Supporting Information

Hydroxylamines as Oxygen Atom Nucleophiles in Transition Metal-Catalyzed Allylic Substitution

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1. Experimental procedure

General. Melting points are uncorrected. ^{1}H and ^{13}C NMR spectra were recorded in $CDCl_3$ at 500 MHz, and at 125 MHz, respectively; Tetramethylsilane (TMS) was used as an internal standard. Low and high resolution mass spectra were obtained by EI, CI or FAB method. Preparative TLC separations were carried out on precoated silica gel plates (E. Merck $60F_{254}$). Optical rotations were recorded with a path length of 1 cm; concentrations are quoted in mg (2 mL). $[\alpha]^{D}$ values are measured in 10^{-1} deg cm^2 g^{-1}. The ratios of products were determined by ^{1}H NMR analysis. Enantiomeric excess was determined by high performance liquid chromatography (HPLC) analysis.

General procedure for iridium-catalyzed reaction of 4A-K with carbonate 1a-d. A mixture of **4A-K** (0.50 mmol), allylic carbonate **1a-d** (0.50 mmol), and $[IrCl(cod)]_2$ (13.4 mg, 0.020 mmol) in MeCN or CH_2Cl_2 (2.5 mL) was stirred under argon atmosphere at 20 °C. After the reaction was completed, the reaction mixture was concentrated under reduced pressure. The ratio of products and combined yield were determined after rough purification by column chromatography (hexame:AcOEt=1:1). Purification of the residue by preparative TLC (hexane:AcOEt=10:1-20:1, 2-fold development) afforded the products **5Aa-Ca** and **6Aa-Dd**.

General procedure for palladium-catalyzed reaction of 4A-K with carbonate 1a. A mixture of **4A-K**, **5Ba**, or **6Ba** (0.50 mmol), allylic carbonate **1a-d** (0.50 or 1.25 mmol), and $Pd(PPh_3)_4$ (23.1 mg, 0.020 mmol) in MeCN (2.5 mL) was stirred under argon atmosphere at 20 °C. After the reaction was completed, the reaction mixture was concentrated under reduced pressure. The ratio of products and combined yield were determined after rough purification by column chromatography (hexame:AcOEt=1:1). Purification of the residue by preparative TLC (hexane:AcOEt=10:1-25:1, 2-

fold development) afforded the products **7Ba**, **8Aa-Dd**, **9Ba-Ca**, **10**, and **11**.

General procedure for of 4E with carbonate 1a in the presence of Et_2Zn. To a solution of **4E** (0.50 mmol) in CH_2Cl_2 (1.0 mL) was added Et_2Zn (1.0 M in hexane, 0.50 mL, 0.50 mmol) under argon atmosphere at 20 °C. After being stirred at the same temperature for 10 min, a solution of **1a** (0.75 mmol) and $[IrCl(cod)]_2$ (13.4 mg, 0.020 mmol) or $Pd(PPh_3)_4$ (23.1 mg, 0.020 mmol) in CH_2Cl_2 (1.0 mL) was added to the reaction mixture at 20 °C. After the reaction was completed, the reaction mixture was diluted with saturated aqueous potassium sodium (+)-tartrate and then extracted with AcOEt. The organic phase was dried over $MgSO_4$ and concentrated under reduced pressure. Purification of the residue by preparative TLC (hexane:AcOEt=20:1, 2-fold development) afforded the product **6Ea** and **8Ea**.

General procedure for enantioselective reaction of 4D-I with carbonate 3a-d.
A mixture of **4D-I** (1.0 mmol) and $Ba(OH)_2 \cdot H_2O$ (139 mg, 1.0 mmol) in $PhCF_3$ (2.0 mL) and H_2O (2.0 mL) was stirred under argon atmosphere at 20 °C for 10 min. To the reaction mixture was added a solution of **3a-d** (1.5 mmol), pybox (44 mg 0.12 mmol) and $[IrCl(cod)]_2$ (40 mg, 0.060 mmol) in $PhCF_3$ (2.0 mL) at 20 °C. After the reaction was completed, the reaction mixture was diluted with saturated aqueous NH_4Cl and then extracted with AcOEt. The organic phase was dried over $MgSO_4$ and concentrated under reduced pressure. The ratio of products was determined by ^1H NMR analysis of crude products. Purification of the residue by preparative TLC (hexane:AcOEt=10:1-25:1, 2-fold development) afforded the products.

2. Characterization data of all obtained compounds

***N*-Benzyl-*N*-hydroxy-1-phenylprop-2-en-1-amine (5Aa).**[1)]
A colorless oil. IR ($CHCl_3$) 3387, 1741, 1710, 1440 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.44-7.23 (10H, m), 6.15 (1H, m), 5.27 (1H, d, *J*=17.4 Hz), 5.22 (1H, d, *J*=10.4 Hz), 4.80 (1H, br s), 4.25 (1H, d, *J*=8.8 Hz), 3.84 (1H, br d, *J*=13.5 Hz), 3.74 (1H, d, *J*=13.5 Hz). ^{13}C NMR ($CDCl_3$) δ 141.1, 138.2, 137.9, 129.3, 128.6, 128.2, 128.0, 127.4, 127.2, 117.7, 75.7, 61.2. MS (CI^+) m/z: 240 ($M+H^+$, 100). HRMS calcd for $C_{16}H_{18}NO$ ($M+H^+$): 240.1388, Found: 240.1382.

***tert*-Butyl [*N*-hydroxy-*N*-(1-phenylallyl)]carbamate (5Ba).**
A colorless oil. IR ($CHCl_3$) 3386, 1697, 1453, 1369 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.41-7.26 (5H, m), 6.35 (1H, br m), 6.23 (1H, m), 5.61 (1H, d, *J*=6.7 Hz), 5.35 (1H, d, *J*=10.4 Hz), 5.39 (1H, d, *J*=17.4 Hz), 1.46 (9H, s). ^{13}C NMR ($CDCl_3$) δ 157.1,138.3, 134.5, 128.3, 127.9, 127.6, 118.4, 82.4, 65.2, 28.3. MS (CI^+) m/z: 250 ($M+H^+$, 40), 194 (100). HRMS calcd for $C_{14}H_{20}NO_3$ ($M+H^+$): 250.1443, Found: 250.1448.

Benzyl [*N*-hydroxy-*N*-(1-phenylallyl)]carbamate (5Ca).
A colorless oil. IR ($CHCl_3$) 3530, 1710, 1496, 1453, 1395 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.38-7.25 (10H, m), 6.21 (1H, m), 5.73 (1H, d, *J*=6.4 Hz), 5.35 (1H, d, *J*=10.4 Hz), 5.29 (1H, d, *J*=17.4 Hz), 5.19 (2H, s), 4.66 (1H, br s). ^{13}C NMR ($CDCl_3$) δ 157.3, 137.8, 135.7, 134.0, 128.5 (2C), 128.3, 128.1, 128.0, 127.8, 118.8, 68.2, 64.9. MS (CI^+) m/z: 284 ($M+H^+$, 100). HRMS calcd for $C_{17}H_{18}NO_3$ ($M+H^+$): 284.1287, Found: 284.1293.

***tert*-Butyl [*N*-(1-phenylallyloxy)]carbamate (6Ba).**
A colorless oil. IR ($CHCl_3$) 3387, 1741, 1440, 1369 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.42-7.30 (5H, m),

7.03 (1H, br s), 6.08 (1H, m), 5.33 (1H, d, *J*=10.1 Hz), 5.32 (1H, d, *J*=18.0 Hz), 5.23 (1H, d, *J*=7.0 Hz), 1.47 (9H, s). ^{13}C NMR ($CDCl_3$) δ 156.4, 138.6, 136.0, 128.5, 128.4, 127.6, 119.2, 88.2, 81.6, 28.2. MS (CI^+) m/z: 250 ($M+H^+$, 35), 194 (100). HRMS calcd for $C_{14}H_{20}NO_3$ ($M+H^+$): 205.1443, Found: 250.1446.

Benzyl [*N*-(1-phenylallyloxy)]carbamate (6Ca).
A colorless oil. IR ($CHCl_3$) 3390, 1748, 1453, 1335 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.40-7.30 (10H, m), 6.08 (1H, m), 5.33 (1H, d, *J*=10.4 Hz), 5.31 (1H, d, *J*=17.1 Hz), 5.24 (1H, d, *J*=7.0 Hz), 5.17 (2H, s). ^{13}C NMR ($CDCl_3$) δ 157.3, 138.2, 135.7, 128.6 (2C), 128.5, 128.4, 128.2, 127.6, 119.6, 88.6, 67.5. One carbon peak was missing due to overlapping. MS (CI^+) m/z: 284 ($M+H^+$, 10), 117 (100). HRMS calcd for $C_{17}H_{18}NO_3$ ($M+H^+$): 284.1287, Found: 284.1285.

***N*-(1-Phenylallyloxy)-*N*-phenylbenzamide (6Da).**
A colorless oil. IR ($CHCl_3$) 3490, 1653, 1491, 1362 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.53 (2H, d, *J*=7.0 Hz), 7.44-7.13 (14H, m), 5.89 (1H, m), 5.28 (1H, d, *J*=10.1 Hz), 5.27 (1H, d, *J*=16.8 Hz). ^{13}C NMR ($CDCl_3$) δ 168.7, 140.2, 137.5, 135.7, 135.1, 130.3, 128.9, 128.8, 128.6, 128.4, 127.9, 127.7, 126.9, 125.1, 120.2, 86.8. MS (FAB^+) m/z: 330 ($M+H^+$, 22), 117 (100). HRMS calcd for $C_{22}H_{20}NO_2$ ($M+H^+$): 330.1494, Found: 330.1488. HPLC (Chiralcel AD-H, hexane/2-propanol=90/10, 0.5 ml/min 254 nm) t_r (*S*) = 24.9 min, t_r (*R*) = 26.9 min. A sample of 88%ee (*S*) by HPLC analysis gave $[\alpha]^{25}_D$ –20.9 (*c* 1.8, $CHCl_3$).

***N*-(1-Phenylallyloxy)-*N*-benzyl(phenyl)methanamine (6Ea).**
A colorless oil. ^{1}H NMR ($CDCl_3$) δ 7.35-7.17 (13H, m), 7.13 (2H, br d, *J*=6.4 Hz), 5.76 (1H, ddd, *J*=17.1, 10.4, 7.3 Hz), 5.06 (1H, d, *J*=10.4 Hz), 5.00 (1H, d, *J*=17.1 Hz), 4.55 (1H, d, *J*=7.3 Hz), 3.81 (4H, s). ^{13}C NMR ($CDCl_3$) δ 140.6, 138.0, 137.8, 129.8, 128.2, 128.1, 127.8, 127.6, 127.2, 117.0, 85.9, 62.6. MS (EI^+) m/z: 329 (M^+, 1), 117 (100). HRMS calcd for $C_{23}H_{23}NO$: 329.1780, Found: 329.1776.

***N*-(1-Phenylallyloxy)-*N*-phenylacetamide (6Fa).**
A colorless oil. IR ($CHCl_3$) 1669, 1495, 1376 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.47-7.18 (10H, m), 6.11 (1H, m), 5.35 (1H, d, *J*=10.4 Hz), 5.32 (1H, d, *J*=17.9 Hz), 5.17 (1H, br d, *J*=4.9 Hz). ^{13}C NMR ($CDCl_3$) δ 170.7, 139.0, 137.3, 135.0, 128.7, 128.5, 128.4, 127.8, 126.7, 124.2, 120.4, 85.9, 22.0. MS (EI^+) m/z: 267 (M^+, 0.4), 93 (100). HRMS calcd for $C_{17}H_{17}NO_2$: 267.1259, Found: 267.1252. HPLC (Chiralcel AD-H, hexane/2-propanol=90/10, 0.5 ml/min 254 nm) t_r (*S*) = 13.8 min, t_r (*R*) = 15.8 min. A sample of 82%ee (*S*) by HPLC analysis gave $[\alpha]^{25}_D$ –14.1 (*c* 0.4, $CHCl_3$).

Benzyl [*N*-(1-phenylallyloxy)-*N*-pheny]carbamate (6Ga).
A colorless oil. IR ($CHCl_3$) 1710, 1338 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.41-7.25 (15H, m), 6.06 (1H, m), 5.30-5.16 (5H, m). ^{13}C NMR ($CDCl_3$) δ 155.1, 140.7, 137.9, 136.0, 135.9, 128.5 (2C), 128.4, 128.2, 128.1, 127.9, 126.1, 123.3, 119.9, 87.5, 67.9. One carbon peak was missing due to overlapping. MS (EI^+) m/z: 359 (M^+, 1), 117 (100). HRMS calcd for $C_{23}H_{21}NO_3$: 359.1521, Found: 359.1518. HPLC (Chiralcel AD-H, hexane/2-propanol=90/10, 0.5 ml/min 254 nm) t_r (*S*) = 15.6 min, t_r (*R*) = 17.5 min. A sample of 68%ee (*S*) by HPLC analysis gave $[\alpha]^{24}_D$ –0.2 (*c* 0.9, $CHCl_3$).

***N*-(1-Phenylallyloxy)-*N*-benzylacetamide (6Ha).**
A colorless oil. IR ($CHCl_3$) 1655, 1396 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.39-7.20 (10H, m), 6.07 (1H,

ddd, *J*=17.1, 10.4, 6.4 Hz), 5.31 (1H, d, *J*=10.4 Hz), 5.25 (1H, d, *J*=17.1 Hz), 5.16 (1H, br d, *J*=6.4 Hz), 4.83 (1H, d, *J*=15.6 Hz), 4.58 (1H, d, *J*=15.6 Hz), 2.09 (3H, s). ^{13}C NMR ($CDCl_3$) δ 173.5, 138.0, 136.5, 135.5, 128.7, 128.6, 128.4, 127.6, 127.4, 119.7, 87.4, 50.7, 21.0. One carbon peak was missing due to overlapping. MS (CI^+) m/z: 282 ($M+H^+$, 11), 117 (100). HRMS calcd for $C_{18}H_{20}NO_2$ ($M+H^+$): 282.1494, Found: 282.1487. HPLC (Chiralcel AD-H, hexane/2-propanol=90/10, 0.5 ml/min 254 nm) t_r (*S*) = 21.4 min, t_r (*R*) = 25.8 min. A sample of 82%ee (*S*) by HPLC analysis gave $[\alpha]^{25}_D$ –11.5 (*c* 1.0, $CHCl_3$).

***N*-(1-Phenylallyloxy)-*N*-benzylbenzamide (6Ia).**
A colorless oil. IR ($CHCl_3$) 1635, 1450, 1405 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.59 (2H, d, *J*=7.3 Hz), 7.46-7.21 (11H, m), 7.09 (2H, m), 5.72 (1H, m), 5.17 (1H, d, *J*=10.4 Hz), 5.11 (1H, d, *J*=17.1 Hz), 5.06 (1H, br d, *J*=7.0 Hz), 4.93 (1H, d, *J*=15.3 Hz), 4.65 (1H, d, *J*=15.3 Hz). ^{13}C NMR ($CDCl_3$) δ 170.7, 137.7, 136.4, 135.5, 134.7, 130.4, 128.6, 128.5, 128.4, 128.3, 127.9, 127.8, 127.6, 119.9, 87.6, 52.4. One carbon peak was missing due to overlapping. MS (CI^+) m/z: 344 ($M+H^+$, 3), 117 (100). HRMS calcd for $C_{23}H_{22}NO_2$ ($M+H^+$): 344.1650, Found: 344.1647. HPLC (Chiralcel AD-H, hexane/2-propanol=90/10, 0.5 ml/min 254 nm) t_r (*S*) = 32.5 min, t_r (*R*) = 35.2 min. A sample of 87%ee (*S*) by HPLC analysis gave $[\alpha]^{26}_D$ –25.9 (*c* 0.9, $CHCl_3$).

2-(1-Phenylallyloxy)isoindoline-1,3-dione (6Ja).
A colorless crystal. mp 91-93 °C (AcOEt/hexane). IR ($CHCl_3$) 1733, 1374 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.81 (2H, m), 7.72 (2H, m), 7.57 (2H, br d, *J*=7.6 Hz), 7.44-7.31 (3H, m), 6.27 (1H, m), 5.76 (1H, d, *J*=8.5 Hz), 5.38 (1H, d, *J*=17.1 Hz), 5.34 (1H, d, *J*=10.4 Hz). ^{13}C NMR ($CDCl_3$) δ 163.9, 136.9, 135.2, 134.4, 129.1, 128.8, 128.6, 127.9, 123.5, 121.5, 90.0. MS (FAB^+) m/z: 280 ($M+H^+$, 6), 117 (100). HRMS calcd for $C_{17}H_{14}NO_3$ ($M+H^+$): 280.0974, Found: 280.0980. Anal. Calcd for $C_{17}H_{13}NO_3$: C, 73.11; H, 4.69; N, 5.02. Found: C, 73.14; H, 4.59; N, 4.86.

1-(1-Phenylallyloxy)pyrrolidine-2,5-dione (6Ka).
A colorless crystal. mp 115-117 °C (AcOEt/hexane). IR ($CHCl_3$) 1727, 1373 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.50 (2H, br d, *J*=7.3 Hz), 7.41-7.33 (3H, m), 6.18 (1H, m), 5.73 (1H, d, *J*=8.5 Hz), 5.38 (1H, d, *J*=12.8 Hz), 5.36 (1H, d, *J*=5.8 Hz), 2.63 (4H, s). ^{13}C NMR ($CDCl_3$) δ 171.5, 136.5, 135.1, 129.2, 128.6, 127.9, 121.3, 88.8, 25.3. MS (FAB^+) m/z: 232 ($M+H^+$, 4), 117 (100). HRMS calcd for $C_{13}H_{14}NO_3$ ($M+H^+$): 232.0974, Found: 232.0979. Anal. Calcd for $C_{13}H_{13}NO_3$: C, 67.52; H, 5.67; N, 6.06. Found: C, 67.67; H, 5.76; N, 6.05.

***N*-(1-(4-Fluorophenyl)allyloxy)-*N*-phenylbenzamide (6Db).**
A colorless oil. IR ($CHCl_3$) 1654, 1604, 1510, 1489, 1360 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.50 (2H, d, *J*=7.3 Hz), 7.43-7.12 (10H, m), 6.94 (2H, br t, *J*=8.9 Hz), 5.90 (1H, m), 5.35-5.24 (3H, m). ^{13}C NMR ($CDCl_3$) δ 168.6, 162.8 (d, *J*=247 Hz), 140.2, 135.5, 134.9, 133.4, 130.4, 129.8 (d, *J*=9.3 Hz), 128.9, 128.8, 127.8, 127.1, 125.2, 120.2, 115.3 (d, *J*=21.7 Hz), 86.0. MS (CI^+) m/z: 348 ($M+H^+$, 1), 135 (100). HRMS calcd for $C_{22}H_{19}FNO_2$ ($M+H^+$): 348.1400, Found: 348.1398. HPLC (Chiralcel AD-H, hexane/2-propanol=95/5, 0.5 ml/min 254 nm) t_r (*S*) = 47.7 min, t_r (*R*) = 49.9 min. A sample of 62%ee (*S*) by HPLC analysis gave $[\alpha]^{25}_D$ –20.0 (*c* 1.3, $CHCl_3$).

***N*-(1-*p*-Tolylallyloxy)-*N*-phenylbenzamide (6Dc).**
A colorless oil. IR ($CHCl_3$) 1653, 1591, 1489, 1360 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.55 (2H, d, *J*=7.0 Hz), 7.43 (2H, d, *J*=7.6 Hz), 7.39-7.18 (6H, m), 7.08-7.02 (4H, m), 5.87 (1H, m), 5.27-5.20 (3H, m), 2.31 (3H, s). ^{13}C NMR ($CDCl_3$) δ 168.7, 140.1, 138.5, 135.7, 135.2, 134.5, 130.2, 129.1, 128.9,

128.8, 127.9, 127.7, 126.8, 124.9, 120.0, 86.6, 21.1. MS (CI^+) m/z: 344 ($M+H^+$, 1), 131 (100). HRMS calcd for $C_{23}H_{22}NO_2$ ($M+H^+$): 344.1650, Found: 344.1646. HPLC (Chiralcel AD-H, hexane/2-propanol=90/10, 0.5 ml/min 254 nm) t_r (*S*) = 27.3 min, t_r (*R*) = 35.6 min. A sample of 72%ee (*S*) by HPLC analysis gave $[\alpha]^{25}_D$ –12.6 (*c* 1.8, $CHCl_3$).

***N*-(1-(Naphthalen-1-yl)allyloxy)-*N*-phenylbenzamide (6Dd).**
A colorless oil. IR ($CHCl_3$) 1653, 1598, 1495, 1353 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.98 (1H, d, *J*=8.2 Hz), 7.83-7.76 (2H, m), 7.51 (2H, d, *J*=7.0 Hz), 7.45-7.15 (12H, m), 6.17 (1H, m), 6.04 (1H, d, *J*=7.9 Hz), 5.36 (1H, d, *J*=17.1 Hz), 5.32 (1H, d, *J*=10.4 Hz). ^{13}C NMR ($CDCl_3$) δ 168.8, 140.2, 135.8, 135.1, 133.8, 133.6, 131.0, 130.3, 129.3, 128.8, 128.6, 127.8, 127.1, 126.4, 126.2, 125.7, 125.5, 125.1, 124.0, 120.5, 84.6. One carbon peak was missing due to overlapping. MS (CI^+) m/z: 380 ($M+H^+$, 1), 167 (100). HRMS calcd for $C_{26}H_{22}NO_2$ ($M+H^+$): 380.1650, Found: 380.1648. HPLC (Chiralcel AD-H, hexane/2-propanol=90/10, 0.5 ml/min 254 nm) t_r (*S*) = 24.9 min, t_r (*R*) = 28.7 min. A sample of 78%ee (*S*) by HPLC analysis gave $[\alpha]^{25}_D$ –5.9 (*c* 1.7, $CHCl_3$).

***tert*-Butyl (*N*-cinnamyl-*N*-hydroxy)carbamate (7Ba).**
A colorless oil. IR ($CHCl_3$) 3258, 1693, 1369 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.37 (2H, d, *J*=7.6 Hz), 7.30 (2H, d, *J*=7.7 Hz), 7.23 (1H, m), 7.20 (1H, br s), 6.57 (1H, d, *J*=15.9 Hz), 6.25 (1H, dt, *J*=15.9, 6.1 Hz), 4.22 (2H, d, *J*=6.1 Hz), 1.47 (9H, s). ^{13}C NMR (CDCl3) δ 157.3, 136.7, 133.4, 128.5, 127.7, 126.5, 123.5, 82.1, 52.8, 28.2. MS (FAB^+) m/z: 250 ($M+H^+$, 13), 117 (100). HRMS calcd for $C_{14}H_{20}NO_3$ ($M+H^+$): 250.1443, Found: 250.1448.

***tert*-Butyl [N-(cinnamyloxy)]carbamate (8Ba).**
A colorless oil. IR (CHCl3) 3385, 1742, 1439, 1369 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.42-7.18 (6H, m), 6.64 (1H, d, *J*=15.9 Hz), 6.33 (1H, dt, *J*=15.9, 6.8 Hz), 4.49 (2H, d, *J*=6.8 Hz). ^{13}C NMR ($CDCl_3$) δ 156.8, 136.3, 135.4, 128.6, 128.0, 126.6, 123.4, 88.2, 81.7, 28.2. MS (FAB^+) m/z: 250 ($M+H^+$, 7), 117 (100). HRMS calcd for $C_{14}H_{20}NO_3$ ($M+H^+$): 250.1443, Found: 250.1435.

Benzyl [*N*-(cinnamyloxy)]carbamate (8Ca).
A colorless oil. IR ($CHCl_3$) 3388, 1745, 1452, 1335 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.50 (1H, s), 7.40-7.23 (10H, m), 6.62 (1H, d, *J*=15.9 Hz), 6.30 (1H, dt, *J*=15.9, 6.7 Hz), 5.17 (2H, s), 4.50 (2H, d, *J*=6.7 Hz). ^{13}C NMR ($CDCl_3$) δ 157.3, 136.1, 135.8, 135.6, 128.7, 128.5, 128.4, 128.2, 128.1, 126.7, 123.0, 77.3, 67.5. MS (CI^+) m/z: 284 ($M+H^+$, 39), 117 (100). HRMS calcd for $C_{17}H_{18}NO_3$ ($M+H^+$): 284.1287, Found: 284.1296.

***N*-(Cinnamyloxy)-*N*-phenylbenzamide (8Da).**
A colorless oil. IR ($CHCl_3$) 3437, 1655, 1491, 1357 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.60 (2H, d, *J*=7.6 Hz), 7.49 (2H, d, *J*=7.9 Hz), 7.43-7.20 (11H, m), 6.59 (1H, d, *J*=15.9 Hz), 6.08 (1H, dt, *J*=15.9, 6.7 Hz), 4.50 (2H, d, *J*=6.7 Hz). ^{13}C NMR ($CDCl_3$) δ 168.4, 139.9, 136.3 (2C), 136.0, 134.9, 128.7, 128.3, 127.9, 127.0, 126.7, 74.9. MS (CI^+) m/z: 330 ($M+H^+$, 100). HRMS calcd for $C_{22}H_{20}NO_2$ ($M+H^+$): 330.1494, Found: 330.1483.

***N*-Benzyl-*N*-(cinnamyloxy)(phenyl)methanamine (8Ea).**
A colorless oil. ^1H NMR ($CDCl_3$) δ 7.44-7.16 (15H, m), 6.27 (1H, d, *J*=15.9 Hz), 5.86 (1H, dt, *J*=15.9, 7.9 Hz), 3.91 (2H, d, *J*=7.9 Hz), 3.90 (4H, s). ^{13}C NMR ($CDCl_3$) δ 137.8, 136.8, 132.9, 129.8, 128.4, 128.2, 127.5, 127.3, 126.5, 125.5, 74.3, 62.9. MS (EI^+) m/z: 329 (M^+, 1), 117 (100). HRMS calcd for $C_{23}H_{23}NO$: 329.1780, Found: 329.1772.

_N_-(Cinnamyloxy)-_N_-phenylacetamide (8Fa).
A colorless oil. IR ($CHCl_3$) 1670, 1493, 1376 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.50 (2H, d, *J*=7.6 Hz), 7.41-7.20 (8H, m), 6.62 (1H, d, *J*=15.9 Hz), 6.28 (1H, dt, *J*=15.9, 6.7 Hz), 4.48 (2H, d, *J*=6.7 Hz), 2.27 (3H, s). ^{13}C NMR ($CDCl_3$) δ 170.1, 138.7, 136.2, 135.8, 128.8, 128.6, 128.5, 128.3, 126.6, 123.3, 121.8, 74.7, 21.8. MS (EI^+) m/z: 267 (M^+, 0.4), 117 (100). HRMS calcd for $C_{17}H_{17}NO_2$: 267.1259, Found: 267.1267.

Benzyl [_N_-(cinnamyloxy)-_N_-phenyl]carbamate (8Ga).
A colorless oil. IR ($CHCl_3$) 1712, 1495, 1338 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.49 (2H, d, *J*=7.0 Hz), 7.40-7.12 (13H, m), 6.55 (1H, d, *J*=15.9 Hz), 6.27 (1H, dt, *J*=15.9, 6.7 Hz), 5.24 (2H, s), 4.52 (2H, d, *J*=6.7 Hz). ^{13}C NMR ($CDCl_3$) δ 154.4, 139.9, 136.0, 135.7, 128.6, 128.4, 128.1, 128.0, 127.9, 126.6, 125.8, 122.6, 122.2, 75.3, 67.7. Some carbon peaks were missing due to overlapping. MS (EI^+) m/z: 359 (M^+, 1), 117 (100). HRMS calcd for $C_{23}H_{21}NO_3$: 359.1521, Found: 359.1518.

_N_-Benzyl-_N_-(cinnamyloxy)acetamide (8Ha).
A colorless oil. IR ($CHCl_3$) 1655, 1396 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.35-7.22 (10H, m), 6.53 (1H, d, *J*=15.9 Hz), 6.18 (1H, dt, *J*=15.9, 6.7 Hz), 4.82 (2H, s), 4.38 (2H, d, *J*=6.7 Hz), 2.21 (3H, s). ^{13}C NMR ($CDCl_3$) δ 172.5, 136.5, 135.8, 128.6, 128.5, 128.4, 128.3, 127.6, 126.6, 121.9, 106.6, 75.5, 50.0, 20.5. MS (CI^+) m/z: 282 ($M+H^+$, 10), 117 (100). HRMS calcd for $C_{18}H_{20}NO_2$ ($M+H^+$): 282.1494, Found: 282.1491.

_N_-Benzyl-_N_-(cinnamyloxy)benzamide (8Ia).
A colorless oil. IR ($CHCl_3$) 1634, 1405 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.69 (2H, d, *J*=7.0 Hz), 7.50-7.17 (13H, m), 6.30 (1H, d, *J*=15.9 Hz), 5.84 (1H, dt, *J*=15.9, 6.7 Hz), 4.95 (2H, s), 4.23 (2H, d, *J*=6.7 Hz). ^{13}C NMR ($CDCl_3$) δ 170.1, 136.4, 135.9, 135.8, 134.4, 130.5, 128.6, 128.5, 128.4, 128.2, 127.9, 127.7, 126.6, 122.0, 75.6, 51.5. One carbon peak was missing due to overlapping. MS (CI^+) m/z: 344 ($M+H^+$, 3), 117 (100). HRMS calcd for $C_{23}H_{22}NO_2$ ($M+H^+$): 344.1650, Found: 344.1645.

2-(Cinnamyloxy)isoindoline-1,3-dione (8Ja).[2)]
A colorless crystal. mp 151-152 °C (AcOEt/hexane). IR ($CHCl_3$) 1732, 1377 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.82 (2H, m), 7.72 (2H, m), 7.44-7.20 (5H, m), 6.67 (1H, d, *J*=15.6 Hz), 6.47 (1H, dt, *J*=15.6, 7.0 Hz), 4.87 (2H, d, *J*=7.0 Hz). ^{13}C NMR ($CDCl_3$) δ 163.9, 137.5, 135.8, 134.5, 128.9, 128.6, 128.5, 126.9, 123.5, 122.0, 78.6. MS (FAB^+) m/z: 280 ($M+H^+$, 10), 117 (100). HRMS calcd for $C_{17}H_{14}NO_3$ ($M+H^+$): 280.0974, Found: 280.0970. Anal. Calcd for $C_{17}H_{13}NO_3$: C, 73.11; H, 4.69; N, 5.02. Found: C, 73.06; H, 4.70; N, 5.02.

1-(Cinnamyloxy)pyrrolidine-2,5-dione (8Ka).
A colorless crystal. mp 174-175 °C (AcOEt/hexane). IR ($CHCl_3$) 1727, 1377 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.43-7.24 (5H, m), 6.65 (1H, d, *J*=15.9 Hz), 6.37 (1H, dt, *J*=15.9, 7.3 Hz), 4.78 (2H, d, *J*=7.3 Hz), 2.66 (4H, s). ^{13}C NMR ($CDCl_3$) δ 171.6, 137.7, 135.6, 128.7, 128.6, 126.9, 121.6, 77.4, 25.3. MS (FAB^+) m/z: 232 ($M+H^+$, 7), 117 (100). HRMS calcd for $C_{13}H_{14}NO_3$ ($M+H^+$): 232.0974, Found: 232.0978. Anal. Calcd for $C_{13}H_{13}NO_3$: C, 67.52; H, 5.67; N, 6.06. Found: C, 67.57; H, 5.75; N, 6.01.

_N_-(4-Fluorocinnamyloxy)-_N_-phenylbenzamide (8Db).
A colorless oil. IR ($CHCl_3$) 1655, 1604, 1509, 1489, 1357 cm^{-1}. ^1H NMR ($CDCl_3$) δ 7.60 (2H, d,

J=7.0 Hz), 7.48 (2H, d, *J*=7.9 Hz), 7.43-7.20 (8H, m), 6.98 (2H, br t, *J*=8.9 Hz), 6.45 (1H, d, *J*=15.9 Hz), 6.00 (1H, dt, *J*=15.9, 7.0 Hz), 4.49 (2H, d, *J*=7.0 Hz). ^{13}C NMR ($CDCl_3$) δ 168.3, 162.7 (d, *J*=248 Hz), 139.9, 135.0, 134.8, 132.2, 130.5, 129.0, 128.6, 128.3 (d, *J*=8.3 Hz), 127.9, 127.0, 124.5, 122.0, 115.5 (d, *J*=21.7 Hz), 74.8. MS (CI^+) m/z: 348 ($M+H^+$, 1), 135 (100). HRMS calcd for $C_{22}H_{19}FNO_2$ ($M+H^+$): 348.1400, Found: 348.1397.

_N_-(4-Methylcinnamyloxy)-_N_-phenylbenzamide (8Dc).
A colorless oil. IR ($CHCl_3$) 1654, 1591, 1489, 1358 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.60 (2H, d, *J*=7.3 Hz), 7.49 (2H, d, *J*=7.9 Hz), 7.42-7.20 (6H, m), 7.18 (2H, d, *J*=8.0 Hz), 7.00 (2H, d, *J*=8.0 Hz), 6.45 (1H, d, *J*=15.9 Hz), 6.02 (1H, dt, *J*=15.9, 6.7 Hz), 4.48 (2H, d, *J*=6.7 Hz), 2.32 (3H, s). ^{13}C NMR ($CDCl_3$) δ 168.4, 139.9, 138.2, 136.4, 134.9, 133.2, 130.5, 129.3, 128.9, 128.6, 127.9, 126.9, 126.6, 124.4, 121.1, 75.1, 21.1. MS (CI^+) m/z: 344 ($M+H^+$, 1), 131 (100). HRMS calcd for $C_{23}H_{22}NO_2$ ($M+H^+$): 344.1650, Found: 344.1645.

_N_-((_E_)-3-(Naphthalen-1-yl)allyloxy)-_N_-phenylbenzamide (8Dd).
A colorless oil. IR ($CHCl_3$) 1653, 1591, 1489, 1360 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.98-7.22 (18H, m), 6.18 (1H, dt, *J*=15.6, 6.7 Hz), 4.62 (2H, d, *J*=6.7 Hz). ^{13}C NMR ($CDCl_3$) δ 168.4, 140.0, 134.8, 133.6, 133.5, 133.4, 131.0, 130.6, 129.0, 128.7, 128.6, 128.5, 128.0, 127.0, 126.2, 125.9, 125.5 (2C), 124.5, 124.2, 123.5, 75.1. MS (CI^+) m/z: 380 ($M+H^+$, 1), 167 (100). HRMS calcd for $C_{26}H_{22}NO_2$ ($M+H^+$): 380.1650, Found: 380.1655.

***tert*-Butyl [_N_-cinnamyl-_N_-(cinnamyloxy)]carbamate (9Ba).**
A colorless oil. IR ($CHCl_3$) 1701, 1369 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.35 (4H, d, *J*=7.7 Hz), 7.30 (4H, t, *J*=7.4 Hz), 7.24 (2H, m), 6.61 (1H, d, *J*=15.9 Hz), 6.57 (1H, d, *J*=15.9 Hz), 6.37-6.23 (2H, m), 4.52 (2H, d, *J*=7.0 Hz), 4.21 (2H, d, *J*=6.4 Hz), 1.51 (9H, s). ^{13}C NMR ($CDCl_3$) δ 156.7, 136.7, 136.3, 135.0, 133.3, 128.5 (2C), 127.9, 127.6, 126.6, 126.4, 124.0, 123.7, 81.5, 76.0, 52.7, 28.3. MS (CI^+) m/z: 366 ($M+H^+$, 7), 310 (100). HRMS calcd for $C_{23}H_{28}NO_3$ ($M+H^+$): 366.2070, Found: 366.2082.

Benzyl [_N_-cinnamyl-_N_-(cinnamyloxy)]carbamate (9Ca).
A colorless oil. IR ($CHCl_3$) 1706, 1347 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.40-7.21 (15H, m), 6.58 (1H, d, *J*=15.9 Hz), 6.57 (1H, d, *J*=15.9 Hz), 6.35-6.22 (2H, m), 5.22 (2H, s), 4.54 (2H, d, *J*=7.0 Hz), 4.28 (2H, d, *J*=6.8 Hz). ^{13}C NMR ($CDCl_3$) δ 157.3, 136.5, 136.2, 136.0, 135.4, 133.7, 128.5 (2C), 128.2, 128.0, 127.7, 126.6, 126.5, 123.5, 123.3, 76.2, 67.8, 52.7. Some carbon peaks were missing due to overlapping. MS (FAB^+) m/z: 400 ($M+H^+$, 6), 117 (100). HRMS calcd for $C_{26}H_{26}NO_3$ ($M+H^+$): 400.1913, Found: 400.1922.

***tert*-Butyl [_N_-(cinnamyloxy)-_N_-(1-phenylallyl)]carbamate (10).**
A colorless oil. IR ($CHCl_3$) 1698, 1369 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.42 (2H, d, *J*=7.0 Hz), 7.39-7.20 (8H, m), 6.47 (1H, d, *J*=15.9 Hz), 6.22-6.12 (2H, m), 5.34-5.27 (3H, m), 4.15 (1H, dd, *J*=15.6, 6.4 Hz), 4.03 (1H, br dd, *J*=15.6, 6.0 Hz), 1.52 (9H, s). ^{13}C NMR ($CDCl_3$) δ 156.9, 139.0, 136.7 (2C), 133.0, 128.4, 128.3 (2C), 127.9, 127.5, 126.4, 124.1, 118.9, 87.6, 81.5, 53.2, 28.3. MS (CI^+) m/z: 366 ($M+H^+$, 9), 310 (100). HRMS calcd for $C_{23}H_{28}NO_3$ ($M+H^+$): 366.2070, Found: 366.2078.

***tert*-Butyl [_N_-cinnamyl-_N_-(1-phenylallyloxy)]carbamate (11).**
A colorless oil. IR ($CHCl_3$) 1699, 1368 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.43 (2H, d, *J*=7.0 Hz), 7.37-7.20 (8H, m), 6.43 (1H, d, *J*=15.9 Hz), 6.26 (1H, m), 6.11 (1H, br m), 5.58 (1H, d, *J*=6.8 Hz), 5.32 (1H,

d, *J*=10.4 Hz), 5.28 (1H, d, *J*=17.4 Hz), 4.36 (1H, br dd, *J*=10.4, 7.0 Hz), 4.12 (1H, br m), 1.46 (9H, s). ^{13}C NMR ($CDCl_3$) δ 156.9, 138.8, 136.4, 134.7, 134.6, 128.6, 128.4, 128.2, 127.8, 127.6, 126.6, 123.4, 118.1, 81.6, 77.0, 65.9, 28.2. MS (CI^+) m/z: 366 ($M+H^+$, 10), 310 (100). HRMS calcd for $C_{23}H_{28}NO_3$ ($M+H^+$): 366.2070, Found: 366.2065.

