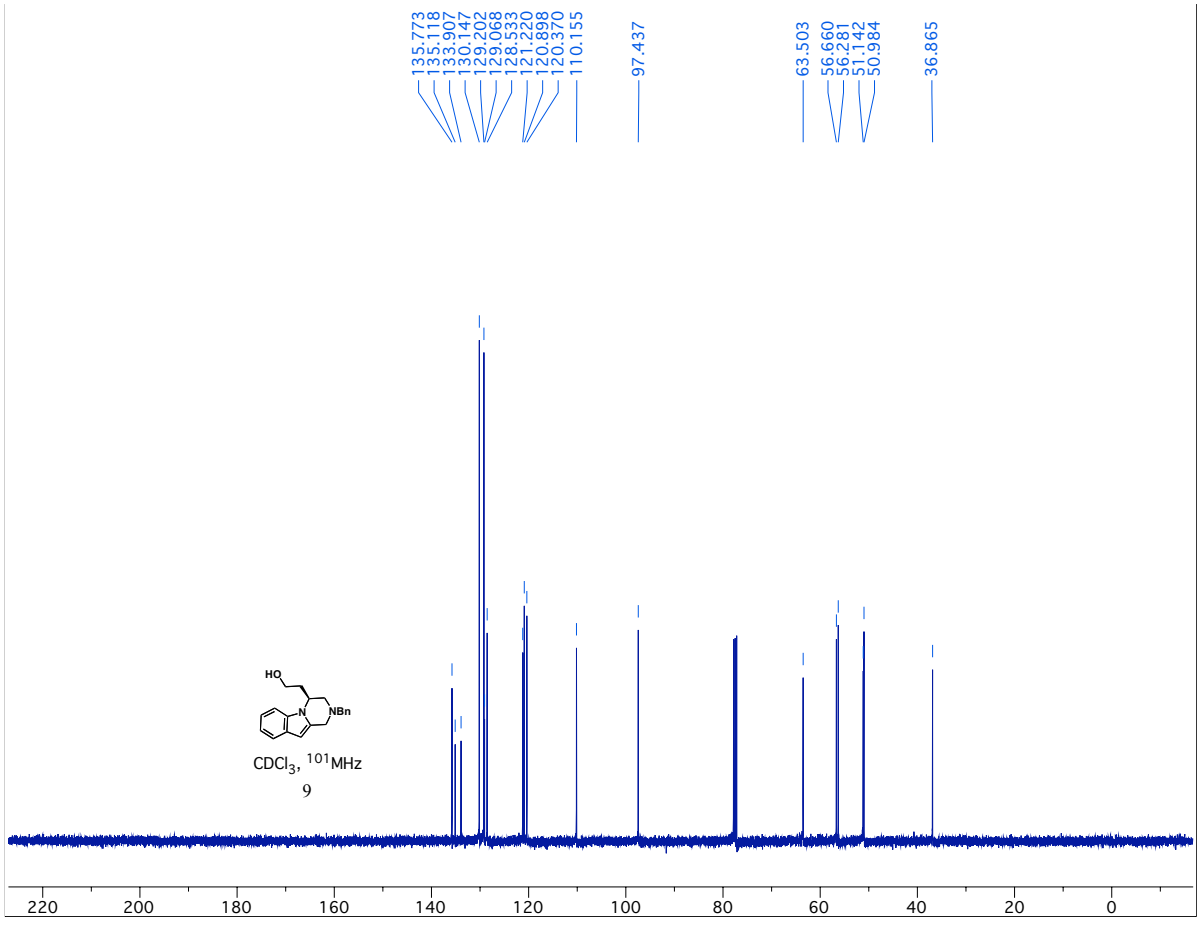

HO2C
NBn
O
CDCl3, 500MHz
7
7 1
1
1
1
1
1
1
2
0
9
8
7
6
5
4
3
2
1
0
-1

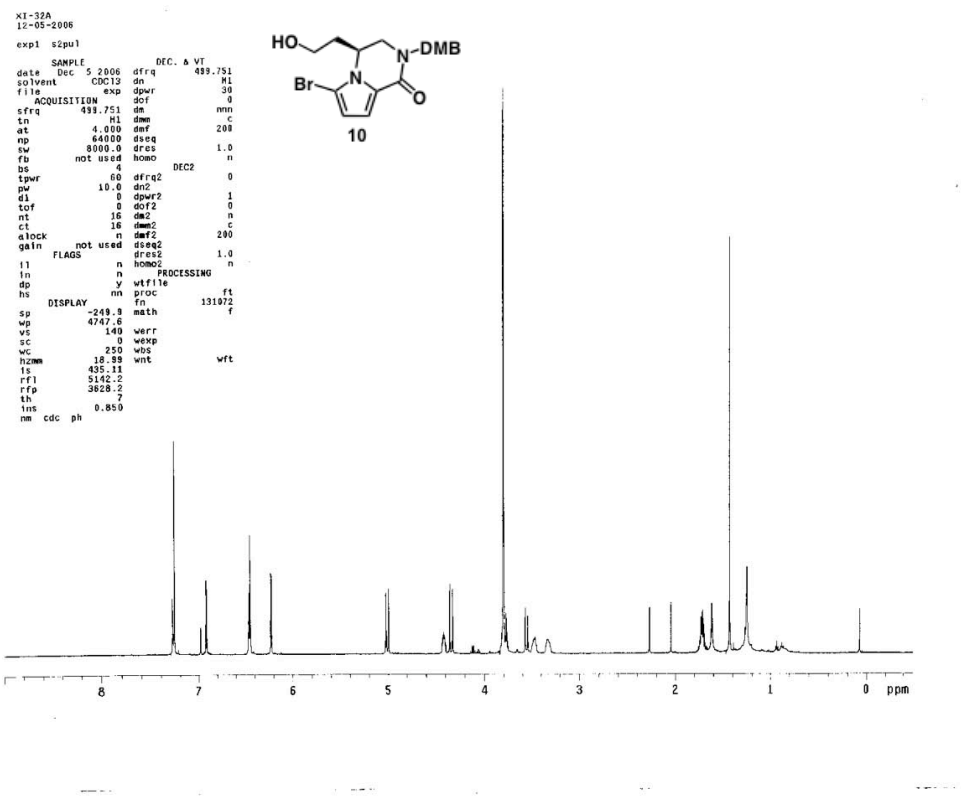

177.641
160.328
136.417
135.542
129.200
128.995
128.267
127.970
127.926
125.338
123.305
121.397
109.778
107.886
49.971
48.605
47.176
35.762
29.968
HO2C
NBn
O
CDCl3, 126MHz
7
220
00
180
160
140
120
100
80
60
40
20
0
-20

