A Facile Approach to Highly Functional Trisubstituted Furans via Intramolecular Wittig Reactions

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Supplementary Information

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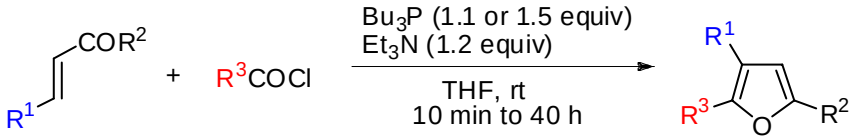
I. General Information: All reactions were carried out under a nitrogen atmosphere in dried glassware. All starting materials were purchased from commercial sources, and used without further purification. THF was continuously refluxed and freshly distilled from sodium benzophenone ketyl under nitrogen. Yields refer to isolated yields of compounds estimated to be > 95 % pure as determined by ^{1}H-NMR. Analytical thin layer chromatography (TLC) was performed using Merck 60 F254 precoated silica gel plate (0.2 mm thickness). Flash chromatography was performed using Merck silica gel 60. The temperature of our RT condition ranges from 27 to 30 ^{o}C. Majority of β-aryl-substituted α,β-unsaturated ketones are commercial available, except **2l**, **2n**, **2o**, **2p**, and **2r**, which are prepared according to the procedure of the reported literature[1].

II. Typical procedure for syntheses of furans 1 from 2 and acid chlorides 3 in the presence of Bu_3P and Et_3N. (TP for Tables 1-3, Schemes 2 and 4)



2 **3** (1.1 equiv) **1** (41-93% yield)

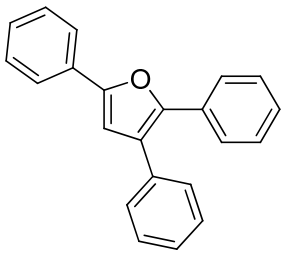
R^1 = aryl, CO_2Et or COPh
R^2 = aryl, alkyl or CO_2Et
R^3 = aryl or alkyl

A dry and nitrogen-flushed 10-mL Schlenk flask, equipped with a magnetic stirring bar and a septum, was charged with a solution of acid chloride **3 (**1.1 equiv) and Bu_3P (137.0 μL, 1.1 equiv) in dry THF (0.5 mL), A solution of **2** (0.5 mmol) in dry THF (2.0 mL) was added, which was followed by the addition of Et_3N (84.0 μL, 1.2 equiv). The reaction mixture was stirred for the indicated time at room temperature. Thereafter, the solvent was removed by evaporation *in vacuo*. Purification by flash chromatography furnished **1**.

III. Spectra data of compounds 1, 2 and 8:

Synthesis of 2,3,5-triphenylfuran (1aa)[2]:

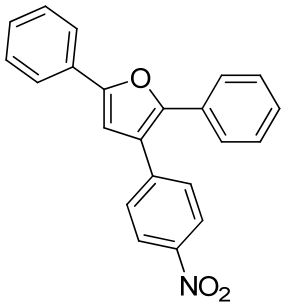
[1] Choudary, B. M.; Kantam, M. L.; Ranganath, K. V. S.; Mahendar, K.; Sreedhar, B. *J. Am. Chem. Soc.* **2004** , 126, 3396-3397
[2] Dudnik, Alexander S.; Gevorgyan, Vladimir. *Angew. Chem., Int. Ed.* **2007**, 46, 5195-5197



Prepared according to **TP** from **2a** (104.3 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 30 min]. Purification by *flash*-chromatography (hexanes; R_f : 0.56) yielded **1aa** as white solids (112.4 mg, 76%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.77 (d, 2H, J = 7.7Hz), 7.61 (d, 2H, J = 7.3Hz), 7.50-7.26 (m, 11H), 6.82 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.5, 147.9, 134.27, 131.1, 130.5, 128.8, 128.7, 128.6, 127.5, 127.4, 127.3, 126.1, 124.5, 123.8, 109.4.
MS (20 eV, EI) *m/z* (%): 296 $[M]^+$ (100).

Synthesis of 3-(4-nitrophenyl)-2,5-diphenylfuran (1ba):

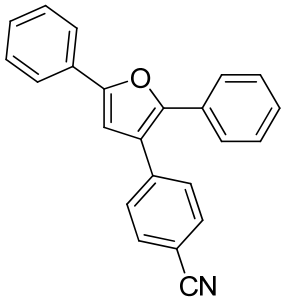


Prepared according to **TP** from **2b** (126.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.41) yielded **1ba** as yellow solids (139.0 mg, 82%).

mp.: 126.5-126.7 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.23 (d, 2H, *J* = 8.8 Hz), 7.81-7.74 (m, 2H), 7.64-7.54 (m, 4H), 7.44 (t, 2H, *J* = 8.0 Hz), 7.40-7.30 (m, 4H), 6.84 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.4, 149.3, 146.7, 141.1, 130.2, 129.9, 129.0, 128.8, 128.6, 128.4, 127.9, 126.6, 123.9, 123.8, 122.2, 108.2.

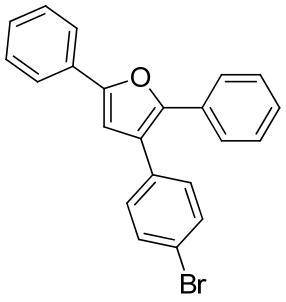
MS (20 eV, EI) *m/z* (%): 342 $[M+1]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3062 (w), 1598 (m), 1517 (s), 1344 (s).
HRMS (ESI) for **$C_{22}H_{16}NO_3$**, **$[M+H]^+$** (342.1130) found: 342.1133.

Synthesis of 4-(2,5-diphenylfuran-3-yl)benzonitrile (1ca)[3]:



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ ethyl acetate: 40/1; R_f : 0.41) yielded **1ca** as white solids (149.4 mg, 93%).
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.79-7.74 (m, 2H), 7.65 (d, 2H, J = 8.4 Hz), 7.57 (d, 4H, J = 4.2 Hz), 7.42 (t, 2H, J = 7.8 Hz), 7.40-7.29 (m, 4H), 6.82 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.3, 149.0, 139.1, 132.4, 130.3, 130.0, 129.0, 128.8, 128.6, 128.3, 127.9, 126.5, 123.8, 122.6, 118.8, 110.7, 108.2.
MS (20 eV, EI) *m/z* (%): 321$[M]^+$ (100).

Synthesis of 3-(4-bromophenyl)-2,5-diphenylfuran (1da):



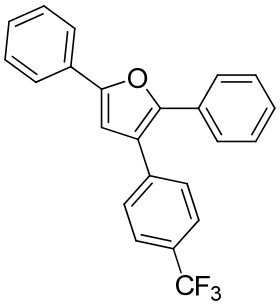
Prepared according to **TP** from **2d** (143.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction

[3] Braun, R. U.; Mueller, T. J. J. *Synthesis* **2004** , 2391-2406.

condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes; R_f : 0.58) yielded **1da** as white solids (136.5 mg, 73%).

mp.: 127.3-127.5 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.78 (d, 2H, J = 7.6 Hz), 7.62 (d, 2H, J = 7.3 Hz), 7.53 (d, 2H, J = 8.4 Hz), 7.45 (d, 2H, J = 7.6 Hz), 7.40-7.27 (m, 6H), 6.80 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.8, 148.0, 133.2, 131.8, 130.8, 130.3, 130.2, 128.7, 128.5, 127.7, 127.6, 126.2, 123.8, 123.2, 121.2, 108.9.
MS (20 eV, EI) *m/z* (%): 376 $[M+2]^+$ (100), 374 (64).
IR (KBr) $\tilde{\nu}$ (cm^{-1}): 3055 (m), 3033 (m), 1547 (m), 1488 (s), 691 (m), 595 (m).
HRMS (ESI) for **$C_{22}H_{16}BrO$**, **$[M+H]^+$** (375.0385) found: 375.0380.

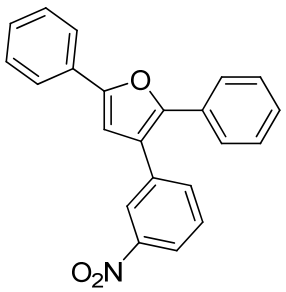
Synthesis of 2,5-diphenyl-3-(4-(trifluoromethyl)phenyl)furan (1ea):



Prepared according to **TP** from **2e** (138.1 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes; R_f : 0.40) yielded **1ea** as white solid (152.1 mg, 93%).

mp.: 103.1-103.9 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.79 (d, 2H, J = 7.6 Hz), 7.70-7.55 (m, 6H), 7.45 (t, 2H, J = 7.5 Hz), 7.41-7.29 (m, 4H), 6.84 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.1, 148.6, 138.1, 130.6, 130.2, 129.4 (quartet, J = 32.0 Hz), 128.8, 128.7, 128.6, 128.0, 127.8, 126.4, 125.6 (quartet, J = 4.0 Hz), 124.2 (quartet, J = 270.0 Hz), 123.9, 123.0, 108.8.
MS (20 eV, EI) *m/z* (%): 364 $[M]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3063 (w), 1617 (w), 1594 (w), 1495 (m), 1325 (s), 1167 (m), 1123 (m), 1067 (s).
HRMS (ESI) for **$C_{23}H_{16}F_3O$**, **$[M+H]^+$** (365.1153) found: 365.1156.

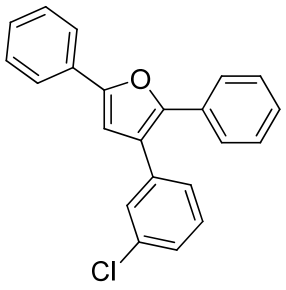
Synthesis of 3-(3-nitrophenyl)-2,5-diphenylfuran (1fa):



Prepared according to **TP** from **2f** (126.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.38) yielded **1fa** as yellow solid (143.5 mg, 84%).

mp.: 126.6-126.8 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.36-8.34 (m, 1H), 8.21-8.15 (m, 1H), 7.81-7.75 (m, 3H), 7.60-7.50 (m, 3H), 7.44 (t, 2H, J = 7.3 Hz), 7.39-7.29 (m, 4H), 6.86 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.2, 148.8, 148.5, 136.0, 134.5, 130.2, 130.0, 129.5, 128.7, 128.6, 128.2, 127.8, 126.3, 123.8, 123.2, 122.0, 121.9, 108.4.
MS (20 eV, EI) *m/z* (%): 341 $[M]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3055 (w), 1528 (s), 1488 (m), 1440 (w), 1351 (s).
HRMS (EI) for **$C_{22}H_{16}NO_3$**, **$[M+H]^+$** (342.1130) found: 342.1139.

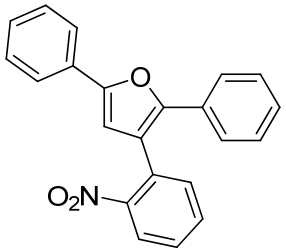
Synthesis of 3-(3-chlorophenyl)-2,5-diphenylfuran (1ga):



Prepared according to **TP** from **2g** (121.4 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes; R_f : 0.5) yielded **1ga** as yellow oil (128.8 mg, 78%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.69 (d, 2H, J = 7.4 Hz), 7.55-7.50 (m, 2H), 7.40 (s, 1H), 7.35 (t, 2H, J = 7.7 Hz), 7.30-7.16 (m, 7H), 6.72 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.8, 148.3, 136.2, 134.5, 130.7, 130.3, 129.9, 128.8, 128.6, 128.5, 127.8, 127.7, 127.4, 126.9, 126.2, 123.8, 128.1, 109,0.
MS (20 eV, EI) *m/z* (%): 333[(M+2)+1]$^+$ (15), 331 [M+1]$^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3055 (w), 1591 (m), 1561 (m), 1488 (s), 1148 (s), 765 (s), 695 (s).
HRMS (EI) for **$C_{22}H_{15}ClO$**, **[M]$^+$** (330.0811) found: 330.0811.

Synthesis of 3-(2-nitrophenyl)-2,5-diphenylfuran (1ha):

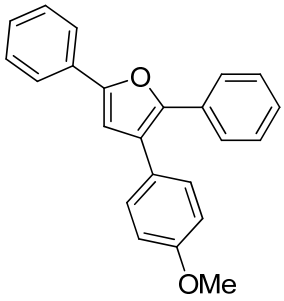


Prepared according to **TP** from **2h** (126.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 60 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.24) yielded **1ha** as orange solid (119.1 mg, 70%).

mp.: 127.0-127.5 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.99 (d, 1H, J = 8.0 Hz), 7.76 (d, 2H, J = 7.4 Hz), 7.63-7.50 (m, 2H), 7.50-7.39 (m, 5H), 7.35-7.21 (m, 4H), 6.71 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.8, 149.5, 148.7, 132.8, 130.1, 129.2, 128.8, 128.7, 128.5, 127.8, 127.7, 125.5, 124.5, 123.9, 119.3, 109.1.
MS (20 eV, EI) *m/z* (%): 342 [M+1]$^+$ (32), 105 (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3063 (w), 1524 (s), 1488 (m), 1457(m), 1347 (m).
HRMS (EI) for **$C_{22}H_{16}NO_3$**, **[M+H]$^+$** (342.1130) found: 342.1139.

Synthesis of 3-(4-methoxyphenyl)-2,5-diphenylfuran[4] (1ia):

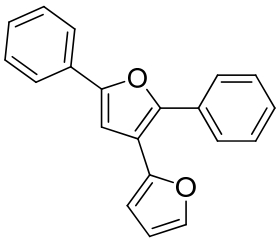
[4] Gopidas, K. R.; Cyr, D. R.; Das, P. K.; George, M. V. *J. Org. Chem.* **1987** , 52, 5505 - 5511



Prepared according to **TP** from **1ia** (119.1 mg, 0.5 mmol), Bu_3P (187.0 µL, 1.5 equiv), Et_3N (90.6 µL, 1.3 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 2 h]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.44) yielded **2ia** as yellow oil (67.1 mg, 41%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.79-7.74 (m, 2H), 7.65-7.61 (m, 2H), 7.45-7.21(m, 8H), 6.96-6.90 (m, 2H), 6.78 (s, 1H), 3.84 (s, 3H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 158.9, 152.4, 147.5, 131.2, 130.6, 129.8, 128.7, 128.4, 127.4, 127.3, 126.6, 126.0, 124.2, 123.8, 114.1, 109.6, 55.2.
MS (20 eV, EI) *m/z* (%): 327 $[M+1]^+$ (100), 312 (11), 221 (9), 105 (11).

Synthesis of 2',5'-diphenyl-2,3'-bifuran (1ja):

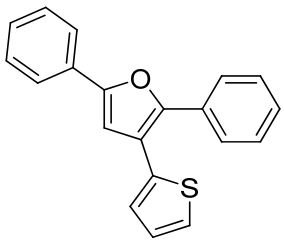


Prepared according to **TP** from **2j** (99.8 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (63.8 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes; R_f : 0.30) yielded **1ja** as red solid (86.4 mg, 60%).

mp.: 70.8-72.4 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.87(d, 2H, J = 7.6 Hz), 7.81 (d, 2H, J = 7.6Hz), 7.55-7.42 (m, 5H), 7.42-7.30 (m, 2H), 6.99 (s, 1H), 6.58 (d, 1H, J = 3Hz), 6.54-6.47 (m, 1H).

^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.8, 148.3, 147.9, 141.5, 130.9, 130.2, 128.7, 128.4, 128.0, 127.7, 126.7, 123.9, 114.8, 111.2, 107.1, 107.0.
MS (20 eV, EI) *m/z* (%): 286 $[M]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3114 (w), 3055 (m), 3033 (w), 1606 (m), 1484 (s), 1359 (w), 1148 (s).
HRMS (EI) for **$C_{20}H_{14}O_2$**, **$[M]^+$** (286.0994) found: 286.0987

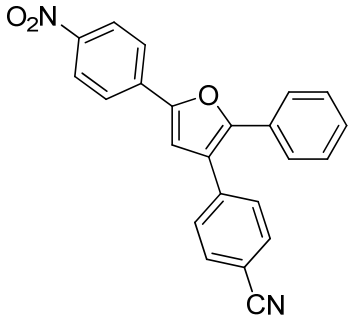
Synthesis of 2,5-diphenyl-3-(thiophen-2-yl)furan (1ka)[5]:



Prepared according to **TP** from **2k** (107.0 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 20 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.41) yielded **1ka** as yellow solid (103.0 mg, 68%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.78 (t, 4H, J = 7.5 Hz), 7.50-7.28 (m, 7H), 7.19 (d, 1H, J = 3.2 Hz), 7.13-7.06 (m, 1H), 6.86 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.5, 148.5, 135.5, 130.7, 130.2, 128.7, 128.4, 127.9, 127.7, 127.4, 126.4, 126.0, 125.1, 123.8, 117.5, 109.6.
MS (20 eV, EI) *m/z* (%): 302 $[M]^+$ (100).

Synthesis of 4-(5-(4-nitrophenyl)-2-phenylfuran-3-yl)benzonitrile (1la):

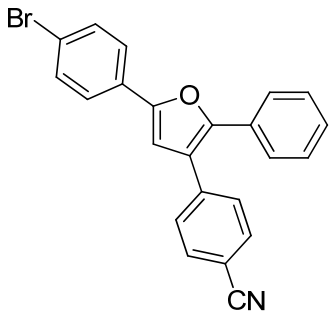


[5] Morrison, B. J.; Musgrave, Oliver C. *J. Chem. Soc., Perkin Trans. 1*, **2002**, 1944–1947.

Prepared according to **TP** from **2l** (139.1 mg, 0.5 mmol), Bu_3P (137.0 μL, 1.1 equiv), Et_3N (84.0 μL, 1.2 equiv), and **3a** (64.0 μL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 20/1; R_f : 0.50) yielded **1la** as yellow oil (100.9 mg, 55%).

mp.: 210.5-212.5 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.29 (d, 2H, J = 8.2 Hz), 7.87 (d, 2H, J = 8.6 Hz), 7.68 (d, 2H, J = 7.8 Hz), 7.56 (d, 4H, J = 7.4 Hz), 7.38 (s, 3H), 7.05 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 151.2, 150.9, 146.7, 138.3, 135.6, 132.6, 129.6, 129.1, 129.0, 128.8, 126.8, 124.4, 124.0, 123.2, 118.6, 112.1, 111.3.
MS (20 eV, EI) *m/z* (%): 367 $[M+1]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3107 (w), 2221 (m), 1598 (s), 1543 (m), 1510 (s), 1443 (m), 1333 (s), 1100 (s).
HRMS (EI) for **$C_{23}H_{14}N_2O_3$, $[M]^+$** (366.1004) found: 366.0999.

Synthesis of 4-(5-(4-bromophenyl)-2-phenylfuran-3-yl)benzonitrile (1ma):

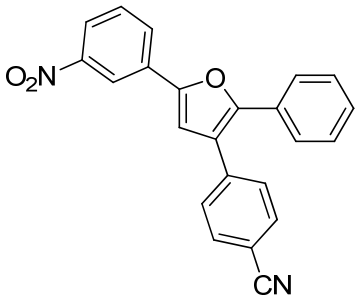


Prepared according to **TP** from **2m** (156.1 mg, 0.5 mmol), Bu_3P (137.0 μL, 1.1 equiv), Et_3N (84.0 μL, 1.2 equiv), and **3a** (64.0 μL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.25) yielded **1ma** as white solid (165.8 mg, 83%).

mp.: 145.0-146.5 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.69-7.44 (m, 10H), 7.41-7.28 (m, 3H), 6.78 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.1, 149.2, 138.7, 132.4, 131.8, 130.0, 128.9, 128.8, 128.6, 128.4, 126.5, 125.2, 122.6, 121.6, 118.7, 110.8, 108.7.
MS (20 eV, EI) *m/z* (%): 401 $[M+2]^+$ (100), 399$[M]^+$ (72).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3055 (w), 2229 (s), 1609 (s), 1488 (s), 1148(m), 1008(m), 695(s).

HRMS (EI) for **$C_{23}H_{14}BrNO$**, **$[M]^+$** (399.0251) found: 399.0259.

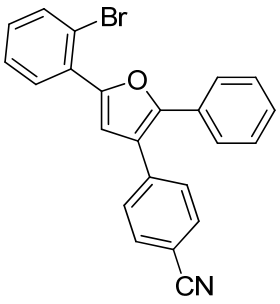
Synthesis of 4-(5-(3-nitrophenyl)-2-phenylfuran-3-yl)benzonitrile (1na):



Prepared according to **TP** from **2n** (139.1mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry CH_2Cl_2 (4.0 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 10/1; R_f : 0.27) yielded **1na** as yellow solid (124.4 mg, 68%).

mp.: 185.5-187.3 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.53 (s, 1H), 8.12 (dd, 2H, J = 8.1, 1.7 Hz), 7.66 (d, 2H, J = 8.2 Hz), 7.63-7.51 (m, 5H), 7.41-7.32 (m, 3H), 6.98 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 150.7, 150.3, 148.7, 138.4, 132.5, 131.5, 129.8, 129.7, 129.1, 129.0, 128.8, 128.7, 126.7, 122.8, 122.1, 118.6, 118.4, 111.1, 110.4.
MS (20 eV, EI) *m/z* (%): 367 $[M+1]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3048 (s), 2303 (m), 2229 (s), 1558 (m), 1532 (m).
HRMS (ESI) for **$C_{23}H_{14}N_2NaO$**, **$[M+Na]^+$** (389.0902) found: 389.0910.

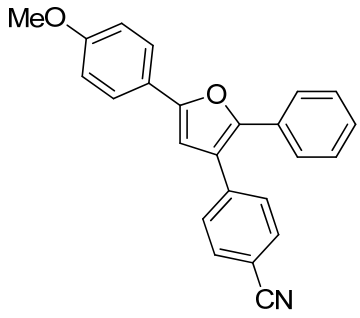
Synthesis of 4-(5-(2-bromophenyl)-2-phenylfuran-3-yl)benzonitrile (1oa):



Prepared according to **TP** from **2o** (156.1 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.39) yielded **1oa** as lemon yellow solid (133.9 mg, 67%).

mp.: 124.5-126.1 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.95-7.86 (m, 1H), 7.73-7.50 (m, 7H), 7.45-7.29 (m, 5H), 7.22-7.11 (m, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 150.6, 149.2, 138.9, 134.3, 132.4, 130.4, 130.1, 129.1, 128.8, 128.7, 128.6, 128.5, 127.5, 126.7, 122.3, 119.6, 118.8, 113.7, 110.8.
MS (20 eV, EI) *m/z* (%): 402 $[(M+2)+1]^+$ (59), 400 $[M+1]^+$ (100),.
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3063 (m), 2229 (s), 1613 (s), 1469 (s), 1156 (m), 1023 (s), 694 (s).
HRMS (ESI) for **$C_{23}H_{15}BrNO$**, **$[M+H]^+$** (400.0337) found: 400.0341.

Synthesis of 4-(5-(4-methoxyphenyl)-2-phenylfuran-3-yl)benzonitrile (1pa):

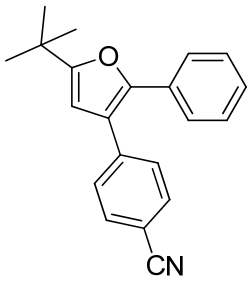


Prepared according to **TP** from **2p** (131.7 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 20/1; R_f : 0.30) yielded **1pa** as lemon yellow solid (121.2 mg, 69%).

mp.: 121.5-123.5 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.68 (d, 2H, J = 8.6 Hz), 7.63 (d, 2H, J = 8.1 Hz), 7.54 (d, 4H, J = 8.3 Hz), 7.39-7.27 (m, 3H), 6.96 (d, 2H, J = 8.6 Hz), 6.67 (s, 1H), 3.85 (s, 3H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 159.4, 153.4, 148.3, 139.2, 132.4, 130.4, 130.0, 128.6, 128.0, 126.4, 125.3, 123.0, 122.5, 118.8, 114.2, 110.5, 106.7, 55.3.
MS (20 eV, EI) *m/z* (%): 351 $[M]^+$ (100).

IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3063 (w), 2229 (s), 1609 (s), 1502 (s), 1303 (m), 1252 (s).
HRMS (MALDI) for **$C_{24}H_{18}NO_2$**, **$[M+H]^+$** (352.1337) found: 352.1341.

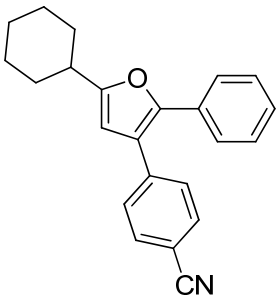
Synthesis of 4-(5-tert-butyl-2-phenylfuran-3-yl)benzonitrile (1qa):



Prepared according to **TP** from **2q** (106.5 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 60 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.27) yielded **1qa** as white solid (78.1 mg, 52%).

mp.: 152.8-153.7 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.58 (d, 2H, J = 8.1 Hz), 7.52-7.42 (m, 4H), 7.36-7.26 (m, 3H), 6.14 (s, 1H), 1.35 (s, 9H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 164.1, 147.7, 139.8, 132.3, 131.0, 128.9, 128.5, 127.8, 126.4, 120.9, 119.0, 110.2, 105.6, 32.7, 29.0.
MS (20 eV, EI) *m/z* (%): 302 $[M+1]^+$ (100), 286 (73).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3055 (w), 2229 (s), 1609 (m), 1558 (m), 1510 (m).
HRMS (EI) for **$C_{21}H_{19}NO$**, **$[M]^+$** (301.1467) found: 301.1469.

Synthesis of 4-(5-cyclohexyl-2-phenylfuran-3-yl)benzonitrile (1ra):

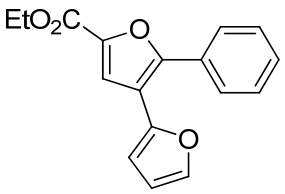


Prepared according to **TP** from **2r** (83.1 mg, 0.5 mmol), tributylphosphine (137.0 µL, 1.1 equiv), triethylamine (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF

(2.5 mL) [reaction condition: RT for 60 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.38) yielded **1ra** as white solid (83.1 mg, 51%).

mp.: 161.3-162.1 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.54 (d, 2H, J = 8.2 Hz), 7.48-7.37 (m, 4H), 7.29-7.18 (m, 3H), 6.09 (s, 1H), 2.70-2.60 (m, 1H), 2.10-2.01 (m, 2H), 1.83-1.64 (m, 3H), 1.44-1.16 (m, 5H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 160.9, 147.6, 139.8, 132.3, 130.9, 128.9, 128.5, 127.8, 126.4, 120.9, 118.9, 110.2, 106.4, 37.2, 31.4, 26.0, 25.8.
MS (20 eV, EI) *m/z* (%): 327 $[M]^+$ (100), 285 (21).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3055 (m), 2221 (s), 1602 (s), 1558 (s), 1448 (s), 1255 (m).
HRMS (MALDI) for **$C_{23}H_{22}NO$**, **$[M+H]^+$** (328.1711) found: 328.1701.

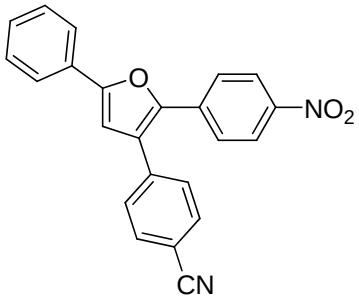
Synthesis of ethyl 2'-phenyl-2,3'-bifuran-5'-carboxylate (1sa):



Prepared according to **TP** from **2s** (179.0 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3a** (64.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 0.5 h]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.30) yielded **1sa** as colorless oil (132.0 mg, 55%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.78 (d, 2H, J = 6.5 Hz), 7.44-7.40 (m, 5H), 6.50-6.49 (m, 1H), 6.45-6.44 (m, 1H), 4.40 (quartet, 2H, J = 7.0 Hz), 1.40 (t, 3H, J = 7.0 Hz).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 158.7, 152.2, 146.6, 143.4, 142.0, 129.8, 129.3, 128.4, 127.5, 119.1, 114.7, 111.3, 107.7, 61.1, 14.4.
MS (20 eV, EI) *m/z* (%): 282 $[M]^+$ (100), 254 (39), 181 (10).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 2988 (w), 1723 (s), 1476 (s), 1321 (s), 1177 (m).
HRMS (MALDI) for **$C_{17}H_{15}O_4$**, **$[M+H]^+$** (283.0970) found: 283.0979.

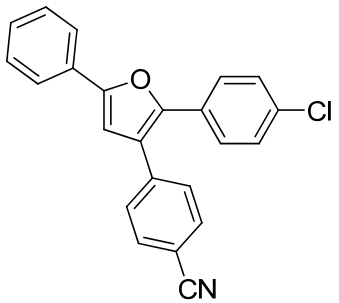
Synthesis of 4-(2-(4-nitrophenyl)-5-phenylfuran-3-yl)benzonitrile (1cb):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3b** (74.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 10/1; R_f : 0.32) yielded **1cb** as yellow solid (119.6 mg, 65%).

mp.: 197.2-199.2 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.16 (d, 2H, J = 7.9 Hz), 7.88-7.30 (m, 11H), 6.84 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 155.0, 146.6, 146.1, 138.3, 136.1, 132.8, 129.3, 129.3, 129.0, 128.7, 126.4, 126.1, 124.1, 124.2, 118.4, 111.9, 109.4.
MS (20 eV, EI) *m/z* (%): 367 $[M+1]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3113 (w), 3061 (w), 2227 (s), 1598 (s), 1544 (m), 1515 (s), 1338 (s), 1110 (m).
HRMS (MALDI) for **$C_{23}H_{15}N_2O_3$**, **$[M+H]^+$** (367.1077) found: 367.1093.

Synthesis of 4-(2-(4-chlorophenyl)-5-phenylfuran-3-yl)benzonitrile (1cc):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3c** (70.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 20/1; R_f : 0.32) yielded **1cc** as white solid (137.3 mg, 77%).

mp.: 138.1-139.0 °C

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.74 (d, 2H, J = 7.4 Hz), 7.65 (d, 2H, J = 8.3 Hz), 7.52-7.40 (m, 6H), 7.37-7.28 (m, 3H), 6.79 (s, 1H).

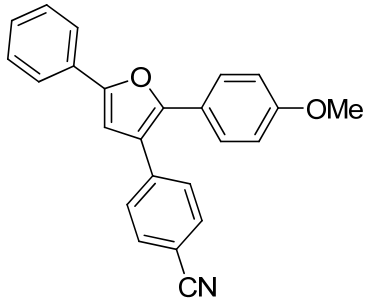
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.5, 147.7, 138.7, 134.0, 132.5, 129.7, 129.0, 128.9, 128.8, 128.7, 128.1, 127.6, 123.8, 123.1, 118.7, 111.0, 108.4.

MS (20 eV, EI) *m/z* (%): 357 $[M+2]^+$ (74), 355 $[M]^+$ (100).

IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3063 (w), 2229 (s), 1609 (s), 1491 (s), 1266 (m), 1097 (m), 957 (m), 821 (s), 761 (m), 691 (m).

HRMS (MALDI) for **$C_{23}H_{15}ClNO$**, **$[M+H]^+$** (356.0842) found: 356.0851.

Synthesis of 4-(2-(4-methoxyphenyl)-5-phenylfuran-3-yl)benzonitrile (1cd):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3d** (78.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 20/1; R_f : 0.32) yielded **1cd** as yellow solid (139.4 mg, 80%).

mp.: 145.0-147.0 °C

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.74 (d, 2H, J = 7.6 Hz), 7.63 (d, 2H, J = 8.2 Hz), 7.54 (d, 2H, J = 8.2 Hz), 7.49 (d, 2H, J = 8.7 Hz), 7.43 (t, 2H, J = 7.5 Hz), 7.35-7.27 (m, 1H), 6.90 (d, 2H, J = 8.7 Hz), 6.80 (s, 1H), 3.84 (s, 3H).

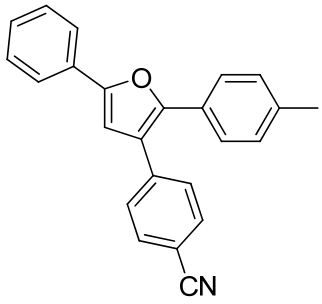
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 159.7, 152.8, 149.2, 139.2, 132.3, 130.1, 128.8, 128.7, 128.1, 127.7, 123.7, 123.0, 121.2, 118.9, 114.1, 110.4, 108.0, 55.2.

MS (20 eV, EI) *m/z* (%): 352 $[M+1]^+$ (100), 336 (10).

IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3113 (w), 3061 (m), 3002 (m), 2962 (m), 2939 (m), 2906 (m), 2227 (s), 1608 (s), 1570 (m), 1516 (s), 1492 (s), 1385 (m), 1301 (m), 1254 (s), 1177 (s), 1028 (s).

HRMS (MALDI) for **$C_{24}H_{17}NO_2$**, **$[M+H]^+$** (352.1337) found: 352.1345.

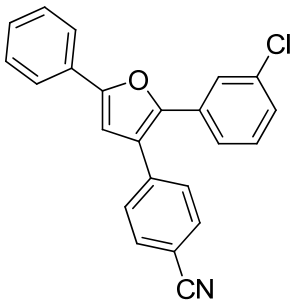
Synthesis of 4-(5-phenyl-2-p-tolylfuran-3-yl)benzonitrile (1ce):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3e** (74.0µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1: 0.42) yielded **1ce** as lemon yellow solid (145.5 mg, 87%).

mp.: 169.5-170.9 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.76 (d, 2H, J = 7.6 Hz), 7.63 (d, 2H, J = 8.1 Hz), 7.55 (d, 2H, J = 8.2 Hz), 7.50-7.39 (m, 4H), 7.36-7.29 (m, 1H), 7.18 (d, 2H, J = 7.9 Hz), 6.81 (s, 1H), 2.41 (s, 3H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.1, 149.4, 139.3, 138.5, 132.5, 130.2, 129.5, 129.1, 128.9, 127.9, 127.6, 126.7, 123.9, 122.1, 119.0, 110.6, 108.2, 21.3.
MS (20 eV, EI) *m/z* (%): 336 $[M+1]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3061 (w), 3031 (w), 2923 (w), 2867 (w), 2227 (s), 1608 (s), 1516 (m), 1493 (s), 1384 (w), 1148 (m), 1051 (m).
HRMS (MALDI) for **$C_{24}H_{18}NO$**, **$[M+H]^+$** (336.1388) found: 336.1395.

Synthesis of 4-(2-(3-chlorophenyl)-5-phenylfuran-3-yl)benzonitrile (1cf):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3f** (72.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.28) yielded **1cf** as lemon yellow solid (118.4 mg, 67%).

mp.: 105.5-107.5 °C

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.73 (d, 2H, J = 7.4 Hz), 7.65 (d, 2H, J = 8.3 Hz), 7.58-7.56 (m, 1H), 7.52 (d, 2H, J = 8.3 Hz), 7.42 (t, 2H, J = 7.8 Hz), 7.36-7.29 (m, 2H), 7.28-7.19 (m, 2H), 6.78 (s, 1H).

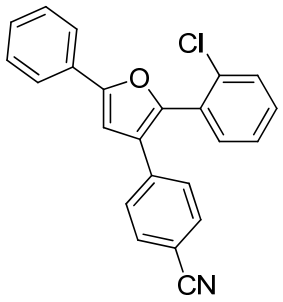
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.8, 147.2, 138.6, 134.7, 132.5, 132.0, 129.8, 129.7, 129.1, 128.8, 128.2, 128.1, 126.2, 124.3, 123.9, 123.6, 118.7, 111.1, 108.5.

MS (20 eV, EI) *m/z* (%): 357 $[M+2]^+$ (34), 356 $[M+1]^+$ (100).

IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3120 (w), 3064 (m), 2227 (s), 1608 (s), 1592 (s), 1254 (m), 1149 (s), 762 (s).

HRMS (MALDI) for **$C_{23}H_{14}ClNO$**, **$[M+H]^+$** (356.0842) found: 356.0851.

Synthesis of 4-(2-(2-chlorophenyl)-5-phenylfuran-3-yl)benzonitrile (1ch):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3h** (70.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.25) yielded **1ch** as white solid (118.1 mg, 72%).

mp.: 118.8-119.4 °C

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.77 (d, 2H, J = 7.8 Hz), 7.56 (d, 2H, J = 8.2 Hz), 7.53-7.29 (m, 9H), 6.98 (s, 1H).

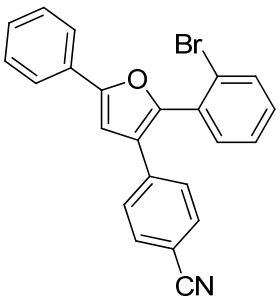
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 154.3, 147.0, 138.2, 133.9, 132.3, 132.1, 130.6, 130.4, 129.9, 129.8, 128.7, 128.0, 127.6, 126.9, 124.5, 123.9, 118.8, 110.3, 106.0.

MS (20 eV, EI) *m/z* (%): 357 $[M+2]^+$ (34), 356 $[M+1]^+$ (100).

IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3117 (w), 3064 (m), 2227 (s), 1610 (s), 1557 (m), 1384 (m), 1182 (s), 1151 (s), 762 (s).

HRMS (MALDI) for **$C_{23}H_{15}ClNO$**, **$[M+H]^+$** (356.0842) found: 356.0854.

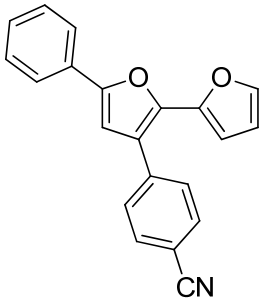
Synthesis of 4-(2-(2-chlorophenyl)-5-phenylfuran-3-yl)benzonitrile (1ci):



Prepared according to **TP** from **2c** (116.6 mg 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3i** (74.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.25) yielded **1ci** as white solid (122.0 mg, 67%).

mp.: 122.2-123.2 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.80-7.75 (m, 2H), 7.74-7.69 (m, 1H), 7.59-7.53 (m, 2H), 7.47-7.29 (m, 8H), 6.98 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 154.3, 148.6, 138.1, 133.8, 132.5, 132.4, 132.1, 131.0, 130.0, 128.9, 128.2, 127.8, 127.6, 124.2, 124.1, 124.0, 118.9, 110.4, 105.9.
MS (20 eV, EI) *m/z* (%): 401 $[M+2]^+$ (93), 400 $[M+1]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3120 (w), 3064 (m), 2227 (s), 1607 (s), 1487 (s), 1462 (m), 1267 (m), 1241 (m), 1147 (s), 1028 (s), 689 (s).
HRMS (MALDI) for **$C_{23}H_{15}BrNO$**, **$[M+H]^+$** (400.0337) found: 400.0348.

Synthesis of 4-(5-phenyl-2,2'-bifuran-3-yl)benzonitrile[3] (1cj):

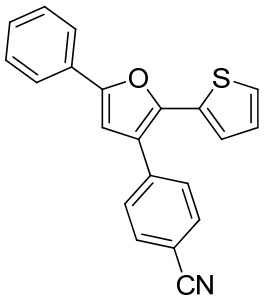


Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3j** (55.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction

condition: RT for 60 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.28) yielded **1cj** as red solid (79.0 mg, 62%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.74 (d, 2H, J = 7.5 Hz), 7.70-7.63 (m, 4H), 7.48-7.38 (m, 3H), 7.41 (t, 1H, J = 7.4 Hz), 6.81 (s, 1H), 6.69 (d, 1H, J = 3.4 Hz), 6.53-6.47 (m, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.4, 145.6, 142.4, 141.1, 137.9, 132.0, 129.7, 129.1, 128.8, 128.1, 123.9, 122.7, 118.9, 111.5, 110.7, 108.3, 107.7.
MS (20 eV, EI) *m/z* (%): 312 $[M+1]^+$ (100).

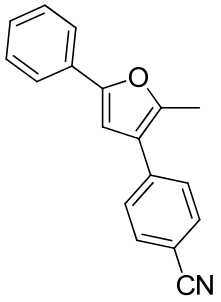
Synthesis of 4-(5-phenyl-2-(thiophen-2-yl)furan-3-yl)benzonitrile (1ck):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3k** (62.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.32) yielded **1ck** as green solid (117.9 mg, 72%).

mp.: 115.1-115.5 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.74-7.64 (m, 6H), 7.43 (t, 2H, J = 7.4 Hz), 7.37-7.27 (m, 2H), 7.25-7.19 (m, 1H), 7.06-6.98 (m, 1H), 6.78 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 153.1, 144.4, 138.4, 132.4, 132.2, 129.7, 129.2, 128.8, 128.0, 127.5, 125.7, 125.0, 123.8, 122.4, 118.8, 111.0, 108.1.
MS (20 eV, EI) *m/z* (%): 327 $[M]^+$ (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3110 (w), 3071 (w), 2227 (s), 1608 (s), 1556 (w), 1525 (w), 1495 (m), 1248 (w), 1146 (m).
HRMS (MALDI) for **$C_{21}H_{14}NOS$**, **$[M+H]^+$** (328.0796) found: 328.0801.

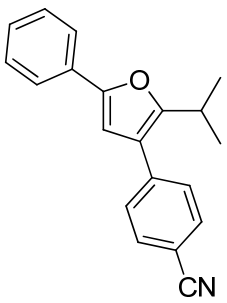
Synthesis of 4-(2-methyl-5-phenylfuran-3-yl)benzonitrile (1cl):



Prepared according to **TP** from **2c** (126.6 mg, 0.5 mmol), Bu_3P (187.0 µL, 1.5 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3l** (40.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 1800 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.25) yielded **1cl** as white solids (28.0 mg, 24%).

mp.: 134.9-136.0 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.72-7.63 (m, 4H), 7.52 (d, 2H, J = 8.2Hz), 7.39 (t, 2H, J = 7.6Hz), 7.30-7.23 (m, 1H), 6.77 (s, 1H), 2.53 (s, 3H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 152.4, 148.9, 138.9, 132.4, 130.3, 128.7, 127.7, 127.5, 123.5, 121.7, 119.0, 109.8, 105.5, 13.5.
MS (20 eV, EI) *m/z* (%): 260 $[M+1]^+$ (19), 259 [M] (100).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3057 (w), 2921 (w), 2220 (s), 1606 (s), 1560 (m), 1504 (m), 1486 (m), 1443 (m), 1223 (m), 1181 (m), 1060 (m).
HRMS (EI) for **$C_{18}H_{13}NO$**, **$[M]^+$** (259.0997) found: 259.0993.

Synthesis of 4-(2-isopropyl-5-phenylfuran-3-yl)benzonitrile (1cm):



Prepared according to **TP** from **2c** (116.6 mg, 0.5 mmol), Bu_3P (137.0 µL, 1.1 equiv), Et_3N (84.0 µL, 1.2 equiv), and **3l** (60.0 µL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 60 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.29) yielded **1cl** as white solid (75.0 mg, 52%).

mp.: 112.1-122.9 °C

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.67 (d, 4H, J = 7.9 Hz), 7.48 (d, 2H, J = 8.1 Hz), 7.39 (t, 2H, 7.6Hz), 7.26 (t, 1H, J = 7.4 Hz), 6.71 (s, 1H), 3.24 (septet, 1H, J = 6.8 Hz), 1.37 (d, 6H, J = 6.8 Hz).

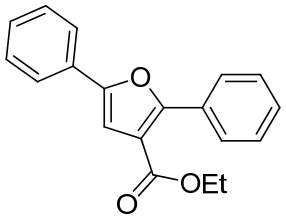
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 157.0, 152.0, 139.1, 132.4, 130.4, 128.7, 128.3, 127.4, 123.5, 120.1, 119.0, 110.0, 105.7, 26.8, 21.6.

MS (20 eV, EI) *m/z* (%): 287 $[M]^+$ (100), 272 (77).

IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3055 (w), 2229 (s), 1609 (s), 1488 (s), 1075 (m), 761 (m).

HRMS (EI) for **$C_{20}H_{17}NO$**, **$[M]^+$** (287.1310) found: 287.1307.

Synthesis of ethyl 2,5-diphenylfuran-3-carboxylate[6] (1ta):



Prepared according to **TP** from **2t** (92.0 μL, 0.5 mmol), Bu_3P (137.0 μL, 1.1 equiv), Et_3N (84.0 μL, 1.2 equiv), and **3a** (64.0 μL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 50/1; R_f : 0.38) yielded **1ta** as white solid (101.3 mg, 70%).

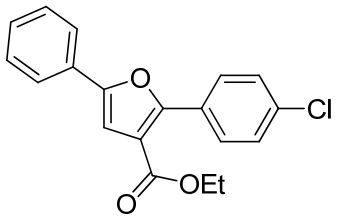
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.12 (d, 2H, J = 7.2 Hz), 7.76 (d, 2H, J = 7.5 Hz), 7.53-7.40 (m, 5H), 7.37-7.30 (m, 1H), 7.11(s, 1H), 4.36 (quartet, 2H, J = 7.1 Hz), 1.39 (t, 3H, J = 7.1 Hz).