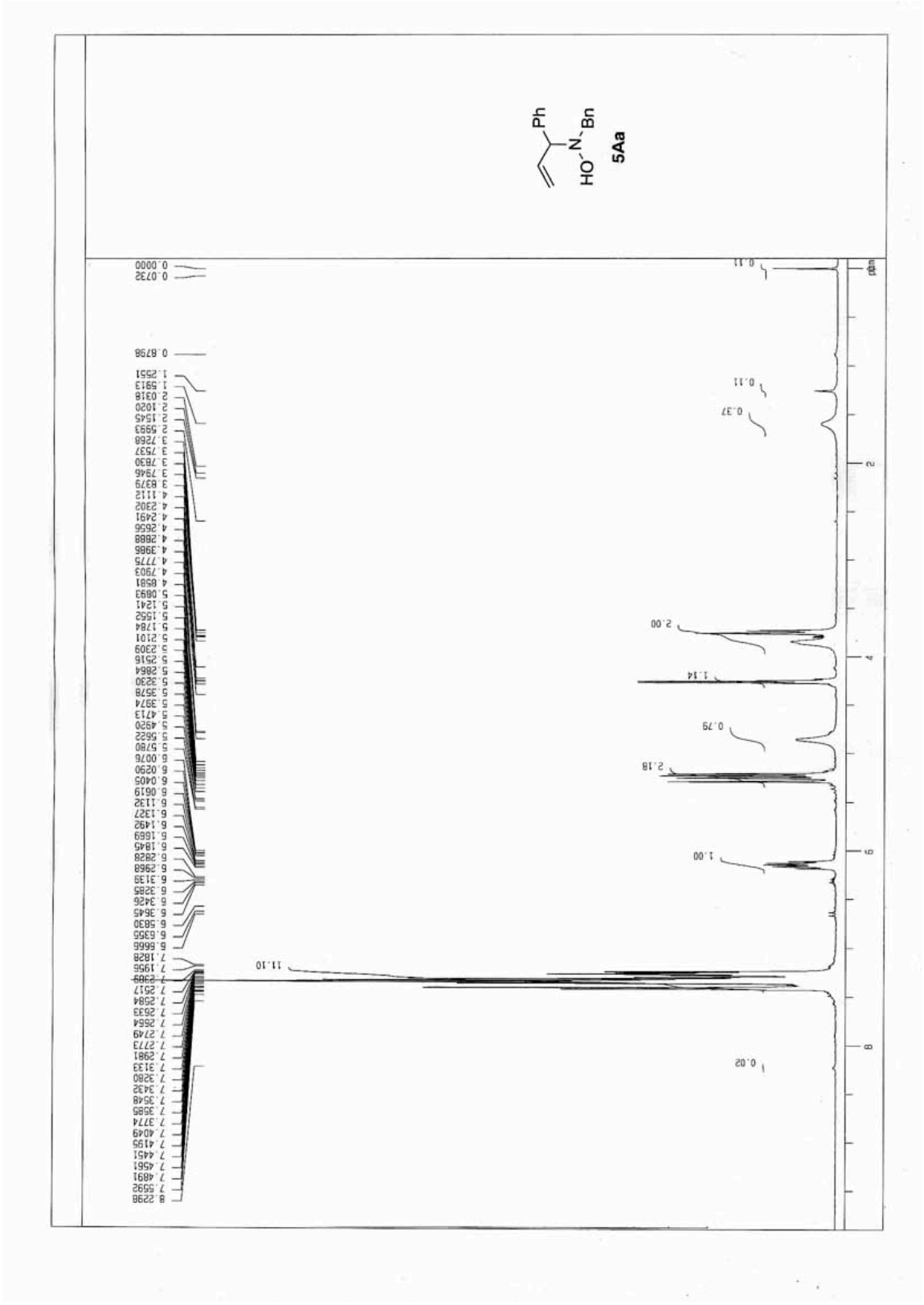
Reduction of 6Da to Alcohol 12

A suspension of oxime ether **6Da** (165 mg, 0.50 mmol) and 20% $Pd(OH)_2$-C (30 mg) in MeOH (2.5 mL) was stirred under a hydrogen atmosphere at 20 °C for 3 h. After the reaction mixture was filtered, the filtrate was concentrated under reduced pressure. Purification of the residue by preparative TLC (hexane:AcOEt=5:1) afforded the product **12** (56 mg, 82%). A colorless oil. IR ($CHCl_3$) 3428, 2969, 1493, 1455, 1380 cm^{-1}. ^{1}H NMR ($CDCl_3$) δ 7.37-7.20 (5H, m) 4.55 (1H, t, *J* = 6.6 Hz), 2.12 (1H, br s), 1.84-1.67 (2H, m), 0.89 (3H, t, *J* = 7.5 Hz). ^{13}C NMR ($CDCl_3$) δ 144.6, 128.4, 127.4, 126.0, 75.9, 31.7, 10.0. MS (EI^+) m/z: 136 (M^+, 9.0), 91 (100). HRMS calcd for $C_9H_{12}O$: 136.0888, Found: 136.0888. A sample of 87%ee gave $[\alpha]^{24}_D$ –46.3 (*c* 1.2, hexane).

References

1) (a) Davies, S. G.; Fox, J. F.; Jones, S.; Price, A. J.; Sanz, M. A.; Sellers, T. G. R.; Smith, A. D.; Teixeira, F. C. *J. Chem. Soc., Perkin Transactions 1* **2002**, *41*, 1757. (b) Le Flohic, A.; Meyer, C.; Cossy, J.; Desmurs, J.-R. *Tetrahedron Lett.* **2003**, *44*, 197.
2) Kim, S.; Lee, T. A.; Song, Y. *Synlett* **1998**, 471.