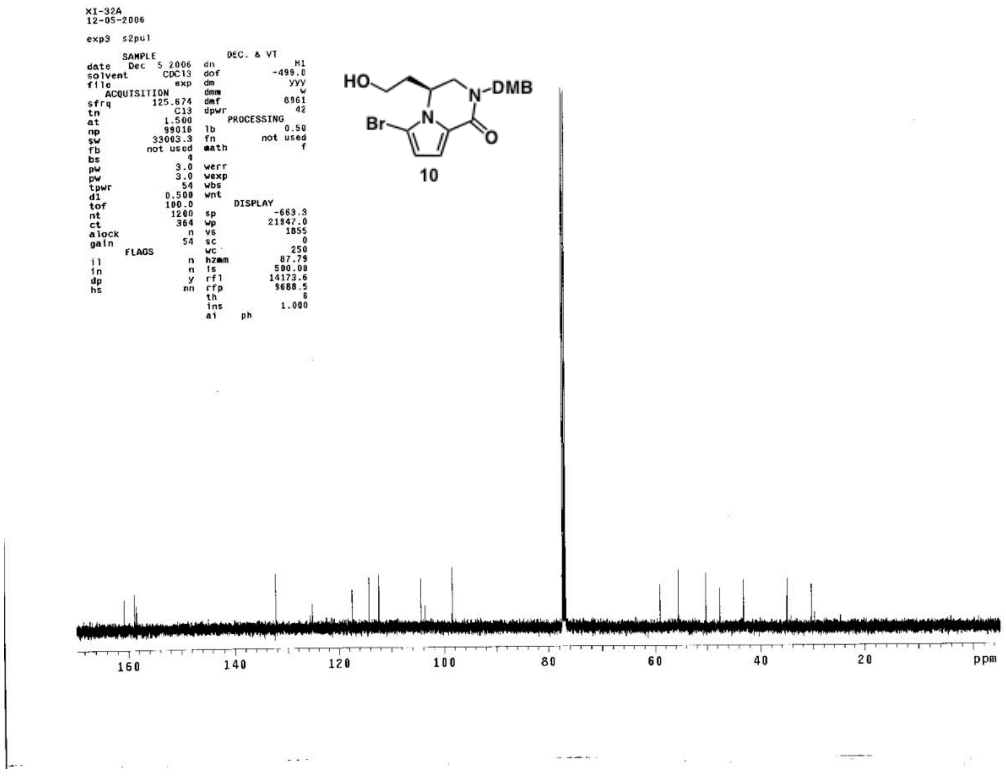

NBn
CDCl3, 500MHz
8
6
1
2
1
2
1
2
1
3
0
9
8
7
6
5
4
3
2
1
0
-1

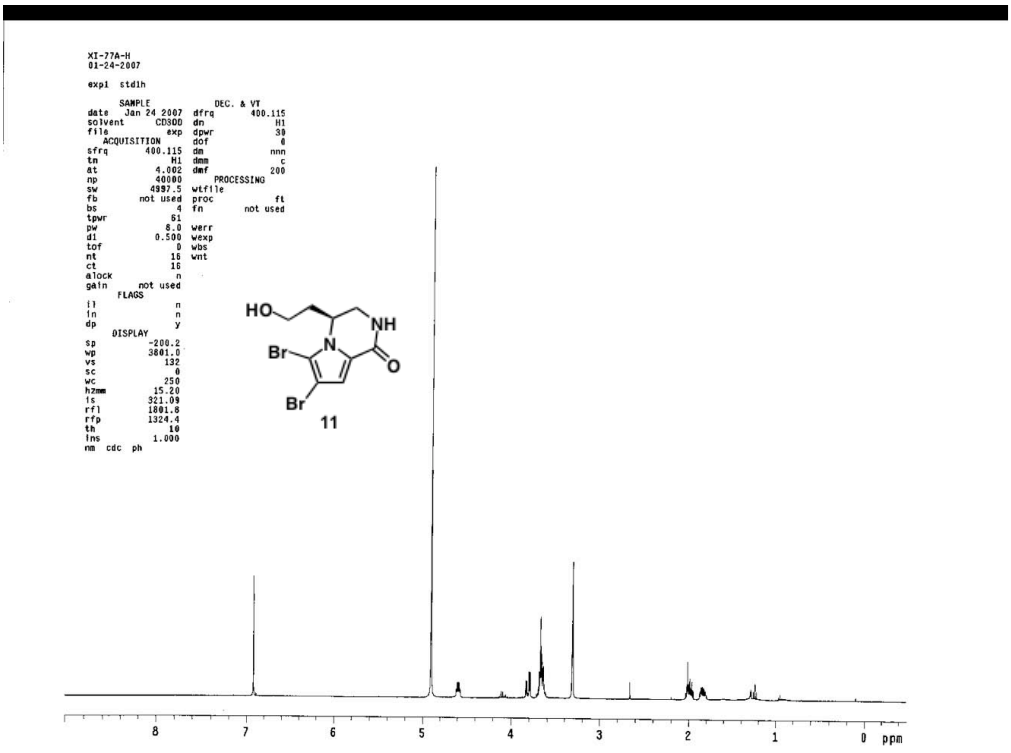

138.174
137.950
136.293
134.800
129.357
129.049
128.887
127.843
120.856
120.459
120.210
117.489
111.001
97.197
62.535
57.080
56.577
52.143
NBn
CDCl3, 126MHz
8
220
00
180
160
140
120
100
80
60
40
20
0
-20