^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 163.4, 156.4, 152.3, 129.7, 129.2, 128.7, 128.3, 128.0, 127.9, 123.9, 115.7, 107.9, 60.5, 14.2.

MS (20 eV, EI) *m/z* (%): 292 $[M]^+$ (100).

Synthesis of ethyl 2-(4-chlorophenyl)-5-phenylfuran-3-carboxylate[6] (1tc):

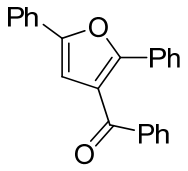
[6] Kajikawa, S.; Noiri, Y.; Shudo, H.; Nishino, H.; Kurosawa, K. *Synthesis*, **1998**, 1457-1462



Prepared according to **TP** from **2t** (92.0 μL, 0.5 mmol), Bu_3P (137.0 μL, 1.1 equiv), Et_3N (84.0 μL, 1.2 equiv), and **3c** (70.0 μL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 10 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 20/1; R_f : 0.54) yielded **1tc** as white solid (98.0 mg, 60%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.06 (d, 2H, J = 8.6 Hz), 7.73 (d, 2H, J = 7.6 Hz), 7.50-7.37 (m, 4H), 7.36-7.28 (m, 1H), 7.08 (s, 1H), 4.34 (quartet, 2H, J = 7.1 Hz), 1.38 (t, 3H, J = 7.1 Hz).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 163.4, 155.1, 152.5, 135.2, 129.5, 128.8, 128.4, 128.2, 124.0, 116.2, 108.0, 67.7, 14.2.
MS (20 eV, EI) *m/z* (%): 328 $[M+2]^+$ (28), 326 (100).

Synthesis of (2,5-diphenylfuran-3-yl)(phenyl)methanone[7] (1ua):

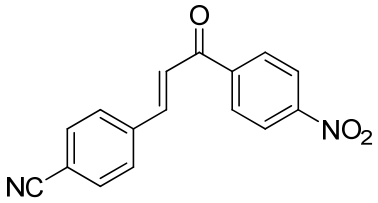


Prepared according to **TP** from **2u** (118.1 mg, 0.5 mmol), Bu_3P (137.0 μL, 1.1 equiv), Et_3N (84.0 μL, 1.2 equiv), and **1a** (64.0 μL, 1.1 equiv) in dry THF (2.5 mL) [reaction condition: RT for 2400 min]. Purification by *flash*-chromatography (hexanes/ethyl acetate: 40/1; R_f : 0.33) yielded **1ua** as yellow liquid (94.6 mg, 58%).

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.92 (d, 2H, J = 7.5 Hz), 7.86-7.74 (m, 4H), 7.59-7.28 (m, 9H), 6.95 (s, 1H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 191.6, 154.8, 152.4, 137.9, 132.8, 129.7, 128.9, 128.8, 128.3, 128.2, 128.1, 127.3, 124.0, 122.7, 108.6.
MS (20 eV, EI) *m/z* (%): 324 $[M]^+$ (100), 247 (78), 105 (71).

[7] Perrier, H.; Bayly, C.; Laliberte, F.; Huang, Z.; Rasori, R.; Robichaud, A.; Girard, Y.; Macdonald, D. *Bio. Med. Chem. Lett.* **1999**, *9*, 323-326.

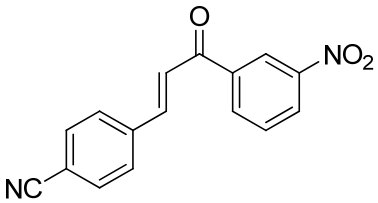
Synthesis of (E)-4-(3-(4-nitrophenyl)-3-oxoprop-1-enyl)benzonitrile[8] (2l):



The compound **2l** was yielded as orange solid (1.15 g, 35%) according to the procedure of the reported literature[1].

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.37 (d, 2H, J = 8.8 Hz), 8.16 (d, 2H, J = 8.8 Hz), 7.83 (d, 1H, J = 15.7 Hz), 7.75 (s, 4H), 7.40 (d, 1H, J = 15.7 Hz).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 188.3, 150.3, 143.9, 142.3, 138.5, 132.8, 129.5, 128.9, 124.2, 124.0, 118.2, 114.1.
MS (20 eV, EI) *m/z* (%): 277 $[M-1]^+$ (100), 260 (7), 231 (15), 156 (7).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3047 (w), 2221 (s), 1731(w), 1672 (s), 1609 (s), 1524 (s), 1333 (s).
HRMS (EI) for **$C_{16}H_{10}N_2O_3$, $[M]^+$** (278.0691) found: 278.0695.

Synthesis of (E)-4-(3-(3-nitrophenyl)-3-oxoprop-1-enyl)benzonitrile[8] (2n):



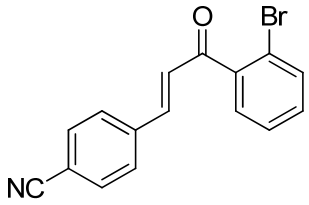
The compound **2n** was yielded as brown solid (0.79 g, 56%) according to the procedure of the reported literature[1].

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.84 (s, 1H), 8.51-8.44 (m, 1H), 8.37 (d, 1H, J = 7.8 Hz), 7.87 (d, 1H, J = 15.7Hz), 7.80-7.70 (m, 5H), 7.61 (d, 1H, J = 15.6 Hz).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 187.4, 148.5, 143.9, 138.9, 138.5, 134.1, 132.8, 130.1, 129.0, 127.5, 123.6, 123.3, 118.2, 114.2.
MS (20 eV, EI) *m/z* (%): 277 $[M-1]^+$ (100).

[8] Dzurilla,M.; Kristian,P. *Collect. Czech. Chem. Commun.* **1970**, 35, 417 - 429

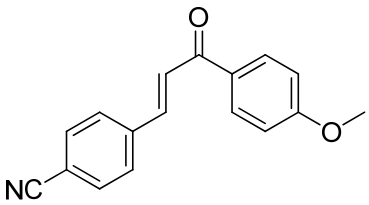
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3092 (w), 3041 (w), 2229 (s), 1668 (s), 1609 (s), 1528 (s), 1432 (m), 1347 (s), 1336 (s).
HRMS (MALDI) for **$C_{16}H_{11}N_2O_3$**, **$[M+H]^+$** (279.07769) found: 279.0775.

Synthesis of (E)-4-(3-(2-bromophenyl)-3-oxoprop-1-enyl)benzonitrile (2o):



The compound **2o** was yielded as yellow solid (2.0784 g, 67%) according to the procedure of the reported literature[1].
mp.: 130.2-131.1 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.70-7.60 (m, 5H), 7.47-7.31 (m, 4H), 7.17 (d, 1H, J = 16.1 Hz).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 193.6, 143.0, 140.5, 138.6, 133.4, 132.6, 131.8, 129.3, 128.7, 127.4, 119.4, 118.2, 113.6.
MS (20 eV, EI) *m/z* (%): 313 $[M+2]^+$ (92), 311 $[M]^+$ (100), 232(51), 156 (30).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3063 (w), 2221 (s), 1668 (s), 1602 (s), 1333 (s), 665 (m), 629 (m).
HRMS (MALDI) for **$C_{16}H_{11}BrNO$**, **$[M+H]^+$** (312.0024) found: 312.0032.

Synthesis of (E)-4-(3-(4-methoxyphenyl)-3-oxoprop-1-enyl)benzonitrile[9] (2p):



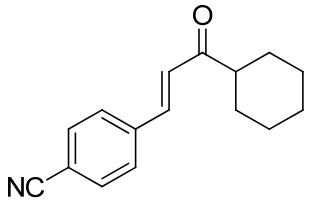
The compound **2r** was yielded as lemon yellow solid (1.96 g, 75%) according to the procedure of the reported literature[1].

^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 8.06-8.01 (m, 2H), 7.78-7.67 (m, 5H), 7.61 (d, 1H, J = 15.6 Hz), 7.02-6.97 (m, 2H), 3.90 (s, 3H).

[9] Schramm; Oana G.; Mueller, Thomas J. J. *Synlett*. **2006**, 1841-1846

^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 187.8, 163.8, 141.2, 139.4, 132.6, 130.9, 130.5, 128.6, 125.0, 118.4, 114.0, 113.2, 55.5.
MS (20 eV, EI) *m/z* (%): 263 $[M]^+$ (100), 135 (49), 108 (7).

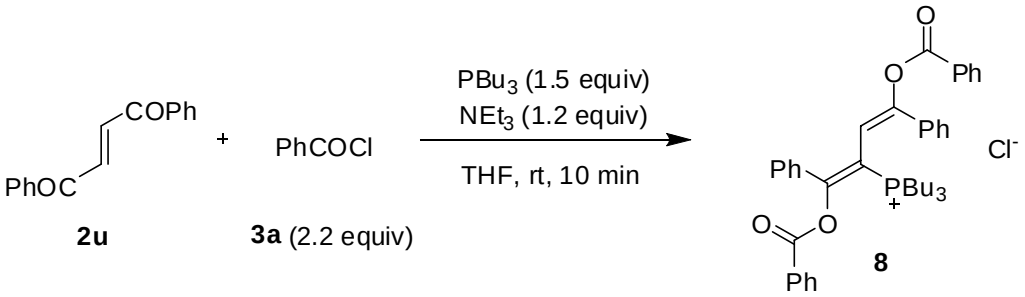
Synthesis of (E)-4-(3-cyclohexyl-3-oxoprop-1-enyl)benzonitrile (2r):



The compound **2p** was yielded as white solid (0.21 g, 20%) according to the procedure of the reported literature[1].

mp.: 93.8-94.6 °C
^{1}H-NMR (400 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.69-7.61 (m, 4H), 7.55 (d, 1H, J = 16.0 Hz), 6.88 (d, 1H, J = 16.0 Hz), 2.68-2.58 (m, 1H), 1.95-1.78 (m, 4H), 1.75-1.66 (m, 1H), 1.49-1.17 (m, 5H).
^{13}C-NMR (100 MHz, $CDCl_3$, 25 °C) δ/ppm: 202.32, 139.6, 139.1, 132.6, 128.5, 127.5, 118.3, 113.3, 48.8, 28.5, 25.8, 25.6.
MS (20 eV, EI) *m/z* (%): 240 $[M+1]^+$ (100), 184 (14), 171 (35), 156 (58), 130 (11), 83 (5).
IR (CH_2Cl_2) $\tilde{\nu}$ (cm^{-1}): 3063 (w), 2982 (w), 2944 (w), 2223 (m), 1661 (s), 1613 (s), 1510 (m).
HRMS (EI) for **$C_{16}H_{18}NO$**, **$[M+H]^+$** (240.1388) found: 240.1398.

Synthesis of ((1Z,3E)-1,4-bis(benzoyloxy)-1,4-diphenylbuta-1,3-dien-2-yl) tributylphosphonium chloride (8):



A dry and nitrogen-flushed 10-mL Schlenk flask, equipped with a magnetic stirring bar and a septum, was charged with a solution of **3a** (128.0 μL, 2.2 equiv), Bu_3P (137.0 μL, 1.1 equiv), Et_3N (84.0 μL, 1.2 equiv) and **2u** (118.1 mg, 0.5 mmol) in dry THF (2.5 mL). The reaction mixture was stirred for 10 min at room temperature.

Thereafter, the solvent was removed by evaporation in vacuo. Purification by simply washing with pentane, and ethyl acetate, then recrystallization (dichloromethane / hexanes) furnishes the adduct **8** and **NEt_3·HCl.**

^{1}H-NMR (500 MHz, $CDCl_3$, 25 °C) δ/ppm: 7.81 (d, 2H, J = 7.9 Hz), 7.74 (d, 2H, J = 7.9 Hz), 7.61 (quartet, 2H, J = 7.3 Hz), 7.49-7.34 (m, 9 Hz), 7.30-7.21 (m, 5H), 6.81 (d, 1H, 4.5 Hz), 2.68-2.54 (m, 6H), 1.32-1.27 (m, 12H), 0.75 (t, 9H, 7.2 Hz).
^{13}C-NMR (125 MHz, $CDCl_3$, 25 °C) δ/ppm: 163.4, 162.8, 162.2, 150.9 (d, J = 8 Hz), 135.2, 134.3, 133.2 (d, J = 7 Hz), 132.9, 131.1, 129.9, 129.7, 129.4, 129.2, 128.6 (d, J = 3 Hz), 128.5, 127.7, 127.5, 126.7, 124.9, 107.9 (d, J = 3 Hz), 103.8 (d, J = 58 Hz), 24.0 (d, J = 3 Hz), 23.9 (d, J = 5 Hz), 21.1 (d, J = 38 Hz), 13.1.
^{31}P-NMR (200 MHz, $CDCl_3$, 25 °C) δ/ppm: 32.7.
MS (20 eV, ESI) *m/z* (%): 648 $[M-34]^+$ (37), 647 $[M-35]^+$ (100).
HRMS (FAB) for **$C_{42}H_{48}O_4P$**, **$[M-Cl]^+$** (647.3285) found: 647.3290.
X-ray analysis: CCDC 792216

VI. Spectra of X-ray crystallography (1da, 1oa, and 8)

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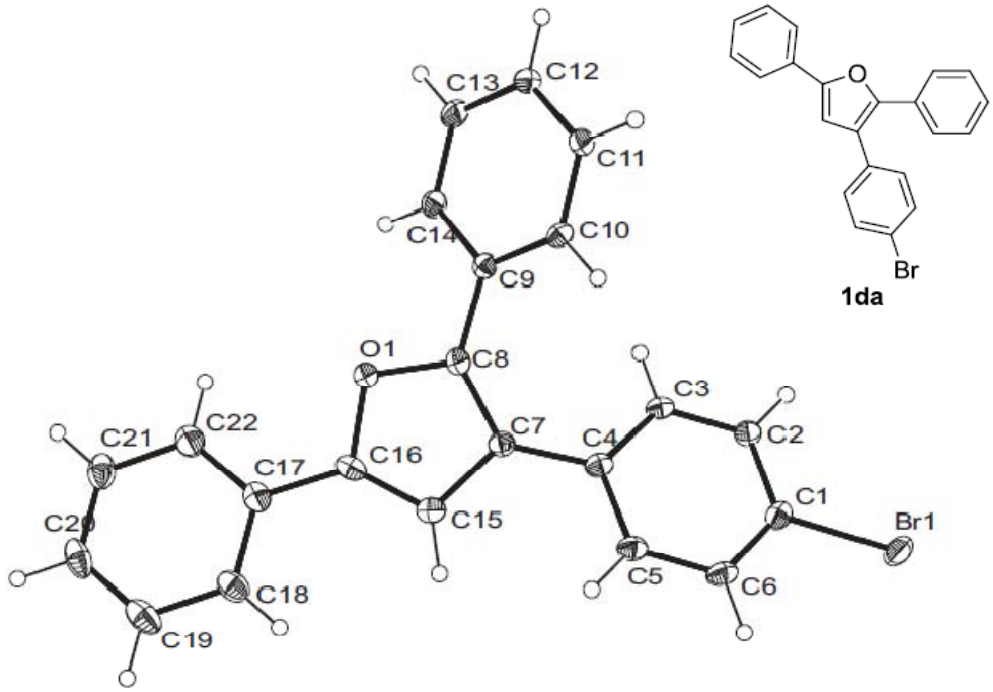
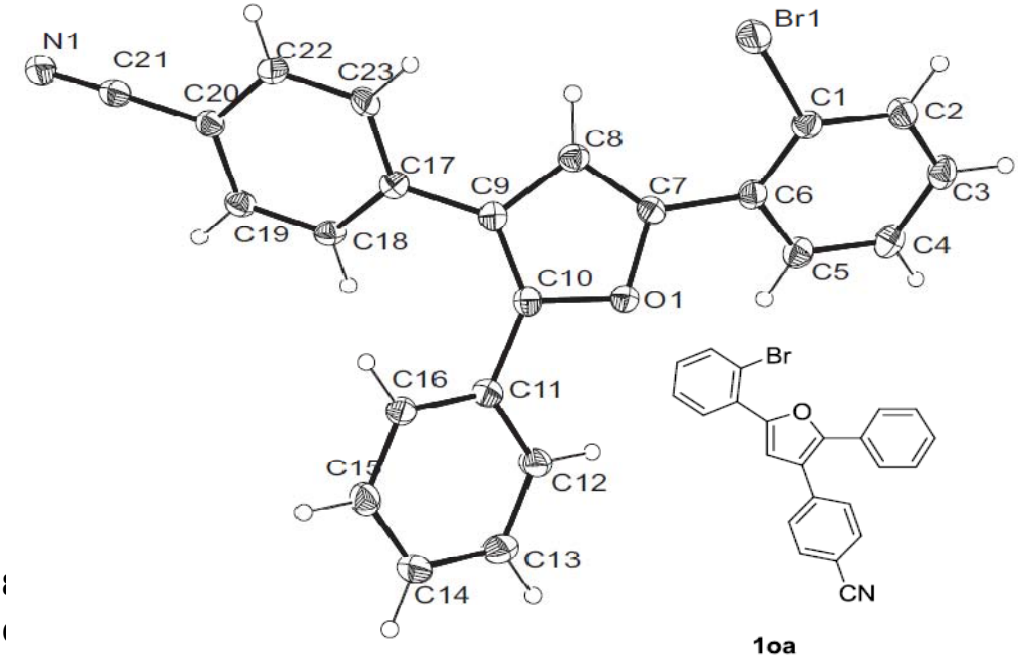
CCDC 792217



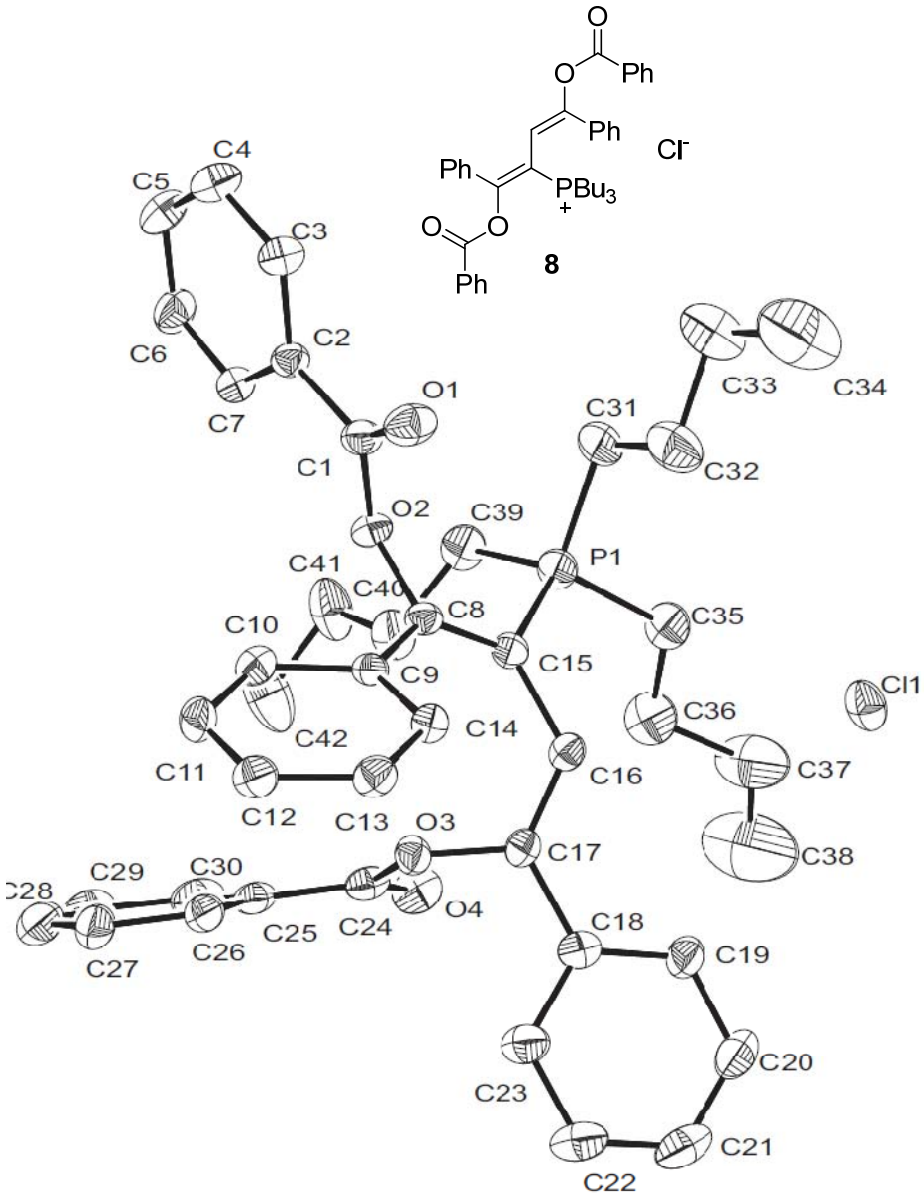
1oa:

CCDC 792218

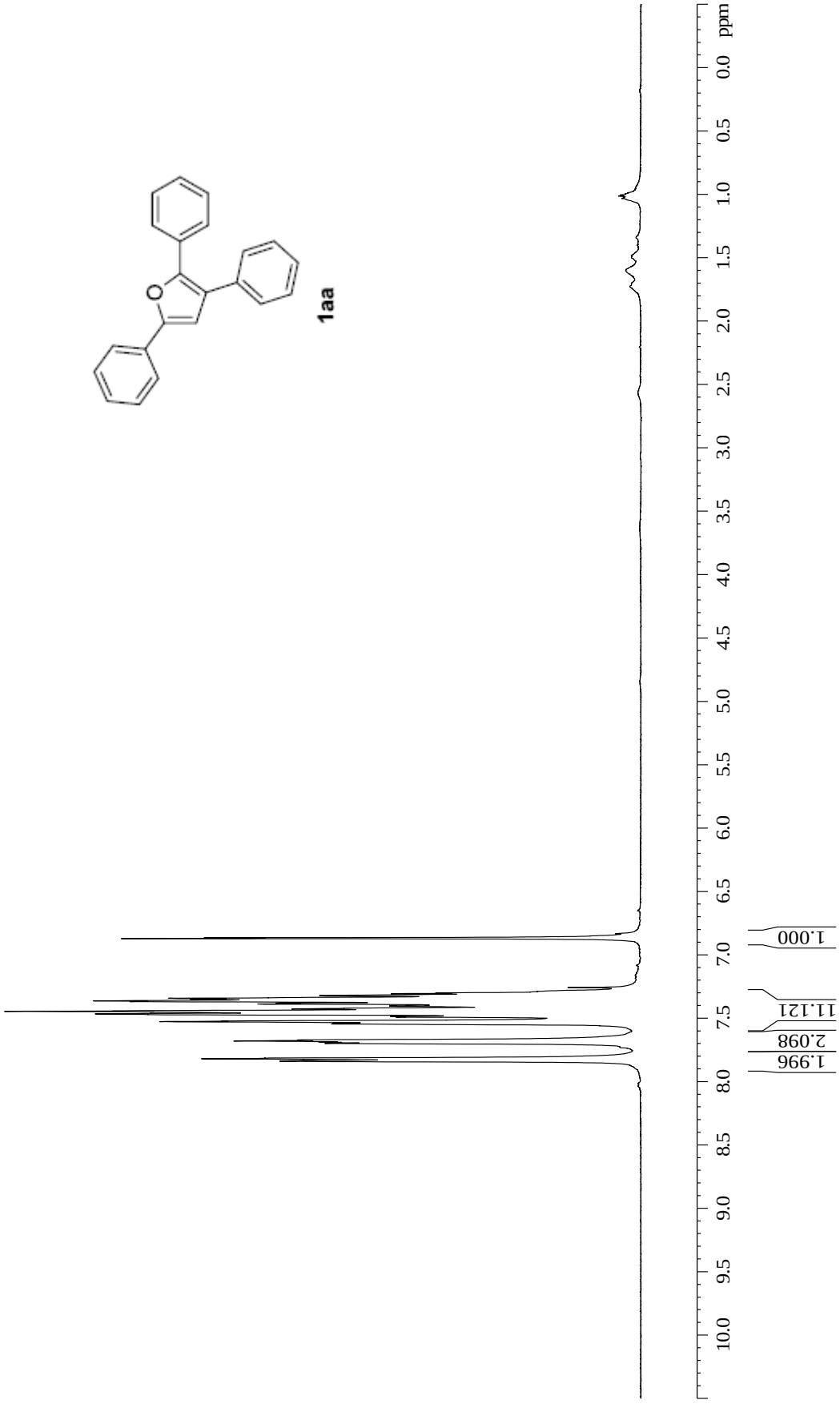


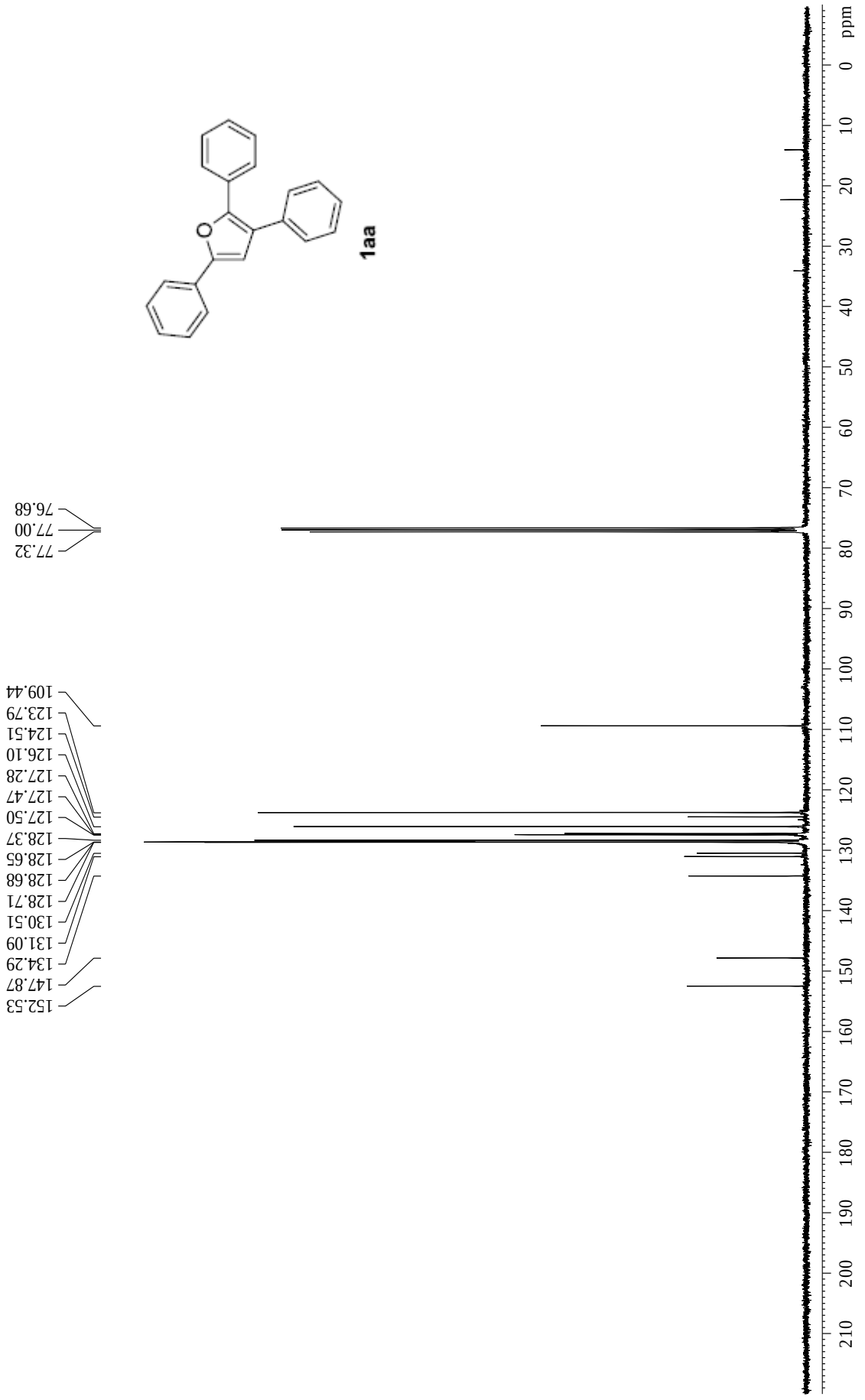
8:

CCDC 792216



V. Spectra of ^{1}H, ^{13}C, and ^{31}P NMR

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140
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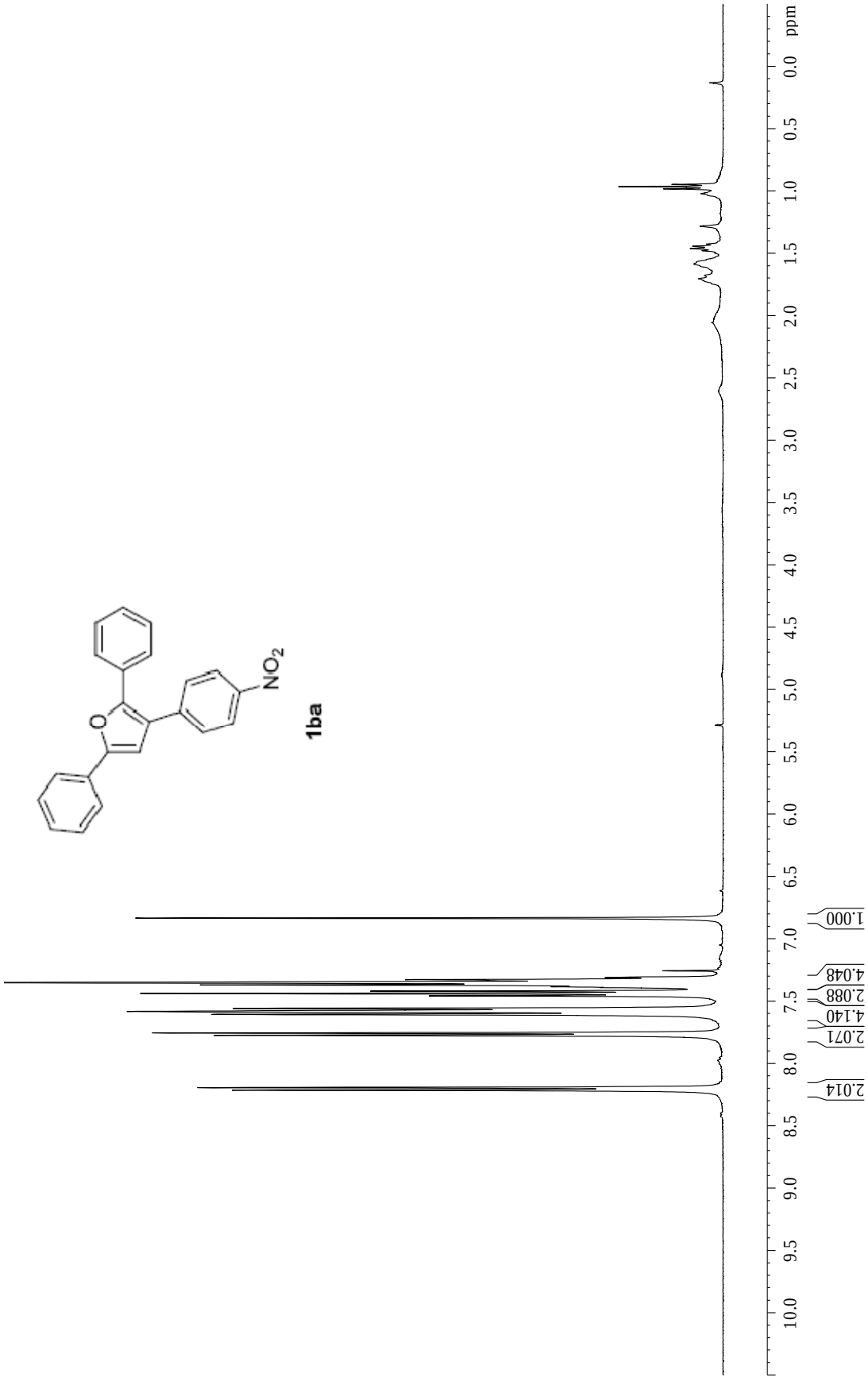
170
180
190
200
210
76.68
77.00
77.32
109.44
123.79
124.51
126.10
127.28
127.47
127.50
128.37
128.65
128.68
128.71
130.51
131.09
134.29
147.87
152.53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3.5
3.0
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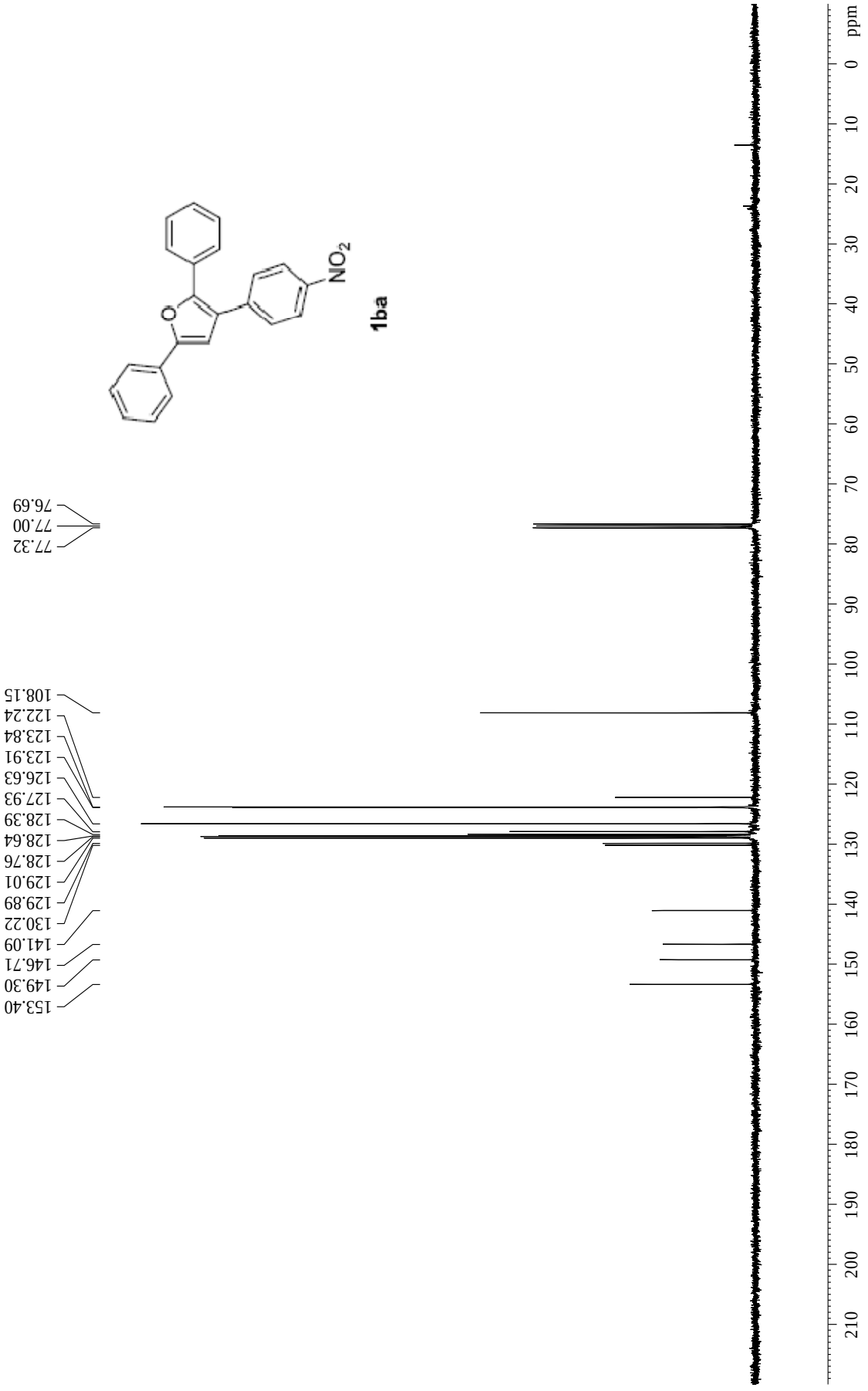
2.014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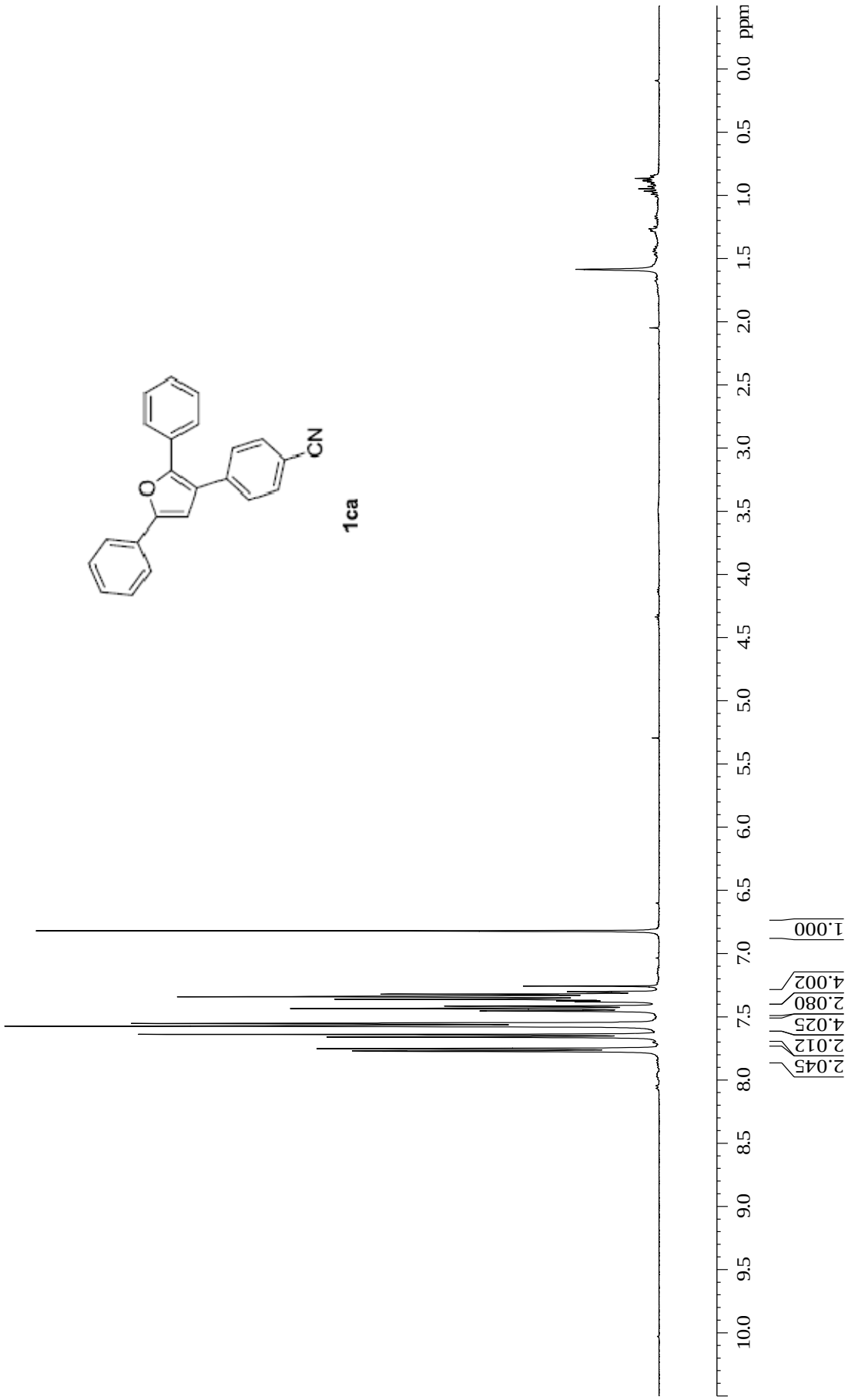
ppm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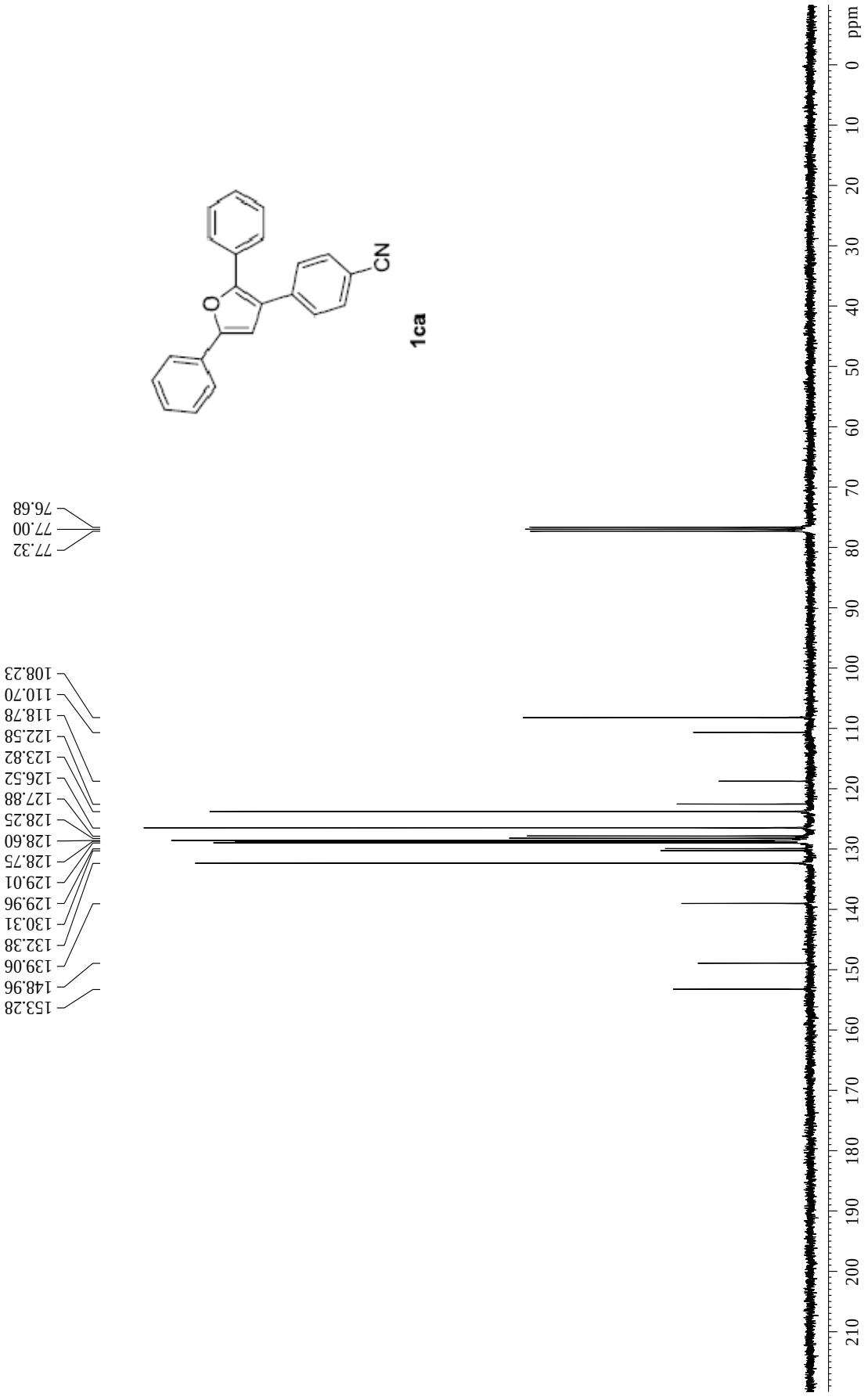
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170
180
190
200
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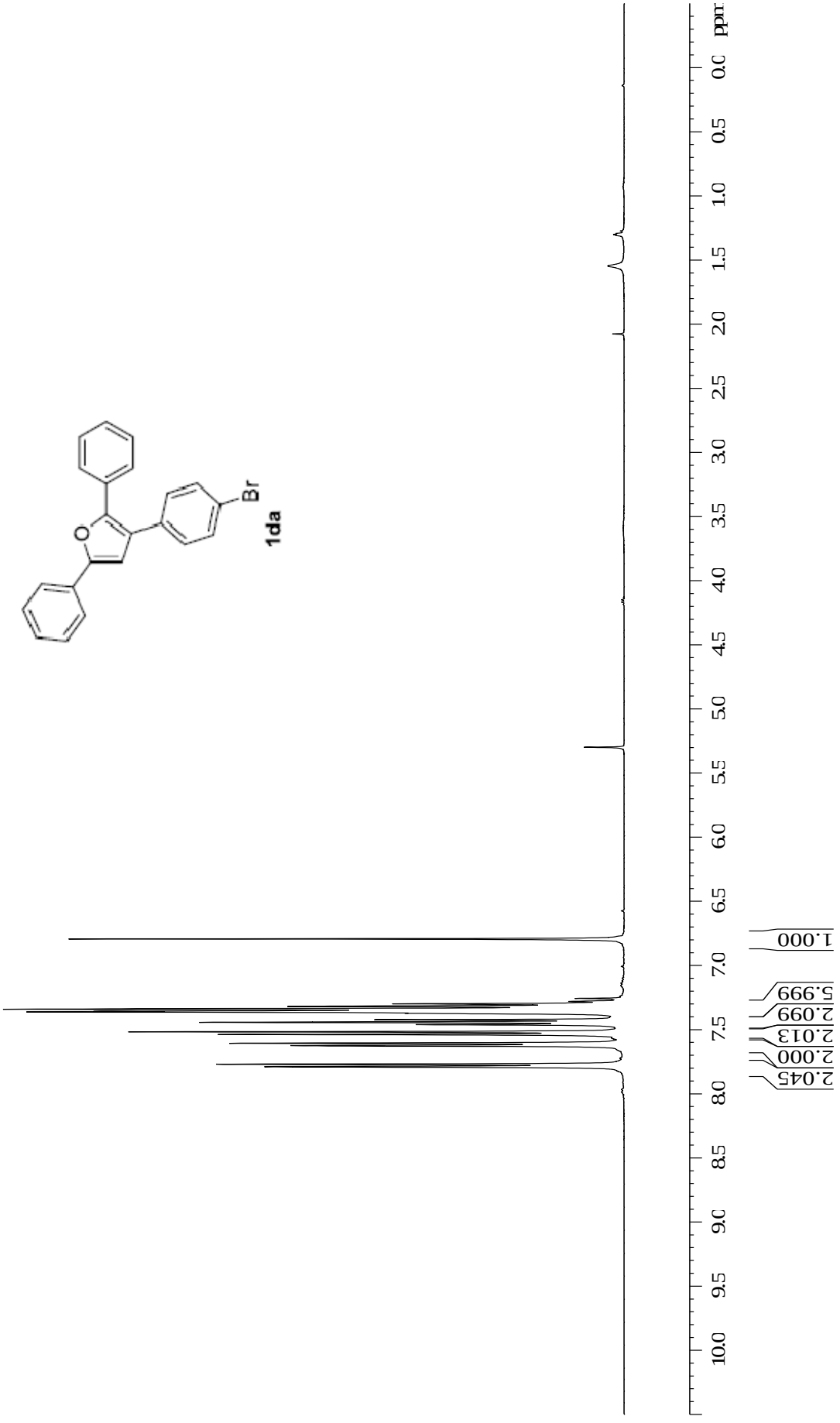
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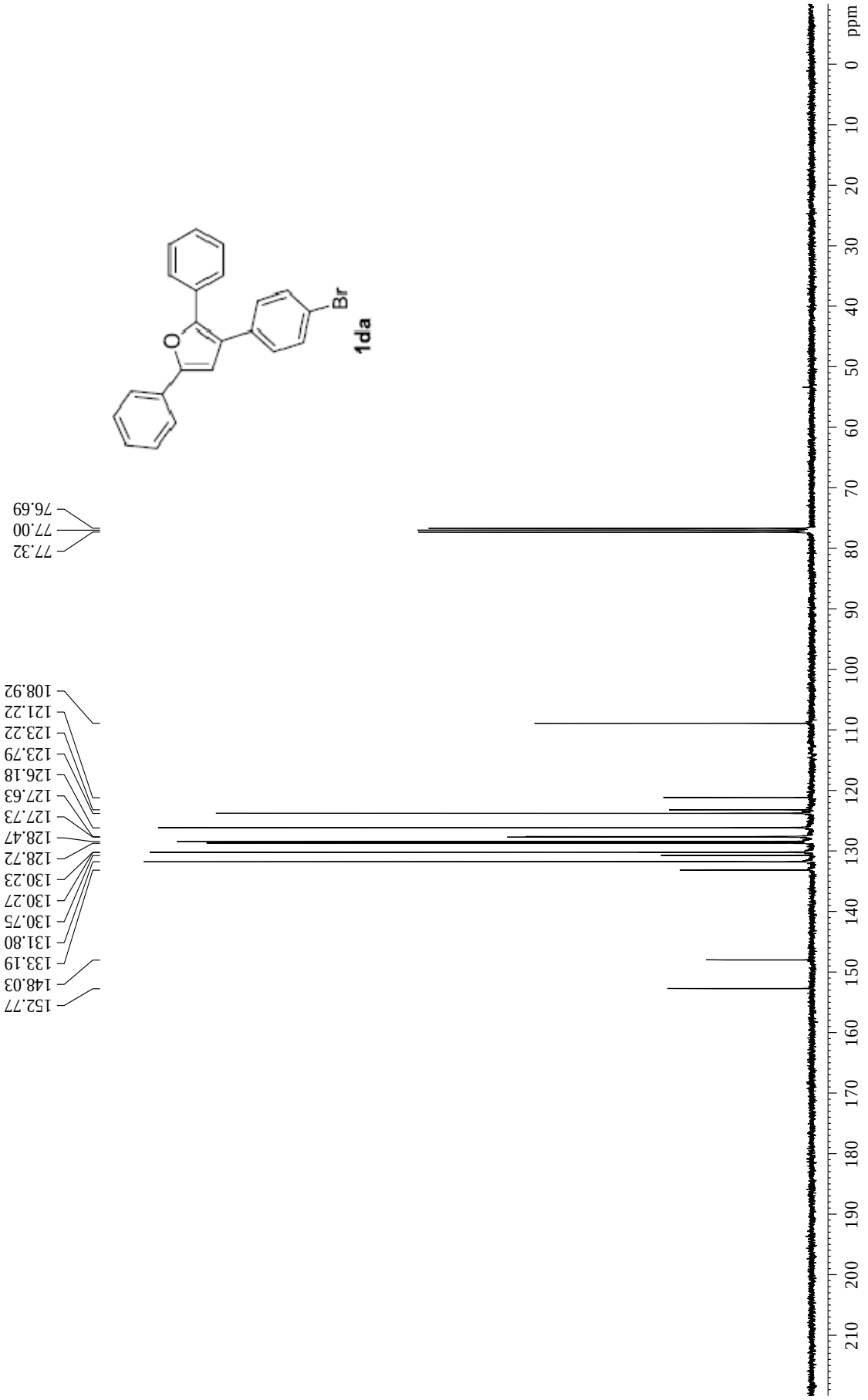
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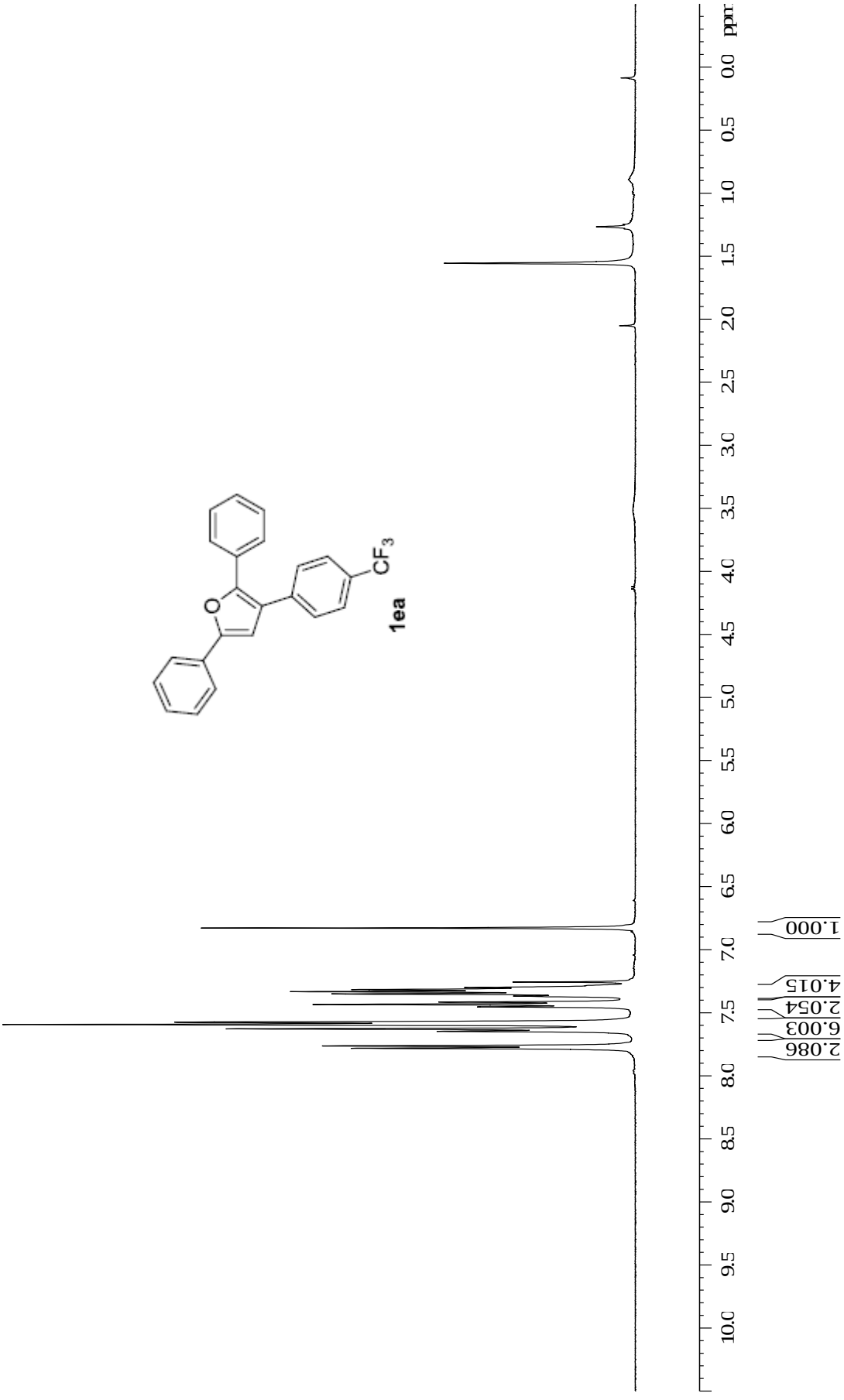
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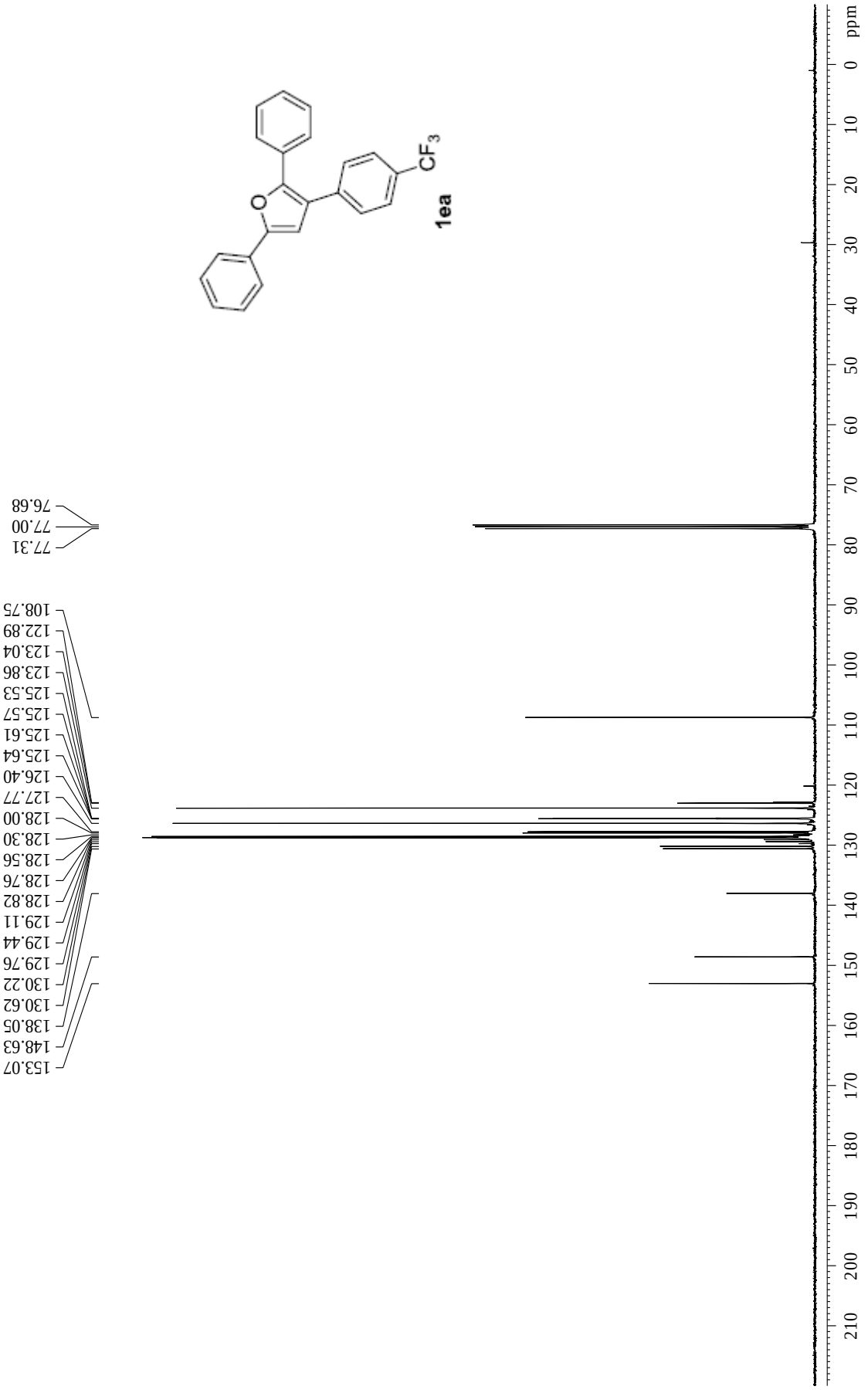
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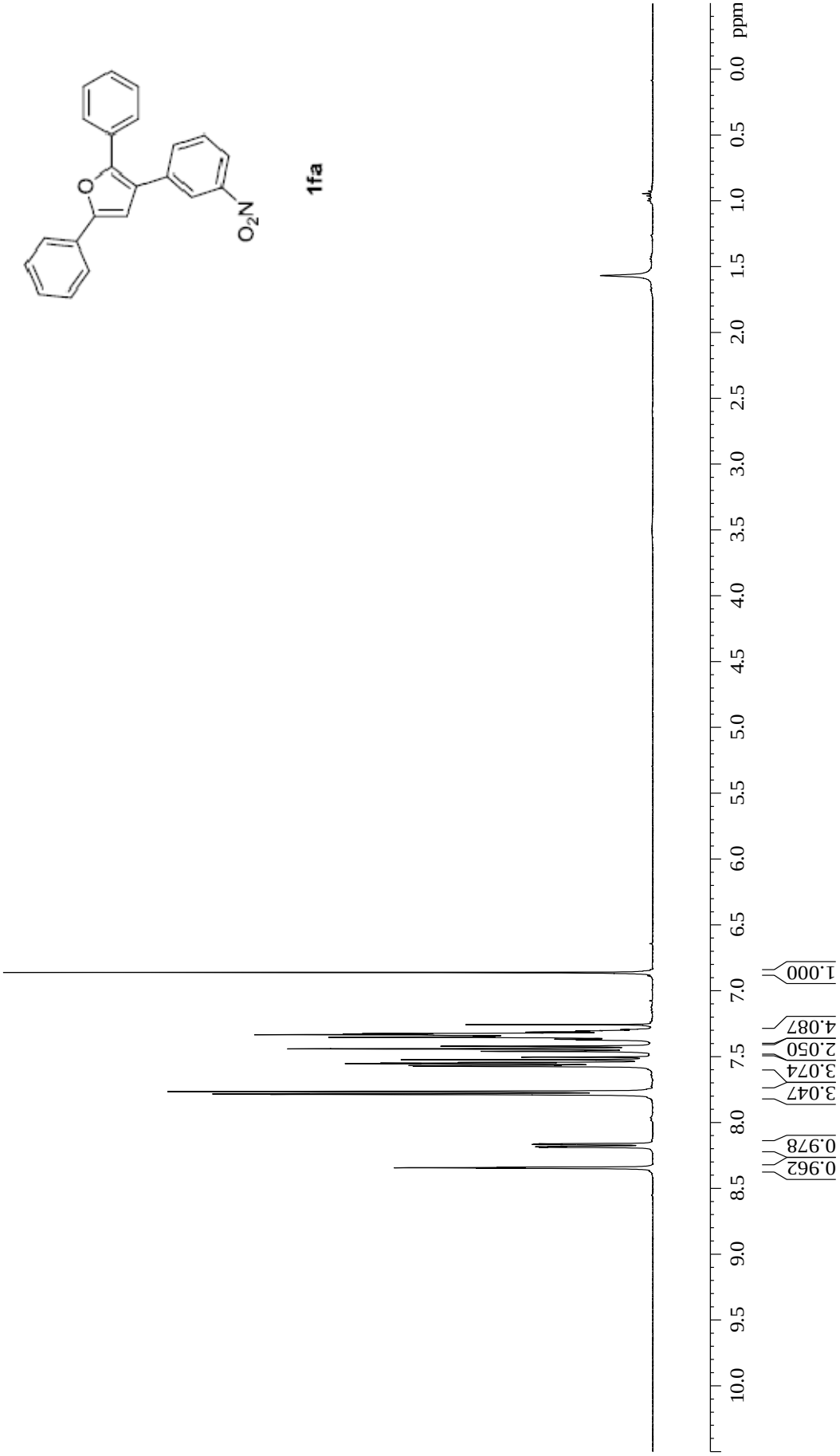
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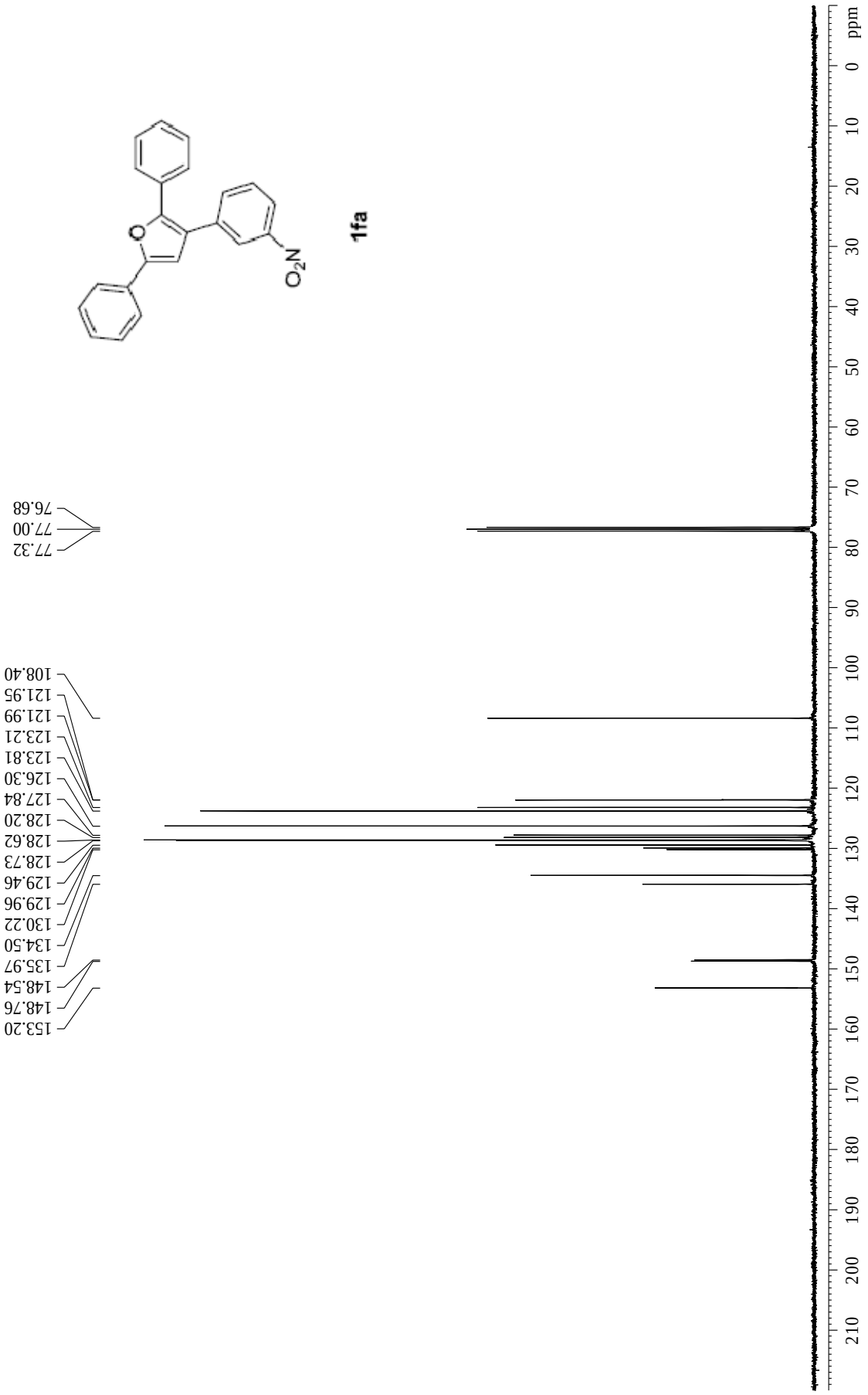
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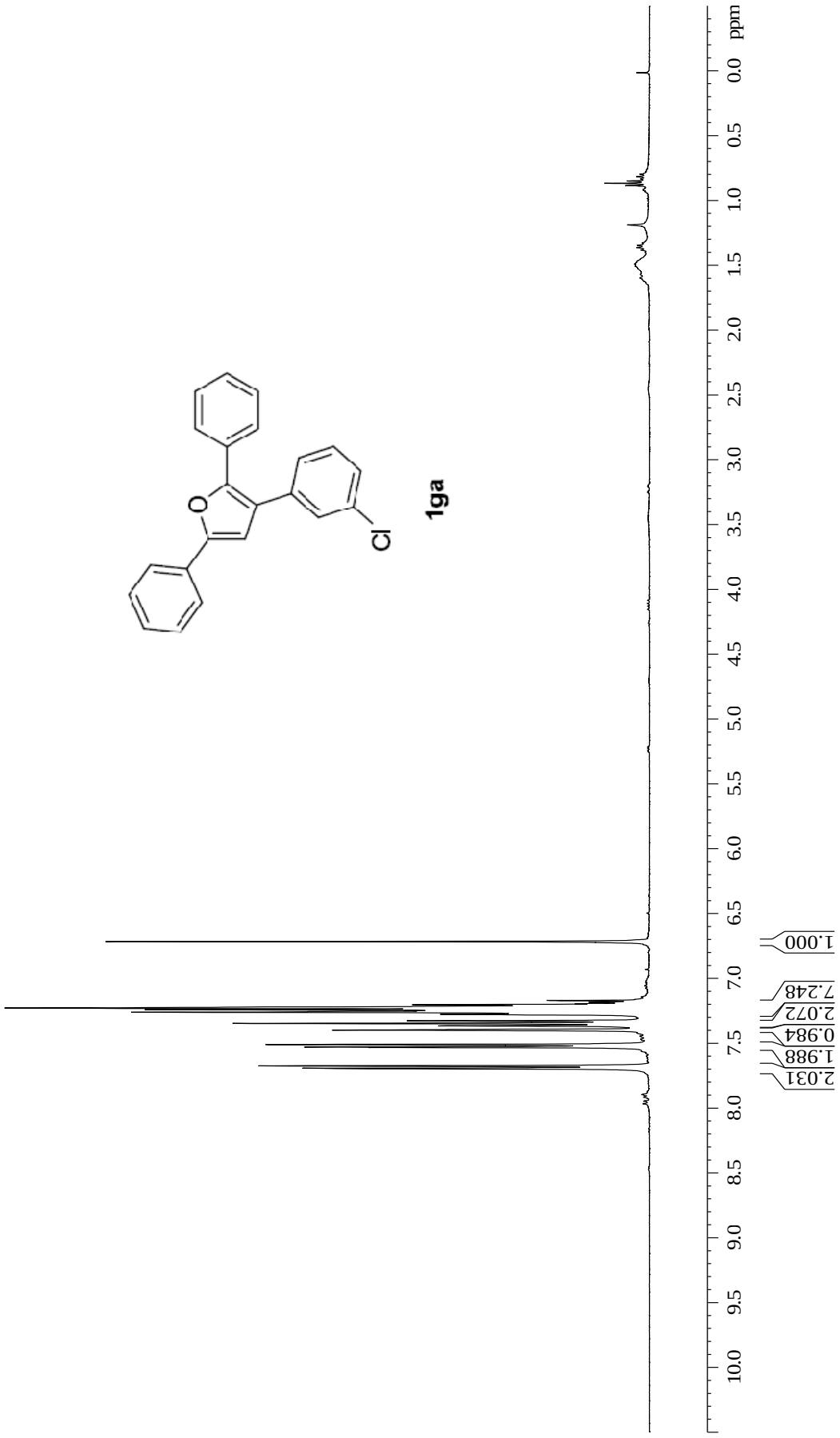
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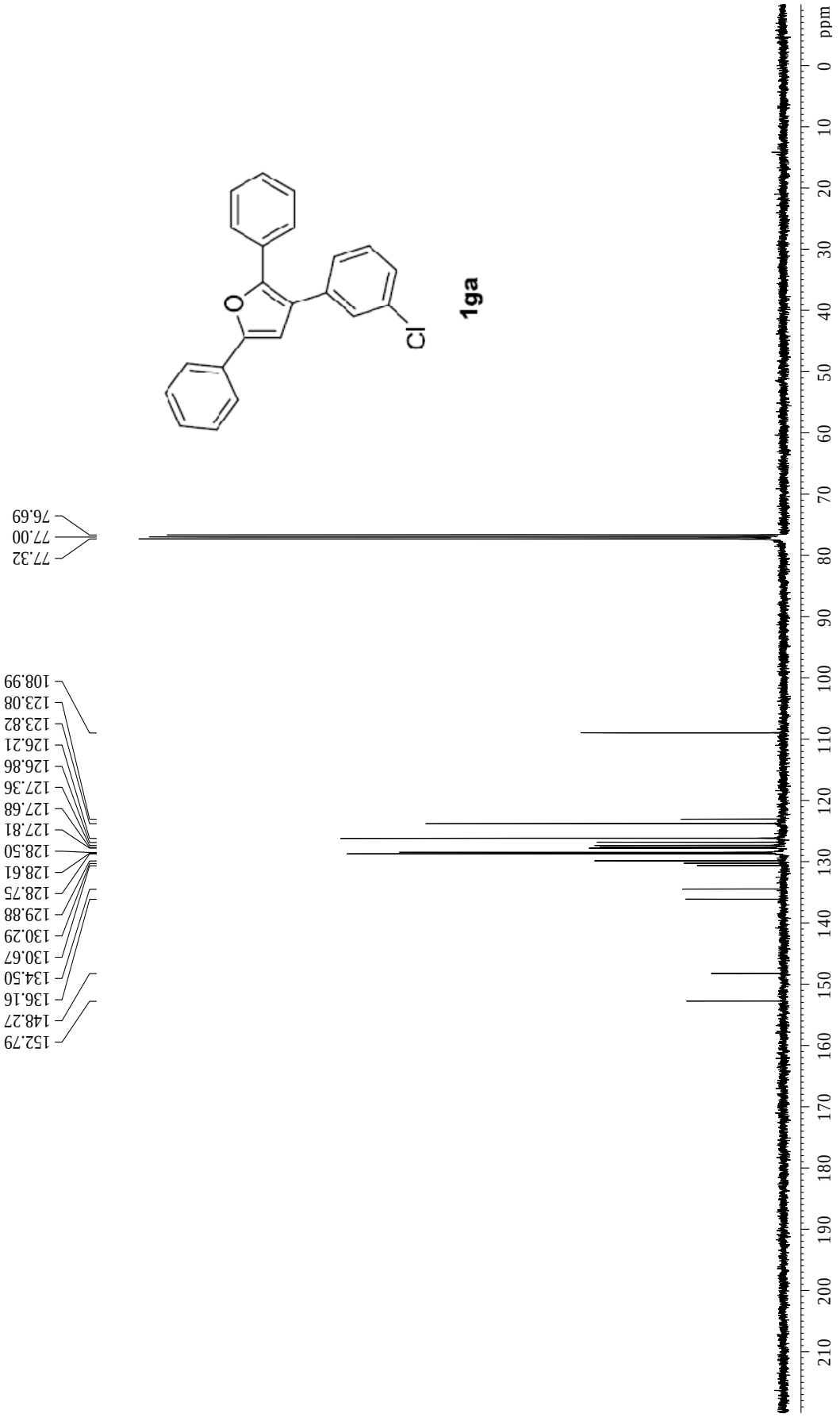
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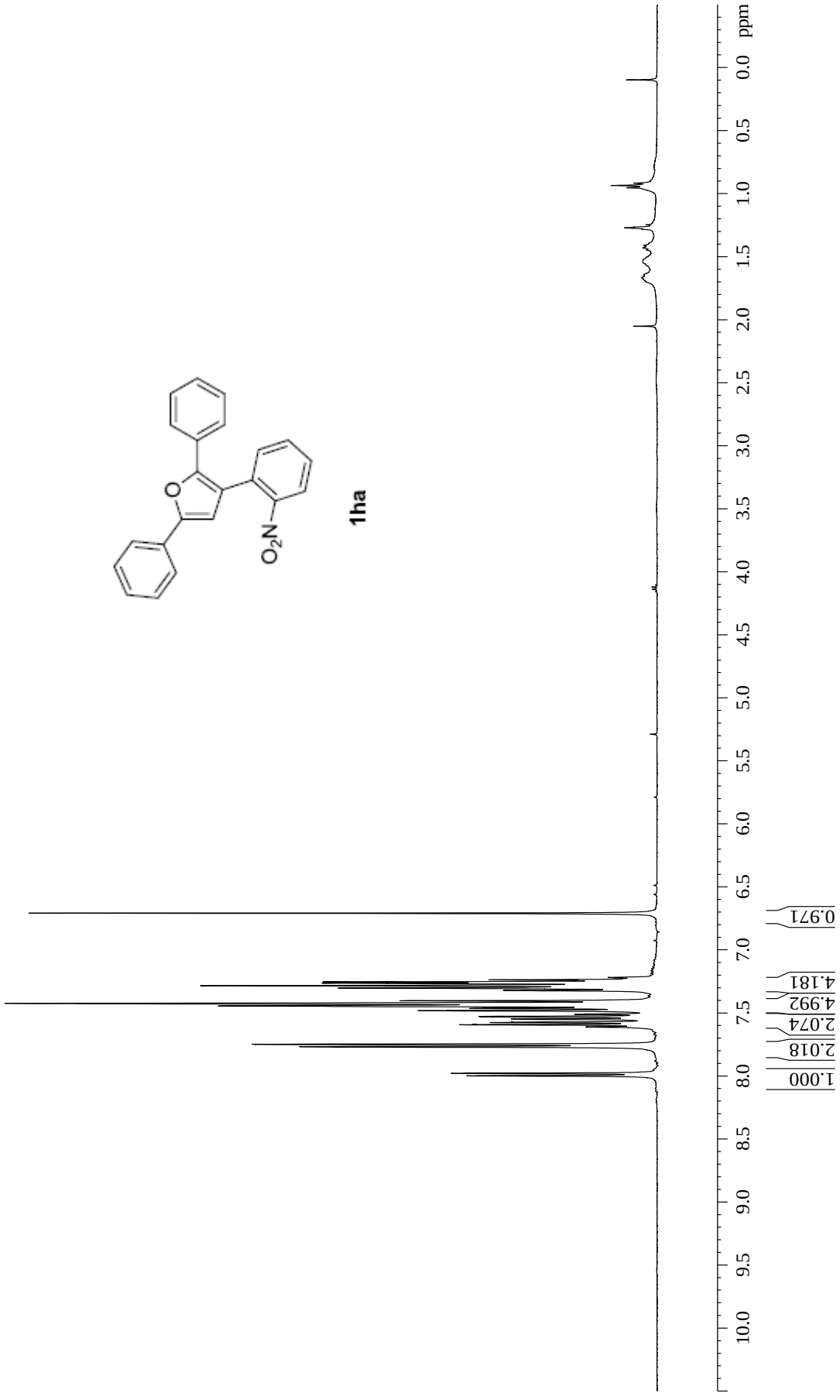
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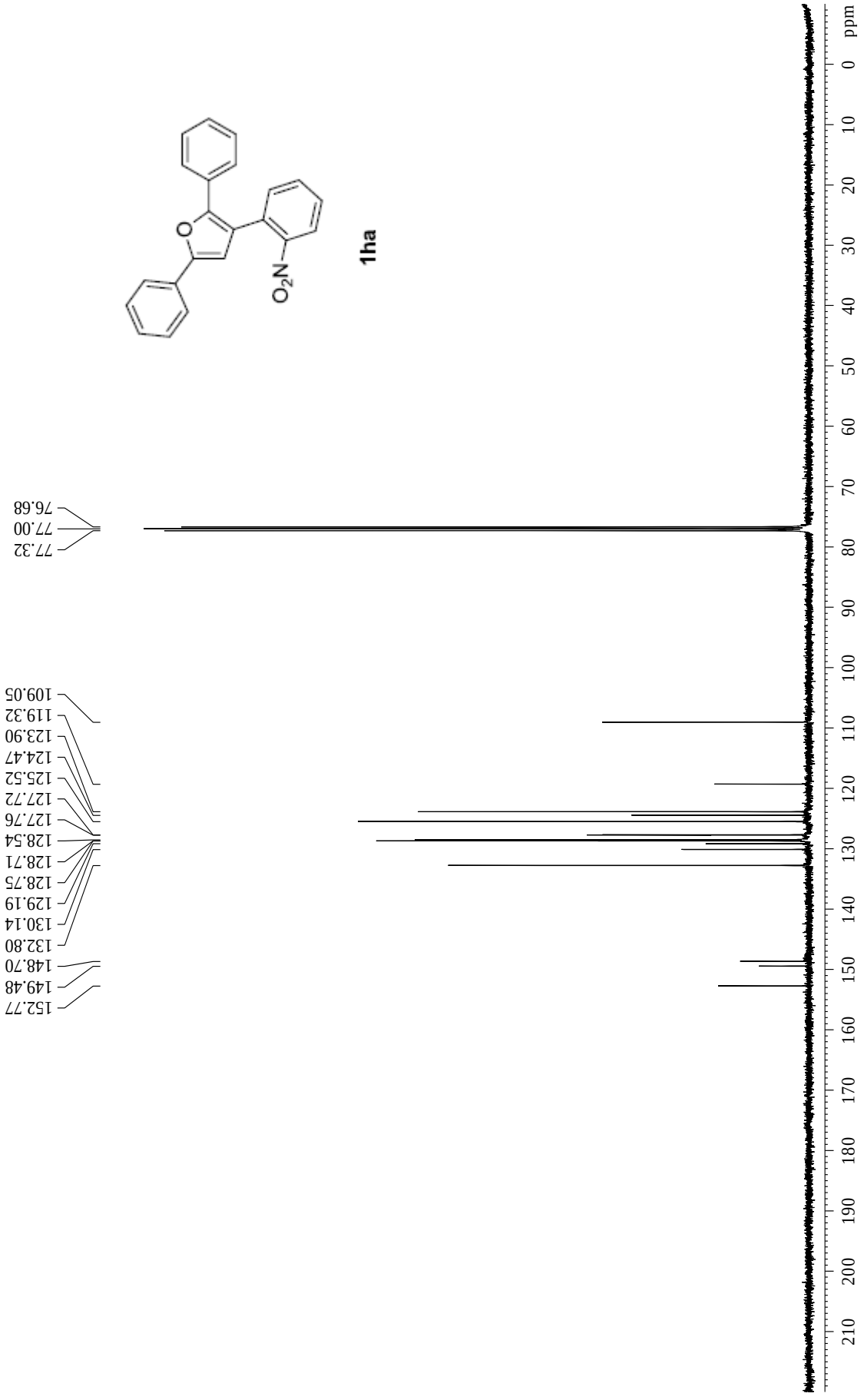
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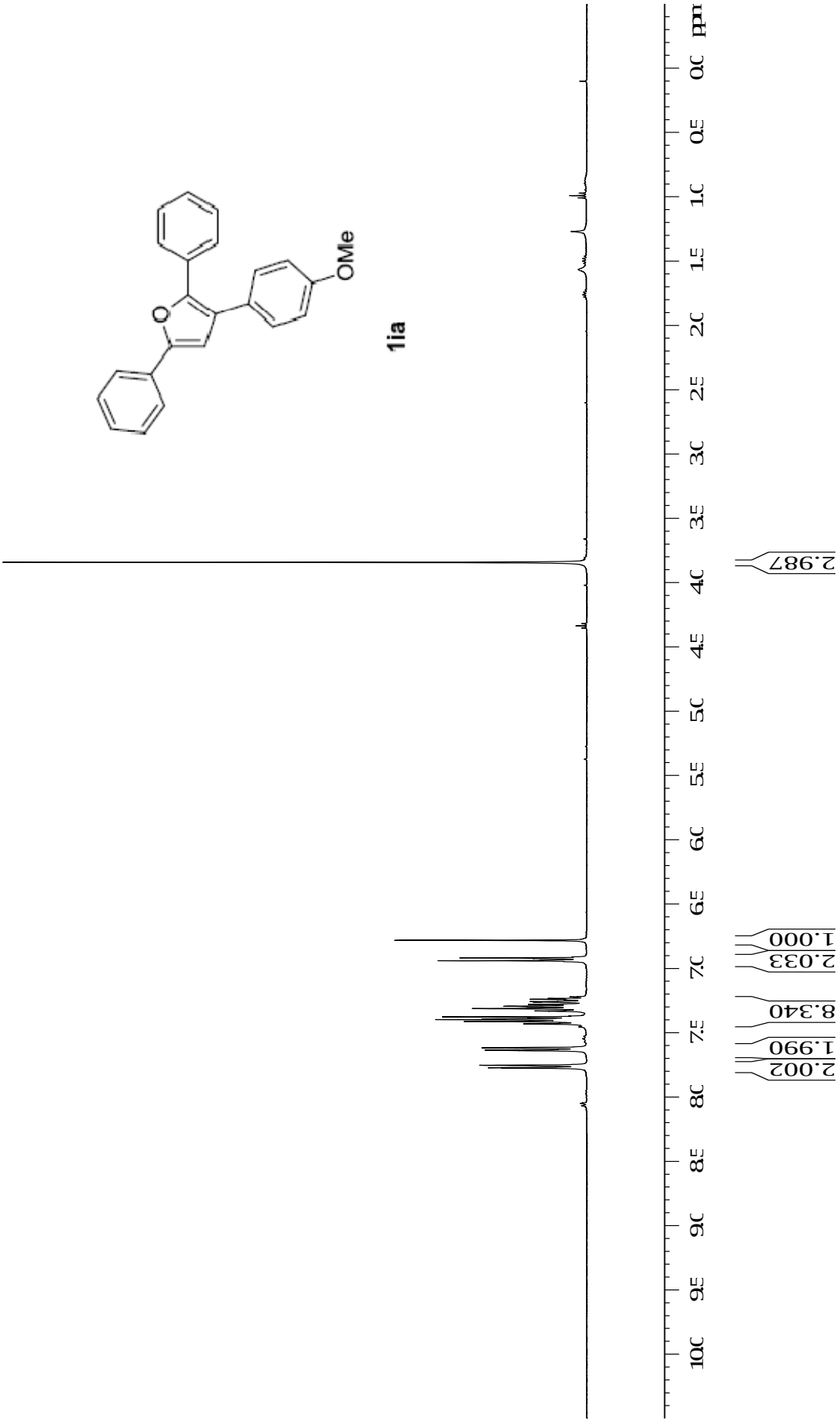
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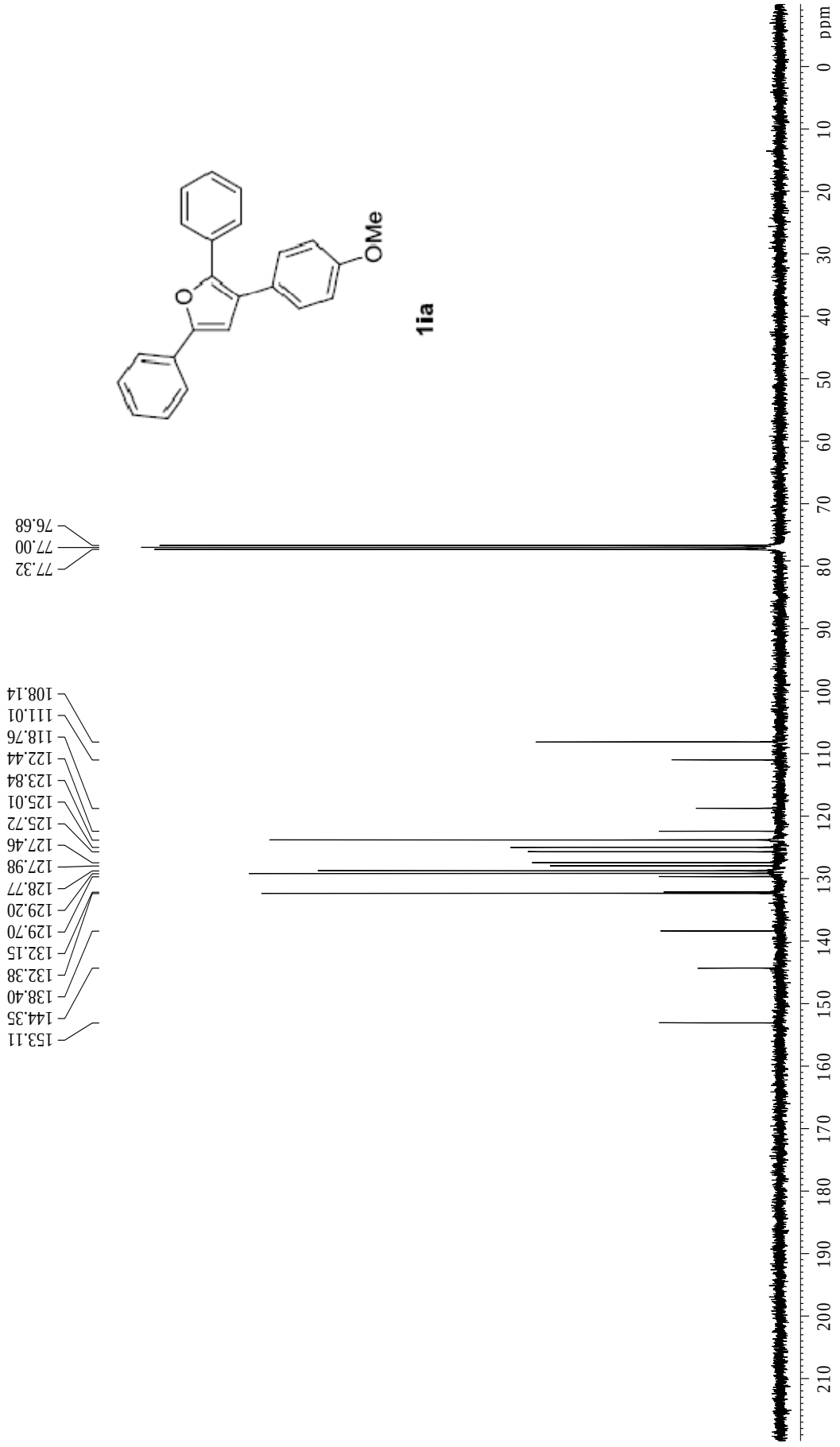
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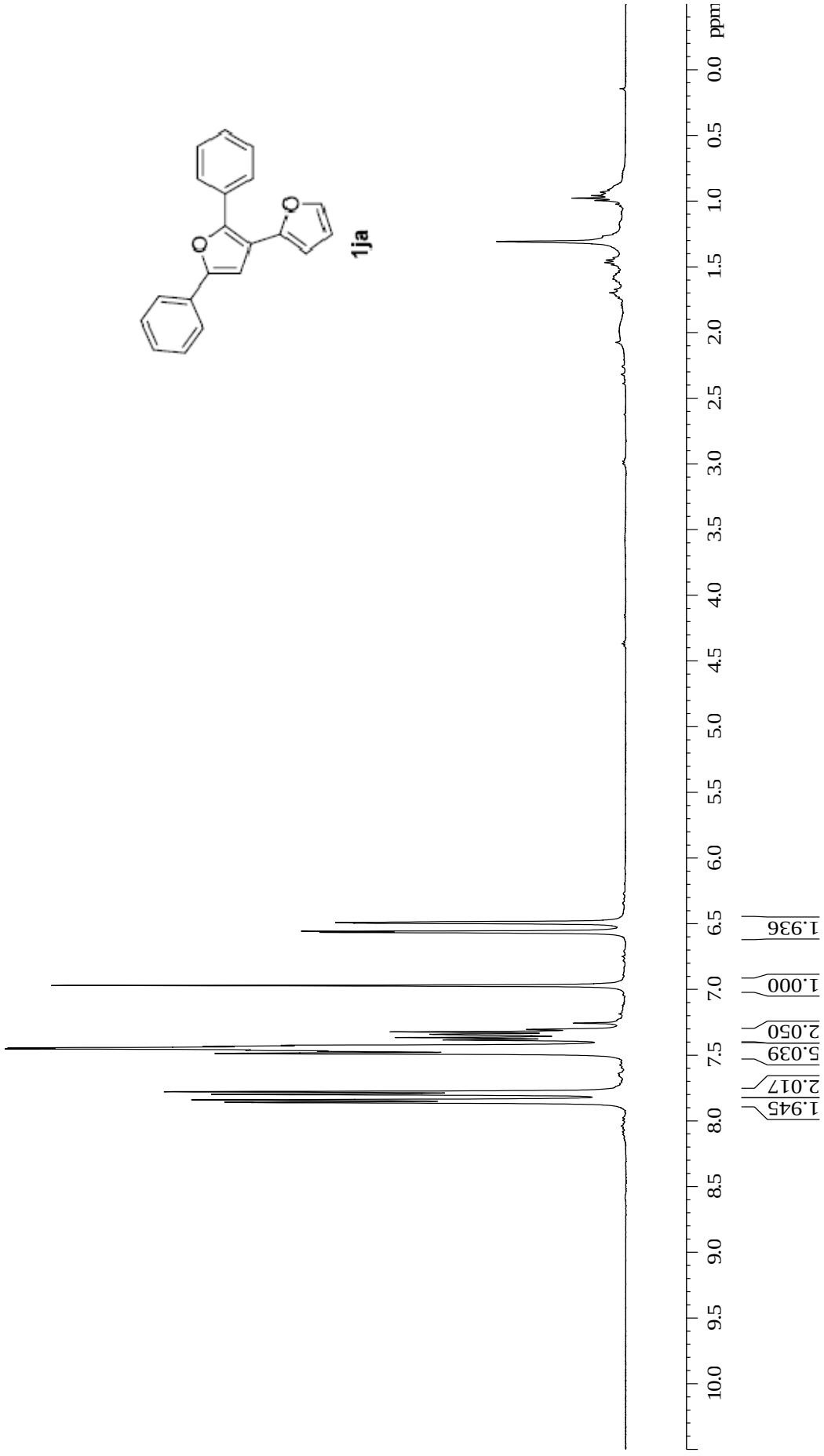
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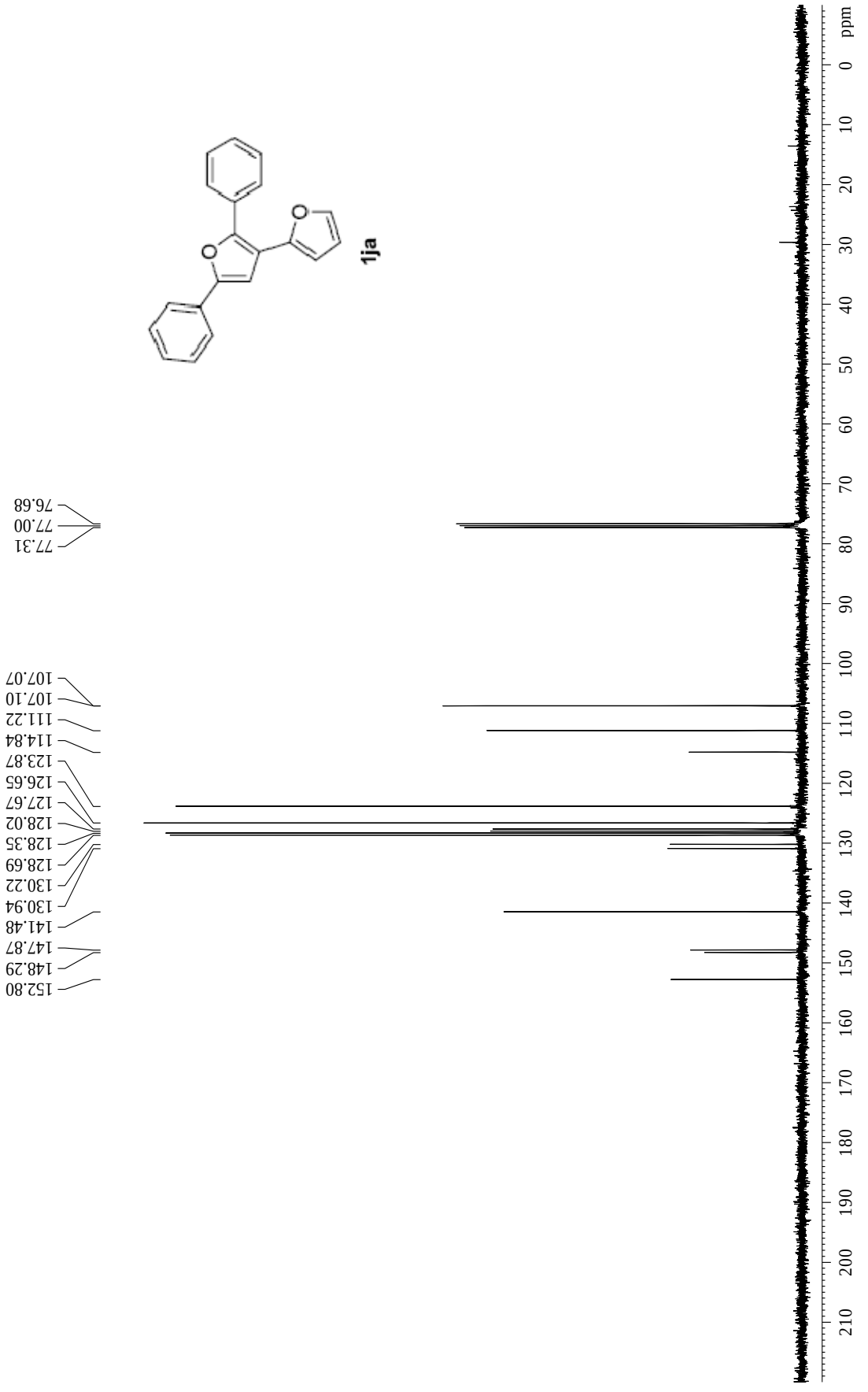
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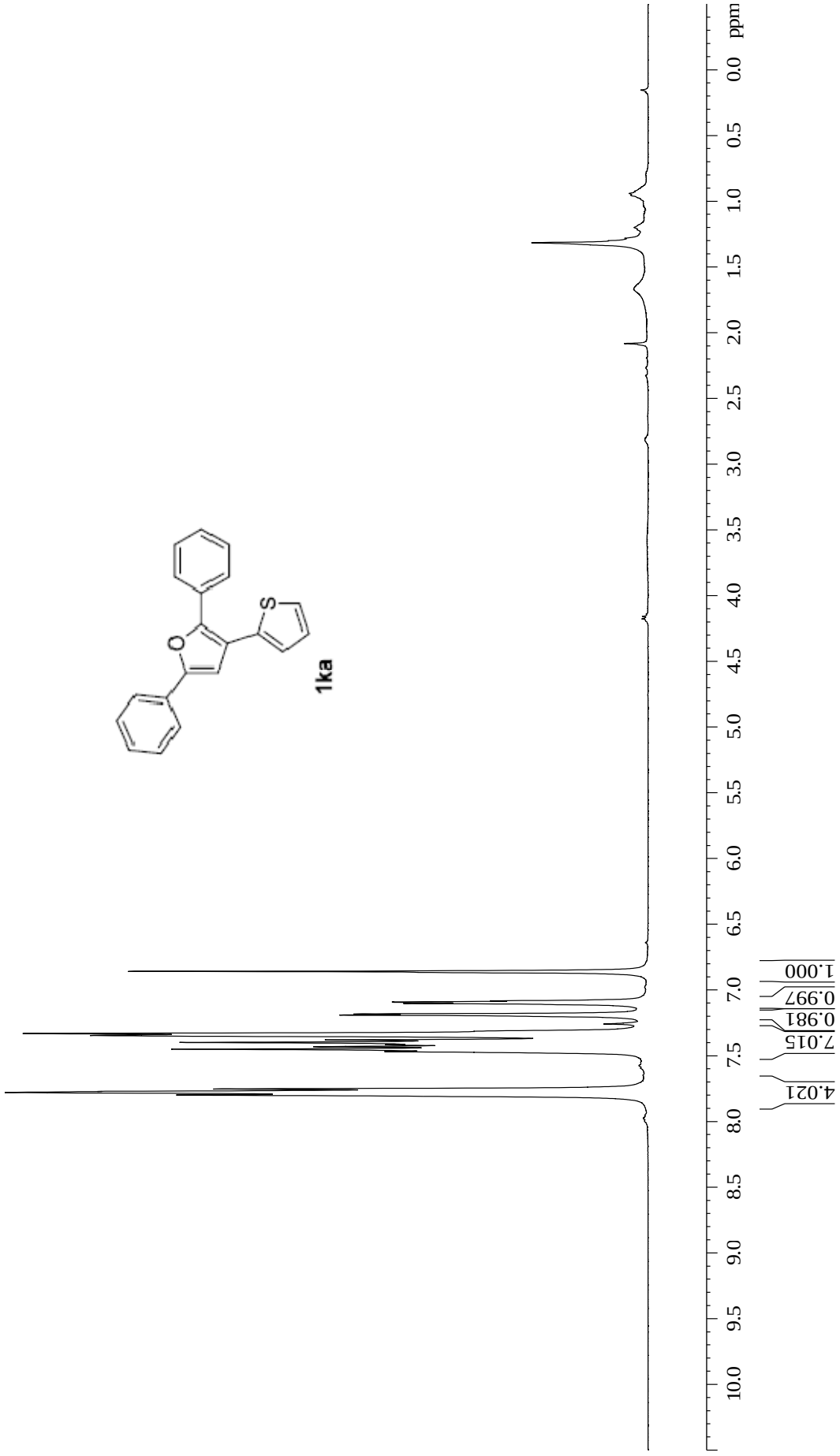
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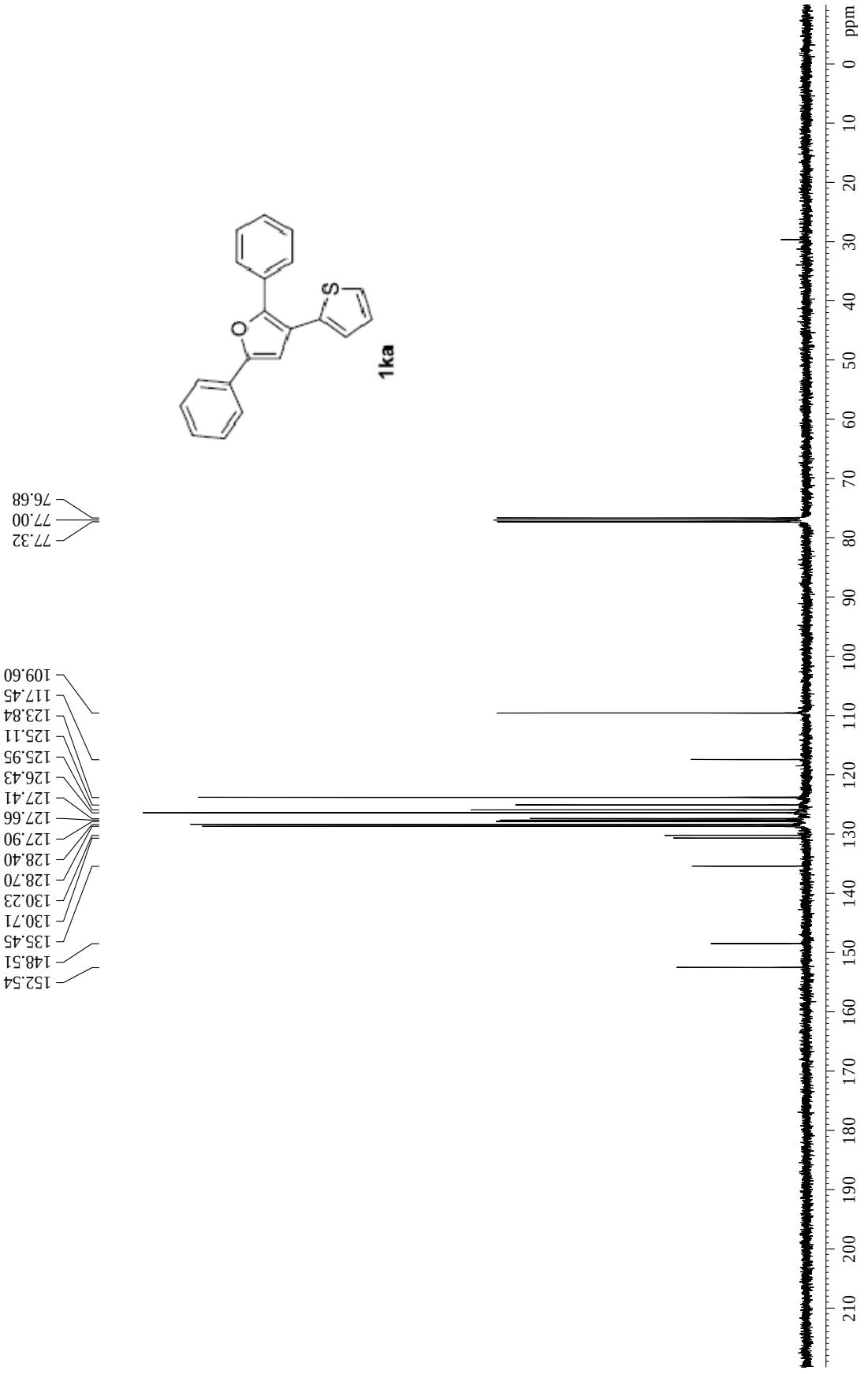
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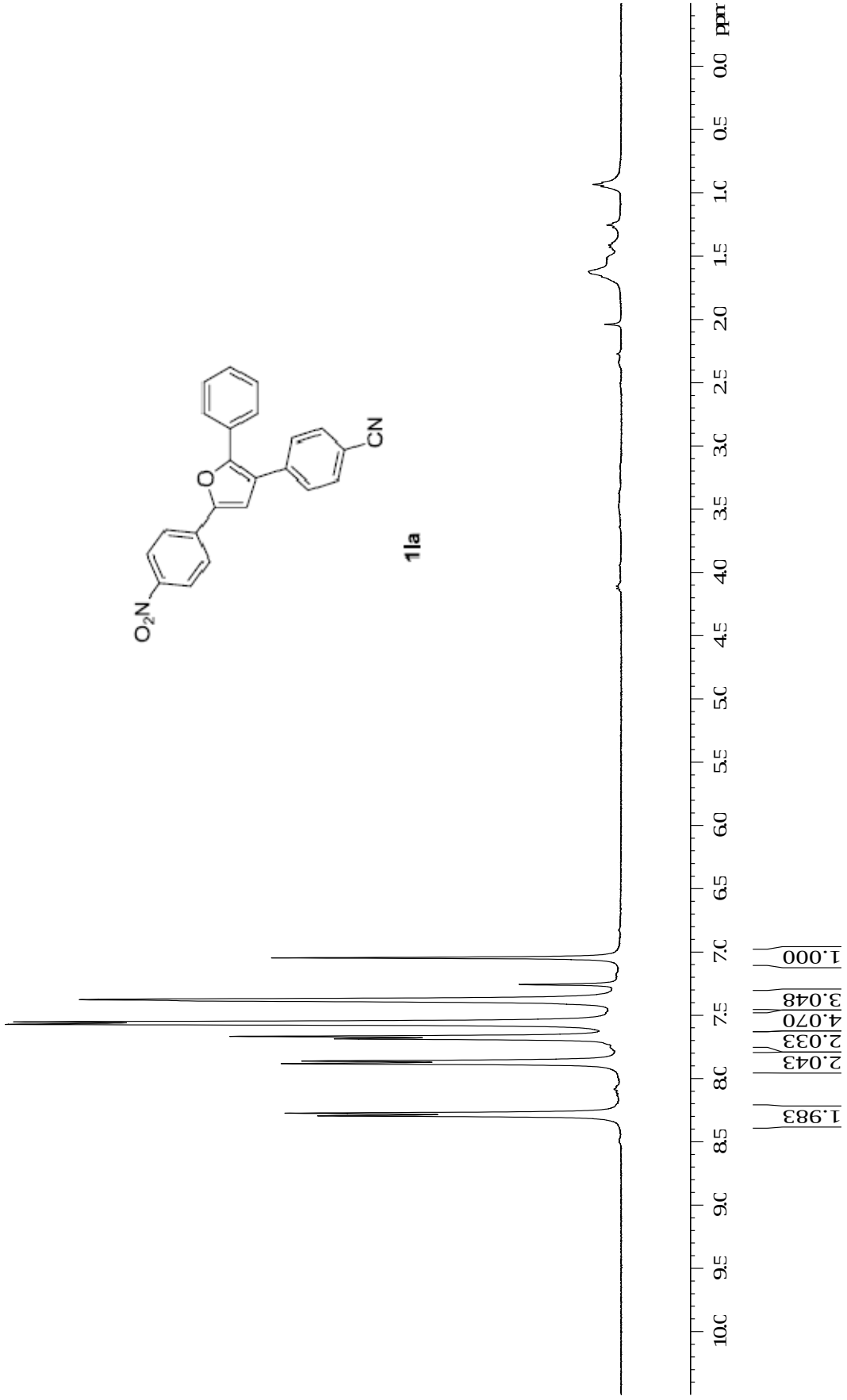
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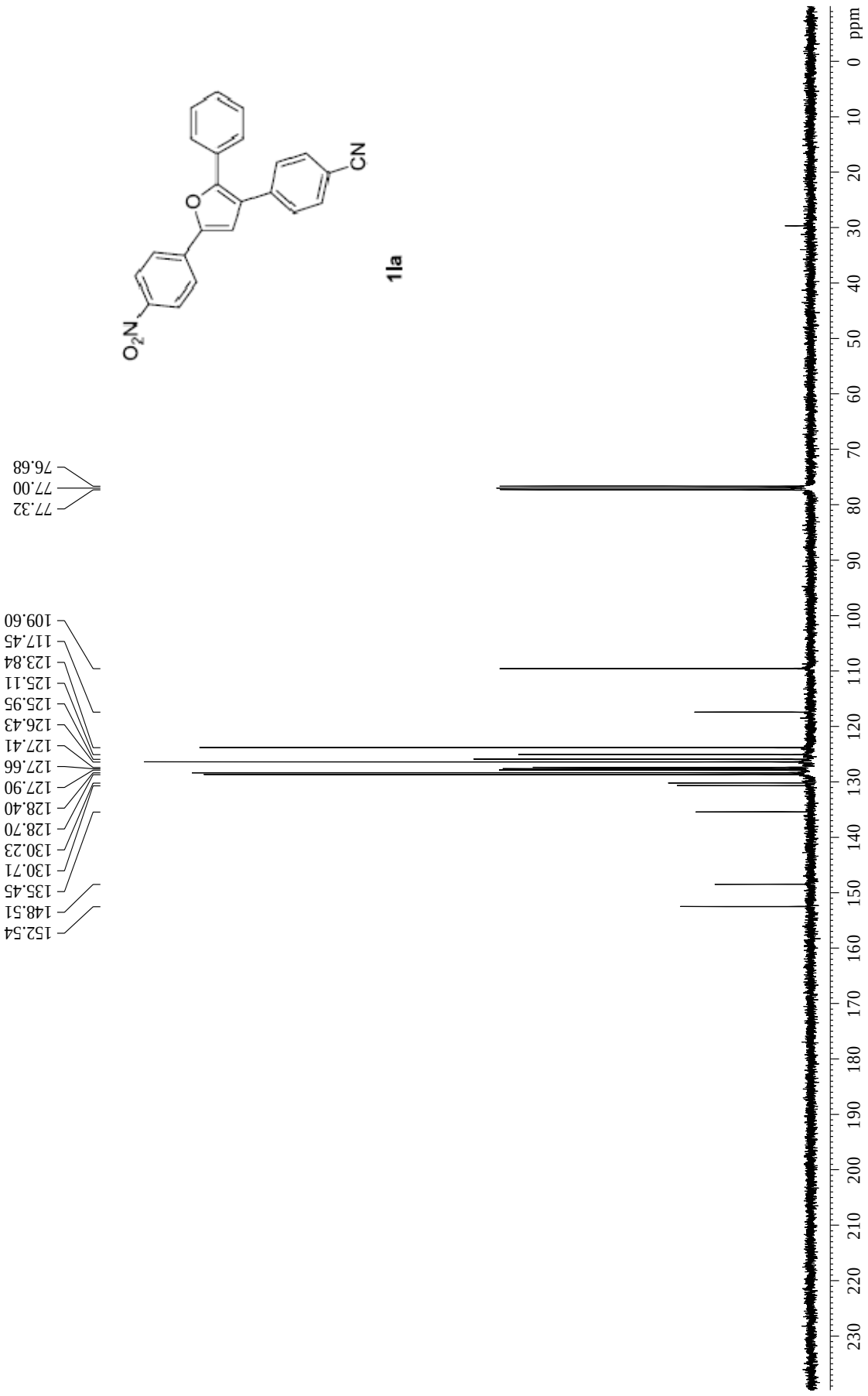
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128.40
128.70
130.23
130.71
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148.51
152.54
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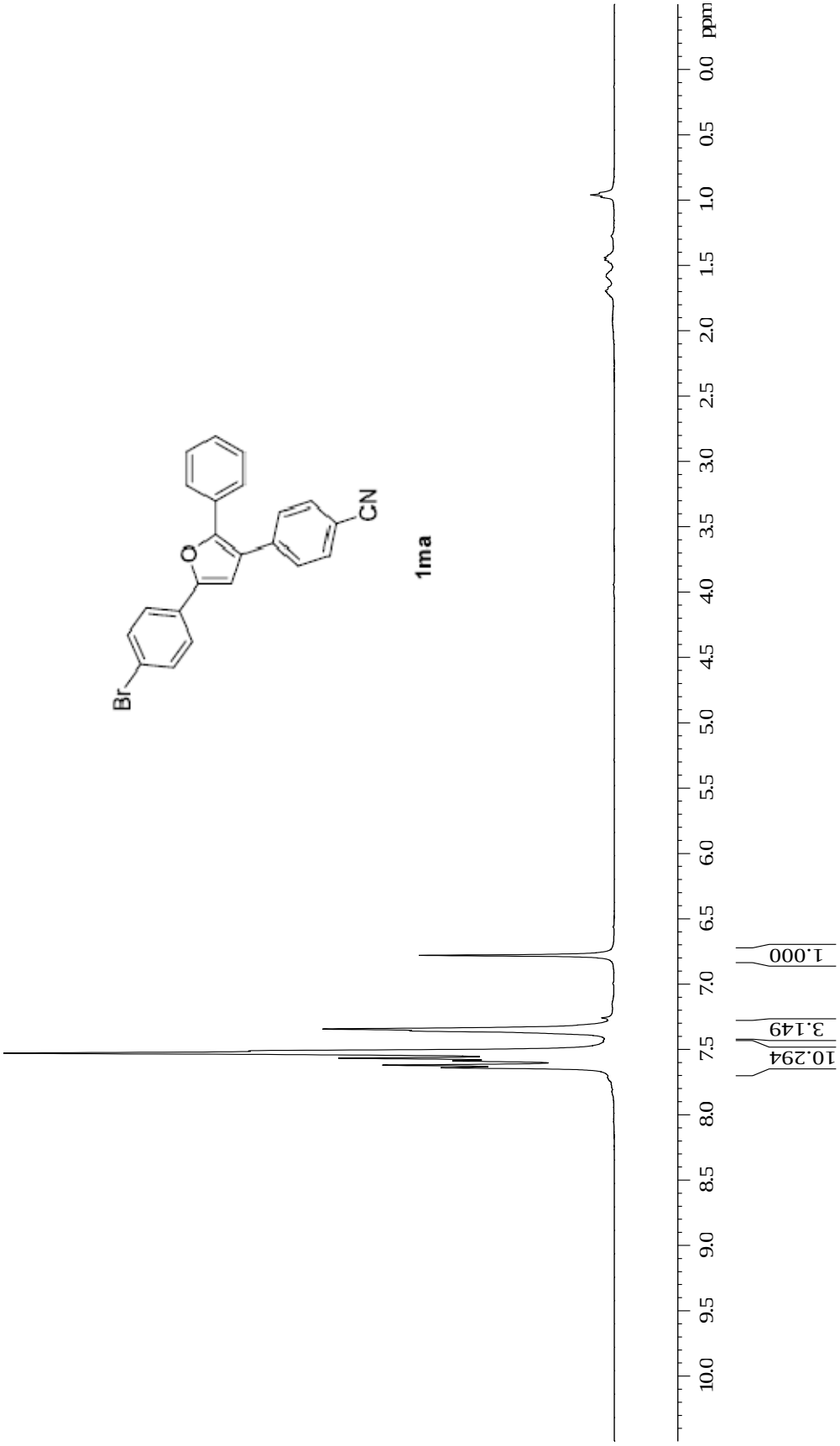
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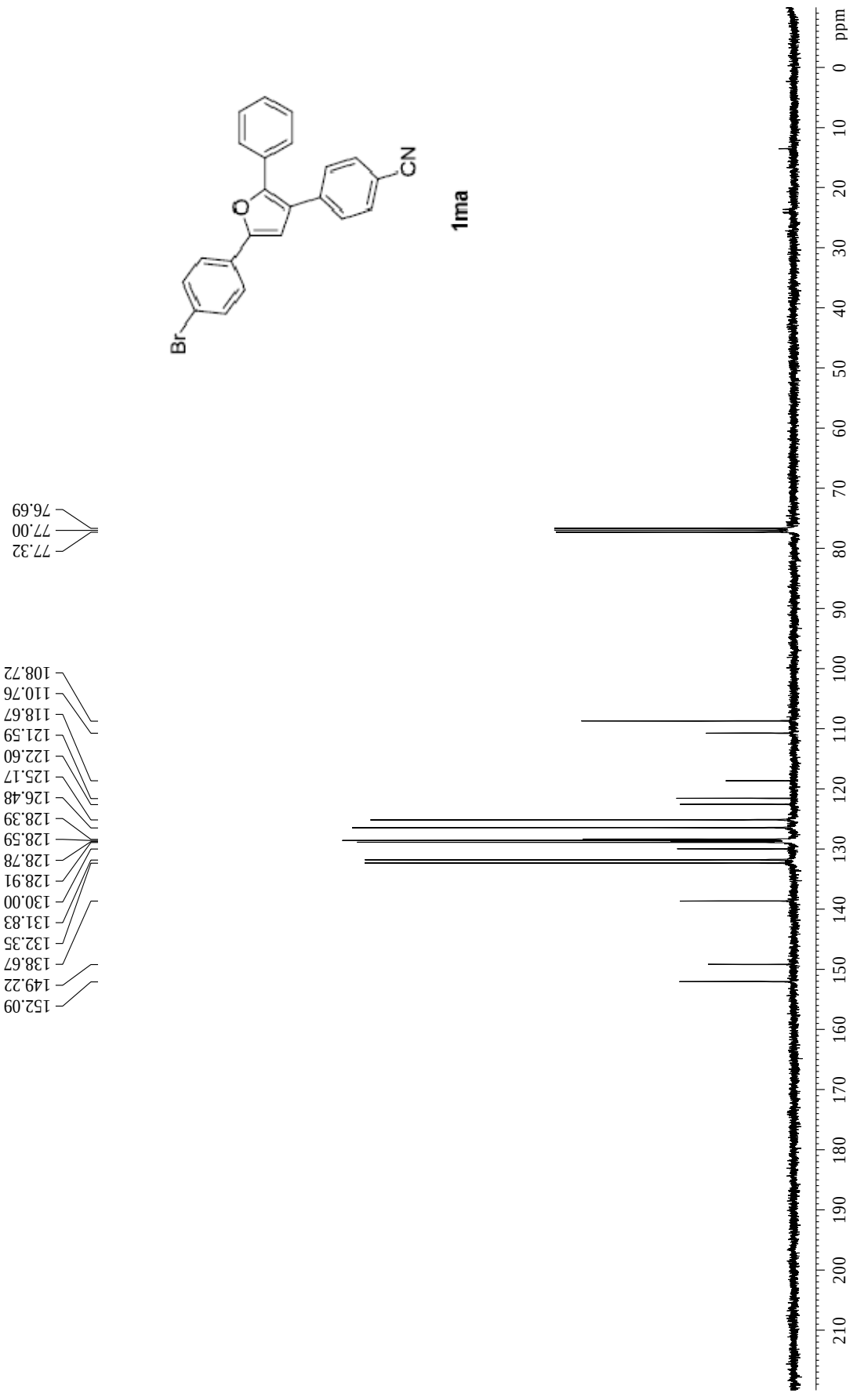