3. Copies of ^{1}H and ^{13}C NMR spectrum of all obtained compounds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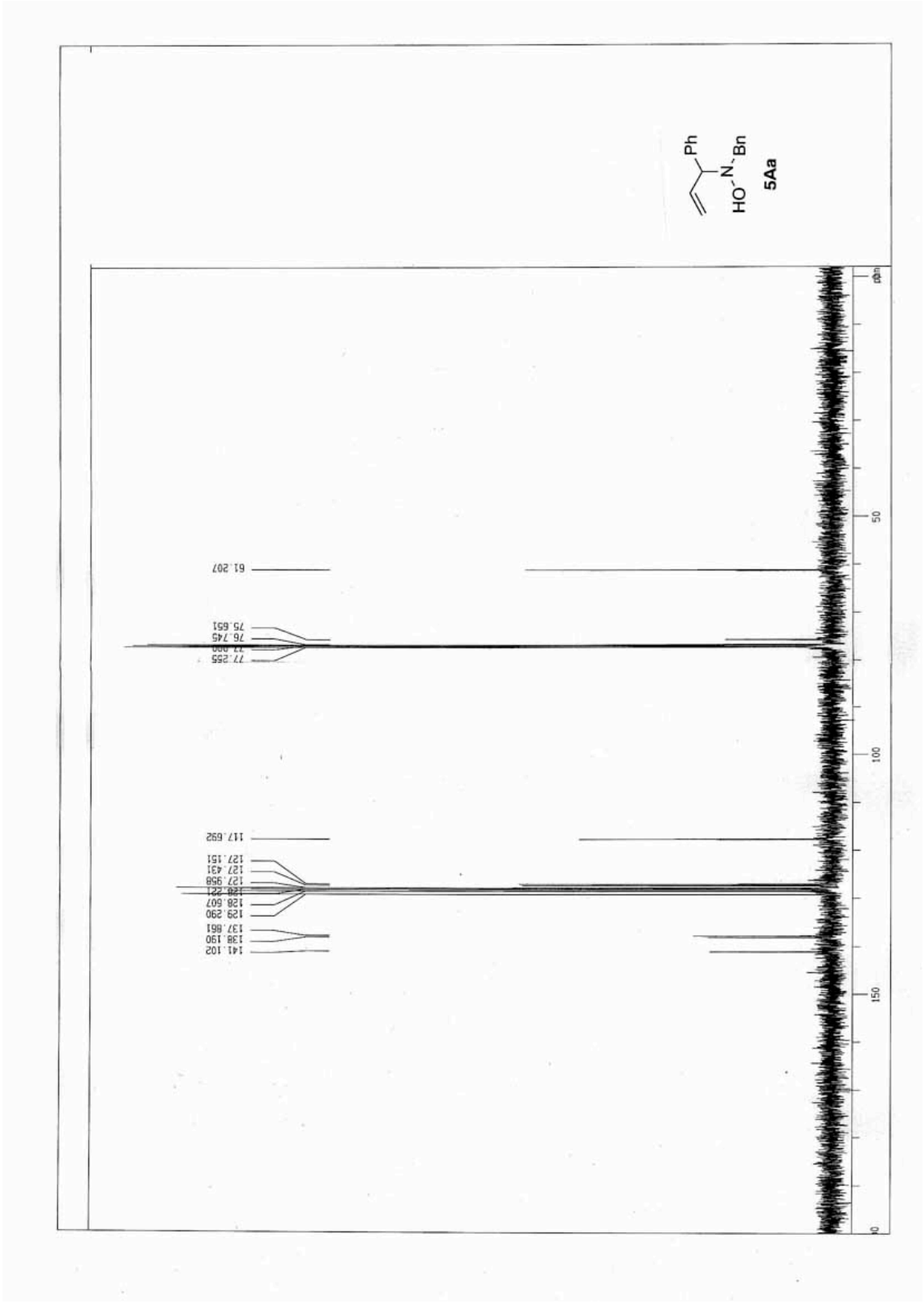
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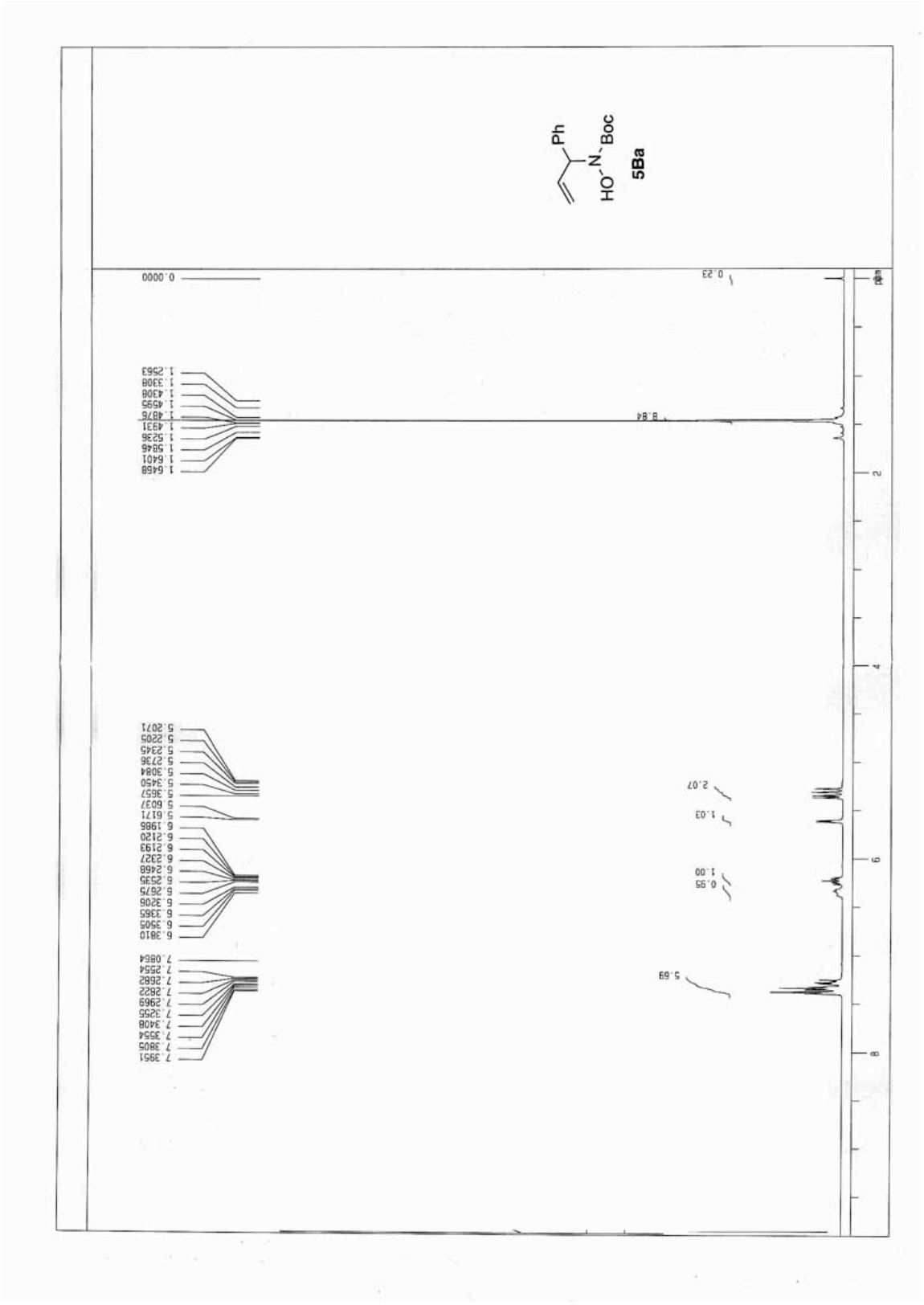
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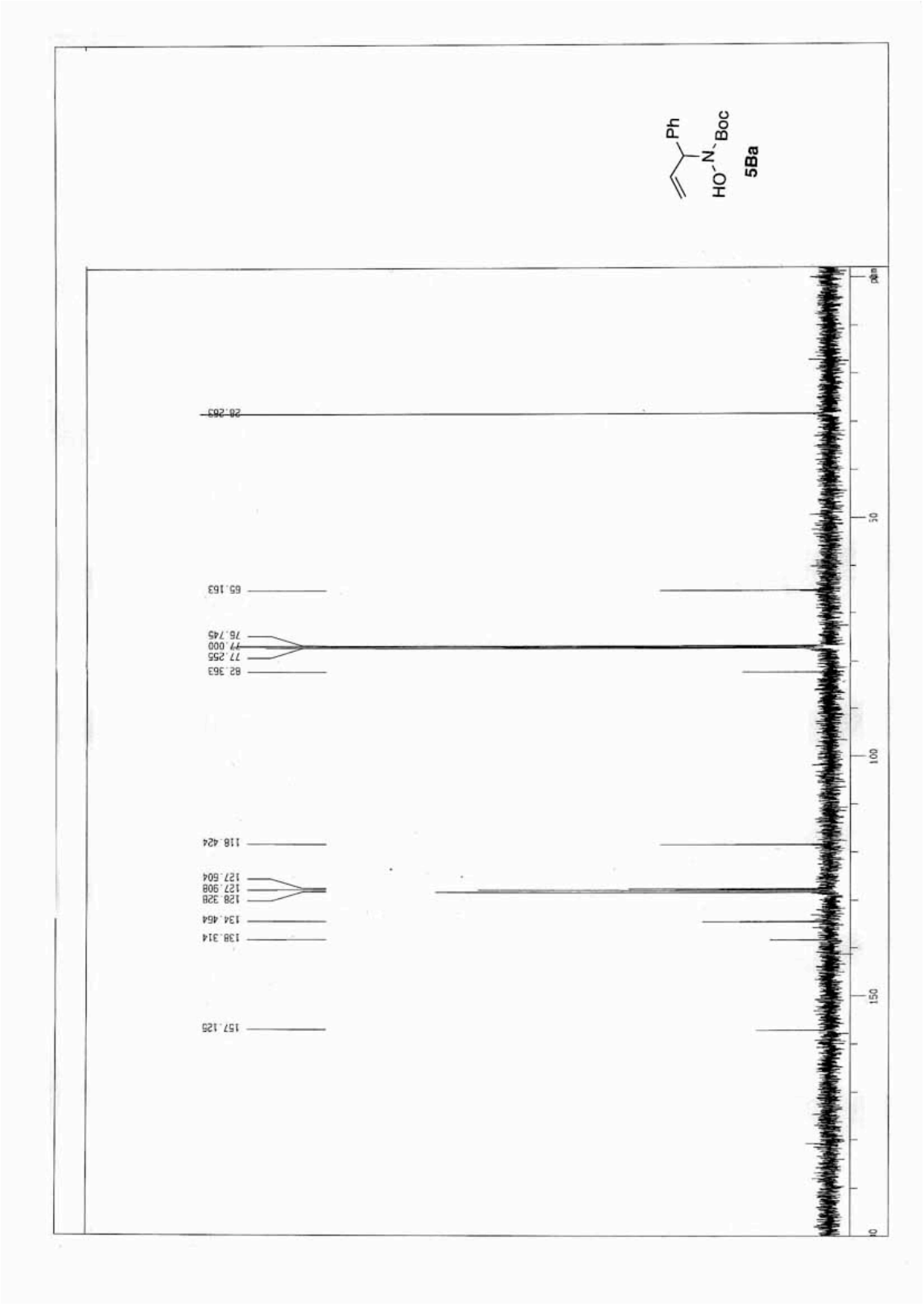
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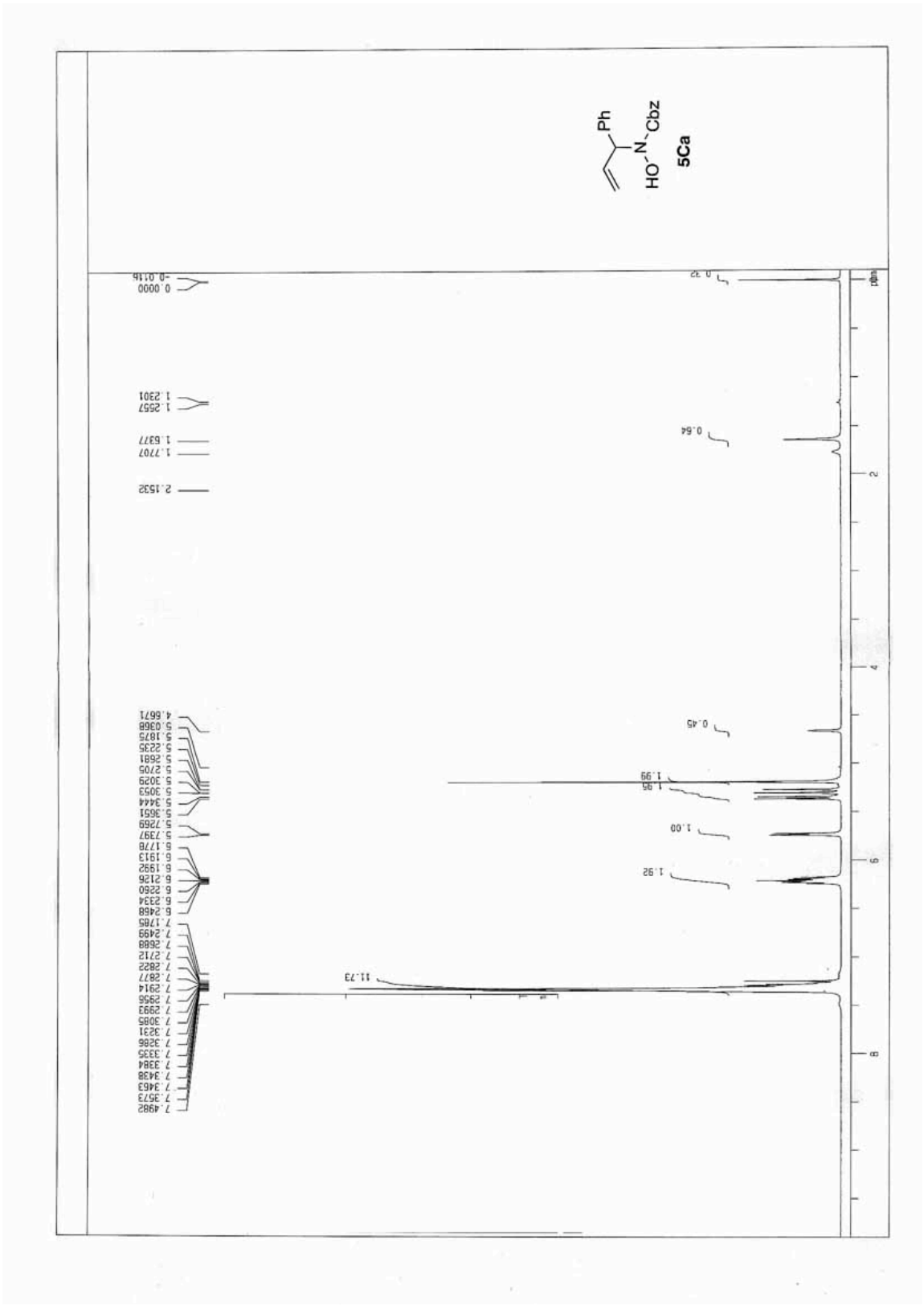
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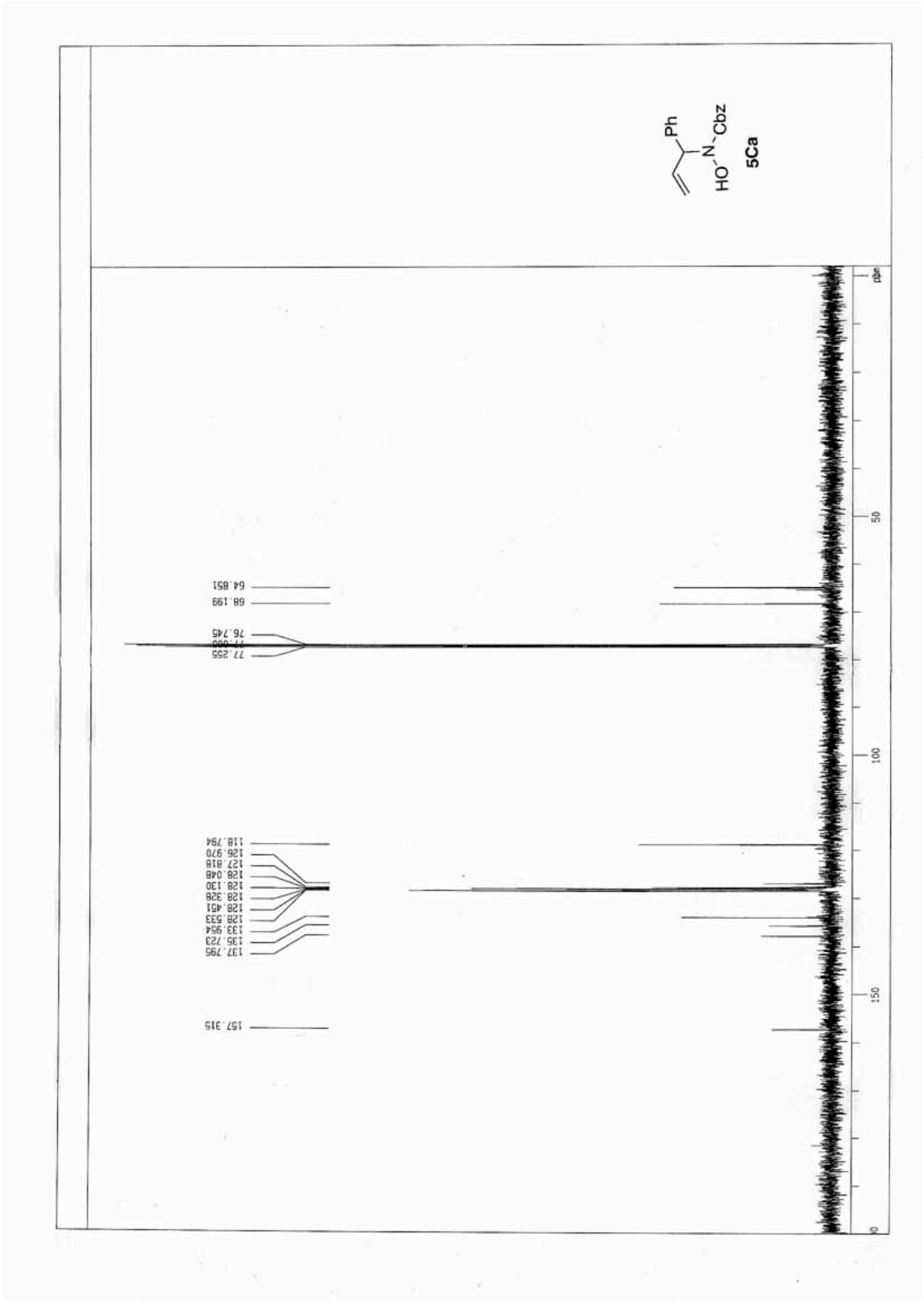
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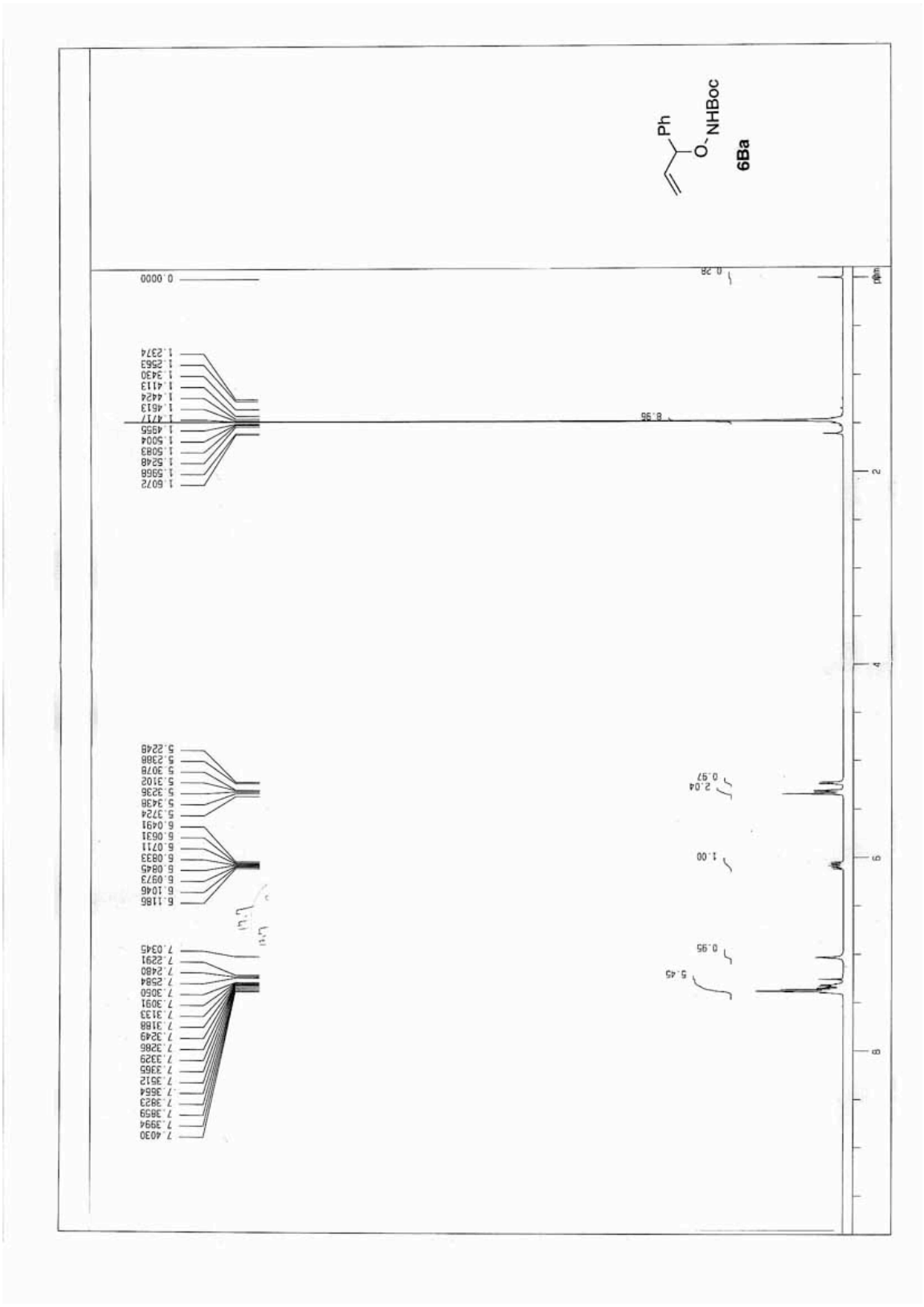
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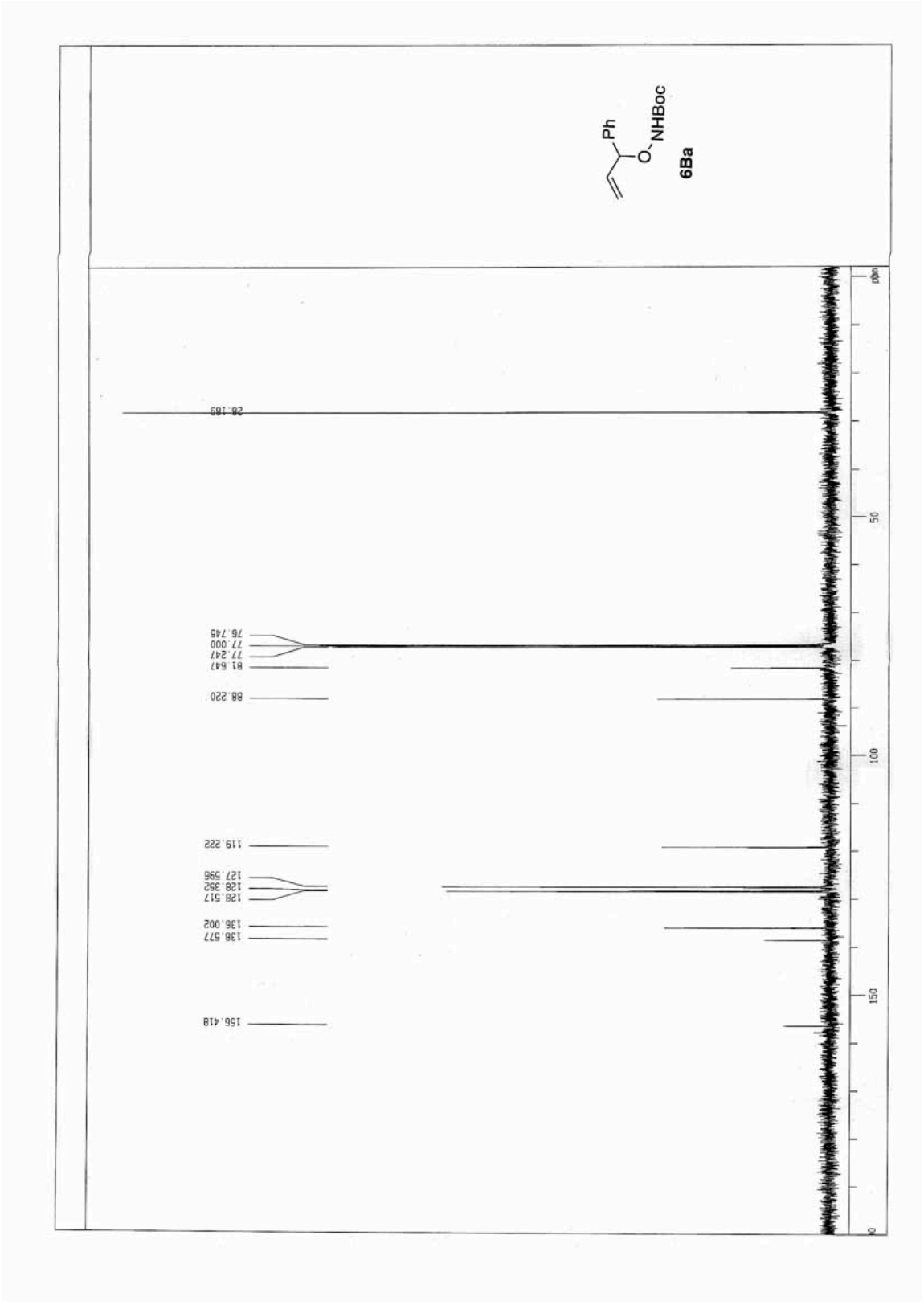
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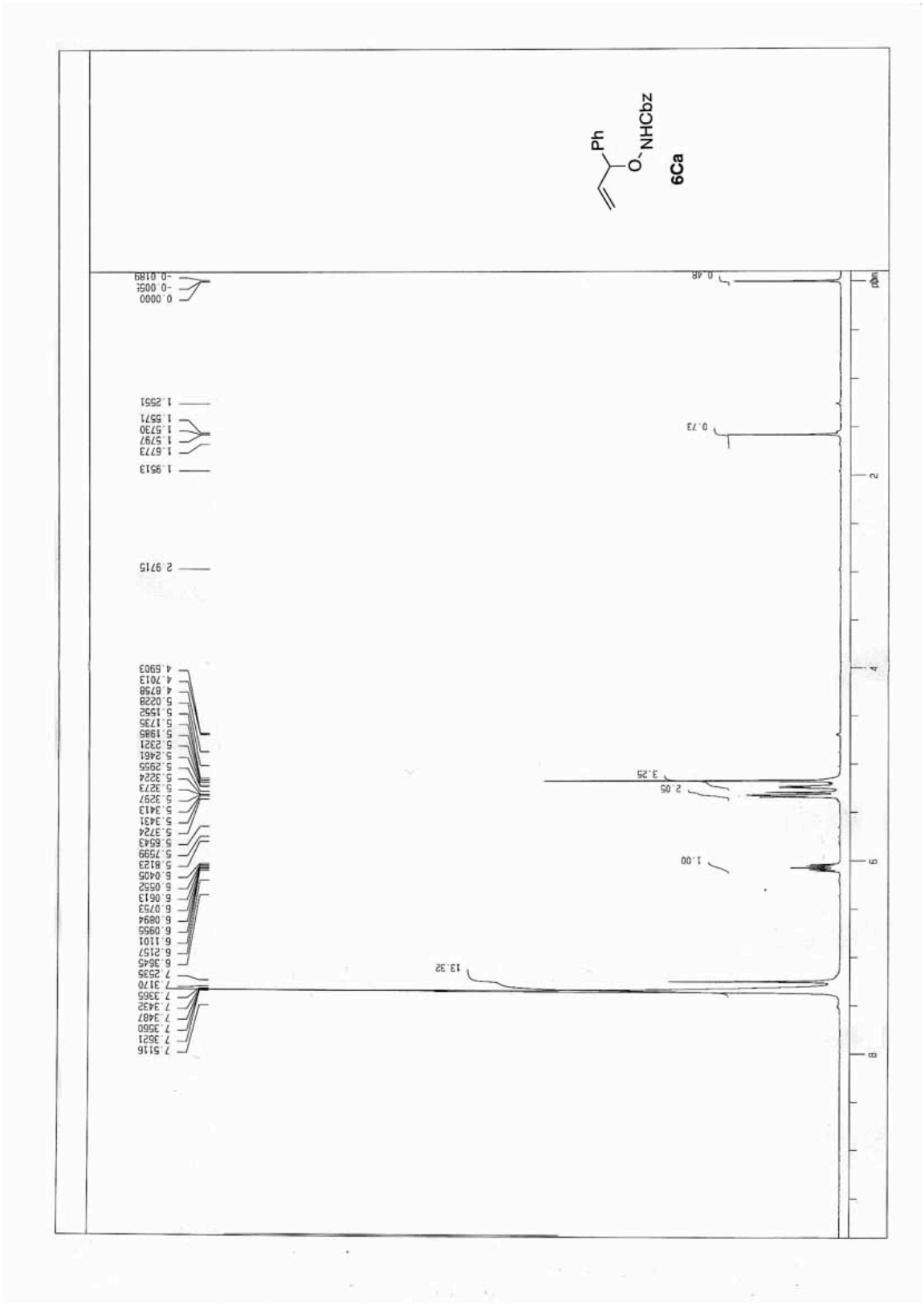
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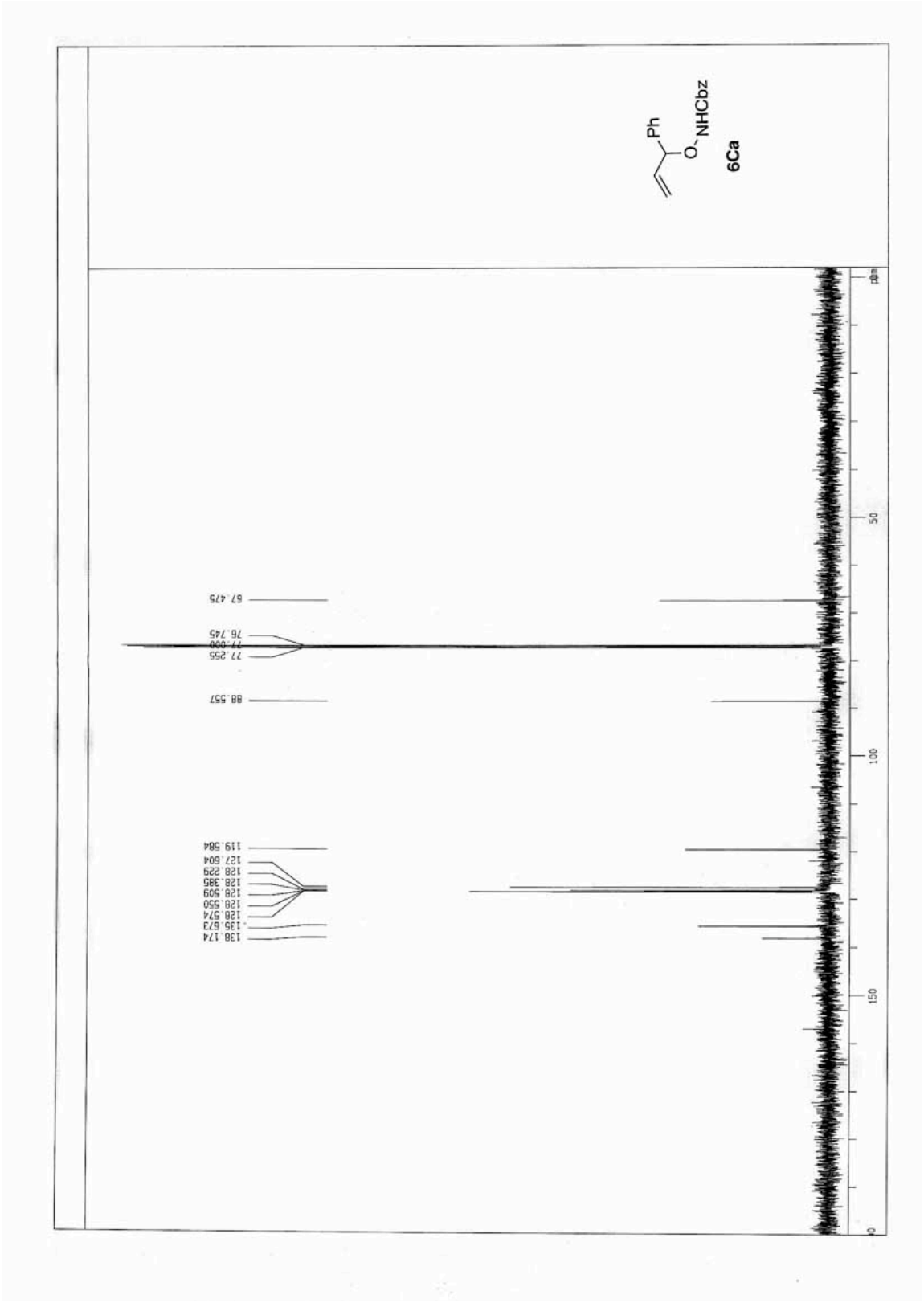
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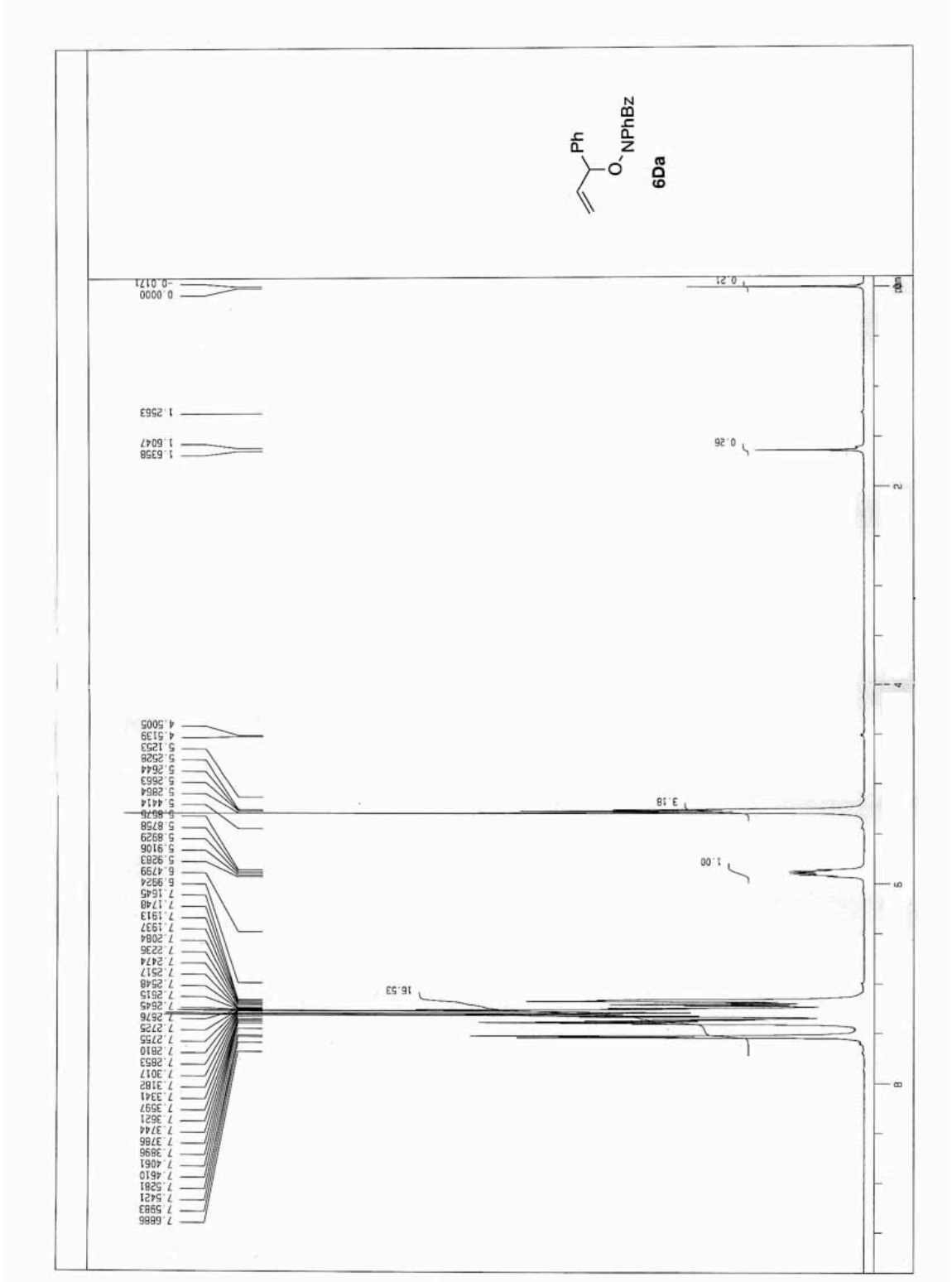
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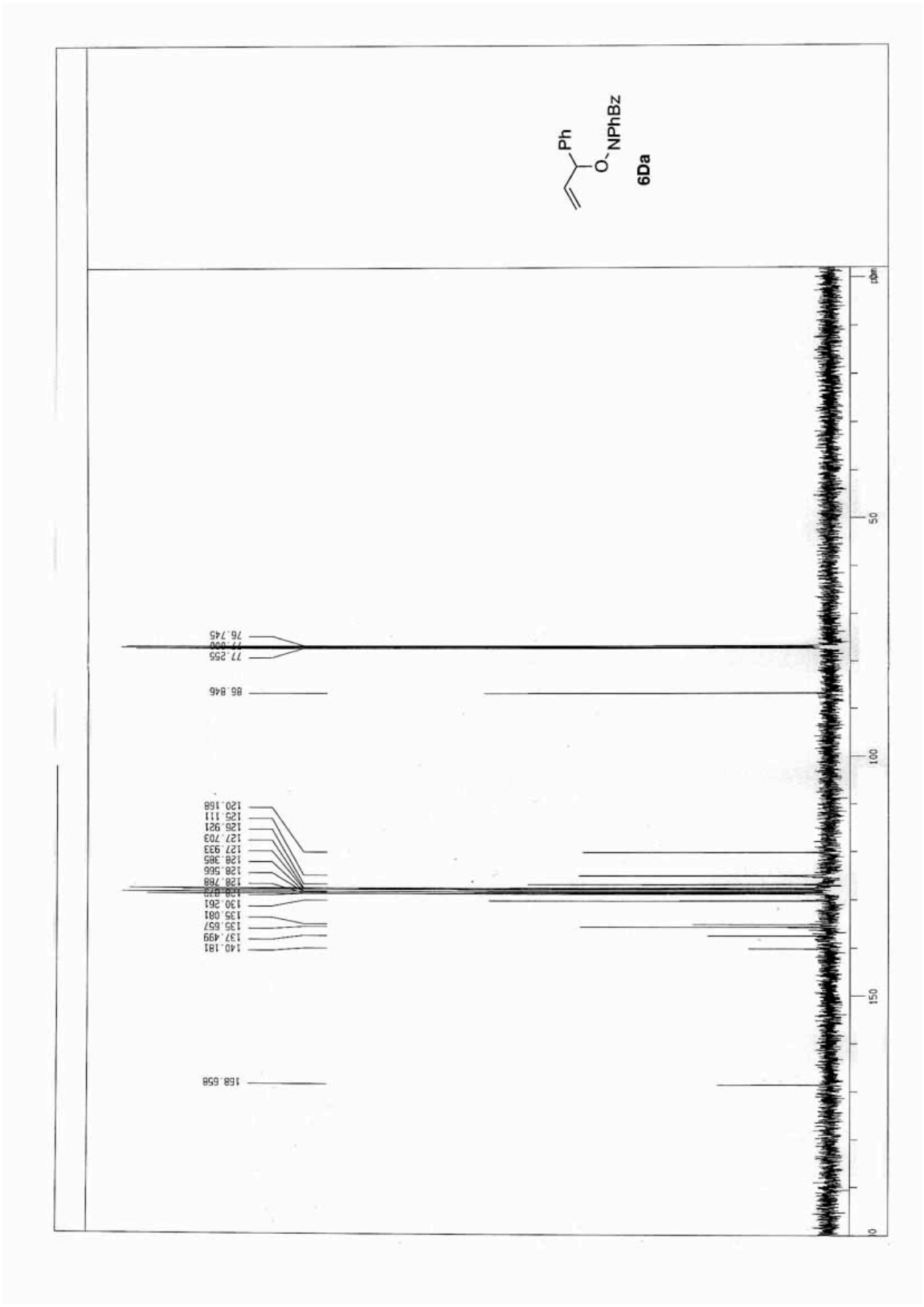
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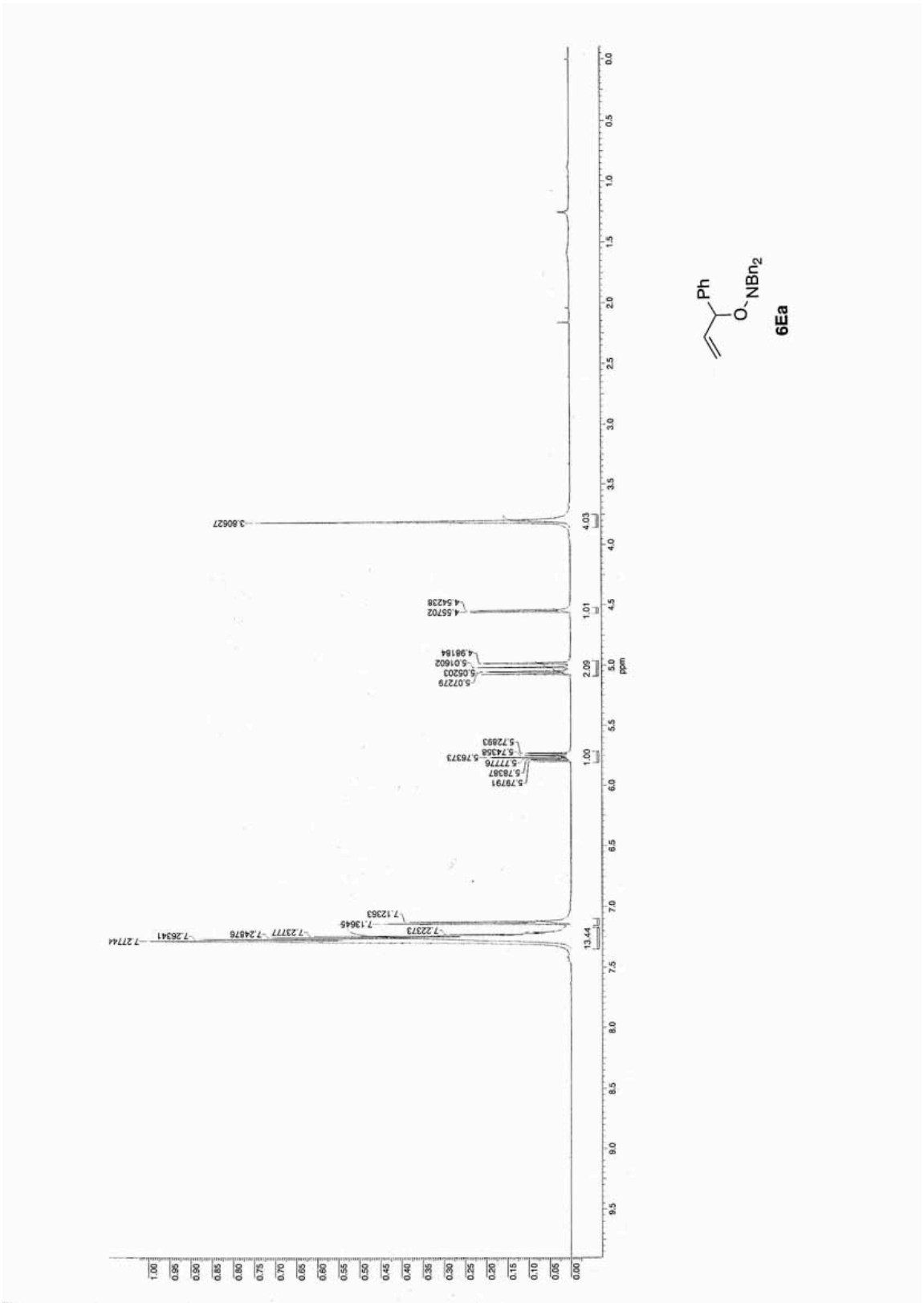
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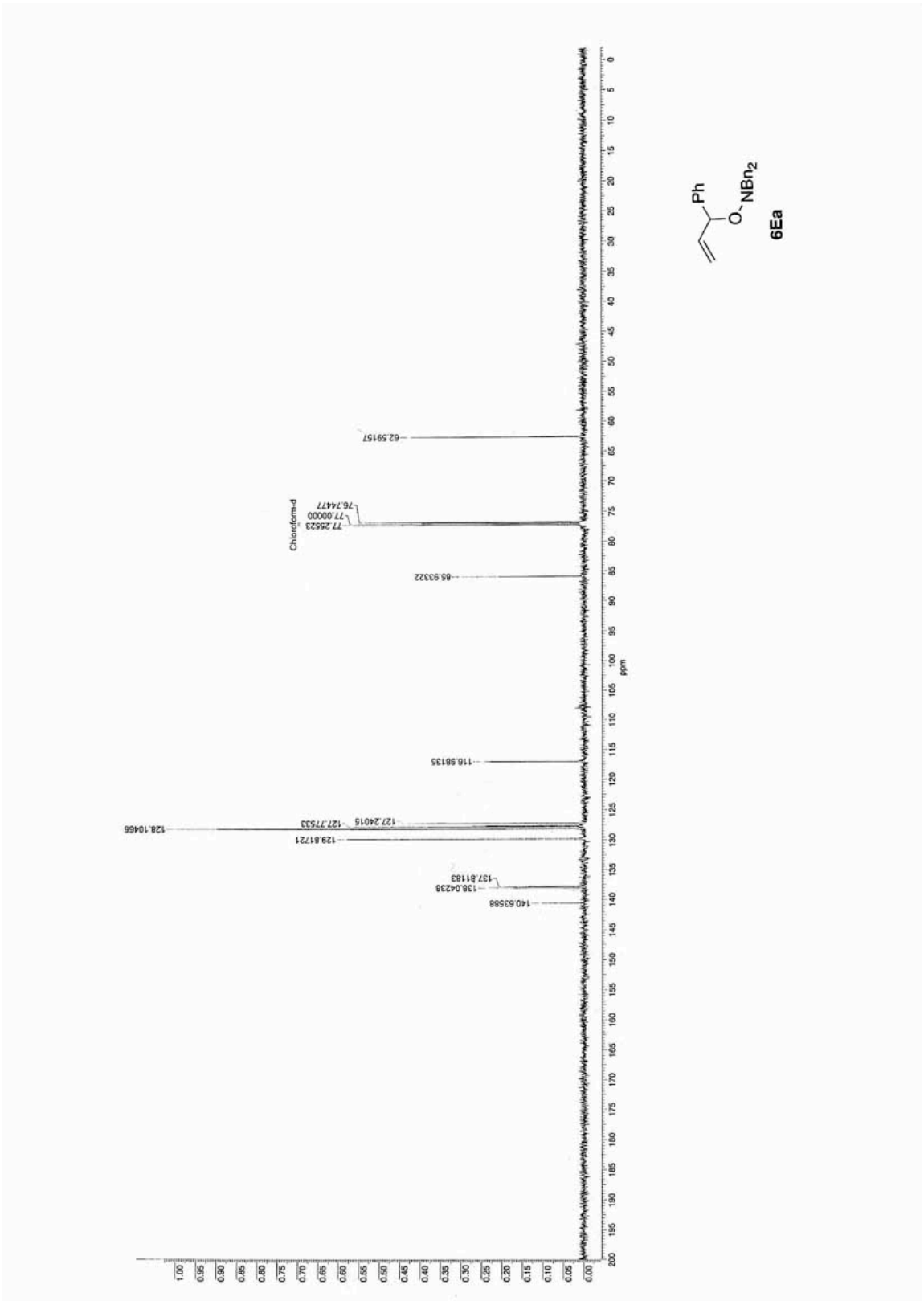
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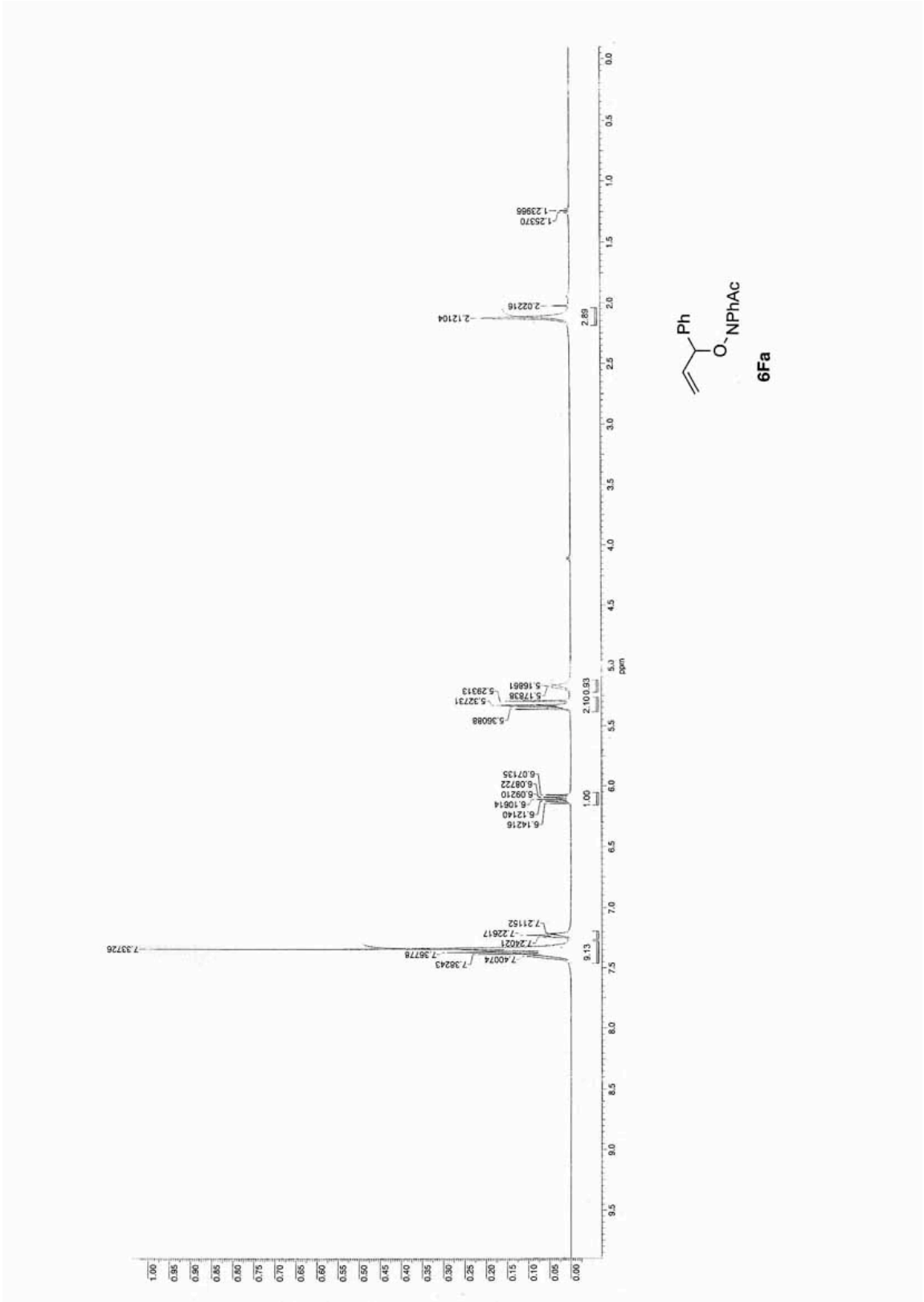
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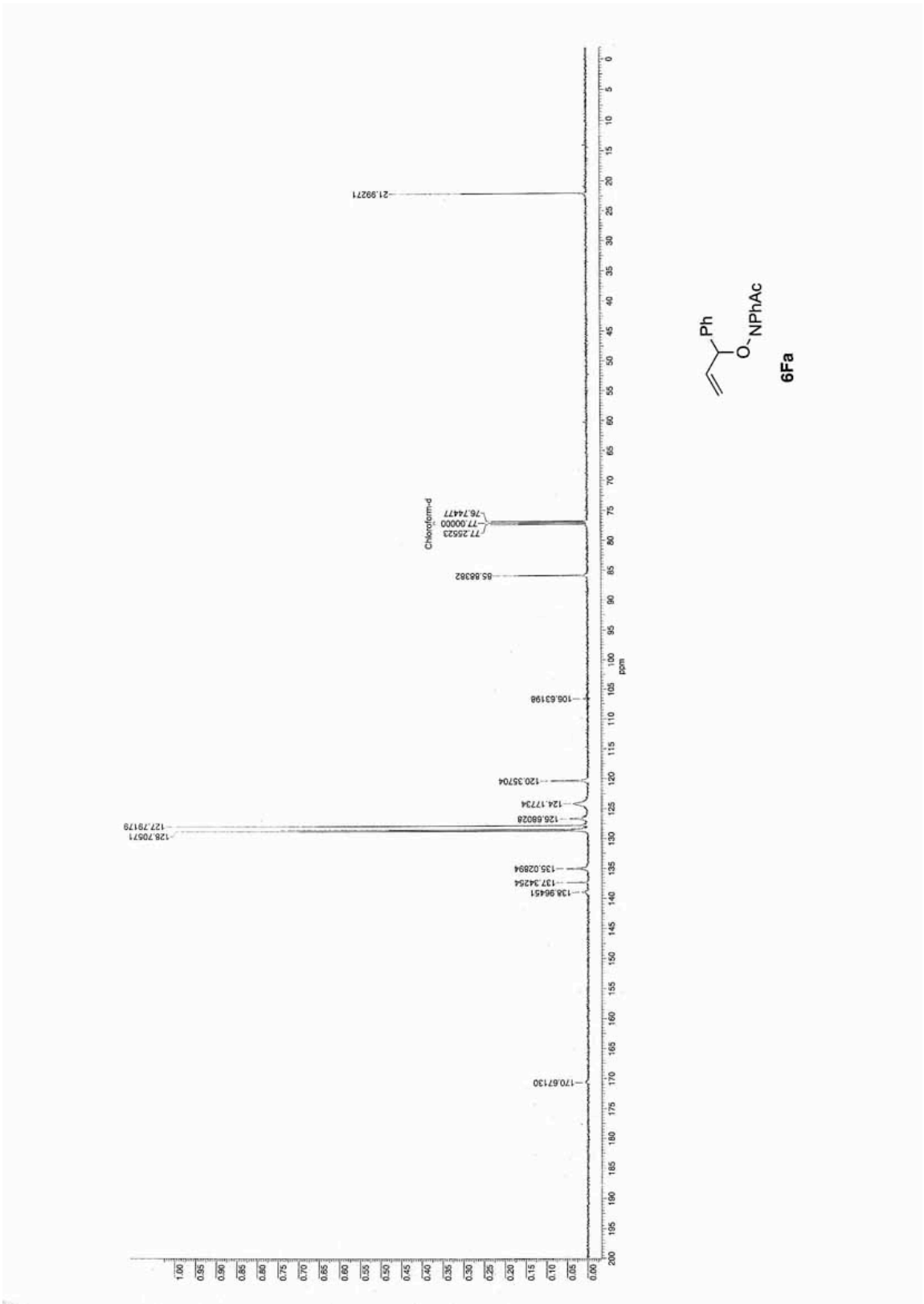
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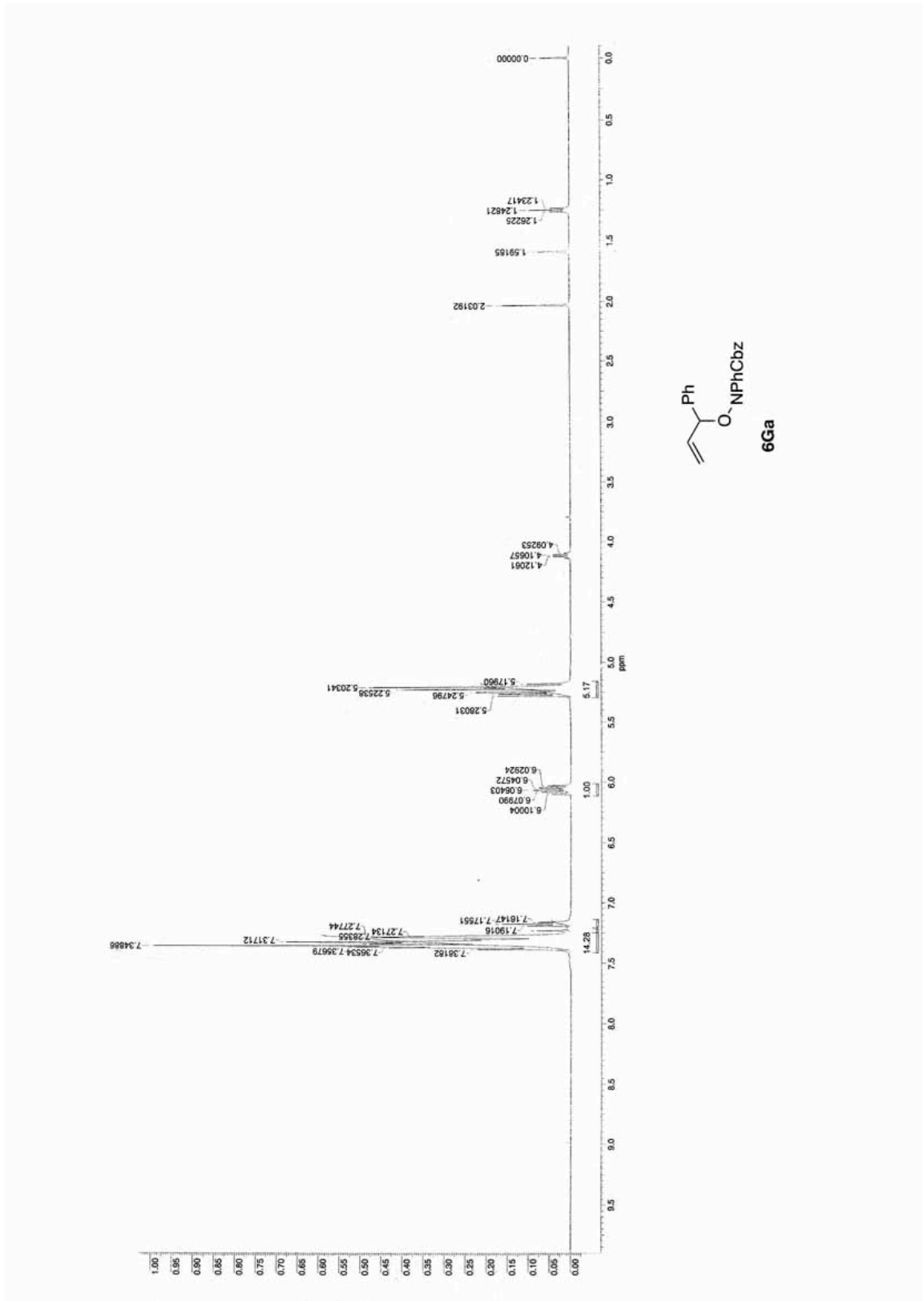
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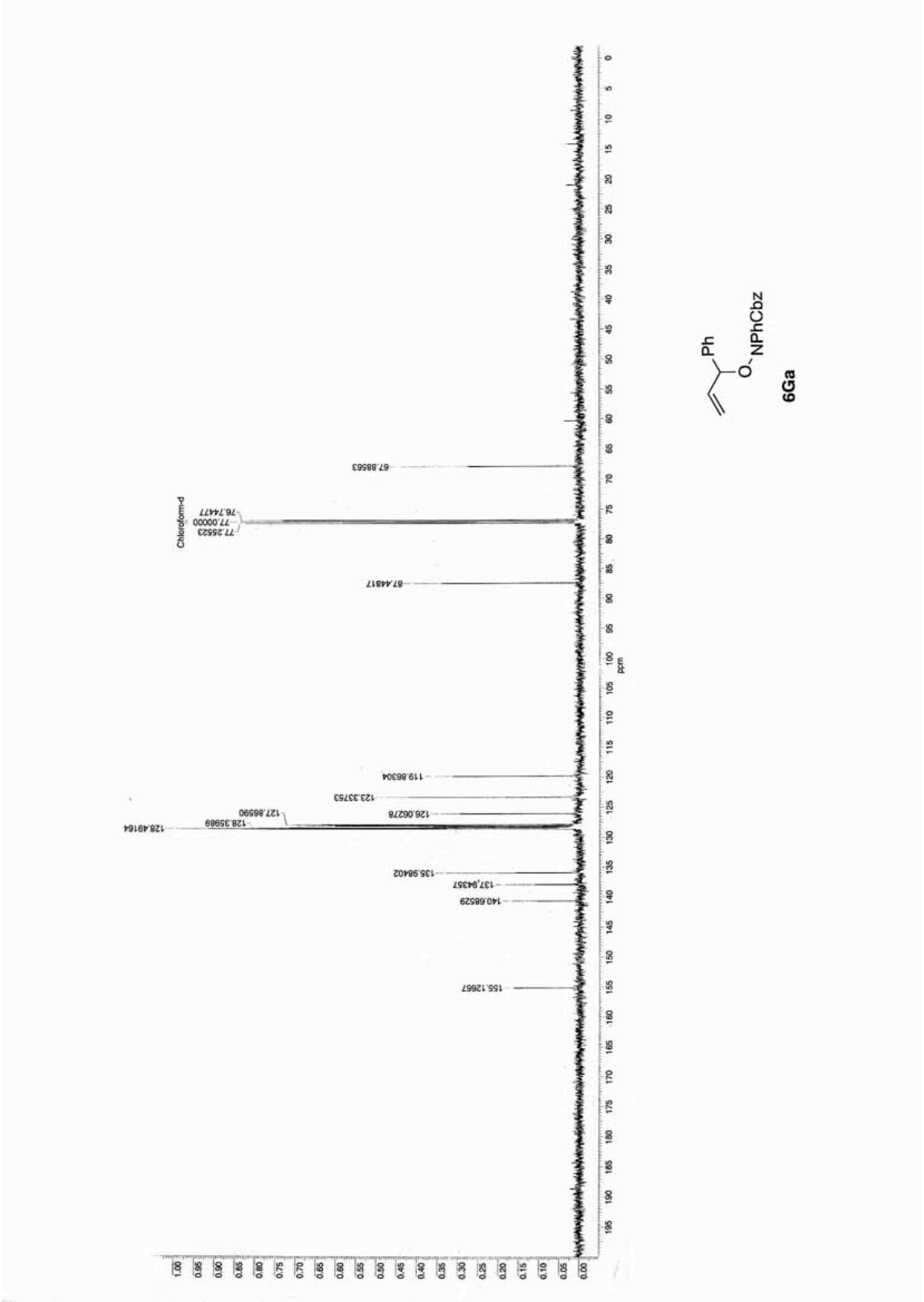
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135.98402
137.94357
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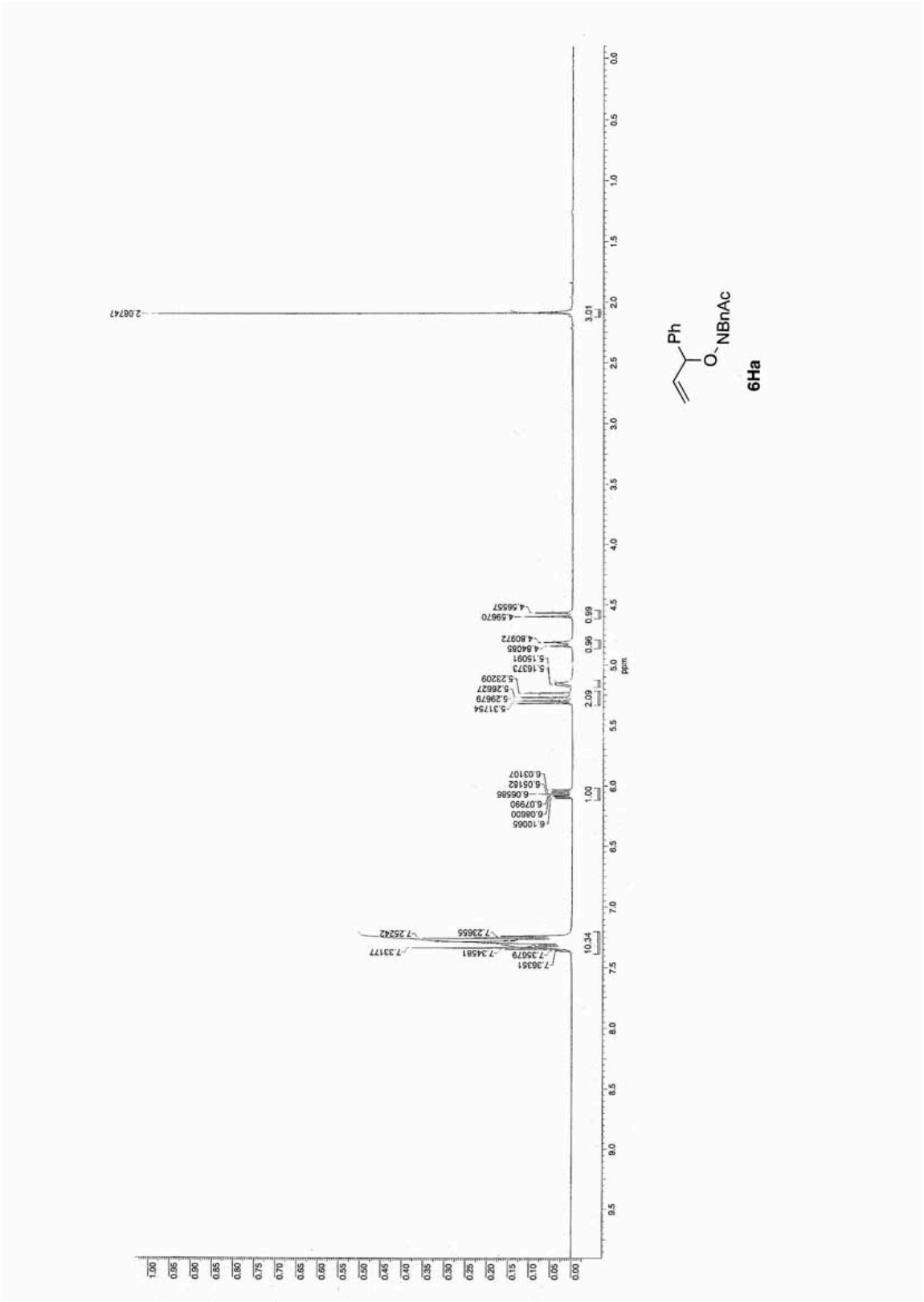
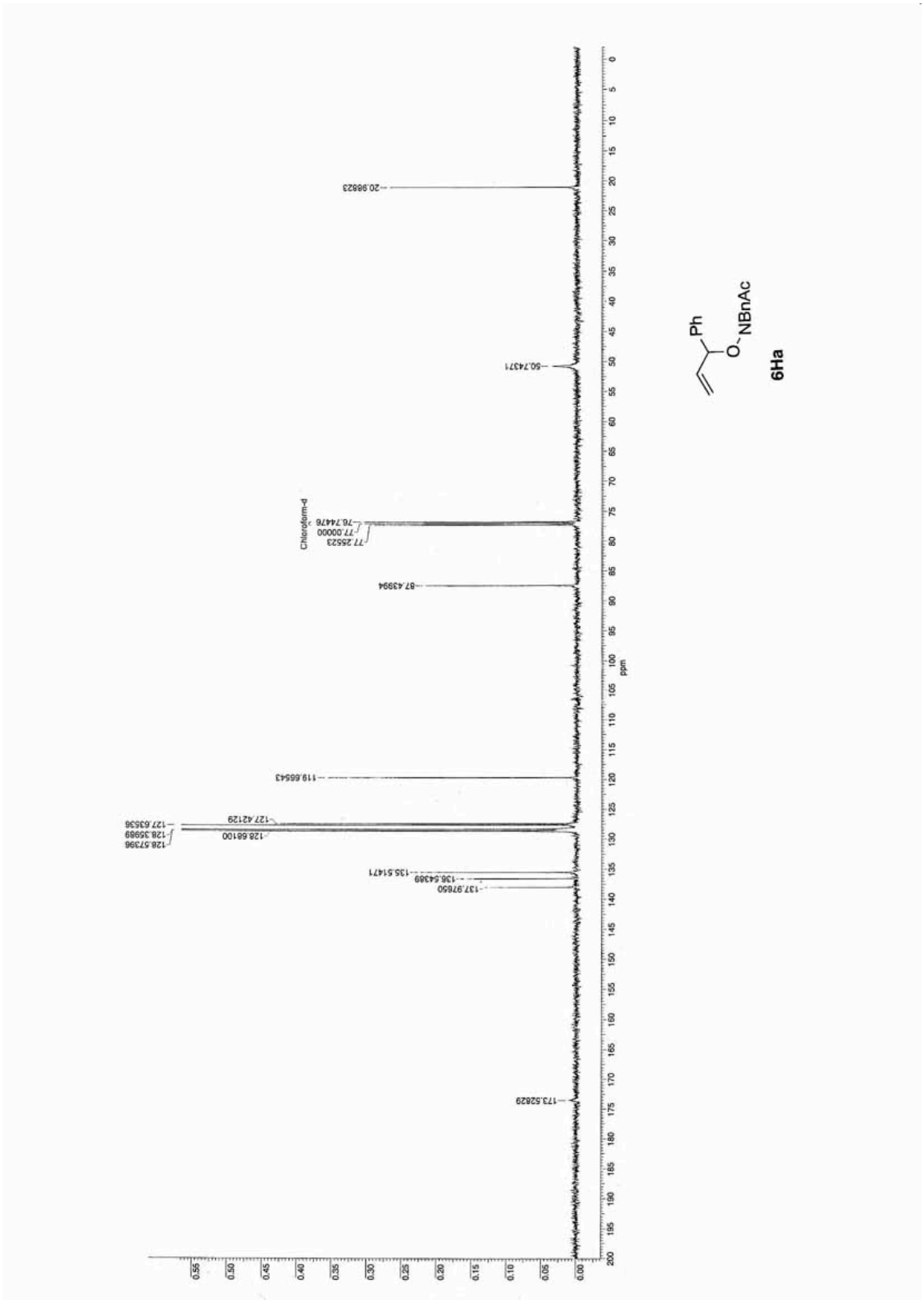
155.12867
ppm