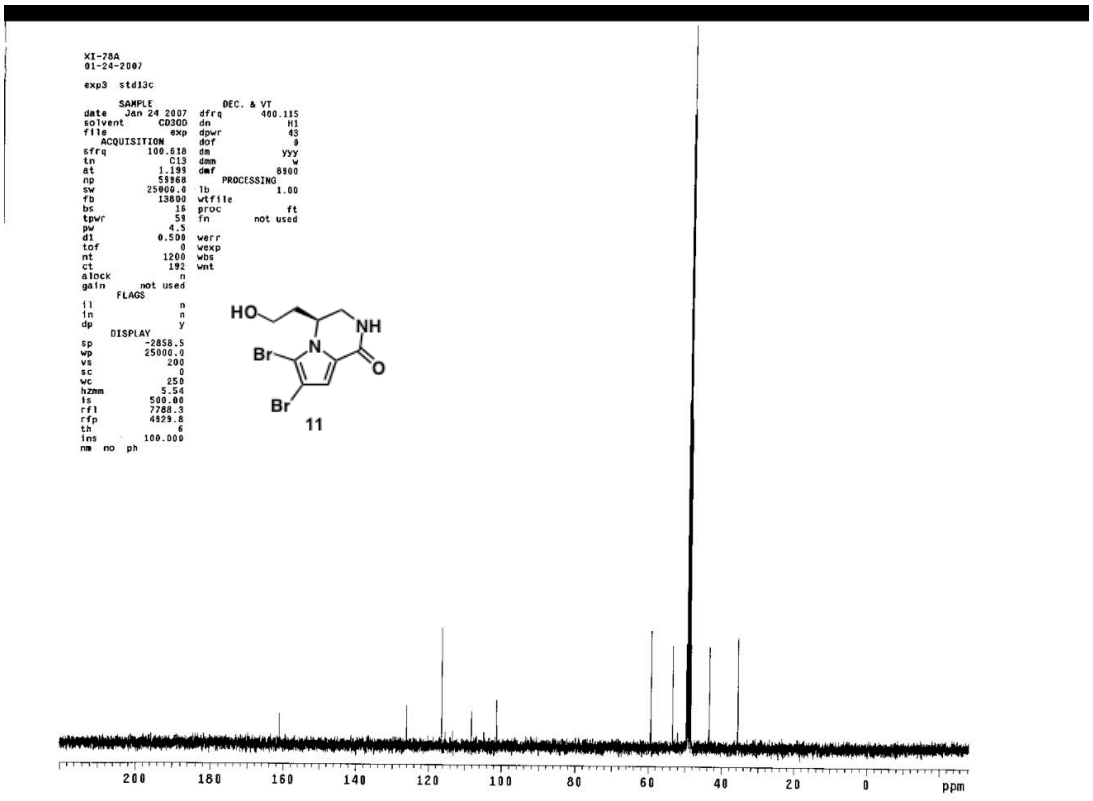

HO
NBn
CDCl3, 400MHz
9
5
2
1
1
1
1
2
2
1
1
1
1
1
1
1
1
0
9
8
7
6
5
4
3
2
1
0
-1

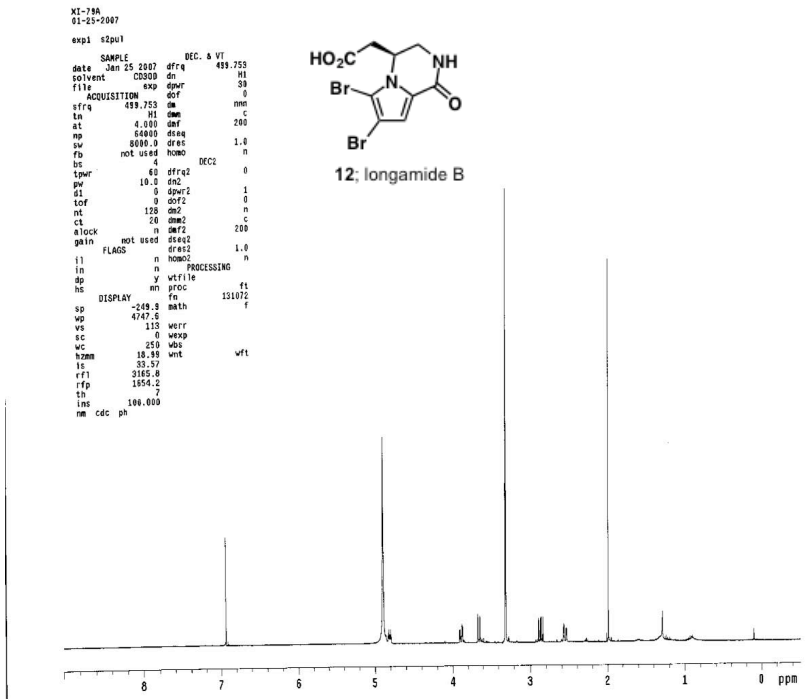

135.773
135.118
133.907
130.147
129.202
129.068
128.533
121.220
120.898
120.370
110.155
97.437
63.503
56.660
56.281
51.142
50.984
36.865
HO
NBn
CDCl3, 101MHz
9
220
200
180
160
140
120
100
80
60
40
20
0