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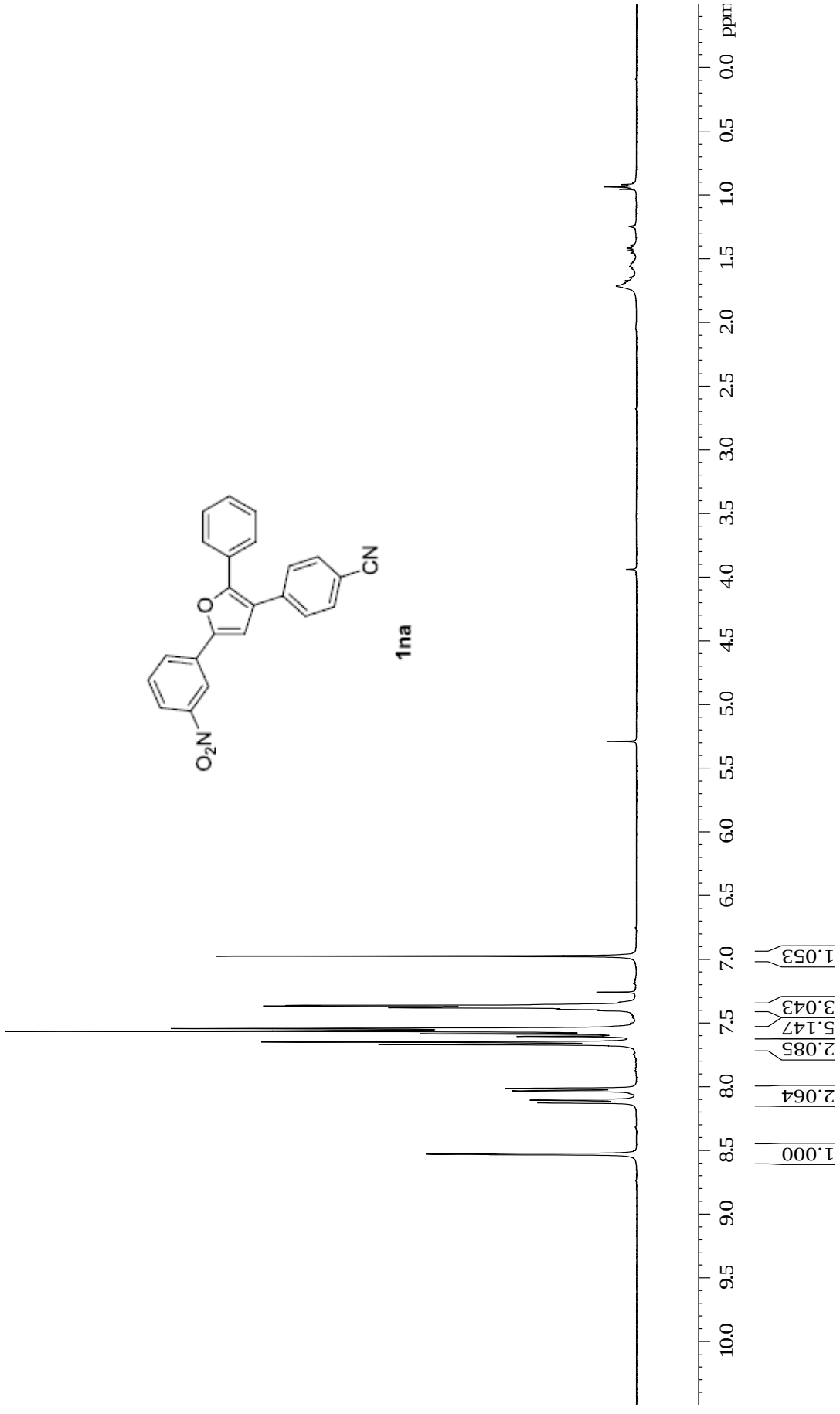
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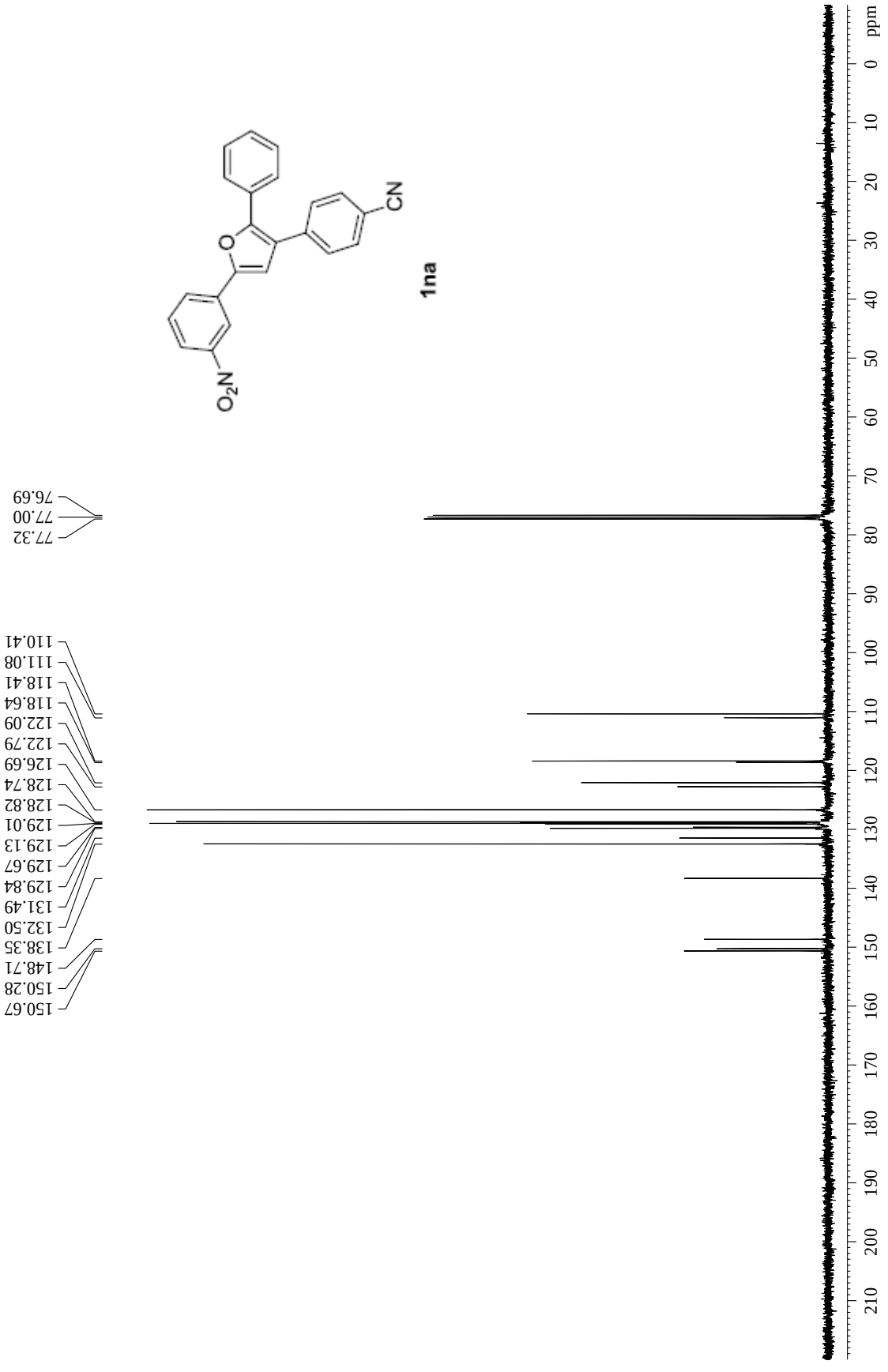
1.053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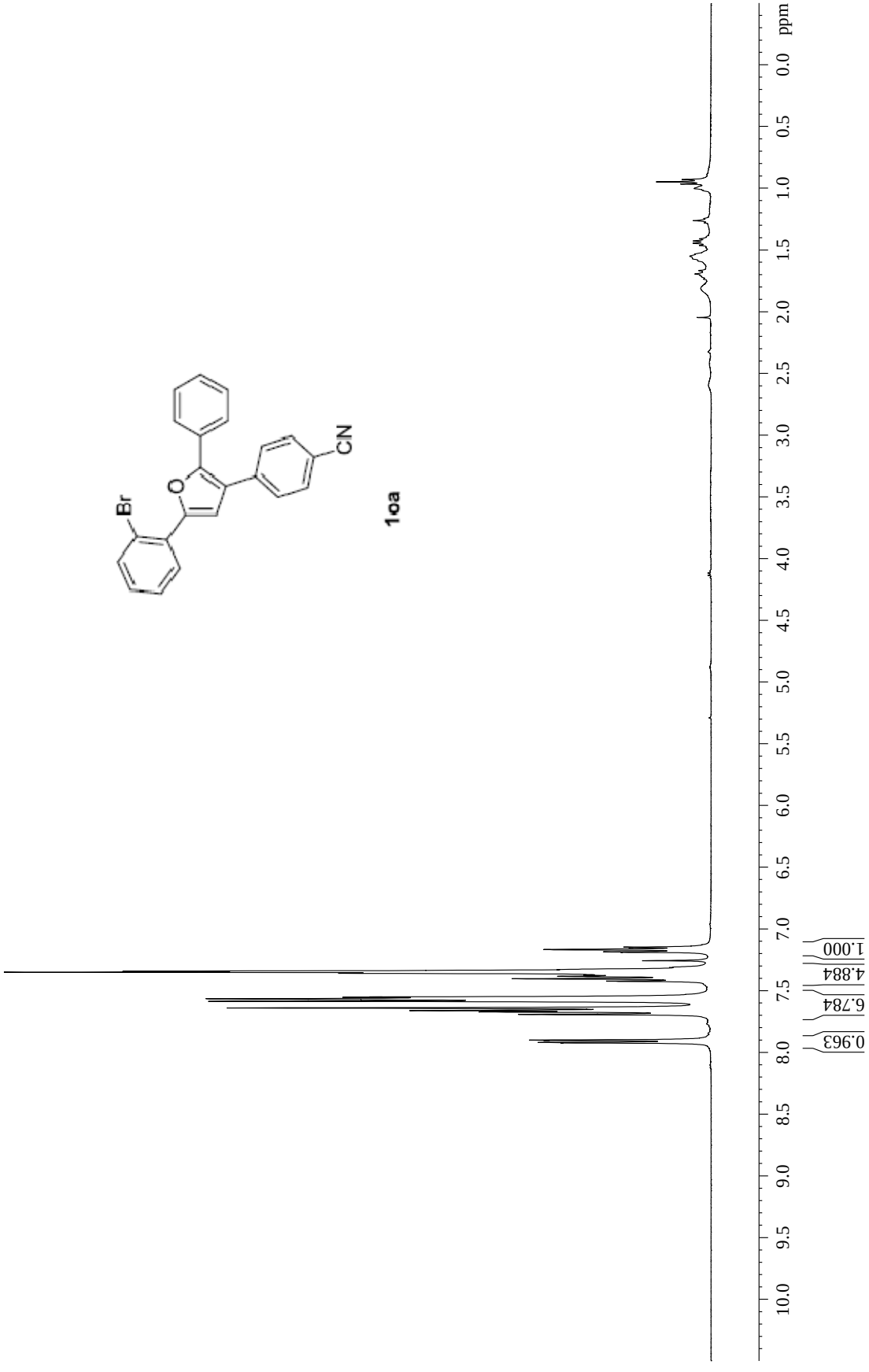
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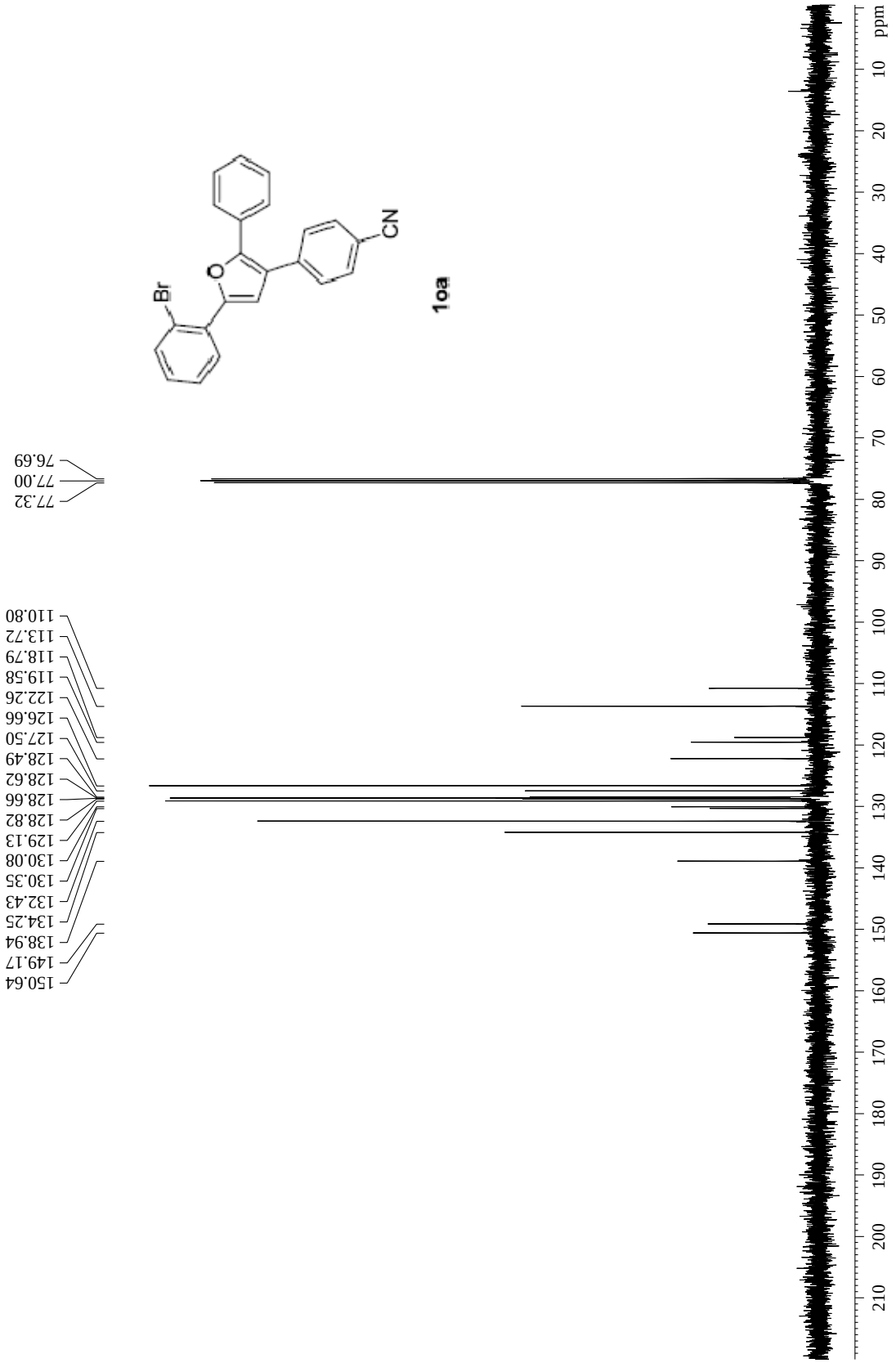
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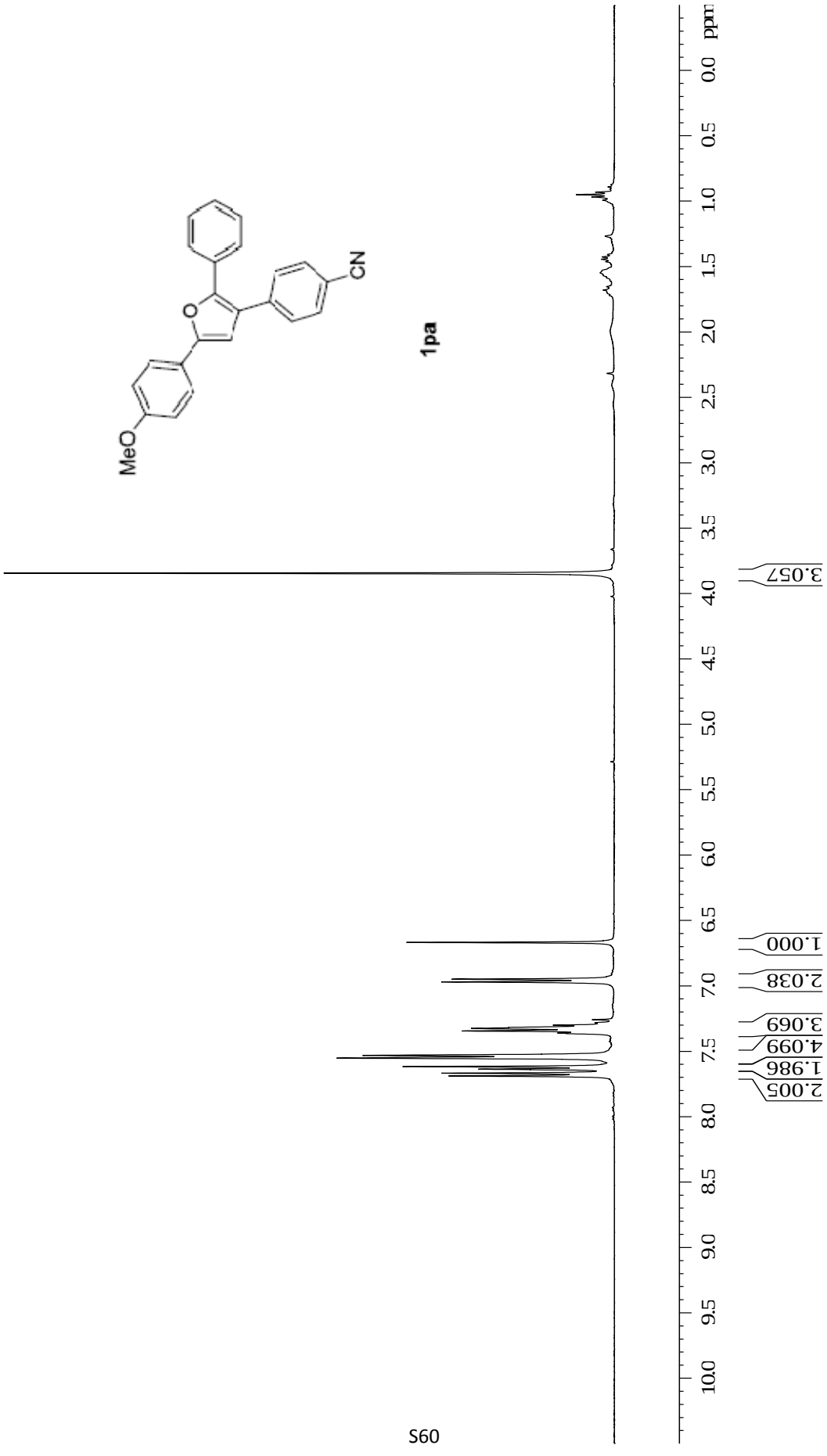
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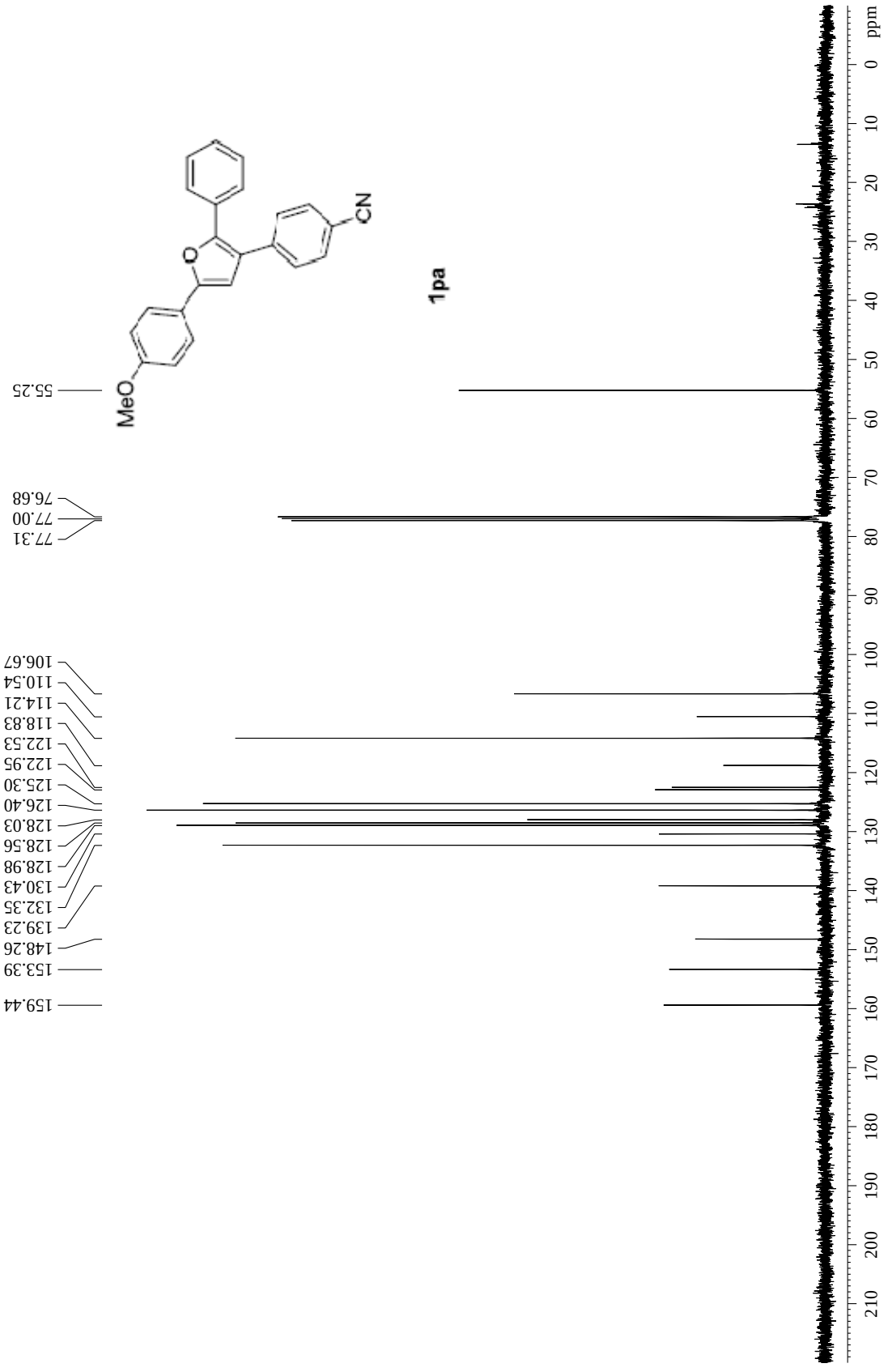
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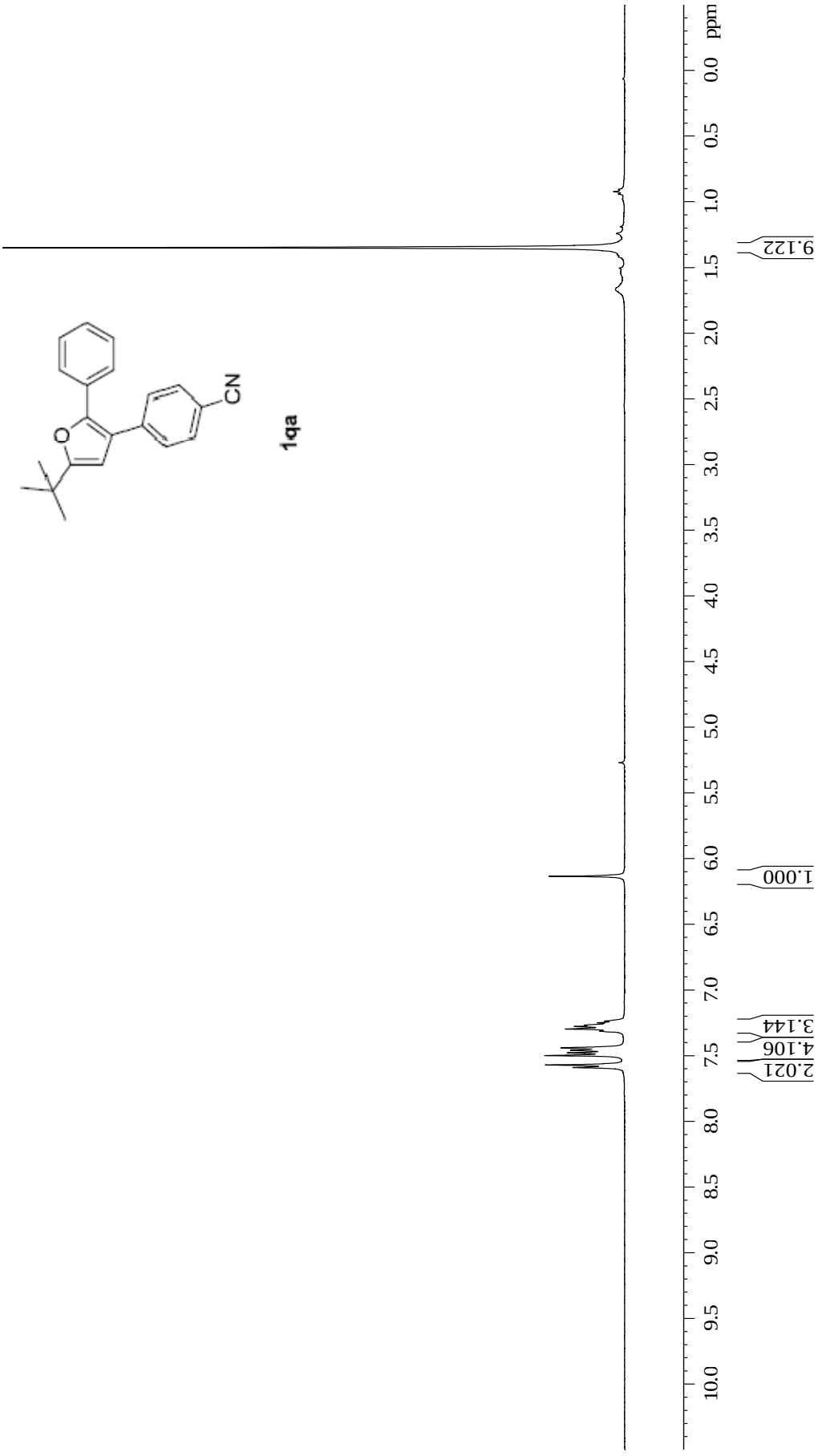
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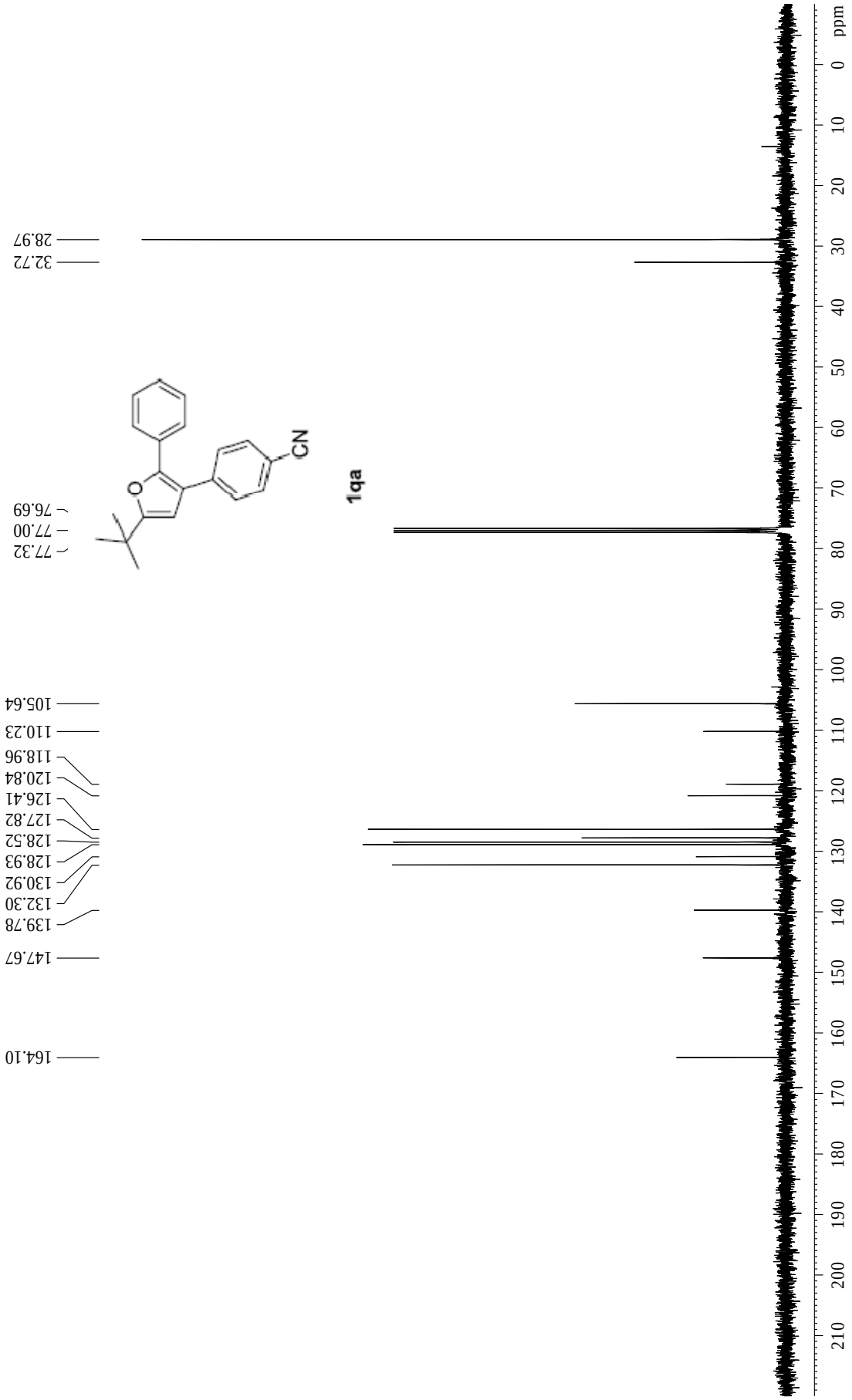
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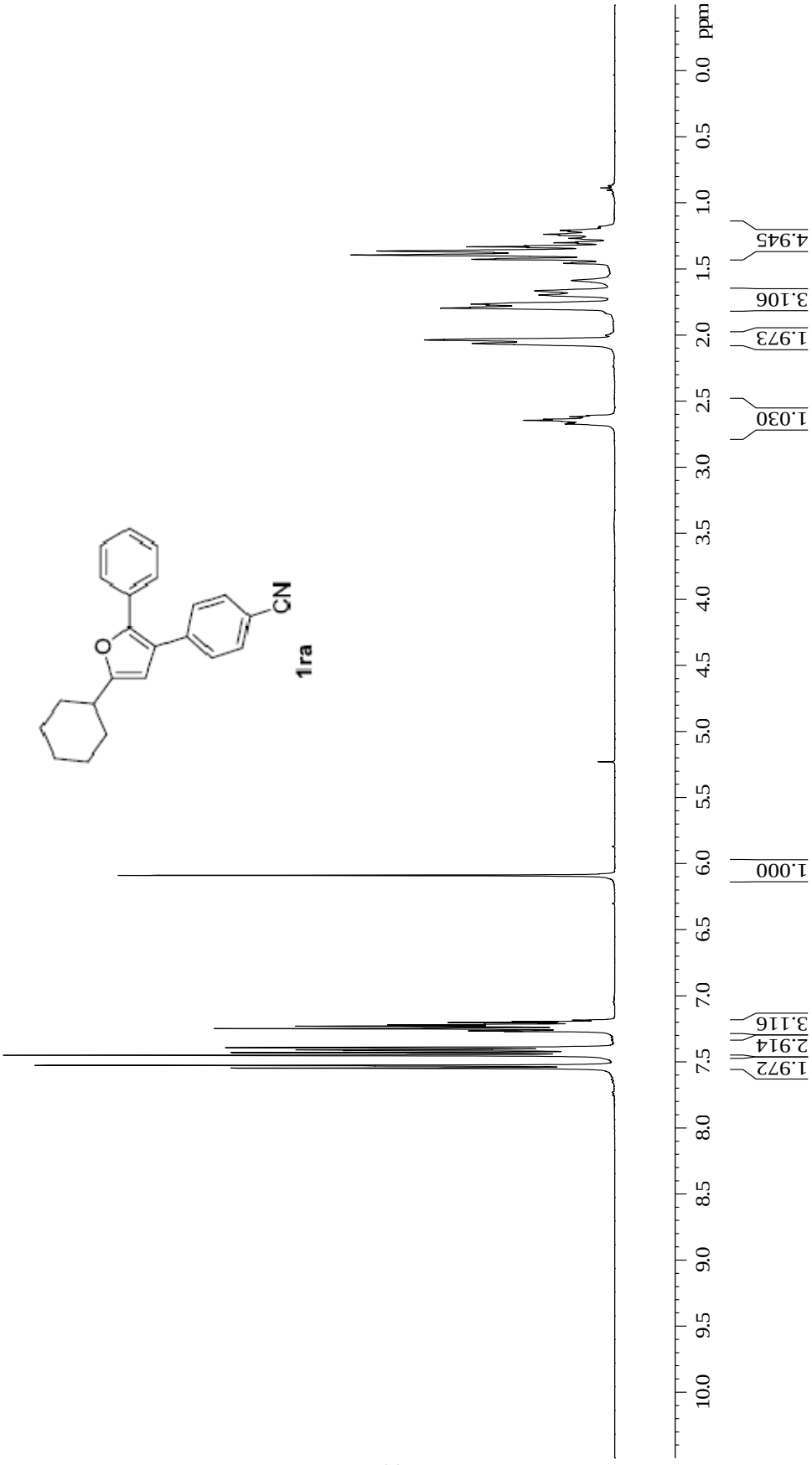
CN
O
ppm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6.0
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8.0
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9.0
9.5
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2.914
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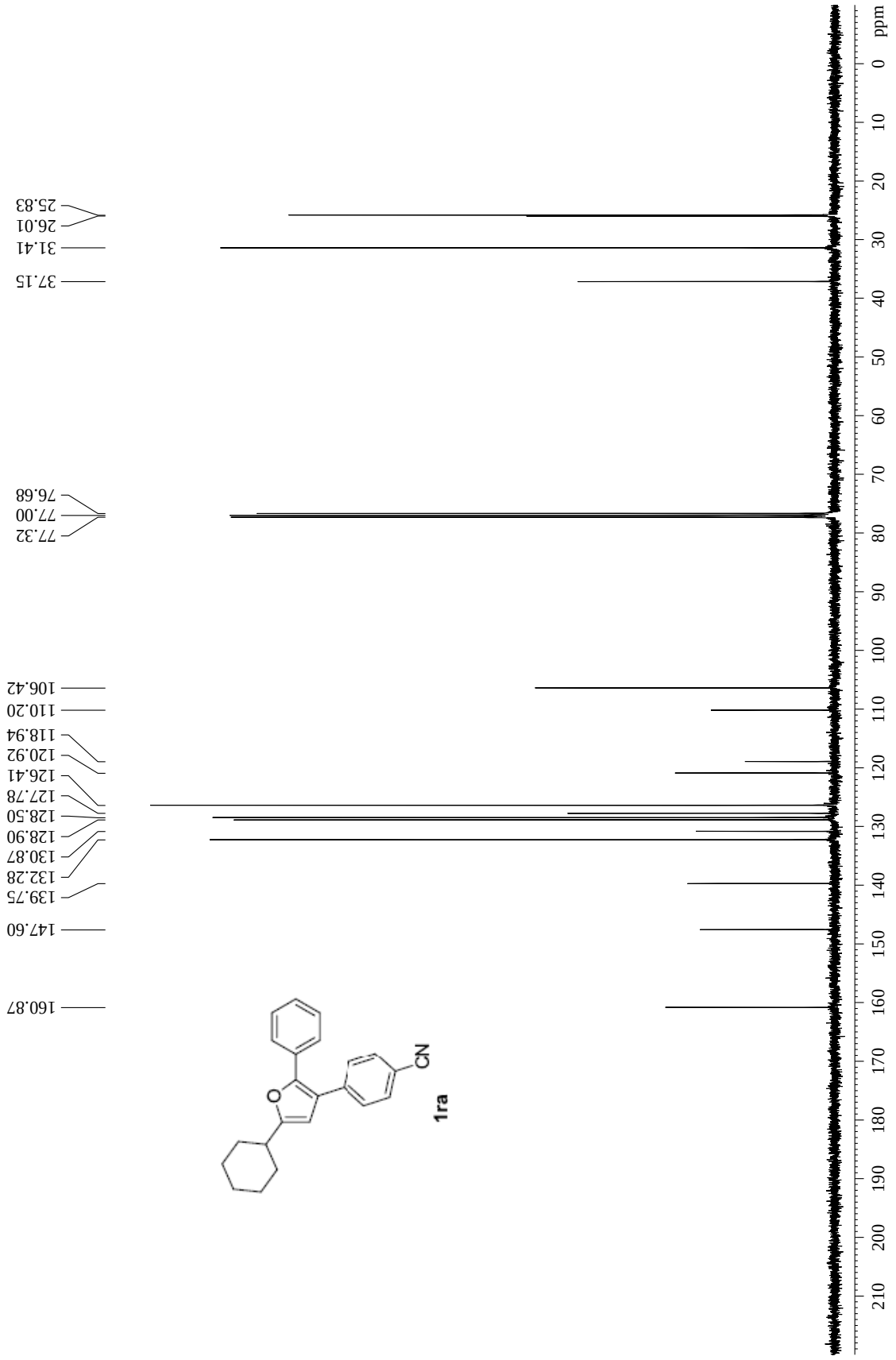
O
CN
1ra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77.00
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37.15
31.41
26.01
25.83
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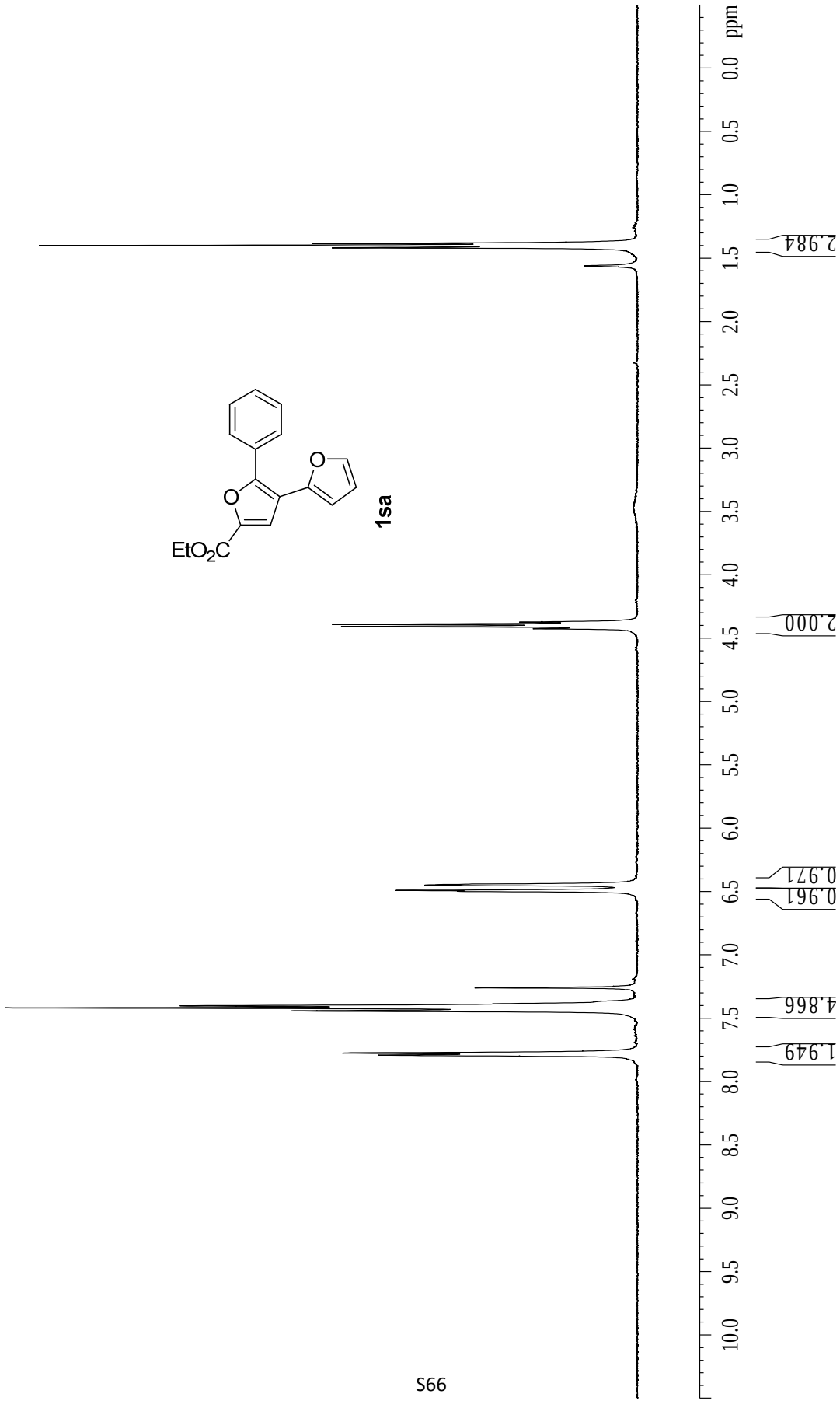
CN
1ra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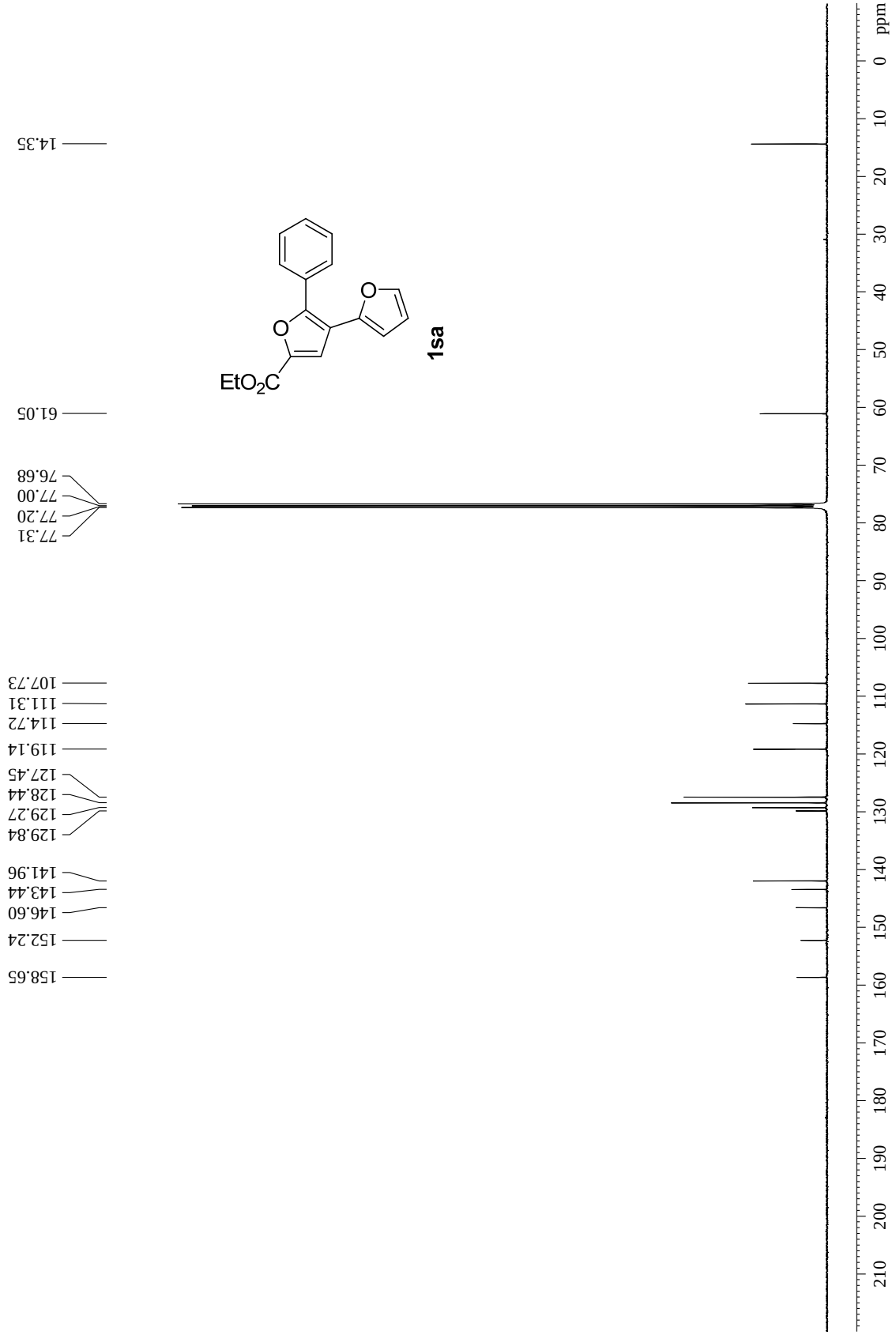
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143.44
146.60
152.24
158.65
O
O
EtO2C
1sa
ppm
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100
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200
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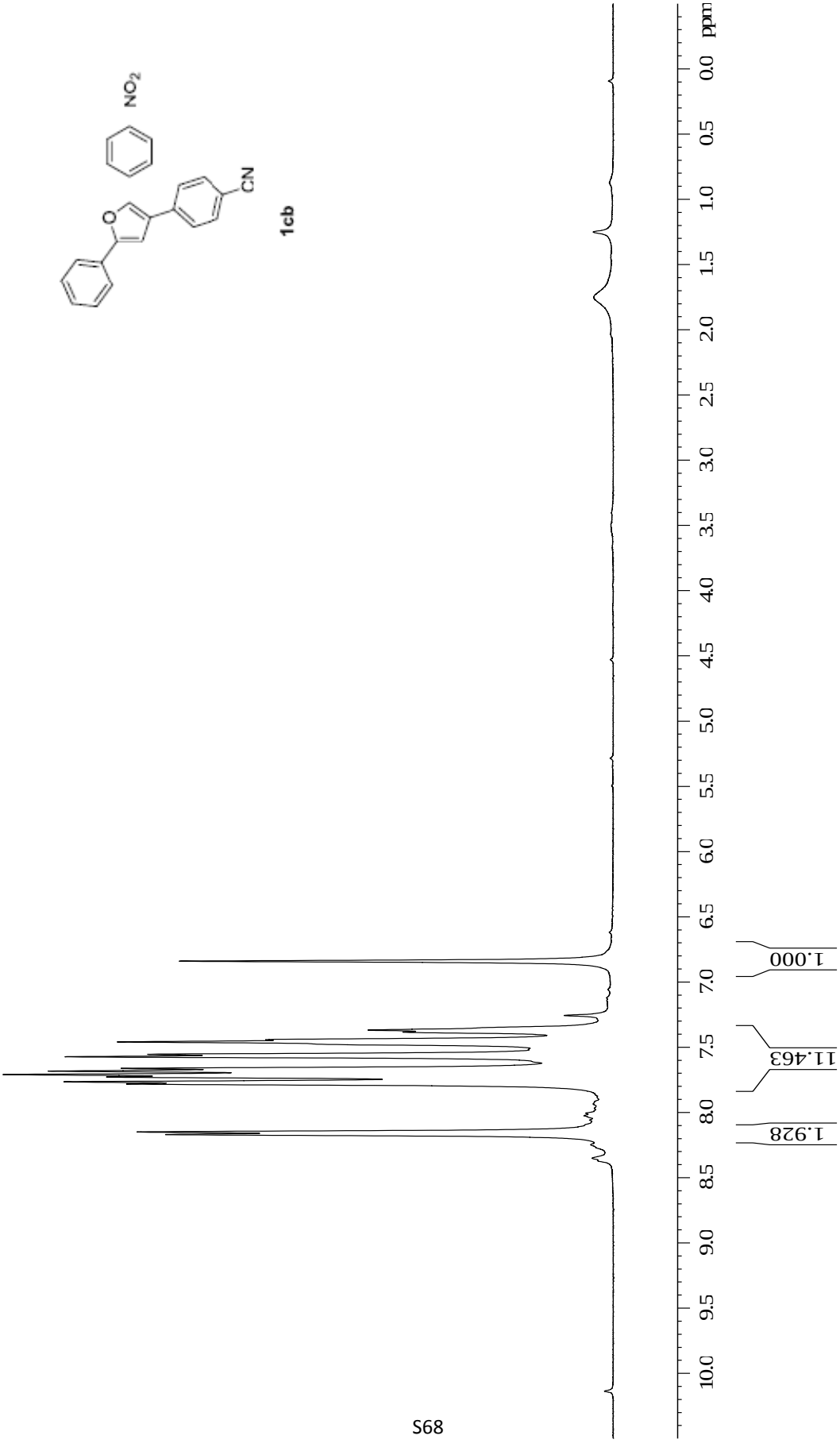
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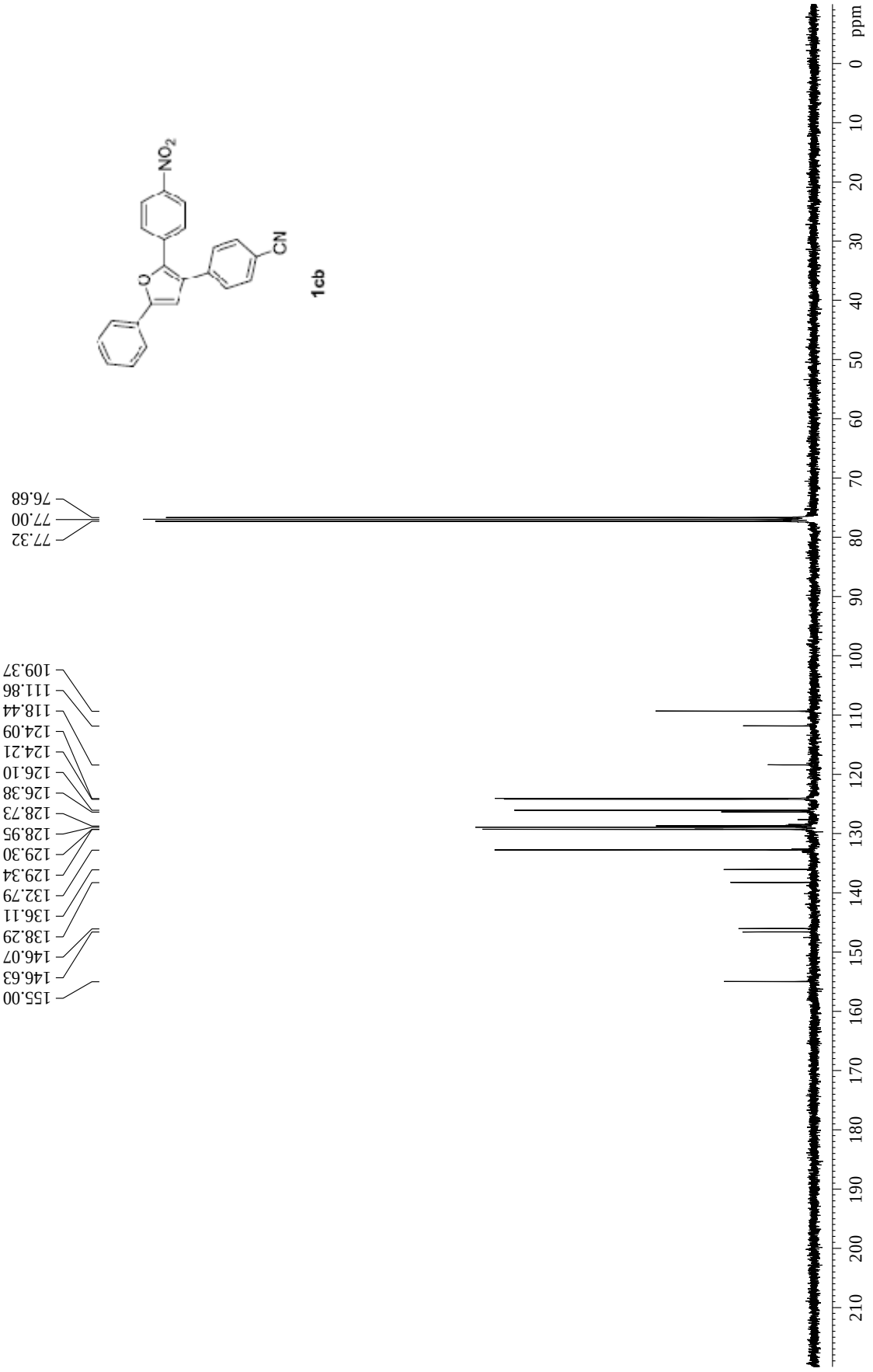
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160
170
180
190
200
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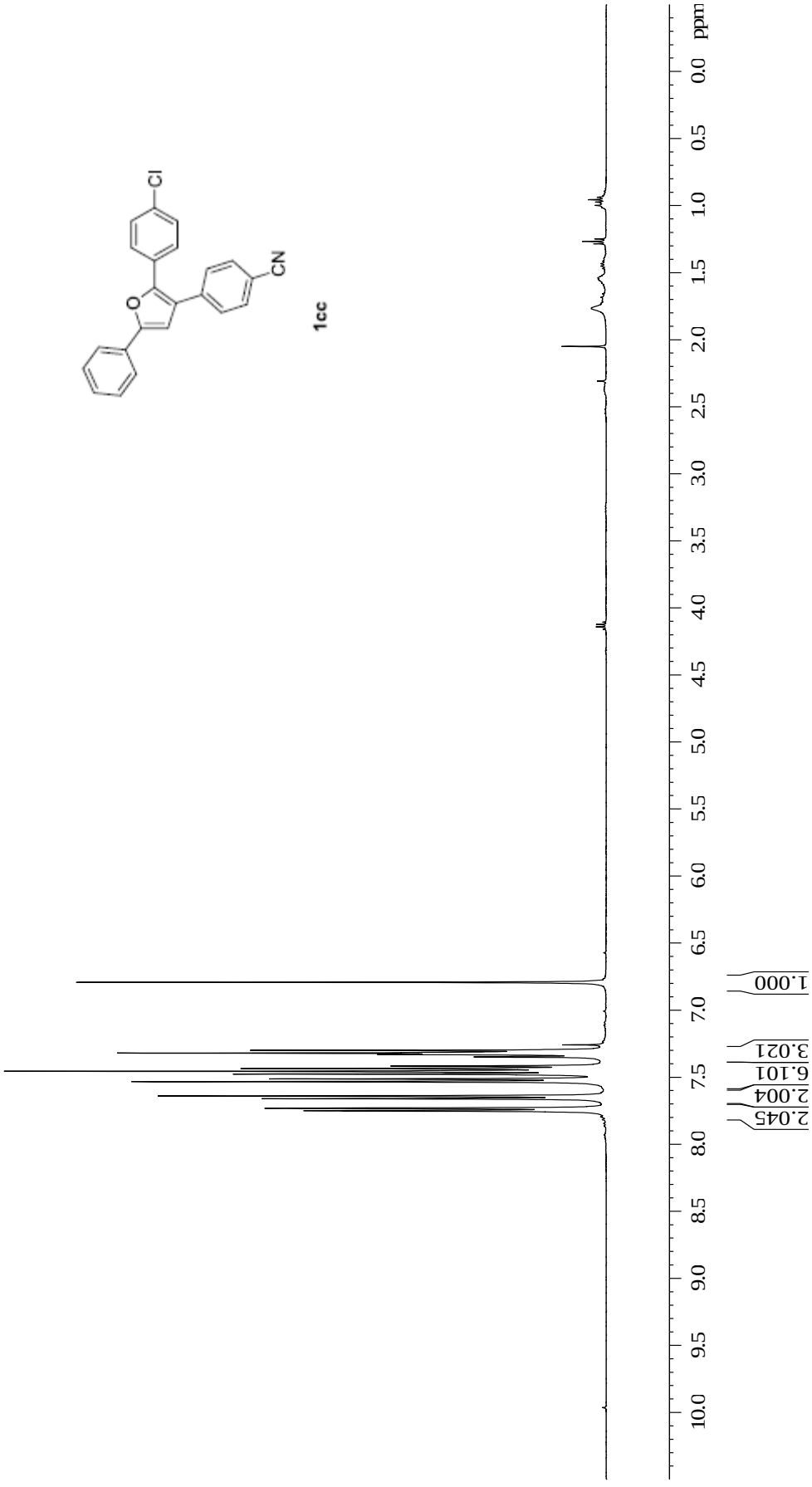
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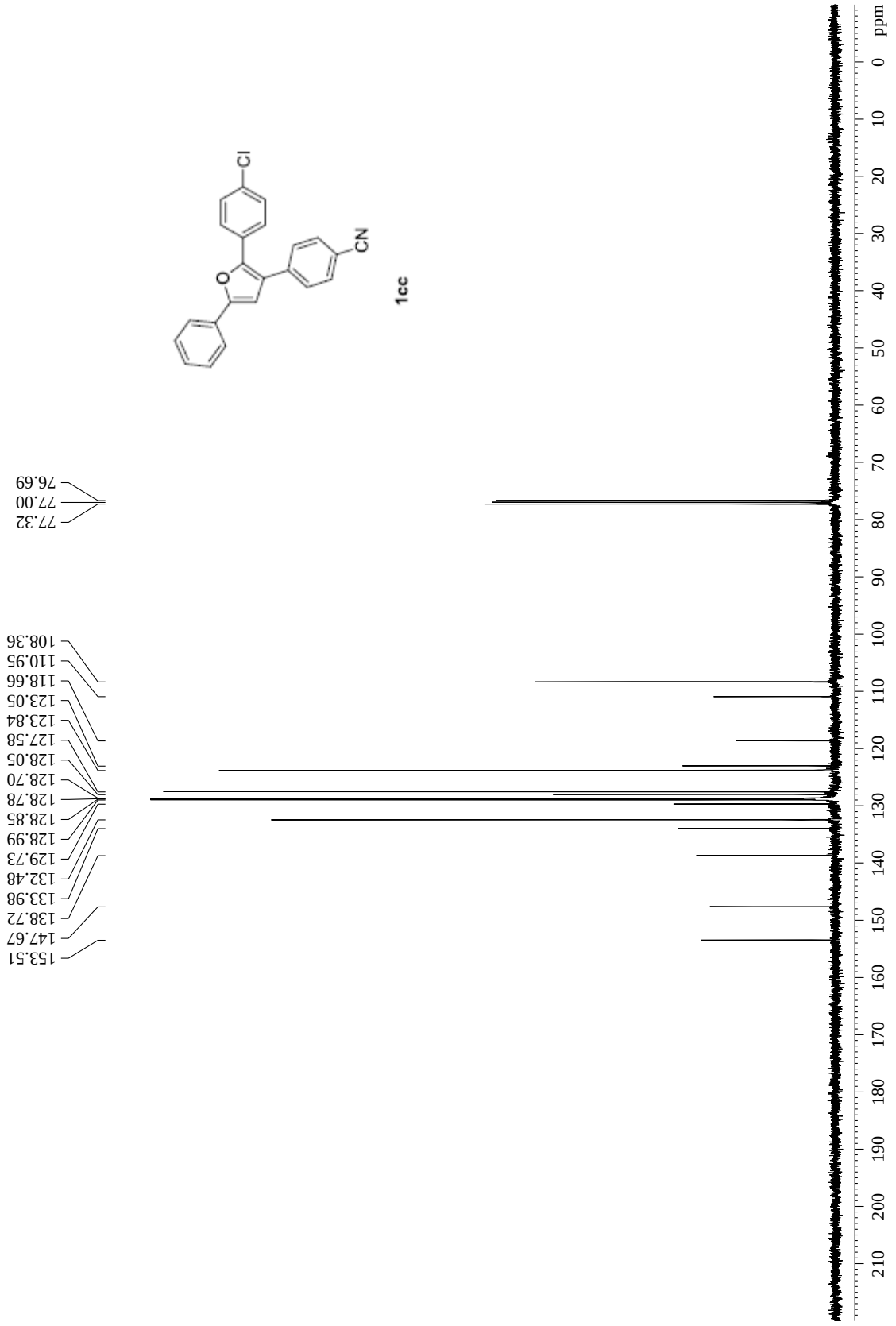
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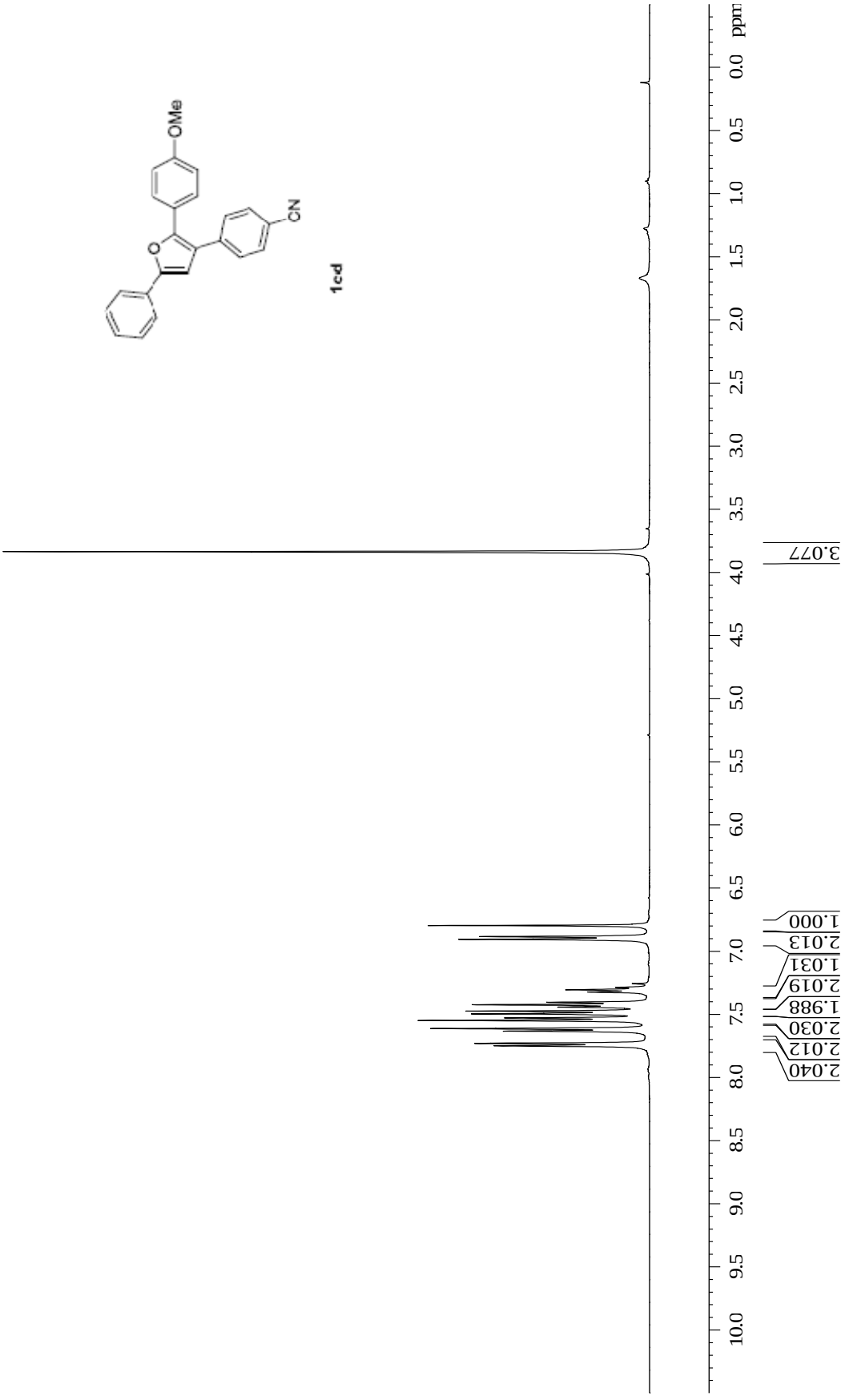
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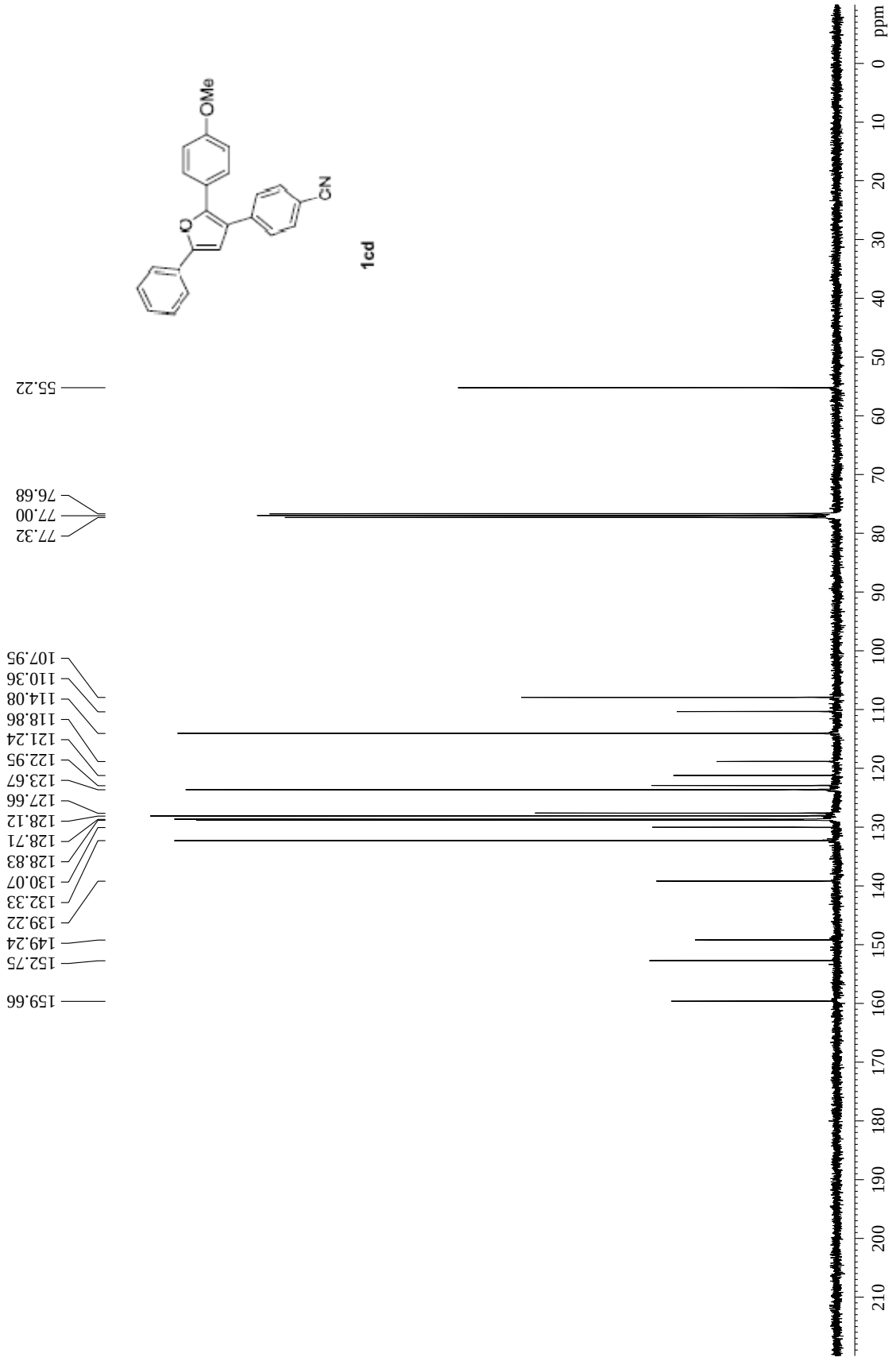
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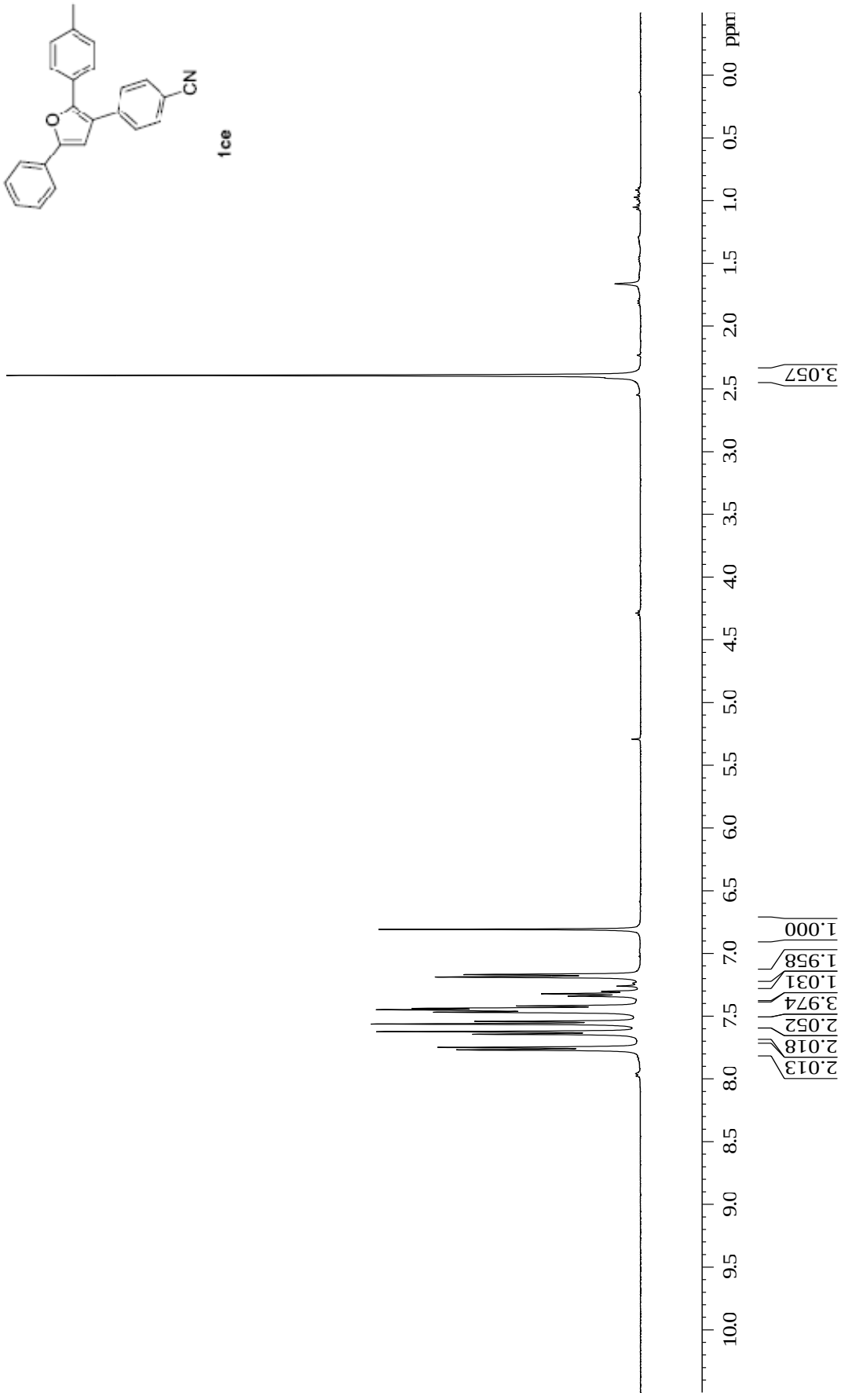
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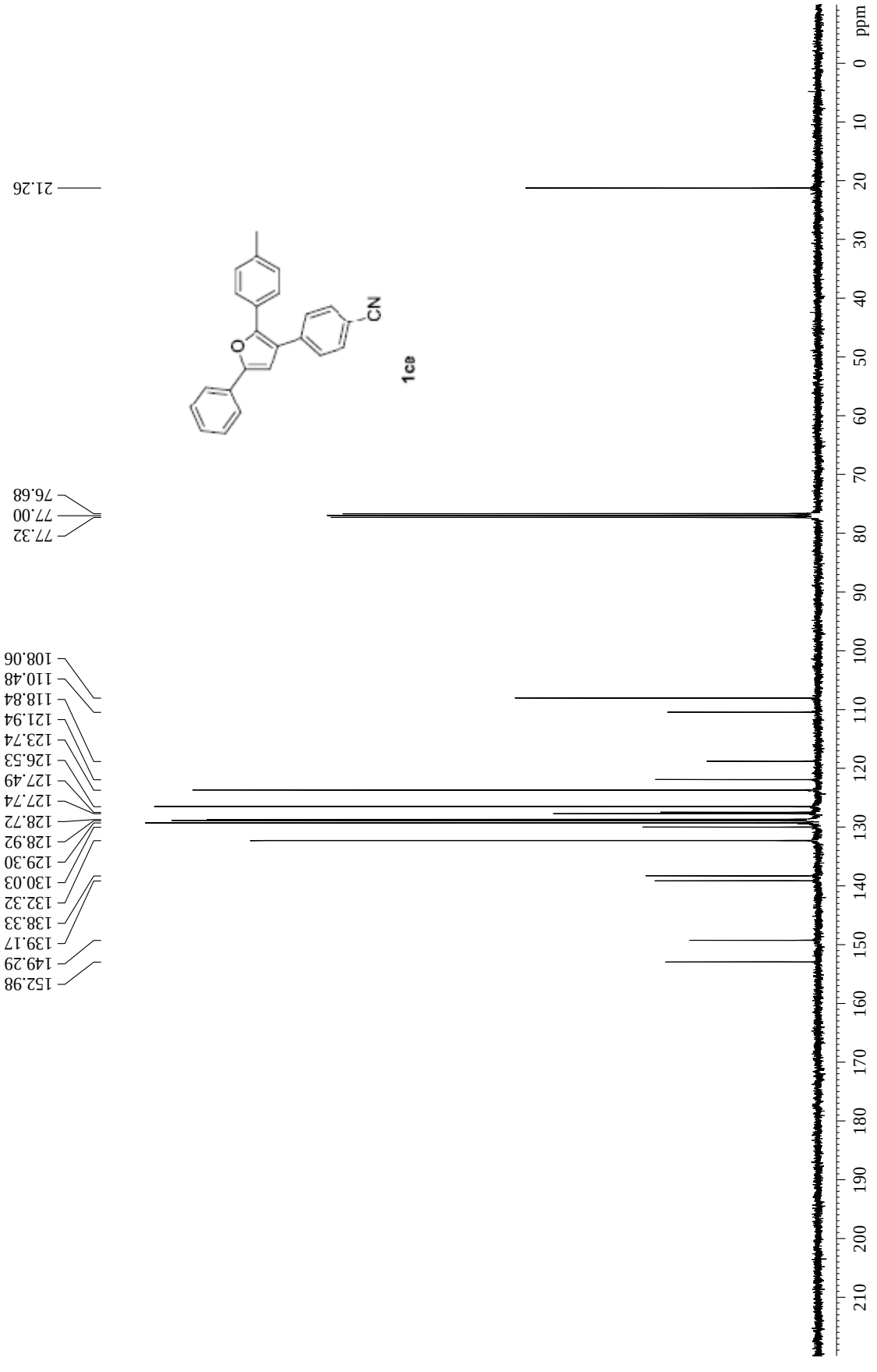
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190
200
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CN