Ph
O
NBnAc
6Ha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O
NBnAc
6Ha
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50.74371
Chloroform-d
77.25523
77.00000
76.74478
87.43994
119.86543
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128.57396
128.35989
127.63536
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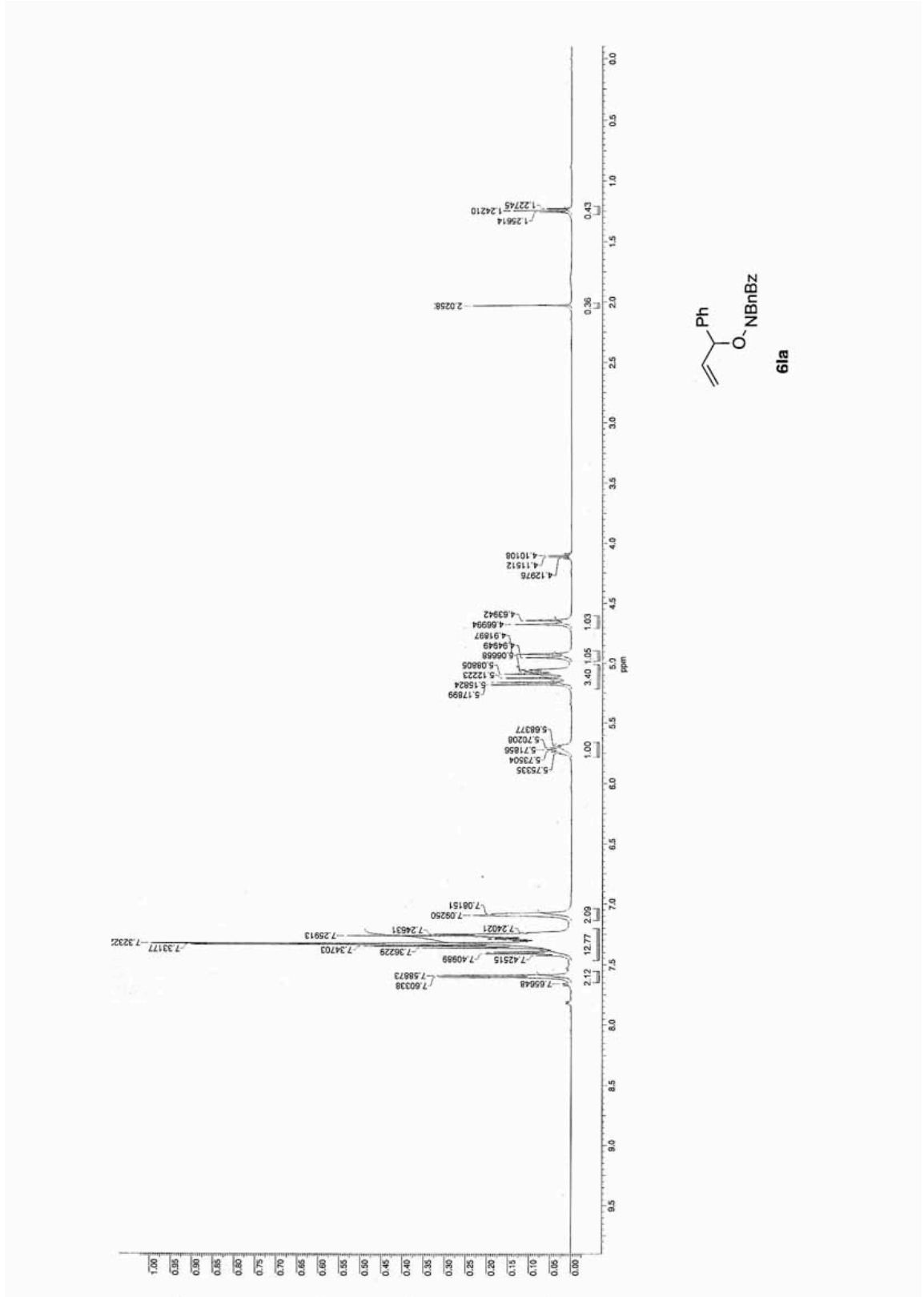
137.97850
173.52829
ppm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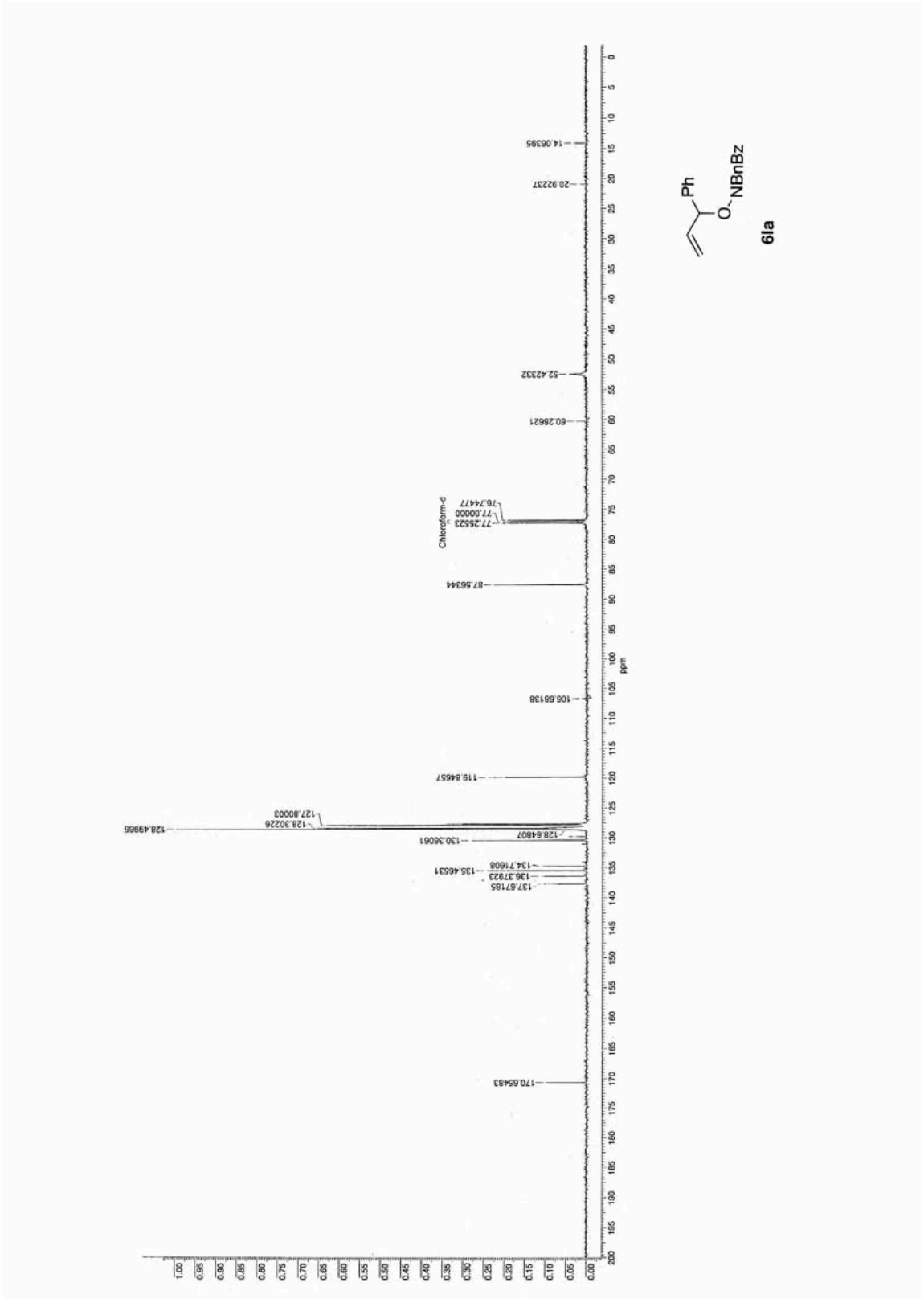
NBnBz
6la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NBnBz
6la
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60.28621
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77.00000
77.25523
Chloroform-d
87.56344
106.68138
119.84657
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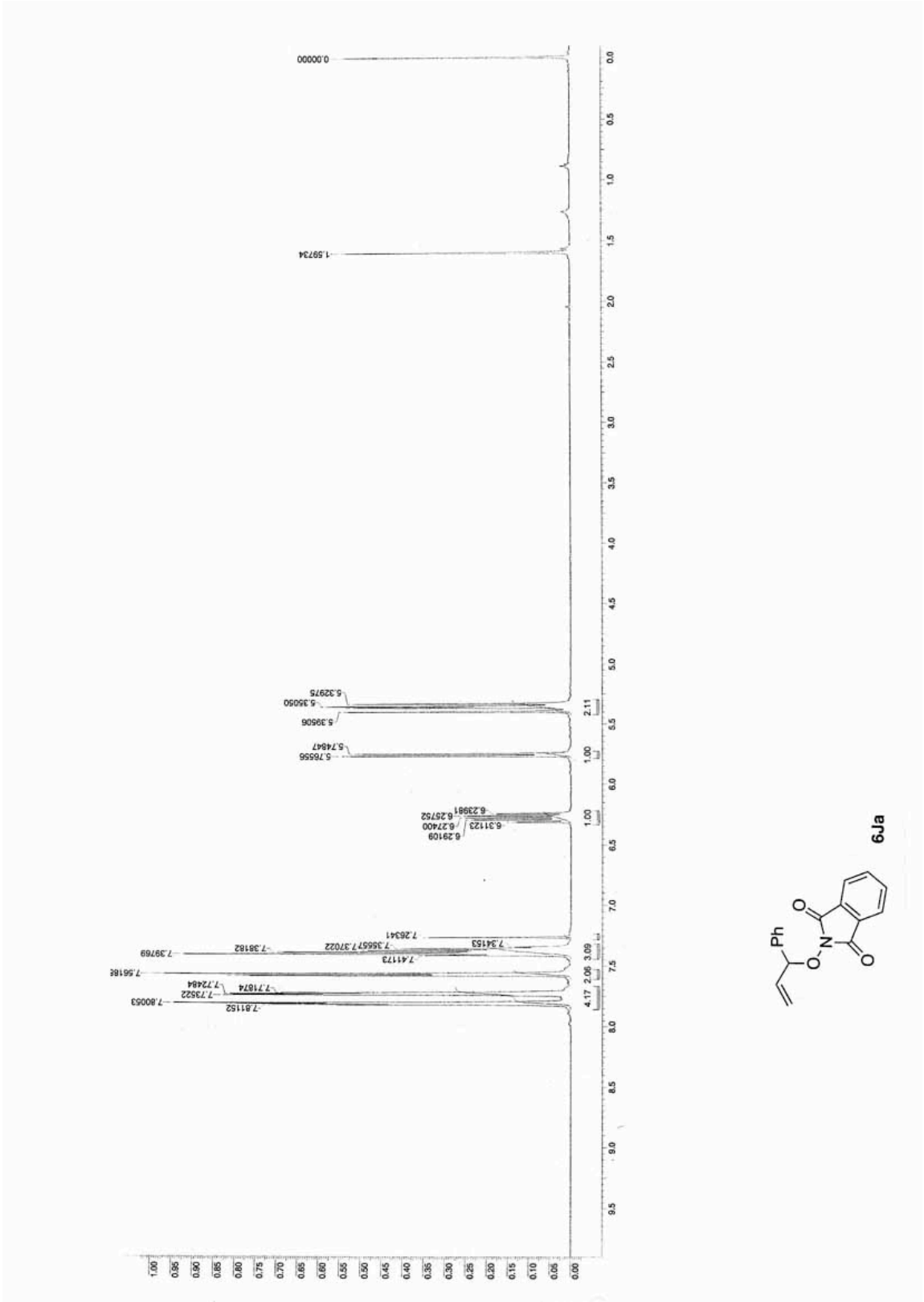
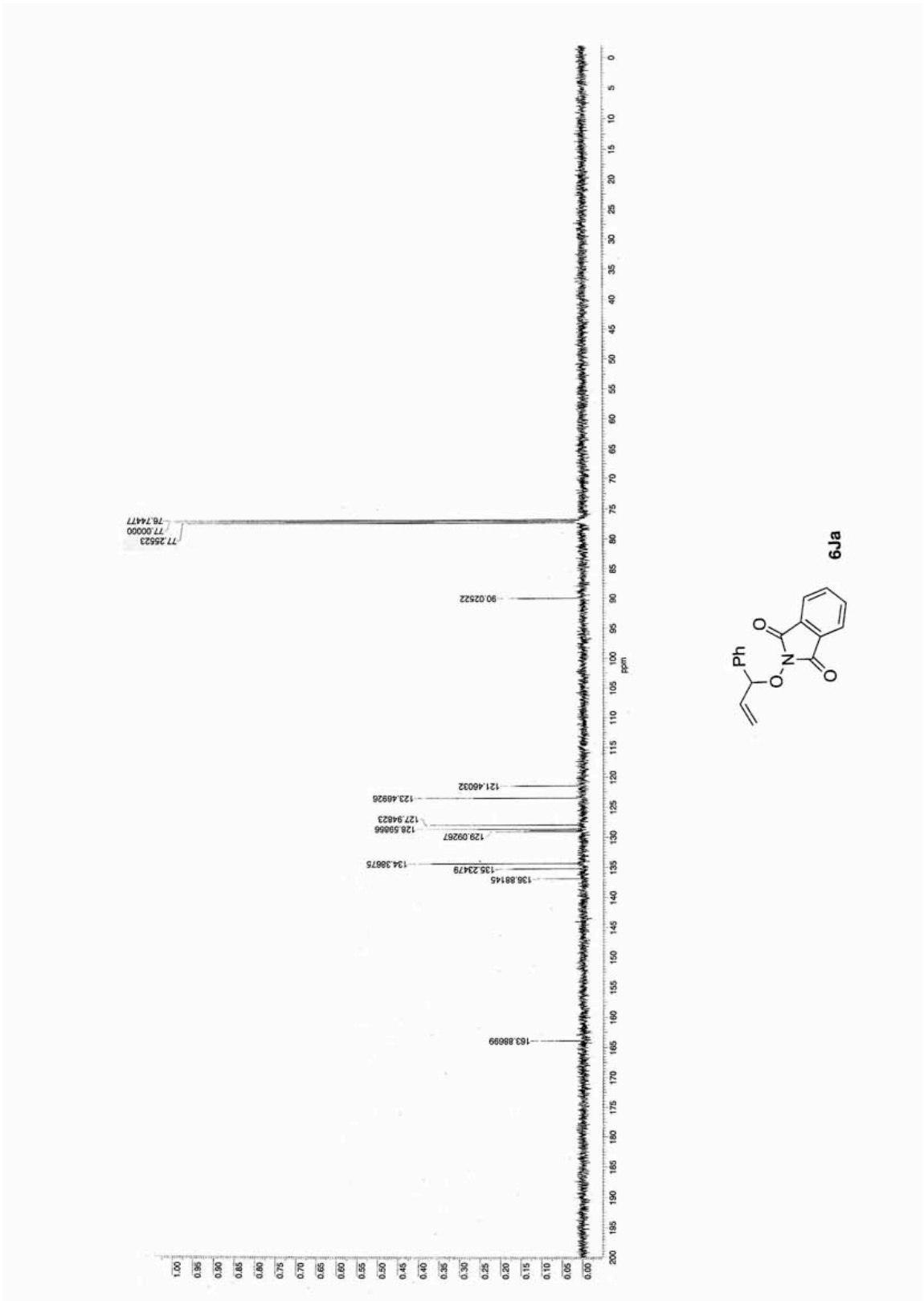
ppm


6Ja
Ph
O
N
O
O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77.00000
76.74477
90.02522
121.46032
123.48926
127.94623
128.59866
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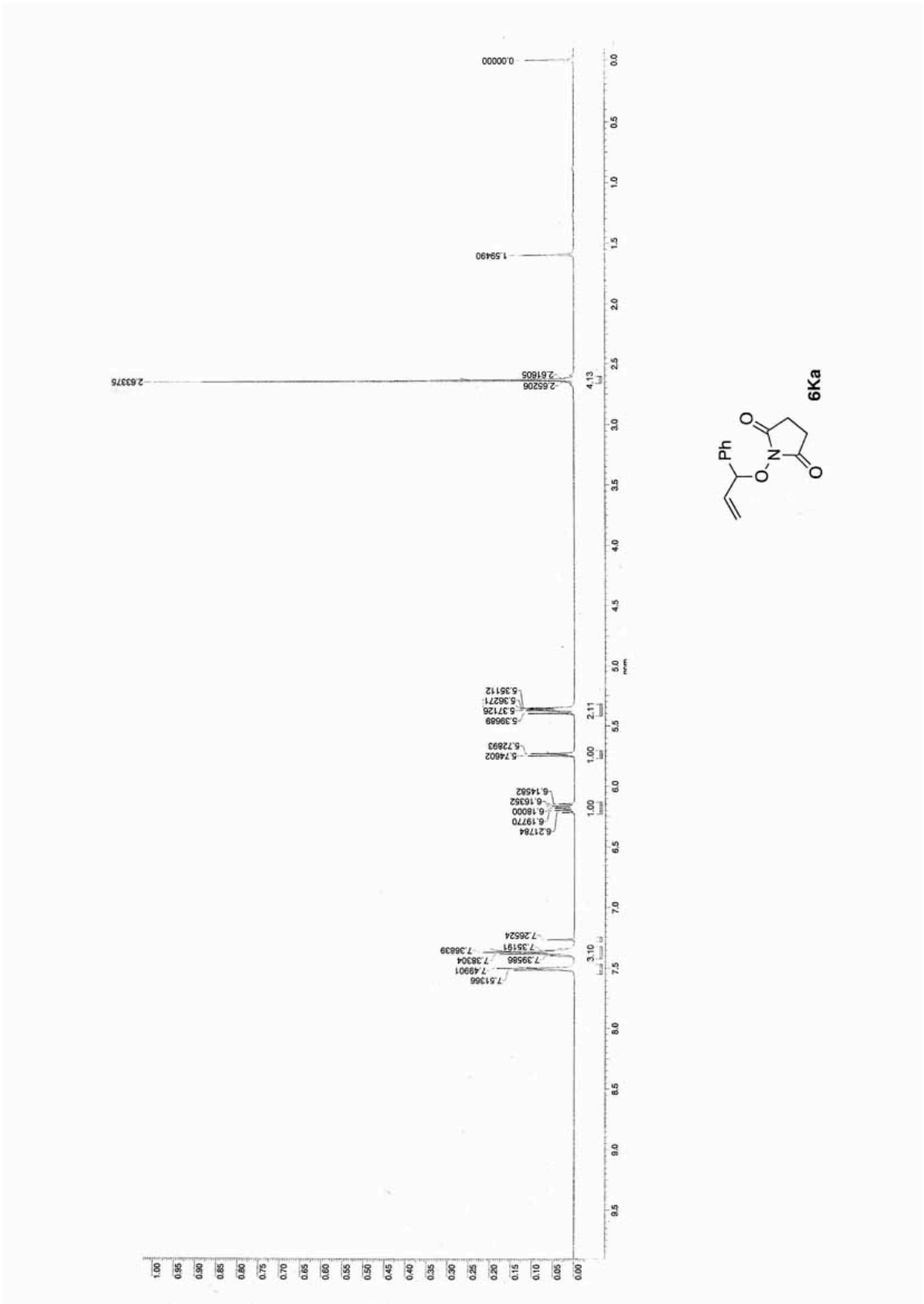
136.88145
163.88699
ppm
6Ja
Ph
O
N
O
O


6Ka
Ph
O
N
O
O
O
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2.63375
4.13
5.36912
5.36271
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5.38689
2.11
5.74602
5.72693
1.00
6.21784
6.19770
6.18000
6.16352
6.14562
1.00
7.26524
7.35191
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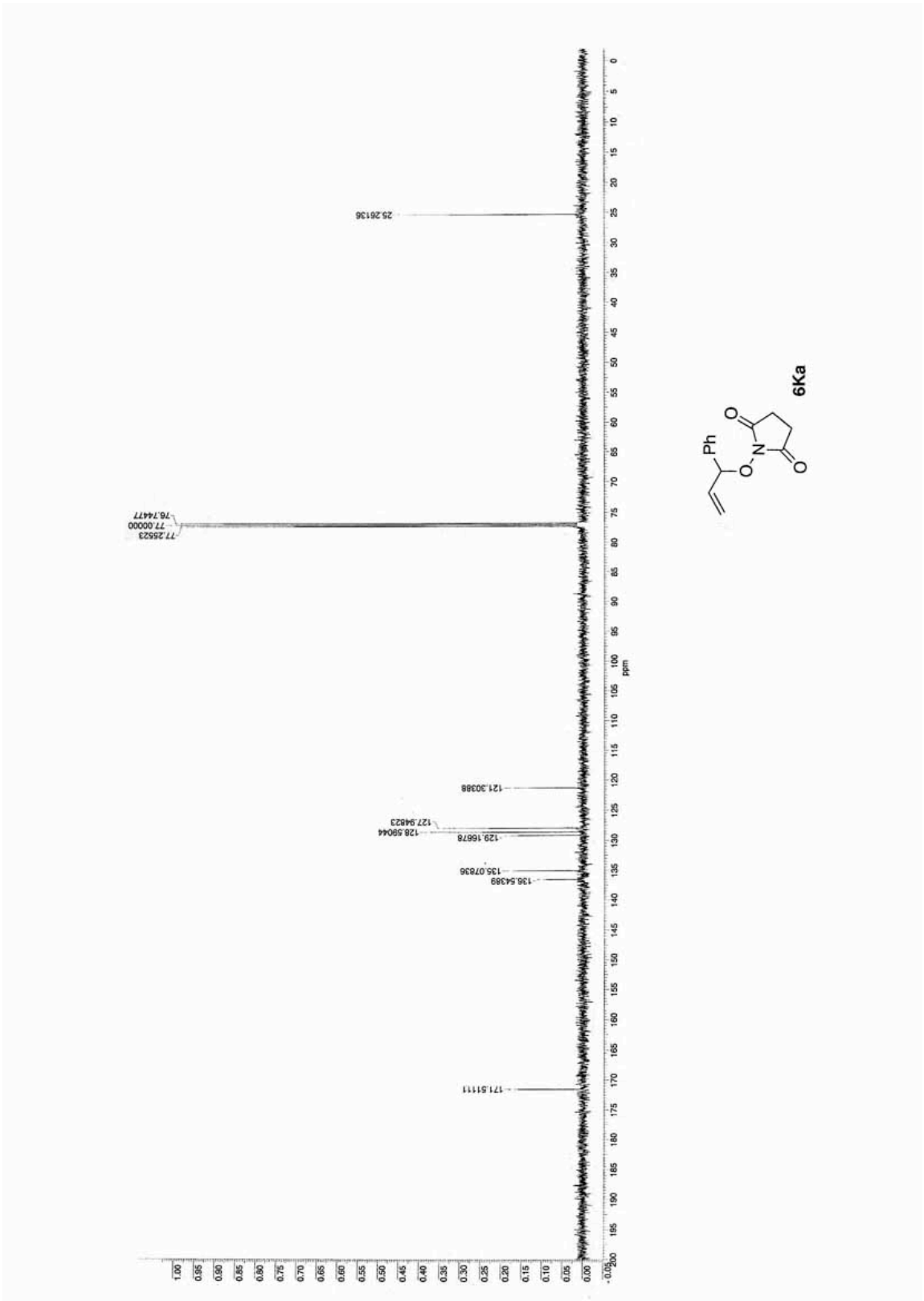
7.51366
3.10
ppm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ppm
Ph
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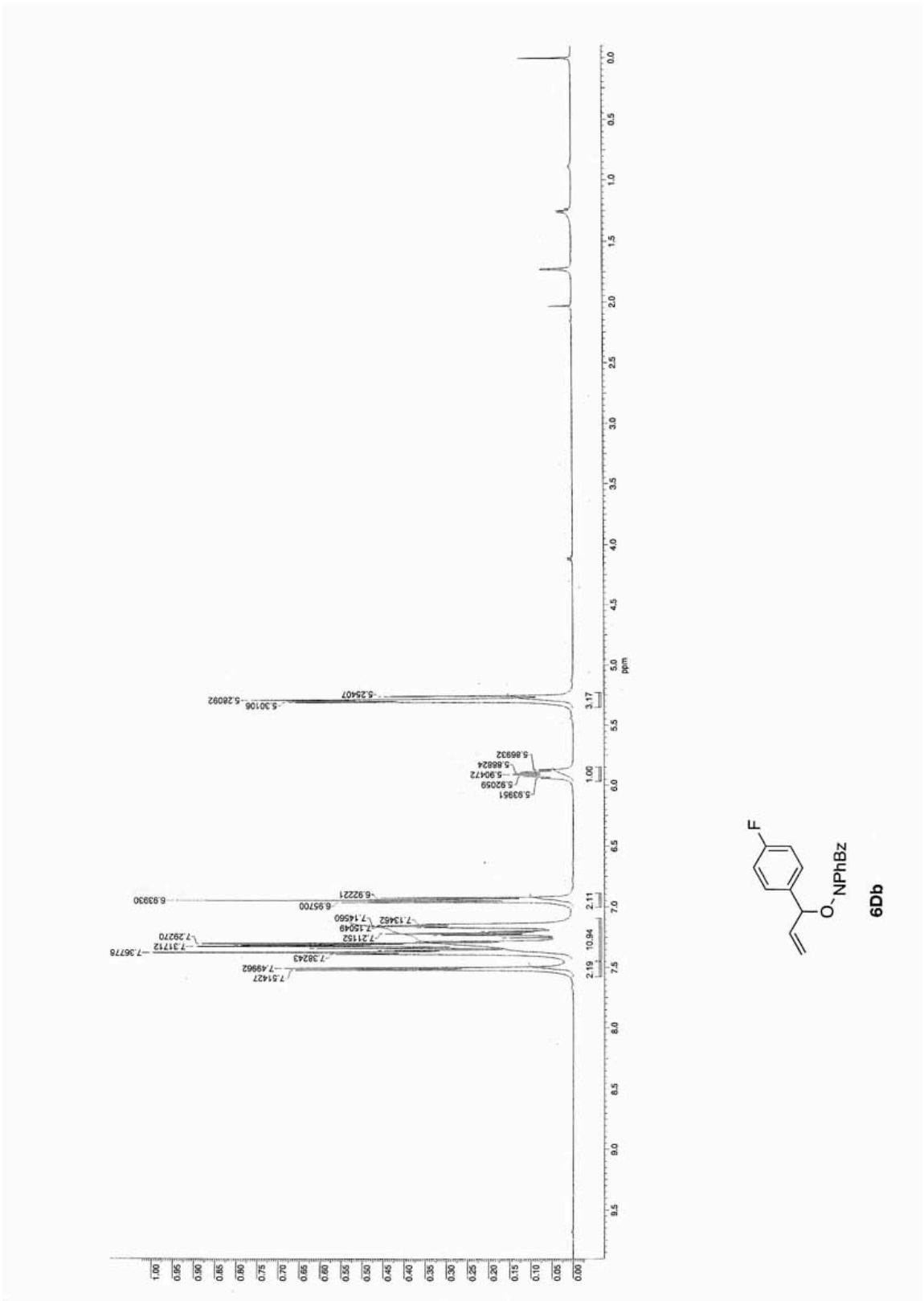
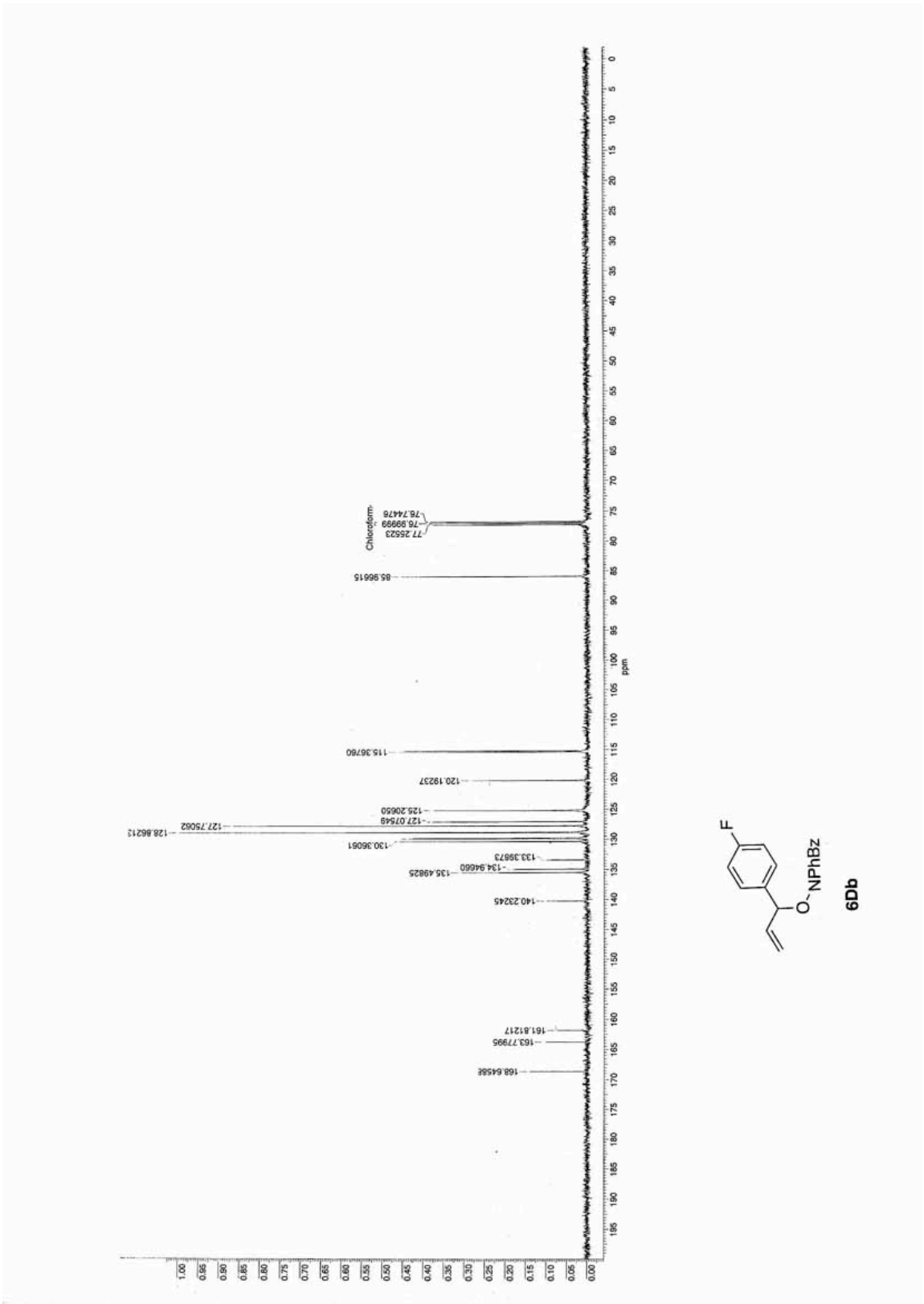
N
O
O
O
6Ka


F
O
NPhBz
6Db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85.96615
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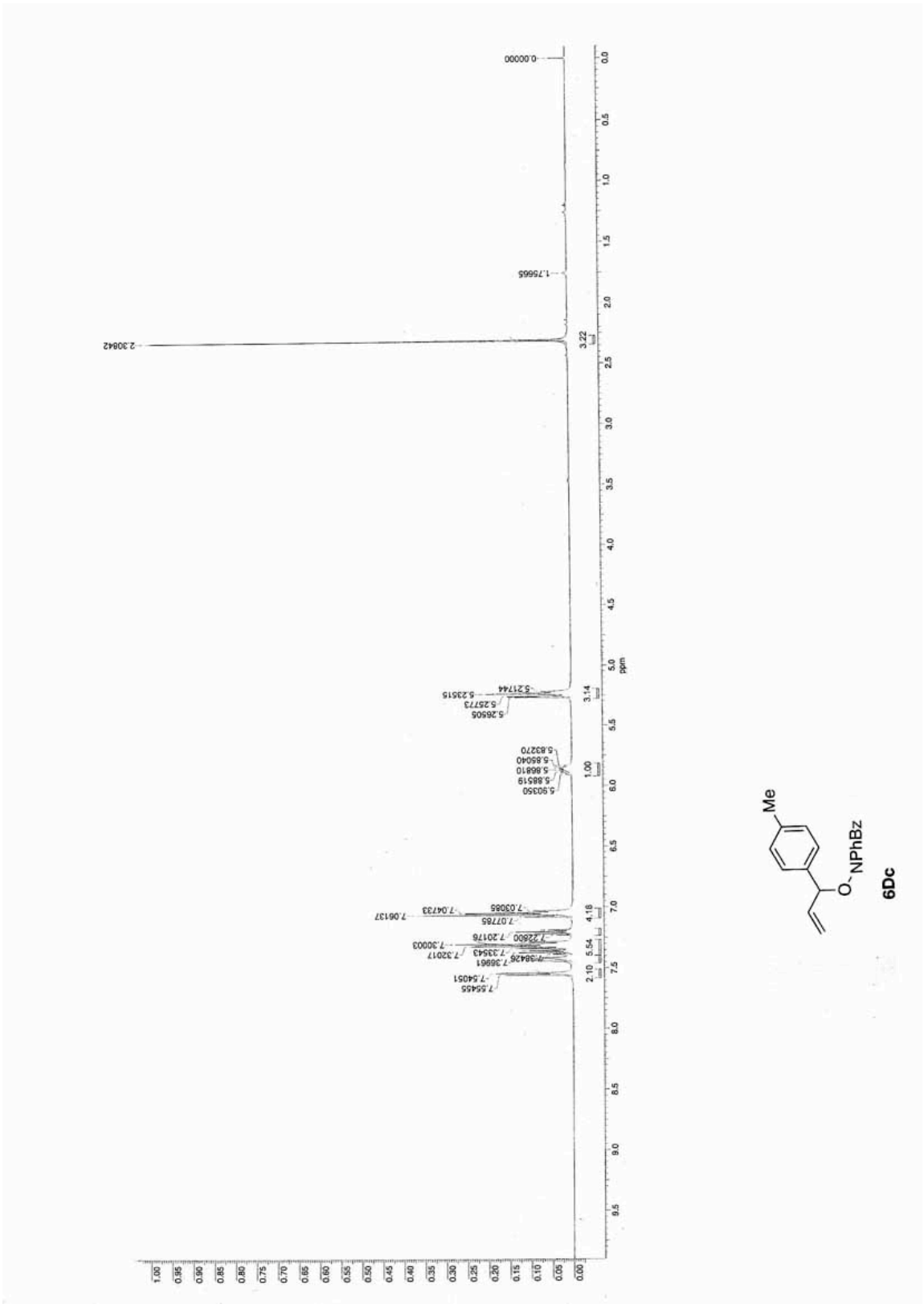
128.86212
130.36061
133.39873
134.94660
135.49825
140.23245
161.81217
163.77995
168.64586
ppm
F
O
NPhBz
6Db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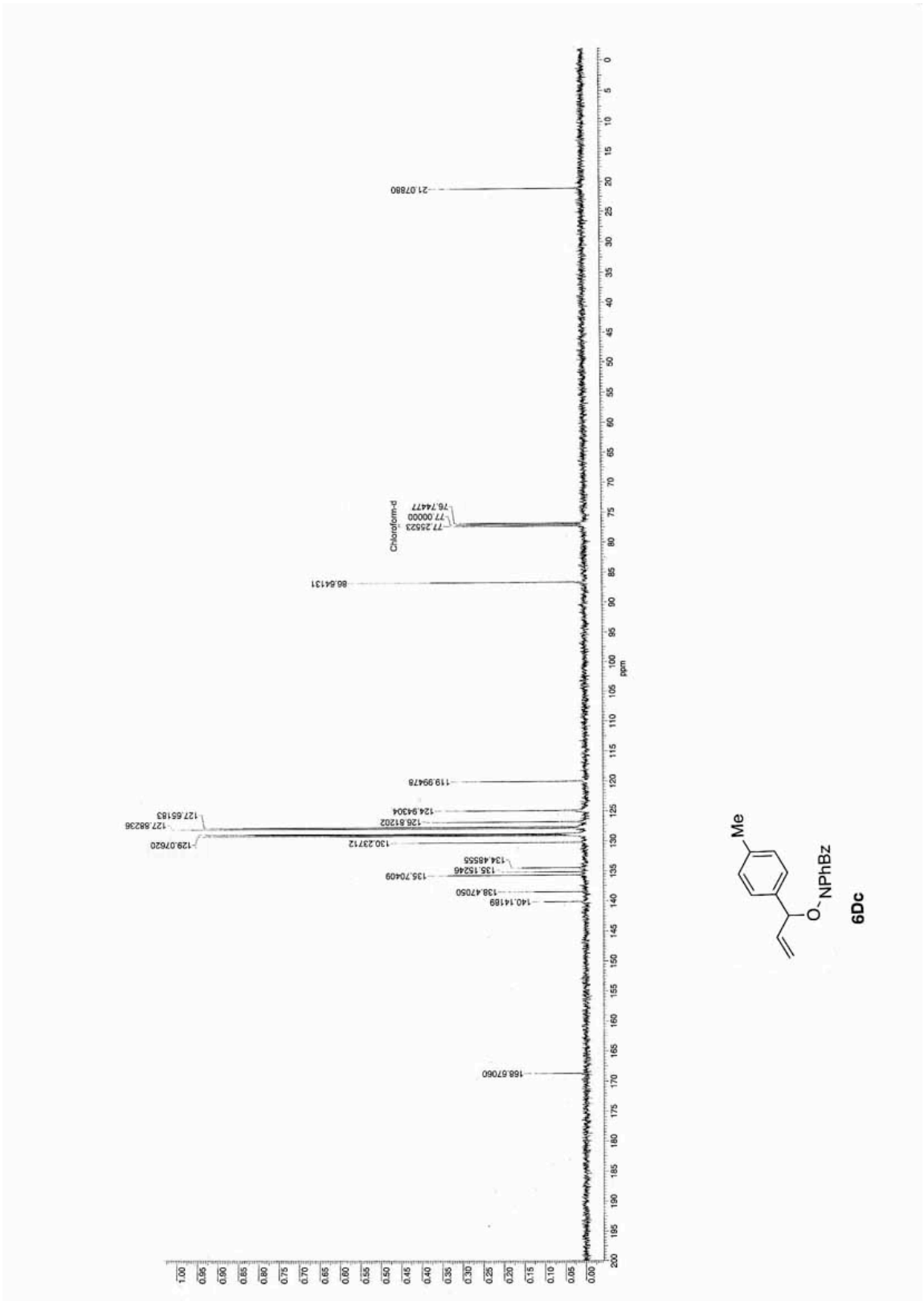
1.75665
2.30842
5.21744
5.23515
5.25773
5.26505
5.83270
5.85040
5.86810
5.88579
5.90350
7.03085
7.04733
7.06137
7.07765
7.22600
7.20176
7.30003
7.32017
7.33543
7.36961
7.38426
7.54051
7.55455
3.22
3.14
1.00
4.18
5.54
2.10
ppm
Me
O
NPhBz
6Dc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Chloroform-d
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119.99478
124.94304
126.81202
127.65183
127.88236
129.07620
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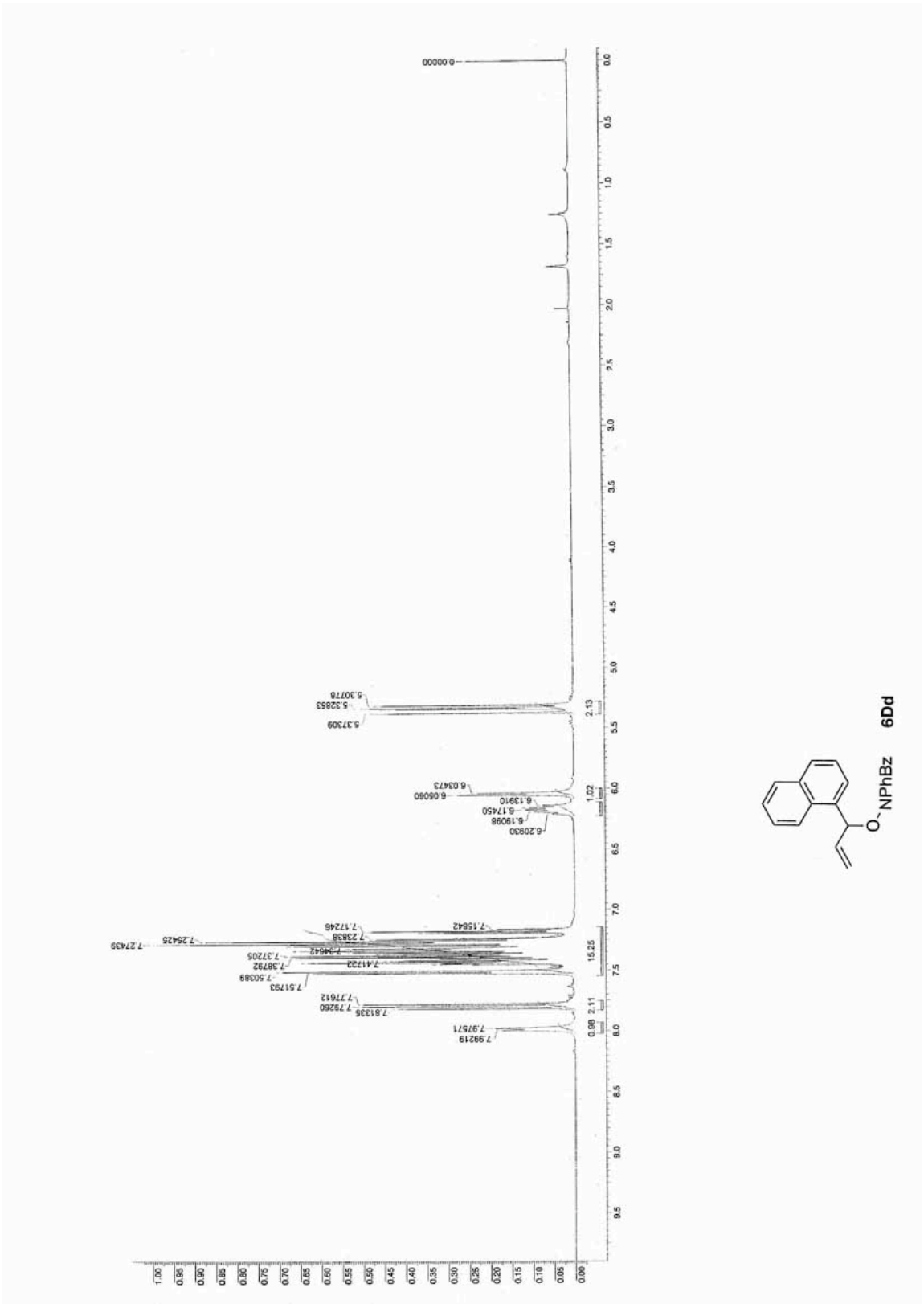
134.48555
135.15246
135.70409
138.47050
140.14189
168.67060
ppm
Me
O
NPhBz
6Dc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5.30778
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5.37309
6.03473
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6.13910
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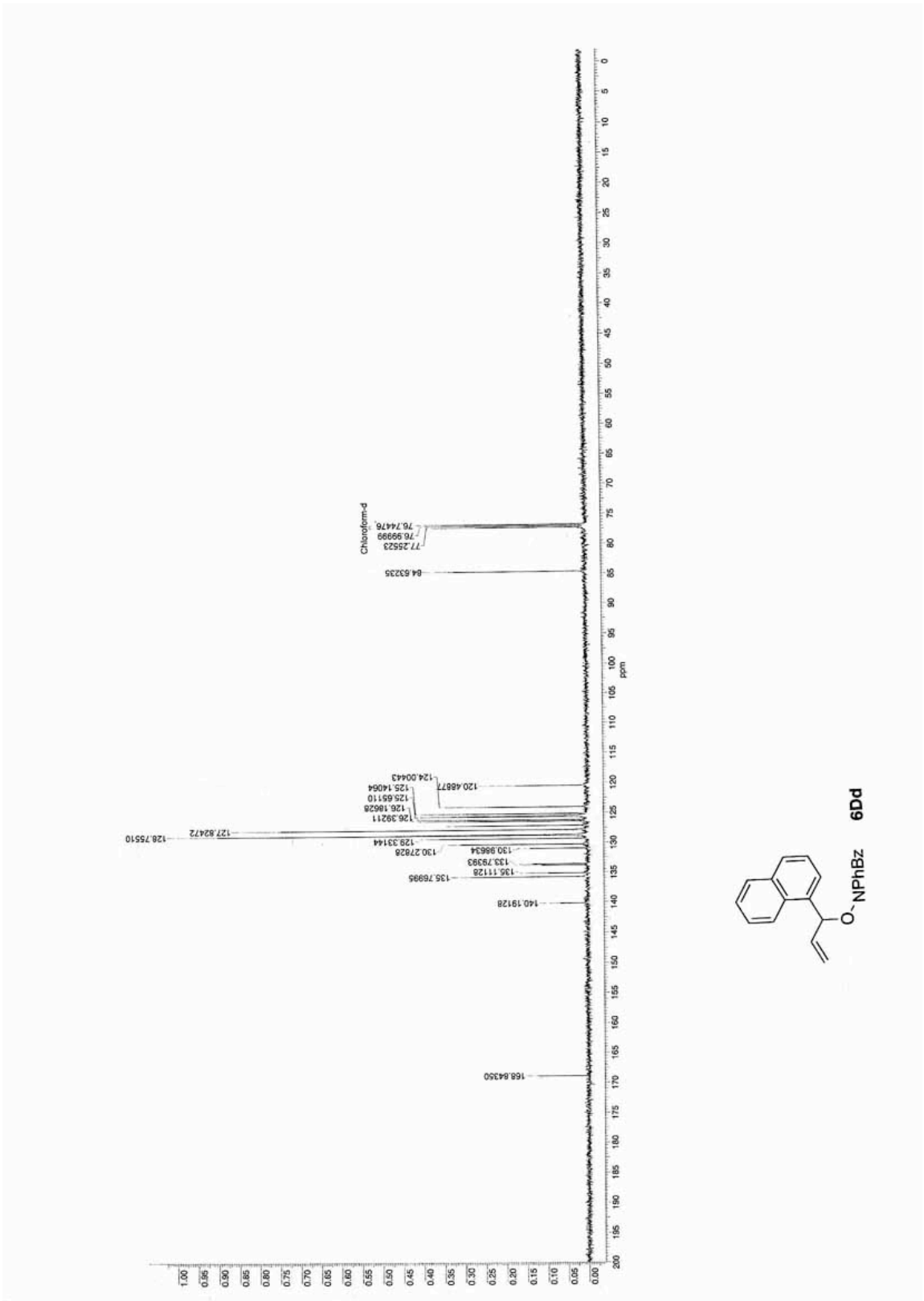
6.19098
6.20930
7.15842
7.17246
7.23838
7.25425
7.27439
7.34642
7.37205
7.41722
7.38792
7.50389
7.51793
7.77612
7.79260
7.81335
7.97571
7.99219
2.13
1.02
15.25
2.11
0.98
NPhBz
6Dd