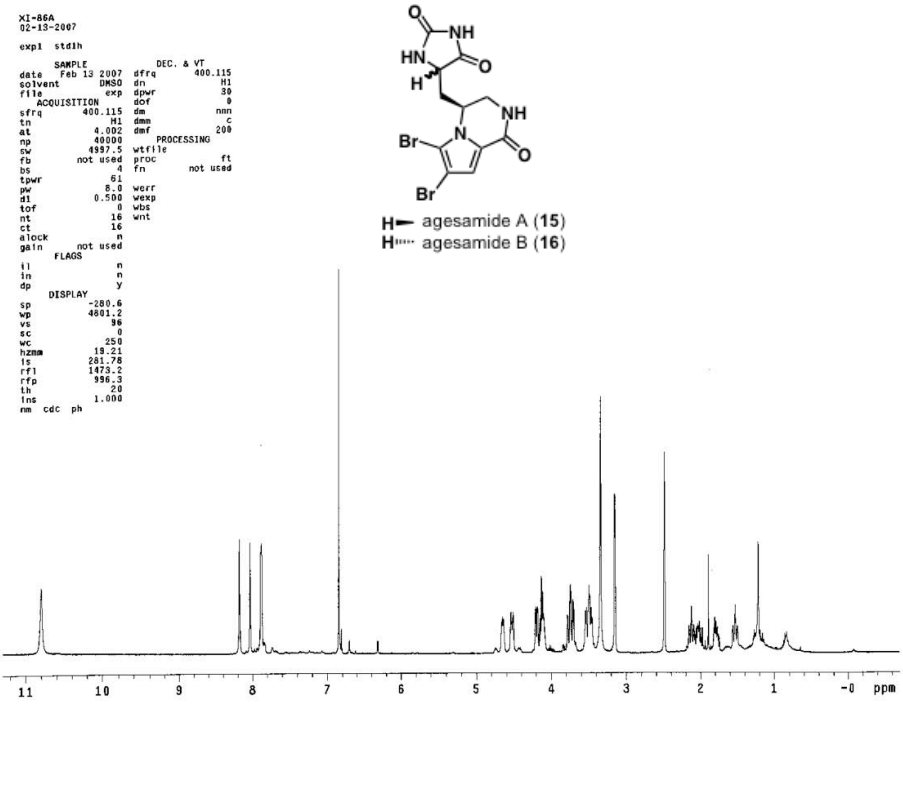

XI-32A
12-05-2006
exp1 s2pul
SAMPLE
date Dec 5 2006
solvent CDCl3
file exp
ACQUISITION
sfrq 499.751
tn H1
at 4.000
np 64000
sw 8000.0
fb not used
bs 4
tpwr 60
pw 10.0
d1 0
tof 0
nt 16
ct 16
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -249.8
wp 4747.6
vs 140
sc 0
wc 250
hzmm 18.99
is 435.11
rfl 5142.2
rfp 3828.2
th 7
ins 0.850
nm cdc ph
DEC. & VT
dfrq 499.751
dn H1
dpwr 30
dof 0
dm nnn
dmm c
dmf 208
dseq
dres 1.0
homo n
DEC2
dfrq2 0
dn2
dpwr2 1
dof2 0
dm2 n
dmm2 c
dmf2 200
dseq2
dres2 1.0
homo2 n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt wft
HO
N-DMB
Br
N
O
10
8
7
6
5
4
3
2
1
0 ppm