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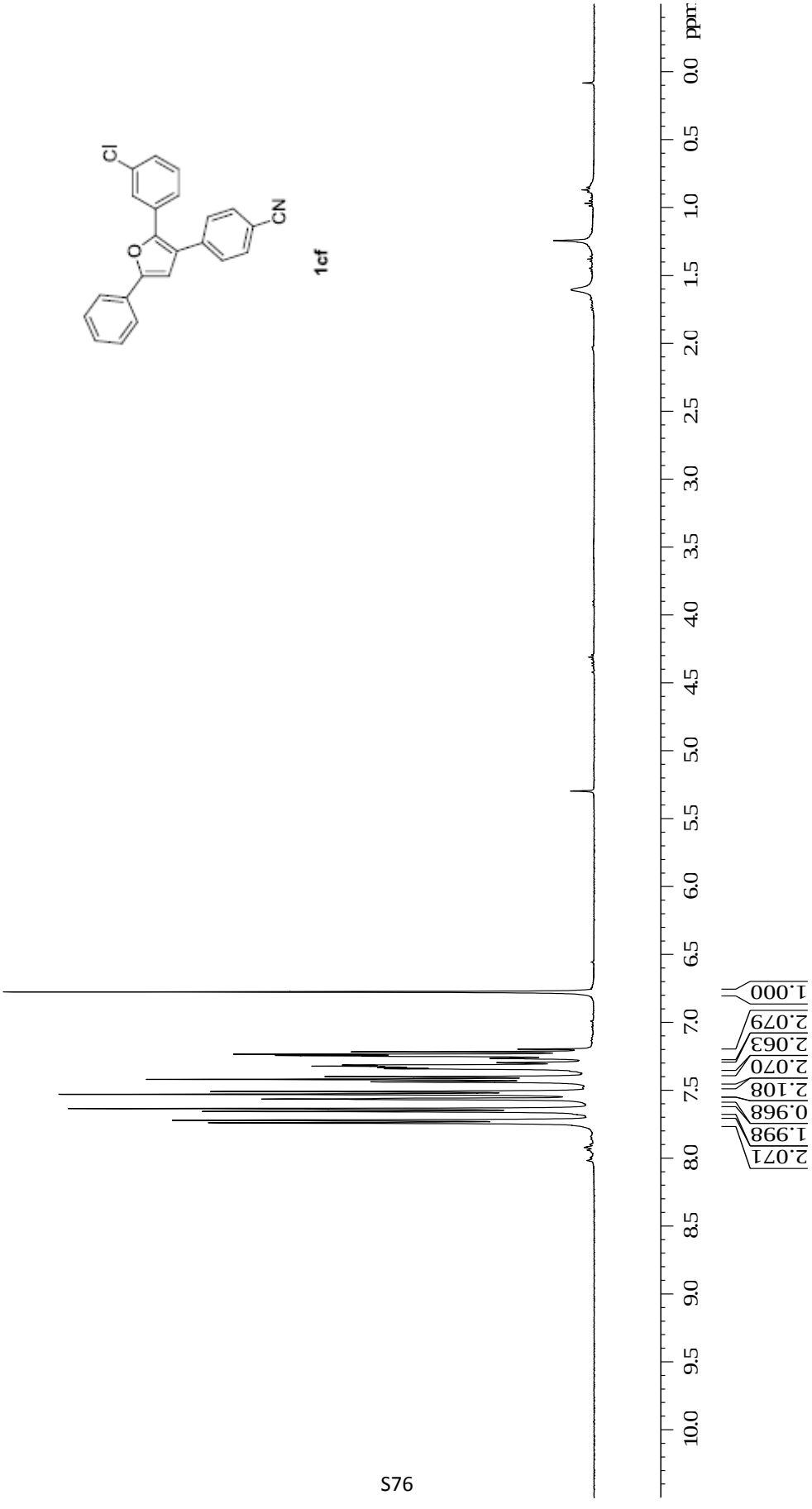
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2.0
1.5
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ppm
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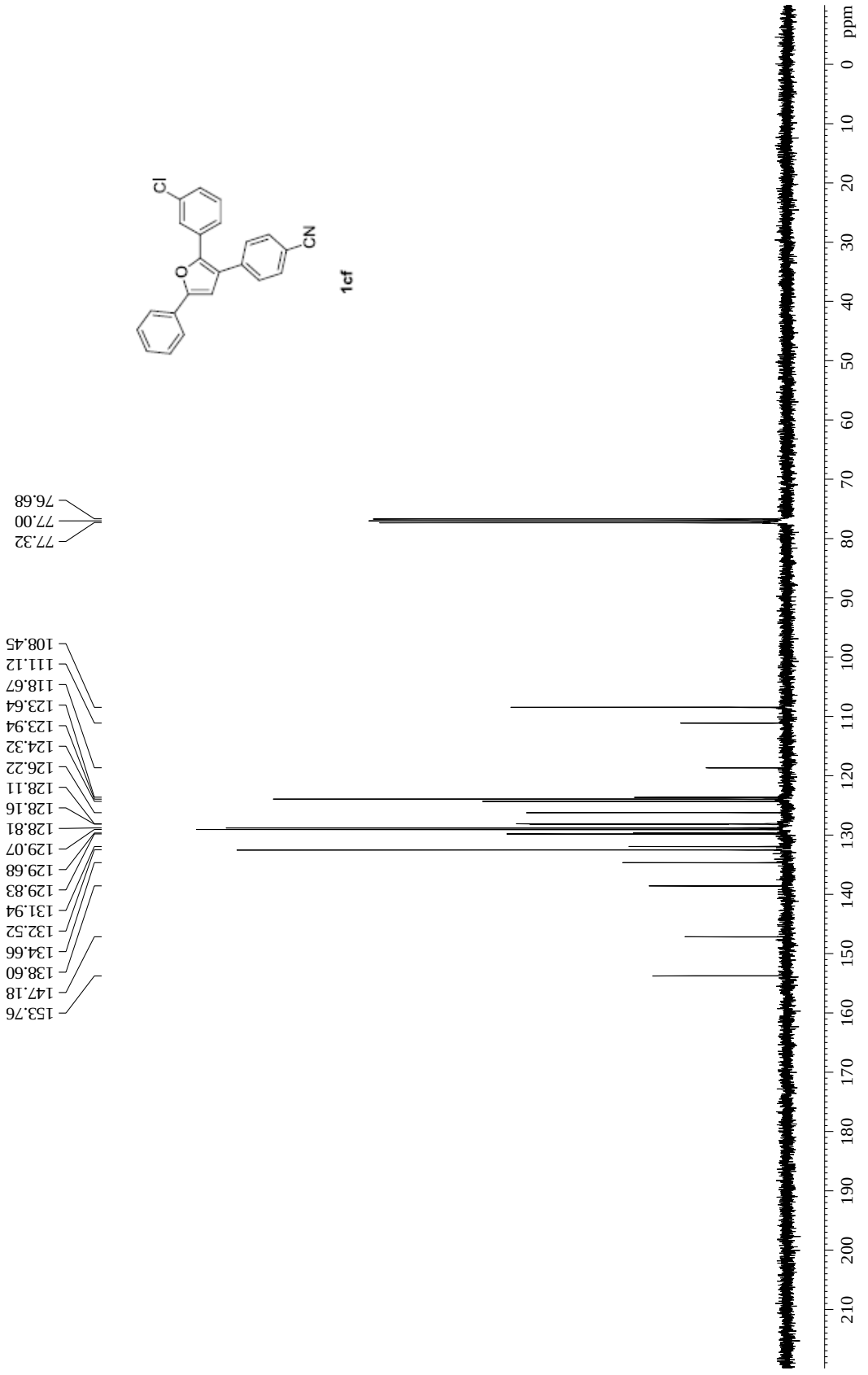
2.071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CN
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1cf
ppm
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150
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170
180
190
200
210
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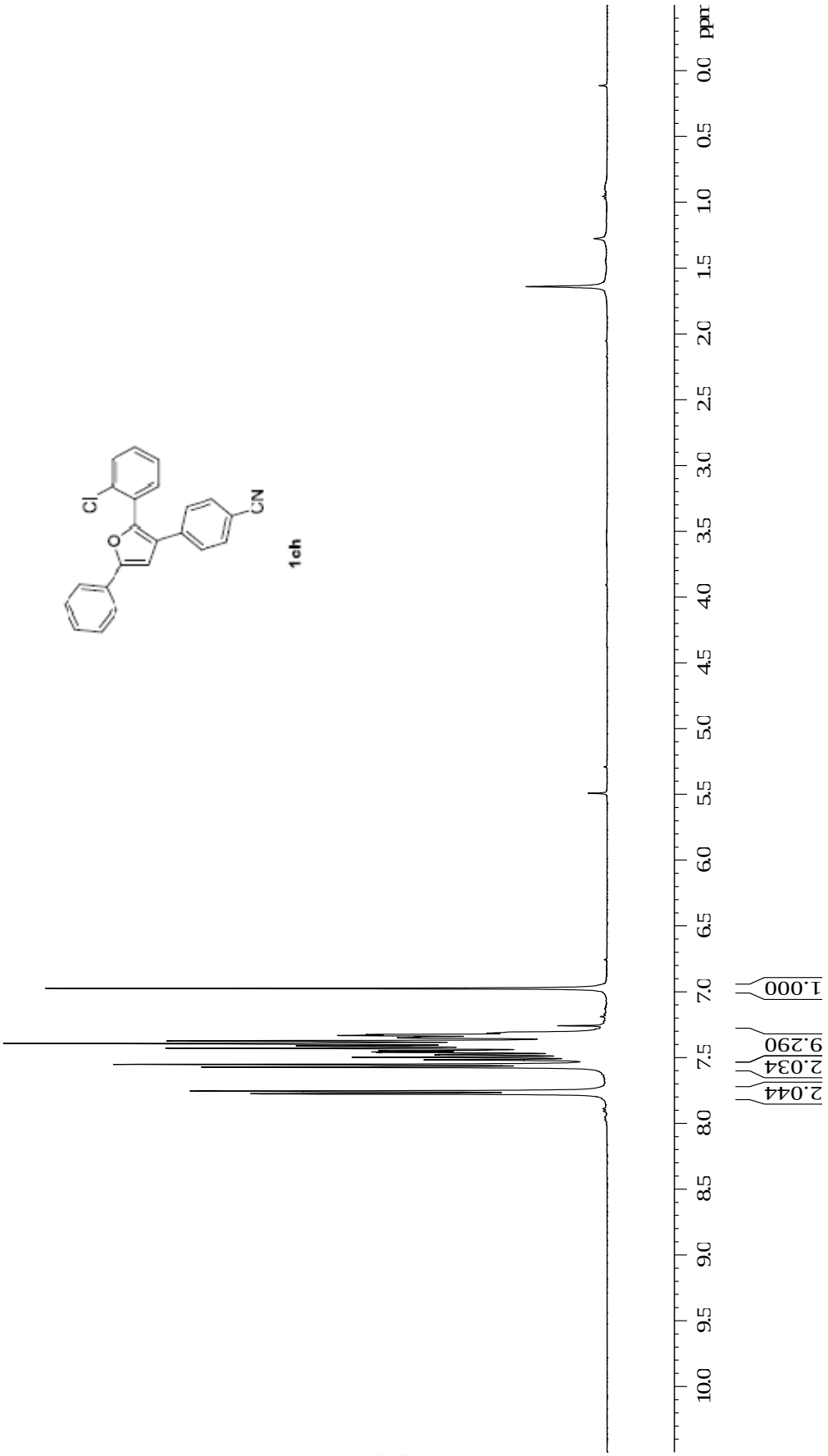
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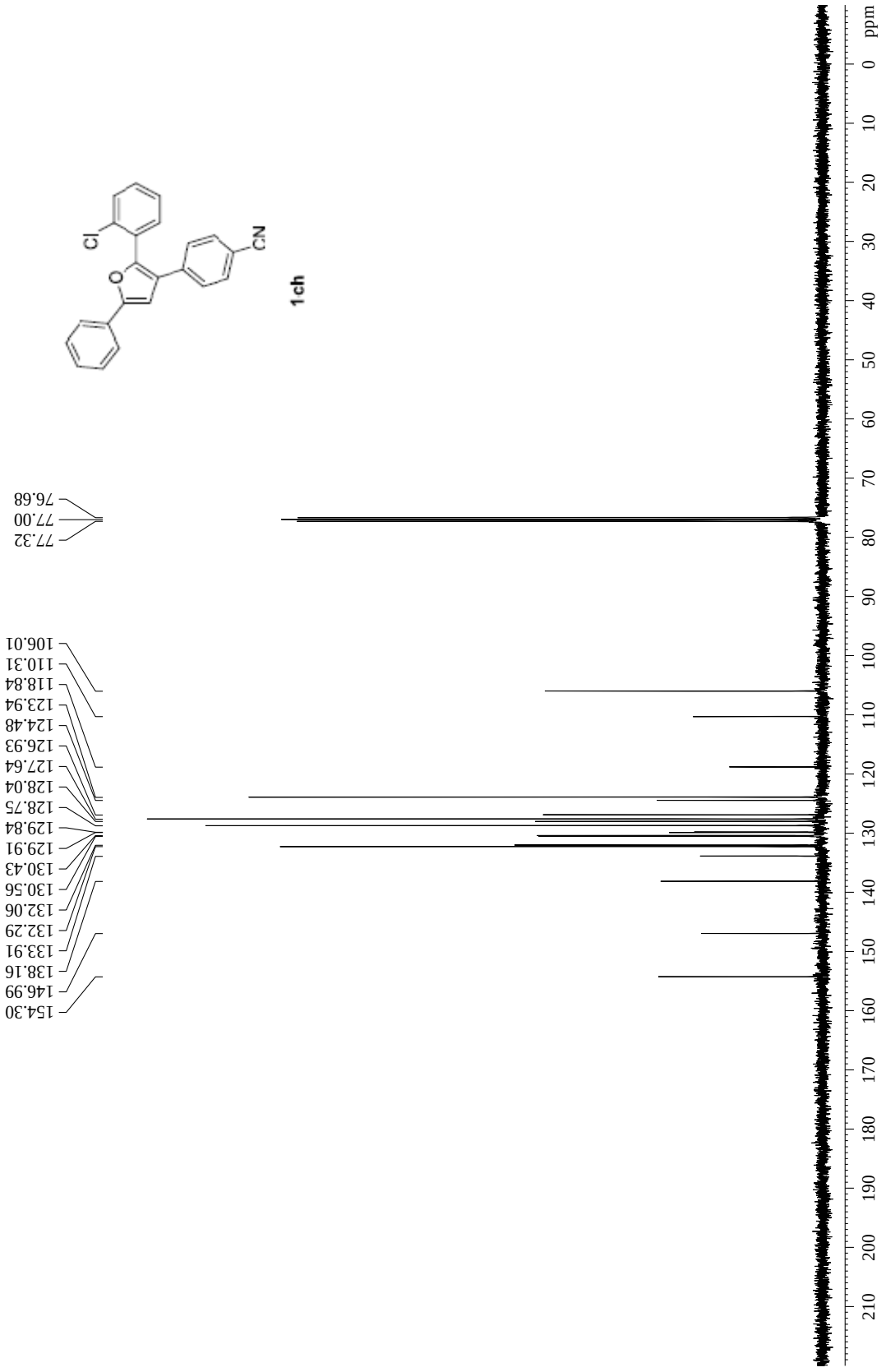
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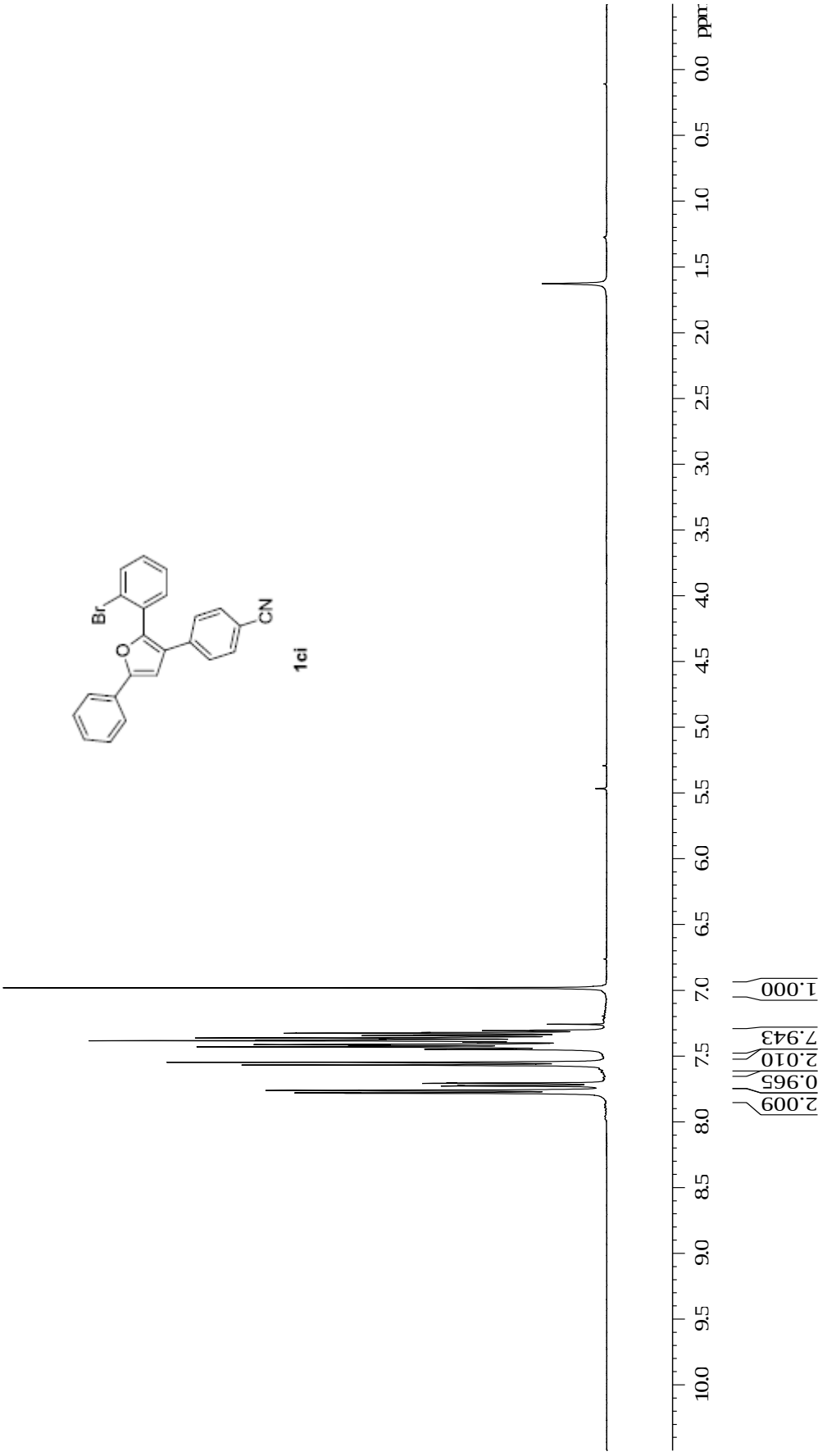
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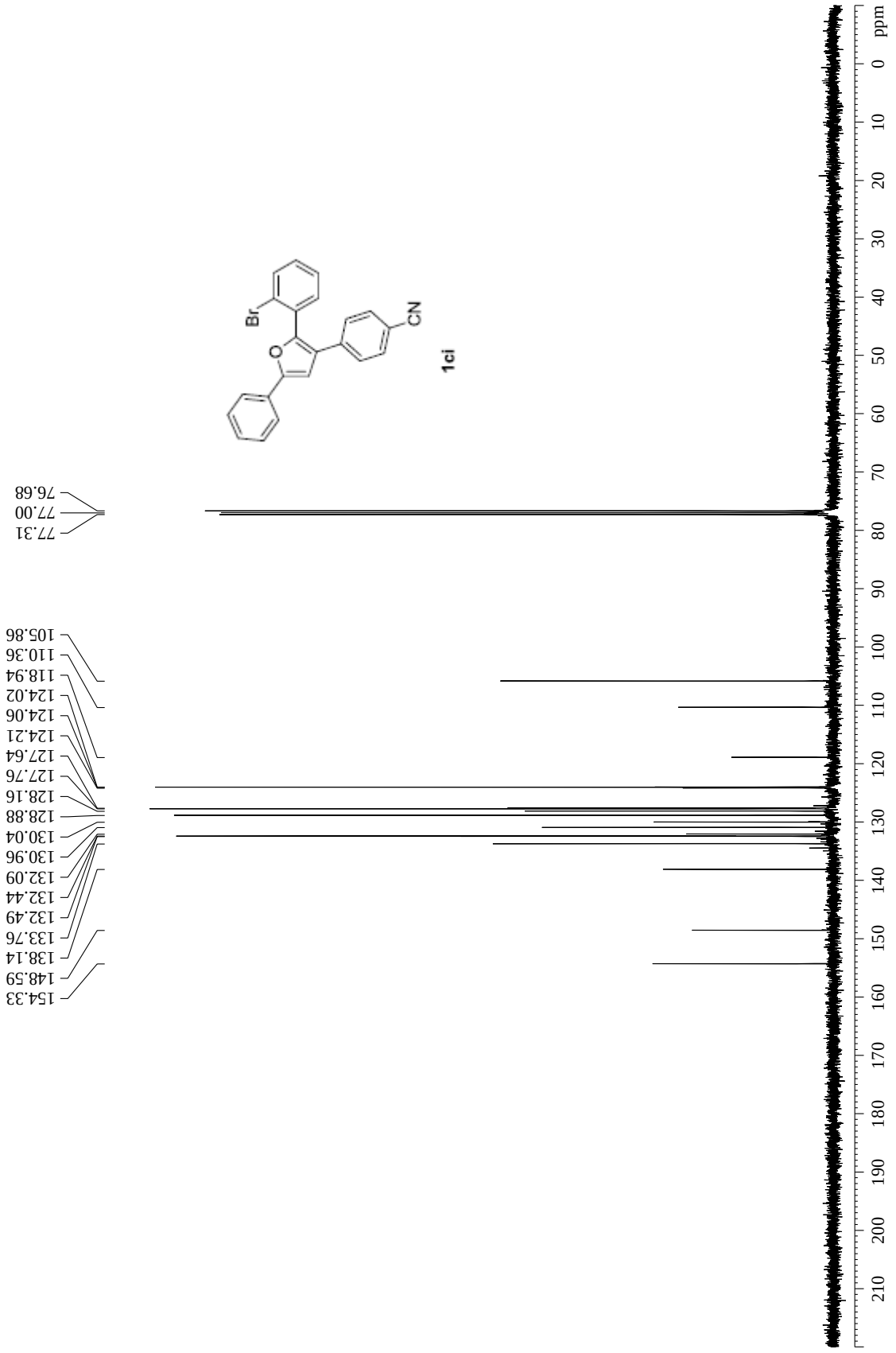
Br
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CN
1ci
ppm
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100
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150
160
170
180
190
200
210
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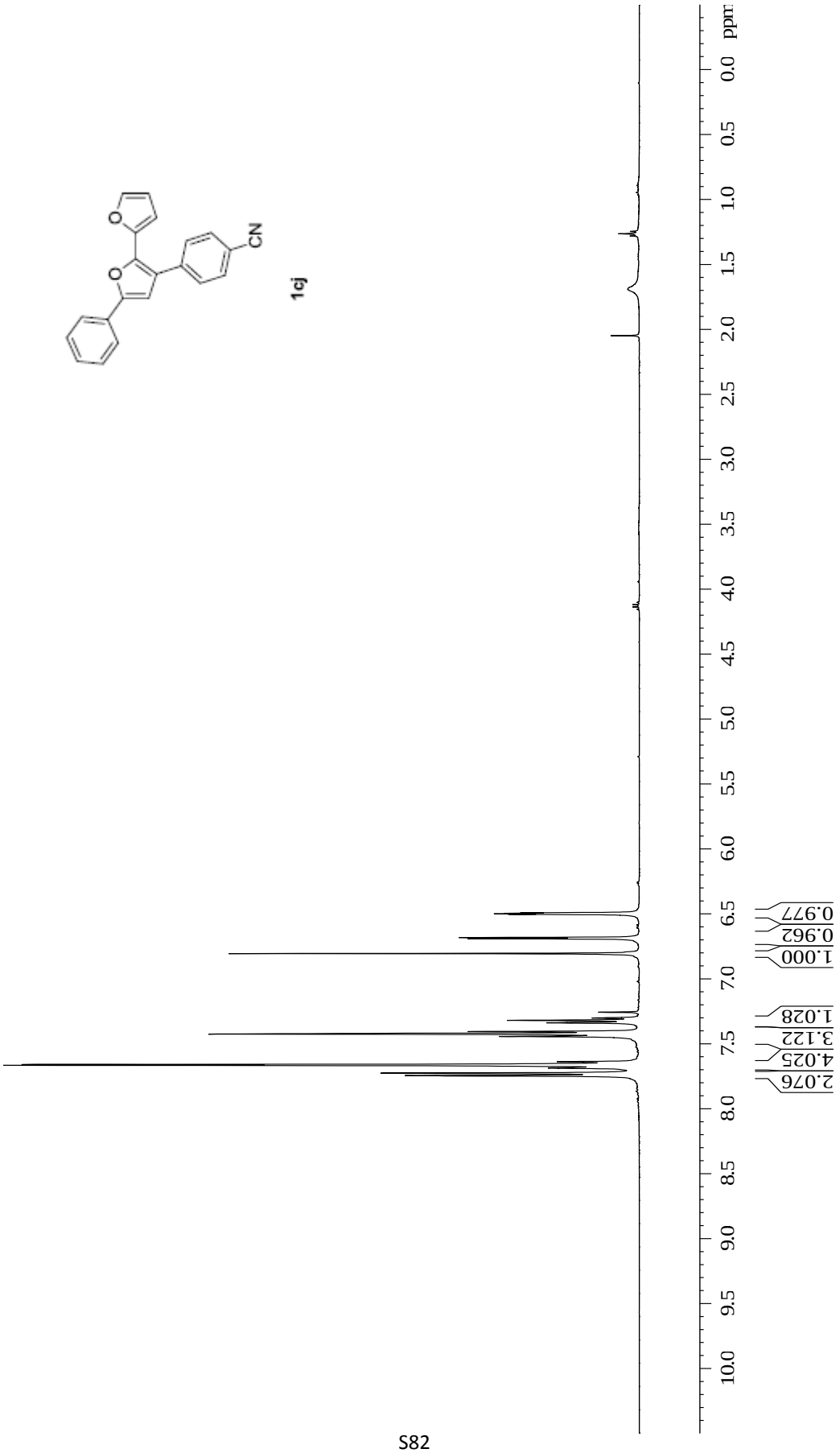
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5.0
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4.0
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3.0
2.5
2.0
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0.5
0.0
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1.000
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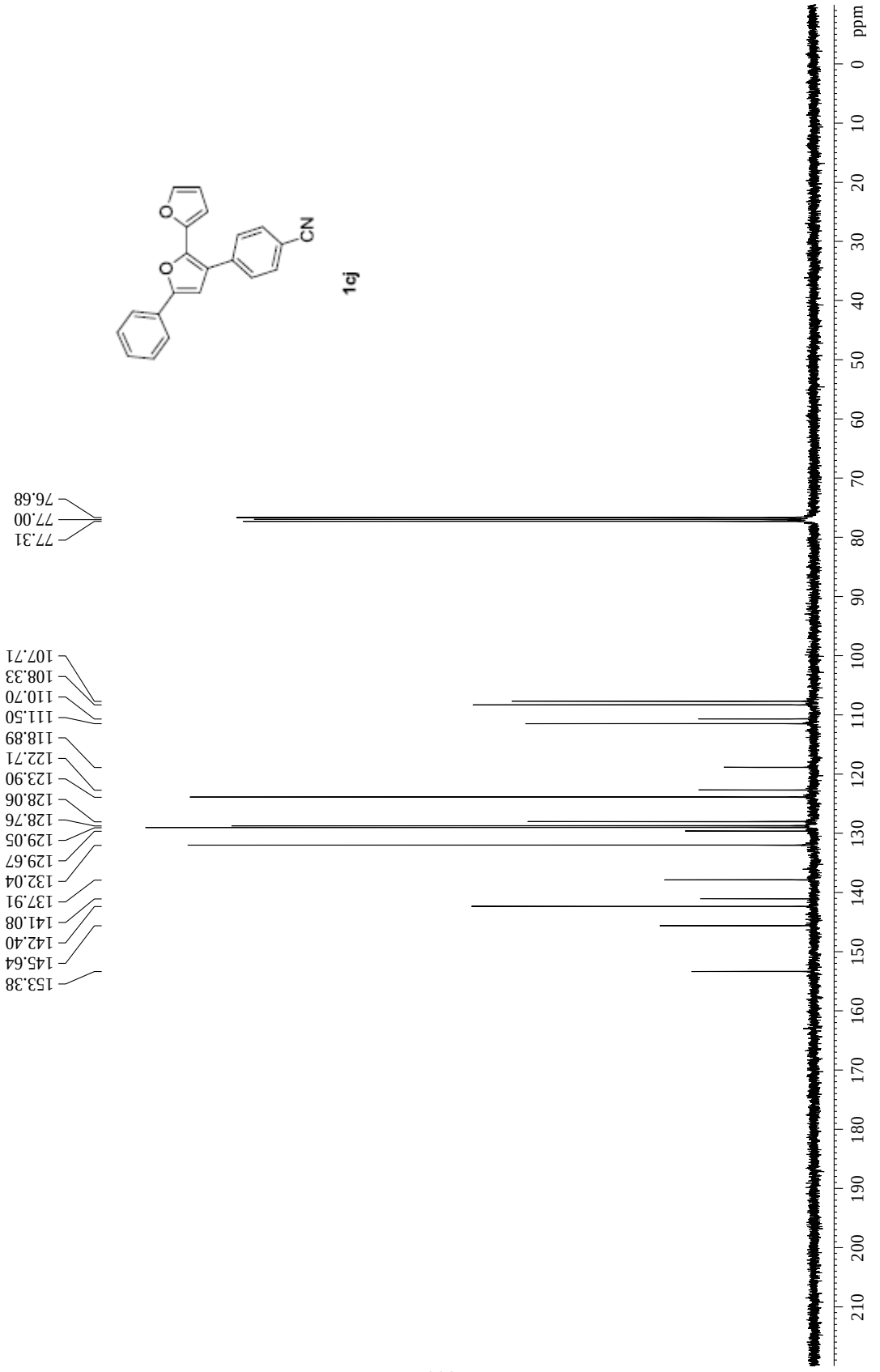
0.977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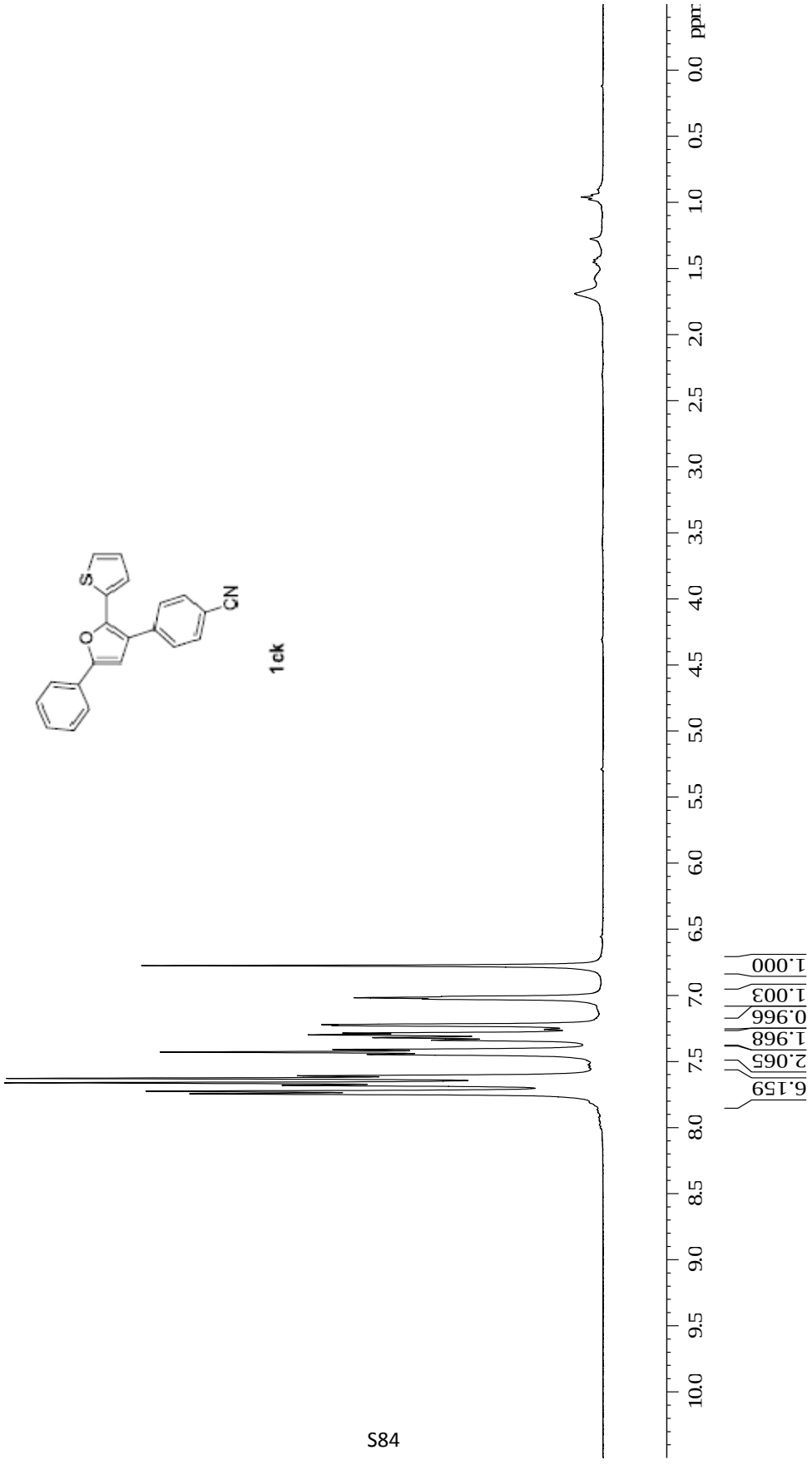
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1.968
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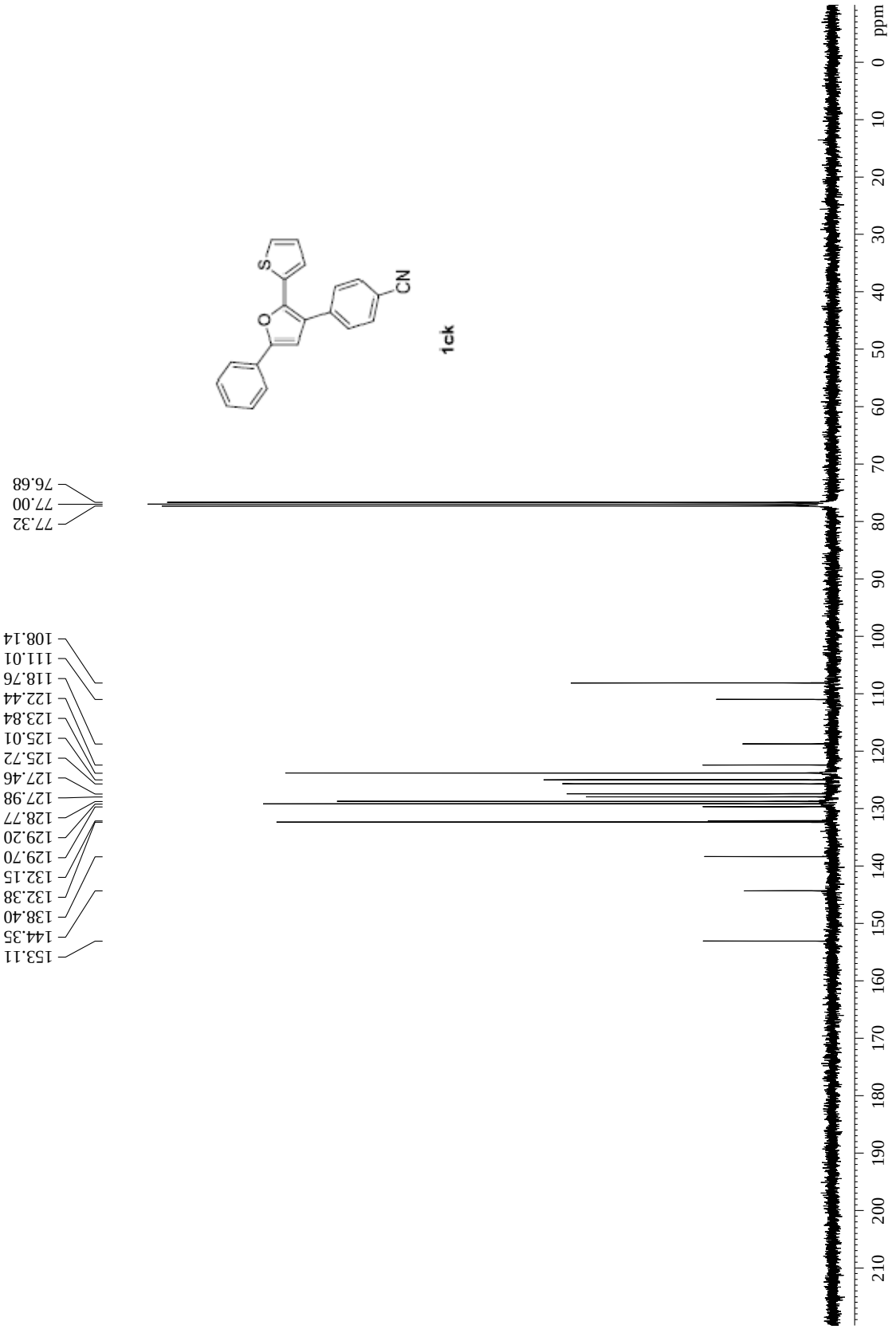
1.000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S
O
CN
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123.84
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108.14
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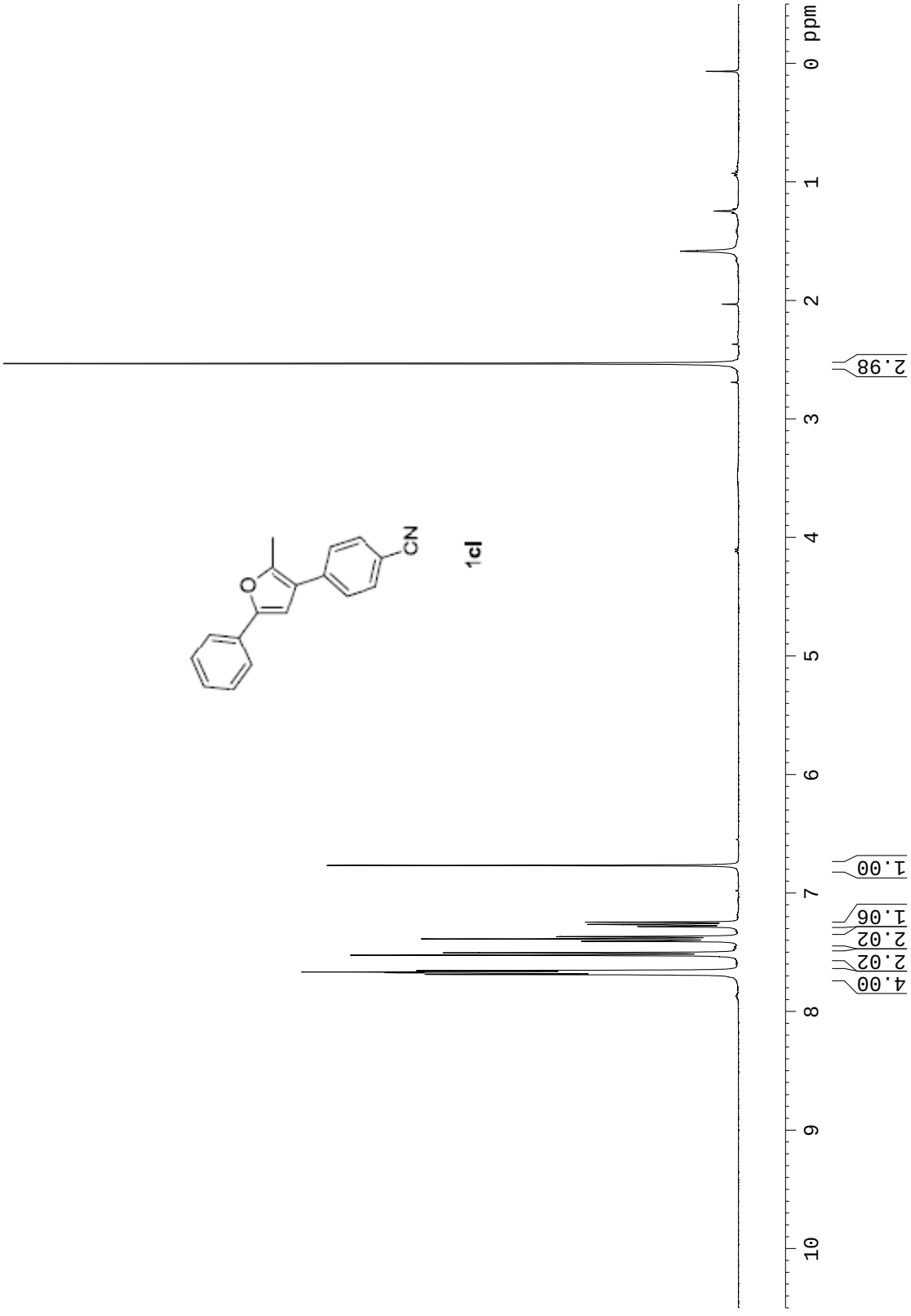
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2
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1.06
2.02
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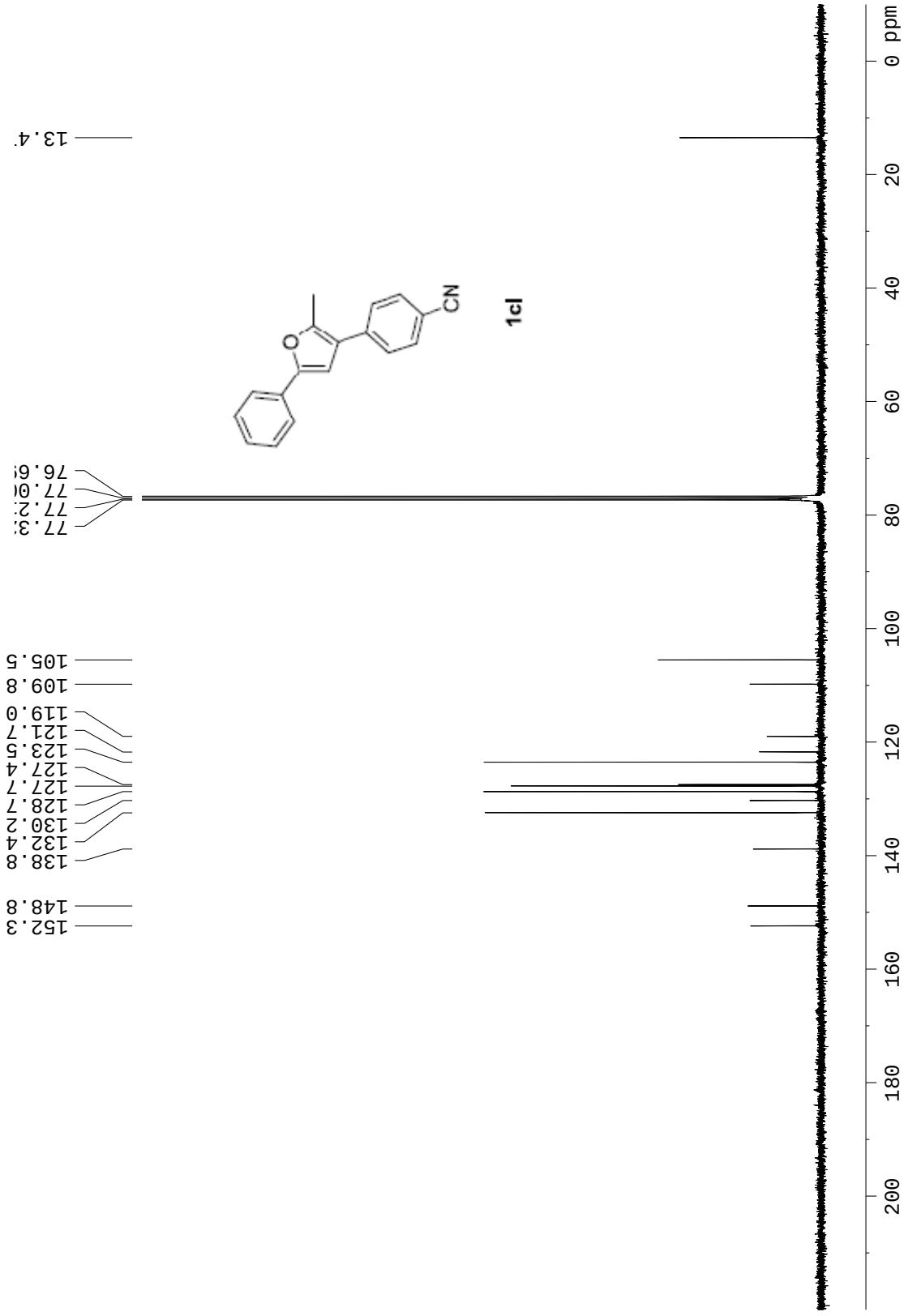
O
CN
1cl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128.7
130.2
132.4
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152.3
O
CN
1cl
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60
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180
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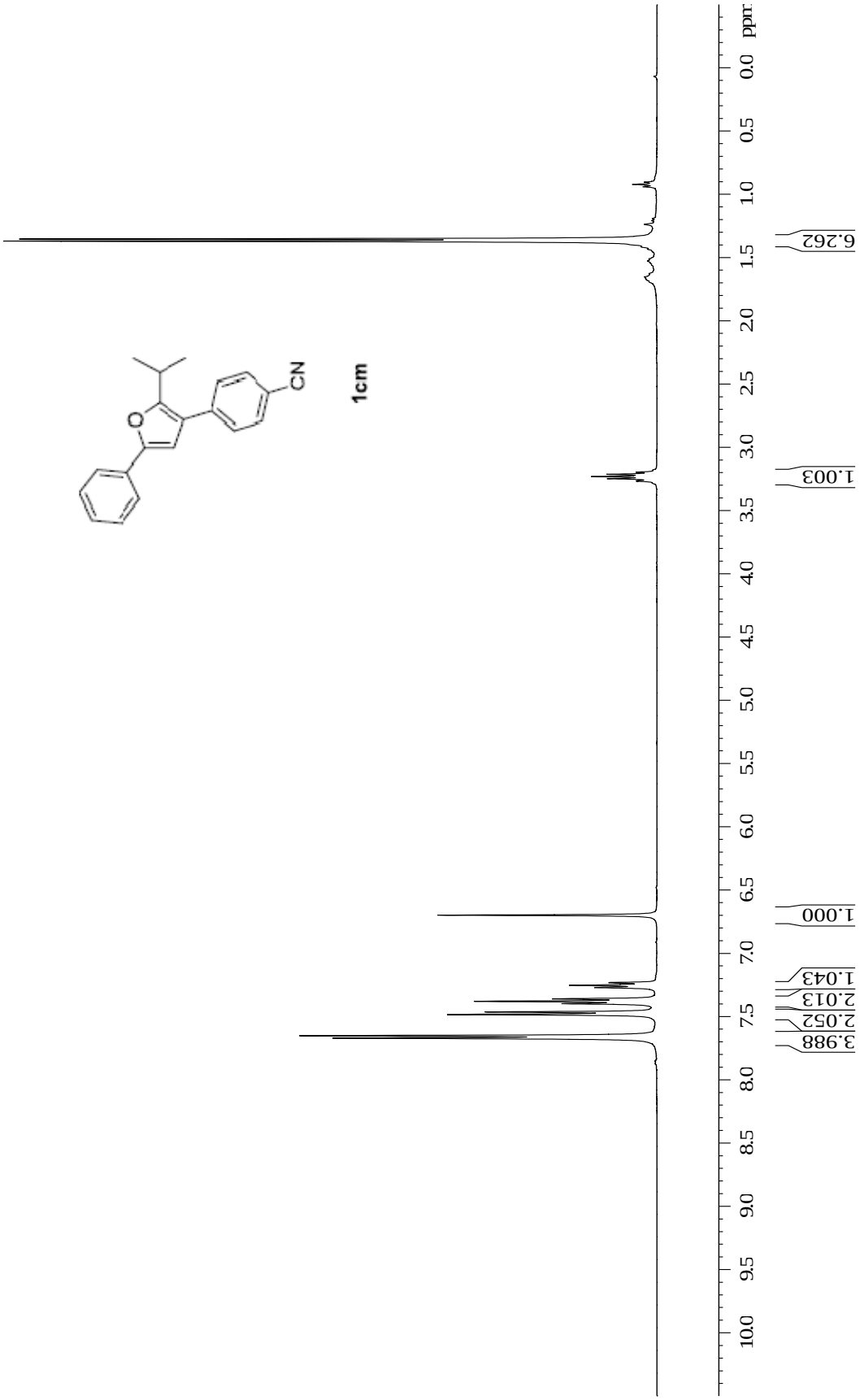
1cm
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1.043
2.013
2.052
3.988
ppm