Chloroform-d
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84.63235
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125.14064
125.65110
126.18628
126.39211
127.82472
128.75510
128.33144
130.27828
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133.75383
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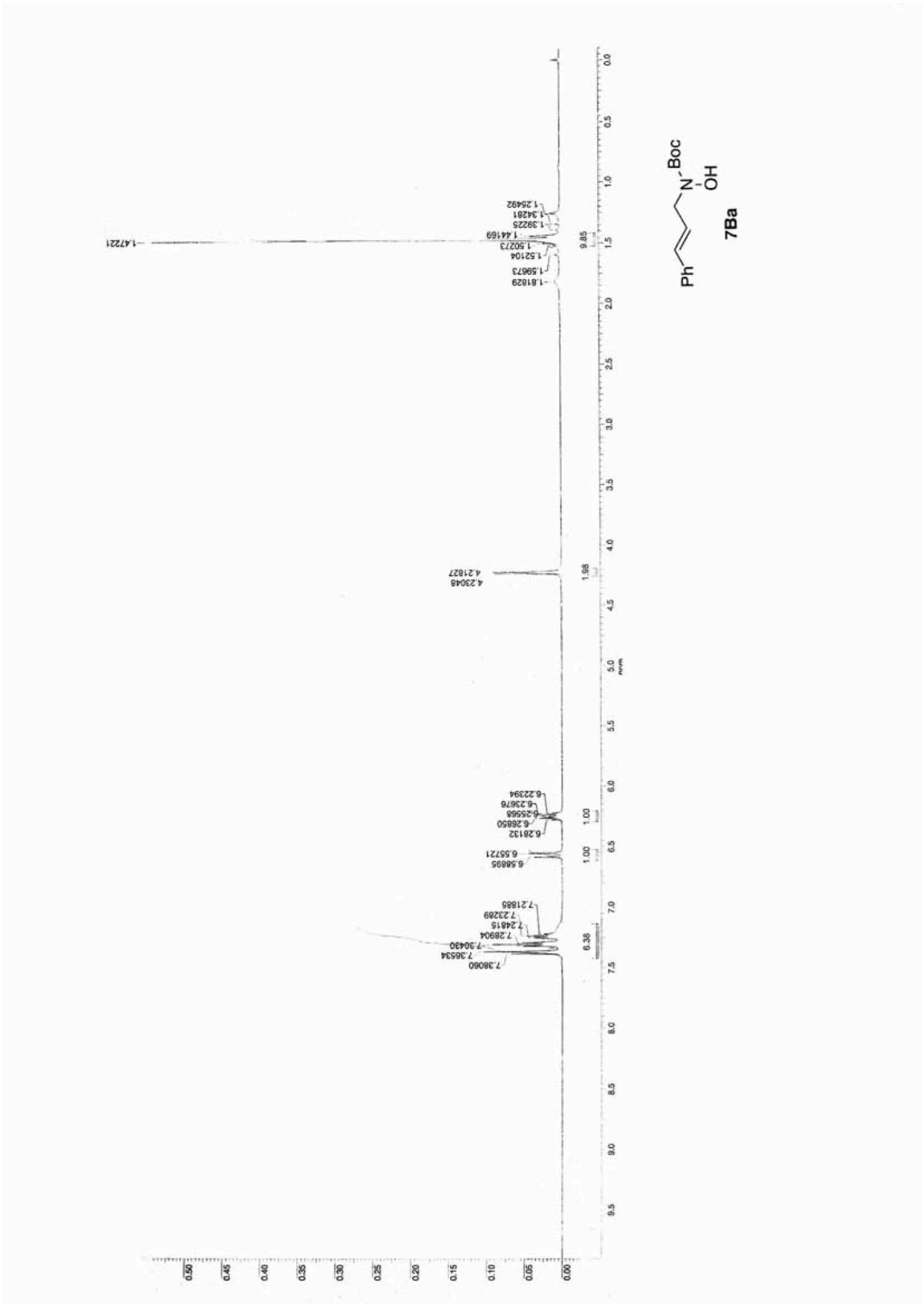
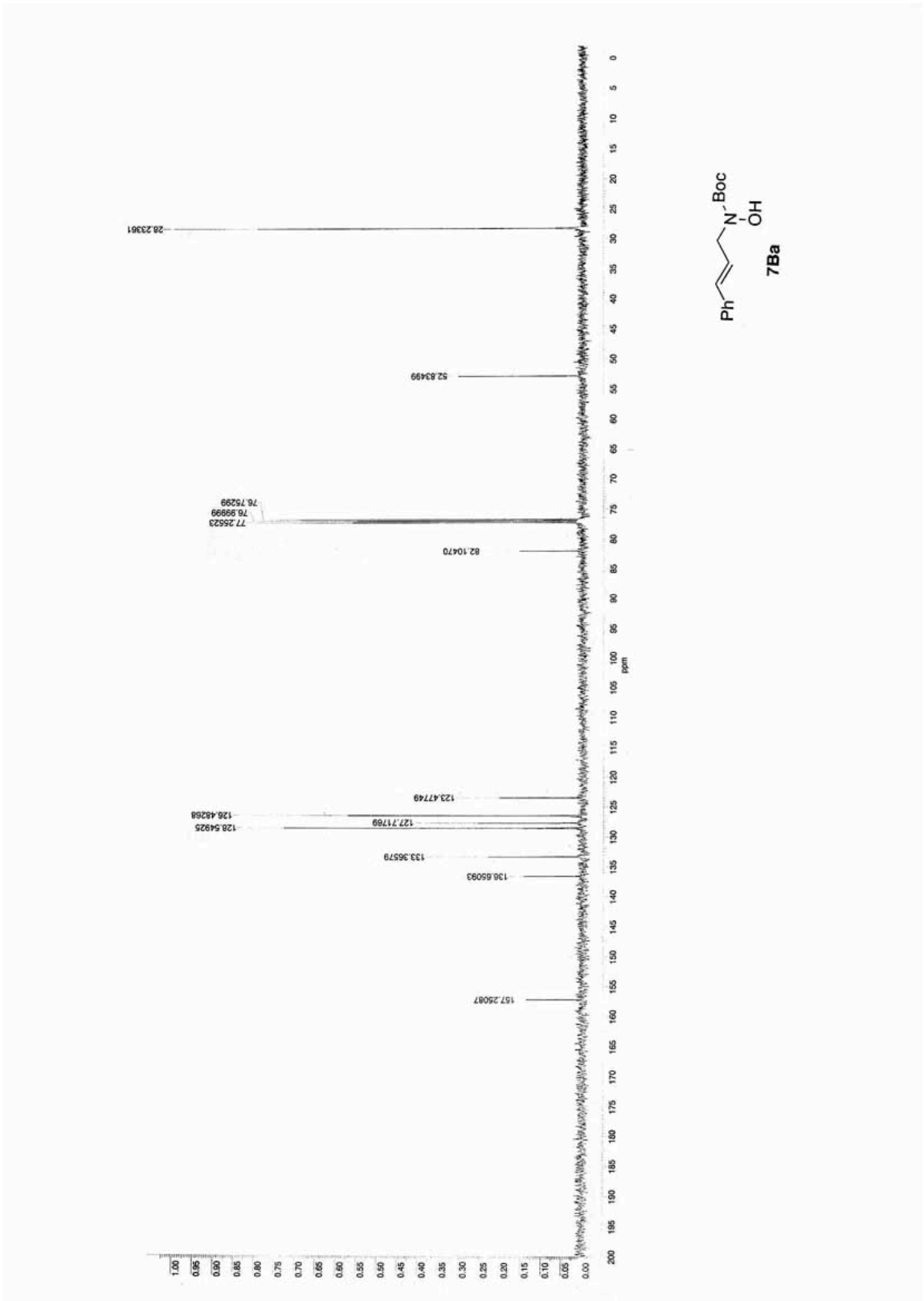
168.84350
ppm
O
NPhBz
6Dd


Boc
N
OH
Ph
7Ba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77.25523
82.10470
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127.71769
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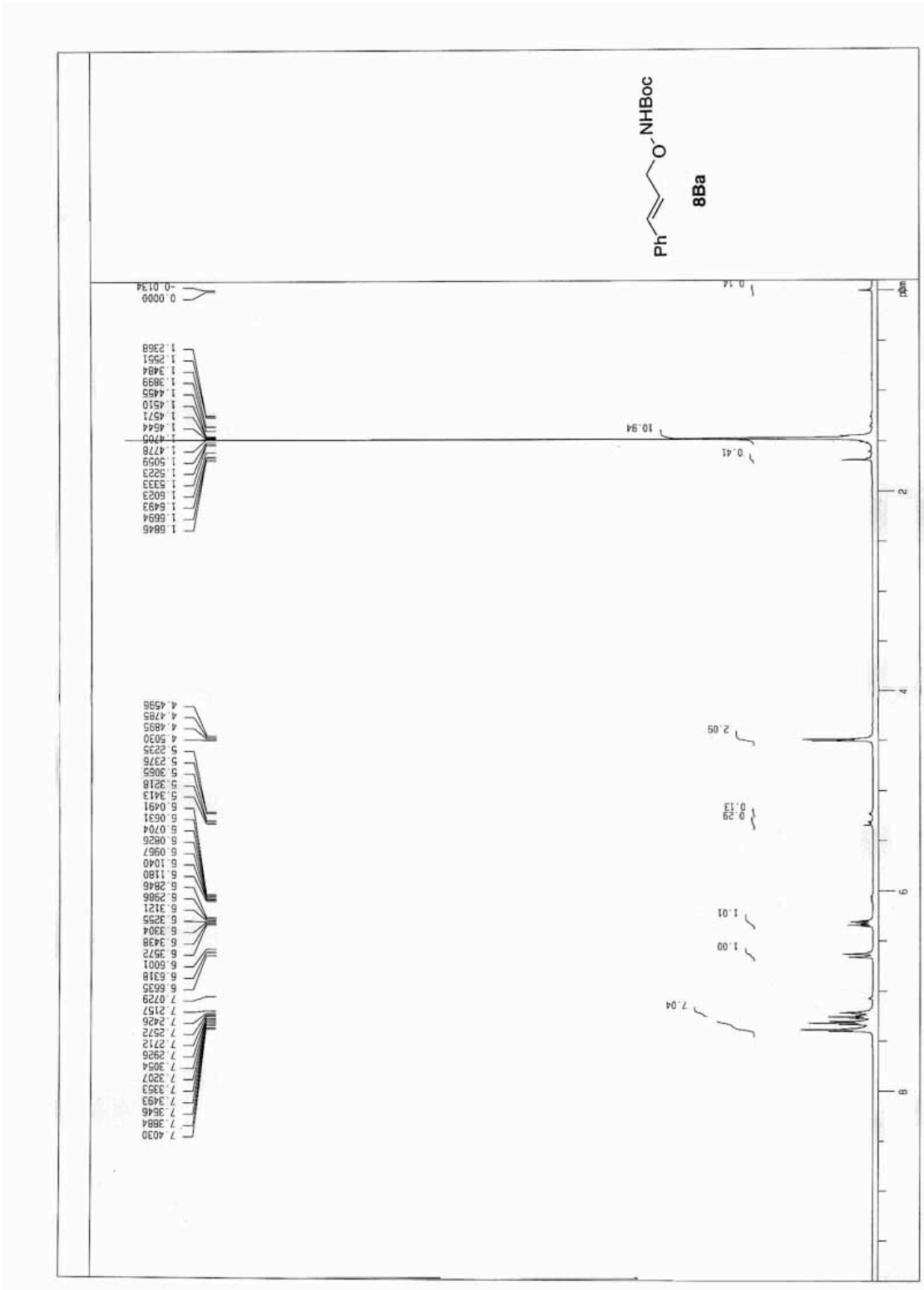
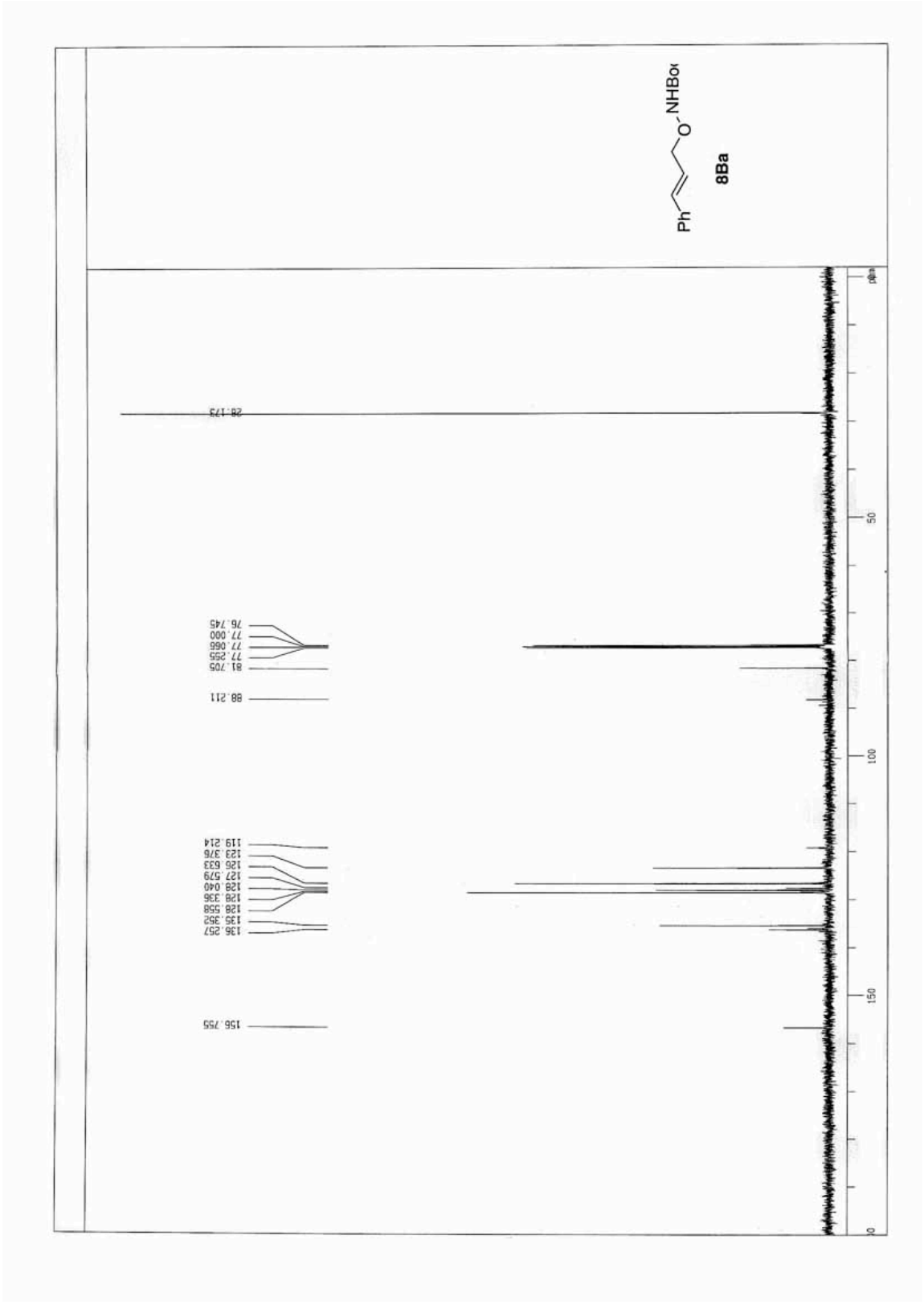
133.36579
136.65093
157.25087
ppm
Ph
N
Boc
OH
7Ba