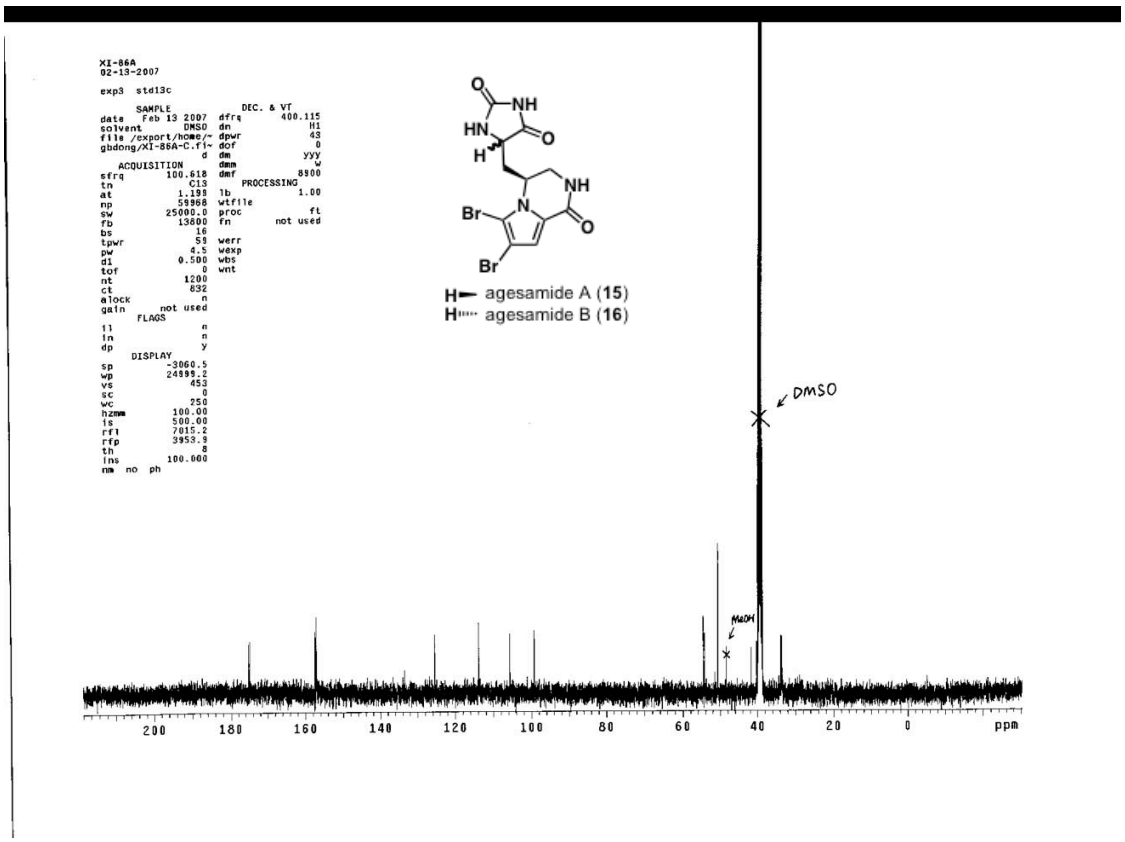

XI-32A
12-05-2006
exp3 s2pul
SAMPLE
date Dec 5 2006
solvent CDCl3
file exp
ACQUISITION
sfrq 125.674
tn C13
at 1.500
np 98016
sw 33003.3
fb not used
bs 4
pw 3.0
pw 3.0
tpwr 54
d1 0.508
tof 100.0
nt 1200
ct 364
alock n
gain 54
FLAGS
il n
in n
dp y
hs nn
DEC. & VT
dn H1
dof -499.0
dm yyy
dmm w
dmf 8861
dpwr 42
PROCESSING
lb 0.50
fn not used
math f
werr
wexp
wbs
wnt
DISPLAY
sp -663.8
wp 21847.0
vs 1855
sc 0
wc 250
hzmm 87.79
is 590.00
rfl 14173.6
rfp 9688.5
th 8
ins 1.000
ai ph
HO
N-DMB
Br
N
O
10
160
140
120
100
80
60
40
20
ppm


XI-77A-H
01-24-2007
expl stdlh
SAMPLE
date Jan 24 2007
solvent CD3OD
file exp
ACQUISITION
sfrq 400.115
tn H1
at 4.002
np 40000
sw 4997.5
fb not used
bs 4
tpwr 61
pw 8.0
d1 0.500
tof 0
nt 16
ct 16
alock n
gain not used
FLAGS
il n
in n
dp y
DISPLAY
sp -200.2
wp 3801.0
vs 132
sc 0
wc 250
hzmm 15.20
is 321.09
rfl 1081.8
rfp 1324.4
th 10
ins 1.000
nm cdc ph
DEC. & VT
dfrq 400.115
dn H1
dpwr 39
dof 0
dm nnn
dmm c
dmf 200
PROCESSING
wtfile
proc ft
fn not used
werr
wexp
wbs
wnt
HO
NH
N
Br
Br
O
11
8
7
6
5
4
3
2
1
0
ppm