21.59
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76.68
77.00
77.31
105.71
109.90
118.95
120.13
123.50
127.40
128.25
128.66
130.43
132.36
139.07
152.04
157.00
1cm
CN
O
ppm
0
10
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70
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100
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140
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200
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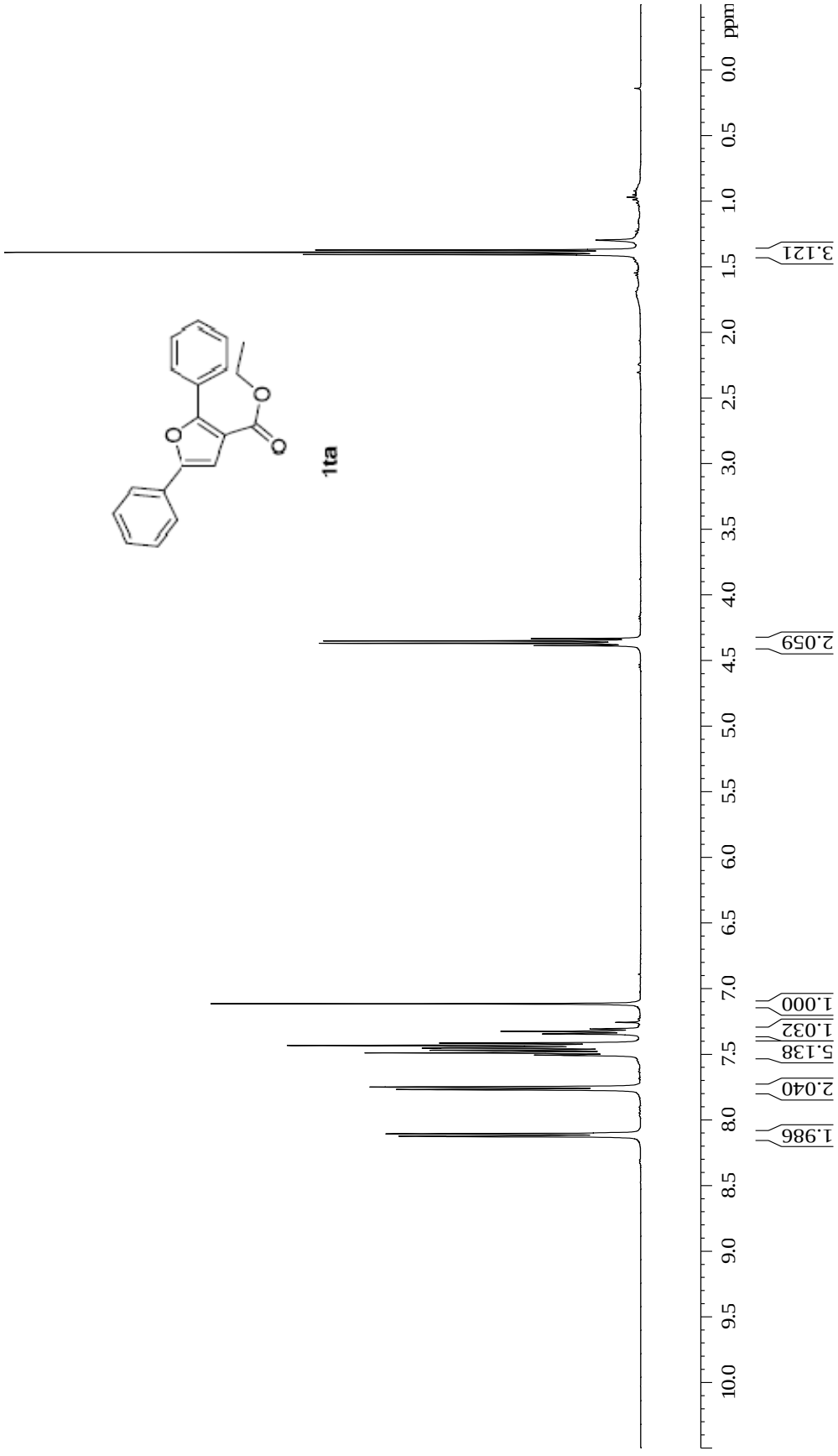
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1.5
2.0
2.5
3.0
3.5
4.0
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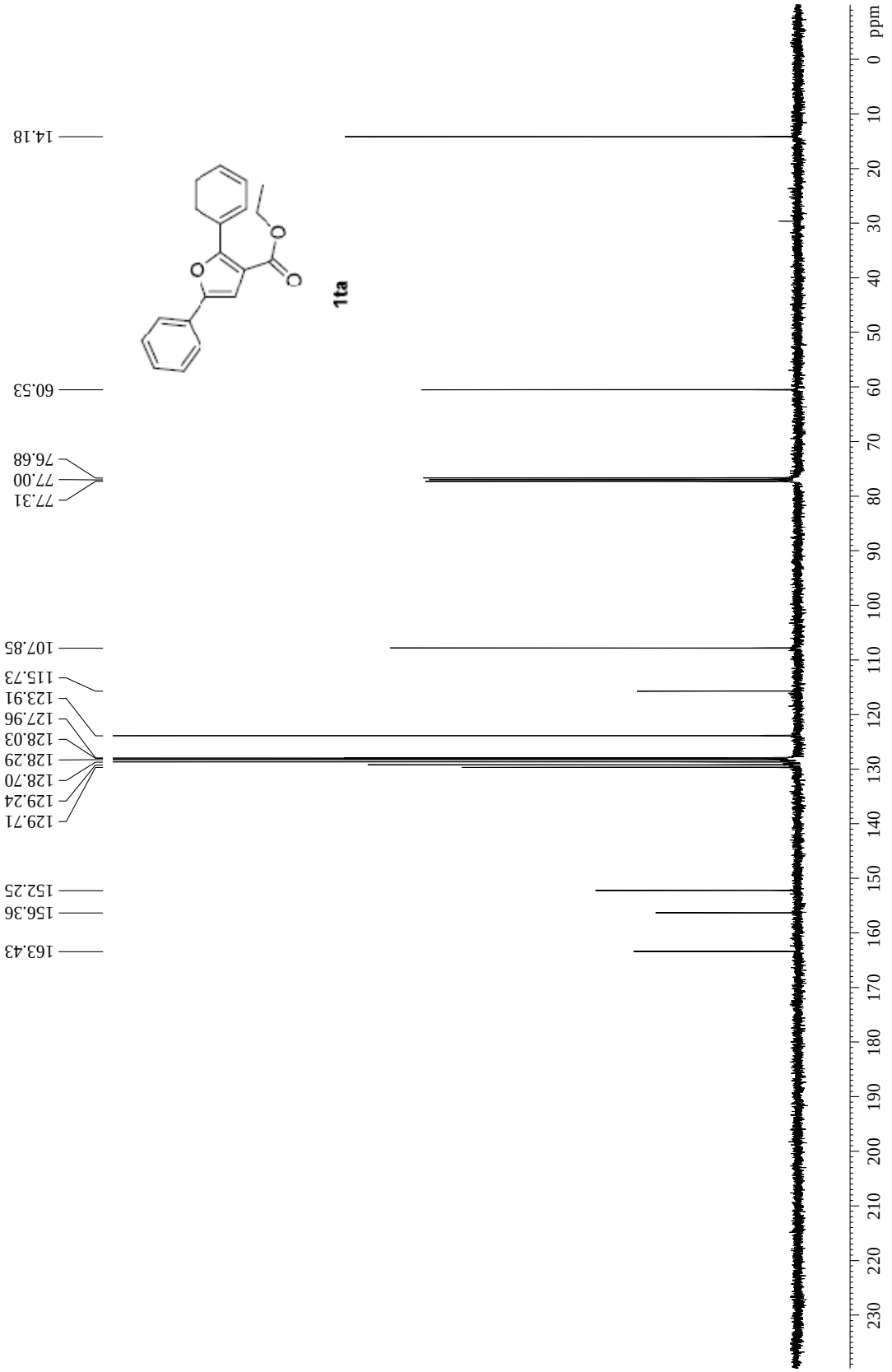
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128.03
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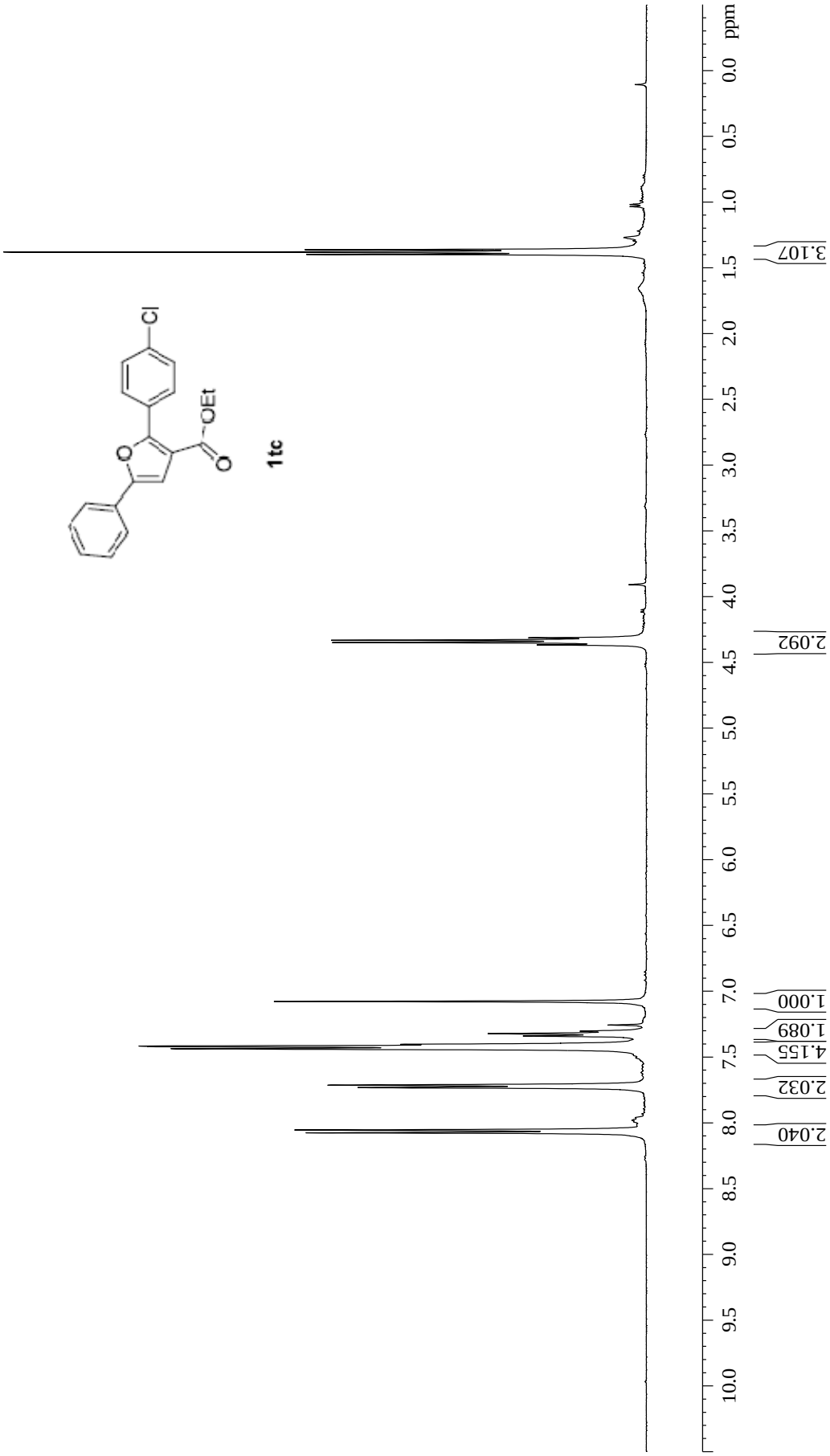
163.43
1ta
ppm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OEt
O
1tc
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8.5
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7.0
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6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
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1.5
1.0
0.5
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4.155
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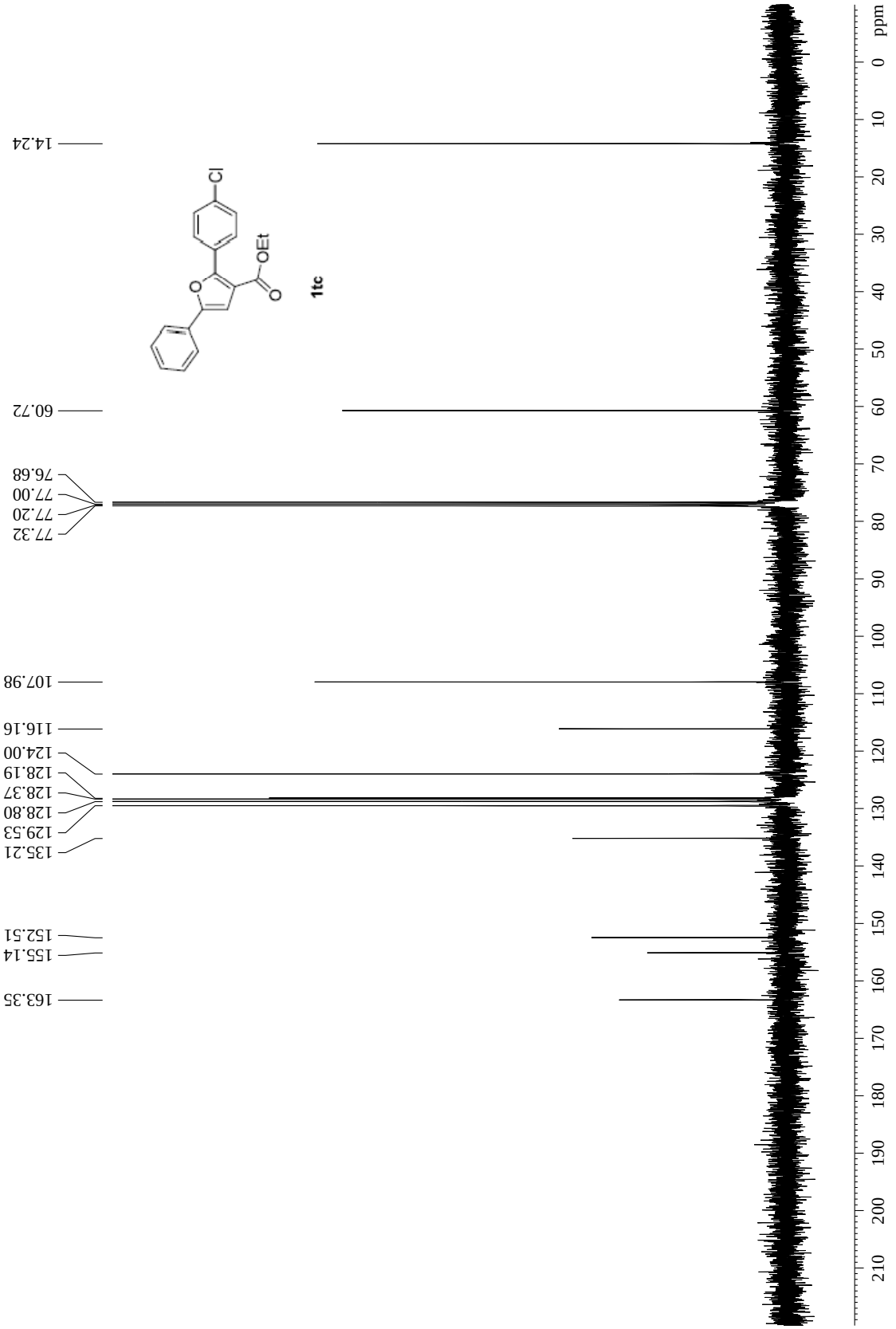
1.000
2.092
3.107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77.20
77.32
107.98
116.16
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128.19
128.37
128.80
129.53
135.21
152.51
155.14
163.35
Cl
OEt
O
O
1tc
ppm
0
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60
70
80
90
100
110
120
130
140
150
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170
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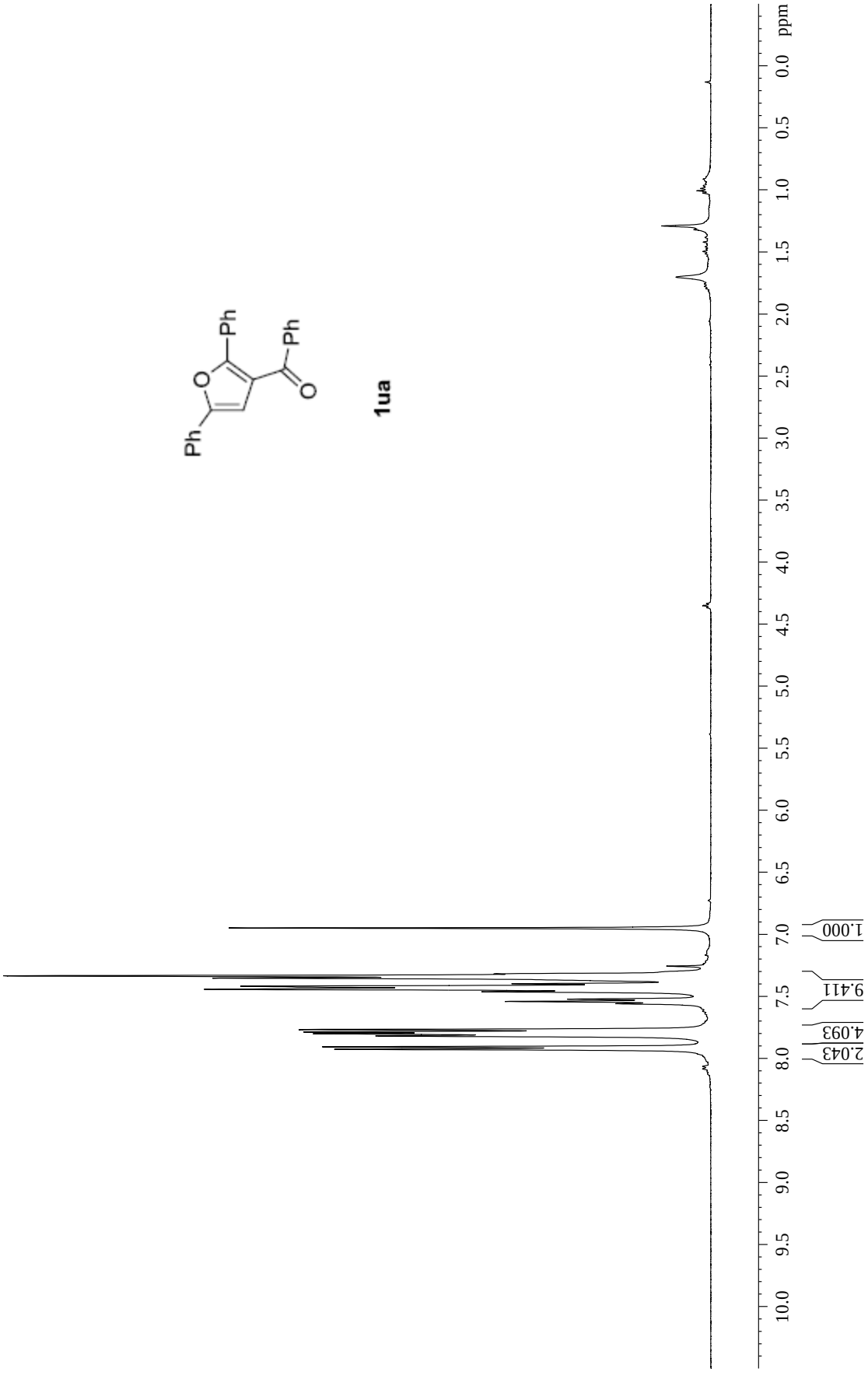
190
200
210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Ph
O
O
Ph
1ua
ppm
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1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
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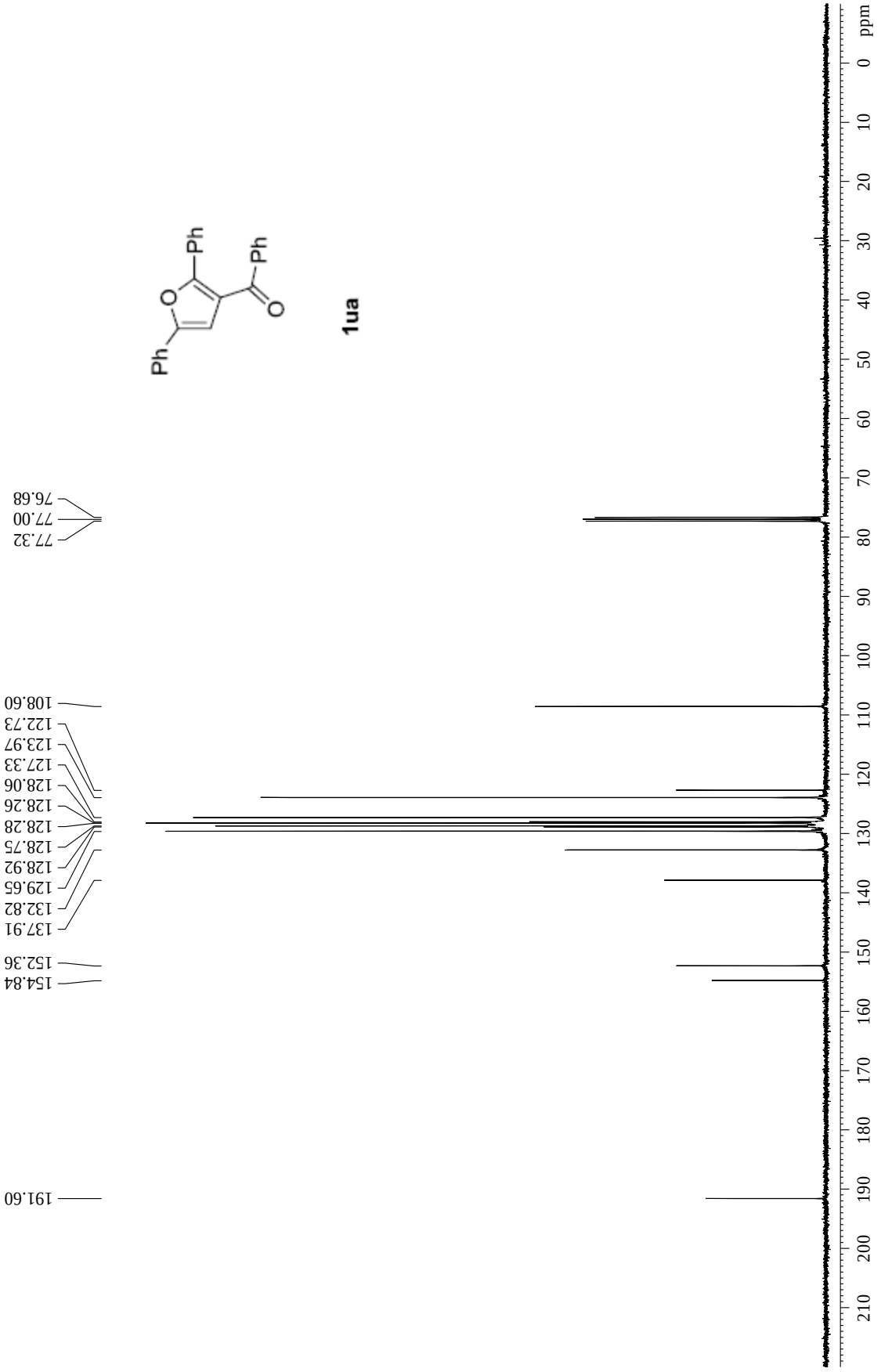
9.0
9.5
10.0
1.000
9.411
4.093
2.043