NHBoc
O
Ph
8Ba


Ph
O
NHBoc
8Ba
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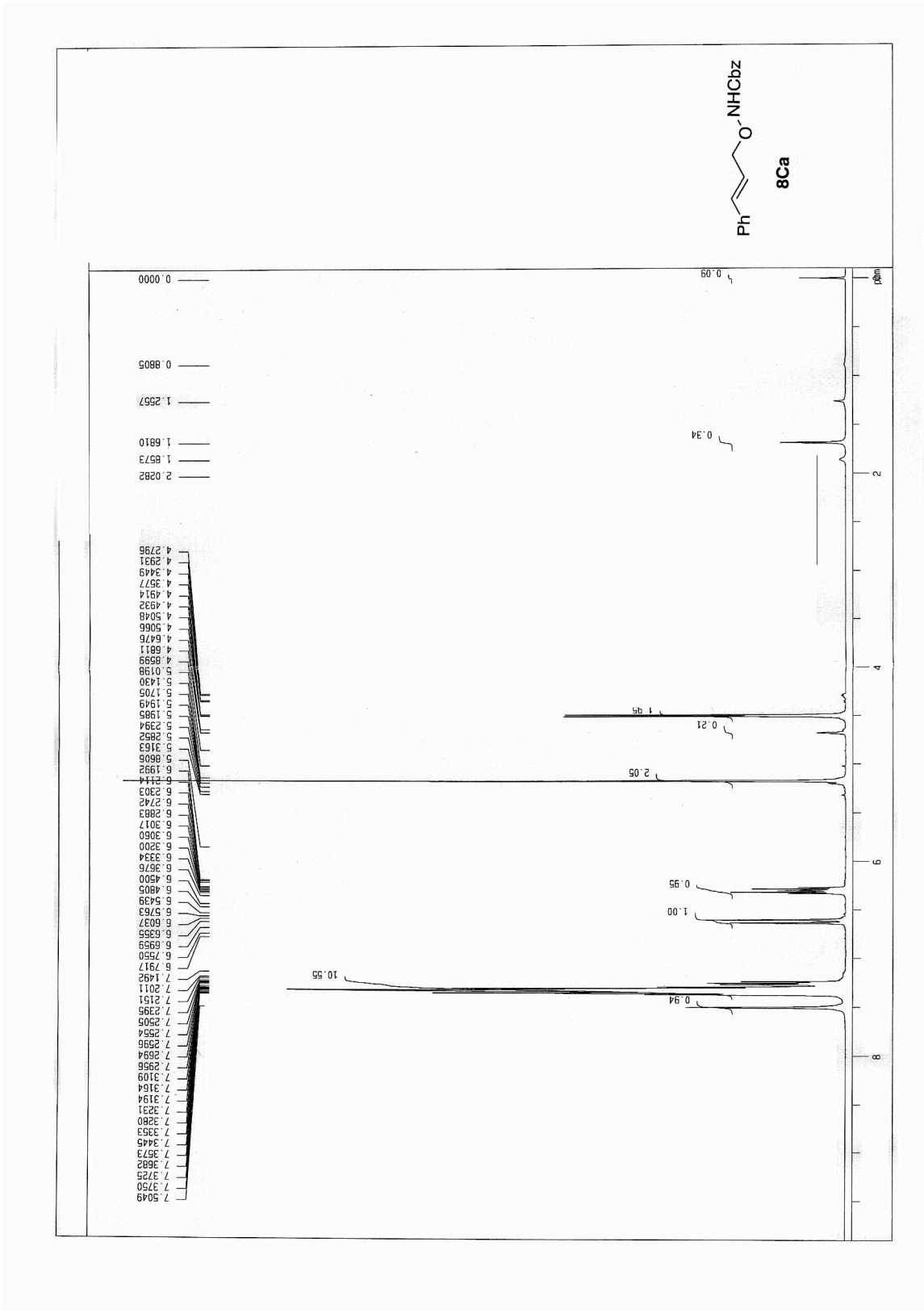
156.755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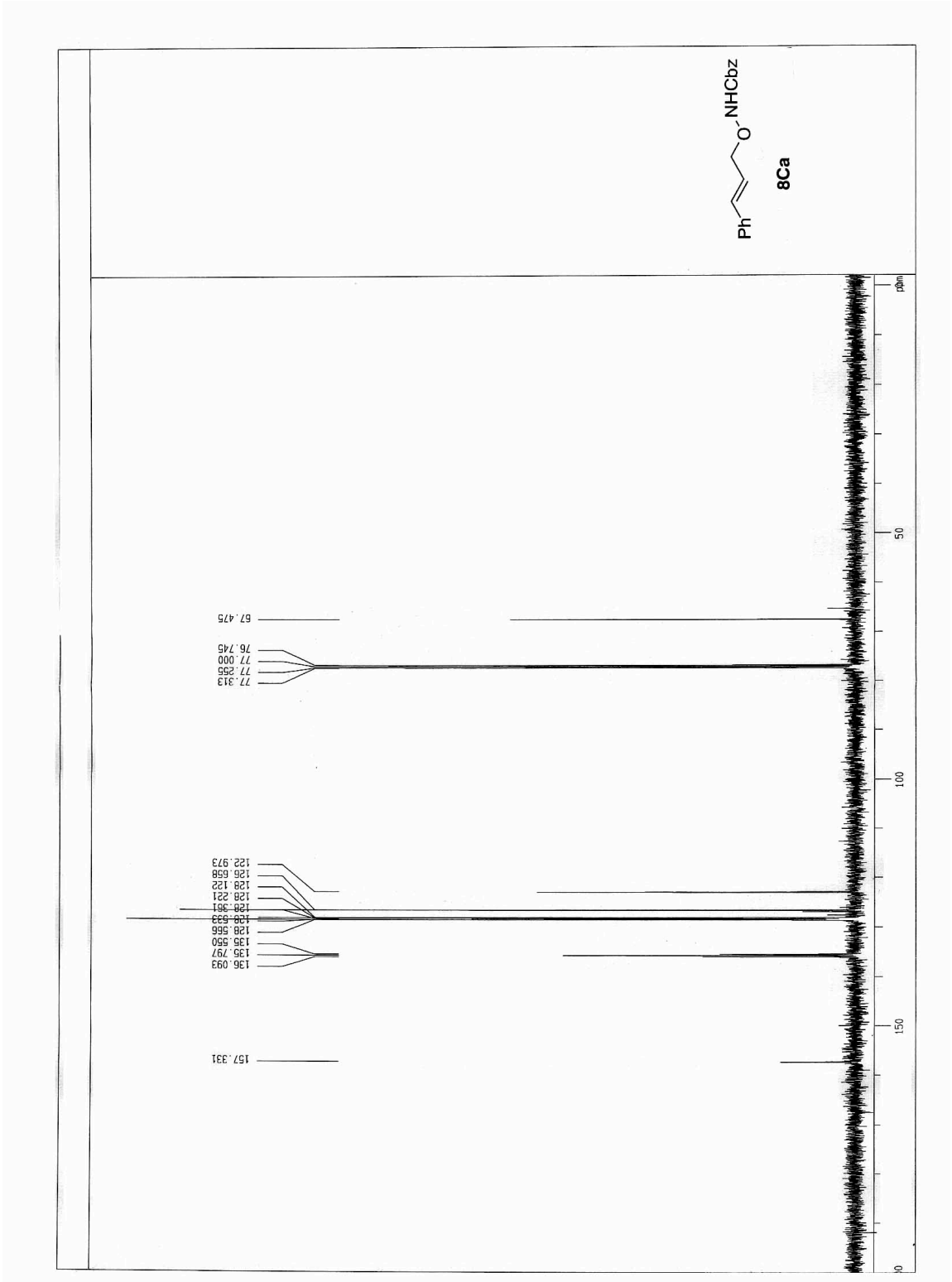
ppm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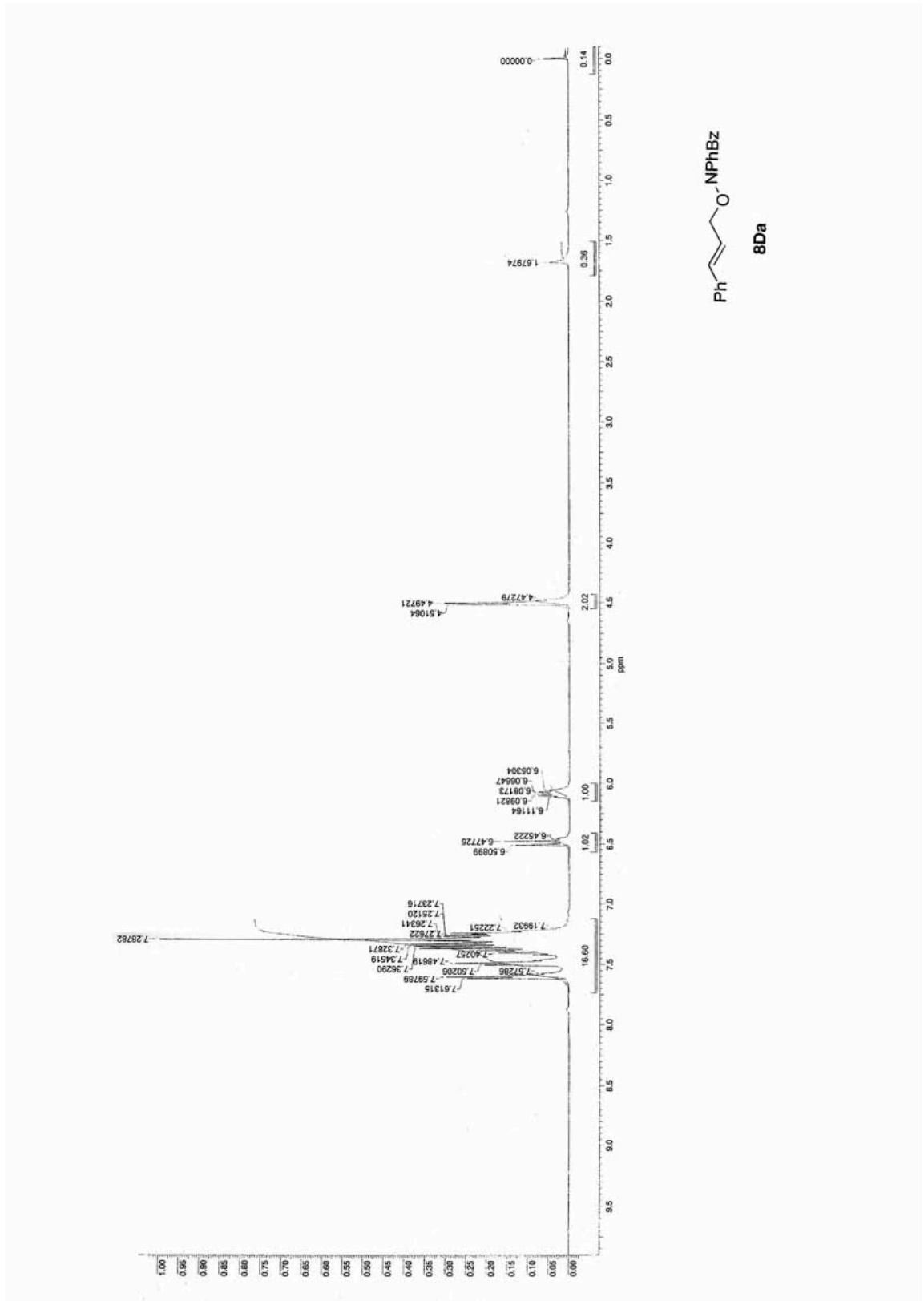
ppm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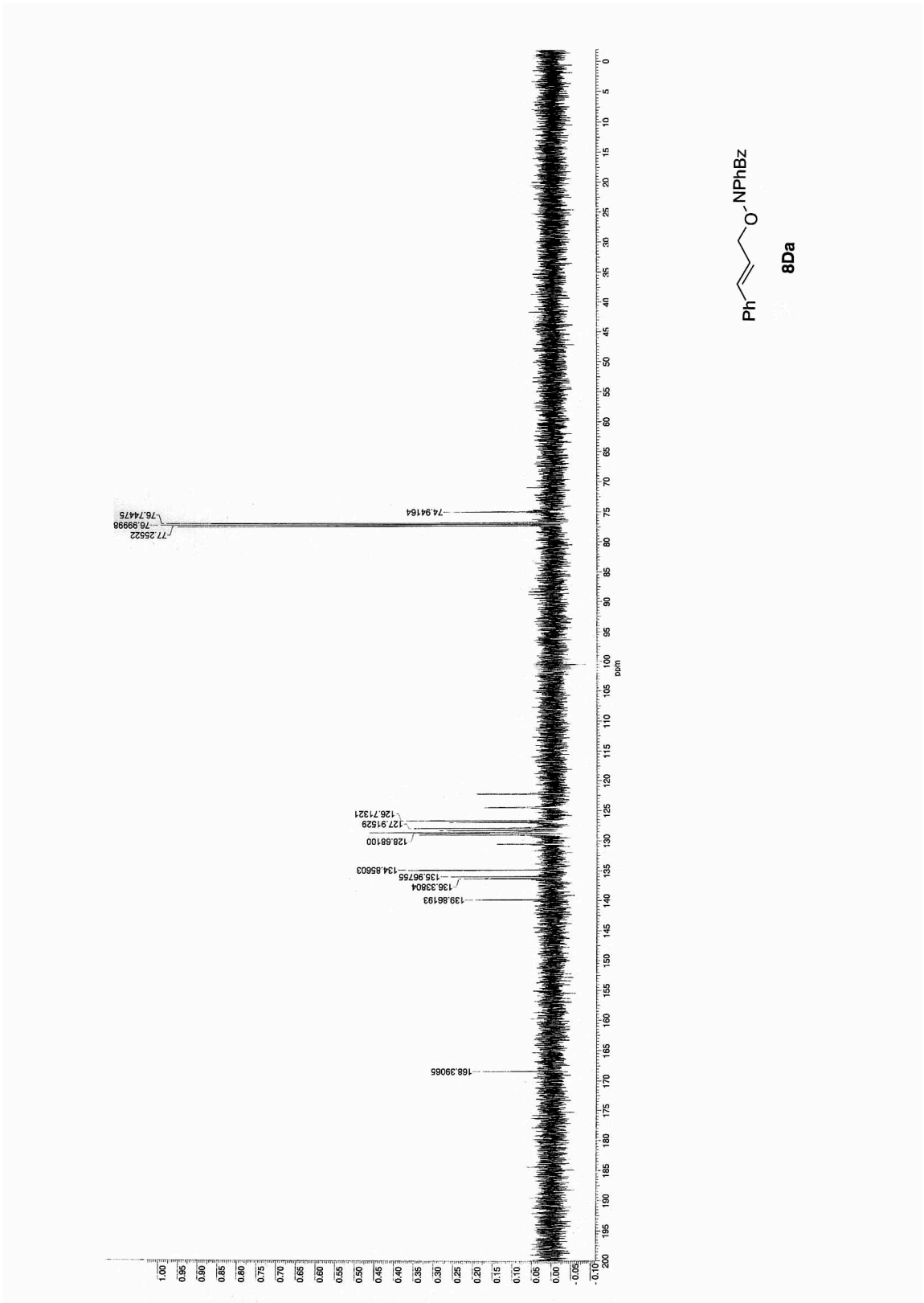
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8Da
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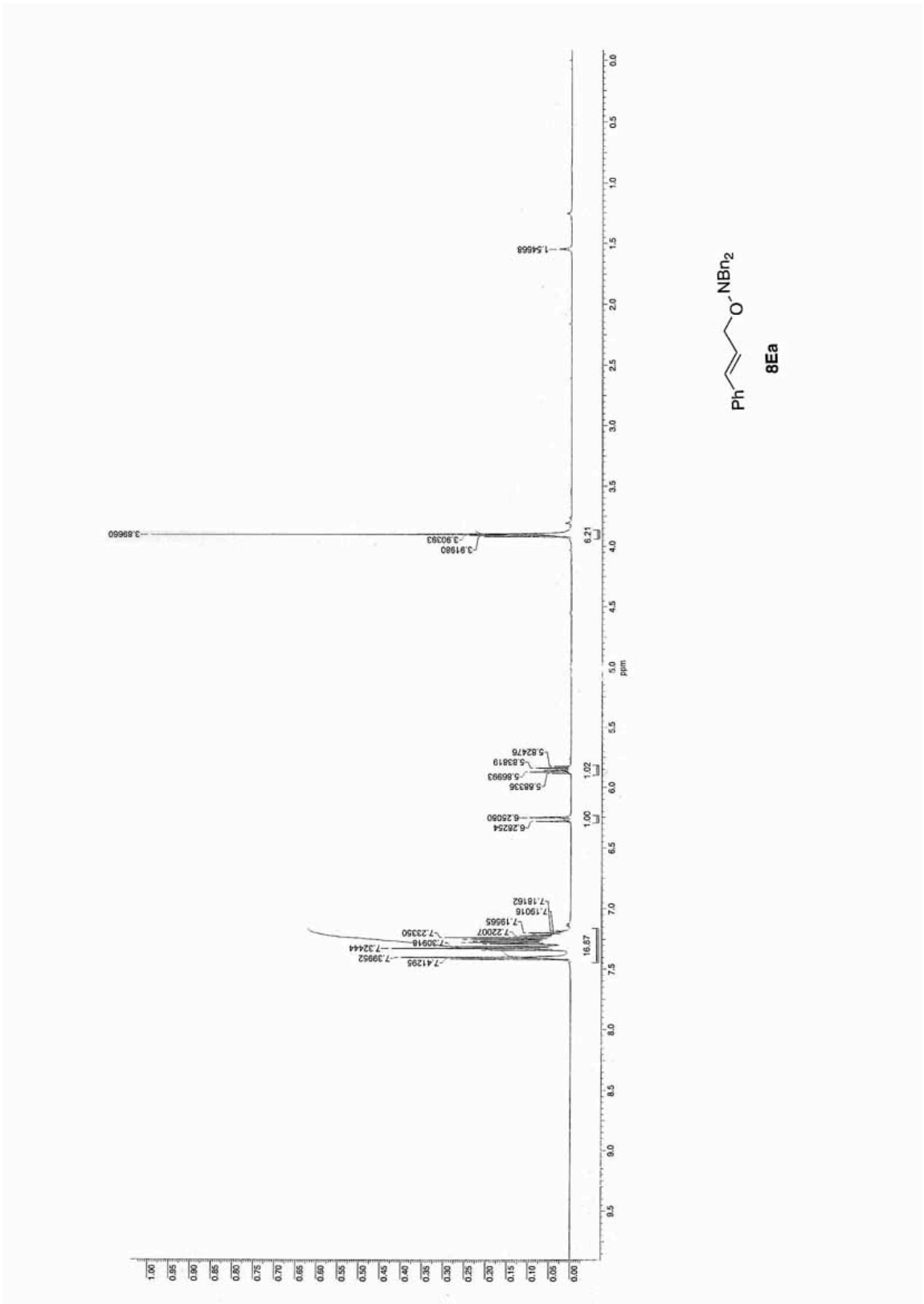
ppm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5.82476
6.26254
6.25080
7.18162
7.19016
7.19565
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7.30918
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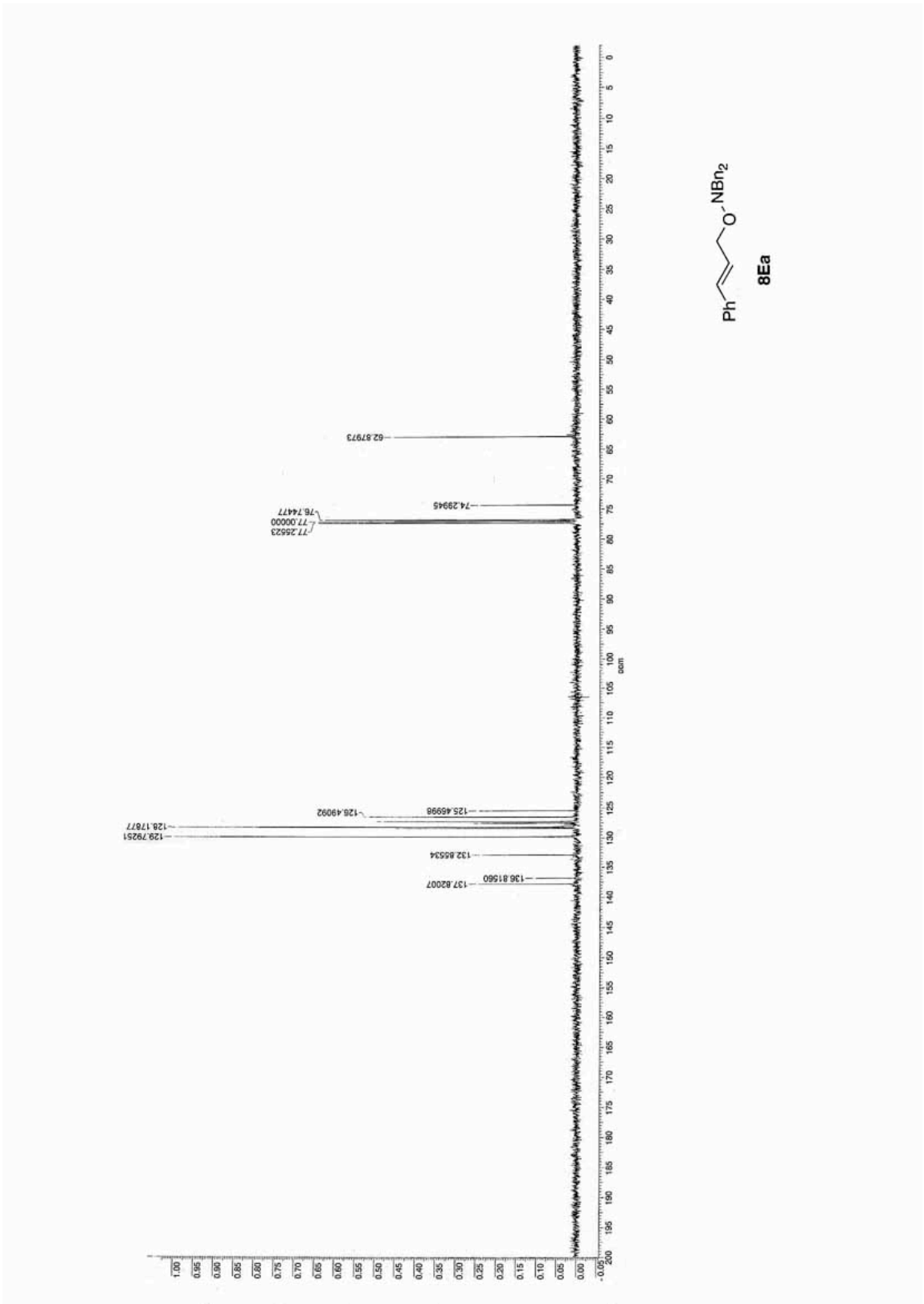
1.00
16.87
ppm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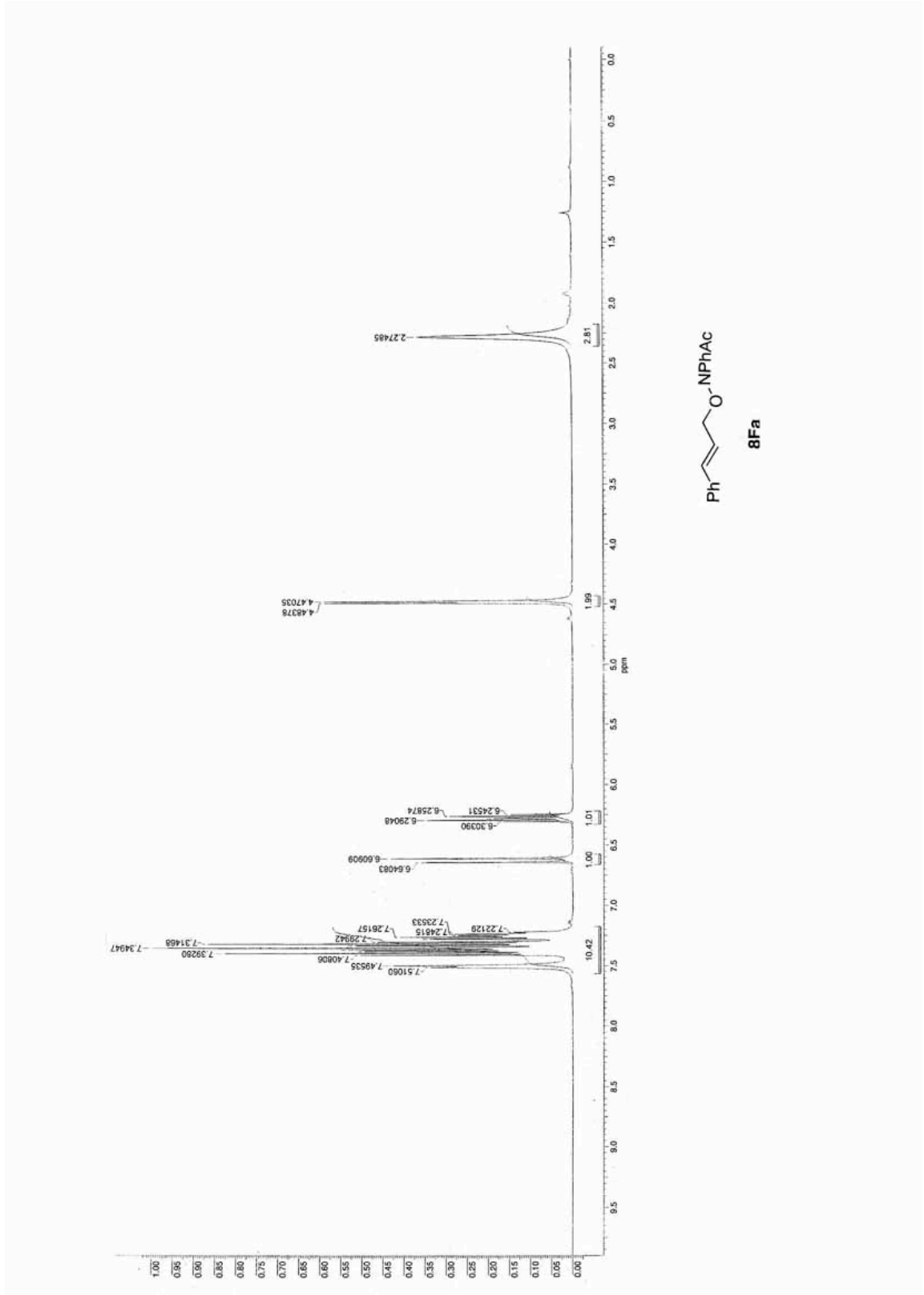
Ph
O
NBn2
8Ea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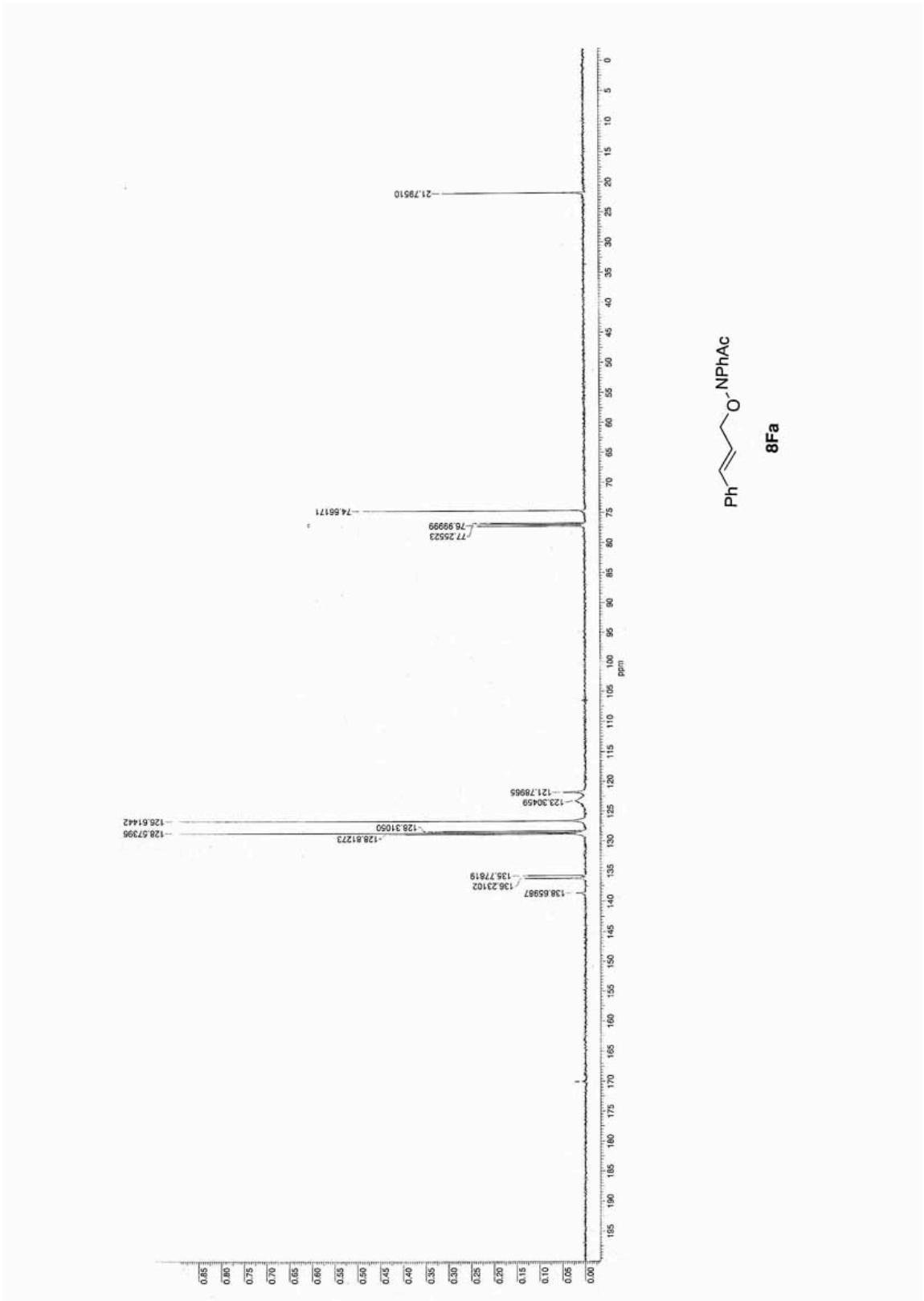
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77.25523
121.78965
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128.31050
135.77619
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138.65987
ppm
Ph
O
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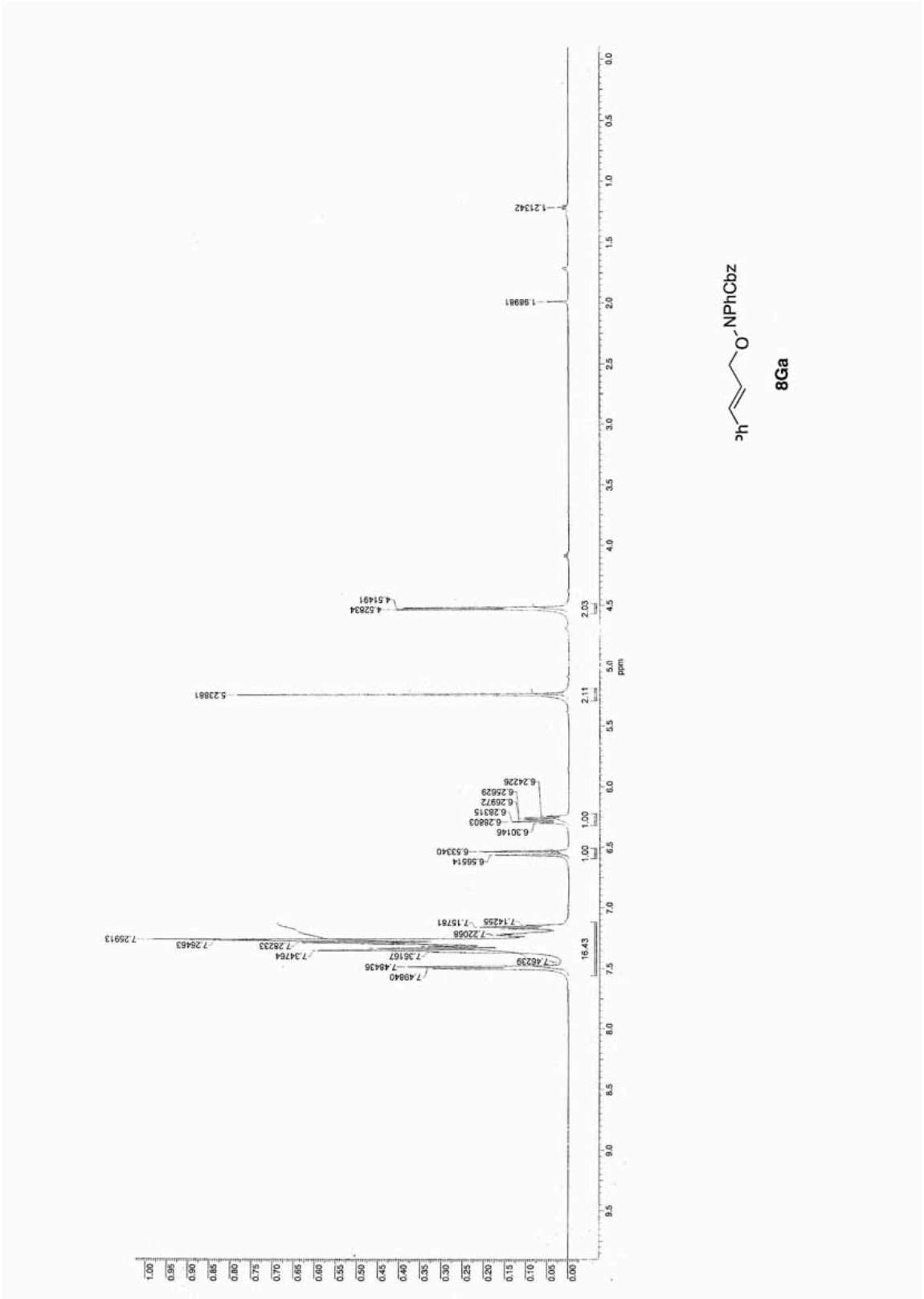
8Fa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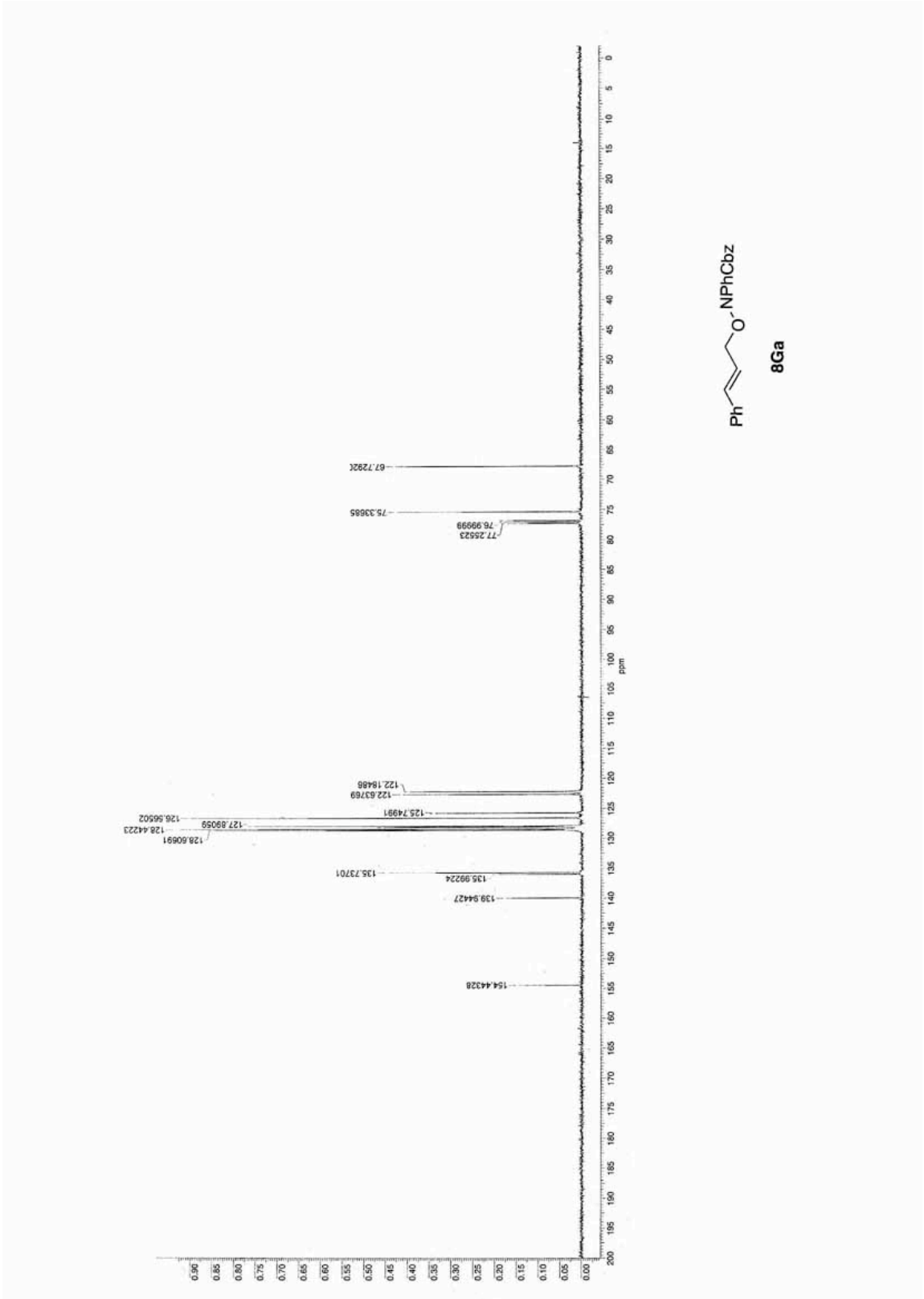
8Ga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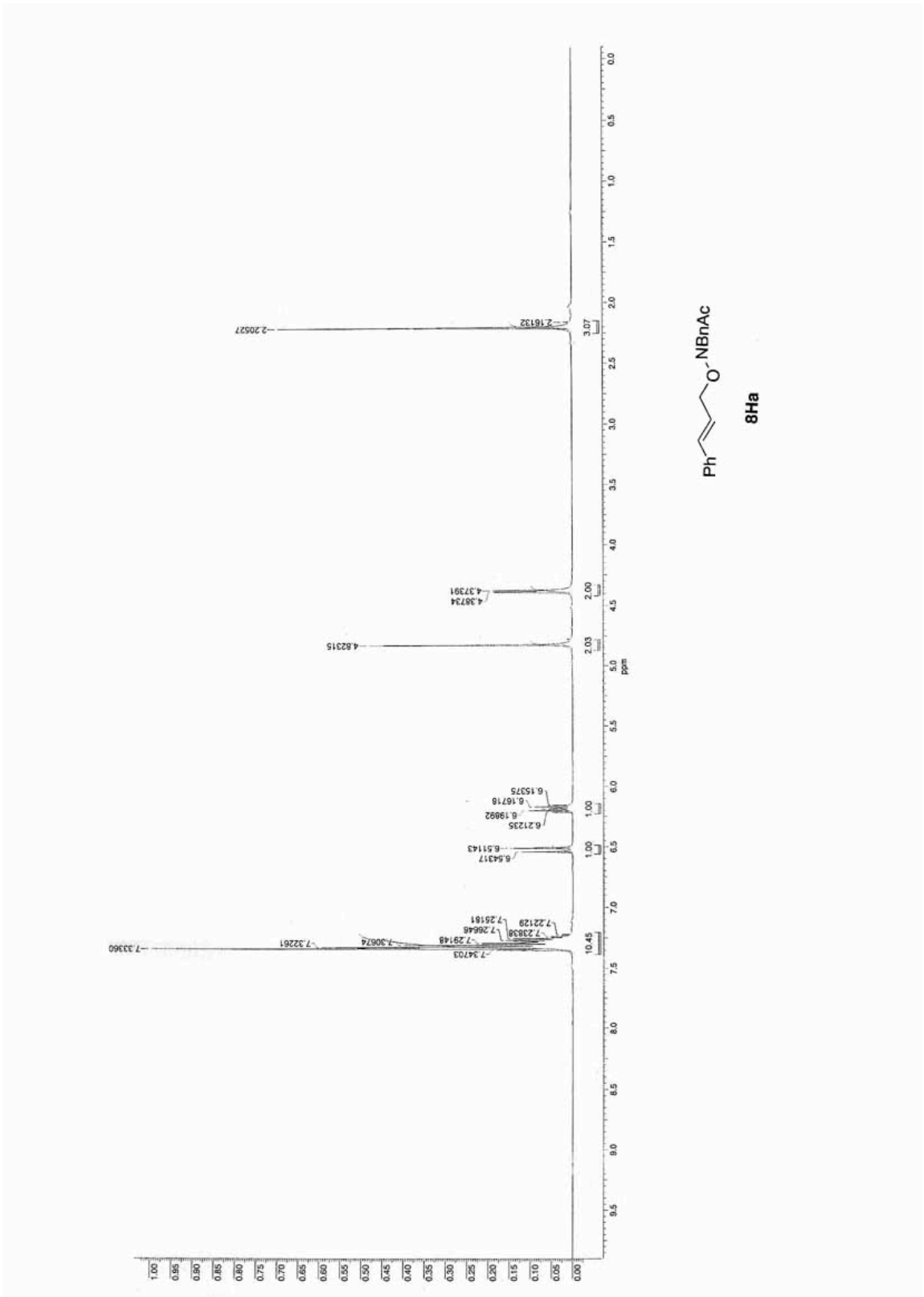
ppm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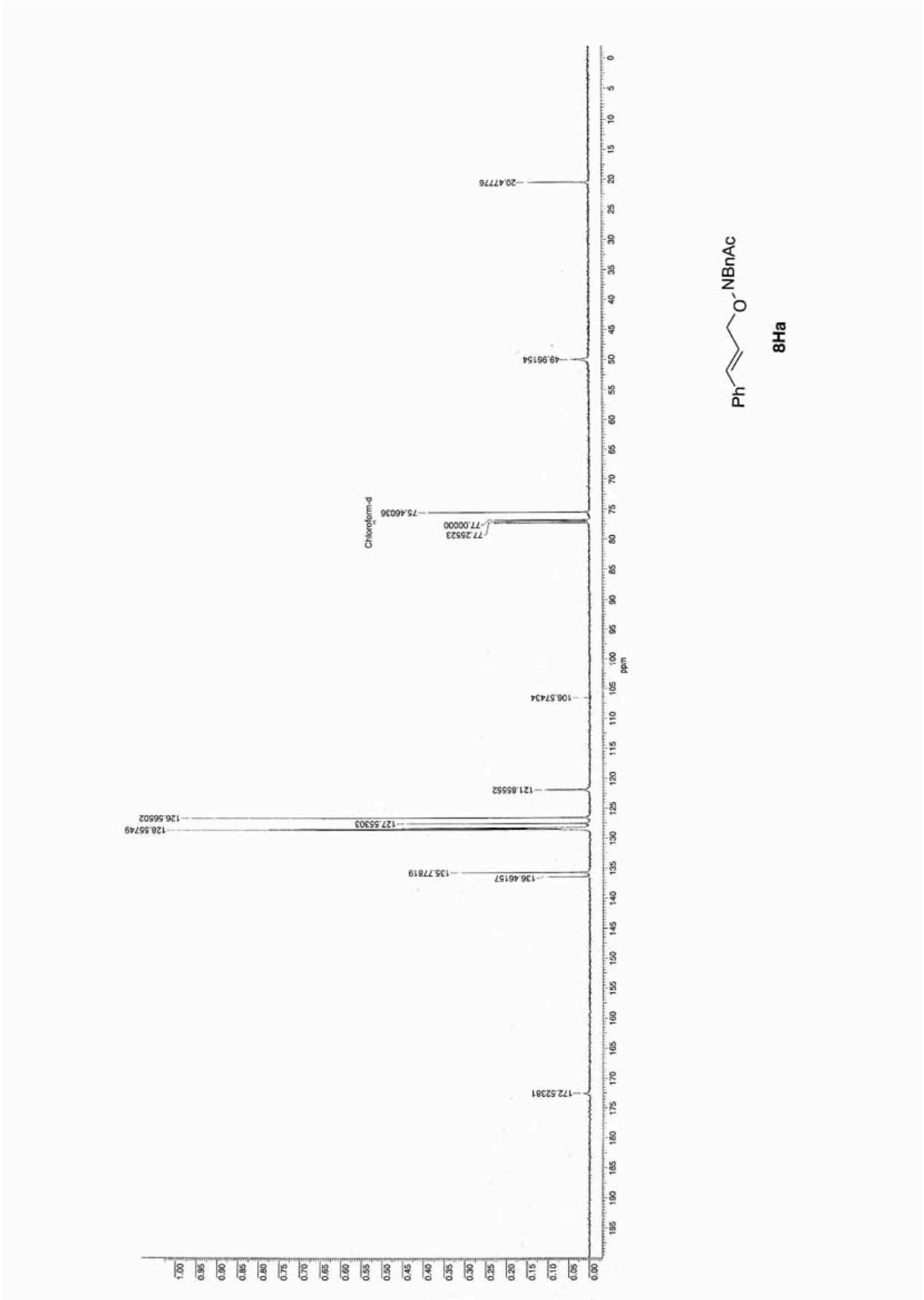
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Chloroform-d
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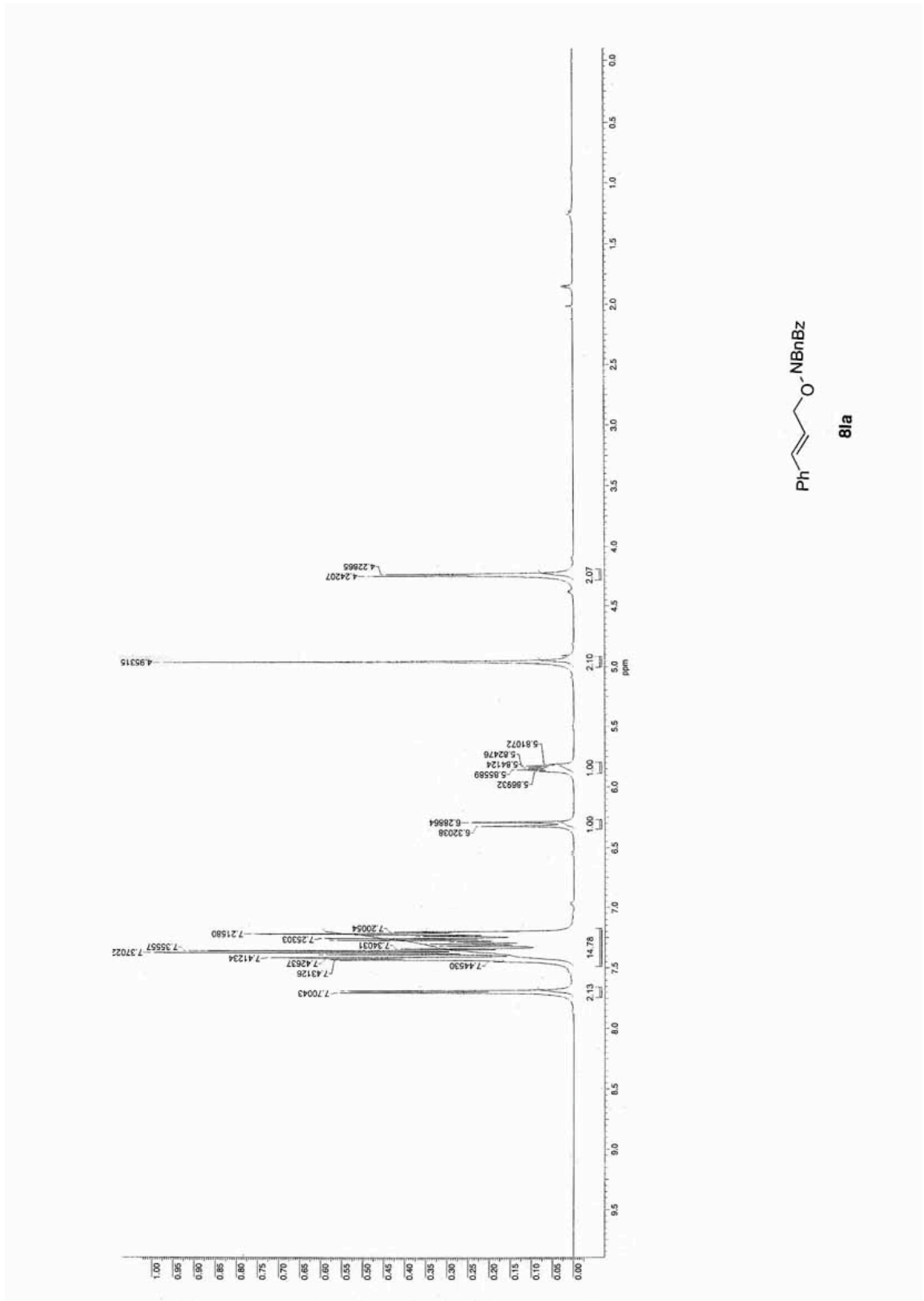
136.46157
172.52381
ppm
Ph
O
NBnAc
8Ha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O
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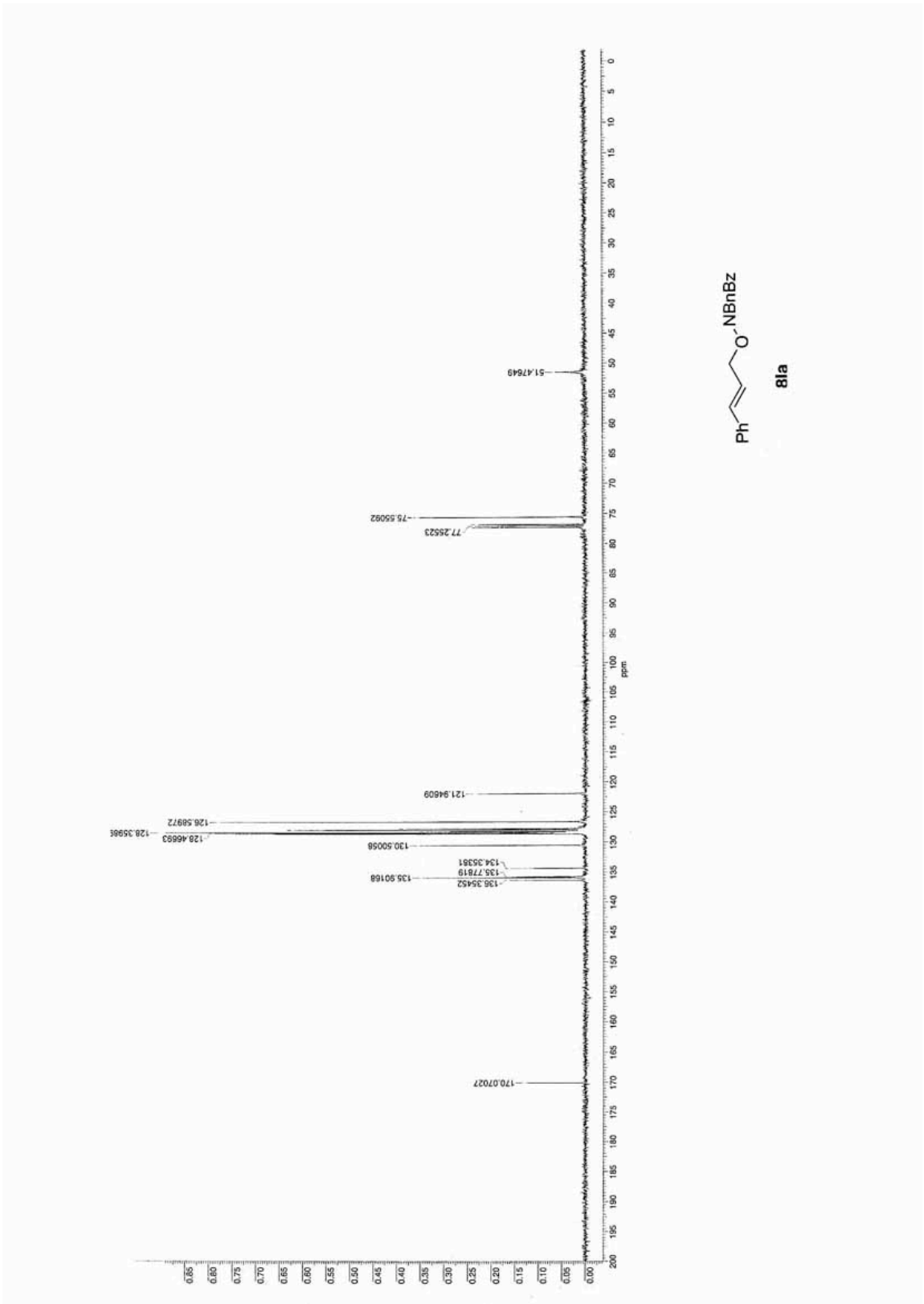
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135.50168
134.35381
130.50058
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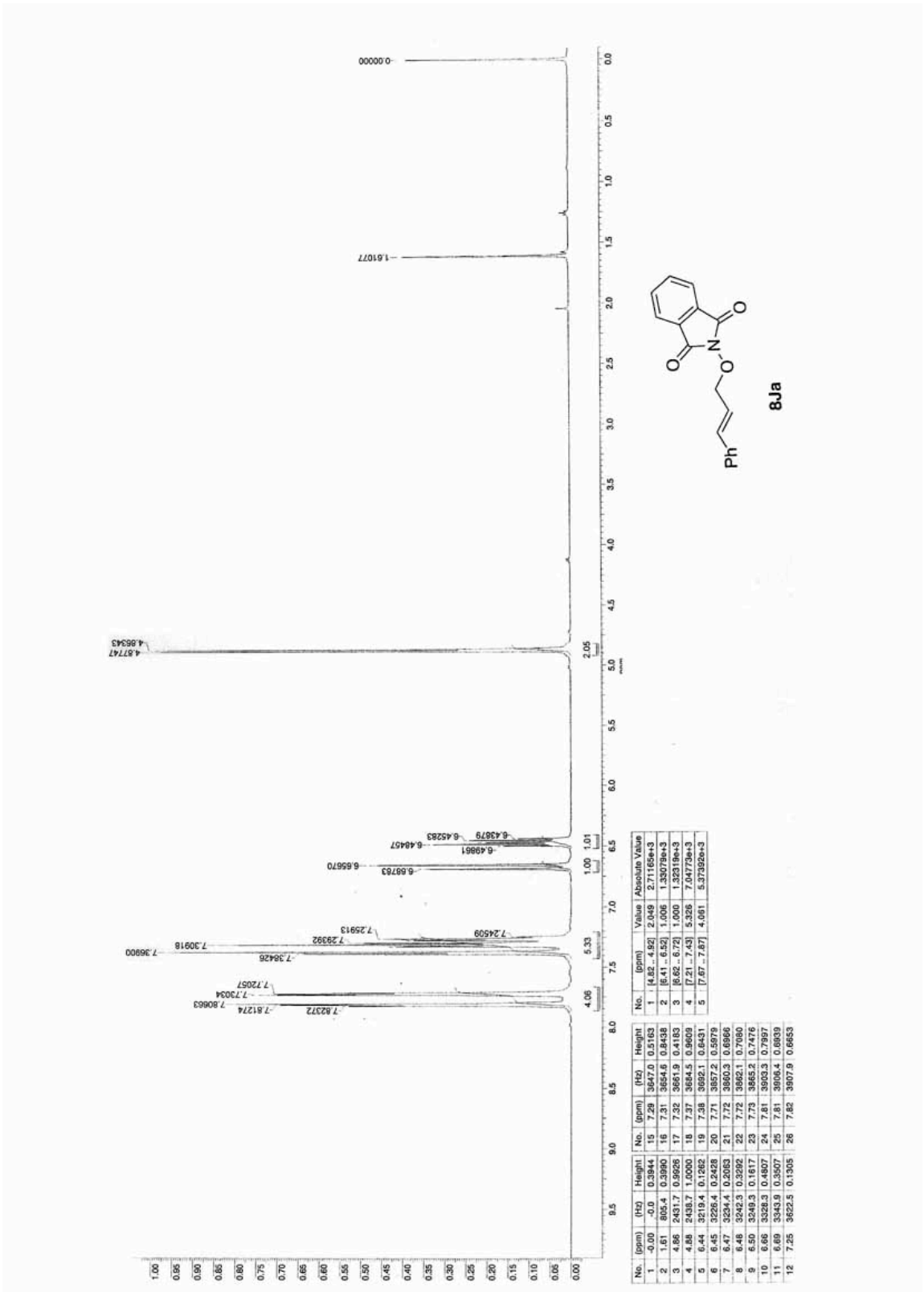
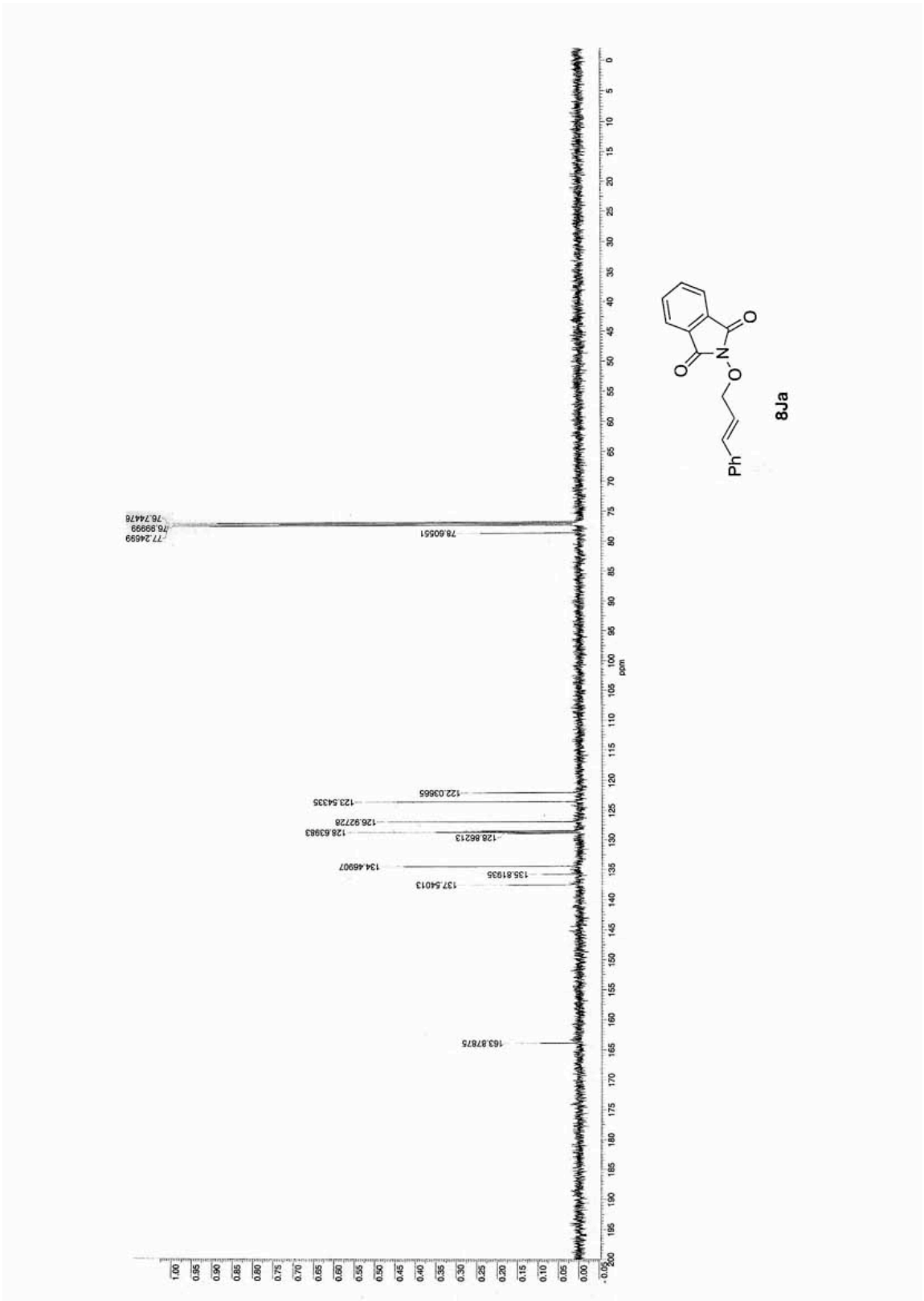
ppm
Ph
O
NBnBz
8la