XI-78A
01-24-2007
exp3 std13c
SAMPLE
date Jan 24 2007
solvent CD3OD
file exp
ACQUISITION
sfrq 100.618
tn C13
at 1.199
np 59968
sw 25000.0
fb 13800
bs 16
tpwr 59
pw 4.5
d1 0.500
tof 0
nt 1200
ct 192
alock n
gain not used
FLAGS
il n
in n
dp y
DISPLAY
sp -2858.5
wp 25000.0
vs 200
sc 0
wc 250
hzmm 5.54
is 500.00
rfl 7788.3
rfp 4929.8
th 6
ins 100.000
nm no ph
DEC. & VT
dfrq 400.115
dn H1
dpwr 43
dof 0
dm yyy
dmm w
dmf 8900
PROCESSING
lb 1.00
wtfile
proc ft
fn not used
werr
wexp
wbs
wnt
HO
NH
N
Br
Br
O
11
200
180
160
140
120
100
80
60
40
20
0
ppm


XI-79A
01-25-2007
expl s2pul
SAMPLE
date Jan 25 2007
solvent CD3OD
file exp
ACQUISITION
sfrq 499.753
tn H1
at 4.000
np 64000
sw 8000.0
fb not used
bs 4
tpwr 60
pw 10.0
d1 0
tof 0
nt 128
ct 20
alock n
gain not used
FLAGS
il n
in n
dp y
hs nn
DISPLAY
sp -249.8
wp 4747.6
vs 113
sc 0
wc 250
hzmm 18.98
is 33.57
rfl 3165.8
rfp 1654.2
th 7
ins 100.000
nm cdc ph
DEC. & VT
dfrq 499.753
dn H1
dpwr 30
dof 0
dm nnn
dmm c
dmf 200
dseq
dres 1.0
homo n
DEC2
dfrq2 0
dn2
dpwr2 1
dof2 0
dm2 n
dmm2 c
dmf2 200
dseq2
dres2 1.0
homo2 n
PROCESSING
wtfile
proc ft
fn 131072
math f
werr
wexp
wbs
wnt wft
HO2C
NH
Br
N
O
Br
12; longamide B
8
7
6
5
4
3
2
1
0 ppm


XI-86A
02-13-2007
expl stdih
SAMPLE
date Feb 13 2007
solvent DMSO
file exp
ACQUISITION
sfrq 400.115
tn H1
at 4.002
np 40000
sw 4997.5
fb not used
bs 4
tpwr 61
pw 8.0
d1 0.500
tof 0
nt 16
ct 16
alock n
gain not used
FLAGS
il n
in n
dp y
DISPLAY
sp -280.6
wp 4801.2
vs 96
sc 0
wc 250
hzmm 19.21
is 281.78
rfl 1473.2
rfp 996.3
th 20
ins 1.000
nm cdc ph
DEC. & VT
dfrq 400.115
dn H1
dpwr 30
dof 0
dm nnn
dmm c
dmf 200
PROCESSING
wtfile
proc ft
fn not used
werr
wexp
wbs
wnt
O
NH
HN
O
H
NH
Br
N
O
Br
H agesamide A (15)
H agesamide B (16)
11
10
9
8
7
6
5
4
3
2
1
-0 ppm


XI-86A
02-13-2007
exp3 std13c
SAMPLE
date Feb 13 2007
solvent DMSO
file /export/home/~
gbdong/XI-86A-C.fi~
d
ACQUISITION
sfrq 100.618
tn C13
at 1.198
np 59968
sw 25000.0
fb 13800
bs 16
tpwr 58
pw 4.5
d1 0.500
tof 0
nt 1200
ct 832
alock n
gain not used
FLAGS
il n
in n
dp y
DISPLAY
sp -3060.5
wp 24999.2
vs 453
sc 0
wc 250
hzmm 100.00
is 500.00
rfl 7015.2
rfp 3953.9
th 8
ins 100.000
nm no ph
DEC. & VT
dfrq 400.115
dn H1
dpwr 43
dof 0
dm yyy
dmm w
dmf 8900
PROCESSING
lb 1.00
wtfile
proc ft
fn not used
werr
wexp
wbs
wnt
H agesamide A (15)
H agesamide B (16)
DMSO
MeOH
200
180
160
140
120
100
80
60
40
20
0
ppm