Ph
Ph
O
O
Ph
1ua
76.68
77.00
77.32
108.60
122.73
123.97
127.33
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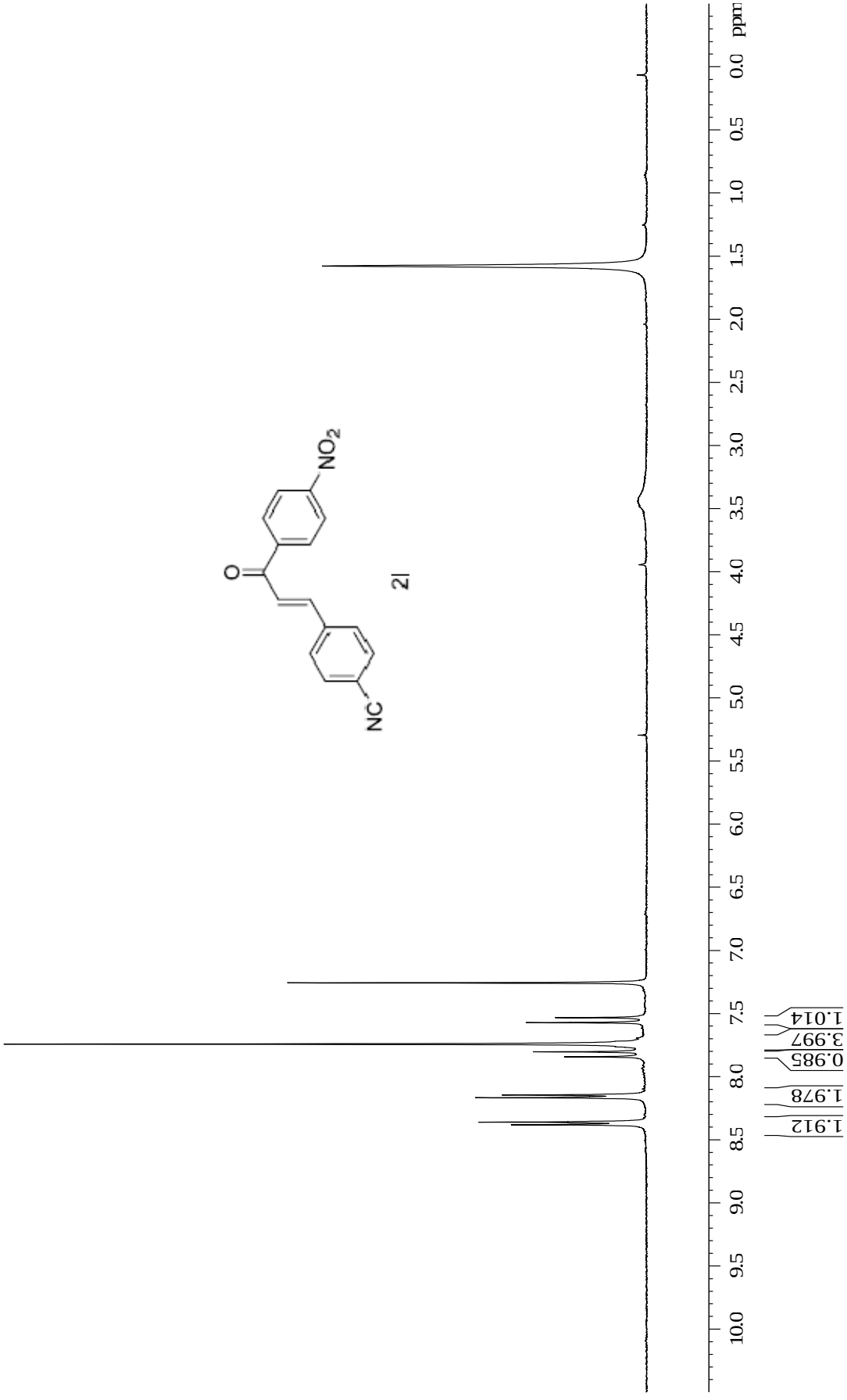
128.26
128.28
128.75
128.92
129.65
132.82
137.91
152.36
154.84
191.60
ppm