No.	(ppm)	Value	Absolute Value
1	[4.82 .. 4.92]	2.049	2.71165e+3
2	[6.41 .. 6.52]	1.006	1.33079e+3
3	[6.62 .. 6.72]	1.000	1.32319e+3
4	[7.21 .. 7.43]	5.326	7.04773e+3
5	[7.67 .. 7.87]	4.061	5.37392e+3

No.	(ppm)	(Hz)	Height
1	-0.00	-0.0	0.3944
2	1.61	805.4	0.3990
3	4.86	2431.7	0.9926
4	4.88	2438.7	1.0000
5	6.44	3219.4	0.1262
6	6.45	3226.4	0.2428
7	6.47	3234.4	0.2063
8	6.48	3242.3	0.3292
9	6.50	3249.3	0.1617
10	6.66	3328.3	0.4907
11	6.69	3343.9	0.3507
12	7.25	3622.5	0.1305

No.	(ppm)	(Hz)	Height
15	7.29	3647.0	0.5163
16	7.31	3654.6	0.8438
17	7.32	3661.9	0.4183
18	7.37	3684.5	0.9609
19	7.38	3692.1	0.6431
20	7.71	3857.2	0.5979
21	7.72	3860.3	0.6966
22	7.72	3862.1	0.7080
23	7.73	3865.2	0.7476
24	7.81	3903.3	0.7997
25	7.81	3906.4	0.6939
26	7.82	3907.9	0.6653


8Ja
Ph
O
N
O
O
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137.54013
135.81935
134.48907
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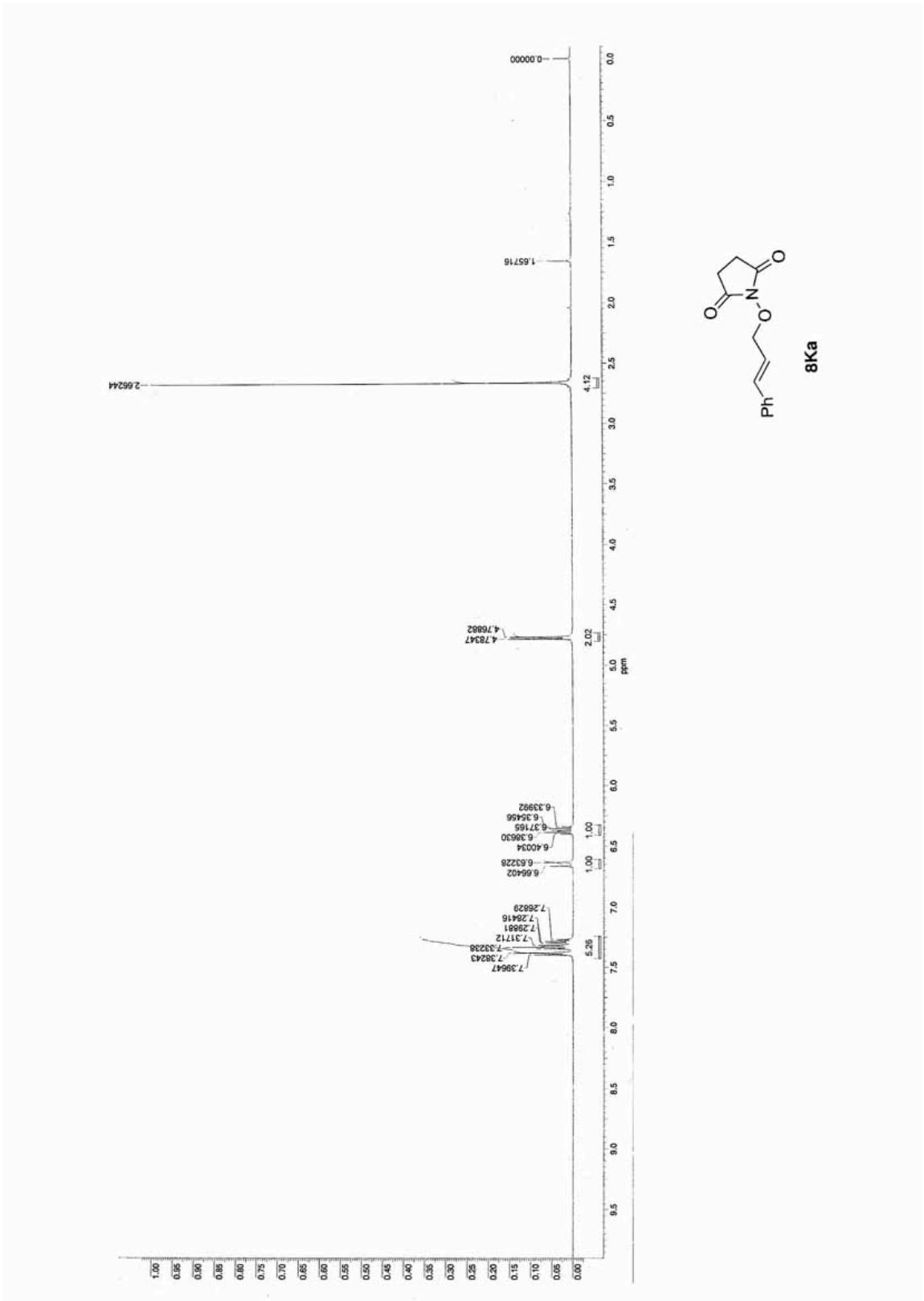
122.03865
78.60551
77.24699
76.99999
76.74476
ppm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6.63228
6.66402
7.26829
7.28416
7.29881
7.31712
7.33238
7.36243
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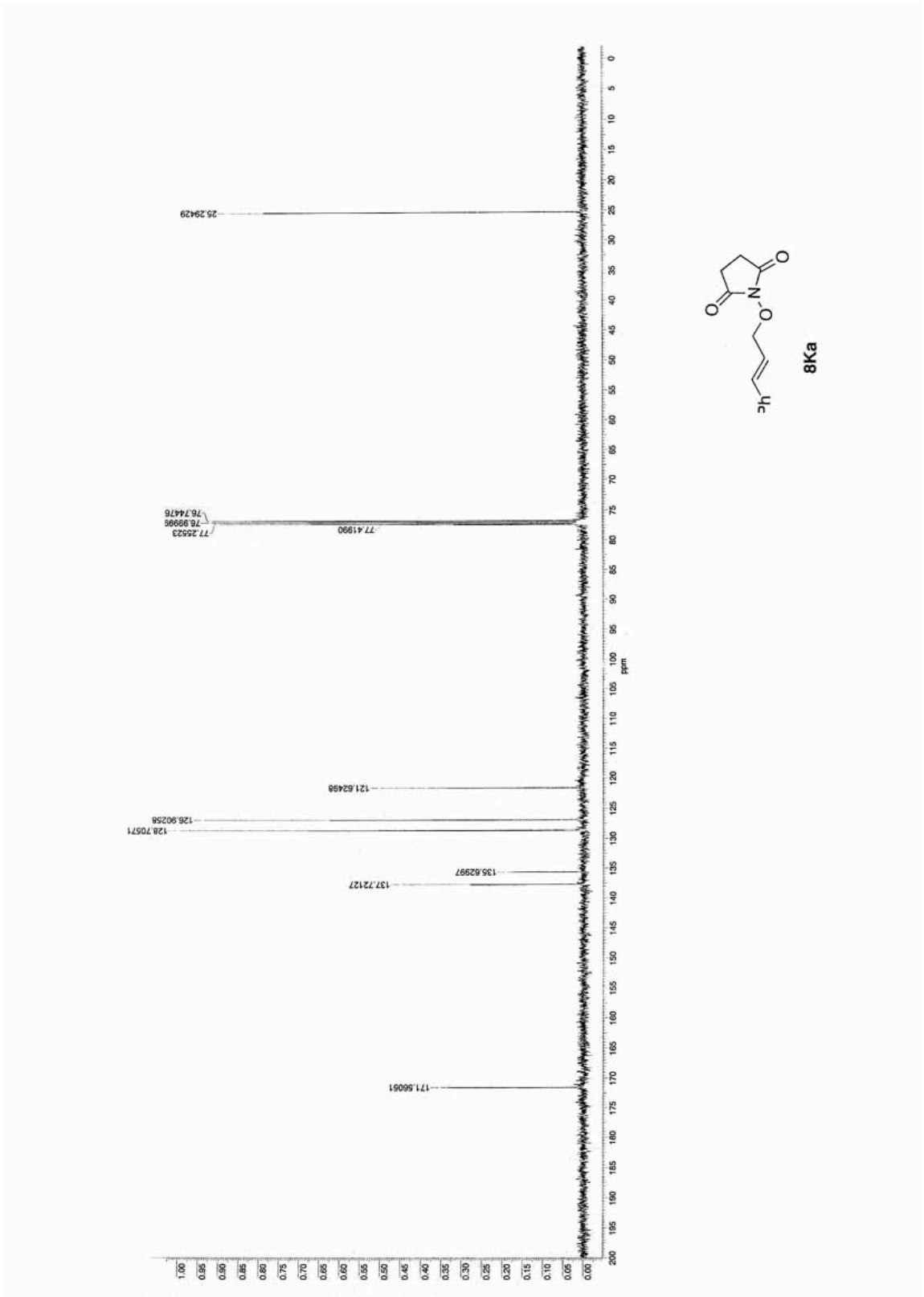
4.12
2.02
1.00
1.00
5.26
ppm
O
O
N
O
Ph
8Ka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76.74476
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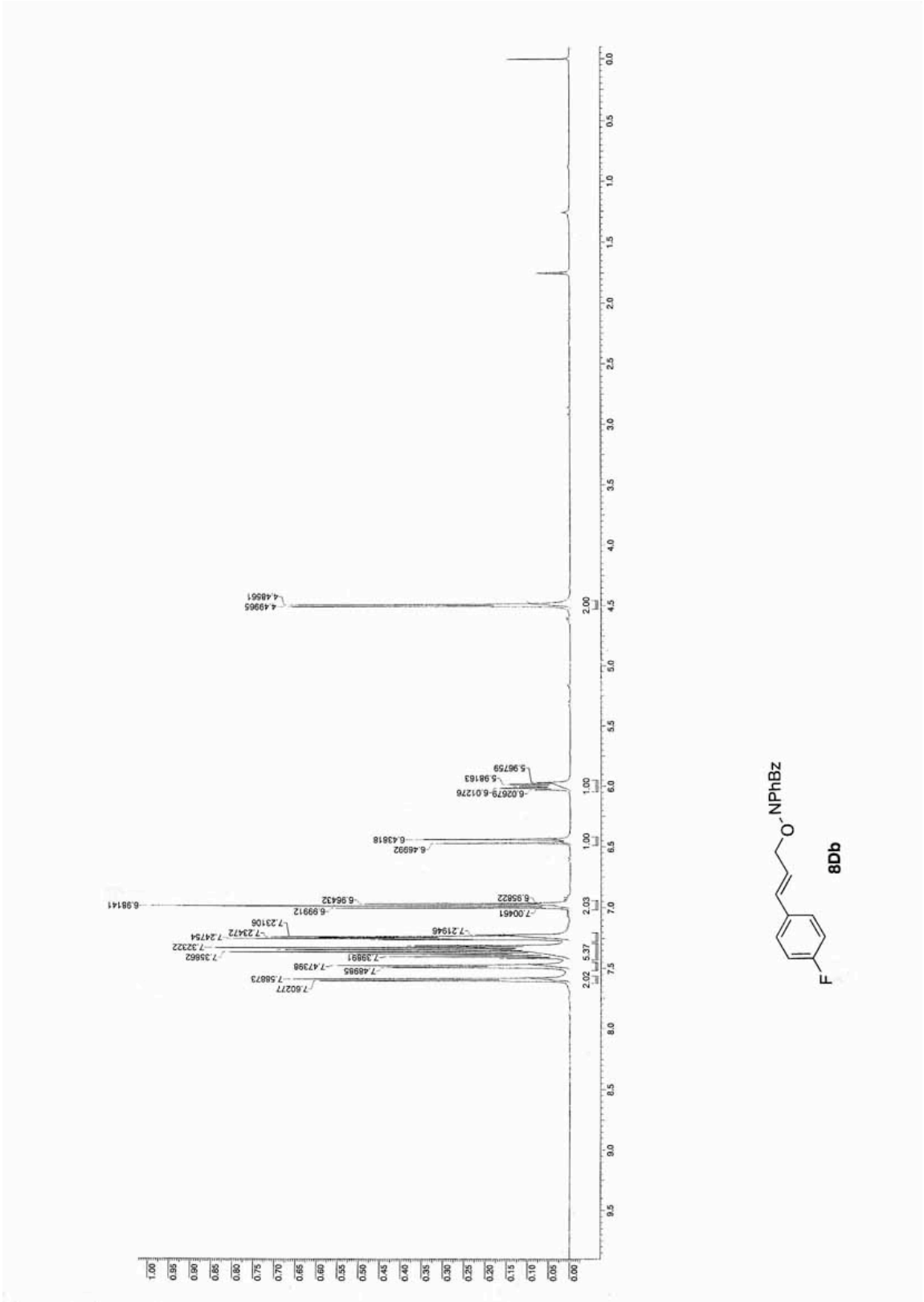
128.90258
128.70571
135.62997
137.72127
171.56061
ppm
8Ka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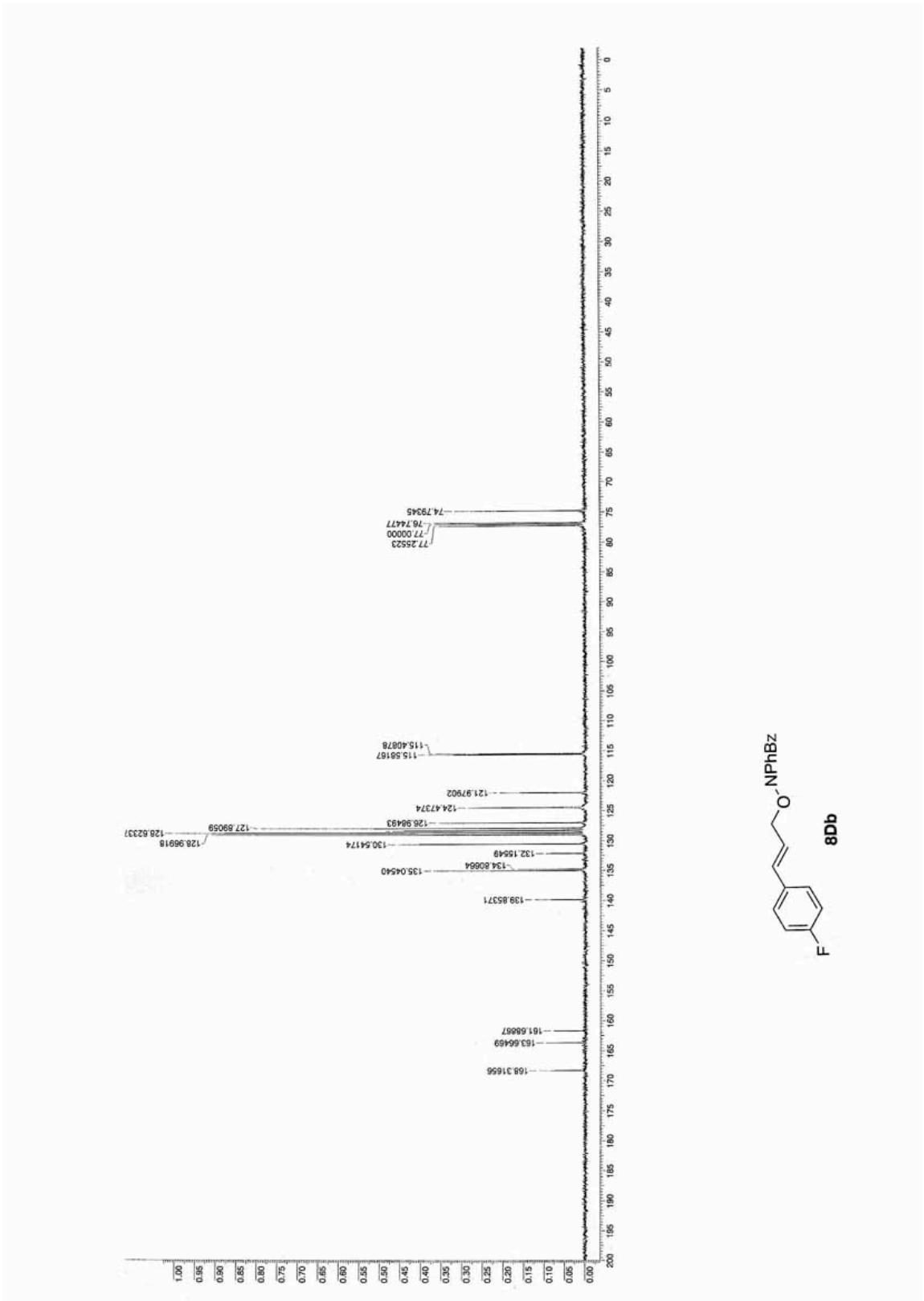
O
F
8Db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115.40878
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121.97902
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128.62337
128.98918
130.54174
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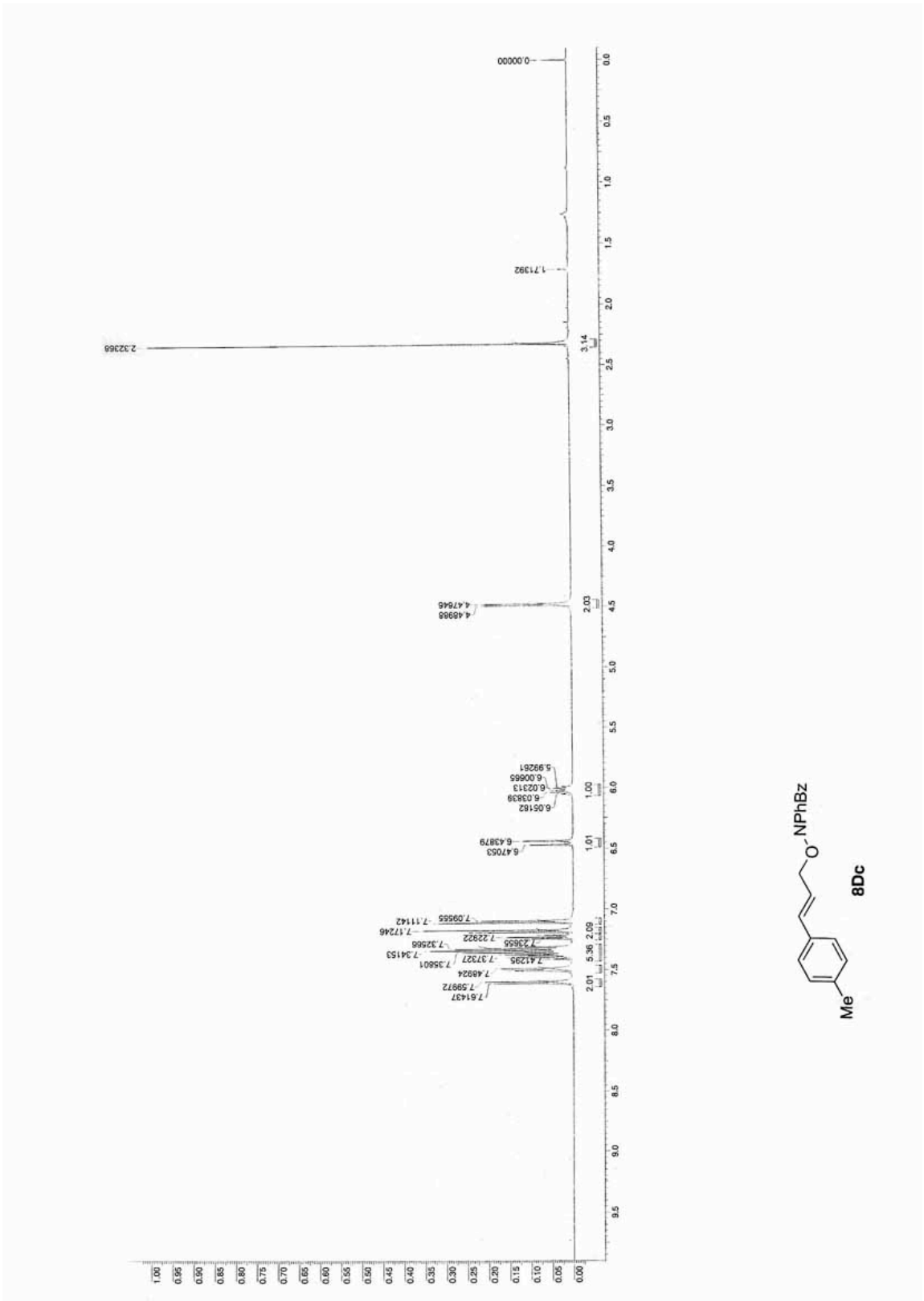
135.04540
139.85371
161.68667
163.66469
168.31656
O
NPhBz
F
8Db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1.71392
2.32366
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4.48986
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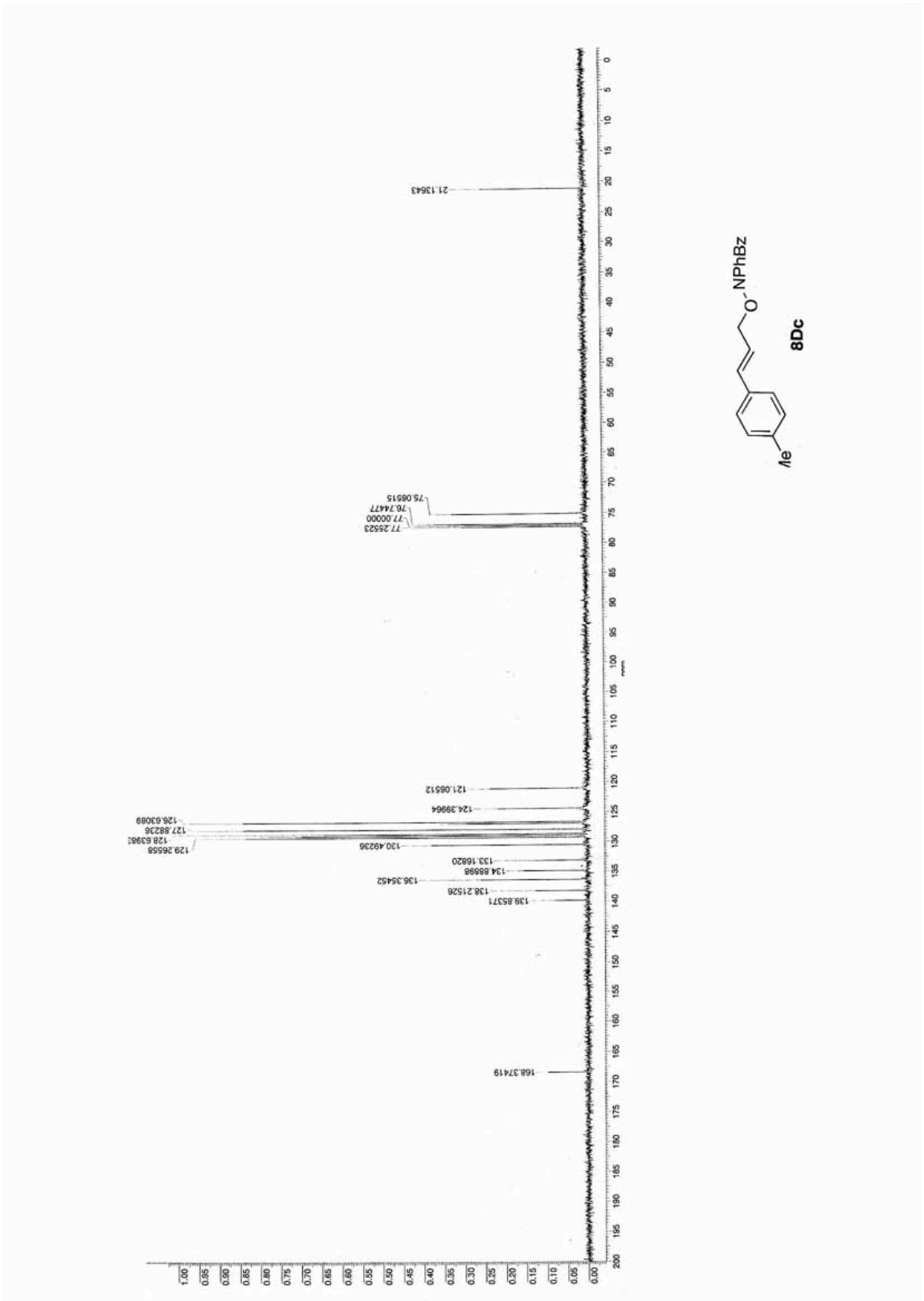
6.03839
6.02313
6.00665
5.99261
6.47053
6.43879
7.09555
7.11142
7.17246
7.22922
7.23655
7.32566
7.34153
7.37327
7.41295
7.35601
7.48024
7.59972
7.61437
3.14
2.03
1.00
1.01
2.09
5.36
2.01
NPhBz
Me
8Dc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77.00000
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139.85371
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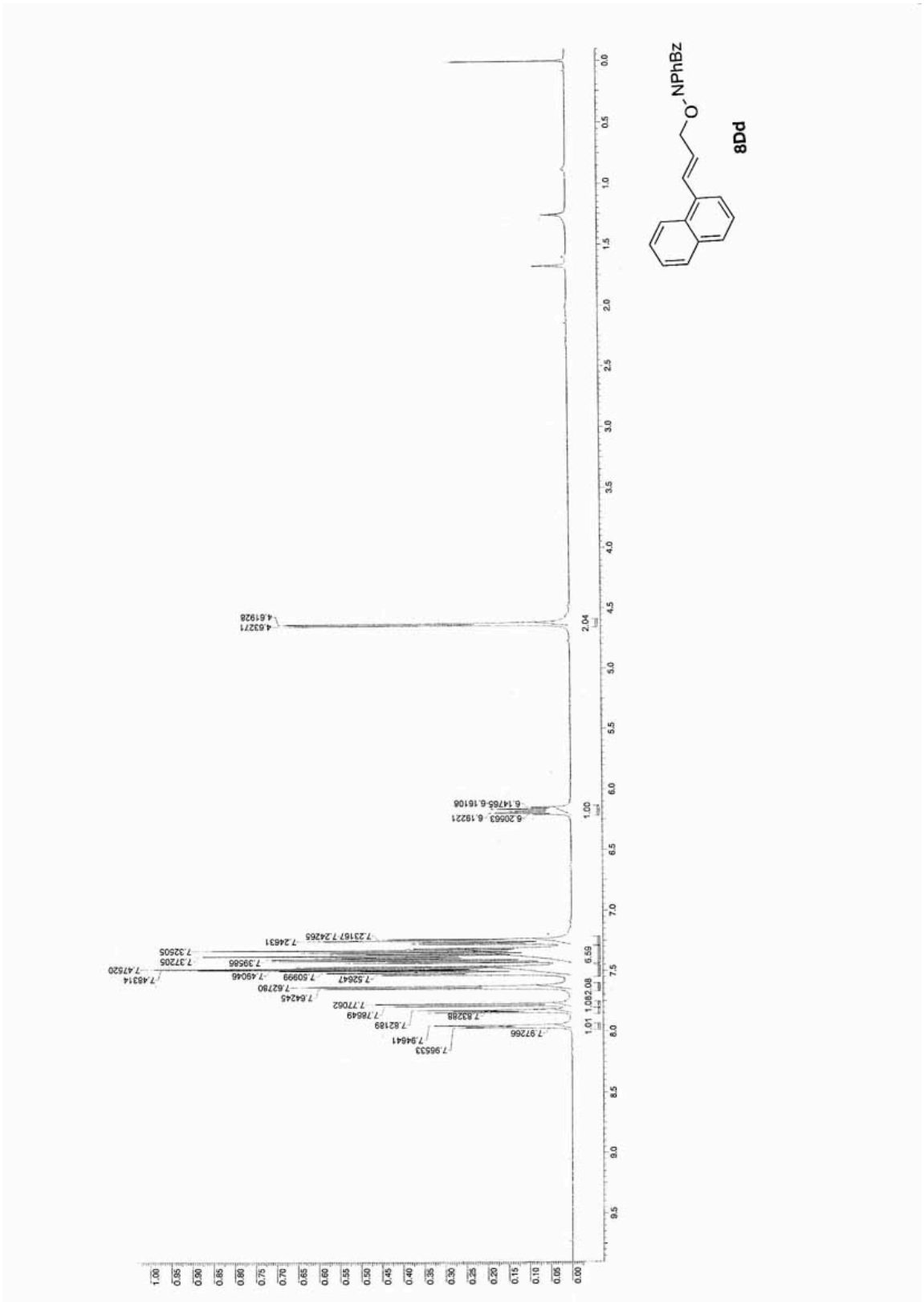
8Dc
Me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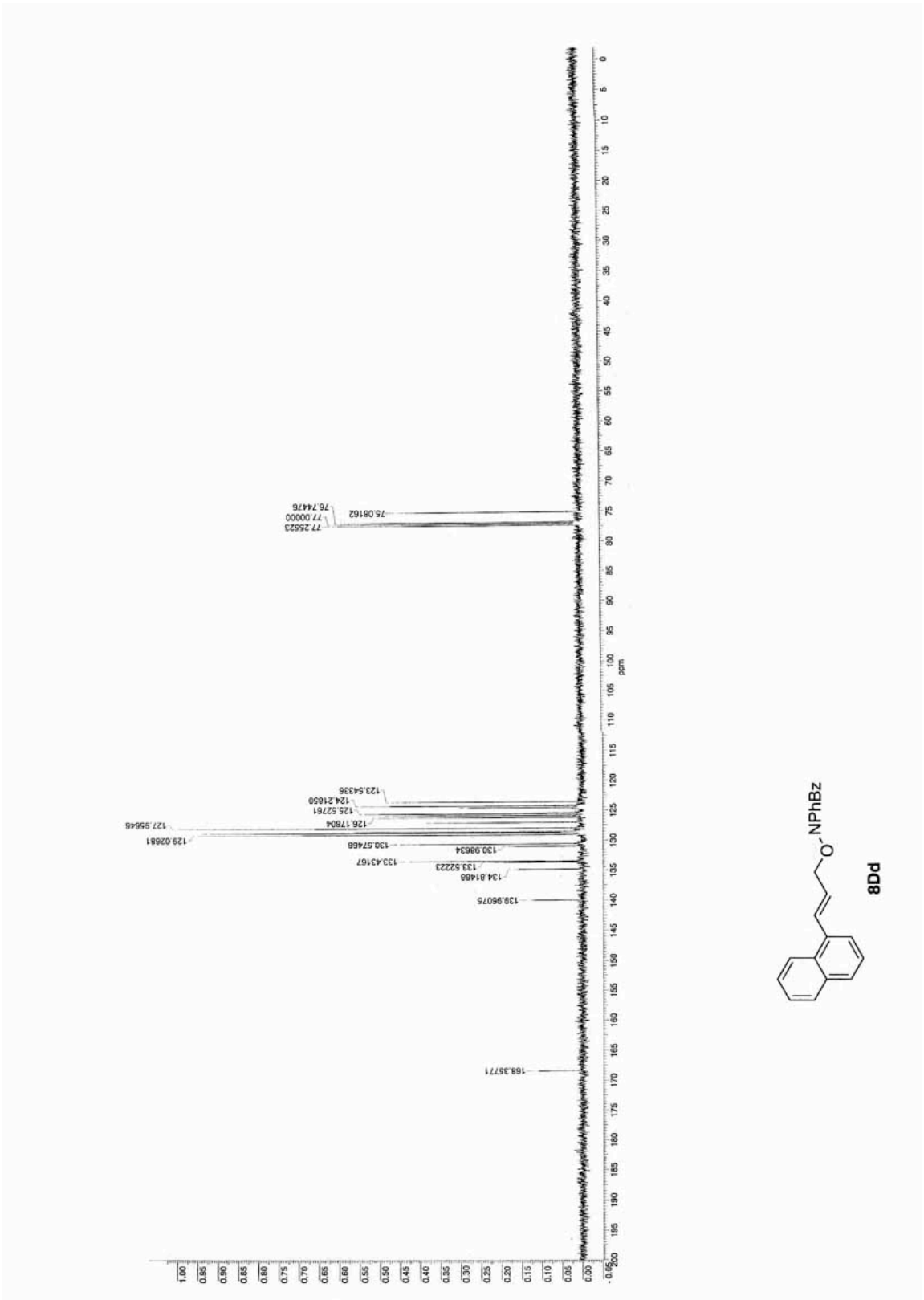
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133.4167
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130.5746
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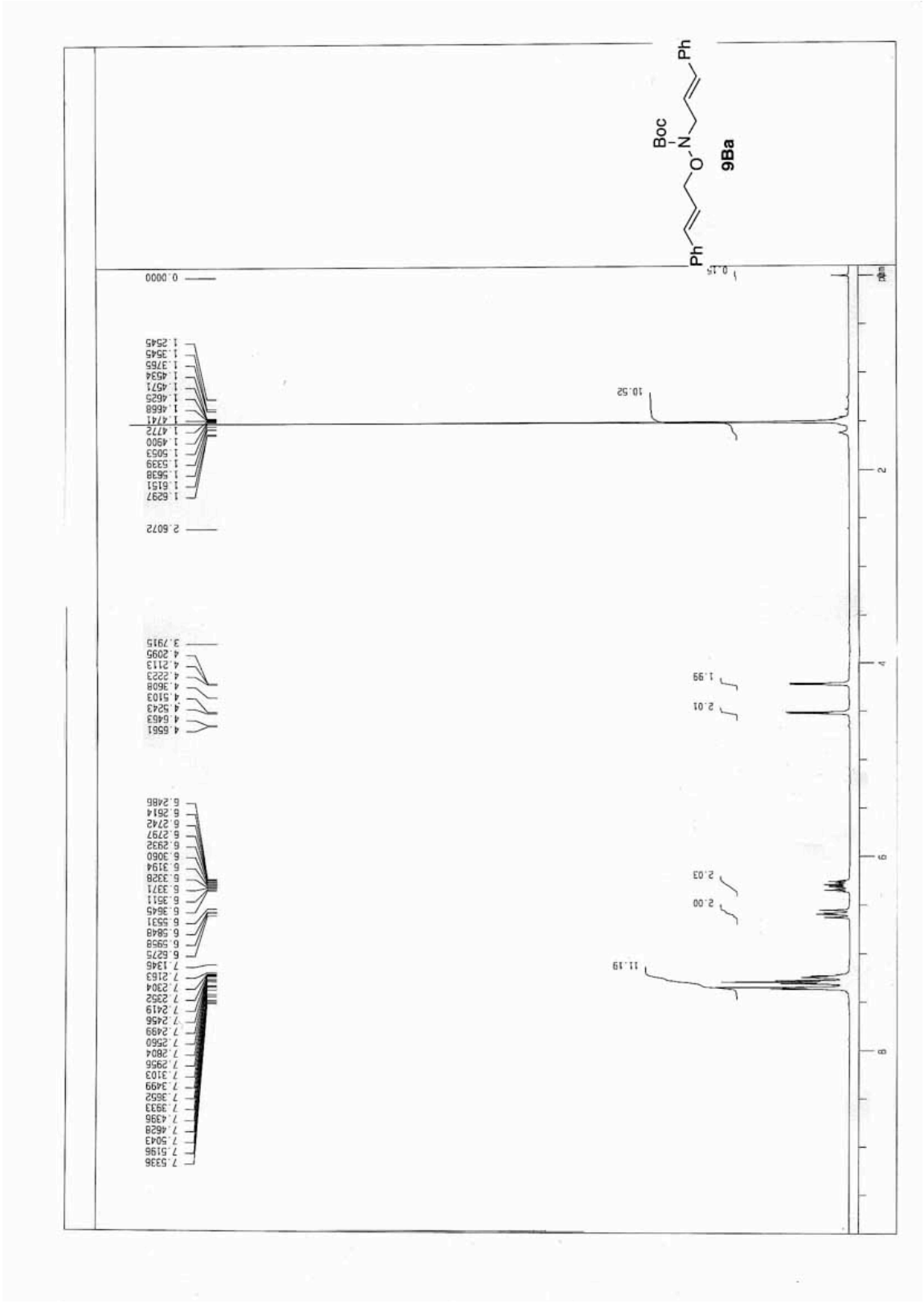
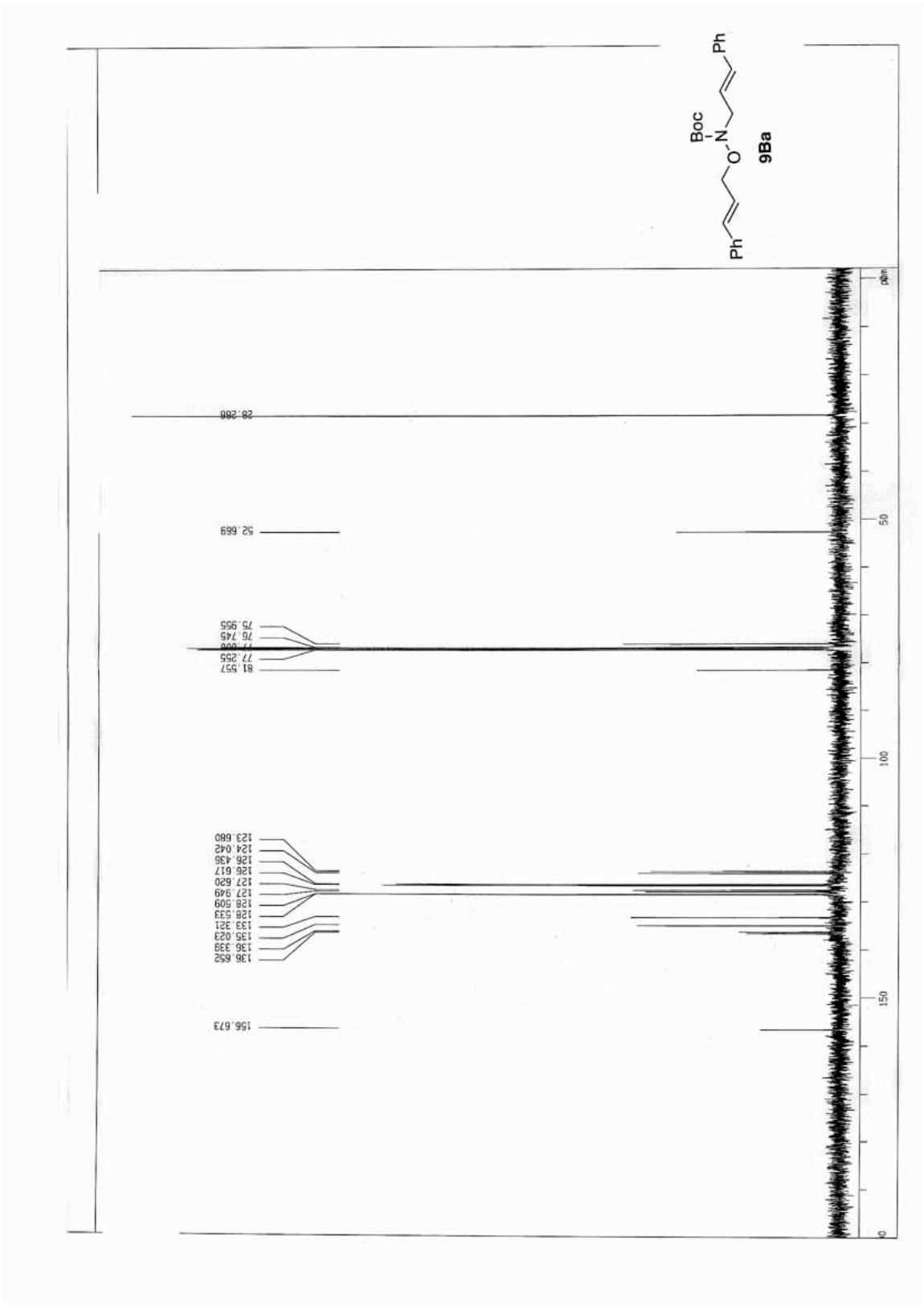
77.2552
77.0000
76.7447
75.0816
ppm
NPhBz
8Dd


Boc
N
O
Ph
Ph
9Ba


Ph
Boc
N
O
9Ba
Ph
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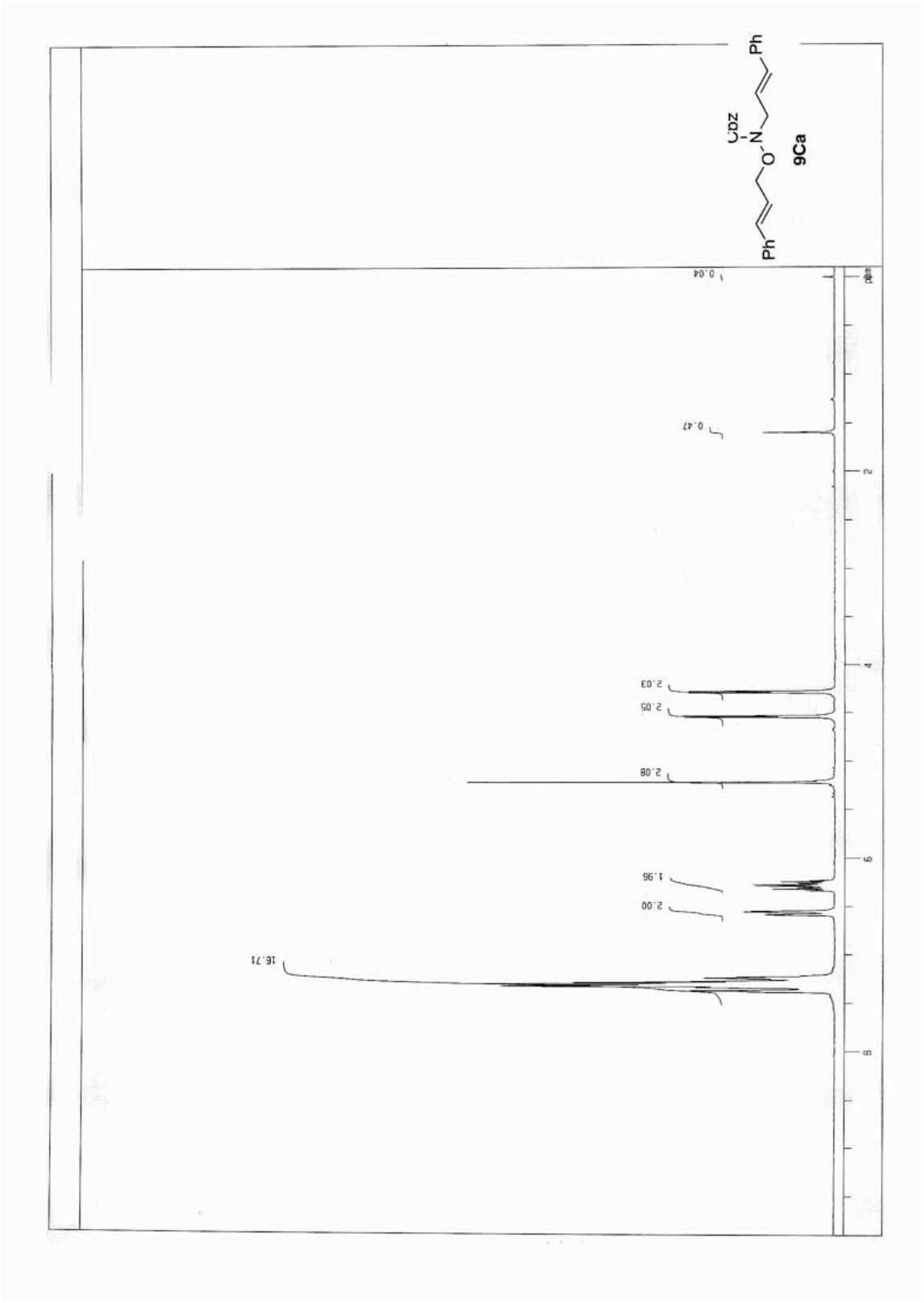
52.669
75.955
76.745
77.000
77.255
81.557
123.680
124.042
126.436
126.617
127.620
127.949
128.509
128.533
133.321
136.023
136.339
136.652
156.673
ppm
50
100
150


Ph
N
O
Ph
9Ca
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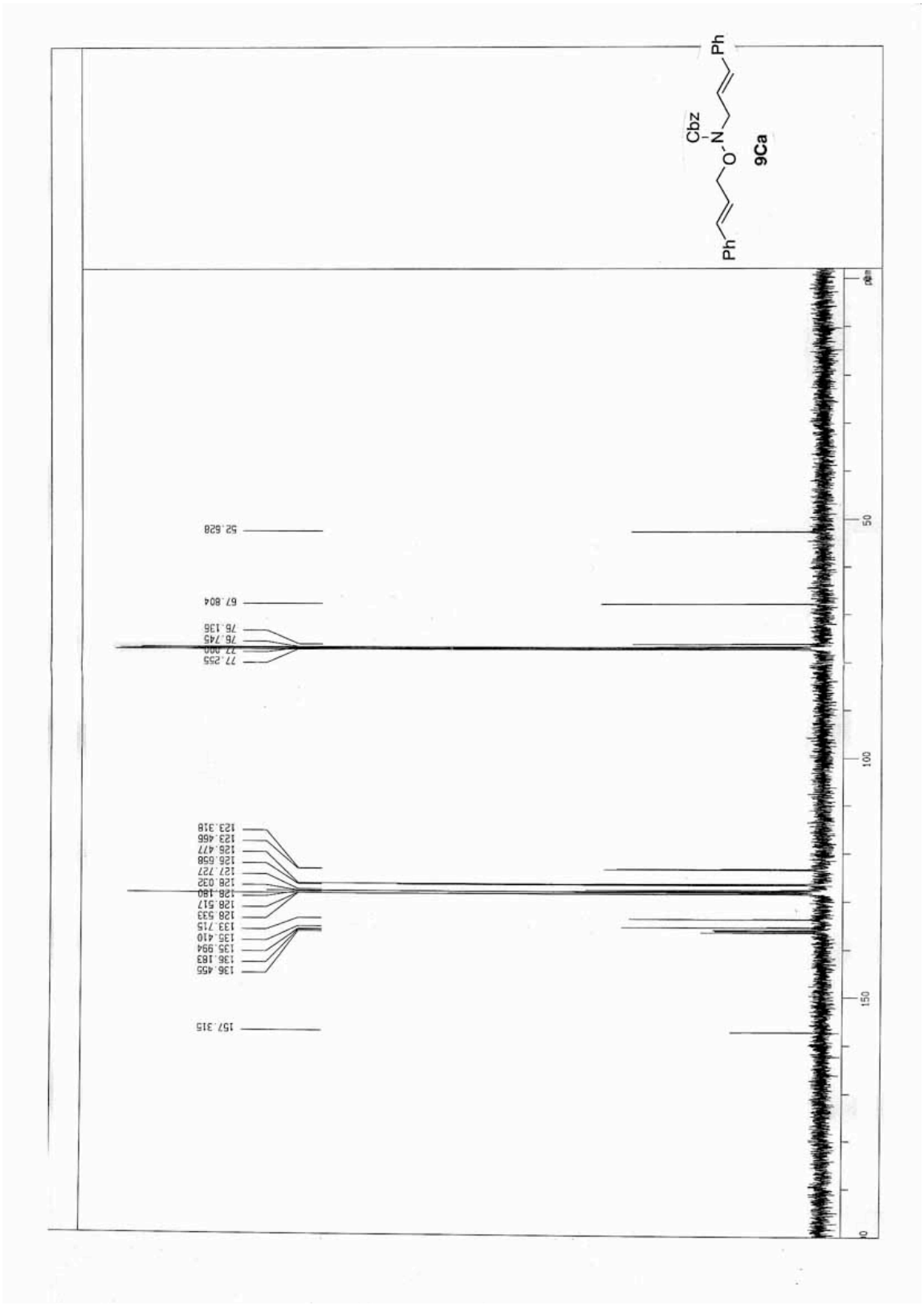
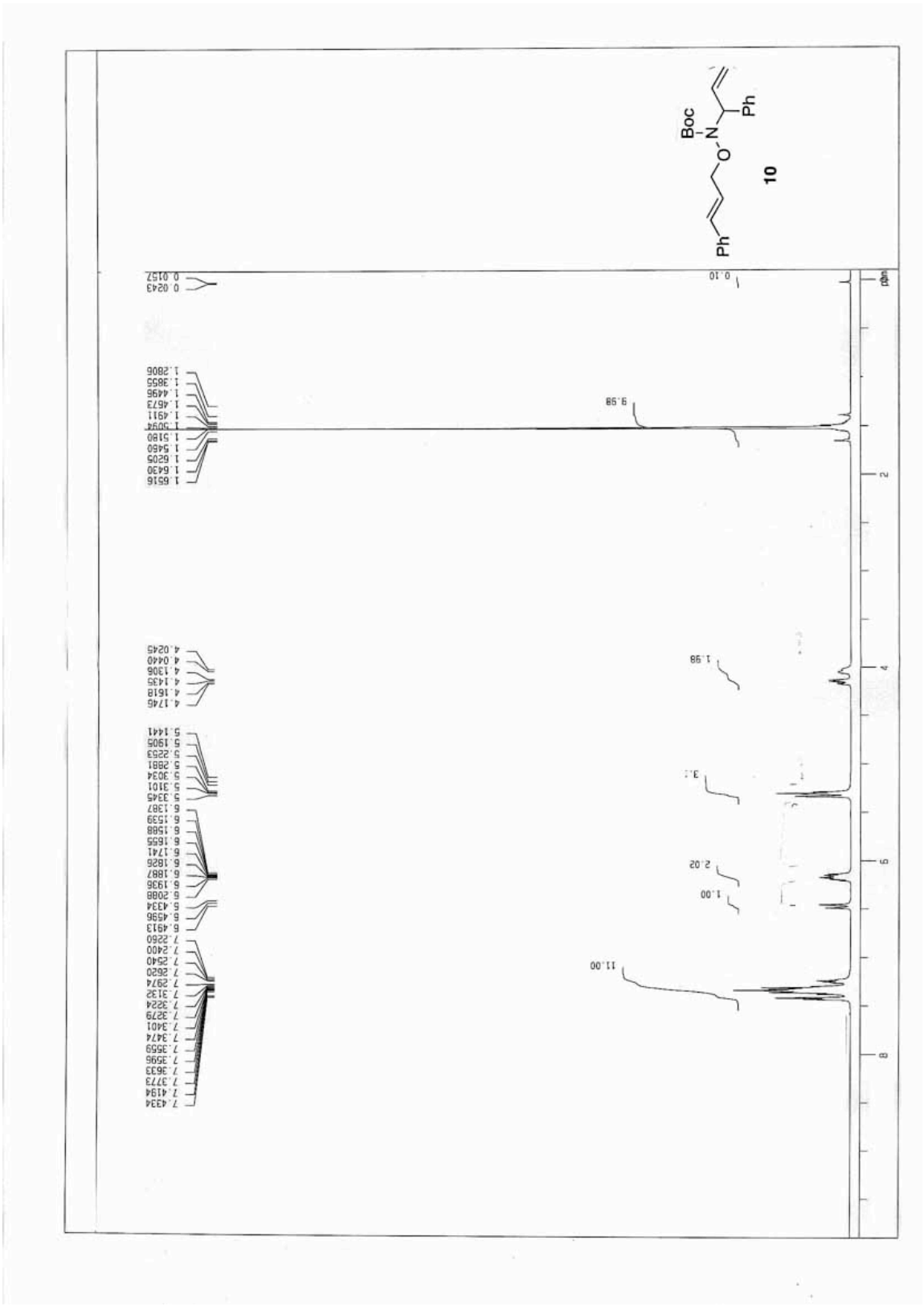
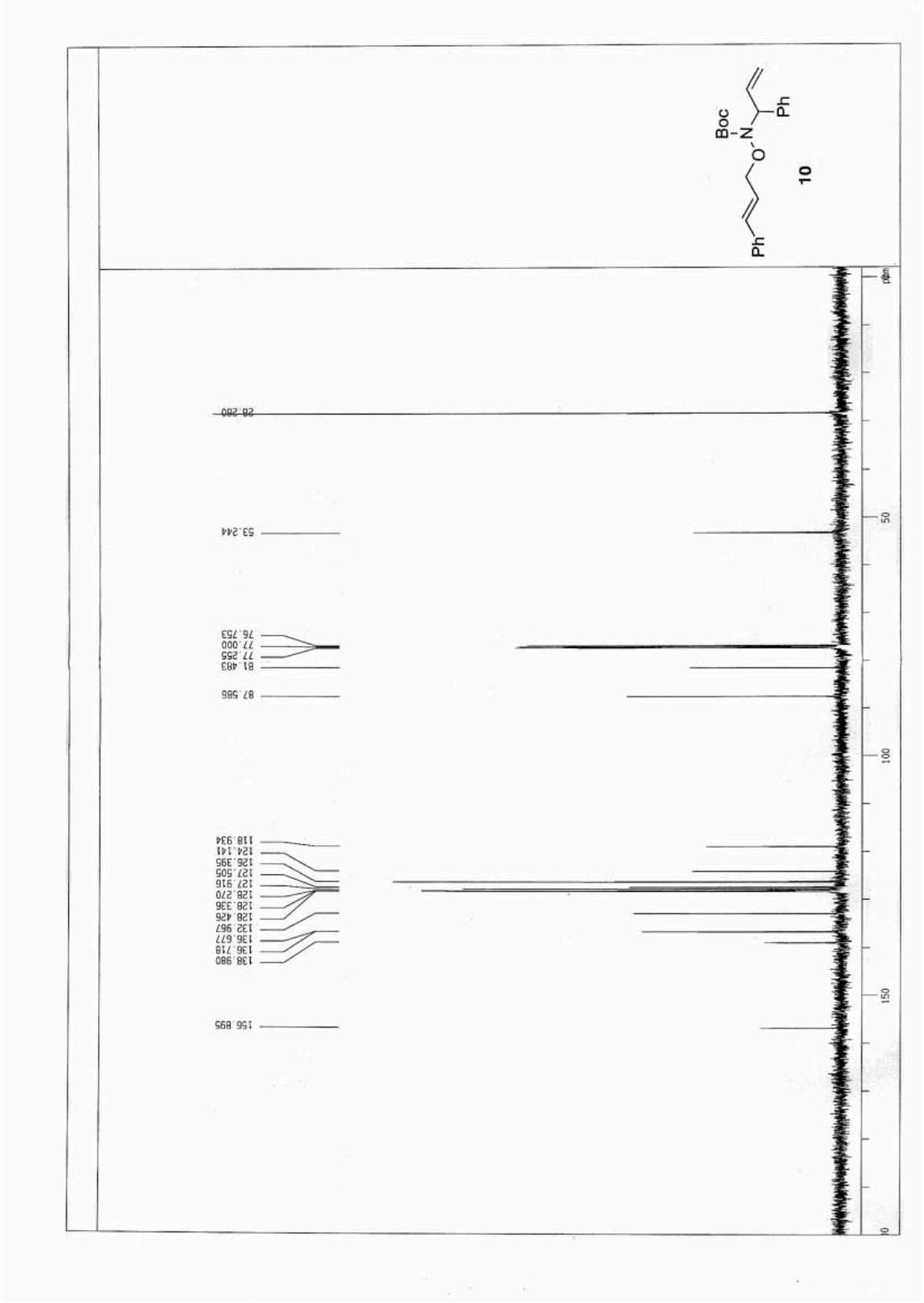
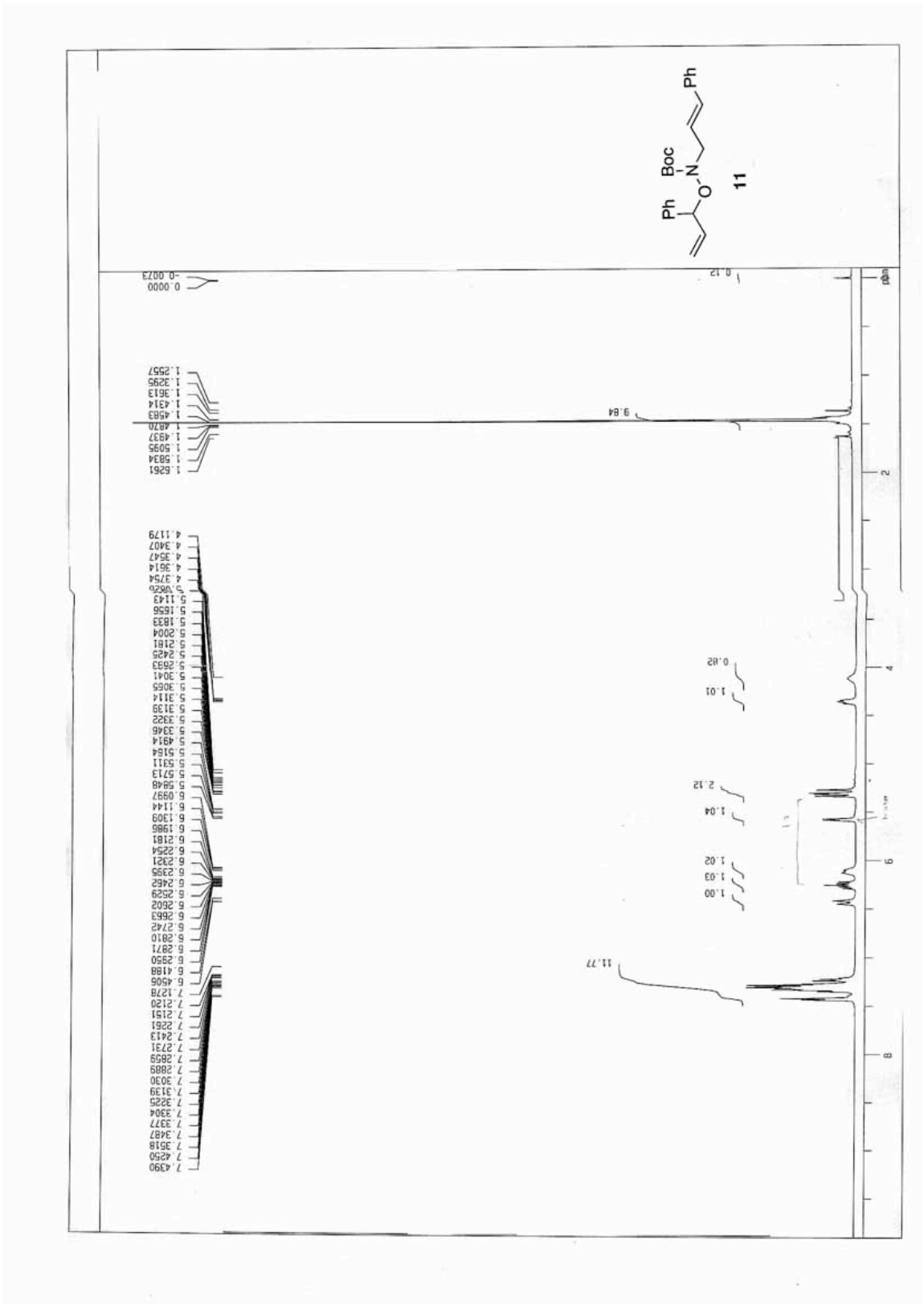
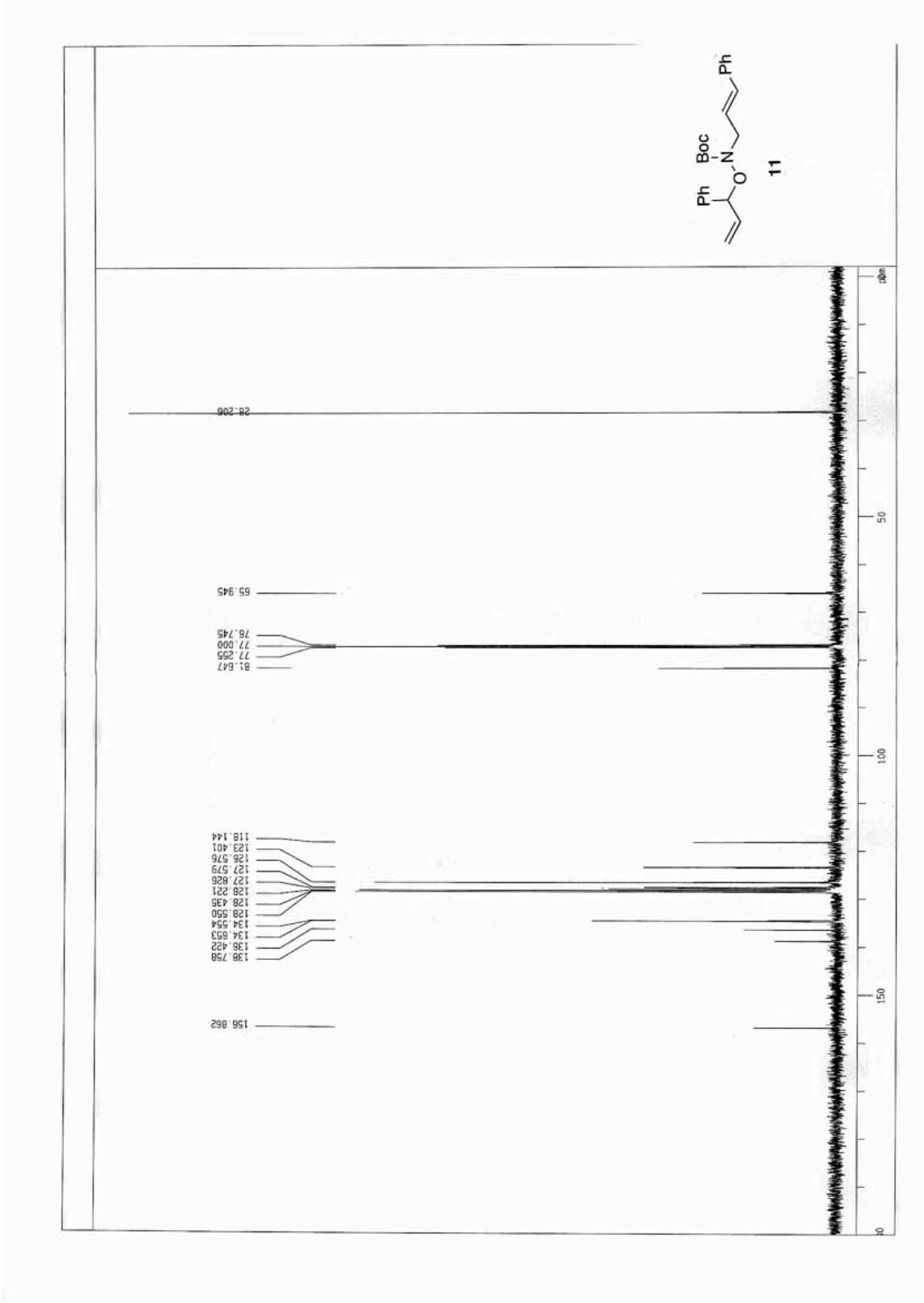
0.47
2.03
2.05
2.08
1.96
2.00
16.71
ppm

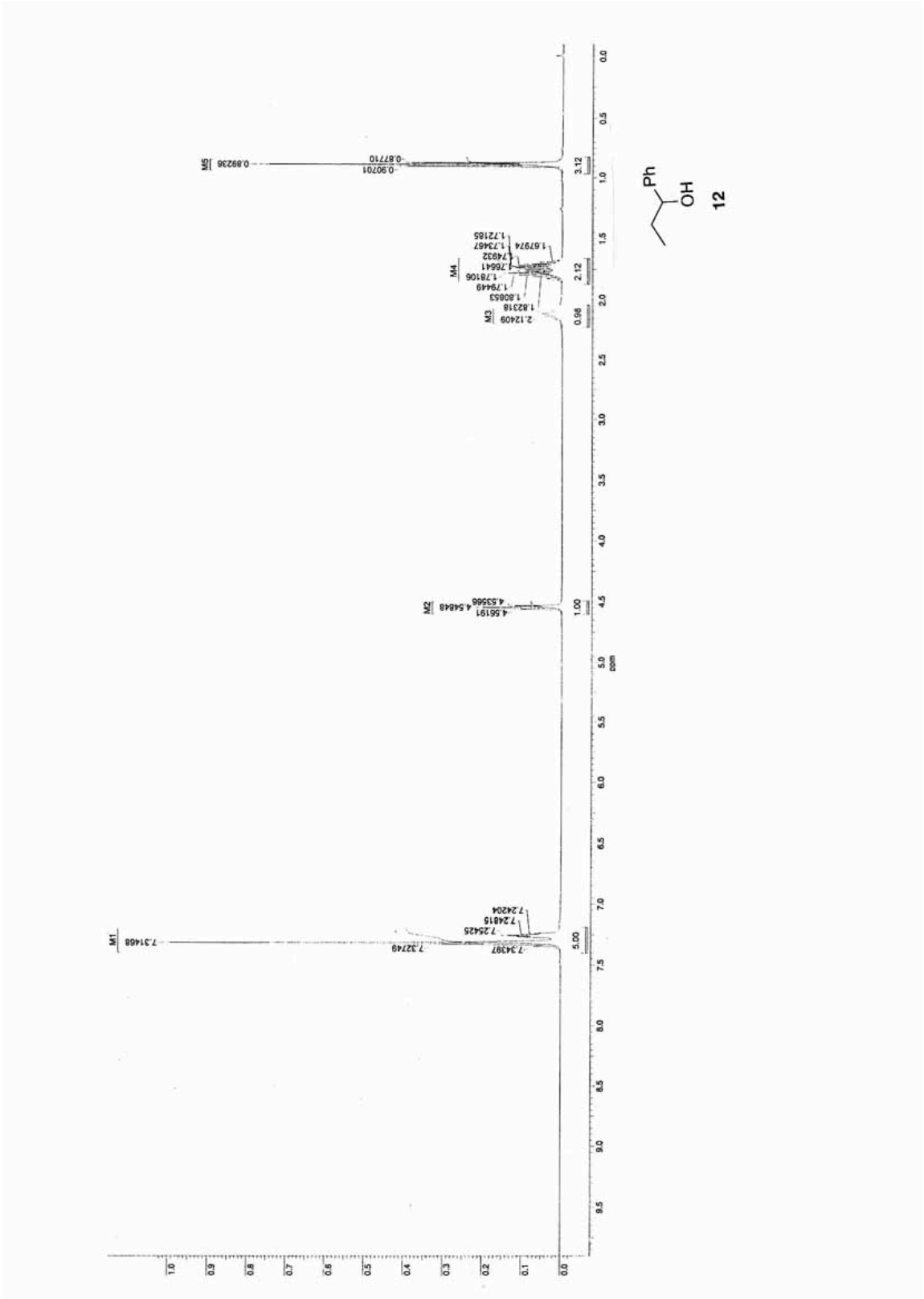

Ph
Cbz
N
O
Ph
9Ca
52.628
67.804
76.136
76.745
77.255
123.318
123.466
126.477
126.658
127.727
128.032
128.180
128.517
128.533
133.715
135.410
135.994
136.183
136.455
157.315
ppm
50
100
150
0

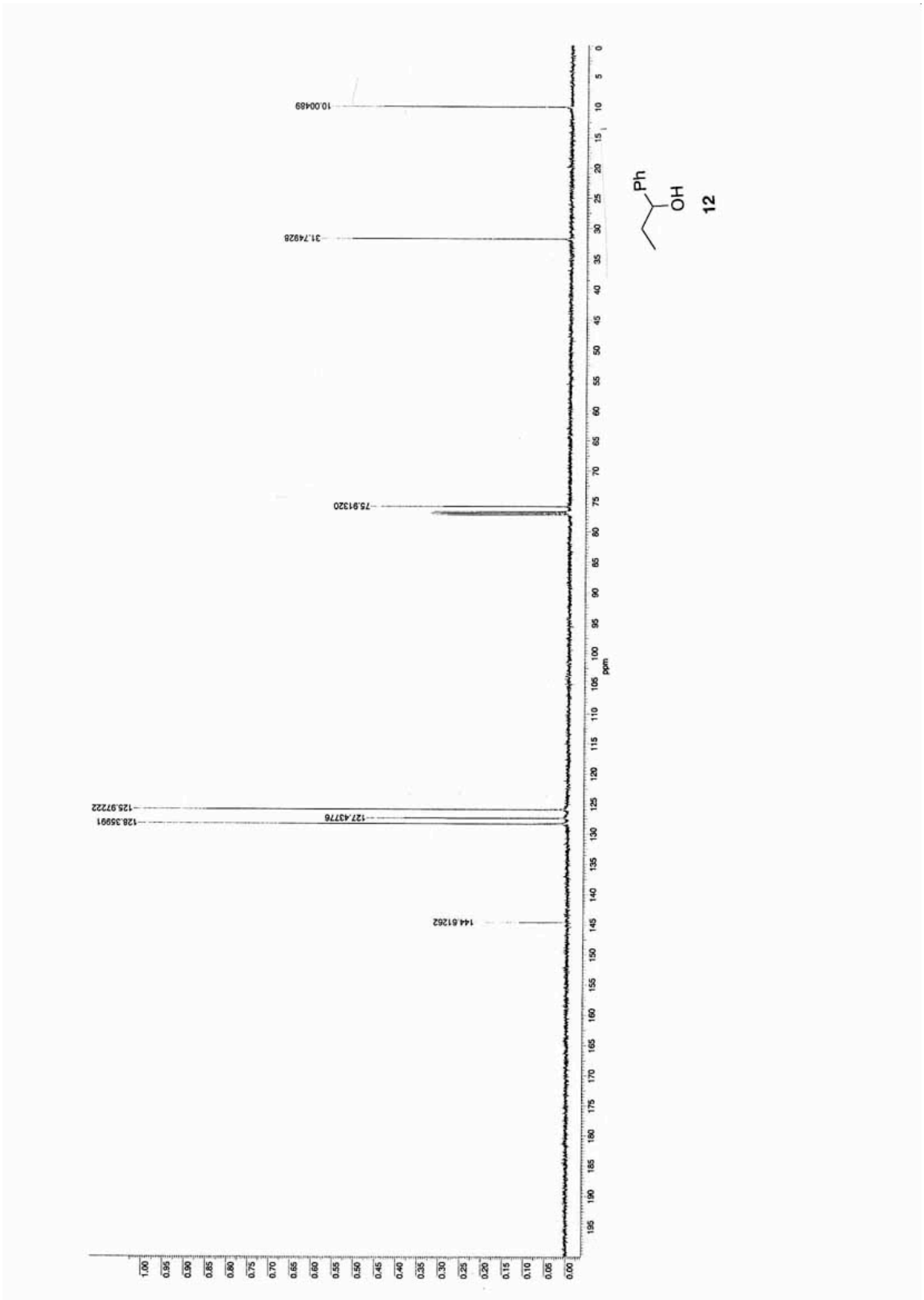

Boc
N
O
Ph
Ph
10


Boc
N
O
Ph
Ph
10
28.280
53.244
76.753
77.000
77.255
81.483
87.586
118.934
124.141
126.395
127.505
127.916
128.270
128.336
128.426
132.967
136.677
136.718
138.980
156.895
ppm
50
100
150


Ph
Boc
N
O
Ph
11


Ph
Boc
N
O
Ph
11
28.206
55.945
76.745
77.000
77.255
81.647
118.144
123.401
126.576
127.579
127.826
128.221
128.435
128.550
134.554
134.653
136.422
138.758
156.862
ppm
50
100
150


Ph
OH
12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31.74928
75.91320
125.97222
128.35991
127.43776
144.61262
Ph
OH
12
ppm