NO2
O
NC
2l
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9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
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1.5
1.0
0.5
0.0
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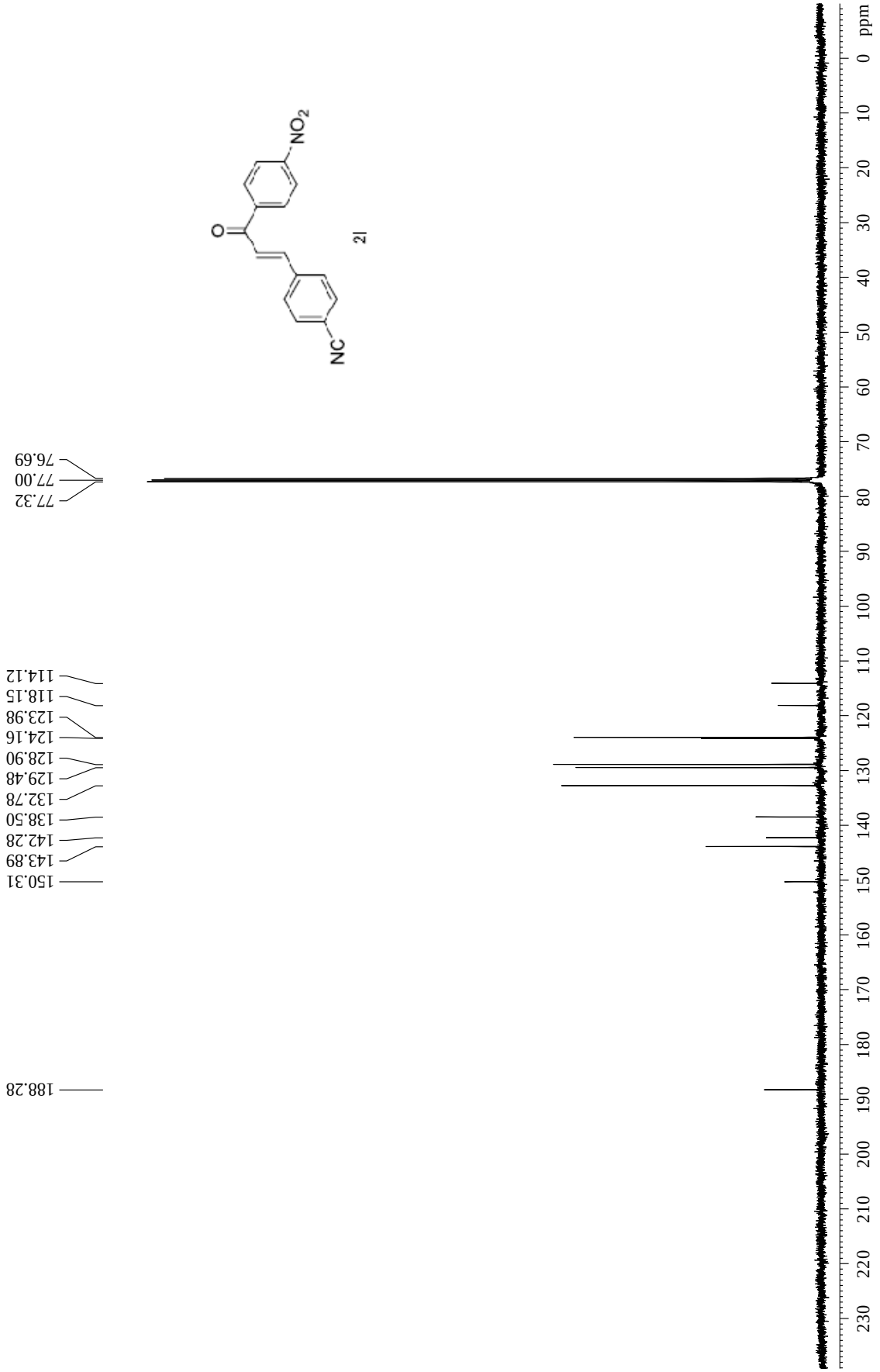
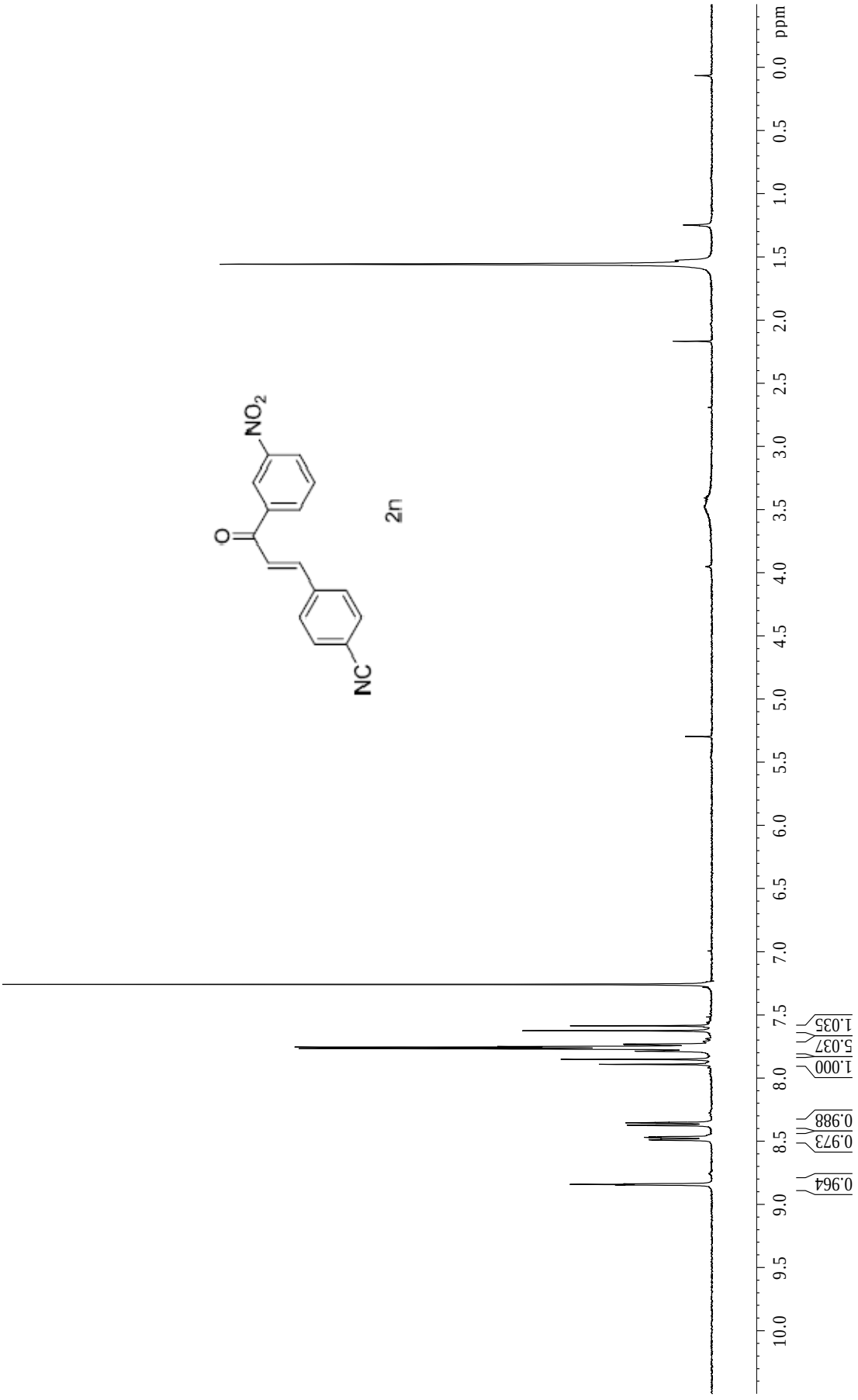
0.985
3.997
1.014


NO2
O
NC
2l
76.69
77.00
77.32
114.12
118.15
123.98
124.16
128.90
129.48
132.78
138.50
142.28
143.89
150.31
188.28
ppm


NO2
O
NC
2n
ppm
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0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
0.964
0.973
0.988
1.000
5.037
1.035


NO2
O
NC
2n
77.32
77.21
77.00
76.68
114.16
118.19
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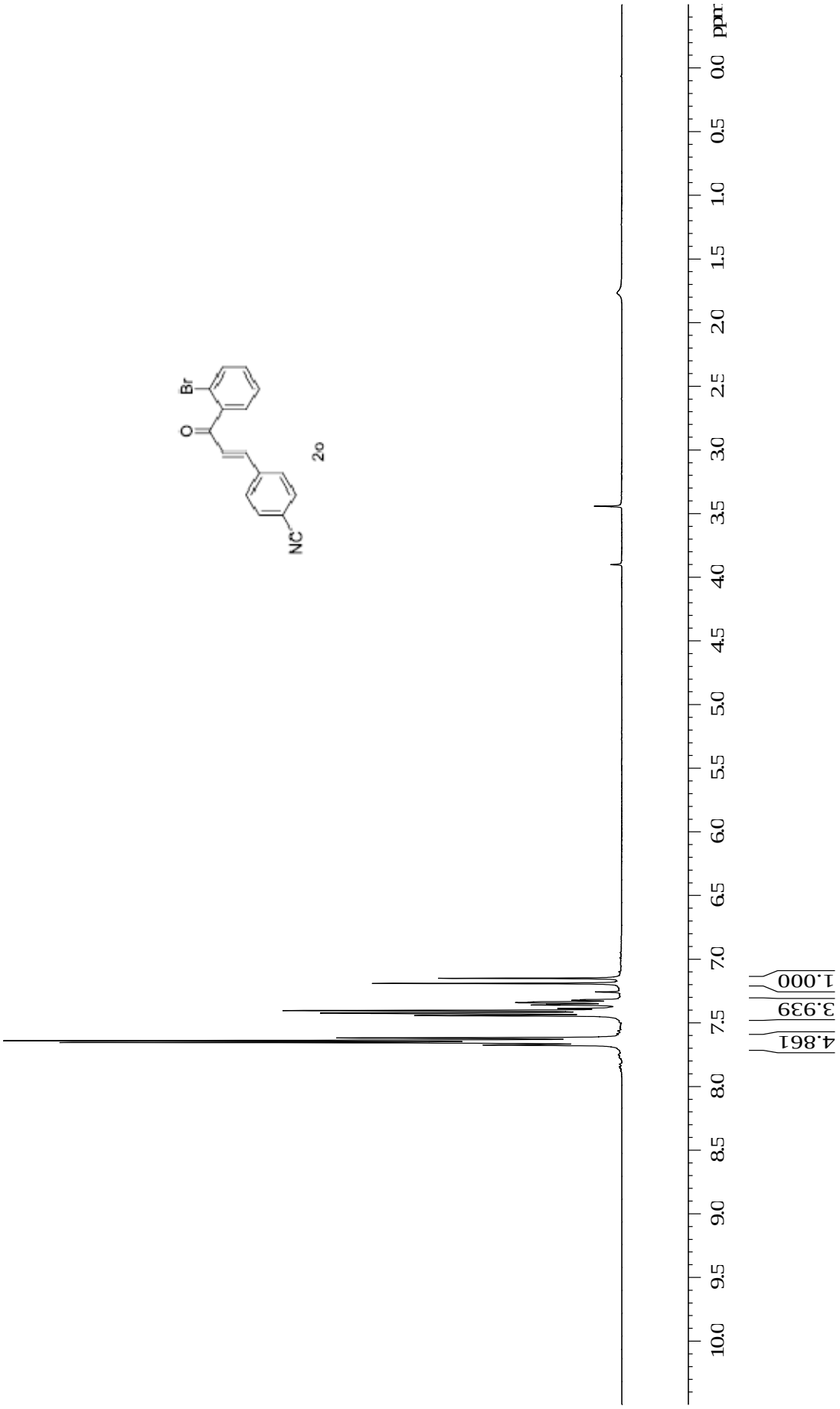
128.96
130.13
132.80
134.10
138.53
138.89
143.94
148.50
187.35
ppm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O
NC
2o
ppm
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1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
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10.0
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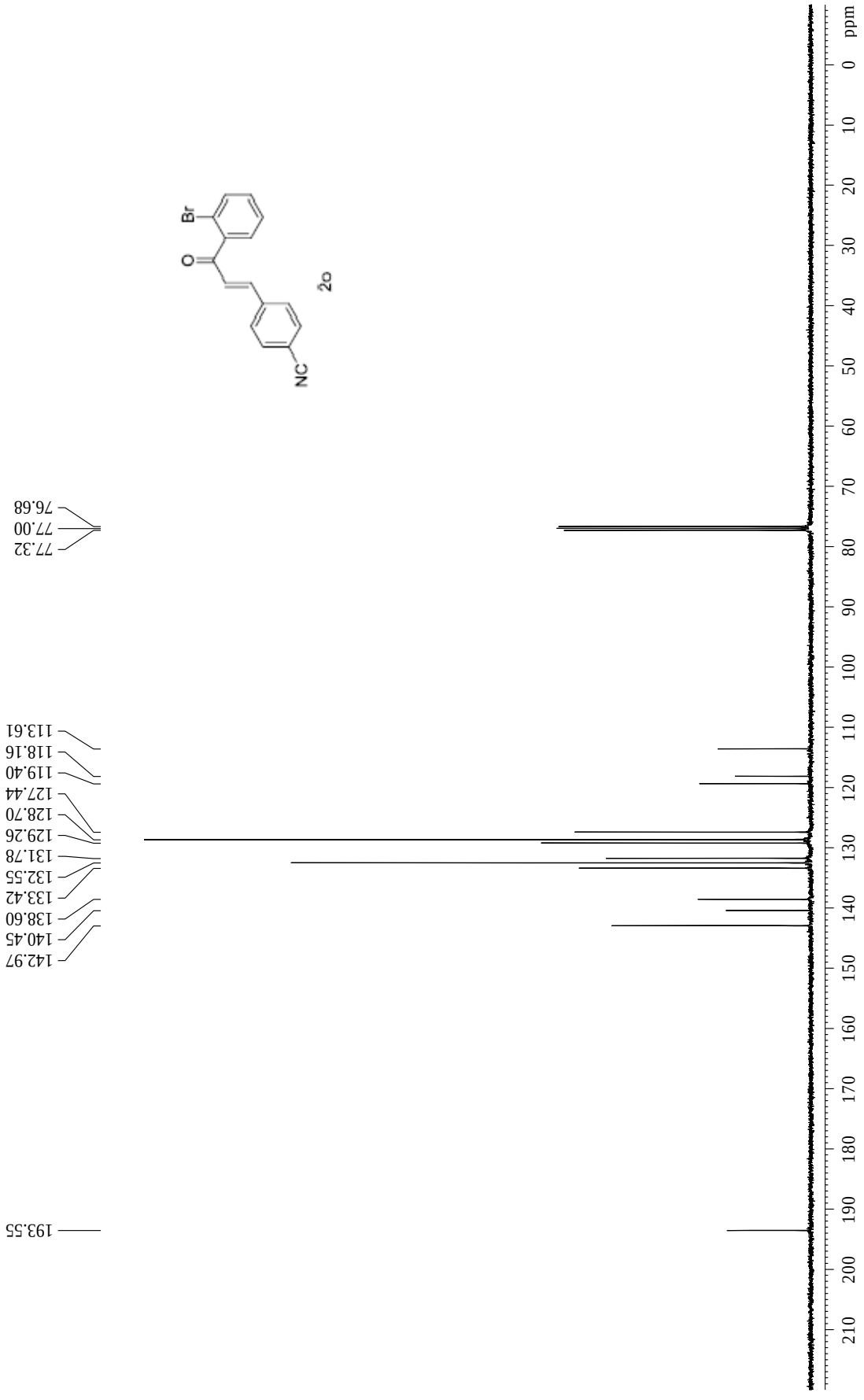
3.939
1.000


Br
O
NC
2o
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77.00
76.68
113.61
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119.40
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128.70
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138.60
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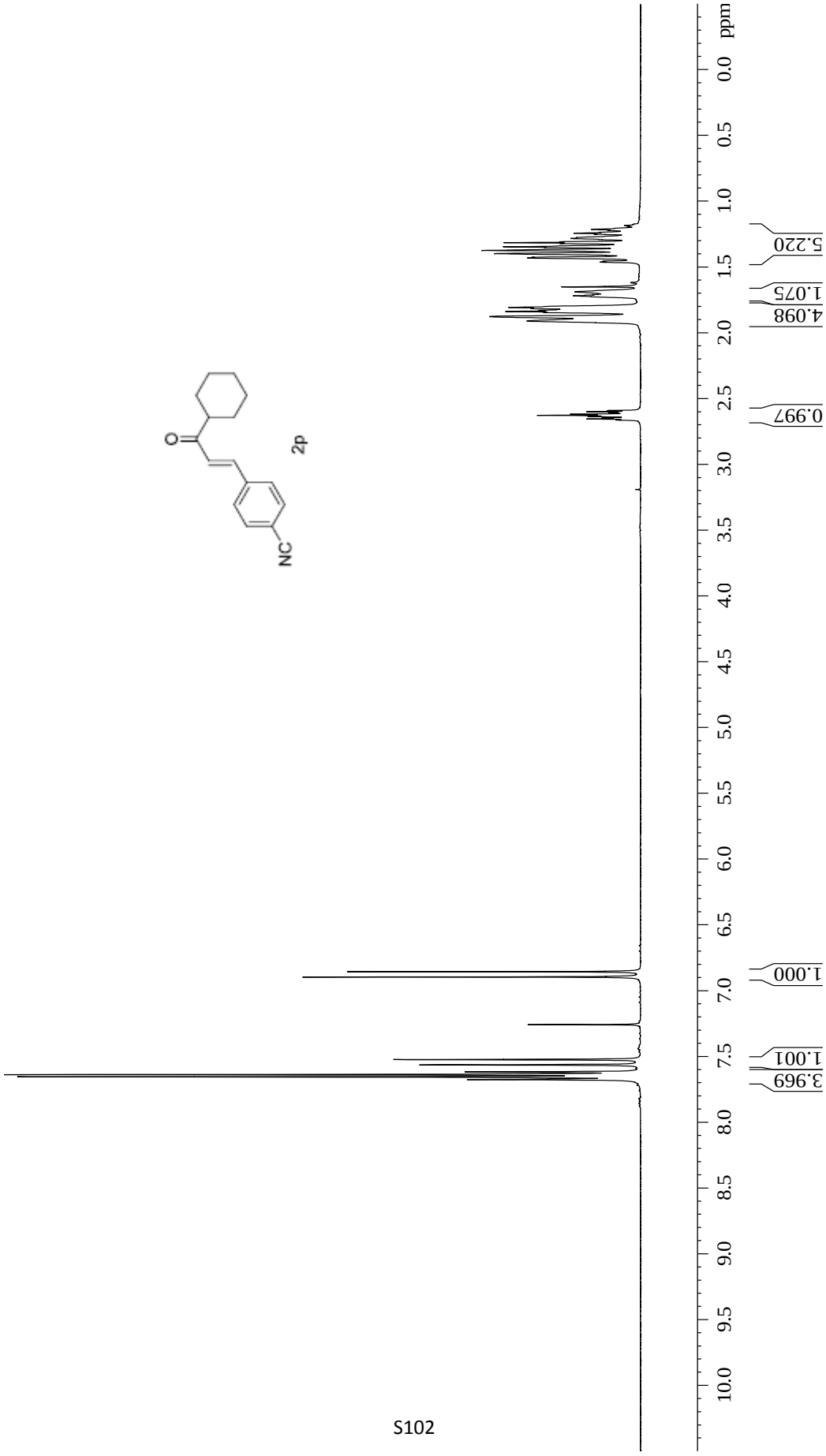
193.55
ppm


O
NC
2p
ppm
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0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
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5.0
5.5
6.0
6.5
7.0
7.5
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4.098
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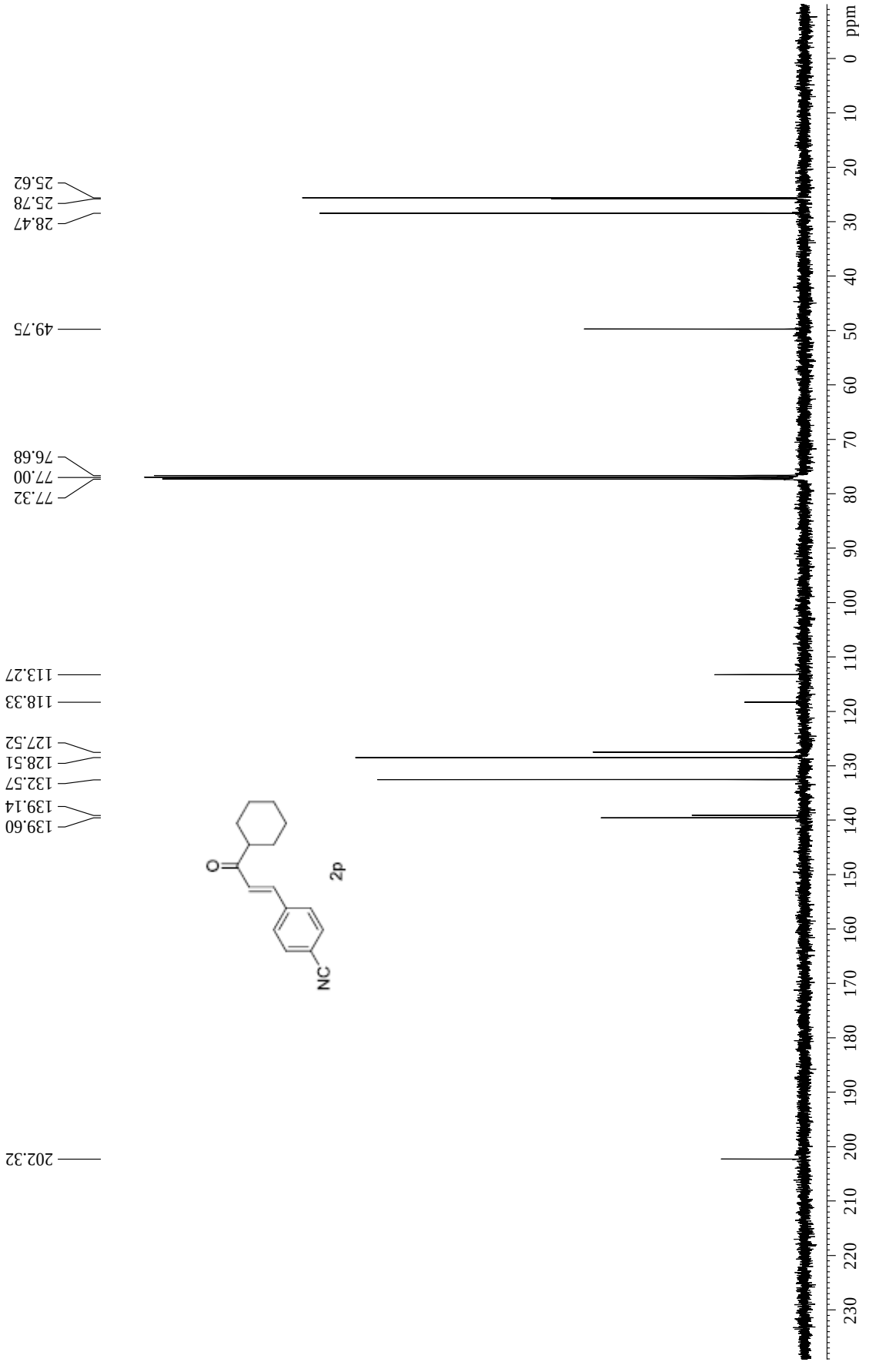
1.000
1.001
3.969


202.32
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77.00
76.68
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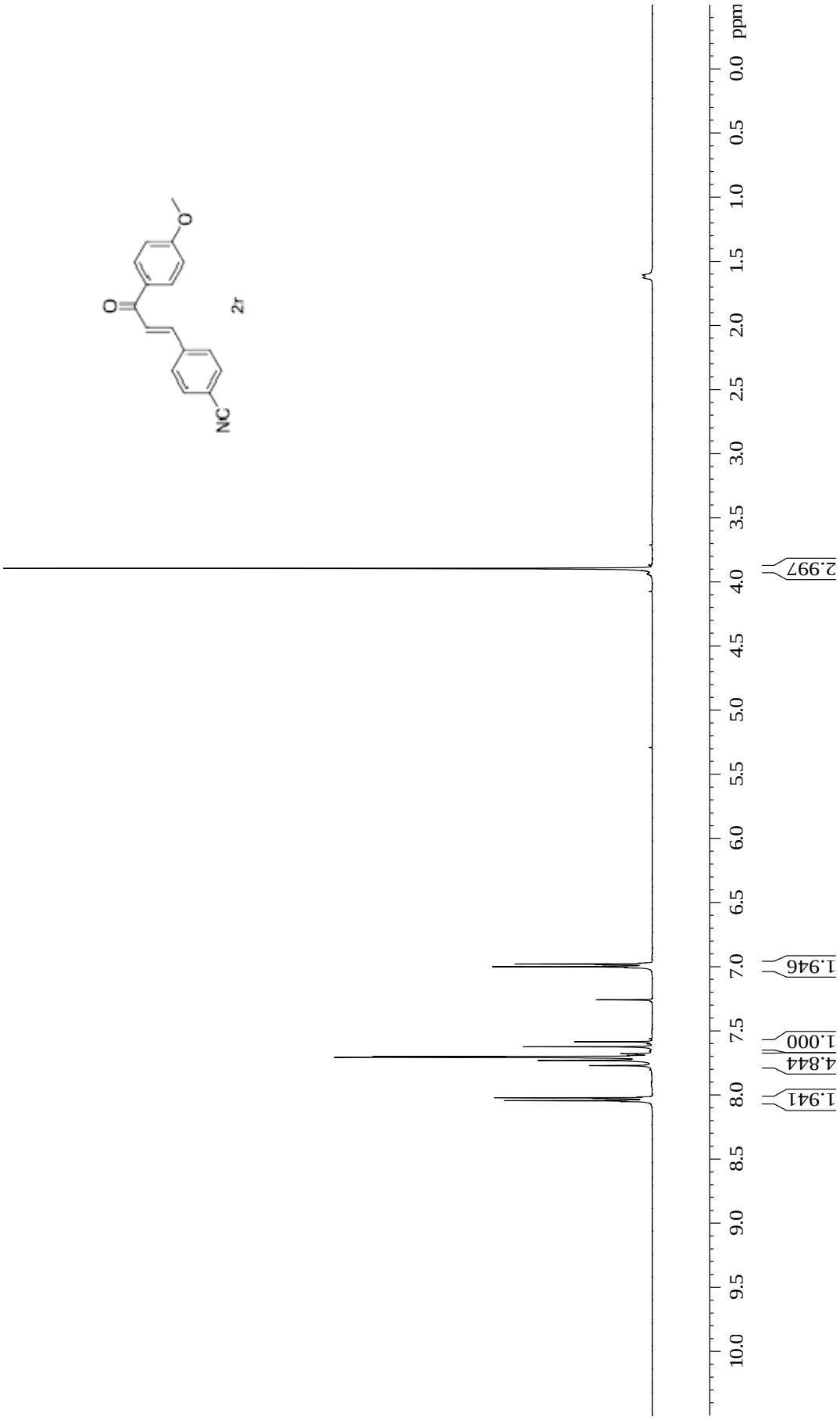
25.78
25.62
O
NC
2p
ppm


O
O
NC
2r
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1.000
4.844
1.941
ppm
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0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
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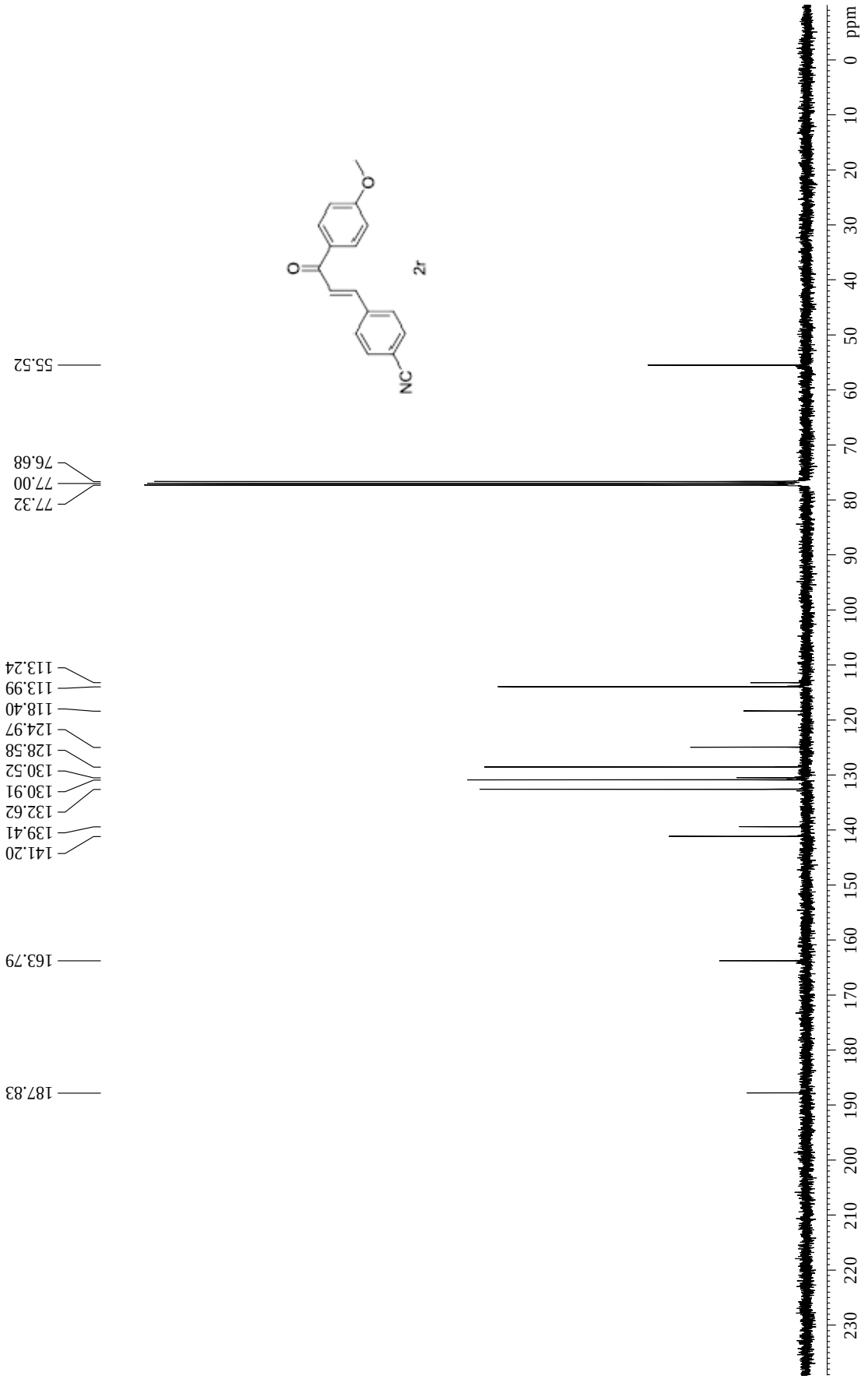
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0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113.99
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124.97
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163.79
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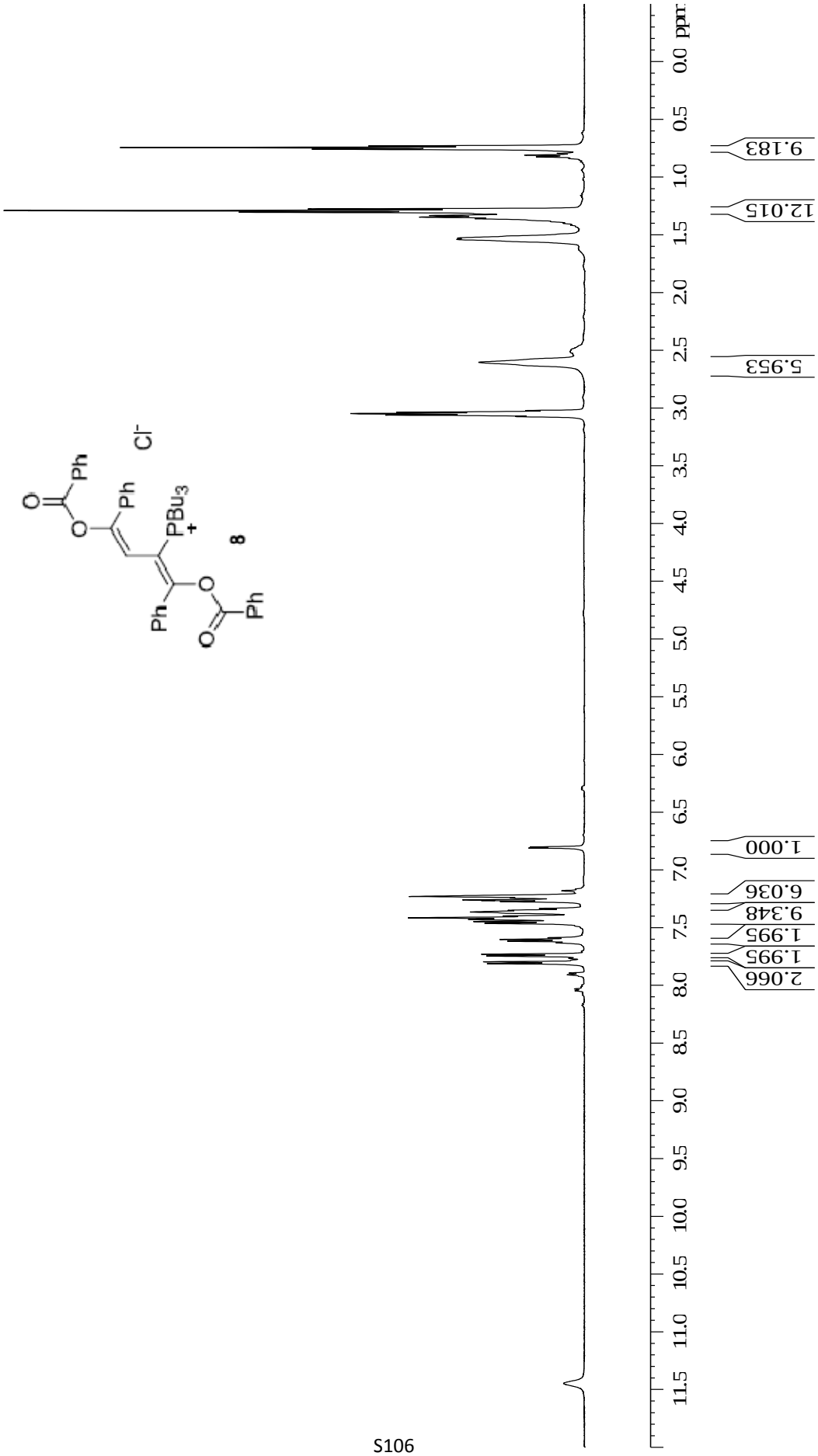
O
NC
2r
ppm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O
O
Ph
PBu3
+
Cl-
8
Ph
O
O
Ph
ppm
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1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
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6.036
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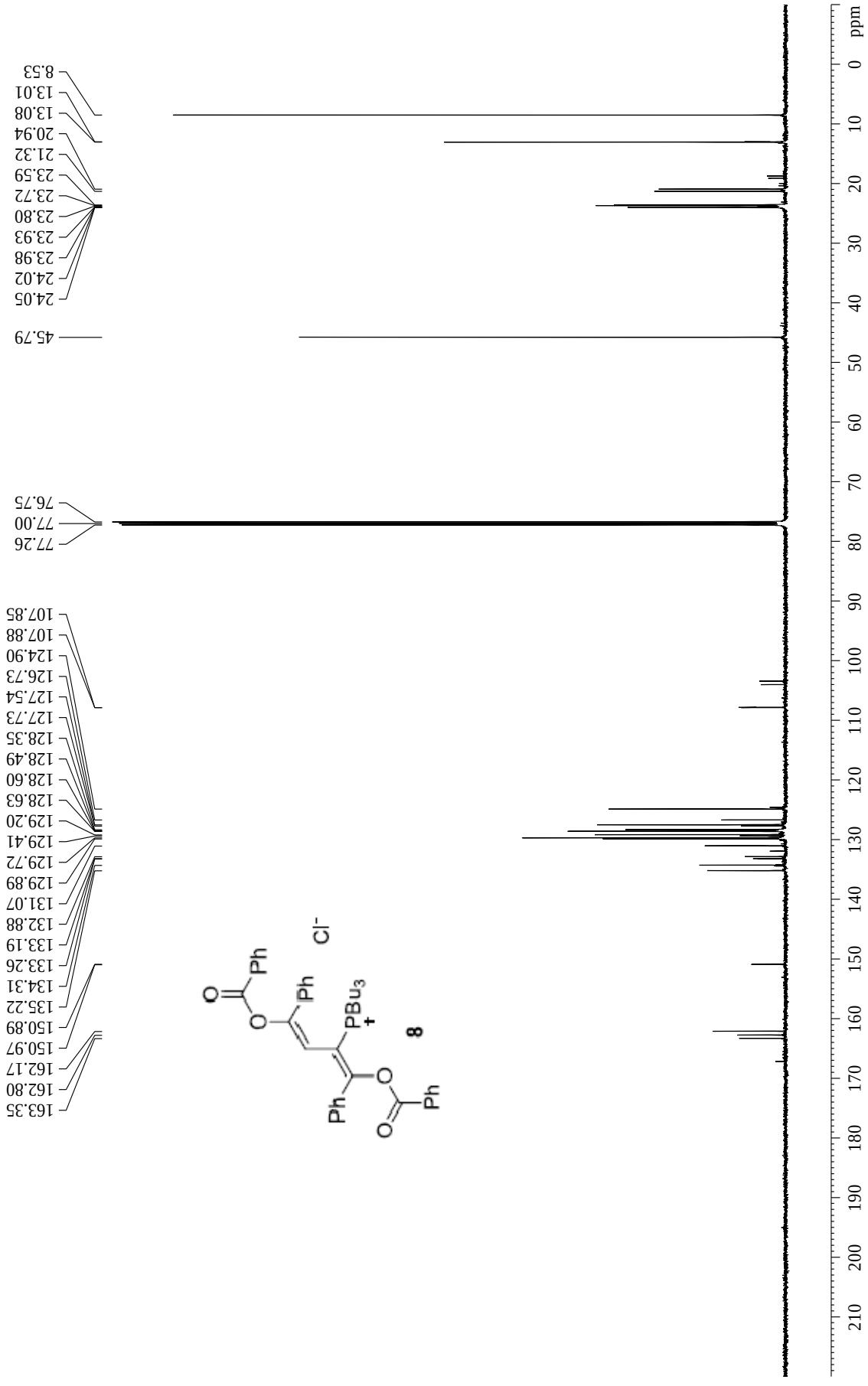
1.995
2.066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23.98
24.02
24.05
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76.75
77.00
77.26
107.85
107.88
124.90
126.73
127.54
127.73
128.35
128.49
128.60
128.63
129.20
129.41
129.72
129.89
131.07
132.88
133.19
133.26
134.31
135.22
150.89
150.97
162.17
162.80
163.35
ppm
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10
20
30
40
50
60
70
80
90
100
110
120
130
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150
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190
200
210
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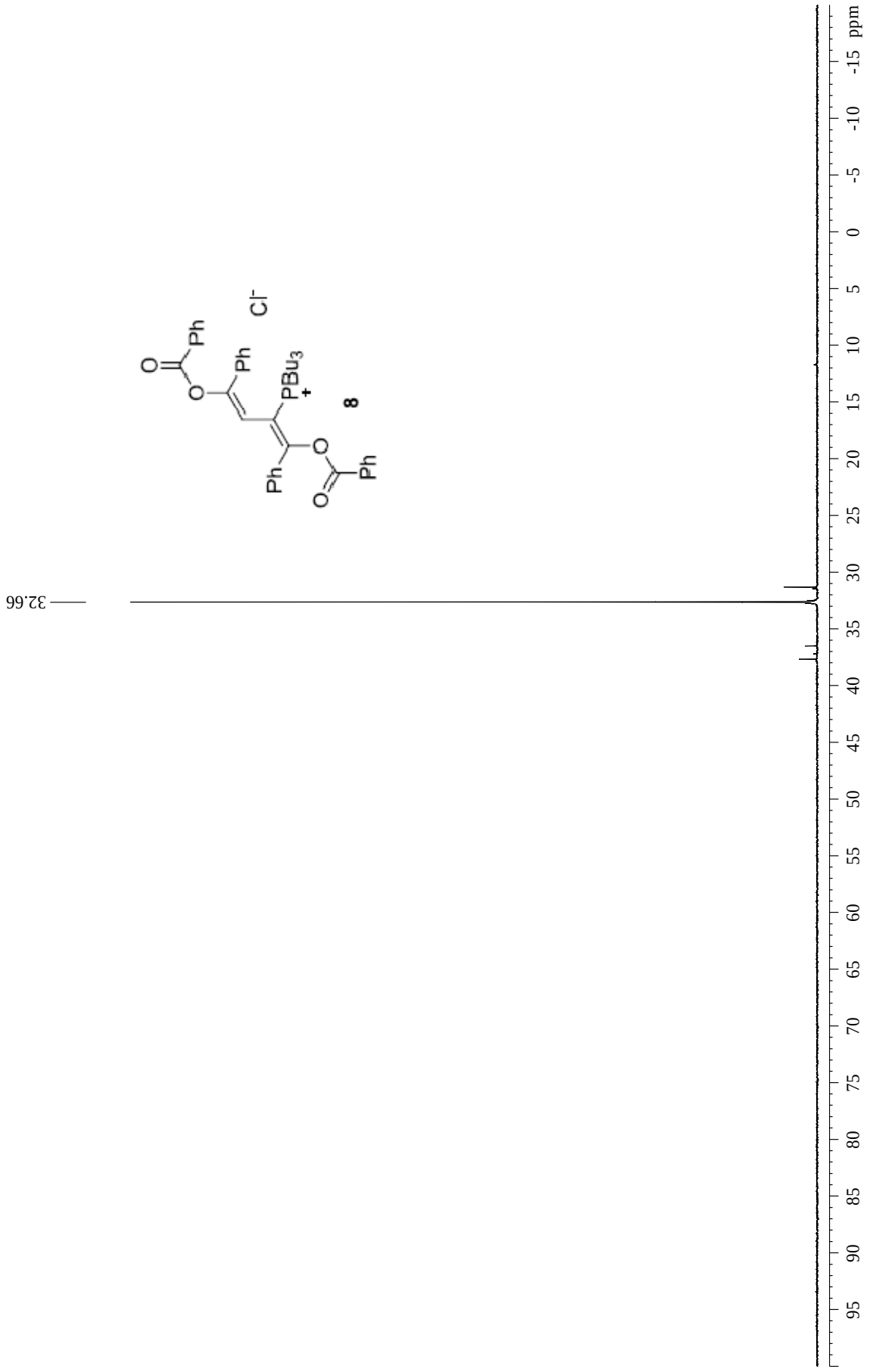
PBu3
+
Ph
Ph
Ph
Ph
O
O
O
O
8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5
0
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-15

Cl-
Ph
O
O
Ph
PBu3
+
8
Ph
O
O
Ph